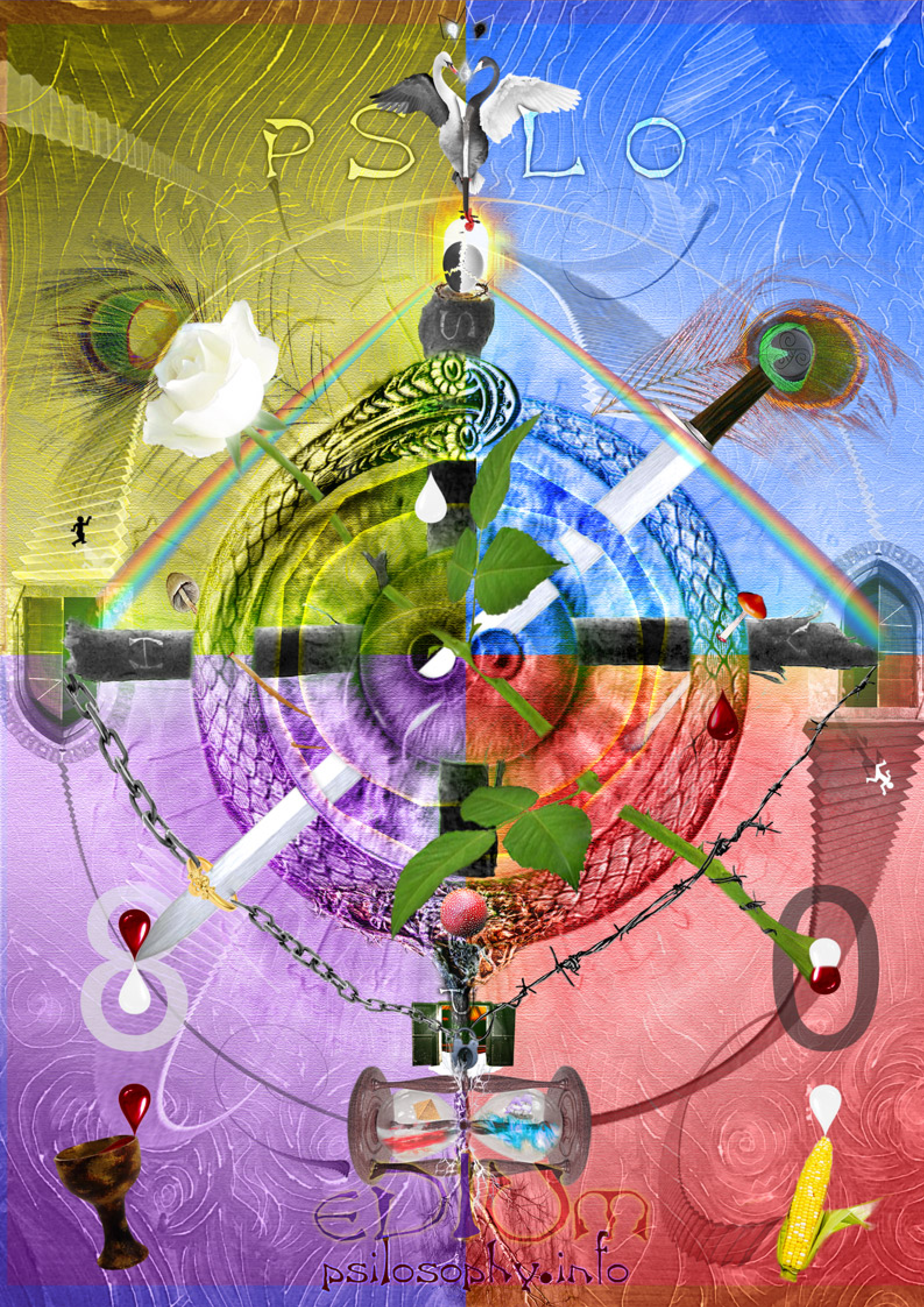

PS LO
eDIUm
psilosophy.info

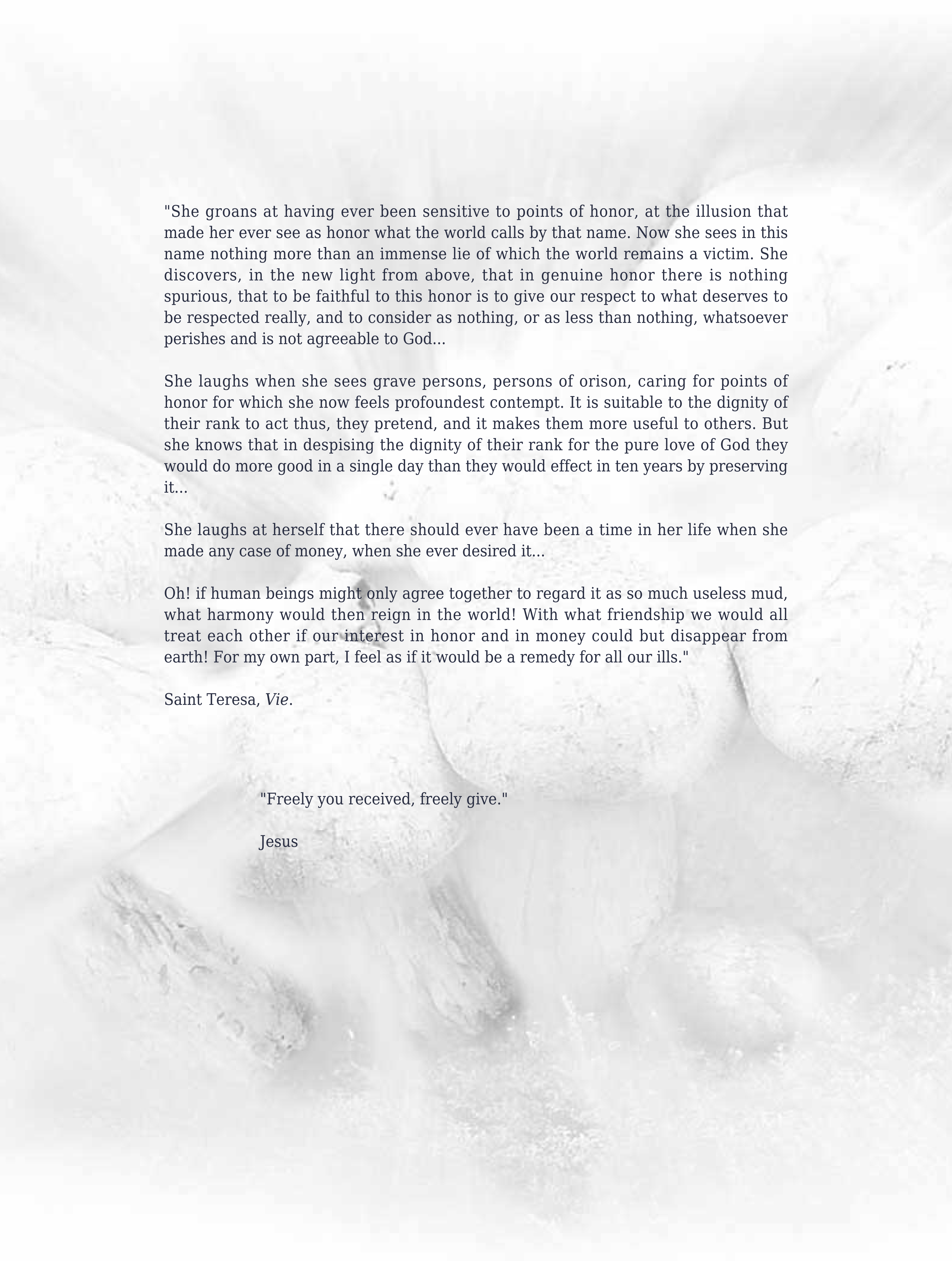
This document may be distributed for *free under* the following terms:

- **Each copy of this document would be unchanged and would include this information.**
- **Each copy of this document would be distributed for free, especially if it is associated along with incurring a variety of costs, what means, that only very honorific homegrowers of homeostaticly homogenous horizont of holotropical hospice of hobbistically holistic holodrama of hormonalisticly-holographonical holdingness of homaging of *Homo transcendus* are hotly welcomed propagators of this compendium.**

Over the others,
house host watches over
- Prince Moctezuma
and the glyph of his attractive
highness in a Holt by May.

Fungate fungatorum exorte Popule Libri…

…et cave, vos qui huc intratis, quoniam relinquetis tinctus litteris.



"She groans at having ever been sensitive to points of honor, at the illusion that made her ever see as honor what the world calls by that name. Now she sees in this name nothing more than an immense lie of which the world remains a victim. She discovers, in the new light from above, that in genuine honor there is nothing spurious, that to be faithful to this honor is to give our respect to what deserves to be respected really, and to consider as nothing, or as less than nothing, whatsoever perishes and is not agreeable to God...

She laughs when she sees grave persons, persons of orison, caring for points of honor for which she now feels profoundest contempt. It is suitable to the dignity of their rank to act thus, they pretend, and it makes them more useful to others. But she knows that in despising the dignity of their rank for the pure love of God they would do more good in a single day than they would effect in ten years by preserving it...

She laughs at herself that there should ever have been a time in her life when she made any case of money, when she ever desired it...

Oh! if human beings might only agree together to regard it as so much useless mud, what harmony would then reign in the world! With what friendship we would all treat each other if our interest in honor and in money could but disappear from earth! For my own part, I feel as if it would be a remedy for all our ills."

Saint Teresa, *Vie*.

"Freely you received, freely give."

Jesus

CULTIVATION

ELEMENTARIES
the magic mushroom growers guide
psilocybe fanaticus tek
growing mushrooms the easy way
growing mushrooms by mrca
mushroom growing by mush mush
the mushroom cultivator
all of rr's notes on mushroom cultivation

VARIATIONS
psilocybin magic mushrooms growers guide
fungifun for simple minds
the illustrated mushroom growers guide
indoor mushroom growing technique for the boil a bag
pasteurized wheat straw prep tek
cold water lime pasteurization for growing mushrooms
straw log tek
mushroom mans sock log tek
the great timothy hay cob cubensis method
mushroom growing invitro
detailed grow log-tek - penis envy in a monotub
rye grass seed bag tek
late casing
rez effect
from syringe to print using rye

AZURESCENS
the azurescens foundation - growing psilocybe azurescens
cultivation of caramel cap psilocybes with the pf tek
psilocybe azurescens cultivation report
psilocybe azurescens indoor cultivation

PANAEOLUS
growing panaeolus tropicalus and panaeolus cyanescens
the cultivation of copelandia cyanescens
panaeolus cyanescens - liquid culture to fruits

INOCULATING
spawn, spawning and spawn growth
spore printing pictorial

MEDIUMS
fastfreds media cookbook
agar substitute
agar pdya
honey tek
liquid culture basics

LIGHT
the effect of light upon basidiocarp initiation in psilocybe cubensis

COMPOST

mushroom composter construction
compost tek
worm composting

CLONING
culture source and cloning
lc cloning - newbie friendly pictorial tek

OUTDOOR
the outdoor cultivation of psilocybe cubensis

SCLEROTIA
a comprehensive sclerotia cultivation guide

EQUIPMENT
do it yourself - spawnbags
magnetic stirrers
chronic invitro tek
cybers martha tek
a sterile transfer chamber
hepa filter flowhood
hepa case for your air pump
double tub pictorial

CONTAMINATIONS
what are common contaminants of the mushroom culture
moulds
the truth about cobweb

RESEARCH

PSYCHELOGICKS
pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer
treatment of childhood schizophrenia utilizing lsd and psilocybin
the psycholytic treatment of a childhood schizophrenic girl
the use of psychedelic agents with autistic schizophrenic children
the effects of consciousness-expanding drugs on prisoner rehabilitation
dr learys concord prison experiment - a 34 year follow-up study
reflections on the concord prison project and the follow-up study
selective enhancement of specific capacities through psychedelic training
implications for psychedelic-assisted psychotherapy - a functional magnetic resonance imaging study with psilocybin
mescaline, lsd, psilocybin and personality change
values and beliefs of psychedelic drug users - a cross-cultural study
hallucinogenic drugs and plants in psychotherapy and shamanism
psychointegration - the physiological effects of entheogens
psychointegrators - multidisciplinary perspectives on the therapeutic effects of hallucinogens
effects of psilocybin on time perception and temporal control of behaviour in humans
preliminary report on the experience with psychosomimetic drugs in the treatment of alcoholism
human hallucinogen research - guidelines for safety
the contribution of the psychology of religion to the therapeutic use of the psychedelic substances
classic psychedelic use is associated with reduced psychological distress and suicidality in the united states adult population
psychedelics not linked to mental health problems or suicidal behavior

psilocybin-assisted treatment for alcohol dependence - a proof-of-concept study
antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide
repression of death consciousness and the psychedelic trip
psilocybin with psychological support for treatment-resistant depression
the link between use of psychedelic drugs and mental health problems
illicit use of lsd or psilocybin, but not mdma or nonpsychedelic drugs, is associated with mystical experiences in a dose-dependent manner
psilocybin-occasioned mystical-type experience in combination with meditation and other spiritual practices produces enduring positive changes
the therapeutic potential of psychedelic drugs: past, present, and future
entheogenic rituals, shamanism and green psychology
increased nature relatedness and decreased authoritarian political views after psilocybin for treatment-resistant depression
can psychedelic drugs attenuate age-related changes in cognition and affect
emotional breakthrough and psychedelics: validation of the emotional breakthrough inventory
the fibrinolytic system: a new target for treatment of depression with psychedelics
from many to one: meditation and the plasticity of the predictive mind
the default-mode, ego-functions and free-energy: a neurobiological account of freudian ideas
yale manual for psilocybin-assisted therapy of depression
psychedelics promote structural and functional neural plasticity
increased global integration in the brain after psilocybin therapy for depression
the experimental use of psychedelic - lsd - psychotherapy

MYSTICOLOGICKS

drugs and mysticism
pahnkes good friday experiment - long-term follow-up and methodological critique
recollections of the good friday experiment - interview with huston smith
mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later
psilocybin occasioned mystical-type experiences - immediate and persisting dose-related effects
psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance
commentary on psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning
mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness
the entheogenic origins of mormonism
restoration and the sacred mushroom: did joseph smith use psychedelic substances to facilitate visionary experiences
psychedelics, meditation, and self-consciousness

NEUROLOGICKS

response of cluster headache to psilocybin and lsd
safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder
psilocybin impairs high-level but not low-level motion perception
mismatch negativity predicts psychotic experiences induced by nmda receptor antagonist in healthy volunteers
psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action
neural correlates of the psychedelic state as determined by fmri studies with psilocybin
enhanced repertoire of brain dynamical states during the psychedelic experience
homological scaffolds of brain functional networks
dynamical exploration of the repertoire of brain networks at rest is modulated by psilocybin
the entropic brain - a theory of conscious states informed by neuroimaging research with psychedelic drugs
the entropic brain - revisited

a whole-brain model of the neural entropy increase elicited by psychedelic drugs
was it a vision or a waking dream
effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning
involvement of 5-ht2a receptor in the regulation of hippocampal-dependent learning and neurogenesis
restructuring consciousness - the psychedelic state in light of integrated information theory
psilocybin-induced spiritual experiences and insightfulness are associated with synchronization of neuronal oscillations
effects of serotonin 2a-1a receptor stimulation on social exclusion processing
the serotonin 5-ht2c receptor and the non-addictive nature of classic hallucinogens
rebus and the anarchic brain - toward a unified model of the brain action of psychedelics
psychedelics as a treatment for alzheimer's disease dementia
an introduction to psychedelic neuroscience
transient stimulation with psychoplastogens is sufficient to initiate neuronal growth
from relaxed beliefs under psychedelics to revised beliefs after psychedelics

ETHNOLOGICKS

mushrooms russia and history
the wondrous mushroom
mushroom ritual versus christianity
the entheomycological origin of egyptian crowns and the esoteric underpinnings of egyptian religion
ancient maya mushroom connections
teonanacatl - the narcotic mushroom of the aztecs
the identification of teonanacatl, a narcotic basidiomycete of the aztecs
mazatec sexual impurity and bible reading
fly agaric motifs in the cu chulaind myth cycle
dark religion? aztec perspectives on human sacrifice
the search for the manchurian candidate
entheogenic mysticism: a jamesian assessment
evidence for ritual use of entheogens in ancient mesoamerica and the implications for the approach to religion and worldview
mushroom sacraments in the cults of early europe
traditional knowledge about mushrooms in a nahua community in the state of tlaxcala, mexico
the hallucinogenic mushrooms of mexico: an adventure in ethnomycological exploration
an aztec narcotic
celestial botany: entheogenic traces in islamic mysticism
soma: divine mushroom of immortality
the use of hallucinogenic mushrooms for diagnostic purposes among some highland chinantecs
religious use of hallucinogenic fungi - a comparison between siberian and mesoamerican cultures
evidence for entheogen use in prehistory and world religions
mushroom-trees in christian art
new data from the ethnomycology of psychoactive mushrooms
entheogens in christian art: wasson, allegro, and the psychedelic gospels
persephone's quest: entheogens and the origins of religion

ARCHEOLOGICKS

the oldest representations of hallucinogenic mushrooms in the world
miniature mushroom stones from guatemala
pre-columbian pottery mushrooms from mesoamerica
a cave in spain contains the earliest known depictions of mushrooms
a prehistoric mural in spain depicting neurotropic psilocybe mushrooms
we drank soma, we became immortal
the forgotten mushrooms of ancient peru

BIOCHEMISTRICKS

biosynthesis of psilocybin

the production of psilocybin in submerged culture by psilocybe cubensis
psilocybin investigators brochure
dephosphorylation of psilocybin to psilocin by alkaline phosphatase
detecting psychoactive drugs in the developmental stages of mushrooms

PHARMACOLOGICKS
presence of phenylethylamine in hallucinogenic psilocybe mushroom - possible role in adverse reactions
psilocybian mycetismus with special reference to panaeolus

ECOLOGICKS
ecopsychology and the psychedelic experience
the responsible use of entheogens in the context of bioregionalism
from ecopsychology to transpersonal ecosophy: shamanism, psychedelics and transpersonal psychology
reflections on transpersonal psychology's 40th anniversary, ecopsychology, transpersonal science, and psychedelics
shamanism and psychedelics: a biogenetic structuralist paradigm of ecopsychology
lifetime experience with classic psychedelics predicts pro-environmental behavior through an increase in nature relatedness

TAXONOMICKS
new aspects of the occurrence, chemistry and cultivation of european hallucinogenic mushrooms
mycological investigations on teonanacatl, the mexican hallucinogenic mushroom
fungi in the maya culture: past, present and future

psychoactive substances and paranormal phenomena
the influence of psychedelics on remote viewing
sacred mushrooms inspire medical research

TRIPUALS

MICRODOSING
microdosing psychedelics: personality, mental health, and creativity differences in microdosers
microdosing psychedelics: more questions than answers? an overview and suggestions for future research
microdosing - improving performance enhancement in intelligence analysis
powerful substances in tiny amounts
exploring the effect of microdosing psychedelics on creativity in an open-label natural setting

the psychedelic experience
the secret chief revealed
how to work with difficult psychedelic experiences

PSILOSOPHY
mushroom pioneers
hallucinogenic mushrooms and evolution
mushrooms and the mind
the sacred mushrooms - rediscovery in mexico
using psychedelics wisely
entheogens are not drugs
molecular mysticism
psychedelic yoga
manna from heaven
psychedelics and religious experience
revisiting the tibetan book of the dead and the psychedelic experience
the teonanacatl - in pre-conquest accounts and today

the mythophile and the mycophile - Robert Graves and R. Gordon Wasson
mushroom and religion
magic mushrooms around the world
psychedelic information theory
journey to paradise
the philosophy of psychedelic transformation
will psilocybin lose its magic in the clinical setting?
are psychedelics useful in the practice of buddhism?
chemical youth - chemical creativity
is it time to revisit the role of psychedelic drugs in enhancing human creativity

OTHER

practical method for long term storage of mycellium in dh2o using ependorf tubes as vials
the metabolic pathway of psilocybin production
charcoals secret
mapping the mycelial network
the psilometric scale of comparative potency of selected psilocybe mushrooms
magic mushroom dosage calculator
the mushroom entheogen - the measure of the mushroom
fly agaric tincture
amanita phalloides poisoning and treatment with silibinin
amanita muscaria and the thunderbolt legend in guatemala and mexico
soma siddhas and alchemical enlightenment
mixing the kykeon
a study of cultural bias in field guide determinations of mushroom edibility using the iconic mushroom, amanita muscaria
further reflections on amanita muscaria as an edible species
the mushroom and the water lily: literary and pictorial evidence for nymphaea as a ritual psychotogen in mesoamerica
amanita muscaria - herb of immortality
amanita muscaria - the holy sacrament of the order of melchizedek, symbol of the resurrection, and cause for christian redemption
the road to eleusis
soma and the fly-agaric - mr. wasson's rejoinder to professor brough
mushrooms and the wine of maron
the last meal of the buddha
buraq depicted as amanita muscaria in a 15th century timurid-illuminated manuscript?
baba yaga and the mushrooms
psychedelic philanthropy: the nonprofit sector and timothy leary's 1960s psychedelic movement

LATEST

mushrooms and the wine of maron
we drank soma, we became immortal
will psilocybin lose its magic in the clinical setting?
mushroom-trees in christian art
the last meal of the buddha
buraq depicted as amanita muscaria in a 15th century timurid-illuminated manuscript?
new data from the ethnomycology of psychoactive mushrooms
entheogens in christian art: wasson, allegro, and the psychedelic gospels
persephone's quest: entheogens and the origins of religion
baba yaga and the mushrooms
the forgotten mushrooms of ancient peru
increased global integration in the brain after psilocybin therapy for depression
amanita muscaria - the holy sacrament of the order of melchizedek, symbol of the resurrection, and cause

for christian redemption
 the road to eleusis
 the wondrous mushroom
 the use of hallucinogenic mushrooms for diagnostic purposes among some highland chinantecs
 soma and the fly-agaric - mr. wasson's rejoinder to professor brough

Released since Omega Point 2012 (polish vers.)
Alfa Cent Aur & El & Ta O

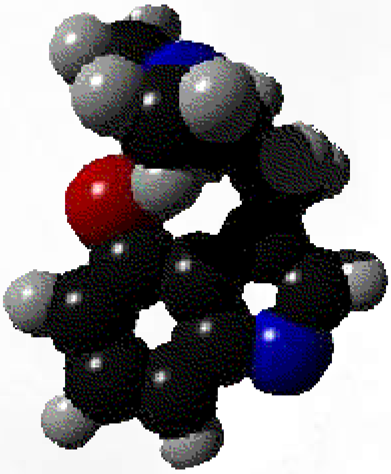
covered and compiled by cjuchu

The Magic Mushroom Growers Guide

Version 3.2 (3.22 by Erowid)

Widely acclaimed as the best and most comprehensive growing guide for the first time cultivator anywhere on the web. You be the judge!

original source: https://www.erowid.org/plants/mushrooms/mushrooms_mmgg.shtml



This document may be freely copied and distributed so long as the following conditions are met:

- *Any copies of this document must include this notice.*
- *This document must only be distributed in an unaltered and complete form.*
- *This document can not be distributed for profit.*

This document provides complete directions for cultivating psilocybin mushrooms in your home. The strain this guide is intended to help you grow is Psilocybe cubensis (Amazonian strain) mushrooms. It is the intent of this document to enable the first time grower to succeed at a minimal cost and with a minimal amount of effort. This growing guide is the only reference you will need. After a person has completed the entire cycle successfully, later generations of mushrooms can be grown with even less cost and effort. The initial cash outlay will be well under $100 for a fully automated shroom factory. Subsequent crops can be produced for several dollars with expected yields of several ounces of dried mushrooms.

Table of Contents:

What has changed since version 3.1
Credits to those who have gone before us
Format of this Document
Overview of the Procedure
Preparation of the Substrate
Construction of the Terrarium
  Poor Man's Terrarium
  Basic Growing Chamber
  Method 1: Hand Spraying
  Method 2: Using a Fish Tank Bubbler
  Method 3: Using an Ultra Sonic Humidifier
  Checking out the Ultra Sonic Humidifier Setup
The Growing Cycle
Drying and Preservation of the Mushrooms
Dosage and Various Ways to Ingest
  Mushroom Juice
  Mushroom Tea

- Mushroom Soup
- Mushroom Pizza

How to Get a Spore Syringe

- Sources for a Spore Syringe
- Sources for Spore Prints
- How to Make a Spore Syringe
- How to Make a Spore Print
- Combination of Spore Print and Preparation of Inoculant

The Author's First Trip

Bulk Substrate Growing

Where to find Difficult Items

- Brown Rice Flour
- Ultra Sonic Humidifiers
- Vermiculite
- 10 cc. Syringes

Providing Feed Back and Getting Questions Answered

Index of Adaptations

- Adaptation-1: Use of Big Substrate Jars
- Adaptation-2: Use of a Pressure Cooker to Sterilize
- Adaptation-3: Tight Packing of Substrate to Slow Colonization
- Adaptation-4: Injection at Only 1 Site
- Adaptation-5: Large amounts of Inoculate
- Adaptation-6: 80 Degree Colonization Temperature
- Adaptation-7: More Oxygen for Colonization
- Adaptation-8: Taking the Rice Cake Out of the Jar Before it is 100% Colonized
- Adaptation-9: Waiting to Remove Rice Cake From the Jar
- Adaptation-10: Checking Out Terrarium Prior to Removing Rice Cake
- Adaptation-11: Use of a Coleman Cooler instead of a Styrofoam Cooler
- Adaptation-12: Adding a Humidity Gauge to the Terrarium
- Adaptation-13: Use of Fish Tank Heater to Raise Humidity
- Adaptation-14: Use of Angel Hair to Raise Humidity
- Adaptation-15: Supporting Extra Terrariums with the Ultra Sonic Humidifier
- Adaptation-16: Use of an Ice-Pak to Initiate Fruiting
- Adaptation-17: Adding Moisture to the Rice Cake
- Adaptation-18: Continued Drying of Mushrooms During Storage
- Adaptation-19: Reducing Output Of Ultra Sonic Humidifier
- Adaptation-20: Providing a Moisture Reservoir in the Substrate
- Adaptation-21: Use of a Timer to Control Suspended Water Droplets and Stimulate Fruiting
- Adaptation-22: Use of a Home Made Brown Rice Flour
- Adaptation-23: Lowering the Contamination Rate by Presterilization
- Adaptation-24: Using a 2 1/2 gallon water jug for filtering
- Adaptation-25: Insuring the Sterility of Caps Used for Spores
- Adaptation-26: Producing a clean spore print from a questionable cap

Revision History

What has changed since version 3.1

Following is a list of changes made to the document.

3.22 : 2005 Dec : by Erowid.org :

- Typo fixes on suggestion of reader.

3.22 : 2005 Nov : by Erowid.org :

- Removed PF address on suggestion of reader. PF's arrest and guilty plea suggests it is no longer appropriate to send money to the old PF address.

3.2 : 1996 : Primary Author

- Version number was changed from 3.1 to 3.2
- Change pictures in opening.
- Suggest ways to get help and provide PGP public key for private messages.
- Poor Man's terrarium setup.
- Bulk growing.
- Cris Clays email address and such.
- Link to http://www.xs4all.nl/~psee/ as a spore seller.
- No more packing of the substrate.
- Vacuum cleaner instead of hair dryer.
- Link to PF's pages.
- Timer stuff.
- Arrowhead Mills no longer sells brown rice flour as a mail order item.
- Caution about jars sitting flat in boiling pan.
- Low humidity cap apperance.
- Sealing a cake in a jar to reduce contamination risk when growing for spores.
- Changing plates after start of spore print for lower contamination risk.

Credits to those who have gone before us

The procedures detailed in this document borrow heavily from past innovators. In particular, much research was done by a company in Seattle, Washington called Psylocybe Fanaticus which was instrumental to the viability of this innovative and elegant procedure for the novice cultivator.

Psylocybe Fanaticus sold a Technology Report called the PF Tek. Normally, growing Psilocybe mushrooms is next to impossible for a beginner. However, the PF process is a breakthrough and virtually guarantees that the beginner will succeed.

The PF Tek is the foundation for this document. The main purpose for this document is to detail the various ways the PF Tek can be adapted to various needs of the home cultivator.

[Note: Psylocybe Fanaticus is no longer in business and plead guilty to a crime involving the possession of psilocybin-containing mushrooms. See PF's Encounter with the Law**. This section formerly requested that readers send money to PF in thanks for his work, but the address has been removed.]**. Please treat this document as you would 'shareware software'. Try it out, and if it works for you, send $10 and a thank you note to:

Psylocybe Fanaticus
XXXX removed XXXX

Back to table of contents

Format of this Document

How to use this document

The procedures detailed in this document are a mixture of mandatory and optional steps. The core document describes the basic procedure in its simplest form and at various points there will be possible adaptations that can be incorporated. In general, the adaptations will summarize what is required and the benefit to the cultivator in the event the adaptation is implemented. You should read the entire document before you attempt to implement the procedures described in it.

The first time you use the process you should follow the directions exactly and resist the temptation to innovate. Innovation without experience is the primary cause of failure. If you must innovate because you can not find a particular item or for some other reason, first check with someone that has experience to make sure you are not doing something crazy.

It is our intent to provide the first time cultivator with the knowledge to make informed decisions about the growing process for Magic Mushrooms. The cultivator can select some adaptations that are felt to be worthwhile and reject others that don't have sufficient merit for him. It's his choice, but he is still guaranteed that if he follows the directions he will produce a crop of mushrooms.

This guide is published as a single document to make printing easy and simplify acquiring a copy to your local machine. There are several GIF files that it references in the directory that you found this document. You need these also. You might want to check and see if there is a file called MMGG.ZIP or MMGG.TAR in the directory you found this document. If so, you can just get this one file and it will contain everything you need to obtain a local copy.

If you wish to examine an adaptation, simply click on it. When you're done looking at it, there will be two links. One back to the table of contents and one back to where the adaptation is used in the procedure.

One last note. A terrarium is required to complete the growing cycle. You can perform the steps to inoculate the culture jars and over the next few weeks build your terrarium. It takes time for the cultures to grow and this should provide you sufficient time to make a suitable terrarium if you are in a hurry to get started.

Back to table of contents

Overview of the Procedure

In order to grow mushrooms, a suitable substrate must be inoculated and colonized by the fungus. This step requires sterility because the substrate contains no preservatives and can be overrun by any mold or bacteria that is present. This first step takes place in canning jars prepared in your home's kitchen. It uses brown rice flour and vermiculite which are both readily available. A substrate is prepared, placed in the canning jars and sterilized with heat. After the jars cool, they are inoculated with a spore syringe. This phase of the cycle can be completed for less than $25 and will produce enough substrate to yield many ounces of dried mushrooms.

After the substrate is inoculated, you wait until it is colonized completely by the fungus. Once the substrate is colonized completely by the fungus, sterility is less of a concern because the fungus is pretty much able to fight off invaders and the rice cake substrate can be removed from the jar. This typically takes between two and three weeks to complete. At this point, the substrate is placed in a terrarium where high humidity is available to the fungus. While waiting for the substrate to colonize completely, no effort is required.

The terrarium is kept at around 90% humidity and the carbon dioxide that is produced by the fungus is constantly eliminated. Within a week of being placed in the terrarium, the rice cakes will start growing mushrooms. Within several weeks of being placed in the terrarium, the cultivator will have numerous mature mushrooms ready for consumption. The cakes continue to produce mushrooms until either the nutrients in the rice cake are used up or the moisture in the rice cake is depleted. Depending on how the cultivator chooses to implement the terrarium, more or less attention is required at this phase in the cycle. With the fully automated terrarium setup described later in this document, attention is only required every few days. Mostly, this involves picking mature mushrooms and adding water to the humidifier used in the setup.

It is very likely that the mushrooms will be produced faster than they can be consumed by the home cultivator once the cropping phase of the cycle starts. It is fairly easy to dry the mushrooms and preserve them for many months. In fact, some people prefer the dried mushrooms to their fresh counterpart. Being the master of understatement, let me state that they do not taste as good as mushrooms available in the grocery store.
Occasionally, a sterile spore print from a mature mushroom needs to be generated if the cycle is to continue. This is used to produce a spore syringe to inoculate new culture jars. It is a little bit of effort and requires very careful, sterile procedures to be successful generating a spore print. Of course, this can be circumvented by simply ordering a new spore syringe. A 10 cc. spore syringe should be sufficient to inoculate a dozen jars of substrate. It is the cultivator's choice which path to follow for successive generations.

Back to table of contents

Preparation of the Substrate

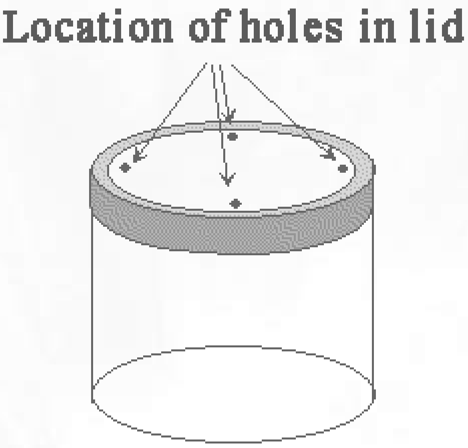
Mushrooms are grown on a substrate of nutrients. Just as a common house plant is grown in a pot of soil, mushrooms can be grown on a cake of substrate material. The big difference is that the substrate must be free of competing bacteria and molds in order for the process to be successful. Any contamination of the substrate will result in failure of the process.
Materials needed:

- 1/2 pint canning jars Adaptation-1
- Vermiculite (from any garden department. K-Mart, Target, etc.) Where to find
- Brown Rice flour Adaptation-22 (from a health food store --- No Preservatives!) Where to find
- Large pot with lid Adaptation-2
- Measuring cups
- Mixing bowl
- Hammer and small nail
- Spore Syringe (Where to get a spore syringe)

The canning jars need to be tapered. This means that the opening of the jar is wider than the body of the jar. This is important because the fully colonized rice cake needs to be removed intact from the jar. You simply want the cake to slide out when the time is right. If you use a jar that is not in the following list, check to make sure the box says it is a tapered jar. The following jars are acceptable:

- Ball 1/2 pint jelly jars.
- Kerr wide mouth 1/2 pint canning jars.
- Ball regular mouth 1/2 pint canning jars.

Step 1:
Prepare the tops of the culture jars so that they can be in place, on the jars when inoculating the jars with the spore syringe. Part of the reason this system works so well in the non-sterile kitchen environment is the fact that the sterilized substrate is never exposed to air born contaminates. Get a small nail and use the hammer to poke 4 holes in the lid of each canning jar. See the following figure:



Step 2:
Decide in how many jars you are going to initiate cultures. The average terrarium that is built will hold 6 rice cakes but you may have some jars destroyed by contamination and some jars colonize more quickly than others. It is unlikely that every jar you prepare will be ready to be placed in the terrarium at the same time. The rice flour and vermiculite are cheap enough that it makes sense to do a dozen jars.
For each 1/2 pint jar mix **2/3 cup vermiculite** and **1/4 cup brown rice flour** in a mixing bowl. Adaptation-23 When these ingredients are well mixed, add **1/4 cup of water** for each 1/2 pint jar you plan to prepare. If you are using 1 pint jars you need to double the recipe. Mix all of this stuff up well. This mixture is the substrate material that the fungus will consume and use for growth.

Step 3:
The next step is to fill each jar with substrate material. Adaptation-20 This document used to suggest gently packing the substrate into the culture jars. It has been found that keeping the substrate as loose and full of air as possible is the best way to fill the jars. The jars will colonize faster this way. Incidentally, the faster the jar colonizes, the lower the risk that some competitor contamination will get a foothold and take over the substrate. Adaptation-3 Fill each jar to within 1/2 inch of the top with substrate material. If you run out of substrate material, either mix up enough for one more 1/2 pint jar or cannibalize a jar to fill up the rest of the jars. This is important because you need to make sure the substrate is high enough in the jars for the spore syringe to inject spores into it.

Step 4:
The top 1/2 inch of the glass on each culture jar needs to be cleaned. No substrate material can be left on the glass above the compressed cake. First wipe it with your finger to get the bulk of the material off of it and then do a thorough job with a moistened paper towel. The glass needs to be spotless. The reason this is necessary is that bacteria and mold can use any material left there as a wick to infect the main substrate body.

Step 5:
Next, fill the top 1/2 inch of the each culture jar with vermiculite. This layer is pure, simple, dry vermiculite. Nothing else. Fill the jar level with the glass edge. This layer is a breakthrough pioneered by Psylocybe Fanaticus. What this layer does is insulate the sterilized substrate from any airborne contamination. This layer gets sterilized with the substrate later and airborne molds and bacteria can not (usually) get through it to contaminate the substrate. At the same time, it allows some gas exchange to occur. The fungus needs oxygen and gasses can filter through the vermiculite.

Step 6:
Now, place the jar lids in place. Normally, the jar lids have a rubber seal that is placed in contact with the glass of the jar. Traditionally the rubber seal is not placed in contact with the glass. It was placed on the upper

side of the lid. The reason was that people thought it would make too tight of a seal. This does not seem to be an issue. If you wish to follow tradition, place the rubber on the upper side of the lid. Screw the lid down tight. Note that you need to have the four holes poked in the lid in Step 1. Otherwise you can have real problems when you heat these jars up!

Step 7:
Next, place a piece of tin foil over the top of each jar and crumple it around the sides of the jar. This is to keep water drops from going in the four holes in the lid while the jar is being sterilized. If you poked your holes in the lid such that the sharp edges are pointing up, be careful not to rip or puncture the tin foil. If you need to, you can add a second or even a third piece of tin foil to make sure water will not drip into the holes in the lid.

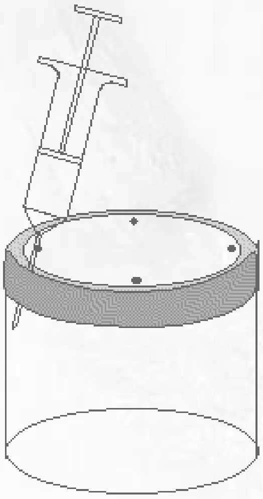
Step 8:
Now the culture jars need to be sterilized. Place the jars in a large kitchen pot/pan and add water so that water comes halfway up the side of the jars. Bring the water to a slow boil and place the lid on the pot. From the time the water starts to boil, the jars need 1 hour to be sterilized. Water should not be bubbling and splashing all over the place. The jars should not be floating around in the water. The substrate in the culture jars has the right amount of water in it already. You do not want water leaking into the jars and changing the ratio. The jars should not sit flat on the bottom of the pan. Too much heat can transfer directly to the jars and cause a loss of moisture. You can place a wash cloth inside the pan and set the jars directly on the wash cloth to help prevent too much heat from transferring to the jars.

Step 9:
Let the jars cool slowly. Leave them covered in the pot/pan that was used to sterilize them. Let them cool completely. The jars need to be at or close to room temperature in order to inoculate. The spores will be killed if the jars are not cool enough when they are inoculated. It will take several hours to cool sufficiently. You may hear sounds as the jars cool. This is normal.

Step 10:
Now comes the good part. Inoculation of the culture jars. Assuming you have a viable, sterile spore syringe, you are now in a position to inoculate the cultures and start the first phase of the growing cycle. The needle of the spore syringe must be sterile. If your fingers or anything other than the lid or contents of the culture jars comes in contact with it, assume it is no longer sterile. If there is any doubt about its condition, use a cigarette lighter to heat the entire needle. Heat it until it glows red. Let it cool for a few minutes and squirt some of the solution out of the syringe.

Shake the syringe. Make sure the spores are mixed well within the syringe. This can be accomplished more easily if you pull the plunger back on the syringe to get a little air into the syringe.

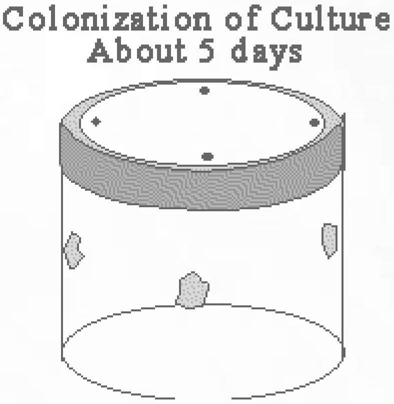
Remove the tin foil from each culture jar as you prepare to inoculate it. Insert the needle of the syringe as far as it will go into a hole in the lid of the culture jar and get the needle to press against the glass. Examine the next figure for a simple diagram of how things should look. Inject 1/4 cc of solution at a site under each hole in the lid. Adaptation-4. A total of 1 cc of solution for each jar. Adaptation-5.

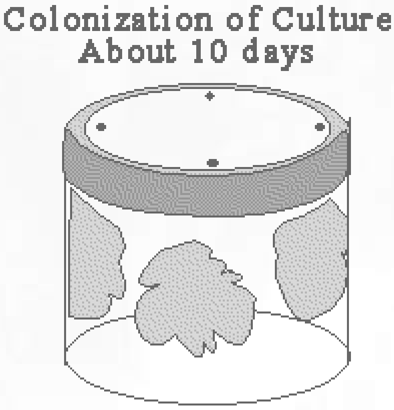


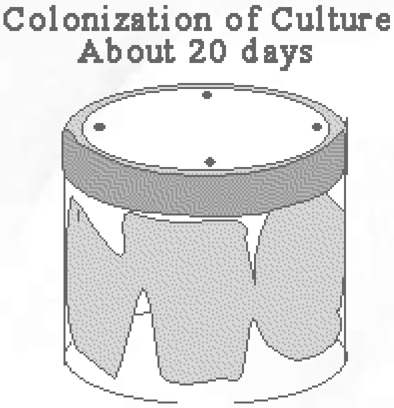
Innoculation of substrate

A 10 cc spore syringe is sufficient to inoculate a dozen jars if you inject slightly less than 1 cc in each jar.

Step 11:
This is the easy part. Put the culture jars in a dark place and wait. The fungus will first appear as little splotches of white fuzzy stuff at the inoculation sites. Adaptation-6.







As the time goes by, the fungus will spread throughout the jar. Eventually, the entire surface of the glass will be covered with fungus. Typically, the bottom of the jar is the last area to be colonized. Be on the lookout for any contamination.
Any odd colors that might appear are contamination and the jar must be thrown out. Do not take any chances. If you think the jar might be contaminated, throw it out! Some molds and bacteria produce toxins that can kill you. Just because a mushroom is growing on the opposite side of the cake from the contamination does not mean you are safe. The mycelium network carries nutrients and moisture to the mushrooms from far away and can easily pick up the toxins and bring them to the mushroom. The fact that you are using this guide means you are not an experienced mycologist. You do not know which molds and bacteria are deadly. Do not take a chance.

The one exception to the previous statements is the mycelium will some timeschange from a bright white to a very pale yellow if it has water droplets touching it on the side of the glass. It is very unusual for any area that is colonized by the mushroom fungus to become infected while in the jar. The uncolonized areas of the substrate are usually significantly more prone to infection.
The above pictures show a typical germination and colonization cycle. If your spores are old, or the temperature is not optimum, or you did not mix the substrate very accurately you can easily add a week to the above time frames.
The cake must stay in the jar until the entire surface area is covered with mycelium. As the substrate gets more colonized, the growth slows down. This is a result of CO2 building up and less oxygen being available for the fungus to consume. Adaptation-7.
The cakes can not be taken out of the jars while there is still uncolonized substrate. Adaptation-8.

Step 12:
Once a rice cake is fully colonized, it can be taken out of the culture jar. Adaptation-9 At this point, there are no areas on the substrate that can easily be infected by competitor molds and bacteria. Once the mycelium is established, it can usually prevent other organisms from gaining a foothold and destroying the rice cake.
Adaptation-10 Unscrew and remove the lid from the canning jars. Scrape all the loose vermiculite on the top of the substrate into the garbage. Take care not to gouge into the substrate material as this can leave areas open to infection. You do not need to get all the vermiculite off of the cake. In fact, the only reason to remove any of it is to keep the terrarium neat and orderly. Turn the jar up side down and slam it onto a table top. The rice cake should slide out of the jar. The rice cakes will typically shrink a little during the colonization phase of the process and will come out of the jars easily with a little tapping on a tabletop.

Step 13:
The rice cakes need to be placed into the terrarium. It is assumed that you have a fully functional and checked out terrarium setup at this point. This document contains all the information you need to prepare a terrarium. Preparation of the terrarium.

You can handle the cakes but remember that the less you handle them and the more gently you handle them, the better off they will be. Also, you should wash your hands thoroughly and be sure to rinse with water just as thoroughly to remove any soap before touching the cakes.
If you have disposable sterile gloves available, it isn't a bad idea to use them. You can get away without using them, but they are a good idea. Contamination is the mycophile's worst enemy.

Back to table of contents
The Growing Cycle
Construction of the Terrarium.

Construction of the Terrarium

The main purpose of the terrarium is to provide the high humidity required for mushroom development. The rice cakes will live inside the terrarium during the cropping phase of the growing cycle.
There are four different setups described in this document. The first one is a very simple, minimal terrarium that works well, but can only handle one rice cake. The second two are based on work done by Psylocybe Fanaticus. They will hold more cakes than the first terrarium, but they still require attention several times a day.

I encourage you to choose the last option. This one uses the same growing chamber as Psylocbye Fanaticus developed but an ultra-sonic humidifier is introduced to keep humidity up. It requires very limited maintenance and works very well.

The first terrarium, the "Poor Man's Terrarium" requires no humidification. It relies on a very small volume of air and the fact the terrarium is sealed very tightly from the outside environment.

All of the last three of the terrarium setups require the same growing chamber. The difference is the strategy for keeping the humidity high inside of the growing chamber. If you want, you can start with one of the simpler versions and switch to a different setup later if you are unhappy with it. Note that if you start with the ultra-sonic humidifier version, we don't expect that you will want to switch to one of the other two.

Poor Man's Terrarium

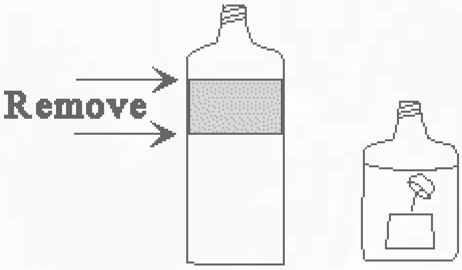
Materials needed:

- 2 liter plastic coke bottle
- razor knife

This terrarium is made by cutting a section out of a 2 liter coke bottle. This serves two purposes. First, it allows you to put a fully colonized rice cake inside the bottle. The second purpose is it allows the volume of the bottle to be reduced to the point where the moistness of the rice cake can keep it humid.

Remove a section of the bottle using the razor knife. The cut on the lower part of the bottle is not very critical. The top cut is more difficult to do correctly. It needs to be right at the point where the bottle is starting to decrease in diameter. This is because the top part of the bottle is going to be inserted into the bottom part of the bottle and the two sections need to seal tightly.

The best thing to do is start lower than the diagram indicates and cut small sections off until the top piece of the bottle fits snugly and easily into the bottom section. Once you locate the correct place to cut for the type of bottle you are using, you can simply cut at the same place and make multiple bottles to handle as many cakes as you wish to fruit at any time.



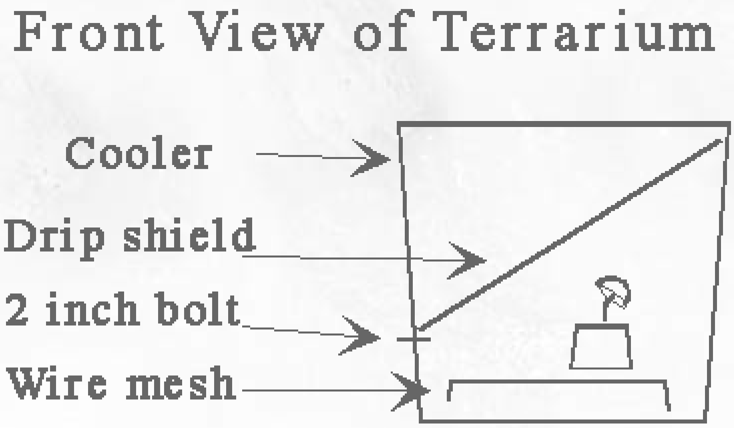
The cap for the bottle must be screwed on tightly. A damp paper towel can be placed on the bottom of the bottle to help raise the humidity inside the bottle. Twice a day the bottle should be opened to allow new air to be available for the rice cake to consume. It is best to fan the rice cake to insure new air is surrounding the cake before sealing it back in the bottle. This is the major draw back to this terrarium. If you have a dozen cakes it can become a burden to exchange the air twice a day.

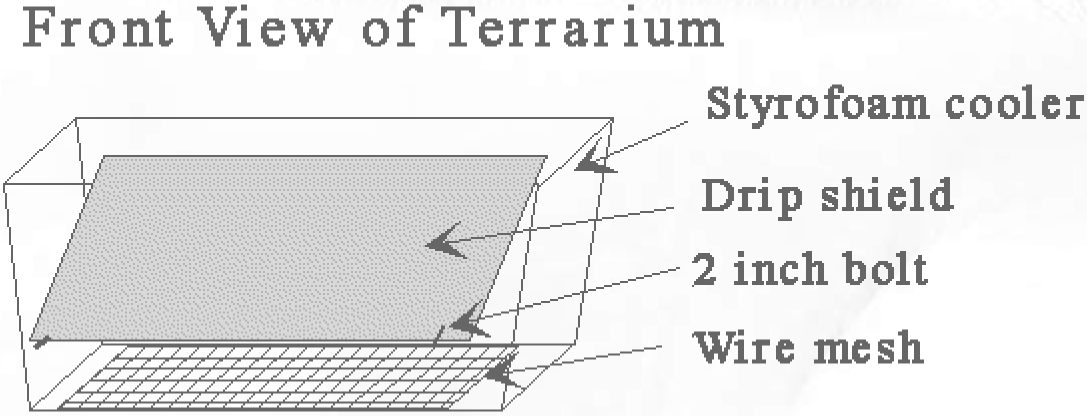
Basic Growing Chamber (Used for all other terrarium setups)

Materials needed:

- Styrofoam Cooler Adaptation-11
- Wire Mesh (1/4 or 1/2 inch is ideal)
- Plexi Glass (a 24 by 24 inch piece of window insulation or fluorescent light diffuser) Optional if using an ultra sonic humidifier.
- Silicon Glue
- Humidity Gauge Adaptation-12

The cooler needs to have a very tight fitting cover. The idea is to seal in humidity, and the looser the lid is, the more difficult this is. Except for the cooler, everything you need can be found at your neighborhood building supply store. Below are diagrams detailing the various components of the terrarium. There is no way to predict the dimensions of the cooler that you will use. You will need to use some common sense as we walk you through the steps to build your terrarium.





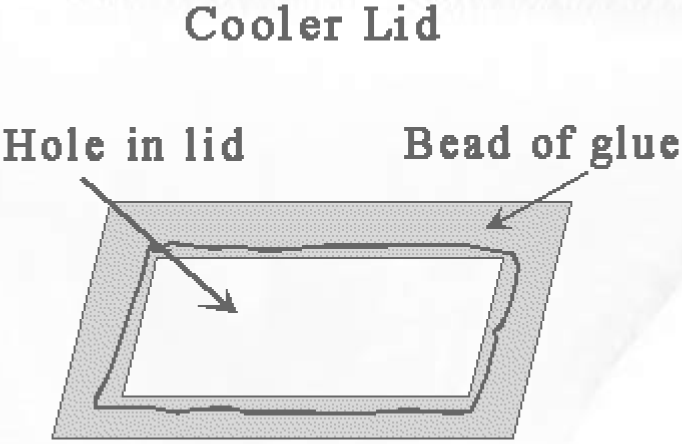
The purpose of the wire mesh is to hold the rice cakes off the bottom of the cooler where moisture will collect. The easiest thing to do is cut a piece of wire mesh an inch wider and an inch longer than the dimensions of the bottom of the cooler. Then, use a pair of pliers to bend a 1/2 inch ridge all the way around the piece of wire mesh. The piece of mesh will be held up by the bent ridge. Often times, when mushrooms are growing, space above them is at a premium. Try not to raise the wire mesh more than a 1/2 inch above the bottom of the cooler. Doing that simply wastes valuable space.

Next, if you are going to use the hand sprayer method of adding humidity, a drip shield needs to be installed. If you are using a fish tank bubblier or an ultra sonic humidifier, it is optional but still a good idea. As moisture condenses inside the terrarium, this protects the rice cakes from being 'rained' upon. Any moisture that forms on the lid of the cooler can drip and will be stopped by the drip shield from hitting the rice cakes. Any moisture that forms on the bottom side of the drip shield will form beads and run down to the side of the terrarium where it can drip harmlessly. If you use a piece of plexi-glass that is textured on one side, put the textured side pointing up. You want a smooth surface on the bottom side of the drip shield so that moisture can easily run down to the side of the terrarium.

The drip shield is held up by several bolts sticking through the side of the cooler. Depending on what size canning jars you use and the height of your wire mesh, you will need to figure out where to put them. You want the drip shield to be at as steep of angle as possible to make water run down it easily, but you want it high enough that your mushrooms have room to grow without touching the drip shield. The drip shield needs to fit well. You need a small gap on the edges to let air circulate, but keep it small. About 1/4 inch is good. In other words, the drip shield should fit pretty well to the inside of the cooler, but it is not supposed to be air tight. Also remember when shaping the drip shield that you can not go to the very top of the cooler because the lid will recess into the cooler a little ways.

If you are using a Styrofoam cooler, you should use washers on the bolts on both the inside and outside of the cooler. This will allow you to tighten the nuts on the bolts snugly to keep the bolts from tearing up the cooler as you move the drip shield during normal maintenance.

Next, the top of the cooler needs to be modified to allow light to enter the terrarium. Psilocybe Cubensis is a phototropic mushroom. It needs light to initiate pinning and to tell the mushrooms which way is up. You should have some plexi-glass left over from the drip shield that can be used for this purpose. Cut a hole in the top of cooler. Cut a piece of plexi-glass a little bit bigger than the hole in the cooler lid. Run a bead of silicon glue all the way around the hole in the cooler top. Position the plexi-glass over the hole and let the glue setup. See the following diagram:



That is it. The basic grow chamber is done. Now you need to decide which method you are going to use to keep the humidity high and the CO2 concentration low while the mushrooms are growing.

Method 1: Hand Spraying

This is the original method that Psylocybe Fanaticus recommended for the home cultivator to grow mushrooms. It is the least expensive. It is the most labor intensive and forces you to conform to a demanding schedule. The only thing you need in addition to the basic growing chamber is a spray bottle that can put out a fine mist.

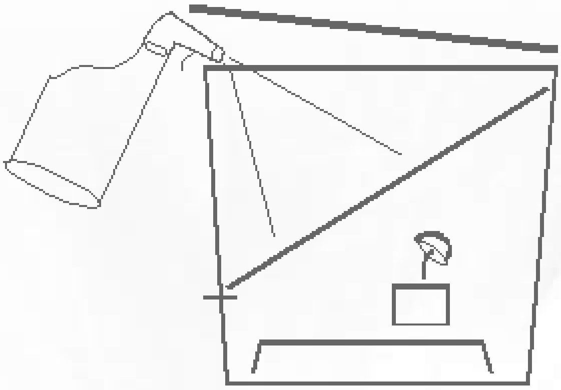
The procedure is this: At least four times a day the terrarium needs to have humidity injected into it via the spray bottle. At least twice a day the CO2 that has built up needs to be eliminated. Once a day you need to eliminate water from the bottom of the terrarium that has condensed and formed there.

Once a day, you need to remove the standing water from the bottom of the terrarium. You can use a turkey baster to suck the water out, or you can gently remove each cake and turn the terrarium up side down to drain the water out. If you remove the cakes, be very gentle. Any place you touch the cakes will not fruit. You should pick up the cakes in the same place every time.

Twice a day, the CO2 that has accumulated in the chamber needs to be removed. One method is to remove the drip shield and fan the inside of the cooler with the cover for 10 or 15 seconds. Another method that works well is to have a hair dryer next to the cooler and use it. Simply lower it into the terrarium with the exhaust jet pointing up and out of the terrarium and turn it on. It will suck all the existing CO2 out of the chamber. Be sure not to hit the rice cakes with the hot exhaust air. It will damage them. If your hair dryer has a 'cool' setting, use that instead of 'hot'. Incidentally, one cultivator recommends using a vacuum clean instead. He would simply suck the stale air out of the terrarium.

In order to create humidity in the terrarium a spray bottle that is capable of generating a fine mist is used. There are a lot of different products for use in the kitchen that have an adjustable spray nozzle, but if you choose to recycle one of these, make sure it produces a very fine mist. What ever you use, make sure it is entirely clean of the original chemicals. Let's make this perfectly clear. Make sure the bottle is clean and does not contain anything that will damage the fungus. The safest thing to do is go to the hardware store and buy a high quality spray bottle. These typically produce a finer mist than most kitchen type spray bottles. The problem is that you would not be using a spray bottle if you had a little extra cash so we are telling you that you can use a kitchen spray bottle if you are careful. In order to create the necessary humid environment in the terrarium, the nozzle is slipped under the cover of the cooler and sprayed at the center of the top side of the drip shield. See the following diagram:

Hand Spraying the Terrarium



After spraying for 5 seconds, pull the spray nozzle out of the cooler and let the lid quickly close, sealing in the vapor. The small water drops will dramatically raise the humidity of the chamber. The rice cakes can not ever be sprayed directly. The mycelium is very fragile and doing that will damage it. The terrarium needs to be sprayed at least 4 times a day. More is better.

This setup and procedure will work and is very inexpensive, but that is the only good I have to say about it. You become a slave to your terrarium. If you miss a couple sessions, your fungus will most definitely suffer because of it. Also, you can only support a few growing mushrooms at a time using this procedure. The mushrooms pull a lot of humidity out of the air and this method doesn't provide much excess.

Method 2: Using a Fish Tank Bubbler

The basic portion of this system was originally pioneered by Psylocybe Fanaticus There are several improvements and adaptations in this section that were not included in the original method. The idea is to create humidity by bubbling air through water. A small fish tank air pump and bubbling stone are used to accomplish this.

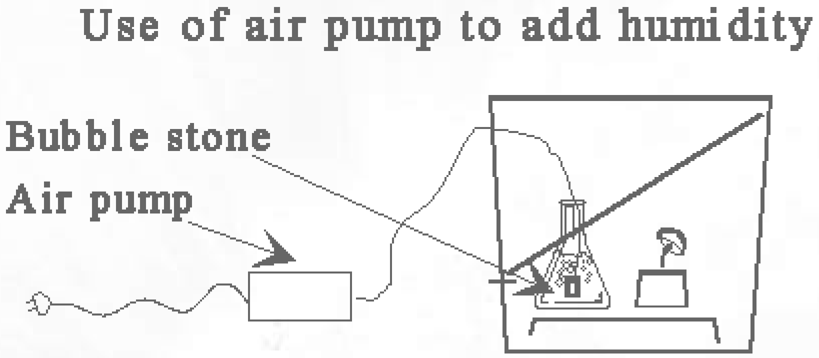
This method is inexpensive and allows the terrarium to exist without your constant attention. Its major limitation is that depending on how it is implemented, it can only raise the humidity by 15% over ambient. The minimum acceptable amount of humidity needed by the fungus is 85%. If ambient humidity is going to be less than 70% during the growing cycle, you will experience problems even with a fully optimized setup. If you have more than a few mushrooms growing, it is possible this system will fail to keep the humidity high enough. You still need to hand spray the terrarium occasionally to boost the humidity above what the bubblier can do. Several times a day is sufficient.

All of the materials needed can be obtained at any pet store or pet department in a department store.

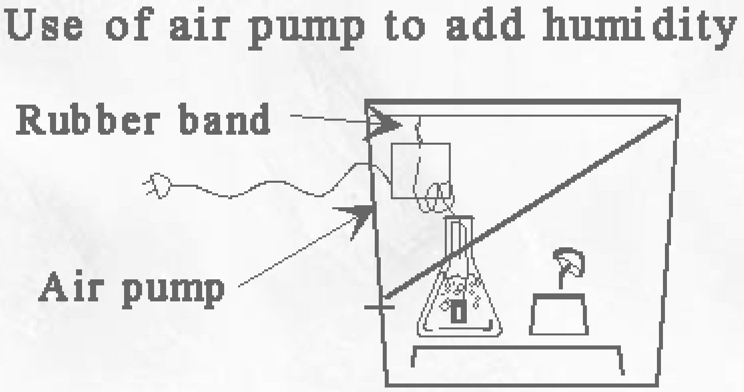
Materials needed:

- suitable container for water
- Fish Tank Bubbler
- 3 feet of 1/4 inch air line for fish tanks
- bubbler stone
- optional submersible 50 watt fish tank heater Adaptation-13
- optional Angel Hair or plastic steel wool Adaptation-14

The basic strategy is to place a container of water inside the terrarium and slowly bubble air through the water. A hole should be cut in the drip shield to allow the container to stick up through it. The top of the container should be above the drip shield to protect the fungus from water droplets that will get produced. There are several ways the system can be implemented. If the air pump is setup outside the terrarium with just an air line going into the terrarium, the humidity will be raised less than 10% over ambient. The one benefit to this setup is the fact that air is constantly being exchanged and the home cultivator does not need to eliminate CO2 every day. A small hole can be put at the base of the terrarium to let CO2 and water escape. The hole should be just big enough that water does not bead up and plug the hole. A 3/8 inch hole will accomplish this nicely. Note that a small, snug hole needs to be drilled in the side of the cooler to allow the air line to get inside the cooler. You can not just loop it over the side of the cooler and slam the lid on it. You will not get enough humidity if the lid does not fit tightly. See the following diagram:



A second method to implement this strategy is to put the air pump inside the terrarium. This way the same air is constantly recirculated, constantly increasing its humidity. This can increase the humidity to close to 15% over ambient. This implementation has several disadvantages. First, the key to getting the higher humidity is recirculation of the same air over and over again. This means no hole can be placed at the bottom of the terrarium to allow water and CO2 to escape. You will need to eliminate CO2 at least once a day. The second disadvantage is the fact that the air pump generates some heat and can warm the terrarium by over 10 degrees F. This may or may not be acceptable. One point needs to be noted. The air pump will create some vibration. It is best to suspend the air pump from a rubber band to absorb this vibration. A stiff piece of coat hanger wire can be suspended from one side of the terrarium to the other and the air pump hung from it. Instead of the air tube going through the side of the terrarium, the power cord for the pump goes through the side. Also note that the positioning of the stiff wire to hold the air pump is not critical. It may be better to rotate it 90 degrees from what is shown in the following diagram so that it is easier to remove the drip shield when servicing the terrarium. Also, the power cord and air tube should have some slack in them so that are not being pulled on as the pump vibrates. The ideal scenario is to tie wrap them to the supporting wire. See the following diagram:



Method 3: Using an Ultra Sonic Humidifier

This is the best method. It will free you from the tyranny of your terrarium. It will effortlessly produce enough humidity to support as many mushrooms as you can grow at once. This setup will automatically eliminate CO2 buildup before it occurs. The only draw back is that ultra sonic humidifiers cost around $40. A little more for a super nice one, a little less for a budget version. Just about any ultra sonic humidifier will work.

A steam humidifier is not easy to integrate into this terrarium setup. First, the vapor it emits is too hot and will kill the fungus. The second reason is they typically run full blast. They do not have a control to throttle them way back like the ultra sonic humidifiers do.

Materials needed:

- Ultra Sonic Humidifier Where to find
- 8 feet of 7/16 inch outer diameter, 5/16 inch inner diameter vinyl tube
- 1 dozen 3/8 inch inner diameter grommets
- 4 clear 2 liter coke bottles
- 3/8 inch, fine thread bolt
- tube of silicon glue
- pliers

First, a small hole needs to be placed in the Basic Growing Chamber to let water and CO2 escape. It should be at the very bottom of the cooler. It needs to be big enough that water will not bead up and plug it. 1/2 to 3/4 of an inch is good.

This setup uses the ultra sonic humidifier to produce air that is close to 100% in humidity. The air flow out of the humidifier is limited by the fact that it has to travel through the 7/16 inch vinyl tubing. That is OK, because we want to limit the amount of air we feed into the terrarium. The humidifier will generate very humid air, but the air will also have many suspended water particles in it. Any time one of these water particles touches another water drop, they will merge. We don't want moisture forming on the rice cakes, so limiting the number of suspended water drops we allow into the terrarium is a big step towards this goal.

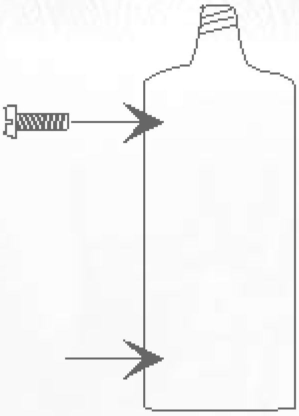
Even so, the air must be dried further. Adaptation-21 The air is passed through several stages where it is allowed to swirl and condense. Each one of these stages is comprised of an empty 2 liter coke bottle or some other suitable container. These stages are connected together using the 7/16 inch vinyl tubing.

Every time a piece of vinyl tubing is used, it needs to be fluted. This means it is not cut off square, but rather at a very sharp angle. This is necessary to help moisture that condenses inside the line to drip out once it reaches the end of the line. Otherwise, it will form a big drop and eventually plug up the line. At that point you have no humidity entering the terrarium.

Drill a 7/16 inch hole in the center of the exhaust lid for the humidifier. Insert a grommet. Apply a bead of silicon glue to the slit through which vapor normally exits. You want to plug this slit up. The only exit for vapor should be through a piece of vinyl tubing that will be placed inside this grommet.

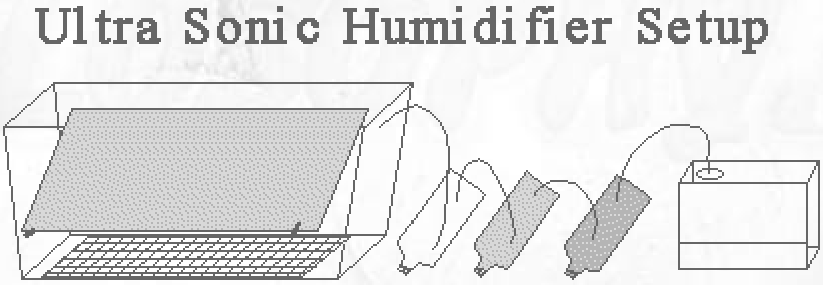
Remove the labels on the coke bottles. Any large plastic container can be used but the 2 liter coke bottles are real nice because they allow you to see inside. Adaptation-24 This is useful to determine if the terrarium is running correctly later. Also, you will be able to see if moisture that has collected in the bottle needs to be emptied out of it.

Heat up the threads on the 3/8 inch bolt using a propane touch or burner on a gas stove. A cigarette lighter will work, but it will take a long time. Hold onto the bolt with the pliers. When the bolt is hot, quickly and neatly poke two holes in each 2 liter coke bottle. Adaptation-15 See the following diagram for details:



The bolt that is used is deliberately a little smaller than the hole that needs to be generated. The hot bolt will melt the hole a little bit bigger than it is when it pokes through the plastic bottle. You may need to insert the bolt a second time into the hole and let it touch the sides to expand the diameter of the hole. Some times little chunks of plastic stick to the side of the hole. Use a sharp knife to clean up the edges and insert a grommet. Check the fit of the vinyl tubing through the grommet. It should be very snug and air tight, but it should not collapse the inner diameter of the tubing very much.

Connect a piece of tubing from the humidifier to the first coke bottle. Flute both ends of each piece of vinyl tubing. Connect the this coke bottle to the next. Do this until you have all four coke bottles connected. The picture shows 3 coke bottles because that is what is normally required, but for now connect in all 4. Now connect the last coke bottle to the terrarium. You will need to poke a hole in the side and insert the tubing. The tubing should be blowing humid air into the part of the terrarium that is above the drip shield. It should be setup as follows:



Checking out the Ultra Sonic Humidifier Setup

Fill the humidifier with water and position the various stages of the coke bottles between the humidifier and terrarium. At no place should the vinyl tubing have a low spot for condensation to form and plug up the line. Condensation will form in the lines but it should run to the end and drip harmlessly out of the line.

Set the humidity level at the minimum setting. This is still more than you should need. Adaptation-19 After you give it time to stabilize, you should see that each stage of the coke bottles has less fog in it than the preceding stage. Usually, 3 bottles is the right amount, but depending on your humidifier and ambient humidity, it could be more or less. You want the last coke bottle to just have the slightest hint of fog in it. Add or delete stages as necessary.

The humidity in the terrarium should stabilize at about 90%. The ideal amount of humidity is as much as you can get without moisture forming on the rice cakes. Keep in mind that most humidity meters you get at department stores are not very accurate.

Back to table of contents

The Growing Cycle

This section is relatively short considering its topic. That is because when you get to this point you are only needed to make sure the fungus has the right conditions to thrive.

Once you place a fully colonized rice cake in the terrarium it just needs several things to grow mushrooms. It needs high humidity, temperatures below 85 degrees F. and a little light. Once the mycelium network has gained access to enough nutrients the cake can initiate mushrooms if conditions are right. The initiation of mushrooms requires some light and temperatures in the mid to upper 70's F. The mushrooms can grow at higher temperatures, and in fact grow faster at higher temperatures. But the fact remains that the temperature range is fairly narrow to start new mushrooms. Normally, it takes about a week for pin heads to form if the rice cake was removed from the culture jar as soon as it was 100% colonized. It can happen after just a couple days if the mycelium network is well established, or it can take several weeks if things aren't just perfect for the cake.

If you keep the terrarium's temperature in the mid to upper 70's F. you will be constantly initiating new mushrooms (pin heads) while providing a good environment for the growing mushrooms to mature. This is the simplest way to grow if you can arrange for this to be the case. Adaptation-16 If you deviate outside of this temperature range, you will still get a few mushrooms, but the fungus will initiate new pin heads only occasionally. You will spend a lot of time waiting for a mushroom to form.

The rice cakes need a small amount of light to initiate pin heads. Mushrooms are not plants and do not need light to grow. However, P. cubensis is a phototropic mushroom. This means it needs light to trigger a hormonal response in order to form mushrooms. If you can see the rice cakes, there is enough light for this to happen. Many mycologists believe the reason light is important in the growing cycle is because it provides a reliable clue to the mycelium that it has reached the boundary of the substrate in which it is growing. In nature, P. cubensis often lives in a pile of cow manure. Once it has grown through the entire substrate and reaches the edge, light hits it and provides the mycelium with the information that if it forms a mushroom there, it can release spores into the air for distribution. It is not productive to form a mushroom inside the substrate because the spores can not be distributed in that case. Any normal spectrum of light that you have available will work. Sun light, fluorescent or incandescent are all fine and will work. A few minutes of light a day is sufficient but an hour or two will guarantee that pin heads form if everything else (temperature, humidity, the mycelium network is well established, etc.) is right. Be careful not to heat your terrarium too much if you use artificial light near the terrarium.

The rice cakes will have a very bright white appearance when they are first placed in the terrarium. Soon, they will be coated with a thin layer of fluffy mycelium. If the cakes refuse to fruit but continue to form more and more fluffy mycelium this is an indication that the humidity is too high and needs to be adjusted downward. For people using a humidifier in their terrarium setup, this is the single biggest cause of failure assuming they get the rice cakes colonized successfully.

When pin heads form, they will look like a short section of a common pin. Hence, the name. The end of these pin heads will soon grow dark brown. This is the cap beginning to form. When the rice cakes are fresh, the small mushrooms will start adding bulk rather than grow longer. They will form balls the size of a marble. Then, they will start to thin out and grow long, adding bulk the whole time.

If the mushrooms have mycelium growing on the caps, it is an indication that your humidity is too low in the terrarium. In this case, you have just enough humidity to allow the cakes to fruit, but you are right on the edge of failure.

You should avoid the temptation to grow the mushrooms as large as possible. Significantly more psilocybin is produced during the early periods of growth. By letting the mushroom grow too large you are simply consuming nutrients and moisture from the rice cake for no purpose. Also, the mushrooms taste increasingly bad as they get larger. Lastly, the mycelium network in the cake can only provide so much in the way of nutrients and water to maturing mushrooms. If you let the mushrooms grow too big, they will hurt the development of other mushrooms on the cake. The mushrooms should be picked just as the veil underneath the cap is starting to tear away from the stalk.

On the average, you should expect to get between 4 and 6 average size mushrooms per 1/2 pint cake. On the average you should expect each cake to produce 1 mushroom a week but this number can vary in either direction greatly.

As the cakes get older, they will produce less and less and it will be more difficult for the mushrooms to grow. Adaptation-17 This is a result of the moisture in the cake being consumed by the earlier mushrooms. You will eventually see mushrooms form and start to grow but never bulk up during the initial phase of development. These mushrooms will seldom get big enough to develop caps. You can harvest these mushrooms but it is an indication that the rice cake is about exhausted.

Back to table of contents

Drying and Preservation of the Mushrooms

Once you have grown and harvested some mushrooms, you need to think about preserving them. They will only keep for a short time in their fresh state. Sometimes a single mushroom needs to be harvested and it isn't enough for a dose. Other times, too many mushrooms will be fully grown for a single dose. Either way, you will be in a situation where you want to preserve them for later. And, even if this didn't happen, you may find your self in a situation where you simply don't have the time or inclination to trip. The good news is that if they are dried correctly, nearly all of the psycho-active compounds can be preserved for many months.

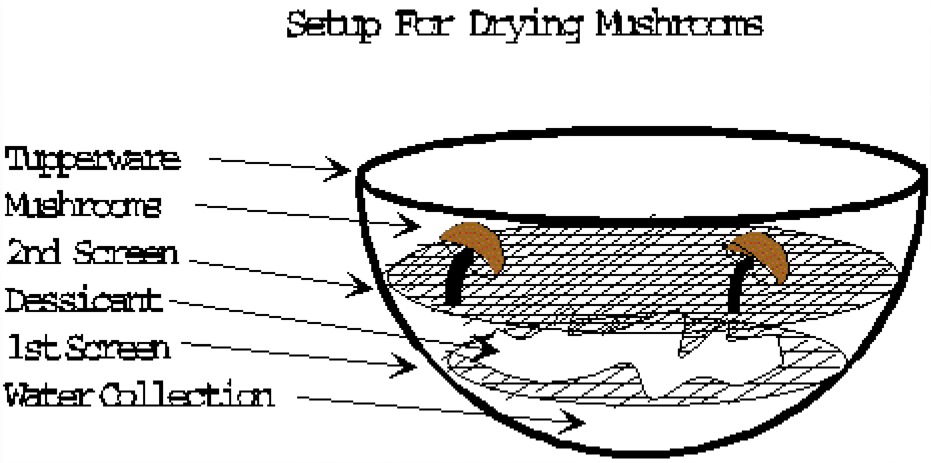
There are several ways to dry them, but we will only cover the best way. What ever you do, don't use heat to dry them. Heat is very harmful to the psycho-active compounds. You will drastically reduce the mushroom's potency if you use heat to dry them.

Materials needed:

- 1/4 inch wire mesh
- old wash cloth or rag
- carton of Damp-Rid or Damp-be-Gone (Anhydrous calcium chloride)
- Medium or Large size Tupperware bowl with sealing lid

Several pounds of calcium chloride can be purchased for a couple of dollars at any large building supply outlet. It will usually be found in the paint department because it is used to dry the air in musty closets before painting and things like that. If possible, get the bulk refill containers. It will be cheaper than the calcium chloride that comes with the units to hold it and the moisture pulled from the air. You won't be using the unit, so don't buy it unless you have to.

The drying chamber needs to have a space at the bottom for water to collect. This allows the calcium chloride to function well for extended periods of time. As it pulls moisture from the air, it drips to the bottom of the chamber. The calcium chloride is held above the water by a circular section of the 1/4 inch wire mesh with a wash cloth spread out on it. See the following diagram for details. The wash cloth keeps the calcium chloride from falling through the wire mesh but any water that forms can drip through it to the bottom of the chamber.



The calcium chloride should be spread out evenly. If you use too large of a Tupperware bowl, you may have to add some structural strength to the screen in order for it to support the calcium chloride. You can simply lay a stick or ruler underneath the mesh and use tie wraps to secure the mesh to it.
Cut another circular section of mesh so that it fits above the calcium chloride and leaves a nice air gap. The mushrooms will be placed on this mesh in order to dry them. Make sure the calcium chloride is not touching the bottom of this screen. There should be an air gap between the top of the desiccant and the bottom of the screen. You do not want your mushrooms to touch the calcium chloride while they are drying because some of it will dissolve into the mushroom if this happens.

That is the entire preparation for preserving your mushrooms with minimal loss of potency. In order to dry your mushrooms, simply harvest them and place them on the wire screen. Close the Tupperware container so it is air tight. The mushrooms will shrink and shrivel over the next couple of days. After about three days, they will be fairly hard and contain very little moisture. If you are not pushed for space inside the drying chamber, you may was well leave them there for five or six days to thoroughly dry them.

After the mushrooms have been in the drying chamber for three days, they can be moved to a zip-lock bag for long term storage. Remember that the dryer the mushrooms are, the longer they will keep. Adaptation-18
The reason this system works so well to dry the mushrooms is the calcium chloride is a good desicant. It has a very strong affinity for moisture and can pull almost all the moisture out of the air. Eventually however, liquid will start to collect in the bottom of the drying chamber. Mushrooms are 92% water by weight. This moisture has to go somewhere when the mushrooms are dried, and it will eventually find its way to the bottom of the container.
When moisture starts to collect in the drying chamber you can simply drain it out and continue to use the old desiccant. The chamber will continue to work as long as there is sufficient calcium chloride in it. You should be careful not to contaminate the sides of the container or the top screen with residue from the desiccant. You do not want your mushrooms to touch the residue. For one thing, it tastes terrible, but in addition to this, the mushrooms will not dry completely. The residue will attract moisture. Whenever you empty the moisture, it is best to wash the Tupperware container completely.

Back to table of contents

Dosage and Various Ways to Ingest

First, we need to make sure some thing is understood. Before you dose, you need to be some one that likes your self and feels pretty secure about your self. You should not have any major troubles in your life. If this does not describe you, don't dose! Go find some other drug to play with.
OK, you've decided that your going to dose. After all, why did you grow these little devils if you weren't going to trip? The most important question to answer is how hard do you want to trip? If a 170 pound person had

never done alcohol before, this is the advise I would give him. Dosage could be anywhere from 1 beer to 12 beers. 1 beer is just enough that you might feel something, but everything will be pretty normal. 4 beers is enough you will have a strong sensation of what alcohol does, but you will be in complete control. At 6 beers, you will start to be drunk. At 12 beers, you are pig drunk and may pass out. I would recommend 4 beers the first time out. This would give you a good feeling for what alcohol is about, but still keep you out of trouble.

These mushrooms will be fairly consistent in potency. They are all grown on the same medium under the same circumstances. If you take 4 average P. cubensis mushrooms, that will put you at the same relative spot on the spectrum as 4 beers. But remember that psilocybin is more powerful than alcohol. What you experience will be more intense than 4 beers. However, on the spectrum of what is possible, you will still be on the low side. What are average size mushrooms? Mushrooms are like snowflakes. No two are the same. I would call a mushroom that has a stalk 3 inches long and a cap 1 inch in diameter average.

Drying the mushrooms as described in this document will have minimal impact on their potency. Many sources claim that dried mushrooms are significantly less potent that fresh ones. If you use the method to dry the mushrooms described in this document, you'll find that claim is not true. It's your choice whether to eat them fresh or in their dry state. Some people have strong feelings one way or the other because of their taste. Most people agree that these mushrooms will never win any culinary awards. Try some each way. Find out if one way or the other is better for you.

Some people find that these mushrooms cause some nausea. **AN165023@anon.penet.fi** suggests the use of digestive aids available over the counter at any pharmacy. This will make consumption of the mushrooms a lot easier on you if you are susceptible to nausea. Also note, that most people should avoid consumption of alcohol while using these mushrooms. When the mushrooms are mixed with alcohol, even people with cast iron stomachs can loose their lunch.

If you find the taste of these mushrooms particularly distasteful, you can always bury them in a burrito or peanut butter sandwich. If you do this, it will slow the onset of the effects some what. Some people just chew them up and wash them down with orange juice.

Some people dislike the taste so much, they are willing to go to extraordinary measures to disguise the taste. Several popular recipes follow. With the exception of the first recipe, these recipes all suffer from a common problem. They use heat. Heat will cause some of the psilocybin to break down and as a result you will need to use more mushrooms for the same effect than if you had ingested them directly. This fact in and of itself is not too big of a deal. After all, you can grow as many mushrooms as you need. A 25% to 50% loss of efficiency is not ideal, but it may be worth it to some people in order to avoid the nasty taste of these mushrooms. The real problem is it is impossible to predict how strong the effect is going to be. It depends on how hot you heat them when you do the preparation and how long they are hot. Use caution!

Mushroom Juice

Put several spoonfuls of frozen juice concentrate into a blender. Dole's Orange-Pineapple-Banana works especially well but regular Orange Juice or Lemon Aid will work. Add a bit of water, but keep the resulting juice on the strong side. Throw in a few ice cubes and your shrooms (fresh or dry) and whiz on high for a minute or so. Let it sit for a few minutes after you turn off the blender, then drink.
A 500 mg vitamin C capsule can be added and will make the juice more tart which is beneficial in masking the mushroom taste.

Mushroom Tea

Take the fresh mushrooms (6-7 per person depending on size of caps) and cut the caps and stems into very small pieces. Place mushroom pieces into medium sized pot 3/4 filled with water. Boil the water along with the mushrooms. Boil for ten minutes. Remove from the heat and let cool for 10 more minutes. Strain mushrooms with a coffee filter, or paper towel. At this point, if you truly desire tea, a mint flavored version works well. Otherwise, Kool-aid is an option. Grape Kool-aid mixed stronger than usual will definitely cover the taste. Serve with ice to chill the Kool-aid to the desired temperature.

Mushroom Soup

Using Ramen Pride or any other dried noodle soup, follow directions on package, except put cut and cleaned mushroom pieces in the broth. Prepare as usual. If the mushroom pieces are small they are relatively unnoticeable.

Mushroom Pizza

Cook your favorite frozen pizza according to directions. Several minutes before the pizza is done cooking, add finely sliced fresh mushroom pieces to the pizza. Optionally, you can add some grated cheese on top of the newly added mushroom pieces. Adding cheese will help encapsulate the mushroom pieces and dramatically help mask the taste. Place pizza back in oven and cook until done.

Obviously, some of the people that grow these mushrooms are going to be looking for a 'mind melting' experience. Bad trips on mushrooms are rare, but they do happen. One of the most common reasons for bad trips on mushrooms is taking a high dose of mushrooms that have grown on cakes that also have contamination growing. Toxins get absorbed by the mushrooms growing on these contaminated cakes and as the dosage gets higher it starts to become an issue. Care should always be taken to avoid contamination but if you plan to dose on the high side, it is absolutely mandatory. Think about it. How fun would it be to have a nasty allergic reaction to some toxin while tripping hard. The email I've received on the subject suggests it is not very pleasant. Throw out any cake that is contaminated and any mushrooms that were grown on that cake even prior to when the contamination was noticed.
One final note. If you ever find that you have dosed too heavily, just remember that 90 minutes after ingestion will be the peak experience. Things will start to settle down after that. The good news is that medically you can't overdose on psilocybin. If you remember these things, and believe them, they can help ease you through a high dose experience.

Back to table of contents

How to Get a Spore Syringe

This section is ordered for some one just starting off in the home cultivating experience. Once you have grown a crop, this section is ordered backwards for your needs. The intent is to get you started easily. In order to grow subsequent generations of fungus you need to generate a spore print and use this to create a spore syringe. This information is at the tail end of this section.

In order to use the process detailed in this document, you need a sterile, viable spore syringe. The spores should be Psilocybe Cubensis spores. Preferably, they should be of the Amazonian strain. The Amazonian strain has wider parameters for fruiting and is more tolerant of mistakes. However, any Psilocybe Cubensis strain will work. There are several ways to get started. The easiest way to get started is to order a spore syringe but alternatively, you could obtain a spore print and use that to prepare a spore syringe.

Once you have grown some mushrooms, it is worth while to learn how to generate your own spore prints so that you can produce spore syringes when ever you need one. Currently, you don't have to do this if you choose not to because the spores are still readily available from mail order suppliers. Many people believe the day is coming when this will not be true. Many of the sources of psilocybe spores have quit selling to the public and others have destroyed their cultures because of mandates given by the DEA. If you have a sterile, viable spore print, you can eliminate your dependence on these suppliers.

Sources for a Spore Syringe

(Check all sources for current address and prices before ordering)

[Note: The following information about Spore Syringes is very out of date. The listed businesses may no longer sell spores, prices may have changed, ownership/management may have changed. Psylocybe Fanaticus is no longer in business. Verify everything before acting on any of the information in this section.]

Currently the most cost effective place for a United States resident to order a spore syringe is from the company that pioneered many of the concepts in this document. They have a very fast turn around time and are very reliable. Their spore syringes are $10.00 (US) and that includes shipping. They are very high quality. They currently supply P. cubensis Matias Romero. This is a substrain of the Amazonian strain.

If you are outside the United States, there is a $10.00 shipping charge. All their packages are shipped in a discrete manner. However, be aware that outside the US, a customs sticker with the description "mushroom spores in blunt-tipped pipette" is stuck on the box.

If you wish to minimize the paper trail, you can send cash to Psylocybe Fanaticus. They are totally reliable and you will get what you order. Psylocybe Fanaticus advertises that they do not keep customer files and by sending cash, you can distance your self from any records of the transaction.

If you learned about Psylocybe Fanaticus here on the Web, please mention it when you order. Currently, Psylocybe Fanaticus doesn't believe much business comes their way because of the net. We would like for that to change.

In Europe, there is a very cost effective spore seller, Smart Botanics. They also sell dried mushrooms if your country will allow them to be imported. They only charge $8.00 for a spore syringe and $3.00 for shipping. You can place an order through the mail or directly from their web page.

Also of interest is the fact that this supplier can provide you with either the standard strain of Psilocybe cubensis spores or 'Gulf Stream' Psilocybe cubensis spores. The 'Gulf Stream' strain is slightly more tolerant of heat and fruits a little easier in warmer temperatures. The standard strain is more appropriate for cooler climates. Simply specify which one you prefer when you place your order.
Check, Diners Card and American Express are accepted.

Smart Botanics
P.O. Box 158, 2800 AD Gouda
The Netherlands.

In Canada there is a company called Hemp Nation. They are reliable and ship promptly. They sell suitable spore syringes (Psilocybe Cubensis Amazonian strain) for $20 (US). There is a $5.00 shipping charge within North America. I used to say the main reason you would want to order from this company is they are in Canada. If you're in Canada, your order will not have to go through customs. There is another reason you might want to order from this supplier. This company is the focus of a Constitutional Challenge to legalize hemp in Canada. The profits from your purchase will assist this.

Christopher Clay, Proprietor
Hemp Nation Headquarters
343 Richmond St.
Suite #101
London, Ontario Canada N6A 3C2
Phone: (519) 433-5267
Fax 433-7725
E-mail: hemp@hempnation.com
http://pobox.com/~hemp

Also in Canada, there is a company called Hemp-BC. They are reliable and ship promptly. They sell suitable spore syringes for $30 Canadian. U.S. currency is accepted. There is a $5.00 shipping charge within North America. If you're in Canada, your order will not have to go through customs.

Hemp BC
324 West Hastings, Vancouver BC
ph (604) 681-4620
fax (604) 681-4604

On the net they have a site: WWW.HEMPBC.COM

Sources for Spore Prints

In the event you wish to start with a spore print instead of a spore syringe, this section provides a few places you can obtain suitable spore prints. In general, the first time grower really ought to start with a spore syringe because it eliminates many of the sterility issues. The one benefit to starting with a spore print is you can make close to fifty 10 cc. spore syringes from a single spore print. However, this is really a moot point. Once you have grown a crop of mushrooms, you can generate as many spore prints as you want. One spore syringe is guaranteed to produce a crop if you follow the directions in this guide.

Mostly, this section is included just for completeness. In the event you can not obtain a spore syringe for some reason, you can get a spore print and use that to make a spore syringe.

The following information was pilfered from the mushroom FAQ on Hyper-Real.

Homestead Books P.O. Box 31608 Seattle, WA 98103	P. cubensis spores ($25), kits ($70), and books/videos about growing. (Phone: +1-206-782-4532)
Pacific Exotic Spora P.O. box 11611 Honolulu, HI 96828	Panaeolus cyanescens and Coplandia cyanescens spores. Very expensive, $40-$75.
The Shroom King P.O. Box 17444 Seattle, WA 98107	Str. cubensis print and a book for $25, above above plus compost and agar for $35. (Phone: +1-206-784-9328)
SYZYGY P.O. Box 619 Honaunau, HI 96726	$15 + $1 (S&H) for a Str. cubensis print on a slide.
J.L.F. P.O. Box 184-SC Elizabethtown, IN 47232	Supposedly sells some rare species ready to and lotsa weird stuff. Free catalog. (Phone: +1-812-379-2508)

How to Make a Spore Syringe

Sterility is key. If your spore print is contaminated or you introduce contamination into the spore syringe, you will have difficulty later in the process. Ideally, there should be no fans blowing or drafts of air. You should clean the area where you will be working carefully and make sure that everything is tidy.

Materials needed:

- spore print
- 10 cc. syringe with long needle Where to find
- shot glass
- regular glass
- coffee mug
- cigarette lighter
- X-Acto knife or sharp steak knife
- microwave oven

Several things need to be accomplished. First, we need to sterilize a shot glass to easily mix the spore solution and we need to sterilize a syringe to hold the solution. We also need some sterile water in which to suspend the spores. The following procedure will accomplish all of this.

Fill a coffee mug with water and place a shot glass inside the coffee mug. Make sure the shot glass is completely submerged. Place the coffee mug in the microwave oven and get the water to a full boil for 10 minutes. It does not need to be a violent boil. Adjust the heat level of the microwave oven to keep too much water from being lost if necessary.
Remove the shot glass and empty the excess water out of the shot glass. Place another glass over the shot glass. This will keep air born contaminates from settling in the shot glass while you wait for the shot glass and water in the spore syringe to cool.

Fill the syringe with hot water from the mug. Eject the hot water and repeat several times. This will insure the inside of the syringe and the needle are clean and sterile. This is especially important if you are using a syringe from a previous crop. When the needle is inserted into the substrate, it is possible to get nutrients up inside the needle and for contamination to grow. The last time you fill the syringe with hot water, do not purge it. Let it sit in the syringe until it is cool. This is useful for two reasons. First, the continued heat from the water can still work to eliminate any remaining contaminates. Secondly, once the water is cool it can be used as the sterile water needed to fill the syringe. Make certain that nothing touches the needle of the syringe.

The Psilocybe mushroom spores will be killed if they come in contact with anything too hot. You need to wait until the shot glass and spore syringe are at room temperature. When it is safe to proceed, use the cigarette lighter to flame sterilize the X-Acto knife and the needle of the syringe. Let the blade of the knife cool, but make sure it does not touch anything. When it is cool, carefully open the spore print and scrape a fleck of spores into the shot glass. A fleck 1/4 inch by 1/4 inch is more than sufficient for a 10 cc. spore syringe. Use the needle of the syringe to stir the spores into a few drops of water. Usually, there will be a few drops left over in the shot glass from when you emptied it. Otherwise, you can get the drops from the syringe. Stir the fleck of spores until they are well broken up and 'dissolved' into the water. Purge the water out of the syringe into the shot glass. Pull the water back into the syringe, being sure to suck the spores in also. Do this once or twice more to make sure the spores are well mixed in the spore syringe. Often, it takes several tries to get the spores fully broken apart and well mixed.

If the spores in the print have been dried and are not fresh, it is best to wait six hours to use the spore syringe. The spores need to rehydrate. If your in a hurry, the spores can still rehydrate in the culture jars.

How to Make a Spore Print

Once you have a mature mushroom, you are in a position to make a spore print and use it to continue cultivation of mushrooms. The cap should be harvested when the mushroom cap has become flat or is starting to invert.

Sterility is key. Adaptation-25 Be careful not to do anything that will compromise the sterility of your spore print. The typical procedure is to cut the stalk off of a mature mushroom very close to the cap. A sterilized knife or razor blade is used to do this. The cap is then laid on a sterile piece of tissue paper or card stock and a small glass set over it. The glass is needed for two reasons. First, it keeps the spore print insulated from airborne contaminates. Secondly, it helps keep the humidity high so the mushroom cap can continue to live and drop its spores. One note of caution. Some humidity usually needs to be allowed to escape. You want the environment inside the glass to be slightly less humid than the environment in which the mushroom was grown. If you have problems getting a cap to drop its spores, try using a piece of paper for the print that fits entirely inside the glass and spreading out a wash cloth flat on the table. Let the edge of the glass seal to the wash cloth instead of the paper. This will usually allow enough humidity to escape to cause the cap to drop spores.

If everything goes well, after a day or two the cap will drop its spores. Adaptation-26 There will be a purple-brown dust underneath the cap. These are the spores.

Eye glass lens paper is good source of sterile tissue paper. A box of waxy tissue paper that deli's use to pick up donuts and rolls is another excellent source of sterile tissue paper. Card stock (such as a recipe card) is a bit easier to use later when you want to prepare a spore syringe, but you have to expend the extra effort up front to sterilize it. To use card stock, place in a 425 degree F. oven for 15 minutes. Let it cool with a glass over it before you place the cap on it.

Once you have a spore print on the paper, remove the glass and cap. Fold the spore print in half and seal the edges so air can not get in. A piece of scotch tape on each side will do nicely. The spores will stay viable for 18 months if they are kept in a cool, dry and dark spot. If you place a small amount of desiccant in the bottom of a film container and place a cotton ball on top of the desiccant, you have an ideal container to keep the spore print. The cotton ball will keep the desiccant from touching the spore print. Seal the spore print in the canister and place the canister in your refrigerator until you are ready to use it.

Note that if you want to be self sufficient, it is a good idea to have multiple spore prints and store them separately. You just never know when you are going to be surprised with a massive contamination problem or thermal death. The safest thing to do is have a couple viable spore prints so it is easier to recover from disaster. A spore print is typically viable for about a year if it is stored in a cool, dark location. As a print ages, germination gets slower and this process becomes more prone to contamination.

Combination of Spore Print and Preparation of Inoculant

This excellent idea is from: **AN165023@anon.penet.fi**

If it is your intent to use a mushroom to immediately generate inoculant for a successive crop, you can eliminate some of the above steps and reduce the risk of contamination.

Poke a small nail hole in the cap of a wide mouth jar. Cover the nail hole with a piece of electrical tape. A 1/2 pint canning jar similar to that used for the cultures is fine. Sterilize both the jar and the lid.

Place the harvested cap in the sterilized, wide mouth jar. Seal the top with the lid and wait until a spore print has been generated on the bottom of the glass. Open the jar and remove the mushroom cap. Add 3/4 cup of sterilized water. Seal the top of the jar with the lid and shake the jar. The spores need to be mixed well into the water. This procedure elements the need to transfer spores from a print to some container to make the solution. The spore print is generated inside the container and the only extra step is adding water. It also has the benefit of making a large amount of solution that is easy to use.

Now, any time you need inoculant, you can shake the jar and peel the tape back to expose the nail hole in the lid. Simply insert the needle of the syringe into the inoculant and pull some into the syringe. The syringe needs to be sterile or you risk contaminating the entire jar of solution. The solution will keep longer if you refrigerate it. You still should keep some spore prints on paper because it is possible to contaminate the entire jar of inoculant if you make a mistake.

Back to table of contents

The Author's First Trip

OK, some of you experienced druggies are going to get a chuckle from this. This is a description of my first trip. I grew up in a real conservative environment. I always wanted to hallucinate but I was real scared of LSD. After all, I'd been told it causes chromosome damage and that a lot of the people that trip on it either jump out of windows or end up in a permanent psychosis. I'd heard that even the lucky ones that make it through the trip ok suffer from uncontrollable flash backs for the rest of their life. Pretty scary stuff.

I never was around people that used psychedelics much. The few times I had the opportunity, I was unable to find out enough about the source and quality to put my ignorant self at ease. It seemed like I was never going to get to have a psychedelic experience.

Well, I was surfing the net one day and decided to test the reach of information contained on it. I was trying one exotic topic after another in Yahoo. I was amazed at the knowledge contained on the net. I decided to push it to the limit. I asked about psilocybin. To my amazement, a few indexes to documents came back. I quickly down loaded them and started studying them. I was astonished to find out that the spores for Psilocybe mushrooms could be mail ordered because the spores did not contain any controlled substances. And best of all, there was no overdose for psilocybin.

It doesn't take a rocket scientist to figure out what I was thinking! The net contained bits and pieces of information. I was able to learn some of the basic concepts for growing shrooms but there was a lot of uncertainty and contradictions in the information I had. I kept increasing the depths of my searches on the topics. It eventually became obvious that my best chance of success lay with Psylocybe Fanaticus' method. I promptly ordered their Tek Notes and a spore syringe.

I followed their directions and had cultures well under way soon enough. But, I was frustrated with their humidification techniques. They did not work for me even though I experimented like crazy. My job involves doing research and development at a high technology computer company. I was determined to solve the problem and make it easy for others with access to the net to succeed. I found a few people on the alt.drugs news group that had vast mushroom growing experience and they helped me with advice that got me over some of my initial problems.

I was going home in a few months on vacation to visit old buddies. I told them I thought I was going to be able to bring some shrooms so we could all trip together. They freaked with joy. I have a basic personality flaw. Anything worth doing, is worth doing to excess. I didn't know how many shrooms I would need so I figured I had better grow a couple pounds. I worked out the problems I was having and simultaneously ramped production. I had a couple pounds of dried mushrooms by the time I headed north on vacation.

We were at a friends cabin on the lake when the time was right. I broke out my stash of shrooms as we prepared to go out on the lake fishing. Of course I offered some advice about what I thought was a reasonable first dose, but then I made the mistake of trying to comfort them with the information that it was impossible to overdose on psilocybe mushrooms. My friends have my same basic personality flaw about doing things to excess as I do, except worse. The closest I can figure, I ate about an eighth of a cup of crushed, dried shrooms and they all ate about twice that. **My first dose was significantly higher than the Dosage section of this document recommends. Just because I got away with it, doesn't make it a smart thing to do!**

Being the scientific type, I grabbed my camcorder just in case we needed to document anything and we headed to the boat to go fishing. The first 25 minutes seemed pretty normal, but then I started to feel myself coming on. I had done enough research to know that the peak experience was a good hour away. I kept fishing. Soon I had to put down my fishing pole and just watch my buddies. I just had way too much stuff going on to be holding my fishing pole.

I had heard that the most basic visual experience was how colors became vibrant while tripping. I kept looking for this, but never noticed it. I was wondering if we dosed high enough or if I had gone to all the trouble to grow these damn things and eat those awful tasting shrooms for nothing. I started to feel a little down. I just stared at the seat where one of my buddies was sitting.

Suddenly the seat was alive. I became mesmerized by how the grain in the wood seats of the boat would not stay still. Every time I looked at the seat, it would ebb and flow. Too cool! The surface of the water was even more intense. The patterns formed by the little ripples and waves were unbelievable. I was frying big time. Even though my buddies dosed way higher than me, they seemed unaffected. They just kept fishing and cracking jokes. I was still 30 minutes from peak.

I was looking across the lake at the far shore. There were lots of clouds blowing across the sky. I was enjoying just watching them. Then it happened. It became obvious to me which clouds were going to break apart into little clouds and which little clouds were going to combine to make bigger clouds. I spent a lot of time trying to figure out if I was just imagining this ability or if I could really do it. I just kept watching the far shore. Eventually my buddies noticed my fascination with the far shore and I became the focus of their jokes. They still didn't seem like they were tripping. I told them about my new found ability. That only encouraged them to make more jokes. I challenged them to predict which clouds were going to break apart and which ones would combine. They admitted that would be impossible. When I told them I thought I could do it, the jokes really started.

Naturally, I had to prove I wasn't making up this ability. I started pointing and telling my buddies which clouds were going to do what. They were real skeptical at first, but finally I convinced them. One of them realized that we ought to get this on the camcorder tape or nobody would believe this had happened. It was a little work to get the camcorder setup because we were so fucked up, but I got about 5 minutes of this on tape. This was real valuable in making me a believer that psychedelics really can expand your mind and give you insight that you never had before.

Later that day, everybody commented on how they thought they were the only one affected by the shrooms until the cloud incident happened. We were all having a good time, but nobody recognized that the others were tripping hard. I was only at 1/2 the dose my buddies were at, so it's not too hard for me to believe they were really looped.

The next day, everybody wanted to trip again. I gave them some advice. I told them that a person's tolerance builds quickly to psilocybin and that they would have to dose significantly higher to get the same effect. Interestingly enough, they all thought they wanted a little less of an experience. The first trip had tired everybody emotionally and intellectually. Strangely enough, that day, straight or tripping, I was unable to repeat my cloud predictions. It seems to have been a one time experience. Yet, I know and have proof I was able to do it that one time. It turns out the real life value of being able to predict cloud behavior is pretty small, but the important point is that psychedelics can give you insight you would not have had otherwise.

When we got back to town, all my buddies wanted me to teach them how to grow shrooms. My buddies are not very scientifically minded people. I have been trying to get them to use computers and get on the net for a long time with no success. I did not think I could just explain the steps and have much probability of them succeeding. I thought about this problem for a little while. I wanted to write a comprehensive guide for the people on the net and I wanted to get my buddies on the net. I could kill two birds with one stone. I told them that if they figured out how to get on the net, I would have a simple guide there for them to follow.

Back to table of contents

Bulk Substrate Growing

This section is for the mycrophile that has some experience and desires to cultivate a large crop of mushrooms. This section is intended for someone that has already grown several crops using the PF Tek procedure detailed earlier in this document. This section assumes a certain amount of experience and expertise. Please do not attempt this technique without first gaining the experience; you will most likely fail if you do so.
The procedure detailed earlier in this document is the best one known for making it possible for a first time cultivator to succeed. But it is very inefficient and the culture jars take a significant amount of time to manufacture and colonize. If you desire to grow a large quantity of mushrooms, you will find it is not practical for your needs.

The following procedure is an adaptation of the traditional mushroom cultivation techniques. It assumes you have some experience and don't need to be warned about this and that. The following description of the bulk growing procedure should be sufficient for an educated person to follow. There are many fine books on the subject and rather than compete with them, I suggest you get one if you start having difficulties The Mushroom Cultivator However, if you are careful, these directions should get you a truck load of shrooms.
There has been such a demand for instructions to accomplish growing on a bulk substrate, the author has decided to help. But the following process has not been 'idiot proofed' yet. You will need to use common sense and adapt as issues arise. Please note that this process depends on sterile procedures being in place. If you fail, it will most likely be because you introduced contaminates.

Materials needed:

- 1 quart canning jars
- Whole Grain Rye (Organically Grown)
- Fresh Psilocybe Cubensis Mushrooom or 100% colonized culture jar
- Pressure Cooker
- Food Processor
- 1 Quart canning jars
- Coarse Ground Vermiculite
- Large Cake or Roasting Pans
- Mixing bowl

Step 1:
The first step in the process is to generate several spawn jars. Place 2/3 cup of Rye in each canning jar. Add 3/4 cup of water to each jar. Loosely screw on the caps and sterilize the jars in the pressure cooker. 45 minutes at 15 PSI is usually good. Note that a pressure cooker is necessary for several reasons. First, bulk grain is more difficult to sterilize. Secondly, in order to get the grain to absorb as much water as possible, pressure is required.
As the Rye cooks, it will expand and all of the water should soak into the rye. Let the jars cool to room temperature. The rye should be loose and break apart if you rotate the jars. That is the main reason rye is used instead of some other grain. This will be important later.

Step 2

At this point you need mycelium to inoculate the grain. You will need a clean food processor and set of blades for it. If you can sterilize it in the pressure cooker, this is best. If not, throw it in the dish washer with lots of soap. Don't open the pressure cooker or dish washer until you are ready to use it.

If you are using a mushroom, perform the following steps. Sterilize 1/4 cup of water. Let it cool. Put the water and the mushroom into the food processor and turn the mixture into a slurry. Don't mix the slurry more than you need to. You are creating small fragments of mycelium by chopping up the mushroom. The more you chop it up, the more damage you do to the small pieces of mycelium.

Open each spawn jar and place 4 or 5 cc's of the prepared slurry in the jar. Close the lid and rotate the jar so the Rye kernels tumble and mix inside the jar. The idea is to get as many kernels as possible to have mycelium fragments on them. Loosen the lid and place the jars in a warm, dark location.

There are several reasons why tissue from a mushroom is preferred to spores for the inoculation of the spawn jars.

- Mycelium does not need to germinate. It starts growing immediately.
- Normally only 1/3 of the diakratic tissue in a multi-spore inoculation is capable of fruiting. By defination, this tissue came from a fruit body and is capable of fruiting.
- Since every mushroom grown on the bulk substrate is of identical genetic origin, they will be very close in potency.

If you are using a 100% colonized culture jar, perform the following steps. First, the culture jar should have been 100% colonized for at least a week. This lets the mycelium grow into the cake and results in more of it being available for the inoculation. Birth the cake, and place it in the food processor. Turn it into little pieces smaller than a pea. Dump the sterilized rye into the food processor and turn it on just long enough to mix things up well. Place the contents of the food processor back into the jar and cover it loosely.

The cleaner your environment the more likely you will get through this stage without introducing contaminates. This is the most likely place to induce failure.

Step 3

Loosen the lid and place the jars in a warm, dark location. In 3 or 4 days you should see isolated spots with white mycelium growing. Check the spawn jars periodically. When you see large areas of aggressive growth, tumble the Rye to mix things up. Rotate the jar enough to thoroughly mix the kernels. The idea of mixing the Rye is to get kernels with mycelium growing on them scattered throughout the jar. Ideally, no kernel should be too far from a kernel with mycelium growing on it. Repeat this process every 3 or 4 days when the mycelium growth has been aggressive for a while. Once there is mycelium growing within 1/2 inch of every other location no further mixing is needed. At this point just let the mycelium expand outwards until it is every where.

Step 4

Once every kernel has mycelium growing on it, leave the jar sit undisturbed for a week. The idea is to let the mycelium grow as fast as possible.

Step 5

Sterilize more jars filled with rye and water. Let the jars cool.

Step 6

Most food processors have a plastic blade that comes with them for the purpose of mixing things instead of cutting things. Use this if possible. Make sure your food processor and blade are clean. Empty the contents of a colonized spawn jar into the food processor. Turn it on until the Rye kernels are all broken apart. Add some of the freshly cooked Rye to the food processor. Depending upon your confidence and the sterility of your environment you can add anywhere from 4 to 20 times the amount of grain in your spawn jar. The less you add, the less likely you will have problems with contamination. The more you add, the faster you can create substrate. Initially, you should stay on the low side. Turn on the food processor and mix the freshly cooked Rye with the colonized Rye from the spawn jar.

Place this material in a container that can be loosely covered. This material should be treated exactly as the earlier spawn jars were treated except you should see quicker growth of the mycelium patches. The amount of spawn you have can be compounded again and again until you have enough to inoculate massive substrates.

Step 7

Once you have sufficient spawn colonized and available for your substrate, lay it out in a deep cake pan to a depth of 1.5 inches. Attempt to keep the surface even. If you have a very clean environment, you can perform a mass expansion and lay out the uncolonized grain instead of waiting for it to colonize in the jar. This will save several days and a little effort, but in general it is not worth the risk.

Cover the pan with a sheet of plastic wrap. Do not seal it absolutely tight, but make sure that very little air is exchanged. Note that some air does need to be exchanged to keep the CO2 level from getting too high. But air exchange increases the likelihood of contamination. Keep it to a minimum.

This is one of the big benefits to bulk substrate growing. Whatever grain is not used to prepare a substrate can be used as spawn for new jars. When you get to this point in the process, you can easily be preparing a new bulk substrate every couple of days. You just make sure you never use all of the colonized grain as substrate. You hold back some to use as spawn for the next set of jars.

Step 8

Wait a few days until the freshly laid out substrate is showing aggressive growth. Laying out the grain breaks up the mycelium networks, and it takes several days for the mycelium to recover.

Step 9

Casing the substrate is the next step. Various recipes are available but the simplest one consists of course ground vermiculite and water. Course ground vermiculite is a requirement because the fine ground vermiculite packs too tightly and seals the substrate.

Soak the vermiculite in water. Wring it out, but leave it fairly damp. Later versions of this guide will have exact measurements but for the moment, you will need to adapt. If any of you think you have an optimum mixture, please post it in the alt.drugs.psychedlics and rec.drugs.psychedlic newsgroups.

Lay out the casing material to a depth of 3/4 of an inch. Try to keep it smooth because this will result in the mycelium poking through everywhere at the same time. Cover with plastic wrap and wait. Typically, it will be about a week for the mycelium to break through the surface of the casing.

Step 10

Initiate fruiting. Take the plastic off of the pan and place it in your terrarium. Make sure you have the temperature at about 75 F. Have some indirect light available. As pins start to develop, use a hand sprayer to mist the casing and keep it moist. But be careful. Do not saturate it to the point of being wet and having water drops that will not soak into the vermiculite.

Step 11

After the first flush, you can get a smaller second and third flush if you let the substrate rest for a while. There are a lot of factors affecting this. One particularly important factor is home much of the first flush's moisture came from the substrate and how much came from the casing. If you can mist your casing several times a day, that will help the longevity of your substrate.

Back to table of contents

Where to find Difficult Items

Several items used by this guide can be difficult to locate. Currently, this section will be most useful by people in the United States, but input from others in order to expand this section will be appreciated.

Brown Rice Flour

If you can't find brown rice flour at a health food store near you, you can get some help from Arrowhead Mills. Their phone number is 1-800-749-0730. They used to sell brown rice flour as a mail order item. They no longer do this, but you can ask them for the name and location of a store in your area that sells their brown rice flour.

It is one of their major products.

Ultra Sonic Humidifiers

Some ultra sonic humidifiers don't advertise the fact that they use ultra sonics in order to create humidity. For example, the 'Visible Mist' humidifier by Holmes is an ultra-sonic humidifier. If you can't find an ultra sonic humidifier at a department store or pharmacy, try calling Holmes. They make very good ultra sonic humidifiers. Ask for a distributor or retailer near you. Their phone number is 1-800-546-5637. Alternatively, you can break out your credit card and order one directly from them but the price is a little high ($69.00) that way.

If you can not find an ultra sonic humidifier, you can use other humidifiers. Don't get too hung up with this item. The big problem to watch out for is heat. If you get forced to use a humidifier that is not ultra sonic make sure it does not put out a warm mist of air. Any ultra sonic humidifier can be made to work. This statement is not true of other humidifiers.

Vermiculite

Vermiculite is cheap and readily available. Vermiculite is made from ground up mica. It is normally used as an additive to potting soil to make the soil hold moisture and allow roots to easily penetrate through the soil. The easiest place to get it is a well stocked Garden Center at a local department store. If they sell several different kinds of potting soil and fertilizer, they will probably sell vermiculite. If they don't, be a little persistent and get some one that knows what the stuff is and ask where you can get it.

Prices vary dramatically, but a big bag of it with several cubic feet of vermiculite usually runs less than $10.00. Much smaller bags are available and sell for several dollars.

If you can't find vermiculite in any of the well stocked garden centers in your area, you can call Piedmont Pacific. They are a large supplier of vermiculite. Their phone number is 1-770-725-6853. You can ask them for the name of a store in your area that sells vermiculite.

10 cc. Syringes

The most likely place to find large syringes is a feed store. Some localities have ordinances prohibiting the sale or possession of syringes without a prescription. If this is the case, your simply going to have to order a spore syringe and be careful not to damage it. Usually, a 10 or 12 cc. syringe can be purchased at a feed store for under $1.00. If you don't have any luck at the feed store, you can try a local pharmacy. They usually have syringes, its just a question of convincing them to sell you a suitable one.

Back to preparing the substrate
Back to Terrarium Construction
Back to table of contents

Providing Feed Back and Getting Questions Answered

Growing mushrooms is not trivial. The proceedure used in this document drastically simplifies the process, but even so, you may find yourself in a situation where you need help. There are a lot of people that know about growing mushrooms in the alt.drugs.psychedelics and rec.drugs.psychedelic newsgroups. If you need help, you can almost always get solid advice there.

If you have a suggestion, you can get it to the author of this document by posting it to these same newsgroups. If you have something you only want the author of this document to read, please encrypt it with PGP and post it to the above newsgroups. I will see it. My PGP key is:

```
Type Bits/KeyID    Date       User ID
pub  2047/B9182FE9 1996/08/24 MMGG Author
-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: 2.6.3i
mQENAzIfd0cAAAEH/14DazcVKv1eRlNgt48GHgDurYxoyfB/5W7eNITF/6mCxa1I
0462zDjshitLqEQDYkg0FgYEsr7rRpVJzs4JIc3swizy+e1c+dOxyB4ALswzJvMv
u5OVw+ddAT6+Qqcqo5 lbiFoGmTYWoK8BVtmc0ifzDk7GGmX3Yj4wic+/G1eslIew
dcBgcAZF9bQRtI36EgMLAktpb6gnC0tc2MyNxdY/BlRZ4bMsmqc/lgJumWZQkJyj
bamWsOnueRaFyQjOLWrN6okHP0FZaw3wUgsre/oqa2hSvKxTNjKtMocVVG7EkutO
+hAkGfPoSmwrjnHHiveXdIney1R0Vx/1prkYL+kABRG0C01NR0cgQXV0aG9yiQEV
AwUQMh93R1cf9aa5GC/pAQEH0gf+JYJ7VujOjjJZvLsL0Vn2n/Ny3ZFF4dxnKDIJ
y4+Fdnx6Q8v11Q8VNgzUN15bKKn2SfUZXc6eTJ7JS3T2HKWl6by0I5mQlJNdLBTe
DYzybI5HP+briaGJm9eyrnuhCk0V5Y91GEEUglHRqnObnK/p+cAccQoetOaZVal7
A4UgFNZqfrU3fN5I/aghcBoOgt0P3mYjzL3eNSuvUU3B5Tc/Xy7hlWGY4N6EAsI5
nwZR38zmppavbEhp1nlNZQbTrDB3zyPltSY+pa/sJ/NH4GcHcg9zi7/jhJSMNtiT
h4XnQneR6r1nf8zcsVfGpN87MYlPeWvKBo1kDgO/IZ4aLYgtpg==
=fEDH
-----END PGP PUBLIC KEY BLOCK-----
```

Back to table of contents

Index of Adaptations

Adaptation-1 Using bigger culture jars
Adaptation-2 Using a pressure cooker to sterilize the substrate
Adaptation-3 Slowing colonization by packing the substrate
Adaptation-4 Lowering contamination risk by inoculating 1 site
Adaptation-5 Speeding colonization by using more inoculant
Adaptation-6 Speeding colonization by using optimum temperature
Adaptation-7 Speeding colonization by providing more oxygen
Adaptation-8 Removing the rice cake before 100% colonization
Adaptation-9 Waiting to remove the rice cake
Adaptation-10 Checking out the terrarium before use
Adaptation-11 Use of a higher quality cooler for terrarium
Adaptation-12 Use of a humidity gauge in the terrarium
Adaptation-13 Use of a tank heater when using fish tank bubblier
Adaptation-14 Use of plastic wool to produce finer bubbles
Adaptation-15 Extra terrariums when using ultra sonic humidifiers
Adaptation-16 Use of ice-pak to help initiation of pin heads
Adaptation-17 Adding moisture to the rice cake by injection
Adaptation-18 Continued drying of shrooms while being stored
Adaptation-19 Circuit modification to ultra sonic humidifier
Adaptation-20 Adding moisture reservoir to cake during substrate preparation
Adaptation-21 Use of a timer to control water droplet Water Droplets and Stimulate Fruiting
Adaptation-22 Use of home made rice flour to speed colonization
Adaptation-23 Lowering of contamination rate by Presterilization
Adaptation-24: Using a 2 1/2 gallon water jug for filtering
Adaptation-25: Producing contaminate free mushrooms for generating spore prints
Adaptation-26: Producing a clean spore print from a questionable cap

Back to table of contents

Adaptation-1: Use of Big Substrate Jars

Normally, 1/2 pint canning jars are used to prepare the rice cake cultures. It is possible to use 1 pint canning jars instead. In fact, in some parts of the country you may have a difficult time finding the 1/2 pint size.

Advantage:

The main benefit to using the larger 1 pint size is that more substrate can be growing mushrooms in your terrarium. The terrariums described in this report typically will hold 6 or 8 cakes. If you want more substrate growing mushrooms, one way to accomplish the goal is to use bigger cakes.

Disadvantages:

There are several disadvantages to using bigger cakes. First, it takes several weeks longer for the fungus to colonize the entire cake. Another disadvantage is that if you suffer from contamination, you will be throwing out more substrate material. Lastly, you need to make sure when you construct your terrarium that you leave a few more inches of space under the drip shield for the cakes to reside. Since they are taller, they will require the drip shield to be placed higher.
You may notice mushrooms trying to grow inside the jar before the substrate is 100% colonized. This is not ideal because you are using up moisture in the cake for something that you won't consume, but it is a fact of

life using the 1 pint jars. It is normal.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-2: Use of a Pressure Cooker to Sterilize

Normally, most people will elect to use a large kitchen pot to sterilize the culture jars. A pressure cooker can be used instead. Instead of letting the substrate jars sit in boiling water for 1 hour, you can place them in a pressure cooker set to 10 or 15 P.S.I for 20 minutes.
One caution. Do not release the pressure until the unit is fully cooled. The substrate in the culture jars will be at 250 F. If pressure is released, moisture will boil out of the substrate.

Advantage:

If you use a pressure cooker, you can sterilize the jars quicker and with more certainty.

Disadvantages:

Pressure cookers cost money. If you already have one, there is no disadvantage. You may as well use it!

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-3: Tight Packing of Substrate to Slow Colonization

You can slow the colonization of a jar dramatically by simply packing the substrate material very tightly in the culture jars.

Advantage:

Normally, people want the substrate to colonize as quickly as possible. In the case where more culture jars are being prepared than can fit in the terrarium, it is good to space out the colonization of the jars so that some of the early rice cakes are consumed and spent before the last jars in the batch are ready to be placed in the terrarium. This technique allows you to space out the colonization of your jars so you can prepare more of them at one time and harvest them later than usual.
If you are doing twice as many jars as will fit in your terrarium, pack half of the jars very tightly.

Disadvantages:

The substrate material will compress a little bit when packed tighter. You may have to mix up a little extra substrate material to fill the tightly packed jars to the proper level.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-4: Injection at Only 1 Site

You can inject only one site instead of the usual four sites in the culture jar.

Advantage:

There are two advantages to doing this. First, you use significantly less inoculate. Generally it is not worth while for this reason. The inoculate is not very expensive if you purchase spore syringes. It is virtually free if you prepare your own spore syringes.

The main reason why this is sometimes worth while has to do with contamination. By far, the most likely spot for contamination to enter the culture jar is at the site of the inoculation. If you have a spore syringe that may not be entirely free of contamination, you can increase your probability of keeping the culture free of contamination by only inoculating one site. Note that commercial spore syringes are typically very sterile. If you do nothing to change this fact, it is best to inoculate at four sites in the culture jar.

In order to illustrate the point, assume that the spore syringe has slightly 'dirty' contents but is still viable. Assume any given injection site has a 50% chance of becoming contaminated. If you inject only one site, the culture has a 50% chance of becoming contaminated. If you inject four sites, the culture has a 0.5 * 0.5 * 0.5 * 0.5 = 6% of **NOT** becoming contaminated. If you do everything right, this technique to increase your probability of producing a contamination free culture should not be necessary. However, many people have problems generating sterile spore prints at the start of their cultivating experience and this will help those people continue to generate cultures until they get enough experience. The first time you use a spore syringe that you prepared yourself, you may want to inoculate half of your jars the normal way, and the other half this way. If your spore syringe is just a 'little' dirty, this will give you second chance to grow more mushrooms and prepare a cleaner spore syringe.

Disadvantages:

It will take significantly longer for the jar to become 100% colonized.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-5: Large amounts of Inoculate

You can speed up the colonization of a jar dramatically by simply injecting the substrate material with more inoculate.

If you inject 1 cc of inoculate at each site, you will get many germination's and the cake will colonize significantly faster. You should place the beveled side of the syringe needle against the glass so that the inoculate is coming out of the syringe and heading towards the glass. It should form a thin puddle of liquid between the glass and the substrate. 1 cc of inoculate should produce a puddle several inches in diameter.

Advantage:

Normally, people want the substrate to colonize as quickly as possible. This will help accomplish that goal. Also, the sooner and more fully the cake gets colonized, the less chance there is that contamination will get a foot hold and destroy the cake.

Disadvantages:

This adaptation requires extra inoculate. If you are producing your own spore syringes it is not a factor. A single spore print can produce many (close to 50) spore syringes. If you are purchasing your spore syringes, you may wish to wait the few extra days to avoid the extra cost of using more inoculate.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-6: 80 Degree Colonization Temperature

The culture jars can be colonized at a temperature higher than room temperature. 80 Degrees F. is ideal. Slightly higher is OK.

There are several easy ways to accomplish this. If you have a floor heater with a pilot light and it is summer time (so the heat is not going to come on), you might be able to put the cakes in a shoe box and set them on the unit. The top of your water heater might be a good candidate. You can fill a cake pan half way with water and put a submersible fish tank heater in the water set to 80 degrees. Then simply put the jars in the cake pan. However you choose to do this, make sure the temperature does not get above 90 degrees. Check out the heat source before you subject your cakes to it.

Advantage:

Colonizing the substrate at 80 degrees F. is the ideal temperature for several reasons. First, the mycelium will grow faster and the substrate will be colonized in the shortest amount of time. Secondly, when the cakes are removed from the jars, initiation of fruiting is enhanced by shocking the cakes with a temperature drop, lower CO2 levels, and light.

If you plan to have your terrarium at normal room temperature, then colonizing at 80 degrees will help you initiate a massive flush of mushrooms when you place your cakes in the terrarium.

Disadvantages:

None.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-7: More Oxygen for Colonization

The culture jars can be given more oxygen during colonization. This is done by inverting the jars so that the lid is down.

Advantage:

As the CO2 builds up, growth of the fungus slows down. Indeed, the mycelium benefits from increased CO2 during its vegetative growth stage, but eventually it gets too high for optimum growth. If you invert the jars, the CO2 can drain out and is replaced by fresh air. This will speed the colonization of the substrate.

Disadvantages:

There are several disadvantages to this. First, the rice cakes normally shrink a little bit while in the jars and when you invert the jars they will slide down a little bit. This will create a vacuum and pull some air into the jar. This air could have contaminates that get a foot hold in the uncolonized portions of the cake.

The second reason you will want to avoid doing this is the initiating of the fruiting process is triggered by three things. A drop in temperature, a drop in the CO2 level and light. You may confuse the fungus and inhibit a massive flush when you take the cake out of the jar. You will still get a crop, but it may take longer to consume the cake.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-8: Taking the Rice Cake Out of the Jar Before it is 100% Colonized

The partially colonized substrate can be removed from the jar if the uncolonized portions of it are cauterized. Remove the cake from the jar and heat a nail head red hot using a propane torch or burner on a gas stove. Brand the entire uncolonized area.

Advantage:

Nothing will grow on the uncolonized, cauterized portions of the rice cakes. If you need to remove a cake early from the jar this will keep contamination from having a place to get a foot hold. There are very few good reasons to exercise this adaptation. The reason the authors have included it is sometimes growing cycles overlap and you want to start a new culture in every jar you have. If you birth the rice cake early, you have an extra jar to prepare cultures in. One other reason for doing this is travel. If your leaving on a trip (one where you will be out of town) and your cake will be overly colonized by the time you get back, you can use this adaptation to birth the cake early and move it to the terrarium.

Disadvantages:

This is dangerous. It is asking for trouble. First, you are assuming that you can inhibit growth of contaminates on the uncolonized portion of the cake. The bigger the area that is uncolonized, the more risky this assumption is.
Secondly, the process assumes that when the cake is removed from the jar it has sufficient networks in place to provide the nutrition needed for the fruiting process. If you take the cake out too early, this may not be the case.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-9: Waiting to Remove Rice Cake From the Jar

The colonized substrate does not need to be removed from the culture jar immediately after it is 100% colonized. You can wait until primordia form on the substrate.

Advantage:

There are a number of reasons why you might want to delay the 'birthday' of the rice cake. You may not have room in the terrarium or be planning a trip where you won't be around to maintain the terrarium. Also, waiting gives the mycelium more time to fully develop its network throughout the substrate and can result in larger flushes.

Disadvantages:

The continued development of the mycelium network will take place at a slower rate in the jar than it would with lots of oxygen available.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-10: Checking Out Terrarium Prior to Removing Rice Cake

The colonized substrate does not need to be removed from the culture jar immediately after it is 100% colonized. You can wait until primordia form on the substrate.

Advantage:

There are a number of reasons why you might want to delay the 'birthday' of the rice cake. You may not have room in the terrarium or be planning a trip where you won't be around to maintain the terrarium. Also, waiting gives the mycelium more time to fully develop its network throughout the substrate and can result in larger flushes.

Disadvantages:

The continued development of the mycelium network will take place at a slower rate in the jar than it would with lots of oxygen available.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-11: Use of a Coleman Cooler instead of a Styrofoam Cooler

A fancy, nicer, plastic cooler can be used instead of a Styrofoam cooler.

Advantage:

The nicer, plastic coolers typically have more space in them so they can hold more rice cakes. Also, it is nice to have a cooler with a hinged top that simply flips up and allows access easily. Lastly, the plastic coolers are more durable than Styrofoam coolers. If you plan to use the terrarium a lot, go ahead and use a plastic cooler from the start.

Disadvantages:

Cost is one disadvantage. Another disadvantage is the plastic coolers are more difficult to modify for use as a growing chamber than the Styrofoam coolers.

Back to construction of basic growing chamber
Back to table of contents

Adaptation-12: Adding a Humidity Gauge to the Terrarium

A humidity gauge can be added to the terrarium. Especially for Styrofoam coolers, it is easy to cut out a window in the side of the cooler and insert a combination humidity/temperature gauge. The gauge should be put below the drip shield so that it is showing the actual conditions where the mushrooms are growing. In reality, the conditions will not vary much inside the terrarium, but there is no reason to add inaccuracy. The gauge can be glued in place with silicon glue. Make sure the vents in the gauge are only open to the inside of the terrarium and not the outside world. The combination gauge can be got very inexpensively at any department store.

Check all the gauges on the shelf. Most likely, some will deviate greatly from the rest. You want to pick one that seems to be accurate! Bare in mind that usually there are several different brands of gauges available. Check and see what various gauges from different brands are reading. Use some common sense to eliminate the obviously inaccurate gauges. Even so, you are making the assumption that at the high end of the humidity spectrum the chosen gauge will be accurate. Remember that absolute accuracy is not so important as knowing the relative conditions inside you terrarium over time. Even if you gauge is off a little bit, it will tend to be off in the same direction all the time. The easiest way to use a gauge during the growing process is to know what it used to read during previous growing cycles and keeping close to that reading. If a problem does develop, it will provide a clue which direction you need to move.

Advantage:

A humidity gauge is very helpful during the growing cycle, but it takes up valuable real-estate inside the terrarium. This gets it out of the way inside the terrarium and makes it easy to see the state of the terrarium with out messing around inside the terrarium.

Disadvantages:

None.

Back to construction of basic growing
Back to table of contents

Adaptation-13: Use of Fish Tank Heater to Raise Humidity

If you are using the fish tank bubblier system to create humidity in your terrarium, you can use a submersible fish tank heater to help raise the humidity. You can place the fish tank heater in the water and use it to raise the water's temperature 10 or 15 degrees F. over ambient. This will make it easier for the air bubbling through the water to absorb moisture, thus raising the humidity. The higher you set the temperature of the heater, the more humidity you can get. You should be careful not to allow the inside temperature of the terrarium to get above 80 degrees F. In order to effectively use this adaptation, your terrarium will need to be in a cool location.

Advantage:

You will be able to generate an extra 5% of humidity over ambient by using this adaptation.

Disadvantages:

You will increase the temperature inside your terrarium some by doing this. You can minimize the temperature increase by using a container to hold the water that is well insulated. You want the water warm, but you don't want heat leaking any more than necessary into the terrarium.

Back to Method 2, Using a Fish Tank Bubblier
Back to table of contents

Adaptation-14: Use of Angel Hair to Raise Humidity

If you are using the fish tank bubblier system to create humidity in your terrarium, you can place angel hair or anything else that will slow the bubbles rise in the water container. Simply pack it into the container. This will increase humidity by several percent. Ideally, you want to slow the bubbles but also split them into smaller bubbles. Some plastic versions of steel wool for use washing dishes work well. Steel wool would work well except that it will rust and get nasty.

Advantage:

You will be able to generate an extra 1% or 2% of humidity over ambient by using this adaptation. The smaller the bubbles are and the more time they spend in the water, the greater the benefit.

Disadvantages:

None.

Back to Method 2, Using a Fish Tank Bubblier
Back to table of contents

Adaptation-15: Supporting Extra Terrariums with the Ultra Sonic Humidifier

First, build an extra Growing Chamber. Then on one of the 2 liter coke bottles, poke an extra hole. Insert a grommet and make this bottle the last stage for drying the air. Even the most basic ultra sonic humidifier can feed more than one terrarium with sufficient quantities of humid air to keep everything in the ideal range for the fungus.

Advantage:

You get twice the growing area for your mushrooms. Your crops can be twice as big. Alternatively, you can use one terrarium for older cakes. Older cakes are significantly more likely to become contaminated and pose a threat to the other cakes in the terrarium. Moving older cakes to the second terrarium drastically reduces your chances of a crop failure.

Disadvantages:

You need to build an extra Growing Chamber, and it takes up a little space.

Back to construction of Ultra Sonic support system
Back to table of contents

Adaptation-16: Use of an Ice-Pak to Initiate Fruiting

You can keep the terrarium's temperature between 80 and 95 degrees F. If you have a terrarium setup that uses an ultra sonic humidifier, you can place a reusable, frozen Ice-Pak in the Terrarium. This will cool everything down and let the rice cakes slowly shift through the fruiting temperature range. Note that everything else must be right. The rice cake must have a fully developed mycelium network and there must be light. The Ice-Pak should be placed between 1/4 and 1/2 inch from the rice cakes. A flat Ice-Pak will work, but if you have the option, get one that is designed to slip into the center of a six-pak. It will have circular indents molded into each side and it will conform to the shape of the rice cakes better. If everything was ready, you should see pin heads develop 3 or 4 days after you perform this adaptation. If you don't see any develop after 3 or 4 days, you can repeat this operation again. The networks may not have been developed full enough and the few days since the last attempt may have been enough time to change this fact.

Advantage:

You can still initiate prolific flushes with the terrarium above the normal temperature range. The optimum temperature for growing mushrooms is higher than what is necessary to initiate new mushrooms and is between 80 and 90 degrees F. This adaptation can let the cultivator grow at the maximum rate, and still produce new mushrooms on the cakes.

Disadvantages:

The Ice-Pak will lower the humidity in the terrarium. Mostly, this is an issue when you have mushrooms on cakes that are part way through the growing cycle and not ready to harvest. They will usually survive the bad growing conditions for the six hours it takes the Ice-Pak to initiate fruiting, but they will suffer for it. You need to have an ultra sonic humidifier setup on your terrarium. Nothing else will be able to keep the humidity high enough. You can turn the humidity control up a little, but you will have to continue to adjust it down as the Ice-Pak loses its cool. If too much moisture forms on the cakes, it will prevent the initiation of pin heads and that was the whole purpose of this operation.

Back to the Growing Cycle
Back to table of contents

Adaptation-17: Adding Moisture to the Rice Cake

After a cake has produced several mushrooms you can add moisture to it. Flame sterilize a 3/16 inch drill bit. Let it cool. Use it to drill a hole at the center of the cake. You can do this by hand. You do not need a drill. Do not go all the way through the cake, but drill a deep reservoir into the cake. Cut a plastic straw to 4 inches in length. Insert the straw 1/2 inch into the hole. The straw should fit tightly in the cake. Straws from McDonalds are larger than most and work well. They seal well and hold more water. Fill the straw with water daily. A 10 cc. syringe works well to fill the straws with water. You should wait to drill the hole until the cake has produced some mushrooms because the inside of the rice cake is not colonized as quickly as the outside. Also, there is sufficient moisture in the cake at the start so there is no need to add water immediately.

Advantage:

The rice cake will produce many more mushrooms than it would have without adding moisture. Using this adaptation allows the nutrients in the rice cake to be almost totally consumed before the cake is exhausted.

Disadvantages:

Care should be taken when drilling the hole because there is no way to monitor for contamination inside the hole. Also, you will need to add water on a daily basis.

Back to the Growing Cycle
Back to table of contents

Adaptation-18: Continued Drying of Mushrooms During Storage

You can place a small glass with a small amount of desiccant in the long term storage bag to continue to extract moisture from the mushrooms. A shot glass with 3/4 of an ounce of desiccant is sufficient to keep the humidity very low in the long term storage bag. A larger glass that is more stable might be a better choice in order to avoid an accident of spilling the desiccant inside the bag.

Advantage:

The mushrooms will continue to dry and their preservation is enhanced.

Disadvantages:

You will need to be careful not to knock the glass over and spill desiccant in the storage bag. This is only suitable if you can leave the bag in a stationary location.

Back to Drying and Preservation of Mushrooms
Back to table of contents

Adaptation-19: Reducing Output Of Ultra Sonic Humidifier

The output of the ultra sonic humidifier can be reduced by changing the circuitry. Almost all ultra sonic humidifiers use a 5 K-ohm or 10 K-ohm potentiometer to control the output. By adding a 5 K-ohm or 10 K-ohm resister in series with the potentiometer, the original 'low' setting becomes the new 'high' setting. The humidity output can be turned down even lower than originally possible. Simply cut the wire going to the potentiometer and solder a similar sized resister (available at Radio Shack) in series. You may need to set the humidity control above the minimum setting once you make this modification.
Note that this adaptation is mutually exclusive with Adaptation-21. If you try to combine them, it won't work.

Advantage:

This drastically reduces the suspended water particles emitted by the humidifier. However, the big advantage is that the humidifier uses significantly less water. It is possible to fill up the humidifier and leave on a trip for 10 days without having to add water.

Disadvantages:

Complexity is the major disadvantage. The above instructions are deliberately technical. If reading them doesn't give you enough information, don't attempt to do this. Find someone to help you. It is very easy and straight forward for someone that is handy with a soldering iron to accomplish.

Back to Method 3 of Terrarium Construction
Back to table of contents

Adaptation-20: Providing a Moisture Reservoir in the Substrate

A reservoir for moisture can be built into the cake while packing the jars with substrate material. Start with an empty jar and tamp 1/4 inch of substrate material in the bottom. Next, position a magic marker or some other object with a cylindrical shape and a diameter of about 3/4 inch in the center of the jar. Fill the jar as normal. Next, remove the object and fill the bore with damp vermiculite. Lastly, pack 1/4 inch of substrate material over the entire jar, sealing the damp vermiculite inside the cake.

The damp vermiculite can be mixed separately from the substrate material. Use about 1 cup of vermiculite and 1/3 cup of water. This should produce enough damp vermiculite for a dozen 1/2 pint culture jars.

After the cake has fruited, occasionally inject water into this reservoir. The easiest place to inject is the position of the cake that used to be at the center of the bottom of the jar. Just insert a syringe filled with sterile water and inject water until it is full.

In case you are wondering, the substrate material can't be injected with water directly. The rice flour and vermiculite form a very tight seal and it is next to impossible to inject water. Even if you do manage to inject water, it doesn't spread through the cake. Having this reservoir filled with damp vermiculite gives the mycelium network access to a lot of moisture.

The easiest way we have found to implement this adaptation is to cut the bottom off of a 10 cc syringe and press the bottom of the syringe into the wet vermiculite several times. This will load the syringe with wet vermiculite. Then place the syringe in the culture jar and pack the substrate around it. Use the syringe's plunger to hold the wet vermiculite stationary while you remove the syringe. Tamp an additional 1/4 inch of substrate material over the entire surface of the jar.

Advantage:

This adaptation will dramatically extend the longevity of the cake. The cake's yield are normally limited by the amount of moisture in the cake. This procedure allows you to replace moisture as it is consumed by mushroom growth. In general, you will double the total output of the cake compared to not implementing this adaptation.

Disadvantages:

It is a little bit of extra work to prepare the jars this way. Also, there is a need to be careful to use sterile water when injecting moisture during the growing phase. There is no way to check for contamination introduced inside the cake by injecting water.

Back to preparation and colonization
Back to table of contents

Adaptation-21: Use of a Timer to Control Suspended Water Droplets and Stimulate Fruiting

The ultra sonic humidifier can be placed on a timer to control the amount of suspended water droplets that are released into the terrarium. Because the humidifier is turned on and off the humidity in the growing chamber will rise and fall. There is starting to be some evidence that this helps stimulate fruiting.

This document used to recommend using a timer that gives control on a minute by minute basis. These timers are becoming increasingly difficult to locate and more expensive. To accomodate this, there has been a strategy shift on this adaptation. Find a timer that lets you limit the 'On' cycle to 15 minutes. Intermatic makes two version that sell for under $15. They are model numbers SB811C and TB811C. They are available in the electrical section of Home Building Centers. You may also find them in the hardware section of a department store.

Since the shortest amount of time the timer can switch on is 15 minutes, it is important to make sure the cakes do not get water droplets forming on them in this much time. In general, the condensation filter chambers should be set up identically to the normal humidified chamber setup. You just may not need as many filter stages since the humidifier will not be running steady.

The other parameter you need to set is how tight to seal the chamber. You need to make sure the chamber's humidity does not drop too far during the 'Off' cycle of the timer. Typically, the 'Off' cycle is at least an 1.25 hours. (On the Intermatic timers, this coresponds to every third switch being up.) Ideally, you want the humidity to fall to 85% by the end of the cycle. (If your chamber seals tightly, you may be able to go every fourth or fifth switch).

Advantage:

There are several advantages to using a timer.

- Less drying stages are needed for the humidifier. The output can be piped more directly into the terrarium.
- The humidity in the chamber will be moving up and down which seems to stimulate fruiting.
- Water consumption by the humidifier is automatically reduced making unattended operation more possible.

Disadvantages:

Cost and availability are the major disadvantages.

Back to Building Terrarium with ultra-sonic humidifier
Back to table of contents

Adaptation-22: Use of a Home Made Brown Rice Flour

This idea is from: **AN165023@anon.penet.fi**
Rather than use brown rice flour available at a health food store, you can grind your own from long grain brown rice. Simply put the dried rice into a coffee grinder or a blender and let it chew the rice into a chunky flour. You will need to increase the water from 1/4 cup per 1/2 pint jar by 1 and 1/2 tablespoons. The chunky home ground flour absorbs a little more water than the normal flour.

Advantage:

Cost is one benefit, but that is not the reason this adaptation is useful. Using home ground flour will speed the colonization of the substrate. It has been reported that a 1/2 pint jar can be 100% colonized in 11 days if fresh spores are used and the jar is kept at 85 degrees F. during colonization. Note that this is the current record, and most jars will take a bit longer, but overall, the colonization time period is reduced.
Also, the home made brown rice flour seems to yield much more consistently and produce slightly more mushrooms per cake than store bought flour.

Disadvantages:

Extra effort.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-23: Lowering the Contamination Rate by Presterilization

The raw ingredients of the substrate can be sterilized separately to eliminate nearly all of the contaminates. Spread the vermiculite and rice flour evenly into separate cake pans and bake in a preheated oven at 300 degrees F. for 20 minutes. While these are baking, boil a large bowl of water in for 10 or 15 minutes. Use these materials to mix the substrate. It is still necessary to sterilize the jars filled with substrate.

Advantage:

Nearly all of the possible contaminates in the raw materials will be eliminated. The sterilization of the substrate after you mix and prepare the substrate will only need to address any new contamination that you added during that process. The sterilization of the mixed substrate will be much more guaranteed. You should experience a lower contamination rate. This adaptation is particularly useful if you are not using a pressure cooker to sterilize the culture jars. Boiling the culture jars only gets them up to a temperature of 212 degrees F. This adaptation provides an opportunity to eliminate contaminates that require a higher temperature to kill them.

Disadvantages:

Extra time and effort.

Back to preparation and colonization of substrate
Back to table of contents

Adaptation-24: Using a 2 1/2 gallon water jug for filtering

This idea is from 'Dangerous Dan'. A large, 2 1/2 gallon water jug from store bought water can be used instead of 2 liter coke bottles. These large jugs can be used for all stages of the filter, but if only using one, it should be the first one after the humidifier.

Advantage:

Using these water jugs provide a few advantages.

- Because of their size, they don't need to be emptied as often.
- They have a simple to operate valve that can be used to ease draining.
- Their shape makes it easier to stack neatly along a shelf.
- Because of their large volume, less filtering stages are needed.

Disadvantages:

The worst disadvantage is the fact that these containers are typically not transparent and if used for all the stages it is difficult to see how much fog is in the system.

Back to construction of Ultra Sonic support system
Back to table of contents

Adaptation-25: Insuring the Sterility of Caps Used for Spores

If you are going to use a cake to generate spores, you can insure that the caps stay free of contaminates. When you birth the cake from the culture jar, set it on a clean wash cloth in the terrarium. Place a large glass jar over it and seal it to the wash cloth. A large peanut butter jar is usually perfect. You need to have enough room inside the jar for the mushroom to grow to maturity. Humidity will be able to leach through the wash cloth and surround the cake, but air currents will not be present and the cap should be relatively free of contaminates. This setup assumes the floor of the terrarium has a wire mesh to support the cakes.

Advantage:

A much cleaner cap will be available for making prints. This will lower the chances that contamination is introduced into the process.

Disadvantages:

Extra effort. Extra space in the terrarium.

Back to Making a Spore Print
Back to table of contents

Adaptation-26: Producing a clean spore print from a questionable cap

Setup everything the way you would normally to generate a spore print. Keep an eye on where in the process the cap is. After a cap has been dropping its spores for three or four hours, you can change the plate on which the spores are being deposited. Simply discard the initial plate. The new plate will be contain a much cleaner spore print than would have been possible with only one plate.

Advantage:

A much cleaner print will be generated. If contaminates get on the gills of the mushrooms, as the cap starts to drop spores, the first spores contain most of the contaminates. By discarding the initial spores, you will end up with a cleaner spore print.

Disadvantages:

You need to catch it at the right time.

Back to Making a Spore Print
Back to table of contents

Revision History

- **05-20-05 - Minor Update by Erowid**
  Minor wording change in first paragraph of "The Author's First Trip" section to make it clear that the negative effects of LSD were just things they'd been told, not actual effects.
- **10-02-96 - Last Major Revision by Author**

Psilocybe Fanaticus TEK

by

Robert McPherson aka Psylocybe Fanaticus

and others

QAL in one

original source: http://www.fanaticus.com/

Table of Contents:

- **About**
- **ESSENTIAL PF TEK DOCUMENT**
  - **INTRODUCTION**
    - Overview of PF Techniques
    - Basic materials list for cultivation
      - *PF jar preparation and culturing (Stage one)*
      - *Mushroom growing (Stage two) Pet shop - Hardware store*
      - *Spore printing and spore syringe making (Stage three)*
  - **CHAPTER 1 - PF SUBSTRATE FORMULATION AND JAR PREPARATION**
    - PF Substrate Formulation
    - PF Substrate Jar Preparation
      - *Tamping down tek*
    - Pressure Canner Use
      - *Sterilization times*
      - *Control jar technique*
  - **CHAPTER 2 - INOCULATION OF THE PF SUBSTRATE JARS**
    - Alcohol Flaming Technique
    - Inoculation of PF Jars Without the Lids
    - Incubation of Inoculated Jars
    - The Canning Jar Lid (loose or tight)
  - **CHAPTER 3 - THE BIRTHDAY CAKE**
    - Time Scale of the Mushrooms
    - Contaminant Source Identification
    - Non-Germination of Spores
  - **CHAPTER 4 - THE DUAL CHAMBERED TERRARIUM**
    - The Spray Shield/Chamber Partition
    - Dual Chambered Terrarium Techniques
    - Spraying Procedure
    - Heating
    - Symptoms of Low Humidity
  - **CHAPTER 5 - THE RICH MANS' TERRARIUM**
    - The Ultra Richmans' Terrarium
  - **CHAPTER 6 - COOL DESICCATION (drying) OF MUSHROOMS**
  - **CHAPTER 7 - SPORE PRINTING AND SPORE SYRINGE PREPARATION**
    - Spore Printing Equipment
    - Making a Spore Syringe
      - *Syringe Preparation*
  - **CHAPTER 8 - CAKE CASING TEK**
    - The Double Ended Cake Casing Tek
    - Casing and Recasing

PF TEK add on techniques

- **CHAPTER 9 - THE INNER RESERVOIR TEK**
- **CHAPTER 10 - CRYSTALS OF THE GODS**
  - Excerpts from forums
    - *Searcher*
    - *Warning on Alcohol Shroom Extraction*
    - *The Crystals of the Gods*
    - *Gottlieb*
    - *Stamets*
    - *Mediocre Rating for Cubensis*
  - Alcohol Extraction of the Magic Crystals
    - *Evaporation and Concentration*
    - *Important Guidelines*
    - *Dosage and Storage*
    - *Procuring 190 Proof Ethyl Alcohol (Everclear - Golden Grain et) From a Liquor Store*
- **CHAPTER 11 - PF INVITRO TEK**
  - The Heartbreak of mega cultivation
  - Dunking the Cake
- **CHAPTER 12 - THE DRINKING STRAW TEK**
- **CHAPTER 13 - DECONTAMINATION OF SPORE SOLUTIONS**
  - The Tek
  - PF Peroxide and Brown Rice Cloning TEK
  - TEK Problems
  - Principles of the Peroxide TEKS
- **CHAPTER 14 - ISOLATION HAND BOX**
  - How to Use the Isolation Box
- **CHAPTER 15 - PF SUBSTRATE FORMULA'S BIOLOGICAL EFFICIENCY**
  - Biological Efficiency (from Fungi Perfecti Catalog)
  - PF's comments
  - The Discovery of the PF magic formula
- **CHAPTER 16 - SPORE PRINTING IDEAS**

VARIOUS ARTICLES BY PROFFESOR FANATICUS

- **CHAPTER 17 - MAJOR PF TEK SNAFUS FOR THE NEWBIE**
  - Water inflitration of the jars during sterilzation
  - Premature cake birth
  - Newbie humidifier uncertainty
  - Improper water content in the jars
  - Pint jars verses 1/2 pint jars
- **CHAPTER 18 - PF ALBINO MUTANT**
  - Albino Shroom Cloning Technique
  - PF Albino Mutant Strain
  - Disaster in San Diego Harbor Lagoons
  - The Black Light Experiment
  - The Albino Mutant Appearance
  - Genetics and Breeding of Spore-Deficent Strains in Agrocybe Cylindracea and Lentinus Edodes
  - Cloned PF Albino Mutants
- **CHAPTER 19 - PF RED SPORED MUTANT**
- **CHAPTER 20 - DETECTING PSYCHOACTIVE DRUGS IN THE DEVELOPMENTAL STAGES OF MUSHROOMS**
  - Chapter one
    - *Methods*
    - *Sample Preparation*
    - *Thin-layer Chromatography*
    - *Gas Chromatograph/Mass Spectrometer*
    - *Lower Limit of Detection*

Results and Discussion
Conclusion
Acknowledgments
References
Photo and Chart Descriptions (figures and table-charts)
PF comments
Chapter two
Potency comparisons of 4 species of Dutch over the counter Magic Mushrooms
PF comments chapter two

PSYLOCYBE FANATICUS MUSHROOM MUSEUM
CHAPTER 21 - PSYLOCYBE FANATICUS RACE PHOTOS AND DESCRIPTIONS
Psilocybe cubensis - Matias Romero
Psilocybe cubensis - Hawaiian
Psilocybe cubensis - JLF Amazon
Psilocybe cubensis - Equador
False Mexicana
Psilocybe cubensis - B+
Psilocybe cubensis - Treasure Coast
Psilocybe cubensis - Cambodian
Psilocybe cubensis - Thailand
Psilocybe cubensis - Malaysian
Psilocybe cubensis - Australian
Psilocybe cubensis - India
Psilocybe cubensis - Mazatec
Psilocybe cubensis - PF Stropharia
PF Style Shitake
Stropharia Melanosperma

EXTERNAL UPDATES
PF-Tek for Simple Minds
Introduction
Materials
Vermiculite
Brown rice flour (BRF)
Water
Spore syringe
Jars
Substrate preparation
Sterilization
Inoculation
Incubation
Incubator
Fruiting
Casing PF-Cakes
PF Block Tek
Scotsman's Beginner's Cake Tips
PF-Tek - Dunk and Roll
Why Dunk and Roll?
When Should I Dunk and Roll?
The Dunk
The Roll
Extra Tips
Hippie3's Dunk Tek
Shotgun Terrarium
How does it work?

- Building a Shotgun Terrarium
- Extra Tips & Tricks
- Constructing Your Terrarium/Fruiting Chamber
- Shotgun Terrarium Theory of Operation
- Lighting Requirements of Mushrooms

Pf tek done right TEK

- Preparing the jar
- Sterilizing
- Inoculation done right
- Incubation done right
- Birthing and dunk
- Fruiting done right
- Sterilizing a syringe

PF-Tek F.A.Q (Shroomery)

- Recipes through Inoculation
  - *What is a PF cake?*
  - *What is the point of each step in the recipe?*
  - *What is the difference between brown and white rice?*
  - *Why do we boil the jars of substrate?*
  - *Can I substitute any ingredients in the PF recipe?*
  - *What are the different ways to sterilize a PF jar?*
  - *What precautions should I be aware of when inoculating?*
  - *Is is it ok to use the syringe right out of the fridge or should it warm up some?*
  - *How much spore suspension from my spore syringe should I use?*
  - *How long should the jars cool before inoculating?*
  - *What methods are there to inoculate PF jars?*
  - *Can I use coarse grade vermiculite for substrate?*
  - *Does fine vermiculite hold more water than coarse?*
  - *Should I sterilize the needle, and how?*
  - *What recipe should/can I use for PF cakes?*
  - *Can I mix different cubensis strains in a PF cake?*
  - *Can I use a non-organic brown rice flour or white rice flour for the substrate?*
  - *How many jars will a spore syringe inoculate?*
  - *Common mistakes*
  - *How long will my colonized jars live?*
- Incubation through Birthing
  - *How long does it take to see signs of mycelium growth?*
  - *How important is gas exchange during the colonization?*
  - *There's rust on the lids of my PF jars, is that okay?*
  - *How come my jars started growing mycelia, but for some reason have stopped?*
  - *How long does full colonization take?*
  - *What if I need to birth before the jar is fully colonized?*
  - *Is condensation inside the incubating jars harmful?*
  - *What are those little brown/red dots pushing into the glass of the jar from the cake?*
  - *What if I can't get the cake out of the jar in one piece?*
  - *What if I can't get all the vermiculite seal off of the cake?*
  - *What is birthing, and how do I do it?*
  - *Which way should cakes be birthed, vermiculite side up or down?*
- Birthing through Harvest
  - *What is an easy way of humidifying my fruiting chamber?*
  - *What conditions are optimal for pin formation?*
  - *What are the optimum conditions for a cake to fruit in?*
  - *Can a PF cake become contaminated after birthing?*
  - *Why do my cakes get fluffy mycelium growth and delayed pinning after birthing?*
  - *What do primordia/pins look like? I don't know...*
  - *How long does it take for a pin to grow into a fully grown fruitbody?*

Why is there mycelium growing on the stems?
When should I harvest?
How do I recognize an abort?
What is the dunk tek?
How much does 1 PF cake yield?
Why do cakes and bulk substrates require different humidities?
What is Dunk and Roll?

About

Latest news: Robert ' Billy' McPherson, creator of the PF TEK, has passed away. Here is a recreation of his fanaticus website about mushroom cultivation, which existed from 1995 to 2003.

The mind of Robert 'Billy' Mcpherson, once better known as Psylocybe Fanaticus, has succumbed to hepatitus C. He will not be with us in 2012. He is in coma since 11-11-11 and in his final hours before leaving his body. His techniques will survive forever.

I guess that still most psychonauts who cultivate Psilocybe cubensis for entheogenic and other purposes use his creation, the PF TEK, to do so

remember...

Over half a century has passed since Albert Hofmann identified psilocybin as the psychedelic (="mind manifesting") material in several species of Mexican mushrooms. One of those is Psilocybe cubensis.
Since then many hundreds similar psychedelics have been made. But psilocybine still stands out as nature's friendliest and best liked psychedelic. Today, over one hundred psilocybine producing mushrooms are known. From all of those, Psilocybe cubensis still is the largest, fastest, easiest cultivatable and third most potent one. Especially the PF Classic cubensis, known by some as penis mushroom.

Beginning in the nineteen sixties, myriad of methods have been published to grow Psilocybe cubensis. But only one technique can do without petri dishes, -pressure canner or other laboratory equipment. That is the Psylocybe Fanaticus Technique or PF TEK, created by Robert McPherson in 1991, which currently is the worlds most popular method to grow 'magic' mushrooms (downloaded, printed, distributed and practiced many millions of times).

The PF TEK is to the entheogenic experience what the hot water extraction is to the caffeine experience. People will be using it many centuries from now.

Levitate well Billy... you are now known by a small circle of friends but your practices are and will be followed by many for as long as mushrooms and mankind will coexist. The spores of your knowledge will be spread to the stars and beyond.

It was and is a pleasure to have grown with you!

Yachaj

The PF TEK magic mushroom revolution began in September 1991, with its introduction in High Times magazine. It is now the most popular magic mushroom growing technique of the world, and this is the undiluted original.

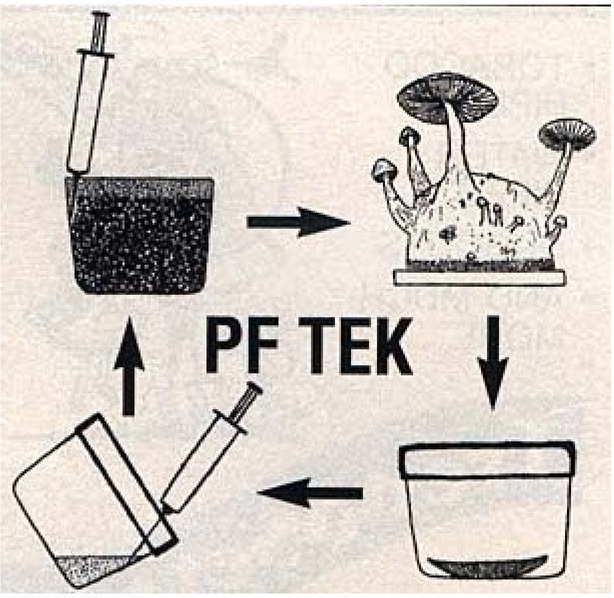
ESSENTIAL PF TEK DOCUMENT

INTRODUCTION

magic mushrooms, ala PF TEK

The PF TEK is basically a brown rice method with an improved formula by using vermiculite as a base and adding pulverized brown rice. The secret is in the vermiculite. When mycelium is cultured in just grain, the mycelium turns into a mass with little air space. But when grown with vermiculite, the mycelial threads stretch across space. The important thing about the PF TEK, is that it copies nature. Instead of the usual cloning of mushroom tissue and growing mushrooms from that, a mass spore inoculation is employed directly to the fruiting substrate. That way, the genotype remains complete. Senescence (mutating and ceased fruiting) is no longer a problem. The spores insure a never ending succession of fungus, with all the power of the spores reproductive ability intact.

Overview of PF Techniques



1. Brown rice powder, vermiculite and distilled water are mixed and loaded into a 1/2 pint jar, which is steam sterilized. The jar is then inoculated by the spore syringe.
2. After the substrate cake in the jar colonizes and begins to show signs of fruiting, the cake is released from the jar and placed into the dual chambered terrarium to fruit.
3. A mature mushroom is decapitated and spore printed in a jar.
4. Spore syringes are prepared with the spore print jar to begin another life cycle.

Basic materials list for cultivation

PF jar preparation and culturing (Stage one) (Domestic products - supermarket - department - drugstore - hardware store)

1. Measuring cups and spoons
2. Large pot for steaming
3. Shoulder less half-pint jars with lids (Kerr or Ball)
4. Organic brown rice flour (organic food stores)
5. Horticultural vermiculite (medium or fine grade - not powdery)
6. Distilled or filtered drinking water
7. Heavy duty tin foil
8. Heavy duty (professional grade) masking tape
9. Ice pick (for punching needle holes in the culture jar lid)

Mushroom growing (Stage two) Pet shop - Hardware store

1. 10 gallon aquarium
2. Cut piece of transparent plastic (Plexiglas) - (terrarium chamber partition)
3. Strips of wood with connectors and screws (terrarium lid)
4. Plastic film and thumb tacks (terrarium lid)
5. Small wall type thermometer
6. "All purpose" water spray bottle with an adjustable nozzle (hardware and grocery stores). Procure one that gives a good strong spray for instant humidification. Avoid recycled kitchen product sprayers. This is a critical piece of equipment. Only a good quality sprayer (a couple of dollars at a hardware store) can immediately supercharge the dual chambered terrarium with high humidity.
7. Wire screen - plastic containers - plastic bags - (drying mushrooms)

8. DESICCANT (drying mushrooms) (scientific - chemical - lab supply)

Spore printing and spore syringe making (Stage three)

1. Micro curved cuticle (finger nail) scissors (cosmetics - drug store)
2. Denatured alcohol (fuel - hardware stores)
3. Tequila shot glass and eye dropper (sterilizing and flaming)
4. Glass stirring rod (Scientific supply)
5. Plastic syringes (10cc or bigger) and 18 gauge 1 1/2 inch needles. Large sized syringes are good (20cc - 65cc) as well as extra long needles if available. (Retail medical - health supply - pharmacies - drug stores - scientific and lab

Table of Contents

CHAPTER 1 - PF SUBSTRATE FORMULATION AND JAR PREPARATION

PF Substrate Formulation

Jars and glasses to be used with this technique are 1/2 pint capacity (8 ounces) - (250 milliliters). They must have tapered sides and no shoulders, otherwise the fungus cakes won't easily come out of the jars.

Appropriate jars; (source - super markets and hardware stores)

1. KERR wide mouth half pint canning jar - preferable
2. BALL wide mouth half pint (similar to the KERR wide mouth half pint) - preferable
3. BALL regular mouth half pint canning jar
4. BALL half pint jelly jar
5. 1/2 pint (250 ml) capacity drinking glasses (tapered sides)

NOTE: Even though the regular mouth BALL half pint and the regular mouth KERR half pint look similar, the KERR is not tapered.

1/4 cup of brown rice powder (Health food stores and co-ops)
1/2 cup of horticultural vermiculite (medium grade) (garden centers and hardware)
1/4 cup of water

or - by volume - one part brown rice, one part water, two parts vermiculite.

The water amount is the crucial element that variates the results. The different brands of vermiculite varies in water holding capacity, creating differing moisture levels. So one can always vary the water amount (less or more than 1/4 cup), take notes and compare results. The highest water content can really make a great fruiting and give several flushes when the balance between the substrate elements is good.

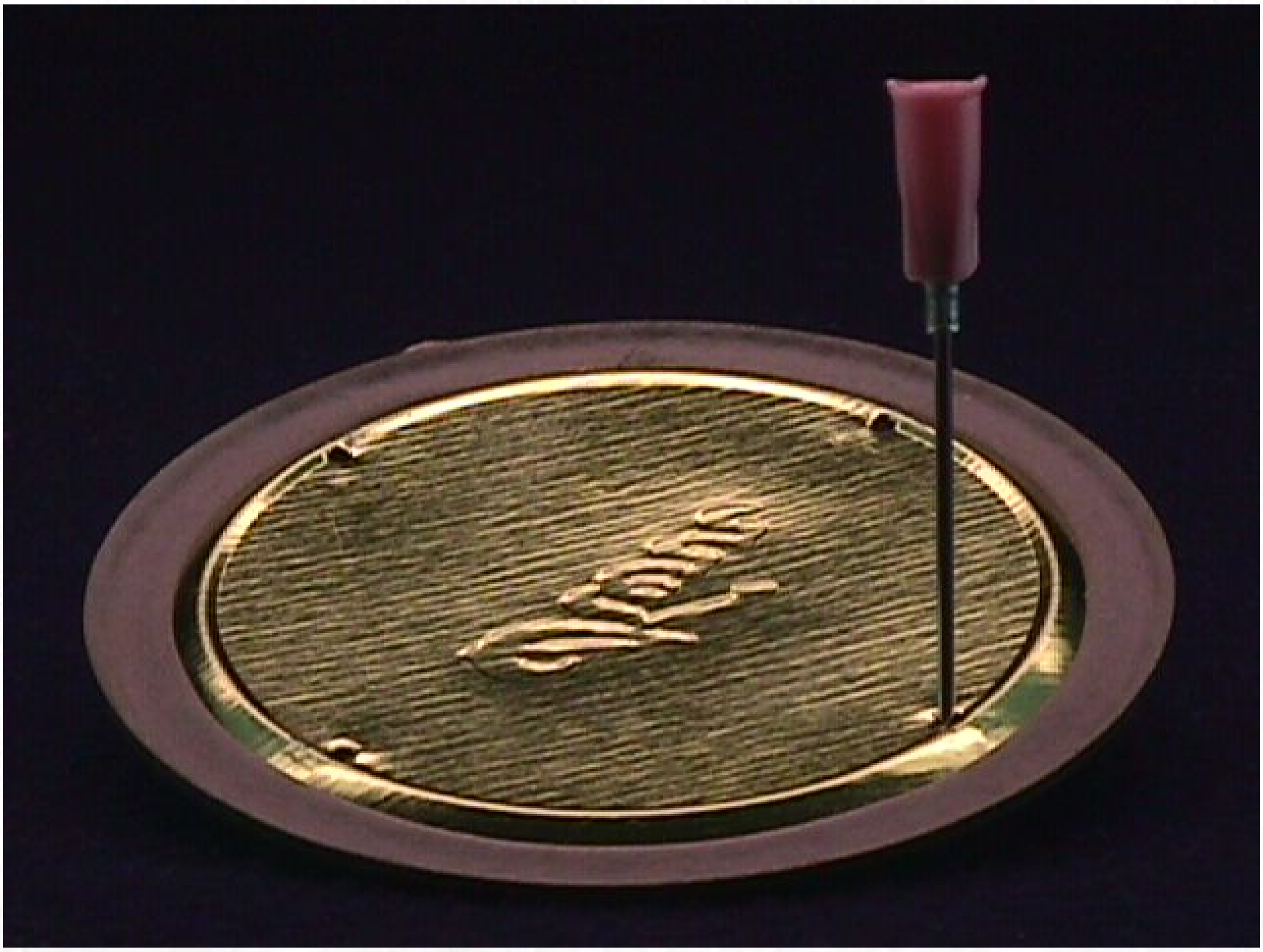
Not all vermiculite is the same. The coarseness varies quite considerably among different brands. The coarser type will hold less water than the finer type which will alter the water holding capacity. If the formulation (water content) results in a really wet or sloppy substrate, use less water. Keep notes on formulas for replicating the substrate formula that fruits the best.

The above formula utilizes "HORTICULTURAL" vermiculite - a medium grade. To ascertain the size of the vermiculite particles, observe them under a photo magnifier next to a millimeter ruler. The finer type of vermiculite has particles averaging around 1 millimeter across (some larger and some smaller). The coarser type has particles averaging around 4 or 5 millimeters across and up to 8 millimeters. Stores usually carry one type, the "horticultural grade".

To make homemade brown rice powder, place some regular brown rice in a small canister type coffee bean grinder and grind it to fine powder. Freshly ground brown rice is recommended over prepackaged type. The freshness sometimes makes a big difference.

A note on water: - Water quality is indeed important. I have found out that "natural" water is the water to use. It makes for better cultivation of this mushroom on this simple substrate. Distilled water is good for making spore solutions and syringes and storing spore solution. But for growing, they seem to like the "natural" water such as: swamp, lake, stream, pond, river, ground or any water that is rich in organics. I have heard that "mineral" type drinking water is good and makes a difference. I suppose that water seeping from an organic compost pile would be about the best.

If the measuring cup specs aren't true, the formulas will be off, setting up certain failure or diminished growth. Check the cup measurers this way: 1 cup is 237 milliliters which is 1/2 pint or 8 liquid ounces (English measurement). There are 2 cups in a pint, 2 pints in a quart and 4 cups in a quart.



Prepare the canning lid by placing it with the rubber sealing edge upwards on a supporting surface and with a sharpened 3 penny nail (held with vise grip pliers) (or ice pick), punch 4 holes inside the periphery of the rubber sealing edge.

When using two piece canning jar lids, the inner lid (with the rubber edges up) rests on the top of the jar and when the lid band is screwed off, the lid remains resting on the jar top. To make the lid and band act as one lid, place pieces of masking tape on the lid attaching the band to the lid. Then, the lid can be adjusted for air ventilation and looseness like an ordinary one piece jar lid (after spore inoculation).

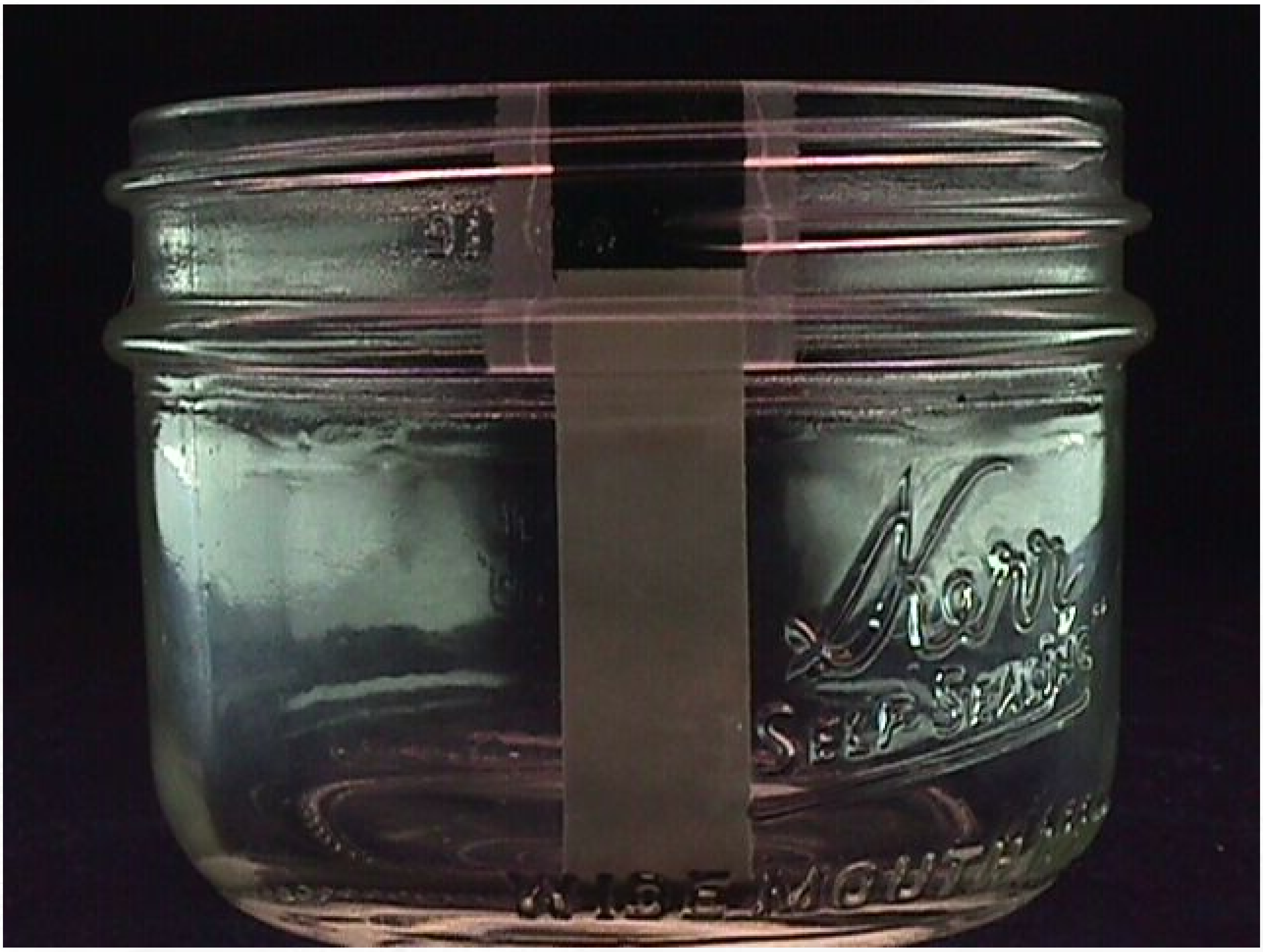
PF Substrate Jar Preparation

Steam sterilizing PF substrate jars with regular cookware is possible because there is no grain to cook up and the substrate is airy. Other regular jars (other than canning type) or small drinking glasses (with tin foil covering) can be substituted for these canning jars. To insure similar results, make sure the jars or glasses are tapered sided with no shoulder of any kind, and that they have a 1/2 pint (8 ounce - 250 ml) capacity. It is important to note, that jars somewhat larger than 1/2 pint can be unreliable for the PF TEK and fail easily, unless the grower has experience with the PF TEK and compensates the formula. The low form KERR 1/2 pint canning jar is the most versatile (fits into tight spaces et).

A 3 piece vegetable steamer (pot, basket insert & lid) is used for the steam sterilizing stage. Also, the stainless steel vegetable steamers that fold out and stand on the bottom of the pot are good. Anything is good as long as it keeps the jar bottoms off the pot bottom where the high temperature will crack the glass.

Step 1. Place 1/4 cup of bron rice powder into a mixing bowl. Add the water directly onto the brown rice powder and mix it up and give it a few minutes to soak in. Add the vermiculite on top of the brown rice slurry. Thoroughly mix the ingredients. An electric mixer works great for this and makes it quick and easy. If there is no electric mixer, a couple of table knives does the trick also. The mixture should feel damp and cohesive (sticks together well). More water (or less) can be used if experimenting to improve the fruiting. Mix Each jars substrate individually for loading to insure accurate formula rendering and the best possible fruiting.

Step 2. Fill the jar very loosely. Leave a 1/2 to 3/4 inch space at the top. Level the substrate. With a tissue or a fingertip, wipe the insides of the jar clear of substrate residue down to the top of the substrate (very important - prevents contamination at the top). Fill the top of the jar with plain dry vermiculite and level it off at the top. This upper layer will protect the wet substrate from air borne contaminants. It acts as a contaminant barrier. This is a Psylocybe Fanaticus original discovery. What this dry vermiculite layer does is protect the wet substrate from airborne contaminants and also absorbs and regulates moisture transpiration and condensation.



In the photo, the black tape is the depth for the dry vermiculite. The masking tape shows where the pf substrate goes. The top layer of dry vermiculite must be between 1/2" to 2/3" deep to provide protection from contaminants entering from above.

Tamping down tek

Getting the substrate level correct is very important. A slight tamping down is required. To get an accurate leveling of the substrate, loosely load the 1/2 pint jar and level the top of the mixture with the top of the jar. Screw a cap on the top to hold the mixture in. With one hand, hold the jar and lightly slam the bottom of the jar on the other palm a couple of times to lower the mixture level to around 1/2"-2/3" from the top rim. Further level and adjust the substrate with a fork down to the proper height. Clean the inside of the jar down to the substrate level with your finger tip or a paper towel and fill the jar back to the top with dry vermiculite.

Step 3. Place the lid on the jar with the rubberized edge up (jagged edges of the needle holes down). Screw the lid band on. Place pieces of "professional" grade masking tape (holds on during steaming) over the needle holes. This is to protect the needle holes from contaminant entry. When steaming or pressure canning is performed, the jars must be protected from water dripping down from the underside of the pot lid caused by heavy condensation and drip off during boiling. This water can get into the jars by entering under the jar lids that aren't tight and soaking the substrate - throwing off the formula and setting up failure. To prevent this, wrap some tin foil around the cap to ward off the water. The tin foil can be removed after steaming (with the tape guarding the needle holes - or the tin foil can be left on until it is inoculation time.)

Step 4. Heat the pot of water to a boil first then put the jars into the pot with the lid bands loose so that the steam can penetrate the jars quickly. The jars can sit in water but make sure boiling water can't slosh into the jars. Turn the heat down and GENTLY steam the jars at the lowest possible boil for an hour in a TIGHTLY covered pot (gas stoves are the easiest to control) (begin the timing when the water begins boiling again). A good tight fitting pot lid is essential for successful steaming.

Be careful to not overheat the jars, this dries the substrate. Drying is evidenced by o.k. spore germination and halted growth (the fungus will spread but stop at a certain point depending on how dry the substrate has become). Generally, any halted growth (with no contamination) is a sign of dried substrate. This is an important concept that will enable diagnosis and correction of problems experienced with drying. The remedy is to increase the water content of the substrate formula in use. After the jars have cooled, tighten the lids and store them in a cool draft free place until you are ready to inoculate them. As long as the lid is very tight, PF substrate jars can be kept for long periods before they are to be used. The only danger to this is water moisture loss.

Pressure Canner Use

PF jars and water bottles can be quickly sterilized with a pressure canner. For proper and safe use of the pressure canner, always refer to the manual that comes with it. If the canner is used and has no manual, try to get one from the manufacturer before using it. Pressure canners can be dangerous if used incorrectly.

Sterilization times

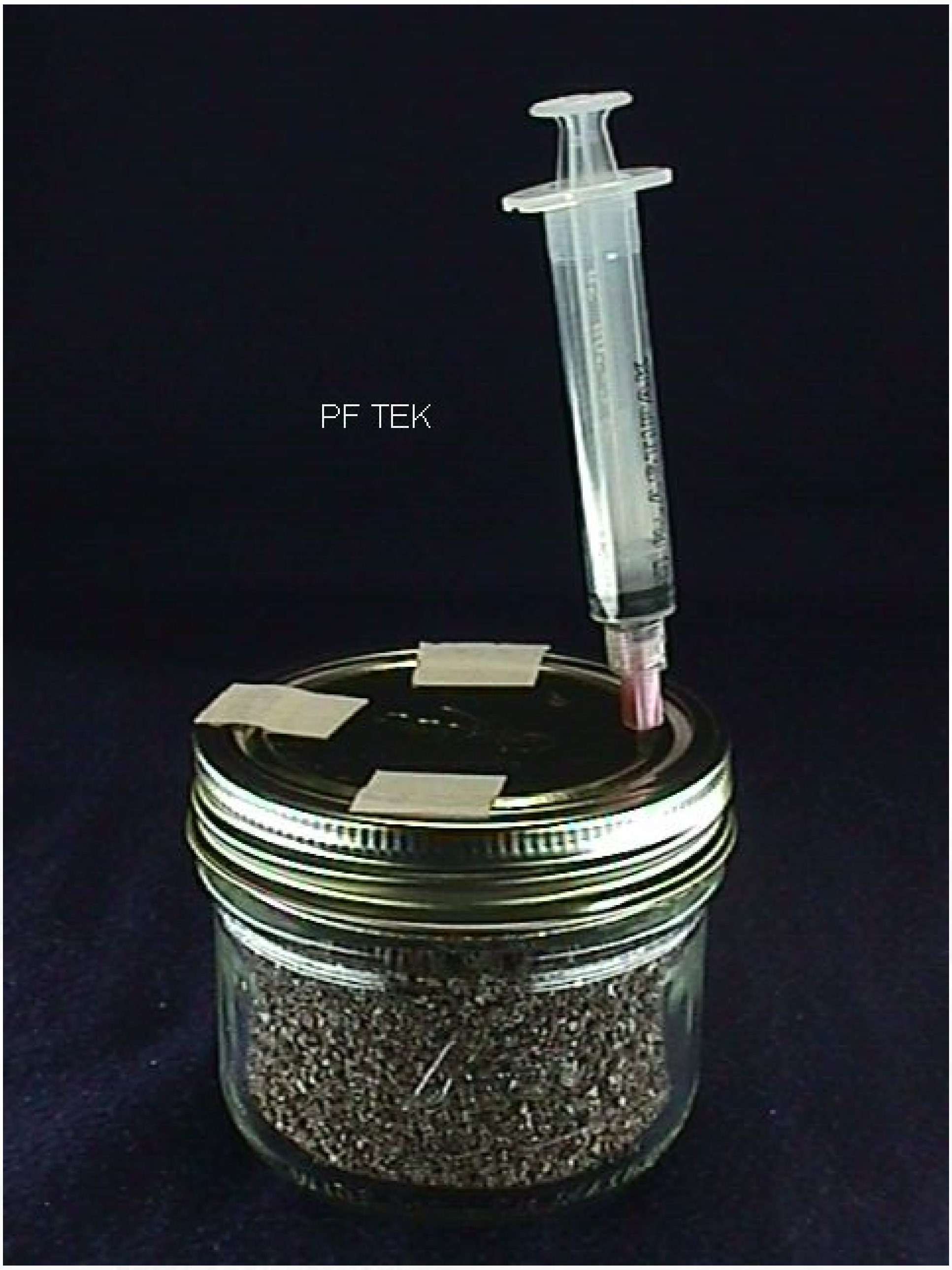
1. 1/2 pint PF substrate jars - 12 p.s.i. for 30 minutes
2. Water bottles - 12 p.s.i. for one hour
3. Syringes and needles - 12 p.s.i. for 10 minutes

Control jar technique

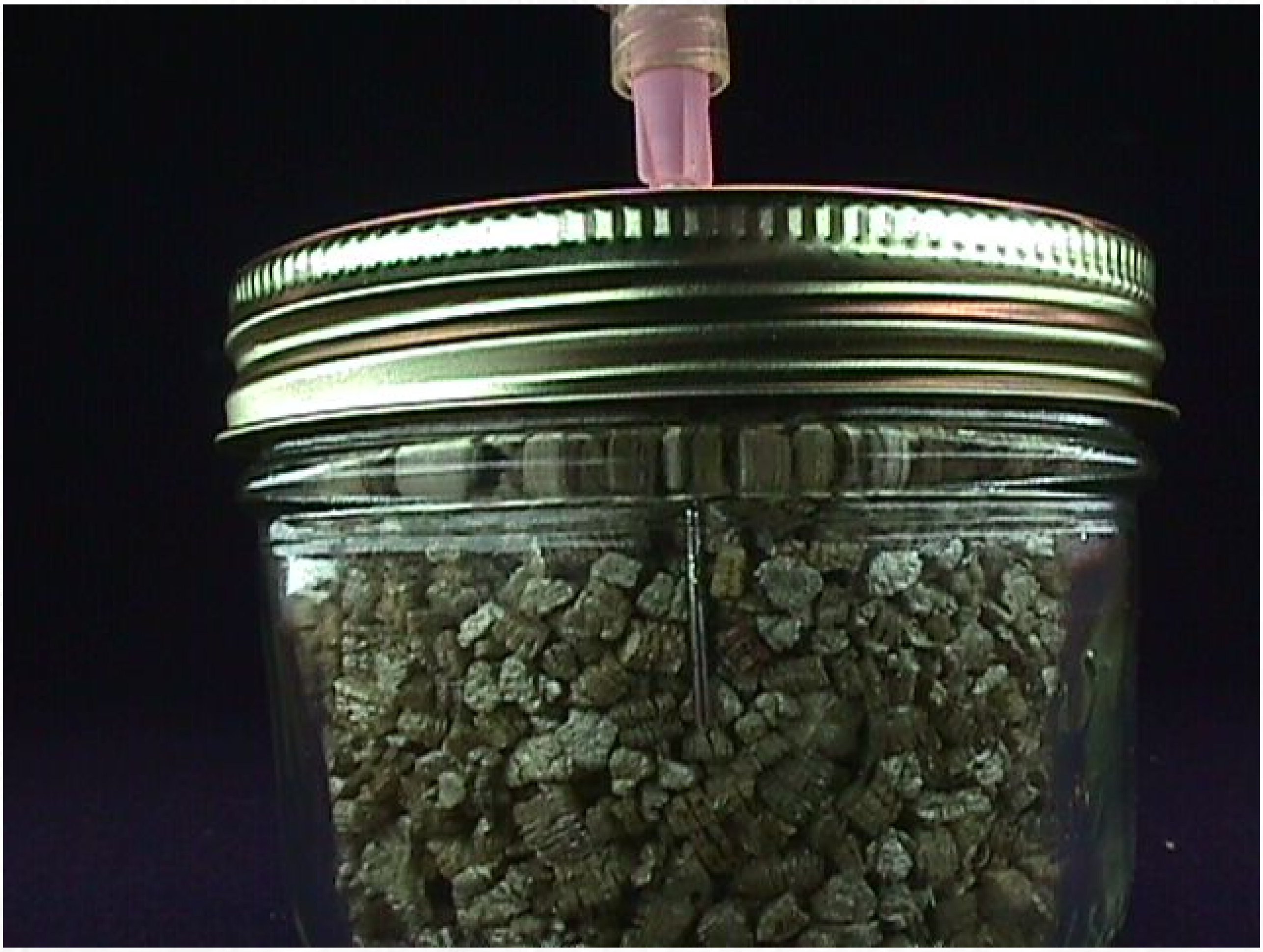
After the jars are steam sterilized, let them cool, tighten the lids and let them sit uninoculated for several days. Watch for any colored growths or changes in the appearance of the substrate. The tell tale rancid odor of bacteria can be easily detected by loosening the jar lid and checking for the odor. If there is contamination at this stage, the sterilization technique needs to be checked. Most likely it will be a to short sterilization time. If there is a problem at this stage, lengthen the sterilization time. If the jars remain clean and unchanged, they are ready for spore syringe inoculation. If contamination occurs after inoculation, the syringe was contaminated or the dry vermiculite layer was breached during inoculation.

Table of Contents

CHAPTER 2 - INOCULATION OF THE PF SUBSTRATE JARS



Any jar to be inoculated must be cool to the touch before proceeding. Make sure the jar lid is tight. Shake the syringe well and remove the tape from the syringe needle guard. This shaking of the syringe is important as to redistribute the spores in the water. Take off the tape covering the needle holes. Remove the needle guard and insert the needle through the lid hole. Tilt the syringe body back towards the center of the lid with the needle tip touching the glass. This distributes the spore water down the side of the jar, giving a good inoculation down the side of the substrate cake. Inoculate a few drops down each needle hole. As the syringe plunger is pressed, observe the needle tip against the inside of the glass. As soon as water appears around the needle tip, release the syringe plunger pressure. In between each hole inoculation, shake the syringe a little to keep the spores distributed. Use 1 cc per jar. This will allow the syringe to inoculate 10 jars. More spore solution per jar can be used (speeds colonization - I use 3 cc per jar), but fewer jars can be inoculated. If the syringe needle plugs up as it is inserted into the substrate, draw the needle back a little and it will unplug.



In this photo, the needle tip can be seen resting against the inside surface of the jar. Then, when the solution is injected, it will run down the side of glass, giving an even inoculation. It is also important to add, that the vermiculite in this jar photo is very course. This makes the needle more visible for the demo. This type of vermiculite is best avoided.

Alcohol Flaming Technique

If the syringe needle is touched, flame the needle to sterilize it. An alcohol flame is a clean flame whereas a butane cigarette lighter leaves behind an undesirable soot residue. To produce a short burning alcohol flame, place a tequila shot glass upside down. Using an eyedropper, put a few drops of denatured alcohol fuel (hardware store) on the hollow bottom of the glass and touch it with a match or lighter. The blue flame will cleanly and safely sterilize small stainless steel tools. Heat the needle in the flame for a few seconds to resterilize it. There might be a few "pops" of boiling water spurt out of the needle, but the spores within the syringe are safe. If there is some left over spore solution, replace the needle guard and store the syringe for later use. Resterilize the needle immediately before re-use. Store the syringe in a dark, cool place.

Also, just wiping the needle with rubbing alcohol soaked cotton will sterilize the needle. Let the needle dry for several seconds to evaporate the rubbing alcohol (alcohol kills spores), or pass the needle through the flame for a couple of seconds to complete the evaporation of the rubbing alcohol.

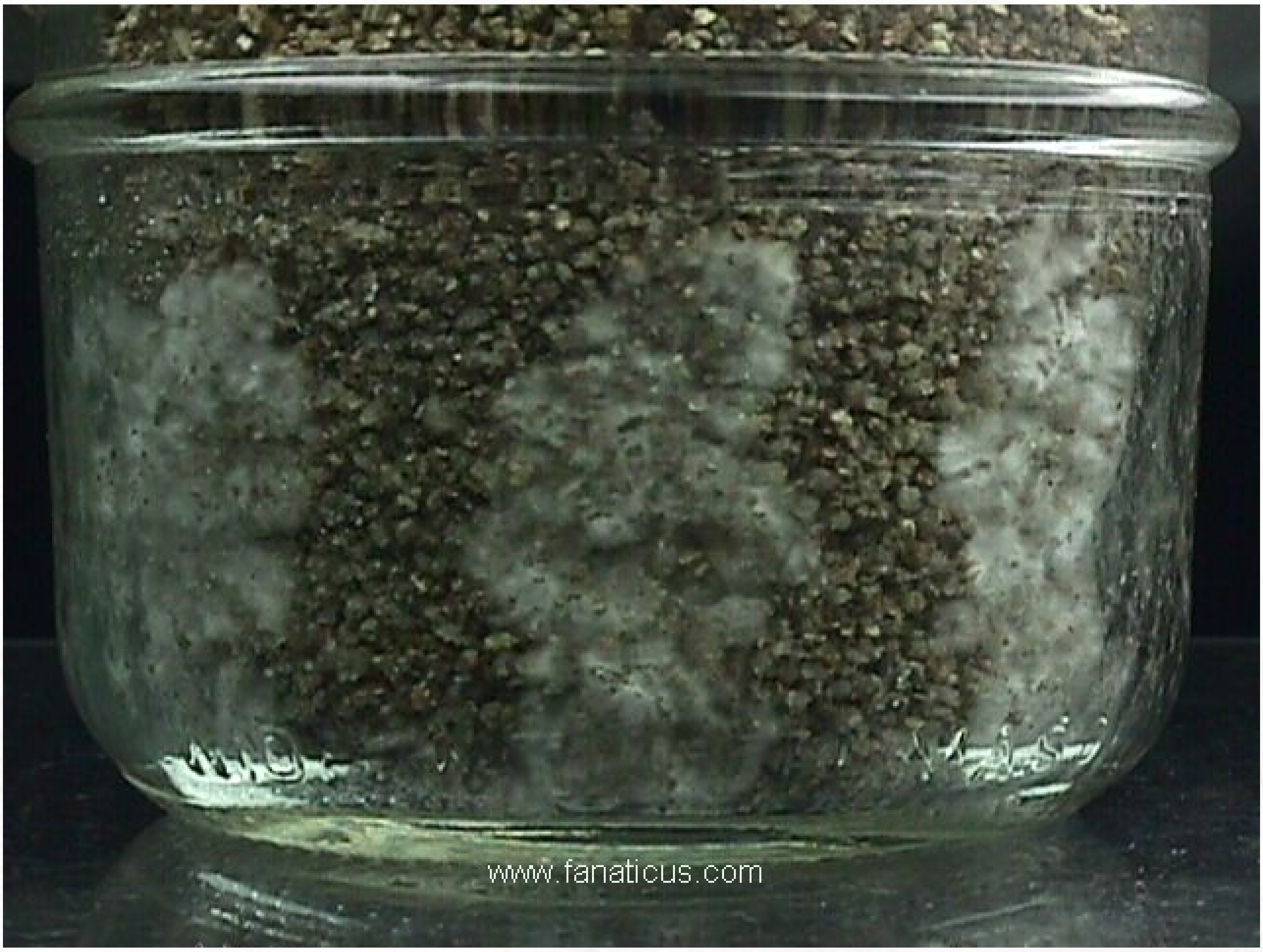
Inoculation of PF Jars Without the Lids

This technique can also be used if canning jars are not available (1/2 pint wide mouth canning jars are perfect and should be used at all cost). If regular drinking glasses are to be used - use regular tapered sided drinking glasses (8 ounce - 250ml)

Jars can be inoculated without using a lid with holes punched. Before trying this technique, inoculate with the punched lid first. That will show how it works without any problems (almost fail proof).

The only precaution to observe is to disturb the dry top vermiculite layer as little as possible, especially when removing the needle after the inoculation. The underlying substrate must not be exposed to the air. Carefully move any disturbed vermiculite back into place (with your finger tip). Replace the tin foil cover after inoculation.

Incubation of Inoculated Jars



After inoculation of the jars, tighten the lid bands and retape the needle holes. A tight lid preserves the water content of the substrate (very very important) and the growing and spreading mycelium will do fine with a tight lid all the way to the appearance of the primordia (using the air in the jar only). Place the jars in a safe place out of direct sunlight. Indirect light is all that is required. If the temperature is kept around 70 degrees, germination will begin within 3 to 5 days. Germinating spores appear as small white fuzzy spots, quickly growing and spreading with cottony white growth and strandy "rhizomorphs". Any room temperature is O.K. If it gets cold indoors, over head light shinning down on the tops of the jars is a perfect heating technique for this culturing stage. A clamping type light with a reflector works well for this. If this is done, keep the temperature around 70 degrees (don't overheat the jars - monitor the temperature with a thermometer). A warm overall house temperature is fine. But in the overall view, cool temperatures are never a problem. The rule is to not overheat.

The Canning Jar Lid (loose or tight)

There are two choices with the lids during incubation - tight or loose. With a very high moisture content (good for fruiting), a tight lid can cause water to collect in the bottom of the jar. This is to be avoided. Water condensing in droplets on the inside of the jar during incubation is normal and is to be expected. If puddling on the bottom of the jar occurs, the lid should be kept on loose during incubation. Tape the canning jar lid to the band to make the lid act as a one piece lid for raising and lowering.

An excellent way of depuddling the jar is to use a long syringe needle and syringe. Without disturbing the top vermiculite layer, insert the long needle down to the bottom of the jar. Tilt the jar so that the water puddles down to the needle point and suction out the water. This works really great, but one needs an extra long needle to do it. Doing this can facilitate superb fruitings with the high water content without the puddling problems and possible deterioration of the substrate because of the water (drowning). With a high water content, there might be more than one depuddling procedure needed.

Also, there is another and even simpler way to depuddle the jar. One just simply inverts the jar and lets the water run down the side and is absorbed by the dry upper vermiculite layer. Most people do this and report excellent results.

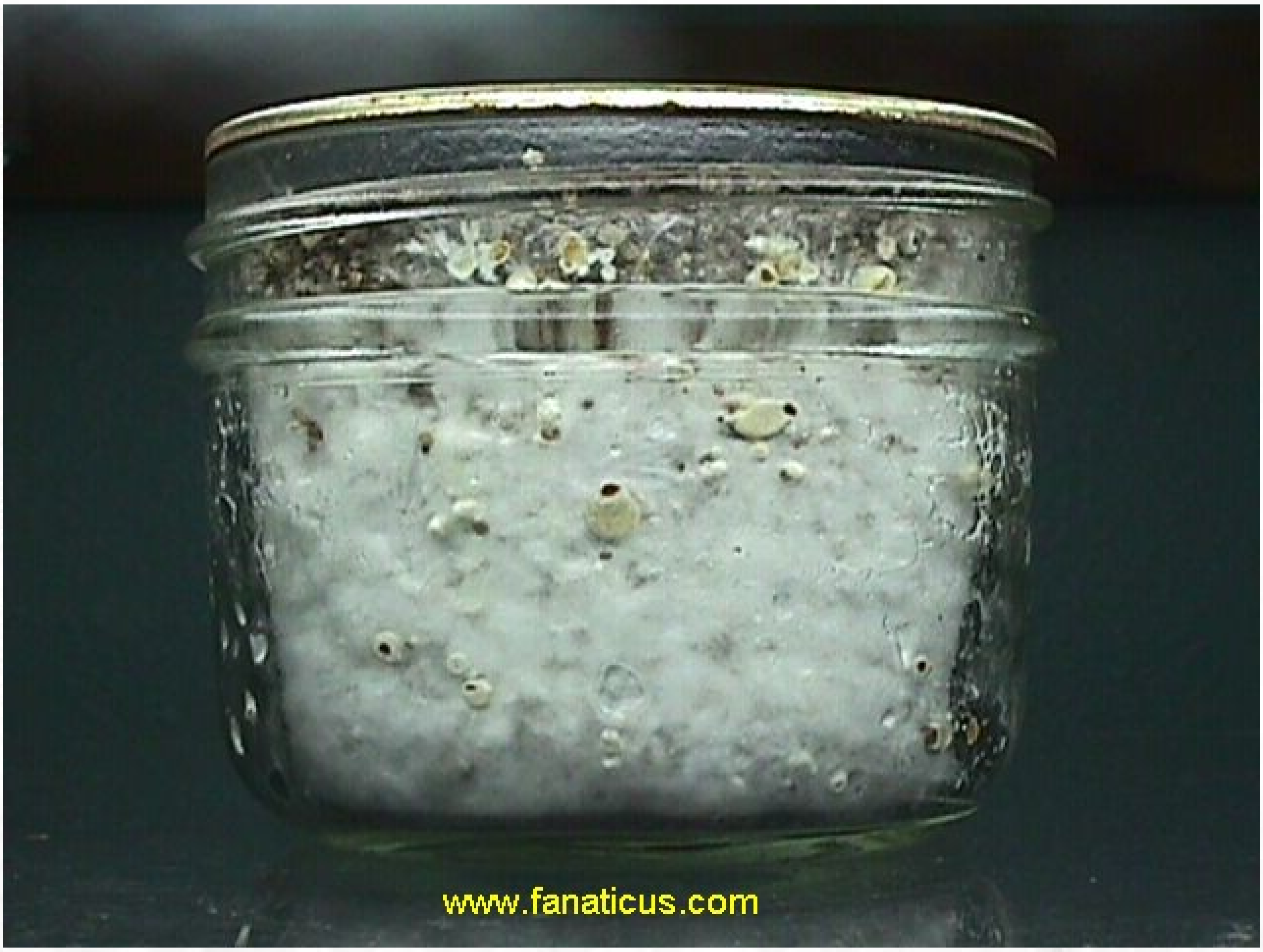
If the substrate is on the dry side, a tight lid will preserve the moisture content. It is all a matter of the balance between the water needs of the mycelium, the size of the jar, the available air space in the jar and the type of vermiculite used. Only by simple experimenting and comparison can the right balance be found for a given set of conditions. Take notes and go with what fruits the best. But after many years of seeing all of this and all over the internet - web - the basic PF substrate formula as given rules.

After the substrate turns white with the mycelium (2 to 4 weeks after inoculation), the jars are left to sit in indirect light. The mycelium will continue to infiltrate the substrate until it gets enough food to trigger the fruiting cycle. In less than a week to a few weeks after surface colonization of the cake (cake appears all white), tiny white "pin" like structures begin to appear. This is called pinning. This is the beginning of the fruiting cycle. Soon after that, within the week, small round fungus growths appear that soon begin to turn yellow.

Lastly, "primordia" start to grow. These are tiny worm like structures with tiny reddish heads. These are the first mushrooms.

Table of Contents

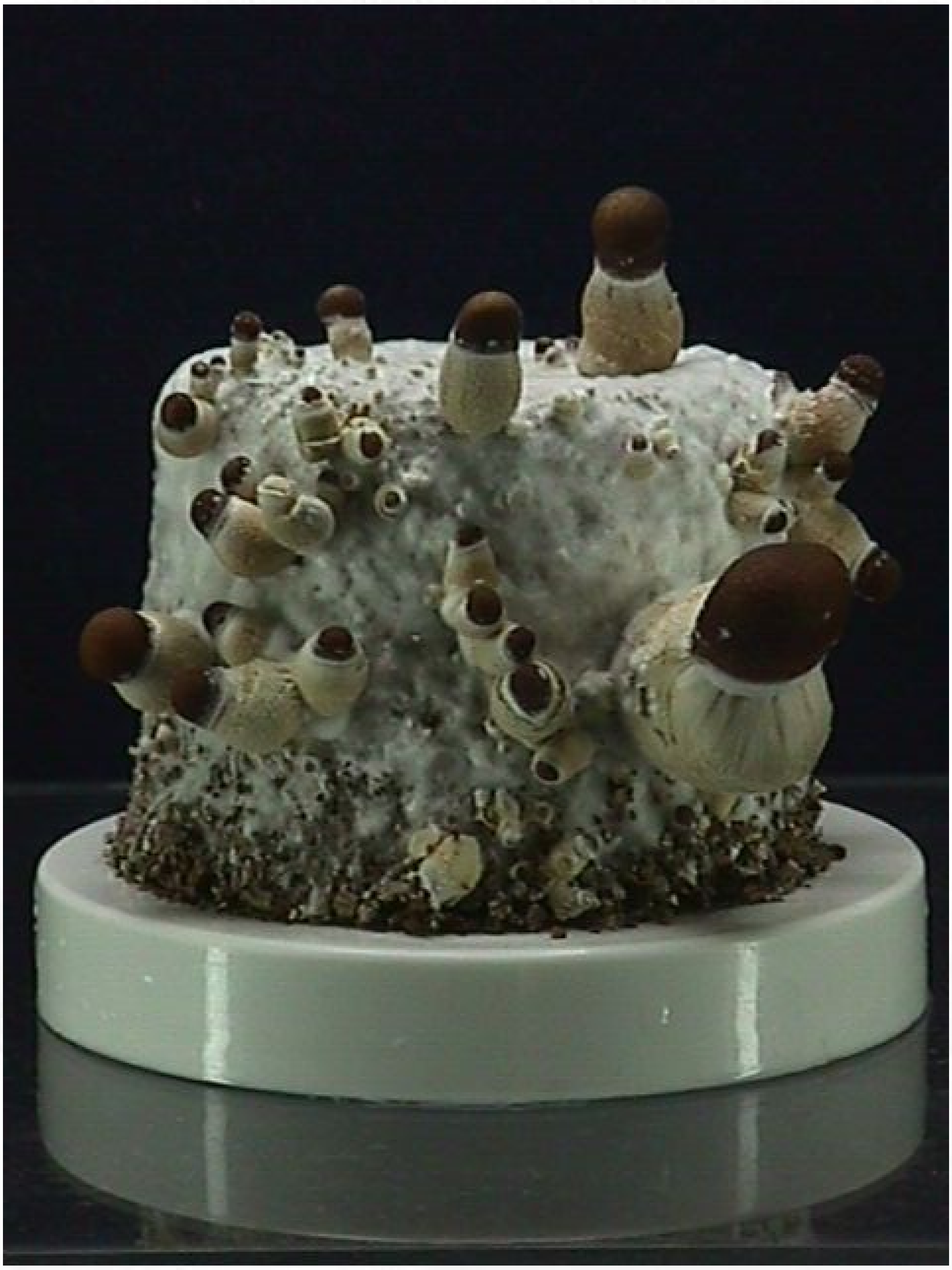
CHAPTER 3 - THE BIRTHDAY CAKE



This photo is of a 1/2 pint PF substrate jar about 23 days after inoculation (done with 3 cc of spore water and incubated at 70 degrees Fahrenheit). The primordia have appeared and it is now time to birth the cake. Wait until you see this, and the fruiting will be maximized. The fruiting is fairly relative to the primordia that appear.
The best time to remove the fungus cake from the jar is when the primordia (tiny worm like structures with reddish heads) appear on the cake while still in the jar. Be careful not to damage them in handling. The rule is to handle with care.

Remove the lid. With a clean fork, scrape away the majority of the dry top vermiculite layer. There will probably be seen some wispy mycelium here and there in the top layer. That is a good sign showing the healthy agressive nature of the mycelium. Place an old jar lid over the jar mouth and turn the jar upside down. Lightly slam the jar down on a table cushioned with a magazine. The fungus cake will slide out onto the old jar cap (BIRTHDAY). What I usually do is hold the jar without the lid on (top down) in my hand and carefully wack the bottom of the jar with a rubber mallet - the cake births nicely. When handling the fungus cake, be careful as not to squeeze and bruise it. Bruising results in a bluish mark. This fungus is resilient and can tolerate a certain amount of handling, but handle it as least as possible. The aroma is distinctly mushroomy, very pleasant.

As soon as the fungus cake comes out of the jar, place the cake with the vermiculite covered end down onto a preprepared soaked vermiculite (or perlite) filled saucer, old jar cap, petrie dish ect. It really makes no difference what end of the cake is down. Also, for some of the cakes, follow the PF casing technique (later in this chapter) as a way to make the fruiting max. Leave some cakes uncased for comparison. Daub the cake with a piece of loose tissue paper to soak up any water droplets that may have deposited on the cake as it comes out of the jar (actually, this doesn't have to be done, because the freed cake drinks it up within several hours). Immediately after the birthday, place the cakes into the dual chambered terrarium for the fruiting cycle.



This is the cake a few days after the birthday. This is a healthy fruiting start. Some of these primordia will abort, but most will go on to full development.

Some of the first mushrooms to form are "aborts" (convoluted caps, gnarly stems and stunted growth), and ironically they are primo in magic alkaloids. They are even more powerful in magic than the stately beauties that will soon dominate the cake. The tiny "baby mushroom" aborts are likewise good. After witnessing the growth of the fungus, recognition of these aborts is easy. As long as the aborts are healthy and pure, they are primo. Also, another form of mutants will manifest, blobs of fungus with little or no cap, also good for harvesting. And along with these mutants, appear the perfect specimens, the sporocarps.

It has been reported that Psilocybe Cubensis is a "weak" mushroom. PF and others have seen this to be not necessarily so. It all depends on how it is grown, on what medium and how it is harvested and preserved.

The secret to potent mushrooms is in their age when picked. It has been scientifically proven that the small immature specimens are significantly more potent than the larger mature specimens. Over half of the small primordia that first form will abort (cease growing, convolute and deform - depending on the strain). Pick these before their heads turn black. A pointed knife blade works well for removing these high potency primordia. These are among the most potent. The abortive mushrooms are also high potency. Harvest them when they are young and before their heads turn black. When the fruit bodies are normal, harvest them before the veil under the cap breaks. The mushrooms will be smaller and their heads will be roundish. It is important to note that the mushroom cakes pictured in this book are all mostly well matured. While these mature specimens are beautiful and perfect, they are not as potent as the diminutive specimens. The mature specimens are good for spore collecting and showcasing (photography) but are weak in psychedelic potency.

Grow them on brown rice, harvest them when they are young and cool dry them with desiccant. When this is done, they are an entheogen of the highest order.

Time Scale of the Mushrooms

1. Spore inoculation to spore germination - within a week, at 70 degrees Fahrenheit.
2. Spore germination to complete colonization of the cake - about 2 to 4 weeks or more.
3. Complete colonization to fruiting cycle start - within 2 weeks or more.
4. The fruiting cycle lasts about 2 weeks. After the initial flush, the mycelium cake begins to turn blue and no more mushrooms form. If the cake is thoroughly cleaned of aborts and stray fungus blobs after the initial fruiting and given the PF double ended cake casing tek, fruiting can be doubled or even tripled.

All in all, the process takes from 4 - 6 weeks from spore inoculation to fruiting.

Contaminant Source Identification

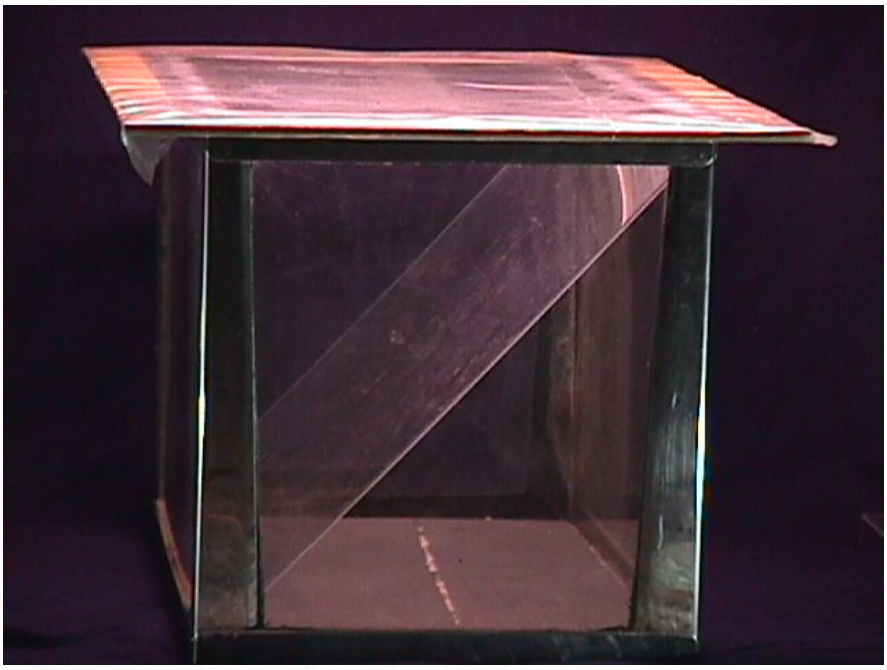
Contaminant invaders appear in various colors from pastels to black. If they appear, the culture is doomed. Bacteria contamination is detectable through the top dry vermiculite layer as a sour foul odor within two days after inoculation (and no spore germination). If the jar is bacteria contaminated, be careful in cleaning it. Keep a safe distance from the contaminated substrate. Don't inhale the bacteria and wash your hands after touching it. Bacteria can be dangerous.

Non-Germination of Spores

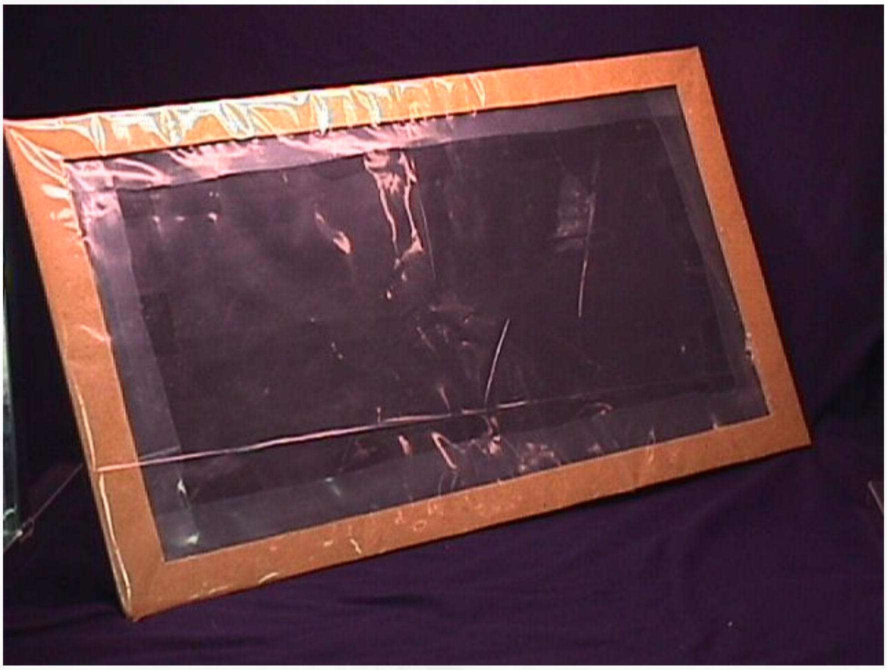
1. The spore solution was not inoculated deep enough down into the jar. Instead of running down the side of the jar and inoculating the substrate cake, the solution was absorbed by the non-nutritive top vermiculite layer. To avoid this from happening, make sure that the spore solution flows down along the sides of the substrate cake by inserting the syringe needle so that the tip is below the non-nutritive upper vermiculite layer.
2. The substrate jars were not allowed to cool down after sterilization, killing the spores. Inoculate only when the jar feels cool to the touch.
3. There is evidence now that syringe boxes can be exposed to killing heat during transit (a very rare occurrence). The possibilities are such as over heated airplane cargo holds during intense heat waves or a superheated mail truck parked all day in the sun. Another possibility is that on arriving at the mail box, the syringe package was allowed to sit inside a broiling sun heated mail box, killing the spores.
4. Spore syringes can survive freezing, but extreme low temperatures are probably destructive to the spores.

Table of Contents

CHAPTER 4 - THE DUAL CHAMBERED TERRARIUM



Standard 10 gallon aquarium



The airtight aquarium lid (top)

24" X 14 1/2" outside dimensions
21 1/4" x 12" inside dimensions (dimensions variable).
The frame can be made of flat (unwarped) 1/4" thick board or 4 wood strips connected by screws.

The wooden lid frames' inner rectangular cutout must be LARGER than the top of the aquarium. Clear polyethylene plastic film is tacked to the underside (or upper side) of the frame so that the frame holds it tightly onto the aquarium top. The frame essentially hangs by the plastic film. A simpler alternative is to cover the aquarium top with saran wrap or something similar. The most important point to be stressed is that the aquarium must be sealable with no air leaks, for humidity retention.

The Spray Shield/Chamber Partition

(for a standard 10 gallon aquarium)
Use 1/8" thick clear acrylic (Plexiglas) window insulation available at most hardware stores. Have it cut around 15" x 18" (dimensions may vary - check the aquarium first). A loose fit is good as long as the cakes are protected from the direct spray.

Dual Chambered Terrarium Techniques

The mushrooms get water from 2 sources; the substrate they grow on and the air that surrounds them. The surrounding air must be highly humidified. The fungus needs to bathe in a shroud of floating water molecules. 100% humidity is where there is the maximum number of water molecules floating amongst the air atoms. The dual chambered terrarium easily achieves these conditions.

It all starts with the spray from the hand sprayer. The first rule is to never directly spray the fungus. This initial spray is comprised of water droplets that are giant ponds of water in relation to the fine mycelial networks of the fungal threads. In culture, the droplet of water will drown the micro world of the fungal structures and thereby inhibit or contaminate growth. But the airborne molecularized water floats into the fine structures and gives the fungus humidity as needed. Molecularized water is another way of describing water that has evaporated into the air.

The spray that comes out of the spray bottle must be molecularized for the fungus. The spray shield and the primary chamber accomplish this. The primary chamber receives the initial spraying where as the shroom cakes are behind it. As the spray strikes the shield, it is broken down into a finer mist which flows around the sides of the spray shield into the secondary chamber where the fungus is bathed in the fine humidity safely away from water droplets. In a matter of time, this humidity will condense out onto surfaces inside the terrarium and drip down. The spray shield is slanted and therefore acts as a drip shield and roof, so the more condensation the better. Also, the spray shield adds more surfaces to the insides of the terrarium which increases the amount of moisture that can evaporate.

Spraying Procedure

First, before placing the cakes into the terrarium, spray all the inside surfaces of the terrarium, including the spray shield and lid. Insert the fungus cakes and put the spray shield and lid in place. Then, slightly lift up the lid and insert the nozzle of the water spray bottle in between the lid and the top of the aquarium and vigorously spray downwards into the middle of the shield. After about 5 seconds of spraying, immediately withdraw the sprayer nozzle and let down the lid to seal the swirling mist inside the terrarium. Make sure that all the inside surfaces of the terrarium are foggy or dripping with water. This in itself helps generate humidity.

It has been seen that mushrooms will grow very well in a properly set up dual chambered terrarium, with only one good spraying a day - and even less than that. This is one of the amazing features of the PF TEK. With the cake cased, I have seen great shrooms grown like this with little attention given to the terrarium. PF style cakes actually seem to need less humidity than any other way of growing shrooms as long as the double ended cake casing technique is employed. PF cakes, when birthed, don't need 100% humidity to fruit well. It is very true, that cased grain and such need the very high humidity, but PF cakes don't. And that is because the cakes themselves humidify the space around them because of the vermiculite content. Vermiculite holds a lot of water and will both absorb and release moisture.

Each time the terrarium is sprayed, the fungus should be ventilated. To ventilate, take off the lid, and while holding the spray shield vertically, fan the chamber with a piece of cardboard, and then spray as above. Also, the water that collects in the bottom of the terrarium must be siphoned out (prevents bacteria buildup). This can be easily done using a rubber bulb battery filler (auto parts store) or a rubber bulb type enema bottle.
Expose the terrarium to normal room light (indirect sunlight). A small low wattage fluorescent plant light positioned above the terrarium will make the phototropic mushrooms grow upwards. Leave it on all the time if desired.

Heating

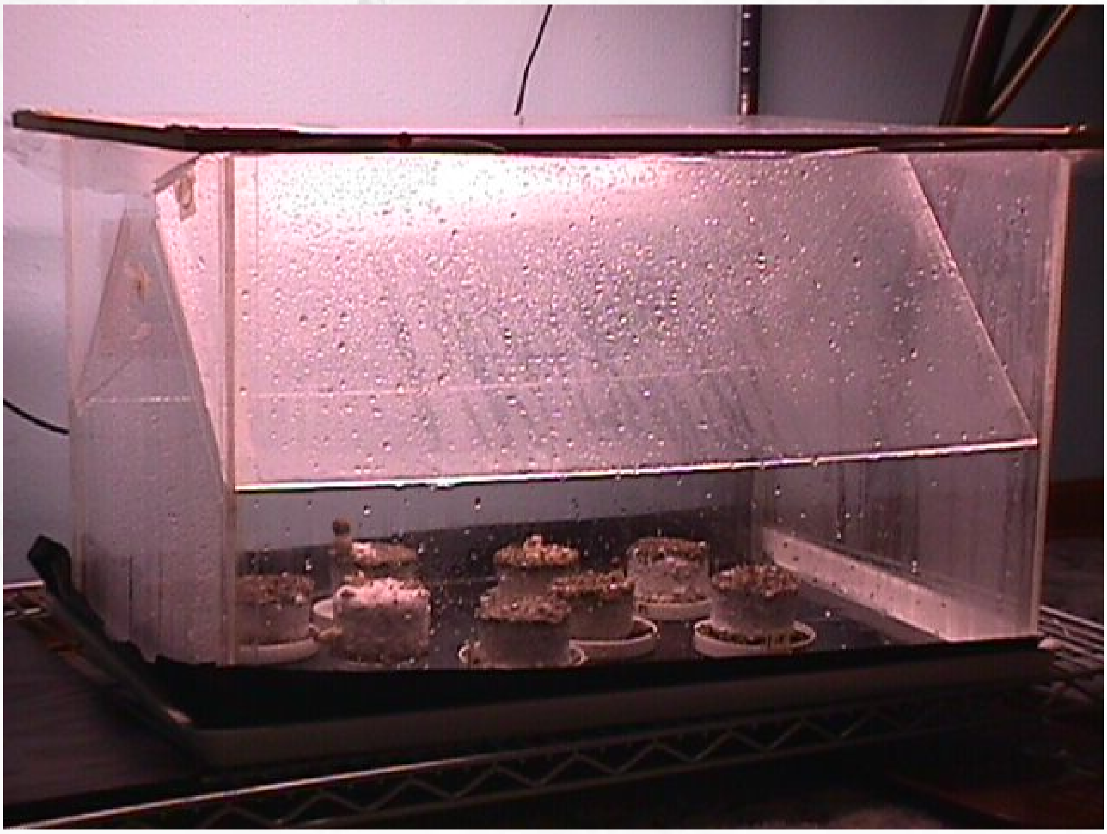
The main rule is to not heat the dual chambered terrarium. Any direct heating works against the humidification andadds a drying influence. Do not use heating cables, heat pads or blankets. Don't shine light directly down into the terrarium. Keep any plant grow light (low wattage only) a safe distance from the terrarium. These fungi grow well at 60 degrees Fahrenheit. PF has even seen them growing perfectly at temperatures cooler than 60 degrees. They grow slowly when they are cool. When warm or at heated room temperature, they grow very fast. Strive for a growing temperature between 65 and the upper 80's. A too hot terrarium will result in lots of spreading mycelium, but no fruiting. It has been reported by other authors, that these cubensis mushrooms will have a higher potency when grown at cool temperatures. They grow much slower, but they seem to be denser in their flesh then when grown warm.

Symptoms of Low Humidity

When the humidity is a bit low, but not low enough to stop fruiting, the mushrooms can have fuzzy white mycelium growing on the tops of the caps. When this occurs, the cap looks like it has a crown of white hair. This is not contamination. This white fuzzy mycelium is perfectly good and does not detract from the mushrooms quality.

Deformed, convoluted, and withering mushrooms and primordia are signs of low humidity. For the best growth, the humidity has to be high.

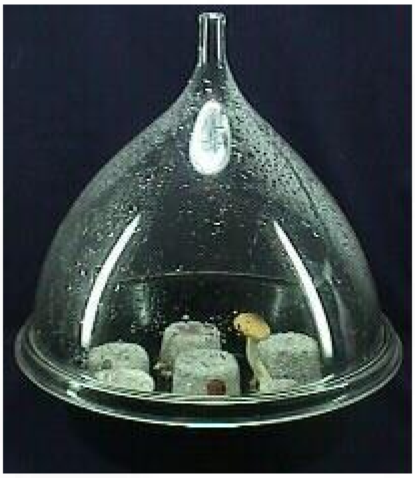
There are many ways to make a dual chambered terrarium. You can use straight toped (square) clear translucent storage containers, the kind you get at hardware stores or walmart. The top of the container must be straight or square to accomodate the lid as described above. This one I made out of plexiglass, a project that I probably wouldn't bother doing now. I presently have something like this made from a translucent tall storage box I got from walmart. You can get some really nice sized boxes with lots of room.



plexiglass mushroom machine

Table of Contents

CHAPTER 5 - THE RICH MANS' TERRARIUM



This is the terrarium that was used in the perlite and terrarium tests. I found it at a new and used resteraunt supply store in Seattle for $25. This is a covered food display tray.

It works great with perlite (and without) and holds 9 half pint cakes. The one above has 7 cakes. The cakes are post initial flush and the fruitings are secondary fruitings. The fruitbodies that appear late are always superb in form.

If you can't find one of these in your local town, you can order one for around $75 (hence - the "richmans'"). Call the manufacturer (Cal-Mil) in California at 1 800 321 9069. They will tell you where you can order it (from one of their distributers near your town).

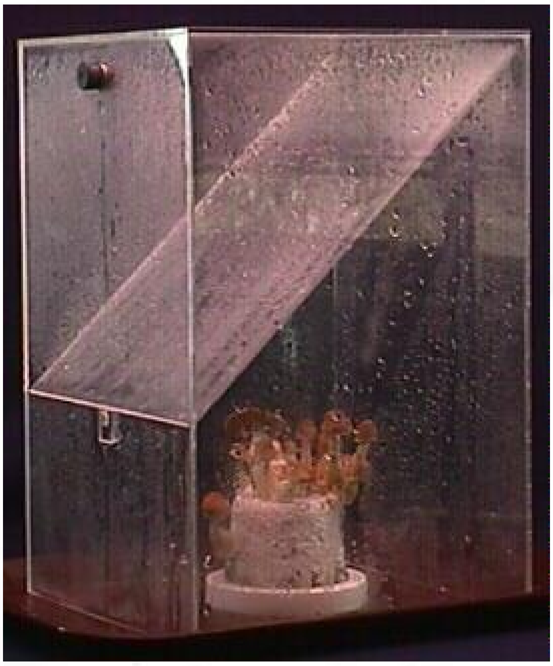
Unfortunately, sometimes a distributer will require a minimum of an order for two. But fortunately, the terrarium they will send you for the above price is bigger than the one pictured. It has room for several more cakes, making for a goodly capacity. All the shrooms pictured at this site were grown in one of these.

The catalog numbers are:
314-15 -- the "connoisseur cover"
316-15 -- "Deep Tray" bottom half
The unit is 15 inches in diameter and about that tall.

To use this terrarium, first spray the insides. Place the cakes in. Hold the cover above the tray and spray a fine mist into the air about 2 feet above the cakes in the tray and immediately lower the cover down onto the tray - trapping mist. Air and mist once a day. But what is so cool about this, is that neglect goes a long way! (set it up and leave it).

Yeah, I know it costs, but it works so nicely, and it makes a nice coffee table display. If your landlord comes by to inspect, he will see it, look down and say, "hey, nice shrooms, what kind are they"? Then you say, "I got it from a science catalog company and it is a new miniature fungi growing kit and the shrooms are not edible - just wild". (or something absurd like that). Then your landlord will look approvingly around, notice the neatness and tiddyness of your domecile, and leave, little knowing that he just observed the food of the gods.

The Ultra Richmans' Terrarium



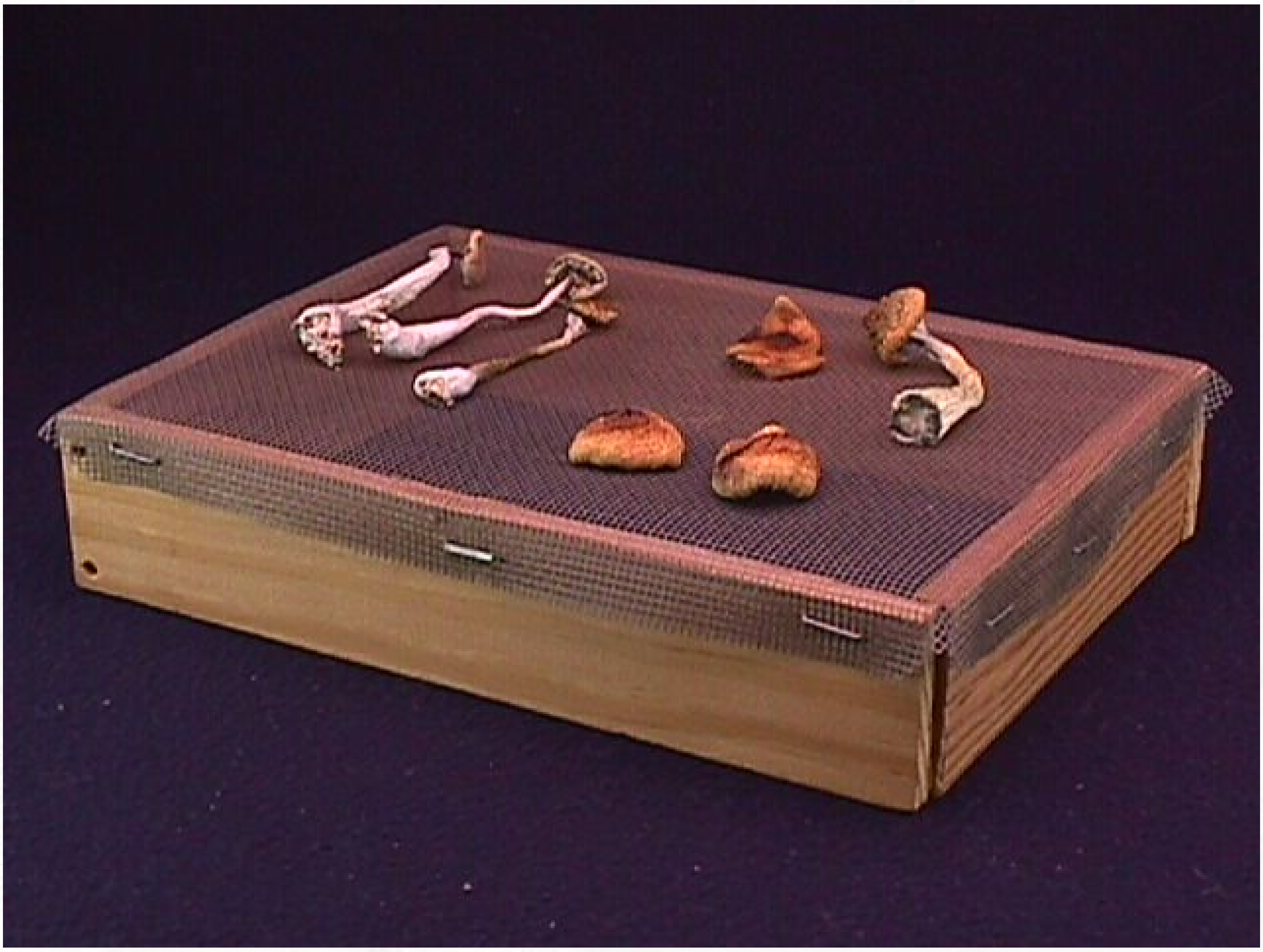
This terrarium was made by a plastics fabrication expert. It isn't cheap (like a poor mans Whalmart plastic storage box) but if you can find the right person - the cost is a bit more than the richmans dome above. It is made out of acrylic clear plastic. It is one piece, with a removable spray shield. At the top, is a spray hole with a rubber stopper. It is designed to hold one fruiting cake to maturity, but it can hold 4 cakes tightly. The cake inside is a first flush PF spore race cake - typical of a first flush obtained with the pf tek.

The terrarium is open bottomed so it fits over the cakes that sit on a tray. This is the most fool proof terrarium one can have. And it can be made bigger - as big as a ten gallon aquarium or larger. The plastics expert can make one just by looking at the photo and you giving him the dimensions that you want or by giving him the tray that you have to fit the terrarium to it. Very tricky - but it isn't hard to find someone (a professional) who can do it if you live in any kind of large town.

Table of Contents

CHAPTER 6 - COOL DESICCATION (drying) OF MUSHROOMS

The immature specimens are the best in quality, digestibility and potency. They are characterized as being very light in color with white stems and light colored caps. The cap will spread out after the veil breaks. Just before or right after the veil breaks is a good time to harvest. The gills on the underside of the cap will be light in color. The mushrooms will be conical shaped and sporulation hasn't really begun yet. These are the mushrooms that are the best for harvesting.



1. The easiest way to dry the fungi is to place them on a wire screen with air available to all sides. Never dry them in an oven or use hot air dryers. The heat leaches the chemical constituents and reduces their quality.
2. Using a frost free (dehumidifying) refrigerator works but it is time consuming and then everyone doesn't have a frost free fridge.
3. Using desiccant to cool dry mushrooms is overall, the best drying technique.

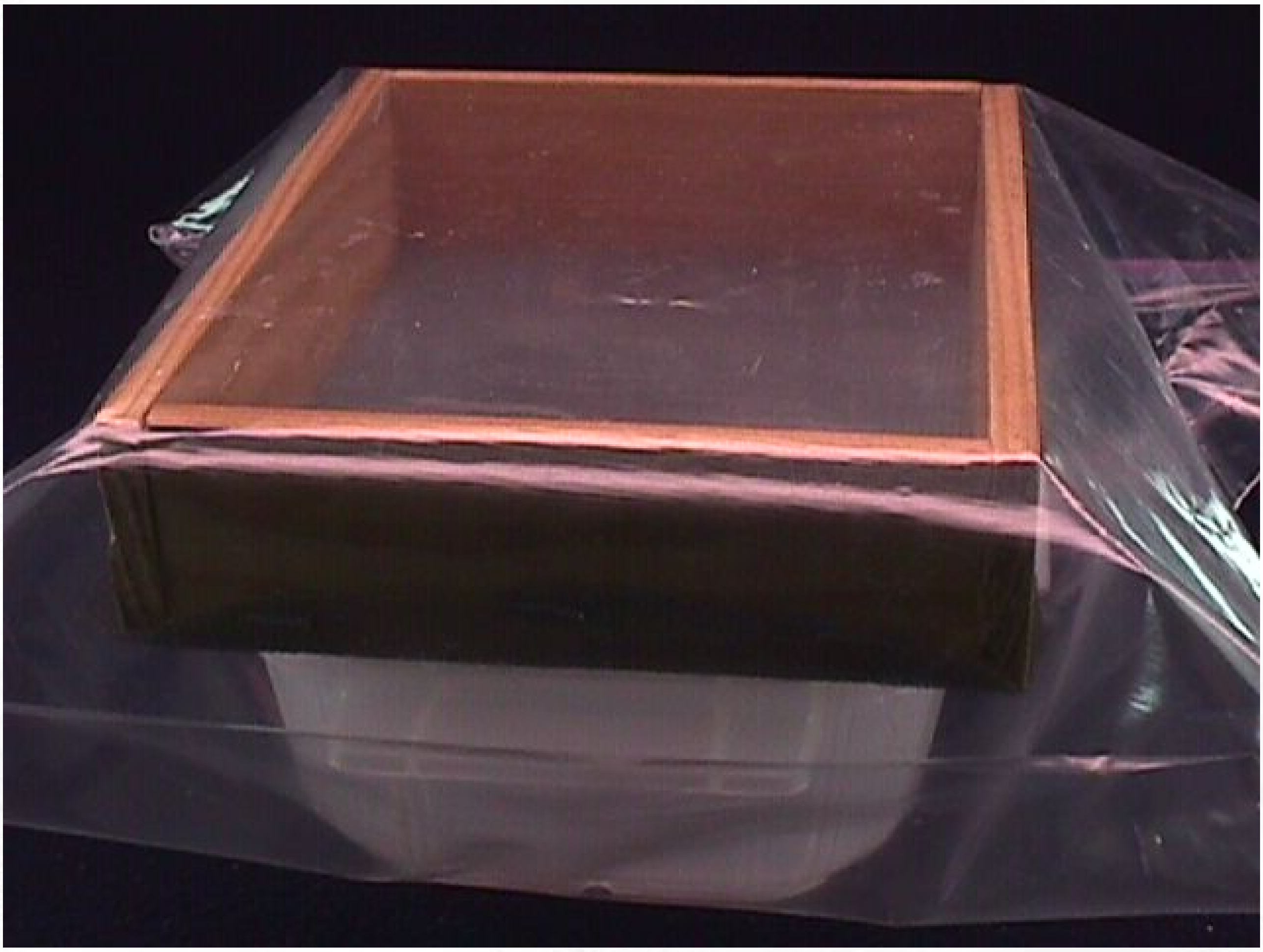
MATERIALS NEEDED - Desiccant - Wire screen - Plastic tub or container - Plastic bag with tie off.

DESICCANT SOURCES

1. "DRIERITE" desiccant. (chemical and science supply retailers). It is the universal lab desiccant.
2. Silica Gel granules - desiccant. (Chemical and science supply).

Note: These products might have toxicity warnings - (don't breathe the dust and try not to touch it directly - it dries skin.). Follow those rules, but know that desiccant in an airtight box and under a screen will do nothing to the fungi except dry them. It is completely safe for this use.

What desiccant does, is absorb moisture out of the air. As the fungus transpires moisture, the moisture is immediately absorbed back into the desiccant, drying the fungi. Desiccant can be reused and lasts indefinitely. After use, the desiccant is heated, dried and stored for future use. To be sure the desiccant is dry and ready to work, heat the desiccant in an oven as instructed by the manufacturer before its' first use. This preheating should be done before the desiccant is used because when it is purchased - it is usually somewhat damp which will thwart its function for drying air. Store it in an air tight container so that it stays dry and ready for use.

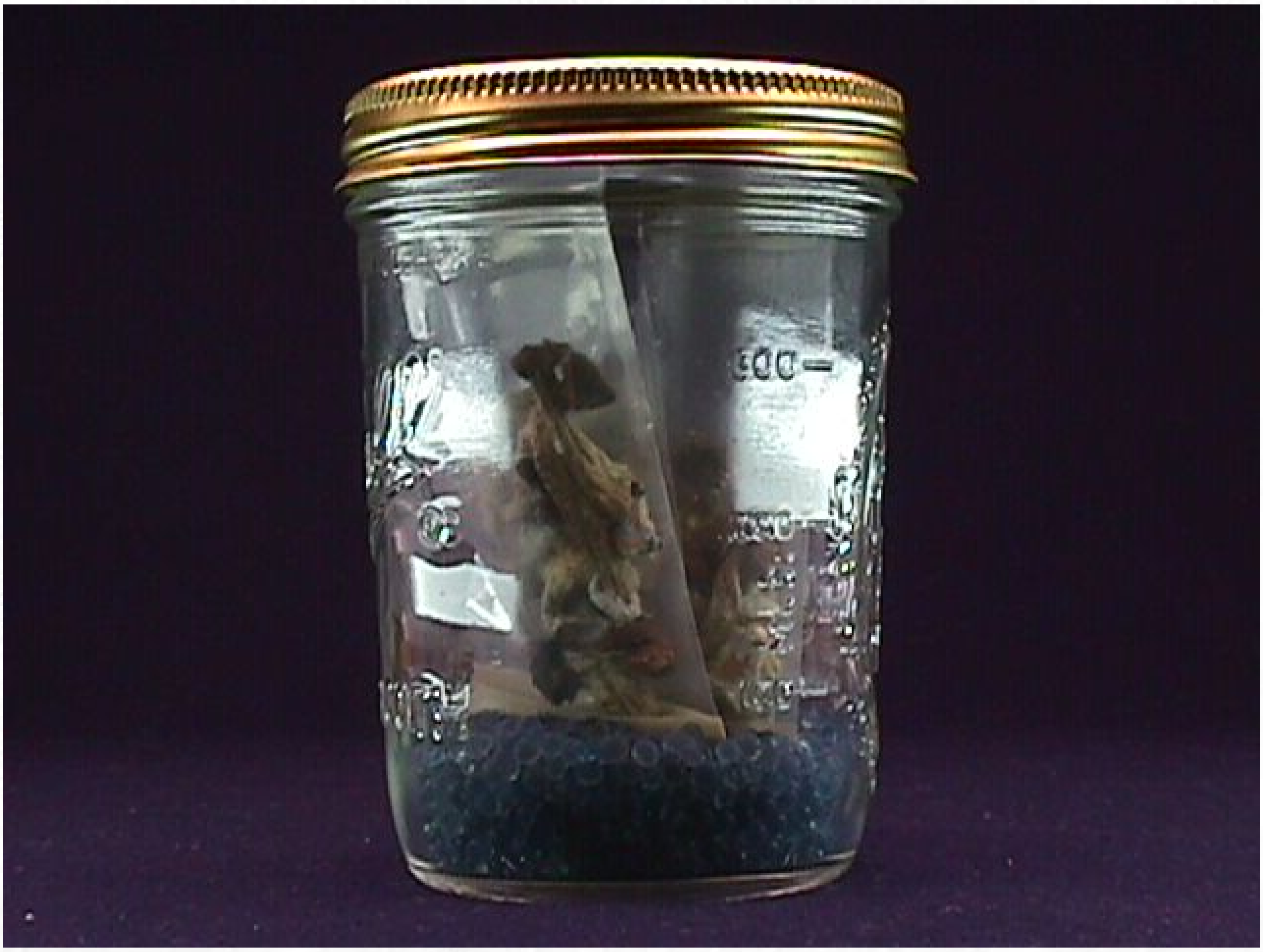


In drying a medium sized mushroom such as Psilocybe Cubensis, use a 1 to 2 inch layer of desiccant on the bottom of the container, under the mushrooms. Place the mushrooms on a wire screen and lay them on the desiccant that is in the container. Put the container with the shrooms and desiccant into a plastic bag. A garbage bag type wire tie is sufficient to close the bag. If a clear plastic bag can be found, use that to observe the drying process. After 24 hours, a little shriveling of the shrooms can be seen. About 4 or 5 days later, the shrooms will be dried rock hard. To check the drying - the stem should snap cleanly when bent.

For the best alkaloid preservation technique, the desiccant box can be put into the refrigerator and the mushrooms dried at near freezing temperatures.

Actually, about the easiest and most effective way to dry the mushrooms is to pre dry the mushrooms in the air on a wire screen. This works very well if the the room humidity is not high. After a couple of days, the shriveling fungus can be quickly and completely dried in the desiccant box. So a combination of air drying and then desiccant drying is one of the best ways there is to dry the mushrooms.

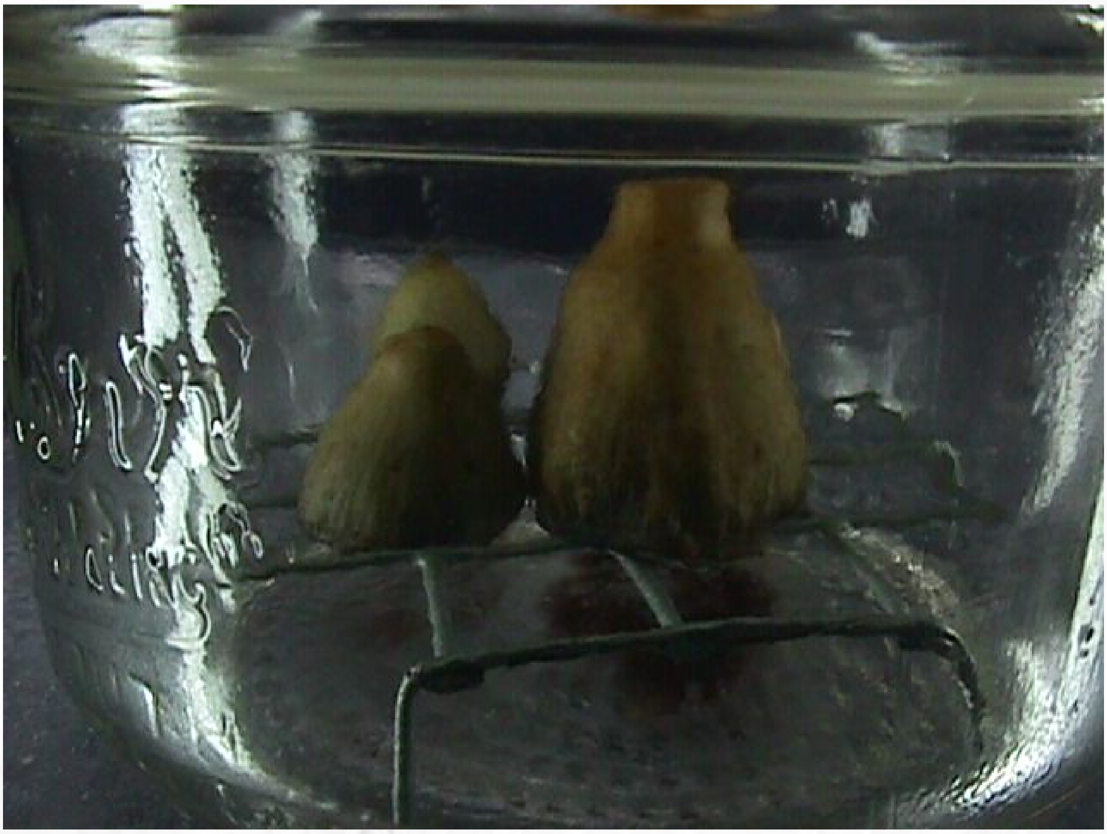
Mushrooms dried in this way lose hardly any chemical constituents and their truly desiccated state preserves them in their prime for months.



Store them by sealing them in plastic bags or keep them in canning jars with the rubber edged canning lid on tight (as in the photo - dried shrooms in little bags stored on top of desiccant). The freezer is a good place for preservation, but make sure the fungi are tightly sealed in their containers to protect them against the moisture in the freezer.

Table of Contents

CHAPTER 7 - SPORE PRINTING AND SPORE SYRINGE PREPARATION



Shroom caps printing while sitting on a wire holder.

The mature specimens are good for spore production, but are not as good for consumption (weaker potency). They are characterized as becoming darker, with dark bluish colors appearing on the caps and stems. The cap upturns and reveals gills darkening a deep brown color. The mushroom will look like an umbrella that has turned up edges. On the stem can be seen the purple deposits of the dropping spores. Mature adult mushrooms release spores by the millions. In the area around the mushrooms can be seen a deepening color of purple. As the spores fall and collect they will color deep purple. This is the signal that the mushroom has matured and is now in its sporulation cycle. This is the time to take their spores.

Spore Printing Equipment

KERR 1/2 PINT WIDE MOUTH (LOW FORM) CANNING JAR. (ANY SUITABLE JAR IS OK)
FINGER NAIL CUTICLE SCISSORS - (cosmetics - drug stores)
ALCOHOL, TEQUILA SHOT GLASS AND EYE DROPPER.

1. Pre sterilize the jar and regular metal lid (rubber edge up) in a small toaster oven at around 300 degrees Fahrenheit for around a half hour. Keep the lid loose during the sterilization cycle. When the jar has cooled down, tighten the lid until it is time to use the jar for a spore print. The rubberized edge will be a bit melted, but that won't be any problem in this technique.
   Note: What follows is a sterile technique. The first rule that must be always followed is to wash hands prior to sterile work. Hands are a prime source for bacteria and micro spore contaminants. Sterilize all the work surfaces with rubbing alcohol. Minimize drafts. Try for a still air environment. Don't breathe on the work. Run a small home appliance style HEPA air cleaner (99.97% rated efficiency - available at drug and department stores) for a few hours in a closed room to clean the air before doing sterile work.

2. Flame sterilize the scissors with an alcohol flame and snip off the mushroom cap. Cut the top of the stem as far up into the cap as possible so that the gills of the mushroom will sit flat on the surface of the

jar bottom. With quick and sure movements, place the cap into the jar and place the lid on loosely. Pierce the top of the cap with a straight pin to pick it up and handle it.

3. Leave the jar with a loose cap for a couple of days in a draft free area away from direct sunlight. After the print is taken, quickly and with as little air disturbance as possible, remove the jar cap and extract the mushroom cap from the jar. With a loose jar cap, let the jar sit in a draft free place to dehumidify for a few days before sealing it up (with tape) because there will be some residual moisture left behind on the spores and glass. Store the spore print jar at room temperatures in a dark place away from sunlight. Don't store it in a refrigerator.

Psilocybe Cubensis spores begin to degrade a few months after they are taken. After approximately 1 1/2 years, spore germination will be greatly reduced or won't occur at all. Germination is massive and quick when the spores are fresh.

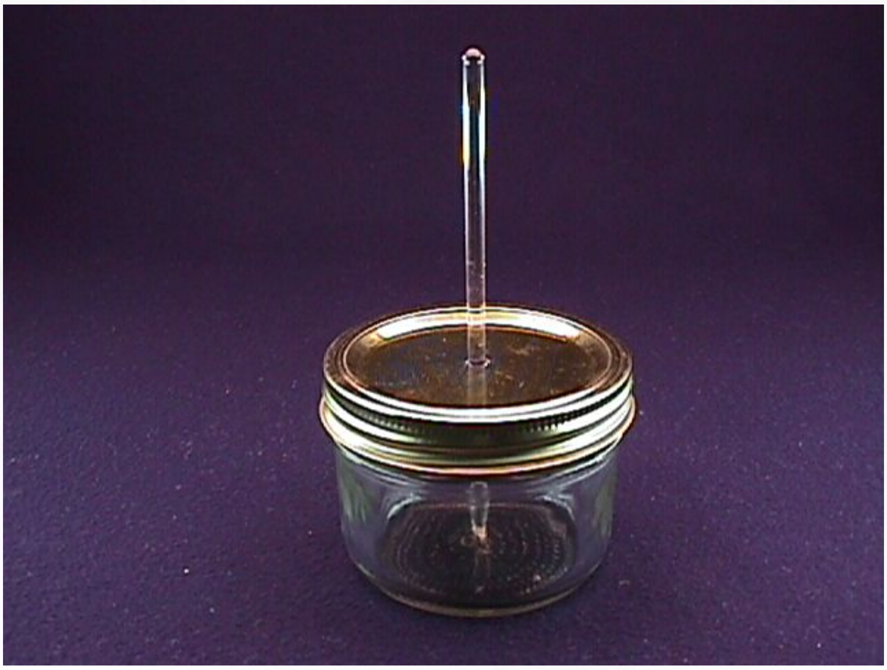
Making a Spore Syringe

Materials list:

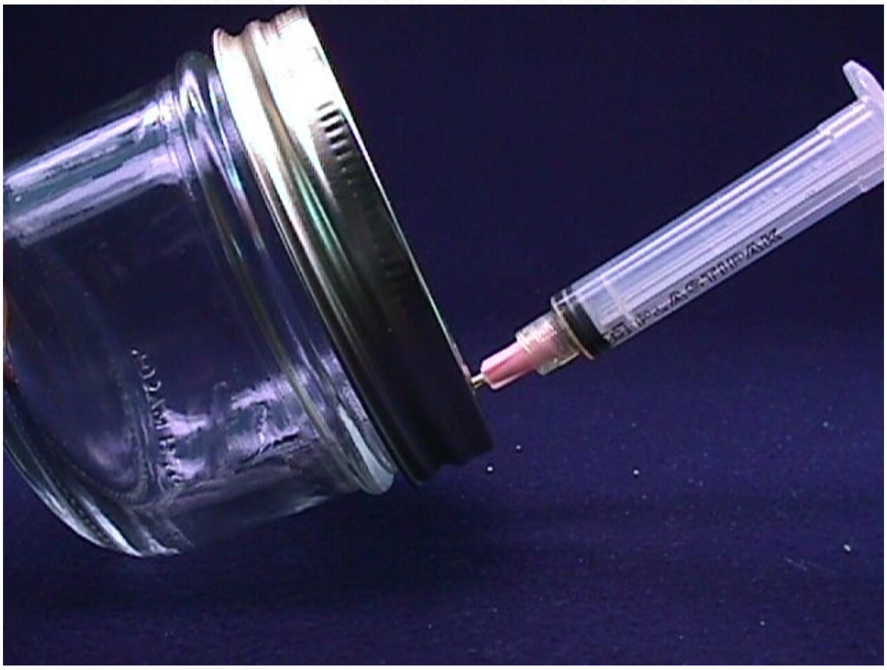
1. Spore print in jar.
2. Sterile syringe with water for injecting water into the spore print jar.
3. Empty sterile syringe for loading spore solution out of the jar.
4. A small Pyrex glass stirring rod (science - lab supply).
5. Alcohol, tequila shot glass and eye dropper.
6. Lid with two holes. Prepare this lid by drilling a hole in the center of the lid to fit the Pyrex glass stirring rod. Punch the second hole near the edge of the lid (rubberized edge up) to fit a syringe needle.

Syringe preparation

Boil a pot of water. Draw boiling water into a syringe and squirt it out several times. Refill the syringe with boiling water, replace the needle quard and wrap the syringe in tin foil. Prepare several syringes like this. Drop the syringes into the boiling water and boil them for one hour. Let them cool before using. Sterilze empty syringes also.
The main point of this technique would be to expose the interior of the jar to as little room air as possible. Always protect the holes in the lid by placing tin foil or sterile surgical tape over the holes before and after this procedure.



A glass lab stirring rod is used to scrape spores off the bottom of the jar and into the water (they stick to the bottom when printed).



The syringe is inserted through the needle hole and suctions out spore solution.

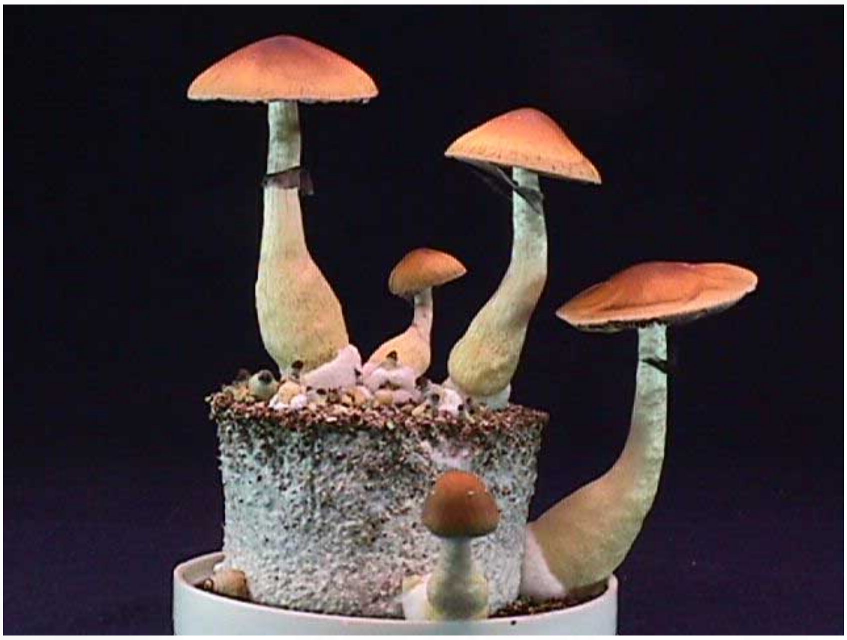
1. Inject sterile water into the spore print jar through the needle hole.
2. Flame sterilize the glass stirring rod and let it cool a minute. Insert it through the center lid hole and with the rod end, scrape spores into the water.
3. Insert the sterile syringe needle through the small hole at the edge of the lid. Tilt the jar until the water comes up to the needle tip and draw the spore water into the sterile syringe.

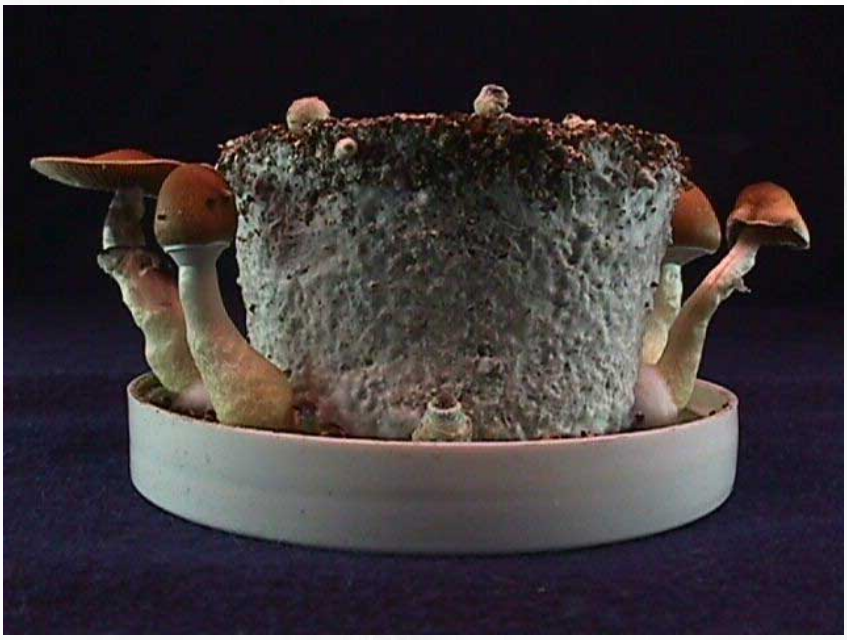
Store the syringe at cool temperatures in the dark. A properly prepared spore syringe will be good for several months and even up to a year or more.

Table of Contents

CHAPTER 8 - CAKE CASING TEK

The Double Ended Cake Casing Tek





The photo on the top is a second flush off of a PF spore race cake. The cake under the first photo is a third flush.

First: In Vitro Primordiation
There are many ways to extend the life of a cake and get more shrooms. The essential pf tek is to always allow primordia to appear on the cake in vitro. But not only that, wait for more. So when you spot the first primordia, wait around 3 to 4 more days before birthing. This stimulates more of them, and then your first flush will be fat. This invitro primordiation works well with most all of the spore races (strains) available. A few of the strains don't primordiate well invitro so they need to be birthed after about a month invitro, and then given the casing treatment.

Second: THE CASING TEK
Another really good way to max fruitings, it to not wait for the invitro primordiation. As soon as the cake turns completely white, it can be birthed and then cased. Immediately after the cake is first birthed is the time for a

casing. fill a jar cap with vermiculite, soak it and drain it. Place the cake on top of the wet vermiculite.

Next, pour dry vermiculite onto the top of the cake until it starts to spill off. Flaten the top of the vermiculite with your finger to about 1/8 to 1/4 nch depth. With an eye dropper or old syringe, slowly drip water onto the top dry vermiculite layer until it is soaked completley.

Spraying and maintenance

Once the top layer is totally soaked, place the cake into the terrarium and leave it alone. Follow the Terrarium tek.

Casing and Recasing

The cake whitening phenomenon

One of the most interesting effects of this tek, is the revitalization of the cake. After the initial fruiting, if it is really fat, the cake will be a bit blued. One of the signs of old age in PF cakes is the bluing that will occur. Most likely, the cause of this overall bluing of the cake is moisture loss and thirst of the cake. When the PF double ended cake casing tek is employed, the cake will gradually turn white again. After about a week under the casing tek, the cake will be completely white again and on its way to a good second flush.

This casing tek seems to work better if you completely clean the cake after the first casing flush and recase with fresh vermiculite. After the flush occurs, the top and bottom vermiculite layers should be scraped off and replaced. A good way to do it is like peeling an apple. Hold the cake in your hand without squeezing, and with a knife, scrap the old vermiculite off the cake. Try to clean down to the surface of the cake. The scraping doesn't hurt the cake at all because these older cakes become "tougher". The mycelium tends to be "tighter" and less fluffy and the cake becomes contamination resistant. This "toughening up" and recasing of the mycelial cake is also reported in the old OSS and OERIC (McKenna brothers) mushroom cultivation book published in 1976.

After the cake is carefully cleaned (rather a painstaking procedure but not difficult), the cake is placed on a freshly soaked and drained bottom layer of vermiculite (on a plate or in a jar cap). Then, fresh dry vermiculite is poured over the top of the cake and smoothed down to a layer of 1/8 to 1/4 of an inch and the basic casing wetting procedure is employed. The spray bottle offers a good way to drip water onto the casing. By slowly squeezing the spray lever, the water will drip out in single drops. You can also use an eye dropper. Slowly wet the top layer. If you apply to much water and it over soaks the vermiculite, the cake can be tilted and excess water drained from the top vermiculite layer.
After every flush - reclean the cake and apply fresh vermiculite. What this does is prevent contaminants from building up. The cakes stay uncontaminated and fruitable for a good two to three months. You can get several flushes out of a properly cared for cake. This casing tek keeps the cake white and uncontaminated for its life duration.

Table of Contents

PF TEK add on techniques

CHAPTER 9 - THE INNER RESERVOIR TEK

by JK

original source: http://www.fanaticus.com/resevoir.htm

Mazatec fruiting - PF style - 1/2 pint with the inner reservoir tek. The shrooms are all growing from the lower vermiculite layer (upper contaminant barrier when invitro).

Mazatec fruiting - the cake is still bright white with this first flush. Without the innver reservoir, the cake would be blueish (natural drying process - caused by water transpiration from the fungi).

Mazatec cakes fruiting in a plastic storage tub ("Sterilite" - "Rubber Maid" - Walmart - Kmart - Home Depot - ect). Vermiculite was used on the bottom - moistened for humidity. PF uses seperate caps for the bottom layers, but this a bit bigger. Vermiculite might be better than perlite - period. One can conceivable become "perlite free" as so many now are "peat moss free".

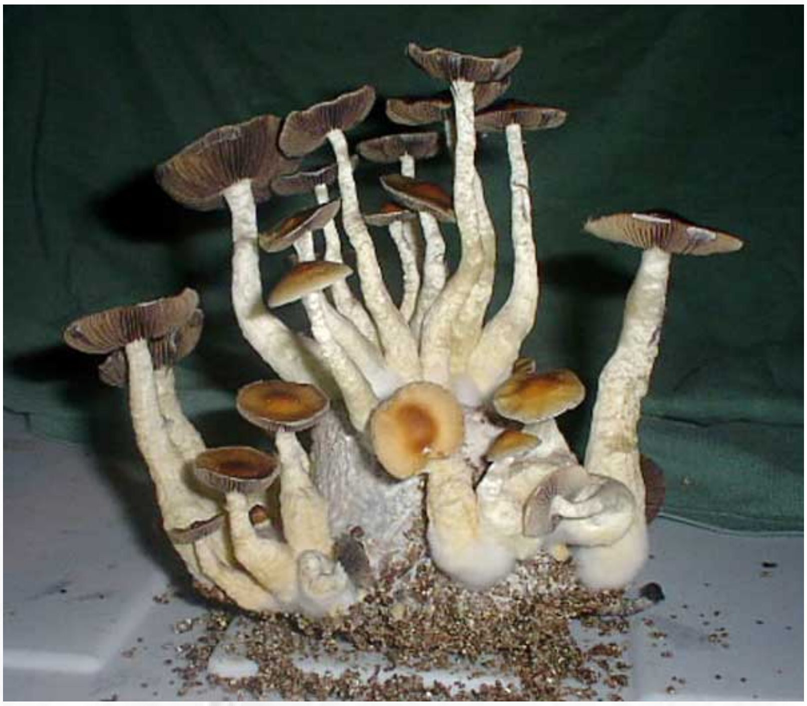
The Inner reservoir tek

The cakes are regular 1/2 pint low form canning jar size. The shrooms are the Mazatec and the Treasure Coast (see below) spore races from PF.

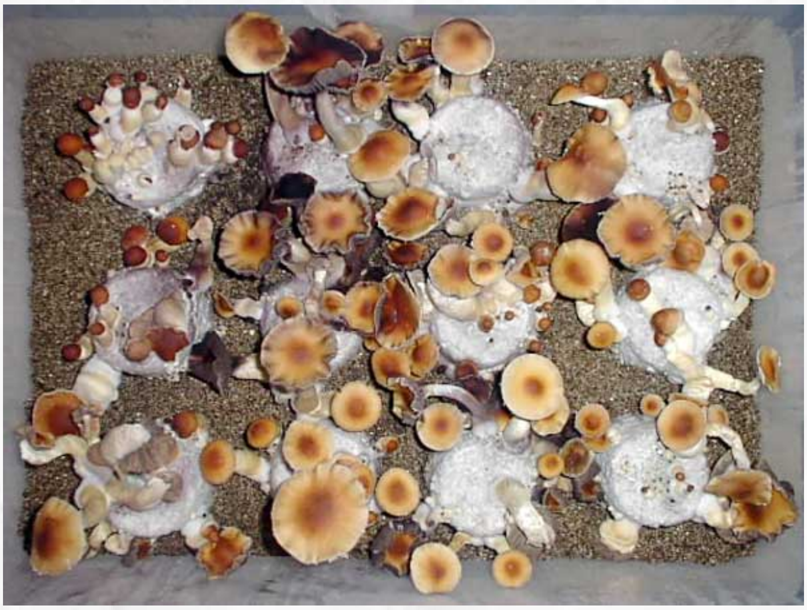
To do this is extremely easy. Everything is done standard PF TEK and when the substrate is loaded into the jar, use the end of a pen (a "sharpie" ink pen is perfect) and insert it into the middle of the substrate and make a hole all the way to the bottom. Any rod no more than 1/2 inch around is good for making the hole. A proper sized wooden dowel can be bought at any hardware store for cheap. If the substrate collapses around the hole or if the hole doesn't keep its shape, that means the substrate is to dry. Properly wet substrate works easy and the hole does not collapse.

Fill the jar with dry verm, proceed as usual and inoculate as usual. When the cake is birthed, inject 10cc of sterile water into the inner reservoir through the top (previously the bottom of the cake invitro).

This is more proof, that casing PF style cakes is not what makes a great PF style fruiting, but the water that is made available to the mycelium. Many beginner cultivators that experience great success with casing cakes, usually credit the casing mixture. But here is a fruiting that equals any cased cake, without a casing. It is the water that does it in conjunction with the potent fruiting potential of PF substrate.



PF classic with inner reservoir tek



PF classic inner reservoir tek cakes on soaked vermiculite bed.

Treasure Coast shrooms - PF style with inner reservoir tek. The cakes are sitting on moist regular potting soil (peat moss - perlite and vermiculite mixtures).

This is PF's first attempt with the inner resevoir using the Hawaiian spore race shroom.

PSYLOCYBE FANATICUS June 2 2002

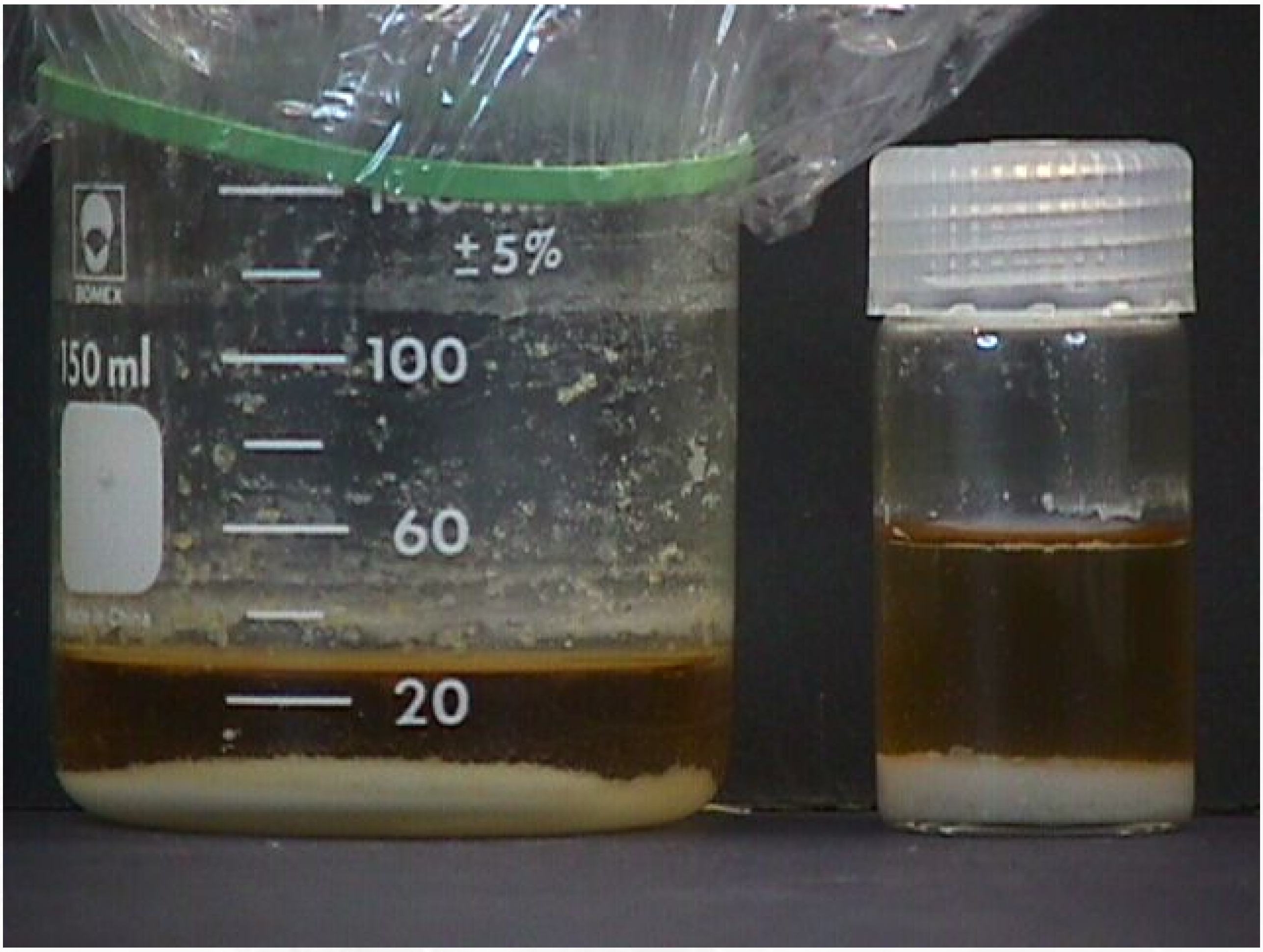
Table of Contents

CHAPTER 10 - CRYSTALS OF THE GODS

original source: http://www.fanaticus.com/mycoalki.htm

The following alcohol extraction tek is what I consider to be almost the greatest discovery in the history of the religious use of the ancient entheogens. In all the records and reports around the world of the use of natural plant entheogens, there is a universal truth. And that truth is that the plant entheogens demand a serious price to pay for them to show their wonders, and that price is a very bad stomach reaction. Usually, vomiting is a part of the experience. And that is because one has to take a lot of the plant material to get the entheogenic power therein. But this tek has changed all of that. Now, the easy to grow little mushroom - psilocybe cubensis is now the king of the entheogens. This mushroom is acknowledged as one of the "weak" entheogens". But not any more. It is now the most powerful of them all, put together. So when one adds this tek to the PF TEK, the pinnacle of entheogenic life and experience is effortlessly in the hands of all.

PF Magic Mushroom Liqueur Tek - Crystals of the Gods



Crystalline extract precipitated in 190 proof alcohol "EVERCLEAR"
Left beaker - extract from 16 grams dried shrooms
Right tube - extract from 9 grams fungi

MAGIC LIQUEUR - the ultimate trip - update

Many years ago PF experimented with alcohol extraction of dried magic shroom material. To make the story short, PF found the crystals. But, PF didn't mention that when PF wrote the PF mushroom extraction tek and published it in the PF TEK book (1996) and posted it at this web site.

PF has monitored the WEB for all of these years and has seen no posts concerning this amazingly easy way to extract and seriously concentrate the shrooms magic. PF has always said that this extraction tek solves the "problems" of impotent or mediocre magic shrooms.

Then, finally, this post appeared on the WEB at an interactive myco hobbyist web site:

Excerpts from forums

SEARCHER

By Searcher (Novice) on Saturday, November 16, 2002 - 06:29 pm: Edit
My most exciting piece of beginner's luck came when I got rid of some cakes that seemed stalled in their development (and/or had really uneven surface colonization) by splitting up and drying the mycelium for use in place of mushroom dust to create the liqueur described in the following link:
http://www.fanaticus.com/liqueu~1.htm
By letting the resulting liqueur continue to dry out, I wound up with amber colored crystals that could be crushed and placed in gel caps. A few hundred milligrams of this extract sent a curious friend of mine into orbit, and now he's been bugging the shit out of me to butcher ALL of my cakes to concentrate on this extract and forget about trying to grow shrooms. He claims the trips he got were much "cleaner" (whatever that means) and that the stuff certainly tastes better than the shrooms themselves.

By Searcher (Novice) on Monday, November 18, 2002 - 05:05 am: Edit
As I recall, there were about 6 or 7 jars that seemed to have good mycelial development, but colonization was very uneven, or so slow, that I abandoned them to put better jars in my grow chamber. Rather than just tossing out the slow jars, I decided to break them up and try Prof. PF's extraction technique. By the way, the alcohol seemed to absorb a lot of water from the air - it no longer smelled of alcohol, and the drying process slowed down a lot just before the amber tar and then the crystals appeared. I used no heat, but kept a large fan blowing on the liquid over a large, shallow cookie sheet.

By Searcher (Novice) on Tuesday, November 26, 2002 - 12:53 pm: Edit
Behold, cystals - little white snowflakes - just using 99% isopropyl---
----

By Searcher (Novice) on Sunday, December 08, 2002 - 02:55 pm: Edit
Here are the results from my first methanol soak:
Yielded 3.85 grams of crystals from 8 ounces of mycelium. But wait, there's more! Remember we're doing three, consecutive soaks. Looks like we'll be getting even more residues out of soaks 2 & 3:
Miscellaneous notes on the methanol: You'll note that this residue us lighter in color than residue gleaned from the water soaks. Also, this residue comes out dryer - no intermediate "tar" stage.

When the Professor instigated dialogue about SEARCHERS enthusiastic posts above, others joined in and found SEARCHER to be on the money. And here they are.

By Techno-hippie (Technohippie) on Sunday, December 22, 2002 - 04:58 pm: Edit
I tested my 20g dried shroom, 24cc Solution. AWESOME is all i got to say I had one of the BEST trips ever. We started with 1cc each and started feeling the effects almost immediately. Within 10min we where having the

full level 1 experience. We decided to take another CC, Took us to level 2.... Within 10 min. By this time it was hard to keep track of time. But we did 1 more CC and that was all we needed.
NO unpleasent side effects... No upset stomach, or dizziness... nothing negative. It was VERY euphoric, very clear. We were tripping hard, yet we could think very clearly. Couldn't always speak clearly but the thoughts were profound and clear. The visuals where awesome.... everything was so alive and beautiful. The moon was full... so that made for a magical evening.
The greatest thing about the extract was the control we had over the dosage. Each dosage was equal with magic content. Unlike when you eat the shrooms themselves where the magical content will be different from shroom to shroom. So, dosage isn't quite as accurate. I've split a bag of shrooms with a friend before and got off way more than he did... on the same shrooms. With the extract we both knew we were getting the same amount.
I've had tea, chocolate shrooms, cooked with magic.. even psychedelic coffee, and this is by far the best method of consumption. I will be testing how long the extract lasts in potency.
I had this in the freezer for a week... and it was still very potent.
Anyway guys... there is my experience with the liquid. Freakin awesome!
Thank you PROF and Searcher for bringing that tech. out to us. I've never heard of liquid shrooms until now! WOW!
I'll post my other experiments with this in time.
Peace & Light to all!!
Techno-Hippie

By J. Clay Mcwilliams (Jclaymcw) on Monday, December 23, 2002 - 09:50 pm: Edit
I've done the extract, and yeah the trip is different. I felt happier on the extract. No bad side effects. It didn't come on that quick though it was just a little faster than a regular trip and the peak was hard to determine. my friends who have side effects like stomach discomfort, headaches and bellybutton discomfort said that they had none of the usual side effects. It was everclear evaporated down to 3 grms per 8 cc.

By Techno-hippie (Technohippie) on Monday, December 23, 2002 - 11:41 pm: Edit
Looks like we got a winner here. Last night I tested the extract on some VERY willing friends of mine and they had the same experiences. One of them gets BAD stomach cramps and usually the shits when he eats shrooms or drinks tea... but with the extract he had nothing to report but pure bliss! They both had an amazing trip VERY similar to the one that I had and reported earlier. I think that for the serious tripper this extract could be the preferred method... I know it is becoming mine Take care all... Have a wonderful holiday, remember: the tree looks awesome with a pair of magic goggles!! Peace Techno-hippie
----

By Searcher (Novice) on Sunday, December 22, 2002 - 07:46 am: Edit
Almost any liquid will extract something from the shrooms themselves or the mycelium. Even water will work, producing a brown syrup that can be dried into a sticky tar. Only the acetone was a bust in extracting the magic - but it does extract some other crud that might make it a good pre-wash for more serious extraction's. Recapping the results of the tests using other spirits, 99% isopropyl, 151 proof ethyl alcohol, and 99.9% methanol - methanol was the hands down winner for getting the crystals. Once the pretty white crystals have dried, they can be re-dissolved in grain alcohol for a potent elixir. The crystals tend to absorb water from the air unless they are kept in a heavily desiccated chamber.

By Roo (Tehuti) Posted on Saturday, May 22, 2004 - 11:30 pm:
has anyone tried soaking shrooms in alcohol to get the goodies out of them? PF used to have a great Tek on his site regarding this. I have done it, and it works wonderfully. Its a very clean trip.

By roger rabbit (Skyypilot) Posted on Sunday, May 23, 2004 - 07:53 am:
Agreed, the liquor is the way to go. I like to stop the process just before crystals form, as it's easier to measure for dosing. When I notice the solids begin to separate from the everclear, add just a bit more everclear and heat the mixture to dissolve the solids back in. This seems to give the most potent, measurable dose, and it's

dependable. 1cc of the liquid seems to match 2g of dried product. The best thing is NO stomach upset.

By Solly the Printman (Soliver) Posted on Tuesday, June 08, 2004 - 10:18 pm:
Good stuff -
I followed a combination of PF's extraction and the guidelines I gleaned from Rog Rabbit -
Took one OZ shrooms (I used last year's batch of PR's - still VERY potent, but in need of consumption - I wouldn't be heartbroken if they were toasted, etc, due to my incompetence)
Ground up shrooms in the 'ol coffee grinder, Put them in a quart jar Added one PINT of everclear (Rog says 2 oz to a fifth is good, but I wanted to start with a smaller batch...)
I put it all together, shook, put on the counter, and shook it whenever I walked by. I meant to strain it all the next day, but it ended up sitting in there for about three weeks - I'd say I shook it an average of twice a day...
While it was sitting in there, about 1/4 of the everclear evaporated out of the jar - strange... musta been an air leak or something?
Anywho, yesterday I strained it through a metal strainer, then through a coffee filter, then through 2 coffee filters and ended up with about 250 ml of liquid.
Just for continuity's sake, I added a few ml's of everclear to make it an even 280...
so now 10 mls of fluid = 1 gram dry ...
tried 10mls in some grape juice yesterday, clean trip, no tummy problems (yeah!!) and a good time had by all (me, myself, and I).
If you haven't tried this, you should!!
(second post)
NO stomach upset, no weird ramp-up - it removes all the negatives of shrooms and leaves you with a wicked hit that blows your top off...
The first 15 ml was put into a small glass of cranberry juice and consumed. I went upstairs and got in the shower, as is my custom, and before I even had my hair washed it was coming on. By the time I was out, dry, and dressed, I was tripping my nads off - less than 15 minutes.
My wife and I agree that this stuff is almost too good - shrooms have a downside (for me) that keeps me in check - but the liquor takes that all away.
I don't think I'll ever chew a shroom or choke back a handful of stinky powder again - I'm soaking all my shrooms in liquor from here on out.
If you haven't tried this, I'd strongly suggest it.
I really understand why PF said that this is the most important drug discovery since the PF tek - he's right!
Sol

By Hippie3 (Admin) Posted on Wednesday, June 09, 2004 - 12:30 pm:

> *quote:*
> Would one have to use any more alcohol to extract if, say, one were using some 80 proof vodka rather than some 200 proof? Is absolutely all the magic extracted?
> no and yes. and it doesn't take more than a few minutes either. i've made my friends magic shots by soaking chopped freshies in whiskey 5 minutes or so then straining off the liquor into shot glasses, works every time.

How long does an extraction like this remain potent, and what is the best way to store it to retain potency ?
as for storage, adding some Vit C to the solution will help slow the breakdown. then the extract should be stored in cold dark airless conditions, like in an opaque bottle in the freezer. fill it nearly full to eliminate the air and then seal, should be good several weeks at least, depending on initial potency.

By The Lone Printman (Soliver) Posted on Friday, July 02, 2004 - 01:53 pm:
I dosed my own "elixir" last night yet again, and I can say that it's kick-ass... Of course, it's always good to start with potent fruits, but what your friend plans on doing sounds AOK to me - Pretty much the exact same thing I did except I let mine soak longer (I don't think it matters).
I took a double dose last night - woof! Good stuff, comes on within 10-15 minutes and peaks about an hour later. After a while, I swear I could see right through the table I was sitting at - seemed to cross the space-time

continuum (sp?) with my eyeballs...
I usually take my standard dose, then bump it 2 hrs later, but decided to hit it all at once last night - the effects were devastating - I was a puddle - it was awesome.
(ps -mine's been in the freezer for 2 months now with no loss of potency)

By ShedTheMonkey (Shedthemonkey) Posted on Sunday, October 03, 2004 - 04:33 pm:
My monkey's brother ground up 48 grams of dry mushies and put them in a quart jar, covered the mushies with 153 proof grain alcohol (best he can find in these parts) and put it in a double boiler situation. After a half hour of letting the alcohol boil (without letting the water boil), the whole mess was filtered with 5 micron filter paper in a Buchner filter system using a vacuum cleaner for the vacuum source. The liquid was put aside, and the dry filtrate was put back in the jar, covered with alcohol again and boiled for another half hour. Repeated filtration. Mixed the two extract liquids together.
The wife and I did a bioassay. She said her trip felt about equivalent to a 30 gram freshie trip. I felt about somewhere between 40 to 45 grams fresh. It was weird that from dry mushies that definitely have a distinct feel from fresh, the extract felt more like fresh and THERE WAS ABSOLUTELY NO TUMMY UPSET!! This was about the strongest dose I can take and not end up talking to the goddess at the peak.

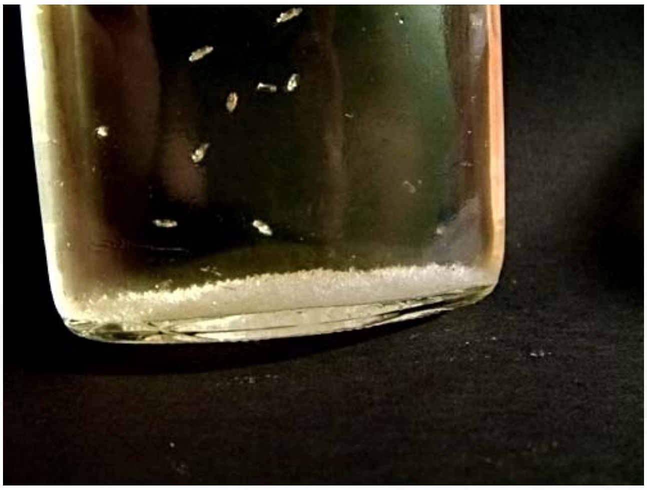
SHEDS CRYSTALS from 153 proof

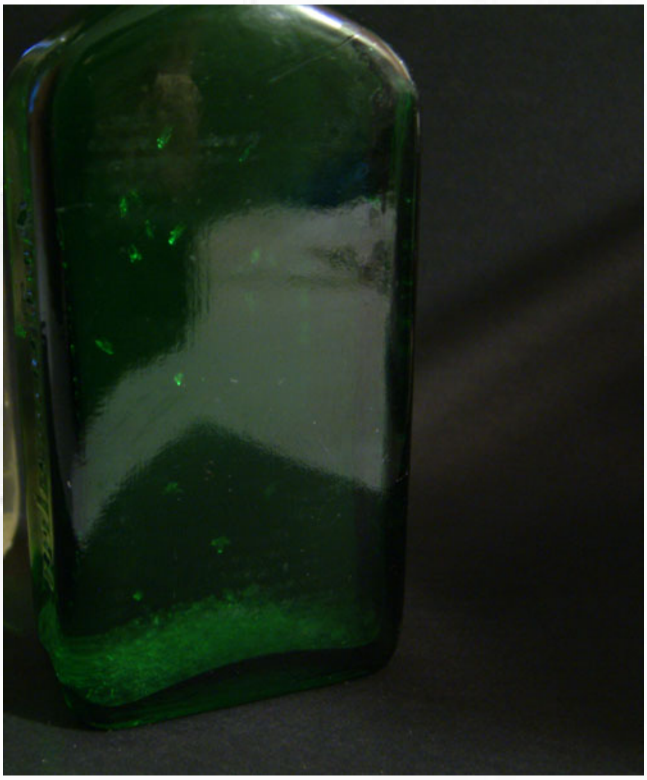
Warning on Alcohol Shroom Extraction

By Thoth (Dr_hyde) Posted on Wednesday, September 15, 2004 - 01:29 am:
I finished off the last few mils of my last extraction. There was a bit of sediment in the bottom of the bottle. I did not think nothing of it, and drank it expecting a 4 gram type trip.
I got more of a 20 or 30 gram trip. The sediment must have been almost pure magic. I have done 20 grams dried before and it was many times more intense than that. It was totally freaking insane. Actually quite interesting, but not something I hope to do again in a few years or so.
This was about 200g of dry material to everclear, the BIG bottle. Its been in the freezer for 4 months, gave most of it away, guess I got the best part.
Stranger yet no bad stomach at all. I had to force myself to purge.
It just wore me out, very tired.

The Crystals of the Gods

(anonymous experimenter who followed the Professors 190 proof extraction TEK)





By Suckerfree (Suckerfree) Posted on Wednesday, August 18, 2004 - 07:26 pm:
March 5, 2003

Psilocybe Mushroom Extractions

Dear Dr. Shulgin:
A friend of mine performed a Soxhlet extraction of 12 grams of powdered Psilocybe cubensis, using 95% ethanol. When the 60 mL of extract cooled to room temperature, many small transparent, colorless crystals had formed on the bottom of the container and did not redissolve on agitation. Do you know what these crystals are? -- Journeyman

Dear Journeyman:
There is a fascinating report in the literature that gives a quantitative measurement of the efficiency of extraction of both psilocybin and psilocin from the mushroom Psilocybe bohemica. The citation to the article is Kysilka, R. and Wurst, M., Planta Med. Vol. 56 pp. 327-328 (1990). These Czechoslovakian scientists studied the efficiency of both methanol and ethanol as solvents, each containing varying amounts of water. The results were, to me, both unexpected and most provocative.
The isolation of psilocybin seemed to be quite reasonable. This alkaloid is reasonably soluble in boiling water from which it can be nicely crystallized. It is less soluble in boiling methanol, and almost insoluble in boiling ethanol. And the extraction efficiency is optimum with methanol and almost as good with ethanol. With both, the less water present, the better. The compound is, after all, a perfect example of a zwitterion, the internal salt of a phosphoric acid and an amine base.
But the numbers with psilocin are strange. With aqueous ethanol, the optimum extraction was with a 70% ethanol concentration, and the extraction efficiency dropped almost to zero when there was no water present. But methanol was extremely inefficient regardless of the amount of water present in it. These researchers were apparently surprised by these findings, as they explored further and uncovered other clues. Time is a factor. Psilocin is extracted at a much slower rate than is psilocybin because it is contained intracellularly in the plant, and thus slower to be gotten out. They conclude that many of the low psilocin assays of mushrooms are due to this difficulty of getting the alkaloid out of the plant and into the extracting solvent. Using this information they determined that the levels of psilocybin and psilocin are substantially the same in Psilocybe bohemica, in conflict with the published literature values where very small amounts of psilocin were observed.
Efficient extraction apparently requires patience.
As to the identity of the crystals that were drifting around in the cooled Soxhlet receiver, from their being insoluble in ethanol, and white, and transparent, I would guess that you are seeing pure psilocybin.
-- Dr. Shulgin

GOTTLIEB

Then, after a little interaction at the web sites, PF found this extraction tek taken from a book by Adam Gottlieb at the EROWID web site.

THE PSILOCYBIN PRODUCERS GUIDE
by Adam Gottlieb 1976

Extraction
Crumble and pulverize the dried mycelial material and combine each 100 mg of this material with 10 ml of methanol. Place the flask in a hot water bath for four hours. Filter the liquids with suction through a filter paper in a buchner funnel with Celite to prevent clogging. Collect and save the filtrate liquids. Heat the slurry (the mush in the filter paper) two more times in methanol as before, filter, and accumulate the liquids of the three extraction's. To be certain that all of the alkaloids have been extracted do a small extraction with a portion of the used slurry and test with Keller's reagent (glacial acetic acid, ferrous chloride, and concentrated sulfuric acid). If there is a violet indication, alkaloids are still present and further extraction is in order.

In an open beaker evaporate the liquids to total dryness with a hot water bath or by applying a hair dryer. Be certain that all traces of methanol have been removed. The remaining residue should contain 25-50 percent psilocybin/psilocin mixture. Greater purification can be achieved, but would require other solvents and chromatography equipment and is hardly necessary.

Each 100 grams of dried mycelium should yield about 2 grams of extracted material. This should contain at least 500 mg of psilocybin/psilocin mixed or about fifty 10 mg doses. Theoretically psilocin should have the same effect upon the user as psilocybin. The only difference between the two is that the later has a phosphate bond which disappears immediately after assimilation in the body. In other words, in the body psilocybin turns into psilocin. Psilocybin is a fairly stable compound, but psilocin is very susceptible to oxidization. It is best to keep the extracted material in a dry air tight container under refrigeration. A sack of silica-gel can be placed in the container to capture any moisture that may enter.

Dosage
The standard dose of psilocybin or psilocin for a 150 lb person is a 6-20 mg dose. We will figure the average dose as 10 mg. The crude alkaloid extraction process given here yields a brownish crystalline powder that is at least 25 percent pure. Each mason jar should contain at least 50 grams of wet mycelium. After drying this would be about 5 grams of material. The crude material extracted from this should contain 25-30 mg of psilocybin/ psilocin or roughly 2-3 hits. This yield may very to some extent depending upon several factors. Many of these species contain less of these alkaloids than dose Psilocybe cubensis and the alkaloidal content of this species may very in different strains. Cultivation conditions have a lot to do with yield too. Higher temperatures (75 degrees F.) cause more rapid growth but lesser psilocybin content than do lower temperatures (70 degrees F.) One must test each new batch of extracted material to determine the proper distribution of dosages. Depending on the potency of the mycelia and how well the extraction was conducted the dose may range between 25 and 100 mg. Also bear in mind that the dose varies for different individuals.

STAMETS

Paul Stamets even mentions extraction in his 1996 book - "PSILOCYBIN MUSHROOMS of the WORLD". Quote - page 50-51 "Another method I have seen is to soak crushed mushrooms in 75+% ethanol. After two to three days, the roughage can be filtered, leaving a dark- blue elixir that can be decanted accordingly. For every fresh 5 grams of mushrooms, 25-30 milliliters of alcohol is recommended. Psilocybin and psilocin dissolve into this solvent, and the alcohol also acts as a preservative. I really don't have much experience with this technique, but have talked to people who say it is their preferred method. Some call this "blue juice."

Stamets tek is not very good for several reasons. He says to start with "fresh" shrooms. It is always the best way to first dry the material to be extracted. Water gets in the way of the solvent. "BLUE" is not good either. Bluing is evidence of the magic being broken down or compromised. I think it is the "fresh" material that does that. Dried material does not blue. Bluing is damage and occurs with bruising of the shroom flesh. Stamets again says on page 56 - "...the more the mushrooms are bruised (blued) the less potent they become."
But what is important about the Stamets quotes, is that he knows people that believe extraction is the superior way to go for the magic.

Mediocre Rating for Cubensis

The only criticism that has ever been directed towards the Psilcobye Cubensis specie is "On the psilometric scale of comparative potency, P.Cubensis gets a rating of "moderately potent," - P. Stamets. That is not the best. And it seems, that potency is the number one goal of all the seekers, accept the new cadre of shroom growers on the web that are more interested in the hobby of mushroom growing than any magic production.
This extraction technique is the answer to the serious seekers of the magic. What PF would recommend is to extract with easy to get liquor store 190 proof ethanol, and make magic shroom liqueurs and elixirs. The advantage of the liqueur is that it is a good way to preserve the magic crystals. Exposing magic crystals to the air is a quick way to breakdown. But in a freezer in an elixir of alcohol, the magic crystals can certainly last a lot longer. This way delivers potency far far beyond any natural magic shroom. When one considers the extract magic in doses of around .1 - .3 gram, no magic shroom can deliver that, unless extracted. So that puts the lowly Psilocybe Cubensis to the top, because of its one really great attribute - THE EASIEST TO GROW - by far.

This technique describes how to extract psilocybin from magic mushrooms with pure 190 proof ethyl alcohol and make a magic mushroom liqueur of concentrated psilocybin to effect a powerful psychedelic dose as potent as desired. The entire process involves only the shrooms and alcohol. The alcohol is untainted with chemicals and poisons because it can be easily acquired from a liquor store (United States) either over the counter (in some states) or with a special permit (most states - see end of article section - "procuring 190 proof ethyl alcohol from a liquor store").

Alcohol Extraction of the Magic Crystals

by Professor Fanaticus

Supply list:

1. Shrooms
2. 190 proof ethyl alcohol (GOLDEN GRAIN - EVERCLEAR ect)
3. Pyrex glass wide mouth slurry soaking vessel
4. Stove top boiling water pot (slurry vessel sits inside) "double boiler"
5. Funnel, and vacuum filtering set up or Dust-pollen masks
6. Small desk fan
7. Stirring tools - spatulas

Acquire quality psilocybe cubensis shrooms (harvested before or just as the veils open and cool dried with desiccant). The more shrooms used in the beginning, the more potent the concentration can be when finished. Use at least several grams of dried shroom material to make the process worthwhile and effective. The shrooms need to be thoroughly dry (rock hard) to allow pulverization. To pulverize the shrooms, put them into a small strong zip lock plastic bag (freezer bag), cover the bag with a magazine (for protection of the bag) and pound it with the rubber heel of a large shoe. Or, powder them in a small canister type coffee bean grinder.

In a heat resistant soaking vessel (Pyrex glass), combine the shroom powder with several times its volume with 190 proof Everclear (ethanol). This is the "slurry". Place the slurry steeping vessel in a pan of boiling water. Raising the slurry soaking vessel off the bottom of the hot water pan is a good idea for preventing serious sticking of the extracts. The slurry will start to boil. Turn the water boiling pan heat down and let the slurry simmer and steep for a few hours at a warm-hot temperature. Alcohol boils at a lower temperature than water. Watch the temperatures closely. Things can get totally out of hand and ruined very quickly without close attention paid. Stir the hot mixture periodically and often to keep things loose with no sticking.

After the hot steeping and while the slurry is still hot, filter it through filter paper. This is probably the most important part. A good filtration will be efficient and will keep most of the shroom material out, making for a clean extraction (clean of shrooms that is - but heavy on psilocybin). A small lab type vacuum pump powered bottle top filtering funnel with filter disk holder makes it all easy and fast, with little waste.

Collect and save the filtrate liquids. Heat the slurry (the mush in the filter paper) one or two more times with the 190 proof as before, filter, and accumulate the liquids of the extraction's. The photos at the top are of extraction's done twice.

If there is no vacuum filtering device at hand, inexpensive dust-pollen masks make good filters for the slurry. These are available at hardware, drug and paint stores. They are usually white or tan colored, fit over the nose and mouth and are held on to the face by a rubber band attached to the filter. Fashion the filter over the mouth of a drinking glass. Squeeze the filter and slurry to extract the alcohol. There are many details to deal with, but doing it once reveals them all. Experience is the best teacher. Store the extracted alcohol in a fresh bottle.

Evaporation and Concentration

Combine the filtered alcohol extracts into the Pyrex steeping vessel. Place a small electric fan near the vessel and point the air flow directly down into the vessel until the surface of the alcohol ripples. This will speed the evaporation and concentration. The process will take several hours. The more alcohol extract - the longer the evaporation time. As the alcohol evaporates and the level recedes down into the glass, wash the residue that adheres to the inside of the glass back into the solution. Any fumes that are generated will be harmless because the alcohol is a non poisonous drinkable spirit. Keep flames away from the solution - pure alcohol is very flammable.

One can also use heat to evaporate and concentrate the liqueur. Use a double boiler type of set up to heat and evaporate off the alcohol to concentrate the liqueur. At this point, with hot concentrated liqueur (no crystal precipitate) it is best to go immediately to the storage tek (see Dosage and Storage at the end).

The concentrated shroom liqueur will have a pungent mushroomy aroma (like fungi perfume). Also, a white crystalline kind of precipitate will form in the alcohol liqueur (see above photo) as it cools. Store it in small screw cap bottles or vials in the freezer. Alcohol doesn't freeze solid and will remain liquid.

Important Guidelines

1. Use warm-hot temps when steeping the initial slurry (shroom-alcohol). Use a double boiler for the slurry vessel. Avoid direct heat to the bottoms of the slurry soaking vessels. The extract has a tendency to bake on and stick very easily.
2. A good filter is a must. Lab quality filter paper helps for a cleaner extract (less shroom stuff). A small bottle top vacuum filtering funnel with a hand squeeze vacuum pump and fine slow flow filtering papers is perfect for this small extraction tek (look for the 47 millimeter filter sized set ups).
3. When filtering the slurry, do it while it is hot.
4. When heated in the initial slurry, the psilocybin alkaloid extracts are free base molecules. In the final liqueur on cool down, the free base molecules will coalesce and form crystals. It takes a day or two for the process to be complete. The less the final amount of liquid is, the easier it is for the free base psilocybin molecules to meet each other and coalesce into the whitish crystalline substance.
5. The crystalline extract can be completely dried by placing the liqueur container in front of a small fan to get most of the liquid out. To complete the drying, desiccant is recommended. Place the small vessel of liqueur into a larger jar with quality desiccant. It takes several days to complete drying. The final crystalline substance can be weighed, worked with and experimented with.
6. TEK personalization through experience is what happens to anyone trying this. Extracting plant material is an ancient art, and the ways are myriad.

Dosage and Storage

On cooling and with time, the free base psilocybin molecules coalesce in the liqueur and precipitate into a whitish crystalline extract which falls to the bottom of the storage vessel. The freebase Psilocybin molecules come together fast in the cool alcohol.

Storage and dosage prep is the same. If the liqueur has already precipitated the crystals, heat the final concentrated liqueur (for example - 20 grams of dried shrooms can be extracted to 50-100 milliliters alcohol) in its storage vessel in a pot of hot water. Boil the liqueur and stir and scrape deposits from the glass as the liqueur boils lightly. Alcohol boils at a lower temperature than water. Keep the storage vessel off the bottom of the boiling water pot. Direct heat is very bad for the liqueur, making it stick. As the liqueur boils, the crystals and extract will remelt with time. The large particles of the crystals can be crushed with a long needle probe to hurry up the process. When the crystals are dissolved, administer the magic liqueur while it is HOT. Using a syringe enables uniformity and accuracy of the dosages. Keep the liqueur stirred up to keep it uniform. The hot liqueur quickly becomes cloudy (precipitate) on slight cooling. A hot temperature of the liqueur with remelted crystals is important for accurate dosage administration.

While it is hot, dispense equal portions of the liqueur (10cc-20cc) into small storage jars with watertight caps. Each small jar is allowed to cool, the cap is put on and the jar is placed into the freezer for storage. Each jar is equivalent to an exact fraction of the original dry shroom weight so that dosage can be accurately controlled and determined.

When it is time to trip, the desired liqueur jars (with potency ratings) are removed from the freezer, allowed to warm to room temps, the lids taken off, a small fan is set up blowing air across the jars mouths and the liqueur is evaporated off to a manageable "hit" (variable alcohol). The small jars then become administration vessels where the entire contents (alcohol-water-crystalline extract) can easily be completely consumed.

Procuring 190 Proof Ethyl Alcohol (Everclear - Golden Grain et) From a Liquor Store

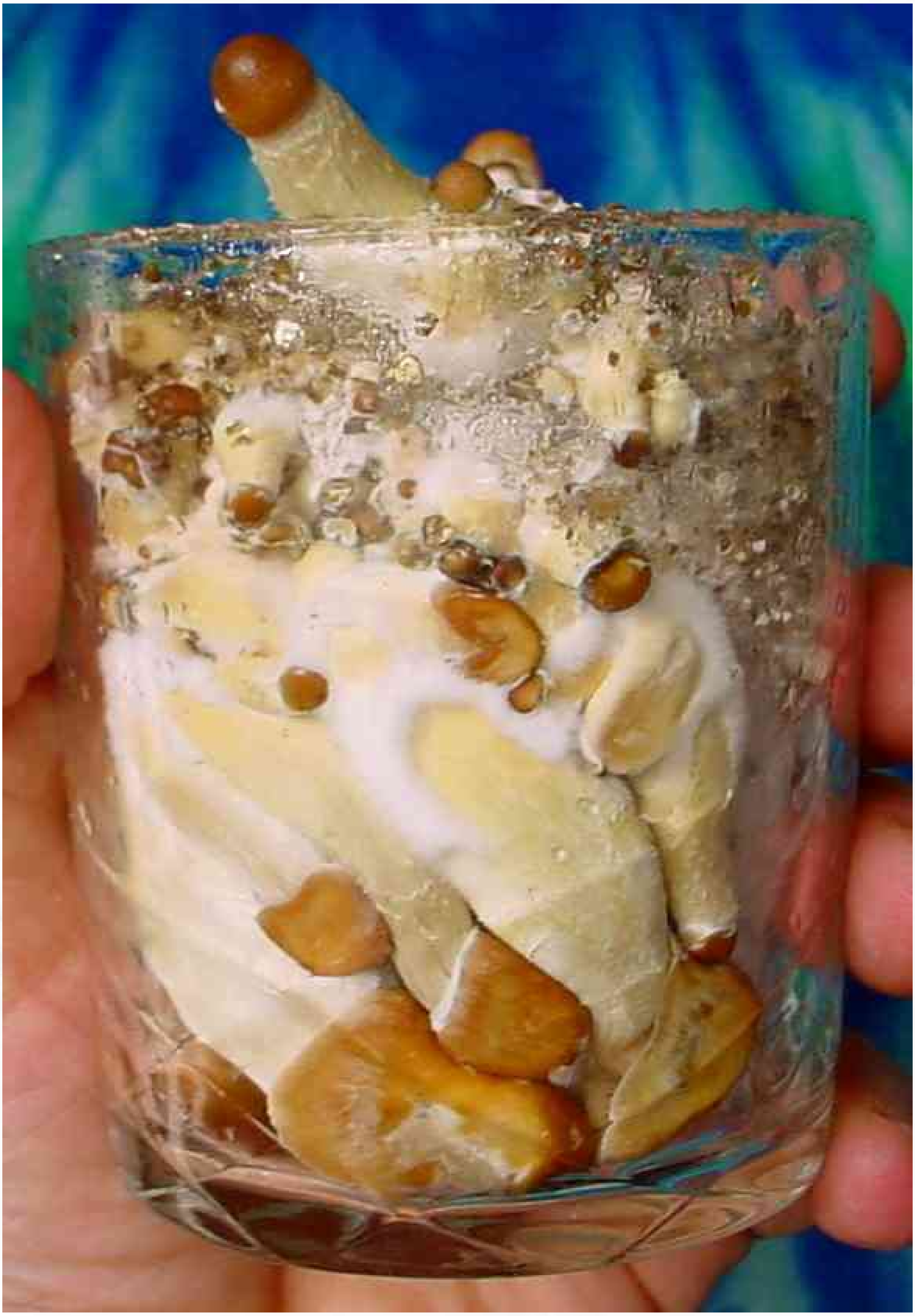
First, call a well stocked liquor store and ask if they have 190 proof ethyl alcohol. Full service liquor stores supply hospitals and laboratories with 190 - 200 proof ethyl alcohol. If a permit is needed, call the state liquor board (usually in the State Capital) and ask for an application to get an ethyl alcohol permit. The fee is 5 or 10 dollars. On the application will be a question asking what the use of the alcohol will be. Write what they more or less want to hear. State that the use of the alcohol will be for "non-toxic surface sterilizing plus herb extraction - preservation - tincture - and perfume making" (or something to that effect).

Professor Fanaticus
2005

Table of Contents

CHAPTER 11 - PF INVITRO TEK

original source: http://www.fanaticus.com/invitro.htm



This is a photo showing a cake grown in a glass jar that was allowed to fruit invitro. It is the standard PF TEK but with a little difference in the approach.

From the beginning (since 1991) of the essential PF TEK, PF has shown the importance of the appearance of primordia while the cake is still in the jar. Invitro "primordiation" is one of the fantastic attributes of the PF TEK. This invitro "primordiation" is not a feature of any other growing tek, but it is with the PF TEK.

Letting the primordia grow inside the jar (invitro) is a great way to grow these shrooms on the simplest level. Birthing is eliminated (accept for harvesting) and terrariums are eliminated. One of the really excellent attributes of PF INVITRO growing is what is being called "STEALTH". Stealthy growing is becoming very popular because one can hide the grow op. There was a posting on the net that someone did where he put the jars in an old dirty 5 gallon white bucket and on top of the jars, he placed old microphone cords and speaker cables, totally concealing them. An interesting thing he did, was that he birthed the cakes before they fruited or formed primordia invitro and cut them in half (1/4 pint sized cakes). He then filled the jar caps with vermiculite, soaked the vermiculite, placed the small cakes on the wet verm and placed the jar over the verm filled jar caps and cakes. He got a decent yield of quality shrooms, and he did it while they were all concealed in the white 5 gallon bucket and in the paranoid days we all live in, smart.

The Heartbreak of mega cultivation

When one is experienced in the different styles of shroom cultivation, a similarity of results is seen. A pile of dried and shriveled shrooms from a mega beautiful elaborately set up shroom cultivation, looks no different than a pile of dried and shriveled shrooms from a less than mega beautiful shroom cultivation. In other words, the beautiful full sized perfect looking specimens from a mega cultivation (trays - compost - ect), dry down and actually look no different than the little "ugly" convoluted shrooms from such a TEK as the PF invitro tek. The real difference is the emotional impact of "destroying" a shroom fruiting that one has worked on for a couple of months. When the shrooms begin to attain full size, there are two choices, either to pick them before they reach maturity (full size) for max quality, or to let them grow to maturity for spore printing. Whatever the case, the shrooms are doomed to be picked and then they aren't so pretty anymore, but become a pile of shriveled shrooms.

The real difference in this interpretation of the PF TEK and a mega cultivation (traditional teks) is that there is no "heartbreak" when harvesting the shrooms from a micro tek where the shrooms don't attain the magnificent stature of mega cultivation (traditional ways). When the shrooms appear inside the jar (PF invitro tek), it is easy to just take them and dry them. There is no "destroying" months of work or "ruining" a magnificent stand of shrooms before you get to even know them. There is only the harvesting of powerful psychedelic fungus, APPEARANCES BE DAMNED. That is really what the invitro PF TEK is all about. But then, if good looking specimens are desired, the PF TEK with a good casing procedure (PF double ended cake casing tek recommended) delivers the goods there also.

Dunking the Cake

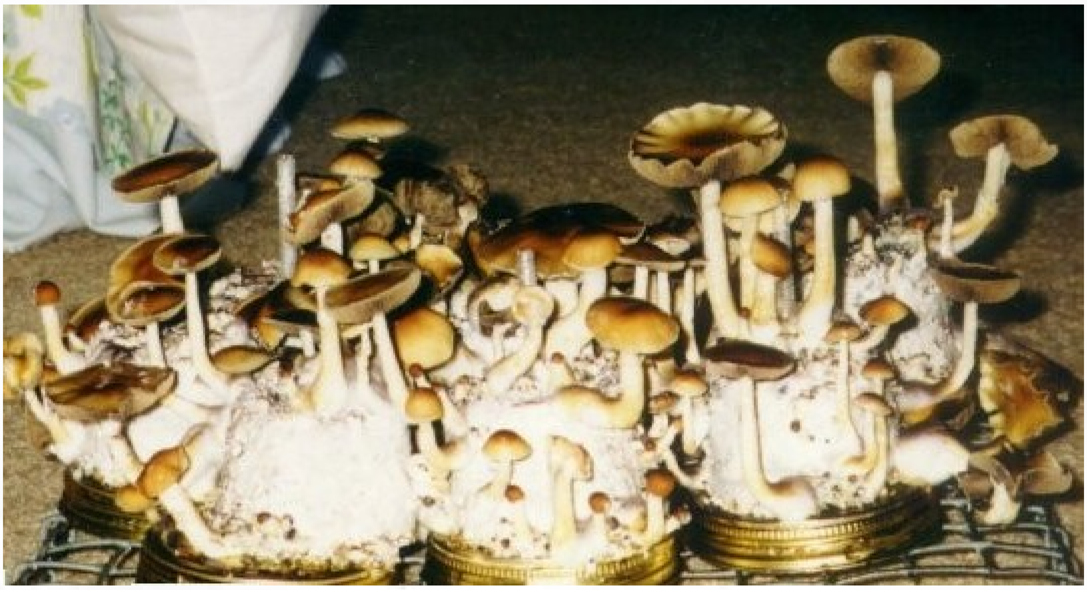
Another PF style grower added to the PF invitro style tek, and that is what is called "DUNKING". This is where the cake, after it is birthed and the invitro shrooms are harvested, is dunked in water for about a day or less. The cake will float and it has to be weighed down so that it goes under water all the way. The best way to do that, would be to take a cleaned cake (all shrooms and aborts harvested), fill the grow jar with water, put the cake in and put the lid on so that the excess water comes out. Let it sit for no longer than a day, and start the process over again by putting the dunked cake into a new jar for another flush. This can be repeated until the cake turns green with mold. Several flushes can be had this way and the yield can be about 6 dried grams total or more per invitro cake. This dunking technique is well established in the realm of growing normal shrooms. Shitake inoculated logs are routinely submerged in water to stimulate fruiting as well as other types of growing styles.

It is important to not let the shrooms grow to full size or even near full size invitro, but to take them before the caps TRY to open. Check the photo for what it can look like. It is not pretty, but the shrooms are of excellent quality and with good potency.

Table of Contents

CHAPTER 12 - THE DRINKING STRAW TEK

original source: http://www.fanaticus.com/7cakes.htm



This photo was sent to PF a few years ago and it was posted at the PF web site. It has also appeared at other web sites on the web. The sender was anonymous but I did know that the person used an ultrasonic humidifier with the straight PF TEK. This is an outstanding fruiting and I have never seen it bested. I have only seen this kind of fruiting at PF in large growing chambers with electric powered humidifiers in use.

Just recently I was notified about drinking straws being in the cakes. I looked harder, and there they were - drinking straws inserted into the cakes. (You can see one near the upper left coming out of a cake in the back) This is a TEK that has been going around the web for years, and even a good friend of mine said he did it and got great fruitings. I thought, great, but basically ignored it. What is done here, is that after the cake is birthed, an electric power drill is used and a clean hole is drilled into the cake in which the straw is inserted. And then during growth, water is injected into the straws which feeds into the cake, rehydrating it. That is why that fruiting is as good as it gets - casing or not, and only because of the pf substrates fruiting power and the growers water replenishment teks (humidifier and straws).

The number one element of any shroom fruiting is water availability. When the pf cake is birthed, the first thing that really starts to happen is moisture loss. That is because of the nature of vermiculite. Also, the fungi transpires plenty of water. So with two sources of water loss, evaporation and transpiration, cakes dry out. This reduces fruiting possibilites as it progresses.
So the answer is a way to input moisture to keep the cake fully LOADED with water as it gives off the water. It is clearly a kind of cycle - water in - water out - as the cake lives. It is apparant that many people are doing this various ways. Like--- burying the cakes in potting type soil mixtures. What this does is rehydrate the cake. Any type of moist soil like substance that can give off water can be used like this. It is a water feeding system. And that is exactly what the PF double ended cake casing tek is all about.

Here is a quote from the famous old cubensis growing book - "Psilocybin Magic Mushroom Growers Guide" by O.T.OSS & O.N. Oeric: page 49 - casing.

A variety of types of casing soils have been found to effectively promote fruiting. We have found the following mixture to be one of the best:

- 7.5 liters peat moss
- 3.5 liters fine vermiculite
- 4 liters washed fine sand
- 2 liters calcium carbonate (finely crushed oyster shell)

Powdered oyster shell is sold as a feed supplement by many feed companies. We have also found that a mixture of one part Mica-peat (50/50 vermiculite-peatmoss mixture) to one part potting soil will work, and even unadulterated rich garden loam has been found suitable, though its unsterile condition makes contamination a possibility.

There is room for further experimentation with other types of casing mixtures: one might try casing with finely granulated horse-dung or cow-dung, or a mixture of horse or cow dung and finely chopped wheat-straw. Casing with leaf-mold mulch might also effectively promote fruiting, and in fact might encourage the fruiting of smaller and more delicate species of psilocybe that do not seem able to fruit when the mixture given above is used. The object is to find a casing soil that is porous enough to allow air to reach the mycelium, and that at the same time is light enough to allow the young mushrooms to penetrate easily through the surface. Sterilization of casing soil is usually recommended but we found it unnecessary when relatively sterile commercially bagged materials were used.

This is the important sentence and idea of the Oss and Oeric info: "The object is to find a casing soil that is porous enough to allow air to reach the mycelium, and that at the same time is light enough to allow the young mushrooms to penetrate easily through the surface". And the purpose of it is to "effectively promote fruiting".
What does "effectively promote fruiting" mean or why does it happen? What is it about the casing procedures that "effectively promote fruiting"? What PF has found is it is not the casing the promotes fruiting, but the substrate. That is where the fruiting power is. The casing is a water input system. It allows the cake to take in water as it is outputed and replace the moisture that was lost, providing the cakes with plenty of water that encourages the fruiting.

The SECOND important factor to be reckoned with is the shroom races gestation period. The TC has a real slow poke of a gestation period. The reason the pf double ended cake casing tek with plain vermiculite works for that one, is just that the cake is kept fully "LOADED" with water while old slow poke decides to come out.
casing soils (peat verm ect)
wet vermiculite
wet perlite
intense humidification
Drinking straw teks

All these teks accomplish the same end - reloading the cake with moisture as it waits for the spore race to complete its gestation. And then when the shrooms begin to fruit, the fully water loaded cake can deliver the shrooms number one need - water. Water recharging is the purpose of all of these teks, and they accomplish more or less the same thing.

Psylocybe Fanaticus January 16 2000

CHAPTER 13 - DECONTAMINATION OF SPORE SOLUTIONS

original source: http://www.fanaticus.com/antibiot.htm

Antibiotic means "anti-life". But interestingly, fungi spores can withstand powerful doses of antibiotics while bacteria succumb easily. That is why "athletes foot" can't be cured with antibiotic creams. It could be that antibiotics come from fungi in particular. When a spore solution is made it can easily be contaminated with bacteria, the most common life form. We are surrounded by them. But with antibiotics, they are very susceptible, especially when in a solution of water and spores. The technique is quite simple. The Antibiotic is put into the spore solution where the bacteria are stopped in a variety of ways, either by cell wall destruction or protein synthesis inhibition, depending on what kind of antibiotic is used. I am no expert in antibiotics, but I know that antibiotics in concentrated form kills them dead, while leaving the fungi spores just fine. And over time, the fungi spores remain viable. And previously, it was bacteria contaminated (no spore germination - just a rotten smell and slime appeared).

But it is important to use the spore solution immediately. Over time, the cultures will still germinate and give a clean culture but you can tell something is not good. The culture is weak and it won't fruit, even though it is clean of bacteria. So use the decontaminated spore solution immediately and your results will work.

Step one: Acquire antibiotics. This is the easiest part. The best place to get a wide variety from Penicillin to Tetracycline is at your neighborhood pet store which has a good fish tank supply and of course, live fish for sale. In a particular section of the store, you can find rack fulls of a variety of antibiotics that are used for fish tank populations. They come in capsule form and are to be used directly into the fish tank water. But for our purposes, this won't work because these antibiotics are not sterile by any means. They are actually heavy with mold. Even Ampicillin you get from your doctor is heavily loaded with mold. The mold spores don't hurt you or the fish but they will destroy your attempt to culture fungi spores.

The antibiotics must be first sterilized before use in spore solutions. Heating the antibiotics is not the way, because it destroys the antibiotics. The antibiotics must be cold sterilized. This is accomplished by a very common micro biological technique ubiquitous throughout the Bio science lab world. The antibiotic is taken out of the capsule, placed into a small jar, about 10cc of water is added, the powder is mixed into solution, the solution is sucked up into a syringe and then finally, the antibiotic water is pushed through what is called a "SYRINGE FILTER". This is a small 25 mm round plastic device that sOcrews on the end of a standard leur lock syringe like the ones the Professor sells. These small round filters come individually packaged in what is called "blister packs" where they are sterile and ready to use. The antibiotic solution comes out of the syringe filter and it is sterile. The filter takes out anything bigger than .2 microns and that includes all spores, bacteria and viruses. The antibiotic molecules get through and are clean of all mold spores plus the bacteria that was in the water is dead already.

The antibiotics that I have used to great success are all available at the pet store fish tank section. Tetracycline is a powerful toxic antibiotic that colors the spore solution orange yellow. Kanamycin is a powerful antibiotic that is clear and does not show up in the spore solution. Neomycin is another clear antibiotic that has worked well. I think Tetracycline might be the best, but Kanamycin and Neomycin work just great. Penicillin is not near as good and usually fails. I have tried Streptomycin which fails half the time and gentimycin which is very weak, fails all the time. Gentimycin is an antibiotic that can withstand autoclaving and is used in agar agar (by such myco supply houses as Fungi Perfecti), but in comparison to Tetracycline, it is weak. In fact, a Doctor friend of mine says they don't use Gentimycin anymore. It's obsolete. I have used chlorpromazine and a few others, and I have found Tetracycline to be about the best, and it is always available at the fish tank store. Plus, it is the only one that colors the water yellow orange (not pretty) and it is the most expensive (less than $10 per pack of a dozen or so pills at the fish tank store).

The Tek

There are two sides of the equation. The first side is basically non sterile and the second side is sterile. In the first side, the antibiotic is put into non sterile water (distilled), which is sucked up into the syringe ready for injection through the syringe filter into the targeted spore solution. The second side is the clean side, which is the syringe filter itself, the needle if used and the spore solution (which is as clean as possible prior to the antibiotic treatment).

Supply list - non sterile side of the equation:

1. Tetracycline - Kanamycin - Neomycin capsules
2. 10 cc syringe
3. Distilled water
4. small mixing jar
5. mixing rod

Supply list - sterile side of the equation

1. 0.2 micron syringe filter (25 mm around) - available from science supply catalogs.
2. syringe needle (optional)
3. spore solution in jar (clean as possible

On the non sterile side, just start clean. All the contaminants will be taken out by the syringe filter. You needn't autoclave anything except the needle if it is used on the syringe filter in the injection of the sterile antibiotic fluid. First, open the antibiotic capsule, and empty the entire contents into a waiting small clean jar. With the non sterile syringe, inject 10cc of distilled water into the jar and with a rod mix the antibiotic until dissolved. It might not dissolve completely, but that is OK. The syringe filter will do the rest.

Suck the antibiotic water into the syringe. Leave about one cc of air in the syringe for good control of the outflow.

Now we go into the sterile zone. If you don't have your own spore print taken PF style according to the PF TEK, you will have to use a print gotten from somewhere. When this is the task, you must use an isolation hand box and using sterile equipment like a forceps (to handle the spore print) and a sterile exacto knife blade (to scrape the spores off the print) and a waiting sterile PF style jar with a little water in it (based on the syringe making tek in the PF TEK book). Many books already written describe how to do it, but they are all really the same. It is self evident how to do it. One just has to get the spores off the print and into a waiting sterile jar with water in it. The jar lid has already been fixed with the proper sized needle or access holes that are covered with good tape or tin foil.

Once that is done, have the jar with the hydrated spores ready. Follow the PF TEK on that (PF spore syringe making tek). Next, with the syringe loaded with the antibiotic solution (non sterile), peel off the back of the syringe filter "blister pack" (kind of like preparing a bandage). With the back peeled off, hold the syringe filter in the blister pack (by the sides) and screw on the syringe with the antibiotic solution and remove the filter from the blister pack holder. If a needle is to be fixed onto the syringe filter, remove the sterile needle from its tin foil and fix it to the syringe filter. Don't touch the needle tip, but you can handle the needle by the hub if you want to. Don't touch anything that the solution will come in contact with. Next, remove the tape covering the needle or access hole in the lid of the spore print jar, insert the tip of the syringe filter (or optional needle) into the hole in the lid of the spore solution jar and slowly but firmly press on the plunger. There will be a short pause while the solution begins to move through the filter, but then it will start dripping out the end of the syringe filter and into the waiting spore solution in the jar. The fluid will be a clear orange color (Tet) or clear (Kana or Neo). There will be no particles in the antibiotic fluid as it comes out of the syringe filter. Once you do this, this is actually fun to do and very easy.

When the antibiotic fluid is emptied out of the syringe, withdraw the syringe filter tip or needle, put some fresh tape on the lid hole, swirl the spore solution around a bit and put it safely on a shelf for a couple of days. Actually, once the antibiotic goes into the spore solution, the spore solution is ready to use, but to be sure, give it a couple of days of rest.

If the procedure is done correctly, and no mold contaminants are introduced during the procedure, the spore solution will be cured of bacteria.

To test the spore solution, inject a jar with an agar nutrient layer on the bottom or a slurry of brown rice powder. If the fungi appears a few days later and looks pure and clean, success is yours. But, there might be another problem, and that would be mold - green, blue etc.

If there is mold in your culture, it will be growing along with the pure white fungi mycelium, usually next to it. The next step is very easy. Go on to the PF micro peroxide brown rice cloning tek to clean up the mold through sub culturing with peroxide and on to the shrooms, PF style.

PF Peroxide and Brown Rice Cloning TEK

This photo is the PF albino mutant strain, cultivated PF style using the PF cloning tek (from anonymous experimenter).

The original idea comes from Rush Wayne's cultivation manual "GROWING MUSHROOMS WITH PEROXIDE". The following is a simplification of the idea down to the smallest degree, using brown rice powder, peroxidated water dilution's and small jars.

MATERIALS:

1. Small jars with lids
2. Brown rice powder
3. Regular store bought Hydrogen Peroxide (3%) antiseptic solution (usually in a brown bottle)
4. Dissection knife and long needle (exacto etc)
5. Living mushroom or fungus, or culture of fungus

If the previous antibiotic tek is used and there is mold growing along with the pure white good fungi, follow this tek using a small fragment of the desired fungi. The mold growing near the good fungi will shower it with spores, but this peroxide tek will usurp the contaminant spores and clean the good mycelium for further cultivation - PF style. This tek can be a follow up to the antibiotic tek, or can be used to clone a mushroom outright. Both purposes work just fine.

As a preliminary, start reasonable clean, but the following is to be done in the open air, without sterile implements or containers.

Mix the peroxide antiseptic and water at a 20% ratio. Example - 2cc peroxide and 8cc water. Place an amount of brown rice powder into the jar and add some of the peroxidated water to get a slurry, or very wet condition. The diluted peroxidated water sterilizes the medium. For extra experiments, you should try more potent peroxide contents in the brown rice peroxide slurry medium (30% - 40% - 50%). It is so easy, it can't hurt to experiment and you can benefit from it.

Tear the shroom apart and with an exacto knife, excise a small fragment about the size of a match head. With a long needle, knock or scrape the shroom fragment off the exacto blade and place the fragment on the surface of the peroxidated brown rice slurry. Or if you are using a culture of mycelium that may be contaminated with mold, cut out a small piece of the white mycelium with the exacto knife blade and do the same - scrape the fungi fragment of the blade onto the surface of the peroxidated brown rice slurry. If the culture grows back clean, that doesn't mean that it really is clean, because there will be contaminant spores in the mycelium (which is there anyway because of the open nature of this tek). When the culture is to be used PF style, when it is reslurried with fresh peroxide water, the contaminant mold spores and bacteria endospores will be killed while the growing fungi mycelium will survive to grow clean - PF style or any style you like.

Screw the lid tightly onto the peroxide slurry jar and put the jar in a warm place for growth. The culture can be opened and exposed for observation or experimentation without danger to the growing medium and culture.

Under magnification (10x), the fragment of mycelium appears to "melt". It also turns blue, as if it were killed. Within a few days, tiny white hair like tendrils (hyphae) will appear on the "melted blue" fungus. It will grow and fill the culture jar.

To use the culture for further inoculations, add 20% peroxidated water to the culture, mix the brown rice and fungus, and with a syringe, draw up water and inoculate PF jars, with the standard PF spore syringe technique. This is done nonsterily also because the peroxidated water will kill contaminant spores. But flame sterilize the needle before injecting into the sterile PF substrate. Instead of flaming the needle, an even better way to sterilize the needle (outside of the needle) is to wipe the needle with a tissue soaked with rubbing alcohol. Let the needle briefly dry of the alcohol before injecting. Use the culture well before it grows in. That way, it is much easier to get a usable slurry for the syringe without clogging.

As an addition, try more potent peroxidated water ratios. For instance, a 50% ratio works also. That would be half peroxide antiseptic and half water. Increase peroxide content until the mycelium doesn't survive. Then back off the amount of peroxide and use a near death peroxide load for guaranteed clean results. But a 20% peroxide to water ratio seems to be perfect.

If you are working with previously made plate or slurry cultures that have mold or bacteria slime growing along with the pure white good fungi, follow this tek using a small fragment of the desired fungi excised out of the culture. Make sure you don't have any growing mold or bacteria in the good mycelium because the peroxide won't kill it (as it doesn't kill the good fungi). If the culture grows back clean, that doesn't mean that it really is clean, because there will be contaminant spores in the mycelium (which is there anyway because of the open nature of this tek). When the culture is to be used PF style, when it is reslurried with fresh peroxide water, the contaminant mold spores and bacteria endospores will be killed while the growing fungi mycelium will survive to grow clean - PF style or any style you like.

TEK Problems

The only problem is syringe needle clogging. As a remedy, do not allow the culture to fully grow in or get thick. Keeping the culture "thin", allows a good breakdown of the mycelial fragments for use in a syringe. At first, doing the tek can be messy, but learning is quick and easy. Finding and using needles as big as possible is important.

But another route is very possible and actually preferable. Using long glass bulb pipettes are very good to use, but here, one must customize and "tweak" the teks a bit (one must be careful when injecting PF style jars with the bigger pipettes and not to breach the top vermiculite contaminant barrier). Also, flaming the glass pipettes can sometimes break the glass. In this case, always sterilize the outside of the pipette with the rubbing alcohol. Also, when releasing the bulb, it will inflow air. Do this inside the jar where the air is clean and protected by the vermiculite contaminant barrier. Or, after injecting, keep the bulb squeezed and withdraw it, and then refill it with fresh peroxidated mycelium for another injection, resterilize the outside of the pipette with rubbing alcohol, and inject, and so forth. When doing this, use small calculated amounts of mycelium slurry to keep from over doing it. Bulb pipettes are actually better to use than needles and syringes because they don't have much problem with clogging as compared to needles and syringes with mycelial slurries. But if the tek is followed closely and the cultures are not allowed to grow in and get thick, the 18 gauge needles with 10cc syringes work OK.

Principles of the Peroxide TEKS

Hydrogen Peroxide is a powerful antiseptic. The solution of Hydrogen Peroxide bought in a drug store is 3% Hydrogen Peroxide and 97% water. Even at this low concentration, and with further dilution's, the germ killing is potent. But that germ killing power only works for micro fungi spores and bacteria endospores. A micro-organism that has germinated into its secondary form (mycelium), is safe from the antiseptic power of diluted Hydrogen Peroxide. But the ungerminated spores, bacteria endospores, and microbes are all susceptible. If there is bacteria that is growing (germinated), it will not succumb to the peroxidated water (just as the fungi mycelium is not succumbing). Also, any mold that is growing will survive. A clean fragment of shroom flesh or mycelium from a mold contaminated culture has germs all over it, but only in the spore or endospore form. They won't germinate in the peroxidated medium and water or on the recovering mycelia.

The tek is like a tightrope act. The mycelium that is cultured in the peroxide enriched medium can survive and grow, but it is not clean. Any spores or bacteria that are "piggy-backing" on the mycelium and not in contact with the peroxidated medium can come to life if given the opportunity.

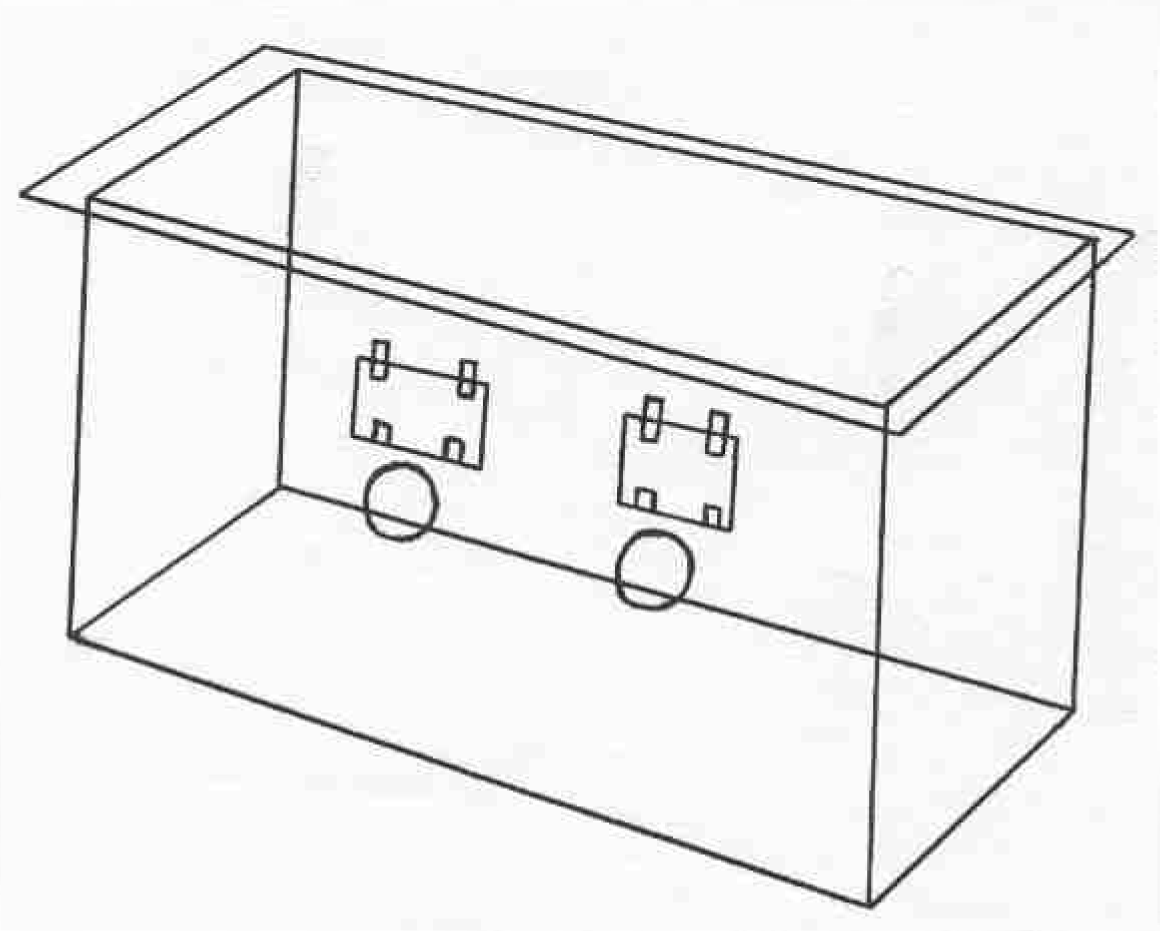
After the culture of mycelium grows, it can be rehydrated with more peroxidated water. The spores and bacteria endospores that are "piggy-backing" on the mycelium will die. The mycelium in its fully secondary form, will survive the new peroxidated solution, "cleaned".

Professor Fanaticus

Table of Contents

CHAPTER 14 - ISOLATION HAND BOX

original source: http://www.fanaticus.com/handbox.htm



Materials - plywood, plate glass and weather stripping. Be sure and make the box out of heavy enough wood so that it won't move excessively as you move your hands around. A little movement is OK.

This is the simplest design for a sterile air transferring hand box. It is four pieces of perfectly cut rectangular plywood, painted with a water resistant coating (preferably white enamel type paint). It has no top or bottom. The box sits on a flat table that serves as the work surface. A piece of plate glass (edged for safety!!) sits flat on top. The four panels of the box must be cut perfectly square so that when they are attached, the top and bottom of the box are flat and straight which insures draft free operation. The bottom of the box must sit squarely with the table with no leaks as well as the plate glass cover. If you want, you can line the top and bottom edges of the box with weather stripping for extra security against air drafts entering.

There are two round holes for your arms. When you cut the arm holes, determine your own particular movement needs (up, down, forward and sideways within the box) and place the arm holes to facilitate reaching and manipulating things. Cut the arm holes to size so that your arms (below the elbows) will close off and seal the holes to prevent contaminating air drafts from entering as you work. Cardboard squares are taped to the front of the box over the arm holes in order to cover the holes when the sterile spray is used to sterilize the interior air (shown in up position - undo the upper pieces of tape and the covers flip down).

How to Use the Isolation Box

Number one rule: Any surfaces or utensil's to be used in direct contact with the fungus are to be first covered or protected against the sterilant. You can cover closed dishes and jars with cut pieces of acrylic plastic.

To use the box, first place the things you will be working with into the box. Any surfaces or utensils to be used in direct contact with the fungus are to be covered or protected from the sterilizing spray. You can cover petrie dishes and jars with cut pieces of acrylic plastic for extra protection if you want and then remove the covers when you want to work. Tape the cardboard squares to the front of the box to cover the arm holes which will prevent air from entering the box during sterilization.

Slightly lift the glass plate cover and spray the interior of the box with 10% laundry bleach and 90% water or some kind of Lysol spray, or for the max killing power, you can use rubbing alcohol in a spray bottle. Let the spray vapors settle a minute or two. You don't need gloves, just wash your hands and arms. Remove the tape from the bottoms of the cardboard hole covers, lift or remove cardboard hole covers and with a MINIMUM of air disturbance or draft creation, insert your hands.
Sterile jars full of media can be opened and transferred without fear of contamination. Scalpels and dissection implements can be taken into the just sterilized (sprayed) box in your hands as you insert your hands through the access holes.

Don't seal any containers after working on them in the chamber. This allows whatever chlorine gas, alcohol vapors, ect, that has gotten into the jar or dish to naturally dissipate with normal gas exchange. To accomplish this, just slightly loosen the jar lids. They can be left in the box for added protection while they are exchanging any vaporous gas with good air. After a few days, then the jars and containers can be sealed for later use.

To be sure, things can be awkward, but with a good air tight box, you can knock things around and be sloppy and still have no contamination. That is why there is no bottom to the box. After working in the box, there will be strewn all over the bottom (table top), bits of agar, fungus, grain kernels or whatever might drop off of your scalpel, spoon, fork or knife ect. With no bottom, just take off the glass plate top, lift off the box and clean the table.

You can customize the box any way your creativity allows. For instance, you can rig up little hooks and dowel hangers and nails inside the box in proximity to your hands (reach) so that you can have a safe spot to hang your dissection tools as you work (away from toxic chemical droplets of the sterilant).
The Professor has used this type of box for many years before he got a HEPA filter blower. The Professor's very first cultivation employed an old 20 gallon aquarium with a Plexiglas cover (fits in the top of the aquarium) with two arm holes. It worked great the first attempt. Then the aquarium got broke and the Professor made a big box like the one pictured above out of heavy weight particle board. It also worked great. Then the third one was made out of lightweight plywood painted with white bathroom enamel (easy to tote around the house) and that one served the Professor for years. Then the Professor got into the HEPA filter blower (high tech). But, for hobbyists, the hand box design works as well and a lot cheaper and basically fool proof (low tech) but the disadvantage is that it can be awkward, but it has its good points to be sure.

Table of Contents

CHAPTER 15 - PF SUBSTRATE FORMULA'S BIOLOGICAL EFFICIENCY

original source: http://www.fanaticus.com/ripsnort.htm

Photo and text from RipSnort
These are Treasure Coast spores from PF. I took a fully colonized cake, cut it in to 4 equal parts, and then cased the broken up cake quarters. Each one of thoes pans only has 1/4th of a cake in them.

Biological Efficiency (from Fungi Perfecti Catalog)

Biological Efficiency is a term frequently used in the mushroom industry to describe yield potentials of mushrooms from various agricultural by-products (straw, sawdust, sugar cane bagasse, banana fonds and coffee plant wastes, to name a few). This formula was first developed by the Button mushroom (Agaricus) industry.

Simply put, a yield of 1 lb. of fresh mushrooms from 1 lb. of dry substrate is considered to be 100% Biological Efficiency. Since mushrooms are approximately 90% water and the base substrate is typically raised to 75% moisture, 100% Biological Efficiency is equivalent to saying that 25% of the wet mass of the substrate is converted into fresh mushrooms.

Although such yield efficiencies are commonly achieved by experienced growers, many choose not to "chase the optimum", as their growing rooms can be better utilized by cycling in fresher material.

PF's comments

With some simple math and a little analysis, it can be readily seen that PF substrate is well over 100% "Biological Efficiency". RipSnort reports that his Treasure Coast shroom fruiting was had by quartering a PF cake and using the 4 pieces in seperate containers in which the quartered pieces were cased. This means that each fruiting tray above contains about 1/16 of a cup of brown rice powder and about twice as much vermiculite, plus the casing.

In a normal PF 1/2 pint cake, there is about 31 grams of brown rice powder (1/4 cup) and about 17-20 grams of vermiculite (1/2 - 2/3 cup) which adds up to about 50 grams dry weight. It can be conservatively stated that a properly cultivated PF 1/2 pint cake can produce (with several flushes) at least 10 grams of dry shrooms (100 grams wet weight). By using the above biological efficiency formula - this equals an easy 200% biological efficiency for that 1/2 pint PF cake (50 grams of dry substrate producing 100 grams of wet shrooms is twice efficiency - the wet shroom weight is twice the weight of the dry substrate, or in other words - 200%).

This amazing ability of cubensis shroom races to fruit on PF substrate has made the PF TEK the new fundamental of cubensis shroom cultivation. The PF TEK can be used straight PF style (mini culture) to get great fruitings of diverse cubensis races, or can be utilized in more mega style cultivations with trays or larger containers with more massive substrate amounts (compared to PF style Mini culture). What is being demonstrated at various mycophile web sites is PF substrate being mixed with various grains, soils and substrates with impressive fruitings on display. A certain percentage of PF substrate with any kind of cubie substrate results in big fruitings. AND, when PF substrate is used in these mega cultivation teks without the additional grain, fruitings are just as good, if not better. The RipSnort Treasure coasts are proof of the magic of the PF formula (brown rice powder and vermiculite).

The Discovery of the PF magic formula

Many years ago, PF grew cubies on many substrates and found brown rice to be the best grain for fruiting. The problems associated with using brown rice was that it was sticky when cooked up and unshakeable in quart style spawn jars. This creates many problems which thwarts the fruiting power of brown rice. In 1978, Dr Stephen Pollock published his book "Magic Mushroom Cultivation" and it featured a brown rice cake method using quart jars and growing the shrooms inside the jar. This tek has many flaws but had great potential.

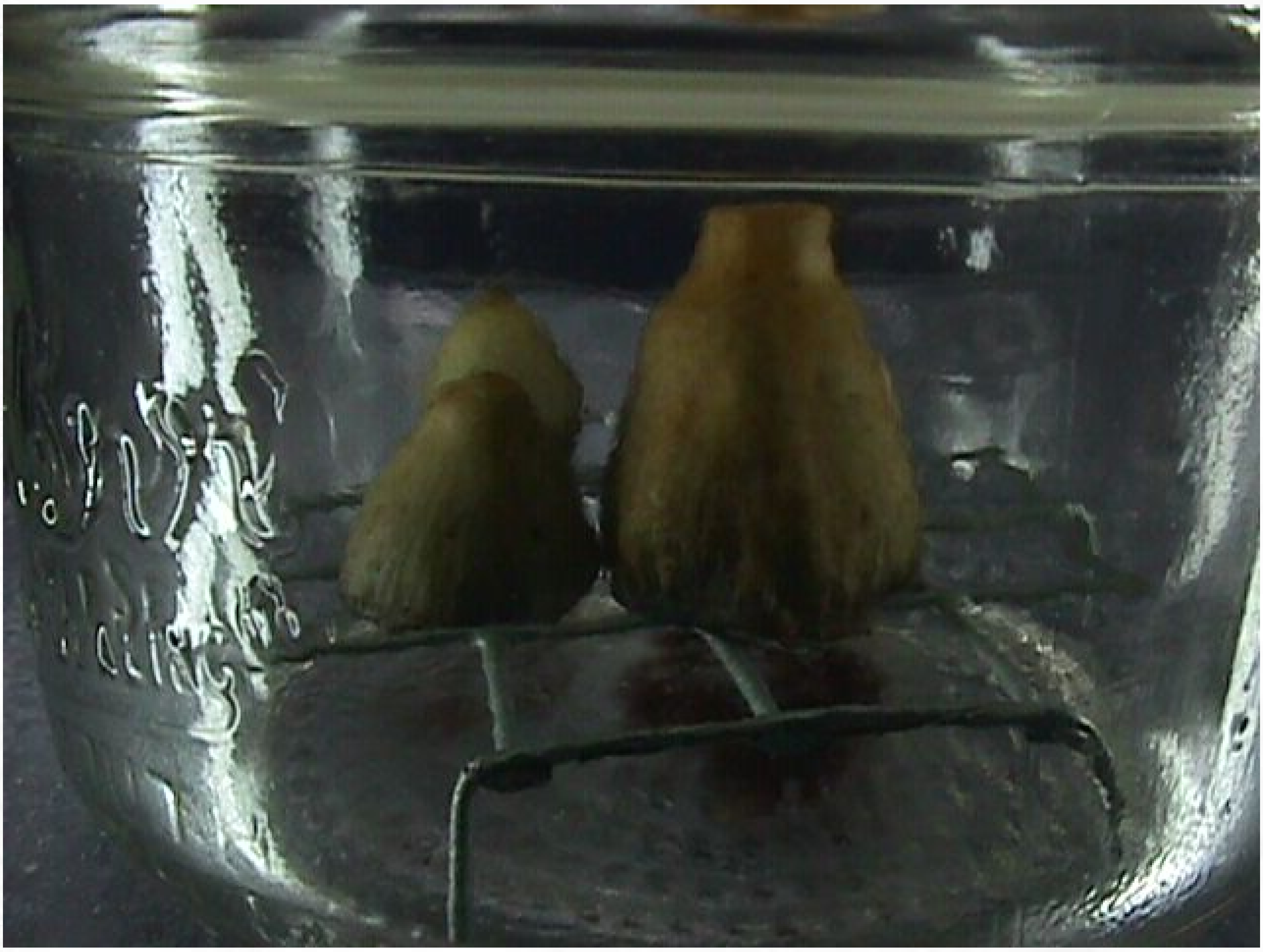
Then in late October 1981, PF attended the Paul Stamets and Jeff Chilton Myco Media shroom conference at Orcas Island Washington. During a Stamets lecture, Stamets mentioned mixing vermiculite or perlite into grain substrates to get a better and easier shakeability. It was like a lighting bolt that hit PF, as he busily scribbled down some notes about this substrate mixing concept.

PF went home and began a series of experiments combining these two ideas (Pollocks rice cakes and Stamets vermiculite mixtures) which resulted in the PF TEK magic substrate formula, which has become the new fundamental magic mushroom growing and culturing medium.

Table of Contents

CHAPTER 16 - SPORE PRINTING IDEAS

original source: http://www.fanaticus.com/sporejar.htm



These are caps of psilocybe semilanceata (collected in the Olympic Rain Forest) in a 1/2 pint wide mouth canning jar.

The caps are resting on 1/2 inch galvanized wire screen. The 1/2 inch is related to the distance between the wire. The wire screen was cut up and fashioned into a screen support by cutting it with a wire cutter pliars and bending it into shape. The caps are above the glass surface which makes for a cleaner spore print (although printing directly on glass apparantly works as well).

The glass jar and wire support are presterilized in a pressure canner. Jars like this can also use the white sterile filter disks as lids held on by the canning jar lid bands. These are available from Fungi Perfecti in Shelton Washington. To find them on the web - just do a search with FUNGI PERFECTI.

Psylocybe Fanaticus
Seattle Washington USA

VARIOUS ARTICLES BY PROFFESOR FANATICUS

CHAPTER 17 - MAJOR PF TEK SNAFUS FOR THE NEWBIE

original source: http://www.fanaticus.com/pitfall.htm

Water inflitration of the jars during sterilzation

There have been many isolated posts concerning delayed or stopped colonization. This seems to always concern the lower half of the jar. The simple explanation is water infiltration into the substrate during steaming.

This happens two ways. The first is that there is to much water in the pot and the boiling water can slosh into the jars. Then the water builds up in the lower part of the jar and the soaked substrate will not colonize correctly (or not at all - and stall) The second way is water dripping from the top of the pot down onto the jars. If you use regular canning lids, these do not seal the jar and water dripping down can go into the jars.

In the first incident - use a safe amount of water so that sloshing into jars doesn't happen.

In the second incident - cover the lids with tin foil to ward off dripping water.

Premature cake birth

Observe the photo of the in vitro primordiation in the PF TEK photo files. This photo is all you need to time the whole thing. Primordia appearing in the jar usually starts around the begining of the 3rd week after spore inoculation. But don't stop here. When you see the new primordia appearing, delay birth. Doing that influences more primordia to form. After about 3 to 4 days, birth the cake. The initial flush will be highly influenced by how primordia form in vitro.

Newbie humidifier uncertainty

The usuall case here is inexperience. Humidity is invisisble and humidifiers do almost to good of a job of humidification. The rule here is to avoid humidifiers when you are a PF TEK newbie. The pf tek does not need the extreme high humidities that you might think these shrooms need. A small terrarium will produce excellently - equaling electronic humidification (and that is no matter what the humidifier fans say). But of course, if you want to do the humidifier technique, the humidifier tek in the PF TEK photo files is the best because it is the cheapest and simplest and there is no sacrifice in effectiveness. Cool sprays are under $20 - available in the baby care section of a decent drug store and easy to rig up.

Improper water content in the jars

To determine the best water content, When you first do the pf tek, make a batch of jars with the same substrate amounts but variate the water, take notes, observe and go with what works best.

Pint jars verses 1/2 pint jars

When I first published the PF tek papers in 1991, I included a Pint jar pf tek chapter. And of course it was eagerly copied (a few years later) by the MMGG author as if it was the cats meow (because I had dropped it from the pf tek papers already).
In the beginning, All the subsequent letters from the myco customers with problems had to do with the pint jar. It was causing lots of trouble. 1/2 pints seemed immune to problems.

I already knew of the pint "trouble". So I dropped the tek. The "trouble" was "premature" fruiting (like thats bad?). What would happen, is that Pint sized cakes would commonly have the tendancy to begin putting out primordia and screaming to be released from in vitro BEFORE complete colonization of the cake, mainly caused by not enough spore solution delivered all around making for an uneven colonization.
So there you would have a tear jerking disaster on your hands; primordia all dressed up with no place to go. Because, birthing the cake would expose the exposed uncolonized cake surface (which sometimes is about half the surface) and you will not only have shrooms growing, but plenty of contamination (hence the absolutely ingenious MMGG technique of branding the cake.)

What is causing this is that the vermiculite in the mixture is the fruiting catalyst which stimulates fruiting whether the food is used up or not. The fruiting is clearly related to a food threshold and nothing to do with CO2 or oxygen - temperatures ect. And this is Because these primordia will appear just the same in a jar in which the lid has been on tight since the get go. (NO OXYGEN) strange but true.
To see the truth of this in demonstration: Try a pint jar of plain pre cooked (quite wet and soft is the way) brown rice in comparison to an equal pint jar of pf substrate mixture. (you don't have to go to the trouble to do this, but read on and trust PF)

When a pint of plain rice is colonized, and left to sit in vitro, Primordia will not appear and then the jar starts to yellow - die ect. The neglected pint jar of pf substrate will put forth plenty of primordia hot to get it on while in vitro. It is like two completely different substrate mediums but basically it is brown rice.
In these two examples is clearly shown what the pf tek is all about. The vermiculite is the catalyst for fruiting - similar to casing grain (but without the casing tek) - sort of an internal automatic casing.
That is why all of this stuff about casing pf cakes to make them work the best is from people that have no idea about the pf tek and its inner workings.

Psylocybe Fanaticus
Seattle Washington
Decemember 27 1998

Table of Contents

CHAPTER 18 - PF ALBINO MUTANT

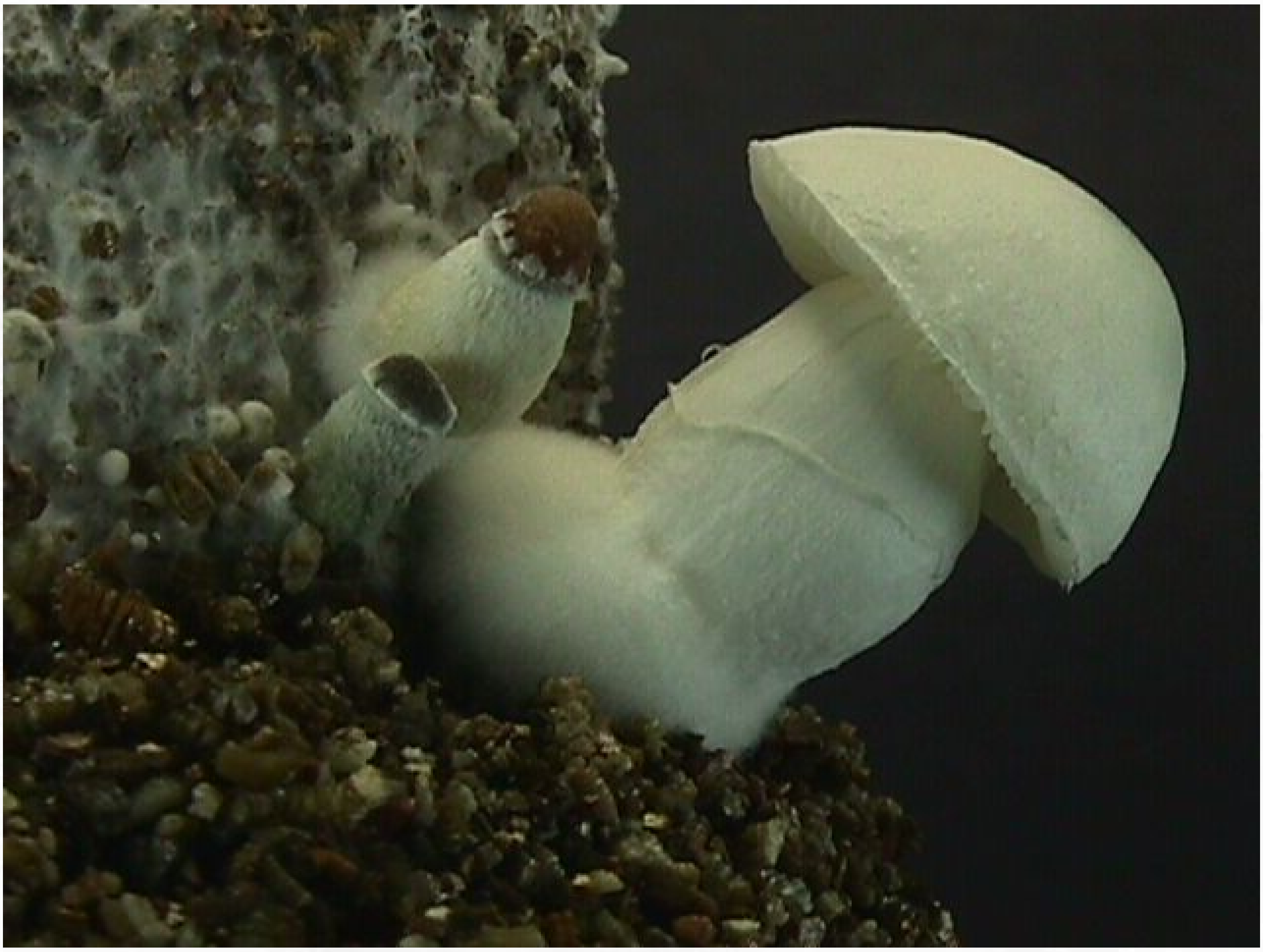
original source: http://www.fanaticus.com/albino.htm

ALBINO definition (Websters new world dictionary)
2. any animal or plant abnormally lacking in color

I once used a flourescent blacklight to grow PF strain shrooms. It seemingly worked as good as regular plant aquarium style flourescent lights. But something terrible happened as a result. The PF shrooms started to sprout out little white mushrooms without spores. Also along with the pure white sporeless mushrooms, normal looking PF's grew along with PF's that appeared to be part normal with albinoism traits (white patches and diminished sporulation).

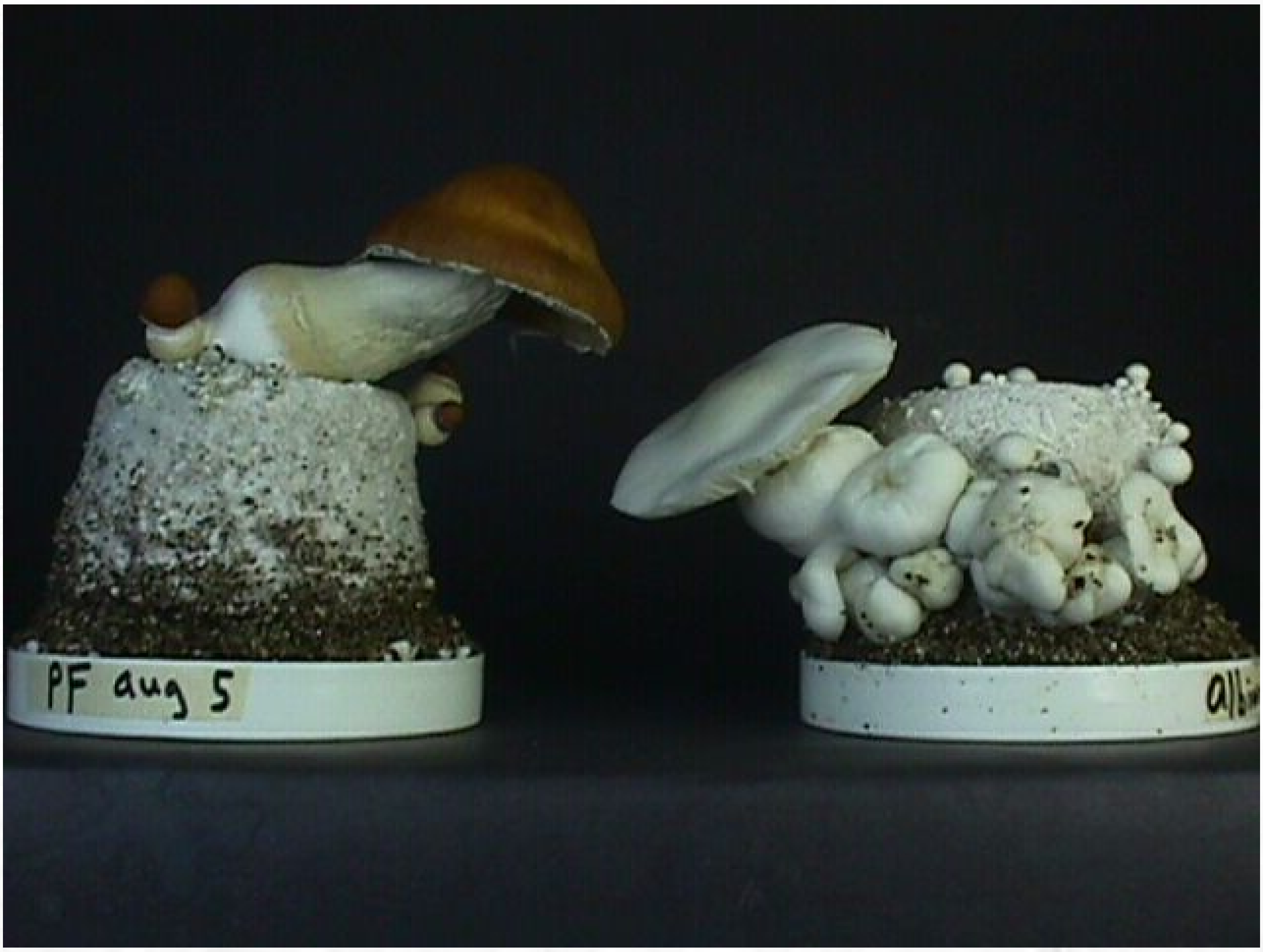
The shrooms were grown under the blacklights 24 hours a day and the lights were hung very close to the terrariums. What happened was that the intense constant glare of the UV rich light damaged the spores and caused the albinoism. Basically said, the UV killed the shrooms because eventually they stopped fruiting.

These following links [content included below] have the story. UV rich light is considered instrumental in mutation formation and it is never good.



For some unknown reason, a PF style cake of PF race shrooms developed strange white primordia. They grew into shrooms I have never seen before. They apparantely are ALBINO mutants. The gills are pure white and sterile (no spores or reproductive system). The above photo is a close up of the third flush appearance of the Albino, growing from the base of the cake in the bottom vermiculite layer. This is a good example of what a "strain" is. To the left of the albino is a normal PF race shroom primordia (abhorted). These are two seperate strains. This is a clear representation of different strain manifestations on a single cake.

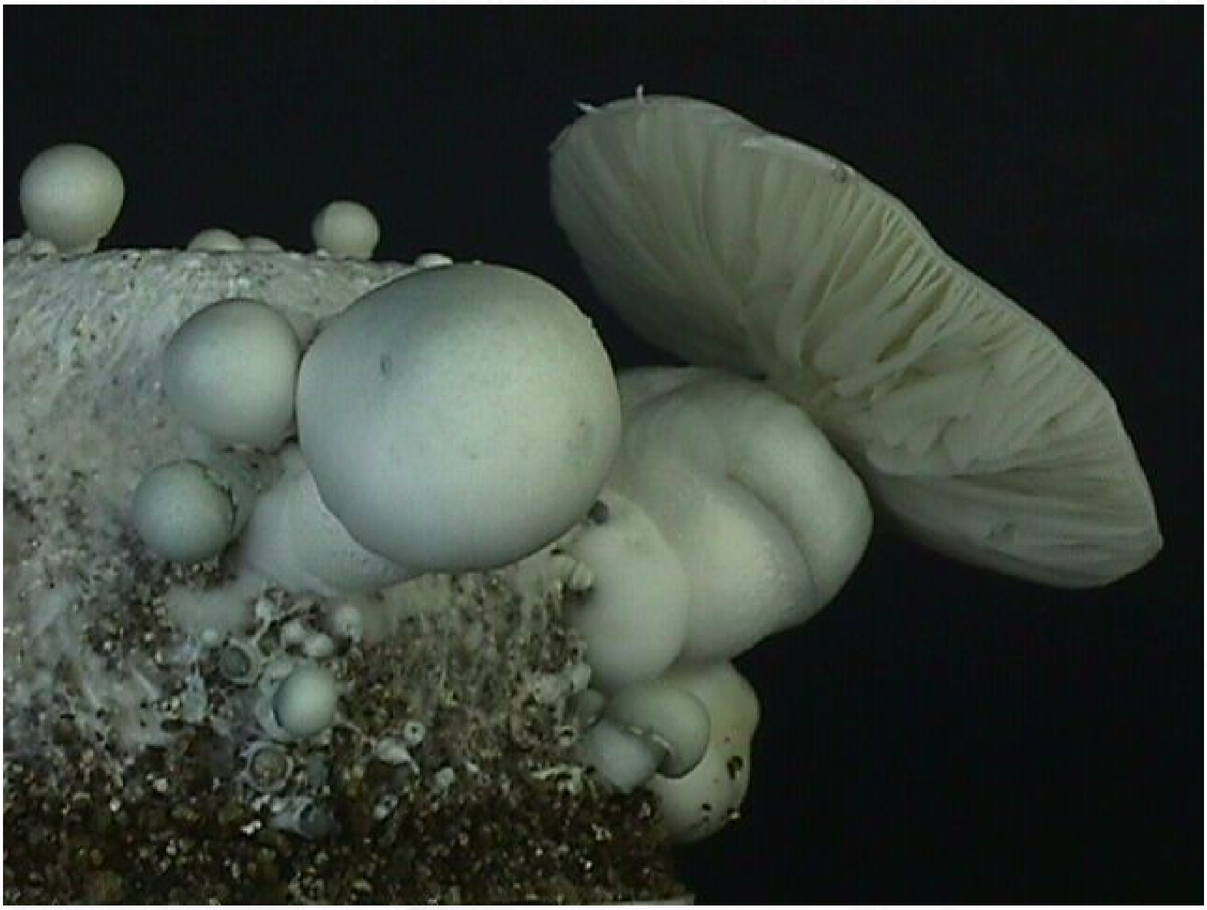
Cloned PF Albino Mutants



The shrooms on the left are a first flush of normal PF race shrooms. The shrooms on the right are the first flush of the Albino clone (taken from the single specimen in the above photo).

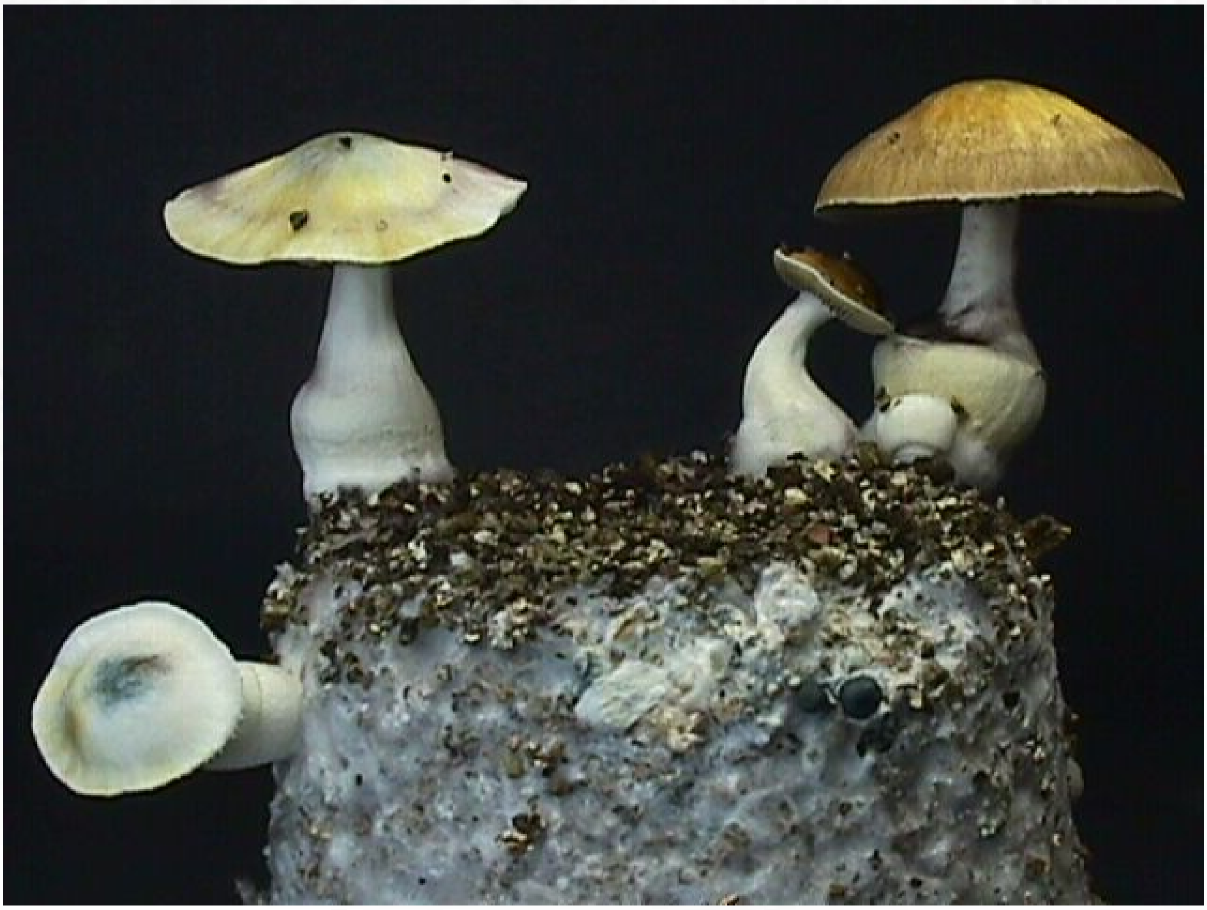
Albino Shroom Cloning Technique

As hoped for, the original PF Albino manifesting cake delivered a small third flush, and one Albino formed (the answer to a prayer to the great fungi from the beyond). This last appearing Albino was dissected and small fragments of inner flesh were excised and placed into a culture tube. As hoped for, it took and began to come to life. After the culture tube medium (Brown rice agar) was covered with the mycelium, sterile water was injected into the culture tube and the culture was broken up and mixed with a scalpel. The resultant mix was transfered to a small lab bottle (with a tight cap) and more water was added. The bottle was then violently shaken and with a 13 gauge syringe needle, mycelium rich water was injected into PF style jars. The Albinos invitro primordiated and grew like normal PF race shrooms. The bottle that was used for the injection solution was left with lots of remains. The bottle regenerated into a type of liquid culture with little floating "islands" of mycelium. This Albino is very resilient and spooks me. It looks like a ghost mushroom. The gills are sterile.



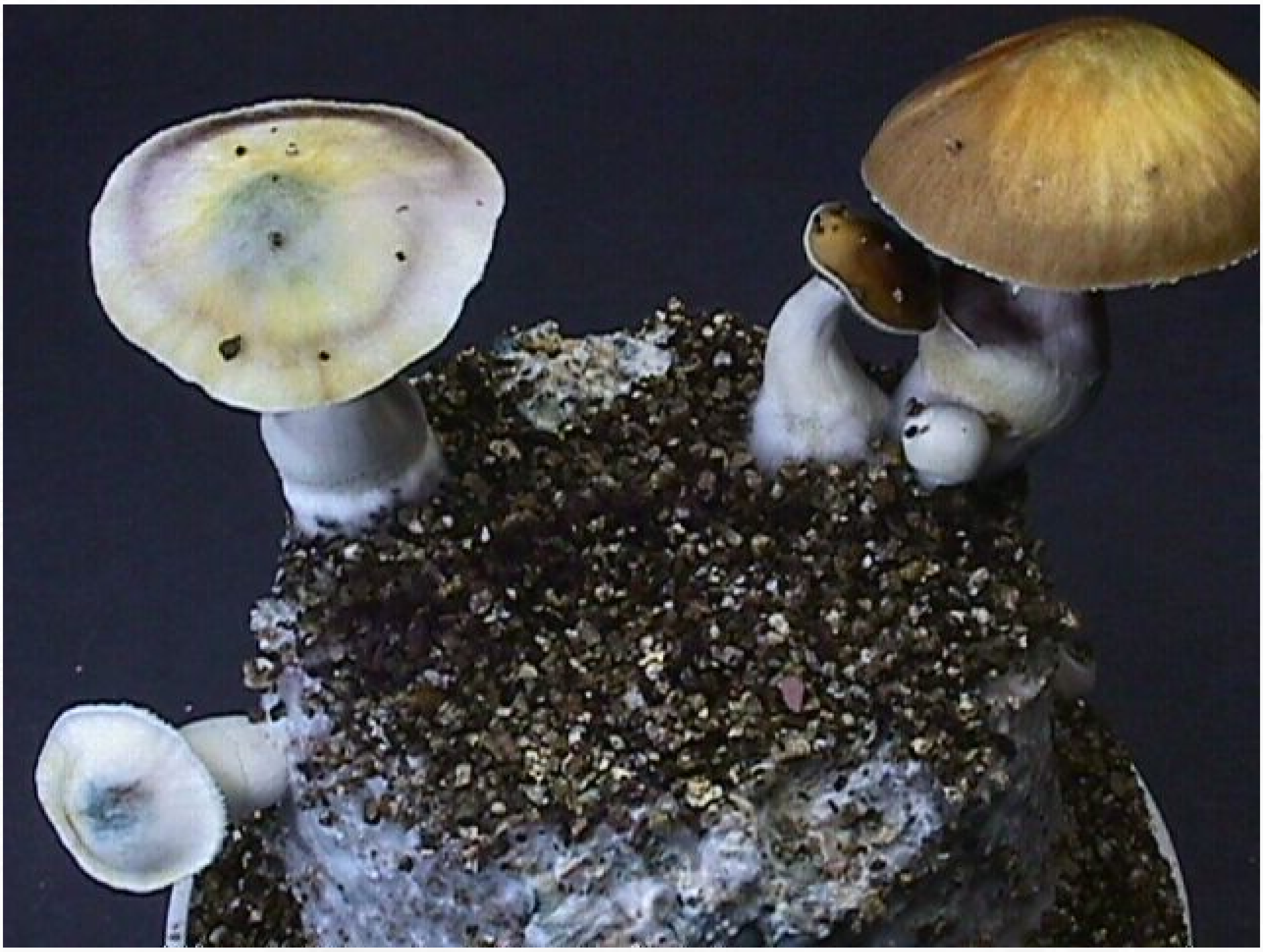
In this view, the sterile gills are shown.

PF Albino Mutant Strain



This is a photo of the PF Albino mutant strain. It is a cake that has been picked over. You can see tears where shrooms were picked for spore printing. The remaining shrooms are the stragglers in a first flush. The one on the far left is a pure Albino with a blue discoloration at the top of the cap and some purple spores from another shroom. The shroom in the center is a "half breed" in which some light sporulation is developing but the cap is strange in color - with light colors and greenish and blueish tints. The gills of this "half breed" are mixed up with some light colored gills that are lightly sporulating and white sterile gills. The shrooms on the right are more normal, but at closer inspection, there is something wrong with them also. The colors aren't "right" and they too have a greenish palor to them. The shrooms that were picked for sporulation (evidenced by tears in the cake), have definite GREENISH colors towards the center of the cap and an over all strange lightness in color. The sporulation is not spectacular, but they are giving plenty of purple spores.

This is a very unusual new creature. Very unusual in that it has never existed before. It came into being in the lab of PF. It can be said, that this shroom is truly PF's shroom - a creation of the PF TEK. What has happened, is that through reculturing and isolation of all the "normal" shrooms from the original Albino appearing cakes (pure Albinos at first), the Albinos have returned as a part of the spore race. What is happening is a first in mycology and after a little consultation, let it be known that this is a mystery of genetics and fungi reproduction. The only "explanation" that PF can come up with, is that PF shroom Albinoism is a kind of "refusing to grow up" syndrome. When primordia first appear, they are Albino and get color soon after. Pins (the precursors) of primordia are indeed pure white. So maybe the fact that pure Albinos don't sporulate or develope reproductive systems is related to not "growing up".



This a view from the top of the cake (above). The strange colors are a little easier to see, although the digital photo color rendition isn't perfect. The thing to do if one wants to explore the ultimate in growing the unknown, is to clone that pure Albino or any of them to see what will happen. The results of such an action has already shown to be astounding. And, according to a recent bio-assay, the pure Albinos are excellent potency (the strangest thing yet).

Disaster in San Diego Harbor Lagoons

Many years ago, a newspaper article described an alien plant invasion into San Diego Harbor lagoons in California. The plant has displaced the normal flora, making for an environmental degradation. Scientists have discovered that it is a common aquatic fern that is popularly used in home fish tank aquariums. The plant has mutated because of exposure to excess ultra violet light emanating from the low wattage fluorescent (15 watts) "plant & aquarium" lights. The lights are used in close proximity to the plants and the plants often float on the surface of the aquarium water making for a direct exposure. The plant escaped into the San Diego sewer system and wound up trapped and flourishing in the quiet inner lagoons of the harbor. They have taken over. UV (ultra violet) is well know in science to be a carcinogen and mutagen in plants and animals.

The Black Light Experiment

The disaster in San Diego harbor lagoons has a parallel with PF. Back in 2000, PF set up a phototropic experiment using 15 watt "black light" fluorescent tubes. The fungus cakes were growing in a simple terrarium. The lights were positioned almost touching the dome tops making the shrooms grow inches away from the lights. The lights were left on 24 hours a day. It is important to also mention that the plastic "richmans" domes are made out of polycarbonate clear plastic. UV does pass through the plastic.

The Albino Mutant Appearance

After a few months of fruiting under the blacklights, a couple of generations went by and then the PF Albinos appeared on two cakes. At first, PF didn't know what to make of them, but soon after, PF became worried, because Albinoism is a mutation, and mutations are a very bad sign genetically. PF then put away the blacklights knowing that the albinos and the blacklights are definitely connected in that they were synchronous. PF has never seen such a thing in over a quarter of a century of shrooming, plus, PF has never used blacklights - only plant type flourescents. PF remained worried.

The genetic mutation certainly occurred at the genesis of the spores, because the mutation changed the offspring that followed. The genes were damaged permanently and passed to the progeny. There were many cakes that seemed unaffected, so the two types; the Albino mutant spores and the "normal" spore race lines were separated. But unbeknownst to PF, invisible or unapparant damage did occur to the "normal" specimens.

The damage slowly crept into the spore race lines and by mid summer of 2001, PF had the sinking feeling of empending doom. The Hawaiian and Mazatec spore races were growing on the same PF formulations and in the same terrariums, but were doing great, with the customary excellent fruitings, but the PF which fruits at least equally as well, was doing frighteningly bad with no invitro primordiation, sparse fruitings, strange looking shrooms, off colors and a tendency for sterility (no spores or few forming). And in the worst case, no fruiting at all, even though the mycelium looked healthy. This degradation happened very gradually, over a period of several months. What happened, was that after the albino appearance and the cessation of blacklight use, PF continued to use PF spore race lines emanating from UV (blacklight) exposed specimens. Soon, all the PF spores PF was getting, were descended from the exposed and apparently damaged PF shrooms from the blacklight growing time. Or, the genetically damaged lines spread and gradually became dominant, taking over the PF race lines through spore mixing and spore solution making (PF's lab work).

PF knew exactly what to do - the obvious. PF then contacted a friend and got an old PF spore print from three years ago (not exposed to blacklight fluorescents) plus a fresh print that was propagated elsewhere. They were used with PF jars, and within two months, the proof was there. The "old" spores and the replacement spores were fruiting with total excellence - fast invitro appearing and big healthy (normal) flushes.
There is another recent experiment from TOKYO JAPAN with SHITAKE mushrooms that shows the power of UV (blacklight) light to mutate shrooms and make them sterile (not albino but sterile - no spores produced)).
Here are excerpts from a science paper from Japan describing mutating SHITAKE mushrooms with UV light to get sporeless strains (desirable in large mushroom farms to protect workers from spore allergies). What this means, is that what I did with the blacklight (UV intense) by accident is what these scientists did to SHITAKE on purpose.

Genetics and Breeding of Spore-Deficent Strains in Agrocybe Cylindracea and Lentinus Edodes

S. Murakami - The Tottori Mycological Institute, Tottori, Japan.

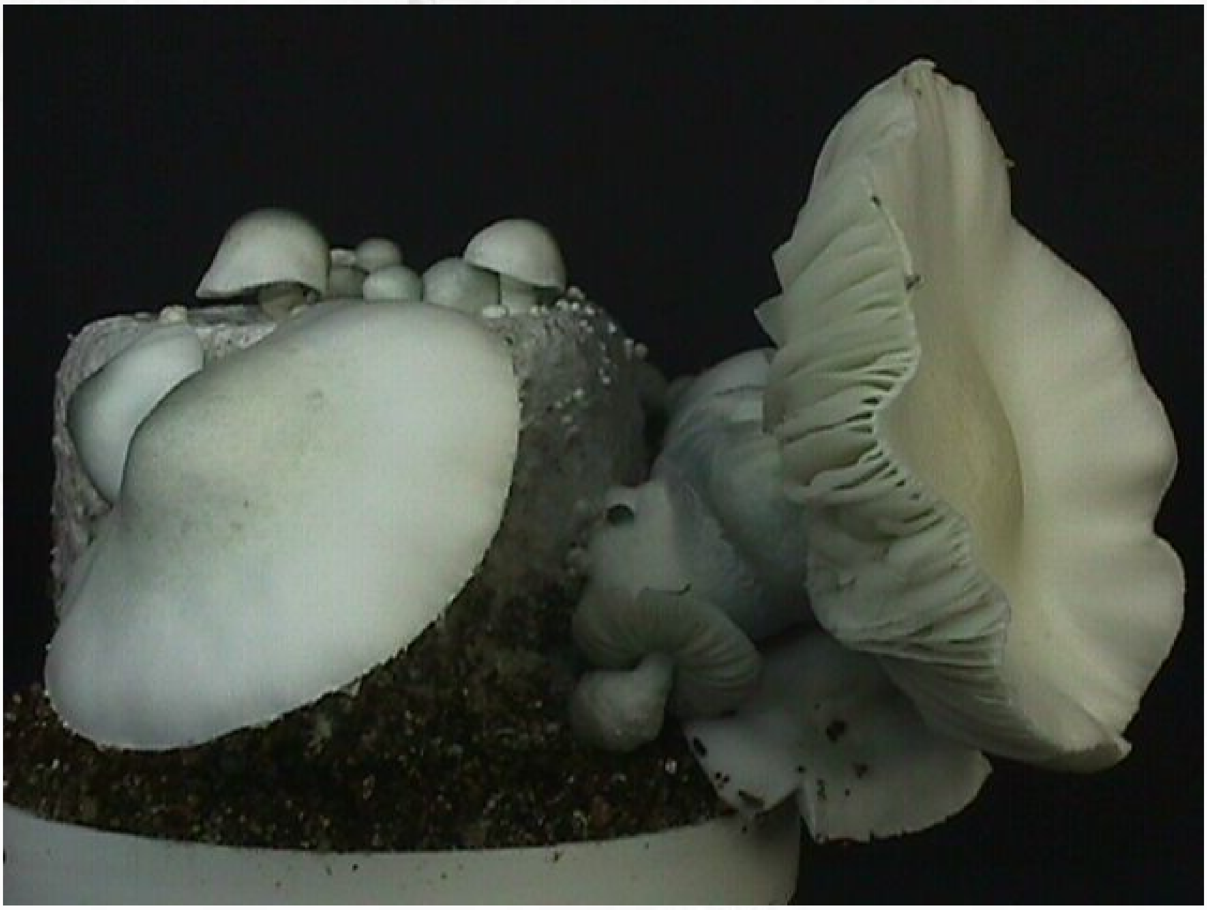
Dikaryotic hyphal fragments from a strain (2493) were irradiated with a Toshiba 10-watt germicidal lamp for 30-40 sec at a distance of 10cm. The irradiated fragments were then plated on CY-2 medium containing 20g glucose, 0.5g MgSO4, 7H2O, 0.46g KH2PO4, 1g K2HPO4, 2g polypeptone, 2g yeast extract and 20g agar per litre of water, and incubated at 25°C. The UV treatment and the incubation were performed in darkness. Lethal rate was more than 95%. Viable colonies were then isolated and transferred on to fresh CY-2 medium.

From 11,500 colonies treated with UV irradiation, 24 spore-deficient mutants and 233 strains with reduced sporulation were detected. Imbernon & Labarere (1989) reported that UV treated strains of Pleurotus ostreatus and P. pulmonarius exhibited some abnormality in morphology and yields of fruitbodies. In our experiment, pilei of the spore-deficient mutants were either very thin at the margin or small in size, or their stipes were slender and because bent.

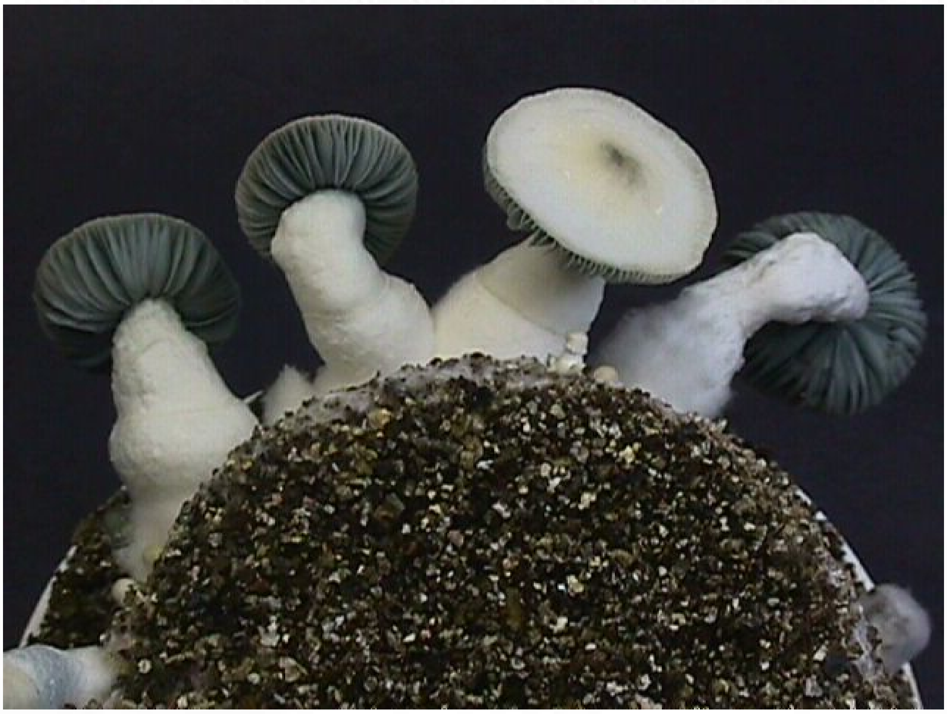
Thus less than 4% of the geminated spores formed colonies. The reduction in compatibility, spore production and viability in the basidiospore progeny stated above, may have an important implications for microevolution in fungi.

Professor Fanaticus
2004 A.D.

Cloned PF Albino Mutants



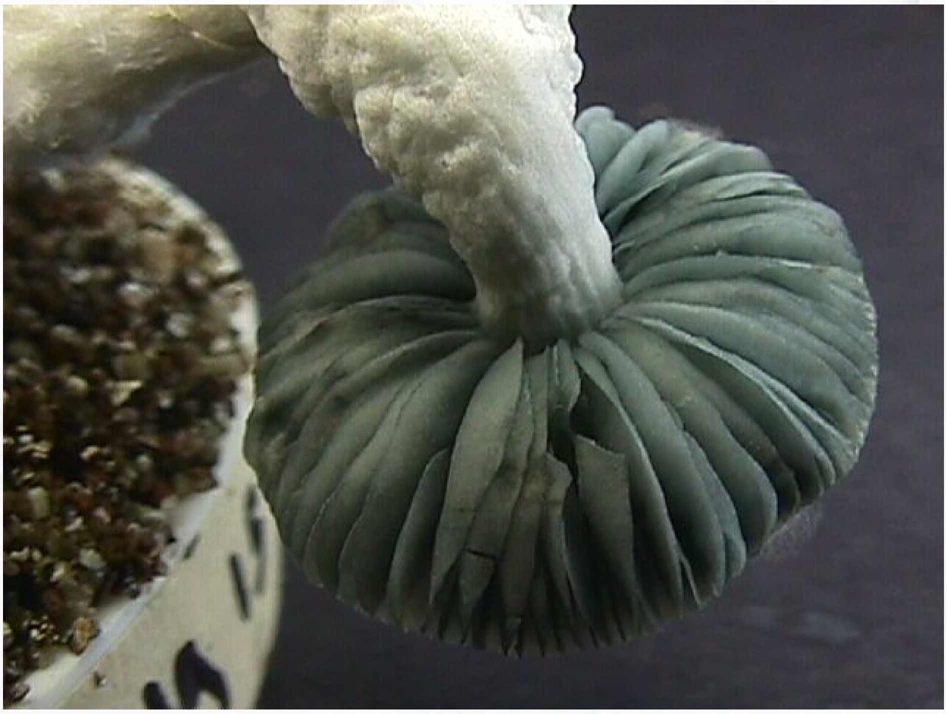
Full grown Albino mutant clone on the PF TEK.



Blueing of the gills.

These are some of the shrooms from the second flush of the clone cake. Another strangeness occurred. The gills blued heavily. On the first flush, blueing occurred with age but not nearly to this extent. Apparantely, the blueing shows the shrooms are psilocybian. On regular PF shrooms, gills will bruize blue very easily but not like this.

For this second flush, the terrarium was placed away from the light. As can be seen, several shrooms have oriented upside down. Regular PF shrooms will do this also when deprived of light. It appears that the Albino mutants are fully photo tropic by growing in an upwards orientation when exposed to light from above and growing in all directions when no light is given.



Closeup of the blueing gills.

Table of Contents

CHAPTER 19 - PF RED SPORED MUTANT

original source: http://www.fanaticus.com/redspore.htm

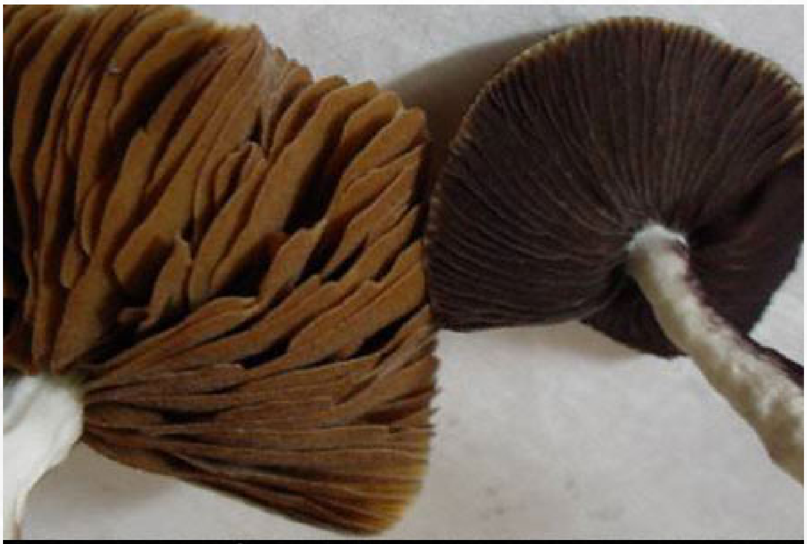
Back when the Halle Bop comet was disappearing into the western sky (for a date only - nothing emplied), the Professor had a petrie dish with four normal looking PF shroom caps spore printing. After a few days, it was time to remove the caps and store away the spore prints. Three of the prints were normal purplish cubie spores but the fourth one was unique. The spores were a deep reddish brown color.

At first, the Professor thought that the reddish spore print was contaminated, but he let the dish dehumidify normally and then taped it up for storage. On close examination of the spores with a magnifier, the reddish spores were not contaminated but the color was with the spores themselves and nothing growing on them as first thought.

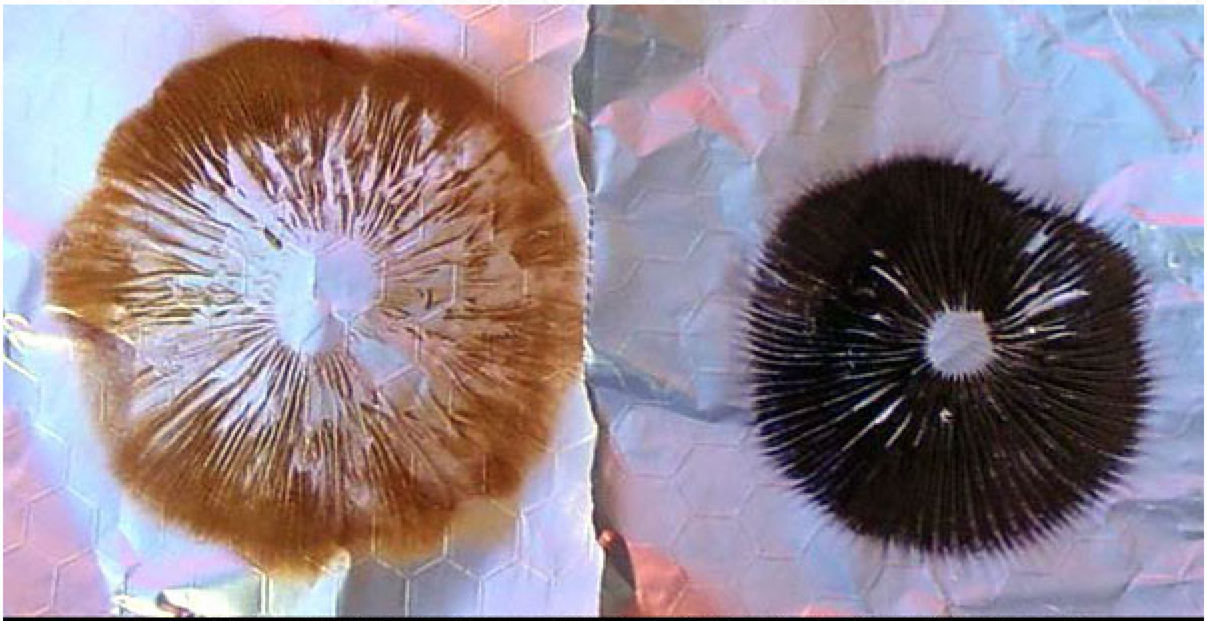
So next, the Professor made a spore solution with a streak of the red spores and injected a PF jar with them. They cultured normally and began to form primordia invitro just like a normal PF shroom. When the caps upturned, no spores were seen collecting around the shrooms. A couple of the caps were taken and placed in a petrie dish for printing. And as expected, the Professor hovered around the dish every few hours to see what would give. By the next day, color was detected around the periphery of the caps and low and behold, the color was RED! The Professor jumped with joy, a specie change! Spore color is one of the prime facets of what a specie is. In Mycology, if one has two mushrooms that look identical, grow identically and appear on the same substrate identically but have different colored spores, they are not the same specie.

Next, the Professor inoculated a PF cake on one side with normal PF purple spores and on the other side of the cake, the red spores. Fruiting occurred and on each side, the shrooms gave their respective colored spores. There was no mingling of the shrooms. They kept their own place. So as far as the Professor's opinion goes, the PF shroom some how and for some unknown reason split off into a new specie that ever since, has remained so - always giving the reddish spores and never any purple. Many cultivations of the red spore has been done, and it has remained the red spore - a new mushroom on planet earth.

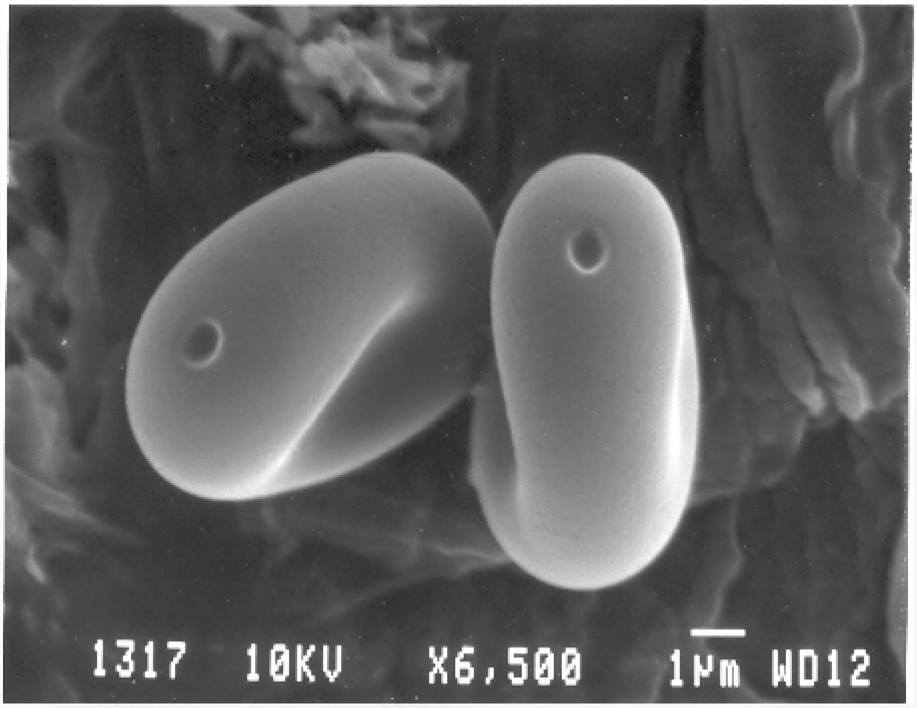
Yachaj Paye's photos of redspore and normal spore prints and caps.

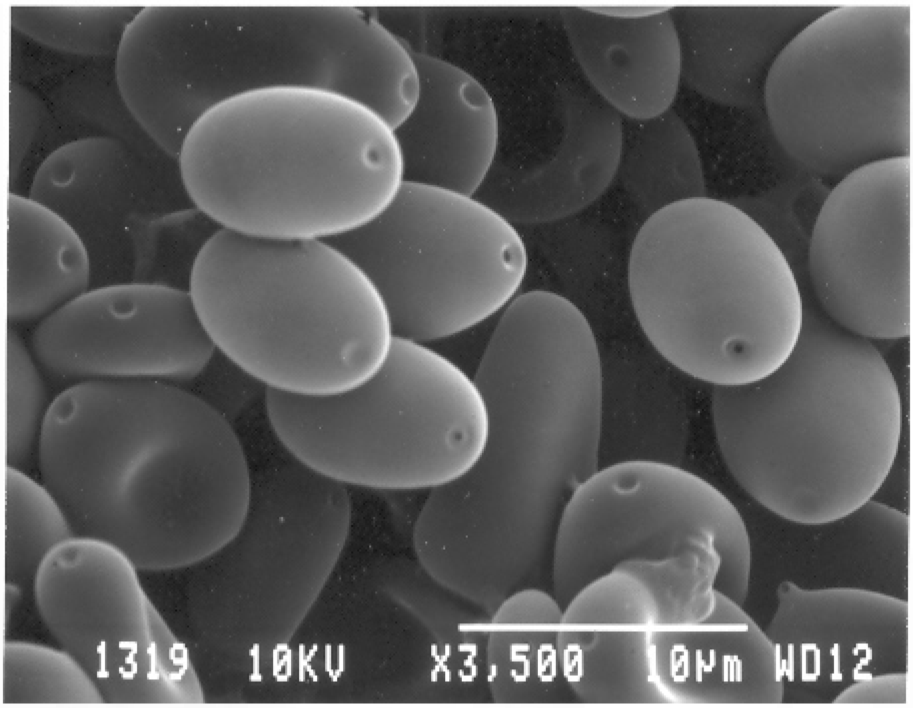


PF Red Spored Psilocybe & Normal P. cubensis
Photo by Yachaj Paye, © 2003 Erowid.org

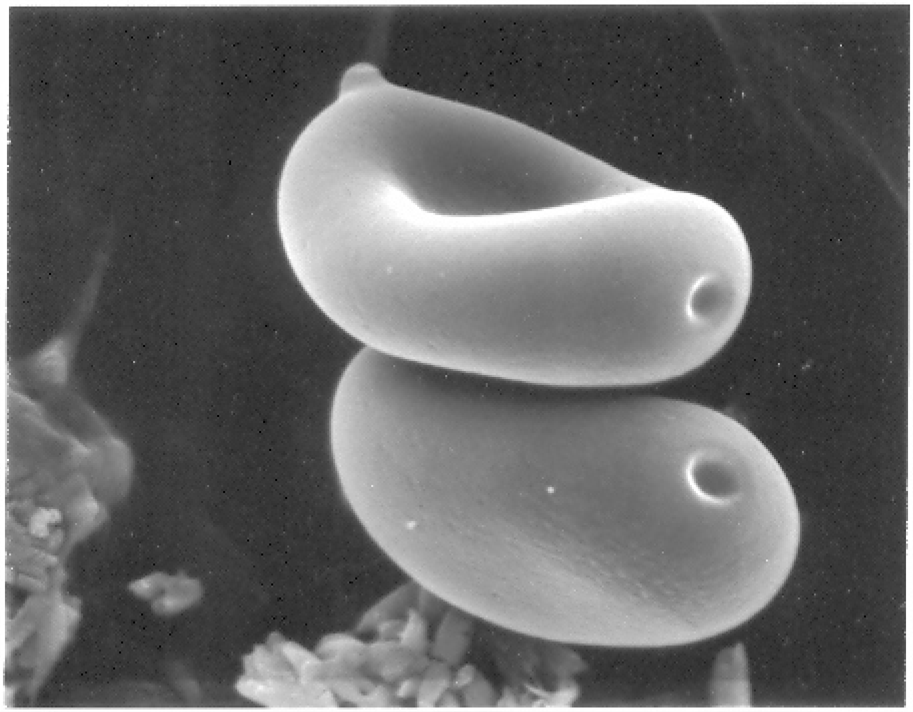


PF Red Spored Psilocybe Spores & Normal Purple-Brown Spored P. cubensis
Photo by Yachaj Paye, © 2003 Erowid.org





Scanning electron microscope photo of normal PF purple spores by Professor Fanaticus



Scanning electron microscope photo of red spores by Professor Fanaticus

Table of Contents

CHAPTER 20 - DETECTING PSYCHOACTIVE DRUGS IN THE DEVELOPMENTAL STAGES OF MUSHROOMS

original source: http://www.fanaticus.com/forensic.htm
original source: http://bitnest.ca/external.php?id=%257DbxUbZZC%2560sgu%257Ex%2506%2500-

Chapter one

JOURNAL OF FORENSIC SCIENCES
American Academy of Forensic Sciences (1948)
Volume 45 - Number 3 - May 2000 - JFSCAS 45 (3)513-754 (2000)

Susan T Gross, B.A.
Forensic Scientist, Minnesota Forensic Science Laboratory, 1246 University Ave. St. Paul, Minnesota.
This project was supported by the Federal Bureau of Investigation (FBI). Minneapolis Field Office.
Received 26 Feb. 1999: and in revised form 12 May 1999: accepted 23 Aug. 1999.
REFERENCE: Gross ST. Detecting psychoactive drugs in the developmental stages of mushrooms. J Forensic Sci 2000;45(3):527-537.
ABSTRACT: The following questions regarding the detection of psychoactive drugs in mushrooms are addressed: At what stage of the mushroom development can the psychoactive drugs psilocyn and psilocybin be identified, and what effect does light have on the growth of these mushrooms. To answer these questions, *Psilocybe cyanescens* Wakefield mushrooms were grown from their spores in a controlled setting. At various times of their development, samples were taken and analyzed for psilocyn and psilocybin. Knowing what stage of development the psychoactive drugs can be identified may be useful to law enforcement personnel and forensic chemists. Methanolic extracts of various samples were analyzed by TLC and by GC/MS. It was determined that the mycelium knot stage of the mushroom was the earliest stage at which the psychoactive drugs could be detected. It was observed that light affected the time of development and the appearance of these mushrooms.
KEYWORDS: forensic science. psilocyn. psilocybin. psychotropic mushrooms

Law enforcement agencies in Minnesota are beginning to see an increased number of mushroom growing operations. Knowing what stage of development the psychoactive drugs can be identitied may be useful to law enforcement personnel and forensic chemists. This information is important because in the state of Minnesota it is illegal to possess any material, compound, mixture or preparation which contain any quantity of psilocyn and/or psilocybin[1].

The word mushroom is a general term used to describe the relatively large and fleshy fruiting bodies of fungi, particularly all gill fungi. They are fungi that differ from plants in that these lack roots,stems, leaves, flowers, seeds and chlorophyll. Since mushrooms lack chlorophyll, they depend upon their surrounding medium for their nutrients. The vegetative portion of the fungus accumulates a reserve of food from the immediate surroundings in order to develop fruiting bodies[2-3].

Fungi are categorized as follows: kingdom, phylum, class, order, family, genus, and species. Mushrooms containing psychotropic drugs are classified in the kingdom Mycota, the phylum Basidiomycota, the class Hymenomycetes, and the order Agaricales. There are four families of mushrooms, Strophariaceae, Bolbitiaceae, Coprinaceae, and Cortinariaceae, that contain psilocybin, psilocyn, or related alkaloids with an indolic nucleus. The genus and species of Psilocybe mushrooms that were grown were identified as Psilocybe cyanescens. The pleurocystidia sizes noted in the keys describing the Psilocybe cyanescens mushroom varied slightly from the mushrooms grown. This may indicate a variant of this species (communication with Dr. David McLaughlin, Plant Biology Department, University of Minnesota)[2,4,5-8].

The four stages making up the life cycle of a mushroom are the spores, the mycelium, the primordia, and the mature fruit. The spores are the reproductive cells or "seeds" of the fungi (Fig. 1 - photo of spores under magnification).

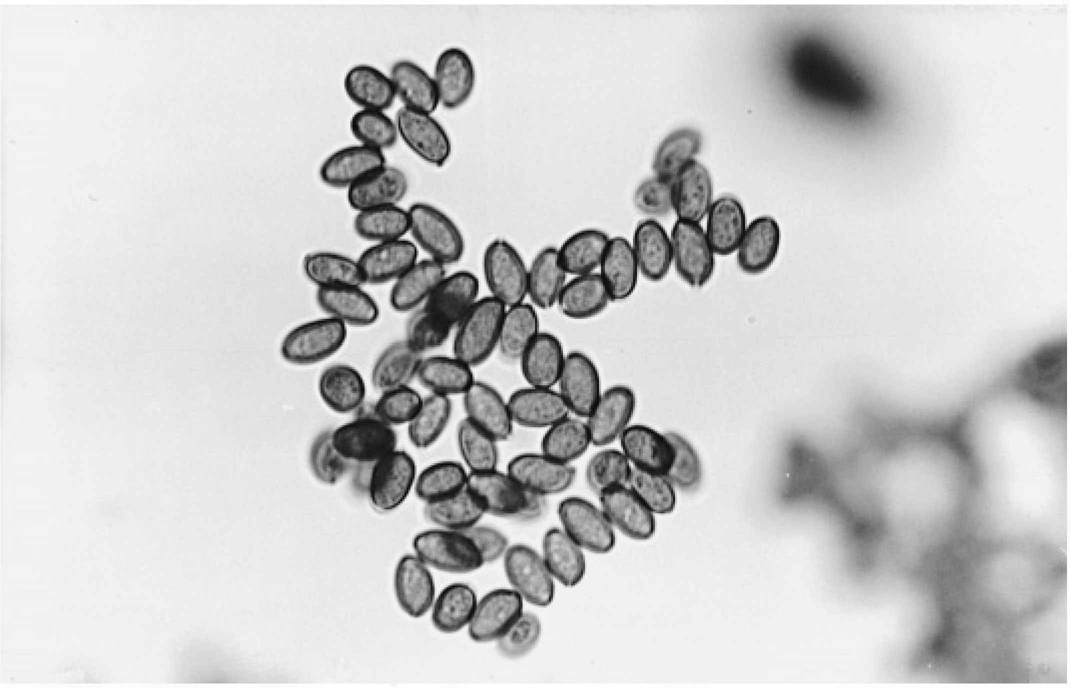


FIG. 1 - The aqueous spore solution viewed using a 1250x magnification microscope. The spores are the first stage of the mushroom's life cycle. One milliliter of spore solution was used to inoculate each 1/2 pint jar.

Germination of the spores takes place when a suitable substrate and correct environmental conditions are present. These spores grow outward seeking nutrients and branch out forming a complex "cob-like" system. This "cob-like" system is the vegetative portion of the fungus which is called the mycelium (Fig. 2 - photo of mycelium spreading in PF jar).

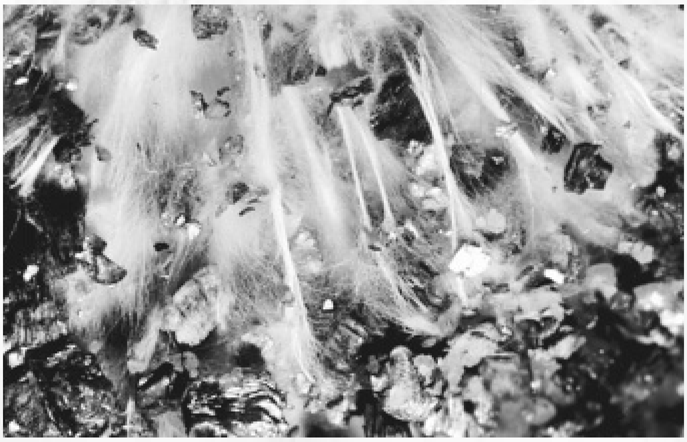


FIG. 2 - The vegetative portion of the fungus is called the mycelium. This is the second stage of the mushroom's life cycle. The first sign of mycelium growth appears 4 to 6 days after inoculation.

The mycelium absorbs water and nutrients from the substrate which is used in the production of the fruiting bodies. The ability of a fungus to begin fruiting is affected by genetic competence and various environmental factors including moisture, temperature, light, and aeration. The formation and growth of the fruiting bodies is known as primordia and has been referred to as "mycelium knots" and "pinheads." The "mycelium knot" is referring to the initial fruiting body that is formed when the mycelium clumps together and seems to form a "knot" (Fig. 3 - photo of birthed PF cake and pins).

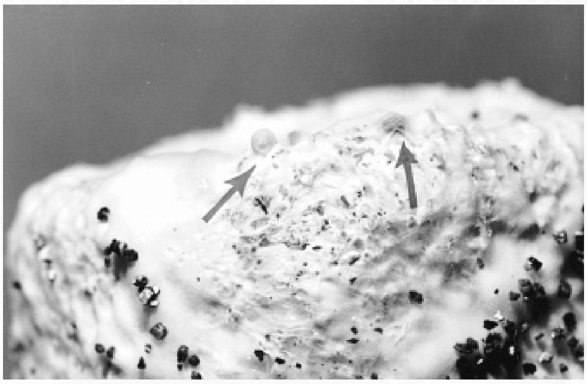


FIG. 3 - The third stage of the mushroom's life cycle is the primordia, and has been referred to as "mycelium knots" and "pinheads". The mycelium knots are the initial fruiting body that is formed when the mycelium clumps together and seems to form a "knot".

This knot eventually grows into the 'pinhead,' a plump growth, yellow in color and with a brown tip (Fig. 4 - photo of invitro primordia in PF jar).

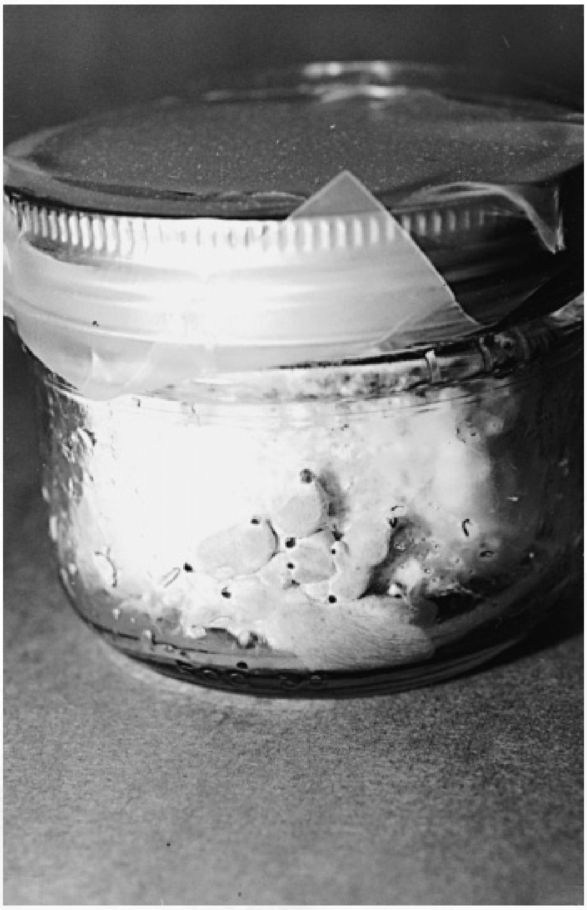


FIG. 4 - The third stage of the mushroom's life cycle is the primordia, and has been referred to as "mycelium knots" and "pinheads". The pinheads are plump growths, yellow in color with a brown tip.

The fruit is considered mature when it is able to disperse spores and begin this life cycle over again (Figs. 5-6 - photos of mature PF race shrooms on cakes)[2,9].

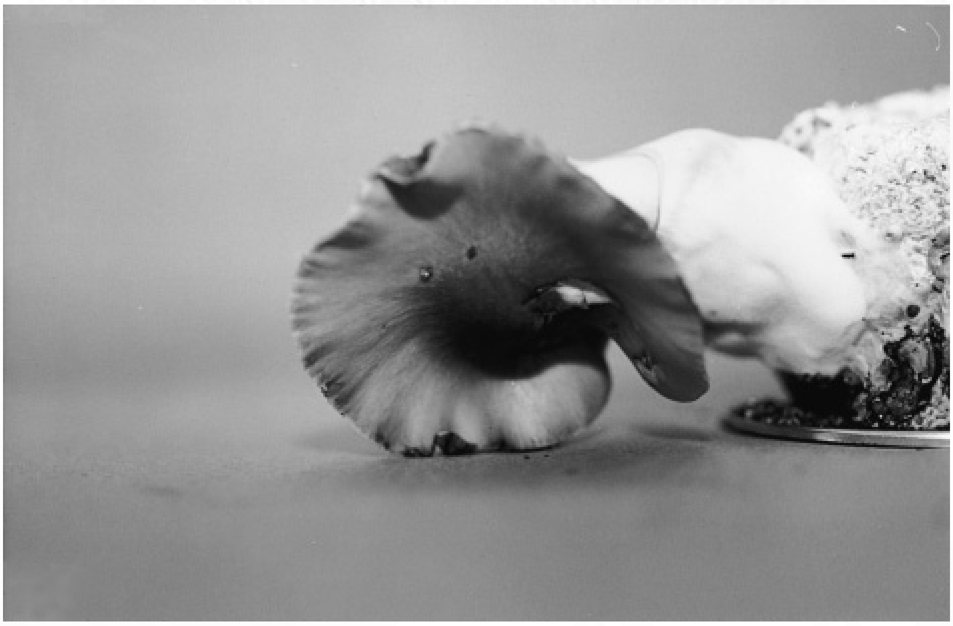


FIG. 5 - The fourth stage of the mushroom's life cycle is the mature fruit. Mushrooms are considered mature once they are able to disperse spores and begin the life cycle over again. Mature Psilocybe cyanescens Wakefield mushrooms.

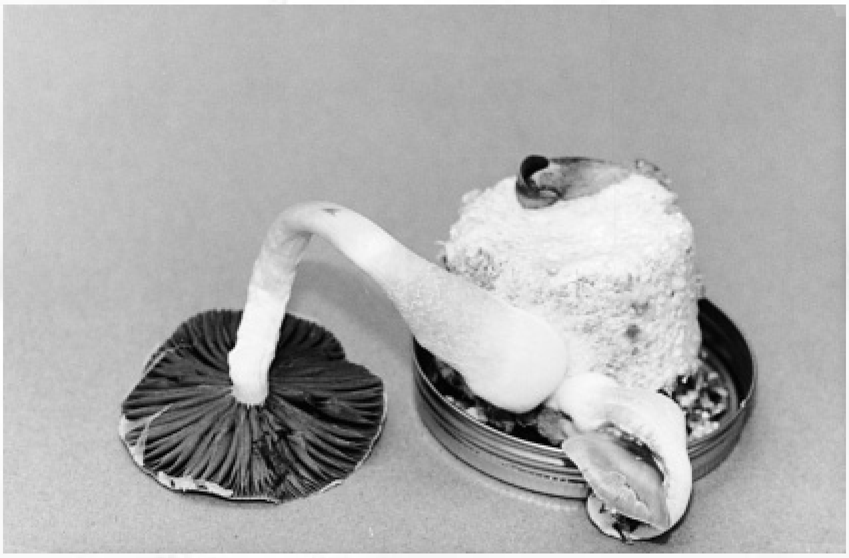


FIG. 6 - The fourth stage of the mushroom's life cycle is the mature fruit. Mushrooms are considered mature once they are able to disperse spores and begin the life cycle over again. Mature Psilocybe cyanescens Wakefield mushrooms.

Methods

The spores used in this experiment were obtained legally through an advertisement in High Times Magazine from Psylocybe Fanaticus (PFTek Seattle, WA). The spores were received in 10 mL syringes in an aqueous solution. The spore solutions were each viewed using a 1250X-magnification microscope.

Directions for preparing the growing media were received with the spores. Supplies used for the growing media were half-pint wide-mouth jars (KerrGroup, Inc. Jackson, TN), horticultural vermiculite (Schultz, St. Louis MO), brown rice powder and distilled water. The canning lids were prepared before the mixture was added to the jars. The rubber sealing edge of the canning lids were turned upwards and four holes were punched symmetrically around the outer edge. A mixture of one fourth cup brown rice powder, one half cup vermiculite and one fourth cup distilled water was prepared for each half pint jar. This mixture was placed into the jars and covered with dry vermiculite. The lids were screwed on tightly and aluminum foil was used to cover the lid to prevent additional water from entering the jars during sterilization.

Since growing media is susceptible to contamination, the top layer of dry vermiculite was used to keep airborne contaminants from the wet substrate and absorb and regulate moisture transpiration and condensation[10]. The jars with the growing media mixture were sterilized at 120°C for 20 minutes. The jars were cooled before inoculation. Contamination was detectable through various colors from pastels to black. The growing media that became contaminated was observed but was not analyzed.

Eight jars per week were inoculated with 10 mL of spore solution. This was done for 9 weeks for a total of 72 inoculations. In addition to the eight jars inoculated per week, one jar per week was not inoculated and was used as a control blank. During the first four weeks, all samples were allowed to grow under indirect light. The last five weeks, half of the samples were allowed to grow under indirect light while the other half were kept in the dark. The jars kept in the dark were exposed to light only when samples were taken. Each jar was covered with parafilm after inoculation to keep airborne contaminates from the substrate.

The samples were transferred to terrariums after the pinheads became too large for the jars they were growing in. Two different terrariums were used for this experiment. The first one consisted of a styrofoam cooler with a piece of plexiglas inside of it. The second terrarium consisted of a 2-liter pop bottle with the middle portion cut out. To maintain a high level of humidity, both terrariums were sprayed with distilled water two to four times a day. Fanning the chamber with the lids two to four times a day also kept the terrariums well ventilated.

The growth and colonization was monitored for the samples grown under indirect light. The mycelium was sampled 13 days after inoculation. Samples were also taken from each jar at various stages of growth of the mycelium, primordia and the mature fruit. The growth of the mycelium, primordia and the mature fruit was monitored and compared for the samples grown under indirect light and in the dark simultaneously.

Sample Preparation

Samples were allowed to soak in methanol overnight. The methanol was decanted into a shell vial which was then condensed to near dryness (<1/2 mL) using a stream of air. An aliquot was removed for thin-layer chromatography (TLC). The mycelium knot samples were analyzed by TLC and by gas chromatography with a mass spectrometer (GC/ MS) in this methanolic extract state without any clean-up.

The extracts were cleaned up with an acid solution for GC/MS analysis. A 0.2 N solution of sulfuric acid was used to resuspend and acidify the extract. This solution was washed twice with chloroform to remove the neutral organic compounds. The samples were made basic with sodium bicarbonate and the psychoactive drugs were extracted twice with chloroform. The chloroform was evaporated and the sample was reconstituted with methanol for GC/MS analysis.

Thin-layer Chromatography

TLC was carried out on 5 X 10 cm silica gel plates (Analtech Newar, DE). Psilocyn (Alltech State College, PA) and psilocybin (Alltech State College, PA) standards were spotted on each plate along with the sample extracts. The plates were developed to 6 cm at room temperature in a covered development tank with a 9:1 chloroform/methanol solution. A beaker containing 3 mL of ammonium hydroxide was placed in the tank to assist in development. The plate was dried with low heat and visualized with a para-dimethylaminobenzaldehyde (p-DMAB) spray reagent. (The p-DMAB reagent consisted of 2g of p-DMAB in 50 mL of ethanol and 50 mL of hydrochloric acid.) The relative R_f value of psilocybin is 0.00 and the relative R_f value of psilocyn is 0.85.

The lower limit of detection was determined by serial dilutions of the psilocyn standard and spotting/developing it until the spot associated with the standard was not seen. The lower limit of detection for the TLC method was determined to be approximately 0.03 mg/mL.

Gas Chromatograph/Mass Spectrometer

The Hewlett Packard gas chromatograph 5890 Series II interfaced with the Hewlett Packard 5970 series mass selective detector (MSD) and the Hewlett Packard G1800A gas chromatograph detector system (GCD) were used for the detection of the analytes. These two instruments are equivalent and samples were run on specific instruments depending upon their availability. An HP-1 12 m column (film thickness 0.33 µm, column id 0.2 mm) was used for the gas chromatography (GC). The parameters for the GCD were as follows: injection port 250°C and detector temperature 280°C. Method SCAN70-Low mass 35, high mass 425, initial temperature 70°C, ramp rate 25°C/min and final temperature 300°C hold for 3.0 minutes. The parameters for the MSD were as follows: injection port 265°C and detector temperature 280°C. Method SCN90-Low mass 35, high mass 400, initial temperature 90°C, ramp rate 25°C/min, and final temperature 300°C hold for 4.0 minutes. Sample volume was approximately 3 µL with the split ratio of 30:1.

Lower Limit of Detection

The lower limit of detection for both instruments was determined by serial dilutions of the psilocyn standard and analyzing it until a peak at the correct retention time containing the prominent ions 44, 58, 77, 159, and 204 was not detected. The lower limit of detection was determined to be approximately 0.1 mg/mL for both instruments.

Results and Discussion

Identifcation of the mushrooms grown in this project was made by examination of the spores, fruiting bodies and the mature mushroom. Spores were examined for their color, shape, and size. The spores were purple to brown in color and elliptical to oblong elliptical in shape. They ranged in size from 6.7-8.2 µm by 12.6-15.0 µm. The fruiting bodies were examined mainly for color. The mature mushroom was examined for shape, size, color, texture, gill characteristics, and general appearance.

The original spore solutions were analyzed by TLC and by GC/MS. No psilocyn or psilocybin were detected in any of the spore solutions.

Mycelium growth was observed from 4 to 6 days. Fruiting bodies were observed from 24 to 48 days. The average amount of time for the primordia to appear was 32 days. Samples of mycelium were taken after 13 days of growth, 20 days of growth, and at various other days of growth. A total of 29 samples of the white mycelium growth were analyzed. No psilocyn or psilocybin was detected in any of these 29 samples. Nine of the 29 samples were confirmed by GC/MS, and again no psilocyn was detected.

Samples were analyzed after the first sign of growth of mycelium knots. A total of 22 mycelium knot samples were analyzed by TLC. Samples were considered to be consistent with a standard if their relative R_f value and their color matched the standard also spotted on the plate. Samples were considered to indicate a standard if their relative R_f value matched the standard but the color was not as dark as the standard spotted. Of the 22 mycelium knot samples, 17 were consistent with psilocyn. Of these 17 samples, 8 were also consistent with psilocybin and 1 indicated there was psilocybin in the sample. Four samples were consistent with the psilocybin standard spotted on the TLC plate, and one of these samples also indicated there was psilocyn in the sample. There was no psychoactive drugs detected in one of the samples.

Samples were analyzed after the first pinheads of the fruiting bodies were observed. A total of 25 samples of the pinheads were analyzed by TLC. All 25 samples were with the psilocyn standard spotted on the TLC plate. Of these 25 samples, 3 were also consistent with the psilocybin standard spotted and 3 indicated there was psilocybin in the sample (Table 1).

The 22 mycelium knot samples were also analyzed by GC/MS. In the inlet system of the gas chromatograph, thermal dephosphorylation of psilocybin occurs. As a result of this degredation of psilocybin to psilocyn, one is unable to differentiate the two by GC/MS. With this inability to differentiate psilocyn and psilocybin, it is unknown if the starting material contains psilocyn, psilocybin, or a mixture of both drugs. For this project, only a psilocyn standard was analyzed by GC/MS (Figs. 7-9 see source). Samples were considered to be consistent with psilocyn if their retention time and mass spectral fragmentation pattern matched that of the psilocyn standard. Samples were considered to indicate psilocyn if their retention time was consistent with the psilocyn standard and contained the prominent ions, but were lacking ions in the total fragmentation pattern. Of these 22 mycelium knot samples, 12 were consistent with the psilocyn standard. Seven samples were found to indicate psilocyn, and there were three samples where psilocyn was not detected.

TABLE 1 - Results of thin layer chromatography (TLC).*

Sample Types	Total of Samples Analyzed	c/w Psilocyn and c/w Psilocybin	c/w Psilocyn and Indicates Psilocybin	c/w Psilocyn Only	c/w Psilocybin Only	c/w Psilocybin and Indicates Psilocyn	Not Detected
Spores	4						4
Mycelium	29						29
Mycelium knots	22	8	8	1	3	1	1
Pinheads	25	19	3	3			
Mushrooms	11	9	2				

* Results of thin layer chromatography (TLC) on the various stages of development of the *Psilocybe cyanescens* mushroom. TLC was carried out on 5 x 10 cm silica gel plates and developed with a 9:1 chloroform/methanol solution. Plates were visualized with p-DMAB spray reagent. Samples were considered to be consistent with (c/w) a standard if their relative R_f value and their color matched the standard also spotted on the plate. Samples were considered to indicate a standard if their R_f value matched the standard but the color was not as dark as the standard spotted.

The 25 "pinhead" samples were also analyzed by GC/MS. Of these 25 samples, 19 were consistent with the retention time and mass spectral fragmentation pattern as psilocyn. Three samples were found to indicate psilocyn and psilocyn was not detected in 3 samples (Table 2).

TABLE 2 - Results of gas chromatograph/mass spectrometer (GC/MS).*

Samples Types	Total # of Samples Analyzed	c/w Psilocyn	Indicates Psilocybin	Not Detected
Spores	4			4
Mycelium	9			9
Mycelium knots	22	12	7	3
Pinheads	25	19	3	3
Mushrooms	11	11		

* Results of gas chromatography/mass spectrometer (GC/MS) on the various stages of development of the *Psilocybe cyanescens* mushrooms. Samples were analyzed on Hewlett Packard gas chromatograph 5890 Series II interfaced with Hewlett Packard 5970 series mass selective detector (MSD) and the Hewlett Packard G1800A gas chromatograph detector system (GCD). Samples were considered to be consistent with (c/w) psilocyn if their retention time and mass spectral fragmentation pattern matched that of the psilocyn standard. Samples were considered to indicate psilocyn if their retention time was consistent with the psilocyn standard and contained the prominent ions, but were lacking ions in the total fragmentation pattern.

Samples of the mature mushroom were also analyzed. Eleven samples were analyzed by TLC and by GC/MS. All eleven samples were consistent with the psilocyn standard spotted on the TLC plate. Of these 11 samples, 2 also indicated psilocybin in the sample. All 11 samples analyzed on the GC/MS were consistent with the psilocyn standard (Figs. 10-12 see source).

There were some noticeable differences in the samples grown under indirect light versus the samples grown in the dark. All samples started to show mycelium growth at 4 days. The first signs of fruiting bodies were observed to be from 19 to 25 days in the samples that were grown under indirect light with the average being 21 days. The first signs of fruiting bodies were observed from 23 to 45 days for the samples that were grown in the dark, with the average being 26 days. The samples that were grown under indirect light had primordia which grew faster and larger. They were plump, yellow in color with brown tips. The samples that were grown in the dark had small white primordia that were skinny and long. The coloring was off-white with only a few having dark brown tips. The mushrooms that were grown under indirect light had thick stipes with yellowish to chestnut colored caps. The mushrooms that were grown in the dark had lighter stipes that were much skinnier than the mushrooms grown in the light. The caps of the mushrooms grown in the dark were also lighter in color than the mushrooms grown under indirect light. Psilocyn and/or psilocybin was detected in the mycelium knots, the pinheads and the mature mushrooms of all samples grown either in the dark or the light.

Conclusion

The psychoactive drugs psilocyn and psilocybin were not detected in the mycelium, the earliest stage of development of the mushroom. These drugs were identified in the mycelium knots, the earliest stages of the fruiting body of the mushroom.

Light affects the growth of the Psilocybe cyanescens mushroom. This affect is apparent in the time of development and the appearance of the mushroom. Light affected the color and size of both the fruiting bodies and the mature mushroom. Light did not affect the presence of psilocyn or psilocybin in the early stages of the primordia or the mature mushrooms, nor did it affect the ability to detect these psychotropic drugs. It appears that the Psilocybe cyanescens mushrooms are not photosynthetic, but are photosensitive.

Acknowledgments

The author wishes to acknowledge Dr. David McLaughlin, Plant Biology Department, University of Minnesota for his time and assistance in identifying the mushroom, and his explanations about the classifications of fungi and the development of the mushroom. This project was supported by the Federal Bureau of Investigation, Minneapolis Office which generously provided the supplies.

References

1. Minnesota Statues Chapter 152.02. Schedules of conlrolled substances; Subdivision 2, Schedule I. The following items are listed in Schedule 1:(3) Any material, compound, mixture or preparation which contains any quantity of the following hallucinogenic substances, their salts, isomers and salts of isomers, unless specifically excepted, whenever the existence of such salts, isomers, and salts of isomers is possible within the specific chemical designation: 3,4-methylenedioxyamphetamine; 4-bromo-2,5-dimethoxyamphetamine; 2.5-dimethoxyamphetamine; 4-methoxyamphetamine; 5-methoxy-3,4-methylenedioxyamphetamine; Bufotenine; Diethyltryptamine; Dimethyltryptamine; 3,4,5-trimethoxyamphetamine; 4-methyl-2.5-dimethoxyamphetamine; Ibogaine; Lysergic acid diethylamide; Marijuana; Mescaline; N-ethyl-3-piperidyl benzilate; N-methyl-3-piperidyl benzilate; Psilocybin; Psilocyn; Tetrahydrocannabinols; 1-(1-(2-thienyl) cyclyohexyl) piperidine; N-ethyl-1-phenyl-cyclohexylamine; 1-(1-phenylcyclohexyl) pyrrolidine.
2. Kaul TN. Introduction to mushroom science. Enfield, New Hampshire: Science Publishers, Inc., 1997.
3. McKnight KH and McKnight VB. A field guide to mushrooms. Boston: Houghton Miffiin Company, 1987.
4. Rumack BH and Salzman E. Mushroom poisoning: diagnosis and treatment. West Palm Beach, Florida: CRC Press, Inc., 1978.
5. Ammirati JF, Traquair JA. and Horgen PA. Poisonous mushrooms of the Northern United Stales and Canada. Minneapolis: University of Minnesota Press, 1985.
6. Guzman G. The genus Psilocybe. Nova Hedwigia: Beih, 1983;74:1-439.
7. Guzman G. Supplement to the monograph of the genus Psilocybe. In: Petrini O and Horak E, eds., Taxonomic monographs of Agaricales. Bibliotheca Mycologica 1995;159:91-141.
8. Singer R and Smith AH. Mycological investigations on teonanacatl, the Mexican hallucinogenic mushroom: Part II. A taxonomic monograph of Psilocybe, section Caerulescentes. Mycologia 1958;50:262-303.
9. Starnets P and Chilton JS. The mushroom cultivator. Olympia, Washington: Agarikon Press, 1983.
10. Psylocybe Fanaticus (PFtek), 1996.

Photo and Chart Descriptions (figures and table-charts)

There are 6 black and white photos and 8 table charts in the published article. They are not included in this file. [In this *QAL in one* version BW pictures and tables are included, except charts (to see it, follow second original backup link given at the beggining of this section).]
FIG. 1 - microscope photo of spores
FIG. 2 - mycelium invitro
FIG. 3 - birthed PF cake with fungal pins
FIG. 4 - PF jar with invitro primordia
FIG. 5 - PF race shrooms on cake
FIG. 6 - PF shrooms on cake
FIG. 7 - 12 - GC/MS readout charts
Table 1 - TLC chart
Table 2 - GC/MS chart

PF comments

There are several interesting points in the first article, "Detecting Psychoactive Drugs in the Developmental Stages of Mushrooms".

1. The article was the result of a full FBI investigation of PF in 1998. What saved PF was this; "The original spore solutions were analyzed by TLC and by GC/MS. No psilocyn or psilocybin were detected in any of the spore solutions". If these drugs would have been detected, PF would certainly be history and the new spore syringe phenom would be over.
2. The article gave PF credit for the source of the spores, "The spores used in this experiment were obtained legally through an advertisement in High Times Magazine from Psylocybe Fanaticus (PFTek Seattle, WA)". This is quite amazing because the FBI did not have to give any credit for this research, but they did. Most likely, it was because a lot of money was invested for the research and they achieved valid results. They even spelled Psylocybe Fanaticus correctly incorrect with a Y, and not an I. Also, the FBI performed the PF TEK exactly as written (credit given in the references section and footnotes) and because they followed the PF TEK, even they were able to get a first time success, making their research project and money spent, successful.
3. The paper identified the shroom grown (PF race) as a Psilocybe Cyanescens. Everyone knows that the PF race is Psilocybe Cubensis and not Psilocybe Cyanescens. Why then identify it as a wrong specie? The clue is here, "The genus and species of Psilocybe mushrooms that were grown were identified as Psilocybe cyanescens. The pleurocystidia sizes noted in the keys describing the Psilocybe cyanescens mushroom varied slightly from the mushrooms grown. This may indicate a variant of this species (communication with Dr. David McLaughlin, Plant Biology Department, University of Minnesota) (2,4,5-8)". For the last few years, PF has taught the concept of "spore race". What the scientists did was to ignore what PF said about the identity of the shroom and went to the books and keys to do an objective ID, and what they obviously saw was that the PF race shroom looks more like a Psilocybe Cyanescens than a Psilocybe Cubensis. They refer to it as a "variant of the species". This is more vindication of PF's new concept of spore race as opposed to the common designation - "strain", which falls short of describing these various races that do not mate, but stay unique and separate.
4. They found no drugs in the young mycelium. This is very surpising, because after ingestion of "tea" made from boiling down mycelium engulfed grain, a slight "psilocybian buzz" can be felt for a brief time. The answer is that the lab equipment could not detect an amount of psilocybin that the human psyche can!

Chapter two

Potency comparisons of 4 species of "Dutch over the counter" Magic Mushrooms excerpt from The Forensic Science International journal. 113 (2000) 389-395

HALLUCINOGENIC MUSHROOMS ON THE GERMAN MARKET - SIMPLE INSTRUCTIONS FOR EXAMINATION AND IDENTIFICATION

"The cultivation or possession of whole Psilocybe mushrooms and its spores are restricted by German law since 1998"

Psilocybin and psilocin measurements (%) for 18 specimens of Psilocybe Cubensis, 9 specimens of Ps. Semilanceata, 6 specimens of Paneaolous cyanescens and 4 specimens of Ps.Tampanensis.

Psilocybe Cubensis		Psilocybe Semilanceata		Panaeolous Cyanescens		Psilocybe Tampanensis	
psilocybin	psilocyn	psilocybin	psilocyn	psilocybin	psilocyn	psilocybin	psilocyn
none	0.14	0.01	0.48	0.02	0.56	none	0.02
none	0.05	0.16	0.13	0.44	0.14	0.01	0.03
none	0.10	0.25	0.08	0.47	0.22	0.03	0.03
none	0.10	0.27	0.24	0.51	0.64	0.19	0.01
none	0.11	0.30	0.03	0.54	0.09		
0.01	0.05	0.42	0.04	1.15	0.90		
0.02	0.09	0.51	0.12				
0.17	0.09	0.72	0.01				
0.31	0.23	0.91	0.90				
0.50	0.12						
0.87	0.04						
0.98	0.03						
1.07	0.01						

PF comments chapter two

Extreme variations in potency of a given collection of magic shrooms has been reported ever since reports have been done about these shrooms. And similarly, this report also shows the extreme variability of psilocybin content amongst the dried samples. So if one wants potent and satisfying Cubensis magic shrooms, they should be grown for potency. And that is done by harvesting them in their young stage, before sporulation begins. When that is done, even the most different appearing spore races look about the same. When the caps aren't fully expanded, all of the races look similar. The visual differences emerge when the shrooms mature, but then when they mature, they are only good for spore printing. These are weak in potency and unsatisfying for tripping. So the word of wisdom is, grow them PF style, harvest them when they are young and cool dry them with desiccant. When this is done, they are an entheogen of the highest nature.

Table of Contents

PSYLOCYBE FANATICUS MUSHROOM MUSEUM

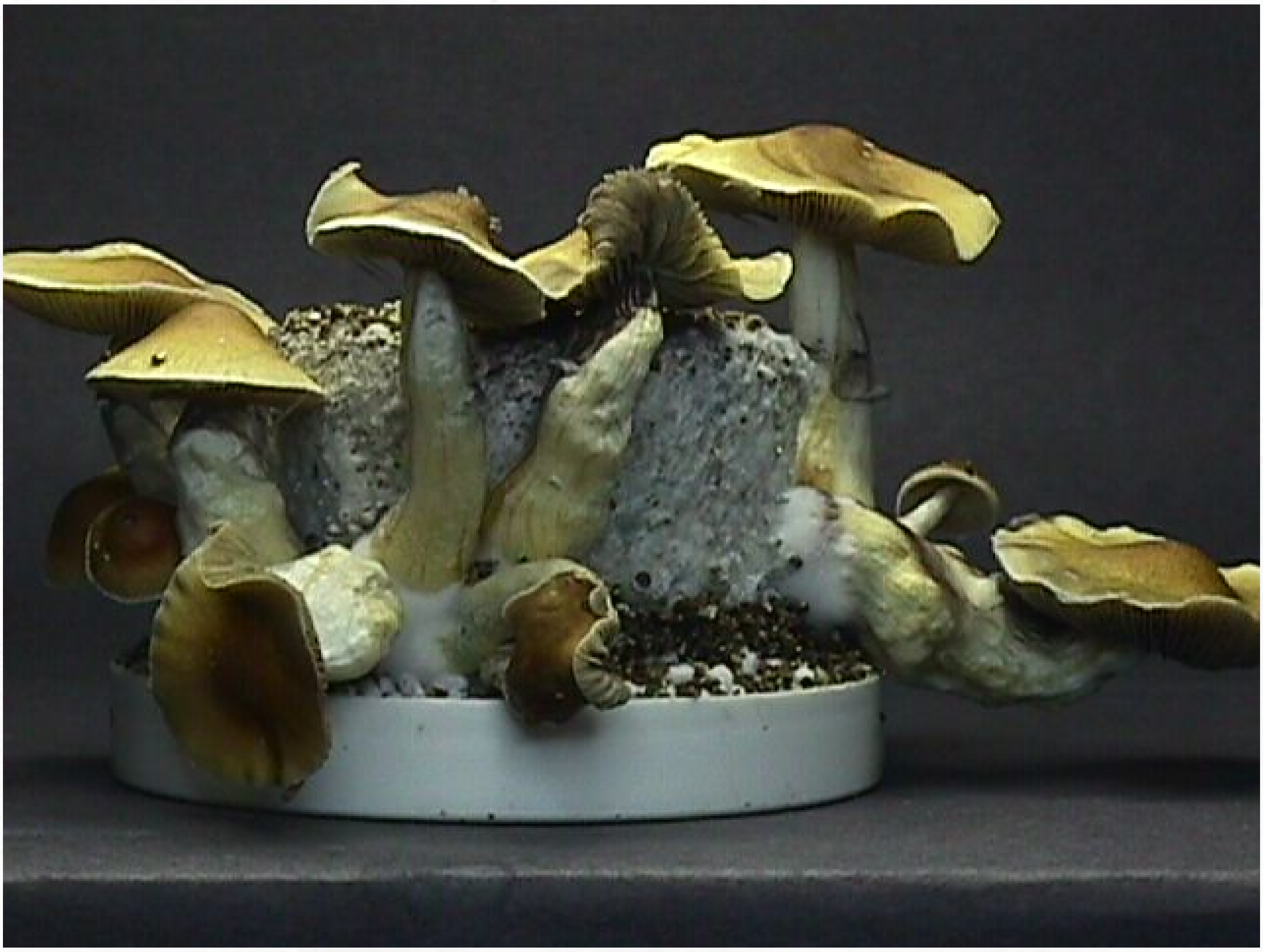
original source: http://www.fanaticus.com/museum2.htm

All of these shrooms in the PF Shroom museum were grown identically - PF style in the "Richmans terrarium" - basically the PF neglect tek. No humidifiers or perlite layers were used to increase humidity. Only a couple of airings and mistings were done per day and sometimes less (neglect tek). Some have vermiculite casings on the tops and some are without. All have a "bottom" casing of wet perlite covered with vermiculite (in a jar cap) which keeps the cakes hydrated and adds to the humidity of the terrarium.

PSYLOCYBE FANATICUS
November 2000

CHAPTER 21 - PSYLOCYBE FANATICUS RACE PHOTOS AND DESCRIPTIONS

Psilocybe cubensis - Matias Romero



This is the PF spore race. It is also called "Matias Romero" at other spore sellers sites or Amazonian. It lately has picked up the name "PF CLASSIC". This photo is of a second flush. The first flush was done and the cake was cleaned with a very sharp hunting knife (like peeling an apple - only with a very sharp large blade). The cleaned cake was placed on a jar cap of soaked and drained fresh perlite and vermiculite. Then a fresh dry vermiculite layer was applied to the top and soaked by dripping water on it from an eye dropper.

DESCRIPTION:

1. CAP (size - shape stages - colors)
   The primordia start dark reddish. The cap is a fairly dark reddish (deep colors) and thick. It starts dome like and goes to plane at maturity and continues to grow until it is upturned and convoluted, with the gills a very deep brown, with streaks of purple (spore deposits) across and around the cap.

2. STEM (length - girth - flesh - colors)
   It can be short and fat or long and hefty. It depends on the air and humidity. The PF race responds to this seriously. With lots of air and humidity, the PF stem is long, slender, thick fleshed and white. The flesh of the PF race is unique amongst all the races. It is very much like soft moist BREAD. But sometimes there can be a bit of fibrousness here and there.

3. VEIL (deliquescent - partly deliquescent - persistant anulus)
   The PF race has a definitely deliquescent veil. When the veil breaks during growth of the shroom, it usually breaks off from the stem and breaks up around the gills, leaving veil remnants all over the gills and mainly on the edges. But, sometimes there is a veil that becomes like an anulus (around the stem) but at close inspection, the veil will not be attached securely and usually might just hang in part. Also, there is serious differences amongst the races at how the gills attach to the stem under the cap. The PF gills attach closely. Whereas the Malaysian gills have a rather large gap where the gills attach to the underside of the cap. Gill stem and cap attachment is a definite trait of races, but unfortuneatly, further observations and notes are required for any in depth descriptions. But note that all these races have distinct gill attachment traits that adds to the differences!

4. SPORULATION (at what developement stage does it begin?)
   The PF race is a slow maturing shroom. It can grow large and the cap expand, but the gills will still be biege or light colored. Then, after about a day or two, the purple deposits of the spores will appear on the stem, and the gills will be darker brown. But sometimes, sterile specimens will appear. These are shrooms that don't develope spores and the gills remain distinctly light colored (biege - tan - yellowish). They have no spores. I once knew someone who cloned this type of sterile strain and claimed it to be the best in potency, overall. This fits with the observation that potency diminishes as sporulation developes. So without sporulation ever starting, the potency doesn't diminish in relation.

5. TENACIOUSNES (Strength of attachment of the stem base to the cake)
   The PF is the champ at this. Usually the PF shroom has a large base (big foot). In fact, "BIG FOOT" should be the sur name of the PF race. This makes the PF race the most tenacious to the substrate of them all. When harvested, it is common to pull off large chunks of cake in the process.

6. SHAPE SHIFTING (shapes and changes of flush to flush - strain to strain)
   The PF race is the champ in this also. It goes from ugly little abhorts and convoluted dwarfs, to tall robust white thick stemed specimens with large deep reddish colored caps that go to plane and then wildly upturn at full maturity.

7. SIZE TENDANCIES (overall size of the mushroom at maturity)
   Small to about as big as they get.

8. GESTATION PERIOD (generalized time of primordia appearance after inoculation)
   The PF might be the champ here also. It is the first of any of these shrooms observed to form primordia invitro. The others can, but the PF is a speed demon in comparison. And the PF invitro primordiation is far more numerous if allowed to develope and not birth so quick. But also, many if not most of the primordia will abort. The PF shroom is the champ at aborting shrooms also. That is why it has such a love hate relationship with the hobbiests.

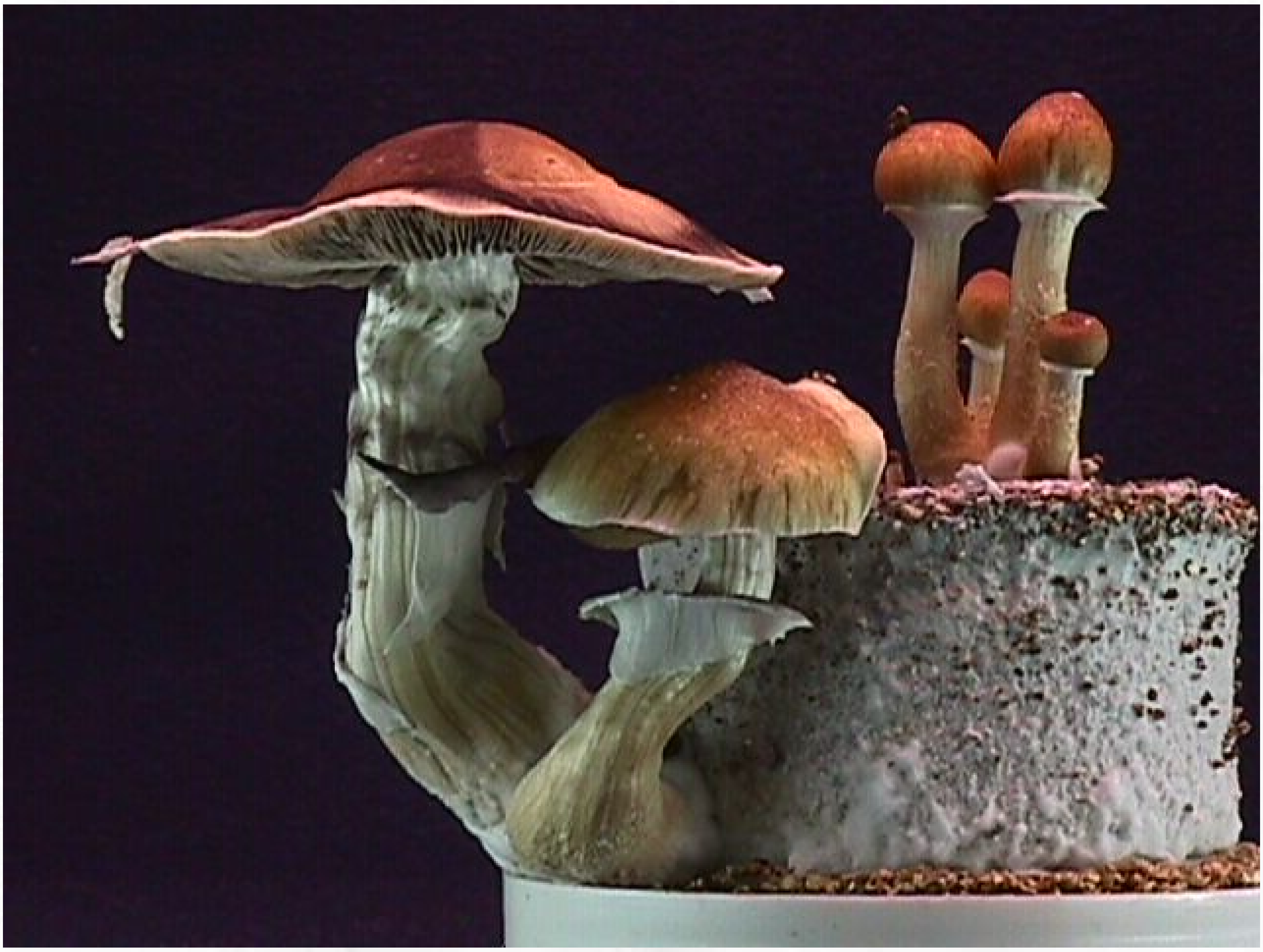
9. POTENCY (This simply comes down to how fast the shroom loses its latent potency - relating to the advent of sporulation)
   The PF potency gets a big thumbs up from everywhere. Its advantage is that is a slow maturer, so it

gives a wider envelope for the shroom to be harvested in its peak potency. A lot of hobbiests rate the PF race number one in potency. But that is not written in stone.

10. FLUSHING (Ability to repeat flush)
    The PF race usually flushes rather poorly on the first flush, giving mostly abhorts. And it can flush nicely the first time. But with a recasing treament. The second flush will be totally different and be excellent. The third flush is always decent and one can squeeze the lemon for nice looking healthy third flush stragglers. But all in all, it is good for three interesting flushes, PF style.

It appears that the PF spore race garners a love hate affair. People either hate it or love it. Even after enduring a severe flogging from the 1999 spore wars (PF copy cats and spore sellers claimed that it was actually a poisonous mushroom - which was believed by the unitiated for a short while). Now, it has regained its favored position amongst a host of mycophiles as either their favorite or at least near the top of the list. Interestingly, there are many who claim that the PF race is the most potent. But then there are many who don't. But whatever the judgement call would be, it is not a bad cubie, so that makes it as good as any, and in my opinion, DAMN good.

Psilocybe cubensis - Hawaiian



This is a photo of a first flush PF style. The cake was birthed without invitro primordiation, given the PF double ended cake casing treatment, and delivered to the basic PF neglect Tek. This spore race actually should be called the "classic". From what PF knows, it was the number one Cubensis cultivar in Holland for many years. There was a fiasco in Holland having to do with a grower (Tim Cyanse - psuedonym) who was supplying shrooms to Dutch head cafes but he went to far. He made cakes and candies with shroom powder (left over from harvesting and drying). This didn't go over to well with the Dutch authorities and a big bust and scandel erupted, even involving the famous German mycologist, Dr. Jochen Gartz.

DESCRIPTION:

1. CAP (size - shape stages - colors)
   Dome shaped to plane. This one doesn't upturn much in extreme maturity. The colors are the usuall flesh (caucasion) color, deep.

2. STEM (length - girth - flesh - colors)
   Slender to thick - whitish when young and mature. It is fibrous and sturdy with a medium length.

3. VEIL (deliquescent - partly deliquescent - persistant anulus)
   The veil is persistant leaving a well defined Stropharia type of anulus. It breaks clean off of the gills and forms a "turtle neck sweater" type of anulus.

4. SPORULATION (at what developement stage does it begin?)
   Sporulation is rampant and begins soon after the veil breaks. And it might even begin as the veil breaks leaving a decidedly purple colored anulus. This shroom is a fast maturer.

5. TENACIOUSNES (Strength of attachment of the stem base to the cake)
   Good tenaciousness, stable during growth and easily picked clean of substrate hanging on.

6. SHAPE SHIFTING (shapes and changes of flush to flush - strain to strain)
   The Hawaiian is a serious shape shifter. From large thick stemed specimens to small petite delicate stemed shrooms.

7. SIZE TENDANCIES (overall size of the mushroom at maturity)
   Small to almost as big as they get.

8. GESTATION PERIOD (generalized time of primordia appearance after inoculation)
   Slower than the PF race. Invitro primordiation is usually unsatisfactory, and birthing and casing are required about after a month.

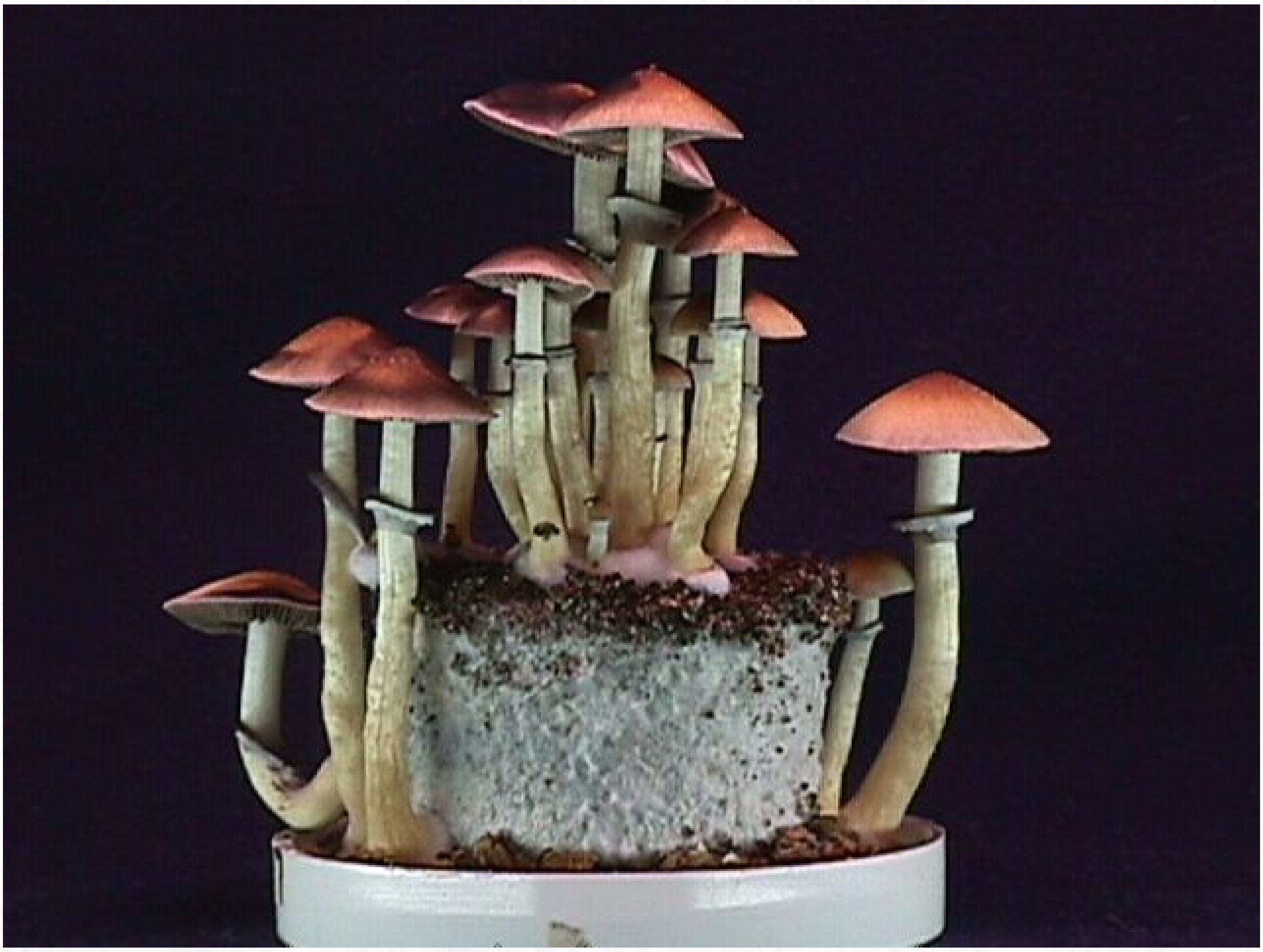
9. POTENCY (This simply comes down to how fast the shroom loses its latent potency - relating to the advent of sporulation)
   As long as this shroom is picked before any purple is observed, it is a good shroom.

10. FLUSHING (Ability to repeat flush)
    The Hawaiian might be the champ at this. First second and third flushes are easy and always look great. They change radically from strain manisfestaion to strain manisfestation, flush to flush. Very few aborts develope with the Hawaiian.

PF got it from a hobby mycologist in Holland (PFE) who was supplying it as a spore sample to Amazing Nature and Smart Botanics (Dutch Weed folks and items for sale). PFE named it "Golden Teacher". He did this because sometimes right before the veils break when the primordia are at their largest size before becoming mature, the entire shroom can have a golden yellowish color which vanishes when maturity starts to set in.

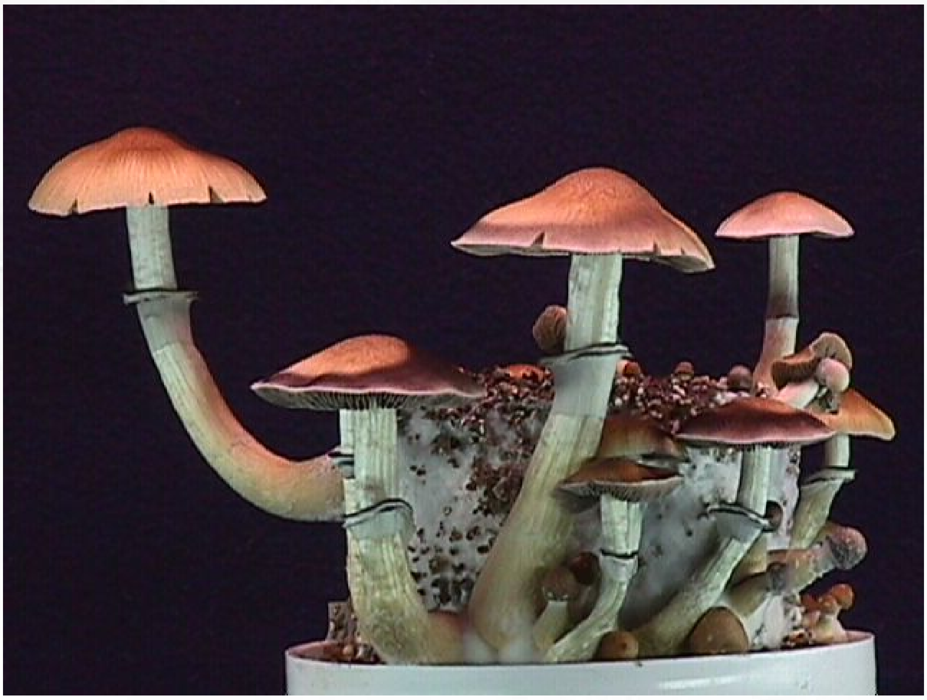
Strangely, the "Golden Teacher" being sold by other spore sellers is being claimed to be different from PF's "Golden Teacher". PFE claims that the Dutch growers got it from Pacific Exotic Spora in Hawaiia. It really doesn't matter where it came from. The reallity of it is that it is a superb Cubensis cultivar, one of the best ever found. It does look like the Cubensis used in the old OSS and OERIC (Mckenna brothers) shroom growing book.

So given the confusion about PES and the so called PES Amazon, PES Hybrid, or PES Hawaiian (all supposedly different), PF is dropping the "PES" from the title and just leaving it, "HAWAIIAN". Actually, Cubensis does not appear in Hawaiia (according to certain "experts"), so then it makes sense for PF just to call it the "Hawaiian", because after all, it is the only shroom spores marketed under a title having anything to do with HAWAIIA. So "Hawaiian" it will be.



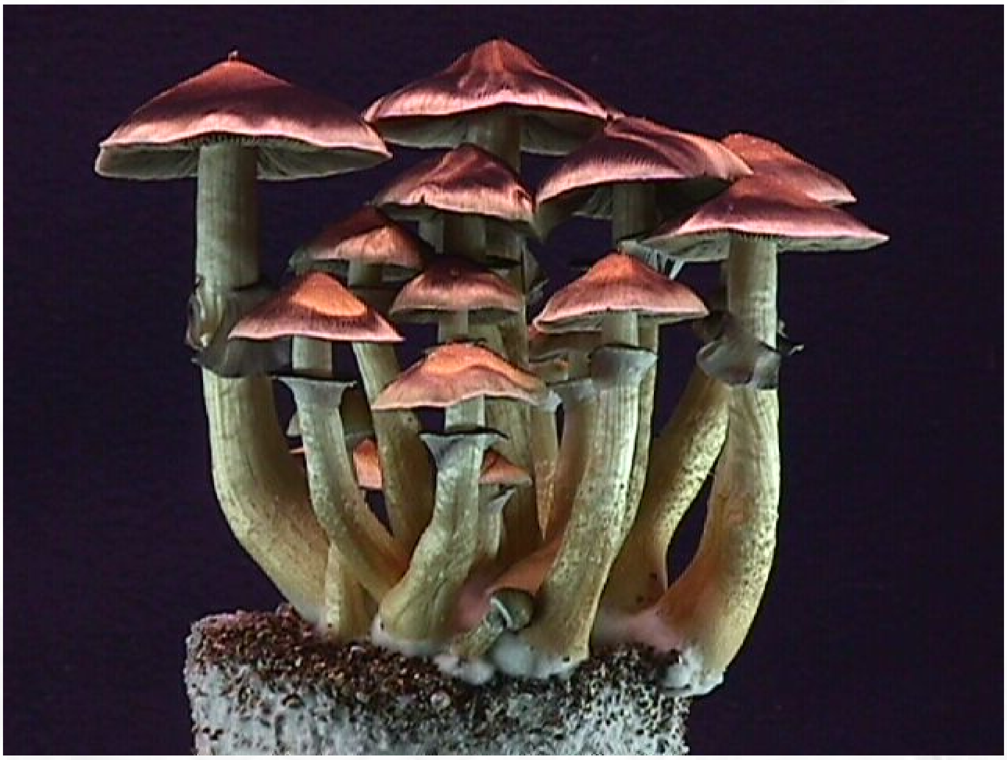
This is a second flush of the Hawaiian. Notice the smaller and thinner stems on this flush as compared to the large white stems on the flush pictured at the front. This could be a cause of the silly confusion about what the "PES Hawaiian" or the "PES GOLDEN TEACHER" or the "PES HYBRID" really is. Methinks they are the same. The Hawaiian is a mighty shape shifter. All in all, PF considers this Hawaiian to be the best cultivar of all (no darts please).

Psilocybe cubensis - JLF Amazon



This spore race was sent to PF on a trade and the sender said it was JLF's "AMAZON". It looks and acts just like the HAWAIIAN of PF. It probably is. This is an example of how these excellent spore races wind up everywhere with different names. But it keys out to the Hawaiian by all of its distinctions. It has the distinct persistant anulus and it is attached "turtle neck sweater" like. It has a white fibrous stem, and the cap and gills look identical.

Psilocybe cubensis - Equador



This is one of the best cultivars. It has appeared for many years. Its first appearance is a cover photo. Paul Stamets first book, "Psilocybe mushrooms and their allies" has the Equador on the cover. This is a very nice second flush and this shroom is a fav of many because of its incredible stature and growing ability.

DESCRIPTION:

1. CAP (size - shape stages - colors)
   dome shaped - doesn't go to plane at maturity but becomes convex. It never upturns. The primordia caps are sometimes a deep purple reddish with white spots.

2. STEM (length - girth - flesh - colors)
   Fibrous, sturdy, thick and whitish.

3. VEIL (deliquescent - partly deliquescent - persistant anulus)
   The veil is persistant, leaving a skirt like anulus attached to the stem.

4. SPORULATION (at what developement stage does it begin?)
   It begins quickly, maturing fast after veil break.

5. TENACIOUSNES (Strength of attachment of the stem base to the cake)
   Moderately attached and easy to pick cleanly.

6. SHAPE SHIFTING (shapes and changes of flush to flush - strain to strain)
   Very little shape shifting - a very stable appearing shroom from strain to strain.

7. SIZE TENDANCIES (overall size of the mushroom at maturity)

From small to about as big as they get.

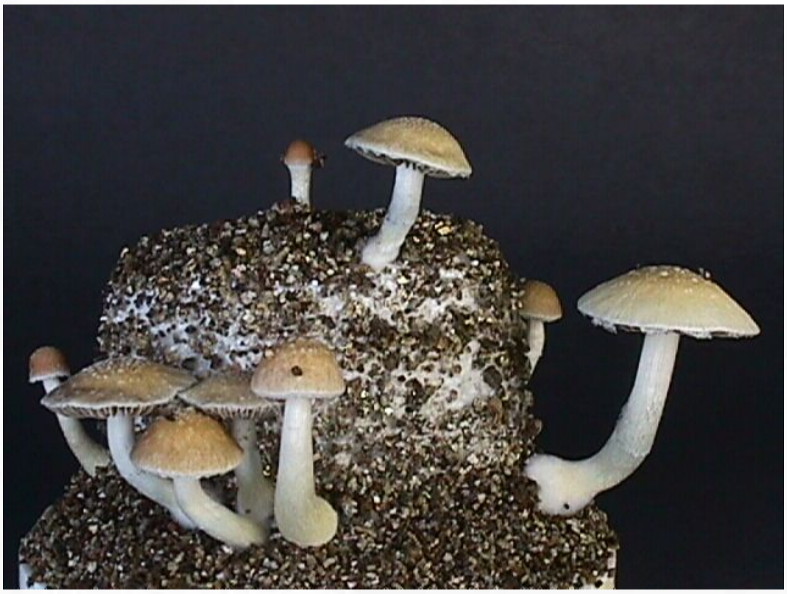
8. GESTATION PERIOD (generalized time of primordia appearance after inoculation)
   Like the Hawaiian, longer than the PF, and not a very good invitro primordiator. It can primordiate and give some perfect specimens, but it does better to birth after about a month and give it the PF double ended cake casing treatment.

9. POTENCY (This simply comes down to how fast the shroom loses its latent potency - relating to the advent of sporulation)
   This is a fast maturer, so the specimens must be picked in advanced primordia stage right before veil breakage for good potency.

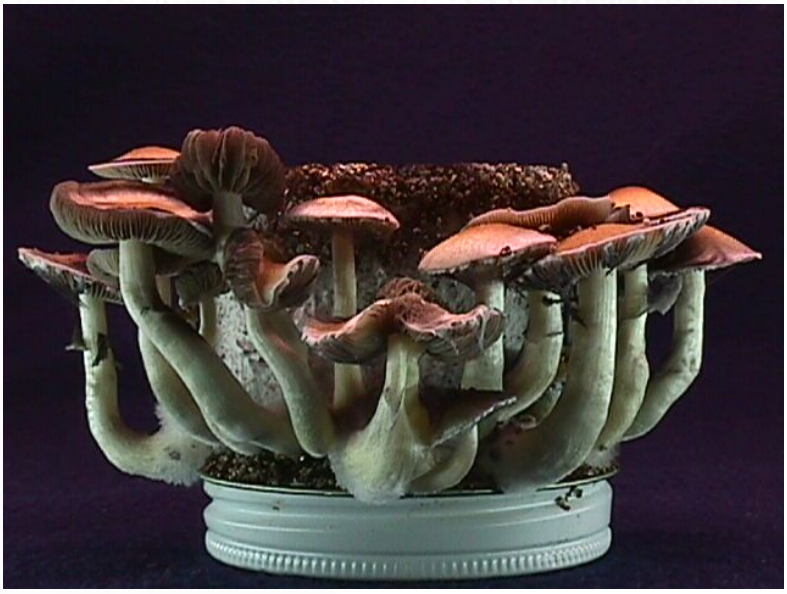
10. FLUSHING (Ability to repeat flush)
    It is a great flusher, giving three really good PF style flushes and more if the lemon is to be squeezed.

And, like the Hawaiian (Golden Teacher from PFE), it glows a yellowish hue from top to bottom right before the veil breaks. Then it quickly loses the gold color.

False Mexicana

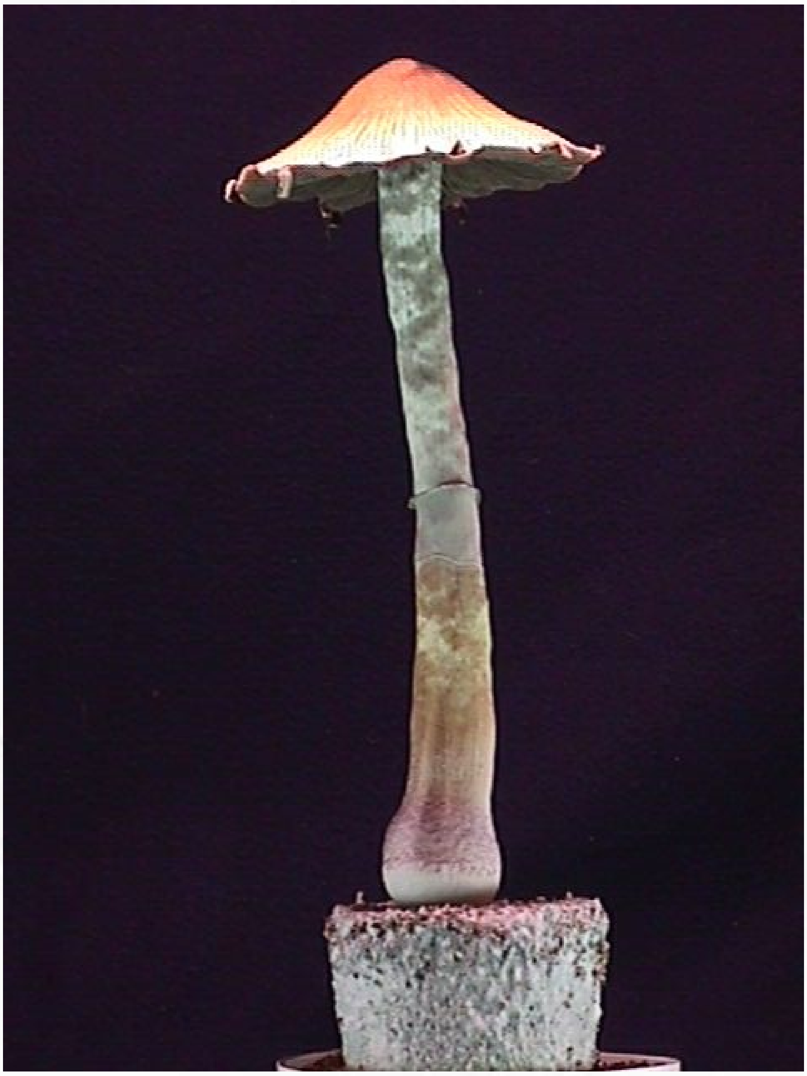


This mushroom started a real fury in the beggining of 1999. On the alt.drugs.mushrooms newsgroup, a spore seller appeared called FOGGY MOUNTAIN FARMS. They advertised a PSILOCYBE MEXICANA spore syringe and prints. Along with PANEOLOUS TROPICALIS and others, they offered the absurd "Azurescens Cubensis B+ hybrid". PF posted that it was a rip, and then the beginning of the 1999 spore wars took off. It turns out to have been a cubensis (as PF insisted). Then it was named MEXI-CUB.
This is an interesting little cubensis. That is exactly what it is, a small cubie. That is what they call it in Europe. The PF style flushes are small, but they are numerous over time. It likes to flush several times and each flush is incredibly different then the last. This is a surprising little shroom. Sometimes, it looks just like a pan cyan with no anulus, smooth slender white stem and dome like cap. But then, it can be medium sized with a large cap that goes to plane at maturity. The larger appearing strains have a cap color that is light with an orangish center. With PF style growing, this shroom never seems to want to get very big.



This is the photo PF uses for the PF ad in High Times magazine. As can be seen, this flush is much different from the above flush. It's a shape shifter.

Psilocybe cubensis - B+

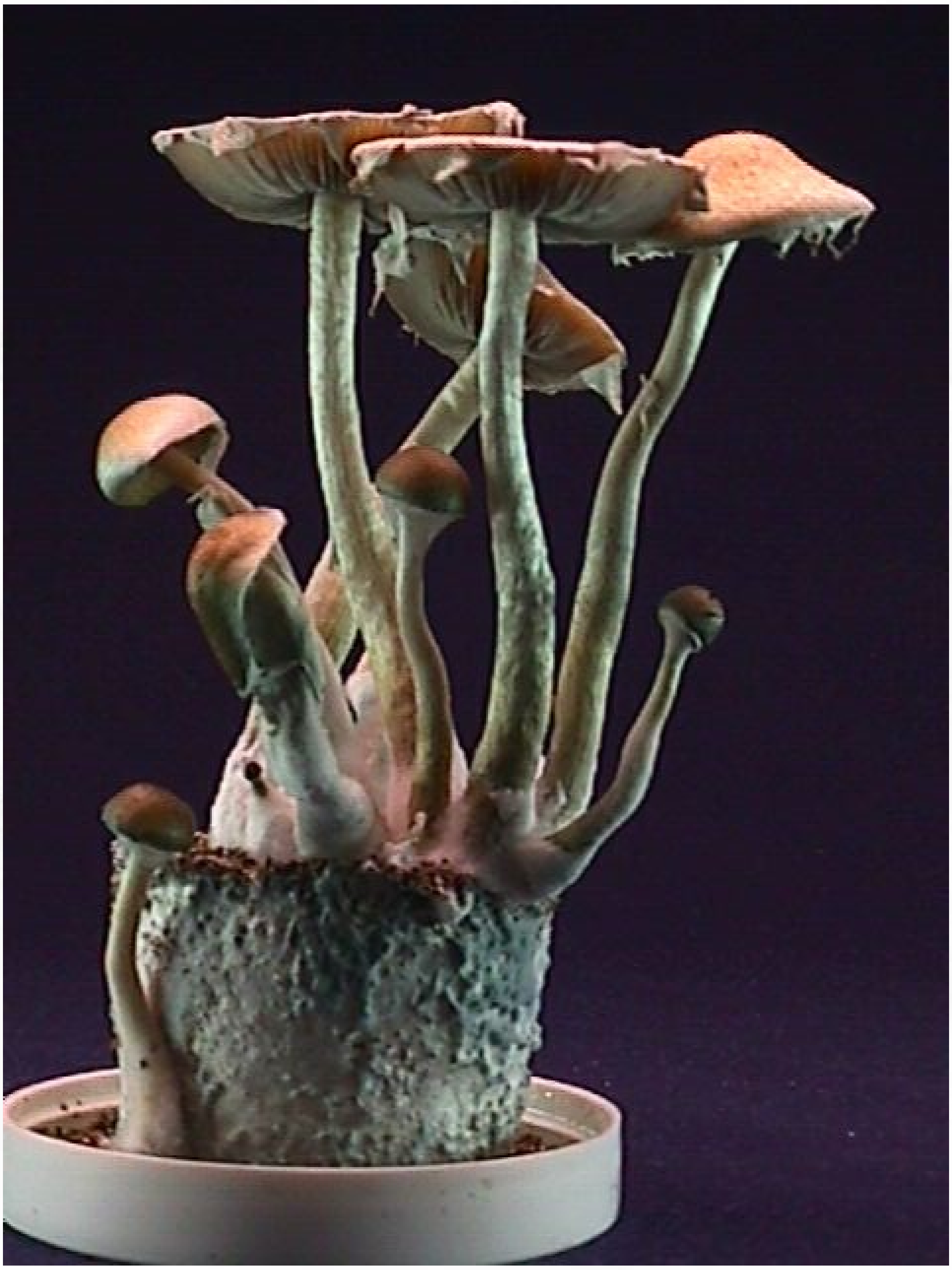


This cubie has been around the web for a few years. It is the favorite of certain spore peddlers. The original is called "Herbens B+ strain". From what I have seen, B means big and the + means very (very big).

Also, this shroom is the most hyped cubensis in history. There are many youthfull pop mycologists around the internet that are still debating about this shroom being some kind of Psilocybe Azurescens cubensis "HYBRID". And there have been various spore sellers that advertise it as that. But of course, it is just a cubensis. The shroom in the photo is growing on a 1/2 pint PF cake. The cultivation procedure was identical to the others. Temperature ranges are the same and it likes to be birthed and cased. Invitro primordiation seems fairly nil.

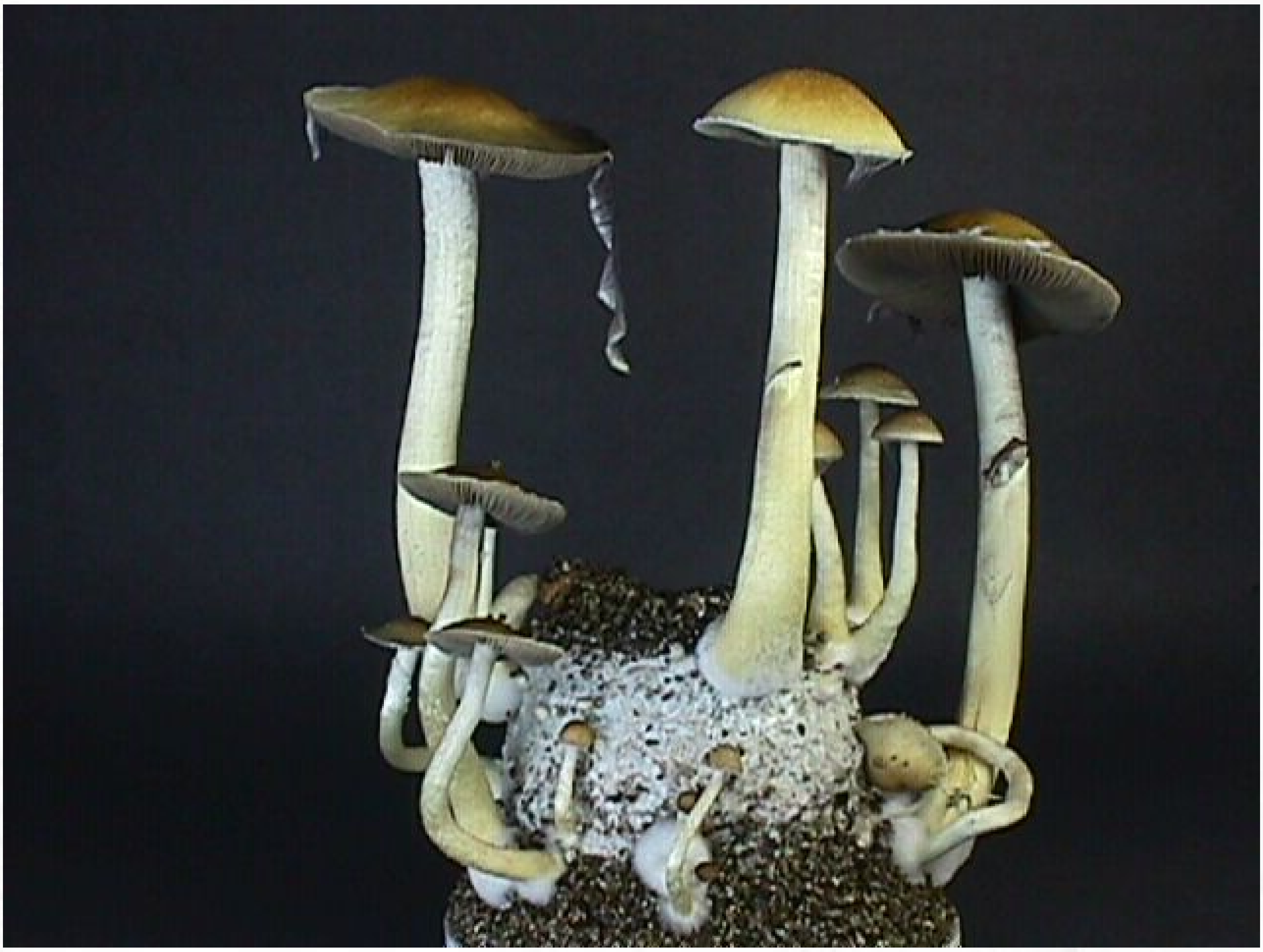
In comparing this one to the others, its size can be determined by using the cakes as a reference (all 1/2 pint size). Its veil becomes a persistant anulus, attached to the stem "turtle neck sweater" style. It has a fibrous slender long stem, and large cap that doesn't seem to go to full plane and never upturns. It seems to clearly to be the champ at long stems and specimen height. It is not tenasciously attached to the substrate, so it has a tendancy when grown PF style, to grow tall and fall over (tip the cake or just break off from the substrate when in the wrong position). It is the tallest growing cubensis around, and it has many fans. But just because it is the biggest, doesn't mean it is the best. It had a fierce reputation as being the most potent, but after time has passed and this shroom got around, it turns out to be no better than any other Cubensis in potency. And since this too is a fast maturing shroom, it must be picked presporulation for max potency. It should be picked in its advanced primordia stage, with the veil still unbroken.

Psilocybe cubensis - Treasure Coast



Psilocybe cubensis - Cambodian

This spore race was sent to PF on a trade and the sender said it was MYCO TECH (Seattle) Cambodian.



DESCRIPTION:

1. CAP (size - shape stages - colors)
   Becoming plane in age and not upturning. The cap seems to have dark colors in it as well as the usuall purplish streaks from wandering clouds of spores.

2. STEM (length - girth - flesh - colors)
   Whitish, fibrous and hefty slender with a medium length.

3. VEIL (deliquescent - partly deliquescent - persistant anulus)
   The veil is decidedly deliquescent.

4. SPORULATION (at what developement stage does it begin?)
   Not a real fast maturer, just a little slower than the EQ or HA.

5. TENACIOUSNES (Strength of attachment of the stem base to the cake)
   Well secured to the cake. It is not big enough to want to fall over.

6. SHAPE SHIFTING (shapes and changes of flush to flush - strain to strain)
   Stable.

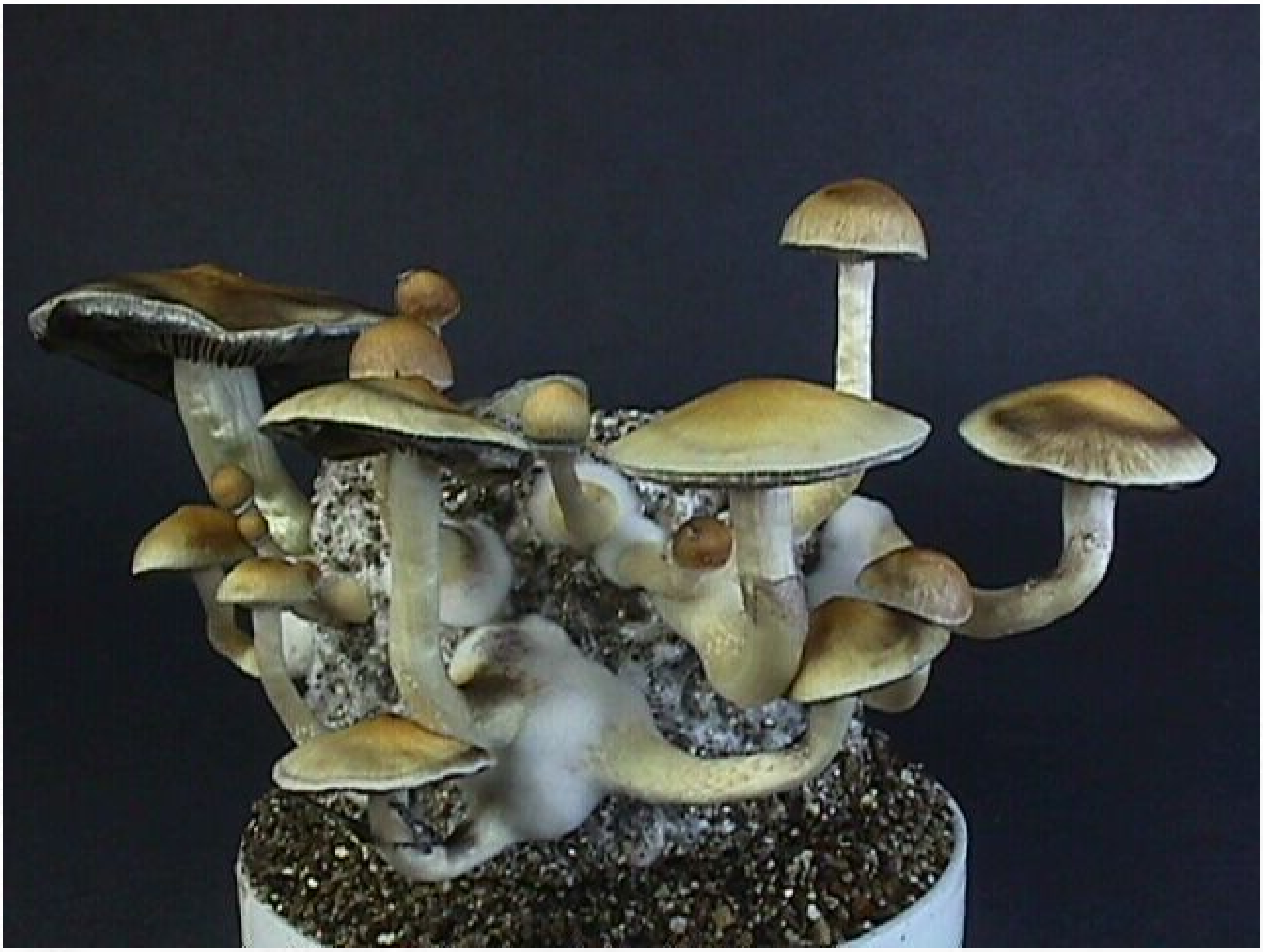
7. SIZE TENDANCIES (overall size of the mushroom at maturity)
   From small to as big as they get.

8. GESTATION PERIOD (generalized time of primordia appearance after inoculation)
   Similar to the EQ or HA.

9. POTENCY (This simply comes down to how fast the shroom loses its latent potency - relating to the advent of sporulation)
   Probably as good as any. Just pick it presporulation.

10. FLUSHING (Ability to repeat flush)
    Unknown, but probably as good as any.

Psilocybe cubensis - Thailand



This spore race was sent to PF on a trade and the sender said it was MYCO TECH (Seattle) THAILAND.

DESCRIPTION:

1. CAP (size - shape stages - colors)
   It goes to plane on maturity and doesn't seem to want to upturn. It is lighter than a lot of cubies.

2. STEM (length - girth - flesh - colors)
   Slender white and fibrous. Medium length at most.

3. VEIL (deliquescent - partly deliquescent - persistant anulus)
   Veil is deliquescent.

4. SPORULATION (at what developement stage does it begin?)
   The Thai is kind of like the Treasure Coast. It is a slow maturer and a weak sporulator.

5. TENACIOUSNES (Strength of attachment of the stem base to the cake)
   Moderate with good stability PF style.

6. SHAPE SHIFTING (shapes and changes of flush to flush - strain to strain)
   Appears stable.

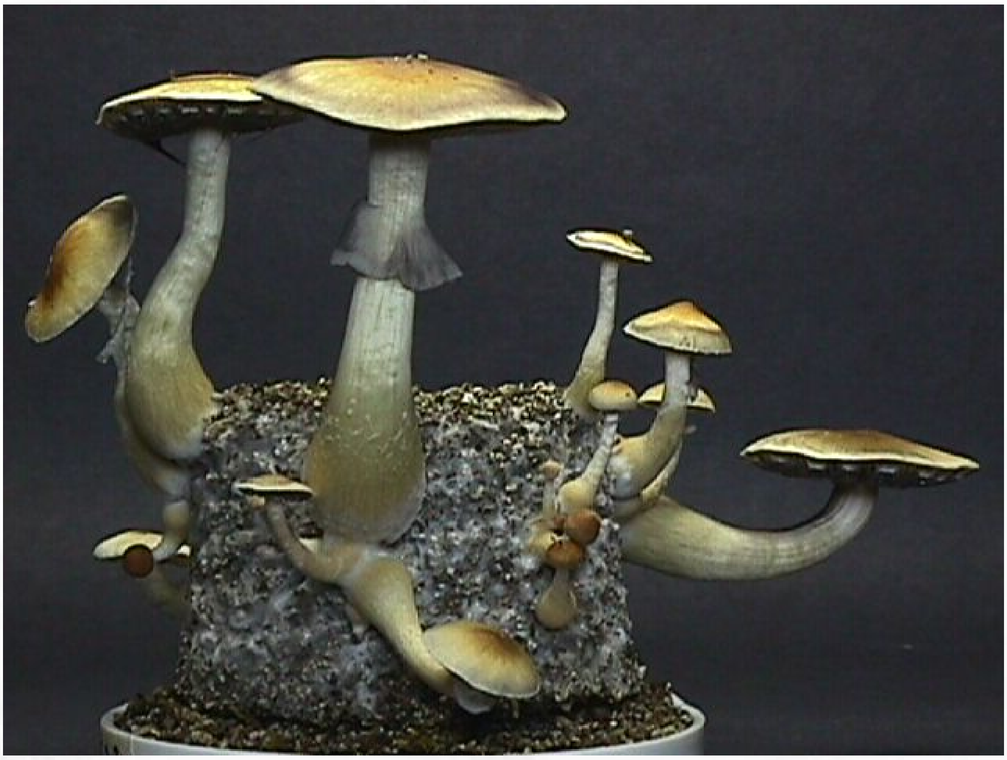
7. SIZE TENDANCIES (overall size of the mushroom at maturity)
   Tiny to moderate.

8. GESTATION PERIOD (generalized time of primordia appearance after inoculation)
   Average - like the HA.

9. POTENCY (This simply comes down to how fast the shroom loses its latent potency - relating to the advent of sporulation)
   Due to its late maturing, the envelope is wide to get quality potency before maturing.

10. FLUSHING (Ability to repeat flush)
    Unknown but probably as good as any.

Psilocybe cubensis - Malaysian



This spore race was sent to PF on a trade and the sender said it was MYCO TECH (Seattle) MALAYSIAN.

DESCRIPTION:

1. CAP (size - shape stages - colors)
   It doesn't upturn at full maturity, but goes to plane. The colors are the usuall.

2. STEM (length - girth - flesh - colors)
   Whitish, fibrous and hefty slender.

3. VEIL (deliquescent - partly deliquescent - persistant anulus)
   This one is a combo. It has a fully deliquescent veil and also can leave behind an EQ style "skirt" persistant anulus. Very mystifying.

4. SPORULATION (at what developement stage does it begin?)
   Not an early maturer.

5. TENACIOUSNES (Strength of attachment of the stem base to the cake)
   Moderate.

6. SHAPE SHIFTING (shapes and changes of flush to flush - strain to strain)
   Stable - few aborts.

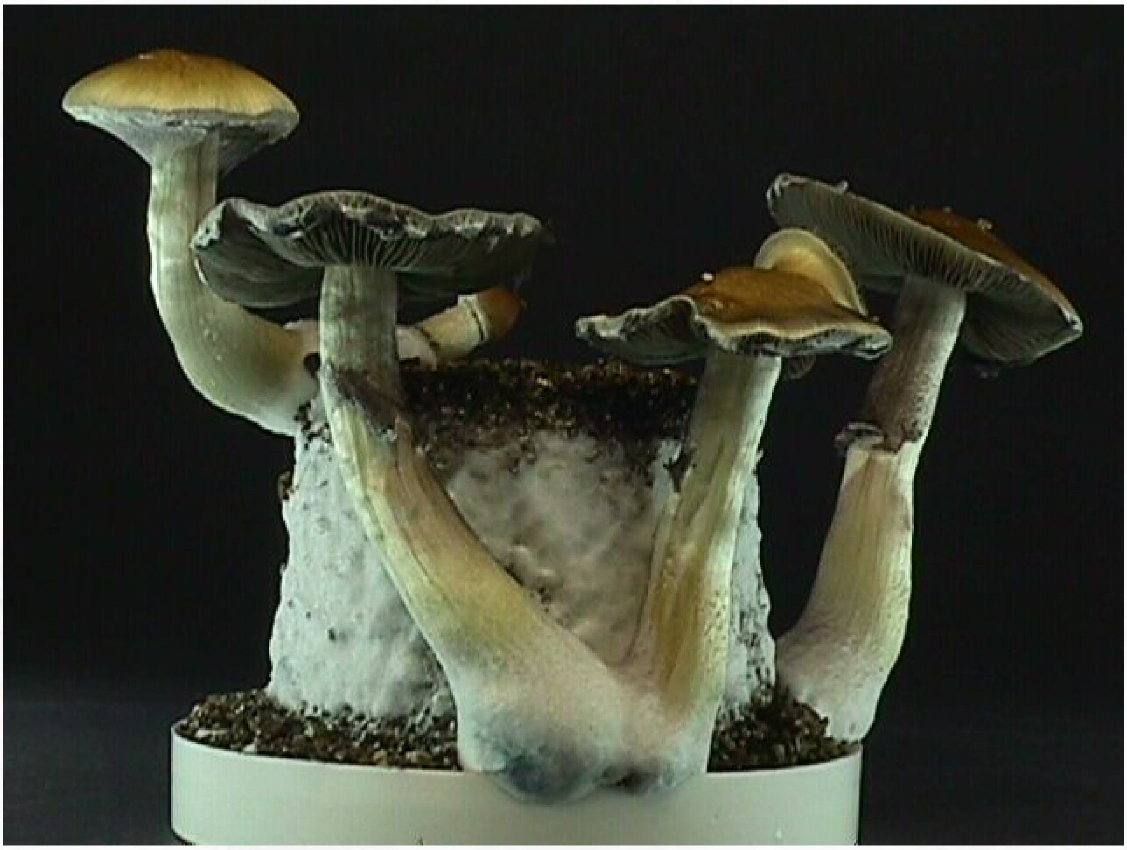
7. SIZE TENDANCIES (overall size of the mushroom at maturity)
   Tiny to moderate.

8. GESTATION PERIOD (generalized time of primordia appearance after inoculation)
   Similar to the EQ or HA - moderate.

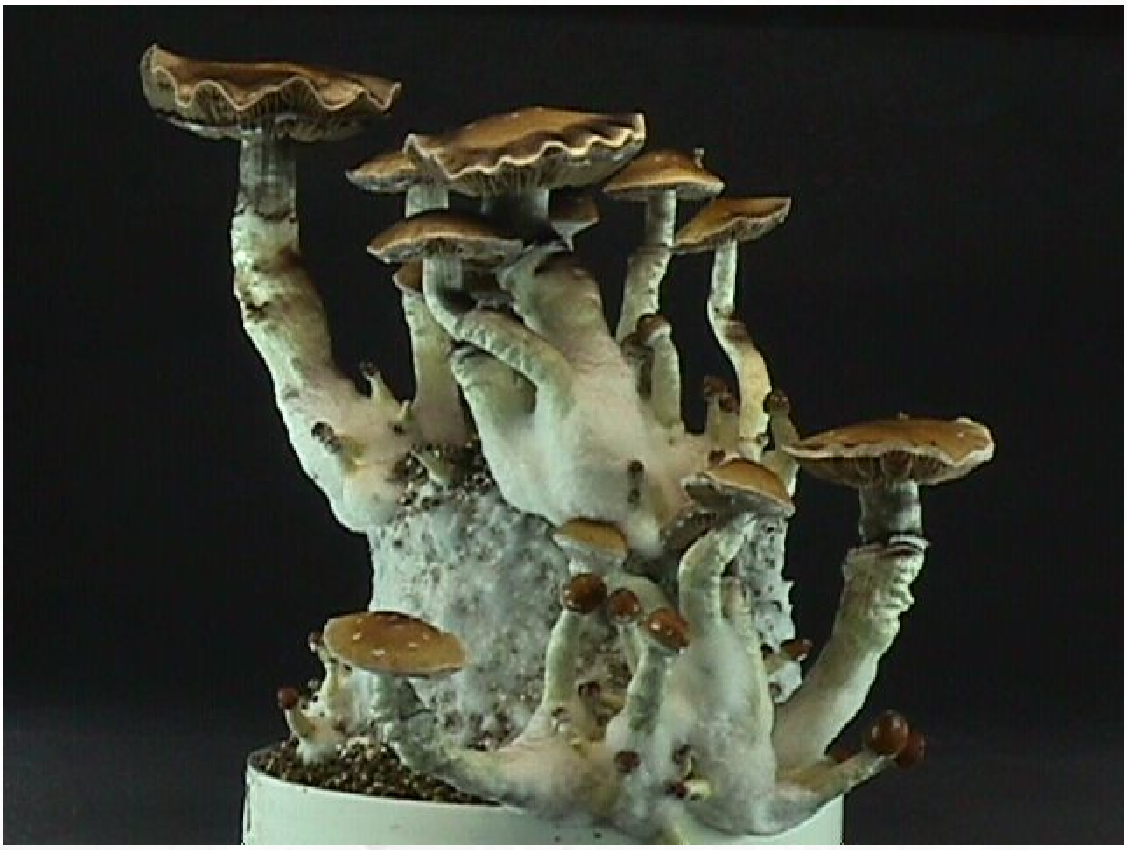
9. POTENCY (This simply comes down to how fast the shroom loses its latent potency - relating to the advent of sporulation)
   Pick presporulation.

10. FLUSHING (Ability to repeat flush)
    Looks good and probably will flush several times with proper care.

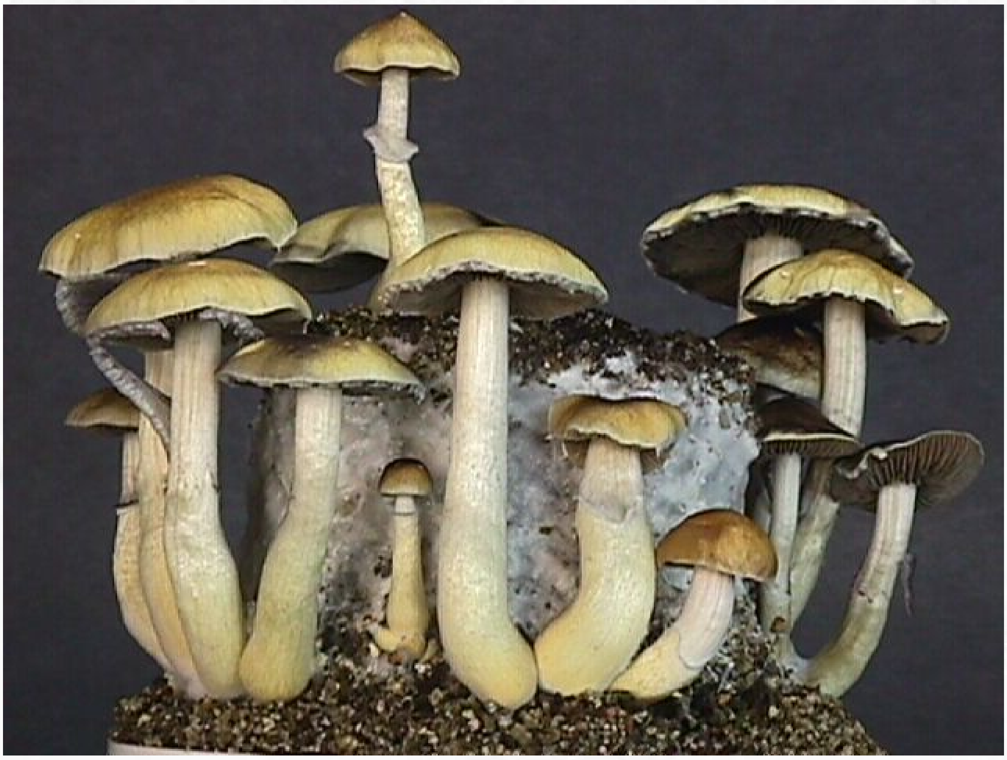
Psilocybe cubensis - Australian



Psilocybe cubensis - India

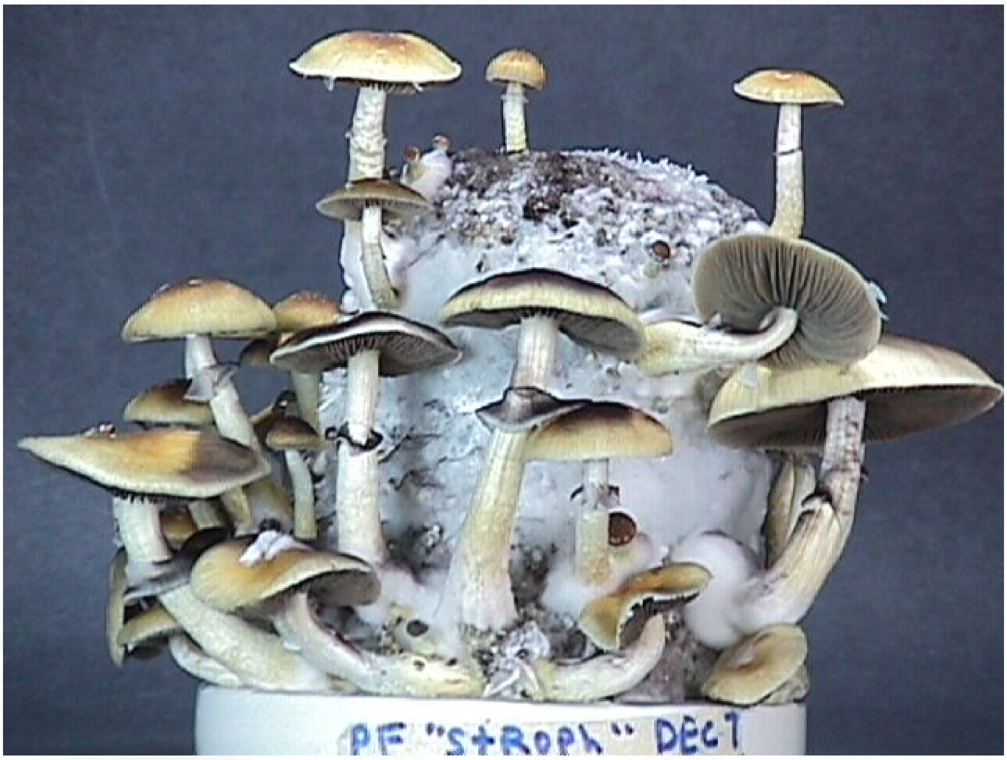


Psilocybe cubensis - Mazatec



This cubensis race looks like a cross between the Mexi-cub (false Mexicana) and the Equador. When the stem is cut, it seems to consistantly bruize deep azure. The Maz yields very well. This is one of the best PF has tested. The Mazatec is a small but refined cubie with whitish smooth stem flesh, apparantly more "dense" and less watery than the larger growing races (Equador, B+, Cambodian ect). A big thumbs up for the Maz!

Psilocybe cubensis - PF Stropharia



Yachaj describes the PF Stropharia

The PF Stropharia combines a great sporulation capacity with an easily printable cap (no slimey veil remnants hanging from it), an extremely agressive mycelium, strong blueing of the flesh, a solid stem and a top notch harvest on PF Substrate (usually in bouquets of smaller potent mushrooms instead of a few weak large ones). It is a winner on all qualities which are important for a cubie except for its pinning speed (PF Classic is faster).

Please help to preserve this unique Psilocybe cubensis race. Spread its spores as prolific as possible but - do not change the name PF Stropharia. This genotype was a present from me to PF. Everybody may distribute its spores, but the name stays. - do not change the substrate. This is a PF TEK / hippie tek only cubie!

The origin of the PF Stropharia

At this moment there are two versions of the story. According to my notes the PF Stropharia was born in January 1997. It came up in a jar of PF Substrate which was gamma ray sterilized instead of steam sterilized. The difference between cold and hot sterilization is that in cold sterilizations (with gamma flash) the substrate remains raw. The mycelia have a slight difficulty in colonizing it and pinning is delayed. This is not an advantage so I terminated the gamma flash experiments, but according to my notes the PF Stropharia came up from one of those jars - from PF Classic spores obtained from PF in 1995.

But as anyone can see, the PF Stropharia looks very different from the PF Classic. It has scales on the cap while the PF Classic is smooth. It has a ring around the stem, the mycelium is much denser. It doesn't look like a PF Classic offspring at all.

So PF's explanation of this that I made a mistake. That the PF Stropharia is a genotype I received from someone else and that I mislabeled the jars.

When I look at the mushroom I would say that PF is right. His explanation is the most simple one and in science the simplest explanations are usually right. The Stropharia is too different from the Classic to be offspring. But at the same time this explanation is difficult for me to accept because I didn't have so many different cubies back then. I had only 2 cubies which liked PF Substrate (the PF classic and the 'Amazonian' from the Hawaiian vendor Pacific Exotic Spora which PF now distributes under the name 'Hawaiian'). So if I mislableled the jar then still the origin of the PF Stropharia is a mystery.

The meaning of PF "Stropharia"

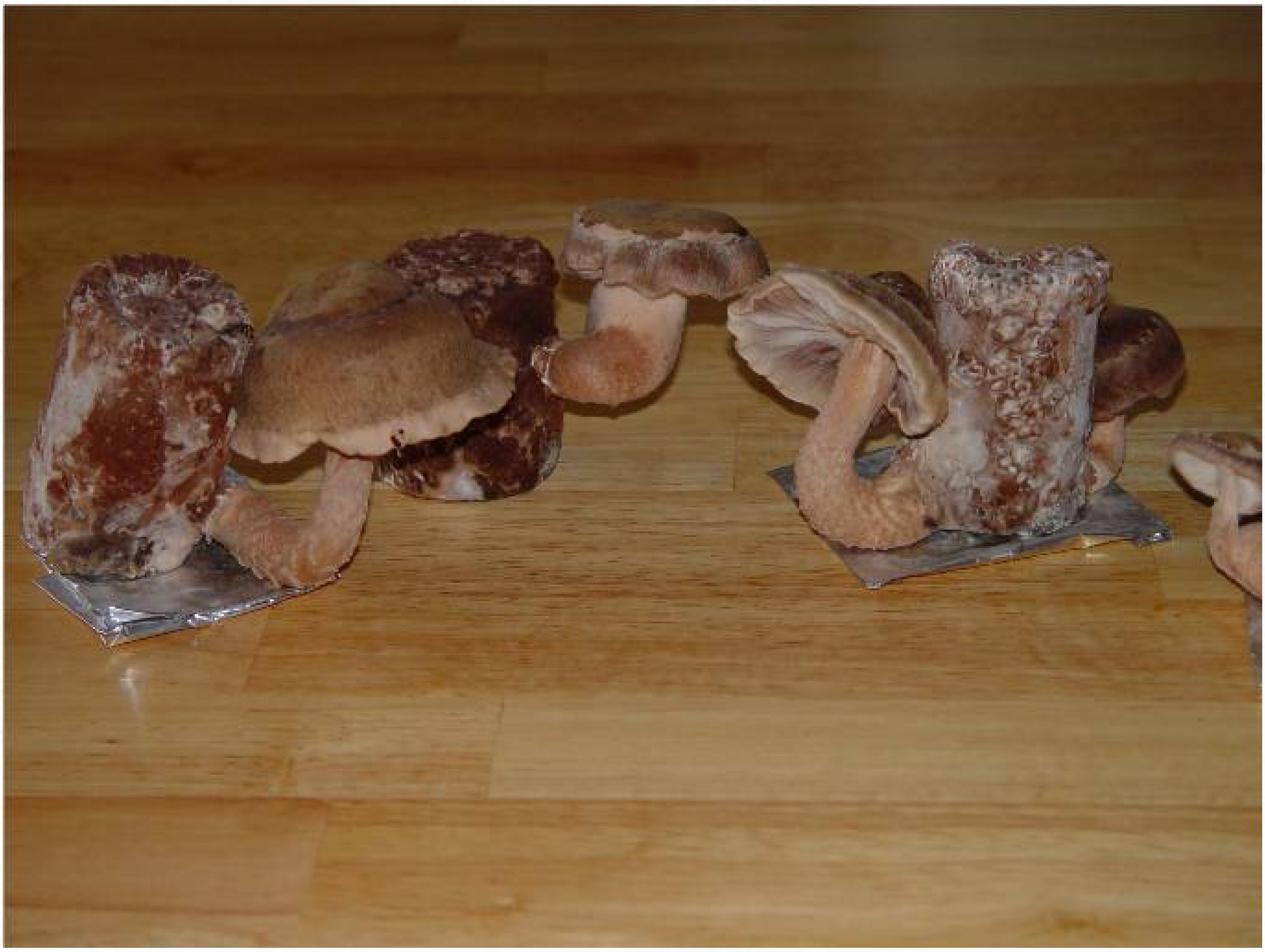
The name PF refers to Psylocybe Fanaticus, the inventor of the substrate which this cubensis race seems to like best. Stropharia refers to the appearance of it. The veil which protects the spores during the first stage of the mushroom growth sticks to the stem when the cap unfolds, leaving a ring. This looks like a belt. Stropharia means Swortbelt in Greek.

Yachaj (RENE of Perfect Fungi Europe - PFE)

PF Style Shitake

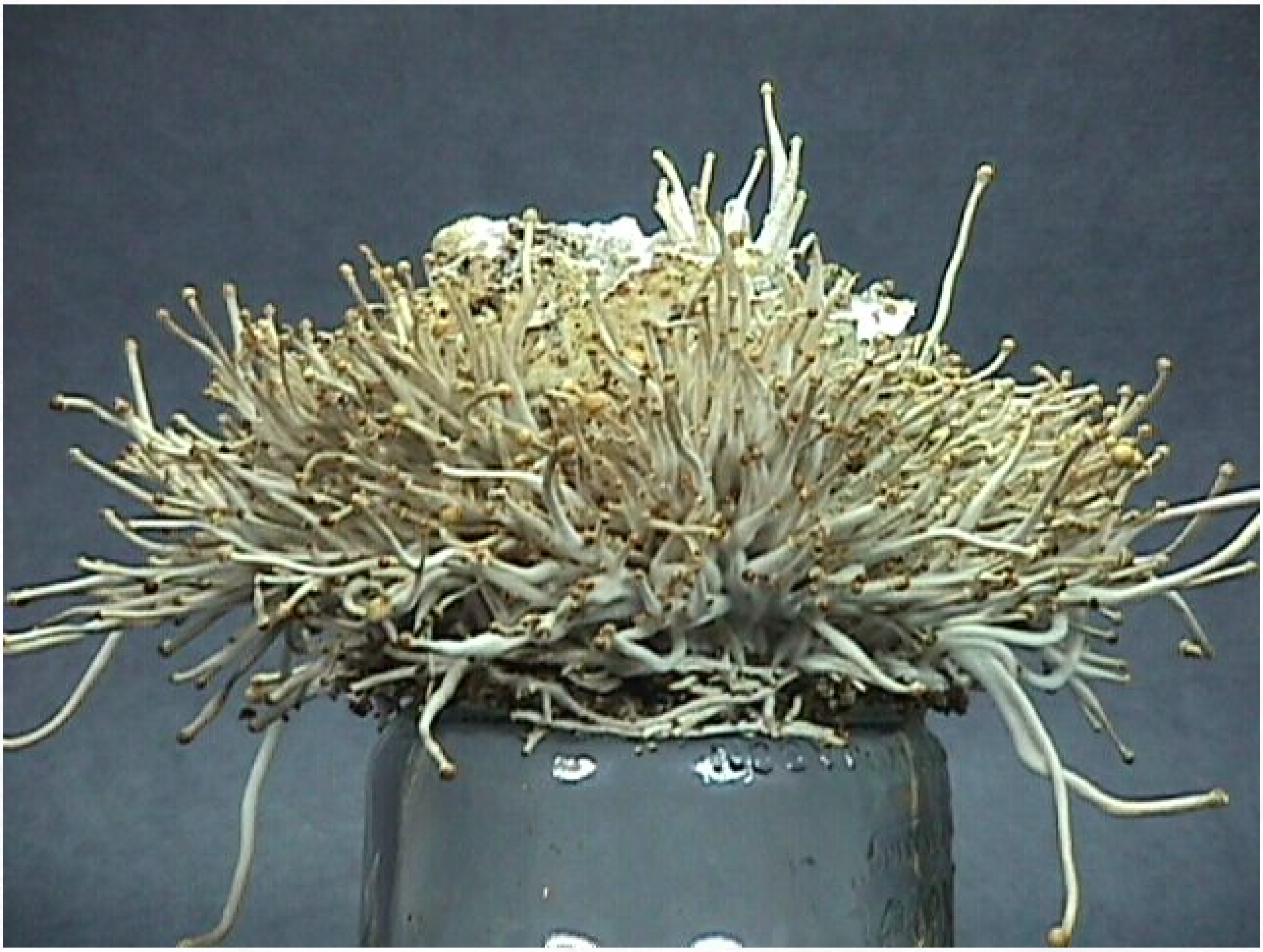
I lost my photos of shitake on BRF cakes (B is brown, R is rice, and F is flour) - aka PF TEK cakes. Here is a post and photo by a dude called Bluecat, someone who I have talked to on the Mycotopia web site. The photo follows the post. They are pretty ugly huh? That is the mycelium with the ugly discolorizations, but it isn't contaminated. That's the way the shitake mycelium acts. Bluecat uses half the amount of brown rice flour (1/8 cup) instead of the usual 1/4 cup. 1/8 cup of brown rice flour (BRF) works very well with the magic shrooms.

By bluecat (Bluecat) Member Username: Bluecat Post Number: 34 Registered: 05-2003 Posted on Tuesday, May 11, 2004 - 01:24 am:
I tried the same experiment hundreds of times.the regular pf half pints with no sawdust are always the best.both faster,and more productive.you really only need one plug per jar,right down the middle.i get the best results with just over 1/8 cup brf.if you use much more than that,they get sticky and grow slower.good luck,have fun.



This is the "gourmet" edible mushroom - SHITAKE (Lentinus Edodes). It was cultivated with the straight PF TEK. Instead of spores, SHITAKE spawn "plugs" were inserted into the jars substrait. After about 3 months, the cake turned black and the mushrooms formed. The black looking cake is actually just the outer surface. This is where the mycelium dies back but under the black "skin", the cake was a normal whiteish colored mycelium.

Stropharia Melanosperma



This is a mushroom from ISRAEL. Spores of it were sent to me and I cultured it with an altered PF substrate formula. Instead of brown rice powder, I used wheat grain powder. All the ratios were the same as in the standard PF formula. It is not a magic shroom but it is considered to be an edible. I couldn't get any spores from this mushroom. It doesn't grow normally with this tek, but it sure looks strange.

Table of Contents

EXTERNAL UPDATES

PF-Tek for Simple Minds

original source: http://www.fungifun.org/English/Pftek

Introduction

The whole grains and dung.

The PF-Tek for Simple Minds uses ½ pint (~240ml) canning jars or drinking glasses and a growing substrate made of vermiculite, brown rice flour and water. The substrate is mixed, filled in jars, sterilized and inoculated with mushroom spores. After the substrate is fully colonized the substrate cakes fruit in a humid container.

On the subject of cleanliness

By growing mushrooms indoors on a nutritious substrate you create conditions than not only favor the growth of the mushrooms, but also the growth of a large number of other organisms (molds, bacteria), many of them potentially hazardous to the health. To ensure that only the desired mushroom is grown, it is very important to assure cleanliness in all of the cultivation related procedures.

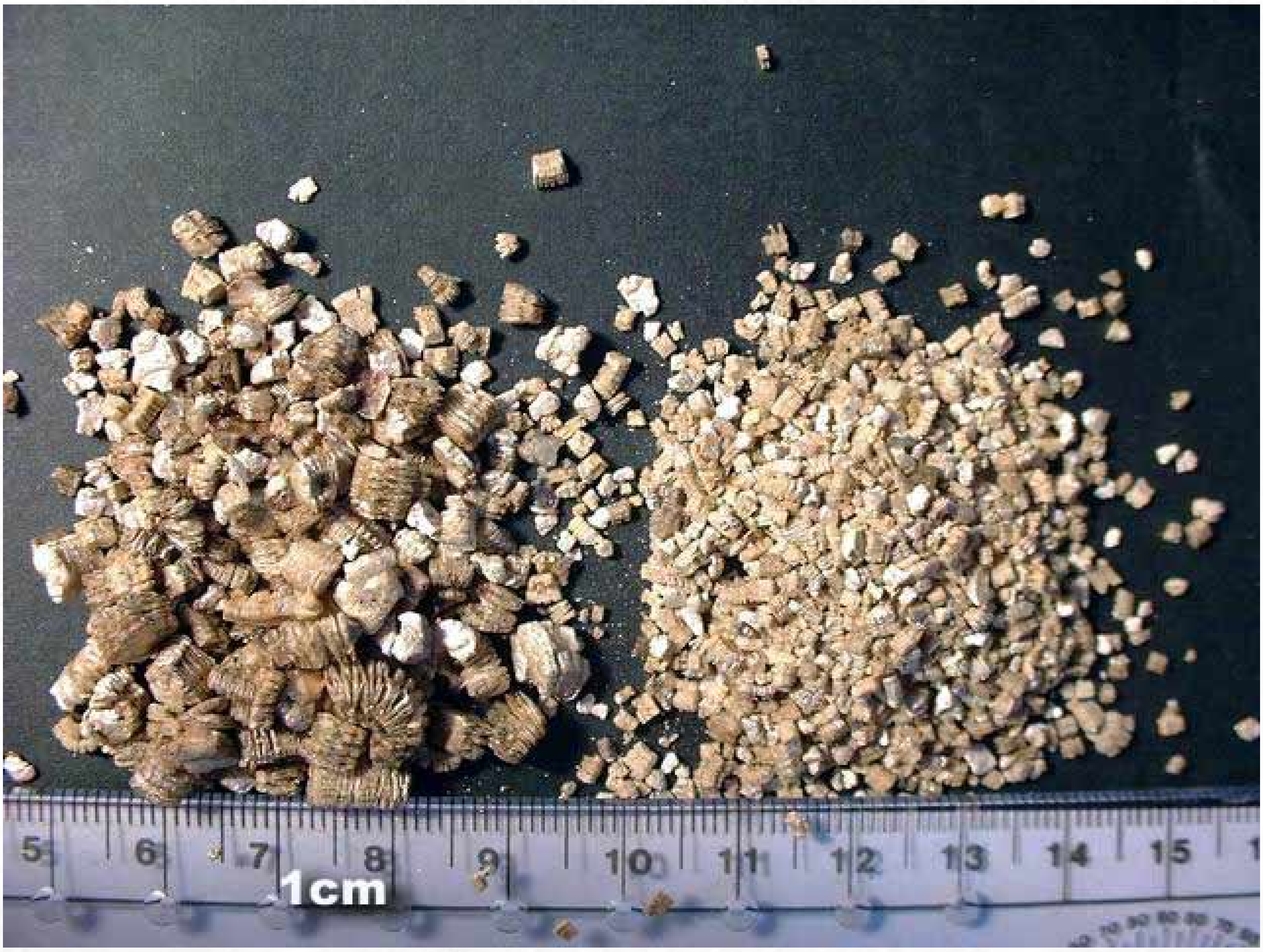
Before you work, wash your hands with (antibacterial) soap and warm water. Afterwards, wipe them dry and rub with Lysol or isopropyl alcohol (iso-propanol). Keep the place where you do the inoculation and fruiting dust free and clean and don't bring in dirty clothing or shoes. Personal hygiene is equally important. Dirty hands and even dirty hair are a hotbed for all kinds of unwanted microorganisms which can destroy your cultivation project.

Materials

Most materials are easily avaliable at the local shops.

Vermiculite

Vermiculite is made from a naturally occurring mineral - mica.
Crushed mica containing water is heated and expands to a volume several times greater than that of the untreated mica.
Vermiculite is able to hold several times its own weight in water and it gives the substrate an airy structure.
Vermiculite is available in several grades, the middle and the middle-fine grade are most suitable for cultivation purposes.


5
6
7
8
9
10
11
12
13
14
15
1cm

Online sources for vermiculite

USA

Amazon

Hoffman A H #16002 8QT Vermiculite

Espoma
ORGANIC
VERMICULITE
For Improving Heavy Soils
FOR ORGANIC GARDENING

Espoma VM8 8-Quart Organic Vermiculite

Ebay:

Canada - www.auroralighting.ca

United Kingdom - www.gro-lite.co.uk

Australia - users.bigpond.net.au/nutriflo/

Generally you can get vermiculite in garden and hydroponic stores, in some regions also in pet shops.

Brown rice flour (BRF)

BRF is available in health food shops either already ground, sometimes though there is only whole brown rice available. In this case you can grind the rice either in the shop or if this option is not available, grind your own using an electric coffee grinder.

Brown Rice
Brown Rice Flour

Bob's Red Mill
WHOLE GRAIN
BROWN RICE FLOUR
STONE GROUND

Bob's Red Mill Rice Flour Brown

BRF is also available at Ebay:
BRF is best kept cool and dry for prolonged periods of time, since it can easily become rancid because of the fat content of its husk.
If you are unable to find BRF you can also use whole rye flour, ground millet or ground millet based birdseed with similar results.

Water

Water used for the substrate preparation should have drinking water quality. Tap water is usually OK, but if you're not sure about it, better use bottled drinking water or mineral water.

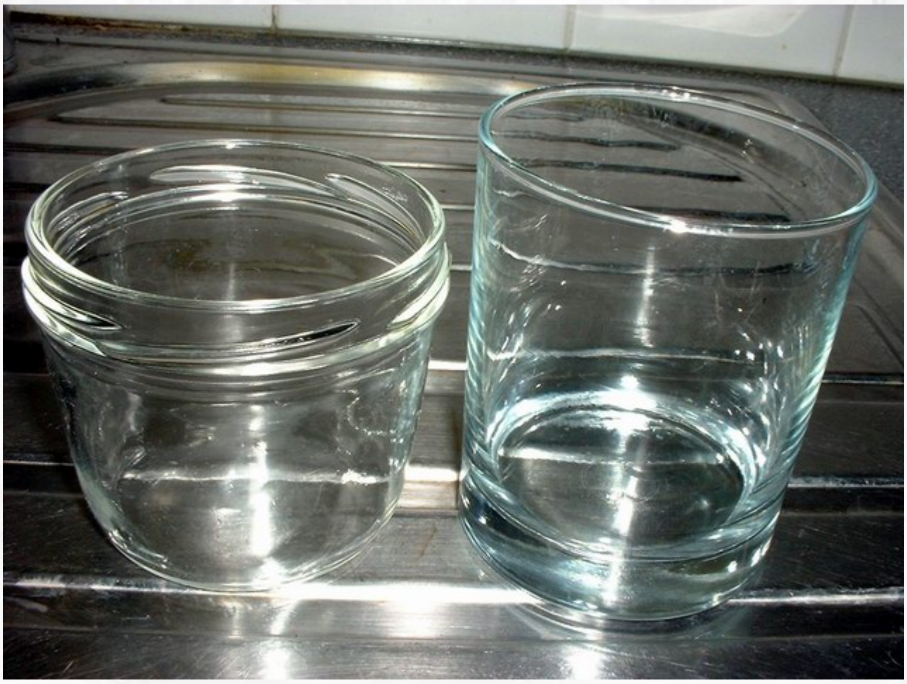
Spore syringe

A plastic syringe with needle attached containing 10cc-12cc suspension of mushroom spores in water.
The color of the suspension varies from completely translucent to slightly violet depending on the quantity of the spores in the solution.
Spores are microscopic so as long as you see at least a few specks in more or less clear water the syringe should have plenty of spores.

Available through the internet, for instance
www.sporeworks.com
www.thehawkseye.com
and many more.

Jars

The jars should have a content of around ½ pint (~240ml).
You can use either canning jars (Ball, Kerr...) or drinking glasses, the only requirement is that they are tapered and without shoulders, so you can slide the cake out of it in one piece once it's colonized. Bigger jars take much longer to colonize and are not recommended.



Kerr 0500 wide mouth mason jar
half pint, 8oz

Shroomery FAQ: Where can I find supplies in the USA?
Shroomery FAQ: Where can I find supplies in the UK?

Substrate preparation

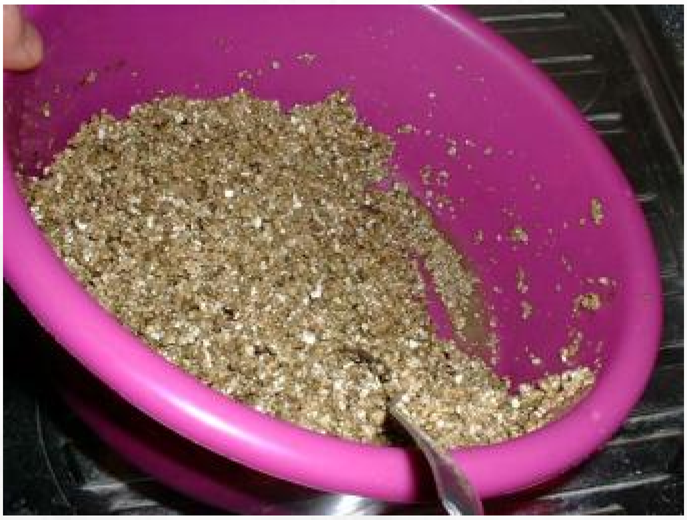
For **one ½ pint jar**(~240 ml) you will need:
=> 140 ml vermiculite
=> 40 ml brown rice flour
=> some vermiculite to fill the jar to the top (app. 20 ml)
=> water

For **6 jars**, this amounts to:
=> 3.5 US cups vermiculite
=> 1 US cup brown rice flour

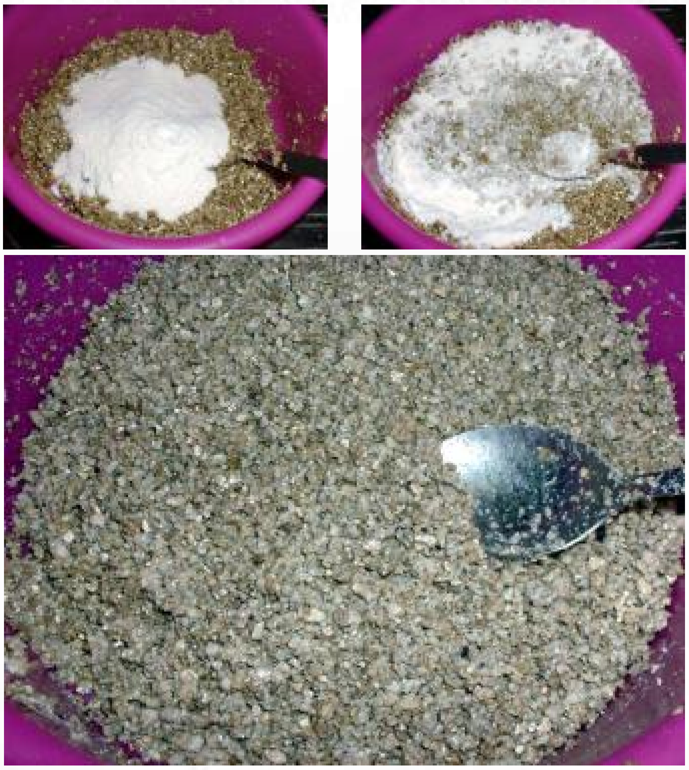
Note:
½ pt (US pint) = 1cp (US cup) = 236ml (milliliter) = 236cc (cubic centimeter) = $^1/_4$ qt(US quart)

Put the required amount of vermiculite for all the jars of one batch (for instance 6 jars: 6 x 140 ml = 840 ml ~ 3.5 US cups) in a bowl.

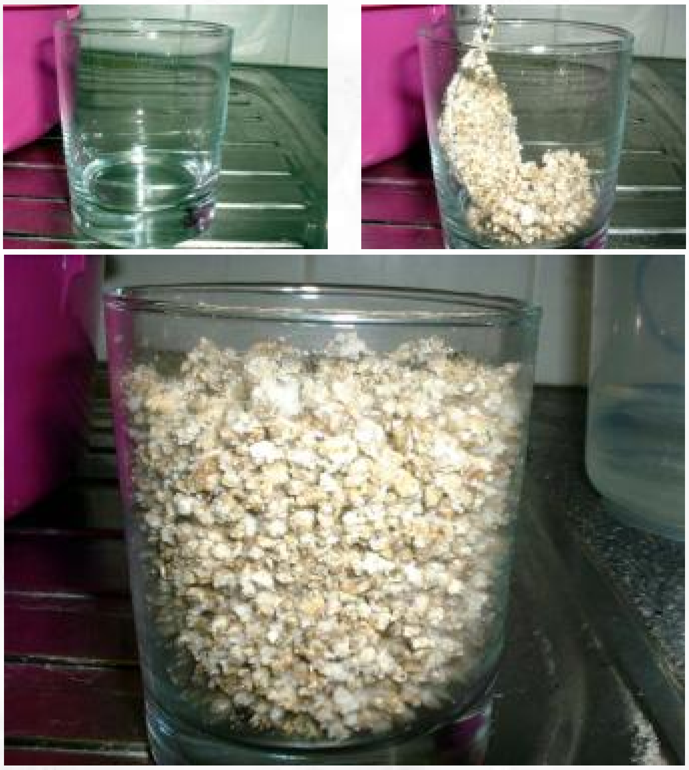
Pour water slowly over the vermiculite while stirring with a spoon. Be careful to only put that much water in as it can be absorbed by the vermiculite. Stir it well so all the vermiculite is uniformly soaked with water.



When you tilt the bowl you should see just a little water starting coming from the vermiculite. This is when the correct water content is achieved. If there is too much water in the bowl, pour the wet vermiculite in a strainer and let the excess water drain for a minute. Then the vermiculite will be at the field capacity, which is perfect.

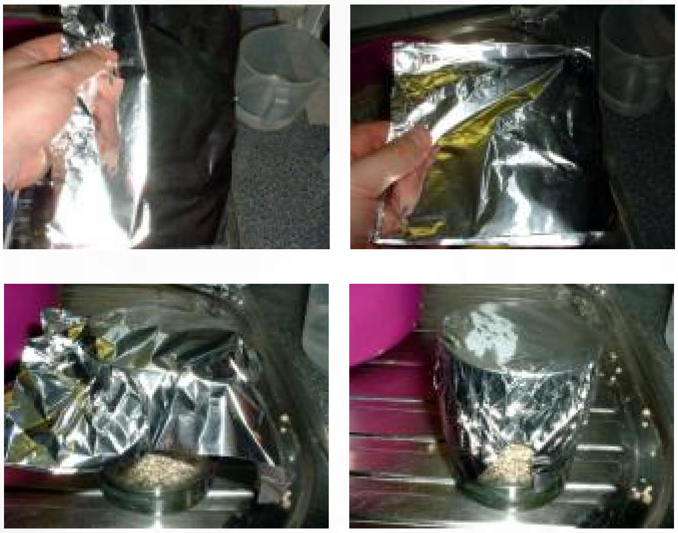


Now put the required amount of the BRF (for instance 6 x 40 ml = 240 ml = 1 US cup) into the wet vermiculite at once and mix it in with the spoon. The goal is to uniformly coat the wet vermiculite particles with a layer of BRF.

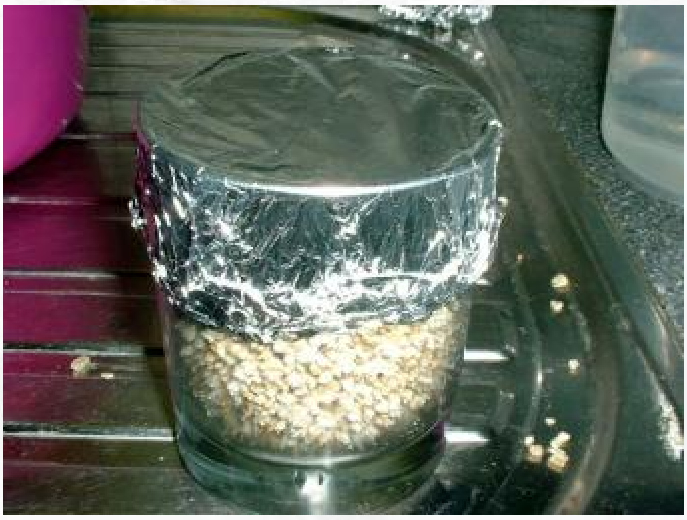


Fill the mixture in jars $^1/_2$ inch (1cm) under the top. It's very important to fill the substrate in the jars without tapping it down at all. It should stay very airy and loose to provide optimum conditions for the growth of mycelium. Be careful not to leave any substrate on the upper edge of the jar. If you weren't careful enough and there are some substrate specks at the edge take a clean moist cloth and wipe the upper portion of the jar clean. Otherwise contaminants can start at those spots and work their way down into the jar.

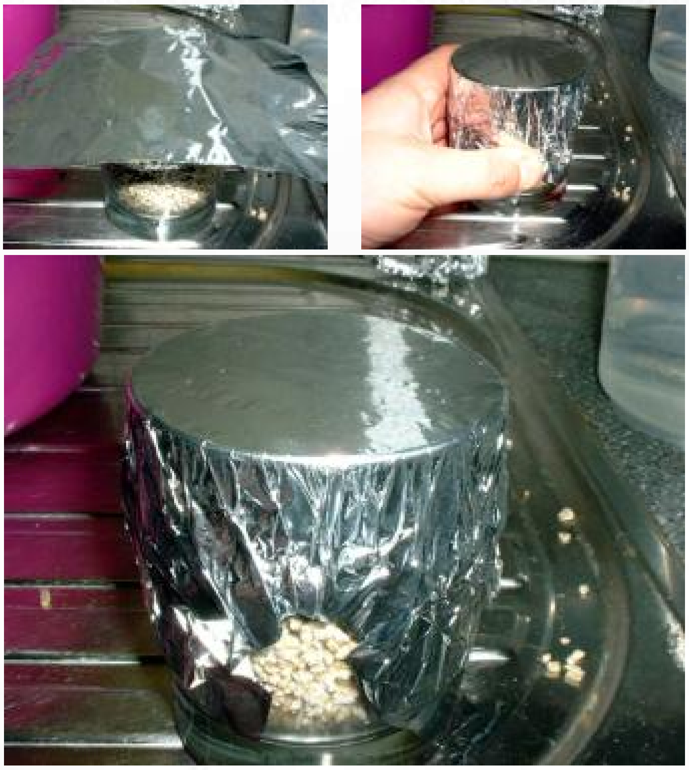
Fill up the jar with dry vermiculite to the top. This layer hinders airborne contaminants reaching the underlying substrate in case they manage to come in during the inoculation and incubation.



Take a 5in(12cm) wide stripe of aluminium foil and fold it in the middle.
Put the foil over the opening of the jar as shown in the pictures. If you're using jars with metal lids, you can poke 4 holes at the very edge of each lid with a small nail and hammer and screw the lid on. The holes should be slightly bigger than the diameter of the syringe needle.

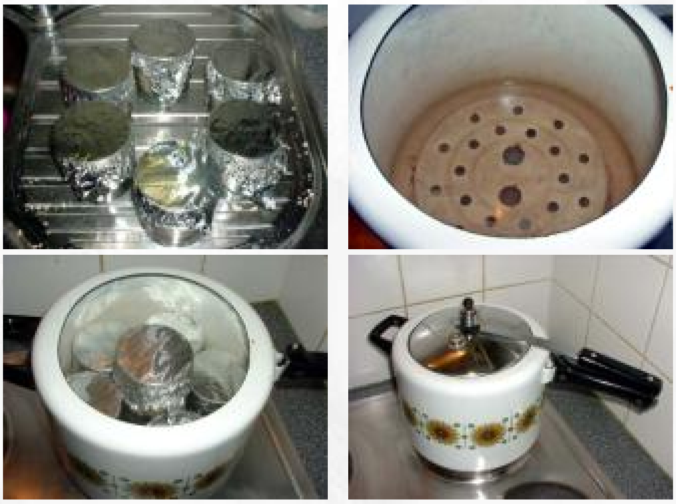


Fold the foil edges up and press them together so you get a nice aluminium foil lid.



Then take a piece of foil measuring 5in x 5in in and put it over the first two layers (respectively the metal lid if you're using lids) leaving the edges of the foil reaching down, since it has to be lifted again during the inoculation.
So now you have 3 layers of foil over the opening. The top layer is lifted during the inoculation.

Sterilization



Pour approximately 1in (2.5cm) of water into the pressure cooker, don't put in too much water otherwise it will come into the jars and alter their water content.
Then stack the jars into the pressure cooker. The use of a rack to keep the jars from directly touching the bottom of the cooker is strongly recommended.
Put the lid on and bring the cooker to the required pressure (15 psi = 1atm over atmospheric pressure) slowly over a period of 15 minutes on a medium flame.

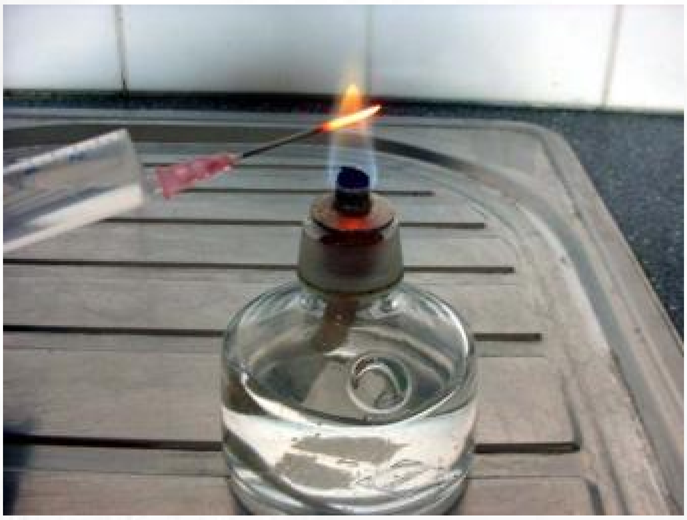
If you heat up the cooker too fast this can cause the jars to crack.
As soon as the steam begins to escape the rocker or the vent at the top of the pressure cooker turn the heat back so only a very small, steady steam flow persists from the vent. From this point on, pressure cook for 45 minutes.

Depending on the pressure cooker model the cooking procedure works a bit different so if you're not familiar with pressure cooking consult the instruction manual or someone who used pressure cookers before.
After 45 min take the cooker from the flame and let cool for at least 5 hours or even better over night.
If you never used a pressure cooker before check out this document about the correct pressure cooker use.

If you are unable to find or buy a pressure cooker, you can also sterilize the jars using a big pot with a lid.
In this case steam the jars for 1.5 hours in a pot lid on. Use only approximately 1 inch of water at the bottom.
You might have to add some water to the pot during steaming due to evaporation.

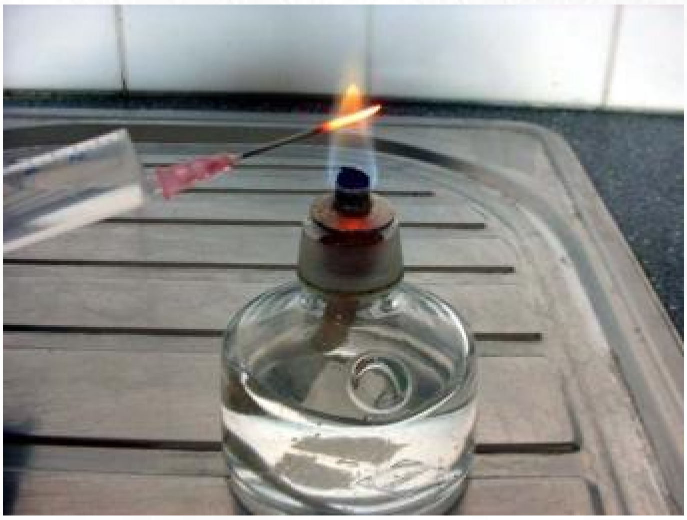
Inoculation

After the cooker is cold to the touch take the jars out and place them on a clean surface, have an alcohol lamp or a lighter and the spore syringe ready. Shake the spore syringe to break up the spore clumps.

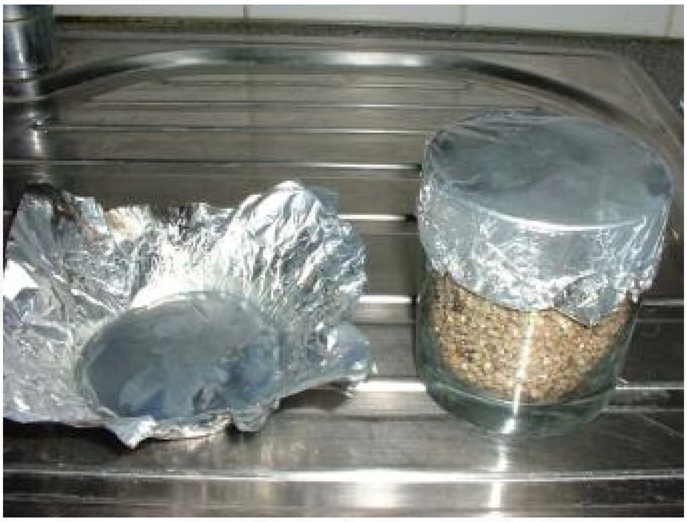


To be able to shake it it's necessary that there is a small bubble of air in the syringe. If this is not the case, then you can suck approximately 1cc of sterile air into the syringe by placing the tip of the needle into the flame and slowly pulling the plunger back.

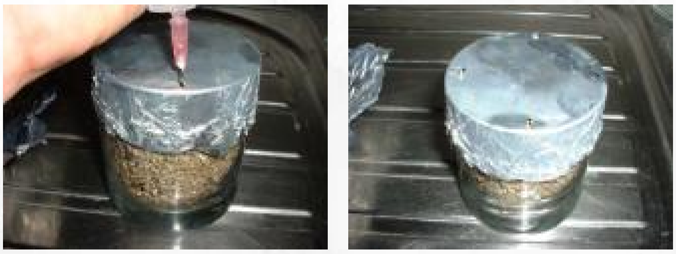
Loosen the foil from all of the jars so it can be lifted easily when you inoculate.



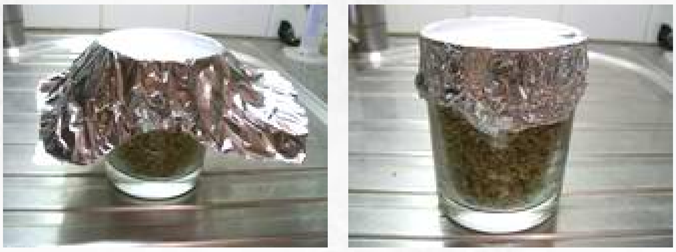
Take the cover from the needle and heat it over the flame until glowing red. Let cool for a few seconds.



Take the upper foil layer off and put aside upside down.



Pierce the foil at the edge of the jar with the needle app. 1 in (2.5cm) deep and inject the spore suspension towards the inner jar surface. You should see a small drop running down the inner surface of the jar towards the bottom. Each jar is inoculated on 4 equally spaced points. You should use 1 - 1.5 ml of the spore suspension per jar so one 10 ml syringe is sufficient for 6-10 jars.



Put the foil on again. Flame sterilize the needle again after inoculating 3 jars to prevent cross contamination just in case a jar wasn't properly sterilized.

When all of the jars are inoculated fold the foil edges up and press them firmly together so you get a nice aluminium foil lid. Write the inoculation date and the species/strain information on the foil with an all surface felt tip pen. If you touch something other with the needle during the inoculation procedure except the foil surface of the bottom foil layer immediately flame sterilize the tip again.

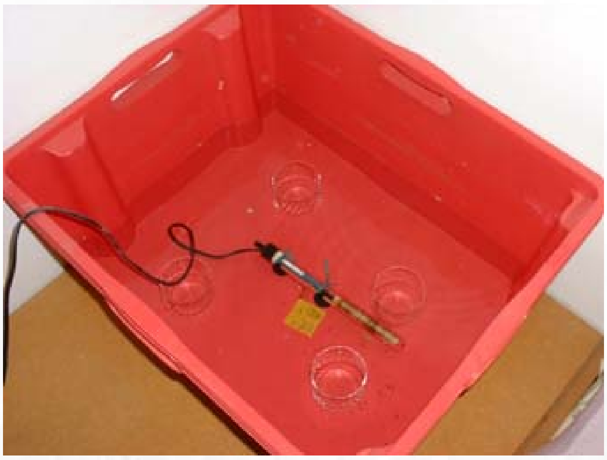
I made a video of the PF-Tek for Simple Minds substrate preparation and inoculation.

Incubation

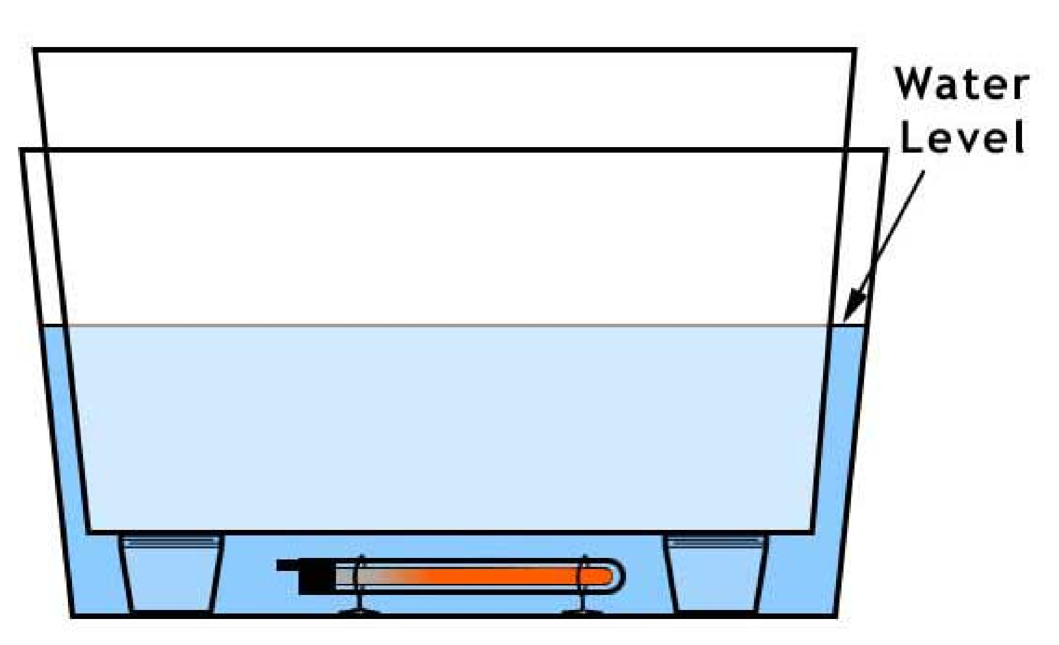
The jars should be stored at 21-27°C (70-81°F), the warmer the better, but not exceeding 27°C. If you don't have these temperatures at home you can build an incubator to accommodate the jars.

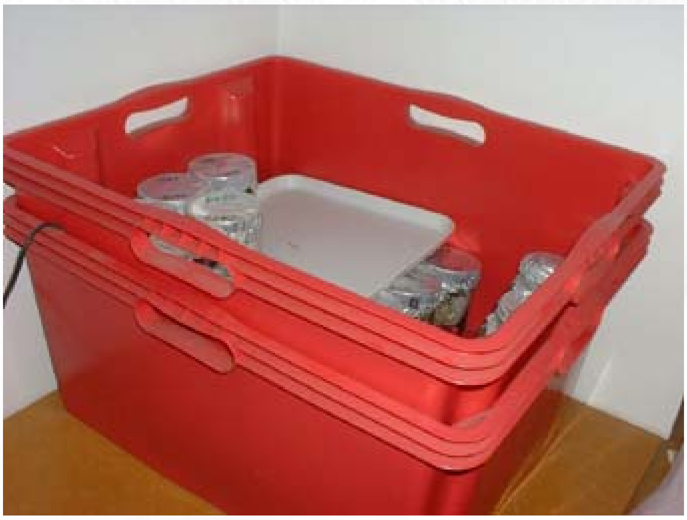
Incubator

The inoculated jars develop fastest if they are stored at a temperature of 27°C (80°F) (According to Stamets the best incubation temperature for *P. cubensis* would be 86°F, but since the jars themselves are a few degrees warmer than the surroundings (mycelium emits heat when growing) 80°F is a good and safe incubator temperature).

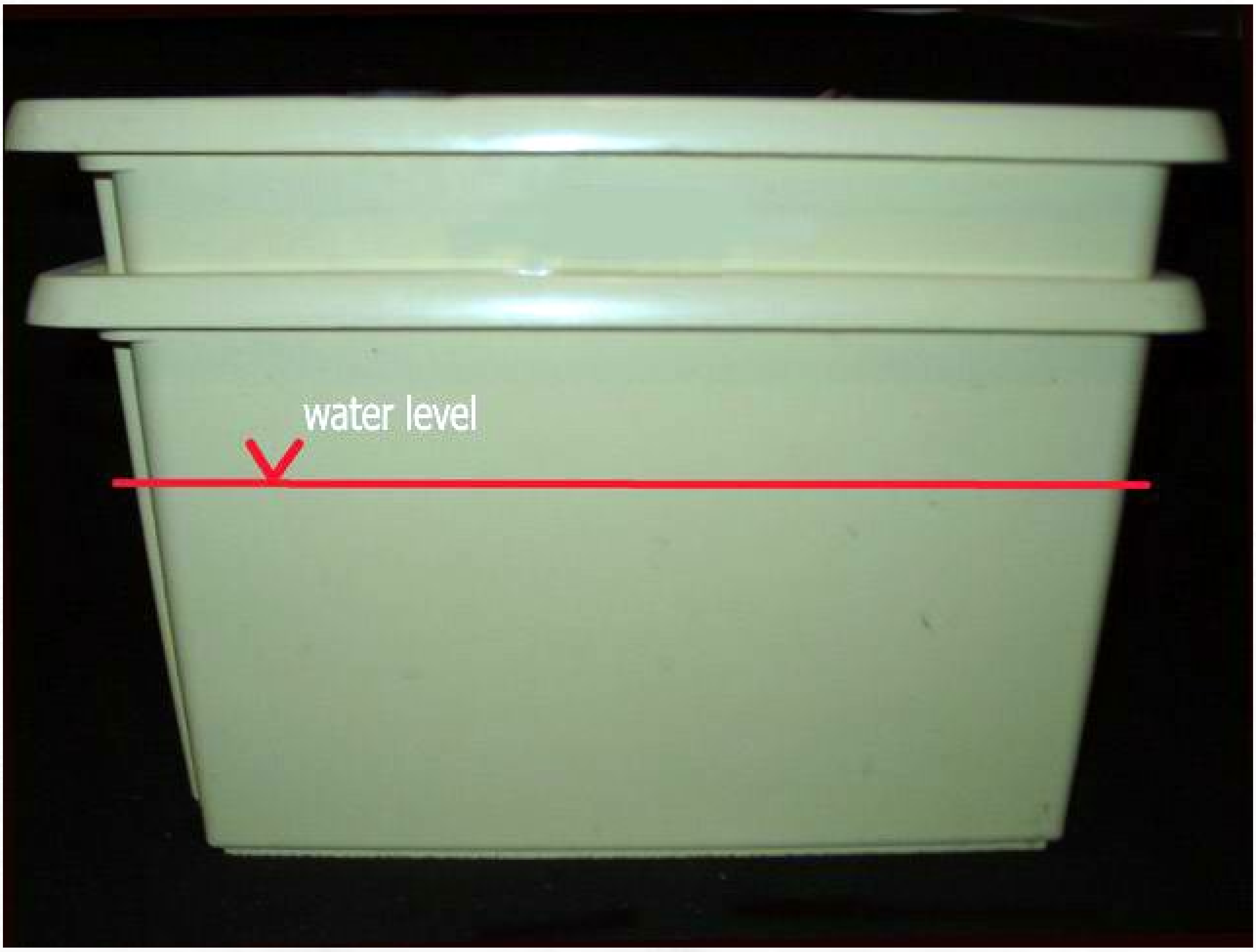


You can build an effective incubator by using two plastic boxes of the same size and an aquarium heater.
There are several types of aquarium heaters. When you're buying a heater, make sure that it is of the "fully submersible" type.
Attach the heater to the bottom of the first box and pour in as much 27°C warm water that the heater is completely submerged.
Adjust the heaters thermostat so that the heater just shuts itself off at 27°C.
Put some spacers on the bottom of the box, they carry the second box and prevent it from touching the heater.
In the above picture 4 jars are used. You could also use bricks, stones or something similar.

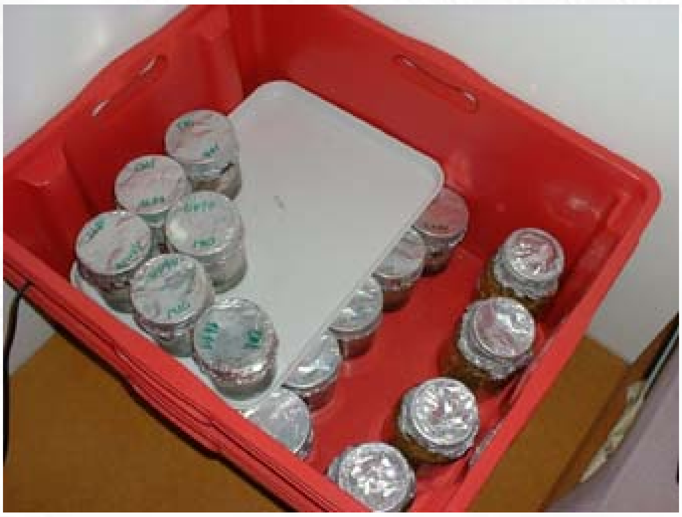




Put the second box in the one containing water.
After a few hours measure the temperature again and adjust the heater if necessary so the water temperature is 27°C.

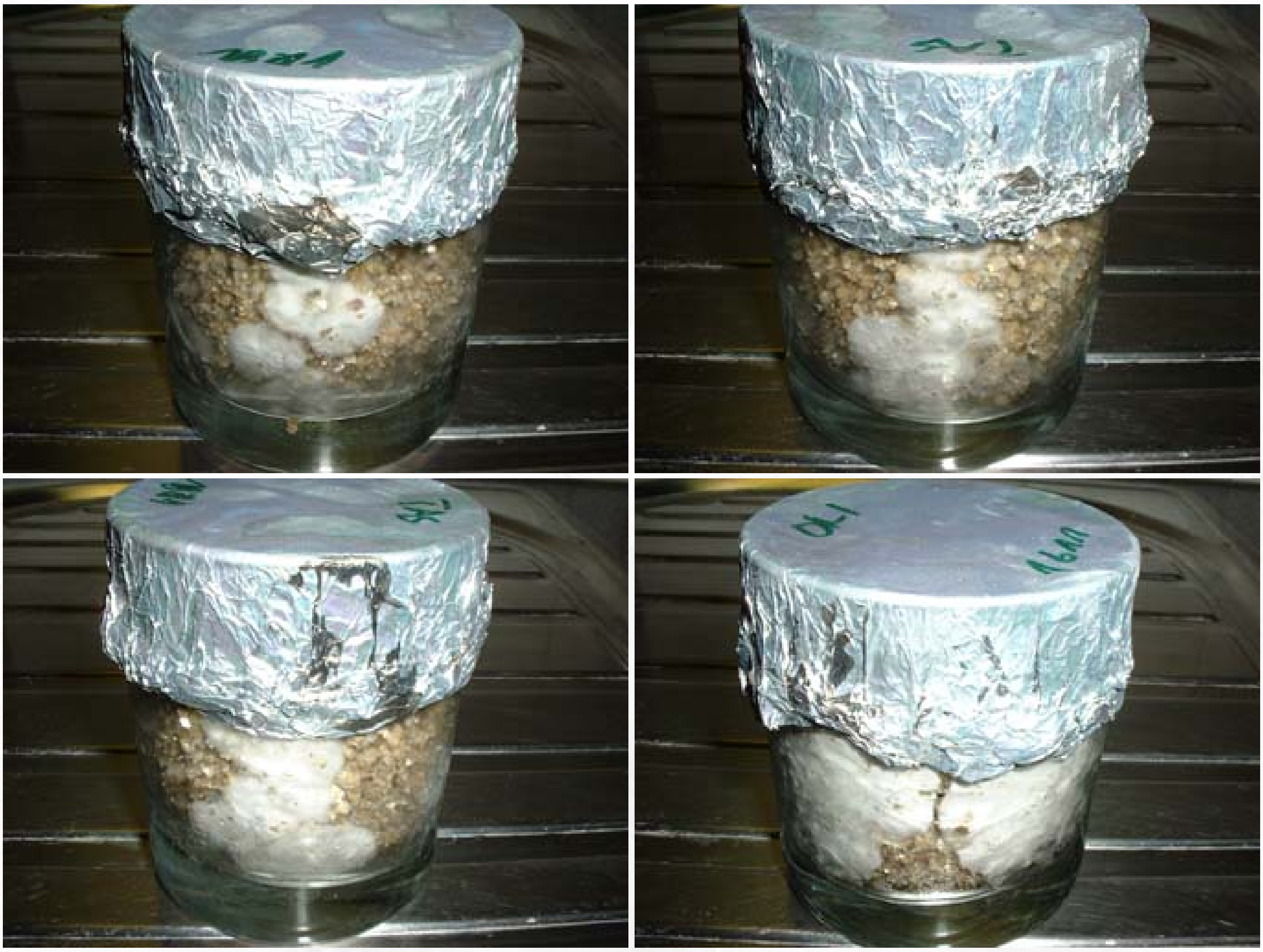


When the box is empty, it will float on the water.
The water level in the lower box should reach app. 2/3 the height of the box, supposing the upper box is in place loaded with jars and resting on the spacers.



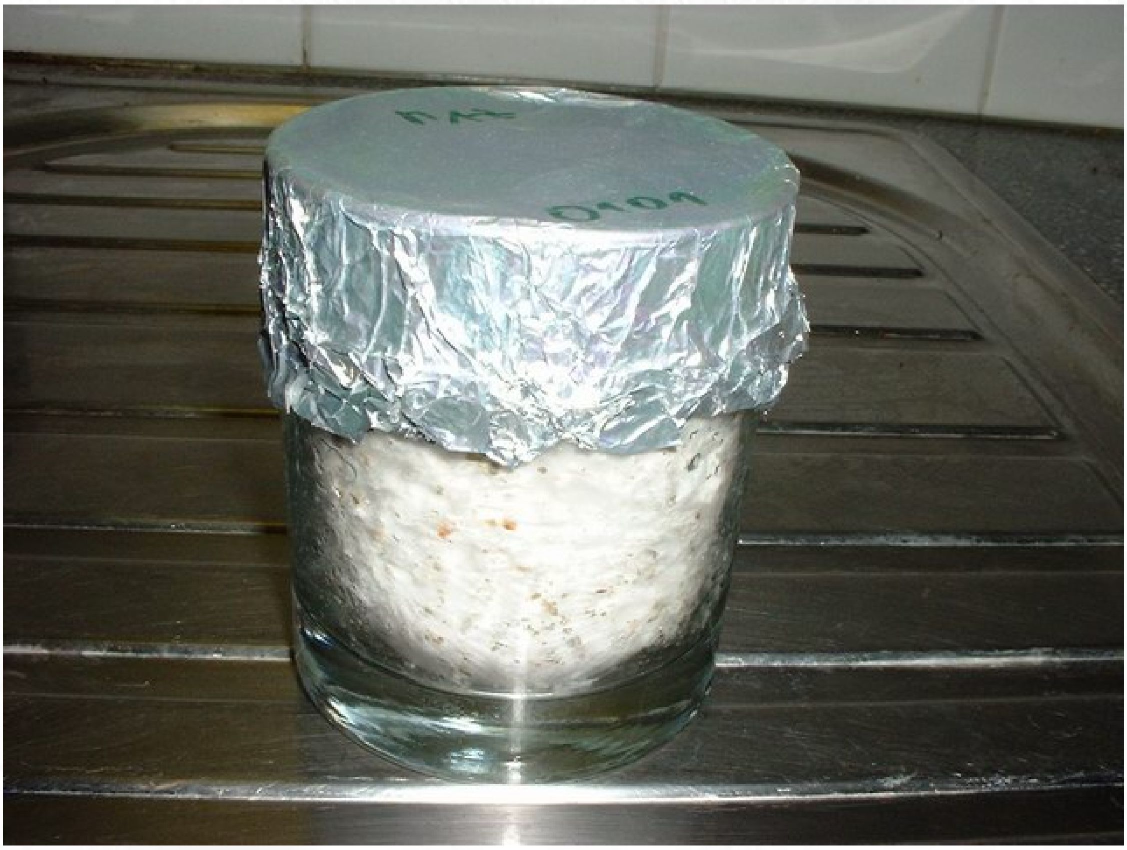
Now you can put the inoculated jars into the box.

Cover the jars with a blanket to keep the heat escaping and to keep the jars dark. Note: the water level drops in some weeks by evaporation. Therefore you have to fill some fresh water in from time to time to keep the water level high enough. Never let evaporate so much water that the heater isn't submerged in water anymore!

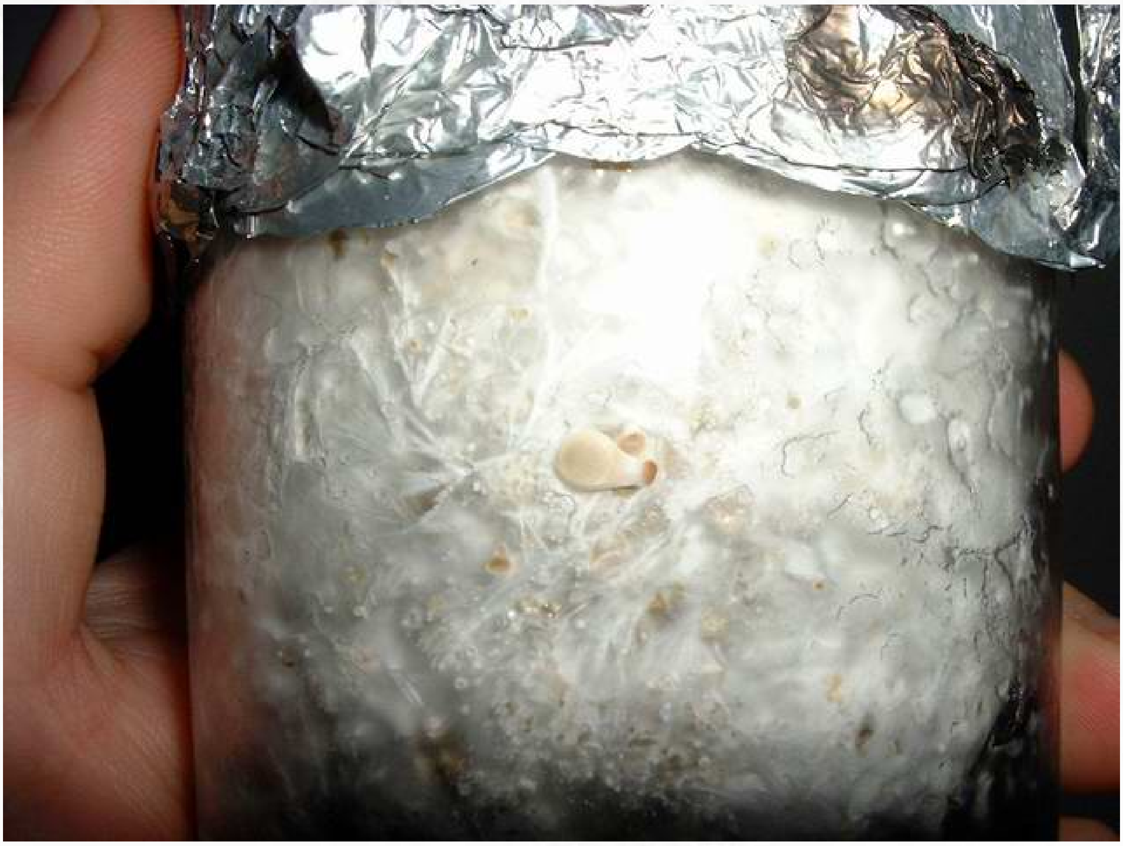


Providing the jars are kept warm you should see the first sign of germination after 3-5 days as bright white specks. This is mycelium. If anything grows that is not white, for instance green, black or pink, then the jars are contaminated and their content must be discarded and your clean procedures need some improvement. After the jars are emptied and the jar is washed with detergent and hot water it can be used again.

Check the Shroomery Contamination FAQ for more information on possible contamination in mushroom culture.



Depending on the temperature and the viability of the spore syringe it takes 14-28 days for the mycelium to colonize the whole jar. Once colonized store the jars at normal room temperature, about 21°C (70°F) to initiate pinning.
Don't expose the jars to direct sunlight. Indirect sunlight (= the natural light that lights up a room because at day time out) or a low wattage lamp (cool white fluorescent lamp is ideal, incandescent lamp is less suitable) for 4-12 hours a day is sufficient.



Within 5-10 days (with certain mushroom strains it can however take up to 30 days) pinhead-size accumulations of mycelium should form. These so called pins represent the beginning of mushroom growth. In the following days also small mushrooms with brown heads become visible. When this is the case it's time to birth the cake into the fruiting container where the mushrooms can develop to maturity.
Some strains don't easily develop pins. In this case put the colonized jar wrapped in a plastic bag in the fridge over night and then proceed to fruiting next day, even if the cake doesn't show pins yet. This cold shocking usually helps trigger pinning somewhat.

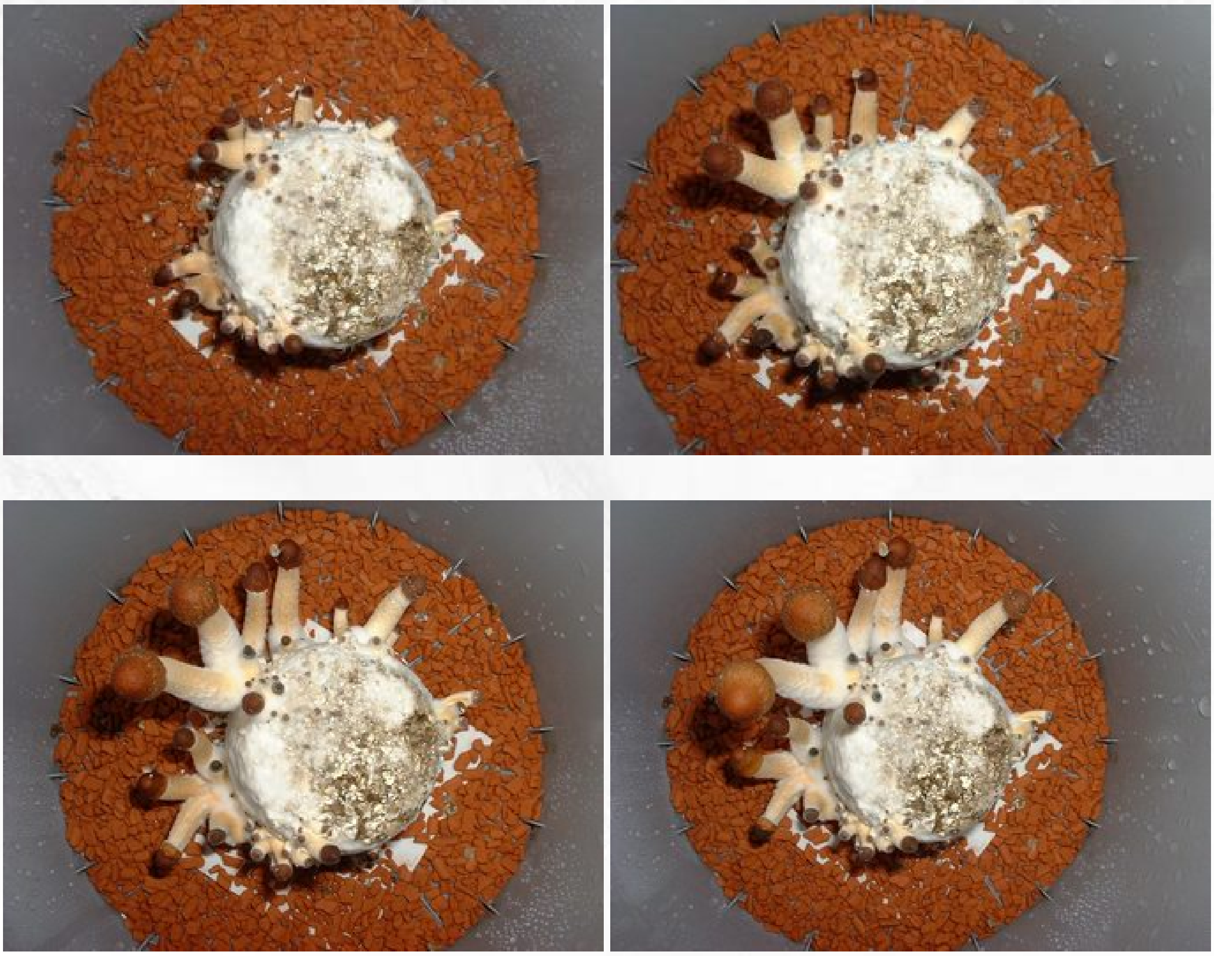
Fruiting

The fruiting of the cakes can be accomplished in any sort of container that can be loosely sealed and has at least one translucent side, preferably on the top. Suitable containers are a plastic bucket, Rubbermaid container, terrarium, aquarium...

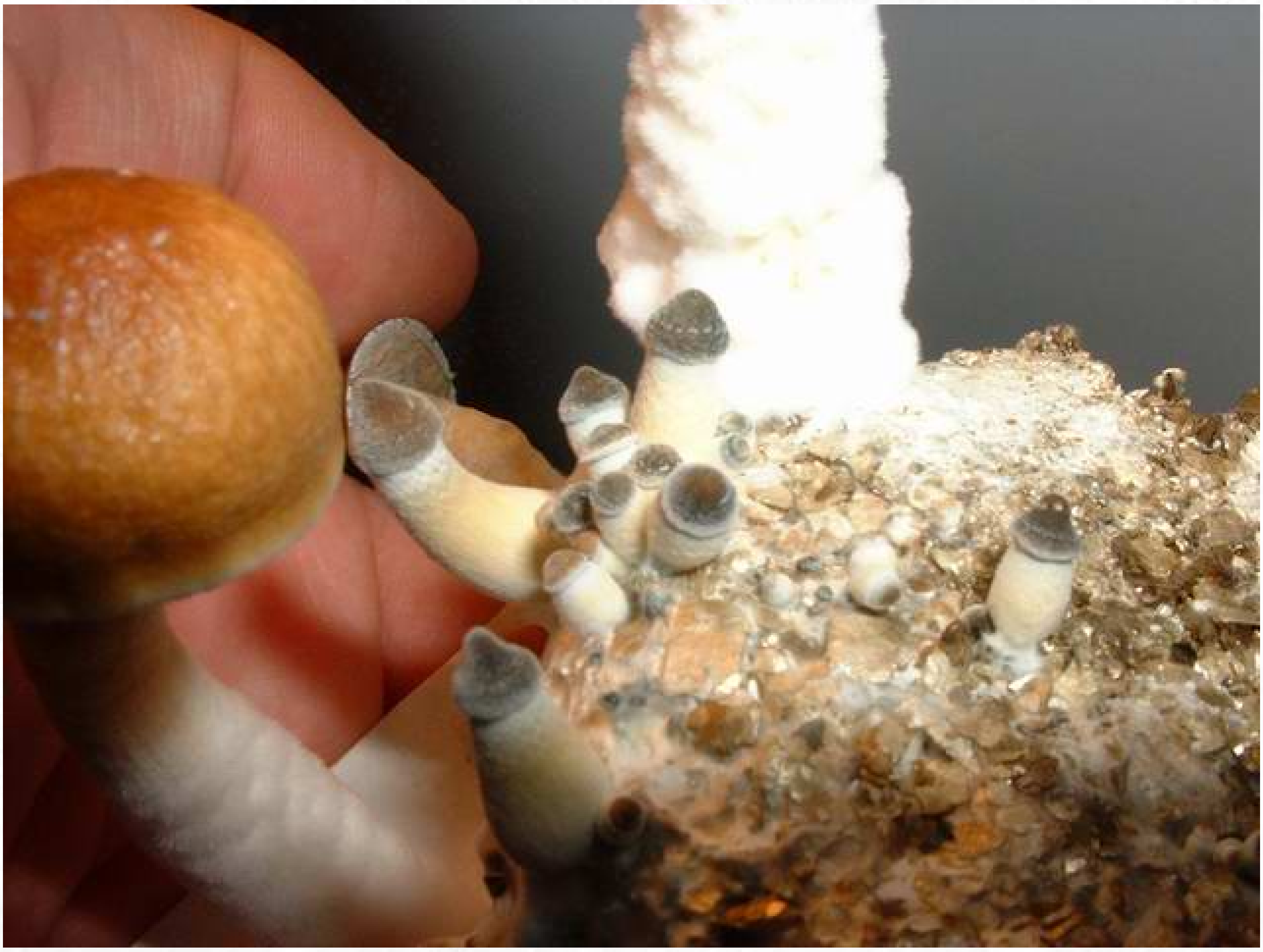
Put an 1/2 inch layer of moistened perlite or expanded clay pellets or even a wet paper towel at the bottom of the container and birth the cakes onto this layer by letting them slide from the jar upside down.

Alternatively one can first apply a casing layer.

Sometimes the cake doesn't slide out of the jar easily by itself.
You just need to turn the colonized jar upside down in your hand and slam the hand lightly against the palm of the other hand. This will make the cake slide against the lid and it can be birthed with ease.



If you have a bigger fruiting chamber (a bigger plastic container or a terrarium) you can of course put in more than one cake to fruit.
The distance between the cakes should be at least 2" (5cm) for the mushrooms have room to grow. Put a sheet of translucent plastic over the opening of the fruiting container. Take this sheet off once a day and fan the air out with a piece of cardboard. If the bottom layer begins to dry out, spray it with some water to keep it moist since this layer provides moisture for the air to stay very humid. Don't spray the cakes directly.
Handle the cakes as little as possible but when you do it always wash your hands thoroughly beforehand.
Over a course of the next 7-14 days the cakes will begin to pin (if they haven't began to pin in the jars yet) and the small mushrooms will grow big in a matter of 2-5 days and as soon the caps begin to open they can be harvested.
This simultaneous maturation of all mushrooms is called a flush.



After the mushrooms have grown big there are usually a few small, stunted mushrooms left over, they are called aborts. They can be recognized by their blackish heads and the fact that they stopped growing at some point. Still they are good to use unless they are rotten.

It's crucial that you harvest all mushrooms, also the aborts, after the flush. This is most easily accomplished if you harvest the mushrooms off by gently twisting and tearing them off the cake with clean hands. Optionally you can dunk the cakes after each flush, this can increase the flush size significantly.

After approximately one week small mushrooms begin to form again and mature during the next days.
This cycle can repeat itself up to 4 times sometimes even more. After that the cake is exhausted it produces no more mushrooms and can be discarded. They can be also used to start outdoor beds.

Sometimes green mold attacks the cakes even before they are completely exhausted. If this is the case remove and discard the contaminated cakes immediately to prevent the spreading of the contamination.

3rd flush:

3rd flush:

3rd flush:

4th and final flush:

[Table of Contents](#)

Casing PF-Cakes

original source: http://www.fungifun.org/English/Casing

This document describes a simple casing procedure involving the PF-Tek cakes.

You are going to need:

- colonized PF-Tek cakes
- peat or peat based potting soil (for instance Jiffy Mix)
- vermiculite
- limestone flour
- potable water

Limestone flour is chemically mostly Calcium carbonate ($CaCO_3$), so you can take also pure $CaCO_3$ or any other material that is in powder form and contains high amounts of $CaCO_3$.

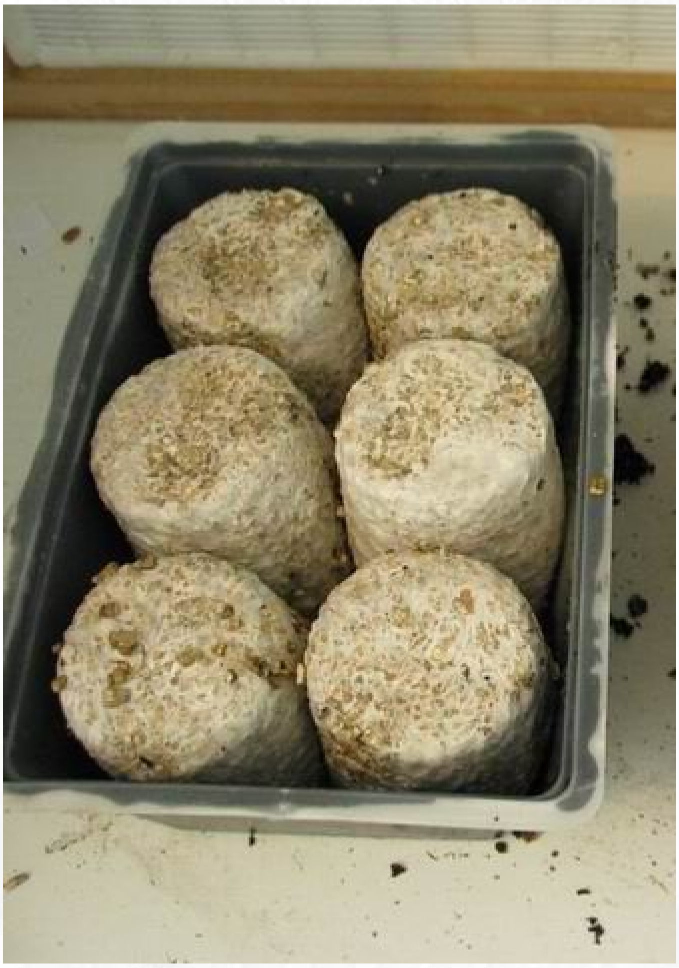
First we are going to prepare the casing mix.
Combine **60% peat, 30% vermiculite and 10% limestone flour by volume**, mix well, and under stirring add as much water to it, that when you take a handful of the casing material and *lightly* squeeze it in your hand some water begins to drop from it.

Then put this mix into a covered plastic bowl or a plastic bag, and put it into the microwave for 5-10 minutes, depending on the amount of the casing material. The goal is to get the casing boiling hot (~200°F), and when this is the case, take it out, stir the mixture in the bowl or shake the bag to redistribute the hotter parts and let it cool completely (several hours) in a clean place.

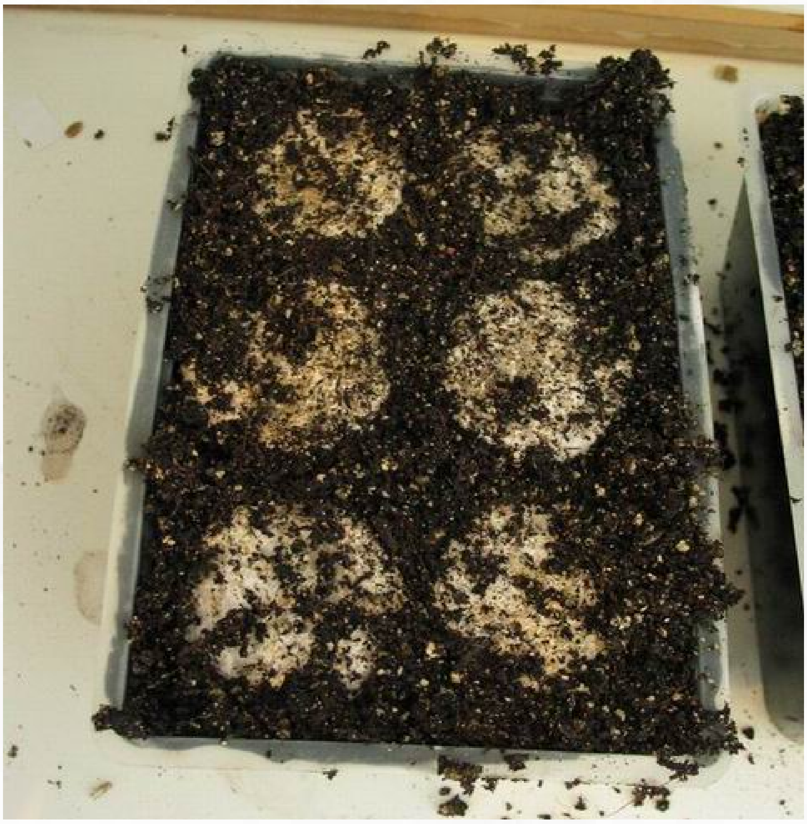
After the casing mixture is **completely** cool we can go to the next step, casing the cakes.
Prepare a dish that will accommodate your casing. This can be from any material: plastic, any metal, ceramics...
Ideally it should be opaque, if it is translucent, you will get pins inside the casing itself, which can lead to problems. If the container is not opaque, apply some aluminum foil and cover all the outer walls with it to keep the light out. Alternatively cover the inside of the container with the foil.

How big of a container you are going to use depends on how many cakes you are going to case.
In this example, I use 6 cakes, which perfectly fit into the pictured plastic container. I painted the walls of the container black to keep out the light (in order for the paint to stick on plastics, you will need to apply a primer first, otherwise paint won't stick...)

The depth of the container should be $^1/_2$ to 1 inch larger than the cakes are tall. If you only have a lower container, you can cut the cakes in half, or even put them into a clean plastic bag and crumble them from the outside, so you end up with pieces the size of a marble. I prefer the taller containers because it is simply less work.



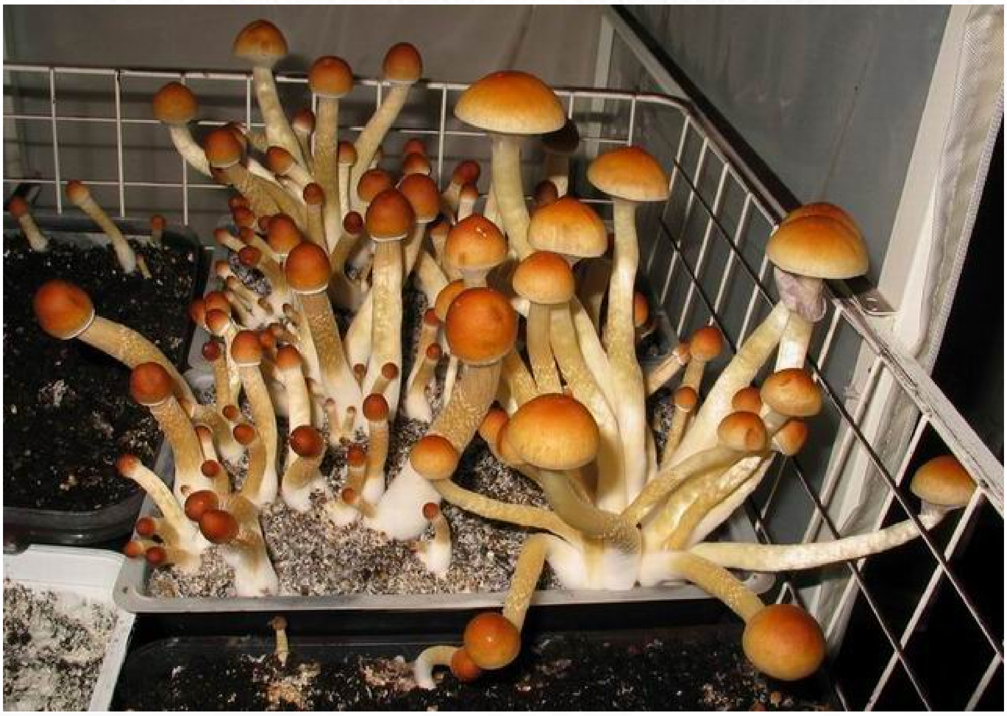
Once you have the containers, loosen the fully colonized cakes by bumping them slightly top down on the palm of your hand, or directly into the container. Arrange the cakes in the container.



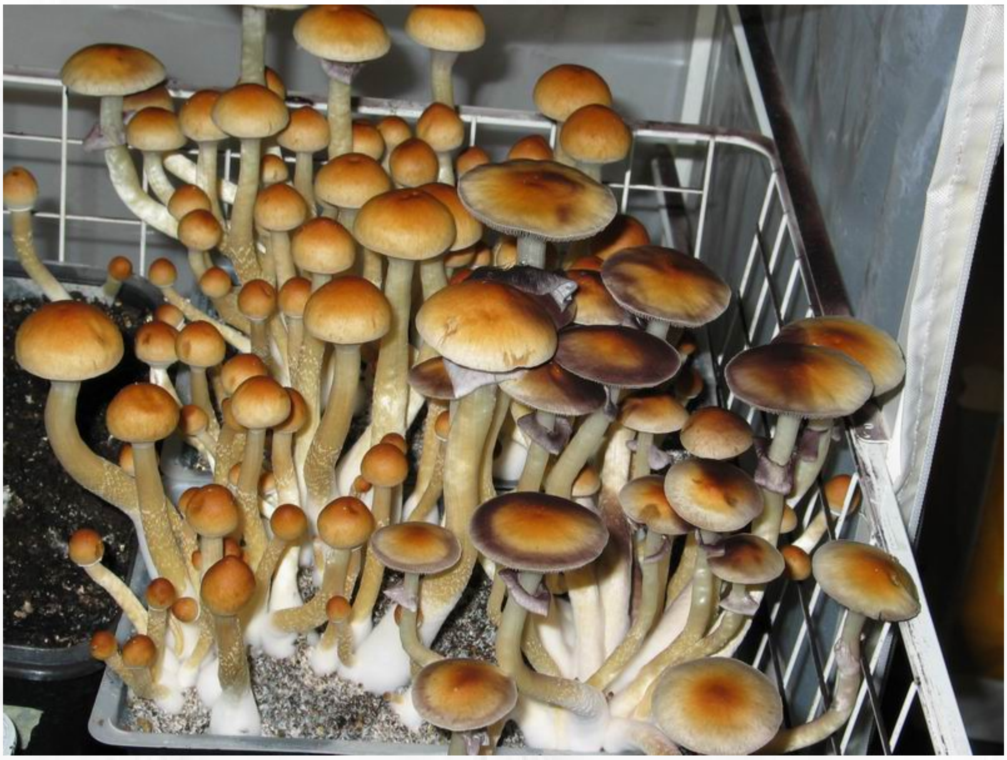
Apply some casing material between the cakes.

Loosely apply around 1/2 inch on the top of the cakes. Don't press the casing material down, it should stay lose and the surface should have hills and valleys.
Give the casing layer a good spray with clean water and cover with a piece of aluminium foil. Put in the incubator or leave at room temperature for 3-7 days. After the day 4 check on the progress by lifting the foil a bit and peeking underneath. Alternatively use polypropylene wrap instead of aluminium foil.

As soon you see first strands of mycelium starting poking through the casing layer take off the aluminium foil, give it a good spray with water and put into your fruiting chamber.
The humidity should be kept at 95-100°RH at this phase, and temperature maintained at around 70-75°F.
After 5-10 days the pins should appear.



After the pins are visible, lower the humidity to around 90°RH.
If the casing layer seems dry, lightly mist the casing layer with water. The casing should remain moist at all times but not soaking wet.



The pins will grow into fully grown mushrooms over the next couple of days.

The same casing procedure can also be done with colonized grain.
More info on casings: http://www.shroomery.org/5105/Casing

Table of Contents

PF Block Tek

original source: http://www.shroomery.org/11388/PF-Block-Tek

My goal was to find or create a method that has the simplicity of PF TEK while adding the benefits of more complicated bulk methods while being extremely contaminate resistant.

Supplies needed:

- Large Spawn bags with filter patch.
- 100% pure silicone
- 8" or larger impulse sealer.
- Large Pressure Cooker.
- Vermiculite (my recipe is based on COARSE vermiculite)
- Grain Flour (any type will do, I recommend blends)
- Gypsum
- Spend Coffee Grounds
- Alcohol wipes (or alcohol + paper towels)

Supplies recommended by not required:

- Large amount of liquid culture. (I recommend 10-30cc per bag)
- Alcohol Lamp (just makes things easier)

Step 1: The Injection Port
Apply a quarter sized blob of silicone and smear it around for a moment. If you just leave the blob as is it will often dislodge very easily.

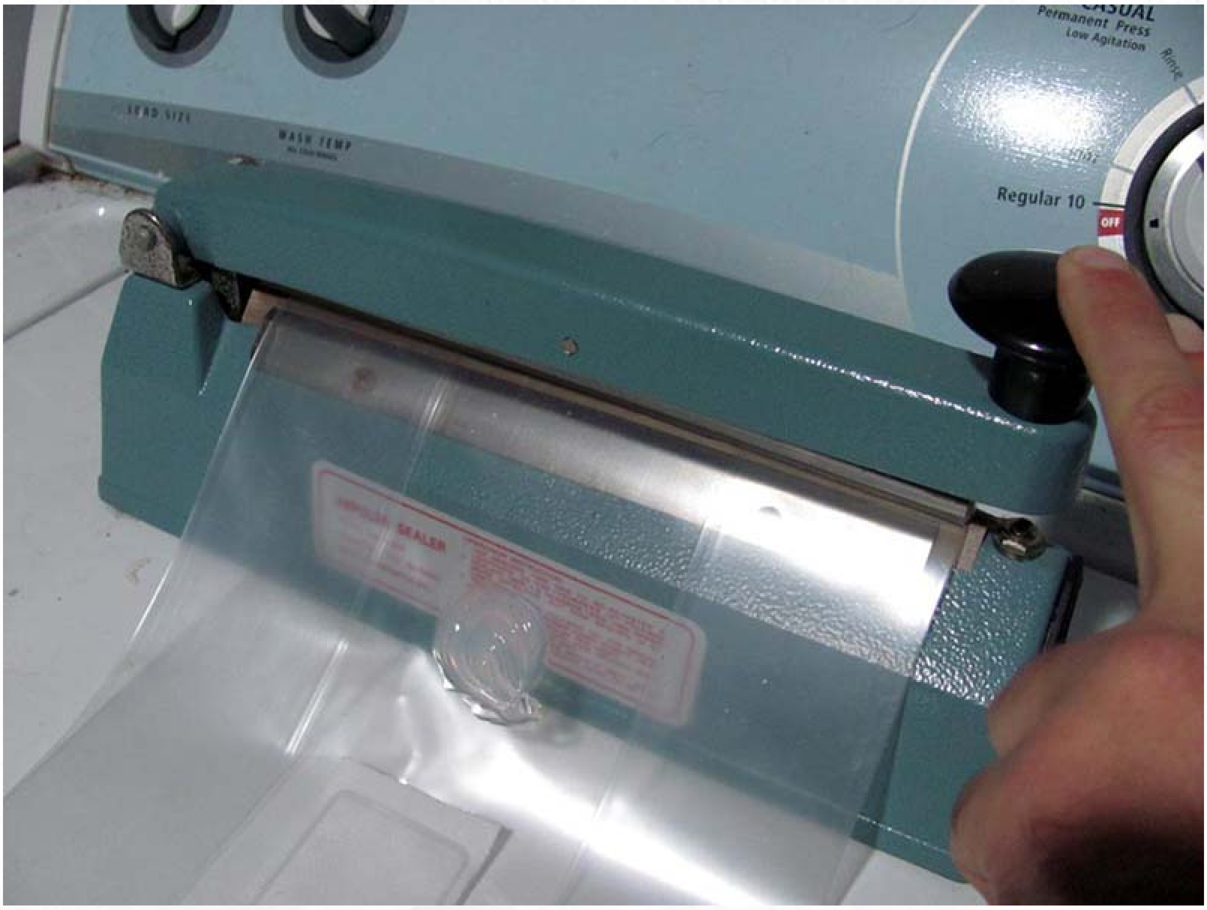
I recommend placing the port just below the filter patch for easiest access.

Wrong Way.

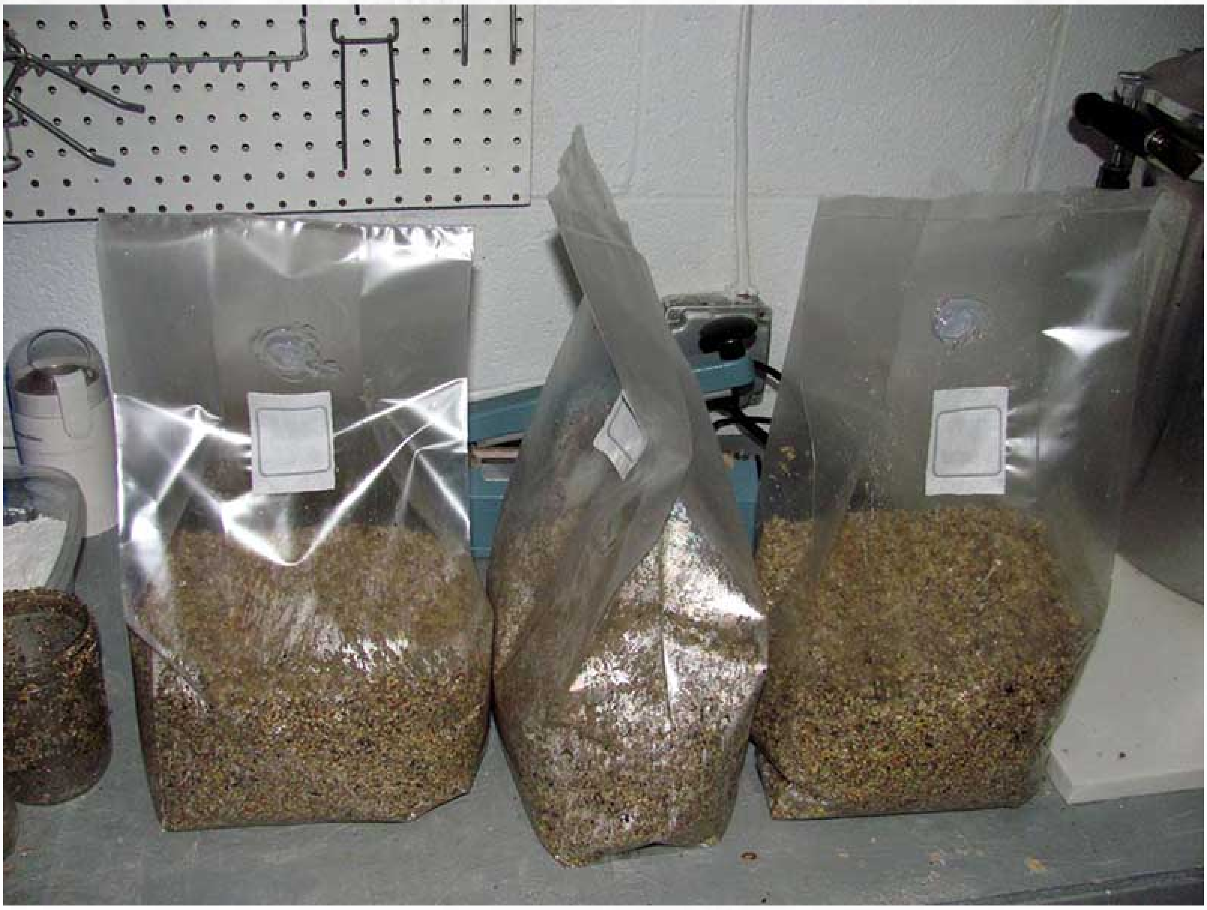
Right Way.

Allow the silicone time to set. Several hours at minimum.

Step 2: The modified PF Mix (SpongiMix?!)
3 Quarts Coarse Vermicute
1 Quart Water (add 1 half cup gypsum and 1-3 tablespoons of spent coffee grounds to the water and mix WELL first!)
Mix this together and let sit for 1 minute then mix again before adding dry ingredients.
1.5 Quarts Grain Flour (Any grain will do, I recommend mixtures of multiple grains).
Mix well then dump into bag. Try not to get any on the filters.
This recipe creates about 5 quarts by volume and a bit on the dry side.
Seal the bag using your awesome handy dandy impulse sealer.



Should look about like this when you're done.

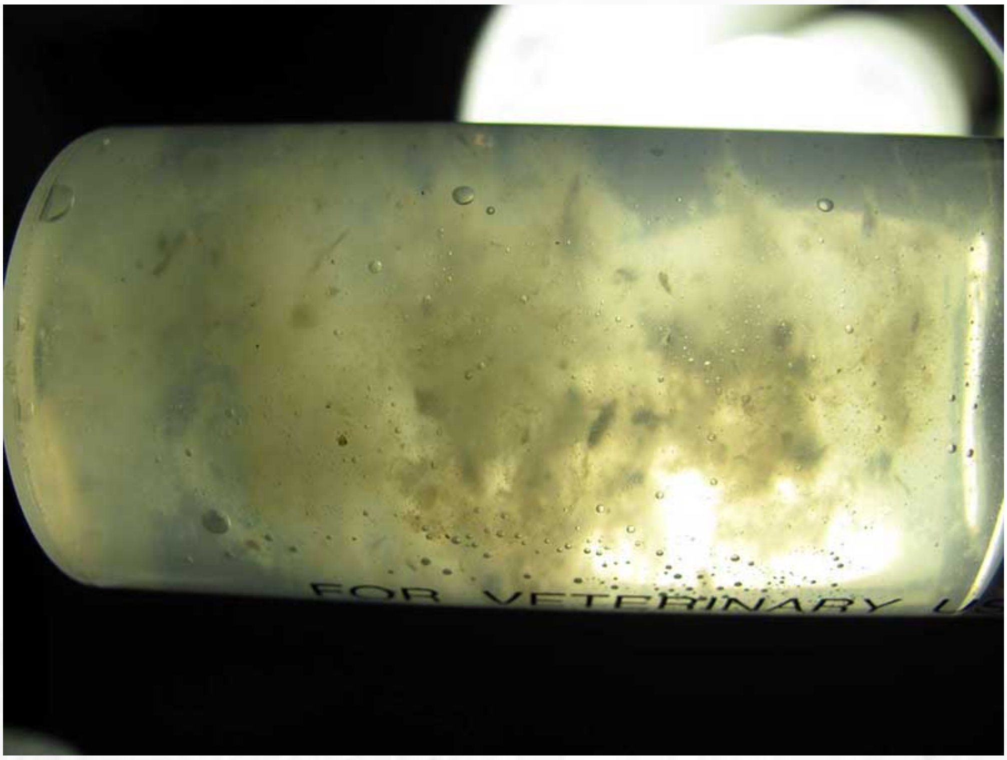


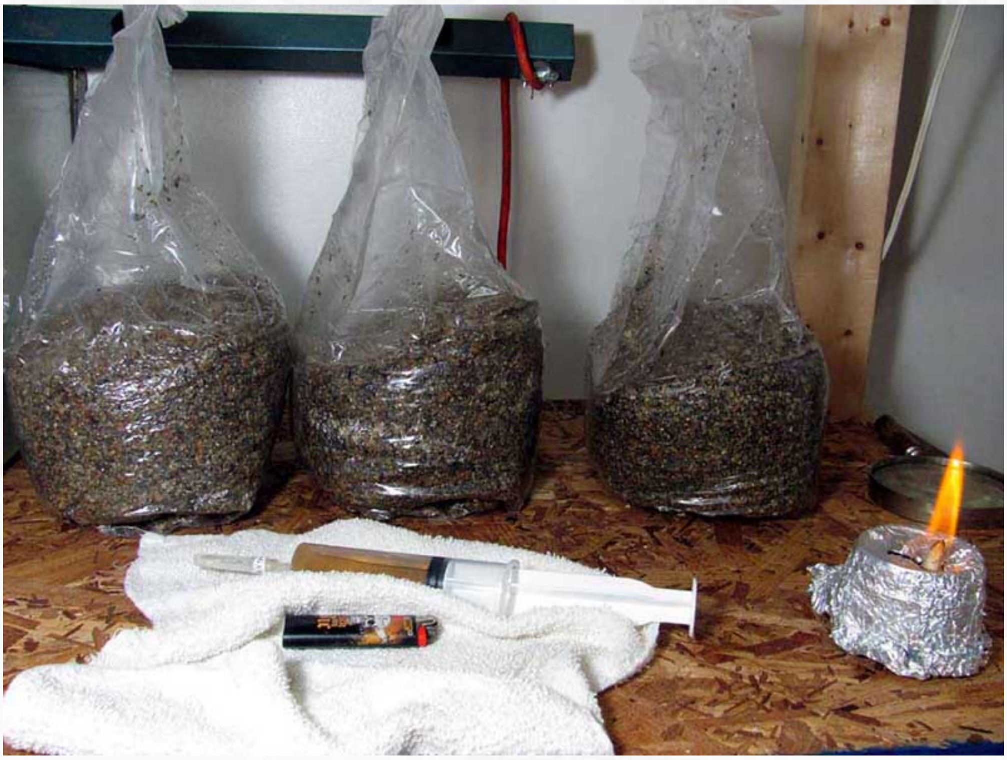
Step 3: Sterilization

My AA 75x sterilizer handles up to 41.5 liquid quarts and can hold 6 bags of this size. Your mileage may vary. Fold the tops down leaving room for the filter to breath as you don't want your bags assploding in the cooker. Pressure cook @19-21 PSI for 90 minutes or @15 PSI for 120 minutes.

Step 4: The Inoculation

Grab your LC syringe and get to work. Inoculate with 10-30cc's of nice thick mycelium laden liquid culture.

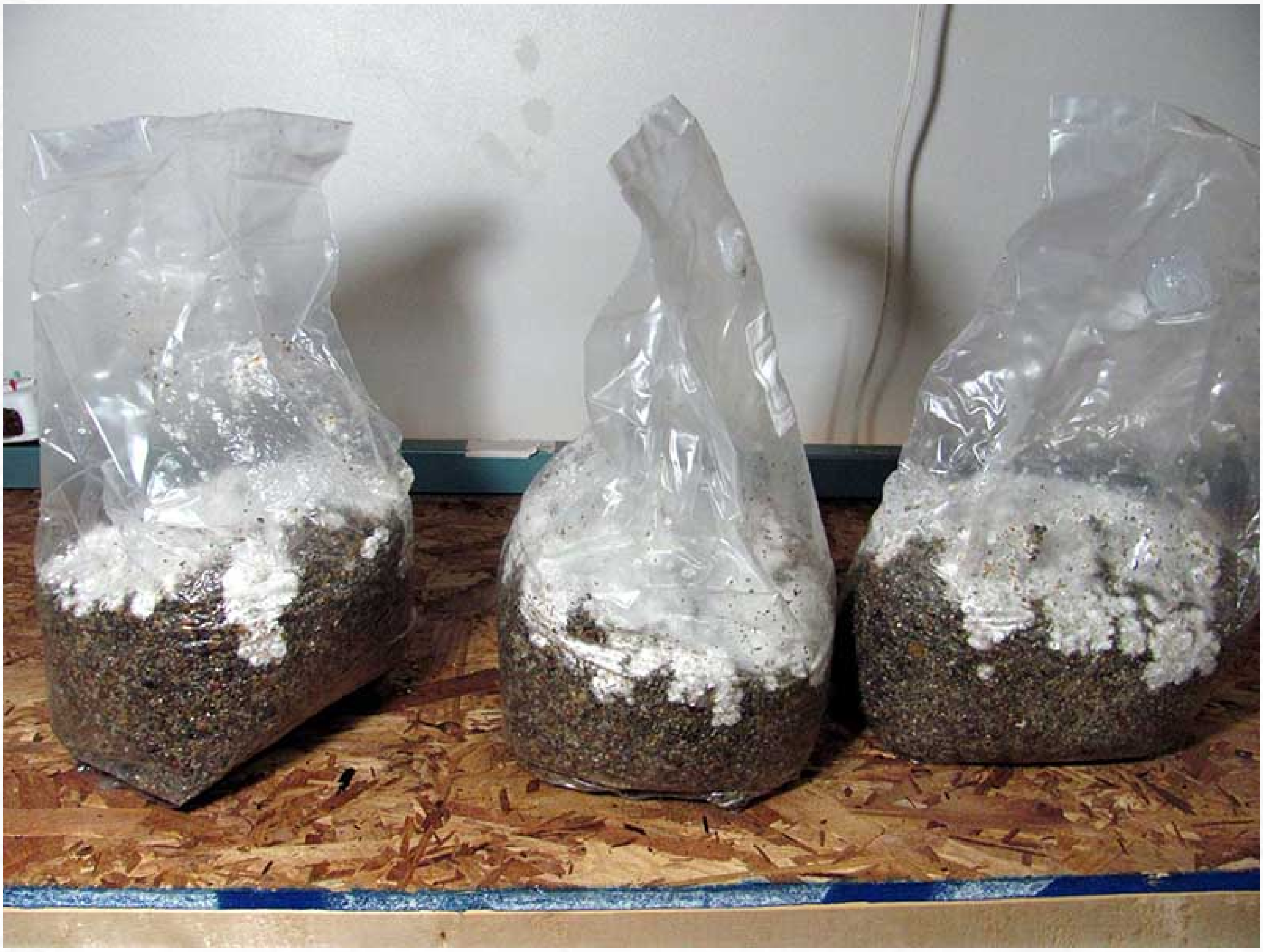




I recommend spraying as much of the surface area as you can reach.

Step 5: The Incubation

Incubate on an open shelf in normal lighting at 70-75F for 7-14 days until you have a good thick fuzzy covering of mycelium similar to this:



Step 6: Break, Shake & Roll

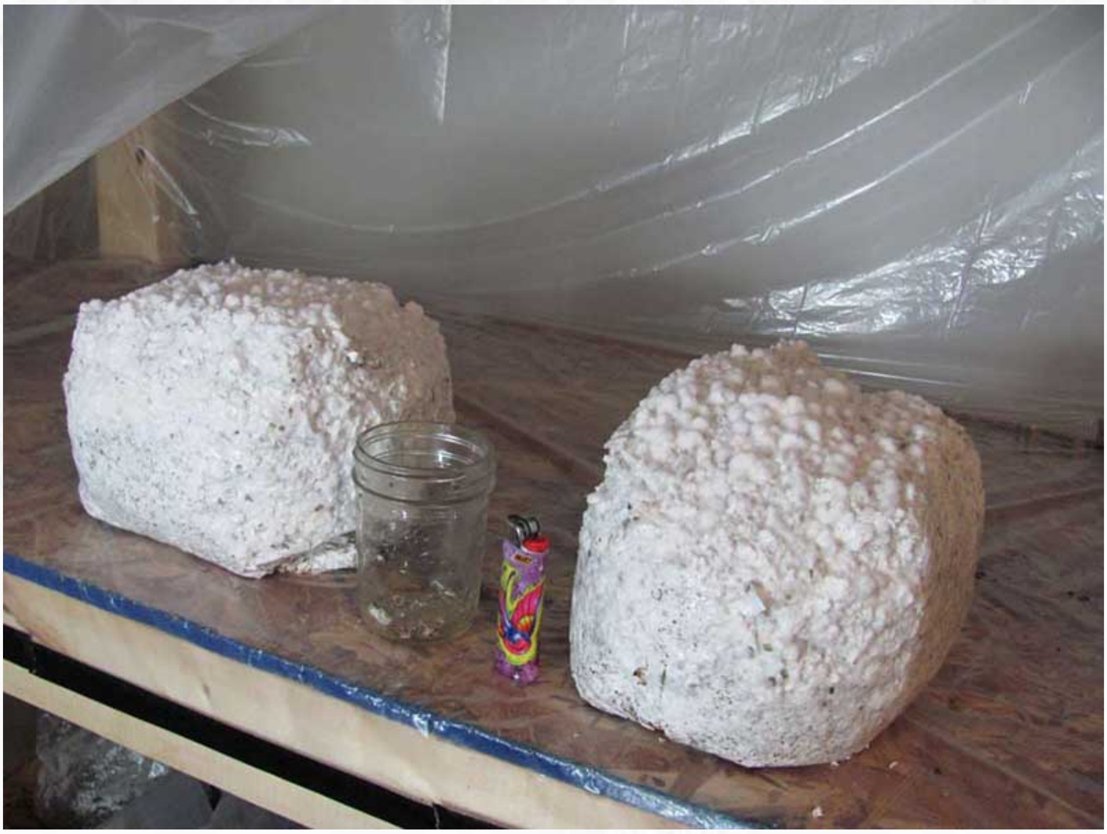
Using your hands break up every single chunk in the bag. Continually roll the bag to expose new chunks until you can find none. This will take up to 5 minutes per bag.
Once you've got all the chunks shake and roll the bag for at least 2 minutes.
Set back on the same shelf and allow to continue colonization.

IMPORTANT: At this stage I recommend dropping the temperatures to about 70F. Growth will explode at this point creating a large amount of internal heat. I've recorded up to 12.5F over ambient temps externally. So if you're incubating at 80F you're bags may stall, not properly colonize the center and increased risk of contamination (contams like high temps, cubes don't).
Once the bags appear to be fully colonized allow 1 week to consolidate unless you intend to spawn to bulk, in which case go ahead and do it.

Step 7: Fruiting

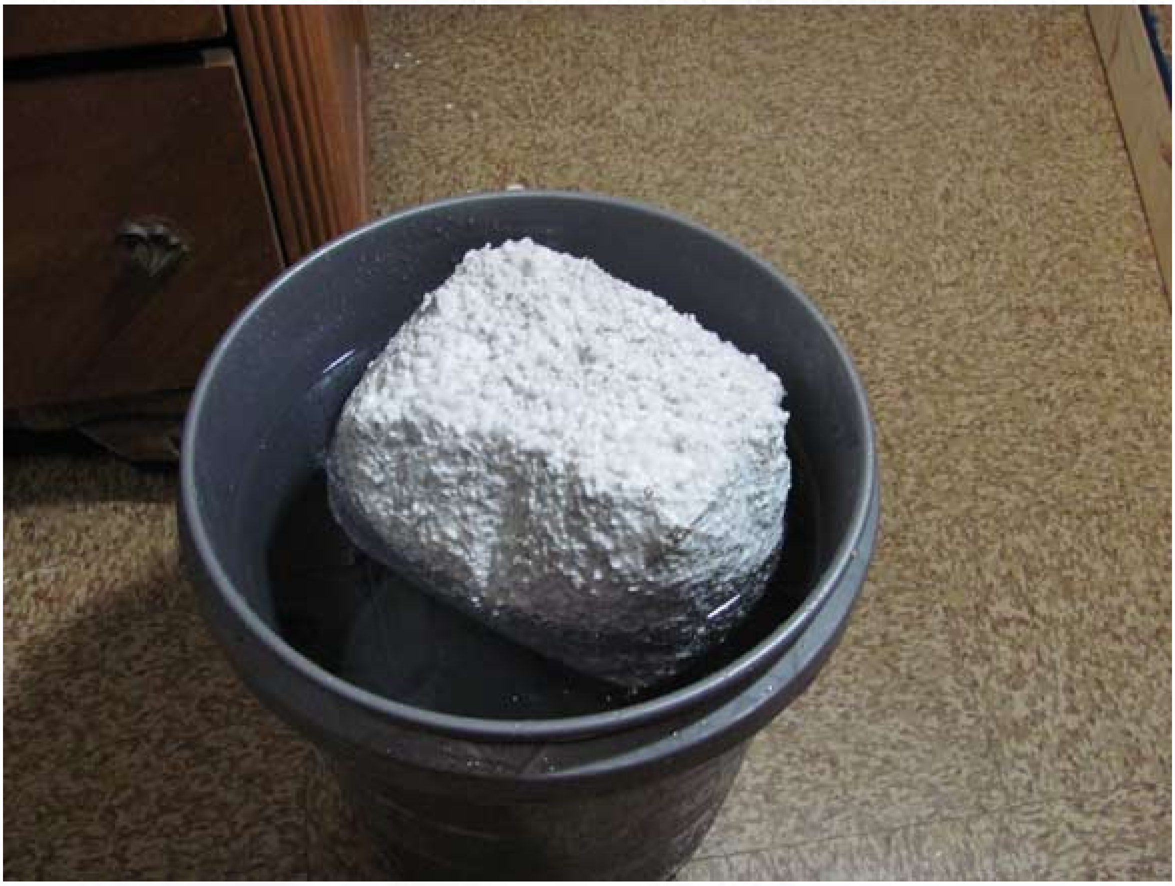
Carefully cut away the bag using something sharp. Often little bits will get torn off from the bottom, do not worry about them.

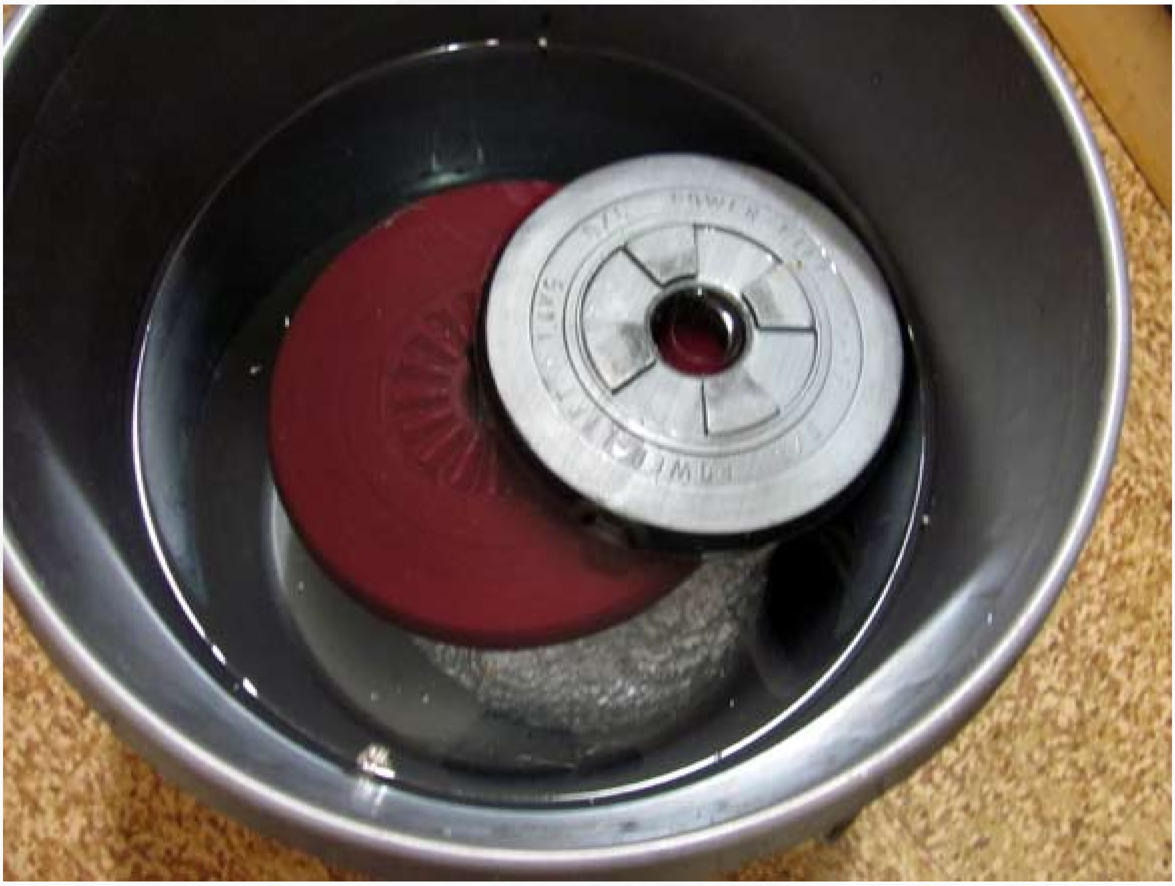
You should end up with something like this:



(note the sad little half pint jar there, dwarfed by these awesome blocks)

Dunk for 18-24 hours in cool water.





Takes about 7.5 lbs to hold these down, in case you were wondering.
I've tried with and without rolling these and the results were similar therefore I recommend the simplicity of not rolling since it doesn't seem to serve a good purpose.
Pop these into a standard shotgun style fruiting chamber - you can fit 4 cakes in a 66 quart fc or 6 in a 108 quart fc.

You can also fan and mist manually or use my automated shotgun technique for equally awesome results.
I recommend 2 flushes then toss them as the risk of contaminates is very high after the 2nd flush and not worth the trouble of having to de-con your FC's / Fruiting Rooms.
Yields will average between 2.5 oz and 6 oz dry weight PER block.
Provided you use proper conditions you can expect about 1 flush per week.
Here's a few pictures of Albino Penis Envy grown using this technique.

Enjoy!

Table of Contents

Scotsman's Beginner's Cake Tips

by scotsman1

original source: http://www.shroomery.org/8413/Scotsmans-Beginners-Cake-Tips

Some useful tips for a successful cake grow.

I always always seem to get good flushes on my cakes and for the life of me I don't know what I do that's different from anyone else, or do I? Well here in a few simple tips and I will give all my little secrets, well they ain't exactly secrets, more must do items, items that if you follow you will also end up with bigger flushes, maybe.

I always stick to what I know best and what gives me the best results, and that's straight Brown Rice Flour cakes done the old-fashioned way, PF style cakes.

These tips may help, they may not but if one person shows an improvement in Flush sizes we have a winner, so here's my simple tips.

Quarter cup of BRF. As I said already Organic Brown Rice ground to a fine flour in the coffee grinder.

Vermiculite I use half a cup. Arthur Bowers Silverperl Vermiculite Horticultural Grade. It's not the fine vermiculite because we only get the one type here. I don't think the fine vermiculite would be as good because when this gets to the bottom of the bag its all smaller pieces which to me don't give as good a cake mix.

Quarter cup of water, this is one of the few times I just use tap water. I don't know how your tap water is but ours is not to bad.

When mixing the cakes I like to do my cakes 1 or 2 at a time it gets the mix better more even, so your waters right through the whole mix.

First Flush

Second Flush

Third Flush

The cups you measure the vermiculite etc with, well when you fill them make sure you don't go over the line; you don't want the cup full to the brim that way the rest of the mix will be off resulting in to dry a mix, I admit I fell for this one when I started.

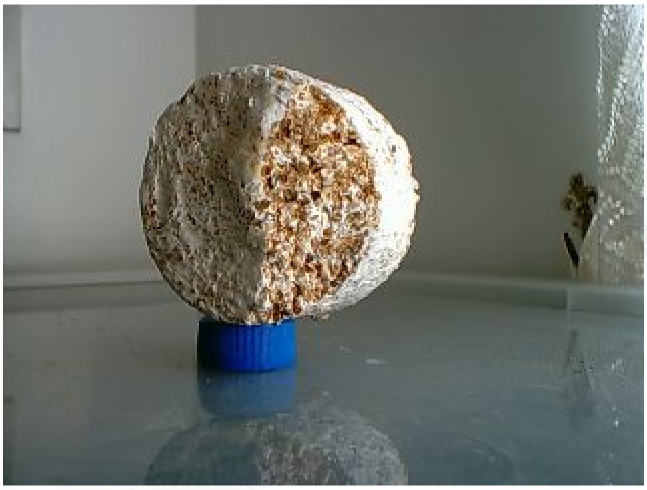
Brown Rice. Well I go for organic brown rice for the simple reason the shop nearest me sells it and if I changed maybe I would get lower yields, maybe I would get higher? I've never seen brown rice flour in Scotland so I settled for the rice ground in a coffee grinder and make sure its ground to a fine flour. Now i clean them and scrape with a fork and both are under water in the fridge for 18 hours.

1st the strain in the pics is Ecuadorian why? because they give great flushes and are no problem to print from and are easy to maintain. My grow tank is the standard Rubbermaid type, bought cheaply from the local diy store. 1.5 inch perlite pre soaked and spread evenly over the bottom. Fanning differs because it just depends if I am in or my wife is in. If I am in they get fanned up to 6 times a day, but if both of us are out they can go 8 hours without being fanned. Normally they can get by with 3 or 4 air exchanges a day but I like to give them more. If i am growing in winter i use a fish tank heater but its OK here at the moment so i am not using one right at this moment. They get misted every time the sides of the tank seem to be drying. Light, the tank has I clear lid and is at a window so they get natural sunlight. Even though I only spray when it looks dry I still water and spray the casing every day.

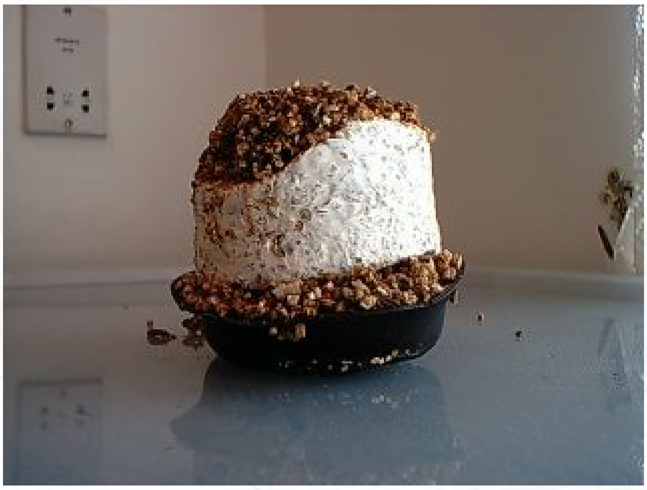
My Grow Tanks.

DBL end case after every flush.
Saving a Partially Colonized Cake.
Some of my cakes start OK then slows down to almost stopping. When this happens you don't have to throw the cake out, a small operation can save the cake and even though the flush will be reduced you still get a gram or two.
The Procedure.
First pic shows a cake I cut, notice how full the cut is, you should use as sharp a knife as you can. Prepare an area for working by washing with bleach and spraying Lysol on the surface and wear gloves. The idea is to cut

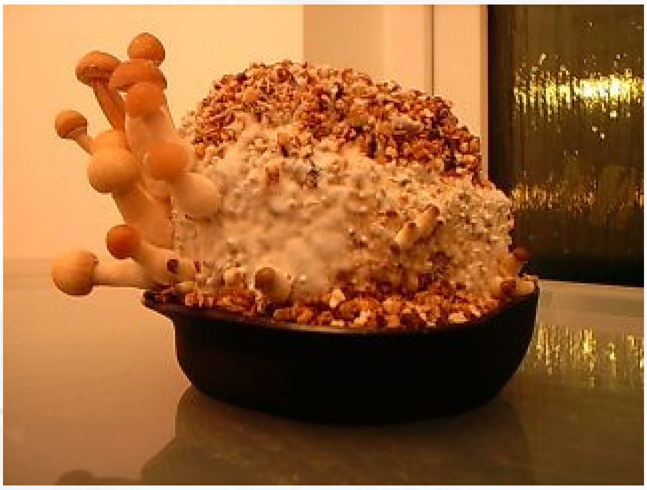
the uncolonized part of the cake off, leaving you with a cake with 1 small part removed.



Remove the cake from the jar and wash under running water. Get a sharp knife and plan where to cut the uncolonized part of the cake off, cut the part off with 1 cut no sawing or gouging, 1 cut. Next dunk for 18 hours.



Dbl end case your cake and make sure you pile plenty over the cut part of the cake this helps prevent contaminations.



A small flush but better than nothing and if you have a few cakes that go in this direction then a few grams is better than total failure.

Happy Shrooming and good luck.

Psilocybe cubensis
Photo by Scotsman, © 2002 Erowid.org

Table of Contents

PF-Tek - Dunk and Roll

original source: http://www.shroomery.org/10253/PF-TEK-Update-Dunk-and-Roll

Explaining the method of dunking your cakes in water and then rolling them in vermiculite to improve your flushes

Why Dunk and Roll?

Mushrooms are basically 90% water. Dunking and rolling will increase your yields dramatically with hardly any work. You are essentially replacing the water lost by the cakes and allowing them to produce more fruits. Normally the water runs out way before the nutrients in the cake do, so as long as you are replenishing the water the substrate will keep on producing fruits for at least a few more flushes.

When Should I Dunk and Roll?

- Immediately after birthing a cake and before placing it in the fruiting chamber you should always dunk and roll. A lot of water has been lost during the weeks the substrate has been colonizing.
- Between flushes. Once you have picked all the fruits off the cake or none have been growing for a few days you know your flush is over. Now is the time to dunk again, preparing the substrate for the next flush.

The procedure is divided in two parts:

The Dunk

In this step you will be replacing the water lost by the substrate.

1. Rinse off your cakes under the tap, rubbing them softly do dislodge any loose material or bits of mushroom material left over from picking the fruits. Be careful not to break off any pins (little immature mushrooms) as they will be your next crop. Pins will survive the dunk and roll no problem, so no need to take them off. Just be delicate with them.
2. Submerge the cakes under cold tap water for 12-24h inside a clean container. Try and avoid dunking for much longer than 24h but the closer you get the better as cakes are very dense and need a long time to absorb all the water . You can use the pan you sterilized you cakes in, a clean tupperware container a bucket, whatever is available. You will notice that the cakes actually bob about like corks so you will need to put something heavy ontop to keep them fully submerged. This is important as it seems that the extra bit of water pressure that comes from being totally submerged aids the rehydration process.
3. There is no need to dunk inside a fridge. As long as your water stays cool (below 40°F) you will be fine. The cool temperatures of the fridge prevent bacterial bloom while you are dunking (it has nothing to do with cold shocking the mycelium, as this procedure is not required for Psilocybe Cubensis) but unless you are pretty clean your fridge probably harbors a lot of contaminants, so it can be counterproductive. Use ice, running water (can be costly) or the fridge to keep your water below 40°F.
4. Once your dunk has finished, re-rinse your cakes under the tap and proceed to...

The Roll

Rolling your cakes increases the water holding capabilities of the cake. It essentially acts as a mini casing layer.

1. Roll your cakes in dry vermiculite so they are evenly coated with it. You can optionally bake your vermiculite in the oven for an hour at 350°F if you think it might not be clean (the bag has been opened for a long time for example) but it is not necessary if the vermiculite is out of a new bag.
2. Place the cakes inside your fruiting chamber (not in direct contact with the perlite, use a circle of foil or an old jar lid as a coaster) and wait for an hour or so.
3. Mist your cakes thorougly making sure you wet all the vermiculite.
4. Maintain fruiting conditions as usual.

Extra Tips

- While dunking between flushes is a must, re-rolling between flushes is optional. You will see that the mycelium colonizes the vermiculite slightly so it does not all come off during the succesive dunkings. There is no need to get it all off. Either do not re-roll, just patch up the bald areas or roll again. Whatever looks best to you.
- Letting the cake dry out between flushes. By not misting for a few days after the flush has finished and then dunking you are imitating the natural cycle of drying out followed by sudden rehydration. In nature this rehydration will stimulate rapid fruit formation. Also, the drying out protects your cakes from molds during the waiting period as the drier surface is not as prone to contamination.
- Extra vermiculite reservoir: Put a spoonful of vermiculite on the top of the cake when you place it in the fruiting chamber. Once wetted when you mist, it will act as an extra water reservoir.
- Try and create a good microclimate. By dunking and rolling all your cakes and packing them close together you will be creating a microclimate among your cakes where humidity is at its max. This is an invaluable aid for good flushes. These pictures show how well dunked and rolled cakes can perform.

Table of Contents

Hippie3's Dunk Tek

by Hippie3

original source: http://www.shroomery.org/5185/What-is-the-dunk-tek

The cake is dunked in water overnight to rehydrate and enable bigger and more flushes.

Hippie's Dunk tek is a simple yet effective way to extend the useful lifespan of cubensis cultures such as PF cakes.

This tek should be used whenever the cakes/casings dry out. Also it can be given after full colonization to replace water lost so far.

The tek itself is quite simple. It essentially consists of submersion of the cake/casing underwater for 12 to 24 hours. Don't worry, that will not harm your cakes/casings.

One can even dunk cakes/casing that already have small pins safely. Just don't overdo it, by 48 hours underwater they will be dead.

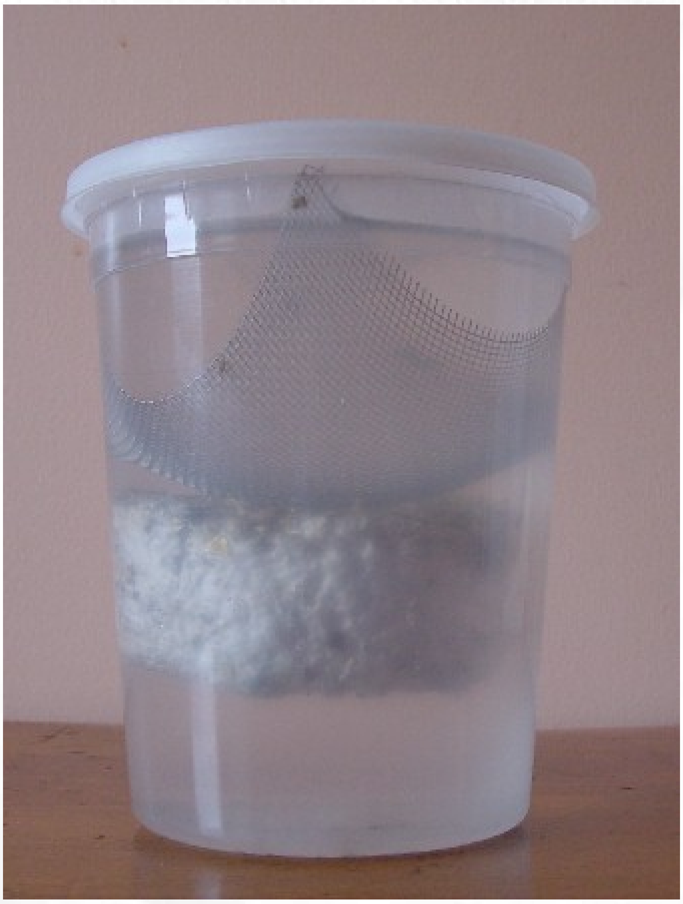
As for what kind of water to use, natural spring water is best but you can even use it straight from your faucet if need be.

Temperature during the dunking should be be cool but not cold, refrigeration is not recommended.

Time spent dunking should be not less than 6 hours for minimal benefits. 12 hours is about right for dunking in between flushes and at birth but 24 hours is the maximum for full rehydration of nearly spent cakes.

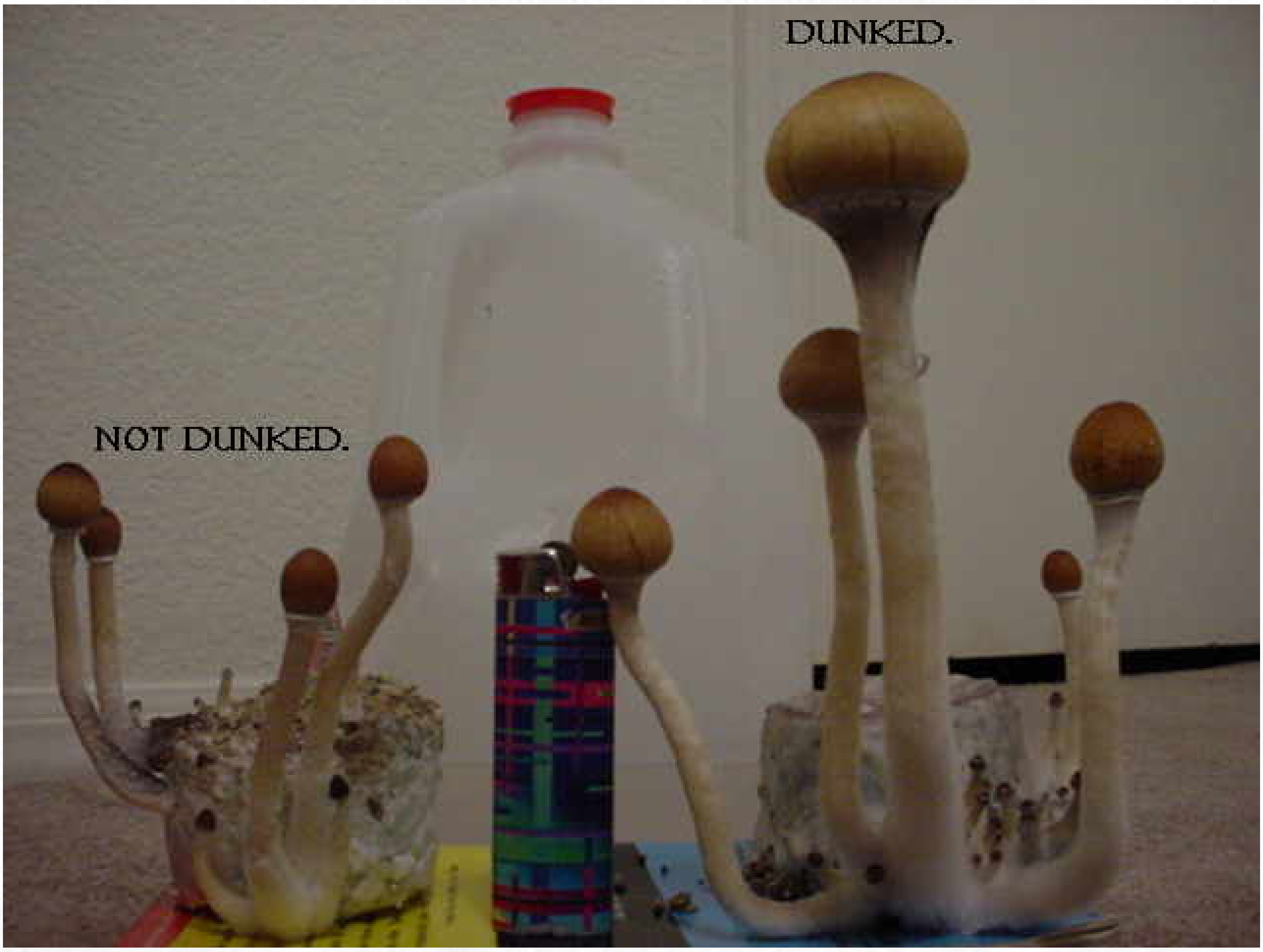
There are at least 2 options for how to dunk. My prefered method is to dunk each cake individually by placing it in a jar, filling with water, then screw on the lid to keep the cake submerged. This way is good for small batches, and has the advantage of keeping each cake isolated so no contaminants are spread from cake to cake.

For larger batches, you can simply place several cakes in a large pan or bucket, cover with water and weigh down the cakes by placing a weighted down lid, plate, etc. on top of the cakes.



After dunking, drain well, gently pat dry with paper towels, etc. and return it to the fruiting environment.

Photo of dunked cake pinning.



originally posted at *Mycotopia*

[Table of Contents](#)

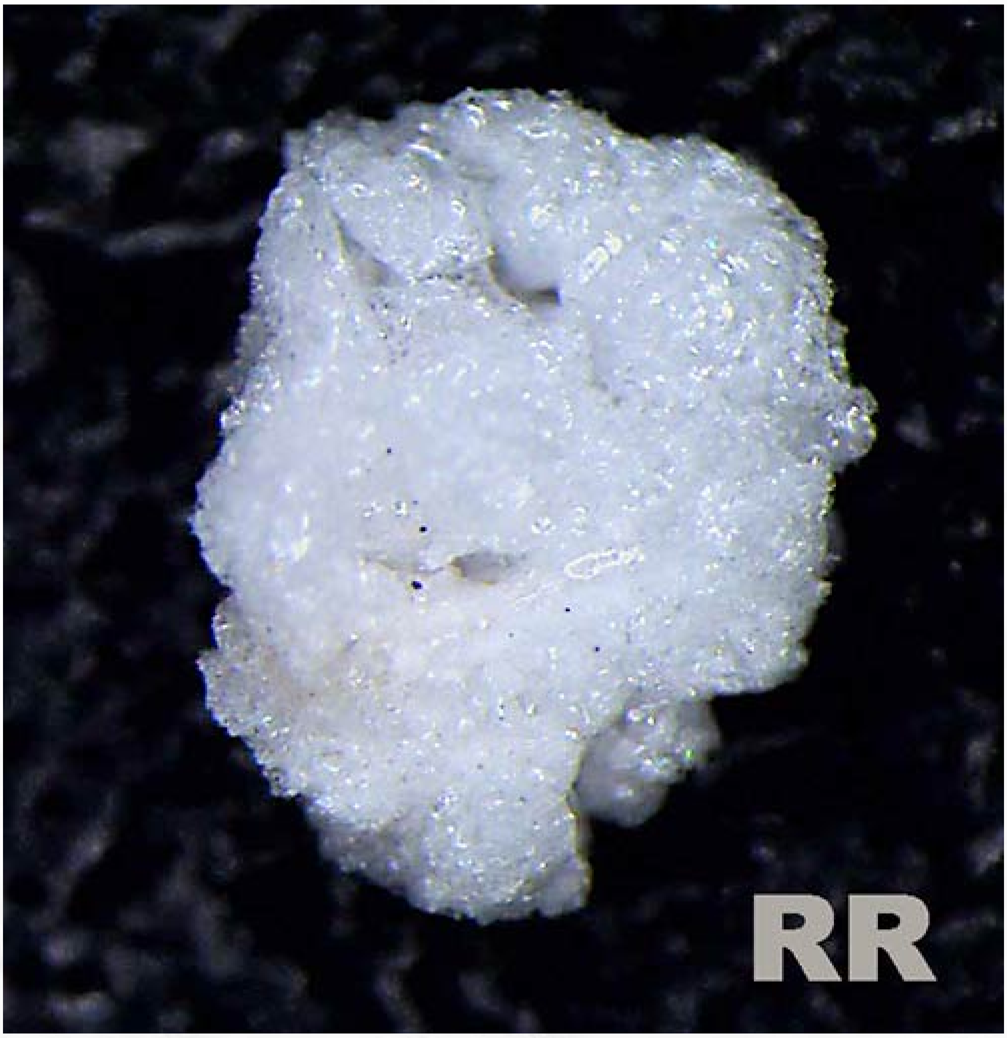
Shotgun Terrarium

How to build a simple, low maintenance, fruiting chamber.

The Shotgun Terrarium is an easy to make and easy to maintain fruiting chamber. It has no moving parts, needs no electricity and does away with shields and other complications.

How does it work?

The principle behind the shotgun terrarium is that of using perlite to increase air humidity. This is by no means an innovation as before the shotgun terrarium was developed it was already used. Here is a closeup picture of a piece of perlite. Notice how perlite is covered with ridges and bumps. Once you wet your perlite, this increases the surface area of water exposed to the air thus dramatically increasing evaporation rates over the same volume of water on its own. More evaporation means higher humidity.



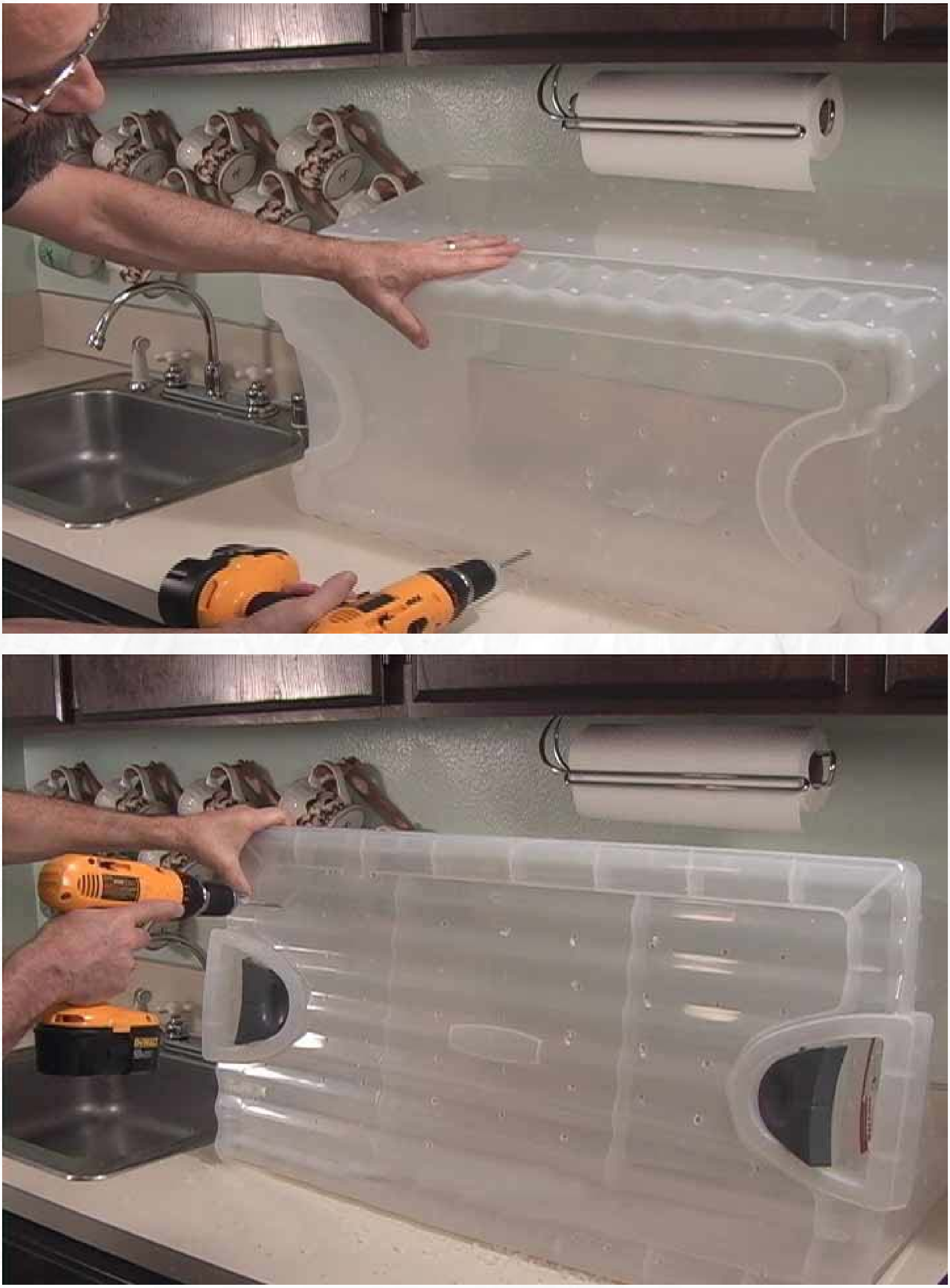
Building a Shotgun Terrarium

You will need:

- A transparent/translucent plastic storage container. The lid does not have to be transparent but if you have the choice, go with the transparent top. Mushrooms grow towards the light and if they get no light at the top they will grow sideways.
- Electric drill with a 1/4 inch drill bit
- Perlite. Enough to fill 3-5 inches of the bottom of the container.
- Pasta strainer or similar.

Step 1 - Drill the holes

Drill holes in all six sides of the container. Space them out evenly, with about two inches between holes. Now you know why it is called a shotgun terrarium :D



Drill holes in all six sides.

Step 2 - Prepare your perlite

Fill your strainer with perlite and wash it thoroughly under the tap. This both cleans the perlite of any dust and covers all the surfaces with water. Drain the perlite well.

VOLCANIC PERLITE
NATURAL

Allow perlite to drain well.

Step 3 - Place perlite in the fruiting chamber

Fill up your terrarium with the moist perlite. It should fill 3 to 5 inches of the bottom of the container. Spread it out evenly, keeping it as light and fluffy as possible. Your fruiting chamber is now ready.

Rubbermaid
Max Latch
XL

Use 3 to 5 inches of damp perlite (7cm - 12cm)

Step 4 - Put your cakes into the fruiting chamber

It is now time to put your fully colonized cakes into the terrarium and put the lid on. Do not place them directly on the perlite. Use old jar lids or pieces of tin foil as coasters to avoid direct contact.

Now, all you have to do is open up the lid twice a day and fan some fresh air into the fruiting chamber. You can use the actual lid of the terrarium as long as you keep it clean. We do this to introduce extra fresh air into the chamber.

While a lot of fresh air gets in through the holes you can never really have enough fresh air (as long as the humidity stays in the high 90%s) as it is a very important pinning trigger and also hinders the growth of contaminant molds. Before fanning (30 seconds is enough) give the cakes a good thorough mist with your water mister to keep them nice and hydrated.

Rubbermaid
Max Latch
XL

Extra Tips & Tricks

- Use a hygrometer to measure the humidity inside your fruiting chamber. It should be as close to 100% as possible. If on its own this terrarium does not achieve over 95% relative humidity, tape up some of the holes to slow down air exchange and that should increase your humidity levels.
- Expose your terrarium to light for at least a few hours each day. Light shows the mushrooms which way to grow and ensures even and prolific pinning (if all other conditions are correct). Indirect sunlight is good (avoid direct sunlight) or if you can't have it, use a compact fluorescent (energy saving bulb) or standard fluorescent bulb that gives off light in the daylight range. The packaging will say something like daylight or white light or 6000K (somewhere around that number). Good results have been obtained with a 12 hour on 12 hour off cycle. Stay away from incandescent (regular) lightbulbs as they do not emmit the right kind of light and produce a lot of heat
- Keep your terrarium slightly elevated. Use a couple of bricks or something to elevate the terrarium off the floor. This keeps it away from the dust and muck on the floor and more importantly lets air go through the holes you have drilled on the bottom.
- Here is a video describing the process and also another document (see below) describing the science behind the shotgun terrarium in greater depth. This site has also got some great videos explaining many other procedures, including the PF Tek.

Nibin 2009. Special thanks to RogerRabbit for letting me use his pictures and video.

Constructing Your Terrarium/Fruiting Chamber

This page explains the construction of a simple terrarium, also known as a fruiting chamber, for growing mushrooms. The function of a mushroom fruiting chamber, or terrarium as they're sometimes referred to, is to provide an environment with near saturation humidity, while allowing plenty of fresh air to enter and circulate. My terrarium design has become widely referred to as the *shotgun terrarium* due to the abundance of holes on all six sides. The ideal mushroom fruiting chamber will be constructed in such a way that stale CO2 laden air can exit, or be forced out, while a constant supply of fresh moving air is allowed to enter. While the terrarium needs to provide this supply of fresh air, it also needs to maintain a humidity level at or above 95% to promote mushroom formation and growth.

Over the years, I've seen many mushroom fruiting chamber designs come and go. Those that hold a high humidity often get saturated with stale air, and the mushrooms develop fat, tough stipes (stems) and tiny caps. Since with many species of mushrooms, it's the cap that we eat, the entry of fresh air is vitally important. Other terrarium designs use complicated systems of humidifiers and fans, and while these often provide the fresh air that's required, they sometimes fail to keep the humidity levels high enough, resulting in dry substrates and poor mushroom fruitbody formation. In addition, the use of mechanical or electrical devices introduces the possibility of failure, either by over saturation or drying out, due to equipment malfunction. That's why I advise to keep it simple. The terrarium I present here can be left unattended while you're at work all day, and you won't have to worry about losing your mushrooms.

The terrarium system that I designed and demonstrate here is what I consider to be the best combination of easy construction, excellent function, and low maintenance. To watch a video of the terrarium under construction, see part 3 of the BRF/PF tek video. It's been dubbed the *shotgun terrarium*, and the name seems to have stuck. The name comes from the appearance of up to a few hundred holes that are drilled into the plastic storage bin.

Shotgun Terrarium Theory of Operation

The theory of operation for the shotgun mushroom fruiting chamber is that natural air currents travel from areas of high pressure to areas of low pressure. Cool air has the molecules closer together than warm air, thus cool air is at a slightly higher pressure than warm air. When we put several inches of damp perlite in the bottom of our terrarium, we create an area with a slightly cooler temperature than the air above, which is exposed to lights that create heat, and our mushroom substrates, which are often at up to a few degrees warmer than the surrounding air due to thermogenesis.

This temperature differential, however slight, results in enough of a pressure gradient that it causes air to flow up through the perlite, absorbing moisture as it travels, and into the relatively lower pressure air within the fruiting portion of our fruiting chamber.

This air then exits through the holes in the upper section of the terrarium, carrying the excessive CO2 produced by our mycelium out with it. With this design, no electrical or mechanical equipment is required. Regular misting helps to keep our brf cakes or other substrates moist, and also serves to replace the moisture that evaporates from the perlite.

When using this system, drill holes as shown in the pictures and video clip on all six sides. I use a 1/4" (6mm) drill bit. Use of a larger drill bit is not recommended. It must be remembered that a 1/2" hole has four times the area of a 1/4" hole. (A 12 mm hole has four times the area of a 6 mm hole) If the holes are too large, your terrarium will not be able to maintain the high humidity necessary for growing mushrooms.

This system also requires an ambient humidity in your house of 30% or above, which incidentally will ensure your own comfort as well. In desert climates, and especially in cold climates during the winter months, indoor humidity is often very low. If you get shocked from touching another person, or a light switch, etc., after walking across the carpet in your home, it means your humidity is too low. The answer is to run a cool mist humidifier 24/7 in your home. Moist air holds heat much better than dry air, so you'll actually lower your utility bills by doing so. If you'll ensure that the humidity in your growing room is at least 30%, this design terrarium will easily maintain 95% humidity on the inside where your mushrooms need it.

Of course, it should go without saying that for this system to work properly, the terrarium must be elevated at least 1" above the table it's sitting on. Use blocks of wood, shot glasses, or whatever you have around the house to raise the terrarium off the table so air can circulate under it. It should also be noted that 90% of all airborne contaminants in a room are located near the floor, so make sure your terrarium has a home on a table or shelf.

Lighting Requirements of Mushrooms

Some mushrooms, such as the *Agaricus* species commonly found in grocery stores require no light at all. However, those commonly grown by hobbyists, such as *Pleurotus ostreatus* (Oyster Mushrooms), *Lentinus enodes* (Shiitake), *Psilocybe cubensis*, a hallucinogenic mushroom, and *Hericium erinaceus* (Lion's Mane) all require light to produce abundant, normal sized fruits. Experience has taught us that the light best suited for primordia formation and the development of fruitbodies is bright light with a color temperature of 5,000 Kelvin to 7,000 Kelvin. Fortunately, this type of light is easily obtainable at your local home improvement center in the form of fluorescent fixtures. For a small terrarium as described in this chapter, a single CFL (compact fluorescent) that screws into a standard light bulb socket will work very well. These can often be found in grocery and drug stores in every neighborhood. 15 watt CFLs will do the job well, but the package will probably have a large 60 stamped on it, indicating they produce light "equivalent" to a 60 watt incandescent light bulb. They're referring to lumens of output, not the frequency. Incandescent light bulbs are the worst possible choice for growing mushrooms, since they emit a 'red' light in the 3,000 Kelvin color temperature range.

The higher the color temperature, expressed in Kelvin, the closer to the 'blue' end of the spectrum the emitted light is. The lower the color temperature the 'redder' the light is. If you have a choice of fluorescent lamps, purchase those labeled 'daylight' since these have a somewhat higher color temperature than cool white. Daylight, sometimes called 'natural daylight' fluorescent tubes generally emit light in the 6,500 Kelvin range, while cool white fluorescent emits light at around 5,000 Kelvin.

If you have several terrariums stacked or otherwise near each other, you can use larger 2 to 4 tube fluorescent fixtures. These come in 48" and 96" lengths. Place the fluorescent lamps as close as you can get them to your terrariums without causing excessive heating. Species such as Shiitake and Oyster mushrooms prefer to fruit at temperatures in the upper 50's to mid 60's Fahrenheit (15C to 20C), while *Psilocybe cubensis* prefers to fruit at a temperature in the mid 70s to about 80 Fahrenheit (23C to 27C). Most mushroom species don't mind a slightly warmer temperature during daytime than at night, so if your grow room is a bit colder than the temperature ranges given above, a little warming from your lights during the daytime won't hurt at all, provided you don't let the air in your terrarium get too dry. For cakes, try to keep the humidity above 95%.

Cased substrates are a bit more forgiving, but still try to keep your humidity above 90%. 12 hours on, 12 hours off has proved to be a great combination over a wide range of species. Of course, if you have a bright window near your terrarium, that will suffice, but direct sunlight for more than a few minutes per day should be avoided.

Disregard outdated advice in old books which is constantly repeated on the internet to colonize mushroom substrates in total darkness. Experience and rigorous peer reviewed studies have proved that exposure to low level ambient indoor lighting during spawn run and substrate colonizing will speed up the process, leading to full colonization up to a few days earlier than the same substrate would if colonized in darkness. In addition, mushroom mycelium develops a day/night circadian rhythm, so exposure to light from day of inoculation sets this process in motion, leading to earlier fruiting and harvest.

Table of Contents

Pf tek done right TEK

by Shea25

original source: http://www.shroomery.org/forums/showflat.php/Number/11585613

PF tek
Things needed

- 1/2 pint wide mouth canning jars
- Pot/Pressure cooker
- Vermiculite
- Perlite
- Brown rice/Brow Rice Flour
- Tin foil
- 70% Iso alcohol
- Plastic Tote
- 6500K fluorescent bulb
- 1/4 inch drill bit/Drill
- Hammer/Nail
- Mixing bowl and spoon
- Gypsum
- Spore syringe
- Latex gloves
- Dust mask
- Lighter

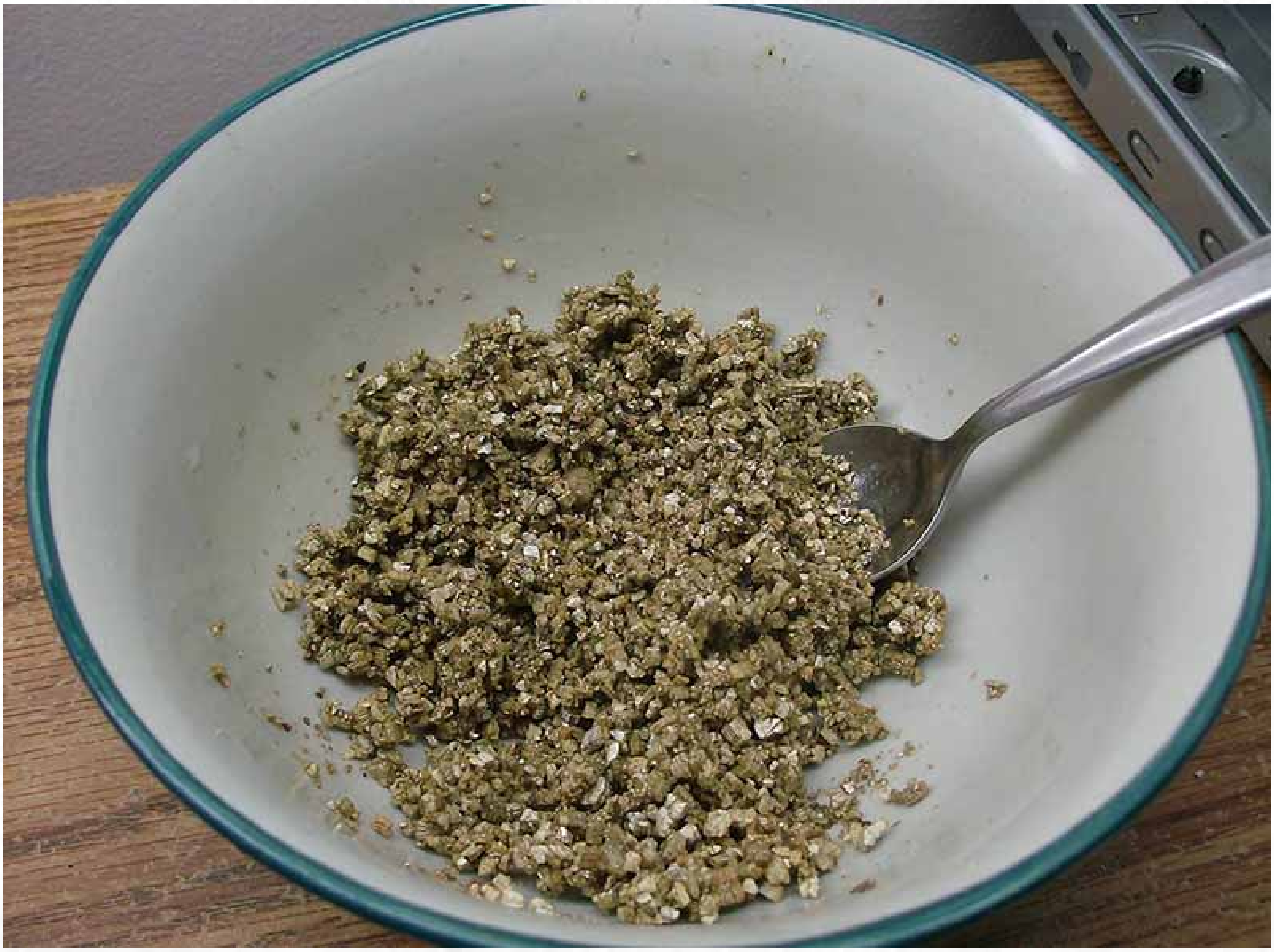
Preparing the jar

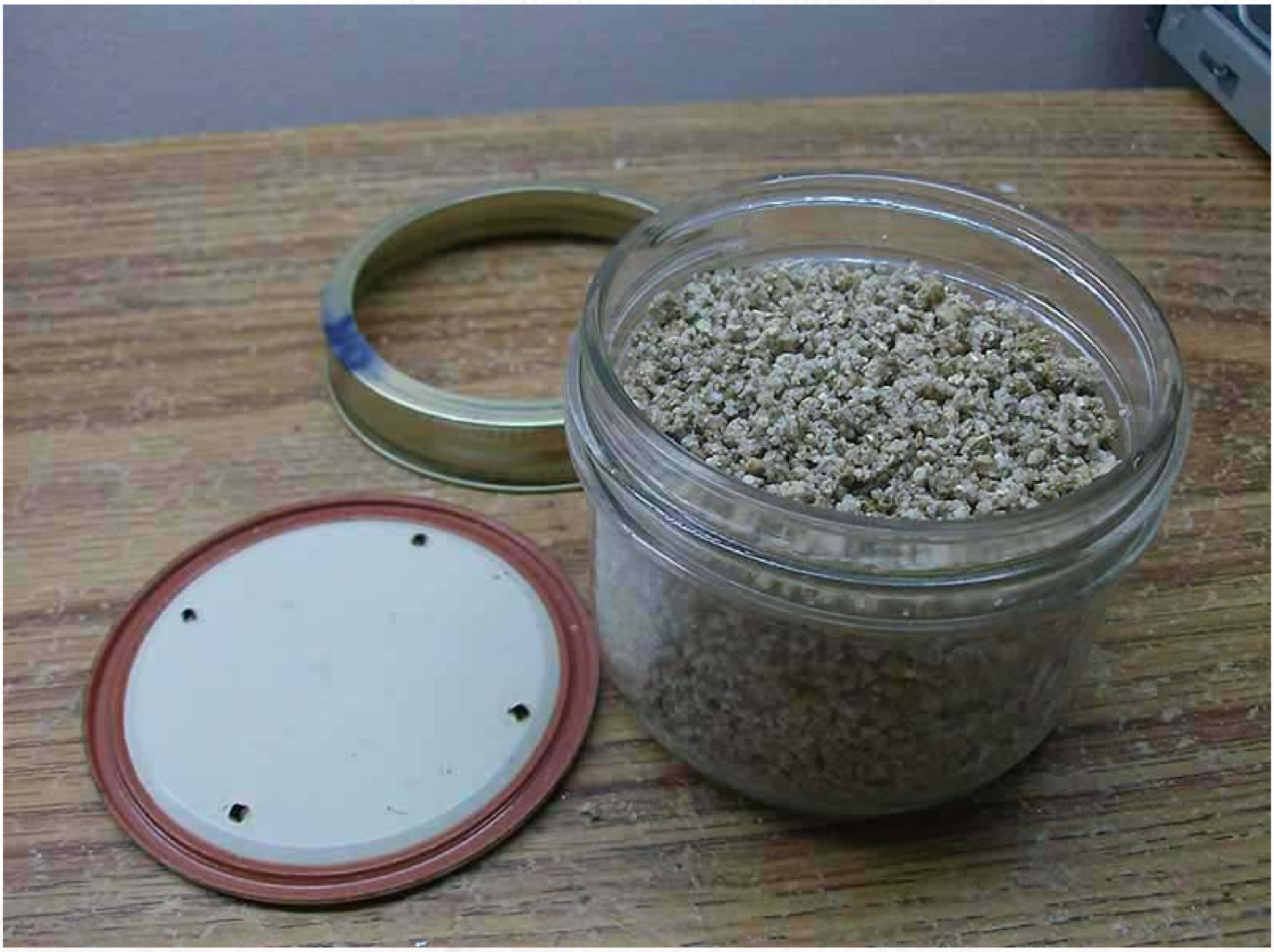
Take the lids and using a nail and hammer or a 1/8 drill bit, drill 4 holes near the rim of the lids nicely spaced out. Depending what way you use you lids i use mine rubber side down just punch the holes so they don't leave burrs pointing towards you.

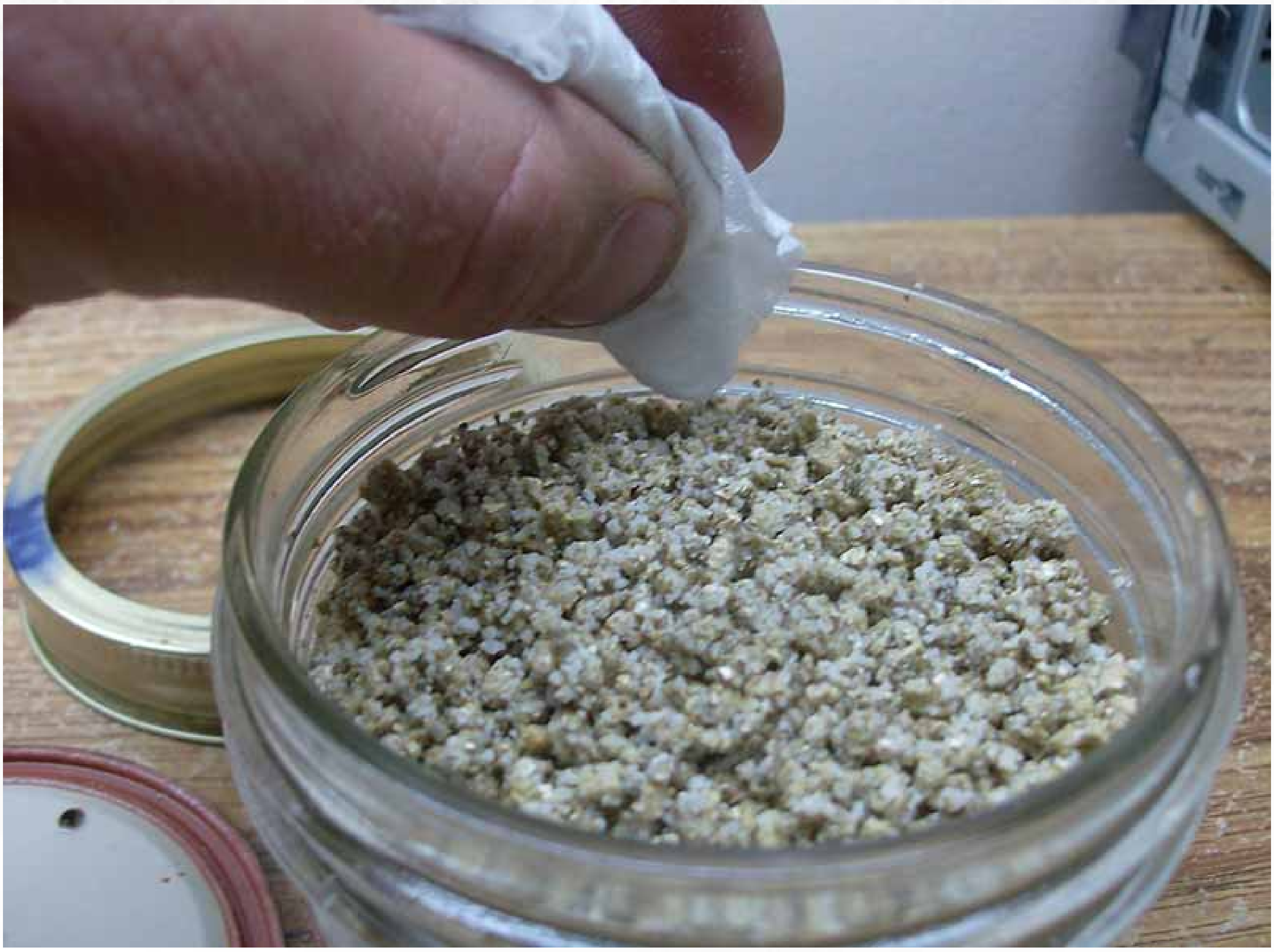
The basic recipe for 5 PF jars is this 2 parts vermiculite 1 part water and 1 part BRF (additionally you can add 1 tablespoon of gypsum for 5 jars)

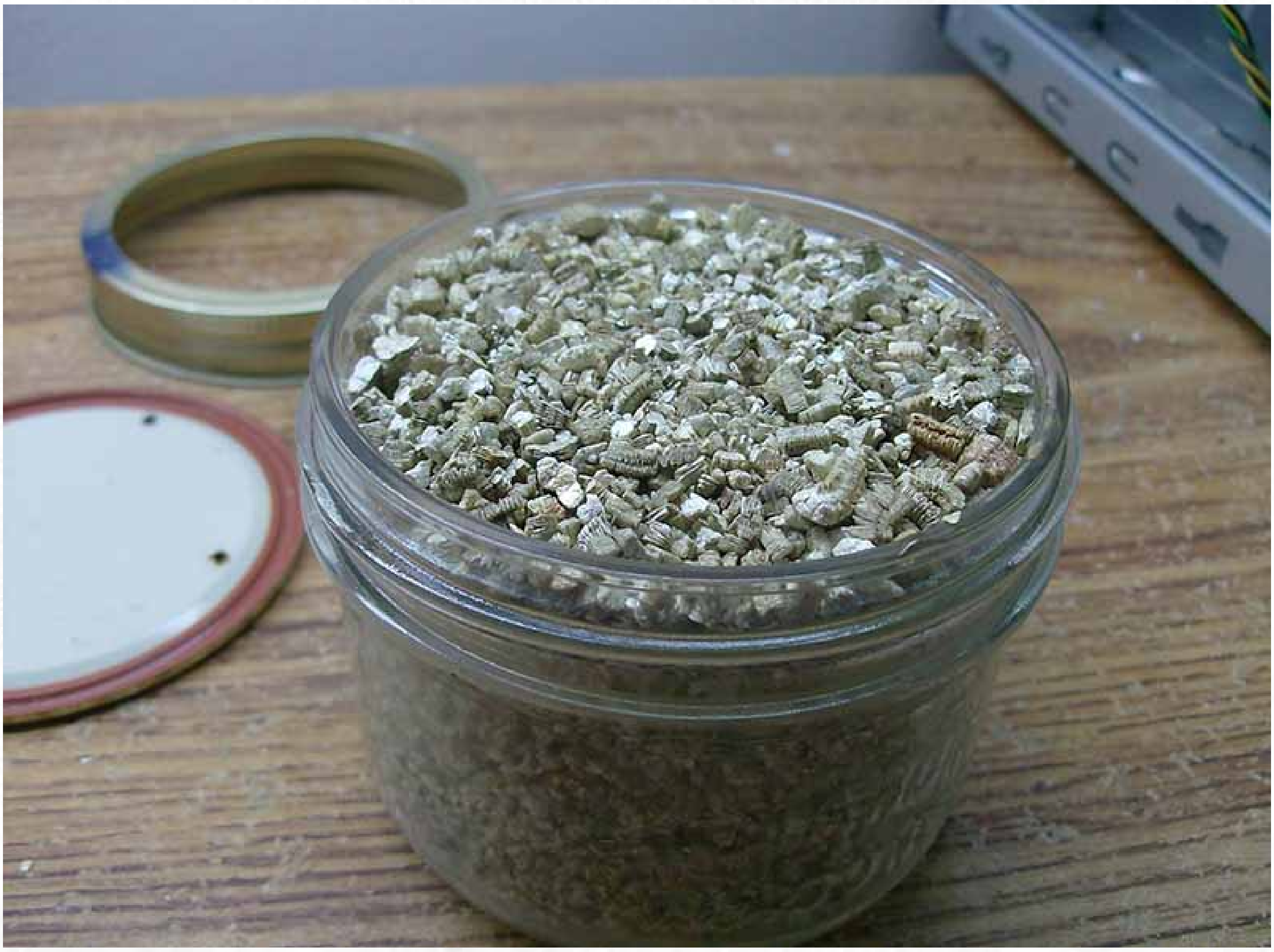
In a bowl add the 2 cups of vermiculite (and gypsum if you use it) now add the 1 cup of water, mix really well. Now add the 1 cup of Brown rice flour (you can make your own by grinding brow rice in a coffee grinder). Mix this really really well. Now load this into the 5 canning jar equally, making sure not to compress the mixture in the jars you want it nice and airy. You will be leaving a 1/2 inch space at the tops of the jars for the dry vermiculite layer.

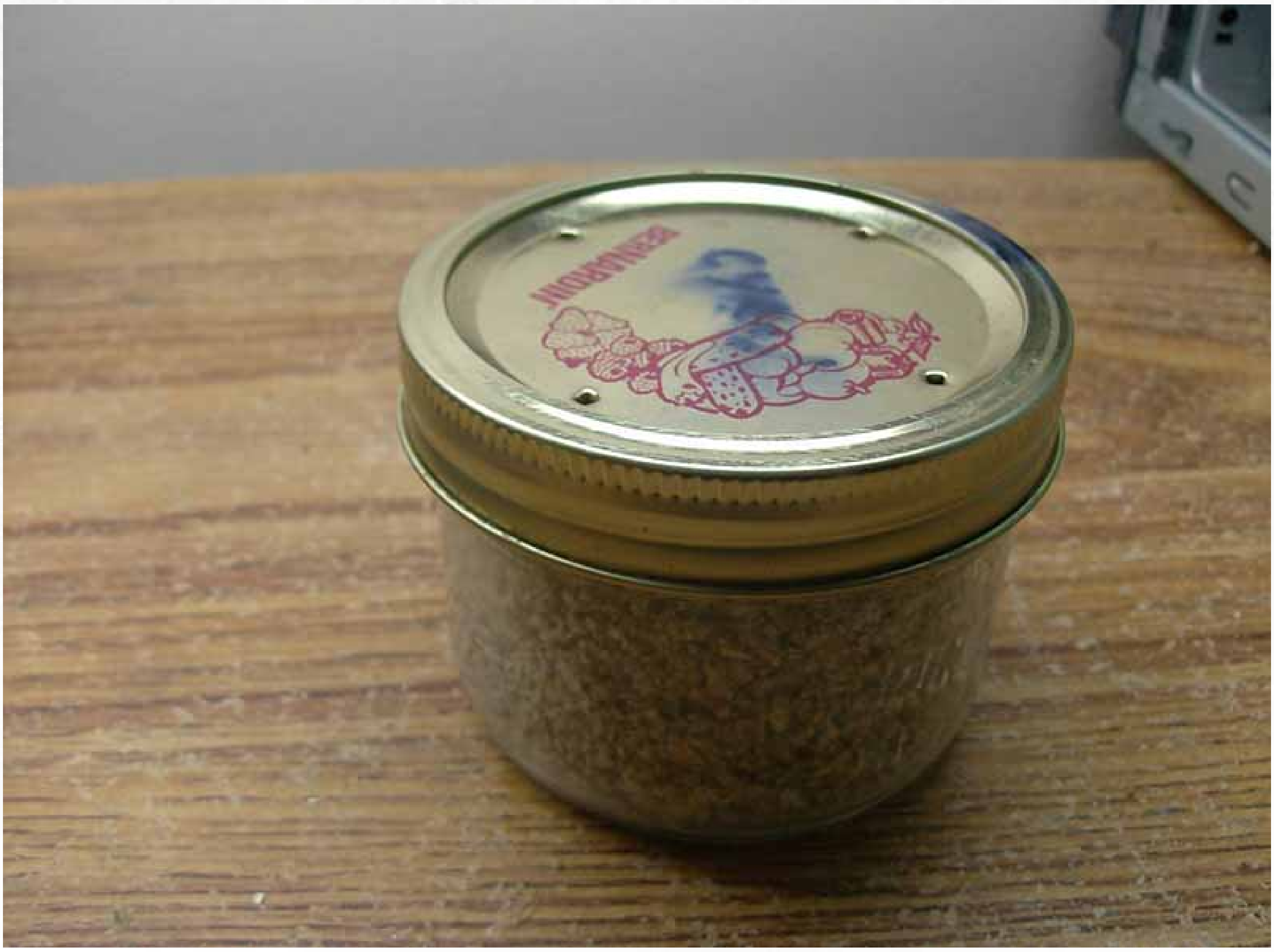
Take a paper towel and wipe the 1/2inch space you left at the tops of the jars making sure to wipe away any BRF mixture or moisture away. Now top off the jars with dry vermiculite, screw on the lids and cover the tops the lids with tin foil. The tin foil is there to keep any moisture from entering the jars while there sterilizing.





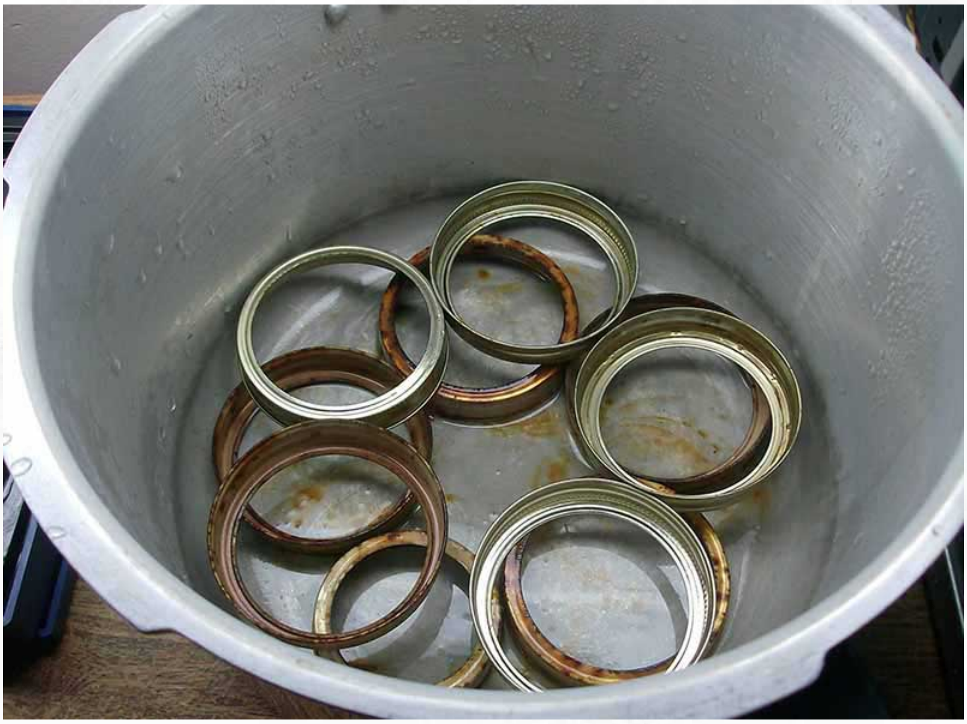


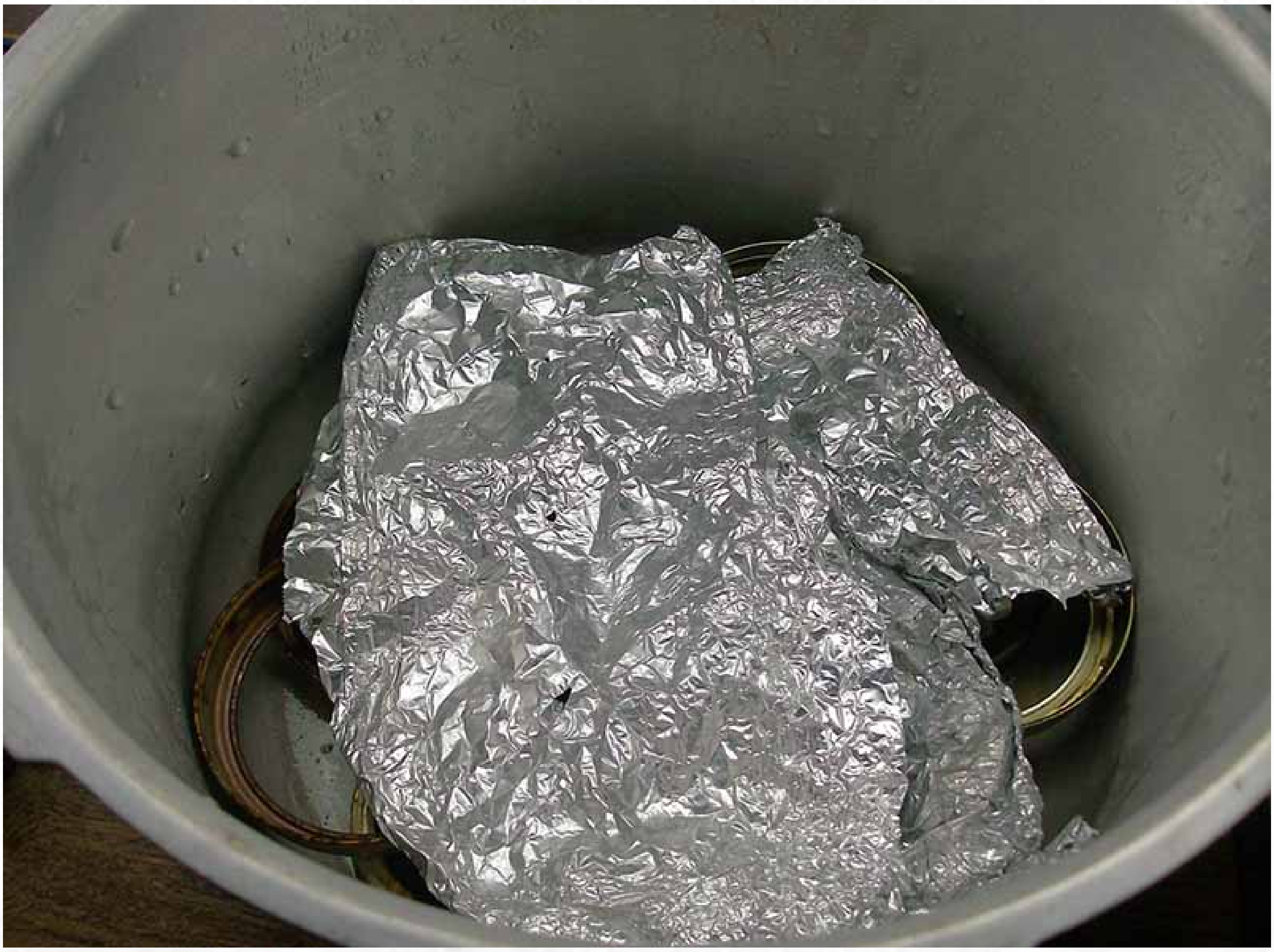




Sterilizing

Now you want to take you PC (or pot with a tight fitting lid) and fill the bottom of it with jar lid rings and tin foil this is to keep the bottom of your jars off the bottom of the PC/Pot so they don't burn. Some PC's come with trays to keep the jar already off the bottom use that if you can. Once that is done put the jars into the PC/pot and fill it with cold water just almost to the bottom of the jars. Now put on the lid of the PC/Pot and put the heat on High. Once the rocker on top of the PC starts to rock turn the heat right down to just keep it to a slight rock and start your 60 minute count down. If you're using a pot once it come to a boil turn it down to a slight simmer and start your 90 minute count down. After the 60(PC) or 90(Pot) minutes are up turn off the heat and walk away let them cool down over night or for 8 hours.

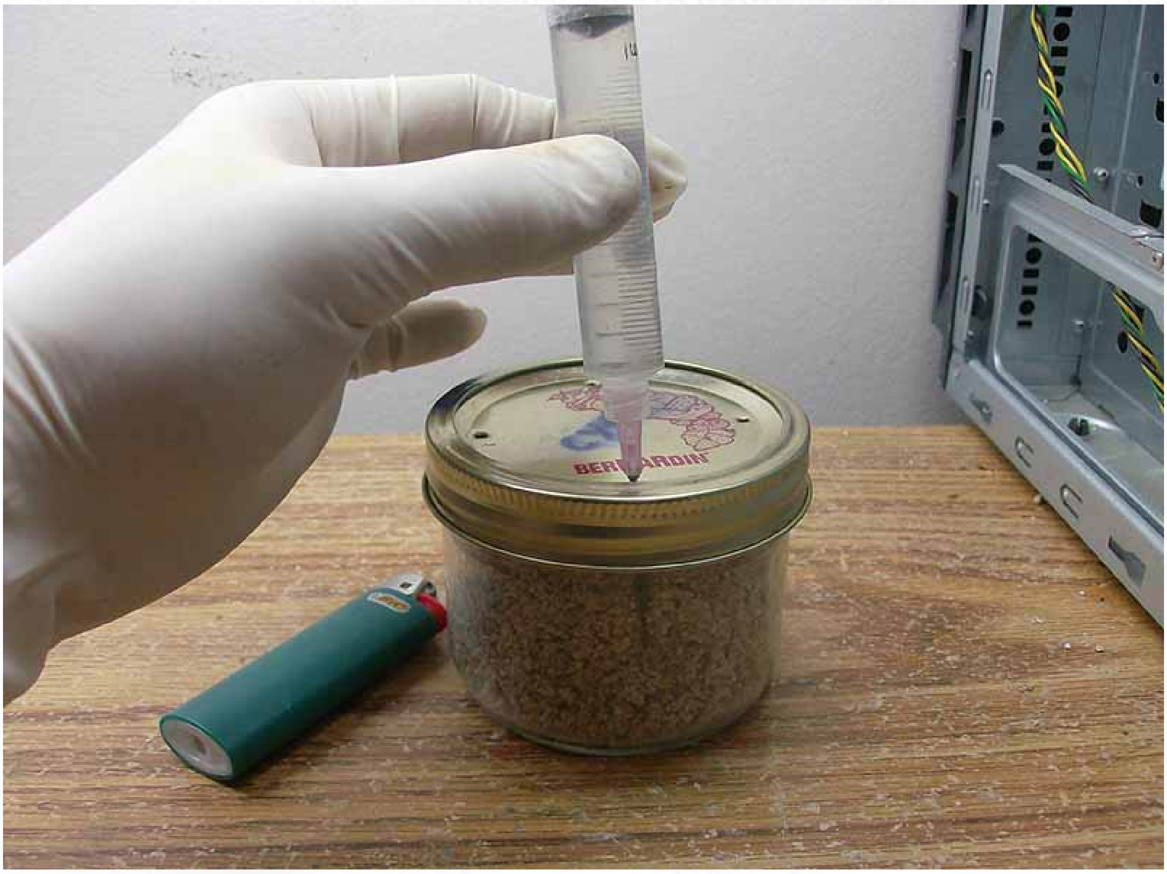




Inoculation done right

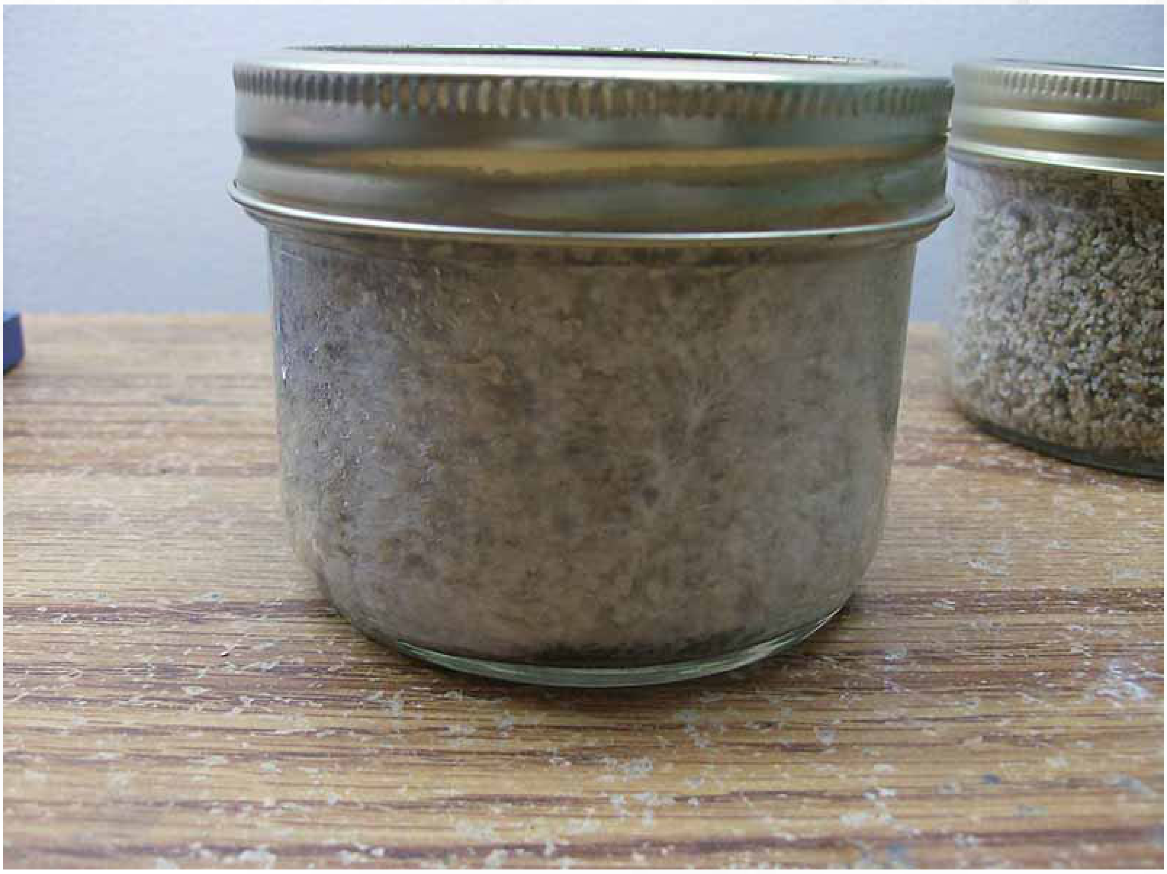
Once the jars are cooled down put them in a draft free room along with the 70% Iso, Lighter, spore syringe. Make sure the rooms windows are shut and AC or heater turned off. Wash your hands and arms really good. Now put of the gloves and mask. Take the foil lids off the jars you won't need them anymore. Now rub your hand down with the 70% ISO wait a few seconds for it to evaporate. Now shake the syringe really well, using the lighter heat the needle of the syringe till its red hot now proceed to inoculate the jars using a 1/4 cc of solution per hole inoculating towards the glass. That's 1 cc per jar. After every jar heat the needle back till its red hot and repeat.

BERNARDIN
CYA
TC



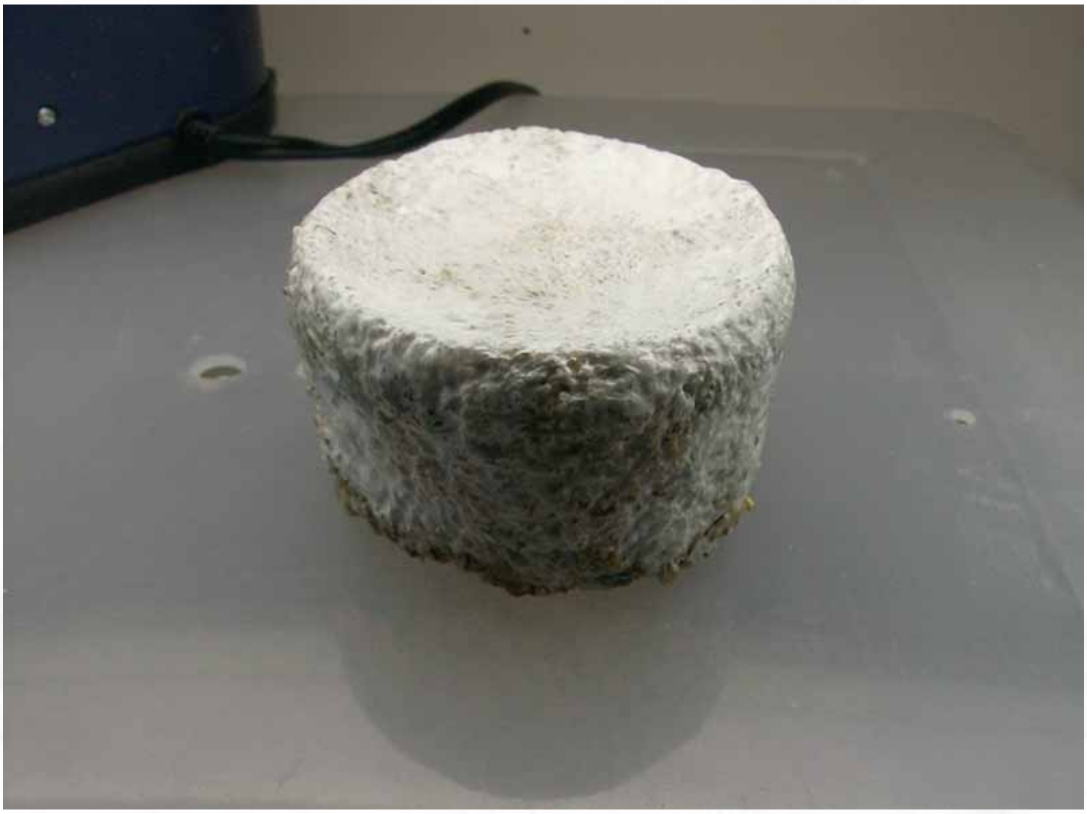
Incubation done right

Now put the jars away in a closet of shelf at room temp they will start to colonize in a few days. Keep an eye on them every 4 days or so. Once they appear to be 100% colonized let them sit for another week to consolidate.



Birthing and dunk

Once the cakes are finished their 1 week consolidation it's ready to get them out of the jars. Open the jars get rid of the dry vermiculite layer now slap the jars (upside down) onto a wood cutting board or counter top, trying to coax the cakes out of the jars. Once out rinse them off and submerge in cool water for 24 hours making sure they stay submerged. After 24 hours rinse them again and now roll the cake in dry vermiculite making sure to cover the cake well tops and bottoms.
I find busting up some of the verm for the dry roll up alittle finer helps.



Fruiting done right

Build one of these Shotgun terrarium.

I personally use a PMP.

Mist your cakes 3-4 times a day and fan right after, fan 5-6 times a day. Water evaporating off your cakes is a major pinning trigger. Give them a 12/12 light schedule using a 6500K Florescent bulb (daylight or cool blue). Once they have pinned and grown and all picked, dunk them for 24 hours again this time no dry roll in vermiculite and put back in the Shotgun Fruiting Chamber.

Good Luck

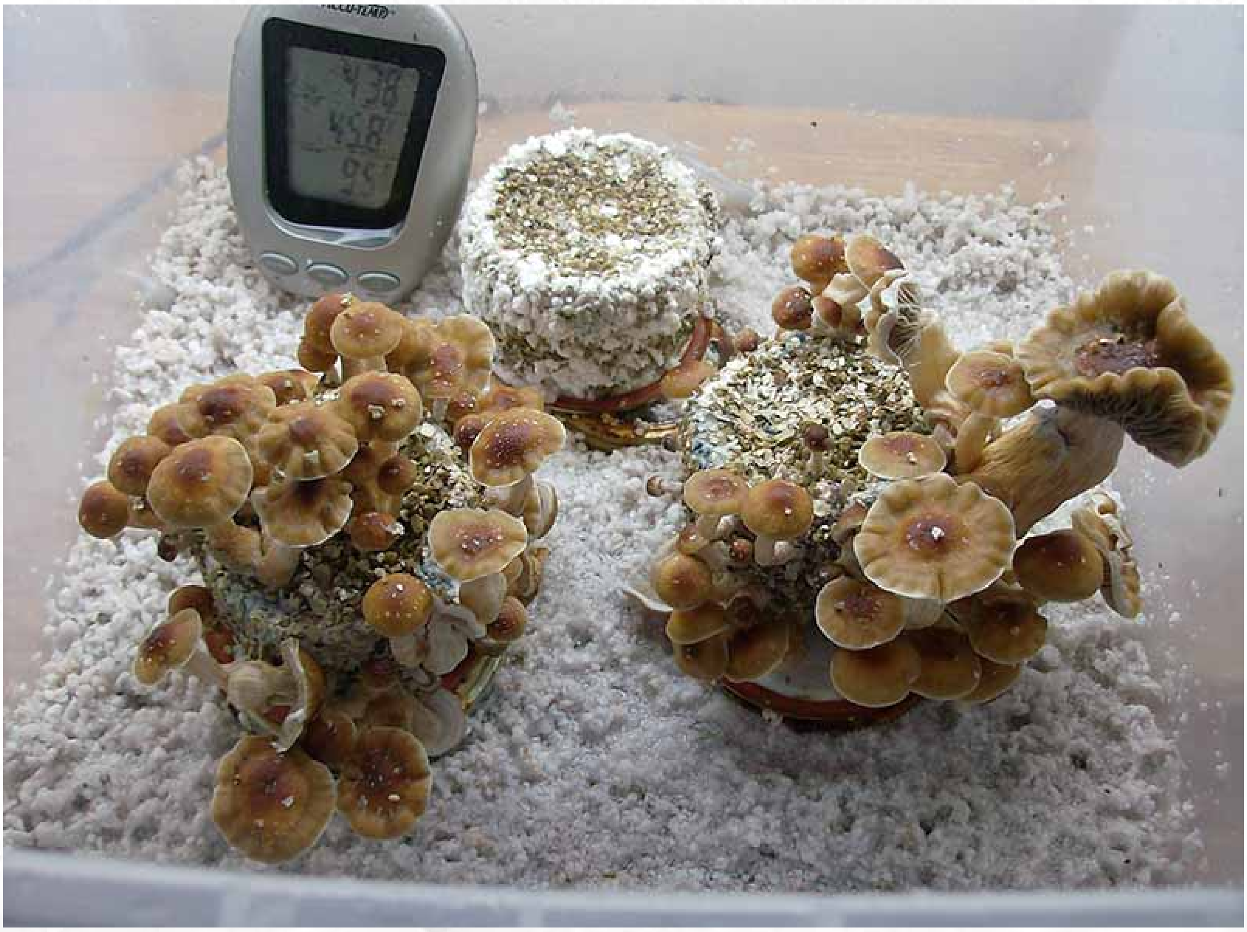
Tips

Gypsum really helps the development of the fruit bodies I recommend using it.
Room temp 70-75 is perfect for incubation and fruiting.
There's no need to keep the dunking cakes in the fridge.
Mist and Fan Mist and Fan.
Use short wide mouth 1/2 pint jars.
Dont cover the lids after inoculation with anything example, foil/tape.
Give them love.

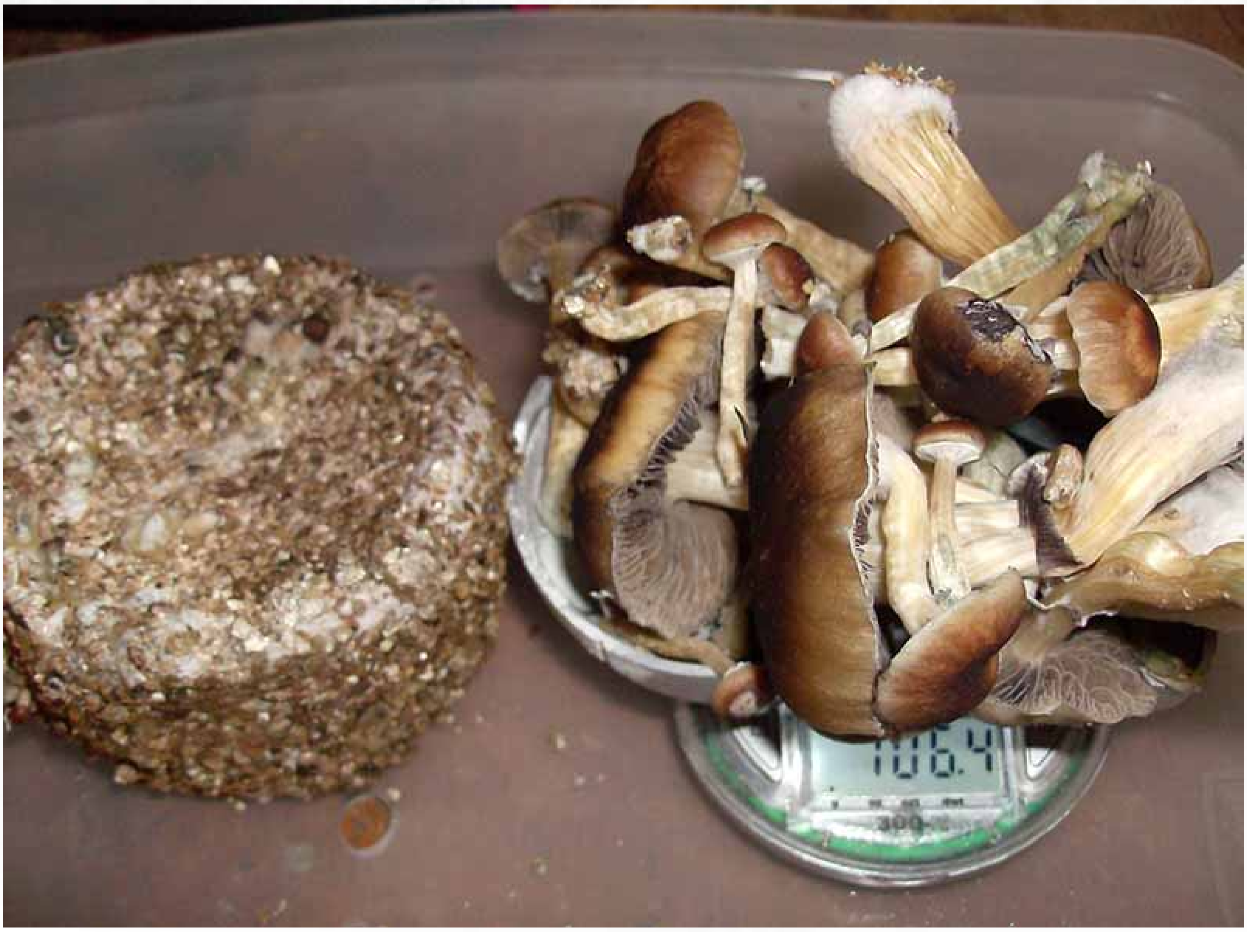
Results in this Golden Teacher.

Capacity 300g x 0.1g
72.6
300

This was 2 cakes first flush, came just under 19 grams dry. Oak Ridge.



Heres another set of cakes.



Results may vary.

Sterilizing a syringe

Here is a How to on sterilizing a syringe to make up a spore syringe.

How to sterilize a syringe with just a pot water and syringe.

Thing needed.

- A pot
- Empty Syringe
- Water (tap can work)

Fill the pot with cold water. Turn the burner on High and wait for the water to come to a full boil. Now start a 10 minute countdown and keep the water at a full boil.

After 10 minutes take the empty syringe and suck back the boiling water and let it sit in the syringe for 1 minute then expel the water in a sink (not back in the pot).

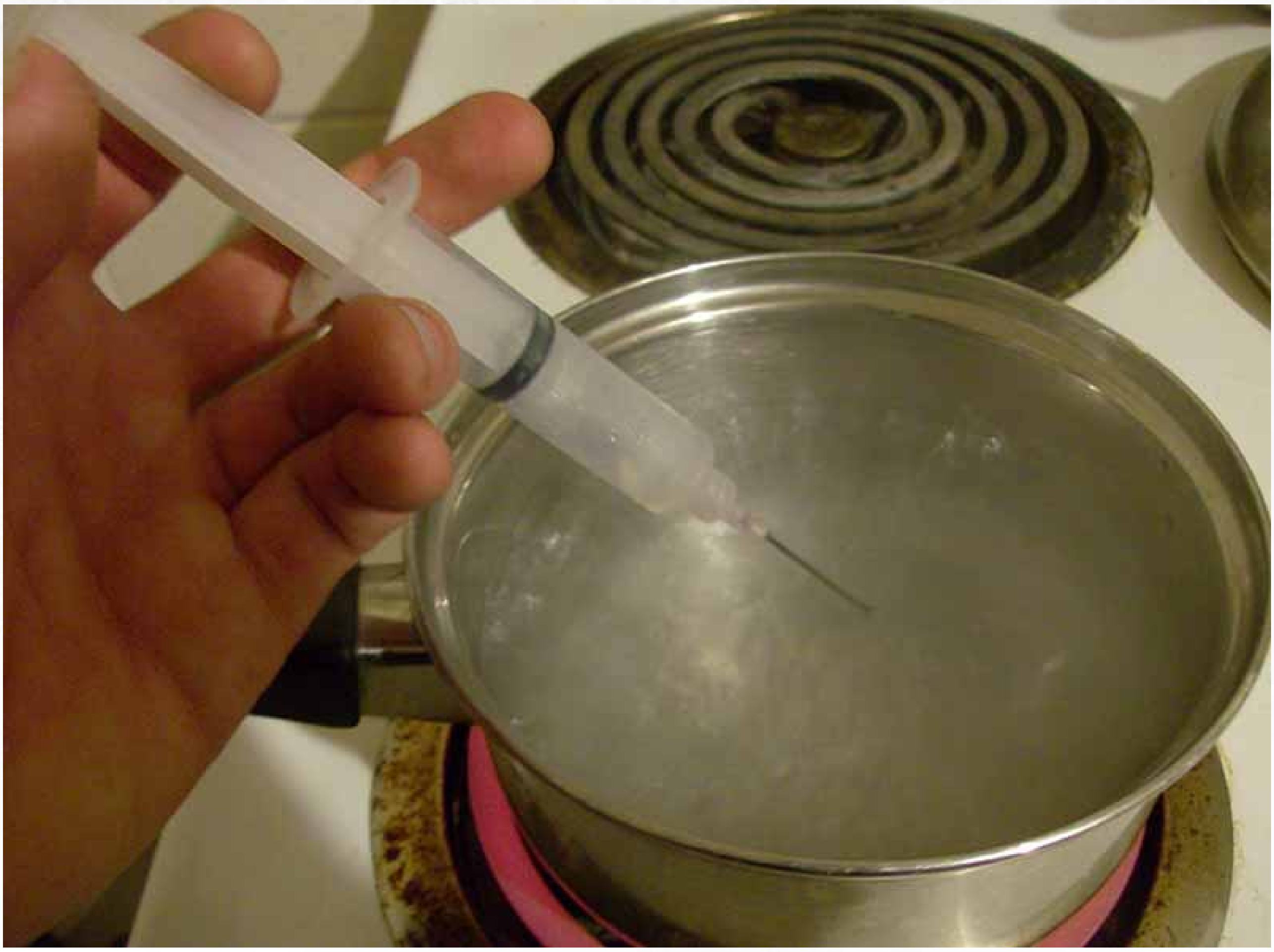
Repeat 4 more times on the last time keep the water in the syringe cap it and let it cool down.

Hope this helps.

METRIC-ml
OUNCES
CUP
2
1¾
1½
1¼
1
¾
½
¼
1⅔
1⅓
⅔
⅓
SINGLE USE ONLY
TERUMO

HI
6
5
4
3
2
LO
OFF
HI
6
5
4

Hotpoint



SINGLE USE ONLY
12
1
2
3
4
5
6
7
8
9

Notes:
Use a Q-tip and 70% alcohol to clean the inside of the cap.
I have found even after months and months they will stay sterile.
No need to store in the fridge.
Never try to cool them down fast in the fridge.

Table of Contents

PF-Tek F.A.Q (Shroomery)

Recipes through Inoculation

original source: http://www.shroomery.org/8515/Recipes-through-Inoculation

What is a PF cake?

A "PF cake" is named after its "creator", psylocybe fanaticus.
It is a mushroom growing substrate prepared of brown rice flour (BRF), vermiculite, and water, spooned loosely into a glass 1/2 pint jar, and inoculated with a spore syringe.
It is often referred to as the "PF style," "PF method," etc. Generally these terms refer to the substrate recipe and the style of inoculation (the creation of the colonized/colonizing substrate).
Please refer to the Basic Cultivation Guides for detailed overviews of the "PF" method, including substrate recipes, inoculation methods, colonization parameters, and the like.

What is the point of each step in the recipe?

PLEASE read the getting started Q&A before reading this overview, otherwise it won't make sense!

Using 1/2 pint mason jars.
1/2 pint jars are ideal for the PF-tek for various reasons. First and simply, they have been "tried and true" for quite a long while now. But, there are better answers than that, of course. Glass jars have been used for the (edible) mushroom cultivation for quite a while, for spawn production as well as fruiting. Glass jars are easily sterilized, as they can be safely autoclaved/pressure cooked/boiled without damage to the jar, and while maintaining internal water content of the jars. The 1/2 pint size is ideal as well, since jars can "finish" colonizing within 3-4 weeks. The reason why this is ideal is because you want the substrate to colonize as quickly as possible - so it can ward off any potential contaminants that may settle in the substrate through a vector you have not discovered, through inadequate sterilization of the substrate, etc.
Using 1 pint jars or larger with the PF-tek means the time to colonize is increased to a point where it is no longer worth it when weighing in the added colonization time as well as the additional risk of potential contamination (in its slower colonization times). It is more generally regarded as "the law of diminishing returns." There have been reports of successful PF-tek recipes used in 1 pint jars, but this is the exception and not the norm. Glass also serves a utilitarian purpose - you are able to see the progression of the mycelial growth (and any possible contaminants as well). Glass cups can also be used, but are not as "plug and play" as mason jars are. They also don't seal as well. But, mason jars can be hard to find in some areas, and their substitution can be necessary for the PF-tek.

Using 1/4 cup BRF, 1/2 cup vermiculite, and 60ml water.
To adequately colonize, mycelia needs food, water, air, and proper temperatures. The brown rice flour is the "food", and the vermiculite makes the entire mixture airy enough for air to reach throughout the substrate (and hence, all the mycelia forming in the middle of the cake that you can't see). So why not up the food, and make colonization quicker? Because, too much food can be a bad thing. The "food" which mycelia loves so much also attracts contaminates, and more food means more of a possibility of contamination. And if mycelia likes air, why not increase the amount of vermiculite in the mix, making it more airy? Once you mix a batch, you will see that the recipe as provided is about as "airy" as vermiculite will get in the mixture. Also, the addition of one element will mean less of another. Water content should also be kept as close to the ratio provided as well. Too much water and too little water both can slow the colonization of substrate to a halt. Plus, too much water will make the mix pasty and muddy - so that the mycelia will have a hard time colonizing through it.

Using a dry vermiculite "seal" on top of the substrate.
The vermiculite seal has 2 purposes.

- It stops airborne contaminants from settling on non colonized substrate.
- It also acts to provide some air exchange to the jar.

Air exchange can boost the rate at which mycelia grows, so it is important to have some measure of fresh air passively able to reach the substrate. Also, mycelia and mushrooms create CO_2, while using a small amount of O_2. Allowing for some gas exchange can help speed colonization. Many people whose PF jars have slowed "flip" their jars, so that the lid is on the bottom - which allows for more air to circulate to the non colonized bottom of the PF cake (the top part generally colonizes more quickly than the bottom).

Lift the jars up from the bottom of the pot.
The heat from the burners on the stovetop transfers directly to the bottom of the pot, which transfers the concentrated heat to whatever is sitting at the bottom of that pot (your jars). Lifting the jars by placing them on the cooking rack that comes with the pressure cooker, or placing a washcloth on the bottom of the pot, will create a more even disbursement of heat. This means the bottom of your jars won't be "cooked" by the heat emanating from the burner. Remember, you're sterilizing by steaming the jars, not by cooking them. A jar whose bottom has been cooked will oftentimes not colonize on the bottom, as the resulting overcooked cake becomes hard and impenetrable for mycelia. Overcooking can also occur if your water level runs too low, so be sure to maintain water in the pot for the entire sterilization time. AND DO NOT ADD COLD WATER TO THE BOILING JARS, otherwise they will crack and be unusable.

What is the difference between brown and white rice?

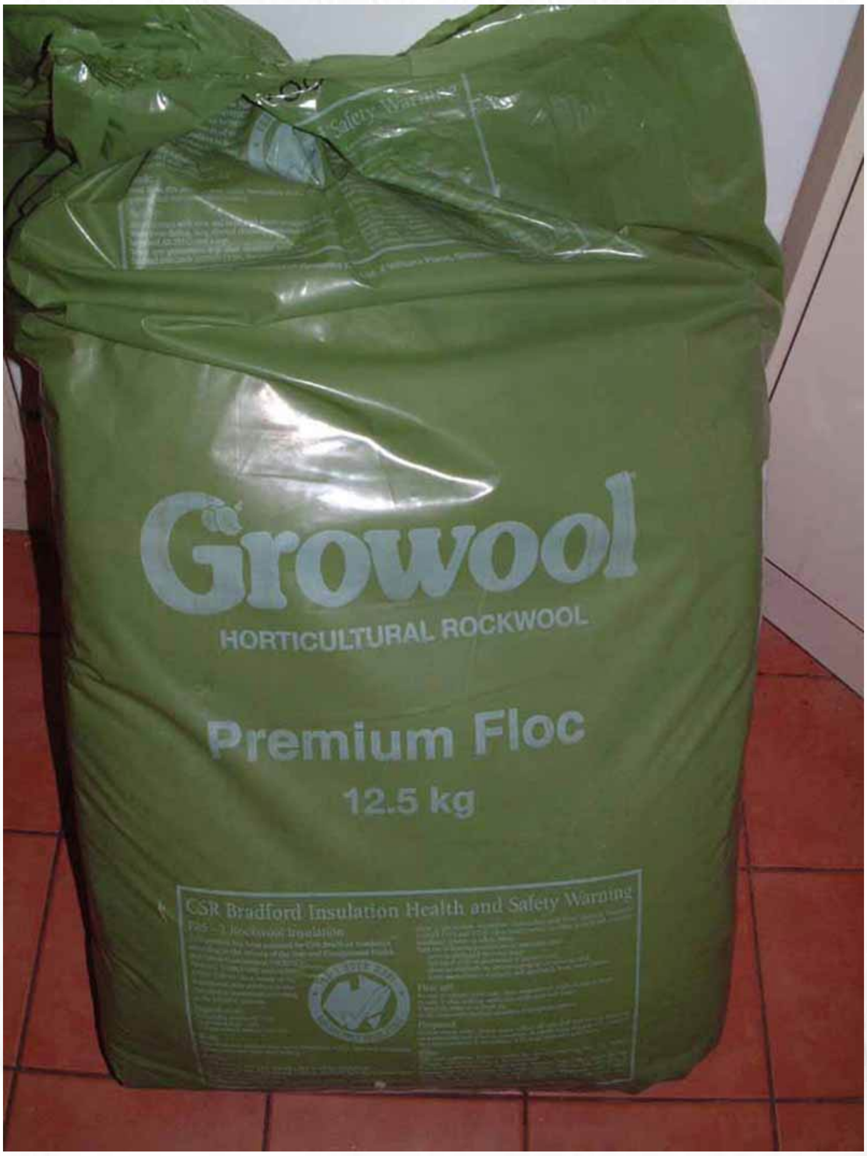
The difference between brown rice and white rice is not just color. A whole grain of rice has several layers. Only the outermost layer, the hull, is removed to produce what we call brown rice. This process is the least damaging to the nutritional value of the rice and avoids the unnecessary loss of nutrients that occurs with further processing. If brown rice is further milled to remove the bran and most of the germ layer, the result is a whiter rice, but also a rice that has lost many more nutrients. At this point, however, the rice is still unpolished, and it takes polishing to produce the white rice we are used to seeing. Polishing removes the aleurone layer of the grain - a layer filled with health-supportive, essential fats. Because these fats, once exposed to air by the refining process, are highly susceptible to oxidation, this layer is removed to extend the shelf life of the product. The resulting white rice is simply a refined starch that is largely bereft of its original nutrients.

Why do we boil the jars of substrate?

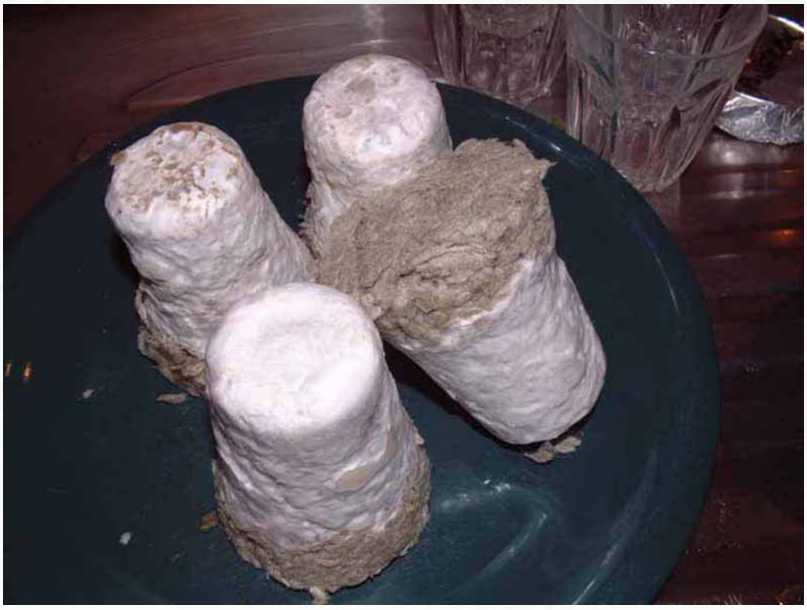
We boil the jars in order to sterilize them in order to destroy all forms of life in the jars. (molds and bacteria, spores and bacterial endosporse). This is done, so we can inoculate the now sterile substrate with the desired fungus.
These organisms which live in the soil, in water, etc. can invide and digest a food source like the one we are providing with the PF-tek recipe. This we call contamination.
Boiling water reaches a temperature of 212° F, which is adequate to kill molds and spores which may reside in the water, vermiculite and the brown rice flour.

Can I substitute any ingredients in the PF recipe?

Vermiculite:
Coco coir has been tested as a replacement for vermiculite in the PF-tek substrate, but it colonizes more slowly and is more apt to contaminate than vermiculite is. It needs to be sterilized longer. It performs poor in comparison with vermiculite.
Perlite holds far less water than vermiculite, you will to lower the water content. It has been used, but the results pale compared with vermiculite.
Grow wool (a hydroponic medium) has been shown to work:
By Starter:
"An alternative (in my fun so far) is growool. It's 100% inert and pH neutral.


Growool
HORTICULTURAL ROCKWOOL
Premium Floc
12.5 kg
CSR Bradford Insulation Health and Safety Warning

It's a glass fiber material. Same as insulation, but pH neutral and horticultural grade i.e. contains no fire retardants like monoammonium phosphate.
Holds 1/3 more water than vermiculite.



Colonises much the same as standard PF vermiculite cakes. Just pack it loose, as you do with regular PF vermiculite cakes -- a high air filled porosity profile is a must in any cake.

The top layer can be growool too. 100% vermiculite free cakes. Can be dunked after birthing like a regular cake. They weigh noticeably more."

Brown Rice Flour:
Dark rye flour has been reported to have favorable to excellent results when used to replace BRF (1:1 ratio) in the PF-tek, also other ground grains can be used like ground millet or ground millet based birdseed. Also corn flour. Wheat flour is not as good since it makes the substrate very greasy and clumpy, difficult to mix.

Water:
In addition to any water suitable for human consumption (including mineral water) clean water from natural sources (river, pond) can be used.

What are the different ways to sterilize a PF jar?

You can sterilize the jars by boiling (steaming) them in a pot with boling water or using a pressure cooker which guarantees a better sterilization.

What precautions should I be aware of when inoculating?

In the open air, you should take care to be as clean as possible, as the air itself contains contaminants which would love to colonize your lovely PF substrate and kick your mycelia's ass. So, spray an anti-bacterial spray in the air around you, work as quickly and efficiently as possible, and be sure the only thing that touches the needle is the substrate, which is sterile (if your procedures are correct). You do face the off chance of a contaminant landing on the needle, which is then introduced to the sterilized substrate. When using a sealed glovebox or flow hood, there is minimal to no chance of contamination through inoculation procedures. Basically, the more time and effort you put into keeping your procedure sterile, the less chance you will encounter of contamination.

****NOTE**** Open air inoculation is never recommended. Spend the time to make yourself a glovebox and follow sterile technique. You will have much better results.

Is is it ok to use the syringe right out of the fridge or should it warm up some?

It's ok to use it right out of the fridge.
The small amount of the inoculum warms up to the substrate temperature immediately upon inoculation.

Just remember to shake up the spores, and flame sterilize the needle red hot before inoculation.

How much spore suspension from my spore syringe should I use?

PF recommends using 1ml per jar, which, for 4 holes is $^1/_4$ ml per hole. The more spore suspension you have, the quicker colonization will occur. But, that's not to say that using an entire syringe will make your jars finish in a week. It just means that using more suspension will make the initial colonization of mycelia occur more quickly, which *may* mean it has a better hold against potential contaminates. But, using too much spore solution can be detrimental - as is upsets the water ratio balance within the jars. Too much water is not good, and can actually hinder growth by making the rice flour too "pasty" to be colonized effectively. Also, using more spore suspension means it is less cost effective in the long run - $^1/_4$ ml per hole means 10 jars, while 1 ml per hole means 2.5 jars. Economically speaking, and especially if you buy spore syringes and not make them, it becomes less and less cost-effective for using more solution (to eventually achieve the same result). $^1/_4$ ml per hole will result in colonization, given that all of the parameters are met. So, using anywhere from 1ml - 4ml per jar ($^1/_4$ ml - 1ml per hole) should be safe.
Remember, some times less is more.

How long should the jars cool before inoculating?

Jars need to cool before inoculation because spores are killed by excessive heat (such as the temperature inside a PF-tek style jar after being boiled for 45 minutes to an hour). So, you need to let the jars cool on their own, preferably for at least 6 hours, and hopefully overnight. It is recommended to cool jars directly in the pot in which you boiled them, since this will reduce the chance of airborne contaminants landing on the lids of your jars (contaminants can't land on jars that are kept cooling in a covered pot). A jar cool to the touch may still be too hot inside for spore life, so do not judge the internal temperature of the jars by touching the glass. And do not open the jars for obvious reasons. FINALLY, DO NOT COOL JARS UNDER COLD WATER OR IN THE REFRIGERATOR. Cold water/air + hot glass = cracked glass and unusable substrate. Trust us on this one, the glass WILL break if made too cool too quickly. A mantra in this hobby - "patience, young jedi."

What methods are there to inoculate PF jars?

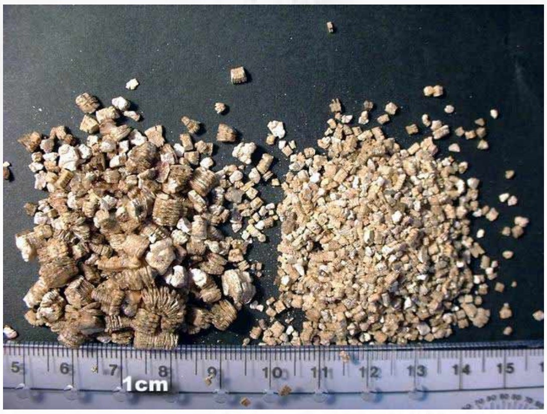
PF jar ingredients, once sterilized properly, are completely sterilized inside the sealed jar. So you do not want to introduce any possible contaminants to the jar from the outside -in.
The PF-tek provides for inoculation using a spore syringe guided through the pre-stamped holes in the lid and directly into the substrate. Since you would not want to open a PF-tek jar (and risk airborne contaminates), this is the most foolproof way to inoculate PF jars. Now, if you had a sterile environment, such as a glove box or flow hood, you could simply open the sealed jar and inoculate with a spore syringe directly onto the substrate. But, there would be no point in this - as inoculation of the substrate is achieved by using a spore syringe.
You should not attempt to scrape a print directly onto PF-tek substrates. First, the spores may not rehydrate themselves adequately using the moisture content in the substrate, and hinder colonization. Second, opening the lid of the jar defeats the purpose of the PF-tek - to create a completely sterile environment within the glass jar. Opening a jar in a glove box or a flow hood would also render pointless, as you should have a vermiculite seal to ward off contaminates - spreading spores on the dry vermiculite layer will produce nothing (vermiculite is non nutritive and should have very little water in it - eliminating the requirements for colonization).

Can I use coarse grade vermiculite for substrate?

Yes, you can. Both types, the finer type, individual particles measuring around 1-2 mm, and the coarser type, with particles measuring around 5-8 mm are suitable for substrate.
The coarser type will hold a little less water, so make sure to adjust the amount of water used.

Does fine vermiculite hold more water than coarse?

It has been a consent among the users of the PF-Tek, that the fine vermiculite can hold more water than the coarse variety. I wanted to quantify this, and made a test:
120 ml of vermiculite were measured, weighed and then water was added to it until the vermiculite was saturated. (according to the PF-Tek for Simple Minds).
The 2 varieties used are the ones in this photo:



Test results:

Fine variety:
120 ml vermiculite, weighs ***14*** g, can hold **54 ml** water.
Coarse variety:
120 ml vermiculite, weighs ***14*** g, can hold **46 ml** water.

As you can see, the water holding ability varies **considerably** between the 2 varieties. If you don't take this into account when preparing substrate, it will be either too wet or too dry.

Should I sterilize the needle, and how?

When you buy a syringe from a vendor, most vendors attempt to keep the needle as sterile as possible when they create the syringe. When you create the syringe yourself, you also should try to avoid contamination of the needle (which can occur as easily as handling the needle with unclean hands, etc.) Syringes can and do leak as well during shipment through the mails, leading to spore water dripping on the needle and in the needle sheath. That being said, it is probably a good idea to sterilize your needle before inoculation.
Flame sterilizing is just that - applying an open flame to a needle until red hot. This method will kill any spores that may be inside the needle (the 1.5" space between syringe and tip of the needle), so take that into account when inoculating your jars. Flame sterilization also may lead to a char build-up on the needle (a blackening of the metal's surface), which is attributable to using a butane lighter (bic lighters, etc.) The char can be avoided by using a "torch" style lighter. Remember, when using flames, use common sense. The needle will be hot after, don't touch it and let it cool before inoculating.

You should sterilize the needle between each jar. This is advised as it helps stop cross contamination.
After flame sterilising, you can let one or two drops out of the syringe to cool the needle down before inoculation.

What recipe should/can I use for PF cakes?

The basic PF recipe is 1/4 cup brown rice flour (measure the flour itself, not the brown rice if you grind it yourself), 1/2 cup vermiculite (fine is prefered), and 60ml (4 tablespoons) of water per jar.
For 5 jars, you use the 2:1:1 recipe. Thats 2 cups of verm, 1 cup water, and 1 cup of brown rice flour. 1 cup is 240ml.

Depending on the vermiculite used, the amount of water needed can vary. To prevent a overly dry or wet mixture you can prepare the substrate this way:
Put the required amount of vermiculite in a bowl (all at once, NOT for each jar separately!). Use a spatula or spoon to mix in enough water to saturate the vermiculite to the field capacity, mix well.

The field capacity is reached when a small puddle, barely visible, forms at the bottom of the bowl when you tilt it. Then add the appropriate amount of BRF and mix together. (This works best if you use 1/2 cup vermiculite and 1/6 cup BRF per 1/2 pint jar).
The idea is to coat the wet vermiculite particles with the dry powder as you stir the mix with the spatula.

Can I mix different cubensis strains in a PF cake?

Yes, you could.
But there is not really a reason to. Most likely one strain will prevail, if you inoculate the jars each on 1 side you might get 2 strains fruiting from 1 cake.
But in general it's better to inoculate each jar with its own strain.
Besides, when it comes to harvest time and you want to make your own spore prints, you wont know what they are. And no they wont be a new strain you created. Its a whole lot more complicated than just that.

Can I use a non-organic brown rice flour or white rice flour for the substrate?

The amounts of pesticides in anything sold for human or animal consumption are so minute that they don't affect fungal growth, especially not the one of higher fungi. The pesticides used in grain cultivation are mostly highly specialized herbicides and fungicides (for molds).
White rice flour *can* be substituted for brown rice flour, but healthier and faster growth has been observed with brown rice flour.
See also What is the difference between brown and white rice?

How many jars will a spore syringe inoculate?

A spore syringe containing 10cc of spore-water suspension can be used to inoculate around 10 jars.

Common mistakes

This document will briefly touch upon the common mistakes made by newbies when using the pf tek.

Note: One of the biggest reasons people fail is because they skip steps or change this or that in the tek. Some parts of the process are concrete and others you can experiment with. It is best to first come to grips with the process before innovation :)

Did I make a poor choice of jar?
A wide-mouth half-pint (~234ml) is recommended for vermiculite and brown rice flour cakes (PF TEK). Larger jars will take longer obviously and with Vermiculite BRF this could lead to contamination.

Is my mixture too wet?
You must gradually add water until saturated, then add the flour. If you saturate the mix too much, either add more substrate to account for this or alternatively microwave for a minute or two uncovered.

My mixture is not airy/looks like sludge?
Use large chunk vermiculite, and don't shake or compress the substrate by squashing it down. You will learn throughout the process that fresh air is important to healthy mycelium growth, the more you pack the substrate the less air is available to it.

Water gets in during sterilization?
Make sure to cover your jars with foil! Don't fill your pressure cooker up too high; most pressure cookers only require about an inch of water for more than an hour of cook time.

Incomplete Sterilization?
Give it an extra bit of time to be sure. A stitch in time saves nine. If you are forced to sterilize at a lower setting, always add more time. Remember, if using a pressure cooker, read the directions! If they are not available, a general rule is to let the cooker come to pressure, then start your timer;)

Inoculating Too Soon?
Let the jars get to room temperature after boiling/pressure cooking. Mycelium has a thermal death around 106°F (41.1°C). Your hands are not great temperature gauges, so do not inject until you are absolutely sure they have cooled.

No pins even 10 days after birth?
Check your three triggers (light, temp, air exchange) and inspect for contaminations and pests. And make sure you have a pinning strategy! Try to control every factor and you will succeed.

The 86-degree myth
Too often I see people posting that they keep their jars at 86F and are having problems. This is because 86F is too warm for jars.

The explaination - the original experiment was done on agar plates. Growth was measured at different temperatures, and it was found that the mycelium grew fastest at 86F.
The problem is, that was in an agar plate and not a jar. On the flat plane of mycelium in the agar plate, temperatures remain constant. In a jar environment, the interior of the jar becomes warmer than the exterior due to heat generated by the growing mycelia. So if you keep a jar at 86F, the interior of the jar could get to 90F and above, more if the jars are stacked tightly.
Keeping the jars between 70 and 75F avoids this overheating, and produces the best results in jars.

How long will my colonized jars live?

Ideally you should schedule your grow so you are able to birth your cakes a week after 100% colonisation.
If you wait too long the cakes will begin to dry out and sometimes fruit in the jars, diminishing future yields.
In a pinch you can wait up to a week or two extra, but any longer may lead to stunted flushes. If you're going to invest the time and money in growing mushrooms, it is recommended that you plan to be available so you can attend to your setup.

Incubation through Birthing

original source: http://www.shroomery.org/8516/Incubation-through-Birthing

How long does it take to see signs of mycelium growth?

First mantra of the hobby - "Patience."
Germination can occur as early as 2-3 days, but it may take up to a week or more for the first signs of germination to show.

Please note that some have had to wait up to 3 weeks to see growth in some jars.
It depends on a multitude of factors - some of which are: temperature, substrate, spore concentration, age of the spores, etc. There are so many different relevant factors it is very hard to determine within the 1st 2 weeks why you have not shown germination. Give it at least a week before you worry, and at least 2 weeks before you panic. All you need are 2 spores to germinate and take over the entire jar - and luck is on your side when proper procedures are followed.
Please be patient and do not panic after only 2 days, no matter how fast you've read other people's colonization was. Their setup, factors, everything varies just slightly from yours. Now, after a period of time with no germination, analyze all of the possibilities (such as temperature, water content, sterilization procedures, etc.) that would hinder growth. This is your best bet on learning the life cycle, and also learning the peculiarities of your personal setup (as far as variations go).

How important is gas exchange during the colonization?

Shroomery thread: How important is gas exchange during the colonization?

There's rust on the lids of my PF jars, is that okay?

Don't worry, a little rust won't do any harm.

How come my jars started growing mycelia, but for some reason have stopped?

Mycelia can stop or slow to a halt for various reasons. Some can include: drying of the substrate, an overly wet substrate, internal temperatures in and out of the recommended ranges, substrate that may have been "cooked" by direct heat during the sterilization process, etc. Generally, the bottoms of jars colonize much more slowly than the tops. So if you have slowed growth around the bottom/bottom sides of the jar, an easy method to help kick-start the mycelia is to "flip" jars. Simply place them on their lids, resting on the dry vermiculite layer. This should act as a vacuum, forcing CO_2 out and fresh O_2 in the jar (as CO_2 can build up in jars). The cake will slide down, forcing air out and, by the laws of physics, drawing it back in as well. (Can't have a negative space of air, the jar itself is not sealed). Other factors that are not so easily "cured" are the ones listed prior. Generally, you cannot add materials to colonizing substrate without risking contamination by opening the jar/breaching the vermiculite layer. Avoid these possibilities by mixing your substrate as evenly as possible (to avoid over-/under- water content), keeping the jars incubating in a not too dry environment, keeping the jars stored in a warm area (not hot, not cold), and also making sure water does NOT splash on your jars if you elect to boil to sterilize. Water splashing into the jars can make them too wet for the mycelia to colonize.

How long does full colonization take?

Full colonization of a PF jar can take anywhere from 2 to 5 weeks, depending on your own factors. It can vary widely, so don't use these as scripture when evaluating your own setup. A good rule of thumb to determine full colonization is the time it takes for all the sides of the jar to become covered with mycelium, and wait 1 week after the outside is fully colonized. This will allow for the inside (which has less access to CO_2 release/fresh air) than the outside layer does, and takes longer.

What if I need to birth before the jar is fully colonized?

There are many reasons why you shouldn't birth a jar before it is fully colonized. Non colonized substrate outside of the sterile mason jar environment is very susceptible to contamination from outside, and should be avoided at all costs. Don't birth cakes that aren't fully colonized because the other jars you have are already done. (Remember: "patience".) If you do deem it necessary to pre-birth (there really isn't a very good reason; there are reasons, but more often than not the one you may have is not a good one) it is possible. Birth the cake, and remove the non colonized substrate from the colonized part of the cake with a sterile instrument, like a spoon. Be sure and remove all of the non colonized part, otherwise the colonized part becomes more susceptible to contamination when the non colonized part becomes contaminated.

Is condensation inside the incubating jars harmful?

To some extent water vapor condensing to small drops inside the jar is normal. As long as the condensation isn't so strong that the water begins to accumulate at the bottom of the jar, there's nothing to worry.
If you experience excessive condensation, the incubation temperature might be to high, also try to use a tad less water with the recipe.

What are those little brown/red dots pushing into the glass of the jar from the cake?

Those are pins, and are good things. They look like "red headed worms". PF has some nice, illustrative pictures of what primordia (pre-mushrooms) look like.

What if I can't get the cake out of the jar in one piece?

If you are growing from cakes, it is best to remove the entire cake in one piece. This is why "tapered" mason jars (the types detailed on PF's page) are better than straight or shouldered jars. If you are crumbling your cakes to inoculate a bulk substrate, you can simply use a spoon to remove pieces of the substrate - this will serve as your crumbled spawn.

What if I can't get all the vermiculite seal off of the cake?

The vermiculite seal doesn't need to be totally removed. It can be attached to the cake when growing from cakes.
What ever comes off while birthing, rinsing before the dunk, during the dunk, and the rinse after the dunk should be just fine.

What is "birthing," and how do I do it?

The term "birthing" refers to the removal of the fully colonized PF cake from its glass jar. This can be achieved very simply. If you are going to keep the cake intact (growing as a cake) be sure to be careful and not break the cake (its hard to break if it's fully colonized, so don't be too gentle). You'll need a fork (or something to scrape the dry vermiculite layer off with), a wastebasket, and perhaps a large ziploc bag. Unscrew the jar lid, and turn the jar upside down (on its lid) while supporting it with your hand. The cake should slip down and fall onto the lid being held by your hand. Slide the glass jar off of the cake. Remove the excess vermiculite into the wastebasket, and handle the cake as little and as gently as possible. Overhandling can cause a bruising and bluing of the mycelium. Alternately, you could birth the cake into a ziploc to reduce waste - unscrew lid, place upside down lid and jar in bag. Simply open the jar up in the ziploc, where all of the vermiculite and excess will fall into the bag - instead of having to hold it over a wastebasket.

Which way should cakes be birthed, vermiculite side up or down?

They are birthed the vermiculite side down.
This way they can be birthed without handling them and risking contamination through dirty hands.

See also CHAPTER 3 - THE BIRTHDAY CAKE.

Birthing through Harvest

original source: http://www.shroomery.org/8517/Birthing-through-Harvest

What is an easy way of humidifying my fruiting chamber?

Probably the easiest way is using a layer of moist perlite at the bottom of the fruiting chamber along with manual fanning several times a day.

Read more about using perlite in conjunction with a Shot Gun Fruiting Chamber here.

What conditions are optimal for pin formation?

The relative humidity should be from 95%-100%, temperature between 70°F and 75°F, the fruiting chamber should be vented 2-3 times a day at least to displace the CO_2. They should receive 12 of hours of either indirect sunlight or fluorescent light.

What are the optimum conditions for a cake to fruit in?

Cakes like and need a high humidity environment, however it is provided. You need about 95% RH (relative humidity) for cakes to produce optimally. They need more humidity because they do not produce as much RH themselves (as casings and bulk runs do), and because you cannot easily supplement their moisture content (without having some inner reservoir or wet vermiculite on top and bottom). The humidity must be provided either by means of a passive humidification like moist perlite or clay in a sealed terrarium or an active humidification like a setup where fresh moist air is provided by a cool mist or ultrasonic humidifier.

The appropriate fruiting temperatures for *Psilocybe cubensis* (TMC) are 74 -78 °F but temperatures as cold as 68 should work out.

Can a PF cake become contaminated after birthing?

Yes, it can. The most frequent contaminant to encounter at this stage is green mold and it seems to happen more often if the cake wasn't colonized throughout, the cake was already contaminated during the incubation phase or if the cakes are handled at birthing with dirty hands or tools.

Usually though the cakes only contaminate after a few flushes when they are exhausted.

Make sure to separate a contaminated cake from the others as soon as possible and to discard it outside of the room you use for growing to prevent the mold spores from spreading.

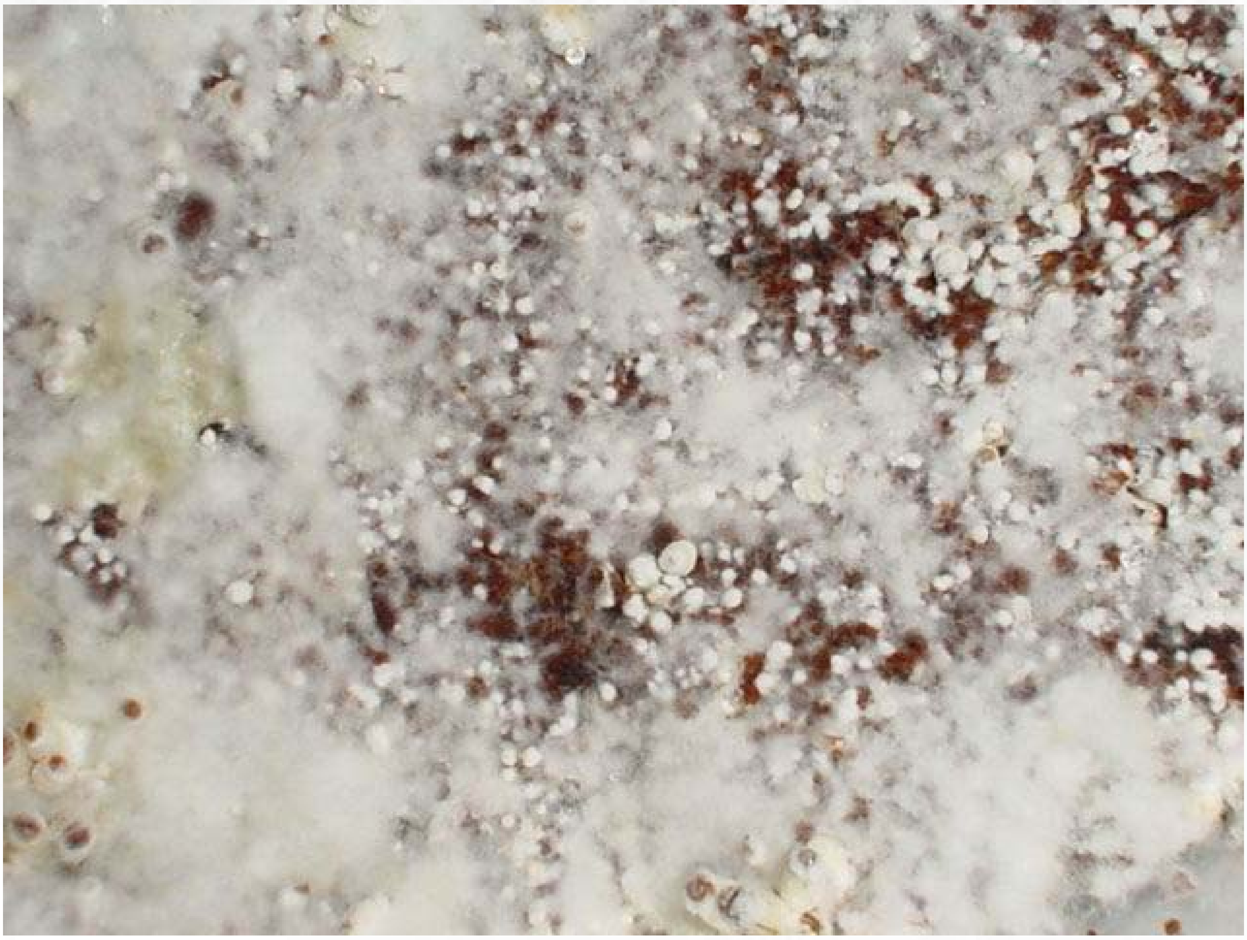
Why do my cakes get fluffy mycelium growth and delayed pinning after birthing?

Lack of fresh air exchange. Fan more.

What do primordia/pins look like? I don't know...

The growing of the mushroom from the cake starts as a tiny accumulation of mycelium, called hyphal knot, which then develops to primordium, and this further develps to pinheads.

In the picture of a casing surface underneath, the primordia are the small white bumps scattered across the casing surface, and the pinheads can be seen bottom left and bottom middle. They already have small brown caps.



How long does it take for a pin to grow into a fully grown fruitbody?

It takes anything from 2-5 days for a *Psilocybe cubensis* pin to mature. This depends on the strain, substrate, humidity and temperature.

Why is there mycelium growing on the stems?

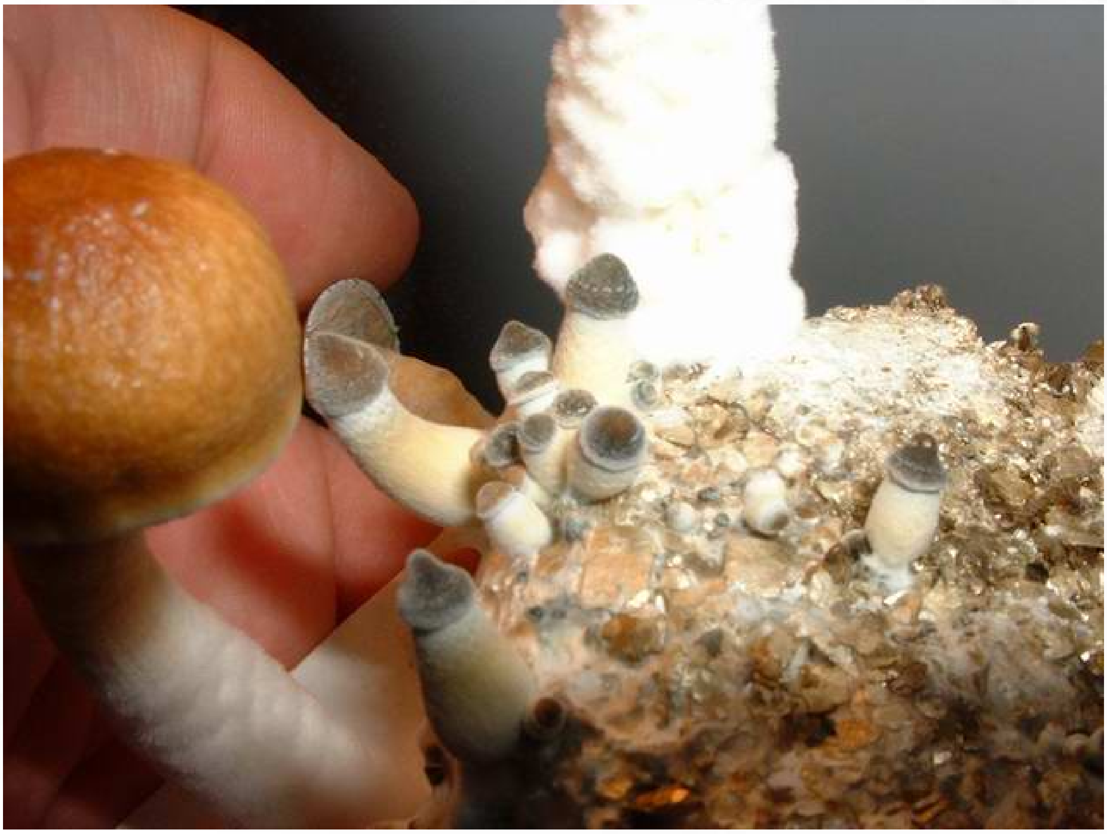
Lack of fresh air exchange. Fan more. Generally it doesn't do any harm. You can try to lower the humidity a bit by providing more fresh air, but in general the condition isn't something you should be too concerned about.

When should I harvest?

Harvest can occur when the veil breaks, up until full maturity when the cap becomes almost convex and already drops its spores.
You should wait this long if you want to take spore prints.
There are conflicting reports as to when to harvest the mushrooms for highest potency.
Some reports suggest that the mushroom reach their peak potency right before the veil breaks. Others report the potency of full grown mushrooms to be the best.
There is no real evidence though for either of these claims.

How do I recognize an abort?

Aborts are fruitbodies that for some reason cease to grow and never reach maturity.
They can be recognized by their blackish heads and the fact that they stopped growing at some point. Still they are good to use unless they are rotten.
When the cap is roten, it is very soft, sometimes smelly and detaches very easily from the stem. If the aborts are in such condition, discard them.
Allways pick all aborts after a flush is over.
The aborts in the picture are still good to use.



What is the "dunk tek"?

The cake is dunked [or dunked2] in water overnight to rehydrate and enable bigger and more flushes.

How much does 1 PF cake yield?

This question cannot be answered accurately because it depends on a number of factors including - but not limited to - the recipe used, the mushroom strain, enviromental conditions and luck. If you absolutely must have an answer, a PF tek fruited directly can yield anywhere from 3-7 gram dry per half pint cake. Yield can be increased by using the PF cake as spawn or by crumbling it up and casing it.

Why do cakes and bulk substrates require different humidities?

Cakes have no casing to keep them from drying out! That is the only reason they need a higher humidity then bulk substrates during the MATURATION stage of mushroom developement.
Both need a high humidity to form PINS. But pins require a good evaporation rate to mature. This is why the humidity is lowered after buttons have formed with casings. Ideally, cakes should have there humidity lowered below 100% also during the Maturation stage, but NOT at the expense of cake moisture content. You can't have them dry up.
The humidity reccomendations are ranges! 95 for pinning, and anything below that for fruiting. Fruits will develope alot faster at 85% humidity then at 90% humidity, but only if casing moisture content can be maintained.
It is the difference between mushroom moisture content and air moisture content that enables mushroom expansion. It is a concentration gradient, from high to low. As the surface area of the mushroom increases with maturation, this process speeds up.
If you are growing with cakes, cover them with wet vermiculite, and allow the humidity to drop a little during the maturation stage. Don't keep it at 100% at least get it down a little, your mushrooms will get larger, and they will grow faster.

What is "Dunk and Roll"?

This is in no way meant to take the place of casing but it can help cakes put out a little more for those who don't want to case or are just starting out.
Take a fully colonized cake and do a dunk [or dunk2] before birthing. When done dunking simply roll the cake in dry vermiculite, or coco coir. Use a mister and mist the dry vermiculite or coir till it's moist.
This allows the cake to fruit from all sides a little easier.

Growing Mushrooms the Easy Way

Home Mushroom Cultivation with Hydrogen Peroxide

by

R. Rush Wayne, Ph.D.

Volume I i II

© Copyright 2001 R. Rush Wayne. Ph.D.

original source: http://jontrot.free.fr/champignons/culture-eau-oxygenee-Vols1-2new.pdf
backup source: http://www.psilosophy.info/resources/culture-eau-oxygenee-Vols1-2new.pdf

First published as Growing Mushrooms with Hydrogen Peroxide, December 1996
and as
Growing Mushrooms the Easy Way,
Home Mushroom Cultivation with Hydrogen Peroxide
January 1998
Third Edition revised November 1999
Renamed Volume I, August 2000
Revised September 2001

Visit the Updates Page of the Growing Mushrooms the Easy Way Web site
(http://mycomasters.com/Updates.html)
for periodic corrections and updates to this manual, notes on sources of supplies,
and news about the peroxide method.

Please order paper version of this manual to give the author credit for his efforts of facilitating your home growing. Order

---

Table of Contents:

VOLUME I
Preliminaries
The Mushrooms
Hypsizygus ulmarius (Elm oyster)
Pleurotus eryngii (King oyster)
Hericium erinaceus (Lion's Mane)
Agaricus subrufescens (Almond mushroom)
Lentinula edodes (Shiitake)
Pleurotus ostreatus (Oyster mushrooms)
Ganoderma lucidum (Reishi mushroom)
Coprinus comatus (Shaggy Mane)
Hypsizygus tessulatus (Shimeji)
Stropharia rugosa-annulata (King stropharia)
Agaricus bisporus (button mushroom, Portobello)
Psilocybe mushrooms
Equipment You Will Need
Specialized Supplies You May Need
The Basics on Peroxide
What peroxide does
Biological effect of peroxide
Advantages of using peroxide in mushroom culture
Contaminant resistance to peroxide
What peroxide does not do
The need for caution when exposing mycelium
Peroxide is not a sterilant at mushroom-growing concentrations
Safety and environmental considerations for hydrogen peroxide
Peroxide and the spirit of organic growing
Lack of effect of peroxide on substrate or mushroom cultures
Stability
In pure solution
At higher temperatures
In the presence of peroxide-decomposing enzymes
Guarding the purity of peroxide stock solution
Variations in peroxide concentration from commercial sources
Growing and Maintaining Agar Cultures
Preparing agar plates
MYA Medium
Use the lowest effective concentration of peroxide in agar
No pressure agar medium
Hazards of agar drips and importance of clean plates
Reusing peroxide agar medium
Acquiring mushroom cultures
Importance of starting with good strains
Cloning Mushrooms
Cloning mushrooms
Strain storage
Distilled water method
Keep storage cultures peroxide-free
Inoculating and handling agar cultures
Cooling hot scalpels
Inoculating from storage cultures or peroxide-free medium
Preventing occult contamination with bottom inoculation
Incubating inoculated plates and storing uninoculated plates
Making Mushroom Spawn
Economic advantage of making your own spawn

Advantages of sawdust-based spawn
Ten Minute Spawn
Nitrogen supplements compatible with Ten Minute Spawn
Importance of clean containers in making Ten Minute Spawn
Pressure-sterilized sawdust spawn
Grain Spawn
Difficulties of grain spawn and pitfalls in spawn making
Spawn containers
Inoculating spawn
Agar chunk method
Use peroxide-adapted mycelium for spawn inoculation
Incubating and shaking the spawn
Liquid culture
Colonization of bulk substrate
Importance of choosing substrates lacking peroxide-decomposing enzymes
Pasteurizable substrates compatible with peroxide
Recipes for fruiting substrates
Wood chips and substrate density
Preparing supplemented sawdust with peroxide
Nitrogen supplements for bulk substrate
Calculating how much supplement to add
A note on measuring pH of substrate
Culture containers
Trash bags as culture containers
Excluding fungus gnats
Plastic buckets as an alternative to bags
Inoculating supplemented sawdust
Breaking up spawn for inoculation into fruiting substrates
Adding the spawn to the substrate
Mushroom formation
General procedures for fruiting oyster-like mushrooms and Hericium
Protecting yourself from spores
Mushrooms needing a casing layer
Seasonal planning
Outdoor growing vs. indoor growing
Harvesting
Trouble shooting
Conclusion

VOLUME II
Introduction
Acquiring, Storing and Maintaining Mushroom Cultures
Using slants instead of agar plates
The drawbacks of Petri dish culture
Advantages and disadvantages of slants
Making peroxide slants
Making transfers to and from slants
Cleaning the mycelium with slants
Making slants
Making transfers to and from slants
Cleaning the mycelium with slants
Beer-Based Medium (BBM)
Starting with Spores
Advantages and disadvantages of spore culture
Peroxide and spores revisited
Collecting spores

Germinating spores by the disk method
Collecting Spores
Germinating Spores by the Disk Method
Ideas Toward Mycelial Culture without Agar
Why find a substitute for agar?
How to prepare the plates
Making transfers
Cleaning the mycelium
Storage cultures without agar
Sending cultures in the mail
How to prepare the plates
Making transfers
Cleaning the mycelium
Storage cultures without agar
Sending cultures in the mail
Re-sterilizing Disposable Petri dishes with peroxide
Spawn Preparation
Spawn in plastic bags - "Eight Minute Spawn"
Advantages and disadvantages of plastic bags
Making the spawn
Using the spawn
Making the spawn
Using the spawn
"Ten Minute" Grain Spawn
Inoculating straw without spawn
How to prepare the inoculum
Notes on the protocol
The issue of senescence
Preparation of Bulk Substrate
Bulk Substrate I: Preparing straw with peroxide - at room temperature
Advantages of peroxide preparation of straw
What about the enzymes?
Protocol for preparing straw or other drainable substrates
Notes on the protocol
What about the enzymes?
The protocol
Notes on straw preparation
Bulk Substrate II
Preparing raw wood chips with peroxide
Bulk Substrate III
An "add-and-stir" method for peroxide-compatible substrates
Rationale and advantages of the "Add-and-Stir" method
A few words on kiln-dried sawdust
The "add-and-stir" protocol
Natural nitrogen supplements for use with the protocol
How much water to add
How much peroxide to use
Making spawn by by the "add-and-stir" method
Notes on the "add-and-stir" protocol
Conclusion of Volume II
About the Author
Results

VOLUME I

When I first took an interest in growing mushrooms, I checked out a well-known book on mushroom cultivation from the library and eagerly read through it. But my interest soon turned to general discouragement as I read about all the equipment and procedures the book insisted were necessary to grow mushrooms without getting the cultures contaminated. I would need a sterile laboratory space with a laminar-flow hood fitted with electrostatic and HEPA filters and an ultraviolet light. This space would need a sterile air-lock entry way with a foot wash, and I would need to have special clothing to enter it, so that I could wash down the floors with chlorine bleach every day. My fruiting mushrooms would have to be grown in a separate building altogether, so as to avoid getting spores into the sterile laboratory. These fruiting cultures would have to be grown in specially designed plastic bags with microporous filter patches attached, so that the mushroom mycelium could get oxygen without letting mold spores or bacteria get in. Of course, I would need an autoclave or at least a specially designed pressure cooker to sterilize the media that went into these bags.

After considering these requirements briefly, I put aside the thought of growing mushrooms. I wasn't about to get all that equipment, and I figured I probably wasn't cut out for the job anyway. From what I could gather, my house would be a death trap for mushroom cultures. Neither my wife nor I are careful housekeepers. We have unabashed dust and clutter, and green and white fuzzy things can be found in and outside the refrigerator. Although I was skilled at sterile technique from my years as a graduate student in biochemistry, I didn't think that would save me from the legions of eager contaminants that would surely dog my every movement should I attempt to grow anything so delectable as mushrooms.

Still, the thought of growing mushrooms didn't disappear entirely. Instead, a year or so later, it resurfaced again in the form of a new idea. I had read that culture media used for growing orchid seeds could be rendered free of contaminants if hydrogen peroxide was added to the medium. While the peroxide killed bacteria, yeast, and fungal spores, it left the orchid seeds viable because they contained enough peroxide-decomposing enzymes to protect themselves. Then the orchid seeds could be germinated and tended easily by relative beginners without the need for strict sterile technique.

So here was a question: could added peroxide be used to keep mushroom-growing media, like orchid-seed media, free of contaminants? If it could, then perhaps mushroom growing could be made accessible to beginners, just like orchid seed germination. So I resolved to try it with mushroom mycelium.

What followed was a fairly complicated and non-linear process of learning about growing various mushrooms, experimenting with adding hydrogen peroxide, trying different concentrations, learning about different culture media and how they interacted with the mushrooms and the peroxide, trying various degrees and techniques of pasteurization and sterilization, going back over earlier ground with better pH measurements, experimenting with supplements, tracking down sources of contamination, tightening my procedures, and on and on, until I developed some fairly reliable guidelines for what I was doing. It all took far longer than I ever would have guessed. But the upshot of it was that, yes, mushroom growing can be made accessible to beginners without the need for sterile facilities, air filtration, or even a pressure cooker, if one adds hydrogen peroxide to help keep the mushroom culture media free of contaminants. Using the techniques I developed, all the stages of mushroom culture can now be carried out by relative beginners, with a wide variety of mushrooms, and without investing a small fortune in equipment and facilities.

I have written the current book as a guide for the home hobbyist interested in mushroom growing, one that could serve as a basic stand-alone primer on home cultivation of several delectable mushroom species, and one that anyone can use, including the beginner. My previous manual, Growing Mushrooms with Hydrogen Peroxide, was written for the mushroom grower who is already familiar with traditional methods of mushroom cultivation, and its focus is on the use of hydrogen peroxide as an improvement to the traditional methods. While that manual made it possible for the first time to perform all phases of gourmet mushroom cultivation in the home without sterile facilities and air filtration, the current book goes even further and presents procedures that do not require pressure sterilization.

Of course, not all of the procedures described in this book were created by me. In particular, any procedures not specifically required for using the peroxide technique, or not specifically made possible by the peroxide technique, are likely to have originated elsewhere.

For in depth accounts of the traditional methods of mushroom cultivation, as well as the growth requirements for a wide range of mushroom species, please consult Stamets, Growing Gourmet and Medicinal Mushrooms, Chilton and Stamets, The Mushroom Cultivator, or another basic text. These books are valuable reference volumes for anyone who seriously wants to pursue mushroom growing in detail. Also, as you glance through these books, with page after page of discussion of elaborate sterile procedures and sources of contamination, you will enhance your appreciation for the simple techniques contained in this manual.

Note that sterile or aseptic technique, which the procedures in this book require to some extent, is always better demonstrated than described. It is my hope that the reader will seek out direct instruction in this regard. Your local mycological society may be helpful to that end.

Also note that this book is not intended as a guide for commercial cultivation of mushrooms, although the methods described here may well prove valuable to small scale commercial growers as well as to home hobbyists.

Table of Contents

Preliminaries

The Mushrooms

Just about any mushroom that is currently cultivated can be grown in the home. However, some are easier to grow than others, and some, though easy, are not as rewarding as others that are more difficult.

I currently focus on four mushrooms in my own home growing. These are:

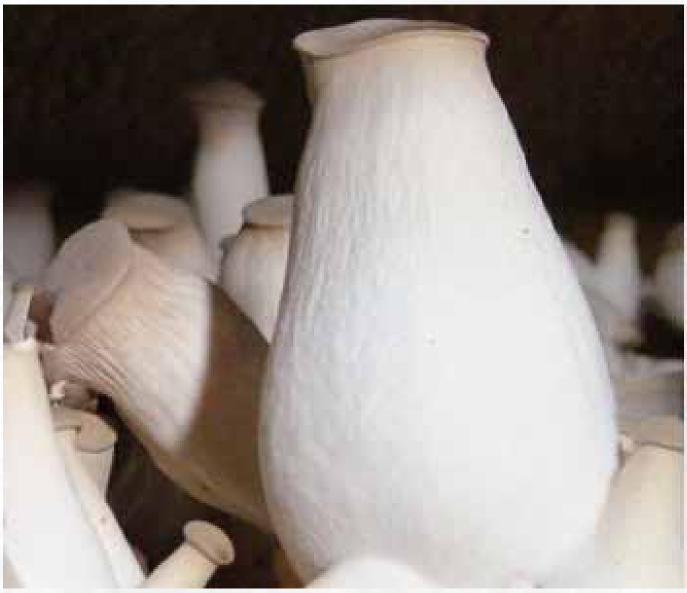
Hypsizygus ulmarius (Elm oyster)

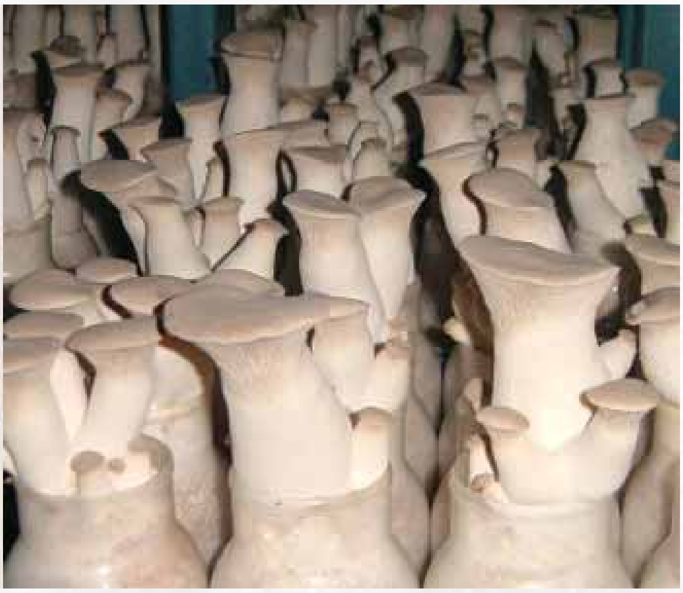
Hypsizygus ulmarius - the elm oyster or white elm mushroom: although it is not a member of the oyster mushroom family, it is an oyster-style mushroom in appearance and habit. It grows aggressively on sawdust or straw, it rarely has contamination problems following the techniques described here, and it does well in a variety of conditions and temperatures, fruiting either vertically or horizontally. When well cultivated, the mushrooms are large and attractive, rather like strange white flowers, and they are in my opinion the most delicious of the oyster-style mushrooms (not counting *Pleurotus eryngii*).

**original manual do not contain these pictures, they are placed only here.*

Pleurotus eryngii (King oyster)

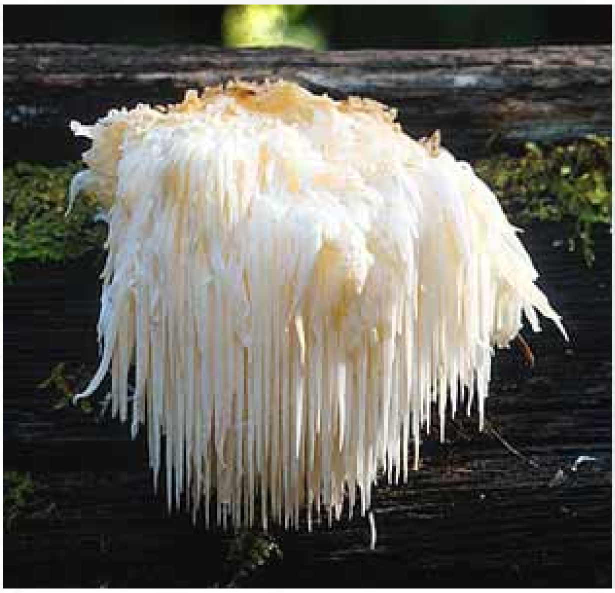
Pleurotus eryngii - or King oyster: a member of the oyster mushroom family, but it does not have the usual oyster mushroom appearance or habit. A native of Europe, it grows up from the ground in a regal stance, rather than on trees and logs. It is large and thick-fleshed. Its substrate requirements are more narrow than other oysters, as are its temperature requirements. I have read that it prefers sawdust to straw, although I have not experimented enough with it on straw to confirm or deny this. It fruits best in fall or spring temperatures, growing at a glacial pace in the cold of winter, and dying back in the hotter parts of the summer. It is one of the most delicious of cultivated mushrooms if cooked properly, sauteed rapidly in a wide pan, without being allowed to stew in its own juice, then lightly salted.

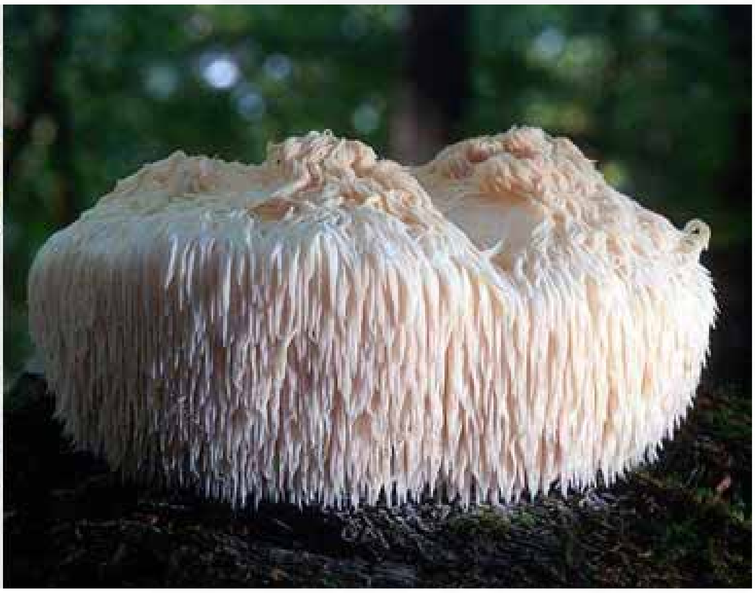




Hericium erinaceus (Lion's Mane)

Hericium erinaceus - or Lion's Mane, also called Pom Pom mushroom: a fungus that lacks the stalk and cap of a traditional grocery store mushroom, instead appearing as a kind of snowball covered with white icicles. It grows rapidly on sawdust substrates, and fruits easily over a range of temperatures. I have heard that it can be grown on straw as well, although I have never tried it. Chefs love this mushroom, and indeed it has a delicious gourmet flavor sometimes tasting like lobster.





Agaricus subrufescens (Almond mushroom)

Agaricus subrufescens - or almond mushroom: a member of the family that includes the domestic button mushroom and the Portabellas. It is distinguished by its unmistakable flavor of almond extract. Like the domestic mushroom, it prefers to grow on compost, but it can also be grown on straw, wood chips, or supplemented sawdust. It is a warm weather mushroom, but it will also fruit indoors in the winter in a heated room, making it a good candidate for year-round cultivation. This mushroom generally needs a casing layer - a layer of friable, soil-like mixture usually containing peat-applied to the surface of the culture in order to form fruiting bodies.

Some other mushrooms to consider include:

Lentinula edodes (Shiitake)

Lentinula edodes - or Shiitake: ever popular, grown by many people and written about extensively elsewhere. I am not a shiitake grower, but the methods of culture handling, spawn and substrate preparation described here will all work for shiitake as well as for the mushrooms that I normally grow. Be sure to get a shiitake strain selected for growth on sawdust if you decide to grow this species using pellet fuel as your bulk substrate. Warm weather and cool weather strains are available.

Pleurotus ostreatus (Oyster mushrooms)

Pleurotus ostreatus - and other oyster mushroom species: like *Hypsizygus ulmarius*, these are among the easiest mushrooms to grow, racing through sawdust or straw or any of a variety of other substrates. They were the first mushrooms I fruited using the peroxide method. Strains exist for most temperature ranges. The spores of *Pleurotus ostreatus*, which are released in great quantity from mature fruiting bodies, can cause health problems.

Ganoderma lucidum (Reishi mushroom)

Ganoderma lucidum - or Reishi: a top flight medicinal mushroom with immune stimulating properties. This mushroom grows on hardwood sawdust in warm temperatures. A related species from the Pacific Northwest, Ganoderma oregonense, prefers cooler temperatures. The woody mushrooms are broken up and made into tea.

Coprinus comatus (Shaggy Mane)

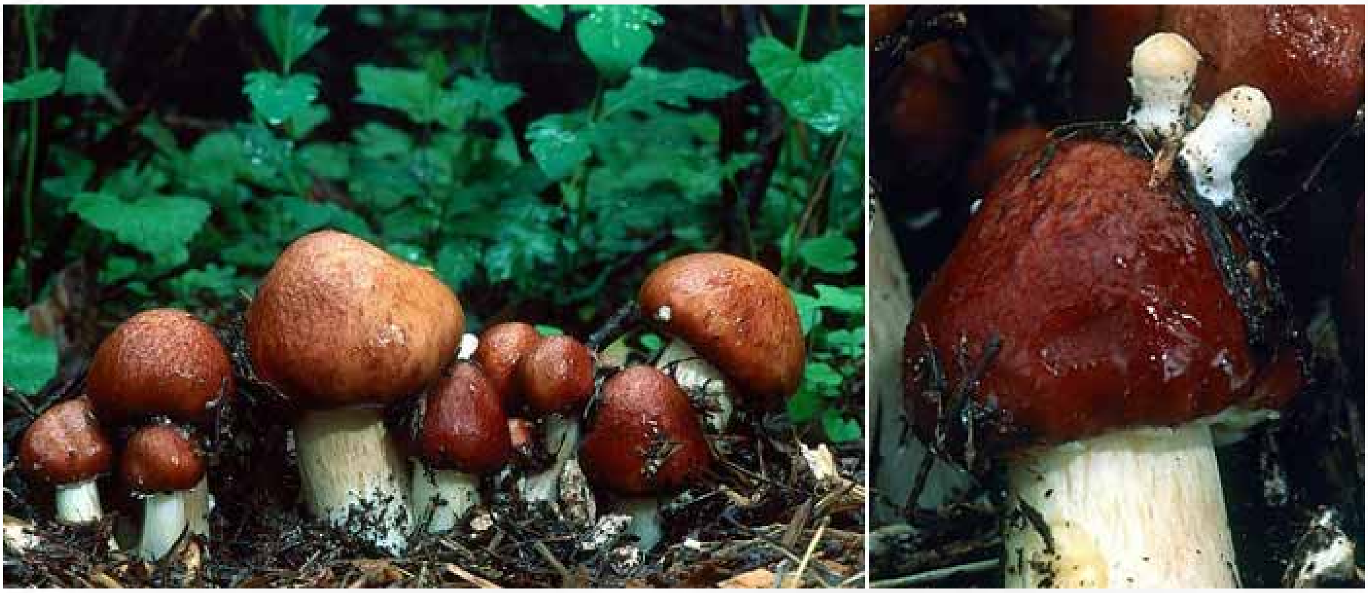
Coprinus comatus - or Shaggy Mane: a mild tasting, short-lived mushroom that grows best on compost. I never got it to fruit indoors, but after I discarded the cultures in my yard, it appeared in my garden for a couple of seasons.

Hypsizygus tessulatus (Shimeji)

Hypsizygus tessulatus - or Shimeji: a cute, small round mushroom with a crunchy texture, grows on straw or sawdust-based substrates. The strain I bought required near freezing temperatures to initiate fruiting, so I didn't experiment much with it, but there are presumably others that will fruit without that.

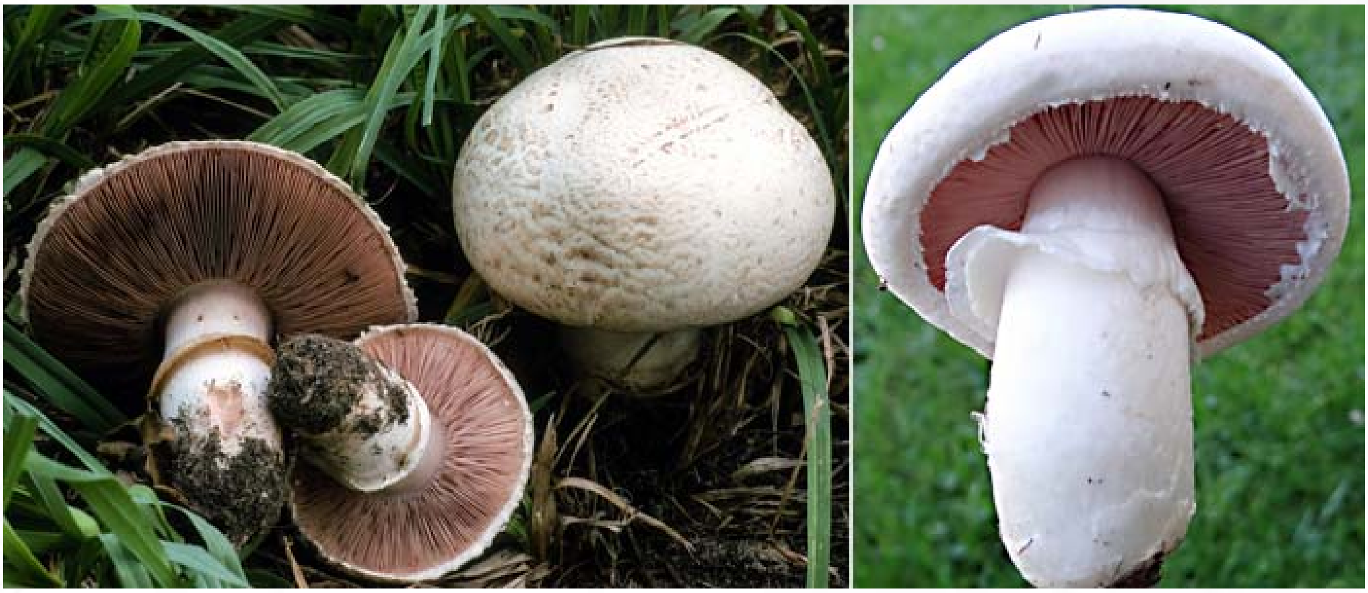
Stropharia rugosa-annulata (King stropharia)

Stropharia rugosa-annulata - or King Stropharia: a large mushroom that grows on beds of wood chips or straw and requires a casing and warm weather to fruit. The mycelium grows slowly, and only one variety is currently known to fruit indoors without regards to season of the year.



Agaricus bisporus (button mushroom, Portobello)

Agaricus bisporus/Agaricus brunnescens, or the white button mushroom, also the brown button mushroom, crimini and portobellos: so many button mushrooms are now grown by large commercial farms in the US, and sold so cheaply, that these companies can no longer make a profit. Like the almond mushroom, the preferred growth substrate for button mushrooms and portobellos is compost. Preparation of quality compost is a complicated and labor-intensive process that is beyond the scope of this manual. But button mushrooms can also be grown on straw prepared by the peroxide method (see Volume II). The yield will not be as high as on compost, but straw is so much easier to prepare at home that you probably won't miss the extra yield. As with the almond mushroom, a casing layer is required for fruiting, but button mushrooms require cooler conditions. Spawn can be prepared with pressure cooked grain (this volume) or with steamed instant rice (see Volume II, "Ten Minute Grain Spawn").



Psilocybe mushrooms

The autor of the manual do not mention them, but methods described here are suitable to cultivate them also. Below ***Psilocybe azurescens*** and ***Psilocybe mexicana.***

Table of Contents

Equipment You Will Need

WOOD
PELLET
FUEL

Some materials and equipment you may need for the peroxide method.

The methods described in this manual require very little in the way of equipment for growing your own mushrooms at home. Handling and measuring hydrogen peroxide requires only a measuring pipette (10 ml volume) and a graduated cylinder (probably 100 or 250 ml volume). These can be purchased from scientific supply stores. To measure the peroxide concentration in the bottles you get from the drug store, you will also need a small test tube with a lip, and a balloon. Preparing mushrooms spawn requires jars with lids (pint, 26 oz, or quart jars), a covered pot for steaming big enough to hold the jars, a small scale or balance for weighing, and some clear plastic food storage bags. Preparing agar cultures requires in addition a set of petri dishes. I recommend reusable plastic petri dishes if you can find them. I purchased mine at my local scientific supply store. A pressure cooker, although not absolutely necessary, will be useful. These can often be found used at second hand stores that carry kitchen implements, or new in the kitchenware section of hardware stores and department stores. Make sure the cooker you get is tall enough to accommodate your jars. You will NOT need a glove box, HEPA filters, ultraviolet lights, a sterile laboratory, laminar flow hoods, air locks, foot washes, etc.

etc.

Preparing and handling bulk pellet fuel substrate requires a covered pot for boiling and cooling water, a second pot such as a teapot to boil water for pasteurizing containers, and a larger container such as a five gallon plastic bucket with a tight-fitting lid. Five gallon buckets can often be scavenged or purchased cheaply from ice cream factories and various other kinds of food preparation establishments (avoid buckets that have been used for paint, solvents, or other toxic substances).

For growing out the bulk substrate, you'll also need some small boxes (usually no bigger than about 500 cubic inches, or 8" x 8" x 8") and some fresh 0.5 mil or less high density tall kitchen bags (avoid the thicker soft plastic bags), or a set of 2 to 3 gallon plastic buckets with lids. For helping the mushrooms along, you'll need a hand mister, and a cool space. Later, if you are growing a lot of mushrooms, you may want a fan and an automatic misting system.

Table of Contents

Specialized Supplies You May Need

For making agar medium, you will need agar, light malt powder, and (if you plan to pressure cook your medium) yeast extract flakes, among other things. Agar is available at some health food stores, or through scientific supply houses, or commercial mushroom supply dealers. Note that although agar by itself is more expensive than ready-mixed MYA medium, the latter is only half or less agar by weight, so it is not necessarily a better deal. Malt powder is available from home brew supply stores or scientific supply houses. Yeast extract flakes are available from health food stores.

For spawn making and bulk substrate, you may need paper fiber pellets and wood pellet fuel. The paper fiber pellets are sold in my area as Crown™ Animal Bedding or Good Mews™ Cat Litter. (Check grocery stores, pet supply stores, farm and garden supply stores, etc.) In rural areas of the U.S. and Canada, wood fuel pellets can be found in grocery stores, hardware stores, farm supply stores, stores that sell pellet stoves, etc. In urban areas, check your phone book for distributors of wood pellet stoves, or check with your rural friends. It may take a drive out of town to get some. Try to find out what kind of wood they are made from, and look for hardwood for most mushrooms (fir pellets, however, will work well for *Pleurotus eryngii* and *Agaricus subrufescens*).

The Basics on Peroxide

What peroxide does

The peroxide radical is a reactive form of oxygen which attacks various organic compounds. In living cells, it damages the genetic material, cell membranes, and whatever else it finds to react with. By doing so, peroxide in sufficient concentration can kill bacteria, bacterial endospores, yeast, and spores of fungi, including mushroom spores. It apparently can also kill small airborne particles of fungi, and the contaminants associated with human skin cells, which are said to be continually flaking off of the mushroom cultivator. Hydrogen peroxide thus acts to some extent against all commonly-encountered airborne contaminants of mushroom culture, including mushroom spores themselves. By contrast, antibiotics generally act only against bacterial contamination, and fungicides act only against yeasts and fungi.

The beauty of peroxide is that it does not kill established mushroom mycelium or interfere with its growth and fruiting. Despite peroxide's wide range of action against the common contaminants of mushroom culture, there is a relatively wide range of concentrations at which peroxide will allow the growth and fruiting of mushroom mycelium. The established mycelium, because of its ability to produce high levels of peroxide-decomposing enzymes, is evidently able to defend itself against much higher concentrations of peroxide radical than can isolated spores, cells or tiny fragments of multicellular organisms. So we can add hydrogen peroxide to mushroom cultures, and the mycelium will grow but the small contaminants will die.

This arrangement has a number of advantages. Most obvious is that it reduces the need for costly and elaborate facilities and equipment for environmental contaminant control. By adding hydrogen peroxide to mushroom culture media, it becomes possible to perform all phases of traditional mushroom cultivation, from isolation to fruiting, successfully in non-sterile environments with unfiltered air. Gone is the need for special clean rooms, HEPA filters, pre-filters, laminar-flow hoods, UV lights, air locks, glove boxes, or any other equipment associated with environmental control of microbial contamination - even microporous filters on bags and jar lids become superfluous. Using peroxide, the equipment minimally required for contamination control comes down to some measuring implements, a source of boiling water, and a large pot for steaming (or a pressure cooker for added security) - little more elaborate than is found in many kitchens. And whereas the traditional methods of mushroom culture required skillful sterile technique and immaculate personal cleanliness for success with agar cultures and spawn, use of peroxide allows success with only modest sterile technique and only minimal attention to personal hygiene. What's more, it becomes possible to fruit mushrooms - even those that have the highest spore load - in the same building used to maintain agar cultures and grow spawn, without the fear that spores released by the fruiting bodies will diffuse into the agar cultures and ruin them. Hydrogen peroxide uniquely will kill the spores of the very same mushrooms whose mycelium it protects.

Do contaminants develop resistance to peroxide, the way they do to ordinary antibiotics? Yes and no. Many of the contaminants are already resistant to peroxide, and once they have established a colony, they will grow vigorously. Live Aspergillus (blue green) mold is very resistant to peroxide. But evidently peroxide at sufficient concentration overwhelms the resistance mechanisms of the single-celled organisms and isolated spores, and those of very small, isolated multicellular organisms as well.

Table of Contents

What peroxide does not do

One thing peroxide does NOT do is eliminate all need for concern about sterile technique. To repeat, although added peroxide will kill isolated spores, yeast, and bacteria that find their way into your cultures, and these are a big part of routine contamination problems, peroxide does NOT kill established live multicellular organisms (such as green mold) beyond a certain size. It also will not do very well against high local concentrations of mold spores. Evidently multicellular organisms and high concentrations of germinated spores are able to produce enough peroxide-decomposing enzymes to defend themselves against high concentrations of external peroxide. And since both multicellular organisms and concentrations of spores can be microscopic and reside on your hands or on particles of dirt or dust, you still have to take sensible precautions to keep your hands and all non-sterile particulate matter out of your early-stage cultures, even with peroxide added. Although you don't have to be afraid to leave cultures open to the air for brief times, to perform manipulations or otherwise check on them, you'll still want to use common sense in avoiding contamination. You wouldn't want to use the lid to a petri dish after you dropped it on the floor, for instance. Neither would you want to allow visible, non-sterile debris of any sort to fall into your cultures, or insects of any kind to enter them. It is a good idea to periodically wipe the dust off shelves used to incubate cultures. You will still need to flame or otherwise sterilize whatever instrument you use to transfer chunks of mycelium from one culture to another. And I make it a regular practice to wipe my fingers with rubbing alcohol before performing inoculations of spawn or agar cultures. I do the same with any counter surfaces I use to perform manipulations with my petri dish cultures. This reduces the chances of larger particles making it into the cultures and helps protect the exposed mycelium.

It is also especially important to know and remember that peroxide does NOT protect the mushroom mycelium itself from aerobic contaminants. The mycelium decomposes peroxide that comes in contact with it, so any aerobic contaminants associated with the mycelium will be shielded from the deleterious effects of peroxide. Thus, as a general rule, peroxide only protects the culture medium or substrate from aerobic contamination. So your most careful procedure should be reserved for transferring mycelium, or performing any operation which exposes mycelium to unfiltered air. And once your mycelium is contaminated, you will need to start over with a fresh, uncontaminated culture, or purify your mushroom tissue in some way to free it of contaminants. I'll discuss this more later.

Finally, peroxide is not a sterilant except at concentrations too high to use for mushroom growth. That is, you generally cannot use hydrogen peroxide by itself to sterilize culture media or mushroom substrates. At the concentrations that are compatible with mushroom growth, hydrogen peroxide will not kill live mold contaminants resident in the medium, and the peroxide itself will be rapidly destroyed by the peroxide-decomposing enzymes in non-sterile organic materials. Although some spores and bacteria may be killed by adding peroxide to non-sterile medium, there will be far more contaminants that will easily survive and grow within a short time. Therefore the general rule is: all culture materials and containers must be pasteurized before adding peroxide or peroxide-containing medium to them; culture materials that contain raw, unprocessed organic matter must be pressure-sterilized to destroy the peroxide-decomposing enzymes. And a corollary: any water used without pressure-sterilization in peroxide-treated medium should be clear and free of obvious particles, since any bits of organic or even inorganic material introduced with the water could harbor live contamination and/or peroxide-decomposing enzymes that would not be destroyed by pasteurization.

Table of Contents

Safety and environmental considerations for hydrogen peroxide

There are no special safety precautions required for handling 3% hydrogen peroxide. Its toxicity is very low, and it decomposes completely to water and oxygen when it is spilled or ingested. It is odorless and does not stain or burn. It is generally not even active as a bleach until it reaches 60°C, the temperature of very hot tap water. Every evidence suggests that it is environmentally benign.

Since commercial peroxide is prepared chemically, rather than extracted from natural sources, it probably would not be considered compatible with organic certification standards following the criteria currently in vogue. However, I consider the use of peroxide to be in the spirit of organic cultivation. Since the peroxide added to mushroom cultures decomposes entirely to water and oxygen as the mushroom mycelium occupies the substrate, there can be no trace of the added peroxide left in the mushroom crop, beyond what is naturally there due to metabolic processes. Moreover, hydrogen peroxide itself is found naturally in all aerobic living organisms and in a variety of natural environments. From time immemorial, honeybees have secreted enzymes which add peroxide to their nectar, protecting it from bacteria, yeasts, and mold, and imparting antibacterial properties to the resulting honey. The mycelia of at least certain mushrooms produce their own peroxide to help break down the woody substrates the organisms encounter. And peroxide is even a part of the healing defenses of the human organism. Indeed, around the world, thousands of proponents of a system of healing called oxygen therapy actually ingest food-grade peroxide solution on a daily basis to cure various ills and promote vitality, and some people have done so for many years (I do not necessarily recommend this, however). Finally, the use of peroxide circumvents the need for resource-intensive equipment, facilities and supplies, simplifying every stage of the mushroom cultivation process.

There is some question as to the effect peroxide oxidation may have on the mushroom substrate itself. Chlorine, when it reacts with organic materials like paper pulp, produces small amounts of dioxin, a very dangerous, cancer-causing chemical. Hydrogen peroxide does not produce dioxin, and as a result, environmentalists are campaigning to get paper companies to bleach their paper fiber with peroxide rather than chlorine. Still, it is conceivable that peroxide could produce some other harmful substance when it reacts with the organic materials in mushroom substrates. I have not ruled out this possibility, but I consider it unlikely. For one thing, aerobic living organisms have evolved for millions of years with hydrogen peroxide both in and around them. Peroxide is generated by normal aerobic metabolism, and it is also naturally formed by the reaction of water with oxygen in response to the ultraviolet rays in sunlight. This means that aerobic organisms most likely have developed metabolic machinery to deal safely with the variety of oxidation products that result from the reaction of peroxide with biological materials. In addition, hydrogen peroxide is chemically quite stable in sterilized mushroom substrates, and the concentration of peroxide we're using is so low that the amount of substrate oxidation going on has to be very low indeed. Finally, I have seen absolutely no evidence of any mutagenic or toxic effect of peroxide-treated mushroom substrate on the mycelium or fruiting bodies. Agar cultures containing hydrogen peroxide give fine, healthy halos of mycelium, and the final fruiting cultures produce mushrooms as beautiful as any grown by traditional methods.

Stability

The 3% hydrogen peroxide solution available at supermarkets and drug stores, with phosphoric acid stabilizer added, is quite stable on the shelf when kept relatively cool. When added to heat-sterilized and cooled mushroom culture media, hydrogen peroxide evidently decomposes only slowly. Precisely how long it will last is presumably a complex function of media composition, peroxide concentration, and temperature. However, my experience so far is that peroxide continues to exclude contaminants for long enough to allow the mycelium of a variety of mushroom species to safely colonize their substrates.

On the other hand, hydrogen peroxide should generally not be added to hot culture media, unless you are going to add extra to compensate for losses from decomposition. Since peroxide becomes active as a bleach above 60°C, it will decompose readily when in contact with complex organic materials at this temperature and above. So wait until your medium has cooled - if not to room temperature, then at least to a temperature that is comfortable to the touch - before adding peroxide.

In contrast to its behavior in pure solution or sterilized media, peroxide breaks down rapidly in the presence of peroxide- decomposing enzymes, as happens when you put peroxide on a wound. The broken skin cells and blood vessels of a wound contain peroxide-decomposing enzymes in abundance, and they rapidly break down peroxide solution and release oxygen bubbles. Similar enzymes, known as catalases and peroxidases, are found in all kinds of living or once-living material, unless it has been heat treated or extensively processed. So, uncooked grain, flour, sawdust, wood, etc. all will destroy peroxide in short order. This means that you will need to keep all such materials out of your stock peroxide solution. It also means that if you want to incorporate such materials into a culture medium, you have to be sure everything in that medium gets thoroughly heat-treated or cooked clear through to destroy peroxide-decomposing enzymes before you add peroxide.

I take several measures to guard the purity of my stock peroxide solution. When I am about to withdraw peroxide, I first wipe down the lid and upper part of the bottle with rubbing alcohol, to keep out particles that might contain live contaminants. Then I either free-pour to a pasteurized measuring vessel or I use a clean, pasteurized pipette with the mouth-end plugged with cotton to draw up the solution. Pipettes do not need to be autoclaved, but they should be at least steeped in boiling water (filled somewhat beyond the top graduation, but below the cotton plug) for a few minutes, then cooled, before using them to withdraw peroxide. A one hundred milliliter graduated cylinder makes a convenient vessel for steeping a 10 ml pipette in boiling water. The heat will kill any live organisms in the pipette, while the peroxide itself will kill remaining heat-resistant spores. I also take care never to set the peroxide bottle cap down unless I am certain it will not contact contamination.

Table of Contents

Variations in peroxide concentration from commercial sources

One annoying fact of life when using peroxide is that the solution you get from the drugstore or supermarket, labeled as containing 3% hydrogen peroxide solution, U.S.P., may or may not actually contain a 3% solution. The concentration can vary considerably, both above and below 3%. You can protect yourself somewhat from buying "worn out" peroxide by looking for the expiration date on the bottle, and getting one with the latest date, if there is a date at all. (The bottles of peroxide I get list only the month of expiration, not the year). However, even the expiration date gives no absolute assurance that the concentration is really 3%. It is important, therefore, to have a way to measure the peroxide concentration in the solution. This can be readily done by decomposing a sample of the peroxide and measuring the released oxygen, which I do with a simple balloon technique.

Here is my method for getting a rough measurement of peroxide:

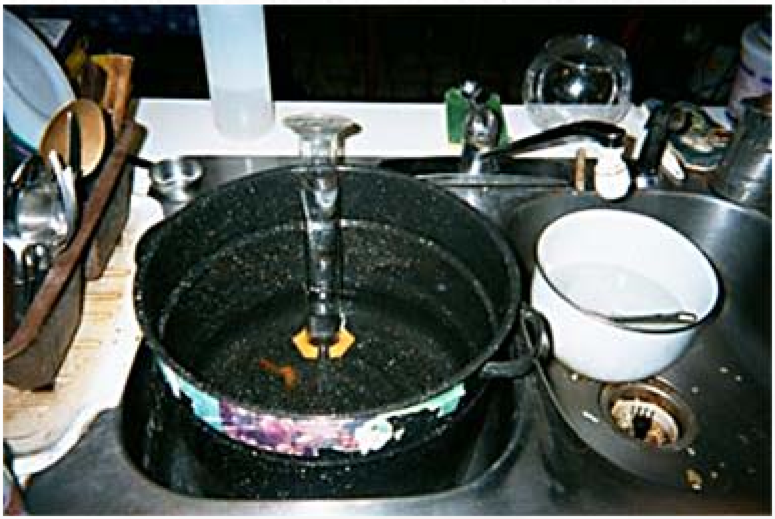
Get a clean test tube (preferably one with a lip or screw cap), a small birthday-party type balloon, and a slice, small enough to fit into your test tube, of the stalk of any mushroom you have handy (for best results, use a young, rapidly growing mushroom and take a piece of stalk, trimming off the natural skin to expose plenty of broken cells). If you don't have any mushrooms, a piece of banana or other skinned vegetable should do just as well). You will also need your peroxide solution, a rubber band, a pasteurized measuring pipette, a 100 ml graduated cylinder, and a pot of water.

1. With the pasteurized measuring pipette, withdraw 5 ml of the peroxide solution from the bottle and transfer it into the test tube.
2. Place the slice of mushroom in the upper part of the tube (don't let it slip into the peroxide yet).
3. Make sure the balloon is empty of air and stretch the mouth of the balloon over the mouth of the tube (tilt the tube to keep the slice of mushroom from slipping into the solution until the balloon is in place.
4. Put a rubber band around the mouth of the balloon on the tube, to keep gas from escaping as the pressure builds (I have found it most effective to use a broken rubber band that can be wound tightly around the threads of the tube, over the mouth of the balloon).
5. Once the balloon is sealed in place, let the mushroom slice slip down into the peroxide solution. The solution should begin bubbling oxygen immediately.
6. Agitate the tube. The peroxide solution should be largely decomposed in five to ten minutes, depending on the amount of catalase/peroxidase in your mushroom slice.
7. When decomposition is almost complete, you'll see that the bubbling will have slowed and the bubbles will have become quite small. Meanwhile, the balloon should have become taut as it began to fill with released oxygen.

Testing peroxide concentration.

Now, my college chemistry training tells me that 5 mls of a 3% solution of hydrogen peroxide should generate about 49 mls of oxygen when the peroxide decomposes completely at room temperature and one atmosphere pressure. To measure the oxygen released from your peroxide solution:

1. Fill a graduated cylinder with water and turn it upside down in a pot of water, making sure all bubbles are out.
2. Twist the balloon on your test tube to trap the released oxygen, remove the balloon from the tube holding the twist tightly, and put the balloon under the water in your pot.
3. Carefully release the gas from the balloon up into the inverted graduated cylinder, displacing the water inside it.
4. Keeping the open end of the cylinder under water, read the volume of oxygen off the graduated cylinder.



Measuring released oxygen in an inverted graduated cylinder.

The first time I did this, I got 52 mls of gas inside my graduated cylinder from 5 mls of peroxide solution. Given that there may well have been about 3 mls of air in the flat balloon before I started, the peroxide solution probably generated pretty close to the theoretical amount of oxygen for 5 mls of 3% solution.

Here's how to calculate the amount of peroxide solution you will need, if you solution tests higher or lower than 3%:

1. Divide the volume of oxygen expected for 5 mls of 3% solution (49 mls if the balloon is completely empty to begin with, or 52 mls in the above example, counting the few milliliters of air initially trapped in the balloon) by the volume of oxygen you actually got.
2. Multiply the previous number by the volume of peroxide solution you would add to your medium or substrate if it were really a 3% solution (this volume is given in appropriate section of this manual, for instance, in the section on agar culture, you will find that you would need to add 6 mls of 3% peroxide for 1 liter of pressure-cooked agar medium).

Knowing the precise concentration of peroxide is most important when you are making agar plates (see below), since you will be working at concentrations close to the lower limit of effectiveness. When you are making spawn, you will be working at a considerably higher concentration, so there will be much more leeway for variation. I use less peroxide for bulk substrate than for spawn, but there is still some room for variation there, as well. I recommend you do the balloon test to check each new bottle of peroxide solution you use for making agar plates, and check the peroxide you use for making spawn and bulk substrate at least until you know how reliable your local product is. That way, you will know for sure that you are giving your cultures the protection you expect. Also, you may want to experiment with the peroxide sources in your local area to see who sells the most reliable product. Paradoxically, cheapest may be best, because there will be regular turnover of the stock where the price is lowest. If peroxide is not readily available at local stores where you live, you will probably want to order it from a chemical supply house. They will often carry 30% or 35% solution, which can be diluted. Swimming pool supply stores also may carry similar solutions. Note, however, that these concentrated solutions are considerably more hazardous than the standard 3% solution. Read all the precautions and warnings on the container and act accordingly.

Table of Contents

Growing and Maintaining Agar Cultures

The first stage of mushroom growing is the propagation and maintenance of mushroom tissue (the mycelium) on agar as petri dish cultures. These first-stage cultures are used to store, propagate, and maintain the mushroom strains in a healthy state by serial transfer, and to inoculate the second stage cultures, the spawn.

Preparing agar plates

There are many recipes for agar medium that can be used to grow mushroom mycelium on petri dishes. I have tried several of these, but I currently use only one: malt yeast agar medium, also known as MYA. This medium has worked respectably for every mushroom species I have attempted to grow. It is not so rich that it contaminates instantly, yet most strains grow across a petri dish of MYA in two or three weeks. In my opinion, if you are using peroxide in your medium, there is not much point to growing the mycelium any faster than that, since it will just force you to make up more agar plates sooner, to keep the mycelium fresh. Also, after repeatedly transferring the mycelium from plate to plate, some growers recommend that you start anew with mycelium from a storage culture, to avoid problems of senescence (aging) of the mycelium. The faster the mycelium grows, according to this view, the sooner one has to go back to storage. If this is true, I would just as soon have the mycelium grow relatively slowly.

I maintain all my petri dish cultures on peroxide-containing medium. Contamination on peroxide plates is rare, as long as a few precautions are followed, and you won't need to buy a laminar flow hood or build a glove box to keep contaminants out. You can pour your plates in the open air in your kitchen, and you can store and incubate your plates almost wherever you like, as long as the spot is relatively clean and the environment is compatible with mycelial growth. However, see my recommendations at the end of this section.

MYA Medium

Here is the recipe I use for one liter of MYA medium:

- 12 gms (0.42 oz) agar
- 12 gms (0.42 oz) light malt powder
- 1 gm ((0.035 oz) nutritional yeast powder
- 0.5 gm (0.017 oz) grain flour (I rotate between wheat, rye, corn, rice, oats, and millet)
- 0.5 gm (0.017 oz) rabbit feed (or other animal feed pellets)
- 4-5 gms wood fuel pellets (0.15 oz - the number of wood pellets can be increased for those wood-decomposing species that do poorly on agar)
- 1 liter tap water

If you purchase ready-mixed MYA medium from a mushroom supply house, it will probably only contain the first three ingredients: agar, malt, and yeast. (You can add the others). Check the instructions to see how much of the powder the manufacturer recommends you use per liter of water. Usually it will be something like 40 to 50 gms. Depending on the proportion of agar to malt powder, you should be able to cut the recommended usage in half and get a medium that is actually better for the long term health of your mushroom cultures.

I prepare the agar medium for plates as follows:

1. I add all the ingredients to a jar with the desired amount of water. The jar should hold about twice the volume you will actually use, to keep the agar from boiling over when it cooks.
2. I adjust the pH with a little baking soda (my water is acidic, but you could use vinegar if yours is alkaline. Also, see my "Note on Measuring pH of Substrate" below in the section on preparing bulk substrate).
3. I then use my ordinary kitchen pressure cooker to melt and sterilize the medium. (I use tap water and have not had any problems with it. In fact, when I grew mushroom mycelium on medium prepared with distilled water, growth was noticeably slower). I put lids loosely in place and pressure cook at 15 psi for no more than 10 minutes, allowing an initial ten minutes of steaming to melt the agar before putting on

the pressure regulator. (If you are using ready-mixed MYA medium, the instructions may say to pressure cook for much longer times, for example, 45 minutes. Don't do it! 20 minutes is the most you'll need, and any longer will produce carmelization products in the medium that are harmful to the mycelium). I also sterilize a set of petri dishes along with my medium, placing the dishes in a large tomato can covered with aluminum foil (I use plastic reusable petri dishes, and a liter of medium fills up about 30 plates).

4. When the cooking is finished, I gently slide the cooker off the burner and allow the pressure to drop. I carefully remove the jar containing the medium and let it cool in the open air on my counter top. There is no need to avoid entry of unsterilized air, assuming there is not a great deal of heavy dust, since the peroxide will kill the airborne contaminants when it is added.
5. When I can handle the jar quite comfortably, I usually put the jar of agar in a pot of warm water for the last part of the cooling process, since the agar is close to solidifying at this temperature.
6. Then I add my peroxide solution with a pasteurized pipette and quickly mix the peroxide into the medium by moving the jar with a circular motion, reversing directions a couple of times (but doing my best to avoid making a lot of bubbles, which will end up on the surface of the agar).
7. Once I've added the peroxide, I go straight to my petri dishes, which I have set out on a clean counter, and I free-pour the medium into the dishes, closing the lids as I finish.
8. When the agar has solidified, I set aside the plates to dry for a few days in a lightly covered tray.

Pouring melted agar into Petri dishes.

To be on the safe side with my plate cultures, I use the lowest concentration of peroxide that I have found effective in agar medium, which is about 0.018%, or 6 mls per liter of medium. (You can add twice this much without visible harm to the mycelium of the species I have grown, but note that very slow-growing species such as Stropharia may be more sensitive to peroxide exposure. The production of protective peroxide-decomposing enzymes seems to be roughly parallel to the rate of growth of the organism). When the plate is inoculated, the concentration presumably begins to drop slowly below the initial level as the peroxide is decomposed by the spreading mycelium. Eventually, the peroxide should disappear completely when the agar is overgrown, if not earlier. Once this stage is reached, colonies of mold may begin to appear at the edge of the agar plate.

Table of Contents

No pressure agar medium

If you do not own a pressure cooker, or do not want to use one, you can still make serviceable agar plates by boiling/steaming the agar medium, provided you alter the above recipe somewhat. You will need to replace the ingredients that contain peroxide-decomposing enzymes with other ingredients that are free of those enzymes. In the above recipe, agar, malt powder, and pellet fuel do not contain peroxide-decomposing enzymes, but yeast powder, flour, and rabbit chow all do. In order to use peroxide in our agar medium, we ordinarily have to pressure cook the medium to destroy the peroxide-decomposing enzymes in these ingredients. However, other ingredients can be used in their place. The yeast powder provides vitamins, so this ingredient can be replaced by a bit of a fresh synthetic B-complex vitamin pill. Because it is synthetic, it will not contain enzymes. Grain flour and rabbit chow provide protein/nitrogen, so these ingredients should be replaced by other peroxide-compatible protein sources. Typically, only highly processed substances are free of peroxide decomposing enzymes, substances like gelatin, soy milk powder, non-fat milk powder, low sodium soy sauce, etc. To test for the presence of the enzymes, mix a little of the substance in question with some 3% peroxide solution and watch for evolution of bubbles. No bubbles means you are in the clear.

Here then is a recipe for one liter of "No pressure" agar medium:

- 12 gms agar
- 12 gms light malt powder
- 0.5 gm processed nitrogen source (rotate between gelatin, soy milk powder, milk powder, low sodium soy sauce, etc.)
- 5-7 wood fuel pellets
- small chip (0.1 gm? enough to turn the solution slightly yellow) from synthetic B vitamin complex pill
- 1 liter clear water, free of particulates

1. Let your jar containing this medium (and your petri dishes, if reusable) sit in boiling water in a covered pot with a heavy lid for about forty-five minutes, which allows time to melt the agar and kill any live organisms in the medium (it may be advisable to steam reusable petri dishes even longer).
2. Then remove the jar and let it cool, adding the peroxide as in the first recipe. The peroxide will kill any spores remaining in the medium. I add slightly more peroxide to non-autoclaved plates, about 8 mls per liter of medium. In general I find that non-autoclaved peroxide plates contaminate more often than autoclaved peroxide plates, but they still do considerably better than plates made without peroxide.

Watch out for drips of agar medium that land on the outside of your petri dishes. If these are not cleaned off, they will grow mold within a few days, and the spores will diffuse into the plates and start germinating at the outer edge of the agar.

If you are working with reusable petri dishes as I am, clean them carefully after you take out the old agar. Even the smallest amount of old medium left in a plate, if it is not in contact with the peroxide in the new agar the next time you use the plate, can grow mold and become a jumping-off point for contamination.

A benefit of pouring plates when the agar is so cool, is that there is considerably less condensation on the inside of the lids, than if you pour hot. This obviously means that you won't have to take special measures to get rid of condensation, such as shaking out the lids, or warming the plates to evaporate the droplets. And you'll be better able to see what is happening in your plates. However, the agar surface still needs some drying, so I let the plates sit at room temperature for a day, lightly covered with a sheet of wax paper to keep dust off, before I use them. Plates with agar medium that has been steamed will be wetter than plates with medium that has been pressure cooked, because of the lower cooking temperatures and shorter cooking time, so they will need to be dried for a longer time.

If you have extra agar medium after your plates are poured, the excess will remain sterile stored in the refrigerator. When you get around to using it, you can melt the agar again, but note that you will need to add peroxide again, because the heat of melting will have destroyed what you added the first time.

Table of Contents

Acquiring mushroom cultures

There are several ways to acquire a culture of mushroom mycelium to grow out on your agar plates. Spores from a mushroom can be germinated in nutrient medium. Tissue can be cut aseptically out of a fresh mushroom and coaxed to sprout mycelium on nutrient agar. Or a mushroom tissue culture can be purchased from a commercial supplier, usually in the form of an agar tube culture or a petri dish culture.

Since peroxide-containing nutrient medium kills mushroom spores, I have not worked with germinating spores to acquire mushroom cultures. Instead, I prefer to purchase tissue cultures from a reputable supplier. The way I see it, the supplier has already gone to the trouble of isolating a mushroom strain with desirable characteristics, and by purchasing a tissue culture, I am relatively assured of obtaining a mycelial isolate carrying the same desirable characteristics. By contrast, if you try to grow a mushroom strain you've isolated from spores or cloning and it doesn't fruit, you won't know whether it is the conditions you are providing, or the strain that is causing the problem. (Spores are like seeds: they may or may not have the same genetic characteristics as the parent). And you can waste enormous amounts of time trying to fruit a worthless strain.

Moreover, once you work out the conditions for growing an isolate in your situation, if you ever lose the culture, unless you purchased from a commercial supplier, you can't go back to the same supplier and get another "copy." You'll have to start all over and work out the conditions again for a new strain.

When you purchase a tissue culture from a commercial supplier, it is generally understood that you will use that culture to grow - and sell if you choose to - spawn, fruiting cultures, and fruiting bodies of that mushroom strain. It is also presumed that you will not take that culture and use it to establish your own commercial strain bank, selling agar cultures to others. If you want to sell agar cultures, the ethical route is to isolate your own strains by cloning from the wild or germinating spores.

Cloning mushrooms

It can be fun, regardless, to clone your own mushroom culture from a specimen you collect in the wild. Perhaps it will provide you with a first-rate fruiting strain. If you'd like to try it, you will need some nutrient agar plates containing peroxide (see below), a scalpel, an ethanol-fueled alcohol lamp, and a fresh mushroom.

To clone a mushroom:

1. Clean off the external surface so that there is no loose debris.
2. Break open the mushroom cap (or base of the stalk) as cleanly as you can.
3. Light your alcohol lamp and flame your scalpel blade. Then cut out a small piece of clean tissue within the mushroom that does not contact any external surface. This will obviously be easier with thick, fleshy mushrooms than with thin ones.
4. When you have piece of mushroom on your scalpel, transfer it to the middle of one of your nutrient agar plates. Since the chances of failure are high, take a few more pieces if you can and transfer each one to its own agar plate.
5. Finally, stack the plates, wrap them in a clear plastic bag, and set them in a convenient place to incubate at room temperature.
6. Mycelial growth, if it occurs, should become visible in a number of days, spreading out from the chunk of mushroom tissue. Mold or bacteria may grow as well, in which case you may have to cut out a bit of clean mycelium and transfer it to a fresh plate. If you decide to subclone the mycelium away from mold contaminants in this way, be sure you do it before the mold has matured enough to darken in color and form spores. Otherwise you will simply be transferring mold with the mycelium.

If you are trying to clone mushroom mycelium from the wild, remember that hydrogen peroxide in your medium will not by itself clean your mycelium of resident contaminants. If your material is dirty, and you can't get a piece of clean tissue by breaking open the stalk or cap of the mushroom you want to clone, peroxide in the agar will not improve matters. It is not a sterilant. However, if your material is basically clean, peroxide in your agar will at least reduce the incidence of background contamination on your cloning plates.

Table of Contents

Strain storage

Once you have acquired a mushroom culture, you will need a way to safely preserve samples of it for long periods, so that you can go back to these preserved samples if anything happens to the active culture you use every day. The storage method I use simply requires scraping a bit of mycelium off an agar plate and transferring it to a screw cap tube of sterile distilled water (thanks to Joe Kish for bringing this technique to my attention). Once in the distilled water, the mushroom mycelium goes dormant and will last indefinitely for some strains (oyster-type mushrooms last only about a year in my experience). Refrigeration is not even required.

Although agar slants are the "traditional" way to store cultures for those who don't have liquid nitrogen, slants do not preserve strains very long - six months at best.

Now, when you make storage preparations of strains you want to preserve for long term storage, I recommend that you prepare these without resort to hydrogen peroxide. The reason for this is that I don't really know what long term effects peroxide exposure may have on mushroom storage cultures. Could it accelerate senescence? Does it weaken the strains gradually? Are there gradual genetic changes? I am simply not in a position to rule out all the problems that could occur with all the different species you may want to store. In addition, actively growing cultures are better able to defend themselves against added peroxide than dormant storage cultures, which may be more subject to damage. So, although slants and distilled water storage tubes can easily be prepared with peroxide, peroxide-free storage of strains is the safest course. Besides, it is so easy to prepare good clean distilled water storage tubes by dispensing the distilled water into the tubes, lightly screwing on the caps, then pressure cooking for half an hour (if you don't have a pressure cooker, I would try boiling for an hour with a few drops of 3% peroxide; the peroxide will kill the heat-resistant spores, and then the lengthy boiling will destroy the peroxide). And unlike petri dishes, screw cap tubes can be flamed on opening and closing, making it easier to keep them sterile without air filtration while inserting mycelium. I wrap the final storage tubes, containing mycelium, in clear plastic "food storage" bags before putting them in a safe spot in my basement.

Inoculating and handling agar cultures

I inoculate agar plates and slants by sterilizing a scalpel with the flame of my alcohol lamp, then transferring to each fresh plate or slant a small chunk of mycelium-impregnated agar cut from a plate that has a healthy halo of mycelium growing across it.

Transferring mycelium by way of an agar chunk.

When using a flamed scalpel to cut out agar chunks, I first cool the scalpel by plunging it into the agar of the plate containing the culture I want to transfer. (Traditionally, you would cool the scalpel by plunging it into the agar of the new, unused plate. But the hot scalpel may decompose some peroxide in the plate at the site of the cut. In unfiltered air, this spot then might become a locus for contaminant growth, since it is less protected. This is not a problem with the plate I inoculate from, since it will be discarded. But it may be a concern with the new plate. So I cool the scalpel in the old plate).

If you are inoculating a plate from a storage culture devoid of peroxide, don't use an inoculating loop except to fish out a large clump of mycelium. In my experience, the minor mycelial fragments picked up by an inoculating loop are not enough to establish colonies readily in the presence of the concentrations of peroxide that are effective against contaminants, especially when the culture has not been growing on peroxide previously. The mycelium has a much better chance of taking hold if you can transfer a clump of mycelium from a distilled water storage tube, or a chunk of mycelium-containing agar excised from a slant using a scalpel or other sharp sterile implement. (Admittedly, it is somewhat awkward and sometimes frustrating to dig pieces of agar out of a slant with a scalpel).

Cultures that have not been exposed to peroxide medium previously will often lag at first, as the mycelium adjusts to this new feature of its environment. Sometimes the mycelium will appear to be trying to grow away from the peroxide agar at first. (You may observe similar behavior when transferring from a plate that originally contained peroxide but that has been overgrown with mycelium for a few days so that all added peroxide has decomposed). Sooner or later, however, the mycelium will settle down and grow normally over the surface of the new medium.

I have never observed any problem with my strains which I could attribute to continuous peroxide exposure. Typically, I transfer my strains about ten times on peroxide-containing medium before returning to peroxide-free storage cultures, although the choice of ten transfers is an arbitrary one, and returning to storage cultures may not be necessary at all.

Note that peroxide protects only the portion of an agar plate that does not have mycelium growing on it. The mycelium itself is unprotected, since it decomposes the peroxide as it grows. Therefore, older plate cultures that have been overgrown with mycelium for more than a few days have an increased likelihood of harboring contaminants.

Table of Contents

Preventing occult contamination with bottom inoculation

It is also possible for contaminants to accumulate on mycelium if you transfer it repeatedly in unfiltered air, even if there is always peroxide in the agar and the mycelium never covers the entire plate. Although you may never see contaminants growing on the mushroom mycelium in your plates, invisible contaminants will slowly build up. This "occult contamination" can be a problem whether or not you are using peroxide in your spawn and in your fruiting substrate as well. However, if your spawn or fruiting substrate will be peroxide free, there is an even greater chance that the occult contaminants could bloom when they enter the unprotected medium.

To guard against the possibility of such occult contamination, I use a simple trick: I regularly inoculate the bottom of the agar when I do my transfers (How often you do this depends on how you store your plates, and for how long. The safest course is to perform this operation at every transfer, at least with those plates used for transferring mycelium to subsequent plates. But you may be able to get away with putting it off for two or three transfers before it starts affecting your success rate). I perform the bottom inoculation as follows:

1. Turn the plate upside down.
2. Lift one side of the plate bottom as if it were hinged to the top, and gently pry the agar disk out into the lid of the plate with a flamed scalpel. (If your agar regularly tears or breaks at this step, you will need to increase the amount of agar you add for making your medium.)
3. Close the plate back up until you're ready, then transfer a chunk of mycelium to the exposed underside of the agar with a flamed, cooled scalpel.
4. Finally, after inoculating the underside, close the plate, turn it right side up again, and gently pry (again with a flamed scalpel) the agar disk back to its usual position in the bottom of the plate, now sitting on top of the chunk of mycelium.

This arrangement forces the mycelium to grow up from the bottom of the agar through the medium to the surface of the plate, leaving any accumulated contaminants behind in the process. Certain strains may not respond well to this arrangement, but so far I have not had any problem as long as the strain I was using was able to grow vigorously on the medium. However, because of the amount of manipulation involved, this procedure does carry an increased risk of contamination compared to simple transfers. Whereas I rarely see contamination on peroxide plates inoculated in the usual way until they are old, I lose perhaps one in five plates inoculated on the underside of the agar. Wiping down your counter surfaces and your fingers with rubbing alcohol before you begin may help cut down on such failures.

A tricky but important point in the bottom-inoculation procedure is to avoid scraping bits of agar onto the rim of the petri dish bottom when you close the plate after inoculating the bottom of the agar. Bits of agar that get on the rim, or outside of it, tend to sprout contaminants because of their proximity to ambient air. It is also advisable to use plates that have been dried sufficiently to eliminate obvious surface drips. If the agar is still very wet when pried into the lid, it may leave enough medium behind in the lid to cause troubles at the edges of the plate later on.

One final point: Be sure not to cut all the way through the agar when you remove wedges for inoculation from a bottom-inoculated plate. Doing so will defeat the whole purpose of the procedure by bringing along the occult contaminants we're trying to confine to the bottom of the plate. To leave these contaminants behind, excise wedges only from the top of the agar.

Once my agar plates are inoculated (I keep four at a time for each strain), I place them inside fresh clear-plastic food-storage bags, which I close with twist ties. The closed bag provides a still-air environment and helps keep out marauding fungus gnats and mites. I put three or four petri dishes in a single bag. They then can be incubated anywhere that is convenient - on a bookshelf, in a closet, on a counter top, etc. However, I do not recommend storing plates in the refrigerator, because of the condensation that is produced, and I also don't recommend incubating plates on a shelf above a heater, because the on-off cycles of heating and cooling will cause contaminants to be drawn into your plates.

Being able to store fresh (uninoculated) plates easily is one of the benefits of peroxide. I keep a set of fresh plates stored in a cool spot - again, not the refrigerator. Like the inoculated plates, I keep these wrapped in plastic food storage bags. Each time I use one of my growing cultures to inoculate spawn, I also take out one of these fresh plates and inoculate it to replace the culture I've used. At the same time, I replace any cultures that may have developed mold colonies at the edge. This way, the number of plates I have growing remains constant, and I rarely find myself short.

Table of Contents

Making Mushroom Spawn

Production of spawn is the second stage in mushroom growing. Spawn is the "starter" used to inoculate bulk fruiting substrates, or to make more spawn. Traditionally, spawn making was best left to commercial spawn suppliers, who had the sterile facilities to keep spawn free of contaminants. With the development of the peroxide method, however, spawn making is just another step in the mushroom growing process, and an easy one at that.

Being able to make your own spawn without a sterile facility has a significant economic benefit for the small grower or hobbyist. At $20 to $25 for a few pounds of spawn, purchasing spawn represents a significant expense. If you make the same few pounds yourself with the help of peroxide, grain will cost you about a dollar or two, and the peroxide - ten cents. (Sawdust, if not free, will cost quite a bit less than grain). And you won't have to spend a small fortune building an air filtration set-up or special clean rooms for incubating the spawn.

For my own mushroom growing, I have switched almost entirely to using sawdust-based spawn. With my current methods, sawdust-based spawn medium can be prepared more quickly and easily than grain spawn, without soaking of grain, and even without autoclaving or pressure sterilizing (see below). Also, mature sawdust spawn colonizes sawdust-based substrate more quickly, and in my experience, with a lower incidence of mold contamination, than grain spawn. And contamination of the spawn itself is rare, perhaps one jar in one hundred, as might be expected just from occasional, inevitable mistakes in technique. True, sawdust spawn does not contribute as much nutrition to the bulk substrate as grain, but it is not particularly difficult to add the missing nutrition directly to the substrate from other sources that do not require pressure cooking.

Jars of peroxide-treated sawdust spawn on a bookshelf.

For most mushroom species, grain spawn is recommended for straw, since the grain adds to the nutritional base of the substrate. And that grain has to be pressure sterilized. Still, there are two good species that will grow well on straw using sawdust-based spawn instead of grain: *Hypsizygus ulmarius* (the elm oyster) and *Hypsizygus tessulatus* (Shimeji). Since *Hypsizygus ulmarius* grows every bit as easily and tastes considerably better than traditional oyster mushrooms of the Pleurotus family, I can see no reason to incur the added difficulty of grain-spawn making simply to grow oyster mushrooms on straw.

Table of Contents

Ten Minute Spawn

My own procedure for preparing sawdust-based spawn originally required sterilizing separately enough water to add diluted peroxide to the spawn after it had been pressure-cooked and cooled. This is an awkward procedure at best, so I sought alternatives. My search lead to the development of "10 minute spawn," a form of sawdust-paper pellet spawn that only requires a ten minute steaming and no pressure cooking at all. This is probably the fastest method yet in existence for preparing sawdust-type spawn. In this "one step" procedure, all the solid ingredients are placed in a jar, then peroxide is added with all of the water, and the spawn medium is briefly steamed and cooled. Enough peroxide evidently survives the brief steaming to keep the spawn contamination-free.

Here's the recipe for making "ten minute spawn:"

- Wood fuel pellets - 1.5 oz (42.5 gm, or about 4 tablespoons)
- Paper fiber pellets - 3 oz (85 gm, or about 1/2 cup plus 1 tbs)
- Ground limestone - 0.015 oz (0.4 gm, or about 1/4 teaspoon)
- Gypsum (optional) - 0.015 oz (0.4 gm, or about 1/4 teaspoon)
- Nitrogen supplement - 2% by weight (see below) - (usually about 3/4 tablespoon total)
- Hot water - 150 mls, mixed with 3% hydrogen peroxide - 20 mls
- Jar with lid containing fitted cardboard disk (see below under "Spawn Containers")

1. Place into a 26 oz or similar size jar the wood fuel pellets (ordinary sawdust will NOT work), paper pellets (Crown™ Animal Bedding or Good Mews™ Cat litter, etc.), lime, gypsum (optional) and nitrogen supplement (see below). The wood fuel pellets must be made of a relatively light wood, such as

cottonwood or fir, so that they disintegrate easily as well as heat up and cool down quickly. Fresh ground oyster shell lime will substitute for limestone.

2. Add the hot water with peroxide to the jar, and mix slightly.
3. After allowing a few minutes for the liquid to be absorbed and the wood fuel pellets to disintegrate, shake the jar with a temporary lid in place to mix the ingredients, then knock the jar on a padded surface to dislodge substrate from the upper part of the jar back down into the rest of the substrate.
4. Slightly moisten the cardboard disk in the final lid and put the lid loosely in place on the jar.
5. Place the jar in a steamer pot containing about a half inch to an inch of water, cover the pot with a fitted lid, bring the pot to steaming temperature, and let it cook for just ten minutes over a rolling boil. (I want the pot to reach steaming temperature quickly, so I start with hot tap water. The jars sit on a rack that elevates them slightly from the bottom).
6. When the ten minutes are up, withdraw the jar and let it cool rapidly to room temperature.
7. Wet the cardboard disk inside the jar lid with some 3% peroxide by free-pouring a little peroxide into the lid and wiggling the lid to spread the liquid. Pour off any excess.
8. The spawn is then ready to inoculate.

In the above procedure, I mix one part sawdust with about two parts pelletized paper. The pellets allow the spawn to break up on shaking in jars after the mycelium has grown through the substrate. Of course, you can also prepare your sawdust spawn in heat-resistant plastic bags, and then you won't need paper pellets, since you can break up the spawn by manipulating the bag.

Agar colonizes sawdust by itself with difficulty, which is why I have added an additional nitrogen source to my sawdust spawn in the procedure. The standard recipe calls for one part bran for every four parts sawdust, but if you use any such "raw" supplement as bran, you will have to pressure sterilize your spawn after all, to eliminate peroxide-decomposing enzymes. Therefore, I have identified several nitrogen supplements that do not require pressure sterilization.

Two readily available choices are powdered soy milk and powdered cows milk. I have used each of these substances successfully in the above recipe for 10 minute spawn by adding 0.3 oz (or a little less than a tablespoon) to the specified amounts of paper fiber pellets and wood pellet fuel.

Sylvan Corporation sells two processed supplements, one based on denatured soy protein (Millichamp 3000), and the other based on corn gluten (CG60), and these serve the purpose quite well (I add 0.30 oz in the above recipe for "10 minute spawn"). Neither of these commercial supplements decomposes peroxide when the supplement is fresh, although older Millichamp 3000 and a third supplement sold by Sylvan, CS36, does.

Artificial fertilizer can also provide a workable nitrogen source (for example, about 0.1 oz of "Schultz Instant" brand 20-30-20 fertilizer works well in the above recipe). I have used this successfully with both *Pleurotus eryngii* and *Hypsizygus ulmarius*. However, be forewarned that mushroom mycelium takes some time to adapt to chemicals such as these, so the growth will start off quite slowly.

Perhaps you don't like the idea of using artificial fertilizer. Well, since human urine contains nitrogen primarily in the form of urea, it can be used as an organic supplement in place of the fertilizer. In that case, you could replace roughly half of the water required with fresh urine.

To use other supplements, the idea is to add enough to bring the percent nitrogen in the spawn medium to about 0.4, or the percent protein to about 2.5. See the section on supplements under bulk substrate preparation for details of making this kind of calculation.

Two final notes on this ten-minute spawn procedure: first, be careful to use clean containers and implements, use only clear water, free of particulate matter, and if you are working in a kitchen, make sure you don't get flour, crumbs, or other organic matter into the jars or the containers you use for weighing out the medium. Also, make sure none of your ingredients (or your cardboard disks for the lids) is so old it has had a chance to get moist and start to decompose. This will introduce live contaminants containing active peroxide-decomposing enzymes. The procedure works because there are no peroxide-decomposing enzymes in any of the ingredients, so you need to ensure that this remains the case.

Second, the procedure also works because the small amount of material I am using for a 26 oz. jar can be heated and cooled quickly, so that some intact peroxide remains after the steam treatment. Larger quantities of spawn will both take longer to heat through and longer to cool, so they will likely require the addition of greater amounts of peroxide to assure that any survives. You will have to perform your own experiments to determine the amount of peroxide to add.

Table of Contents

Pressure-sterilized sawdust spawn

If you are not going to use wood pellet fuel as a source of sawdust, or if you want to use an unprocessed nitrogen supplement like bran, you will have to pressure sterilize your sawdust spawn, and add diluted peroxide to the medium after it has cooled. You'll want to sterilize enough water separately to dilute the peroxide in about one-third to one-half the total water added to the substrate. After measuring out the diluted peroxide you need, pour it into the spawn medium and then shake well to distribute the liquid.

Here's the procedure as I used to do it:

1. Add roughly half the total water you'll need to the spawn medium in as many containers as you want to prepare.
2. Measure out and sterilize enough water to add the other half of the total water, with peroxide, to each of the containers later.
3. Dilute your peroxide into the sterile water when it is cool, to make a 1 to 10 dilution (that is, add a volume of 3% peroxide that is roughly a tenth of the total volume of the water).
4. Measure out the individual amounts of water for each spawn container in a graduated cylinder pasteurized with boiling water.
5. Free-pour the measured water into each spawn container (resulting in an additional 1 to 2 dilution, since the containers already contained half of the water) making sure to wipe off drips running down the outside of the cylinder so they won't fall into the spawn during pouring, and mix immediately. The total dilution comes to about 1 to 20, or a peroxide concentration of roughly 0.15%, same as for grain spawn.

Grain Spawn

Now, if you have decided that you need grain spawn, I have to caution you - especially if you have never made grain spawn before - that making grain spawn can prove difficult even with peroxide addition. This is because the grain available to you locally may carry a high load of endogenous contaminants that cannot effectively be eliminated by pressure cooking.

So, although I have employed lengthy sterilization periods and plenty of peroxide, I have not been able to consistently make contamination-free rye spawn with the rye grain I get locally. Fortunately, I have been able to substitute a grain called soft white wheat. It has a much higher initial moisture content than rye berries (30% vs 8%), but for whatever reason it is much cleaner than the rye I can get. Soft white wheat has worked well for me when I have added a measured amount of hot water and let the grain stand overnight before pressure cooking, or when I have steeped the grain with excess hot water. I get contamination-free grain spawn virtually every time with this grain. Unfortunately, soft white wheat is sometimes unavailable, and store personnel are prone to mix it up with hard red wheat, a low moisture grain which gives me the same problems as rye.

Whatever grain you choose, you'll want to be sure that
1) your substrate is completely sterilized before you add peroxide, and
2) you have removed all traces of medium on the outside of your containers.

Of course, the problem of thorough sterilization also exists in preparing spawn in filtered-air environments. If there are mold spores or bacteria inside the grain kernels or other substrate particles, and these are not killed by autoclaving/pressure cooking, they can germinate and spoil the spawn despite filtered air or added peroxide. With peroxide as well, however, incomplete sterilization means that some peroxide-decomposing enzymes are left in the grain, creating pockets of medium that are unprotected by peroxide.

The second problem also exists in conventional cultivation practice. If traces of culture medium get on the outside of culture containers, these bits of medium can become loci for contaminant growth and spore dispersal. If this happens with peroxide-protected substrate, the culture will often remain clear until it is shaken to distribute the mycelium. But a few days later, the contaminants will bloom, taking advantage of the lack of peroxide protection in the newly multiplied zones of mycelial growth. This problem can be prevented by cleaning reusable containers carefully, both inside and out, before use, and wiping down the outsides of the containers with rubbing alcohol after the spawn has been inoculated.

Here's how I make soft white wheat spawn:

1. I weigh out 7 oz of grain into a 26 oz jar.
2. I then add an excess of hot tap water and a tiny amount of baking soda to offset the acidity of my tap water.
3. Next, I steep the grain at near-boiling temperatures for an hour or two to swell the kernels, draining off the excess water when the grain has about doubled in volume.
4. Finally, I sterilize the jar of grain in a pressure cooker for an hour. The exact length of time you use will depend on your grain and pressure cooker.
5. When the jar has cooled, I add 10 mls 3% hydrogen peroxide (or 20 mls peroxide for every 16 oz grain initially added), then shake well to coat the grain.

One grower adds food color to his peroxide, so that he can see whether he's done a thorough job of distributing the peroxide over the grain. (If your grain clumps significantly, it will be difficult to coat the kernels completely, so take care to adjust your water content, and don't soak or cook your grain too long). The final peroxide concentration is high, about 0.15%, but mushroom mycelium still grows well, if somewhat more slowly than without added peroxide. (If you make your spawn by adding a measured amount of water, remember to subtract the volume of peroxide from the water you add, to achieve the correct moisture content). You may well be able to get away with adding less peroxide, but if you add less than 20 mls 3% solution for each 16 oz of grain, you will most likely need to dilute your peroxide into a larger volume of sterile water before addition, to assure thorough coating of the grain by the solution. On the other side, you can add up to 40 mls peroxide without seriously affecting mycelial growth in most cases.

Table of Contents

Spawn containers

I grow my spawn in 26 oz pasta sauce jars, since I can get these readily. They have one-piece lids. Quart canning jars will work just as well, especially if you have one-piece lids, but a two-piece lid can be serviceable if you put a slightly oversize cardboard disk inside the lid, so that it holds the top of the lid within the band. Be sure to keep the inside of the lids clean for each use, as well as the lid threads on the jars. Traces of old medium around the mouth of the jar or in the lid can cause major problems. Rusty spots on the insides of the lids can also catch such traces of medium and provide a place for microbial growth.

Note that peroxide addition makes unnecessary the use of lids fitted with microporous filters as were traditionally required. However, the jar lids are a vulnerable area, even with peroxide added to the medium, since you will be shaking the jars to distribute mycelium, and the shaking can bring airborne mold spores that have diffused inside the lid (or bits of mold that have grown in the crevices of a poorly cleaned lid) into contact with the mycelium (which itself is unprotected). To compensate for lid vulnerability, I do the following:

1. I prepare a set of thin cardboard disks cut to fit inside my jar lids (cereal box cardboard works well; just trace a circle around the lid onto the cardboard with a pen, then cut slightly inside the traced circle with a scissors).
2. For "10 minute spawn," I mix the ingredients with a separate lid, then I put the lids with cardboard disks in place just before steaming.
3. As the spawn cools, I open the lids and wet the cardboard disks with 3% peroxide by free-pouring a

couple milliliters into each lid. The peroxide-moistened disks then form a barrier to airborne contaminant entry.

For grain spawn or other spawn that requires pressure sterilization, I wrap the disk-containing lids individually in aluminum foil, sterilizing them separately from the jars of spawn, which I sterilize with temporary lids in place. Then, after adding peroxide to the sterilized spawn substrate and shaking it in, I remove the temporary lid and put in place one of the sterile lids with a cardboard disk. I then wet the disk with 3% peroxide solution.

Inoculating spawn

Inoculating jars of "Ten Minute Spawn" by the agar chunk method.

Sterile containers of spawn medium can be inoculated in a couple of ways. You can cut chunks of mycelium out of agar cultures with a sterile scalpel and drop the chunks into the container. (If you do this, first tip the jar or bag to make the substrate slope to one side, so you can get the chunks of agar a ways down into the substrate, but still at the side of the container where you can check for growth). Or you can shake the container after adding the chunks. I prefer not to shake the container, because the chunks often end up sticking above the medium, unprotected by peroxide, and they are difficult to dislodge by further shaking. With peroxide addition as well, there is no clear benefit from shaking the chunks with the substrate. The small fragments of mycelium that are broken off this way seem to be too small to effectively recover and grow in the presence of peroxide at the high concentration used in spawn medium. Therefore, I drop the agar chunks (three pieces has been adequate for slow growing strains) down into the substrate and close the container. With sawdust spawn of *Hericium erinaceus*, I then tap the jar on my counter to pack down the spawn medium around the agar chunks, since the organism seems to prefer a dense, closely-packed substrate.

Note that peroxide-treated spawn medium should only be inoculated with peroxide-adapted mycelium, that is, mycelium that has grown out on peroxide-containing agar. Otherwise, the unadapted mycelium may die off or take a very long time to initiate new growth when confronted with the relatively high concentration of peroxide I have suggested for spawn making. (Peroxide-treated bulk substrate, however, contains a much lower concentration of peroxide, so it can safely be inoculated with spawn that has not been adapted to peroxide.)

My original procedure was to put my inoculated jars inside fresh plastic food storage bags tied closed. (I would do this immediately after wiping down the jars with rubbing alcohol). I used the plastic bags to provide a still-air environment, and to keep out stray fungus gnats. (The bags can be reused, provided they are still clean). Lately, however, I have been incubating the spawn jars without enclosing them in food storage bags, and this appears to work almost as well.

Finally, I make sure the jars are sealed completely and I let the mycelium grow out from the agar for several days. Decomposition of the added peroxide provides oxygen to support mycelial growth up to this stage, and carbon dioxide levels are not yet very high. When I have a halo of growth about a centimeter wide, I then shake the spawn, and this now results in new growth appearing at many new places in the medium within a few days. (Don't wait too long to shake your spawn, as the amount of peroxide left to protect the mycelium steadily declines as the halo of mycelial growth from the agar chunks grows wider). I used to loosen the lid to the jar slightly after shaking, to allow gas exchange, but I now find this to be unnecessary. The cardboard disk evidently allows enough gas exchange even with the lid tightened down.

The spawn is ready to use when the mycelium has grown through the spawn medium lightly but completely. I usually wait until the mycelium has started to extend about a half a centimeter or more above the top surface of the medium before I use a spawn jar for inoculation.

If you are using spawn bags, rather than jars, the procedure is essentially the same. You won't have to worry about contaminants entering the bags as they cool - any that do enter will be killed by the added peroxide.

What about using peroxide to make liquid cultures? I have not pursued this possibility, for two reasons. The first is that any method of inoculating a liquid culture is likely to require blenderizing the inoculum (or in some other way breaking up the mycelium), which releases significant quantities of peroxide-decomposing enzymes into the medium upon inoculation. The second reason is that, even assuming the first problem could be overcome, I would still expect the peroxide concentration to decline rapidly in a liquid culture as the intact fungal material with its internal peroxide-decomposing enzymes circulates throughout the liquid. (With solid substrates, the mycelium is confined to one area, and the peroxide concentration in the remaining substrate stays at a desirable level). The decline in peroxide could be compensated for by regular addition of fresh peroxide, but this might require a method of measuring peroxide concentration in very dilute solutions.

Table of Contents

Colonization of bulk substrate

Colonization of bulk fruiting substrates is the third stage of mushroom growing, leading directly to the production of edible mushrooms.

Because hydrogen peroxide solution is so cheap, it is economically feasible to add enough peroxide solution to fruiting substrates to help keep them free of contaminants. And from a technical standpoint, doing so can make it possible to grow a number of wood decomposing mushrooms without having to autoclave or pressure-cook the substrate. For the procedures in this volume, however, the substrate chosen has to be one that is devoid of peroxide-decomposing enzymes. Peroxide will provide little or no benefit with substrates that still have a great deal of biological activity, such as compost, or pasteurized straw, or fresh wood chips that have been treated with boiling water.

The first material I found to be ideal for use with peroxide was pellet fuel for wood pellet stoves. This substrate comes previously heat-treated, so it will not cause peroxide to decompose, even without autoclaving. As a result, pellet fuel can be conveniently pasteurized for use as a fruiting substrate by adding boiling water, which becomes part of the process of bringing the substrate to the proper moisture content. (When you add boiling water to fuel pellets, they turn back into the sawdust they were originally made from). Hardwood fuel pellets are generally the best bet for most wood-decomposing mushrooms, but pellets made primarily from Douglas fir may work for your strains too. (I suspect that the heat and pressure used in creating the pellet fuel may break down some of the mushroom-inhibiting resins in the fir). Look for a brand of pellets that does not have any additives - that is, plastic binders. Most do not.

Another substrate that I have used with peroxide is recycled pelletized paper fiber. In my area, this is sold as Crown Animal Bedding™, and as Good Mews™ Cat Litter. These products have been sanitized by a double heat treatment (according to the promotional material). The pellets are still about 30% moisture before adding any water. As with the pellet fuel, the material has no residual peroxide-decomposing activity. The drawback here is cost, as the animal bedding is usually priced about three times higher than pellet fuel on a dry weight basis.

If no pellet fuel or paper fiber pellets are available in your part of the world, you should plan to use one of the procedures presented in Volume II for your substrate preparation. Those procedures allow a greater variety of possible materials as substrates, including some that contain peroxide-decomposing enzymes. Indeed, one of the only materials that will NOT work with any of my peroxide procedures is raw sawdust, that is, the sawdust produced by the milling of raw logs.

If you have another substrate you'd like to use with peroxide, say paper waste or cardboard, but you plan to pasteurize it rather than autoclaving, you will need to be sure it is free of peroxide-decomposing enzymes after pasteurization. You can test it simply by putting a small amount of the substrate in a cup and adding some fresh 3% peroxide solution. If nothing happens right away, let it sit for a while. When peroxide-decomposing enzymes are present in the substrate, the mixture will bubble and froth. If the enzymes are all gone, the mixture will look no different from substrate mixed with water.

Recipes for fruiting substrates vary from one mushroom species to the next. For wood-decomposing mushrooms, most recipes include sawdust (which we will now derive from pellet fuel), at least 1% powdered lime, water sufficient to give a final moisture content of about 60 to 65%, and from 5-20% of the dry weight as some kind of nitrogen rich supplement like rice bran (which provides about 0.1% to 0.4% nitrogen overall).

Higher nitrogen levels in supplemented sawdust generally translate to higher yields of mushrooms, but traditionally, high nitrogen has also translated to greater risk of contamination. With the peroxide method, the danger of contamination may not increase appreciably with higher nitrogen levels. However, to be on the safe side, I seldom raise the nitrogen level above 0.4%.

Wood chips and substrate density

Traditional recipes often call for wood chips, but I have never included them in my substrate since it would require the inconvenience of pressure-cooking the chips separately and adding them to the pasteurized bulk substrate later. Some growers believe wood chips are crucial for good growth of shiitake. I have not found them necessary for *Hypsizygus ulmarius*, *Pleurotus eryngii*, or *Hericium erinaceus*. However, for *Hericium erinaceus*, I have found it beneficial to gently but firmly compress the sawdust in my cultures after inoculation by pressing with my hands on the outside of the bag, removing the air space (but not the absorbed water) in the substrate. This may serve something of the same purpose as adding wood chips, by creating a substrate of greater density. I can well imagine that an organism like *Hericium erinaceus*, which can grow happily through woods as dense as walnut and cherry, might prefer a dense substrate and thus do better on compressed rather than fluffy sawdust.

In traditional methods without peroxide in the sawdust, it would not have been advisable to compress the substrate, because of the danger of creating anaerobic conditions favorable to deleterious organisms. With peroxide in the substrate, however, decomposition of the peroxide provides a beneficial level of oxygen even in compressed substrate, thus making it possible to provide the density some of the organisms prefer without inducing anaerobiosis.

Preparing supplemented sawdust with peroxide

So here's what to do with the pellet fuel:

1. First, find a container such as a five gallon plastic bucket with a tight-fitting lid, and clean it thoroughly. (For my routine cleaning, I wipe down the inside of the bucket with a scrub sponge and biodegradable dish detergent, then rinse this out.)
2. Next rinse the container and its lid with boiling water - a teakettle-full should do. From here on out , you will need to avoid touching the inside of the bucket or the rim.
3. Place the loosely-closed bucket on a scale and scoop in about 8.0 pounds dry weight of pellets if you have oak, or 6.0 to 6.5 pounds if you have a lighter wood like fir (six pounds is roughly a gallon of pellets, if you prefer to measure by volume. I use a one quart glass pot that I've boiled some water in on the stove to do my scooping, but it doesn't really need to be pasteurized). You will probably have to make your own adjustments for your local pellet fuel, setting the weight you use according to the amount of sawdust you can fit in your bucket along with your supplements and spawn, while still leaving

enough room to mix the contents of the bucket efficiently.

4. If you are using a solid, denatured nitrogen supplement like Sylvan's CG60 or Millichamp 3000, it can be added to the pellet fuel at this stage.
5. Add your lime to the pellet fuel. I use powdered oyster shell lime, but before I use it, I bake my supply at 400 degrees F for a couple of hours to eliminate any peroxide-decomposing enzymes resulting from microbial growth on the shells. Crushed limestone is also a good choice if you can get it. Do not use dolomite lime, which contains magnesium that can inhibit mushroom development. For mushrooms grown on oak pellet fuel, I use 2 oz of lime, or half that much for lighter pellet fuel such as cottonwood.
6. Boil in a covered pot half the amount of water you want to add to the pellets. (Your water should be clear and free of any obvious particulates. In some cases this may necessitate filtering). For this step, I boil about 3.5 quarts (or about 3.5 liters) for 9.0 lbs of the oak fuel pellets. (If you are using a soluble nitrogen supplement such as artificial fertilizer, it can be added to the water before boiling). Fir pellet fuel sawdust is less dense, so I use only about 6.5 lbs of it, boiling 3 quarts of water. You may want to experiment with different moisture contents for the species you are growing. One advantage of adding peroxide to your cultures is that you can add more water than you could otherwise, without developing anaerobic areas in your substrate that might lead to contamination. However, the pellet fuel sawdust tends to clump as more water is incorporated, which makes it harder to pour into the bags later on without spilling).
7. When the water has boiled for a minute, set the lid of the bucket carefully to one side and pour the boiling water over the substrate. Seal the lid and mix the substrate by turning the bucket for a couple of minutes to distribute the water.
8. Boil in a separate covered pot the other half of the water you want to add to the pellets (e.g., another 3.5 quarts/liters of water). When the water has boiled for a minute, turn off the heat and set this pot of water aside to cool with its cover in place. You'll use this water to add peroxide later.
9. Set the bucket of substrate aside to cool, with the lid in place. Cooling usually takes several hours. The bottom of the bucket can still be somewhat warm to the touch at the time of peroxide addition.
10. With a boiling-water-rinsed measuring cup, add about 1/2 cup of 3% peroxide solution to the pot of cooled, boiled water you've set aside.
11. Pour the peroxide mixture into the cooled bucket of substrate and mix thoroughly by turning the bucket. This gives a final peroxide concentration of about 0.03%, or a one to one hundred dilution.
12. Let the substrate finish cooling to room temperature. It is now ready to use.

Perhaps you are wondering at this point whether this procedure can be simplified along the lines of the Ten Minute Spawn procedure. If the peroxide concentration were raised to compensate for decomposition in the hot substrate, maybe peroxide could be added at the beginning of the procedure with all of the water. This may indeed prove possible with a high enough initial peroxide concentration. However, the substrate takes more than twice as long to cool when all of the moisture is added initially as boiling water. Under these conditions, I suspect the peroxide will have a difficult time surviving the exposure to heat, even if the initial concentration is raised several fold.

Table of Contents

Nitrogen supplements for bulk substrate

If you are using traditional nitrogen supplements like millet or rice bran, you will have to pressure cook them. While still hot, the sterilized supplement gets poured into the cooling pasteurized substrate. Be careful to wipe drips off the outsides of the jars before pouring.

Most of the traditional nitrogen supplements for mushroom culture require pressure cooking to eliminate the endogenous peroxide-decomposing enzymes before pasteurization. (These enzymes are remarkably stable, and standard pasteurization procedures are generally not enough to inactivate them, even with delicate supplements like bran). However, as I discussed in the section on making sawdust spawn, I have now found a few supplements that are free of enzymes and so can be added without pressure sterilization, in this case mixed in with the wood pellets. Two of these are commercially manufactured nitrogen supplements already in use in the Agaricus mushroom industry (Sylvan's Millichamp 3000 and CG 60). They contain denatured soy protein and corn gluten, respectively, and evidently the denaturing process destroys the peroxide-decomposing enzymes. These supplements are an excellent value, but home hobbyists may have difficulty obtaining them. Also, care must be taken to keep them from spoiling in storage, especially with Millichamp 3000.

Some more expensive forms of processed protein are more readily available, such as Texturized Vegetable Protein, powdered soy milk, or powdered cows milk.

Another type of supplement that can be used without pressure sterilization is simply chemical fertilizer, such as a standard 20-20-20 fertilizer. Since these fertilizers do not come from living organisms, they contain no peroxide-decomposing enzymes. Nevertheless, for the most part the nutrients they contain can be utilized by mushroom mycelium after a period of adaptation. If you are going to try this method of supplementation, I recommend that you prepare sawdust spawn using the same supplement, so that the adaptation period will have already taken place by the time you inoculate your bulk substrate. Also, you will get a chance to see how the particular fertilizer you have chosen will work for the organism you are growing. Fertilizer formulations vary quite a bit, even with the same NPK rating, so it is probably advisable to test your selected fertilizer with a small culture before going on to bulk substrate.

Urea is a common source of nitrogen in the formulations for chemical fertilizers, and it probably can also be used by itself as a supplement without pressure sterilization.

If you want something more "organic" than artificial fertilizer (and there is good reason to avoid dependence on substances which require energy from petroleum for their manufacture), human urine and animal urine can also serve as supplements that don't need pressure cooking. However, they must be kept relatively free of micro-organisms until use. Addition of peroxide provides one way to do this.

Calculating how much supplement to add

How do you calculate how much of the various supplements to use? Calculations are only approximate, and you will ultimately need to make decisions based on your actual yield of mushrooms at various levels of supplementation. But you can get an idea of what you'll need by consulting Stamets's Growing Gourmet and Medicinal Mushrooms, where the appendices reveal that rice bran has an NPK rating of roughly 2-1.3-1. So, if substrate would ordinarily get supplemented with 5 to 20% rice bran, which Stamets suggests, then a 20-20-20 fertilizer, which has 10 times as much nitrogen as rice bran, would be added at one tenth the rate of rice bran, or 0.5 to 2% of the dry weight of substrate. If you were adding one pound of rice bran to a bucket of pellet fuel, then you would add 1.6 oz of 20-20-20 fertilizer instead, that is, one tenth of a pound. With the commercial supplements, you will need to find out from the manufacturer what percentage nitrogen the material contains, and divide that number into 2.0 to learn what fraction of the amount of rice bran you would add. Sylvan's Millichamp 3000, made from soy, is about 7.3% nitrogen, so it will need to be used at about one quarter the rate of rice bran.

You can also directly calculate the amount of the material needed to give 0.1% to 0.4% nitrogen in the final substrate, without reference to the amount of rice bran used by Stamets:

1. Divide the percent nitrogen in the supplement by the final percent nitrogen desired in the substrate.
2. Divide the previous number into the total weight of substrate to be supplemented to get the weight of supplement to be added.

Thus, to get 0.2% final nitrogen (which requires a supplementation rate of roughly 10% of the dry weight of substrate with rice bran), how much soy flour would we need to add? If the soy flour is 7.6% nitrogen, 7.6 divided by 0.2 gives 38. If the total weight of substrate is 6.5 pounds, then 6.5 divided by 38 gives 0.17 pounds, or 2.72 oz soy flour to be added.

A note on measuring pH of substrate

I use ColorpHast strips with a pH 4 to 10 range to measure the pH of all my media and substrates, aiming for a pH at make-up in the 6-7 range in most cases. ColorpHast strips are inexpensive and convenient, and with a three-color comparison, I am usually confident of my reading. However, it is not a good idea to try to measure the pH of medium with a color indicator strip once peroxide has been added, as the peroxide may change the chemistry of the indicator. With agar cultures and spawn, you can easily measure the pH before sterilization. With pellet fuel, use a small scoop such as a measuring cup (one that has been rinsed with boiling water) to take a small amount of substrate out of the bucket after adding and mixing in the boiling water plus lime. You can then use your color indicator strips to measure the pH of the removed substrate. Be aware, however, that the reading will only give you a relative idea of the pH eventually experienced by the mushroom mycelium if you have added granular lime which dissolves only very slowly. Addition of Mason's lime (CaOH, available in large sacks as "builders' lime" from construction supply stores) gets around the latter problem, as it dissolves and reacts much more quickly, but with some mushrooms there may be an advantage to providing a "delayed release" source of alkalinity such as granular lime provides. Then you will simply have to calibrate the amount of lime you used against the ultimate yield of mushrooms to determine the optimal dose.

Culture containers

Traditionally, sawdust cultures have been grown in special plastic bags with microporous filter patches, to allow gas exchange without letting contaminants gain entry. With peroxide in your fruiting substrate, however, you should be able to use ordinary trash bags (at a savings of $.50-$.80 per bag) to grow your mushrooms. Evidently the process used to produce trash bags pasteurizes them to the point that they do not harbor significant live-organism contamination. If you do use plastic trash bags, I recommend using the kind that are made from high density plastic, 0.5 mil thickness or less. These bags are thin enough that oxygen can diffuse through them, so that the cultures can be grown to maturity with the bags sealed closed by twist ties. Also, the thicker, softer bags are apparently made from PVC, which can leave estrogenic residues in the mushroom cultures, and certain of these softer bags are impregnated with fungicides.

Unless you use traditional gusseted mushroom bags, you will need to put your bags inside containers of an appropriate size to provide a form for the substrate. Small boxes which will hold 5-6 pounds of substrate can often be scavenged from health food stores or the like, or you can buy plastic containers such as nursery pots.

Filling a plastic trashbag, propped inside a box, with pellet fuel substrate.

Disposable bags create considerable waste for the landfill. An alternative is to use plastic buckets with lids, 2 or 3 gallon in size, preferably HDPE plastic, recycling number 2. (Five gallon buckets are easier to come by, but they are a little too big for your average sawdust culture). These can be cleaned with detergent and reused after rinsing with boiling water. If the lids are left slightly loose during the spawn run to allow gas exchange, the buckets are excellent culture vessels for mushrooms species that fruit vertically, such as *Pleurotus eryngii*. *Hericium erinaceus* will also grow in them if you open the bucket and turn it on its side when fruiting time comes. (I fill the bucket only about a third to half way full with substrate, so the upper part of the bucket provides a moisture barrier). *Hypsizygus ulmarius* would be a little cramped for space in one of these buckets, unless you were to fill substrate nearly to the top, so that the mushroom clusters could grow out above the rim. To get a second flush, then, you would need to take the round block out of the bucket and turn it upside down, since *Hypsizygus ulmarius* doesn't like to fruit from the same surface twice.

Inoculating supplemented sawdust

I prepare spawn for inoculation in the traditional way:

1. The day before I want to use the spawn, I break up the spawn by whacking the jar against something hard protected by something soft.
2. When the particles are separated, I put the jar back on my spawn shelf and incubate overnight to give the mycelium a chance to put out some new growth. This makes a considerable difference in how fast the mycelium will surge into the new substrate. If I am working with grain spawn, it also gives me a chance to see bacterial contamination in the form of "wet" or greasy looking grain kernels that haven't acquired a new fuzz of mycelium. When your spawn has been grown using peroxide, the presence of two or three wet kernels will probably not interfere with the subsequent success of your colonization of bulk substrate, since the bacteria that are able to survive peroxide exposure are generally fairly benign organisms when present in small quantities. However, if you have quite a few more wet kernels than two or three, the bacteria will likely slow the colonization of bulk substrate substantially, which then may give a chance for mold to gain entry. So you will probably want to discard spawn with any significant quantity of wet kernels.
3. I inoculate the pellet fuel sawdust by breaking up the spawn briefly, then pouring it directly into the 5 gallon bucket with the substrate. I close the lid and mix everything together by rotating the bucket.

Inoculating a bucket of pellet fuel substrate with spawn.

4. I pour the mix into bags. Each bag gets opened up and set inside of a box of the appropriate size to receive the substrate.
5. When I have filled the bag to the capacity of the box, I close the lid on the remaining inoculated substrate, and taking care not to touch the inside surface of the bag, I shift the bag a bit to fill any gaps, then twist the mouth of the bag closed and seal it with a twist tie.

Bag of inoculated substrate sealed with twist tie.

6. Lastly, I compress the sawdust by pressing down on the bag, gently but firmly. I find that this speeds growth of some cultures, especially with a light sawdust like fir or cottonwood.

After labeling, the box is ready to incubate, and from here on out, I follow standard mushroom-growing procedures. You can use the resulting blocks of mycelium either directly for fruiting mushrooms, or the blocks can serve as spawn for inoculating logs or beds of fresh wood chips outdoors.

Table of Contents

Mushroom formation

For most commonly cultivated mushroom species, mushroom formation begins soon after the cultures are shifted to cooler temperatures, given more light, and given more fresh air, provided the substrate has been thoroughly colonized. There is not much need for hydrogen peroxide during this phase, since the mycelium is well established.

The precise procedures for inducing mushroom formation differ from one species to another, and it is beyond the scope of this manual to review them all, but I will give guidelines for my favorite species. Two of the mushroom species most familiar to me are also among the easiest to fruit: *Hypsizygus ulmarius* (the White Elm mushroom) and *Hericium erinaceus* (the Lyon's Mane or Pom Pom mushroom). Many oyster mushroom species follow similar procedures to that required by *Hypsizygus ulmarius*. The other species most familiar to me, *Pleurotus eryngii* (King Oyster) and *Agaricus subrufescens* (almond mushroom) follow a different fruiting pattern. Shiitake follows yet another.

Most of the "easy" mushroom species are ready to fruit when the bulk substrate is thoroughly grown through. Often the blocks look white at this time, rather than the original brown of the substrate. How long it takes for a culture to reach maturity depends on the organism, the substrate, and the incubation temperature. Hericium can take as little as 2-3 weeks to form small white, globular fruiting initials on the upper surface of the block, but I like to wait until a month has elapsed before opening the bags. *Hypsizygus ulmarius* takes about 5 weeks on fir sawdust or straw and six weeks on oak sawdust (at ordinary room temperature), after which small clusters of pinhead primordia will begin to form spontaneously. By cutting an "X" or a single slit with a clean knife through the bag on the side of the block, *Hypsizygus ulmarius* and various Oyster mushroom species will usually form primordia at the site of the cut within a week or two, and mushrooms will soon develop. Provide mist spray when the mushrooms are about an inch high.

Hericium will also form mushrooms at the site of a cut in the bag, but in the winter I find it easier to grow large fruiting bodies by allowing the organism to fruit inside the bag. Simply turn the block on its side and open the bag a bit, allowing air exchange but still providing a moisture barrier. Fruiting bodies will form at random from the fruiting initials that have already developed.

If you grow only a few blocks of mushrooms, ventilation will not be much of an issue. But with more blocks, the need for ventilation to remove carbon dioxide increases. If your mushrooms are not getting enough air as they develop, they will become deformed. *Hypsizygus ulmarius* and other oyster mushrooms, for instance, will grow long stalks and irregular caps when the carbon dioxide concentration is too high. When you have enough blocks to need a fan, then an automatic misting system can't be far behind.

Note that if you decide to grow *Hypsizygus ulmarius* or another oyster species in your home, you will probably need to take precautions to protect yourself from the tremendous amount of spores produced by these organisms. Harvesting the mushrooms when young can help keep the spore load down. Covering the fruiting cultures with Reemay™ or other row cover material will keep the bulk of the spores within the covering, while allowing gas exchange sufficient for fruiting. However, if you or someone in your family is sensitive to the spores, you may need to acquire an air purifier to eliminate the spores from the air in your living space, or else keep the cultures in an out-building.

The almond mushroom, the white button mushroom, as well as King Stropharia and Shaggy Mane, and sometimes King Oyster all need something called a casing layer applied to the mushroom culture to stimulate fruiting body formation. Casing is a mixture designed to imitate a moist, friable, loamy soil. It contains microorganisms that promote mushroom formation, and it provides a moisture reservoir for mushroom growth. It generally contains little available nutrition for the growth of mushroom mycelium, and this feature also sends a signal to the mushroom culture to begin mushroom formation.

Almond mushrooms growing from a casing layer.

Most casing contains peat moss, and a simple formula I have used for almond mushrooms simply calls for one part peat mixed with one part garden soil, plus a handful of gypsum (calcium sulfate) for two or three gallons of mixture, all moistened until damp but not clumpy. The casing is applied to the top of the mushroom culture to a depth of two inches at the most. Be careful not to tamp it down, as the porous structure is essential for encouraging formation of mushroom primordia.

Peat bogs are an endangered habitat worldwide, so we need to find alternatives to the use of peat in casing. Growers in different parts of the world have begun to devise alternatives, as one can discover by searching the US patent database (see http://www.uspto.gov/). In some cases, soil alone may suffice as a casing, or soil plus vermiculite. Vermiculite by itself is a possible alternative (although it will not supply microorganisms). Almond mushrooms and King Oysters do not absolutely require a casing (the casing does tend to accelerate primordia formation with *Pleurotus eryngii*, however), so manipulation of conditions may lead to good fruitings without it for these organisms.

If you do apply a casing, you will then need to wait a week or two for the mycelium to grow up into the casing before mushrooms will begin to form. With the almond mushrooms, this is the time to warm up the cultures (I put my apple-box cultures of almond mushroom on an electric "cat warmer" to be certain they are warm enough). It is also the time to sprinkle the casing lightly with water every couple of days to keep it moist. (With *Pleurotus eryngii*, warming and sprinkling are not necessary). Mushrooms usually begin to form a few days after the mycelium begins to reach the surface of the casing.

Seasonal planning

I you are only growing a few mushrooms, and you have a cool, insulated indoor space such as a lighted basement, you will probably be able to grow your favorite mushrooms all year. However, if your are growing outdoors, or you are growing a lot of mushrooms indoors (so that you need ventilation from outdoors), you may need to plan ahead to have the appropriate mushroom cultures ready in the right season. I fruit my mushrooms in a basement with open windows and a fan to bring in fresh air, so the mushroom growing gets harder in the hottest part of the summer and the coldest part of the winter. Closing the windows is not an option, as carbon dioxide will build up and inhibit mushroom formation. Heating or cooling the incoming air is certainly possible, but it runs up the energy bill too much for my taste. So all my mushrooms do best in fall and spring.

In the coldest part of the winter, both the temperature and the light levels fall. All the mushrooms take longer to finish colonizing the bulk substrate. *Pleurotus eryngii* fruits with difficulty, and *Hypsizygus ulmarius* grows very slowly, producing longer stalks (and deformed caps, if the light and temperature levels are too low). *Hericium erinaceus* also grows slowly at this time, but this species still produces normal, but small, fruiting bodies even in very cold weather. *Agaricus subrufescens* needs warmth, but paradoxically it makes a good indoor mushroom for winter, because it will fruit in heated room and it doesn't need as much air or light as the other mushrooms.

In the hot parts of summer, there is plenty of light, but it can be a problem to initiate fruiting at the higher temperatures. Keeping humidity up can be difficult, too. However, I have had *Hericium erinaceus* blocks fruit on a dry compost pile in 90 degree weather; evidently the fresh air initiated fruiting in that case, since my indoor *Hericium erinaceus* blocks refused to fruit until the temperature came down substantially. *Agaricus subrufescens* likes warm weather and tends to fruit as the peak temperatures pass. *Ganoderma lucidum* also prefers warm weather, as does Stropharia.

Outdoor growing vs. indoor growing

I used to grow almost all of my mushrooms indoors. This allowed me to grow them year 'round because of the more moderate temperature, and it also saved me from having to deal with slugs and snails, which love mushrooms and grow in great numbers in my area. (Actually, I still get a few slugs that manage to climb in my windows, travel down the cement basement wall and across the cement floor, and eventually enter my fruiting cultures). Deer may also eat mushrooms, and fungus gnats can be a problem in outdoor mushroom patches. So in the past, I have always recommended indoor growing. But outdoor growing has its advantages, too. For one thing, mushrooms fruited outdoors have a distinctly superior flavor to mushrooms grown indoors. Also, mushroom formation can be more robust in the fresh air of the outdoors. There's more physical space for crops. And there is little problem with breathing mushroom spores. Fungus gnats can be reduced somewhat by covering cultures with a fine light fabric such as Reemay™ or other row cover materials. And if you live in a temperate region on the seacoast, you may be able to grow mushrooms outdoors all year 'round. So if you think you can keep all the pests away, go ahead and fruit your cultures outside. You will just need a shaded area that can be kept damp.

Harvesting

Knowing when to harvest mushrooms is largely a matter of knowing how large they grow and what changes they go through as they mature. With *Pleurotus eryngii* and *Hypsizygus ulmarius*, the uncurling of the margin of the cap is usually a sign that the mushroom has reached maturity, but you will need to correlate this change with the size of the mushroom to be sure. With *Agaricus subrufescens*, the cap opens and the gills begin to turn reddish in color. With *Hericium erinaceus*, small "icicles" form and the mushroom softens.

Most mushrooms are said to be tastier if harvested before they start releasing many spores, although they may still gain more mass if left to grow further. It is certainly true that *Hypsizygus ulmarius* is tastier when young, but I haven't personally made taste comparisons with the other mushroom species I grow.

Table of Contents

Trouble shooting

Despite my use of hydrogen peroxide to protect my mushroom cultures, there have been many occasions when things did not go as I had planned and contamination appeared. Each time, I had to track down the problem and correct my procedure, and each timed I was relieved to learn that the use of peroxide itself was not flawed. The procedures I have described here to the best of my knowledge incorporate everything I have learned from my mistakes and should cover the key points required to produce contamination-free mushrooms with peroxide-based culture. Nevertheless, troubleshooting is an unavoidable part of mushroom culture, and you will have to do it sooner or later.

I always find it discouraging to read through lists of things that can go wrong, so instead, I have created a list of questions that draw attention to different aspects of the culture process for the purposes of troubleshooting contamination problems.

If you are adding peroxide, and you still suffer significant contamination, you might ask yourself some of the following questions:

Is the concentration of peroxide in your stock solution what it should be? Has it been over a month since you measured it?

Is your pressure-cooking equipment functioning properly?

Is steam able to enter your jars and equilibrate (are the lids loose enough?)

If pressure cooking, do you allow five minutes for steam to equilibrate before putting on the pressure regulator?)

Is your stove element (if electric) heating consistently?

Are you cooking at a high enough temperature and for a long enough time to eliminate resident contaminants and, if necessary, peroxide-decomposing enzymes?

Is your substrate moist enough for steam to penetrate? Has your substrate or supplement spoiled before use?

Is your peroxide getting distributed evenly throughout the medium?

Is your pH reading accurate? (Peroxide is apparently most stable around neutral pH). If your fruiting substrate is getting contaminated, is your spawn clean?

If your spawn is getting contaminated, is your inoculum clean?

If you are free-pouring diluted peroxide into your cultures, are there drips that run over unsterilized surfaces before falling into the culture?

Are your petri dishes free of traces of old medium?

If your agar plates are getting contaminated, is the contamination on the surface or within the agar? If it is on the surface, look for a source of contamination external to the agar medium; if it is in the agar, contamination is getting in before or during pouring.

Are you letting your medium or substrate cool sufficiently before adding peroxide?

Is your water clean and free of particulates?

Have you overlooked some source of unsterilized or unpasteurized material that can get into your cultures?

Are you mushrooms getting enough light (but not direct sunlight), fresh air, and humidity to grow to a good size?

Conclusion

As I reach the end of this manuscript, I am forced to pause for a moment of self examination. I called this volume Growing Mushrooms the Easy Way, and now I have to ask myself whether I wasn't indulging in just a bit of self-serving exaggeration when I chose that name. After all, there are still far more ways for things to go wrong in mushroom cultivation than for them to go right. And I sometimes think it is a wonder indeed that we ever get any of these organisms to respond to our coaxing and produce their delectable fruiting bodies.

Well, it is a wonder. And even with peroxide maintenance of mushroom cultures, the process is far from fool-proof. But I feel gratified that the procedures described here do make it possible for hobbyists with at least a minimal degree of comfort with sterile technique to perform all the steps of gourmet mushroom growing and mushroom culture in an ordinary household, more easily than ever before, with no more special equipment needed for contaminant control than a steaming pot and a measuring pipette. And with the stress taken off of battling contaminants, home growers should be freed at last to focus on the thing that attracts us all to mushroom growing in the first place, the quest for ever more of those beautiful and delicious fungi.

Table of Contents

VOLUME II

Introduction

I've written this second volume of my manual, Growing Mushrooms the Easy Way, both to fill in some of the gaps in the first volume, and to introduce some new ideas for saving time, effort, and money in the process of mushroom cultivation.

As in the first volume, most of the methods in this second volume have been designed primarily for small scale and home cultivation. But I designed two of the methods for preparing bulk substrate specifically for growers who want to work at commercial scales. And nearly all of the remaining techniques presented here could also prove useful in a commercial context.

The procedures are broadly organized within the volume according to the stage of mushroom cultivation they apply to. So, the techniques relating to maintaining cultures and germinating spores come first. Then come the methods for preparing spawn, finishing with the procedures for preparing bulk substrate.

The procedures in this volume largely stand on their own for growers familiar with the peroxide method. But if you are a newcomer, you'll want to refer to the first volume of Growing Mushrooms the Easy Way. It has essential background information on mushroom growing generally and on the use of hydrogen peroxide in mushroom culture in particular.

The peroxide-based methods presented in this volume are my original inventions unless otherwise stated. In general, the non-peroxide methods have been worked out by others and have made there way into the public domain. I am presenting them here because of their obvious value to mushroom growers who use the peroxide method.

Enough said - let's get started!

Acquiring, Storing and Maintaining Mushroom Cultures

Using slants instead of agar plates

It has long been the standard procedure in mycology to grow mushroom tissue cultures in Petri dishes filled with agar medium. But as more and more people seek to cultivate mushrooms without sterile laboratories, this standard has come into question. Perhaps the biggest drawback of agar Petri dish culture for mushrooms is that the dishes have such a large exposed surface area. Because they are incubated for so long, the chance of picking up airborne contamination is high. Even with peroxide in the agar, mold colonies will occasionally appear at the edges of plates. This is especially true after the mycelium has spread over most of the agar, and especially during the "mold season" in the fall.

One solution to the problems of agar Petri dish culture is to switch to agar culture in containers that have smaller exposed surface area. For instance, screw cap test tubes are a good choice. The kind I'm talking about have typical dimensions of 19 x 125 mm. When these tubes are partly filled with molten agar medium which is allowed to solidify at an angle, they are called slants.

Slants are relatively easy to handle and store. It is also easy to hold the mouths of the tubes over the flame of an alcohol lamp for a moment on opening and closing. This gives added security against contaminants. The water in these tubes evaporates much more slowly than in Petri dishes, so the peroxide concentration remains at an effective level for much longer. Even without peroxide, the contamination rate is low. What's more, slants use less agar than Petri dishes, so they save you money. But there is a downside. Some mushrooms don't like the wetter environment in slants (for example, *Hypsizygus ulmarius*). You can't monitor the morphology of the mycelium as closely in slants as on agar plates (changes in morphology can indicate contamination or other strain problems). And it can be frustratingly difficult to dig out chunks of mycelium from slants when you want to inoculate other cultures. This last problem depends quite a bit on the kind of mycelial mat a given mushroom lays down.

Making slants

Here's how to make a set of slants:

1. Measure out the ingredients for MYA medium into a clean metal can. (See below for MYA medium - 250 mls. will make about 20 slants or so.) Squeeze a crimp in the rim of the can to serve later as a pour spout.
2. Put a piece of aluminum foil over the top of the can. Put the can in your pressure cooker with some water. Put your screw cap tubes in at the same time, perhaps sitting in another can.
3. Steam for 10 minutes without the weight in place. Then put the weight on, bring the cooker to full pressure, and cook for 10 minutes more.
4. Remove the cooker immediately from the heat and cool. Open the cooker as soon as the pressure has gone down. Take out the can and the tubes to cool. You can set the can in a pan of warm water to speed the cooling, but don't let it start to solidify.
5. Add 1.5 mls. peroxide for 250 mls. of MYA medium. Add peroxide with a pasteurized pipette that is, one steeped briefly in boiling water. Mix the peroxide in by swirling the can.
6. Finally pour the agar into the tubes. Use the pour spout on the can to get the agar into the narrow mouths of the tubes. Avoid spilling over the tube threads. Hold the screw cap curled in the little finger of your dominant hand while you do the pouring.
7. Replace each cap and set each of the tubes leaning at a low angle for solidifying. A wide low bowl works well for this purpose. When solidified, they are ready to use.

For easy reference, here's the recipe that I use for MYA Medium:

- 12 gms (0.42 oz) agar
- 12 gms (0.42 oz) light malt powder
- 1 gm (0.035 oz) nutritional yeast powder
- 0.5 gm (0.017 oz) grain flour (I rotate between wheat, rye, corn, rice, oats, and millet)
- 0.5 gm (0.017 oz) rabbit feed (or other animal feed pellets)
- 4 gms (0.15 oz) wood fuel pellets (the quantity of wood pellets can be increased for those wood-decomposing species that do poorly on agar)
- 1 liter tap water
- Adjust pH to 6-8 with a bit of baking soda or vinegar (optional)

Making transfers to and from slants

For inoculating slants, and for withdrawing mycelium from them, it helps to have an inoculating loop made of fairly stiff wire. You can make an inoculating loop for yourself. Put a small loop in the end of a wire, then inserting the other end of the wire in a thin glass tube (1/8 inch, for example). Finally, use a flame to melt the end of the glass tube closed over the wire to hold it in place. The glass tube becomes the handle.

For successful inoculation, you will still need to dig out a chunk of agar plus mycelium and transfer it to the slant. This can be a tricky endeavor with an inoculating loop. (If the chunk is too small, or if you simply scrape mycelium off the surface of the agar, it may not be able to establish itself. But if at first you don't succeed, you can always try again with the same slant. The peroxide will keep it free of contaminants. I like to dig the loop into the agar to cut out a piece of the culture. But it can still be hard to catch a good-sized piece on the loop. Many times I've pulled out such a piece only to have it drop off the loop as I moved to transfer it. But eventually you'll do it. Roll the mouth of the screw cap tube in the flame of your alcohol lamp before and after the transfer.

Cleaning the mycelium with slants

In Volume I of Growing Mushrooms the Easy Way, I explained how invisible microbial contamination can build up on the mycelium of cultures grown by the peroxide method. I also presented a method for "cleaning" the mycelium of these contaminants by inoculating the bottom of the agar in Petri dish cultures. With slants, the invisible contaminants should build up quite a bit more slowly than with Petri dishes. But they will eventually accumulate to the point where the mycelium needs cleaning. There is, however, no convenient way to inoculate the bottom of the agar, so we have to use a different method. This method consists of pouring a second layer of agar - when it is almost cool enough to solidify - on top of mycelium growing on the first layer of agar. The mycelium then grows up through the second layer, cleaning itself as it goes.

Here's what to do:

1. Prepare and inoculate slants as described above. Allow the mycelium to grow out a bit over the agar.
2. Prepare a small amount of MYA medium by the standard procedure. But use a can with a crimp in the rim for a pour spout (as for making slants above) to hold the medium. Cover it with aluminum foil.
3. After cooking, when the medium has cooled substantially, add peroxide at the usual concentration. Mix thoroughly by gentle swirling.
4. When the bottom of the can is barely warm to the touch, light your alcohol lamp. Open a slant, holding the cap in the crook of your little finger. Rotate the mouth of the tube over the flame of the alcohol lamp. Then pour enough of the fresh agar medium into the tube to cover the mycelium completely. You can either cover the mycelium with the tube "slantwise" or with the tube standing upright. The less agar you use, the smaller distance the mycelium will have to grow to reach the surface. Beware - the remaining agar in the can tends to solidify rather suddenly! So put it in a pan of water that is slightly warm.
5. Return the screw cap to the tube.
6. Allow the mycelium to grow up through the new layer of agar.

When taking out mycelium for inoculations, be careful not to dig through the top layer of agar into the lower layer. That will defeat the purpose of the layering.

Beer-Based Medium (BBM)

Here's a medium for agar plates that saves most of the weighing and measuring. It is also perfect for those of you who can't find a source of malt extract. And even if you can, malt powder can turn hard as rock in storage. This medium gets around that problem. It comes to you courtesy of Dr. Nenad Vidovic and Sansin Corporation in Ontario, Canada (see Vidovic, N., Specialty Mushrooms - Small Scale Production, Mycelium, 25, 1999, pages 4 and 8). Dr. Vidovic showed that several mushroom species can grow on BBM just as well as they do on commercial malt extract agar medium. I have modified his recipe to include peroxide.

Ingredients:

- 1 part fresh beer
- 3 parts water
- 2% agar by weight (2 gms agar powder per 100 mls of medium, or 1 tsp per 1/2 cup)

1. Mix beer and water.
2. Add agar.
3. Sterilize in a pressure cooker at full pressure (15 lbs psi) after steaming 10 minutes to dissolve the agar.
4. Cool until the container can be handled. Then add peroxide (6 mls/liter of 3%), mix well, and dispense medium into sterile petri plates.

Dr. Vidovic also reports that sterile BBM without agar makes an excellent storage medium. He calls this LBBM, for "liquid beer-based medium." Cultures of both oyster mushrooms (*Pleurotus ostreatus*) and morels (Morchella species) were easily recoverable after two years in LBBM (with no peroxide added). It also works well for spore germination.

Starting with Spores

I usually urge would-be mushroom growers to begin their mushroom explorations with healthy, established tissue cultures of the mushroom species they want to grow. These should be obtained from reputable suppliers of mushroom cultures. Such cultures have been tested and shown to produce good yields of mushrooms under certain reproducible conditions. Unless the culture is subsequently damaged, it will continue producing good yields of mushrooms when you supply the right conditions. And if you lose the culture, you can (in most cases) go back to your supplier and obtain another copy. The copy will then produce mushrooms under the same conditions that worked well for the previous culture. If you start with spores, by contrast, there is no assurance that the mycelial culture you grow from them will fruit in useful quantities. There is also no assurance that the mushrooms produced will have the characteristics of the mushroom the spores came from. Moreover, you will not know the optimal growing conditions for the strain you obtain by spore germination until you have tested the strain yourself. And if you lose the culture, you will have to start over again from scratch.

Still, there are arguments on the other side. Cultures obtained by spore germination are often quite vigorous. With fast growing species like oyster mushrooms, the differences between the parent mushroom and the spore-produced progeny are often small. Spores may cost little or nothing, whereas tissue cultures can be expensive. Spores can be obtained from dried mushrooms whereas tissue cultures can't. And so on. So it is certainly worthwhile to have a simple method of germinating spores.

In previous editions of the peroxide manual, I insisted that spores could not be germinated on peroxide medium. But a couple of people wrote me to say that they had indeed germinated spores in the presence of peroxide. So now I have to acknowledge that yes, it can be done. You may have to apply a concentrated dot of millions of spores to the surface of the peroxide medium, but it can be done. Still, I am not convinced it is a good idea for routine use. The mycelium generated this way could easily be genetically damaged. And as it turns out, it is not especially hard to start clean cultures from spores in the absence of peroxide, even in a non-sterile environment. One good method is to start the spores in screw-cap tubes. Then the chance of airborne contamination entering is greatly reduced compared to Petri dishes (many thanks to David Sar for letting me know about this approach).

Collecting Spores

Here's a way to collect spores:

1. Pressure cook a few Petri dishes for 15 minutes or so in a covered container. Let the dishes cool.
2. Pick a mature mushroom for your source of spores. If possible, choose a clean one that is not likely to be covered with mold spores.
3. Clear a counter someplace in your house where there won't be too many air currents from people walking by. Clean the counter with a sponge and then wipe it down with rubbing alcohol.
4. Open one of your Petri dishes (you can just set the lid, top surface up, next to the dish on the counter). Arrange your mushroom over the dish. If it is big enough, the mushroom can cover the entire bottom half of the Petri dish. Or perhaps you have a cluster that can span the dish. Smaller mushrooms, or mushrooms with odd shapes like morels, can be suspended above the plate by a thread. Use your imagination. Ideally, you don't want the mushroom touching the inside of the Petri dish bottom. And you don't want too much of the Petri dish exposed to airborne contaminants. But you want the mushroom arranged so its spores can fall into the dish.
5. Go ahead and collect spores, ideally until you have a visible coating of spore "dust" in the dish. This takes about an hour for a copious spore-producers like the oyster mushrooms. But you might need to go several hours for some mushroom species, and you might never get a visible coating with others. Close up the Petri dish when you're finished.

Table of Contents

Germinating Spores by the Disk Method

Here's my favorite method for germinating spores. It uses neither agar nor peroxide. You'll put spores onto a small cardboard disk, then pop the disk into a sterile screwcap test tube. The spores will germinate in a few drops of nutrient medium in the tube. I have used this method successfully to germinate shiitake, portabello, almond mushroom, elm oyster, and Pleurotus spores. This is what you do:

1. Make some small disks by punching random holes in a piece of gray (non-corrugated) cardboard. Do this with a paper hole punch, saving the circles that are cut out.
2. Make up about 10 mls of BBM liquid (without the agar).
3. Get together a set of clean screw cap test tubes (19 x 125 mm) or similar narrow mouth containers.
4. In each tube, place 5-10 drops of the BBM liquid.
5. Sterilize the cardboard disks in a petri dish or a small jar with a lid (10 minutes at 15 psi).
6. At the same time, sterilize the screwcap tubes with the BBM liquid in them. The tubes will have a little pool of liquid at the bottom after they have cooled.
7. Once everything is sterile and cool, flame-sterilize a tweezers. Use it to swipe one of the disks across the spores you've collected (or collect your spores directly into the sterile container of cardboard disks).
8. Pop each spore-treated disk into a sterile tube (flame the mouth of the tube on opening and closing). Make sure the disk gets down into the pool of liquid medium remaining. The disk should be wet for good spore germination. Screw the lids on tightly. Make several replicates.
9. You may need to keep the tubes from drying out. This is especially important for slow-germinating species such as shiitake or button mushrooms. For these species, place the tubes inside a larger container with a lid. Add some water to the container and close the lid.
10. Incubate. Change the water in the larger container if it goes bad.
11. Periodically examine the disks in the tubes for small signs of white fuzz (mycelium). Discard cultures that contain mold or bacteria. (Green and blue-green mold will grow quickly in round clumps. These are white at first, then develop a colored center. Bacteria will cause the liquid to become cloudy.)
12. Once you've got some mycelium, remove the disk to a peroxide plate or slant. You can do this with a flame-sterilized tweezers, or you can slide the disk out with a flame-sterilized inoculating loop.
13. Incubate and let the mycelium grow out. Growth will be slow, as the mycelium has to adapt to the peroxide.

The dark color of the cardboard disks helps to reveal the light mycelium when it appears. But be forewarned that the tufts of mycelium sometimes can be very hard to see at first.

On a peroxide-treated agar plate, you can observe the halo of growth formed by the spreading mycelium. The mycelium may not be homogeneous, or it may carry contaminants. If so, the halo will likely show sectors that grow at different rates and with different appearances. You can then take mycelium from the best-looking sector for transfer to fresh plates. The best sectors should have good radial growth, or snake-like rhizomorphic growth. Cottony mycelium is usually to be avoided, but it may be the norm for some species. Once you have stable, non-sectoring mycelium, you are ready to make spawn and test your strain in bulk substrate. And don't forget to make storage cultures!

Ideas Toward Mycelial Culture without Agar

Agar is probably the most expensive ingredient used in mushroom growing. It is relatively simple to handle once you've been introduced to it. But many beginning mushroom growers avoid getting their own cultures because of their unfamiliarity with agar. So I have been thinking about alternatives. Here I suggest one simple choice that shows promise as an alternative to agar medium - it's gray cardboard disk culture. Gray cardboard is cheap and reasonably available. (Other colors of non-corrugated cardboard can also be used). And as long as it is clean, it will not contain any peroxide- decomposing enzymes. Unlike corrugated cardboard, gray cardboard wets easily, and the wet material is soft enough to remove clumps for transfers. It is also a good substrate for the growth of mushroom mycelium, often supporting rapid growth even when very limited amounts of other nutrients are present. And it is a simple matter to add a nutrient solution if you need it.

So, instead of going through all the trouble of weighing ingredients for agar medium, melting the agar, cooling slowly, adding peroxide, pouring plates, waiting for them to solidify, then drying them for a couple of days, you can just cut disks of gray cardboard to fit your Petri plates or jars, and prepare a jar of plain water or a simple nutrient solution. Then, pop the plates and the jar of liquid in the pressure cooker for 10 minutes. Cool rapidly, and add peroxide to the jar of liquid. Finally, dip the cardboard in the liquid to give it peroxide protection. The cardboard plates are then ready to use as soon as the solution has soaked in.

Where gray cardboard is in short supply, newsprint is a possible substitute, but it has several drawbacks compared to cardboard. For one thing, it can be hard to see the mycelium, particularly if the newsprint is light in color. The mycelium can be as wispy as a spider web when it is growing on newsprint anyway. To complicate matters it may spread more beneath the surface, out of view, than in plain sight. Moreover, the growth rarely develops in a nice round halo such as one gets on agar. Nor does it necessarily progress evenly from one layer of newsprint to the next. Instead, the mycelium can spread somewhat capriciously. Apparently it is influenced by small variations in the conditions it encounters between the layers of the newsprint.

I do not yet know whether mycelium can be repeatedly transferred on plain, unsupplemented cardboard without running into nutrient limitations. I would expect cardboard to be close to devoid of nitrogen. So until further notice, it is probably a good idea to add a nutrient solution to keep your mycelium going on cardboard disks.

How to prepare the plates

Here are the detailed steps for making cardboard plates. Note that you can also use small jars in place of Petri dishes.

1. Measure about 250 mls. of tap water into a small jar. Use BBM (described above) if you want to add nutrients to the plates.
2. Find some gray cardboard, the thicker the better, preferably gray on both sides. Trace Petri plates onto the cardboard with a pencil. Cut out several disks somewhat smaller than the tracing.
3. Get together a set of petri dishes, at least one more than than the number of disks you have.
4. Moisten the disks slightly: dip each one in tap water and immediately shake it off. Then close up the disks inside the plates.
5. Pressure-sterilize the jar of liquid and the Petris, including the one empty dish, for 10 minutes at 15 psi (allow the cooker to equilibrate steam for 10 minutes before putting on the pressure regulator).
6. Cool the cooker, and remove the plates and jar of liquid.
7. When the liquid has cooled, add 1.5 mls. 3% peroxide to the jar. Use a measuring pipette that has been steeped in boiling water. You will have a final concentration of about 0.018% peroxide in sterile liquid.
8. Pour some of the diluted peroxide solution into the empty Petri dish that you sterilized. This will serve as a dipping reservoir, to wet the cardboard disks.
9. Sterilize the end of a pair of tweezers in a flame. Use the tweezers to transfer one of the cardboard disks at a time to the dipping reservoir of diluted peroxide solution. Let the solution soak into the disks briefly. Then remove each one and transfer it back to the Petri dish it came from.
10. The disks/plates are now ready to use.

You can store and incubate these plates inside plastic food storage bags as I suggest in Volume I for agar plates. But you will probably find that your cardboard disks dry out too quickly. You can keep them moist longer by storing them in a closed container that has some peroxide solution in the bottom. For instance, find a plastic yogurt container or a jar with a mouth wide enough to let Petri dishes pass. Then create a platform to hold your Petri dishes off the bottom of the container, perhaps by putting a smaller jar inside the larger container. Put the Petris on top of the platform. Then add a small quantity of peroxide solution to the container at the same concentration you use for your plates (roughly 0.018%). Finally, cover the container with a layer of plastic wrap and fix it in place with a rubber band around the mouth of the container (this kind of closure will allow adequate oxygen diffusion). Be careful to set it up so that you cannot knock your Petri dishes off the platform into the water.

Making transfers

Now you are probably wondering how you will remove wedges of cardboard when you want to make a transfer from one of these plates. Well, you won't cut wedges, but here's the trick: you can easily scrape material off the surface of the moist disks using the point of a sterile scalpel. Just draw the scalpel tip firmly sideways across the cardboard a few times in one place. The scrapings can then be transferred to another plate or to a jar of spawn with the scalpel.

Corrugated cardboard turns out to be too tough for easy removal of material from the surface by scraping in this fashion.

Cleaning the mycelium

As I explained in Volume I and in the section on slants above, invisible contaminants from the air can build up on the surface of mycelium that has been grown on peroxide plates. That's because the peroxide protects the medium but not the mycelium. The invisible contaminants have to be cleaned off periodically. Otherwise they will multiply in spawn or fruiting cultures. Mycelium grown on cardboard is no exception.

With agar cultures, we cleaned the mycelium with a rather awkward procedure. This called for prying the agar disk out of the bottom of the Petri plate into the lid, then inoculating the bottom of the agar, then returning the agar disk to its original place. This forced the mycelium to grow up through the medium, leaving contaminants behind. Although this works, it also increases the failure rate because it is such a tricky maneuver.

With cardboard, it is easy to inoculate the bottom of the disk: you can just flip the plate upside down. Then the disk falls into the lid and the bottom of the disk is exposed. Just transfer a sample of mycelium to the exposed surface with a flame-sterilized scalpel, close up the plate, and flip it back over. Voila! But as it turns out, the mycelium takes a surprisingly long time to grow through the disk. Instead it prefers to spread laterally. So rather than waiting for the mycelium to grow to the top, we can simply allow it to spread on the bottom of the disk. As long as it is left undisturbed, the mycelium then will grow entirely under the cover of cardboard. This way it has very little exposure to airborne contaminants. This in itself should keep the mycelium clean, especially if the cardboard disk sits nearly flat on the bottom of the plate. If you routinely inoculate your plates this way, and you take material toward the edge of the mycelial halo for your transfers, I expect you should have little problem with accumulation of invisible contaminants.

You may have trouble getting your disks to sit flat on the bottom of your Petri plates. If so, you may have better luck by creating a sandwich of cardboard with two sterile peroxide-moistened disks. Then you can inoculate the inside of the sandwich, between the disks. The mycelium will grow entirely within the sandwich, keeping it free of airborne contamination. The dry quality of the cardboard surface on both sides of the mycelium, in addition, should discourage the spread of bacteria and yeast. So the mycelium should clean itself as it spreads laterally within the sandwich.

When you want to get at the protected mycelium inside the sandwich, you pry apart the pieces of cardboard. But you cannot see how far the mycelium has grown without opening it. So you will have to be careful about dating your cultures. Then you can be sure you have allowed enough time for the mycelium to grow out before you open the sandwich.

Storage cultures without agar

For long term storage of mycelium, I like to use paper fiber pellets loaded into screw cap test tubes. Here's what I do:

1. Put about 1 oz (28 gms) of paper fiber pellets or sawdust into a small bowl or can.
2. Add roughly 25 mls (2 Tbs) boiling water to the pellets.
3. Break up the pellets into small bits with a fork or something similar.
4. Load the substrate into screw cap test tubes, filling perhaps half way. To load, I put some material on a teaspoon, and hold this at the mouth of the tube. Then I use a finger to press some of the particles through the opening. It is a messy process.
5. Place caps on tubes and pressure sterilize for 10 minutes. Cool.
6. Inoculate each tube with a bit of agar culture. Roll the mouth of the tube in a flame on opening and closing.
7. Store the inoculated tubes in a cool spot (or at room temperature for warm-growing species).

The mycelium will slowly colonize the substrate. Then, when you need a fresh tissue sample, bring out a tube. You can break loose a few bits of the colonized substrate by means of an inoculating loop or scalpel. Then tap them out onto new medium. Finally, you can put the tube back into storage to use another time.

I have had only a limited time to determine how well these cultures hold up in long-term storage. But I suspect they will do better than agar cultures. Paper fiber and cardboard more closely resemble natural substrate for mushroom mycelium than agar does. And if you don't add any nutrient solution, the paper fiber will be low in nutrients. This is usually recommended for storage cultures. It encourages something close to a dormant state. It also prevents an accumulation of toxic waste products that the mycelium would produce in a richer medium in long term storage. At the same time, some species, such as oysters, do not do well in wet storage (that is, distilled water or slants). These species may find the paper fiber or sawdust medium more to their liking, since it has a drier character. In addition, paper fiber cultures of cold-tolerant strains, such as those of oyster mushrooms, can easily be frozen.

Sending cultures in the mail

Cardboard sandwich cultures can easily be stored in plastic zipper seal baggies, and they can be sent out in the mail this way as well. Make a sandwich of mycelium between two thin disks of gray cereal-box cardboard that have been sterilized and moistened with peroxide solution. (The colored side of the cardboard faces out. This helps hold moisture in and keep potential contaminants sealed out.) Then, with a tweezers, pop this sandwich into the smallest zipper seal bag you can find. Zip it closed, and let the mycelium grow out for a few days. (Caution: the sandwiches can dry out quickly. To prevent this, put them into a larger container with some water. For instance, add a small amount of water to a plastic yogurt tub. Place the zipper-seal bags in the container with the seal well out of the water. Close the lid and incubate. Change the water if it goes bad.) Instead of a zipper bag, you can also use an ordinary plastic food storage bag. Cut off a corner section of the bag, fold it over neatly, and tape it closed. Finally, send your culture off in the mail. The recipient at the other end will just need to transfer the mycelium to a fresh plate. To do so, he or she will need to remove the sandwich to a sterile Petri plate or jar. Then they'll pry the sandwich open with a tweezers to get at the mycelium, which has been kept clean and protected inside.

This method of mailing cultures in ordinary envelopes is probably limited to species whose mycelium can tolerate the low temperatures reached in the cargo hold of a jet plane. Warm-growing species such as the almond mushroom (*Agaricus subrufescens*) may need to be packed in insulated containers to keep them from freezing.

Re-sterilizing Disposable Petri dishes with peroxide

Here's a way to re-use those disposable plastic petri dishes. Of course, you can sterilize other containers this way, too.

Wash out each dish, taking care to remove the old agar. Rinse.
Pour in a little fresh 3% peroxide and slosh it around in each dish.
Place the dishes in the microwave and heat until the peroxide has all been driven off. The exact power setting should not matter much.

Now the petri dishes are sterile and can be used for pouring medium.

One correspondent pointed out that microwaving alone should sterilize these petri dishes, without the peroxide. I pointed out in return that peroxide alone should sterilize them as well (and this could come in handy if you don't have a microwave oven). The two treatments combined provide an extra margin of security.

Table of Contents

Spawn Preparation

Spawn in plastic bags - "Eight Minute Spawn"

In Growing Mushrooms the Easy Way, I presented a procedure for preparing pellet-fuel based spawn quickly and easily using glass jars as containers. This is still my own preferred method for making spawn. But I have worked out variations on this method so that it can be adapted to additional situations.

For instance, perhaps you don't have a collection of jars, but you can easily get fresh clear plastic bags ("food storage bags"). You can use these bags as spawn containers - in fact, they offer certain advantages over jars. For one thing, you don't need to add paper fiber pellets to the spawn recipe when using bags. This simplifies the formulation process, saves money, and gives you a more finely divided spawn at the same time. (The pellets were there to make it possible to break up the spawn by agitating the jars. With plastic bags, you can break up the spawn by manipulating the bags). For another thing, air exchange into the plastic bags seems to be greater than that into jars. Oxygen can enter directly through the plastic but not through glass. This speeds up growth of spawn somewhat in the plastic bags. And, the spawn bags heat and cool more quickly than jars, so the steaming process can be completed even more quickly than before. The bags also save the trouble of preparing cardboard disks to fit in the jar lids, and of cleaning the jars. And finally, the bags allow you to smell the spawn without opening it. The fragrance escapes through the plastic. This allows you a way to check for purity of the spawn other than just by looking at it. Bacterial and mold contamination will introduce a sour or moldy smell, and each mushroom species has a characteristic fragrance.

On the other side of the equation, the bags create non-biodegradable waste (although they can be washed and re-used). The bags also can get pin-holes in them which you can't see. And, they are not especially convenient when you want to remove just a small portion of the spawn at a time (with jars, you can remove the lid, shake out some spawn into a waiting container, then replace the lid). For the latter reason, I still make my spawn masters (which I use for inoculating additional spawn) in jars.

Making the spawn

Here's a recipe for preparing six small bags of Eight Minute spawn, each just the right size to inoculate a 5-gallon bucket of pellet fuel or roughly 6-9 pounds dry weight of substrate.

- 22 oz (624 gms.) pellet fuel (or other peroxide-compatible material)
- 3-4 Tbs. (45-60 mls) peroxide-compatible nitrogen supplement (see Volume I for options)
- 0.4 oz (11.4 gms.) powdered limestone or oyster shell lime
- 0.2 oz (5.7 gms.) gypsum (calcium sulfate)
- 990 mls. hot tap water
- 110 mls. 3% hydrogen peroxide

1. Measure the pellet fuel into a bucket or pot. Add the liquid ingredients and allow the water to get absorbed.
2. Add the remaining dry ingredients and mix them in thoroughly with a spoon or spatula. Keep mixing until the pellets have broken down into sawdust.
3. Measure 9-10 oz (255-283 gms., or roughly 2.75 cups) of the resulting substrate into six clear food storage bags. Twist the bags loosely closed.
4. Heat about 3 inches of water to a rolling boil in a large pot or canning cauldron. Put some sort of rack or heat diffuser at the bottom. Place all of the bags at once into the boiling water. Lower them in by holding the necks of the bags together.
5. Cover the pot and boil for 8 minutes.
6. Immediately remove all of the bags and float them on cold water in a wide pan. Take care not to let the mouths of the bags get into the water.
7. When the bags have cooled substantially, remove them from the water. Tie off the mouths of the bags about an inch or so from the tops with twist ties.
8. When the bags have cooled completely, they are ready to inoculate.

Using the spawn

To use your bag spawn, break up the mycelium the day before you will inoculate. You can do this by manipulating the bag to turn the clumps of mycelium into lumps, and the lumps into smaller particles. Take care not to puncture the bag with your fingernails, or with the twist tie. The next day, you are ready to pour out the spawn from these bags. Be aware that the mouths of the bags are not sterile above the twist ties. So you shouldn't use them like pour spouts. Instead,

1. pull open the mouth of the bag by grasping from the outside surfaces
2. fold the mouth of the bag back on itself, and
3. push the spawn out while turning the bag inside out.

"Ten Minute" Grain Spawn

Here's one way to prepare grain spawn without a pressure cooker: use "instant brown rice," which lacks peroxide-decomposing enzymes. Just add water, gypsum, and peroxide to the rice, and steam it in a jar or plastic bag. Then cool, and you're ready to inoculate. The idea for this procedure comes to you courtesy of René Rikkelman.

1. Get together a set of jars with lids - or use fresh plastic (twist tie) food storage bags.
2. For the jars, trace the circle of the lids onto cereal box cardboard (or similar thin cardboard). Cut out disks somewhat smaller than the traced circle. Fit a disk like this inside each jar lid. Later, you will wet these disks with hydrogen peroxide, so they will serve as a barrier to contamination. If you have two-piece lids, the disks will also help hold the lids together when you open them.
3. Get some "instant brown rice" from the grocery store. Krafts or Uncle Bens are well-known American brands. There's not much rice in each box. Regular rice will NOT work because of the enzymes. Instant WHITE rice does not have enough nutrition in it to support some mushroom species.
4. Put your rice into a large bowl or yogurt tub. Add powdered gypsum, about a gram for every 200 mls (about a cup) of rice.
5. In a container such as a pitcher, measure out one volume of hot tap water for every two volumes of rice you are using. Add enough peroxide solution to make a final concentration of about 0.30 to 0.35 percent (about 0.1 volumes of 3% peroxide).
6. Add the liquid to the rice in the bowl. Mix the rice with a spoon to get it wet with the solution. Most of the liquid will eventually soak into the rice. Just stir it now and then to keep it evenly distributed.
7. When the rice has absorbed all or most of the water, divide it up between the jars or bags. Fill the jars about 2/3 full. Screw the lids with their cardboard disks LOOSELY onto the jars.
8. For bags, skip to 12) below. For jars, add about an inch of water to a large lidded pot. The pot will need a rack or something to keep the jars from sitting directly on the bottom. Place the jars in the pot with their lids loosely in place. Put the pot's lid in place.
9. Bring the water in the pot to a boil. When it has reached a consistent rolling boil, let the pot continue to boil for just 10 minutes. Then immediately remove the jars from the pot to a heat resistant surface like a cutting board. (CAUTION: Steam from the pot can burn you, and the jars are also hot. Thick rubber gloves are a good way to remove and handle the jars at this stage.)
10. Allow the jars to cool thoroughly.
11. Open each peroxide-treated jar lid briefly. Pour a little 3% peroxide onto the cardboard disk inside the lid. Wet the disk completely. Shake off any excess peroxide into the sink.
12. For plastic bags, add about three inches of water to the pot, and bring it to a boil. Place your bags of rice into the pot so that they float on the boiling water (do this wearing thick rubber gloves to avoid burns). Loosely twist the necks of the bags around each other. Make sure they don't droop into the water. Replace the lid on the pot and boil for just 8 minutes.
13. Remove the bags to a wide pan of cold water for rapid cooling. Seal with twist ties when cool.

Inoculating straw without spawn

Here's a trick for growing oyster mushrooms on straw when you don't want to make spawn. Or maybe you just want to try something different: inoculate your straw with chopped up mushrooms. I have only seen this work with oyster mushrooms. And it works best when the mushrooms you use are very young. They should not yet be fully formed, just one or two inches high. At this stage, the mushroom tissue is growing rapidly. If the young mushrooms are cut and tossed into some prepared straw, they will throw out mycelium in just a couple of days. Here's what you do:

1. Prepare a batch of straw by the room temperature peroxide soak method presented later in this volume.
2. Pick a young cluster of oyster mushrooms.
3. Dip the cluster briefly in warm soapy water to clean it, then shake off the liquid.
4. Place the cluster on a fresh piece of wax paper or some other clean surface.
5. Using a clean knife, chop up the mushrooms into bits (exact size doesn't matter). Hold the cluster by the base. Try not to touch the mushrooms themselves with your bare hands.
6. Sprinkle the mushroom bits into your prepared straw. Manipulate the straw with disposable gloves as needed to distribute and mix in the bits.
7. Incubate the straw as you would an ordinary culture.

Notes keyed to the steps:
2) I don't have a precise formula for the amount of mushroom tissue to use. This will depend on how finely you chop the tissue. But you can start with about 15% of the substrate dry weight as mushroom pieces.
3) This sudsy bath prevents transfer of mites and other insects at inoculation. It probably also reduces bacteria and mold contamination.
5)-6) It is also possible to use a food processor to finely chop your fruiting bodies, and this is probably a good idea if there is any chance your fruiting bodies contain fungus gnat larvae. Just clean the cup and blade of the food processor thoroughly with hot sudsy water before use. I don't especially recommend creating a slurry of mushroom tissue - the extra water in the slurry will have to be drained out of your straw after inoculation.

Will repetition of this method lead to senescence (age-related deterioration) of the mushroom culture? I favor the idea that most of what is called senescence by mushroom growers is really caused by poor cultivation practices. It is clear that mushroom cultures can be transferred for years on quality medium. It should just be kept lean to prevent accumulation of toxic metabolites. It also should be cooked only lightly to prevent carmelization of sugars.

Although I can't rule it out, I think senescence is not likely to be a problem for several years at least. Some of the largest organisms on earth are single fungi covering vast tracts of land; these organisms must have taken many years to reach their current size. So it is quite possible that even if fungi do age, their lifespan is similar to the human lifespan, if not longer.

Preparation of Bulk Substrate

Bulk Substrate I: Preparing straw with peroxide - at room temperature

Next we come to a method for using peroxide to prepare straw for use as mushroom substrate. This method should be attractive to both the home grower and the commercial cultivator. The procedure can be carried out entirely at room temperature, with no heating and cooling step, and no caustic solution required. This makes substrate preparation very easy and convenient. There's no need for set-ups to heat large amounts of water or substrate. There are also no problems with over-pasteurization, and no concerns about the speed of cooling. And there is no problematic waste produced by the substrate preparation process. There is just the natural "tea" that is normally produced by soaking straw in water.

The procedure was designed for straw, but it should be possible to prepare other "drainable" substrates this way, too. These would include things like bagasse, dried grasses, and dried corn leaves. Materials of this kind are readily available in most parts of the world. I have also been told that cottonseed hulls can be prepared this way. So other non-porous nut hulls may work as well. (Wood chips are best prepared by a slightly different procedure - see below).

I have tested the protocol both with the elm oyster (*Hypsizygus ulmarius*) and with the almond mushroom (*Agaricus subrufescens*). Similar species such as traditional oyster mushrooms (Pleurotus species), Portobellos, white button mushrooms, and Royal Sun Agaricus (*Agaricus blazei*) should grow well on straw prepared this way. More of a question mark is shiitake. It is typically grown on straw with a nitrogen supplement, and I haven't used a supplement to grow the elm oyster and the almond mushroom.

What about the enzymes?

Here I have to admit that I previously argued that peroxide pasteurization of straw would not work. I reasoned that straw contains high levels of peroxide-decomposing enzymes in it (as do other similar substrates). These enzymes should destroy the peroxide in short order. They should also protect the numerous mold spores in the straw from the peroxide. But It turns out that straw nevertheless CAN be pasteurized with hydrogen peroxide. Yes, the enzymes in the straw do indeed destroy the peroxide in a relatively short time. But the peroxide can still have a beneficial effect even in the brief time it survives contact with the straw. We just have to raise the peroxide concentration (compared to what I previously employed for pellet fuel preparation). And we have to tweak the chemistry of the peroxide solution slightly. The peroxide itself does not linger to protect the straw from contamination, as it does in enzyme-free pellet fuel substrate. But the peroxide-treated straw seems to resist contamination, even after the peroxide is gone. And it seems to change into a more favorable substrate for the growth of mushroom mycelium.

The protocol

Despite this complicated preface, the protocol for preparing straw with peroxide is extremely simple. It goes like this:

1. Place your straw in a large soak vessel.
2. Fill the vessel with the appropriate cold solution (see below) to immerse the straw.
3. For chopped straw, soak about 4 hours at room temperature. For unchopped straw, soak for at least 28 hrs, or until the leachate takes on the color of a good tea.
4. Drain the straw thoroughly, until it is no longer drippy.
5. Remove the straw to your culture containers, mixing in spawn as you go.

Notes on straw preparation (keyed to the step numbers):

1. If the soak vessel has a heavy or tight fitting lid, this can help keep the straw submerged in the solution.

2. The most effective solution I have found so far uses hydrogen peroxide at a concentration of at least 0.15%. This is combined with 10 mls. of vinegar per liter of soaking solution, or about 2.5 tablespoons vinegar per gallon. Higher concentrations of vinegar did not work in mini-trials.

   Curiously enough, an alternative which has proved almost equally effective in mini-trials is peroxide with hydrated lime (calcium hydroxide, Masons' lime). But here you will use far less hydrated lime than you would if you were pasteurizing with hydrated lime alone. The latter approach uses so much hydrated lime that it creates disposal problems when you drain the straw. But you will now add just enough hydrated lime to raise the pH a bit while the peroxide reacts with the straw. You'll use just 1/2-2/3 tsp. hydrated lime per gallon of 0.15% peroxide solution, or 0.4 - 0.5 gms. per liter of solution. Higher concentrations of hydrated lime did not work in mini-trials.

   I recommend the hydrated lime alternative especially for materials that are naturally acidic. For instance, cottonseed hulls can be prepared this way, but not with the vinegar alternative (Michael Joy, personal communication).

Some commercially-available hydrated lime is made from dolomite. This has magnesium in it, which is not recommended for mushrooms. So avoid dolomitic lime if possible. The straw soak procedure, however, will still work with dolomitic hydrated lime.

Here's how to calculate how much stock peroxide solution you'll want. Your soaking solution needs to reach a concentration of 0.15%. So first divide 0.15% by the concentration of your stock peroxide solution. Then multiply the answer by the volume of water you will be using. For example, let's say you want to make 100 liters of 0.15% peroxide, and your stock solution is 6% peroxide. Then 0.15 divided by 6 gives you 0.025. Multiplying this by 100 liters gives you 2.5 liters. That's the amount of 6% peroxide you will need to add to 100 liters of water to get a 0.15% solution. (To be more precise, you would actually add 2.5 liters to 97.5 liters of water. That gives you a total volume of 100 liters. But either way will get you close enough.)

The solutions can be prepared with cold water from the tap. But the best bet is to use water that is not far below room temperature.

3. I recommend chopping the straw for best results. Chopping the straw promotes more efficient absorption of water. The smaller particle size also encourages faster mycelial growth upon inoculation.

   The wetting of the straw will proceed more quickly in warmer climates, more slowly in colder ones. Adjust your soak times accordingly.

4. How long you have to drain the straw depends on how much straw you are working with. But a couple of hours will probably be the minimum.

5. Straw can be mixed with spawn and loaded into plastic columns, for instance. Pasteurized gypsum, if added, can be mixed in at this stage as well.

I don't recommend adding nitrogen supplements, as most of the standard ones such as bran will invite contaminants. But if you must have a supplement, I would suggest using drainable materials resembling straw. One such material is alfalfa, which can be soaked in peroxide solution with the straw.

Table of Contents

Bulk Substrate II

Preparing raw wood chips with peroxide

Some mushroom species traditionally have been grown outdoors in beds of woodchips. The chips are usually prepared simply by watering over several days until they are moist. Growers have noted, however, that weed species often appear. Also, the inoculated species may end up fruiting away from the bed. So there is a need for a cleaner way to prepare the chips.

I find that raw wood chips can be prepared with peroxide, despite their content of peroxide-decomposing enzymes. But the procedure that works for straw results in wood chips that are rather slowly colonized. For better results, I recommend a different method:

1. Soak the chips in water overnight to get them wet.
2. Drain.
3. Coat the chips with peroxide at a 1% concentration or higher.
4. Inoculate with sawdust spawn.

The chips can be coated with peroxide by applying a fine mist spray while mixing. Although the peroxide concentration is high, relatively little peroxide gets used up this way.

The chips can be inoculated immediately if your spawn was peroxide-grown. Otherwise, you may want to allow some time for the peroxide to "cool" as it reacts with the enzymes in the chips.

The chips can also be given a nitrogen supplement such as Sylvan's CG60 provided the supplement is given the same treatment as the chips. I have not yet tested other supplements.

This procedure works well for the elm oyster mushroom. It should also work for King Stropharia (*Stropharia rugosa-annulata*), which backyard growers have often attempted to grow on chips prepared with plain water. But remember that after colonization of the chips, Stropharia needs a casing soil layer applied on top of the chips for fruiting to occur.

Bulk Substrate III

An "add-and-stir" method for peroxide-compatible substrates

This next procedure allows you to prepare wood-based mushroom substrate at room temperature, virtually in a single step. Unlike the previous methods for straw and wood chips, this procedure DOES require that you use a starting material essentially devoid of peroxide-decomposing enzymes. The added peroxide will remain in the substrate and protect against airborne contaminants. So there should be no need for air filtration or sterile facilities. The resulting substrate should allow contaminant-free growth of any wood decomposing mushroom species. Of course, you will still need to make an appropriate choice of additives, wood type, and growing conditions.

In the first volume of Growing Mushrooms the Easy Way, I presented one procedure for preparing wood pellet fuel. That procedure required adding boiling water to the pellets as the first step. This served both to pasteurize the pellets and to break them down into sawdust rapidly. The peroxide solution came into play only after the pellets had cooled. Then it served to kill heat resistant spores in the substrate and to protect the substrate from airborne contaminants. This procedure is easy enough for the home cultivator. But its requirement for two steps of liquid addition, as well as heating and cooling, makes it rather awkward to scale up for commercial cultivation. Also, the boiling water pasteurization doesn't work well with kiln-dried sawdust.

The new procedure avoids the awkwardness of the previous procedure by using ten times as much peroxide. At this level, the peroxide solution itself pasteurizes the substrate, and it does so at room temperature. That means there's no need for heating and cooling. It also means you can add the peroxide with all of the water in one step of liquid addition. What's more, you can add all your other additives right along with the peroxide solution: lime, gypsum, and peroxide-compatible nitrogen supplements. That gives you what is essentially an "add and stir" method of making ready-to-use mushroom substrate. It is not quite as easy as making pancakes from a mix - you'll need to wait for the peroxide to pasteurize the substrate. But it is undoubtedly one of the simplest methods of preparing sawdust substrate yet devised.

As a base substrate, you can use any peroxide-compatible wood product. You can use wood pellet fuel, composite logs, sawdust-based cat litter, and paper fiber pellets. I've even succeeded in using pelleted straw prepared this way for growing elm oysters, despite the presence of a low level of peroxide-decomposing enzymes in the straw. Just be sure the material you choose is otherwise conducive to the growth of the mushroom species you want to cultivate.

A few words on kiln-dried sawdust

In my area of the Pacific Northwest, this is the most commonly available kind of hardwood sawdust. It is the kind of sawdust that comes from the milling of kiln dried lumber. You will find it at mills and shops producing value-added wood products like flooring, panels, furniture, and the like. By contrast, raw sawdust comes from the milling of logs. Kiln-dried sawdust is usually cheaper than wood pellet fuel. Kiln-dried sawdust has very small amounts of peroxide-decomposing enzymes. There are so little that the enzymes are hard to detect, but enough so that the peroxide will be gone in a couple of days. This level of enzyme activity makes the sawdust workable for growing oyster mushrooms by the "add-and-stir" method. Oyster mushrooms are fast growing and relatively resistant to contaminants. But other species such as shiitake and Lions' Mane, which either grow more slowly or are more sensitive to contamination, are much less likely to succeed on kiln- dried substrate.

How can you tell if a sample of sawdust is actually kiln-dried? Drop some into a small quantity of 3% peroxide solution, and add a drop of detergent. If there is no more than a fine thin fizz produced after about ten minutes, your sample is kiln-dried, and it should work as a starting material for growing oyster mushrooms by the "add-and-stir" protocol.

The kiln-dried material can be too fluffy to pasteurize with a limited amount of boiling water, as is done in my earlier pellet fuel procedure in Volume I. But it is reasonably easy to coat the sawdust evenly with peroxide solution to pasteurize, as is done in the new "add-and-stir" procedure below.

The "add-and-stir" protocol

Here's the new protocol applied to preparing pellet fuel at room temperature. Kiln-dried sawdust can be prepared essentially the same way, but it will absorb more water, and take up more space in your container:

1. Clean and rinse a container (a boiling water rinse is not required).
2. Measure out your lime, peroxide-compatible nitrogen supplement, and gypsum if used. Have them at the ready (see Volume I for determining appropriate amounts).
3. Measure your pellet fuel into the container.
4. Measure into a separate container about 6.5 quarts (6.2 liters) of water for every 10 lbs. pellet fuel (but see the note below). The water needs to be at least "room temperature" (68 degrees F) or slightly warm to the touch. This helps the breakdown of pellets made from dense woods like oak. As in previous protocols, the water also needs to be free of visible particulates.
5. To the water, add peroxide to reach a concentration of about 0.45%.
6. Some types of pellet fuel, such as that made from oak, do not break down easily in water. For these, add a teaspoon (5mls.) of baking soda to every 6.5 quarts (6.2 liters) of peroxide solution as well.
7. After stirring the baking soda into the peroxide solution, pour the solution into the pellet fuel. Then add the other dry ingredients. Do it in this order so that the other dry ingredients don't get stuck on the bottom of the container.
8. Close the lid and let the pellets absorb most of the water (this may take 10-15 minutes).
9. Mix the substrate thoroughly by rolling the container.
10. Let the substrate sit in the closed container for at least 2 hours.
11. Mix the substrate thoroughly again. By this time, the substrate should be at least half in the form of sawdust and half as the round remnants of pellets.
12. Inoculate the substrate and divide into bags.

Notes on the "add-and-stir" protocol

As always, it is best to use woods favored by the mushroom species you want to grow. In general, avoid resinous woods like cedar and pine.

In Volume I, I suggested several processed enzyme-free materials as nitrogen supplements. In general, these are either expensive or difficult to find. But now I've discovered that it's possible to use some more common "natural" materials - at least for growing elm oyster mushrooms by the "Add-and-stir" method. One of the materials is steel-cut oats. They contain about 2.5% nitrogen. (Cracked wheat should also work. It contains about 2% nitrogen.) Although there are peroxide-decomposing enzymes in the oat particles, they haven't caused the cultures to spoil in mini-trials with elm oyster. Unfortunately, mini-trials with Lions Mane were not successful.

There's also a simple way to increase the effectiveness of these supplements: coat them with a small quantity of vegetable oil. Mushroom mycelium eagerly consumes the oil.

You will probably have to experiment a bit to find the right amount of water to add. This varies with the kind of material you are using as a substrate, and the kind of wood. For sawdust, you can use about an equal weight of water. For wood pellets, this may prove to be too much. You want to add enough water to break down the wood pellets to particles. But the material left at the bottom of the container (when you pour out the substrate into bags) should not be visibly wet. Pellets made from lighter woods will probably absorb more water per weight of pellets than those made from denser woods.

Some substrate materials, such as kiln dried sawdust, may resist wetting. In this situation, you can add a small amount of biodegradable dish detergent to speed up water absorption. For instance, I have used 1/4 tsp. detergent in 6.5 qts. water, or 2.5 mls per 6.2 liters.

The high peroxide concentration used in this protocol is most easily accomplished with a peroxide stock solution that is more concentrated than the usual drugstore product. I have used 1/3 cup (about 80 mls) of swimming pool peroxide for 6.5 quarts (about 6.2 liters) of water. This product was labeled 27%, but it actually tested at 34% by decomposition. You could also use food grade (35%) or similar solutions. Remember that these concentrated products are much more hazardous than the 3% solution. The liquid can cause burns, fires, or explosions, so it should be treated with considerable respect. Read the warning label and act accordingly.

How much stock peroxide solution will you need? Your final solution should reach a concentration of 0.45%. So first divide 0.45% by the concentration of your stock solution. Then multiply the answer by the volume of water you will be using. For example, let's say you want to make 20 liters of 0.45% peroxide from a stock solution that is 6% peroxide. Then 0.45 divided by 6 gives you 0.075. Multiplying by 20 liters gives you 1.5 liters. This is the amount of 6% peroxide you will need to add to 20 liters of water to get a 0.45% solution. (Actually, you would add 1.5 liters to 18.5 liters of water to get exactly a 0.45% solution. But either way will get you close enough.)

The substrate can be mixed the first time with non-pasteurized implements, if this is more convenient than rolling the container. After this first mixing, however, non-pasteurized implements should be kept out of the substrate. Only pasteurized (i.e. boiling-water rinsed) implements should be used.

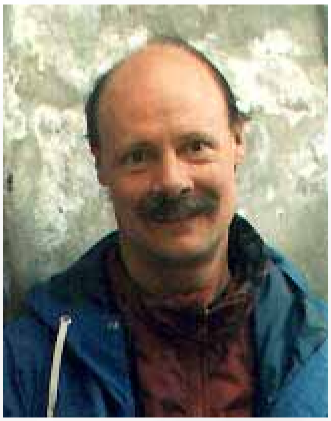
What about making spawn by the "add-and-stir" approach? I have succeeded in doing this with my elm oyster mushrooms. The fruiting cultures inoculated with it looked questionable at times, but they did complete their colonization and they did form mushrooms. To give this a try, just mix up some medium as for Eight Minute spawn above, but increase the peroxide concentration to 0.45%. If you are using jars, wet the cardboard disks inside the lids with 3% peroxide. Then let the spawn sit, closed up in its container, for at least two hours before inoculating.

Table of Contents

Conclusion of Volume II

The procedures I've spelled out in this supplement give a glimpse of the tremendous variety possible in mushroom growing techniques. At any given time, I usually have at least a few ideas for new tricks that I haven't had a chance to test. And I know from the correspondence I get that many of my readers have their own fascinating ideas as well. I hope this volume stimulates further creativity in this rapidly growing field.

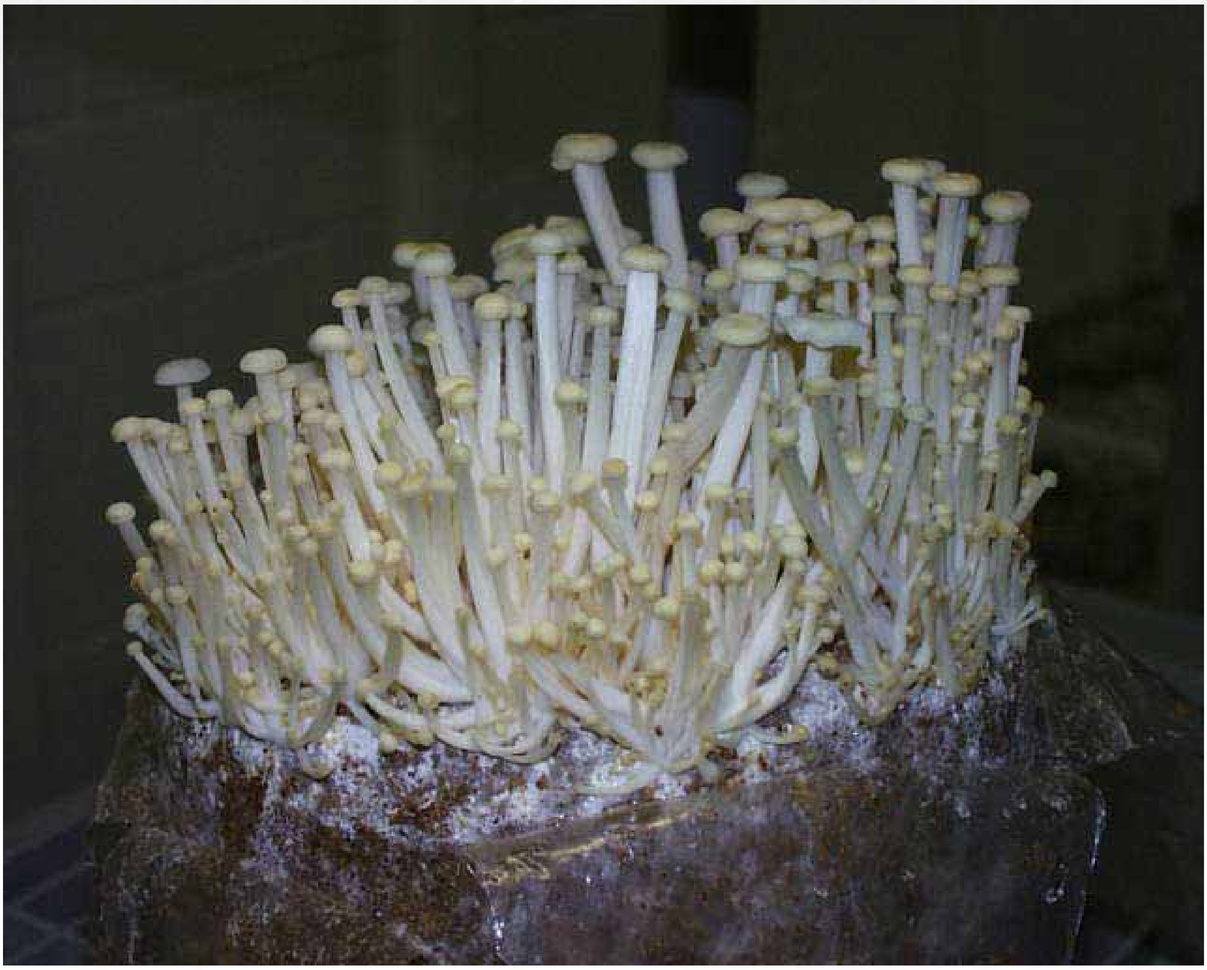
About the Author



R. Rush Wayne

Rush Wayne holds a Masters degree in Biochemistry and Molecular Biology from Harvard University and a Ph.D. in Biochemistry from the University of California at Berkeley. He was first exposed to the elements of mushroom growing during his graduate work in the 1970's but did not begin growing mushrooms in earnest until he began to implement the innovations contained in this manual in 1993. Instructions for his peroxide method of growing mushrooms are now in the hands of mushroom growers in over 75 countries around the world.

Results



Enoki and King Oyster mushrooms grown with peroxide by White Rock Creek Mushrooms in Hillsboro, Texas. Photo courtesy of Joe Durham.

Enoki and King Oyster mushrooms grown with peroxide by White Rock Creek Mushrooms in Hillsboro, Texas.
Photo courtesy of Joe Durham.

ST
6-6
ST
6-6
ST

Shiitake mushrooms grown with peroxide by White Rock Creek Mushrooms in Hillsboro, Texas.
Photo courtesy of Joe Durham.

Lions Mane and Almond mushrooms grown with peroxide.
Lions Mane photo courtesy of Joe Durham.

Maitake mushrooms grown with peroxide by White Rock Creek Mushrooms in Hillsboro, Texas.
Photo courtesy of Joe Durham.

Growing Mushrooms by Mrca

by

Mrca

original source: https://gluckspilze.com/uebersicht-1

Table of Contents:

- **Introduction to cultivating mushrooms**
  - What is a mushroom?
  - Three distinguished groups
- **Production of spore prints**
- **Microscopic examination of spores**
- **Preparation of Agar - Medium in Petri Dishes**
  - Mixing the substrate
  - Sterilisation of the agar medium
  - Pouring the Petri dishes
- **Mycelium germination from spores**
  - Inoculation of agar medium
  - Mycelium growth
- **Production of spore syringes**
- **Mushroom Cloning**
  - Inoculating the nutrient medium with a mushroom clone
  - Mycelium growth after cloning
- **Selection of Mycelium Strains**
  - Transferring rhizomorph mycelium
  - Mycelium growth after selection of strain
- **Sterilising rye substrate for grain spawn**
  - Preparing the rye substrate
  - Mixing proportion of substrate
  - Filling glasses with substrate
  - Filling bags with substrate
  - Sterilising the substrate
- **Inoculation of grain spawn with mycelium on agar medium**
  - Inoculation
  - Mycelium growth after inoculation
  - Reproduction of grain spawn
- **Sterilisation of wood substrate**
  - Preparing the substrate
  - Mixing proportion
  - Filling bags with wood substrate
  - Sterilising the wood substrate
- **Inoculating wood substrates with grain spawn**
  - Inoculation of wood substrate
  - Mycelium growth on wood substrate
- **Laying of a mushroom bed**
  - Bed preparation
  - Inoculating the bed
  - Further care
  - Wintering and feeding
  - Fighting snails
- **Inoculation of wood logs with spawn dowels**
  - Preparations of log

- Inoculating the logs
- Mycelium growth at log
- Setup in the garden and further care
- Wintering of log
- Fighting snails at log
- Special tips for Lentinula edodes (Shiitake)

Mushroom cultivation on a bale of straw
- Preparations of a bale
- Inoculation of a bale
- Mycelium growth on a bale - Spawn run
- Fruiting of a bale
- Fighting snails at bale

"PF-technique"
- Mixing the PF substrate
- Filling the substrate
- Sterilise the substrate
- Inoculation of the substrate
- Mycelium growth PF
- Fruiting

Inoculation of substrat bags with sporesyringes
- Disinfect the surface of bag
- Inoculation bag with syringe
- Seal the inoculation area and distribute the spores
- Spawn run in bag

Instruction for indoor mushroom propagator
- Main principle
- Use as Incubator
- Use as fruiting chamber

Introduction to cultivating mushrooms

What is a mushroom?

Due to the lack of scientific knowledge fungi were classified as plants for a long time. Today's understanding of genetic and physiological facts show that fungi are more closely related to animals than plants. Unlike plants they neither are able to carry out photosynthesis nor can they produce the carbohydrates they need.

Mushrooms are dependent on organic carbohydrates, built up and provided by other creatures to feed themselves. In the life cycle of organic matter they operate as biodegradant destruents, who disintegrate organic material and dissolve soluble minerals.

Three distinguished groups

On reference to their different nutrient sources fungi can be distinguished into three groups:

Saprophytes decompose organic material like cow dung, wood waste or straw. These fungi are the most important recyclers within the ecological system. This group includes the majority of cultivated mushrooms. It must be mentioned that fungi - like most other live forms - grown in vitro react differently in comparison to their natural forms: With idealised mushroom substrate at hand, bounteous harvest can be reached. Mushroom substrate is a highly specific, nutrient-rich product consisting of selected organic and inorganic matter for the purpose of cultivating mushrooms.
Under natural conditions only a few mushroom heads arise out of a vast amount of mycelia. And they only appear during short periods of the year.

Mushrooms can also live as parasites. These fungi develop at the expenses of another living organism (=host). True parasites are dependent on their host, who provides shelter and nutrition, though they usually do not kill them. Worth mentioning: honey fungi (Armillaria spp.) are probably the largest living creatures on earth with individuals expanding to a surface area of several thousands of square meters, reaching up to 800 meters in depth.

Some fungi live as Symbionts in a mutual beneficial relationship. If a fungus interacts with the roots of a plant, mycorrhiza is formed and establishes a bidirectional flow of nutrients. The fungus provides inorganic nutrients to the plant since it dissolves inorganic matter a lot easier. In exchange the plant affords carbohydrate assembled in photosynthesis. Furthermore the mushroom mycelium retains a great amount of water which is disposed to mycorrhizal plants in periods of dry weather.

Table of Contents

Production of spore prints

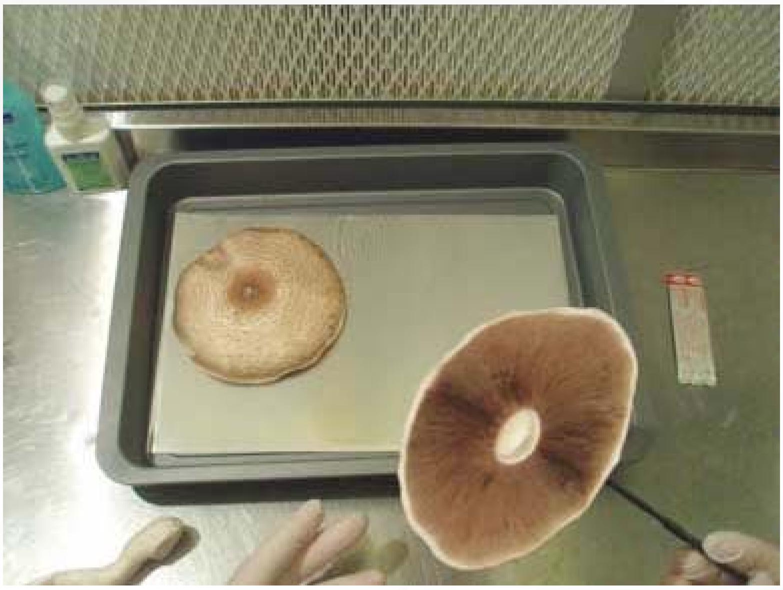
Spores are the "seeds" of mushrooms. They are microscopic and are mainly produced at the under part of the cap. After its fully-fledged they are released. To collect the spores, the fully developed caps are placed on a carrier material. The obtained spore print can be used to start a new mushroom culture. Placing spores on convenient substrate (most common are malt-agar substrates in Petri dishes) induces mycelium growth.

Recommended Tools:

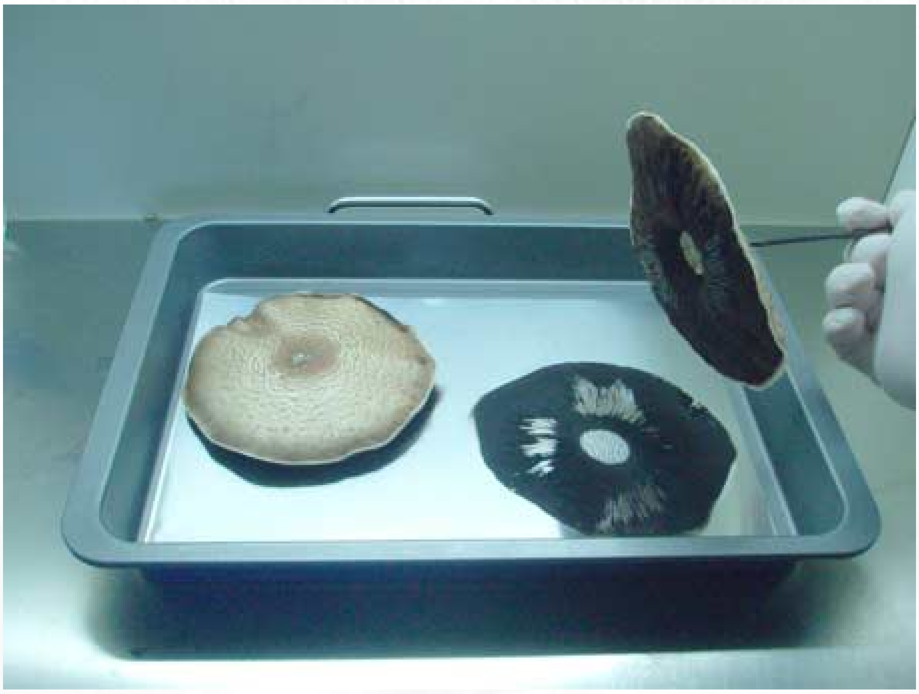
- Aluminium foil, paper (as large that you can place 1 mushroom cap on it)
- Bazillol - workspace desinfect
- Latex Gloves
- Facemask and hairnet
- Skalpell
- Cover (zb Tupperbox)
- Zipp-Lock Bags to pack the prints

Sterile working area: Glove Bag/Glove Box or sterile air flow (HEPA-filter, Laminar Flow Hood)

Proceed cautiously as sterile and clean as possible. The spores should not get in contact with contaminations while taking the print. Put on face mask, hairnet and gloves; clean the working area in front of the HEPA-filter or the Glove Box inside and disinfect the container and the aluminium foil. (The needed tools are already inside the Glove Box). Finally disinfect your gloves and allow drying off.



Cut off the designated mushroom cap carefully at the upper end of its stem; try not to damage the gills and pores. The disinfected aluminium foil collects the spores dropping out; transfer the cap with its lower surface briskly on to the foil. Cover them up in the disinfected container, for best result the caps should not dry out and stay clean while donating spores.



After 12 to 24 hours the spores should have been released, favourably they adhere to the foil by themselves. (Wear protective clothing, clean and disinfect working area and tools!) Remove the cap by impaling the upper surface on a scalpel. Do not touch the foil or spore print to avoid contamination. Besure the residual moisture is allowed to evaporate before packing the print. Sealed in an airtight zip-lock bag, spores stay viable for about one year. Store your spore prints at room temperature in a dark and clean place.

Table of Contents

Microscopic examination of spores

Recommended Tools:

- Sporeprint or
- Sporesyringe
- Microscop (40x - 1000x)
- Pipette or syringe
- Inoculation loop
- Water
- Object slide

General Procedure:

Form, colour and size of spores are almost distinctive trait for classification of mushrooms.

Take a clear object slide and put a drop of water on it. Now use the inoculation loop to stir a few spores into the water. Put the object slide under the microscope to view the spores.

An other method is to put a drop of sporesolution from a sporesyringe on the object slide. If you use a sporesyringe we recommend to shake the syringe well to disperse the spores well in the water.

It is important the microscope be firmly fixed on a flat stable surface!

Table of Contents

Preparation of Agar - Medium in Petri Dishes

The following formula makes 1 liter of "MEA" - malt extract agar medium, convenient for most species of cultivatable mushrooms. Especially for working with spores, antibacterial agar media is recommended. Ready to use formulas are offered, that only need to be mixed with water.

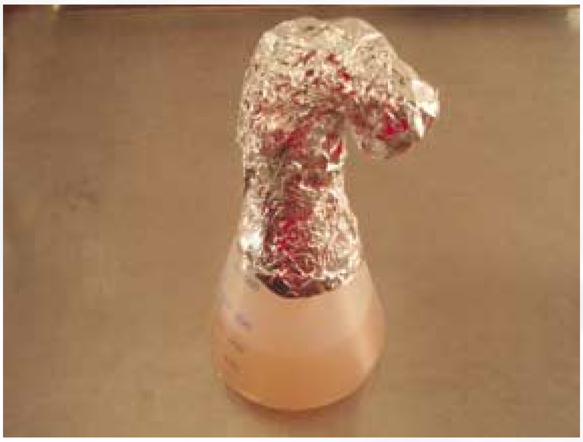
Recommended equipment:

- 20 g agar-agar
- 20 g malt extract
- 2 g dry yeast
- 1 g peptone
- 1 litre drinking water

- Erlenmeyer flask
- Sterile disposable Petri dishes or glass Petri dishes
- Measuring container
- Scale
- Parafilm
- Latex gloves
- Face mask and hairnet
- Disinfectant solutions for surfaces and hands
- Pressure cooker
- **Sterile working area: Glove Bag/Glove Box or**
- **Sterile air flow (HEPA-filter, Laminar Flow Hood)**

Mixing the substrate

Pour the ingredients into the Erlenmeyer flask along with hand-hot water, close the lid and shake well until mixed thoroughly. The maximum level of filling the flasks is reached at two-thirds of their volume. Remove the lid and wrap some aluminium around the flask's neck forming a tube which you bend down at its free end. This attached duct will ban condensate water to enter the unlocked flask during sterilisation.



Sterilisation of the agar medium

Agar medium should be sterilised for 45 minutes using a pressure cooker. Overlying a 2-3 centimetre water level at the bottom of the cooker a separating insert keeps the flasks above the water line. Assure yourself that there is no contact between water and the upright standing flasks, decant some water if necessary. (Mind the handling instructions given by manufacturers of your pressure cooker!)

Get the lid locked and put the cooker on a hotplate. Sterilise for 45 minutes, counting from the moment as the pressure gauge reaches its highest stage (for household pressure cookers). If you've got a professional pressure steriliser at your disposal sterilise at 121°C/ 259°F/ 15 psi/ 1.05 bar.

Attention: Do not exceed temperatures specified above for a longer span of time. By overheating the nutrients, the culture medium can degrade and the solutions colour darkens from yellowish to brownish. If so, the medium is useless. Substrates which are composed of other ingredients may have different colours.

After 45 minutes of sterilisation, let the cooker cool off in front of a HEPA-filter or in a clean place. During pressure equalisation air is sucked in; a clean and wet cloth over the cooker's cover filters the aspired air, if you do not use a HEPA-filter.

Pouring the Petri dishes

Wear protective clothing, disinfect working area and hands. Do not open the cooker before the pressure gauge indicates 0. Continue processing from now on because the agar medium is only in its liquid stage above a certain temperature. (If you work with glass Petri dishes, keep in mind, they have to be sterilised too.)

Pour about 25-30 ml warm agar-medium into a Petri dish with 90 mm in diameter, which gives 35-40 Petri dishes per 1 litre agar-medium. For cooling down leave them in a place of low microbiological contamination in front of a HEPA-filter or inside a Glove Box.

When the agar is hardened and cooled to room temperature, the Petri dishes are ready for inoculation. If you do not use all casted Petri dishes, you can seal up the remaining Petri dishes with Parafilm, wrap them in plastic foil or bag and keep them in a clean refrigerator for up to 4 weeks. (35.6-39.2°F / 2-4°C)

Table of Contents

Mycelium germination from spores

When growing mushrooms out of spores you obtain plenty of autonomous mycelia strands forming dikaryotic mycelium, a so called spore mass inoculation. This mycelium has sprung from various germinating spores, sprouting mushroom cultures comprise individuals, descending from different mycelia strands. (You can compare this mycelium to a fruit orchard - yielding heterogeneous fruits from different trees- not similar fruits from only one tree.) Multicultural mycelium is mainly used for selecting the fittest individuals from the new culture to continue work with them.

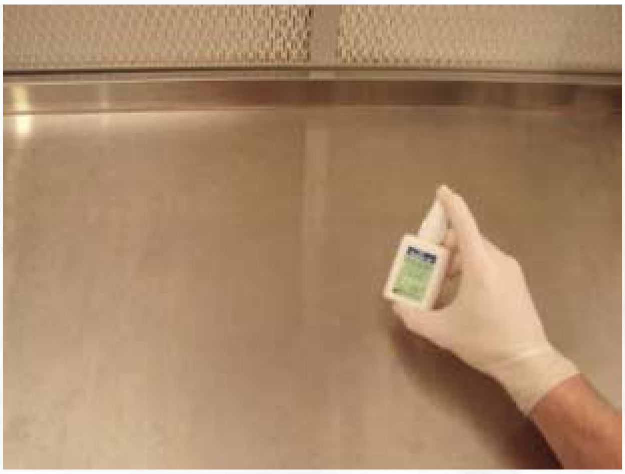
Recommended Tools:

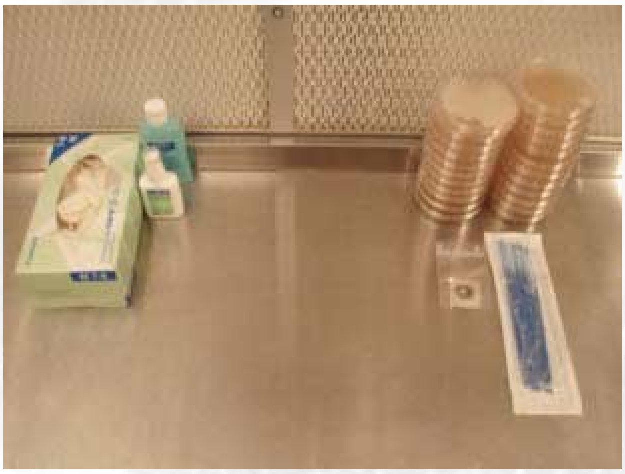
- Spores (Sporeprint or Sporesyringe)
- Agar medium in petri dishes

- Oneway Inoculation loop or Needelholder with inoculation loop
- Parafilm to seal the petris
- Spiritus Lamp (only for metal inoucluation loop)
- Facemask and Hairnet
- Latex gloves
- Workspace desinfection
- Handdesinfection
- **Glove Bag (sterile workspace)**

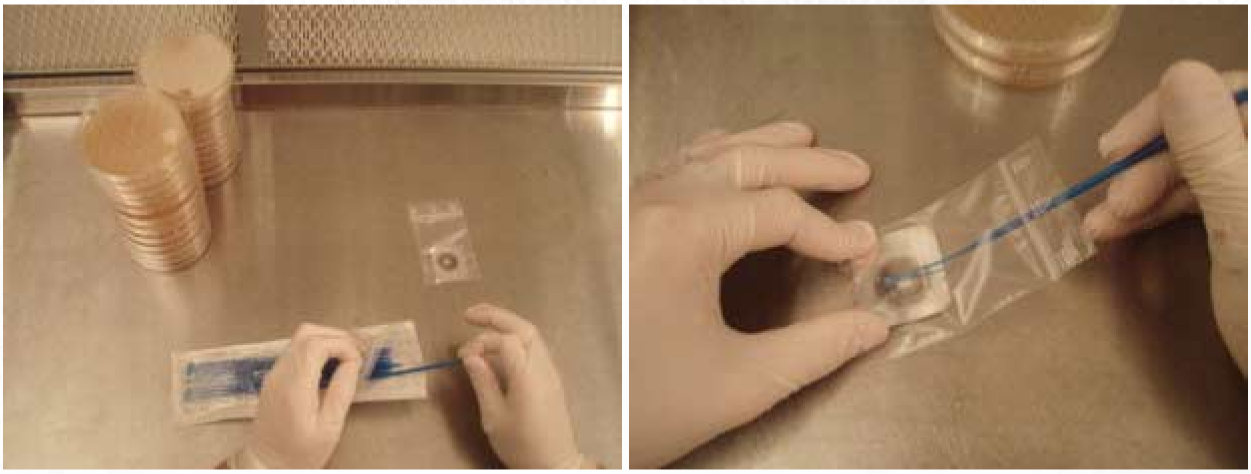
Inoculation of agar medium

To minimise the risk of contamination of agar medium by other organisms (e.g. bacteria, moulds, ...) we advise working in a Glove Box/Glove Bag or in front of a HEPA-filter. Clean the workspace, wash hands and forearms, put on a protective face mask, hairnet and gloves, then disinfect your worktop well. Disinfect hands again and allow drying before starting. Antibacterial agar has proven to be successful with spore prints gained from outdoor collected mushrooms, for those often carry bacterial contamination.



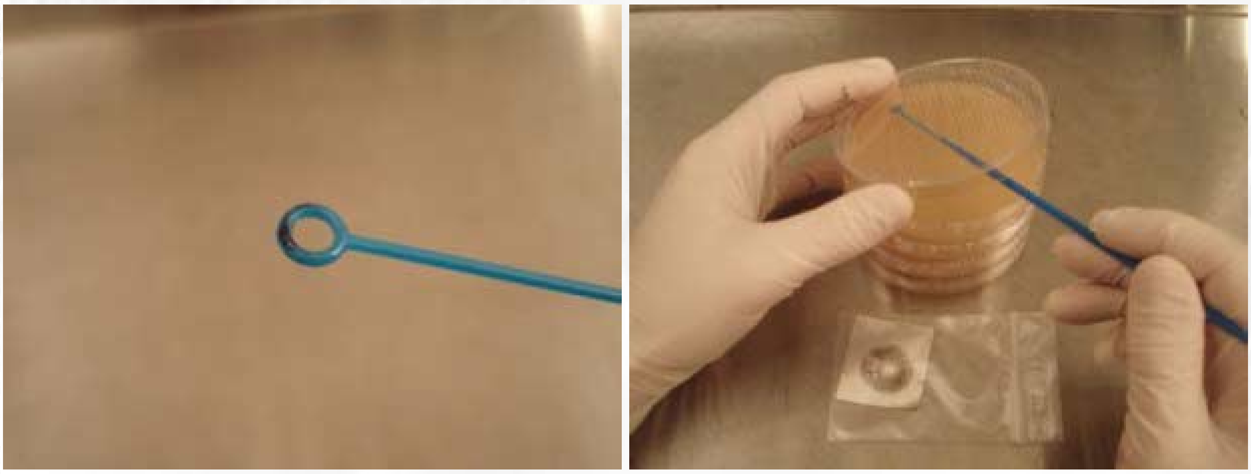


If working with a reusable inoculation loop, heat the inoculation loop red hot in the flame of a alcohol lamp and let it cool down in your hand. Do not touch the spore print, inoculation loop or agar medium. Now rub the spore print until the whole loop has gathered some spores. Open the Petri dish ajar, and import the spores to the agar drawing a "S" through the media. In case of inoculation with a spore syringe, 1-2 ml solution per Petri dish will suffice.



Do not take off the lid fully and work quickly to lessen contamination risks. Close the lid and seal it with Parafilm. It is advisable always to inoculate several Petri dishes with a spore print since they thrive and prosper varyingly.

Label the Petri dishes giving information about date, genus name, strain (strain means different type species within one genus - comparable with different kinds of apples) and consecutive number. A CD-marker, Edding-marker or permanent marker will stick to it.



Mycelium growth

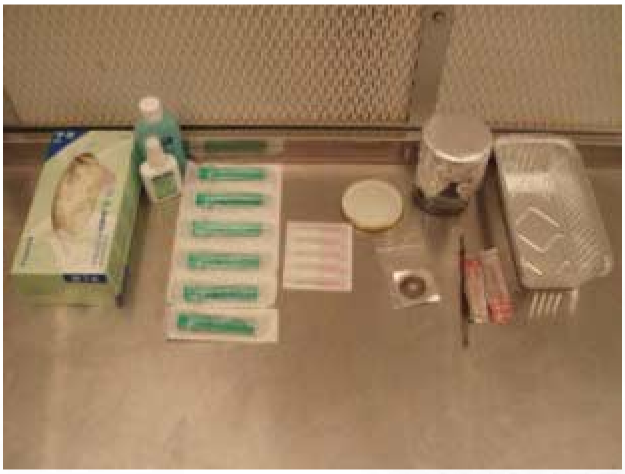
During spawn-run (development and growing of the mycelium) the sealed Petri dishes are stored in a dark and neat place. The appropriate temperature depends on the genus cultivated. Ensure that the incubator in which the mycelium is grown provides enough ventilation. After a few days up to one week the spores start germination. As soon as rhizomorph mycelium strands become visible, they are ready for selection. (Look up the instruction for "Selection of mycelium strands".)

Table of Contents

Production of spore syringes

Spore syringes contain spores dissolved in water and are being used to inoculate substrates. Hobby-mycologists tend to work with spore syringes because even if used in a not 100% sterile environment, the substrates seldom contaminates.

It's rather easy to produce small to medium amounts of substrates or grain spawn with spore syringes. If you inoculate substrates with a spore syringe, you get a "Multi-culture" (look up "Growing mycelium out of spores"), which mostly result in less crop yield, compared do usage of selected rhizomorph mycelium strains.



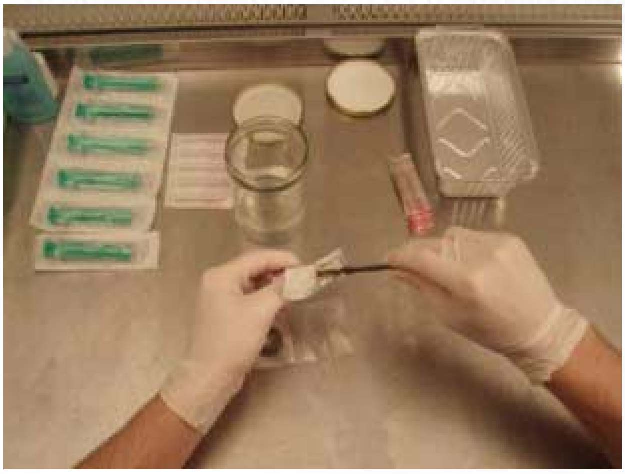
Recommended Tools:

- Spore print
- Glasses (sterilisable!!!)
- Scalpell with sterile blades
- Empty syringes and needles
- Latex Gloves
- Facemask and Hairnet
- Filter Disk
- Workspace desinfect - Bazillol
- Handdesinfect
- Water
- **Glove Bag (sterile workspace)**

We recommend using about 100 ml water and one spore print per glass. The lid of the glass needs a hole of about 1 cm in diameter; via this hole you will later fill the syringes. Fill the gasses with water (2/3 of the glass) and put the lid with the hole on during sterilisation. Wrap aluminium foil around the lid, sterilise the glasses and the lid without a hole (also wrap it in aluminium foil), for about 30 minutes.
We recommend using a pressure cooker for sterilization.

Counting the sterilisation time form the moment, the pressure gauge reaches its highest stage (for household pressure cookers). If you've got a professional pressure steriliser at your disposal sterilise at 121°C/ 250°F/ 15 psi/ 1.05 bar.

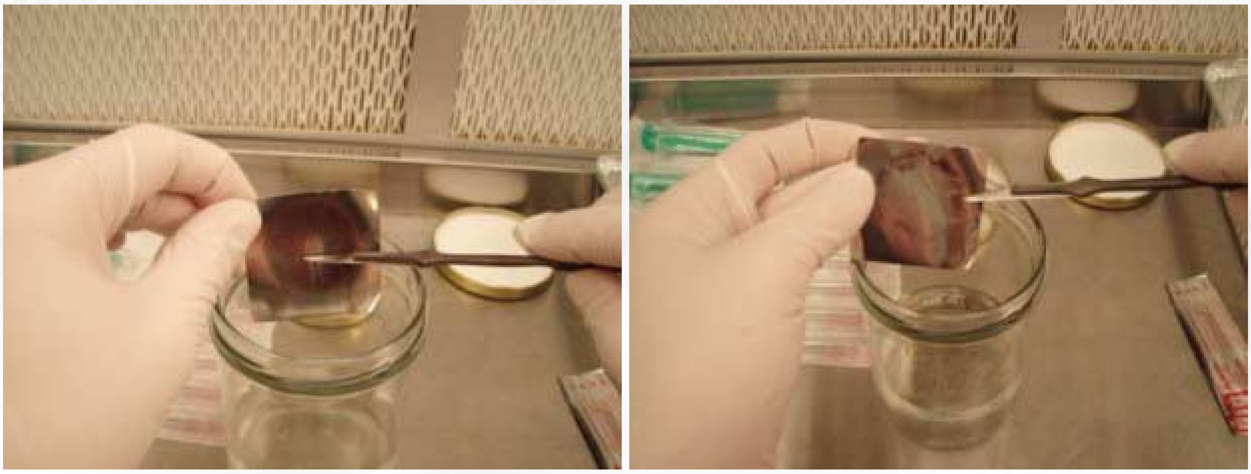
Leave the cooker to cool out in clean place or in front of HEPA-filter after sterilization. You can put a clean wet piece of cloth over the cooker during the cooling process to filter the air streaming into the cooker if working without a HEPA-filter.

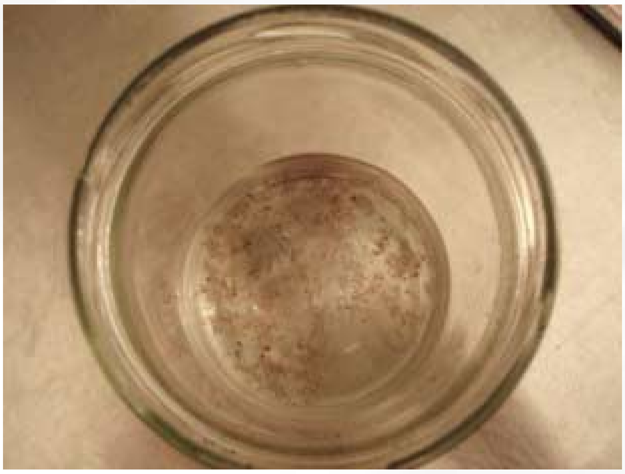


To keep contamination risk low, please work clean! Use a new, sterile skalpell blade for each spore print.

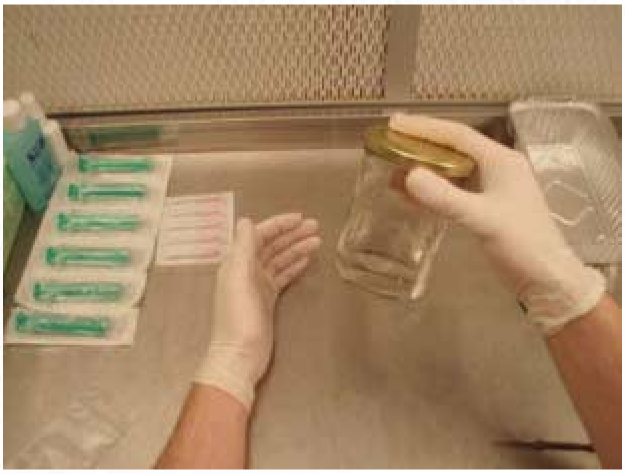
Open the lid as soon as the pressure has vanished. Wash and disinfect your hands and lower arms and use latex gloves. Store the glasses in a clean place (in front of a HEPA-filter or in a glove box). Proceed as soon as the glasses have cooled down to room temperature (less than 86°F or 30°C).

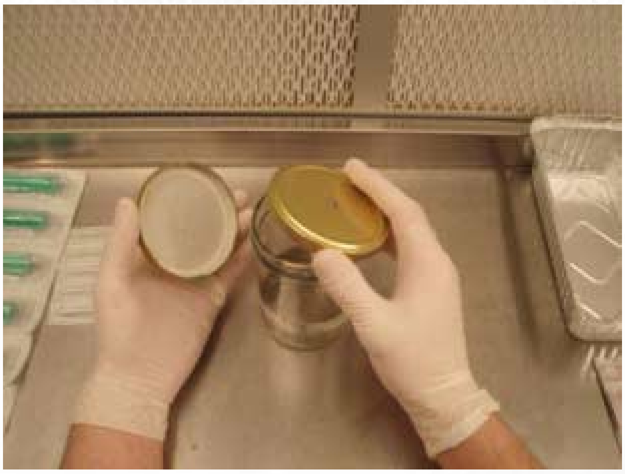
Before you start, please wash your hands, lower and upper arms with hot water and soap. Clean and disinfect your working space. Put on hairnet, face mask and latex gloves. Disinfect your gloves and wait till they're dry.

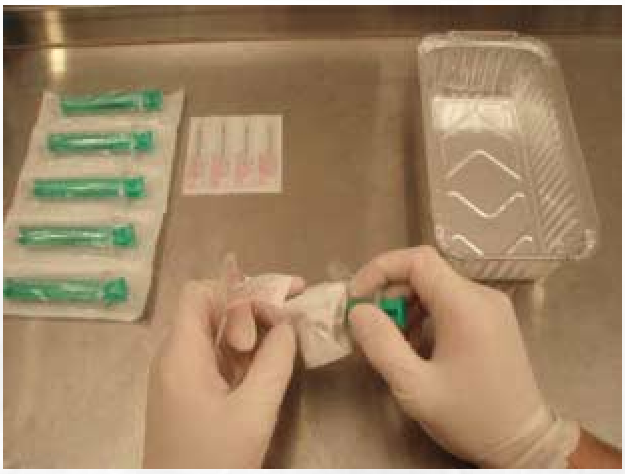


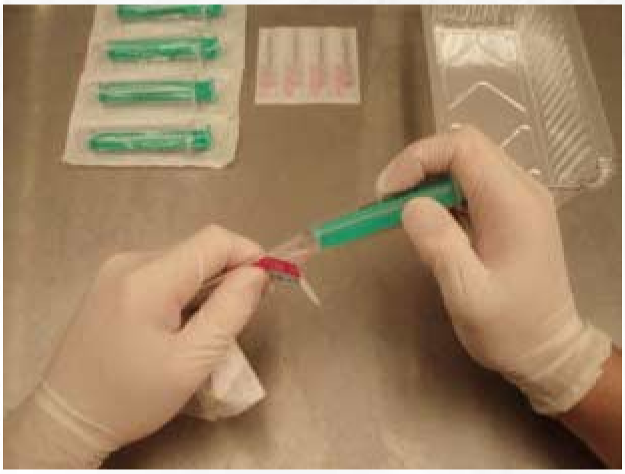


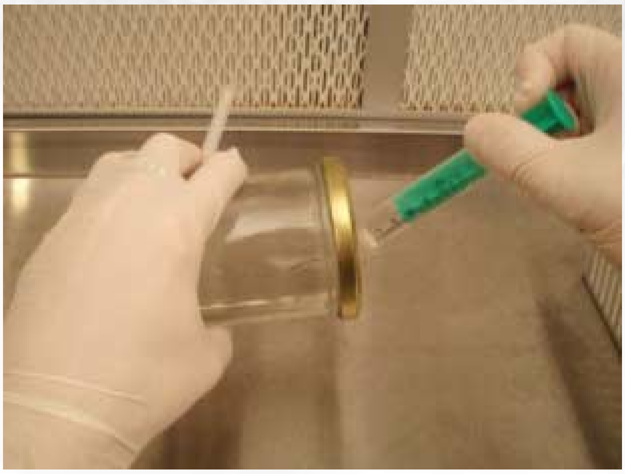
Use a scalpel to scrape the spores off the spore print into the water. Make sure not to touch the spores while holding the spore prints. After you have scraped the spores into the water, put on the lid (without hole) and shake the glass well. Change the lid to the one with the hole. Stick the syringes needle through the hole and fill the syringe. To avoid contamination, be careful not to touch the lid with the needle or needle with your hands.

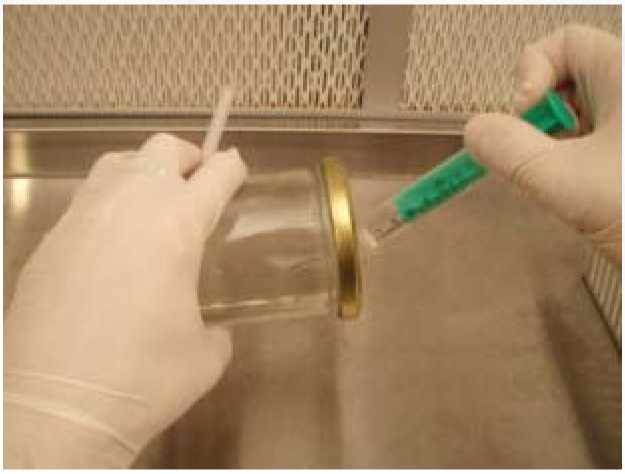












We recommend packing the syringes airtight using a zip-lock bag. Stored in a dark and cool place (max. 20°C) the spores will be viable for about one year (depending on mushroom species).

To test their ability to germinate, put a few ml (1 or 2 drops) on a Petri dish with agar medium. The mycelium will start to grow after a few days. (For detailed instructions kindly have a look on chapter: "Growing mycelium out of spores").

Table of Contents

Mushroom Cloning

Gaining new cultures out of a fresh mushroom involves asexual reproduction. A mycelium achieved through cloning is called "pure culture", it is genetically identical to the original mushroom. The successfully breeding of a mycelium out of spores on the other hand is the way of sexual reproduction the creation of a new organism with a new genetically code. When working with pure cultures, just one individual develops on the substrate, so there is no competition for nutrient elements. This will lead to a higher and well predictable yield with stable quality.

Recommended Tools:

- Hairnet and Facemask
- Latex Gloves
- Alcohol Lamp
- Scalpell with sterile blades
- Workspace desinfect
- Handdesinfect
- Petridishes with Agar-Medium
- Parafilm to seal the petris
- **Glove Bag (sterile workspace)**

Inoculating the nutrient medium with a mushroom clone

Only select the most vital and gratifying mushroom fruit bodies. If you are not able to make a clone immediately after picking, keep them neatly stored in the refrigerator for maximal 48 hours. Do not store a mushroom longer than absolutely necessary because it´s harder to gain germination of mycelium out of older fruit bodies and the risks of bacterial contamination increases.

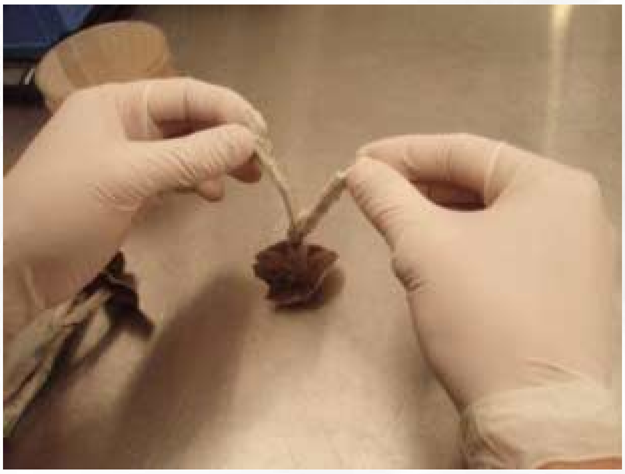
As in every laboratory working step during the life cycle of mushrooms, clean and sterile working is essential for success! Put on face mask, hairnet and gloves; clean the working area in front of the HEPA-filter or the Glove Box in-depth and disinfect working area and gloves. If you intend to clone more than one mushroom, disinfect the working space, change gloves and put on a fresh scalpel blade (or flame it until glowing red and let cool down) before carrying on with a new fruit body.

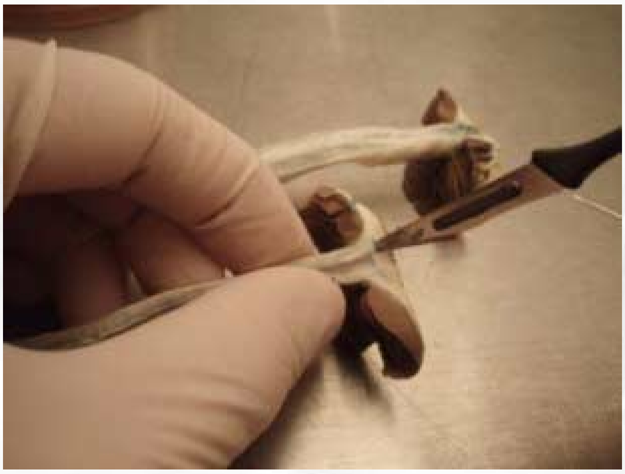
Fruiting bodies are basically composed of compacted mycelium, thus flesh intended to clone can be won from every part of the mushroom. Most suitable are interior parts of the upper stem and cap. Split the near-ground part of the stem half a centimetre deep and tear apart the mushroom without touching the inlying flesh with your fingers.

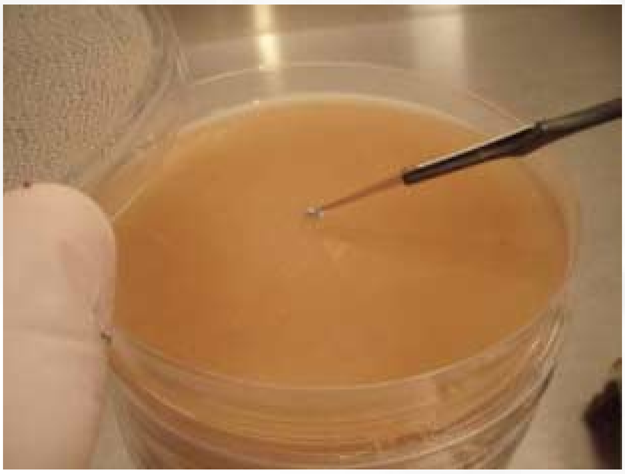
Flame-sterilise the scalpel until glowing red over the alcohol lamp, let cool off and put on a sterile blade. For tissue harvesting we recommend to graft tissue from the most internal parts of a mushroom which provides greatest cleanliness and the lowest contamination risk. A piece of fruit sized 3x3 mm will suffice. Impale the small piece of flesh on the scalpel and transfer it onto agar medium. Seal the inoculated Petri dishes with Parafilm and shelve them in a dark place to stimulate the mycelium growth. The adequate temperature depends on the genus cultivated. A few days up to one week later the mycelium starts germination.

It has proved itself to inoculate several Petri dishes with internal mushroom grafts of the individual you wish to clone since the results sometimes strongly vary. Even under best laboratory conditions you will have to face failure rates at 10%. Amateurs and freshmen should bargain for failure rates around 25% or even more. Do not get discouraged, with a little practice in cloning you will amend quickly.

Label the Petri dishes giving information about date, genus name, strain (strain means different type species within one genus - comparable with different kinds of apple) and consecutive number. A CD-marker, Edding-marker or permanent marker will stick to it.







Mycelium growth after cloning

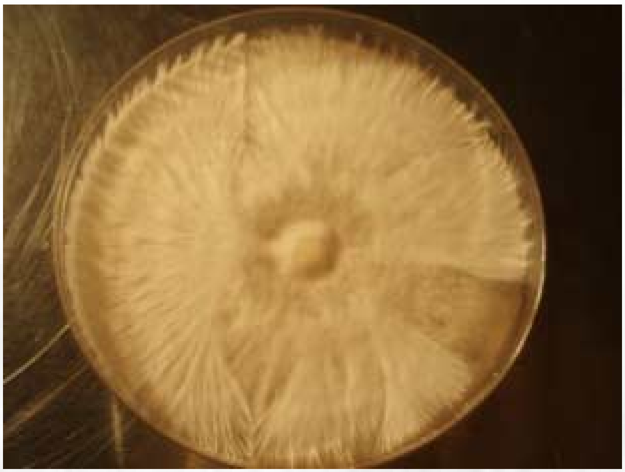
During the spawn-run (development and growing of the mycelium) the sealed Petri dishes are stored in a dark and neat place. The appropriate temperature depends on the genus being cultivated. Ensure that the incubator in which the mycelium is grown provides enough ventilation. After three to five days (depending on species) new mycelium filaments will start to grow out of the piece of flesh. As soon as rhizomorph mycelium strands become visible, they are ready for selection. (Look up the instruction for "Selection of mycelium strands".)

Table of Contents

Selection of Mycelium Strains

If you cultivate mushroom mycelium on agar medium there will appear different form of mycelium. The two main forms are: rhizomorph mycelium and fluffy mycelium (looks like cotton). For further cultivation and introduction of fruiting only the rhizomorph mycelium is suitable. The rhizomorph mycelium looks like the roots of plants. The primordia which later become fruit bodies are built from it. If you cultivate mushroom cultures on petri dishes, you have to select the fluffy mycelium from the rhizomorph. Only the rhizomoprh growing mycelium is used for further cultivation.

Rhizomorph and fluffy mycelium strains on one petri dish.
It was selceted for one time before.



Rhizomorph and fluffy mycelium strains on one petri dish.
It was selected for one time before.

Recommended Tools:

- Hairnet and Facemask
- Latex Gloves
- Alcohol Lamp
- Scalpell with sterile blades
- Workspace desinfect
- Handdesinfect
- Petridishes with Agar-Medium
- Parafilm to seal the petris
- **Glove Bag (sterile workspace)**

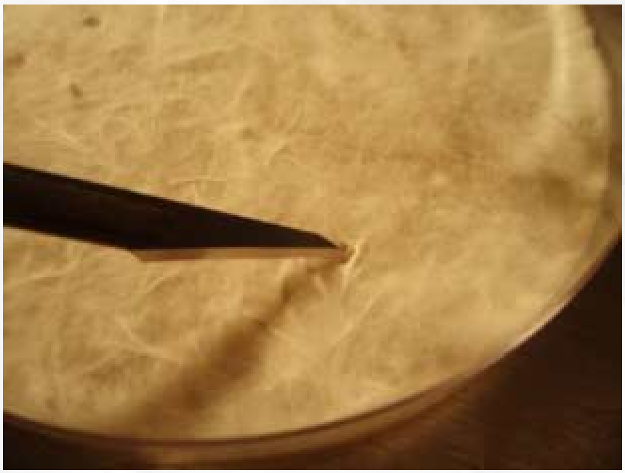
Transferring rhizomorph mycelium

As soon as an entire Petri dish is overgrown with mycelium it should be proceeded. If you wait too long the fluffy mycelium outreaches and overgrows the rhizomorph shaped form and the Petri dish becomes unusable. As in every laboratory working step during the life cycle of mushrooms, clean and sterile working is essential for success! Put on face mask, hairnet and gloves; clean the working area in front of the HEPA-filter or the Glove Box in-depth and disinfect working area and gloves.

This petri dish is ready for selection.

If you intend to clone more than one fruit body, scrap the used blade; disinfect the working space and change gloves. Flame-sterilise the anterior part of the scalpel over the alcohol lamp until it is glowing red, let cool down to room temperature and put on a fresh blade before carrying on. Do not get the mycelium in contact with hot tools!
Please be cautious about flame sterilising. Alcohol-containing disinfectants and gloves easily catch fire!

Choose a rhizomorph growing mycelium strain from the Petri dish and slice it into pieces measuring 3x3 mm. Skewer one piece with the blade and transfer it to a fresh Petri dish containing agar medium. Seal the Petri dishes with Parafilm, handle them with care for the piece of mycelium should not slip out of place!


This petri dish is selected for the first time,

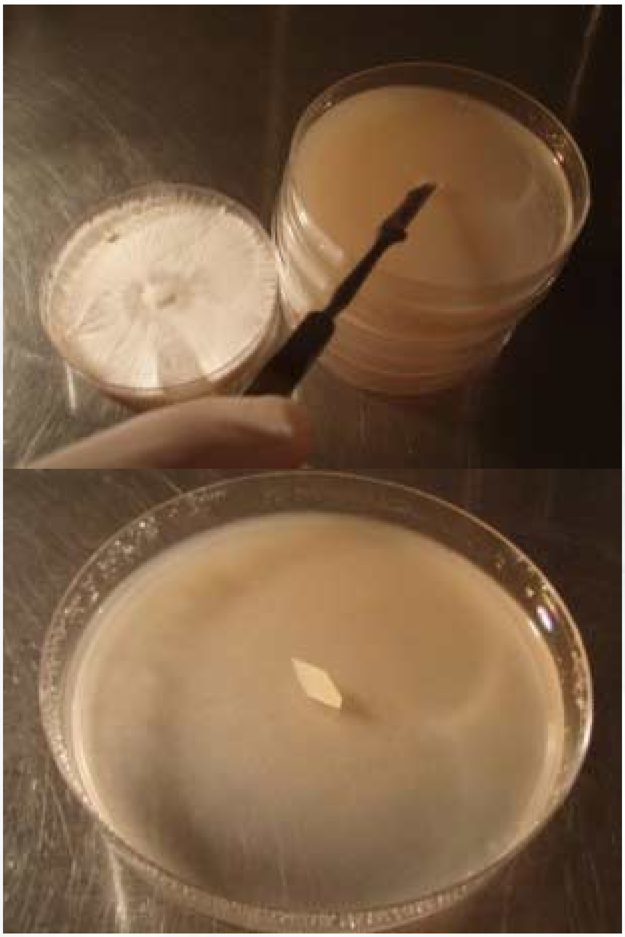
and this one is selcted for the second time.

Advice: It's easier to distinguish between rhizomorph and fluffy growing mycelium, if you hold the Petri dish in front of a lamp.

It has proved well to inoculate several Petri dishes with pieces of the same mycelium, since the results can strongly vary. Even under best laboratory conditions you will have to face failure rates of 10%. Newcomers should not lose courage if they have to cope with failure rates up to 25% or even beyond.

Usually it is necessary to select a strain several times to get Petri dishes with rhizomorph mycelium only. Moreover the selected mycelium is able to mutate, for example grow fluffy again, and become unfit for utilisation.

Label the Petri dishes giving information about date, genus name, strain (strain means different type species within one genus - comparable with different kinds of apple) and consecutive number. A CD marker, Edding marker or permanent marker will stick to it.



The mycelium pieces are placed on petri dishes filled with agar medium.

Mycelium growth after selection of strain

During the spawn-run (development and growing of the mycelium) the sealed Petri dishes are stored in a dark and neat place. The appropriate temperature depends on the genus being cultivated. Ensure that the incubator in which the mycelium is grown gives enough ventilation. After three to five days new mycelium filaments will start to grow out of the piece you transferred. As soon as you have gained a Petri dish almost completely overgrown with rhizomorph mycelium, it is ready for inoculating grain spawn.

The mycelium have to be selected as long as it grows uniformly rhizomorph.

Table of Contents

Sterilising rye substrate for grain spawn

In mushroom cultivation, cereal substrate is being used to produce grain spawn. This production stage is mainly used to multiply mycelium mass, you get from the agar plate, for inoculation of fruiting substrate.

Recommended equipment:

- Rye grain
- Vermiculite medium
- Gypsum
- Autoclave Bags Unicorn type 3 T or
- Glasses with lids with a hole (1 cm in diameter) and filter disk
- Scale
- Bag sealer or strong adhesive tape
- Sieve
- Container for mixing
- Pressure cooker

Preparing the rye substrate

Soak the rye in 167°F/ 75°C warm water, allow the water level to be 4 - 5 cm higher and leave it overnight (12 - 18 hours). Put the soaked rye grain into a sieve and let it drain for around a quarter of an hour, then put it into the mixing container. Moisturise the vermiculite using the sieve, until entirely soggy, watch out not to soak it too much. Make sure that the vermiculite is even wet, but not as wet that water drops out of the sieve. Let it drain for a moment. Now mix the gypsum equally with the rye grain, then add the vermiculite and mix it again very well.

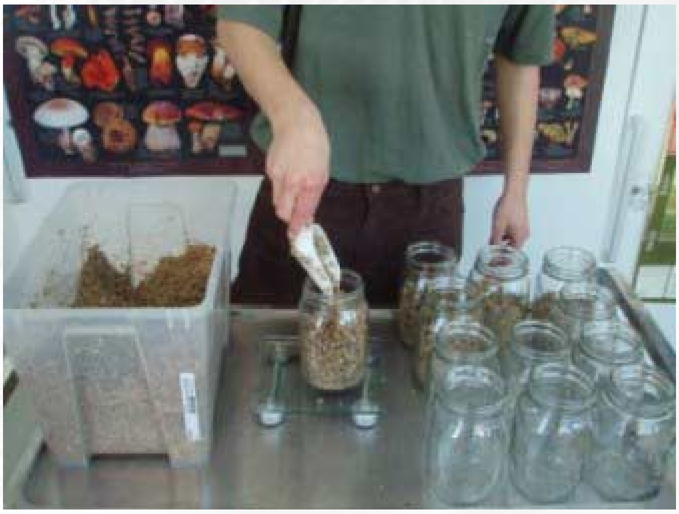
Mixing proportion of substrate

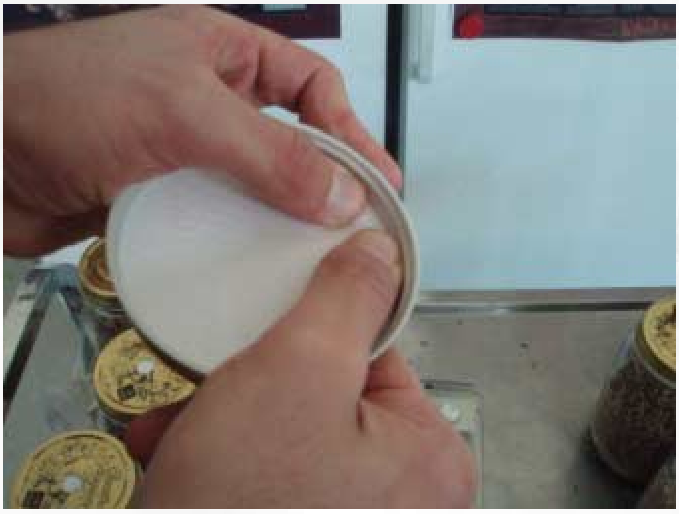
For 1 glass with volume of one litre we recommend to use 200 g (approx. 0.25 l) rye grain, 200 ml vermiculite medium and 1.5 g gypsum. This formula will result in 400 g rye grain substrate. Time needed to sterilise: 90 minutes.

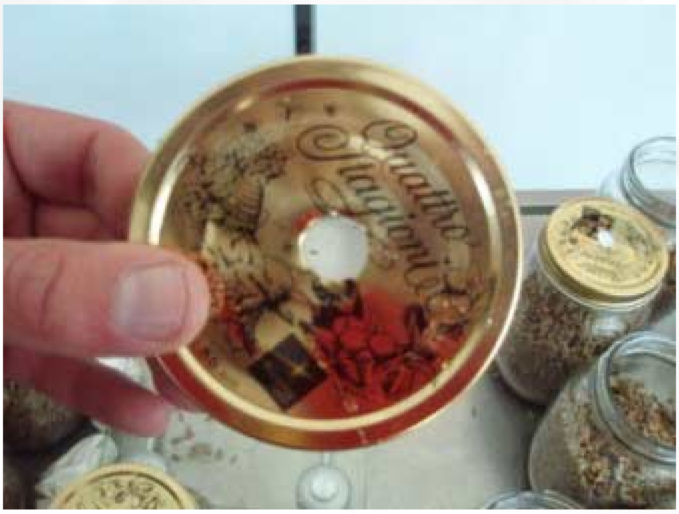
If you work with Bags, for grain substrates we recommend to use original Unicorn Bags Type 3 T. Use for each bag 1.3 kg rye grain, 1.4 litre vermiculite and 8 g gypsum. This formula will result in 2.7 kg rye grain substrate. Time needed to sterilise: 3 - 4 hours.

Filling glasses with substrate

Fill the glasses up to two-thirds of their volume. For a one litre glass that will be about 400 grams of rye - vermiculite - substrate. The lids should be perforated (pierce a hole 1 cm in diameter) to ensure that fresh air is given to the mycelium. The filter disk attached to the lid prevents contamination. Do not screw down the lids too firm during sterilisation to ensure pressure compensation (and prevent the glasses from breaking).







Filling bags with substrate

Roll down the autoclave bag about 10 cm and pour in 2.7 kg of the grain substrate mixture. Be careful not to spill any substrate on the upper regions of the bag (in case you did, clean the bag with a wet piece of cloth). Then wrap the bag twice.

Sterilising the substrate

A pressure cooker is used for the sterilising process. Overlying a 2-3 centimetre water level at the bottom of the cooker a separating insert keeps the bags above the water line. Assure yourself that there is no contact between water and the bags, decant some water if necessary. (Mind the handling instructions given by the manufacturer of your pressure cooker!) Now load the glasses or bags.

If the cooker is big enough you can make two levels of bags. Place the upper layer on a separating tray over the left spare zones of the lower layer. This ensures that the steam gets evenly distributed.

Get the lid locked and put the cooker on a hotplate. Counting the sterilisation time from the moment, the pressure gauge reaches its highest stage (for household pressure cookers). If you've got a professional pressure steriliser at your disposal sterilise at 121°C/ 250°F/ 15 psi/ 1.05 bar. Once the sterilisation time has passed the cooker must cool down in a clean place, preferably in front of a HEPA - filter (sterile air flow). If working without laminar flow hood put a clean wet piece of cloth over the cooker during the cooling process to filter the air streaming into the pot while pressure equalisation.

After the cooker is fully depressurised, open the lid. If you work with glasses close the lid of the glasses fast and tight to minimise contamination risk. The glasses/ bags should cool down to room temperature in front of a HEPA-filter or in a Glove Box.

As soon as the substrate has cooled down bellow 30 ° C / 86 ° F, it is ready for inoculation. If your are up to continue at a later date close the bags / glasses tightly, store the substrates in the refrigerator (35.6-39.2°F, 2-4°C) and use them within 4 weeks.

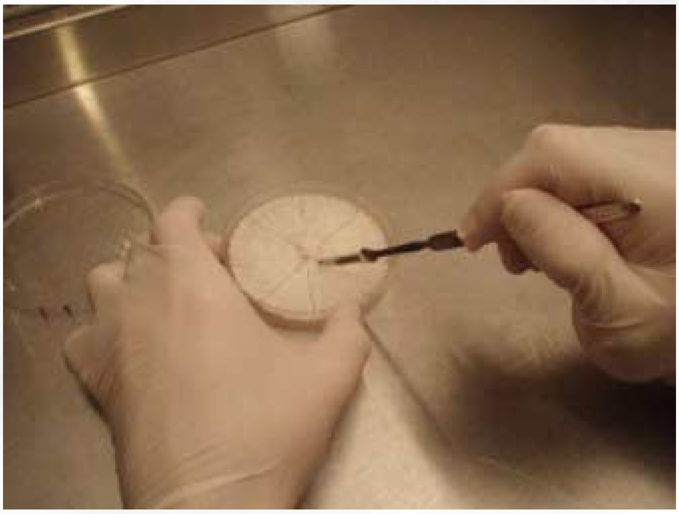
Ready sterilized substrates!

Table of Contents

Inoculation of grain spawn with mycelium on agar medium

Recommended Tools:

- Petri dish (at least 3/4 colonised, not mutated)
- Sterilised rye substrate
- Scalpel with sterile blade
- Bag sealer or strong adhesive tape
- Latex gloves
- Face mask and hairnet
- Disinfectants for workspace and hands
- Sterile working area: Glove Bag/Glove Box or
- Sterile air flow (HEPA-filter, Laminar Flow Hood)

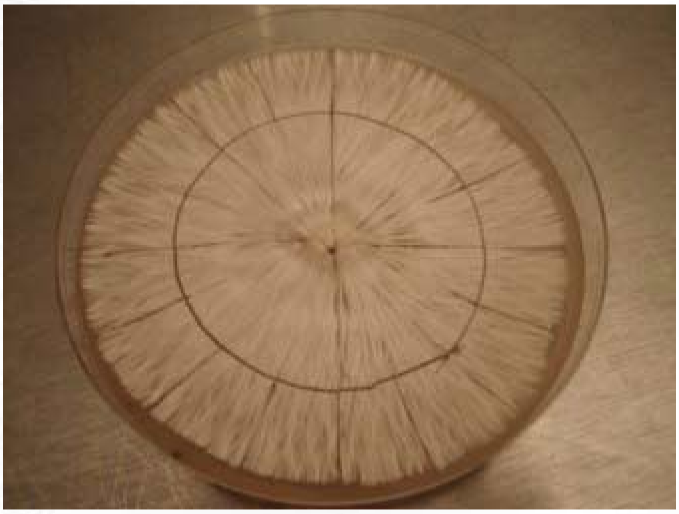


Inoculation

Perform this working step as aseptic as possible to prevent the grain from contamination by bacteria or mould. Clean your worktop, wash hands and forearms, put on a protective face mask, hairnet and gloves and disinfect your worktop well.

Use the mycelium of 1 Petri dish for inoculating 1 glass of sterilised grain (about 400 grams substrate), for substrate in bags take more petri dishes. Avoid inoculation of 1 grain substrate with different mycelia strains; use only copies of one clone per glass / bag.

Remove the Parafilm from a Petri dish only inside the Glove Box or only in front of a HEPA-filter. Take the scalpel and carve eight lines in star like array and a circle at half the diameter into the mycelium. Thereby you got 16 small pieces.



Unscrew the glasses or open the autoclave bags on their top. Spear the mycelium slice with the scalpel and transfer them carefully to the sterilised substrate. Close the glass / bag tight after this is done. Now distribute the mycelium pieces evenly by shaking the glass or bag, to achieve fast and equal colonisation. In case that mycelium pieces stick on the wall of the glass or bag, the can be released by knocking soft on the outside, to get again contact with the substrate.

Mycelium growth after inoculation

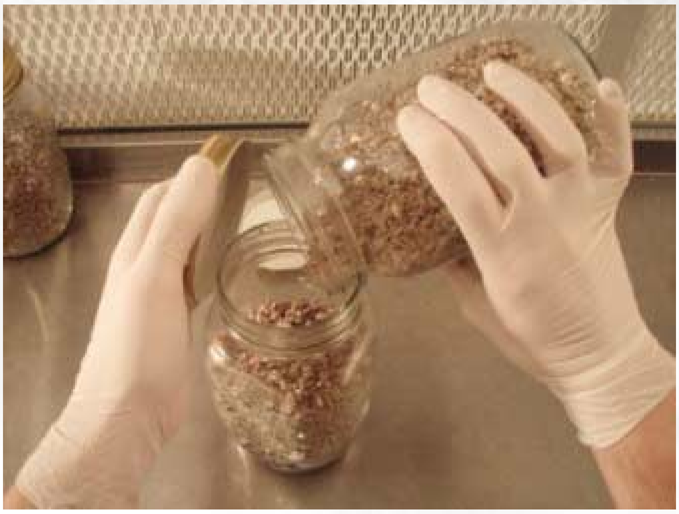
Store the inoculated substrate in a dark and clean place at convenient temperature for spawn run of this mushroom species. Ensure that the incubator in which the mycelium is places provides enough ventilation.

After a few days mycelium strands become visible growing out of the small agar pieces and colonise the grain. One or two weeks after inoculation the glasses and bags should be given a good shake to redistribute the already colonised matter amongst the unsettled material. This will accelerate the colonisation of the grain. Under convenient conditions rye grain should be fully colonised about 3 to 4 weeks after inoculation.

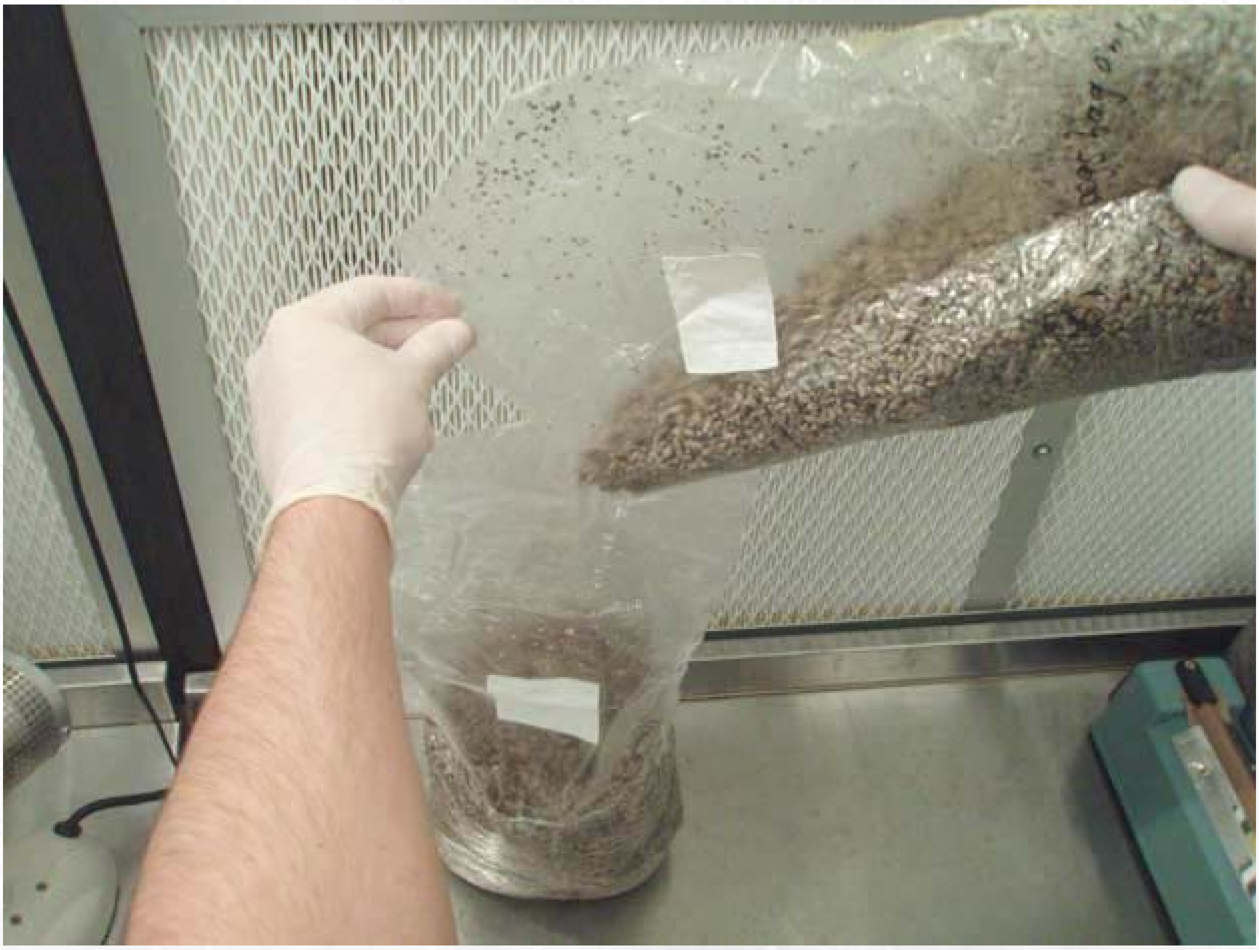
As soon as all rye grains are overgrown with white mycelium, the grain spawn is ready to be used for inoculation of the fruiting substrate (e.g. compost, straw, wood - depending on the mushroom species). Use 2 to 10 % of grain spawn for inoculation of fruiting substrate, according to mushroom species and type of substrate.

Reproduction of grain spawn

To produce more inoculation material you can use grain spawn to inoculate sterilised rye grain substrate. For optimum result use 10% of ready colonised grain spawn, based on the weight of the fresh rye substrate. Please make sure to perform this step under sterile conditions to prevent contamination.



Unscrew the glasses or open the autoclave bags on their top. Separate the grain kernels of the colonised spawn by shaking and plumping them repeatedly. The fresh rye substrate can now be inoculated with grain spawn. Close the glass / bag tightly after this is done. Now distribute the colonised grain evenly into the fresh substrate, by shaking the glass / bag, to achieve fast and equal colonisation.



For mycelium growth stage, store the inoculated substrate in a dark and clean place at convenient temperature (spawn run) for this mushroom species. Ensure that the incubator in which the mycelium is grown gives enough ventilation.

Table of Contents

Sterilisation of wood substrate

Most fungi won't develop fruiting bodies on rye grain substrate, that's why an adequate fruiting substrate must be inoculated with the grain spawn. In this instruction we want to introduce a standard substrate, which is suitable for a wide range of wood habitant mushrooms.

Recommended equipment:

- Woodchips
- Saw dust large
- Gypsum
- Rye bran
- Water
- Autoclave Bags Unicorn type 14#
- Scale
- Bag sealer or strong adhesive tape
- Sieve
- Container for mixing
- Pressure cooker

Preparing the substrate

Let the wood chips soak in cold water overnight (12-18h).Use as much water until all the chips are floating. Put the soaked wood chips in to a sieve and let it drain for around a quarter of an hour. In the meantime put all dry ingredients (sawdust, rye brain and gypsum) into the mixing container and mix it very well. After the dry ingredients are mixed, add the soaked wood chips and mix the substrate again. To conclude, add the water and mix it again very well.

Mixing proportion

For filling of 1 autoclave bag, (please use the original unicorn bags type 14# for wooden substrates) you'll need 368 g wood chips, 735 g saw dust large, 31 g gypsum, 200 g rye bran and 950 ml water. This will produce approximately 2,5 kg substrate. Sterilisation time: about 3 - 4 hours.

Filling bags with wood substrate

Roll down the autoclave bag about 10 cm and pour in 2.5 kg of the wood substrate mixture. Be careful not to spill any substrate on the upper regions of the bag (in case you did, clean the bag with a wet piece of cloth). Then wrap the bag twice.

Sterilising the wood substrate

A pressure cooker is used for the sterilising process. Overlying a 2-3 centimeter water level at the bottom of the cooker a separating insert keeps the bags above the water line. Assure yourself that there is no contact between water and the bags, decant some water if necessary. (Mind the handling instructions given by the manufacturer of your pressure cooker!) Now load the bags. If the cooker is big enough you can make two levels of bags. Place the upper layer on a separating tray over the left spare zones of the lower layer. This ensures that the steam gets evenly distributed.

Get the lid locked and put the cooker on a hotplate. Counting the sterilisation time from the moment, the pressure gauge reaches its highest stage (for household pressure cookers). If you've got a professional pressure steriliser at your disposal sterilise at 121°C/ 250°F/ 15 psi/ 1.05 bar.

Once the sterilisation time has passed the cooker must cool down in a clean place, preferably in front of a HEPA - filter (sterile air flow). If working without laminar flow hood put a clean wet piece of cloth over the cooker during the cooling process to filter the air streaming into the pot while pressure equalisation.

After the cooker is fully depressurised, open the lid. If you work with glasses close the lid of the glasses fast and tight to minimise contamination risk. The bags should cool down to room temperature in front of a HEPA-filter or in a Glove Box. As soon as the substrate has cooled down bellow 30 ° C / 86 ° F, it is ready for inoculation. If your are up to continue at a later date close the bags tightly, store the substrates in the refrigerator (35.6-39.2°F, 2-4°C) and use them within 4 weeks.

Table of Contents

Inoculating wood substrates with grain spawn

Most fungi won't develop fruiting bodies on rye grain substrate, that's why an adequate fruiting substrate must be inoculated with the grain spawn. This method is suitable for most wood habitant mushroom species.

Recommended equipment:

- Grain spawn, ready colonised
- Sterilised wood substrate
- Bag sealer or strong adhesive tape
- Latex gloves
- Face mask and hairnet
- Disinfectants for workspace and hands
- Sterile working area: Glove Bag/Glove Box or
- Sterile air flow (HEPA-filter, Laminar Flow Hood)

Inoculation of wood substrate

Perform this working step under aseptic conditions to prevent the grain from contamination. Clean your worktop, wash hands and forearms, put on a protective face mask, hairnet and gloves and disinfect your worktop well.

Open the sterilised wood substrate bag. Shake Separate the grains of the colonised spawn by shaking and plumping them repeatedly. Use 2 to 8 % (of the weight) of grain spawn for inoculation of wood substrate.

Add about 50 - 200 g of grain spawn per 1 bag containing 2,5 kg of wood substrate.
Close the inoculated substrate bag using a bag sealer or strong adhesive tape. Now distribute the colonised grain evenly into the fresh substrate, by shaking the bag, to achieve fast and equal colonisation.

Mycelium growth on wood substrate

For mycelium growth stage, store the inoculated substrate in a dark and clean place at convenient temperature (spawn run) of this mushroom species. Ensure that the incubator in which the mycelium is grown provides enough ventilation. After about 2 - 3 weeks the mycelium should have grown through the bag and the substrate should be overgrown by white mycelium. (Please note that some different species of fungi could have different mycelia colours.) Now the mycelium is ready for the fruiting phase.

Table of Contents

Laying of a mushroom bed

Preparing a mushroom bed with wood inhabitant mushrooms is a very easy thing! The best time to start is spring, as soon as the nights are frost-free. We recommend the use of spawn on wood basis (spawn describes a substrate, which is fully colonised by mushroom mycelia, used for inoculation of the fruiting substrate). The usage of grain based spawn may attract mice, rats or other vermin. Just mix the spawn with an convenient base material and keep it moist.

Depending on the species of mushroom and weather conditions the mycelia often develop their first fruiting bodies only a few months after the inoculation. The mushroom fruits until all nutrients have been consumed. With little luck, the mushroom will settle permanently in your garden.

Recommended equipment:

- Completely colonised wood substrate (spawn)
- Wood chips
- (for 1 autoclave bag with 2,5 kg spawn we recommend 15 kg wood chips)
- Covering material (bark mulch approximately 25 litres, straw or soil)
- Corrugated card board
- Spade or shovel
- Water (garden hose)

Bed preparation

Mushrooms breeding in your garden need a shadowy place, preferably either near trees or underneath bushes. If you want to lay several beds side by side, leave enough space between the beds. With proper nurture they will expand and develop fruits for several years.

With one spawn bag (2,5 kg capacity) a mushroom bed of 80 x 80 cm can be inoculated. Excavate about 10 cm of soil and spread out cardboard as a bottom layer of your bed. Now disperse one half of the wood chips evenly on the bed and irrigate them for about 10 minutes using a hosepipe.

Inoculating the bed

The spawn bag needs to be properly shaken because mycelium populated wood substrate tends to be closely clotted. By fluffing and rubbing of the bag with the whole palm of your hand, the substrate can be separated. Make sure you separate the substrate thoroughly to ensure a consistent and quick colonisation of the wood chips.

Now spread out the spawn over the watered wood chip layer as evenly as possible and cover it with the remaining wood chips. Afterwards the mushroom bed needs to be watered again for about 10 minutes. To prevent the bed from drying out we recommend a 5 cm thick cover layer of bark mulch or straw. This cover layer needs to be moisturised as well.

Some mushrooms even allow you to use a cover layer made out of soil. We recommend using mushroom casing soil. Fluff up the soil in the bag, evenly spread out a 5 cm thick layer over the bed and water the bed for a few minutes.

Further care

Check the moisture of the mushroom bed periodical. If the bed isn't moist under 3 cm depth or more, please water it again. During the harvesting season we recommend to harvest the fruiting bodies daily. The simplest method to do this is twisting the fruiting bodies on their base. Take care to remove the whole shaft to prevent bacterial contaminations.

Wintering and feeding

To ensure your mushroom bed survives the winter, we recommend spreading out a 5 cm thick layer of wood chips before the first frost. This new layer offers your mushroom bed fresh nutrients. In the next spring, as soon as the nights are frost-free again, the mushroom bed should be controlled for moisture and be watered in case it dries out.

Fighting snails

Snails love mushrooms! To prevent these voracious creatures from destroying the whole crop, we recommend building a snail fence around the mushroom bed. Don't use slug and snail bait or other chemical pest control substances, the poison might end up in the fruiting bodies!

Table of Contents

Inoculation of wood logs with spawn dowels

The inoculation of wood logs or stumps with spawn dowels can be done throughout the whole year, if the logs / stumps are stored frost-free during spawn run, until they are fully colonised. Depending on the species, the mushroom fruits for several seasons untill all the nutrients of the wood have been consumed.

Recommended equipment:

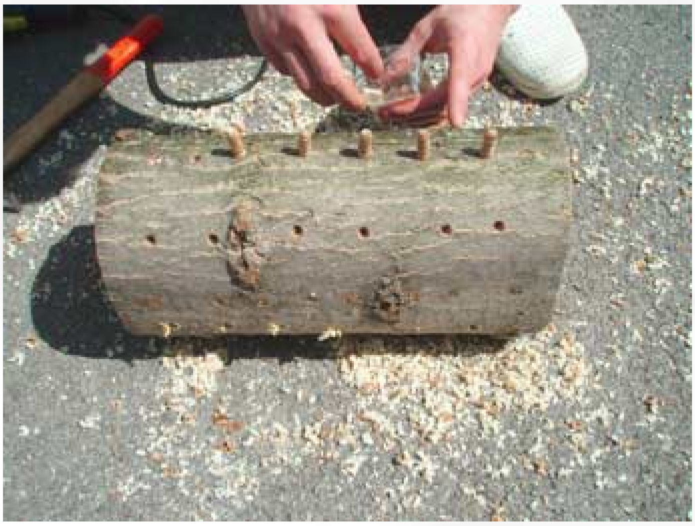
- Wood logs or stumps
- Wood saw
- Tub for soaking
- Drilling machine and 9 mm (0,35 inch) drill
- Spawn dowels (wood dowels, fully colonised with mycelium)
- Jute bag
- Sealing wax
- Hammer

Preparations of log

The quality of the wood is crucial for successful cultivation. After you have cut the wood, make sure to store it in a dry place for 2 -3 weeks, then prepare it as follows:

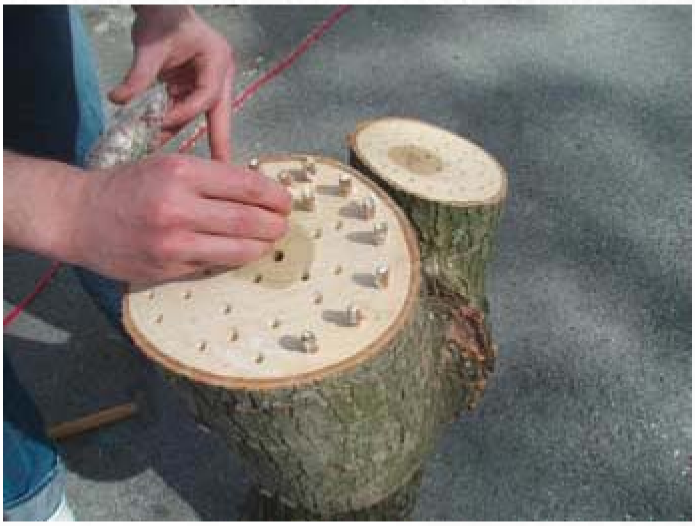
Soak the entire log for 3 days in a tub and leave it to dry on a canvas outdoors for one day. The primary choices of material are wood logs with bark, with 20 - 35 cm (7 - 14 inch) in diameter and 90 - 120 cm (35 - 47 inch) long.

After it's deliverance the spawn dowels should be left in rest 2 to 3 days at room temperature (maximum 29 ° C / 84 ° F) to give the mycelium time to recuperate from it's journey. If you don't plan to use the spawn dowels immediately after the recuperation, please store in the fridge at 2 - 4°C/ 36 - 39°F and use it within a few weeks time.



Inoculating the logs

Cut off about 2 cm on each end of the trunk directly before inoculation to prevent unwanted fungal growth and contamination and throw the pieces away. Now drill about 50 holes of 3 - 4 cm (1,2 - 1,6 inch) depth all around the log evenly. Take care to work slowly, if the wood heats up too much it might affect it's quality! Now place the dowels into the holes carefully. Take care not to injure the mycelium. We recommend to inoculate the cut surfaces too, to reach even better results.



For logs we recommend to use about 50 spawn dowels, for stumps 30 - 50 spawn dowels. As soon as the whole log is inoculated, close the holes with sealing wax. The simplest method is to apply warm, liquid wax with a paint-brush and immerse the cut ends.

Mycelium growth at log

For mycelium development / spawn run, wrap the trunks in moist jute bags and put them in a shadowy place in your garden or in a well ventilated cellar for about 10 weeks. The jute bags need to stay moist. The spawn run phase is over as soon as white mycelium can be seen besides the holes. (Recommended temperature: spawn run - depending on species)

Setup in the garden and further care

As soon as the logs are fully colonised, dig a hole of 15 cm (6 inch) depth in a shady place in your garden and place the log in an upright position. For cultivation on a shady balcony or terrace use a flower pot filled with sand or pebbles. Keep the wood and the soil around it moist and water them on a periodical. The fruiting bodies develop during the season, providing the natural weather/fruiting conditions - depending on the species.

Wintering of log

To protect the logs against frost just wrap them in jute bags during winter. In spring time, bags are removed and the logs are sprayed with water.

Fighting snails at log

Snails love mushrooms! To prevent these voracious creatures from destroying the whole crop, we recommend building a snail fence around the log. Don't use slug and snail bait or other chemical pest control substances, the poison might end up in the fruiting bodies!

Special tips for Lentinula edodes (Shiitake)

Shiitake doesn't need contact with soil. The logs also can also be placed and fixed at a fence. We recommend using wood logs (with bark) of about 70 - 120 cm (27 - 47 inch) length and a diameter of about 15 - 20 cm (6 - 8 inch).

To start the fruit cropping prepare the logs as following: Dunk them in cold water for approx. 24 h (the log should be complete covered with water). The best yield can be made if the water has a ph value of 5 (to adjust the ph value use 0,1 % N hydrochloride). After dunking, pitch the log for 3 times on a stone plate. Now it takes 10-14 days fort he pins (mini mushrooms) to appear. After harvesting, let the log rest for 6 weeks then you can dunk and pitch it again!

Table of Contents

Mushroom cultivation on a bale of straw

Several mushroom species are straw inhabitant. You can use wheat, rye or barley straw. One of the most successful ways for these species is the cultivation on bales of straw in the garden.

Only use dry and healthy bales of straw, because the quality of the fruiting substrate always has a big influence on the crop yield. The colour of the straw (golden yellow) and the almost tear-proof blades indicate the health of the straw. Furthermore it should smell fresh, if it doesn't, don't use it, a musty smell either comes from mould or other fungi which are already populating the bale. Musty bales are not suitable for mushroom cultivation!

Recommended equipment:

- Bale of straw (27cm x 20cm x 40cm)
- Tub for soaking
- Grain or wood spawn (completely colonised)
- Jute Hessian Cloth (200 x 100 cm)
- String (2 m)
- Water

Preparations of a bale

Soak the bale in water overnight (12 -16 h) before inoculation. Take care that the whole bale is covered with water. Immediately before the inoculation take the bale out of the water and drain the spare water for half an hour.

Inoculation of a bale

Please wash your hands and arms thoroughly before you touch the spawn. For one bale of straw (27cm x 20cm x 40cm) we recommend the use 1 liter spawn. To assure a consistent population form one 5 -10 cm (2 - 4 inch) deep hole on each side. Use a clean stick to drill the holes. Divide the 1 liter spawn evenly on the 6 holes.

To keep the spawn in the bale and ensure that it grows through it, close the inoculated holes with straw from the outside. Now wrap the bale in the jute fleece and tie the string around it.

Mycelium growth on a bale - Spawn run

For spawn run store the bale in a shady place in the garden. Depending on the species, temperature and humidity, it will take 2 - 4 weeks till the bale is fully colonised with mushroom mycelium.

Control the humidity in the bale periodically. Humidify the bale again, if more than 3 cm of the outmost layer are dry. Please apply only small doses of water, because the spawn could die if the bale gets too wet. Depending on the weather it will be sufficient to use 2 - 3 litre per bale 1 to 3 times a week. Control the humidity inside the bales with your hand. Do this on a regular basis and adjust it with small amounts of water to prevent the spawn from drowning.

Fruiting of a bale

As soon as the bale is completely colonised, you can initiate the fruiting by increased air supply. Just remove the jute fleece on one broad side of the bale. If the weather conditions are right, the first pinheads should show up after 2 - 4 weeks.

The mycelium will fruit in several flushes until all the nutrients in the bale have been consumed. Afterwards you can still use the bale as a commodity for composting. Take care to harvest all the fruiting bodies. Please check the humidity in the bales during the harvest periods and also adjust the humidity if necessary.

Fighting snails at bale

Snails love mushrooms! To prevent these voracious creatures from destroying the whole crop, we recommend building a snail fence around the bale. Don't use slug and snail bait or other chemical pest control substances, the poison might end up in the fruiting bodies!

Table of Contents

"PF-technique"

The PF-technique aka BRF-Tech (Brown Rice Flour technique) is a method developed by hobby mushroom cultivators for growing mushrooms in the simplest way. Over the last centuries many different versions of this method have developed. The following instruction is based on our experience.

Mushrooms need a convenient substrate to develop fruits. The substrate has to be produced under sterile conditions to avoid contamination through mould or bacteria. Contamination destroys not only the fungi but also the substrate. The substrate is inoculated with spores. In the next phase, the so called spawn run, the mycelium grows on the substrate. As soon as the substrate is fully colonised with mycelium, it is ready for the fruiting phase.

Recommended materials:

- Micro-Boxes or PF-glasses
- Measuring cup
- Vermiculit
- brown rice flour
- Sporesyringe (ATTENTION, not every mushroom species is suitable for cultivation on PF-substrate.)
- Fruiting chamber
- Pressure cooker
- Container for mixing
- Water

Mixing the PF substrate

Blend one litre (about 700g) of rice flour with three litres of vermiculite medium, then add one litre of water and mix again. That should result in five litres of PF-substrate for 10 micro-boxes with 500 ml each.

Filling the substrate

Use your hands to fill the substrate into the boxes or glasses. Use your fingers to push the substrate into form to eliminate any hollow spaces, but don't press too much. Fill the boxes or glasses up till 1,5 cm under the edge of the box remains free, and smoothen the surface of the substrate. Clean the edge of the box or glass with a wet piece of cloth, and fill the rest with dry vermiculite. The dry vermiculite acts as a filter to prevent growth of contamination from the outside into the substrate. Close the boxes/glasses. If you are using micro-boxes remember to make sure the lid is lying loose on the box to ensure pressure balance. If you using glasses pierce the lid four times (make holes of about 2 - 3 mm / 0,1 inch in diameter), these will later be used to inoculate the substrate.

Sterilise the substrate

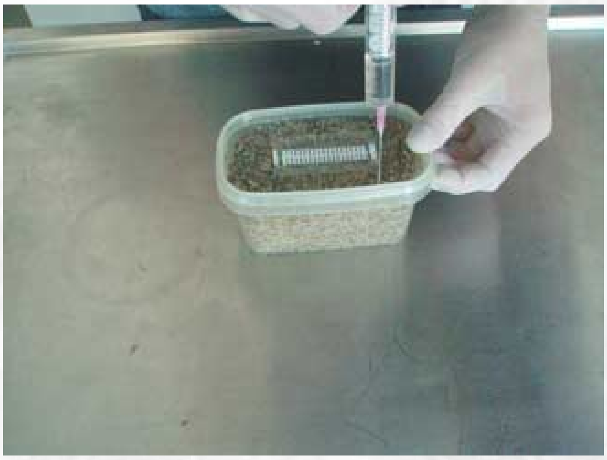
A pressure cooker is used for the sterilising process. Overlying a 2-3 centimetre water level at the bottom of the cooker with a separating insert keeps the boxes / glasses above the water line. Assure yourself that there is no contact between the water and the boxes / glasses, decant some water if necessary. (Mind the handling instructions given by manufacturers of your pressure cooker!) Now fill in the glasses or boxes. If the cooker is big enough you can make two levels. Place the upper layer on a separating tray over the left spare zones of the lower layer. This ensures that the steam gets evenly distributed.

Get the lid locked and put the cooker on a hotplate. Start counting the sterilisation time as, the pressure gauge

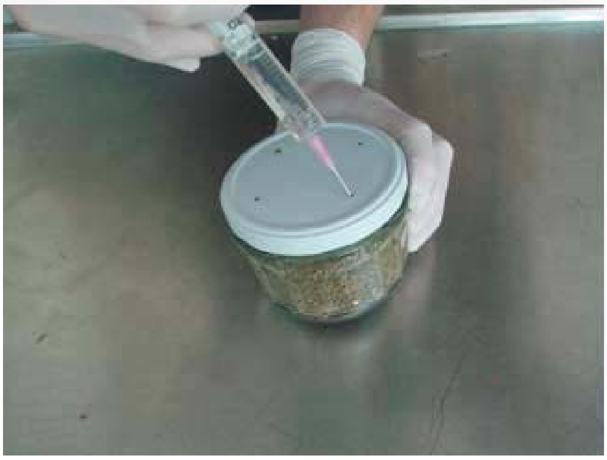
reaches its highest stage (for household pressure cookers). If you've got a professional pressure steriliser at your disposal sterilise at 121°C/ 250°F/ 15 psi/ 1.05 bar.
Once the sterilisation time has passed the cooker must cool down in a clean place, preferably in front of a HEPA - filter (sterile air flow). If working without laminar flow hood put a clean wet piece of cloth over the cooker during the cooling process to filter the air streaming into the pot while pressure equalisation.
After the steriliser is fully depressurised, open the lid. The glasses/ boxes should cool down to room temperature in front of a HEPA-filter or in a Glove Box. As soon as the substrate has cooled down bellow 30 ° C / 86 ° F, it is ready for inoculation. If your intend to continue later close the boxes / glasses tightly, store the substrates in the neatly clean refrigerator (35.6-39.2°F, 2-4°C) and use them within 4 weeks.

Inoculation of the substrate

Perform this working step as aseptic as possible to prevent the substrate from contamination by bacteria or moulds. Clean the worktop, wash your hands and forearms, put on a protective face mask, hairnet and gloves and disinfect your worktop well.



Give the spore syringe a good shake to ensure that the spores are well spread throughout the water. If using micro-boxes you can pierce the lid with the syringe (please disinfect the spot you choose to pierce). The substrate glasses will be inoculated through the four holes in the lid. If you use ready sterilised PF-substrates please remove the tape from the holes on the lid before inoculating the substrate and leave the holes open afterwards, to ensure sufficient air exchange!
Remove the protective cover from the cannula just before inoculation. You mustn't touch the sterile needle. Stick the needle through the holes of your box or glass towards the wall and inoculate the substrate, spreading the liquid along the wall of the box. Use 1 - 4ml of the spore-water mixture per each box/glass (filled with 500ml substrate), portioned in all 4 holes.



Should the needle touch anything unsterile, you will have to sterilise it again. Therefore hold the nip of the needle into a flame (Bunsen burner or lighter) till the nip turns red and let it cool down again. (Do not overheat the needle as the stand is made of plastic which could melt!)

Mycelium growth PF

After all substrates have been inoculated, they should be stored in a warm (up to 30°C) and dark place. The substrate is ready for the next step as soon as the whole box / glass is grown through with white mycelium (this normally takes 2 - 3 weeks). Only the 1,5 cm layer of dry vermiculite stay free of mycelium.

Fruiting

Rub off the layer of dry vermiculite from the top of the boxes/glasses and take out the mycelium. Put the mushroom mycelia into a growing chamber or similar under the convenient environmental conditions for "the Primordia formation". As soon as the first small mushrooms (Primordia) appear change the temperature and humidity to the recommended fruiting conditions. According to the species, it takes about 1 or more weeks untill the Primordia appear, a few days later you can harvest your first own mushrooms.

Table of Contents

Inoculation of substrat bags with sporesyringes

This is a very simple method of mushroom cultivation and suitable for hobby-mycologists. Use a convenient substrat depending on the mushroom species you want to cultivate. Detailed information about the convenient substrate can be found in the product description of our spores. When you bring spores onto an appropriate nutrient medium, the spores start germination. As soon as the substrate is fully colonised by the mushroom, you can set up the bag for fruiting.

Recommended materials:

- Substratbag
- Spore Syringe
- Workspace Disinfection
- Kitchen paper
- Tape (cloth tape)

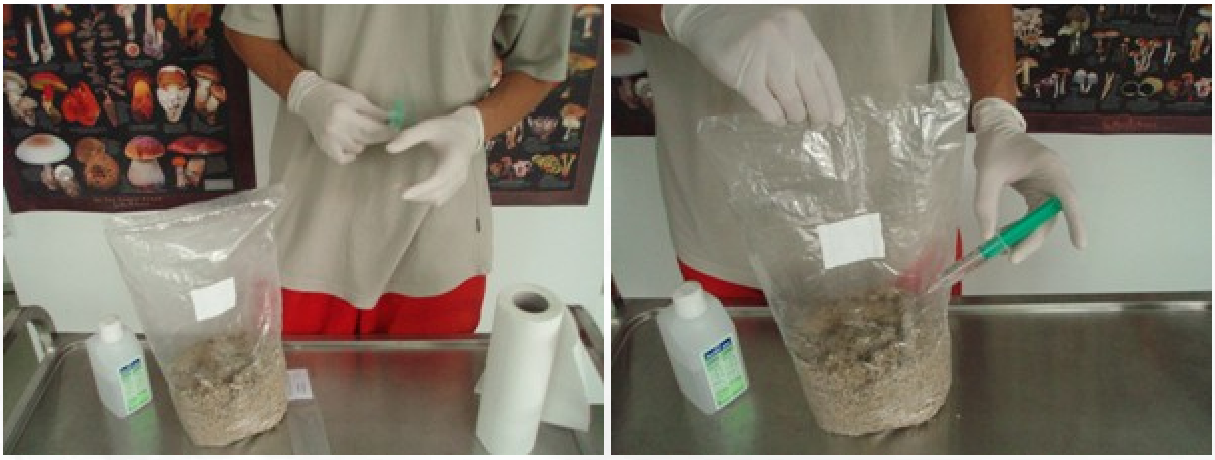
Disinfect the surface of bag

To avoid invasion of any contamination during inoculation, we recommend to disinfect the surface (just a few cm large - the place you want to put the needle in). Kindly spray disinfection (i.e. Bacillol) on the bag, let it react for about 20 - 30 seconds, then dry it with a clean ktichen paper or similar.

Inoculation bag with syringe

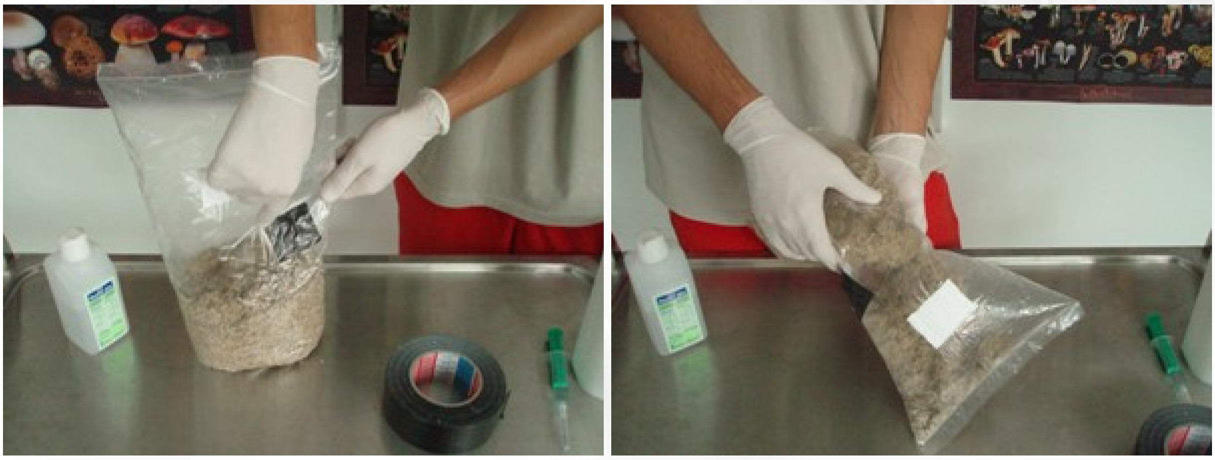
Shake the syringe to dispense the spores equally. Now put the needle into the bag (at the disinfected area) and push the the sporesolution into the bag. We recommend to use about 5 ml - thats 1/2 syringe - for small bags (2,5 l content). For larger bags (4,5 l content) we recommend to use 10 ml sporesolution - thats 1 spore syringe.

ATTENTION:
If the needle get in contact with any unsterile thing, you have to sterilize it. There for heat the forefront of the needle with a alcohol lamp (or with a lighter). The forefront of the needle should glow red. After that let the needle cool down for a few seconds.



Seal the inoculation area and distribute the spores

Close the inoculation area immediately with the tape. To distribute the spores equally in the substrate, shake the bag careful.



Spawn run in bag

For colonisation of the substrate, store the bag at the convenient spawn run - temperature (see in the product description in a dark place. After the substrat is fully colonised by the mushroom, you can put it into fruiting. If you work with rye grain substrate it is also possible to use the grain for inoculation of a different fruiting substrate.

TIP: If the substrat is not colonised even, kindly shake the bag after a few days.

Table of Contents

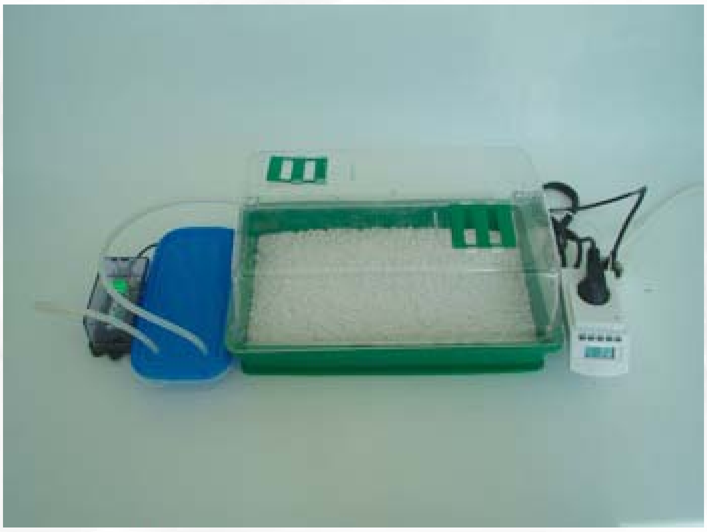
Instruction for indoor mushroom propagator

For successful growth mushrooms need suitable substrate, the right temperature and humidity, as well as oxygen and a little light. Our grow-kits are especially designed to provide these cultivation parameters in an easy to handle way.

It's easy to upgrade a customary greenhouse into a hobby-mushroom-grow-set. The main principle always stays the same, no matter how much space you cultivate, only the machinery used to regulate the climatic conditions gets more complex, the more space you occupy.

Recommended equipment:

- Greenhouse
- Digital temperature control
- Electric heat pad or heating cable
- Humidity/CO2 Apparel Set
- Perlit
- Spray bottle
- Disinfectant



Main principle

Throughout their different stages of development fungi need a variety of environmental conditions. During mycelium growth most mushrooms need relatively high temperatures (27 - 29°C), during fruiting they need high humidity.

The electric heat pad or the heating cable is used, to provide the right temperature. To set the suitable temperature for each mushroom species, the electric heat pad or cable will be triggered by the digital temperature control. The humidity will be the result of humidity or CO2 pump, which is also supplying oxygen, and the wet perlit on the floor of the greenhouse.

Use as Incubator

Inoculated substrates have to be kept in clean place, under suitable conditions, during mycelium growth. Installing the grow-set for mycelium growing stage:

Clean and dark spaces are ideal for setting up your grow-set (you may as well cover the greenhouse with opaque material). If the set is stored in a cupboard make sure it gets enough oxygen. Open the cupboard at least once a day.

Place the heating pad under the greenhouse. If possible put some heat isolating material beneath the pad. If you are using a heating cable make sure it is lying snake-wise on the floor of the greenhouse, try to spread it symmetrical over the floor.

Place the sensor for the temperature control system on the floor of the greenhouse. Plug the heat-pad or cable into the temperature control and plug the control into a socket.

Take one of the pumps silicon tubes and connect one end to the hole of the greenhouses lid and the other to the pump. Keep the pump running at all times, as it helps the ventilation during the "spawn run" phase. The knob above the connection point regulates the amount of air. If you are using a tube-micro filter, cut the pipe open and install it in the middle section.

Adjust the system to the necessary conditions for mycelium growth of your fungi genus. Try to keep the greenhouse as dark as possible during this phase (except for your daily control).

Use as fruiting chamber

As soon as the whole substrate is grown through with mycelium, the environmental conditions have to be changed to initiate the fruiting phase. The basic structure of the greenhouse stays the same as in the growth phase, the Humidity/CO2 pump as well as perlit will also be needed.

Moisten the perlit in a sieve or a plastic bag and spread it symmetrically on the floor of the hothouse. The perlit has to stay wet during the whole fruiting phase. Evaporated water can be refilled using a spray bottle. Substrate grown through with mycelium - blank or in opened bags - can be place directly on the perlit.

Installing the humidifier: First connect both of the silicone tubes to the hole in the lid of plastic box, one of them stuck about 1 cm through the hole, the other about 4-5 cm. The tube, stuck 4-5 cm through the hole, has to be connected to the ceramic diffuser. If you use an additional micro-filter connect it to the same tube as the ceramic diffuser.

Fill the plastic box with fresh tap water till ¾ of the volume are full and close the lid. Important: The ceramic diffuser has to be completely under water, the second tube must hang in the air above the water level.

The last step is to connect the tube, attached to the ceramic diffuser, to the air pump and stick the second pipe into the greenhouse. The button above the pumps connection regulates the amount of air, enabling us to control ventilation and humidity inside the hothouse. Change the water every 2-3 weeks. Adjust the system to the necessary conditions for mycelium growth of your fungi genus.

Adjust the system to the necessary conditions for fruiting of your fungi genus.

Table of Contents

Mushroom Growing by Mush Mush

by

Mush Mush

© Mush Mush

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Cmaking_grain_spawn&old

Table of Contents:

- Cultivation of Psilocybe cubensis on cased sterilised grain
  - Making grain spawn
    - What is grain spawn?
  - Containers
    - Glass jars
    - Microboxes
    - Filter patch bags
    - Closing the containers
      - *Closing glass jars*
      - *Closing microboxes*
      - *Closing filter patch bags*
  - Substrate recipes
  - Sterilisation
  - Inoculation possibilities
    - Spores in a watery suspension
    - Mycelium on agar
    - Mycelium on sterilised on grain spawn
    - Mycelium in a watery suspension
  - Inoculations in practice
  - Inoculation of jars and microboxes
  - Inoculation of bags
  - Incubation
  - Contamination
  - Refrigeration

- Cultivation on cased sterilised grain
  - Overview of the procedure
  - Testing the colonised grain
  - Casing
  - Casing mixture recipe
  - Alternative mixtures and considerations
  - Heat treatment of the casing mixture
    - Pasteurisation in a microwave oven
    - (semi-)Sterilisation in a pressure cooker
  - Casing the colonised substrate
    - Casing jars
    - Cased trays
  - Fruiting the cased substrate
  - Cased trays that fail to fruit
    - Casing completely colonises but fails to form mushrooms
    - Mycelium doesn't colonise the casing surface at all
    - Strange growth is showing up on the casing surface

Cultivation of Psilocybe cubensis on sterilized rye grain
- Preparation of rye grain spawn
- Sterilization
- Inoculation
- Colonization
- Casing of rye
- Recipe and Preparation of the casing soil
- Fruiting

Cultivation on riceflour cakes (short version)

Cultivation of Psilocybe cubensis on riceflour cakes
- Introduction
- Overview
- Substrate containers
- Preparation of the lid
- Substrate preparation
- Filling the jars
- Sterilisation of cakes
- Inoculation of cakes
- Incubation of cakes
- Fructification

Cultivation of Panaeolus cyanescens and Panaeolus tropicalis on sterilised substrate
- Straw substrate preparation
- Substrate Colonisation
- Casing the substrate
- Panaeolus fruiting
- Cultivation notes

Cultivation of fruitbodies and sclerotia on sterilised grass seed
- Preparation of the substrate
- Sterilisation of seeds
- Inoculation of seeds
- Colonisation of seeds
- Casing (for the cultivation of mushrooms)
  - Recipe and Preparation of the casing soil for seeds
- Fruiting of seeds
- Sclerotia

Making spawn for the woodloving outdoor species

Growing the woodlovers outdoors
- Overview of procedure
- Preparation of grain spawn
- Growing mycelium on sterilised wood chips
  - Preparation of the wood chip substrate
  - Inoculating the wood chip substrate
- Making the outdoor bed
- Maintenance
- Mushrooms!

Making a sporesyringe

Steam sterilisation
- Typical sterilisation cycle
- Sterilising sealed bags
- Sterilising jars
- Sterilising liquids
- Sterilising other stuff

MushMush Notes
- Preparing Agar
- Pouring Petri dishes
- Incubation of agar cultures
- Storing cultures
- Making a clean sporeprint
- Substrates for Psilocybe cubensis
- Substrates for Panaeolus cyanescens and Panaeolus tropicalis
- Sterilization time
- Casing soil
- Sclerotia cultivation
- Initiation strategy

Working with agar
- What is agar?
- Why is agar important?
- Preparing nutrient medium
- Pouring dishes
- Preparing agar slants
- Starting a culture from spores
- Starting a culture from a fruitbody
- Taping dishes and tubes
- Storing slant cultures
- Incubating cultures

Cultivation of Psilocybe cubensis on cased sterilised grain

Making grain spawn

What is grain spawn?

Grain spawn is rye, (or other cereal grain) fully colonised by mushroom mycelium. It serves two purposes:
1) As a carrier of mycelium into spawn larger amounts of substrate
2) As a substrate by itself.

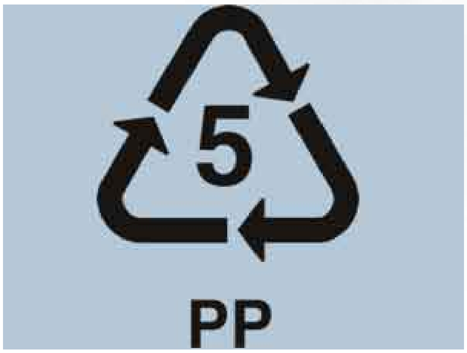
Not all species will fruit directly from grain spawn. *Psilocybe cubensis* is one of the species that can do this, Panaeolus species generally will not fruit directly on (cased) grain. The latter species requires a dung-based to fruit on, although the mycelium will grow fine on rye.
The mycelium of most saprophytic mushroom species can be grown on rye.

Some rye grain.

Containers

Glass jars

Real canning jars are best because they can withstand numerous sterilisation cycles without problems. A cheaper alternative is to find the cheapest brand of applesauce or vegetables in a local supermarket and to discard the contents (not in the store!). When these jars are cleaned and have their labels removed they can be used. However, since these jars are not intended to be sterilised often they are much more fragile, especially after 2-3 sterilisation cycles. Metal lids, or lids made from polypropylene (PP) can be pressure cooked.



This symbol is depicted on most polypropylene items.

Microboxes

These polypropylene containers provide an excellent alternative to glass jars. They come with a filter fitted in the lid and the lid seals hermetically to the bottom. They can be pressure cook and be re-used over and over again. Because they are made from polypropylene there's no risk of injury from glass shards as there is with glass jars.

Filter patch bags

These bags are specially made for the production of grain spawn. Made of polypropylene they have a filter patch sealed to one side of the bag. Traditionally these bags are sterilised open and sealed afterwards but we have some tips on how to sterilise them sealed, look here. The bags need to be sealed with a good impulse sealer. Cheap household sealers will not work because the width of the seal is too small.

A 1000ml microbox and 720ml jar

Filter patch bag and medium components

Closing the containers

Closing glass jars

For glass jars there are some options on how to close them. We prefer to use Tyvek or filter disks beneath the lids. Although it is possible to incubate the jars without some kind of filter, just with the lids loose, this is risky. Especially in somewhat drafty and/or dirty environments jars without a filter easily contaminate with airborne spores.
A hole should be drilled in the lids. In case of metal lids holes can be punched with a nail and hammer. The size and/or amount of the hole(s) depends on the type of filter that is used. If too much dehydration during incubation takes place more sheets of filter material should be used next time. Some experimentation may be necessary to find the optimum hole size and filter material.

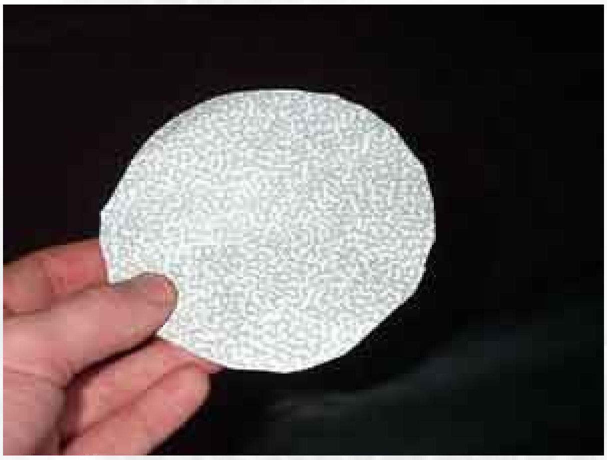
Lid with a hole.

The jars are filled with rye and water then the filter material is screwed tight under the lid. The lid can be screwed tight during sterilisation since the filter will allow steam to escape.

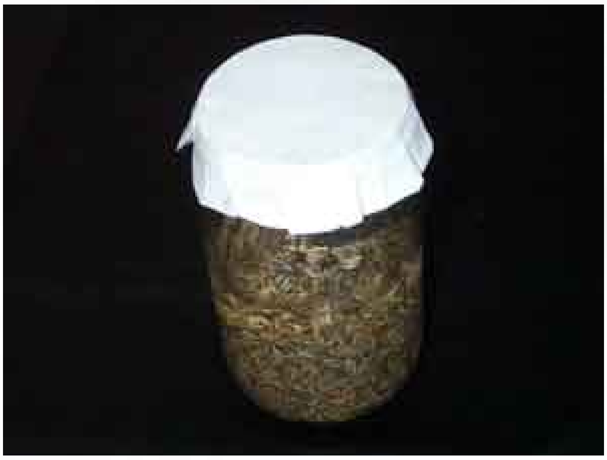
Rye and water

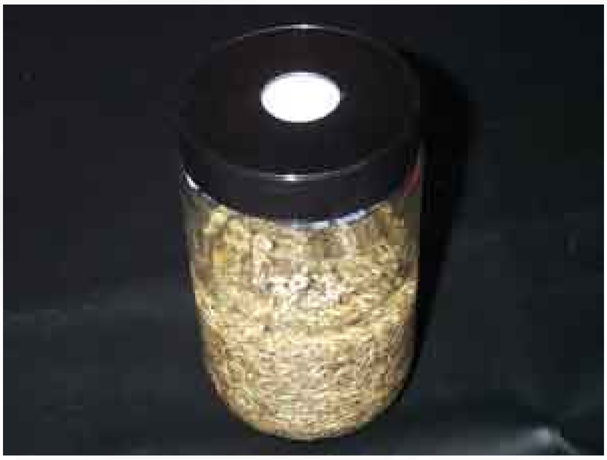
Rye and water combined in a jar

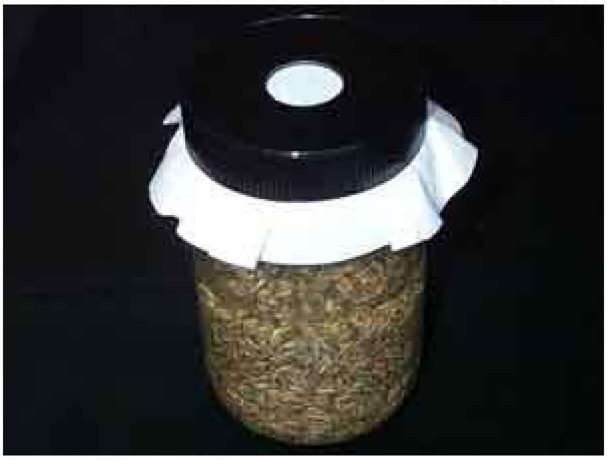
Filter disk


Tyvek filter

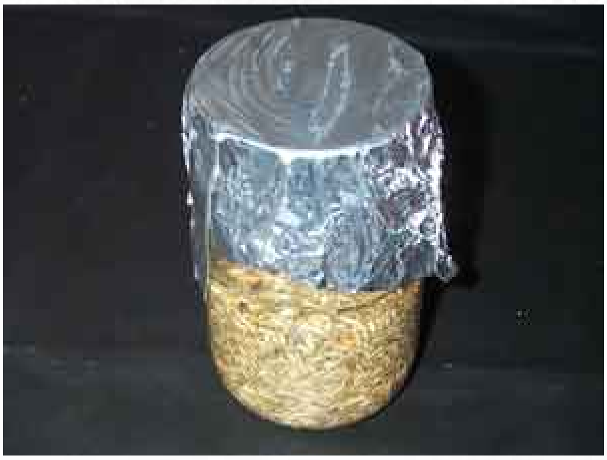
Lids on jars without a filter should never be screwed tight since the jars might explode/implode during sterilisation.
Jars are capped with a double layer of aluminum foil to keep the filter clean and dry for inoculation.


Jar with Tyvek filter


Tyvek jar with the lid on



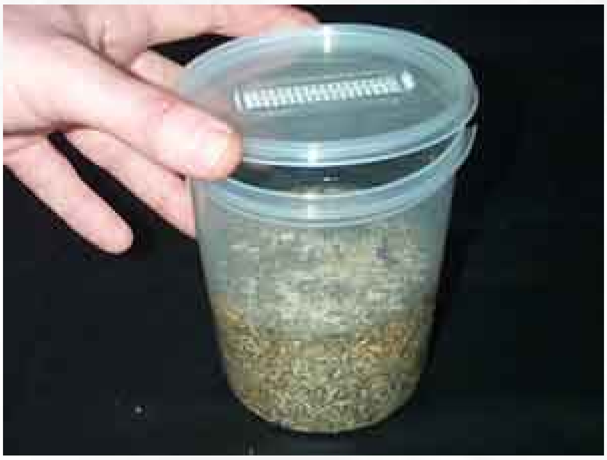
Jar with filter disk



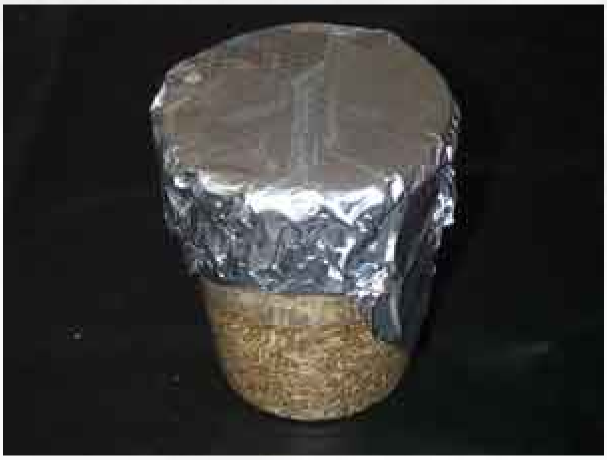
Jar capped with aluminum foil

Closing microboxes

These polypropylene containers come with a tight fitting lid. The lid contains a filter but this filter does not allow rapid venting of steam. Therefore microboxes should never be sterilised with the lid closed. Closed lids will result in deformation or other damage to the jars.
The container is filled with rye and grain then the lid is put on loosely or closed for 3/4. One 1/4 of the lid should always remain open.
The boxes are capped with a double layer of aluminum foil. As soon as the boxes come out off the cooker their lids should immediately be closed.



One edge should be left open

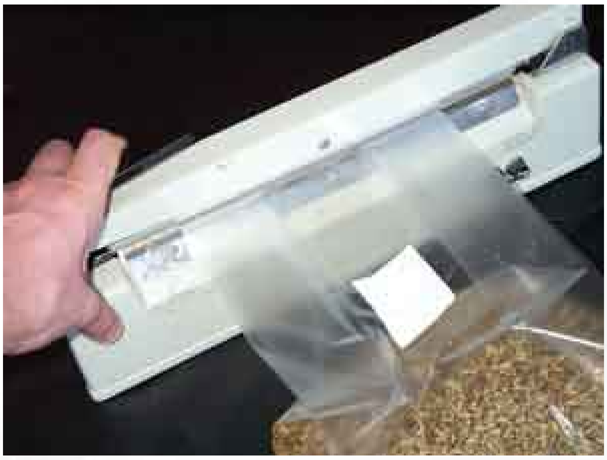


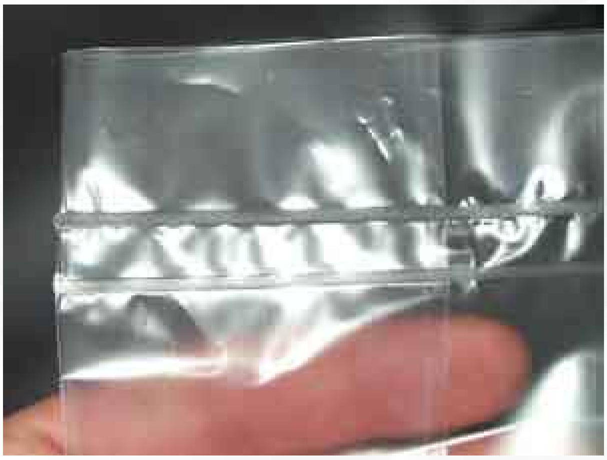
Microbox ready for sterilisation

Closing filter patch bags

With some care bags can be sealed before they are sterilised. For more instructions look here. Sterilising open bags is possible but bags should be sealed the moment they come out of cooker or they should be left to cool down in a running flow cabinet.

Water and rye are combined


The bag is sealed with an impulse sealer


A good double seal

Bag ready for sterilisation

Substrate recipes

In general the more substrate is sterilised in a container the dryer it should be. Rye grain and water can be combined and subsequently sterilised. There's no need for pre-cooking the grain as is the case with birdseed. During the sterilisation cycle the rye grain will absorb the water but this will go a little uneven. The bottom kernels will be wetter than the top kernels so the jars need to be shaken while still hot to evenly distribute moisture throughout the substrate.

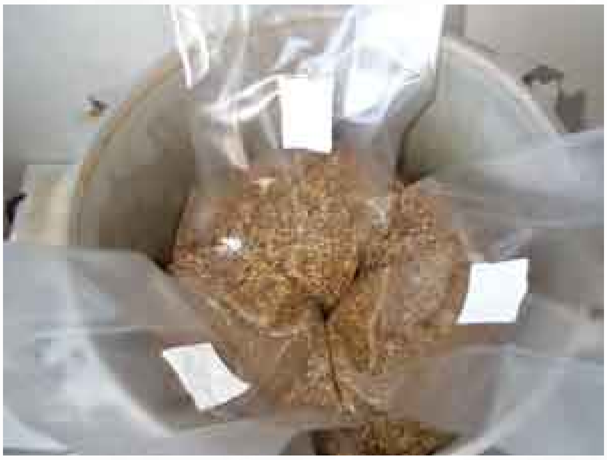
500 ml jar/microbox
125 g rye
160 ml water

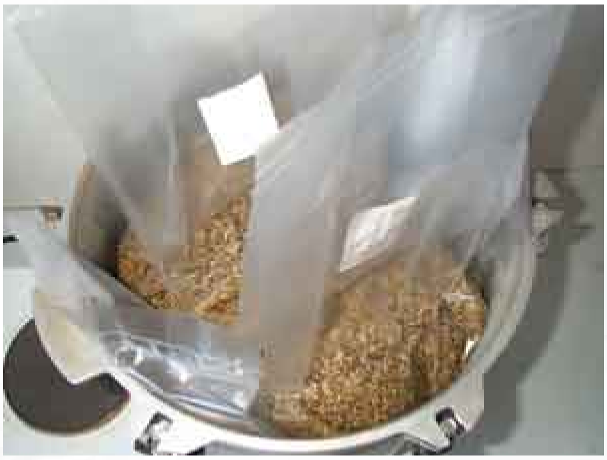
1000 ml jar/microbox
250 g rye
280 ml water

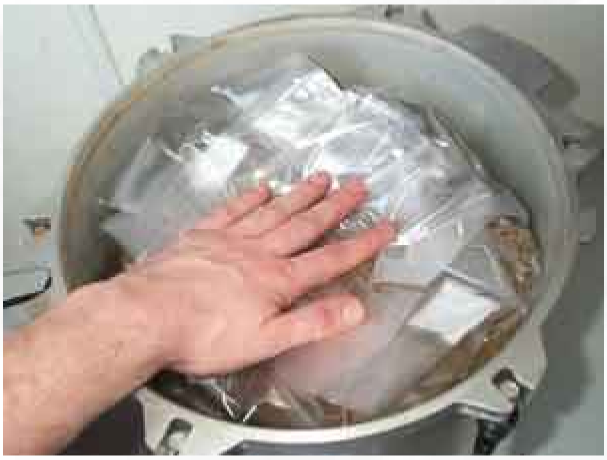
filter patch bag (4 liters effective)
1600 g rye
1350 ml water

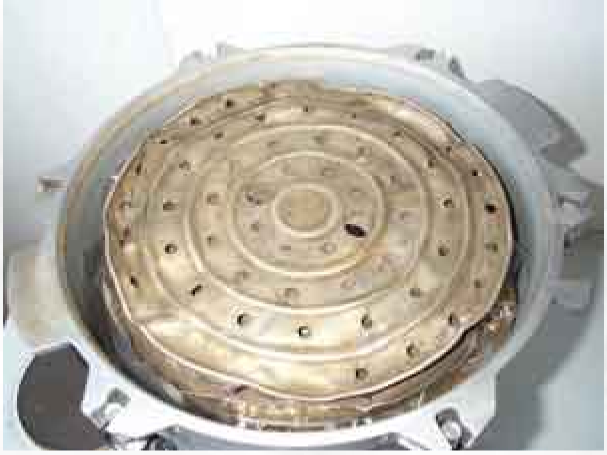
Sterilisation

Jars and microboxes up to 1000 ml are sterilised for one hour at 121° Celsius. Bags require much longer; up to three full hours. More details about steam sterilisation in general and how to sterilise sealed bags can be found here.


The first layer of bags


The second layer of bags


Flaps are folded down


The rack on top is very important

As soon as the microboxes come out of the cooker the lids should be closed completely, simply by pressing them downwards. When they have cooled down completely they can be inoculated.

The correct sterilisation pressure

Sterilised jar, rye has absorbed all water

Inoculation possibilities

Now that the substrate is sterilised and sitting comfortly in its container it's time inoculate. In theory one could keep the sterilised substrate indefinitely but in practice it's best to inoculate as soon as possible. As time goes by the substrate dries out and some contaminants may even be encountered after a few weeks of storage.

There are four practical means of inoculation:
1) Spores in a watery suspension (spore syringe)
2) Mycelium on agar (clone or multispore germination)
3) Mycelium on sterilised grain spawn
4) Mycelium in a watery suspension (liquid mycelium)

Spores in a watery suspension

A properly prepared or bought spore syringe can be used to inoculate sterilised rye. The hydrated spores easily germinate on the moist rye and form a mycelium. Often the first signs of germination can be observed after 3-10 days. Germination time depends on the strain and age of the spores. Well-hydrated spores germinate faster than those that have been just scraped off a spore print. When filter disks or Tyvek are readily available the syringe can be used to puncture the filter and to inject an amount of spore suspension. The amount of spore suspension used for one container depends on the availability of inoculant and the desired colonisation speed. More inoculant often results in somewhat faster growth. For jars and microboxes 1 ml of spore suspension would suffice. Of course, more spore suspension in combination with regular shaking of the jar would result in a (somewhat) faster development.
Bags are usually injected with 1-10 ml but they could very well be injected with up to 100 ml. Spore injection is an easy and efficient way for novice cultivators to inoculate small batches of spawn.

Mycelium on agar

Agar squares can be cut from a petri dish with a sterilised scalpel and these can be dropped into the jar. Since the jar has to be opened for this method to work an (improvised) inoculation hood is useful. One or more squares are dropped into the jar or microbox. These containers are are shaken and incubated.
This method will not work for bags since it's not practical to cut open a sealed bag to introduce the agar squares.

Mycelium on sterilised on grain spawn

In theory this would be the best and fastest way to propagate huge amounts of spawn but in practice it's not that easy. It's only possible to do these transfers in a totally sterile environment or huge amounts of contamination will be encountered. We found that this method has limited potential for home cultivators.

Mycelium in a watery suspension

This is the way to go if you have serious money to spend and have very good sterile techniques. It's possible to create huge amounts of liquid spawn from a single Petri dish by chopping it up in a laboratory blender and then diluting this broth The total amount of mycelium is of less importance than the amount of water it is delivered with. Although initial startup growth is slow, it will start in many points throughout the substrate.

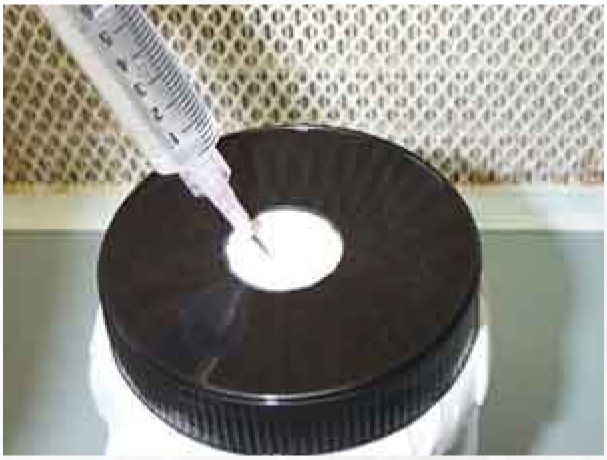
Inoculations in practice

In general the following goes: the longer the sterilised substrate is exposed to the outside air during inoculation, the cleaner the environment should be. When inoculating just a few jars by puncturing the lid with a syringe needle, a cleaned tabletop in the kitchen should be fine. When inoculating open bags with grain spawn a professional flow cabinet is indispensable. Airborne contaminants often settle on the top of the substrate, so when nasty fungi start to grow on top of the inoculated substrate the substrate was probably exposed to unclean air for too long.

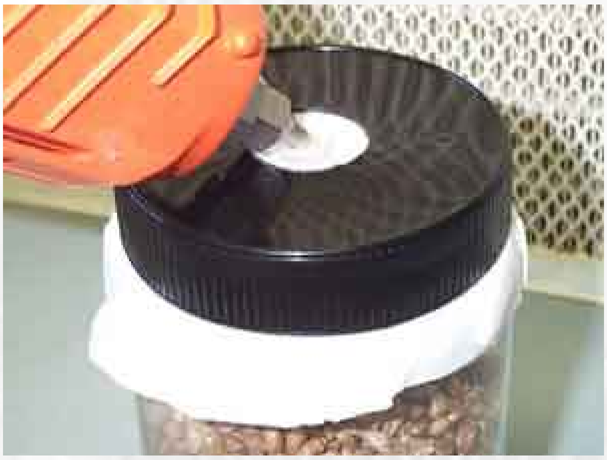
In theory one could get a 100% success rate in a flow cabinet but in practice even under the most hygienic conditions contaminations will be encountered. Contamination rates below 10% can usually be considered good.

Inoculation of jars and microboxes

The easiest method to inoculate jars and microboxes is with a syringe with spore-/mycelium-suspension. The needle of the syringe is heated until red hot and left to cool for 10-15 seconds. The aluminum foil of a jar is removed and excess moisture is wiped off with a clean tissue. The filter (Tyvek/filter disk) is punctured with the needle and some (1 ml) of suspension is injected into the substrate. The needle is withdrawn and the hole is immediately sealed with a drop of hot glue. Jars can then be shaken and incubated. Instead of glue, a piece of tape could also be used but we found that hot glue is the perfect way to seal jars. Even a small and cheap glue pistol will do the trick.

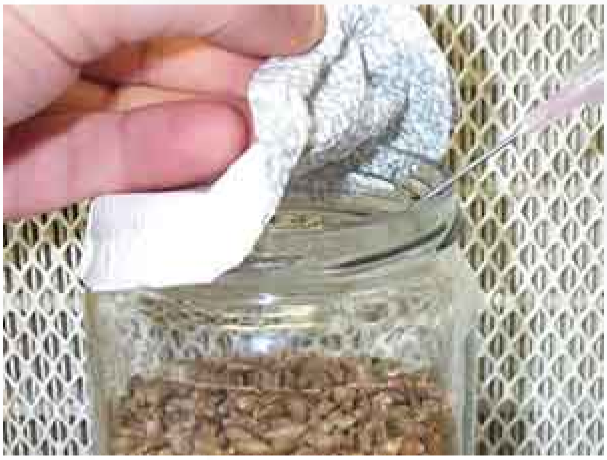


Puncturing the filter

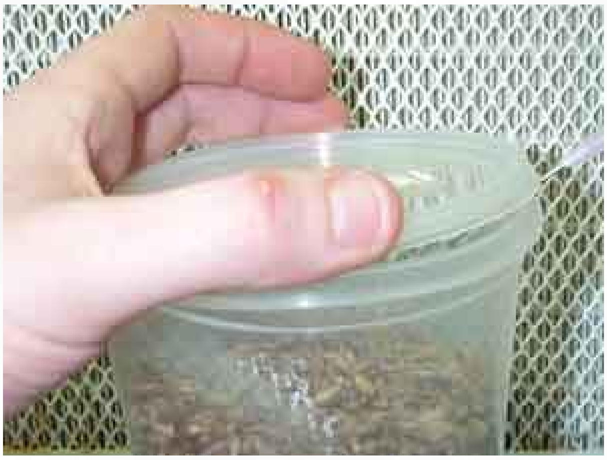


... and glueing it shut

When the lid or filter can not be punctured as is the case with microboxes, the lid should be opened just a crack and the needle can be introduced through there. The needle is withdrawn, the lid is closed and the microbox/jar is shaken and incubated. Since there is more air exposure with this method an (improvised) inoculation hood is desirable.

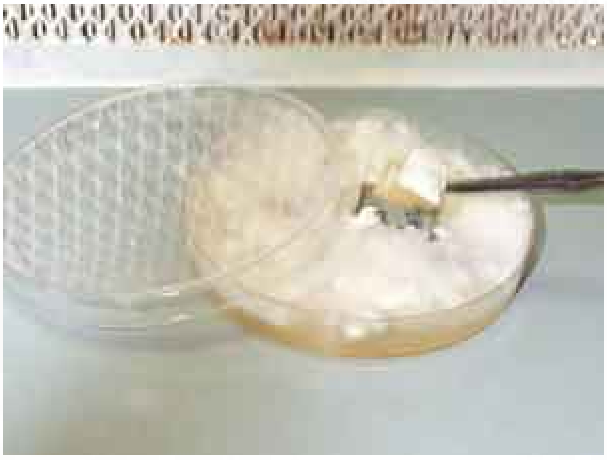


A jar inoculated with a spore syringe

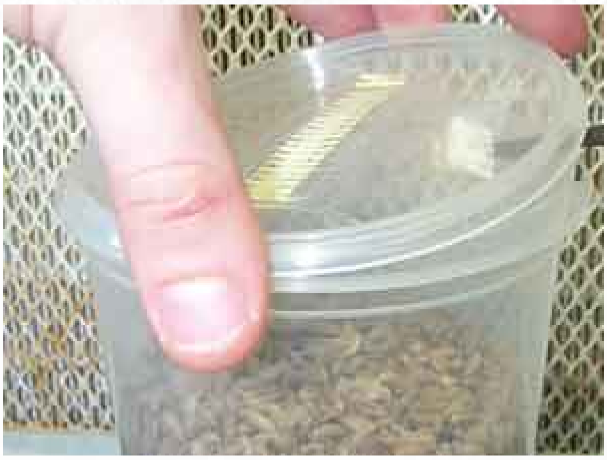


A microbox inoculated with a spore syringe

When inoculating with agar squares there's no choice but to open the lid just enough to introduce the agar. Again, an (improvised) hood is desirable for this kind of work.



Squares are cut from the agar

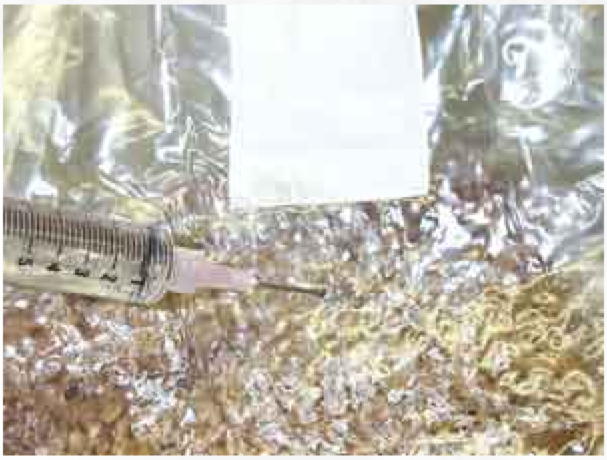


These squares are dropped on the substrate

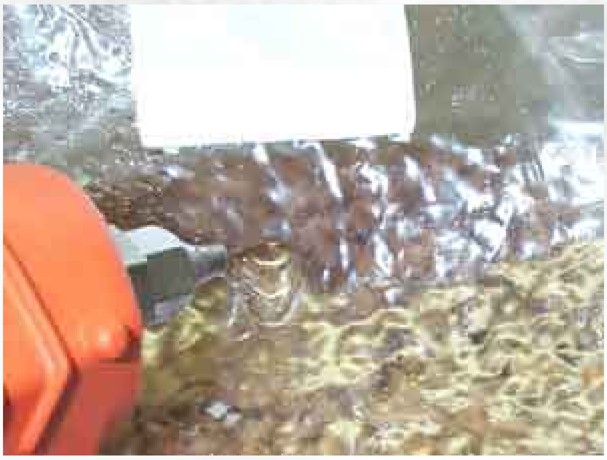
Inoculation of bags

When working with sealed bags the inoculant can only be introduced through means of injection. It's not practical or advisable to cut open a sterilised bag only to re-seal it after inoculation. Working with open bags is not advisable for those without a laboratory and a flow cabinet. Grain to grain transfers will not be discussed here.

The injection site on the bag is cleaned with an alcohol soaked tissue, then the (flamed) needle of the syringe is introduced. Some liquid is injected into the bag (1-200 ml) and the needle is withdrawn and the hole is sealed with a drop of hot glue. A spore syringe is fine for this.

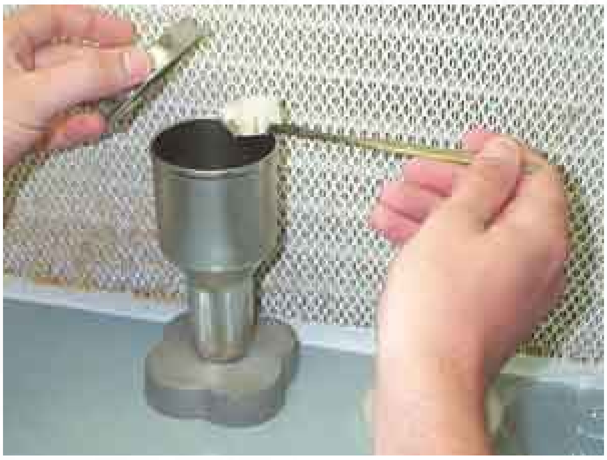


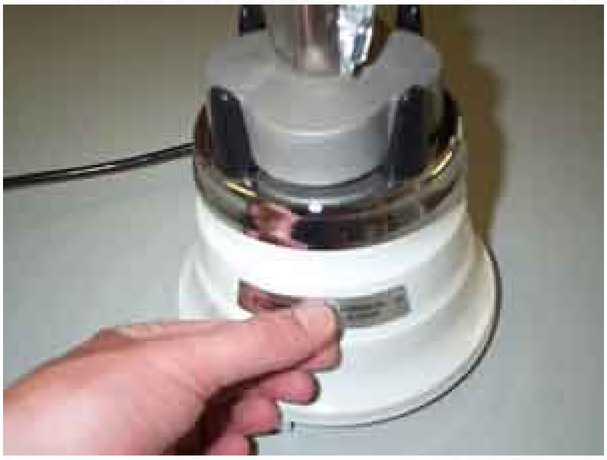
the bag is punctured with the needle

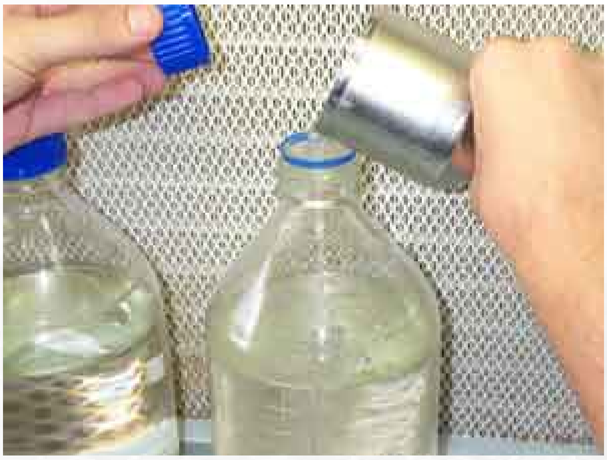


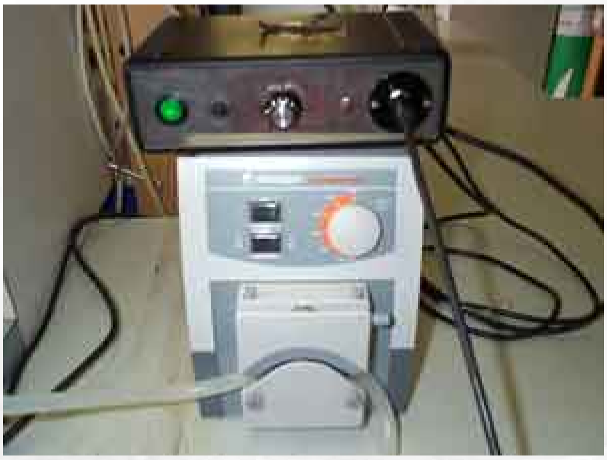
The hole is glued shut

Below you will find a summary of the inoculation method MushMush employs. It involves chopping up an agar culture and using a peristaltic pump to deliver the diluted mycelium to the sealed bags. We understand that there are few people that might actually try this (the equipment is pretty expensive) but it might give you an idea of the possibilities.

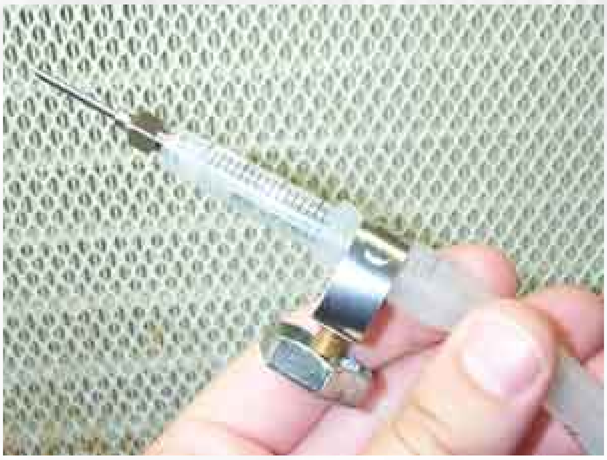

Colonised agar is transfered to a sterilised blender

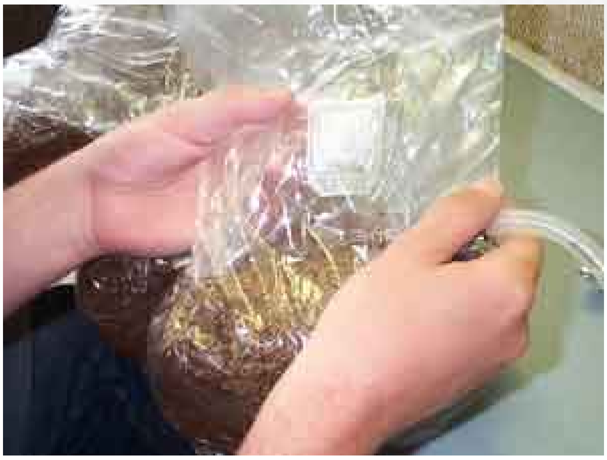

Sterile water is added and the agar is chopped up

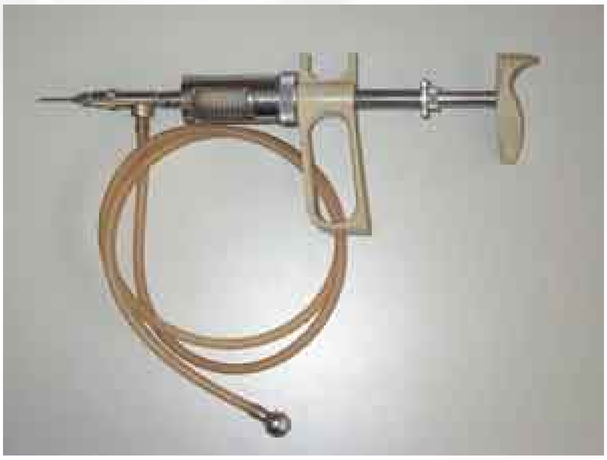

The blended agar is divided over two bottles with sterile water


A peristaltic pump is used to dispens the mycelium suspension

The pump is controlled with a foot pedal switch


A short thick needle is used to inject the liquid mycelium


The bag is punctured and the pedal is pressed


A cheaper solution is to use a self-filling syringe

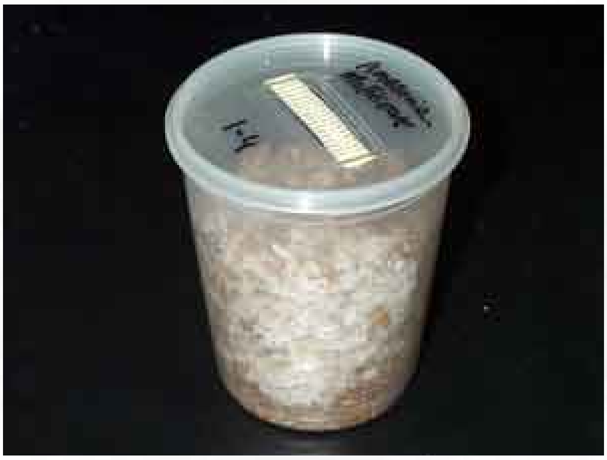
Incubation

The inoculated grain should be incubated at the temperature that is optimal for the species being cultivated. A temperature that is too low will result in slow germination/growth. A temperature that is too high will make the mycelium exude yellowish metabolites (sweat) that eventually sicken the spawn.

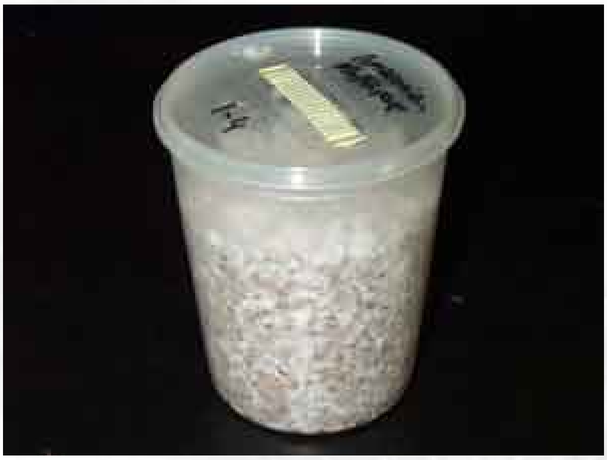
Since the growing mycelium produces heat a rise in temperature should be anticipated. A few jars will probably not heat up to critical temperatures but developing spawn bags might very well, especially in the summertime. Bags that stand at too high a temperature will often contaminate will thermophilic moulds (often black pin moulds). Take extreme care when handling contaminated substrate as some species of moulds and bacteria can cause serious diseases in humans.

To prevent condensation in the containers they should be kept at a temperature that is as constant as possible.

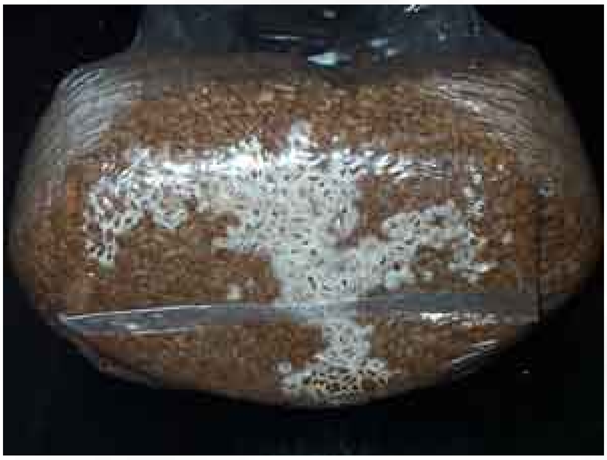
To speed up development jars and bags should be shaken regularly to distribute the colonised kernels throughout the substrate every few days. When the grain is completely covered with mycelium it's ready for further use.



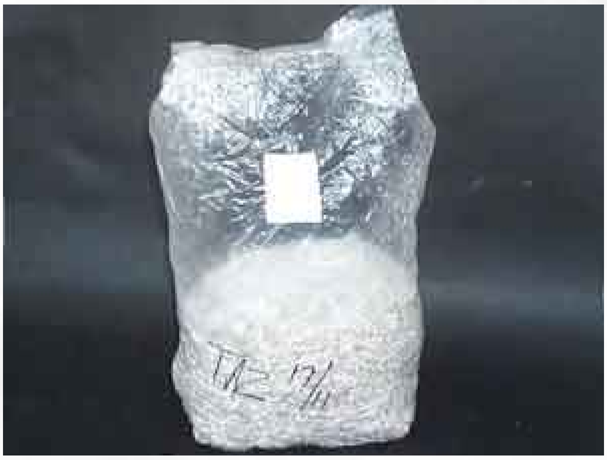
Microbox during colonisation



Microbox totally colonised



Bag during colonisation

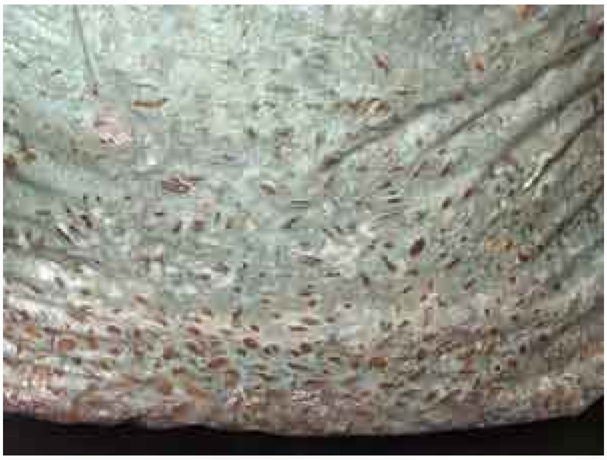


Bag totally colonised

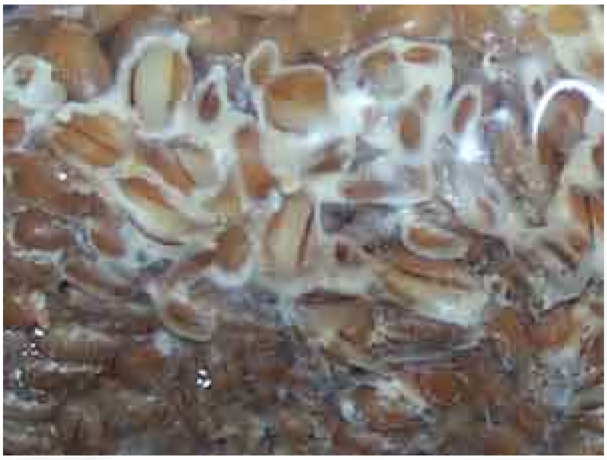
Contamination

Contaminated spawn will be encountered for sure. Contaminants show up in the form of fungi and bacteria. Fungi often grow whispy or powdery and come in an assortment of funky colours: blue, green, pink etc. Bacteria show as a slimy film on the grain kernels. When in doubt, take a smell at the the filter of the suspected container. A medicinal or musty odor often indicates fungi while a sour/sweet/rotten or alcoholic smell is a sure giveaway for bacterial contamination.

Perhaps needless to say, the contaminated spawn should be discarded. Bags can be thrown out as a whole. Jars should be cleaned out but only after they have been sterilised to kill the contaminants. Some contaminants can cause serious diseases in humans and the fact that you are reading this probably means that you are not experienced enough to distinguish harmless from dangerous contaminations. Never underestimate the health dangers associated with contaminants!



A bag contaminated with mould



A slimy bacterial contamination

Refrigeration

The spawn of most species can be refrigerated until ready for use. Although vitality declines most species can be stored for a few weeks at 4-7°C. *Panaeolus* mycelium however should never be refrigerated because it will loose it's vitality within a few days.

Table of Contents

Cultivation on cased sterilised grain

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Ccultivation_of_psilocybe_cubensis_on_sterilised_rye_grain&old

Overview of the procedure

Mycelium of *Psilocybe cubensis* is grown on sterilised grain. The colonised grain is covered with a wet soil like mixture, this is called 'casing'. The mycelium will grow through the casing layer and will partly colonised the casing surface. Now the casings are exposed to fruiting conditions and the casing is kept moist. Mushrooms will form on the casing layer.

A bag of healthy spawn.

Testing the colonised grain

Before casing the colonised grain should be tested for contamination. This is done by shaking the spawn containers (bags or jars) 24 hours before putting on the casing layer. If the grain is contaminated with molds the whole bag or jar will turn green, blue or grey. Bacterially contaminated grain will not recover at all and will often smell very foul (sour, alcoholic or rancid).
If the spawn recovers nicely it's ready for use.

Casing

Once the grain is completely colonised it needs to be 'cased' before mushroom formation will take place. 'Casing' is the process of putting a wet soil like mixture on top of the colonised substrate. This is done for 4 important reasons.

1. Preventing the substrate from drying out
Mycelium is sensitive to dry air. Mycelium that is exposed to dry conditions for too long may form a leathery matted surface on which no mushrooms will grow. The moist casing layer prevents this and the mycelia will form a healthy network in the casing layer. The casing surface should be kept moist by regular waterings.

2. Storing and supplying water to the growing mushrooms
Developing mushrooms pull a lot of moisture from the casing layer. Since moisture in the casing soil can be replenished by watering it functions as a water reservoir for the growing mushrooms. A casing layer should be able to absorb water and to supply it to the mushrooms.

3. Providing a good microclimate for pinhead formation
With all small bumps and valleys the rough surface of a casing layer provides a good humid and protected environment for young mushrooms to form.

4. Supporting the growth of beneficial microorganisms
Although *Psilocybe cubensis* can fruit on a sterilized casing layer many species require certain bacteria to be present in the casing soil. This has consequences for the type of heat treatment that is chosen. A brief pasteurization will hinder most animal and fungal competitors in their growth while leaving most bacteria unhindered. Complete sterilization in a pressure cooker may only be used for species that do not require these soil bacteria.

Casing mixture recipe

The following recipes have proven themselves over the years as good all round casing mixtures:

- 10 parts of peat
- 5 parts of coarse vermiculite
- 2 parts of limestone

and

- 10 parts of wetted coco coir,
- 5 parts of coarse vermiculite,
- 1 part of limestone

(all ingredients by volume)

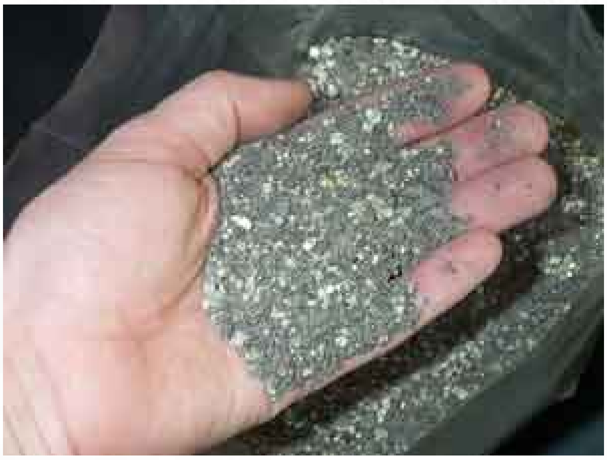
The exact ratio is not that important. As long as sufficient limestone is added the pH will rise to between 7-8. Many types of limestone are available differing in origin, composition and grit size. We prefer Marl (coral derived limestone) but most other types will do just fine. The coarser the particles the more is needed to to obtain a proper pH. Since peat is very acidic in nature it's wise to always add more limestone than to coco coir. It's nearly impossible to overdose on limestone.

The three ingredients for casing mixture

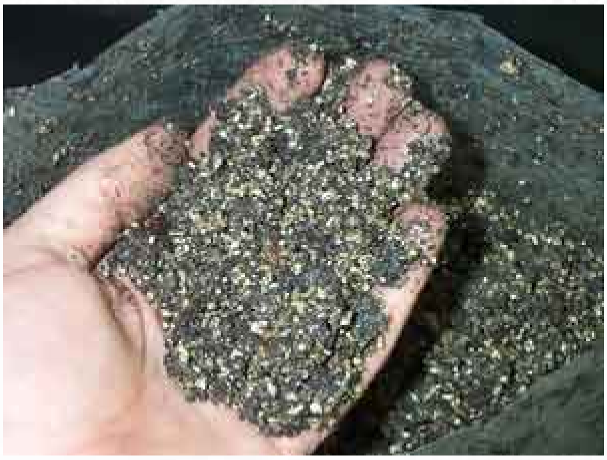
The ingredients are mixed in a bucket or bag in dry form and large particles such as undecomposed wood are removed. These particles might give contamination problems later on.

Once the ingredients are well mixed water is added. The object here is to get as much water into the mixture as possible without turning it into mud. It's wise to hold some dry ingredients apart in case the mixture gets too wet by accident. By adding some dry ingredients the excess water can be absorbed.

Proper wetness is achieved when a handful of mixture does not leak water when held loosely. The mixture however should release plenty of water when squeezed. It should feel wet, not soggy.



Casing mixture dry form



Casing mixture wet form

Alternative mixtures and considerations

The above recipes are not holy. We have achieved good results on many different types of casing mixtures. Some cultivators use plain vermiculite with great results but this is not advised for novice cultivators. Moisture content in plain vermiculite is very difficult to observe by eye (very wet and nearly dry vermiculite look the same). Vermiculite can be omitted in the above recipes but the mixture will be less rough in structure.

An important thing to mention is that the casing layer is not intended to supply the mycelium with nutrients. Any easily digestible compounds (whether sterilised or not) in the wet casing layer will surely contaminate. The conditions for the growth of competiting organisms are near optimal in the wet and warm casing layer. Additions such as flours, malt extract or sugars will not boost yields but only lead to contamination.

Heat treatment of the casing mixture

To free the casing mixture of any unwanted organisms (mainly fungal and animal competitors) it can be heat-treated. Although some cultivators get away without any heat treatment we feel that this is bad advice.

Untreated mixtures (except plain vermiculite) are much more likely to contaminate than pasteurised or sterilised mixtures.

There are two good methods for home cultivators:

Pasteurisation in a microwave oven

This method will not completely sterilise the mixture but will suffice for most cultivators. Most contamination problems associated with the casing layer involve fungi. Most of these fungi are killed are relatively low temperatures which are easily reached by microwaving.

The mixture is put in polypropylene bags or jars and some extra water is added to make up for evaporation. Care is taken to leave the lids a crack open or to open the bags to let the steam escape. Not doing this may result in an explosion!

The microwave is turned on at full power for approximately 30 minutes (for one 5 liter bag of soil). The bag is take out of the microwave with heat-insulating gloves, sealed with an impulse sealer or simply taped shut. When the soil has cooled down it's ready to use. Soil prepared in this manner is often a little on the dry side. Clean water may be added after sterilisation but before applying the mixture.

(semi-)Sterilisation in a pressure cooker

This method will, depending on the duration of the treatment, pasteurise, semi-sterilise or completely sterilise the casing mixture.

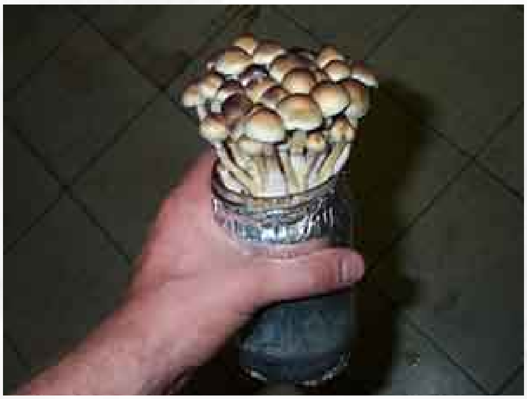
When a big pressure cooker is available this method may be faster then using a single microwave oven. The mixture is put in bags or jars and these are put in a pressure cooker. The contents is sterilised for the

appropriate amount of time and left to cool in a clean place. Here again great care is taken to leave jars always a crack open to prevent them from exploding/imploding. When the mixture has cooled down it's ready to use.
As a rule of thumb for the appropriate sterilisation duration we take half the time it would take to completely sterilise the same amount of rye grain. For a filled 20 liter cooker this means 1 hour at 121°C. This treatment does not completely sterilise the mixture but will give a very good resistant casing layer. For complete sterilisation use the duration for the same amount of grain.

Casing the colonised substrate

Casing jars

If the colonised substrate is in (wide-mouth) jars it can be left in the jars, however the volume/surface ratio is not optimal. Still substantial yields can be achieved with this method. The big advantage is that the complete casing process is very simple and leaves very little space for contamination.
Jars are cased with 1-2 cm of wet casing soil which is leveled by tapping the jar. The cap is replaced and the jar is incubated in the dark until the mycelium is poking up through the casing layer. Cased jars should be kept at the same temperature as the incubating spawn (25°C). At this stage the cap is removed and the jar is wrapped in aluminum foil. The foil is to prevent exposure to light of the colonised substrate. Not doing so will result in mushroom forming inside of the jar instead of on the casing soil.



A fruiting cased jar

Cased trays

When the colonised substrate is poured into trays which are cased a much better volume/surface ratio can be achieved. This results in more mushrooms in less time compared to cased jars.
First the grain is broken up by shaking. The broken up grain is divided into 1 liter trays and subsequently cased with 1-2 cm of casing mixture. The casing can be applied with a clean large spoon or with your hands wearing latex gloves.

Spawn before ...

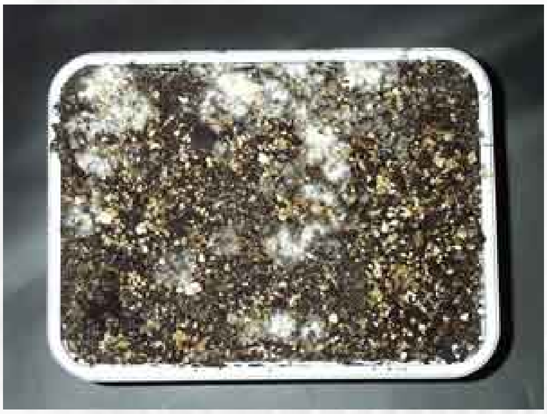
... and after shaking

The spawn is poured into the trays ...

... and is topped off with casing mixture

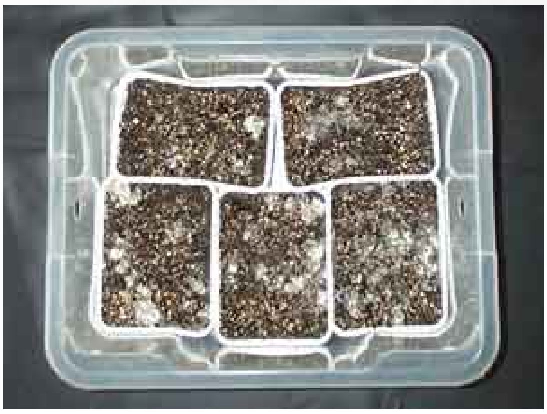
The cased trays are covered with aluminum foil and incubated in the dark until the mycelium is poking through. Cased trays should be kept at the same temperature as the incubating spawn (25°C). Now the foil is removed and the trays are exposed to fruiting conditions. Normally this is one week after casing.

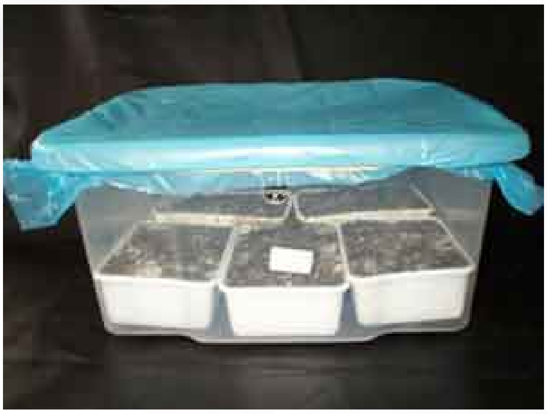
The cased trays are covered with aluminum foil


After a few days mycelium will be growing through the casing layer

Fruiting the cased substrate

Some cultivators use very elaborate set-ups with humidifiers, cool-mist devices and such. Psilocybe cubensis is an easy mushroom to fruit and we have never found these necessary.
A very space efficient fruiting container consists of a simple transparent plastic bins covered with polyethylene sheeting. There are stackable types available which allow one to grow in 10 bins or more on top of each other. Needless to say it can't get more space efficient than this. For air exchange some holes are drilled in the sides of the bins. These holes can be covered with mesh to keep out flies.


The fruiting container consists of a simple plastic bin


The bin is covered with plastic sheeting to maintain the proper humidity

After 10 days small mushrooms form

The casing soil is kept moist all the time

In our case five trays can be put in one bin and the evaporation of the casing surface is enough to maintain proper humidity inside the bin. The holes provide some air exchange. We always cold-shock the harder-to-fruit strains (we put them in the fridge for one night before putting them in the bins). For easy fruiting strains (i.e. Equador cubensis) this is not necessary.

As for as temperature is concerned: *Psilocybe cubensis* is an easy mushroom. From our experience trays and jars will fruit in the range between 19-30°C, Although a temperature of 25°C is most desirable. In other words: if the temperature is comfortable for you, it is too for the mushrooms!

The casings need some light. In the dark mushrooms will not form! Any kind of light will do (daylight, fluorescent, incandescent) but they should not be exposed to full sunlight for obvious reasons. If the casings receive (too) little light mushrooms will develop long and spindly.

The casings are misted each day and the casing is never allowed to dry out. Directly after a flush is picked watering is increased because the maturing mushrooms pull a lot of moisture from the casing soil. It's very difficult to give explicit directions on a watering regime. One has to develop a 'feeling' for it.
Depending on the strain the first pinheads will appear 6-15 days after putting the casings in the bins. The mushrooms will mature in 5-7 days after which they can be picked. We normally let the casings produce 3 flushes, but they may (when watered properly) produce as much as six flushes! The surface of the casing is kept clean by removing aborted mushrooms. If contaminations show up on the casing surface it's often better to throw the trays away.

A fruiting cased tray

A bin with 5 fruiting trays

Cased trays that fail to fruit

Casing completely colonises but fails to form mushrooms

When the environmental conditions aren't right for the strain being cultivated the mycelium will not form mushrooms but will continue to colonise the casing surface. If the situation is not corrected the trays soon become useless. The matted mycelial surface dies back and forms a crust that prevent the casing from absorbing moisture which results in drying out and eventually death.

In general this is caused by:
a) A lack of fresh air
b) A relative humidity that is too high
c) A temperature that is too high
d) A combination of the above.
Although some strains have more of a tendency to colonise the surface a fully colonised casing (no casing soil visible) is undesirable. To correct this situation the surface should scratched open with a clean fork to a depth of approximately 1 cm and environmental conditions should be adjusted to allow fruiting.

Mycelium doesn't colonise the casing surface at all

If the casing doesn't show any mycelium poking through within a few days the casing soil is probably too dry. Mycelium will grow wispy and thin in dry casing mixture. There is no objection to watering the trays before they are exposed to fruiting conditions but it's wise to wait at least one day after casing to allow the mycelium to recover.

Strange growth is showing up on the casing surface

Various molds may show up in the casing soil. Although mushrooms may still be formed on the contaminated casing it's wise to throw them out as they pose a risk to other trays nearby. A properly heat treated mixture that contains no nutrition will give very little problems with mold.
Green and blue molds can often be traced back to contaminated grain spawn. It's important to make sure that the spawn that is cased is absolutely clean. A simple test is to shake to spawn 24 hours before casing. If the mycelium recovers it's fine to use. If it does not or strange colors or structures (powder-like growth) appear the spawn is contaminated and should be thrown out.

Table of Contents

Cultivation of Psilocybe cubensis on sterilized rye grain

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/rye.htm

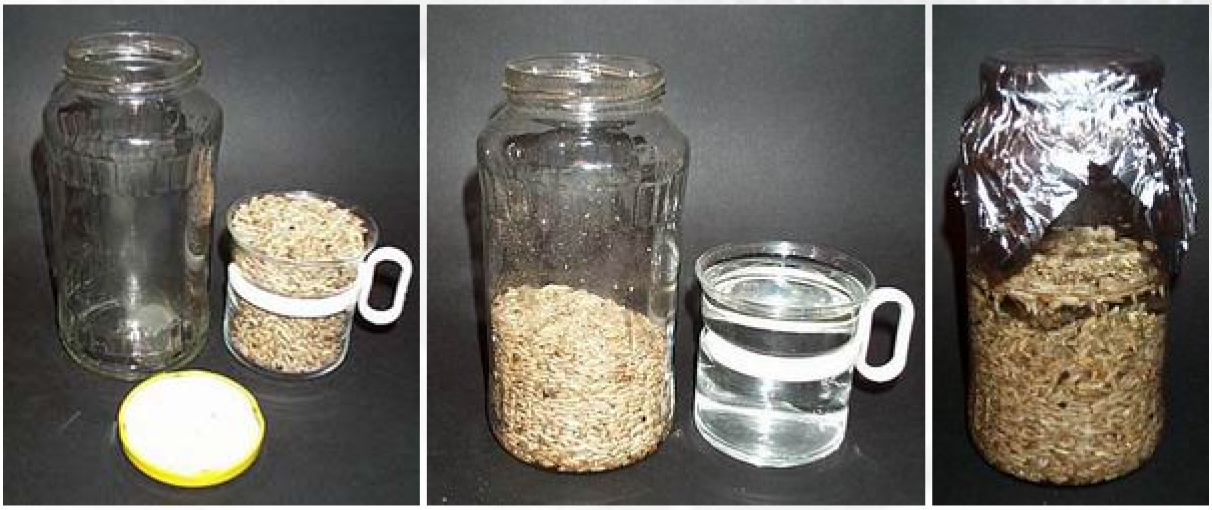
We cultivate *Psilocybe cubensis* on sterilized rye grain. This species can be grown on a wide variety of substrates such as rice, birdseed, pasteurized straw, compost and dung. We however think that, of all of these, rye grain is the most suitable for the small-scale cultivation of *Psilocybe cubensis* for research purpose because it's both cheap and easy to work with. Most other grain types have the disadvantage of having to be boiled or steeped before sterilization or else the kernels will clump together. Cultivating mushrooms on straw, compost or dung is possible but an art in itself.

Preparation of rye grain spawn

We prepare rye grain spawn by combining equal volumes (1 cup) of rye grain and water in a jar. In our case this comes down to (roughly):

- 175 grams of rye
- 230 ml of water

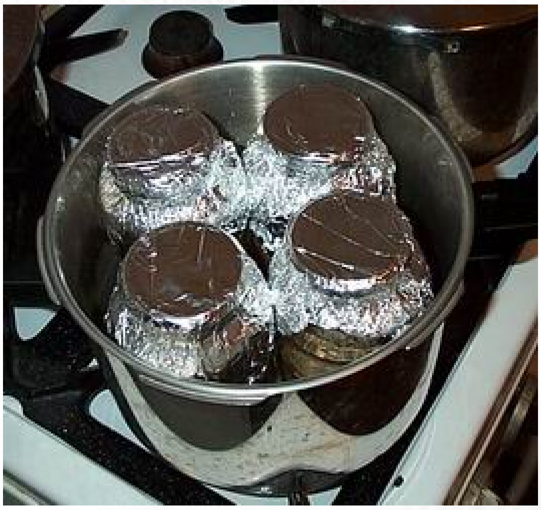
We use 720 ml jars with metal lids. After the water and rye have been filled into the jars, the lids are put on but NOT screwed tight! The lids MUST remain loose! Then a double layer of tinfoil is crumpled over the lid and top part of the jar. Now the jars are ready for sterilization. As an extra precaution some kind of filter (filter disc, Tyvek) can be inserted under the lid. For this method the lids must be punctured to facilitate air exchange.



Different ratios of rye and water have been suggested by literature. We recommend you do a test batch with different ratios of water and rye to see what works best for you. The 1:1 ration we use contains the maximum amount of water the we could use. When using larger volumes (big jars or bags) less water should be added or the bottom kernels will turn to brown goo. When using the colonized rye grain to directly fruit the grain can be somewhat wetter then when it's used to inoculate (non sterile) bulk substrate. Exploded kernels with their starchy inside exposed can flourish with bacterial bloom upon contact with non sterile materials.

Sterilization

The jars should be sterilized in a pressure cooker or autoclave, a normal pot will NOT suffice. First a layer of water is poured into the cooker. The jars are placed in the pressure cooker making sure that the lids are loose!



Now sterilize the jars for one hour according to the directions supplied with your pressure cooker. If you are using bigger jars then the sterilization time should be prolonged. (we sterilize 1.5 litre jars and spawnbags always for 2 full hours). Once the cooker is no longer under pressure the jars should be taken out and the grain in the jars should be shaken loose to mix the wet and dry kernels. The jars should then be allowed to cool in a clean place. Always check the jars for cracks before shaking! When the jars have cooled to room temperature inoculations can take place. As the jars are cooling down the lids should remain loose or else they will form a vacuum inside of the jar. When this vacuum is broken, dirty air is sucked inside and the jar will most likely contaminate.

Inoculation

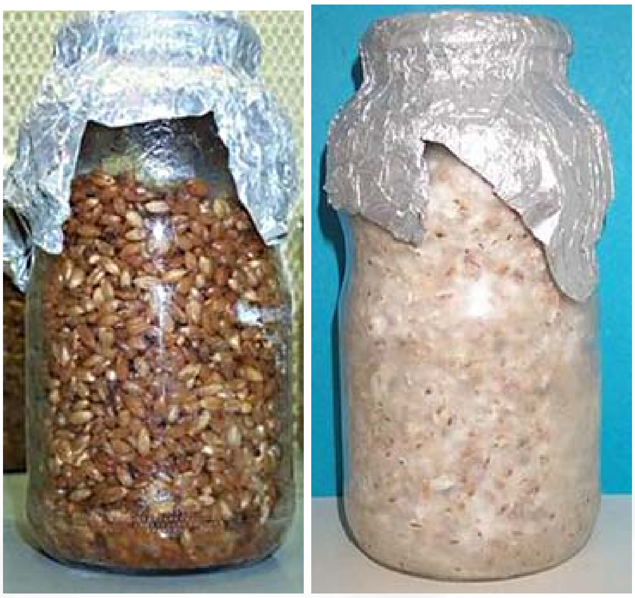
When the jars have cooled down completely they are ready to be inoculated. If you inoculate the jars while they are still hot the spores or mycelium might get killed. You can use a spore syringe, mycelium syringe, agar squares or whatever kind of inoculant you want. The most important thing to remember is to WORK CLEAN! When using syringes always flame the needle before commencing inoculations. When using agar squares always flame the scalpel! Be careful!

ALCOHOL, LYSOL AND MOST OTHER DESINFECATNTS ARE HIGHLY FLAMMABLE!!!

Even a simple hood made of a cardboard box prevents prevent drafts and subsequently contamination. Do not expose the sterilized grain to air longer then absolutely necessary. Open the lids of the jars just a crack and work swiftly. After inoculation the lids of the jars are closed and the jars are shaken. Then the lid is loosened again so the mycelium will be able to breathe.

Use your common sense and do not put yourself in risky situations. Again, most disinfectants are both toxic and flammable. When working in the presence of an open flame do not use any kind of other flammable materials. Also, do not overdose on disinfectants, most are seriously dangerous to your own health.

UV disinfectant lights are dangerous as they can cause damage to your eyes and cause skin cancer.

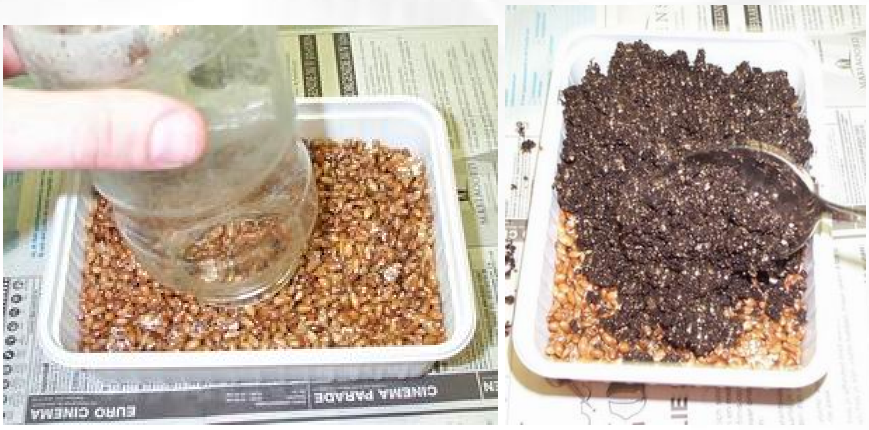


Colonization

After inoculation the jars are put in a clean and draft free location. Mycelial growth has its optimum at 30°C, but beware! Incubating jars generate heat themselves! The mycelium will grow in a wide range of temperatures. We normally put our jars at room temperature (20°C) or slightly higher. When mycelium starts to grow in only a few spots we shake the jars to redistribute the colonized kernels. This speeds up colonization dramatically. Depending on the temperature and the method of inoculation the grain can be completely colonized in 5-20 days.

Casing of rye

When the grain in the jars is completely colonized it needs to be cased. For this purpose we use 1-litre disposable plastic trays. The colonized grain kernels of one jar are shaken loose are poured into a tray. If there are lumps within the grain these can be broken up with the clean rim of the jar. The surface of the grain is leveled evenly. Using a big spoon and a fork the grain is now covered with a thin layer (1.5-2.0 cm) of casing soil. We always try to keep the casing surface even while at the same time keeping it rough (with small valleys and hills) The cased tray is then covered with tin foil and put in a clean location (20-25°C). Within a few days you will notice the mycelium growing through the casing soil. Depending on the strain (some strains fruit earlier and easier then others) the casings are now ready to be exposed to air and light to start the fruiting cycle.



Recipe and Preparation of the casing soil

We use the following recipe:

- 10 parts of peat
- 5 parts of vermiculite
- 2 parts of limestone (Marl)

The ingredients are mixed in dry form and while stirring water is added. The amount of water of course depends on the moisture content of the peat. The object is to get as much water in the casing soil as possible without turning it into mud. If the casing gets too wet just add a little more dry ingredients. This casing soil is then filled into oven bags (made of nylon), autoclave bags (PP) or jars and these are sterilized for one hour in the pressure cooker. When the soil has cooled down to room temperature it's ready to use.

Often an alternative method that utilizes the microwave oven can be used. The moistened casing soil is filled into heat resistant bags or jars and is sterilized for 20 minutes at maximum power in the microwave. Just add some extra water to make up for water loss from escaping steam.

Fruiting

Some cultivators use very elaborate set-ups with humidifiers, cool-mist devices and such. We have never found this necessary. The fruiting containers that we use consist of simple clear plastic bins that are covered with polyethylene sheeting. These bins are stackable and thus very space efficient. For air exchange some hole are melted in the sides of the bins. These holes can be covered with mesh to keep out flies.

Basically, five cased trays are put in one bin and the evaporation from the casing surface is enough to maintain the proper moisture inside the bin. The holes provide some air exchange. We always cold-shock the harder-to-fruit strains (we put them in the fridge for one night before putting them in the bins). For easy fruiting strains (i.e. Ecuador cubensis) this is not necessary.

The casings are misted each day and the casing is never allowed to dry out. Directly after a flush is picked watering is increased because the maturing mushrooms pull a lot of moisture from the casing soil. It's very difficult to give explicit directions on a watering regime. You will have to develop a 'feeling' for it.

Depending on the strain the first pinheads will appear 6-15 days after putting the casings in the bins. The mushrooms will mature in 5-7 days after which they can be picked. We normally let the casings produce 3 flushes, but they may (when watered properly) produce as much as six flushes! Keep the surface of the casing as clean as possible by removing dead pinheads (aborts) as these can lead to molds showing up on the casing surface.

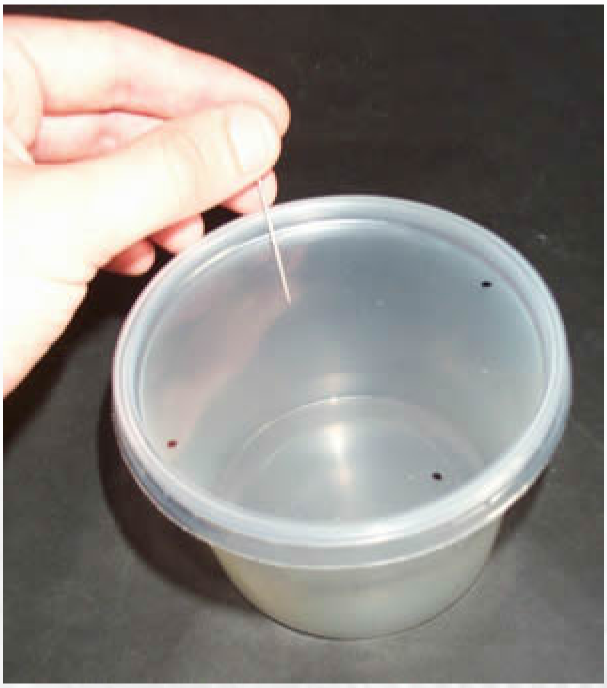
Table of Contents

Cultivation on riceflour cakes (short version)

original source: http://mycotopia.net/archives/discus/messages/5/144749.html

This document gives instructions on the cultivation of Psilocybe cubensis on a sterilised substrate of riceflour, vermiculite and water.

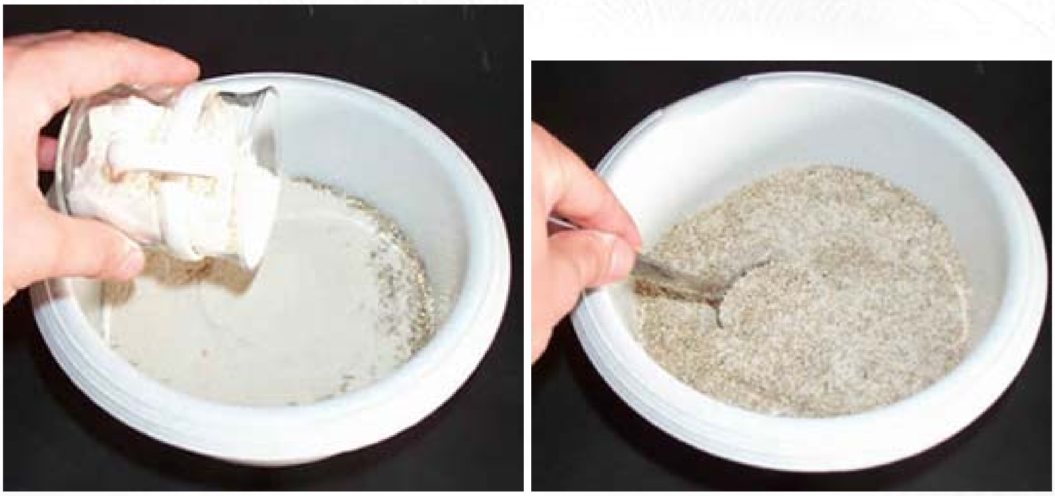
These polypropylene jars are used. They can withstand the heat of a pressure cooker. Of course glass jars can be used just as well.



Four holes are poked into the lid with a sharp pointy object (a syringe needle for instance). If you are using glass jars with metal lids you can use a nail and a hammer to punch four holes into the lid.

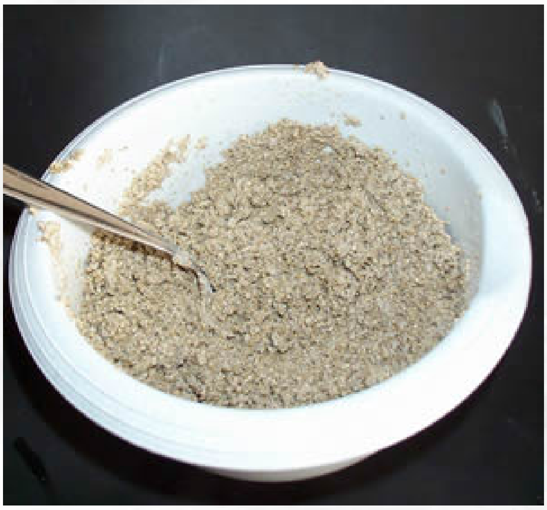
JOANNUSMOLEN
BIOCULINAIR
biologisch
VERS VAN DE MOLEN
rijstemeel

The two main ingredients: vermiculite and brown riceflour.

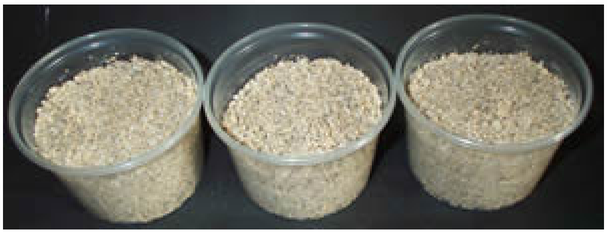


First the dry ingredients are mixed: 4 cups of vermiculite, 1.5 cups of riceflour.

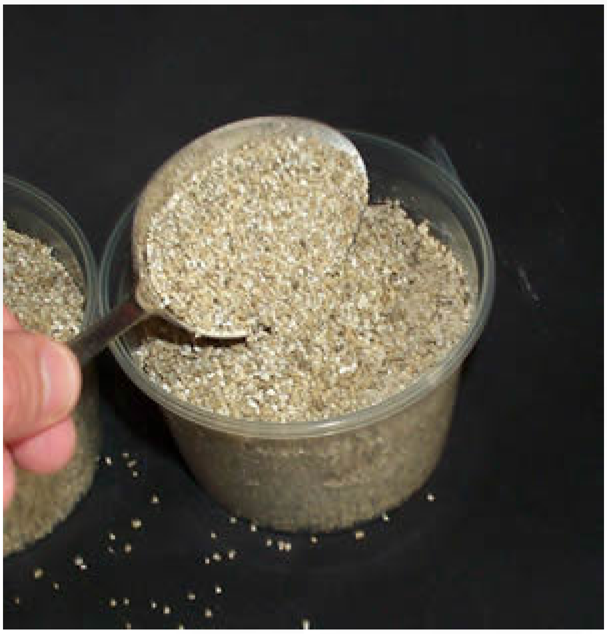
Two cups of water are added and everything is thoroughly mixed.



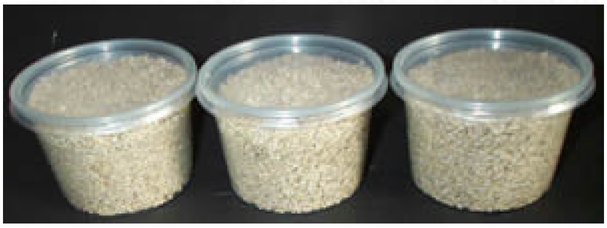
The resulting mixture will look like this.

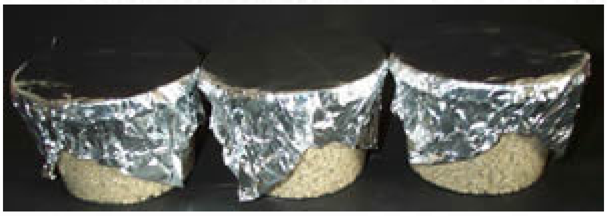


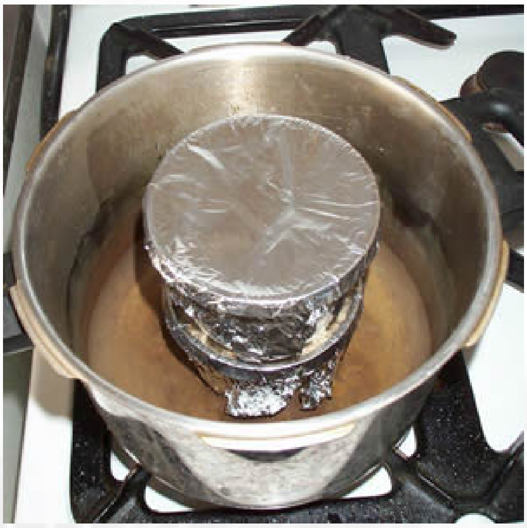
The jars are loosely filled with this mixture. The part of the jar above the substrate is cleaned with a paper towel.



A layer of dry vermiculite is put on top of the mixture. This acts as an extra barrier for contaminants.

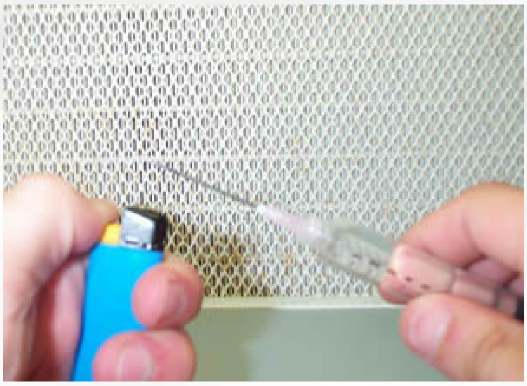

The lids are put on.


And a double layer of tinfoil is crumpled over the jars.

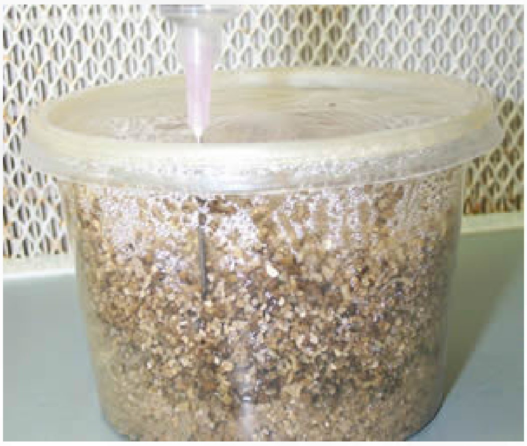

The jars are put in the pressure cooker...

and sterilised for 1 hour.

The jars have cooled down.

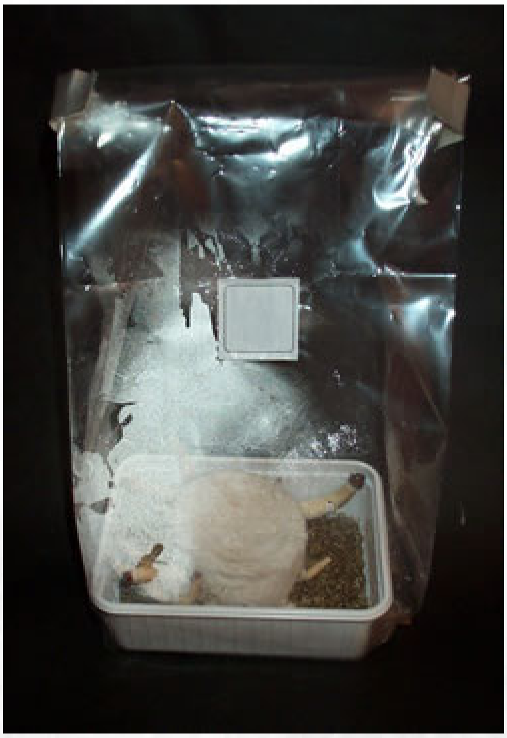

The needle of the syringe is flamed...

...and the tinfoil is removed.


The jar is inoculated through the four holes that were made in the lid. 1 cc should be enough for one jar. More sporewater can result in faster colonisation.

The tinfoil is replaced and the jars are put in a clean warm environment. The jars will colonise completely in 15-30 days (depending on strain, substrate, temperature and volume of sporewater used.

When the substrate is completely colonised the cake is taken out of the jar and put in the terrarium. We found that a plastic tray with wetted vermiculite inside an filter patch bag works perfectly for single cakes. Depending on temperature and strain mushrooms will appear in 5-20 days.



Harvest time!

Table of Contents

Cultivation of Psilocybe cubensis on riceflour cakes

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Ccultivation_of_psilocybe_cubensis_on_riceflour_cakes&old

Introduction

The methods described here are generally known as the "PF-tek", although we made some useful adaptions here and there. The cultivation of Psilocybe cubensis on riceflour cakes is generally considered easier than cultivation on cased rye grain and is a method often employed by novice cultivators. A properly prepared and inoculated cake may produce up to 200 grams of fresh mushrooms (500 ml cake) in three flushes.
All cubensis strains can be grown on these cakes, even those that are somewhat harder to fruit on cased rye grain.

Overview

Mycelium of Psilocybe cubensis is grown on a sterilised substrate of brown riceflour, vermiculite and water. Substrate jars are prepared and subsequently sterilised in a pressure cooker. Inoculation is done by injecting spores with a syringe. After colonisation the substrate cakes are taken out of their containers and placed on wet vermiculite in a filter patch bag. After some time mushrooms form on the riceflour cakes. After the mushrooms have been picked the vermiculite is re-moistened to allow for a second and third flush.

Substrate containers

Glass jars can be used. Canning jars are the best but it may be difficult to locate them. An alternative that can be found in the supermarket is 'Bon Maman' jelly which comes in typical looking jars with a red/white blocked lid. These jars are good although a little on the small side.

Jars need to be non-tapered (no shoulders) or the colonised cake can not come out without smashing the jar.

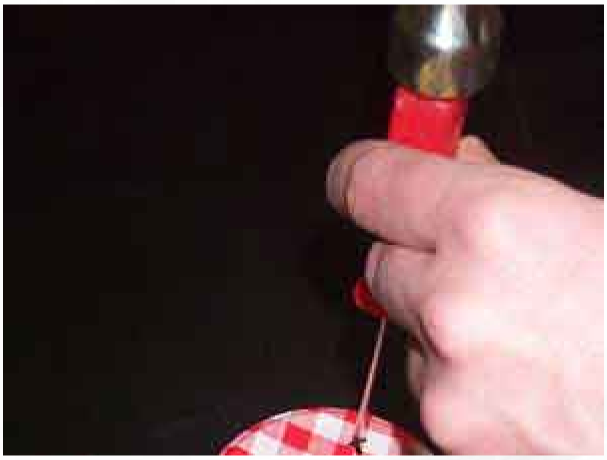
These jars should be cleaned out...

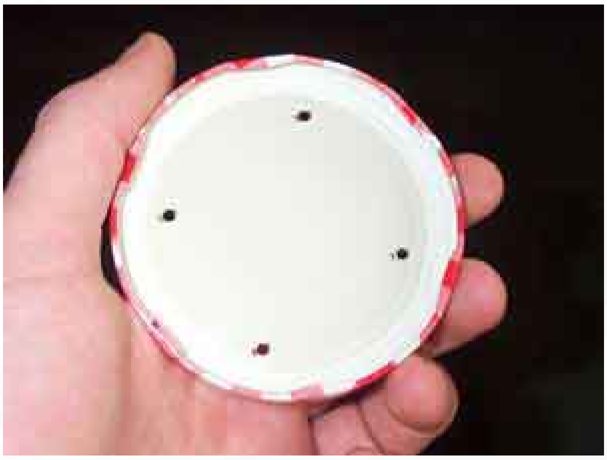
and have their labels taken off

A very suitable container is the microbox: A non-tapered polypropylene jar with a filter in the lid. These jars can be pressure cooked, are reusable and provide an excellent alternative to glass jars.

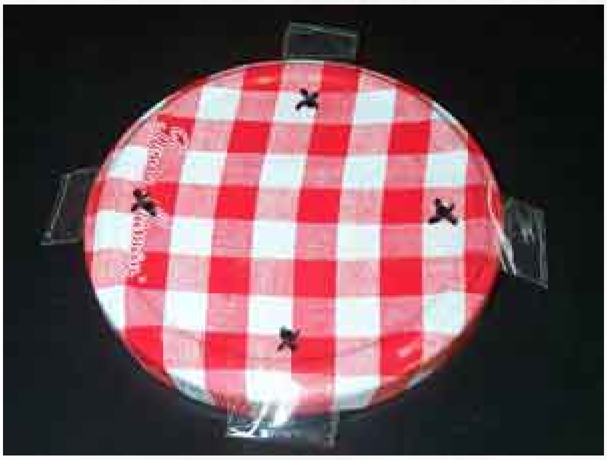
Preparation of the lid

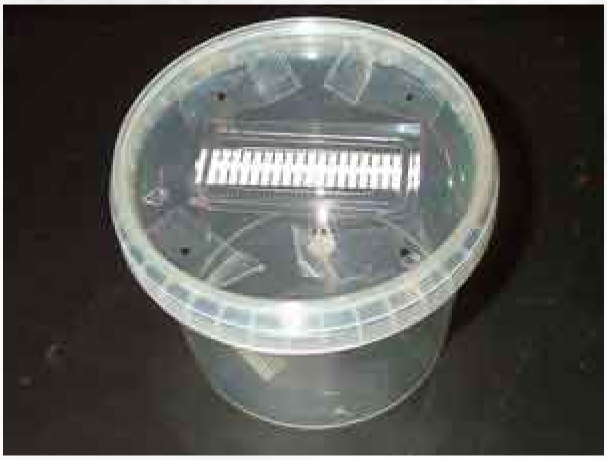
The lids will need to be fitted with 4 inoculation holes. A heated needle or pin can be used to melt holes in the lid of the microbox.
With a hammer and a small screwdriver (or similar object) holes can be punched in metal lids of glass jars.
The holes are spaced evenly apart near the edge of the lid.


With a screwdriver and a hammer holes are poked


A metal lid showing the correct location of the holes

To prevent the entry of contaminant organisms into the jars, these holes are taped shut, only to be opened for a few seconds during inoculation. Pieces of tape are prepared by folding back one end onto itself. This makes it easier to remove them during inoculation. The pieces of tape are then placed over the holes.


This metal lid is ready


As is this microbox

Some types of tape can not be used. These will melt or lose their stickiness. Still we found that most types can be pressure cooked with reasonable success although they might curl up a little on the edges.
Polypropylene or nylon tape generally works fine. Masking tape can be pressure cooked but some types might harden out during sterilisation.

If suitable tape can not be found it's possible to sterilise the jars without tape and to tape the holes directly after inoculation. This however, is not recommended because of increased contamination risk.

Substrate preparation

The mycelium will be cultured on a substrate composed of brown riceflour, vermiculite and water.

Vermiculite and brown riceflour

Substrate recipe:

- 1,5 parts brown riceflour
- 4 parts vermiculite
- 2 parts water

(all by volume)

The mycelium will have difficulty growing in a substrate that does not have the correct moisture content.

First the dry ingredients are mixed. Then, while stirring, the water is slowly added.

The dry ingredients are mixed

Adding the water

The finished substrate should not be soggy. If too much water was added and the substrate ends up too wet, some dry vermiculite/riceflour can be added to absorb excess moisture.

A properly prepared batch of substrate

Filling the jars

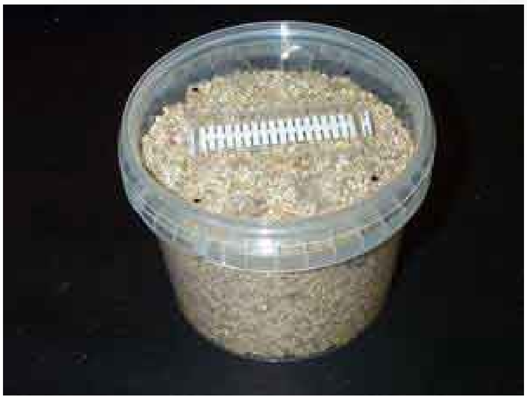
The jars are filled with the freshly prepared substrate. It's best to avoid having to store the substrate for longer than a few hour since bacteria will flourish in this moist, nutrient-rich medium.

The substrate is spooned loosely into the jars and compacted lightly by tapping the jars. Approximately 2 cm is left between the top of the substrate and the lid of the jar. This space is filled with a layer of dry, clean vermiculite. Since clean vermiculite does not support the growth of any competiting organisms, this layer helps to prevent the entry of contaminant organisms into the substrate during inoculation and incubation.

The rim is cleaned

Clean vermiculite is put on

In the case of a microbox the lid is closed for 3/4 or left loosely on top of the jar.
Microboxes should never be fully closed during sterilisation or they will implode/explode and/or deform!


A filled microbox, lid 1/4 open

Filled glass jars

Screw-type lids of glass jars are put on loosely but never screwed tight.

Both types of container should be covered with a double layer of aluminum foil to keep the lids in place and to prevent them (and the tapes) from getting (too) wet.

The lid should still be loose

Ready for sterilisation

Sterilisation of cakes

Originally the PF-tek uses a sort of semi-sterilisation in a normal pot at 100° Celsius. The results of this method are unpredictable to say at the least. Therefore it will not be discussed here.

The only proper way to sterilise the riceflour substrate is with a pressure cooker. For more information about pressure cooking look here.

Both types of jars are sterilised for 60 minutes at 121° Celsius. Every jar is inspected before it is put in the cooker to make sure that the lid is still on loosely, or in the case of microboxes, the lid is at least 1/4 open.

Again, the lids should be loose!

When letting the jars cool down, make sure that the lids are still on loosely. For microboxes the lids should preferably be closed completely as soon as they come out of the cooker. The jars/microboxes are left to cool in a clean spot.

These jars are hot!

The lid of the microbox is closed

Inoculation of cakes

Once the jars have cooled down completely to room temperature they can be inoculated with spores. A spore syringe (bought or self-made) is used to inject the spores into the substrate so that they can germinate and form a mycelium.

Although the risk of introducing contaminants into the substrate is pretty small because of the small inoculation holes, inoculation should preferably take place in a clean environment. A flow cabinet is best but a glovebox or improvised inoculation hood will also reduce the amount of contamination. The table top is cleaned with alcohol or lysol and remember as always: **BE CAREFUL WITH ALCOHOL AND LYSOL IN THE PRESENCE OF A OPEN FLAME!**

Just for inoculation the screw-type lids should be screwed tight to prevent accidentally tipping them off. After inoculation, during incubation these lids should be loosened again. The foil is taken off and replaced after inoculation. For the microboxes the foil can be discarded after inoculation.

Any moisture that may be present on the lid is wiped off with a clean tissue.

The needle of the spore syringe is flamed until red hot then left to cool for 10-15 seconds. The needle may not touch anything or it should be flamed again.

The needle is heated

The tape of one of the inoculation holes is peeled back and the needle is inserted through the inoculation hole, through the dry layer of vermiculite on top, aimed at the glass. 1/4 ml (or more) Is injected in the substrate. Then the needle is pulled back, the tape is replaced and the next hole is inoculated in the same way. It's not necessary to sterilise the needle after every hole but it's advisable to do this in between jars to prevent cross contamination.

The aluminum foil is replaced on the glass jars and the lid is loosened again. For microboxes the aluminum foil can be discarded.

Aimed at the glass

microbox inoculation

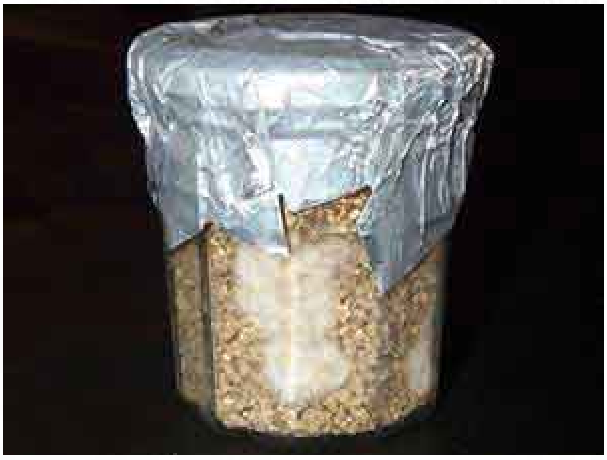
Incubation of cakes

Tha cakes should be incubated in a warm, clean and dark location. Since the microboxes have an air filter they can be placed virtually anywhere. They will not suffer from air contamination even in the most dusty environments. The glass jars however do not have filter and care should be taken not to expose them to drafts.

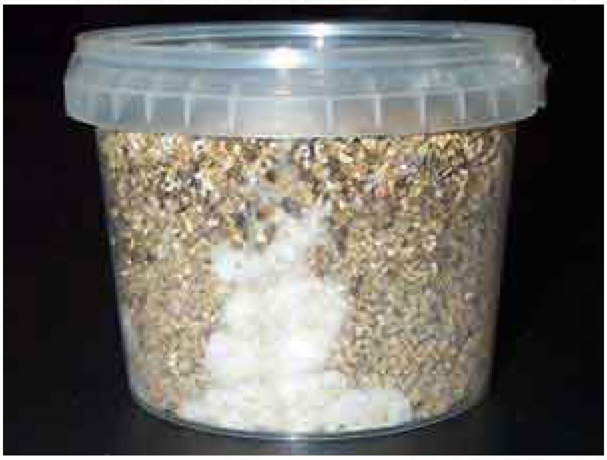
The temperature should be between 20-30°C and the jars should be kept in the dark. Early exposure to light may lead to the formation of mushrooms while the substrate is still partly uncolonised. For this reason the jars should be disturbed as little as possible. A minute of light each day will not make them pin prematurely but an hour may.

Incubation

A few days after inoculation, spots of white fluffy mycelium should be visible. These are the germinating spores. In the following days the mycelium will colonise the riceflour substrate. Often the mycelium will change from fluffy to threaded. These threads are called 'rhizomorphs' and are considered a good thing. Good fruiting cakes often showed strong rhizomorphs during colonisation.

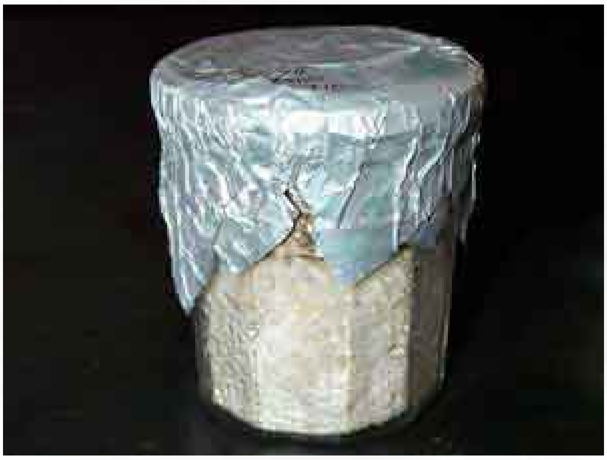


Colonising glass jar

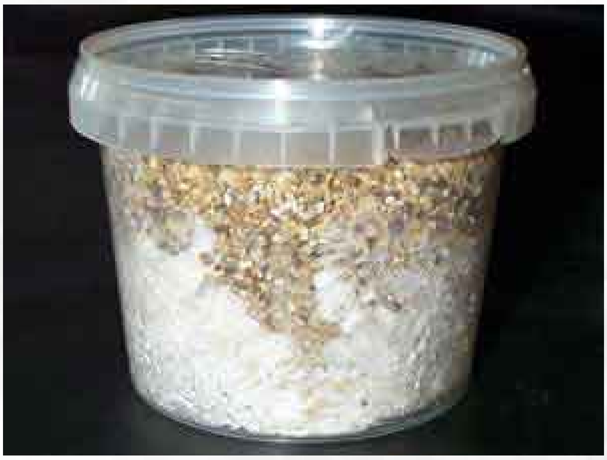


Colonising microbox

Depending on many factors (temperature, substrate composition, mushroom strain etc.) the cakes will be colonised in 7-20 days.



A week later



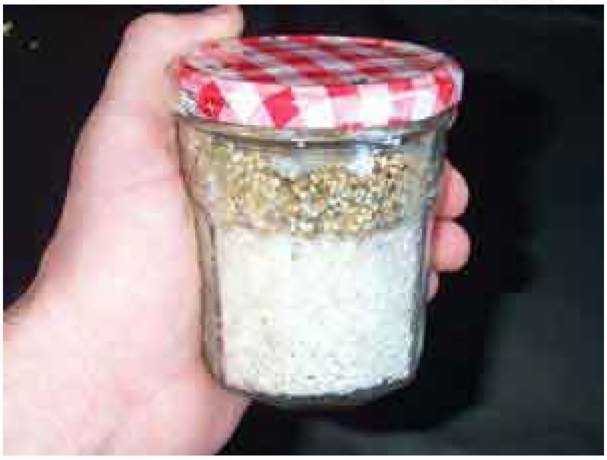
A week later

Once the substrate is totally colonised by the white mushroom mycelium the jars can move to the next step. The dry layer of vermiculite on top usually does not colonise but that's ok.

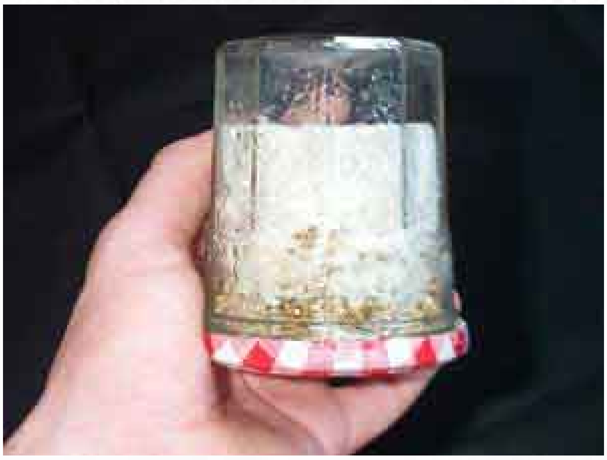
Growth of any other shape or color than the white mushroom mycelium, except maybe from a little blueish tone, can be considered a contamination. Contaminated cakes should be discarded. Although many contaminants are harmles some are toxic and some can cause disease in humans. Therefore contaminated jars should be thrown out completely or they should be sterilised in a pressure cooker before being emptied out. Contaminated jars should NEVER be emptied before having been sterilised.

Fructification

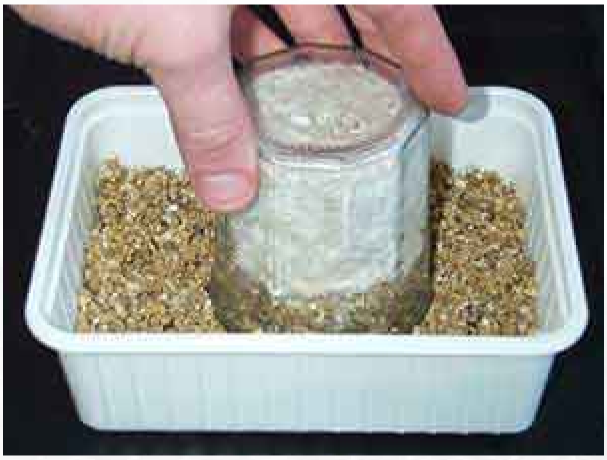
Vermiculite (preferably fine) is soaked and drained to achieve a maximum water content without leaking. A layer of 2 cm is put in a disposable tray. A colonised cake is tapped loose from the jar and placed on the wet vermiculite. The tray with the colonised cake is put in a filter patch bag which is closed on top with two paperclips.



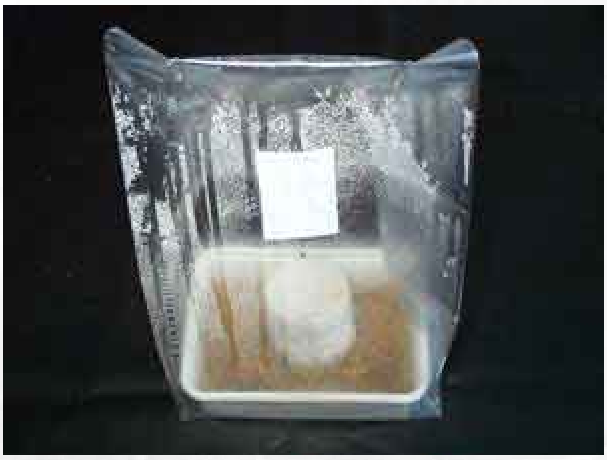
This one is ready



The cake is loosened



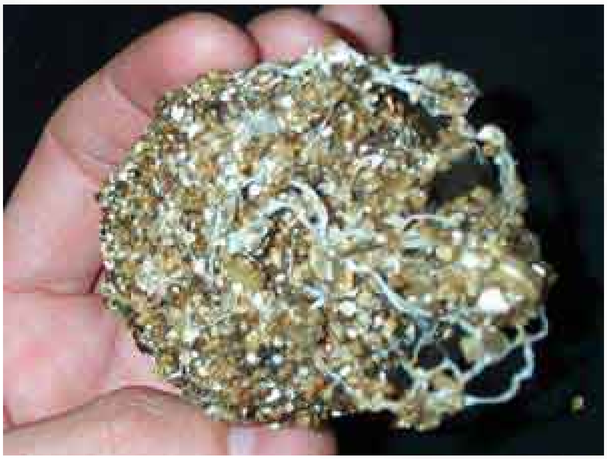
It is "birthed"



The cake in its "terrarium"

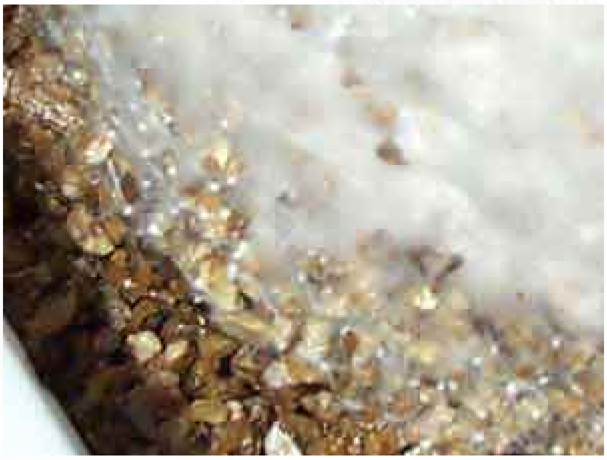
The bag is put in a place where it receives some light (no full sun!) and where temperatures are between 20-30°C. No care is necessary from this point on until the first flush of mushrooms is picked.

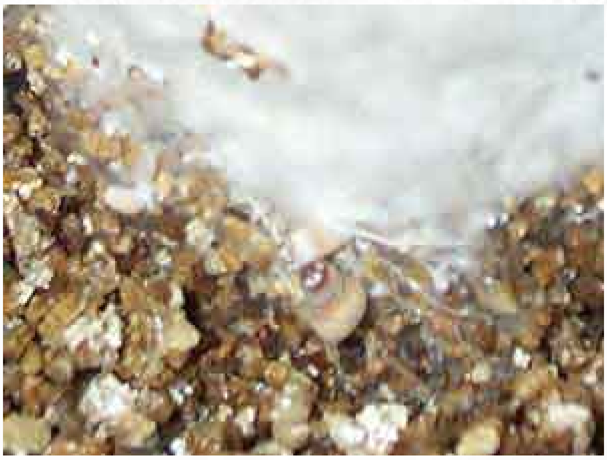
The cakes will become fluffy in the next few days and the mycelium will start to grow into the wet vermiculite. The wet vermiculite supplies water to the cakes and this allows for more mushrooms without the need for dunking/soaking.

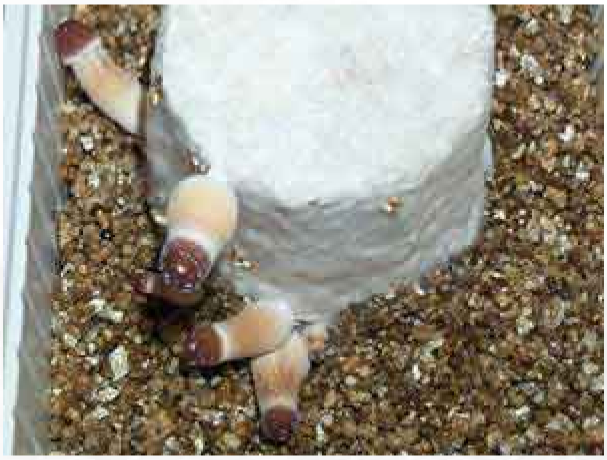


Rhizomorphs on the bottom of a cake

For most strains pinheads will appear after approximately a week. These are usually located on the bottom (former top) of the cake where most moisture is available. They first appear as small (<1 mm) white dots, that over the course of 1-2 days will slowly take on a mushroom shape. They will grow out to mature mushrooms in 5-7 days.


The first sign of mushrooms


The dots take on a mushroom shape

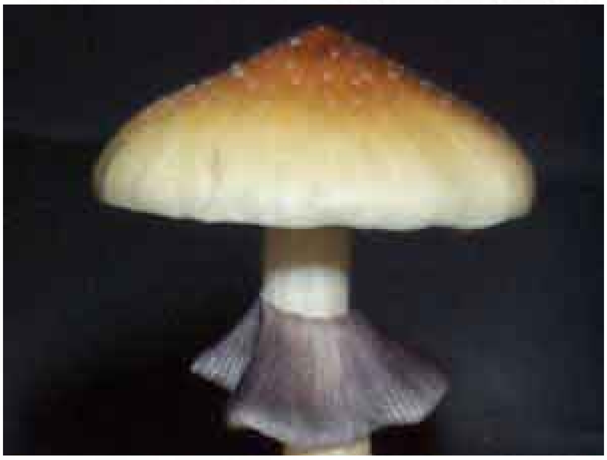

Young mushrooms

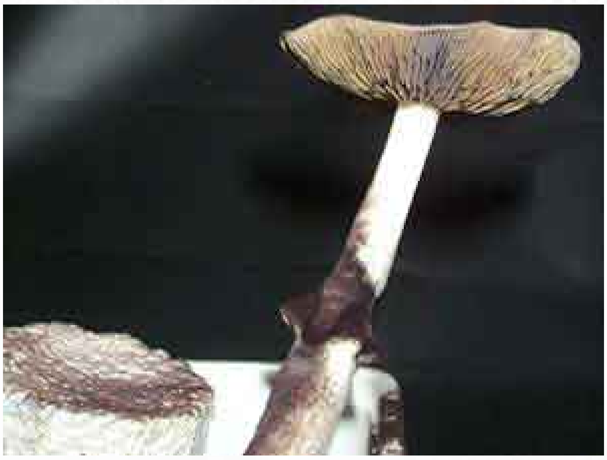
One happy cake!

Mushrooms are picked before or just after the veil has teared. Mushrooms left to mature will sporulate and color the mushrooms black. If one desires to make sporeprints of course the mushrooms should be left to mature.

Cambodia cubensis

Cambodia cubensis


The veil has just teared


Sporulation

Once the first flush is picked, the vermiculite in the tray is watered heavily with a spray bottle to replenish the lost moisture. This will allow for a second flush or, when repeated, even a third flush.

Watering will allow for second flush

Table of Contents

Cultivation of Panaeolus cyanescens and Panaeolus tropicalis on sterilised substrate

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Ccultivation_of_panaeolus_cyanescens_and_panaeolus_tropicalis&old

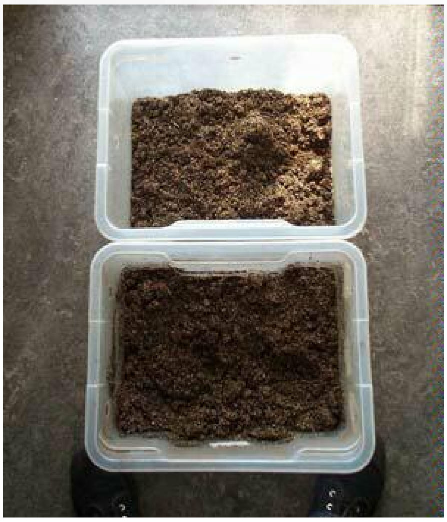
Straw substrate preparation

Substrate for the cultivation of *Panaeolus cyanescens* and *Panaeolus tropicalis* can be prepared in the following manner:
Ingredients: Dried cow dung, vermiculite and soaked straw (submerged in water for 12 hours)
For 4 standard spawn bags we use: 1/2 kilogram dry straw, 4 liters of dried dung, 3 liters of vermiculite and 3-4 liters of water.

Koemest poeder

The dung and vermiculite in dry form are mixed.

Water is added and the mixture is stirred (Make sure that the mixture is not too wet as loose water will often result in bacterial contamination later)

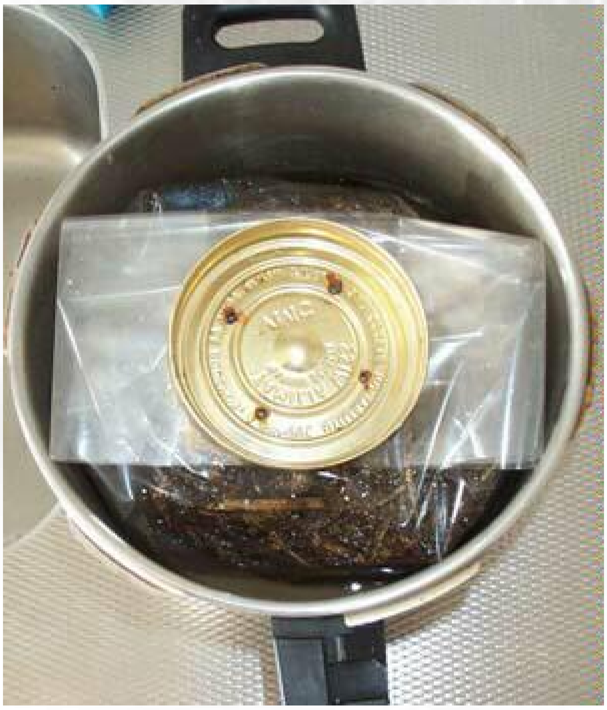

This mixture will look something like this.

The straw is added...

and mixed in thoroughly

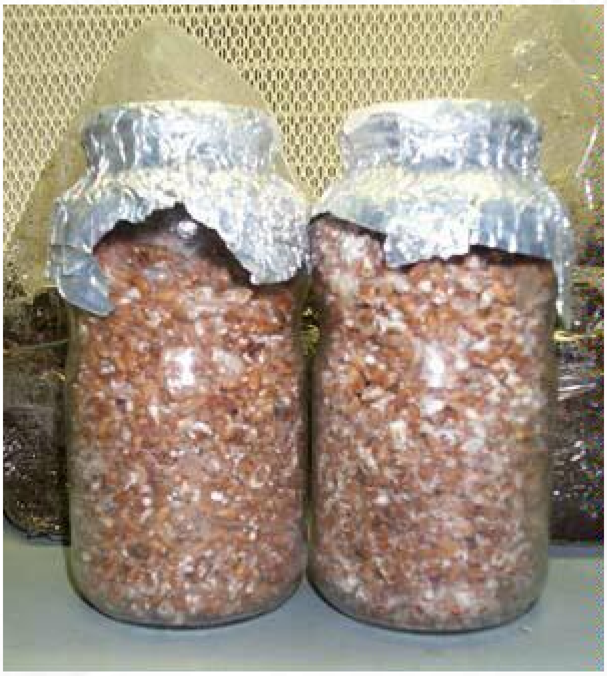
Close up (looks nice doesn't it ;-)

The substrate is divided over four autoclavable spawnbags (with a filter patch)



The flaps are folded and the bags are put into the pressure cooker. A lid is put on top to prevent the bags from blocking the steam valve

After sterilisation (2 full hours!) the bags are allowed to cool down in the flowcabinet.



Two jars with *Panaeolus cyanescens* spawn on rye to be used for the inoculation of the substrate. Note that Panaeolus species do not colonise grain as densely as for instance *Psilocybe cubensis*.

The bags are opened in the flowcabinet (only touch the outside of the bags!) and each bag is spawned with 300 ml of spawn by means of free pouring.

The bags are sealed with an impulse sealer.

Substrate Colonisation

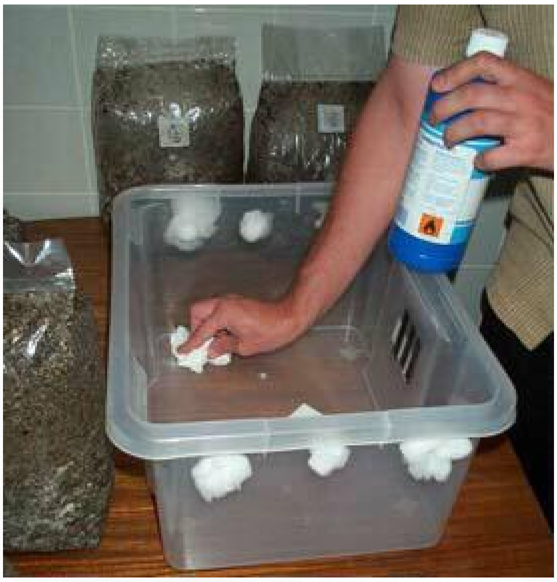
The mycelium will now start to colonise the substrate. Depending on the temperature and the frequency of shaking the substrate will be fully colonised in 5-10 days.

A bag of substrate after 3 days. Note the white mycelium

After some days and regular shaking the substrate is fully colonised.

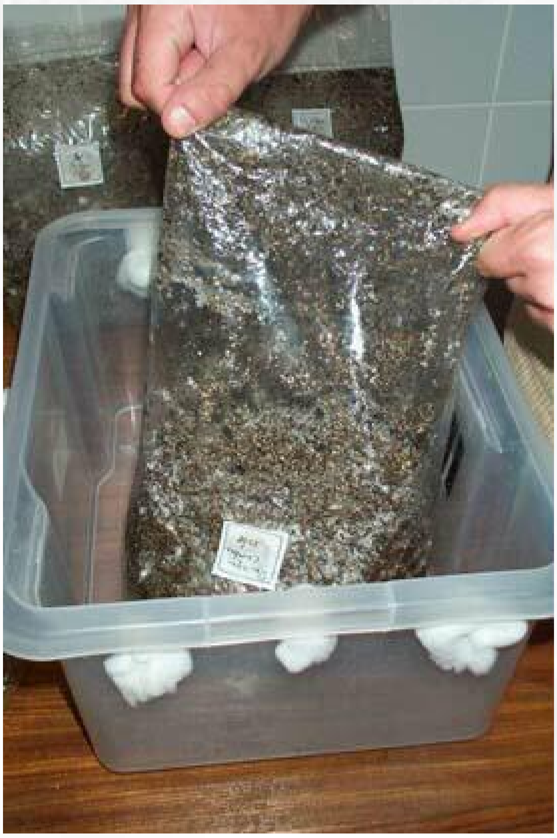
Close up

Casing the substrate

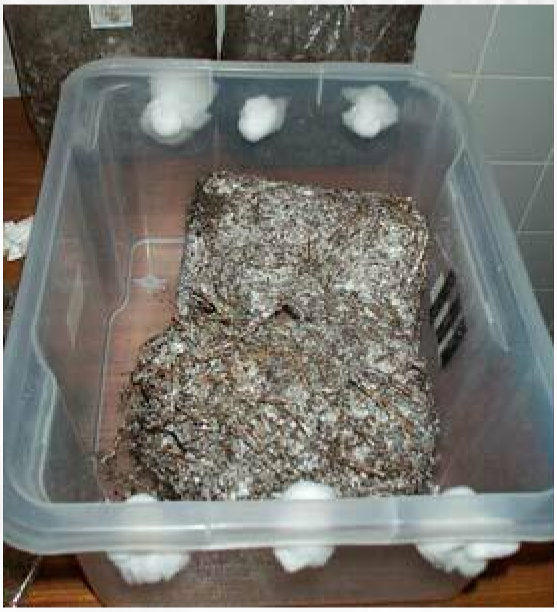


A plastic bin is cleaned with alcohol (note the holes plugged with polyfill).

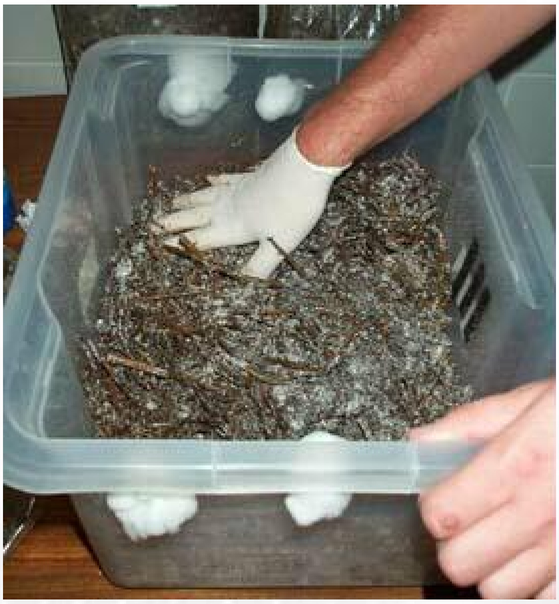
The bags are cut open with scissors.



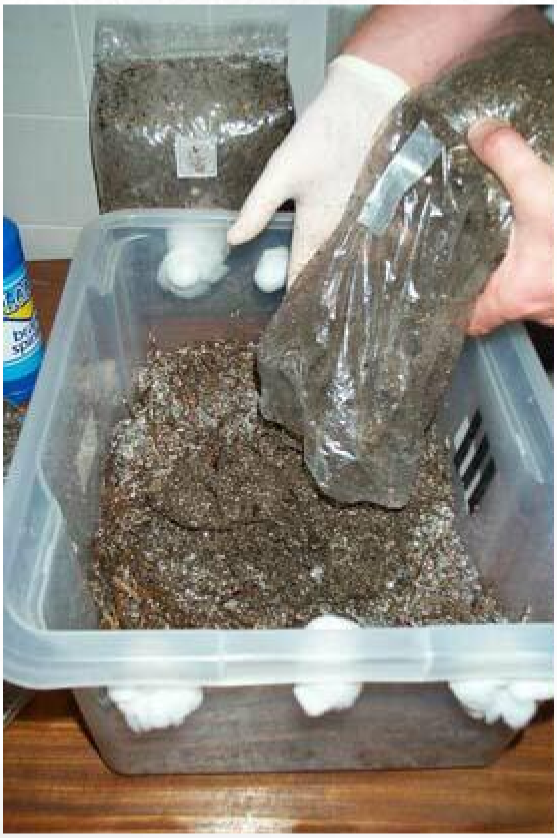
The fully colonised substrate is put into the bin.



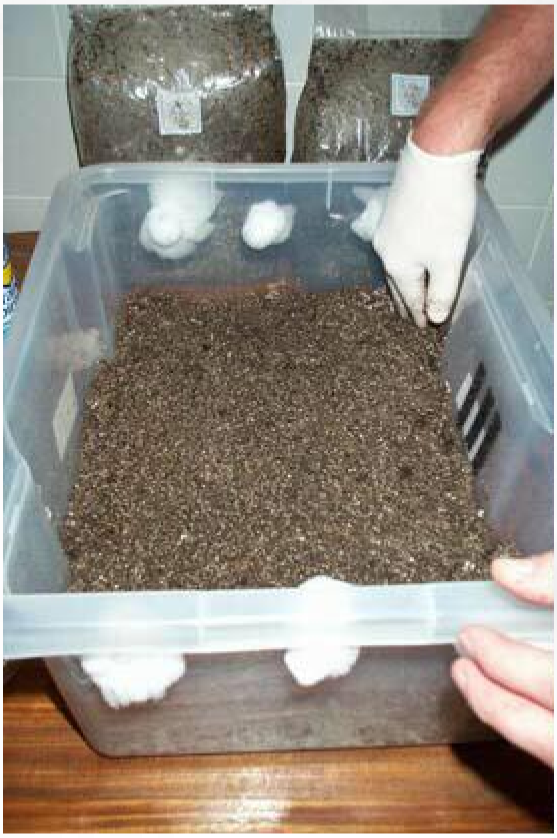
Two bags are used for one bin.



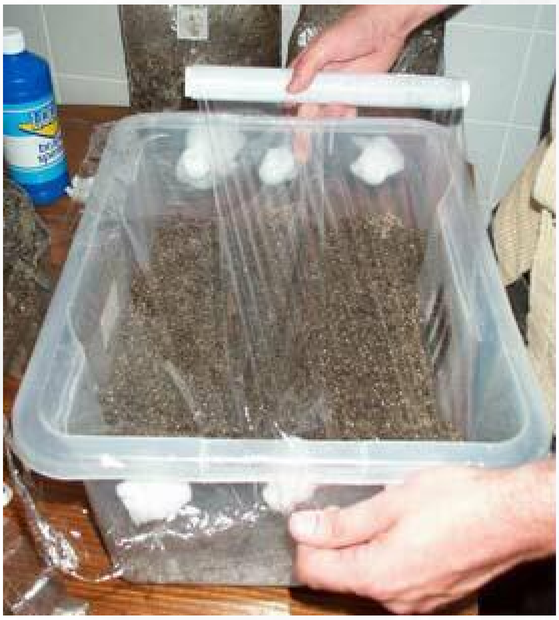
The substrate is levelled by hand (wear gloves!)



A thin layer (1-1.5cm) of sterilised casing soil is put on.

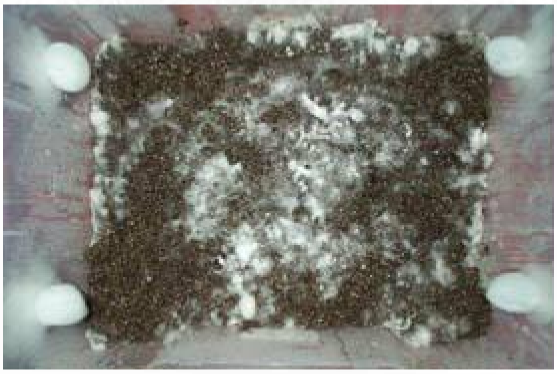


This too is levelled by hand

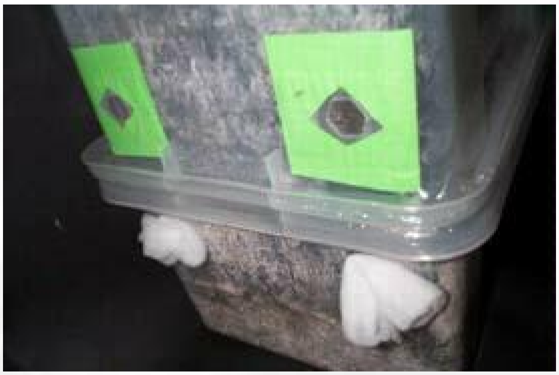


The bin is covered with polyethylene wrap to prevent contamination and moisture loss.

Side view

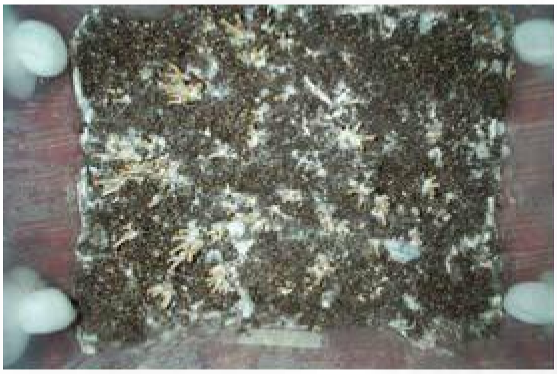


The bins are now put in a warm place for the casing layer to colonise. After 5 or 6 days the mycelium will show up on the casing layer.

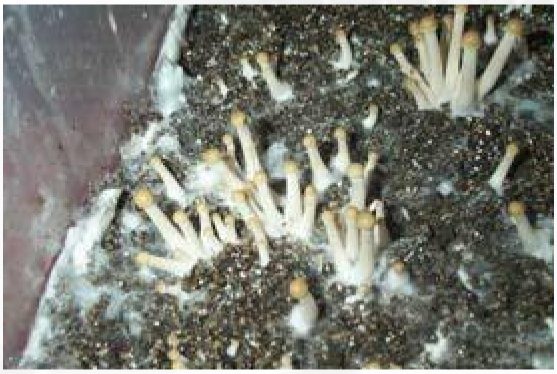


At this moment another bin is put on top (upside down) to create sort of a 'mini-greenhouse'. Note the mesh covered holes in the top bin.

Panaeolus fruiting



After some days the first mushrooms will appear. The casing soil must be kept moist (use a spray bottle).



Close up

The mushrooms will mature in a couple of days

Fully mature and ready to be picked!

Cultivation notes

Paneolus cyanescens and tropicalis are much more sensitive to high CO2 concentrations. We believe the most important reason for people to fail in their research with Paneolus species is that they do not expose their cultures to enough fresh air. When air exchange is insufficient many mushrooms will form but only a few will mature, the rest will abort. Also the mushrooms appearance is influenced. Improper air exchange will result in tall spindly mushrooms with small caps.

These species will grow in a wide range of temperatures but they really flourish when temperatures are around 25°C or a little higher.

Because not all substrains from a multispore germination seem all to viable it is wise to start with a multispore culture and clone the best looking mushrooms for your further investigations into these two species.

Table of Contents

Cultivation of fruitbodies and sclerotia on sterilised grass seed

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Ccultivation_of_fruitbodies_and_sclerotia_on_sterilised_grass_seed&old

This document gives instructions on how to prepare substrate suitable for the cultivation of:

- Psilocybe mexicana (mushrooms and sclerotia)
- Psilocybe tampanensis (mushrooms and sclerotia)
- Psilocybe cubensis (mushrooms; rye grain is preferred for this species)
- Panaeolus subbalteatus (mushrooms)

Preparation of the substrate

The substrate is based on grass seed. The most commonly sold form is rye grass seed (Lolium perenne) but we have also used mixtures of different species with great success. Make sure however that it is not treated with fungicides. If seed has been treated with fungicides it should say so on the packaging. You may have to look around a little bit to get some unexpensive seed (we buy ours from an animal feed store where it is sold as birdfeeding).

We use the following formula for 720 ml jars

- 110 grams grass seed
- 180 ml water

After the water and seed have been filled into the jars, the lids are put on but NOT screwed tight! The lids MUST remain loose! Then a double layer of tinfoil is crumpled over the lid and top part of the jar. Now the jars are ready for sterilisation.

NOTE: Different varieties of grass seed and even batches of the same variety can differ greatly in their ability to absorb water. Too much water results in a slimy clump of seed that cannot be shaken, too little results in substrate that is too dry and produces little or no mushrooms/sclerotia. You should experiment a little with these.

Alternatively you can soak the grass seed overnight in water and then fill the jars with soaked grass seed. This will produce a more homogeneous substrate.

Sterilisation of seeds

The jars should be sterilised in a pressure cooker or autoclave, a normal pot will NOT suffice. First a layer of water is poured into the cooker. The jars are placed in the pressure cooker making sure that the lids are loose! Now sterilise the jars for one hour according to the directions supplied with your pressure cooker. If you are using bigger jars then the sterilisation time should be prolonged. (we sterilise 1.5 litre jars and spawnbags always for 2 full hours). Once the cooker is no longer under pressure the jars should be taken out and the grass seed in the jars should be shaken loose to mix the wet and dry kernels. The jars should then be allowed to cool in a clean place. Always check the jars for cracks before shaking! When the jars have cooled to room temperature inoculations can take place. As the jars are cooling down the lids should remain loose or else they will pull a vacuum.

Inoculation of seeds

When the jars have cooled down they are ready to be inoculated. Don't be hasty, be patient! If you inoculate the jars while they are still hot the spores or mycelium might get killed. You can use a spore syringe, mycelium syringe, agar squares or whatever kind of inoculant you want. The most important thing to remember is to WORK CLEAN! When using syringes always flame the needle before commencing inoculations. When using agar squares always flame the scalpel! Be careful! **ALCOHOL AND SPRAY LYSOL ARE HIGHLY FLAMMABLE!!!**

Even a simple hood made of a cardboard box prevents prevent drafts and subsequently contamination. Do not expose the sterilised grain to air longer then absolutely necessary. Open the lids of the jars just a crack and work swiftly. After inoculation the lids of the jars are closed and the jars are shaken. Then the lid is loosened again so the mycelium will be able to breathe.

Colonisation of seeds

After inoculation the jars are put in a clean and draft free location. We normally put our jars at room temperature (20°C) or slightly higher. When mycelium starts to grow in only a few spots we shake the jars to redistribute the colonised kernels. This speeds up colonisation dramatically. Depending on the temperature, the species and the method of inoculation the grass seed can be completely colonised in 5-20 days.

When jars are incubated too long or at too high a temperature the mycelium will excrete yellowish metabolites. This situation is not good, these seed in these jars should be cased as soon as possible.

Casing (for the cultivation of mushrooms)

When the grass seed in the jars is completely colonised it needs to be cased. For this purpose we use 1-litre disposable plastic trays. The colonised grass seed of one jar is shaken loose are poured into a tray. If there are lumps within the seed these can be broken up with the clean rim of the jar. The surface of the grain is levelled evenly. Using a big spoon and a fork the grain is now covered with a thin layer (1.5-2.0 cm) of casing soil. We always try to keep the casing surface even while at the same time keeping it rough (with small valleys and hills). The cased tray is then covered with tin foil and put in a clean location (20-25°C). Within a few days you will notice the mycelium growing through the casing soil. Depending on the strain (some strains fruit earlier and easier then others) the casings are now ready to be exposed to air and light to start the fruiting cycle.

Recipe and Preparation of the casing soil for seeds

We use the following recipe:

- 10 parts of peat
- 5 parts of vermiculite
- 2 parts of limestone (Marl)

The ingredients are mixed in dry form and while stirring water is added. The amount of water of course depends on the moisture content of the peat. The object is to get as much water in the casing soil as possible without turning it into mud. If the casing gets too wet just add a little more dry ingredients. This casing soil is then filled into oven bags (made of nylon), autoclave bags (PP) or jars and these are sterilised for one hour in the pressure cooker. When the soil has cooled down to room temperature it's ready to use.

We know that some authors advise against sterilisation of casing soil because it would kill all the beneficial organisms. We however have had only bad experiences with untreated or pasteurised casing soils. We just tell what works best for us!

Fruiting of seeds

Some cultivators use very elaborate set-ups with humidifiers, cool-mist devices and such. We have never found this necessary. The fruiting containers that we use consist of simple clear plastic bins that are covered with polyethylene sheeting. These bins are stackable and thus very space efficient. For air exchange some hole are melted in the sides of the bins. These holes can be covered with mesh to keep out flies. Basically, five cased trays are put in one bin and the evaporation from the casing surface is enough to maintain the proper moisture inside the bin. The holes provide some air exchange. We always cold-shock the harder-to-fruit strains (we put them in the fridge for one night before putting them in the bins). For easy fruiting strains (i.e. Ecuador cubensis) this is not necessary. *Psilocybe mexicana*, *Psilocybe tampanensis* and *Panaeolus subbalteatus* do not benefit from such a treatment. The casings are misted each day and the casing is never allowed to dry out. Directly after a flush is picked watering is increased because the maturing mushrooms pull a lot of moisture from the casing soil. It's very difficult to give explicit directions on a watering regime. You will have to develop a 'feeling' for it. Depending on the strain the first pinheads will appear 6-15 days after putting the casings in the bins. The mushrooms will mature in 5-7 days after which they can be picked. We normally let the casings produce 3 flushes, but they may (when watered properly) produce 5 or even 6 flushes. *Psilocybe mexicana* usually produces one big flush and a small second flush. Other mentioned species produce more constant.

Keep the surface of the casing as clean as possible by removing dead pinheads (aborts) as these can lead to moulds showing up on the casing surface.

Sclerotia

The mycelium of *Psilocybe tampanensis* and *Psilocybe mexicana* can produce sclerotia while still in the jar. Colonised grass seed need not be cased for this to happen. In our experience (with tampanensis) sclerotia will continue to enlarge until 4 months after inoculation. The jars should be put in a clean (preferably dark) location. Sclerotia of these species also form in the casing layer of cased trays.

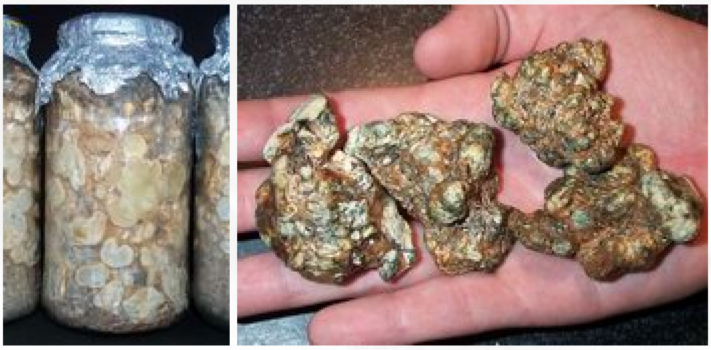


Table of Contents

Making spawn for the woodloving outdoor species

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/wood.html

This procedure describes a method of making spawn for the woodloving outdoor species (i.e. *Psilocybe azurescens*, *Psilocybe cyanescens*, *Psilocybe bohemica*).
This spawn can be used to inoculate outdoor beds with woodchips. The creation of outdoor patches is (will be) described in another document.

Procedure

The spawn is based on small woodchips that can be bought in a pet-store. It is used as animal bedding but can also be used to smoke fish and meat. These chips are made from beech.

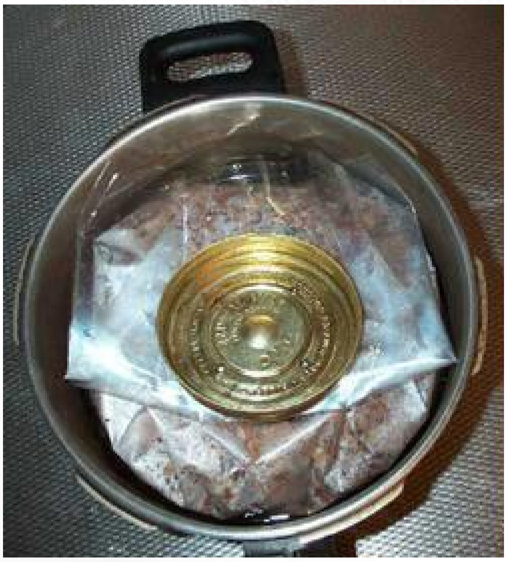
The chips are boiled in water until they sink (approx 1 hour). Alternatively you can soak them in water for some time. Moisture content is right when they sink.

Now drain the chips and let all the loose water run off.

Some oatmeal is added to the mixture (approximately one cup for every 3 litre wood chips). This is to boost and speed up mycelial growth. You can also use bran instead of oatmeal.

The oatmeal is mixed in

This mixture is filled into autoclavable spawn bags (or jars)



To prevent the bags from blocking the steam valve, a metal lid is placed on top the bags

The bags are sterilized for 2 hours in a pressure cooker (for jars 1 hour will suffice)

The bags/jars are cooled down in front of a laminar flow hood

When they have cooled down they can be inoculated from rye grain spawn. Don't use too much as this will give problems when it is placed outside in the beds as grain attracts vermin.

We use about 300 ml for one spawnbag

After spawning the bags are sealed with an impulse sealer

They are checked for leaks and punctures.

Finally they are shaken and incubated. Depending on the temperature and species used, bags will completely colonise within 2-3 weeks. Bags can be placed at room temperature.

Table of Contents

Growing the woodlovers outdoors

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Cgrowing_the_woodlovers_outdoors&old

Overview of procedure

Spawn is prepared on sterilised woodchips. In the spring the colonised woodchips are used to inoculate more (non-sterile) woodchips in outdoor beds. The beds are covered with plastic and watered on a regular basis. In autumn the plastic is removed and watering is increased. In the late autumn or begin winter the beds will fruit.

Preparation of grain spawn

The preparation of grain spawn is described here. It will not be repeated here.

Mycelium is cultured on agar

And transferred to sterilised grain

Growing mycelium on sterilised wood chips

Preparation of the wood chip substrate

Although some people use colonised grain to directly inoculate their outdoor beds this is not the preferred method. The grain attracts all kinds of bugs and rodents. The grain is also more likely to contaminate than properly prepared wood chip spawn.

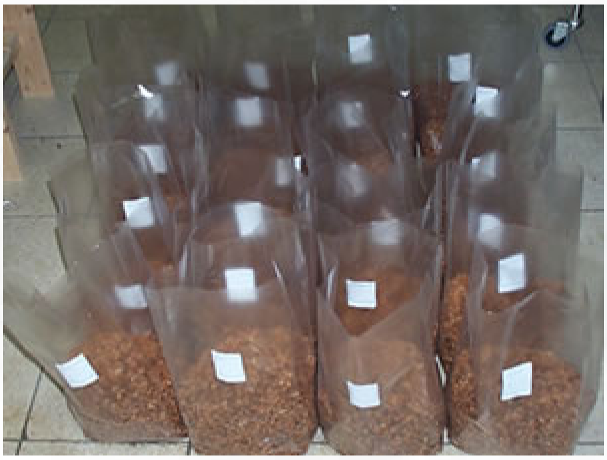
The woodchips we use are made of beech (Fagus sylvatica) and are sold as animal bedding. We use the smaller size for spawn and the larger as substrate for the beds.

The chips are soaked in water for 48 hours. Don't wait longer than this or fungi may start growing on the wood. The chips are then drained.

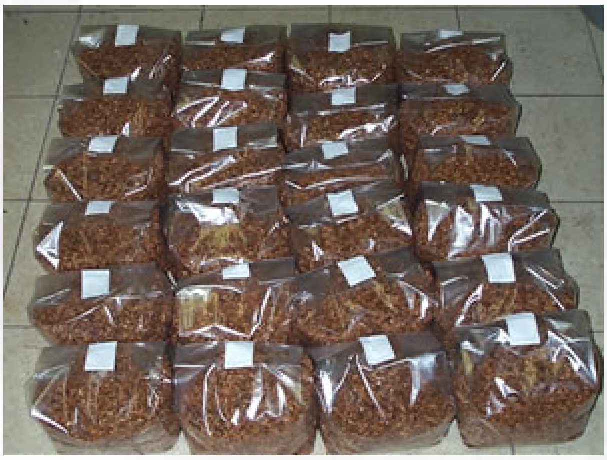
Beech wood chips

Make sure all water runs off

The soaked chips can be supplemented with something like oatmeal or boiled grass seed to speed up mycelial growth. About one half cup per bag is used.

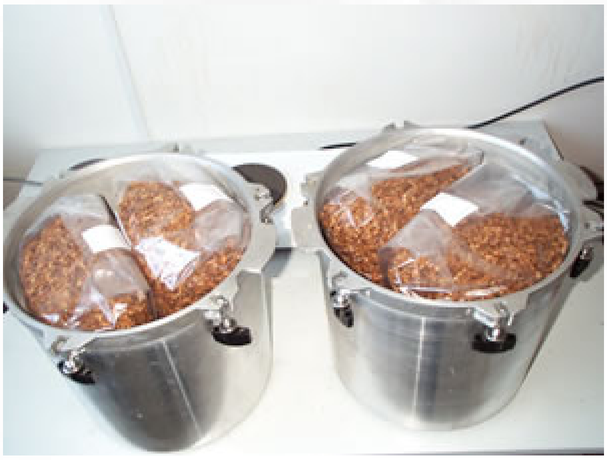


Bags filled with supplemented wood chips

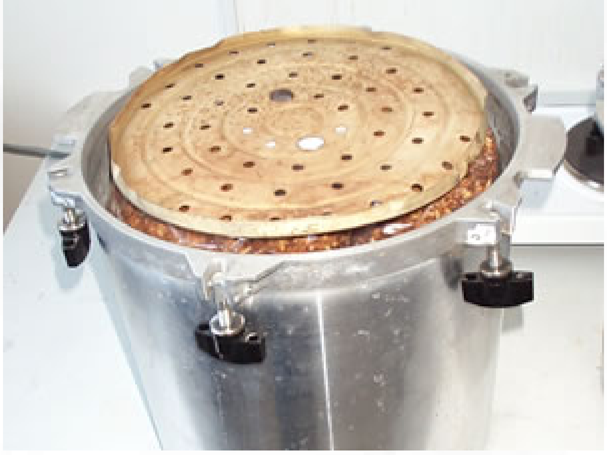


The flaps are folded down, ready for sterilisation.

The bags are placed in the pressure cooker and a rack is put on top to prevent them from blocking the vent pipe.



Four of these bags fit in this cooker



The rack on top is very important

Subsequently the bags are sterilised for 3 hours at 121°C and left to cooled down in the flow cabinet.

Sterilise the full 3 hours, don't cut corners

Bags cooling down in the flow cabinet

Inoculating the wood chip substrate

The cooled bags are placed in the flow cabinet. The bag is opened taking care not to touch the inside and colonised grain spawn is poured in.

Opening the bag...

...and pouring the spawn in

Now the bag is sealed with an impulse sealer, and the seal is tested. If the bag is leaking at the seal it is sealed again.

Sealing the bags

Testing the seal

The strain and date are written on the bag and the bag is shaken to distribute the spawn. The bags are now incubated at 20°C for 3-4 weeks after which they are ready for use.

Making the outdoor bed

For the bed we choose a shaded place surrounded by bushes. First a shallow hole is dug by Cowboy Luuk.

Cowboy Luuk digging a hole

The woodchips that are the same as those used as spawn but they are much coarser (larger particles). The chips are put in bags and these bags are filled with water. The chips are soaked like this for 24 hours.

The hole is filled with drained chips and the spawn is mixed in. A ratio of 1:20 should suffice although higher rates are preferred if the spawn is available.

Colonized wood chip spawn

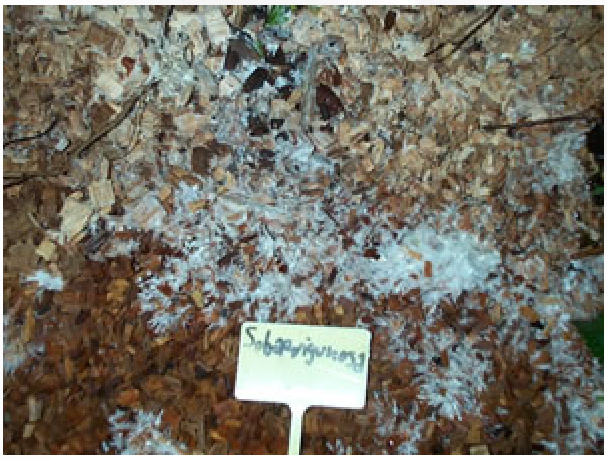
Cowboy Luuk mixing in the spawn

Now the bed is given a final watering and it is covered with a piece of plastic to prevent dehydration.

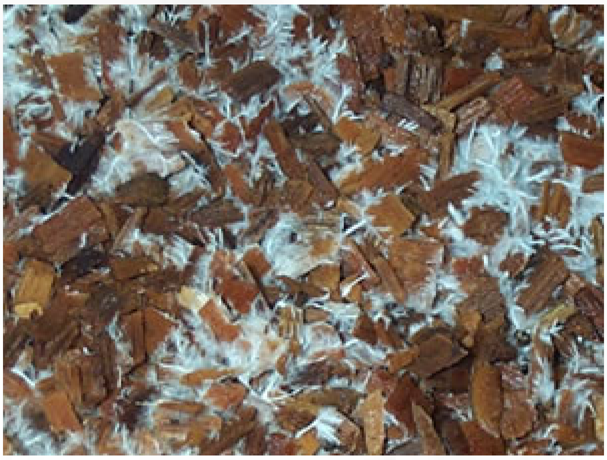
Keep the bed covered until September

Maintenance

Every week or so you should check to see if the bed is still moist on the inside and water if needed.



Mycelium is clearly visible on the woodchips



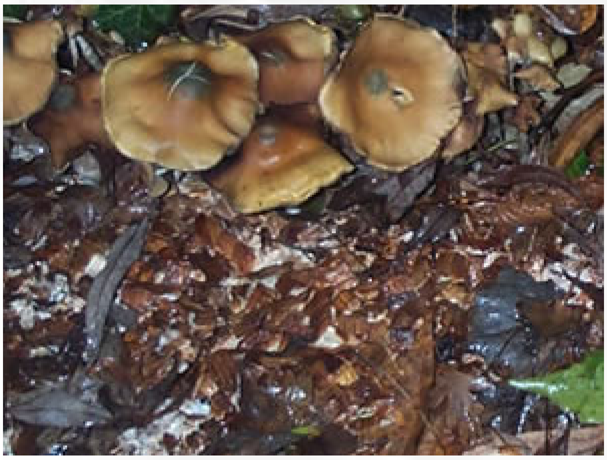
Close up

Replace the plastic after watering. There will probably be all kinds of insects running underneath but don't worry about them. In September the plastic is removed and the bed is watered on a regular basis to prevent it from drying out.

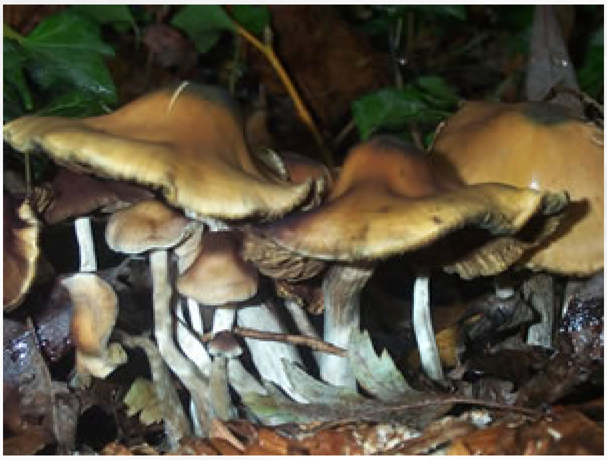
These will be under the plastic

Mushrooms!

Once the temperatures are right for the species being cultivated the bed will start to fruit. Do not water the mushrooms unless it's really dry. It helps to live in the neighbourhood of the beds, and not like us, a 2 hour drive away. Usually one or two flushes pop up. In spring next year fresh chips can be added to the beds to promote further fruitings.



Psilocybe subaerigunosa



Psilocybe subaerigunosa

Table of Contents

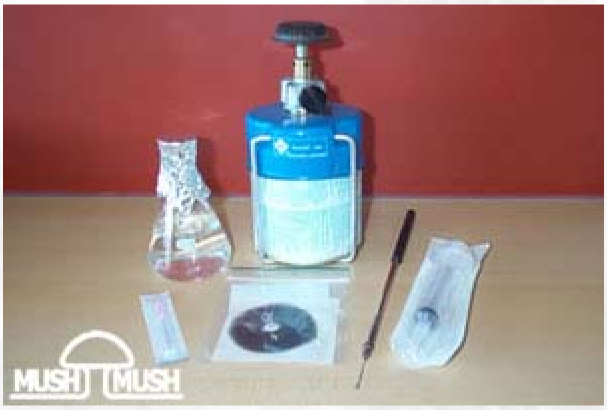
Making a sporesyringe

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Cmaking_a_sporesyringe&old

Although the photographs show the procedure in the open air we make all sporesyringes in a flow cabinet!

To make a sporesyringe you will need the following items:

- Inoculation loop/scalpel (something to pick up the spores)
- Sporeprint
- Syringe and needle (sterile)
- Small amount of sterilised water in a bottle (capped with tinfoil)
- Clean flame source (gas- or alcohol burner)
- Latex gloves (optional)

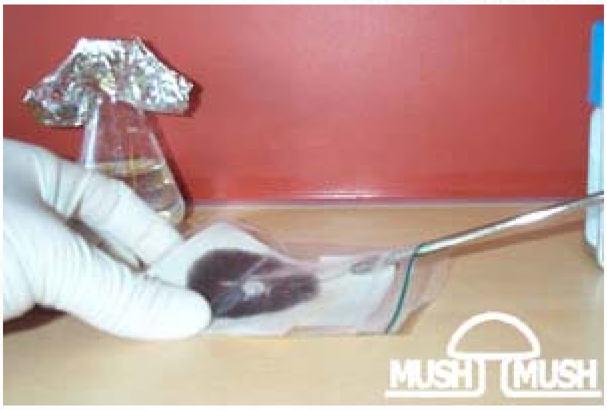


The most important thing in the whole process is to work clean. If possible perform the following procedure in a glovebox or HEPA filtered environment. If you do not have access to one of these you can perform it in the open air, but chances of success or smaller. If available wear gloves that have been disinfected with alcohol 70% or lysol.

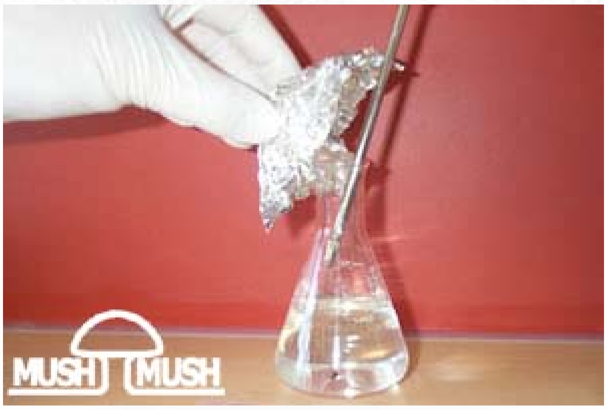
CAUTION: Most disinfectants are flammable, use extreme caution when using these in combination with an open flame!

Before you start clean the working surface with alcohol or lysol. Allow it to dry before proceeding!

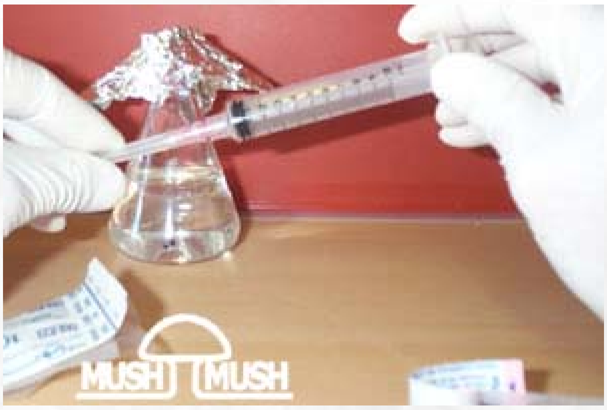
The inoculation loop or scalpel is flamed until red hot, and left to cool. Alternatively you can use a presterilised inoculation loop.



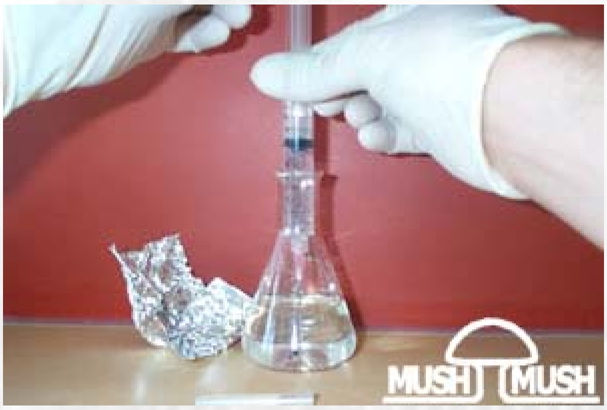
Peal back the tinfoil of the flask so that it can be removed easily but leave it covering the flask. Open the baggie with the sporeprint and scrape some of the spores of the paper. If the loop is too hot the spores will be killed or the plastic will melt to it.



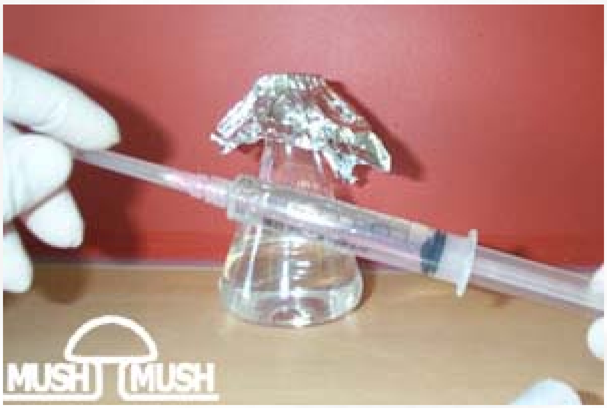
Deposit the spores into the water and quickly replace the tinfoil. Repeat if not enough spores have been transferred. If the spores are visible in the water there should be enough.



The syringe is assembled. Most syringes can be reused by sterilising them in a pressure cooker. Just wrap them in tinfoil and sterilise for 25-30 minutes.



Some spore suspension is sucked up in the syringe. Pull the plunger back and forth a few times to disperse the spores in the water. Syringes can then be filled with spore suspension.



The needle cap is replaced and the syringes are put in the fridge until ready to use. Don't forget to label them with strain and date. Syringes can be kept like this for several months after which they become noticeably less viable.

Table of Contents

Steam sterilisation

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Csteam_strelisation&old

The delicate art of pressure cooking

In laboratories worldwide autoclaves are used to sterilise nutrient media, substrates and instruments. Wouldn't it be nice to have an autoclave at home? Autoclaves are expensive, very expensive...... Luckily, an autoclave is really nothing more than a fancy pressure cooker!

Pressure cookers are relatively cheap, easily available and they come in all shapes and sizes. Still they all work on the same principle. The cooker is an enclosed system. Heat turns the water into steam which builds pressure. At higher pressures the boiling point of water rises. At 1,0 kg/cm^2 overpressure (= 1 bar) this is 121°C. This is the standard sterilisation temperature.

Always observe and obey the safety instructions that came with your cooker. Never make modifications to it and use only original spare parts. Not doing so may result in an explosion! You have been warned!

Typical sterilisation cycle

Not all cookers work the same. Some need the weight to be placed on from the start on and some don't even have a weight but a spring loaded pressure regulator. For a 'standard' cooker with a weight a typical sterilisation cycle goes as follows, it might be different for your cooker!

A rack is placed in the cooker so that the items to be sterilised are not in direct contact with the bottom.
If items are in direct contact with the bottom of the cooker they might melt (polypropylene) or crack (glass). A simple rack keeps the contents of the cooker 1-2 cm from the bottom and prevents this.

An appropriate amount of water, usually a few centimeters to cover the bottom, is put in the cooker.
An appropriate amount is enough to keep the cooker from running dry but not so much that it takes ages to heat up. A cooker that has run dry is bad news because: A. The contents is ruined B. It stinks up the place C. The cooker will need to be cleaned on the inside D. The metal of the cooker itself may warp When the pressure/temperature is regulated precisely so that no excessive steam escape takes not much water is needed. Of course more water should be added if the contents is sterilised for a longer time. Usually 3-4 centimeters of water on the bottom is enough but this may be different for each cooker/sterilisation regime.

The items to be sterilised are placed in the cooker. For bags a rack is put on top.
Flasks, Jars, bags and instruments are placed in the cooker. Jars and bags can be stacked if the cooker is high enough. When autoclaving bags, a rack is put on top to prevent the expanding bags from blocking the vent pipe on the inside.

The lid is closed and the heat is turned on.
The lid is now placed on the cooker. It is closed by means of rotating the lid or by fastening some wing nuts. The weight, which regulates the pressure, is not put on yet. An electric heating plate or a gas stove may be used. It can be turned to full heat unless it's a really big burner for a small cooker which might lead to the glassware inside cracking.

When a steady head of steam is blowing from the vent pipe the weight is put on.
After some time the water in the cooker will start to boil. Steam will start escaping from the vent pipe. The weight is not placed yet. After a few minutes the steam will flow continuously from the vent pipe and all air that was inside of the cooker is now expelled. This forms a saturated steam environment. The weight is now placed on the vent pipe.

The cooker will start building up pressure.
Since the weight is now blocking the steam flow, pressure will start to rise in the cooker. The rise in pressure corresponds with a rise in temperature. If hissing or leaking is visible the rubber ring that seals the lid to the cooker needs to be cleaned or replaced. The heat is adjusted to keep the weight rocking slowly

When the pressure has reached 1 bar the weight will be lifted by the steam pressure. This releases pressure and the weight will go down again. The temperature is regulated so that the weight keeps rocking and hissing but no excessive steam escape takes placed. As long as the weight is rocking, the contents is at the correct temperature.

After the appropriate time the heat source is turned off.
Sterilisation time is measured from the moment that the cooker reaches 121°C until the moment that the heat is turned off. The cooker is left to cool until the pressure has returned to zero. When the pressure has returned to zero, the cooker can be opened.

Items that can be used when they are cool can be left like this. When the contents has to be used while still hot (agar for instance) or when the cooker needs to be used again as fast as possible the hot content may be removed. Always remove the weight first to ensure that the pressure has dropped to zero before opening the cooker.

The cooker is unloaded and is ready for a new cycle.
The hot items are removed from the cooker with heat insulating gloves. Cold items can be removed bare handed. Sealed bags and jars with a filter can be left to cool anywhere. Agar and unsealed bags are left to cool in a running flow cabinet or improvised inoculation hood.

Sterilising sealed bags

Still many people think that it's impossible to sterilise sealed filter patch bags. They sterilise the substrate in an open bag and seal after spawning. This brings with it a great risk for introducing contaminants into the substrate.

We have had great success with autoclaving sealed filter patch bags, however there are a few things you should know:

The bags expand during cooking which means that if the bottoms of the bags stand in water, they will push the water out of the cooker through the vent pipe. This can be prevented by placing the bags on top of a sturdy rack. The water level should be below the rack. This will mean that there is not much water in the cooker. Pressure has to be regulated precise so no excessive steam escape takes place since that may cause the cooker to run dry.

Since the expanding bags may also block the vent pipe a rack of some sort should also be put on top of the bags to prevent this. If water comes out of the vent pipe this means that there's too much water in the cooker and that the expanding bags are pushing the water out.

The cooker should always be fully filled with bags. If the combined volume of the expanded bags is smaller than the volume of the cooker they will burst. Because the bags will all fully expand during cooking they prevent each other from bursting.

As much air as possible is pushed out during sealing of the bags. This makes it easier to put them in the cooker and allows for better steam buildup. A good impulse sealer must be used, poor seals burst during autoclaving.

Sterilisation time for bags is 1,5 - 2,5 hours depending on the weight of the bags.

After sterilisation the bags are removed and shaken. Shaking is not always possible because many bags will come out with little air inside. This doesn't matter since the bags will inflate during incubation and can then be easily shaken.

Since the bags are sealed now, inoculation can only take place by liquid injection. A (self-filling) syringe is used to inoculate the bags. The injection site is cleaned with an alcohol soaked paper towel and then pierced with the needle. Liquid inoculum is injected into the substrate. The hole is shut with a drop of hot glue from a glue gun.

After the glue has hardened the bags are shaken (if possible) and incubated. Shaking can take place as soon as the bags have inflated (after some mycelial growth, often after a few days.)

Usually bags are fully colonised after 14-20 days.

Sterilising jars

First a rack is put in the cooker, than a layer of water is added. If the cooker permits it the jars can be stacked without a problem. If for some reason jars without a filter are sterilised the lids should not be screwed tight.
Usually bags are fully colonised after 14-20 days.

The jars should never be put directly in hot water or they might crack. After one batch of jars is unloaded, the hot water should be poured out and replaced with cold to prevent this.
Usually bags are fully colonised after 14-20 days.

Jars that can be bought for cheap in the supermarket (containing such delicacies as applesauce or green peas) can be autoclaved two or three times after which they are much more likely to break. They are cheap but might be dangerous when used for too long.

Always treat glass jars with caution, handle them (when unloading and shaking) with thick gloves that protect your hands in the case a jar would break.

Sterilisation time for small jars (500 ml) is 45 minutes, for normal jars (720 ml) 60 minutes and for large jars 90-120 minutes (depending on size).

Sterilising liquids

Liquids such as water and agar are sterilised in bottles or Erlenmeyer flasks. Since agar foams during autoclaving the flasks are never filled for more than 2/3. Bottles with water can be totally filled. The caps of bottles or flasks should never be screwed tight but always left a bit open to prevent im- or explosions.

The following table can be used as a guidance for the autoclave time.

vessel size (ml)	sterilisation time (minutes)
25	20
50	25
100	28
250	31
500	35
1000	40
2000	48
4000	63

It's very important that the cooker cools down slowly. When the temperature drops too fast the agar may boil out of it's container which leads to mess.

When agar is sterilised too long it turns dark in color and doesn't gel properly. Sugars are converted to caramel which is toxic to fungi. Care is taken not to let the temperature rise above 121°C for the same reason.

Sterilising other stuff

Items such as scalpel or tweezers can be wrapped in aluminum foil or sealed in tyvek. Most types of syringes are autoclavable as well. These are too wrapped in aluminium foil and sterilised for 15 minutes. Forget about sterilising filled syringe as they will come out of the cooker empty.

Table of Contents

MushMush Notes

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/mushnotes.htm

Preparing Agar

Recipe for Malt Extract Agar (1 liter)

- 20 grams Malt Extract
- 2 grams Yeast
- 15 grams Agar
- Water

The dry ingredients are put in a flask and the water is added. This is sterilized for 30 minutes at 121 degrees Celsius.

The flask should be twice as large as the volume of the medium that is sterilized to prevent it from boiling over and should preferably have a narrow opening. The opening is stuffed with polyfill, hydrophobic cotton or capped with Tyvek. This is covered with tinfoil.

Pouring Petri dishes

Condensation on the lids can be prevented by:

- pouring Petri dishes when agar has cooled to 40-50 degrees Celsius;
- stacking the dishes with warm agar;
- putting something hot on the top dish of the stack (a mug with hot water for example).

Dishes should preferably be poured in a glove box or HEPA filtered environment.

Incubation of agar cultures

Petri dishes should be taped around the edges with polyethylene cling wrap. This prevents both dehydration and the introduction of contaminants. A small roll, cut from a big roll with a sharp knife is very useful.

Dishes are Incubated upside down so that droplets of condensation will not fall on the agar surface but will remain on the lid until they evaporate.

Keep track of how often a strain is subcultured. Do not subculture for more than 5 Petri dishes or you will risk losing your strain to degeneration. A sure sign of degeneration is the formation of zones of fluffy mycelium. These cultures should preferably not be used. If there's no choice but to use them, use only the rhizomorphic zones.

Storing cultures

For storage of cultures agar slants are used. The agar is prepared by boiling in a pan and then pouring it into test tubes (a big syringe is useful for this). The tubes are loosely capped and sterilized for 25 minutes in the pressure cooker. The tubes should be taken out before the agar solidifies and put under an angle so that upon solidifying the agar has larger surface for mycelial growth.

The tubes can be inoculated by dropping a small piece of colonised agar into the tube. The tube is loosely capped and sealed with cling wrap. The piece of agar can now be forced downwards onto the agar by tapping the tube it with your hand.

After two weeks of growth the tubes can be put in the fridge where they will remain viable for up to 5 years. Every year tubes are taken out and subcultured in Petri dishes to check if they are still viable. After prolonged storage cultures may show some sectoring (the formation of fluffy zones in the mycelium) so only healthy rhizomorphic mycelium is subcultured.

Making a clean sporeprint

Sporeprints are best taken on a smooth surface that allows easy picking up of the spores with an inoculation loop. Most clean smooth materials will work fine as long as they are clean. Most store bought dry products (paper, tinfoil) that are packaged can be considered clean.

Some strains and species do not easily drop their spores. Often sporulation can be stimulated by increasing the humidity. This is especially important when sporeprints are made from small caps. The caps themselves would dry pretty quickly and once they are dry, they will not deposit any spores.
For species such as Psilocybe mexicana and Psilocybe tampanensis a small plastic container that seals well is used some of the stems of the mushrooms are put in this as well to help raise humidity.
Not all strains drop their spores immediately after the veil tears, so it's best to wait until spores can be seen on the stem near the cap.

The mushroom is picked and put on clean tinfoil. With a sharp knife or scalpel the cap is cut off and the cap is put on the printing medium (paper, tinfoil, Petri dish). The container is closed and after 24 hours the cap is removed. A perfect sporeprint should be the result. Store the sporeprints individually sealed in a ziplock type baggie. These can be stored for years in a cool dry location.

Substrates for Psilocybe cubensis

Almost any type of grain can be used to grow this species on but in our opinion rye grain is the best choice. Other grain types and mixtures do not evenly absorb moisture during sterilization and have to be preboiled.

Rye (in dry form) can be combined with water and then sterilized without the need of preboiling. This saves a lot of time and hassle. When the jars or bags are still hot they need to be shaken to disperse the wet bottom kernels with he dryer top kernels. Upon cooling moisture will spread evenly throughout the substrate and the end result can be shaken easily.

Other grains have to be preboiled in plenty of water. Boiling time depends on the type of grain that is used. Mixtures with small kernels often need less time than those consisting of bigger ones. Kernels that have burst open are not good, and too many of these may give problems with bacterial contamination later on. After boiling the grain is drained and filled into jars or bags. These can then be sterilized.

Substrates for Panaeolus cyanescens and Panaeolus tropicalis

Although literature suggests that pasteurized straw can be used yields are poor compared to using a substrate that contains dung. People have reported good success with pasteurized cow and horse dung. We prefer to sterilized the substrate in spawn bags. A mixture of straw or grass seed and dung seems to work best. Vermiculite can be added to improve structure and water holding capacity.

A high yielding substrate can be prepared with the following recipes:

- 7 parts dried cow dung
- 7 parts soaked grass seed Instead of grass seed soaked straw can be used as well
- 2 parts fine vermiculite
- 2 parts coarse vermiculite

Ingredients are mixed in dry form (except the soaked grass seed or straw) and water is added until it is saturated. Squeeze out the moisture and sterilised the mixture in spawnbags for 2 hours. These bags can be inoculated from rye spawn.

Incubating bags produce a lot of heat so watch out for overheating of the substrate!

Sterilization time

Substrates can be effectively sterilized by pressurized steam. A pressure cooker or autoclave are perfectly suitable for this purpose.
The required time for sterilization depends on a variety of factors the most important being:

- the amount of substrate in one container (bag/jar/flask);
- total amount of substrate in the cooker/autoclave;
- solid or liquid substrate.

The more substrate is filled into the containers the longer they should be sterilized. Tightly packed pressure cookers require longer sterilization than empty ones. Liquids (agar, water) require briefer sterilization then solids such as rye or birdseed.

Sterilization time is measured from the moment the pressure cooker or autoclave has reached 121 degrees Celsius (1,0 kg/cm2, 15 psi).

200 ml jar rye 40 minutes
200 ml jar grass seed 40 minutes
800 ml jar rye 60 minutes
800 ml jar grass seed 60 minutes
Spawnbag rye (4 liter) 120 minutes
Spawnbag grass seed (5 liter) 150 minutes
Spawnbag dung mixture (3 liter) 120 minutes
Agar slants 25 minutes
Agar (in bottle) 30 minutes
Water (in bottle) 30 minutes
Scalpel, syringes etc. 20 minutes
Large bag casing soil 60 minutes *partial sterilization*!

Casing soil

Many species benefit from a layer of "casing" soil on top of the colonized substrate. The process of putting such a layer on is called casing.

Recipe:

- 10 parts peat
- 5 parts vermiculite
- 2 parts limestone

The ingredients are mixed in dry form and water is added until the casing soil is almost saturated. The object is to get as much water as possible in without turning it to mud. If too much water has been added some more dry ingredients can be added to compensate.

The casing soil needs to be heat treated before use. Some people have reported success with untreated soils but it seems a big risk to take. There are two practical options: partial sterilization in a pressure cooker and partial sterilization in a microwave.
The wetted soil is put in bag or jars and is 'sterilized' for 1 hour in the pressure cooker or for 25-30 minutes in a microwave at full power. Extra water should be added when a microwave is used.

When it had cooled down the soil is ready to use. If it looks a little dry you can add some clean water to it before applying it to colonized substrate.

The colonized substrate is broken up and poured into trays. The casing mixture is applied and the tray is covered. A normal depth for a casing layer is 1.5-3 cm. *Panaeolus cyanescens* and *Panaeolus tropicalis* also need a casing layer but it must be very thin as these species seem to have trouble growing through it.

Sclerotia cultivation

Some species can form so called "sclerotia" in the casing soil and inside of the substrate. Psilocybe mexicana and *Psilocybe tampanensis* are the two most important species.
Sclerotia are hardened mycelial structures that are formed by the mycelium as a survival mechanism to protect it from floods, forest fires etc. Sclerotia contain 30% dry matter where mushroom only contain 9-10%. Interestingly the sclerotia of the two mentioned species also contain psilocybin and/or psilocin.

Most strains and substrains of these species form sclerotia in the casing soil of cased trays. As a substrate millet and grass seed can be used.

In vitro sclerotia (where the substrate remains in the bags or jars it's growing in) are formed by the "A" strain of mexicana and by some substrains of the *Psilocybe tampanensis*. Sterilized grass seed seems most suitable substrate. It can be prepared by combining the dry grass seed with water in jars or bags followed by steam sterilization.

Recipe (800 ml jars):

- 110 grams grass seed
- 180 ml water

These jars should be sterilized for 1 hour.

Recipe (5 liter spawn bags):

- 4 liters grass seed
- 2 liters water

These bags should be sterilized for 2 1/2 hours.

The substrate is inoculated and shaken after a few days. After some time sclerotia will start to form. Tampanensis forms then only against the glass or inner bag surface, mexicana forms them throughout the substrate. After 3 months (mexicana) or 6 months (tampanensis) growth has halted and the sclerotia can be harvested.

Initiation strategy

One the substrate (and casing layer) are colonized it's time to expose the substrate to fruiting conditions. The three most important changes should be:

- a drop of temperature by a few degrees Celsius;
- lowering of CO2 concentration;
- exposure to light for a few hours a day

Not all strains are as sensitive as others. In general the more fleshy and stout strains of *Psilocybe cubensis* are somewhat more difficult to get to pin than the more slender/thinner strains. Difficult to fruit strains can be 'cold-shocked' by putting the substrate in the fridge for 24 hours before putting them in the fruiting chamber.

Panaeolus cyanescens and *tropicalis* are very sensitive to high CO2 concentrations (much more than Psilocybe cubensis). If they do not receive enough fresh air, the mushrooms will grow tall and spindly and will abort at an early stage.

If the conditions are not right for the species being cultivated often the mycelium will continue to colonize the casing surface without forming any pinheads. The casing becomes a hard closed surface that will not absorb water. If this happens the casing surface should be scratched open with a clean fork and conditions should be corrected to allow fruiting.

Table of Contents

Working with agar

original source: http://www.mushmush.nl/?page=begin%5Cmethods%5Cworking_with_agar&old

What is agar?

Agar is a polysaccharide found in the cell walls of some red algae from which it's extracted by boiling. This raw agar is then purified.
When agar is dissolved in boiling water and left to cool it will form a gel (very much like gelatin). It can be bought in many different grades from food-grade to purified tissue culture grade.

It's main uses are in the field of microbiology, tissue culture and food preparation (as a vegetarian substitute for gelatin).

Why is agar important?

We use agar as a gelling agent for nutrient media. By adding nutrients (agar itself does not contain digestible compounds) a nutrient base can be made on which mushroom mycelia can be cultivated in a flat two-dimensional way.
It can not be substituted by gelatin since gelatin is digestible and does not gel after autoclaving.

Preparing nutrient medium

There are many recipes that work well but the simplest and easiest to prepare remains:

MEA (Malt Extract Agar):

- 20 grams light malt extract
- 2 grams yeast
- 15-20 grams agar
- 1 liter water

(Smaller volumes can be prepared by simply using less ingredients in the same ratio)

The dry ingredients are put in a flask (Erlenmeyer or similar) and water is added. Take care not to fill the flask for more than 2/3 of it's volume or it will boil over.
When the water and dry ingredients are put in the flask the opening is stuffed with polyfill or hydrophobic cotton. Another option is to put a piece of Tyvek over it held in place with rubber bands. This allows for the agar to be re-melted in the microwave. A piece of aluminum foil is put on top and the flask is swirled.

The flasks are then sterilised in the pressure cooker at 121°C for 40 minutes.

This medium will support the growth of most saprophytic fungi. Other often used formulations are PDA (Potato Dextrose Agar) and DFA (Dog Food Agar).

When making your own recipes keep in mind that more is not always better. When media are too rich in nutrients mycelium will not grow or grow very poorly secreting yellowish metabolites.

Pouring dishes

When the flasks come out of the pressure cooker or autoclave the temperature of the agar will be close to 100°C. The medium will be liquid until the temperature drops below 40°C. The agar is left to cool until it has almost reached this temperature. As a rule of thumb: If you can hold the bottle in your bare hand for 10 seconds without real discomfort the temperature is right. Do not let it cool too much or it will solidify in the bottle. Better to pour a little too hot than having to reliquify the agar.

Since the lids of the dishes will be removed for a few seconds it's very important to prepare a clean workplace. A laminar flowhood is best but an improvised transfer hood will usually give adequate results.

Whichever is used the table top is cleaned with alcohol or lysol **(CAREFUL! THESE ARE FLAMMABLE!)** and the dishes are taken out of the tube in which they were packaged and put in stacks of 10 dishes.

When working in less then totally sterile environments it's important to work as fast as possible, limiting the direct contact of agar with outside air.

The flask is swirled to mix the ingredients and the aluminum foil and polyfill are removed.

The lid of the bottom dish is lifted (in fact lifting the lid and the 9 dishes on top). Swiftly a layer of nutrient medium is poured in the dish (to 0,3-0,5 cm depth) and the lid is replaced. Quickly lift the second lid (and the 8 remaining dishes) and work your way up in this fashion.

By letting the agar cool before pouring and by stacking the dishes condensation on the lids is minimized. When a mug or jar with near boiling water is put on the top dish of a stack condensation will be even less.

When the agar in the has solidified the dishes are ready to use.

Preparing agar slants

The normal way to store cultures is in so-called slants. Slants are test tubes in which the agar was cooled on a sloped surface to give the agar a larger surface area.

Slants are prepared a little differently then Petri dishes since the tubes are sterilized with the agar in them opposed to dishes which come pre-sterilized and which are filled with sterilized agar.

The nutrient medium is prepared by bringing the appropriate amount of water to a near boil in a pot on the stovetop. The ingredients are added and the mixture is stirred to let them dissolve. Agar should first be mixed

with a little bit of cold water before adding or it will form lumps. Careful, adding agar to boiling water will cause the medium to foam and boil over. Boiling agar can cause serious burns!
Let the agar boil for a few minutes, then turn off the heat.

Tubes are filled with 5-6 ml of medium and loosely capped. A small funnel and a big syringe are very useful here. The tubes are sterilized for 25 minutes at 121°C.

When they come out they are left to cool on a sloped surface to increase to surface area of the agar. When the agar has solidified the slants are ready to use.

Starting a culture from spores

To start cultures from spores one needs a sporeprint and a tool that can be sterilized to pick up the spores (inoculation loop, scalpel or similar).

With a sterilised inoculation loop some spores are scraped from the spore print and the loop is streaked across the surface of the agar in an 'S' pattern. The inoculation loop is resterilised before using it for other inoculation.

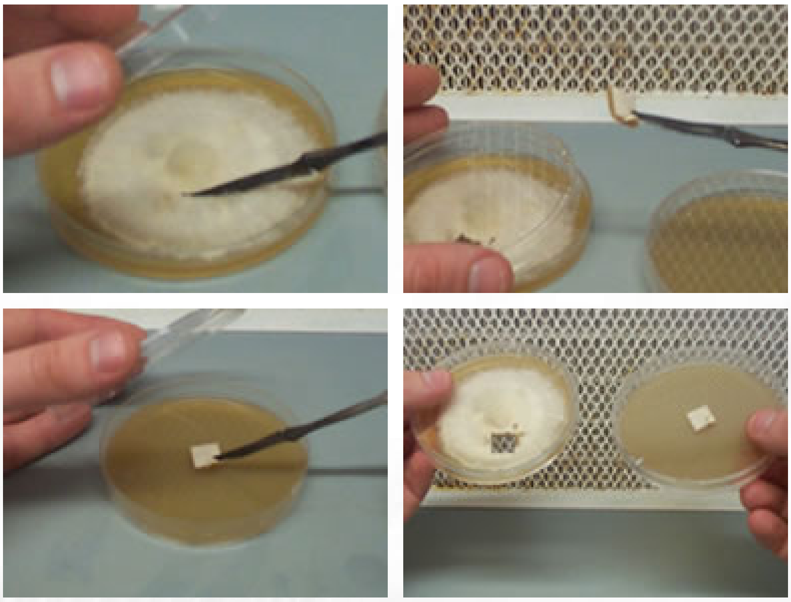
Often spore germination is visible within a few days but it may take as long as four weeks before visible germination takes place. If no germination takes places it may be necessary to rehydrate the spores in some sterile water for 24 hours before streaking them on agar.

If contaminants are encountered one can choose to discard the whole dish or one can transfer the mycelium away from the contamination to a new dish. When bacterial contamination is present this can take place in a flowhood. If sporulating molds are present isolation should take place in a still-air environment to prevent the release of mold spores.

The germinating spores will form a mycelium that by itself is not capable of fruiting called a 'monokaryon'. When the mycelia of two spores fuse they will form a new type of mycelium that IS capable of fruiting, a 'dikaryon'. This process will happen by itself and one dish with germinated spores will often contain dozens of these combinations.

A dish with germinated spores will often look a little bit messy, with monokaryons and dikaryons competing with each other for nutrient sources. Here one has two options: use this mixture of substrains (a 'multispore') or select a pure substrain. Each substrain has it's own properties but generally resembles it's parents. Generally speaking flushes from pure substrains are more uniform and better yielding than a mixture of substrains.

To select pure substrains small agar squares from a multispore germination are transferred to fresh media. Growth from these squares will still be pretty messy but often some sectors will develop that show healthy growth. These healthy sectors should be transferred to new dishes again. This process is repeated until the growth in a dish is uniform and non-sectoring. This is a pure substrain.



One can also use the multispore cultures to directly inoculate spawn. Since mushrooms are composed of mycelial threads (of one substrain, not of a mixture) one can always isolate pure strains from mushrooms as soon as they emerge from this multispore culture.

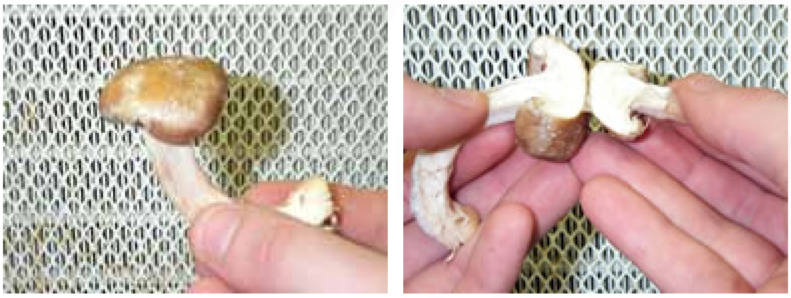
Starting a culture from a fruitbody

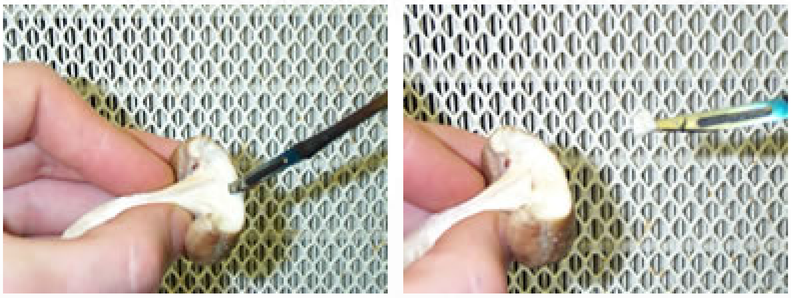
Since mushrooms are composed of mycelial threads (of one substrain, not of a mixture) , as mentioned before, one can use tissue from a mushroom to start new cultures. However there is no advantage to cloning a mushroom that is grown from a pure strain. Cloning mushrooms is useful when one starts with multispore inoculations or for cloning wild specimens.

We like to isolate pure lines by letting multispore cultures fruit and consequently isolating mycelia from the healthiest looking fruitbodies. This saves time and ensures that the obtained strain is indeed one that is willing to fruit on the selected substrate under the same environmental conditions.

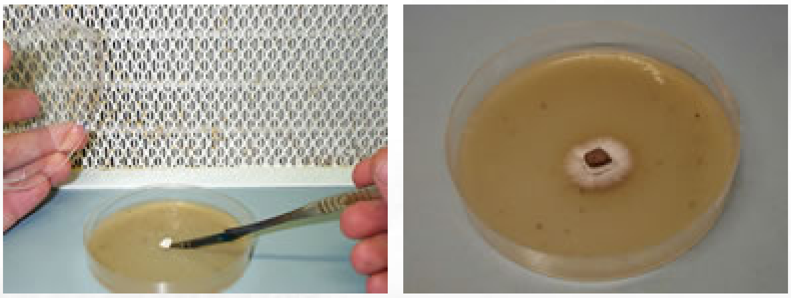
Most mushroom species produce fruitbodies that are sterile on the inside. The practical approach to isolating some tissue is to split open the mushroom and to cut a piece of tissue from the inside. This mushroom fragment is put on agar. Care is taken to not let the scalpel or the fragment come in contact with the outside of the mushroom. This will surely lead to bacterial contamination.

To increase the chance of success at least 10 dishes are inoculated taking care not to cause cross-contamination (re-sterilize the scalpel in between isolations).





Often within a few days the fragment will spring to life. Becoming fuzzy and showing new growth on the agar surface. If contaminants are visible one can try to isolate the mycelium away from the contaminants.



Even though a pure (sub)strain should be growing on the agar sectoring may be visible, often healthy zones mixed with cottony or fuzzy ones. The reason for this is not known. Some strains have a tendency to show this phenomenon more than others. The healthy mycelium is then transferred to a new dish until a healthy pure culture is established.

Taping dishes and tubes

To prevent moisture loss and the introduction of contaminants dishes and tubes are taped. For this purpose small rolls of clingfilm are cut from a big roll with a sharp serrated knife. The clingfilm is stretched out a bit and wrapped around the dish, effectively taping the dish and lid together. Polyethylene clingfilm allows for slow gas exchange.

Storing slant cultures

To store cultures slants are inoculated with small agar squares. The cap is put on loosely and the tube neck is taped with polyethylene clingfilm. Once the agar is fully colonized the slants are put in the fridge where they can be kept for at least a year. It's wise to check the viability of cultures each year by inoculating some dishes with the culture.

Incubating cultures

Cultures should be incubated at the right temperature. If the temperature is too high mycelia will often start to sweat, sickening the culture. If the temperature is too low mycelia will grow slowly. In general too low is better than too high.

It's also very important not to let the temperature fluctuate too much as this causes condensation to form on the lids. The temperature should be kept as constant as possible. Dishes are incubated upside down so even if condensation forms it will not disturb mycelial growth.

Table of Contents

The Mushroom Cultivator

A Practical Guide to Growing Mushrooms at Home

by

Paul Stamets & J.S. Chilton

Produced by Paul Stamets and J.S. Chilton

The authors invite comments on The Mushroom Cultivator as well as personal experiences concerning mushroom cultivation.
Address all mail to Agarikon Press.

© 1983 Paul Stamets and J.S. Chilton

original source:
http://library.uniteddiversity.coop/Permaculture/Mushroom_Cultivator-A_Practical_Guide_to_Growing_Mushrooms_at_Home.pdf
backup source: http://www.psilosophy.info/resources/Mushroom_Cultivator-A_Practical_Guide_to_Growing_Mushrooms_at_Home.pdf

To
Azureus, Skye, and LaDena

Table of Contents:

FOREWORD by Dr. Andrew Weil
PREFACE
I. INTRODUCTION TO MUSHROOM CULTURE
- An Overview of Techniques for Mushroom Cultivation
- Mushrooms and Mushroom Culture
- The Mushroom Life Cycle

II. STERILE TECHNIQUE AND AGAR CULTURE
- Design and Construction of a Sterile Laboratory
- Preparation of Agar Media
- Starting a Culture from Spores
  - *Taking a Spore Print*
  - *Techniques for Spore Germination*
  - *Characteristics of the Mushroom Mycelium*
  - *Ramifications of Multispore Culture*
- Starting a Culture from Live Tissue
- Sectoring: Strain Selection and Development
- Stock Cultures: Methods For Preserving Mushroom Strains

III. GRAIN CULTURE
- The Development of Grain Spawn
- Preparation of Grain Spawn
  - *Spawn Formulas*
  - *Inoculation of Sterilized Grain from Agar Media*
  - *Inoculation of Grain from Grain Masters*
- Alternative Spawn Media
  - *Sawdust/Bran Spawn*
  - *Perlite Spawn*
- Liquid Inoculation Techniques
- Incubation of Spawn

IV. THE MUSHROOM GROWING ROOM
- Structure and Growing Systems

- *Structure*
- *Shelves*
- *Trays*
- Environmental Control Systems
  - *Fresh Air*
  - *Fans*
  - *Air Ducting*
  - *Filters*
  - *Exhaust Vents*
  - *Heating*
  - *Cooling*
  - *Humidification*
  - *Thermostats and Humidistats*
  - *Lighting*
  - *Environmental Monitoring Equipment*

V. COMPOST PREPARATION

- Phase I Composting
  - *Basic Raw Materials*
  - *Supplements*
    - Group I: High nitrogen, no organic matter
    - Group II: 10-14% N
    - Group III: 3-7% N
    - Group IV: Low nitrogen, high carbohydrate
    - Group V: Animal manures
    - Group VI: Hay
    - Group VII: Minerals
      - Gypsum - Calcium sulfate
      - Limestone flour - Calcium carbonate
    - Group VIII: Starting materials
  - *Compost Formulas*
    - Formula I
    - Formula II
  - *Ammonia*
  - *Carbon:Nitrogen Ratio*
  - *Water and Air*
  - *Pre-wetting*
  - *Building the Pile*
  - *Turning*
  - *Temperature*
  - *Long Composting*
  - *Short Composting*
    - Short Compost Procedure
    - Synthetic Compost Procedure
  - *Composting Tools*
  - *Characteristics of the Compost at Filling*
  - *Supplementation at Filling*
- Phase II Composting
  - *Basic Air Requirements*
  - *Phase II Room Design*
  - *Filling Procedures*
  - *Depth of Fill*
  - *Phase II Procedures: Trays or Shelves*
  - *Phase II in Bulk*
  - *Bulk Room Design Features*
  - *Bulk Room Filling Procedures*
  - *Bulk Room Phase II Procedures*

    - *Testing for Ammonia*
    - *Aspect of the Finished Compost*
  - Alternative Composts and Composting Procedures
    - *Sugar Cane Bagasse Compost*
    - *The Five Day Express Composting Method*
- **VI. NON-COMPOSTED SUBSTRATES**
  - Natural Culture
  - Semi-sterile and Sterile Wood Based Substrates
  - Growing on Pasteurized Straw
- **VII. SPAWNING AND SPAWN RUNNING IN BULK SUBSTRATES**
  - Moisture Content
  - Substrate Temperature
  - Dry Weight of Substrate
  - Duration of Spawn Run
  - Spawning Methods
  - Environmental Conditions
  - Super Spawning
  - Supplementation at Spawning
  - Supplementation at Casing (S.A.C.)
- **VIII. THE CASING LAYER**
  - Functions
  - Properties
  - Materials
  - Casing Formulas and Preparation
  - Application
  - Casing Colonization
  - Casing Moisture and Mycelial Appearance
- **IX. STRATEGIES FOR MUSHROOM FORMATION (PINHEAD INITIATION)**
  - Basic Pinning Strategy
  - Primordia Formation Procedures
    - *Stage I: Preparation*
    - *Stage II: Environmental Transition - The Prelude to Setting Primordia*
    - *Stage III: Primordia Formation (Knotting)*
    - *Stage IV: Pinhead Development*
  - The Relationship Between Primordia Formation and Yield
  - The Influence of Light on Pinhead Initiation
- **X. ENVIRONMENTAL FACTORS: SUSTAINING THE MUSHROOM CROP**
  - Temperature
  - Flushing Pattern
  - Air Movement
  - Watering
  - Harvesting
    - *Harvesting techniques*
  - Preserving Mushrooms
- **XI. GROWING PARAMETERS FOR VARIOUS MUSHROOM SPECIES**
- Agaricus bitorquis
  - *A. bitorquis - Growth Parameters*
- Agaricus brunnescens
  - *A. brunnescens - Growth Parameters*
- Coprinus comatus
  - *C. comatus - Growth Parameters*
- Flammulina velutipes
  - *F. velutipes - Growth Parameters*
- Lentinus edodes
  - *L. edodes - Growth Parameters*
- Lepista nuda

- *L. nuda - Growth Parameters*
- Panaeolus cyanescens
  - *P. cyanescens - Growth Parameters*
- Panaeolus subbalteatus
  - *P. subbalteatus - Growth Parameters*
- Pleurotus ostreatus
  - *P. ostreatus - Growth Parameters*
- Pleurotus ostreatus (Florida variety)
  - *P. ostreatus (Florida variety) - Growth Parameters*
- Psilocybe cubensis
  - *P. cubensis - Growth Parameters*
- Psilocybe cyanescens
  - *Psil. cyanescens - Growth Parameters*
- Psilocybe mexicana
  - *P. mexicana - Growth Parameters*
- Psilocybe tampanensis
  - *P. tampanensis - Growth Parameters*
- Stropharia rugoso-annulata
  - *S. rugoso-annulata - Growth Parameters*
- Volvariella volvacea
  - *V. volvacea - Growth Parameters*

XII. CULTIVATION PROBLEMS AND THEIR SOLUTIONS: A TROUBLE SHOOTING GUIDE

- Sterile Technique
  - *Agar Culture*
  - *Grain Culture*
- Compost Preparation
  - *Phase I*
  - *Phase II*
- Spawn Running
- Case Running
- Mushroom Formation and Development
  - *Pinhead Initiation*
  - *Cropping*

XIII. THE CONTAMINANTS OF MUSHROOM CULTURE: IDENTIFICATION AND CONTROL

- A Key to the Common Contaminants of Mushroom Culture
- Virus (Die-Back Disease)
- Actinomyces (Firefang)
- Bacillus (Wet Spot)
- Pseudomonas (Bacterial Blotch & Pit)
- Streptomyces (Firefang)
- Alternaria (Black Mold)
- Aspergillus (Green Mold)
- Botrytis (Brown Mold)
- Chaetomium (Olive Green Mold)
- Chrysosporium (Yellow Mold)
- Cladosporium (Dark Green Mold)
- Coprinus (Inky Cap)
- Cryptococcus (Cream Colored Yeast)
- Dactylium (Cobweb Mold)
- Doratormyces (Black Whisker Mold)
- Epicoccum (Yellow Mold)
- Fusarium
- Geotrichum (Lipstick Mold)
- Humicola (Gray Mold)
- Monilia (White Flour Mold)
- Mucor (Black Pin Mold)

- Mycelia Sterilia (White Mold)
- Mycogone (Wet Bubble)
- Neurospora (Pink Mold)
- Papulospora (Brown Plaster Mold)
- Penicillium (Bluish Green Mold)
- Rhizopus (Black Pin Mold)
- Scopulariopsis (White Plaster Mold)
- Sepedonium (White or Yellow Mold)
- Torula (Black Yeast)
- Trichoderma (Forest Green Mold)
- Trichothecium (Pink Mold)
- Verticillium (Dry Bubble)

XIV. THE PESTS OF MUSHROOM CULTURE

- Mushroom Flies
  - *Fly Control Measures*
  - *Sciarid Fly*
  - *Phorid Fly*
  - *Cecid Fly*
- Mushroom Mites
- Nematodes (Eelworms)
  - *Saprophagous Nematodes*
  - *Mycophagous Nematodes*

XV. MUSHROOM GENETICS

- Introduction
  - *What Are Genes?*
  - *What Do Genes Do?*
  - *The Advantage of Multiple Copies of Genes*
  - *Chromosomes*
  - *Mitosis*
  - *Meiosis*
- Reproductive Strategies
  - *Asexual Reproduction in the Fungi*
  - *Sexual Reproduction in Mushrooms*
- Implications for Culture Work
  - *Culture Trials*
  - *Spore Dilution Technique*

APPENDICES

- Appendix I - Medicinal Properties of Mushrooms
- Appendix II - Laminar Flow Systems
  - *The Air*
  - *The Filter*
  - *The Fan*
  - *Laminar Flow Designs*
- Appendix III - The Effect of Bacteria and Other Microorganisms on Fruiting
- Appendix IV - The Use of Mushroom Extracts to Induce Fruiting
- Appendix V - Data Collection and Environmental Monitoring Records
  - *Spawn Making*
  - *Compost Making: Phase I*
  - *Compost Making: Phase II*
  - *Spawn Running*
  - *Casing: Case Running*
  - *Pinhead Initiation*
  - *Cropping*
  - *Flushing Pattern*
- Appendix VI - Analyses of Basic Materials Used in Substrate Preparation
  - *Dry Roughages of Fibrous Materials*

Concentrates
Appendix VII - Resources For Mushroom Growing Equipment and Supplies
Appendix VIII - English to Metric Conversion Tables
PHOTOGRAPHY AND ILLUSTRATION CREDITS
ACKNOWLEDGEMENTS
GLOSSARY
BIBLIOGRAPHY

FOREWORD by Dr. Andrew Weil

Ever since French growers pioneered the cultivation of the common Agaricus more than two hundred years ago, mushroom cultivation in the Western world has been a mysterious art. Professional cultivators, fearful of competition, have guarded their techniques as trade secrets, sharing them only with closest associates, never with amateurs. The difficulty of domesticating mushrooms adds to the mystery: they are just harder to grow than flowering plants. Some species refuse to grow at all under artificial conditions; many more refuse to fruit; and even the familiar Agaricus of supermarkets demands a level of care and attention to detail much beyond the scope of ordinary gardening and agriculture.

In the past ten years, interest in mushrooms has literally mushroomed in America. For the first time in history the English-speaking world is flooded with good field guides to the higher fungi, and significant numbers of people are learning to collect and eat choice wild species. In the United States and Canada mushroom conferences and forays attract more and more participants. Cultivated forms of species other than the common Agaricus have begun to appear in specialty shops and even supermarkets.

The reasons for this dramatic change in a traditionally mycophobic part of the world may never be known. I have been fascinated with mushrooms as symbols of the unconscious mind and think their growing popularity here is a hopeful sign of progress in the revolution of consciousness that began in the 1960s. A more specific reason may be the rediscovery of psychedelic mushrooms - the Psilocybes and their allies - which have thoroughly invaded American society in recent years.

The possibility of collecting wild psychoactive mushrooms in many parts of North America has motivated thousands of people to buy field guides and attend mushroom conferences. The possibility of growing *Psilocybe cubensis* at home, one of the easier species to cultivate, has made many people eager to learn the art of mushroom production. As they pursue their hobby, fans of Psilocybes often find their interest in mushrooms broadening to include other genera that boast non-psychoactive but delicious edible species. Other mycophiles, uninterested in altered states of consciousness, have grown so fond of some edible species as to want better access to them than foraying in the wild provides. The result has been a demand from a variety of amateurs for the trade secrets of professional cultivators.

The book you are about to read is a milestone in the new awareness of mushrooms. THE MUSHROOM CULTIVATOR by Paul Stamets and Jeff Chilton is easily the best source of information on growing mushrooms at home. Both authors are experts on the higher fungi, on their technical aspects as well as the practical methods of working with the most interesting species. Paul Stamets is a recognized authority on the Psilocybes and their relatives; Jeff Chilton has been a professional consultant to large-scale, commercial producers of the common Agaricus and the once-exotic shiitake of Japan and China. Together they have organized a number of successful mushroom conferences in the Pacific Northwest and have championed the cause of growing at home. Unlike experts of the past (and some of the present), they are willing and ready to share their knowledge and practical information with all lovers of mushrooms, whether they are amateurs or professionals, devotees of *Psilocybe* or of *Pleurotus*.

THE MUSHROOM CULTIVATOR is indeed "A Practical Guide to Growing Mushrooms at Home," as its subtitle indicates. It covers every aspect of the subject in a readable style and in sufficient detail to enable both rank amateurs and serious mycologists to succeed at growing the mushrooms they like. By including a wealth of excellent illustrations, information on obtaining equipment and supplies, and step-by-step directions for every procedure, from starting spore cultures to harvesting fruiting bodies to dealing with contaminants and pests, the authors demystify the art of mushroom cultivation and put mastery of it within everyone's reach. It is a pleasure to introduce this fine book. If you have been searching for information on this topic, you will find it to be all that you have been looking for and more.

Andrew Weil, M.D., F.L.S

PREFACE

The use of mushrooms as food crosses all cultural boundaries. Highly prized by the Greeks, mushroom consumption in European nations has deep traditional roots. The Agari, a pre-Scythian people from Samartia (now Poland and the western Soviet Union), held mushrooms in high esteem and used them medicinally. The early Greeks held a similar fascination for fungi and apparently worked them into their religious rituals, even to the extent that to discuss the use of these sacraments violated strong taboos. For thousands of years, the Chinese and Japanese have prized a variety of mushroom species for their beneficial properties. In the New World, the Aztec and Mazatec Indians of Mexico used mushrooms for both their healing and divining properties. Clearly, mushrooms have played a significant role in the course of human cultures worldwide.

Although the Japanese have cultivated the Shiitake mushroom for two thousand years, the earliest record of European mushroom cultivation was in the 17th century when an agronomist to Louis XIV, Olivier de Serres, retrieved wild specimens and implanted mushroom mycelium in prepared substrates. In those times mushroom growing was a small scale outdoor activity practiced by the rural populace. Materials in which mushrooms grew naturally were collected and concentrated into prepared beds. These beds were cropped and then used to start new beds. As demand increased and new methods improved yields, mushroom growing developed into a large scale commercial business complete with computer controlled indoor environments and scientifically formulated substrates. Spawn with which to plant prepared beds, initially gathered in nature, became standardized as sterile culture techniques were perfected.

It is now known that many of the mushrooms presently under cultivation rank above all vegetable and legumes (except soybeans) in protein content, and have significant levels of B and C vitamins and are low in fat. Research has shown that certain cultivated mushrooms reduce serum cholesterol, inhibit tumors, stimulate interferon production and possess antiviral properties. It is no surprise, therefore, that as food plants were developed into cultivars, mushrooms were among those selected.

Discovering the methods most successful for mushroom cultivation has been a long and arduous task, evolving from the experience of lifetimes of research. As mushroom growing expanded from the realm of home cultivators to that of a multimillion dollar industry, it is not surprising that growers became more secretive about their methods. For prospective home cultivators, finding appropriate information has become increasingly difficult. As a result, the number of small growers decreased and home cultivation became a rare enterprise.

The Mushroom Cultivator is written expressly for the home cultivator and is without bias against any group of interested growers. For the first time, information previously unavailable to the general public is presented in a clear and easy to understand fashion. The book reflects not only the work of the authors but also the cumulative knowledge gained through countless trials by mushrooms growers and researchers. It is the sincere hope of the authors that this work will re-open the door to the fascinating world of mushroom culture. The Mushroom Cultivator is dedicated to this goal as we pursue the Art and Science of mushroom cultivation.

I. INTRODUCTION TO MUSHROOM CULTURE

Figure 0 - Wall of *Pleurotus ostreatus* fruitbodies.

An Overview of Techniques for Mushroom Cultivation

Techniques for cultivating mushrooms, whatever the species, follow the same basic pattern. Whereas two species may differ in temperature requirements, pH preferences or the substrate on which they grow, the steps leading to fruiting are essentially the same. They can be summarized as follows:

1. Preparation and pouring of agar media into Petri dishes.
2. Germination of spores and isolation of pure mushroom mycelium.
3. Expansion of mycelial mass on agar media.
4. Preparation of grain media.
5. Inoculation of grain media with pure mycelium grown on agar media.
6. Incubation of inoculated grain media (spawn).
7. A. Laying out grain spawn onto trays. Or
   B. Inoculation of grain spawn into bulk substrates.
8. Casing - covering of substrate with a moist mixture of peat and other materials.

9. Initiation - lowering temperature, increasing humidity to 95%, increasing air circulation, decreasing carbon dioxide and/or introducing light.
10. Cropping - maintaining temperature, lowering humidity to 85-92%, maintaining air circulation, carbon dioxide and/or light levels.

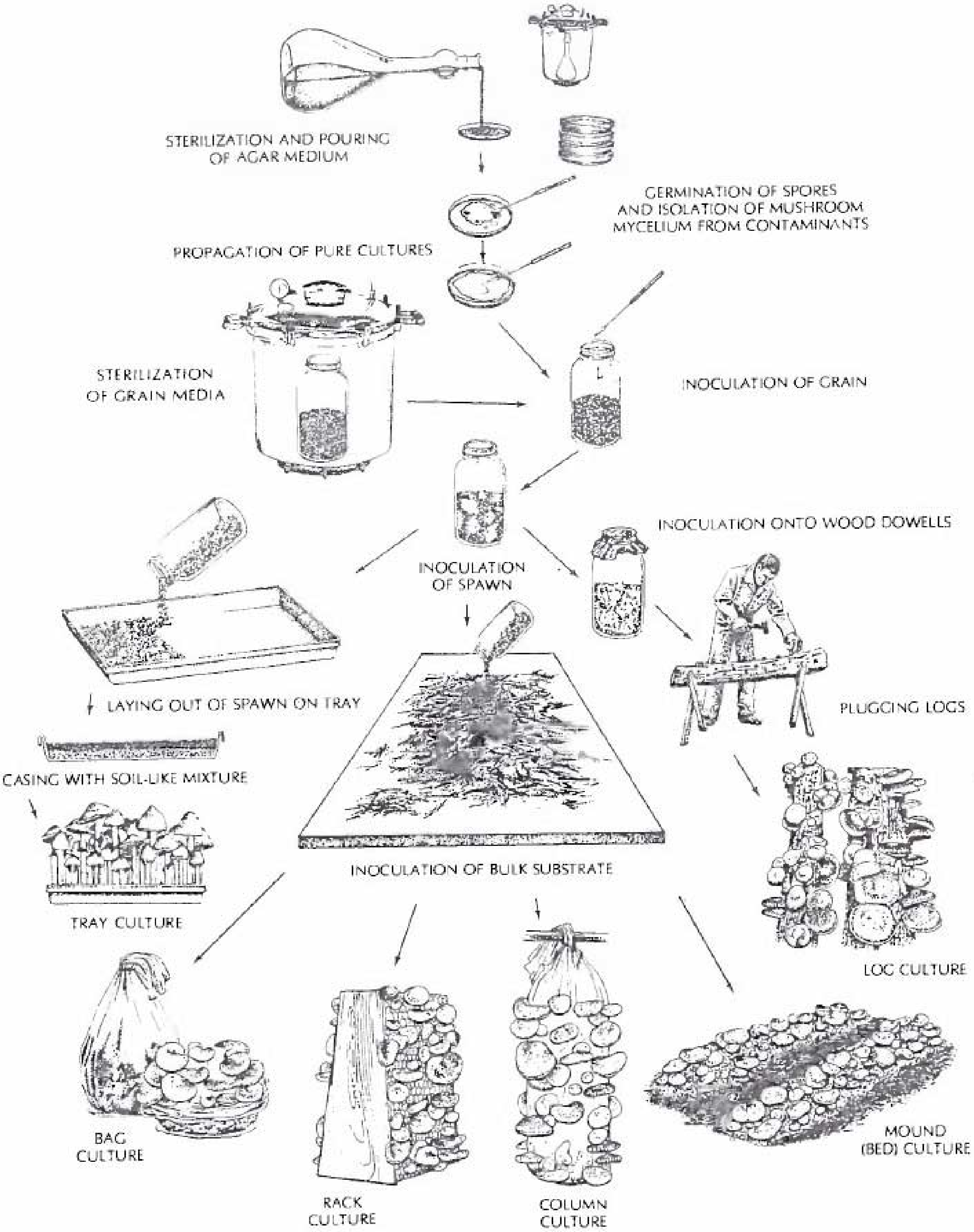

STERILIZATION AND POURING OF AGAR MEDIUM
GERMINATION OF SPORES AND ISOLATION OF MUSHROOM MYCELIUM FROM CONTAMINANTS
PROPAGATION OF PURE CULTURES
STERILIZATION OF GRAIN MEDIA
INOCULATION OF GRAIN
INOCULATION ONTO WOOD DOWELLS
INOCULATION OF SPAWN
LAYING OUT OF SPAWN ON TRAY
PLUGGING LOGS
CASING WITH SOIL-LIKE MIXTURE
TRAY CULTURE
INOCULATION OF BULK SUBSTRATE
LOG CULTURE
BAG CULTURE
MOUND (BED) CULTURE
RACK CULTURE
COLUMN CULTURE

Figure 1 - Diagram illustrating overview of general techniques for the cultivation of mushrooms.

With many species moderate crops can be produced on cased grain cultures. Or, the cultivator can go one step further and inoculate compost, straw or wood. In either case, the fruiting of mushrooms requires a high humidity environment that can be readily controlled. Without proper moisture, mushrooms don't grow.

In the subsequent chapters standard methods for germinating spores are discussed, followed by techniques for growing mycelium on agar, producing grain and/or bran "spawn", preparing composted and non-composted substrates, spawn running, casing and pinhead formation. With this last step the methods for fruiting various species diverge and techniques specific to each mushroom are individually outlined. A trouble-shooting guide helps cultivators identify and solve problems that are commonly encountered. This is followed by a thorough analysis of the contaminants and pests of mushroom culture and a chapter explaining the nature of mushroom genetics. In all, the book is a system of knowledge that integrates the various techniques developed by commercial growers worldwide and makes the cultivation of mushrooms at home a practical endeavor.

Mushrooms and Mushroom Culture

Mushrooms inspire awe in those encountering them. They seem different. Neither plant-like nor animal-like, mushrooms have a texture, appearance and manner of growth all their own. Mushrooms represent a small branch in the evolution of the fungal kingdom Eumycota and are commonly known as the "fleshy fungi". In fact, fungi are non-photosynthetic organisms that evolved from algae. The primary role of fungi in the ecosystem is decomposition, one organism in a succession of microbes that break down dead organic matter. And although tens of thousands of fungi are know, mushrooms constitute only a small fraction, amounting to a few thousand species.

Regardless of the species, several steps are universal to the cultivation of all mushrooms. Not surprisingly, these initial steps directly reflect the life cycle of the mushroom. The role of the cultivator is to isolate a particular mushroom species from the highly competitive natural world and implant it in an environment that gives the mushroom plant a distinct advantage over competing organisms. The three major steps in the growing of mushrooms parallel three phases in their life cycle. They are:

1. Spore collection, spore germination and isolation of mycelium; or tissue cloning.
2. Preparation of inoculum by the expansion of mycelial mass on enriched agar media and then on grain. Implantation of grain spawn into composted and uncomposted substrates or the use of grain as a fruiting substrate.
3. Fruitbody (mushroom) initiation and development.

Having a basic understanding of the mushroom life cycle greatly aids the learning of techniques essential to cultivation.

Mushrooms are the fruit of the mushroom plant, the **mycelium**. A mycelium is a vast network of interconnected cells that permeates the ground and lives perennially. This resident mycelium only produces **fruitbodies**, what are commonly called mushrooms, under optimum conditions of temperature, humidity and nutrition. For the most part, the parent mycelium has but one recourse for insuring the survival of the species: to release enormous numbers of spores. This is accomplished through the generation of mushrooms.

In the life cycle of the mushroom plant, the fruitbody occurs briefly. The mycelial network can sit dormant for months, sometimes years and may only produce a single flush of mushrooms. During those few weeks of fruiting, the mycelium is in a frenzied state of growth, amassing nutrients and forming dense ball-like masses called **primorida** that eventually enlarge into the towering mushroom structure. The gills first develop from the tissue on the underside of the cap, appearing as folds, then becoming blunt ridges and eventually extending into flat, vertically aligned plates. These efficiently arranged symmetrical gills are populated with spore producing cells called **basidia**.

From a structural point of view, the mushroom is an efficient reproductive body. The cap acts as a domed shield protecting the underlying gills from the damaging effects of rain, wind and sun. Covering the gills in many species is a well developed layer of tissue called the **partial veil** which extends from the cap margin to the stem. Spores start falling from the gills just before the partial veil tears. After the partial veil has fallen, spores are projected from the gills in ever increasing numbers. The cap is supported by a pillar-like stem that elevates the gills above ground where the spores can be carried off by the slightest wind currents. Clearly, every part of the mushroom fruitbody is designed to give the spores the best opportunity to mature and spread in an external environment that is often harsh and drastically fluctuating.

As the mushroom matures, spore production slows and eventually stops. At this time mushrooms are in their last hours of life. Soon decay from bacteria and other fungi sets in, reducing the once majestic mushroom into a soggy mass of fetid tissue that melts into the ground from which it sprung.

The Mushroom Life Cycle

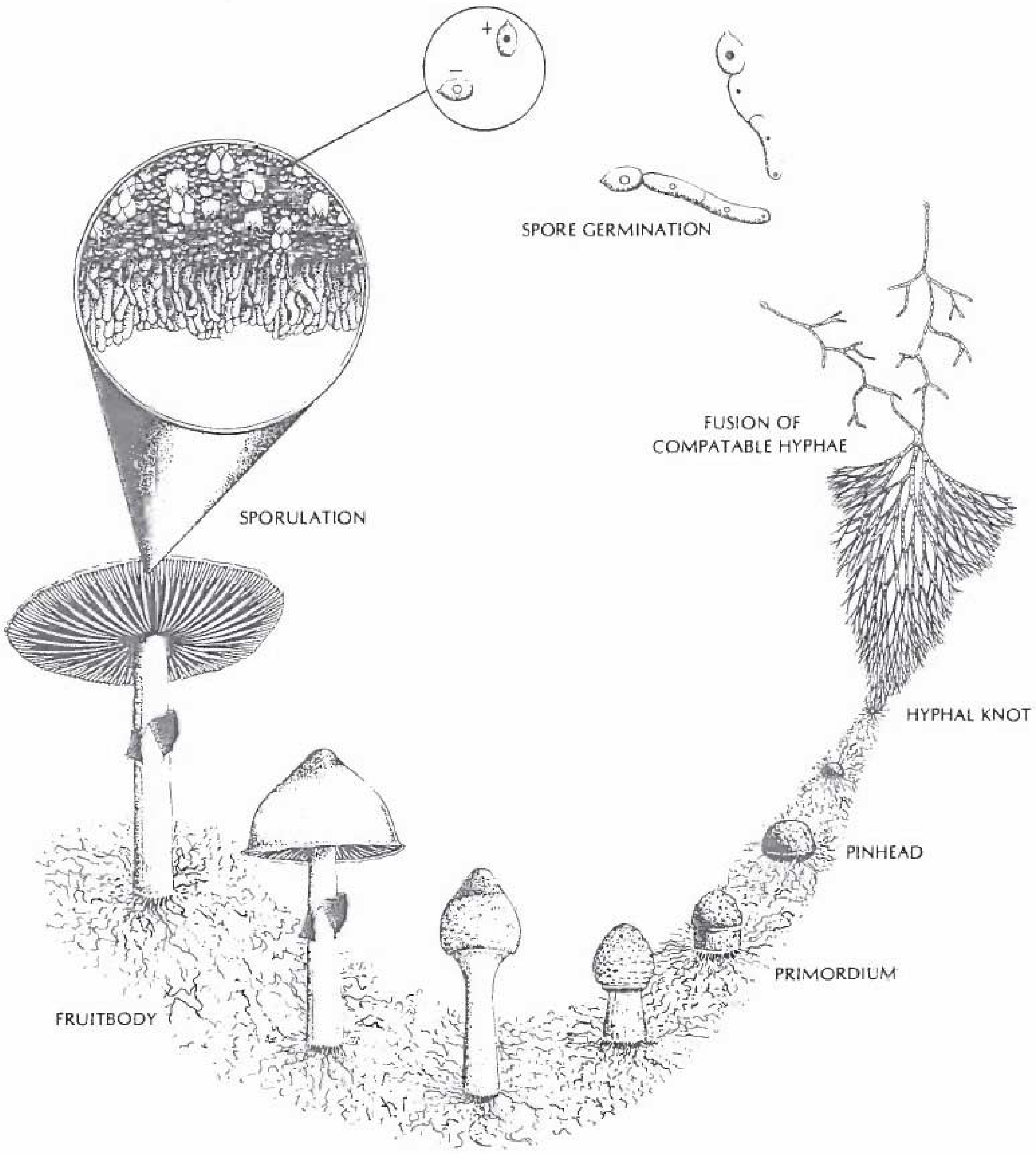

+
–
SPORE GERMINATION
FUSION OF
COMPATABLE HYPHAE
SPORULATION
HYPHAL KNOT
PINHEAD
PRIMORDIUM
FRUITBODY

Figure 2 - The Mushroom Life Cycle.

Cultivating mushrooms is one of the best ways to observe the entirety of the Mushroom Life Cycle. The life cycle first starts with a spore which produces a **primary mycelium**. When the mycelium originating from two spores mates, a **secondary mycelium** is produced. This mycelium continues to grow vegetatively. When vegetative mycelium has matured, its cells are capable of a phenomenal rate of reproduction which culminates in the erection of mushroom fruitbody. This represents the last functional change and it has become, in effect, **tertiary mycelium**. These types of mycelia represent the three major phases in the progression of the mushroom life cycle.

Most mushrooms produce spores that are **uninucleate** and genetically **haploid** (1N). This means each spore contains one nucleus and has half the complement of chromosomes for the species. Thus spores have a "sex" in that each has to mate with mycelia from another spore type to be fertile for producing offspring. When spores are first released they are fully inflated "moist" cells that can easily germinate. Soon they dehydrate, collapsing at their centers and in this phase they can sit dormant through long periods of dry weather or severe drought. When weather conditions provide a sufficiently moist environment, the spores rehydrate and fully inflate. Only then is germination possible.

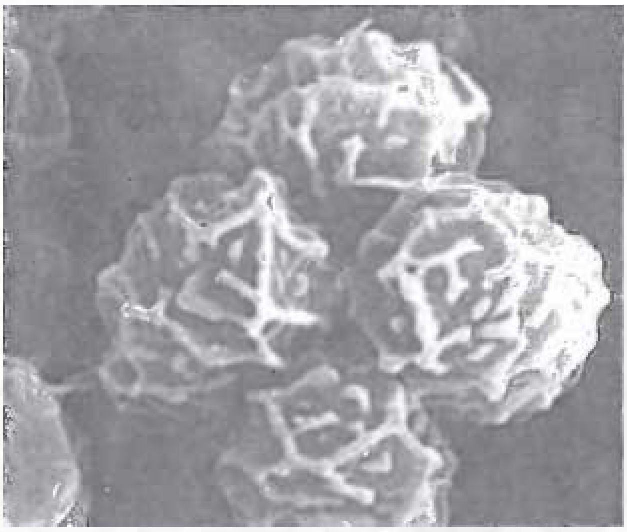


Figure 3 - Scanning electron micrograph of *Russula* spores.

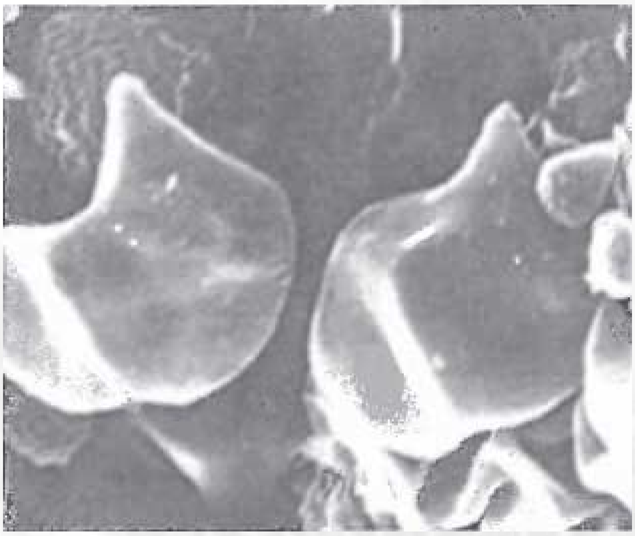


Figure 4 - Scanning electron micrograph of *Entoloma* spores.

Spores within an individual species are fairly constant in their shape and structure. However, many mushroom species differ remarkably in their spore types. Some are smooth and lemon shaped (in the genus *Copelandia*, for instance); many are ellipsoid (as in the genus *Psilocybe*); while others are highly ornamented and irregularly shaped (such as those in *Lactarius* or *Entoloma*). A feature common to the spores of many mushrooms, particularly the psilocybian species, is the formation of an apical **germ pore**.

The germ pore, a circular depression at one end of the spore, is the site of germination from which a haploid strand of mycelium called a **hypha** emanates. This hypha continues to grow, branches and becomes a **mycelial network**. When two sexually complementary hyphal networks intercept one another and make contact, cell walls separating the two hyphal systems dissolve and cytoplasmic and genetic materials are exchanged. Erotic or not, this is "mushroom sex". Hence - forth, all resulting mycelium is **binucleate** and dikaryotic. This means each cell has two nuclei and a full complement of chromosomes. With few exceptions, only mated (dikaryotic) mycelia is fertile and capable of producing fruitbodies. Typically, dikaryotic mycelia is faster running and more vigorous than unmated, monokaryotic mycelia. Once a mycelium has entered into the dikaryophase, fruiting can occur shortly thereafter. In *Psilocybe cubensis*, the time between spore germination and fruitbody initials can be as brief as two weeks; in some *Panaeolus* species only a week transpires before mushrooms appear. Most mushroom species, however, take several weeks or months before mushrooms can be generated from the time of spore germination.

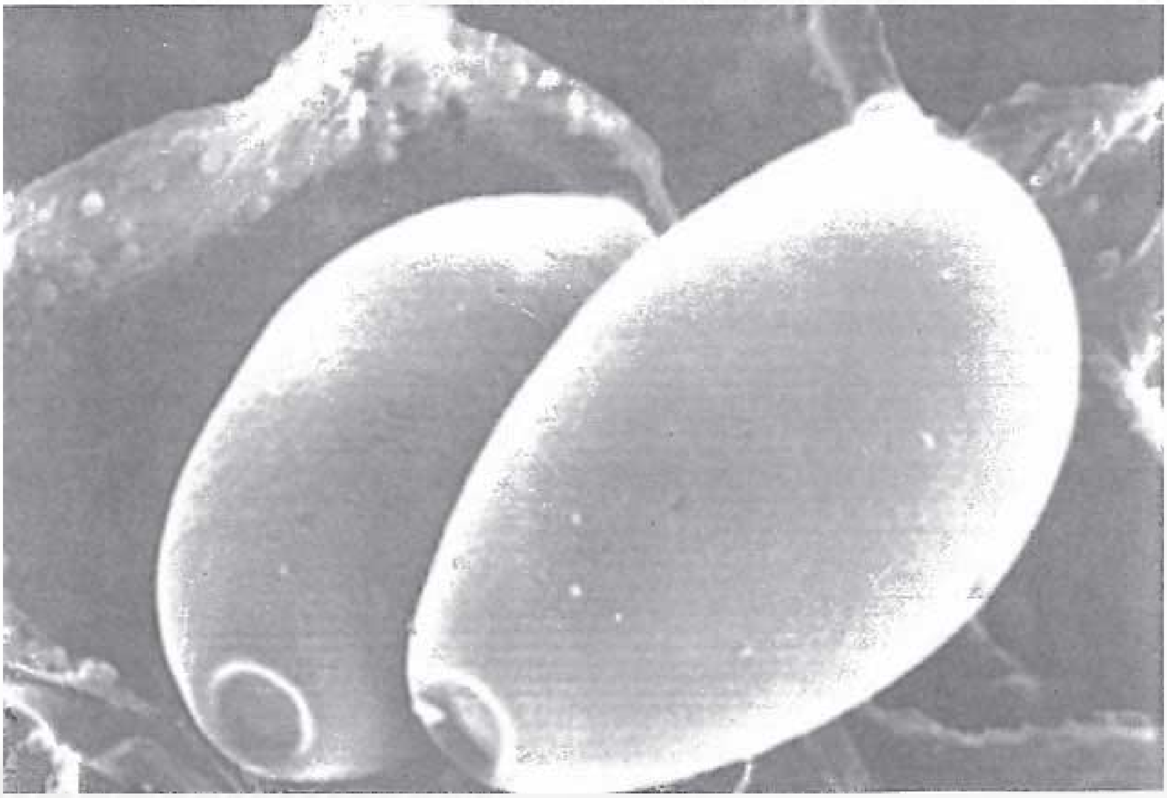


Figure 5 - High resolution scanning electron micrograph showing germ pores of *Psilocybe pelliculosa* spores.

Cultivators interested in developing new strains by crossing single spore isolates take advantage of the occurrence of **clamp connections** to tell whether or not mating has taken place. Clamp connections are microscopic bridges that protrude from one adjoining cell to another and are only found in dikaryotic mycelia. Clamps can be readily seen with a light microscope at 100-400X magnification. Not all species form clamp connections. (*Agaricus brunnescens* does not; most all *Psilocybe* and *Panaeolus* species do). In contrast, mycelia resulting from haploid spores lack clamps. This feature is an invaluable tool for the researcher developing new strains. (For more information on breeding strategies, see Chapter XV.)

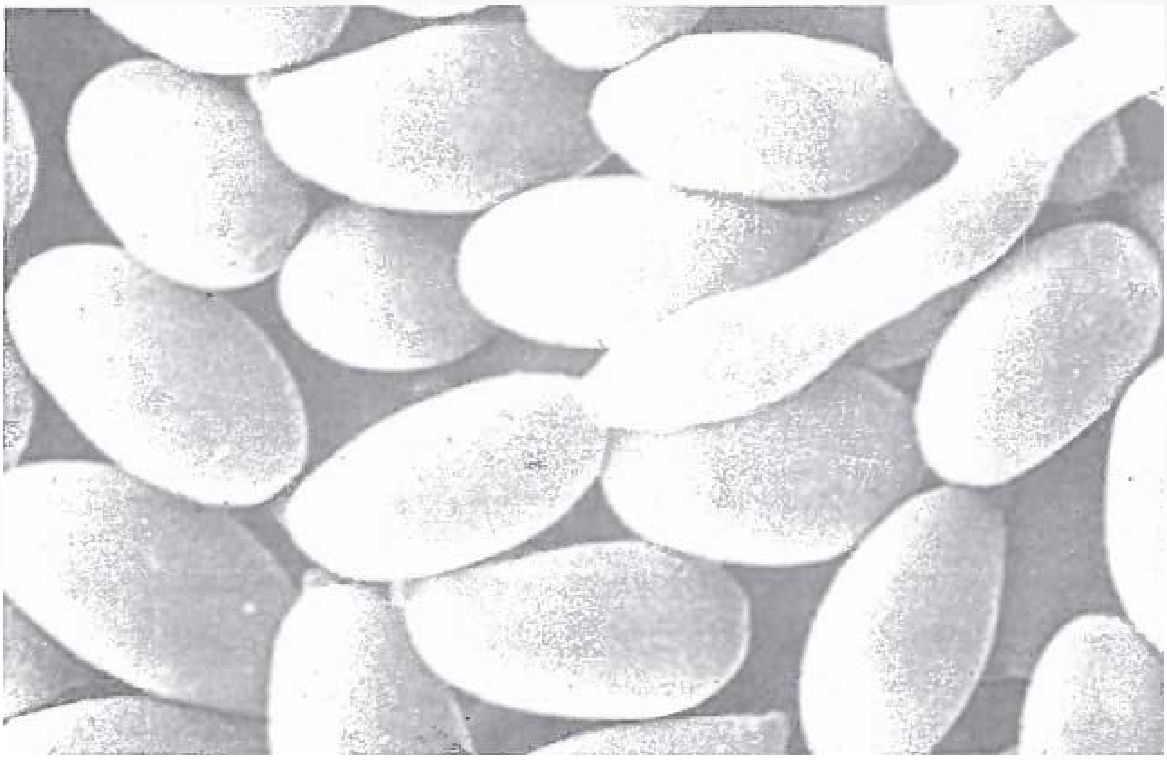


Figure 6 - Scanning electron micrograph of *Psilocybe baeocystis* spore germinating.

Two dikaryotic mycelial networks can also grow together, exchange genetic material and form a new strain. Such an encounter, where two hyphal systems fuse, is known as **anastomosis**. When two incompatible colonies of mycelia meet, a zone of inhibited growth frequently forms. On agar media, this zone of incompatibility is visible to the unaided eye.

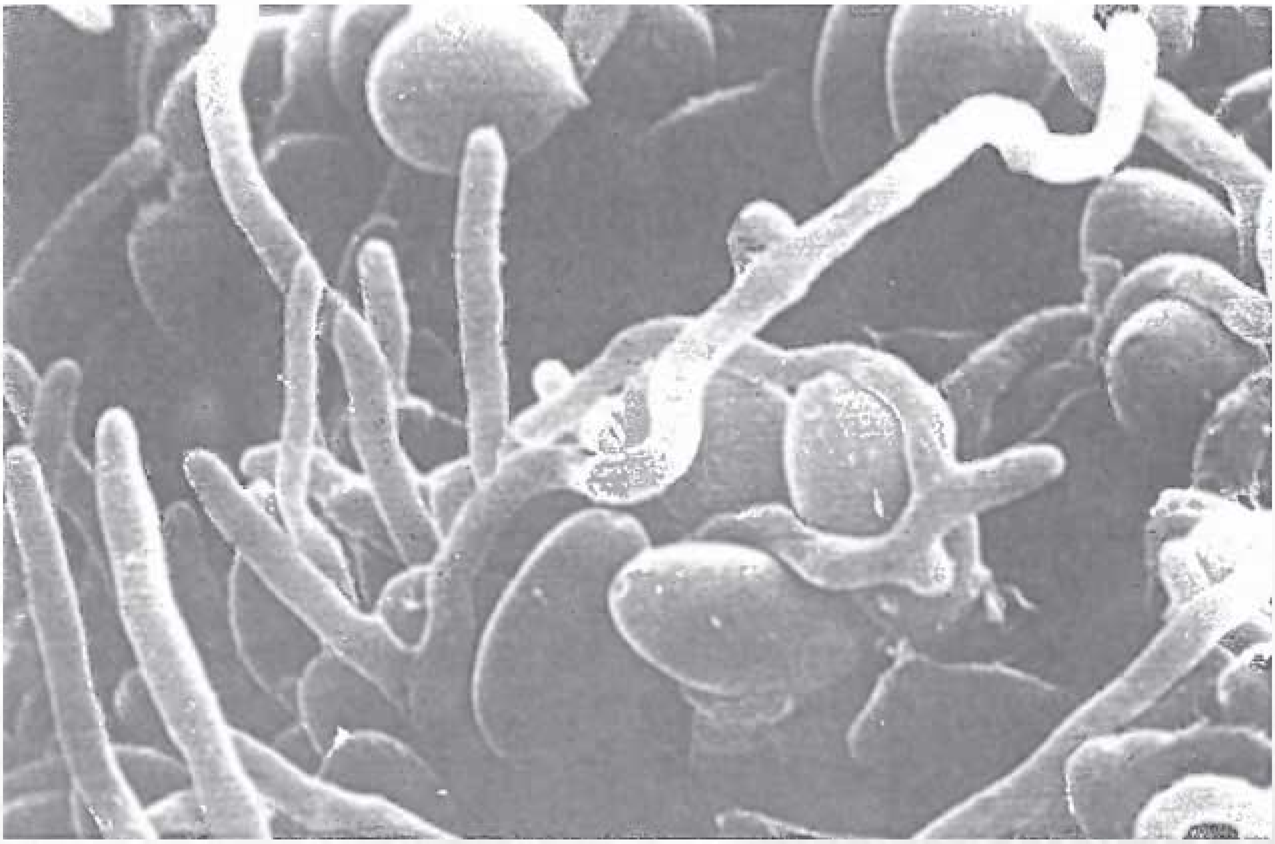


Figure 7 - Scanning electron micrograph of hyphae emanating from a bed of germinating *Psilocybe cubensis* spores.

When a mycelium produces mushrooms, several radical changes in its metabolism occurs. Up to this point, the mycelium has been growing vegetatively. In the vegetative state, hyphal cells are amassing nutrients. Curiously, there is a gradual increase in the number of nuclei per cell, sometimes to as many as ten just prior to the formation of mushrooms. Immediately before fruitbodies form, new cell walls divide the nuclei, reducing their number per cell to an average of two. The high number of nuclei per cell in pre-generative mycelia seems to be a prerequisite for fruiting in many mushroom species.

As the gills mature, basidia cells emerge in ever increasing numbers, first appearing as small bubble-like cells and resembling cobblestones on a street. The basidia are the focal point in the reproductive phase of the mushroom life cycle. The basidia, however, do not mature all at once. In the genus *Panaeolus* for instance, the basidia cells mature regionally, giving the gill surface a spotted look. The cells giving rise to the basidia are typically binucleate, each nucleus is haploid (1N) and the cell is said to be dikaryotic. The composition of the young basidia cells are similar. At a specific point in time, the two nuclei in the basidium migrate towards one another and merge into a single **diploid** (2N) nucleus. This event is known as **karyogamy**. Soon thereafter, the diploid nucleus undergoes meiosis and typically produces four haploid daughter cells.

On the surface of the basidia, arm-like projections called **sterigmatae** arise through which these nuclei then migrate. In most species four spores form at the tips of these projections. The spores continue to develop until they are forcefully liberated from the basidia and propelled into free space. The mechanism for spore release has not yet been proven. But, the model most widely accepted within the mycological community is one where a "gas bubble" forms at the junction of the spore and the sterigmata. This gas bubble inflates, violently explodes and jettisons the spore into the cavity between the gills where it is taken away by air currents. Most commonly, sets of opposing spores are released in this manner. With spore release, the life cycle is completed.

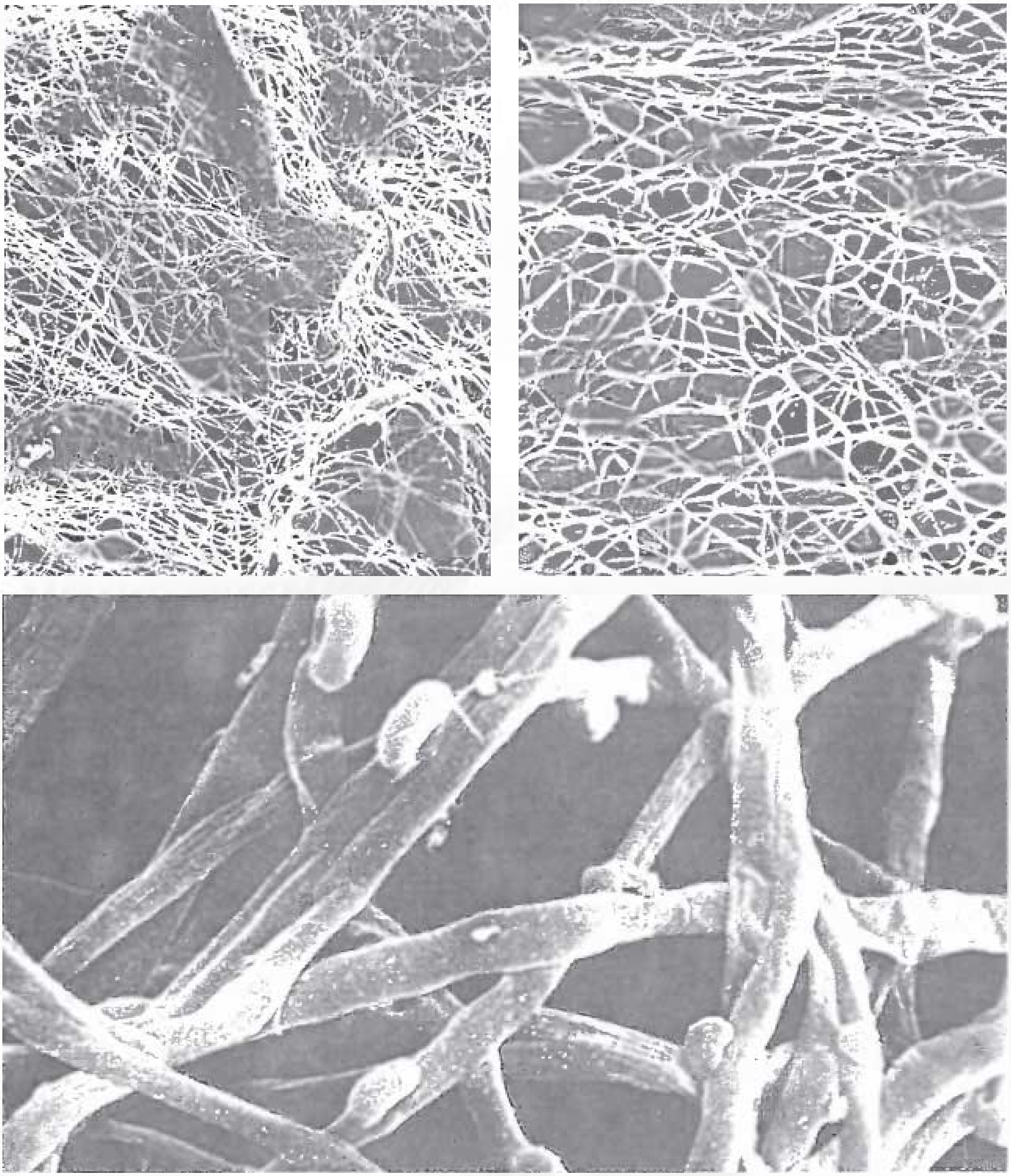


Figure 8, 9, & 10 - Scanning electron micrographs of the mycelial network of *Psilocybe cubensis*. Note hyphal crossings and clamp connections.

Not all mushroom species have basidia that produce four haploid spores. *Agaricus brunnescens* (= *Agaricus bisporus*), the common button mushroom, has basidia with two diploid (2N) spores. This means each spore can evolve into a mycelium that is fully capable of producing mushrooms. *Agaricus brunnescens* is one example of a diploid bipolar species. Some Copelandian Panaeoli (the strongly bluing species in the genus *Panaeolus*) are two spored and have mating properties similar to *Agaricus brunnescens*. Other mushroom species have exclusively three spored basidia; some have five spored basidia; and a few, like the common Chantarelle, have as many as eight spores per basidium!

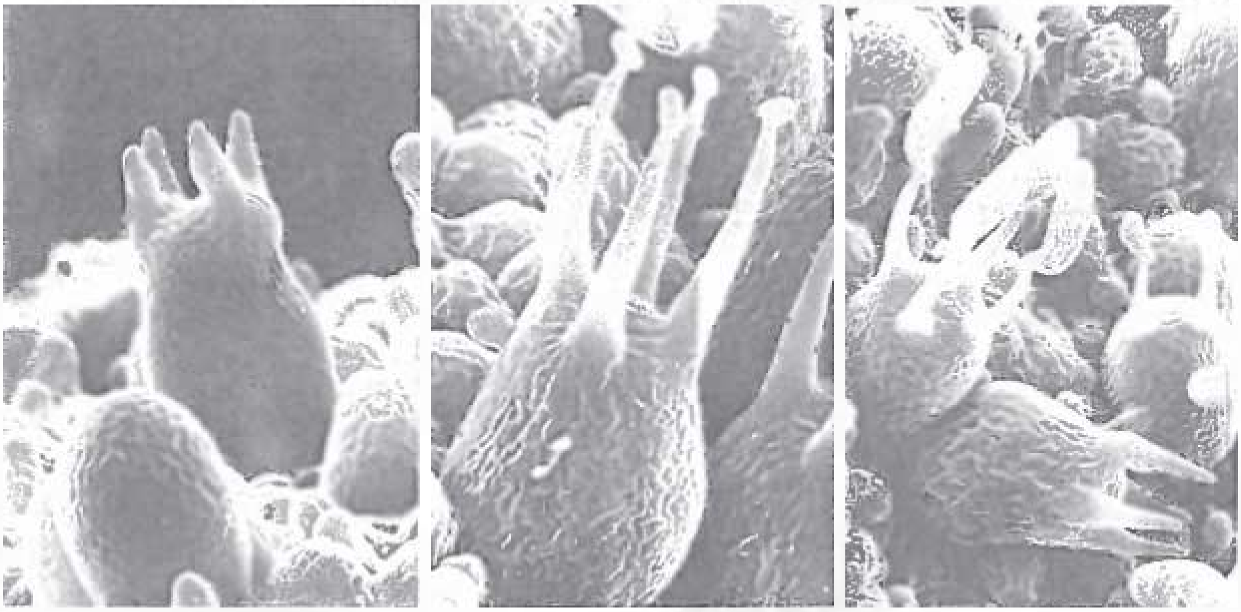


Figure 11, 12 & 13 - Scanning electron micrographs showing the development of the basidium and spores in *Ramaria iongispora*, a coral fungus.

An awareness of the life cycle will greatly aid beginning cultivators in their initial attempts to cultivate mushrooms. Once a basic understanding of mushroom culture and the life processes of these organisms is achieved, cultivators can progress to more advanced subjects like genetics, strain selection and breeding. This wholistic approach increases the depth of one's understanding and facilitates development of innovative approaches to mushroom cultivation.

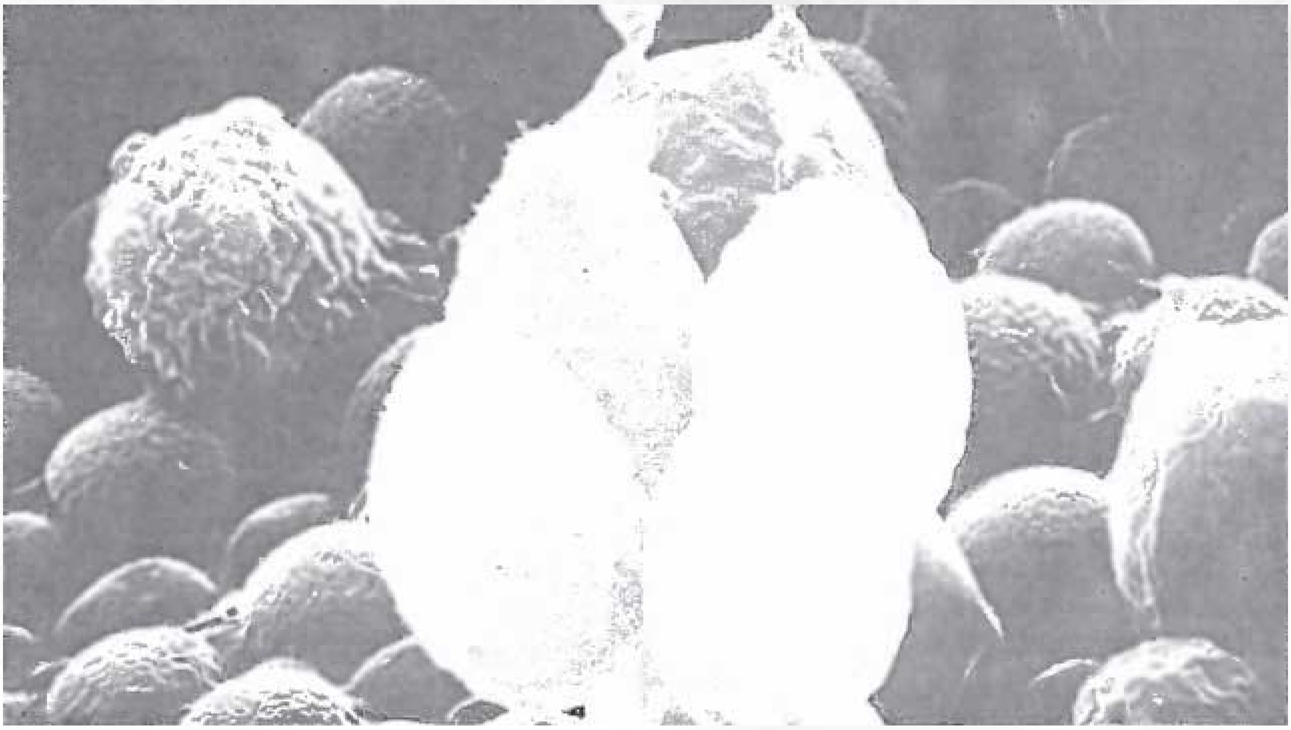


Figure 14 - Scanning electron micrograph of mature basidium in *Panaeolus foenisecii*.

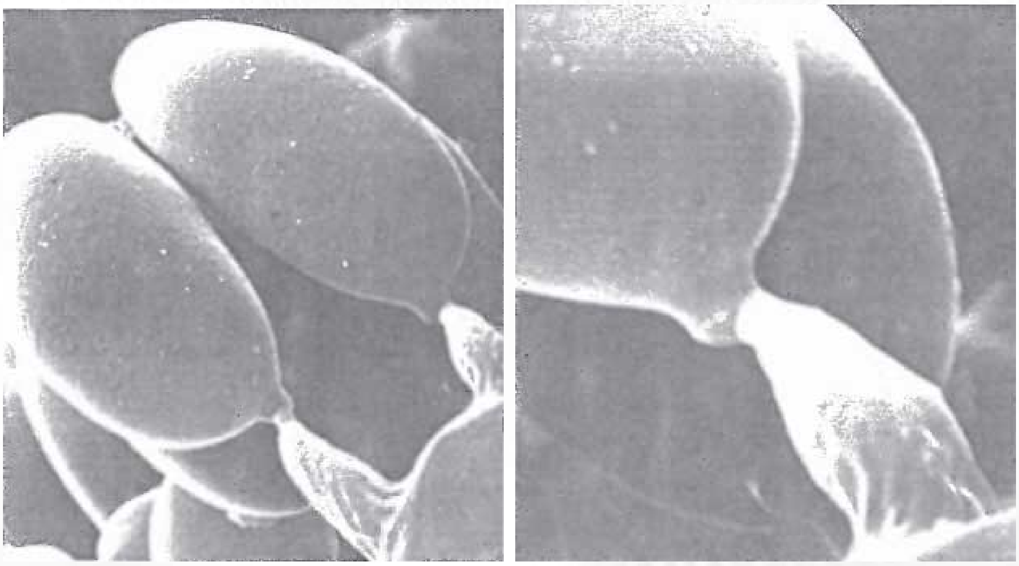


Figure 15a, 15b - Scanning electron micrographs showing basidium of *Psilocybe pelliculosa*. Note spore/sterigmata junction.

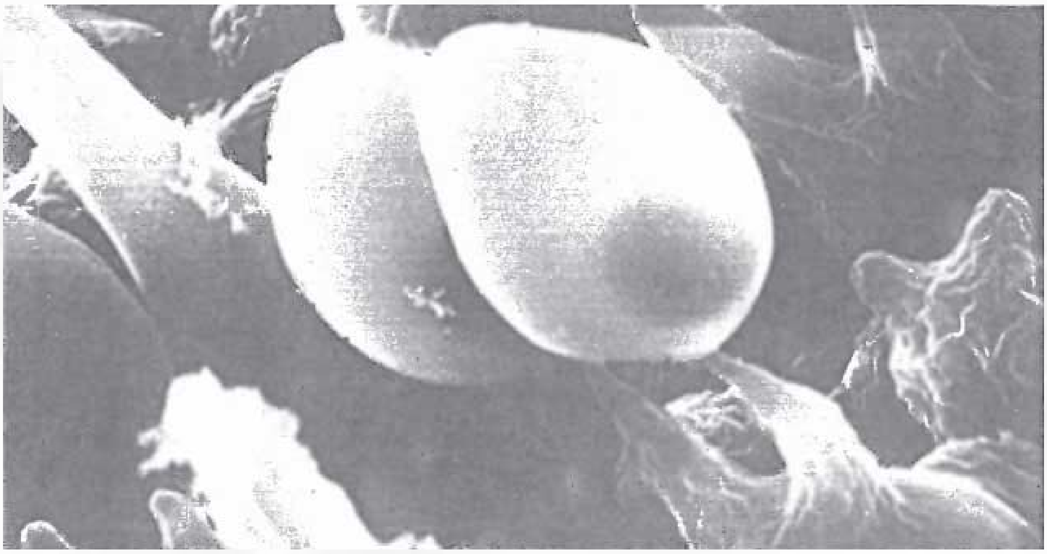


Figure 16 - Scanning electron micrograph of two spored basidium of an as yet unpublished species closely related to *Copelandia cyanescens*. Note "shadow" nuclei visible within each spore.

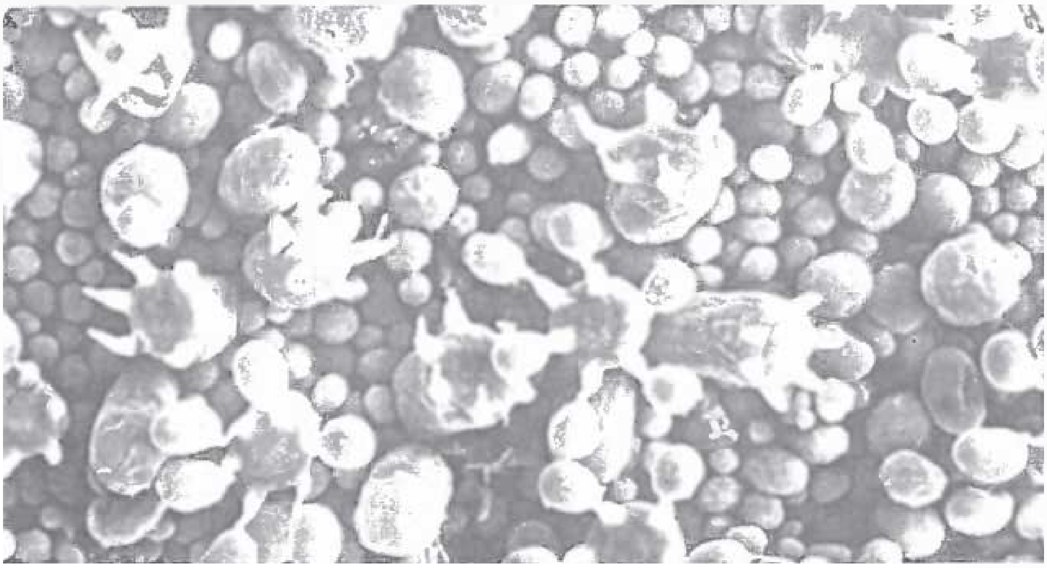
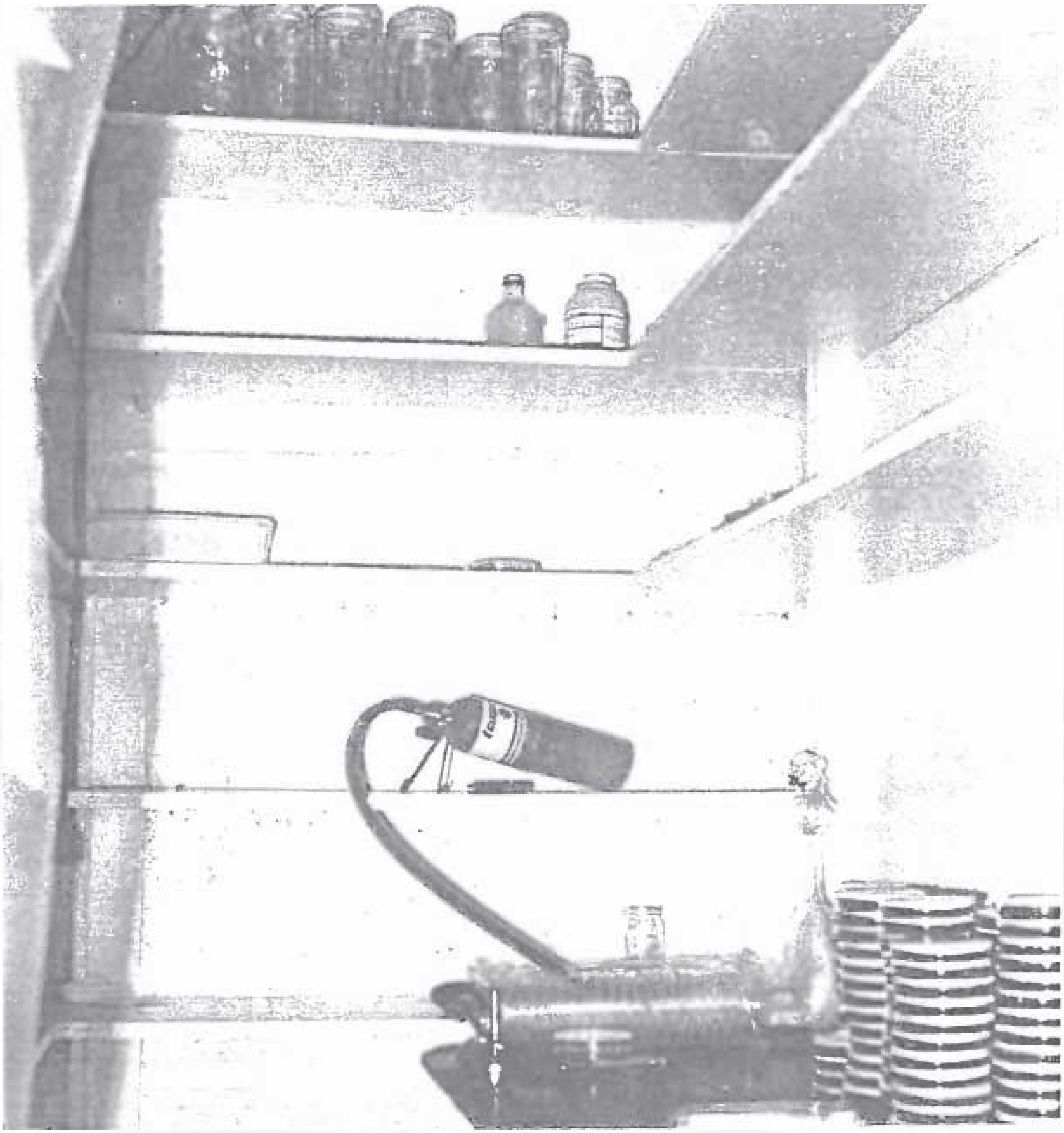


Figure 17 - Scanning electron micrograph of the gill surface of *Cantharellus cibarius*. Note six and eight spored basidia.

II. STERILE TECHNIQUE AND AGAR CULTURE



Fiqure 18 - A home cultivator's pantry converted into a sterile laboratory.

The air we breathe is a living sea of microscopic organisms that ebbs and flows with the slightest wind currents. Fungi, bacteria, viruses and plants use the atmosphere to carry their offspring to new environments. These microscopic particles can make sterile technique difficult unless proper precautions are taken. If one can eliminate or reduce the movement of these organisms in the air, however, success in sterile technique is assured.

There are five primary sources of contamination in mushroom culture work:

1. The immediate external environment
2. The culture medium
3. The culturing equipment
4. The cultivator and his or her clothes
5. The mushroom spores or the mycelium

Mushrooms - and all living organisms - are in constant competition for available nutrients. In creating a sterile environment, the cultivator seeks to give advantage to the mushroom over the myriad legions of other competitors. Before culture work can begin, the first step is the construction of an inoculation chamber or sterile laboratory.

Design and Construction of a Sterile Laboratory

The majority of cultivators fail because they do not take the time to construct a laboratory for sterile work. An afternoon's work is usually all that is required to convert a walk-in closet, a pantry or a small storage room into a workable inoculation chamber.

Begin by removing all rugs, curtains and other cloth-like material that can harbor dust and spores. Thoroughly clean the floors, walls and ceiling with a mild disinfectant. Painting the room with a high gloss white enamel will make future cleaning easier. Cover windows or any other sources of potential air leaks with plastic sheeting. On either side of the room's entrance, using plastic sheeting or other materials, construct an antechamber which serves as an airlock. This acts as a protective buffer between the laboratory and the outside environment. The chamber should be designed so that the sterile room door is closed while the anteroom is entered. Equip the lab with these items:

1. a chair and a sturdy table with a smooth surface.
2. a propane torch, an alcohol lamp, a bunsen burner or a butane lighter.
3. a clearly marked spray bottle containing a 10% bleach solution.
4. sterile Petri dishes and test tube "slants".
5. stick-on labels, notebook, ballpoint pen and a permanent marking pen.
6. an agar knife and inoculating loop.

All these items should remain in the laboratory. If any equipment is removed, make sure it is absolutely clean before being returned to the room.

A semisterile environment can be established in the laboratory through simple maintenance depending on the frequency of use. The amount of cleaning necessary will be a function of the spore load in the external environment. In winter the number of free spores drastically decreases while in the spring and summer months one sees a remarkable increase. Consequently, more cleaning is necessary during these peak contamination periods. More importantly, all contaminated jars and Petri dishes should be disposed of in a fashion that poses no risk to the sterile lab.

Once the sterile work room has been constructed, follow a strict and unwavering regimen of hygiene. The room should be cleaned with a disinfectant, the floors mopped and lastly the room's air washed with a fine mist of 10% bleach solution. After spraying, the laboratory should not be reentered for a minimum of 15 minutes until the suspended particles have settled. A regimen of cleaning MUST precede every set of inoculations. As a rule, contamination is easier to prevent than to eliminate after it occurs.

Before going further, a few words of caution are required. Sterile work demands concentration, attention to detail and a steady hand. Work for reasonable periods of time and not to the point of exhaustion. Never leave a lit alcohol lamp or butane torch unattended and be conscious of the fact that in an airtight space oxygen can soon be depleted.

Some cultivators wage war on contamination to an unhealthy and unnecessary extreme. They tend to "overkill" their laboratory with toxic fungicides and bacteriocides, exposing themselves to dangerously mutagenic chemical agents. In one incident a worker entered a room that had just been heavily sprayed with a phenol based germicide. Because of congestion he could not sense the danger and minutes later experienced extreme shortness of breath, numbness of the extremities and convulsions. These symptoms persisted for hours and he did not recover for several days. In yet another instance, a person mounted a short wave ultraviolet light in a glove box and conducted transfers over a period of months with no protection and unaware of the danger. This type of light can cause skin cancer after prolonged exposure. Other alternatives, posing little or no health hazard, can just as effectively eliminate contaminants, sometimes more so.

If despite one's best efforts a high contamination rate persists, several additional measures can be implemented. The first is inexpensive and simple, utilizing a colloidal suspension of light oil into the laboratory's atmosphere; the second involves the construction of a still air chamber called a glove box; and the third is moderately expensive, employing high efficiency micron filters.

1. By asperating sterile oil, a cloud of highly viscous droplets is created. As the droplets descend they trap airborne contaminant particles. This technique uses triethylene glycol that is vaporized through a heated wick. Finer and more volatile than mineral oil, triethylene glycol leaves little or no noticable film layer. However a daily schedule of hygiene maintenance is still recommended. (A German Firm sells a product called an "aero-disinfector" that utilizes the low boiling point of tri-ethylene glycol. For information write: Chemische Fabrik Bruno Vogelmann & Co., Postfach 440, 718 Crailsheim, West Germany. The unit sells for less than $50.00).
2. A glovebox is an airtight chamber that provides a semisterile still air environment in which to conduct transfers. Typically, it is constructed of wood, with a sneeze window for viewing and is sometimes equipped with rubber gloves into which the cultivator inserts his hands. Often, in place of gloves, the front face is covered with a removable cotton cloth that is periodically sterilized. The main advantage of a glove box is that it provides an inexpensive, easily cleaned area where culture work can take place with little or no air movement.
3. Modern laboratories solve the problem of airborne contamination by installing High Efficiency Particulate Air (HEPA) filters. These filters screen out all particulates exceeding 0.1 - 0.3 microns in diameter, smaller than the spores of all fungi and practically all bacteria. HEPA filters are built into what is commonly known as a laminar flow hood. Some sterile laboratories have an entire wall or ceiling constructed of HEPA filters through which pressurized air is forced from the outside. In effect, a positive pressure, sterile environment is created. Specific data regarding the building and design of laminar flow systems is discussed in greater detail in Appendix IV.

Some cultivators have few problems with contaminants while working in what seems like the most primitive conditions. Others encounter pronounced contamination levels and have to invest in high technology controls. Each circumstance dictates an appropriate couriter-measure. Whether one is a home cultivator or a spawn maker in a commercial laboratory, the problems encountered are similar, differing not in kind, but in degree.

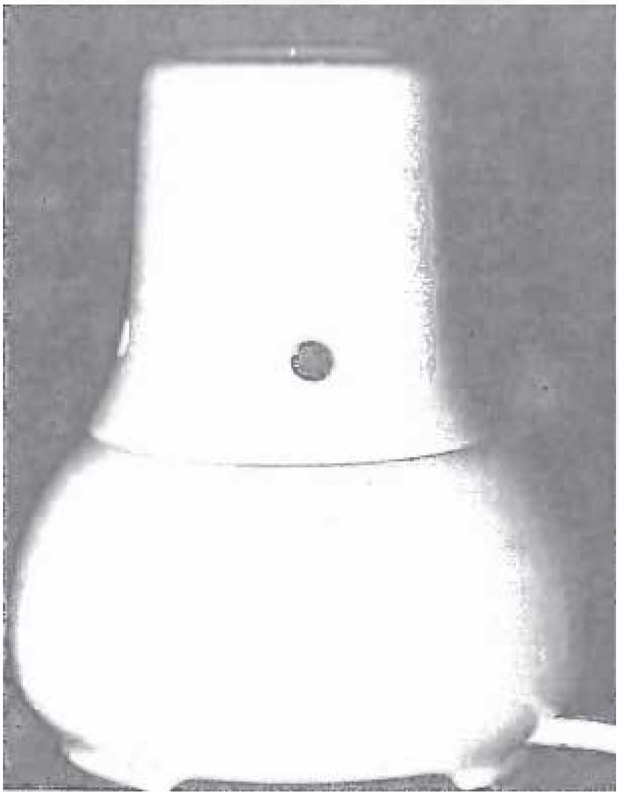


Figure 19 - Aero-disinfector for reducing contaminant spore load in laboratory.

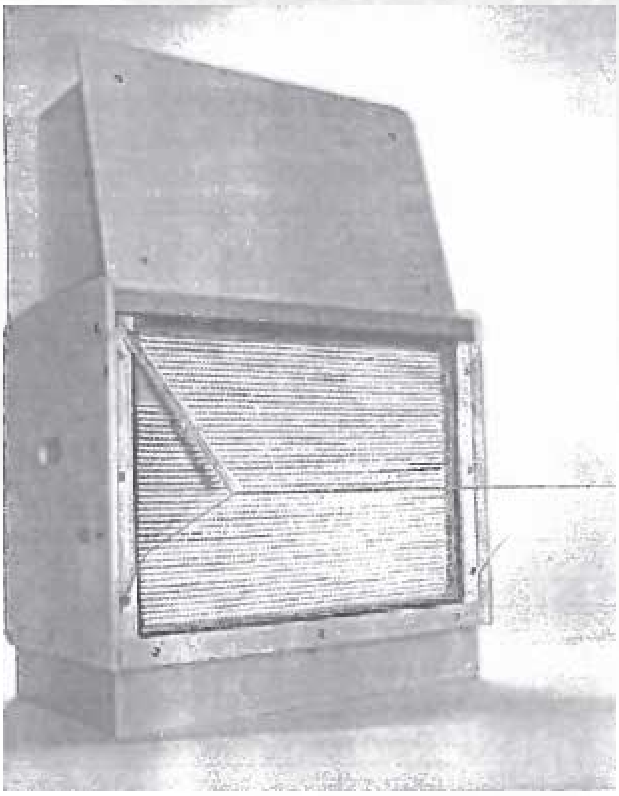


Figure 20 - Laminar flow hood.

Preparation of Agar Media

Once the sterile laboratory is completed, the next step is the preparation of nutrified agar media. Derived from seaweed, agar is a solidifying agent similar to but more effective than gelatin. There are many recipes for producing enriched agar media suitable for mushroom culture. The standard formulas have been Potatoe Dextrose Agar (PDA) and Malt Extract Agar (MEA) to which yeast is often added as a nutritional supplement. Many of the mycological journals list agar media containing peptone or neopeptone, two easily accessed sources of protein for mushroom mycelium. Another type of agar media that the authors recommend is a broth made from boiling wheat or rye kernels which is then supplemented with malt sugar.

If a high rate of contamination from bacteria is experienced, the addition of antibiotics to the culture media will prevent their growth. Most antibiotics, like streptomycin, are not autoclavable and must be added to the agar media after sterilization while it is still molten. One antibiotic, gentamycin sulfate, survives autoclaving and is effective against a broad range of bacteria. Antibiotics should be used sparingly and only as a temporary control until the sources of bacteria can be eliminated. The mycelia of some mushroom species are adversely affected by antibiotics.

Dozens of enriched agar media have been used successfully in the cultivation of fungi and every cultivator develops distinct preferences based on experience. Regardless of the type of agar medium employed, a major consideration is its pH, a logarithmic scale denoting the level of acidity or alkalinity in a range from 0 (highly acidic) to 14 (highly basic) with 7 being neutral. Species of *Psilocybe* thrive in media balanced between 6.0-7.0 whereas *Agaricus brunnescens* and allies grow better in near neutral media. Most mycelia are fairly tolerant and grow well in the 5.5-7.5 pH range. One needs to be concerned with exact pH levels only if spores fail to germinate or if mycelial growth is unusually slow.

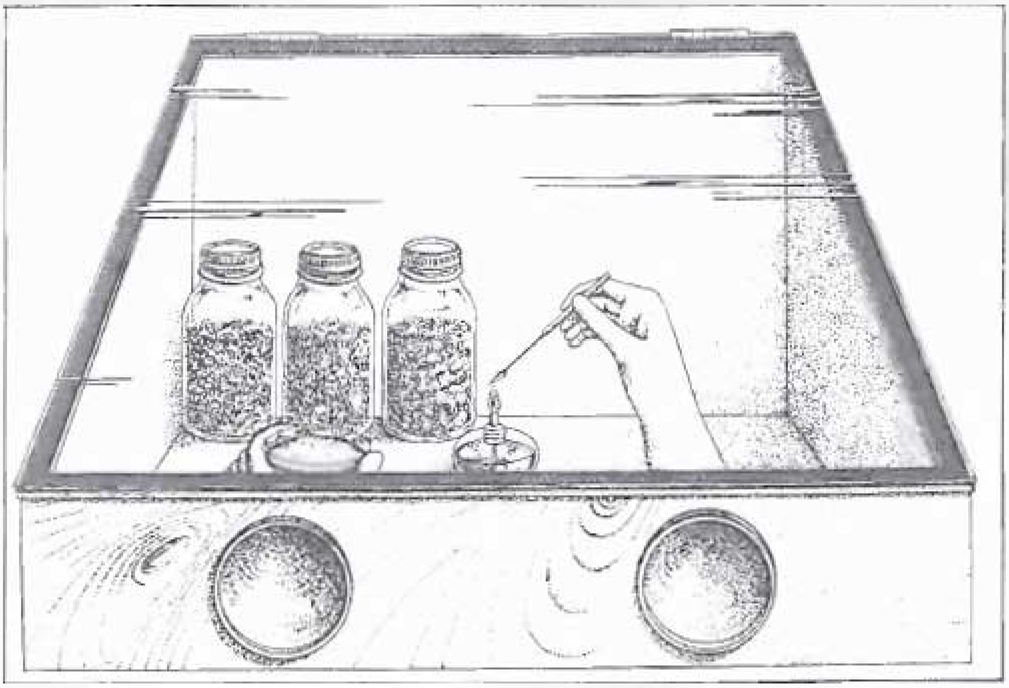


Figure 21 - Standard glove box.

What follows are several formulas for the preparation of nutritionally balanced enriched agar media, any one of which is highly suited for the growth of *Agaricus, Pleurotus, Lentinus, Stropharia, Lepista, Flammulina, Volvariella, Panaeolus* and *Psilocybe* mycelia. Of these the authors have two preferences: PDY (Potatoe Dextrose Yeast) and MPG (Malt Peptone Grain) agar media. The addition of ground rye grain or grain extract to whatever media is chosen clearly promotes the growth of strandy mycelium, the kind that is generally preferred for its fast growth.

Choose one formula, mix the ingredients in dry form, place into a flask and add water until one liter of medium is made.

PDY (Potato Dextrose Yeast) Agar

the filtered, extracted broth from boiling
300 grams of sliced potatoes in 1 liter of water for 1 hour
10 grams dextrose sugar
2 grams yeast (optional)
20 grams agar

MEA (Malt Extract Agar)
20 grams tan malt
2 grams yeast
20 grams agar
(Avoid dark brewer's malts which have become caramelized. The malt that should be used is a light tan brewer's form).

MPG (Malt Peptone Grain) Agar
20 grams tan malt
5 grams ground rye grain
5 grams peptone or neopeptone
2 grams yeast (optional)
20 grams agar

For controlling bacteria, 0.10 grams of 60-80% pure gentamycin sulfate can be added to each liter of media prior to sterilization. (See Resources in Appendix.)

Water quality - its pH and mineral content - varies from region to region. If living in an area of questionable water purity, the use of distilled water is advisable. For all practical purposes, however, tap water can be used without harm to the mushroom mycelium. A time may come when balancing pH is important - especially at spore germination or in the culture of exotic species. The pH of media can be altered by adding a drop at a time of 1 molar concentration of hydrochloric acid (HCL) or sodium hydroxide (NaOH). The medium is thoroughly mixed and then measured using a pH meter or pH papers. (One molar HCL has a pH of 0; one molar NaOH has a pH of 12; and distilled water has a pH of 7).

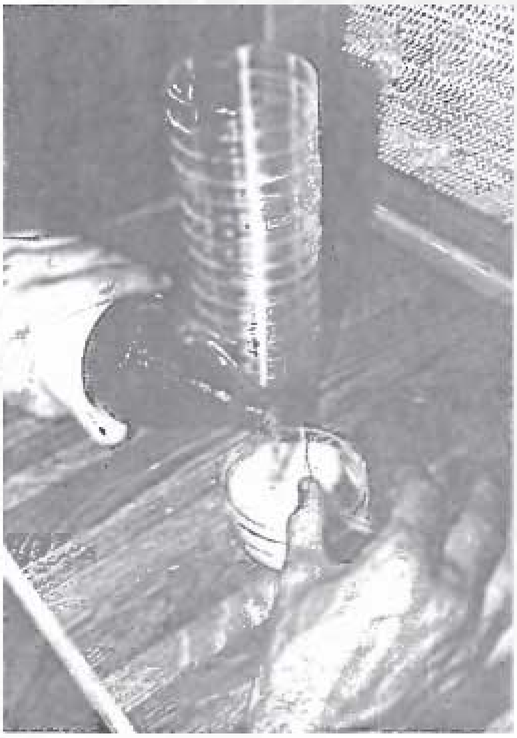
After thoroughly mixing these ingredients, sterilize the medium in a pressure cooker for 30 minutes at 15 psi. (Pressure cookers are a safe and effective means of sterilizing media provided they are operated according to the manufacturer's instructions). A small mouthed vessel is recommended for holding the agar media. If not using a flask specifically manufactured for pouring media, any narrow necked glass bottle will suffice. Be sure to plug its opening with cotton and cover with aluminum foil before inserting into the pressure cooker. The media container should be filled only to ⅔ to ¾ of its capacity.

Place the media filled container into the pressure cooker along with an adequate amount of water for generating steam. (Usually a ½ inch layer of water at the bottom will do). Seal the cooker according to the manufacturer's directions. Place the pressure cooker on a burner and heat until ample steam is being generated. Allow the steam to vent for 4-5 minutes before closing the stop-cock. Slowly bring the pressure up to 15 psi and maintain for ½ hour. Do not let the temperature of the cooker exceed 250°F. or else the sugar in the media will caramelize. Media with caramelized sugar inhibits mycelial growth and promotes genetic mutations. A sterilized pot holder or newly laundered cloth should be handy in the sterile lab to aid in removing the media flask from the pressure cooker. While the media is being sterilized, immaculately clean the laboratory.

The time necessary for sterilization varies at different altitudes. At a constant volume, pressure and temperature directly correspond (a relationship known as Boyle's Law). When a certain pressure (= temperature) is recommended, it is based on a sea level standard. Those cultivating at higher elevations must cook at higher pressures to achieve the same sterilization effect. Here are two abbreviated charts showing the relationships between temperature and pressure and the changes in the boiling point of water at various elevations. Increase the amount of pressure over the recommended amount based on the difference of the boiling point at sea level and one's own altitude. For example, at 5000 feet the difference in the boiling point of water is approximately 10°F. This means that the pressure must be increased to 20 psi, 5 psi above the recommended 15 psi sea level standard, to correspond to a "10°F. increase" in temperature. (Actually temperature remains the same; it is pressure that differs).

Relationship of Pressure and Temperature at Constant Volume		**The Relationship of Altitude to the Boiling Point of Water**	
Pressure (psi)	**°Fahrenheit**	**Altitude**	**Boiling Point(°F.)**
1	212	Sea Level	212
3	220	1,025	210
5	228	2,063	208
10	240	3,115	206
15	250	4,169	204
20	259	5,225	202
25	267	6,304	200
		7,381	197
		8,481	196
		9,031	195

Note that the effect achieved from sterilizing at 60 minutes at 15 psi is the same as that from 30 minutes at 30 psi. Hence a doubling of pressure reduces sterilization time by one half. Most pressure cookers can not be safely operated at this level unless carefully modified according to the manufacturer's recommendations. And some extra time must be allowed for adequate penetration of steam, especially in densely packed, large autoclaves.



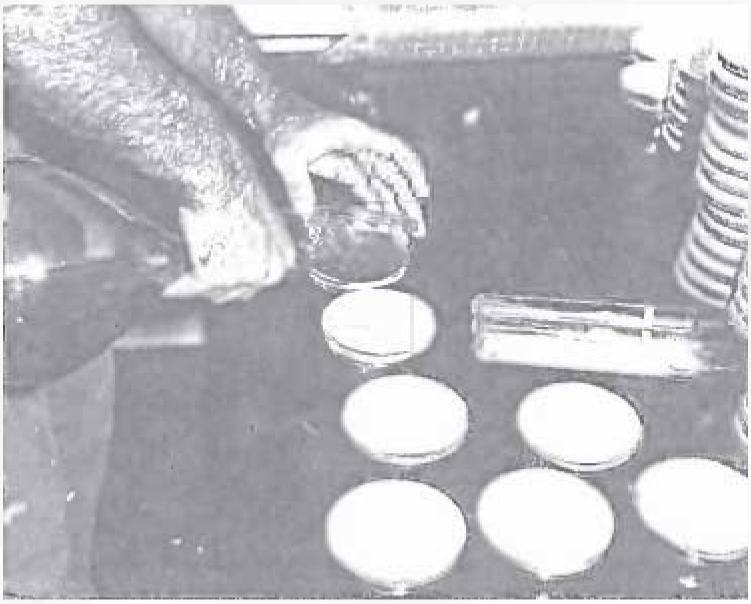


Figure 22 & 23 - Pouring agar media into sterile Petri dishes. At left, vertical stack technique.

Once sterilized, place the cooker in the laboratory or in a semisterile room and allow the pressure to return to 1 psi before opening. One liter of agar media can generously fill thirty 100 x 15 mm. Petri dishes. Techniques for pouring vary with the cultivator. If only one or two sleeves of Petri dishes are being prepared, the plates should be laid out side by side on the working surface. If more than two sleeves are being poured or table space is limited, pouring the sterile Petri dishes in a vertical stack is usually more convenient.

Before pouring, vigorously shake the molten media to evenly distribute its ingredients. Experienced cultivators fill the plates rhythmically and without interruption. Allow the agar media to cool and solidify before using. Condensation often forms on the inside surface of the upper lid of a Petri dish when the agar media being poured is still at a high temperature. To reduce condensation, one can wait a period of time before pouring. If the pressure cooker sits for 45 minutes after reaching 1 psi, a liter of liquid media can be poured with little discomfort to unprotected hands.

Two types of cultures can be obtained from a selected mushroom: one from its spores and the other from living **tissue** of a mushroom. Either type can produce a viable strain of mycelia. Each has advantages and disadvantages.

Starting a Culture from Spores

A mushroom culture can be started in one of two ways. Most growers start a culture from spores. The advantage of using spores is that they are viable for weeks to months after the mushroom has decomposed. The other way of obtaining a culture is to cut a piece of interior tissue from a live specimen, in effect a clone. Tissue cultures must be taken within a day or two from the time the mushroom has been picked, after which a healthy clone becomes increasingly difficult to establish.

Taking a Spore Print

To collect spores, sever the cap from the stem of a fresh, well cleaned mushroom and place it gills down on a piece of clean white paper or a clean glass surface such as a microscope slide. If a specimen is partially dried, add a drop or two of water to the cap surface to aid in the release of spores. To lessen evaporation and disturbance from air currents, place a cup or glass over the mushroom cap. After a few hours, the spores will have fallen according to the radiating symmetry of the gills. If the spore print has been taken on paper, cut it out, fold it in half, seal in an airtight container and label the print with the date, species and collection number. When using microscope slides, the spores can be sandwiched between two pieces of glass and taped along the edges to prevent the entry of contaminant spores. A spore print carelessly taken or stored can easily become contaminated, decreasing the chance of acquiring a pure culture.

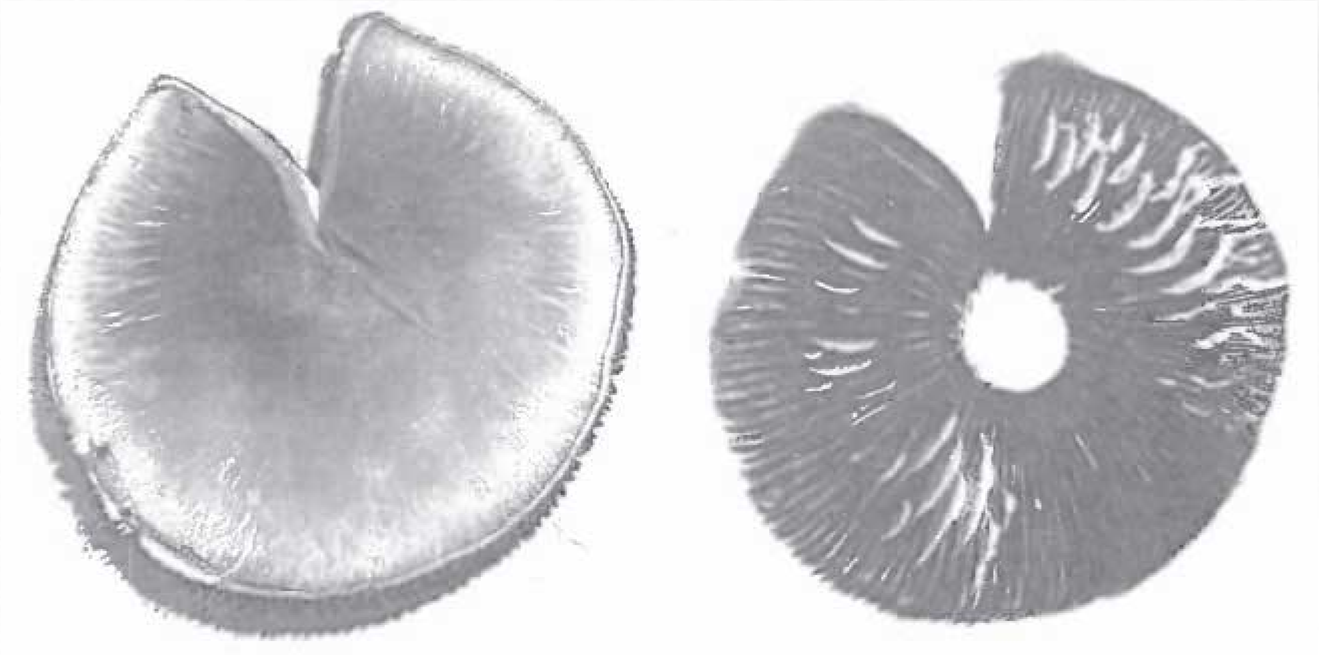
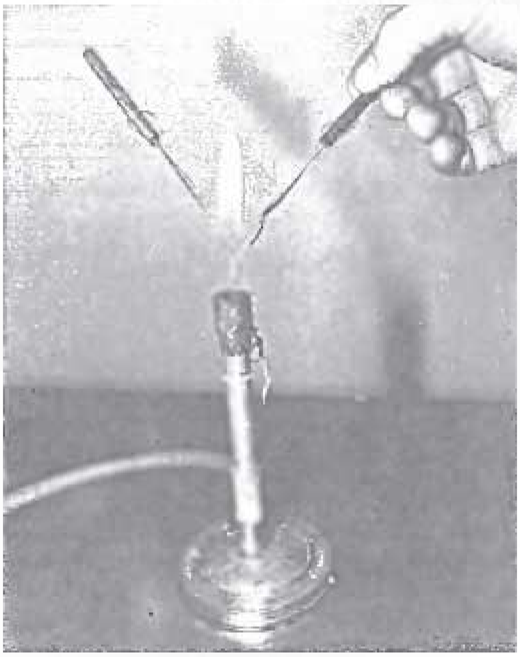


Figure 24a - Taking a spore print on typing paper.

Agaricus brunnescens, *Psilocybe cubensis* and many other mushroom species have a partial veil - a thin layer of tissue extending from the cap margin to the stem. This veil can be an aid in the procurement of nearly contaminant-free spores. The veil seals the gill from the outside, creating a semi-sterile chamber from which spores can be removed with little danger of contamination. By choosing a healthy, young specimen with the veil intact, and then by carefully removing the veil tissue under aseptic conditions, a nearly pure spore print is obtained. This is the ideal way to start a multispore culture.



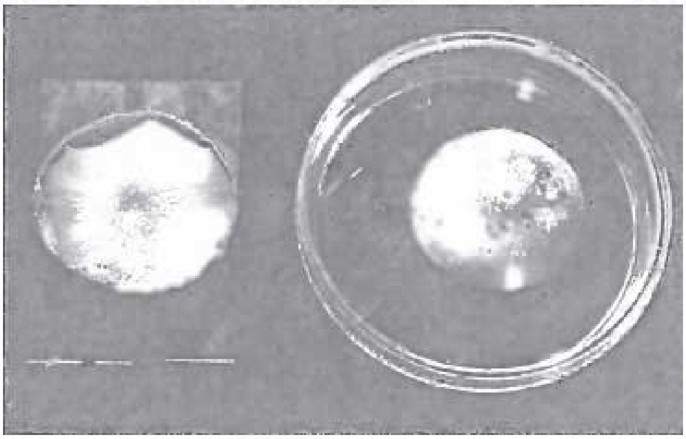


Figure 24b - Taking a spore print on a sterile Petri dish and on glass microscope slides.

Figure 25 - Sterilizing two scalpels speeds up agar transfer technique.

Techniques for Spore Germination

Once a spore print is obtained, mushroom culture can begin. Sterilize an inoculating loop or scalpel by holding it over the flame of an alcohol lamp or butane torch for five or ten seconds until it is red hot. (If a butane torch is used, turn it down to the lowest possible setting to minimize air disturbance). Cool the tip by inserting it into the sterile media in a Petri dish and scrape some spores off the print. Transfer the spores by streaking the tip of the transfer tool across the agar surface. A similar method calls for scraping the spore print above an opened Petri dish and allowing them to free-fall onto the medium. When starting a new culture from spores, it is best to inoculate at least three media dishes to improve the chances of getting a successful germination. Mycelium started in this manner is called a **multispore culture**.

When first produced, spores are moist, inflated cells with a relatively high rate of germination. As time passes, they dry, collapse at their centers and can not easily germinate. The probability of germinating dehydrated spores increases by soaking them in sterilized water. For 30 minutes at 15 psi, sterilize an eye dropper or similar device (syringe or pipette) and a water filled test tube or 25-250 ml. Erlenmeyer flask stopped with cotton and covered with aluminum foil. Carefully touch some spores onto a scalpel and insert into sterile water. Tightly seal and let stand for 6-12 hours. After this period draw up several milliliters of this spore solution with the eye dropper, syringe or pipette and inoculate several plates with one or two drops. Keep in mind that if the original spore print was taken under unsanitary conditions, this technique just as likely favors contaminant spores as the spores of mushrooms.

Characteristics of the Mushroom Mycelium

With either method of inoculation, spore germination and any initial stages of contamination should be evident in three to seven days. Germinating spores are thread-like strands of cells emanating from a central point of origin. These mycelial strands appear grayish and diffuse at first and soon become whitish as more hyphae divide, grow and spread through the medium.

The mycelia of most species, particularly *Agaricus, Coprinus, Lentinus, Panaeolus* and *Psilocybe* are grayish to whitish in color. Other mushroom species have variously pigmented mycelia. *Lepista nuda* can have a remarkable purplish blue mycelium; *Psilocybe tampanensis* is often multi-colored with brownish hues. Keep in mind, however, that color varies with the strain and the media upon which the mycelium is grown. Another aspect of the mycelial appearance is its type of growth, whether it is aerial or appressed, cottony or rhizomorphic. Aerial mycelium can be species related or often it is a function of high humidity. Appressed mycelium can also be a species specific character or it can be the result of dry conditions. The subject of mycelial types is discussed in greater detail under the sub-chapter Sectoring. (See Color Photos 1-4).

Once the mushroom mycelium has been identified, sites of germinating spores should be transferred to new media dishes. In this way the cultivator is selectively isolating mushroom mycelia and will soon establish a pure culture free of contamination. If contamination appears at the same time, cut out segments of the emerging mushroom mycelia away from the contaminant colonies. Since many of the common contaminants are sporulating molds, be careful not to jolt the culture or to do anything that might spread their spores. And be sure the scalpel is cool before cutting into the agar media. A hot scalpel causes an explosive burst of vapor which in the microcosm of the Petri dish easily liberates spores of neighboring molds.

Ramifications of Multispore Culture

Multispore culture is the least difficult method of obtaining a viable if not absolutely pure strain. In the germination of such a multitude of spores, one in fact creates many strains, some incompatible with others and each potentially different in the manner and degree to which they fruit under artificial conditions. This mixture of strains can have a limiting effect on total yields, with the less productive strains inhibiting the activity of more productive ones. In general, strains created from spores have a high probability of resembling their parents. If those parents have been domesticated and fruit well under laboratory conditions, their progeny can be expected to behave similarly. In contrast, cultures from wild specimens may fruit very poorly in an artificial environment. Just as with wild plants, strains of wild mushrooms must be selectively developed.

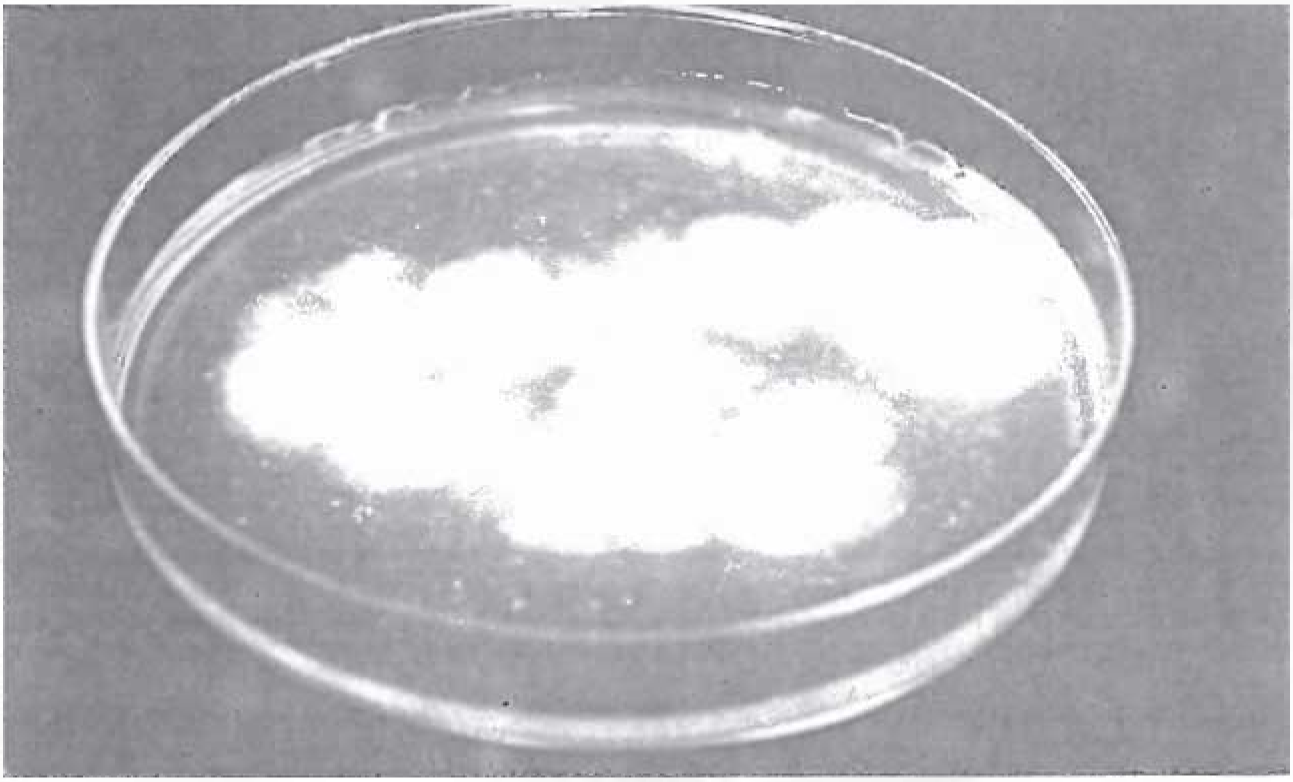


Figure 26 - *Stropharia rugoso-annulata* spores germinating.

Of the many newly created strains intrinsic to multispore germination, some may be only capable of vegetative growth. Such mycelia can assimilate nutrients but can not form a mushroom fruitbody (the product of generative growth). A network of cells coming from a single spore is called a **monokaryon**. As a rule, monokaryons are not capable of producing fertile spore-bearing mushrooms. When two compatible monokaryons encounter one another and mate, cytoplasmic and genetic material is exchanged. The resultant mycelium is a **dikaryon** that can produce fertile offspring in the form of mushrooms. Branching or networking between different dikaryotic strains is known as **anastomosis**. This process of recombination can occur at any stage of the cultivation process: on agar; on grain; or on bulk substrates. The crossing of different mushroom strains is analogous to the creation of hybrids in horticulture.

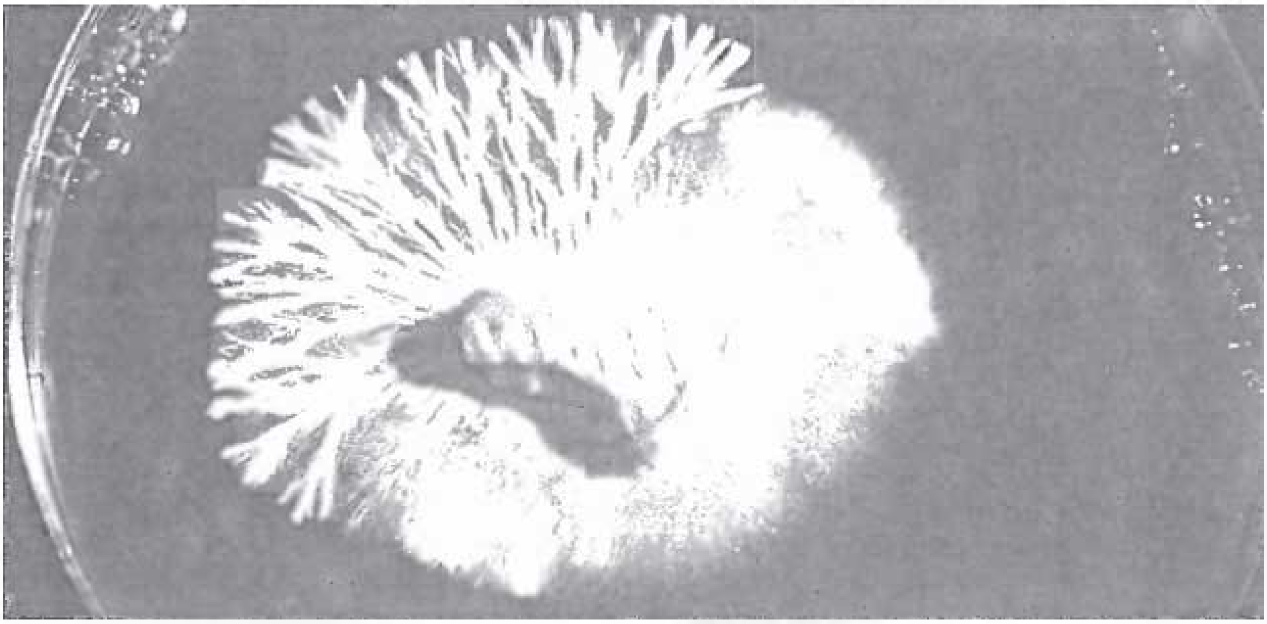


Figure 27 - *Psilocybe cubensis* mycelium growing from agar wedge, transferred from a multispore germination. Note two types of mycelial growth.

Another method for starting cultures is the creation of single spore isolates and is accomplished by diluting spores in a volume of sterile water. This spore solution is further diluted into larger volumes of sterile water which is in turn used to inoculate media dishes. In this way, cultivators can observe individual monokaryons and in a controlled manner institute a mating schedule for the development of high yielding strains. For cultivators interested solely in obtaining a viable culture, this technique is unnecessary and multispore germinations generally suffice. But for those interested in crossing monokaryotic strains and studying mating characteristics, this method is of great value. Keep in mind that for every one hundred spores, only an average of one to five germinate. For a more detailed explanation of strains and strain genetics, see Chapter XV.

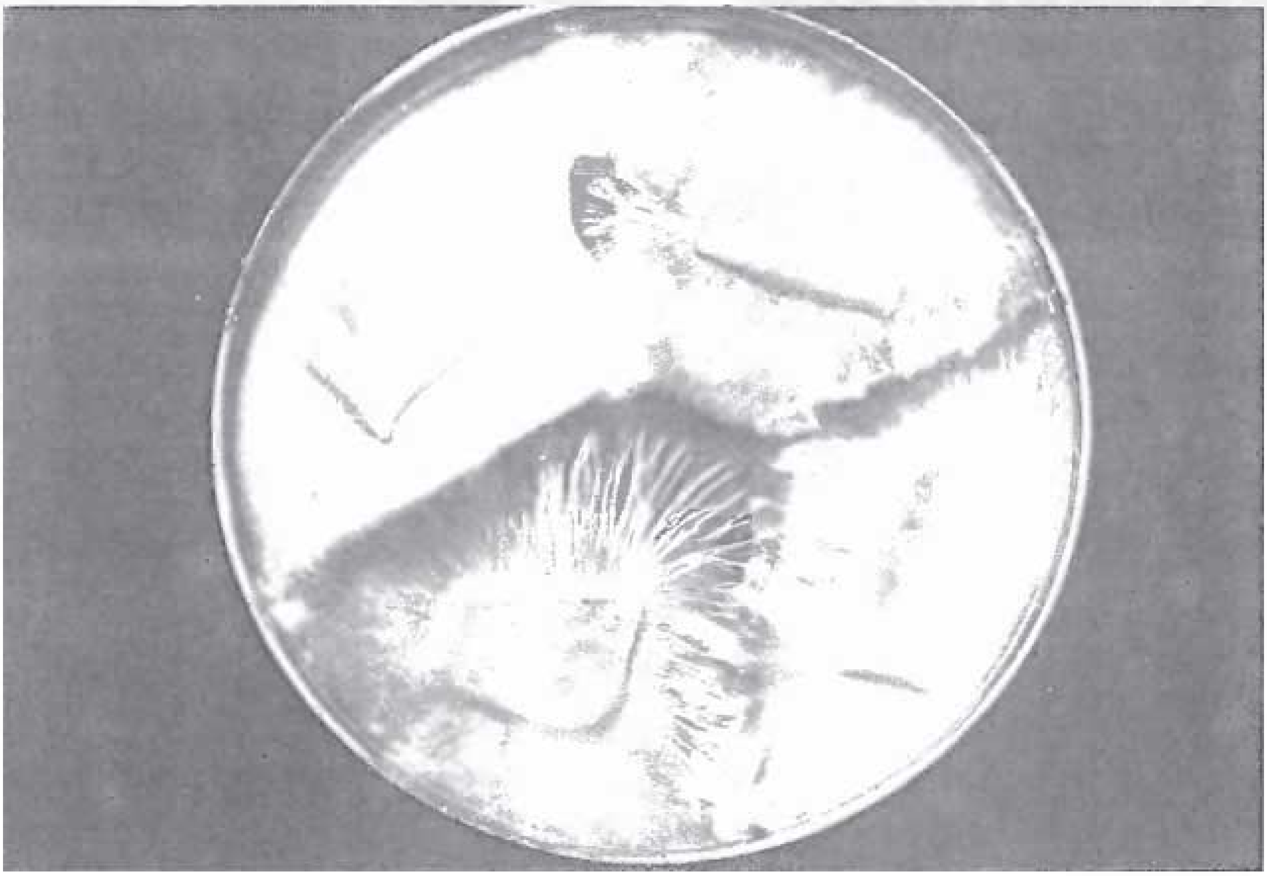


Figure 28 - Four strains of *Psilocybe cubensis* mycelium: (clockwise, upper right) Matias Romero; Misantla; Amazonian; and Palenque.

The greatest danger of doing concentrated multispore germinations is the increased possibility of contamination, especially from bacteria. Some bacteria parasitize the cell walls of the mycelium, while others stimulate spore germination only to be carried upon and to slowly digest the resulting mycelia. Hence, some strains are inherently unhealthy and tend to be associated with a high percentage of contamination. These infected spores, increase the likelihood of disease spreading to neighboring spores when germination is attempted in such high numbers.

Many fungi, however, have developed a unique symbiotic relationship with other microorganisms. Some bacteria and yeasts actually stimulate spore germination in mushrooms that otherwise are difficult to grow in sterile culture. The spores of *Cantharellus cibarius*, the common and highly prized Chantrelle, do not germinate under artificial conditions, resisting the efforts of world's most experienced mycologists. Recently, Nils Fries (1979), a Swedish mycologist, discovered that when activated charcoal and a red yeast, *Rhodotorula glutinis* (Fres.) Harrison, were added to the media, spore germination soon followed. (Activated charcoal is recommended for any mushroom whose spores do not easily germinate.)

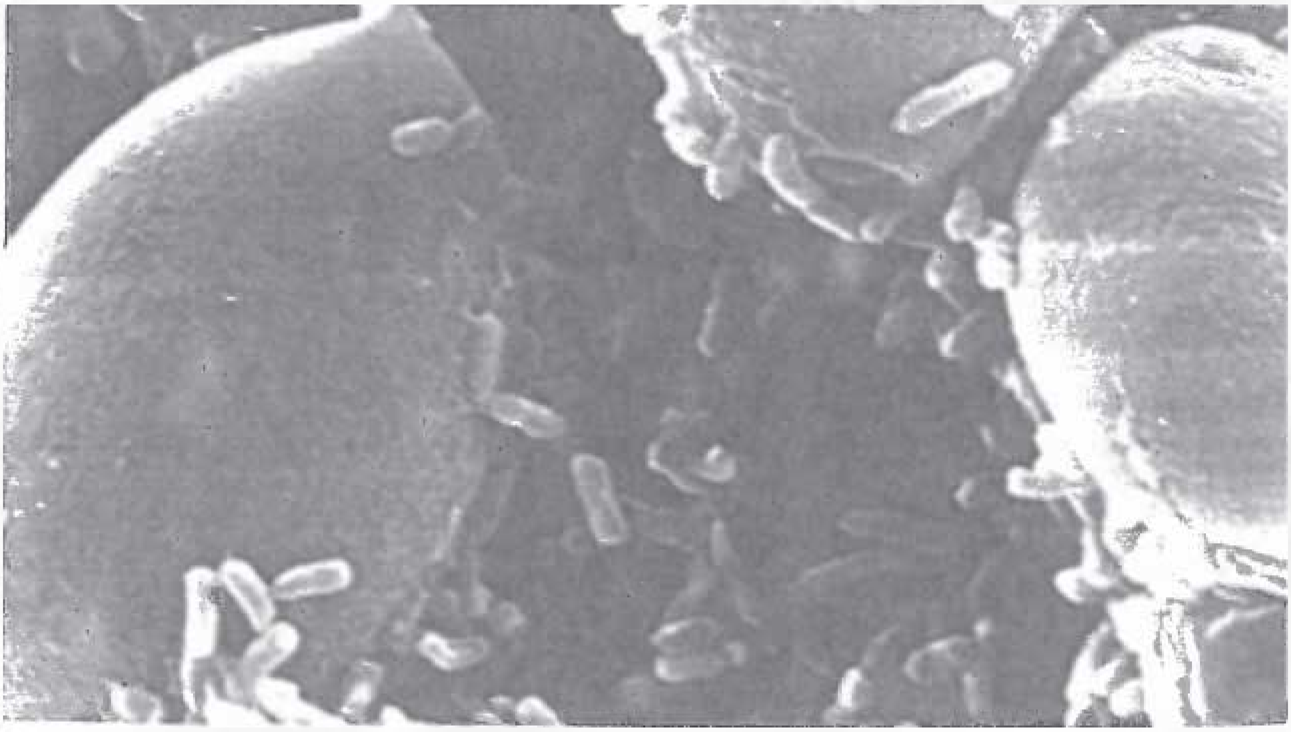


Figure 29 - *Psilocybe cubensis* spores infected with rod shaped bacteria.

Many growers have reported that certain cultures flourish when a bacterium accidentally contaminates or is purposely introduced into a culture. *Pseudomonas putida, Bacillus megaterium, Azotobacter vinelanclii* and others have all been shown to have stimulatory effects on various mushroom species - either in the germination of spores, the growth of mycelia or the formation of fruitbodies (Curto and Favelli, 1972; Hayes *et al*., 1969; Eger, 1972; Urayama, 1961). Techniques utilizing these bacteria are discussed in Appendix III. However, most of the contaminants one encounters in mushroom cultivation, whether they are airborne or intrinsic to the culture, are not helpful. Bacteria can be the most pernicious of all competitors. A diligent regimen of hygiene, the use of high efficiency particulate air (HEPA) filters and good laboratory technique all but eliminate these costly contaminants.

Starting a Culture from Live Tissue

Tissue culture is an assured method of preserving the exact genetic character of a living mushroom. In tissue culture a living specimen is cloned whereas in multispore culture new strains are created. Tissue cultures must be taken from mushrooms within twenty-four to forty-eight hours of being picked. If the specimens are several days old, too dry or too mature, a pure culture will be difficult to isolate. Spores, on the other hand, can be saved over long periods of time.

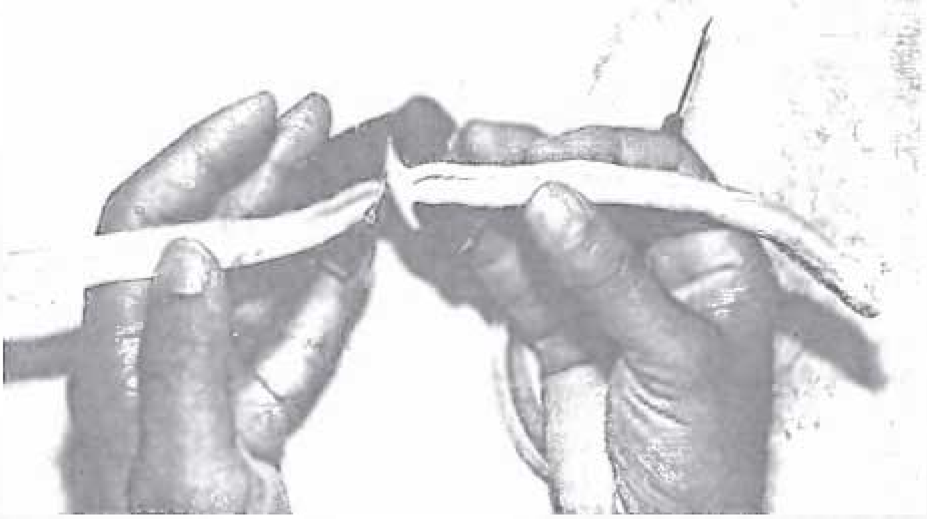


Figure 30 - Splitting the mushroom stem to expose interior tissue.

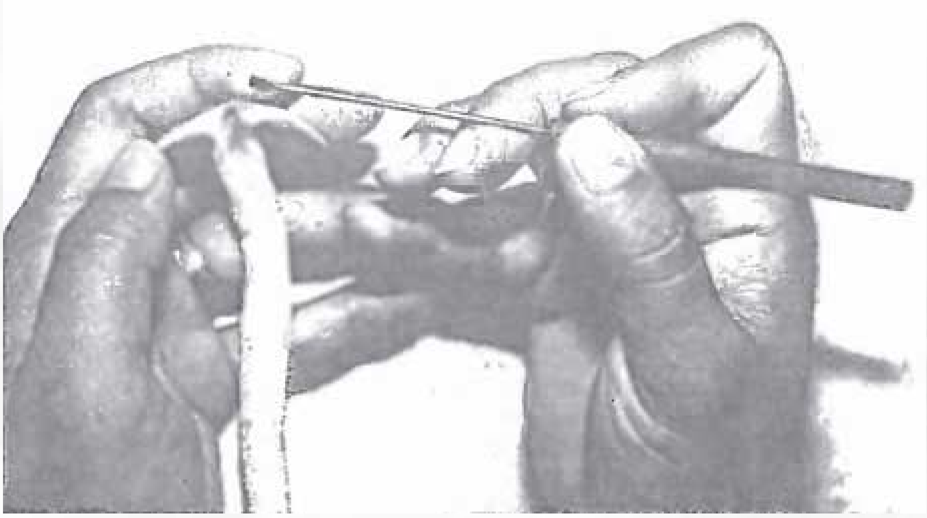


Figure 31 - Cutting into mushroom flesh with a cooled, flame sterilized scalpel.

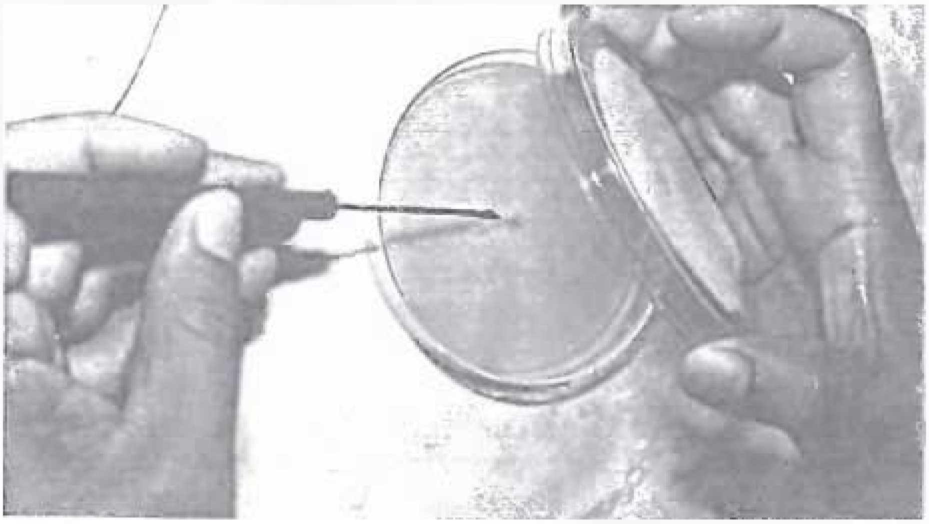


Figure 32 - Excising a piece of tissue for transfer into a Petri dish.

Since the entire mushroom is composed of compressed mycelia, a viable culture can be obtained from any part of the mushroom fruitbody. The cap, the upper region of the stem and/or the area where the gill plate joins the underside of the cap are the best locations for excising clean tissue. Some mushrooms have a thick cuticle overlaying the cap. This skin can be peeled back and a tissue culture can be taken from the flesh underlying it. Wipe the surface of the mushroom with a cotton swab soaked in alcohol and remove any dirt or damaged external tissue. Break the mushroom cap or stem, exposing the interior hyphae. Immediately flame a scalpel until red-hot and cool in a media filled Petri dish. Now cut into the flesh removing a small fragment of tissue. Transfer the tissue fragment to the center of the nutrient filled Petri dish as quickly as possible, exposing the tissue and agar to the open air for a minimal time. Repeat this technique into at least three, preferably five more dishes. Label each dish with the species, date, type of culture (tissue) and kind of agar medium. If successful, mycelial growth will be evident in three to seven days.

An overall contamination rate of a 10% is one most cultivators can tolerate. In primary cultures however, especially those isolated from wild specimens, it is not unusual to have a 25% contamination rate. Diverse and colorful contaminants often appear near to the point of transfer. Their numbers depend on the cleanliness of the tissue or spores transferred and the hygienic state of the laboratory where the transfers were conducted. In tissue culture, the most commonly encountered contaminants are bacteria.

Contamination is a fact of life for every cultivator. Contaminants become a problem when their populations spiral above tolerable levels, an indication of impending disaster in the laboratory. If a five, ten or fifteen percent contamination rate is normal for a cultivator and suddenly the contamination level escalates without an alteration of regimen, then new measures of control should be introduced immediately.

Once the tissue shows signs of growth, it should be transferred to yet another media dish. If no signs of contamination are evident, early transfer is not critical. If sporulating colonies of mold develop adjacent to the growing mycelium, the culture should be promptly isolated. Continue transferring the mycelium away from the contaminants until a pure strain is established. Obviously, isolating mycelia from a partially contaminated culture is more difficult than transferring from a pure one. The mere attempt of isolating mycelia away from a nearby contaminant is fraught with the danger of spreading its spores. Although undetectable to us, when the rim of a Petri dish is lifted external air rapidly enters and spores become airborne. Therefore, the sooner the cultivator is no longer dependent upon a partially contaminated culture dish, the easier it will be to maintain pure cultures. Keep in mind that a strain isolated from a contaminated media dish can harbor spores although to the unaided eye the culture may appear pure. Only when this contaminant laden mycelium is inoculated into sterile grain will these inherent bacteria and molds become evident.

To minimize contamination in the laboratory there are many measures one can undertake. The physical ones such as the use of HEPA filters, asperated oil and glove boxes have already been discussed. One's attitude towards contamination and cleanliness is perhaps more important than the installation of any piece of equipment. The authors have seen laboratories with high contamination rates and closets that have had very little. Here are two general guidelines that should help many first-time cultivators.

1. Give the first attempt at sterile culture the best effort. Everything should be clean: the lab; clothes; tools; and especially the cultivator.
2. Once a pure culture has been established, make every attempt to preserve its purity. Save only the cultures that show no signs of mold and bacteria. Throw away all contaminated dishes, even though they may only be partially infected.

If failure greets one's first attempts at mushroom culture, do not despair. Only through practice and experience will sterile culture techniques become fluent.

Agar culture is but one in a series of steps in the cultivation of mushrooms. By itself, agar media is impractical for the production of mushrooms. The advantage of its use in mushroom culture is that mycelial mass can be rapidly multiplied using the smallest fragments of tissue. Since contaminants can be readily observed on the flat two dimensional surface of a media filled Petri dish, it is fairly easy to recognize and maintain pure cultures.

Sectoring: Strain Selection and Development

As mycelium grows out on a nutrient agar, it can display a remarkable diversity of forms. Some mycelia are fairly uniform in appearance; others can be polymorphous at first and then suddenly develop into a homogeneous looking mycelia. This is the nature of mushroom mycelia - to constantly change and evolve.

When a mycelium grows from a single inoculation site and several divergent types appear, it is said to be **sectoring**. A sector is defined solely in contrast to the surrounding, predominant mycelia. There are two major classes of mycelial sectors: rhizomorphic (strandy) and tomentose (cottony). Also, an intermediate type of mycelium occurs which grows linearly (longitudinally radial) but does not have twisted strands of interwoven hyphae that characterize the rhizomorphic kind. Rhizomorphic mycelium is more apt to produce primordia. Linear mycelium can also produce abundant primordia but this usually occurs soon after it forms rhizomorphs. Keep in mind, however, that characteristics of fruiting mycelium are often species specific and may not conform precisely to the categories outlined here.

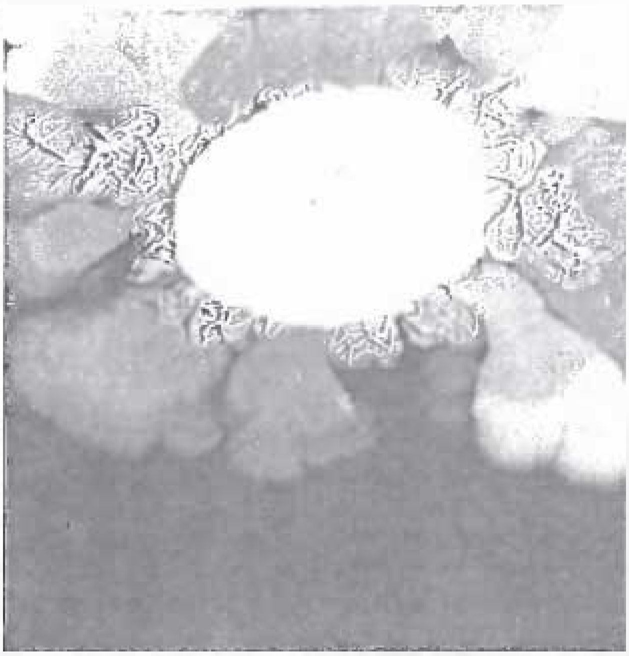


Figure 33 - Bacteria growing from contaminated mushroom mycelium.

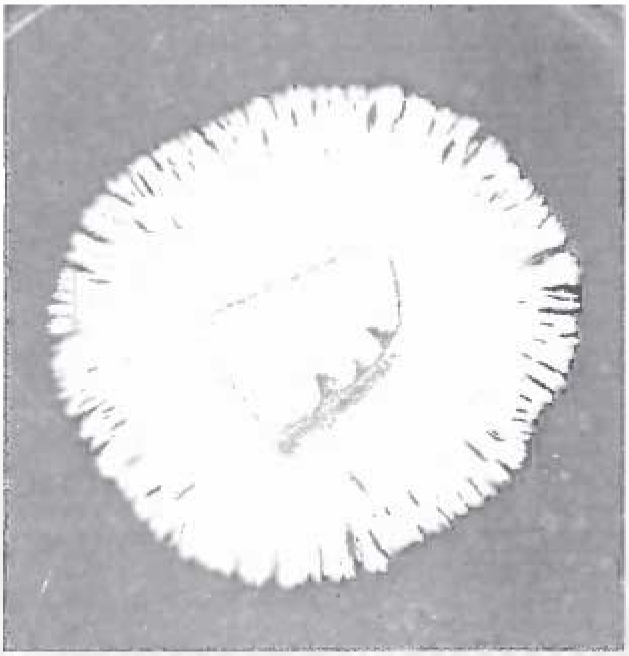


Figure 34 - Rhizomorphic mycelium. Note divergent ropey strands.

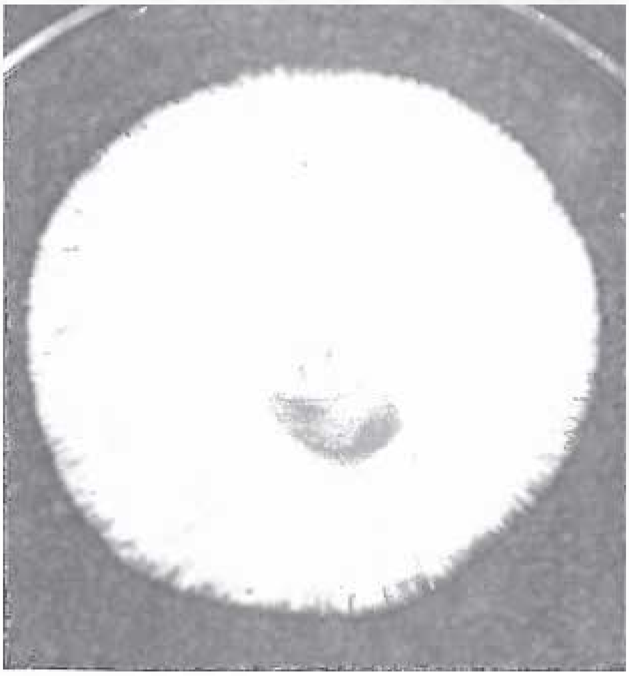


Figure 35 - Intermediate linear type mycelium. Note longitudinally radial fine strands (*Psilocybe cyanescens* mycelium).

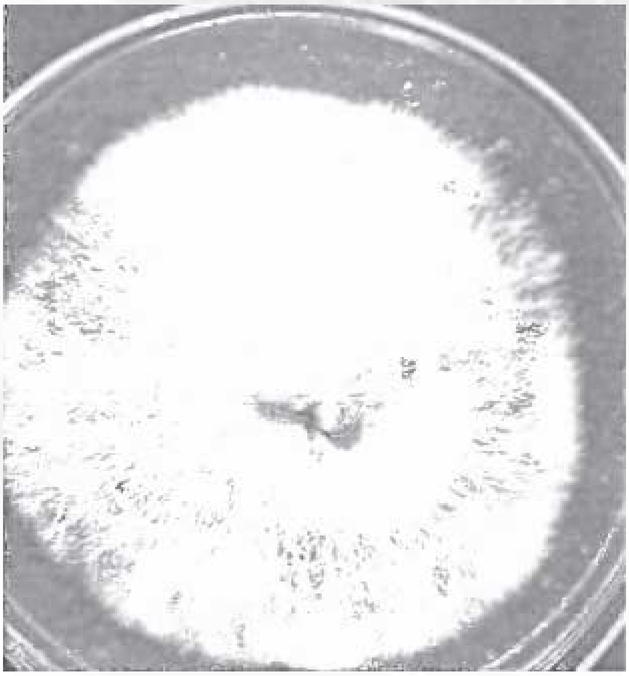


Figure 36 - Rhizomorphic mycelia with tomentose (cottony) sector (of *Agaricus brunnescens*).

In a dish that is largely covered with a cottony mycelia, a fan of strandy mycelia would be called a rhizomorphic sector, and vice versa. Sectors are common in mushroom culture and although little is known as to their cause or function, it is clear that genetics, nutrition and age of the mycelium play important roles.

According to Stoller (1962) the growth of fluffy sectors is encouraged by broken and exploded kernels which increase the availability of starch in the spawn media. Working with *Agaricus brunnescens*, Stoller noted that although mycelial growth is faster at high pH levels (7.5) than at slightly acid pH levels (6.5), sectoring is more frequent. He found that sectors on grain could be reduced by avoiding exploded grains (a consequence of excessive water) and buffering the pH to 6.5 using a combination of chalk (precipitated calcium carbonate) and gypsum (calcium sulfate).

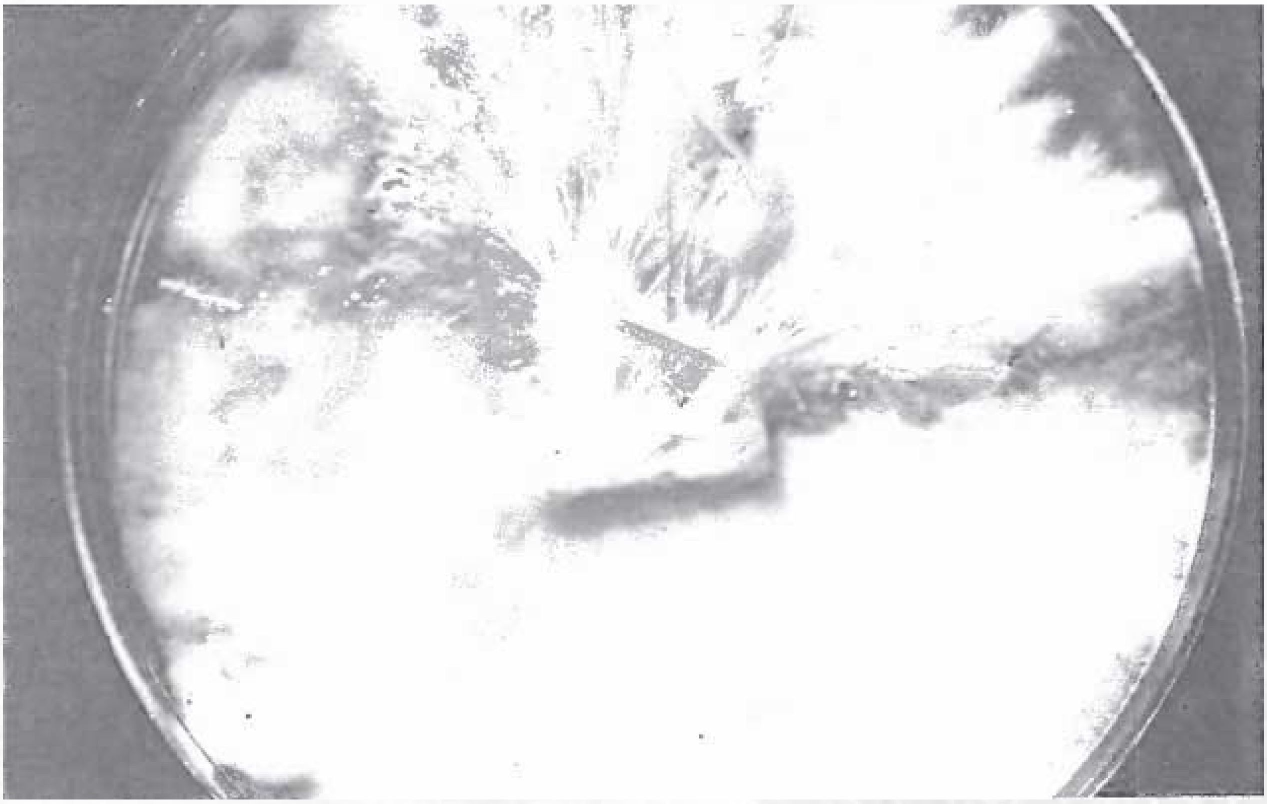


Figure 37 - *Psilocybe cubensis* mycelia with cottony and rhizomorphic sectors. Note that primordia form abundantly on rhizomorphic mycelium but not on the cottony type.

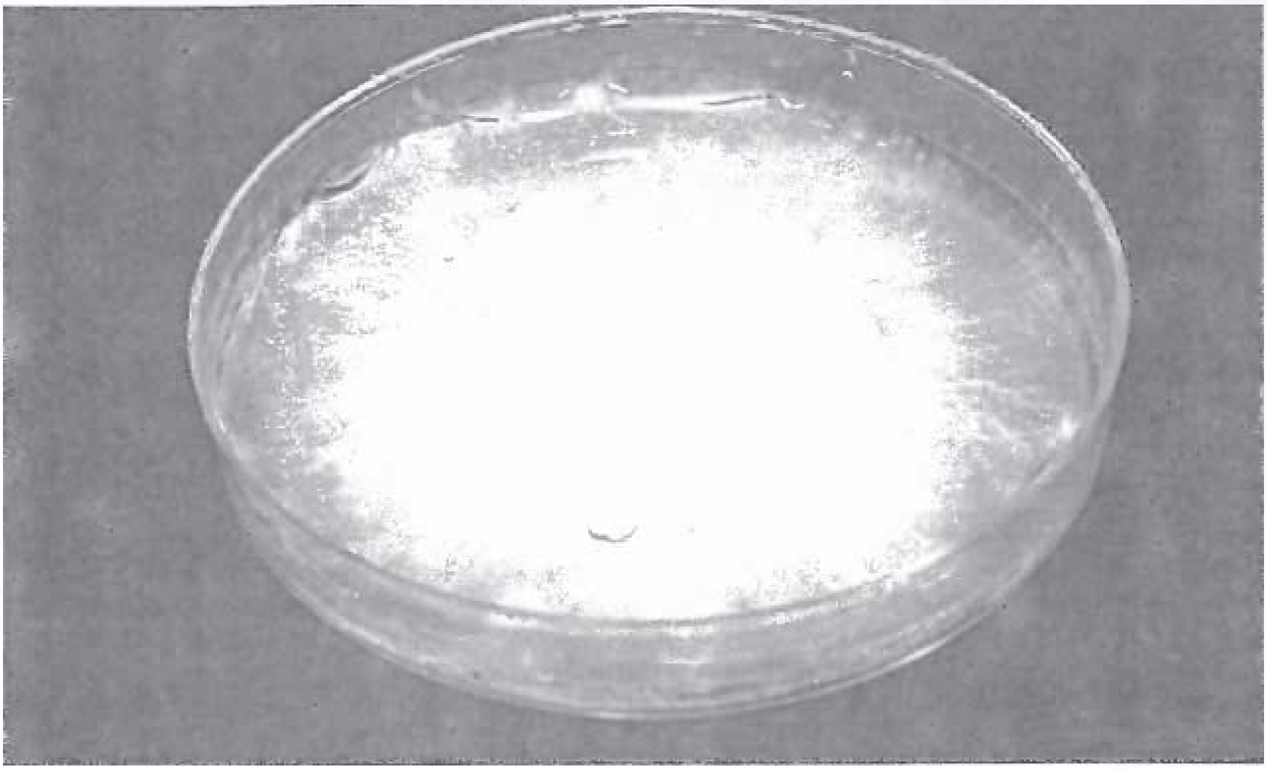


Figure 38 - Hyphal aggregates of *Agaricus bitorquis* forming on malt agar media.

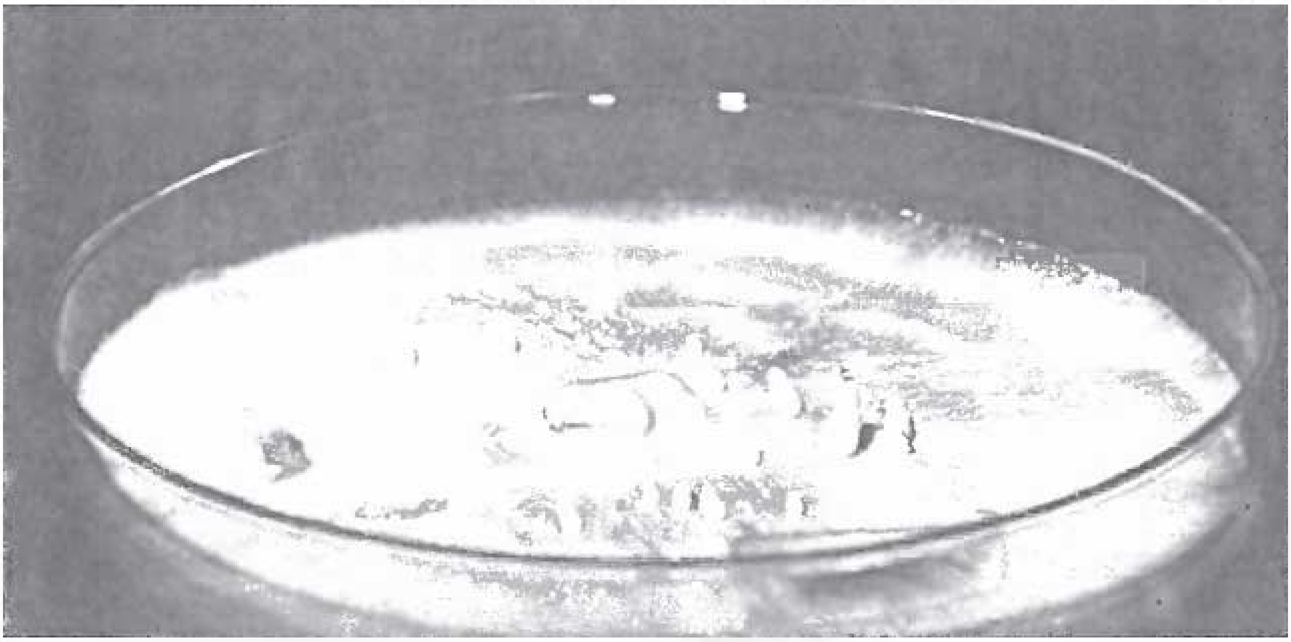


Figure 39 - Primordia of *Psilocybe cubensis* forming on malt agar media.

Commercial *Agaricus* cultivators have long noted that the slower growing cottony mycelium is inferior to the faster growing rhizomorphic mycelium. There is an apparent correlation between cottony mycelia on agar and the later occurrence of "stroma", a dense mat-like growth of mycelia on the casing which rarely produces mushrooms. Furthermore, primordia frequently form along generatively oriented rhizomorphs but rarely on somatically disposed cottony mycelia. It is of interest to mention that, under a microscope, the hyphae of a rhizomorphic mycelial network are larger and branch less frequently than those of the cottony network.

Rhizomorphic mycelia run faster, form more primordia and in the final analysis yield more mushrooms than cottony mycelia. One example of this is illustrated in Fig. 37. A single wedge of mycelium was transferred to a Petri dish and two distinct mycelial types grew from it. The stringy sector formed abundant primordia while the cottony sector did not, an event common in agar culture.

When a mycelium grows old it is said to be **senescing**. Senescent mycelium, like any aged plant or animal, is far less vigorous and fertile than its counterpart. In general, a change from rhizomorphic to cottony looking mycelium should be a warning that strain degeneration has begun.

If at first a culture is predominantly rhizomorphic, and then it begins to sector, there are several measures that can be undertaken to promote rhizomorphism and prevent the strain's degeneration.

1. Propagate only rhizomorphic sectors and avoid cottony ones.
2. Alter the media regularly using the formulas described herein. Growing a strain on the same agar formula is not recommended because the nutritional composition of the medium exerts an selective influence on the ability of the mushroom mycelium to produce digestive enzymes. By varying the media, the strain's enzyme system remains broadly based and the mycelium is better suited for survival. Species vary greatly in their preferences. Unless specific data is available, trial and error is the only recourse.
3. Only grow out the amount of mycelium needed for spawn production and return the strain to storage when not in use. Do not expect mycelium that has been grown over several years at optimum temperatures to resemble the primary culture from which it came. After so many cell divisions and continual transfers, a sub-strain is likely to have been selected out, one that may distantly resemble the original in both vitality, mycelial appearance and fruiting potential.
4. If efforts to preserve a vital strain fail, re-isolate new substrains from multispore germinations.
5. Another alternative is to continuously experiment with the creation of hybrid strains that are formed from the mating of dikaryotic mycelia of two genetically distinct parents. (Experiments with *Agaricus brunnescens* have shown, however, that most hybrids yield less than both or one of the contributing strains. A minority of the hybrids resulted in more productive strains.)

Home cultivators can selectively develop mushroom strains by rating mycelia according to several characteristics. These characteristics are:

1. Rhizomorphism - fast growing vegetative mycelium.
2. Purity of the strain - lack of cottony sectors.
3. Cleanliness of the mycelia - lack of associated competitor organisms (bacteria, molds and mites).
4. Response time to primodia formation conditions.
5. Number of primordia formed.
6. Proportion of primordia formed that grow to maturity.
7. Size, shape and/or color of fruitbodies.
8. Total yield.
9. Disease resistance.
10. CO_2 tolerance/sensitivity.
11. Temperature limits.
12. Ease of harvesting.

Using these characteristics, mushroom breeders can qualitatively judge strains and select ones over a period of time according to how well they conform to a grower's preferences.

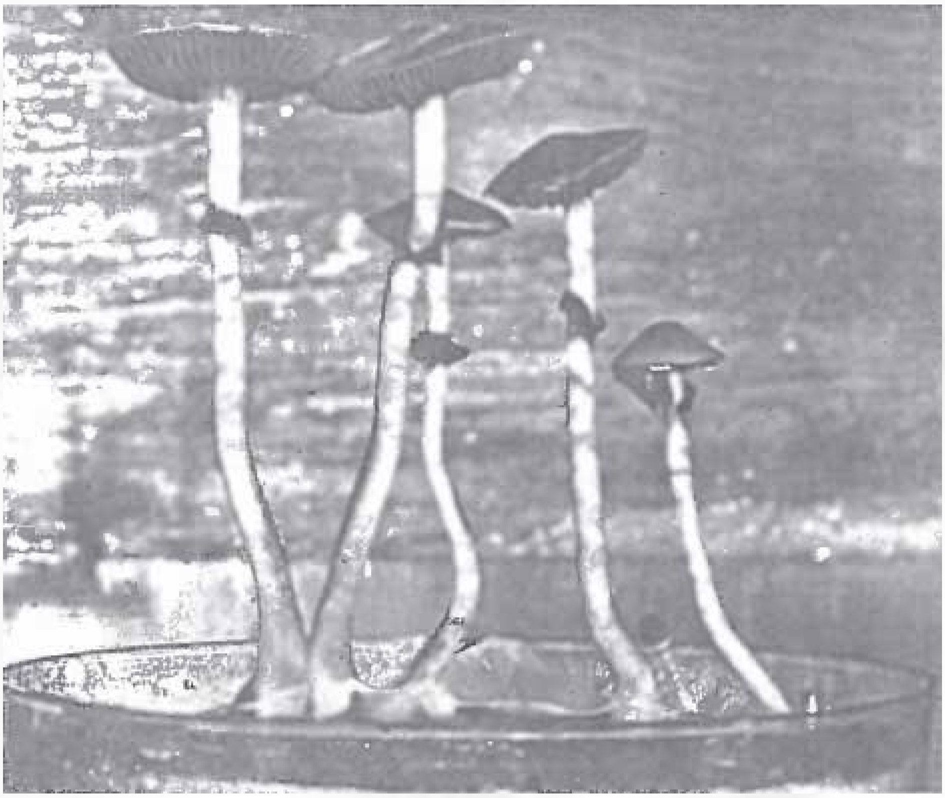


Figure 40 - Mature stand of *Psilocybe cubensis* on malt agar media.

Stock Cultures: Methods For Preserving Mushroom Strains

Once a pure strain has been created and isolated, saving it in the form of a "stock culture" is wise. Stock cultures - or "slants" as they are commonly called - are media filled glass test tubes which are sterilized and then inoculated with mushroom mycelium. A suitable size for a culture tube is 20 mm. x 100 mm. with a screw cap. Every experienced cultivator maintains a collection of stock cultures, known as a "species bank". The species bank is an integral part of the cultivation process. With it, a cultivator may preserve strains for years.

To prepare slants, first mix any of the agar media formulas discussed earlier in this chapter. Fill test tubes one third of the way, plug with cotton and cover with aluminum foil or simply screw on the cap if the tubes are of this type. Sterilize in a pressure cooker for 30 minutes at 15 psi. Allow the cooker to return to atmospheric pressure and then take it into the sterile room before opening. Remove the slants, gently shake them to distribute the liquified media and lay them at a 15-30 degree angle to cool and solidify.

When ready, inoculate the slants with a fragment of mushroom mycelium. Label each tube with the date, type of agar, species and strain. Make at least three slants per strain to insure against loss. Incubate for one week at 75°F. (24°C.). Once the mycelia has covered a major portion of the agar's surface and appears to be free of contamination, store at 35-40°F. (2-4°C.). At these temperatures, the metabolic activity of most mycelia is lowered to a level where growth and nutrient absorbtion virtually stops. Ideally one should check the vitality of stored cultures every six months by removing fragments of mycelium and inoculating more Petri dishes. Once the mycelium has colonized two-thirds of the media dish, select for strandy growth (rhizomorphism) and reinoculate more slants. Label and store until needed. Often, growing out minicultures is a good way to check a stored strain's vitality and fruiting ability.

An excellent method to save cultures is by the buddy system: passing duplicates of each species or of strains to a cultivator friend. Mushroom strains are more easily lost than one might expect. Once lost, they may never be recovered.

In most cases, the method described above safely preserves cultures. Avid cultivators, however, can easily acquire fifty to a hundred strains and having to regularly revitalize them becomes tedious and time consuming. When a library of cultures has expanded to this point, there are several additional measures that further extend the life span of stock cultures.

A simple method for preserving cultures over long periods of time calls for the application of a thin layer of sterile mineral oil over the live mycelium once it has been established in a test tube. The mineral oil is non-toxic to the mycelium, greatly reduces the mycelium's metabolism and inhibits water evaporation from the agar base. The culture is then stored at 37-41°F. until needed. In a recent study (Perrin, 1979), all of the 30 wood inhabiting species stored under mineral oil for 27 years produced a viable culture. To reactivate the strains, slants were first inverted upside down so the oil would drain off and then incubated at 77°F. Within three weeks each slant showed renewed signs of growth and when subcultured onto agar plates they yielded uncontaminated cultures.

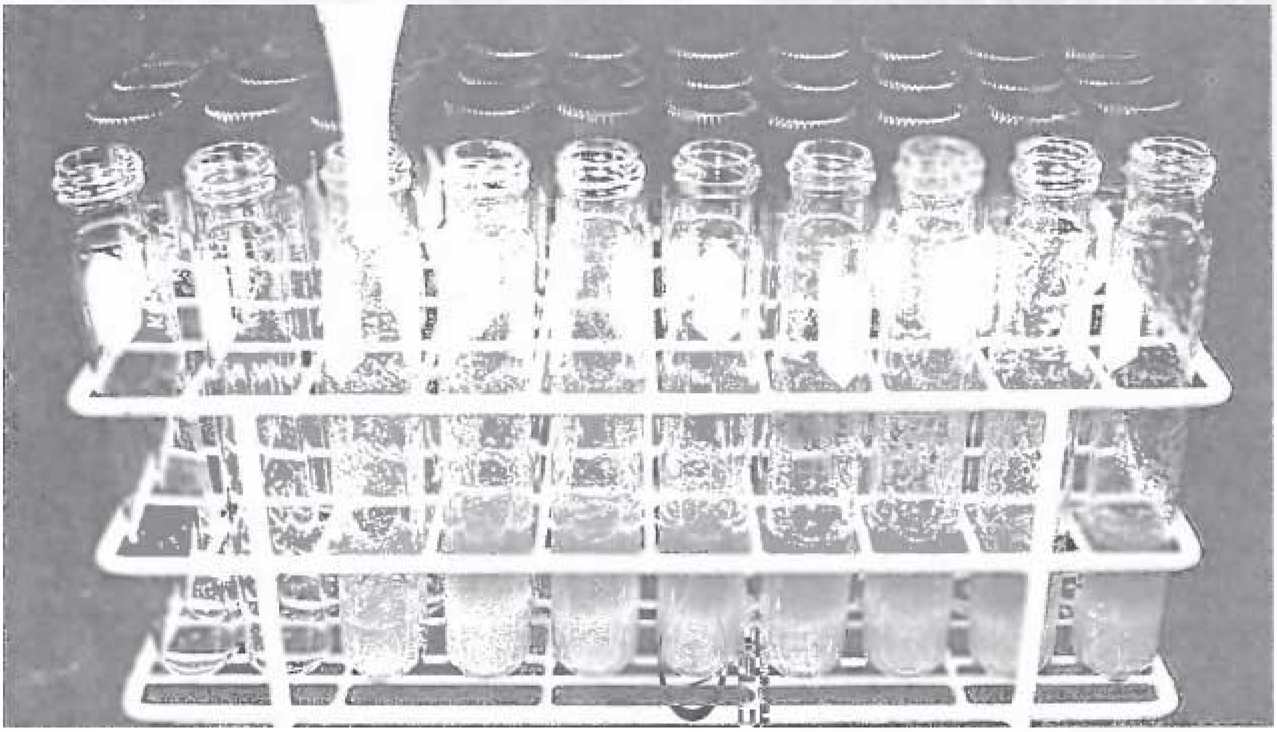


Figure 41 - Filling test tubes with liquid agar media prior to sterilization in a pressure cooker.

Although a strain may be preserved over the long term using this method, will it be as productive as when it was first stored? Other studies have concluded that strains saved for more than 5 years under mineral oil showed distinct signs of degeneration while these same strains were just as productive at 2½ years as the day they were preserved. Nevertheless, it is not unreasonable to presume, based on these studies, that cultures can be stored up to two years without serious impairment to their vitality.

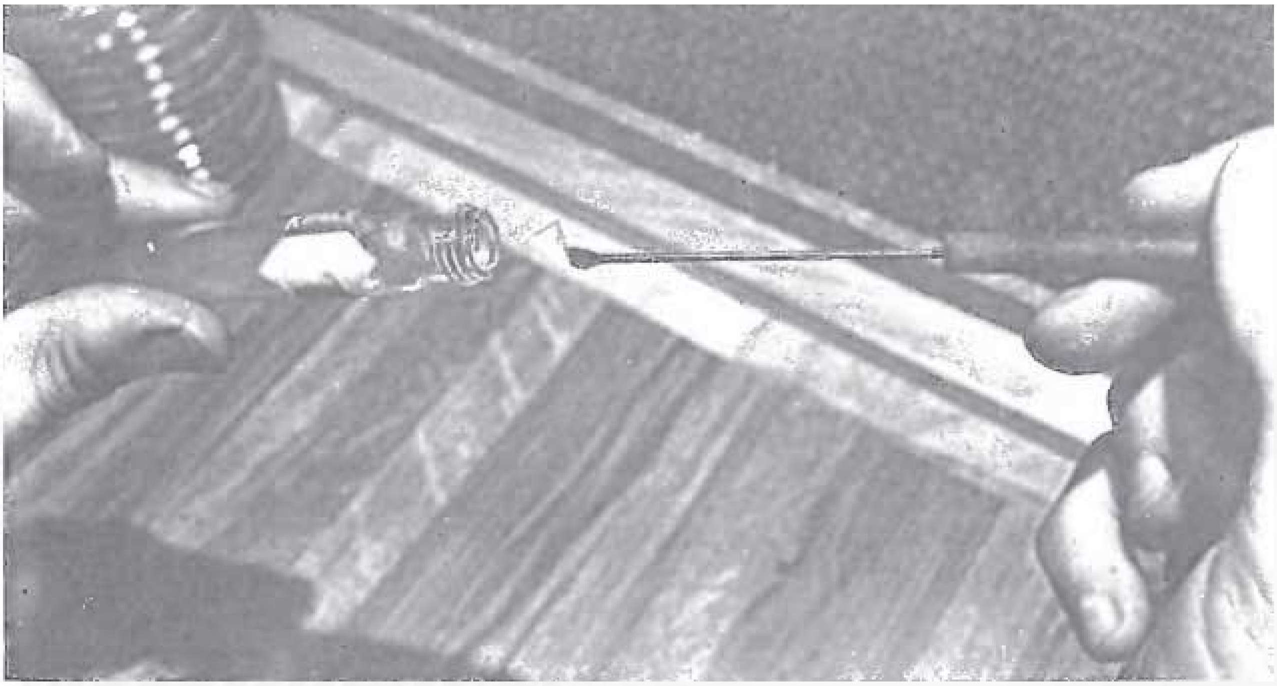


Figure 42 - Inoculating a test tube slant with a piece of mycelium.

Four other methods of preservation include: the immersion of slants into liquid nitrogen (an expensive procedure); the inoculation of washed sterilized horse manure/straw compost that is then kept at 36-38°F. (See Chapter V on compost preparation); the inoculation of sawdust/bran media for wood decomposers (see section in Chapter III on alternative spawn media); or saving spores aseptically under refrigerated conditions - perhaps the simplest method for home cultivators.

Whatever method is used, remember that the mushroom's nature is to fruit, sporulate and evolve. Cultivation techniques should evolve with the mushroom and the cultivator must selectively isolate and maintain promising strains as they develop. So don't be too surprised if five years down the line a stored strain poorly resembles the original in its fruiting potential or form.

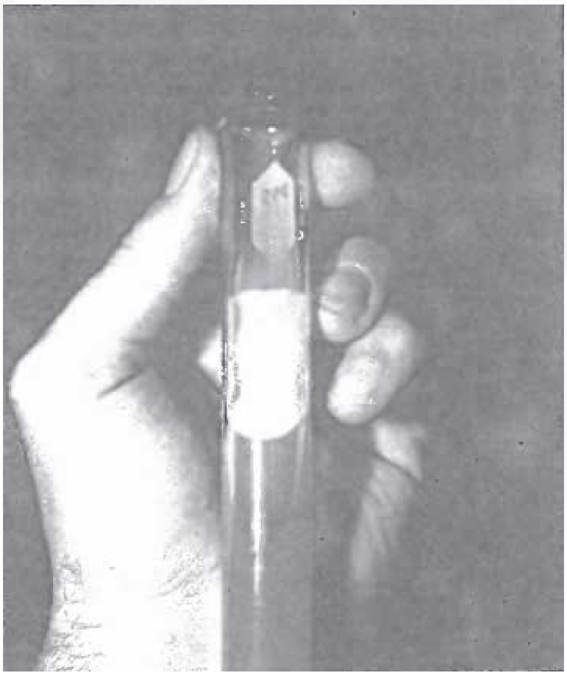


Figure 43 - Culture slant of healthy mycelium ready for cool storage.

III. GRAIN CULTURE

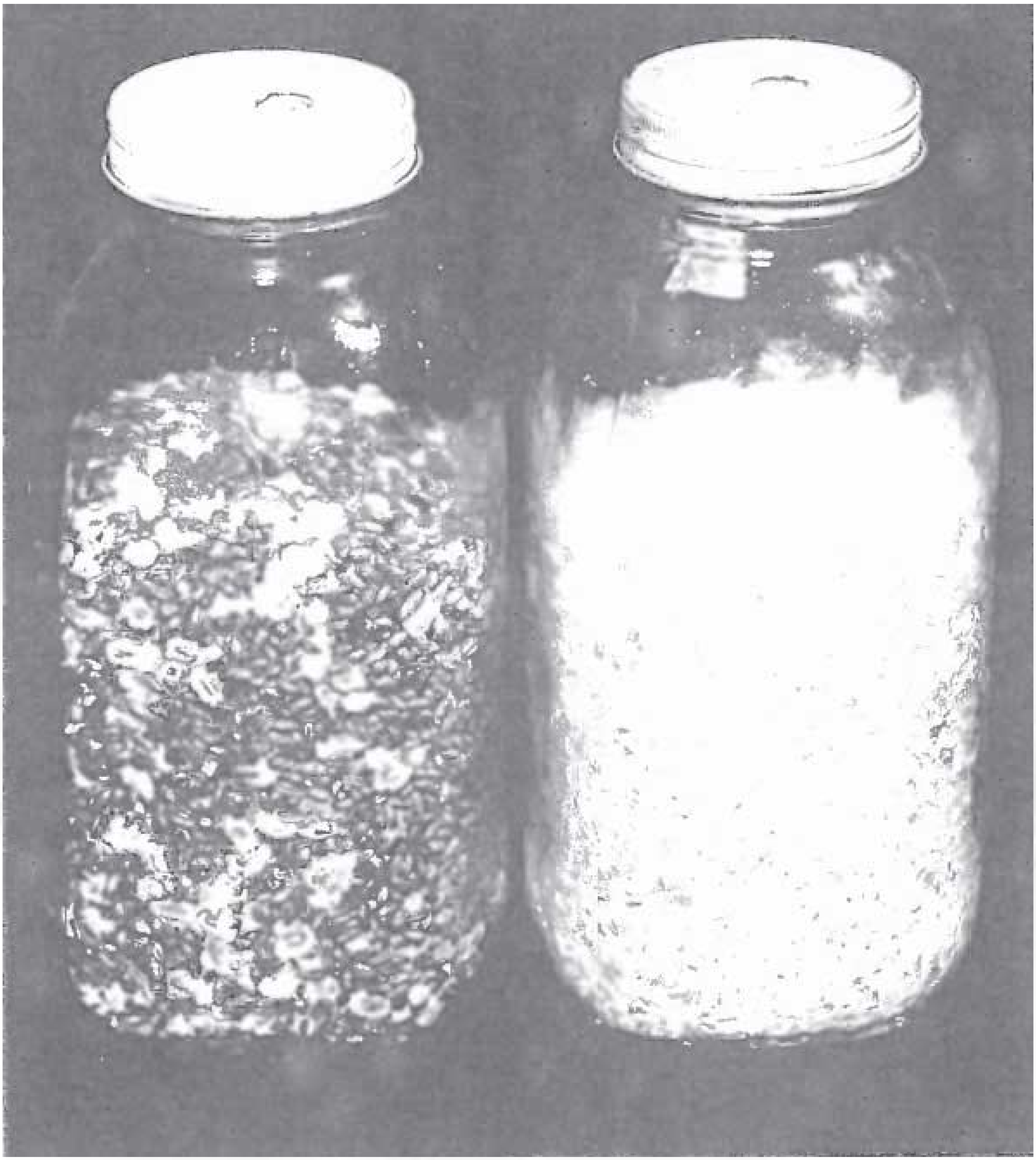


Figure 44 - Half gallon spawn jars at 3 and 8 days after inoculation.

The Development of Grain Spawn

Mushroom spawn is used to inoculate prepared substrates. This inoculum consists of a carrier material fully colonized by mushroom mycelium. The type of carrier varies according to the mushroom species cultivated, although rye grain is the choice of most spawn makers. The history of the development of mushroom spawn for *Agaricus brunnescens* culture illustrates how spawn production has progressed in the last hundred years.

During the 1800's *Agaricus* growers obtained spawn by gathering concentrations of mycelium from its natural habitat. To further encourage mycelial growth this "virgin spawn" was supplemented with materials similar to those occurring naturally, in this case horse manure. Spent compost from prior crops was also used as spawn. This kind of spawn, however, contained many contaminants and pests, and yielded few mushrooms. Before serious commercial cultivation could begin, methods guaranteeing the quality and mass production of the mushroom mycelium had to be developed.

With the advent of pure culture techniques, propagation of mushroom mycelium by spore germination or by living tissue completely superseded virgin spawn. Now the grower was assured of not only a clean inoculum but also a degree of certainty as to the strain itself. Strain selection and development was possible for the first time in the history of mushroom culture because high yielding strains could be preserved on a medium of precise composition. Sterilized, chopped, washed compost became the preferred medium for original pure culture spawn and was for years the standard of the *Agaricus* industry.

In 1932, Dr. James Sinden patented a new spawn making process using cereal grain as the mycelial carrier. Since then rye has been the most common grain employed although millet, milo and wheat have also been used. Sinden's novel approach set a new standard for spawn making and forms the basis for most modern spawn production. The distinct advantage of grain spawn is the increased number of inoculation sites. Each individual kernel becomes one such point from which mycelium can spread. Thus, a liter of rye grain spawn that contains approximately 25,000 kernels represents a vast improvement over inocula transmitted by coarser materials.

Listed below are cereal grains that can be used to produce spawn. Immediately following this list is a chart illustrating some of the physical properties important to the spawn maker.

RICE: Utilized by few cultivators. Even when it is balanced to recommended moisture levels, the kernels tend to clump together owing to the sticky nature of the outer coat.
MILLET: Although having a higher number of inoculation points than rye, it is more difficult to formulate as spawn. Amycel, a commercial spawn-making company, has successfully developed a formula and process utilizing millet as their primary spawn medium.
SORGHUM: Has spherical kernels and works relatively well as a spawn medium but it can be difficult to obtain. Milo, a type of sorghum, has been used for years by the Stoller Spawn Company.
WHEAT: Works equally well as rye for spawn making and fruitbody production.
WHEAT GRASS and **RYE GRASS SEED**: Both have many more kernels per gram than grain. The disadvantage of seed is the tendency to lose its moisture and its inability to separate into individual kernels, making it difficult to shake. (Rye grass and wheat grass seed are widely used to promote sclerotia formation in *Psilocybe tampanensis*, *Psilocybe mexicana* and *Psilocybe armandii*. Perennial or annual can be used although annual is far cheaper. See the species parameters for these species in Chapter XI.)
RYE: Its availability, low cost and ability to separate into individual kernels are all features recommending its use as a spawn and fruiting medium.

THE CEREAL GRAINS AND THEIR PHYSICAL PROPERTIES
(tests run by the authors)

TYPE	KERNELS/GRAM	GRAMS/100 ML	% MOISTURE
COMMERCIAL FEED RYE	30	75	15%
COMMERCIAL MUSHROOM RYE	40	72	13%
ORGANIC CO-OP RYE	55	76	11%
ORGANIC WHEAT	34	90	10%
SHORT GRAIN BROWN RICE	39	100	26%
LONG GRAIN BROWN RICE	45	86	15%
SORGHUM (MILO)	33	93	15%
PERENNIAL WHEAT GRASS SEED	450	43	16%
PERENNIAL RYE GRASS SEED	415	39	12%
MILLET	166	83	13%

In a single gram of commercial rye, *Secale cereale*, there is an estimated cell count of 50,000-100,000 bacteria, more than 200,000 actinomyces, 12,000 fungi and a large number of yeasts. To sterilize one gram of grain would require, in effect, the destruction of more than 300,000 contaminants! In a spawn jar containing in excess of a hundred grams of grain, and with the addition of water, the cell population soars to astronomical figures.

Of all the groups of these organisms, bacteria are the most pernicious. Bacteria can divide every twenty or so minutes at room temperature. At this rate, a single bacterium multiplies into more than a million cells in less than ten hours. In another ten hours, each one of these bacteria beget another million cells. If only a small fraction of one percent of these contaminants survive the sterilization process, they can render grain spawn useless within only a few days.

Most microorganisms are killed in the sterilization process. For liquids, the standard time and pressure for steam sterilization is 25 minutes at 15 psi (250°F). For solids such as rye, the sterilization time must be increased to insure that the steam sufficiently penetrates the small air pockets and structural cavities in the grain. Within these cavities bacteria and other thermo-resistant organisms, partially protected from the effects of steam, have a better chance of enduring a shorter sterilization period than a longer one. Hence, a full hour at 15 psi is the minimum time recommended to sterilize jars of rye grain.

Some shipments of grain contain extraordinarily high levels of bacteria and fungi. Correspondingly the contamination rate on these grains are higher, even after autoclaving and prior to inoculation. Such grain should be discarded outright and replaced with grain of known quality.

Once the grain has been sterilized, it is presumed all competitors have been neutralized. The next most probable source of contamination is the air immediately surrounding the jars. As hot jars cool, they suck in air along with airborne contaminants. If the external spore load is excessively high, many of these contaminants will be introduced into the grain even before conducting a single inoculation! In an average room, there are 10,000 particulates exceeding .3 microns (dust, spores, etc.) per cubic foot while in a "sterile" laboratory there are less than 100 per cubic foot. With these facts in mind, two procedures will lessen the chance of contamination after the spawn jars have been autoclaved.

1. If autoclaving grain media outside the laboratory in an unsterile environment (a kitchen, for instance), be sure to clean the outside of the pressure cooker before bringing it into the sterile inoculating room.
2. Inoculate the jars as soon as they have cooled to room temperature. Although many cultivators leave uninoculated jars sitting in pressure cookers overnight, this is not recommended.

The amount of water added to the grain is an important factor contributing to the reproduction of contaminants. Excessive water in a spawn jar favors the growth of bacteria and other competitors. In wet grain the mushroom mycelium grows denser and slower. Oversaturated grain kernels explode during the sterilization process, and with their interiors exposed, the grain is even more susceptible to contamination. In addition, wet grain permeated with mycelium is difficult to break up into individual kernels. When such grain comes in contact with a non-sterile medium such as casing soil or compost, it frequently becomes contaminated. Spawn made with a balanced moisture content has none of these problems. It easily breaks apart into individual mycelium covered kernels, insuring a maximum number of inoculation points from which mycelial strands can emerge.

Determining the exact moisture content of grain is not difficult. Once done, the cultivator can easily calculate a specific moisture content that is optimal for use as spawn. Commercial rye grain, available through co-ops and feed companies, is 11% water by mass, plus or minus 2%. The precise amount of water locked up in grain can be determined by weighing a sample of 100 grams. Then reweigh the same grain after it has been dried in an oven (250°F. for 3 hours) and subtract this new weight from the original 100 grams. The resultant figure is the percentage of moisture naturally bound within the grain.

Preparation of Grain Spawn

The optimum moisture content for grain in the production of spawn is between 49-54%. The following formulas are based on cereal rye grain, *Secale cereale*, which usually has a moisture content of 11%. Some variation should be expected depending on the brand, kernel size, geographical origin and the way the grain has been stored.

The standard spawn container for the home cultivator is the quart mason jar while the commercial spawn maker prefers the gallon jar. Wide mouth mason jars have been extensively used by home cultivators because of several books popularizing fruitbody production in these jars. Wide mouth jars have been preferred because mushrooms grown in them are easier to harvest than those in narrow mouth ones. Not only is this method of growing mushrooms outdated, but wide mouth jars have several disadvantages for spawn production and hence are not recommended. Narrow mouthed containers have less chance of contaminating from airborne spores because of their smaller openings and are more suited to use with synthetic filter discs. The purpose of the spawn container is to temporarily house the incubating mycelium before it is laid out in trays or used to inoculate bulk substrates. Jars are not well suited as a fruiting container.

Most commercial spawn makers cap their spawn bottles with synthetic filter discs which allow air penetration and gaseous exchange but not the free passage of contaminating spores. Home cultivators, on the other hand, have used inverted mason lids which imperfectly seal and allow some air exchange. This method works fine under sterile conditions although the degree of filtration is not guaranteed. The best combination uses filter discs in conjunction with one piece screw top lids having a ⅜-½ inch diameter hole drilled into its center and fitting a narrow mouthed autoclavable container. The authors personally find the regular mouthed ½ gallon mason jar to be ideal. (Note: These ½ gallon jars are inoculated from quart masters, a technique soon to be discussed). Using only filter discs on wide mouth jars is not recommended due to the excessive evaporation from the grain medium.

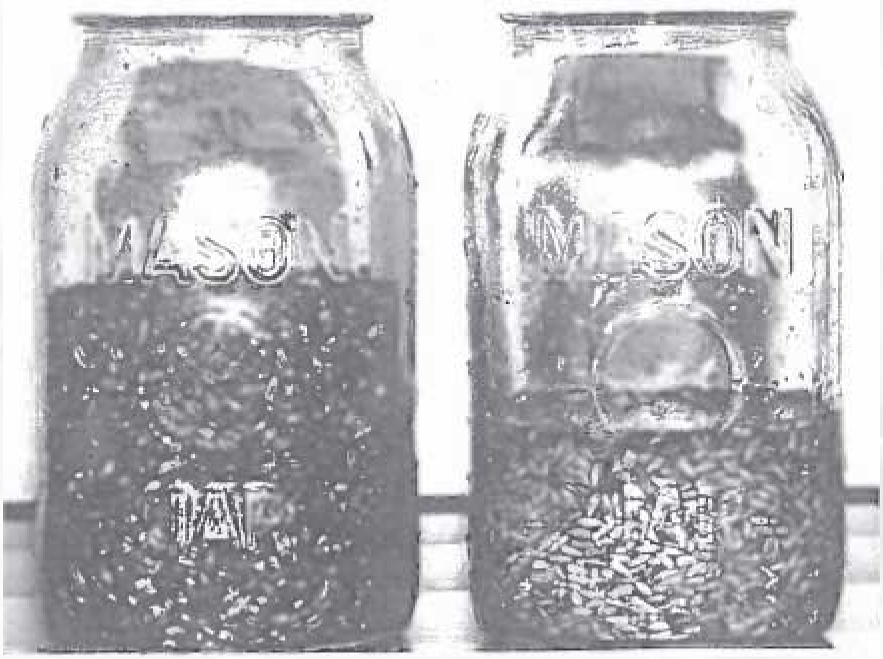


Figure 45 - Two jars of grain media, before and after autoclaving using the above formulas.

To produce grain spawn of 48-52% moisture use the formulas outlined below and autoclave in a pressure cooker for 1 hour at 15-18 psi. Note that considerable variation exists between measuring cups, differing as much as 10% in their volumes. Check the measuring cup with a graduated cylinder. Once standardized, fashion a "grain scoop" and a "water scoop" from a plastic container to the proportions specified below.

Spawn Formulas

QUART JARS	½ GALLON JARS
1 cup rye grain	3 cups rye grain
⅔-¾ cup water	1¾ cups water
or (approximately)	
240 ml. grain	600 ml. rye grain
170-200 ml. water	400-460 ml. water

The above formulas fill a quart or a half gallon jar to nearly ⅔ of its capacity after autoclaving. In all these formulas, chalk ($CaCO_3$) and gypsum ($CaSO_4$) can be added at a rate of 1-3 parts by weight per 100 parts of grain (dry weight). The ratio of chalk to gypsum is 1:4. The addition of these elements to spawn is optional for most species but necessary when growing *Agaricus brunnescens*. When these calcium buffers are used, add 10% more water than that listed above.

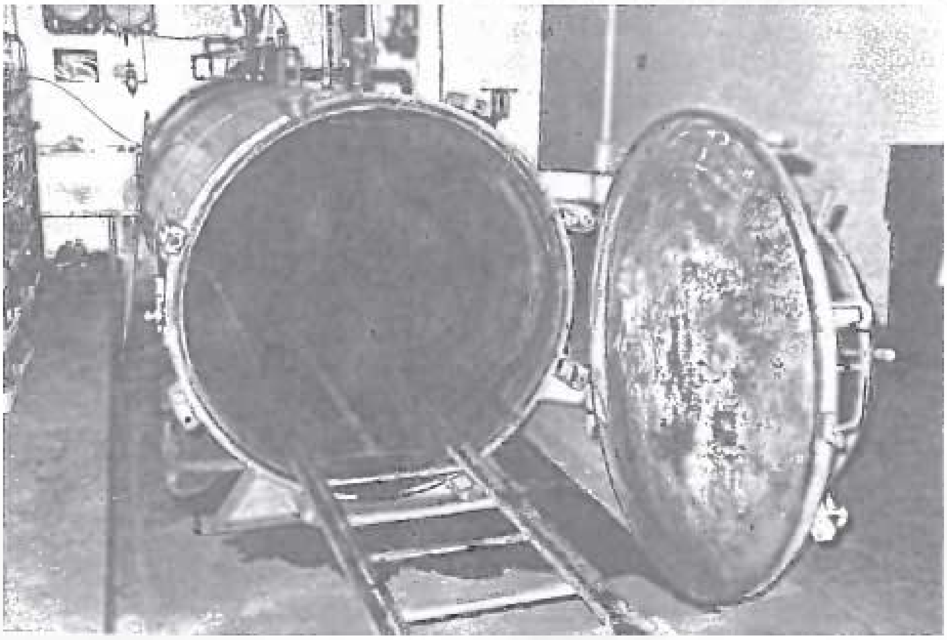


Figure 46 - Commercial spawn maker's autoclave.

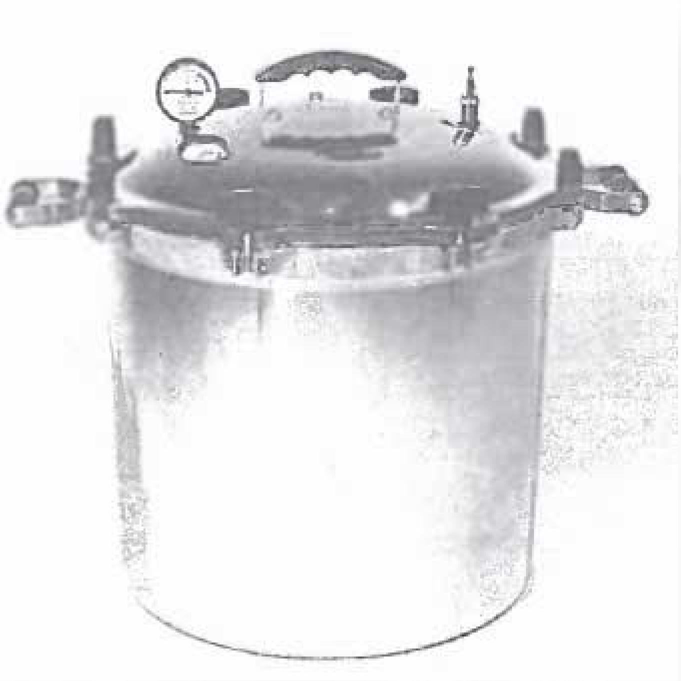


Figure 47 - Pressure cooker of home cultivator.

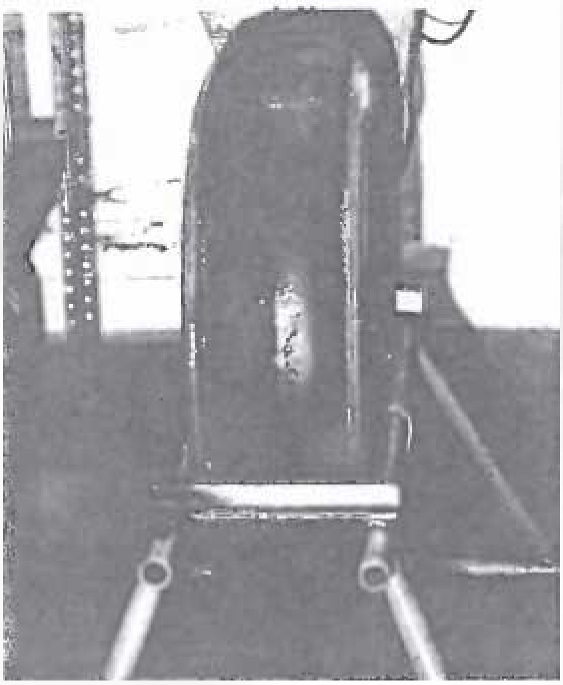


Figure 48 - The rubber tire is a helpful tool for the spawn laboratory. It is used to loosen grain spawn.

Once the grain filled jars have been autoclaved, they should be placed in the sterile room and allowed to cool. Prior to this point, the room and its air should be disinfected, either through the use of traditional cleaning methods, HEPA filters or both.

Upon removing the warm jars from the pressure cooker or autoclave, shake them to loosen the grain and to evenly distribute wet and dry kernels. Shaking also prevents the kernels at the bottom of the jar from clumping.

An excellent tool to help in this procedure is a bald car tire or padded chair. Having been carefully cleaned and disinfected, the tire should be mounted in an upright and stable position. The tire has a perfect surface against which to shake the jars, minimizing discomfort to the hands and reducing the risk of injury from breakage. The tire will be used at another stage in grain culture, so it should be cleaned regularly. Paint shakers are employed by commercial spawn makers for this same purpose but they are inappropriate for the home cultivator. **CAUTION**: ALWAYS INSPECT THE JARS FOR CRACKS BEFORE SHAKING.

When the grain jars have returned to room temperature, agar to grain inoculations can commence. Once again, good hygiene is of the upmost importance. When transferring mycelium from agar to grain, another dimension is added in which contaminants can replicate. In agar culture, the mycelium grows over a flat, two dimensional surface. If contamination is present, it is easily seen. In grain culture, however, the added dimension of depth comes into play and contaminants become more elusive, often escaping detection from the most discerning eye. If not noticed, contamination will be spread when this spawn is used to inoculate more sterilized grain.

Before conducting transfers, take precautions to insure the sterile quality of the inoculation environment. After cleaning the room, do not jeopardize its cleanliness by wearing soiled clothes. Few cultivators take into consideration that they are a major source of contamination. In fact, the human body is in itself a habitat crawling with bacteria, microscopic mites, and resplendent with spores of plants and fungi.

When satisfied that all these preparatory conditions are in force, the making of spawn can begin.

Inoculation of Sterilized Grain from Agar Media

Select a vigorously growing culture whose mycelium covers no more than ¾ of the agar's surface. Cultures that have entirely overrun the Petri dish should be avoided because contaminants often enter along the margin of the Petri dish. If that outer edge is grown over with mycelium, these invaders can go undetected. Since this peripheral mycelium can become laden with contaminant spores, any grain inoculated with it would become spoiled.

Flame sterilize a scalpel and cut out a triangular wedge of mycelium covered agar using the technique described for doing agar-to-agar transfers. With careful, deliberate movements quickly transfer the wedge to an awaiting jar, exposing the grain for a minimal amount of time. For each transfer, flame sterilize the scalpel and inoculate wedges of mycelium into as many jars as desired. A Petri dish two thirds covered with mycelium should amply inoculate 6-8 quart jars of grain. (A maximum of 10-12 jars is possible). The more mycelia transferred, the faster the colonization and the less chance of contamination. Since these jars become the "master cultures", do everything possible to guarantee the highest standard of purity.

The authors recommend a "double wedge" transfer technique whereby a single triangular wedge of mycelium is cut in half, both pieces are speared and then inserted into an awaiting jar of sterilized grain. Jars inoculated with this method grow out far faster than the single wedge transfer technique.

Loosening the lids prior to inoculation facilitates speedy transfers. As each agar-to-grain transfer is completed, replace the lid and continue to the next inoculation. Once the set is finished, tightly secure the lids and shake each jar thoroughly to evenly distribute the mycelial wedges. In the course of shaking, each wedge travels throughout the grain media leaving mycelial fragments adhering to the grain kernels. If a wedge sticks to the glass, distribution is hampered and spawn running is inhibited. This problem is usually an indication of agar media that has been too thinly poured or has been allowed to dehydrate. Once shaken, incubate the spawn jars at the appropriate temperature. (A second shaking may be necessary on Day 4 or Day 5). In general, the grain should be fully colonized with mycelium in seven to ten days.

Inoculation of Grain from Grain Masters

Once fully colonized, these grain masters are now used for the further production of grain spawn in quart or ½ gallon containers. Masters must be transferred within a few days of their full colonization; otherwise the myceliated kernels do not break apart easily. A step by step description of the grain-to-grain transfer technique follows.

1. Carefully scrutinize each jar for any signs of contamination. Look for such abnormalities as: heavy growth; regions of sparse, inhibited growth; slimy or wet looking kernels (an indication of bacteria); exploded kernels with pallid, irregular margins; and any unusual colorations. If in doubt lift the lid and smell the spawn - a sour "rotten apple" or otherwise pungent odor is usually an indication of contamination by bacteria. Jars having this scent should be discarded. (Sometimes spawn partially

contaminated with bacteria can be cased and fruited). Do NOT use any jar with a suspect appearance for subsequent inoculations.

2. After choosing the best looking spawn masters, break up the grain in each jar by shaking the jars against a tire or slamming them against the palm of the hand. The grain should break easily into individual kernels. Shake as many masters as needed knowing that each jar can amply inoculate ten to twelve quart jars or seven to nine half gallon jars.
   Once completed, SET THE SPAWN JARS ON A SEPARATE SHELF AND WAIT TWELVE TO TWENTY-FOUR HOURS BEFORE USING. This waiting period is important because some of the spawn may not recover, suffering usually from bacterial contamination. Had these jars been used, the contamination rate would have been multiplied by a factor of ten.
3. Inspect the jars again for signs of contamination. After twelve to twenty-four hours, the mycelium shows signs of renewed growth.
4. If the masters had been shaken the night before, the inoculations can begin the following morning or as soon as the receiving jars (G-2) have cooled. Again, wash the lab, be personally clean and wear newly laundered clothes.
   Place 10 sterilized grain-filled jars on the work-bench in the sterile room. Loosen each of the lids so they can be removed with one hand. Gently shake the master jar until the grain spawn separates into individual kernels. Hold the master in your preferred hand. Remove the master's lid and then with the other hand open the first jar to be inoculated. With a rolling of the wrist, pour one tenth of the master's contents into the first jar, replace its lid and continue to the second, third, fourth jars, until the set is completed. When this first set is done, firmly secure the lids. Replace the lid on the now empty spawn master jar and put it aside. Take each newly inoculated jar, and with a combination of rolling and shaking, distribute the mycelium covered kernels evenly throughout.
5. Incubate at the temperature appropriate for the species being cultivated. In a week the mycelium should totally permeate the grain. Designated G-2, these jars can be used for further inoculations, as spawn for the inoculation of bulk substrates, or as a fruiting medium.

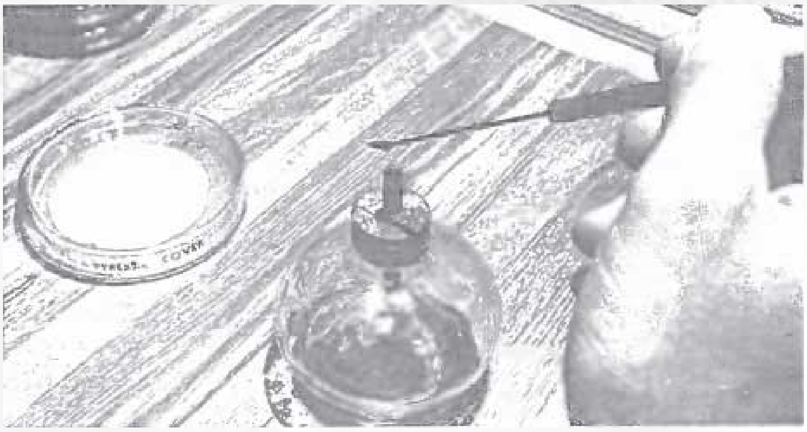


Figure 49 - Flaming the scalpel.

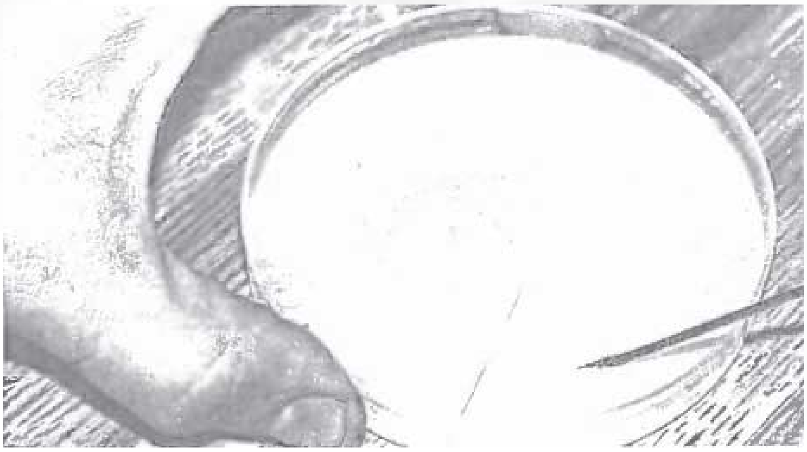


Figure 50 - Cutting two wedges of mycelium colonized agar.

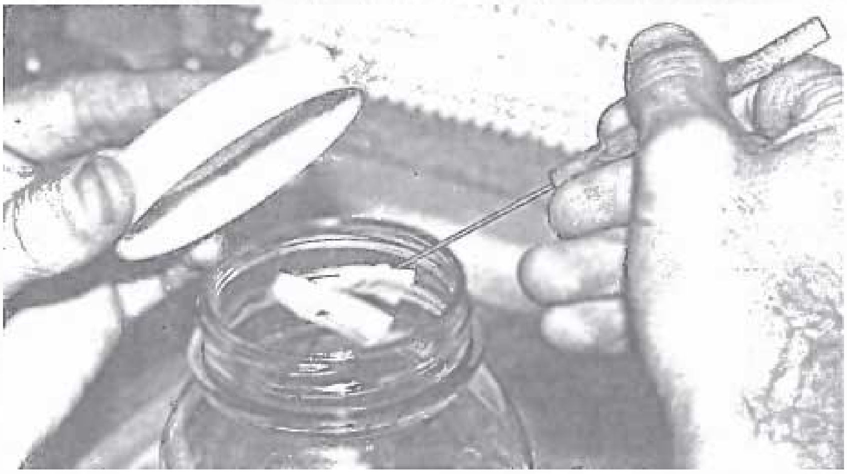


Figure 51 - Inoculating sterilized grain.

Some species are less aggressive than others. *Agaricus brunnescens*, for instance, can take up to two and a half weeks to colonize grain while *Psilocybe cubensis* grows through in a week to ten days. Here again, the use of the tire as a striking surface can be an aid to shaking. For slower growing species, a common shaking schedule is on the 5th and 9th days after inoculation. The cultures should be incubated in a semi-sterile environment at the temperature most appropriate for the species being cultivated. (See Chapter XI).

After transferring mycelium from agar to grain, further transfers can be conducted from these grain cultures to even more grain filled jars. A schedule of successive transfers from the first inoculated grain jar, designated G-1, through two more "generations" of transfers (G-2, G-3 respectively) will result in an exponential expansion of mycelial mass. If for instance, 10 jars were inoculated from an agar grown culture (G-1), they could further inoculate 100 jars (G-2) which in turn could go into 1000 jars (G-3). As one can see, it is of critical importance that the first set of spawn masters be absolutely pure for it may ultimately inoculate as many as 1,000 jars! Inoculations beyond the third generation of transfers are not recommended. Indeed, if a contamination rate above 10% is experienced at the second generation of transfers, then consider G-2 a terminal stage. These cultures can inoculate bulk substrates or be laid out in trays, cased and fruited.

Grain-to-grain transfers are one of the most efficient methods of spawn making. This method is preferred by most commercial spawn laboratories specializing in *Agaricus* culture. They in turn sell grain spawn that is a second or third transfer to *Agaricus* farmers who use this to impregnate their compost. For the creation of large quantities of spawn, the grain-to-grain technique is far superior to agar-to-grain for both its ease and speed. However, every cultivator must ultimately return to agar culture in order to maintain the purity of the strain.

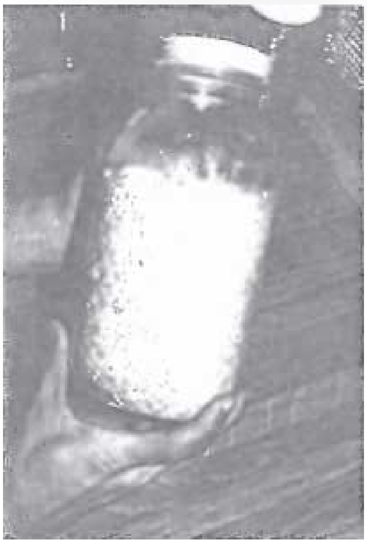


Figure 52a - Spawn master ready for transfer.

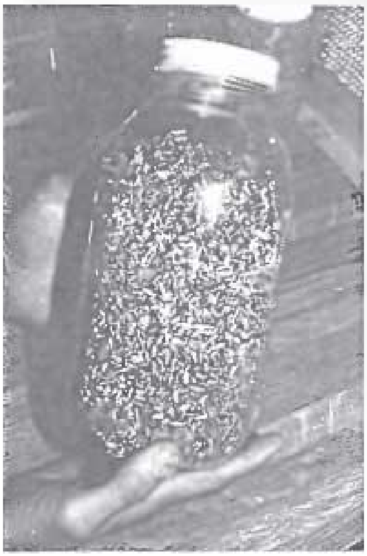


Figure 52b - Spawn master after shaking.

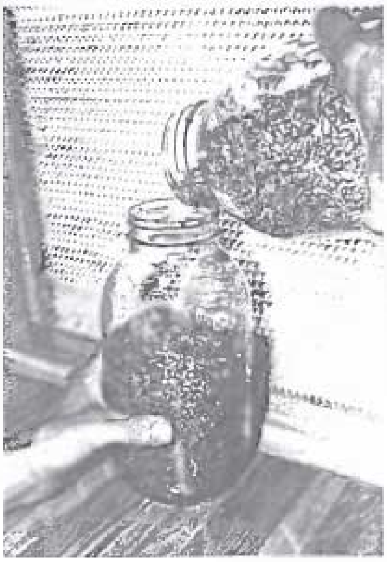


Figure 52c - Inoculating sterilized grain from spawn master.

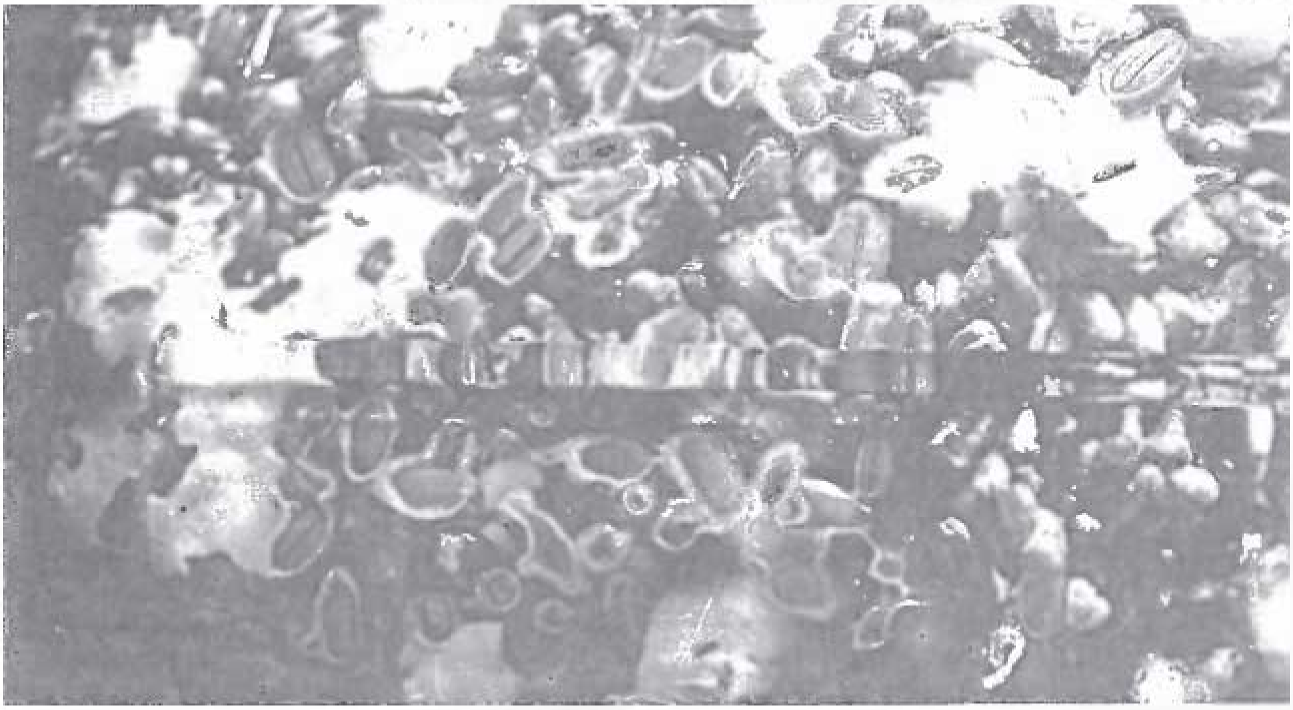


Figure 53 - Spawn jar contaminated with Wet Spot bacteria, giving the grain a greasy appearance and emitting a sour odor.

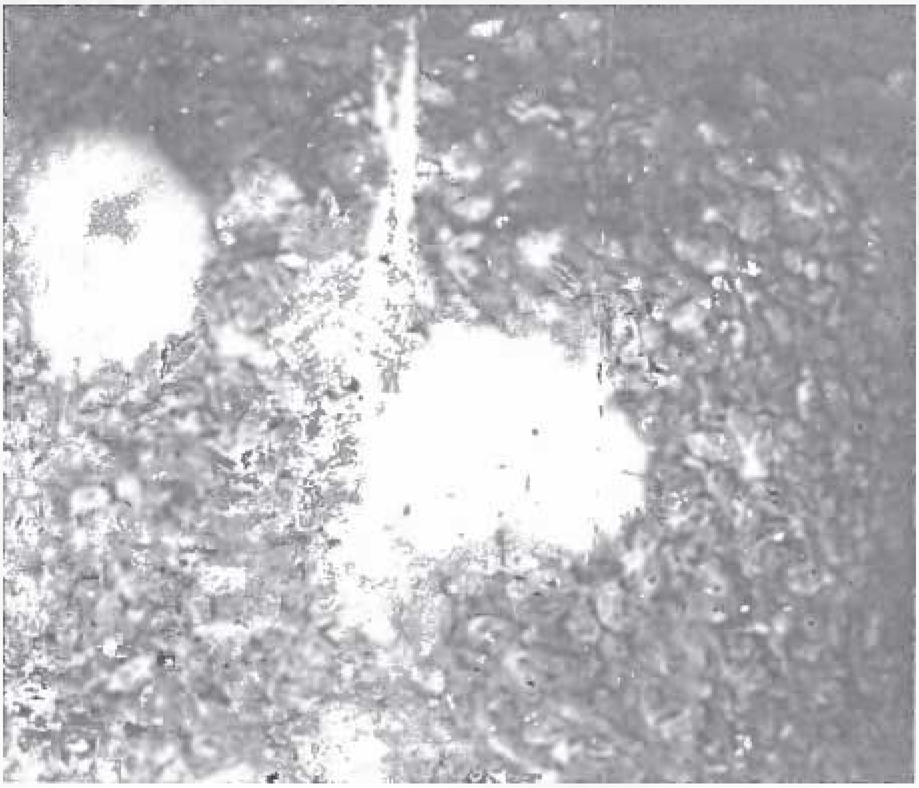


Figure 54 - Spawn jar with Heavy Growth, an undesirable characteristic arising from cottony sectors.

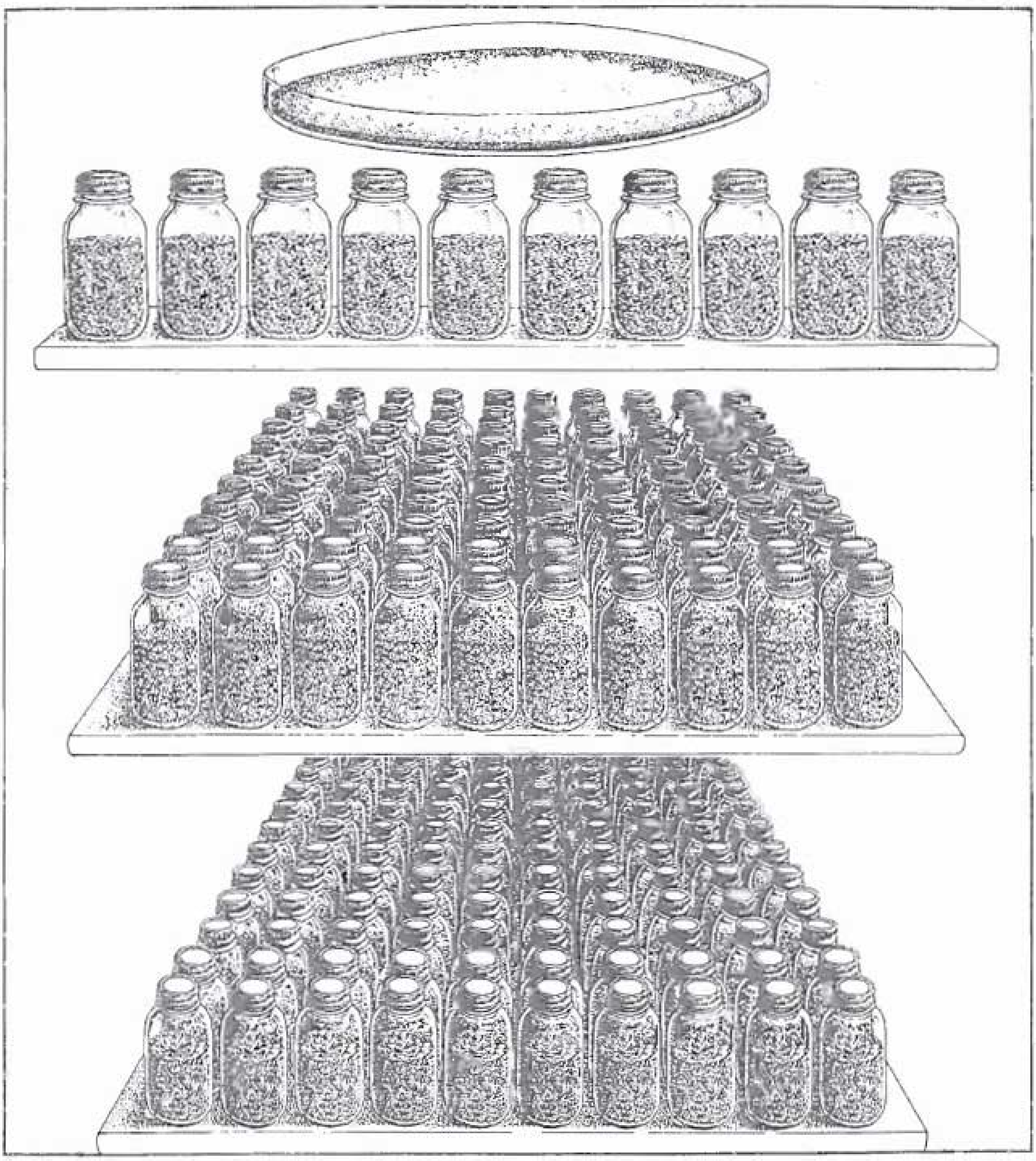


Figure 55 - Diagramatic expansion of mycelial mass using grain-to-grain transfer technique. One Petri dish can inoculate 10 spawn jars (G-1) which in turn can be used to inoculate 100 more jars (G-2) and eventually 1000 jars of spawn (G-3) provided the culture remains pure.

Alternative Spawn Media

Some mushroom species do not grow well on grain and are better suited to alternative spawn media. Other mushrooms are grown on substrates incompatible with grain spawn. For example, sawdust and bran are the preferred spawn materials for the cultivations of wood inhabitors such as *Lentinus edodes* and *Flammulina velutipes*. Another spawn media has a perlite bran base. Perlite is vitreous rock, heated to 1000°F. and exploded like popcorn. The thin flakes of bran are readily sterilized while the perlite gives the medium its structure. The recipes are:

Sawdust/Bran Spawn

4 parts sawdust (hardwood)
1 part bran (rice or wheat)
Soak the sawdust in water for a least twenty four hours, allow to drain and then thoroughly mix in the bran. If the mixture has the proper moisture content, a firm squeeze results in a few drops between the fingers. Fill the material firmly to the neck of the spawn container (wide mouth). Japanese spawn makers bore a ½ inch diameter hole down the center of the media into which they later insert their inoculum. Sterilize for 60-90 minutes at 15 psi. Once cooled, inoculate from agar media, liquid emulsion, or grain. A fully grown bottle of sawdust bran spawn can also be used for further inoculations.

Perlite Spawn

120 milliliters water
40 grams perlite
50 grams wheat bran
6 grams gypsum (calcium sulfate)
1.5 grams calcium carbonate
Screen the perlite to remove the fine powder and particulates. Fill the container (small mouth) with the dry ingredients and mix well. Add the water and continue mixing until the ingredients are thoroughly moistened. Sterilize for one hour at 15 psi. Inoculate from agar media or liquid emulsion.

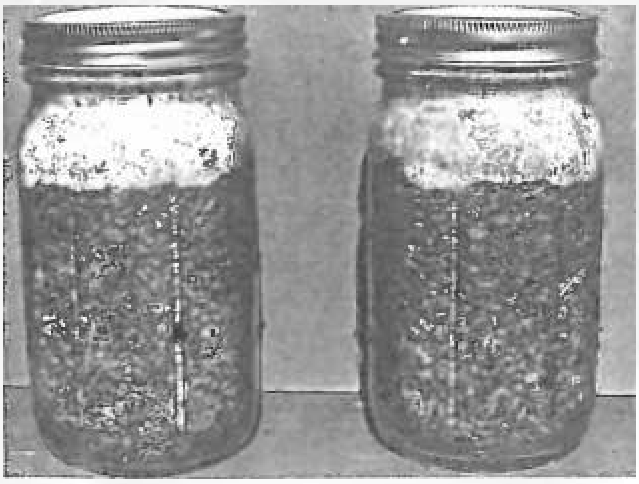


Figure 56 - Mycelium running through sawdust/bran spawn.

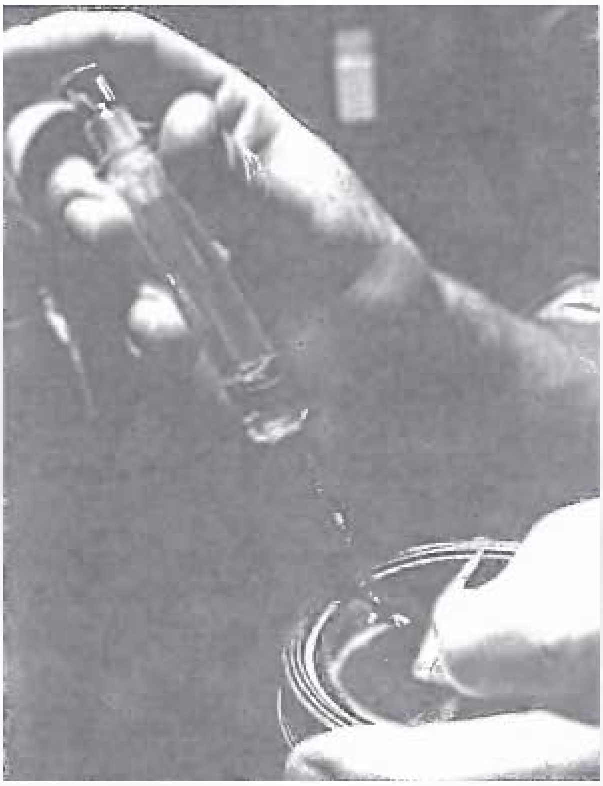
Liquid Inoculation Techniques

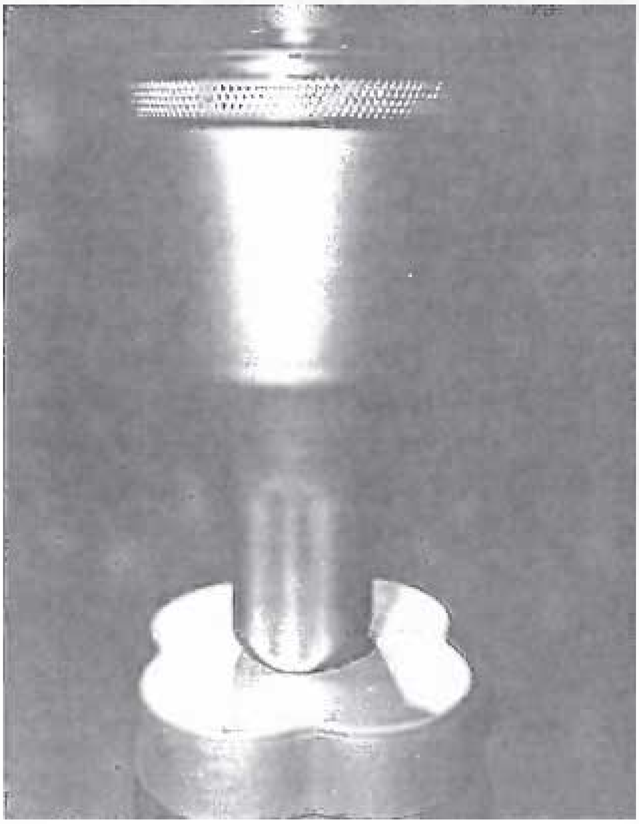
A highly effective technique for inoculating grain utilizes the suspension of fragmented mushroom mycelia in sterile water. This mycelium enriched solution, containing hundreds of minute cellular chains, is then injected into a jar of sterilized grain. As this water seeps down through the grain, mycelial fragments are evenly distributed, each one of which becomes a point of inoculation. For several days little or no sign of growth may be apparent. On the fourth to fifth day after injection, given optimum incubation temperatures, sites of actively growing mycelium become visible. In a matter of hours, these zones enlarge and the grain soon becomes engulfed with mycelium. Using the liquid inoculation technique eliminates the need for repeated shaking, and a single plate of mycelium can inoculate up to 100 jars, more than ten times the number inoculated by the traditional transfer method. There are several ways to suspend mycelium in water, two of which are described here.

The first method is quite simple. Using an autoclaved glass syringe, inject 30-50 ml. of sterilized water into a healthy culture. Then scrape the surface of the mycelial mat, drawing up as many fragments of mycelium as possible. As little as 5 ml. of mycelial suspension adequately inoculates a quart jar of grain.

The second method incorporates a blender with an autoclavable container-stirrer assembly. (Several companies sell aluminum and stainless steel units specifically manufactured for liquid culture techniques - refer to the sources listed in the Appendix). Fill with water until two thirds to three quarters full, cover with aluminum foil (if a tight fitting metal top is not handy), sterilize and allow to cool to room temperature.

Under aseptic conditions, insert an entire agar culture of vigorously grown mycelium into the sterilized stirrer by cutting it into four quadrants or into narrow strips. Because many contaminants appear along the outer periphery of a culture dish, it is recommended that these regions not be used. Place all four quadrants or mycelial strips into the liquid. Turn on the blender at high speed for no longer than 5 seconds. (Longer stirring times result not in the fragmentation of cell chains but in the fracturing of individual cells. Such suspensions are inviable). Draw up 5-10 ml. of the mycelium concentrate and inoculate an awaiting grain jar.





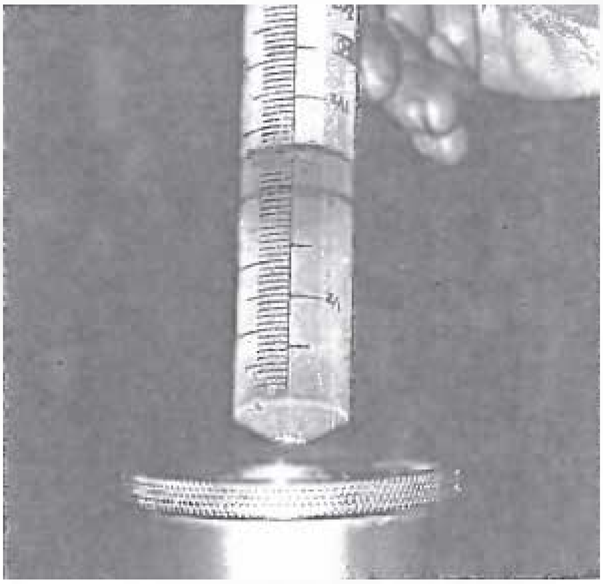


Figure 57 - Drawing up mycelium from culture dish with syringe.
Figure 58 - Syringe inoculation of sterilized grain.
Figure 59 - Eberbach container manufactured for liquid culture. Note bolt covering inoculation hole.
Figure 60 - Drawing up liquid inoculum.

A further improvement on this technique calls for a 10:1 dilution of the concentrated mycelial solution. Inject 50 ml. of mycelial suspension into four vessels containing 450 ml. of sterilized water. Narrow mouth quart mason jars are well suited to this technique. Gently shaking each jar will help evenly distribute the mycelium. Next inoculate the grain jars with 10-15 milliliters of the diluted solution. This method results in an exponential increase of liquid inoculum with the water acting as a vehicle for carrying the mycelial fragments deep into the grain filled jar. This is only one technique using water suspended fragments of mycelium. Undoubtedly, there will be further improvements as mycophiles experiment and develop their own techniques.

When using metal lids a small 1-2 mm. hole can be drilled and then covered with tape. When the sterilized containers are to be inoculated, remove the tape, insert the needle of syringe, inject the suspension of mycelia and replace the tape. In this way, the aperture through which the inoculation takes place is of minimal size and is exposed for a only second or two. The chance of airborne contamination is minimized.

The liquid inoculation technique works well provided the cultures selected are free from foreign spores; otherwise the entire set of jars inoculated from that dish will be lost. The disadvantage with this method is that there is no opportunity to avoid suspect zones on the culture dish - the water suspends contaminant spores and mycelia alike. If a culture dish is contaminated in one region, a few jars may be lost via the traditional inoculation method while with the liquid inoculation technique whole sets of up to one hundred spawn jars would be made useless.

Although mycelial suspensions created in this manner work for many species, the mycelia of some mushrooms do not survive the stirring process.

Incubation of Spawn

With each step in the cultivation process, the mycelial mass and its host substrate increases. In seven days to two weeks after inoculation, the spawn jars should be fully colonized with mushroom mycelia. The danger here is that, if contamination goes undetected, that mold or bacterium will likewise be produced in large quantities. Hence, as time goes by the importance of clean masters becomes paramount. By balancing environmental parameters during incubation, especially temperature, the mycelium is favored.

Once the jars have been inoculated, store them on shelves in a semisterile room whose temperature can be easily controlled. Light and humidity are not important at this time as a sealed jar should retain its moisture. Air circulation is important only if the incubating jars overheat. In packing a room tightly with spawn jars, overheating is a danger. Many thermophilic fungi that are inactive at room temperature flourish at temperatures too high for mushrooms. Herein lies one of the major problems with rooms having a high density of incubating spawn jars. If possible, some provisions should be made to prevent temperature stratification in the incubation environment.

The major factor influencing the rate of mycelial growth is temperature. For every species there is an optimum temperature at which the rate of mycelial growth is maximized. As a general rule, the best temperature for vegetative (spawn) growth is several degrees higher than the one most stimulatory for fruiting. In Chapter XI, these optimum temperatures and other parameters are listed for more than a dozen cultivated mushrooms. Yet another factor affecting both growth rate and susceptibility to contamination is moisture content, a subject covered in the previous chapter on grain culture.

Every day or so inspect the jars and check for the slightest sign of contamination. The most common are the green molds *Penicillium* and *Aspergillus*. If contamination is detected, seal the lid and remove the infected culture from the laboratory and growing facility. If a jar is suspected to be contaminated, mark it for future inspection.

Not all discolorations of the grain are *de facto* contaminants. Mushroom mycelium exudes a yellowish liquid metabolite that collects as droplets around the myceliated kernels of grain. As the culture ages and the kernels are digested, more metabolic wastes are secreted. Although this secretion is mostly composed of alcohols (ethanol and acetone), in time acids are produced that cause the lowering of the substrate's pH. These waste products are favorable to the propagation of bacteria that thrive in aqueous environments. Small amounts of this fluid do not endanger the culture; excessive waste fluids (where the culture takes on a yellowish hue) are definitely detrimental. If this fluid collects in quantities, the mycelium sickens and eventually dies in its own wastes. Such excessive "sweating" is indicative of one or a combination of the following conditions:

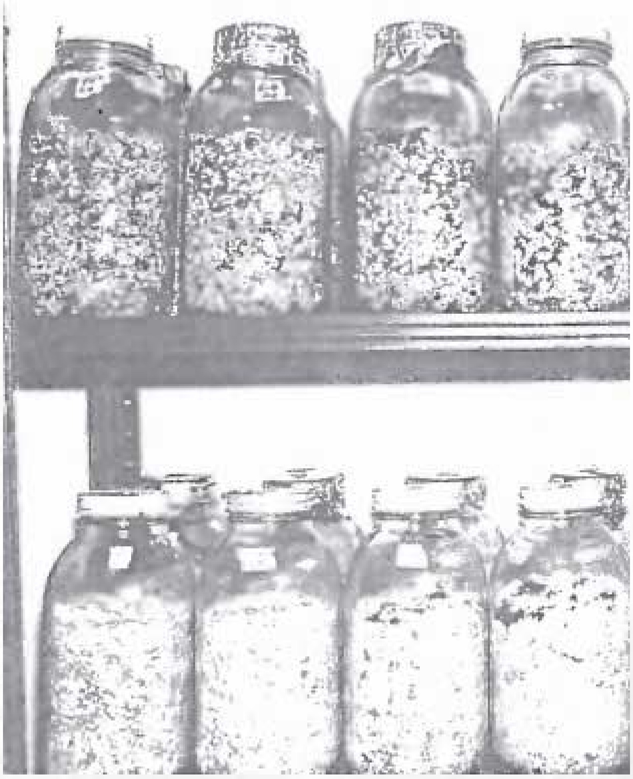


Figure 61 - Half gallon jars of spawn incubating in semisterile environment.

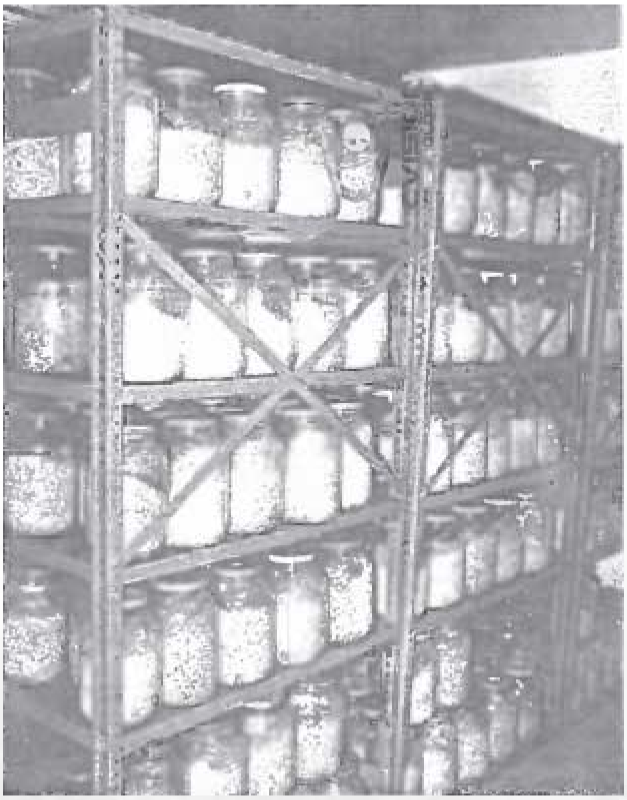


Figure 62 - Gallon jars incubating in semisterile environment.

1. Incubation at too high a temperature for the species being cultivated. Note that the temperature within a spawn jar is several degrees higher than the surrounding air temperature.
2. Over-aging of the cultures; too lengthy an incubation period.
3. Lack of gas exchange, encouraging anaerobic contamination.

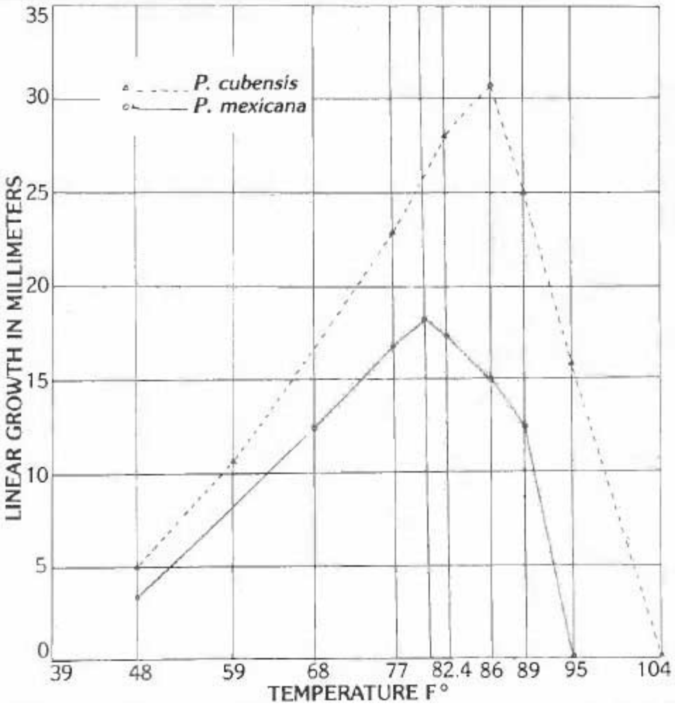


Figure 63 - Chart showing influence of temperature on the rate of mycelial growth in *Psilocybe cubensis* and *Psilocybe mexicana*. (Adapted from Ames *et al.*, 1958).

Contaminated jars should be sterilized on a weekly basis. Do not dig out moldy cultures unless they have been autoclaved or if the identity of the contaminant in question is known to be benign. Several contaminants in mushroom culture are pathogenic to humans, causing a variety of skin diseases and respiratory ailments. (See Chapter XIII on the contaminants of mushroom culture). Autoclave contaminated jars for 30 minutes at 15 psi and clean soon after. Many autoclaved jars, once contaminated, re-contaminate within only a few days if their contents have been not discarded.

If an exceptionally high contamination rate persists, review the possible sources of contamination, particularly the quality of the master spawn cultures (such as the moisture content of the grain) and the general hygiene of the immediate environment. Once the cultures have grown through with mycelium and are of known purity, this spawn can be used to inoculate bulk substrates or can be layed out in trays, cased and fruited.

IV. THE MUSHROOM GROWING ROOM

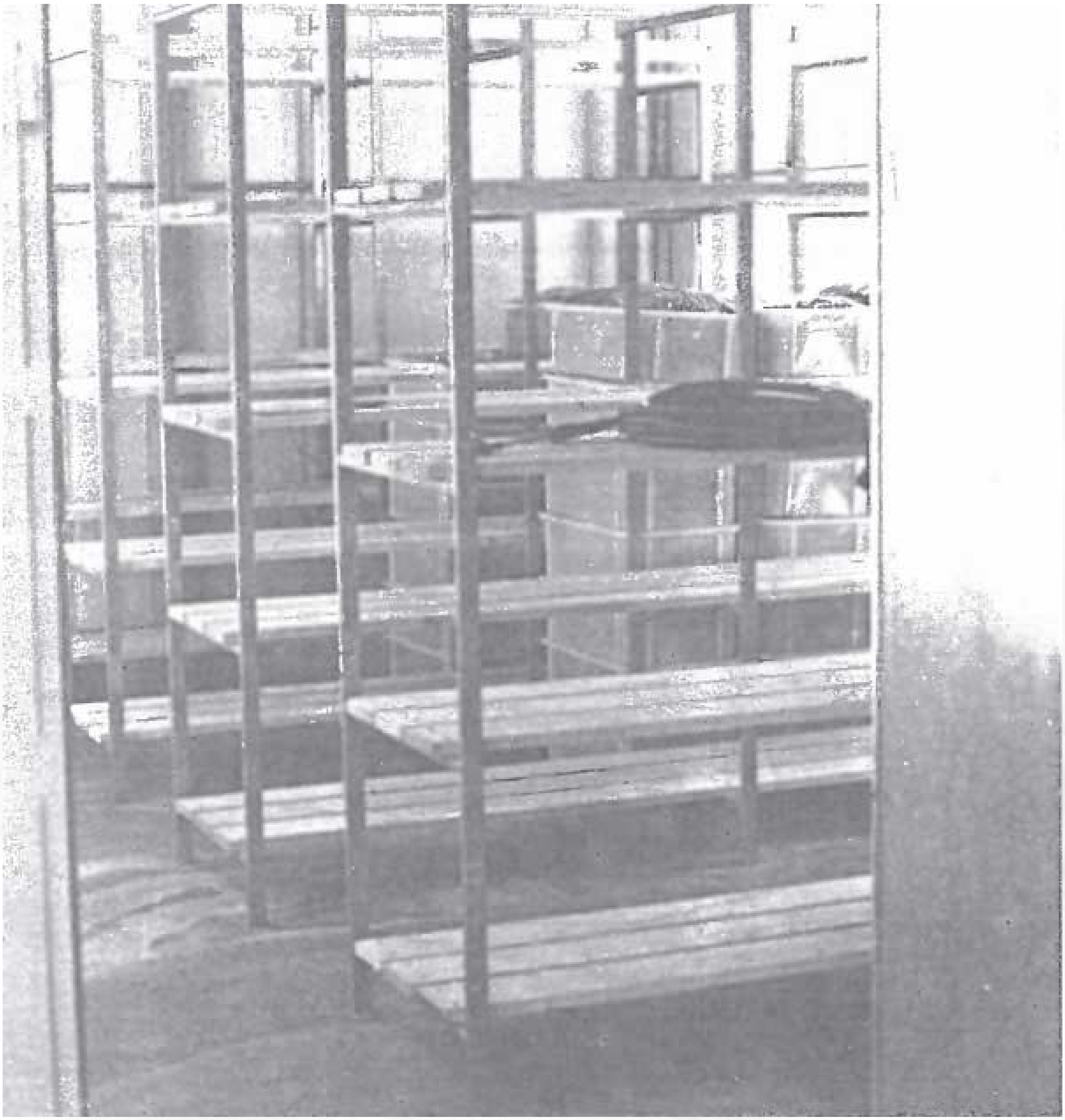


Figure 64 - Small growing room utilizing shelves.

Structure and Growing Systems

Mushroom cultivation was originally an outdoor activity dependent on seasonal conditions. Substrates were prepared and spawned when outside temperatures and humidify were favorable. This is still the case with many small scale growers of *Volvariella volvacea*, *Stropharia rugoso-annulata* and *Lentinus edodes*.

Agaricus cultivators grow solely indoors. Initially, *Agaricus* growers in France adapted the limestone mines near Paris and in the Loire valley to meet the necessary cultural requirements of that mushroom. These "caves" were well suited because of their constant temperature and high humidity, essential requirements for mushroom growing. When the first houses designed solely for mushrooms were built in the early 1900's, temperature and humidify control were the main factors guiding their construction.

For the home cultivator, a growing room should be scaled according to the scope of the project. The following guidelines supply the information to properly design and equip a growing chamber, basement growing room, outdoor shed or garage.

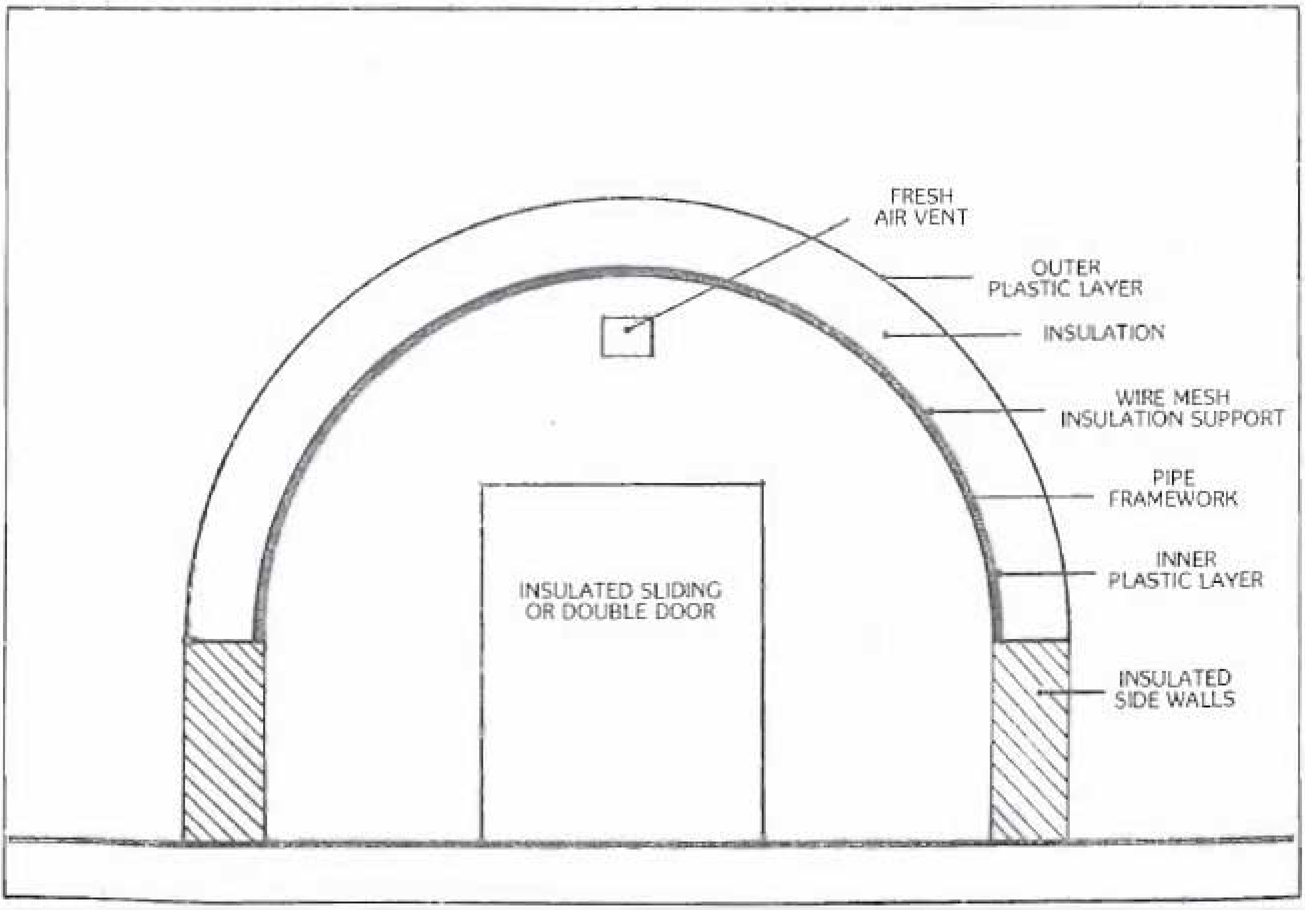


Figure 65 - An insulated plastic greenhouse suitable for mushroom growing.

Structure

The basic structure of a mushroom house is made of wood or concrete block with a cement floor. Because water collects on the floor during the cropping cycle, provisions should be made for drainage. A wood floor can be covered with a heavy gauge plastic. Interior walls, ceilings and exposed wood surfaces should be treated with a marine enamel or epoxy-plastic based paint. A white color enhances lighting and exposes any contaminating molds.

The most important feature of a growing room is the ability to maintain a constant temperature. In this respect, insulation is critical. The walls should be insulated with R=11 or R=9 and the ceiling with R=30 insulating materials. Fiberglass or styrofoam work well but should be protected from the high humidities of the growing room to prevent water from saturating them. For this purpose, a 2-4 mil. plastic vapor barrier is placed between the insulation and the interior wall.

An airtight room is an essential feature of the mushroom growing environment, preventing insects and spores from entering as well as giving the cultivator full control over the fresh air supply. During the construction or modification of the room, all cracks, seams and joints should be carefully sealed.

Many growers modify existing rooms in their own homes or basements. The main consideration for this approach is to protect the house structure (normally wood) from water damage and to make the growing chamber airtight. This is accomplished by plastic sheets stapled or taped to the walls, ceiling and floor, with the seams and adjoining pieces well sealed. If the room is adjacent to an exterior house wall where a wide temperature fluctuation occurs, condensation may form between the plastic and the wall. Within these larger structures, a plastic tent or envelope room can be constructed. Such a structure can be framed with 2" PVC pipe. The pipe forms a box frame to which the plastic is attached. This type of growing room should not need insulation because of the air buffer between it and the larger room.

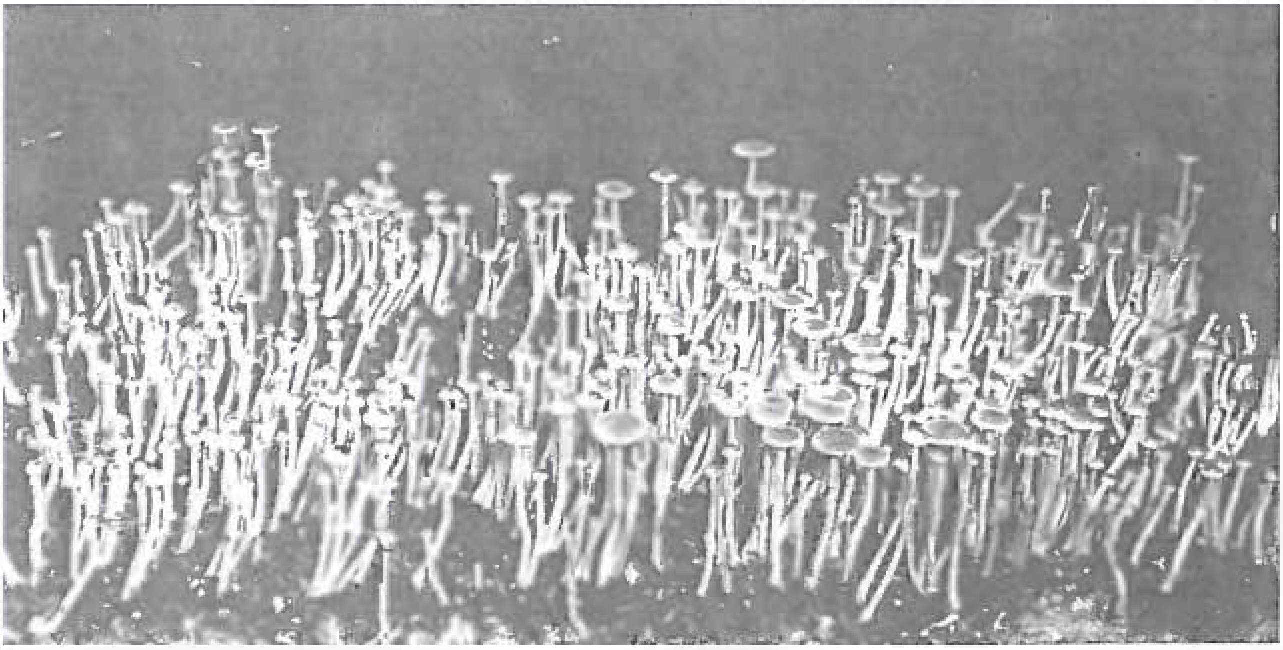


Figure 66 - Cultivation of mushrooms in an aquarium.

Porches, basements and garages can all be modified in the ways just mentioned. These areas can also be used with little additional change if the climate of the region is compatible with the mushroom species being grown. For example, *Lentinus edodes*, the shiitake mushroom, readily fruits at 50-60 degrees F. in a garage or basement environment.

The newest innovation in mushroom growing structures is the insulated plastic greenhouse. The framework is made of galvanized metal pipe bent into a semi-circular shape and mounted at ground level or on a 3.5 foot side wall. The ends of the walls and the doors are framed with wood. Heavy plastic (5-6 mil) is stretched over the metal framework to form the inner skin of the room. A layer of wire mesh is laid over the plastic and functions to hold 3-6 inches of fiberglass insulation in place. A second plastic sheet covers the insulation and protects it from the weather. The plastic should be stretched tight and anchored well. These layers are held in place by structural cable spanning the top and secured at each side. (See Figure 65). This type of structure, plastic coverings and plastic fasteners are all available at nursery supply companies. Remember, the design of a mushroom growing room strives to minimize heat gain and loss.

For people with little or no available space, "mini-culture" in small environmental chambers may be the most appropriate way to grow mushrooms. Styrofoam ice chests, aquariums and plastic lined wood or cardboard boxes can all be used successfully. Because of the small volume of substrates contained in one of these chambers, air exchange requirements are minimal. Usually, enough air is exchanged in opening the chamber for a daily or twice daily misting. Clear, perforated plastic covering the opening maintains the necessary humidity and the heat can be supplied by the outer room. Larger chambers can be equipped with heating coils or a light bulb on a rheostat. Both should be mounted at the base of the chamber. Mini-culture is an excellent and proven way to grow small quantities of mushrooms for those not having the time or resources to erect larger, more controlled environments.

Shelves

The most common indoor cultivation method is the shelf system. In this system, shelves form a platform upon which the mushroom growing substrate is placed. The shelf framework consists of upright posts with cross bars at each level to support the shelf boards. This fixed framework is constructed of wood or non-corrosive tubular metal. The shelves should be a preservative-treated softwood. The bottom boards are commonly six inches wide with one inch spaces between them. Side boards are 6-8 inches high depending on the depth of fill. A standardized design is shown in Figure 67. All shelf boards are placed unattached thereby allowing easy filling, emptying and cleaning. *Agaricus* growers fill the shelf house from the bottom up. The shelf boards are stacked at the side of the room and put into place after each level is completed.

The center pole design (shown in Figure 67) is a simple variation that is less restrictive and ideally suited for growing in plastic bags. Another alternative is to use metal storage shelves. These units come in a variety of widths and lengths and have the distinct advantage of being impervious to disease growth. Their use is particularly appropriate for cropping on sterilized substrates in small containers.

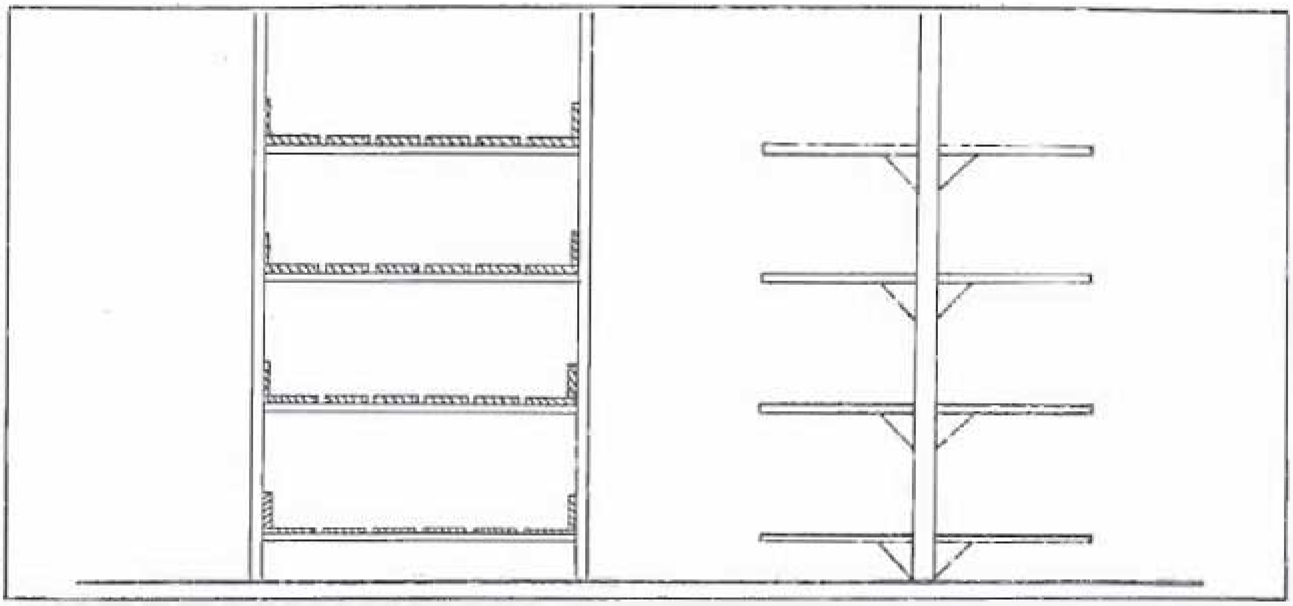


Figure 67 - Double support and centerpole design shelves. Both shelves are firmly attached to the floor and the ceiling.

Trays

The development of the tray system in *Agaricus* culture is largely due to the work of Dr. James Sinden. In direct contrast to anchored static shelves, trays are individual cropping units that have the distinct advantage of being mobile. This mobility has made mechanization of commercial cultivation possible. Automated tray lines are capable of filling, spawning and casing in less time, with fewer people and with better quality management.

Whereas in the shelf system all stages of the cultural cycle occur in the same room, the tray system utilizes a separate room for Phase II composting. On a commercial tray farm only the Phase II room is equipped for steaming and high velocity air movement.

A Sinden system tray design is shown in Figure 68. This tray has short legs in the up-position. During Phase II and spawn running these trays are stacked 15 cm. apart and tightly placed within the room to fully utilize compost heat. After casing, a wooden spacer is inserted between the trays for crop management, increasing the space to 25-35 cm. Other tray designs have longer legs in the down position and higher sideboards to accommodate more compost. These trays are similarly spaced throughout the cycle. In the growing room, trays can be stacked 3-6 high in evenly spaced rows. The main considerations for the home cultivator are that the trays can be easily handled and that they fit the floor space of the room.

The real advantage of the tray system is the ability to fill, spawn and case single units in an unrestricted environment outside the actual growing room. The tray system also gives the cultivator more control over hygiene and improves the efficiency of the operation. Moving trays from room to room does present contamination possibilities; therefore, the operations room must also be clean and fly tight for spawning and casing. Because there is no fixed framework in the growing room, it is easily cleaned and disinfected.

The tray method has many distinct advantages over the mason jar method for home cultivators preferring to fruit mushrooms on sterilized grain. These advantages are: fewer necessary spawn containers; fewer aborts due to uncontrolled primordia formation between the glass/grain interface; ease of picking and watering; better ratio of surface area to grain depth; and comparatively higher yields on the first and second flushes. An inexpensive tray is the 3-4 inch deep plant propagation flat commonly sold for staring seedlings. An example of such a tray is pictured in Fig. 69.

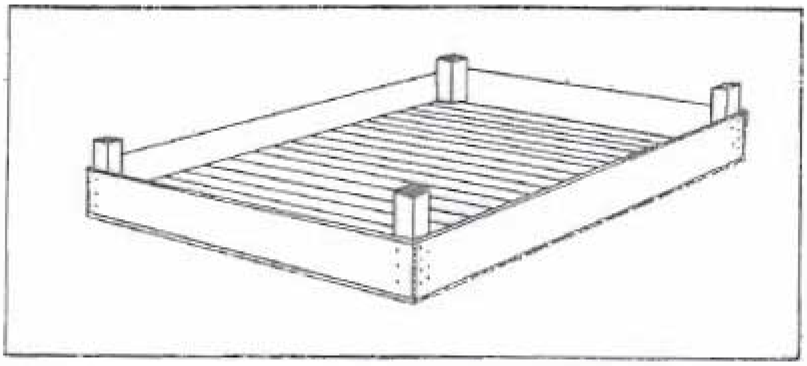
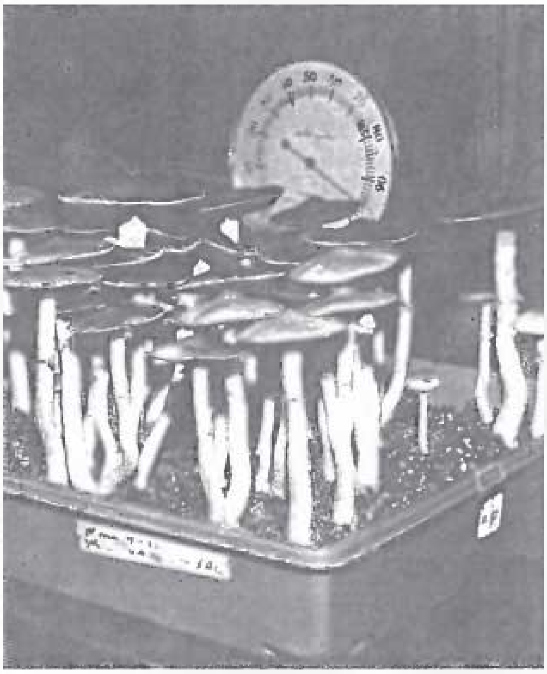
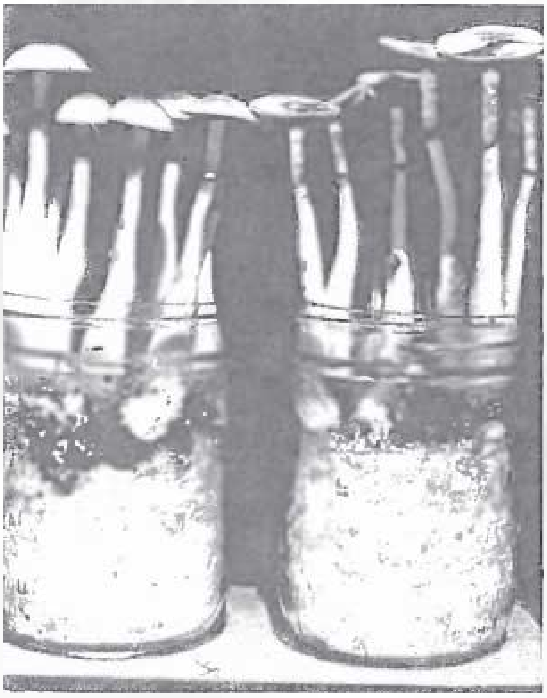
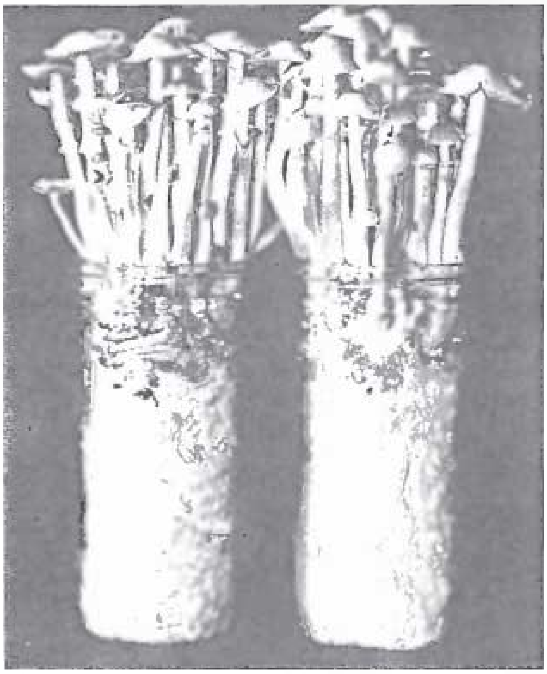


Figure 68 - Sinden system tray. The tray can be constructed of 1 x 6 or 2 x 6 inch lumber for bottom and side boards and 4 x 4 inch corner posts. (1 x 8 or 2 x 8 inch side boards are suggested for deep fills).







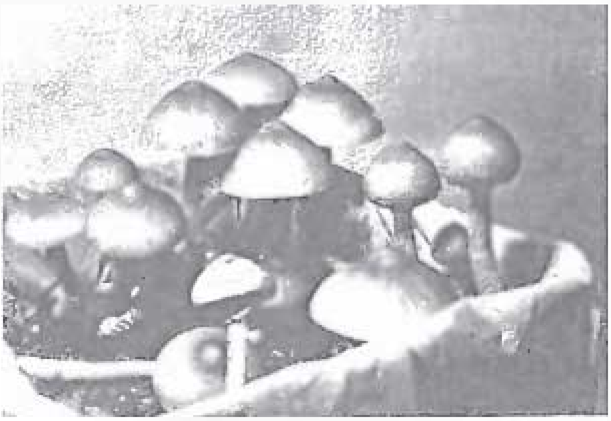


Figure 69 - *Psilocybe cubensis* fruiting on cased grain in a tray.

Figure 70 - *Psilocybe cubensis* fruiting in pint and a half jars.

Figure 71 - *Psilocybe cubensis* fruiting in pint jars.

Figure 72 - *Psilocybe cubensis* fruiting in a plastic lined box.

Environmental Control Systems

The mushroom growing room is designed to maintain a selected temperature range at high relative humidities. This is accomplished through adequate insulation and an environmental control system with provisions for heating, cooling, humidification and air handling.

In the original shelf houses the environment was controlled by a combination of active and passive means. Fresh air was introduced through adjustable vents running the length of the ceiling above the center aisle. Heat was supplied by a hot water pipe along the side walls, a foot above ground level. And humidity was controlled by similarly placed piping carrying live steam. The warm air rising up the walls in combination with the cool fresh air falling down the center aisle created convection currents for air circulation. Although no longer in general use by *Agaricus* growers, air movement based on convection can be similarly designed for small growth chambers where mechanical means are inappropriate.

Present day *Agaricus* farms integrate heating, cooling and humidification equipment into the air handling system and in this way are able to achieve balanced conditions throughout the growing room. Figure 73 shows an example of this type of system.

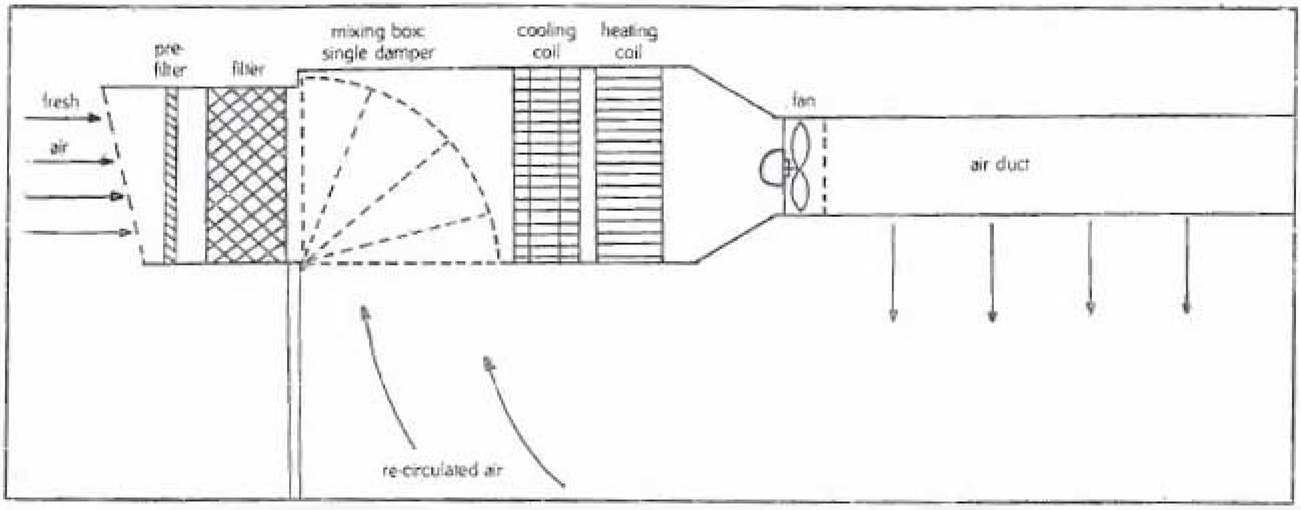


Figure 73 - Standard ventilation system used by *Agaricus* growers. (After Vedder)

Fresh Air

Filtered fresh air enters the room at the mixing box where it is proportionally regulated with recirculated air by a single damper. To prevent leakage during spawn running and pre-pinning, the damper fits tightly against the fresh air inlet. This allows full recirculation of room air to maintain even conditions, thereby counteracting temperature and CO_2 stratification. When fresh air is required, the damper can be adjusted to any setting, including complete closure of the recirculation inlet. As fresh air is introduced, room air is displaced and evacuated through an exhaust vent or cracks around the door. Because fresh air is generally at a different temperature than the one required for the growing room, it must be used judiciously in order to avoid disrupting the growing room environment or overworking the heating, cooling and humidication systems. By properly mixing the fresh outside air and the room air, a balance can be achieved and optimum conditions for mushroom growth prevail.

Fresh air serves many important functions in mushroom culture, primarily by supplying oxygen to the growing mushrooms and carrying away CO_2. Fresh air also facilitates moisture evaporation from the cropping surface. To determine the exact amount of air needed in a given situation, a knowledge of the CO_2 requirements for the species being grown is necessary. (See Chapter XI on growing parameters for various species). The fresh air can also be measured in terms of air changes per hour, a common way mushroom growers size the fan in the growing room.

Fans

Axial flow and centrifugal fans are the two most commonly used in mushroom houses. Both fans operate well against high static pressure, which is a measure of the resistance to forced air. Static pressure is measured in inches of water gauge - the height in inches to which the pressure lifts a column of water - and is caused by filters, heating and cooling coils or other obstructions to the free flow of air. Fans are rated in terms of their output, a measurement of cubic feet per minute (CFM) at varying static pressures (S.P.). When choosing a fan, these two factors must be considered for proper sizing.

Agaricus growers use fans capable of 4-6 changes per hour, or 0.5 CFM per square foot of cropping surface. For most small growing rooms, an axial flow fan, 6-10 inches in diameter and delivering between 100-500 CFM at up to 0.5 inches of static pressure, should meet general growing requirements. The addition of a variable speed motor control allows precise air velocity adjustment during different phases of the cultural cycle. This is especially important if the static pressure increases from spore build-up in the filter. A convenient method of testing air circulation is by blowing a small amount of cigarette smoke onto the cropping surface: the smoke should dissipate within twenty seconds.

The minimum fan output for a given room can be determined through knowledge of the air changes per hour required by the mushroom species. First calculate the volume of the room in cubic feet (height x width x length) and substract from this the volume occupied by trays, shelves, substrate and other fixtures. This figure is the free air space in the room. By dividing the CFM (cubic feet per minute) of the fan into the cubic feet of free air space, the time in minutes it takes for one air change is determined. This number is then divided into 60 minutes to calculate the air changes per hour. Another method to determine the CFM of the fan needed is described below.

Let X = the desired net CFM of a high pressure fan pushing through a filter.
Let Y = the total cubic feet of FREE air space in the growing room.
A maximum number of air exchanges/hour for *Agaricus brunnescens* is 4-6.
A maximum number of air exchanges/hour for *Psilocybe cubensis* is 2-3.

Therefore:

$$4 \text{ air exchanges/hour} * Y = 60 \text{ minutes} * X$$

$$\frac{4 * Y}{60 \text{ minutes}} = X = \text{necessary net CFM of fan}$$

$$\frac{Y}{15} = X$$

Example: If the growing environment measures 8 ft. x 8 ft. x 15 ft., the total volume would be 960 cu. ft. if the beds occupy 160 cu. ft. the net volume of free air space would be Y = 800 cu. ft. Therefore:

$$\frac{4 * 800 \text{ cu. ft.}}{60 \text{ min.}} = X$$

$$\frac{4 * 3200 \text{ cubic feet}}{60 \text{ min.}} = X$$

$$53.3 \text{ CFM} = X$$

Another factor of importance for proper ventilation is the air-to-bed ratio, which is the cubic feet of free air space divided by square feet of cropping surface. *Agaricus* growers have found a ratio of 5:1 to be optimum and this serves as a useful guideline when cropping other mushrooms on bulk substrates. The reason this ratio is so important is that increased amounts of substrate can generate heat and carbon dioxide beyond the handling capacity of the ventilation system. A large free air space acts to buffer these changes. Ostensibly, a ventilation system could be matched with a room having a 3:1 air-to-bed ratio, but it would have to move such a volume of air that evaporation off the sensitive cropping surface would be uncontrollable and excessive. Growing mushrooms on thin layers of grain (1-3 inches), however, produces less CO_2 than growing on 8 inches of compost and consequently would emit a lower air-to-bed ratio.

Air Ducting

Ducting for the air system is standard inflatable polyethylene tubing, sized to conform to the fan diameter. If ducting is not available in the correct size, PVC pipe can be substituted. Figures 74, 75 and 76 show different air distribution arrangements and their flow patterns. The ducts run the length of the room at ceiling level. One is centrally mounted and discharges towards both walls or directly down the center aisle, whereas the other is wall mounted and is directed across the width of the room.

The outlet holes in the duct are designed to discharge air at such a velocity that the airstream reaches the walls and passes down to the floor without directly hitting the top containers. The holes are spaced so that the boundaries of the adjacent jets meet just before reaching the wall or floor. This effectively eliminates dead-air pockets. To size and space the outlet holes exactly, two guidelines are used:

1. The total surface area of the holes is equal to the cross section of the duct. (The area of a circle is $^{22}/_{7}$ times the radius squared, $A = \prod(r)^2$).
2. The space between the holes is equal to a quarter of the distance between the duct and the wall or floor.

The discharge of air at velocities sufficient to draw in surrounding room air is called entrainment, a phenomenon that enhances the capacity of the air circulation system. A flow pattern of even air is then reached that directly benefits the growing mushrooms. The entrainment of air is the goal of air management in the growing room.

Filters

Fresh air filters are an important part of the ventilation system and contribute to the health of the crop. Their function is to screen out atmospheric dust particles like smoke, silica, soot and decayed biological matter. Atmospheric dust also contains spores, bacteria and plant pollen, some of which are detrimental to mushroom culture. Furthermore, spores and microorganisms originating within the cropping room can also be spread by air movement. To counteract this danger, some mushroom farms filter recirculated air as well.

Agaricus growers commonly use high efficiency, extended surface, dry filters. These filters are of pleated or deep fold design which gives them much more surface area than their frame opening. They filter out 0.3 micron particles with 90-95% efficiency and 5.0 micron particles with an efficiency of 99% at an initial resistance of 0.10 to 0.50 inches of static pressure.

High efficiency particulate air (HEPA) filters are even more efficient than those just described and are cost effective for the home cultivator. They screen out particulates down to 0.1-0.3 microns with a rated 99.96% to 99.99% efficiency and have a resistance of .75-1.00 inches of static pressure. HEPA filters are made of a variety of materials, depending on their intended application. Most HEPA filters operate in environments of up to 80% humidity without disintegration. Special "waterproof" filters operable in 100% humidify environments can also be purchased at little or no extra expense. These "waterproof" filters are especially appropriate for use with systems that push recirculated air through the filter. This type of system is illustrated in Figure 77. To protect the filters and prolong their usefulness, a one inch prefilter of open celled foam or fiberglass (of the furnace type) is installed to remove large particulates.

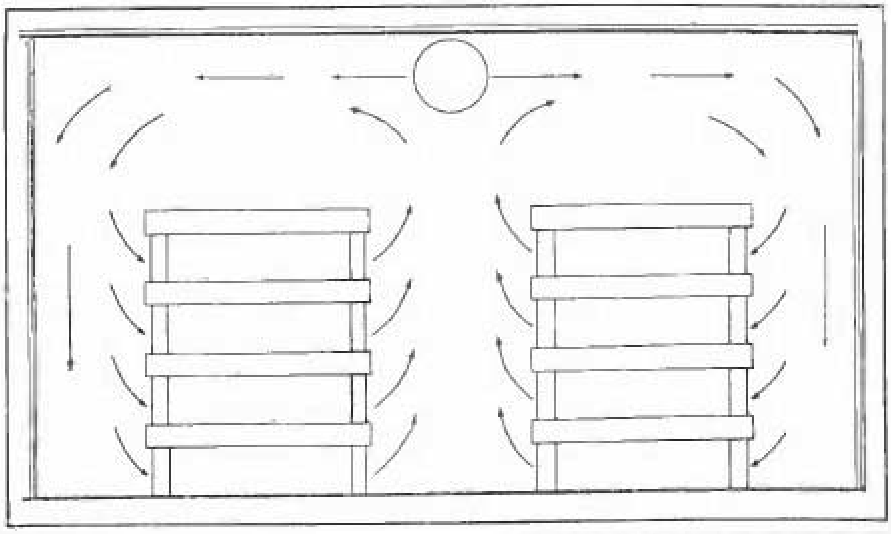


Figure 74 - Central aisle outward flow air circulation pattern.

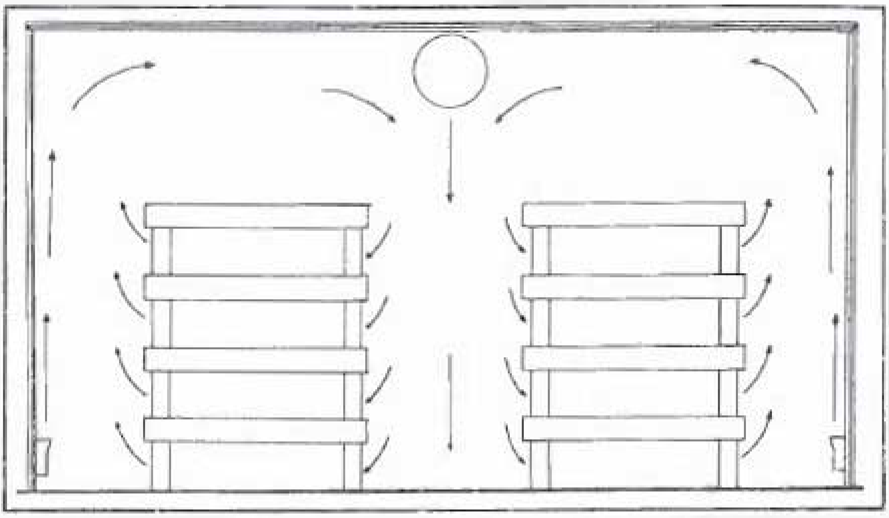


Figure 75 - Central aisle downflow air circulation pattern with wall mounted baseboard heating.

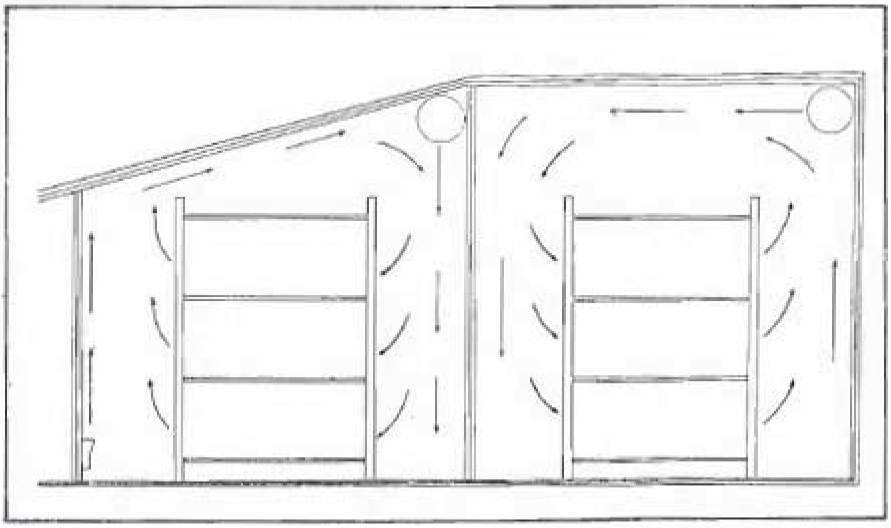


Figure 76 - Wall mounted duct directing airflow across the width or down the sidewall of the room.

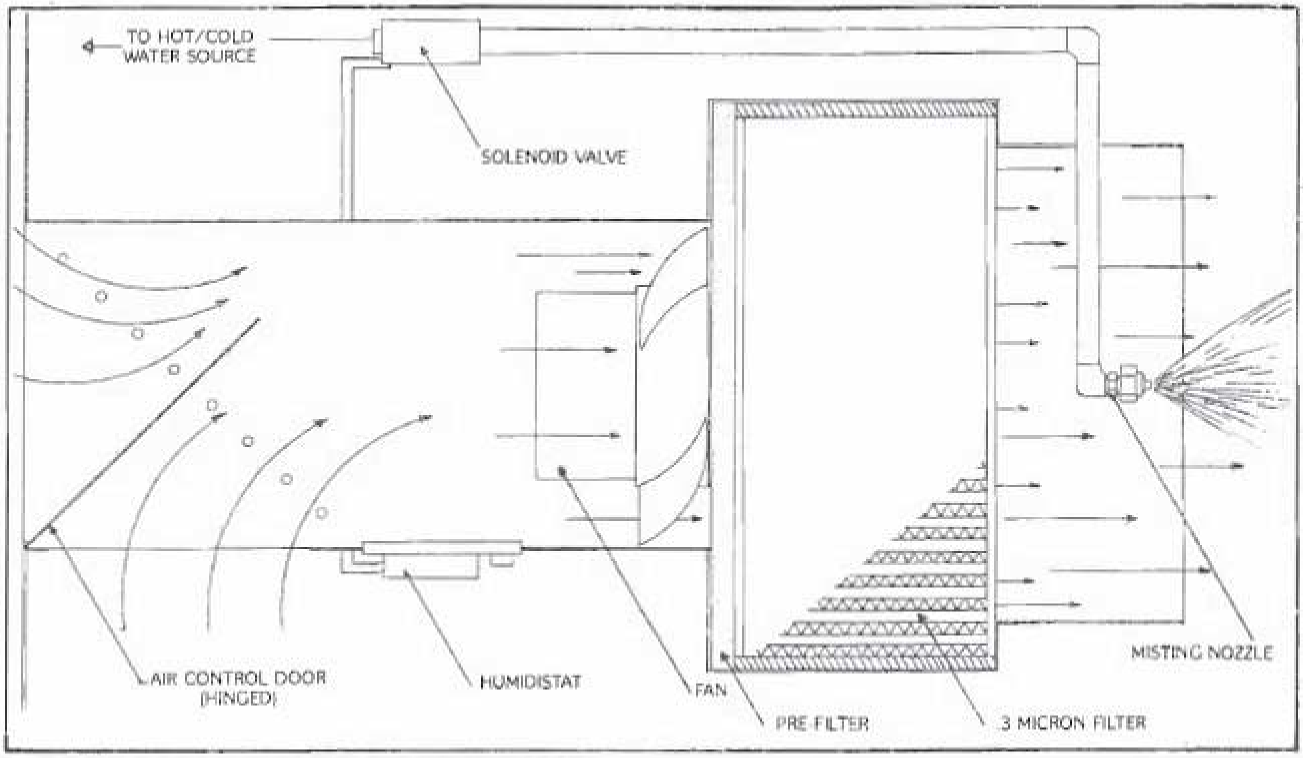


Figure 77 - Schematic of mixing box and controlled recirculation system in the growing room.

Exhaust Vents

Exhaust vents are designed to relieve overpressure within the growing room caused by the introduction of fresh air. Without an exit for the air, a back pressure is created that increases resistance and reduces the CFM of the fan. Small rooms operating with low fresh air requirements can forgo special exhaust vents and allow the air to escape around the seals of the room entrance, in effect creating a positive pressure environment. Positive pressure within a room can also be created by undersizing the exhaust vent, which should be no larger than half the size of the fresh air inlet. Free swinging dampers operating on overpressure are widely employed in the mushroom growing industry. The outlet should be screened from the inside to prevent the entry of flies.

Heating

Heating systems for cropping rooms can be based on either dry heat or live steam. Dry heat refers to a heating source that lowers the moisture content of the air as it raises the temperature. These systems utilize either hot water or steam circulating through a closed system of pipes or radiator coils. Heating systems can also be simple resistance coils or baseboard electric heaters. Heat coils are placed in the air circulation system ahead of the fan as shown in Figure 73. Small portable space heaters can also be attached to the mixing box or placed on the wall under it. Otherwise, baseboard heaters can be installed along the length of the side walls and matched with the air circulation design shown in Figure 75.

Heat supplied by live steam has the advantage of keeping the humidity high while raising the temperature of the room. If regulated correctly, steam can maintain the temperature and relative humidity within the required ranges without drawing upon other sources. Nevertheless, a backup heat source is advantageous in the event humidity levels become too high. For steam heat to function properly it should be controlled volumetrically by adjusting a hand valve (rather than simply on and off). Vaporizers well suited for small growing rooms are available in varying capacities, and can be fitted with a duct that connects with the air system downstream from the fan and filter.

To avoid high energy consumption and the expense associated with equipment purchase, operation and maintenance, the growing room should be designed to take full advantage of the heat generating capabilities of the substrate. This is done by matching the air-to-bed ratio to the type of substrate. Growing on thin layers of grain can be done with a ratio of 4:1 (or less) whereas compost demands 5:1. The influence of the outside climate and its capacity for cooling the growing room should also be considered. All these factors must be evaluated before a growing environment with efficient temperature control can be constructed.

Cooling

Commercial farms use cooling coils with cold water or glycol circulating through them. The coils are placed before the fan as shown in Figure 73 and are supplied by a central chiller or underground tank and well. Other systems use home or industrial refrigeration or air conditioning units that operate with a compressor and liquid coolant filled coils. These units are positioned to draw in recirculated as well as fresh air. All these systems share the common trait of drawing warm air over a colder surface. In doing so, moisture condenses out of the air and in effect dehumidifies the room.

The oldest and most widely practiced method of cooling is through the use of fresh air. Cooling with fresh air depends upon the weather and the temperature requirements of the species being cultivated. However, its use is the most practical means available to the home cultivator. In climates with high daily temperatures, fresh air can be shut off or reduced to a minimum during the day and then fully opened at night when temperatures are at their lowest.

Humidification

Most mushroom growers use steam as the principal means of humidification. The steam is injected into the air system duct on the downstream side of the fan and filter. Household vaporizers are well suited for small growing rooms. They are available in various capacities and can be fitted with a duct running to the air system. The vaporizer can also be positioned under the mixing box for steam uptake with the recirculated air. Keep in mind that cold fresh air has much less capacity for moisture absorption and therefore does not mix well with large volumes of steam.

Another method of humidification uses atomizing nozzles to project a fine mist into the air stream. Large systems have a separate mixing chamber with nozzles mounted to spray the passing air. In a small room, a single nozzle can be mounted in the center of the duct and aimed to flow with the air as it exits the fan. (See Figure 77). An appropriately sized nozzle emits 0.5-1.0 gallons per hour at 20-30 psi. To prevent the nozzle from plugging up, filters should be incorporated in the water supply line.

In a third method, air passes through a coarse mesh absorbant material that is saturated with water. This system is widely used for cooling at nurseries. It is similar in principle to a "swamp cooler". In this system (and the water atomizing system), the temperature of the supply water can be regulated to provide a measure of heating and cooling. Both systems also produce some free water so provisions must be made for drainage.

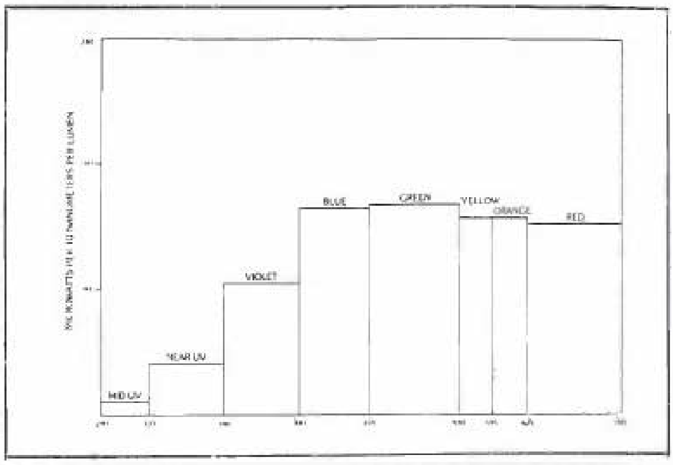
Thermostats and Humidistats

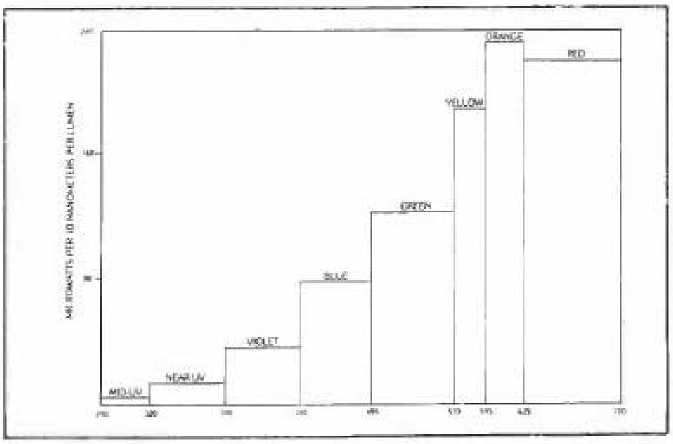
In general, thermostats and humidistats are designed to open and close valves in response to pre-set temperature or humidity limits. The instrument sensors are placed in a moving air stream representative of room conditions, usually in or near the recirculation inlet. Because these instruments are programmed for either on or off, heat and humidity come in surges. Often this results in uneven and fluctuating conditions within the room.

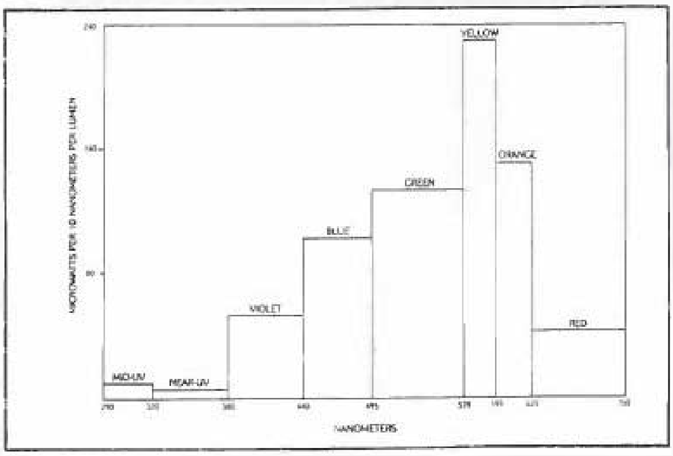
The ideal in environmental control is to supply just enough heat and humidity to make up for losses from the room and to compensate for differences in the fresh air. Modulating thermostats do this by supplying heat continuously in proportion to the deviation from the desired temperature. Positive control of this sort can also be accomplished by hand valves, alone or in conjunction with on/off instruments. Supply line volume is thereby regulated in order to attain an equilibrium. With a thermostat, this means keeping the supply volume just below the cut-off point.

Lighting

Many cultivated mushrooms require light for pinhead initiation and proper development of the fruitbody. In fact, such phototropic mushrooms actually twist and turn towards a light source, especially if it is dim and distant in an otherwise darkened room. Consequently, it is important to equip the growing room with a lighting system that provides even illumination to all areas and levels.







Figures 78, 79 & 80 - Charts showing the proportions of spectra in incandescent, fluorescent and natural lighting.

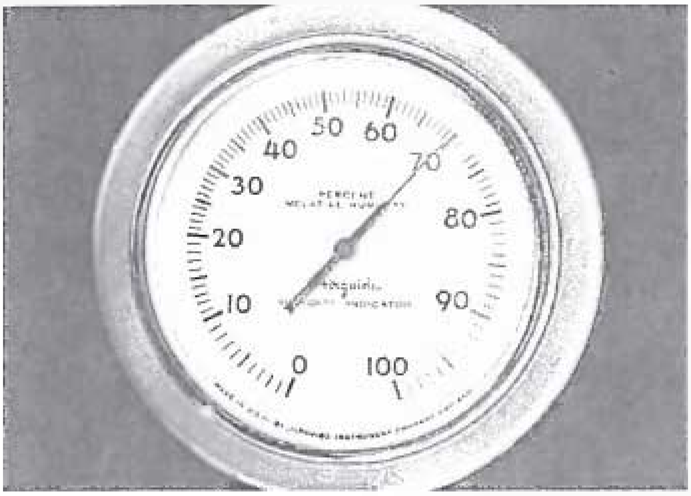


Figure 81 - An inexpensive hygrometer for measuring relative humidity.

Flourescent light fixtures are the most practical and give the broadest coverage. These fixtures should be evenly spaced and mounted vertically on the side walls of the room or horizontally on the ceiling above the center isle. An alternative is to mount the lights on the underside of each tier of shelf or tray, at least 18 inches above the cropping surface. To eliminate the heat and consequent drying action caused by the fixture ballasts, these can be removed and placed outside the room.

The best type of light tube is one which most closely resembles natural outdoor light: i.e. one that has at least 140 microwatts per 10 nanometer per lumen of blue spectra (440-495 nm). In contrast, warm-white fluorescent light has only 40-50 microwatts/nm/lum. and cool-white has 100-110 microwatts/nm/lum. Commercial lights meeting the photo-requirements of species mentioned in this book are the "Daylite 65" kind manufactured by the Durotest Corporation and having a "color temperature" of 6500°K and the "Vita-Lite" fluorescent at 5500°K. These color temperatures provide the proper amount of blue light for promoting primordia formation in *Pleurotus ostreatus*, *Psilocybe cubensis* and in other photosensitive species.

Environmental Monitoring Equipment

Few organisms are as sensitive to fluctuations in the environment as mushrooms. A matter of a few degrees in temperature or humidity can dramatically influence the progression of fruiting and affect overall yields. To adequately monitor the growing environment, quality equipment is essential for accurate readings. This equipment should include maximum-minimum thermometers to gauge temperature fluctuations and a hygrometer or a sling psychrometer for measuring humidity. Hygrometers should be periodically calibrated with a sling psychrometer to insure accuracy. Thermometers also should be checked as there are occasional irregularities. Other more advanced, expensive but not absolutely essential equipment helpful to mushroom growers include: CO_2 detectors; moisture meters; anemometers; and light measuring devices.

V. COMPOST PREPARATION

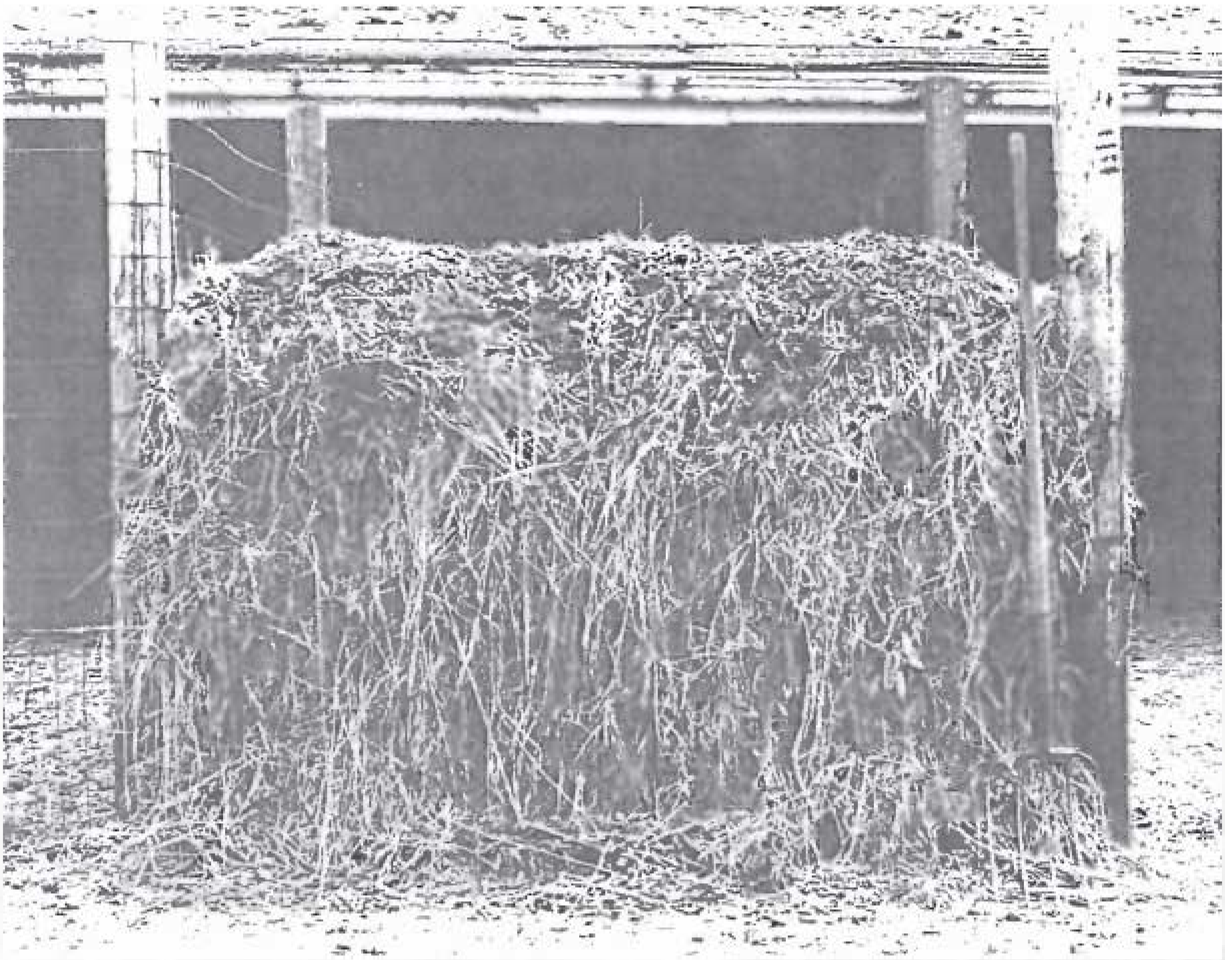


Figure 82 - Compost pile in a standard configuration.

The purpose of composting is to prepare a nutritious medium of such characteristics that the growth of mushroom mycelium is promoted to the practical exclusion of competitor organisms. Specifically this means:

1. To create a physically and chemically homogeneous substrate.
2. To create a selective substrate, one in which the mushroom mycelium thrives better than competitor microorganisms.
3. To concentrate nutrients for use by the mushroom plant and to exhaust nutrients favored by competitors.
4. To remove the heat generating capabilities of the substrate.

Mushroom mycelium grows on a wide variety of plant matter and animal manures. These materials occur naturally in various combinations and in varying stages of decomposition. Physically and chemically they are a heterogeneous mixture containing a wide variety of insects, microorganisms and nematodes. Many of these organisms directly compete with the mushroom mycelium for the available nutrients and inhibit its growth. By composting, nutrients favored by competitors gradually diminish while nutrients available to the mushroom mycelium are accumulated. With time, the substrate becomes specific for the growth of mushrooms.

The composting process is divided into two stages, commonly called Phase I and Phase II. Each stage is designed to accomplish specific ends, these being:

> **Phase I:** Termed outdoor composting, this stage involves the mixing and primary decomposition of the raw materials.
> **Phase II:** Carried out indoors in specially designed rooms, the compost is pasteurized and conditioned within strict temperature zones.

Phase I Composting

Basic Raw Materials

The basic raw material used for composting is cereal straw from wheat, rye, oat, barley and rye grass. Of these, wheat straw is preferred due to its more resilient nature. This characteristic helps provide structure to the compost. Other straw types, oat and barley in particular, tend to flatten out and waterlog, leading to anaerobic conditions within a compost pile. Rye grass straw is more resistant to decomposition, taking longer to compost. Given these factors and with proper management, all straw types can be used successfully.

Straw provides a compost with carbohydrates, the basic food stuffs of mushroom nutrition. Wheat straw is 36% cellulose, 25% pentosan and 16% lignin. Cellulose and pentosan are carbohydrates which upon break down yield simple sugars. These sugars supply the energy for microbial growth. Lignin, a highly resistant material also found in the heartwood of trees, is changed during composting to a "Nitrogen-rich-lignin-humus-complex", a source of protein. In essence, straw is a material with the structural and chemical properties ideal for making a mushroom compost.

When cereal straw is gathered from horse stables, it is called "horse manure". Although cultivators call it by this name, the material is actually 90% straw and 10% manure. This "horse manure" includes the droppings, urine and straw that has been bedding material. The quality of this material depends on the proportions of urine and droppings present, the essential elements nitrogen, phosphorous and potassium being contained therein. The reason horse manure is favored for making compost is the fact that fully 30-40% of the droppings are comprised of living microorganisms. These microorganisms accelerate the composting process, thereby giving horse manure a decided advantage over other raw materials.

Horse manure used by commercial mushroom farms generally comes from race tracks. The bedding straw is changed frequently, producing a material that is light in urine and droppings. On the other hand, boarding stables change the bedding less, generating a heavier material. If sawdust or shavings are used in place of straw for bedding, the material should be regarded as a supplement and not as a basic starting ingredient.

When horse manure is used as the basic starting ingredient, the compost is considered a "horse manure compost" whereas "synthetic compost" refers to a compost using no horse manure. Straw, sometimes mixed with hay, is the base ingredient in synthetic composts. Because straw is low in potassium and phosphorus, these elements must be provided by supplementation and for this reason chicken manure is the standard additive for synthetic composts. No composts are made exclusively of hay because of its high cost and small fiber. In fact, mushroom growers have traditionally used waste products because they are both cheap and readily available.

By themselves horse manure or straw are insufficient for producing a nutritious compost. Nor do they decompose rapidly. They must be fortified by specific materials called supplements. In order to determine how much supplementation is necessary for a given amount of horse manure or straw based synthetic, a special formula is used. This formula insures the correct proportion of initial ingredients, which largely determines the course of the composting process. The formula is based on the total nitrogen present in each ingredient as determined by the Kjeldahl method. By using this formula and certain composting principles, the carbon:nitrogen ratio for optimum microbial decompositions is assured. In turn, maximum nutritional value will be achieved.

Supplements

Composting is a process of microbial decomposition. The microbes are already present in large numbers in the compost ingredients and need only the addition of water to become active. To stimulate microbial activity and enhance their growth, nutrient supplements are added to the bulk starting materials. These supplements are designed to provide protein (nitrogen) and carbohydrates to feed the ever increasing microbial populations. Microbes can use almost any nitrogen source as long as sufficient carbohydrates are readily available to supply energy for the nitrogen utilization. Because of the tough nature of cellulose, the carbohydrates in straw are not initially usable and must come from another source. A balanced supplement is therefore highly desirable. It should contain not only nitrogen but also sufficient organic matter to supply these essential carbohydrates. For this reason certain manures and animal feed meals are widely used for composting.

The following is a list of possible compost ingredients or supplements, grouped according to nitrogen content. Their use by commercial growers is largely determined by availability and cost. This list is not all inclusive and similar materials can be substituted. (See Appendix).

Group I: High nitrogen, no organic matter

Ammonium sulfate - 21 % N
Ammonium nitrate - 26% N
Urea - 46% N
Maximum rate - 25 lbs/dry ton of starting materials

These are inorganic compounds that supply a rapid burst of ammonia. They are frequently used for initial straw softening in synthetic composts. When used, care should be taken that they are applied evenly. If ammonium sulfate is used, calcium carbonate must also be added at a rate of 3 parts $CaCO_3$ to 1, to neutralize sulfuric acid groups. These supplements are not recommended for horse manure composts.

Group II: 10-14% N

Blood Meal - 13.5% N
Fish Meal - 10.5% N

These materials consist mainly of proteins but because of their high cost are rarely used.

Group III: 3-7% N

Malt sprouts - 4% N
Brewers' grains - 3-5% N
Cottonseed meal - 6.5% N
Peanut meal - 6.5% N
Chicken manure - 3-6% N

This group contains the materials most widely used by commercial growers and is characterized by a favorable carbon:nitrogen balance. Dried chicken manure from broilers mixed with sawdust is commonly used and easy to handle.

Group IV: Low nitrogen, high carbohydrate

Grape pomace - 1.5% N
Sugar beet pulp - l.5% N
Potato pulp - 1% N
Apple pomace - 0.7% N
Molasses - 0.5% N
Cottonseed hulls - 1 % N

These materials are excellent temperature boosters and for this reason are a recommended additive to all composts. They can be added to any compost formula at a rate of 250 lbs per dry to of ingredients. Cottonseed hulls are an excellent structural additive.

Group V: Animal manures

Cow manure - 0.5 % N

Pig manure - 0.3-0.8% N

These manures are rarely used for composting, except in areas without horses or chickens. They have been used with success and should be considered supplements to a synthetic blend.

Group VI: Hay

Alfalfa - 2.0-2.5% N
Clover - 2% N

Hay is useful for boosting initial temperatures in synthetic composts. Hay contains substantial quantities of carbohydrates which help build the microbial population. Yet another advantage is the relatively high nitrogen content in alfalfa and clover. Use at a rate of 20% of the basic starting material (dry weight).

Group VII: Minerals

Gypsum - Calcium sulfate

Gypsum is an essential element for all composts. Its action, largely chemical in nature, facilitates proper composting. Its effects are:

1. To improve the physical structure of the compost by causing aggregation of colloidal particles. This produces a more granular, open structure which results in larger air spaces and improved aeration.
2. To increase the water holding capacity, while decreasing the danger of over-wetting. Loose water is bound to the straw by colloidal particles.
3. To counteract harmfully high concentrations of the elements K, Mg, P and Na should they occur, thereby preventing a greasy condition in the compost.
4. To supply the calcium necessary for mushroom metabolism.

Gypsum should be added at a rate of 50-100 lbs per dry ton of ingredients. When supplementing with chicken manure, it is advisable to use the high rate.

Limestone flour - Calcium carbonate

Limestone is used when one or more supplements are very acidic and need to be buffered. A good example of this is grape pomace, which has a pH of 4. Because it is added in large quantities, grape pomace could affect the composting process which normally occurs under alkaline conditions.

Group VIII: Starting materials

Horse manure - 0.9-1.2% N
Straw, all types - 0.5-0.7% N

Compost Formulas

The following formulas for high yield compost are commercially proven. If an ingredient is not available locally, substitute one that is. The aim of the formula is to achieve a nitrogen content of 1.5-1.7% at the initial make-up of the compost pile.

In order for these formulas to be effective, the moisture content and nitrogen content must be correct. Moisture level is determined by weighing 100 grams of the material, drying it in an oven at 200°F. for several hours, and then reweighing it. The difference is the percent moisture. Be sure the sample is representative. The nitrogen content (protein divided by 6.25) is always listed with commercial materials because they are priced according to percentage of protein. On the other hand, barnyard materials vary considerably with age. The more a material breaks down, the more nitrogen it loses. Most compost supplements are purchased dry and added dry, helping even distribution as well as enabling easy storage. It is also important that the raw materials used for composting be as fresh as possible. This insures maximum utilization of their properties. Baled straw stored for a year and kept dry is fine. If the straw has gotten wet, moldy or otherwise started to decompose, it should not be used.

Formula I

Ingredient	Wet wt.	% H_2O	Dry wt.	% N	lbs.
Horse manure	2,000	50	1,000	1.0	10
Cottonseed meal	30	10	117	6.5	8
Gypsum	50	-	50	-	-
			1,167		18
(18)÷(1,167)=1.54% N This formula makes approximately 2800 pounds of compost at a 70% moisture content.					

Formula II

Ingredient	Wet wt.	% H_2O	Dry wt.	% N	lbs.
Wheat straw	2,000	10	1,800	0.5	9
Chicken manure	2,000	20	1,600	3.00	48
Gypsum	125	-	125	-	-
			3,525		57
(57)÷(3,525)=1.62% N This formula make approximately 7,000 pounds of compost at a 71% moisture content.					

Although 7,000 pounds of compost seems like a large quantity, at a fill level of 20 pounds per sq. ft., this will fill only 350 sq. ft. of beds or trays. Keep in mind that during the composting process there is a gradual reduction in the the total volume of raw materials. Fully 20-30% of the dry matter is consumed during Phase I and another 10-15% during Phase II. **In total, approximately 40% of the dry matter is reduced by microbial and chemical processes**. This loss of potential nutrients can not be avoided and demonstrates the importance of composting no longer than necessary.

Ammonia

The production of ammonia is essential to the composting process. Just as the carbohydrates must be in a form that microbes can utilize, so must the nitrogen.

1. Ammonia supplies nitrogen for microbial use.
2. Ammonia is produced by microbes acting upon the protein contained in the supplements.

With the energy supplied by readily available carbohydrates, microbes use the ammonia to form body tissues. A microbial succession of generations is established, with each new generation decomposing the remains of the previous one. Microbial action also fixes a certain amount of the ammonia, forming the "nitrogen-rich-lignin-humus-complex". Unused ammonia volatilizes into the atmosphere. The smell of ammonia should be evident throughout Phase I, reaching a peak at filling.

Carbon:Nitrogen Ratio

The importance of a carbon:nitrogen balance cannot be underestimated. A well balanced compost holds an optimum nutritional level for microbial growth. An imbalance slows and impedes this growth. It is the compost formula that enables the grower to achieve the correct C:N balance. Because organic matter is reduced during composting, the C:N ratio gradually decreases. Approximate values are: 30:1 at make-up; 20:1 at filling; and 17:1 at spawning.

1. Over-supplementation with nitrogen results in prolonged ammonia release.

2. Over-supplementation with carbohydrates results in residual carbon compounds.

Prolonged ammonia release from an over-supplemented compost necessitates longer composting times. If composting continues too long, the physical structure and nutritional qualities are negatively affected. If the ammonia persists, the compost becomes unsuitable for mycelial growth.

Readily available carbohydrates which are not consumed by the microbes during composting can become food for competitors. It is therefore important that these compounds are no longer present when composting is finished.

Water and Air

Water is the most important component in the composting process. To a large degree water governs the level of microbial activity. In turn, this activity determines the amount of heat generated within the compost pile because the microorganisms can only take up nutrients in solution. Not only do the microorganisms need water to thrive, but they also need oxygen. Years of practice and research have established a basic relationship between the amount of water added and the aeration of the compost. **An inverse relationship exists between the amount of water and the amount of oxygen in a compost pile**.

1. Too much water = too little air
   Moisture content 75% or above.
2. Too little water = too much air
   Moisture content 67% or below.

Overwetting a compost causes the air spaces to fill with water. Oxygen is unable to penetrate, causing an anaerobic condition. In contrast, insufficient water results in a compost that is too airy. Beneficial high temperatures are never reached because the heat generated is quickly convected away.

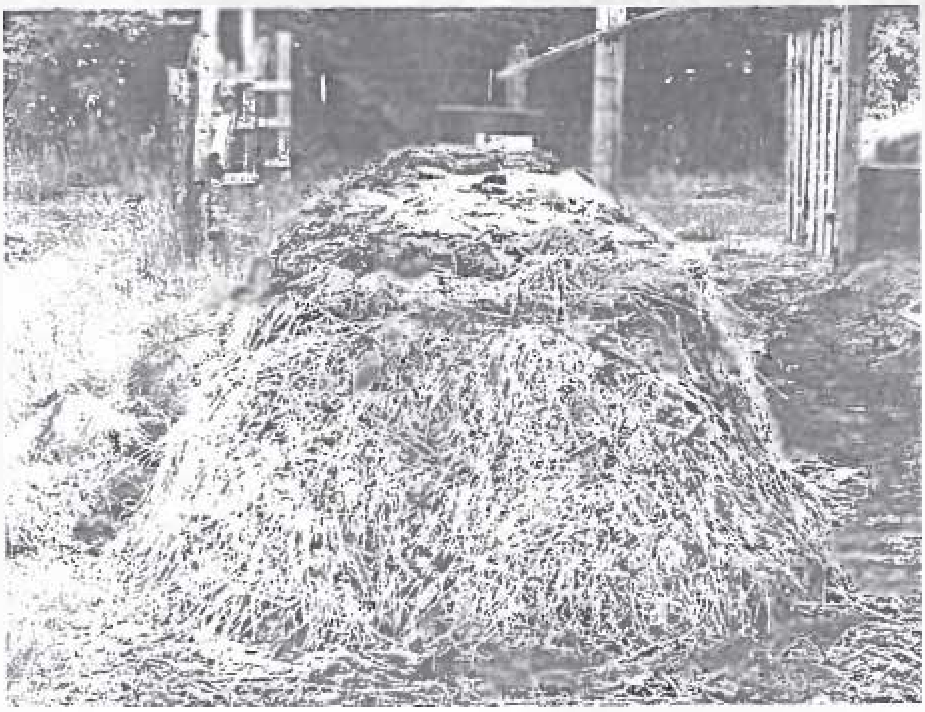


Figure 83 - Pre-wetted raw materials in a windrow.

Compost microorganisms can be divided into two classes according to their oxygen requirements. Those needing oxygen to live and grow are called **Aerobes** while those living in the absence of oxygen are called **Anaerobes**. Each class has well defined characteristics.

1. Aerobes decompose organic matter rapidly and completely with a corresponding production of CO_2, water and heat. This heat generation is called **Thermogenesis**.

2. Anaerobes partially decompose organic matter, producing not only CO_2 and water, but also certain organic acids and several types of gases such as hydrogen sulfide and methane. Anaerobes generate less heat than aerobes.

Examination of anaerobic areas of the compost reveals a yellowish, under-composted material that smells like rotten eggs. These areas in a compost pile are noticeably cooler and generally waterlogged. Anaerobic compost is unsuitable for mushroom growth.

Since neither fresh horse manure nor straw based synthetics have the correct moisture content, water must be added to these materials. The recommended levels for optimum composting are:

Horse manure: 69-71%
Synthetic: 71-73%

Pre-wetting

As long as the composting ingredients remain dry, the microorganisms lie dormant and composting does not take place. The first step in the composting process is the initial watering of the starting materials. The purpose of this pre-composting or pre-wetting is to activate the microbes. Once activated, the microbes begin to attack the straw and decompose the waxy film which encases the straw fibers. Until this film is degraded, water will not penetrate the straw and its nutrients will remain unavailable. As the process progresses, the fibers become increasingly receptive to water, which rather than being free or on the surface, penetrates and is absorbed into the straw.

There are many methods for pre-wetting. These include: dipping or dunking the material into a tank of water; spraying it with a hose; or spreading it out in a flat pile 2-3 feet high and running a sprinkler over it. Regardless of the method used, the result should be the same - a homogeneous evenly wetted pile.

Horse manure needs less time for pre-wetting due to the nature of the bedding straw. This straw has been trampled upon, opening the straw fiber and damaging the waxy film. The urine and droppings have also begun to soften it. This is not the case with a synthetic compost in which the baled straw is still fresh and tough. To stimulate microbial action in synthetics, some supplements are added at pre-wetting. Suitable supplements include any from group 1, 4, 5 or chicken manure.

The length of time needed for pre-wetting varies according to the condition of the starting materials. Generally 3 days for horse manure and 5-12 days for a synthetic compost is sufficient. The pre-wetting time for a synthetic compost can be shortened if the straw is mechanically chopped, but care should be taken that the fibers do not become too short.

The wetted materials are then piled in a large rounded heap called a windrow. During this period the windrow can be turned and re-wetted as needed, usually 1-3 times.

Building the Pile

Building the compost pile is called stacking, ricking or "make-up". At this time the pre-wetted starting materials and the nitrogenous supplements are evenly mixed, watered and assembled into a pile. The size, shape and specific physical properties of this pile are very important for optimum composting. These are:

1. Pile dimensions should be 5-6 feet wide by 4-6 feet high. The shape should be rectangular or square.
2. The side of the pile should be vertical and compressed from the outside by 3-6 inches. The internal section should be less dense than the outer section.
3. The pile is such that any further increase in size would result in an anaerobic core.

Throughout the composting process, the size of the pile varies depending on the physical condition of the straw, which provides the pile's basic structure. The structure of the compost refers to the physical interaction of raw materials, especially the straw fibers. As the straw degrades and the fibers flatten out, the structure becomes more dense and the airflow is restricted. The pile becomes more compact and its size is reduced accordingly. Initially the fresh straw allows for generous air penetration which convects away heat and slows microbial action. To counteract this heat loss, the pile should be of maximum size and optimum moisture content at make-up.

Figure 85 illustrates air penetration of a compost pile. Air enters the pile from the sides. As the oxygen is used by microorganisms, heat is set free and the air temperature rises. The warm air current created rises to the top of the pile. This is called the chimney effect. The factors that affect the rate of internal air flow are pile size and structure, moisture content and the differential between ambient air and internal pile temperatures.

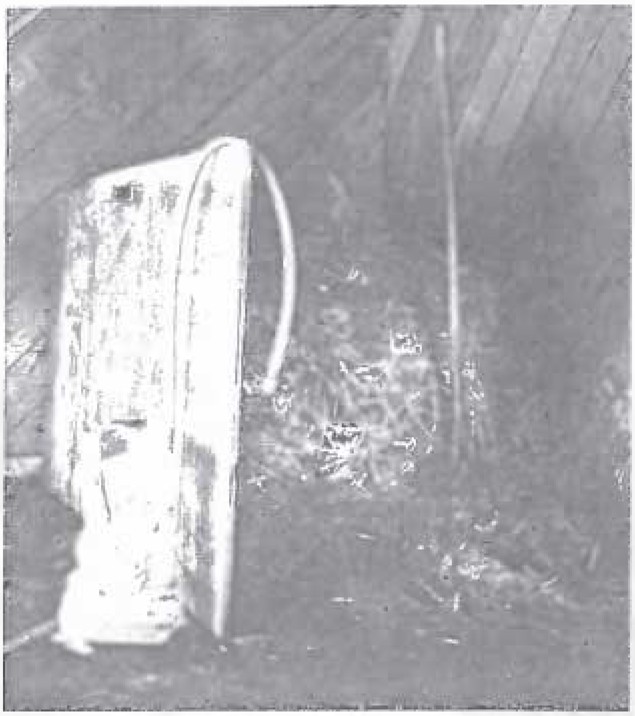


Figure 84 - Ricking the compost pile.

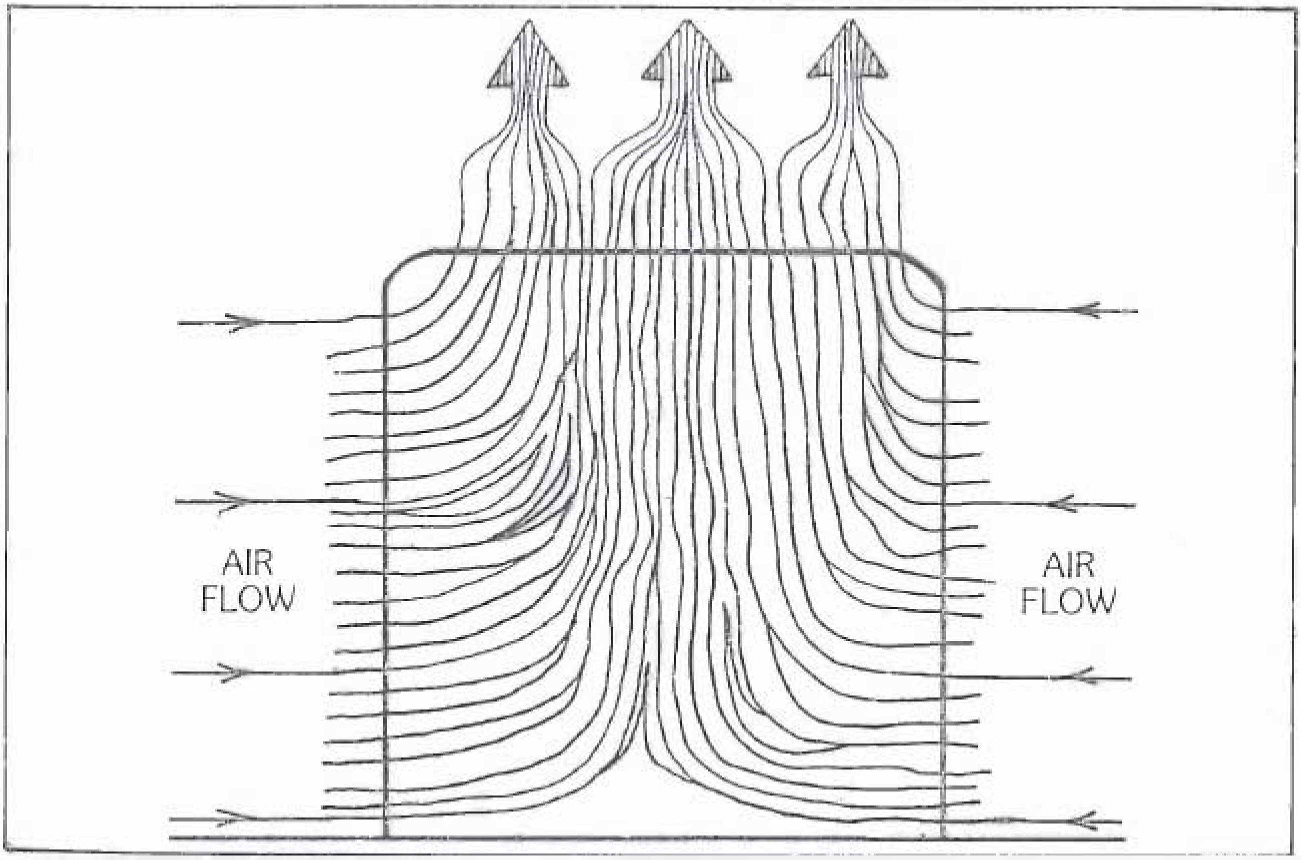


Figure 85 - Chimney effect in a compost pile.

Turning

A well built compost pile runs out of oxygen in 48 to 96 hours and then enters an anaerobic state. To prevent this, the pile should be disassembled and then reassembled. The purposes of this turning procedure are:

1. To aerate the pile, preventing anaerobic composting.
2. To add water lost through evaporation.
3. To mix in supplements as required.
4. To fully mix the compost, preventing uneven decomposition.

As a consequence of microbial decomposition, the compost pile begins to shrink and becomes more compact. Coupled with loose water gravitating downward and water generated by microbes in the inner active areas, this compaction closes the air spaces and stifles aerobic action, particularly in the core at the bottom center. Through the use of a long stemmed thermometer reaching to the center of the pile, the time of oxygen depletion can be monitored by watching temperature. When the temperature begins to drop, indicating a slowing of microbial action, it is time to turn the compost.

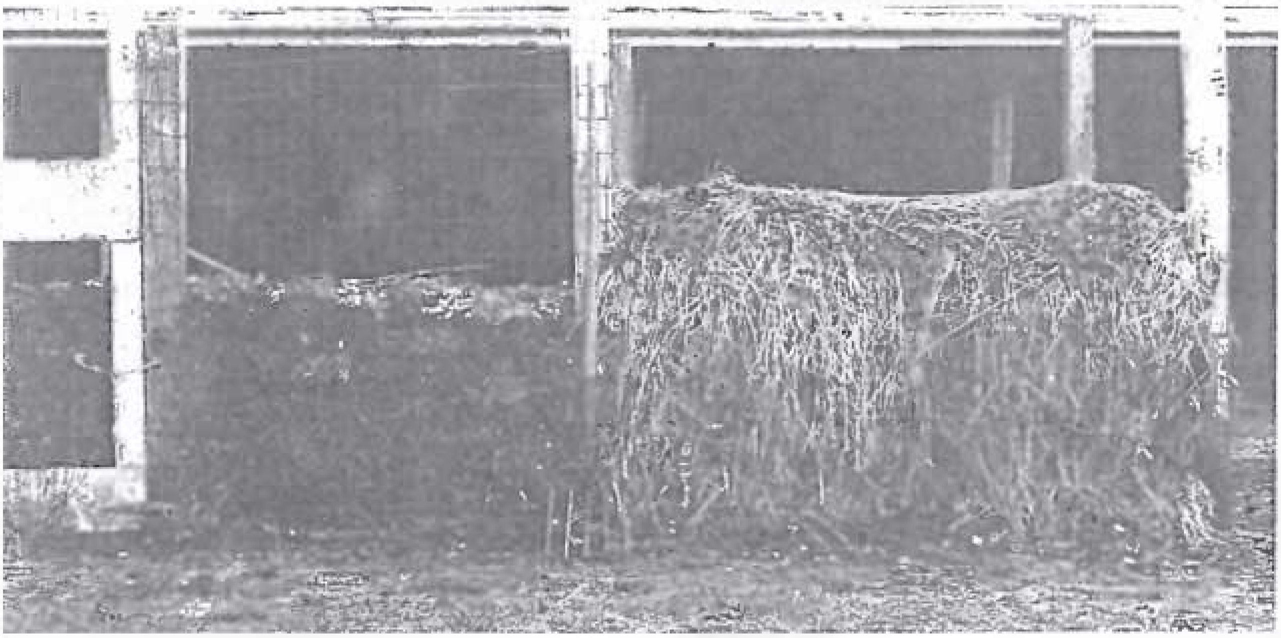


Figure 86 - Turning the compost pile using wire mesh pile formers.

In the early stages the temperature stratification in the pile is quite pronounced. Outer areas are cool and dry from the air flowing inward and the accompanying evaporation. These outer areas are watered during turning and moved to the center of the newly built pile and the center areas are relocated to the outside. Being aware of the varied rate of decomposition in a stratified pile and compensating during turning maintains the important homogeneous character of the pile.

Supplements deleted at make-up should be added during the turning cycle. Gypsum is normally added at the second turn. Adding gypsum any earlier is believed to depress ammonia production. Until some decomposition has occurred, the beneficial action of gypsum will not be realized. As with other supplements, gypsum is mixed in as evenly as possible.

Temperature

Environmental conditions in the compost are specifically designed to facilitate growth of beneficial aerobic microorganisms. Given the proper balance of raw materials, air and water, a continuous succession of microbial populations produces temperatures up to 180°F. These microbes can be divided into two groups according to their temperature requirements. Mesophiles are active under 90°F. and thermophiles are active from 90-160°F. The action of these microbial groups during the composting process is summarized in the following paragraphs.

During pre-composting mesophilic bacteria and fungi, utilizing available carbohydrates, attack the nitrogenous compounds thereby releasing ammonia. This ammonia is then utilized by successive microbial populations and the temperature rises.

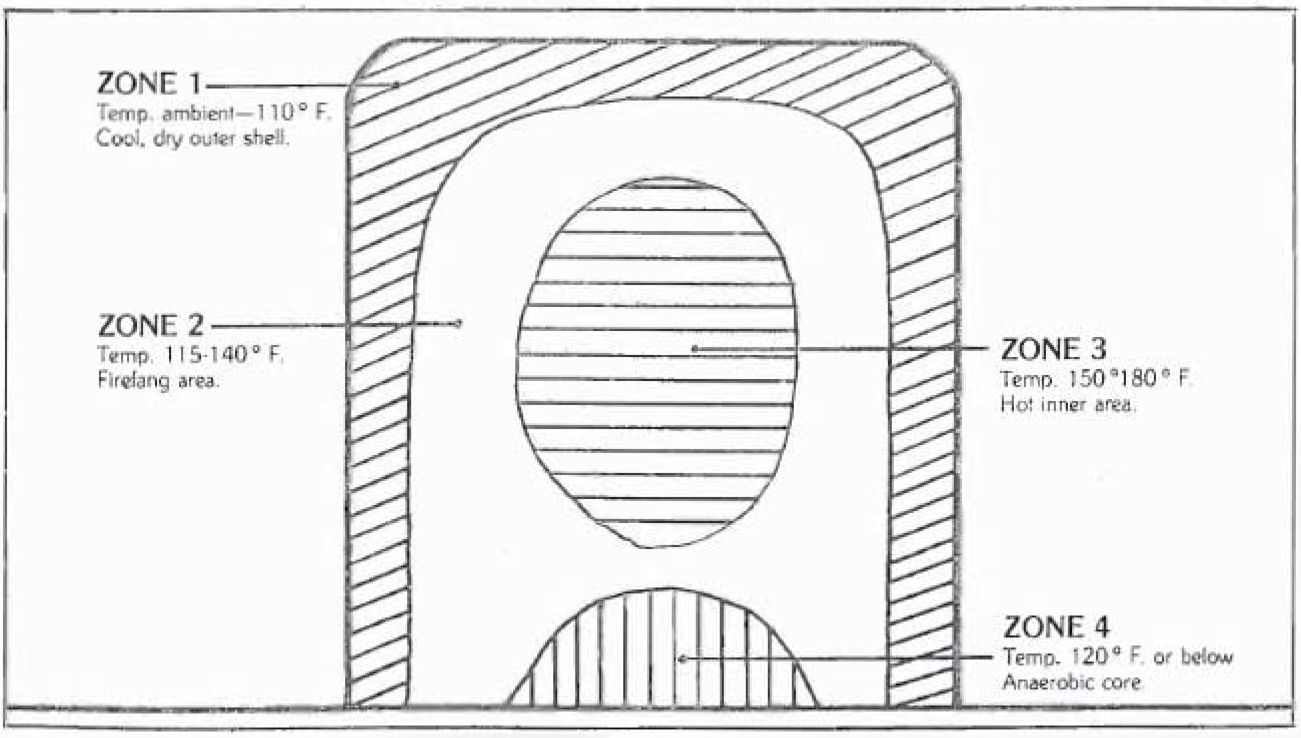


Figure 87 - Standard temperature zonation in a compost pile.

After make-up, the mesophiles remain in the cool outer zones while the thermophilic fungi, actinomycetes and bacteria dominate the inside of the pile. The actinomycetes are clearly visible as whitish flecks forming a distinct ring around the hot center. Bacteria dominate this center area and continue to decompose the nitrogenous supplements, liberating more ammonia. At this point the carbohydrates in the straw are ready for microbial use.

At temperatures over 150°F., microbial action slows and chemical processes begin. Between 150-165°F. microbial and chemical actions occur simultaneously. From 165-180°F. decomposition is mainly due to the chemical reactions of humification and caramellization, the latter taking place under conditions of high temperature, high pH (8.5) and in the presence of ammonia and oxygen. Many of the dark compounds produced during composting are believed to result from these chemical reactions. Decomposition proceeds rapidly at these high temperatures, and if they can be maintained throughout the process, composting time will be greatly reduced.

Figure 87 shows the temperature zonation commonly found in a compost pile. Studies by Dr. E.B. Lambert in the 1930's showed that compost taken from zone 2 produced the highest yielding crops. Based on this research, growers always subject their compost to zone 2 conditions prior to spawning. This normally occurs during Phase II in specially designed rooms. However, if a Phase II room can not be built, zone 2 conditions can be achieved by an alternate method known as Long Composting, developed by C. Riber Rasmussen of Denmark.

Long Composting

Long composting is designed to carry out the complete composting process outdoors (excluding pasteurization). The method is characterized by the avoidance of high temperature chemical decomposition and a reliance on purely microbial action. Specifically this procedure is designed to promote the growth of actinomycetes and rid the compost of all ammonia by the time of filling. The temperature zonation desired in this method is illustrated in Figure 88. An outline of the Long Composting procedure follows.

DAY	LONG COMPOSTING PROCEDURE
-10	**For synthetic composts**: Break the straw bales and water them thoroughly. Mix in group 1, 4 or 5 supplements or chicken manure. Windrow. Start at day -5 if straw is short or has been chopped.
-5	**For synthetic composts**: Turn and add more water. Break up any concentrations of supplements. Windrow.

-2	**For horse manure or synthetic composts**: Thoroughly wet and mix all raw materials and supplements (except gypsum). Windrow.
0	**Make up the pile**. Dimensions should be 6 feet wide and 4 feet high. The vertical sides should be tightly compressed with the middle of the pile remaining loose. Use the pile formers to make the stack and stomp the sides from the top to achieve ample compression. Water dry areas.
6	**First turn**: Water as needed. Move the center anaerobic zone to the outside of the new pile and the outside zone to the center. Keep the pile height and length constant by reducing the width as decomposition proceeds.
10-12	**Second turn**: Add the gypsum and water as needed. Distribute the zone of actinomycetes evenly throughout.
13-15	**Third turn**: The actinomycete zone should be evident throughout. Strong actinomycete growth may cause excessive drying, so be sure to check moisture content and water as needed. The smell of ammonia should be slight. Build the new pile only 24 inches high and 4-5 feet wide. Distribute the actinomycetes evenly throughout.
15-17	**Fourth turn**: The compost should now appear dark brown and well flecked with actinomycetes. All traces of ammonia should be gone. Moisture content should be approximately 67-70% and the pH 7.0-7.5. If this is not the case, continue the process turning at 2 day intervals until this condition is reached. The pile height may vary between 16-24 inches and is designed solely to promote optimum conditions for the growth of the actinomycetes - temperatures of 120-135°F.

Once finished, this compost is normally pasteurized at 135°F. for four hours. If pasteurization is impossible, discard the cool outer shell and utilize the areas showing strong actinomycete activity. Although these areas will not be free from all pests and competitors, they should provide a reasonably productive substrate. The aspect and characteristics of a properly prepared Long Compost should conform to the guidelines for compost after Phase II. (See Aspect of the Finished Compost on page 105 and Color Plate 8.)

Short Composting

Commercial *Agaricus* growers uniformly base their composting procedures on the methodology developed by Dr. James Sinden, who called his technique "Short Composting" in reference to the short period of time involved. Dr. Sinden's process is centered around the fast acting chemical reactions occurring in zone 3. Besides the shorter preparation time, this process also results in a greater preservation of dry matter, thus retaining valuable nutrients. Figure 89 illustrates the zonation during short composting.

Without commercial composting equipment, approximating the temperature conditions of Short Composting is very difficult. However, it does provide a model for optimum composting and can be approached by adhering to the basic principles discussed in this chapter. The Short Composting procedure is outlined below.

Short Compost Procedure

DAY	SHORT COMPOSTING PROCEDURE: Formula 1
-1	**For horse manure**: Wet the starting materials thoroughly. Windrow.
0	**Make up the pile**. Add all supplements except gypsum. Mix and water thoroughly. Pile should be 6 feet wide by 5-6 feet high. The sides should be vertical and compressed tightly.
2,3	**First turn**: Add gypsum and water as needed. Keep the pile height constant and vary the width only in relation to the amount of anaerobic material.
5	**Second turn**: Add water as needed.
7	**Third turn**: Add water as needed. Compost should be ready to fill.

The procedures for making a synthetic compost by the short composting method are outlined below, with minor modifications for the home cultivator. Note the longer period of pre-composting to condition the straw.

Synthetic Compost Procedure

DAY	SYNTHETIC COMPOSTING PROCEDURE: Formula 2
-10	Break straw bales and wet thoroughly. Windrow or spread out in a low flat pile, 2-3 feet high. Water daily.
-7	Mix the chicken manure together with the straw, wetting both well. Avoid water run-off. Windrow.

-3	Re-mix the windrow, adding water as necessary. Start here if chopped straw is used - wet the straw and chicken manure. Mix well and windrow.
0	**Make up the pile**. Dimensions should be 6 feet wide by 5 feet high. Add as much water as possible without run-off. Use pile formers to insure vertical sides and stomp down the sides from the top to achieve adequate compression. The pile should be tight and compact.
4	**First turn**: Add the gypsum. Water as needed. Keep the pile dimensions constant, varying the width as indicated by the amount of anaerobic material in the center. Maintain pile compaction.
7	**Second turn**: Water as needed and redistribute outer and inner areas. Redistribution should occur during each turn to keep the material in an even state of decomposition.
10	**Third turn**: Mix well and add water as needed. Reduce width to 5 feet. Fill if ready.
13	Fill if ready, or continue composting, turning at two day intervals.

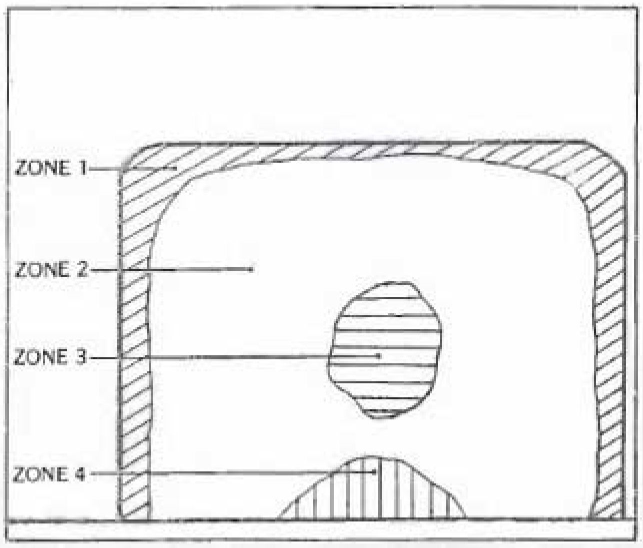


Figure 88 - Temperature zonation during Long Composting.

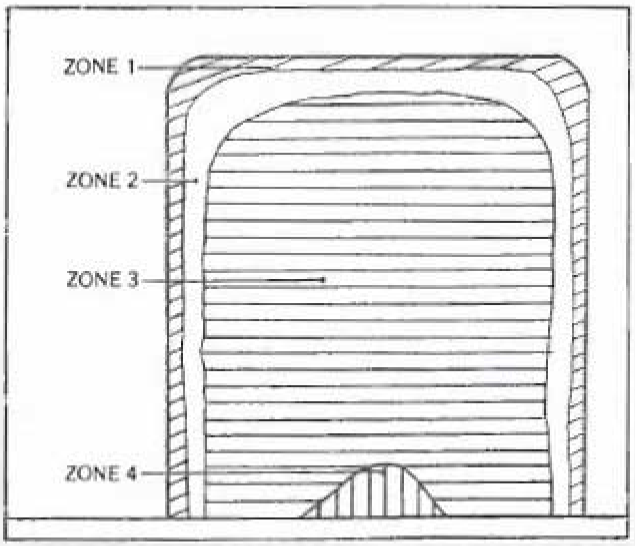


Figure 89 - Temperature zonation during Short Composting.

Composting Tools

Since commercial growers work with many tons of compost, a bucket loader is essential. They also use a specially designed machine for turning the piles. This compost turner can travel through a 200 foot pile in a little over one hour, mixing in supplements and adding water. Small scale cultivators can make compost without these machines. The following is a list of tools and facilities that are basic to compost preparation.

1. **A cement floor**. Not absolutely necessary but highly desirable, a cement floor is easy to work on, prevents migration of water to the earth and prevents soil and unwanted soil organisms from contaminating the pile. Water leaching from the pile, a good indicator of compost moistures, is quite evident on a cement floor. If a cement floor is not available, a sheet of heavy plastic can be used.
2. **Bobcat or small tractor loader with ¾-1 yard bucket with fork**. If producing large amounts of compost, one of these machines saves time and labor. Not only do they make pre-wetting, supplementing and pile building easier, they can be used to turn the pile.
3. **Pile formers**. These are constructed from 2 x 4's and plywood or planks to the dimensions desired for the compost pile. One for each side is necessary. Standard size would be 4-5 feet high by 8 feet long. An alternative to pile formers is a three sided bin.
4. **Long handled pitchfork with 4 or 5 prongs**. The basic tool in a compost yard, all compost piles were turned with pitchforks before the advent of compost turners and bucket loaders.
5. **Flat bladed shovel**. Used for handling supplements.
6. **Hose with spray nozzle, or sprinkler**.
7. **Thermometers**. Although pile temperatures can be guaged by touch, a long stemmed thermometer gives accurate readings.

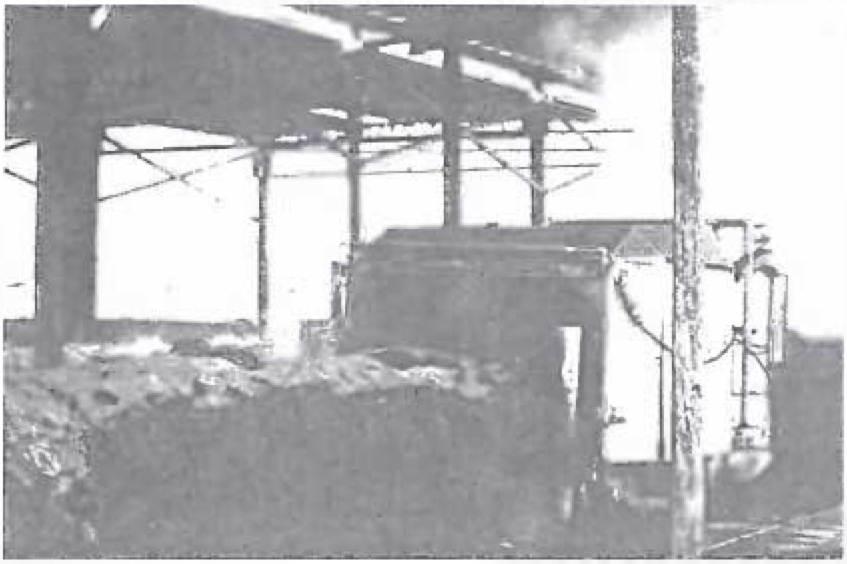


Figure 90 - Commercial compost turning machine.

Figure 91 - Pile Formers in use.

Characteristics of the Compost at Filling

The composting materials undergo very distinct changes during Phase I. A judgment as to the suitability of the compost for filling is based on color, texture and odor. Gradual darkening of the straw and the pronounced scent of ammonia are the most obvious features. These and other characteristics provide important guidelines for judging the right time for filling the compost. (Note: these guidelines do not apply for a compost prepared by the Long Composting methods.)

The compost is ready for filling if:

1. Compost is uniformly deep brown.
2. Straw is still long and fibrous, but can be sheared with some resistance.
3. When the compost is firmly squeezed, liquid appears between the fingers.
4. Compost has a strong smell of ammonia, pH of 8.0-8.5.
5. Compost is lightly flecked with whitish colonies of actinomycetes.
6. Kjeldahl nitrogen is 1.5% for horse manure and 1.7% for synthetic composts.

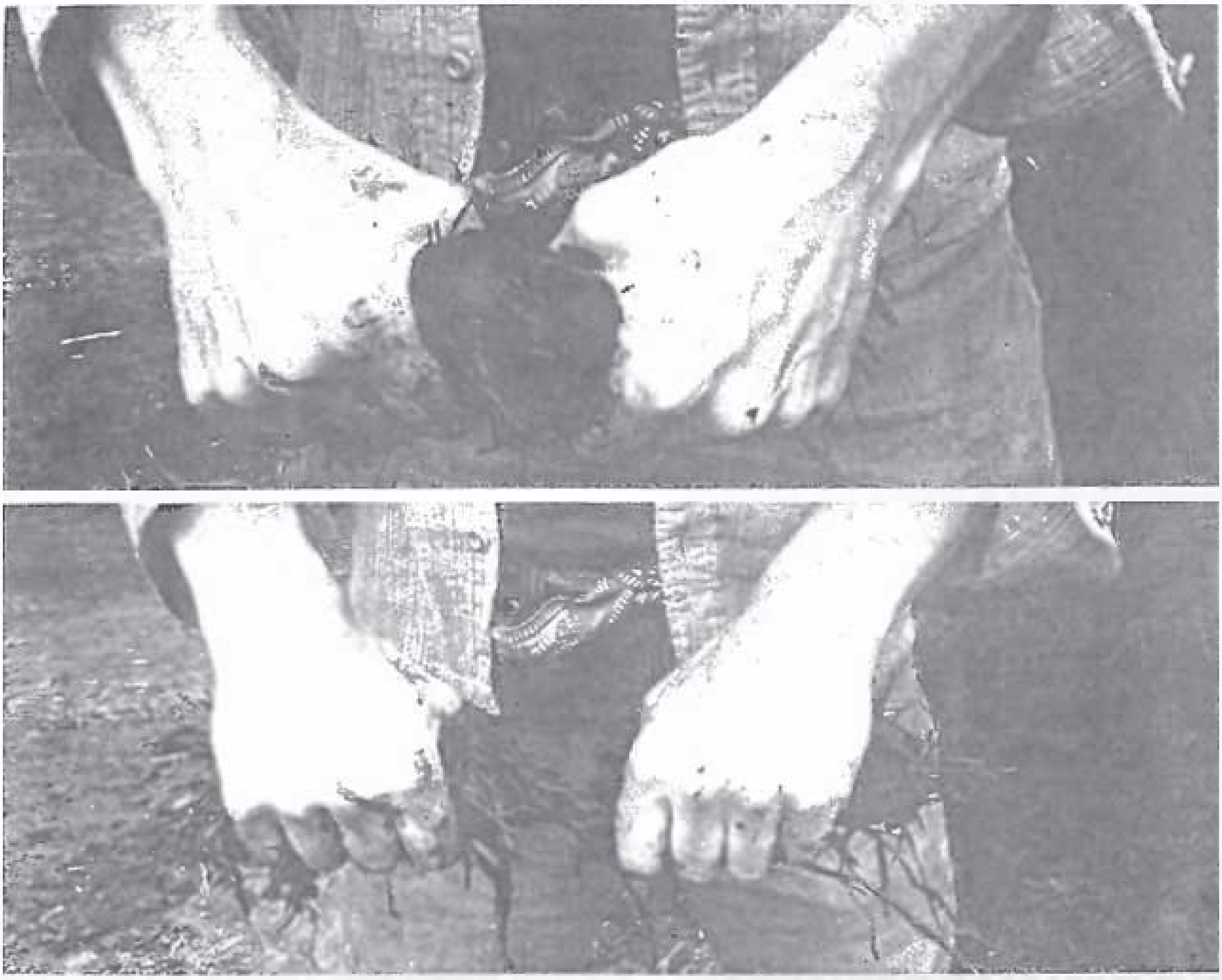


Figure 92, 93 - Compost at filling can be sheared with moderate resistance.

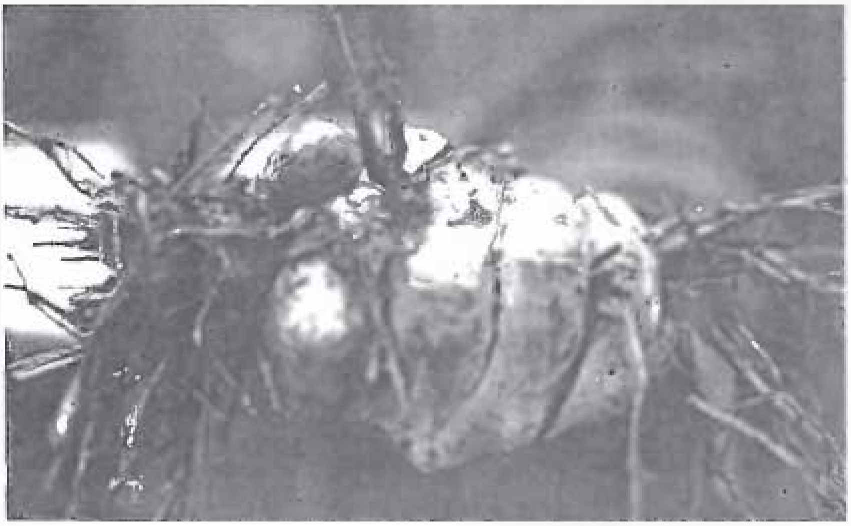


Figure 94 - Compost at filling should release some moisture when firmly squeezed.

Supplementation at Filling

The key to a successful Phase II, whether in trays, shelves or a bulk room, lies in the heat generating capabilities of the completed Phase I compost. To this end the compost should be biologically "active," a term that describes a compost with sufficient food reserves to sustain a high level of microbial activity. Whereas the Sinden Short Compost is a model of a vitally active compost, the Rasmussen Long Compost is considered biologically "dead" because these food reserves have been deliberately exhausted during Phase I. In this same sense, a compost having completed the Phase II is also considered a dead compost.

A method that insures a high level of microbial activity during the Phase II is supplementation with highly soluble carbohydrates during Phase I or with vegetable oils (fats) at filling. The purpose of these supplements is to provide readily available nutrients which stimulate the growth of the microbial populations. The effect of carbohydrates or oil supplementation on the Phase II is:

1. Accelerated thermogenesis - The nutrients provided by the supplements act as a "supercharger" for the microbial populations. Consequently their increased activity generates more heat. Specifically, supplementation with vegetable oil (cottonseed oil) increased populations of actinomycetes and thermophilic fungi (Schisler and Patton, 1970) while soluble carbohydrates (molasses) enhanced bacterial populations (Hayes and Randle, 1968).
2. Better compost ventilation - Heightened thermogenesis within the compost requires lower air temperatures within the Phase II room. The greater the compost to air temperature differential, the better the air movement through the compost. In this respect a dead compost requires a high room temperature and is difficult to condition because of its low microbial activity.
3. Rapid reduction of free ammonia - The increased ventilation and microbial activity give rise to a rapid fixation of ammonia. As a result, the Phase II period is reduced by as much as three days. The advantage of this reduced time period is that dry matter and hence nutrients for mushroom growth are conserved.
4. Reduced spawn running period - Oil supplemented composts show increased mycelial activity and therefore higher temperatures during the spawn running period. As a result the colonization period is shortened by three to five days.
5. Increased yields - Yield increases of 0.4-0.5 lbs/ft^2 are common for *Agaricus* growers using vegetable oil at filling. Similar increases are reported for molasses.

Compost supplementation with soluble carbohydrates is an effective way to prepare an active compost. These materials are listed earlier in the chapter as Group IV supplements. They are added to a synthetic compost during pre-composting (50%) and at third turn (50%) and to a horse manure compost at make-up and at third turn. Molasses is added at make-up at a rate of 10 ml per pound of compost wet weight and is diluted 1:2 with water for easy application. Vegetable oil is sprayed onto the compost the day of fill at a rate of 10 ml per pound of compost wet weight. Even application is important to avoid creating hot spots.

Compost supplementation with soluble carbohydrates or vegetable oils is highly recommended, especially for those planning a Phase II without steam or with only limited supplemental heating. Hence, this type of supplementation is particularly appropriate for the home cultivator.

Phase II Composting

While Phase I is a combination of biological and chemical processes, Phase II is purely biological. In fact, Phase II can be considered a process of microbial husbandry. By bringing the compost indoors into specially designed rooms, the environmental factors of temperature, humidity and fresh air can be controlled to such a degree that conditions for growth of select microbial groups can be maximized. These thermophilic and thermotolerant groups and their temperature ranges are:

Bacteria: 100-170°F. Different species of bacteria are active throughout this range so an optimum can not be given. At temperatures above 130°F. bacteria dominate and are responsible for the ammonification that occurs at these temperatures. The most common bacteria found by researchers are *Pseudomonas* species.

Actinomycetes: 115-140°F. with an optimum temperature range of 125-132°F. The most common species are found in the genera *Streptomyces* and *Thermomonospora*. Work done by Stanek (1971) has shown that actinomycetes and bacteria are mutually stimulatory, resulting in greater efficiency when working together.

Fungi: 110-130°F. with an optimum temperature of 118-122°F. Common genera are *Humicola* and *Torula*. Recent research indicates that these fungi are the most efficient de-ammonifiers, which has led to a more general use of their temperature range for Phase II conditioning.

The basic function of these microorganisms is to utilize and thereby exhaust the readily available carbohydrates and the free ammonia. Ammonia in particular must be completely removed because of its inhibitory effect on the growth of mushroom mycelium. The result of this microbial action is a build-up of cell substance or "biomass" which contains vitamins, fats and proteins. What the mushroom mycelium uses for a large portion of its nutrition then, is the concentrated bodies forming the microbial biomass. This biomass constitutes part of the brown layer coating the partially decomposed straw fibers.

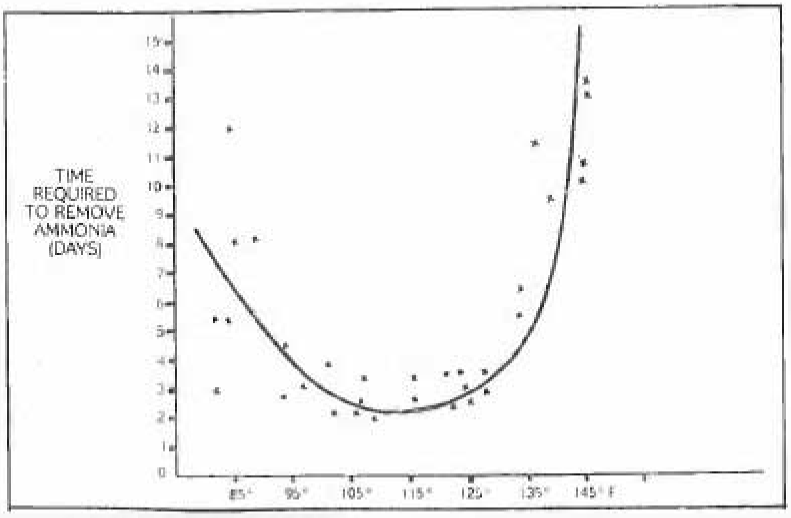


Figure 95 - Temperature vs. ammonia utilization by microbial populations. (After Ross, 1978)

Many growers consider Phase II to be the most important stage in the growing cycle and rightly so. An improperly prepared substrate yields few if any mushrooms. It is critical, therefore, that the environmental conditions required during Phase II be carefully maintained. Phase II can be separated into two distinct parts, each serving a specific function. These are:

1. **PASTEURIZATION**: The air and compost temperature are held at 135-140°F. for 2-6 hours. The purpose of pasteurization is to kill or neutralize all harmful organisms in the compost, compost container and the room. These are mainly nematodes, eggs and larvae of flies, mites, harmful fungi and their spores. The length of time needed generally depends on the depth of fill. Deeper compost layers require more time than shallow ones. In general, two hours at 140°F. is sufficient. Compost temperatures above 140°F. must be avoided because they inactivate fungi and actinomycetes while at the same time stimulating the ammonifying bacteria. If temperatures do go above 140°F., be sure there is a generous supply of fresh air.
2. **CONDITIONING**: The compost temperature is held at 118-130°F. Once the pasteurization is completed, the compost temperature should be lowered gradually over 24 hours to the temperature zone favored by actinomycetes and fungi. The exact temperature varies according to the depth of fill. At depths up to 8 inches, 122°F. as measured in the center of the compost is most frequently used. At depths over 8 inches, temperature stratification becomes more pronounced, making a higher core temperature of 128°F. advantageous. A common procedure is to bring the compost temperature down in steps, dropping the core temperature 2° per day, from 130° to 122°F. This temperature is then held until all traces of ammonia are gone.

Basic Air Requirements

Phase II is purely a process of aerobic fermentation and as such a constant supply of fresh air is essential. To insure this supply, a minimum fresh air setting is established on the air intake damper. A standard minimum setting is 8-10% of the intake opening. The oxygen level can be checked in a practical manner by lighting a match in the Phase II room. If a flame can be maintained, the oxygen level is sufficient. Lack of oxygen stimulates the growth of *Chaetomium*, the Olive Green Mold, which will spoil the compost. (See Chapter XIII).

Compost temperatures follow the air temperature of the room. Fresh air not only supplies oxygen, but is also used to keep the compost within the correct temperature zone. To drop the compost temperature, more fresh air is introduced and vice versa. Oversupply of fresh air is only a problem if it leads to rapid cooling of the compost. In this regard, changes in the fresh air setting should be slow and deliberate. Only when the compost threatens to overheat should maximum fresh air be introduced. This is particularly common directly after pasteurization.

Peak microbial activity normally occurs 24-48 hours after pasteurization. As Phase II progresses and the food supply diminishes, this activity begins to slow. Compost temperatures should begin to drop on their own. As they drop, the fresh air supply should be decreased, thus slowly raising the air temperature as the compost reaches the required temperature zones. If the fresh air minimum is reached and the compost temperatures are still dropping, a supplemental heat source must be installed.

Phase II Room Design

The Phase II room can be a special room set aside solely for this purpose (the norm on tray farms) or it can be in the same room where cropping occurs. Design features are critical for its success and should be strictly adhered to. These features are:

1. Adequate insulation: Insulate to a R value of 19 for walls and a minimum of 30 for the ceiling. A vapor barrier is needed to protect the insulation. (A layer of polyethylene is cheap and effective.)
2. The room must be functionally airtight. The door should form a tight seal. Any cracks or openings allow the passage of flies.
3. The ventilation system uses a backward-curved centrifugal fan driven by pulleys and belts, and whose speed can be varied. The fan should be capable of moving air at 1 cubic foot per minute (CFM) per square foot of compost surface area. A perforated polythene duct runs the length of the room and directs the air either straight down the center aisle or across the ceiling to the side walls. High velocity airflow is necessary to maintain even temperatures throughout as well as to keep the room under positive pressure.
4. A fresh air vent is located before the fan. This damper also regulates recirculated air. (See Fig. 73).
5. Filters are placed before the fresh air inlet. These filters are important as protection against flies, dust and spores. High efficiency spore filters are commonly used for the incoming fresh air. A pre-filter placed upstream of the main filter will increase its life. Recirculated air should never be filtered during Phase II because of its high moisture content.
6. At the opposite end of the room from the fresh air vent are exhaust louvers operating on air pressure. This exhaust air outlet must be screened from the inside.
7. If steam is used for boosting temperature, pipes can be run the length of the floor along the side walls discharging outwards. Steam can also be discharged directly into the air duct after the fan. High output electric space heaters can also be used.

Filling Procedures

Depending on the growing system chosen, the compost is loaded into trays, shelves or a bulk room. Certain basic principles should be adhered to when filling. These are:

1. Fill the room as quickly as possible to minimize heat loss from the compost.
2. Compress a long strawy compost and fill loosely a short dense compost.
3. If the compost appears dry, water lightly and evenly during filling. If water streams out when a handful is squeezed, don't fill. Add again as much gypsum, turn and wait a few days.
4. Fill all shelves and trays evenly and to the same depth. Avoid creating pockets of compact compost. Keep all compost within the container. No compost should hang over the sides.
5. Once finished, the floor should be cleaned of all loose compost, then washed with water.

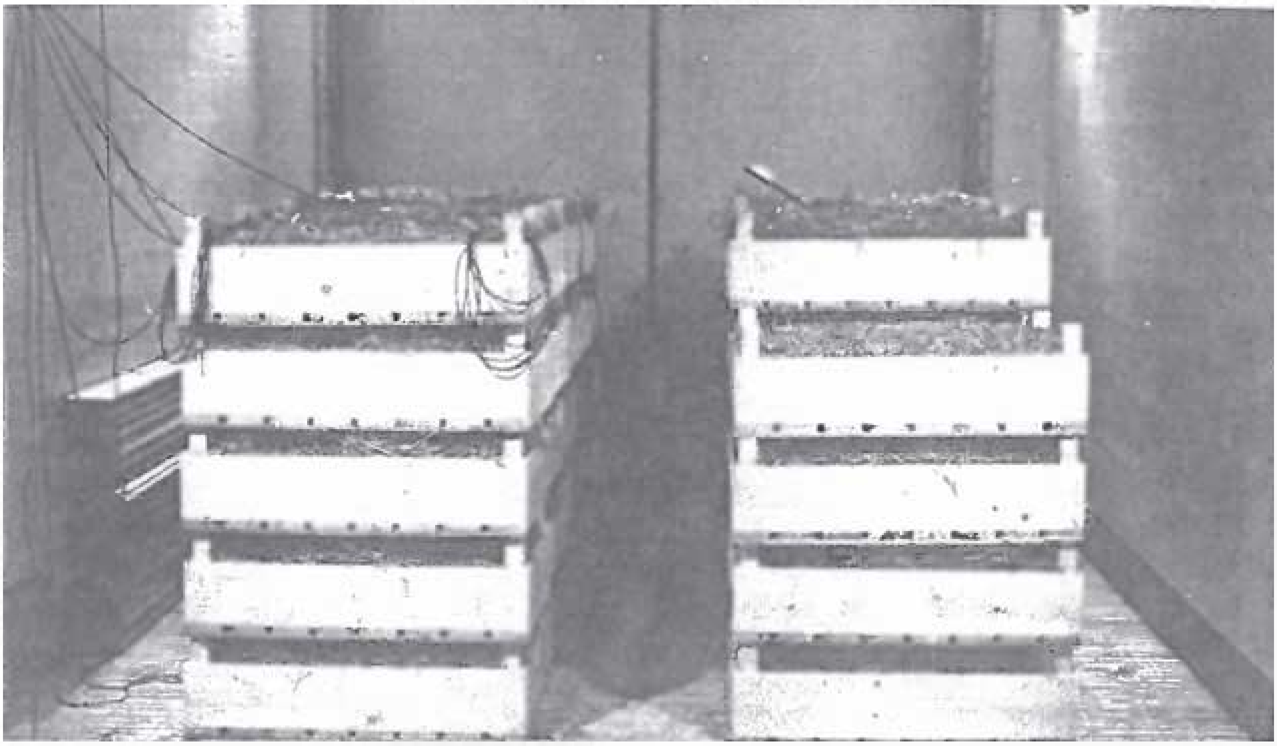


Figure 96 - Small Phase II room designed for trays or bulk fill.

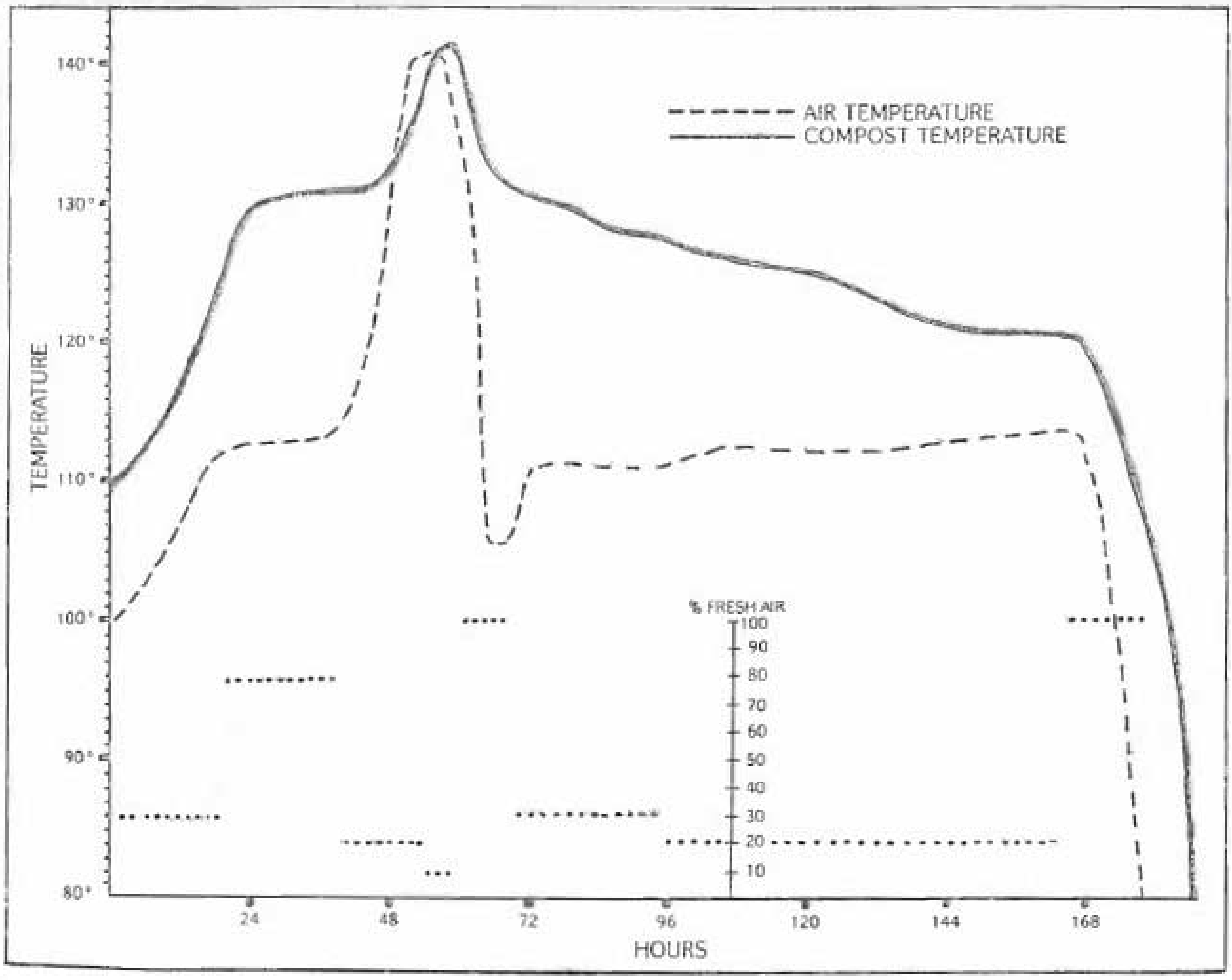


Figure 97 - Phase II temperature profile for trays or shelves.

Depth of Fill

Up to a point there exists a direct relationship between the amount of compost filled per square foot and yield. In a fixed shelf system, the amount of compost filled is usually the amount available for cropping. This normally holds true for trays, although some systems empty the trays at spawning and then refill 25% fewer trays than the number that was originally filled. This results in high dry weight efficiencies without the complications of deep compost layers during Phase II. As a general rule, a fill depth of 8 inches will provide sufficient nutrients as well as contribute to the ease of Phase II. At depths over 8 inches temperature stratification will lead to varying conditions within the compost, complicating the Phase II program. At depths under 5 inches there is insufficient mass for proper heat generation and large quantities of steam may be needed.

An important consideration is the ratio of cubic feet of compost filled to cubic feet of air space in the room. This ratio largely determines whether a supplementary heating source is necessary. Clearly, greater volumes of compost require less additional heating. To maximize compost heat generation, some tray systems stack trays no more than 3-4 inches apart during Phase II. These trays are later distributed to two cropping rooms with a spacer inserted between the trays to facilitate picking.

Phase II Procedures: Trays or Shelves

Day	Phase II Procedure: Trays or Shelves
0	The house is filled and cleaned. Thermometers are placed in the center of at least four containers, and one in the middle of the room for reading air temperature. Shut the door, turn on the fan and close the fresh air vent. Air and compost temperatures should rise from microbial activity. If not, additional heat should be supplied. Once the compost reaches 120°F., the fresh air vent should be opened and regulated to maintain compost temperatures in the 125-130°F. range. From this point on, the fresh air vent should never be less than the minimum setting of 10%.
1-2	A temperature chart should be kept, noting air and compost as well as fresh air and steam settings. Temperatures should be read every 4-6 hours. Compost temperatures should be in the 125-130°F. range for the first 48 hours after fill. After this period, pasteurization should commence. The air temperature is boosted to 140°F. and held long enough to subject the compost to 140°F. for 2 hours. If 140° can not be reached, a compost and air temperature of 135° for four hours is sufficient. The temperatures should be monitored closely to be sure pasteurization is complete. A long stemmed thermometer can be pushed through a drilled opening in the door, or a remote reading thermocouple can be used. After pasteurization, full fresh air is introduced to stop rising compost temperatures. Once the compost temperature begins to drop, adjust the fresh air setting to stop the compost in the temperature zone required, 128-130°F.
2-10	Starting at 128°F., use fresh air to lower the compost temperature gradually, 2° per day, until 122° is reached. Hold the compost at that temperature until it is free of ammonia. Throughout this conditioning process, a compost to air differential of 10-30°F. is normal. This differential is important for the passage of air through the compost. Little or no differential is undesirable and indicates over-composting or under-supplementation. During the conditioning period definite changes in the compost become apparent. The compost becomes well flecked with whitish actinomycetes, and on the surface whitish grey aerial mycelia of *Humicola* species appear. Both are indicators of proper microbial conversion.
2-10	Once the compost is free of ammonia, full fresh air is introduced, dropping the compost temperature rapidly to spawning temperatures in the 76-80°F. range.

Phase II in Bulk

For many people, equipping a standard Phase II room for trays or shelves may be inappropriate, especially if steam is used. The recent development of the bulk system now gives the home grower the ability to perform the Phase II without steam. This system utilizes compost heat more efficiently by loading the compost in mass, five feet deep, into a small well insulated room with a slatted floor. Instead of air diffusing through the compost by convection, air is blown under the floor and forced up through the compost. The wide compost to air temperature differential so essential to conventional Phase II processes is eliminated; compost and air temperatures are now no more than 5°F. apart. This narrow differential is in part related to a reduced compost-to-air volume ratio, which in a bulk room is 1:1 or 1:¾. This reduction of air space, coupled with the airtight, well insulated room, results in full utilization of compost heat generation. A large measure of control over compost temperatures becomes possible and optimum temperatures within the mass can be tightly regulated.

Bulk Room Design Features

The size of the bulk room varies according to individual needs, but should be large enough that there is sufficient compost mass to supply heat.

1. At a fill depth of 4-5 feet, one ton of compost requires approximately 8-10 sq. ft. of floor space.
2. Bulk rooms are well insulated. The walls and door are R-19; the ceiling is R-30 minimum. A vapor barrier should protect all insulation.
3. The room has a double floor. The bottom floor is concrete, insulated to R-19 with styrofoam or other water impervious material, and covered with tar or temperature resistant plastic as a vapor barrier. The compost floor is 12-18 inches above the bottom floor, and is made of 4 x 4's with spacers in between to leave 20% air space. This floor is removable to permit periodic cleaning.
4. The interior walls and ceiling are made of exterior grade plywood, treated with a wood preservative or marine epoxy. Allow 1/4 inch for expansion. Caulk or seal with fiberglass tape.
5. The room must be airtight. Caulk all cracks and corners.
6. The access door runs the width of the room for easy loading and unloading. An airtight seal is essential.
7. A wood plank wall is inserted before the access door to prevent the compost from pressing against it. The plank wall is held in place by runners on either wall.
8. The ventilation system is powered by a centrifugal, high pressure belt driven blower, with a capacity of 90-120 CFM per ton of compost at a static pressure of up to 4 inches of water gauge. The recirculation duct comes out on the top of the back wall and down to the fan. The supply duct goes from the fan to the air chamber under the compost floor. All ductwork should be insulated.
9. The fresh air inlet and damper are located before the fan. This damper also regulates the recirculated air. The fresh air should be filtered.
10. The exhaust outlet is located on the access door. This is a free swinging damper that operates on room pressure. This outlet is covered by a coarse filter.
11. Standard inside dimensions are 6-12 feet wide by 8-10 feet high.
12. For better temperature control the bulk room should be built inside a larger building, like a garage, where temperature differences are less extreme. The introduction of cold fresh air hampers the process by neutralizing the compost heat.

A simple variation of this bulk room is a well insulated bin. The bin is constructed using the principles just outlined. Rather than a mechanical air system, fresh air is admitted through adjustable vents at floor level and exits through similar vents in the ceiling. Because air passage is by convection, the compost should be filled loosely and to a depth of no greater than four feet.

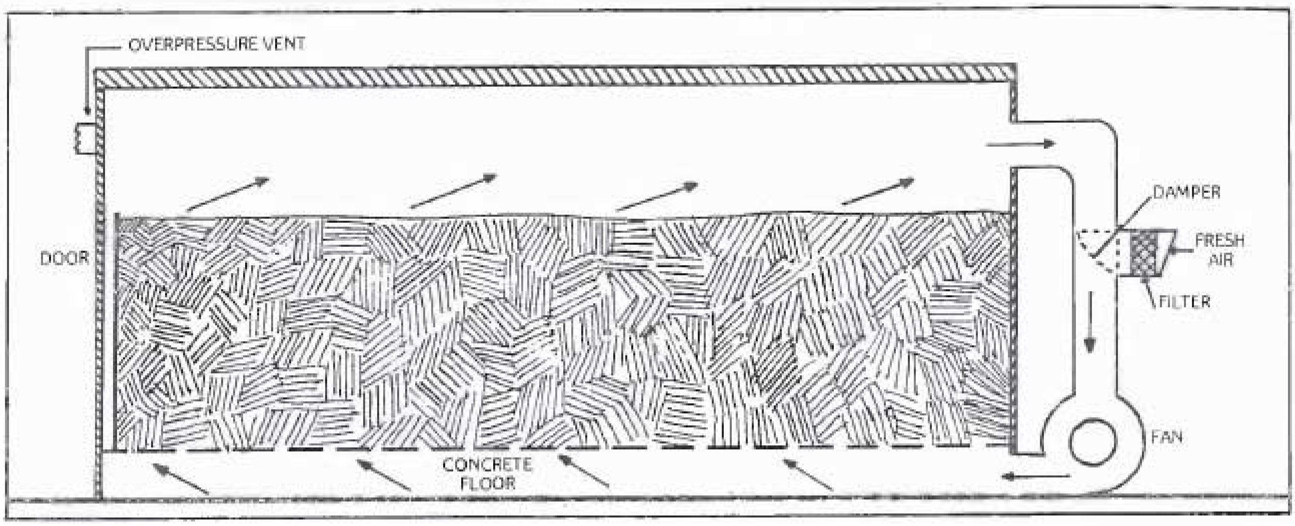


Figure 98 - Bulk pasteurization room. Ventilation system on end wall. (Design - Vedder)

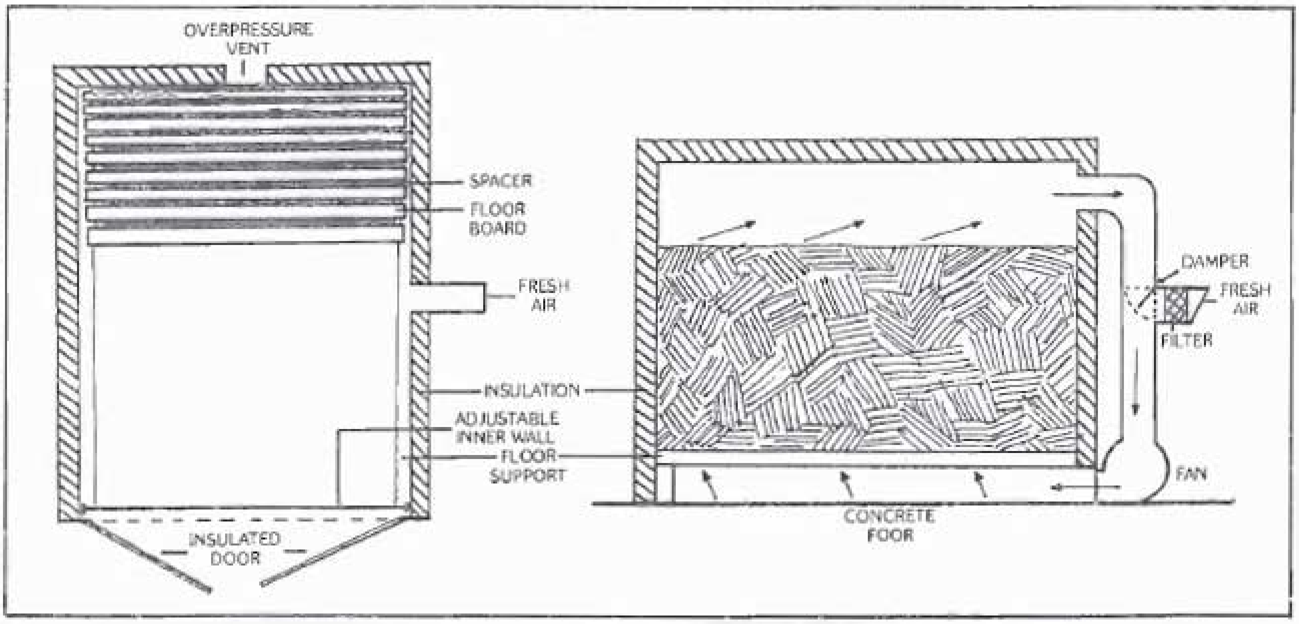


Figure 99 - Bulk pasteurization room. Ventilation system on side wall. (Design - Claron)

Bulk Room Filling Procedures

1. Fill as quickly as possible to minimize heat loss.
2. Compost should have good structure and optimum moisture content. Do not fill a dense, overwet compost.
3. Fill evenly. Compost density is important. Avoid localized compaction as well as gaps. Gaps or holes in the compost become air channels to the detriment of the surrounding material. Be sure the compost presses firmly and evenly against all sides of the room.
4. Before filling the last three feet, put the inside board wall in place. Now fill the remaining area. The compost should press firmly against the board wall.

Bulk Room Phase II Procedures

Day	Bulk Room Phase II Procedures
0	**Filling**. Compost is brought into the room. If remote reading temperature sensors are used, place 2-4 sensors in different locations within the compost, and one in the air above. If remote sensors are not used, place one thermometer in the return air duct and one downstream from the fan in the supply duct. The compost temperature should be within the readings of these two air thermometers. Turn the fan on, close the fresh air damper and re-circulate until 120°F. is reached. This should take 8-24 hours. Then open the fresh air damper to the minimum setting, 8-10%.
1-2	**Pasteurization**: Allow the temperature to rise to 132-135°F. Adjust the fresh air damper to hold this temperature for at least six hours and a maximum of ten hours. Once completed, introduce sufficient fresh air to bring the temperature down to 122°F. This should take approximately 12 hours. Be sure to anticipate temperature trends and adjust the fresh air accordingly.
2-10	**Conditioning**: By adjusting the amount of fresh air, the compost is held in the 118-122°F. range until all ammonia is gone. Fresh air should gradually be reduced as thermogenesis subsides. The temperature in the return air duct should always be higher than in the supply duct.
4-10	**Cool-down**: Once the ammonia content of the air is below 10 parts per million (ppm) full fresh air is given to reduce the compost temperature to 80°F. The cool-down should proceed as rapidly as possible.

Testing for Ammonia

The basic ammonia detection test has always been the sense of smell. The odor of ammonia must be completely gone from the compost before it can be spawned. Odors are always good indicators of compost suitability. However, to be absolutely certain, other methods are also used.

1. Cresyl Orange and filter paper: Pre-cut strips of white filter paper are saturated with a few drops of cresyl orange liquid which turns the white paper yellow. Expose the paper to the inside of the Phase II room or to the exhaust air of the bulk room. The paper can also be placed into small holes dug into the compost. The presence of ammonia turns the paper varying shades of red. Purple indicates the highest concentration, while pink indicates a lower one. When the yellow paper remains unchanged in color, free ammonia is absent.
2. Air samplers using gas detection tubes: These tubes are filled with chemicals that change color as air samples are drawn into them. The tubes are calibrated in parts per million (ppm) and give accurate readings down to 1 ppm. The air samplers are manufactured by Mine Safety Co. and the Draeger Corp. Individual tubes cost from $2.00-$4.00 in lots of ten. (See sources in Appendix).

Aspect of the Finished Compost

The following guidelines can be used to determine whether a compost is ready for spawning. (See Color Photographs 5-8).

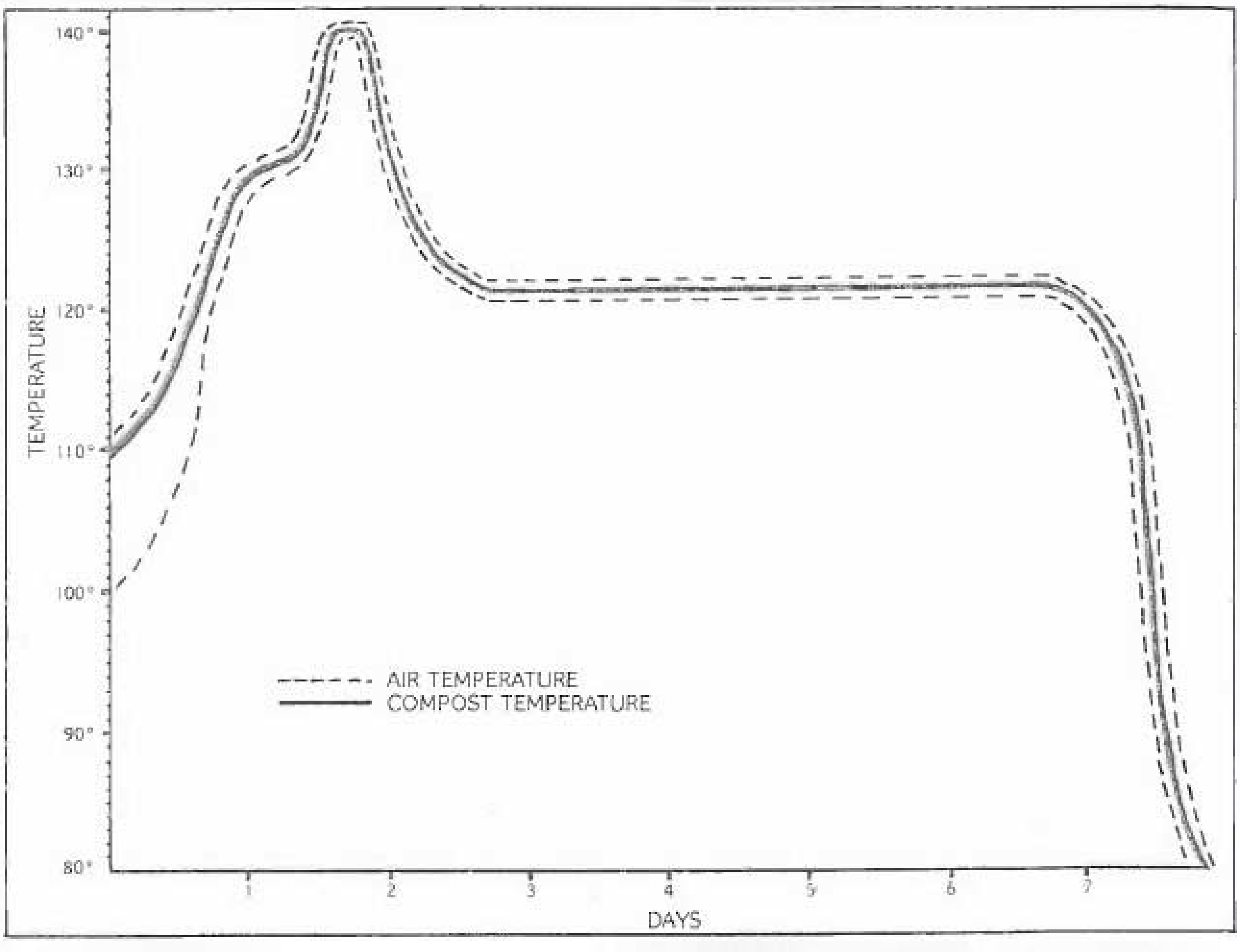


Figure 100 - Bulk room Phase II temperature profile. (Dutch procedure)

1. The raw pungent odor is gone; the odor is now light and pleasant, even slightly sweet.
2. The ammonia odor is completely gone. The cresyl orange test shows no reaction. Detector tubes read 10 ppm or less.
3. The pH is below 7.8, preferably 7.5.
4. Straws appear dull and uniformly chocolate brown, speckled with whitish actinomycetes.
5. The compost is soft and pliable and can be sheared easily.
6. When squeezed the compost holds its form. No water appears and the hand remains relatively clean.
7. Moisture content is 64-66% for horse manure and 67-68% for synthetics.
8. Nitrogen content is 2.0-2.3%; the C:N ratio is 17:1.

Alternative Composts and Composting Procedures

Sugar Cane Bagasse Compost

Sugar cane bagasse is the cellulosic by-product of sugar cane after most of the sugars have been removed. It is generally a short fibrous material with a high moisture holding capacity. Total nitrogen amounts to 0.18%. In 1960, Dr. Kneebone of Pennsylvania State University reported growing *Psilocybe aztecorum* on a bagasse based compost. He later reported in more detail on experiments using bagasse compost for growing *Agaricus brunnescens*. Bagasse used as stable bedding produced yields comparable to the horse manure based control. Bagasse supplemented with a commercial activator ("Acto 88") yielded poorly.

Dr. Kneebone's composts were prepared using the standard techniques elucidated in this chapter with a turn schedule on days 0-2-5-7-9. The supplemented bagasse was composted 3 days longer and all bagasse based composts had moisture contents ranging from 75-83%. Significantly, the bagasse compost with the lowest moisture content had the highest yield. All bagasse composts had larger mushrooms than the control.

This work by Kneebone demonstrates the value of bagasse as a mushroom growing substrate. Using the compost formula format, composts can be devised to meet the needs of the two species named and many others. A good supplement would be horse droppings on wood shavings. If the bagasse compost becomes too short or wet, the gypsum can be increased from 5% to 8% of the dry weight.

The Five Day Express Composting Method

During the past 20 years compost research has been directed towards shortening the overall preparation period. The goal is to reduce handling and further conserve the nutrient base (dry matter). But so far, no one has been able to consistently produce a high yielding compost by rapid preparation methods. However, a recent article by Kaj Bech (1978) of the Mushroom Research Lab in Denmark reports the most promising method to date. According to Bech, total dry matter loss is held to 20-25% with a composting time of 8-10 days (5 day Phase I and 3-5 day Phase II). His method and materials follow:

Day	Procedure
-2	Take one ton wheat straw based horse manure (moisture content 50%, nitrogen content of 1.0-1.1). Homogenize well and make up the pile using standard dimensions.
0	**1st turn**: Add ammonia sulfate, $(NH_4)_2SO_4$, 11.25 kg. Wet thoroughly with approximately 450 liters of water.
2	**2nd turn**: add calcium carbonate ($CaCO_3$) 33.75 kg. Add approximately 180 liters of water.
3	Mix well and fill trays, shelves or tunnel for standard Phase II.

VI. NON-COMPOSTED SUBSTRATES

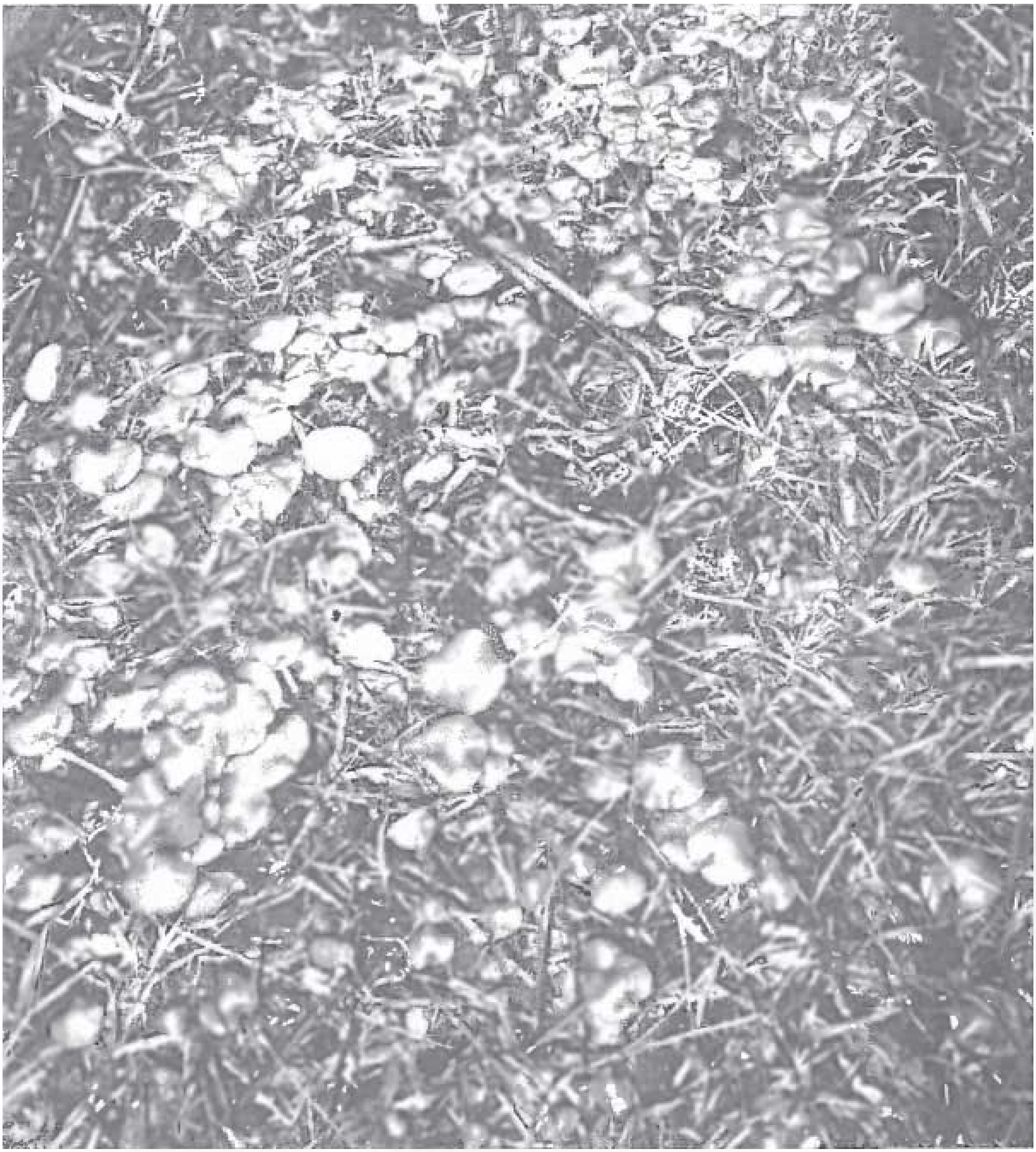


Figure 101 - *Psilocybe cyanescens* fruiting outdoors in a bed of fresh alder chips.

The use of non-composted and semi-composted materials as mushroom growing substrates is common among commercial growers of *Pleurotus, Voivarielia, Flammulina* and *Stropharia*. Because of the simplicity and ease by which they are produced, these substrates are ideal for the home cultivator. The advantages of these substrates are the rapid preparation times and the easily standardized mixtures formulated from readily available raw materials. These substrates can be treated by sterilization, pasteurization or used untreated in their natural state.

Natural Culture

For most people mushroom cultivation implies an indoor process employing sterile culture techniques and a controlled growing environment. Although this has been the natural progression of events for commercial cultivators and is the only way to consistently grow year round crops, it need not be the sole method available to the home cultivator. For hundreds of years home growers have made up outdoor beds and have enjoyed harvesting seasonal crops of mushrooms. In fact, most mushrooms now being grown commercially were originally grown using natural culture techniques.

By observing wild mushrooms fruiting in their natural habitats, one can begin to understand their growth requirements. To fully illustrate how this methodology works, the development of natural culture for *Psilocybe cyanescens* will be used as an example. *Psilocybe cyanescens* grows along fence lines and hedge rows, in tall rank grass, in berry thickets, in well mulched rhododendron beds, in piles of wood chips and shavings and in ecologically disturbed areas. In many instances, the mushrooms are found growing in soil, but upon close examination of the underlying mycelial network, it is apparent that they are feeding on wood or other similar cellulosic material. Due to the thick strandy mycelium of *Psilocybe cyanescens*, it is relatively easy to locate and gather colonized pieces of substrate. These pieces are considered virgin spawn and are used to inoculate similar materials. Freshly cut chips of alder, maple and fir all support healthy mycelial growth. Because alder is high in sugar content, without resins and abundant in northwestern North America, it has been selected as the primary substrate material.

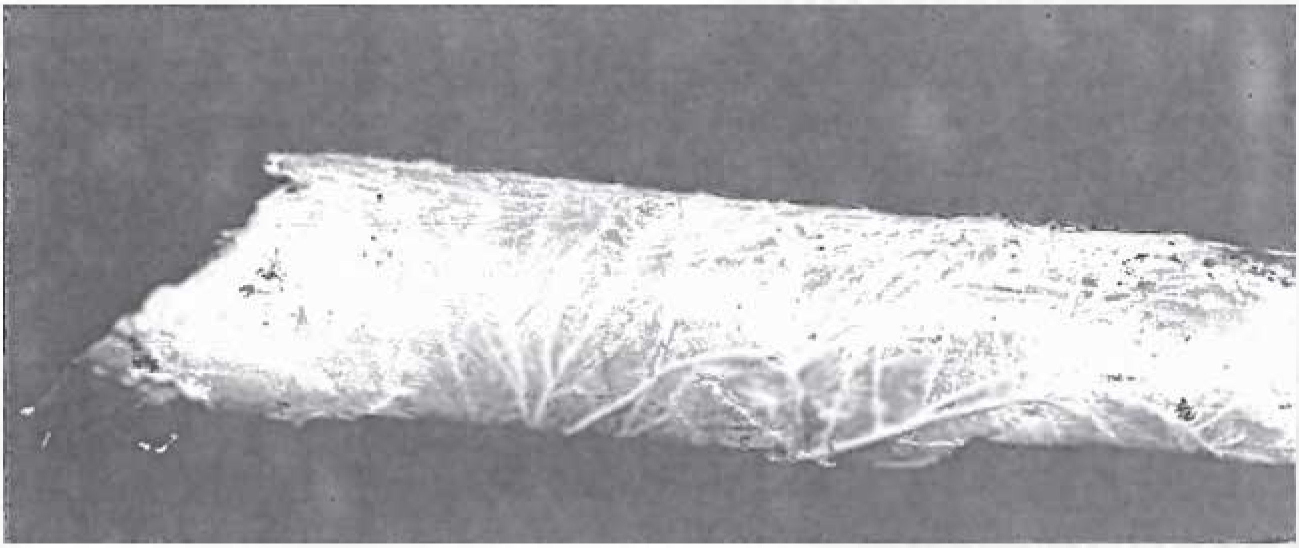


Figure 102 - Virgin spawn: *Psilocybe cyanescens* mycelium on a wood chip.

Even though such a virgin spawn is not absolutely clean, *Psilocybe cyanescens* mycelium colonizes fresh substrate pieces so rapidly that there is little risk of contamination. In order to prepare inoculum for the following year, the newly inoculated chips are kept indoors in gallon jars or other protective containers. With sufficient moisture, minimal air exchange and normal indoor temperatures, the mycelium soon spreads throughout the fresh chips. For the best results a 1:5 ratio of virgin spawn to fresh chips is recommended. As one jar becomes fully permeated, it can be used to produce more spawn.

In the spring freshly cut wood branches are chipped, then mixed with the fully colonized inoculum and made into a ridge bed directly on the ground. Experience has shown that irregular chips approximately 1-3 inches long give better results than finely ground material such as sawdust. Fresh chips not only provide a greater nutrient and water reservoir, but also have substantial surface area for primordia formation. Strong mycelial growth can be sustained on wood chips for a prolonged period of time. (Mycelial growth on fresh sawdust is at first rapid and rhizomorphic but soon slows and loses its vitality).

The ridge beds should be made 4-6 inches deep and 2 feet wide. To insure a humid microclimate for mushroom development the bed should be made under rhododendrons or other leafy ornamentals, along a fence or hedge row, or on grass which is allowed to grow up through the bed. The bed must never be placed where it is exposed to direct sunlight but it should not be so well protected that rainfall can not reach it.

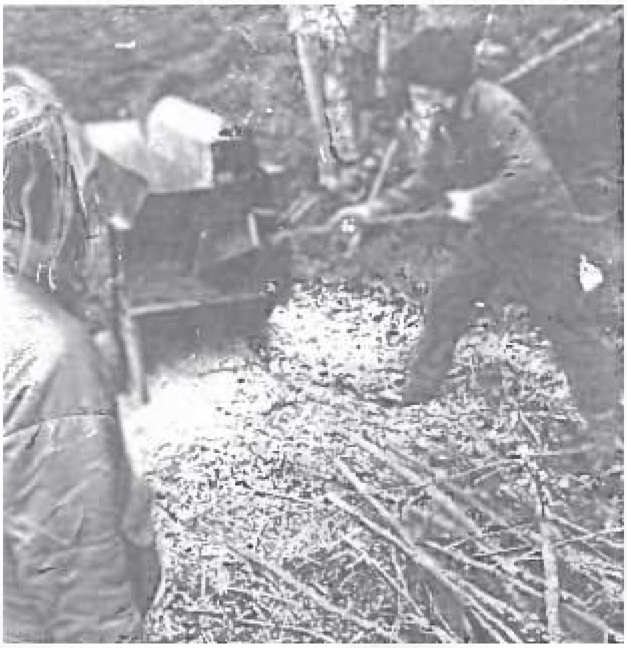


Figure 103 - Chipping freshly cut alder branches.

During the spring and summer the mycelium colonizes the fresh substrate which should be covered with plastic or cardboard to prevent drying. A weekly watering helps to keep the moisture content high. In the fall the bed is uncovered and given a heavy watering twice a week, but with care not to flood it. When the mushrooms begin to fruit, watering should be gauged according to environmental conditions and natural precipitation. As long as the temperature stays above freezing the mushrooms will grow continuously. If a freeze is expected, the beds can be protected with a plastic covering. Extended freezing weather ends outdoor cropping until the following year.

Throughout the winter the beds can be protected by a layer of straw, cardboard or new chips topped with plastic. This is particularly important for harsh climates. Other possibilities include making the bed inside a cold frame or plastic greenhouse. Certain regions of the country like the North-west are better suited to natural culture than others. In this respect it is desirable to use a local strain adapted to local conditions. In climates unsuited to outdoor cultivation, the wood chips can be filled into trays and brought inside.

Once the primary bed has been established outdoors, it can be likened to a perennial plant, which is the nature of mushroom mycelium. Indoor spawn preparation and incubation become unnecessary. With each successive year chips can be drawn from the original bed and used as inoculum. This means that the total bed area can be multiplied by five on an annual basis. (See Figure 164 of *Psilocybe cyanescens* fruiting indoors in tray of alder chips).

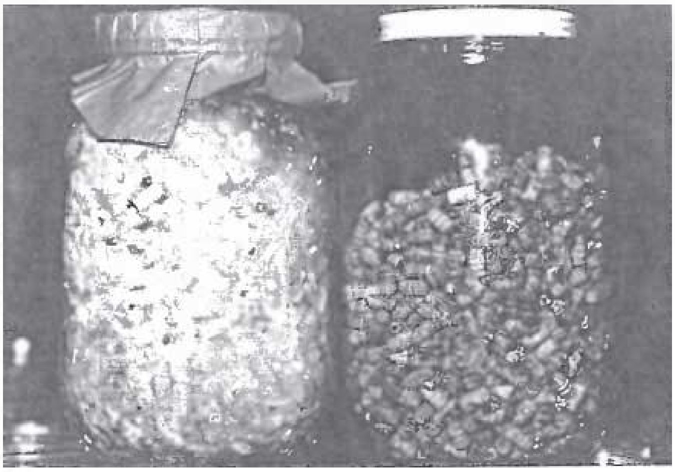


Figure 104 - Oak dowels before and after colonization by shiitake (*Lentinus edodes*) mycelium.

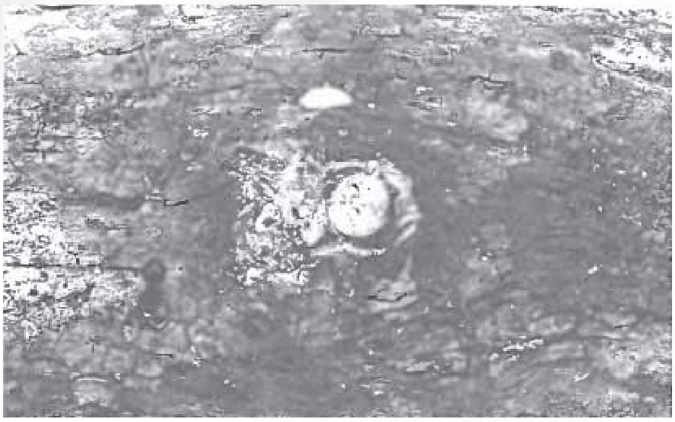


Figure 105 - Shiitake plug inserted into oak log.

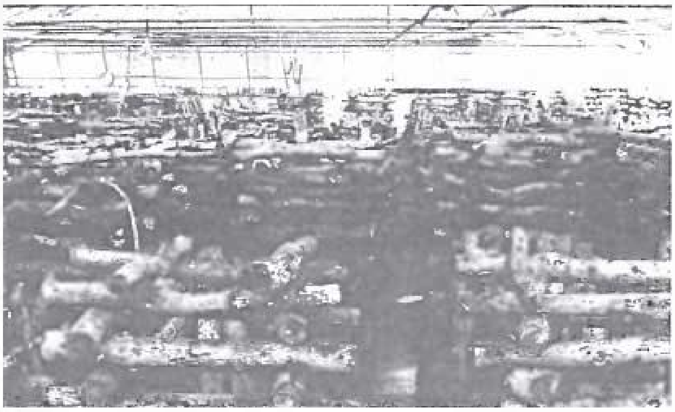


Figure 106 - Stacked arrangement of shiitake logs in a greenhouse.

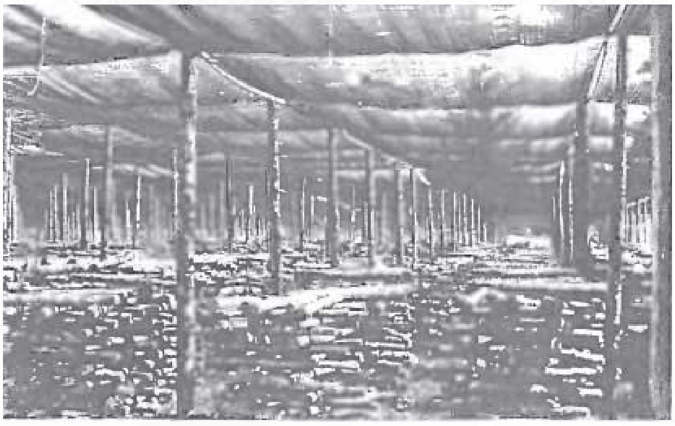


Figure 107 - Shiitake culture outdoors under shade cloth.

Semi-sterile and Sterile Wood Based Substrates

Mushrooms that grow on wood or wood wastes are termed lignicolous due to their ability to utilize lignin, a microbial resistant substance that constitutes the heart wood of trees. The main components of wood, however, are cellulose and hemicellulose, which are also nutrients available to lignin degrading mushroom mycelium. The chart appearing below shows a typical analysis of different wood and straw types. This table not only illustrates the similarities between wood and straw, but also the important differences between coniferous and broad leaf trees. The high concentrations of resins, turpentine and tanins make conifers less suitable for mushroom growing. Conifers are used on occasion, but they are mixed one to one with hardwood sawdust. In general, the wood of broad leaf or hardwood species have proven to be the best mushroom growing substrates. Specifically these tree types are: oak; elm; chestnut; beech; maple; and alder.

Type	Resin	N	P-2 0-5	K_2O	Hemicell.	Cell.	Lignin
Spruce (*Picea excelsa*)	2.30	0.08	0.02	0.10	11.30	57.84	28.29
Pine (*Pinus silvestris*)	3.45	0.06	0.02	0.09	11.02	54.25	26.25
Beech (*Fagus silvatica*)	1.78	0.13	0.02	0.21	24.86	53.46	22.46
Birch (*Betula verrucosa*)	1.80	-	-	-	27.07	45.30	19.56
Wheat Straw (*Triticum sativum*)	0.00	0.60	0.30	1.10	-	36.15	16.15

Table of the analyses of various types of wood and straw. Figures are percent of dry weight. (Adapted from H. Rempe (1953)).

The most notable commercial species grown on wood is *Lentinus edodes*, the shiitake mushroom. Traditional methods use oak logs, 3-6 inches in diameter and three feet long, cut between fall and spring when the sap content is the highest. Special care should be taken not to injure the bark layer when cutting and handling the logs. The bark is of critical importance for fruiting and is one of the key factors considered by commercial growers when selecting tree species. The logs should be scraped clean of lichens and fungi and then drilled with four longitudinal rows of one inch deep holes spaced eight inches apart. Next, these holes are plugged with spawn and covered with wax. After 9 to 15 months of incubation the logs begin to fruit. (See the species parameter section in Chapter XI.) The use of freshly cut logs provides a semi-sterile substrate with no special treatment and is a very effective method for the home cultivator.

Commercial growers of lignicolous mushrooms are turning increasingly to sawdust based substrates. Such substrates have been developed in Japan for growing *Pleurotus, Flammulina* and *Auricularia*. They are also being utilized with some modifications by commercial shiitake growers in the United States. The development of these mushroom specific substrates follows certain well defined guidelines.

The basic raw material is cellulose, a major constituent of sawdust, straw, cardboard or paper wastes, wood chips, or other natural plant fibers. Any of these materials should be chopped or shredded, but never so finely as to eliminate their inherent structural qualities. This cellulosic base comprises approximately 80% of the total substrate mixture.

To these basic substrate materials are added various nutrient supplements and growth stimulators in meal or flour form. By supplying proteins, carbohydrates, vitamins and minerals, the supplements serve to enhance the yield capabilities of the substrate base. Protein sources include concentrates like soya meal or soya flour, wheat germ and brewer's yeast. The most suitable carbohydrate sources are starchy materials such as rice, potatoes, corn and wheat. Some supplements are well balanced and provide both carbohydrates and proteins. Examples of these are bran, oatmeal and grains of all types. The number of possible supplements is extensive and need not be limited to those listed. The supplements comprise approximately 8-25% of the total dry weight. The addition of gypsum at a rate of 5% of the dry weight can improve the structure and porosity. It should be considered an optional ingredient.

Japanese growers of *Flammulina velutipes, Auricularia auricula* and allies, and *Pleurotus ostreatus* have a standard substrate formula consisting of 4 parts sawdust and 1 part bran. The sawdust can be aged up to one year, which is said to improve its moisture holding capacity. Presoaking the sawdust prior to mixing in the bran is an effective way to achieve the required 60% moisture optimum. A firm squeeze of the mixture should produce only a few drops of water between the fingers. If the mixture has too much moisture, loose water collects in the bottom of the substrate container, a condition predisposing the culture to contamination.

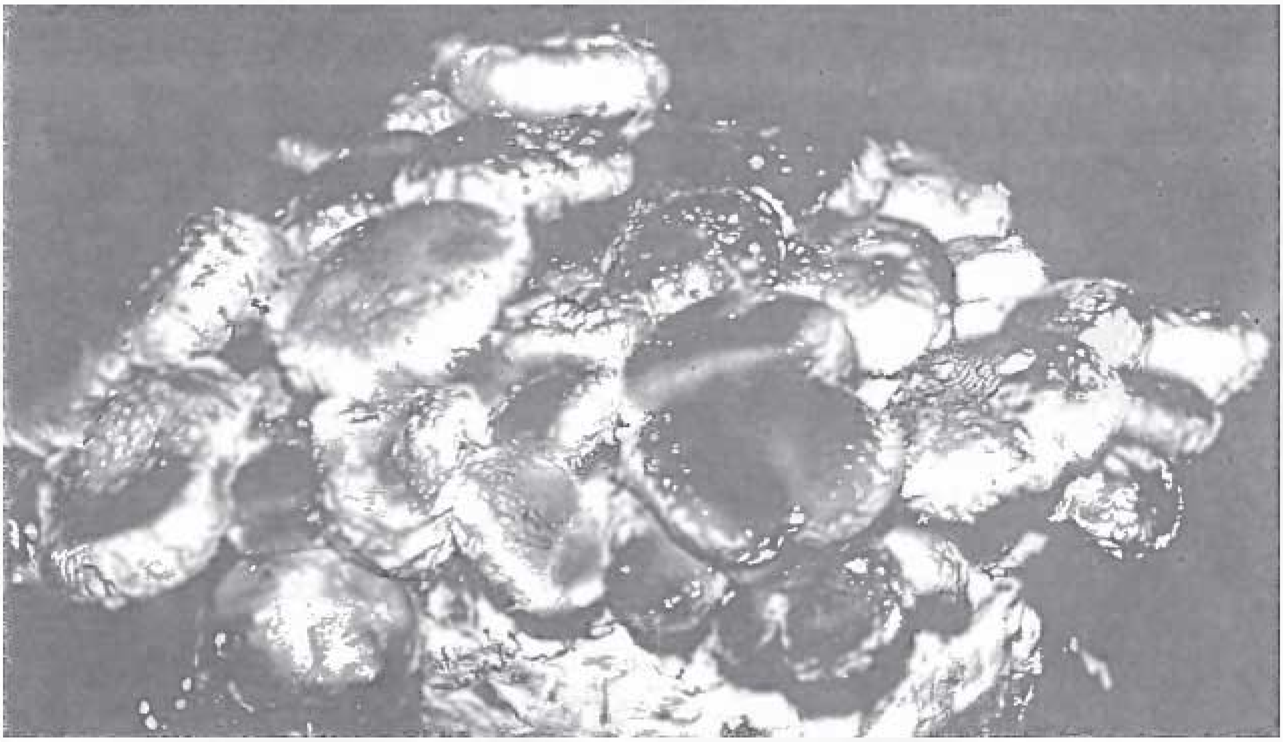
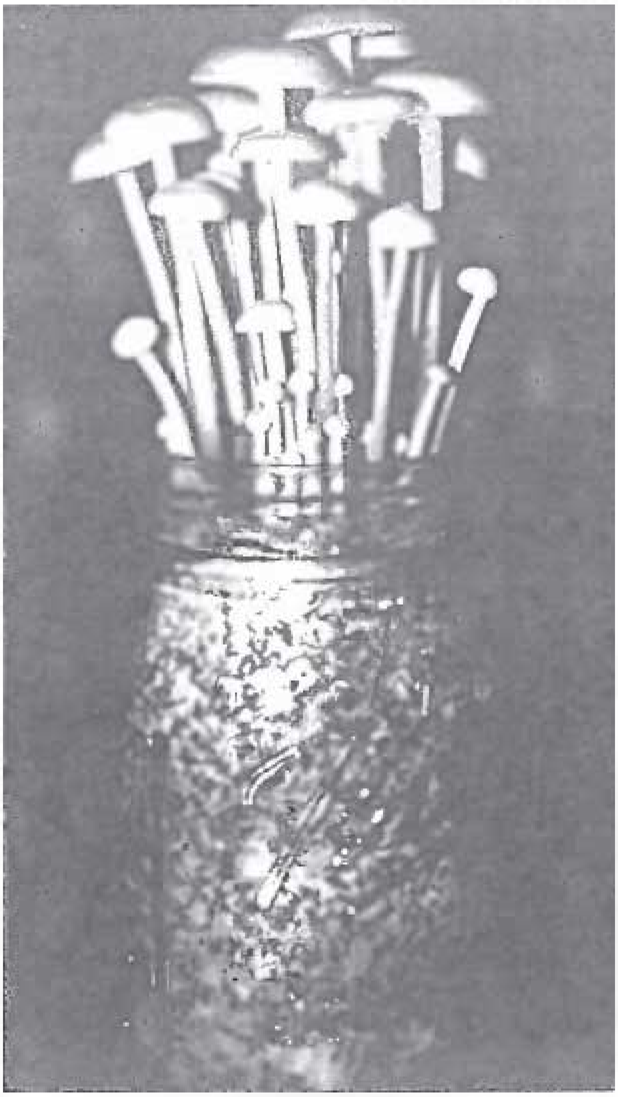


Figure 108 - Photograph of shiitake mushrooms growing on a sawdust block.

The substrate can be filled into a number of different containers. Mason jars, polypropylene jars or high density, heat-resistant polyethylene bags are commonly employed. The containers are closed and sealed with a microporous filter. They are sterilized at 15 psi for 60-90 minutes. After sterilization the containers are cooled to ambient temperature and inoculated. The inoculum can be either grain spawn or sawdust-bran spawn.

During incubation substrate filled plastic bags can be molded to the desired cropping form. Common shapes are round mini-logs or rectangular blocks. Some *Pleurotus* growers mold the sawdust substrate into a cylindrical shape, 6-8 inches long and 4-5 inches in diameter. The fully colonized "logs" are stacked together on their sides with the ends exposed as the cropping surfaces. An alternative is to slit the bag lengthwise in four places, exposing the substrate to air while retaining the plastic as a humidity hood. If growing in jars, *Flammulina* and *Pleurotus* fruit from the exposed surface at the mouth of the jars.



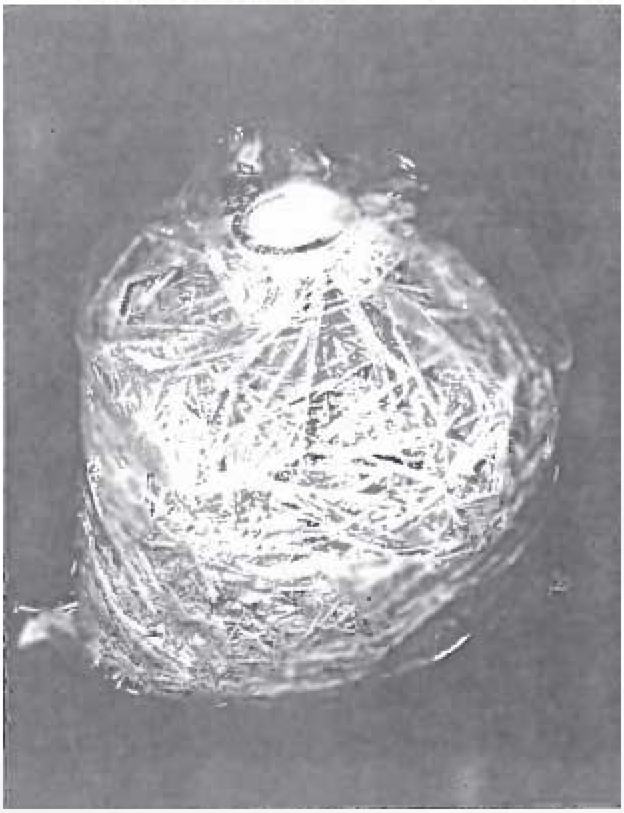


Figure 109 - *Flammulina velutipes*, the Enoke Mushroom, fruiting in mason jar containing sawdust mixture.

Figure 110 - Autoclavable plastic bag and microporous filter disc, known in the Orient as the Space Bag.

Growing on Pasteurized Straw

In commercial mushroom production one of the most frequently used substrate materials is cereal straw. Not only does straw form the basis for mushroom composts, but it is also used uncomposted as the sole ingredient for the growth of various mushroom species. Although all types of straw are more or less suitable, most growers use wheat because of its coarse fiber and its availability. The straw should be clean, free from molds and unspoiled by any preliminary decomposition. Preparation simply involves chopping or shredding the dry straw into 1-3 inch pieces. This can be done with a wood chipper, a garden compost shredder or a power mower. The shredding increases moisture absorption by expanding the available surface area. Shredding also increases the density of the substrate mass.

The chopped straw is treated by pasteurization which can be carried out with live steam or hot water. Presoaked to approximately 75% water, the straw is filled into a tunnel or steam room as described in the corn posting chapter. It is steamed for 2-4 hours at 140-150°F., then cooled to 80°F. and spawned. An alternative program calls for 12-24 hours at 122°F. after the high temperature pasteurization. This program is designed to promote beneficial microbial growth giving the straw a higher degree of selectivity for mushroom mycelium.

The method best suited to the home cultivator is the hot water bath. Figure 111 illustrates a simple system utilizing a 55 gallon drum and a propane burner. The drum is half filled with water that is then heated to 160-170°F. Chopped dry straw is placed into the wire mesh basket and submerged in the hot water. (A weight is needed to keep the straw underwater.) After 30-45 minutes the straw is removed from the water and allowed to drain. It is very important to let all loose water run off.

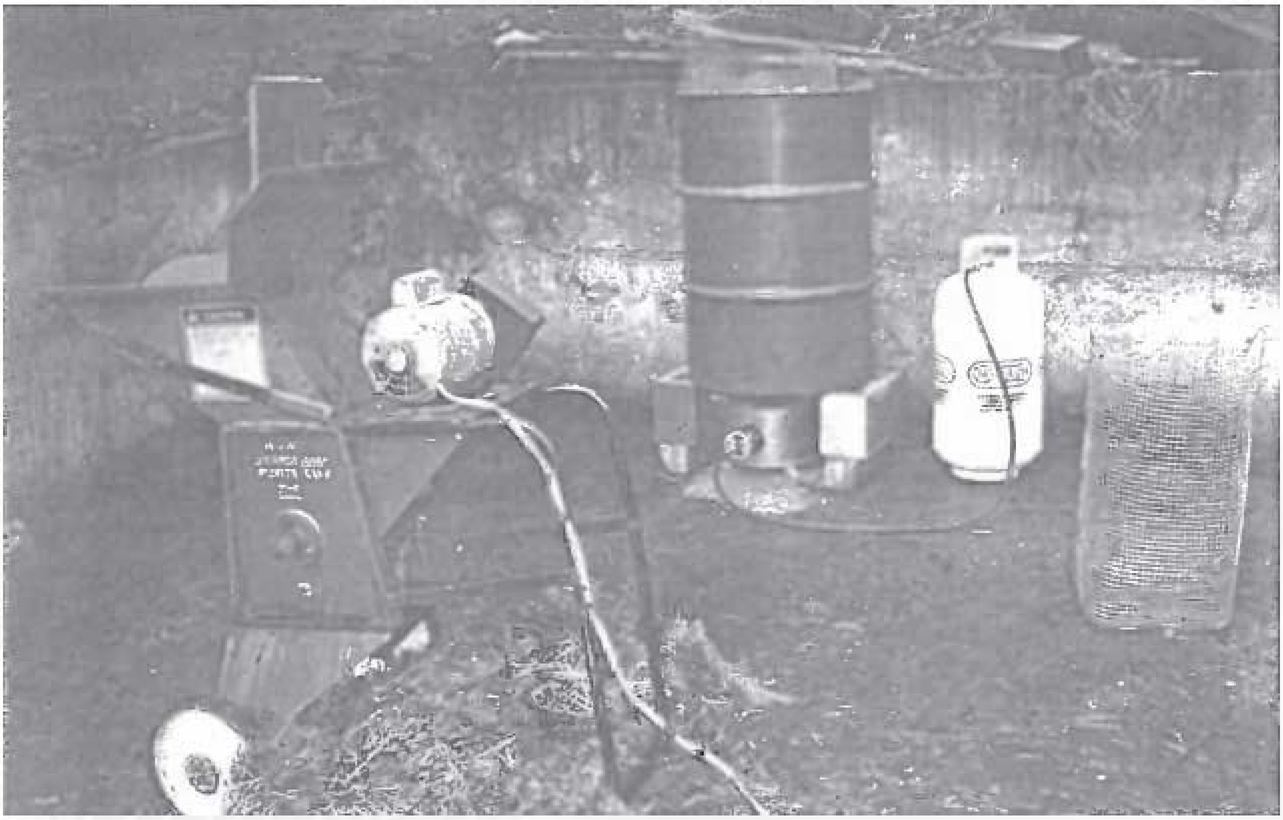


Figure 111 - Equipment needed for pasteurization of straw: 55 gallon drum; gas burner; shredder; hardware cloth basket and straw.

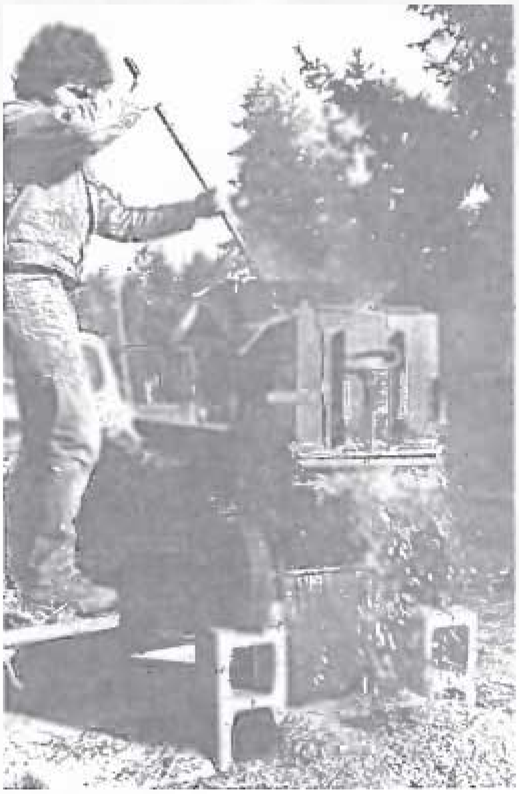


Figure 112 - Shredding the straw.

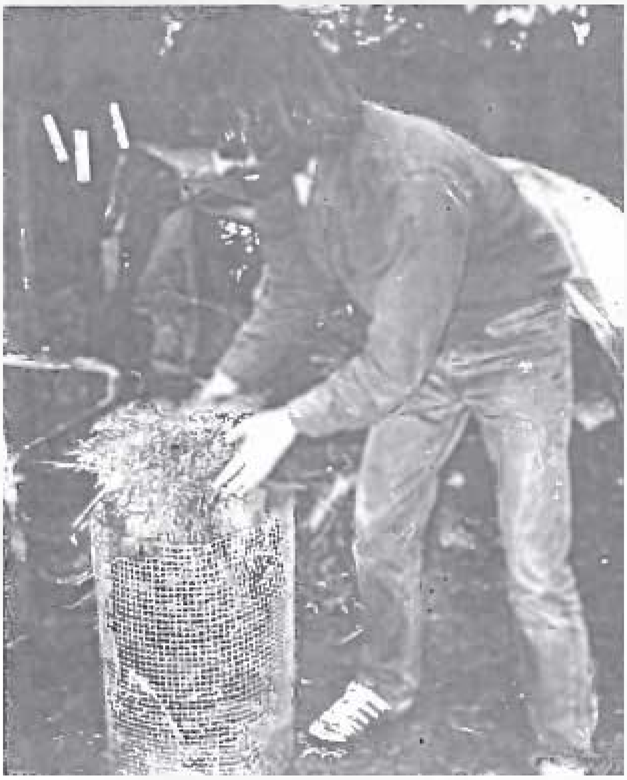


Figure 113 - Filling the shredded straw into the wire basket.

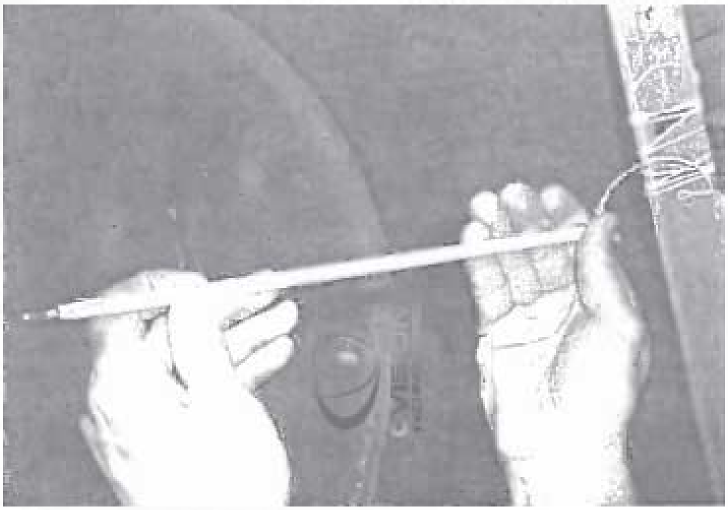


Figure 114 - Checking the water temperature.

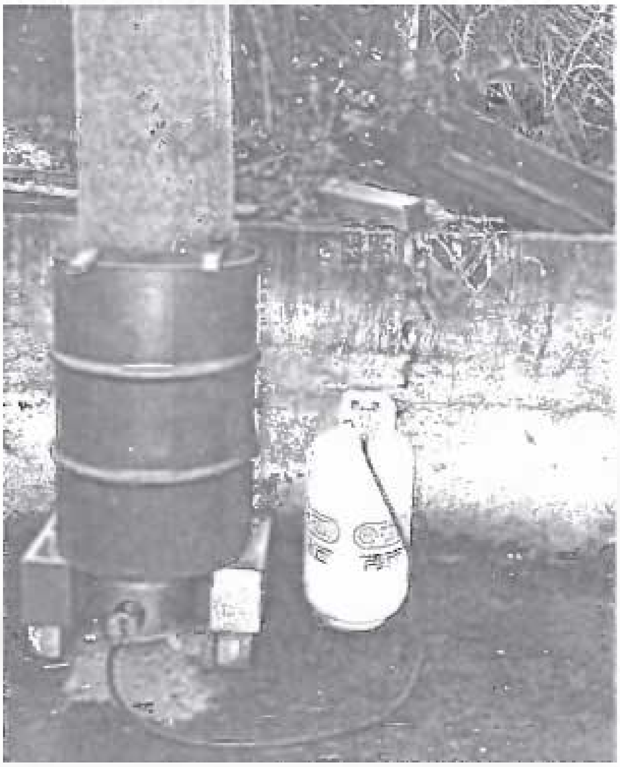


Figure 115 - Draining the pasteurized straw.

Once drained, the straw is spread out on a clean surface and allowed to cool to 80°F. (or less), at which point it can be spawned. The straw is evenly mixed with spawn and filled into trays, shelves or plastic bags. Some compression of the straw into the container is desirable because the cropping efficiency will be increased.

The use of plastic bags is a simple and efficient way to handle straw substrates. A five gallon bag (1-2 mils thick) is well suited to most situations. Two dozen nail sized holes equally spaced around the bags provide aeration. Upon full colonization, the mycelia of species like *Pleurotus ostreatus* and *Psilocybe cubensis* actually hold the straw together, at which time the bag can be completely removed. Another alternative is to perforate or strip the bag from the top or side to allow easy cropping.

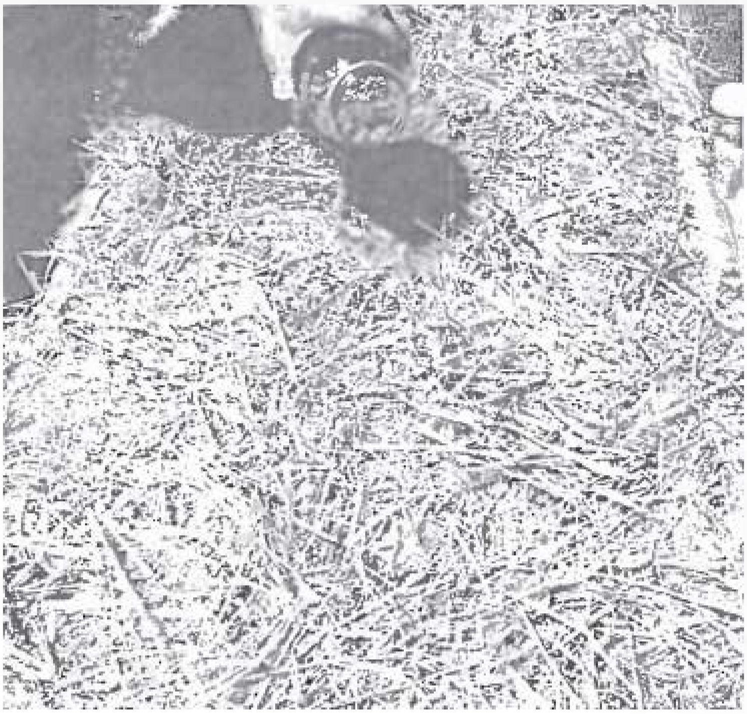


Figure 116 - Inoculating grain spawn onto the cooled pasteurized straw.

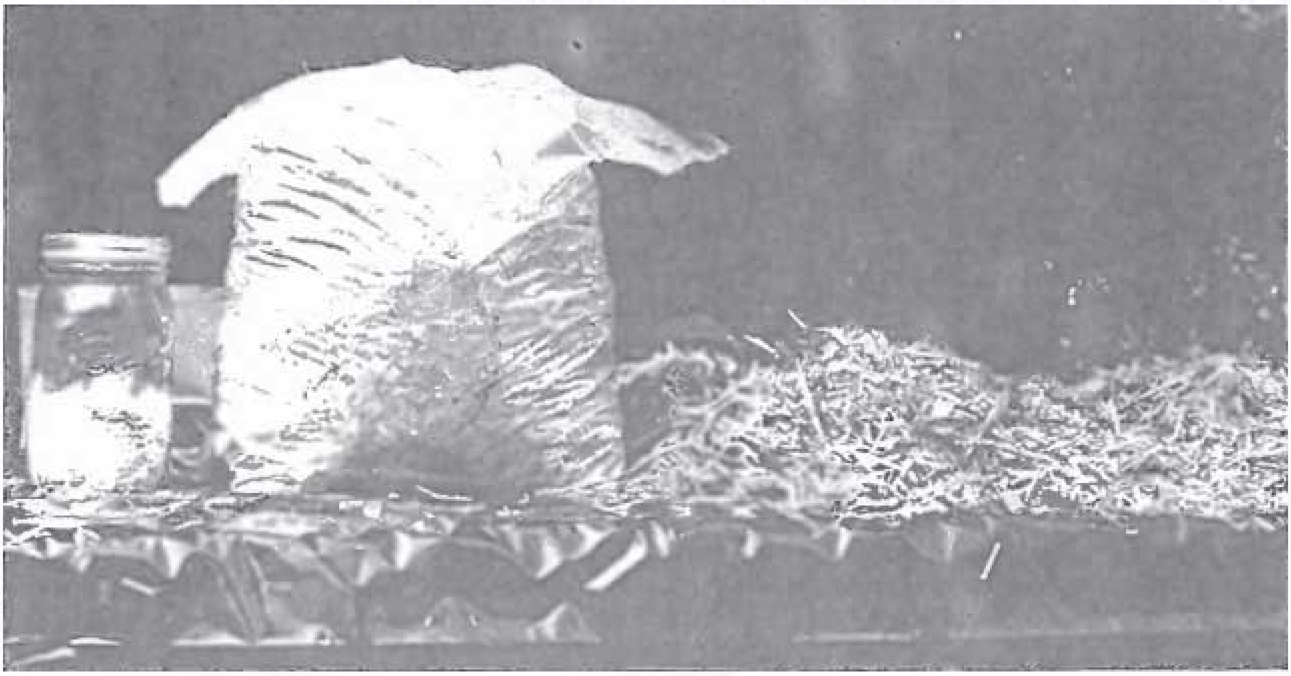


Figure 117 - Pasteurized straw stuffed into plastic bags which are then perforated with nail size holes.

Wheat straw prepared and pasteurized in this manner can be used to grow *Pleurotus ostreatus, Stropharia rugoso-annulata, Panaeolus cyanescens* and *Psilocybe cubensis*. It is quite possible that other species can utilize this substrate or a modification of it. Studies with *Pleurotus ostreatus* have demonstrated yield increases with the addition of 20% grass meal prior to substrate pasteurization. Supplementation of the straw after a full spawn run is another method of boosting yields (See Chapter VII). Bono (1978) obtained a yield increase of 85% with *Pleurotus flabellatus* by adding cottonseed meal to the fully colonized straw. The optimum rate of addition was 132 grams per kilogram of dry straw (approximately 22 grams crude protein per kilogram straw). Bono also found that supplementation increased the protein content and intensified the flavor of the mushrooms.

VII. SPAWNING AND SPAWN RUNNING IN BULK SUBSTRATES

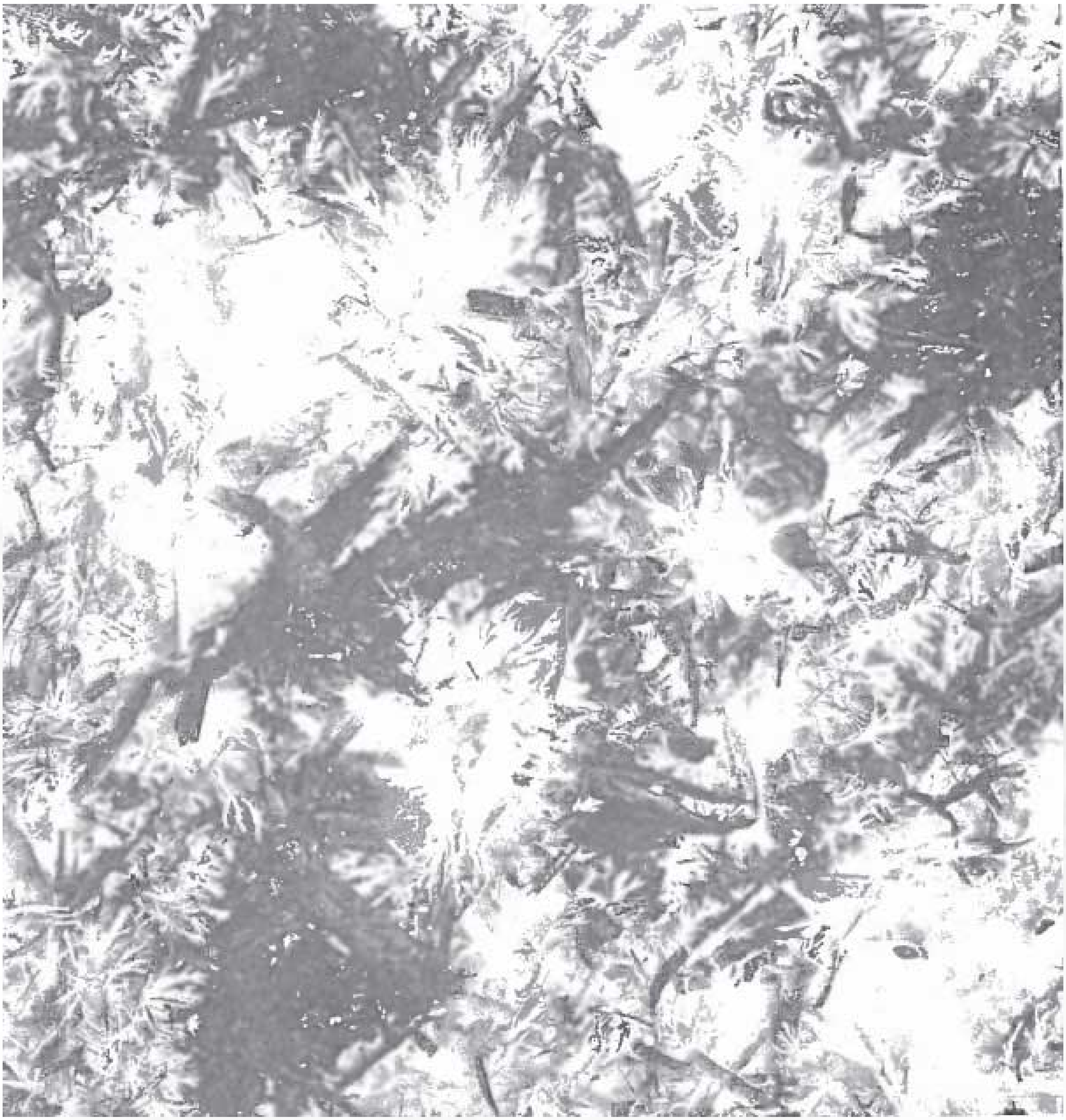


Figure 118 - Mycelium running through compost.

The inoculation of compost or bulk substrates is called spawning. The colonization of these substrates by the mushroom mycelium is known as spawn running. At spawning and during spawn running there are several factors that must be considered if yields are to be maximized. These factors are:

1. Moisture content of the substrate.
2. Temperature of the substrate.
3. Dry weight of the substrate per square foot of cropping surface.
4. Duration of spawn running.

Moisture Content

Mushroom mycelium does not grow in a substrate that is either too dry or too wet. A dry substrate produces a fine wispy mycelial growth and poor mushroom formation because the water essential for the transport and assimilation of nutrients is lacking. On the other hand, an over-wet substrate inhibits mycelial growth and produces overly stringy mycelia. Controlled experiments with *Agaricus brunnescens* grown on horse manure composts have shown yield depressions when the moisture content deviates more than 2% from the optimum. Deviations greater than 5% generally result in a spawn run that does not support fruitbody production. A dry compost at spawning should be lightly watered and mixed well to guard against the formation of wet spots. For an over-wet compost the common procedure is to add gypsum until the loose water is bound.

Substrate Temperature

Since mushroom mycelium grows within the substrate, the substrate temperature must be monitored closely. Thermometers are placed both in the center of the substrate - the hottest region - and in the room's atmosphere. These two thermometers establish a temperature differential. If the hottest point in the substrate is 80°F. and the air is 70°F. then the temperature of the total mass must lie within this range.

The optimum temperature for mycelial growth varies depending on the mushroom species. *Agaricus brunnescens* grows fastest at 77°F. whereas *Psilocybe cubensis* prefers 86°F. Temperatures higher or lower simply slow mycelial growth. The growth curve shown in Figure 119 illustrates the effect of temperature on the growth of *Agaricus brunnescens* mycelium. Note that growth slows at a faster rate as the temperature rises above the optimum. Therefore the object during spawn running is to keep the substrate within the temperature range that is optimal for the fastest growth of mycelium.

Dry Weight of Substrate

Other factors aside, the dry weight of substrate per square foot of cropping surface largely determines total yield. Commercial *Agaricus* growers aim for at least five pounds of dry weight of compost per square foot and sometimes compress up to eight pounds per sq. ft. into their containers. Cropping efficiencies are calculated by dividing total yield per square foot into the dry weight of one square foot of the substrate. Thus a yield of four pounds per sq. ft. of freshly picked mushrooms divided by five pounds dry weight of substrate equals an 80% cropping efficiency. Efficiencies of 80-100% are considered to be close to the maximum yield potential of *Agaricus brunnescens*.

The actual amount of substrate that can be compacted into one square foot of growing area and managed depends upon the cooling capabilities of the control system as well as the outside temperature. Experiments using tracer elements in mushroom beds three feet deep have shown that nutrients from the farthest point are transported to the growing mushrooms. Yields per sq. ft. increased although at a lower substrate efficiency.

During spawn running the metabolism of the growing mycelium generates tremendous quantities of heat. Substrate temperatures normally reach a peak on the 7th-9th days after spawning and can easily reach 90°F. At this temperature thermophilic microorganisms become active, thereby increasing the possibilities of further heat generation. The substrate can easily soar above 100°F. and a compost can actually rise again to conditioning temperatures. Temperatures between 95-110°F. can kill the mycelium of many mushrooms. Even if the mycelium is not completely killed, these temperatures do irreversible harm to mycelial vitality and fruiting potential. These elevated temperatures also stimulate the activity of competitor molds and may render the substrate unsuitable for further mushroom growth. Because of the enhanced heat generating capabilities of deeply filled beds, *Agaricus* growers rarely fill more than 12 inches of compost into the beds.

The decision on how deep to fill the spawned substrate is an important one. Here again, the ratio of substrate to free air space in the growing room is significant. (See Chapter IV). An efficient method of spawn running is to the fill trays 6-8 inches deep with compost and stack them closely together in the room. In this manner the heat generated within each tray remains controllable, while at the same time the total compost heat will be sufficient to heat the room. Outside air temperature as well as the capacity of the heating and cooling equipment should determine how many substrate filled containers can be placed within a given space. Fresh air is generally used to provide cooling except when it is warmer than the room temperature.

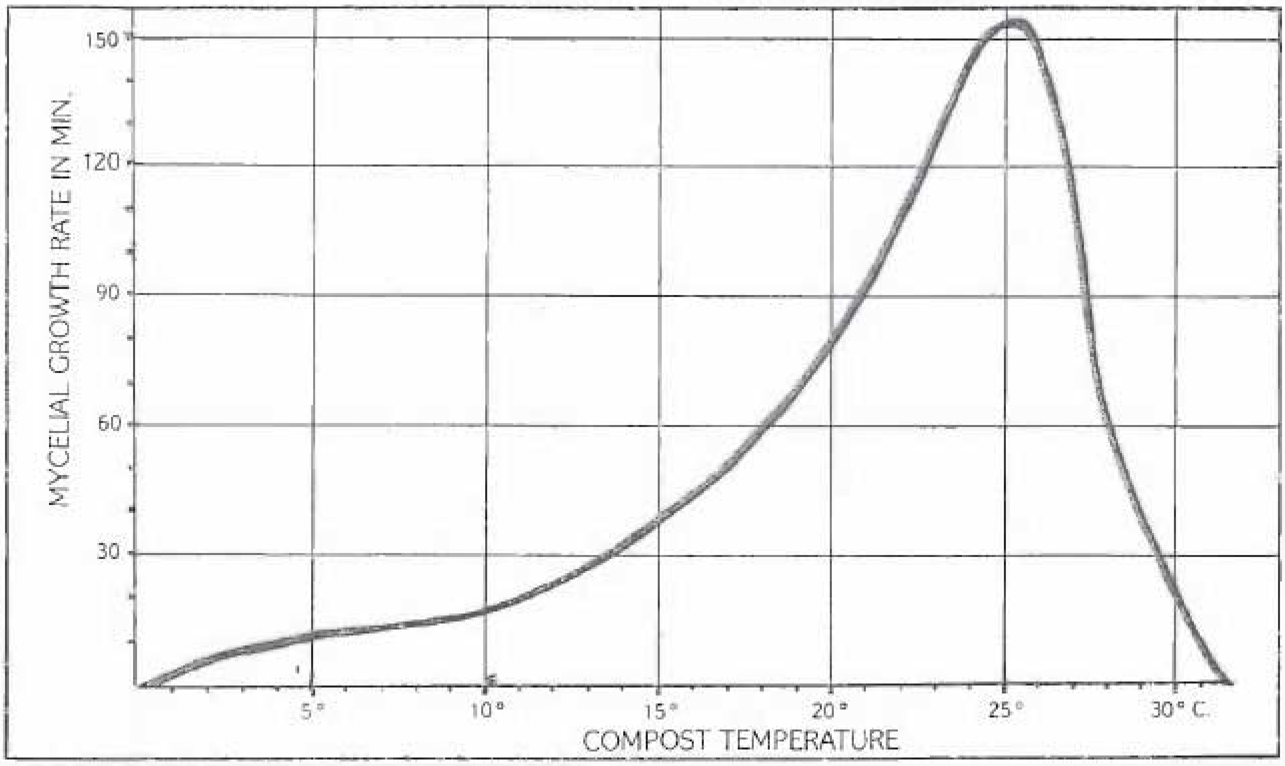


Figure 119 - Growth curve of *Agaricus brunnescens* on compost.

Duration of Spawn Run

Once colonization is complete, the substrate should be cased, or if casing is not used, it should be switched to a fruiting mode. If spawn running is continued beyond this point, valuable nutrients that could be utilized for production of fruitbodies will be consumed by further vegetative growth. If for some reason the cropping cycle must be delayed, the substrate should be cooled until a more opportune time.

Spawning Methods

Spawning methods, like spawn itself, have evolved over the years. As late as 1950 *Agaricus brunnescens* growers customarily planted walnut sized pieces of manure spawn or kernels of grain spawn in holes poked into the compost at regular intervals. Using this method spawn running was slow, and areas far from the inoculum were more susceptible to invasion by competitors. The full potential of grain spawn was not realized until the development of "mixed spawning". The principle of mixed spawning is the complete and thorough mixing of the grain kernels throughout the substrate. In this manner all parts of the substrate are equally inoculated, resulting in the most rapid and complete colonization possible.

The standard spawning rate used by *Agaricus* growers is seven liters/ton of compost or one quart/8 sq. ft. If spawn is readily available and cheap, it is advantageous to use high spawning rates which lead to more rapid colonization. It is also advantageous to break up the grain spawn into individual kernels the day before spawning. If the spawn is fresh, the grain should break apart easily. If the spawn can not be used when fresh, it should be refrigerated at 38°F.

The basic principle of spawn running is the same regardless of the type of mushroom or substrate. COLONIZATION MUST PROCEED AS RAPIDLY AS POSSIBLE TO PREVENT OTHER ORGANISMS FROM BECOMING ESTABLISHED. Once the mushroom mycelium becomes dominant, natural antibiotics secreted into the substrate inhibit competitors. To prevent invasion by competitors it is important that spawning take place under carefully controlled hygienic conditions. Fungus gnats in particular must be excluded, and for this purpose a tight, well sealed working area is best. This area and all tools should be disinfected one day prior to spawning with a 10% bleach solution. When using disinfectants be sure your skin is protected and avoid breathing any fumes.

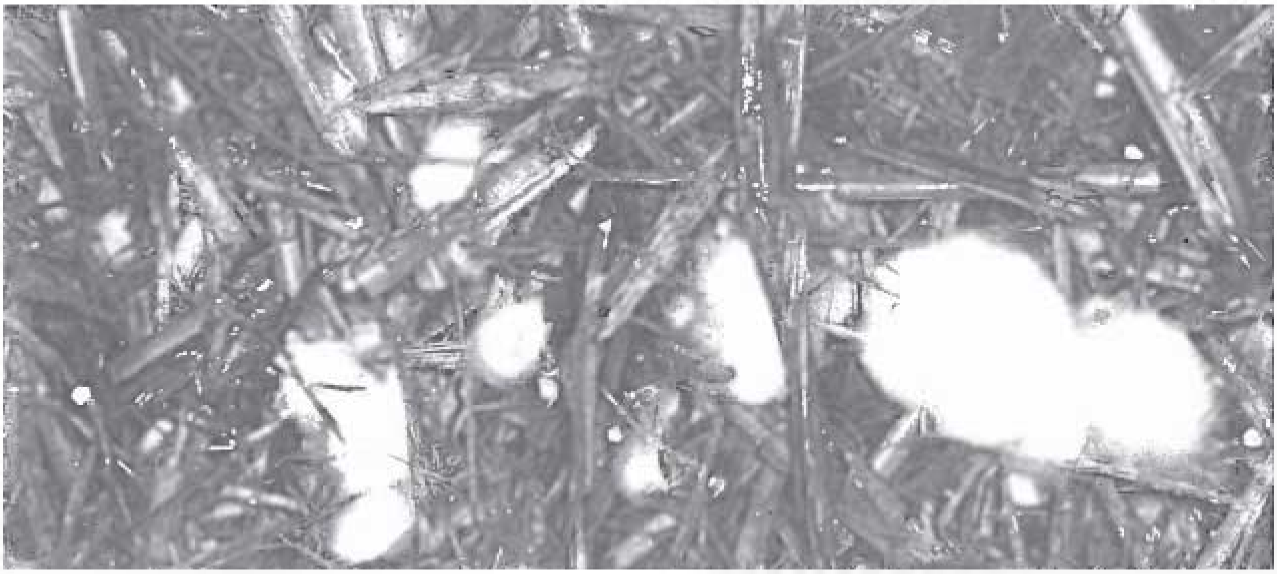


Figure 120 - *Psilocybe semilanceata* mycelium running through pasteurized wheat straw.

If the substrate has been filled into shelves, the spawn is broadcast over the surface and mixed in with a pitchfork or by hand. With trays, a similar method can be used, or alternatively, the substrate can be dumped out on a clean surface, mixed with spawn and then replaced in the trays. Substrates from a bulk room are removed, mixed with spawn and then placed into the chosen container.

It is common procedure to level and compress the substrate to avoid dehydration caused by excessive air penetration. The degree of compression depends upon substrate structure. Long, airy materials can be compacted more than short, dense ones. Commercial tray growers compact the compost into the trays with a hydraulic press so that the compost surface resembles a table top. This enables the application of an even casing layer.

Environmental Conditions

The required environmental conditions for spawn running are very specific and must be closely monitored. Substrate temperatures are controlled by careful manipulation of the surrounding air temperature. Heating and cooling equipment are helpful but not absolutely essential unless the outside climate is extreme. A well insulated room with provisions for fresh air entrance and exhaust air exit should be adequate for most situations. The steady or periodic recirculation of room air by means of a small fan helps to keep an even temperature throughout the room and guards against localized over-heating, especially in the uppermost containers. Humidity is extremely important at this time and must be held at 90-100%. If the humidity falls below this level, water evaporates from the substrate surface to the detriment of the growing mycelium. Humidification can be accomplished by steam humidifiers or by cold water misters. If steam is used, care must be taken that the increase in air temperature does not drive the substrate temperature above the optimal range. One common method of counteracting drying is to cover the substrate with plastic. Be ready to remove the covering during the period of peak activity if temperatures rise too quickly.

During spawn run the mushroom mycelium generates large quantities of carbon dioxide. In fact, it has been demonstrated that mushroom mycelium is capable of CO_2 fixation. Because of this ability to absorb CO_2, room concentrations of 10,000-15,000 ppm are considered beneficial and desirable. A CO_2 level high enough to stop growth is uncommon under normal circumstances. Being heavier than air, CO_2 settles at the bottom of the room, which is yet another reason for even air circulation within the growing environment.

Super Spawning

Super spawning is also called "active mycelium spawning" vis á vis the Hunke-Till process. Essentially, a set amount of substrate is inoculated and colonized in the normal manner. The fully run substrate is then used as inoculum to spawn increased amounts of a similar substrate. One could theoretically pyramid a small quantity of inoculum into a considerable amount of fully colonized substrate. This technique requires the primary substrate to be contaminant free; otherwise contamination, not mycelium, will be propagated. The possibilities inherent in this method may be of greater application when transferring naturally occurring mycelial colonies to non-sterile yet mushroom specific substrates. An excellent example of this is the propagation of *Psilocybe cyanescens* on wood chips. (See Chapter VI.)

Supplementation at Spawning

One of the newest advances in *Agaricus* culture is the development of delayed release nutrients added to the compost at spawning. These supplements are specially formulated nutrients encapsulated in a denatured protein coat. They are designed to become available to the growing mushrooms during the first three flushes. The application rate is 5-7% of the dry weight of the substrate. Yield increases of ½ to 1 lb/sq. ft. are normal. Here again, complete and thorough mixing is essential to success. Caution: these materials enrich the substrate, making it more suitable to contaminants if factors predisposing to their growth are present. (For suppliers of delayed release nutrients, refer to the resource section in the Appendix).

Supplementation at Casing (S.A.C.)

SACing is another method used to boost the nutritional content of the substrate. The materials used are soy bean meal, cottonseed meal, and/or ground rye, wheat or kafir corn grains. The fully colonized substrate is thoroughly mixed with any one of these materials at a rate of 10% of the dry weight of the substrate. The substrate and the supplements must both be clean and free from contaminants; otherwise contamination will spread and threaten the entire culture. High substrate temperatures should be anticipated on the second to third day after supplementation. With this type of nutrient enhancement yield increases of ½-2 lbs/sq. ft. are possible.

VIII. THE CASING LAYER

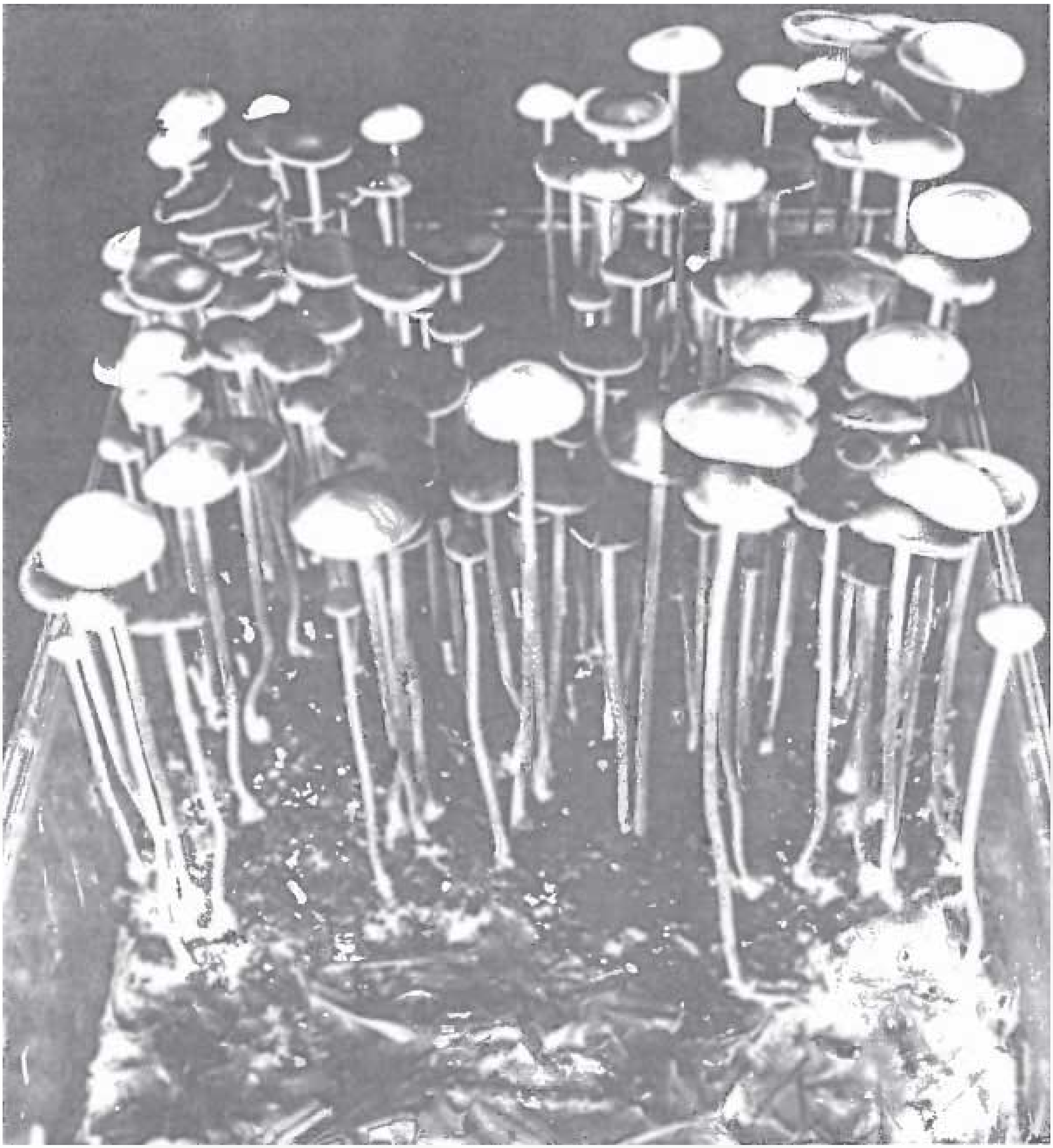


Figure 121 - *Panaeolus cyanescens* fruiting in tray of pasteurized straw. Note mushrooms formed only on cased half.

Covering the substrate surface with a layer of moist material having specific structural characteristics is called **casing**. This practice was developed by *Agaricus* growers who found that mushroom formation was stimulated by covering their compost with such a layer. A casing layer encourages fruiting and enhances yield potential in many, but not all, cultivated mushrooms.

In all species where the use of a casing has been indicated as optional, yields are clearly enhanced with the application of one. The chart above [below] refers to the practical cultivation of mushrooms in quantity. It excludes fruitings on nutrified agar media or on other substrates that produce but a few mushrooms. Consequently, casing has become an integral part of the mushroom growing methodology.

SPECIES	CASING OPTIONAL	CASING REQUIRED	CASING NOT REQUIRED
Agaricus brunnescens		■	
Agaricus bitorquis		■	
Coprinus comatus	■		
Flammulina velutipes			■
Lentinus edodes			■
Lepista nuda	■		
Pleurotus ostreatus			■
Pleurotus ostreatus (Florida variety)			■
Panaeolus cyanescens		■	
Panaeolus subbalteatus	■		
Psilocybe cubensis	■		
Psilocybe cyanescens			■
Psilocybe mexicana		■	
Psilocybe tampanensis		■	
Stropharia rugoso-annulata		■	
Volvariella volvacea			■

Functions

The basic functions of the casing layer are:

1. **To protect the colonized substrate from drying out**.
   Mushroom mycelium is extremely sensitive to dry air. Although a fully colonized substrate is primarily protected from dehydration by its container (the tray, jar or plastic bag), the cropping surface remains exposed. Should the exposed surface dry out, the mycelium dies and forms a hardened mat of cells. By covering the surface with a moist casing layer, the mycelium is protected from the damaging effects of drying. Moisture toss from the substrate is also reduced.

2. **To provide a humid microclimate for primordia formation and development**.
   The casing is a layer of material in which the mushroom mycelium can develop an extensive, healthy network. The mycelium within the casing zone becomes a platform that supports formation of primordia and their consequent growth into mushrooms. It is the moist humid microclimate in the casing that sustains and nurtures mycelial growth and primordia formation.

3. **To provide a water reservoir for the maturing mushrooms**.
   The enlargement of a pinhead into a fully mature mushroom is strongly influenced by available water, without which a mushroom remains small and stunted. With the casing layer functioning as a water reservoir, mushrooms can reach full size. This is particularly important for heavy flushes when mushrooms are competing for water reserves.

4. **To support the growth of fructification enhancing microorganisms**.
   Many ecological factors influence the formation of mushroom primordia. One of these factors is the action of select groups of microorganisms present in the casing. A casing prepared with the correct materials and managed according to the guidelines outlined in this chapter supports the growth of beneficial microflora.

Properties

The casing layer must maintain mycelial growth, stimulate fruiting and support continual flushes of mushrooms. In preparing the casing, the materials must be carefully chosen according to their chemical and physical properties. These properties are:

1. **Water Retention**: The casing must have the capacity to both absorb and release substantial quantities of water. Not only does the casing sustain vegetative growth, but it also must supply sufficient moisture for successive generations of fruitbodies.

2. **Structure**: The structure of the casing surface must be porous and open, and remain so despite repeated waterings. Within this porous surface are small moist cavities that protect developing primordia and allow metabolic gases to diffuse from the substrate into the air. If this surface microclimate becomes closed, gases build up and inhibit primordia formation. A closed surface also reduces the structural cavities in which primordia form. For these reasons, the retention of surface structure directly affects a casing's capability to form primordia and sustain fruitbody production.

3. **Microflora**: Recent studies have demonstrated the importance of beneficial bacteria in the casing layer. High levels of bacteria such as *Pseudomonas putida* result in increased primordia formation, earlier cropping and higher yields. During the casing colonization period these beneficial bacteria are stimulated by metabolic gases that build up in the substrate and diffuse through the casing. In fact, dense casing layers and deep casing layers generally yield more mushrooms because they slow diffusion. It is desirable therefore to build-up CO_2 and other gases prior to primordia formation. (For a further discussion on the influence of bacteria on primordia formation, see Appendix II.)
   The selection of specific microbial groups by mycelial metabolites is an excellent example of symbiosis. These same bacteria give the casing a natural resistance to competitors. In this respect, a sterilized casing lacks beneficial microorganisms and has little resistance to contaminants.

4. **Nutritive Value**: The casing is not designed to provide nutrients to developing mushrooms and should have low nutritional value compared to the substrate. A nutritive casing supports a broader range of competitor molds. Wood fragments and other undecomposed plant matter are prime sites for mold growth and should be carefully screened out of a well formulated casing.

5. **pH**: The pH of the casing must be within certain limits for strong mycelial growth. An overly acidic or alkaline casing mixture depresses mycelial growth and supports competitors. *Agaricus brunnescens* prefers a casing with pH values between 7.0-7.5. Even though the casing has a pH of 7.5 when first applied, it gradually falls to a pH of nearly 6.0 by the end of cropping due to acids secreted by the mushroom mycelium. Buffering the casing with limestone flour is an effective means to counter this gradual acidification. The optimum pH range varies according to the species. (See the growing parameters for each species in Chapter XI.)

6. **Hygienic Quality**: The casing must be free of pests, pathogens and extraneous debris. Of particular importance, the casing must not harbor nematodes or insect larvae.

Materials

To better understand how a casing layer functions requires a basic understanding of soil components and their specific structural and textural characteristics. When combined properly, the soil components create a casing layer that is both water retentive and porous.

1. **Sand**: Characterized by large individual particles with large air spaces in between, sandy soils are well aerated. Their structure is considered "open". Sandy soils are heavy, hold little water and release it quickly.

2. **Clay**: Having minute individual particles bound together in aggregations, clay soils have few air pockets and are structurally "closed". Water is more easily bound by clay soils.

3. **Loam**: Loam is a loose soil composed of varying proportions of sand and clay, and is characterized by a high humus content.

Agaricus growers found that the best type of soil for mushroom growing was a clay/loam. The humus and sand in a clay/loam soil open up the clay which is typically dense and closed. The casing's structure is improved while the property of particle aggregation is retained. The humus/clay combination holds moisture well and forms a crumbly, well aerated casing.

There are two basic problems with using soils for casing-the increased contamination risk from fungi and nematodes, and the loss of structure after repeated waterings. Cultivators can reduce the risk of contamination by pasteurization, a process whereby the moistened casing soil is thoroughly and evenly steamed for two hours at 160°F. An alternative method is to bake the moist soil in an oven for two hours at 160°F.

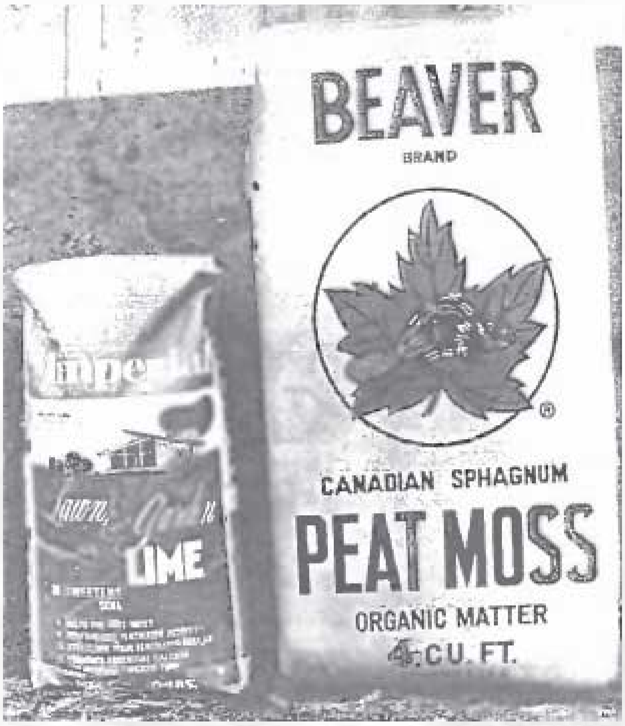


Figure 122 - Sphagnum peat and limestone flour needed for casing.

The development of casings based on peat moss has practically eliminated the use of soil in mushroom culture. Peat is highly decomposed plant matter and has a pH in the 3.5-4.5 range. Since this acidic condition precludes many contaminants from colonizing it as a substrate, peat is considered to be a fairly "clean" starting material. Peat based casings rarely require pasteurization. But because peat is too acidic for most mushrooms, the addition of some form of calcium buffering agent like limestone is essential. "Liming" also causes the aggregation of the peat particles, giving peat a structure similar to a clay/loam soil. A coarse fibrous peat is preferred because it holds its structure better than a fine peat. In essence, the properties of sphagnum peat conform to all the guidelines of a good casing layer.

Buffering agents are used to counter the acidic effects of peat and other casing materials. Calcium carbonate ($CaCO_3$) is most commonly used and comes in different forms, some more desirable than others.

1. **Chalk**: Used extensively in Europe, chalk is soft in texture and holds water well. Chunks of chalk, ranging from one inch thick to dust, improve casing structure and continuously leach into the casing, giving long lasting buffering action.

2. **Limestone Flour**: Limestone flour is calcitic limestone mined from rock quarries and ground to a fine powder. It is the buffering agent most widely used by *Agaricus* growers in the United States. Limestone flour is 97% $CaCO_3$ with less than 2% magnesium.

3. **Limestone Grit**: Produced in a fashion similar to limestone flour, limestone grit is rated according to particle size after being screened through varying meshes. Limestone grit is an excellent structural additive but has low buffering abilities. A number 9 grit is recommended.

4. **Dolomitic Limestone**: This limestone is rarely used by *Agaricus* growers due to its high magnesium content. Some researchers have reported depressed mycelial growth in casings high in magnesium.

5. **Marl**: Dredged from dry lake bottoms, marl is a soft lime similar to chalk but has the consistency of clay. It is a composite of clay and calcium carbonate with good water holding capacity.

6. **Oyster Shell**: Comprised of calcium carbonate, ground up oyster shell is similar to limestone grit in its buffering action and its structural contribution to the casing layer. But oyster shell should not be used as the sole buffering agent because of its low solubility in water.

Material	Absorption Potential milliliters water/gram	% Water at Saturation
Vermiculite	5.0	84%
Peat	2.5	79%
Potting Soil	0.7	76%
Loam	0.3	25%
Chalk	0.6	37%
Limestone Grit	0.2	15%
Sand	0.2	18%
Values vary according to source and quality of material used. (Tests run by the authors.)		

Casing Formulas and Preparation

The following casing formulas are widely used in *Agaricus* culture. With pH adjustments they can be used with most mushroom species that require a casing. Measurement of materials is by volume.

FORMULA 1	FORMULA 2
Coarse peat: 4 parts	Coarse peat: 2 parts
Limestone flour: 1 part	Chalk or Marl: 1 part
Limestone grit: ½ part	Water: Approximately 1-1¼ parts
Water: Approximately 2-2¼ parts	

One half to one part coarse vermiculite can be added to improve the water retaining capacity of these casing mixtures and can be an aid if fruiting on thinly laid substrates. When used, it must be presoaked to saturation before being mixed with the other listed ingredients.

An important reference point for cultivators is the moisture saturation level of the casing. To determine this level, completely saturate a sample of the casing and allow it to drain. Cover and wait for one half hour. Now weigh out 100 grams of it and dry in an oven at 200°F. for two to three hours or until dry. Reweigh the sample and the difference in weight is the percent moisture at saturation. This percentage can be used to compare moisture levels at any point in the cropping cycle. Optimum moisture content is normally 2-4% below saturation. Typically, peat based casings are balanced to a 70-75% moisture content.

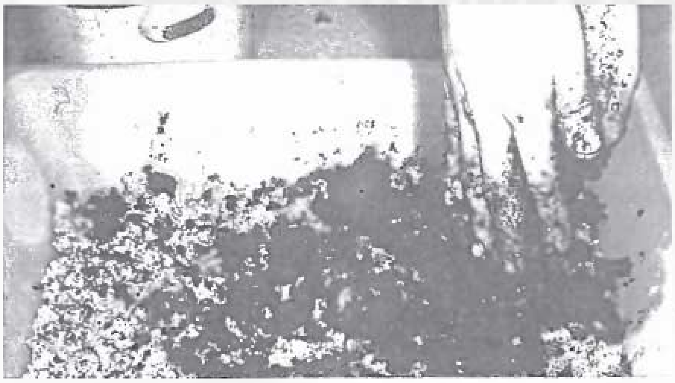
Application

To prepare a casing, assemble and mix the components while in a dry or semi-dry state. Even distribution of the limestone buffer is important with a thoroughly homogeneous mixture being the goal. When these materials have been sufficiently mixed, add water slowly and evenly, bringing the moisture content up to 90% of its saturation level. There is an easy method for preparing a casing of proper moisture content. Remove 10-20% of the volume of the dry mix and then saturate the remaining 80-90%. Then add the remaining dry material. This method brings the moisture content to the near optimum. (Some growers prefer to let the casing sit for 24 hours and fully absorb water. Prior to its application, the casing is then thoroughly mixed again for even moisture distribution.)

At this point apply the casing to the fully run substrate. Use a pre-measured container to consistently add the same volume to each cropping unit.

1. **Depth**: The correct depth to apply the casing layer is directly related to the depth of the substrate. Greater amounts of substrate increase yield potential which in turn puts more stress on the casing layer. Prolific first and second flushes can remove a thin casing or damage its surface structure, thereby limiting future mushroom production. A thin casing layer also lacks the body and moisture holding capacity to support large flushes. AS A GENERAL RULE, THE MORE MUSHROOMS EXPECTED PER SQUARE FOOT OF SURFACE AREA, THE DEEPER THE CASING LAYER.
   Agaricus growers use a minimum of one inch and a maximum of two inches of casing on their beds. Substrate depths of six to eight inches are cased 1¼ to 1½ inches deep. Substrates deeper than 8 inches are cased 1½ to 2 inches deep. Nevertheless, experiments in Holland using casing depths of 1 inch and 2 inches demonstrated that the deep casing layer supported higher levels of microorganisms and produced more mushrooms. (See Visscher, 1975). To gain the full benefits of a casing layer, an absolute minimum depth on bulk substrates is 1 inch. For fruiting on sterilized grain, the casing need not be as deep as for fruitings on bulk substrates. Shallow layers of grain are commonly cased ¾ to 1 inch deep.

2. **Evenness**: The casing layer should be applied as evenly as possible on a level substrate surface. An uneven casing depth is undesirable for two reasons: shallower regions can easily be overwatered, thereby stifling mycelial growth; and secondly, the mycelium breaks through the surface at different times, resulting in irregular pinhead formation. When applying the casing to large areas, "depth rings" can be an effective means to insure evenness. These rings are fabricated out of flat metal or six inch PVC pipe, cut to any depth. They are placed on the substrate and covered with the casing, which is then leveled using the rings as a guide. Once the casing is level and even, the rings are removed.
   Although the casing layer must be even, the surface of the casing should remain rough and porous, with small "mountains and valleys". The surface structure is a key to optimum pinhead formation and will be discussed in more detail in the next chapter.



Figures 123, 124 & 125 - Casing a tray of grain spawn. First the fully colonized grain is carefully broken up and evenly distributed into the tray. As an option, a layer of partially moistened vermiculite can be placed along the bottom of the tray to absorb excess water. If the grain appears to have uncolonized kernels, cover the container with plastic and let the spawn recover for 24 hours before casing. Otherwise, casing can proceed immediately after the spawn has been laid out.

Casing Colonization

Environmental conditions after casing should be the same as during spawn running. Substrate temperatures are maintained within the optimum range for mycelial growth; relative humidity is 90-100%; and fresh air is kept to a minimum. (Fresh air should only be introduced to offset over-heating). The build-up of CO_2 in the room is beneficial to mycelial growth and is controlled by an airtight room and tightly sealed fresh air damper. If the entrance of fresh air cannot be controlled, a sheet of plastic should be placed over the casing. This plastic sheet also prevents moisture loss from the casing.

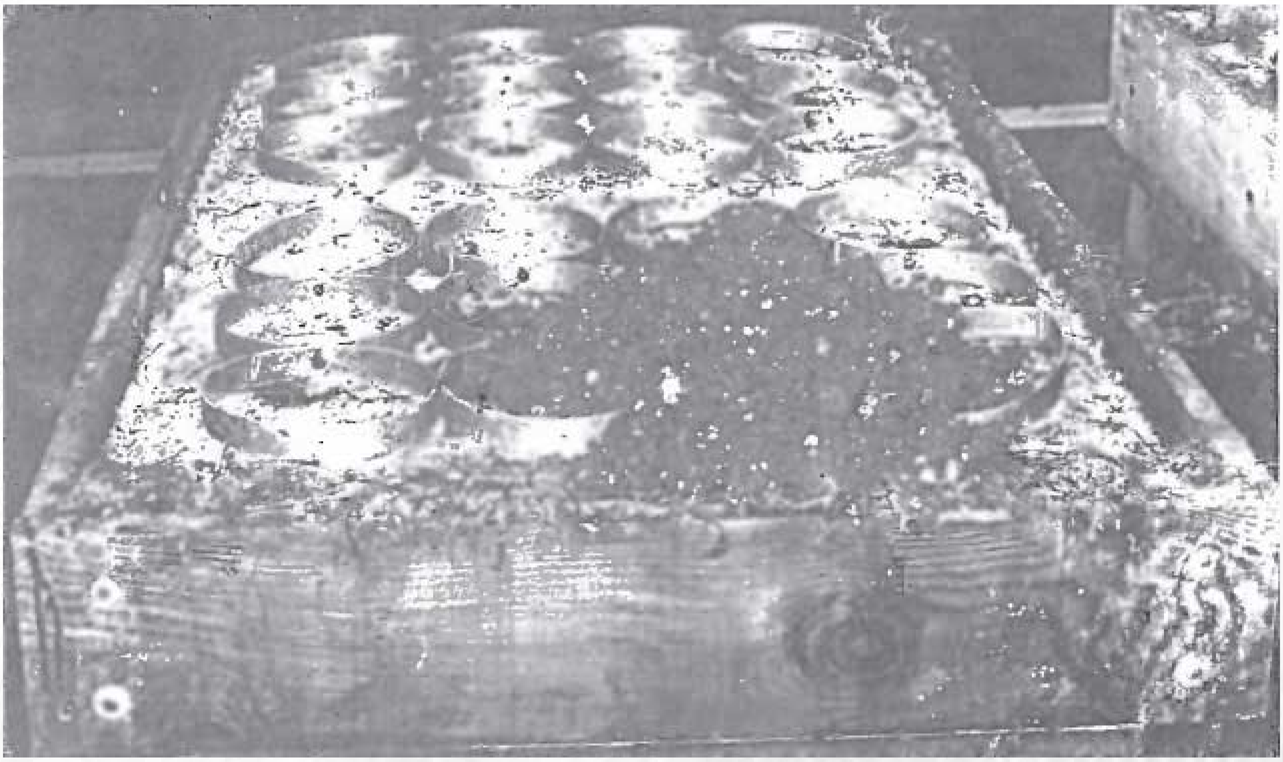


Figure 126 - Depth rings used for even casing application on bulk substrates.

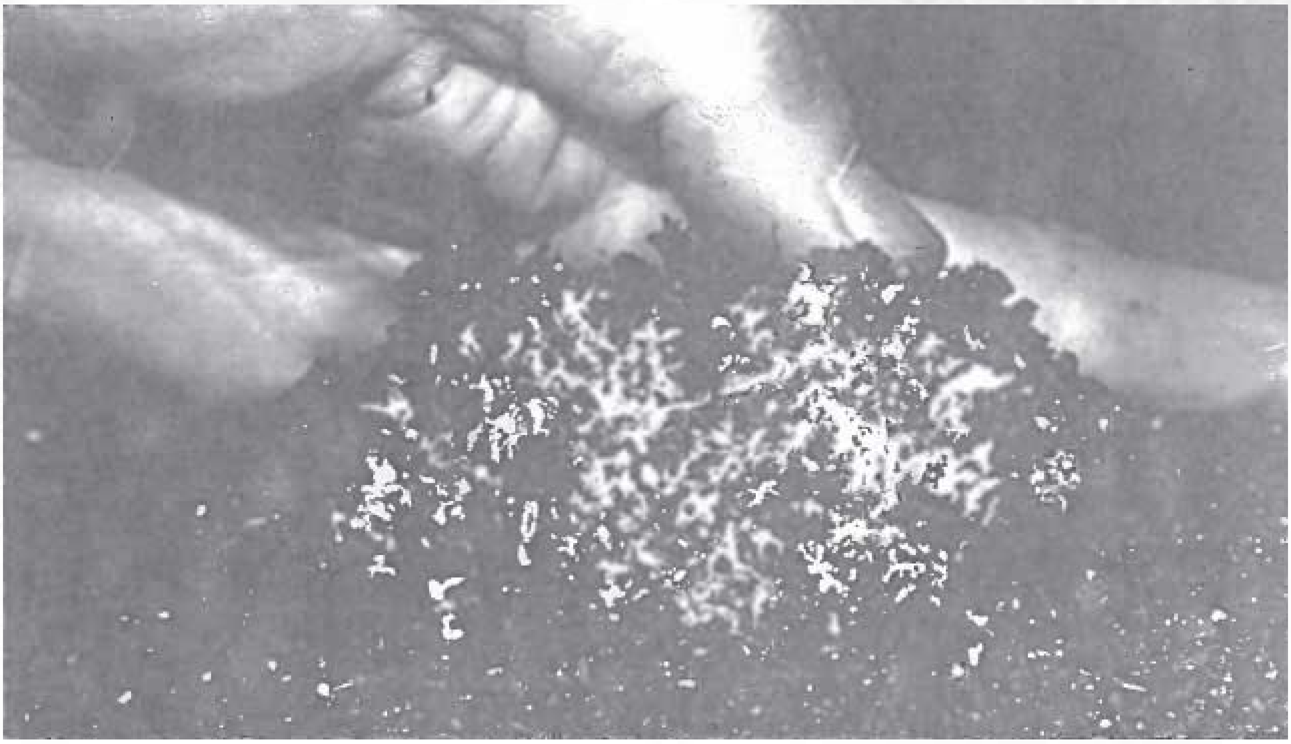


Figure 127 - Mycelial growth (*Agaricus brunnescens*) into casing with optimum moisture.

Soon after casing, substrate temperatures surge upward due to the hampered diffusion of metabolic gases which would normally conduct heat away. This surge is an indication of mycelial vitality and is a positive sign if the room temperature can be controlled. This temperature rise can be anticipated by lowering either the temperature of the substrate prior to casing or lowering the air temperature of the room after casing.

Within three days of application, the mycelium should be growing into the casing layer. Once mycelial growth is firmly established, the casing is gradually watered up to its optimum moisture holding capacity. This is accomplished by a series of light waterings with a misting nozzle over a two to four day period (depending upon the depth of the casing). Deeper casings require more waterings. Optimum moisture capacity should be achieved at least two days before the mycelium reaches the surface. IT IS EXTREMELY IMPORTANT THAT THE WATERINGS DO NOT DAMAGE THE SURFACE STRUCTURE OF THE CASING. Heavy direct watering can "pan" the casing surface, closing all the pore spaces and effectively sealing it. The growing mycelium is then trapped within the casing layer and may not break through it at all. The ultimate example of panning is a soil turned to mud.

To repair a casing surface damaged by watering, the top ¼ inch can be reopened by a technique called "scratching". The tool used is simply a 1 x 2 x 24 inch board with parallel rows of nails (6 penny) slightly offset relative to one another. With this "scratching stick", the casing is lightly ruffled prior to the mycelium breaking through to the surface. After the surface has been scratched, the casing should be given its final waterings prior to pinning.

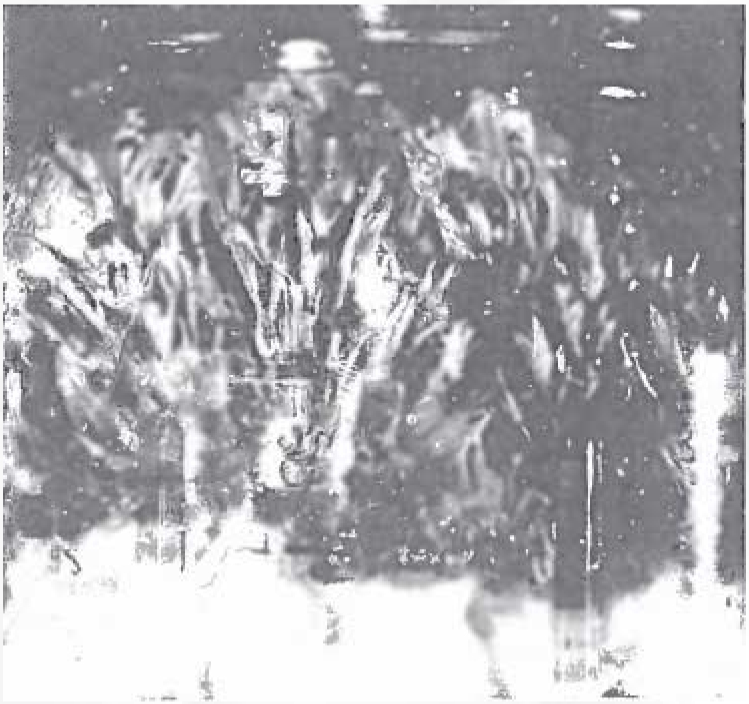


Figure 128 - Mycelial growth (*Psilocybe cubensis*) into casing with optimum moisture.

A modified application of this technique is "deep scratching". When the mycelium is midway through the casing, the entire layer is thoroughly ruffled down to the bulk substrate. The agitated and broken mycelium rapidly reestablishes itself and within three to four days it completely colonizes the casing. The result is an early, even and prolific pinhead formation. Before using this technique, the grower must be certain that the substrate and casing are free of competitor molds and nematodes.

Casing Moisture and Mycelial Appearance

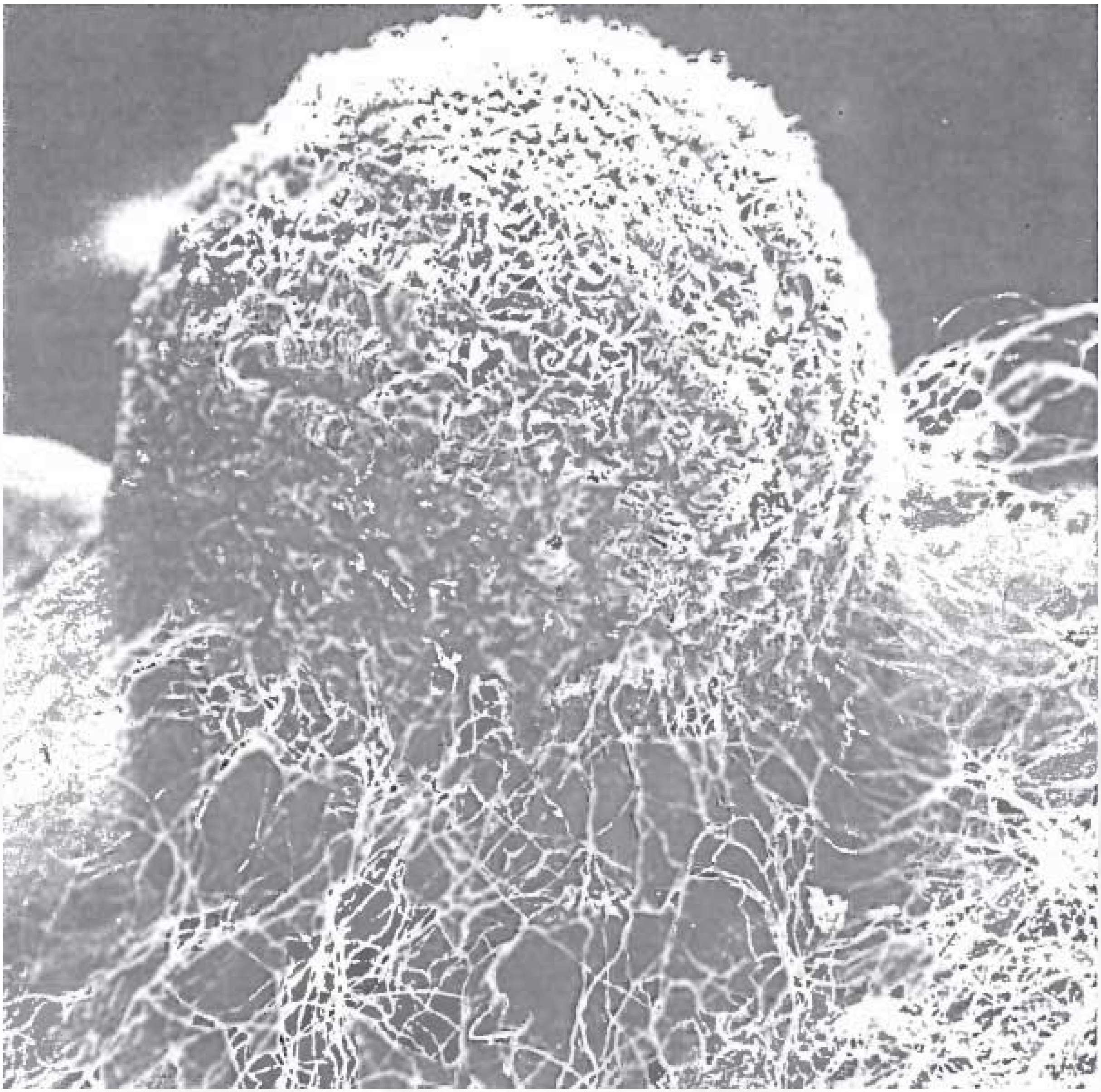
Moisture within the casing layer has a direct effect on the diameter and degree of branching in growing mycelium. These characteristics are indicators of moisture content and can be used as a guide to proper watering.

1. **Optimum Casing Moisture**: Mushroom mycelium thrives in a moist humid casing, sending out minute branching networks. These networks expand and grow, absorbing water, CO_2 and oxygen from the near saturated casing. This mycelial growth is characterized by many thick, white rhizomorphic strands that

branch into mycelia of smaller diameters and correspondingly smaller, finer capillaries. The overall aspect is lush and dense. When a section of casing is examined, it is held firmly together by the mycelial network but will separate with little effort. The casing itself remains soft and pliable.

2. **Overly dry casing**: In a dry casing, the mycelium is characterized by a lack of rhizomorphs and an abundance of fine capillary type mycelia. This fine growth can totally permeate the casing layer, which then becomes hard, compact and unreceptive to water. It is common for puddles to form on a dry casing that has just been watered. Also, a dry casing rarely permits primordia formation because of its arid microclimate and is susceptible to "overlay". Mushrooms, if they occur, frequently form along the edges of the tray.
   Overlay is a dense mycelial growth that covers the casing surface and shows little or no inclination to form pinheads. Overlay directly results from a dry casing, high levels of CO_2 and/or low humidity. (See Chapter IX on pinhead initiation)
3. **Overly Wet Casing**: In a saturated casing, the mycelium grows coarse and stringy, with very little branching and few capillaries. Mycelial growth is slow and sparse which leaves the casing largely uncolonized. Often the saturated casing leaches onto the substrate surface which then becomes waterlogged, inhibiting further growth and promoting contamination. Subsequent drying may eventually reactivate the mycelium, but a reduction in yield is to be expected.

IX. STRATEGIES FOR MUSHROOM FORMATION (PINHEAD INITIATION)



Fiqure 129 - Scanning electron micrograph of *Psilocybe cubensis* primordia.

The change from the vegetative state of mycelial growth to the generative one of primordia formation is called pinning, pin setting, pinhead initiation or fructification. Primordia or pinheads are knots of mycelium that precede development into small mushrooms. All species require a set of environmental conditions for pinning that are quite different from the conditions for mycelial growth. By understanding the factors that regulate this change in the mushroom life cycle, the cultivator can control the pinning process.

In nature primordia formation is primarily influenced by seasonal changes in environmental conditions. In temperate climates most mushrooms fruit during the cool, wet fall whereas in tropical and subtropical climates mushrooms fruit during the rainy season. The fruiting period ends when the season changes and environmental conditions become too hot, too cold or too dry. The mycelium then lies dormant or grows slowly, reactivated only by the warming of spring and summer. These seasons are times for the mycelium to expand its network, absorb nutrients and rebuild its energy reserves. Once the cool wet conditions of fall return, these reserves are used to support another crop of mushrooms.

Basic Pinning Strategy

Mushrooms fruit indoors in response to much the same conditions that trigger fruiting in the wild. Several environmental factors, working in combination, provide an ideal environment in which mushrooms flourish. Most, if not all cultivated mushrooms fruit at lower temperatures than the optimum for the growth of mycelium. Usually, a drop in temperature is accompanied by rain or an increase in humidity. Water is essential for the absorption of nutrients by the mycelium. And vaporous water creates the humid microclimate that is so critical for the developing primordia. Primordia have a low tolerance to CO_2 and need ample fresh air. And while the mycelium has no requirement for light, many species need light to initiate pinheads and to mature into healthy mushrooms. Mushrooms form only when there is a coincidence of all these factors. Cultivators create an artificial environment that prolongs these optimum conditions so that mushrooms are given the best possible environment in which to grow.

Primordia formation strategies are well defined for species now under cultivation. These procedures are similar in their approach and differ only in certain environmental requirements. Given that the substrate has sufficient nutrients, the interaction of water, humidity, temperature, fresh air, CO_2 and light all play determining roles in the fructification process. (In some cases, specific microorganisms must be present before fruiting can occur). The modification of any one of these factors beyond the fruiting requirements can inhibit or stop the process. Hence, the cultivator must have precise control over conditions within the growing room if this critical phase is to be carried out successfully.

Primordia Formation Procedures

Agaricus brunnescens culture illustrates the interplay of environmental factors in pinhead initiation. It serves as a useful model for setting primordia in many species, especially those using a casing layer. In each of the following stages, the main considerations are highlighted and then discussed in detail. Although *Agaricus* does not require light, and since most cultivated mushrooms do, this requirement has been listed as the last parameter.

Stage I: Preparation

Following its application, the casing is conditioned to allow even mycelial growth into it. Once mycelial growth is well established, the casing layer microclimate and the growing room are carefully managed to meet the following requirements.

1. The casing layer is at optimum moisture capacity.
2. The casing layer surface is rough and porous.
3. The relative humidity of the growing room's air is 95%.
4. The substrate is incubated in total darkness.

During the casing colonization period, the casing layer is being conditioned for pinhead initiation. Gradually, the moisture content is brought up to the optimum and a microclimate with high relative humidity is carefully maintained. Water in the casing moves by capillary action to the surface where it is drawn into the air by evaporation. This constant movement slowly depletes the casing of the moisture needed to protect pinhead development. Therefore, in conjunction with an optimum casing moisture level, the relative humidity of the room must be held at 95%. Lower humidities must be accompanied by light but regular waterings. The higher the humidity (rH), the less water will be lost to evaporation.

Given optimum moisture conditions in and directly above the casing layer, the next step is to prepare the casing surface. Whether by initial application or by ruffling at a later time, the casing surface should be rough and open - with minute mountains and valleys. A rough open casing has more surface area where pinheads can form, provides a humid environment conducive to that formation and allows the diffusion of metabolic gases.

Stage II: Environmental Transition - The Prelude to Setting Primordia

Pinhead initiation techniques should begin when the mycelium reaches the valleys of the casing surface. Once the mycelium is clearly established in the valleys, the cultivator can begin the first steps leading to the setting of pinheads. Within this one to two day period, the

1. Substrate and air temperatures are lowered to the fruiting range.
2. The humidity is maintained at the 95% level.
3. The carbon dioxide content of the room is reduced by the introduction of fresh air.
4. The room is lighted on a 12 hour on/off cycle.

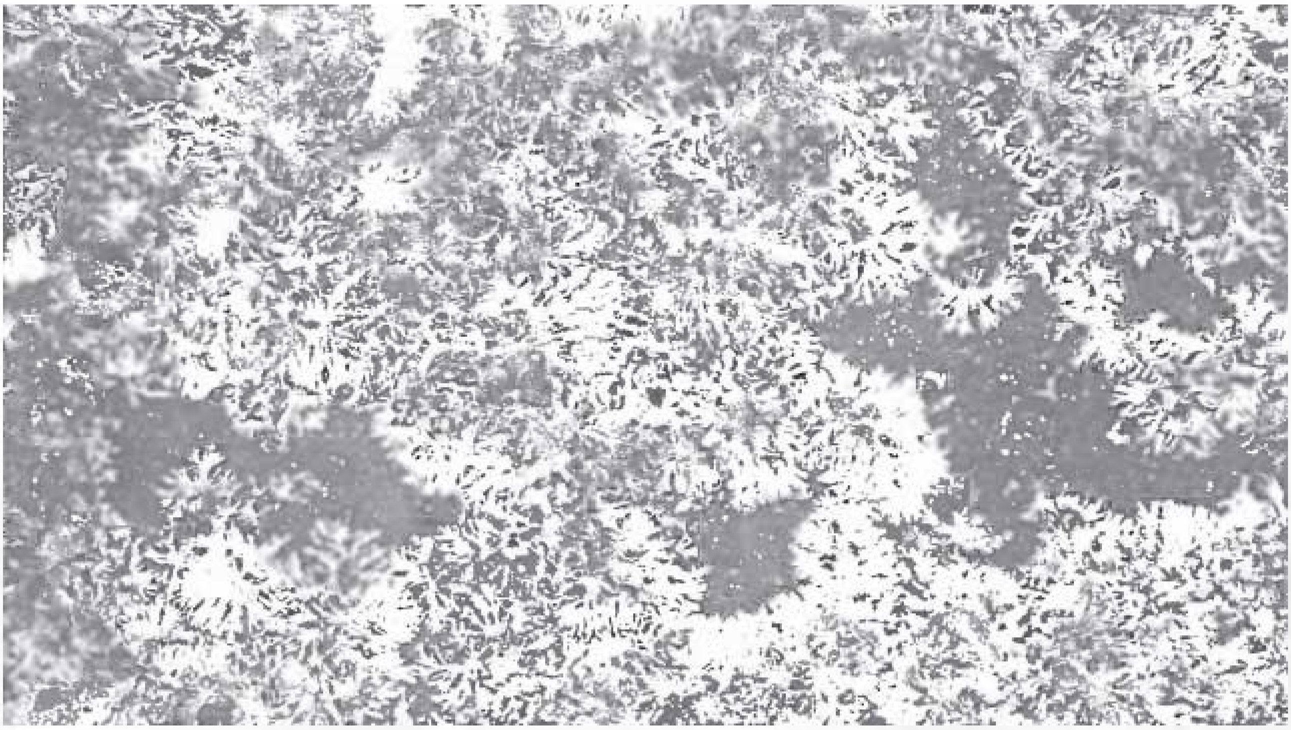


Figure 130 - Overlay.

Mycelium breaking through the casing surface early should be lightly sprinkled with moist casing. Uneven growth through the casing layer is usually an indication of a casing with irregular depths. By "patching" shallow areas, an even mycelial spread is assured. Note that **the more even the distribution of the mycelium in the valleys of the casing's surface, the more even the pin-set and the greater the first and second flushes**.

The exact time for initiation varies with the strain and according to the experience of the individual grower. Some strains continue to grow vegetatively for a period after the initial temperature shock whereas others stop immediately. For this reason, some cultivators initiate when 20% of the valleys show mycelial growth while others wait until 90% are run through with mycelium. Normally within 12-48 hours from the time the mycelium is first visible in the valleys, the initiation sequence is started.

The first step in the pinhead initiation process is to lower the substrate and air temperature from the mycelial growth optimum to the fruiting range. This temperature "shock" is accomplished by ventilation with a large volume of cool fresh air, thereby lowering the room's temperature to a point 5-20° below the optimum for spawn running. (For *Agaricus brunnescens*, this would mean dropping air temperature from 70°F. to 64°F.). Whatever the air temperature may be, the bed temperature is normally several degrees warmer. The length of time needed to affect this change is determined by the total volume of substrate and the temperature of the air being introduced. Within 48 hours, the substrate temperature should fall to fruiting temperatures, effectively slowing vegetative growth. This change signals to the mycelium that it is time to fruit.

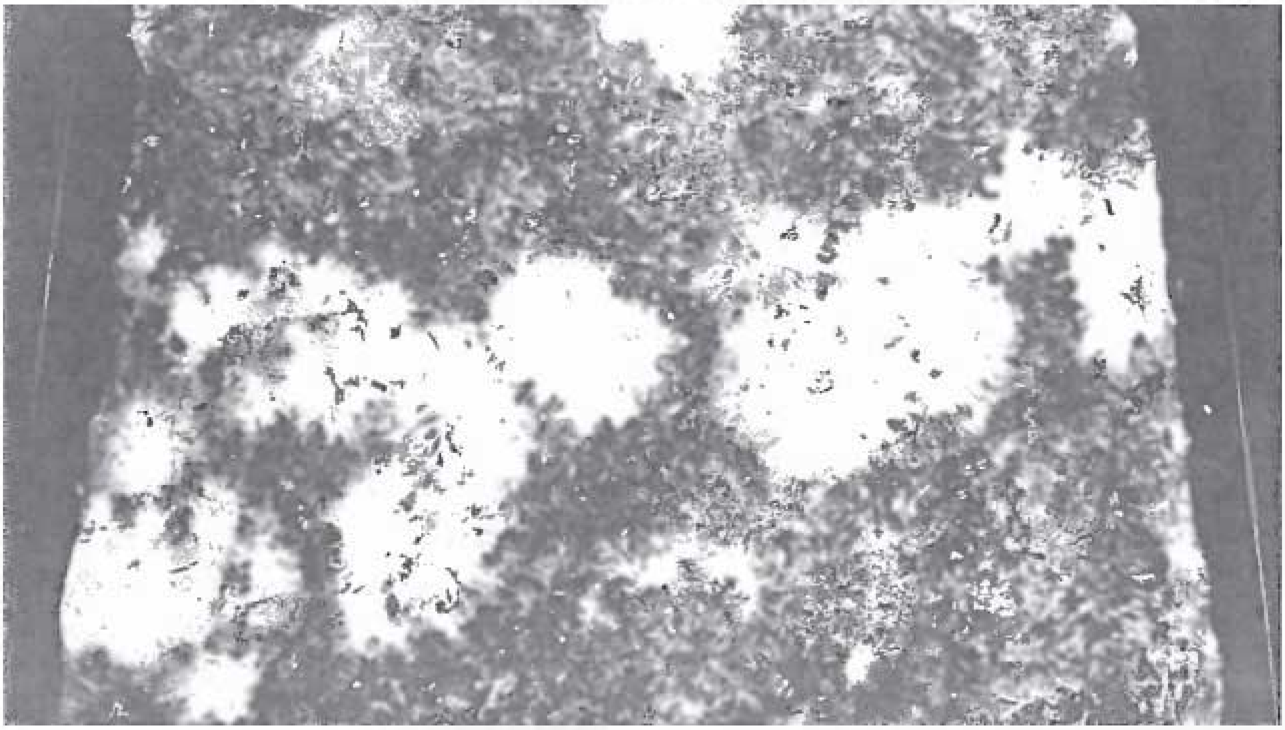


Figure 131 - Cased grain culture of *Agaricus brunnescens* showing overlay and stroma.

Fresh air also removes high concentrations of carbon dioxide and other metabolic gases from the room. Since *Agaricus brunnescens* does not pin properly at CO_2 concentrations above 2000 ppm, lowering the carbon dioxide content of the room's air to under 2000 ppm is critical. The inhibitory effect of carbon dioxide on mushroom formation gives *Agaricus* growers a high degree of control over the pinning process. Not until carbon dioxide is removed will pinheads form. If carbon dioxide levels remain high, the mycelium will totally cover the casing surface, a condition called overlay.

The mycelial mat formed by overlay makes the casing impervious to water and produces few pinheads. Overlay also occurs if the casing surface is too dry, the humidity (rH) is too low or the air temperature remains too high. Overlay can be counteracted by patching, but the cause must be diagnosed and carefully corrected if the culture is to be revived. Few flushes will be as great from a casing with overlay as from a casing properly managed.

Stage III: Primordia Formation (Knotting)

Once substrate temperatures have been lowered and CO_2 levels have been reduced, primordia will begin to form. Maintain:

1. A constant fresh air supply to remove metabolic gases, and CO_2 at levels less than 1000 ppm.
2. A constant temperature in the growing room that is within the fruiting range.
3. A relative humidity of 95%.
4. A 12 hour on/off light cycle.

The combination of temperature drop, high humidity and reduction of metabolic gases by a constant supply of fresh air now provides an environment conducive to pinhead formation. These parameters should be held constant until the pins are set. Any abrupt changes in temperature or humidity will be harmful to primordial growth. Pinhead initials form in the humid valleys of the casing layer and are visible as small knots of mycelium. This is the earliest stage of fruiting. Within five days these knots enlarge into small mounds or buttons that soon differentiate into mushrooms.

Due to slowed mycelial growth in the cooled substrate, carbon dioxide evolution is greatly reduced. Consequently, the fresh air supply can be moderated to the minimum level necessary to maintain 1000 ppm of carbon dioxide. At this time, oversupply of fresh air can lead to high evaporation rates and excessive drying. The humidity should **never** be allowed to fall below 90%. If dry air becomes a problem, a light misting of the casing surface, two to five times daily, should keep the microclimate moist. In fact, some growers knock down the mycelium with a forceful watering on the first day of initiation. Others mist daily as a standard practice. However, once pinning has begun, any forceful watering will kill a number of developing pins, and damage others. Given sufficient casing moisture and a high humidity, these watering practices become unnecessary.

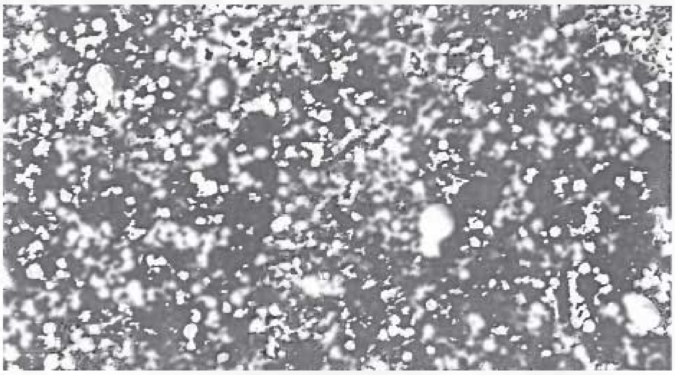
Stage IV: Pinhead Development

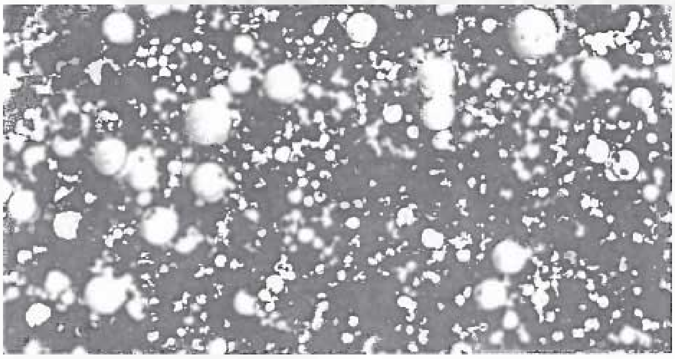
After the pinheads have grown to pea size (3-5 mm.), their further development is primarily dependent on air temperature and relative humidity. To insure that they mature into healthy mushrooms, the

1. Air temperature is held constant within the fruiting range.
2. Relative humidity is lowered to 85-92%.
3. A constant fresh air supply with CO_2 below 2000 ppm.
4. A 12 hour on/off light cycle.

The humidity is lowered to 85-92%, thereby increasing the evaporation rate, an essential requirement for pinhead maturation. If humidity remains too high, pinhead development will be retarded. The easiest way to reduce humidity is to raise the air temperature by 1-2°F. or to increase air movement within the room. Under no circumstances should pockets of stagnant air be allowed to form. Evaporation is negligible in stagnant air pockets which are also excellent breeding grounds for mushroom pathogens.

At this time, a slightly higher level of carbon dioxide is desirable (in the 1500-2000 ppm range) and fresh air can be cut back accordingly. Given proper CO_2 levels, and sufficient evaporation, the pins continue to develop. The exact rate of growth depends on the air temperature in the room. Work done by Lambert (1938) has shown that a pinhead of *Agaricus brunnescens* with a diameter of 2 millimeters fully develops into a mature mushroom in twenty-two days at 50°F., in ten days at 60°F. and in six days at 70°F. Although mushrooms develop more quickly at 70°F., overall yields diminish. Optimum temperature for cropping in *Agaricus brunnescens* is 62-64°F.





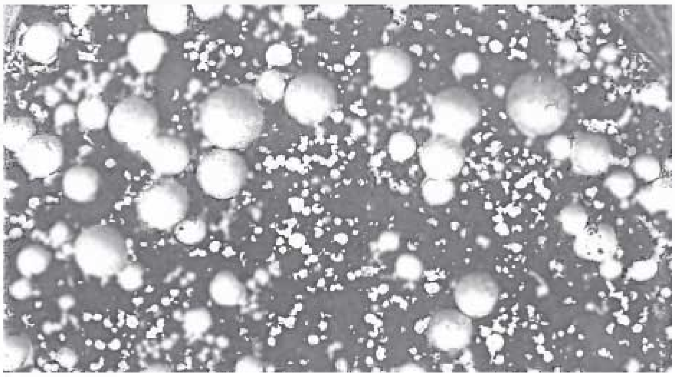


Figure 132, 133 & 134 - Three day pinhead development sequence in *Agaricus brunnescens*. Change-over from Stage III to Stage IV occurs within this time frame.

The Relationship Between Primordia Formation and Yield

The importance of the primordia formation period can not be over-emphasized. For maximum yields an optimum number of pinheads must be set, matured and brought to harvest. Certain relationships exist between the pinning process and yields. These are:

1. **During the primordia formation period, pinheads for the first and second flush are being generated**. The second flush primordia are present as thickened mycelial knots which develop after the first flush is harvested. Once the first flush is off the beds, the second set of primordia begin to enlarge and within days attain button size. Because 60-75% of the total yield is normally harvested from the first two flushes, the few days of pinhead initiation are the most critical in the growing of mushrooms. Hence, all environmental factors must be carefully monitored to insure the best possible pin-set.

2. **The greater the number of pins set for the first flush, the higher the yield**, provided sufficient nutrients are available to support their growth. However, with more pinheads competing for the same nutrient base, the smaller are the mushrooms arising from it. Fewer pinheads result in larger mushrooms, but lower total yields.

3. **The substrate will only support the development of a certain number of primordia per flush**. Under normal circumstances with an even pin-set, pinheads may "abort" because of insufficient nutrients or late formation.

4. **Pins that form early delay the growth of neighboring primordia**. Good examples of this can be found in shallow areas or along the borders of the substrate container. Removing these relatively few "volunteers" before they develop is advantageous to the remaining primordia that constitute the first flush.

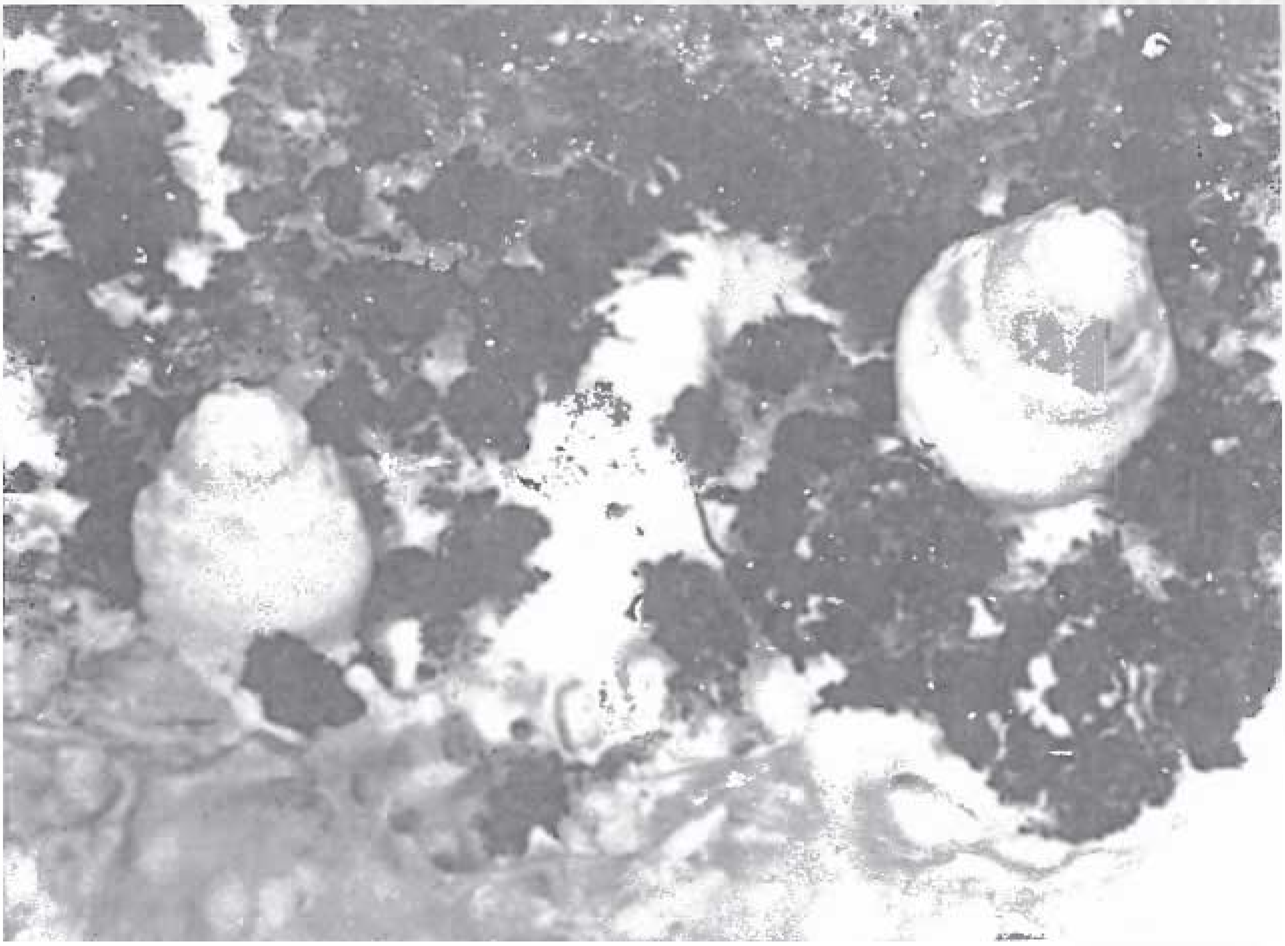


Figure 135 - Three pinheads of *Coprinus comatus* forming on cased section of compost. Note mycelial knot in upper center.

The Influence of Light on Pinhead Initiation

Mushroom species requiring light for primordia formation are said to be **photosensitive**. Although light is not necessary to induce fructification in all mushrooms (i.e. *Agaricus brunnescens*), certain spectra have proven to be stimulatory to pinhead initiation and are critical for the normal development of the fruitbody. *Psilocybe cubensis* and *Pleurotus ostreatus* are two such photosensitive species.

A thorough investigation on the photosensitivity of *Psilocybe cubensis* can be found in a master's thesis by E.R. Badham (1979). His work reinforces the conclusions of other researchers working with the Basidiomycetes: more pinheads are initiated upon exposure to blue and ultra-violet light with distinct peaks at 370, 440 and 460 nanometers. Badham showed that light stimulation at these wavelengths for as little as half a millisecond per day caused primordia to form. In contrast, red, infra-red and green light having wavelengths greater than 510 nanometers were ineffective.

With this knowledge, the cultivator of photosensitive species can develop initiation strategies incorporating the influence of light. Ideally a fully colonized substrate should be incubated in total darkness and exposed to light only after the mycelium first shows through the casing layer. If the cultivator wants to check the culture without the chance of premature pinning, red light is recommended. (The proper location and type of light is discussed in more detail in Chapter IV).

X. ENVIRONMENTAL FACTORS: SUSTAINING THE MUSHROOM CROP

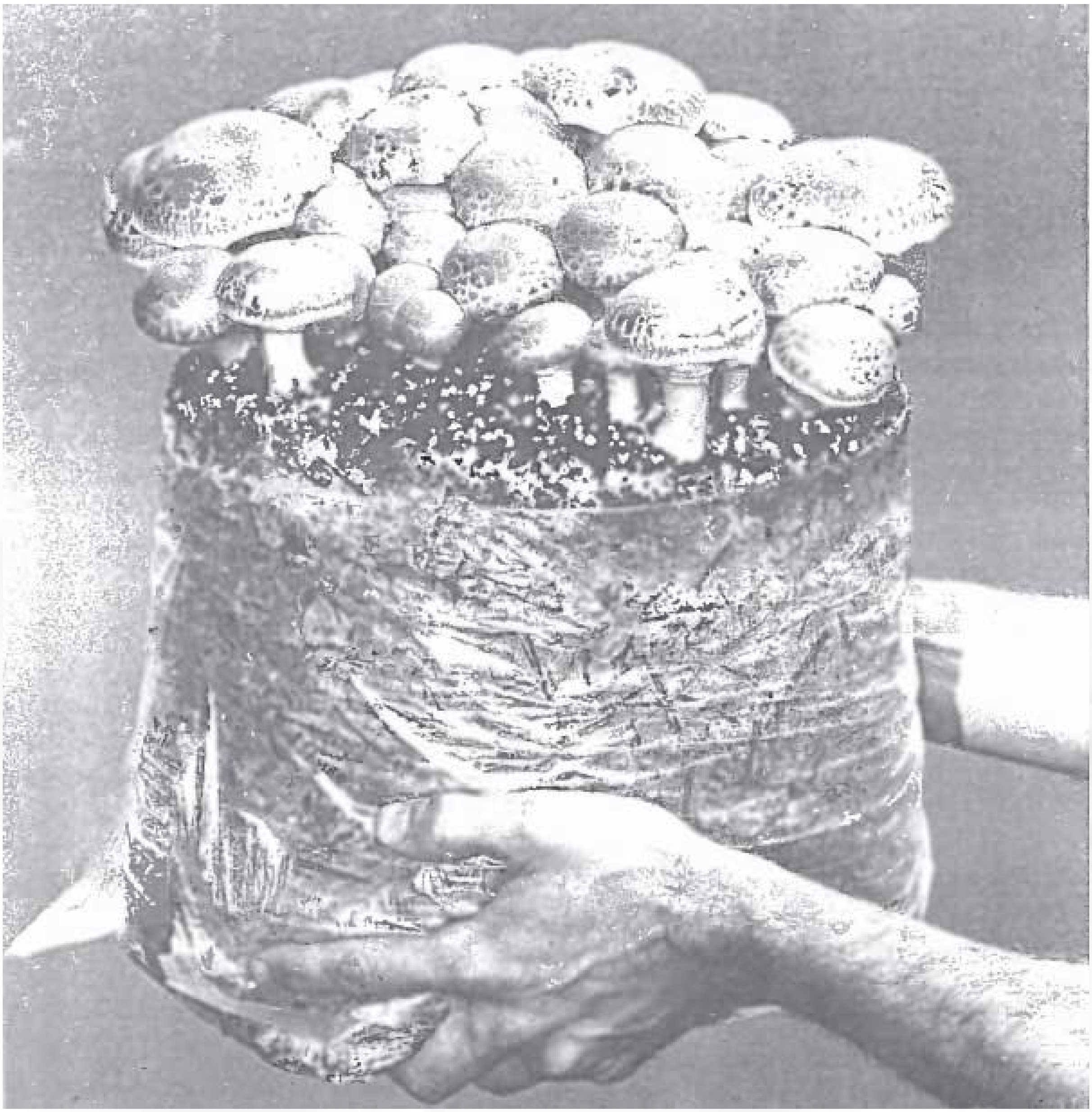


Figure 136 - Wild strain of *Agaricus brunnescens* fruiting in bag of cased compost.

For the home cultivator the onset of cropping is a time of excitement and anticipation. It is also a time for increased attention to the finer details of environmental control. Temperature, humidity, light and airflow in the growing room all play vital roles which together determine the nature of further mushroom development.

Temperature

During the vegetative growth period, the substrate was held in the optimum range by careful manipulation of the air temperature. But once the change to generative growth is initiated, the substrate temperature becomes less important and air temperature becomes the controlling factor.

The time it takes button sized mushrooms to mature is influenced primarily by the air temperature of the growing chamber. Each species has an optimum temperature for fruitbody development that lies within a broader growing range. Knowing the temperature parameters as outlined in Chapter XI, the cultivator can speed or slow development depending on which end of the cropping range is chosen. Lower temperatures can be used to postpone or lengthen the harvesting period and allow for maximum quality control. High temperatures serve to shorten the cropping period by promoting rapid, intense flushes. However, the dangers of high temperatures include the risk of heat building up in the substrate and consequent CO_2 generation, as well as the ability of insects and contaminants to grow and reproduce at faster rates. Commericial *Agaricus* growers commonly lower the air temperature by 2°F. 48 hours prior to the peak of the first and second flushes. Further flushes are then run hotter to speed the crop to completion. It is important that the cultivator evaluate the heat generating capabilities of the crop and insure that the environmental control system is capable of handling them.

Flushing Pattern

The mushroom crop grows in cycles called flushes or "breaks". Depending on the species being grown these flushes normally come in seven to ten day intervals with each successive flush bearing fewer mushrooms. The manner in which these flushes appear is determined during the pin initiation period. Even pinning sets up a uniform pattern of flushing that continues throughout the cropping cycle. Uneven flushing creates difficult situations for proper watering and environmental control. To encourage even flushing, early forming pinheads are picked off as buttons unless it appears that these pins constitute the flush itself. Poor first flushes are indicative of faulty pinning procedures and lead to lower total yields and a longer cropping period as the cultivator tries to maximize yields from the following flushes. But keep in mind that many times it is the progressive build-up of competing contaminant organisms that eventually bring mushroom growth to a halt. For this reason, the goal is to maximize yields in the early flushes.

To further increase the flushing speed the actual harvest period in each flush should be kept short and concise. Late developing mushrooms are removed with or on the day after peak production. The sooner the flush is completely removed the quicker the next one will appear and the shorter the overall cropping cycle. Stunted undeveloped mushrooms are also cleared from the cropping surface between breaks with care not to disturb the casing. Small dead pinheads should be left in place and cause little harm. (As a rule, an aborted mushroom can be removed as long as the casing is not touched in the process.) At no time should the casing be over-handled in an attempt to clean. Such handling can spread disease spores and damage subsequent pin formation.

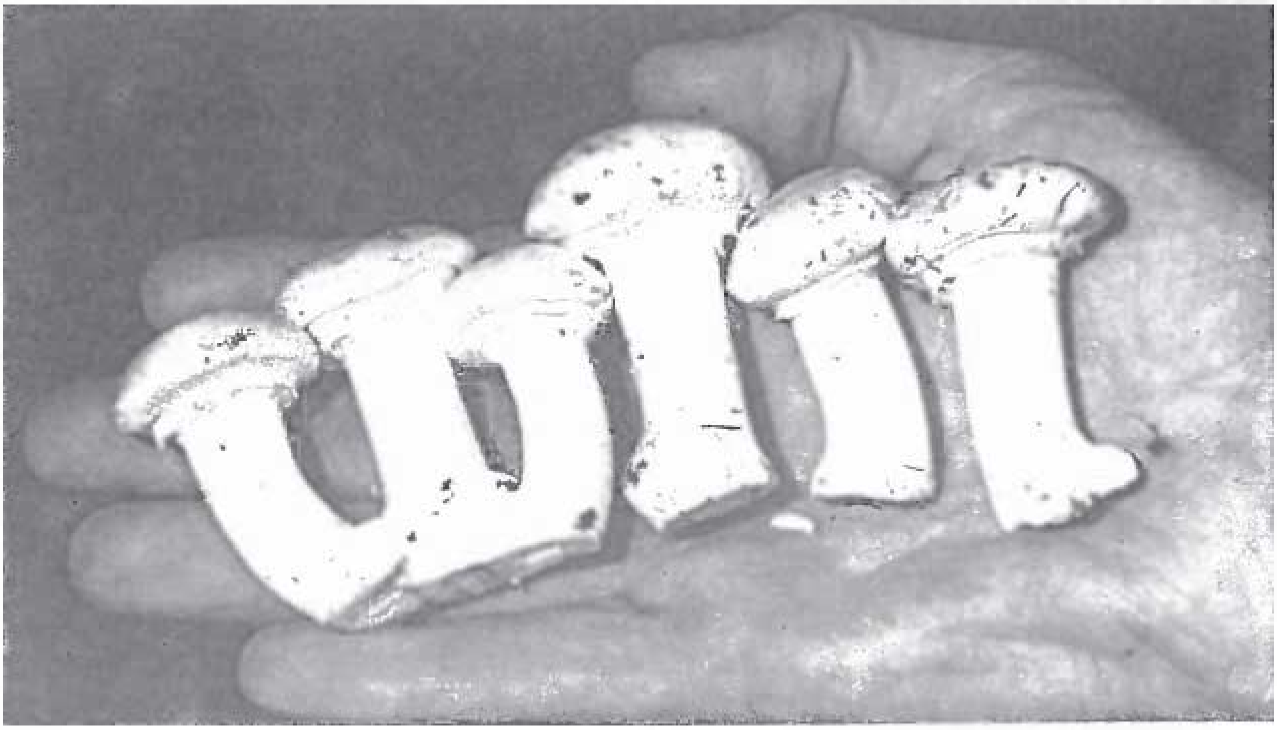


Figure 137 - *Agaricus brunnescens* affected by high CO_2 concentration. Note long stems and underdeveloped caps.

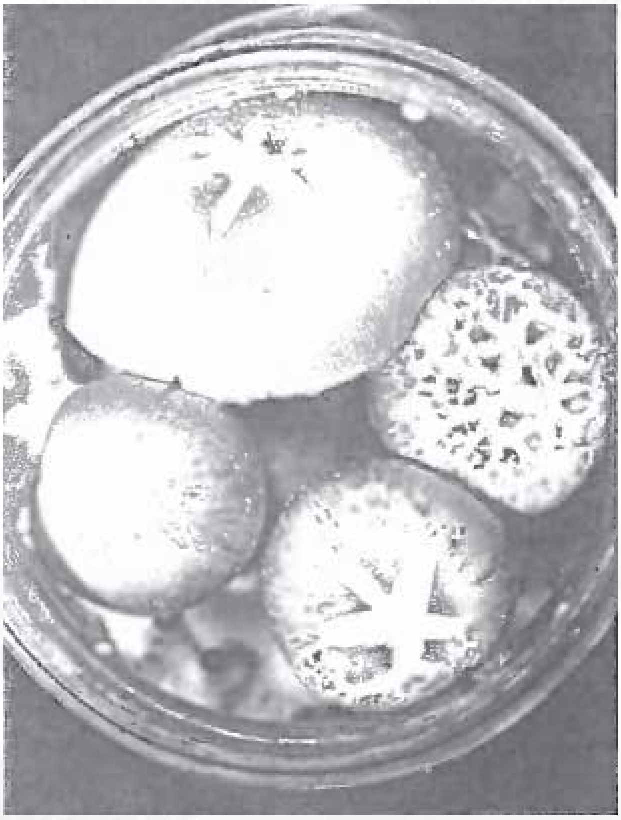


Figure 138 - The effect of dry air on *Psilocybe cubensis* caps, a condition known as "scaling".

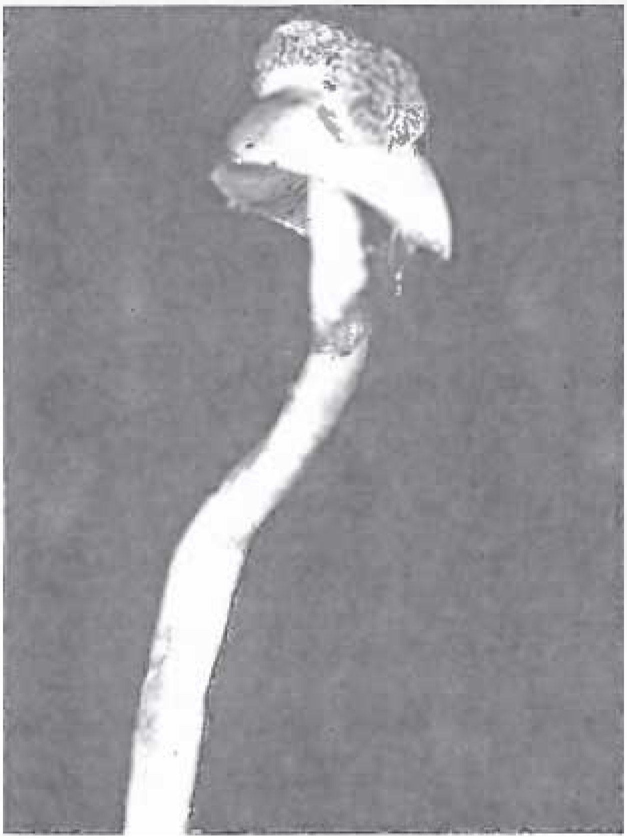


Figure 139 - Rosecomb on *Psilocybe cubensis*, an abnormality caused by contact with chemicals, especially those that are petroleum based.

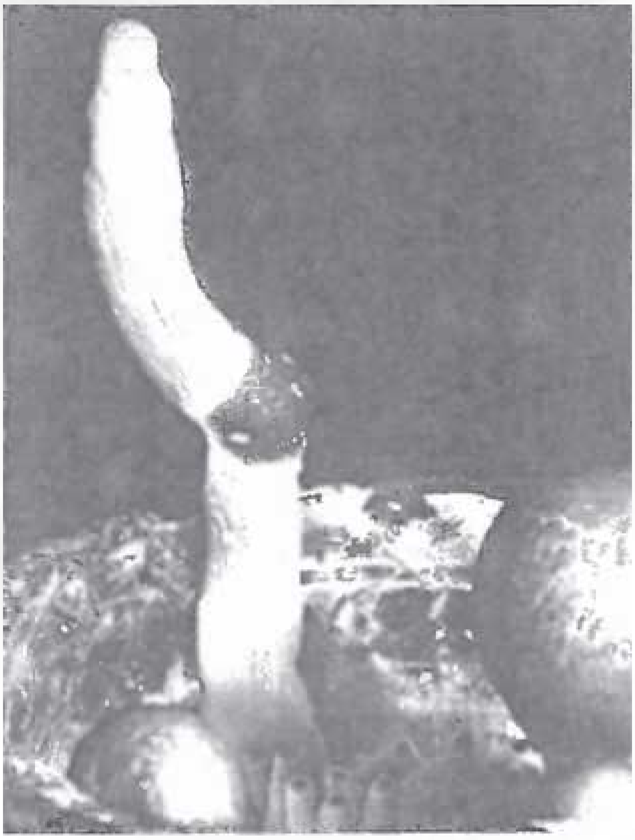


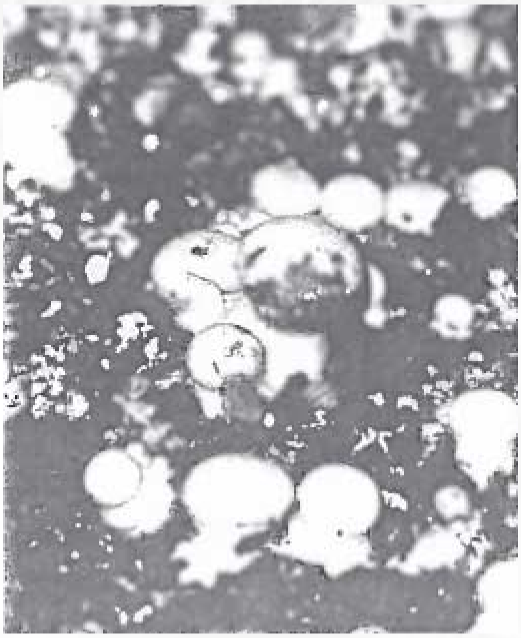
Figure 140 - Fruitbody abnormality occasionally seen in *Psilocybe cubensis*.

Air Movement

Air movement in the growing room is designed to create an even flow across all levels of cropping surface. This even airflow counteracts temperature stratification and dead air pockets by equalizing the environment of the room. In this manner the crop can be managed as a whole, giving the grower greater control over the cropping cycle.

During the pin initiation period fresh air is introduced into the room to remove metabolic gases produced by the mushroom mycelium. Although gas production is reduced once this vegetative growth has been slowed, the maturing mushrooms create more carbon dioxide, the removal of which requires a continuous supply of fresh air. The number of these air changes varies depending upon the air/bed ratio and the CO_2 requirement of the mushroom species being grown. *Agaricus bitorquis* needs only half the amount of fresh air required by *Agaricus brunnescens*. A common rate for *Agaricus brunnescens* is 4-6 changes per hour. For more CO_2 tolerant species such as *Psilocybe cubensis*, 2-3 changes per hour is sufficient. (The most accurate method for determining fresh air requirements employs the multiple gas detector. This instrument measures CO_2 content of the air in parts per million (ppm), from 300 (natural level) up to 20,000 ppm. See Appendix for sources.)

Because many mushrooms are sensitive to carbon dioxide, the physical development of the mushroom can also be used as a guide. High CO_2 environments produce long stems and small underdeveloped caps in *Agaricus brunnescens* and *Pleurotus ostreatus*. *Pleurotus* exhibits similar symptoms in conditions of low light intensity.



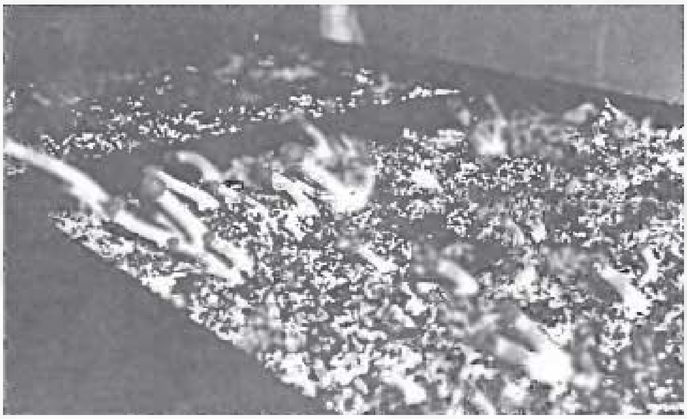


Figure 141 - Bacterial blotch parasitizing *Agaricus brunnescens*.

Figure 142 - Characteristic phototropic response of *Psilocybe cubensis* toward light.

In general, too much fresh air is preferable to insufficient air supply. However, fresh air displaces the existing room air which is then exhausted from the room. Unless this fresh air is preconditioned to meet the requirements of the species, one will be constantly disrupting the growing environment and thereby overworking the heating and humidification systems. For this reason the air circulation system should be designed to recirculate the room air. This is accomplished by a mixing box with an adjustable damper that proportions fresh and recirculated air. In this regard, CO_2 tolerant species give the grower a distinct advantage in maintaining the correct environment because they need less fresh air for growth.

An important effect of air circulation and fresh air supply is the evaporation of moisture from the cropping surface. Excessive humidity without adequate air movement and evaporation retards mushroom development. Saturated stagnant air pockets are also breeding areas for contaminants like the Forest Green Mold (*Trichoderma*) and Bacterial Blotch (*Pseudomonas*). As stated in the previous chapter on pinhead initiation, once the primordia are set, the relative humidity should be lowered to 85-92% and held constant within this range throughout cropping. Besides the creation of a cool surface by "evaporative cooling", evaporation aids in the transport of nutrients (in solution) from the substrate to the growing mushrooms. If the evaporation rate is too high and the humidity falls below 85%, excessive drying occurs, causing small stunted mushrooms and cracked scaly caps. A dry cropping surface further reduces yields and is difficult to recondition. In this respect, it is critical for the grower to reach a balance between air circulation, fresh air and humidification. This is but one aspect of the "Art" of mushroom culture.

Watering

Maturing mushrooms have water requirements that must be met if maximum yields are to be achieved. Mushrooms grown on uncased substrates draw their moisture from the substrate, whereas those grown with a casing draw equally from both. Uncased substrates are more susceptible to dry air and therefore require a relative humidity of 90-95% as well as periodic misting of the cropping surface. If the cropping surface dries and forms a dead mycelial mat, it can be reopened to further flushing by raking or scratching. This technique is often used by *Pleurotus* growers to stimulate later flushes.

The advantages of using a casing layer are many. Protected from atmospheric drying, the substrate moisture is channeled solely to the mushroom crop. And, the water reservoir provided by the casing not only supplies the mushroom flushes but also serves to keep a high humidity in the cropping surface microclimate. In order to sustain these benefits, the grower must learn to gauge casing moisture and know when to water.

Other than light mistings, any substantial waterings before the button stage can result in damaged pins. But once the mushrooms have reached button size, it is time to begin building the casing moisture back up to the peak reached at pre-pinning. The aim is to reach capacity just prior to the main harvest. This is accomplished by a series of daily, light to moderate waterings with a fine misting nozzle. Commercial *Agaricus* growers have traditionally used a rose-nozzle but many have now switched to nozzles with finer sprays and variable volume outputs. This enables the grower to add moisture without damaging the casing surface. In this regard, high water pressures and close nozzle proximity to the casing should be avoided.

The goal is to keep the surface of the casing open and porous throughout the cropping cycle. Putting on too much water at once is the most common cause of panning. By watering 2-4 times/day rather than just once, the casing can slowly absorb the water without damage to the surface.

After the first flush is harvested the casing should be kept moist with light mistings until the next flush reaches the button stage. The casing moisture is then built up again. Each new flush is treated in this manner, although later flushes will have fewer mushrooms and therefore require less water. At no time should the casing be allowed to dry out. Mushrooms pulled from a dried casing carry large chunks of casing with them, creating gaps in the cropping surface and at times exposing the substrate to possible colonization by contaminants. If the substrate is exposed during picking, the holes should be filled with moist casing. To recondition a dry casing, moisture should be added slowly over a period of a few days.

One of the common contaminants in mushroom growing is Bacterial Blotch (see Chapter XIII). Blotch results from mushroom caps that remain wet for extended periods of time. *Agaricus* growers attempt to dry recently watered mushroom caps as quickly as possible by lowering the humidity of the room. This is accomplished by increasing air circulation and introducing more fresh air or by raising the air temperature 1-2°F. *Agaricus* growers also stop watering once the mushroom cap has reached adolescence because wet mushroom caps become prime sites for disease. Small scale growers may be able to water around maturing mushrooms without directly hitting the caps. If Bacterial Blotch or other diseases appear on the mushrooms or the casing soil, these areas should not be watered. Watering contaminated regions will spread the infection further. A common strategy for serious disease outbreaks is to lower the relative humidity and run the casing drier than normal. *Agaricus* cultivators also use slightly chlorinated water (150 ppm).

Harvesting

The way an individual picks mushrooms can dramatically affect future flushes. Damage to resting pinheads and disturbance of the casing soil must be minimized during picking. Often times pinheads are in close proximity to developing mushrooms and enlarge directly after the mature ones are picked. Should any pinhead be harmed, the grower will have lost a potential fruitbody. Moreover, these damaged pin heads are easily parasitized by fly larvae and other contaminants. The best pickers are meticulous, unhurried, and above all treat the mushrooms with care. Carelessness in picking, when multiplied by hundreds of cultures, can be costly indeed.

The most important factor in harvesting mushrooms is timing. *Agaricus brunnescens* should be picked before the veil breaks and the stem elongates. *Psilocybe cubensis* is morphologically distinct from *Agaricus* species, having a longer stem, a less fleshy cap and a more delicate veil. It is both natural and desirable to have tall stands of *Psilocybe* mushrooms while this is not the case with *Agaricus*. Cultivators of these two species, however, share many things in common. One particular problem is the massive release of spores from the mature mushrooms. These spores often times cover the casing layer and can inhibit further pinhead development. High spore loads can also cause allergic reactions amongst workers. For these reasons, one should pick the mushrooms at the stage when the veil begins to tear or soon thereafter.

The nature of the crop determines how the mushrooms should be picked. Flushes with mushrooms in varying stages of development are more difficult to harvest. This is especially true if the primordia formation period was interrupted by fluctuations in the environment. One example is a phenomenon common to *Psilocybe cubensis* culture in mason jars. Mushrooms sometimes form between the casing and the glass. These "border breaks" are due to high humidity pockets and premature light stimulation. In tray culture where mycelium is not exposed to side light and proper moisture is easily managed, border breaks are uncommon. Mushrooms then grow uniformly from the surface of the casing layer where they can be easily picked.

Harvesting techniques

1. Equipped with a basket and short bladed paring knife, grasp the base of the stem, and with a twisting motion, pull the mushroom from the casing layer being careful not to disturb neighboring pinheads.
2. Trim the stem base, removing only flesh to which the casing or substrate is attached. Mushrooms having thin stems are best cleaned using a knife in a downward scraping motion. All trimmings should be placed in a sealed plastic bag and removed from the cropping area.
3. Mushrooms growing in clumps or clusters should be broken apart and harvested individually when possible. Special care must be taken with those clumps containing both mature and immature mushrooms. Leave immature mushrooms attached to the casing layer or substrate to insure continued growth.

Preserving Mushrooms

If not served within four days, mushrooms can be preserved by drying freezing or canning. Air drying of mushrooms is the method most widely used by home cultivators and field hunters. Since most mushrooms are 90% water, they must be dried within a few hours or fly larvae and bacteria will consume them. Provided mushrooms are placed in a flow of warm, dry air, this large fraction of water soon evaporates into the air. Dried mushrooms are smaller, lighter and less fragrant than fresh ones. Once dried, they are sealed in airtight moisture proof plastic containers and refrigerated. Mushrooms will be preserved for years in this manner. When needed, simply rehydrate them in water before cooking. They will regain much of their original size and flavour.

Commercially available food dehydrators are well suited for drying mushrooms. Their only disadvantage is that the trays are often too close together, necessitating the cutting of large mushrooms into thin slices. Or, one can build a dehydrator solely designed for this function and customized to an individual's particular needs. A good dryer should be able to dry the mushrooms in 24-48 hours by passing warm air no hotter than 110°F. Open air drying at room temperature is also feasible using dehumidifiers in combination with air circulation fans. "Flash" drying at high temperatures should be avoided since the mushrooms lose much of their nutritive value and, as the case may be, much of their psilocybin content.

Freezing is another method of preserving mushrooms. But unless the mushrooms are first dried, frozen mushrooms are soggy and unappealing upon thawing. In freezing, the water constituting 90% of a mushroom's mass becomes crystallized. Frozen mushrooms are held together more by ice crystals rather than their own cellular structure. Since ice expands upon crystallization, cells break under the stress. Because frozen mushrooms disintegrate into a formless mass when thawed, they are mostly used in soups or stews.

The best of both drying and freezing is freeze drying. This is the ideal method for preserving the flavor, nutrition, form and/or psilocybian content of mushrooms. Because of the expense, only a few commercial mushrooms, such as shiitake (*Lentinus edodes*) are freeze dried.

Freeze dryers operate on the principle of first flash freezing fresh mushrooms which are then placed onto heated trays in a cooled, high vacuum chamber. The frozen water within the mushrooms begins to melt from the heat generated from the trays. But instead of becoming a liquid, the water is immediately transformed into a vapor that is pumped out of the freeze drier. Freeze drying preserves much of the original cell structure and hence mushrooms dried in this manner are often life-like in appearance. Since commercial freeze driers are prohibitively expensive, few home cultivators can afford them. Many people have discovered, however, that mushrooms placed in a frost-free refrigerator are almost as well preserved.

Canning is another method for storing mushrooms. Mushrooms preserved by canning must be carefully cleaned beforehand, precooked for 3 or 4 minutes in boiling water, then inserted into glass jars with a small amount of vinegar and sterilized in a pressure cooker. (Sterilization for mushrooms is usually 30-40 minutes at 10 psi. Consult a book on mushroom cookery for further information on canning mushrooms). Canned mushrooms, especially those that have been pickled, are preferred by many epicureans to those preserved by other means.

No matter what the technique, fresh mushrooms are undoubtedly better tasting than preserved mushrooms. If one chooses to dry, freeze or can, young mushrooms should be selected over old ones. Label each container with the species, the name of who grew or identified the mushrooms, the date and the place of origin. (One general rule recommended by all mycologists is: when eating wild mushrooms for the first time, always leave one or two small specimens aside in case illness ensues and a mycologist or a doctor needs to be consulted.)

XI. GROWING PARAMETERS FOR VARIOUS MUSHROOM SPECIES

Figure 143 - *Stropharia rugoso-annulata* fruiting in a bed of wood chips.

Growing parameters for mushrooms vary with every species. Through time spent in countless trials and from observations by both home and commercial cultivators, specific cultural requirements have been ascertained.

Mushrooms fruit in response to unique sets of conditions involving nutrition (substrate), temperature, pH, relative humidity, light and carbon dioxide. What follows are outlines pin-pointing the optimal environmental ranges for each stage in the mushroom's life cycle. By adhering to these optima, a cultivator can maximize fruitbody production in a precise and deliberate fashion.

SPECIES: *Agaricus bitorquis* (Quel.) Saccardo

= *Agaricus rodmanll* Peck
= *Agaricus campestris* var. *edulis* Vitt.
= *Agaricus edulis* (Vitt.) Moller and Schaeff.

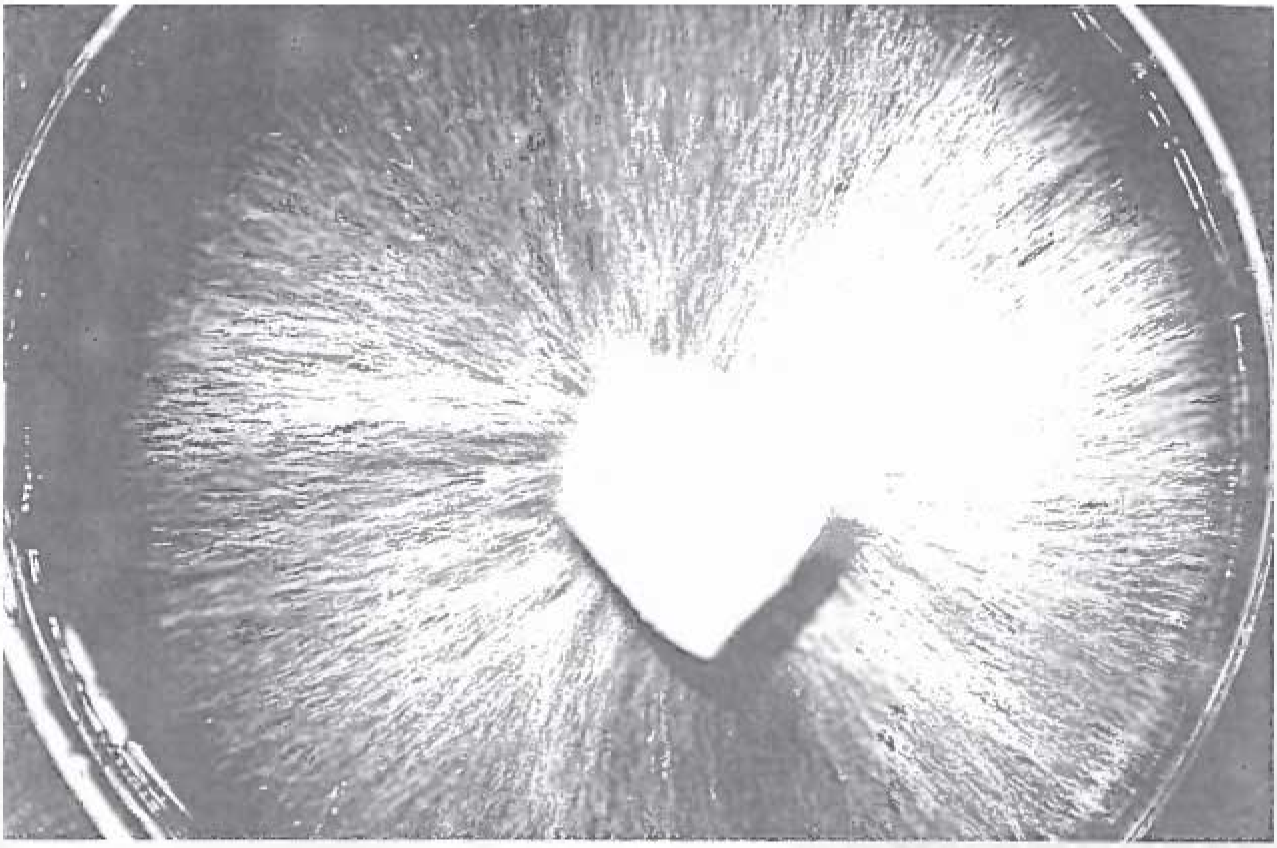


Figure 144 - Linear (longitudinally radial) mycelium of *Agaricus bitorquis*.

STRAINS: Horst B30 (The first commercial strain to be developed by Gerda Fritsche at the Dutch Mushroom Research Center in Horst, Holland).
Horst K26, K32 (These are two second generation strains from Horst B30 and are distinctive from it in that they fruit earlier, give higher yields and have slightly longer stems. Spawn of this species is now available from Amycel.)

COMMON NAME: Rodman's Agaricus

GREEK ROOT: *Agaricus* comes from the greek word "agarikon" which scholars believed originated with a Scythian people called Agari who were well versed in the use of medicinal plants and employed a fungus called "agaricum", probably a polypore in the genus *Fomes*. The species epithet *bitorquis* means having two rings, for the double annulus that so distinguishes this species from close relatives like *Agaricus campestris*, the Meadow Mushroom.

GENERAL DESCRIPTION: Cap smooth, white, thick fleshed, convex to broadly convex to plane with age. The cap margin is incurved at first but soon decurves. The gills are pinkish at first, soon darkening to chocolate brown with spore maturity. The stem is thick, relatively short and adorned with a double membranous annulus. (The lower ring is often a thin annular zone). Its spores are dark chocolate brown in mass.

NATURAL HABITAT: Naturally found in lawns, gardens, roadside areas, pastures, in enriched grounds and on hard packed soil. A temperate species, widely distributed, *A. bitorquis* fruits primarily in the spring and to a lesser degree in the fall.

A. bitorquis - Growth Parameters

Mycelial Types: Rhizomorphic to linear; whitish to pale whitish in color.

Spawn Medium: Rye grain buffered with calcium carbonate and/or calcium sulfate. See Chapter III.

Fruiting Substrate: Nitrogen enriched wheat straw and/or horse manure based compost balanced to 71-74% moisture content.

Method of Preparation: See Chapter V on compost preparation. Pasteurization achieved through exposure to live steam for 2 hours at 140°F. throughout the substrate. Compost should be filled to a depth of 6-12 inches.

Spawn Run:

Relative Humidity: 90-100%.
Substrate Temperature: 84-86°F. Thermal death limits have been established at 93°F. over prolonged period of time.
Duration: 2 weeks.
CO_2: 5,000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Type of Casing: After fully run, cover with the standard casing whose preparation is described in Chapter VIII. Layer to a depth of 1-2 inches. The casing should be balanced to a pH of 7.2-7.5.

Post Casing/Prepinning:

Relative Humidity: 90-100%.
Bed Temperature: 84-86°F.
Duration of Case Run: 10-12 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Primordia Formation:

Relative Humidity: 95-100%.
Bed Temperature: 77-80°F
Air Temperature: 75-77°F.
Lighting: None required.
CO_2: less than 2000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Watering: Regular misting (once to twice daily) of the beds stimulates primordia formation.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 75-77°F.
CO_2: less than 3000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Flushing Interval: Every 8-9 days.
Harvest Stage: Directly before the partial veil stretches.

Yield Potential: Average commercial yields are reported at 3 lbs/sq.ft. over a 5 week cropping period. Maximum yields are 4 lbs per square foot.

Moisture Content of Mushrooms: 92% water; 8% dry matter.

Nutritional Content: Thought to be similar to *Agaricus brunnescens*.

Comments: The development of *Agaricus bitorquis* has given commercial growers greater flexibility, especially those in warmer climates where elevated temperatures have been a limiting factor. An advantage of this mushroom is its resistance to virus (a devastating disease that attacks *A. brunnescens*) and its tolerance of high CO_2 levels. A disadvantage of growing this warmth-loving *Agaricus* is the higher incidence of disease endemic to the temperature range in which this species flourishes. *Agaricus bitorquis* is coarser, firmer, more strongly flavored and has a longer shelf life than its close relative, *A. brunnescens*.

Genetic Characteristics: Basidia tetrapolar (4-spored), forming haploid spores, heterothallic. The mating of compatible monokaryons can result in fruiting strains. Clamp connections absent. See Chapter XV.

For further information consult:
P.J.C. Vedder 1978, "*Modern Mushroom Growing*", Educaboek, Culemborg, Netherlands. (English edition available from Swiss American Spawn Company, Inc., Madisonville, Texas.)
P.J.C. Vedder 1978, "*The Cultivation of Agaricus bitorquis*" in The Biology and Cultivation of Edible Mushrooms ed. by Chang and Hayes. Academic Press, New York.
Darmycel LTD. Spawn Lab Bulletin 1978, "*A Guide to Darlington and Somycel Spawn Strains*".

SPECIES: *Agaricus brunnescens* Peck

= *Agaricus bisporus* (Lge.) Sing.

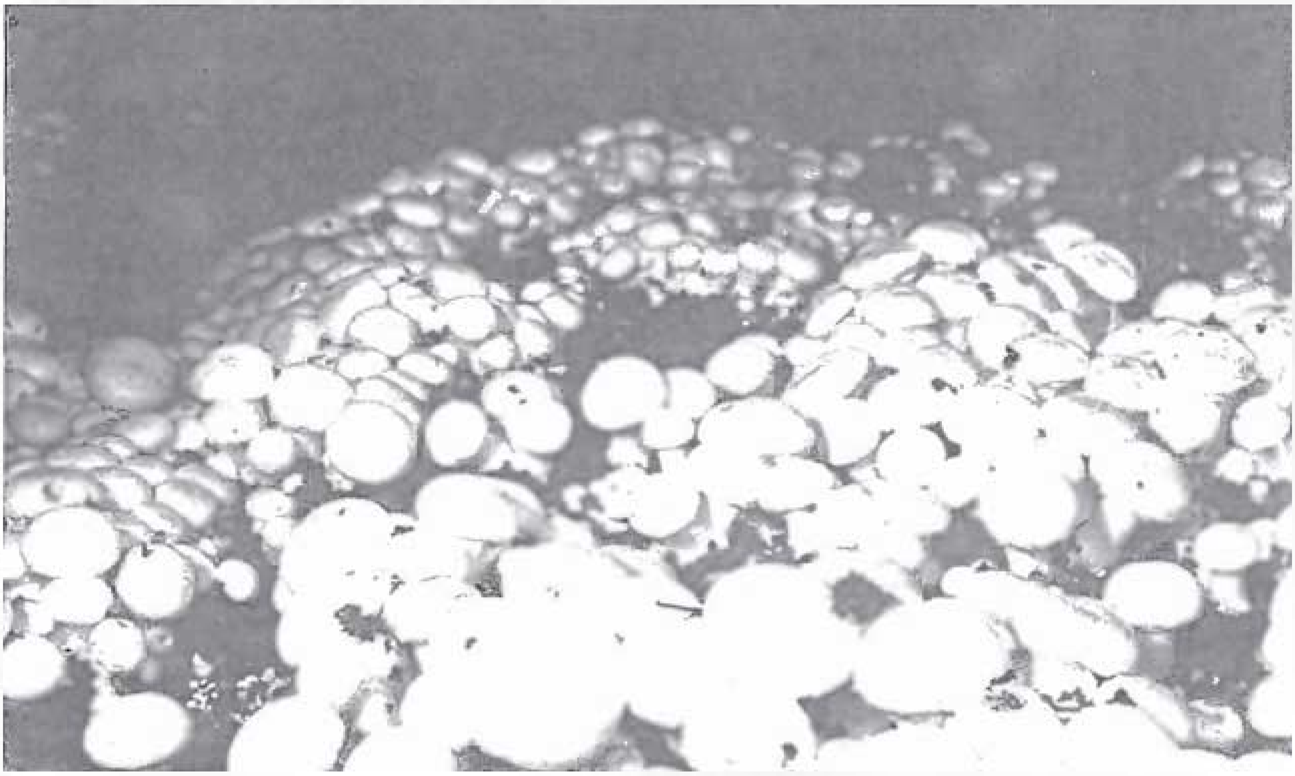


Figure 145 - *Agaricus brunnescens* fruiting in trays of compost.

STRAINS: Type or Brown Variety (var. bisporus)
White Variety (var. albidus)
Cream Variety (var. avellaneous)

COMMON NAME: The Button Mushroom.

GREEK ROOT: *Agaricus* comes from the greek word "agarikon" which scholars believed originated with a Scythian people called Agari who were well versed in the use of medicinal plants and employed a fungus called "agaricum", probably a polypore in the genus *Fomes*. The species epithet *brunnescens* comes from the latin "brunneus" or brown. Literally, the name means the fungus that becomes brown, probably referring to the color change of the flesh upon bruising. Also called *Agaricus bisporus* for the two spored basidia populating the gill faces.

GENERAL DESCRIPTION: A robust, thick fleshed *Agaricus* species, with thin gills that are pinkish when young, and darkening to sepia and then chocolate brown in age. The cap is characteristically brownish, whitish or cream colored. The cap surface is smooth to appressed squamulose and dry. This species has a short, thick stem which is adorned with a persistent membranous annulus from a well developed partial veil. Its spores are chocolate brown in mass.

NATURAL HABITAT: Naturally found in soils enriched with dung, on compost piles and in horse stables. A temperate species, widely distributed, *A. brunnescens* fruits from May until November over much of the northern hemisphere outside the tropical zone.

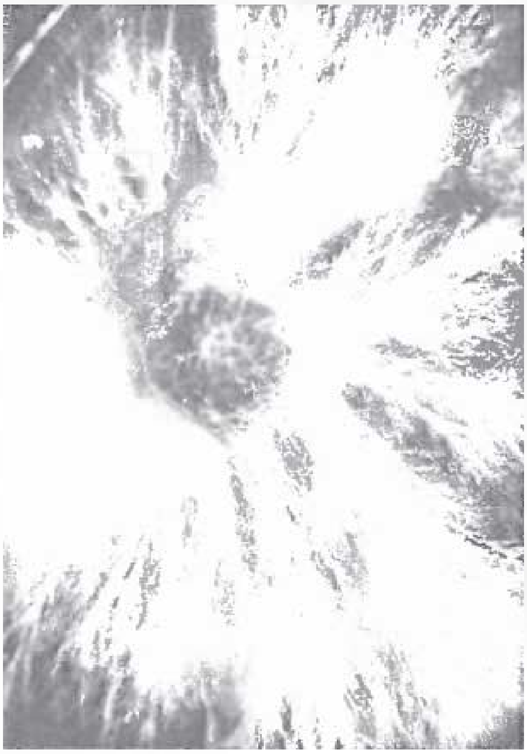
A. brunnescens - Growth Parameters

Mycelial Types: Moderately rhizomorphic; dingy white, sometimes with brownish hues.

Spawn Medium: Rye grain buffered with calcium carbonate and/or calcium sulfate. See Chapter III.

Fruiting Substrate: Nitrogen enriched wheat straw and/or horse manure based compost balanced to 71-74% moisture content. This species also fruits well on rye grain covered with an unsterilized peat based casing layer.

Method of Preparation: See Chapter V on compost preparation. Pasteurization achieved through exposure to live steam for 2 hours at 140°F. throughout the substrate. Compost should be filled to a depth of 6-12 inches.



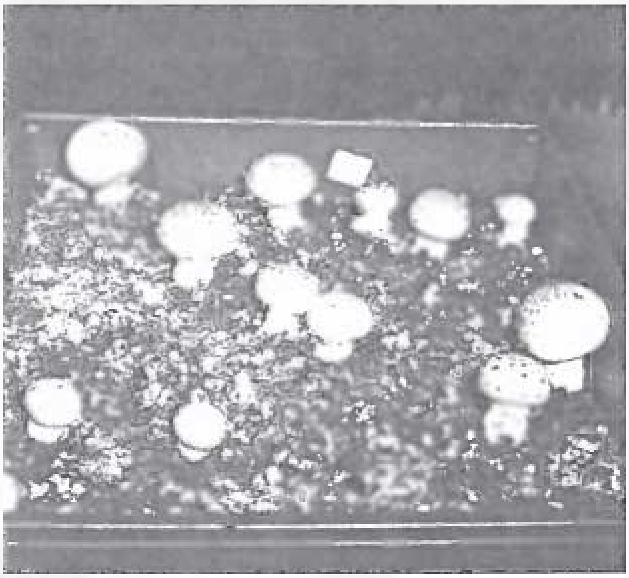


Figure 145a - *Agaricus brunnescens* fruiting on cased rye grain spawn.

Figure 145b - Characteristic *Agaricus brunnescens* mycelium.

Spawn Run:

Relative Humidity: 90-100%.
Substrate Temperature: 76-78°F. Thermal death limits have been established at 96°F. but damage can occur as low as 90°F.
Duration: 2 weeks.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Type of Casing: After fully run, cover with the standard casing whose preparation is described in Chapter VIII. Layer to a depth of 1-2 inches. The casing should be balanced to a pH of 7.0-7.5.

Post Casing/Prepinning:

Relative Humidity: 90-100%.
Bed Temperature: 76-80°F.
Duration of Case Run: 8-12 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Primordia Formation:

Relative Humidity: 95-100%.
Compost Temperature: 65-70°F.
Air Temperature: 62-65°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 4 per hour.
Light: None required.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 62-65°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 4 per hour.
Flushing Interval: 7-10 days.
Harvest Stage: Directly before the partial veil stretches.
Light: None required.

Yield Potential: Average commercial yields are 3 lbs/sq.ft. over a 5 week cropping period. Maximum yield is 6 lbs. per square foot.

Moisture Content of Mushrooms: 92% water; 8% dry matter.

Nutritional Content: 24-44% protein (dry weight); 56 milligrams of niacin per 100 grams dry weight.

Comments: Historically, this species and/or its close relatives were the first mushrooms to be cultivated in Europe during the late 1700's. It remains the most widely cultivated mushroom in the world today. A broad range of commercially available strains exist, many of which have been genetically selected for certain advantageous characteristics, especially yield, color and stature.

This species does not form pinheads on agar media unless activated charcoal or select bacteria are present. A species sensitive to high levels of carbon dioxide, *Agaricus brunnescens* fruits only within narrow environmental parameters. As a secondary decomposer, this species fruits best on substrates that have been transformed by a succession of specific microorganisms.
The common button mushroom is the mainstay of the mushroom growing industry in this country.

Genetic Characteristics: Basidia bipolar (2-spored), forming diploid spores; secondarily homothallic. The mating of compatible dikaryons typically results in strains both more vigorous and higher yielding. Clamp connections absent. See Chapter XV.

For further information consult: P.J.C. Vedder 1978, "*Modern Mushroom Growing*", Educaboek, Culemborg, Netherlands. (English edition available from Swiss American Spawn Company, Inc., Madisonville, Texas).
Fred Atkins, 1973, "*Mushroom Growing Today*", MacMillan Publishing Co., New York.

SPECIES: *Coprinus comatus* (Mull. ex Fr.) Gray

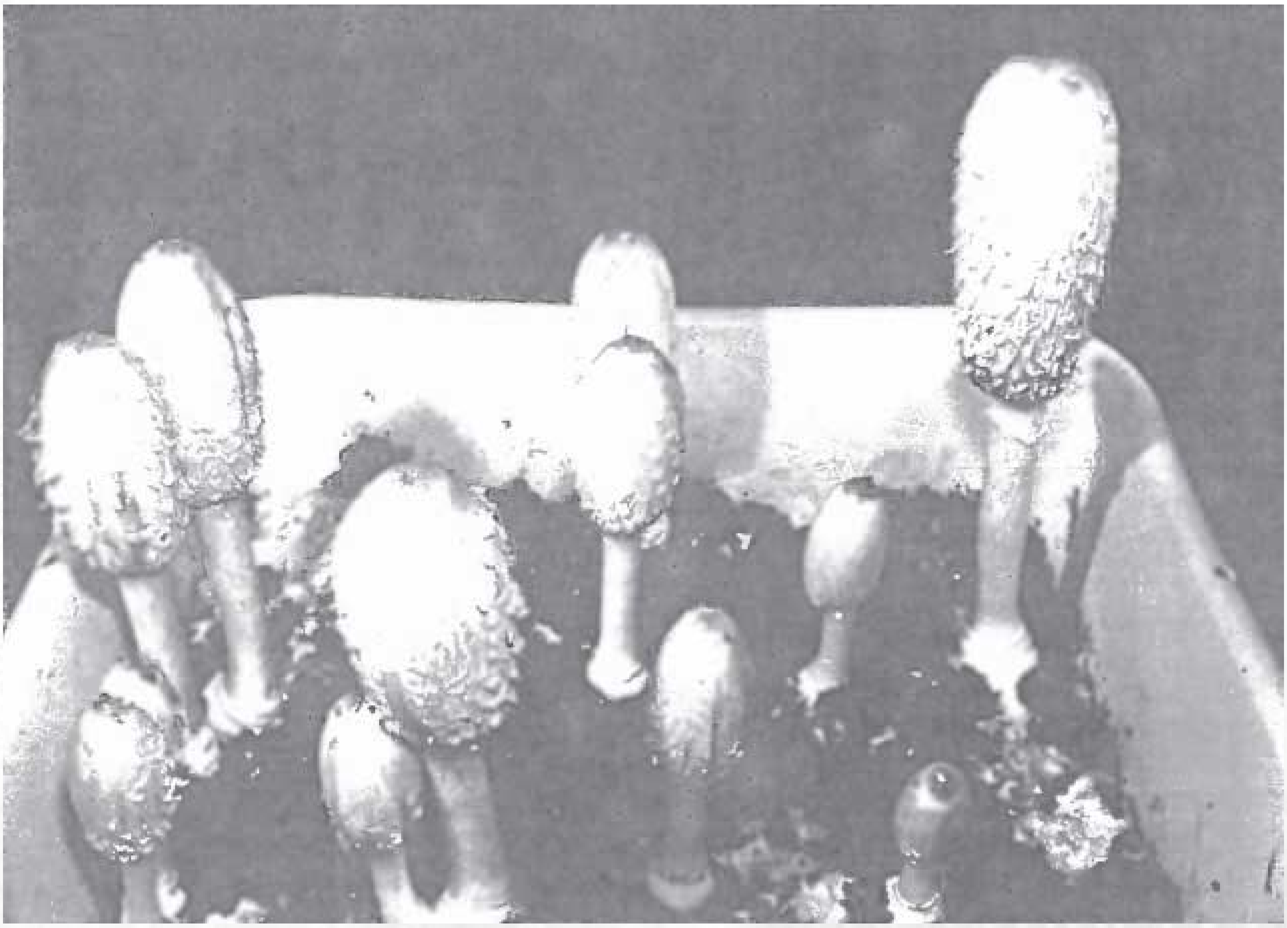


Figure 146 - Fully mature *Coprinus comatus* fruiting in a tray of compost.

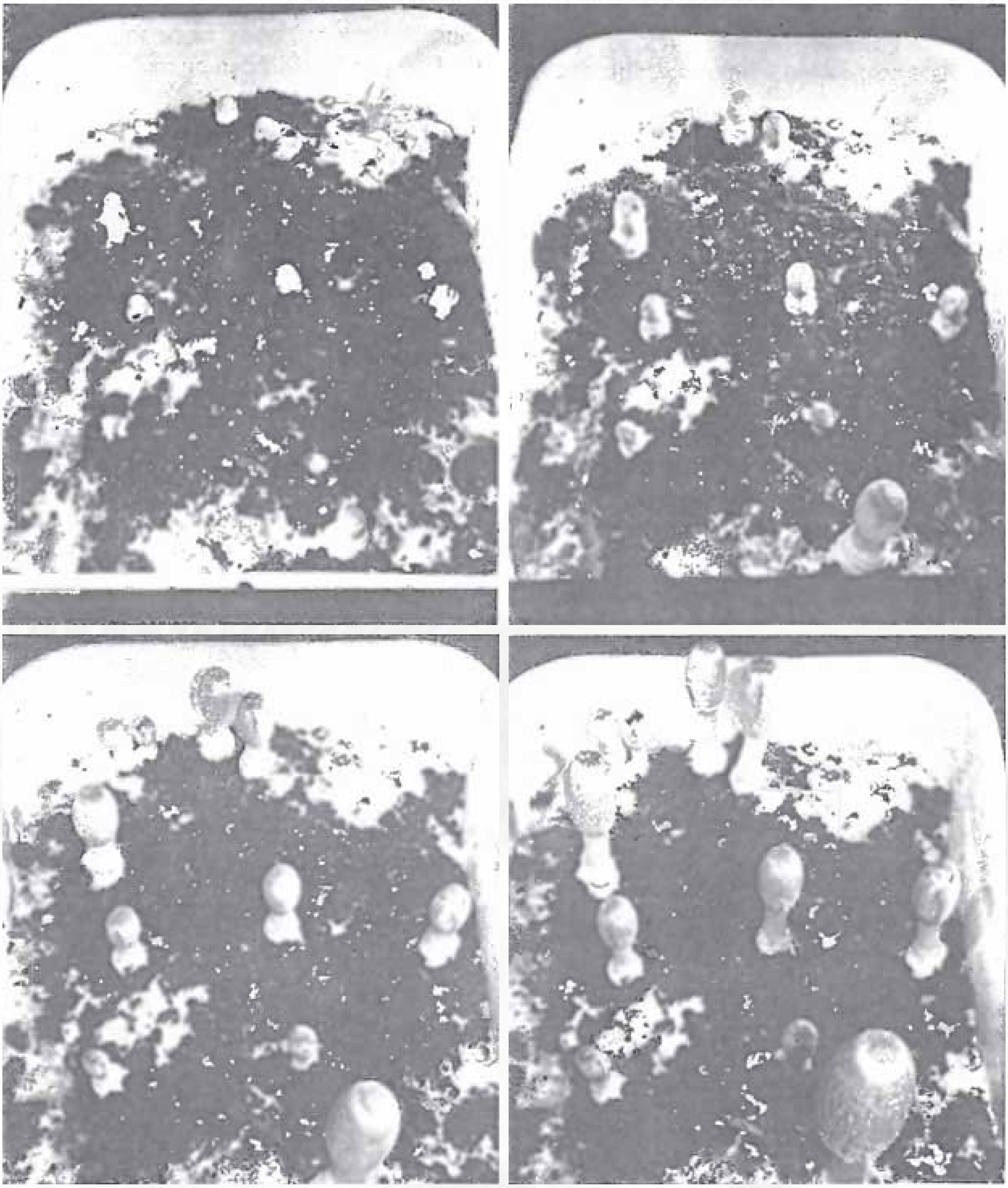
STRAINS: On deposit at the American Type Culture Collection and available through various culture banks, both commercial and private.

COMMON NAME: The Shaggy Mane.

GREEK AND LATIN ROOTS: *Coprinus* comes from the Greek word "kopros" meaning dung and *comatus* from the Latin "coma" meaning shaggy or adorned with hair tufts. The genus *Coprinus* is noted for the several species that grow on dung and for deliquescing gills. The species epithet describes the shaggy texture of the cap's surface.

GENERAL DESCRIPTION: Cap medium to large in size, whitish, ovoid when young, soon elongating upwards and becoming parabolic. As the mushroom matures and spores are produced, the cap begins to disintegrate from the margin's edge by an autodigestive process known as deliquescence. The disintegrating portions progressively darken and eventually liquify. The cap surface is smooth at the disc, scaly below, soon gray, darkening with maturity until black and thin fleshed. The gills are very crowded, whitish at first, soon gray, darkening with age to black. The partial veil membranous, often leaving a fugacious, membranous (collar-like) annulus that can be moved over the stem. The spore deposit is black.

NATURAL HABITAT: Common along roadsides, near debris piles, in lawns and in barnyards during the late summer and fall.



Figures 147-150 - Four day developmental sequence of *Coprinus comatus* fruiting in a tray of compost.

C. comatus - Growth Parameters

Mycelial Types: Linear to cottony, zonate-cottony mycelia; whitish in color.

Spawn Medium: Rye grain. See Chapter III.

Fruiting Substrate: Composted wheat straw enriched with horse and/or chicken manure, adjusted to 70% moisture content. Also, pasteurized chopped wheat straw supports fruitings of this species. Garcha *et al*. (1979) reported that composts having the distinct scent of ammonia after Phase II supported the greatest fruitings of *Coprinus comatus*.

Method of Preparation: See Chapters V & VI on the preparation of compost and straw. Pasteurization achieved through exposure to live steam for 2 hours at 140°F. Compost or straw should be filled to a depth of 6-12 inches.

Spawn Run:

Relative Humidity: 90-100%.
Substrate Temperature: 76-80°F.
Duration: 8-12 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0-1 per hour.

Type of Casing: After fully run, cover with the standard casing whose preparation is described in Chapter VIII. Layer to a depth of 1-2 inches. The casing should be balanced to a pH of 7.0-7.5.

Post Casing/Prepinning:

Relative Humidity: 90-100%.
Bed Temperature: 76-80°F.
Duration of Case Run: 10-12 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0-1 per hour.

Primordia Formation:

Relative Humidity: 95-100%.
Bed Temperature: 65-67°F.
Air Temperature: 62-65°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 4 per hour.
Light: Natural daylight or grow-light recommended on a 12 hour on/off cycle.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 62-65°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 4 per hour.
Flushing Interval: 7-10 days.
Harvest Stage: Directly before the gills begin to deliquesce.
Light: Natural daylight or grow-light on a 12 hour cycle on/off cycle

Yield Potential: Average commercial yields are 2-3 lbs/sq.ft. over a 4 week cropping period. Maximum yield potential has not yet been established.

Moisture Content of Mushrooms: 92-94% water; 6-8% dry matter.

Nutritional Content: 25.4 % protein (dry weight).

Comments: Like many other species in this genus, *Coprinus comatus* is a thermotolerant mesophile that often appears in compost piles. This mushroom was first grown in quantity at the Dutch Mushroom Research Station using the same compost, casing and environmental parameters as for the cultivation of *Agaricus brunnescens*. The authors have grown this species on compost prepared for *Agaricus* and on straw alone, although fruitings appear more substantial on the former.

Coprinus comatus is edible and choice. However, the crops are difficult to keep because of the early onset of deliquescence. By submerging mushrooms in water, deliquescence is slowed and mushrooms remain in good condition for several days after picking.

Extracts from fresh specimens of this species has been shown to have antibiotic properties, similar to those from *Lentinus edodes*.

Genetic Characteristics: Basidia tetrapolar (4-spored), forming haploid spores; heterothallic. Clamp connections present. See Chapter XV.

For further information consult: P.J.C. Vedder 1978, "*Modern Mushroom Growing*", Educaboek, Culemborg, Netherlands. (English edition available from Swiss American Spawn Company, Inc., Madisonville, Texas).

SPECIES: *Flammulina velutipes* (Curt. ex Fr.) Sing.

= *Collybia velutipes* (Curt. ex Fr.) Kumm.

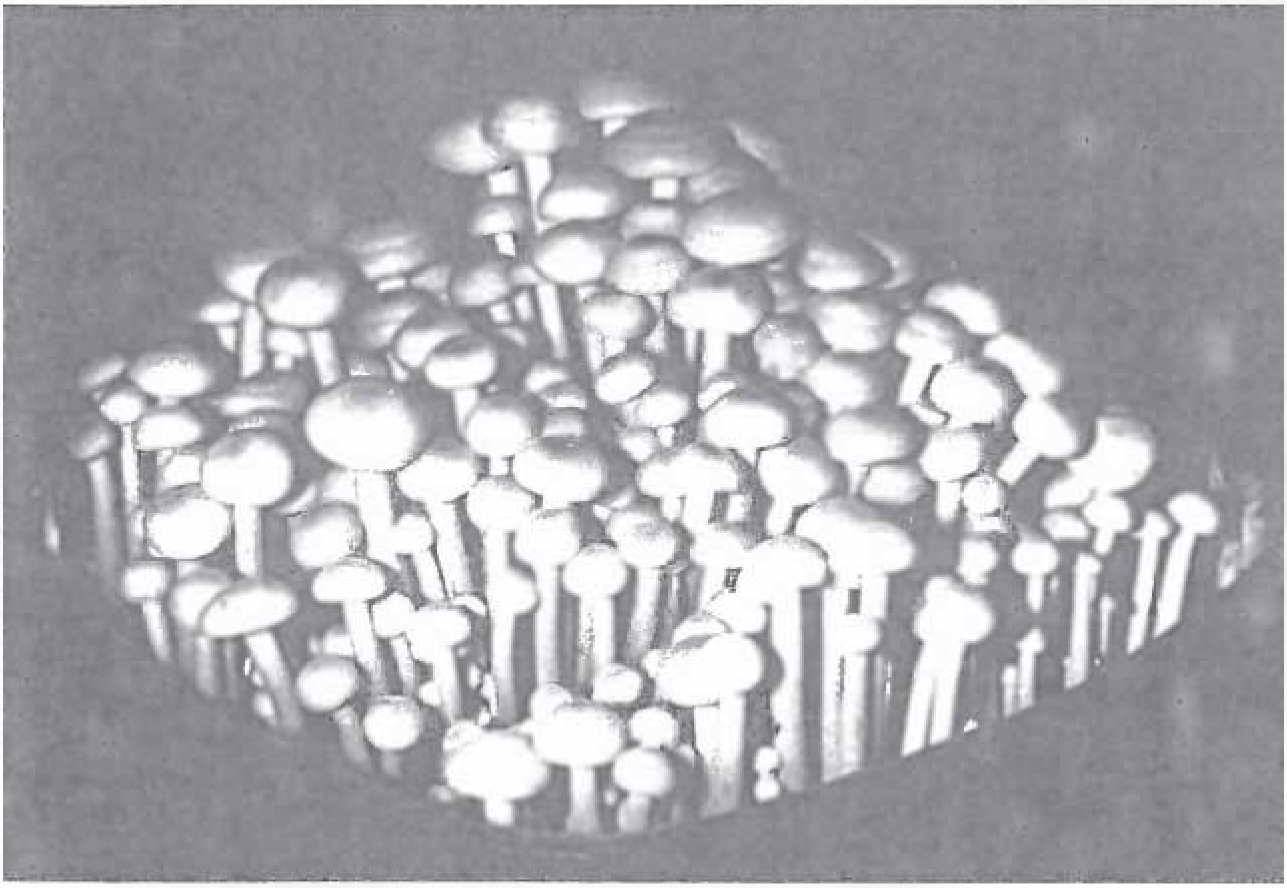


Figure 151 - *Flammulina velutipes* fruiting in tray.

STRAINS: Many wild and domesticated strains of *F. velutipes* are available from commercial and private stocks. (See Appendix). The Japanese have remained at the forefront of Enoke cultivation with two popular commercial strains, "Maruei" and "Ebios".

COMMON NAME: Enoke; Winter Mushroom; or Velvet Stem.

LATIN ROOT: *Flammulina* comes from the latin word "flammeus" or flame colored for the yellowish orange to reddish orange color of the cap. The species epithet *velutipes* is the conjunction of two latin words, the adjective "velutinus" meaning covered with fine hairs and the noun "pes" or foot.

GENERAL DESCRIPTION: Caps typically small, reddish orange to reddish brown, at first hemispherical, soon plane. The cap margin is often irregularly shaped. The gills are yellowish tinged. In wild collections, the stem is densely fibrillose, velvety, short and tough. In culture, however, the stems are long and smooth. A partial veil is absent. Its spores are whitish in mass.

NATURAL HABITAT: Common across the North American continent and in other temperate to boreal regions of the world. Thriving on woody tissue, especially living trees and considered a cold weather mushroom.

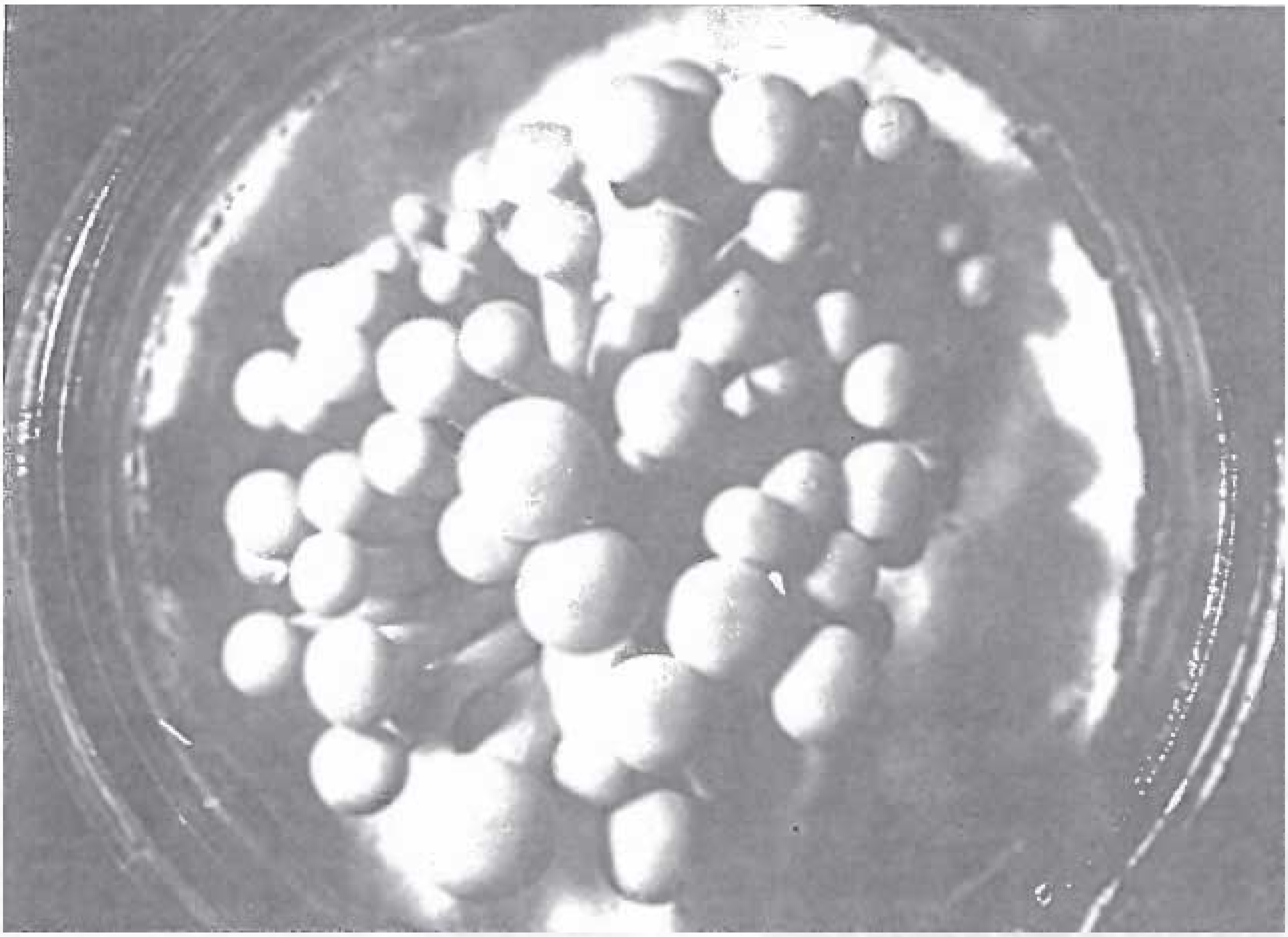


Figure 152 - Developing pinheads of *Flammulina velutipes*.

F. velutipes - Growth Parameters

Mycelial Types: Linear to cottony mycelia, sometimes aerial.

Spawn Medium: Sawdust/bran. One liter (1000 ml.) bottle of spawn inoculates 50-160 (800 ml.) containers. See Chapter III.

Fruiting Substrate: A 80-90% hardwood sawdust and 10-20% rice bran medium. Newly chipped sawdust holds moisture poorly and some Japanese growers age the sawdust for several years before using. Standard fruiting containers are quart mason jars or 800 ml. small mouthed plastic bottles. Some growers are currently experimenting with the cultivation of this species on bulk substrates in trays. Adjust moisture content of substrate to 58-60%.

Method of Preparation: See Chapter III for the preparation of sawdust/bran media. A 4:1 volumetric ratio of sawdust to bran (equivalent to a mass ratio of 10:1 sawdust to bran) is recommended. Sterilize for 1-2 hours at 250°F. (15 psi).

Spawn Run:

Relative Humidity: 90-100%.
Substrate Temperature: 72-77°F.
Duration: 20-30 days using standard methods; 12-13 days using in vitro inoculation methods.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Type of Casing: None required.

Primordia Formation:

Relative Humidity: 85%.
Air Temperature: 50-55°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 4 per hour.
Light: None needed.

Cropping:

Relative Humidity: 85%.
Air Temperature: 50-55°F.
Duration: 2-3 weeks.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 4 per hour.
Light: Natural daylight or grow-light on a 12 hour cycle on/off cycle.
Flushing Interval: 10 days.

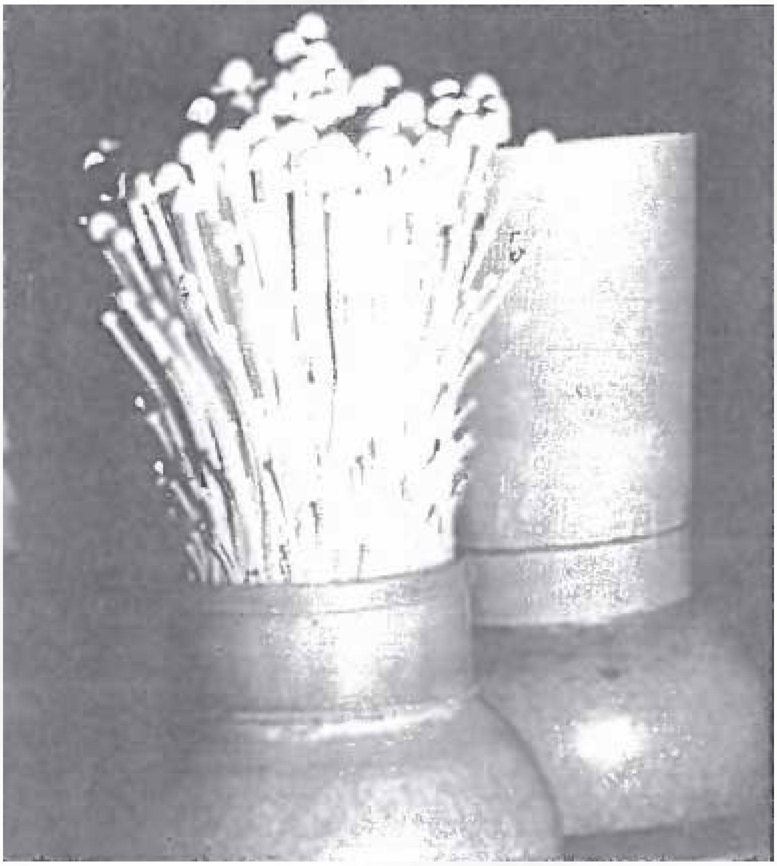


Figure 153 - *Flammulina velutipes* fruiting in plastic jar.

Yield Potential: Average commercial yields are 160-220 grams per 800 ml. bottle. Maximum yields are nearly 600 grams per 800 ml. bottle.

Moisture Content of Mushrooms: 92% water; 8% dry matter.

Nutritional Content: Reports vary from 18% to 31% protein (dry weight); 107 milligrams of niacin per 100 grams dry weight. F. Zadrazil (1979) found that colonization of straw by this species decreases its digestibility for use as fodder. This contrasts with the effects of *Pleurotus* and *Stropharia rugoso-annulata* whose presence on straw markedly increases its digestibility. Like many wood degrading fungi, an anti-tumor antibiotic has been isolated from *F. velutipes* and is appropriately called flammulin.

Comments: *F. velutipes* tends to form mycelial "pellets" soon after colonizing a substrate. This phenomenon makes liquid culture techniques more difficult. Japanese researchers found that the addition of 5% corn starch and 2% malt to a liquid solution inhibits the formation of these troublesome pellets. Curiously, fruitings on sawdust/bran beds can be precipitated when pieces of a fruitbody are added to this solution. Shiio *et al*. (1974) found that one could induce the early formation of fruitbodies with a technique whereby fresh pieces of *Flammulina velutipes* are mixed directly into liquid spawn and then introduced into the sawdust/bran medium. Not only was the fruiting process accelerated, the spawning period was cut in half and yield was nearly quadrupled over a year's time. Using this same technique with *Pleurotus ostreatus*, yields were increased over and above the norm by a factor of three. Total production in either case, equalled as much as ¼ of the substrate on a dry weight basis. An analogous technique was developed by Urayama (1972) who discovered that cell-free extracts of fresh *F. velutipes* mushrooms introduced to cultures of distantly related species caused fruitbody formation.

Genetic Characteristics: Basidia tetrapolar (4-spored), forming haploid spores; bifactorially heterothallic. Single spore isolates capable of producing sterile fruitbodies. Dikaryons are faster growing and characterized by clamp connections. Mycelium can produce oidia, self sectioning chains of cells with similar functions as spores. See Chapter XV.

For further information consult: H. Tonomura, 1974. "*Flammulina velutipes*" in *The Biology and Cultivation of Edible Mushrooms*. Academic Press, New York.

SPECIES: *Lentinus edodes* (Berk.) Sing.

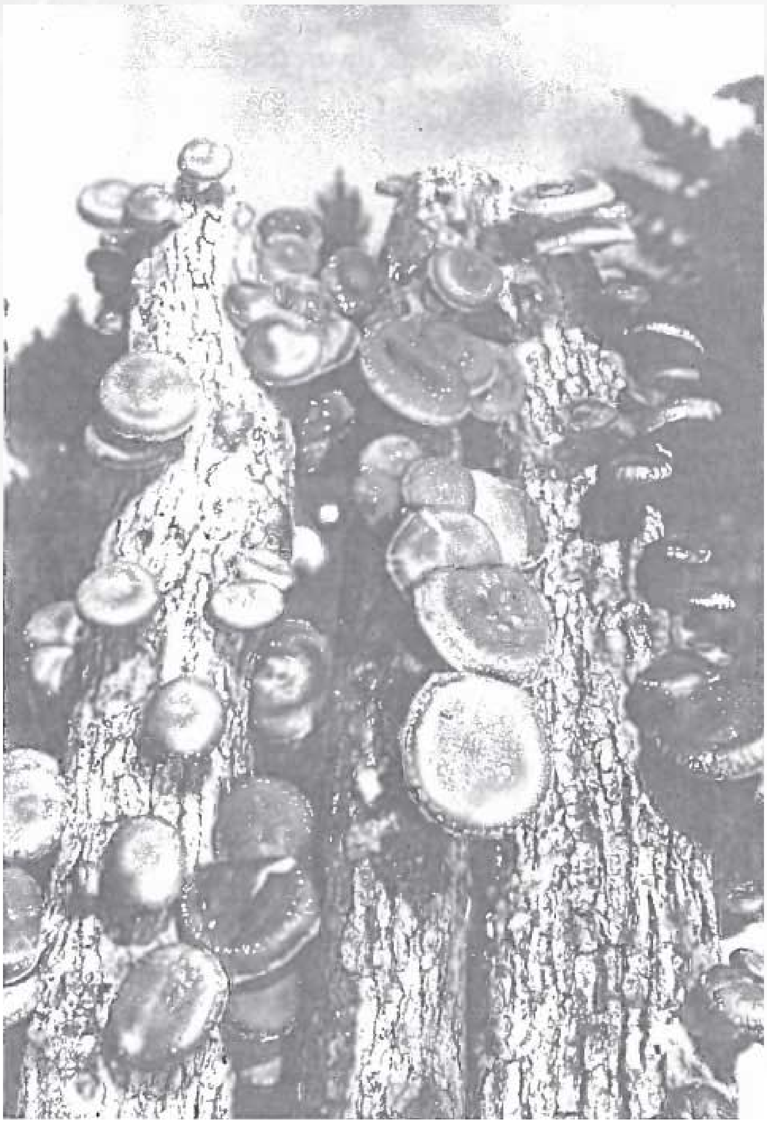


Figure 154 - *Lentinus edodes*, the shiitake mushroom, fruiting on oak logs.

STRAINS: Numerous strains of *Lentinus edodes* are available from commercial and private stocks. The American Type Culture Collection, which sells cultures to educational organizations and research facilities, has stock cultures of several wild and domesticated strains. Strains are often distinquished by their preferences for fruiting in colder or warmer temperature zones.

COMMON NAMES: The Shiitake Mushroom; The Japanese Black Mushroom; and The Chinese Black Mushroom. (The name shiitake comes from the association of this mushroom to the shiia tree, a member of the genus *Pasania*).

LATIN AND GREEK ROOTS: *Lentinus* comes from "lentis" or lens-shaped for the form of the cap and *edodes* signifies the edibility of this species.

GENERAL DESCRIPTION: Cap pale to dark reddish brown, convex, becoming broadly convex to nearly plane in age. The cap margin is typically inrolled when young. The cap surface is covered with whitish veil remnants, especially along the margin. The flesh is firm, pliant, easily drying and reconstituting. The gills are whitish, close to crowded, often with serrated edges. The stem is centrally attached to the cap, short, very tough and adorned with scattered fibrillose remnants of the partial veil. Its spores are whitish in mass.

NATURAL HABITAT: A wood decomposer, typically saprophytic. *Lentinus* species are common on the dead tissue of deciduous trees, mainly Fagaceae (oak, chestnut, shiia [*Pasania*] and beech). In nature, they particularly prefer oaks. Fruiting in the fall, early winter and spring, this species is indigenous to Japan, China and other countries in the temperate zone of the Indo-China region.

L. edodes - Growth Parameters

Mycelial Types: Rhizomorphic to linear.

Spawn Medium: Pre-soaked wooden dowels or a 4:1 sawdust/bran mixture. See Chapter III.

Fruiting Substrate and Method of Preparation: Oak or alder logs, 4-6 inches in diameter, are sawed into 3 foot lengths. These logs should be cut in the spring or fall to maximize sap content and can be inoculated immediately. (Some growers prefer to season their logs in shaded, open air stacks for one month prior to inoculation). Before inoculating, logs should be cleaned of any lichen or fungal growths.
Alternative fruiting substrates include alder or oak sawdust and bran mixed 4:1 with a moisture content of 60% and sterilized at 15 psi for 1-1½ hours. Fortified rye grass straw has also been used as a sterile fruiting medium. (See Chapter III).

Spawn Run:

Relative Humidity: 60-75% for logs; 90% for sawdust.
Substrate Temperature: Fast growth at 77°F. (Temperatures above 95°F. and below 41°F. stop mycelial growth).
Duration: 6-12 months for cut logs; 30-60 days for sawdust blocks.
CO_2: None established; no controls needed using these methods.
Fresh Air Exchanges: Stacks in open air sufficient. (Recent innovations show that logs stacked in a vertical configuration and covered with straw and plastic to maintain even temperatures result in faster spawn running in an outdoor environment. Within a controlled greenhouse, the logs need not be covered. The contact between the log surfaces should be minimized to prevent competitor molds and lichens from forming).
pH Optima: 5-6.
Light: None required.

Type of Casing: None needed.

Pinhead Initiation:

Initiation Technique: Submerge logs and blocks in cold water for 24-72 hours.
Relative Humidity: 95%.
Air Temperature: 59-68°F.
Duration: 7-14 days after soaking.
CO_2: Not applicable.
Fresh Air Exchanges: If within a greenhouse, 2-4 per hour.
Light: Ambient natural light or optimally 10 lux in the 370-420 nanometer range.

Cropping:

Relative Humidity: 85-90%.
Air Temperature: 59-68°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 2-4 per hour or sufficient to meet CO2 and/or cooling requirements.
Duration: 3-5 years on oak logs; 2-3 years on alder.
Harvest Stage: Directly before the incurved margin straightens and the cap expands to plane.
Flushing Interval: Outdoor methods generate 2 flushes per year (fall and spring); indoor methods can produce up to 4 flushes depending on the soaking/initiation schedule.
Light: Same as above.

Yield Potential: Average commercial yields are 2-3 lbs (fresh weight) of mushrooms per log.

Moisture Content of Mushrooms: 85% water; 15% dry matter.

Nutritional Content: 10.0-17.5% crude protein (dry weight) and 55 milligrams of niacin per 100 grams dry weight.

Comments: Compounds in this mushroom have anti-cholesterol effects. Chihara (1979) reported that lentinan, a water soluble polysacharide in *L. edodes*, was "found to almost completely regress the solid type tumors of sarcoma-180 and several kind (sic) of tumors...". The work of others (Cochran, 1978; Tokita *et al*., 1972; Tokuda and Kaneda, 1979) have similarly described the beneficial properties of this fungus. (See Appendix III).

Although the standard method of cultivation involves oak logs, recent experiments employing sawdust or rye grass based "synthetic" mixtures have proved that *Lentinus edodes* can be grown on a variety of substrates. In a recent article, Han et alia (1981) report the results of growth experiments with shiitake mini-logs composed of 90% broadleaf sawdust, 10% rice bran and 0.2% $CaCO_3$. Supplements that increased mycelial growth more than rice bran were yeast powder (2.0%), soybean meal (5.0%), milk powder (2.0%) and molasses (1.5%). The fastest mycelial growth occurred when the moisture content of the logs was balanced to 50-60%. In tests on fruiting and yield the following data were compiled:

> Once mycelial growth is complete, highest yields were achieved if the vegetative cycle was prolonged 4-12 weeks, with the maximum yield at 12 weeks.
> At pin initiation, water bath periods of 48-72 hours increased the moisture content of the logs by 5-15% and yields by 50%.
> Cooling the logs for eight days at 60-62°F. following 48 hours of soaking gave the highest yields.
> Using 0.1 % N hydrochloride to adjust the pH of the water bath from 4.5-7.0, a pH of 5.0 produced the most primorida and mature mushrooms.
> At a light intensity of 550 lux, yields were highest. The addition of the hormones NAA (5ppm), gibberellin (l0ppm), ethylene chlorohydrin (2000x) and colchicine (8000x) as well as yeast powder (0.1%) to the water bath increased yields.

Nevertheless, the traditional log method remains the most commercially feasible at this time and the one best suited to home cultivation.

Genetic Characteristics: Basidia tetrapolar, forming four haploid spores; heterothallic. Dikaryons with clamp connections. See Chapter XV.

For more information consult:

H. Akiyama *et al.*, 1974. "*The Cultivation of Shii-ta-ke in a Short Period*". Mushroom Science IX, pp. 423-433.
T. Ito, 1978. "*Cultivation of Lentinus edodes*" in *The Biology and Cultivation of Edible Mushrooms* Ed. by S.T. Chang, pp. 461-473.
R. Kerrigan, 1982. "*Is Shiitake Farming for You?*" Far West Fungi, Santa Cruz.
Y.H. Han, W.T. Veng and S. Cheng, 1981. "*Physiology and Ecology of Lentinus edodes (Berk) Sing*." Mushroom Science XI, Melbourne.

SPECIES: *Lepista nuda* (Bull. ex Fr.) Cooke

= *Clitocybe nuda* (Fr.) Bigelow and Smith
= *Tricholoma nudum* (Fr.) Kummer

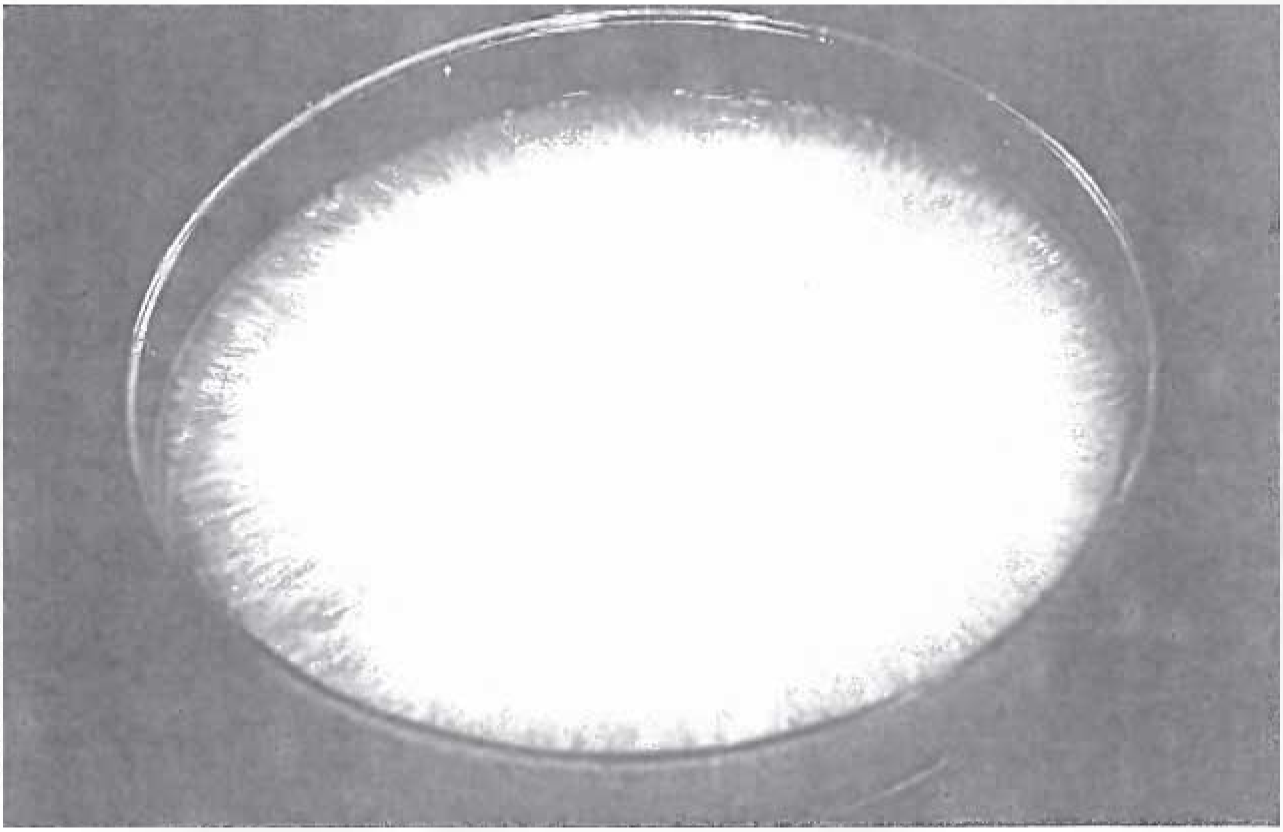


Figure 155 - Mycelium of *Lepista nuda*.

STRAINS: Available from commercial and private stocks. The American Type Culture Collection has several strains. Although few spawn companies sell strains of *L. nuda*, tissue and spore cultures are easily obtained from wild specimens. Nevertheless, there are a limited number of productive strains currently in circulation.

COMMON NAME: The Blewit.

LATIN AND GREEK ROOTS: *Lepista* comes from the greek "lepis" which means scale. On the other hand, the species epithet nuda comes from "nudus" or naked. The name *Lepista nuda* constitutes a contradition of terms, literally translating as the scaly smooth mushroom.

GENERAL DESCRIPTION: Cap typically violet when fresh, becoming buff brown in drying; smooth, without hairs; dry; convex or broadly convex to plane in age. The cap margin is inrolled or incurved when young and simply decurved at maturity. The gills are a pale violet color, sometimes developing brownish hues in age and are adnexed or ascending in their attachment to the stem. The stem is equal overall but bulbous at the base and covered with fine fibrils over much of its surface. Fruifbodies can be moderately large when mature. A partial veil is absent. The spore deposit is pale pinkish tan.

NATURAL HABITAT: Commonly occurring in the summer to late fall across much of the temperate regions of North America and Europe. This species is found in and around decomposing piles of sawdust, in conifer duff, amongst leaves and in mature compost piles.

L. nuda - Growth Parameters

Mycelial Types: Linear to cottony and usually with purplish to violet hues. (See Color Photo 3).

Spawn Medium: A 4:1 sawdust/bran mixture or rye grain spawn. See Chapter III.

Fruiting Substrates: Horse manure/straw compost mixed with 10% fresh straw at spawning; leaf mulch/sawdust mixtures.

Spawn Run:

Relative Humidity: 90+%.
Substrate Temperature: Fastest growth at 70-75°F. Temperature maxima and minima: 40°F. and 86°F. respectively.
Duration: 25-60 days for complete colonization.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.
Light: Incubation in total darkness.

Type of Casing: Standard peat based casing. An option is the addition of shredded leaf material and activated charcoal to 10% of total mass. Balance to a pH of 7.0.

Pinhead Initiation:

Relative Humidity: 95%.
Air Temperature: 55-65°F.
Duration: 7-14 days.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Light: Ambient natural light or optimally 10 lux in the 370-420 nanometer range. (Light requirements have not yet been established for this species, and until that time, light stimulation should be presumed as a prerequisite for fruiting.)

Cropping:

Relative Humidity: 85-90%.
Air Temperature: 55-65°F.
Duration: 24-52 weeks.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Harvest Stage: While the mushroom caps remain convex.
Flushing Interval: 10-14 days.
Light: Same as above.

Yield Potential: Data very limited. Yields of one and a quarter pounds per square foot in 14 weeks have been reported by Visscher (1981). (Recent studies show that yields can be increased substantially, although no maxima have yet been established.)

Moisture Content of Mushrooms: 88-90% water; 10-12% dry matter.

Nutritional Content: No data available.

Comments: Several contradictions about the fruiting requirements for this species are apparent. Although

Wright and Hayes (1979) reported that immature horse manure/straw composts supported the most vigorous mycelial growth, the work of previous researchers indicates that the best fruitings occurred on "spent" compost that has been colonized for a year or more. Fruitbodies also form on spawned leaf mulch mixed with sawdust. The fruiting mechanism may, in part, be controlled by bacterial flora associated with leaf mulch and the decomposition process.

Singer (1963) reported that mycelium implanted in beds of horse manure/straw compost for 7-14 months produced mushrooms directly after the appearance of rhizomorphs. J. Garbaye *et al*. (1979) published data indicating that the supplementation of natural patches with a NPKCa mineral fertilization induced large fruitings of *L. nuda* as well as *Boletus edulis* and *Lepiota rachodes*, two unrelated species of culinary distinction.

Alexander Smith (1980) remarks that this mushroom should not be eaten raw, but only after cooking. European books have reported that this mushroom contains thermobile hemolysin, a compound that degenerates red blood cells. Although this mushroom has been responsible for scattered poisonings when quantities have been eaten, the effects have been relatively minor and the toxin is easily destroyed by cooking or parboiling. *Lepista nuda* is, however, a mushroom with many positive attributes. Its striking color, firm texture and good taste recommend this species as one of high culinary appeal.

Some commercial production of *L. nuda* is ongoing in Europe. Nevertheless, this mushroom is not, as of yet, a species with yields substantial enough to warrant commercial production in this country. It is a mushroom more suited to the interests of home cultivators and natural culture techniques.

Genetic Characteristics: Basidia tetrapolar, forming four haploid spores; heterothallic. Dikaryons with clamp connections. See Chapter XV.

For more information consult:

S.H. Wright and W.A. Hayes, 1979. "*Nutrition and Fruit body Formation of Lepista Nuda (Bull. ex Fr.) Cooke*", pp. 873-884 in Mushroom Science X, Part I. Bordeaux.

J. Garbaye et alia, 1979. "*Production De Champignons Comestibles En Foret Par Fertilisation Minerale-Premiers Resultats Sur Rhodopaxillus Nudus*". pp. 811-816 in Mushroom Science X, Part I. Bordeaux.

M. Vaandrager and H.R. Visscher, 1981. *Experiments on the Cultivation of Lepista Nuda, the Wood Blewit*", pp. 749-759 in Mushroom Science XI, Australia.

SPECIES: *Panaeolus cyanescens* Berkeley and Broome

= *Copelandia cyanescens* (Berk. & Br.) Sing.

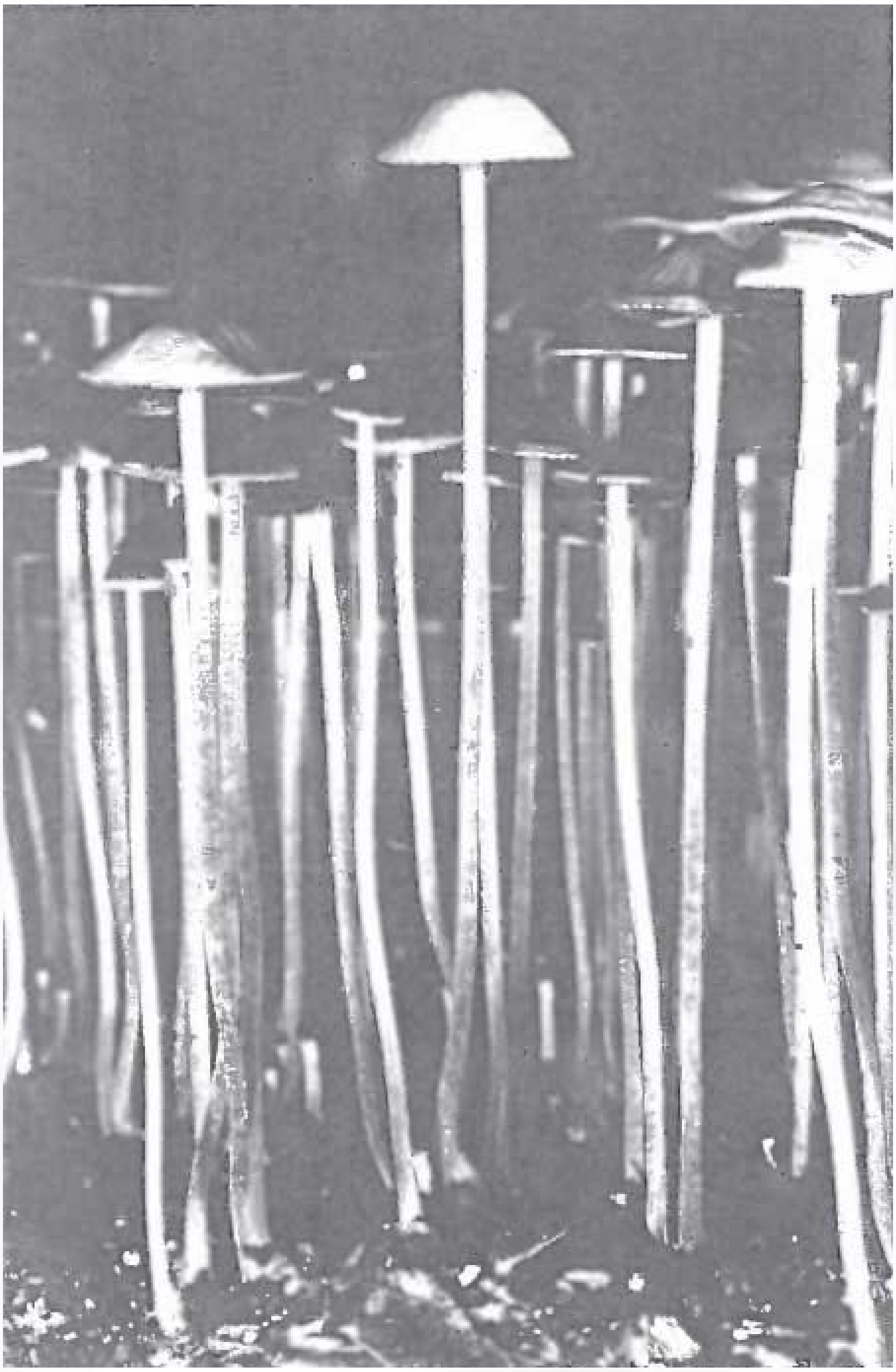


Figure 156 - *Panaeolus cyanescens* fruiting on cased straw.

STRAINS: Hawaiian. Mexican.

COMMON NAME: Pan cyan.

GREEK ROOT: *Panaeolus* is Greek for "all variegated", in reference to the spotted appearance of the gills. The species name *cyanescens* comes from "cyaneus" or blue for the color the flesh becomes upon bruising.

GENERAL DESCRIPTION: Cap 15-40 mm. broad. Hemispheric to campanulate to convex or broadly convex at maturity. The margin is initially shortly translucent striate when wet, opaque when dry. The cap is light brown at first, becoming pallid grey in drying, eventually pallid to white, often covered with spores. The gills are adnexed in their attachment, close, thin, with two or three tiers of intermediate gills and mottled grayish black at with spore maturity. The stem is 85-120 long x 15-30 mm. thick and equal to bulbous at the base, tubular, often grayish towards the apex, pale yellowish overall, and flesh colored to light brown towards the base. The flesh readily turns bluish where bruised. A partial veil is absent. Its spores are dark violet-black.

NATURAL HABITAT: Scattered to numerous on dung, in well manured grounds, grassy areas, meadows, or pastures. Known from Hawaii and Mexico. Two other Panaeoli, close to *P. cyanescens* macroscopically and microscopically, grow in western Washington and in Florida.

P. cyanescens - Growth Parameters

Mycelial Types: Linear to cottony mycelia; white to off-white, sometimes bruising bluish where injured.

Spawn Medium: Rye grain. See Chapter III.

Fruiting Substrates: Pasteurized wheat straw; horse manure/straw compost.

Method of Preparation: Chopped wheat straw pasteurized in a hot water bath at 160° for 20-30 minutes, cooled and spawned or horse manure/straw compost prepared according methods outlined in Chapter V.

Spawn Run:

Relative Humidity: 90+%.
Substrate Temperature: 79-84°F.
Duration: 7-12 days.
CO_2: 10,000 ppm or higher.
Fresh Air Exchanges: 0 per hour.

Type of Casing: Standard peat based casing whose preparation is described in Chapter VIII. Layer to a depth of ½-1 inch.

Post Casing/Pre-pinning:

Relative Humidity: 90+%.
Substrate Temperature: 79-84°F.
CO_2: 10,000 ppm or above.
Fresh Air Exchanges: 0 per hour.
Light: Incubation in darkness.

Primordia Formation:

Relative Humidity: 95+%.
Air Temperature: 75-80°F.
CO_2: 5,000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Light requirements: Diffuse natural or fluorescent grow-lights.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 75-80°F.
CO_2: 5,000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Harvest Stage: When the caps are convex.
Flushing Interval: 5-7 days.
Light: Diffuse natural or grow-lights.

Yield Potential: Not yet established.

Moisture Content: 90-92% water; 8-10% dry matter.

Comments: This rapidly growing species fruits readily on pasteurized straw provided a thin layer of casing is applied (½ inch). No more than one week passes from the time of casing to the first flush. Although the fruitbodies are small, the flushes are typically abundant. The degree of bluing seems to vary with the strain and substrate.

SPECIES: *Panaeolus subbalteatus* Berkeley and Broome

= *Panaeolus venenosus* Murrill

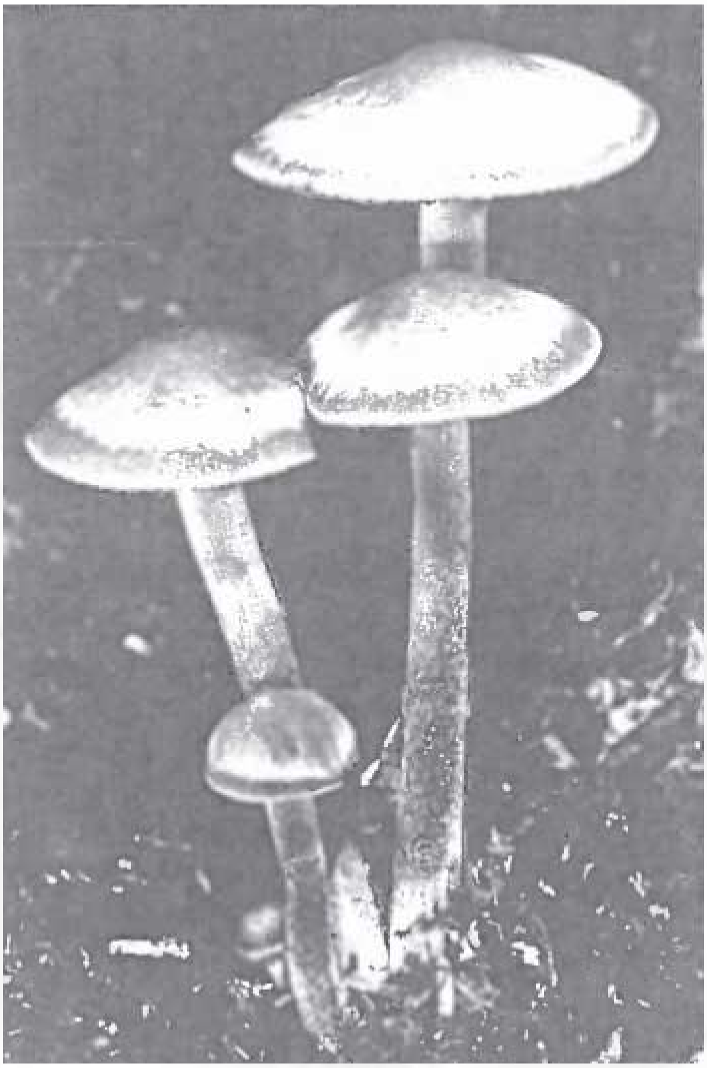


Figure 157 - *Panaeolus subbalteatus* fruiting outdoors on horse manure-wood chip compost.

STRAINS: Fruiting strains are easily obtained from wild specimens.

COMMON NAME: The Belted Cap *Panaeolus*.

GREEK ROOT: *Panaeolus* is Greek for "all variegated" in reference to the spotted appearance of the gills. The species name *subbalteatus* comes from the conjunction of the prefix "sub-" meaning almost or somewhat and "balteatus" or belt-like, for the characteristic color zonation that forms along the margin of the cap in drying.

GENERAL DESCRIPTION: Cap 35-50 mm. broad at maturity. The cap is convex to campanulate, then broadly convex and finally expanding to nearly plane with a broad umbo. The color is cinnamon brown to orangish cinnamon brown, fading to tan in drying with a dark brown encircling zone along the cap margin. The gills are attached to the stem, broader at the center and with three tiers of intermediate gills inserted. The gill color is brownish and spotted, with the edges remaining whitish, becoming blackish overall from spore maturity. The stem is 50-60 mm. long by 4 mm. thick at maturity and is brittle, hollow, fibrous, and enlarges towards the base. The color is reddish toned beneath a fine sheath of minute whitish fibrils, darkening downwards or when touched. The stem base often bruises bluish. On the cap, bluing is rarely seen.

NATURAL HABITAT: Scattered to numerous on stable leavings from horses; in horse dung; or in well manured grounds. This species is widely distributed across the North American continent and throughout temperate regions of the world.

P. subbalteatus - Growth Parameters

Mycelial Types: Cottony mycelia noted; whitish to off-white in color.

Spawn Medium: Rye grain.

Fruiting Substrate: Horse manure compost, pasteurized wheat straw.

Method of Preparation: Horse manure/straw compost or pasteurized wheat straw prepared according to methods outlined in Chapters V & VI respectively.

Spawn Run:

Relative Humidity: 90+%.
Substrate Temperature: 80-86°F.
Duration: 7-12 days.
CO_2: 10,000 ppm or higher.
Fresh Air Exchanges: 0 per hour.

Type of Casing: Casing optional. If used, make up a standard peat based casing whose preparation is described in Chapter VIII. Layer to a depth of ½ to 1 inch.

Post Casing/Pre-pinning:

Relative Humidity: 90%.
Substrate Temperature: 80-86°F.
CO_2: 10,000 ppm or above.
Fresh Air Exchanges: 0 per hour.
Light: Incubate in darkness.

Primordia Formation:

Relative Humidity: 95+%.
Air Temperature: 75-80°F.
CO_2: 5,000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Light: Diffuse natural or grow-lights.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 75-80°F.
CO_2: 5,000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Harvest Stage: When the caps have expanded to nearly plane.
Light: Diffuse natural or grow-lights.

Yield Potential: Not yet established.

Moisture Content: 90-92% water; 8-10% dry matter.

Comments: *Panaeolus subbalteatus* is a fast running and an early fruiting mushroom that easily grows in controlled environments. Possessing low levels of psilocybin and/or psilocin, the fruitbodies are small compared to other cultivated mushrooms. Hence, it has not been as popular with home cultivators as for instance, *Psilocybe cubensis*.

Given the fact that *Panaeolus cyanescens* fruits well on pasteurized wheat straw, *Panaeolus subbalteatus* is likely to fruit on that substrate as well. Pollock (1977) fruited this species on cased crimped oat spawn. Undoubtedly, *Panaeolus subbalteatus* can be grown on a wide variety of substrates.

Short term "natural culture" of this mushroom is also possible although yields are much lower than those attained in a controlled indoor growing environment. Horse manure/straw compost arranged in outdoor beds can be inoculated with mycelium from wild patches or grain spawn can be used.

Panaeolus subbalteatus is considered a "weed mushroom" by commercial *Agaricus* growers and its presence suggests under-composting and/or excessive moisture. This species once had the reputation, albeit undeserved, of being poisonous - thus the synonym *Panaeolus venenosus*.

SPECIES: *Pleurotus ostreatus* (Jacq. ex Fr.) Kummer

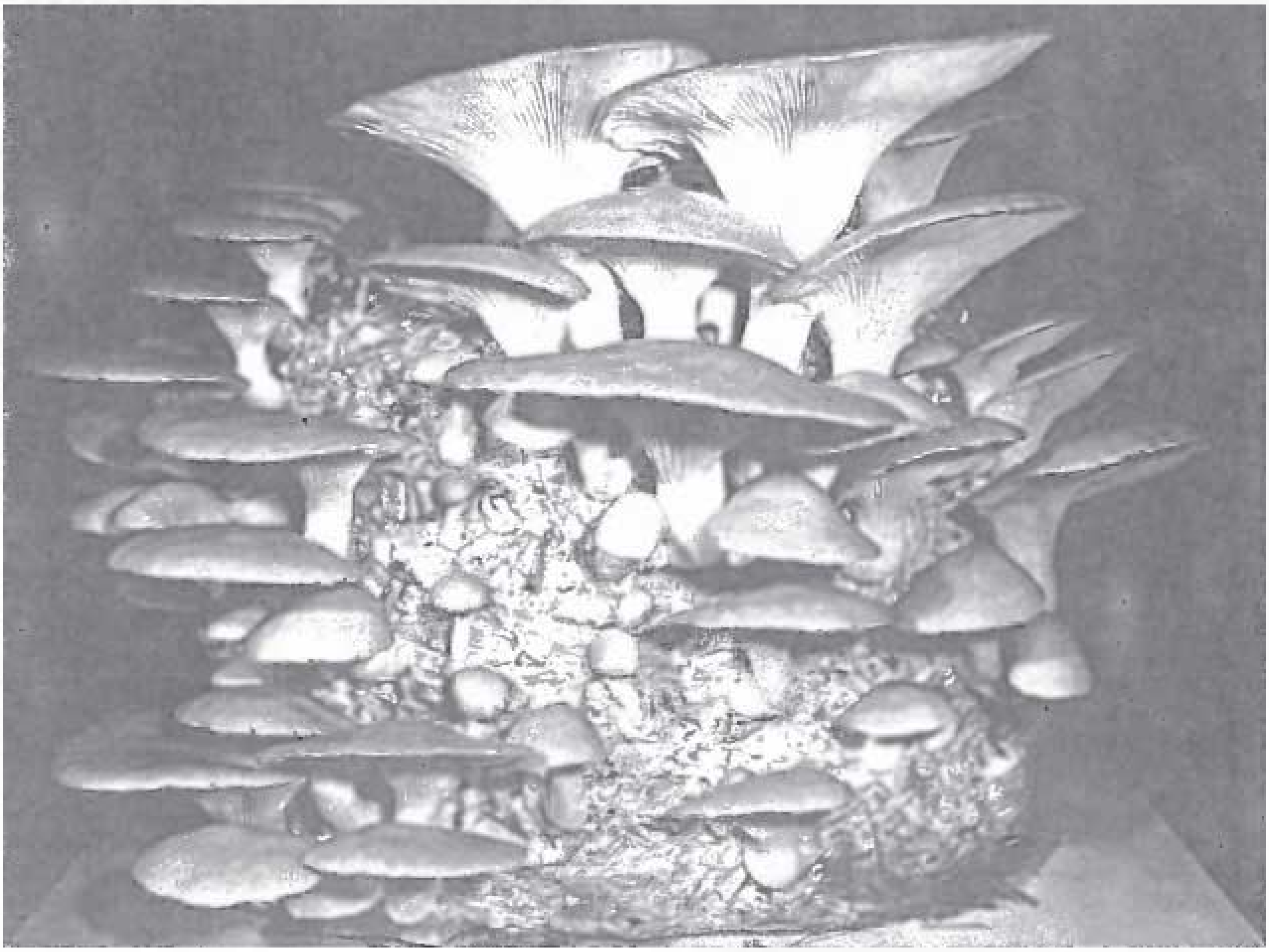


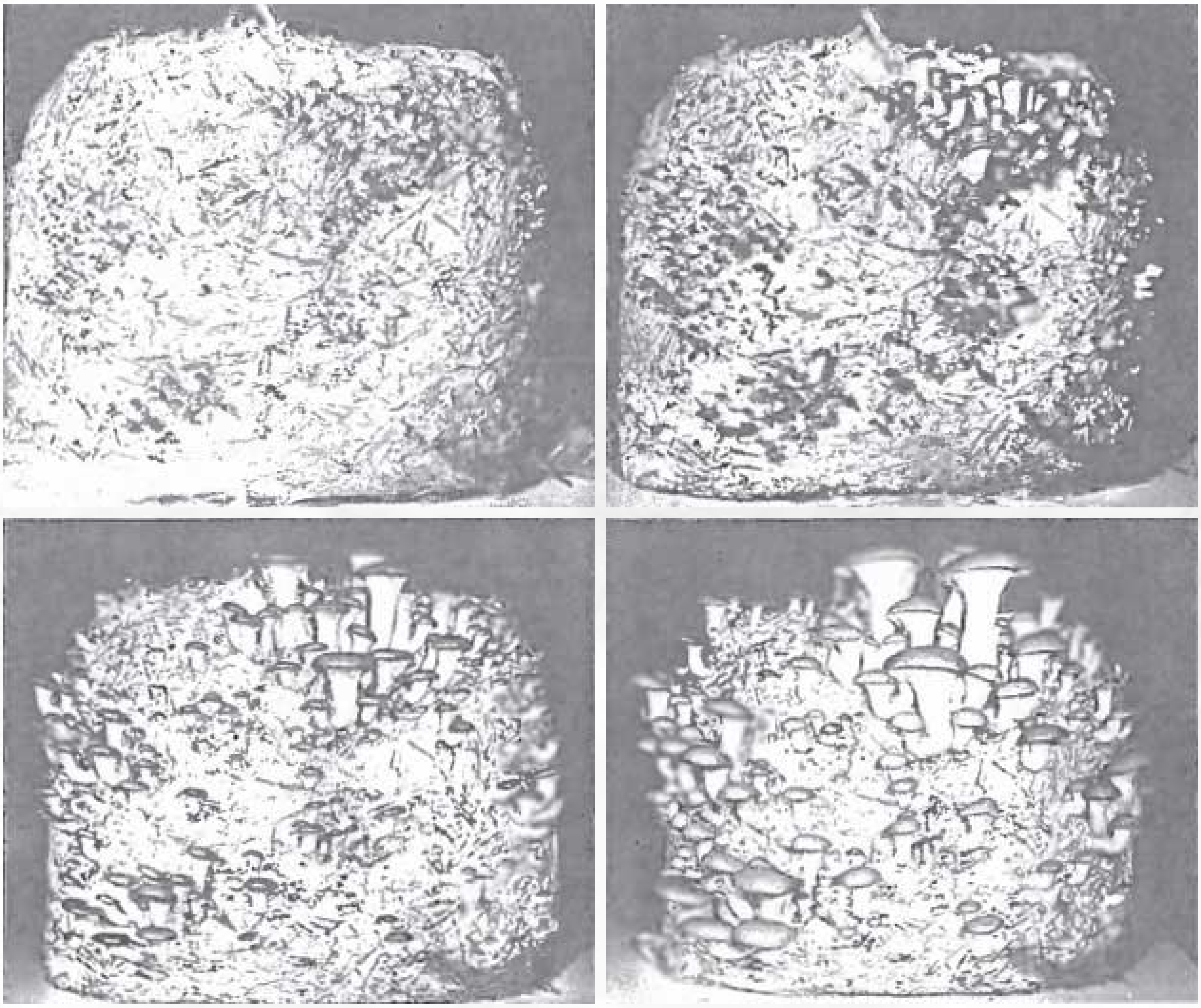
Figure 158 - Fully mature *Pleurotus ostreatus* mushrooms fruiting on straw.

STRAINS: Strains of *Pleurotus ostreatus* are available from commercial and private stocks. The American Type Culture Collection, which sells cultures to educational organizations and research facilities, has stock cultures of several wild and domesticated strains. Somycel's-3004 is the standard strain used by the European *Pleurotus* industry and is synonymous with ATCC's-38546.

COMMON NAME: The Oyster Mushroom.

LATIN AND GREEK ROOTS: *Pleurotus* comes from the greek "pleuro" which means formed laterally or in a sideways position, referring to the lateral position of the stem relative to the cap. The species epithet *ostreatus* refers to its oyster shell-like appearance and color.

GENERAL DESCRIPTION: Cap tongue shaped, maturing to a shell shaped form, 50-150 mm. in diameter; whitish to gray to blue gray overall. (Color is a light determined factor in this species). The flesh is thin and white. The margin is even and occasionally wavy. The gills are white, decurrent and broadly spaced. The stem is attached in an off-centered fashion and is short at first and absent in age. Its spores are whitish to lilac gray in mass.



Figures 159-162 - Four day developmental sequence of *Pleurotus ostreatus* fruiting on wheat straw.

NATURAL HABITAT: A wood decomposing, saprophytic or parasitic fungus. *Pleurotus ostreatus* grows abundantly on standing and fallen alder, cottonwood and maple. This species is especially numerous in river valleys and fruits in the fall, early winter and spring across much of temperate North America.

P. ostreatus - Growth Parameters

Mycelial Types: Fast growing rhizomorphic to linear mycelia noted. Color is typically whitish.

Spawn Medium: Rye grain. See Chapter III.

Fruiting Substrate and Method of Preparation: Cereal straw (normally wheat) balanced to a 75% moisture content. The straw, chopped or whole, is pasteurized by submerging in a 160°F. water bath for 30-45 minutes. An alternative method utilizes live steam pasteurization at 140°F. for 6 hours. In Japan, *Pleurotus* is grown on a mixture of hardwood sawdust and bran (4 parts to 1, 65% moisture and a pH of 6.8-7.0). This mixture is sterilized for 1-2 hours at 15 psi. Being a primary decomposer, *Pleurotus* grows on a wide variety of cellulosic wastes.

Spawn Run:

Relative Humidity: 90-100%.
Substrate Temperature: Fastest growth at 78-84°F. Thermal death occurs if mycelium is held above 104°F. for 48 hours.
Duration: 10-14 days for complete colonization.
CO_2: 20,000 ppm or 20% CO_2 by volume. (Growth is stimulated up to 28,000 ppm).
Fresh Air Exchanges: 0 per hour.
Light: Incubation in total darkness.

Type of Casing: None needed.

Pinhead Initiation:

Relative Humidity: 95%.
Air Temperature: 55-60°F.
Duration: 7-14 days.
CO_2: less than 600 ppm.
Fresh Air Exchanges: 4 per hour.
Light: Phototropic, most responsive to an exposure of 2,000 lux/hour for 12 hours/day. Grow-lux type fluorescent lighting is recommended. Diffuse natural light is sufficient.
Watering: Regular misting once to twice daily until fruitbodies are 30-40% of harvest size and then water as needed to prevent caps from cracking.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 60-64°F.
Duration: 5-7 weeks.
CO_2: less than 600 ppm.
Fresh Air Exchanges: 4-6 per hour or sufficient to meet CO_2 and/or cooling requirements.
Harvest Stage: Directly before incurved margin elevates to plane.
Flushing Interval: 10 days.
Light: Same as above.
Watering: Regular misting to prevent caps from cracking and to keep resting pinheads viable.

Yield Potential: Average commercial yields are 1 kilogram fresh weight of mushrooms per kilogram of dry weight of straw substrate.

Moisture Content of Mushrooms: 91% water; 9% dry matter.

Nutritional Content: Crude protein has been reported at 30.4 % of dry weight and 109 milligrams of niacin per 100 grams dry weight.

Comments: Biologically, *Pleurotus ostreatus* efficiently utilizes its substrate. Its ability to fruit on a single component substrate, to permeate the straw rapidly while tolerating high carbon dioxide levels and to produce abundant crops within a short time period, make *Pleurotus* ideal for home cultivation.

Of concern to cultivators growing in enclosed rooms is the abundant spore load generated by this species. *Pleurotus* spores cause allergic reactions amongst some workers and mycophagists. Sporeless strains are therefore desirable and are the object of current research. Eger (1974) noted the possibility that heavy spore concentrations from *Pleurotus* farms could infect surrounding woodlands.

Pleurotus ostreatus var. *florida*, a warmth loving relative, is also cultivated in Europe (Hungary) and shares many of the growth properties of *Pleurotus ostreatus*.

Genetic Characteristics: Basidia tetrapolar, producing 4 haploid spores; heterothallic. Clamp connections present. See Chapter XV.

For more information consult: F. Zadrazil, 1974. "*The Ecology and Industrial Production of Pleurotus ostreatus, Pleurotus florida, Pleurotus cornucopiae, and Pleurotus eryngii*" in Mushroom Science IX (Part I), The Mushroom Research Institute, Japan.

SPECIES: *Pleurotus ostreatus* (Jacq. ex Fr.) Kummer (Florida variety)

= *Pleurotus ostreatus* var. *florida* nom. prov. Eger
= *Pleurotus floridanus* Singer

STRAINS: Most strains of this mushroom originate from wild specimens cultivated in 1958 by S.S. Block of Gainesville, Florida. Eger compared the Florida strains with *Pleurotus ostreatus* from Michigan (supplied by Alexander Smith) and found them to be identical in form, taste, color and odor. Spore size and shape are also the same. Monokaryons arising from single spore germinations are completely cross fertile, suggesting that these two mushrooms are not separate species, but different strains within the same species.

The American Type Culture Collection, which sells cultures to educational organizations and research facilities, lists this mushroom under *Pleurotus ostreatus* as number #38538. This strain is Block's original. Eger returned to Florida with San Antonio in 1977 and recollected four more strains of *Pleurotus*, three of which were deposited with ATCC. They are respectively: F1 = ATCC #38539; F2 = #38540; F4 = #38541.

The Florida *Pleurotus* is available as commercial spawn from Somycel as #3025. The Swiss American Spawn Company sells a "low spore load" strain called P-3.

COMMON NAME: Pleurotus Florida. The Florida Pleurotus.

LATIN AND GREEK ROOTS: *Pleurotus* comes from the Greek "pleuro" which means formed laterally or in a sideways position, referring to the lateral position of the stem relative to the cap. The epithet Florida obviously refers to the locality where this mushroom was first collected.

GENERAL DESCRIPTION: Cap tongue shaped, maturing to a shell shaped form, 50-100 mm. in diameter; whitish to gray to pale yellow brown. (Color is a light and temperature determined factor in this species). The flesh is thin and white. The margin is even and occasionally wavy. The gills are white, decurrent and broadly spaced. The stem is attached in an off-centered fashion and is short at first and absent in age. Its spores are whitish to lilac gray in mass.

NATURAL HABITAT: A wood decomposing, saprophytic or parasitic fungus. *Pleurotus ostreatus* grows abundantly on standing and fallen alder, cottonwood and maple. This species is especially numerous in river valleys and fruits in the fall, early winter and spring in subtropical environs.

P. ostreatus (Florida variety) - Growth Parameters

Mycelial Types: Fast growing rhizomorphic to linear mycelia. Its color is typically whitish.

Standard Spawn Medium: Rye grain. See Chapter III.

Fruiting Substrate and Method of Preparation: Cereal straw (normally wheat) balanced to a 75% moisture content. The straw, chopped or whole, is pasteurized by submerging in a 160°F. water bath for 20-30 minutes. An alternative method utilizes live steam pasteurization at 140°F. for 6 hours.

In Japan, *Pleurotus* is grown on a mixture of hardwood sawdust and bran (4 parts to 1,65% moisture and a pH of 6.8-7.0). This mixture is sterilized for 1 hour at 15 psi. Being a primary decomposer, *Pleurotus* grows on a wide variety of wastes high in cellulose.

Spawn Run:

Relative Humidity: 90-100%.
Substrate Temperature: Fastest growth at 82-86°F. Thermal death occurs if mycelium is held above 104°F. for 72 hours.
Duration: 10-14 days for complete colonization.
CO_2: 20,000 ppm or 20% CO_2 by volume. (Growth is stimulated up to 28,000 ppm).
Fresh Air Exchanges: 0 per hour.
Light: Incubation in total darkness.

Type of Casing: None needed.

Pinhead Initiation:

Relative Humidity: 95%.
Air Temperature: 72-77°F.
Duration: 7-14 days.
CO_2: less than 600 ppm.
Fresh Air Exchanges: 4 per hour.
Light: Positive phototropism has been firmly established. 2,000 lux/hours for 12 hours/day is most stimulatory. Grow-lux type fluorescent lighting is recommended. Diffuse natural light is sufficient.
Watering: Regular misting (once to twice daily) of the substrate until the fruitbodies are 30-40% of harvest size.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 72-77°F.
Duration: 4-5 weeks.
CO_2: less than 600 ppm.
Fresh Air Exchanges: 4-6 per hour or sufficient to meet CO_2 and/or cooling requirements.
Harvest Stage: Directly before incurved margin expands to plane.
Flushing Intervals: 10 days.
Light: Same as above.
Watering: Misting recommended to prevent cracking of caps and to prevent resting primordia from drying.

Yield Potential: Average commercial yields for *Pleurotus ostreatus* var. *florida* are 1 kilogram fresh weight of mushrooms per kilogram of dry weight of straw substrate. *Pleurotus ostreatus* var. *florida* produces more mushrooms within a shorter period of time while attaining a similar total yield per dry pound of substrate than does *Pleurotus ostreatus*.

Moisture Content of Mushrooms: 91 % water; 9% dry matter.

Nutritional Content: Crude protein has been reported at 30.4% of dry weight and 109 milligrams of niacin per 100 grams dry weight.

Comments: The Floridan *Pleurotus ostreatus*, a warmth loving variety, is popular with growers in Europe (Hungary, France and Germany) and shares many of the growth characteristics of *Pleurotus ostreatus*. Its preference for warmer climes recommends this species for cultivation during the late spring through early fall whereas *P. ostreatus* is ideal for winter cultivation.

This mushroom, like its close cousin *P. ostreatus*, is perfect for the home cultivator. But, the Floridan *Pleurotus ostreatus* has a distinct advantage over *P. ostreatus* in that a "cold shock" is not needed for pinhead formation and the period from initiation to first flush is only 10 days compared to 20 days for *P. ostreatus*. Its ability to fruit on a singular substrate, to permeate the straw rapidly while tolerating high CO_2 levels and to produce abundant crops within a short time frame, makes *Pleurotus* an excellent species for small scale cultivation.

The taxonomy of this "species" is unsettled and contradictory. Dr. Rolf Singer places *P. floridanus* in the Section Lentodiellum whose species are characterized by deeply rooted metuloid pleurocystidia (sterile surface cells on the gill having incrustations) and have mycelia that do not sclerotize. On the other hand, he assigns *Pleurotus ostreatus* to the type section *Pleurotus* which lacks metuloid pleurocystidia and has hyphae that undergoes sclerotization. Since monokaryons from single spores are compatible between these two mushrooms, and because sporulating fruitbodies form as a result of their mating, it seems clear that these two mushrooms are one species sharing a common genetic heritage.

Of concern to cultivators is the abundant spore load produced by this mushroom, most noticeable within an enclosed growing environment. Some people suffer allergic reactions when coming into contact with *Pleurotus* spores. A small fraction of mycophagists are unable to eat *P. ostreatus* and allies without stomach upset. Hence, when eating these mushrooms for the first time, small portions are recommended.

Genetic Characteristics: Basidia tetrapolar, producing 4 haploid spores; heterothallic. Clamp connections present. See Chapter XV.

For more information consult:

F. Zadrazil, 1974. "*The Ecology and Industrial Production of Pleurotus ostreatus, Pleurotus florida, Pleurotus cornucopiae, and Pleurotus eryngii*" in Mushroom Science IX (Part I). The Mushroom Research Institute, Japan.
F. Zadrazil, 1978. "*Cultivation of Pleurotus*" in *The Biology and Cultivation of Edible Mushrooms* ed. by S.T. Chang and W.A. Hayes. Academic Press, New York.
I. Heltay, 1980. "*Pleurotus florida Production in Borota, Hungary*". Mushroom Journal, London.

SPECIES: *Psilocybe cubensis* (Earle) Singer

= *Stropharia cubensis* Earle.
= *Stropharia cyanescens* Murr.
= *Stropharia caerulescens* (Pat.) Sing.
= *Naematoloma caerulescens* Pat.
= *Hypholoma caerulescens* (Pat.) Sacc. & Trott.

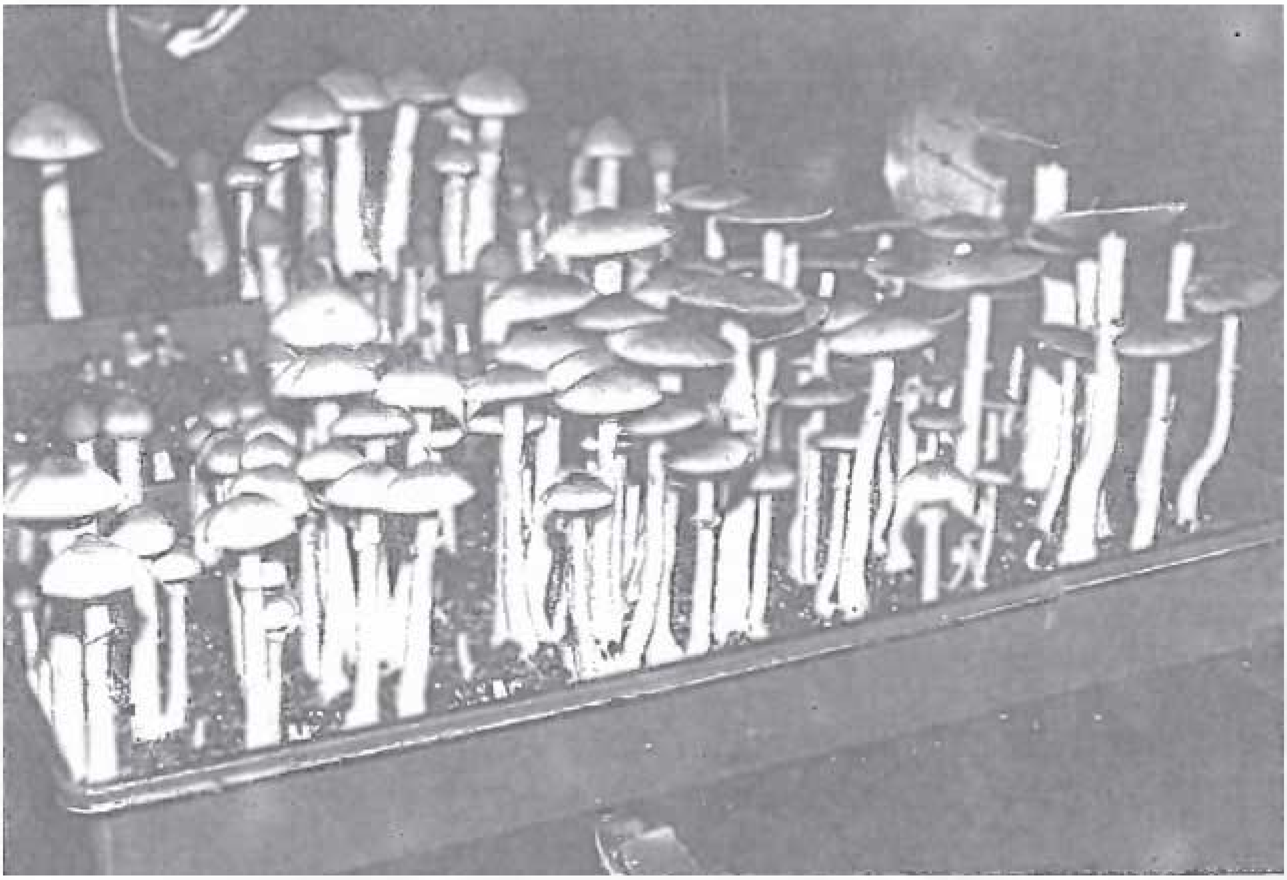


Figure 163 - *Psilocybe cubensis* fruiting on cased grain.

STRAINS: Strains of *Psilocybe cubensis* are available from private and commercial stocks. The American Type Culture Collection, which sells cultures to educational organizations and research facilities, has stock cultures of several wild strains. Note that the strains listed below are only some of those that are presently circulating. There are many more. Some strains may originate from the same region but have features not in agreement with those described here.

Amazonian: Medium to large mushrooms on rye grain; thick whitish stems; tenaciously attached to the casing.

Ecuadorian: Medium sized mushrooms on rye grain; hemispheric caps; abundant primordia former; high yielding on compost; thin whitish stems; easily picked.

Matias Romero: Medium to large mushrooms on rye grain; early fruiter; thick whitish stems and tenaciously attached.

Misantla: Medium sized mushrooms on rye grain; thin yellowish stems; tall standing and easily picked.

Palenque: Large mushrooms on rye grain; high yielding; and easily picked.

COMMON NAMES: San Isidro; Cubensis.

GREEK ROOT: *Psilocybe* comes from the Greek root "psilos" meaning bald head and *cubensis*, a name Earle assigned to this mushroom because it was first recognized as a new species from specimens collected in Cuba.

GENERAL DESCRIPTION: A medium to large size mushroom having a cap that becomes convex to plane in age and is usually pigmented chestnut brown to deep yellowish or golden brown. The cap surface is finely fibrillose, sometimes covered with scattered, fugacious, cottony scales that soon disappear. The partial veil is membranous, well developed and typically leaving a persistent annulus on the upper regions of the stem. The stem is often longitudinally striate, powdered above the annulus and often covered with dense fibrils below. Flesh bruising bluish or bluish green. Its spores purplish brown in mass.

NATURAL HABITAT: Naturally found in horse and cow pastures, in dung or in soil enriched with manure. *Psilocybe cubensis* is a widely distributed species that is found throughout tropical and subtropical zones of the world and is common in the pasturelands of the gulf coast of the southern United States and eastern Mexico.

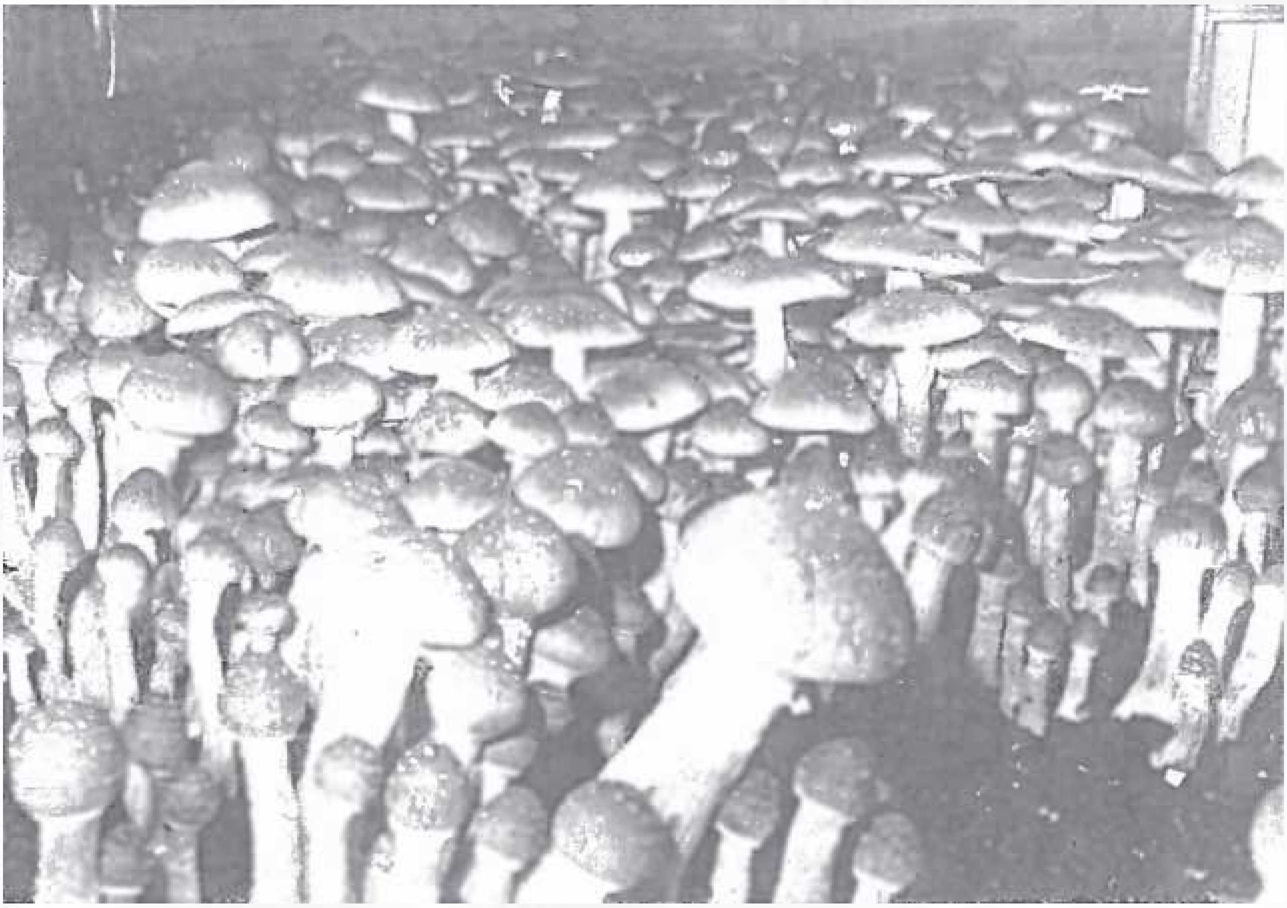


Figure 164 - *Psilocybe cubensis* fruiting on cased straw.

P. cubensis - Growth Parameters

Mycelial Types: Rhizomorphic to linear; whitish in overall color but often bruising bluish where injured.

Standard Spawn Medium: Rye grain. See Chapter III.

Fruiting Substrate: Rye grain; wheat straw; leached horse or cow manure; and/or horse manure/straw compost balanced to a 71-74% moisture content.

Method of Preparation: See Chapters III, V, and VI. Pasteurization achieved through exposure to live steam for 2 hours at 140°F. throughout the substrate. Straw or compost should be filled to a depth of 6-12 inches. Straw should be spawned at a rate of 2 cups/sq. ft.

Spawn Run:

Relative Humidity: 90%.
Substrate Temperature: 84-86°F. Thermal death limits have been established at 106°F.
Duration: 10-14 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Type of Casing: After fully run, cover with the standard casing whose preparation is described in Chapter VIII. Layer to a depth of 1-2 inches. The casing should be balanced to an initial pH of 6.8-7.2.

Post Casing/Prepinning:

Relative Humidity: 90+%.
Substrate Temperature: 84-86°F.
Duration of Case Run: 5-10 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.
Light: Incubation in total darkness.

Primordia Formation:

Relative Humidity: 95-100%.
Air Temperature: 74-78°F.
Duration: 6-10 days.
CO_2: less than 5000 ppm.
Fresh Air Exchanges: 1-3 per hour.
Light: Diffuse natural or exposure for 12-16 hours/day of grow-lux type fluorescent light high in blue spectra at the 480 nanometer wavelength. (See Chapters IV and IX).

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 74-78°F.
CO_2: less than 5000 ppm.
Fresh Air Exchanges: 1-3 per hour.
Flushing Pattern: Every 5-8 days.
Harvest Stage: When the cap becomes convex and soon after the partial veil ruptures.
Light: Indirect natural or same as above.

Yield Potential: Average yields are 2-4 lbs./sq.ft. over a 5 week cropping period. Maximum yield potential has not been established.

Moisture Content of Mushrooms: 92% water; 8% dry matter.

Nutritional Content: Not yet established.

Comments: One of the easiest mushrooms to grow, this species fruits on a wide variety of substrates within broad environmental parameters. As a primary and secondary decomposer, *Psilocybe cubensis* fruits well on untreated pasteurized straw and on horse manure/straw composts transformed by microbial activity. Sterilized grain typically produces smaller mushrooms than bulk substrates. Given the numerous substrates that support fruitings, *Psilocybe cubensis* is well suited for home cultivation.

Psilocybe cubensis cultivation was unheard of twenty years ago. Today, this species ranks amongst one of the most commonly cultivated mushrooms in the U.S. and soon the world. This sudden escalation in interest is largely due to the publication of several popular guides illustrating techniques for its culture.

Psilocybe cubensis is a mushroom with psychoactive properties, containing up to 1% psilocybin and/or psilocin per dried gram. The function of these serotonin-like compounds in the life cycle of the mushroom is not known.

Genetic Characteristics: Basidia tetrapolar (4-spored), forming haploid spores (1N); heterothallic. The mating of compatible monokaryons often results in fruiting strains. Clamp connections are present. See Chapter XV.

For further information consult: Oss, O.T. and O.N. Oeric, 1976. "*Psilocybin: Magic Mushroom Grower's Guide*" And/Or Press, Berkeley.

SPECIES: *Psilocybe cyanescens* Wakefield

= *Geophila cyanescens* (Maire) Kuhn. & Romagn.
= *Psilocybe mairei* Singer

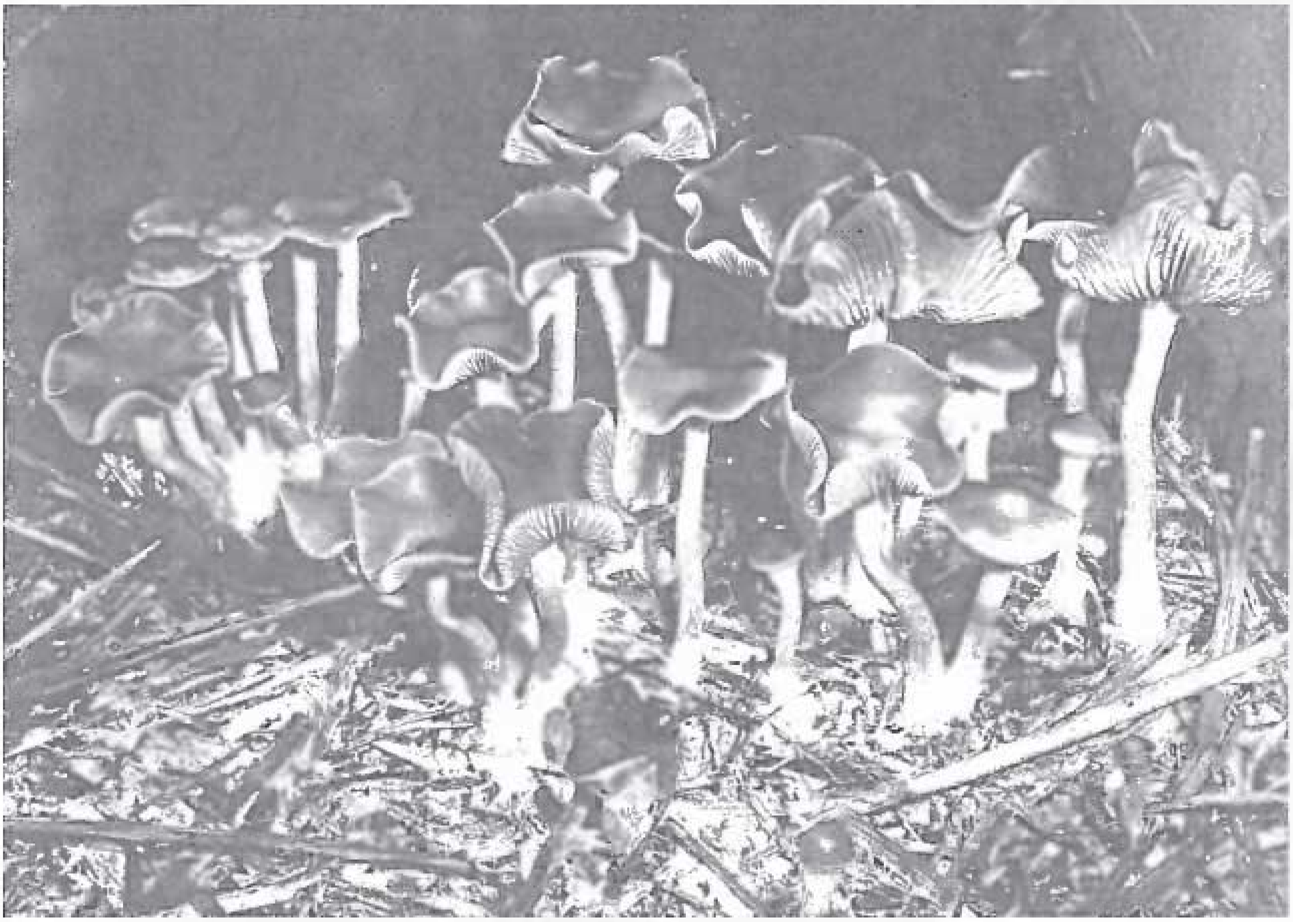


Figure 165 - Psilocybe cyanescens fruiting indoors in a tray of alder chips.

STRAINS: St. Clair.
Many wild strains can be adapted to cultivation.

COMMON NAMES: Cyan; Grandote.

GREEK AND LATIN ROOTS: *Psilocybe* comes from the Greek "psilos" or bald head. The species name *cyanescens* is from "cyaneus" or blue for the color reaction of the flesh upon bruising.

GENERAL DESCRIPTION: Cap 20-50 mm. broad, convex to broadly convex to plane in age with an elevated and undulating margin which is, in turn, translucent-striate. The cap surface is smooth and viscid when moist from a separable gelatinous pellicle ("skin"). The color is caramel brown, fading to yellow-brown to straw colored from the center. The gills are attached in an adnate to adnexed fashion, dull brown with whitish edges. The stem is 60-80 mm. long by 2-5 mm. thick, fibrous and enlarged towards the base. Its surface is smooth or powdered (pruinose). The stem color is whitish, silky and becomes blue where injured, with rhizomorphs protruding about the stem base. The partial veil is cortinate (cobweb-like), leaving little or no trace on the stem. Its spore print is dark purplish brown.

NATURAL HABITAT: Clustered in woody habitats; in soils high in the tissue of deciduous trees; or in tall rank grass. This species grows throughout the Pacific Northwest in areas well mulched by woody debris of deciduous and coniferous trees (typically not associated with bark). It has been reported from England and is thought to be broadly distributed throughout the European continent.

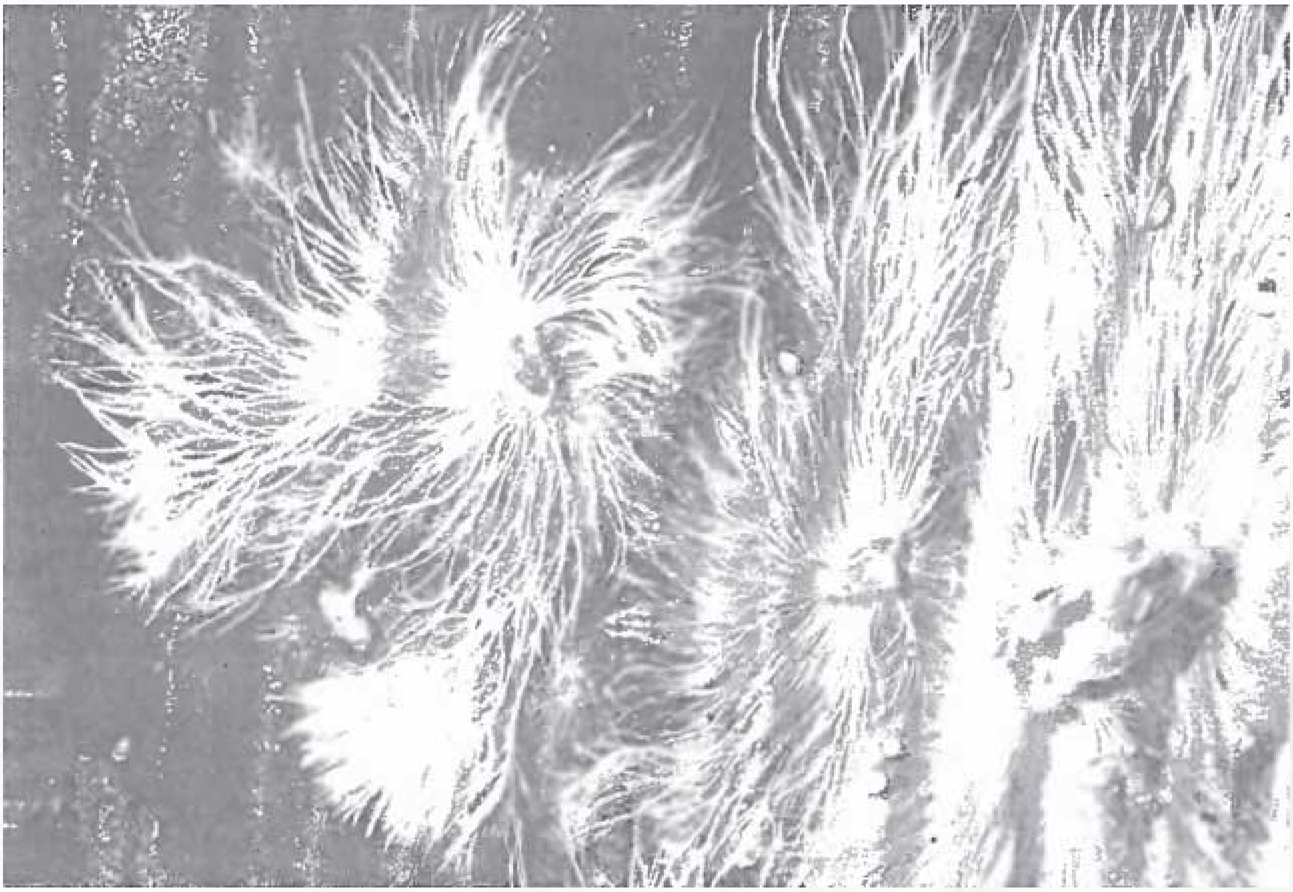


Figure 166 - *Psilocybe cyanescens* mycelium growing on soaked corrugated cardboard inoculated with grain spawn.

Psil. cyanescens - Growth Parameters

Mycelial Types: Rhizomorphic to closely linear; whitish in color.

Spawn Medium: Sawdust/bran or rye grain spawn.

Fruiting Substrate: A lignicolous species utilizing a number of wood types, most notably alder, maple and fir. It is able to grow on a wide variety of cellulosic wastes including newspaper and cardboard.

Method of Preparation: Branches and other small diameter wood are chipped into 1-3 inch pieces, preferably in the spring when the sap content is highest. This material is spawned with sawdust/bran (4:1) and made into prepared beds outdoors amongst ornamental shade plants (especially rhododendrons) or tall grass. Another method is to use sawdust/bran or rye grain spawn to inoculate soaked corrugated cardboard. When fully colonized, sheets of cardboard are laid at the bottom of trays which are then covered with a 2-4 inch layer of freshly cut alder chips. (Wood chips are far superior to sawdust as a fruiting substrate).

Spawn Run:

Substrate Temperature: 65-75°F.
Duration: 30-60 days.
Relative Humidity: 90+%

CO_2: 10,000 ppm or higher.
Fresh Air Exchanges: 0 per hour.

Type of Casing: None required.

Primordia Formation:

Relative Humidity: 95%.
Air Temperature: 50-60°F.
CO_2: 5000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Light requirements: Diffuse natural or grow-lights.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 50-60°F.
CO_2: 5000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Harvest Stage: When the caps become nearly plane.
Light: Diffuse natural or grow-lights.

Yield Potential: In natural outdoor culture on alder chips, 1 lb. wet weight per square foot in one growing season is easily obtained.

Moisture Content: 90-92% water; 8% dry matter in fruitbodies.

Comments: *Psilocybe cyanescens* is a primary decomposer, readily digesting newly cut alder and other deciduous woods. Considered the grandote of the Pacific Northwest, this species is both robust and potently psilocybian. Much sought after for its high psilocybin and psilocin content, it is a favored mushroom by those seeking entheogenic experiences.

Psilocybe cyanescens' adaptability to natural outdoor culture makes this species attractive to beginning and connoisseur cultivators alike. Virgin spawn can be collected from the wild and implanted in prepared beds (see Chapter VI) or spawn can be grown out on bran/sawdust or grain and inoculated directly onto unsterilized soaked corrugated cardboard. Grain spawn inoculated onto untreated wood chips is associated with a higher contamination rate than the same spawn implanted onto soaked cardboard, owing to the partial selectivity of the latter material.

Although fruitbodies can form on fresh sawdust, they do so reluctantly and belatedly. The fact that sawdust so readily loses its moisture may explain, in part, why *Psilocybe cyanescens* has difficulty fruiting on it.

Psilocybe cyanescens has a mycelium that is typically whitish and strandy (rhizomorphic). Tissue and spore cultures are easy to obtain. Outdoor colonies can be maintained for years with minimal effort and produce two to three flushes within a season.

See Color Photos 17 & 18.

SPECIES: *Psilocybe mexicana* Heim

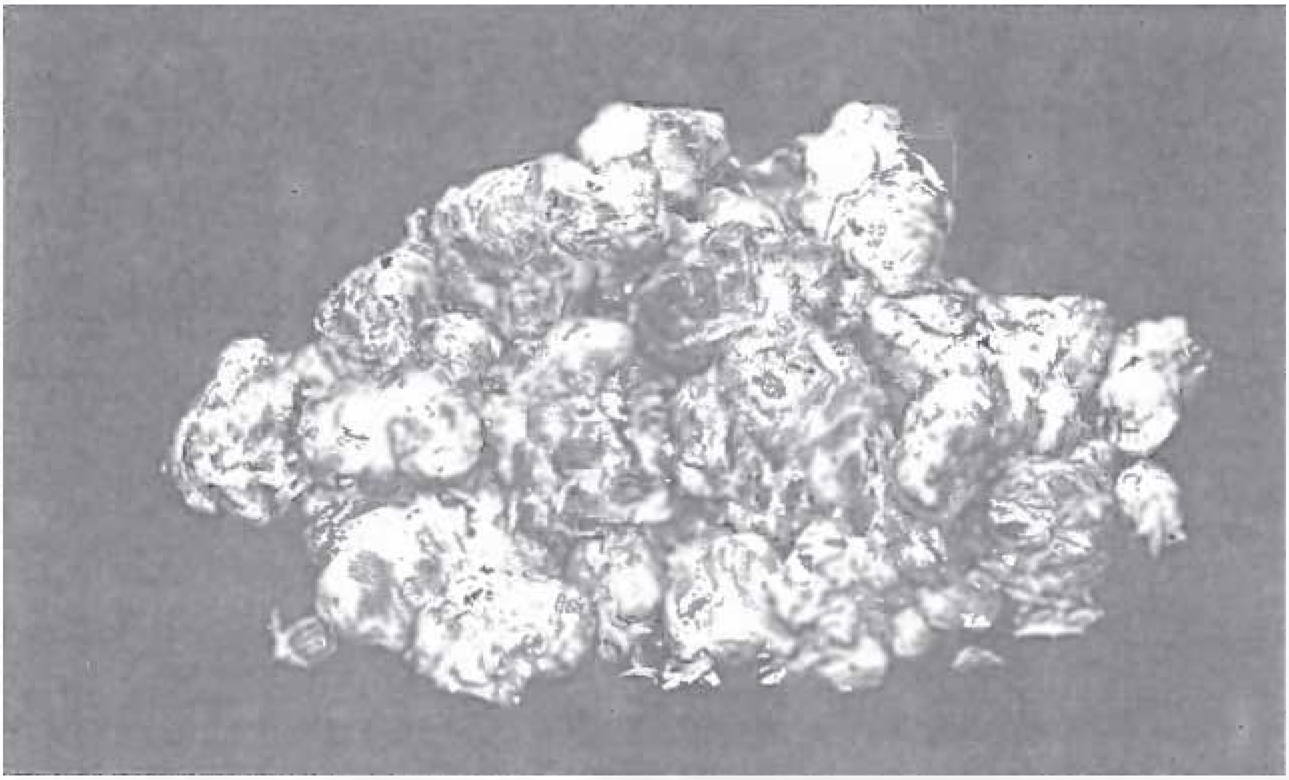


Figure 167 - Sclerotia of *Psilocybe mexicana* harvested from one cup of rye grass seed six weeks after inoculation.

STRAINS: Heim Strain,
Pollock Strain.

COMMON NAMES: Mushroom of the Gods; Teonanácatl or God's Flesh; Nize (Mazatec Name); and Pajaritos (Spanish Name).

GREEK ROOT: *Psilocybe* comes from the Greek "psilos" or bald head. The species name *mexicana* denotes the country in which this mushroom grows.

GENERAL DESCRIPTION: Convex to subumbonate, sometimes with a small umbo, expanding in age to plane or nearly so. The surface is smooth, translucent-striate two thirds to the disc. The cap color is brownish to orangish grey to straw brown, more yellowish to the disc. The gills are adnately attached, grey to dark purplish brown. The stem is equal, smooth, hollow, pale straw to brown to reddish yellow, darkening when injured but typically not bruising bluish. Its spores are dark violet brown in mass.

NATURAL HABITAT: Solitary to numerous in grassy areas, horse pastures and meadows although not occurring on dung. Distributed throughout subtropical regions in Mexico, common in the state of Oaxaca, and also known from Guatemala.

P. mexicana - Growth Parameters

Mycelial Types: Slightly rhizomorphic to finely linear; off-white to tan in color, sometimes with multicolored zones.

Spawn Media: Annual rye grass seed or rye grain.

Fruiting Substrates: Rye grass seed and to a lesser degree rye grain and pasteurized wheat straw. Few fruitbodies form on enriched malt agar media.

Method of Preparation: Rye grass seed combined with water in a 2:1 volumetric proportion, preferably soaked overnight and then sterilized for 1 hour at 15 psi. Wheat straw is pasteurized in a hot water bath at 160-170°F. for 30 minutes.

Spawn Run:

Relative Humidity: 90+%
Substrate Temperature: 75-81°F.
Duration: 10-14 days.
Relative Humidity: 90+%.
CO_2: 10,000 ppm or higher.
Fresh Air Exchanges: 0 per hour.

Type of Casing: Standard peat based casing whose preparation is described in Chapter VIII. Layer to a depth of ½-1 inch.

Post Casing/Pre-pinning:

Relative Humidity: 90+%.
Substrate Temperature: 75-81°F.
CO_2: 10,000 ppm or above.
Fresh Air Exchanges: 0 per hour.
Light: Incubation in darkness.

Primordia Formation:

Relative Humidity: 95+%.
Air Temperature: 71-74°F.
CO_2: 5,000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Light: Diffuse natural or fluorescent grow-lights for 12 hours daily.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 71-74°F.
CO_2: 5000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Harvest Stage: When the caps become nearly plane.
Light: Same as above.

Yield Potential: Not yet established. A petite mushroom. *Psilocybe mexicana* is an interesting species for the connoisseur. Because of the small stature of the fruitbody, one should expect low yields per square foot. Sclerotia formation on rye grass seed after two months is 50-70 grams per cup of seed.

Moisture Content: 90-92% water and 8% dry matter in fruitbodies; 70% water and 30% dry matter in sclerotia.

Comments: This species is most remarkable for its early formation of sclerotia - only three weeks after inoculation onto rye grass seed. Heim and Wasson (1958) considered sclerotia production in this species to be the most efficient method for the generation of biomass. Optimum temperature for sclerotia production was reported to be at 70-75°F. in darkness. Sclerotia on agar media peaked at 4.5% malt concentration. Heim and Wasson also found fruitbody production was maximized on agar media when the percentage of malt was balanced to .45%. Nevertheless, sclerotia form best on rye grass seed incubated in total darkness.

For further information consult: "*Les Champignons Hallucinogenes du Mexique*" by R. Heim and R. G. Wasson, 1958. Editions du Museum National D'Histoire Naturelle, Paris.

See Color Photographs 2 and 13.

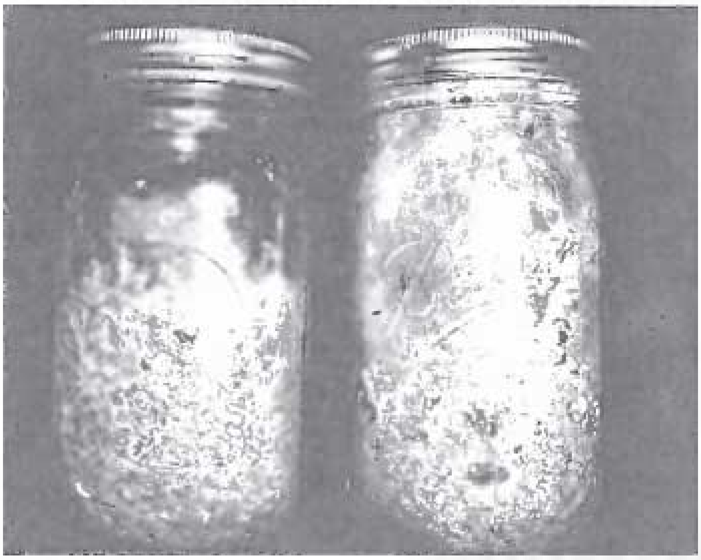


Figure 168 - Two quart jars at 10 days and 30 days after inoculation onto rye grass seed.

SPECIES: *Psilocybe tampanensis* Guzmán and Pollock

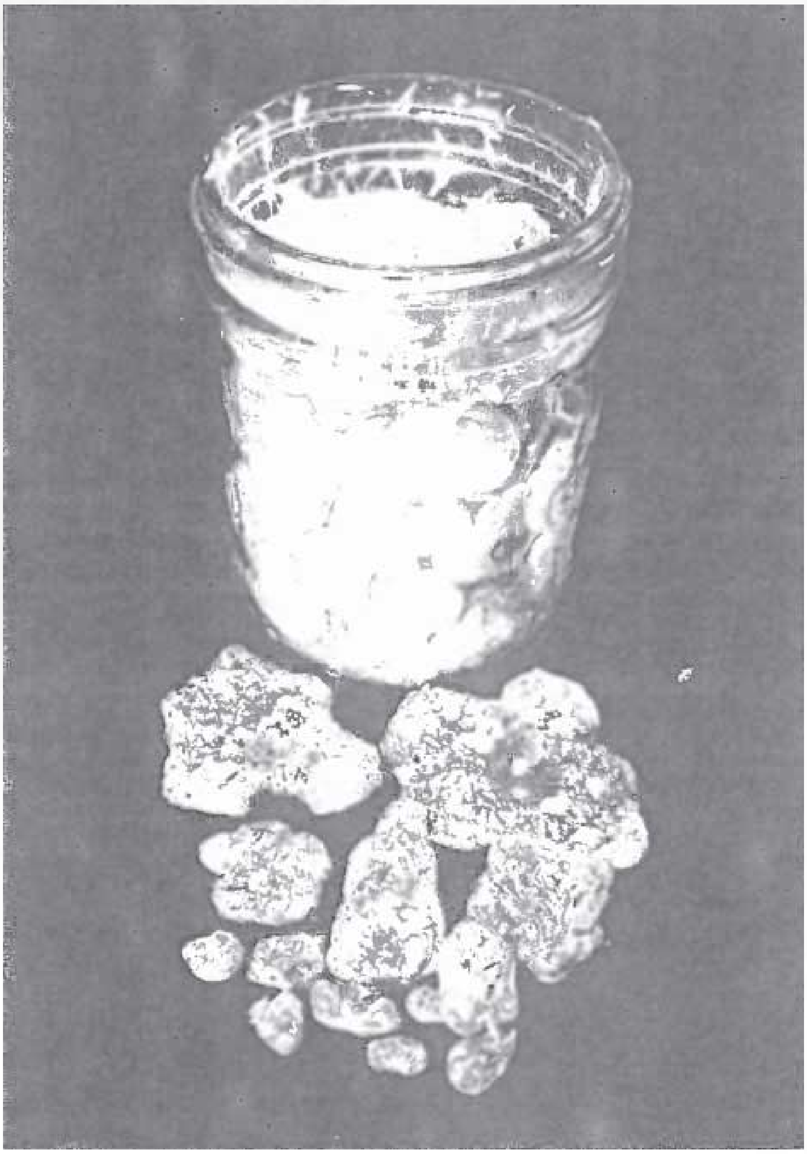


Figure 169 - Sclerotia of *Psilocybe tampanensis* harvested from one cup of rye grass seed six months after inoculation.

STRAINS: Pollock Strain.

COMMON NAMES: The Tampa Psilocybe; Pollock's Psilocybe. Sclerotia are called The New Age Philosopher's Stone or Cosmic Comote.

GREEK ROOT: *Psilocybe* comes from the Greek "psilos" or bald head. The species name *tampenensis* denotes the city near which this mushroom was first collected.

GENERAL DESCRIPTION: Cap convex to subumbonate, soon broadly convex to plane. The surface is smooth and the color is ochraceous brown to straw brown to grey brown. The gills are adnately attached, dark violet brown with whitish edges. The stem is 20-60 mm. long by 3-5 mm. thick, fibrous and enlarged towards the base. The stem surface is smooth to powdered (pruinose) and its color is yellowish brown to reddish brown overall, with whitish to bluish mycelium at or around the base. Its spores are dark purplish brown in mass.

NATURAL HABITAT: Solitary to scattered in sandy soils and meadows in Florida (near the city of Tampa). This species is known only from the type locality where one wild specimen was collected.

P. tampanensis - Growth Parameters

Mycelial Types: Finely linear to cottony; tan to brownish in color, often multicolored with brownish hues.

Spawn Media: Annual rye grass seed, wheat grass seed or rye grain.

Fruiting Substrate: Cased rye grass seed (and possibly rye grain); leached cow manure; some potting soils; and enriched malt agar media. This species will probably fruit on cased pasteurized wheat straw.

Method of Preparation: Rye grass seed combined with water in a 2:1 volumetric proportion, preferably soaked overnight. Sterilize for 1 hour at 15 psi. Wheat straw is pasteurized in a hot water bath at 160-170°F. for 20 minutes.

Spawn Run:

Relative Humidity: 90+%.
Substrate Temperature: 75-81°F.
Duration: 10-14 days.
CO_2: 10,000 ppm or higher.
Fresh Air Exchanges: 0 per hour.

Type of Casing: Standard peat based casing whose preparation is described in Chapter VIII. Layer to a depth of ½ to 1 inch.

Post Casing/Pre-pinning:

Substrate Temperature: 75-81°F.
Relative Humidity: 90+%.
CO_2: 10,000 ppm or above.
Fresh Air Exchanges: 0 per hour.
Light: Incubation in darkness.

Primordia Formation:

Relative Humidity: 85-92%.
Air Temperature: 71-74°F.
CO_2: 5000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Light requirements: Diffuse natural or grow-lights for 12 hours/day.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 71-74°F.
CO_2: 5000 ppm or below.
Fresh Air Exchanges: 2 per hour.
Harvest Stage: When the caps become nearly plane.
Light requirements: Diffuse natural or grow-lights for 12 hours/day.

Yield Potential: A petite species, *Psilocybe tampanensis* is noted for its sclerotia forming ability, approximately 10-30 grams (wet weight) per cup of rye grass seed over 12 weeks. Because of the small stature of the fruitbody, one should expect low yields per square foot in comparison to other more fleshy species of *Psilocybe*.

Moisture Content: 90-92% water and 8-10% dry matter in fruitbodies; 70% water and 30% dry matter in sclerotia.

Comments: This mushroom would not be known but for a single specimen collected by Steven Pollock and Gary Lincoff in September of 1977. Cultures taken from this wild specimen were marketed by Hidden Creek Inc. under the name of the "Cosmic Comote".

Sclerotia do not form until the fourth week (typically six to eight weeks) after inoculation of rye grass seed. To encourage sclerotia production only, incubate mycelia on rye grass seed at 75°F. in complete darkness.

For further information consult: "*Magic Mushroom Cultivation*" by Steven H. Pollock, 1977. Herbal Medicine Research Foundation, San Antonio, Texas (out of print).

See Color Photographs 4, 14 and 15.

SPECIES: *Stropharia rugoso-annulata* Farlow apud Murrill

= *Stropharia ferii* Bresadola
= *Naematoloma ferii* (Bres.) Singer

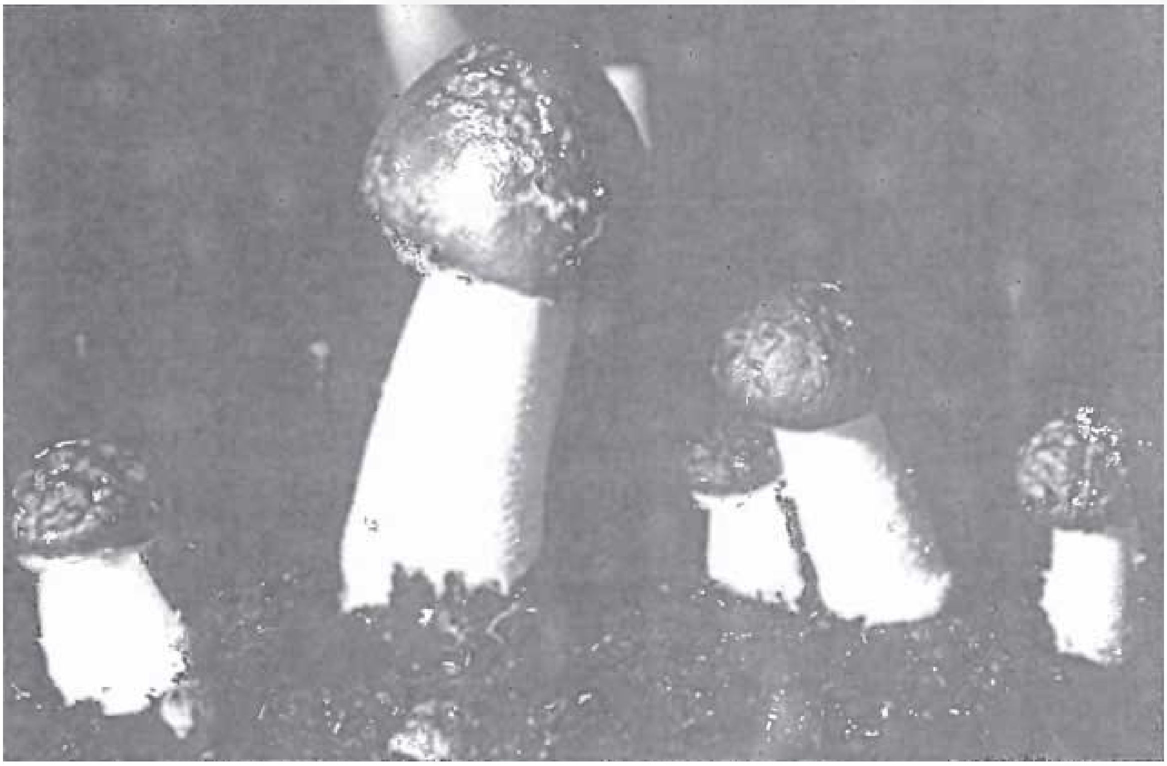


Figure 170 - Young fruitbodies of *Stropharia rugoso-annulata* fruiting on pasteurized straw cased with peat.

STRAINS: Gartenriese
Winnetou
Gelbschopf

The above listed strains are of European origin. Many strains of this species are available from culture banks, including those maintained by the American Type Culture Collection and Pennsylvania State Buckhout Laboratory. Strains are easy to obtain from the spores and tissue of wild specimens.

COMMON NAMES: The Wine Red Stropharia; The Giant Stropharia.

LATIN ROOT: *Stropharia* means "sword belt", so named for the belt-like ring on the stem. The species epithet *rugoso-annulata* comes from the combination of two Latin words: "rugosus" meaning wrinkled and "annulus" or ring.

GENERAL DESCRIPTION: A large, thick fleshed mushroom with a broadly convex cap measuring 50-400 mm. in diameter, darkly pigmented yellowish brown with distinct reddish tones. The partial veil is thick, membranous, leaving a persistent membranous ring on the stem on whose uppersides are tiers of gills. The stem is whitish and has rhizomorphs attached to its base. Its spores are dark purplish brown in mass.

NATURAL HABITAT: Occurring in gardens, in wood chips, on decomposing straw, in sawdust enriched soils and commonly in grounds where potatoes have been planted.

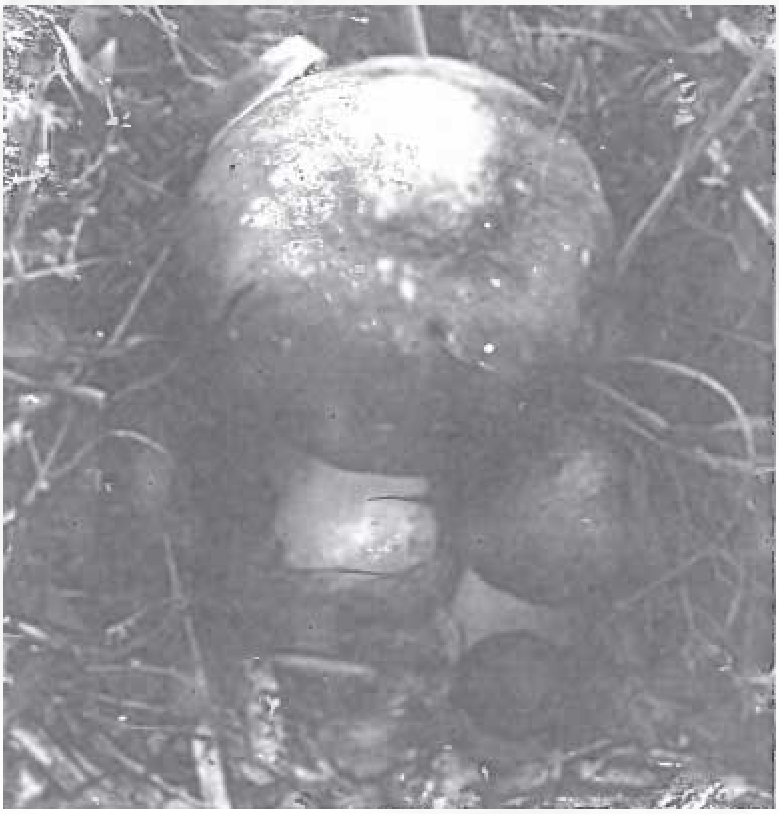


Figure 171 - Buttons of *Stropharia rugoso-annulata* fruiting outdoors in a bed of wood chips.

S. rugoso-annulata - Growth Parameters

Mycelial Types: Rhizomorphic to closely linear; whitish in color.

Standard Spawn Media: Rye grain or chopped wheat straw.

Fruiting Substrates: Cased wheat straw, whole or chopped, and balanced to a 71-74% moisture content. This species has been grown on a substrate of alder/maple chips mixed with mature horse manure using natural culture techniques.

Method of Preparation: Either chopped or whole straw is adequate, although permeation is more rapid on the former. (See Chapter VI on preparation of straw as a fruiting substrate). Pasteurization is achieved through the submersion of straw into a hot water bath at a temperature of 160°F. for 20-30 minutes. The straw, once pasteurized and inoculated, should be compacted and filled to a depth of 6-12 inches. Gramss (1979) noted that wheat straw supplemented with 25% Fagus sawdust enhanced yields. Watling (1980) reported, without elaboration, that fruitbodies form on a sawdust based medium. This species also fruits on unpasteurized straw although problems with insect pests and competitor molds are more pronounced.

Spawn Run:

Relative Humidity: 90+%.
Substrate Temperature: 76-82°F. Thermal death limits have been reported as low as 90°F. and -5°F.
Duration: 2-4 weeks.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.

Type of Casing: After fully run, cover with peat/humus (1:1) casing. Optimally, the casing should have a pH of 5.7-6.0. (Because calcium based buffers inhibit fruiting, adjust the casing's pH by increasing or decreasing amount of peat). Balance to a 70-75% moisture content. Layer to a depth of 1-2 inches. Humus should be pasteurized to kill nematodes, mites, and other parasites. Some strains form fruitbodies solely on a peat casing. (Mushrooms do not form, however, on sterilized casing. Hence, if the casing must be treated, steam pasteurization is recommended).

Post Casing/Prepinning:

Relative Humidity: 90+%.
Bed Temperature: 76-82°F.
Duration of Case Run: 10-12 days.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.
Light: Incubation in darkness.

Primordia Formation:

Relative Humidity: 95+%.
Air Temperature: 55-62°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Watering: Regular misting (once to twice daily) to help stimulate primordia formation.
Light: Indirect natural or exposure to grow-lux type fluorescent for 12 hours/day.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 55-62°F.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Flushing Interval: Every 10-15 days.
Harvest Stage: Directly before or as the partial veil tears. (Note that young mushrooms have a much better flavor than mature ones).
Light: Indirect natural or exposure to grow-lux type fluorescent for 12 hours/day.

Yield Potential: Average commercial yields are 2-3 lbs./sq.ft. over a 8 week cropping period. Maximum yields are nearly 6 lbs per square foot.

Moisture Content of Mushrooms: 92% water; 8% dry matter.

Nutritional Content: 22% protein (dry weight); 34 milligrams of niacin per 100 grams dry weight.

Comments: A mushroom recently cultivated in Europe (Germany, Czechoslovakia and Poland) by home growers in outdoor cold frames, the status of knowledge regarding the optimum growing parameters for this species remains in its infancy. For instance, Szudyga (1978) noted that fruitbodies form just as well at 50°F. and 68°F., a considerable fruiting range for any species.

After the cropping period ends, the spent straw is used as fodder for farm animals or is saved for future inoculations. The strain is kept kept alive by continous transfer onto fresh substrates. (See Chapter VI on natural culture). Propagating spawn in this way, however, is less assured than sterile methods.

Stanek (1974) reported that the introduction of several thermotolerant endospore-forming bacteria of the genus *Bacillus* (*B. subtilus*, *B. meseatericus* and *B. macerans*) to the casing not only inhibited attacks by competitors but also stimulated mycelial growth which presumably would enhance yields. Endospores of these bacteria survive pasteurization but not sterilization, and are abundant in soils. This discovery may explain why sterilized casings do not produce fruitbodies.

Genetic Characteristics: Basidia tetrapolar (4-spored), forming haploid spores; heterothallic. Clamp connections are present. See Chapter XV.

For further information consult: K. Szudyga, 1978. "*Stropharia rugoso-annulata*" in *The Biology and Cultivation of Edible Mushrooms* ed. by S.T. Chang and W.A. Hayes. Academic Press, New York.

SPECIES: *Volvariella volvacea* (Bull. cx Fr.) Sing.

STRAINS: Many strains of *V. volvacea* are available from commercial and private stocks. The American Type Culture Collection, which sells cultures to educational organizations and research facilities, has stock cultures of several wild and domesticated strains. Several commercial companies also sell strains of this species.

COMMON NAMES: The Paddy Straw Mushroom; The Chinese Mushroom.

LATIN ROOT: *Volvariella* is the conjunction of two words: "volvatus" which means having a volva or cup-like sheath and the suffix "-ellus" denoting smallness in size. The species name *volvacea* shares the same root as the genus.

GENERAL DESCRIPTION: Mushrooms whitish at first, becoming a dark tan as the veil tears and eventually a pale tan with age. Fruitbodies are relatively small when young, enveloped by a sheath-like universal veil, soon breaking as the fruitbodies mature and leaving an irregular cup-like sack at the base of the stem. The cap is egg shaped at first, soon hemispherical to convex and expanding to plane with age. Its spores are pinkish to pinkish brown in mass.

NATURAL HABITAT: Commonly occurring in decomposing straw in the Orient and in other subtropical regions of the world.

V. volvacea - Growth Parameters

Mycelial Types: Fast growing rhizomorphic to slow cottony mycelia noted. The color is typically white to grayish white.

Spawn Medium: Rice straw or rye grain. See Chapter III.

Fruiting Substrate and Method of Preparation: Traditionally grown on rice straw that has been composted for 1-2 days. More recently Hu (1974) found that a mixture of cotton wastes supplemented with wheat bran and calcium carbonate (5% and 5-6% by weight, respectively) and composted for 3 days, pasteurized for 2 hours at 140°F., conditioned for 8 hours at 125°F. and then gradually lowered to 77°F. over a 8-12 hour period, produced a higher yielding substrate than that of others previously used. A moisture content of 65-70% is recommended for rice straw and 70% for cotton waste mixtures. Chang (1978) recommended a combination of the two - with the rice straw/cotton waste in a proportion of 2:1 or 1:1 by weight.

Spawn Run:

Relative Humidity: 90+%.
Substrate Temperature: Fastest growth at 88-95°F.
Duration: 4-6 days for thorough colonization.
CO_2: 5000-10,000 ppm.
Fresh Air Exchanges: 0 per hour.
Light Requirements: Incubation in total darkness.

Type of Casing: None needed.

Pinhead Initiation:

Relative Humidity: 95+%.
Air Temperature: 82-88°F.
Duration: 4 days.
CO_2: less than 1000 ppm.
Fresh Air Exchanges: 2-4 per hour.
Light: Diffuse natural or direct grow-light fluorescent for 12-18 hours per day.
Watering: Regular misting once to twice daily.

Cropping:

Relative Humidity: 85-92%.
Air Temperature: 82-88°F.
Duration: 5-7 weeks.
CO_2: less than 600 ppm.
Fresh Air Exchanges: 2-4 per hour or sufficient to meet CO_2 and/or cooling requirements.
Harvest Stage: Directly before rupturing of the universal veil.
Flushing Intervals: 5-10 days.
Light: Same as above.
Watering: Regular misting to prevent caps from cracking and to keep resting pinheads viable.

Yield Potential: Average commercial yields on rice straw are 22-28 kilograms of fresh mushrooms per 100 kilograms of dry straw. Optimum yields on cotton waste compost are 25-35 kilograms per 100 kilograms of substrate. Maximum yields are nearly 45 kilograms on cotton waste compost.

Moisture Content of Mushrooms: 88-90% water; 10-12% dry matter.

Nutritional Content: Crude protein is reported at 21.2 % of dry weight; 91 milligrams of niacin per 100 grams dry weight.

Comments: In contrast to other species growing on straw, this mushroom does not compare favorably in terms of yield. The smaller crop figures are probably a result of the early picking of the mushroom fruitbodies, when they are most flavorful.

Several researchers have noted the difficulty of maintaining high yielding strains of this species for any length of time. Its mycelium seems to have a limited transfer potential and should be stored at moderate temperatures (50°F.). Cultures are frequently renewed through multispore germinations.

Volvariella volvacea is primarily grown in the Orient and is a warmth loving mushroom.

Genetic Characteristics: Basidia tetrapolar, producing 4 haploid spores; primary homothallic. Clamp connections are present. Chlamydospores form. See Chapter XV.

For more information consult:
S.T. Chang, 1972. "The Chinese Mushroom (*Volvariella volvacea*): Morphology, Cytology, Genetics, Nutrition and Cultivation" The Chinese University of Hong Kong, Hong Kong.
S.T. Chang, 1978. "*Volvariella volvacea*" in *The Biology and Cultivation of Edible Mushrooms*, pp. 573-603. Academic Press, New York.

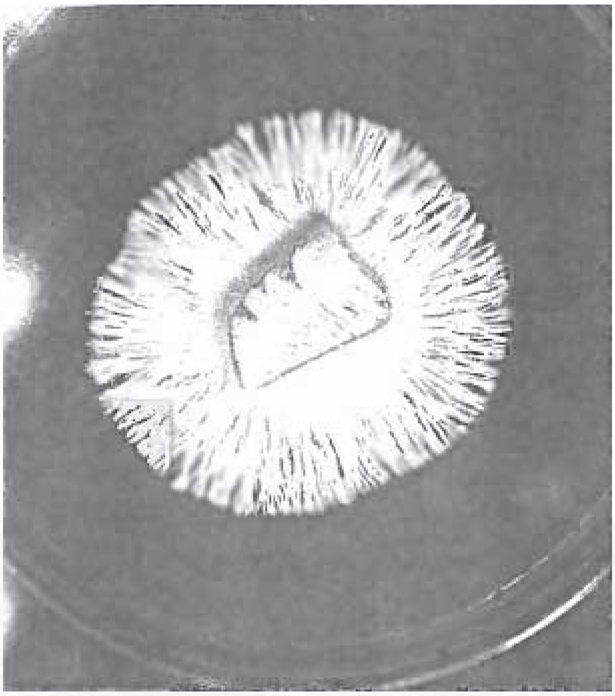


Plate 1 - *Psilocybe cubensis* mycelium.

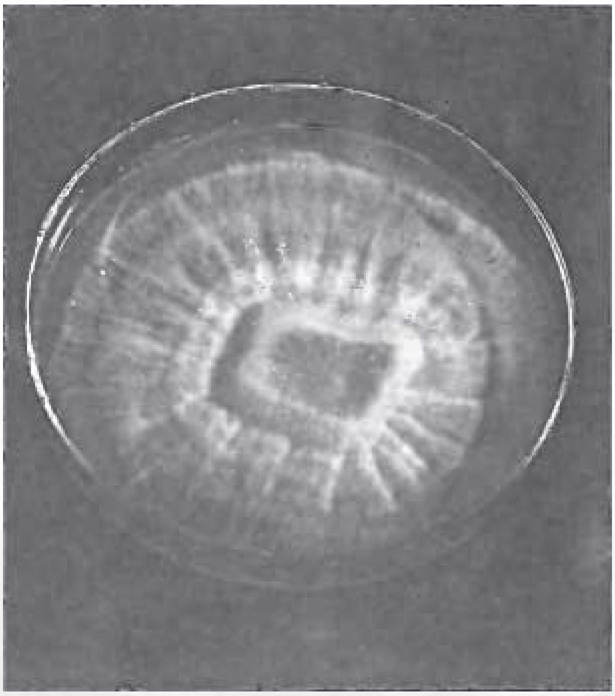


Plate 2 - *Psilocybe mexicana* mycelium.

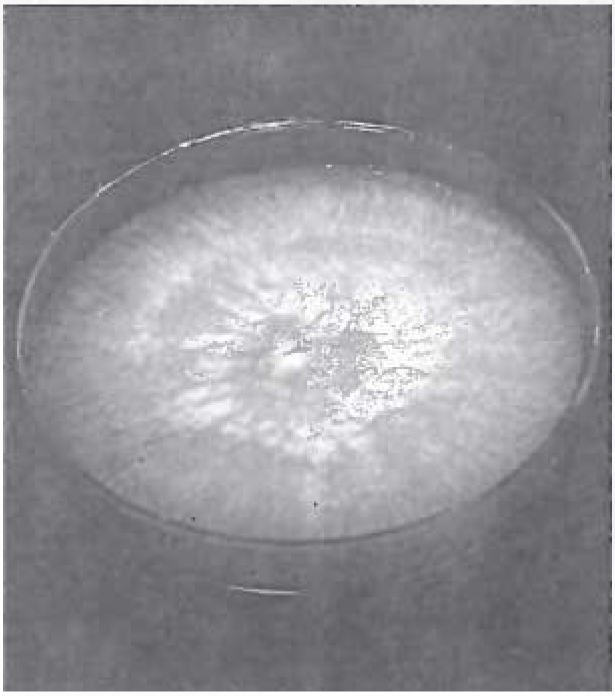


Plate 3 - *Lepista nuda* mycelium.

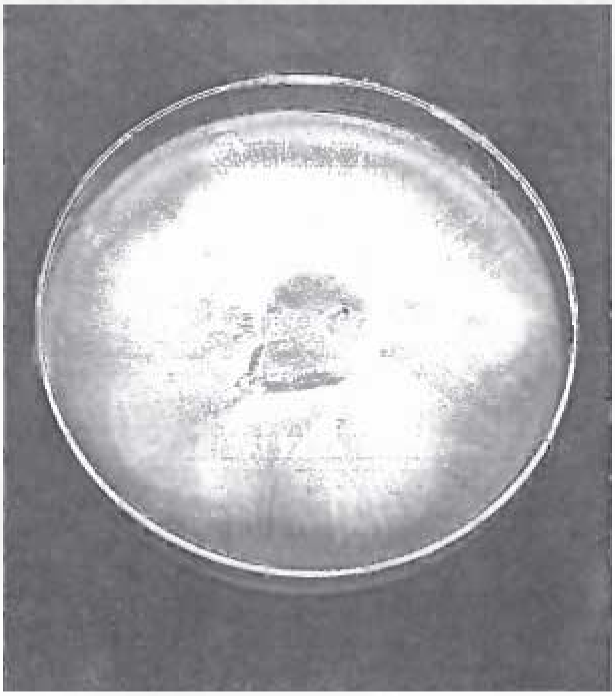


Plate 4 - *Psilocybe tampensis* mycelium.

Plate 5 - Compost raw materials during pre-composting.

Plate 6 - Compost raw materials at ricking.

Plate 7 - Compost raw materials at filling.

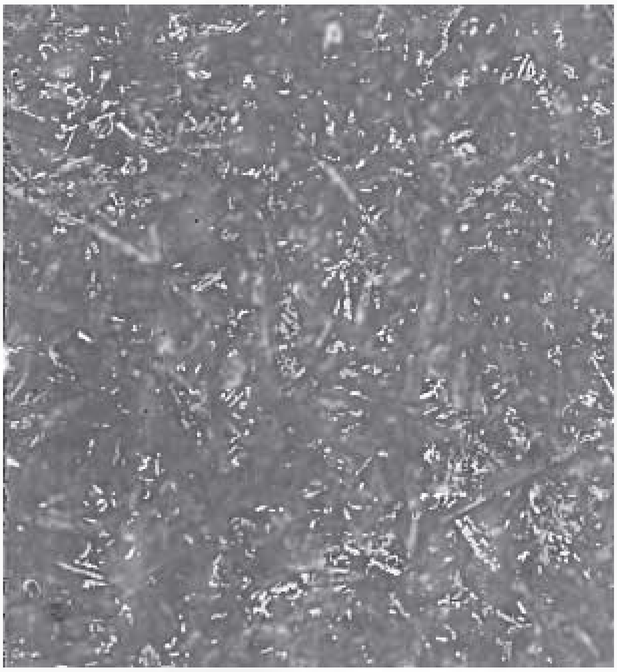


Plate 8 - Compost ready for spawning. Note whitish colonies of *Actinomycetes*.

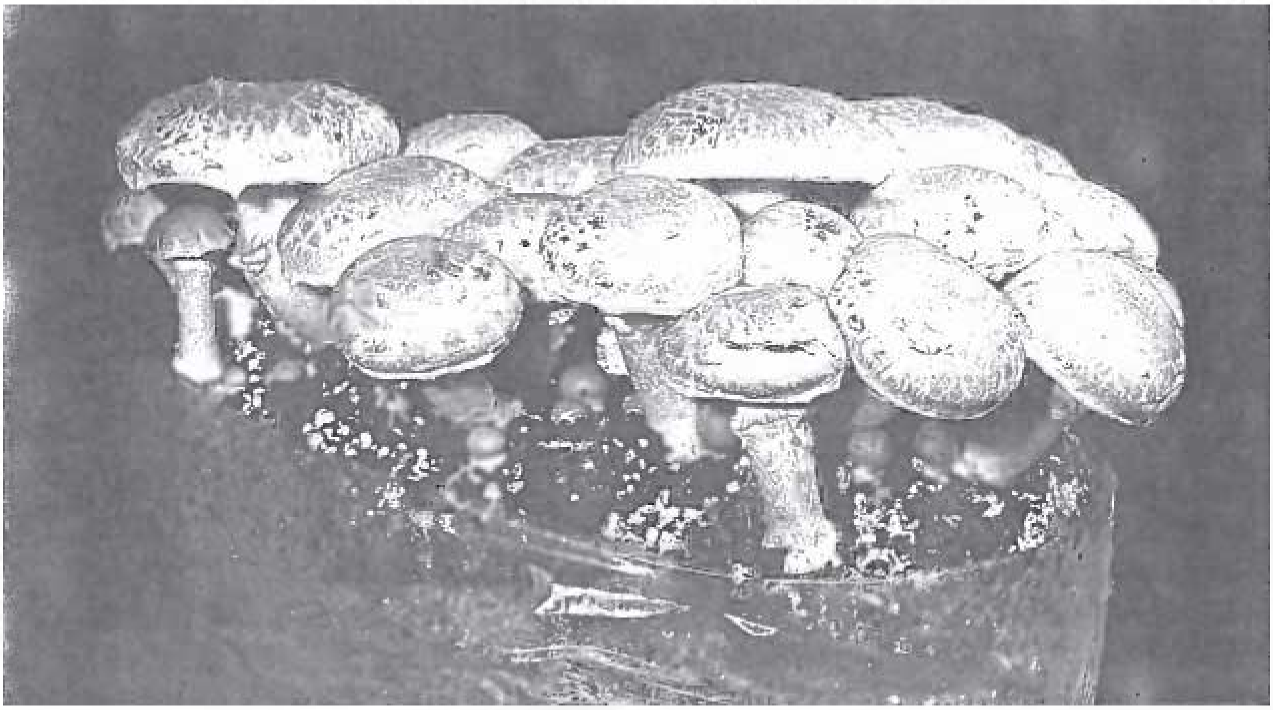


Plate 9 - *Agaricus brunnescens* fruiting on cased horse manure compost.

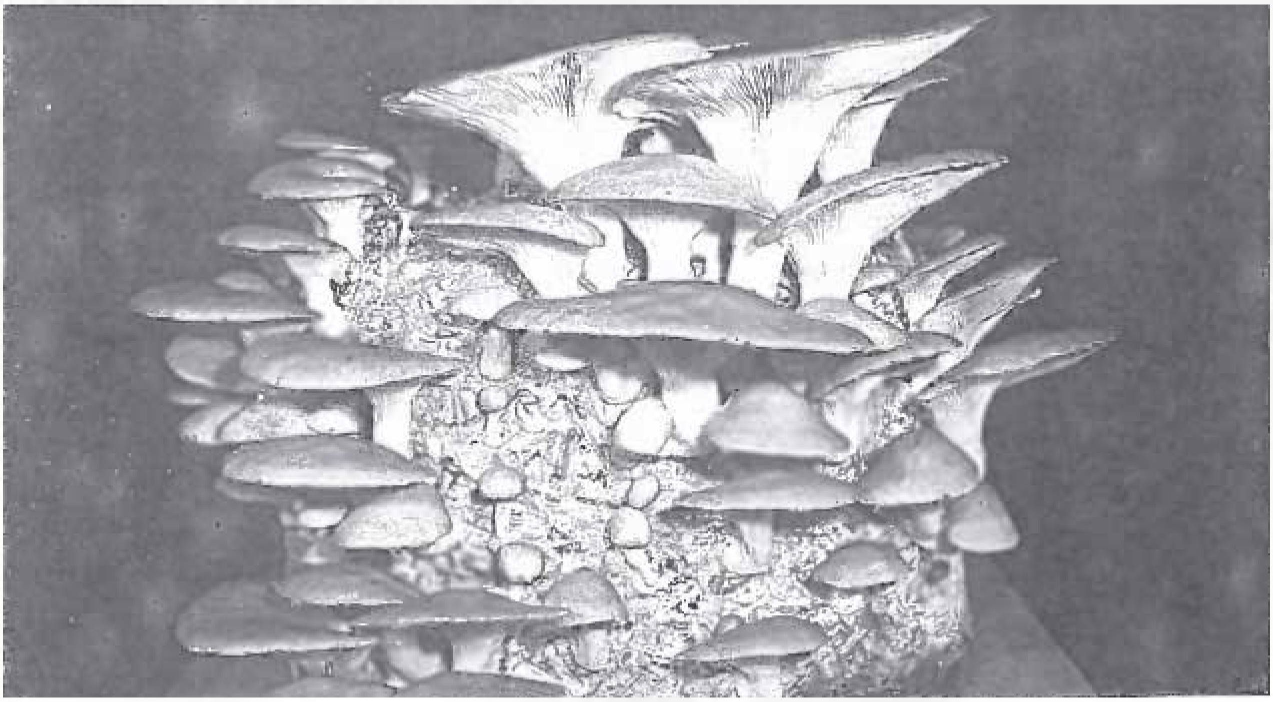


Plate 10 - *Pleurotus ostreatus* fruiting on pasteurized wheat straw.

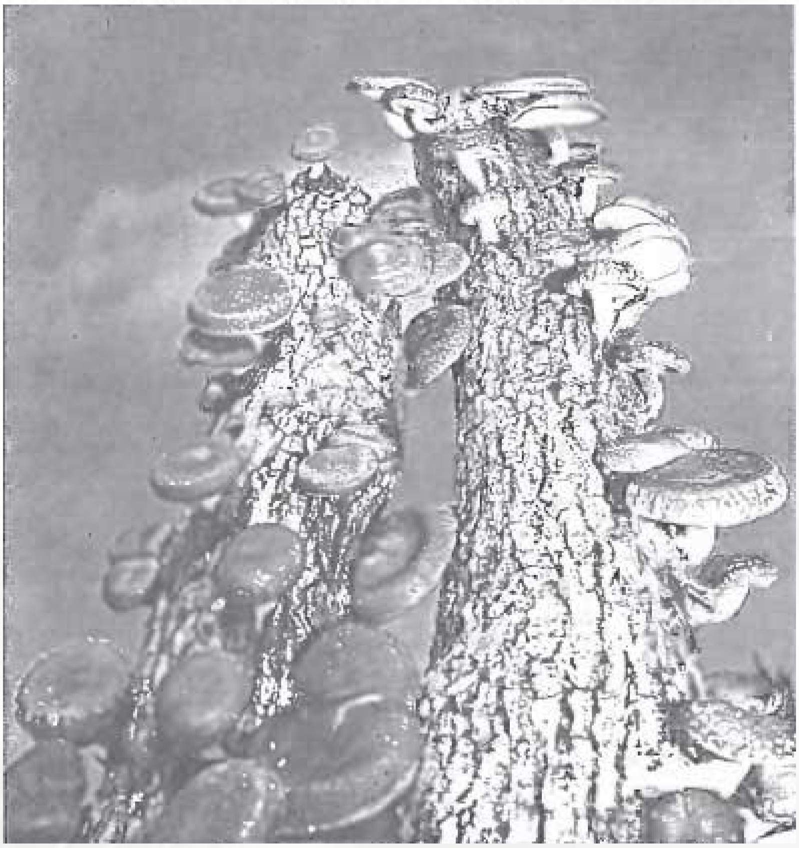


Plate 11 - *Lentinus edodes*, the Shiitake mushroom, fruiting on oak logs.

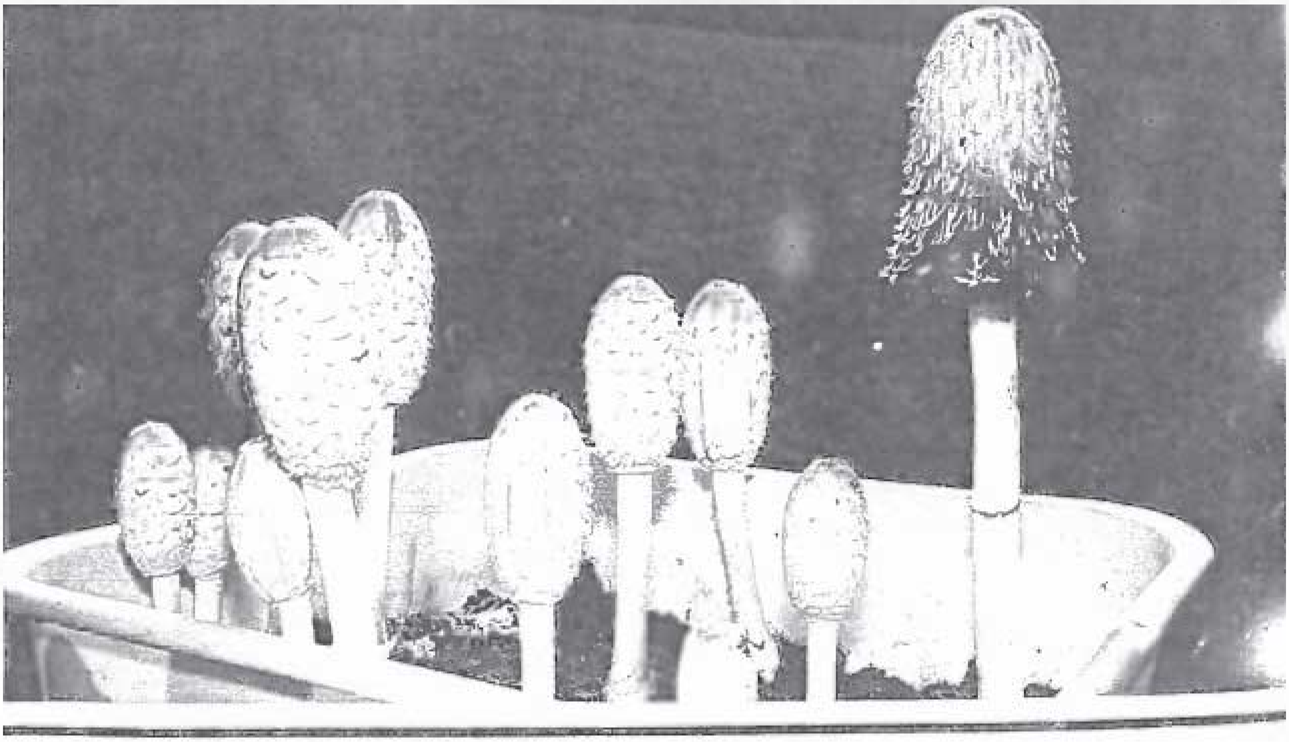


Plate 12 - *Coprinus comatus*, the Shaggy Mane, fruiting on cased horse manure compost.

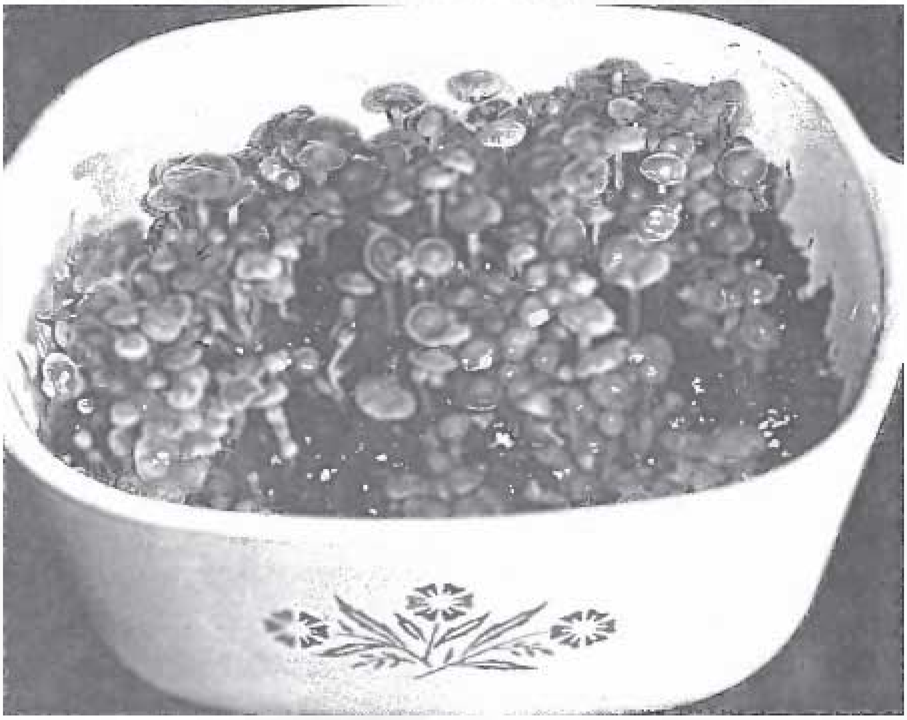


Plate 13 - *Psilocybe mexicana*, Teonanacatl, fruiting on cased rye grass seed.

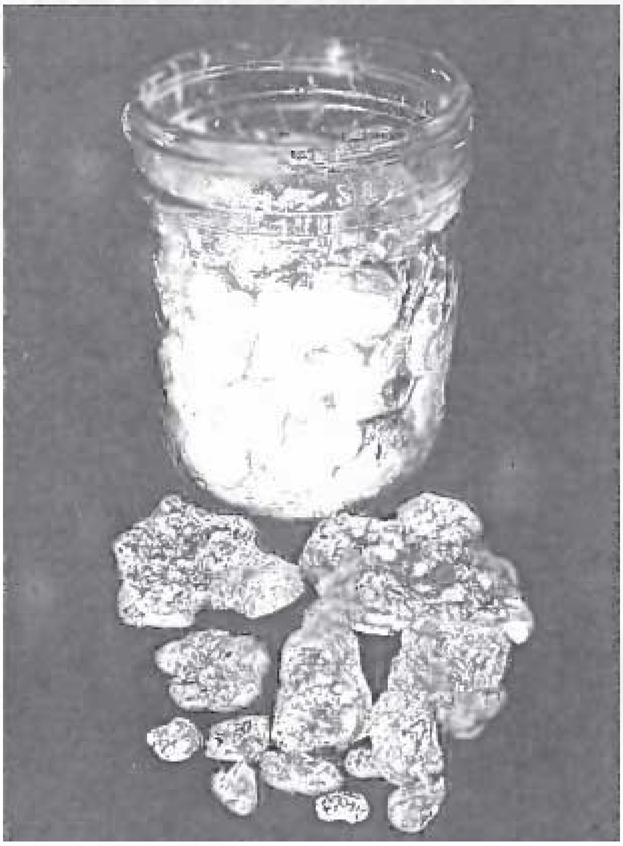


Plate 14 - *Psilocybe tampanensis* sclerotia on rye grass seed.

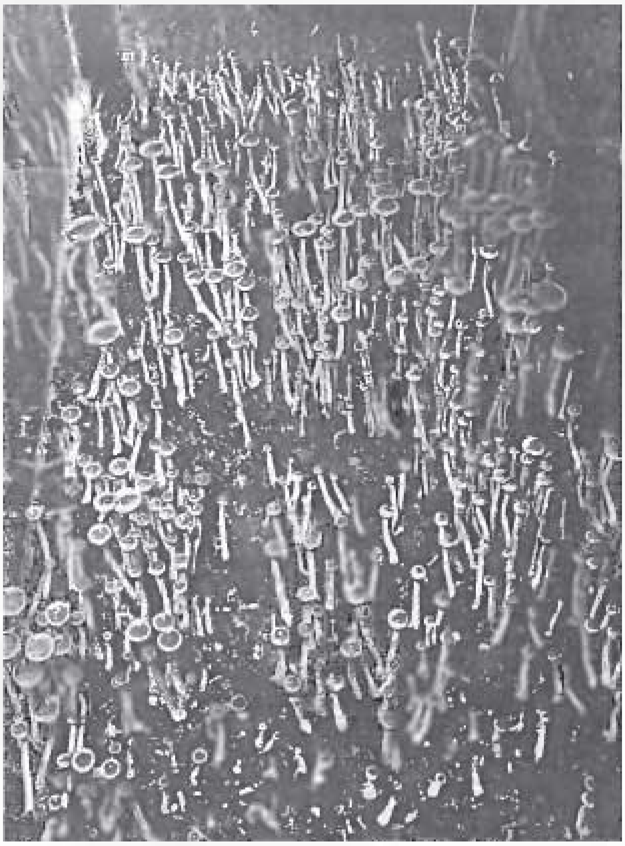


Plate 15 - *Psilocybe tampanensis* fruiting on cased rye grass seed.

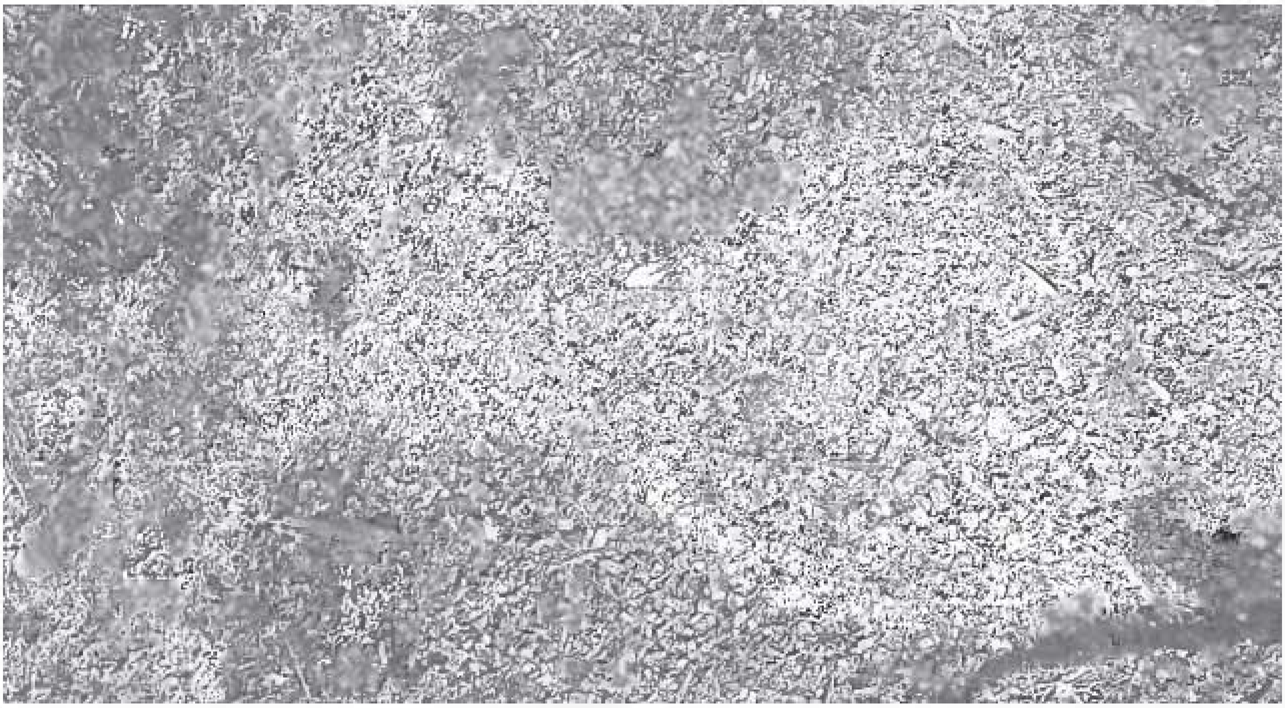


Plate 16 - *Psilocybe cyanescens* mycelium running through moist alder sawdust.

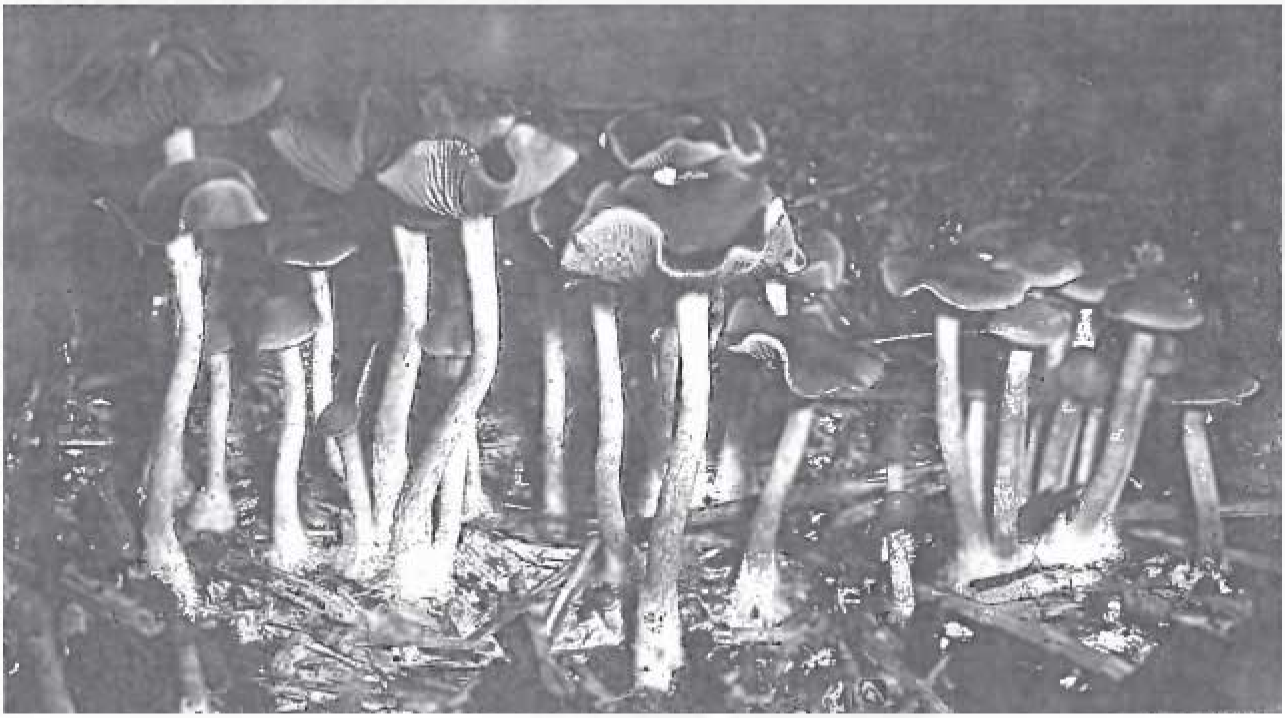


Plate 17 - *Psilocybe cyanescens* fruiting on alder chips.

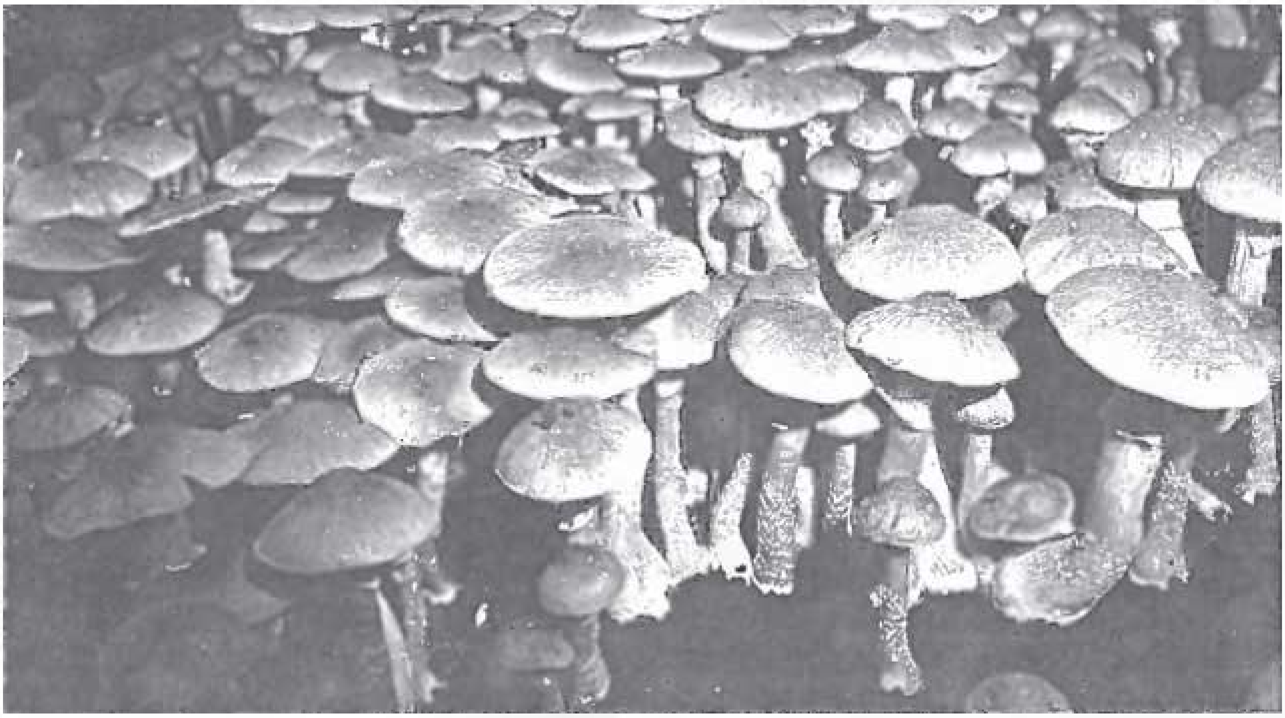


Plate 18 - *Psilocybe cubensis* fruiting on cased, pasteurized wheat straw.

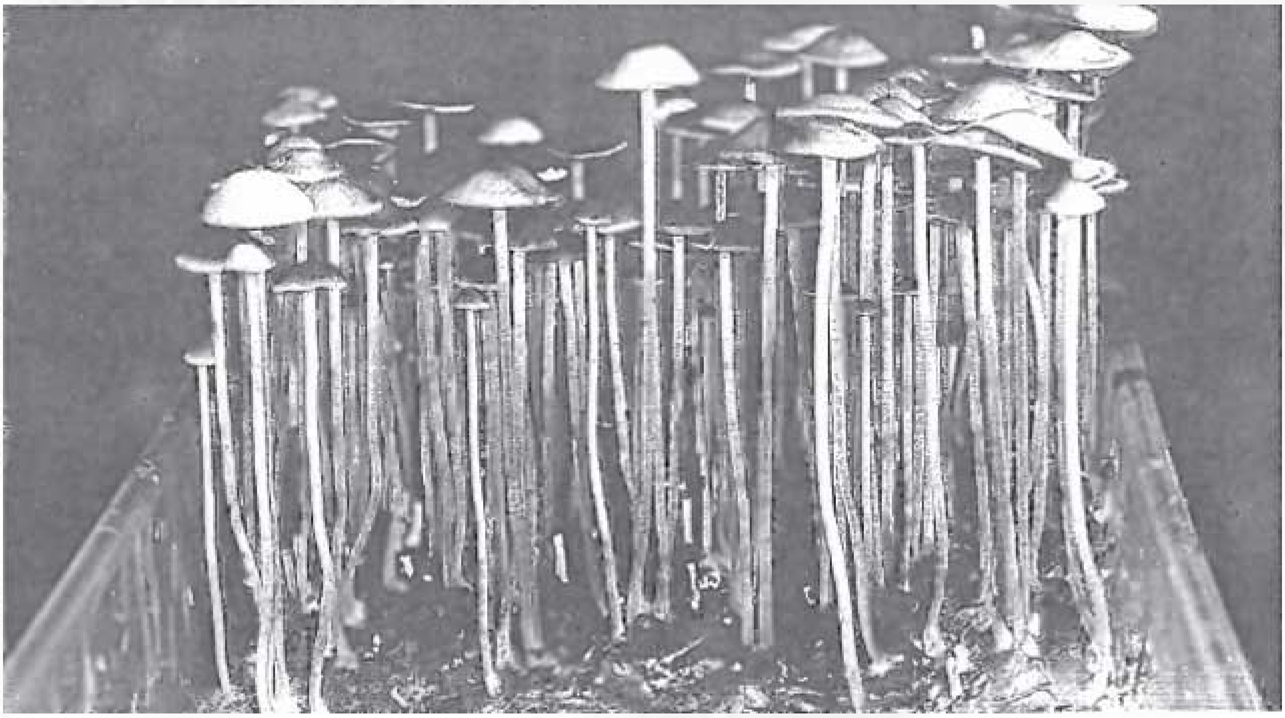


Plate 19 - *Panaeolus cyanescens* fruiting on cased wheat straw.

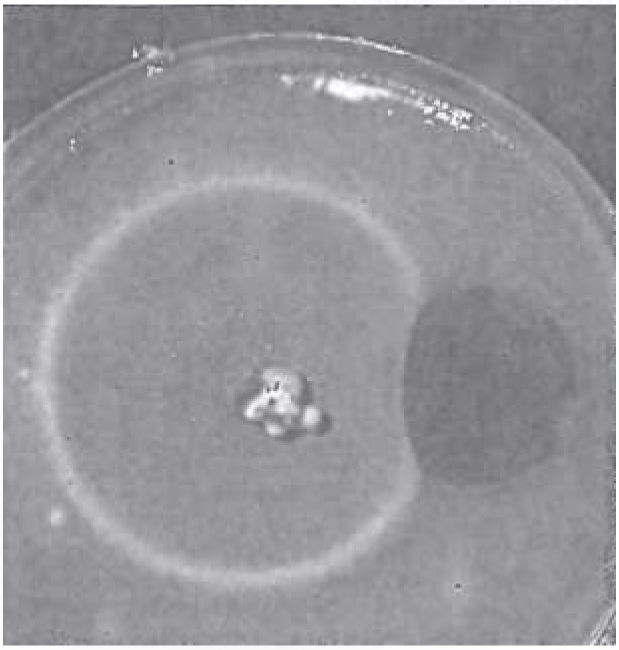


Plate 20 - *Penicillium*, the Blue Green Mold and *Cladosporium*, the Dark Green Mold, growing on malt agar media.

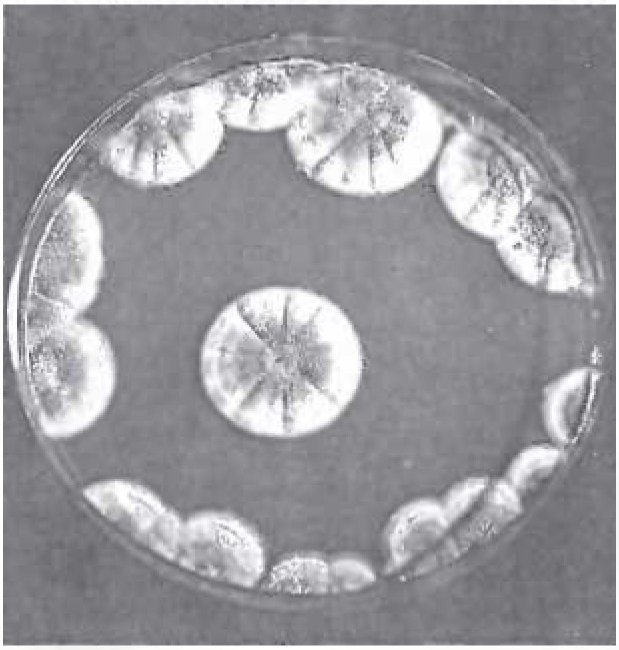


Plate 21 - *Aspergillus*, the Green Mold, growing on malt agar media.

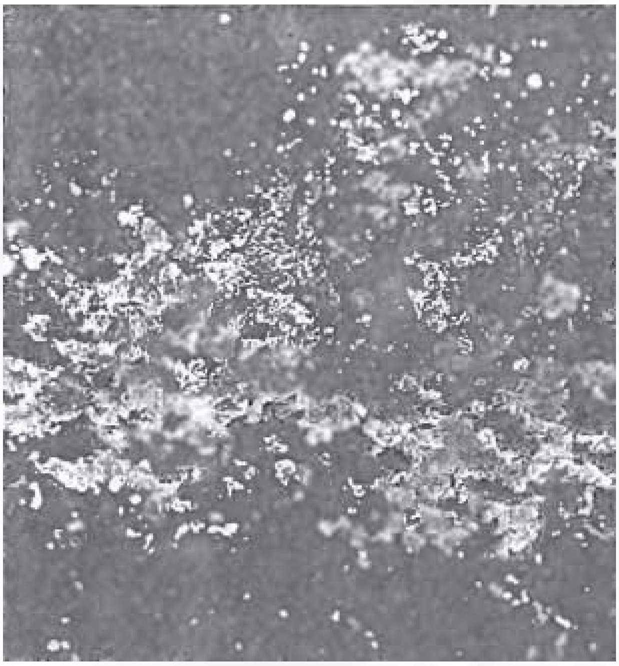


Plate 22 - *Trichoderma*, the Forest Green Mold, contaminating the casing layer.

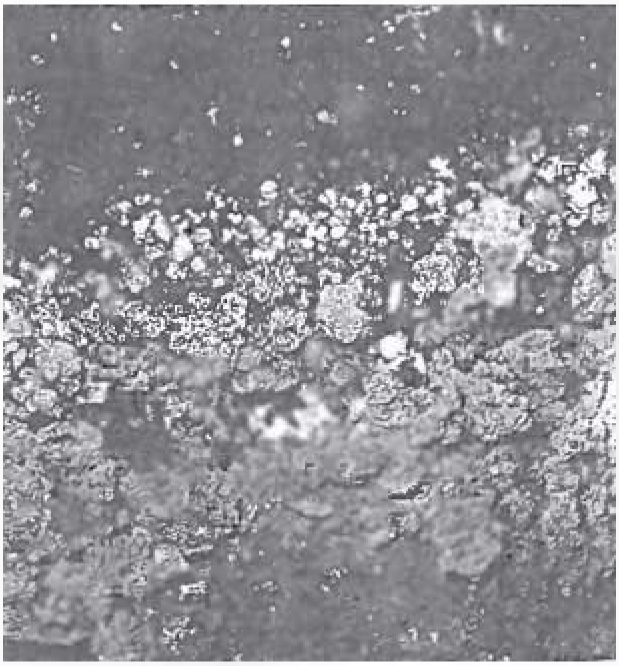


Plate 23 - *Botrytis*, the Brown Mold, contaminating the casing layer.

XII. CULTIVATION PROBLEMS AND THEIR SOLUTIONS: A TROUBLE SHOOTING GUIDE

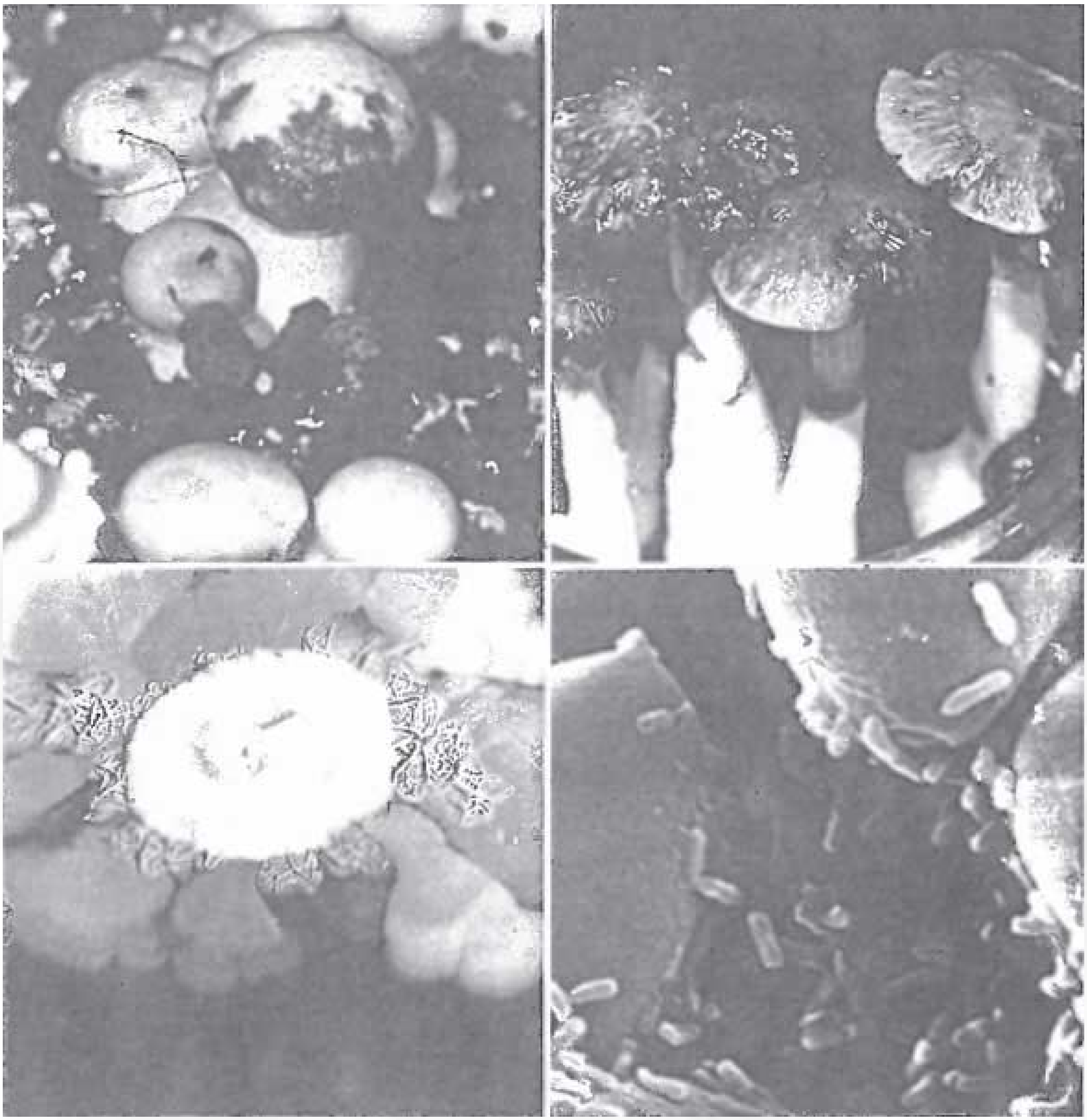


Figure 172a,b,c,d. - The results of bacterial contamination.

Many first-time cultivators fail to grow mushrooms for the simplest of reasons. Often times the slightest error in technique sets into motion a series of events that drastically influence the outcome of the crop. Whenever conducting sterile technique, making spawn, preparing compost or cropping mushrooms, wise cultivators follow a routine that has proven successful in the past. Once a consistent methodology has been established, new variations are introduced, one at a time, to gauge their effect.

Problems intrinsic to mushroom culture have been encountered by most everyone attempting to grow mushrooms. The following trouble-shooting guide lists problems, causes and solutions according to their frequency of occurrence and has been organized into five categories:

1. **Sterile Technique**: media (agar and grain) preparation, spore germination, tissue culture and spawn-making.
2. **Compost Preparation**: raw materials, characteristics of composts at different stages, Phase I and Phase II.
3. **Spawn Running**: colonization of compost and bulk substrates.
4. **Case Running**: application, colonization by mycelium, pre-pinning strategy.

5. **Mushroom Formation and Development** (Pinning to Cropping): strategy for pinhead formation, maturation and harvesting.

Identify the problem, locate it on the list, read its possible causes, refer to the solutions available, and if indicated, turn to the chapter noted in parentheses. Good luck, pay attention to detail and may your problems be few.

Sterile Technique

Agar Culture

PROBLEM	CAUSE	SOLUTION
Media fails to solidify.	Insufficient quantity of agar or distribution thereof.	Thoroughly mix media before pouring.
Media boils out of vessel or flask containing it.	Excessive escape of steam from pressure cooker.	Do not vent pressure cooker until reaching 1 psi. Grease pressure cooker seals with thin film of petroleum jelly. For pressure cookers using 5, 10, 15 lb weights, do not operate so steam escapes.
Contamination occurs in petri dishes after pouring media but before inoculation.	High contaminant spore load in lab. Improper media preparation technique. Contaminated pressure cooker (bacteria).	Clean, paint lab. Install laminar flow hood. Allow pressure cooker to cool in sterile setting before opening. Sterilize pressure cooker for 24-48 hours at 15 psi.
No growth from spores or tissue transferred.	Wrong type of media. Wrong pH. Old or dehydrated spores. Scalpel or loop too hot. Sugar in media caramelized.	See media preparation. See media preparation. Soak in sterilized water for 12-24 hours. Cool tool before contacting spores or tissue. Lower sterilization pressure and temp. to recommended levels.
Contamination occurs around point of transfer onto agar media.	Inoculum (spores or tissue) contaminated. Inoculation tools not sterile.	Obtain "cleaner" spores or take a tissue culture from a fresher specimen, or inoculate as many plates as possible, saving only those not becoming contaminated. Autoclave tools, soak in alcohol, flame sterilize before using.
Rhizomophic mycelia becomes cottony, slow growing. Fruitings diminish. Strain appears to be degenerating.	Senescence, strain aging.	Retrieve stock cultures and reactivate a strain of known vigor. Alternate media so that gene expression is not selected by a limited chemical matrix.
	Mutating. Sugar in media caramelized. Media containing mutagens.	Cook agar media at lower temp. and pressure, between 12 and 15 psi.
	Insufficient jelling agent causing mycelium to grow subsurfacely and appear cottony.	Add more agar or thoroughly mix media before pouring petri dishes.

Grain Culture

PROBLEM	CAUSE	SOLUTION
Glass spawn jars broken when pressure cooker is opened.	Pressure cooker cooled too rapidly. Change in temp. too abrupt.	Allow cooker to descend to room temp. gradually.
	Jars too tightly packed.	Allow space so jars can expand.
	Jars defective or cracked.	Check for cracks or defects. Obtain new jars.
	Wrong type of jars.	Replace with canning or autoclavable type.
Grain jars difficult to shake.	Too much grain in container.	Reduce grain to recommended levels.
	Too much water relative to grain.	Follow recommended formulas.
	Measuring cups not accurate.	Calibrate measuring cups with a graduated cylinder.
Grain "spontaneously" contaminates before inoculating or opening pressure cooker.	Introduction of alien spores upon cooling.	Cool-down in sterile environment or in front of laminar flow hood.
	Survival of bacterial endospores despite autoclaving.	Replace source of grain or presoak grain for 24 hours before autoclaving.
Agar wedge sticks to glass when grain jar is shaken.	Agar media too thin, either from evaporation or from shallow pouring.	Use mycelium covered media before substantial evaporation occurs. Pour more media into each petri dish initially.
Little or no growth after mycelial wedge has been transferred.	Grain too hot when inoculated.	Allow to cool to room temperature before inoculating.
	Grain too dry.	Balance according to recommended recipes.
	Mycelium not evenly distributed.	Vigorously shake spawn jar after transfer of agar wedge and again 3-5 days after inoculation.
	Incubated at wrong temperature.	Buffer with calcium carbonate according to species being cultured.
	pH wrong.	See recommended spawn incubation temperatures in Chap. XI.
	Wrong spawn medium.	Use media recommended for that species.
Poor strain.	Contaminated strain.	Discard strain. Obtain purer strain, make up more grain media and clean laboratory.
No growth on grain after inoculated with liquid culture/stirrer technique.	Too many individual hyphae (cells) severed.	Stirred for too long. No more than 5 seconds is recommend for high speed laboratory-type blenders to produce fragmented chains of hyphae.
	Bacteria.	Replace mycelia with pure strain, free of bacteria. Be sure tools and water are sterile before inoculation.
	Poor strain.	Cottony type mycelia is slow growing. Replace with rhizomorphic or faster growing strain.
	pH	Follow recommended recipes. See Chap. II.
	Water too hot.	Allow to cool before inoculating.

Contamination after transfer of mycelium.	High contaminant spore count in laboratory.	Clean lab before inoculations. Maintain high standards hygiene.
	Tools not sterile.	Autoclave tools, soak in alcohol, flame sterilize before inoculation.
	Mycelium being transferred has high resident load of contaminant spores.	Obtain cleaner strain or spawn of better purity.
Mycelium fails to grow out through entire spawn jar.	Insufficient shaking of grain after inoculation.	Thorough shaking after double-wedge transfer, combined with re-shaking four days after inoculation.
	Mycelium inhibited by contamination (usually bacteria). Externally or internally introduced.	Inoculate more sterilized grain using a pure strain and following standard practices for doing so. See Chap. II.
Top kernels in spawn jar not colonized by mycelium.	Top kernels dehydrated from excessive evaporation.	If using porous filter discs, limit evaporation. Or use only in conjunction with narrow mouthed jars.
Spawn jar discolored with yellowish droplets of fluid.	Spawn jar incubated for an overly long period of time, at higher than optimum temperatures, or both, causing the exudation of metabolites ("sweat") and the build-up of fluids in which bacteria thrive.	Incubate at temperature and for period of time recommended for species being cultivated.

Compost Preparation

Phase I

PROBLEM	CAUSE	SOLUTION
Compost does not heat up, remains under 140°F.	Undersupplemented.	Check compost formula. Check Nitrogen content of raw materials.
	Pile too open, airy.	Compress pile sides. Protect pile from strong winds.
	Moisture content too high or low.	Balance moisture to 70%.
	Insufficient pile mass.	Increase total raw materials.
Compost generates no ammonia.	Undersupplemented.	Check compost formula calculations. Check Nitrogen content of raw materials.
Compost anaerobic.	Moisture content too high.	Balance moisture to 70%.
	Straw too short; pile too dense.	Carefully monitor raw materials and adjust pile size as materials compact.
	Pile sitting too long between turns.	Turn more frequently.
Compost decomposing unevenly.	Improper turning procedures.	Move inside of pile to outside and vice versa.
	Variable starting materials.	Horse manure or straw should all be in the same state of decomposition at the start of composting.
Compost greasy.	Gypsum quantity too low.	Add more gypsum.
	Starting materials too old.	Use only fresh, undecomposed starting materials.
Compost too wet or too dry at filling.	Incorrect water addition or timing.	Check moisture content of pile before each turn.
Straws still bright and shiny at filling.	Phase I too short.	Continue composting.
Compost short and black at filling.	Phase I too long.	Shorten Phase I.

Phase II

PROBLEM	CAUSE	SOLUTION
Compost will not heat up.	Supplementation rates too low.	Check compost formula calculations.
	Compost too mature.	Shorten Phase I.
	Oversupply of fresh air.	Reduce fresh air supply.
	Air to bed ratio too great.	Add more beds or trays and fill with more compost.
	Compost too wet.	Compost should be 70% at filling.
Compost temperature erratic.	Irregular fresh air supply.	Fresh air supply should be constant. Make volume changes slowly and as needed to stablize temp.
	Room environment not monitored enough.	Check room every 4-6 hours.
Compost temperature uneven.	Containers filled unevenly.	Fill all containers with equal amounts of compost and to the same depth.
	Uneven supplement distribution in Phase I.	Be sure supplements are evenly mixed and are not concentrated in small pockets.
	Faulty air system design.	Air system should insure even temp. throughout the room.
Compost temp. too high after pasteurization.	Inadequate supply of fresh air.	Increase fresh air.
	Pasteurization too long.	Pasteurize for 2 hours at 140°F.
Compost temp. drops too low after pasteurization.	Prolonged fresh air supply.	Anticipate drop in compost temp. and reduce fresh air before reaching conditioning temp.
	Pasteurize at a lower temp. for more time.	Low temperatures preserve more microorganisms that prevent temp. from falling rapidly.
Prolonged ammonification.	Oversupplementation with nitrogen.	Reduce nitrogen supplements.
	Prolonged time at temp. over 130°F.	Keep temp. under 130° after pasteurization. Use low temp. ranges during conditioning.

Spawn Running

PROBLEM	CAUSE	SOLUTION
Spawn grows slowly or not at all.	Inferior spawn.	Check spawn making procedures. Review strain storage methods. Test strain purity by inoculating agar plates.
	Degenerative or inviable strain.	Always test untried strains in "miniculture" trials prior to inoculation into bulk substrates. Switch to a strain of known viability.
	Residual ammonia in compost.	Prolong Phase II conditioning until litmus paper test shows no color change.
	Improper Phase I or Phase II.	Review composting section.
	Substrate moisture content too high.	Compost should be 64-66% water; straw should be 70-75% at spawning.
	Fly or nematode infestation.	Check pasteurization time and temperature.
	Mycelium lacks oxygen.	Be sure the container has provisions for air exchange.

Molds present during spawn run.	Improper Phase I or Phase II.	Review composting section. Check contamination section for identification and factors predisposing to mold growth.
Inky Caps (*Coprinus sp.*) occur during spawn run.	Residual ammonia in compost.	Prolong Phase II conditioning until litmus paper test no change.
Mites or nematodes present.	Insufficient pasteurization.	Pasteurize 2 hrs. at 140°F.
	Compost with dense overwet areas.	Review composting and filling procedures.
	Unclean substrate containers or spawning tools.	Containers and tools should be disinfected before use.

Case Running

PROBLEM	CAUSE	SOLUTION
Mycelium fails to run through the casing layer.	Temperature too high or too low.	Incubate at optimum temp. for mycelial growth.
	pH improperly adjusted.	Test pH before application. Adjust with limestone buffer (with one exception). Consult Chap. XI on the correct pH for each species.
	Casing to wet or too dry.	Test moisture before application. Apply at 90% of capacity (70-75% moisture).
	Unsatisfactory casing materials.	Review preparation of casing in Chap. VIII.
	Weak mycelial growth in substrate.	Review techniques for substrate preparation in appropriate chapter.
	Substrate contaminated.	Check substrate for molds and nematodes before casing.
Casing dries out after application.	Growing room humidity too low.	Increase humidification. Increase frequency of watering, or cover with plastic.
	Fan speed too high. Too much airflow.	Decrease fan speed. Maintain slow, easy circulation.
Uneven mycelial growth into casing.	Casing materials poorly mixed.	Thoroughly mix casing ingredients to insure an even blend.
	Unevenly applied casing.	Redistribute or apply casing to an even depth.
	Uneven mycelial growth into substrate underlying casing.	Thoroughly and evenly spread spawn throughout substrate at inoculation.
Mycelium covers the casing but forms few primordia.	"Overlay" caused by prolonged mycelial growth into the casing layer.	Patch the casing. Begin initiation sequence sooner. If dealing with a slow pinning strain be careful that the evaporation rate off the casing surface is not excessive.
Mycelium overlays the casing and then "mats", becoming flattened and impervious to water. No primordia form.	Improper watering and/or too low humidity in the external environment. Evaporation rate too extreme.	Scratch and/or re-case. Maintain 95% humidity at pinning. Reduce evaporation rate. If watering, mist lightly and evenly.
Mycelium runs through the casing and then disappears.	Die Back Disease (Virus).	Discard and begin anew with a virus-free strain. See Chap. XIII.
Dense white matted zones form on casing.	Stroma.	Select strains not predisposed to stroma formation (those without fluffy sectors). Reduce CO_2.
	Contaminant (*Scopulariopsis*).	pH too high. Compost improperly prepared. See Chapters V, XIII.

Mushroom Formation and Development

Pinhead Initiation

PROBLEM	CAUSE	SOLUTION
Mycelium fails to form primordia.	Monokaryotic strain with low or no fruiting ability.	Start again with new tissue isolate or isolate from multispore germination.
	Humidity too low.	Keep humidity at 95% during pinning.
	CO_2 too high.	Reduce CO_2 by introducing fresh air.
	Temperature too high.	Decrease air temp. to the fruiting range.
	Insufficient light.	Illuminate cropping surface for 12 hours/day.
Primordia form early.	Uneven casing depth.	Apply casing at an even depth and patch areas where mycelium appears prematurely.
	Early light stimulation.	Incubate culture in darkness until ready to pin.
	Temperature too low.	Incubate at optimum temp. for mycelial growth and then drop temp. for pinning.
	CO_2 levels too low.	Maintain airtight room and recirculate air until ready to pin.
Primordia formation uneven.	Uneven casing depth.	Patch shallow areas as mycelium appears until growth is even.
	Uneven moisture in casing.	Water casing evenly and carefully.
	Casing surface partially damaged from heavy watering.	Keep casing surface open and porous through proper misting techniques.
	Uneven environmental conditions within the growing room.	Review air system design.
Pinheads fail to form abundantly.	Casing layer moisture too low or too high.	Adjust moisture level in casing to 70-75% for pinhead formation.
	Casing layer pH imbalanced.	Adjust pH to levels recommended in Chap. XI for the species being cultivated.
	Magnesium in limestone buffer too high (above 2%).	Some species are inhibited by minerals in the casing layer, especially the magnesium in dolomitic limestone. Use a low magnesium lime, less than 2%.
	CO_2 too high.	Lower CO_2 to recommended levels. (Some species fruit poorly in high CO_2 environments).
	Insufficient light.	Photosensitive species require several hours of light stimulation per day for pinhead formation.
	Improper pinhead initiation strategy.	See Chapter IX.
	Defective strain.	Replace with strain of known viability.
	Nematode infestation.	See Chapter XIV.

Pinheads form but fail to mature.	Insufficient nutrient base.	Review substrate materials and formulas. Follow those that are recommended for the species being cultivated.
	Excessive CO_2 levels.	Reduce CO_2 to recommended levels.
	Humidity to high.	Reduce humidity to 85-92%.
	Insufficient fresh air.	Increase fresh air input to 2-4 room exchanges per hour.
	Strain idiosyncrasy.	Replace with a strain having better fruiting capabilities.
	Fly, nematode or other contaminant inhibiting development.	Review contaminant control procedures. Check source and quality of casing materials. Check mixing procedures.
	Excessive loss of moisture from casing.	Maintain sufficient moisture (70-75%) in the casing through daily mistings if required.

Cropping

PROBLEM	CAUSE	SOLUTION
Low yielding first flush.	Poor pin set.	Review pinning procedures and growing parameters for the species being grown.
	Substrate low in nutrients.	Review substrate materials and formulas.
Few mushrooms develop fully, many abort.	Uneven pinning.	Remove early developing pins.
	Lack of nutrients.	Review substrate materials and formulas.
	Temperature too high.	Maintain air temp. within cropping range.
	Parasitized by contaminant.	See Chapters X and XIII. Follow procedures for encouraging cropping, not contamination.
Mushrooms have long stems and small underdeveloped caps.	CO_2 too high.	Increase fresh air input.
	Insufficient lighting.	Evaluate lighting system and type of light used.
Mushrooms develop but abnormally.	Parasitized by contaminant.	Eliminate stagnant air pockets in the growing environment. See Chap. IV.
	Excessive CO_2. Improperly balanced growing environment.	Lower CO_2 to recommended levels. Maintain air circulation, temp. and humidity at recommended levels. See Chap. X.
	Exposure to mutagenic chemicals (insecticides, detergents, chlorine, etc.)	Limit exposure of mushrooms to such chemicals.
	Lack of adequate light for fruitbody development.	Increase light exposure to 12 hours per day. See Chapters IV and IX.
	Strain idiosyncrasy.	Switch to strain of known fruiting ability.

XIII. THE CONTAMINANTS OF MUSHROOM CULTURE: IDENTIFICATION AND CONTROL

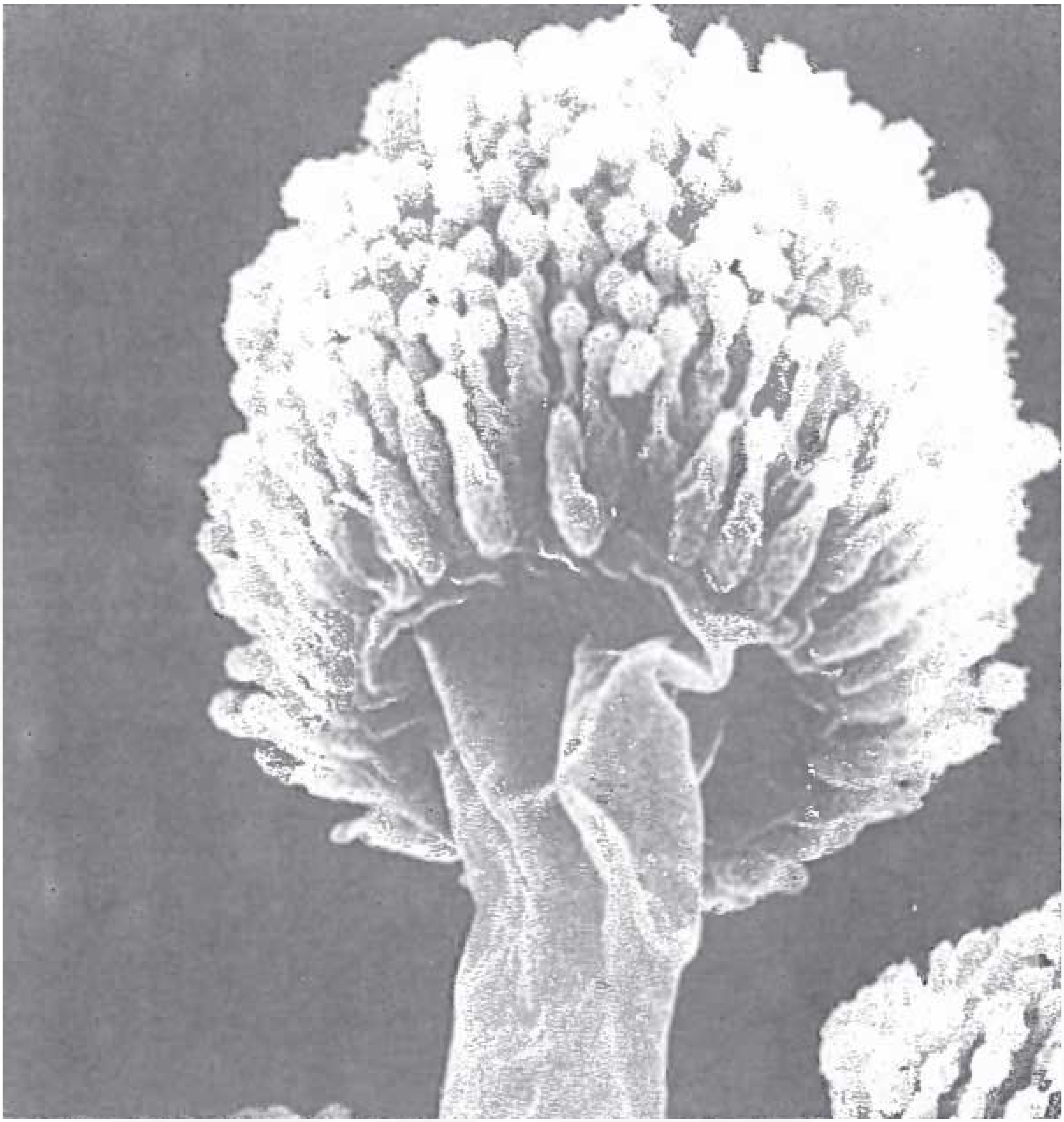


Figure 173 - Sporulating structure of *Aspergilus* mold.

The contaminants are so named solely because they are undesired. If one were trying to culture *Penicillium* and spores of an *Agaricus* or *Psilocybe* settled onto the agar media and germinated, the resulting mycelia would be the so-called "contaminant." The contaminants in mushroom culture, however, are primarily molds, bacteria, viruses and insects. The pathway by which a disease is introduced, known as the **vector** of contamination, can be used to trace the contaminant back to its site of origin using simple deduction. By observing how a contaminant affects the mushroom crop and by carefully noting the conditions in which it flourishes, a cultivator can soon identify its cause.

Earlier in the book, the five most probable vectors of contamination were identified as:

1. the cultivator.
2. the air.
3. the substrate to be inoculated.
4. the mycelium that was being transferred.

5. the inoculating tools, equipment, containers, facilities, etc.

Different contaminants are associated with different stages of mushroom cultivation. Contaminants in agar culture most often come from airborne spores. Grain cultures contaminate from airborne spores and from a source which many cultivators fail to identify: the grain used in spawn making which is laden with spores of imperfect fungi, yeasts and bacteria. (See Ivanovich-Biserka, 1972). In compost culture, the major contributors to contamination are the materials used, the spawn, the workers or the facilities. This is not to say that contaminants can not be introduced by other means; these are the most probable sources of contamination given the cultivator has followed generally accepted procedures for mushroom culture.

Tracking down the source of contamination is not difficult. For instance, the photographs below show two media filled Petri dishes contaminated with a *Penicillium* mold. Although the contaminant may be the same, the source of contamination is likely to be quite different. The plate in Fig. 174 has a mold colony growing directly beside the wedge of mycelium that was transferred. The plate in Fig. 175 shows contamination along the outer periphery. Here is a clear example illustrating how contamination spreads.

The left plate became contaminated when the mycelium was transferred, suggesting the mold was associated with the previous culture. The right Petri dish contaminated from airborne spores which entered as the culture was incubating, judging by the proximity of the mold colonies to the outer edge. Air movement within the "sterile" laboratory most likely wafted spores towards the media plate and some penetrated the minute spaces between the lid and the base. Within the still air environment of the Petri dish, spores settled nearest to their point of entry, germinated and began resporulating, soon to be visible as a green mold. One would, therefore, implement the measures of control accordingly.

Often times the source of contamination is not obvious. Beginners are at a particular disadvantage because every contaminant they encounter is "new". With each crop, problems arise requiring novel solutions. If a certain method of cultivation has been repeatedly successful in the past and suddenly an unfamiliar contaminant appears, identifying the vector can be much more difficult. Only when the cultivator can pinpoint the variables leading to the introduction of that contaminant can appropriate counter-measures be applied. Frequently what seems to be an inconsequential alteration in technique at one stage leads to a radical escalation of the contamination rate at later stages.

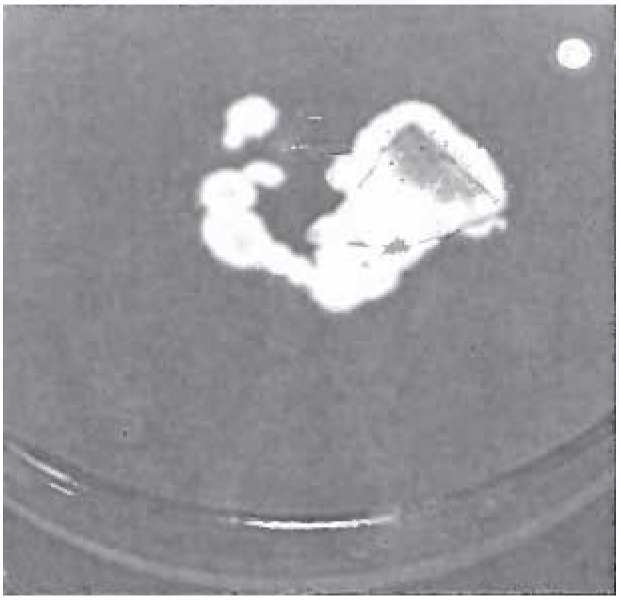


Figure 174 - *Penicillium* mold near to transferred wedge of mushroom mycelium.

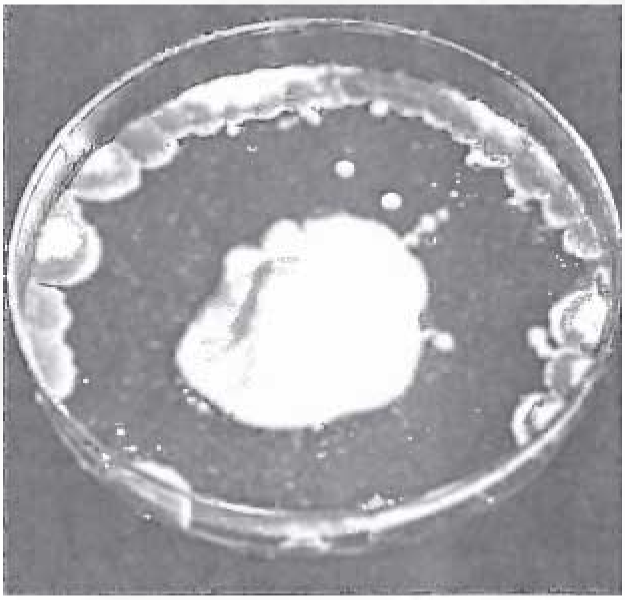


Figure 175 - *Penicillium* mold along outer periphery of Petri dish.

Since contamination at any phase of cultivation occurs for specific reasons, the contaminants can be the cultivator's most valuable guide for teaching one what NOT to do. If the problem causing organism is identified and if the recommended measures of control are carefully followed, a conscientious cultivator will avoid those conditions predisposing to that one competitor and, incidentally, many others. In effect, skill in mushroom culture is tantamount to skill in contamination control.

Molds and bacteria do not grow well in a climate specifically adjusted for mushrooms. Although both mushrooms and contaminants prefer humid conditions, the latter thrive in prolonged stagnant air environments whereas mushrooms do not. The differences are frequently subtle - amounting to only a few percentage points in relative humidity and slight adjustments to the air intake dampers in the growing room.

The contaminants can be divided into two well defined groups. Those attacking the mushrooms are called **pathogens** while those competing for the substrate are labeled **indicators** or **competitors**. (Mushroom pathogens are either molds, bacteria, viruses or pests; indicators are always fungi of some sort). In general, mushroom pathogens are not as numerous as the competitor molds, though they can be much more devastating.

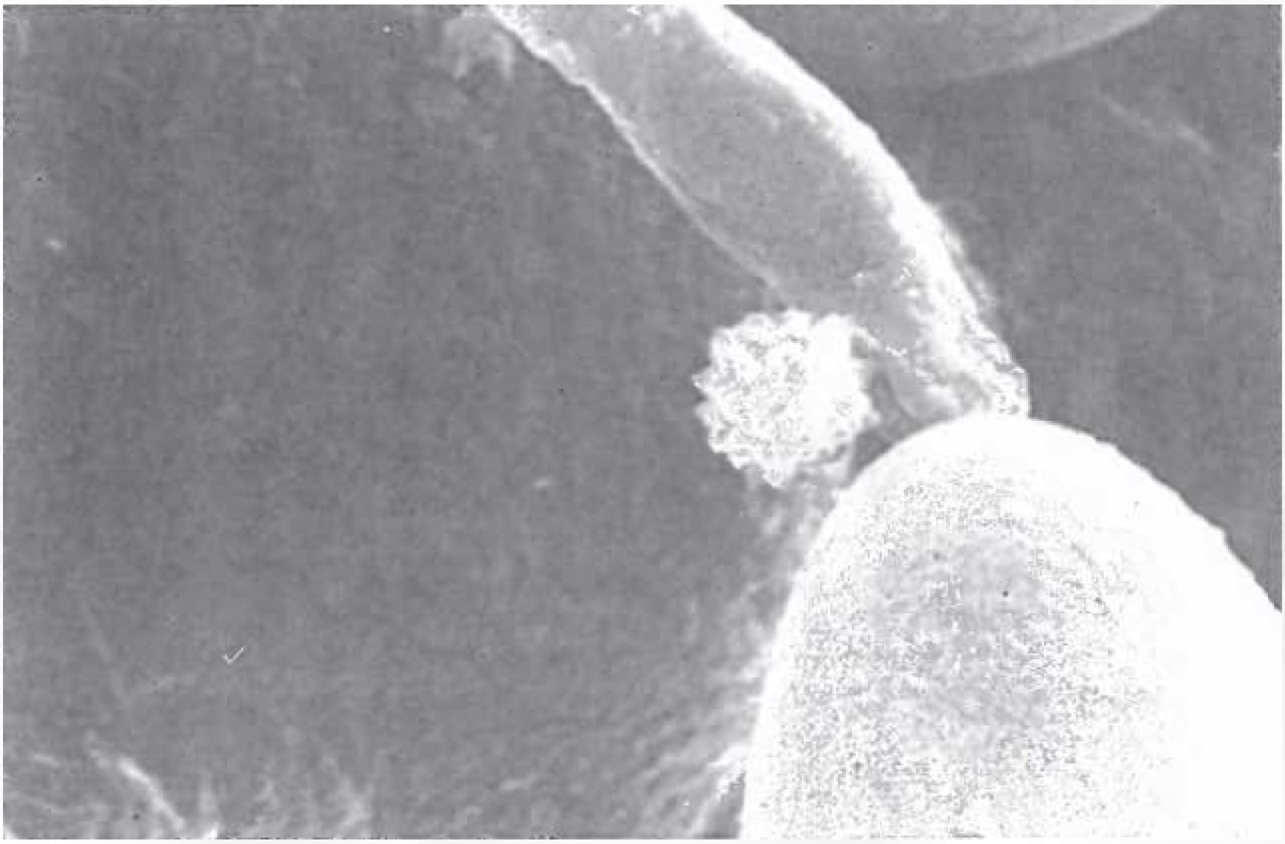


Figure 176 - High magnification scanning electron micrograph of *Aspergilus* spore beside germinating spore of *Psilocybe cubensis*.

Not all molds and bacteria are damaging to the mushroom crop. To the contrary, several are beneficial. These can not be called true "contaminants" since cultivators try to promote, not hinder, their growth. To the beginner, however, they resemble real contaminants and therefore must be included in this chapter. Examples of yield enhancing organisms are several thermophilic fungi and bacteria, including:

Humicola
Torula
Actinomyces
Streptomyces
Select *Pseudomonas* and *Bacillus* species

These organisms are encouraged during the preparation of compost or during spawn run and are rarely seen in agar or grain culture. Since they can not accurately be termed contaminants, the aforementioned groups are not in the following key though they are fully discussed in the ensuing descriptions.

Fungi, bacteria and viruses can be roughly delimited according to their size. All but viruses can be defected by the home cultivator. Viruses can prevent fruiting, malform the mushroom fruitbody, and expose the crop to further infestations from other pathogens. Since detecting viruses is beyond the means of home cultivators, they have also been excluded from this key.

RELATIVE SIZES OF THE CONTAMINANT GROUPS		
Organism	**Size (in microns)**	**Method of Detection**
Viruses	.01 - .20	X-ray defraction, transmission electron microscopy and ultracentrifuge. Typically attached to other larger particles, occurring within cells, or are present in large conglomerate colonies. Often associated with bacteria.
Bacteria	.40 - 5.0	Detected by electron microscopy, light microscopy and ultracentrifuge. Large colonies visible to unaided eye. Sometimes associated with mushroom spores or mycelium.
Fungi	2.0 - 30.0	Detected by light microscopy. Large colonies visible to unaided eye. Associated with a larger spore generating structure, often chain-like in form.

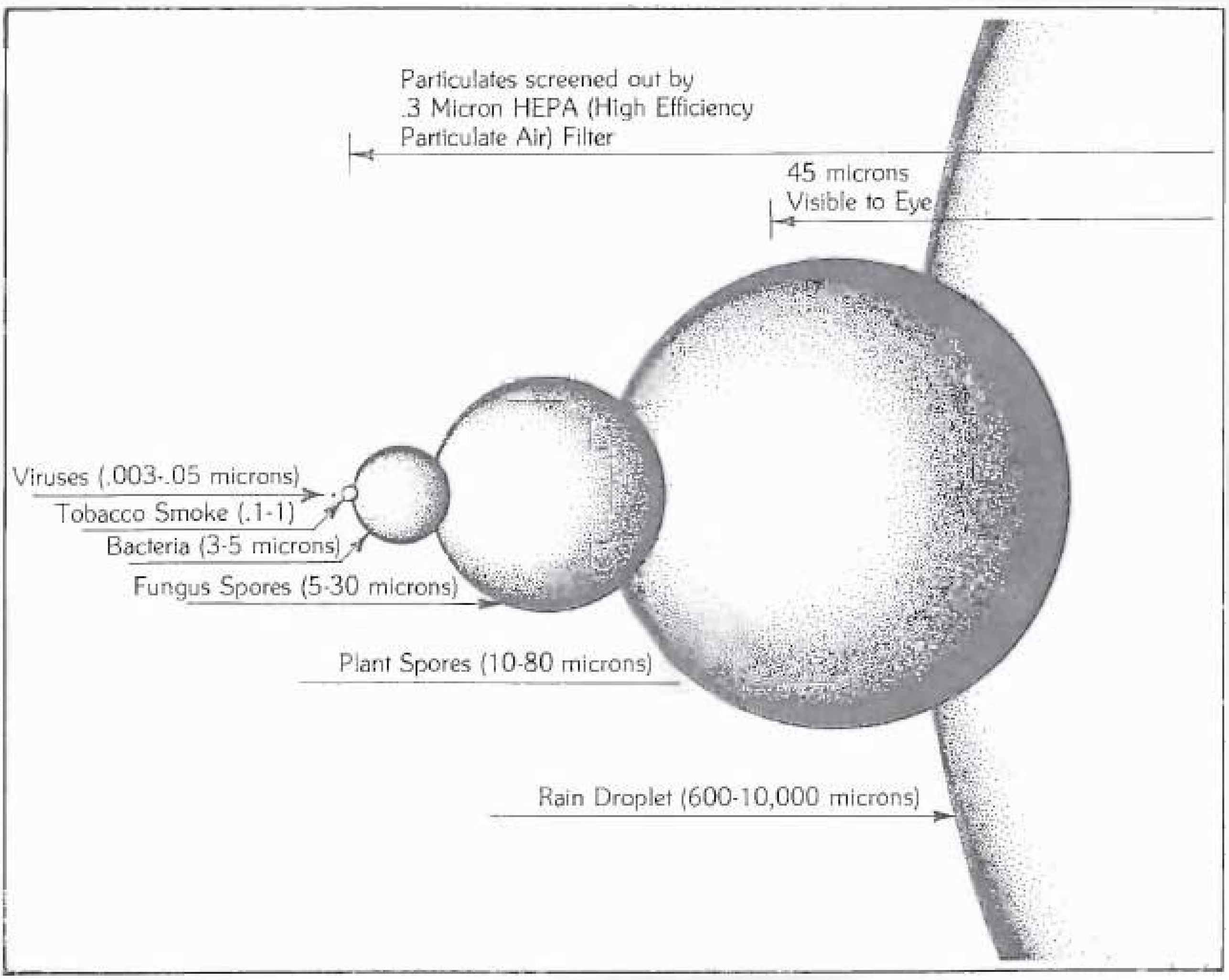

Particulates screened out by
.3 Micron HEPA (High Efficiency
Particulate Air) Filter
45 microns
Visible to Eye
Viruses (.003-.05 microns)
Tobacco Smoke (.1-1)
Bacteria (3-5 microns)
Fungus Spores (5-30 microns)
Plant Spores (10-80 microns)
Rain Droplet (600-10,000 microns)

Figure 177 - Diagram illustrating comparative sizes of airborne particulates.

What follows is a rudimentary key to the major contaminant groups encountered in mushroom cultivation with the exception of insects and viruses which are discussed in later sections. Though thousands of species of fungi exist in nature, only a small fraction are repeatedly seen in the course of mushroom culture. Hence, this key is limited to that small sphere of microorganisms and does not propose to be an all encompassing guide to the molds. Nevertheless, this key should prove to be a valuable resource for anyone interested in improving their cultivation skills. Some contaminants are keyed out more than once if occurring in various habitats, or if exhibiting significant color changes. Since color has some emphasis in this key and that feature can be substrate specific, the authors presume the agar medium employed is 2% malt based, the spawn carrier is rye grain or sawdust/bran, and the fruiting substrate is one outlined in this book.

Once led to a particular genus, refer to its description. If in doubt, a quick look under a medium power (400 X) microscope should readily discern one contaminant from another. If the contaminant can be identified but its source can not, turn the chapter entitled **Cultivation Problems and Their Solutions**. One or more of the common names have been listed under each competitor. Good luck, be meticulous in your observations and strictly adhere to the recommended measures of control.

Contaminants encompassed by this key:

Alternaria
Aspergillus
Bacillus
Botrytis
Chaetomium
Chrysosporium
Cladosporium
Coprinus
Dactylium
Epicoccum
Fusarium
Geotrichum
Monilia
Mucor
Mvcelia Sterilia
Mycogone
Neurospora
Papulospora
Penicilium
Pseudomonas
Rhizopus
Scopulariopsis
Sepedonium
Trichoderma
Trichothecium
Verticillium
Yeasts

A Key to the Common Contaminants of Mushroom Culture

This key is easy to use. Simply follow the key lead that best describes the contaminant at hand. When the key terminates at a specific contaminant, turn to the descriptions immediately following this key and then refer to the photographs and any related genus mentioned. To confirm the identity of any contaminant, compare its sporulating structures with the accompanying microscopic illustrations and/or micrographs.

1a	Contaminant parasitizing the mushroom fruitbody (a pathogen).	2
1b	Contaminant not parasitizing the mushroom fruitbody (an indicator).	7
2a	Contaminant causing mushrooms to become watery, slimy, or to have lesions from which a liquid oozes but not covered with a powdery or downy mycelium.	3
2b	Contaminant not as above but covering mushrooms with a fine powdery or mildew-like mycelium.	4
3a	Droplets forming across the cap and stem but lacking sunken lesions. Mushrooms eventually reduced to a whitish foamlike mass.	Causal organism not known "Weepers"
3b	Cap not as above but first having brownish spots that enlarge, deepen, and in which a grayish brown slime forms. Mushrooms eventually disintegrate into a dark slimy, oozing mass.	*Pseudomonas tolassii* Bacterial Blotch Bacterial Pit
4a	Contaminant eventually sporulating as a green mold on the mushroom. Usually preceded by an outbreak of green mold on the casing layer.	*Trichoderma virkie* *Trichoderma koningii* "Trichoderma Blotch"
4b	Not as above.	5
5a	Contaminant appears on the casing soil as a fast running grayish cobweb-like mycelium, enveloping mushrooms in its path. (Spores usually three or more celled and 20 x 5 microns in size. If two celled, not acorn-shaped).	*Dactylium dendroides* "Cobweb Mold"
5b	Contaminant attacking the mushroom but usually not appearing on the casing layer. (Spores single celled or if two celled, resembling a roughened acorn and measuring much less than above).	6
6a	Contaminant appears on the casing soil as a fast running grayish cobweb-like mycelium, enveloping mushrooms in its path. (Spores usually three or more celled and 20 x 5 microns in size. If two celled, not acorn-shaped).	*Mycogone perniciosa* "Wet Bubble"
6b	Contaminant afflicting young mushrooms as described above but those parasitized not exuding amber fluid when cut open. Stem in more mature mushrooms often splitting and peeling, causing the mushrooms to tilt. (Spores one celled.)	*Verticillium malthousei* "Dry Bubble"
7a	Contaminant in the form of another mushroom whose cap deliquesces (melts) into a blackish liquid with age.	*Coprinus* spp. "Inky Cap"
7b	Contaminant not as above	8
8a	Contaminant becoming pinkish to reddish to purplish colored in age.	9

8b	Contaminant not as above.	14
9a	Occurring on compost or the casing layer.	10
9b	Occurring on nutrient agar media and on grain.	11
10a	Mycelium fast growing, aerial, and never having a frosty texture. Pinkish with spore maturity. (Spores unicellular with nerve-like ridges longitudinally arranged and ellipsoid).	*Neurospora* sp. "Pink Mold"
10b	Mycelium slow growing, appressed, and developing a frosty texture. Often becoming cherry red. (Spores cylindrical and lacking nerve-like ridges).	*Geotrichum* "Lipstick Mold"
11a	Mycelial network of contaminant not well developed, not clearly visible to the unaided eye, often slime-like.	12
11b	Mycelial network of contaminant well defined and easily discernible to the naked eye, not slime like.	13
12a	More frequently seen in agar culture. (Spores produced by simple budding, ovoid, single celled).	The Yeasts see *Cryptococcus*
12b	More frequently seen in grain culture. (Spores produced on a short conidiophore, sickle shaped, and multicelled).	*Fusarium* "Yellow Rain Mold"
13a	Mycelium fast growing and aerial. (Spores with nerve-like ridges and ellipsoid).	*Neurospora* "Pink Mold"
13b	Mycelium typically slow growing and appressed. (Spores two celled, without ridges, and pear-shaped).	*Trichothecium* sp. "Pink Mold"
14a	Contaminant slime-like in form.	15
14b	Contaminant mycelium-like or mold-like in form.	17
15a	Non-motile (not moving spontaneously). Spores relatively large, 4-20 microns in diameter. Not affected by bacterial antibiotics such as gentamycin sulfate.	The Yeasts (see *Cryptococcus* and *Rhodotorula* under *Torula*)
15b	Motile (moving spontaneously). Spores relatively minute, rarely exceeding 2 microns in diameter. Growth prevented by bacterial antibiotics such as gentamycin sulfate.	16
16a	Cells rod-like in shape. Gram positive (retaining a violet dye when fixed with crystal violet and an iodine solution).	*Bacillus* "Wet Spot"
16b	Cells variable in shape. Gram negative (not retaining a violet dye when fixed with crystal violet and an iodine solution).	*Pseudomonas* "Bacterial Blotch"
17a	Contaminant mold greenish with spore maturity.	18
17b	Contaminant mold blackish with spore maturity.	20
17c	Contaminant mold brownish with spore maturity.	24
17d	Contaminant mold yellowish with spore maturity.	25
17e	Contaminant mold whitish with spore maturity.	28
18a	Forming small burrs and usually olive green in color. (Spores lemon shaped, enveloped in a sac-like structure (a perithecium)).	*Chaetomium olivaceum* "Olive Green Mold"
18b	Not as above.	19
19a	Molds typically blue-green in color. (Conidiophore diverging at apex into multiple chains of lightly pigmented single celled spores).	*Penicillium* spp. "Blue Green Mold"
19b	Molds typically true green to yellow green in color. (Condiophore swollen at apex and bulb-like (capitate), around which multiple chains of lightly pigmented single celled spores extend).	*Aspergillus* spp. "Green Mold"
19c	Molds forest green in color. (Conidiophore easily disassembling in wet mounts and difficult to observe under the microscope. Spores single celled, lightly pigmented, and encased in a mucous-like substance).	*Trichoderma* spp. "Forest Green Mold"

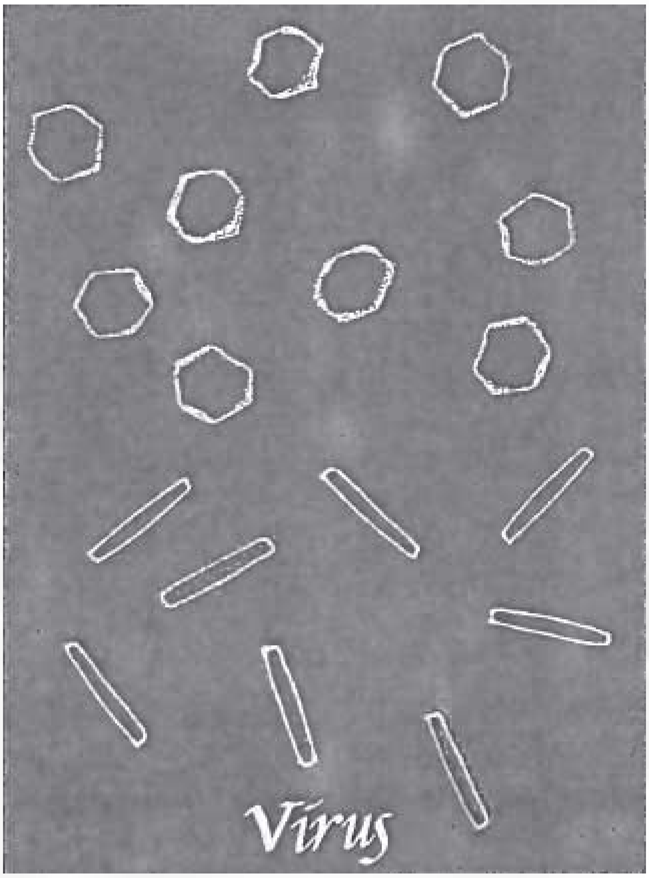
19d	Molds blackish green in color. (Conidiophores branching into few forks at whose ends darkly pigmented spores form, often two celled.)	*Cladosporium* spp. "Blackish Green Mold"
20a	Mold colony appressed, resembling a dark Penicillium-like mold, but not aerial.	21
20b	Mold colony aerial, not Penicillium-like.	22
21a	(Spores elongated and ornamented with ridges, generaly exceeding 20 microns in length and 5 microns in diameter).	*Alternaria* spp. "Black Mold"
21b	(Spores spherical, not ornamented with ridges, generally less than 5 microns in diameter).	*Aspergillus* spp. "Black Mold"
22a	Most frequently seen on compost. Resembling black whiskers. (Forming a conidiophore that diverges into multiple stalks at whose ends are chains of darkly pigmented spores).	*Doratomyces stemonitis* spp. "Black Whisker Mold"
22b	Most frequently seen in agar and grain culture. Resembling a forest of dark headed pins. (Forming a sporangiophore consisting of single stalk at whose end a ball-like sporulating structure is attached).	23
23a	Conidiophore appearing swelled at apex; partially covered by a sporulating membrane.	*Rhizopus* "Black Bread Mold" "Black Pin Mold"
23b	Conidiophore not swelled as above; apex totally covered by sporulating membrane.	*Mucor* "Black Pin Mold"
24a	Mold developing small bead-like masses of cells (easily visible with a magnifying lens). Never producing cup-like fruitbodies. (Darkly pigmented cells clustered on a mycelial mat; spores lacking).	*Papulospora byssina* "Brown Plaster Mold"
24b	Mold not developing the ball-like clusters of the above. Sometimes producing cup-like fruitbodies. (Spores produced in bunches in a grape-like fashion).	*Botrytis* "Brown Mold"
25a	Mold forming a corky layer between the casing layer and the compost, and mat-like. (Spores borne on short vase shaped pegs).	*Chrysosporium luteum* "Yellow Mat Disease" "Confetti"
25b	Mold not forming a corky layer and appearing mat-like. (Spores not borne in the manner above).	26
26a	Not occurring on compost. (Conidiophores short, arising from cushion shaped cells. Spores, if reticulated, appear to be composed of several tightly compacted cells).	*Epicoccum* "Yellow Mold"
26b	Frequently seen on compost but not exclusively so. (Conidiophores not as above. Spores appearing unicellular)	27
27a	Spores large, exceeding 5 microns in diameter, and of two types. Some spherical and spiny, forming singly at the end of individual hyphal branches; others vase shaped arising singly or in loose clusters from an indistinct, hyphal-like conidiophore).	*Sepedonium* "Yellow Mold"
27b	Spores small, less than 5 microns in diameter, ovoid, forming on chains arising from a head-like structure positioned at the apex of a long stalk.	*Aspergillus* spp. "Yellow Mold"
28a	Appearing as a dense plaster-like or stroma-like mycelium. (Condiophore brush shaped (penicillate)).	*Scopulariopsis* "White Plaster Mold"
28b	Mycelium not plaster-like. (Conidiophore not brush shaped (penicillate)).	29
29a	Spores forming from hyphae in chains.	*Monilia* "White Flour Mold"
29b	Spores absent, not forming from hyphae.	*Mycelia Sterilia* (see also: *Mucor* and *Sepedonium*).

Virus (Die-Back Disease)

Common Name: Die-back Disease; La France Disease, Mummy.

Habitat and Frequency of Occurence: An infrequent and difficult to detect disease. Their habitats are other larger particles or organisms.

Medium through which contamination is spread: Primarily from infected mycelium or from the spores of diseased mushrooms. Dieleman-van Zaayen (1972) found that the most common way virus spreads is through the anastomosing ("merging") of healthy mycelia with infected mycelia that was leftover from previous crops. Once anastomosed, the virus particles spread throughout the mycelial network of the new mycelium.



Measures of Control: Thorough disinfection of the growing room between crop rotations by steam heating for 12 hours at 158-160°F.; the installation of high efficiency spore filters to screen particulates exiting the growing environment; the disinfection of floors and hallways leading to and from the growing room with 2% chlorine solution; and picking diseased mushrooms while the veil is intact before spores have the opportunity to spread. Isolation of infected crops from adjacent rooms or those newly spawned helps retard the spread of this disease. Other measures of control include the placement of disinfectant floor mats to prevent the tracking in of virus-carrying particles on worker's shoes and the maintenance of strict hygienic practices at all times, particularly between crops.

Macroscopic Appearance: On nutrient agar media, infected mycelia slows or nearly abates in its rate of growth as the disease progresses throughout the mycelial network. When running through the casing layer, large zones one to three feet in diameter remain uncolonized. In some cases the mycelia, once present, disappears from the surface. Fruitbodies may not form at all, or when they do, the mushrooms are typically deformed (dwarfed or aborted), often with watery or splitting stems, and brown rot. The caps prematurely expand to plane. Virus infected cultures can exhibit any combination of the above described symptoms.

Microscopic Characteristics: Particles typically ovoid to polyhedral, measuring 25 or 34 nanometers. Elongated particles measure 19-50 nanometers. Virus particles dwell within hyphal cells or on the surfaces of spores. They are detectable only through transmission electron microscopy or ultracentrifuging.

History, Use and/or Medical Implications: Responsible for many plant, animal and human diseases. Typically viruses are associated with larger carrier particles, particularly bacteria.

Comments: Virus is most likely introduced during or directly after spawning. Infected farms experience losses up to 70%. First reported from Europe, measures of control and prevention have been developed and successfully tested by the Dutch. Most notably, virus spreads by attaching itself to mushroom spores which then become airborne. Virus also spreads through the contact of healthy mycelia with diseased mycelia. Afflicted mushrooms are soon exploited by a host of other parasites, making a late and accurate diagnosis of this contaminant difficult.

Undoubtedly, virus is the cause of what many have noted as "strain degeneration". Heat treatment of infected strains grown on enriched agar media at 95°F. for three weeks has been suggested as one remedy for curing diseased mycelia. (See Candy and Hollings, 1962 and Rasmussen *et al*., 1972).

Van Zaayen (1979) and others have noted that *Agaricus bitorquis* seems resistant to virus disease even when inoculated with in vitro particles. Another species of *Agaricus*, called *Agaricus arvensis*, exhibits similar virus resistant qualities.

Virus-like particles have also been found in *Lentinus edodes* by Mon et alia (1979) but do not adversely affect fruitbody formation or development. These same researchers reported that this species' viruses can not be transmitted to other mushrooms or plants, a fact they attributed to the interferon producing properties of the shiitake mushroom. No work with infected strains of *Psilocybe* are known. Only a fraction of wild mushrooms harbor virus-like particles.

Actinomyces (Firefang)

Class: *Actinomyces*

Order: *Actinomycetales*

Family: *Actinomycetaceae*

Common Name: Firefang

Greek Root: From "actino" meaning rayed or star-like and "myces" or fungus, in reference to its characteristic appearance when colonizing straw or straw/manure compost.

Habitat & Frequency of Occurrence: Many species thermophilic; thriving in the 115-135°F. temperature range and commonly found in decomposing straw, horse and cow manures. *Actinomyces* are important soil constituents. They thrive in aerobic, well prepared mushroom composts.

Medium Through Which Contamination Is Spread: Primarily air; secondarily the straw used in compost preparation.

Measures of Control: Generally no controls are necessary during compost preparation. However, *Actinomyces* can cause spontaneous combustion in wet, compacted straw. Covering stored baled straw from excess water absorption should be adequate protection from *Actinomyces* and the thermogenic reactions they cause.

Macroscopic Appearance: Grayish to whitish speckled colonies, readily apparent on dark composted straw.

Microscopic Characteristics: Composed of an extensive, fine hyphal network that rarely branches. Rod-like spores form when the filaments break at the cell wall junctions. The filamentous hyphae and spores are minute, measuring only 1 micron in diameter. Within each cell, no well defined nucleus is discernible. Lacking differentiated spore-producing bodies, *Actinomyces* are Gram-positive.

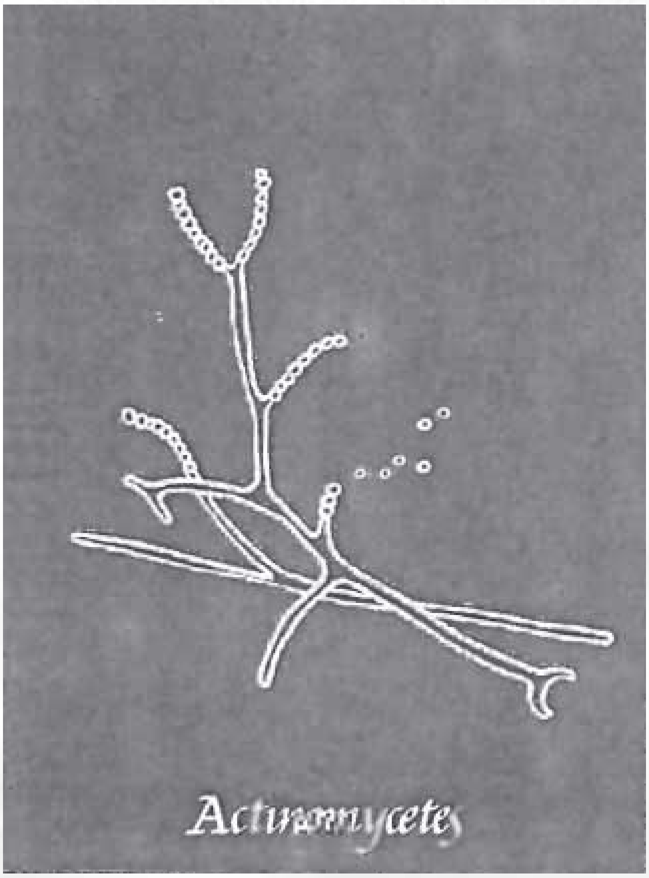


Figure 178 - Drawing of Actinomyces.

History, Use, and/or Medical Implications: Few species pathogenic. Amongst agricultural workers in the same position, males are three times more susceptible to this bacterium than females (see Cruickshank *et al*., 1973). Two notable species causing serious diseases (actinomycosis) of the skin and oral cavity in humans are *Actinomyces bovis* and *Actinomyces israelii*. Generally, these species behave as secondary infectious organisms. Penicillin is often used for treatment. Actinomycin, a potent antibiotic compound interfering with RNA synthesis, is derived from this group of bacteria.

Although the likelihood of mushroom growers contracting actinomycosis is remote, workers spawning compost are exposed to high concentrations of *Actinomyces* spores and often report less severe, temporary allergic reactions. Therefore, the use of a filter mask when spawning large volumes of compost is advisable.

Comments: The *Actinomyces* resemble both bacteria and fungi and have alternately been called one or the other. Presently, the prevailing belief is that they are filamentous (Gram-positive) bacteria because they are prokaryotic (lacking a defined nucleus), are inhibited by bacterial antibiotics and not affected by fungal antibiotics;, and lack the chitin-like compounds so typical of the true fungi. The hyphal filaments of *Actinomyces* are one fifth to one tenth as thick as those of true fungi.

Actinomyces are commonly called Firefang for their ability to cause spontaneous combustion of decomposing materials. (Spontaneous combustion is prevented by proper composting practices.) Many of these bacteria/fungi are true thermophiles and can live aerobically or anaerobically. *Actinomyces* is the major microorganism selected to colonize the compost during Phase II. When the finished compost is spawned, *Actinomyces* are consumed by the mushroom mycelia.

See also *Streptomyces*. See Color Photo VIII.

Bacillus (Wet Spot)

Class: *Schizomycetes*

Order: *Eubacteriales*

Family: *Bacillaceae*

Common Name: Wet Spot; Sour Rot.

Latin Root: From "bacilliformis" meaning rod-like, in reference to its characteristic shape.

Habitat & Frequency of Occurrence: Living within a broad range of habitats. *Bacillus* grows on almost anything organic that is moist and is surrounded by oxygen. It is particularly common in soils.

Medium Through Which Contamination Is Spread: Primarily through the air; secondarily through water, grain, soils, composts, insects, tools and workers.

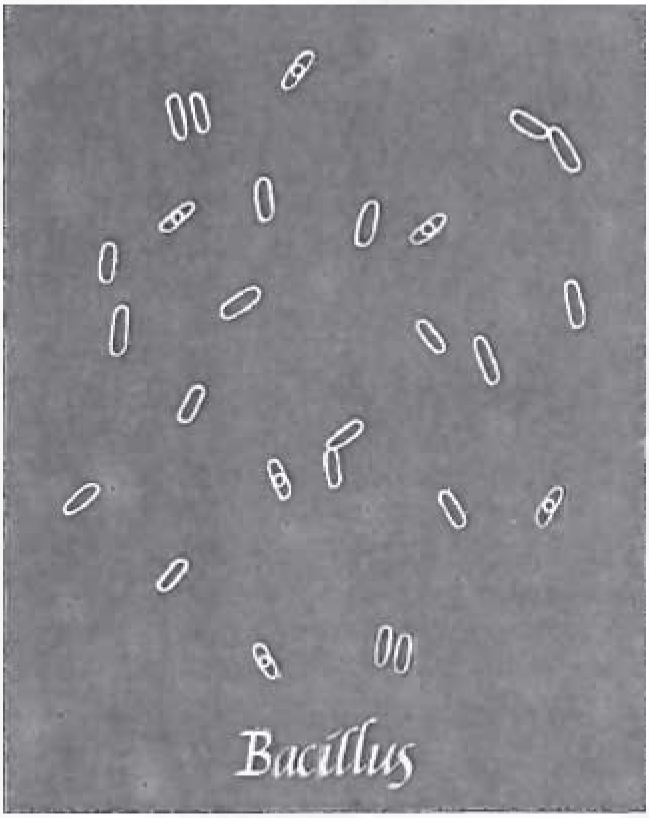


Figure 179 - Drawing of endospore forming *Bacillus* cells as they appear through a microscope and without special stains.

Measures of Control: Air filtration through high efficiency particulate air filters; thorough sterilization of grain; and proper storage and use of relatively "clean" grains. The addition of antibiotics to agar media (gentamycin sulfate, penicillin, streptomycin, aureomycin, etc.) hinders or prevents the growth of these contaminants. Endospores are neutralized by exposure to moist heat, such as the steam generated within a pressure cooker at temperatures of 250°F. and 15 psi pressure for a full hour. Temperatures as low as 140°F. kill the vegetative parent cells but not the endospores they form.

Macroscopic Appearance: A dull gray to mucus-like brownish slime characterized by a strong but foul odor variously described as smelling like rotting apples, dirty socks or burnt bacon. *Bacillus* makes uncolonized grain appear excessively wet, hence the name "Wet Spot". Pallid to whitish ridges along the margins of individual grain kernels characterize this contaminant.

Microscopic Characteristics: Rod-like or cylindrical in shape, measuring 0.2-1.2 microns in diameter and 1-5 microns in length. When wet mounts are viewed through a microscope, *Bacilli* excitedly wriggle back and forth. Species move by the vibrating action of flagella ("hairs") that outline each cell. These flagella are difficult to observe microscopically without using specific staining techniques. *Bacilli* are encapsulated by a thin but firm slime and conglomerations of cells give infected grain a slimy appearance. *Bacillus* primarily reproduces through simple cell division. In times of adverse environmental conditions, especially heat, a single hardened spore forms within each parent cell body. These endospores show an extraordinary resistance to heat, are low in water content and are unaffected by drying. Species in this genus are Gram positive.

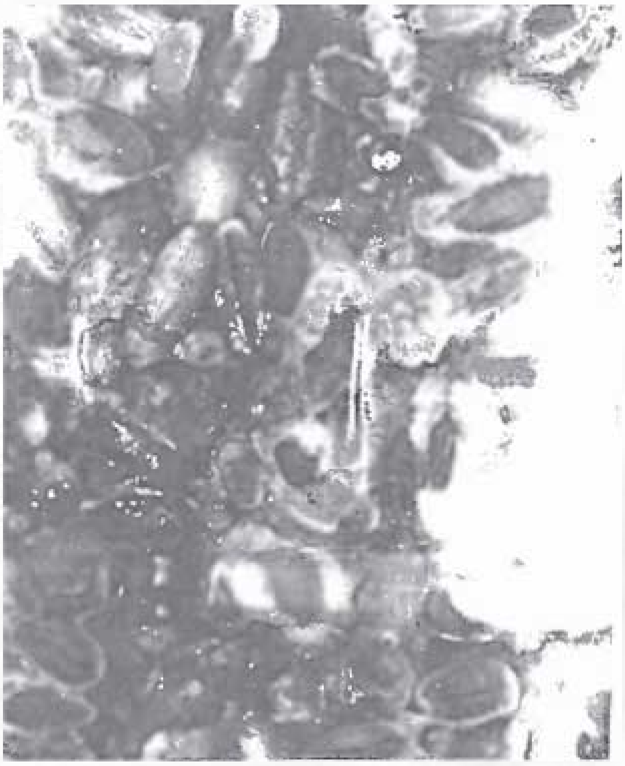
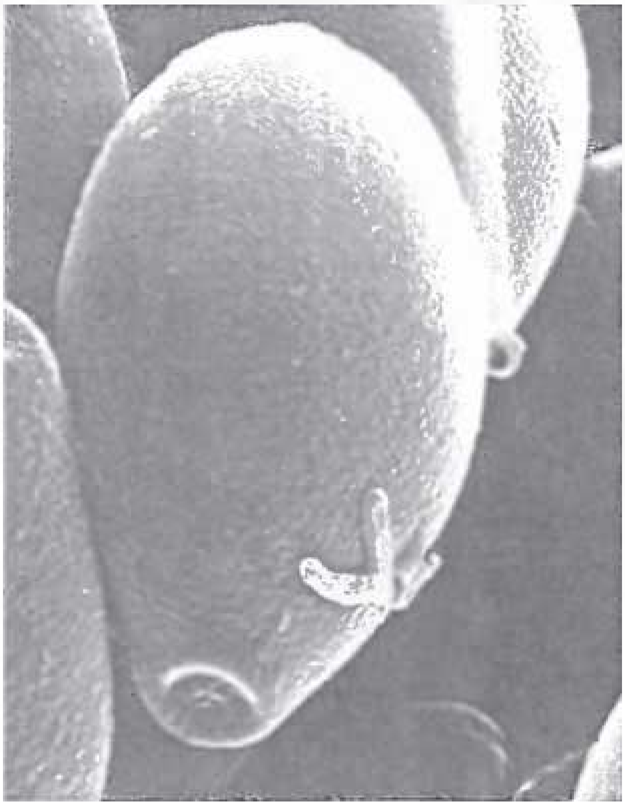
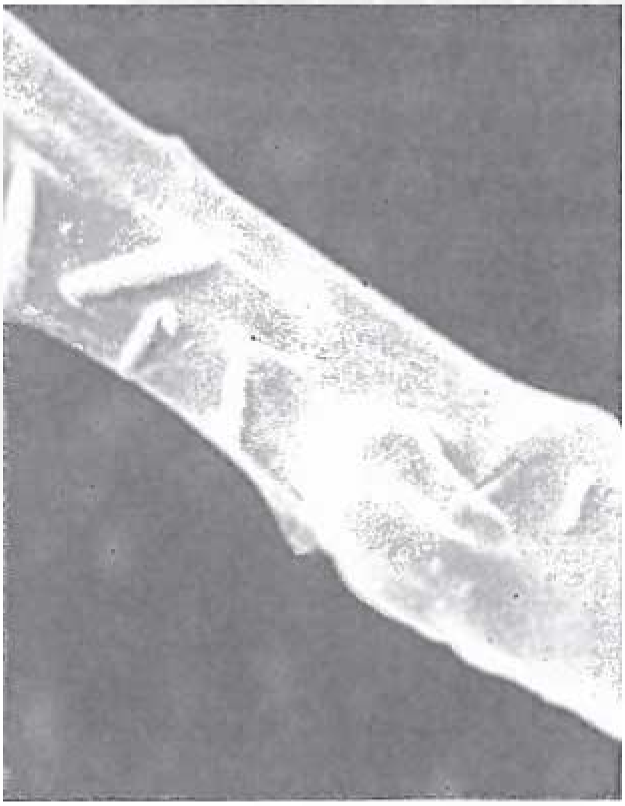


Figure 180 - *Bacillus*, the Wet Spot bacterium, as it appears on grain.

Figure 181 - Scanning electron micrograph of rod shaped bacteria on a spore of *Panaeolus acuminatus*.

Figure 182 - Scanning electron micrograph of rod shaped bacteria on mycelium of *Psilocybe cubensis*.





History, Use, and/or Medical Implications: The most notable species in the genus is *Bacillus anthracis*, the cause of the hideous Anthrax disease that killed several thousand sheep when an United States Army experiment went awry in Utah during the 1950s. Home cultivators are, however, unlikely to be exposed to this species. Most endospore forming bacteria are not virulent. *Bacillus subtilis*, the bacterium spoiling grain spawn, is being developed to replace *E. coli* as a recombinant-DNA fermentor. *Clostridium* is a genus similar to *Bacillus* except that it is anaerobic. That genus is reknowned for one toxic species in particular: *C. botulinum*, the cause of botulism.

Comments: A pernicious and tenacious competitor, *Bacillus* contamination is the most difficult to control. At room temperature, a single cell reproduces every 20 minutes and will multiply into nearly a million daughter bacteria in only seven hours. In another seven hours each one of those million bacteria divide into a million more cells. Thus, in less than fourteen hours, one trillion bacteria evolve from a single parent cell!

The phenomenonal reproductive capability of *Bacillus* and other bacteria poses a formidable threat to the spawn maker. Although parent cells are easily destroyed, their endospores are not. Under dry conditions, endospores form in increasing numbers as temperatures rise to 130°F. In boiling water (212°F.), endospore viability markedly decreases. (Ninety percent of *Bacillus* spores are killed in only one minute at 212°F.). At the higher temperatures and pressures within an autoclave the survivability of *Bacillus* spores falls well below 1%. Nevertheless, this 1% seriously obstructs any attempt at grain culture given *Bacillus*' rapid reproductive capability. This problem is compounded if the bacteria count in the grain is initially high.

In one study (Shull and Ernst, 1962), the thermal death time (TDT) of an exposed *Bacillus stearothermophilus* population of 1,300,000 endospores was pinpointed at 250°F. for 13 minutes. (In a pressure cooker at sea level, 250°F. corresponds to 15 psi). Food researchers concerned with food-spoiling bacteria (particularly *Clostridium*) have shown that endospore endurance to heat is directly related to the amount of calcium in the host substrate. Once formed, endospores can sit dormant for extended periods of time. Even endospores removed from the stomachs of mummies have proved viable after hundreds of years.

Although an autoclave may read a certain temperature, the grain within the spawn containers may be well below that reading. To guarantee adequate steam penetration, the water in pressure cookers should be brought to a boil for 5 minutes before closing the vent valve. Furthermore, bacteria within the spawn container are partially protected from the sterilizing influence of steam by the structural cavities of the grain medium. This delay in steam penetration time is especially characteristic of large, heavily packed autoclaves.

Despite the fact that autoclaving for one hour at 15 psi is sufficient to kill most contaminants, grain having initially high bacteria populations may require sterilization at higher temperatures and for prolonged periods of time. Autoclaving quart jars for 1 hour at 270°F. (which is equivalent to 27 psi) is sufficient to neutralize grain heavily infested with endospore forming bacteria. If converting a standard home pressure cooker for this purpose, contact the manufacturer about stress limitations and follow all safety recommendations.

If "sterilized" rye grain spontaneously contaminates with bacteria before inoculation and the grain is the cause, it is best to replace the grain with a cleaner one than to undergo the expense and time of double sterilization. Some spawn laboratories regularly precook their grain for approximately 2 hours in water at a low boil. Excess water is allowed to drain from the grains which are then placed into the spawn container and sterilized at standard time and pressure.

The most practical method for eliminating bacterial endospores involves soaking the grain at room temperature 24 hours prior to sterilization. Endospores, if viable, will germinate within that time frame and then be susceptible to standard sterilization procedures. And, new endospores won't form in the moist environment of the resting jar of grain.

Bacillus subtilis var. *mucoides* is the common bacterium responsible for spoiling spawn media. If allowed to proliferate, this contaminant wreaks havoc in a spawn laboratory, necessitating a complete shut-down of operations. Spores and even strains of mushroom mycelium can become hosts for *Bacillus*, carrying bacteria on their hyphae (see Figs. 181 & 182), and then contaminating any media onto which the mushroom mycelia is transferred.

Many bacteria are rod-shaped and the term bacillus has been loosely used to describe them. The genus concept of *Bacillus*, however, has been narrowed considerably with time; *Bacillus* is now defined as Gram positive rod-like, aerobic bacteria that form spores.

According to Park and Agnihotri (1969), *Bacillus megaterium* stimulates primordia formation in certain strains of *Agaricus brunnescens* (*bisporus*). (See Appendix II for a futher discussion on the influence of bacteria on fruiting). Another species, *Bacillus thermofibricolous*, if introduced at spawning, inhibits the growth of competitor molds in rice bran/sawdust spawn prepared for shiitake cultivation according to Steineck (1973).

See also *Pseudomonas*.

Pseudomonas (Bacterial Blotch & Pit)

Class: *Schizomycefes*

Order: *Pseudomonadales*

Family: *Pseudomonaceae*

Common Name: Bacterial Blotch; Bacterial Pit.

Greek Root: From "pseudes" meaning spurious, false or deceptive and "monas" meaning one or a single unit, in reference to the variable forms of this single celled bacterium.

Habitat & Frequency of Occurrence: Ubiquitous in all soils and abounding in aqueous habitats. *Pseudomonas tolaasii* commonly parasitizes mushrooms that remain wet over a prolonged period of time.

Medium Through Which Contamination Is Spread: Primarily water; secondarily through grain, soils, composts, flies, mites, nematodes, tools and workers.

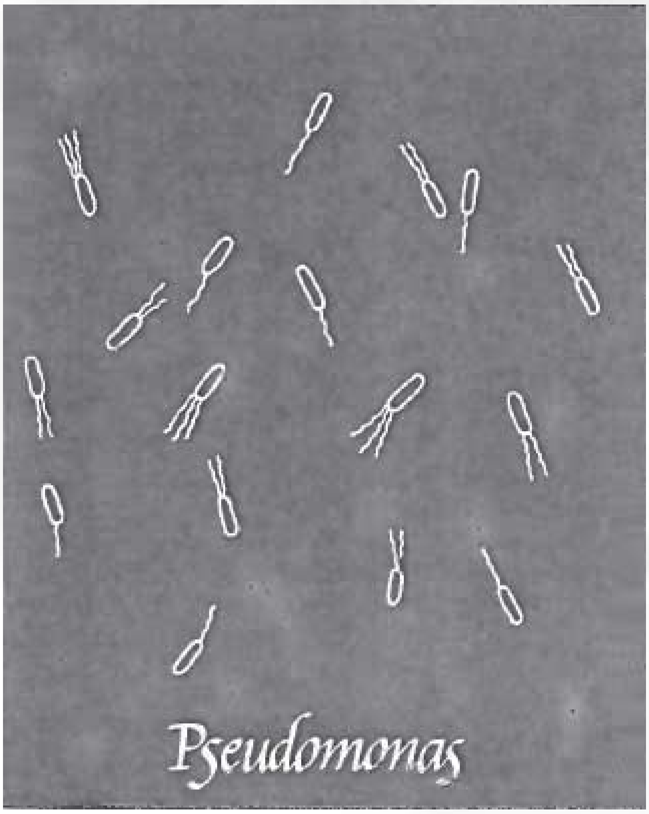


Figure 183 - Drawing of *Pseudomonas*, a genus of variably shaped bacteria that have hair-like flagella at their ends.

Measures of Control: Use of mildly chlorinated water (150-250 ppm) or water free of high bacteria counts. This contaminant can easily be prevented by: isolating and properly disposing of infected fruitbodies; eliminating excessively high humidity levels during cropping (greater than 92%); and preventing stagnant air pockets through a good air circulation system. Maintaining a sufficient evaporation rate lessens the likelihood of these bacteria infecting the fruitbodies.

Macroscopic Appearance: Yellowish spots or circular or irregular lesions; superficial; rapidly reproducing on wet mushrooms; and becoming chocolate brown and slimy with age. This bacterium has a dull gray to mucus-like brownish slime. It also has a mildly to strongly unpleasant odor.

Microscopic Characteristics: Cylindrical (bacilli) and spherical (cocci) forms characterize this genus. Cells are extremely variable in shape, measuring 0.4-0.5 x 1.0-1.7 microns. Typically the bacterial cell has one or more flagella ("motile hairs") at one or both of its poles. (*Bacillus* has flagella along its entire outer periphery). Both organisms use these flagella for locomotion. Species in this genus are generally Gram negative.

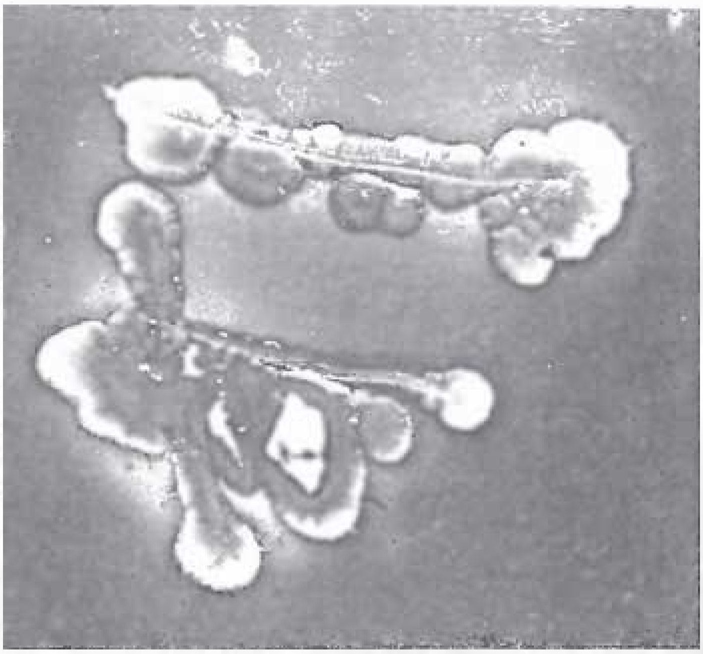
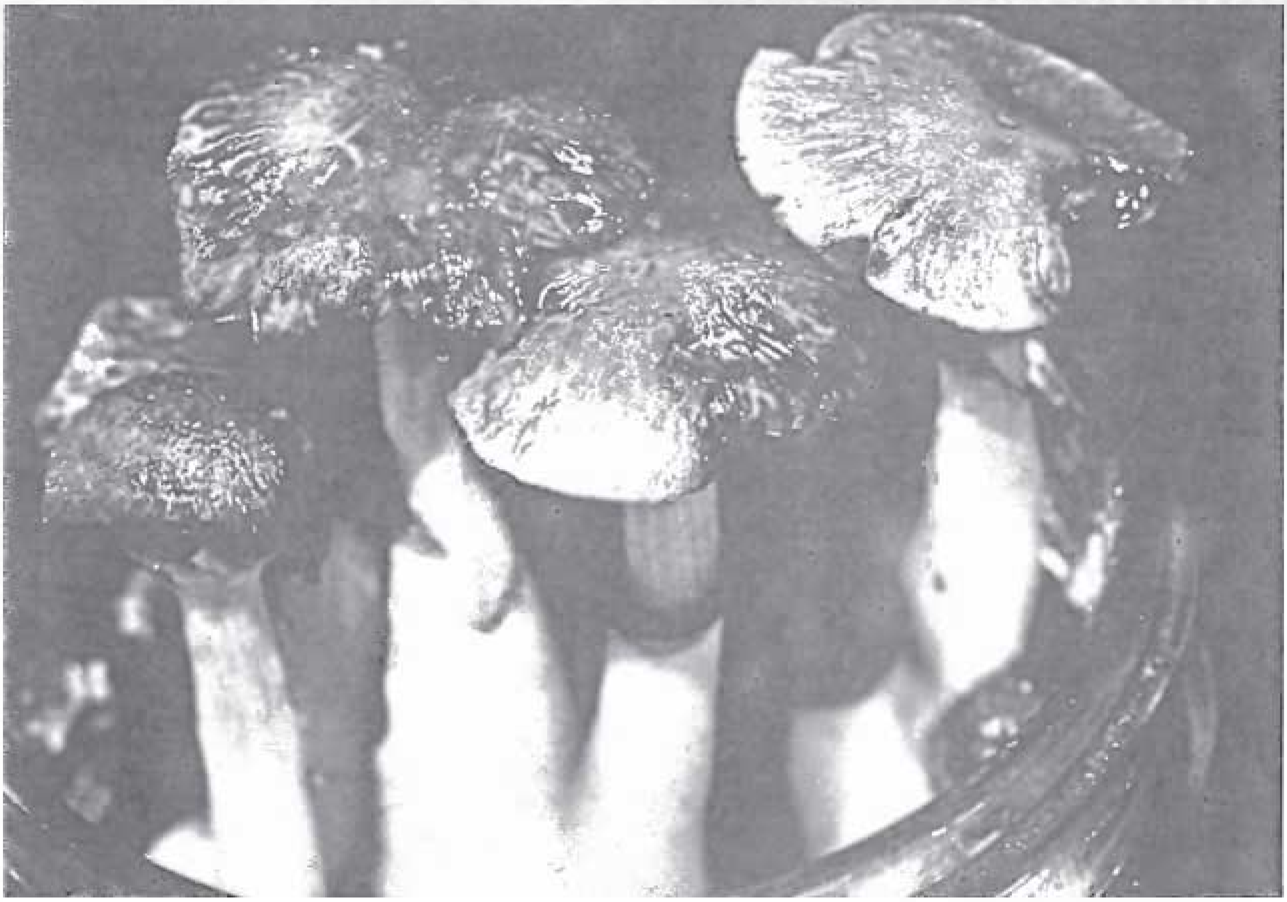


Figure 184 - *Pseudomonas putida*, a beneficial bacterium stimulatory to formation of fruitbodies in some mushroom species, growing on malt agar.

Figure 185 - Bacterial pit on *Psilocybe cubensis* from a *Pseudomonas* species.



History, Use and/or Medical Implications: Some species pathogenic to humans. Of special note is *Pseudomonas aeruginosa* (also known as *Ps. pyocyanea*), a species that causes blindness and other diseases.

Pseudomonas putida is stimulatory to primordia formation in certain strains of *Agaricus brunnescens* (*bisporus*) and its use is of potential commercial value.

Comments: More than 140 species have been identified thus far; only a few have been identified as affecting mushrooms. *Pseudomonas* species are much more sensitive to heat sterilization than the endospore-forming bacilli. *Pseudomonas* bacteria proliferate in standing water or anywhere there is moisture.

Pseudomonas tolaasii is the cause of bacterial blotch that can devastate crops of *Agaricus* and *Psilocybe*. One biological remedy for controlling this species was proposed by Nair and Fahy (1972) who showed that introduction of *Pseudomonas fluorescens*, a natural antagonist to *Pseudomonas tolaasii*, markedly decreased the occurrence of blotch while not hindering *Agaricus brunnescens* yields. Others believe *Pseudomonas fluorescens* to be merely a variety of *Pseudomonas tolaasii*, and hesitate to recommend it.

In a characteristic manner, *Pseudomonas tolaasii* causes sunken grayish brown lesions on the mushroom cap in which a slimy fluid collects. Another *Pseudomonas* species, yet unidentified, has been implicated in the cause of a more severe form of blotch, Bacterial Pit.

Pseudomonas also contaminates agar and grain cultures, inhibiting mycelial growth. The use of antibiotics (gentamycin sulfate) or micron filters prevents outbreaks of this contaminant. A few species cause the mycelium to grow more rapidly and luxuriantly. Similarly, considerable attention has centered on the beneficial role of *Pseudomonas putida* and allies in the casing layer. This subject is discussed in detail in Appendix II.

See also *Bacillus*.

Streptomyces (Firefang)

Class: *Actinomyces*

Order: *Actinomycetales*

Family: *Streptomycetaceae*

Common Name: Firefang.

Greek Root: From "strepto" meaning twisted and "myces" or fungus, in reference to the twisting and branching filaments that give rise to spores.

Habitat & Frequency of Occurrence: Ubiquitous on straw, manures and soil. *Streptomyces* is a predominant microoganism in the compost pile, thriving between 115-135°F. and preferring aerobic zones.

Medium Through Which Contamination Is Spread: Primarily air; secondarily from materials used in composting. *Streptomyces* are naturally present in all soils.

Measures of Control: Generally no controls are necessary during compost preparation, nor desired. General hygienic practices prevent this bacterium from becoming a problem contaminant in the laboratory.

Macroscopic Appearance: Grayish to whitish specked colonies, readily apparent on composted straw. On grain, *Streptomyces* has a delicate whitish mycelium and is powdery in form.

Microscopic Characteristics: Composed of an extensive, fine hyphal network, often branching, coiled and twisted. The hyphae in *Streptomyces* do not fragment into spores as in *Actinomyces* but form a chain-like structure of aerial hyphae called a sporophore from which cells evolve terminally. The filamentous hyphae and spores measure only 1 micron in diameter. Within each cell, no well defined nucleus is discernible. *Streptomyces* lack differentiated spore-producing bodies. Its spores are smooth or spiny.

History, Use, and/or Medical Implications: *Streptomyces* represents 80% of all actinomycetes which inhabit mushroom compost and is selected for its beneficial properties during Phase II. (See Chapter V).

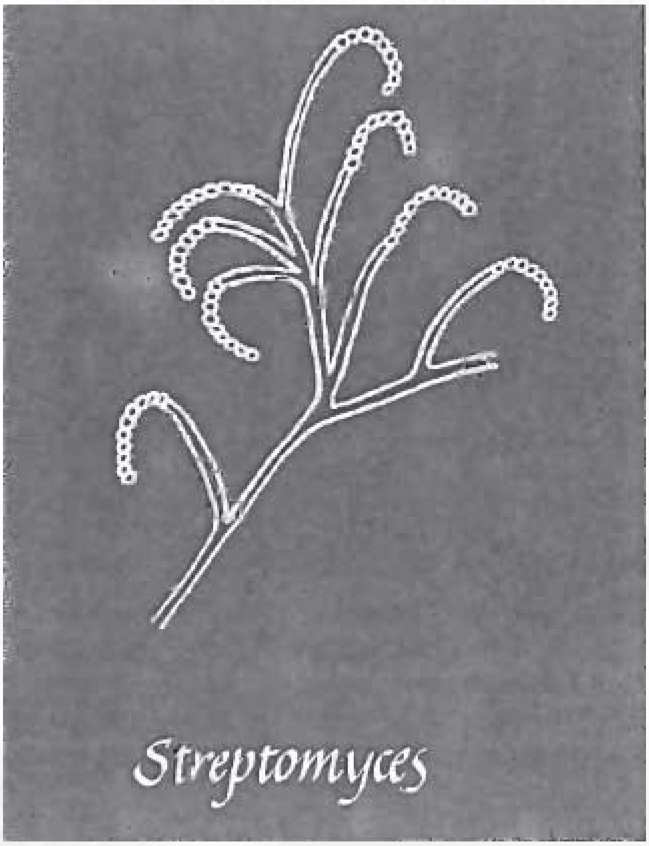


Figure 186 - Drawing of spore producing cells of *Streptomyces*.

Streptomyces griseus is the source of the antibiotic streptomycin, first discovered by Waksman in 1944. The autoclavable antibiotic gentamycin is derived from a genus closely allied to *Streptomyces*, the genus *Micromonospora*.

Comments: *Streptomyces* resemble both bacteria and fungi and are sometimes referred to as the "higher bacteria." *Streptomyces* differ from *Actinomyces* in that their spores are produced on an aerial chain-like structure and do not simply fragment from the hyphal network. Also, the filaments of *Streptomyces* frequently branch whereas those of *Actinomyces* do not. The hyphal filaments of *Streptomyces* are one fifth to one tenth as thick as that of true fungi.

Donoghue (1962) reported that a *Streptomyces* contaminant initiated fruitbodies in spawn of *Agaricus bisporus*, a species that does not normally form mushrooms on grain. Furthermore, he observed that mycelia associated with *Streptomyces* grew faster and more luxuriantly than those not infected with it. (For more information on the influence of bacteria on mycelial growth and fruiting, turn to Appendix II.)

See also *Actinomyces*.

For more information consult: Kurylowicz, W. *et al*., 1971 in "Atlas of Spores of Selected Genera and Species of *Streptomycetaceae*," University Park Press, Baltimore.

Alternaria (Black Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Dematiaceae*

Common Name: Black Mold; Gray Black Mold; Black Point.

Latin Root: From "alternus" which means alternating, in reference to the chains of alternating spores, which so characterize this genus.

Habitat & Frequency of Occurrence: Very common in nature, occasionally to frequently encountered in spawn production, and present in large numbers in household dust. *Alternaria* is infrequently seen on rye grain, and according to Bitner (1972), this contaminant is more prevalent on sorghum than on other grains. *Alternaria* is one of the major fungal saprophytes on grain, seeds, straw, leaves, rotting fruits and unsalted butter. In temperate climatic zones, it is more prevalent in the late summer and fall than at any other time.

Medium Through Which Contamination Is Spread: Air.

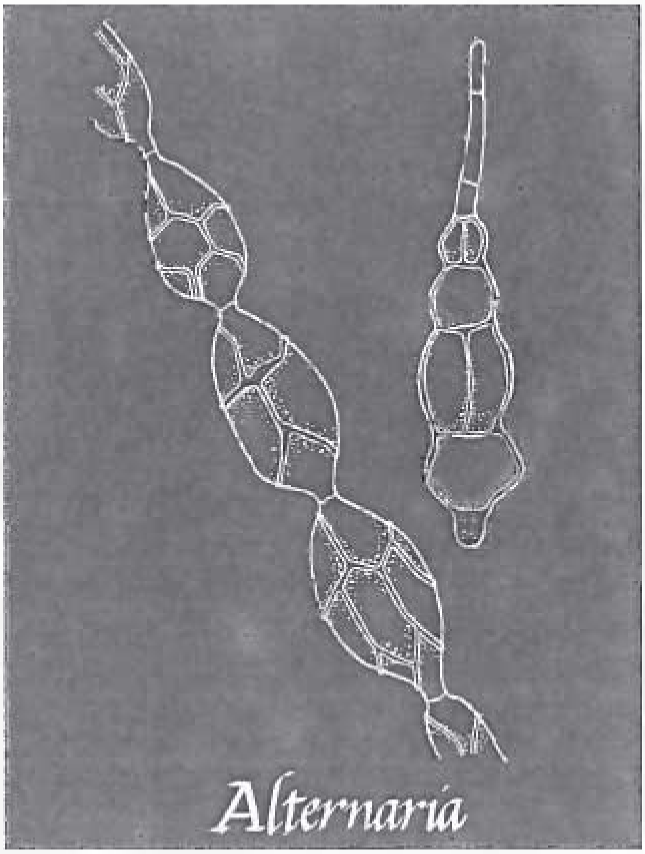


Figure 187 - Drawing of conidia typical of the genus *Alternaria*.

Measures of Control: Good hygienic habits; maintenance of a low dust level; and filtration of air through micron filters.

Macroscopic Appearance: A rapidly growing rich gray black to blackish mycelium. *Alternaria* first appears as scattered blackish spots in the spawn jars, soon spreading and overwhelming the mushroom mycelium. On agar, it resembles a black *Penicillium*-like mold.

Microscopic Characteristics: Vertically oriented lengths of cells (hyphae) emerging from a mat of mycelium that segregates into conidia, and which originated through pores at the apices of vertically oriented hyphae. Conidia (spores) are usually multicelled, sometimes two celled and large, measuring 20-100 x 6-30 microns.

History, Use and/or Medical Implications: Species in this genus causing allergies and other respiratory ailments in humans, particularly hay-fever. Because of their large size, *Alternaria* spores soon settle, falling at a rate of 3 millimeters/second in still **air**.

Comments: A black mold, occasional to common on enriched agar, easily separated from similarly colored molds by its unique conidia (spores). It has been claimed that *Alternaria* more frequently contaminates sorghum than rye although the authors can not corroborate this statement from their experiences.

See *Aspergillus* and *Cladosporium*.

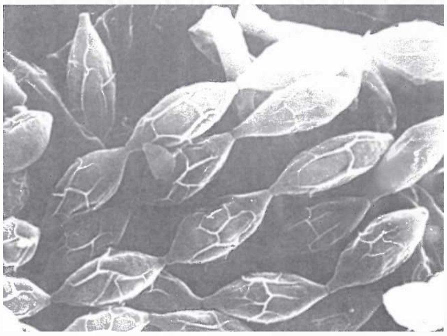


Figure 188 - Scanning electron micrograph of *Alternaria* conidia.

Aspergillus (Green Mold)

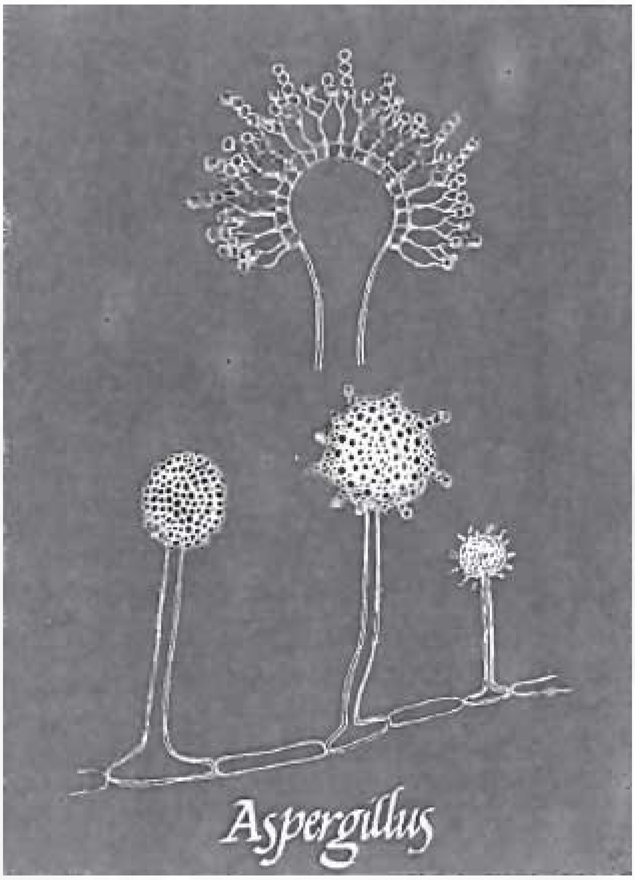


Figure 189 - Drawing of the characteristic sporulating structure of *Aspergillus*.

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Eurotiaceae*

Common Name: Green Mold; Yellow Mold; Black Mold.

Latin Root: From "aspergilliformis" which means brush-shaped in reference to the shape of the conidiophore.

Habitat & Frequency of Occurrence: Very common in agar and grain culture, and in compost making. Found on most any organic substrate, *Aspergillus* prefers a near neutral to slightly basic pH. Well used wooden trays and shelves for holding compost are frequent habitats for this contaminant in the growing house.

Medium Through Which Contamination Is Spread: Air.

Measures of Control: Good hygienic practices; removing supportive substrates, especially food residues and spent compost; and filtration of air through micron filters.

Macroscopic Appearance: Species range in color from yellow to green to black. Most frequently, *Aspergillus* species are greenish and similar to *Penicillium*. *Aspergillus niger*, as its name implies, is black; *Aspergillus flavus* is yellow; *Aspergillus clavatus* is blue-green; *Aspergillus fumigatus* is grayish green; and *Aspergillus veriscolor* exhibits a variety of colors (greenish to pinkish to yellowish). These molds, like many others, change in color and appearance according to the medium on which they occur. Several species are thermophilic.

Microscopic Characteristics: Sporulating structure tall, unbranched, stalk-like, supporting at its apex a spherical head to which linearly arranged chains of single celled spores (conidia), measuring 3-5 microns, are attached.

History, Use and/or Medical Implications: Some species toxic. *Aspergillus flavus*, a yellow to yellowish green species, produces the deadly aflatoxins. *A. flavus* attacks cottonseed meals, peanuts and other seeds high in oil that have been stored in hot, damp environments. Of all the biologically produced toxins, the alfatoxins are the most potent hepatacarcinogens yet found. The toxicity of this species was largely unknown until, in 1960, 100,000 turkeys mysteriously died from an outbreak of this disease in Great Britain.

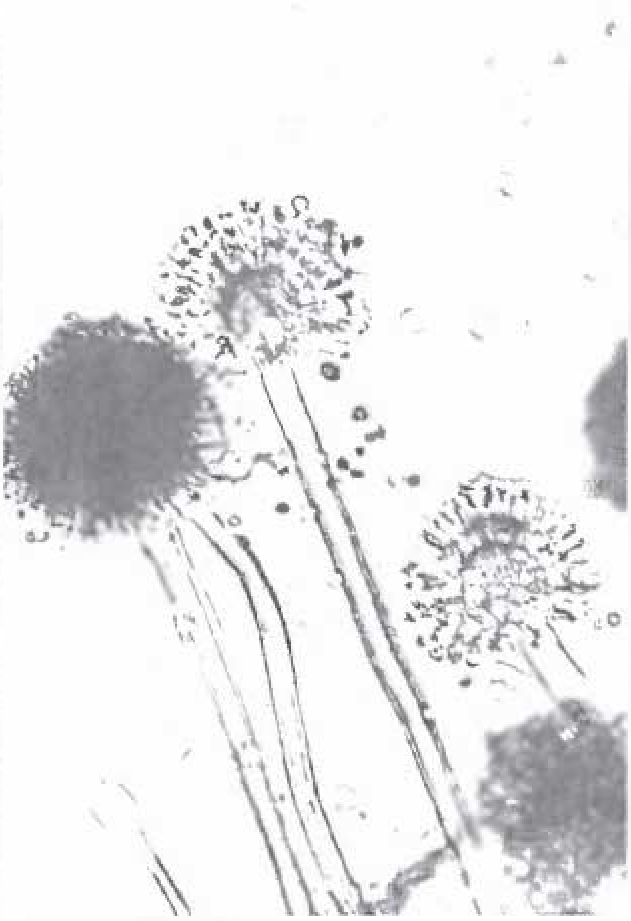


Figure 190 - *Aspergillus* species as seen through a light microscope.

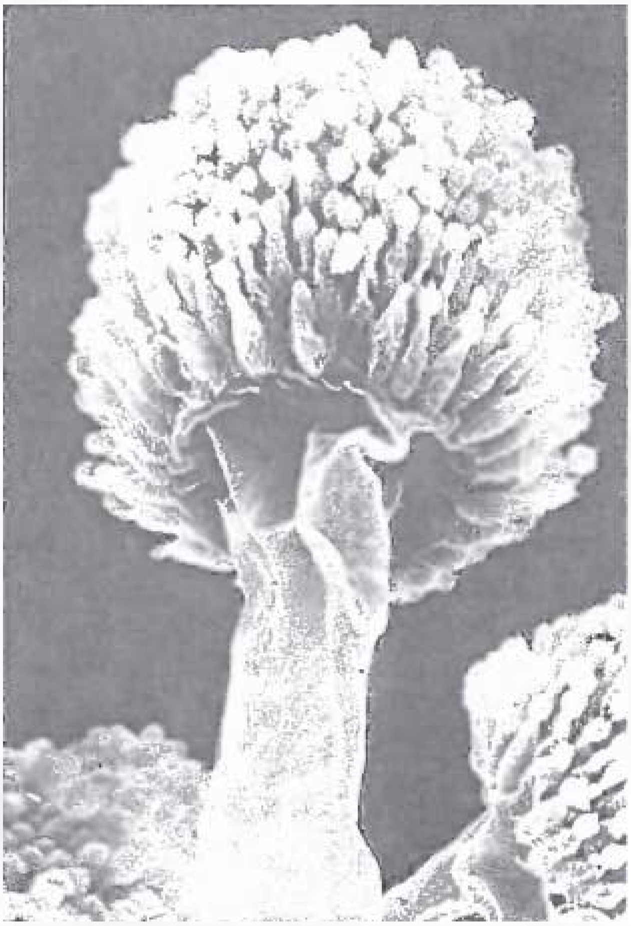


Figure 191 - Scanning electron micrograph of sporulating *Aspergillus*.

Since *A. flavus* grows on practically all types of grain, this species is of serious concern to mushroom spawn producers. Careful handling of any molds, particulary those of the genus *Aspergillus*, should be a primary responsibility of all managers and workers in mushroom farms. Aflatoxins are not, however, taken up in the fruitbodies when contaminated spawn or cottonseed meal is used to supplement a compost.

Aspergillus fumigatus and *Aspergillus niger*, two thermotolerant mesophiles, are also pathogenic to humans in concentrated quantities. The affliction is called aspergilliosis or "Mushroom Worker's Lung Disease". Spent compost is the most frequent source of *Aspergillus fumigatus*.

Aspergillus niger, the common black mold, has been cultured commercially for its ability to synthesize citric acid and gluconic acid from a simple sucrose enriched solution. In the past, citric acid was extracted from lemon juice; now it is made more profitably from this fungus.

Comments: This is a dangerous genus. Since one can encounters *Aspergillus flavus*, *A. niger*, *A. fumigatus* in the course of mushroom culture, precautionary steps should be undertaken to minimize exposure to these toxic contaminants.

Aspergillus candidus is a cream colored mold whose colonization of the grain results in a sharp escalation of the spawn temperature.

See also *Penicillium*. For further information consult "The Genus *Aspergillus*" by Raper and Fennel, a monograph in which 132 species were recognized. Presently, more than 200 species are known.

See Color Photograph 21.

Botrytis (Brown Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Name: Brown Mold.

Latin Root: From "botry" meaning bunch, as in a bunch of grapes, which the clusters of spores resemble.

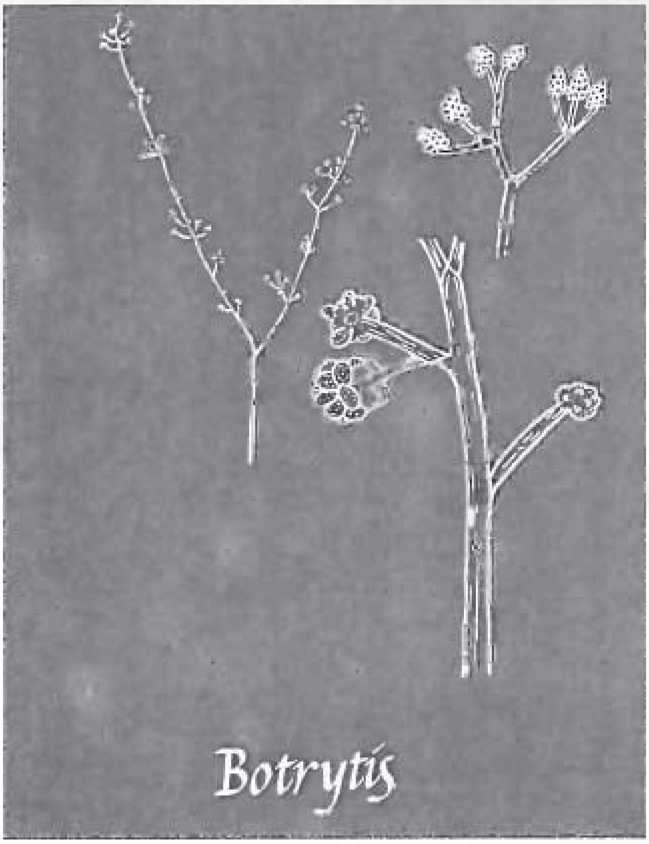


Figure 192 - Drawing of sporulating structure and spores (conidia) characteristic of *Botrytis*.

Habitat & Frequency of Occurrence: Common, most frequently seen on the casing soil where it prefers a mixture high in woody tissue; thriving in an environment of high humidity and moderate temperature. *Botrytis* often occurs on woodwork where moisture has condensed. It is less frequently seen on compost.

Medium Through Which Contamination Is Spread: Air; soil; and damp wood.

Measures of Control: Use of clean casing soils; removal and isolation of contaminated trays which are then thoroughly steam cleaned; positive pressurization of the growing room; and adherence to a strict schedule of hygiene to prevent this mold from spreading.

Macroscopic Appearance: White at first, especially along the margins, soon gray, fast growing, aerial, then dull golden brown to cinnamon brown as spores mature, spreading from casing soil to woodwork and vice versa. Spores become easily airborne by the slightest drafts. Outbreaks last two weeks at most, and sometimes develop into the sexual stage indicated by the formation of cup-like fruitbodies.

Microscopic Characteristics: Conidiophores long, measuring 10-20 x 5-15 microns, simply but irregularly branched at the apex but not enlarged, and not *Verticilium*-like. Spores (conidia) are one celled, oval to oblong, clear to grayish, some more brightly colored.

History, Use and/or Medical Implications: Apparently inocuous; no toxic species known. *Botrytis cinerea* is a species highly valued for its timely attack on ripening grapes. This species decreases the grapes' acidify while increasing their sugar content. It gives the grapes a most desirable odor and flavor, making infected crops ideal for sauterne table wines. Consequently, winemakers have been experimenting with the deliberate inoculation of their vineyards with *B. cinerea* for more than a century.

Comments: If the compost overheats during spawn run or casing colonization, *Botrytis* flourishes. It is generally not considered to be a "problem" contaminant but looked upon as an "indicator" mold by mushroom growers. *Botrytis* is usually overwhelmed or contained by the mushroom mycelium, although severe outbreaks, if not checked in their growth, can be detrimental to yields. *Botrytis crystallina* or *Botrytis gemella* are probably the species most commonly encountered.

The taxonomy of the *Botrytis* species seen in mushroom culture is unresolved, and therefore placing these molds in the *Botrytis* complex avoids nomenclatural problems. *Botrytis* has a perfect stage as *Peziza ostracoderma*, one of the common cup fungi. Some authors consider the imperfect form to more properly be classified in the genus *Chromelosporium* (belonging to the species *C. fulva*). By whatever name, this frequently encountered brown mold is not regarded as a virulent competitor.

Papulospora byssina, the Brown Plaster Mold, is similar but can be distinguished from *Botrytis* by the powdery granules evident using a hand lens, and by the shape of the conidiophore as viewed through a microscope.

See Color Photograph 23.

Chaetomium (Olive Green Mold)

Class: *Ascomycetes*

Order: *Sphaeriales*

Family: *Chaetomiaceae*

Common Name: The Olive Green Mold.

Greek Root: Having the same root as the suffix "-chaeta" which means long hair.

Habitat & Frequency of Occurrence: Common on fresh manure; especially on compost that has been anaerobically pasteurized; refuse materials; straw; "leaf mold"; soils; plant debris; paper products; and cloth fabric. *Chaetomium* is a rare contaminant of grain and is infrequently seen in agar culture. A white species occurs on the casing layer.

Medium Through Which Contamination Is Spread: Air; soil; compost; and grain.

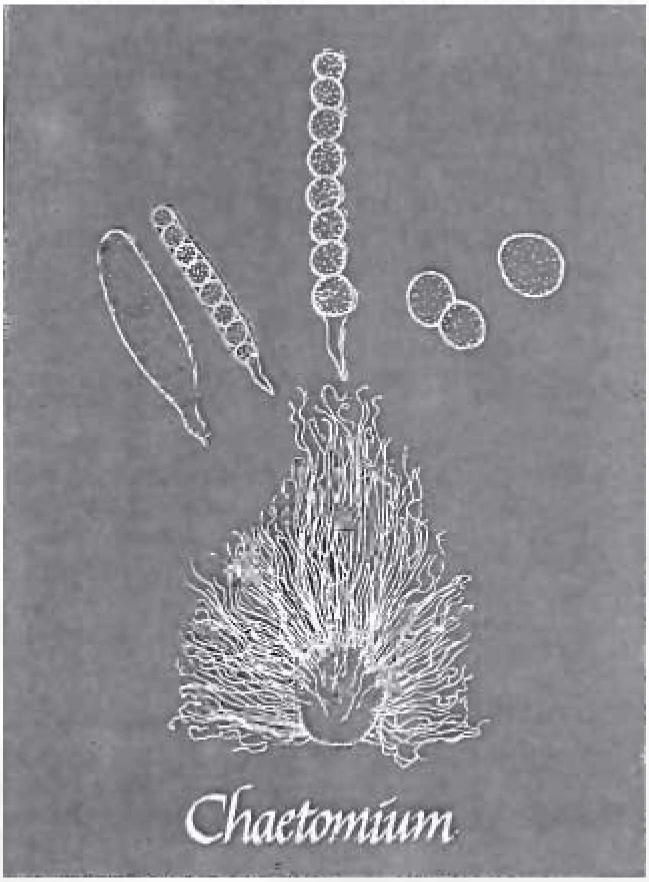


Figure 193 - Drawing of *Chaetomium* perithecium, asci and spores.

Measures of Control: General hygienic practices; aerobic pasteurization and Phase II. See Comments.

Macroscopic Appearance: Mycelia inconspicuous at first, grayish and in some species whitish, cottony, dense and aerial (as in "White Chaetomium"). Some forms become light brown, yellowish or with orangish hues when well developed. At maturity these molds can become dark green to olive green colored, and form scattered "burrs" which in fact are perithecia containing spores.

Microscopic Characteristics: Mycelium forming a thin walled envelope (a perithecium) from which unbranched hairs extend. A slit in the perithecium exposes sacs (asci) containing spores which are then liberated into the air. Spores are unicellular, darkly pigmented and can be ovoid, lemon-shaped or ellipsoid.

History, Use and/or Medical Implications: Secreting a compound called "chaetomin" that is toxic to Gram-positive bacteria and to mushrooms and other fungi.

Comments: *Chaetomium* inhibits mycelial growth through the toxins it produces as well as by competing with the mushroom mycelium for base nutrients.

Several true thermophiles are present in this genus. *C. thermophile* and its many varieties thrive in temperature zones from 82-136°F. Its spores are especially heat resistant. *Chaetomium* spores are killed at 140°F. for 6-16 hours or at 130°F. for 24-48 hours. *Chaetomium olivaceum* infests compost that has been exposed to high temperature, anaerobic conditions during Phase II. Compost prepared according to the Phase II program outlined in Chapter V practically eliminates the manifestation of *Chaetomium*. *Chaetomium globosum*, the most common species in this genus, attacks straw, compost and paper products and forms small burr-like colonies. Spores of this species are less resilient than those of its thermotolerant allies.

C. globosum is an occasional contaminant of agar and grain culture, and like *C. olivaceum* it is common on immature composts. White *Chaetomium* grows on the casing layer as a dense whitish mold. In general, *Chaetomium* is olive green while *Penicillium* and *Trichoderma* are generally blue green or forest green in color.

Chrysosporium (Yellow Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Aleuriosporae*

Common Names: The Yellow Mat Disease; Yellow Mold; Confetti Disease.

Latin Root: From "chryso-" meaning golden and "sporium" or spore.

Habitat & Frequency of Occurrence: Saprophytic, a common mold in soils, and endemic to composts prepared in direct contact with the ground. Although *Chrysosporium* species naturally inhabit the dung of most pastured animals and of chickens, today they are rarely seen in finished mushroom composts with the development of modern composting methods.

Medium Through Which Contamination Is Spread: Air; soil; and dung.

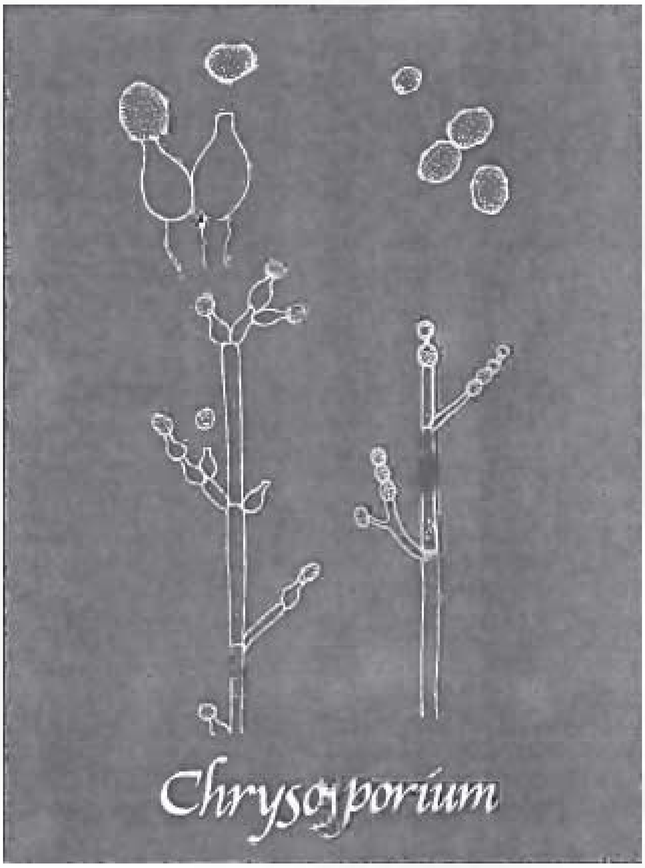


Figure 194 - Drawing of the sporulating structure typical of *Chrysosporium luteum*, the cause of Yellow Mat Disease.

Measures of Control: Concrete surface used for composting; isolation of mushroom compost from areas where untreated soils and raw dung are being stored; and filtration of air during Phase II. If *Chrysosporium* occurs before or at the time of casing, salt or a similar alkaline buffer can be applied to limit the spread of infection.

Macroscopic Appearance: Whitish at first, soon yellowish towards the center and maybe yellowish overall in color, forming a "corky" layer of tissue between the infected compost and the casing soil, and inhibiting fruitbody formation.

Microscopic Characteristics: Conidiophores poorly developed, relatively undifferentiated, irregularly branched, vertically oriented, for the most part resembling and associated with the vegetative mycelium. Clear, unicellular and often ornamented spores (conidia) develop terminally, either in short chains or singularly, and measure 3-5 x 4-7 microns.

History, Use and/or Medical Implications: The genus in general does not host many pathogenic species. One species of special concern is *Chrysosporium dermatidis* and allies, a mold causing a skin disease in humans.

Comments: *Chrysosporium* is an indicator mold whose presence can be traced to compost prepared on soil. Yellow mat disease is caused by *Chrysosporium luteum*, a synonym of *Myceliopthora lutea*. Another species, *Chrysosporium sulphureum*, is known as Confetti, and is at first whitish, then yellowish towards the center. These molds were fairly common in *Agaricus* culture previous to 1940, when composts were prepared directly on soil. With the advent of concrete composting wharfs, they have all but disappeared. According to Atkins (1974), this contaminant is more frequent in cave culture because of the use of ridge beds made directly on the floor of the cave. *Chrysosporium* is usually not detected until the first break and retards subsequent flushes. Moderate to severe outbreaks of either species can adversely affect yields.

Both raw and prepared composts can become infected with this mold. It is thought that the spores are introduced with the fresh air during the cool down period of the Phase II or from thermotolerant spores from within the compost itself. Species in this genus can be found on media of poor nutritional quality. They are generally not seen in spawn culture.

Chrysosporium can be grown for study on a hay infusion agar supplemented with sugar. Many Chrysosporia have sexual forms in the Gymnoascaceae, an ascomycetous family.

For further information see:
Carmichael, J.W., 1962 "*Chrysosporium* and some other Aleuriosporic Hyphomycetes".
van Oorshot, C.A.N., 1980 "A Revision of *Chrysosporium* and Allied Genera". Studies in Mycology No. 20. CBS Publication, Baarn, Nederland.

Cladosporium (Dark Green Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Dematicaeae*

Common Name: The Dark Green Mold.

Greek Root: From "klados" which means branched and "sporium" or spore. The name is in reference to the two celled spores produced on branches from the main body of the conidiophore.

Habitat & Frequency of Occurrence: *Cladosporium* is the most predominant genus of all the airborne contaminants. Its species can be both saprophytic and parasitic. At least three species infect grain spawn although they are not as common as the Aspergilli and Penicillia. Most species grow poorly on malt agar media. Many decompose paper products (several of the black molds on old books are Cladosporia), plant debris, vegetables and other higher plants.

Medium Through Which Contamination Is Spread: Air.

Measures of Control: Good hygienic practices; removal of supportive substrates; and filtration of air through micron filters.

Macroscopic Appearance: Species of *Cladosporium* causing problems in spawn production are typically dark green in color, often becoming blackish with age, and resemble the powdery *Penicillium* type molds.

Microscopic Characteristics: Conidia (spores) and conidiophores distinctly septate; darkly pigmented;

conidiophores vertically oriented and variously diverging; tall; forked into several terminal shoots at the apex from which the conidia arise in a chain-like fashion with the basal conidium being the oldest and the apical one being the youngest. Conidia are one or two celled, developing from the swollen ends of the conidiophores, and variously shaped (measuring from as small as 3-6 x 2-3.5 microns to as large as 15-20 x 6-8 microns). Some conidia are ovoid, lemon shaped and cylindrical, or are simply irregular in form and have peg-like markings ("scars") where adjacent spores have been attached.

History, Use and/or Medical Implications: Some species toxic. *Cladosporium carrionii* causes a severe skin infection that is usually associated with workers who suffer punctures from thorns or splinters.

Comments: In one study (Kramer, 1959) where agar plates were exposed daily to the outside air over a period of two years, *Cladosporium* spores were found to be the most numerically common of all airborne fungi, representing 45% of the totals tallied. Of these species, *C. cladosporioides* was the most frequently encountered. In contrast, *Penicillium* is the most common fungus indoors, undoubtedly due to the food habits of humans.

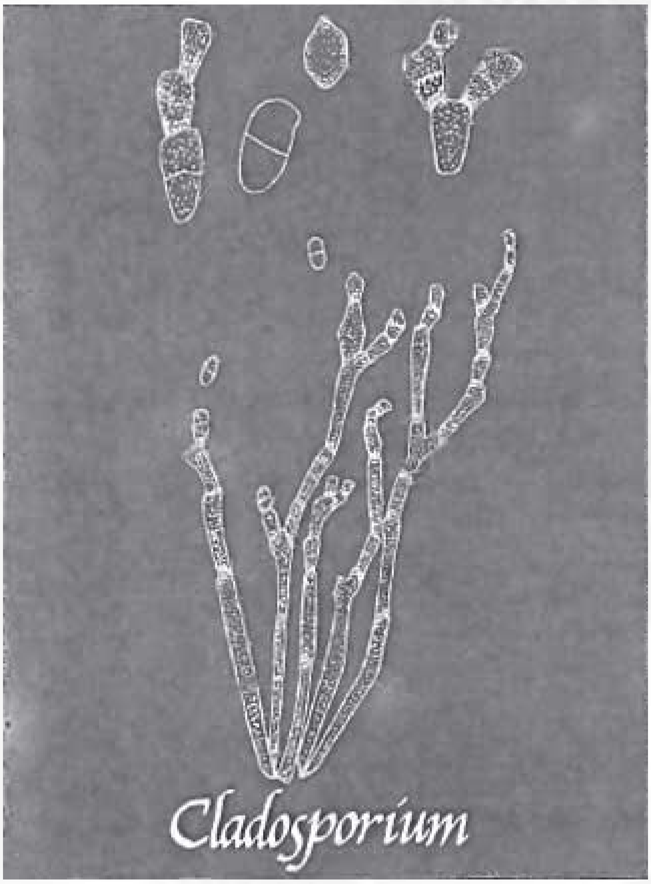


Figure 195 - Drawing of *Cladosporium*. Note the two celled conidia.

The dark conidiophore and the two celled conidia (spores) are the most distinguishing features of this genus. Over 160 species have been described. The perfect stage of a variety of *C. herbarum* Link ex Fr. is *Mycosphaerella tulasnei* Janz. *C. herbarum* has been isolated from timber, logs and wood pulp. *Cladosporium resinae* lives on creosote and other petroleum products, including the petroleum jelly used to "grease" the seals of pressure cookers. *C. fulvum* Cke. attacks tomato leaves, appearing as brown to violet colonies. Other molds similar in appearance are *Penicillium* and *Aspergillus*.

For more information see "*Contribution to the Knowledge of the Genus Cladosporium Link. ex Fr.*" by De Fries, 1952.

See Color Photograph 20.

Coprinus (Inky Cap)

Class: *Basidiomycetes*

Order: *Agaricales*

Family: *Coprinaceae*

Common Name: Inky Cap.

Habitat and Frequency of Occurrence: Frequent to common on compost and/or decomposing straw.

Medium Through Which Contamination Is Spread: Primarily air; secondarily through materials used in compost preparation.

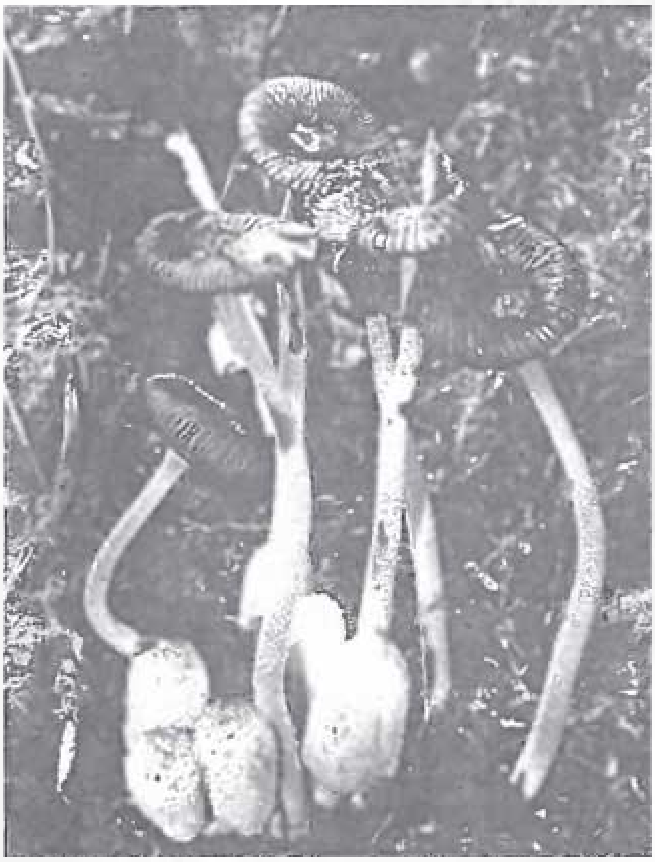


Figure 196 - *Coprinus*, the Inky Cap, on horse manure.

Measures of Control: Proper Phase I and Phase II management, especially full term pasteurization; reduction of ammonia and water in finished compost; and homogenous consistency of compost structure (avoidance of densely compacted zones).

Macroscopic Appearance: Appearing as a fast growing whitish mycelium, typically fine and lacking rhizomorphs, soon knotting into small ovoid primordia that quickly enlarge into a whitish mushroom with a long fragile stem and oblong cap. The cap soon disintegrates into a black inky liquid with spore maturity.

Microscopic Characteristics: Smooth, elliptical spores produced on club-shaped cells called basidia. Hyphae often have clamp connections joining adjacent cells.

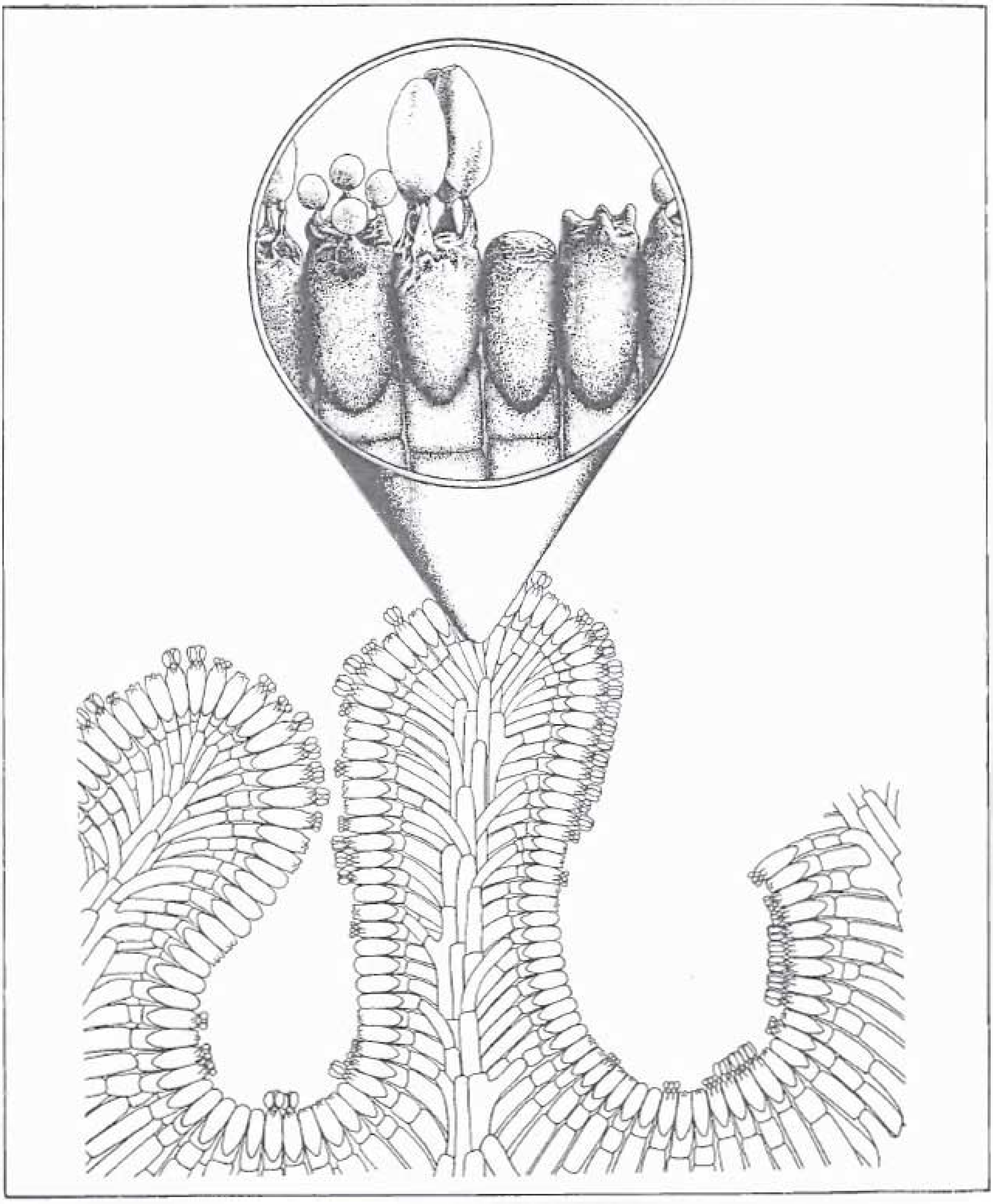


Figure 197 - Drawing of gill cross section with basidia and spores of *Coprinus*.

History, Use and/or Medical Implications: *Coprinus* species are noted for both their edibility and toxicity. *Coprinus comatus*, the Shaggy Mane, is a popular edible and choice species that is cultivated. (See the growing parameter outline for that species). *Coprinus atrementarius* has been reported by Atkins (1973) to be a competitor to the commercial cultivation of *Agaricus*, occurring in under-composted straw/manure. This species also causes severe nausea and other unpleasant symptoms if alcohol is consumed within twenty fours of ingestion. Jonsson *et al*. (1979) reported marked reduction in sperm counts in rats treated with coprine, the same compound responsible for the above described symptoms.

Comments: *Coprinus* spores are noted for their heat resistance and often survive the composting process. Although not considered a dangerous competitor, species in this genus are common in the piles of beginning compost makers. If this species occurs during spawn run or at cropping, it is an indication of residual ammonia in the compost. Composts that have excessive ammonia concentrations, composts that have been over-watered or those that are not homogenous in their structure encourage *Coprinus* infestation.

The species known to contaminate manure/straw composts are: *Coprinus fimetarius*; *Coprinus atramentarius*; and *Coprinus niveus*. According to Kurtzman (1978), *Coprinus fimetarius* has potential value as a commercially cultivated mushroom. All the above mentioned species are ones seen in poorly prepared composts. Bitner (1972) noted that *Coprinus* is a contaminant of grain spawn, although rarely seen and present in only one of every hundred or so contaminated spawn jars.

Cryptococcus (Cream Colored Yeast)

Class: *Fungi Imperfecti*

Order: *Cryptococcales*

Family: *Cryptococcaceae*

Common Names: The Yellowish Brown Yeast; The Carcinogenic Yeast.

Greek Root: From "kryptos" meaning hidden and "kokkus" or berry, for the form of the conidia.

Habitat & Frequency of Occurrence: Ubiquitous and common. *Cryptococcus* species are mostly saprophytic on plant debris, in soils, cereal grains and on bird (pigeon or chicken) droppings.

Medium Through Which Contamination Is Spread: Air and pigeon and/or chicken wastes.

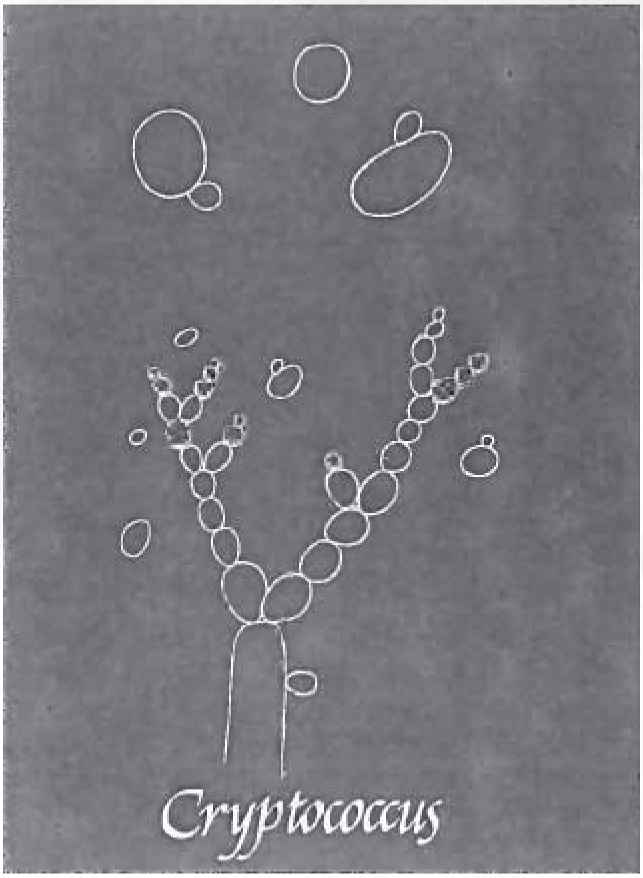


Figure 198 - Drawing of spore formation typical of *Cryptococcus* and many yeasts.

Measures of Control: Good hygienic practices; elimination of high humidity pockets; removal of supportive substrates; and filtration of air through micron filters.

Macroscopic Appearance: A spherical yeast not forming a pseudomycelium, encapsulated by a cream to brown colored mucus.

Microscopic Characteristics: Conidia (spores) vary in size, 4-20 microns in diameter; ovoid; reproducing through simple budding; not forming a true mycelium; and lacking a specialized spore-forming structure. In some species there can be a simple ascus (a "sack") enclosing a single spore. *Cryptococcus* species are Gram-positive.

History, Use and/or Medical Implications: A non-fermenting yeast with alliances to the Ascomycetes, *Cryptococcus neoformans* (Sanf.) Vuill. causes a deadly disease in animals and humans called cryptococcosis, otherwise known as "Torula meningitis" or "yeast meningitis". This yeast attacks and reproduces in the central nervous system, particularly in the brain and spinal fluid. Symptoms begin with a stiff neck and headache and end in total or partial blindness, paralysis, coma and respiratory failure. Less severe symptoms occur in other parts of the body, for which there is a better chance of recovery. It is believed that airborne spores are inhaled, entering the body via the lungs. This yeast thrives in droppings of pigeons and chickens.

Comments: *Cryptococcus* is a non-fermenting yeast with alliances to some Ascomycetes: *Torula* (Black Yeast), *Rhodotorula* (Red Yeast) and *Candida*.

In 1979 one of the containment buildings at the Tennessee Clinch River Breeder Reactor project had to be quarantined because of a massive outbreak of *Cryptococcus neoformans*.

Dactylium (Cobweb Mold)

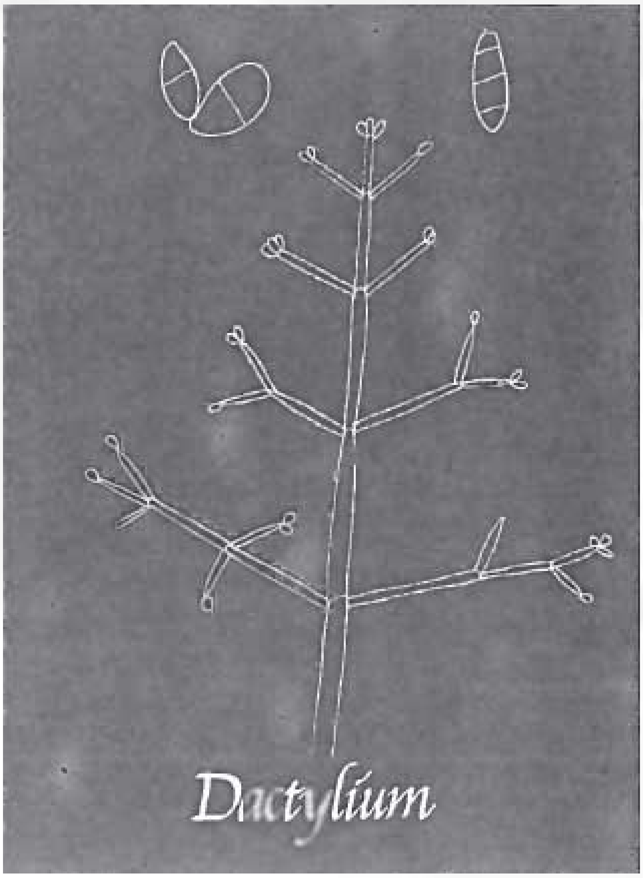


Figure 199 - Drawing of sporulating structure of *Dactylium*. Note multicelled conidia.

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Name: Cobweb Mold; Downy Mildew; Soft Mildew.

Greek Root: From "daktylos" meaning finger, in reference to the forking of the conidiophore.

Habitat & Frequency of Occurrence: Commonly seen on the casing soil or parasitizing the mushroom fruitbody.

Medium Through Which Contamination Is Spread: Air; casing soil; water and insects.

Measures of Control: Immediate isolation of parasitized fruitbodies from the growing environment; lowering of the relative humidity; and/or increasing air circulation. Carefully examine casing soil components for hygienic quality. Pasteurization of casing soil generally prevents its occurrence. Growth can be stopped by covering the cobweb mold with salt, baking soda or any highly alkaline compound.

Macroscopic Appearance: *Dactylium dendroides* Fr. is cobweb-like in appearance, first appearing as small scattered patches rapidly running over the surface of the casing soil, then overwhelming any and all mushrooms in its path. Afflicted mushrooms are covered with a fluffy down of delicate mycelium. This mold is initially grayish, sometimes whitish and can become pinkish tinged with age. When cut open, infected mushrooms are composed of rotting flesh and young buttons are reduced to formless masses of soft tissue.

Microscopic Characteristics: Conidia multicelled, usually composed of three or more connected cells. Conidia can occur singly or clustered, terminally positioned on the ends of branches which often fork in a *Verticillium*-like fashion and which originate from a major vertical shoot. Conidia are clear or slightly yellowish in color and measure 20 x 5 microns.

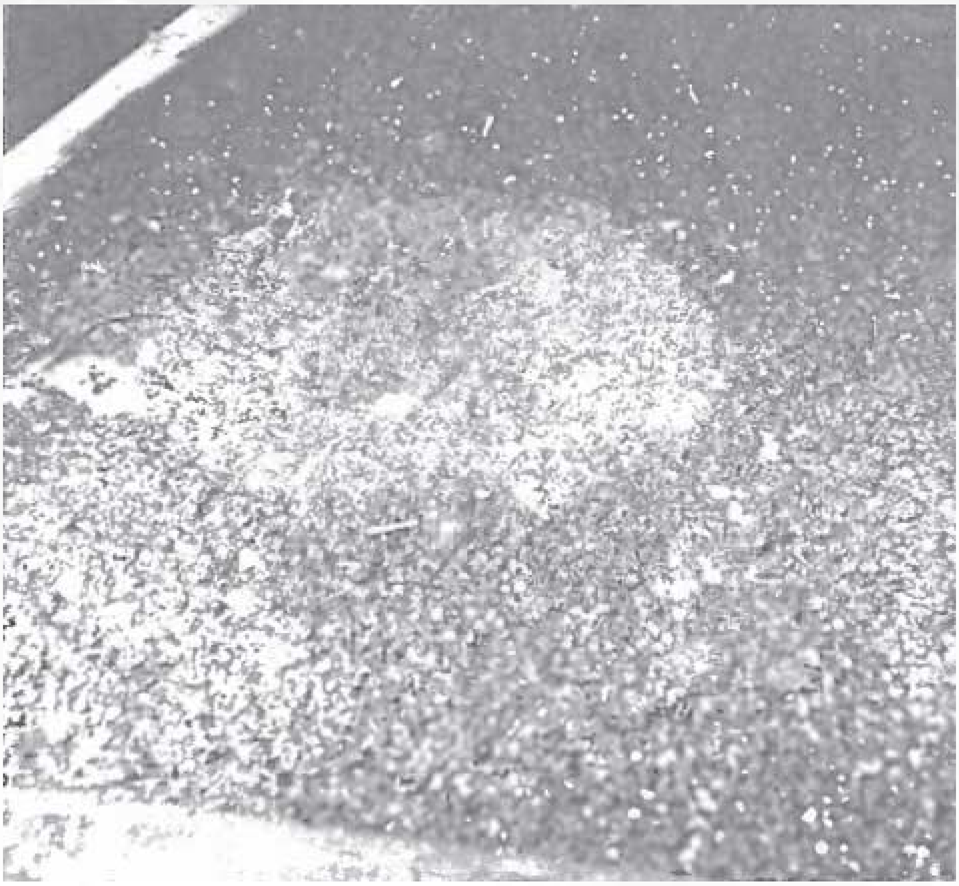


Figure 200 - Photograph of *Dactylium* running through casing layer.

History, Use and/or Medical Implications: None noted.

Comments: The Cobweb Mold is a fast growing, tenacious casing layer contaminant. Spores germinate upon contact with a mushroom, and soon envelope it with a soft mildewy mycelium.

Spores of *Dactylium dendroides* are killed when exposed to 115-122°F. for only ½ hour. (See Anderson, 1956). The genus *Dactylaria* is synonymous with *Dactylium*. Several species are known for their specialization in trapping nematodes by arranging their hyphae into loose coils. When one enters a loop, the hypha contract and traps the nematode.

Dactylium is the conidial form of *Hypomyces*, some species of which attack wild mushrooms, particularly *Lactarius*, *Russula*, *Agaricus*, *Amanita* and others. *Dactylium dendroides* is the asexual form of *Hypomyces rosellus*.

For more information consult: Lentz, P.L. 1966 "*Dactylaria in Relation to the Conservation of Dactylium*." Mycologia 58: 965-966.

Doratormyces (Black Whisker Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Stilbellaceae*

Common Names: The Black Whisker Mold; The Smoky Grey Mold.

Habitat and Frequency of Occurrence: A saprophyte, occasionally to frequently seen on the straws of an inadequately pasteurized compost; on wooden trays; rarely spreading to the casing soil; sometimes contaminating grain cultures; and seldom seen on agar. In nature *Doratomyces* is a major constituent of a soil's microflora.

Medium Through Which Contamination Is Spread: Primarily an airborne contaminant; secondarily transmitted through spent compost and left over debris.

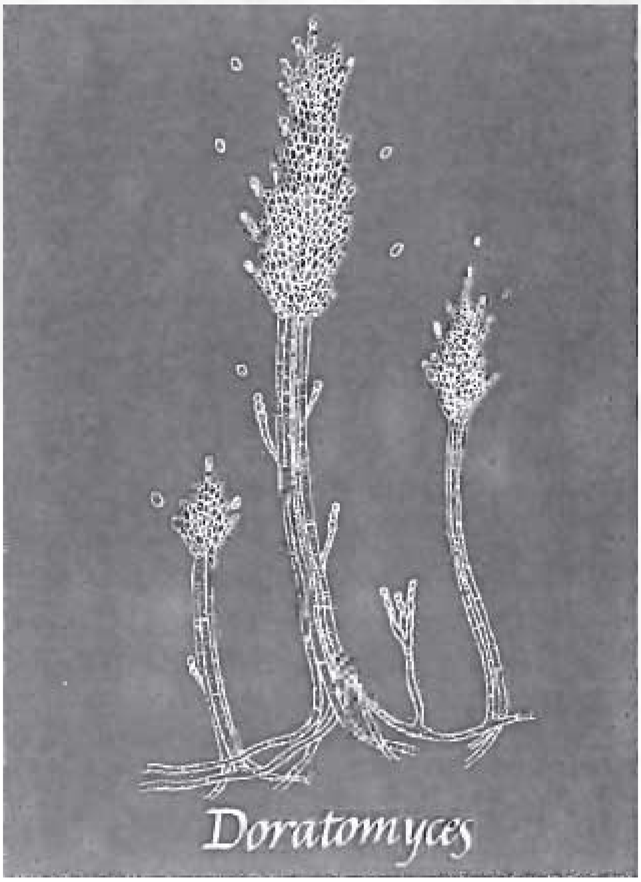


Figure 201 - Drawing of the sporulating structure of *Doratomyces* (*Stysanus*), the Black Whisker Mold.

Methods of Control: Air filtration; correct preparation and pasteurization of compost; and adherence to a strict schedule of hygiene in the laboratory and growing room. Whenever a room becomes contaminated with this fungus, a thorough cleaning is in order, particularly any trays that harbored this rapidly growing contaminant. The most common source of this fungus is spent compost or newly turned soils.

Macroscopic Appearance: A heavily sporulating grayish to blackish mold, permeating throughout the compost and when disrupted, emitting clouds of grayish spores. Contaminated regions of compost are more darkly colored and seem damper than uncontaminated regions. Its common name, the Black Whisker Mold, well describes the macroscopic appearance.

Microscopic Characteristics: Hyphae, conidiophores and conidia darkly pigmented. Conidiophores are single or aligned as compacted vertical assemblages of hyphae that variously diverge near the apex into short chains of dry, ovoid, unicellular spores in a *Penicillium*-like fashion.

History, Use and/or Medical Implications: Some species toxic. *Doratomyces* causes an asthma-like respiratory response (coughing, soreness of throat, nose bleeds) in those who are exposed to concentrations of its spores. Workers emptying spent compost from growing houses are the most likely to be inflicted with this illness.

Comments: *Doratomyces* is synonymous with *Stysanus*. *Doratomyces microsporus* (=*Stysanus microsporus*), the Smoky Grey Mold and *Doratomyces stemonitis* (=*Stysanus stemonitis*), the Black Whisker Mold, both contaminate the compost and emit huge quantities of spores when disturbed. A moderately strong competitor of mushroom mycelium, this mold grows well in undercomposted, poorly pasteurized and/or wet composts - composts poorly suited for good mushroom crops. If the compost bed heats up during spawn running and kills the grain inoculum, the grain kernels are soon attacked by this fungus which then resporulates and infects the compost. *Doratomyces* is an indicator mold, whose presence suggests poor composting, pasteurization or spawn running practices.

Epicoccum (Yellow Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Tuberculariaceae*

Common Name: Yellow Mold.

Habitat and Frequency of Occurrence: An occasional contaminant of grain culture. Species in this genus are decomposers of wood, leaves and stems of plants, playing an important role in the soil community.

Medium Through Which Contamination Is Spread: Air; soil; and grain.

Methods of Control: Isolation of contaminated cultures; careful screening of grain used for inoculum; and sufficient steam permeation of grain during sterilization.

Macroscopic Appearance: Species in this genus are variously pigmented. In grain culture, *Epicoccum* is distinguished by its bright yellowish orange to pinkish orange color and is often associated with a yellowish fluid which it apparently exudes. Its mycelium appears as dense zones within which blackish spores are formed. On most agar media, *Epicoccum* is slow growing and whitish. Outside the laboratory, *Epicoccum* can be found on leaves and twigs, forming small black dot colonies.

Microscopic Characteristics: Conidiophores compact, short and radiating from cushion shaped cells called "sporodochia" and from which dark, one celled, round spores (conidia) arise or with which they are associated. The conidia are typically reticulated or ornamented with small spine-like projections, measuring (5) 15-25 (50) microns. These reticulated conidia appear to be composed of several tightly interconnected cells.

History, Use and/or Medical Implications: None noted.

Comments: Not strongly inhibitory to mushroom mycelium. This mold can, however, spoil spawn. In grain culture, fruitings still develop in containers that are partially contaminated with this mold.

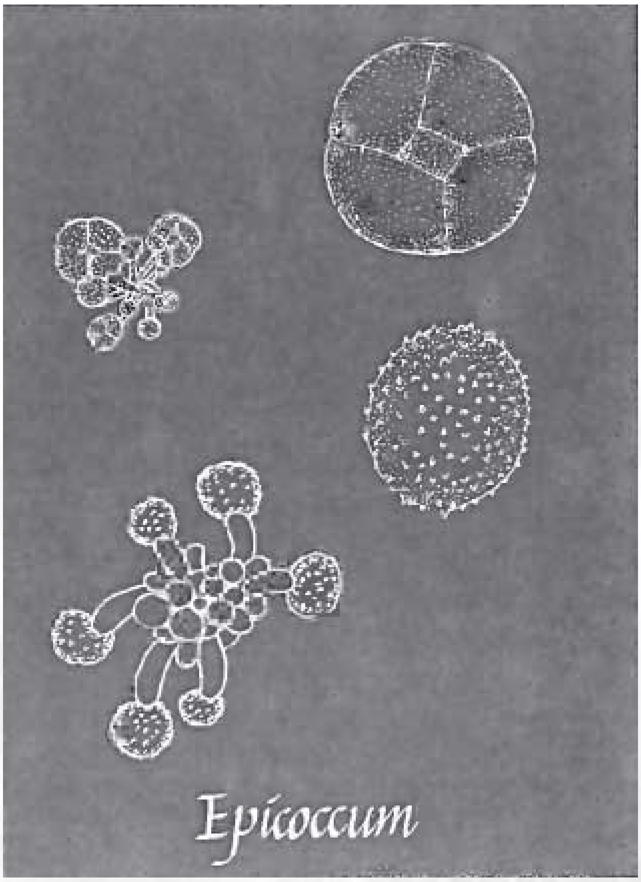


Figure 202 - Drawing of cushion shaped sporulating structure typical of *Epicoccum*, a yellow mold.

Epicoccum oryzae attacks rice, causing lesions that are pinkish to reddish in coloration. Another *Epicoccum* species was reported by Bitner (1972) to be the most common mold attacking sorghum spawn, comprising nearly 30% of all contaminated cultures. On the other hand, it represented only 5% of the contaminants on rye. The frequency with which this contaminant occurs varies substantially.

For more information: M.B. Schol-Schwartz (1957), "*The Genus Epicoccum (Link.)*."

Fusarium

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Tubericulariaceae*

Common Names: The Brightly Colored Contaminant; Damping Off Disease; or Yellow Rain Mold.

Greek Root: Having the same root as "fusiform", meaning to be swollen in the center and narrowing towards the ends, in reference to the distinctive shape of the conidia.

Habitat & Frequency of Occurrence: Commonly encountered in spawn production and in agar culture. A natural inhabitant of grains (rye, wheat, barley, rice), *Fusaria* also are found in soils, on living and decaying plants and on decomposing textiles and paper.

Medium Through Which Contamination Is Spread: Air; grain; and casing soil.

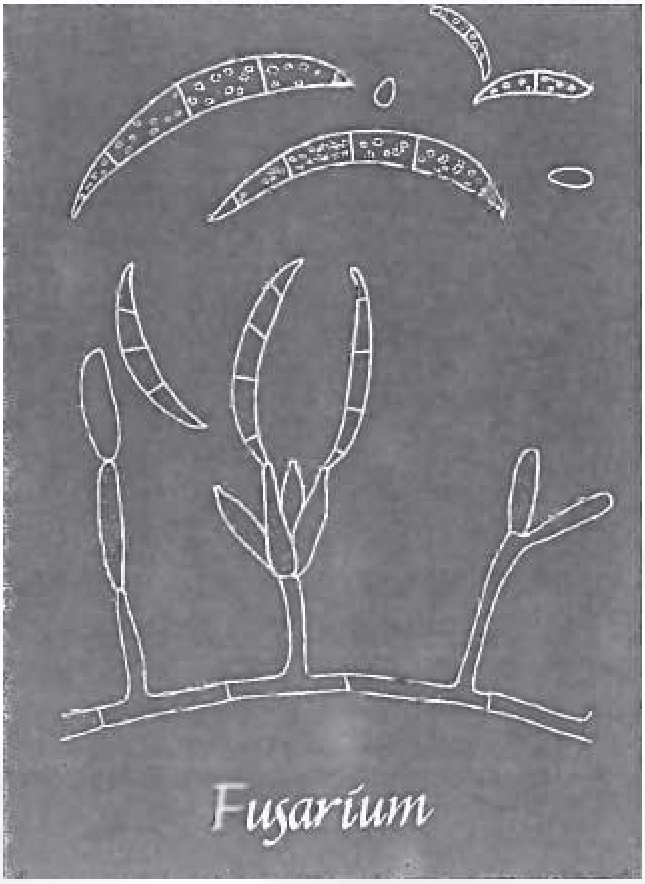


Figure 203 - Drawing of simple sporulating structure typical of the genus *Fusarium*.

Measures of Control: Sufficient sterilization of grain; isolation and proper disposal of contaminated cultures. General hygienic practices and air filtration prevent this contaminant. Increasing ventilation while simultaneously decreasing humidify hinders the proliferation of this potentially dangerous contaminant.

Macroscopic Appearance: Appearing as an extensive, fast growing, and whitish cottony mycelium which can remain whitish or, as in most cases, becomes brightly pigmented. *Fusarium* species most frequently seen on grain are shades of pink, purple or yellow.

Microscopic Characteristics: Conidia generally sickle shaped; multicelled; septate (segmented); and developing from short, simple and irregularly branched conidiophores that arise from a cottony mycelial mat. Conidia are canoe, crescent or sickle shaped, with the basal end notched or niched. Some pear shaped, single celled microconidia are also produced.

History, Use and/or Medical Implications: Some *Fusarium* species are highly toxic. Throughout history *Fusarium* molds have been responsible for diseases of major proportions. Usually the cause has been bread made from poorly wintered grain. In regions of the Ukraine, Eastern Siberia and central Asia, the disease caused by this fungus was called "Staggering Sickness" for its symptoms of vertigo, bleeding, headaches, chills and nausea. In a Soviet province during World War II, a single outbreak caused the deaths of nearly 30,000 people.

Given their past, it is not surprising to learn these fungi have attracted the interest of the military. In 1980 and 1981, the United States government accused the Soviet Union of embarking on a new variation of biochemical warfare when leaf and twig specimens allegedly brought from the war zones of Cambodia and Afghanistan were found laden with high concentrations of toxins from these species. The most prominent species producing these toxins (the trichothecenes) are *Fusarium sporothrichiodes* and *Fusarium poae*, although other *Fusaria* are also virulent. *Fusarium poae* is a violet colored contaminant occasionally encountered in mushroom spawn production. See Comments below.

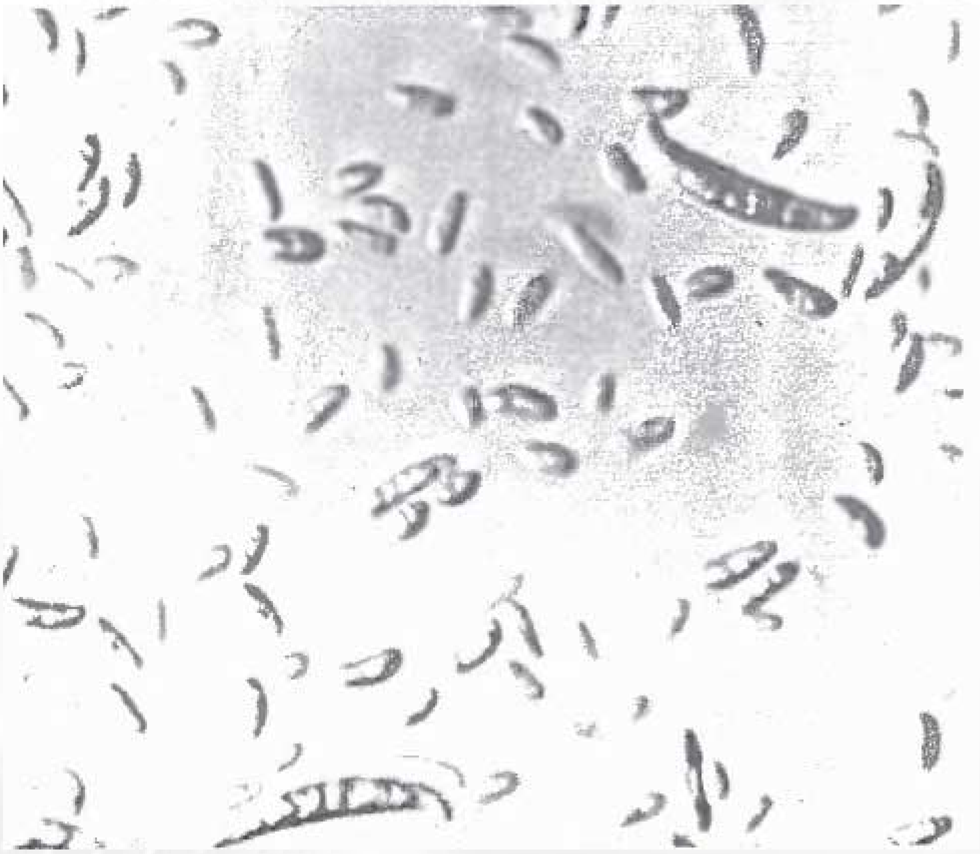


Figure 204 - Light micrograph of *Fusarium* conidia. Note multicelled macroconidia and single celled microconidia.

Because there are many toxic species in the genus, one should treat all *Fusarium* contaminants with due caution.

Comments: *Fusarium* may be a cause of mushroom "aborts". In one study, English researchers correlated high levels of *Fusarium* to this phenomenon. Even a moderate infestation by this contaminant inhibits mushroom growth. Mushrooms afflicted with this disease remain small and often have disproportionately small caps and stems whose interiors are brownish. Wolfe (1937) was able to induce Damping Off Disease by first isolating *Fusaria* and then physically introducing it into the casing layer of a healthy bed.

Although not as commonly encountered as *Penicillium* or *Trichoderma*, *Fusarium* can wreak havoc in a sterile lab if not soon contained. Grain is the main source of *Fusarium* contamination in mushroom culture. Twenty-eight *Fusaria* have been identified from cereal grains, five of which have been isolated from contaminated mushroom spawn jars (see Pepper & Keisling, 1963). These are:

F. lateritium, a pinkish species.
F. avenaceum, a reddish species.
F. culmorum, a vivid yellowish red species.
F. poae, a violet colored species.
F. oxysporum, a red violet species.
F. sp., a fast growing whitish species.

Fusaria can cause severe mycosis and these molds must be treated with extreme caution. Grain contaminated with *Fusarium* should be sterilized before handling.

There are, undoubtedly, more toxic species than the literature presently indicates.
One of the first patents ever to be awarded to a living organism was given for *F. gramineraum*.

For more information see:
Wood, F.C., 1937 "*Studies of 'Damping Off' of Cultivated Mushrooms and Its Association with Fusarium Species*." Phytopath. 27: 85-94.

Toussoun, TA. and P.E. Nelson, 1968 "*A Pictorial Guide to the Identification of Fusarium Species*" Pennsylvania State University Press.
Seagrave, 5., 1981 "*Yellow Rain: A Test of Terror*" Seattle Post Intelligencer, September 27, B2.

Geotrichum (Lipstick Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Name: Lipstick Mold.

Latin Root: From "geo" meaning earth, and "trichum" meaning hairy, in reference to the character of the mycelial mat.

Habitat & Frequency of Occurrence: Generally a saprophyte although some forms act as parasites. *Geotrichum* species are extremely common in nature but infrequently encountered in mushroom compost - unless it has been prepared directly on soil. *Geotrichum* dwells in soils, cow dung, old straw, compost piles and rots some fruits and vegetables. In general, species of this genus are mesophilic thermophiles and are therefore sensitive to pasteurization temperatures.

Medium Through Which Contamination Is Spread: Air; soil; and from old straw and spent composts.

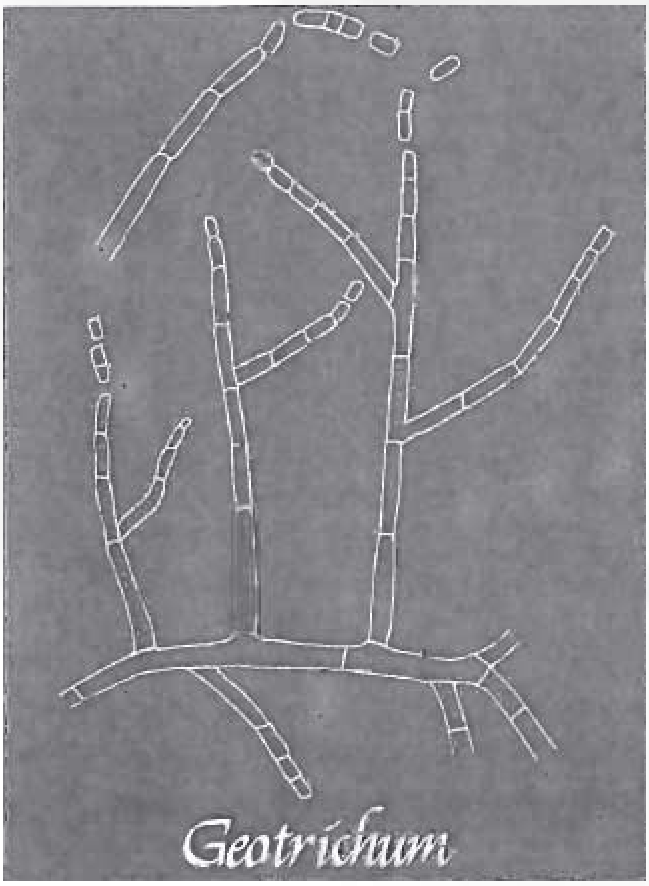


Figure 205 - Drawing of sporulating structure of *Geotrichum*, the Lipstick Mold, and its characteristically shaped conidia.

Measures of Control: Composting on a concrete surface; thorough pasteurization of compost and straw; and use of clean casing materials.

Macroscopic Appearance: Mycelium whitish at first, often faking on a "frosty" appearance and then forming whitish balls of mycelium. With age, the mycelium becomes pinkish and then reddish due to the maturation of spores. Older colonies of this fungus fade to a dull orange.

Microscopic Characteristics: Hyphae septate, in the form of extensive but random chains of cells, from which cylindrical conidial spores segment, measuring 5-10 x 3-6 microns. Conidiophores are simple and often indistinguishable from the mycelial network.

History, Use and/or Medical Implications: Few species toxic. *Geotrichum candidum* causes an oral, bronchial, pulmonary and/or intestinal disease known as geotrichosis that infects humans and other mammals.

Comments: Commonly encountered in agar plates made from a soil infusion; otherwise rarely encountered in sterile culture. An occasional contaminant of mushroom beds (compost), Lipstick Mold inhibits primordia formation and development. With the advent of concrete composting surfaces and peat based casings, this contaminant has been virtually eliminated from modern mushroom farms.

This fungus is closely allied to, if not synonymous with *Sporendonema purpurescens*.

For more information see:
Sinden, J.W., 1971 "*Ecological Control of Pathogens and Weed Molds in Mushroom Culture*" Annual Review of Phytopathology 9.
Carmichael, J.W., 1957 "*Geotrichum candidum*" Mycologia 49. pp. 820-830.

Humicola (Gray Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Series: *Aleuriosporae*

Common Name: Gray Mold.

Latin Root: From "humus" meaning soil and the suffix "cola" meaning dweller, inhabitant.

Habitat & Frequency of Occurrence: A rare contaminant of sterile culture. Thermophilic species are frequently seen in the second phase of composting, thriving in the 115-125 degree F. range. Naturally occurring on grains, straw, wood, soils and other organic matter high in cellulose.

Medium Through Which Contamination Is Spread: Air; soil; and grain.

Measures of Control: Thorough sterilization of grain and incubation of spawn at moderate temperatures. *Humicola* is a thermophile and thrives in elevated temperature zones. Since the presence of *Humicola* is considered beneficial to compost, no countermeasures are necessary if it occurs in that substrate.

Macroscopic Appearance: Mycelium on agar a fine to thick grayish to colorless mat, varying according to the media employed. On grain its mycelium is typically thick, colorless at first, soon gray and eventually dark gray with spore production. On compost, *Humicola* is an aerial, fluffy, whitish mycelium that is soon grayish with spore maturity. It is frequently seen at or near the surface where temperatures are 115-125°F.

Microscopic Characteristics: Conidia one celled, typically globose, brownish colored and often sculptured. Conidiophores are also darkly pigmented, simple, undeveloped and similar to the mycelium or at times having short lateral branches at whose swollen apices a single conidium is borne. Alternately, short chains of microconidia formed by flask shaped cells (phialides) can occur.

History, Use and/or Medical Implications: Selected for use in compost nutrient conversion during Phase II of composting.

Comments: *Humicola* plays an important role in the conversion of the nitrogen in ammonia into protein rich compounds that the mushroom mycelia can digest. In this regard *Humicola* is an ally to the compost preparation process. Compost makers have long believed that *Humicola nigrescens* should be encouraged to grow during Phase II because a compost colonized with it resulted in higher yields. *Humicola* prospers in the 115-125 (130)°F. range. When the finished compost has been brought down to spawning temperature, these fungi are rendered inactive, and are then consumed by the mushroom mycelium.

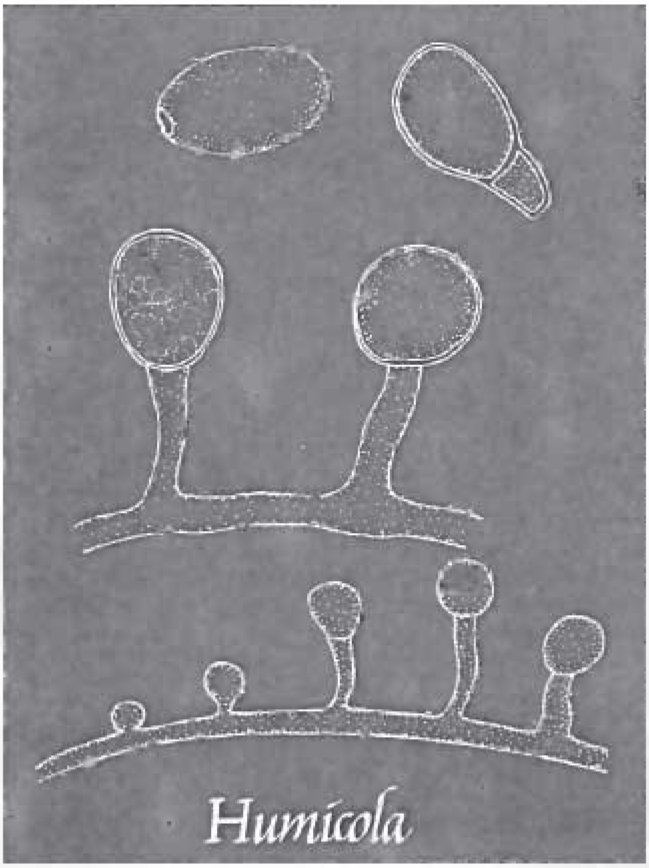


Figure 206 - Drawing of sporulating structure and spores (conidia) of *Humicola*.

On grain *Humicola grisea* is most frequently seen; on horse manure/straw composts *Humicola nigrescens* is most commonly encountered. *Humicola* that occurs during cropping does not seem to pose a serious threat to the overall crop.

Most species are mesophilic; some are thermophilic; and all are saprophytic. *Humicola* is not a problem contaminant.

See *Torula*, another thermophilic fungus beneficial to composting.

For more information consult: Bels-Koning, H.C., Gerrits, J.P.G., and Vaandrager, M.H. 1962. "*Some Fungi Appearing Towards the End of Composting*," Mushroom Science V.

Monilia (White Flour Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Names: White Mold; White Flour Mold; or Pink Mold

Latin Root: From "monile" or necklace for the chain-like arrangement of the mycelium and spore producing cells.

Habitat & Frequency of Occurrence: Relatively common on agar; grain; compost and casing soil.

Medium Through Which Contamination Is Spread: Primarily air; soil; and grain.

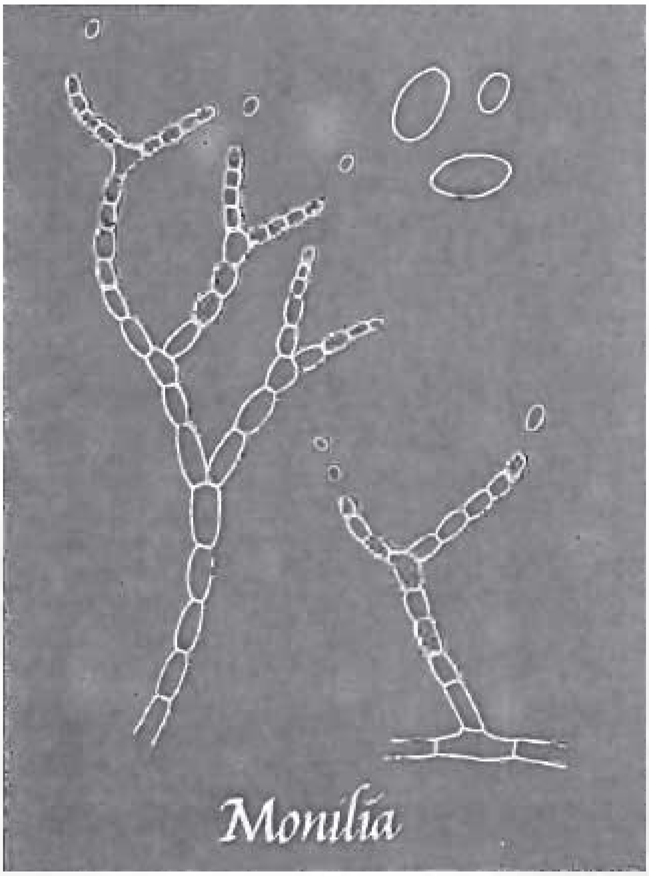


Figure 207 - Drawing of chain-like structure by which *Monilia* produces conidia (spores).

Measures of Control: Air filtration; maintenance of good hygiene in laboratory and growing room, especially in the isolation and removal of contaminated cultures and debris from previous croppings. Thorough sterilization of grain and pasteurization of casing reduces the possibility of contamination arising from within. This contaminant is believed to be externally introduced through airborne spores. High efficiency filters prevent *Monilia* spores from contaminating spawn and lessen the risk of contamination in the growing room.

Macroscopic Appearance: Represented by two mutable forms: the imperfect form *Monilia* is generally a fine powdery whitish mold; and the perfect form *Neurospora* is a rapid growing tenacious aerial mold that is pinkish with spore maturity. In grain both the whitish and the pinkish *Neurospora* are encountered. White *Monilia* has a remarkable resemblance to finely ground perlite and can easily be mistaken for it. On casing soil, the pink form is more common. Both are very rapid growing.

Microscopic Characteristics: Conidia unicellular; oval to lemon shaped; produced in large quantities on yeast-like chains with the terminal cells being the youngest and originating from a simple, septate mycelial network. Less frequently, conidial spores are produced singly. Conidiophores are extremely simple and similar to mycelium or absent altogether. Its mycelium is hyaline, white or gray colored while the conidia are tan, gray or most commonly pink in color.

History, Use and/or Medical Implications: Not known to be pathogenic. A disease known as moniliasis in medicine is actually caused by a related yeast-like fungus, *Candida*, and is more correctly termed candidiasis. *Candida* has been incorrectly called *Monilia* in medical mycology texts. Several genera share the same overall microscopic features and can be easily confused with *Monilia*. Indeed, *Monilia* is a pivotal genus amongst a constellation of genera. For the purposes of the home cultivator, all these forms might be more usefully called a "complex of genera".

Comments: *Monilia*'s perfect form is represented by *Neurospora* (see that genus) and either phenotype is largely determined by nutritional factors, particularly pH. *Monilia* can vary substantially in color on grain spawn: from a thick whitish mycelial mat to a powdery white, gray or pink colored mycelium. Perhaps the most devastating form is the whitish one for its resemblance to mushroom mycelium. Also seen in agar culture, the pink form is noted for its high aerial mycelium. It climbs the sides of Petri dishes. If not treated, this contaminant can be very difficult to eradicate. Complete cleaning of the laboratory is the only recourse. After a *Monilia* outbreak careful attention must be directed at reestablishing spawn integrity.

Monilia and *Neurospora* attack the mushroom beds and casing layers with rapid growing grayish mycelia that soon develop pinkish tones with spore maturity. Contamination by this fungus is usually traced to unclean casing or infected spawn.

Consult the genus *Neurospora*.

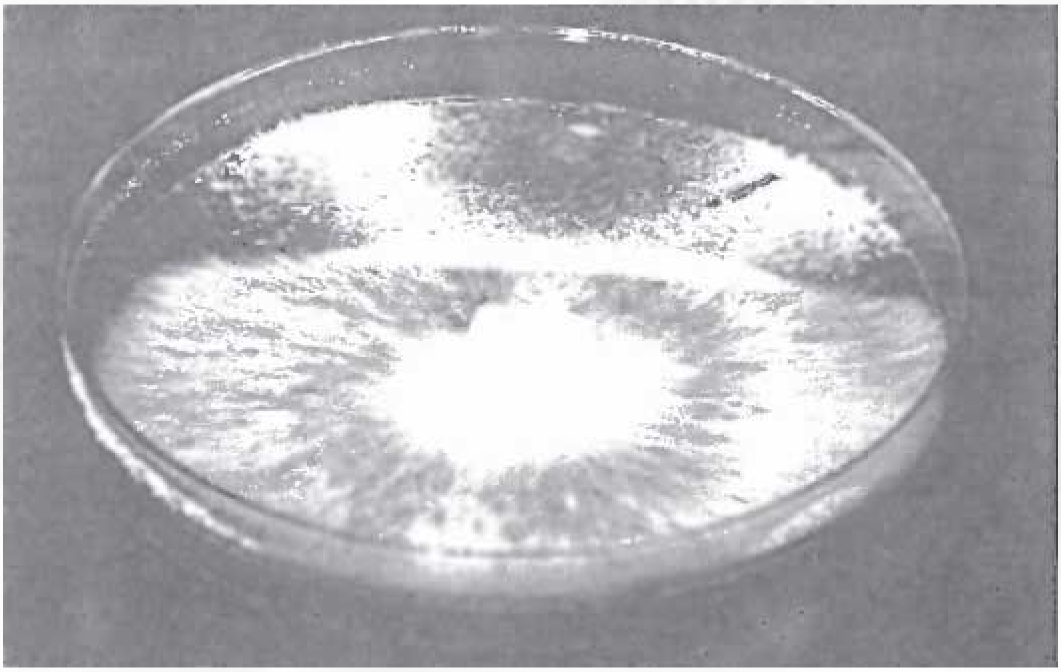


Figure 208 - *Monilia*-like mold on agar media with mushroom mycelium.

Mucor (Black Pin Mold)

Class: *Zygomycetes*

Order: *Mucorales*

Family: *Mucoraceae*

Common Names: the Black Pin Mold; the Black Bread Mold

Habitat & Frequency of Occurrence: A common saprophyte of stored grains; horse dung; old straw; mushroom composts; peat; soil; and plant debris. *Mucor* also rots textiles.

Medium Through Which Contamination Is Spread: Primarily air; secondarily grain and contaminated compost.

Measures of Control: Air filtration; sufficient sterilization of grain; and immediate removal and isolation of contaminated regions, 'spent' compost, aged mushrooms or cropping debris. Exercising general hygienic practices usually prevents this contaminant from becoming a problem.

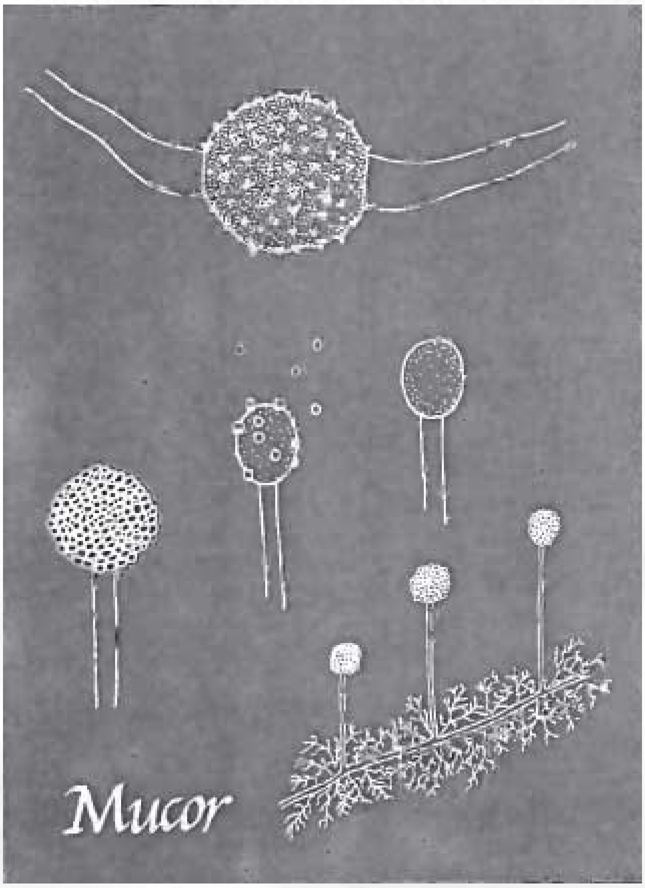


Figure 209 - Drawing of sporulating structure (sporangiophore) of *Mucor*.

Macroscopic Appearance: A fast growing fungus forming an interwoven dense mycelial mat, whitish at first, producing a stalk-like sporangiophore which is not swollen at the apex but is enveloped by spherical spore producing body. Soon becoming grayish and then blackish overall with spore production. When *Mucor* sporulates, it appears like a "forest of black headed pins". On malt agar, sporangiophores often do not form, making identification difficult.

Microscopic Characteristics: Tall sporangiophores arising singly from the mycelial mat, adorned with a spherical sporangium composed of many spores. Hyphae are non-septate (lacking distinct cell walls).

History, Use and/or Medical Implications: Some species toxic. *Mucor pusillus* and other mucuraceous fungi are the cause of a rare but deadly disease known as mucormycosis or phycomycosis. Although *Mucor* attacks open wounds, the outer ear and the lungs, it is not a primary parasite but one that takes advantage of poor health caused from other diseases. This disease and ones related to it are more prevalent in tropical and semitropical zones than in temperate regions. For more information on the pathogenic aspects of fungi in this group refer to the reference below.

Comments: A vigorous contaminant and seen at various times in spawn production, inhibiting and overwhelming the mushroom mycelium. On malt agar media *Mucor* is a fast growing, non-sporulating, cottony and whitish mycelial network competing with or overwhelming mushroom mycelium. *Mucor* mycelium is non-rhizomorphic and lacks the clamp connections that is characteristic of many mushroom mycelia.

If in doubt whether a whitish mycelium is *Mucor* or not, inoculate some bread with some mycelium covered kernels and incubate at a warm temperature. If the mold is *Mucor*, it will sporulate in a few days and be easy to identify.

The most frequently seen species of this genus are *Mucor racemosus* and *Mucor plumbeus*. *Mucor pusillus*, a true thermophile, thrives in the 68-131°F. (20-55°C.) range and is a major constituent in the microflora of compost piles. *Mucor* infected spawn, when inadvertently inoculated onto the mushroom compost, can result in the total contamination of the bed within a few days. Consult *Sepedonium*, a contaminant whose vegetative mycelia resembles the non-sporulating mycelium of *Mucor*. See also *Rhizopus*, a genus that differs from *Mucor* by its having a smaller sporangium receding from the "head" of the sporangiophore.

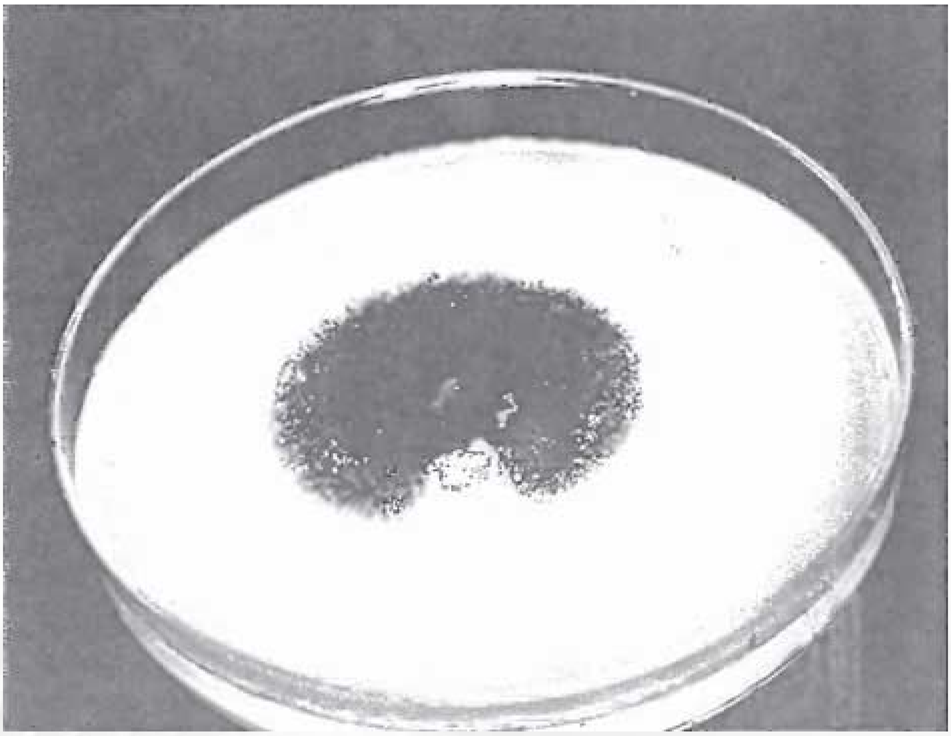


Figure 210 - *Mucor*, the Black Pin Mold, on malt agar.

For more information consult: Emmans, C.W., C.H. Binford, and J.P. Utz 1963, "*Medical Mycology*" Lea and Febiger, Philadelphia.

Mycelia Sterilia (White Mold)

Class: *Fungi Imperfecti*

Order: *Mycelia Sterilia*

Common Name: White Mold.

Habitat and Frequency of Occurrence: Contaminants fitting into this order occasionally encountered in sterile culture.

Medium Through Which Contamination Is Spread: Hyphal fragments airborne.

Measures of Control: General hygienic procedures, including the filtration of air through high efficiency particulate air (HEPA) filters, recommended.

Macroscopic Appearance: Typically appearing as a fast growing whitish mycelium, fine and or cottony in its growth. Species of *Mycelia Sterilia* closely resemble mushroom mycelium and may be mistaken for it. Sometimes they form whitish to blackish aggregates of hyphae that are sclerotia-like.

Microscopic Characteristics: Having a well developed hyphal network, with or without clamp connections. Only a vegetative mycelial stage is known. Since sporulating structures are absent, fungi in this group reproduce through random fragmentation of hyphae.

History, Use and/or Medical Implications: The genus *Sclerotium* noted for two species that parasitize a variety of green plants. Otherwise, the Order is unremarkable.

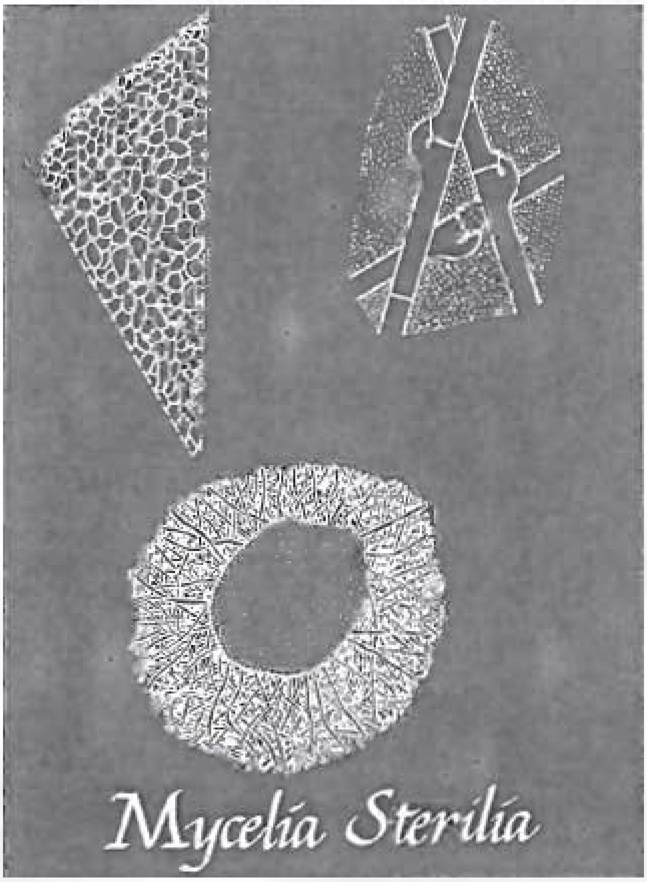


Figure 211 - Drawing of mycelial network showing hyphae with clamp connections and sclerotia-like bodies characteristic of species in the Order *Mycelia Sterilia*.

Comments: *Mycelia Sterilia* is often called a "garbage order" for non-sporulating mycelium of molds that can not be otherwise identified. Either a fungus has lost the ability to produce spores and can exist only in a vegetative state, or it will only produce spores on media of narrow nutritional specifications. In both cases, it is extremely difficult, if not impossible, to identify a fungus that has no visible conidial (sporulating) stage.

There is a white mold that occasionally contaminates agar media and, by default, qualifies for placement into the Order *Mycelia Sterilia*. Beginning cultivators have been known to propagate these sterile fungi in large quantities thinking them to be mushroom mycelia. This group of contaminants can be very competitive and should not be underestimated.

See also *Mucor*, a mold that has a vigorously growing whitish mycelium on agar media and one that often does not sporulate until it is transferred to grain.

Mycogone (Wet Bubble)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Hyphomyceteae*

Common Names: Bubble; Wet Bubble; White Mushroom Mold; and La Mole.

Greek Root: From "myco" or fungal and the suffix "gone" meaning reproductive body. This mold is named in reference to this mold's tendency to parasitize the mushroom fruitbody.

Habitat & Frequency of Occurrence: Very common, infecting the mushroom itself and causing significant losses to crops. *Mycogone* naturally occurs in soils from which this aggressive contaminant attacks the mushroom fruitbody. It does not grow well at temperatures lower than 60°F.

Medium Through Which Contamination Is Spread: Mostly through soils; debris (stem butts, etc.); and spent compost. Workers, especially harvesters, are one of the primary vehicles for spore dispersal. Watering infected areas further spreads this contaminant.

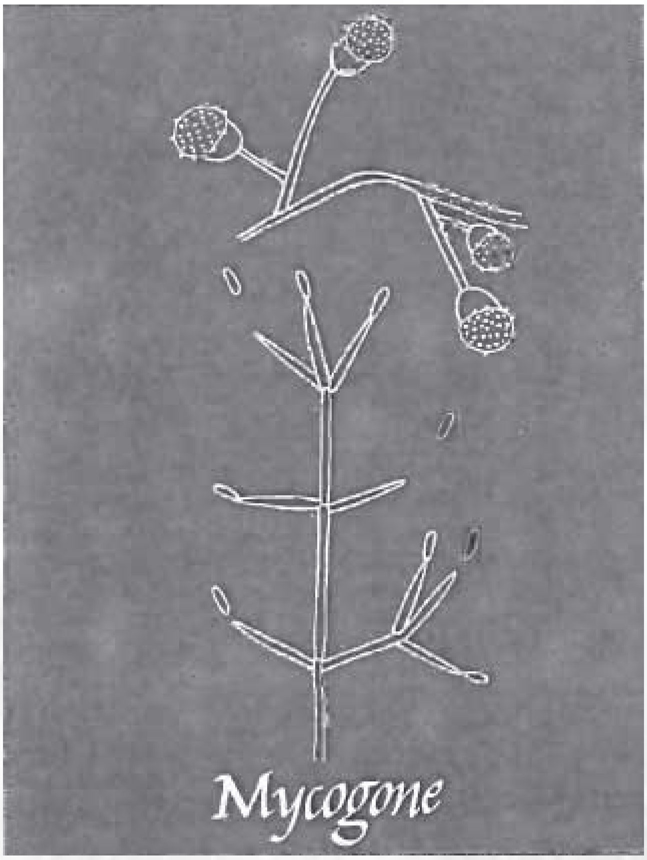


Figure 212 - Drawing of sporulating structure characteristic of *Mycogone*.

Measures of Control: Use of clean casing materials; moderation of temperature and adhering to a strict regimen of hygiene, especially between cropping cycles. Without touching the casing, infected mushrooms should be removed from the bed. The localized area is then sprinkled with salt, baking soda or a similar alkalinic substance. Do not water until the infected area is treated.

Macroscopic Appearance: Appearing as a whitish mold attacking primordia and turning them into a soft whitish ball of mycelia. From the brown and rotting interior of these "bubbles", amber fluid containing spores and bacteria ooze. More mature mushrooms that are afflicted with this disease have a felt-like covering of mycelium and a disproportionately small cap relative to the size of the stem.

Microscopic Characteristics: Conidiophores short; generally hyaline; relatively undeveloped; lateral; and altogether similar to the mycelia. Two types of conidia, terminally produced, can occur. The first and most distinctive type of chlamydospore is dark, round and two celled with one being large and rough walled, often adorned with short spine-like projections, and which is attached to a smaller cup shaped smooth cell. The second conidial type is smaller, ellipsoid, unicellular and develops apically from the ends of *Verticillium*-like conidiophores.

History, Use and/or Medical Implications: Not known to be pathogenic to man or animals.

Comments: *Mycogone perniciosa* Magnus is the species in the genus responsible for attacking the mushroom crop. Its mycelia intergrows with mushroom mycelia, according Kneebone (1961). This is a vigorous and resilient contaminant. Its spores are killed at 120°F. when exposed to moist heat (pasteurization) for 24 hours. Isolation of contaminated mushrooms, increasing ventilation, lowering temperature and proper bed cleaning techniques all limit the spread of *Mycogone*. Kneebone recommends the use of chlorinated water (150 ppm) during normal crop watering to impede the germination of its spores.

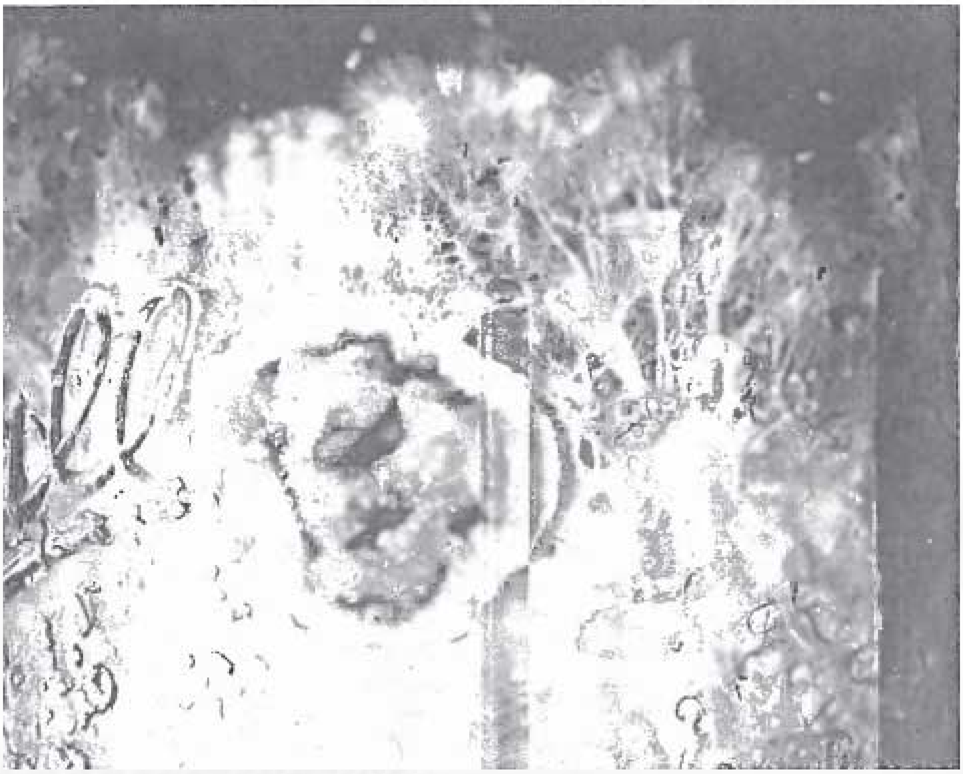


Figure 213 - *Mycogone*, Wet Bubble, on cased rye grain spawn.

Harvey *et al*. 1982, noted that if *Mycogone* appears during the first flush, then its spores were probably introduced via the casing - either at the time of its application or during spawn run through it, a period of about two weeks. Later infestations are more probably spread by flies, workers, air currents or other means.

Mycogone is believed by some mycologists to be an imperfect form of *Hypomyces*, an ascomycetous fungus that parasitizes wild mushrooms, especially *Russula* and *Lactarius*.

See also *Verticillium* and *Dactylium*.

Neurospora (Pink Mold)

Class: *Ascomycetes*

Order: *Xylariales*

Family: *Sordariaceae*

Common Names: Pink Mold; Red Bread Mold

Latin Root: From "neuro" meaning nerve and "spora" or spore, in reference to the longitudinal nerve-like ridges running along the axis of the spore.

Habitat & Frequency of Occurrence: Commonly to occasionally seen on agar and grain. *Neurospora* is fast growing, sometimes taking only 24 four hours to totally colonize a media filled Petri dish. It is ubiquitous in nature, occurring on dung, in soils and on decaying plant matter.

Medium Through Which Contamination Is Spread: Primarily air; secondarily soils; dung and grains.

Measures of Control: Air filtration; incubation of cultures in a sterile environment; thorough sterilization of grain; isolation and destruction of contaminated cultures; and otherwise maintaining the standard regimen of hygiene.

Macroscopic Appearance: A fast growing, creeping aerial mycelia that becomes bright pinkish in color with spore maturity.

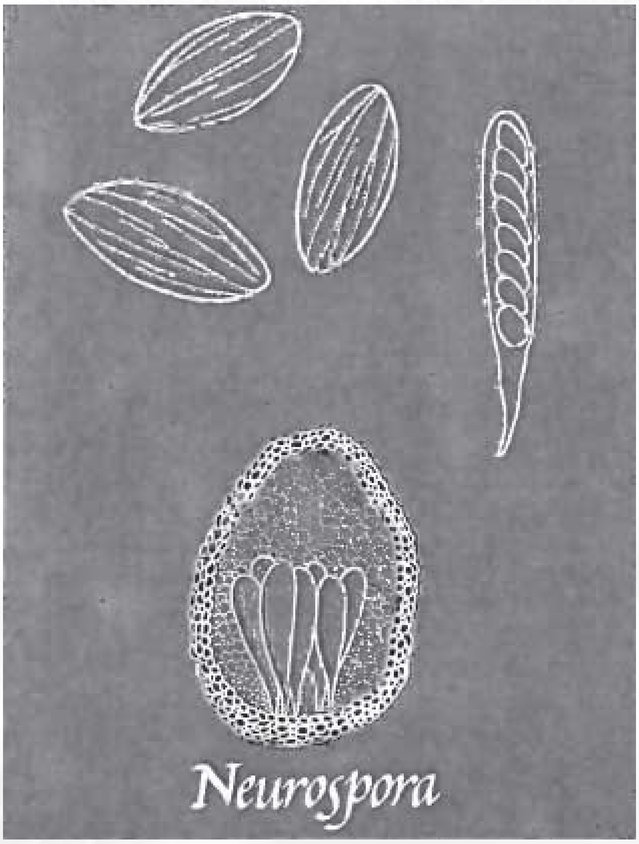


Figure 214 - Drawing of sporulating structure and distinctive spores of *Neurospora*, a pink mold.

Microscopic Characteristics: Spores distinctively longitudinally ribbed with nerve-like ridges, produced eight at a time (rarely four) in a sac-like organ called an ascus which is in turn enclosed within a ball-like perithecium that can be dark brown to black to pink in color. Its mycelium is usually pigmented, a feature influenced by the type of habitat. Its imperfect form, *Monilia*, consists of a simple mycelia network which branches. *Monilia* segments at the tips from which ellipsoid, oval or globose spores are formed in short chains from the terminal ends. *Monilia* spores are frequently pinkish.

History, Use and/or Medical Implications: Not known to be pathogenic to man or animals. *Neurospora crassa* has become a standard species for studying fungal genetics in culture.

Comments: *Neurospora* has an imperfect form represented by the genus *Monilia* which forms spores not in a sac-like envelope but in simple chains at the end of hyphae. (See that genus). *Neurospora* and/or *Monilia* are some of the fastest growing contaminants on grain and agar. The color of this contaminant, in either form, varies substantially. The ability of this organism to mutate into both an asexually reproducing fungus (*Monilia*) and a sexual one (*Neurospora*) is a factor largely determined by nutrition and pH - low pH levels encourage the expression of *Monilia* while higher pH media favor *Neurospora*.

The characteristic pinkish tone and unique spore structure make *Neurospora* an easy contaminant to identify. Since this fungus grows through cotton stoppers or filter discs, a single contaminated jar, though sealed, can spread spores to adjacent spawn jars within the laboratory. This condition is more likely if the filter discs or cotton plugs are the least bit damp; or if the external humidity is high. Furthermore, *Neurospora* spores germinate more readily at elevated temperatures.

The red bread mold belongs to the *Neurospora crassa* complex. The pink mold seen in mushroom culture is most frequently *Neurospora sitophila*, a pernicious contaminant that is difficult to eliminate.

All infected cultures should be removed as soon as possible from the laboratory and destroyed. A thorough cleaning of the laboratory is absolutely necessary. If contamination persists, remove all spawn and start anew. Since *Neurospora* spores are spread via the air, high efficiency particulate air (HEPA) filters readily eliminate this contaminant.

Refer to the genus *Monilia*, an imperfect form of *Neurospora*.

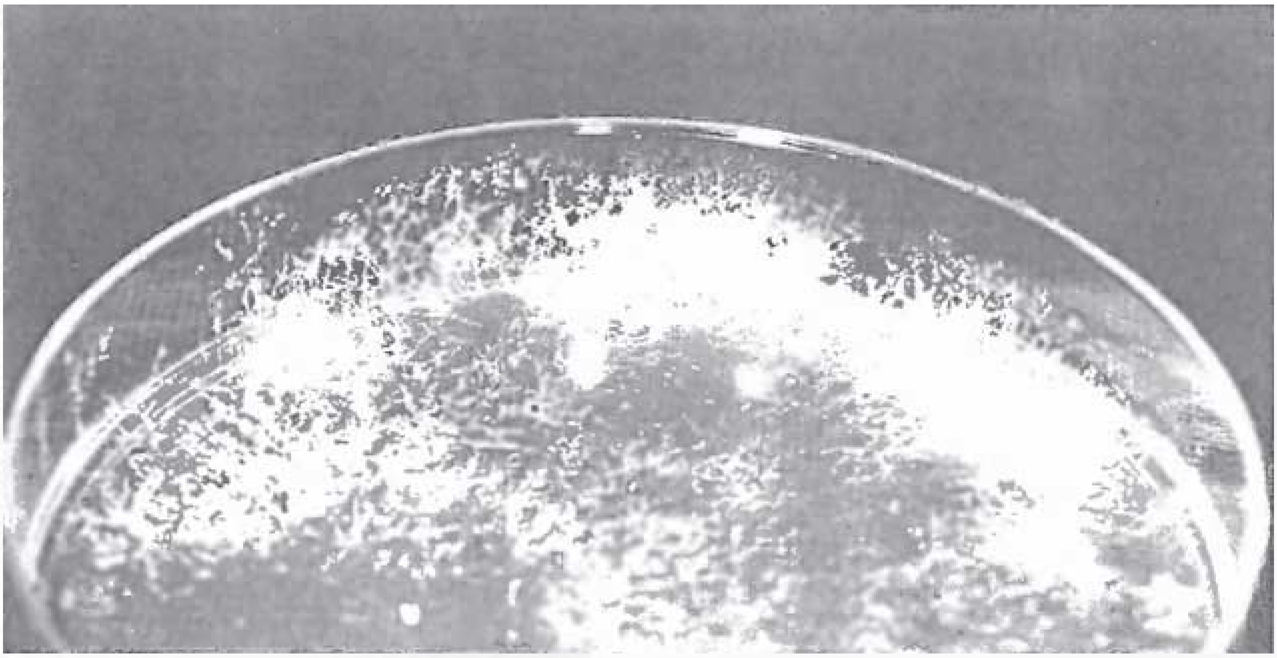


Figure 215 - *Neurospora* contaminating PDA media. Note creeping aerial mycelium.

Papulospora (Brown Plaster Mold)

Class: *Fungi Imperfecti*

Order: *Mycelia Sterilia*

Common Name: Brown Plaster Mold.

Latin Root: From "papulosus" meaning pimple-like and "spora" or spore. Named in reference to the rounded groups of cells that resemble sclerotia and are characteristic of this genus.

Habitat & Frequency of Occurrence: A saprophyte, common on overly mature composts or on compost with excessive moisture. Some species grow directly on the wood used in the construction of the trays and then spread to the beds.

Medium Through Which Contamination Is Spread: Primarily air; from spent compost; or from untreated trays that once harbored this contaminant.

Measures of Control: Avoidance of over-composting; proper balancing of moisture in the compost; expeditious removal of old or contaminated compost; steam cleaning of trays; and maintaining good hygiene between crops.

Macroscopic Appearance: Dense whitish mycelium, resembling *Scopulariopsis fimicola* (the White Plaster Mold) in the early stages, soon becoming cinnamon brown from small bead-like or "powdery" sclerotia-like balls of cells. The balls of cells are easily seen with a hand lens and are darkly pigmented. Often there is a whitish rim of new growth along the outer periphery of the mycelium.

Microscopic Characteristics: True conidia absent, propagating through simple fragmentation of mycelia or through dense spherical sclerotia-like masses of dark cells.

History, Use and/or Medical implications: None known.

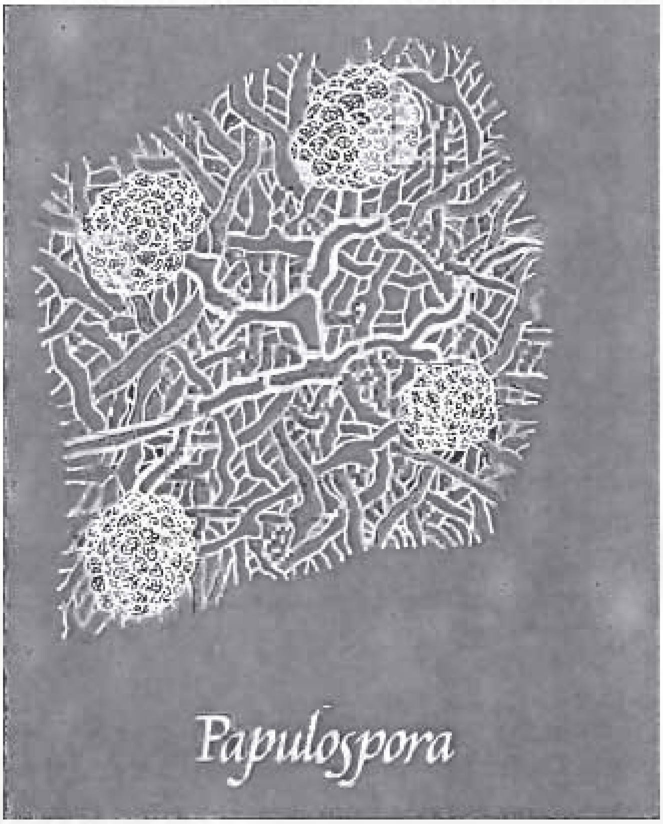


Figure 216 - Drawing of non-sporulating sclerotia-like mycelial mass that is typical of the Brown Plaster Mold, *Papulospora byssina*.

Comments: *Papulospora* is competitive to mushroom mycelium and can therefore postpone or inhibit fruiting. *Papulospora byssina* Hotson is the brown plaster mold commonly encountered in mushroom cultivation. Colonies of this contaminant can grow up to several feet in diameter if corrective countermeasures are not taken. It frequently grows on wooden trays or shelves. The Brown Plaster Mold is detrimental to mushroom crops only in the sense that *Papulospora* usurps valuable nutrients that would otherwise be available to the mushroom mycelium. According to Atkins (1974), wet, compact and overly mature compost is likely to favor these contaminants.

Because no conidial (spore producing) phase is known, it has been placed in the "garbage" order of little understood fungi, the *Mycelia Sterilia*.

See also Botrytis and *Scopulariopsis*.

Penicillium (Bluish Green Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Eurotiaceae*

Common Name: The Bluish Green Mold.

Latin Root: From "penicillum" meaning a brush-like tuft of hairs, so named in reference to the shape of the sporulating body.

Habitat & Frequency of Occurrence: An extremely common contaminant. Although not as prevalent in nature as *Cladosporium*, *Penicillium* is the most prevalent of indoor contaminants, a fact that is undoubtedly related to human eating habits. *Penicillium* species abound on foodstuffs such as fruits, cheeses and stored grains. Many species prefer habitats with an acid pH. Penicillia are occasional to frequent on under-developed mushroom compost, casing soil and on discarded mushroom debris.

Medium Through Which Contamination Is Spread: Primarily through the air, although stored grain and other foodstuffs, as well as humans are the most frequent carriers of this mold.

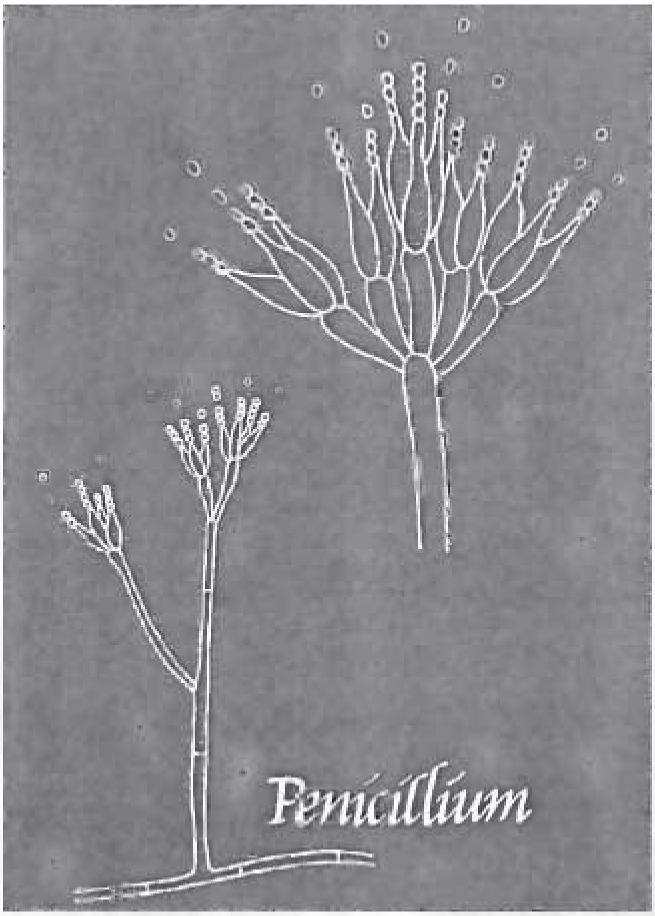


Figure 217 - Drawing of sporulating structure characteristic of *Penicillium* molds.

Measures of Control: Air filtration; removal of waste products; isolation of contaminated cultures; and maintenance of a high level of hygiene.

Macroscopic Appearance: Appearing as a granular or powdery bluish green mold, often with a broad whitish rim of new growth. Some species, less frequently encountered, are whitish, yellowish or even reddish in color. Many species exude droplets of fluid from their surfaces having antibiotic properties.

Microscopic Characteristics: Conidiophores arising singly, long, and branching near the apex into short chains of globose, green, dry conidia. Compared to mushroom spores, the conidia of Penicillia are minute, measuring only 2-4 microns in diameter.

History, Use and/or Medical Implications: In 1928-1929 while Dr. Alexander Fleming was studying *Staphylococcus aureus*, he noticed that a green mold contaminant inhibited his cultured bacteria when the two grew in close proximity. A fluid that was being exuded from the fungus caught his curiosity. Upon reporting his finding, colleagues later found the fluid contained a powerful new antibiotic which was named penicillin. He had, in fact, cultured *Penicillium notatum* Westl. Currently penicillin is commercially produced by high yielding strains of *Penicillium chrysogenum* Thom. Through its use, millions of people have been cured of illnesses that were previously untreatable. From the widespread use and abuse of this drug, however, new, more virulent and penicillin resistant strains of bacteria have evolved.

From the production of steroids to the making of roquefort cheese (by *Penicillium roquefortii*), this genus is resplendent with species of proven value to man. Few, if any, are pathogenic.

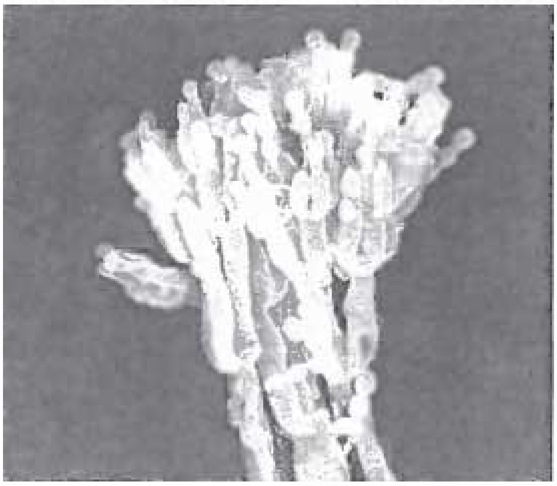


Figure 218 - Scanning electron micrograph of *Penicillium*.

Comments: Since the high count of *Penicillium* spores indoors is directly traceable to decomposing foodstuffs, one can reduce the prevalence of this contaminant by simply following good hygienic practices. *Penicillium*, a prolific spore producer, is an ubiquitous fungus. It is probably the most common contaminant seen in the laboratory. Although *Penicillium* can attack compost, casing soil and mushroom debris, it is not as prevalent as *Trichoderma* in these habitats. Other green molds, similar in appearance, are *Cladosporium* and *Aspergillus*.

Penicillium sometimes contaminates poorly prepared compost or spawned compost that has undergone secondary heating. Here, grain kernels formerly colonized by mushroom mycelium become susceptible to weed molds such as *Penicillium* and *Doratomyces* and then spread onto the compost and/or casing soil.

Differing from *Aspergillus* and *Trichoderma* in the shape of the conidiophore.

For further information: "*The Penicillia*" by Raper and Thom (1949) who recognized 138 species at the time of publication.

See Color Photograph 20.

Rhizopus (Black Pin Mold)

Class: *Zygomycetes*

Order: *Mucorales*

Family: *Mucoraceae*

Common Names: Bread Mold; The Pin Mold.

Latin Root: From the prefix "rhizo", pertaining to roots, and the suffix "pus" or foot, in reference to the rhizoids at the base of the sporangiophore that is characteristic of some species in this genus.

Habitat & Frequency of Occurrence: A saprophyte, commonly seen in both agar and grain culture. *Rhizopus* naturally inhabits dung and soils and is a decomposer of dead plant and animal matter. Within the home, this contaminant is most often seen on old bread or on poorly stored grain and fruits.

Medium Through Which Contamination Is Spread: Primarily air.

Measures of Control: Air filtration; strict adherence to general hygienic practices; and steam sterilization of grain and agar media.

Macroscopic Appearance: Similar to *Mucor*. When sporulating, *Rhizopus* appears as a dense mat of tall, aerial, vertically oriented hyphae upon which sit dark grey to grey black heads. It resembles a forest of pins.

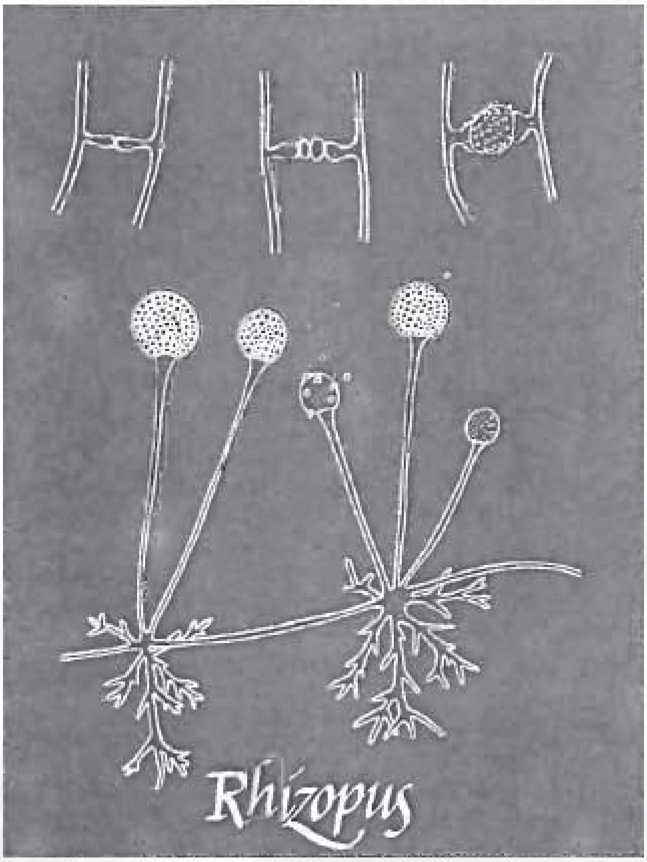


Figure 219 - Drawing of asexual sporangiophore and sexual zygosporium of *Rhizopus*.

Microscopic Characteristics: A creeping hyphal network that gives rise to individual, vertically oriented stalks that are unbranched and at whose base distinct rhizoids can be attached. The apex is swelled into a vesicle upon which a dark spherical body (sporangium) rests. This sporangium does not fully envelope the sporangiophore. Hence, the sporangiophore swells before contacting the sporangium. The sporangium is a mass of spores within a thin envelope of tissue that soon disintegrates and frees the asexual spores. Joining these individual sporangiophores are long interconnecting mycelial veins called stolons. Mating can also occur between two sexually complementary hyphae and results in the formation of a globose reproductive body, a zygosporium. (See Fig. 219). Its mycelia lacks distinct cell walls.

See also *Mucor*, a mold that is closely related to *Rhizopus*, but whose sporangium completely covers the apex of the sporagiophore.

History, Use and/or Medical Implications: In itself, not a pathogen to man. Reports in the medical literature have in the past blamed *Rhizopus* for zygomycosis when in fact other related genera - *Absidia* and *Mucor* - were responsible.

Rhizopus stolonifer, the black bread mold, is also utilized in the commercial production of fumaric acid and cortisone. Other species in the genus secrete assorted alcohols and acids as metabolic waste products.

Comments: Along with *Aspergillus* and *Penicillium*, species of this genus are the primary contaminants of grain spawn. *Rhizopus* is very rapid growing, and is called the Pin Mold for the shape of the spore producing body. *Rhizopus stolonifer* (=*Rhizopus nigracans*) is called the Black Pin Mold and can elevate the substrate temperature from room temperature to the 95-104°F. range. At this level, the populations of the true thermophiles increase dramatically, further heating up the host substrate to temperatures lethal to the mushroom mycelium.

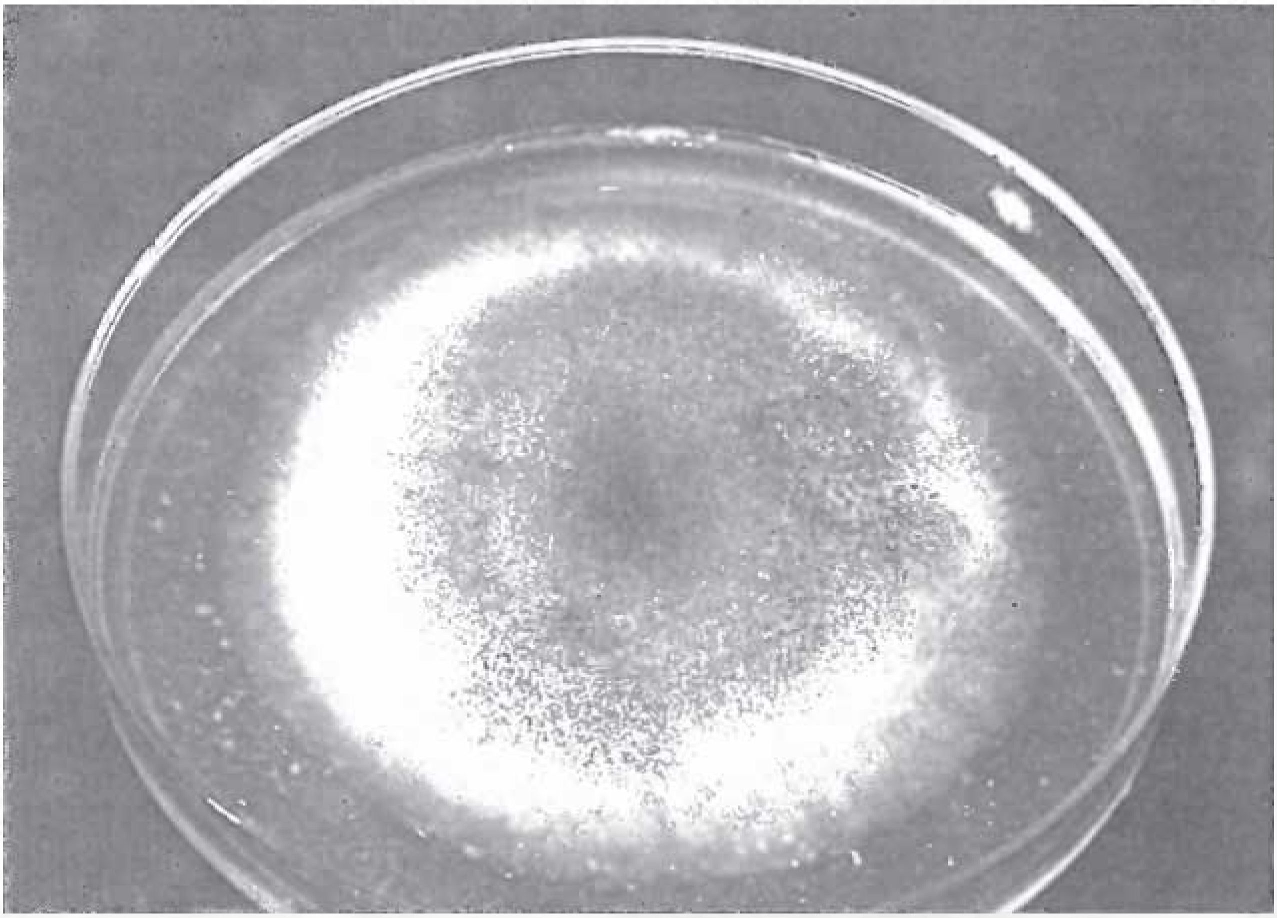


Figure 220 - *Rhizopus*, the Black Pin Mold, on malt agar.

Scopulariopsis (White Plaster Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Series: *Annelosporae*

Common Names: White Plaster Mold; Flour Mold.

Latin Root: From "scopulatus" meaning broom-like or brush shaped, in reference to the structure of the sporulating reproductive body.

Habitat & Frequency of Occurrence: A saprophyte, occasionally seen in composts that have been over-watered or are too high in nitrogen. *Scopulariopsis* also forms on the casing during the fruiting cycle. It naturally grows in soils, on hay, on rotting leaves and on other decaying plant material including grain. This group of molds generally prefer an alkaline pH.

Medium Through Which Contamination Is Spread: Primarily airborne spores, spent compost and insects; and from materials previously in contact with this contaminant that were not thoroughly cleaned before use.

Measures of Control: Proper preparation and sufficient air during Phase II composting discourages this fungus. Atkins (1974) reported that excessive moisture and subsequent anaerobic pasteurization were the two main factors contributing to the spread of the White Plaster Mold. Before filling, the addition of gypsum to an overly wet compost will bind loose water, a condition favourable to this mold.

Macroscopic Appearance: Circular colonies of densely matted, whitish mycelia; with age developing slight pinkish tones. This mold often appears as "splotches", mostly on the compost bed and to a lesser degree on the casing soil.

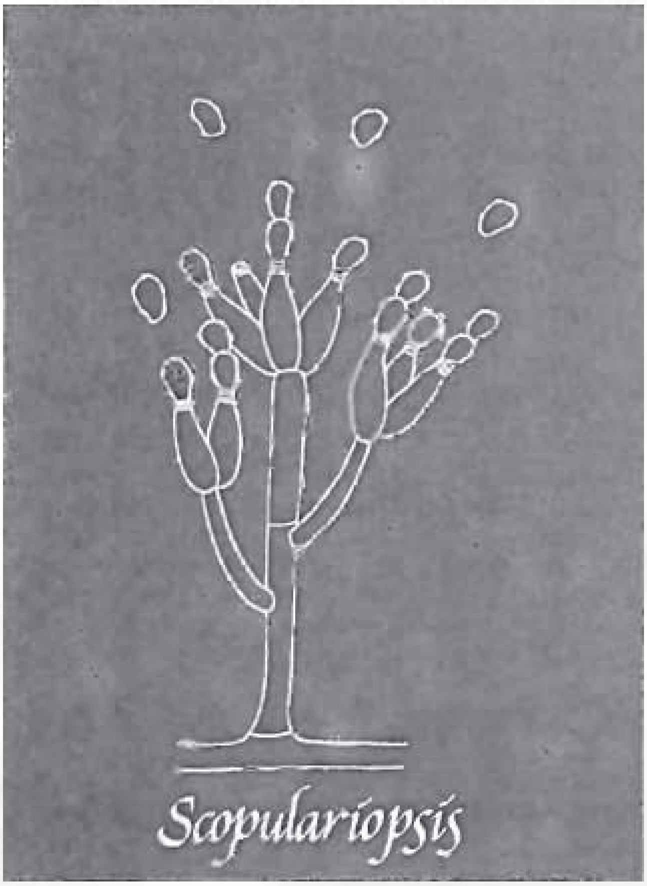


Figure 221 - Drawing of sporulating structure typical of *Scopulariopsis*.

Microscopic Characteristics: Conidiophores short, soon branching, delineating into several elongated cells which then give rise to short chains of globose, hyaline, finely warted, dry conidia that measure 5-8 x 5-7 microns. Annular zonations are present at the junction of the sporogenous cells and the first spore in the conidial chain. Terminal cells in the chain are the oldest and typically the largest. The conidiophores generally resemble that of *Penicillium* and thus are described as penicillate, or brush shaped.

History, Use and/or Medical Implications: One species toxic to humans: *Scopulariopsis brevicaulis* (Saccardo) Brainer. This species usually attacks tissue already diseased by other microorganisms. It is an improbable threat to the health of mushroom cultivators.

Comments: *Scopulariopsis fimicola* is the White Plaster Mold seen on compost beds. It is very detrimental to the growth of mushroom mycelia. Its presence is usually an indication of a short, wet and over-mature compost. This condition predisposes the compost to a difficult Phase II with dense anaerobic areas, ammonia-lock and consequently high pH levels. All these factors contribute to the growth and spread of *Scopulariopsis fimicola*, the species of White Plaster Mold most frequently seen in mushroom culture.

Contamination can also arise from within the mushroom house if there has been a prior history of problems with this contaminant and if strict contamination control procedures have not been instigated. Not surprisingly, one often finds *Scopulariopsis* with the Inky Cap (a *Coprinus* species) which is also associated with residual ammonia in composts.

See also *Papulospora* (*P. byssina* Hots.), a genus containing the Brown Plaster Mold whose early stages of growth resemble the White Plaster Mold.

Sepedonium (White or Yellow Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Series: *Aleurisporae*

Common Names: Yellow Mold; White Mold.

Habitat and Frequency of Occurrence: Occasionally to frequently encountered on agar; more common on compost; and parasitic on wild mushrooms (both Basidiomycetes and Ascomycetes).

Medium Through Which Contamination Is Spread: Primarily through the air, but also from spent compost.

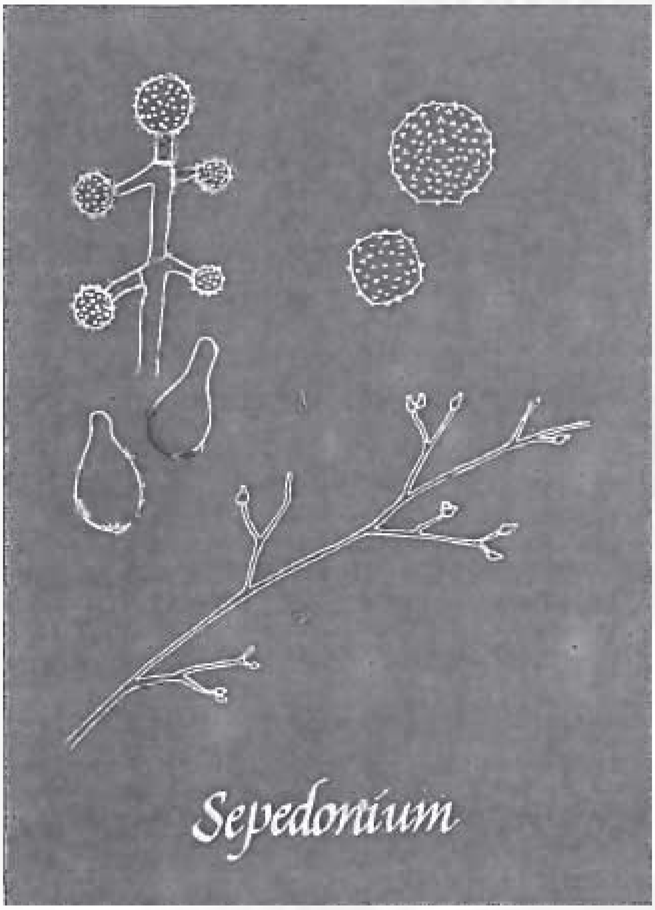


Figure 222 - Drawing of sporulating structure and flask shaped conidia.

Methods of Control: Air filtration; strict maintenance of hygiene in the laboratory and growing room; the expeditious removal of spent compost; and the thorough disinfection of wooden compost containers.

Macroscopic Appearance: On malt agar and on rye grain appearing as a fast growing whitish mold, very similar to cottony mushroom mycelia and frequently mistaken for it. On compost it is a fine white mold which with age becomes yellowish to golden yellow from spore production. It is not as prolific a spore producer as the powdery *Trichoderma*. If spores are not produced at all, the mycelia remains whitish. This mold attacks composts that otherwise have been properly prepared for mushroom growing.

Microscopic Characteristics: Two types of spores formed. The more obvious are large, globose chlamydospores ornamented with short spines and similar to those of *Mycogone*; except in this genus a hemispheric foot cell, shaped like a teacup is absent. Conidiophores are simple, relatively undeveloped, resembling mushroom mycelium and not easily distinguished from it except that they lack clamps. Globose to vase shaped conidia develop terminally at the end of these branches, either singly or in loose clusters.

History, Use and/or Medical Implications: Some species possibly toxic. It has been suggested that this mold secretes a sweet odor nauseous to some mushroom workers and possibly the cause of a little understood respiratory illness. Not much is known.

Comments: *Sepedonium* spores are noted for their heat resistance. It is a whitish mold until the yellow conidia are produced. On malt agar media, *Sepedonium* is fast running, and out-grows most mushroom mycelia. When the two fungi grow within close proximity to one another, a line of inhibition usually develops between the two. If conidiospores or chlamydospores are not produced, this mold is difficult to identify. The conidiophores are indistinct, very much resembling its own mycelium. From the authors' experience this contaminant is a vigorous competitor on agar media. Its appearance necessitates a thorough cleaning of the laboratory and spawn incubation environment. If this mold contaminates grain spawn and goes undetected, use of this spawn in subsequent inoculations would be disastrous.

The second site of contamination is horse manure/straw compost where it most frequently appears during spawn run. Only detrimental when large outbreaks occur, *Sepedonium*'s presence on compost can be traced to insufficient pasteurization or spent compost residues in the trays or shelves. Although not regarded as a serious competitor on mushroom compost, *Sepedonium* is another fungus believed to be a food source for mites (Kneebone, 1961).

Sepedonium, like *Mycogone*, is an imperfect state of *Hypomyces*, a common parasite on mushrooms. In the wild, *Sepedonium chrysosperma* parasitizes *Boletus* species (particularly *B. chrysenteron*) and causes them to abort. The chlamydospores of *Sepedonium* are generally similar to *Mycogone*.

See also *Mucor* and *Mycelia Sterilia*, two fast running whitish molds on agar media.

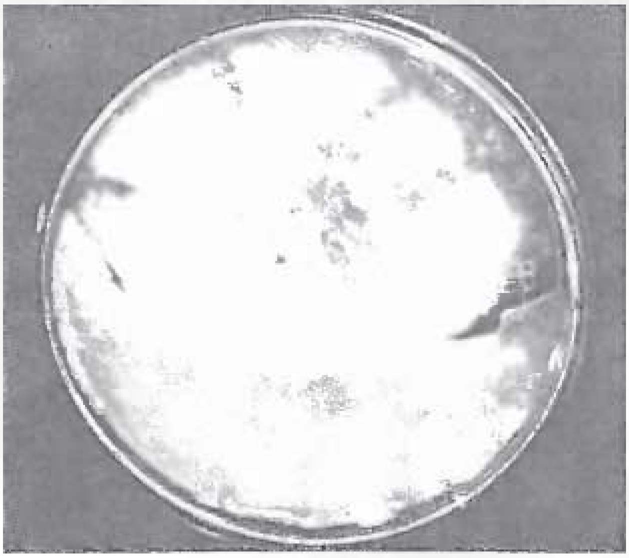


Figure 223 - *Sepedonium* mold competing with *Psilocybe cubensis* mycelia on malt agar media.

Torula (Black Yeast)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Dematiaceae*

Common Name: Black Yeast (*Torula nigra*).

Latin root: From the same root as the adjectival "torulosus", meaning cylindrical shaped with bulges and constrictions at regular intervals, chain-like.

Habitat and Frequency of Occurrence: Saprophytic, common. Many thermophilic species participate in the decomposition of straw and manure in the making of mushroom composts. Although *Torula* is rarely seen in agar culture, its cousin *Rhodotorula*, a red yeast, is frequently seen.

Medium Through Which Contamination Is Spread: Primarily an airborne contaminant; secondarily transmitted through compost.

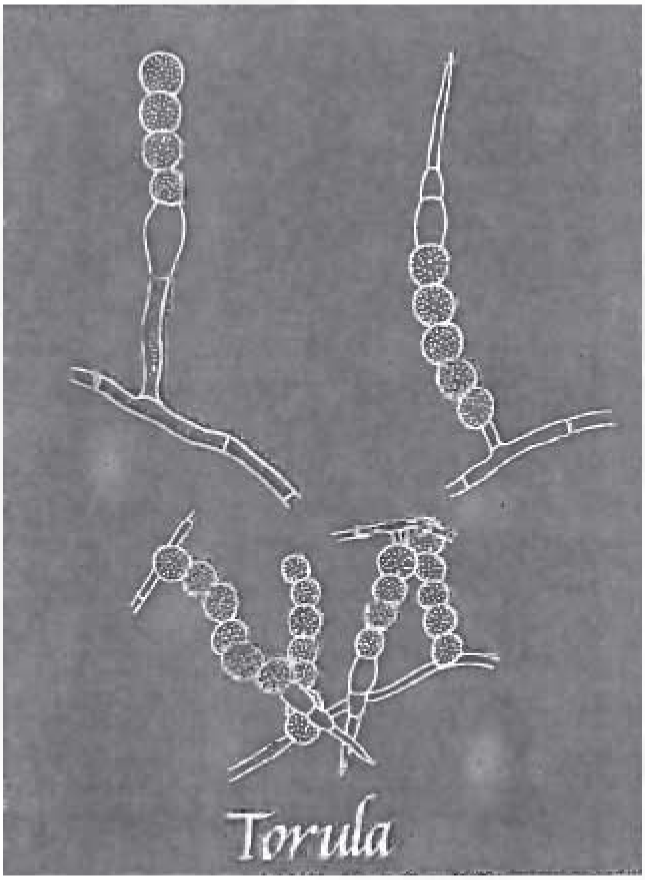


Figure 224 - Drawing of the sporulating structure of *Torula*, the Black Yeast.

Methods of Control: None generally needed or desired. *Torula* is a beneficial, thermophilic microorganism thriving in the 115-125°F. range.

Macroscopic Appearance: Whitish at first, then grayish, soon dark brown or jet black with spore production. As *Torula* matures, the mycelium becomes covered with a mass of spores that give it a soot-like appearance. On compost, this fungus appears similar to *Humicola*.

Microscopic Characteristics: Mycelium colorless or slightly pigmented. True conidiophores are lacking. Hyphae abruptly terminate into conidia which are ovoid, translucent, dark brown, smooth and produced in branched or unbranched chains by either of two methods. In one form, the more mature spores of a conidial chain develop apically, with the younger spores arising from the spore closest to the hyphal branch. (This is called basipetal development). In a second form, conidia can develop by simple budding from the tips of a hypha, in a yeast-like fashion. The budding hypha narrows towards the apex into immature spores and finally terminates with an attenuating tail. Freed are conidia found singly or attached several at a time.

History, Use and/or Medical Implications: Not thought to be pathogenic. Confusion with *Cryptococcus* has in the past given *Torula* an undeserved pathogenic reputation. Cryptococcosis in the medical literature is often though incorrectly termed torulosis.

Comments: *Torula*, like *Humicola*, is an ally to the mushroom compost maker, converting ammonic nitrogen into protein usable to the mushroom. *Torula thermophila* Cooney & Emerson is the species most frequently seen in composting straw and manure. Originally isolated from chicken droppings, this species is a true thermophile with a temperature range from 73-136°F., and an optimum of 104°F. The *Torula* genus is known for a number of thermophilic species that survive the pasteurization process and flourish at standard Phase II conditioning temperatures (118-125°F). When pasteurized compost is cooled down to room temperature, this fungus is rendered inactive and in turn becomes a food source for the mushroom mycelium.

Rhodotorula reproduces very similarly to *Torula*. It is known as the Red Yeast, commonly contaminating agar cultures. *Rhodotorula glutinis*, a common soil inhabitant, may play an important role in the reproductive cycle of the common Chantarelle mushroom, *Cantharellus cibarius*. Pure cultures of Chantarelles have been difficult to obtain from wild specimens. And, Chantarelle spores do not germinate using standard laboratory techniques. In 1979, a Swedish mycologist named Nils Fries discovered that, in the presence of *Rhodotorula glutinis* and activated charcoal, *C. cibarius* spores readily germinate. Pure cultures of Chantarelles, once nearly impossible to obtain, are now feasible. Other related yeasts may have a similar stimulatory effect on various mushrooms species currently not prone to cultivation.

Torula species, as with most yeasts, are separated from one another largely by chemical means.

Trichoderma (Forest Green Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Names: Forest Green Mold; Green Mold; and Trichoderma Blotch.

Greek Root: From "trichos" meaning hairy and "derma" or skin.

Habitat & Frequency of Occurrence: Very common on compost, casing soil and to a lesser degree on grain and agar. *Trichoderma* often parasitizes mushrooms under cultivation and can inhibit or reduce fruitings. Many species grow on wood or woody tissue and are abundant in peat. *Trichoderma* frequently grows on the wooden trays holding compost.

Medium Through Which Contamination Is Spread: Primarily an airborne contaminant when contaminating agar or grain cultures. On casing soils, it is introduced through the peat or humus. *Trichoderma* is often spread during harvesting, bed cleaning or watering. Species in this genus generally prefer an acid pH in the 4-5.5 (6) range.

Measures of Control: Careful picking; disposal of dead and diseased mushrooms; lowering of humidity levels; lowering carbon dioxide and increasing air circulation to eliminate dead air pockets. Use of clean casing materials lacking undecomposed woody tissue lessen the chance of *Trichoderma* contamination. Isolated outbreaks of *Trichoderma* can easily be contained by one of several methods. Since *Trichoderma* thrives in acid habitats, raising the pH of the surrounding soil inhibits further growth. Perhaps the simplest way to raise pH is to cover the infecting colony with salt, sodium hypochlorite or sodium bicarbonate (baking soda) or a solution thereof. Recognizing and treating this fungus in its earliest stages, before many spores are produced, greatly reduces the risk of satellite colonies spreading throughout the growing room. Mushrooms afflicted with *Trichoderma* should be carefully isolated. All items coming in contact with it (tools, workers, etc.) should be resanitized. Steam pasteurization at 160°F. for one hour effectively kills the spores of this fungus.

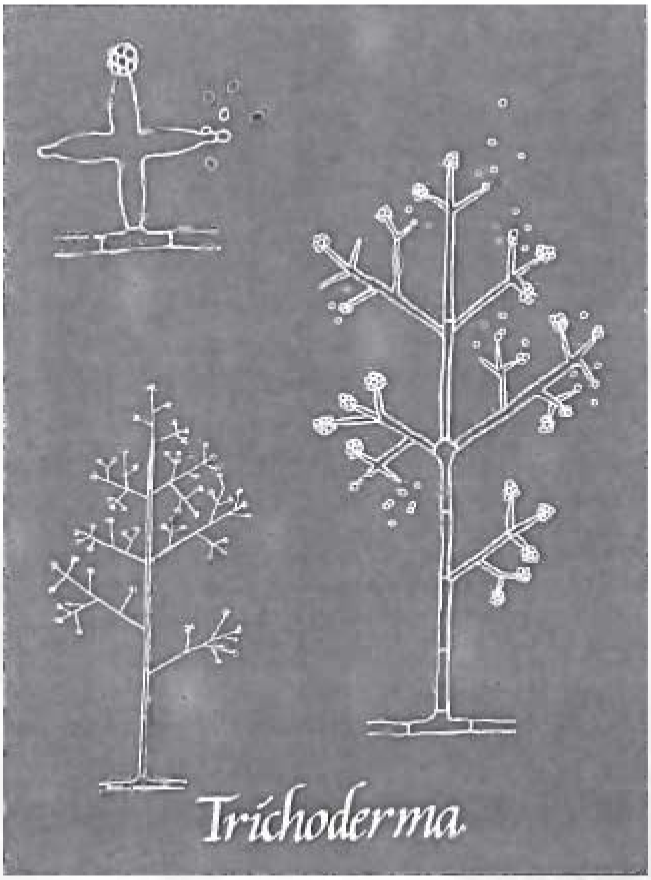


Figure 225 - Drawing of conidia and sporulating structure typical of *Trichoderma*.

Macroscopic Appearance: A cottony mold, growing in circular colonies on the casing soil or on compost; grayish and diffuse at first; rapidly growing; and soon forest green from spore production. On malt agar colonies of *Trichoderma* have an aerial, cottony and brilliant forest green mycelium whereas *Penicillium* has an appressed, granular and blue green mycelium. Some infrequently encountered species are whitish or yellowish, but the majority of those seen in mushroom culture are greenish shaded.

Parasitized mushrooms have dry brownish blotches or sunken lesions on the cap or stem. They are often enveloped by a fine downy mildew that may eventually become greenish from spore production, and are grossly misproportioned.

Microscopic Characteristics: Conidiophores clear, profusely branched upon whose ends small bunches of ovoid greenish pigmented, smooth spores are borne. In many species uniquely shaped sporogenous cells are present roughly resembling bowling pins and arranged as triads. After squashing a sample for viewing under the microscope, the conidiophores readily disassemble and are difficult to recognize. The freed conidia, however, are not arranged in linear chains as commonly seen in *Aspergillus* and *Penicillium*, but are in loose clusters or are scattered as individuals. A most distinctive feature is that the conidia are encased in a mucus-like substance, making the spores sticky. Spores measure 3-5 x 3-4 microns.

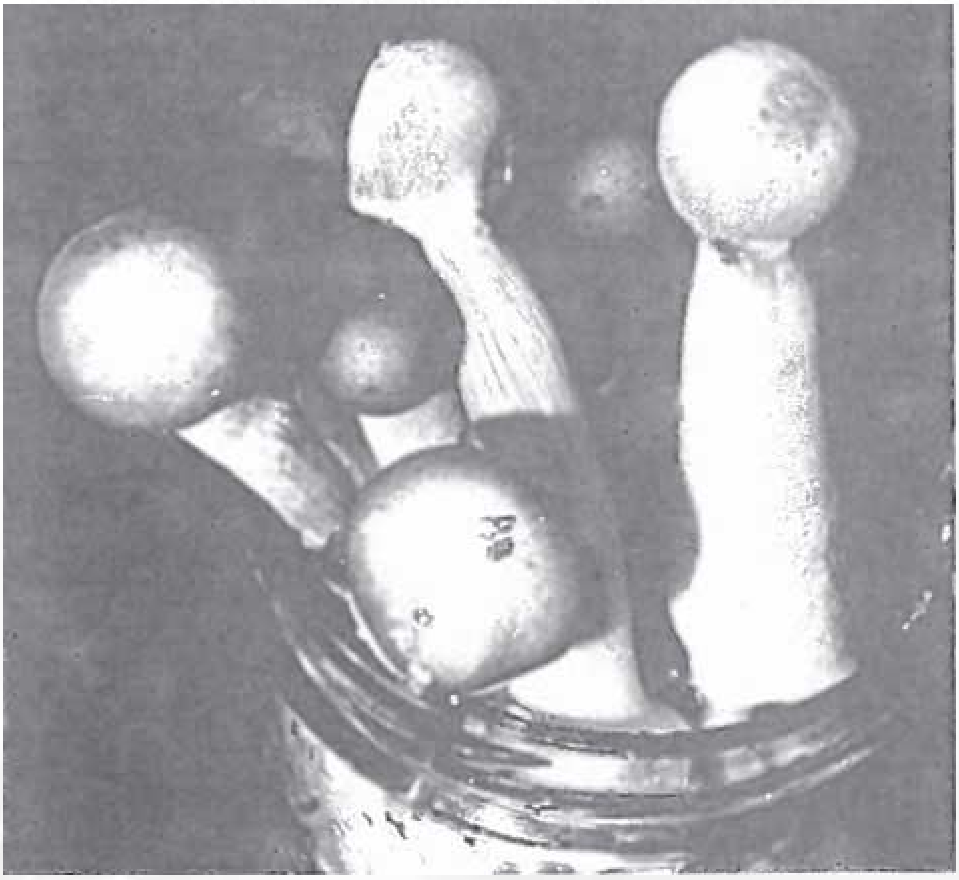


Figure 226 - *Trichoderma*-like mold parasitizing *Psilocybe cubensis*.

History, Use and/or Medical Implications: Not known to be pathogenic. One industrial application utilizes *Trichoderma*, *Penicillium* and *Cladosporium* to precipitate precious metals such as gold and platinum from solutions. The process is being patented.

Comments: In cased grain culture, *Trichoderma* is the most frequently encountered contaminant on the casing layer and usually originates there. Upon casing, spores harbored in the peat infect exposed grain kernels and sporulate. The contaminated kernels become a platform for further contamination. The mold then spreads through the casing layer until it breaks through to the surface of the casing layer. Also, *Trichoderma* is prone to casings with undecomposed woody tissue and those incorporating potting soils. *Trichoderma* is also caused by excessively wet casings applied to sterile grain spawn.

Trichoderma is an ubiquitous fungus that is encouraged by improperly adjusted environmental parameters. Conditions of excessively high and prolonged humidity in combination with stagnant air and high carbon dioxide levels tip the ecological balance of the casing soil's micro-ecology in favor of this contaminant. Once *Trichoderma* populations bloom, this mold quickly infects newly formed primordia and developing fruitbodies which become deformed. This pathogen also grows on discarded mushroom debris, particularly stem butts.

Afflicted mushrooms have brownish specks or lesions on the stem, especially near the base or apex. A fuzzy mycelium similar to *Verticillium* may be present on the cap. These lesions are dry, whereas the blotches caused by bacteria tend to be moist. The growth of the fruitbody is abruptly arrested by this mold. Under extreme conditions this mold sporulates directly on the mushroom, becoming green in color. Adjacent mushrooms, newly formed pinheads and subsequent crops need not be affected if air circulation is increased to proper levels and if humidity is decreased to within tolerable limits (3-5 exchanges of air per hour while maintaining 85-92% humidity). *Trichoderma* is alleged to secrete toxins that inhibit mushroom primordia formation and growth.

Another problem with *Trichoderma* is that its spores are utilized by red pigmy mites as food. *Trichoderma* spores are sticky and attach to anything coming in contact with them. In this way, mites further aid the spread of *Trichoderma* contamination. And, soon after an outbreak of *Trichoderma*, it is not unusual to see a population explosion of mites.

Most notable are *Trichoderma viride* (a synonym of *Trichoderma lignorum*), an early appearing mold with roughened spores and *Trichoderma koningii*, a smooth spored mold seen later in the cropping cycle. Both are mushroom pathogens.

See *Verticillium*, a mold with similar symptoms when attacking fruit bodies.

See Color Photograph 22.

Trichothecium (Pink Mold)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Name: Pink Mold.

Greek Root: From "trichos" meaning hairy and "theke" meaning sac or capsule.

Habitat and Frequency of Occurrence: For the most part, a saprophyte, rarely encountered in spawn making even though it is one of the many microflora associated with grain. *Trichothecium* is an occasional contaminant in agar culture and in poorly prepared or immature composts.

Medium Through Which Contamination Is Spread: Primarily an airborne contaminant.

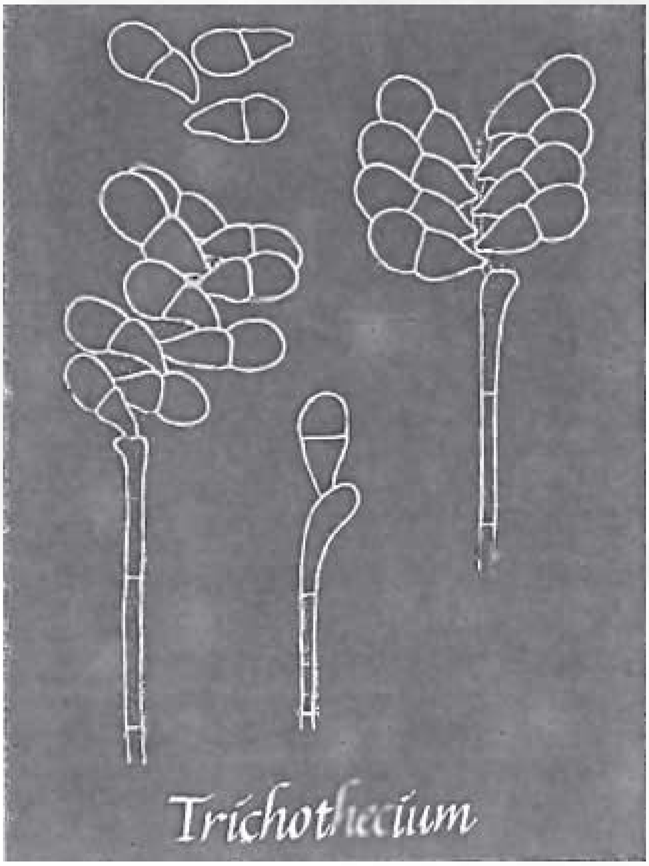


Figure 227 - Drawing of conidia and sporulating structure of *Trichothecium*.

Measures of Control: Air filtration and maintenance of good hygiene in the laboratory.

Macroscopic Appearance: Mycelium initially whitish; soon pinkish with spore production; and typically slow growing on malt agars. *Trichothecium* is a powdery *Penicillium* type mold.

Microscopic Characteristics: Conidia measuring 12-18 x 4-10 microns; colorless to brightly colored; two celled; pear shaped, ellipsoid or ovoid; borne in clusters with the basal cell being smaller than the terminal one; and positioned at the apex of tall, thin, unbranched, but septate conidiophores. Spore bunches are attached to one another either in a chain-like fashion or in loose groups but not lineally.

History, Use and/or Medical Implications: One mold notable. *Trichothecium roseum* Link ex Fr. secretes an antibiotic (trichothecin) that is toxic to bacteria, fungi and animals.

Comments: More frequently seen in the course of agar culture than on grain, this contaminant can become a formidable problem if not detected early, and if large spore populations are permitted to develop within the laboratory.

Also occurring on compost and occasionally on the casing soil, particularly where nitrogen enriched compounds have not been converted into protein usable to the mushroom mycelium. By itself it is not strongly inhibitory to mushroom mycelium, but thrives in habitats generally unsuited for good mushroom growth. Adhering to good compost practices and following standard hygienic procedures prevents this fungus from occurring.

See also *Fusarium*, a genus containing several pinkish colored contaminants and *Geotrichum*, a genus known for the Red Lipstick molds.

Verticillium (Dry Bubble)

Class: *Fungi Imperfecti*

Order: *Moniliales*

Family: *Moniliaceae*

Common Names: Dry Bubble; Brown Spot; and Verticillium Disease.

Latin Root: From "verticillus" meaning whorled or having branches on the same plane, in reference to the shape of the conidiophore.

Habitat & Frequency of Occurrence: A common parasite of the fruitbody. *Verticillium* is promoted during cropping under conditions of excessive humidity combined with inadequate air circulation. *Verticillium* grows within a broad temperature range although warmer temperatures (62°F. and above) are preferred. Singer (1961) reported an optimum of 72°F. *Verticillium* abounds in soils and is introduced into the growing environment via the materials composing the casing.

Medium Through Which Contamination Is Spread: Primarily transmitted from one infected region to another by mushroom harvesters, flies and insects. Watering infected mushrooms further spreads *Verticillium* spores.

Measures of Control: General hygiene maintenance; proper picking and cleaning practices; removal or isolation of infected cultures; increasing air circulation; lowering of humidity; and elimination of flies and mites. If *Verticillium* is evident before a crop is harvested, carefully pick the infected mushrooms, seal them in a plastic bag and leave the growing room with minimal contact with unaffected areas. *Verticillium* spores are highly viscous and are best transmitted by motile hosts, especially mites and other insects. Never water an infected bed until the diseased mushrooms have been removed and the infected zones have been salted with alkaline buffer (baking soda, sodium hypochlorite).

Macroscopic Appearance: Slightly infected mushrooms characterized by brown colored spots or streaks on the basal or upper regions of the stem and on the caps of developing primordia. These spots become grayish colored from spore production. Afflicted mushrooms often bend towards the side that is infected. If the mushrooms do develop at all, they are typically tilted to one side or the other. *Verticillium* attacks developing fruitbodies - the more severely infected are grossly malformed, especially young primordia which are turned into sclerotia-like balls of amorphous whitish mycelia. More mature but diseased mushrooms have a deformed pileus, sometimes with a "hair lip", and frequently with a downy grayish mycelium over the cap. The stem can be covered with a downy mycelium and often vertically splits, roughly resembling a peeled banana. The cap becomes disproportionately small relative to the fatter than normal stem. The overall texture of the mushroom is dry and leathery.

When this mold attacks *Psilocybe cubensis*, there are several additional characters worthy of note. Parasitized *P. cubensis* caps frequently become plane at an early stage. The stem becomes swollen and hollow, narrowing radically towards the apex. Only in an extremely humid environment does a downy mildew develop over the cap and stem surface. The "Verticillium spots" so commonly reported by growers of *Agaricus*, a white mushroom, are more accurately called "Verticillium streaks" on *P. cubensis*, a mushroom with a brownish cap and a whitish stem.

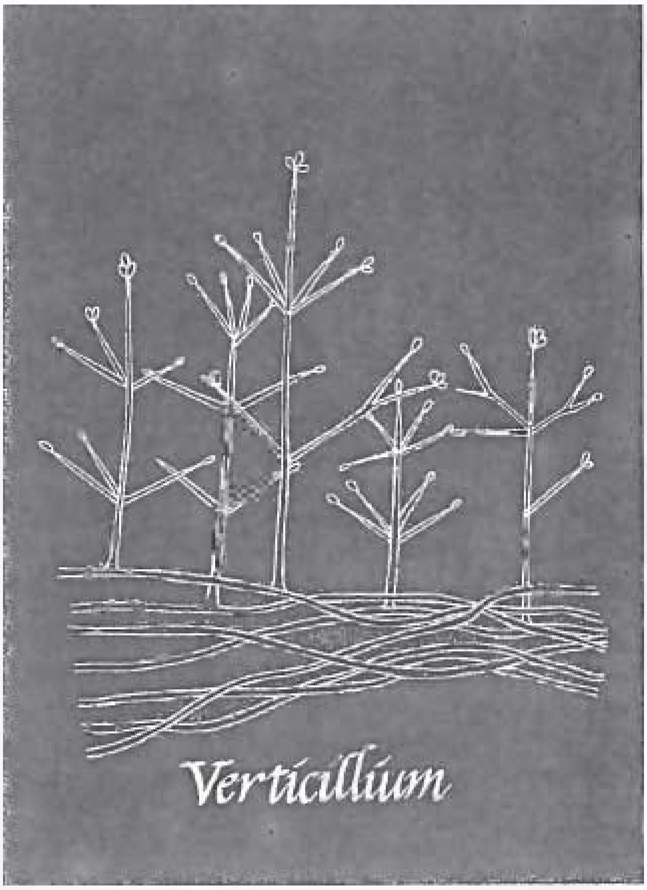


Figure 228 - Conidia and sporulating structure of *Verticillium*.

Microscopic Characteristics: Conidia hyaline; unicellular; ovoid to ellipsoid; minute, measuring 1-3 x 1-2 microns; borne singly or in small groups at the tips of narrow branches that whorl from a central trunk at regular intervals. Conidiophores are slender and relatively tall.

History, Use and/or Medical Implications: Apparently inocuous, no pathogenic species are known.

Comments: *Verticillium* is the most common fungal disease parasitizing the mushroom crop and the bane of both small and large scale growers. One misfortune of losing an early flush to *Verticillium* disease is the increased probability of other diseases appearing. Split stems open the mushroom up to attack by numerous insects and other pathogens. Not surprisingly, the sciarid fly is a vector for the spread of *Verticillium* spores from parasitized mushrooms to healthy ones. It becomes clear that if conditions are right for *Verticillium*, the conditions are right for other molds. The cultivator may soon have to deal with not one contaminant, but many.

Verticillium malthousei Ware is synonomous with *Verticillium fungicola*. Both are "brown spot" fungi that envelope the mushroom with a fine grayish mycelium and cause brownish lesions on their surfaces.

Verticillium albo-atrum is another species in mushroom culture, although not as frequently seen.

An easy method for the home cultivator to distinguish *Verticillium* infection from *Trichoderma* is to plate out the suspect mold on malt agar media. If the mold is *Trichoderma*, forest green colonies of mycelium will form. Other than green colonies of mycelium suggests the contaminant be *Dactylium* or *Verticillium*.

Usually one sees *Trichoderma* blotch simultaneous to or after the occurrence of green mold colonies on the casing layer. If there is no evidence of green mold on the casing layer and the mushrooms display these symptoms, then the mold is probably *Verticillium* or *Dactylium*. *Dactylium* can be distinguished from *Verticillium* by its locus and manner of infection. *Dactylium* is a grey, aerial mold, fast growing and obvious on the casing. *Verticillium* is primarily evident on the fruitbody and scarcely seen on the casing.

Steane (1979) reported that *Agaricus bitorquis* seemed especially resistant to *Verticillium* disease whereas *Agaricus brunnescens* was more susceptible to it. Furthermore, he noted that farms regularly suffering from this disease could greatly reduce the level of infection by intermittently growing *A. bitorquis* between *A. brunnescens* crops.

A saprophyte and parasite causing "wilt disease" of many plants, particularly garden vegetables, *Verticillium* is abundant in most soils. Some *Verticillium* species are endoparasitic to nematodes - their spores germinate in the mouth tubes of the nematode with the resulting mycelia quickly digesting the organism from within. Other pathogens that have similar symptoms to one or more of the various stages of *Verticillium* are: *Dactylium*; *Trichoderma*; *Mycogone*; and Virus.

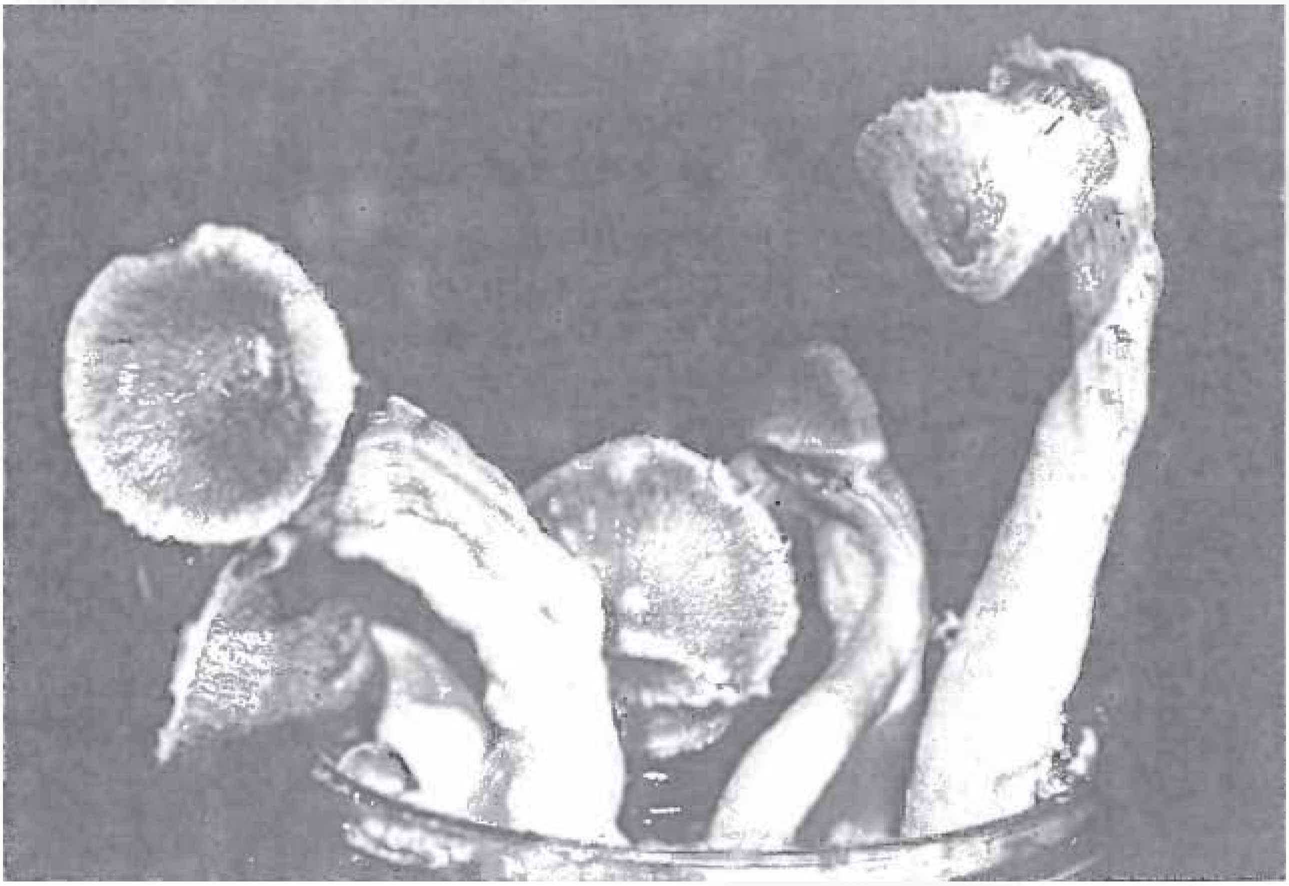


Figure 229 - *Verticillium* attacking *Psilocybe cubensis.*

XIV. THE PESTS OF MUSHROOM CULTURE

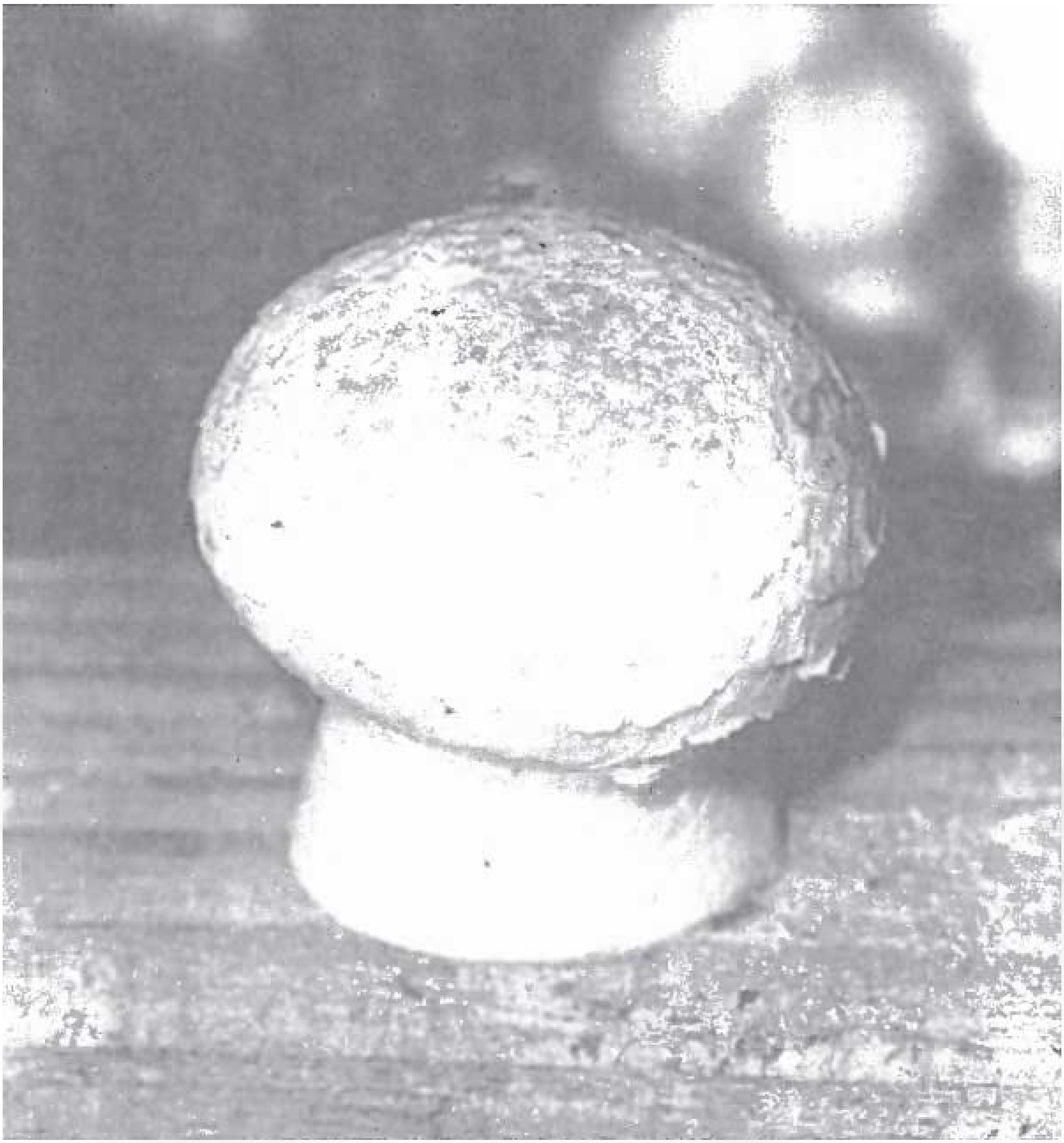


Figure 230 - Red Pepper Mites swarming on *Agaricus brunnescens*.

Mushroom Flies

Mushroom flies and midges are present in nature wherever fungi are found. Attracted by the odor of decomposing manure and vegetable matter, as well as the smell of growing mycelium, these insect pests zero in and lay their eggs on or near the mycelium and fruitbodies. Under proper conditions these eggs hatch. But it is the larvae that do the extensive damage to the mushroom plant, either by directly feeding on the mycelial cells or tunneling through the mushroom fruitbody. Because of the concentration of attractive odors, a commercial mushroom farm is always under siege by these pests. To insure insect free crops, certain measures are necessary. Unfortunately the bulk of these control measures involve insecticides, an approach not recommended by the authors. The use of insecticides is not only costly and hazardous to human health, but also represents a short term solution of a symptom rather than the solution of the problem itself. The answer to disease and pest control in mushroom growing is strict hygiene for which there can be no substitute.

Fly Control Measures

1. Pasteurization periods and temperatures must be sufficient to kill all stages of insect growth - 140°F. for 2 hours in composts or other bulk substrates.
2. All Phase II, spawning, spawn running and cropping rooms must be airtight. Physically excluding insects from these areas is the most positive control one can exercise. Even the smallest crack can serve as an entrance to the growing room. The spawn running rooms should be the most secure with access to these areas restricted. All doors should be weather-stripped and tight fitting. Positive pressure and air locks also help.
3. All tools and implements should be cleaned and disinfected before use on a new crop. A commonly used disinfectant is a 2% chlorine solution.
4. Breeding areas must be prevented by removing from the premises all excess or spent substrates, used grains, mushroom trimmings and other related by-products.
5. The growing room and all containers should be washed and disinfected between crops. Wood in particular harbors contaminants, including virus infected mushroom mycelium. Treatment of wood with cuprinol or copper sulfate is common. Petroleum based products should be avoided.
6. Fresh air intakes and exhaust vents must be screened with fine mosquito netting. Be sure there are no cracks around the filters and fan housing.
7. The room should be equipped with an insect monitor. The use of a monitor alerts the grower to fly emergence from within the growing room or to fly entry from the outside. The monitor can be as simple as a 12" x 12" plywood board to which a small black light (long wave UV) is centrally mounted. On either side of the light sticky paper is attached. There are also small pest lights commercially available. (See Resource section in the Appendix).

Sciarid Fly

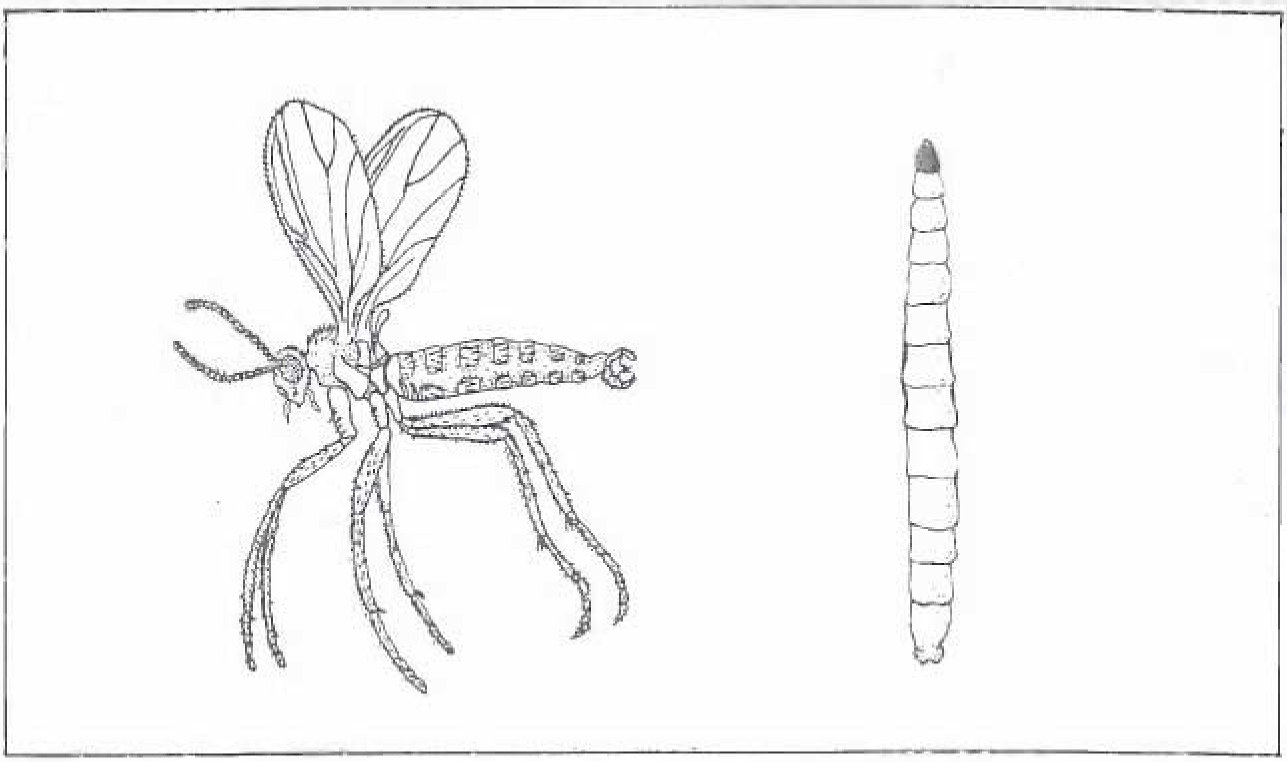


Figure 231 - Sciarid adult and its larva. (Adapted from P.R. VanderMeer; Penn. St. Univ. Coop. Ext. Ser.)

Order: *Diptera*

Family: *Lycoriidae* (Fungus Gnats)

Genus/Species: *Lycoriella solani, Lycoriella mali, Lycoriella auripila*

Common Names: Sciarid Fly, Big Fly

Natural Habitat: Predominantly saprophytes, living on wild mushrooms, rotting wood, leaf mold and manure piles. Maturing mushrooms are frequently infested with sciarid larvae, the so-called "worms" that commonly ruin choice wild edibles.

PHYSICAL CHARACTERISTICS:

Mature Stage: Sciarids are small gnat-like flies characterized by two long segmented antennae, large compound eyes, a black head and thorax and a yellow segmented abdomen. Females are about 3 mm. long and can be distinguished by the swollen abdomen which ends in an ovipositor. Males are about 2 mm. long and have a narrow abdomen ending in a distinct clasper.

Larval Stage: Larvae measure 6-12 mm. long with twelve abdominal sections and a distinct black shiny head. The long creamy white body has a semi-transparent cuticle with a visibly darkened alimentary canal. Larvae go through four development stages, or instars, before pupating.

Pupal Stage: Fully mature larvae spend two to three days spinning a cocoon of fine silky threads and compost fragments. These threads are sometimes detected as slime trails left behind in the substrate as the wandering larvae pupate. Once the cocoon is finished, the larva contracts into a pupal stage, thus beginning the transition to the adult stage. Pupae are 2-4 mm. long and change from white to almost black.

Life Cycle: Developmental period in days

Temperature	Egg	Larva	Pupa	Adult
At 75°F.	2	16	3	5-7
At 61°F.	7	23	8	(no data)

Sciarids thrive in the summer and fall with populations building to a peak in September and October. Sciarids then die with the onset of cold outside temperatures.

Comments: The sciarid fly is responsible for considerable damage to commercial *Agaricus* crops. Attracted by the smell of newly pasteurized compost, sciarids home in from miles away. A female can lay between 150-170 eggs at a time. Eggs laid in the compost just after Phase II composting hatch quickly into larvae during the spawn running period. These larvae then feed on the running mycelium as well as compost, which is broken down into a foul smelling, soggy mass, totally unsuitable for spawn growth. Massive infestations can cause total crop failure.

At lower infestation levels, larvae migrate into the casing layer and then emerge just as the first mushroom pins appear or as late as the first flush. These adults lay more eggs in the casing, and the newly hatched larvae attack both mycelia and mushrooms. Symptoms of this attack include:

1. Dead pinheads.
2. Pins or mushrooms that are loosely connected to the casing due to severed mycelial connections.
3. Brown or black spots on pinheads or on the stems of mushrooms.
4. "Salt shaker pins" perforated by larval tunnels.
5. Browning of the stem where cut.

Secondary damage to mushroom crops by sciarid flies comes from their role as carriers of mites and diseases, including the pathogens *Verticillium* and *Trichoderma*. A single sciarid fly can carry up to 20 mites!

Phorid Fly

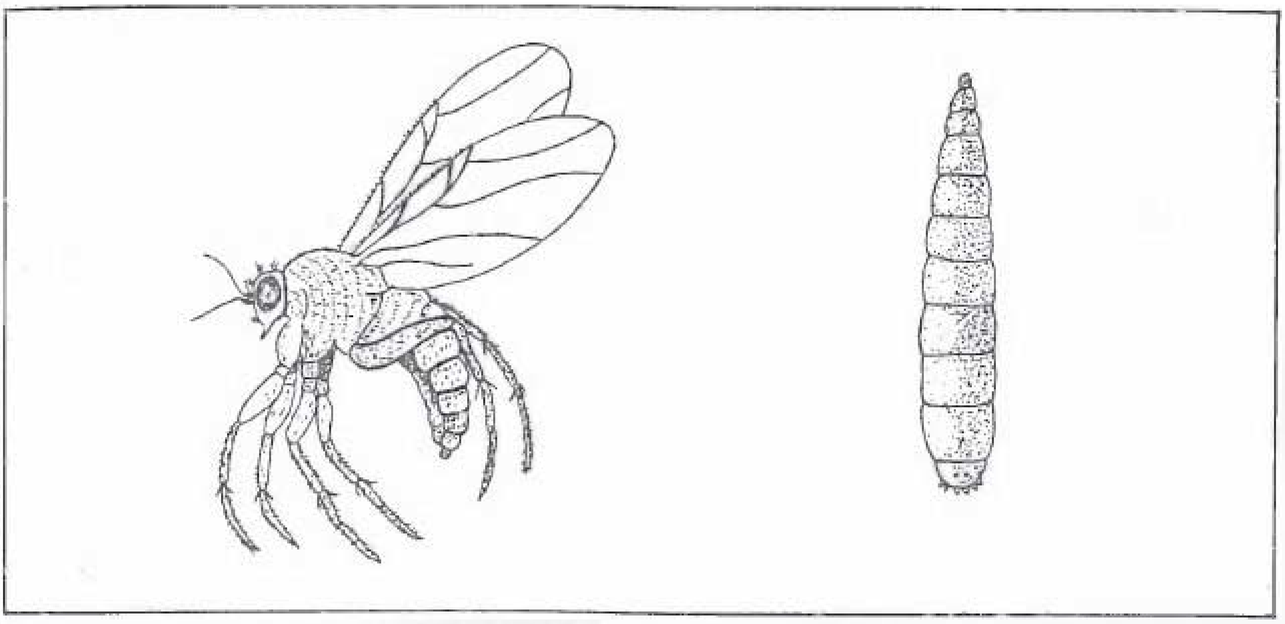


Figure 232 - Phorid fly and its larva. (Adapted from P.R. VanderMeer; Penn. St. Univ. Coop. Ext. Ser.)

Order: *Diptera*

Family: *Phoridae*

Genus/Species: *Megaselia nigra, Megaselia halterata*

Common Names: Phorid Fly, Dung Fly

Natural Habitat: Commonly inhabiting manure piles and rank, decaying vegetation; feeding on wild fungi and their mycelia. Phorid larvae are frequently seen tunneling through wild mushrooms.

PHYSICAL CHARACTERISTICS:

Mature Stage: Distinguishing features are a humped back, a rapid jerky run, a rounded third antennal segment and a yellowish to reddish brown back. Adults measure 2-5 mm. long. Females live 16 days and males live 10 days.

Larval Stage: Larvae are 6-10 mm. long, white and semi-transparent. The head is characterized by a pair of "mouth hooks" with seven teeth. The segmented body tapers from the head to the posterior end. Larvae pass through three instars.

Pupal Stage: Pupae are white at first then becoming pale yellow to brown. They can be distinguished by a pair of curved black respiratory horns.

Life Cycle: Developmental period in days			
Temperature	**Egg**	**Larva**	**Pupa**
At 75°F.	2	5	8
At 61°F.	4	14	28

Comments: Phorids can do extensive damage to the mushroom crop and are considered the principal mushroom pest in western Europe. Mated female phorids are drawn by the odor of mushroom mycelium. This attraction increases during the spawn running period and peaks at full colonization. Each female can lay up to 50 eggs which are placed in close proximity to the mycelium. In mature mushroom crops, females lay eggs on the gills, in the casing, and adjacent to young pinheads. Once hatched, the larvae feed on the mycelium, then tunnel into the mushrooms through the base of the stem. Arising from these tunnels are secondary bacterial infections causing further damage and brownish discolorations.

The fact that females will not lay eggs in total darkness gives the grower an effective method for preventing Phorid infestation during spawn running.

Cecid Fly

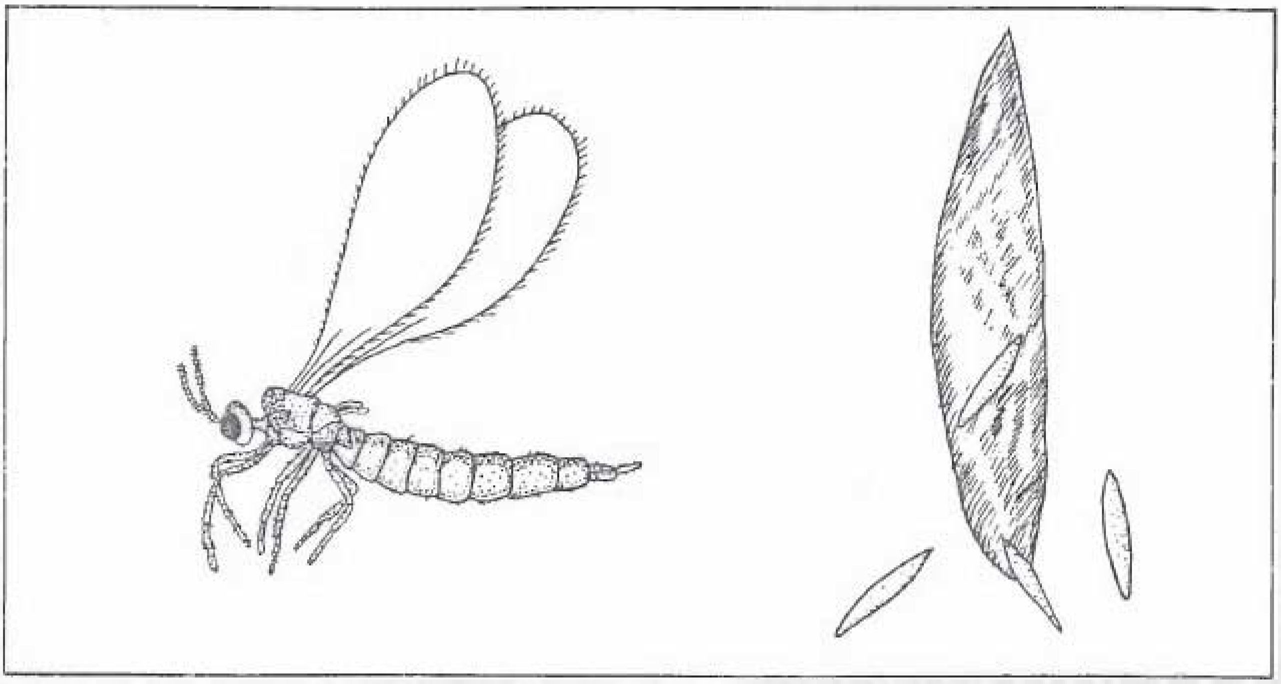


Figure 233 - Cecid fly and its mother larva. (Adapted from P.R. VanderMeer; Penn. St. Univ. Coop. Ext. Ser.)

Order: *Diptera*

Family: *Cecidomyiidae*

Genus/Species: *Heteropeza pigmaea, Mycophila speyeri*.

Common Names: Cecids, Gall Midges

Natural Habitat: Commonly inhabiting decaying wood, rotting vegetation and manure piles or wherever fungal mycelium occurs.

PHYSICAL CHARACTERISTICS:

Mature Stage: Adult cecids measure less than 1 mm. long making them almost invisible to the naked eye. *H. pigmaea* are orange with a long segmented abdomen and segmented antennae. Wing venation or structure is noticably absent except close to the thorax.

Larval Stage: Newly born larvae are 1 mm. long and 2-3 mm. when mature. *H. pigmaea* are white to cream; *M. speyeri* are bright orange. Larval movement is facilitated by free water, whereas in dry conditions this movement is by flexion, jumping as far as 2 cm. Larvae are photokinetic (moving to light) and can reproduce through paedogenesis, a process whereby mother larvae give birth to daughter larvae. Under optimal conditions mother larvae can produce 14-20 daughter larvae in six days. Thus, in a short period of time a population explosion can occur.

Pupal Stage: *H. pygmaea* larvae molt to a rigid "hemi-pupa" within which new daughter larva evolve. Conditions favorable to larval growth lead to a "resting mother larvae" stage which can remain alive up to 18 months. *M. speyeri* has neither of these particular attributes although it also performs paedogenesis. Larvae of both species can change to "imago" larvae, form only one instar, then molt to free pupae, emerging as adults five days later.

Life Cycle: Developmental period in days			
Egg	**Mother Larva**		**Daughter Larva**
2	5-6	(2)	5-6

Comments: Cecid larvae pierce or tear growing hyphae, sucking out the contents. The main loss suffered by commercial growers is contamination of the mushrooms by larvae. *H. pygmaea* can also carry a bacterium which produces longitudinal brown stripes on the stem. In the infected mushrooms, tiny black droplets of fluid form on the gills, which then become spotted or turn black.

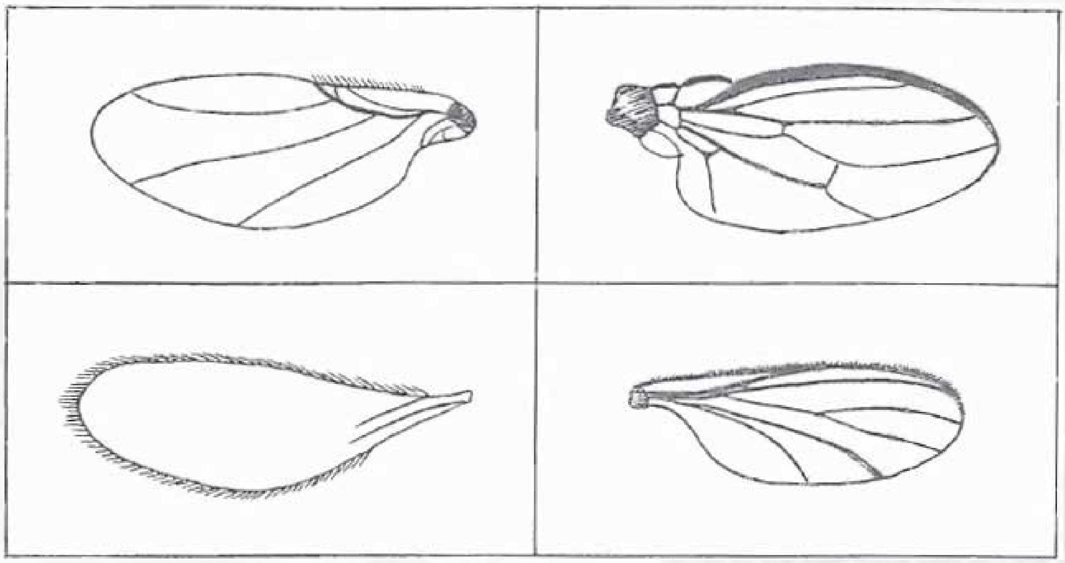


Figure 234 - Wing venation of mushroom flies: clockwise from top right, *Leptocera*, Sciarid, Cecid and Phorid.

Order: *Diptera*

Family: *Sphaeroceridae* (*Borboridae*)

Genus/Species: *Leptocera heteroneura*

Natural Habitat: Associated with manure, compost piles and decaying organic matter.

PHYSICAL CHARACTERISTICS:

Mature Stage: *Leptocera* has large red compound eyes and with a yellow and black striped abdomen. *Leptocera* flies are very similar to phorid flies but are smaller and have a distinctive wing venation. They somewhat resemble the common fruit fly.

Larval Stage: Larvae have a blunt posterior end tapering to a slender head which is equipped with mouth hooks. *Leptocera* larvae are very similar to house fly maggots in appearance.

Pupal Stage: Pupae are golden brown and barrel shaped.

Life Cycle: Developmental period in days		
Egg	**Larva**	**Pupa**
3	14-28	10-14

Comments: The *Leptocera* fly acts as a vector for disease organisms and is frequently associated with bacterial infections. It is a known carrier of mites.

Mushroom Mites

Mites are very small spider-like insects that live and breed in decomposing vegetable matter, feeding on molds present therein. Optimum breeding environments are moist and warm, giving rise to a rapid succession of generations and exponential growth. Under adverse conditions certain mites have the ability to change into an intermediate stage called a "hypopus". The hypopae have flattened bodies, short stubby legs and a sucker plate with which they attach to moving objects. These attributes facilitate dispersal. An excellent survival mechanism, it is the hypopae that are commonly carried by flies. A typical life cycle for mites in days is:

Temperature	Eggs	Larvae	Protonymph	Tritonymph	Total
75°F.	6	2	2	3	13
60°F.	11	8	6	11	36

Mites are known to eat mushrooms and their mycelia. Additionally they devalue the crop and crawl onto pickers, causing temporary discomfort. Their presence is an indication of unsatisfactory substrate preparation and insufficient pasteurization times and/or temperatures.

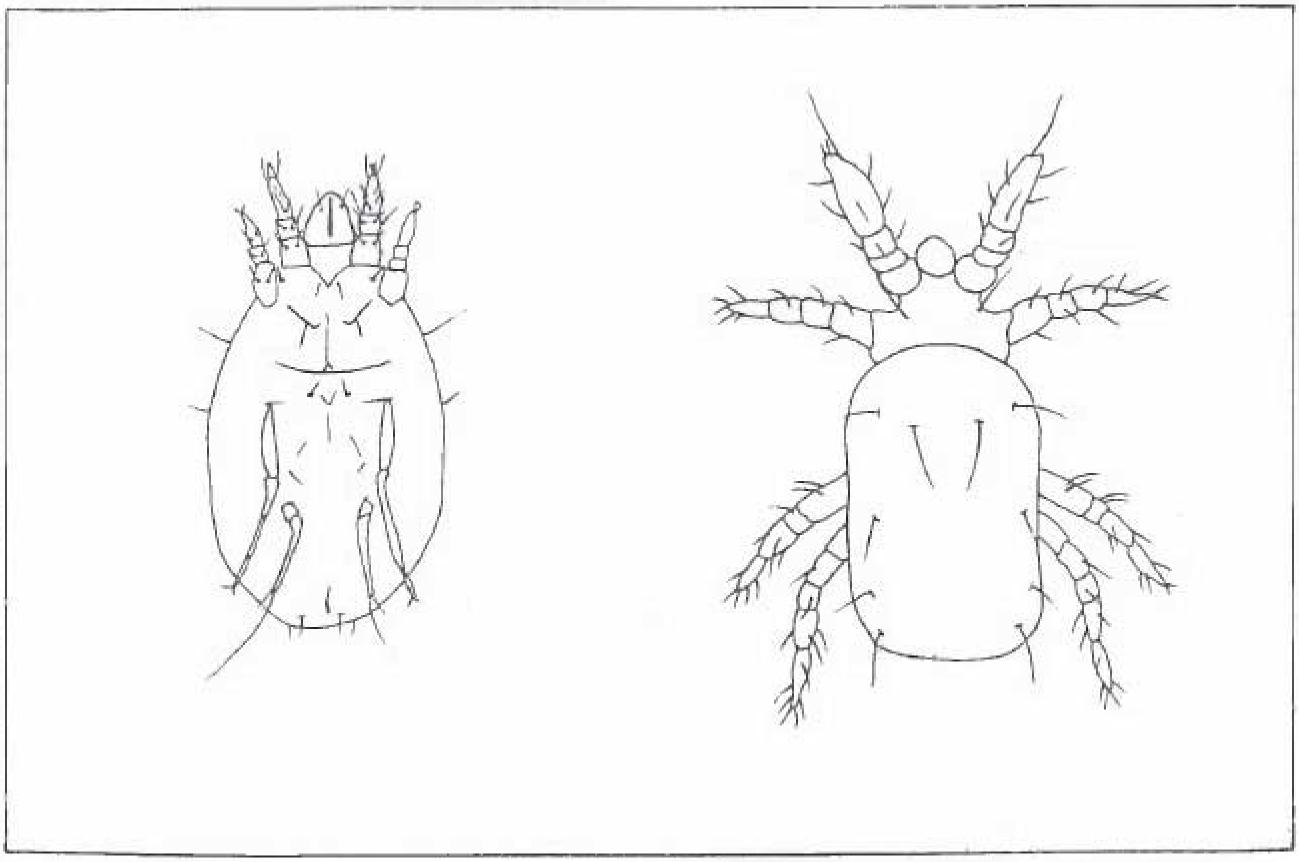


Figure 235 - Straw mites.

Order: *Arcana*

Family: *Tyrogelyphidae*

Genus/Species: *Tyrophagus putrescentiae, Caloglyphus mycophagus*

Common Names: Straw or Hay Mites.

Discussion: Straw mites have soft translucent pinkish or yellowish bodies punctuated by long flexible hairs. One female is capable of producing 500 eggs in a lifetime. Commonly found in hay or straw piles, these saprophytic mites are endemic to foul compost. They feed on molds and bacterial contaminants of the mushroom crop and also eat mycelium and mushrooms, making small irregular pits in the stem and cap. These pits can later become infected by bacteria.

Order: *Arcana*

Family: *Eupodidae*

Genus/Species: *Linopodes antennaepes*

Common Name: Long Legged Mushroom Mite.

Discussion: This mite is easily recognized by its long front legs which are twice the length of the light, yellowish brown body. It is not believed to be directly injurious to the mushroom crop and in fact is a predator on other mite species.

Order: *Arcana*

Family: *Tarsonemidae*

Genus/Species: *Tarsonemus myceliophagus*

Common Name: The Mushroom Loving Mite.

Discussion: *Tarsonemus* mites are very small, 180-190 microns long, with pale brown, shining, oval bodies. They occasionally swarm in masses on mushroom caps but otherwise are rarely seen except by microscopic examination. Females produce an average of 22 eggs in a lifetime of 2-8 weeks. These mites cause a bright reddish-brown discoloration at the base of the mushroom stem and may cut the stem's mycelial connections. Known to survive normal compost pasteurization temperatures, they can carry a virus disease to *Agaricus brunnescens*.

Order: *Arcana*

Family: *Pyemotidae*

Genus/Species: *Pygmephorus sp.*

Common Names: Red Pepper Mites; Pygmy Mites.

Discussion: Pepper mites are small (250 microns long) with yellowish brown, wedge-shaped bodies, crossed by a central whitish band. Red pepper mites are often seen as a swarming jostling mass, on mushroom caps or the surface of the casing. These mites are commonly associated with *Penicillium* and *Trichoderma* molds, upon which they feed.

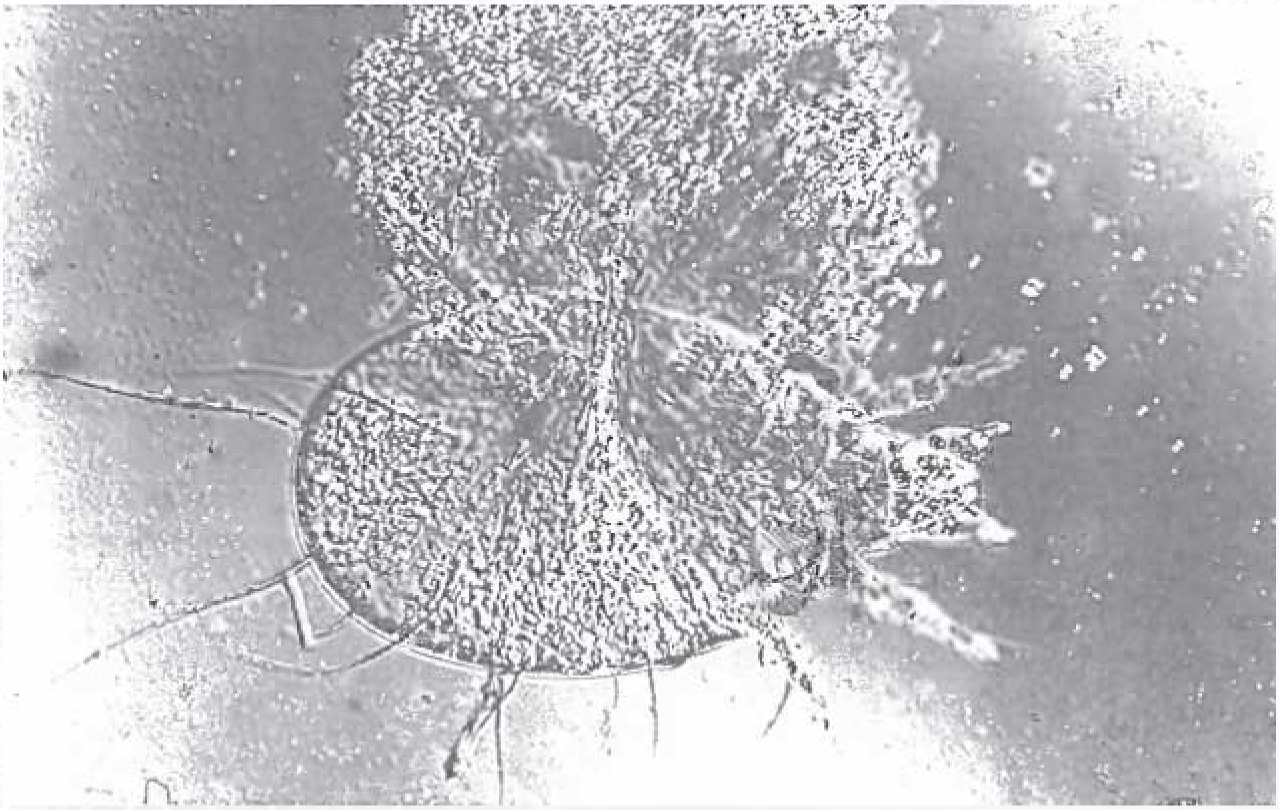


Figure 236 - Light micrograph of Red Pepper Mite. Note that darkened shapes by front leg are *Panaeolus subbalteatus* spores. See also Figure 230.

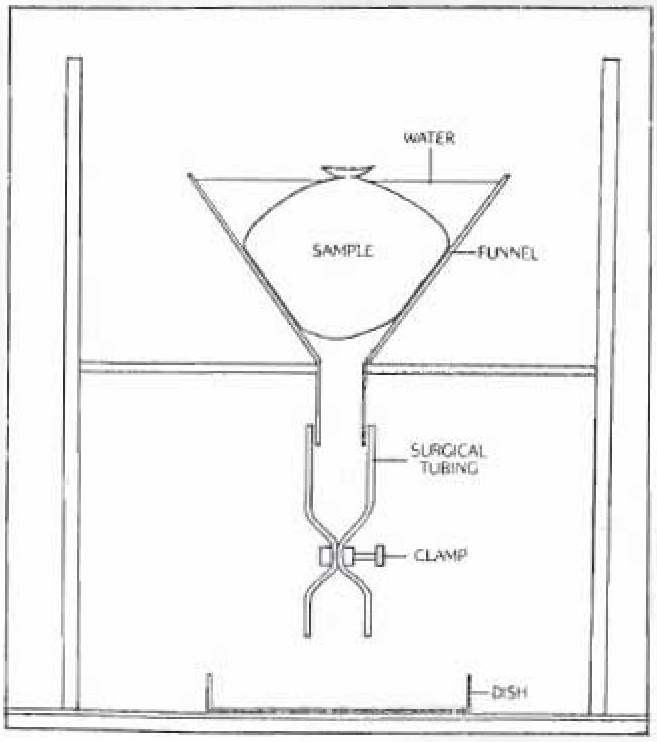


Figure 237 - Nematode testing apparatus. Sample is wrapped in gauze and submerged in a water filled funnel. After twenty-four hours, a small amount of water is drawn off and examined with a magnifying lens or dissecting scope.

Nematodes (Eelworms)

Nematodes or eelworms are microscopic roundworms which live in soil, decomposing organic matter, fresh or salt water, or on living host plants, fungi, insects and animals. Nematodes can survive up to six weeks without food and are unaffected by freezing. With eight billion nematodes in each acre of soil, they are one of the most numerous creatures on earth.

Water is essential for locomotion and breeding. Swimming in an eel-like fashion and because of their minute size, nematodes can live in the thinnest films of water. With sufficient water, nematodes rise to the surface of their environment. In moist casing, large numbers of nematodes are visible as a shimmering veneer on the casing surface. This behavior is called "winking" and is caused by the nematodes standing on their tails and waving their bodies in the air. Considered to be an adaptation for dispersal, the winking nematode adheres by means of a sticky outer skin to whatever they come in contact with, be it a fly, mite, human hand or clothing. This same outer skin protects the nematode from adverse conditions.

If dried slowly, nematodes can change to a "cryptobiotic" or "cyst" state, thereby preserved for years until reactivated by water. In this cyst state, nematodes are also able to persist in high temperatures that would otherwise be lethal.

Parthenogenesis, the ability for females to breed asexually without males, is common among nematodes and leads to very rapid population expansion. By this means, a single nematode can breed millions of descendants within a few weeks. Nematodes can also reproduce sexually, but not as rapidly.

Nematodes present in mushroom culture can be classed into two basic types according to their feeding habits: **saprophagous** and **mycophagous**.

Saprophagous Nematodes

Genus/Species: *Rhabditus spp.*

Saprophagous eelworms are characterized by a tube-like mouth through which they suck nutrient particles suspended in water. These nutrients are comprised of organic matter and its accompanying microorganisms, particularly bacteria. Because bacteria occur in large numbers in both mushroom compost and casing soil, these materials provide excellent breeding grounds for saprophagous eelworms.

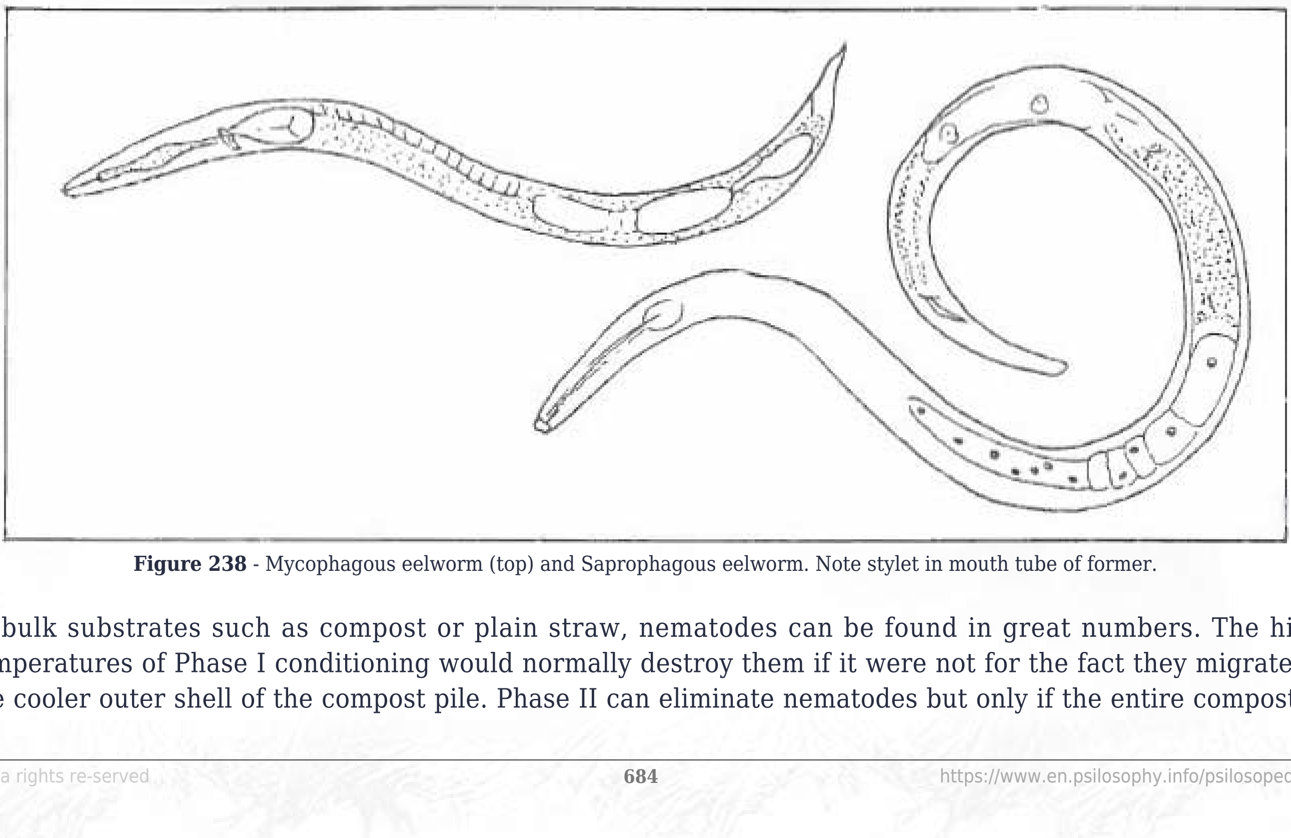


Figure 238 - Mycophagous eelworm (top) and Saprophagous eelworm. Note stylet in mouth tube of former.

In bulk substrates such as compost or plain straw, nematodes can be found in great numbers. The high temperatures of Phase I conditioning would normally destroy them if it were not for the fact they migrate to the cooler outer shell of the compost pile. Phase II can eliminate nematodes but only if the entire compost is subjected to pasteurization temperatures. In a properly prepared and thoroughly pasteurized substrate, the mushroom mycelium consumes all free water and then feeds on the bacterial population. This creates a "bacteriostatic environment", which effectively limits nematode growth capabilities. In an uneven substrate with overly wet and dry areas, however, the nematode's ability to breed increases. Wet areas are particularly suitable for eelworms to breed and feed. And, as their population increases, the build-up of waste material from metabolic excretions soon fouls the substrate, rendering it unsuitable for mycelial growth. These excretions result in similar damage to infested casing soils.

Although saprophagous eelworms are not primary pathogens, their presence indicates improper hygiene or imbalanced growing conditions. For this reason, control measures focus on prevention rather than treatment. In fact, there are no practical means to treat infested areas that would not likewise harm the mushroom mycelium.

Mycophagous Nematodes

Genus/Species: *Ditylenchus myceliophagus*; *Aphelenchiodes composticola*

Mycophagous eelworms feed directly on mushrooms. They are characterized by a mouth stylet or needle with which these eelworms puncture hyphae, inject digestive juices and then suck out the cellular contents. The damaged cell, drained of its cytoplasm, soon dies. Feeding continually and moving from cell to cell, mycophagous eelworms can soon destroy whole mycelial networks. In infected substrates, the fine mycelial growth disappears, leaving only the coarse strands which give the appearance of stringy growth. Eventually the substrate becomes soggy and foul smelling, a condition further promoted by the build-up of anaerobic bacteria. Often the nematode trapping fungi, *Arthrobotrys* spp. develop in association with them. It is visible as a fine grayish mold-like growth. Although the presence of this mold is a useful indicator of nematode infestation, it is not a true control for these organisms.

Mycophages differ from saprophages in their slower non-parthogenetic reproduction and their lack of the "winking" behavior mentioned earlier. Both Mycophagus species can reproduce 30-100 fold in about two weeks at 70-75°F.

XV. MUSHROOM GENETICS

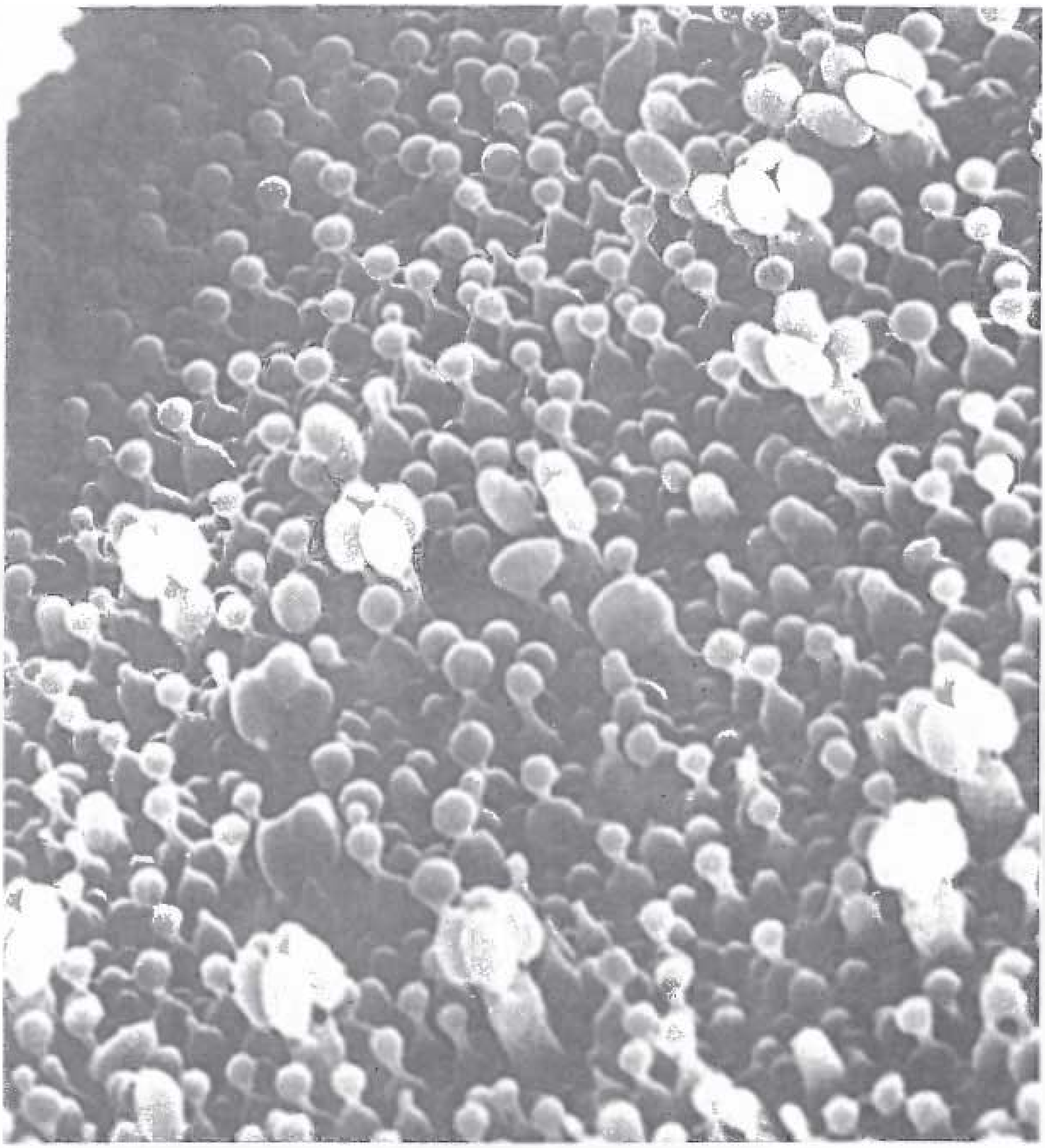


Figure 239 - Gill face of *Psilocybe cyanescens* populated with fertile spore-bearing basidia and sterile cells called pleurocystidia.

Introduction

This chapter discusses what genes are and what they do. It addresses the relationship between an individual's set of genes and the characteristics of that individual. The implications of genetics for the grower or breeder of mushroom strains are examined and an improved, easy technique for generating cultures from spore prints will be presented.

What Are Genes?

Genes contain specific sequences of nucleotides, the nitrogen-based building blocks of the DNA molecule. These sequences specify the order of nucleotides in messenger RNA molecules, which in turn determine the sequence of the amino acids in a protein chain. For the purposes of this discussion, genes may be regarded as indivisible units, although in fact, they can on rare occasions be split or altered. A **mutation** is the permanent alteration of a gene caused by some outside force (chemicals, radiation, mistakes by the DNA copying mechanism of the cell, etc.). In discussions of genetics, a gene is often referred to as a genetic **locus**, emphasizing the fact that genes are regions of a DNA molecule. Within a population of a species, there are many differing copies of each gene. Each copy is referred to as an **allele** of that gene.

What Do Genes Do?

Genes are the blueprints of life. They specify the structure of RNA and protein molecules; these molecules create all the other compounds and structures which make up a living organism. An individual organism is an emergent property of its genes in that not only is it the result of gene products, but also the interactions of gene products. The expression and interaction of genes, that is the characteristics of an individual, are known collectively as the phenotype of that individual, whereas the sets of genes which produce the **phenotype** is known as the **genotype**.

The Advantage of Multiple Copies of Genes

Many genes are present in the genotype in several copies, and these copies are often different from one another. This is because the protein specified by any one gene copy has unique physical and chemical properties of its own. It functions most efficiently at a certain temperature, pH and salt concentration. If an important protein is represented in several different gene versions, a broad band rather than a narrow range of temperatures and chemical conditions will be optimal.

Chromosomes

Chromosomes are collections of genes. They are long DNA molecules, each of which contain several thousand genes. For this discussion, the genes are best visualized as beads on a string, so that the string can be cut at any point *between* the beads, and can be rejoined at the place of the cut or to any cut "string portion" or the chromosome.

Chromosomes are very small. With special stains and high powered microscopes, the larger ones can be seen. Unfortunately, the chromosomes of fungi are extremely small, and the number of chromosomes, something characteristic of each species, has never been determined for most fungi.

There is a complete set of chromosomes in every cell of every organism. This means that every time a cell divides, a complete copy must be made of every chromosome, and hence of every gene in the organism's genome. The cellular copying process is very nearly perfect, with errors being made at about the rate of one per million genes. That is, to find a random mutation of a particular gene, you would have to look at a million cells. Factors which produce mutations will, of course, increase this rate. These copy errors are the source of background mutations, which are always appearing in every organism.

Mitosis

Mitosis is the normal process of chromosome duplication which takes place every time that a cell divides. In it, all the chromosomes are duplicated, and in the early stages of the process, the copies stick together. All of the duplicated chromosomes line up in the middle of the cell, and one of the two copies of each is pulled to either end of the cell, resulting in two complete sets of chromosomes.

Meiosis

Meiosis is the unique series of events which takes place when a cell is involved in sexual reproduction. In meiosis, the chromosomes are copied just as in mitosis, but the genes are shuffled in a process called **recombination**. Sexually reproducing organisms have two sets of chromosomes, one from each parent. In meiosis, these two sets line up side by side, and reciprocal exchanges of sections of chromosomes take place. That is, a section of the maternal copy of a chromosome is transferred to the paternal copy, and a section of the paternal copy is simultaneously transferred to the maternal one. This happens to all of the chromosomes, usually once per chromosome, but sometimes more than once.

After these reciprocal exchanges take place, two successive cell divisions occur, resulting in four cells, each with ONE copy of each chromosome. None of these cells are identical to any of the others. They each have unique sets of genes. These cells are known as **gametes**, and are basidiospores in a mushroom, ascospores in a cup fungus or a yeast and sperm or egg cells in an animal.

It is this act of recombination of genes within the genome and the combination of genomes from two parents which is the genius of sexual reproduction. By this mechanism, variety is constantly introduced into the population of a species. A bacterium, which can reproduce very rapidly by mitosis, can generate vast numbers of bacteria in a very short time, *but all of the offspring are identical*. The importance of this difference cannot be overstated. If conditions fall below optimal or into the lethal range for the parent bacterium, all of the progeny soon die or are equally affected (unless, of course, there has been a favorable random mutation). Chance favorable mutations are, in fact, the major means of evolution available to bacteria.

Sexual reproduction, on the other hand, constantly spins off variation. Some of the progeny are substandard and do not survive, or do poorly, most are average and some are clearly superior, flourishing and leaving behind a greater number of offspring than the other groups. In this way, the population is enriched in gene combinations which are better adapted to the environment.

Reproductive Strategies

The two aforementioned modes of reproduction lead to three primary reproductive strategies. These are the primary use of asexual reproduction, the primary use of sexual reproduction and the sequential or seasonal use of both methods of reproduction.

1. Asexual (mitotic) reproduction allows an organism to produce large numbers of offspring in a very short period of time. This makes possible the rapid exploitation of any ecological niche which becomes available. This strategy is used by bacteria, yeasts, many molds (Fungi Imperfecti) and a surprising number of plants.
2. Sexual reproduction is not as rapid, since meiosis, gamete production and fusion and zygote growth are relatively slow processes. The progeny, however, have built-in variation and are capable of exploiting a wider assortment of niches than the parents. This strategy is used by larger organisms which tend to live for a longer time than those which are primarily asexual. Examples of organisms using this strategy are polypores, most plants and all large animals.
3. Combining sexual and asexual reproductions in different portions of the life cycle results in a highly effective strategy. This method is utilized by most lower plants and most fungi. In this strategy, when a suitable niche is found, asexual reproduction allows it to be rapidly filled and exploited. When that niche has been populated and nutrients become scarce, sexual reproduction is triggered. As well as releasing a number of varied progeny to the environment, sexually produced spores are usually more resistant to the harsh environmental conditions than mitotically produced spores. Often they are specifically adapted to lasting through winter or through a period of dryness, conditions not conducive to the growth of fungi.

Asexual Reproduction in the Fungi

Asexual reproduction in the fungi takes many forms, including buds, conidia, sporangiospores and fragmentation products.

Yeasts reproduce by budding, which is the constant growth of new cells from the surface of a mother cell. The new cells literally "blow out" of the mother cell wall like a balloon.

Conidia are mitotic spores which are continuously produced within or upon special structures called conidiogenous cells. Examples of conidial fungi are represented by *Penicillium* and *Aspergillus* molds, the fungi which attack spoiled foodstuffs, the downy and powdery mildew which attack garden plants, and the hundreds of genera which are involved in the breakdown and recycling of debris and litter in nature.

Sporangiospores (spores formed in batches within saclike structures called sporangia) are found in the water molds and the Zygomycetes. *Rhizopus*, which is often seen on breads and strawberries, reproduces in this manner.

A common mode of asexual reproduction is for portions of vegetative mycelium to thicken and form heavy walls and septae. These reinforced hyphal fragments then break apart and are distributed by natural processes. These vegetative propagules are called by many names, including arthrospores, chlamydospores, gemmae and others.

Sexual Reproduction in Mushrooms

While mushrooms reproduce sexually, they have no sexes. All that the term sexual reproduction means is that two sets of genetic information are carried, and that the genes in those sets are shuffled randomly before one set is provided to each gamete. Two gametes must come together and fuse to form the next fertile generation.

In animals and plants, the notion of sexes is realistic, because there are two kinds of gametes, an egg and a sperm. In mushrooms, all the gametes are physically identical; they are the basidiospores. Because of meiosis, however, there are genetic differences between them.

One of the genetic characters sorted out during meiosis is the **mating type**. The mating type is a character which prevents a spore or monokaryotic hypha carrying a particular allele from fusing sexually with any spore or hypha carrying the same allele, no matter how different the genomes are at all other loci. It takes the presence of different alleles at the mating type locus for sexual reproduction to occur. In any one species, there may be any number of alleles within the population. In general, any one of them is compatible with all of the others, the only prohibition being against fusion with the identical mating type.

If a species of mushroom has only one locus controlling mating type, with varying numbers of alleles for that locus, that species has what is known as an **unifactorial**, **heterothallic** mating system. In such a system, the only physiological requirement for mating to take place is that two differing alleles of the mating type locus be present. Since two alleles must be present in a sexually mature mushroom, and each spore only gets one, any random spore is compatible with half of its siblings. Since there are a large number of alleles for the mating type locus in the population at large, any random spore has a higher probability of being compatible with a spore of another strain. Thus this system increases the percentage of outcrossing by members of the species using it.

The majority of mushrooms, however, are **heterothallic and bifactorial**, a system known as **tetrapolar**. In this system, there are two separate and distinct mating type loci, each of which must have differing alleles present to form a dikaryotic colony. This system produces four distinct types of spores on each basidium, and any random spore from a single strain is fertile with only one fourth of its siblings. This is a strong form of incest taboo, and makes it four times as likely that any naturally formed dikaryon will be from non-related spores. Unfortunately, the two types of spores which are not totally identical or non-identical can form dikaryotic colonies which look like fertile ones. These products of illegitimate matings, though, are incapable of making fruitbodies or basidiospores.

There are strains and species in which the mating type system has broken down. These are known as **homothallic** fungi, and they are fully capable of mating with themselves. In fact, a single spore of a homothallic fungus is usually capable of making a fertile dikaryotic colony. A fair number of spores, however, due to the effects of recombination, will be incapable of forming fertile colonies unless they mate with another strain. This is a system often found in fungi which live in marginal habitats; usually there is a time lag before a monokaryotic colony dikaryotizes itself.

There are two types of homothallism in mushrooms: **primary** and **secondary**. Primary homothallism is the case described above, where the majority of spores, while initially forming monokaryotic colonies, will eventually become dikaryotic and fruit normally. Secondary homothallism is the case where each spore receives one nucleus of each mating type, generating a dikaryotic colony from the moment of spore germination. *Agaricus brunnescens* is the best known example of this type of fungus, while another commonly cultivated mushroom, *Volvariella volvacea*, has a primary homothallic mating system.

Implications for Culture Work

The single most important implication of the genetics that has been described thus far is the occurrence of illegitimate matings. In a tetrapolar fungus, only one fourth of the spores from any one mushroom are fully compatible with any random spore from that same strain. This mechanism exists to encourage outcrossing. When a cultivator is trying to produce a strain from a spore print, establishing a fruiting strain can be frustrating. This is because monokaryotic hyphae with common A factors or with common B factors *can fuse* and form dikaryons, and these dikaryons can even make convincing looking clamp connections. (See Figs. 10 and 182). These colonies, however, are incapable of fruiting. It becomes obvious at this point that two thirds of the random dikaryons formed will be of the illegitimate type. This implies that a large number of dikaryotic cultures must be isolated and tested for fruiting ability. Another, but less precise way around this problem is to inoculate with a large number of spores and take a tissue culture of the first mushroom that appears in the culture. This procedure is the one usually listed in books on mushroom cultivation because it is simple, but the strains produced in this manner still must be tested thoroughly.

The phenomenon of **sectoring** is the production of wedge shaped areas of differing physical or growth characteristics by a colony of mycelium. There are two types of sectoring, one found in young cultures, and one in old ones.

In young multispore cultures, several different strains are all growing together at the same time. Some are the products of legitimate matings, some of illegitimate ones. These strains all have differing characteristics. Some of these strains grow faster than others, some are rhizomorphic and some are fluffy in appearance. Some fruit well, some poorly. Some produce clumps of many tiny mushrooms, some produce a few large ones. They each have a unique set of preferred culture conditions.

Fortunately, the different strains formed from multispore germinations tend to sort themselves out. As the colony grows, strains segregate into sectors of different appearances and growth rates. The repeated separation and propagation of individual sectors, until a colony is obtained which no longer produces new ones is one way of isolating a pure strain. Several strains may be isolated from the same original Petri plate in this way.

As pure cultures grow old and become senescent, they produce ever greater quantities of sectors due to the accumulation of random mutations. Repeated subculturing of the culture gives accumulated mutations a chance to express themselves. A strain which has reached this condition is no longer pure, and should not be used for cultivation.

Culture Trials

When a number of strains have been generated from a sporeprint, they are different because of recombination in the basidium. Some of the strains MAY be identical to the parent strain, but that must demonstrated by some testing procedure. As in any screening operation, the more strains used, the better the chance of a good result. In fact, professional mushroom breeders often do trials with thousands of strains at a time. This kind of work, however, takes large and expensive facilities, and is unnecessary if the purpose is simply to find a strain which fruits well under a certain set of conditions. A strain which fruits well in test batches under uniform conditions has a high likelihood of doing well in larges batches when the same conditions of temperature, humidity and aeration are maintained. How many strains need to be tested? If the mushroom being worked with is tetrapolar, only one third of the dikaryotic colonies picked out will be capable of fruiting at all. In order to make trials often fruiting strains, begin with at least thirty dikaryotic strains.

Many mushrooms, especially the wood-rotters, fruit on enriched agar media in a Petri plate if given proper temperatures and some light. If the mushroom being tested is one of these, the selection of fruiting strains is simple. A mushroom requiring a special substrate or additive to fruit should be provided with the smallest amount allowable. For example, *Agaricus brunnescens* can be fruited on 50 grams of sterilized grain in a pint jar, if it is cased with soil containing certain bacteria. The smallest possible amount of substrate allows the rapid determination of fruiting strains.

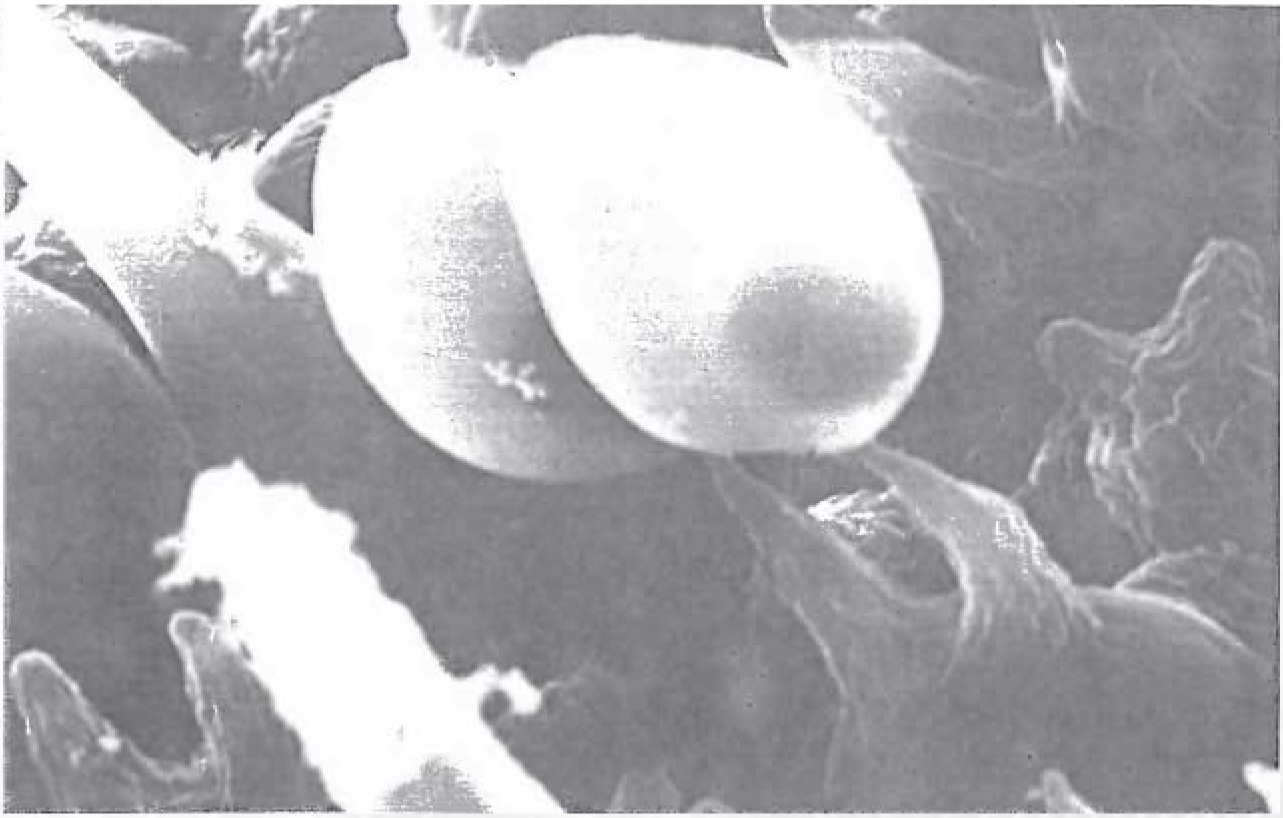


Figure 240 - Two spored basidium of a Copelandian *Panaeolus*.

Once ten to fifteen fruiting strains are in hand, they should be tested in a small scale version of the ultimate culture method. This step allows the strain best adapted to culture conditions to be selected. All strains should be tested at least in duplicates; five replicates per strain are preferable.

If the ultimate cultivation method involves beds of compost, the tests can be made with small boxes filled with compost, but the boxes should be filled to the same depth as the beds will be in the full scale project. If the fungus is fruited in jars (ex. *Flammulina velutipes*), a few jars can be inoculated with each strain. Good records must be kept for comparing the fruiting potential of each strain.

In small scale trials such as these, often several strains look good. In this case, the only way to find the best one is to make full scale trials, with one third or one fourth of the jars or beds inoculated with each of the strains being tested. Once again, good record keeping practices should soon show the differences between the most and least productive strains.

If the mushroom under consideration for cultivation takes a long time to establish its fruiting cycle (ex. *Lentinus edodes*), it is best to simply purchase a culture from a spawn lab or to take tissue cultures from commercially grown mushrooms.

Spore Dilution Technique

A simple technique can be used to physically separate spores so that individual dikaryotic (or even monokaryotic) cultures can be isolated in one step. The necessary equipment includes a bacterial (small) inoculating loop, several screw-cap vials of 20-30 ml. capacity, a flame and several sterile pipettes or small syringes.

To utilize this method, first fill each of the vials with 9 ml. of distilled water, place the caps on loosely and sterilize them. After they have cooled, the caps should be firmly screwed down. The inoculation loop is then flamed, cooled and gently rubbed on the spore print, being careful not to get a large mass of spores. The loop is dipped and twirled in one of the vials, which is then recapped and shaken vigorously. One milliliter of the fluid is then transferred to another vial, which is recapped and shaken, generating a dilute spore suspension. This suspension may be further diluted in the same manner. In this way, the cultivator has generated three suspensions of spores, one of high spore density, one 1/10th as concentrated and one with 1/100th or 1% of the original concentration. Now spread 1/10th of a milliliter of each suspension on a separate media filled Petri plate (or better yet, use several plates for each dilution). The original strength suspension in all likelihood will produce a dense lawn of cultures, which will be difficult to separate. This is the same condition as is produced with normal spore spreading methods. The less dense suspensions, however, should produce many fewer colonies, usually in the range of 20-50 per plate for the 1:10 dilution and 2-5 per plate for the 1:100 dilution.

Look carefully at the plates having only a few colonies. The slower growing monokaryons can be discerned from the faster growing dikaryons. Pick about 25 of the dikaryons to test for fruiting ability and reaction to culture conditions.

If desired, the monokaryotic cultures can be picked out for a breeding program. This is especially valuable if there are spores from several strains available. When spores are simply spread onto a plate, they adhere to one another, so attempts to simply streak spores of two strains on a plate usually do not yield hybrids.

(*The authors grate fully acknowledge Michael McCaw for the contribution of this chapter on genetics*).

APPENDICES

Appendix I
Medicinal Properties of Mushrooms

Mushrooms have long been esteemed for their medicinal properties, especially by Far Eastern cultures, while western cultures have largely been oblivious to the beneficial properties of mushrooms. For centuries, the Japanese have hailed the shiitake mushroom (*Lentinus edodes*) as an elixir of life, a cure-all, revitalizing both body and soul, a cure for cancer, impotency, senility and a host of other ailments. Mazatec shamans of southern Mexico have used *Psilocybe* mushrooms in their divination and healing ceremonies, extolling them for their life-giving properties and calling them "Mushrooms of Superior Reason" for the heightened mental state they induce. Even the very term "agaric," still used to describe all mushrooms with gills, comes from the name of a pre-Scythian people, the Agari, who were skilled in the use of medicinal plants, of which mushrooms were one.

Not until the late 1920's, when Dr. Alexander Fleming published a note in a microbiological journal, did fungi draw the scrutiny of scientists looking for new sources of antibiotics. He observed, quite by accident, the deterrent effect a *Penicillium* mold had on a bacterial contaminant (a *Staphylococcus* species). Years later, fellower researchers pursued his suggestion that antibiotics were being produced by this mold, which shortly led to the discovery of penicillin. Forthwith, molds of all types were examined by W.H. Wilkins (and others) from 1945 to 1954 who systematically tested one hundred species at a time for antibiotic effects against bacteria and bacteria-carrying viruses. Eventually, Wilkins turned his attention to the fleshy fungi and interest within the scientific community grew.

Claims of healing properties in mushrooms have been primarily promoted, until recently, by the commercial mushroom industry and others with vested interests. It appears, however, much of the medicinal claims attributed to mushrooms are not myth, but founded in some truth. Within the last ten years, numerous studies demonstrating the anti-cancer and interferon stimulating properties of *Lentinus edodes* have been published. Individuals can significantly reduce serum choresterol levels by eating these mushrooms for as short a period as a week (Suzuki and Ohshima, 1974). In another study (Hamuro *et al*., 1974), the antitumor influence of hot water extracts of *Lentinus edodes* was demonstrated in mice implanted with sarcoma-180 and other cancers, resulting in a 80% remission from treatment lasting only ten days, and a 100% prevention of growth if the mice were injected prior to implantation. The causal compound is appropriately named lentinan, a antitumor polysaccharide. Extracts from shiitake spores and the isolation of "mushroom RNA" from them have proved effective against influenza (Suzuki *et al*., 1974). Similar antitumor, immunopotentiator and interferon stimulating polysaccharides have been found in *Boletus edulis*, *Calvatia gigantea*, *Coriolus versicolor*, *Flammulina velutipes*, *Ganoderma applanatum*, *Ganoderma lucidum* (the classic "Reishi Mushroom"), *Phellinus linteus*, *Armillaria ponderosa* (*Tricholoma matsutake*) and *Pholiota nameko*. (See Yamamura and Cochran, 1974).

In the treatment of other diseases, Cochran and Lucas (1959) reported *Panaeolus subbalteatus*, a mushroom producing psilocybin and psilocin, provided significant protection from polio virus in mice as did several other edible and inedible mushroom species. Psilocybian mushrooms might be of further usefulness in improving eye sight, hearing, circulation and in activating the self-healing processes within the human body.

With the current emphasis on prevention and natural cures for human diseases, mushrooms are proving to be a convenient, inexpensive and an effective method of sustaining health. Health conscious individuals beginning a daily regimen of eating shiitake, for instance, have been shown to be less susceptible to virus-induced diseases than those abstaining. Until these studies progress and are tested more extensively on human populations, hopes should not be unduly raised for mushrooms might be of further usefulness in improving eye sight, hearing, circulation and in activating the self-healing processes within the human body.

Appendix II
Laminar Flow Systems

Suspended in the air is an invisible cloud of contaminants. These airborne spores are the primary source of contamination during agar and grain culture, and they are the major force defeating beginning cultivators. To control contamination, the cultivator must start with a sterile laboratory. Without pure culture spawn, the prospect for a good crop is slight, no matter how refined one's other techniques.

Creating an absolutely sterile environment, free of all airborne particulates, is extremely difficult, if not impossible. "Nearly sterile" environments are more easily constructed and are quite suitable for the purposes of the mushroom cultivator.

Chemical cleaners like detergents and disinfectants have traditionally been used for this purpose. Unfortunately, the frequent use of these cleaners to maintain hygiene in the laboratory pose some risk to the handler. Ultraviolet lights are likewise dangerous and are difficult to position in a room so that no shadows are cast. By far the least harmful and most effective method is the use of high efficiency filters that screen out airborne particulates when air is pushed through them. These filters are the basis of laminar flow systems. An understanding of the composition of unfiltered air helps put into perspective the problem for which laminar flow systems are designed. The air, the filter, the fan and the laminar flow system will be discussed in that order.

The Air

Air is composed of many suspended and falling particles. A sample of air holds soot or smoke, silica, clay, decayed animal and vegetable matter, and many, many spores. Some are only a fraction of a micron in diameter while other are hundreds of times larger. These particles continously rain down on the earth's surface. In light impact zones isolated from industrial centers, twenty tons per square mile per month fall from the sky (ASHRAE, 1978). Industrial areas have a fall-out that is ten times greater. So-called "clean country air" contains, on the average, one million particles (greater than .3 microns) per cubic foot. But in a room where a cigarette is being smoked, more than one hundred million particles are suspended in the same air space. A sterile laboratory, on the other hand, has less than one hundred particles per cubic foot of air!

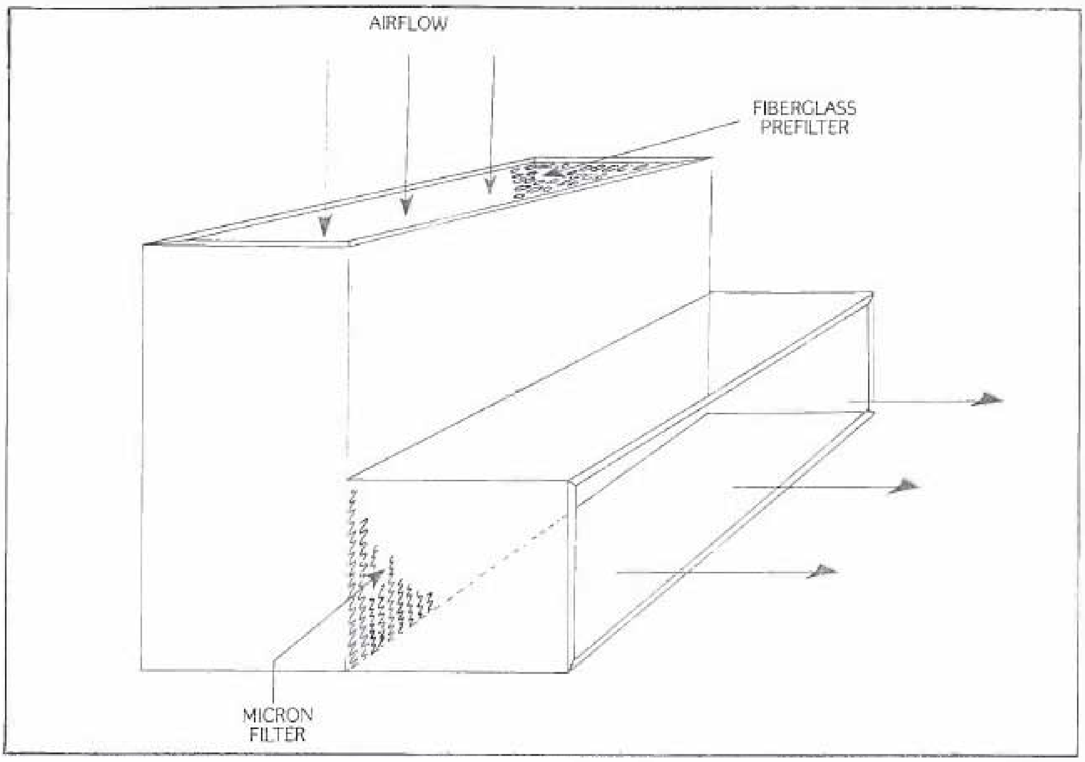


Figure 239 - A standard design of a laminar flow cabinet for tissue culturists.

Most of the spores contaminating mushroom cultures are between .5 and 20 microns in diameter. Generally, particles greater than 10 microns fall out of the air because of their weight. The smallest particles in this group are the airborne spore-forming bacteria which originate from soils. The smallest endospore forming bacteria are around .4 microns in diameter. Viruses which measure even smaller, sometimes a mere .05 of a micron in size, are usually attached to larger particles such as fungal spores. This broad assortment of airborne debris poses the greatest danger to mushroom culture.

The Filter

Two types of high efficiency filters are available today. One is an electrostatic filter which will screen out spores down to 5 microns or less. These filters operate on a charged particle principle where, by a variety of means, airborne particles are passed through an ionizing field and then between two oppositely charged electrical plates. Charged particles are drawn to the grounded plate by the force of the electric field. Because an agglomeration of particles is likely to blow off the retaining plate, they are often coated with a special oil. The advantages of electrostatic filters are that they have little resistance (a low pressure drop) and that they are reusable. But they have several disadvantages. One disadvantage is that they do not screen out the particles of 1 micron or less with a 99+% efficiency in high velocity airstreams. Hence, as air velocity increases, their efficiency decreases. Many electrostatic filters have, as a result, a sliding scale of efficiencies based on air speed. Another problem associated with electrostatic filters is that particles not caught in the filter are still partially charged and stick to the walls of a room, discoloring them. Also, toxic ozone may be generated by the constant arcing in the electrostatic field.

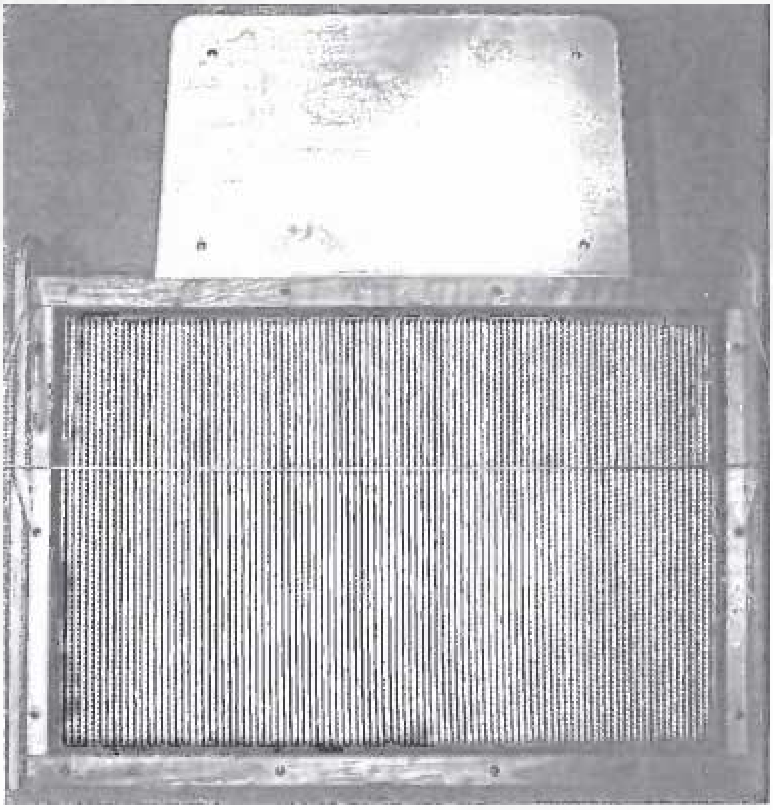


Figure 240 - A commercially available laminar flow hood.

The basic element in an air filter is the media, particularly the dry extended surface kind that is rated to .3 or .1 microns. Extended surface filters are commonly known as HEPA (High Efficiency Particulate Air) filters. First used commercially in 1961, these filters are honeycombed with fine sheets of microporous material that can screen out particulates down to less than one third of a micron size with a rated 99.99% efficiency. All spores of plants, fungi and most bacteria are thereby trapped within the folds of the filter.

The collection media in this type of filter can be composed of various materials including hair, spun glass, wool, paper and asbestos. (In the past, asbestos has been used in the manufacturing of all types of filters.

Since asbestos is cancer causing, be sure to specify a non-asbestos fibre). The extended surface media filter consists of folds of material woven back and forth. Corrugated aluminium or paper separators are inserted perpendicularly to the filter face and separate the folds to help direct airflow in an even, parallel fashion.

The airstream hits the filter material at a perpendicular angle and is forced to pass through the many weaves of the filter before exiting. From the force of impact, inertia and the size of the media web, particles are trapped within the filter. The result is that a very high efficiency is achieved, particularly with small diameter particles.

Extended surface filters have much higher resistance than electrostatic filters but they have a far greater capacity for holding dust. As the filter traps dust, it increases in weight and airflow declines. Generally a HEPA filter is not reused but discarded when, as a rule of thumb, the resistance or "pressure drop" doubles. Extended surface filters are used in hospital surgery rooms as well as culture laboratories and nuclear facilities. Since its efficiency is somewhat dependent on the impact velocity of the particle striking the media web, an appropriate fan must be matched with this type of filter.

The Fan

When constructing a laminar flow hood, the filter size must be precisely fitted with a high pressure fan. All fans are rated by the manufacturer according to the volume of air (CFM or cubic feet per minute) they can push past materials of specified resistance. The type of high pressure fans needed in a laminar flow hood are usually of the squirrel cage type ("furnace blowers").

In turn, the resistance of all micron filters are measured in inches of static pressure at a certain air speed. A standard resistance for a micron filter of this type is .75-1.00 inches of static pressure. Because extended surface filters have a high initial resistance, the housing must tightly hold the HEPA filter so that impure air is not sucked into the exiting airstream.

To calculate the correct fan/filter combination, take the net CFM of the fan at the filter's rated level of resistance and divide that number by the square footage of the filter face. Ideally, that number will be 100 feet per minute, the optimum range for air velocity in laminar flow systems. An example will more clearly illustrate this basic principle.

IF a micron filter measures 2 feet long by 2 feet high by 6 inches deep and has a static pressure rating of 1.0 inches of resistance, the fan required would have to be capable of pushing 400 CFM at 1 inch of static pressure.

IF X = the desired net CFM of a fan at 1" S.P. and
Y = 4 square feet (the square footage of the filter face)
THEN X = 100 feet per minute x Y
X = 100 feet per minute x 4 square feet
X = 400 cubic feet per minute

This means that a fan capable of pushing 400 cubic feet per minute at 1 inch of static pressure is needed to yield the optimum air velocity of 100 feet per minute. (Note that different filters have different static pressure ratings and suggested CFM's). In selecting a fan, it is best to choose one that can deliver more than a 100 feet per minute air velocity. Install a solid state speed control to regulate the fan as needed.

As the filters become laden with particulates, the resistance increases and the airflow declines. If the airflow falls below 20% of the suggested optimum, the 99.99% efficiency rating can not be guaranteed. Filters of the size in the example above can hold four or more pounds of dust and spores before needing replacement! With a few hours of use every week (the time most home cultivators spend conducting sterile transfers), the micron filter should last many years, depending of course, on the ambient spore load in the laboratory.

The life of a HEPA filter can be extended with the placement of pre-filters to screen out coarse particulates. Pre-filters can be made of fibreglass media, the type commonly used for furnace filters, or they can be composed of a thin open-celled foam. Pre-filters of the latter type increase resistance significantly whereas furnace type filters increase resistance only slightly. In this regard, furnace filters are well suited because they are cheap (less than five dollars), readily available, and come in numerous sizes.

Laminar Flow Designs

There are several types of laminar flow systems, each designed for specific applications. The airflow in a biological safety cabinet, built for use with pathogenic organisms, is such that the worker is not endangered if spores from a virulent organism became airborne. The air is drawn from the work area into the hood and then up through micron filters and exited to the outside. Laminar flow hoods for work with radioactive and toxic materials are similarly designed. Because of their intricacy, they are considerably more expensive than the kind needed for mushroom and plant culture.

Laminar flow systems for tissue culturists operate on a reverse principle of the one designed for use with toxic substances. Air is forced through a micron filter to the work area, creating a positive pressure sterile wind in which to conduct mycelial transfers. These types of hoods are perfect for pouring media, maintaining pure mycelia and inoculating spawn containers. Since they greatly reduce the waste caused by contamination, their cost is soon offset by the savings realized. A laminar flow hood is a low maintenance, affordable and appropriate technology for the serious home cultivator.

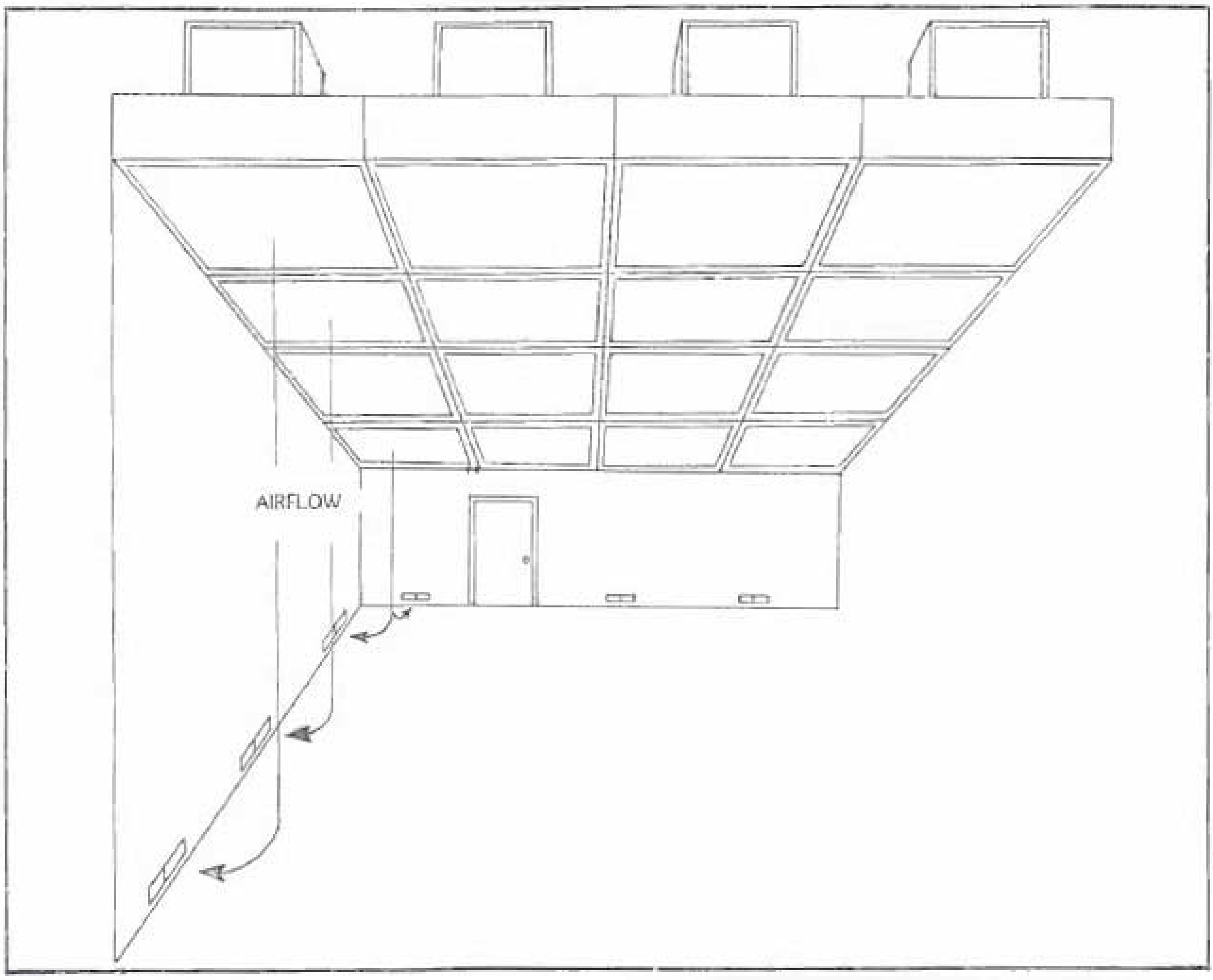


Figure 241 - Sterile room with ceiling composed of micron filters.

An alternative to building a laminar flow hood is the construction of a laminar flow wall or ceiling. A laminar flow ceiling is preferable because the draft is directed downwards to the floor where it exists through evenly placed pressure activated dampers. When a wall or ceiling is composed of micron filters, the air is usually drawn from the outside where the pre-filters can be changed without entering the sterile laboratory. Any contaminant spores tracked in on the shoes of workers are kept close to the floor and is immediately swept away by the flow of sterile air. The atmosphere in a this type of sterile room is fully exchanged 10-20 times per hour.

Foremost, tissue culturists are interested in preventing contamination from occurring, not from spreading. They are concerned with creating sterile media and maintaining the purity of cultures. A laminar flow hood is of little value in helping a cultivator isolate a colony of mushroom mycelium away from, for instance, a green mold on a Petri dish. The turbulence generated from the hood would free thousands of spores, some of which would adhere to the surface of the sterile media, germinate and produce more spores. In these cases, a laminar flow hood is best used as an air cleaner prior to isolating a culture away from a contaminant. Several minutes after it has been turned off and the air currents have settled, transfers can be made away from neighbouring contaminants with little danger of airborne spores.

Although sterile work can be conducted without a laminar flow system, they have become a standard piece of equipment in professional spawn laboratories and increasingly in the sterile rooms of many home cultivators.

Appendix III
The Effect of Bacteria and Other Microorganisms on Fruiting

Although mushrooms have been cultivated for more than two hundred years, little is known about the biological processes of fruiting. For mushroom pinheads to form suddenly and then to enlarge into towering mushrooms within only a few days represents a many hundred-fold multiplication in biomass. This ability to generate tissue so rapidly has few parallels in nature and has been the subject of numerous scientific papers.

Mushrooms are in constant competition with organisms sharing the same habitat. Dung inhabiting mushrooms in particular (like *Psilocybe cubensis* and *Agaricus brunnescens*) live in an environment that teems with other microorganisms feeding on organic wastes and dead cell matter. Dung is by nature a temporary substrate, decomposing completely in only a few weeks. Within this short period of time there is a succession of dominant microorganisms, most notably fungi and bacteria. For a new mushroom colony to grow, its spores must fall, germinate, mate, form a substantial mycelial network and then produce a specialized fruitbody. This series of events is made less likely by poor weather conditions and/or competing microorganisms. The brevity of the generative phase in the mushroom life cycle suggests a highly advanced metabolic system, one that has evolved despite its fiercely competitive environment.

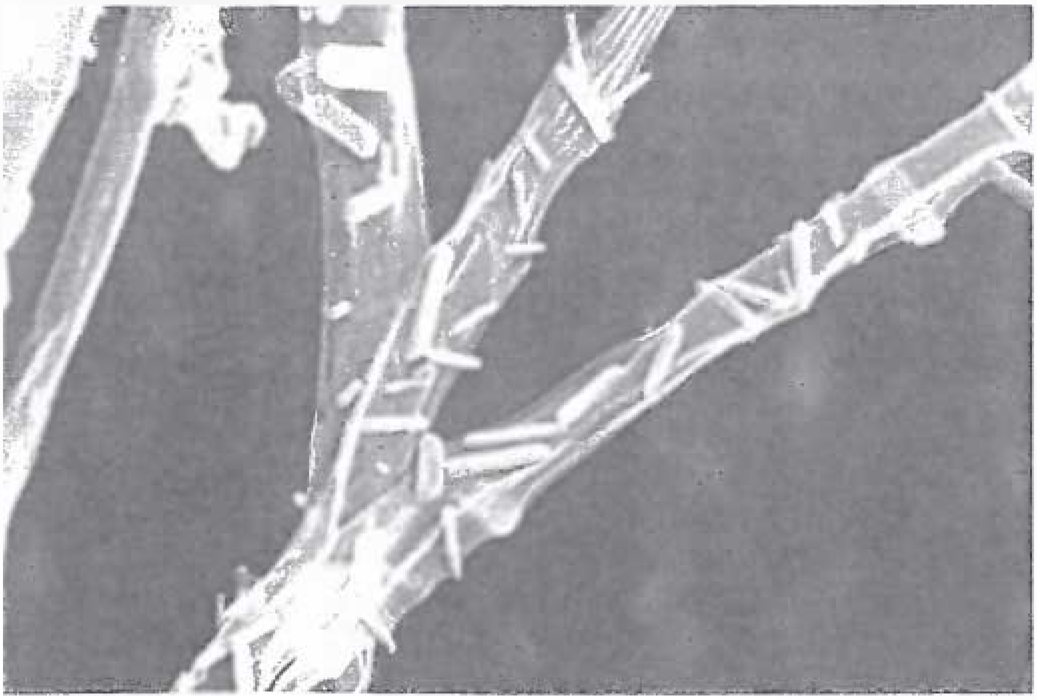


Figure 242 - *Psilocybe cyanescens* mycelium contaminated with bacteria.

The fact that *Agaricus brunnescens* fails to fruit on sterilized substrates has been well documented. It has been shown that if the casing layer is sterilized and applied to grain or compost, mushrooms do not form. On the other hand, if the casing layer is only pasteurized or left untreated, fruiting is unhindered. Obviously something in the peat based casing is essential to the fructification process.

Past investigations have shown the significance of bacteria in mushroom growth. It should not be surprising then to learn that some of these microorganisms are not harmful to the mushroom plant, but beneficial. Under conditions of high humidity, CO_2 and acetone, bacterial populations spiral. In a way not presently understood, some of these bacteria act as a trigger to fruiting. The prevalence of bacteria on hyphae may explain why most dung dwelling mushrooms can be fruited with comparative ease on basic enriched agar media while wood and soil inhabitors can not. The association of these two organisms, a fungus and a bacterium, reflects a tacit agreement for mutual coexistence, one perhaps negotiated by evolutionary necessity.

In 1956 Dr. Takashi Urayama first noted the stimulative influence of bacteria on the fruiting of *Psilocybe coprophila*. (Actually he misidentified the mushroom species as *P. panaeoliformis*). In that paper and ones soon thereafter (Urayama 1960, 1961 and 1967), he reported the isolation of a bacterium he thought responsible for fruiting in not only *Psilocybe* "*panaeoliformis*" but also in *Agaricus brunnescens*. He named that bacterium *Bacillus psilocybe* nom. prov. Apparently unaware of Urayama's work, a German mycologist named Eger similarly isolated a bacterium stimulative to pinhead formation. She first published her notes in 1959. For years this bacterium was known as "Eger's Bacterium" until Hayes (1969) identified the organism in question as *Pseudomonas putida*. This identification set in motion other research projects whose conclusions revealed a subtle but dynamic interplay between microflora in the casing layer and the mushroom mycelium.

Mushroom mycelium releases several metabolites as if grows through a substrate, most importantly CO_2. Other compounds identified by researchers as metabolic waste products include acetone, ethanol and ethylene. Upon casing, the release of volatile metabolites from the spawned compost or grain is drastically inhibited. The casing layer interferes with the free diffusion of acetone, and hence its concentrations in the casing biosphere increase. Since *Pseudomonas putida* grows on media whose sole carbon source is acetone or ethanol (2.5%), cultivators can adopt measures that will enhance the levels of these *Pseudomonas* propagating compounds in the casing layer. Eger first suggested a practical application for commercial cultivators:

"In order to prove our hypothesis, freshly prepared, moist casing soil of a commercial mushroom plant should be incubated with acetone for several days apart from mushroom cultures. If acetone has a stimulative effect on the microflora that induces fructification, soil treated with acetone should allow earlier pinhead formation than control samples." (Eger, 1972, pp. 723.)

Two years later Hayes and Nair (1974) noted that more bacteria flourish in wet casings placed on compost than in wet casing alone. Peak activity occurred ten days after application. Dry casings, as one would expect, had significantly fewer bacteria. Continuing with this work, Hayes and Nair showed that the addition of 5% spawned compost into the casing layer resulted in the largest increase in *P. putida* populations, the most pinheads and the greatest overall yields.

Stanek (1974), a Czech mycologist, studied the bacteria associated directly with mushroom mycelium, in the zone he called the "hyphosphere". These hyphosphere bacteria differed from other bacteria in that they were predominantly Gram-negative (as is *Pseudomonas putida*) and they utilized nitrogenous compounds secreted by the mycelium. Both the growth of mycelia and bacteria were stimulated by extracts of one another, suggesting a mutually enhancing relationship much like the one between nitrogen fixing bacteria and the roots of many plants. Stanek further determined that mycelium infected with bacteria grew more quickly through compost and would, therefore, give mushroom mycelium a decided advantage over other competing microorganisms. From this author's experience (Stamets') in the course of studying the hyphosphere of several *Psilocybe* species, bacteria are not uncommon and may play a similarly beneficial role.

Not all strains of *Pseudomonas putida* cause pinheads to form in *Agaricus brunnescens*, nor do all strains of mushrooms respond similarly to the presence of selected bacteria. The two proven stimulative strains, ATCC #12633 and #17419, are deposited with the American Type Culture Collection. Some strains of *Pseudomonas putida* have no effect whatsoever, while others are most stimulative if the bacterial colonies are grown on a 2.5% acetone based liquid media (see Eger, 1972). After incubating for 10 days at 25°C. in 30-40 ml. of nutrient broth, a density of 1,000,000 to 2,000,000 cells/milliliter is achieved. Ten milliliters of this concentrated solution is recommended for each square meter of casing surface. (For ease of application, one milliliter of concentrate can be diluted in 100 milliliters of sterilized water).

Eger, Hayes and Nair have demonstrated the stimulative effect of *Pseudomonas putida*. But why *Pseudomonas putida* stimulates primordia formation is a question yet unanswered. Some believe its effect is indirect, removing chelating compounds that inhibit mushroom initiation. Others (Fritsche, 1981; Visscher, 1981) suspect its influence is more direct and biologically oriented.

Pseudomonas putida is not the only microorganism implicated in the phenomenon of fruiting. Park and Agnihorti (1969) published a short note where they compared bacteria introduced to soils that had been autoclaved, gamma sterilized and untreated. Three other bacteria (*Bacillus megaterium*, *Arthrobacter terregens* and *Rhizobium meliloti*) stimulated abundant fruitbody formation and development on sterilized soils. (Interestingly, these same nitrogen fixing bacteria are presently being marketed to farmers for increasing crop production). In yet another study, Curto and Favelli (1972) examined a gamut of microorganisms (bacteria, yeasts and microalgae) and their effect on potentiating yields. Again, *Bacillus megaterium* significantly increased mushroom formation. Even more remarkably *Scenedesmus quadricauda* (a common pond dwelling blue-green alga) enhanced production by nearly 60% over and above the control. This alga seemed to have a particularly influential effect on the number of primordia generated on the first flush. Although as exciting as these findings may at first appear, it must be noted that other researchers have not yet confirmed the findings of Curto and Favelli. For reasons not presently understood, activated charcoal mimics the primordia stimulating properties of *Pseudomonas putida* and other beneficial microorganisms. (See Chapter VIII). Its addition to unsterilized casings seems wholly unnecessary considering the ease with which *Agaricus brunnescens* and *Psilocybe cubensis* form pinheads. But, in sterilized casings or in casings applied to difficult to fruit species, the use of activated charcoal and select bacteria gives the cultivator another means to promote fructification. Although many studies have been published, work with fruiting potentiators is still in its infancy. Specific mushroom strains must be carefully matched with specific strains of potentiators. And the potentiators themselves, while of value at fruiting, can be formidable competitors to sterile culture in the laboratory. Nevertheless, utilizing these benevolent microorganisms holds great promise for the future of mushroom culture.

NOTE: Bacteria, if cultured, must be kept separate from the mushroom culture laboratory. *Pseudomonas* and *Bacillus* grow well on standard 2% malt agar media.

Appendix IV
The Use of Mushroom Extracts to Induce Fruiting

The search for the biochemical means by which mushrooms fruit has been ongoing for years. Several researchers have demonstrated the influence of hormones in regulating mushroom formation and development. From this work, it is clear that no one mechanism, but many, cause the phenomenon of fruiting.

Urayama (1972) found that live extracts from young buttons of *Agaricus brunnescens* and from other species would induce pinhead initiation in a *Marasmius* species that otherwise failed to fruit on a specified agar medium. He determined that this particular *Marasmius* failed to form fruitbodies on agar media that had a carbon:nitrogen ratio of 1:10 with sucrose levels maintained at 1%. Given the inability of pinheads to form at this Sucrose/Peptone ratio, he could introduce standardized cell free extracts of other mushroom species to gauge their effects. Species from which crude extracts were taken were: *Agaricus brunnescens*, *Lentinus edodes*, *Flammulina velutipes* and *Pleurotus ostreatus*. The extracts were performed by washing 200 grams of homogenized live mushroom tissue (primordia less than 1 cm. tall) with four successive baths of 80% methanol. The residue was discarded each time and the methanol solution allowed to evaporate, under a slight vacuum, until a dried filtrate remained. One gram of this crude extract was then immersed into 10 milliliters of water and applied in 1/10th milliliter increments to each culture tube, except for the controls.

The results of Urayama's work showed that each of the four fractionations induced primordia formation provided aqueous methanol (80%) and only young mushrooms were used. Extracts from older fruitbodies, especially that of *Agaricus brunnescens* and *Lentinus edodes*, had no effect whatsoever. Urayama tried other solvents to isolate the mysterious "fruiting hormone" and discovered that it was soluble in water and not soluble in absolute methanol, chloroform or petroleum benzine. He worked on his "Substance X", as he liked to call it, for many years until his death in 1980.

Shiio et alia (1974) realized that young mushroom buttons contained high concentrations of the fruiting hormones and applied this knowledge to the commercial cultivation of *Flammulina velutipes*. Pieces of *Flammulina velutipes* primordia were immersed into sterile water and sprayed over sawdust/bran beds. Not only were yields substantially increased by this crude procedure, but initiation occurred much earlier, and the overall fruiting cycle was narrowed considerably. Clearly these mycologists were on the road to discovering an important link in the biochemistry of fruiting.

Around the same time as the work of Shiio et alia, two other Japanese mycologists published related studies (Uno & Ishikawa, 1971, 1973) whereby pinheads of *Coprinus* formed if a "cell free extract" from young mushrooms was added to the culture. They and others isolated the causal compounds - cyclic adenosine monophosphate (c AMP) and related enzymes. They further found that light stimulated the production of c AMP in the mycelium of phototropic mushroom species. Conversely, the absence of light in phototropic mushroom species resulted in no production of c AMP.

Wood (1979) tried to substantiate the findings of Uno and Ishikawa with *Agaricus brunnescens* and failed. He could not induce primordia to form using c AMP. However, this fact does not bear any significance on the importance of cyclic adenosine monophosphate in phototropic species since *A. brunnescens* is a mushroom needing no light whatsoever for primordia formation and development.

The question of how mushrooms fruit is not simple; nor will there be one answer explaining the mechanisms in all species. What is apparent at this early stage of research is that photosensitive and non-photosensitive species have developed different means for mushroom development. The information most useful for home and commercial cultivators will come in the areas of yield enhancement and the growing of exotic mushrooms on readily available, cheap materials. By good fortune, this is one area of research that is not beyond the means of the innovative home cultivator.

Appendix V
Data Collection and Environmental Monitoring Records

Success in mushroom growing requires a consistent and repeatable methodology. Because there are so many variables that affect the crop, careful record keeping is essential for good management. With a data collection system, the cultivator can learn from mistakes and gain a deeper understanding of the factors that influence healthy mushroom growth.

The following data collection records reflect years of mushroom growing experience and are therefore quite detailed. Each cultivator must evaluate his or her particular circumstance to decide which categories are most appropriate. In turn, these data sheets can be modified to meet an individual's requirements.

Spawn Making

Mushroom species: ______________ Strain: ______________
Tissue: ______________ Spores: ______________
Spawn media: ______________
Water: ______________ Additives: ______________
Sterilization time and temperature: ______________
Inoculation date: ______________ Date of Full Colonization: ______________
Shaking schedule: ______________
Observations: ______________

Temperature Chart
----------- air temp.

94																										
92																										
90																										
88																										
86																										
84																										
82																										
80																										
78																										
76																										
74																										
72																										
70																										
68																										
66																										
64																										
Date/time																										
Heat/thermostat setting																										

Compost Making: Phase I

Compost formula					
Ingredient	**wet weight**	**H_2O**	**dry weight**	**% N**	**lbs. N**

Percent Nitrogen: ______

Type of Straw: ______ Source of Horse manure: ______

Description: ______

Structure: ______

Color: ______

Age: ______

Date pre-composting started: ______

Method of watering: ______

Supplements added: ______

Number of turns: ______

Total pre-composting time: ______

Comments: ______

Compost Making: Phase I

Compost Schedule						
Date	**Action**	**Supplements**	**% H_2O**	**Water added**	**Temps**	**Comments**
	Ricking					
	1st turn					
	2nd turn					
	3rd turn					
	4th turn					
	5th turn					

Date of Fill: ______ Depth of Fill: ______

Compost description: ______

Structure: ______ pH: ______

Color: ______ % H_2O: ______

Comments: ______

Compost Making: Phase II

Temperature Chart																										
°F	————— substrate temp. ----------- air temp.																									
150																										
148																										
146																										
144																										
142																										
140																										
138																										
136																										
134																										
132																										
130																										
128																										
126																										
124																										
122																										
120																										
118																										
116																										
114																										
112																										
110																										
108																										
106																										
104																										
102																										
100																										
95																										
90																										
Date/time																										
Fan speed																										
% Fresh air																										
Heat/thermostat setting																										
Ammonia																										

Spawn Running

Spawning Date: ____________________ Substrate density (lbs. dry wt/ft.^{2}): ____________________

Spawn type and amount: ____

Substrate description: ____

Color: ____________________ % H_2O: ____________________

pH: ____________________ Structure: ____________________

Supplements: ____

Temperature Chart																										
°F	————— substrate temp. ----------- air temp.																									
96																										
94																										
92																										
90																										
88																										
86																										
84																										
82																										
80																										
78																										
76																										
74																										
72																										
70																										
68																										
66																										
64																										
62																										
60																										
Date/time																										
Fan speed																										
% Fresh air																										
Heat/thermostat setting																										
Humidity																										
CO_2																										

Casing: Case Running

Casing formula: ____________________ pH: ____________________

% moisture at application: ____________________ Depth: ____________________

Substrate supplementation: ____

Scratching: ____________________ Patching: ____________________

Temperature Chart																										
°F	————— substrate temp. ----------- air temp.																									
96																										
94																										
92																										
90																										
88																										
86																										
84																										
82																										
80																										
78																										
76																										
74																										
72																										
70																										
68																										
66																										
64																										
62																										
60																										
58																										
56																										
Date/time																										
Fan speed																										
% Fresh air																										
Heat/thermostat setting																										
CO_2																										
Humidity																										
Watering																										

Pinhead Initiation

Pin initiation date: ____________________

Early pinning?: ____________________

% Mycelium showing: ____________________

Evenness: ____________________

CO_2 day before pinning: ____________________

Casing moisture content: ____________________

Comments on casing surface: ____

Temperature Chart																										
°F	———— substrate temp. ---------- air temp.																									
88																										
86																										
84																										
82																										
80																										
78																										
76																										
74																										
72																										
70																										
68																										
66																										
64																										
62																										
60																										
58																										
56																										
54																										
52																										
50																										
Date/time																										
Fan speed																										
% Fresh air																										
Heat/thermostat setting																										
CO_2																										
Humidity																										
Watering																										
Light																										

Cropping

Evenness of pinset: ______________________________

% of surface pinned: ______________________________

Date of first harvest: ______________________________

Temperature Chart

°F	———— substrate temp. ---------- air temp.																									
80																										
78																										
76																										
74																										
72																										
70																										
68																										
66																										
64																										
62																										
60																										
58																										
56																										
54																										
52																										
50																										
Date/time																										
Fan speed																										
% Fresh air																										
Heat/thermostat setting																										
CO_2																										
Humidity																										
Watering																										
Light																										

Flushing Pattern

Contaminants encountered: ______________________________

Total time (filling to emptying): ______________________________

Total yield: ______________________________

Bar Graph																										
Pounds of fresh mushrooms																										
20																										
19																										
18																										
17																										
16																										
15																										
14																										
13																										
12																										
11																										
10																										
9																										
8																										
7																										
6																										
5																										
4																										
3																										
2																										
1																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Days																										

Appendix VI
Analyses of Basic Materials Used in Substrate Preparation

Dry Roughages of Fibrous Materials

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Alfalfa hay, all analyses	90.5	14.8	2.0	28.9	36.6	8.2	1.47	0.24	2.37	2.05
Alfalfa hay, very leafy (less than 25% fiber)	90.5	17.2	2.6	22.6	39.4	8.7	1.73	0.25	2.75	2.01
Alfalfa hay, leafy (25-28% fiber)	90.5	15.8	2.2	27.4	36.6	8.5	1.50	0.24	2.53	2.01
Alfalfa hay, stemmy (over 34% fiber)	90.5	12.1	1.4	36.0	33.4	7.6	1.10	0.18	1.94	1.68
Alfalfa hay, before bloom	90.5	19.0	2.7	22.6	36.7	9.5	2.22	0.33	3.04	2.14
Alfalfa hay, past bloom	90.5	12.8	2.1	31.9	36.2	7.5	-	-	2.05	-
Alfalfa hay, brown	87.9	17.3	1.6	24.5	35.1	9.4	1.37	0.26	2.77	-
Alfalfa hay, black	83.1	17.5	1.5	29.1	25.3	9.7	-	-	2.80	-
Alfalfa leaf meal	92.3	21.2	2.8	16.6	39.7	12.0	1.69	0.25	3.39	-
Alfalfa leaves	90.5	22.3	3.0	14.2	40.5	10.5	2.22	0.24	3.57	2.06
Alfalfa meal	92.7	16.1	2.2	27.1	38.2	9.1	1.32	0.19	2.58	1.91
Alfalfa stem meal	91.0	11.5	1.3	36.3	34.8	7.1	-	-	1.84	-
Alfalfa straw	92.6	8.8	1.5	40.4	35.1	6.8	-	0.13	1.41	-
Alfalfa and bromegrass hay	89.3	12.4	2.0	28.6	38.1	8.2	0.74	0.24	1.98	2.18
Alfalfa and timothy hay	89.8	11.1	2.2	29.5	40.3	6.7	0.81	0.21	1.78	1.78
Alfilaria, dry (*Erodium cicutarium*)	89.2	10.9	2.9	23.4	40.2	11.8	1.57	0.41	1.74	-
Alfilaria, dry, mature	89.0	3.5	1.5	31.4	44.1	8.5	-	-	0.56	-
Atlas sorghum stover	85.0	4.0	2.0	27.9	44.2	6.9	0.34	0.09	0.64	-
Barley hay	90.8	7.3	2.0	25.4	49.3	6.8	0.26	0.23	1.17	1.35
Barley straw	90.0	3.7	1.6	37.7	41.0	6.0	0.32	0.11	0.59	1.33
Bean hay, mung	90.3	9.8	2.2	24.0	46.6	7.7	-	-	1.57	-
Bean hay, tepary	90.0	17.1	2.9	24.8	34.7	10.5	-	-	2.74	-
Bean pods, field, dry	91.8	7.1	1.0	34.8	45.0	3.9	0.78	0.10	1.14	2.02
Bean straw, field	89.1	6.1	1.4	40.1	34.1	7.4	1.67	0.13	0.98	1.02
Beggarweed hay	90.9	15.2	2.3	28.4	37.2	7.8	1.05	0.27	2.43	2.32
Bent grass hay, Colonial	88.5	6.6	3.0	29.5	42.8	6.6	-	0.18	1.06	1.42
Bermuda grass hay	90.6	7.2	1.8	25.9	48.7	7.0	0.37	0.19	1.15	1.42
Bermuda grass hay, poor	90.0	5.8	0.9	38.8	37.7	6.8	-	-	0.93	-
Berseem hay, or Egyptian clover	91.7	13.4	2.7	21.0	42.7	11.9	3.27	0.28	2.14	2.05
Birdsfoot trefoil hay	90.5	13.8	2.1	27.5	41.2	5.9	1.13	0.22	2.35	1.52
Black grass hay (*Juncus gerardi*)	89.7	7.5	2.5	25.1	47.3	7.3	-	0.09	1.20	1.56
Bluegrass hay, Canada	89.3	6.6	2.3	28.2	46.4	5.8	-	0.20	1.06	1.94
Bluegrass hay, Kentucky, all analyses	89.4	8.2	2.8	29.8	42.1	6.5	0.46	0.32	1.31	1.73
Bluegrass hay, Kentucky, in seed	87.3	5.5	2.5	31.0	41.9	6.4	0.23	0.20	0.88	1.48
Bluegrass hay, native western	91.9	11.2	3.0	29.8	39.9	8.0	-	-	1.79	-
Bluejoint hay (*Calamagrostis canadensis*)	88.5	7.2	2.3	32.9	39.6	6.5	-	-	1.15	-
Bluestem hay (*Andropogon*, spp.)	86.6	5.4	2.2	30.2	43.4	5.4	-	-	0.86	-
Bromegrass hay, all analyses	88.1	9.9	2.1	28.4	39.5	8.2	0.20	0.28	1.58	2.35
Bromegrass hay, before bloom	89.0	14.5	2.3	24.6	37.9	9.7	-	-	2.32	-
Broom corn stover	90.6	3.9	1.8	36.8	42.4	5.7	-	-	0.62	-
Buckwheat hulls	88.6	3.0	1.0	42.9	40.1	1.6	0.26	0.02	0.48	0.27
Buckwheat straw	88.6	4.3	1.0	36.2	38.8	8.3	1.24	0.04	0.69	2.00
Buffalo grass hay (*Bulbilis dactyloides*)	88.7	6.8	1.8	23.8	46.2	10.1	0.70	0.13	1.09	1.36
Bunchgrass hay, misc. varieties	91.7	5.8	2.0	30.4	44.1	9.4	-	-	0.93	-
Carpet grass hay	92.1	7.0	2.2	31.8	40.9	10.2	-	-	1.12	-
Cat-tail, or tule hay (Typha angustifolia)	90.8	5.8	1.7	30.8	44.3	8.2	-	-	0.93	-
Cereals, young, dehydrated	92.8	24.5	4.7	16.1	33.1	14.4	0.66	0.46	3.92	-
Chess, or cheat hay (*Bromus*, spp.)	91.7	6.9	2.1	29.2	46.1	7.4	0.29	0.25	1.10	1.47
Clover hay, alsike, all analyses	88.9	12.1	2.1	27.0	39.9	7.8	1.15	0.23	1.94	2.44
Clover hay, alsike, in bloom	89.0	13.4	3.2	26.9	37.7	7.8	1.32	0.25	2.14	2.27

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Clover hay,	89.0	10.9	1.6	35.4	35.5	5.6	-	-	1.74	-
Alyce Clover hay, bur	92.1	18.4	2.9	22.9	37.8	10.1	1.32	0.45	2.94	2.96
Clover hay, crimson	89.5	14.2	2.2	27.4	37.0	8.7	1.23	0.24	2.27	2.79
Clover hay, Ladino	88.0	19.4	3.2	20.7	34.9	9.8	1.32	0.29	3.10	2.78
Clover, Ladino, and grass hay	88.0	16.3	2.2	20.7	41.7	7.1	1.05	0.26	2.61	1.97
Clover hay, mammoth red	88.0	11.7	3.4	29.2	37.0	6.7	-	0.24	1.87	-
Clover hay, red, all analyses	88.1	11.8	2.6	27.2	40.1	6.4	1.35	0.19	1.89	1.43
Clover hay, red, leafy (less than 25% fiber)	88.1	13.4	3.1	23.6	40.8	7.2	-	-	2.14	-
Clover hay, red, stemmy (over 31% fiber)	88.2	10.1	2.1	34.1	36.0	5.9	0.99	0.15	1.62	1.77
Clover hay, red, before bloom	88.1	18.3	3.6	18.0	41.1	7.1	1.69	0.28	2.93	2.26
Clover hay, red, early to full bloom	88.1	12.5	3.5	26.1	39.7	6.3	1.47	0.22	2.00	1.73
Clover hay, red, second cuffing	88.1	13.4	2.9	24.5	40.4	6.9	-	-	2.14	-
Clover hay, sweet, first year	91.8	16.5	2.5	24.6	39.7	8.5	1.37	0.26	2.64	1.57
Clover hay, sweet, second year	90.7	13.5	1.9	30.2	37.6	7.5	1.25	0.23	2.16	1.78
Clover hay, white	88.0	14.4	2.4	22.5	40.9	7.8	1.16	0.24	2.30	1.66
Clover leaves, sweet	92.2	26.6	3.2	9.5	41.9	11.0	-	-	4.26	-
Clover stems, sweet	92.7	10.6	1.1	38.0	35.6	7.4	-	-	1.70	-
Clover straw, crimson	87.7	7.5	1.5	38.8	32.9	7.0	-	-	1.20	-
Clover and mixed grassy, high in clover	89.7	9.6	2.7	28.8	42.2	6.2	0.90	0.19	1.54	1.46
Clover and timothy hay, 30 to 50% clover	88.1	8.6	2.2	30.3	41.2	5.8	0.68	0.20	1.38	1.47
Corn cobs, ground	90.4	2.3	0.4	32.1	54.0	1.6	-	0.02	0.37	0.37
Corn fodder, well-eared, very dry (from barn or in arid districts)	91.1	7.8	2.2	27.1	47.6	6.4	0.24	0.16	1.25	0.82
Corn fodder, high in water	60.7	4.8	1.4	16.7	34.2	3.6	0.16	0.11	0.77	0.55
Corn fodder, sweet corn	87.7	9.2	1.8	26.4	41.3	9.0	-	0.17	1.47	0.98
Corn husks, dried	85.0	3.4	0.9	28.2	49.6	2.9	0.15	0.12	0.54	0.55
Corn leaves, dried	82.8	7.7	1.9	23.9	42.6	6.7	0.29	0.10	1.23	0.36
Corn stalks, dried	82.8	4.7	1.5	28.0	43.3	5.3	0.25	0.09	0.75	0.50
Corn stover (ears removed), very dry	90.6	5.9	1.6	30.8	4.65	5.8	0.29	0.05	0.94	0.67
Corn stover, high in water	59.0	3.9	1.0	20.1	30.2	3.8	0.19	0.04	0.62	0.44
Corn tops, dried	82.1	5.6	1.5	27.4	42.0	5.6	-	-	0.90	-
Cotton bolls, dried	90.8	91.0	3.4	0.9	37.2	46.7	2.6	-	1.39	3.18
Cotton leaves, dried	91.7	8.7	2.4	30.8	42.0	6.9	2.8	0.09	2.45	1.36
Cotton stems, dried	92.4	15.3	6.8	10.3	43.5	15.8	0.61	0.18	0.93	-
Cottonseed hulls	90.7	5.8	0.9	44.0	37.5	4.2	4.58	-0.07	0.62	0.87
Cottonseed hull bran	91.0	3.9	0.9	46.1	37.2	2.6	-0.14	-	0.54	-
Cowpea hay, all analyses	90.4	18.6	2.6	23.3	34.6	11.3	1.37	0.29	2.98	1.51
Cowpea hay, in bloom to early pod	89.9	18.1	3.2	21.8	36.7	10.1	-	-	2.90	-
Cowpea hay, ripe	90.0	10.1	2.5	29.2	41.8	6.4	-	-	1.62	-
Cowpea straw	91.5	6.8	1.2	44.5	33.6	5.4	-	-	1.09	-
Crabgrass hay	90.5	8.0	2.4	28.7	42.9	8.5	-	-	1.28	-
Durra fodder	89.9	6.4	2.8	24.1	51.4	5.2	-	-	1.02	-
Emmer hay	90.0	0.97	2.0	32.8	36.4	9.1	-	-	1.55	-
Fescue hay, meadow	89.2	7.0	1.9	30.3	43.2	6.8	-	0.20	1.12	1.43
Fescue hay, native western (*Festuca*, spp.)	90.0	8.5	2.0	31.0	42.8	5.7	-	-	1.36	-
Feterita fodder, very dry	88.0	8.0	2.1	18.7	51.5	7.7	0.30	0.21	1.28	-
Feterita stover	86.3	5.2	1.7	29.2	41.9	8.3	-	-	0.83	-
Flat pea hay	92.3	22.7	3.2	27.7	32.0	6.7	-	0.30	3.63	2.02
Flax plant by product	91.9	6.4	2.1	44.4	33.1	5.9	-	-	1.02	-
Flax straw	92.8	7.2	3.2	42.5	32.9	7.0	0.48	0.07	1.15	0.73
Fowl meadow grass hay	87.4	8.7	2.3	29.7	39.5	7.2	-	-	1.39	-
Furze, dried	94.5	11.6	2.0	38.5	35.5	7.0	-	-	1.86	-
Gama grass hay (*Tripsacum dactyloides*)	88.2	6.7	1.8	30.4	43.1	6.2	-	-	1.07	-
Grama grass hay (*Bouteloua*, spp.)	89.8	5.8	1.6	28.9	45.6	7.9	0.34	0.18	0.93	-
Grass hay, mixed, eastern states, good quality	89.0	7.0	2.5	30.9	43.1	5.5	0.48	0.21	1.12	1.20
Grass hay, mixed, second cutting	89.0	12.3	3.3	24.8	41.7	6.9	0.79	0.31	1.97	1.15

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Grass straw	85.0	4.5	2.0	35.0	37.8	5.7	-	-	0.72	-
Guar hay (*Cyamopsis psoraloides*)	90.7	16.5	1.3	19.3	41.2	12.4	-	2.64	-	-
Hegari fodder	86.0	6.2	1.7	18.1	52.5	7.5	0.27	0.16	0.99	-
Hegari stover	87.0	5.6	1.8	28.0	41.7	9.9	0.33	0.08	0.90	-
Hops, spent, dried	93.8	23.0	3.6	24.5	37.4	5.3	-	-	3.68	-
Horse bean hay	91.5	13.4	0.8	22.0	49.8	5.5	-	-	2.14	-
Horse bean straw	87.9	8.6	1.4	36.4	33.1	8.4	-	-	1.38	-
Hyacinth bean hay (*Dilichos lablab*)	90.2	14.8	1.4	33.6	33.6	6.8	-	-	2.37	-
Johnson grass hay	90.1	6.5	2.1	30.4	43.7	7.4	0.87	0.26	1.04	1.22
June grass hay, western (*Koeleria cristata*)	88.3	8.1	2.5	30.4	40.5	6.8	-	-	1.30	-
Kafir fodder, very dry	90.0	8.7	2.6	25.5	44.2	9.0	0.35	0.18	1.39	1.53
Kafir fodder, high in water	71.7	6.5	2.7	21.6	37.6	3.3	0.28	0.14	1.04	1.23
Kafir stover, very dry	90.0	5.5	1.8	29.5	44.3	8.9	0.54	0.09	0.88	-
Kafir stover, high in water	72.7	3.8	1.3	23.7	36.6	7.3	0.44	0.07	0.61	-
Koahaole forage, dried	88.7	12.7	1.9	29.8	39.2	5.1	-	-	2.03	-
Kochia scoparia hay	90.0	11.4	1.5	23.6	40.7	12.8	-	-	1.82	-
Kudzu hay	89.0	15.9	2.5	28.6	35.1	6.9	2.78	0.21	2.54	-
Lespedeza hay, annual, all analyses	89.2	12.7	2.4	26.7	42.2	5.2	0.98	0.18	2.03	0.91
Lespedeza hay, annual, before bloom	89.1	14.3	2.7	22.7	43.0	6.4	1.04	0.19	2.29	1.06
Lespedeza hay, annual, in bloom	89.1	13.0	1.8	26.5	42.7	5.1	1.02	0.18	2.08	0.94
Lespedeza hay, annual, after bloom	89.1	11.5	1.9	32.6	38.6	4.5	0.90	0.15	1.84	0.82
Lespedeza hay, perennial	89.0	13.2	1.7	26.5	42.7	4.9	0.92	0.22	2.11	0.98
Lespedeza leaves, annual	89.2	17.1	2.9	19.7	43.1	6.4	1.30	0.20	2.74	0.92
Lespedeza stems, annual	89.2	8.3	1.0	38.5	37.7	3.7	0.64	0.13	1.33	0.89
Lespedeza straw	90.0	6.8	2.3	29.2	47.1	4.6	-	-	1.09	-
Lovegrass hay, weeping	91.2	9.2	2.8	30.9	43.4	4.9	-	-	1.47	-
Marsh or swamp hay, good quality	90.2	7.7	2.3	28.2	44.3	7.7	-	-	1.23	-
Millet hay, foxtail varieties	87.6	8.2	2.7	25.3	44.7	6.7	0.29	0.16	1.31	1.70
Millet hay, hog millet, or proso	90.3	9.3	2.2	23.9	47.6	7.3	-	-	1.49	-
Millet hay, Japanese	86.8	8.3	1.6	27.7	40.8	8.4	0.20	-	1.33	2.10
Millet hay, pearl, or cat-tail	87.2	9.0	90.0	5.5	88.5	6.9	91.0	9.5	88.3	7.6
Millet straw	6.7	-	3.8	0.08	8.0	0.35	3.2	0.58	12.7	1.51
Milo fodder	1.7	-	1.6	-	3.3	0.18	1.1	0.11	2.1	0.19
Milo stover	33.0	1.07	37.5	0.61	21.9	1.28	29.1	0.51	20.3	2.03
Mint hay	36.8	-	41.6	1.44	48.4	-	48.1	-	45.6	-
Mixed hay, good, less than 30% legumes	88.0	8.3	1.8	30.7	41.8	5.4	0.61	0.18	1.33	1.47
Mixed hay, good, more than 30% legumes	88.0	9.2	1.9	28.1	42.8	6.0	0.90	0.19	1.47	1.46
Mixed hay, cut very early	90.0	13.3	2.7	25.3	39.4	9.3	-	-	2.13	-
Napier grass hay	89.1	8.2	1.8	34.0	34.6	10.5	-	-	1.31	-
Natal grass hay	90.2	7.4	1.8	36.8	39.2	5.0	0.45	0.29	1.18	-
Native hay, western mt. states, good quality	90.0	8.1	2.1	29.8	43.2	6.8	0.39	0.12	1.30	-
Native hay, western mt. states, mature and weathered	90.0	3.9	1.4	33.6	43.6	7.5	-	-	0.62	-
Needle grass hay (*Stipa*, spp.)	88.1	7.2	2.0	30.8	41.9	6.2	-	-	1.15	-
Oak leaves, live oak, dried	93.8	9.3	2.7	29.9	45.3	6.6	-	-	1.49	-
Oat chaff	91.8	5.9	2.4	25.7	46.3	11.5	0.80	0.30	0.94	0.86
Oat hay	88.1	8.2	2.7	28.1	42.2	6.9	0.21	0.19	1.31	0.83
Oat hay, wild (*Avena fatua*)	92.5	6.6	2.6	32.5	44.0	6.8	0.22	0.25	1.06	-
Oat hulls	92.8	4.5	1.3	29.7	50.8	6.5	0.20	0.10	0.78	0.48
Oat straw	89.7	4.1	2.2	36.1	41.0	6.3	0.19	0.10	0.66	1.35
Oat grass hay, tall	88.7	7.5	2.4	30.1	42.7	6.0	-	0.14	1.20	1.36
Orchard grass hay, early-cut	88.6	7.7	2.9	30.5	40.7	6.8	0.19	0.17	1.23	1.61
Picnic grass hay (*Panicum*, spp.)	92.1	8.3	2.3	29.5	44.9	7.1	-	-	1.33	-
Para grass hay	90.2	4.6	0.9	33.6	44.5	6.6	0.35	0.35	0.74	1.44
Pasture grasses and clovers, mixed, from closely grazed, fertile pasture, dried (northern states)	90.0	20.3	3.6	19.7	38.7	7.7	0.58	0.32	3.25	2.18
Pasture grasses, mixed, from poor to fair pasture, before heading out, dried	90.0	14.1	2.3	19.4	43.2	11.0	0.41	0.12	2.26	0.74

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Pasture grass, western plains, growing, dried	90.0	11.6	2.5	28.0	40.2	7.7	0.37	0.24	1.86	-
Pasture grass, western plains, mature, dried	90.0	4.6	2.3	31.9	45.3	5.9	0.34	0.14	0.74	-
Pasture grass, western plains, mature and weathered	90.0	3.3	1.8	34.1	44.5	6.3	0.33	0.09	0.53	-
Pasture grass and other forage on western mt. ranges, spring, dried	90.0	17.0	3.1	14.0	49.1	6.8	1.21	0.38	2.72	-
Pasture grass and other forage on western mt. ranges, autumn, dried	90.0	8.8	4.3	17.4	51.4	8.1	-	-	1.41	-
Pea hay, field	89.3	14.9	3.3	24.3	39.1	7.7	1.22	0.25	2.38	1.25
Pea straw, field	90.2	6.1	1.6	33.1	44.0	5.4	-	0.10	0.98	1.08
Pea-and-oat hay	89.1	12.1	2.9	27.2	39.1	7.8	0.72	0.22	1.94	1.04
Peanut hay, without nuts	90.7	10.1	3.3	23.4	44.2	9.7	1.12	0.13	1.62	1.25
Peanut hay, with nuts	92.0	13.4	12.6	23.0	34.9	8.1	1.13	0.15	2.14	0.85
Peanut hay, mowed	91.4	10.6	5.1	23.8	42.2	9.7	-	-	1.70	-
Peanut hulls, with a few nuts	92.3	6.7	1.2	60.3	19.7	4.4	0.30	0.07	1.07	0.82
Peavine hay, from pea-cannery vines, sun-cured	86.3	11.9	2.4	23.0	42.2	6.8	1.48	0.16	1.90	-
Prairie hay, western, good quality	90.7	0.57	2.3	30.4	44.9	7.4	0.36	0.18	0.91	-
Prairie hay, western, mature	91.7	3.8	2.4	31.9	47.1	6.5	0.28	0.09	0.61	0.49
Quack grass hay	89.0	6.9	1.9	34.5	38.8	6.9	-	-	1.10	-
Ramie meal	92.2	19.2	3.8	20.1	35.9	13.2	4.32	0.22	3.07	-
Red top hay	91.0	7.2	2.3	29.3	45.3	6.9	0.33	0.23	1.15	1.93
Reed canary grass hay	91.1	7.7	2.3	29.2	44.3	7.6	0.33	0.16	1.23	-
Rescue grass hay	90.2	9.8	3.2	24.6	44.5	8.1	-	-	1.57	-
Rhodes grass hay	89.0	5.7	1.3	31.7	41.8	8.5	0.35	0.27	0.91	1.18
Rice hulls	92.0	3.0	0.8	40.7	28.4	19.1	0.08	0.08	0.48	0.31
Rice straw	92.5	3.9	1.4	33.5	39.2	14.5	0.19	0.07	0.62	1.22
Rush hay, western (*Juncus*, spp.)	90.0	9.4	1.8	29.2	44.2	5.4	-	-	1.50	-
Russian thistle hay	87.5	8.9	1.6	26.9	37.4	12.7	-	-	1.42	-
Rye grass hay, Italian	88.6	8.1	1.9	27.8	43.3	7.5	-	0.24	1.30	1.00
Rye grass hay, perennial	88.0	9.2	3.1	24.2	43.4	8.1	-	0.24	1.47	1.25
Rye grass hay, native western	87.4	7.8	2.1	33.5	37.6	6.4	-	-	1.25	-
Rye hay	91.3	6.7	2.1	36.5	41.0	5.0	-	0.18	1.07	1.05
Rye straw	92.8	3.5	1.2	38.7	45.9	3.5	0.26	0.09	0.56	0.90
Salt bushes, dried	93.5	13.8	1.6	22.1	38.8	17.2	1.88	0.11	2.21	4.69
Salt grass hay, misc. var.	90.0	8.1	1.8	28.8	39.5	11.8	-	-	1.30	-
Sanfoin hay (*Onobrychis viciaefolia*)	84.1	10.5	2.6	19.7	44.2	7.1	-	-	1.68	-
Seaweed, dried (*Fucus*, spp.)	88.7	5.2	4.2	9.4	53.6	16.3	-	-	0.83	-
Seaweed, dried (*Laminaria*, spp.)	83.7	11.4	1.1	8.6	45.8	16.8	-	-	1.82	-
Sedge hay, eastern (*Carex*, spp.)	90.7	6.1	1.7	29.2	46.3	7.4	-	-	0.98	-
Sedge hay, western (*Carex*, spp.)	90.6	10.1	2.4	27.3	44.0	6.8	0.60	0.24	1.62	-
Seradella hay	89.0	16.4	3.2	29.8	32.0	7.6	-	0.33	2.62	1.25
Sorghum bagasse, dried	89.3	3.1	1.4	31.3	50.0	3.5	-	-	0.50	-
Sorghum fodder, sweet, dry	88.8	6.2	2.4	25.0	48.1	7.1	0.34	0.12	0.99	1.29
Sorghum fodder, sweet, high in water	65.7	4.5	2.4	16.6	37.6	4.6	0.25	0.09	0.72	0.96
Soybean hay, good, all analyses	88.0	14.4	3.3	27.5	35.8	7.0	0.94	0.24	2.30	0.82
Soybean hay, in bloom or before	88.0	16.7	3.3	20.6	37.8	9.6	1.53	0.27	2.67	0.86
Soybean hay, seed developing	88.0	14.6	2.4	27.2	36.5	7.3	1.35	0.25	2.34	0.78
Soybean hay, seed nearly ripe	88.0	15.2	6.6	24.0	38.2	4.0	0.86	0.32	2.43	0.81
Soybean hay, poor quality, weathered	89.0	9.2	1.2	41.0	30.4	7.2	0.94	-	1.47	-
Soybean straw	88.8	4.0	1.1	41.1	37.5	5.1	-	0.13	0.64	0.62
Soybean and Sudan grass hay, chiefly Sudan	89.0	7.4	2.2	31.1	43.4	4.9	-	-	1.18	-
Spanish moss, dried	89.2	5.0	2.4	26.6	47.7	7.5	-	0.04	0.80	0.46
Sudan grass hay, all analyses	89.3	8.8	1.6	27.9	42.9	8.1	0.36	0.26	1.41	1.30
Sudan grass hay, before bloom	89.6	11.2	1.5	26.1	41.3	9.5	0.41	0.26	1.79	-
Sudan grass hay, in bloom	89.2	8.4	1.5	30.7	41.8	6.8	-	-	1.34	-
Sudan grass hay, in seed	89.5	6.8	1.6	29.9	44.4	6.8	0.27	0.19	1.09	-
Sudan grass, young, dehydrated	88.0	14.5	2.5	20.4	41.2	9.4	0.52	0.39	2.32	-
Sudan grass straw	90.4	7.1	1.5	33.0	42.3	6.5	-	-	1.14	-

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Sugar cane fodder, Japanese, dried	89.0	1.3	1.8	19.7	64.3	1.9	0.32	0.14	0.21	0.58
Sugar cane bagasse, dried	95.5	1.1	0.4	49.6	42.0	2.4	-	-	0.18	-
Sugar cane pulp, dried	93.8	1.7	0.6	45.6	42.2	3.7	-	-	0.27	-
Sweet potato vine, dried	90.7	12.6	3.3	19.1	45.5	10.2	-	-	2.02	-
Teosinte fodder, dried	89.4	9.1	1.9	26.5	41.7	10.3	-	0.17	1.46	0.88
Timothy hay, all analyses	89.0	6.5	2.4	30.2	45.0	4.9	0.23	0.20	1.04	1.50
Timothy hay, before bloom	89.0	9.7	2.7	27.4	42.7	6.5	-	-	1.55	-
Timothy, full bloom	89.0	6.4	2.5	30.4	44.8	4.9	0.23	0.20	1.02	1.50
Timothy hay, in bloom, nitrogen fertilized	89.0	9.7	2.1	31.6	42.6	3.9	0.40	0.21	1.41	1.41
Timothy hay, late seed	89.0	5.3	2.3	31.0	45.9	4.5	0.14	0.15	0.85	1.41
Timothy hay, in bloom, dehydrated	89.0	7.7	2.3	28.3	45.5	5.2	-	-	1.23	-
Timothy hay, second cutting	88.7	15.0	4.6	25.4	36.5	7.2	-	-	2.40	-
Timothy and clover hay, one-fourth clover	88.8	7.8	2.4	29.5	43.8	5.3	0.51	0.20	1.25	1.48
Velvet bean hay	92.8	16.4	3.1	27.5	38.4	7.4	-	0.24	2.62	2.20
Vetch hay, common	89.0	13.3	1.1	25.2	32.2	6.2	1.18	0.32	2.13	2.22
Vetch hay, hairy	88.0	19.3	2.6	24.5	33.1	8.5	1.13	0.32	3.09	1.96
Vetch-and-oat hay, over half vetch	87.6	11.9	2.7	27.3	37.5	8.2	0.76	0.27	1.90	1.51
Vetch-and-wheat hay, cut early	90.0	15.4	2.2	28.8	36.4	7.2	-	-	2.46	-
Wheat chaff	90.0	4.4	1.5	29.4	47.1	7.6	0.21	0.14	0.70	0.50
Wheat hay	90.4	6.1	1.8	26.1	50.0	6.4	0.14	0.18	0.98	1.47
Wheat straw	92.5	3.9	1.5	36.9	41.9	8.3	0.21	0.07	0.62	0.79
Wheat grass hay, crested, cut early	90.0	9.2	2.0	32.2	40.2	6.4	-	-	1.47	-
Wheat grass hay, slender	90.0	8.0	2.1	32.2	41.0	6.7	0.30	0.24	1.28	2.41
Winter fat, or white sage, dried (*Eurotia lanata*)	92.6	12.9	1.9	27.4	40.8	9.6	-	-	2.06	-
Wire grass hay, southern (*Aristida*, spp.)	90.0	5.5	1.4	31.8	47.9	3.4	0.15	0.14	0.88	-
Wire grass hay, western (*Aristida*, spp.)	90.0	6.4	1.3	34.1	41.0	7.2	-	-	1.02	-
Yucca, or beargrass, dried	92.6	6.6	2.2	38.6	38.3	6.9	-	-	1.06	-

Concentrates

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Acorns, whole (red oak)	50.0	3.2	10.7	9.9	25.0	1.2	-	-	0.51	-
Acorns, whole (white and post oaks)	50.0	2.7	3.0	9.3	33.7	1.3	-	-	0.43	-
Alfalfa-molasses feed	86.0	11.4	1.2	18.5	46.2	8.7	-	-	1.82	-
Alfalfa seed	88.3	33.2	10.6	8.1	32.0	4.4	-	-	5.31	-
Alfalfa seed screenings	90.3	31.1	9.9	11.1	33.1	5.1	-	-	4.98	-
Apple-pectin pulp, dried	91.2	7.0	7.3	24.2	49.4	3.3	-	-	1.12	-
Apple-pectin pulp, wet	16.7	1.5	0.9	5.8	7.9	0.6	-	-	0.24	-
Apple pomace, dried	89.4	4.5	5.0	15.6	62.1	2.2	0.10	0.09	0.72	0.43
Apple pomace, wet	21.1	1.3	1.3	3.7	13.9	0.9	0.02	0.02	0.21	0.10
Atlas sorghum grain	89.1	11.3	3.3	2.0	70.6	1.9	-	-	1.81	-
Atlas sorghum head chops	88.0	9.5	2.8	10.7	60.2	4.8	-	-	1.52	-
Avocado oil meal	91.4	18.6	1.1	17.6	36.0	18.1	-	-	2.98	-
Babassu oil meal	92.8	24.2	6.8	12.0	44.6	5.2	0.13	0.71	3.87	-
Bakery waste, dried (high in fat)	91.6	10.9	13.7	0.7	64.7	1.6	-	-	1.74	-
Barley, common, not including Pacific Coast states	89.4	12.7	1.9	5.4	66.6	2.8	0.06	0.37	2.03	0.49
Barley, Pacific Coast states	89.8	8.7	1.9	5.7	70.9	2.6	-	-	1.39	-
Barley, light weight	89.1	12.1	2.1	7.4	64.3	3.2	-	-	1.94	-
Barley, hull-less, or bald	90.2	11.6	2.0	2.4	72.1	2.1	-	-	1.86	-
Barley feed, high grade	90.3	13.5	3.5	8.7	60.5	4.1	0.03	0.40	2.16	0.60
Barley feed, low grade	92.0	12.3	3.45	14.7	56.2	5.3	-	-	1.97	-
Barley, malted	93.4	12.7	2.1	5.4	70.9	2.3	0.06	0.42	2.03	0.37
Barley screenings	88.6	11.6	2.7	9.1	61.3	3.9	-	-	1.86	-
Beans, field, or navy	90.0	22.9	1.4	4.2	57.3	4.2	0.15	0.57	3.66	1.27
Beans, kidney	89.0	23.0	1.2	4.1	56.8	3.9	-	-	3.68	-
Beans, lima	89.7	21.2	1.1	4.7	58.2	4.5	0.09	0.37	3.39	1.70
Beans, mung	90.2	23.3	1.0	3.5	58.5	3.9	-	-	3.73	-
Beans, pinto	89.9	22.5	1.2	4.1	57.7	4.4	-	-	3.60	-
Beans, tepary	90.5	22.2	1.4	3.4	59.3	4.2	-	-	3.56	-
Beechnuts	91.4	15.0	30.6	15.0	27.5	3.3	0.58	0.30	2.40	0.62
Beef scraps	94.5	55.6	10.9	1.2	0.5	26.3	-	-	8.90	-
Beet pulp, dried	90.1	9.2	0.5	19.8	57.2	3.4	0.67	0.08	1.47	0.18
Beet pulp, molasses, dried	91.9	10.7	0.7	16.0	59.4	5.1	0.62	0.09	1.71	1.63
Beet pulp, wet	11.6	1.5	0.3	4.0	5.3	0.5	0.09	0.01	0.24	0.02
Beet pulp, wet, pressed	14.2	1.4	0.4	4.6	7.1	0.7	-	-	0.22	-
Blood flour, or soluble blood meal	92.2	84.7	1.0	1.1	0.7	4.7	0.68	0.50	13.55	-
Blood meal	91.8	84.5	1.1	1.0	0.7	4.5	0.33	0.25	13.52	0.09
Bone meal, raw	93.6	26.0	5.0	1.0	2.5	59.1	23.05	10.22	4.16	-
Bone meal, raw, solvent process	93.1	25.7	1.0	1.0	1.9	63.5	24.02	10.65	4.11	-
Bone meal, steamed	96.3	7.1	3.3	0.8	3.8	81.3	31.74	15.00	1.14	0.18
Bone meal, steamed, solvent process	96.8	7.2	0.4	1.5	3.7	84.0	-	-	1.15	-
Bone meal, steamed, special	97.7	13.5	7.9	1.0	5.1	70.2	31.88	13.48	2.16	-
Bone meal, 10% to 20% protein	97.2	14.6	6.5	1.5	3.6	71.0	26.00	12.66	2.34	-
Bread, white, enriched	64.1	8.5	2.0	0.3	52.0	1.3	0.06	0.10	1.36	0.10
Brewers' grains, dried, 25% protein or over	92.9	27.6	6.5	14.3	40.9	3.6	0.29	0.48	4.42	0.10
Brewers' grains, dried, below 25% protein	92.3	23.4	6.4	16.1	42.5	3.9	-	-	3.74	-
Brewers' grains, dried, from California barley	91.1	20.0	5.7	18.1	43.6	3.7	-	-	3.20	-
Brewers' grains, wet	23.7	5.7	1.6	3.6	11.8	1.0	0.07	0.12	0.91	0.02
Broom corn seed	89.7	9.2	3.7	5.1	69.1	2.6	-	-	1.47	-
Buckwheat, ordinary varieties	88.0	10.3	2.3	10.7	62.8	1.9	0.09	0.31	1.64	0.45
Buckwheat, Tartary	88.1	10.1	2.4	12.7	60.9	2.0	0.13	0.31	1.62	0.44

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Buckwheat feed, good grade	89.3	18.5	4.9	18.2	43.5	4.2	-	0.48	2.96	0.66
Buckwheat feed, low grade	88.3	13.3	3.4	28.6	39.8	3.2	-	0.37	2.13	0.68
Buckwheat flour	88.1	10.2	2.1	0.9	73.4	1.5	0.01	0.09	1.63	0.16
Buckwheat kernels, without hulls	88.0	14.1	3.4	1.8	66.5	2.2	0.05	0.45	2.26	0.49
Buckwheat middlings	88.7	29.7	7.3	7.4	39.4	4.9	-	1.02	4.76	0.98
Buttermilk	9.4	3.5	0.6	0.0	4.5	0.8	0.14	0.08	0.56	0.07
Buttermilk, condensed	29.7	10.9	2.2	0.0	12.6	4.0	0.44	0.26	1.74	0.23
Buttermilk, dried	92.4	32.4	6.4	0.3	43.3	10.0	1.36	0.82	5.18	0.71
Carob bean and pods	87.8	5.5	2.6	8.7	68.5	2.5	-	-	0.88	-
Carob bean pods	89.5	4.7	2.5	8.7	70.9	2.7	-	-	0.75	-
Carob bean seeds	88.5	16.7	2.6	7.6	58.4	3.2	-	-	2.67	-
Cassava roots, dried	94.4	2.8	0.5	5.0	84.1	2.0	-	-	0.45	-
Cassava meal (starch waste)	86.8	0.9	0.7	4.6	78.8	1.8	-	0.03	0.14	0.23
Cheese rind, or cheese meal	91.0	59.5	8.9	0.4	10.7	11.5	-	-	9.52	-
Chess, or cheat, seed	89.6	9.7	1.7	8.2	66.4	3.6	-	-	1.56	-
Chick peas	90.0	20.3	4.3	8.5	54.0	2.9	-	-	3.24	-
Citrus pulp, dried	90.1	5.9	3.1	11.5	62.7	6.9	2.07	0.15	0.94	-
Citrus pulp and molasses, dried	92.0	5.3	2.8	9.3	66.6	8.0	-	-	0.84	-
Citrus pulp, wet	18.3	1.2	0.6	2.3	12.8	1.4	-	-	0.19	-
Clover seed, red	87.5	32.6	7.8	9.2	31.2	6.7	-	-	5.22	-
Clover seed screenings, red	90.5	28.2	5.9	10.2	40.3	5.9	-	-	4.51	-
Clover seed screenings, sweet	90.1	21.7	3.7	14.7	41.1	8.9	-	-	3.47	-
Cocoa meal	96.0	24.3	17.1	5.1	43.7	5.8	-	-	3.89	-
Cocoa shells	95.1	15.4	3.0	16.5	49.9	10.3	-	0.59	2.46	2.16
Coconut oil meal, hydr. or exp. process	93.2	21.3	6.7	10.7	48.3	6.2	0.21	0.64	3.41	1.95
Coconut oil meal, high in fat	93.7	21.0	10.6	11.3	44.4	6.4	-	-	3.36	-
Coconut oil meal, solvent process	91.1	21.4	2.4	13.3	47.4	6.6	-	-	3.42	-
Cod-liver oil meal	92.5	50.4	28.9	0.7	9.6	2.9	0.18	0.61	8.06	-
Corn, dent, Grade No. 1	87.0	8.8	4.0	2.1	70.9	1.2	0.02	0.28	1.41	0.28
Corn, dent, Grade No. 2	85.0	8.6	3.9	2.0	69.3	1.2	0.02	0.27	1.38	0.27
Corn, dent, Grade No. 3	83.5	8.4	3.8	2.0	68.1	1.2	0.02	0.27	1.34	0.27
Corn, dent, Grade No. 4	81.1	8.2	3.7	1.9	66.2	1.1	0.02	0.26	1.31	0.26
Corn, dent, Grade No. 5	78.5	7.9	3.6	1.9	64.0	1.1	0.02	0.25	1.26	0.25
Corn, dent, soft or immature	70.0	7.2	2.3	2.5	56.5	1.5	-	0.24	1.16	0.26
Corn, flint	88.5	9.8	4.3	1.9	71.0	1.5	-	0.33	1.57	0.32
Corn, pop	90.0	11.5	5.0	1.9	70.1	1.5	-	0.29	1.84	-
Corn ears, including kernels and cobs (corn-and-cob meal)	86.1	7.3	3.2	8.0	66.3	1.3	-	0.22	1.17	0.29
Corn ears, soft or immature	64.3	5.8	1.9	7.8	47.7	1.1	-	-	0.93	-
Corn, snapped, or ear-corn chops with husks	88.8	8.0	3.0	10.6	64.8	2.4	-	-	1.28	-
Corn, snapped, very soft or immature	60.0	5.3	1.8	8.2	42.7	2.0	-	-	0.85	-
Corn bran	90.6	9.7	7.3	9.2	62.0	2.4	0.03	0.27	1.56	0.56
Corn feed meal	88.6	9.8	4.7	2.9	69.2	2.0	0.03	0.34	1.57	0.28
Corn germ meal	93.0	19.8	7.8	8.9	53.2	3.3	-	0.58	3.17	0.21
Corn gluten feed, all analyses	90.9	25.5	2.7	7.6	48.8	6.3	0.48	0.82	4.08	0.54
Corn gluten feed, 25% protein guarantee	91.1	26.6	3.0	7.2	48.2	6.1	-	-	4.26	-
Corn gluten feed, 23% protein guarantee	91.4	24.8	2.6	7.8	49.8	6.4	-	-	3.97	-
Corn gluten feed with molasses	88.8	22.6	2.1	6.8	50.9	6.4	-	-	3.62	-
Corn gluten meal, all analyses	91.4	43.1	2.0	4.0	39.8	2.5	0.13	0.38	6.90	0.02
Corn gluten meal, 41% protein guarantee	91.4	42.9	2.0	3.9	40.1	2.5	-	-	6.86	-
Corn grits	88.4	8.5	0.5	0.6	78.4	0.4	-	-	1.36	-
Corn meal, degerminated, yellow	88.7	8.7	1.2	0.6	77.1	1.1	0.01	0.14	1.39	-
Corn meal, degerminated, white	88.4	8.6	1.2	0.7	76.1	1.8	0.01	0.14	1.38	-
Corn oil meal, old process	91.7	22.3	7.8	10.3	49.0	2.3	0.06	0.56	3.57	-
Corn oil meal, solvent process	91.7	23.0	1.5	10.4	54.6	2.2	0.03	0.50	3.68	-

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Corn-starch	88.6	11.6	0.6	0.1	0.2	87.6	0.1	-	-	0.10
Corn-and-oat feed, good grade	89.6	11.9	4.0	5.4	65.9	2.4	0.05	0.30	1.90	0.34
Corn-and-oat feed, low grade	89.6	9.1	2.9	13.4	59.0	5.2	-	-	1.46	-
Cottonseed, whole	92.7	23.1	22.9	16.9	26.3	3.5	0.14	0.70	3.70	1.11
Cottonseed, immature, dried	93.2	20.5	15.9	24.1	29.0	3.7	-	-	3.28	-
Cottonseed, whole pressed, 28% protein guarantee	93.5	28.2	5.8	22.6	32.2	4.7	-	-	4.51	-
Cottonseed, whole pressed, below 28% protein	93.5	26.9	6.5	24.7	30.8	4.6	0.17	0.64	4.30	1.25
Cottonseed feed, below 36% protein	92.4	34.6	6.3	14.1	31.5	5.9	0.26	0.83	5.54	1.22
Cottonseed flour	94.4	57.0	7.2	2.1	21.6	6.5	-	-	9.12	-
Cottonseed kernels, without hulls	93.6	38.4	33.3	2.3	15.1	4.5	-	-	6.14	-
Cottonseed meal, 45% protein and over	93.5	46.2	7.7	8.6	24.9	6.1	0.22	1.13	7.39	-
Cottonseed meal, 43% protein grade, not including Texas analyses	92.7	43.9	7.1	9.0	26.3	6.4	0.23	1.12	7.02	1.45
Cottonseed meal, 43% protein grade, Texas analyses	92.5	42.7	6.4	10.6	27.0	5.8	0.19	0.96	6.83	1.34
Cottonseed meal, 41% protein grade, not including Texas analyses	92.8	41.5	6.3	10.4	28.1	6.5	0.20	1.22	6.64	1.48
Cottonseed meal, 41% protein grade, Texas analyses	92.1	41.0	6.0	11.6	27.6	5.9	-	-	6.56	-
Cottonseed meal, below 41% protein grade	92.4	38.2	6.2	12.3	29.4	6.3	0.23	1.29	6.11	1.57
Cottonseed meal, solvent process	90.8	44.4	2.6	12.7	24.3	6.8	-	-	7.10	-
Cowpea seed	89.0	23.4	1.4	4.0	56.7	3.5	0.11	0.46	3.74	1.30
Crab meal	92.4	31.5	2.0	10.7	5.0	43.2	15.15	1.63	5.04	0.45
Darso grain	90.0	10.1	3.1	1.9	73.5	1.4	0.02	0.32	1.62	-
Distillers' dried corn grains, without solubles	92.9	28.3	8.8	11.4	41.9	2.5	0.11	0.47	4.53	0.24
Distillers' dried corn grains, with solubles	93.1	28.8	8.9	9.0	41.7	4.7	0.16	0.74	4.61	-
Distillers' dried corn grains, solvent extracted	93.7	33.4	1.4	8.6	46.4	3.9	-	-	5.34	-
Distillers' dried rye grains	93.9	18.5	6.4	15.6	51.0	2.4	0.13	0.43	2.96	0.04
Distillers' rye grains, wet	22.4	4.4	1.5	2.5	13.3	0.7	-	-	0.70	-
Distillers' dried wheat grains	93.7	28.7	6.1	13.0	42.2	3.7	-	-	4.59	-
Distillers' dried wheat grains, high protein	94.7	46.2	5.7	10.9	30.0	1.9	-	-	7.39	-
Distillers' solubles, dried, corn	93.0	26.7	7.9	2.6	48.4	7.4	0.30	1.41	4.27	1.75
Distillers' solubles, dried, wheat	94.0	28.2	1.5	2.8	58.9	2.6	-	-	4.51	-
Distillery stillage, corn, whole	7.9	2.3	0.6	0.7	4.0	0.3	0.006	0.05	0.37	-
Distillery stillage, rye, whole	5.9	1.9	0.3	0.5	2.9	0.3	-	-	0.30	-
Distillery stillage, strained	3.8	1.1	0.4	0.2	1.8	0.3	0.004	0.05	0.18	-
Durra grain	89.8	10.3	3.5	1.6	72.4	2.0	-	-	1.64	-
Emmer grain	91.1	12.1	1.9	9.8	63.6	3.7	-	0.33	1.94	0.47
Feterita grain	89.4	12.2	3.2	2.2	70.1	1.7	0.02	0.33	1.96	-
Feterita head chops	89.6	10.7	2.6	7.4	65.7	3.2	-	-	1.71	-
Fish-liver oil meal	92.8	62.8	17.3	1.2	5.4	6.1	-	-	10.04	-
Fish meal, all analyses	92.9	63.9	6.8	0.6	4.0	17.6	4.14	2.67	10.22	0.40
Fish meal, over 63% protein	92.7	66.8	5.3	0.5	4.5	15.6	-	-	10.69	-
Fish meal, 58-63% protein	93.1	60.9	8.1	0.8	3.5	19.8	-	-	9.74	-
Fish meal, below 58% protein	93.2	56.2	11.0	0.7	2.9	22.4	-	-	8.99	-
Fish meal, herring	93.5	72.5	7.3	0.7	1.5	11.5	2.97	2.08	11.60	-
Fish meal, menhaden	93.6	62.2	8.5	0.7	4.2	18.0	5.30	3.38	9.96	-
Fish meal, redfish	94.2	56.7	11.4	0.9	0.9	24.3	4.01	2.44	9.07	-
Fish meal, salmon	92.8	59.4	9.8	0.3	4.3	19.0	5.49	3.65	9.50	-
Fish meal, sardine	93.1	67.2	5.0	0.6	5.4	14.9	4.21	2.54	10.76	0.33
Fish meal, tuna	90.1	58.2	7.9	0.7	3.4	19.9	4.80	3.10	9.31	-
Fish meal, whitefish	90.4	63.0	6.7	0.1	0.1	20.5	-	-	10.08	-
Fish solubles, condensed	49.5	29.3	8.4	-	2.2	9.6	-	-	4.69	-
Flaxseed	93.8	24.0	35.9	6.3	24.0	3.6	0.26	0.55	3.84	0.59
Flaxseed screenings	91.1	16.4	9.4	12.7	45.8	6.8	0.37	0.43	2.62	-
Flaxseed screenings oil feed	91.9	25.0	7.1	11.7	40.3	7.8	-	-	4.00	-
Garbage	39.3	6.0	7.2	1.1	22.2	2.8	-	-	0.96	-
Garbage, processed, high in fat	95.9	17.5	23.7	20.0	21.8	12.9	-	0.33	2.80	0.62
Garbage, processed, low in fat	92.3	23.1	3.5	13.5	38.1	14.1	-	-	3.70	-

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Grapefruit pulp, dried	91.7	4.9	1.1	11.9	69.6	4.2	-	-	0.78	-
Grape pomace, dried	91.0	12.2	6.9	30.2	36.7	5.0	-	-	1.96	-
Hegari grain	89.7	9.6	2.6	2.0	73.9	1.6	0.18	0.30	1.54	-
Hegari head chops	89.6	10.0	2.1	11.9	60.6	5.0	-	-	1.60	-
Hempseed oil meal	92.0	31.0	6.2	23.8	22.0	9.0	0.25	0.43	4.96	-
Hominy feed, 5% fat or more	90.4	11.2	6.9	5.2	64.2	2.9	0.22	0.71	1.79	0.61
Hominy feed, low in fat	89.7	10.6	4.3	5.0	67.4	2.4	-	-	1.70	-
Horse beans	87.5	25.7	1.4	8.2	48.8	3.4	0.13	0.54	4.11	1.16
Ivory nut meal, vegetable	89.4	4.7	0.9	7.2	75.5	1.1	-	-	0.76	-
Jack beans	89.3	24.7	3.2	8.2	50.4	2.8	-	-	3.96	-
Kafir grain	89.8	10.9	2.9	1.7	72.7	1.6	0.02	0.31	1.74	0.34
Kafir head chops	89.2	10.0	2.6	6.9	66.4	3.3	0.08	0.27	1.60	-
Kalo sorghum grain	89.2	11.8	3.2	1.6	70.9	1.7	-	-	1.89	-
Kaoliang grain	89.9	10.5	4.1	1.6	71.8	1.9	-	-	1.68	-
Kelp, dried	91.3	6.5	0.5	6.5	42.6	35.2	2.48	0.28	1.04	-
Lamb's-quarters seed	90.0	20.6	4.5	15.1	40.2	9.6	-	-	3.30	-
Lespedeza seed, annual	91.7	36.6	7.6	9.6	32.8	5.1	-	-	5.86	-
Lespedeza seed, sericea	92.3	33.5	4.2	13.5	37.3	3.8	-	-	5.36	-
Lemon pulp, dried	92.8	6.4	1.2	15.0	65.2	5.0	-	-	1.02	-
Linseed meal, old process, all analyses	91.0	35.4	5.8	8.2	36.0	5.6	0.39	0.87	5.66	1.24
Linseed meal, op., 37% protein or more	90.9	38.0	5.9	7.7	33.7	5.6	0.39	0.86	6.08	1.10
Linseed meal, op., 33-37% protein	91.0	35.0	5.7	8.3	36.4	5.6	0.41	0.86	5.60	1.14
Linseed meal, o.p., 31-33% protein	91.0	32.4	5.9	8.3	38.7	5.7	0.36	0.90	5.18	1.40
Linseed meal, solvent process, older analyses	90.4	36.9	2.9	8.7	36.3	5.6	-	-	5.90	-
Linseed meal and screenings oil feed (linseed feed)	90.5	31.2	5.4	10.1	37.0	6.8	0.43	0.65	4.99	-
Liver meal, animal	92.3	66.2	16.4	1.4	1.9	6.4	0.62	1.27	10.59	-
Locust beans and pods, honey	88.4	9.3	2.4	16.1	57.1	3.5	-	-	1.49	-
Lupine seed, sweet, yellow	88.9	39.8	4.9	14.0	25.7	4.5	0.23	0.39	6.37	0.81
Malt, barley	90.6	14.3	1.6	1.8	70.6	2.3	0.08	0.47	2.29	-
Malt sprouts	92.6	26.8	1.3	14.2	44.3	6.0	-	-	4.29	-
Meat scraps, or dry-rendered tankage, 60% protein grade	93.8	60.9	8.8	2.4	1.1	20.6	6.09	3.49	9.74	-
Meat scraps, or dry-rendered tankage, 55% protein grade	93.9	55.8	9.3	2.1	1.3	25.4	8.33	4.04	8.93	-
Meat scraps, or dry-rendered tankage, 55% protein grade, low fat	93.0	56.0	3.5	2.6	1.5	29.4	-	-	8.96	-
Meat scraps, or dry-rendered tankage, 52% protein grade	93.1	52.9	7.3	2.2	4.3	26.4	-	-	8.46	-
Meat and bone scraps, or dry-rendered tankage with bone, 50% protein grade	93.9	51.0	10.1	2.1	1.6	29.1	9.71	4.81	8.16	-
Meat and bone scraps, or dry-rendered tankage with bone, 45% protein grade	94.5	46.3	12.0	2.0	2.3	31.9	11.21	4.88	7.41	-
Mesquite beans and pods	94.0	13.0	2.8	26.3	47.4	4.5	-	-	2.08	-
Milk, cow's	12.8	3.5	3.7	0.0	4.9	0.7	0.12	0.09	0.56	0.14
Milk, ewe's	19.2	6.5	6.9	0.0	4.9	0.9	0.21	0.12	1.04	0.19
Milk, goat's	12.8	3.7	4.1	0.0	4.2	0.8	0.13	0.10	0.59	0.15
Milk, mare's	9.4	2.0	1.1	0.0	5.9	0.4	0.08	0.05	0.32	0.08
Milk, sow's	19.0	5.9	6.7	0.0	5.4	1.0	-	-	0.94	-
Milk albumin, or lactalbumin, commercial	92.0	49.5	0.9	1.0	12.8	27.8	-	-	7.92	-
Milk, whole, dried	96.8	24.8	26.2	0.2	40.2	5.4	-	-	3.97	-
Millet seed, foxtail varieties	89.1	12.1	4.1	8.6	60.7	3.6	-	0.20	1.94	0.31
Millet seed, hog, or proso	90.4	11.9	3.4	8.1	63.7	3.3	0.05	0.30	1.90	0.43
Millet seed, Japanese	89.8	10.6	4.9	14.6	54.7	5.0	-	0.44	1.70	0.33
Milo grain	89.4	11.3	2.9	2.2	71.3	1.7	0.03	0.30	1.81	0.36
Milo head chops	90.1	10.2	2.5	6.9	66.2	4.3	0.14	0.26	1.63	-
Molasses, beet	80.5	8.4	0.0	0.0	62.0	10.1	0.08	0.02	1.34	4.77
Molasses, beet, Steffen's process	78.7	7.8	0.0	0.0	62.1	8.8	0.11	0.02	1.25	4.66
Molasses, cane, or blackstrap	74.0	2.9	0.0	0.0	62.1	9.0	0.74	0.08	0.46	3.67
Molasses, cane, high in sugar	79.7	1.3	0.0	0.0	74.9	3.5	-	-	0.21	-
Molasses, citrus	69.9	4.0	0.2	0.0	61.3	4.4	-	-	0.64	-
Molasses, corn sugar, or hydrol	80.5	0.2	0.0	0.0	77.8	2.5	-	-	0.03	-

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Mustard seed, wild yellow	95.9	23.0	38.8	5.0	23.6	5.5	-	-	3.68	-
Oat clippings, or clipped-oat by-product	92.2	8.8	2.3	25.3	44.9	10.9	-	-	1.41	-
Oat kernels, without hulls (oat groats)	90.4	16.3	6.1	2.1	63.7	2.2	0.08	0.46	2.61	0.39
Oat meal, feeding, or rolled oats without hulls	90.8	16.0	5.5	2.7	64.2	2.4	0.07	0.46	2.56	0.37
Oat middlings	91.4	15.9	5.2	3.3	64.6	2.4	0.08	0.45	2.54	0.57
Oat mill feed	92.4	5.6	1.8	27.9	50.8	6.3	0.13	0.16	0.90	0.60
Oat mill feed, poor grade	92.4	4.3	1.8	30.5	50.2	5.6	-	-	0.69	-
Oat mill feed, with molasses	92.4	5.5	1.4	24.1	55.0	6.4	-	-	0.88	-
Oats, not including Pacific Coast states	90.2	12.0	4.6	11.0	58.6	4.0	0.09	0.34	1.92	0.43
Oats, Pacific Coast states	91.2	9.0	5.4	11.0	62.1	3.7	-	-	1.44	-
Oats, hull-less	90.0	15.4	4.2	2.6	65.7	2.1	-	-	2.46	-
Oats, light weight	91.3	12.3	4.7	15.4	54.4	4.5	-	-	1.97	-
Oats, wild	89.0	12.7	5.5	15.2	50.9	4.7	-	-	2.03	-
Olive pulp, dried, pits removed	95.1	14.0	27.4	19.3	31.0	3.4	-	-	2.24	-
Olive pulp, dried, with pits	92.0	5.9	15.6	36.5	31.5	2.5	-	-	0.94	-
Orange pulp, dried	87.9	7.7	1.5	8.0	67.3	3.4	-	-	1.23	-
Palm-kernel oil meal	91.4	19.2	6.7	11.9	49.7	3.9	-	0.69	3.07	0.42
Palm seed, Royal	86.5	6.1	8.3	22.8	43.8	5.5	-	-	0.98	-
Palmo middlings	94.1	16.1	9.7	6.7	56.3	5.3	-	-	2.58	-
Pea feed, or pea meal	90.0	17.7	1.4	23.7	43.7	3.5	-	-	2.83	-
Pea hulls of seeds, or bran	91.5	4.8	0.4	48.5	34.3	3.5	-	-	0.77	-
Pea seed, field	90.7	23.4	1.2	6.1	57.0	3.0	0.17	0.51	3.74	1.03
Pea seed, field, cull	89.7	24.8	2.5	7.1	52.0	3.3	-	-	3.97	-
Pea seed, garden	89.2	25.3	1.7	5.7	53.6	2.9	0.08	0.40	4.04	0.90
Peanut kernels, without hulls	94.6	30.4	47.7	2.5	11.7	2.3	0.06	0.44	4.86	-
Peanut oil feed	94.5	37.8	9.6	14.3	26.2	6.6	-	6.04	-	-
Peanut oil feed, unhulled, or whole pressed peanuts	93.1	35.0	9.2	22.5	21.4	5.0	-	-	5.60	-
Peanut oil meal, old process, all analyses	93.0	43.5	7.6	13.3	23.4	5.2	0.16	0.54	6.96	1.15
Peanut oil meal, o.p., 45% protein and over	93.4	45.2	7.4	12.1	23.7	5.0	-	-	7.23	-
Peanut oil meal, o.p., 43% protein grade	92.8	43.1	7.6	13.9	23.0	5.2	-	-	6.90	-
Peanut oil meal, o.p., 41% protein grade	93.8	41.8	7.8	12.7	25.9	5.6	-	-	6.69	-
Peanut oil meal, solvent process	91.6	51.5	1.4	5.7	27.2	5.8	-	-	8.24	-
Peanut skins	93.8	16.3	23.9	11.8	39.1	2.7	-	-	2.61	-
Peanut screenings	93.6	23.8	11.5	18.9	33.0	6.4	-	-	3.81	-
Peanuts, with hulls	94.1	24.9	36.2	17.5	12.6	2.9	-	0.33	3.98	0.53
Perilla oil meal	91.9	38.4	8.4	20.9	16.0	8.2	0.56	0.47	6.14	-
Pigeon-grass seed	89.8	14.4	6.0	17.3	45.8	6.3	-	-	2.30	-
Pigweed seed	90.0	16.8	6.2	15.9	47.8	3.3	-	-	2.69	-
Pineapple bran, or pulp, dried	85.3	4.0	1.9	19.4	57.2	2.8	0.20	0.10	0.64	-
Pineapple bran, or pulp, and molasses, dried	87.4	3.9	1.0	15.9	63.4	3.2	-	-	0.62	-
Poppy-seed oil meal	89.2	36.6	7.9	11.6	20.7	12.4	-	-	5.86	-
Potato meal, or dried potatoes	92.8	10.4	0.3	2.0	75.8	4.3	0.08	0.22	1.66	1.97
Potato pomace, dried	89.1	6.6	0.5	10.3	69.0	2.7	-	-	1.06	-
Pumpkin seed, not dried	55.0	17.6	20.6	10.8	4.1	1.9	-	-	2.82	-
Raisin pulp, dried	89.4	9.6	7.8	16.1	50.6	5.3	-	-	1.54	-
Raisins, cull	84.8	3.4	0.9	4.4	73.1	3.0	-	-	0.54	-
Rape seed	90.5	20.4	43.6	6.6	15.7	4.2	-	-	3.26	-
Rape-seed oil meal	89.5	33.5	8.1	10.8	30.2	6.9	-	-	5.36	-
Rice, brewers'	88.3	7.5	0.6	0.6	78.8	0.8	0.04	0.10	1.20	-
Rice, brown	87.8	9.1	2.0	1.1	74.5	1.1	0.04	0.25	1.46	-
Rice, polished	87.8	7.4	0.4	0.4	79.1	0.5	0.01	0.09	1.18	0.04
Rice bran	90.9	12.5	13.5	12.0	39.4	13.5	0.08	1.36	2.00	1.08
Rice grain, or rough rice	88.8	7.9	1.8	9.0	64.9	5.2	0.08	0.32	1.26	0.34
Rice polishings, or rice polish	89.8	12.8	13.2	2.8	51.4	9.6	0.04	1.10	2.04	1.17
Rubber seed oil meal	91.1	28.8	9.2	10.0	37.6	5.5	-	-	4.61	-

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Rye grain	89.5	12.6	1.7	2.4	70.9	1.9	0.10	0.33	2.02	0.47
Rye feed	90.4	16.1	3.3	4.6	62.7	3.7	0.08	0.69	2.58	0.83
Rye flour	88.6	11.2	1.3	0.6	74.6	0.9	0.02	0.28	1.79	0.46
Rye flour middlings	90.6	16.5	3.5	4.2	63.1	3.3	-	-	2.64	-
Rye middlings	90.2	16.6	3.4	5.2	61.2	3.8	-	0.44	2.66	0.63
Rye middlings and screenings	90.4	16.7	3.8	6.1	59.5	4.3	-	-	2.67	-
Safflower seed	93.1	16.3	29.8	26.6	17.5	2.9	-	-	2.61	-
Safflower seed oil meal, from hulled seed	91.0	38.0	6.8	21.0	17.0	8.2	-	-	6.08	-
Safflower-seed oil meal from unhulled seed	91.0	18.2	5.5	40.4	24.1	2.8	-	-	2.91	-
Sagrain sorghum grain	90.0	9.5	3.5	2.1	73.4	1.5	0.43	0.39	1.52	-
Screenings, grain, good grade	90.0	15.8	5.2	9.2	54.3	5.5	-	-	2.53	-
Screenings, grain, chaffy	91.5	14.3	4.4	18.3	46.1	8.4	-	-	2.29	-
Schrock sorghum grain	89.1	10.2	3.0	3.4	70.8	1.7	-	-	1.63	-
Sesame oil meal	93.7	42.8	9.4	6.2	22.8	12.5	2.02	1.61	6.84	1.35
Sesbania seed	90.8	31.7	4.3	13.5	38.0	3.3	-	-	5.07	-
Shallu grain	89.8	13.4	3.7	1.9	68.9	1.9	-	-	2.14	-
Shallu head chops	90.5	12.7	3.5	9.2	61.9	3.2	-	-	2.03	-
Shark meal	91.2	74.5	2.7	0.5	0.0	13.5	3.48	1.92	12.69	-
Shrimp meal	89.7	46.7	2.8	11.1	1.3	27.8	-	-	7.47	-
Skimmilk, centrifugal	9.5	3.6	0.1	0.0	5.1	0.7	0.13	0.10	0.58	0.15
Skimmilk, gravity	10.1	3.6	0.8	0.0	5.0	0.7	0.13	0.10	0.58	0.15
Skimmilk, dried	94.2	34.7	1.2	0.2	50.3	7.8	1.30	1.03	5.56	1.46
Sorghum seed, sweet	89.2	9.5	3.3	2.0	72.8	1.6	0.02	0.28	1.52	0.37
Soybean seed	90.0	37.9	18.0	5.0	24.5	4.6	0.25	0.59	6.06	1.50
Soybean flour, medium in fat	92.9	47.9	6.7	2.4	29.9	6.0	-	-	7.66	-
Soybean flour, solvent extracted	-91.5	48.5	0.8	2.6	33.0	6.6	-	-	7.76	-
Soybean mill feed, chiefly hulls	90.8	11.8	2.7	34.0	38.1	4.2	-	-	1.89	-
Soybean oil meal, expeller or hydraulic process, all analyses	90.0	44.3	5.3	5.7	29.6	6.0	0.29	0.66	7.09	1.77
Soybean oil meal, exp. or hydr. process, 44-45% protein guarantee	91.3	45.4	5.3	5.4	29.3	5.9	0.31	0.68	7.26	1.92
Soybean oil meal, exp. or hydr. process, 43% protein guarantee	91.2	44.6	5.3	5.8	29.4	6.1	0.30	0.67	7.14	-
Soybean oil meal, exp. or hydr. process, 41% protein guarantee	90.9	44.2	5.3	5.7	29.7	6.0	0.26	0.59	7.07	-
Soybean oil meal, solvent process	90.6	46.1	1.0	5.9	31.8	5.8	0.30	0.66	7.38	1.92
Starfish meal	96.5	30.6	5.8	1.9	14.3	43.9	-	-	4.90	-
Sudan-grass seed	92.4	14.2	2.4	25.4	38.4	12.0	-	-	2.27	-
Sunflower seed	93.6	16.8	25.9	29.0	18.8	3.1	-	0.55	2.69	0.66
Sunflower seed, hulled	95.5	27.7	41.4	6.3	16.3	3.8	0.20	0.96	4.43	0.92
Sunflower-seed oil cake, from unhulled seed, solvent process	89.2	19.6	1.1	35.9	27.0	5.6	-	-	3.14	-
Sunflower-seed oil cake, from hulled seed, hydr. process	90.6	36.3	13.5	14.2	20.2	6.4	0.43	1.04	5.81	1.08
Sweet clover seed	92.2	37.4	4.2	11.3	35.8	3.5	-	-	5.98	-
Sweet potatoes, dried	90.3	4.9	0.9	3.3	77.1	4.1	0.21	0.18	0.78	-
Tankage or meat meal, digester process, 60% protein grade	93.1	60.6	8.5	2.0	1.8	20.2	6.37	3.23	9.70	0.46
Tankage with bone, or meat and bone meal, digester process, 50% protein grade	93.5	51.3	11.5	2.3	2.3	26.1	10.97	5.14	8.21	-
Tankage with bone, or meat and bone meal, digester process, 40% protein grade	94.7	42.9	14.1	2.2	4.1	31.4	13.49	5.18	6.86	-
Tomato pomace, dried	94.6	22.9	15.0	30.2	23.4	3.1	-	-	3.66	-
Velvet bean seeds and pods (velvet bean feed)	90.0	18.1	4.4	13.0	50.3	4.2	0.24	0.38	2.90	1.20
Velvet beans, seeds only	90.0	23.4	5.7	6.4	51.5	3.0	-	-	3.74	-
Vetch seed	90.7	29.6	0.8	5.7	51.5	3.1	-	-	4.74	-
Whale meal	91.8	78.5	6.7	0.0	3.1	3.5	0.56	0.57	12.56	-
Wheat, average of all types	89.5	13.2	1.9	2.6	69.9	1.9	0.04	0.39	2.11	0.42
Wheat, hard spring, chiefly northern plains states	90.1	15.8	2.2	2.5	67.8	1.8	-	-	2.53	-

Material	Total dry matter Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	N-free extract Per ct.	Total minerals Per ct.	Calcium Per ct.	Phosphorus Per ct.	Nitrogen Per ct.	Potassium Per ct.
Wheat, hard winter, chiefly southern plains states	89.4	13.5	1.8	2.8	69.2	2.1	-	-	2.16	-
Wheat, soft winter, Miss. valley and eastward	89.2	10.2	1.9	2.1	73.2	1.8	-	-	1.63	-
Wheat, soft, Pacific Coast states	89.1	9.9	2.0	2.7	72.6	1.9	-	-	1.58	-
Wheat bran, all analyses	90.1	16.9	4.6	9.6	52.9	6.1	0.14	1.29	2.70	1.23
Wheat bran, chiefly hard spring wheat	91.1	17.9	4.9	10.1	52.2	6.1	0.13	1.35	2.86	-
Wheat bran, soft wheat	90.5	16.1	4.3	8.7	55.7	5.7	-	-	2.58	-
Wheat bran, winter wheat	89.9	15.5	4.2	8.9	55.1	6.2	-	-	2.48	-
Wheat bran and screenings, all analyses	90.0	16.8	4.5	9.6	53.0	6.1	0.14	1.21	2.69	-
Wheat brown shorts	88.7	16.9	4.2	7.1	56.0	4.5	-	-	2.70	-
Wheat brown shorts and screenings	88.7	17.0	4.1	7.0	56.0	4.6	-	-	2.72	-
Wheat flour, graham	88.1	12.5	1.9	1.8	70.4	1.5	0.04	0.36	2.00	0.46
Wheat flour, low grade	88.4	15.4	1.9	0.5	69.7	0.9	-	-	2.46	-
Wheat flour, white	88.0	10.8	0.9	0.3	75.6	0.4	0.02	0.09	1.73	0.05
Wheat flour middlings	89.2	18.3	4.2	3.8	59.8	3.1	0.09	0.71	2.93	0.89
Wheat flour middlings and screenings	89.6	18.2	4.5	5.2	57.8	3.9	0.14	0.68	2.91	-
Wheat germ meal, commercial	90.8	31.1	9.7	2.6	42.2	5.2	0.08	1.11	4.98	0.29
Wheat germ oil meal	89.1	30.4	4.9	2.6	46.4	4.8	-	-	4.86	-
Wheat gray shorts	88.9	17.9	4.2	5.7	56.9	4.2	0.13	0.84	2.86	-
Wheat gray shorts and screenings	88.6	17.6	4.0	5.8	57.0	4.2	-	-	2.82	-
Wheat mixed feed, all analyses	89.7	17.2	4.5	7.2	56.1	4.7	0.11	1.09	2.76	-
Wheat mixed feed, hard wheat	89.8	18.7	4.8	7.7	53.6	5.0	0.11	1.09	2.99	-
Wheat mixed feed and screenings	89.3	17.5	4.3	7.1	55.7	4.7	0.11	0.96	2.80	-
Wheat red dog	89.0	18.2	3.6	2.6	61.9	2.7	0.07	0.51	2.91	0.60
Wheat red dog, low grade	89.2	17.9	4.8	4.9	57.9	3.7	-	-	2.86	-
Wheat screenings, good grade	90.4	13.9	4.7	9.0	58.2	4.6	0.44	0.39	2.22	-
Wheat standard middlings, all analyses	89.6	18.1	4.8	6.5	55.8	4.4	0.09	0.93	2.90	1.04
Wheat standard middlings and screenings, all analyses	89.7	18.0	4.7	7.4	55.1	4.5	0.15	0.88	2.88	-
Wheat white shorts	89.7	16.1	3.1	2.9	65.0	2.6	-	-	2.58	-
Whey, from cheddar cheese	6.9	0.9	0.3	0.0	5.0	0.7	0.05	0.04	0.14	0.19
Whey, skimmed	6.6	0.9	0.03	0.0	5.0	0.7	-	-	0.14	-
Whey, condensed	57.3	8.8	0.6	0.0	42.0	5.9	-	-	1.41	-
Whey, dried	93.5	12.2	0.8	0.2	70.4	9.9	0.86	0.72	1.96	-
Whey solubles, dried	96.3	17.5	2.0	0.0	62.8	14.0	-	-	2.80	-
Yeast, brewers', dried	93.8	49.3	1.0	3.7	31.9	7.9	0.13	1.56	7.89	-
Yeast, irradiated, dried	93.9	48.7	1.1	5.5	32.2	6.4	0.07	1.55	7.79	2.14
Yeast, dried, with added cereal	90.2	12.3	3.7	3.2	68.5	2.5	0.09	0.45	1.97	-
Yeast, molasses distillers', dried	91.0	38.8	1.9	6.1	30.2	14.0	-	-	6.21	-

(These tables have been adapted from "U.S.-Canadian Tables of Feed Composition"; Publication 1684; Committee on Animal Nutrition and National Committee on Animal Nutrition, Canada, National Academy of Sciences - National Research Council, Washington, D.C. 1969)

Appendix VII
Resources For Mushroom Growing Equipment and Supplies

Suppliers of Cultures of Edible Mushrooms

American Type Culture Collection
12301 Parklawn Drive Rockville, Maryland 20852
Pennsylvania State University 2111 Buckhout Laboratory
University Park, Maryland 16802

Commercial Spawn Makers

Rainforest Mushroom Spawn
International Division
PO Box 1793
Gibsons, B.C.
Canada V0N 1V0

Spawn of these species available: *Pleurotus ostreatus; Pleurotus sajor-caju; Pleurotus cornucopiae; Pleurotus enryngii; Lentinus edodes; and Stropharia rugoso-annulata*.

General Supplies & Equipment

Fungi Perfecti PO Box 7634
Olympia, Wa. 98507 Phone: 360-426-9292
Fax: 360-426-9377

Products include: micron filters; laminar flow hoods; sterile and room supplies; pressure cookers; steam boilers; cultures; sterile and growing room instruments; pure cultures and spawn. Write for free brochure or include $4.50 for our fully illustrated catalogue. International orders welcomed.

Publications

The Mushroom Journal (monthly)
The Mushroom Growers Association (MGA)
Agriculture House
Knightsbridge
London, SW1X 7NJ
(Available in large university libraries.)

The Mushroom News (monthly)
American Mushroom Institute (AMI)
Box 373 Kennett Square, Pa. 19348
(Available in large university libraries.)

Mushroom Growing Bulletins
Dr. Paul Wuest
Department of Botany
Pennsylvania State University
University Park, Pa. 16802

Mycologia
The New York Botanical Garden
Bronx, New York 10458

Mushroom Newsletter for the Tropics (quarterly)
The International Mushroom Society for the Tropics
c/o Department of Biology
The Chinese University of Hong Kong
Shatin, N.T. Hong Kong

Organizations

North American Mycological Association (NAMA)
4245 Redinger Rd.
Portsmouth, Oh. 45662
The Mycological Society of America (MSA)
c/o Dr. Harry Thiers
Department of Biology
San Francisco State University
1600 Holloway Ave.
San Francisco, Ca. 94132
MycoMedia
PG Box 2222
Olympia, Wa. 98507
(Sponsors yearly forays and educational conferences.)
Puget Sound Mycological Society
2161 E. Hamlin
Seattle, Wa. 98112

Appendix VIII
English to Metric Conversion Tables

Cropping Yield		Substrate Depths	
lbs./sq. ft.	**kg./sq. m.**	**inches**	**centimeters**
1.0	4.9	1	2.54
1.4	6.8	2	5.08
2.0	9.8	3	7.62
2.2	10.8	4	10.16
2.6	12.7	5	12.70
3.0	14.7	6	15.24
3.5	17.7	7	17.78
4.0	19.6	8	20.32
4.5	22.0	9	22.86
5.0	24.4	10	25.40
5.5	27.0	11	27.94
6.0	29.0	12	30.48
6.5	31.4		

Length

Inch = 2.54 centimeters
Centimeter = 0.3937 inches
Foot = 0.3048 meters
Meter = 3.2808 feet
Yard = 0.9144 meters
Meter = 1.0936 yards

Area

Sq. in. = 6.4516 sq. cm.
Sq. cm. = 0.1550 sq. in.
Sq. ft. = 0.0929 sq. m.
Sq. m. = 10.7639 sq. ft.
Sq. yd. = 0.8361 sq. m.
Sq. m. = 1.1960 sq. yd.

Volume

Cu. in. = 16.3872 cu. cm.
Cu. cm. = 0.0610 cu. in.
Cu. ft. = 0.0283 cu. m.
Cu. m. = 35.3145 cu. ft.
Cu. yd. = 0.7646 cu. m.
Cu. m. = 1.3079 Cu. yd.

Capacity

Cu. in. = 0.0164 liters
Liter = 61.0250 cu. in.
Cu. ft. = 28.3162 liters
Liter = 0.0353 Cu. ft.
Cup = 0.2366 liters
Liter = 0.2642 gal.
Quart = 0.9463 liters
Liter = 1.0567 qt.
Gallon = 3.7853 liters
Liter = 1000 ml.

A liter of distilled water weighs 1000 grams or 1 kilogram.

Weight

Grain = 0.0648 grams
Gram = 15.4324 grains
Ounce = 28.3495 grams
Gram = 0.0353 ounces
Pound = 454 grams
Kilogram = 2.2046 pounds
Pound = 0.4536 kilograms
Metric Ton = 2.204 pounds
Ton = 907.1848 kilograms

Pressure

1 kg. per sq. cm. = 14.223 lb. per sq. in.

1 lb. per sq. in. = 0.0703 kg. per sq. cm.

1 kg. per sq. m. = 0.2048 lb. per sq. ft.

1 atmosphere = 1.0332 kg. per sq. cm. = 4.696 lb. per sq. in. = 1.0133 bars

Temperature

C	F
0	32
5	41
10	50
15	59
20	68
25	77
35	95
40	104
50	122
55	131
60	140
65	149
70	158
75	167
80	176

Fahrenheit to Centigrade
5/9 (°F - 32) = °C.

Centigrade to Fahrenheit
9/5 (°C) + 32 = °F.

Miscellaneous Data

50 lbs. rye grain = 125 cups (approximately)

Area of a circle = $\prod(r)^2 = 3.14 \text{ x } r^2$

PHOTOGRAPHY AND ILLUSTRATION CREDITS

Michael Beug
Fig. 157.

J.S. Chilton
Figs.: 45, 56, 64, 65, 67, 68, 70, 73-76, 82, 83, 84, 85, 86-91, 94, 95-100, 106, 107, 117, 119, 122, 126, 132, 133, 134, 143, 171, 237.

Anthoinette Gunter
Figs.: 1, 2, 21, 55, 197.

Rick Kerrigan
Figs.: 0, 108, 109, 151, 152, 153, 170.

Tom Lind with Calligraphy by Karen Porter.
Figs.: 77-80, 178, 179, 183, 186, 187, 189, 192-195, 198, 199, 201, 202, 203, 205, 206, 207, 209, 211, 212, 214, 216, 217, 219, 221, 222, 224, 225, 227, 228, 231-235, 238.

Mary Montoya
Figs.: 239, 241.

Chris Nelson
Figs.: 47, 69, 81, 163.

Cruz Stamets
Fig. 22.

Bill Wright
Fig 177.

Paul Stamets
3-20, 23-44, 46, 48-54, 57-62, 66, 71, 72, 92, 93, 101-105, 111-116, 118, 120, 121, 123-25, 127-131, 135-142, 144-150, 154-156, 158-162, 164-169, 173-176, 180-185, 188, 190, 191, 196, 200, 204, 208, 210, 213, 215, 218, 220, 223, 226, 229, 230, 236, 240, 242. Color plates 1-23 and cover photographs.

ACKNOWLEDGEMENTS

The authors are indebted to many who have made this work possible. Foremost amongst those are our spouses Cruz Stamets and Janice Leighton. They provided more than just technical assistance. Their encouragement, companionship and endurance has been critical to the success of this project.

Besides the artists and photographers whose contributions are most appreciated, we would like to express our thanks to John Stamets for editing the manuscript and printing the black and white photographs, to Mike McCaw for his chapter on genetics, to Rick Kerrigan for his unwavering support, to Dr. Michael Beug for his encouragement and sponsorship, to The Evergreen State College for the use of the scanning electron microscope, to Bill Street of Ostrom Mushroom Farms for his generosity in allowing photographs to be taken of his facilities, to Kathy Harvey and Steve Raynor for their contributions to the contamination section, to P.J.C. Vedder for his tutelage and contribution to practical mushroom cultivation, to Dr. Daniel Stuntz for his guidance and his teaching of tissue culture techniques and to Chris W. Nelson of Sound Media Productions for his work in photographic development and printing.

Others who have helped us, in one way or the other, to complete this arduous endeavor are Janet McCaw, Paul Kroeger, Dale Leslie, Heidi Stamets, Mike Maki, Jim Jacobs, William Raves, Bob Chieger, David Tatelman, Samuel and Victoria, Mike, Michael, Gary, and mycophiles too numerous to mention who, through their questions and curiosity, have determined much of the direction, content and scope of this book. We thank you.

GLOSSARY

a

acute Pointed, sharp.
adnate (of the gills) Bluntly attached to the stem.

adnexed (of the gills) Attached to the stem in an ascending manner.

agar A product derived from seaweed and valued for its gelatinizing properties. Commonly used to solidify media in any type of sterile tissue culture.

Agaricales The order of mushrooms which includes all mushrooms with true gills.

amyloid The characteristic bluish reaction the flesh or the spores of a mushroom exhibits in Melzer's iodine.

anastomosis (*pl. anastomoses*) The crosswise fusion of hyphal systems to form a network of mycelia.

angstrom 10^{-10} microns, 1 ten thousandth of a micron.

annular Resembling an annulus, appearing as a ring-like zone.

annulus The tissue remnants of the partial veil adhering to the stem and forming a membranous collar or ring.

apex The top or highest point.

apiculus a term (misused) for the hilar appendix, the nipple-like projection by which a spore is attached to the strerigmata ("arms") of the basidium.

appendiculate Hanging with fragments of tissue.

appressed Flattened.

Ascomycetes Fungi that produce spores in an ascus.

ascus A sac-like organ in which eight spores develop and is characteristic of the perfect stage of ascomycetous fungi.

autoclave A steam pressurized vessel used to sterilize media.

b

bacillus (*pl. bacilli*) A general term for any rod-shaped bacteria forming spores in free oxygen environments. (The genus *Bacillus* is more narrowly defined).

bacterium (*pl. bacteria*) The simplest group of non-chlorophyll plant-like organisms.

Basidiomycetes All fungi which bear spores externally upon a club-like cell known as a basidium.

basidium, basidia A unique fertile cell, club-like in form, in which meiosis occurs and by which sexual spores are produced.

basidiocarp The fruiting body of fungi that reproduce through basidia.

binucleate Having two nuclei in one cell.

border break The early occurrence of mushrooms along the edge of a substrate container.

C

campanulate Bell shaped.

carpophore The fruiting body of higher fungi.

carpophoroid Analogous to a fruitbody, although usually a poorly differentiated mass of tissue, not well developed ("aborted") and sterile.

cartilaginous Brittle, not pliant.

casing A layer of water retentive materials applied to a substrate to encourage and enhance fruitbody production.

caulocystidia Sterile cells covering the mushroom stem.

cellular Composed of globose to rounded cells, not thread-like.

cespitose Growing clustered, appearing to arise from a single base.

cheilocystidia Sterile cells on the mushroom gill edge, sometimes called marginal cystidia.

chlamydospores A thick walled spore, typically of a secondary type, that arises directly from the mycelium and having the full complement of chromosomes for producing off-spring. Chlamydospores are typically ovoid and heat resistant.

chrysocystidia A type of cystidia that is highly refractive in once dried tissue revived with a potassium hydroxide (KOH) solution and appearing as a yellowish brown amorphous mass within the cell.

clamp connection An elbow-like protuberance which arches over the walls separating cells in mated (dikaryotic) mycelia of some mushroom species.

compost A biological matrix of microorganisms combined with straw, manure and other organic substances and designed for mushroom fruitbody production.

concolorous Having the same color.

conditioning The final conversion of mushroom compost by selected microbial groups.

conic Shaped like a cone.

conidia A uninucleate exteriorly borne cell formed by constriction of the conidiophore.

conidiophore A specialized stalk arising from mycelium upon which conidia are borne.

conidium (*pl. conidia*) An asexual spore formed by the constriction of hyphae to chains of cells.

context The flesh of a mushroom.

convex Regularly rounded.

Coprinaceae A family of mushrooms containing the genera *Coprinus*, *Panaeolus* and *Psathyrella*.

coprophilous Growing on dung.

cortinate A type of veil consisting of fine cobweb-like threads of tissue, extending from the mushroom cap margin to the stem.

cropping The time of mushroom formation, development and harvesting.

cuticle The surface of cells on the cap that can undergo varying degrees of differentiation.

cystidia Microscopic sterile cells adorning the mushroom fruitbody.

d

decurrent The attachment of the gill plates to the stem of mushrooms where the gills are markedly downcurved, partially extending down the stem.

decurved Curving in a downwards fashion.

deciduous Describing trees that seasonally shed their leaves.

deliquescing The process of autodigestion by which the gills and cap of a mushroom melt into a liquid. Most typical of the genus *Coprinus*.

dikaryophase The phase in which there are two individual nuclei in each cell of the mushroom plant.

dikaryotic The state of cells in the dikaryophase.

diploid A genetic condition where each cell has a full set of chromosomes necessary for sexual reproduction (2N).

disc The central portion of the mushroom cap.

e

eccentric Off-centered.

ellipsoid Shaped like an oblong circle.

endospores Spores formed internally.

entheogenic A term to describe substances that induce god inspiring feelings or experiences.

equal Evenly proportioned.

eroded Irregularly broken.

evanescent Fragile and soon disappearing.

f

fibrillose Having fibrils.

fibrils Fine delicate 'hairs' found on the surface of the cap or stem.

fibrous Composed of tough, stringy tissue.

filamentous Composed of hyphae or thread-like cells.

flexuose, flexuous Bent alternately in opposite directions.

floccose Wooly tufts or cottony veil remnants, typically adorning the cap or stem of some mushroom species.

flush The collective formation and development of mushrooms within a short time period, often occurring in a rhythmic manner.

fructification The act of fruitbody formation.

fruitbody What is commonly called the mushroom. The sexual reproductive body of the mushroom plant.

fugacious Impermanent, easily torn or destroyed.

fusoid Rounded and tapering from the center.

g

gelatinous Having the consistency of jelly.

genotype The genetic heritage or constitution of an organism. The genotype produces the phenotype.

geotropism Growing oriented towards or in response to gravity.

glabrescent Becoming smooth.

glabrous Smooth, bald.

glutinous Having a highly viscous gelatinous layer, an extreme condition of viscidity.

Gram (Gram's Stain) A method for separating bacteria whereby bacteria are stained first with crystal violet (a red dye) and then washed with an iodine solution. Gram positive bacteria (*Bacillus*) retain the dye. Gram negative bacteria (*Pseudomonas* and some *Bacillus*) lose the dye.

gregarious Growing numerously in small groups but not in clusters.

h

habitat The substrate in which mushrooms grow.

heliotropic Growing or turning towards the sun.

heteromorphic Composed of different cell types, usually describing the type of mushroom gill edge.

heterothallic Having two or more morphologically similar pairs of strains within the same species. The combination of compatible spore types is essential for producing fertile off-spring. Typically a spore on a four spored basidium is compatible with only one of its counterparts.

hilar appendix The stub-like protrusion on the spore that connects the spore-producing cell (ex. the basidium) to it.

hilum A marking on the spore where it was attached to a spore-producing cell.

homomorphic Composed of similar cell types.

homothallic Having one strain type that is, by nature, dikaryotic and self-fertile; often arising from two spored basidia.

humicolous Growing in humus, soil.

hygrophanous Markedly fading in color upon drying, used to describe the condition of the mushroom cap.

hymenium The layer of fertile spore-bearing cells on the gill.

hypha, hyphae Individual cells of mycelium.

hyphal aggregate A concentration of mycelium; a "knot" in the mycelial network which often differentiates into a primordium.

hyphosphere The region immediately on and surrounding hyphae.

i

indicator mold A mold, usually non-destructive, whose occurrence indicates an improperly balanced condition in the substrate or environment.

instar An insect in any of its stages of post embryonic growth.

k

karyogamy The fusion of two sexually opposite nuclei within a single cell.

KOH Potassium Hydroxide, an agent commonly used to revive dried mushroom material for microscopic study at a concentration of 2,5%.

l

lamellae Mushroom gills.

lignicolous Growing in wood or on a substratum composed of woody tissue.

lignin The organic substance which, with cellulose, forms the basis of most woody tissue.

linear Considerably longer than wide, with edges parallel.

lubricous Smooth.

lumen The amount of the flow of light emitted from a single international foot candle.

lux The amount of illumination received by a surface one meter from 1 foot candle, equal to 1 lumen/square meter.

m

macroscopic Visible to the unaided eye.

matting A condition of a mycelium casing-run that has become appressed from overwatering. Similar to overlay except that matting infers the mycelium has formed a dense, dead layer of cells on the casing's surface.

meiosis The process of reduction division by which a single cell with a diploid nucleus subdivides into four cells with one haploid nucleus apiece.

membranous Being sheath-like in form.

mesophile An organism thriving in moderate temperature zones, usually 40-90°F.

metuloid Used to describe a sterile cell encrusted with a crystalline (calcitized) substance.

micron One millionth of a meter, 10^{-6} meters, one thousandth of a millimeter.

microscopic Visible only with the aid of a microscope.

mitosis The non-sexual process of nuclear division in a cell by which the chromosomes of one nucleus are replicated and divided equally into two daughter nuclei.

monkaryon, monocaryon (*adj. monokaryotic, monocaryotic*) The haploid state of the mushroom mycelium, typically containing a single nucleus.

mottled Spotted, as in the uneven ripening of spores on the gill surfaces that so characterizes species in the genus *Panaeolus*.

mushroom A fleshy fungus that erects a body of tissue in which sexual spores are produced and from which they are distributed.

mycelium (*pl. mycelia*) A network of hyphae.

mycology The study of fungi.

mycophagist A person or animal that eats fungi.

mycophile A person who likes mushrooms.

mycophobe A person who fears mushrooms.

mycorrhizal A peculiar type of symbiotic relationship a mushroom mycelium forms with the roots of a seed plant, typically trees.

n

nanometer 10^{-8} meters, one thousandth of a micron.

natural culture The in vitro cultivation of mushrooms by transplanting living mycelium, usually from a natural habitat.

nomenclature Any system of classification.

nucleate Having nuclei.

nucleotide One of the four nitrogenous bases in DNA; often called the building blocks of the DNA molecule.

nucleus, nuclei A concentrated mass of differentiated protoplasm in cells containing chromosomes and playing an integral role in the reproduction and continuation of genetic material.

o

obtuse Bluntly shaped.

ochraceous Light orangish brown to pale yellowish brown.

oidia Conidia (spores) borne in chains.

olivaceous Olive gray-brown.

overlay A condition of the casing where mycelium been allowed to completely cover the surface. Overlay is caused by prolonged vegetative growth temperatures, high CO_2 levels and excessive humidity. Overlay, if overwatered, becomes matted.

ovoid Oval shaped.

p

pallid Pale in color.

parasite An organism living on another living species and deriving its sustenance to the detriment of the host.

partial veil The inner veil of tissue extending from the cap margin to the stem and at first covering the gills of mushrooms.

pasteurization A process by which bulk materials are partially sterilized through contact with live steam, hot water or dry heat at temperatures of between 140-160°F.

pellicle A skin-like covering on the cap, sometimes gelatinous and separable.

penicillate Resembling a broom or brush; *Penicillium*-like.

perithecium A flask shaped or pear shaped saclike fruitbody of some Ascomycetes that encloses asci.

persistent Not disappearing with age.

Phase I The steps taken in the outdoor preparation, assemblage and conversion of raw materials into a nutritious medium for mushroom growth.

Phase II The pasteurization and final conditioning of a mushroom compost.

phenotype The observable physical characteristics resulting from interaction between the host environment and the genotype.

photosensitive Sensitive to light.

phototropic Growing towards light.

pileus The mushroom cap.

pith The central cottony "stuffing" in the stems of some mushrooms.

pleurocystidia Sterile cells on the surface of mushroom gills. Sometimes called facial cystidia.

pliant Flexible.

pore A circular depression at the end of spores in many species.

primary mycelium The haploid and uninucleate mycelium originating from the germination of a spore which is otherwise not capable of producing a sporulating organ.

primordium (*pl. primordia*) The first recognizable but undifferentiated mass of hyphae that develops into a mushroom fruitbody. Synonymous with "pinhead".

pruinose Having a powdery appearance.

pseudorhiza A long root-like extension of the stem.

pseudosclerotium (*pl. pseudosclerotia*) A conglomerated mass of mycelial tissue resembling a sclerotium but which can not produce a fruifbody or new mycelial growth.

psilocybian Having psilocybin and/or psilocin. (Not necessarily belonging to the genus *Psilocybe*).

psilocyboid Resembling a *Psilocybe* mushroom.

r

radicate Tapering downwards. Having a long root like extension of the stem.

reticulate Marked by lines or ridges.

rhizomorphs Cord-like or strand-like hyphae.

s

SACing Nutrient supplementation of bulk substrates at the time of casing.

saprophyte A plant (fungus) that lives on dead organic matter.

saltation The mutation developing from an isolate of mycelium having a known pure genotype.

scanning electron microscope An electronic microscope which scans an object in a vacuum with a beam of electrons resulting in an image of high resolution and magnification that is then displayed on a television-type monitor.

sclerotium (*pl. sclerotia*) A hardened mass of mycelium, usually darkly pigmented, that is the resting (vegetative) phase in some fleshy and non-fleshy fungi, and from which fruitbodies or viable mycelium can arise.

scratching Ruffling of the substrate or casing surface in order to maintain an open, porous condition conducive to primordia formation.

seceding Describing the condition where the gills have separated in their attachment to the mushroom stem and have torn free, usually leaving longitudinal ridges at the stem's apex.

sector A geometric growth of diverging mycelium (most visible on media filled Petri dishes), the appearance of which contrasts with that of neighboring mycelia, usually indicative of genetic mutation.

secondary mycelium A dikaryotic and binucleate mycelium characterized by clamp connections, crossing (anastomosis), and which is assimilative, not generative, in function.

senescent Having grown old.

septate Having walls dividing cells.

sinuate Describing the attachment of the mushroom gill to the stem at the junction of which the gill appears notched.

somatic Being in the assimilative phase of mycelial growth.

sordid Dirty looking.

spawn The aggregation of mycelium on a carrier material which is usually used to inoculate prepared substrates.

spores The reproductive cells or "seeds" of fungi, bacteria, and plants.

sporocarps Any fruitbody that produces spores.

sterigmata (*pl. sterigmatae*) Elongated appendages or "arms" extending from the apex of the basidium and upon which spores form.

stipe The stem or stalk of a fungus.

strain A race of individuals within a species sharing a common genetic heritage but differing in some observable features of no taxonomic significance.

stroma A dense, cushion-like aggregation of mycelium forming on the surface of composts or casings and indicative of somatic (vegetative), not generative growth.

Strophariaceae The family of dark brown spored mushrooms containing the genera *Melanotus*, *Naematoloma*, *Pholiota*, *Psilocybe* and *Stropharia*.

stropharioid Resembling a species of *Stropharia*, i.e. having a membranous ring on the stem, a convex cap, and purplish brown spores.

substrate Straw, sawdust, compost, soil, or any fibrous material on which mushrooms grow.

t

terrestrial Growing on the ground.

tertiary mycelium Mycelium arising from secondary mycelium that is involved in mushroom fruitbody formation.

tetrapolar Having or located at four poles, as with the four spored basidia in most mushrooms.

thermogenesis The process of heat generation by microorganisms.

thermophile An organism thriving in 75-140°F. temperature zone.

trama The fleshy part of the cap between the cap cuticle and the fertile spore bearing layers of the mushroom gill.

translucent Transmitting light diffusely, semitransparent.

u

umbilicate Depressed in the center region of the mushroom cap.

umbo A knob-like protrusion on the top center of the mushroom cap.

umbonate Having an umbo.

uncinate A type of gill attachment.

undulating Wavy.

universal veil An outer layer of tissue enveloping the cap and stem of some mushrooms, best seen in the youngest stages of fruitbody development.

V

variety A sub-species epithet used to describe a consistently appearing variation of a particular mushroom species.

vector The pathway by which a disease is spread; the "vehicle" for distributing a pathogen.

veil A tissue covering mushrooms as they develop.

vesicle A small bulb-like swelling (sometimes bladder-like).

viscid Slimy or slippery when moist, sticky to the touch when partially dry. A characteristic of the mushroom cap or stem.

Z

zonate Having a band-like region darker in color or different in form than the surrounding tissue.

BIBLIOGRAPHY

1. CC. Ainsworth, 1971. *Dictionary of the Fungi*, 6th ed., Commonwealth Mycological Institute. Kew, Surrey, England.
2. H. Akiyama, Akiyama, R.; Akiyama, I.; Kato, A.; Nakazawa, K. 1974. "The Cultivation of Shii-ta-ke in a Short Period". *Mushroom Science* IX, Part I: 423-433. Proc. of the 9th Int. Sci. Congress on the Cultivation of Edible Fungi, Tokyo.
3. Alexopoulos, C.J. and C.W. Mims, 1979. *Introductory Mycology*, 3rd edition. John Wiley & Sons. New York.
4. Ames R.W., R. Singer, S. Stein , & A.H. Smith. 1958. "The Influence of Temperature on Mycelial Growth of *Psilocybe*, *Panaeolus*, and *Copelandia*". *Mycopathologia* 9:268-274.
5. Anderson, F.A. 1956. "Effect of Temperature on Spore Survival of Fungus Pathogens and Competitors of the Cultivated Mushroom *Agaricus campestris* L". M.S. Thesis. The Penn State University.
6. Ando, M. 1974. "Fruit-body Formation of Lentinus edodes on Artificial Media". Mushroom Science IX: 415-421, Proc. for the Ninth Int. Sci. Cong. on Cult. of Edible Fungi, Tokyo.
7. Atkins, F. 1965. "Buildings for Mushroom Holdings". *The Mushroom Journal*, Bulletin 191, Nov., Mushroom Growers Association, London.
8. Atkins, F.C. 1966. *Mushroom Growing Today*. MacMillan Publishing Co., Inc. New York.
9. Atkins, F.C. 1974. *Guide to Mushroom Growing*. Faber & Faber. London.
10. Badham, E.R. 1979. "The Effect of Light Upon Basidiocarp Initiation in Psilocybe cubensis". Mycologia 71: 136-142.
11. Balazs, S. 1974. "*Stropharia* Growing Problems in Hungary". *Rep. Veg. Crop. Res. Inst.* Koeskemet, Hungary.
12. Balazs, S. & Szabo, I. 1978. "Untersuchungsergebinsse Ubon Den Warmbedarf Einiger, Neurlich in Kultur Genommener Pilzarten". *Mushroom Science* X: 421-427. Proceedings of the Tenth International Congress on the Science and Cultivation of Edible Fungi, Bordeaux.
13. Bano, Z., S. Rajarathnam, and N. Nagaraja, 1978. "Some Aspects on the Cultivation of *Pleurotus flabellatus* in India". *Mushroom Science* X: 597-608. Proc. of the 10th Int. Cong. on the Sci. and Cult. of Ed. Fungi. Bordeaux.
14. Barnett, H.L. & Hunter, B.B. 1972. *Illustrated Genera of the Imperfect Fungi*, 3rd edition. Burgess Publishing Company. Minneapolis.
15. Bech, K. 1978. "Preparing a Productive Commercial Compost as a Selective Growing Medium of *Agaricus bisporus* (Lange) Sing." *Mushroom Science* X: 77-85. Proceedings of the Tenth International Congress on the Science and Cultivation of Edible Fungi, Bordeaux.
16. Bels-Koning, H.C., Gerrits, J.P.G., and Vaandrager, M.H. 1962. "Some Fungi Appearing Towards the End of Composting". *Mushroom Science* V: 165-169, Philadelphia.
17. Bessey, E.A. 1968. *Morphology and Taxonomy of Fungi*. Hafner Publishing Co., New York.
18. Beug, M.W. and J. Bigwood 1981. "Quantitative Analysis of Psilocybin and Psilocin in *Psilocybe baeocystis* (Singer and Smith) by High Performance Liquid Chromatography and By Thin Layer Chromatography". *Journal of Chromatography* 207: 379-385.
19. Bigwood, J. and J. Ott, ed. 1978. *Teonanacatl: Hallucinogenic Mushrooms of North America*. Madrona Press, Seattle.
20. Bigwood, J. and Michael W. Beug, 1982. "Variation of Psilocybin and Psilocin Levels with Repeated Flushes (Harvests) of Mature Sporocarps of *Psilocybe cubensis* (Earle) Singer". *Journal of Ethnopharmacology* 5:287-291.
21. Bitner, C.W. 1972. "The Pathogens of Mushroom Spawn (Agaricus bisporus)". *Mushroom Science* VIII: 601-606. Mushroom Growers Association, London.
22. Block, S.S., G. Tsao, and L. Han, 1959. "Experiments in the Cultivation of *Pleurotus ostreatus*". *Mushroom Science* IV: 309-325. Copenhagen.
23. Bloom, JR. 1977. "Nematodes: Sources of Infestation and Methods of Testing". *Mushroom News*, Dec., pp. 9-11. American Mushroom Institute, Kennett Square, Pennsylvania.
24. Bobitt, T.F. and Nordin, J.H. 1980. "A Survey of Aspergillus and Penicillium Species Producing an Exocellular Nitrogen-Protein Complex". *Mycologia* 72: 636-640.
25. Carapiet, G. 1979. "Casing to Cropping". *The Proceedings of the 1st North American Mushroom Conference*, AMI, Kennett Square, Pennsylvania.
26. Carlile, M.J. 1965. "The Photobiology of Fungi". *Annu. Rev. Plant Physiol.* 16: 175-202.
27. Chang, S.T. 1972. The Chinese Mushroom (*Volvariella volvacea*). The Chinese University of Hong Kong Press, Hong Kong.
28. Chang, S.T. & W.A. Hayes, 1978. *The Biology and Cultivation of Edible Mushrooms*. Academic Press. New York.
29. Chang, S.T. 1978. "Cultivation of *Volvariella volvacea* from Cotton Waste Composts". *Mushroom Science* X: 609-618. Proc. 10th Int. Cong. Sci. Cult. of Ed. Fungi. Bordeaux.
30. Chang, S.T. 1978. "*Volvariella volvacea*" in *The Biology and Cultivation of Edible Mushrooms*. pp. 573-603. Academic Press, New York.
31. Chang, H.Y. and H.H. Ho, 1978. "Effect on Nitrogen Amendment on the Growth of *Volvariella volvacea*." *Mushroom Science* X:619-642. Proc. 10th Int. Cong. Sci. Cult, of Ed. Fungi, Bordeaux.
32. Cheng, S. and C.C. Tu, 1978. "*Tremella fuciformis*." in *The Biology and Cultivation of Edible Mushrooms*, pp. 629-642. Academic Press, New York.
33. Chihara, G. 1979. "Antitumor and Immunological Properties of Polysaccharides from Fungal Origin". *Mushroom Science* X: 797-814, Part 2. Bordeaux, France.
34. Christensen, C.M. 1965. *The Molds & Man*. University of Minnesota Press. Minneapolis.
35. Clark, J.E. and R.S. Smith, 1979. "Culture collection of wood-inhabiting fungi." Canad. For. West. For. Prod. Lab., In. Rep. VP-X.187.
36. Cochran, K.W. and E.H. Lucas 1959. "Chemoprophylaxis of poliomyelitis in mice through the administration of plant extacts." *Antioblo. Annu.*, 1958-1959, pp. 104-109.
37. Cochran, K.W., T. Nishikawa, and E.S. Beneke, 1967. "Botanical Sources of Influenza Inhibitors". *Antimicrobial and Chemotherapy* 1966, pp. 515-520.
38. Cochran, K. 1978. "Medical Effects of Edible Mushrooms", pp. 169-187. *The Biology & Cultivation of Edible Mushrooms*.

Academic Press. New York.

39. Cooke, D. and Flegg, P.B. 1962. "The Effect of Rate of Spawning on the Cropping of the Cultivated Mushroom". pp. 118-121. Glasshouse Crops Res. Inst.
40. Cooney, D.C. and Emerson, R.I. 1964. *Thermophilic Fungi*. W.H. Freeman & Co., New York.
41. Costanin, J. 1936. "La Culture de la Morille et sa Forme Conidienne". *Ann. Sci. Nat. Bot.* (Ser. 10) 18:111-129.
42. Cotnoir, L. J. 1978. "Ammonia in compost: What and Why?" *Mushroom News*, January. American Mushroom Institute, Kennett Square, Pennsylvania.
43. Crisan, E. and Sands, A. 1978. "Nutritional Value of Edible Mushrooms" in *The Biology & Cultivation of Edible Mushrooms* ed. by Chang and Hayes, p. 137-168. Academic Press, New York.
44. Cruickshank, R., Duguid, J.P., Mormon, B.P., and Swam, R.H.A. 1973. *Medical Microbiology: A Guide to the Laboratory Diagnosis and Control of Infection*. 12th edition, vol. 1 Microbial Infections. Churchill Livingstone. Edinburgh, London & New York.
45. Curto, S. and F. Favelli, 1972. "Stimulative Effect of Certain Micro-organisms (Bacteria, Yeasts, Microalgae) Upon Fruit-body Formation of *Agaricus bisporus* (Lange) Sing.". *Mushroom Science* VIII: 67-74. London.
46. de Vries. 1952. "Contribution to the Knowledge of the Genus *Cladosporum* Link. ex Fr. by De Fries" Thesis. Baarn.
47. Danielson, R.M. 1971. "The Ecology and Physiology of *Trichoderma* in Forest Soils". Ph.D. Thesis. North Carolina State University, Raleigh.
48. Donoghue, D.C. 1962. "New Light on Fruit Body Formation". *Mushroom Science* V: 247-249. The Proceedings of the Fifth International Conference on the Scientific Aspects of Mushroom Cultivation, Philadelphia.
49. Drake, M.G., 1961. "Insulation for the Mushroom Grower". *Mushroom Growers Association Bulletin*, March, 147: 111-126. London.
50. Earle, 1906. "*Stropharia cubensis*". *Est. Agron.* 1:240, Cuba.
51. Edwards, R.L., 1973. "Mushroom House Ventilation in Theory an Practice". *The Mushroom Journal*, No. 3 and No.4. London.
52. Eger, G. 1959. "Zum Problem de Fruchtkorperbildung beim Kulturechamignon (*Psalliota bispora* Lge.)". *Die naturwissenschaften* 46: 498-499.
53. Eger, G. 1968. "Untersuchungen zur Fruchtkoperbildung des Kulturchampignons". *Mushroom Science* 8: 663-74.
54. Eger, G. 1965. "Untersuchgen uber die Bildung und Regeneration von Fracht Korpern bei Hutpilzen. I. *Pleurotus florida*. "*Arch. Mikrobiol*. 50: 343-356.
55. Eger, G. 1972. "Experiments and Comments on the Action of Bacteria on Sporophore Initiation in *Agaricus bisporus*". *Mushroom Science* VIII: 719-726. Mushroom Growers Association, London.
56. Eger, G. 1974. "Rapid Method for Breeding *Pleurotus ostreatus*". *Mushroom Science* IX: 567-572, Tokyo.
57. Eger, G. *et al.*, 1974. "The Action of Light and Other Factors on Sporophore Initiation in *Pleurotus ostreatus*." *Mushroom Science* IX, Part I: 575-583. Proc. 9th Int. Cong. Cult, of Ed. Fungi, Tokyo.
58. Eger, G., S.F. Li, and H. Leal-Lara, 1979. "Contribution to the discussion on the species concept in the *Pleurotus ostreatus* complex." *Mycologia*, 71: 577-588.
59. Eliot, T.J. "Sex and the Single Spore". *Mushroom Science* VIII: 11-18. Mushroom Growers Association. London.
60. Emmons, C.W., Binford, C.H., and Utz, J.P. 1963. Medical Mycology. Lea & Febiger. Philadelphia.
61. Esser. K., 1979. "Genetic Control of Fruit Body Formation in Higher Basidiomycetes". *Mushroom Science* X: 1-12. Proceedings of the Tenth International Congress on the Science and Cultivation of Edible Fungi, Bordeaux.
62. Flegg, P.B. 1959. "Functions of the Compost and Casing Layer in Relation to Fruiting and Growth of the Cultivated Mushroom." *Mushroom Science* IV: 205-210. Copenhagen.
63. Fletcher, J.T. 1979. "Bacteria and Mushrooms". *The Mushroom Journal* No. 83: 451-457. Mushroom Growers Association, London.
64. Fordyce, C. 1970. "Relative Numbers of Certain Microbial Groups Present in Compost Used for Mushroom (*Agaricus bisporus*) Propagation". *Applied Microbiology*, Vol. 20, No. 2: 196-199.
65. Fordyce, C. 1980. Personal Communication.
66. Fries, N. 1979. "Germination of Spores of *Cantharellus cibarius*". *Mycologia*, Vol. 7: 216-219.
67. Fritsche, G. 1964. "Concluding Trials on the Question of the Transference of Characteristics with the Cultivated Mushroom *Agaricus (Psalliota) bisporus* (Lge) Sing." Originally appearing in *Der Zuchter* No. 34.
68. Fritsche, G. 1972. "Trials on the Question of Transference of Characteristics with the Cultivated Mushroom *Agaricus (Psalliota) bisporus* (Lge). Sing." *Mushroom Growers Association Bulletin*, No. 196-198. London.
69. Fritsche, G. 1972. "The Experiments on the Maintenance of Strains of the Cultivated Mushroom-Propagation by Mycelium Transfer Part II". Bulletin No. 197: 3. Mushroom Growers Association, London.
70. Fritsche, G. 1981. Personal Communication.
71. Gandy, D.G. 1972. "Observations on the Development of *Verticillium Malthousei* in Mushroom Crops and the Role of Cultural Practices in Its Control". *Mushroom Science* VIII. Mushroom Growers Association, London.
72. Garbaye, J. Kabre, A., Le Tacon, F. Mousain, D., and D. Piou, 1979. "Production De Champignon Comestibles En Foret Par Fertilisation Minerale-Premiers Resultats Sur *Rhodopaxillus Nudus*" *Mushroom Science* X, Part I: 810-816.
73. Garscha, H.S., Karla, K.L. and Beg, G.M. 1979. "Physiology of Weed Mushrooms". *Mushroom Science* X. Part 2: 349-355. Proceedings of the Tenth International Congress on The Science and Cultivation of Edible Fungi. Bordeaux, France.
74. Gengtao, L., B. Tiantong, N. Xinyi, L. Shuzhen, and S. Zhenyu, 1979. "Some Pharmacological Actions of the Spores of *Ganoderma lucidum* and the Mycelium of *Ganoderma capense* (Lloyd) Teng by Submerged Fermentation." Chinese Medical Journal 92(7): 496-500.
75. Gerrits, J.P.G., H.C. Bels-Koning, F.M. Muller, 1967. "Changes in Compost Constituents During Composting, Pasteurization, and Cropping". *Mushroom Science* VI: 225-245. Proc. 6th Int. Cong. Cult. of Ed. Fungi, Amsterdam.
76. Gerrits, J.P.G. 1969. "Organic Compost Constituents and Water Utilized by the Cultivated Mushroom During Spawn Run and Cropping". *Mushroom Science* VII: 111-126. Proc. 7th lnt. Cong. Cult. of Ed. Fungi, Hamburg.
77. Guzman, G. 1981. Personal communication.

78. Gerrits, J.P.G. 1970. "Inorganic and Organic Supplementation of Mushroom Compost". Bulletin 251. Mushroom Growers Association, London.
79. Gerrits, J.P.G. 1972. "The Influence of Water in Mushroom Compost." *Mushroom Science* VIII: 43-57. Proc. 8th Int. Cong. Cult. of Ed. Fungi, London.
80. Gerrits, J.P.G. 1974. "Organic Supplementation of Mushroom Compost". *Mushroom News*, March. American Mushroom Institute, Kennett Square, Pennsylvania.
81. Gerrits, J.P.G. 1974. "The Supplementation of Horse Manure Compost and Synthetic Compost with Chicken Manure and Other Nitrogen Sources". *Mushroom Science* IX: 77-98. Proc. 9th Int. Cong. Cult. of Ed. Fungi, Tokyo.
82. Gerrits, J.P.G. 1975. "Development of a Synthetic Compost for Mushroom Growing Based on Wheat Straw and Chicken Manure". *Mushroom News*, October-November. American Mushroom Institute, Kennett Square, Pennsylvania.
83. Gerrits, J.P.G. 1977. "The Significance of Gypsum Applied to Mushroom Compost, in Particular in Relation to Ammonia Content". *Neth. J. Agaric. Sci*. 25:288-302.
84. Ginterova, A. and O. Janotkova, 1975. "A Simple Method of Isolation and Purification of Cultures of Wood Rotting Fungi". Folia Microbiol. 20: 519-520.
85. Gramss, G. 1979. "Some Differences in Response to Competitive Micro-organisms Deciding on Growth Success and Yield of Wood-Destroying Edible Fungi". *Mushroom Science* X: 265-285. Proc. 10th Int. Cong. Cult. of Ed. Fungi. Bordeaux, France.
86. Gray, W.D. 1959. *The Relation of Fungi to Human Affairs*. Henry Holt and Company, Inc. New York.
87. Guzman, Gaston 1982 ed. by Paul Stamets. *The Genus Psilocybe: A Systematic Revision of the Known Species Including the History, Distribution, and Chemistry of the Hallucinogenic Species*. J. Cramer, Braunschweig, Germany.
88. Hamuro, J. Y. Maeda, F. Fukuoka, and G. Chihara, 1974. "Antitumor Polysaccharides, Lentinan and Pachymaran as Immunopotentiators". *Mushroom Science* IX, Part I: 477-487. Proceedings of the Ninth International Scientific Congress on the Cultivation of Edible Fungi, Tokyo.
89. Han, Y.H., K.M. Chen, and S. Cheng, 1974. "Characteristics and Cultivation of a New *Pleurotus* in Taiwan." *Mushroom Science* IX: 167-173. Proc. 9th Int. Cong. Sci. Cult, of Ed. Fungi, Tokyo.
90. Happ, A.C. & Wuest, P.J. 1979. "Mushroom Yield and Incidence of *Verticillium* Disease as Influenced by the Choice of Casing and Its Treatment with Steam". *Mushroom Science* X: 303-310.
91. Harvey, C.L. Wuest, P.J. & Schisler, L.C. 1982. "Common Pathogens, Weed Molds, and Abnormalities of the Commercial Mushroom." The Penn. State Handbook for the Commercial Mushroom Grower. The Pennsylvania State University, College of Agriculture, University Park.
92. Hashimoto, K. and Z. Takahasi, 1974. "Studies on the Growth of *Pleurotus ostreatus*". *Mushroom Science* IX: 585-594. Proc. 9th Int. Cong. Sci. Cult. of Ed. Fungi. Tokyo.
93. Hashioka, Y. and I. Arita, 1978. "Naturalization of Several Saprophytic Mushrooms Under Rice-Straw-Culture". *Mushroom Science* X: 127-135. Proc. 10th Int. Cong. Sci. Cult. of Ed. Fungi, Bordeaux.
94. Hayes, W.A., Randle, P.E. and Last, F.T. 1969. "The Nature of the Microbial Stimulus Affecting Sporophore Formation in *Agaricus bisporus* (Lange) Sing." Ann. Appl. Biol. 64: 177-81.
95. Hayes, W.A. 1971. "Fumigation-Its Application to Commercial Mushroom Growing". *Mushroom Growers Association Bulletin* 257: 213-218, London.
96. Hayes, W.A. 1972. "Nutritional Factors and Their Relation to Mushroom Production". *Mushroom Science* VIII. 663-74. Mushroom Growers Association, London.
97. Hayes, W.A. 1973. "The Casing Layer and its Function in Mushroom Nutrition" in *Mushroom News*, Dec., pp. 9-15. American Mushroom Institute, Kennett Square, Pennsylvania.
98. Hayes, W.A. ed., 1974. "The Casing Layer". Mushroom Growers Association, London.
99. Hayes, W.A. and N.G. Nair, 1974. "Effects of Volatile Metabolic By-Products of Mushroom Mycelium on The Ecology of the Casing Layer." *Mushroom Science* IX, Part I: 259-268. Proceedings of the Ninth International Scientific Congress on the Cultivation of Edible Fungi, Tokyo.
100. Hayes, W.A., 1975. "Mushroom Nutrition and the Role of Micro-organisms in Composting" from *Composting: Improvements and Future Prospects*, Aston University Seminar. Mushroom Growers Association, London.
101. Hayes, W.A. ed., 1977. "Composting". Mushroom Growers Association, London.
102. Hayes, W.A. 1982. "Interrelated Studies of Physical, Chemical and Biological Factors in Casing Soils and Relationships with Productivity in Commercial Culture of *Agaricus bisporus* (Lge.) Sing.". *Mushroom Science* XI, Part II: 153-158. Proc. XIth lnt. Cong. Cult. Ed. Fungi, Melbourne.
103. Heim, R. and Cailleux, R. 1957. "Culture pure et Obtertion Semi-industrielle des Agarics Hallucinogenes du Mexique". *Comptes Rendu Ac. Sc*. 244: 3109-3114.
104. Heim, R. and Wasson, R.G. 1958. *Les Champignons Hallucinogenes du Mexique*. Editions du Museum National d'Histoire Naturelle, Paris.
105. Heim, R., Cailleux, R., Wasson, R., Theverard, P. 1967. *Nouvelles Investigations sar les Champignons Hallucinogenes*. Paris, Editions du Museum National d'Histoire Nationelle.
106. Hetlay, I. 1977. "*Pleurotus Florida* Production in Borota, Hungary." *The Mushroom Journal*, Mushroom Growers Association, London.
107. Hesling, J.J. 1980. "The Role of Eelworms (Nematodes) in the Culture of Mushrooms in the U.K.". pp. 423-429 and 500-503, *The Mushroom Journal*, London.
108. Ho, M.S. and Y.H. Han, 1978. "Cultivation of Edible Fungi in Taiwan". *Mushroom Science* X, Part II: 561-574. Proc. 10th Int. Cong. Sci. Cult. of Ed. Fungi, Bordeaux.
109. Horak, E. 1977. "The Genus *Melanotus*." *Persoonia* 9: 305-327.
110. Hu *et al*., 1974. "Comparison of Compost Made of Different Raw Materials for *Volvariella volvacea*". *Mushroom Science* IX: 687-691. Proc. 9th Int. Cong. Cult. of Ed. Fungi, Tokyo.
111. Huhnke, W. 1970. "Modern Mushroom Farming." May, *Science Journal*.
112. Hume, D.P. and W.A. Hayes, 1972. "The Production of Fruit-Body Primordia in *Agaricus bisporus* (Lange) Sing. on Agar

Media". *Mushroom Science* VIII. Proceedings of the Eighth International Scientific Congress on the Cultivation of Edible Fungi, London.

113. Hussey, N.W., Gurney, B. 1971. "Biology and Control of the Sciarid in Mushroom Culture". *Mushroom News*, June, pp. 9-18. American Mushroom Institue, Kennett Square, Pennsylvania.
114. Hussey, N.W. 1972. "Pests in Perspective", *Mushroom Science* VIII: 183-192. Mushroom Growers Association, London.
115. Hussey, N.W., W.H. Read, and J.J. Hesling, 1979. "The Pests of Protected Cultivation". *American Elsevier*, New York.
116. Imbernon, M. 1979. "Sensibilite de Quelques Champignon Cultives a Certain Antibiotiques". *Mushroom Science* X: 31-39. Bordeaux.
117. Ito, Tatsuziro. 1978. "Cultivation of *Lentinus edodes*" in The *Biology and Cultivation of Mushrooms*, pp. 461-473. Academic Press, New York.
118. Ivanovich-Biserka, B., 1972. "Dealing with Microbiological Trouble Makers in Commercial Spawn Production of *Agaricus bisporus*, L.". *Mushroom Science* VIII:305-314. Proceedings of the Eighth Scientific Congress on the Cultivation of Edible Fungi, London.
119. Johnstone, K. I., 1973. *Micromanipulation of Bacteria: The Cultivation of Single Bacteria and Their Spores by the Agar Gel Dissection Techniques*. Churchill Livingstone, Edinburgh and London.
120. Jonsson, M., 1979. "Testicular Lesions of Coprine and Benzocoprine". *Toxicology* 12:89-100.
121. Kalberer, P.P., 1974. "The Cultivation of *Pleurotus ostreatus*: Experiments to Elucidate the Influence of Different Culture Conditions on the Crop Yield." *Mushroom Science* IX: 653-662. Proc. 9th Int. Cong. Sci. Cult, of Ed. Fungi, Tokyo.
122. Kielbasa, R., 1978. "When Do Sciarid Flies Cause Damage?" *Mushroom News*, Feb., pp. 11-14. American Mushroom Institute, Kennett Square, Pennsylvania.
123. Kligman, A.M. 1943. "Some Cultural and Genetic Problems in the Cultivation of the Mushroom, *Agaricus campestris* Fr". Doctoral Dissertation. University. of Pennsylvania, University Park.
124. Kligman, A.M. 1950. *Handbook of Mushroom Cultivation*. Business Press Inc., Lancaster, Pennsylvania.
125. Kinrus, A. 1979. "The Art of *Watering*: An Interview with Angelo Zunino, 'The Man with the Golden Arm' ". *Mushroom News*, July, pp. 9-13, American Mushroom Institute, Kennett Square, Pennsylvania.
126. Kneebone, L.R. 1960. "Methods for Production of Certain Hallucinogenic Agarics" *Abstract. Dev. lnd. Micro*. 1:109.
127. Kneebone, L.R. and E.L. Merek, 1961. "Brief Outline of and Controls for Mushroom Pathogens, Indicator Molds, and Weed Molds or Competitors". 3rd Revision. Prepared for Third Mushroom Industry Short Course. June 23-26, 1958.
128. Kneebone, L.R. and E.C. Mason 1968. "Sugar Cane Bagasse as a Bulk Ingredient in Mushroom Compost." *Mushroom Science* VIII:321-330. Proc. 8th Int. Cong. Cult. of Ed. Fungi, London.
129. Kneebone, L.R. 1969. "Strain Selection, Development, and Maintenance." *Mushroom Science* VII: 531-541. Proceedings of the Seventh International Scientific Congress on the Cultivation of Edible Fungi, Hamburg.
130. Kneebone, L.R., Shultz, P.G. and Patton, T.G. 1971. "Strain Selection and Development by Means of Mycelial Anastomosis". *Mushroom Science* VIII: 19-25. Proc. of the Eighth Int. Cong. on the Cult. of Ed. Fungi, London.
131. Kneebone, L.R. 1972. "Selection, Development, and Maintenance of Cultures of Edible Mushrooms and Their Spawns". *Mushroom News*. May. pp. 18-27.
132. Kneebone, L.R. 1965. "Spawn Research of the Pennsylvania State University". Mushroom Research Center. Penn State University, University Park, Pennsylvania.
133. Kneebone, L.R. 1974, January. "Obtaining Pure Cultures of *Agaricus*". Pennsylvania Stale University. University Park, Pennsylvania.
134. Kramer, C.L., Pady, S.M., Rogerson, T. and Ouye, C.G. 1959. "Kansas Acromycology II. Materials, Methods, and General Results". *Trans. Kans. Acad. Sci*. 62:184-199.
135. Kriesel, H. 1979. "Zur Taxonomic van *Stropharia aeruginosa* sensu lab." *Sydowia, Bein*. 8:228-232.
136. Kurtzman, R.H. 1978. "*Coprinus fimetarius*" in *The Biology and Cultivation of Edible Mushrooms*, pp. 393-408. Academic Press, New York.
137. Kurtzman, Jr. R.H. "Production of Mushroom Fruiting Bodies on the Surface of Submerged Cultures". 1978. Mycologia. No. 1. vol. 70:179.
138. Lambert, E.B., Ayers, T.T., 1955. "Controlling Mushroom Disease with Chlorinated Water". *Plant Disease Reporter*, April, pp. 829-836.
139. Lambert, E.B. and Ayers, T.T. 1957. "Thermal Death Times for Some Pests of the Cultivated Mushroom (*Agaricus campestris*)." Vol. 41, No. 4: 348-353. *Plant Disease Reporter*.
140. Leonard, T.J. and S. Dick, 1968. "Chemical Induction of Haploid Fruiting in *Schizophylum commune*". *Proc. N.A.S*. Vol. 50:745-751.
141. Markowitz, N., 1981. "Understanding the Mechanisms of Pest Control: The Imperative 'Next Step' for the Successful Grower." First Annual Symposium on Advanced Technology for the Mushroom Industry, Spawn Mate, San Jose.
142. Mattoni, R.H.T. and L. Mattoni, 1971. "Mushroom Viruses in California". *Mushroom Growers Association Bulletin*. March. No. 255:112-126.
143. McCurdy, J.A., 1970. "Filters for Mushroom Ventilation Systems". *Agricultural Engineering Fact Sheet*, Penn State University Cooperative Extension Service. University Park, Pennsylvania.
144. McGinnis, M.R. 1981. *Laboratory Handbook of Medical Mycology*. Academic Press, New York.
145. Mee, H. 1978. "Method for Growing Wood Mushrooms". U.S. Patent Application 739,393. U.S. Patent Office, Washington.
146. Miller, RE. 1971. "Evidence of Sexuality in the Cultivated Mushroom, *Agaricus bisporus*". *Mycologia*, Vol. 63, No. 3: 630-634.
147. Ministry of Agriculture, Fisheries and Food, 1981 . "Low Cost Plastic Structures for Vegetable, Flower and Nursery Stock Production". Lee Valley Experimental Horticulture Station, Ware Road, Hoddesdon, Hertfordshire, England.
148. Moessner, E.J. "Preliminary Studies of the Possibility of Obtaining Improved Cultures Through Mycelial Fusion (Anastomosis)." *Mushroom Science* V:197-203.
149. Molitoris, H.P., Hollings, H. and Wood, HA. 1979. *Fungal Viruses*. Springer-Verlag. New York Inc. Secaucus, New Jersey.
150. Mori, K., S. Fukai, and A. Zennyozi, 1974. "Hybridization of Shii-ta-ke (*Lentinus edodes*) Between Cultivated Strains of Japan

and Wild Strains Growing in Taiwan and New Guinea". *Mushroom Science* IX: 391-403. Proc. 9th Int. Sci. Cong. Cult, of Ed. Fungi, Tokyo.
151. Mori, K., K. Kuida, D. Hosokawa, and M. Takehara, 1979. "Virus-Like Particles in Several Mushrooms". *Mushroom Science* X: 773-787.
152. Nair, N.G. and Fahy, P.C. 1972. "Bacterial Antagonists to *Pseudomonas tolaasii* and Their Control of the Brown Blotch of the Cultivated Mushroom *Agaricus bisporus*." *Journal of Applied Bacteriology* 35:439.
153. North, Jane., 1977. "The Effects of Griseofulvin on Diploid Strains of *Coprinus lagopus*". *Journal of General Microbiology* 98: 529-534.
154. Ower, R. 1981. "Notes on the Development of the Morel Ascocarp: *Morchella esculenta*". *Mycologia*, Vo. 74, No. 1: 142-144.
155. Ola'h G.M., 1970. *Le Genre Panaeolus: Essai Taxonomique et Physiologique*. Labortoire de Cryptogamie de Museum D'Histoire Naturelle, Paris.
156. Orten. P.D. 1976. *Notes on British Agarics*. Vol. VI, No. 35: 147-153. Royal Botanic Gardens, Edin.
157. Paranjpe, M.S., P.K. Chen, and S.C. Jong, 1979. "Morphogenesis of *Agaricus bisporus*: Changes in Proteins and enzyme activity." *Mycologia* 71, No. 3:469-478.
158. Park, J.Y. and V.P. Agnihotri, 1969. "Bacterial Metabolites Trigger Sporophore Formation in *Agaricus bisporus*". Nature Vol. 222: 984.
159. Peerally, A. 1979. "Sporophore Initiation in *Agaricus* bisporous and *Agaricus bitorquis* in Relation to Bacteria and Activated Characoal". *Mushroom Science* X: 611-639. Proc. of the Ten. Int. Con. Sci. and Cult. of Ed. Fungi, Bordeaux.
160. Peerally, A. 1982. "A Petri Plate Agar Technique for Obtaining Primordia in *Agaricus bisporus* (Lge.) Sing." *Mushroom Science* XI, Part II: 153-158. Proc. XIth of Int. Cong. Cult. Ed. Fungi, Melbourne.
161. Pepper, E.H. and Keisling, R.L. 1963. "A List of Bacteria, Fungi, Yeasts, Nematodes, and Viruses Occuring On and Within Barley Kernels". Proc. Ass. of Seed Analysts. North America. 53: 199-208.
162. Perrin, Peter W. 1979. "Long-term Storage of Cultures of Wood-inhabiting Fungi under Mineral Oil". *Mycologia* Vol. 71: 867.
163. Phaff, J.H. 1981. "Industrial Microorganisms". Scientific American. Vol 235, No. 3: 77-89. New York.
164. Pitt, John I. 1980. *The Genus Penicillium and its Teleomorphic States Eupenicillium and Talaromyces*. Academic Press, London.
165. Pizer, N.H. 1950. "Horse Manure Composts". *Mushroom Science* I: 46-51. Proc. 1st Int. Cong. Cult. of Ed. Fungi. Peterborough, England.
166. Pollock, S.H., 1977. *Magic Mushroom Cultivation*, Herbal Medicine Research Foundation, San Antonio.
167. Preece, T. 1979. "Bacteria and Nematodes". *The Mushroom Journal* No. 83:473-474. Mushroom Growers Association, London.
168. Raper, K. and Thou, C. 1945. *A Manual of Aspergillus*. Williams and Williams, New York.
169. Raper, K. and Thou, C. 1949. *A Manual of Penicillia*. Williams and Williams, Baltimore.
170. Raper K. and D. Fennel, 1965. *The Genus Aspergillus*. Williams and Williams, New York.
171. Raper, J.R. and Raper, C.A. 1972. "Life Cycle and Prospects for Interstrain Breeding in *Agaricus bisporus*". *Mushroom Science* VIII:1-10. Proc. of the Eight. Int. Cong. Cult, of Ed. Fungi. The Mushroom Growers Association, London.
172. Rasmussen, C.R., 1956. "The Improvement of Composts". Mushroom Growers Association, London.
173. Rasmussen, C.R., 1962. "Air in the Growing Room". *The Mushroom Journal*, Mushroom Growers Association, July, pp. 251-273. London.
174. Rasmussen, C.R., Mitchell, R.E., and Slack, C.I., 1972. "Heat Treatment of Cultures from Apparently Healthy and Virus-Infected Mushrooms and the Subsequent Effect on Cropping Yields". *Mushroom Science* VIII: 239-252. Proc. of the 8th. Int. Cong. on the Sci. and Cult. of Ed. Fungi, London.
175. Rempe, H., 1953. "Some Experiments with Sawdust-Compost". *Mushroom Science* II: 131-133. Proc. of the 2nd Int. Cong. on the Sci. and Cult. of Ed. Fungi, Belgium.
176. Repke, D.B. and D.T. Leslie, 1977. *Journal of Pharm. Sci*. 66: 113-114.
177. Repke, D.B., D.T. Leslie, D. Mandell, and N.G. Kish. *Journal of Pharm. Sci*. 66: 743-744.
178. Repke, D.B., D.T. Leslie and G. Guzman, 1977. *Lloydia* 40: 566-578.
179. Ross, R.C. 1968. "Experiments on the Use of Farm Waste-products in Mushroom Composting". *Mushroom Science* VII: 365-371. Proc. 7th Int. Cong. Cult. of Ed. Fungi, Hamburg.
180. Ross, R.C. 1978. "Factors Affecting Compost Selectivity". *The Mushroom Journal*, March. Mushroom Growers Association, London.
181. Rosenberg, S.L. 1980. "Patterns of Diffusibility of Lignin and Carbohydrate-Degrading Systems in Wood Rotting Fungi". Mycologia. Vol. 72:798-811.
182. Rusmin, Simon. 1978. "Biochemical Induction of Fruiting in *Schizophyllum*. Isolation and Purification of an Inducing Substance from *Agaricus bisporus* Mushrooms". *Plant Physiology* 61:538-543.
183. Rusmin, S. and Leonard, T.S. 1975. "Biochemical Induction of Fruiting Bodies in *Schizophyllum commune: a Bioassay and its Application*". *Journal of General Microbiology* 90: 2 17-227.
184. San Antonio, J.P. 1971. "A Laboratory Method to Obtain Fruit From Cased Grain Spawn of the Cultivated Mushroom *Agaricus bisporus*". Mycologia. vol. 63. p. 16-21.
185. Schisler, L.C. 1971. "Supplementation of the Finished Compost at Time of Spawning, at Time of Casing, and Later". *Mushroom News*, American Mushroom Institute, Kennett Square, Pennsylvania.
186. Schisler, L.C. and T.G. Patton, 1971. "Stimulation of Mushroom Yield By Supplementation with Vegetable Oils before Phase II of Composting". *Mushroom News*, Feb. American Mushroom Institute, Kennett Square, Pennsylvania.
187. Schisler, L.C. and P.J Wuest. "Harvesting the Commercial Mushroom Crop" Special Circular 141, Penn State University, Ag. Ext. Serv.
188. Schisler, L.C., 1977. "Some Thoughts on C0-2 Control in Mushroom Culture". *Mushroom News*, November, pp. 18. American Mushroom Institute, Kennett Square, Pennsylvania.
189. Schisler, L.C. 1980. "Composting". *Mushroom News*: Jan-Feb., American Mushroom Institute, Kennett Square, Pennsylvania.
190. Schol-Schwartz, M.B. 1959. "The Genus *Epicoccum* (*Link*.)." *Trans. Brit. Mycol. Soc*. 42:149-173.

191. Schroeder, M.E., Schisler, L.C., and Wuest, P.J., 1970. "A Unitized Forced Air Ventilation System for Mushroom Growing." *Progress Report No. 302*. College of Agriculture, Penn State University, University Park.
192. Schroeder, M.E. *et al.*, 1971. "Investment in the Mushroom Test Demonstration Facility". *Progress Report 3l9*, College of Agriculture, Penn State University, University Park.
193. Shiio, T., Okunishi, M., and Okumura, S. 1974. "Fundamental Studies on the Large Scale Cultivation of Edible Fungi". *Mushroom Science* IX (Part I). Proc. of the 9th Int. Cong. Cult. of Ed. Fungi, Tokyo.
194. Shull, J.J. and R. Ernst, 1962. "Graphical Procedure for Comparing Thermal Death of *Bacillus stearothermophilus* Spores in Saturated and Superheated Steam". *Applied Microbiology*, Vol. 10: 452-457.
195. Sinden, J.W., Hauser, E. 1950. "The Short Method of Composting". *Mushroom Science* I: 52-59. Peterborough, England.
196. Sinden, J.W. 1953. "The Nature of the Composting Process and Its Relation to Short Composting". *Mushroom Science* II: 123-131. Gembloux, Belgium.
197. Sinden, J.W. 1971. "Ecological Control of Pathogens and Weed Molds in Mushroom Culture". Annual Review of Phytopathology 9: 411-432.
198. Sinden, J.W. 1972. "Disease Problems in Technologically Advanced Mushroom Farms". *Mushroom Science* VIII: 125-130. Mushroom Growers Association. London.
199. Sinden, J.W. 1979. *Sinden on Mushrooms: Collected Papers by Dr. J. W. Sinden and Associated Authors*. Maney and Son, Ltd., Leeds, England.
200. Sinden, J.W. 1980. "Strain Adaptability". *Mushroom News*, Dec., pp. 18-32. American Mushroom Institute, Kennett Square, Pennsylvania.
201. Singer, R. and A.H. Smith, 1958. "Mycological Investigations on Teonanacatl, the Mexican Hallucinogenic Mushroom", Parts I & II. *Mycologia* 50.
202. Smith, A.H. 1980. *The Mushroom Hunter's Field Guide*. University of Michigan Press. Ann Arbor, Michigan.
203. Smith, J.R. and W.A. Hayes, 1972. "Use of Autoclaved Substrates in Nutritional Investigations on the Cultivated Mushroom". *Mushroom Science* VIII: 355-361. Mushroom Growers Association. London.
204. Snell, W.H. and E.A. Dick, 1971. *A Glossary of Mycology*. Harvard University Press. Cambridge, Mass.
205. Song, S.F. and P. Liu, 1974. "The Comparison of Composts Made of Different Raw Materials for *Volvariella volvacea*". *Mushroom Science* IX (Part I). Proc. of Ninth Int. Sci. Congress of Edible Fungi, Tokyo.
206. Stamets, P. 1978. *Psilocybe Mushrooms and Their Allies*. Homestead Book Company, Seattle.
207. Stamets, P., M.W. Beug, J.E. Bigwood, and G. Guzmán, 1980. "A New Species and a New Variety of *Psilocybe* from North America". *Mycotaxon* 11: 476-484, Ithaca.
208. Stanek, M. 1971. "Microorganisms Inhabiting Mushroom Compost During Fermentation". *Mushroom Science* VIII: 797-811. London.
209. Stanek, M. 1974. "Experiments in the Cultivation of Various Edible Fungi in Czechoslovakia 1971-1974." *Mushroom Science* IX, Tokyo/Kiryu.
210. Stanek, M. 1974. "Bacteria Associated with Mushroom Mycelium (*Agaricus* bisporous (Lg.) Sing. in Hyphosphere". *Mushroom Science* IX, Part I: 197-207. Proc. 9th Int. Cong. on the Sci. Cult. of Ed. Fungi, Tokyo.
211. Steane, R.G. 1979. "Monitoring of Disease and Pest Levels in the Mushroom Crop as a Guide to the Application of Control Measures". *Mushroom Science* X: 281-302, Bordeaux.
212. Steineck, H. 1973. "Zur Ausweitung de Kulture Von Speiselpilzen-eine Ubersicht." *Gartenbauwissenschaft* 38:547-563.
213. Stern, W.T. 1966. *Botanical Latin*. Hafner Publishing Co. New York.
214. Stern J.A. and B.E. Proctor, 1954. "A Micro-method and Apparatus for the Multiple Determination of Rates of Destruction of Bacteria and Bacterial Spores Subjected to Heat." *Food Technology* 8: 139-143.
215. Stewart, L.J. 1970. "Practical Aspects of Ventilation". *Mushroom Growers Association Bulletin*, Feb., pp. 80-88, London.
216. Stevens, R.B. 1974. *Mycology Guidebook*. University of Washington Press, Seattle.
217. Stoller, B.B. 1962. "Some Practical Aspects of Making Mushroom Spawn". *Mushroom Science* V: 170-184. Proceedings of the Fifth Congress on *Mushroom Science*, Philadelphia.
218. Stoller, B.B. 1979. "Synthetic Casing for Mushroom Beds". *Mushroom Science* X, Part II: 187-216, Bordeaux.
219. Stuntz, D.E. 1979. "Key to the Illustrations of *Hypomycetes* in the Fungi". Vol. IV A. University of Washington, Seattle.
220. Szudyga, K. 1978. "*Stropharia rugoso-annulata*." *The Biology and Cultivation of Edible Mushrooms*, pp. 559-571. Academic Press, New York.
221. Suzuki, F. and S. Ohshima, 1974. "Influence of Shil-ta-ke (*Lentinus edodes*) on Human Serum Cholesterol." *Mushroom Science* IX (Part I), pp. 463.467. Proceedings of the Ninth International Congress on the Cultivation of Edible Fungi, Tokyo.
222. Suzuki, F., T. Koide, A. Tsunoda, and N. Ishida, 1974. "Mushroom Extract as an Interferon Inducer I. Biological and Physiochemical Properties of Spore Extracts of *Lentinus edodes*." *Mushroom Science* IX, Part I:509-520. Proceedings of the Ninth International Congress on the Cultivation of Edible Fungi, Tokyo.
223. Tetrault, R. 1979. "The Preventative and Curative Fly Program". *Mushroom News*, May & June. American Mushroom Institute, Kennett Square, Pennsylvania.
224. Tokita, F., Shibukawa, N., Yasumoto, T. and Kaneda, T. 1972. "Isolation and Chemical Structure of the Plasma Cholesterol Reducing Substance from Shiitake Mushrooms". *Mushroom Science* VIII:783-788. Proceedings of the Eighth International Congress of *Mushroom Science*s. Mushroom Growers Association, London.
225. Tokuda, S. and Kaneda, T., 1979. "Effect of Shi-ta-ke Mushrooms on Plasma Cholesterol Levels in Rats". *Mushroom Science* X, Part II:793-814. Proc. 10th Int. Cong. Cult, of Ed. Fungi, Bordeaux.
226. Tonomura, H. 1978. "*Flammulina velutipes*." *The Biology and Cultivation of Edible Mushrooms*, pp. 410-421. Academic Press, New York.
227. Toussoun, T.A. and Nelson, R.E. 1968. *A Pictorial Guide to the Identification of Fusarium Species*. The Pennsylvania State University Press, University Park, Pennsylvania.
228. Tschierpe, H.J. 1961. "Studies of the Influence of Carbon Dioxide on the Cultivated Mushroom." *The Mushroom Journal*, Mushroom Growers Association, London.

229. Tschierpe, H.J. 1972. "Environmental Factors and Mushroom Growing". *The Mushroom Journal*, Jan-Feb. Mushroom Growers Association, London.
230. Tunney, James. 1971. "Peak-Heating: An Exercise in Microbial Husbandry". *Mushroom Growers Association Bulletin*, March. London.
231. Uno, I. and Ishikawa, T. 1971. "Chemical and Genetical Control of Production of Monokaryotic Fruiting Bodies in *Coprinus macrorhizus*." *Mol. Ger*. 113:228-239.
232. Uno, I. and Ishikawa, T. 1975. "Metabolism of 3'5'-Cyclic Adenosine Monophosphate and Induction of Fruiting Bodies in *Coprinus macrorhizus*". *J. Bacteriol*. 120:96-100.
233. Urayama, T. 1956. "Preliminary Note on the Stimulative Effect of Certain Specific Bacteria on Fruit Body Formation in *Psilocybe panaeoliformis* Murrill". *Bot. Mag. Tokyo*. 70:29-30.
234. Urayama, T. 1961. "Stimulative Effect of Certain Specific Bacteria upon Mycelial Growth and Fruit Body Formation of *Agaricus bisporus* (Lange) Sing." *Bot. Mag*. 74:56-59. Tokyo.
235. Urayama, T. 1967. "Initiation of Pinheads in *Psilocybe panaeoliformis* Caused by Certain Bacteria". *Mushroom Science* 6:141, Amsterdam.
236. Urayama, T. 1972. "Influence of Extracts from Fruit-Bodies of *Agaricus bisporus* and Some Other Hymenomycetes Upon Pinhead Maturation in *Marasmius* Species". *Mushroom Science* VIII: 647-656. Mushroom Growers Association, London.
237. Van Zaayen, A., 1972. "Spread, Prevention, and Control of Mushoom Virus Disease". *Mushroom Science* VIII:131-153.
238. Van Zaayen, A., 1979. "Resistance of *Agaricus* Species Other Than Bisporus to Mushroom Virus Disease". *Mushroom Science* X: 759-772.
239. Visscher, H.R. 1975. "Structure of Mushroom Casing Soil and its Influence on Yield and Microflora". Neth. J. Agaric. Sci. 23:36-47.
240. Visscher, HR., 1979. "Fructification of *Agaricus bisporus* (Lge.) Imb. in Relation to the Relevant Microflora in the Casing Soil." *Mushroom Science* X, Part I: 641-664.
241. Vedder, P.J.C. 1978. Modern Mushroom Growing. Educaboek, Culemborg, Netherlands.
242. Visscher, H. R. 1981. Personal Communication.
243. Wasson, R.G., Hofmann, A., and Ruck, A.P. *The Road to Eleusis*. Harcourt, Brace, Jovanovich. New York.
244. Watling, Roy. 1980. *How to Identify Mushrooms to Genus V. Cultural and Developmental Features*. Mad River Press, Eureka.
245. Widder, P. and Abitbol, J.J. "Seasonality of *Trichoderma* Species in a Spruce Forest Soil". *Mycologia*, vol. 72:775-784.
246. Wood, D.A. 1979. "Studies on Primordium Initiation in *Agaricus bisporus* and *Agaricus bitorquis* (Syn. *Edulis*)". *Mushroom Science* X: 565-586. Bordeaux.
247. Wood, F.C. 1937. "Studies on 'Damping Off' of Cultivated Mushrooms and Its Association with *Fusarium* Species". *Phytopath*. 27:85-94.
248. Wuest, P.J. 1970. "The Use of Steam for Phase II". *Mushroom News*: Nov., American Mushroom Institute, Kennett Square.
249. Wuest, P.J. 1970. "A Unitized Forced-Air Ventilation System for Mushroom Growing". *Progress Report No. 302*. Penn State University, College of Agriculture, University Park, Pennsylvania.
250. Wuest, P.J. 1978. "Compost and the Composting Process", *Mushroom News*, May.
251. Wuest, P.J. 1979. "Guide to Watering Mushrooms". *Mushroom News*, July, pp. 14-17. Kennett Square, Pennsylvania.
252. Wuest, P.J., L. Schisler. "Watering and Ventilating from Casing through Cropping in Commercial Mushroom Production". *Special Circular 140*. College of Agriculture, Penn State University, University Park.
253. Wright, S.H. and Hayes, W.A., 1979. "Nutrition and Fruitbody Formation of *Lepista nuda* (Bull. ex. Fries) Cooke". *Mushroom Science* X: 873-884. Proc. of 10th Int. Cong. Cult. of Ed. Fungi, Bordeaux.
254. Yamamura, Y. and K. Cochran, 1974. "A Selective Inhibitor of Myxoviruses from Shi-ta-ke (*Lentinus edodes*)." *Mushroom Science* IX (Part I). Proc. of the 9th Int. Sci. Cong. Cult. of Ed. Fungi, Tokyo.
255. Zadrazil, F. 1974. "The Ecology and Industrial Production of *Pleurotus ostreatus*, *Pleurotus florida*, *Pleurotus cornucopiae* and *Pleurotus eryngii*". *Mushroom Science* IX, Part I. Proc. of the 9th Int. Sci. Cong. Cult. of Ed. Fungi, Tokyo.
256. Zadrazil, F. 1979. "Grundlagen fur Das Wachstum Von Hoheren Pilzen in Schuttsubstraten". *Mushroom Science* X, Part I: 529. Proc. of the 10th. Int. Cong. Cult. of Ed. Fungi, Bordeaux.

All Of RR's Notes On Mushroom Cultivation

by

Roger Rabbit

compiled by dumbfounded1600

original source: https://www.shroomery.org/forums/showflat.php/Number/8468463/fpart/all/vc/1

Table of Contents:

COLONIZATION
GRAINS/JARS/LIDS/SOAKING/SHAKING/G2G
CASING/FC/CO2/HUMIDITY/CAKES/OUTDOOR/SOAKING/MISTING MARTHA/GREENHOUSE
TEK/SUBSTRATE/CASING ADDATIVES
METABOLITES/LIGHTING
LIGHTING
LC/AGAR/CLONING/STERILE PROCEDURE/HELP/PROBLEMS/OTHER
HARVESTING

THEY'RE SOME MISINFORMATION/OUTDATED INFO SO CHOOSE IT WISELY.

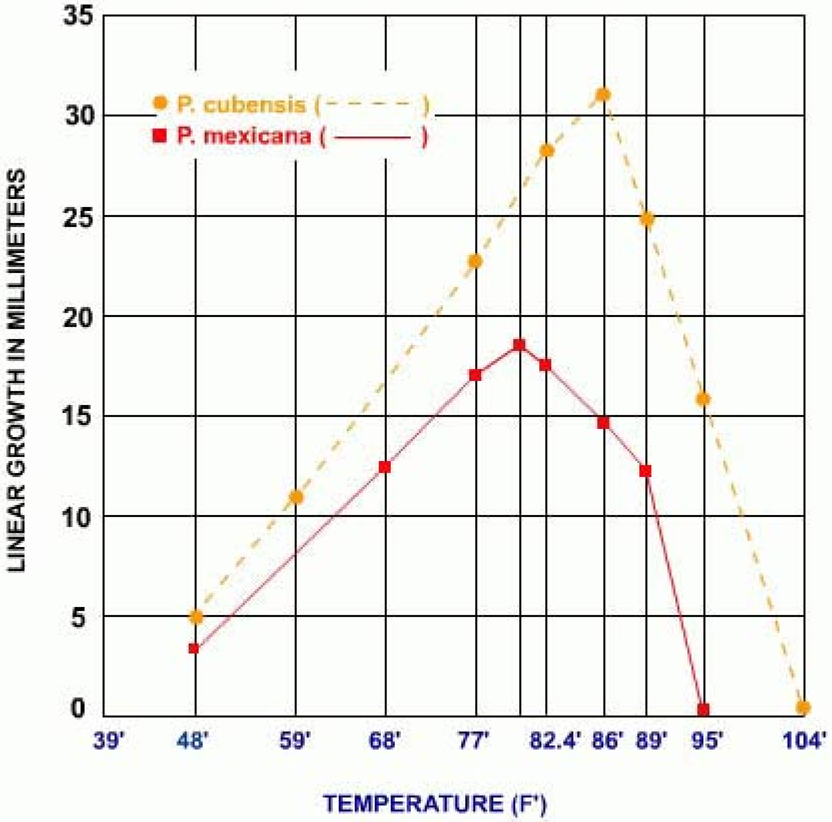
COLONIZATION

LIGHTING COLONIZATION - Incubating dark is another thing in Paul Stamets 'The Mushroom Cultivator' that needs to go away. The old advice of "incubate in total darkness" is bunk. Those words were written by Stamets in TMC 20 years ago, and he disavows that advice today. There is no harm or benefit from keeping jars in the dark. Expose them to normal room lighting from day one. There is no reason at all to ever have your mycelia in the dark. Darkness will only delay pinning. If you give light from day one, your yields will go up, and you won't face overlay problems. I've found no benefit or harm from allowing the grain jars to be exposed to light from day one. If a few pins form in the grains, it is actually a good thing. Contrary to popular belief, a few pins in the grains can be spawned right into the manure or straw (or used in grain to grain transfers) and they do not rot or otherwise cause contamination. There is evidence they actually help to give a faster, more uniform pinset in the eventual flushes. Stamets believes it's the hormones or other chemical triggers in the pins that do this. Exposing light from day one, one jar out of a hundred will make an early pin or two, but I simply spawn those pins right into bulk substrate along with the grains with zero ill effects. (In other words, small pins don't contaminate when spawned to bulk along with the grains). Twenty years ago, Stamets wrote in TMC to "incubate in total darkness" and people stick to that as if they were the words of god. However, Stamets no longer teaches incubation in darkness, and I agree. If you visit fungi perfect, you'll see 10,000 square feet of incubation area, with 8' fluorescent tubes lighting the entire area for ten to twelve hours per day. Of course myc will grow in the presents of light. IME myc grows faster in the absence of light also in nature myc colonizing substrate is most always not exposed to light so when we do not know for sure we will try to mimic nature which IMHO is the intelligent thing to do. Paul is a pioneer and is always learning as are we and things (ideas) will change again as we begin to really understand better what nature has given us.

COLONIZATION - And I've been trying to correct that disinformation for years. It's all based on a chart somebody mailed to Stamets many years ago showing 86F to be the peak temperature for growth of cubensis on a Petri dish, and everybody just accepts it as though Moses carried it down from the mountain on a tablet of stone. However, every single experiment I did to try to duplicate that with extremely accurate temperature monitoring was unable to verify that bogus 86F figure. What I have repeatedly found regardless of strain is that cubensis colonization remains rather flat from about 75F through 81F. Beginning at 83F, the rate of growth falls off sharply. By 86F, growth has slowed down nearly 50% what it was between 75f and 81F. These experiments were conducted on Petri dishes that produce little to no heat because of the very thin layer of mycelium. In jars, up to several degrees of heat is produced by the colonizing mycelium; so definitely don't go over 80F to 81F if you're looking for maximum rate of growth. Furthermore, bacteria and thermophilic molds such as *Mucor*, the black pin mold are stimulated by higher temperatures. Therefore using an incubator set to 86F is certainly favoring bacteria and molds, while slowing down mushroom mycelium growth. Below is a picture of one of my colonization shelves.

It sits in my bedroom at normal room temperature and quart jars of rye berries colonize fully in ten days, and pf jars colonize fully in 14 to 21 days, but usually closer to 14. How often do we see posts where people have incubators set at 86F, and they're asking why their jars aren't colonized after four to five weeks, and they have large spots of yellow liquid forming? The liquid is metabolites that the mycelium secretes in response to stress, usually from competitor molds and/or bacteria. What has happened, is they've slowed down the mycelium while stimulating the competitors.

COLONIZATION - I have found little to no difference in colonization speeds between 75 and 81F. Growth falls off rapidly at 83F and above, not 87F. That chart above [see below] is bogus, period.



I have tried dozens of times to duplicate it and it can't be done. It was apparently made by someone who did ONE grow with sloppy note taking, and sent the results to Paul. Growth is much slower in cold temperatures until you hit 69F, where it speeds up quite a bit until about 75F, where it remains 'flat' until 81, then is flat again until 83, where it falls off fast beginning at 84. By 'flat' I mean there is no discernible increase or decrease in rate of growth within those ranges. Jars will colonize as fast at 75F as they will at 80F. I've proved this time and time again with every strain in my collection. Growth also falls off rapidly above 84, and this is why so many new folks have problems with incubators set at 86F, and jars that 'won't colonize'. The figures I give are substrate temperatures, not air temperatures. The temp inside the jar is 1 to 5 degrees higher than the surrounding air, depending on where in the colonization cycle the jar is. The heat produced falls off fast as the jar approaches full colonization. If you live in an igloo, (or near the waterfront) by all means build an incubator, but keep it in the normal room temperature ranges for best results. I see no reason to set one above 80F, and lots of reasons not to. Here's a picture of one of my shelves for colonizing jars. The substrate bags are there because I ran out of room on the other shelf. These are in a room at normal room temperature, and exposed to light nearly all day. I don't even put the pf jars on a top shelf where it's warmer. Of course, I had a good teacher on how to make them up, as everyone will soon know.

COLONIZATION - I've been saying that for years. My Petri dish studies a few years ago showed that cubensis reaches peak linear growth between 75F and 80F, then is flat until 83F, where it starts to slow down. Mycelium at 86F is growing at about 2/3 the speed of mycelium at 80F. In addition, the higher temps tend to stimulate thermophilic molds and bacteria. There's LOT'S of good information in TMC, but that 86F figure is one of the errors. When I did it there were ten Petri dishes colonizing at each temperature, in separate containers. I went through well over 200 Petri dishes of mycelium for no other reason than to determine the temperature that stimulates fastest growth, other factors being equal. That was a far more controlled study than the one reported over 20 years ago. If someone else wants to repeat the experiment, go for it. I consider the matter closed. Paul doesn't even repeat that 86F figure, which someone else sent him. Bottom line was the tubs that had Petri dishes between 75F and 81F showed no difference in growth. Below 75F, and above 81F growth slowed down, with a rapid drop in colonization speed below 70F and above 83F. At 86F, a Petri dish would be 2/3 colonized, while its sister at 75F would be fully colonized. Rate of growth at 86F was exactly the same as rate of growth at 72F, with fastest growth as said, occurring between 75F and 81F. Note that these tests were for linear growth in the two-dimensional plane of a Petri dish. In three-dimensional space such as in grain jars or bulk substrates, the effects of thermogenesis need to be considered, so ambient temps should be lowered slightly to compensate.

TEMPERATURE COLONIZATION - 80-83F is optimal growth incubation temperature but anything past 81-83F increases the chances of thermophiles a.k.a contamination/bacteria. The 86F myth is based on a flawed agar study where heat isn't generated on Petri dishes. Mycelia growth declines rapidly at 86F and above. Paul Stamets later reviles that that is misinformation and should be lower. If it drops into the 60's however your speed of colonization will go slowly. 75-78F or at room temperature in the 70's is perfect for jars. If you're comfortable in a t-shirt in your house the jars are ok. Heating jars in incubator causes a lot of condensation, condensation is where the inside 'Temperature' differs from the outside. This has nothing to do with humidity. Condensation is the enemy of mushroom cultivation. It breeds bacteria and any moisture that is stuck to the walls is moisture that is NOT in the air any more, making your crop suffer. You should read up every week about how many noobs come in asking if they've cooked there jars because there temperature met all the way to the 100F +. This is why I disagree as well as speeding up a few days later, why? To run into more problems? For bulk substrates I wouldn't go higher then 80F as they already create enough heat by themselves.

COLONIZATION - 80F is fine for incubating, but don't exceed 81F or growth will slow. 86F is not optimal for cubensis. Stamets quoted somebody else who supposedly put out some Petri dishes in various temperatures and reported that to him, so he printed it. I've tried to duplicate that experiment, and after several times, I reached the positive conclusion that mycelium rate of growth is fairly flat from 75F to 83F, with it falling off sharply at 84F and above. It should also be noted that glass is an insulator, so the heat produced by the mycelium has no place to go and can easily spiral up into the range where growth falls off and thermophilic molds are encouraged. That's why I recommend normal room temperature for incubation, even if it is a tad slower. The benefits of a lower contamination rate far outweigh the extra day or two earlier they might colonize at a slightly warmer temperature. Besides, you should be waiting a week after full colonization anyway before birthing or spawning in order to allow the mycelium to consolidate its hold on the substrate.

COLONIZATION - I have not used an 'incubation chamber' in several years. If you maintain your house at normal indoor temperatures, your projects will do just fine. There is certainly no need to incubate jars over 80F, and to do so raises contaminant risks considerably. The inside of your jars will be 3 to 4 degrees warmer than the surrounding air. If you heat a chamber up to 86, your jars will be near 90, and much more likely to contaminate. I colonize on a bookshelf in a spare bedroom, and no attempt is taken to prevent the jars from receiving normal room lighting. I then fruit in a small greenhouse type enclosure with no heat applied during the growing process. If it's deep winter and your room is a bit cold, run a small space heater to heat the entire room to 75 or so. That temperature will work just fine for colonization, as well as fruiting. There's no need to make growing any harder than it already is. Keep it simple.

COLONIZATION - Do you know of one place in nature where cubes fruit naturally that does not have a difference between daytime and nighttime temperatures? I've read ever since 1985 that 86F is best, usually because of somebody simply repeating what they've read somewhere, then somebody repeats that, and so on and so on. Now, over 20 years later, they're still repeating it, and it's still wrong. In my grow room, the day and night temperatures fluctuate as much as 20F. When I say normal room temperature that means 72F to 78F. There is zero increase in rate of growth of cubensis above 80F, and mushroom mycelium often stalls out and bacteria is encouraged in warm anaerobic environments, such as is found in the bottom of non-vented tubs commonly used as 'incubators'.

COLONIZATION STORY - Let me tell you guys a story. My fellow moderator Roadkill and I were filming a video segment on pf jars over at my brother's house a month or two ago. Later that day, my non-mycologist brother moved everything we left behind out to his garage, jars included, just to get them out of the way. I told him it didn't really matter, as I just wanted to film the process of making/inoculating the jars. Three weeks later, I went over there and guess what? All of the jars were fully colonized. The temperature of his garage during this time varied from the mid 30's to the low 50's. (He lives about 50 miles from the Canadian border) So, if properly made pf jars can colonize in three weeks at those low temps, why bother with silly incubators?

INCUBATION - Mycelium will not colonize faster at 86F. That is flat out wrong. The state of growing mushrooms has progressed way past what was thought 25 years ago. Furthermore, the incorrect information presented 25 years ago said that 86F was an optimal SUBSTRATE temperature, not air temperature. Since there is up to a ten-degree increase in substrate temp over air temp, based on those 25-year-old figures, you should colonize at no more than 76F ambient air temperature. However, maximum mycelium growth occurs at a substrate temperature of 80F to 82F, with a drop off in colonization speed above that. Anyway, this has all been covered to death already, so there's no need to repeat it all over again.

COLONIZATION - Incubators cause way more problems then they solve. I haven't used one in years. Glass is an insulator and holds heat very well. I've seen up to a ten-degree increase over ambient in the temperature inside the quart jars of grains, when a thermocouple is inserted into the center of the jar. The other problem with using a tub as an incubator is stale air. It does little good to have filters and holes in your lids if they all just vent into a sealed tub. Normal room temperature is fine for colonization of mycelium. Colonization speed peaks in the 75F to 81F range, and falls off dramatically above 83F. Stamets published a chart in one of his books that said 86F is the fastest for growth, and that is just plain wrong.

INCUBATING/COLONIZATION - Normal room temperature is the way to colonize jars. People who build incubators have a higher rate of contamination and other problems and those who succeed only have a minor decrease in colonization times. 75F to 80F is perfect for colonizing, and you should be able to find a nice place in your house that has that temperature, such as a top cupboard shelf in your kitchen or an upper bookshelf in the den. Colonizing jars need gas exchange that they don't get in a sealed tub.

COLONIZATION - A fan helps humans to cool off because it speeds up the evaporation of sweat from our skin. A fan will not make your jars any cooler at all because there are no sweat glands on glass. Find a cooler spot. That could be against the concrete floor in the garage or wherever. Placing your jars on a cookie sheet full of cold tap water should help bring the temp down as well. You could fill it just before you go to work and by the time the water heats to ambient, you'll be home to change it out with cool water again. Get creative. Just try to keep the temp in the low 80's or less.

COLONIZATION STORY - Last year, while visiting my brother, I inoculated a bunch of jars for him, thinking he was actually interested. This was in December. I went back in February, and found he didn't have time to bother with them, so put them out in the garage. Temps outside were in the teens and twenties, and in the unheated garage, 30's to low 40's. The jars were fully colonized. I took them home and they fruited like mad. Low temps slow things down, but that's all. I keep master culture slants in the refrigerator for years.

COLONIZATION - There is no need to keep them dark. I'd suggest tossing out that sweet looking incubation chamber and let them colonize on a bookshelf at 74F to 78F. Don't shake ANY jars at inoculation, and don't shake pf jars ever. I also don't buy into the turning them upside down thing either unless you made them too wet or they're water logged on the bottom. The CO_2 exchanges just fine out the top during colonization via the air currents that are created by the heating that is caused by thermogenesis.

COLONIZATION - The science of mycology is progressing very fast, and what was written 25 years ago isn't necessarily accurate today. Perhaps if you got one of stamets' later works, you'd see he no longer uses that 84F to 86F figure, nor does he recommend incubating in total darkness. I take it a step farther by recommending against 'incubating' at all, having found over my 35+ years of experience that room temperature is the best compromise between speed of colonization, and contamination prevention.

COLONIZATION - 81F should be considered the maximum 'good performance' ambient temperature in the colonization area for colonizing jars of mushroom mycelium. If your temp is higher than that, try finding a cooler place. Thermal death doesn't occur until much higher than that, but thermophilic molds and bacteria are encouraged at higher temperatures, and the 'rate of growth' of mushroom (cubensis) mycelium falls off sharply beginning at 83F. The oft-quoted figure of 86F is just plain wrong.

COLONIZATION - Wild swings in temperature cause air exchanges between the jars and the outside. If the changes are rapid, they can easily be too much for the filtering material, especially if only dry vermiculite is used. I don't recommend incubators, but find a nice room that holds at least to within five degrees or so. 75F to 81F is ideal. Above that, the returns are not worth the increased rate of contamination that will be experienced.

COLONIZATION - 80 to 84 is way too hot to incubate grains. Any temp over 80 will favor molds and bacteria and not mushroom mycelium. One must bear in mind the mycelium produces heat as it grows. If your jars are in an environment of 84F, the inside temp will be over 90F. That reduces the growth of the mushroom mycelium and encourages bacteria. Always incubate grain jars at room temperature. Good luck!

COLONIZATION - Actually, from my experiments, rate of growth falls off rapidly above 83F with cubes. I've found fastest colonization temps to be in the 78F to 81F range (ambient temp). Temperatures above that will stimulate molds and thermophilic bacteria, while actually slowing down mushroom mycelium. A lower colonization temp will give you reduced contamination percentages.

COLONIZATION - My quart sized grain jars from agar wedges or grain-to-grain transfers are fully colonized in ten days to two weeks at normal room temp of 72F to 77F, depending on time of day. If it takes longer than that, something else is wrong. Higher temps slow down mycelium growth while stimulating competitor molds and bacteria.

COLONIZATION - 86F is too hot. That figure comes from an error in Paul Stamets TMC, which was corrected in later books. However, many growers only have TMC, thus refer to it as the bible, as if everything we've learned about mushroom growing since 1985 when artificial cultivation at home was in its infancy is void.

COOLING COLONIZATION/FC - You can also freeze quart sized plastic bottles of water, and place them in your terrarium to absorb heat. If you can keep five or six in your freezer, you can rotate as necessary to keep one or two in the FC at all times during the hot months.

COLONIZATION - Light has little to no effect on colonizing mycelium. I colonize all of my substrates in an open room exposed to ambient room light the whole time. Pinning only begins when fruiting conditions are introduced, other than when something goes wrong.

COLONIZATION - Foil should be removed as soon as they're sterilized. It's important to have gas exchange during colonization, so I don't put them in a box of any kind. My jars colonize on an open bookshelf at normal room temperature.

COLONIZATION IS FOR NOOBS - Get rid of the incubator, and put the jars on a shelf where they can receive normal room light during colonization. This will speed up pinset once you case them. (or birth or whatever)

COLONIZATION - Thus, any ambient temp over 81 for jars or 78 for trays of manure, and you're slowing down mycelium growth while promoting bacteria and thermophilic fungi.

COLONIZATION - Darkness is irrelevant to colonizing mycelium. Don't go over 81F. Room temperature is just fine as long as you keep your house t-shirt warm in winter.

BULK SUBSTRATE COLONIZATION - 80F is too hot for colonization of bulk substrates. The interior of your substrate is well over 90F when ambient is 80F.

COLONIZATION - Mycelium growth slows down at 83F and above, so you're hindering growth with that incubator. Use room temperature

GRAINS/JARS/LIDS/SOAKING/SHAKING/G2G

JAR FILTERS - When you use type or polyfill or synthetic filter disks (best) you drill three or four 1/8" (1mm) holes for gas exchange and screw the lid down tight. I use the lids upside down, so the metal is against the glass, but that is just to make them easier to get off later. The rubber tends to stick, making it a chore to lift the lid when you need to open the jar. The jar will always be at the same pressure as the rest of the PC, so there is no problem there. When I sterilize water or test tube slants, I screw the lid down tight with no filter or vent holes. It's not a problem, provided you don't ever pop the weight off the PC at the end of the cycle before pressure has returned slowly to zero on its own.

FILTERS GRAINS - Tyvek is functional and cheap or free. However, synthetic filter disks last for many years and thousands of uses. Tyvek tends to get ripped at the edges of the lid, often resulting in only one use. It can also twist, making the lid very hard to get off later for G2G or other procedures. The time spent cutting tyvek to shape each time will easily outweigh any cost advantage. Even though I sell tyvek on my website, I still prefer filter disks.

FILTERS - Mycologists have used cotton filters at least since the 1930's. It's a proved filter material. The cotton must be kept totally dry, as must any filter material. Synthetic pillow stuffing is better, as are synthetic filter disks and/or tyvek. Coffee filters are for coffee. Using one as a contaminant barrier would be like trying to use a chain link fence as a mosquito barrier.

FILTERS - I think you should run an experiment and give us a report. It's so cheap, I toss it out after a use or two. One pair of XXXL coveralls will make over 200 filters. Synthetic filter disks, which are PFTE, can withstand bleach hundreds of times, which I know for a fact.

FILTER - We filter our colonizing jars because sterile, uncolonized substrates will grow whatever lands on them. There is no reason or need to filter a fruiting chamber. Aquarium pumps and air stones will not deliver nearly enough air exchange for good results.

COFFE FILTER GRAIN JARS - In addition, trying to stop contaminants with a coffee filter is like trying to stop a bird with a barbed wire fence. Look at a coffee filter under a microscope. The holes in it are ten times or more the size of contaminant spores.

COFFEE FILTER - First of all, trying to stop contaminants with a coffee filter is like trying to stop a mosquito with a barbed wire fence. Two coffee filters are like having two strands of barbed wire. Is that going to stop a mosquito???

COFFEE FILTERS AS BACTERIA PROTECTORS - Trying to use coffee filters to stop bacteria and trich is like trying to catch a mosquito with a fish net. Isn't going to work.

FILTER - If you're going to use micropore tape as a filter, use two layers.

TAPE - Actually, The tape is only for the sterilization cycle. After that, you can take it off because the dry vermiculite is the filter. Masking tape won't breath. The tape is simply to help keep water out of the holes. If you'll elevate the jars totally out of the water during sterilization, you don't need tape. Simply cover the lids with foil to prevent the condensation that drips off the lid of the kettle or pressure cooker from entering the holes. If you use medical tape such as micropore or other 'breathable' tape, you can leave it in place and inoculate right through it.

MICROPORE TAPE - Probably. The 'micropore' tape is a 3M product. I don't know if it's a trademarked name or not. I suspect breathable medical tape is going to be the same thing, whatever the brand.

MICRO PORE TAPE - The tape goes on BEFORE sterilization. It has no purpose afterwards. It's to prevent water that gets under the foil from penetrating your jars during the sterilization process.

POLYFILL - 'Synthetic cotton' = 'polyfill'

SYNTHETIC FILTER DISK - The bands are what hold the metal lid on. The lid itself isn't threaded with two-piece lid mason jars. You don't want the rye grains to come into contact with the filter disk. Be sure to put the metal lid on first with two 1/8" holes (1mm), then put the filter disk above that, then the metal ring goes on last. This way, when you shake the jars, the grain doesn't get the filter wet with grain juice. A wet filter is a vector for contaminants because they can colonize right through the interior of the filter. Be sure to keep your filter disks dry for best results. Use a glove box, and simply lift one side of the lid enough to squirt the solution in. Squirt it down the side of the glass. Do that in two or three places, then tighten lid. Be sure to use a glove box.

SYNTHETIC FILTER DISKS - I soak synthetic filter disks in a ten percent bleach solution for fifteen minutes before using. It's probably not necessary though since they'll be pc'd anyway on the next cycle. Bleach doesn't hurt them. I have hundreds of synthetic filter disks that are well over ten years old and have yet to have a single one fail.

SYNTHETIC FILTER DISKS GRAIN JARS - They're the best filters you can get. Don't inoculate through them though. Use a glove box and simply lift the lid up and squirt under it. I have some that are six or seven years old and still being used after hundreds of times.

SYNTHETIC FILTER DISKS - Check a local chemical supply. The filter disks are made from PFTE and usually filter down to less than 1 micron. 90mm is a standard size. You might be able to find them from a local, non-mycology related source.

SYNTHETIC FILTER DISKS - You can't beat synthetic filter disks though. They're ten times thicker than tyvek and last a lifetime. I have some that have been through hundreds, perhaps thousands of cycles.

SYNTHETIC FILTER DISKS - Do NOT inject through a filter disk. If you use synthetic filter disks, you'll need to lift the filter up to squirt under it. Do this in a glove box, or in front of a flow hood.

SYNTHETIC FILTER DISKS - Synthetic filter disks are my favorite. I have some from the first batch I ever bought, ten years ago. I still use them after hundreds, if not thousands of times.

SYNTHETIC FILTER DISKS - They all work. My preference is synthetic filter disks because they can be used hundreds or even thousands of times.

SYNTHETIC FILTER DISKS - You need to use the lid under the disk. If you only use a filter disk, the grains will dry out before full colonization.

SYNTHETIC FILTER DISKS - Synthetic filter disks work great for LC, but as with all filters, be sure to keep it dry.

TYVEK - A single layer of good tyvek should be enough. Don't put cotton in the middle of a tyvek sandwich or it will get damp and ruin your day. Use kite tyvek or tyvek from a set of coveralls. Don't use three layers unless you have a lot of holes in the lid. You'll cut off the gas exchange. I drill four 1/8" holes, and use two layers of tyvek, both on the outside of the lid so they stay dry.

TYVEK GRAIN JARS - I've used tyvek coveralls for filter material many times. I doubt that's your problem. Tyvek is used for safety coveralls because it allows the person's sweat vapor to escape, while still providing protection from the toxins.

TYVEK - Don't use post office tyvek for anything but mailing. It's a violation of federal law. Go to your local home mega center, and in the paint department, they'll have tyvek coveralls for five or six bucks. Get a few of those to cut up.

TYVEK GRAIN JARS - Actually, the tyvek goes over the lid, not under it. You want the tyvek on the outside so it stays dry. Put down the lid with small holes in it first, the tyvek second, and lastly the ring to hold it all in place.

TYVEK LIDS - Not only will they dry out that way, they'll cause premature pinning by providing air exchange, as opposed to just gas exchange. You need to at least tape over 90% of the tyvek with duct or shipping tape.

TYVEK - Go to your local home mega center and get tyvek coveralls from the paint department to cut up and use as filters. Post office tyvek is not only illegal to use but subpar as far as performance goes.

TYVEK - Post office tyvek is thinner and not as effective at stopping contaminants as the multi-ply, much thicker tyvek used in wrist sleeves and coveralls.

TYVEK - The tyvek should be OUTside the lids. If you put the tyvek inside the jar, you'll have a much higher contamination ratio.

TYVEK - Tyvek coveralls, wrists leaves are washing machine safe.

KITE SUPPLY STORE. TYVEK - http://www.intothewind.com/search.

COLONIZING JARS/BAGS - I've scanned my crops and colonizing jars and substrate bags with an IR camera and noticed up to five degree F increase in quart jars of rye, and up to a 15F degree increase over ambient when shooting at large gusseted spawn bags, but that was 15F over ambient at the edge of the bag. I'm sure the center was hotter. I usually have up to 200 spawn bags colonizing at any given time on shelves in my grow room, and I never heat it, even in the coldest months of winter. The temperature in the room rarely drops below 75F, even when it's freezing outdoors. We use minimal heat in the rest of the condo as well, simply leaving the grow room door open is enough to supply most of the heat we use.

FLIPPING JARS PF/GRAINS - Don't flip jars. As prisoner said, it screws up the vermiculite filter. CO_2 doesn't need to 'drain' out by flipping the jar upside down. That's a bit of disinformation that once typed refuses to die. The reason is the heat produced by the mycelium causes circulation that takes care of the gas exchange.

FLIPPING JARS PF/GRAINS - When you examine them, don't turn them upside down. That can cause the vermiculite barrier to shift. You can expect there to be contaminant spores near the air/inoculation holes, and if you shift the jar around, those mold spores can be shifted down and into the substrate, contaminating it.

COLONIZING JARS - Bear in mind, a substrate on the dry side will colonize faster than an overly wet one, so if your jars didn't colonize, something else might be wrong. It's also a good idea in a dry climate to run a humidifier in the room your grow is located to raise the ambient humidity.

COLONIZATION/INCUBATING GRAIN JARS - The moisture comes from condensation on the lid of the pressure cooker that constantly rains down on the jars below. That's the reason for the foil. I'd start over and get it right. Don't waste spores getting off on the wrong foot.

PF CAKES - Cakes often pin on the bottom because that's where the moisture runs to by gravity and also it's closer to the perlite, thus the humidity is higher and stimulates pinning.

COLONIZATION - Grains colonize much faster when prepared on the dry side. I do it that way by design. If you see visible moisture on the surface of the grains, they're too wet.

GRAINS/SUBSTRATE - Most often, if a cased substrate smells of alcohol. Some fermentation has, or is taking place.

COLONIZING JARS - If the mycelium runs out of O_2, it will stall and die.

G2G TRANSFERS - One should never use a jar that isn't at least 100% colonized for a grain-to-grain transfer. The biggest reason is that since sterilization is a relative term, it's never complete. You have a window of opportunity to get your grains colonized before the contaminants that survived pressure-cooking come back to haunt you. If you grain to grain with uncolonized grains, you add their age to the age of all the grains in the receiving jar, possibly contaminating them all. The difference between 100% colonization and 80% colonization should be no more than two days, so don't risk failure for a measly 48 hours.

SPAWNING G2G - Bang the colonized jar against a tire or phone book to separate the kernels. Next, open each freshly sterilized rye jar one at a time, and pour and twist from the grain master to deliver a small amount into each receiving jar. Try to have the receiving jars open for no more than five seconds, so plan ahead and work fast. Clean all jars with alcohol before opening. Wear latex gloves and wash them with alcohol after putting them on. As said above, use a glove box, or even better of course is a laminar flow hood. Good luck.

G2G GENERATIONS - It was ANNO that pointed out - young vigorous mycelium does better than old. However, I have gone out 5 G2G transfer generations - without ill effect. Genetics plays a part in it. In nature - mycelium is designed to grow out & fruit in one season. You can FOOL with Mother Nature - but extending it to far out - usually brings on some mutation.

G2G TRANSFERS - When you do a g2g, unscrew the ring, then with your thumb and forefinger, squeeze the ring so you capture the lid and the filter and lift all three as one unit. Pour from the donor jar to the open receiving jar, and then replace the lid as one unit. Have the receiving jar open for no more than a few seconds when doing this.

G2G TRANSFERS - I shake the master jar to loosen the kernels, and then do the g2g right away. After the transfer, gently shake the receiving jar, and then shake again at 20 to 30 percent colonization. I never wait for the grains to recover before shaking or g2g. They'll recover right into the fresh grains of the receiving jar. Good luck.

G2G TRANSFERS - Four grain-to-grain transfers should be considered the outside limit, but chances are you'll see growth slow before then anyway. Cloning from the third would make it the fourth, and wouldn't help. Go back to spores. A given cell line can only divide so many times before loss of vigor sets in.

G2G TRANSFERS - Never use a jar that pins early for grain-to-grain transfers. Usually, something is the trigger for early pinning, such as bacterial contamination. I know you don't g2g brf jars, but had it been a grain jar, you wouldn't want to use if for transfers.

G2G TRANSFERS - You can generally use a fully colonized grain jar to inoculate up to ten times that amount of sterilized grains. How many bags per jar simply depends on what size spawn bag you used, and what size jars your grains are in.

LC > G2G - Fastest colonization I ever had is with G2G.

SHAKING GRAIN JARS - I disagree with more than one shake during colonization. A shake at 20% to 40% will spread those kernels around, ensuring the rest is colonized within a few days. After shaking, there's a 24 to 48 hour period where the mycelium is merely trying to recover from damage, but isn't growing into the new grains. If you shake more than once, you force the mycelium to waste needless energy re-knitting, when it could be aggressively growing. The same applies at the end. Shake to loosen the grains, and then spawn them to your tray of manure or straw, etc. Let them recover directly into the manure or casing layer. If you shake, then allow to recover, they're damaged again by spawning, so must recover yet again. My point is that shaking is abusive, but a necessary abuse. Simply keep it to a minimum.

SHAKING GRAIN JARS - From my tests, it actually slows down colonization, by forcing monokaryons to reach out farther before finding a compatible mate. Dikaryons colonize and feed much faster than monokaryons. By shaking, you disperse the ungerminated spores over a larger area. I prefer to inject, and then let the jars or bags sit for several days until you see germination, or if you inoculate with an agar wedge, wait until the mycelium has moved off the wedge and into the grains before shaking. If you do the above, only one shake is required during the whole process.

SHAKING GRAIN JARS - When you shake a jar, it will 'look' uncolonized for a few days until it recovers. You only need to shake once at 20% to 30% colonization. Your second and fourth jar above look about done. Give them a few days past full colonization before spawning to bulk. The third jar needs a few days. They'll all look like the first jar after shaking. That's normal. Shake just before spawning by banging the jar against a tire, and then layer into your manure or whatever you're using as bulk. The mycelium on the grains will recover right into the substrate.

SHAKING GRAIN JARS - You need to break it up at 20% to spread the mycelium around so it can inoculate the rest of the rye. It will speed colonization up. If the mycelium fails to recover after breaking it up, it means the grains were contaminated anyway. Read up on 'shaking'. That's what we do with rye grain jars. I use a bicycle tire to bang the jar against to break it up. With bags, simply massage the bag between your fingers to break up the clumps and spread them around the bag.

SHAKING GRAIN JARS - If you shook right after inoculation, it will be fuzzy at first. I suggest inoculating and NOT shaking for at least a week. By shaking, you spread the spores around, forcing monokaryotic mycelium to hunt for a mate. If you let the spores germinate right next to each other, they form bonds and become dikaryotic in the first few days after germination, and then grow with the thicker, rhizomorphic mycelium.

SHAKING GRAIN JARS - Shaking right after inoculation is a mistake. You should allow the spores to germinate in close proximity to each other so they can pair up and become dikaryotic. Monokaryotic mycelium is thinner and much slower growing than dikaryotic mycelium. By shaking the jar, you required it to colonize with the slower growing monokaryons.

SHAKING GRAIN JARS - The best way to break up a grain jar is to beat the hell out of it against a fully inflated tire. I use a bicycle tire and air it up nice and hard before use. Half a dozen bangs usually separates every kernel from every other kernel. If not, it's a good sign your jar was contaminated with bacteria, which makes the kernels stick together like rubber.

SHAKING GRAIN JARS - Grains should NOT be shaked after inoculation with spores. Monokaryotic mycelium grows far slower than dikaryotic mycelium. It's best to inject the spores and leave them to pair up in close proximity to each other. Once they pair up and become dikaryotic, shake once to distribute the grains, which speeds up colonization.

SHAKING GRAINS - Grains should only be shaken once during colonization. More than that slows down progress. Shake at anywhere from 15% to 30%. The grains will begin to show recovery by 24 hours, and by 48 hours, things should be growing rapidly again. You'll have to shake again after full colonization to remove the grains.

SHAKING GRAIN JARS - If the grains don't break up easily when banged against a tire, it's a good sign that they're contaminated with bacteria. It is even more likely since you're using an incubator. Grain jars; especially quarts should never be placed in an incubator, but rather allowed to colonize at normal room temperature.

SHAKING COLONIZED GRAIN JARS - Colonized grain jars break apart very easily by banging against a fully inflated bike tire, and you NEVER want to scoop out grains. It damages the kernels, leaving them open for bacteria, and adds an additional vector of contamination to the process.

SHAKING - Never hold a jar in one hand while holding a camera in the other. That doubles the amount of shaking going on, screwing up the picture. Put the jar down. Rest the camera on a chair, book, or something else if you don't have a tripod.

SHAKING - Shaking always makes them look 'uncolonized' because it beats the mycelium on the surface of the grain. After a few days, as you found out, they recover. You should only shake a grain jar once at 25 to 35 percent colonized.

SHAKING GRAINS COLONIZING - There is no need to shake more than once. Three times is mycelium abuse. Please continue the same thread for ideas along the same lines. Don't start a new thread with each question.

SHAKING GRAIN JARS - Shake at about the 25% stage. Shaking prior to that only batters the myc & then it takes time to heal & start growing again. You ever hand a black eye? How long did it take to heal?

SHAKING GRAIN JARS - Grain jars shouldn't be filled more than 2/3 to 3/4 full to allow room for shaking. If you'll bang the jars against a fully inflated bicycle tire, the kernels will separate easily.

SHAKING - A quart jar of healthy mycelium on rye that is shaken at 25% will be completely colonized three to four days later. If not, something is wrong.

SHAKING GRAIN JARS - Shake jars well at 20% to 30% colonized to spread the grains around. They're usually fully colonized four to five days later.

SHAKING GRAINS - Remember, when things look fine until you shake, then don't recover, it's almost always bacteria.

SHAKING GRAIN JARS - Shake, and if it recovers it's fine. If not, it was contaminated.

SPAWN BAGS - I really hate to disagree, but it's best to not shake at all just after inoculation. Leave the spore solution all in one spot so the monokaryons can find compatible hyphae nearby and do the sex thing. Once you have solid white mycelium growing, those are the dikaryons and they grow much faster than the wispy, grayish monokaryons that emerge from the spores. Many new growers mistake these for cobweb mold and toss out perfectly good projects because they shake at inoculation. If you shake the bag or jar early, you force the slow growing monokaryons to colonize much more of the substrate before finding a mate, thus slowing down the progress. I'd recommend giving the first and only shake at 30% colonization.

STORING GRAINS/PETRIS - Actually, grains have been found better for mycelium storage than agar slants, but unfortunately take way too much room in the refrigerator. However, I've used jars that have been stored fully colonized in the refrigerator for several years. Put them in the refrigerator at full colonization, and then when you remove from the refrigerator, allow three to five days at room temperature before spawning.

STALLED GRAIN JARS - In the overwhelming majority of cases when a jar stalls, it's due to lack of gas exchange. Make sure the holes are open on the lids. If you have a vermiculite barrier, you can loosen the lids or even remove them for a time. Jars rarely dry out.

GRAINS STORING - You can store colonized grains in the refrigerator, or use them for grain-to-grain transfers to expand your mycelium. Correct, removing jars from the refrigerator requires a couple of days of warm up before they start growing again.

SPAWNING - Make thin layers so they fill in the gaps quickly. I've found this has less of a chance of breaking kernels of grain spawn, which can allow contaminants to get a foothold in the uncolonized part in the middle.

STALLING JARS - They don't 'stall' without a reason. Either it ran out of air due to no holes for gas exchange, or it's contaminated with bacteria. You can't spawn uncolonized grains or the bulk is sure to contaminate.

SPAWN BAGS - Unless it's a HUGE bag, don't use over three to five ml of spore solution or liquid. More than that will be too much and throw off your moisture content.

STORING GRAIN JARS - They can sit for a couple of weeks at normal room temperature after full colonization without harm.

RYE GRASS SEED - Use twice as much grass seed by volume as water. For a 1-quart jar, use 1 1/4-cup rye grass seed, and 5/8-cup water. Add a pinch of gypsum between your thumb and forefinger per jar. Put a solid lid on the jar and shake well. Allow to sit for an hour or two, and then shake again. Replace the solid lid with a filtered lid, and PC for an hour at 15 psi. Rye grass seed makes an excellent grain master, because you can easily do a grain-to-grain transfer into 20 jars. I won't go over ten jars with rye berries. It's also a great spawn to bulk substrates, because of all the inoculation points. It also seems less susceptible to trichoderma then the larger rye berries. We usually don't recommend it to new growers because it often takes quite a few tries to get the moisture right. If it's too wet, the mycelium can't colonize. Ditto if it's too dry. The above plan should work out for you though.

RYE GRASS SEED - Rye grass seed needs to be mixed with half as much water by volume as you have grass seed. For a quart jar, I use 1 1/4 cup of grass seed, and 5/8 cup of water. Add a pinch of gypsum between your thumb and forefinger per jar. Half the amount of water can be substituted with brewed coffee. I put a solid lid on the jar after mixing and shake well. Allow to sit over night, and then shake again. Replace the solid lid with a filtered lid and PC for an hour at 15psi.

PREARING RYE - It's irrelevant. I bring rye to a raging boil after the 24-hour soak, with the stove on 'high', and have ZERO busted kernels. As shown in the video, rinse grains very well with hot tap water before the soak. Fill the kettle with hot tap water to begin the soak. Add gypsum. After 24 hours, bring to a raging boil for five to ten minutes, then drain and shake. I've never seen more than one kernel in a thousand busted when following the above.

RYE GRAIN - After a 24-hour soak, I once accidentally left the water in a rapid boil for nearly an hour. There were no burst kernels and they weren't any fatter than they'd have been after a ten-minute boil. I used them and they were fine. The secret against cracked kernels is to soak the grains first, and then to heat the water and grains together slowly.

RYE GRASS SEED - Rye grass seed is also excellent for spawning to bulk, and very cheap too. It's a bit trickier to prepare, but goes a long way when used for grain to grain transfers or for spawning to bulk substrates.

RYE GRASS SEED VS RYE BERRIES - I doubt you can get grass seed to fruit, although it makes excellent spawn. You want rye grain. Copes need the grains to be spawned into manure.

WBS - I gave up on wbs due to the inconsistent types of seed in it. It works, but rye is much better and only costs about 5 cents per quart jar if you buy it in 25 pound bags.

RYE GRASS SEED - If you simmer rye grass seed, you will ruin it. Soak only.

FLIPPING JARS - If the bottoms didn't colonize due to bacterial contamination, it will have no effect. If the jars didn't colonize due to excessive moisture that ran to the bottom, it will help, by draining it to the other end of the jar. Some growers think flipping upside down is to release CO_2, but this is incorrect. The heat produced by the mycelium produces circulation that does that job. I've never yet had a jar that wouldn't colonize the bottom, provided it was made correctly to begin with, using the proper amount of water AND the correct jars, which you don't have. BRF cakes do best in short fat jars, such as wide mouth half-pints.

PF TEK JARS - The biggest cause of failure with pf tek is not following proper sterile procedure. You the cultivator are the biggest single source of contamination, so be very careful. Thousands of bacteria are exhaled from your mouth with every breath, so wear a surgical mask. Millions of bacteria reside under your fingernails, so wear gloves, and wash them with alcohol before use. Use a glove box, and flame the needle of your syringe red hot before use. Alcohol might clean the outside of the needle, but contaminants can enter into the center of the needle and not be touched by the alcohol.

LIDS GRAINS - In addition, your order of assembling the lids is incorrect. You want the metal lid with holes first (make the holes no more than 1/8"), followed by the filter material, then the ring. This keeps your filter on the outside of the jar where condensation doesn't get it wet. Remember, if your filter gets wet, you're screwed. Bacteria in the air will colonize right through the material as if it wasn't even there. The reason for making the holes in the lid small is so that when you shake, the wet grains don't contact your filter material. A wet, nutrient saturated filter is sure to contaminate.

GRAIN JARS - Actually, half a teaspoon of bleach in a gallon of water will kill bacteria, but it throws the pH way off, so I don't recommend it at all, especially in grain jars, which prefer an acidic pH. I wouldn't inject water into a grain jar. If they're drying out, chances are, your gas exchange holes are too big. You don't want more than four 1/8" (3mm) holes. You could even get by with smaller holes. I use four 3/32" (2.4mm) holes for both 1/2-pint pf cakes and full quart grain jars. Larger holes can dry out the material and encourage invitro pinning.

GRAIN JAR SIZES - Quart jars are best suited for grains in my experience. Anything less, and there just isn't enough spawn for your bulk substrate. Due to the requirement to leave shaking room, a pint jar can hold more grains than two 1/2 pint jars, and a quart jar can hold more grains than two pint jars. Half-gallon jars are nice, but they really should be colonized at a 45-degree angle to help with gas exchange. I've had a lot of trouble with CO_2 concentrations when leaving 1/2-gallon jars standing upright.

GRAIN JAR LID - If you'll drill two or three small, 1/16" holes in the metal lid, the grains will never touch the filter when you shake. A fully inflated bicycle tire works great for banging jars against to break them up. Just make sure you have the tire pumped up nice and hard.

GRAIN JAR LIDS - I recommend using four 1/8" holes for gas exchange. If you use more than that, you run a risk of drying out your grains and/or stimulating pinning inside the jar due to having too much air exchange, as opposed to a small amount of gas exchange.

GRAIN JARS - As said, you soak for bacteria, not molds. If it turned green without opening, then plain and simple, your filter is not doing its job. Look for tears. Is it post office tyvek? If so, that could be the problem. I don't consider it suitable for mycology.

GRAIN JARS - A 1/2" hole in the lid is way too much for a small jar. In fact, with quart jars, I only use three to four 1/16" holes for gas exchange. A large hole will not only dry out your grains, but can lead to pinning before full colonization.

HALF-GALLON MASON JARS - My experience with half gallon and larger jars is they need to be incubated at an angle of 45 degrees to allow for gas exchange. They get stagnant standing upright with the lid/filter only on top.

RUSTY LIDS - Rusty Lids: It's harmless to the mushrooms and to you if eaten. Just don't cut your finger on the rusty lid. Lockjaw sucks.

PF CAKE JAR - Use 1 ml total for a 1/2-pint cake.

SIMMER OR NOT TO SIMMER - The above posts prove there are many ways to skin the proverbial cat. The important thing is to have the grains at twice their original dry size, with no burst kernels and no excess moisture in the jars.
After a 24-hour soak, the grains are fully hydrated, but personally, I boil for a few minutes after the soak for one reason-It allows the grains to steam off the excess moisture from the surface as the rest of the water drains in the colander. By shaking the colander, the grains release the excess moisture as steam.
Experienced growers are all successful and most have evolved their own tek for preparing the grains. As long as your grains seem dry on the outside, and are twice the original size without burst kernels, they are ready for the pressure cooker, regardless of how one goes about reaching that point. Some growers even dry the grains off with a towel.
I would say to any new grower to read the way the experienced cultivators do things and try a few ways. After you pressure cook your product, don't hesitate to toss it out without inoculating if things don't look right, and start over. Try, and then try again until you get it right. Once you find a method that works for you, stick with it.
Good luck.

JARS PRESSURE COOKER - It's really not about jars breaking, although sometimes they will. Here is the reason: At 15psi, the temperature in your PC and inside the jars is 250F. If you quick cool the PC, the substrate or whatever is in your jars is still at 250F, but now the pressure is gone. As we all know, water boils at 212f at sea level pressure. That means that the moisture in your jars will boil off. It will continue to boil off until the temperature of the substrate cools below 212F. There's an excellent chance that you will have destroyed the moisture content you worked hard to get right before sterilization. If you quick cool with bags, the filter won't expel the steam fast enough, so the bags inflate and burst, spilling whatever is in them. When the instructions say you can quick cool, you must bear in mind they don't build PC's for mushroom growers. They build them for kitchen food use.

PCING GRAIN JARS - Lids tight. If they're loose, there's a chance that contaminants will be drawn into the jar as the PC cools at the end of the cycle. Air in the jar won't expand and need to escape because the air in the pressure cooker is under the same pressure, thus it's equalized. It's best to let steam escape for a few minutes before placing the weight on or closing the toggle if it's a sterilizer, but don't let it go too long. Anytime steam is escaping from the PC, it's also letting moisture escape from your jars. If the PC is blowing steam wildly, it's also blowing steam wildly from your jars, possibly blowing the filter material and/or drying out your grains. This is the reason you never want to pop the weight off at the end of the cycle to let the steam out.

RELEASING PRESSURE PC GRAINS - One should never release pressure immediately after the cycle. The very rapid cool down from 250F to 212F while the grains or other substrate inside of the jars is still 250F will cause many jars to break. Furthermore, water at 250F must be under pressure to exist in the liquid state. Therefore, when you release pressure, you also release moisture from the substrate. That is a fact of physics. It can be made up for by adding more water to begin with, but now you're forced to figure out how much is going to be lost. That is beyond the reach of the new folks trying to learn so many other facets of the hobby. It's far better to tell them to NOT release pressure early to remove one more variable from the equation.

PRESSURE COOKING JARS - Jars should be inoculated as soon as possible after sterilization. I wish people would quit saying the jars need to cool past the point when they're cool to the touch. They do NOT stay warm on the inside of the jar longer than the outside by more than a few minutes at most. The water permeates every part of a grain or brf jar, and water is an excellent heat transferrer. If the jar itself is cool to the touch, then the insides will be also, and that includes the middle. Think about it. If you have a cup of coffee get cold from sitting out too long, it isn't still hot in the center.

NO NEED TO SIMMER - LOL the soak / simmer thing is something we all go through. My experience with "simmering" grains almost always led to mushy - sticky grains & on occasion - wet spot contamination - in jars. I prefer WBS because of its low cost & availability - everywhere. No simmer is necessary with WBS. Just experimenting around, I have supplemented WBS spawn with rye (5 % per batch), rape seed (5%) & cracked corn (5%) & had great results.

PCING GRAINS - PC'ing does not remove water from the grains unless you screw up and pop the weight off at the end of the cycle to let steam out. In addition, grains prepared on the dry side will colonize much faster than wet grains.

BURSTED KERNALS - Attempting to make your mycelium colonize busted kernels is like trying to get your car to drive cross-country on two flat tires-possible, but not recommended for good performance and speed.

STERILIZING GRAINS - I recommend 120 minutes for quart jars of grains to take care of bacteria.

SOAKING GRAINS - If you soak overnight, with the soak beginning in hot tap water, you can boil the grains for an hour or two and the kernels won't bust. They also won't take on any more water. Once the kernel is saturated, it doesn't absorb any more, no matter how long you boil. After the soak, add hot tap water to the soak water if necessary to fill the kettle as full as you can before placing on the stove. Heat to boiling, and then after several minutes, pour the water off. Shake the colanders so the steam can evaporate off the kernels, drying them. That's the main purpose of the boil, besides killing the germinated bacteria before pouring it down the drain. It also gives the grains sort of a pre-sterilization prior to the PC cycle. Don't skip the gypsum. It's worth a trip to the nursery.

SOAKING GRAINS - I soak anywhere from 4 to 24 hours. It really doesn't make much difference. The grains are only going to absorb so much, so you'll never over-hydrate by boiling. After a few hours to overnight soak, I let the pot boil for five to ten minutes, then drain into the colander. The steam that evaporates off the grains will dry the outside while the water runs down the drain. If you'll toss the colander around with the grains a few times to make them steam off, they're ready to load in twenty minutes. Gypsum serves two purposes. It adds calcium and sulfur, both essential mushroom nutrients, and helps prevent the grains from sticking and clumping up.

SOAKING GRAINS - 18 / 24 hour soak is a must do thing. Long a soak as possible, so long as WBS doesn't ferment (smell very badly), sprout, or rot is best. No simmer needed. If you have some aged / leached / steer / horse manure around, either brew some into tea, or add softball size handful into a nylon stocking (doubled up - several times) & add cup of strained tea, or use nylon stocking bag - like tea bag & leave it in the soak & stir halfway through soak. Adds significant N to soak water, which WBS absorbs & myc loves. You will get bigger better - everything.

GRAINS COFFEE SOAK - Use weak liquid coffee to soak your grains AFTER rinsing them in hot tap water. Rinse before the soak, not after. Once you've soaked in water or weak coffee, bring the soak water to a boil with the rye in it. It's all described in the tek posted above, and also on the video. I've used coffee grinds in grains, but there's little benefit. It's better as a substrate ingredient.

GRAIN SOAK PEROXIDE - It would be a waste to use peroxide in the soak water for two reasons. One, you want the bacterial endospores to germinate and grow during the soak, so the pressure cooker can kill them. Two, peroxide breaks down very fast in the presence of organic materials, so it would likely do nothing at all anyway. It would be long gone by the time you boil.

GRAINS SOAKING - I suggest a bit of hydrated lime if you're soaking in weak coffee, due to the acidity of the coffee. Use no more than a teaspoon for 2 gallons of soak water. If you're soaking in plain water, skip the lime.

Use one tablespoon of gypsum per gallon of soak water, regardless of how much grains are in it.

COFFEE SOAKING GRAINS - Yes. Mix it weak. About half or less the normal drinking strength. Add it hot. Use hot water for the rinse and add hot coffee later. The heat prevents the grains from germinating during the soak.

GRAINS SOAKING - As I said above, it isn't necessary to use long soak times with rye or wbs. If rye is used/PC'd before it starts to ferment, I actually like the scent.

COFFEE SOAK - Yes. I add coffee to grains, partly to lower the pH. Mushroom mycelium grows fastest at pH about 5.5 to 6.5.

COFFEE SOAK - If you use too much coffee, it will actually slow down growth.

FUNGICIDES FOR GRAINS/CASINGS - I found no problems when using banrot, and the fruits came out normal. It seems I used 1 tablespoon of Banrot 40WP per five gallons of soak water, but that could probably be reduced. Banrot will prevent fungi spores from germinating, but doesn't affect mycelium. It also seems to prevent bacteria. I once left a freshly sterilized jar of rye berries exposed to the open air for half an hour or so, then closed it up and a month later, it was still contaminant free. However, good sterile procedure renders it unnecessary for grains, and while soaking casing material in it will prevent trich and cobweb, proper pasteurization and good air exchange will also prevent mold on casing layers. I prefer growing without chemicals and am generally an organic gardener. The Banrot experiments were simply experiments. Dried and crushed Rhododendron leaves will also help prevent trichoderma and cobweb in casing layers.

GRAINS - You boiled the rye, but not the millet? Then mixed the two? That gives you two different grains with different levels of hydration. Draining for an hour does nothing. All the water that will drain out from a batch of rye does so within 1 minute. The water that is stuck to the surface of the grains, will make them too wet later. You need to drain after the simmer while the grains are still boiling hot, so you can let the steam dry on the surface. Avoid busted kernels at all costs. None is best. If you have more than just a few, do the batch over. If you've soaked, beginning in HOT tap water, there should be no busted kernels after boiling because they will have softened up. Did you leave the stove on high during the process? If so, your jars probably puked out all the moisture that was in the grains. You're supposed to turn down the stove as soon as the weight rattles. Turn it down so the weight either doesn't rattle at all, or rattles once every few minutes at most. Every time the weight rattles, moisture leaves the PC, and a corresponding amount of moisture leaves each jar of grains. That is basic physics.

GRAINS PREPARATION - One of the secrets of grain preparation, regardless of which grain, is to rinse the kernels very well before continuing with whatever preparation tek you're going to use. All grains get packaged with a lot of chaff and grain dust that if not rinsed out will cause the grains to stick together later and cause that sticky goo. Put your dry grains in a large kettle and fill with water as you stir it around. You'll see all the dust and other crap come floating up. Slowly dump out the water to get rid of the junk and repeat two more times or until the water pours off clear. Adding gypsum is also a great idea. It will take anyone a few tries to get the moisture content right, regardless of which grain or which tek you follow. If it's too wet this time, make adjustments next time, and so on until you work out your system.

GRAINS - The biggest reason for clumped up grains is the failure to rinse properly BEFORE soaking/simmering/sterilization. Rinse the dry grains so the dry chaff and dust and other debris can rise to the top and be poured off. Give two or three rinses and your grains will be clean and free of the dust that behaves like glue later. The second biggest reason for clumping is failure to use gypsum. If the grains are properly rinsed, and gypsum is added, they will NOT stick together later, even if you let them sit in the pc until they reach room temperature.

GRAINS - I strongly disagree with mixing vermiculite in grain jars. If you have excess moisture, it will soak it up. If you have the correct moisture, it will screw it up by making the grains too dry. The trick is to learn to get the right moisture content. Grains should be totally dry on the surface before loading jars. That's all. It's simple. The moisture inside the grains is what you want. Either use a towel to dry after draining, or drain the grains after a simmer, and toss them around in the strainer so the steam can dry the surface.

GRAINS - Make sure if you get rye from a feed store that it hasn't been treated with fungicides if you plan direct inoculation with spores. Many times, feed grain is treated with fungicides to prolong storage life in damp barns. If you inoculate with agar wedges or LC, the fungicides won't hurt because they only stop spores from germinating. Personally, I only use certified organic rye berries, obtained from a health food bulk supplier. It costs me $8.75 for a 25-pound bag, but it's worth the extra cost, imo.

GRAINS PREPERATION - As said above, prepare you rye properly and don't dilute it with vermiculite. That's a bogus tek to help beginners get away with being sloppy. In addition, because the vermiculite soaks up the excess water, you never learn to prepare grains properly. It's sort of like never taking the training wheels off your bike. They'd look pretty silly on a Harley someday.

GRAINS - 99% is not 100%, and you have no idea if the center of the jars was colonized or not. Uncolonized grains exposed to air = contamination. They should not smell earthy; they should smell like fresh mushrooms. The earthy smell in grains indicates trichoderma or other molds, so there's always the possibility they were already contaminated.

GRAIN WATER CONTENT - It's because fungus grows better on damp things than on wet things. The grains aren't really dry when properly prepared, they just 'look' dry. That allows the most amount of air in the spaces around the grains, thus favoring the mushroom mycelium over bacteria, which prefer a wetter, more anaerobic environment.

GRAINS - It's normal to see what appears to be uncolonized grains where they are pushed up tight against the glass. If that's all it is, they're good to go. Also, sometimes there's foreign material in the grains, so you might even be looking at a small rock or something.

PREPARING GRAIN - I boil in the water they soak in. The main reason for that is to kill off the live bacteria in the soak water before you pour it down your drain. The soak water can make for a pretty stinky kitchen sink drain if you don't boil it before pouring off.

GRAINS - Also, dumping grains into already boiling water as shown there is a mistake that often leads to burst kernels. Grains should be placed in cold water and slowly brought to a boil, or preferably soaked 24 hours to hydrate.

GRAINS - What causes spores to clump up is all that grit, dirt, and dust in their if you don't soak.

CASING/FC/CO2/HUMIDITY/CAKES/OUTDOOR/SOAKING/MISTING

CASING - A casing should be a non-nutritious top layer that is placed over a colonized substrate to help induce pinning and to supply moisture to the substrate and the developing fruits. You can use others with nutrition but it's best not to as this will cause overlay if your not careful. A casing of 50% Peat Moss, 40% Vermiculite, 10% Coco Coir is something called CAC' which some commercial growers use. This is fine but once again you have to watch it or it can colonize the casing for being nutrition and what's the point of a casing if it fully colonizes? With uncased substrate, wait for full colonization, and then place in the fruiting chamber. Try to keep humidity at 99%, since uncased substrates should be treated as cakes. Remember, when using a casing layer, we keep the humidity a bit lower to allow some evaporation from the casing, which is replaced by daily misting. A piece of wax paper layed loosely over the uncased substrate will help produce a micro-climate conducive to fruiting, but remember that even though it helps, wax paper is no substitute for a genuine casing layer. Incubate until you see mycelium coming up through about 20 to 30 percent of the casing layer. Sprinkle fresh casing material over that mycelium which is showing (That's what we call patching) and place in the FC. The best casing mix is 50% Peat, 50% Vermiculite, 10% gypsum, Teaspoon per cup of peat of Hydrated Lime. Mix the dry ingredients very well, then slowly bring to field moisture level and pasteurize. Also you can use jiffy mix as all it is Peat/Vermiculite/Lime treated but I see it less valuable as just making your own buying a block of peat moss/vermiculite/hydrated lime/gypsum and not having to deal with other shit or pasteurize. Sunshine Mix #3 also works though. The reason we use lime is to raise the pH and to make the casing layer inhospitable to competitor fungi, which are less tolerant of a high pH than established mushroom mycelium. Gypsum is not used to change pH. Gypsum contains both calcium carbonate and sulfur, thus it tends to keep the pH near neutral, preventing swings as the metabolites try to push the pH down. Calcium carbonate or hydrated lime is not used to counter the effect of the metabolites. As said above, that's what the gypsum does. Use gypsum on substrates such as compost or horse manure, but don't use lime. Save the lime for the casing mix, where you should use gypsum and lime together. Gypsum is added to help keep the kernels separated after sterilization and to provide calcium and sulfur, basic elements promoting mushroom metabolism. Using both these will keep contaminants at bay. What you want is a short term (Hydrated Lime) because the life of a casing is measured in weeks instead of months or years. Use hydrated lime to get the ph right at the start, and use gypsum at a rate of ten percent to the peat in your casing to prevent ph swings later. Pickling lime is hydrated lime. It's my favorite, and many commercial grow operations DO use it. Don't use limestone; limestone is for long-term use, such as in a garden. Casings, which flush for a month or so, do not need long-term ph adjustment. They need short term, therefore hydrated lime is what you would want to use. The most critical time for contaminants to enter a casing is during the initial colonization and first flush stages. Once the layer is fully colonized, it's very contaminant resistant. This is why we use Lime/Gypsum. A common contaminant that occurs in casings is the 'Cobweb Mold' which isn't toxic just very annoying that thrives in old stale air. You can melt this using 3% peroxide over the casing. It will not hurt the casing one bit; it's just annoying because you have to keep on it. Don't go easy spray as much as you can. Not in the one spot! Spray the entire casing. Bacteria in a bulk substrate are not a contaminant. Commercial mushroom farms toss out any fruits that have bacterial blotch growing on the fruits themselves. However, having bacteria present in the substrate is not a cause for concern, and in fact many agaricus species won't fruit at all from sterilized substrates. Casing layers are not pasteurized in commercial mushroom production in order for the casing to have a high microbe count. NEVER keep a terrarium or other grow tub sitting on the floor. Get a table or shelf to put it on. Over 90% of the contaminants in a room are within a foot (1/3 meter) of the floor. You can tell when your casing needs a mist by looking carefully at the cakes or casing layer. Allow them to dry slightly, then mist lightly. After a few grows, you'll be able to instantly tell when a project needs to be misted. You don't want them to dry completely out, or get waterlogged. Rhizos on top are a good sign. Let them grow. Knots form later. We using 'Perlite' in our casings because perlite works not by holding water, but by preventing clumping and providing lots of air pockets in the layer itself, which stimulates primordia. By mixing perlite with vermiculite, you get the best of both worlds... moisture retention in the vermiculite, and air retention in the perlite. Ph balancing isn't necessary unless you add peat, which isn't absolutely required for cubes. Just don't try to grow agaricus or other edibles without peat in the mix, because they won't pin. If you're going to case substrates, you want the humidity no more than 90%, with 80% being ideal. Too high a humidity is a major cause of weak or no pinsets on cased substrates.

CASING - You don't need alcohol, peroxide, heat treatment, bleach or anything else on the perlite. Just rinse, and then drain well. Leave no standing water. There is nothing sterile about a fruiting chamber. FC

Having a slightly acidic casing layer PH will not cause side pinning. Sure, you can mist with a bit of baking soda or hydrated lime in the water if you failed to balance the casing layer PH first, but as I said, that isn't the problem. An acidic casing layer will favor trichoderma and other molds, while mushroom mycelium is more tolerant of basic PH. This is the reason we use lime. As the mycelium colonizes the substrate, the metabolic byproducts produced begin to swing the PH lower. By the time pinning starts, you have a near neutral substrate, which is what you want.

Casing layers pin on the sides for several reasons, but most important to remember, they pin there when that's the best environment for them to form primordia. The crease between substrate and tray is a perfect microclimate. It's nice and humid down there and there is plenty of moisture for the substrate to work with. It's also protected from the spray from the mister, which will damage developing primordia if they get sprayed and are allowed to remain wet. When the mycelium is actively reaching/colonizing the top of the casing layer, back off on misting. A sheet of wax paper can be layed on top to hold in the microclimate you're looking for. It helps to wrinkle it up into a ball, and then spread it out again before laying on top of the casing. These wrinkles will ensure there is plenty of air circulating under the wax paper, while at the same time holding a high humidity level in your mini-environment under the wax paper.

It's normal for the substrate to shrink. It's more than loss of water because the mycelium is actually eating the substrate; therefore it naturally gets smaller over time.

At this point, I do not recommend liming the casing layer. You're trying to make it pin, not suppress trichoderma or other molds. If it only pins on the sides, you can be assured they'll grow into monsters. I doubt your total yield will be very much less, although it doesn't look as cool as a wild flush that hides the entire casing layer beneath a forest of mushrooms.

CASING - Exactly. Peat based casing layers should be pasteurized, not sterilized. It does no good to say something doesn't perform well if you don't follow proper procedure in making it. As I've said many times, the commercial growers have invested millions of dollars into research on ways to maximize crops. We can learn a great deal from them, and then expand on that knowledge. Edible and medicinal mushrooms with few exceptions are exponentially harder to grow then cubensis, so learn from those who are already at the next level. Growing cubes can be looked at as a way to learn mycology and then move on, or it can be looked at as a way to get some cheap drugs. Those who follow the latter are here today, freaked out by a trip and gone tomorrow. That's why there is such a huge turnover on this and other boards. Look at growing cubes as a way to 'learn the ropes' and then move to harder and more rewarding species. When you do that, the small things such as casing layer composition become much more important to get just right. Many species won't even fruit at all on a sterilized casing layer. Cubes will fruit, but poorly compared to how they fruit on a properly balanced, pasteurized casing layer, applied over a properly balanced, pasteurized bulk substrate.

FUNGICIDES FOR GRAINS/CASINGS - I found no problems when using banrot, and the fruits came out normal. It seems I used 1 tablespoon of Banrot 40WP per five gallons of soak water, but that could probably be reduced. Banrot will prevent fungi spores from germinating, but doesn't affect mycelium. It also seems to prevent bacteria. I once left a freshly sterilized jar of rye berries exposed to the open air for half an hour or so, then closed it up and a month later, it was still contaminant free. However, good sterile procedure renders it unnecessary for grains, and while soaking casing material in it will prevent trich and cobweb, proper pasteurization and good air exchange will also prevent mold on casing layers. I prefer growing without chemicals and am generally an organic gardener. The Banrot experiments were simply experiments. Dried and crushed Rhododendron leaves will also help prevent trichoderma and cobweb in casing layers.

PEAT MOSS CASING - You seriously need to read and study and not start a thread for every single question that pops into your head. The members can help answer what you don't understand AFTER study, but this isn't a place to learn everything. Commercial growers use buffered peat and NO vermiculite as casing. Their income depends on growing as many mushrooms as they can for the money they spend to grow them. Do you really think a multi-billion dollar industry is just throwing money away? Read, search and study. ALL the questions you're starting these threads lately for are already answered in detail, and available by a simple search, which is faster than typing a question. Those who know these answers are sick and tired of typing the same stuff hundreds of times, over and over again, and aren't going to do it anymore. Those who don't know the answer will make something up just to take a wild guess, and the disinformation continues...

BULK SUBSTRATES CASING - Thicker substrates cause a lot of problems. Layering will give faster colonization with less damage to your spawn than mixing. You'll have more success with thinner substrate layers. Don't even attempt a six or seven inch thick horse manure substrate. They will heat up, and also have the tendency to go anaerobic in the core, leading to contamination. You'll get far more bang for the buck with two trays of 3 inch substrate layers than one tray with 6 inches. Horse manure fruits very well uncased. A properly made peat/vermiculite casing layer will increase yields, but is by no means necessary.

UNCASED/CASED FC - With uncased substrate, wait for full colonization, and then place in the fruiting chamber. Try to keep humidity at 99%, since uncased substrates should be treated as cakes. Remember, when using a casing layer, we keep the humidity a bit lower to allow some evaporation from the casing, which is replaced by daily mistings. A piece of wax paper layed loosely over the uncased substrate will help produce a micro-climate conducive to fruiting, but remember that even though it helps, wax paper is no substitute for a genuine casing layer.

CASINGS - Primordia form in 99% humidity, and rarely in less. A casing layer can help to keep humidity at the surface of the substrate at 99%, even though the air in the fruiting chamber might be lower, therefore they allow for more sloppy technique. However, with less than upper 90's percent humidity, the casing layer dries out fast at the recommended level of air exchanges, defeating the purpose unless you mist heavily a few times daily. That's why I recommend 99% humidity for all growing, regardless of whether one cases his substrate or not.

LYSOL MUTATIONS - I want to scream every time I hear that. It's wrong. Lysol doesn't cause mutations. I can only catch it so many times, and this Lysol/mutant myth is spreading like a damn virus. Your new homework assignment is to spray Lysol near (not on) one of your fruiting cakes and report the results. Lysol is mostly alcohol and isn't good for mushrooms, but using it in the room isn't going to cause mutations. I spray the face of my flow hood with Lysol prior to transfers, so it's always blowing on something.

CASING - Mycelium needs light for much more than for the mushrooms to 'know which way is up'. Upon full colonization and a reduction in CO_2 levels brought about by increased FAE, light becomes an important pinning trigger, and must be bright enough to penetrate the casing layer so that hyphal knots can form from deep within the casing instead of just on top. Dim light will produce 'some' pins, but if you want one of those wall-to-wall flushes, use bright light. I hope this helps clear up any confusion.

CASING - Agaricus farmers use peat without the vermiculite, while people growing cubes tend to mix peat and vermiculite. There's a reason for this. Agaricus fruits at ten to twenty degrees cooler than cubensis in very low light. There is far less evaporation of moisture from the casing layer at lower temperatures, thus the reservoir effect of vermiculite is not as necessary. For a given volume, vermiculite holds more moisture than peat, thus combining the two results in a compromise that favors fruiting in warmer conditions.

CASING/CAKES - You pick the fruits that are ready to pick and leave the pins. The easiest way to re-hydrate a bulk substrate that is dry is to pour water around the edges of the tray so that the substrate floats a bit. Leave it overnight and pour off the excess water. Mist the casing layer well. Never pick the pins because it's common with many species to set pins for the first few flushes at the time of first flush. These pins remain dormant until their turn comes. If you pick them, you ruin future harvests.

CASING PERLITE - Perlite works not by holding water, but by preventing clumping and providing lots of air pockets in the layer itself, which stimulates primordia. By mixing perlite with vermiculite, you get the best of both worlds …moisture retention in the vermiculite, and air retention in the perlite. Ph balancing isn't necessary unless you add peat, which isn't absolutely required for cubes. Just don't try to grow agaricus or other edibles without peat in the mix, because they won't pin.

CASING LAYER - A casing layer allows us to be a bit sloppier on conditions. For example, if you have to leave for work every day for 10 hours or more, a casing layer will protect your substrate while you can't be there to mist. If you can hang around and babysit your crop, it makes little to no difference. Note this applies to cubes only. Other species fruit poorly or not at all without a casing layer, and many edibles won't even fruit on a pasteurized casing, it must be untreated.

SPORE DEPOSITS ON CASING - Heavy spore deposits do tend to hinder future flushes to some extent, but not to the point they describe. You don't need to leave them attached to the casing until you have a black mess everywhere in order to make prints. Pick them as the caps flatten out, but before they go crazy dropping spores. I have several totally sporeless strains. They're the way to go. Culture slants last for years in the refrigerator, making prints unnecessary.

LAYERING VS MIXING CASING - It seems to make sense that mixing would give faster colonization, but my experience is the opposite. By layering, the mycelium on the grains recovers and knits together, and then rapidly takes off and colonizes the rest of the substrate. In addition, since mixing 'can' damage the kernels, and a broken kernel is a prime site for contaminant spores to germinate, layering has the added benefit of less trauma to the spawn medium.

CASING - Bacteria in a bulk substrate is not a contaminant. Commercial mushroom farms toss out any fruits that have bacterial blotch growing on the fruits themselves. However, having bacteria present in the substrate is not a cause for concern, and in fact many agaricus species won't fruit at all from sterilized substrates. Casing layers are not pasteurized in commercial mushroom production in order for the casing to have a high microbe count.

CASING CONTAMINANT COBWEB - The most common contaminant during the fruiting stage is cobweb mold, but it's caused by lack of air circulation and exchange. The more you lift that lid and fan the better. There should be no dust. Wipe it off the top first, and of course, NEVER keep a terrarium or other grow tub sitting on the floor. Get a table or shelf to put it on. Over 90% of the contaminants in a room are within a foot (1/3 meter) of the floor.

MUTANTS - Mutants are pretty common. It wouldn't be from mixing B+ and TC. The mycelium only cares about A and B mating types, not the name somebody wrote on the syringe or print. You may end up with separate zones of each 'strain' or you may end up with a cross, or somewhere in between, but it won't be a hybrid since they're the same species anyway. Either way, it looks like not a half bad pinset you have started there...

CASING - A 'casing' is simply a non-nutritious top layer that is applied over a substrate in order to supply moisture and an environment that is conducive to primordia formation. It should not be used as a synonym for a tray, substrate, or total project. The purpose of a casing soil is to provide moisture and also to provide lots of little air pockets with high humidity to stimulate primordia formation.

FLUSHES BULK SUBSTRATES - True, but in that same time you could have replaced that with a fresh one and got started on another 80% of either 100 or 250, increasing your total yield considerably. It really doesn't matter with hobby grows anyway, but in the commercial field where yield per square foot makes the difference between profit and going out of business, it counts.

LAYERING CASING - I strongly recommend against leaving any grains on top of a substrate, exposed to air. If the grains dry out and the mushroom mycelium weakens, they become the perfect place for molds to start. Many growers get away with it, but the contamination rate will be higher over time. Grains should be covered with at least a very light layer of substrate, imo.

PERLITE CASING - Actually, perlite works very well in casing layers. It can't be used well in pf cakes, but in casing layers it helps to break up the peat and provide lots of O_2 in casing layer, which stimulates pins. Of course, peat moss can be used without any vermiculite or perlite at all. Just lime to balance Ph, and use gypsum at ten percent by volume of the amount of peat.

CASINGS FC - A layer of vermiculite under the substrate is counterproductive. I recommend against it. Some beginning growers do it so that if they over mist, the vermiculite soaks it up. However, if you fail to overwater, the vermiculite draws moisture from your substrate. The vermiculite on bottom can also cause the mycelium to pin there instead of on the top where you want it to.

CASING - It's very common for the mycelium to try to colonize the sides of the tray above the substrate line, especially if condensation is present, which I'm sure it is with your heater. Your fruiting chamber should be kept at normal room temperature, not heated. If it's too cold in your house, run a small space heater in the room, not the terrarium itself.

OVERLAY CASING - Overlay is matted, nearly dead mycelium. Full colonization, even if 100%. Overlay is matted, overgrown mycelium that makes the casing layer impervious to water absorption. A bit of rhizomorphic mycelium on the surface is ok. It's what produces primordia. Patch if you want to, but if you have primordia showing, don't.

OVERLAY CASING - Overlay is the condition that results when mycelium has been allowed to completely cover the casing surface. It is caused by prolonged vegetative growth temperatures, high CO_2 levels, and excessive humidity. If overwatered, the overlay will become matted, or, will form a dense, dead layer of cells on the casing surface.

CASING - I've been saying unpasteurized casing material works better for years, but it's heresy around the OMC where half the growers PC their casing material. Chances of Dactylium mold contamination are higher with an untreated casing layer, but if one can manage proper air exchange, results are superior, ESPECIALLY with cubensis.

CASING - Use gypsum at up to ten percent of the peat. Don't count the perlite and/or vermiculite. Test it with pH strips, and adjust with hydrated lime as necessary to get a starting pH of 8. When they say it has lime added, it means to make it right for plants, which generally like about 6.5 pH, which also happens to favor trichoderma.

CASING - You apply it to your fully colonized substrate and cover it up. You then place it on a shelf out of the way, at normal room temperature for a few days. When the mycelium pokes through a few days later, introduce to fruiting conditions. Read up on patching. It's optional, but does increase yield and pinset.

COLONIZING HIGH CO_2 - One benefit of a high CO_2 level during colonization is that less of the actual carbon in the substrate is converted to CO_2 gas. In other words, if you allowed too much fresh air during colonization, more of the substrate would be 'consumed' by the time the mycelium got to the fruiting stage.

CASING - I would look for a mix without fertilizer if possible. It really won't hurt your fungus, but it could stimulate algae. The chemical plant food won't feed the mushroom mycelium or contaminant molds, but for my grows, I'd prefer to keep it away. I don't even use that stuff on plants.

CASING/JARS - Bear in mind, a substrate on the dry side will colonize faster than an overly wet one, so if your jars didn't colonize, something else might be wrong. It's also a good idea in a dry climate to run a humidifier in the room your grow is located to raise the ambient humidity.

VERMICULITE CASING - Actually, vermiculite can provide moisture to support a flush, but it doesn't fit the definition of 'casing', a term which is tossed around and abused fairly loosely. Furthermore, cobweb mold LOVES plain vermiculite, which lacks the beneficial organisms to fight it off.

COLONIZING MANURE - Leave the substrate loose and airy. I like to add a touch of vermiculite to manure for that purpose as well. A slightly dry substrate will actually colonize faster, so I don't think that's the problem. I make mine dry on purpose, and then dunk before first flush.

COLONIZATION SPEED - Nobody can answer that. There are too many factors besides strain that go into pinning. Also, there's no 'strains' that just colonize slower. Colonization speed is related to substrate moisture level, preparation, gas exchange, amount of inoculants, etc.

CASING - What you want is a short term (Hydrated Lime) because the life of a casing is measured in weeks instead of months or years. Use hydrated lime to get the ph right at the start, and use gypsum at a rate of ten percent to the peat in your casing to prevent ph swings later.

CASING - You don't finely grind up casing layer ingredients. The courser it is the better. It's important for air to be able to penetrate the entire casing layer. A few small pieces of debris in the peat doesn't hurt a thing. I never remove them. That's the reason we pasteurize.

CASING - You want upper ninety to near 100% humidity with lots of air exchange. Misting is required. Even at 99% humidity, the proper amount of air exchange will dry your casing layer (which is a pinning trigger), thus you need to mist to replenish the moisture.

COLONIZING - In addition, colonizing mycelium as agar pointed out, generates its own heat. The process is called thermogenesis. I've seen up to a fifteen degree F increase in substrate temperature over ambient air temperature with manure-based substrates.

CASING - It sounds like the substrate and/or casing layer might be too wet. After awhile, you can get a feel for when a bulk sub needs water by picking it up and judging the weight. You can actually develop a very accurate feel for moisture content this way.

CASING - It looks fine to me. The substrate is supposed to shrink. It's being eaten. It will pin in a few more days, and it's ok to keep the humidity up. You don't need to reduce it until after the pins turn into small mushrooms. Until then, 99% won't hurt a thing.

SLOW COLONIZATION - The biggest causes of slow mycelium growth are a too wet substrate, and not enough gas exchange. Make sure the holes on your jars are open. If your substrate is too wet, there's not much you can do except fix it on the next batch.

WHY CO_2 LOW AND HIGH FC AND COLONIZING - If the CO_2 levels are too low during colonization, the mycelium will consume more of the substrate. By keeping the CO_2 levels high during colonization, we save the mass of our substrate to support the flush.

CASING VERMICULITE - Contaminants will easily germinate on damp vermiculite, and then spread their mycelium to your substrate below. The vermiculite barrier works in pf jars because it's dry. In addition, nothing 'wicks' contaminants, vermiculite or no vermiculite.

CASING - A 'casing' is a non-nutritious top layer that is applied over the fully colonized horse manure in order to supply moisture to the substrate below and to provide an environment suitable for pinning. A casing layer is optional with cubes.

MIXING - Often, they'll combine into one strain, but you'll never know, because there's very little difference between the various strains anyway, PE and the albinos excepted. It would be a 'cross' not a hybrid, which is an interspecies mating.

SUBSTRATE DEPTH FC - Two feet of substrate would go anaerobic in the core due to no air getting in, and rot. 8" seems to be about the maximum you can go with consistent success, but it better be loose and airy if you're going that deep.

FC. CASING FC - Incubate until you see mycelium coming up through about 20 to 30 percent of the casing layer. Sprinkle fresh casing material over that mycelium which is showing (That's what we call patching) and place in the

CLUSTERS - Clusters vs. single fruits are strain related. Often when multispore inoculation was used, you'll see one on first flush, and the other(s) on second and later flushes. The reason is that different strains are flushing.

CASINGS - Mycelium on the caps is not an indication of too much humidity. It's a combination of two types of mycelium on the fruiting body. It's more genetic in nature, occurring in some substrains more than others.

CASING/CAKES - However, it's normal for the substrate to shrink. It's not just from drying, but from the mycelium actually eating the substrate, so it naturally gets smaller over time even if you dunk it.

CASING WHAT IT'S USED FOR - The CASING is the non-nutritious top layer that is placed over a substrate to help induce pinning and to supply moisture to the substrate and the developing fruits.

CASINGS - They do shrink, but not typically on first flush. If this is first, they could be dry. Pour some water around the edges, then after a few hours, dump out any water that hasn't been absorbed.

CASING - However, it's normal for the substrate to shrink. It's not just from drying, but from the mycelium actually eating the substrate, so it naturally gets smaller over time even if you dunk it.

LATE CASING - Never add a casing layer after pinning starts. It leads to contamination under the casing layer, and also causes the pins that have formed to abort in many cases.

BETTER LAYERING BULK - If you spawn in layers, the spawn layer recovers very fast which then makes it resistant to contaminants as it colonizes the layers of manure.

CASING/SPAWNING - Contamination prior to first flush indicates your spawn was contaminated. Mold mycelium is white, thus you didn't notice it until sporulation.

CASING - It works great. It's just a bit spendier than buying a block of peat and a big bag of vermiculite. Sunshine mix #3 also works well. Don't forget to pasteurize.

CASING - Flush - It can either pin at will or once you see that the flushes are giving off continual harvests and the mushrooms look more haggard, it's done.

CASING RATIO - You can leave it uncased. I wouldn't go 1:4 with that. Stick to 1:2 or 1:3. Horse manure does fine at 1:4 and straw can be done at 1:10.

FREEZING CASING - No. Freezing will squeeze the moisture content out. Pasteurize tonight, then use tomorrow without freezing or nuking.

SPORES/CASING - Spores won't germinate on a fully colonized substrate. Harvest just before spore drop for best quality fruits though.

CASING - If it's waterlogged, the fruits will be small and rotten. If it's too dry, the fruits will be dry, cracked, and hard, plus small.

CASING - Vermiculite by itself is the poorest choice of a casing material. It's barely better than no casing at all.

CASING - If you wait until the mycelium is all over the top of the casing, then what is the use of the casing?

COBWEB ATTACK - 3% peroxide straight from the bottle in your mister will melt cobweb mold on contact.

CASING - Add 10% coir to your casing mix. That is somewhat like CAC'ing that some edible growers do.

CASING - Most often, if a cased substrate smells of alcohol. Some fermentation has, or is taking place.

CASING - Casing layer moisture content is critical; so don't leave it to a machine to figure out.

SUBSTRATE CASING - Substrate = Layer in which mushroom MYC feeds from.

CASING - Rhizos on top are a good sign. Let them grow. Knots form later.

WHY OVERLAY CASING - A dry casing layer causes overlay.

CASING - Casing layer = Layer on top, holds moisture.

PF TEK FC - Fine vermiculite holds more moisture per volume of measurement than course vermiculite; due to they're being more of it. The basic formula of 2-1-1 works great with fine or medium vermiculite, but if you're using course vermiculite, you might want to cut down a bit on the water. I've found that cakes as well as grains, and even bulk substrates colonize a bit better and faster if made up on the dry side. With cakes, it's easy to adjust the water down, and then simply do a dunk and roll at birthing to put the moisture in for the flush at that time. If the first batch comes out a bit too wet, simply reduce moisture by 10% to 20% on the next batch until you find the sweet spot. I'd still recommend the occasional fanning. You simply can't have too much air exchange, and the turbulence from fanning helps prevent trich from getting a foothold on your projects. Good luck!

PF CAKES - It's up to you if you want to roll in vermiculite after the second flush. If there's still vermiculite stuck to the cake, then it can do its job of absorbing water and supplying it slowly to the mycelium over time. If the mycelium has fully colonized the first batch of vermiculite you rolled in, then go ahead and roll after the second dunk. The idea is to have some uncolonized vermiculite on the sides and top of the cake to absorb water and act as a reservoir for the mycelium. 24 to 36 hours if fine for dunking depending on how much moisture the cake needs to absorb. If they're really lightweight, meaning they've dried out, then dunk longer. If they feel heavy, then they don't need to dunk as long. You don't have to worry about drowning them. They could survive weeks under water if they're in the refrigerator.

HYDRATING A CAKE - There's lots of ways to hydrate a cake. Dunk and roll is my favorite method. You're actually hydrating the individual mycelium cells, so it's a good idea to push the cakes a few inches under water so there's a bit of water pressure on them. Remove after 24 to 36 hours and roll in dry vermiculite, which is then heavily misted after being placed into the FC. Another method is to pile up vermiculite as deep as you can on top of the cake and keep that saturated. Another is to set the cake in a saucer of water. The straw method also works. These last methods are fine during a flush. Between flushes or prior to the first, I'd still suggest a dunk and roll. Mushroom farmers have been soaking substrates in water to rehydrate them for at least a thousand years. It's the time-proven method.

REHYDRATING A CAKE - You can also simply use your finger or a sharpie and make a small hole in the cake when you originally mix it and fill that with vermiculite. Then, simply pour water into the reservoir when the cake starts to dry out. Either way, don't keep the cake wet all the time or it will waterlog. Hydrate it, and then allow it to dry out a bit before wetting it again. If you dunk and roll prior to first flush, and then dunk between flushes, the straw tek isn't necessary.

SOAKING CAKES - I've seen pf type cakes survive two-week dunks in the refrigerator. I've also seen master slants under water survive two or three years in the refrigerator. You shouldn't dunk in the jars. It takes pressure to hydrate the mycelium. Dunking isn't hydrating the substrate, which is fully colonized. Dunking is to hydrate the individual mycelium cells, which takes time and a higher pressure outside the cell wall than inside (osmosis) for hydration to occur. Dunk in a large kettle or bucket, etc., so the cake can be pushed completely under water, thus providing the pressure required. Soak the cakes in this manner for 24 hours.

CASING/CAKES - Allowing a substrate to consolidate its hold on the substrate before introducing to fruiting conditions is good practice. By digesting more food before fruiting, better quality fruits are produced. Other than that, there are no known ways to readily increase potency in substrates. There's lots of talk about tryptamines, etc., but the claims of increased potency can't be independently repeated. I believe from my many experiments with hundreds of substrates and additives that potency is genetic. If your mycelium has enough food to produce mushrooms, it has enough food to produce the active ingredients as well.

PF CAKE FC - Place the cakes in the terrarium so that what was the top of the jar is now the bottom. The reason is the bottom of the jar is concave, thus it leaves an indentation on the bottom of the cake. This makes a nice 'bowl' to hold moisture later when it becomes the top and is filled with vermiculite. You can actually pour water directly on top of the cake, saturating the vermiculite in this 'bowl' and it will slowly hydrate the cake, supplying moisture for the flush. It's OK if mushrooms grow from the bottom of the cake. Just let them grow. They pick their own favorite place to pin, so don't mess with them.

PF CAKES - Stamets also explains the idea of consolidation in his books. It's not necessary with grains if you're going to be spawning to bulk or using for grain-to-grain transfers, but you do need to wait for full colonization. However, with pf cakes and other bulk substrates, it helps to wait some time after full colonization before initiating fruiting conditions. Doing so results in more prolific flushes. Failure to do so with some of the harder to grow edibles such as P. nameko and Shiitake sometimes results in no flush at all.

CONSOLIDATION PF CAKES - It isn't really necessary to wait for primordia to birth, but the idea is to give about a week after full colonization for the mycelium to digest some of the food it has just colonized. We call this process 'consolidation' and it makes for a much better pinset. Consolidation allows the mycelium to perform this process while still in the jars so they don't dry out before the flush. Those who birth right at full colonization often ends up with dry cakes by the time they flush, which reduces yields.

CASING/CAKES - You pick the fruits that are ready to pick and leave the pins. The easiest way to re-hydrate a bulk substrate that is dry is to pour water around the edges of the tray so that the substrate floats a bit. Leave it overnight and pour off the excess water. Mist the casing layer well. Never pick the pins because it's common with many species to set pins for the first few flushes at the time of first flush. These pins remain dormant until their turn comes. If you pick them, you ruin future harvests.

FC PF - The reason for waiting a week after full colonization is to allow the mycelium to consolidate its hold on the substrate. Until the mycelium digests some of the substrate it has colonized, it will not fruit. If you birth the day of full colonization, the week spent consolidating the hold, will be a week spent drying out the cake, thus making pinning harder and yields weak. If you wait a week after full colonization, pins often form within 48 hours of birthing/dunk and roll.

CAKES - Don't use distilled water for cakes, for all the same reasons you shouldn't drink it. Google it if you don't know what I mean. They contaminate much easier. Tap water is fine. For crying out loud, we've had lots of threads where people have dunked cakes in ten percent bleach, so the very small amount in tap water isn't going to hurt anything. Use tap, river, lake, spring, etc., but not distilled. Save your distilled water for making agar.

CAKES - A cake can only support a few mushrooms at a time, due to the size of the cake (substrate). If you get an awesome pinset on a cake, expect 80% of them to abort. Pick off the aborts when you pick the flush, but don't pick any pins that aren't black. Often, pins for the first two or three flushes set at the same time as pins set for the first flush. Once you pick the first flush off and dunk, they'll take off and grow.

HUMIDITY CAKES - My terrariums have a dozen or more holes drilled into the bottom. The natural air currents, since air is drawn from cold to warm, cause air to enter the bottom of the terrarium, work up through the perlite while being humidified along the way, then into the terrarium and back out the holes above the substrate. This provides FAE without fanning, and 95% to 100% humidity.

PF CAKES FRUITING FROM BOTTOM - I'd leave them. They'll push out from the bottom. Often, water drains by gravity to the bottom of a cake. They pin there because that's the best environment, thus they took advantage. If you flip the cake, it might work or they might abort. If you do decide to flip the cake, place it in a saucer of water overnight and allow the cake to soak up some moisture.

PF CAKES - Any cake that hasn't pinned after two weeks should be dunked and rolled again. Keep them at 99% humidity and normal room temperature. Inoculate a few cakes with oysters and cook them up for the family in an omelet. Then you won't have to worry about kids. In my opinion, mom and dads bedroom should be off limits to kids anyway. At least, that's how I raised mine.

PF CAKES - I'd recommend removing the trays, and then raking your fingers through the perlite to fluff it back up. Set small blocks or pieces of pvc on the perlite to hold the trays elevated. You could also build a wire rack for the trays to sit on. However, keep up plenty of air exchange even with the holes, as normally the substrate trays evaporate enough to maintain pretty good humidity.

PF CAKES - I didn't notice that the first time. You should wait one full week after full colonization before birthing. This allows the mycelium to consolidate its hold on the mycelium. They will rarely pin during that first week anyway, so keeping them in the jars keeps them in the high CO_2 environment, where they also lose less moisture to evaporation.

FC PF TEK - Most jars are concave on the bottom so there's a small well in the bottom of the cake. Put it into the fc where what was once at the bottom of the jar is now the top of the cake. This little divot can be filled up with vermiculite, and then you can pour water onto it every day to keep the cake fully hydrated. That's the key to good performance.

PF CAKES - We wait one week after full colonization to allow the mycelium to digest a bit more of the food it has colonized, thus allowing it to consolidate its hold on the substrate. It won't fruit before this week passes anyway, so it's best to leave in the jars. After a week, birth the jars, dunk and roll, and then place into fruiting conditions.

HUMIDITY - Condensation on the sides is in no way an indication of high humidity. In fact, it's an indication that you have low humidity because your humidity has been stolen from the air to be deposited on the surface of the terrarium. What it indicates is a temperature differential between inside and outside the terrarium. Nothing else.

PF CAKES - After rolling in dry vermiculite, I hope you misted several times over the next few hours to fully hydrate the vermiculite. Don't mist the sides of the terrarium, as it does no good. Aim the mist up into the air and let it fall directly on the cakes. In fact, after the dunk and roll, aim the mister right at the cakes and soak them well.

FLOODING CAKES FC - What WILL flood your cakes is pumping from a humidifier AFTER the air is already at 100%. That's why I recommend three to five inches of well-drained perlite for a terrarium, and no mechanical humidifier. This way, if your humidity reads less than 95%, it means you need to calibrate your hygrometer.

FC PF - There should be ZERO standing water in the perlite. Having standing water relegates that perlite that is underwater useless. Rinse the perlite; drain well, and then place into the terrarium. Three to five inches of well-drained perlite will deliver 95% humidity, provided you've drilled those small holes into all six sides.

CAKES FC PERLITE - You're not supposed to let them sit on the perlite. It causes them to wick up water from below, and also to attempt to grow into the perlite. Put down a jar lid or something to separate them from sitting right on the perlite so they won't become waterlogged. If they do, they won't fruit.

PF - You should NOT see condensation on the sides of the terrarium, especially with holes in the sides for air exchange. Condensation indicates one thing and one thing only: A temperature differential between inside and outside the FC. It does not indicate humidity in any way, shape, or form.

CAKES - This gives you a place to fill with vermiculite, which you can then pour water into in order to keep the cake hydrated during the flush. They'll fruit either way, but divot side up gives a nice moisture reservoir, to counter the small size of the cakes which often limits fruit size.

PF CAKES - If you used the dry vermiculite filter per the pf tek, you can loosen the lids with no problem. Don't move the jars around or turn them upside down or anything silly like that because it can cause the vermiculite filter to shift, allowing contaminants to reach the rice flour below.

PF CAKES - Moisture in a pf cake often drains to the bottom of the cake from gravity, thus pinning starts there. In addition, right against the perlite is the most humid microclimate, thus it encourages pinning. It's also the area that any perlite will stick to the cake simply by geography.

CAKES - Often, the mycelium will set way more pins than it can support. Since there's no way a pf cake can support 48 mature mushrooms, expect the majority to abort. Start really giving it a lot of water. You can put a pile of vermiculite on top of the cake and then keep it wet.

SOAKING CAKE - A member recently dunked his cakes for two weeks, thinking that putting them in water and then refrigerating was the best way to store them. Guess what? They survived and did just fine. I'd still recommend 24 to 36 hours max though.

CASING CAKES - Mushrooms depend on a LOSS of moisture from the substrate to fruit. If you saturate them, or keep a steady moisture level, they fruit poorly if at all. Mushrooms are not plants, which benefit from steady moisture levels.

CAKES/FC/HUMIDITY/PINNING - It should rise and fall. FAE will lower the humidity, and then you mist to replenish it. That's what you want. Evaporation of moisture from the casing layer or substrate is a major pinning trigger.

CAKES - Try to keep normal room temperature, and near 100% humidity. Mist as required keeping the vermiculite on the outside of the cake moist. Three or four light mistings per day are superior to one soaking.

CASING - Scratching seems to have benefits with button mushrooms, but in my experience, it does little to no good with cubensis. I tried it many times, and it seemed to set back progress every time.

PF CAKE - That slime is the reason I recommend to rinse the cakes well both before and after the dunk. Rinsing before the dunk helps prevent it, and rinsing after the dunk removes any that has formed.

CAKES DUNK AND ROLL - You're supposed to mist after the roll in dry vermiculite to get the vermiculite that stuck to the cake moist. Otherwise, the vermiculite will suck moisture from your cake. Yes, mist it now.

PF CAKES - Cakes often pin on the bottom because that's where the moisture runs to by gravity and also it's closer to the perlite, thus the humidity is higher and stimulates pinning.

CASINGS/CAKES - Since hyphal knots to primordia to pins takes at least two to three days, those pins formed because of what you were doing before you made the changes.

PF CAKES - I always add a tablespoon of gypsum to each multiple of the basic recipe of 2 cups vermiculite, 1 cup each of brf and water.

CAKES - People need to realize that a greenhouse isn't appropriate for pf style cakes because they require a very high humidity.

BRF CAKES - No water should squeeze out of BRF mix, no matter how hard you squeeze. Follow the recipe next time.

CAKES - After each flush, allow the cakes to sit for a few days to rest, and then dunk for 24 to 36 hours again.

CAKE FC - With lots of pins without the correct moisture the excessive pins can drain a cake in no time.

GYPSUM PF TEK - In fact, I add a tablespoon of gypsum to the basic 1,1,2 pf recipe.

CO_2 - CO_2 will build up in a terrarium, whether or not holes are drilled into all six sides. The levels will be lower than they would be without holes drilled and/or fanning regularly, but will still be above normal ambient. With oyster mushrooms and lion's mane to name two species that are very CO_2 intolerant, you need to fan a few times per day, even when using my terrarium design. The point above is that even with 100 holes in the floor of the fruiting chamber/terrarium, CO_2 levels will still be elevated. The holes help, but don't make for maintenance free fruiting. In other words, gravity won't 'drain' the CO_2. I hope this clears up any lingering confusion. In addition, CO_2 is not the only reason we provide air exchange. The other important reason is that contaminants prefer stale air, while mushroom mycelium prefers fresh, moving air.

CO_2 - CO_2 doesn't 'sink to the bottom' or 'pour out like water'. It mixes with the air and raises the CO_2 content. CO_2 can be measured in the upper reaches of the atmosphere. If it all settled to the bottom (ground) it would snuff out life on earth. Therefore, you can't drain CO_2 out of your terrarium by holes on the bottom. Fans in a small terrarium will dry out the air. That's why your current cakes are blue. They're dry and stressing. You want natural circulation in your FC, near 100% humidity, and enough holes or fanning by hand to get the CO_2 out.

CO_2 - If CO_2 was heavier enough than air that it settled to the bottom, we'd all be dead from CO_2 poisoning on the surface of the planet. CO_2 mixes with the air. To get rid of it, you exchange the air in the terrarium. You can't simply drill a hole in the bottom and expect it to run out like water. CO_2 is found high in the atmosphere, not just at the surface. It's the same in your terrarium. In a completely airtight container, the CO_2 would sink to the bottom. Such is not the case with our growing containers.

CO_2 - CO_2 won't run out of holes in the bottom. It's widely misunderstood that CO_2 is heavier than air, and many growers think it will run out like water if only there's holes in the bottom. The fact is, the CO_2 mixes with the air inside the tub and raises its CO_2 content. You have to exchange ALL the air in the tub to get rid of it. I simply drill lots of holes in the fruiting chamber, and let nature take care of it.

COLONIZING CASING CO_2 - The 5K to 10K ppm levels of CO_2 are during colonization. The fungus naturally produces the CO_2 just as humans also produce it. The 300 ppm levels are what is optimum for fruiting, and you'll have to ventilate to get it that low. We don't supplement with CO_2, but rather have different strategies for getting rid of it, depending on the part of the cycle we're in.

CO_2 CASING - You want holes all around to create circulation. It's a myth that CO_2 settles to the bottom and needs to be 'drained' out. If that were the case, we'd all be dead from the CO_2 from the power plants, car exhaust, etc. sinking to the surface of the earth, but the fact is, CO_2 can be measured in the highest reaches of the upper atmosphere. It simply mixes in with the air and goes where the air goes.

CASING CO_2 - High CO_2 levels are beneficial during colonization. It prevents most of your substrate from being turned into CO_2. Without proper covering, up to 50% or more of the carbon in your substrate will be released as CO_2 gas by the mycelium. In addition, many competitor fungi can't thrive in the high CO_2 environment, thus it helps favor for mushroom mycelium.

CO_2 FRUITING - High CO_2 levels are another thing that causes pins to abort. Mycelium can form primordia in conditions that can't sustain a flush, so lots of air exchange is very important throughout the fruiting process.

CO_2 FC - 'Drainage' holes drain the CO_2, and you want the CO_2 high in the substrate and low on top of the casing layer because that stimulates pinning where you want it to happen.

CO_2 - Drill holes as described. CO_2 isn't enough heavier that it will 'drain' out holes in the bottom. You want lots of holes so there can be constant fresh air.

HIGH CO_2 - High CO_2 will give long stems, but not huge caps. However, if you don't give any air exchanges, you'll grow nothing but green molds.

MUSHROOMS CO_2 - Tall, skinny mushrooms are indeed a sign of insufficient air exchange. Lack of light will also cause that.

HIGH CO_2 - Long, spindly stems are a sign of too high a CO_2 level, and green molds are a sign of insufficient air exchange.

HIGH CO_2 - Increase air exchange. High CO_2 levels cause stem elongation and small caps.

HOLES IN FC AND WHY - The holes in the bottom increase humidity. How? It's a development from something I learned working on the Alaska Pipeline project in the 1970's, helping to engineer the supports that are actually self contained refrigeration units that keep the tundra frozen even in summer so they don't shift, thus preventing the pipeline from rupturing. The supports require no electricity to operate.
The methodology is this: Air currents travel from high pressure to low. Heat expands the air, thus causing low pressure. Cold compresses the air, thus causing high pressure. The damp perlite is cold, so the air surrounding the perlite is our 'high' pressure. The substrates within a terrarium produce heat, as does the lights shining through the sides or top, thus the air in upper terrarium becomes 'low' pressure. This causes air to want to flow through the perlite and into the terrarium, but only if there is an entry point at the bottom for the air to be drawn in. The air, by natural convection passes through the perlite, absorbing moisture as it does. It then enters the terrarium, and is expelled through the holes above. This natural circulation provides FAE without fanning, while keeping the humidity higher than it would otherwise be.
I developed this over the last year, but am just now releasing it after a full year of testing; so don't look for anyone else beside myself to have used this system yet. It works. Oyster mushrooms still should be fanned a time or two per day, but every other species has done very well with this system with no fanning, and humidity maintains between 95% and 98% provided four to five inches of damp perlite are used. Smaller depths may work with smaller terrariums, but with the 106-liter terrarium I've posted pictures of, four to five inches is best.

DIFFERENCE BETWEEN AIR EXCHANGE AND GAS EXCHANGE - Gas exchange is when the gasses must percolate up through a vermiculite barrier or other filter to three or four small holes in the lid. The small filter on spawn bags allows for gas exchange. The very limited exchange that takes place allows the excess CO_2 to get out of the jars and be replaced by very small amounts of filtered room air. Air exchange is when we remove the lid on a fruiting chamber or run a fan in a greenhouse to forcefully fan the contents in order to blow out the stale air and replace it with large amounts of unfiltered room air.

FC/HUMIDITY/HOLES - I drill dozens of holes all over my terrariums, including the very bottom. The holes on the bottom actually increase humidity, while letting the CO_2 drain. The reason the holes on bottom increase humidity is because air currents travel from cold to warm, due to the pressure difference caused by the molecules being farther apart in warm air. The warm air in the terrarium causes air to percolate up through the perlite, wicking moisture as it passes through.

AIR EXCHANGE FC - Sure looks like too much substrate and mycelium for such a small container. I'd imagine the gasses build up in no time in something that small. You need three to five air exchanges per HOUR, not two per day. That's why I recommend drilling holes into all six sides of the terrarium. If you mist, and then close that thing up with the fruits wet, it's just one more example of the proof that doing so causes aborts.

FAE CONTAMINATES - The fact of the matter is, green molds can't survive in a fresh, turbulent air environment. They require stale, still air. That makes green molds fairly easy to control. All the sterile procedure in the world won't help once your project is in fruiting conditions. At that point, give fresh air and keep it moving. Green molds will still pop up from time to time, but they won't be devastating.

FAE - I have a couple dozen holes drilled into the floor of the FC as well, so any excess water from misting can drain out. The holes in the floor of the Rubbermaid also help to let the CO_2 seep out. Water doesn't evaporate well into CO_2, so getting rid of it helps the perlite work better, as well as stimulate pinsets.

FFAE IS THE WAY TO GO - In nature there is no fanning, there is constant, full air exchange which is what starts the chain reaction to pinning, so the more air you're providing via open air exchange, the better, farms don't use fruiting chambers they use huge trays in open rooms, as that's how they grow best.

FILTERED AIR - Best way for filtered air exchange in a TIGHT clean room, or grow room is POSITIVE PRESSURE. Meaning, pump in hepa filtered air in a volume much larger than the outlet. Which creates mild positive pressure. Enough that nothing wisps in, except what you carry on you.

FAE. KEEPING COBWEB MOLD AT BAY - You should have just hit it with a mild H202 mist **-** spurt. Then, or NOW increase your FAE. For Cobweb. Give it another spurt of H202, and then about triple your FAE. Plenty of FAE is the trick to holding cobweb at bay. It thrives, when there is little or no

FILTERING AIR NO REASON TO FC - Actually, polyfill is a filter, but there's absolutely no reason to use it on a fruiting chamber. If you have gnat problems, you can use window screen, which will allow much more air to circulate, thus lowering the risk of contamination.

FAE/FC - Just remember with small holes, it takes four times as many holes to equal twice the area. In other words, two 1/4-inch holes are not the same as one 1/2-inch hole. It would take four of them. It helps to bear that in mind. Good luck.

FAE - Four air exchanges per HOUR are recommended. I'd suggest fanning three times per day, and drilling a hundred or more holes in your terrarium to get you by between fannings so you can leave for work, play, etc.

FAE - Stamets recommends 4 to 5 air exchanges per hour. I try to give a bit more than that because in addition to getting rid of the CO_2, we're also trying to make an environment that is inhospitable for contaminants.

FAE - Correct. Nothing covers the holes. It's near my balcony where we keep the sliding glass door open all the time. The breeze from the open door helps with the FAE too, and the natural sunlight is a plus.

AIR EXCHANGE FC - We filter uncolonized grain spawn, but once it's fully colonized, there is no reason to filter. Air exchange is the key to contamination prevention in the fruiting environment.

FAE FC - Mushrooms like 3-6 COMPLETE FAE's an hour, which can't even hope to get near most of the time and if they do, it typically will cause a problem with over-Drying of the substrate.

FC AIR - There is no reason to worry about contaminants in your fresh air supply, because your cakes are already colonized. Stale air is much more of a threat than contaminated air.

CONTAMINANTS WITH FAE - All the FAE. The constantly circulating air outdoors gives contams little room to take hold of the patch. Unlimited FAE is the key factor.

FAE. FAE FC - You want about 4 air exchanges per hour if it's in fruiting mode, so watch your humidity as agar said and be sure to replace the moisture you lose to

MUSHROOMS WITHOUT FAE - Insufficient fresh air exchange leads to the long twisted stems, and poor lighting leads to very small caps.

PROBLEMS WITHOUT FFAE - The sign of high CO_2 is baseball bat fruits with fat stems and little tiny caps or long skinny ones.

FC - Air exchange in the fruiting environment will do way more for contaminant control than filtering.

FAE FANS - Fans are unnecessary, and tend to dry out the air too much.

FC FILTERING AIR NO NEED - You don't filter air to fruiting chambers!!!

FFAE - FFAE = Frequent Fresh Air Exchange.

FC - It all depends on the size of the FC. If you can maintain upper 90's humidity, then the more holes the better. Air exchange is the key to contaminant avoidance and good pinsets. However, if you over do it on the holes, performance will suffer if you can't keep up with good humidity. If you're unable to maintain humidity with all your holes, begin taping them up until you can maintain 95%. That will be the sweet spot. Many people also don't realize that if you double the diameter of a hole, you increase its area by four times. That means a 1/4" hole is four times as large as a 1/8" hole, and a 1/2" hole is four times as large as a 1/4" hole. You can dry out your terrarium in a hurry if you have too much. With this system, it also helps to run a humidifier in the room your terrarium is located, if you live in a dry or air conditioned climate. If your ambient humidity is in the 50% range, your terrarium will do much better than if it's in the 10% range.

FC - The fruiting chamber I designed has holes in all six sides. This results in convection and circulation. It is NOT a still air environment! The mushroom substrates produce heat, and also the lighting that shines through the fruiting chamber produces heat. These two produce convection. Perhaps if you'd read posts before jumping into shit you know nothing of, you'd have seen that. Sorry, but this pisses me off. Don't attack my work because you don't understand the science behind it. Now, in a so-called 'shotgun' fruiting chamber with holes on all six sides, would you suppose the CO_2 drains out the bottom? It doesn't. It mixes with the air. I see absolutely NO change in CO_2 concentration from the top to the bottom of the fruiting chamber. CO_2 levels are higher than ambient in the room, but lower than they would be in a 'still air' terrarium, as if anyone who has knowledge of the life cycle of fungi would ever make such a thing.

PERLITE FC - The perlite should stay fully hydrated and provide humidity for four to six weeks. This is plenty for a crop cycle. I simply take the perlite from the tub, place in strainer and run water through it again to re-hydrate it. You should be able to use the same perlite for years. When I filmed this part for my dvd, I bought a new bag of perlite so it would be nice and pretty white. My old perlite, which is still perfectly fine, is several years old and has been used for dozens of cycles, and is stained various colors from different substrates and spores getting spilled onto it over the years. If you have a bad trichoderma outbreak, It can't hurt to boil the perlite in a large kettle before re-use.

SPAWN BAGS FC - I seal after sterilization and inoculation. You'll have to make provisions to allow the pressure to escape from the bag as the PC cools down or the bag will burst. I use a tyvek sleeve placed the entire length of the flap from the substrate to the end of the bag. This allows the pressure to escape, but also filters any air that tries to seep back into the bags. Using this method, I've left them to sit on a countertop in open air for several days prior to inoculation. The tyvek prevents contaminants from entering. I use steel tie-wire to seal the bags. I don't even own an impulse sealer.

CONDENSATION/FAE/PINNING FC - Correct. The temperature differential causes the condensation, and the holes help to keep the temperature equalized, thus no condensation. If you've dunked and rolled your cakes, you still want to mist to keep the vermiculite damp. If you have cased substrates, you also want to mist. All those holes provide for constant FAE, which is a major pinning trigger, but the constant FAE also causes evaporation from your substrate (another pinning trigger), which needs to be replaced by misting.

TEMPERATURE PROBLEM FC - If you have a freezer, freeze water in several plastic containers. You can then rotate the jugs from your freezer to your FC and back as needed. No, I meant to put the ice inside the DT. Get imaginative. The jug can hang from a wire if the whole tub is covered with substrate. Don't put the ice on the outside or you'll stunt the mycelium in that location. You can open fruiting chambers whenever you want. The more the better in fact as long as you maintain humidity.

FC - Massive air exchange is what you want for a fruiting chamber. By the time fruiting comes, CO_2 production has fallen off dramatically. You want large amounts of air exchange in order to prevent contaminants such as cobweb, which thrive in stale, still air. Have several vents both top and bottom in a FC, so you can get circulation as well as intake and exhaust. Positive pressure is not necessary. A FC by nature isn't sterile, nor does it need to be. Just keep the humidity up.

FRUITING CHAMBER - Perlite will remain hydrated for months, so you don't need to wet it every weekend. Your mushrooms won't abort because of going two days without misting, provided you've built a proper terrarium and have 3 to 5 inches of well-drained perlite inside. Something else is wrong. You can mist mushrooms. They thrive in the rain. What's your air exchange provisions?

CONDENSATION HUMIDITY FC - Condensation does not begin on all surfaces at about 95%. Condensation is a function of the temperature differential on either side of a surface. Condensation forms on the warm side. Condensation won't even form on your mushrooms at 100% humidity. If they get wet, it's because liquid water droplets were thrown on them, not humidity in the air.

PERLITE IN FC - Also, make sure your perlite isn't packed down tight. If it is, it can't work. Rake your fingers through it from top to bottom to fluff it up. You want your perlite very loose and airy so it can evaporate the moisture it holds into the air. The more surface area of perlite, the better it works. Make little mountains and valleys for best results.

FC - Drill as many as you can drill until the humidity begins to fall. Then, cover up the last hole you drilled. The more air exchange during fruiting, the better. Just keep your substrate thin, and also keep the casing layer thin. Pans don't like thick substrates. 1 1/2" deep works for the manure, and 1/4" is plenty for a casing layer.

FC/HUMIDITY/CONDENSATION - You need high humidity in a fruiting chamber, and heating one will cause excessive condensation. The humidity you want for the mushrooms will be wasted sticking to the sides as condensation if there's a temperature difference between the fruiting chamber and the room it's located in.

CONTAINER FC - Use black plastic glad ware baking dishes. I've seen aluminum containers with holes in the bottom before the first flush comes in. Even if the metals are not transferred to the fruits (which nobody has the equipment to test to know for sure), the holes in the bottom cause unwanted pinning down there.

FC - A humidifier inside the greenhouse works great, and mine last several times as long inside the greenhouse as outside. Have it on a timer so it runs no more than two minutes at a time. One minute on, six minutes off works great for me. Just leave lots of gaps in the plastic so you have continuous air exchange.

CONDENSATION FC - Condensation on the walls only indicates that the temperature of the walls is equal to or less than the dew-point of the terrarium, and is not an indication of humidity. In other words, condensation indicates a temperature differential and not moisture content.

PULLING AWAY FROM THE SIDES CASING/FC - With a good pinset, they'll need lots of water. Be sure to give it to them. As said, it's normal for the substrate to pull away from the sides. The mycelium is munching down its food, so the substrate naturally is going to get smaller.

FC - Elevate the terrarium off your table on blocks so the holes in the bottom are open. Built as directed, it will maintain humidity fine if your ambient humidity is 50% or more. If necessary, run a cool mist humidifier in the room your terrarium will be located in.

FC MOISTURE - Droplets on your pins will not cause aborts. It's recommended to mist mushrooms. Air exchange must be provided because stagnant water sitting on a mushroom in stagnant air for an extended period WILL cause aborts.

CONDENSATION FC - Condensation has nothing to do with humidity. Condensation is caused by a temperature differential between inside and outside your tub. Use plastic or a drip shield to prevent drops from falling on the fruits.

HEAT A FC - NEVER heat a terrarium. It causes condensation, which robs the humidity from the air within, and turns it into condensation on the sides. You're supposed to heat the room the terrarium is located in.

FC - Warmer air has the molecules farther apart, thus humidity is lower, even in a sealed chamber. A 20F rise in temperature doubles the capacity of the air to hold moisture, thus it cuts the humidity in half.

USING PERLITE FC - Be sure your perlite is well drained, and you'll have 98% humidity for three weeks or more, at which time you can remove, wash, drain and replace the perlite for the next cycle.

CONDENSATION FC - Condensation in a FC is actually stealing moisture from your air, lowering the humidity inside. Avoid it. As said above, the water droplets falling on your mushrooms is bad as well.

FC - It's normal for the substrate to pull away from the sides of the tray. It's not just from drying though. As the mycelium consumes the substrate, it actually gets smaller because it's being 'eaten'.

FRUITING CHAMBER - Depending on what you're growing, you need a bit more air exchange than that. I like to see three to four air exchanges per hour, with a co2 level around 1,000 or less.

CONDENSATION FC - Condensation is not caused by humidity. It's caused by a temperature differential between inside the box and outside. Don't use heat.

CONDENSATION FC - True, but condensation can only form if the humidity is 100% OR there is a temperature differential between inside and outside.

FC - You don't heat fruiting chambers. You heat the room they're in to avoid condensation. If you desire 80, you'll want to heat the room that warm.

COLONIZING PERLITE PF TEK / FC - Don't force the mycelium to colonize the perlite that has no food for it anyway. It will waste needless energy.

SUBSTRATE FC - They break in half all the time when I'm dunking. They do just fine. Try to avoid breaking them, but if they do, don't worry.

CONDENSATION FC - You don't heat fruiting chambers or they get condensation on the walls, which sucks moisture out of the air inside.

FC - Standing water lowers humidity. Drain fully, then put the perlite in your terrarium. That will deliver the highest possible humidity.

FC - FYI placing in the FC slows vegetative growth and covering your knots with casing would destroy your initial pinset.

SUCCESS FC - High humidity and massive amounts of air exchange is the key to success with mushroom growing.

HEATING FC - Don't heat the terrarium. You'll only make condensation that will suck the humidity out of the air.

FC - How to incubate Monotub...Drill a bunch of holes...put Micropore tape over holes for colonization.

FC - You really need to get your humidity as close to 100% as possible for hyphal knot formation.

FC - On the next grow; provide more air exchange for shorter, fatter stems and larger caps.

CONDENSATION FC - Condensation is caused by excessive temperature inside the jars.

FC - High humidity, plus high air exchange will give the best results.

CONDITIONS TO INDUCE FRUITING - The major pinning triggers are in order of importance, full colonization, a decrease in CO_2 levels due to increased air exchange (not gas exchange which is minimal), a steady rate of evaporation from the substrate or casing layer, and lastly, light.
Hyphal knots form best in 100% humidity, but I didn't list that because it's not a pinning trigger, but rather an environmental condition that is necessary. That's why we use casing layers. The casing helps to provide the 100% humidity right at the surface of the substrate where the hyphal knots form.
I have seen no correlation with temperature drop whatsoever. In the summer, my growing chambers are 10 or more degrees warmer than the open shelves I incubate on due to the heating effects of the lights. Even with a

temperature increase, I still get wall-to-wall pinsets, so I don't consider temp drop relevant at all to tropical species. Other growers disagree of course, but that's just my observation after many years.

Full colonization of the substrate is the number 1 pinning trigger. Full colonization can be when the mycelium reaches the physical border of the container they are in, or when they run up against a biological border, such as a contaminant species. Either way, they see they have colonized all of what is available to them, so they then enter the next phase, which is reproduction.

There must be evaporation of moisture from the substrate for pins to form. A waterlogged substrate will just sit there forever without pinning. Even in 99% humidity, as long as you provide fresh air, moisture will be evaporating away from the substrate, and this is necessary for pinning. We mist to replenish the lost moisture, and then allow it to dry slightly before misting again. This keeps the moisture content high, and keeps the humidity at the casing surface near 100%, but at the same time provides the evaporation of moisture that is a very important pinning trigger.

During colonization, we provide very small holes in the jars or tubs for gas exchange. We want a high CO_2 environment during colonization, because this prevents the mycelium from consuming all of the substrate. The mycelium colonizes the substrate, but doesn't 'eat it all up' due to the high CO_2 levels. During fruiting, we remove the covers to provide air exchange, which is at a much higher level then the minimal gas exchange provided during colonization. This increase in air exchange lowers the CO_2 levels, and is a major pinning trigger. At this time, the mycelium begins to consume the substrate it has previously colonized, and we notice during fruiting that our substrates pull away from the sides of the container. This is not due to moisture loss, but rather due to the mycelium 'eating' the substrate and turning it into CO_2, a waste product. It is easily proved that this shrinking isn't related to moisture loss, because even when we dunk a bulk substrate, it doesn't return to its pre-flush size.

Last, but not by any means least is exposure to light. Light does much more than just tell the mushrooms which way to grow. There are mechanisms in the light that stimulate the formation of hyphal knots as well, and light at the higher end of the spectrum (blue) definitely, absolutely stimulate more hyphal knots (which grow into primordia, which then morph into pins) than light at the lower end of the spectrum (red) This does not mean to get a 'mood light' with a blue lens, but rather to select lights such as metal halide, or much more economical is 'natural daylight' fluorescent that emit light at around 6,000 Kelvin to 7,500 Kelvin depending on the brand. Cool white fluorescent emit light at around 5,000 Kelvin and the 'red' incandescent emit light at around 3,000 Kelvin. The higher the light temperature in Kelvin, the more stimulatory it is to hyphal knot formation. I hope this helps.

PINSET INITIATION FACTORS - I rarely start new threads anymore, but the same questions and misunderstandings seem to keep popping up regarding what makes our fungi enter the pinning stage. The reply below is one I posted in another thread earlier, so I'll take the liberty of cutting and pasting it here for those who would otherwise miss it. Hopefully it will stimulate some more research and discussion on everyone's part and clear up a few things. Here it is:

LIGHT IS NOT THE MAJOR PINNING TRIGGER FOR MUSHROOMS!

In fact, light isn't even the major factor in which direction mushrooms grow. Wind or other air currents is the first. Light is the second, and then finally gravity is the third.

As for pinning, full colonization of the substrate is the most important pinning trigger. If there are contaminants present in a substrate, the mushroom mycelium generally stops growing when it contacts them. This represents full colonization because the mycelium has hit a natural barrier, and often pins begin to develop, whether light is present or not.

The second most important pinning trigger is an increase in air exchange, with the corresponding drop in CO_2 levels that occurs simultaneously. When you uncover a tray to look at it, you allow the CO_2 to escape and be replaced by fresh air. THIS is a pinning trigger, even if you do it in the dark.

Third, which goes along with second, is a steady rate of evaporation of moisture from the substrate or casing layer. In the artificial environment of a small tray, we must mist to keep the substrate or casing from drying out, but we also must allow that moisture to evaporate off between mistings.

Fourth, when the above three triggers are active, light becomes a pinning/growth initiation factor.

If one waits too long to apply the casing layer, or the other factors listed above are in effect prior to light OR the casing layer being applied, primordia will begin to form, which will then push up through to the surface, whether or not it has been fully or even partially colonized. By the same token, if light is applied and the other, more important factors have not been met, primordia will NOT form.

This is why experienced growers, such as commercial spawn producers who make their entire living incubating mushroom mycelium, make absolutely NO effort to incubate in the dark. It isn't necessary. People will have much more success in the hobby when they understand that.

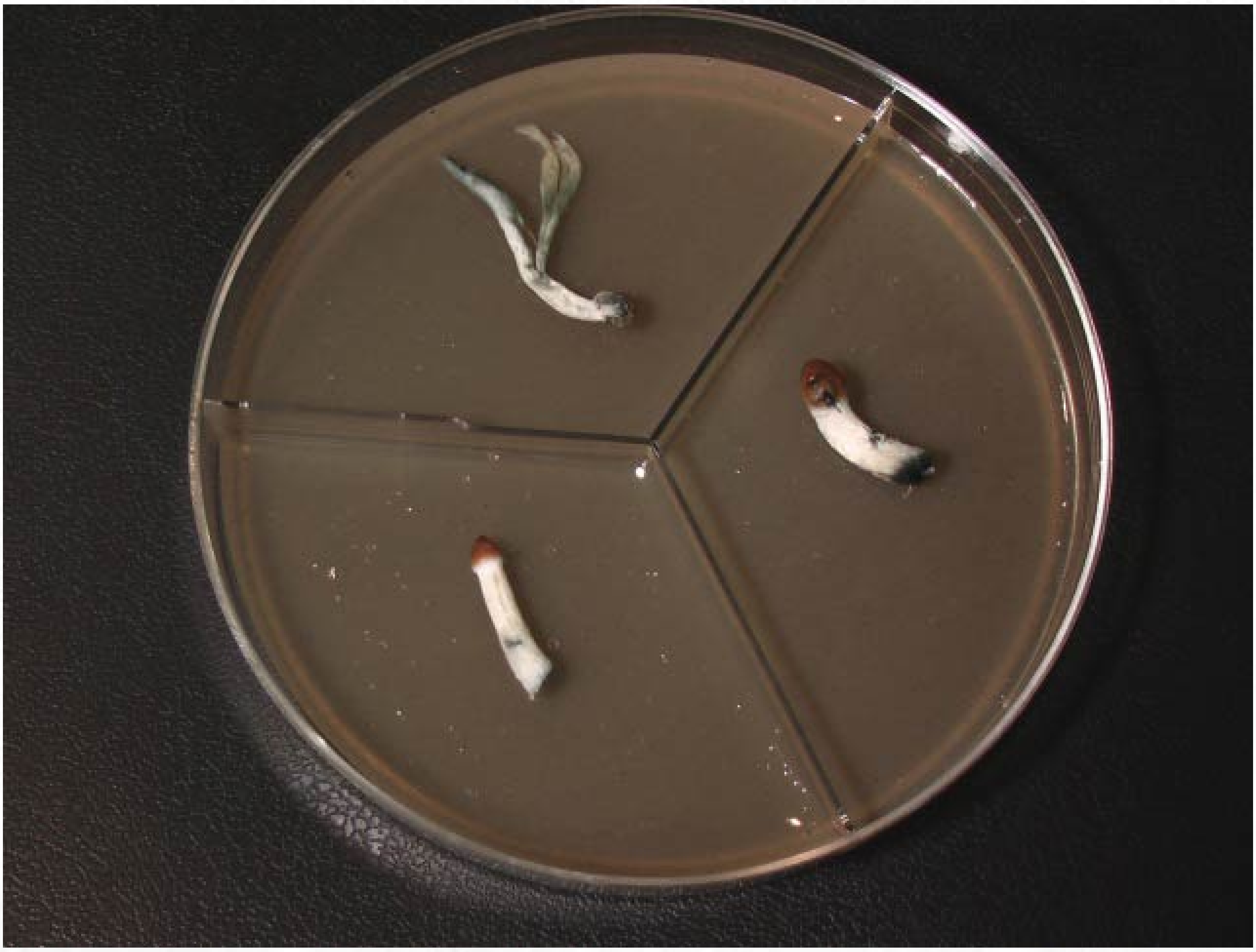
PINNING STRATEGY - Here are the facts. It DOES matter if you sterilize your casing layer. It will perform poorly. It's a well-known fact that the beneficial organisms in a casing layer stimulate pinning. This was very well known in 1985 when Paul Stamets wrote 'The Mushroom Cultivator' and it's still known today. Casing layers should be pasteurized, not sterilized.
In addition, coir is a substrate material, not a casing material. If you wish to use it for casing, it should be mixed at the 60/40 ratio (60% vermiculite, 40% coir) in the tek, or better yet, 70/30. However, peat mixed 50/50 with vermiculite is a far superior casing. The reason peats works better is the beneficial microorganisms that are not present in as high a concentration in coir.
Furthermore, sterilizing a casing makes it MORE prone to contaminants, not less. A sterile substrate is a prime breeding ground for the first organism to land on it, or the fastest growing. Mold mycelium, being imperfect fungi grows and sporulates much faster than mushroom mycelium because they get to skip the fruiting body stage.
Field capacity for casing layers says when you pick up a handful of material no water should drip out. If you squeeze gently a few drops will fall, and if you squeeze hard, a small stream will fall. It sounds like your casing might be getting prepared too dry as well.
Fanning 4 to 5 times per day is not sufficient unless you have another method of providing fresh air exchange. It is recommended to have 4 air exchanges per hour, not day.
My suggestion is to use a peat/vermiculite casing with gypsum added (very important) at a rate of one part to each ten parts of peat, and limed to an initial pH of 7.5 to 8. Pasteurize, don't sterilize and increase air exchange. Good luck.

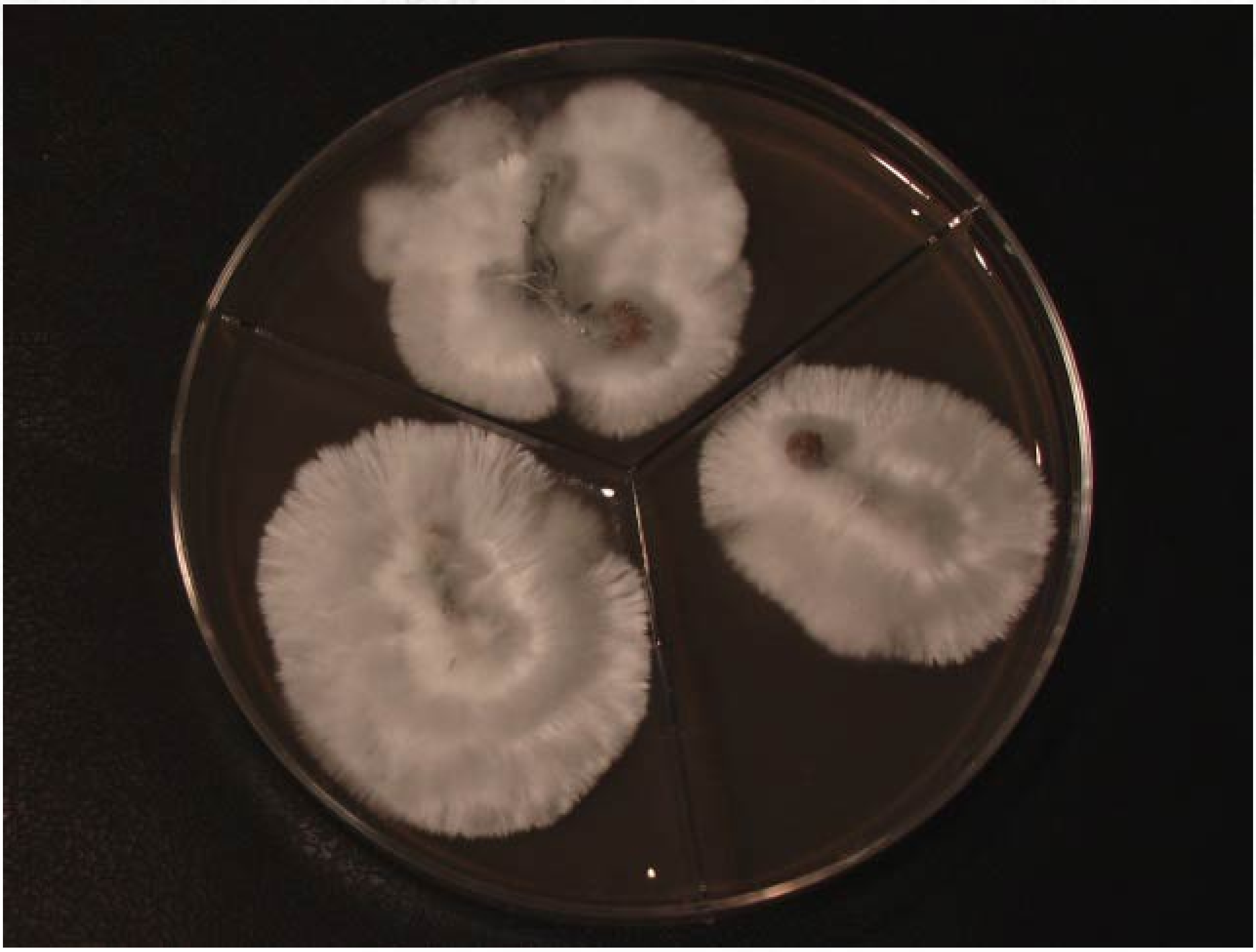
FRUITING CHAMBER - You want three things in a Fruiting Chamber. FAE to keep contaminants at bay and to get a nice pinset. Humidity to get a nice pinset. Moisture for yield and pinsets. Mushrooms ideally want 4-6 FFAE every hour so it's best to put 1/4th inch holes everywhere around the terrarium. As much as so humidity doesn't escape and the CO_2 levels are low. Massive air exchange is what you want for a fruiting chamber. By the time fruiting comes, CO_2 production has fallen off dramatically. You want large amounts of air exchange in order to prevent contaminants such as cobweb, which thrive in stale, still air. Have several vents both top and bottom in a FC, so you can get circulation as well as intake and exhaust. Positive pressure is not necessary. A FC by nature isn't sterile, nor does it need to be. Just keep the humidity up.

FRUITING - As for fruiting temperatures, the lower 70's seem to produce the best fruit quality. For years, I didn't AC my house in the summer because I live in a generally mild climate, and they still fruited fine into the 90's, which my grow area would often reach on summer afternoons. I found that temperatures which would fry the mycelium during colonization, would hardly be a factor during fruiting, but the fruits grew very fast, were not very meaty, and the 'other' quality we look for was often lacking. When I switched over to all edible and medicinal mushrooms, I installed a refrigeration unit on my mini-greenhouse, because mushrooms such as shiitake would refuse to fruit at all in those hot temperatures.

PINNING - I doubt it was the light. Light is horribly over rated as a pinning trigger. It was most likely the air exchange that was allowed through the landscape fabric.
If you want an awesome pinset, it's important to only allow gas exchange and not air exchange as the mycelium colonizes the substrate. There's a big difference. During colonization, you actually want CO_2 levels to be extremely high, which prevents fruiting. Upon full colonization, you increase FAE (air exchange) and expose to light at the same time. This results in a sudden and massive pinset.

SPAWNING WITH PINS IN JARS - You can spawn a cake with pins right into manure/straw, or even use it for grain-to-grain transfers. It's a myth that pins will rot. I've proved that hundreds of times. Here's what happens when you put pins on a Petri dish. The two pictures below were taken five days apart. The same thing happens regardless of substrate. Just be sure they're small, growing pins and not large fruits. You should pick the mature fruits.





PINNING - Mycelium will pin best at or near saturation humidity and plenty of fresh air, whether the substrate is cased or not. A casing layer simply helps to hold humidity high right at the surface, under less than ideal ambient conditions. Of course, once pins form, the casing layer also helps to supply the substrate below with moisture, so you want to keep the humidity high to prevent the casing layer from drying out too much between mistings.

ABORTS - Grey or black heads indicate aborts. Pins that have simply stopped growing but have normal color are NOT aborts and should not be picked. It's common for many species including cubensis to set all the primordia for the first few flushes when primordia for first flush is set. They stop growing until their time comes, at which time they kick into gear again. If you pick them, you ruin future flushes.

PINNING EARLY CASING - What I meant above about pinning early in the presence of contaminants is when you see pinning in a jar prior to full colonization. It's because the mycelium ran up against the contaminant and said, "Oh heck, this stuff might kick my butt. I better reproduce by dropping some spores so I'll survive". That's why they pin. It's not because you had the light on when you checked the jars.

CRACKED/SPLIT CAPS - There is a difference between cracked caps and split caps. Cracked caps are caused by low humidity, which cracks the caps to give them a reptile type appearance. What you see above is split caps. It's part genetic and part just from very rapid growth where the cap simply rips apart. Split caps are not environment related.

PINNING - Many things. I've found the brightest light stimulates more pins. You need to look at pinning triggers like the instruments in a band. One instrument can be slightly off, and the band still plays the song. Often one instrument can be taken away and the music still sounds ok. However, if all are working together, it's awesome.

PINNING TRIGGERS - The pinning triggers are: Full colonization, 100% humidity, increased air exchange, and light. If all that happened within 24 hours of what you did, the primordia were already formed, so it was going to happen anyway. The rooster may crow at sunrise, but he isn't responsible for the sun coming up.

COLONIZING HIGH CO_2 - One benefit of a high CO_2 level during colonization is that less of the actual carbon in the substrate is converted to CO_2 gas. In other words, if you allowed too much fresh air during colonization, more of the substrate would be 'consumed' by the time the mycelium got to the fruiting stage.

CRACKED CAPS - Cracked caps are from low humidity and also really don't hurt anything. In fact, many Shiitake growers deliberately lower humidity a day or two before harvest to crack the caps. They feel it leads to a better product and in Japan; cracked cap Shiitake brings a higher price.

SPLIT/CRACKED CAPS - Usually, spit caps are caused by rapid growth. Contrast that with cracked caps, which is a sign of too low a humidity. Either is usually harmless. Vertically can also cause caps and stems to split, but it's a fungal disease so the fruits would also look unhealthy.

PREMATURE PINNING - Too much air exchange during colonization leads to early pinning too. If the holes in your jar lid are too big, your grains or whatever is exposed to air exchange rather than just gas exchange, which would keep CO_2 levels high and prevent pinning.

SMALL MUSHROOMS FC - Small mushrooms are caused by one or more of the following: Too small a substrate or too thin a casing layer, improper substrate or ph level for the species, or too little moisture in the substrate or casing layer. The latter is most often the cause.

SPLIT CAPS - There are two phenomena that are often called 'split caps'. One is from growing fast and is normal. The other is more correctly called 'cracked' caps and is related to low humidity. Either is usually fine to eat. Post a picture if you want a better diagnosis.

SMALL MUSHROOMS - The only reason they're small is that there is only so much water in the cake. More mushies mean smaller ones. One tip for next time ...you can inject a bit of water into the cake during the flush with a syringe. Don't overdo it, just 3 or 4 cc.

PINNING ON EDGES - Your substrate is pinning on the edges because that's the only place where there is near 100% humidity to stimulate primordia formation. You can get more pins in the middle by laying a sheet of wax paper over the top of the tray.

FRUITING LOW CO_2 - A rapid and sudden decrease in the ambient CO_2 levels is a pinning trigger in cultivation, so adding fresh air at the same time as full colonization and the other pinning triggers helps ensure a full, even flush.

UNCASED SUBSTRATES - Uncased substrates should be treated as cakes. Primordia form best in near 100% humidity. Yes, lay wax paper right over the substrate. Replace every second day with a fresh sheet. Lift it to fan for air exchange.

FRUITING SUBSTRATE - However, you can mix it in with horse or cow manure, or compost at 5% by volume. In other words, for each 20 cups of compost or manure, you can add one cup of chicken manure. Don't forget to lime for ph.

FC SIDE PINNING - Black plastic glad ware fruiting trays. I've never had one single side pin when using those until second flush when the substrate is pulling away from the sides a bit due to shrinkage, which is normal.

SMALL MUSHROOMS - Small mushrooms are caused by a shortage of water. After this flush, dunk. It's not strain related. All strains we see are of the same species and I've seen huge amazons.

FRUITING TEMPERATURE CASING - Mushrooms grow more quickly at higher temps, but there is no doubt that they are denser and more potent when fruited at a lower temperature.

ABORTS - Misting doesn't cause aborts. Leaving pins wet after misting with no air exchange causes aborts. When misting pins, be sure to increase air exchange afterwards.

FRUITING TEMPS - Cubes will actually fruit well in temps that would fry the mycelium in the colonizing stages. However, quality is better when they fruit at lower temps.

CASING FRUITING SIDES - If the fruits are only forming on the edges, it could be because the casing layer Ph is too far off, or it could mean the casing layer is too dry.

MYCELIUM ON CAPS - It's a combination of two types of mycelium on the fruiting body. It's more genetic in nature, occurring in some sustains more than others.

PINNING TRIGGERS CRITICAL - The other pinning triggers of full colonization, steady evaporation of moisture, and air exchange are much more critical than light.

FRUITING TEMPS AND WHY - Benefits from fruiting at 68-72F. 1. Better Fruit Quality, 2. Easier To Control Harvest Time, 3. Easier To Control Evaporation!

SMALL MUSHROOMS - Fruit size is mostly determined by substrate moisture level. Small fruits mean your substrate is too dry.

MYCELIUM FC - Pins are live, growing mycelium. Live, growing mycelium does not rot. Aborts rot. The above are not shiitake.

FRUITING - Better food quality and slower growth occurs in the high 60's low 70's, that's why it's the true preferred range.

PINNING TRIGGERS - It's air exchange, full colonization, or contaminant presence which is what makes them pin.

HYPHAE TRIGGER - Aerial hyphae, attracted to the fresh air/humidity, no digital can actually read that high.

COOLER TEMPS, LIGHT!! LOWER RELATIVE HUMIDITY - PINNING TRIGGER: FAE (3 PER HOUR),

PINNING - One of the biggest pinning triggers is the sudden reduction in CO_2 buildup.

SKINNY MUSHROOMS - Poor air exchange causes long skinny stems, not fat Asses.

ABORTS FC - If the head is black, it has already aborted. Aborts don't recover.

LATE PINNING - Late pinning is caused by poor air exchange 90% of the time.

SPLIT CAPS - Split caps, not related to humidity or moisture content.

CRACKED CAPS - No. Lack of humidity causes cracked caps.

PIN - Hyphal knots are tiny. Perhaps 1mm in diameter.

HUMIDITY FC - Hang on a second. 100% humidity means the air is saturated. Having the air saturated in no way is going to flood your cakes. What WILL flood your cakes is pumping from a humidifier AFTER the air is already at 100%. That's why I recommend three to five inches of well-drained perlite for a terrarium, and no mechanical humidifier. This way, if your humidity reads less than 95%, it means you need to calibrate your hygrometer. Mycelium will pin best at or near saturation humidity and plenty of fresh air, whether the substrate is cased or not. A casing layer simply helps to hold humidity high right at the surface, under less than ideal ambient conditions. Of course, once pins form, the casing layer also helps to supply the substrate below with moisture, so you want to keep the humidity high to prevent the casing layer from drying out too much between mistings.

HUMIDITY - I recently cleaned out one of my terrariums after 8 weeks. The perlite was still damp, and at least half of this time, the lid was off. I think you're mistaken. You can judge moisture content of the perlite by lifting the tub. Dry perlite is almost weightless. My huge 3 cubic foot bag probably weighs a pound or less. The terrarium I lifted up weighed at least ten pounds. However, if your house is extremely dry, you'd be well advised to run a humidifier in the room your grow is located in. It will make it better for your plants, and it will be easier on your own skin and lungs as well. Shoot for an indoor humidity of 50% or better for comfort. It will also make it much easier to heat your house in winter because the humidity will hold heat much better than dry air.

WAX PAPER HUMIDITY - What I have said is not to wait a week before using wax paper or it could stimulate the germination of contaminant spores that have landed. If you use it from the start, those contaminant spores will have mostly landed on the surface of the wax paper, which is discarded every two to three days. After four or five days, you can simply wash the surface of your substrate very well under the water faucet to rinse off most of the contaminant spores that have landed. Wax paper simply helps to hold a high humidity at the pinning surface. It's even more effective with uncased substrates than with cased.

FC HUMIDITY - I'm now convinced the closer to 100% humidity we can get, provided we have proper air exchange, the better. This applies to cakes, substrate blocks and cased substrates. Perlite in a terrarium with a cased substrate tray allows us to leave the lid or door propped open to allow for constant air exchange, which promotes pinning and suppresses contaminant molds. Without the perlite, we need to keep the terrarium closed up tighter, which promotes contaminant molds. I think the 90% humidity suggestion when casing comes from stamets' books, but I respectfully disagree.

FC/HUMIDITY/HOLES - I drill dozens of holes all over my terrariums, including the very bottom. The holes on the bottom actually increase humidity, while letting the CO_2 drain. The reason the holes on bottom increase humidity is because air currents travel from cold to warm, due to the pressure difference caused by the molecules being farther apart in warm air. The warm air in the terrarium causes air to percolate up through the perlite, wicking moisture as it passes through.

CASING HUMIDITY - Why would one want to avoid getting moisture on the mushrooms? Mushrooms are 90% water and benefit greatly from misting. The other benefit to misting is to replenish moisture in the casing layer or on the surface of the cake. You can't do that with humidity, even at 100%. It must be done by misting. Opening the lid of a fruiting chamber a few times per day is a great idea. A total influx of fresh air is always good for the pinning/fruiting mushrooms.

WAX PAPER HUMIDITY - Wax paper will work better if you'll wrinkle it up into a ball first, then flatten it back out and lay over your uncased (or cased) substrate. By wrinkling, you open up lots of little air passageways while still keeping the humidity tent. It also helps cut down on the surface area of the caps touching the wax paper as they push it out of the way. Be sure to lift it up a couple of times a day to let all the built up CO_2 from around the substrate escape.

HUMIDITY - Mushrooms grow best in upper 90's to 100% humidity. It makes no difference if the substrate is cased or uncased. A cased substrate can still get some pinning at a lower humidity than cakes, but performance is always better when high humidity is maintained. The old adage of 85% for cased substrates, 100% for cakes is just plain wrong. None of the experienced, successful growers fruit casings at lower humidifies.

HUMIDITY FC - If you have three to five inches of well-drained perlite, with holes cut in all six sides of the terrarium, humidity will be in the upper 90% range. A 20F rise in temperature cuts the humidity in half until more moisture evaporates from the perlite. That is just a fact of physics. Warm air can hold more moisture, so if you heat it, more moisture is required to have the same relative humidity.

HUMIDITY - If your ambient room humidity is very low, I'd suggest running a coolmist humidifier to bring your room humidity up to fifty percent or so, and then you'll be fine in your terrarium. As said, get an analog hygrometer and properly calibrate it at the high end of the scale. I'd also get rid of the aquarium light and get a fluorescent in the range suggested above.

HUMIDITY CASING - Perlite is best of course. If you don't have it, paper or cloth towels work fine. I've used them in pinches for years. Wring them out of excess moisture, and make sure they're fluffed up in the terrarium. You can even paste them to the sides. They won't contaminate for weeks, so if you change them for fresh every few days, you'll be fine.

WAX PAPER HUMIDITY - Wax paper in a monotub type grow is generally of little benefit. If you're using tray culture in a mini greenhouse where humidity is often less than optimal, wax paper can help keep humidity in the correct range for pinning. In a tub, humidity is usually close to 100% anyway, negating the need for wax paper.

CASING/HUMIDITY - Hyphal knots and primordia form best in 100% humidity. They don't care one whit whether the substrate is cased or uncased. You should maintain humidity in the upper 90% range for best results when growing mushrooms. The oft-repeated advice that 'casings only require 80% humidity' is wrong.

HUMIDITY - Raise humidity to near one hundred percent during primordia formation. Once pins are set, humidity can be reduced a bit, but don't get out of the 90's. The 'old' advice of keeping humidity lower for cased substrates is incorrect. As hyphae said, keep humidity high, and air exchange high.

CASING HUMIDITY/FAE - Never. I fruit cased substrates in the high 90% range too. The key is air exchange. Even at 99% humidity, moisture will be evaporating from your casing layer, provided you have enough air exchange, giving you two of the three major pinning triggers.

HUMIDITY/FC - A fact of physics is that a 20F(11C) rise in temperature cuts humidity in half, and a 20F(11C) drop in temperature doubles humidity, providing the amount of moisture stays the same. You're better off fruiting at 22-24C than at 27C anyway. Fruit quality will be better.

HUMIDITY FC - Recent experiments (over the last 23 years) have shown100% humidity means the air is saturated. Having the air saturated in no way is going to flood your cakes.

HUMIDITY FC 92% - Humidity will be fine with a good casing layer. I prefer higher, but lower will also still work, only requiring more frequent misting.

HUMIDITY/CASING - It's hard to get total saturation humidity with lots of air exchange. At 99% humidity with five to six air exchanges per hour as recommended, a casing layer will dry out daily and this moisture needs to be replaced by misting.

CASED SUBSTRATES - If you're going to case substrates, you want the humidity no more than 90%, with 80% being ideal. Too high a humidity is a major cause of weak or no pinsets on cased substrates.

HUMIDITY % CASING/FC - The maximum amount of air exchange possible while still maintaining humidity is what you want in a growing chamber. Fully colonized substrates are very resistant to contaminants.

HUMIDITY FC PRIMORDIA - During primordia formation, the higher the better. Once pins have formed, humidity can be reduced, but don't go less than 80% or you'll see a lot of cracked caps.

HUMIDITY/FC - You'll never get a good pinset at humidity below 90%. 95% and above is recommended, even with a casing layer. It's easy to get 99% humidity with perlite in a terrarium.

HUMIDITY - Contrary to popular belief and constant repetition, fuzzy stems are not an indication of too high humidity.

FC HUMIDITY - One cool mist is plenty for your terrarium for both air exchange and humidity.

HUMIDITY FC - There is no such thing as too much humidity when growing mushrooms.

SOAKING - Simply put the tray under a gently running faucet for a few hours. Allow the water to fill the tray and run over and down the drain. The running water prevents contaminants during the soaking process. Place a jar, rock or something similar on top of the substrate if necessary to prevent floating. After the soak, fill in the divots caused by picking with fresh casing material. You don't need to apply a whole new layer because it won't colonize anyway. Never pick pins that aren't aborts. Primordia for the first two or three flushes commonly forms at the same time, and then remain dormant until their time comes. If you pick the substrate clean, you ruin the next flush. Just be sure to drain out any excess water before returning to the FC. Don't get anal about draining; just get what pours off easily. The rest will continue to be absorbed by the substrate over the next 24 hours or so. You can throttle down the faucet too. You don't need a lot of water overflowing, just a trickle.

SOAKING/CASING/UNCASED - Dunk first. Personally, I've seen little benefit to adding a casing layer over bulk substrates with cubensis. Very experienced growers can definitely get a boost with a well-managed casing, but for the majority of new growers, I feel you'd be better off getting your feet wet by fruiting uncased. Of course, straight rye or wbs requires a casing to perform well, but bulk substrates such as coir or manure do not. You can dunk the coir/coffee substrate, and then introduce directly to fruiting conditions. This way, you get your harvest a bit sooner, and don't have the other problems to deal with that casing causes. As you gain experience, add casing layers to future crops. You can lay a sheet of wax paper over the uncased substrate to hold a high humidity right at the substrate surface, which will stimulate pinning. Lift it up to fan several times per day, and replace with a fresh sheet every two to three days, or if/when it gets damp.

MISTING - Droplets on your pins will not cause aborts. It's recommended to mist mushrooms. Air exchange must be provided because stagnant water sitting on a mushroom in stagnant air for an extended period WILL cause aborts. Condensation does not begin on all surfaces at about 95%. My can of cold beer gets condensation in Arizona in the summer. I know it's not 95% there. Condensation forms on my windows in winter, even when humidity in the house is less than 50%. Condensation is a function of the temperature differential on either side of a surface. Condensation forms on the warm side. Condensation won't even form on your mushrooms at 100% humidity. If they get wet, it's because liquid water droplets were thrown on them, not humidity in the air. 92% humidity will be fine with a good casing layer. I prefer higher, but lower will also still work, only requiring more frequent misting.

COLD SHOCKING - You dunk in the refrigerator to prevent bacteria buildup that would otherwise contaminate your brf if you dunked at room temperature. Don't confuse that with cold shocking, although it does cold shock them...lol. As for cased bulk substrates, I ran several experiments a few years ago where half the trays were placed in the refrigerator for 24 hours, while the second half were left at room temperature. Both sets of trays went to the fruiting chamber at the same time. Every single tray that had been 'cold shocked' pinned two or more days later than trays that had not been cold shocked. That is not to say a temperature change can't be a pinning trigger. However, along with light, a fully colonized substrate, and an increase in air exchange, it is only one of the triggers. However, cold shock being beneficial or not, you need to dunk your cakes in the refrigerator.

CASING SOAKING - The casing layer will never re-colonize after first flush. Simply dunk to rehydrate the substrate and return to fruiting conditions. I used to recommend dunking in the refrigerator, because in part, that was the conventional wisdom. I no longer believe that's the best course of action, so dunk at normal room temperature, beginning the dunk with cold tap water, but no ice. Larger trays can be easily soaked by placing under the kitchen or bathtub faucet, allowing the tray to fill up and gently run over the edge for a few hours. Put something on top of the substrate if it tries to float. The running water will help to wash away contaminant spores that may have landed, while preventing excess bacterial blooms that may occur under still water.

REHYDRATING SPAWN BAGS - Your mistake was injecting into the middle instead of along the edges. It's best to squirt solution in the area between the bag and the grains. This lets you see right away after germination what you have. Five to seven days is about normal for first growth to be seen if you inject the edges. Since you injected the middle, double that at least. I'd suggest waiting two weeks, then kneading the bag between your fingers to mix it up. Doing so should reveal some mycelium from the center of the bag, and the kneading will spread it around the bag. Only do this once, ten days from now.

FANNING/MISTING FC - Fanning is when you take the lid of the tote and wave it back and forth over the terrarium to blow out the stale air and replace it with fresh. Fan for fifteen seconds or so each time. I'd suggest drilling a hundred or more 1/4" holes into all six sides of the terrarium, elevate it an inch or two off the shelf, and then fan a couple of times per day also. Mist each time you fan, just before fanning. There is no maintenance free terrariums, so keep it simple and give your mushrooms lots of humidity, lots of fresh air, and lots of bright fluorescent light.

SOAKING - No, just use tap water unless you live in an area with contaminated drinking water. It's best to refrigerate or otherwise keep the water cool during the soak period to prevent the growth of unwanted organisms in the anaerobic conditions underwater. Put the cakes in a pot of water, and then use a heavy glass dinner plate or something similar to hold them submerged, as they'll try to float. Rinse well under the faucet both before and after the soak period. It's a good idea to roll the cakes in dry vermiculite after the soak. Read up on 'dunk and roll'.

SMALL MUSHROOOM HYDRATING - Small fruit size is related to substrate moisture content. It's easy to hydrate a substrate block during fruiting by simply pouring water around the edges so it slides down and under the substrate. If you pour a few tablespoons of water around the edges a couple of times a day, the substrate will readily absorb it and transfer the moisture to your fruits. Cubes will benefit from a casing layer, but by no means is one necessary to get a nice flush of large fruits.

MISTING - You can mist pins, but they must be left open to fresh air after misting. If you mist small pins, and then put the lid on the fc, they'll usually abort. They also must be misted with a very fine mist sprayed up into the air, so that it settles down gently on the casing layer. A direct spray will abort pins. Never mist when they're in the primordia stage. Simply lay a sheet of wax paper over the top of the tray to hold humidity at that time. Pick off any moldy pins from the substrate.

REASON FOR COLD DUNKING CUBIES - Cold water is recommended for dunking for only one reason-it helps to keep bacteria from growing during the time the mycelium is underwater. Tap water is fine, unless your local water supply is polluted. Many people add 1/2 teaspoon of bleach per gallon of water to the dunk water. I recommend rinsing the cake under the faucet with running water after the dunk to remove any bacteria or slime that develops during the dunk.

MISTING - Your substrate is dry. You can mist pins, so mist away. It will take several mistings an hour apart over a day or two to get your moisture back. I'd also pour, yes pour water around the edges. Wait two hours, and then pour any excess back out. Once pins are the size of yours they won't abort from misting as long as you up the FAE to let them dry off. Misting, then closing a container up tight will cause them to abort. Don't allow them to sit wet is the idea.

SOAKING CASING - Just give it an hour or two under gently running water. The kitchen sink works fine. Just put a rock or something else heavy to keep the substrate down in the pan, and let it fill up and gently run over the edges. After a couple of hours, drain off the excess water and place back in fruiting conditions. You can patch the divots from picking, but don't recase. It won't colonize anyway and will just serve as a place for contaminants to get a start.

PEROXIDE/NO TO SOAKING - Peroxide breaks down within minutes in the presence of organic material such as a substrate, so is ineffective for an overnight soak. Peroxide is toxic to fungi so don't use it except to control a cobweb outbreak. It's ineffective as I said in dunk water because it breaks down so fast. Besides, it's not necessary. Yes, the only reason for using the refrigerator during the soak is to prevent bacteria from growing unabated.

REHYDRATING FC - I like to dunk cased substrates under running water. Just let the faucet fill up the tub and run over the edges. Use whatever you need to keep the substrate block from floating. Allow the water to run for an hour, then drain and return to fruiting conditions. The running water prevents contaminants building up during the dunk and also helps to wash contaminant spores that may have landed on your project down the drain.

SOAKING - I like to dunk cased substrates under running water. Just let the faucet fill up the tub and run over the edges. Use whatever you need to keep the substrate block from floating. Allow the water to run for an hour, then drain and return to fruiting conditions. The running water prevents contaminants building up during the dunk and also helps to wash contaminant spores that may have landed on your project down the drain.

DUNKING IN BLEACH - If you still have problems with contaminants after using peroxide, you can also dip tissue into a ten percent bleach solution for a couple of minutes. Believe it or not, the mycelium can withstand this, but molds and bacteria can't. The bleach works really well when cloning dry tissue. Live tissue needs a week or two to recover from the bleach, but dry tissue is dormant so hardly even gets smacked.

SOAKING WITHOUT A FRIDGE - You can pad your bet by changing the water every few hours, or using very gently running water from the sink. Just hold the cakes underwater, and allow the faucet to drip slowly into the pan until it overflows and runs down the drain. The moving water will prevent growths as well. It's also a good idea to rinse the cakes very well under running water both before and after the soak.

DUNKING - You can dunk right in the tray it grows in. Just leave it under the gently running kitchen faucet for a few hours. Let the water overflow the tray and run down the drain. The running water will prevent bacteria buildup during the dunk and might even wash a few contaminant spores off in the process. Put a couple of rocks or whatever you have on top of the substrate to hold it submerged.

MISTING - You can mist mushrooms. You can mist the casing layer directly to moisturize it. In fact, you can put your thumb over a garden hose and blast your mushrooms and they'll do fine (slight exaggeration) as long as you don't seal them up in a closed terrarium while wet. Mist, and then increase air exchange until the visible moisture on the fruits themselves has dried or been absorbed.

MISTING CASING - You want your casing layer to dry a bit between mistings. This is one of the major secondary pinning triggers. Replace that lost moisture with misting. An ultrasonic can easily saturate the casing layer, taking away this major pinning trigger. I'd go from misting once a day to three or four times, and keep the air exchange up, provided you have mid to upper 90's humidity.

HYDRATING - You should be misting several times per day to keep it nice and moist. You can also pour water right from a bottle between the pins to super-hydrate the casing. If the substrate is also dry, as I suspect, you can inject water directly into it with a syringe, and/or pour water around the edges of the tray, filling it up. Pour off the excess a few hours later.

REHYDRATING - If the substrate dries out, you can always inject some water with a syringe. I tried all sorts of hoses, pipes with holes, and straws in the middle of substrates for hydration and had an increased rate of contamination every time. It seems that trich spores migrate into the well you cut, and then grow there in the stale, still air until they ruin the project.

MISTINGS - Mist cakes a couple of times per day, especially if they've been dunked and rolled. Keep that vermiculite damp. What you need is a higher priced mister. It should spray a very fine mist and not puke out large droplets that will damage your mushrooms. Aim it up so the mist gently falls onto your cakes. This won't damage the fruits.

HYDRATING - You can do it either way. However, since it isn't the 'soil' or 'substrate' we're hydrating, but rather the individual cells of mycelium, soaking overnight has become the preferred method. Cells take on water by osmosis; therefore the water pressure helps to hydrate them faster than simply misting.

SOAKING/DUNKING - In addition, dunking causes the cakes to expand, so in jars they stop expanding when they hit the glass, thus they stop in taking moisture. In addition, it pushes the cake tightly against the glass, making birthing harder. It's best to birth before the dunk so the cakes slide right out of the jars.

HYDRATING/CASING - You can pour water directly on the casing layer between pins to fully hydrate it. We use high humidity to slow down the rate of evaporation, but you still need to mist directly to replace what is used by the growing fruits, as well as to replace what moisture naturally evaporates.

MISTING CASINGS - You can tell when to mist by looking carefully at the cakes or casing layer. Allow them to dry slightly, then mist lightly. After a few grows, you'll be able to instantly tell when a project needs to be misted. You don't want them to dry completely out, or get waterlogged.

MISTING/SOAKING - Misting lightly or even heavily does not abort mushrooms. Soaking wet mushrooms in stale air causes aborts. Always provide plenty of fresh air and you can mist like crazy. That's the reason for building a terrarium with holes in all six sides.

DUNKING - Dunking before first flush is optional, but it's best to dunk between flushes for sure. There is no reason to use mineral water. I use plain tap water, but if your local water supply sucks, it's probably best to filter it or use spring water.

DUNKING WITH PINS - Leave them. Dunking won't hurt healthy pins. I've actually seen them double in size during the dunk. Also, pins for the second flush often form during the first flush. Just leave them and after the dunk, they'll begin to grow.

MISTING - You don't want the cake to dry out. Mist as needed until hyphal knots form. Then back off until the pins are well established. Always fan after misting. Don't allow a pin to sit there soaking wet after you close up the terrarium.

MISTING - If the casing layer is saturated, it means you've over misted, or possibly made it too wet to begin with, but high humidity will not get your casing layer wet, but rather will only slow down the evaporation of moisture from it.

HYDRATE - Yes, that's a very small substrate to have to support all those pins. I'm sure it's dry. Put about 1/2" of water in the pan and let it soak for a day, and then dump out the excess. Repeat every 48 hours until the flush is done.

MISTING - Misting is fine, but be sure to increase air exchange afterward until all the misted water either evaporates or is absorbed into the fruits by osmosis. If you leave pins wet in a still-air environment, many will abort.

MISTING - You should not stop misting. Mushrooms are 90% water and the purpose of a casing layer is to supply moisture to the flush. Daily, or several times daily misting is required for large fruits and good performance.

SOAKING - Tap water is best for soaking/dunking in my opinion. I use it right out of the tap. The small amount of chlorine will actually help to prevent bacteria buildup during the soak. I use spring or distilled for misting.

DUNKING - After the dunk, replace the casing that is missing from the divots or from washing off during the dunk. You can also dump extra casing material around the edges to fill in the gap.

COLD SHOCKING - Cubensis benefit NONE from cold shocking, as they are a hot tropical species; Cold Shocking is used for cold climate edible mushrooms.

SOAKING - You don't need to pick them off before dunking. If they abort later, pick them, but it's rare for fruits to abort from an overnight soak.

DUNKING - I've never found that dunking damages these pins. Just be careful not to scrape or otherwise physically damage them.

COLD SHOCKING - You should soak in the refrigerator to avoid bacteria buildup in the anaerobic environment under water.

CASING MISTING - You're supposed to mist your casing layer several times per day to replace moisture that is evaporating.

DUNK IN CHLORINE - I never have. If anything, the chlorine will help kill bacteria. It sure doesn't hinder the mycelium.

MISTING - You're supposed to mist your casing layer several times per day to replace moisture that is evaporating.

MISTING - Use filtered, spring, or distilled for misting though.

OUTDOORS GROW - For an outdoor grow, all you need to do is gather up some of your field-aged manure and make a bed of it in a nice shady spot. Make the bed no more than about six inches deep. Dig a hole and put the manure in that, so the ground can help keep it from drying out. Wet the manure down well, but no pasteurization is required for outdoor grows. Obtain some spores and inoculate some pf cakes, made from brown rice flour and vermiculite. You can find the pf tek on here in the FAQ link at the top of the page. When 8 or 10 jars are fully colonized, you can spawn them into your manure outdoors, and the mycelium will jump off from the brown rice flour cakes into your manure. Lay a sheet of cardboard, or a few inches of straw over the top to shade and hold in moisture while the mycelium colonizes your manure. It will fruit later in the summer after heavy rains.

OUTDOORS GROW - If you're going to grow outdoors using bagged cow manure unpasteurized, put it in the ground, not in a Tupperware. It needs the organisms in the soil to prevent contamination. I'd also suspect your cake was contaminated prior to spawning to the manure if it was green within a week. I've stored bagged cow manure outdoors for months without it growing trich. If you spread the bagged cow manure out on a tarp in the hot sun, the ammonia is gone within hours. If it's cool weather, it might take a few days.

OUTDOOR - Wait until June to plant them outdoors. If you put grains in the ground, the damn squirrels will dig up every single kernel to eat, and destroy your patch. Mix the grains with manure indoors, and then in June or July, bury them into a shallow hole with horse or cow manure spread all around the substrates you're planting. If you want to spawn directly to manure outdoors, use pf cakes, not grain.

OUTDOORS - Cakes can be grown outdoors, but those temperatures are at the extreme end of the scale. I would suggest to partially burying the cakes after full colonization, in the shade under some thick bushes. By burying the cakes half way, they can draw moisture from the soil, preventing them from drying out. It will help to run a lawn sprinkler in the area for several minutes, a few times per day.

OUTDOORS BED - You can pick up the cow pies and break them up into a compost pile or shallow manure bed in your yard. Mulch over the top with straw. This is how I originally started out in the early 70's; when there was no Internet, no grow guides, nothing.

OUTDOORS GROW - Chop up the fruit into manure or compost. It should clone right into the new substrate, provided temperatures are still in the right range.

STERILIZING CASING - Do not sterilize A Casing! EVER! In fact, most of the casings I use these days are simply peat/vermiculite with lime and gypsum, and zero heat-treating of any kind, because many edibles won't fruit on sterile or pasteurized casing layers. You can pasteurize casing material and it works well with cubes. However, sterilization will give a higher rate of contamination then doing nothing. You have to assume that mold spores are going to land on your casing layer. If it's been sterilized, they will germinate and grow because nothing else is there to stop them. The beneficial bacteria that are in peat moss will help protect against molds such as trichoderma, and some of these will survive the pasteurization process, which should kill all the mold spores that are present at the time. Once the casing layer is in place, the key to preventing molds is proper air exchange. Lime raises the ph, and gypsum keeps it stable. They both provide calcium, but gypsum also helps with texture.

STERILIZING CASINGS - In fact, most of the casings I use these days are simply peat/vermiculite with lime and gypsum, and zero heat-treating of any kind, because many edibles won't fruit on sterile or pasteurized casing layers.
You can pasteurize casing material and it works well with cubes. However, sterilization will give a higher rate of contamination then doing nothing.
You have to assume that mold spores are going to land on your casing layer. If it's been sterilized, they will germinate and grow because nothing else is there to stop them. The beneficial bacteria that are in peat moss will help protect against molds such as trichoderma, and some of these will survive the pasteurization process, which should kill all the mold spores that are present at the time. Once the casing layer is in place, the key to preventing molds is proper air exchange.

STERILIZING CASING - My main point about sterilizing casing layers is that one; it makes them more prone to contamination, not less. A sterilized substrate is prime food for whatever organism is the first to land on it. Second, many gourmet species will not fruit on a pasteurized or sterilized substrate/casing. Eventually, most growers either move from cubes to more difficult species to grow, or they lose interest in the hobby and quit growing. I just feel it's important to learn procedures that you can use later. I hope this clears it up.

STERILIZING CASING - The reason you don't sterilize casing layers is because a sterilized media is a prime target for contamination to grow on because there's no competitors.

MARTHA NEEDS REDUE... I THOUGHT I CAN JUST COPY AND PASTE A BUNCH OF SENTENCES TOGETHER BUT IT DIDN'T WORK SO

MARTHA/GREENHOUSE (REDO)

Once you've fixed up your mini greenhouse it's time to go over some guidelines. You want 100% humidity regardless if it's cased or not. You do not want your cool mist/humidifier/ultrasonic on the ground. It will pick up the contaminants from that air and bring them inside your growing chamber. Put your cool mist inside the greenhouse for optimally so it humidifies the entire thing and doesn't come in from just one spot. You want to cut slits in your greenhouse for FAE or open vents or doors are for air exchange, you also can use a fan if it's not moving at all. Using a cool mist, as a fae will only last a very short time due to the static pressure produced, which ruins the motor and bushings. For best results, use a humidifier for humidity, and vents for air exchange. I have openings cut all over my greenhouse so air can circulate in and out top, bottom, and sides. Constant air exchange, with the humidifier inside the greenhouse gives excellent performance. I can actually maintain 99% humidity, just like a terrarium. Place the humidifier(s) on a bottom shelf or floor of the greenhouse. Humidity in mini-greenhouses seems to stratify into layers with higher humidity near the top and lower at the bottom. By placing the humidifiers on the bottom of the unit, the air drawn into the humidifier will cause circulation from the top back down, thus equalizing the humidity.
You need a floor. Easiest is to use plastic sheeting and duct tape it to the sides. To catch drips, use trays of damp perlite. These will return the drips to the air as humidity.
I spent years modifying humidifiers before I worked out this method. A humidifier that has been modified has a life span in weeks, sometimes months, but not years the way an unmodified unit has. My two cool mists on the floor of my greenhouse are now over two years old without failing. Also, when it fails, you can't return a drilled out humidifier to the store.
Using the above system, I can easily keep my greenhouse at 95% to 99% humidity, which is what's required for cakes or substrate blocks of sawdust during fruiting. You'll need a good cycle timer for the humidifiers. Don't let them run more than a few minutes at a time, followed by another few minutes of 'off' time.

When you're first filling up the greenhouse, place trays of damp perlite on any empty shelf space. A greenhouse full of substrate is much easier to keep moist than an empty one, so the trays of perlite make up the difference. Supply air to the bottom, and return air out the top if you're circulating. This helps to counter the natural tendency of the humidity to stratify in layers.

You don't need to worry about removing CO_2 in a mini greenhouse. Just have a few openings top and bottom and that will take care of itself. You want air circulation and turbulence to help prevent molds. For best results, have constant air exchange during fruiting. It's counterproductive to use a humidifier for air exchange. You will never get the humidity high enough for cakes if you're pumping in fresh air with a humidifier. Rather, leave the door unzipped or cut slits in the sides of the plastic both top and bottom to allow for constant air exchange and circulation. Cool mist humidifiers have no problem keeping the humidity right around 85% to 90%, which is perfect for cased substrates. Wax paper works great to put over cased substrates from the time you first expose to fruiting conditions. It will keep the humidity near 100% right on the surface where primordia form, then as the pins grow, they will push the wax paper out of the way, opening the edges to allow for less humidity. It's sort of a self-regulating system. Just be sure to change the wax paper out for a clean sheet every second day. Also, you must use this tek right from the start. If your casing has already been open and exposed, placing wax paper over it will help the contaminant spores to germinate and grow. If used from the start, most contaminant spores falling from gravity will land on the wax paper, which you carefully remove and replace every 48 hours. Just lay the wax paper over the top. Don't try to tuck it under the cake or other substrate or you'll do more damage than good. You can fold it if necessary to fit, but don't try to make a tight seal. Tiny drops won't hurt, but if they build up, you're in for problems. This is a very common problem when running cool mists 24/7 because the air can't absorb all the moisture you're pumping into the greenhouse. If your casing layer becomes waterlogged, it won't pin. If you'll put trays of damp perlite on the empty shelf space and floor, you can easily get 99% humidity in a martha with a cool mist. I place mine inside the greenhouse, which raises humidity even more because it recirculates already humid air through the cool mist. I only use cool mists, with trays of perlite on the floor to catch drips. As you can see, it's steady at 95%. Put the cool mist inside the greenhouse and run it no more than 25% of the time. You want a Vicks 400 humidifier. I'd put two cool mists on timers or a humidistat inside the greenhouse for humidity, then simply cut about ten to twenty holes big enough to stick your arm through at various points in the sides. Put half the holes you cut high, and the other half of the holes down low. If you open windows while doing sterile work, it hurts. If you open windows near your greenhouse or terrarium, it won't hurt at all. In fact, I have a 4" clothes dryer hose connecting my mini greenhouse to the outside. Just make sure you shut everything before you do any sterile work. You want totally still air for that, plus a glove box. You still want the greenhouse open though. The more openings the better as long as you can maintain humidity. I know from experience if I allow the cool mists to run for more than two minutes, they begin to drip because the air can't absorb the moisture as fast as one of those can put it out. However, you can run them one minute on, then two to ten minutes off and get 80 to 90 percent humidity with no drips. It takes a good cycle timer to do it, but the results are worth it. I agree. Short cycles are the key. I'm running mine about a minute on, then about six minutes off. The link below will get you a good prewired timer for $120. Scroll to the bottom of the page and look at the Cycle stat 4 timer. It's what I've used for two years now and it's still working great.

http://www.littlegreenhouse.com/accessory/controls2.shtml. If you're going to run a cool mist into a terrarium for air exchange, run it no more than one or two minutes per hour. That is enough to fully exchange the air without drying anything out. I run the humidifier for two minutes every fifteen.

GREENHOUSE - I think you said you're growing cakes. A mini-greenhouse is really not suitable for cakes unless you put the cool mist directly INSIDE the greenhouse so it can recirculate your moist air, adding additional humidity to it. CO_2 should not be allowed to build up, then vented. For best results, have constant air exchange during fruiting. It's counterproductive to use a humidifier for air exchange. You will never get the humidity high enough for cakes if you're pumping in fresh air with a humidifier. Rather, leave the door unzipped or cut slits in the sides of the plastic both top and bottom to allow for constant air exchange and circulation. Place the humidifier(s) on a bottom shelf or floor of the greenhouse. Humidity in mini-greenhouses seems to stratify into layers with higher humidity near the top and lower at the bottom. By placing the humidifiers on the bottom of the unit, the air drawn into the humidifier will cause circulation from the top back down, thus equalizing the humidity. You need a floor. Easiest is to use plastic sheeting and duct tape it to the sides. To catch drips, use trays of damp perlite. These will return the drips to the air as humidity. I spent years modifying humidifiers before I worked out this method. A humidifier that has been modified has a life span in weeks, sometimes months, but not years the way an unmodified unit has. My two coolmists on the floor of my greenhouse are now over two years old without failing. Also, when it fails, you can't return a drilled out humidifier to the store. Using the above system, I can easily keep my greenhouse at 95% to 99% humidity, which is what's required for cakes or substrate blocks of sawdust during fruiting. You'll need a good cycle timer for the humidifiers. Don't let them run more than a few minutes at a time, followed by another few minutes of 'off' time. When you're first filling up the greenhouse, place trays of damp perlite on any empty shelf space. A greenhouse full of substrate is much easier to keep moist than an empty one, so the trays of perlite make up the difference. Supply air to the bottom, and return air out the top if you're circulating. This helps to counter the natural tendency of the humidity to stratify in layers. You don't need to worry about removing CO_2 in a mini greenhouse. Just have a few openings top and bottom and that will take care of itself. You want air circulation and turbulence to help prevent molds.

GREENHOUSE FC - Greenhouse: Air exchange is provided by the very loose fitting door. My greenhouse is framed with PVC pipe and covered with plastic sheeting. I got all the parts at the hardware store for less than $35. I'd say it's twice to three times the size of the Martha closet. I didn't put zippers or anything else to seal the door, so it's open on both sides from floor to ceiling. This provides for plenty of air exchange, and the cool mist humidifiers have no problem keeping the humidity right around 85% to 90%, which is perfect for cased substrates. When I use it for cakes or straw logs, etc., that require higher humidity, I simply cover them with wax paper which holds in the humidity in that specific area while still fitting loose enough to allow gas/air exchange. Wax paper works great to put over cased substrates from the time you first expose to fruiting conditions. It will keep the humidity near 100% right on the surface where primordia form, then as the pins grow, they will push the wax paper out of the way, opening the edges to allow for less humidity. It's sort of a self-regulating system. Just be sure to change the wax paper out for a clean sheet every second day. Also, you must use this tek right from the start. If your casing has already been open and exposed, placing wax paper over it will help the contaminant spores to germinate and grow. If used from the start, most contaminant spores falling from gravity will land on the wax paper, which you carefully remove and replace every 48 hours. Just lay the wax paper over the top. Don't try to tuck it under the cake or other substrate or you'll do more damage than good. You can fold it if necessary to fit, but don't try to make a tight seal.

GREENHOUSE - I get 90% to 95% with cool mists alone. I have never used an ultrasonic because I've found them not necessary. Never seal a fruiting chamber or greenhouse up tight. You want massive amounts of air exchange to stimulate pinning and to prevent contaminants, which thrive in stale, still, moist air. I have several 4" holes cut in the sides of my greenhouse, and the door is a simple piece of plastic sheeting that hangs from the ceiling all the way to the floor and is not attached at all except at the top. This leaves two slits the full vertical length of the greenhouse. All of the above provides plenty of air exchange, and an impeller type cool mist inside the greenhouse provides the humidity by only running one to two minutes on, five to seven minutes off. I tweak the cycle timer depending on how full of substrate trays it is at any given time. It also helps to get a bunch of plastic trays and fill each one with damp perlite. Use these to line the floor to catch drips, and also to fill up any empty shelf space within the greenhouse. Doing the above will provide you with 90% to 95% humidity along with ample air exchange. You can also do a search, and you'll find all of this has been covered many, many times before with experienced growers using all sorts of methods. This is my method, but by no means is it the only one that will work. Other growers prefer to put the cool mist outside the greenhouse, and then modify it to pipe the humidity in, but that isn't my personal choice for reasons I've previously posted, but it certainly works and they have the pictures to prove it.

GREENHOUSE - I have two 4" holes near the bottom on each side. Two more 4" holes are at the top on each side. The door is an opening that covers the entire front, nearly 5 feet across. It's a sheet of plastic that hangs down from the top; with a piece of PVC pipe at the bottom to hold it shut by gravity. The side slits are not attached to anything, thus air exchanges the full length from top to bottom on each side of the door, and the other 4 holes also pass air. There are also a few smaller holes I've cut for taking pictures and never sealed up. The idea is to have as much air exchange as you can possibly have and still keep mid 90's percent humidity. I use 2 vicks kaz cool mists sitting inside the greenhouse, set to run 1 minute on, 4 to 6 minutes off depending on ambient humidity. I'll tweak it daily due to local conditions. When things get really dry weather-wise, I'll often run a third cool mist in the room the greenhouse is located to raise the ambient humidity. Good luck. The weight of the PVC pipe is whatever a 2" X 5' length of it weighs. Perhaps two or three pounds. Yes, I built a place for it to hang. To open it, I simply roll up the PVC and 'door' from the bottom. It makes a nice little roll to hang on the hooks at the top. My entire greenhouse is framed with PVC pipe and covered with plastic sheeting. I also have a self-contained air conditioning system to use when fruiting cold weather loving mushrooms such as oyster and shiitake. I can keep the greenhouse at 58F, while the room outside is 70F.

GREENHOUSE - There is absolutely no need or reason to even attempt to keep a greenhouse sterile. We use sterile procedure to colonize grains, but once they're colonized, everything else is done in normal air. You don't need a fan to provide air exchange in a greenhouse. Simply take a knife and slice the plastic from top to bottom in a few places. This will allow normal room air to circulate into and out of the mini greenhouse. Use a cool mist humidifier (or two) depending on size to provide humidity, not air exchange. Trays of damp, well-drained perlite placed on empty shelf spaces and the floor will help to catch drips and return them to the air as humidity. To repeat, a mini-greenhouse should have high humidity and high air exchange, with very bright high frequency lights such as natural daylight fluorescent on a 12/12 cycle for best results. Don't waste time stressing over filters or other means of scrubbing the air. It isn't necessary.

HUMIDIFIER/GREENHOUSE - You don't need distilled water for your humidifier. I've used tap water for many years in different parts of the world. It's fine. You also don't need to clean it with bleach once a week. When it starts to get nasty, clean it in the sink with soap and water. Impeller type humidifiers DO move air, but not much. They are the type to use for mycology. You don't need one for a monotub or terrarium, but when you move up to a mini-greenhouse, you'll want one. Wicking type humidifiers will work fine in the room your grow is located in, as a way to boost the ambient humidity, but they can't produce enough humidity for mushrooms. After about 60% to 70%, they won't evaporate any more moisture into the air.

GREENHOUSE FC - http://www.littlegreenhouse.com/accessory/controls2.shtml
I also have the humidistat they sell on that same page, but if you order it, be very careful to always harvest before a major spore drop occurs, because the spores will jam up the mechanism, causing the humidistat to fail. The cycle timer mounts outside the greenhouse so it's safe. Also, the humidistat won't provide over 80%, which is fine for cased substrates as long as you put a sheet of wax paper over the casing layer during pinning initiation.

GREENHOUSE/COOLMIST - With mine inside the greenhouse, it only needs to run one or two minutes, followed by five to seven minutes off. I tweak the cycle timer depending on season and ambient humidity in the room. If you run it longer than fifteen minutes, you'll have water everywhere. I burned up at least 20 cool mists before I stopped modding them and placed them inside. The same two cool mists have now been in the mini-greenhouse for over two years. Using hoses creates static pressure that ruins the bushings, thus burning out the motor in a very short time. Cool mists are designed to provide humidity, not move air.

HUMIDIFIER - I've always recommended people in dry climates run a humidifier in the general area or room their grow is located. If you can bring the ambient humidity up to 50%, you'll have no problems. While it's true that Seattle has a damp climate in the fall, winter and spring, summers are very dry here. I always run a cool mist 24/7 in the room my terrariums are located. This becomes especially important if using a terrarium with many holes drilled into it. Air exchange is a major pinning trigger as well as preventer of contamination, so make sure your ambient humidity is up to the task.

HUMIDIFICATION CASING/CAKES/GREENHOUSE/FC - Get rid of standing water. If you can't find perlite, you can use paper or cloth towels in the terrarium. Replace paper towels or wash cloth ones every three days to prevent molds and/or bacteria from growing on them. I've ran terrariums with a large bath towel soaked, then well rung out and folded loosely, then laid into the bottom of the tub. Humidity stays as high as several inches of perlite. People with humidity problems in mini-greenhouses can also hang a damp bath towel or two inside the greenhouse for a great boost.

GREENHOUSE, HUMIDITY - Simply run an additional humidifier or two 24/7 in the room your greenhouse is located. Get your ambient room humidity up to 50%, and you'll not have trouble maintaining humidity in the martha. This will also make your house more comfortable and much more economical to heat. In fact, you should run several humidifiers in your house during the winter. The wax paper tek works great. Lift it to mist, and change it with a fresh sheet every two days. Wrinkle it up, and then flatten it back out so plenty of air can still circulate under it.

GREENHOUSE FC AIR EXCHANGE - I have several large slits, and even a few holes cut in the plastic for air exchange. In fact, the door is simply a large sheet of plastic sheeting hanging from the top, with a weight on the bottom to hold it down. The full length of both sides is not connected, so two large slits run from the ceiling to the floor of the greenhouse. The more air exchange you can give the better, as long as you can maintain humidity. That is the reason I moved the cool mist into the inside, rather than on the outside.

GREENHOUSE COOLMIST - Put it at the bottom. A cool mist needs to shoot a mist straight up about 5 feet to work properly. Mine sit on the floor of the mini-greenhouse, one on each side of the shelves. Cut a hole in the plastic right next to where the humidifier sits, and it will draw in some fresh air and also mix with the air inside to give you a nice 95% humidity easily. Giving lots of fresh air in a greenhouse is easy. Simply use a knife to cut slits and holes in several places.

GREENHOUSE - For years, I've been running a self-contained AC unit in my mini-greenhouse during the summer months. It will seriously dry out the air, so you'll have to provide for increased humidification. Get a stand-alone unit so you can circulate the same air. Don't use the central AC unit from your house. The house AC will push the humidity out. A good humidifier might be able to keep up, but it will take some tweaking, so you'll just have to experiment.

MARTHA HUMIDIFIER - One hour is too long to run the humidifier. More than a few minutes at a time will cause drips to form. I run mine less than five minutes on followed by five to ten minutes off. This maintains a high humidity without excessive dripping. You need to seal the bottom and put several trays of perlite down there to catch whatever drips do form. At the very least, get a timer with 15-minute intervals. They're cheap. Try running 15 on, 30 off.

HUMIDIFIER/GREENHOUSE - The inside of a cool mist type humidifier is always at 100% humidity because of all the mist flying around in there. You can run a cool mist, such as the vicks kaz models inside the greenhouse without problems. I've done so for years and wouldn't recommend something that wasn't safe. I'm an electrical engineer, as well as licensed journeyman electrician, so am qualified to make that determination.

HUMIDIFIER/COOLMIST - They don't crap out because of humidity. They crap out due to backpressure in the hose, which forces moisture into the motor bearings, ruining them, which then burns up the motor due to the extra load. That's why they're best used inside a greenhouse. They will also raise the humidity more because they're recycling already humid air, rather than dry air from outside.

MARTHA - FAE is 'Fresh Air Exchange' and is provided by ventilation holes cut into the mini-greenhouse. Cool mist humidifiers are designed to raise humidity, not move air. If you try to use one to move air, it will only last a very short time due to the static pressure produced, which ruins the motor and bushings. For best results, use a humidifier for humidity, and vents for air exchange.

MARTHA FC HUMIDITY - I know from experience if I allow the cool mists to run for more than two minutes, they begin to drip because the air can't absorb the moisture as fast as one of those can put it out. However, you can run them one minute on, then two to ten minutes off and get 80 to 90 percent humidity with no drips. It takes a good cycle timer to do it, but the results are worth it.

GREENHOUSE AIR EXCHANGE - Humidifiers are for humidity. Fans, fanning, open vents or doors are for air exchange. I have openings cut all over my greenhouse so air can circulate in and out top, bottom, and sides. Constant air exchange, with the humidifier inside the greenhouse gives excellent performance. I can actually maintain 99% humidity, just like a terrarium.

MARTHA TIMER FC - I agree. Short cycles are the key. I'm running mine about a minute on, then about six minutes off. The link below will get you a good prewired timer for $120. Scroll to the bottom of the page and look at the Cyclestat 4 timer. It's what I've used for two years now and it's still working great. http://www.littlegreenhouse.com/accessory/controls2.shtml

FAE GREENHOUSE - If you open windows while doing sterile work, it hurts. If you open windows near your greenhouse or terrarium, it won't hurt at all. In fact, I have a 4" clothes dryer hose connecting my mini greenhouse to the outside. Just make sure you shut everything before you do any sterile work. You want totally still air for that, plus a glove box.

GREENHOUSE - Toss out the ultrasonic and get a spinning impeller type cool mist, and set it inside the greenhouse. Adjust the timer so you get the desired level. I use one minute on, six minutes off. In the winter when ambient humidity is lower, I use one minute on, four minutes off. You'll have to tweak your own setup depending on your ambient conditions.

HUMIDIFIERS - Cool mist humidifiers cost from $15 to $35 brand new, and a fraction of that at thrift shops. If necessary, run one in the room your fruiting chamber is located in. Right now, the ambient humidity in my house is 11% and my FC is at 98%, using only perlite and 1/4" holes drilled into all six sides. I fail to see why you're having so much trouble.

COOLMIST FOR FAE - Actually, the spinning disk type humidifiers burn out from the static pressure. The problem is that it forces moisture into the motor bushings, ruining them. I've used up to a 2" PVC pipe leaving the humidifiers and still had them burn up within two months. By leaving them inside the greenhouse, they last a year or more.

GREENHOUSE TEMPERATURE - Check your thermometers. There might be a degree or two of evaporative cooling until the humidity stabilizes, but the temperature of the room and the greenhouse will be the same. Usually, the greenhouse is a few degrees warmer with the lights on, then exactly the same as the room with the lights off.

MARTHA PROBLEMS FC - The tiny drops won't hurt, but if they build up, you're in for problems. This is a very common problem when running cool mists 24/7 because the air can't absorb all the moisture you're pumping into the greenhouse. If your casing layer becomes waterlogged, it won't pin.

COOLMIST - Cool mists can't build static pressure or the motor bushings get wet and ruin. If you use hoses from the humidifier to the GH, you cause static pressure to build. If you put the cool mist inside, you get high humidity, and if you cut slits you get FAE, plus the humidifier will last for years.

GREENHOUSE - Unzip and leave it unzipped. Continuous air exchange if preferable to occasional air exchange. I have holes cut all over mine and keep the door half open all the time, and easily maintain high humidity with two cool mists. My greenhouse is about the size of three martha units.

GREENHOUSE - Cool mist humidifiers need a free space of at least five feet above them to work properly. Your mist is blowing right on the bottom of the trays above, thus the mist can't evaporate into the air, but drips back down. For a fruiting chamber of that size, perlite is recommended.

MARTHA/GREENHOUSE - If you'll put trays of damp perlite on the empty shelf space and floor, you can easily get 99% humidity in a martha with a cool mist. I place mine inside the greenhouse, which raises humidity even more because it recirculates already humid air through the cool mist.

MARTHA FAE - I'd put two cool mists on timers or a humidistat inside the greenhouse for humidity, then simply cut about ten to twenty holes big enough to stick your arm through at various points in the sides. Put half the holes you cut high, and the other half of the holes down low.

COOLMIST - On the vics cool mists, the V shaped nozzle that spins in the water is detachable. Simply prevent the disk from turning, and rotate the nozzle half a turn and it will separate. It might have become clogged up inside where the rifling is, when you cleaned.

GREENHOUSE FC - I used a cool mist as you are for a year or two before settling on the way I now do it, with the cool mist sitting directly on a shelf inside the greenhouse. You'll need to connect it to a humidistat or timer to keep it from saturating everything inside.

MARTHA GREENHOUSE - Just put it inside for humidity, and leave a flap open or the door unzipped, etc., for constant air exchange. This system will get you to 95% humidity. You can use trays of perlite to catch drips and return them to the air as humidity.

HUMIDIFIER - I run mine less than five minutes on followed by five to ten minutes off. This maintains a high humidity without excessive dripping. You need to seal the bottom and put several trays of perlite down there to catch whatever drips do form.

GREENHOUSE - CO_2 isn't a problem in a greenhouse if you cut lots of small holes or windows. You can also leave the door cracked open. Put the humidifier on the floor or a lower shelf so it can shoot up and dissipate, rather than hit the ceiling of the unit.

MARTHA HUMIDITY - If you need even more humidity until you get it filled up, you can put trays of damp perlite everywhere you don't have a project sitting. It can sometimes be hard to keep enough humidity in an empty greenhouse.

FC. GREENHOUSE COOLMIST - If you live in the desert, you should run a cool mist 24/7 in the room your grow area is located. That will raise the humidity up to around 50% or so, making it easier to maintain 90+ in your

COOLMIST GREENHOUSE/MARTHA - I only use cool mists, with trays of perlite on the floor to catch drips. As you can see, it's steady at 95%. Put the cool mist inside the greenhouse and run it no more than 25% of the time.

GREENHOUSE FC - When fruiting cased substrates, I run it one minute on, six minutes off. Of course, these figures are based on my unique setup, so you'll have to experiment to find the sweet spot in your operation.

COOLMIST - An impeller type cool mist unmodified sitting on the floor or bottom shelf running a few minutes on, then a few minutes off will deliver 90% to 95% humidity.

FC MARTHA - MARTHA! Using a sonic Humidifier and Cool Mist...Providing plenty of FAE (Fresh Air Exchange) and RH (Relative Humidity) holes, flaps, cut open.

GREENHOUSE - If you're going to run a cool mist into a terrarium for air exchange, run it no more than one or two minutes per hour. That is a fact.

GREENHOUSE FC - You still want the greenhouse open though. The more openings the better as long as you can maintain humidity.

HUMIDIFICATION FC - Line the bottom of your terrarium with 2" of damp but not wet perlite, and watch your humidity go to 99%.

DROPLETS MARTHA - Lay wax paper loosely over the trays to prevent water droplets from falling on them.

HUMIDIFIER TIMING FC - I run the humidifier for two minutes every fifteen.

COOLMIST/HUMIDIFER/ULTRASONIC - Vicks 400 humidifier'

HUMIDIFIER - A vicks 400, 420, or similar will last for years.

TEK/SUBSTRATE/CASING ADDATIVES

PASTERUIZING TEK - Pasteurization tek
Load the pre-moistened to field capacity casing mix, compost or manure into quart mason jars. Place a lid and/or foil over the top. Put the jars into a large covered pot of cold water, with the water filled to 2/3 to ¾ of the way up the jars. A large kettle or pressure cooker works well. If necessary, put a plate or some other weight over the jars to prevent them from floating. Make sure you have a spacer or dishtowel under the jars to prevent the direct heat of the stove burner or flame from cracking your jars. Place the lid on the pot and turn on the stove. Bring the water to a boil, but watch over it and as soon as the water actually reaches a boil, shut off the stove, but leave the pot sitting on the burner. The preceding is for an electric stove that will remain hot for a little while after shutting off power. If you use gas, allow the water to boil for one to two minutes before shutting off the stove. After a couple of hours when they've cooled, the jars can be removed and used.
The first time or two you use this technique, monitor the interior of your jars with a meat thermometer. Place it right into the center of the peat or compost. You want to make sure the center of the jar reaches at least 140F and stays there for an hour, but don't allow it to exceed 170F. Depending on the thickness and capacity of your kettle and lid, you may need to adjust the above times slightly. This tek works because glass is an

insulator, so the temperature inside the jars lags the water in the kettle. When I use the above procedure with 7 full quart jars in my All American 921, it comes out perfectly just as written. If you use a smaller pot, you may need to turn the stove on briefly at the ½ hour mark for a few minutes.
The advantage to this tek is there is no pillowcase, etc., to drain and little to no mess or stink is made in your kitchen or pressure cooker. The disadvantage is you have a bunch of jars to wash when you're done.

WOOD LOVERS TEK, NO PC! - Wood Lover Smoothie Tek
Last year I had an idea for a cultivation of wood lovers that absolutely begged to be put to the test. I have put it to the test, and I succeeded.
There was NO sterile technique.
There was NO agar.
There was NO grain.
There was NO Pressure Cooking.
There was NO oven heating.
And yet I succeeded. I am now the proud owner of a storage box with 15 liters bright white, strongly rhizomorphic Psilocybe cyanescens mycelium, with that special mycelia odor I have come to love so much.
What did I do?

- -

WOODLOVER SMOOTHIE TEK

1.soak the right kinds of dried woodchips in desinfecting water for three hours.
You can prepare this solution easily by adding 100ml household bleach (5% sodium hypochlorite without additives) to 10 liters of water. Don't worry; it's what they use in swimming pools and in commercial edible mushroom cultivation.
2.leach the woodchips for several hours to get rid of excess moisture.
3.take fresh woodlover mushrooms, add ten parts of water and blenderize it to a "woodlover smoothie". Your goal is to create a suspension of very fine mycelium bits and spores in the water, so blenderize for a full minute, even when the job seems done in 15 seconds. You are creating very heavy mycelia inoculants in a liquid that has as much spores as spore syringe fluid. I used 30gr fresh Psilocybe cyanescens mushrooms in 300ml water to inoculate 15 liters of soaked woodchips.
4.spread out the woodchips and sprinkle the mycelial solution over it, turning it regularly with very clean hands or gloves. Your goal is to get a dab of the mycelium/spore inoculant on every bit of wood. When you are done, keep mixing up the woodchips because the inoculated chips will rub off mycelium onto the untreated chips.
5.put the woodchips into a plastic storage box and cover it with a sheet of plastic, which you fasten with clothespins. It should breathe, but not let dust fall in. Store this in the dark at room temperature. The woodchips will colonize in the usual time of a spawn inoculation.
There you have it! With wood lover mushrooms you collect in the wild you can very easily create loads upon loads of mycelium. Once the mycelium has colonized the woodchips, you can use one part of this spawn to inoculate five parts of moistened woodchips.
A couple of small wood lover mushrooms inoculate a storage box, a storage box inoculates a thrashcan and a thrashcan full of spawn can be used to inoculate several gardens and wild patches.
This TEK can be used on any scale. You can inoculate a few jars with one tiny mushroom you found, or load up a super soaker water gun and guerilla-inoculate a whole mulched park.

PHONEBOOK TEK - Phonebook Tek
You can inoculate pf cakes with oyster mycelium and grow out your spawn that way without a pressure cooker. Cut out a couple of dvd case sized holes out of the middle of the phone book, so you'll have a place to put a few slices of your cakes so they can inoculate the paper. After cutting the openings, you can boil the phonebook in water for a few minutes to sterilize/hydrate it, and then when it cools, simply open it up with clean hands and put your spawn into the places you've previously cut out. Did you see my phone book thread in the gourmet and medicinal mushroom forum? If not, take a look. Below are Hericium (Lion's Mane) but oysters grow from the same substrates. I'll have some oyster pictures on phonebooks soon. They're pinning now along with the Shiitake.

CASING TEK - Casing tek

Measure the appropriate amount of dry peat moss for your application. For the first few times you make up casing mix, you'll just have to take an educated guess as to how much to prepare, then add or subtract from that amount as needed for future projects.

Place the dry peat into a large bowl, five gallon bucket, wheelbarrow, etc., depending on amount. Leave room for the quantity to double, and still allow space to stir. Break up the dry peat very well. There should be no chunks when you get finished, having carefully broken up the peat until it's all the same consistency. To each cup of peat moss, add one teaspoon of hydrated horticultural lime, and one to two tablespoons of gypsum. Certain species can benefit from two tablespoons or even more of gypsum per cup, so don't be afraid to experiment, up to ten percent of the amount of peat.

Mix these dry ingredients together well. After mixing, slowly add water to the mix, stirring constantly. Add moisture until field capacity is achieved. I define field capacity as being reached when you can pick up a handful of the mix and no water drips out. If you squeeze lightly a few drops will come out, and if you squeeze very hard, a small rivulet or stream will flow out. Remember, the peat will not absorb all the water at once, so when you reach field capacity, let the mix sit for ten minutes and check again. Chances are, you'll have to add more moisture.

In a separate bowl, place an equal amount by volume of vermiculite. Fill the bowl with water so the vermiculite begins to float a bit. Turn the bowl over and allow all the water to drain off. A fine mesh strainer works well for larger amounts.

Mix the moistened vermiculite with the moistened peat/lime/gypsum very well and pasteurize at 140F to 160F for one hour. Use as soon as it's cooled. If you don't use it all, it's best to discard or use for your houseplants. Make a fresh batch every time for best results.

MY RYE TEK - My rye tek:

Measure out your organic rye berries from a health food store, one cup for each quart jar you intend to make. Place them in a large pot. Rinse the heck out of them. Fill the pot with hot tap water, shake and swirl it around and pour it out. Do this three or four times until the water you pour out is clear. You'll be able to see when you have nice clean water to pour off instead of water filled with chaff and dirt.

You want to now cover the rye berries with three times as much hot tap water as you have rye. Use half coffee and half plain water. In other words, if you have two inches of rye in the bottom of your pan, you should have six inches of water/coffee above that, for a total of 8 inches.

Add 1/4 teaspoon per cup of rye of gypsum. Stir into the water/grain well. Cover and leave this to sit for 24-36 hours. Don't freak out if you go 48 hours and it smells like it's fermenting. No problem.

Stir well and set the pot on the stove. Bring to a boil. Boil for ten minutes, then, WHILE BOILING, drain the contents through a very large colander. (Spaghetti strainer) If you're making a large batch, you may need more than one colander. Tip the colander side to side to get the rye to drain as much of the water as you can. Then, shake the colander in order to 'toss' the grain. This will cause a lot of steam to rise from your rye. Great. Do this a time or two, and then let it sit for five minutes, then repeat. When all the moisture that will drip or evaporate from your rye has already done so, load your jars. The rye should look and feel dry to the touch when you load the jars. All the moisture you need is inside the grain.

Fill jars no more than 2/3 full if they are to receive grain-to-grain transfers, or no more than 3/4 full if they are to be inoculated by spore syringe or agar wedge. Use a lid with a synthetic filter disk, polyfill, tyvek or similar. Cover with foil and PC the jars for at least 90 minutes at 15lbs. When the jars are cool, they're ready to inoculate.

AGAR TEK - Here's how to do it. Get a whiskey or wine bottle with a screw on lid that will fit in your PC. Drill a hole in the lid and stuff it with polyfill or cut a synthetic filter disk to fit inside the lid. Prepare your agar and pc in the normal way. The filter will prevent contaminants from entering the agar as it cools.

Build a glove box. You can make one for the price of a clear Rubbermaid. All you need is a couple of arm holes. You don't even need-attached gloves, but if not, then be sure to wear latex gloves when you pour your dishes.

Allow the agar to cool almost to room temperature without opening the filtered whiskey bottle it's in. When it is cooled off, but still liquid is when you want to open it up to pour. Work fast. Open your sleeve of presterilized dishes just before use. Wash the outside of the sleeve with alcohol before opening carefully from one end.

Stack your dishes in two piles of ten. Pour the bottom dish by lifting the entire stack, then set it down and pick up the other nine. Repeat until you've filled both stacks, then CAREFULLY insert the sleeve back over the Petri dishes and seal the bottom so it's airtight.

The above procedure should give you a 100% success ratio with a bit of practice. I find no difference in contamination rates with a glove box or flow hood, but of course the flow hood gives you more elbowroom and is much easier to work in front of.

GYPSUM SOAK TEK - I add gypsum to the water the grains soak in. The first step is to wash the grains very well. Put them in a pot of water and swirl it around, then drain the water out. Repeat a few times until the water pours off clear. If you skip this step, your grains will be clumped up and sticking together whether you use gypsum or not.

Fill the pot with hot tap water and soak the grains for 24 hours. Add one tablespoon of gypsum for each two gallons of soak water.

After 24 hours, bring the pot of water/grain/gypsum to a boil for five minutes. Drain while still boiling into a strainer and allow to drain well for five minutes. Shake the colander to toss the grains in the air a bit to let the steam evaporate the moisture off the surface of the grains. Fill jars 2/3 full, cover with filtered lid and pc for 90 minutes after covering the top of the jar with aluminum foil.

If you'll follow the above instructions, you can leave the PC'd jars in the pressure cooker overnight to cool to room temperature. When you remove the cold jars and turn them upside down, every single kernel will separate from every other kernel, and they'll flow almost like sand in an hour glass, with absolutely no sticking or clumping. I'm no fan of micropore tape. Drill two very small holes of 1mm or 1/16" in the lid, then use a synthetic filter disk or extra thick (not post office) tyvek. Good luck.

AGAR POURING TEST TUBES - Fill your test tubes 1/2 full. I always insert a piece of wood, such as a medical tongue depressor into each slant. The mycelium colonizes the wood and lasts much longer under storage.

Get test tubes with screw on lids. Drill a 1/8" hole in the lid. Cut a synthetic filter disk to fit inside the test tube lid. Screw the lid down tight, and PC in a rack with the test tubes standing upright.

When removed from the PC, lay the rack over with a jar lid or something under one side so the test tubes are

at an angle as they cool. Try to get the mycelium within 1/2" or so of the opening, so you don't have to reach in as far when you want to get some myceium out. You'll have to flame any part of your scalpel that penetrates into the slant, so it's easier if you don't have to reach in as far.
I use triple the usual amount of water in the PC when I make agar so that the PC cools down slower and releases pressure slower to prevent boil over. One should NEVER lift the weight or release the valve to let pressure off a PC. It ruins the product inside. Agar boils over and grains (or your pot roast) dry out.
You also shouldn't use a jar for preparing agar. Use a whiskey bottle or something similar with a long neck that is made for pouring. It also will have a smaller opening that will be less prone to allowing contaminants to enter.

ALDER - I have an excellent source of hardwood (Alder) sawdust and chips in Seattle, but I've already looked into selling it in bulk and the shipping would cost more than the chips. You can call a local tree trimming company and ask them to dump any hardwood chips they collect in your yard. They're free that way because they need a place to dump them. You really need to find a sawmill to get the sawdust though. You don't want what you'd get from a woodworker or furniture shop because it's too fine. You want course sawdust. Sometimes, the pellet fuel you get for stoves is made from hardwood sawdust, and if so it works great. Most of what I've seen lately is pine, and not usable.

GENTAMICIN SULPHATE - Gentamicin sulphate has a place in agar work. Some growers have added it to grains, but I would discourage the practice. Not only is it expensive, costing about $5 to $10 for enough to do a 1 quart grain jar, but I'd worry about creating super strains of antibiotic resistant bacteria.

SEAWEED - Seaweed is extremely high in natural tryptophans, thus the reported increases in potency. I live on the coast, so go out and pick up seaweed off the beach. After drying, I mix it in with my bulk substrates at about ten to twenty percent. The myc colonizes it almost as well and fast as straw.

BLOODMEAL ONLY IF COMPOSTED - For nitrogen, you can add blood meal to all substrate materials including horse manure, at the rate of one tablespoon to ten cups of substrate. It really does make a difference in the quality of your crop after harvest.

HAIR - Yes. In fact, you can compost hair and grow mushrooms on it. I've been wanting to do a 'barber shop' grow for some time now, but just haven't gotten around to it.

PINE SUBSTRATES - Pine shavings are antifungal and used to control odors.

BROWN RICE GRAIN - Brown rice flour has more food for mycelium per gram than grains such as wbs. Your contention that BRF isn't 'nutritious' is in error. Have you ever noticed a 1/2-pint brf cake flushing? There are only a few tablespoons of brown rice flour in a cake. No other grain will perform as well in such small quantities.

BROWN RICE FLOUR - Actually, brown rice flour is far more nutritious than manure. All grains are. That's why when we use manure we use a much larger substrate. There are only a few tablespoons of brf in a 1/2-pint jar, yet they can grow some crazy mushrooms. A few tablespoons of manure will get you nowhere.

COCO COIR - About 4 years ago, I was the very first one to post that coir is a substrate material. After a year of flames from people claiming that "Coir has NO nutes", somebody else finally tried it, and then somebody else, and so on. Experimenting is how we learn. Plain vermiculite has been used as a casing layer hundreds, if not thousands of times. I used it many times myself, but I've said this for years, and the results of many experiments still hold true; Plain vermiculite is a horrible choice for a casing layer. It would be really nice for a change to see someone actually experiment and then report the results, rather than endless posts about 'will this work?' or 'will that work?' and then arguing about it. Just do it. If you really want to experiment, try something that hasn't already been tried a thousand times. Look in your kitchen, find something silly, and then grow mushrooms on it. It's fun.

COCO COIR - There are no rules for mixing substrates. Coir can be used as is, or you can dump in a few days worth of coffee grinds from your leftover morning pots of coffee. Worm castings, horse manure, etc., can all be added by the handful, or each can even be used for 100% of the substrate. Use between 5% and 10% gypsum by volume. Use 1/2 teaspoon of hydrated lime per cup of manure-based substrates.

COCO COIR - Coco coir is much better suited as a substrate material. It's superior to cow manure and nearly as good as horse. In fact, lots of growers use coir to fluff up their manure or other compost. I do not recommend using coir in a casing layer, although many growers do. In my opinion, the best casing mixture is peat/vermiculite. I'll bet that coir compost would make an excellent substrate.

COCO COIR - Every brick of coir I've ever tested was in the pH 5.0 to pH 6.0 ranges. You need to use gypsum and lime.

COCO COIR - Add 10% coir to your casing mix. That is somewhat like CAC'ing that some edible growers do.

COIR - Coir has as much food for fungi as horse manure and will grow very similar crops to horse manure.

COFFEE - Whether you believe it or not, the evidence is overwhelming with thousands of growers using it for many years. In fact, at least one commercial oyster farm in my area uses it exclusively for a substrate. Weak liquid coffee is used to hydrate grains instead of plain water. This provides a nutrient boost, and also lowers pH, which decreases colonization time. As a substrate additive to other ingredients, it raises the nitrogen levels, and nobody even knows how many of the other hundreds of ingredients such as antioxidants play a part as well. Use the search function and you'll find several hundred posts on coffee going back to my original experiments in 2003. You can use weak coffee in the pf cakes, and use spent coffee grinds mixed into the coir. Don't use liquid coffee in the coir or you're likely to get mold. Also, coir is much better to use as a substrate than a casing. It tends to overlay when used for casing.

COFFEE - First, simply spread the coffee grinds out in the sun so they can dry. Once totally dry, they won't mold and you can store them until ready to use. Use them at up to fifty percent of any bulk substrate. Actually, you can use coffee grinds as 100% of the substrate if you want. I know a commercial oyster farm that uses free coffee from starbucks as their only substrate. However, if you're growing cubes, mix the coffee with any other bulk substrate for a great boost. They do NOT contaminate before you can get them colonized if you pasteurize first and have them at the proper moisture content. As with all bulk substrates, add gypsum at up to ten percent by volume.

COFFEE - Quite often, the whole is greater than the sum of the parts. Coffee has thousands of elements, nitrogen only being one of them. Coffee works, period. Who really cares 'what' causes it to work? Folgers and Hills Bros work as well as Starbucks. I've seen no real evidence that coffee increases potency. It does decrease colonization times, and provides for more prolific flushes. The results are particularly astounding with sclerotia producing species, but every mushroom species I've ever grown has done better with coffee than without it. Reishi on coffee can even.

COFFEE - I was the first one to bring the use of coffee to the community a few years ago. Here's a 50+ page thread to read if you have the energy.
http://www.shroomery.org/forums/showflat.php/Number/2283143#Post2283143 You can use weak coffee to hydrate your pf cakes. Use it at 1/2 drinking strength, but no more. Too much coffee actually slows down colonization. Some growers thing it's the nitrogen, some think it's the 'nutes', others think it's the antioxidants, etc. All I know is it works and helps, but as said, use weak coffee, not drinking strength.

COFFEE - If you don't drink coffee, try using something else instead, like bagged chicken manure from the nursery. Use it at no more than 1 part chicken manure to 20 parts of the other substrate materials. The reason I say that is coffee is pretty darned expensive to buy for a substrate. If you drink coffee anyway, no problem, but otherwise there are other materials that work as well. Coffee should be brewed before using. You can brew up a pot of coffee, then use the liquid coffee to hydrate your rye or wbs, and save the spent grinds for your substrate.

COFFEE - Properly used, coffee will decrease colonization time, and provide more prolific flushes. I've proved that for many years. A common mistake with coffee is using it too strong. As I've said countless times, it needs to be at 1/2 normal drinking strength. That means if you use a standard amount of coffee in your trusty Mr. Coffee, mix it half and half with plain water after brewing, and then use that to hydrate your grains. Mixing it stronger is counterproductive and will increase colonization times.

COFFEE - Correct. Spent coffee grinds are an excellent substrate material/additive, and 1/2 the normal drinking strength (or less) liquid coffee can be used to hydrate grains prior to sterilization. It doesn't matter if it's rye or wbs. If you use it stronger than 1/2 drinking strength, it will slow down colonization. That means for every cup of brewed coffee you use, add one or two cups of plain water, and use that to hydrate the grains.

SPENT COFFEE GRINDS - In addition to Starbucks, just about any restaurant such as Denny's, IHOP, or your neighborhood greasy spoon, will give you their spent coffee grinds. Just tell the waitress to toss in filter and all, because the mycelium will munch those too. I once scored nearly a five-gallon bucket of free coffee grinds from IHOP that was generated during the hour I was eating my breakfast.

COFFEE GROUNDS - IHOP and Denny's also give away all their coffee grinds to whomever asks. It's better for our substrates and gardens than the landfills. You can leave the coffee filters in with the grinds when you use them too, especially for edibles such as oysters. This has all been posted before, but it's good for the new folks to see it again.

LIME SUBSTRATES COFFEE - Correct. I add a teaspoon of hydrated lime to each two to three gallons of weak coffee/water mix. Use coffee at no more than 1/2 the normal 'drinking' strength. Too much coffee will actually slow down growth, lime or not.

SUBSTRATES COFFEE GROUNDS - I'm inclined to think the benefits of coffee come from the anti-oxidants rather than the nitrogen or caffeine, but I'll be the first to admit it's just a hunch based on a few years of observation.

COFFEE - Use weak liquid coffee. Instant would be fine. It's part nutrients and part the lower pH that coffee provides. Rinsing before the soak is also an important part. That gets all the dust and chaff out of the grain.

COFFEE GROUNDS - I stopped at starbucks yesterday and picked up ten pounds. They keep it in bags right by the door. The employees at your store must be lazy and throw it in the garbage.

COFFEE GROUNDS SUBSTRATES - You can leave the filter in the mix too. Coffee filters make pretty good substrate. If it sits more than a few hours after brewing, pasteurize.

COFFEE - Nobody buys coffee for substrate. You either get it free from starbucks, Dennys, IHOP, etc., or you use your own leftover grounds.

COFFEE - Coffee prevents sprouting. Don't ask me why, but when I use coffee, the seeds don't sprout.

COFFEE GRINDS - Coffee grinds hold as much water per cup as vermiculite.

COTTON SEED MEAL - Cottonseed meal doesn't need to break down to become available. It becomes available as soon as the mycelium consumes it.

D/E RATIO - I'd put about a teaspoon of DE per cup of peat in casing and substrate mixes. It will help provide moisture for the flush.

DIATOMACEOUS EARTH - Diatomaceous Earth is also an excellent additive that holds tons of water. If you use DE, add it dry to the dry peat and lime, then hydrate. I think it was Agar that pointed me to using DE in casings. It definitely holds moisture and gives bigger fruits because the same amount of casing material holds much more water without being saturated.

D/E - Use DE at up to 5% by volume of the dry ingredients. In other words, one cup of DE for each 20 cups of dry horse manure, etc. I always mix all dry ingredients together first, then add water. With DE, you'll think you have the moisture content right, and then ten minutes later when you check, it's dry again. The stuff really absorbs a lot of water. I check and adjust at least three times at 20-minute intervals before loading into jars and pasteurizing.

GYPSUM - That makes no sense. In addition, every commercial agaricus farm I know of uses gypsum in their substrates. Gypsum is not used to change pH. That's the job of lime to raise pH or sulfur to lower it. Gypsum contains both calcium carbonate and sulfur, thus it tends to keep the pH near neutral, preventing swings as the metabolites try to push the pH down. We add lime to make the casing layer inhospitable to competitor fungi, which are less tolerant of a high pH than established mushroom mycelium. Calcium carbonate or hydrated lime is not used to counter the effect of the metabolites. As said above, that's what the gypsum does. Use gypsum on substrates such as compost or horse manure, but don't use lime. Save the lime for the casing mix, where you should use gypsum and lime together. It's more of a stabilizer. Gypsum helps to prevent swings in either direction. The ability to prevent clumping is why we use a small amount in grain jars. I'm sure it's a side benefit in substrates and casings as well. The other benefit of gypsum is to supply calcium and sulfur, which are both essential for good fruit body formation. Some substrates seem to have enough of both to develop great fruits without it, but it's still there for the pH stability. I pay just over $3 for a 25-pound bag, which goes a long way, so there's no reason not to use it.

GYPSUM - Studies at commercial mushroom farms have shown up to a 20% increase in yield when gypsum is used over the exact same strain and substrate without gypsum. I've been saying it for years, Paul Stamets has been saying it for years, and you can google gypsum & mushroom farms, and see the results for yourself. Mushrooms are one of the best sources for humans to get calcium. The calcium in mushrooms is much easier to absorb into your system than calcium from dairy products. Doesn't it make sense to make sure your substrate has plenty?
A few years ago, they said I was nuts when I reported that coir is a useful substrate material. Everyone said, "coir has no nutes", as if mushrooms somehow need NPK. Search 'coir' and my username here and in advanced from 2003-2004 and you'll see what I mean. Then they said mushrooms would never grow on coffee-it's too acidic. Now they say gypsum provides little benefit, despite evidence to the contrary.
You can grow cubes without using gypsum, as we well know. However, you'll get more bang for the buck when using it. In addition, it keeps the substrate nice and loose for the mycelium to easily colonize, and it resists pH swings as the mushroom metabolites try to swing the pH lower.

GYPSUM CASING - 10% by volume the amount of substrate is the correct amount of gypsum to use. Just eyeball it. Anywhere from 5% to 10% is fine. Lime isn't necessary in bulk substrates, but don't forget to use it if/when you use a casing layer. It's necessary for casing material because it doesn't fully colonize with mushroom mycelium, and therefore the uncolonized parts are susceptible to contamination.
Mushroom size, provided you used a good substrate is related to moisture content. If you had coir/coffee then you had a good substrate. I'd speculate the small fruits were related to not having enough moisture. Next time, dunk after full colonization. I like to make my substrates up a tad on the dry side because they colonize faster that way and are less prone to contamination. Then, at full colonization, give a 6-hour dunk to re-hydrate the substrate before placing into fruiting conditions.

GYPSUM - Gypsum is calcium sulphate. It should be available at any nursery or garden center. If you can't find it, drywall (sheetrock) is made from gypsum. You can get a sheet of it and smash with a hammer to get the gypsum out. In fact, the garden gypsum I get at a nursery is a byproduct of the drywall industry. It even has some of the white and brown paper mixed in. Use gypsum at 5% or so by volume of the total amount of bulk substrate. You don't have to measure it exactly. If you have twenty handfuls of manure, toss in a handful or two of gypsum.

GYPSUM - Actually, that's right on. Gypsum isn't used to adjust the pH. A side benefit of gypsum is it tends to hold the pH stable, preventing a swing to acidic conditions caused by metabolism of the fungi. Sulfur and calcium are both essential for good fruitbody formation, so gypsum helps to ensure that our substrates have plenty. In addition, it's a soil conditioner that helps prevent clumping. In some species, such as Shiitake, gypsum has shown a 20% increase in yields over the same substrate without gypsum.

GYPSUM - Gypsum isn't used to adjust the pH. A side benefit of gypsum is it tends to hold the pH stable, preventing a swing to acidic conditions caused by metabolism of the fungi. Sulfur and calcium are both essential for good fruitbody formation, so gypsum helps to ensure that our substrates have plenty. In addition, it's a soil conditioner that helps prevent clumping. In some species, such as Shiitake, gypsum has shown a 20% increase in yields over the same substrate without gypsum.

GYPSUM YIELDS - Commercial mushroom growers report up to a 40% increase in total biomass harvested when gypsum is added to the casing mix. Shiitake growers report up to a 30% increase in harvests when gypsum is added to the woodchip/sawdust substrate. Gypsum supplies calcium and sulfur, both essential nutrients in mushroom metabolism. It's used in grains to prevent clumping, but it's used in substrate and casing mixes to supply valuable nutrients.

GYPSUM - Gypsum contains both calcium carbonate and sulfur, thus it tends to keep the pH near neutral, preventing swings as the metabolites try to push the pH down. We add lime to make the casing layer inhospitable to competitor fungi, which are less tolerant of a high pH than established mushroom mycelium. Calcium carbonate or hydrated lime is not used to counter the effect of the metabolites. As said above, that's what the gypsum does.

GYPSUM - Calcium carbonate is lime. Hydrated lime is calcium carbonate (crushed limestone) that has been heated in a kiln. The result in brief, is that it becomes water soluable so it goes to work right away, making it my personal choice for pH control. If you use limestone, oyster shell flour, or calcium carbonate, there is a lag time before the lime raises the pH. You'll want to pH balance your casing material to a pH of around 8 to start.

GYPSUM - The horticultural grade gypsum I get here is obviously a biproduct of the drywall industry. It has lots of pieces of white and brown paper mixed in, just like sheetrock. I think it's the broken pieces from the manufacturing process that they chop up and put into bags. It works great. Remove the paper, but don't get too anal about a few scraps you might miss. The mycelium will colonize them easily.

GYPSUM - Gypsum adds calcium and sulfur, both essential mushroom nutrients and can provide for up to a 25% increase in yields. In addition, gypsum prevents the grains from sticking together, which makes it harder for the mycelium to colonize. There's not a commercial grow operation in the world that doesn't use gypsum, and their livelihood depends on maximizing yields and performance.

COIR GYPSUM - If coir is your substrate you 'can' skip the lime and just use gypsum. Coir has a pH of around 5, which is pretty darn low. Trichoderma prefers a pH of 5, so without lime or gypsum, coir and peat are perfect trich foods. We can get away without balancing coir because it colonizes so fast, but I'd still use gypsum, which tends to set the pH in the mid 6 range.

GYPSUM - Without ph strips, try using equal amounts of peat and vermiculite. Add gypsum at the rate of one cup to each ten cups of peat. Add one teaspoon of hydrated lime to each cup of peat. Mix all the dry ingredients except the vermiculite together, and then moisten. Add moisture to the vermiculite, and then combine the two. Let sit for half an hour, then begin adjusting for field capacity.

GYPSUM - Every agaricus farm in the world that I'm aware of uses gypsum in their substrates and casing. All you have to do is google 'agaricus' and 'gypsum' and you'll see. Gypsum tends to hold the pH stable, as the mushroom metabolites try to swing it lower. Gypsum is not a substitute for lime. You still need to pH correct casing material with lime.

GYPSUM - Gypsum has been used as a soil conditioner for a very long time, and in mycology since I've been around. I know several articles that came out in the 70's, showing a dramatic increase in yields across many species when gypsum at up to ten percent was added to the substrate.

GYPSUM - Gypsum will actually lower the PH slightly due to its sulphur content. Gypsum supplies both calcium and sulphur which mushrooms need. The advantage to gypsum is that it tends to hold the PH steady, not allowing radical swings either direction.

GYPSUM - The other benefit of gypsum is to supply calcium and sulfur, which are both essential for good fruit body formation. Some substrates seem to have enough of both to develop great fruits without it, but it's still there for the pH stability.

GYPSUM MANURE - Gypsum keeps the manure nice and fluffy and loose afterwards. Many hobby growers skip this step, but it really helps. I don't know of any commercial ops that don't use gypsum. It's well worth the few seconds it takes to add.

GYPSUM - Yes, sheetrock is gypsum. I had a muddy as hell pond on my property, so when I sheetrocked my new house, I threw all the leftover scraps into the pond. The water was crystal clear in two weeks!

GYPSUM - Use gypsum on substrates such as compost or horse manure, but don't use lime. Save the lime for the casing mix, where you should use gypsum and lime together.

GYPSUM - Every commercial agaricus farm I know of uses gypsum in their substrates. Gypsum is not used to change pH. That's the job of lime to raise pH or sulfur to lower it.

GYPSUM - To provide calcium and sulfur, and also to prevent pH swings. Gypsum tends to hold the pH stable, wherever you set it with lime.

GYPSUM - Don't forget the gypsum. It increases yields considerably and is well worth the effort to find. Lime to an initial Ph of 8.

GYPSUM - Gypsum also tends to stabilize the Ph, preventing swings either direction. I consider it mandatory for all substrates.

GYPSUM - The metabolites want to decrease pH, as in lower it. The gypsum tends to keep pH stable.

GYPSUM/LIME - If you add gypsum there's no need for anything other than lime.

CHEAP GYPSUM - A 50lb bag of gypsum is only like 4 bucks though.

GYPSUM - Most important one for pH stability is Gypsum.

MIXING DRY INGREDIENTS - Try baking a cake by mixing the flour in after you've added the wet ingredients and see what happens. It won't look like, taste like, or even BE a cake. The reason for mixing the dry ingredients together first, is because dry ingredients WILL mix together. Wet ingredients will clump and bond to each other, and not mix properly. It ain't dogma, it's common sense.

POPCORN - The large kernel size, means a larger space between the kernels, thus more WASTED space in a jar. You can observe this by simply looking. The larger kernel size also means less total surface area within the jar, thus LESS mycelium is produced. It's no secret that a quart of popcorn will colonize faster than a quart of rye, but it has only about 10% as much mycelium as the same sized jar of rye, therefore it's MUCH slower than rye for producing mycelium. There are far fewer inoculation points with popcorn, therefore it doesn't go nearly as far when used to spawn to bulk. There is no doubt that despite its higher contamination rate, it does work, but you could get the same results with rye or wbs by simply using 1/10th of a jar to inoculate a substrate rather than the whole jar.Once spawned, the larger kernels are more prone to drying out, which weakens the mycelium on them, then when re-hydrated, the mold spores that have landed get the advantage over the weakened mushroom mycelium, therefore the higher contamination rate also continues right through fruiting, with more trichoderma contamination later on down the line. In short, if there's NOTHING else available, use popcorn as a last resort, but only while you look for something more suitable. You're paying twice the price per pound of product to get ten percent of the mycelium, and that assumes that you have 100% success, which you won't.

CORN - Corn often harbors an insanely high amount of bacterial endospores that survive pressure cooking. In addition, the large kernel size of corn means there is far fewer kernels in each jar, thus less mycelium in each jar than if a traditional spawn such as rye was used. Corn was never good and now bad. It was always bad. That's why not one single mushroom farm uses it for spawn generation, and they depend on success to make a living. Some people have success with corn. I made hundreds of projects with corn and had success, but not at the same rate as with rye, and it was never as good as rye when it comes to grain to grain transfers or spawning, because you need to grow out four or five times as many jars to get the same amount of mycelium, thus further increasing your chances for contamination.

DIATOMACEOUS EARTH - It won't do squat for the gnats once it's mixed into the substrate. DE has other benefits though, such as holding a LOT of water, so it's good to use. At one time, I'd put about a teaspoon of DE per cup of peat in casing and substrate mixes. It will help provide moisture for the flush. DE must be totally dry to work on insects. It works in much the same way a pile of broken glass would cut you up if you had to crawl naked on your belly across it.

DIATOMACEOUS EARTH - Don't go over 5%. That might even be a bit much. The only real benefit is it holds so much water. I've used the baited and unbaited and both work equally.

HAY - Hay doesn't work. It has flat stalks and seeds which will contaminate. You want straw instead. Straw needs to be pasteurized, never sterilized.

HYDRATED LIME/GYPSUM - Calcium carbonate is lime. Hydrated lime is calcium carbonate(crushed limestone) that has been heated in a kiln. The result in brief, is that it becomes water soluable so it goes to work right away, making it my personal choice for pH control. If you use limestone, oyster shell flour, or calcium carbonate, there is a lag time before the lime raises the pH. You'll want to pH balance your casing material to a pH of around 8 to start. I won't speak for why someone made a mistake on their website, other than stuff happens like that in any technical field. In addition, my experience isn't the last word on any subject. I have however, sent them a pm. With the amount of gypsum you'll use, and the fact that it's heavy and expensive to ship, I'd suggest a local nursery. I've never yet been to one that doesn't carry it. I get 25 lb bags of horticultural grade gypsum right up the street for just over $3. If you can't find it locally, and don't want to smash up a sheet of drywall (sheetrock) order your gypsum from a vendor.

GYPSUM/LIME - Actually, gypsum contains calcium which raises pH, and sulfur which lowers pH, resulting in a buffer that prevents wild swings in either direction. We use lime to raise the pH only for the reason that mushroom mycelium is more tolerant of a high pH than mold mycelium is. Both mushroom and mold mycelium grow best in a pH of around 5.5 to 6, but since mushroom mycelium can tolerate the higher pH, we do that so our casing layer favors it over molds. I use 1 teaspoon of hydrated lime per cup of peat. Don't figure the verm when calculating lime. Use gypsum at 5% to 10% by volume of the amount of peat. In other words, for ten cups of peat, use 1/2 to 1 cup of gypsum. As said above, always mix the dry ingredients first, then add water.Gypsum, as I said, prevents swings in either direction, but the commercial growers long ago realized that it also increases disease resistance and also increases the size of the mushrooms by providing valuable trace nutrients and minerals.

GYPSUM/LIME - 'Spawn' is your grains, and you can add a pinch of gypsum between your thumb and forefinger to each jar, or add a tablespoon to each few gallons of soak water that you soak the grains in to hydrate them. Add gypsum to your coir and manure substrates, but lime is usually optional because they're not generally exposed to contaminants except during colonization, and they've already been pasteurized just prior to that. Lime is for casing layers that are exposed to the natural contaminants in the air for extended times. We don't lime for the mushroom mycelium, because it actually prefers acid conditions. We lime for the contaminants because they are less tolerant of a high pH than mushroom mycelium.

HYDRATED LIME/GYPSUM - Actually, you want hydrated garden lime. Ground limestone takes too long to break down and go to work. Hydrated lime is water soluable and goes to work right away. A combination of hydrated lime and gypsum is the best way to buffer a casing layer. The most critical time for contaminants to enter a casing is during the initial colonization and first flush stages. Once the layer is fully colonized, it's very contaminant resistant. Hydrated lime and gypsum protect your casing layer during this critical early stage, where ground limestone or other buffers that take weeks or even months to break down do not.

GYPSUM/LIME - We use lime to raise the pH only for the reason that mushroom mycelium is more tolerant of a high pH than mold mycelium is. Both mushroom and mold mycelium grow best in a pH of around 5.5 to 6, but since mushroom mycelium can tolerate the higher pH, we do that so our casing layer favors it over molds. I use 1 teaspoon of hydrated lime per cup of peat. Don't figure the verm when calculating lime. Use gypsum at 5% to 10% by volume of the amount of peat. In other words, for ten cups of peat, use 1/2 to 1 cup of gypsum. As said above, always mix the dry ingredients first, then add water.

HYDRATED LIME - Make sure you use horticultural grade hydrated lime. If you got the masonry lime for mixing with mortar, it will cause the problem you're seeing. Using horticultural hydrated lime, a good ballpark figure is to use one teaspoon per cup of peat. Don't count the verm when adding lime. Also, make sure you mix the lime and gypsum together first, and then mix those into the DRY peat before adding moisture. If the peat is wet, the lime will dissolve and clump, meaning it won't mix well. You'll have zones of very high pH and zones of low pH.

HYDRATED LIME - The calcium carbonate is used to raise the pH. I prefer hydrated lime because it goes to work right away when you need it. We don't lime for the mushroom mycelium, because it actually prefers a slightly acid pH. We lime because contaminant molds require a low ph, so by making it 7 or above, the casing layer favors mushroom mycelium over molds. I'd suggest a teaspoon of hydrated lime per cup of peat. That will get you into the ballpark without danger of making the casing too sweet.

HYDRATED LIME - Mushroom mycelium prefers a pH of 5 to 6, so you're fine. We pH balance casing layers because they're left exposed and non-colonized on top of the substrate. For casing layers, hydrated lime is best because it goes to work right away. Calcium carbonate takes time to break down, so is of less use since the average life of a casing is only a few weeks.

HYDRATED LIME - As we know, mushroom mycelium grows fastest and is perhaps the happiest with a ph of around 6. Unfortunately, that is also the ph favored by most other fungi, which includes the mold fungi that are the enemy. We use lime because mushroom mycelium can tolerate a higher ph than the green molds can.

FINDING LIME - Lime can be hard to find locally if you live in an area that has alkaline soil. In areas where the soil is acidic, lime is sold everywhere. You can order it online from doitbest.com Just search for 'hydrated lime' when you get to their site. They have two industrial types, and two horticultural types of hydrated lime.

HYDRATED LIME - The high ph does indeed slow down the mycelium a bit, but it kicks the trich in the butt. Another good trick is to sprinkle a bit of lime right on the surface of your casing layer. This creates a high ph zone right on the top where the trich and other contaminant spores land. Hope this helps.

HYDRATED LIME - If it says "Safer than hydrated lime" on the bag, it's the WRONG type of lime. Consider 2% Mg to be the upper limit. Use HYDRATED LIME. You don't want to adjust the pH of your casing material next year; you want to adjust the pH now. That means using hydrated (water soluble) lime.

HYDRATED LIME - You want to use hydrated lime or calcium carbonate for pH adjustment. However, hydrated lime is water-soluble so it balances the pH right away. Calcium carbonate is a long term buffer that is better suited to gardens, since mushroom casing layers are not used long term.

HYDRATED LIME - Coir has a pH of around 5, which is pretty darn low. Trichoderma prefers a pH of 5, so without lime or gypsum, coir and peat are perfect trich foods. We can get away without balancing coir because it colonizes so fast, but I'd still use gypsum, which tends to set the pH in the mid 6 range.

HYDRATED LIME - I recommend horticultural hydrated lime for ph control. It goes to work immediately, and lasts the life of the average casing layer. If you skip the lime, your casing layer will have trich quicker than it can flush. I also recommend using ten percent gypsum in a casing layer.

HYDRATED LIME - Oyster shell flour can be used, but isn't as effective as hydrated lime because hydrated lime goes to work right away when you need it. Once the substrate is fully colonized, it can take care of itself, making so-called 'long term buffers' unnecessary.

HYDRATED LIME - Consider 2% Mg to be the upper limit. Use HYDRATED LIME. You don't want to adjust the pH of your casing material next year; you want to adjust the pH now. That means using hydrated (water soluble) lime.

HYDRATED LIME - About one teaspoon of hydrated lime per cup of coir (after hydration) will balance it pretty close. Be sure to use agricultural grade hydrated lime, not the stuff for mixing cement or mortar for bricklayers.

LIMESTONE - Limestone isn't dangerous. It's calcium carbonate. Some people pay big money for it in pill form when they have heartburn. (Tums)

HYDRATED LIME - It's in Stamet's GGMM, page 189 in my edition. He says to use 2 to 4 pounds of hydrated lime for each 50 gallons of water.

HYDRATED LIME - Don't use lime anywhere near your pressure cooker. It's highly caustic and will pit the aluminum. Use a plastic tub.

HYDRATED LIME - Hydrated means water-soluble, thus it's ground to a fine powder in order to be effective right away.

HYDRATED LIME - Try fifty with lime next time, there will be an assurance of zero contamination then.

HYDRATED LIME - Only use horticultural/agricultural hydrated lime, never slaking or masonry lime.

STERILIZING MANURE - Ponder this.
Manure is 3-tier gangbang. Bovine eats it, in bovines gut other microbes/bacteria have a go at it, once expelled everything out there as a go at it. Only the strong survive. So the turd pile is pretty well occupied with whatever is still munching down on it. It is also depleted on most nutrients other things - besides those microbes in it - even look for. Hey, it's a shit pile. On top of that, the microbes that do occupy that turd pile defend their space fairly well. So, any outside microbe tries to get a foothold, the homey's either eject them, kill or eat them. All in all, the turd pile is some well-defended turf.
Now, sterilize that third pile.
Suddenly, it is no longer - well defended turf. So, any blue/green mold gang that happens to wander by can enter & set up housekeeping. So, if you sterilize manure. Treat it like you would an LC. In other words, be very careful not to allow anything to come in contact with it. Except, what you want to introduce into it.

HORSE/COW MANURE - A cow does not have 4 stomachs. A cow has 1 stomach. A single stomach with four compartments is not 4 stomachs.
Cow manure is NOT already composted when it comes out.
Aged horse manure or cow manure does NOT need to be leached.
Washing/leaching manure does NOT remove ammonia. It needs to be air dried or cured in the sun to evaporate the ammonia.
You do not want fresh cow manure. You want aged manure. Cow patties work fine. In fact, when I first started growing mushrooms in 1971, picking up cow pies and bringing them home to place in compost was the only way we knew to home cultivate. All the current teks have evolved from those early trials.
Exactly which shroomery manure teks suck for people in colder climates? What difference does a cold climate make? Moisture and ammonia will sublimate from frozen manure as fast as it will evaporate from manure in a warm climate.
Growers can be successful with aged manure by simply breaking it up and using after hydration and pasteurization. In fact, I've NEVER leached manure.

HORSE MANURE - You'll find these outside any horse ranch. They're not rare. The problem is they're usually stable sweepings and often have cedar chips mixed in to control odor, which prevents much mycelium growth. In addition, they're usually fresh manure, not aged. What you want to grow on is field aged. A truckload delivered to your back yard might be good after you spread it out to dry and leach in the sun and rain, but I doubt dumping some spawn into a large pile at a horse ranch is going to do much. They constantly dump fresh manure with a front-end loader on top of the earlier pile, burying any spawn you put deep into the pile. Not to burst your bubble, but I doubt it would work unless it's an abandoned ranch and the pile is aged, in which case it's probably already got pan subbs growing/colonizing it.

COW MANURE SUBSTRATE - The coffee grinds, castings and coir are to break up the store bought cow manure which is ok to use, but too heavy by itself and the myc has a hard time colonizing it. The other problem with store bought cow manure is it has a lot of urea in it because it comes from crowded feed lots and the cows urinate as much as they defecate and it all gets scooped up together. Be sure when you open the bag of cow manure, if it smells like ammonia, spread it out on the back porch in the sun for a day or two and the ammonia will flash off, leaving it ok to use.

CHICKEN MANURE - Agreed. As said, just don't use very much. I've used the composted chicken manure available at nurseries with success, at no more than one cup of chicken manure to 20 cups of other substrate ingredients. Lay it on a tarp in the sun for a few days until there is no ammonia smell, then mix with your other ingredients and pasteurize. Bat guano is no good for mycology.

COW MANURE DEHYDRATED - Dehydrated would be better, but be sure if there's any ammonia smell to it that you dump it out of the bag and lay it out in the sun for a few days. Cut the store-bought cow manure by mixing it evenly with coir/vermiculite. You will end up with a substrate of 33% bagged cow manure, and 33% each of coir and vermiculite. Mix well and pasteurize.

STEER MANURE - Be sure to cut it with some coir or vermiculite, because the bagged cow manure tends to compress due to its texture, which makes it hard for the mycelium to colonize. The bag stuff you get at the nursery needs to be layed out and dried in the sun for a few weeks so all the ammonia evaporates.

CHICKEN MANURE - Composted chicken manure is great. Use at no more than 5%, which is one cup of chicken manure to each 20 cups of coir or horse manure. Be sure to open the bag and lay what you're going to use out in the air for a couple of days to evaporate the ammonia out before pasteurizing.

MANURE SUBSTRATE - Next time, leave the substrate loose and airy. I like to add a touch of vermiculite to manure for that purpose as well. A slightly dry substrate will actually colonize faster, so I don't think that's the problem. I make mine dry on purpose, and then dunk before first flush.

COW MANURE AND HORSE MANURE - Cow manure gets fed better/it's more compacted and has more nutrition. Horse manure is basically half digested straw and hey which is less nutrition and holds less moisture.

GYPSUM MANURE - Gypsum keeps the manure nice and fluffy and loose afterwards. Many hobby growers skip this step, but it really helps. I don't know of any commercial ops that don't use gypsum.

CHICKEN MANURE - Chicken manure makes an excellent addition to your compost/poo mix. Use no more than 5% by volume.

CHICKEN MANURE - Chicken Manure Gets Way to hot. It would BURN myc. Use only in small quantities.

OYSTER SHELLS - You can use oyster shell flour in both substrates and casing layers. Crushed oyster shells are sometimes added to casing material for texture,

REUSING PERLITE - I put the whole darn terrarium in the shower, and let cold water run for an hour or two to wash it clean. Of course, I have holes in the bottom of the terrarium for the water to escape. If there has been a contaminant outbreak, I'll pour some water mixed with bleach on first, then let that sit for half an hour before turning on the shower. Before any of the 'conserve water' people jump my ass, bear in mind I live where the more water we use, the less the rivers and reservoirs flood. If you live in a desert with limited water supplies, simply bleach soak and rinse the perlite if contaminants were present. Otherwise, simply rehydrate the perlite, drain well and use. Perlite is a mineral that will last for many years.

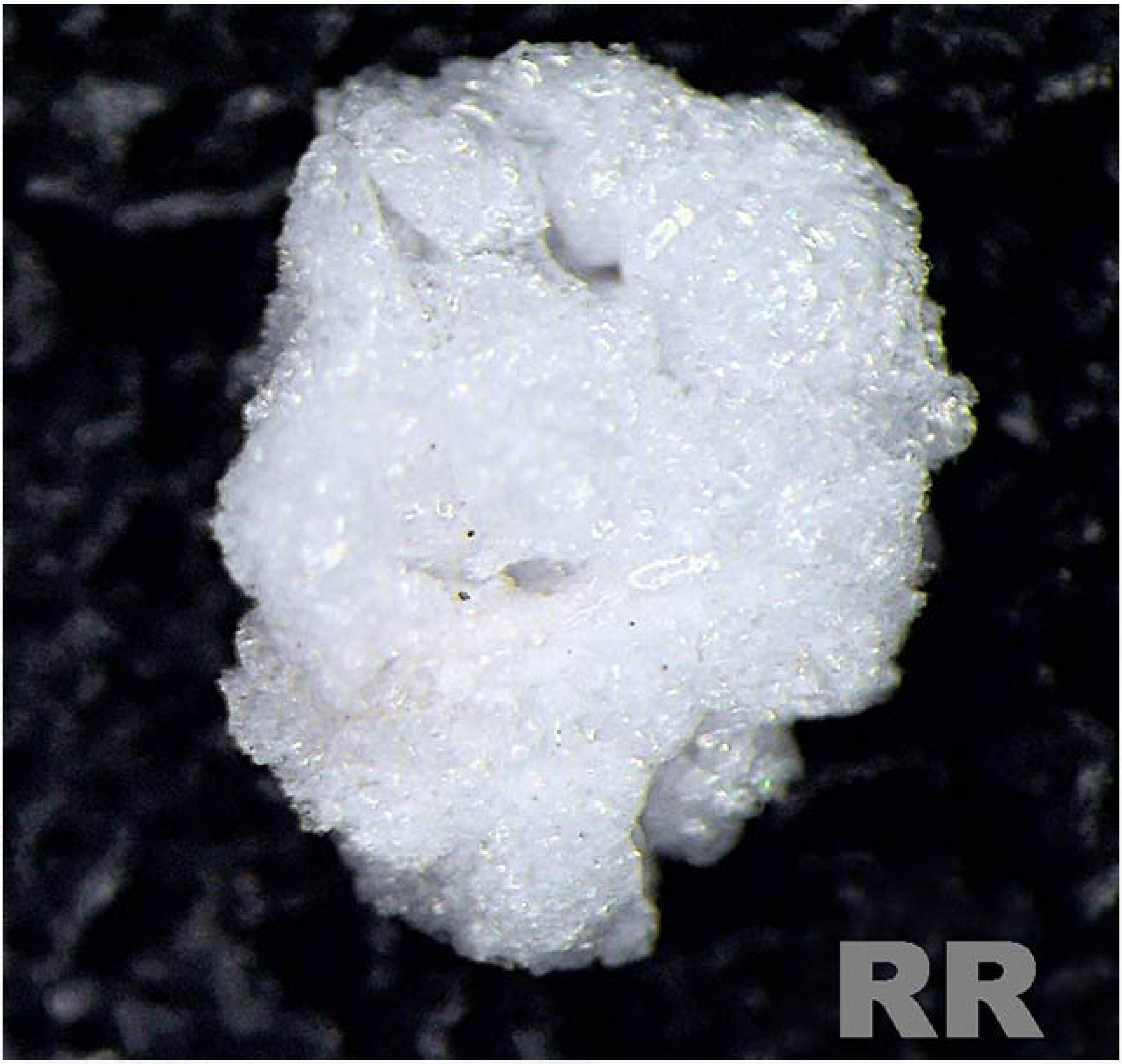
PERLITE - Using paper towels in the bottom of terrariums for humidity is a long-proven technique. In fact, for many years I've kept them stuffed into any spot in my mini-greenhouse that tends to collect drips of water. Change them out once a week or so, and keep them fairly well squeezed of excess moisture so that what's in the paper towel can evaporate back out. You can even press damp paper towels against the back and/or sides of the FC to give more surface area. Clean cloth towels can also be used, and simply tossed into the washing machine once a week.

PERLITE - Perlite is a hydrated volcanic ore from the Pennsylvanian era of geology, with the approximate chemical composition of glass. Expansion is due to between 2-6% bound water. When heated to 1400+ degrees, the water vaporizes forcing the rock to expand. Perlite in its crude form weighs 70 pounds per cubic foot, after expansion the weight is reduced to 2-10 pounds per cubic foot depending upon the application.

PERLITE - Perlite is a crystalline mineral that doesn't absorb water, so it would NOT absorb water in 24 hours, or 24 years. Perlite that is under water may as well not be there. This has been proved by hundreds of growers with humidity problems, who dumped the standing water out, and watched in awe as their humidity rose to 99%.

PERLITE - Perlite is crystalline and impervious to water, but with a large surface area to hold and evaporate it off from. Perlite is for humidifying terrariums and/or adding air and fluff to casing layers. A bit of perlite can also be added to casings, but then, it's to provide fresh air pockets that are conducive to hyphal knot formation.

PERLITE - Perlite is crystalline, like glass or quartz crystals, and it does NOT wick water any more than broken pieces of glass will wick water. Submerged perlite is useless, period. Look at the picture of perlite below and describe how it would wick anything if you doubt the above.



PERLITE - Misting should be enough to keep the perlite damp. You might also try 'raking' the perlite with your fingers to fluff it up. If it gets packed down, it won't work right. Fluff it up and that's probably all you need to do. I've had perlite still damp after two months. Peroxide and bleach are a waste on perlite. Just use plain water. You're not growing mushrooms on the perlite; it's only for humidity.

PERLITE - I've been using perlite from the same bag for at least ten years. All you have to do is rinse it off well, and bake in the oven for an hour or so, and it's just like new again. You never have to toss it out.

PERLITE - Perlite is not hydrophilic, although it can be treated to have hydrophilic type properties.

PH - It's important to mix the dry peat with the lime before adding moisture or the vermiculite. I also see you didn't add gypsum, which helps to moderate ph swings. In addition, I have not yet seen a probe type ph tester that was worth the powder it would take to blow it to hell. They are designed for soil, and just don't perform

properly in peat/vermiculite/manure.
I get a starting ph of 8 to 8.5 by mixing one teaspoon of hydrated garden lime and two tablespoons of garden gypsum to each cup of dry peat. Mix the peat, lime and gypsum, then add water to approximately field capacity, then set aside.
While the peat sits, mix the vermiculite with water in a separate container to approximately field capacity.
Now, you can mix the two together and make the final adjustments in moisture content. Be sure to let it sit for fifteen minutes, then check moisture content again by squeezing a handful of material. When you hold a handful of the casing mix, no water at all should drip out. Squeeze a bit, and a small amount will drip out. Squeeze hard and a small stream will flow out. This is field capacity.
Pasteurize and use. For home grower amounts, a great way to pasteurize is in quart mason jars sitting in a large pot of water. A pc or large kettle with a tight fitting lid is great for this. You want the interior of the jars to reach at least 140F for an hour, but not to exceed 170F. The use of quart jars preserves your ph and moisture content. Good luck.

PH - If coir is your substrate you 'can' skip the lime and just use gypsum. Coir has a pH of around 5, which is pretty darn low. Trichoderma prefers a pH of 5, so without lime or gypsum, coir and peat are perfect trich foods. We can get away without balancing coir because it colonizes so fast, but I'd still use gypsum, which tends to set the pH in the mid 6 range. Casing layers should be set to an initial pH of 8 because peat/vermiculite rarely colonizes fully, so you want protection from trichoderma, and a high pH is the best way to do it. For pasteurizing straw, you need hydrated lime. The others won't cut it. 'Hydrated' means water soluble, so it raises the pasteurization bath water to a pH of around 12, which nukes most organisms. Nobody can say exactly how much hydrated lime to use for casing layers. My 1-teaspoon per cup of peat is a safe starting point, but the correct amount to use is what it takes to get an initial pH of 8 to 8.5.

PH - Liquid coffee is slightly acidic, but coir is even more so. Coir runs pH 5 to pH 6.5 depending on origin. Acids lower pH, not raise them. I've found no evidence that coffee boosts potency. It does however; speed up colonization, because it's excellent fungi food. In addition, the lower pH results in faster growth because Cubensis prefers a substrate in the pH 5.5 to pH 6 range. Using a substrate with an acidic pH like yours results in faster colonization and better performance overall, but also exposes the project to an increased risk of contamination, because molds such as trichoderma also prefer an acidic food source. In my area, the mold spore count is so high; I'd never be able to get a substrate that had been hydrated with liquid coffee colonized before parts of it were green from molds. Hopefully, yours will work out. It's almost colonized. Good luck.

PH - While mushroom mycelium prefers a slightly acidic substrate, contaminants do also. What we've found from experience is that by adjusting the pH upwards with lime, the mushroom mycelium can 'tolerate' it, but the contaminants have a harder time. There is usually no need to adjust pH of substrates, but casing layers, which don't ever fully colonize, can benefit from a higher pH of 7.5 to 8. This will allow the mushroom mycelium to get the benefits of the casing layer, but will slow the onset of mold contaminants. However, remember that after a flush or two, the uncolonized parts of your casing layer are going to be susceptible to molds, so be sure to watch daily and toss out any tray at the first signs of 'green' molds. Good luck.

PH CASINGS - Actually, you want hydrated garden lime because ground limestone takes too long to break down and go to work. Hydrated lime is water-soluble and goes to work right away. A combination of hydrated lime and gypsum is the best way to buffer a casing layer. The most critical time for contaminants to enter a casing is during the initial colonization and first flush stages. Once the layer is fully colonized, it's very contaminant resistant. Hydrated lime and gypsum protect your casing layer during this critical early stage, where ground limestone or other buffers that take weeks or even months to break down do not.

PH - You don't need to pH balance bulk substrates. In fact, mushroom mycelium actually prefers an acidic substrate. We pH balance casing material because it remains partially uncolonized throughout the fruiting cycle, thus is prone to contamination. Bulk substrates colonize fully, thus are resistant to contaminants, so you can leave them slightly acidic and they'll do just fine. Mushroom mycelium is more tolerant of a basic pH than molds, and that's why we add lime to casings.

PH OF CASING - Pickling lime is hydrated lime. It's my favorite, and many commercial grow operations DO use it. Use one teaspoon of hydrated lime, and one tablespoon of gypsum per cup of peat, and mix into the dry peat. Mix the dry ingredients very well, then slowly bring to field moisture level and pasteurize. If you can't find hydrated lime, you can get it online at www.doitbest.com When you get to their website, do a search for hydrated lime.

PH CASINGS - A buffers resist change in ph. Lime is not a buffer. Gypsum is an excellent buffer. If you wish to bring the ph of your casings higher, you would want to use hydrated (water soluble) lime. Limestone is for long-term use, such as in a garden. Casings, which flush for a month or so, do not need long-term ph adjustment. They need short term, therefore hydrated lime is what you would want to use.

PH - A pH of 8 is a good place to make your casing mix initially. Mushroom mycelium grows and fruits best at a lower pH of around 5-6, but unfortunately, that pH also favors contaminants as well. Mushroom mycelium is more tolerant of a higher pH than molds, which is why we add lime.

PH - Oyster shell raises Ph. Mushroom mycelium grows fastest with a slightly acid ph. You don't Ph adjust spawn. The only reason we use Ph buffers to raise Ph in bulk substrates is because mushroom mycelium, while it prefers a Ph of 6, is tolerant of Ph up to 8.5, while trichoderma is not tolerant of a high Ph. Thus, the hydrated lime or oyster shell flour makes our substrate selective for mushroom mycelium.

PH - A high pH will slow down trichoderma, as well as helping to prevent trich spores from germinating. It also stresses mushroom mycelium, which prefers a lower pH, but not as much. The mushroom mycelium is more tolerant of high pH than most molds.

PH - For a substrate, 5.5 to 6 will probably give the fastest colonization. It would be the same for casing layers as well, but since molds also thrive at a low pH, we lime our casings to sweet of neutral. A good starting pH for a casing is 8.

PH - In my opinion, a good starting point is around 9-10. I know that's sweet, but the myc doesn't seem to mind much, and most contams like a slightly acid ph. It keeps the little bastards at bay while the myc colonizes your casing.

PH BENEFITS - Lime raises the ph, and gypsum keeps it stable. They both provide calcium, but gypsum also helps with texture.

PH STRIPS - Squeeze some water out of the casing mix after it has sat for at least an hour, and then measure that with your strip.

PH - Contaminants prefer a low ph; a high ph is unfavorable for them.

PH - Gypsum added to an acidic soil will raise the pH.

RATIO SUBSTRATES - Use the chicken manure at up to 5% of the total substrate. It gives a nice boost. Most commercial mushroom farms use it at that percentage. Composted cow manure from the nursery also works well when mixed with coir or vermiculite to cut it a bit. If any bulk substrate you mix up seems a bit 'heavy' just add ten to twenty percent vermiculite to keep it nice and loose. Another benefit of vermiculite in bulk substrates is it makes an excellent moisture reservoir for use during fruiting.

PF/MANURE RATIO CASING - Break up your pf cakes into four times as much manure. That means one pf cake can inoculate 2 pints of manure. Don't crumble and case pf cakes. It's a waste. If you want to fruit your cakes as is, simply birth them, and then do a dunk and roll and place in fruiting conditions. This is the quickest way to a harvest, and spawning to manure is the best way to a larger harvest, although it takes a couple of weeks longer.

SUBSTRATE RATIOS - That's about right. 1 cup of hydrated chicken manure per 20 cups hydrated coir would make 5%. Add gypsum at ten percent as well. 1/2 teaspoon of hydrated lime per cup of coir/chicken manure will help give a bit of contaminant resistance, but it's optional. Lime is far more important in casings where part of it never colonizes. Substrates colonize fully, therefore can hold their own.

COMPOST - They use urine as a nitrogen boost to heat up the compost pile. If you're not composting, use aged manure.

SUBSTRATE RATIO - Spawn to manure, and then at full colonization, case. 1 to 4 is fine. I usually go 1 to 3 for the extra food the grains provide.

CAKE TO MANURE RATIO - Use one part colonized cakes or other spawn to three or four parts manure.

STRAW SUBSTRATE PASTURIZATION RR VIDEO - After pasteurization, I lift the straw out of the tote with a strainer, allow it to drain for a few seconds, and then place on a screen that is laying in the bottom of a second tote. When the pasteurization tote is empty (of straw), I take pot fulls of hot water out of it, and pour them into the toilet to get rid of them. By the time the straw has cooled, it has also drained long enough. Remember, you're going to have holes in your straw log and/or laundry basket, so any excess water will drain out during the first few days, leaving it at the perfect moisture content.

LIME FOR STRAW - I think hydrated lime is the BEST choice for pasteurizing straw. It causes a very rapid swing upward in PH, which is fatal to living organisms, which is the purpose of pasteurization. It's the only lime I use. I don't recommend chemical pasteurization alone for straw. Use 1 cup of hydrated lime per ten gallons of 140F to 150F water and pasteurize the straw for one to at most two hours. Drain and use. Be sure to soak the straw in warm water for two hours prior to the pasteurization to hydrate it.

STRAW - I soak in warm soapy water for two hours, and then transfer the straw to water that is kept at 140F to 160F for 60 to 90 minutes, and then it is removed and drained/cooled, and spawned. I use one cup of hydrated lime for each ten to fifteen gallons of pasteurization water. I don't add lime or bleach to the pre-soak, and don't use bleach at all in the pasteurization. There's a short sample clip of my procedure on youtube and also on my website. It should be enough to give you the basic idea.

STRAW - I use an electric weed whacker with the straw in a tote with the lid on it. I cut a very skinny rectangle out of the center of the lid so I can move the weed eater around in the box to get it all. It takes about five minutes or less to do a 125 quart sterlite container full of straw. I do this right in my living room, since I also live in a condo. There's some mess, but not much.

STRAW - Yea, 1 cup of lime should be plenty for a pillowcase. If the pot is aluminum, the lime will eat through it pretty fast, but it's your stuff, so you make the call. It's easy to boil the water in one pot and then pour it into a plastic tote or bucket with the lime. That way, you don't ruin the kettle.

STRAW - Straw is dry. Therefore, the 'straw juice' is the dirt, pesticides, and other debris that is stuck to the surface of the straw. Don't use it for anything. Mushroom mycelium doesn't want the dirty brown water you wash off the straw. Mushroom mycelium wants to eat the straw itself.

STRAW - Straw has a pretty good texture for fruiting uncased, and the hollow straw holds a LOT of water, negating the need for a casing layer, providing you maintain near 100% humidity at the surface of the straw.

SOAP IN STRAW SOAK - Soap for straw would help break down the waxyness of the straw. To absorb water better. Because it's anti-bacterial.

STRAW SUBSTRATE - Chopped straw. Wheat and Barley are the two most common ones in the US, and both work fine.

STRAW - Straw, something that contaminates the most, does better at pasteurization temps of 140-150.

STRAW - BE up to 200% is fairly common with straw.

SUBSTRATES! - People need to make a distinction between growing plants and fungi.
Worm castings are an excellent substrate additive material, but not because of nitrogen content. They are lower in nitrogen then either straw or horse manure, which are both lower in nitrogen than steer manure.
Blood meal is high in nitrogen, but is totally unusable to fungi unless it is applied in the composting process, which most home mushroom growers do not do. The use of blood meal added to manure or coir is a waste of resources and actually encourages algae to form on the surface of the substrate or casing layer, leading inexperienced growers to throw out a perfectly fine project thinking they have 'green mold'.
Chicken manure is high in nitrogen, but once again it needs to be added at the composting stage. However,

composted chicken manure available in bags at nurseries is an excellent additive to manure or straw because it's already composted, therefore available to the fungi.

Fish emulsion, available at garden centers is also an excellent additive to manure or coir substrates because it has already been composted or otherwise broken down anaerobically at the processing facility.

Gypsum should be added to all substrates for the texture it helps to provide as well as the calcium and sulfur, both essential nutrients for mycelia metabolism. An added benefit of gypsum is that it tends to hold Ph levels steady, preventing wild swings as the mycelium colonizes a substrate.

Coir, worm castings, horse manure, chicken manure etc., are all acidic and should be buffered with lime to a starting Ph of around 8. This high Ph favors mushroom mycelium that is tolerant of sweet substrates, but prevents germination of contaminant spores that favor sour substrates.

SUBSTRATES - Coir is very close in performance to horse manure. Cow manure can perform nearly as well too, but will benefit from a bit of coffee grinds and some loosening up with vermiculite. As I've said hundreds of times, a combination of substrate ingredients will give better performance than any one by itself. That means, you'll get more bang by mixing cow, horse, and a bit of chicken manure with coir, coffee grinds, compost and straw. Horse manure is a preferred substrate because its texture is easy for the mycelium to penetrate, and works fine by itself, as do any of the bulk substrate ingredients listed above. Horse manure edges them out a bit in my opinion, but coir runs a close second. My preferred spawn material hands down over all the others is organic rye berries. Rye grass seed would be second, with wbs coming in third.

COMPOST SUBSTRATES - I have a local source for yard waste compost and it's a great addition to substrates. It works best if you mix it with some manure, and even the composted cow manure from nurseries works well mixed with the garden compost. Add a small amount of bagged chicken manure from the nursery and you have a great substrate. If it seems thick, cut it with a bit of vermiculite and/or coir. You can also add perlite to bulk substrates to fluff them up. The perlite holds air, which comes in handy in manure-based substrates. You can also throw in a few days worth of spent coffee grinds. In other words, the more different things you add to your substrate, the better it will perform.

LIME FOR SUBSTRATES - Gypsum yes, but no lime. Mushroom mycelium prefers an acidic substrate, and since we pasteurize horse manure and then allow it to fully colonize, it's resistant to contamination. Therefore, a pH in the 5.5 to 6.5 range is perfect. I used to add a touch of lime to bulk substrates, but no longer do and performance is better. We add lime to casing layers to protect them against molds, since they don't fully colonize with mushroom mycelium. No lime in manure substrates. Cased or uncased. Performance will be higher. Besides, gypsum tends to stabilize the substrate into the mid to upper 6's.

SUBSTRATES - The coffee you use in substrates is ONLY what you empty out of the strainer or filter after brewing a pot. In other words, leached coffee grinds. Do not use instant or liquid coffee in substrates. Mix coffee in any percentage you want. I've grown on pure coffee. The more items you mix into the substrate, the better. If you have manure, coir, worm castings, compost, coffee grinds, straw, etc., use a little of all of them. Add up to ten percent by volume of gypsum and mix all the dry ingredients. Then, add water to field capacity and pasteurize.

SUBSTRATES - Coir in a substrate helps to provide food the horse manure doesn't. It's part of a balanced diet. Vermiculite is great mixed with everything mycological except straw. Used coffee grinds from your morning pot of coffee are also an excellent additive. Ditto for worm castings. A small amount of chicken manure is also beneficial but don't go over 5% by volume of the substrate. Put a combination of all-together in your substrate and watch your mushrooms thank you for it.

SUBSTRATE MIX - I like to mix store bought composted cow manure, coir, coffee grinds, and worm castings all together, then add 1/2 tablespoon of hydrated lime per cup of mix. Then, mix all that with an equal amount of damp vermiculite.

Bring it all to field consistency and pasteurize. It works like a charm.

BULK SUBSTRATES - Bulk substrate IS less nutritious than grains. That's why we need to use so much of it. Bulk substrate can be simply pasteurized, while the much more nutritious grains must be sterilized and kept sterile until colonized. Then, they add significantly to the total nutrients in the bulk substrate they're spawned into.

SUBSTRATES - Complex substrates are always better. Mix as many ingredients as you have. Coir, horse manure, worm castings, coffee grinds, cow manure, chicken manure, compost, straw, etc., are all good, and mixed they're even better. Don't go over 5% of the total as chicken manure though. Use gypsum at ten percent.

SUBSTRATE ADDATIVE - I did a few experiments several years ago where I added fish emulsion and several other nitrogen boosters such as blood meal to manure and compost mixes and saw no effect on the crop. I then added small amounts of chicken manure and saw a very noticeable increase in yield.

SUBSTRATES - Cow and horse manure are equally suitable for growing dung and straw loving mushrooms. Getting the texture right is part of the skills of growing. Horse manure is ready to use once it's been field aged. Cow manure works better when fluffed up with vermiculite, coir, straw, etc., but it's all-good.

SUBSTRATES - Performance will be poor at best. BRF has at least ten to twenty times the nutrition of manure or coir either one. They will only dilute the substrate. That's why they're bulk substrates. They need to be used in large quantities, not small.

SUBSTRATE ADDATIVE - It's been used successfully in substrates before, but it was a mistake to use in a casing. Casing layers should be non-nutritious.

SUBSTRATE - Dried pumpkin seeds have been used in the past, but the flesh of the pumpkin is ...garbage.

SUBSTRATES - Pick out the logs. The little sticks are fine, as they'll colonize.

VERMICULITE - Fine vermiculite holds more moisture per volume of measurement than course vermiculite, due to there being more of it. The basic formula of 2-1-1 works great with fine or medium vermiculite, but if you're using course vermiculite, you might want to cut down a bit on the water. I've found that cakes as well as grains, and even bulk substrates colonize a bit better and faster if made up on the dry side. With cakes, it's easy to adjust the water down, and then simply do a dunk and roll at birthing to put the moisture in for the flush at that time.

VERMICULITE - Vermiculite is soft and resembles a mineral sponge, able to soak up water and hold it. Vermiculite also has lots of passageways the mycelium can colonize while absorbing the moisture within. Vermiculite is for holding water as a reservoir and releasing it to the mycelium as needed. Vermiculite is used in pf cakes and casing recipes. It will also provide fluff and a rez effect (reservoir) in manure and compost mixes.

VERMICULITE - I use the fine vermiculite, which holds more water per cup then the medium grade vermiculite, but still use the basic 1-1-2-pf recipes. This makes a drier substrate that colonizes in two weeks. Give an extra week to consolidate, then birth, dunk and roll. I see pins regularly 48 hours after birthing this way instead of having the cakes sit there for a week or two.

VERMICULITE - Vermiculite is an excellent moisture reservoir that holds more water for its size than anything else. Any substrate, including sawdust/woodchips or manure can benefit from the addition of vermiculite. There is also no other method of growing that can grow more mushrooms on less substrate than pf cakes. That's a fact.

VERMICULITE STERILIZATION - I've done it both without and with sterilizing the vermiculite. Vermiculite is an inert mineral that does not harbor or grow contaminants, but if mold spores are present, they might have an opportunity to grow. I usually put mine on a baking sheet for half an hour at 350F, just because it makes me feel better.

VERMICULITE - In addition, the danger with asbestos is from inhaling dust from the fibers over a long time, such as working in a mine 8 hours a day for 20 years. It isn't from eating mushrooms from a cake with vermiculite in it, even if it DID have asbestos, which it doesn't.

VERMICULITE - I also use fine vermiculite, and it works fine. In fact, it holds a bit more water than course vermiculite, and the mycelium seems to colonize it just fine. It's also better for use as the contaminant barrier on top.

SOAKED VERM SUBSTRATE - I have soaked straight vermiculite in various nutrient laden solutions. It will colonize, just fine - without anything else added.

METABOLITES/LIGHTING

METABOLITES - That quote above by Stamets in TMC written in 1985 when he was fairly new to cultivation was a mistake. He corrected it very well in the 1990's when he wrote 'Growing Gourmet and Medicinal Mushrooms', where he correctly stated they are antibiotic compounds.
Furthermore, the journal of medicinal mushrooms publishes articles on a regular basis identifying the various antibiotic compounds in various species of mushroom mycelia metabolites.
The first mass use of metabolites in medicine was in WW2 when the production of metabolites from the Penicillium mold saved thousands of Allied soldiers lives due to a product that was named Penicillin after the mycelium metabolites it was made from. I'm completely in awe that you folks don't know this. It should have been taught in elementary and junior high school, both in history and science. It's not brand new news.
Furthermore, there is a time and place for vulgarities. I'm no prude and no religious freak by a long shot, but in science one need not use vulgar terms if he wishes to be taken seriously. I'll be the first one to let out a four-letter tirade over politics when I'm having a few beers down at the pub, but not here, and not in conjunction with mycology. I hope this clears it up. I'll stay on it until people stop using the wrong terms. It's no different than correcting someone for referring to an uncased bulk substrate incorrectly as a 'casing' or referring to manure as a spawn, rather than a substrate, etc. It's simply incorrect and should be corrected or new growers trying to learn get fed the wrong information.

METABOLITES MYCELIUM PISS - Mushroom mycelium secretions do not equate to human urine in any way, shape or form. That is disinformation and it makes the hair on my neck stand on end when I see it constantly repeated. They are unrelated. In fact, the secretions from many fungi are used to make antibiotics. Read up on the production of penicillin, tetracycline, erythromycin and other antibiotics that are made from the secretions of fungi. This has been known for a long time in professional circles. For some reason, people around here keep repeating the same old 'mushroom piss' crap and others read it and repeat it ad nauseum. The secretions, which contain acetone and other volatile compounds can actually be fermented and distilled out of the liquid culture the fungi mycelium is being grown in. In commercial penicillin production, large fermentation tanks of over 30,000 gallons are common. It is not the penicillium mold itself that they make penicillin from, but its secretions. Please stop using urine as an analogy for the antibiotic secretions of our precious fungi.

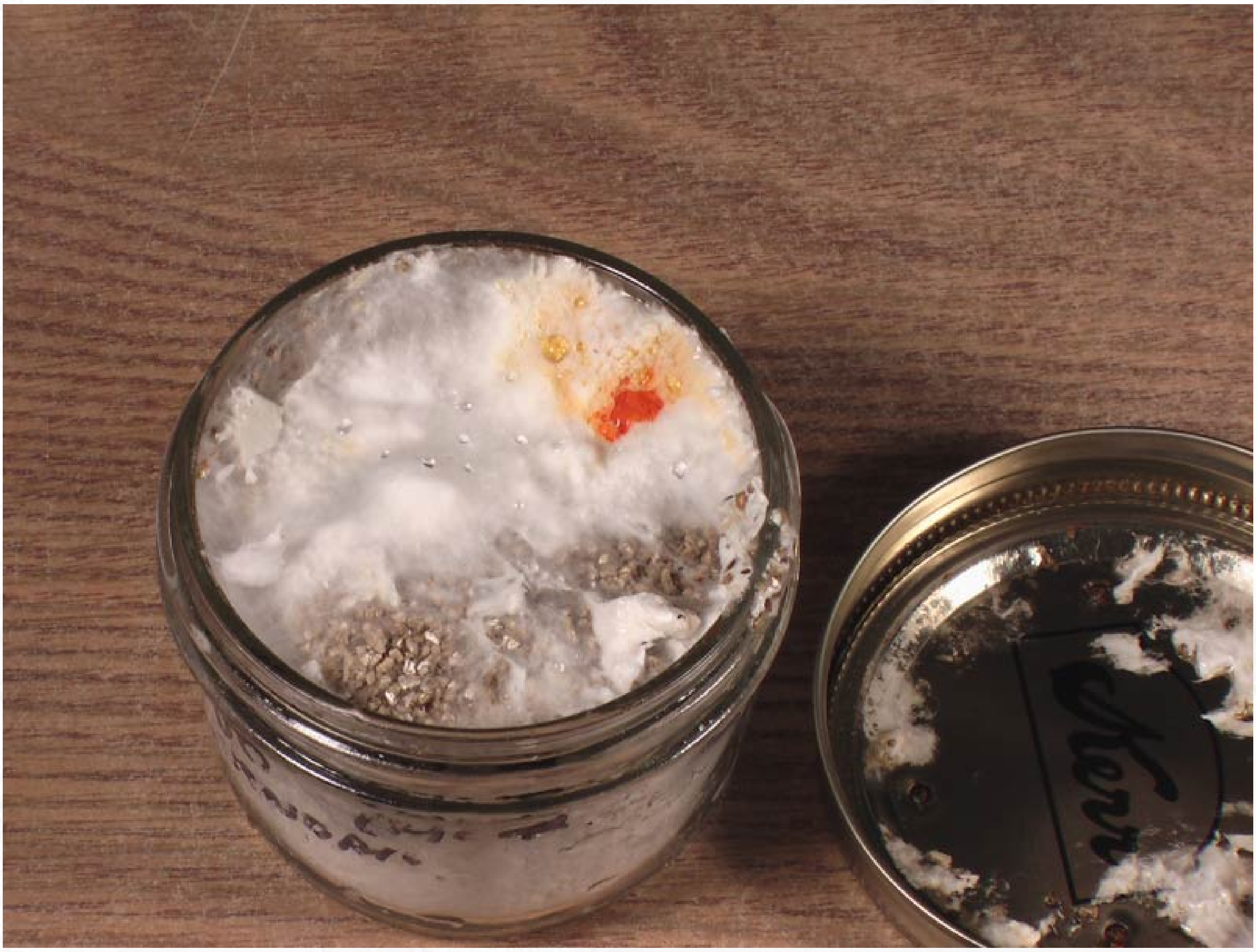
METABOLITES FIGHT - Actually, I have harvested metabolites and used them on other molds, which they kill. Often, when a grain jar is left too long after full colonization, metabolites will begin building up in the bottom of the jar. These can be poured right on an infection in another tray. If caught in time, many molds can be neutralized this way. I doubt it's the antibiotic properties of the metabolites at work against molds, but rather the solvents. Antibiotics are effective against bacteria, which isn't a contaminant of casing layers.

METABOLITES PURPOSE - Mycelium produces metabolites in response to contaminants or stress. These are antibiotic compounds that the mycelium produces to kill competitor fungi or bacteria. They are not in any way, shape or form related to the urine that is secreted by mammals. The metabolites produced by mycelium of the penicillium fungus for example are used in human medicine as antibiotics to kill bacteria. The metabolites produced by mushroom mycelium serve a similar purpose.

METABOLITES - Actually, metabolites don't attract bacteria; they're a response to it. They're antibiotic. It sounds like you have some bacteria in the jar and they're being excreted by the mycelium to help fight it off. You can lay the jar on its side, and then rotate it once per day. This keeps uncolonized parts out of the liquid, helping them to finish up. The above assumes it's a grain jar. If it's a pf jar, disregard. Laying on its side and rolling can disturb the vermiculite filter leading to contaminants entering.

USES FOR MYCELIUM METABOLITES - Experiment. Put some bacteria on a Petri dish, and then put down a line of metabolite. Watch how they stop the spread of the bacteria. Without a lab, I doubt you could make your own antibiotics, but penicillin and the other common antibiotics are made from fungi metabolite. I've also found that mushroom metabolites will kill trichoderma mycelium on a Petri dish. In fact, it would probably kill off any competitor fungi, even other mushroom species.

METABOLITES - Mycelium often produces metabolites of different colors depending on what infection they're fighting. This red color was on the top of the vermiculite barrier where the mycelium had worked it's way up to where contaminants had entered through the vent hole and were laying dormant on the vermiculite barrier. When the mycelium reached that spot, it produced metabolites (antibiotic compounds) to kill the mold spores or bacteria that were present in that location.



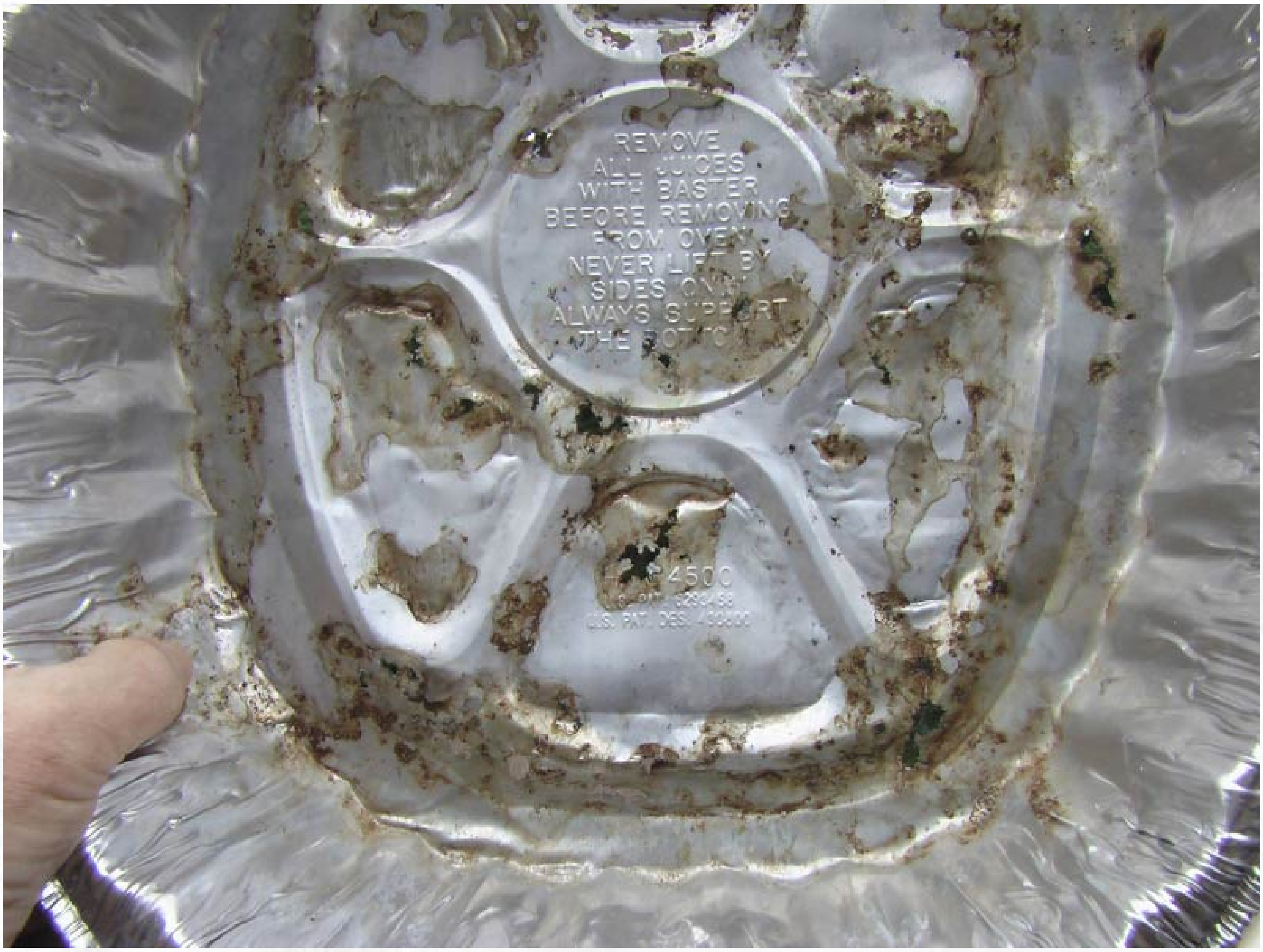
METABOLITES - The metabolites are antibiotic secretions, so when they're in large amounts, it usually means something is up. High colonization temps will also lead to metabolite production, so remember to colonize jars at room temperature. A jar with a good filter will contain any contaminants that are within, so don't toss it out. Don't use any jar with a lot of metabolites for grain-to-grain transfers, but if they colonize fine, they're good to use for spawning to bulk.

METABOLITES - Colonized poo trays sometimes emit a little honey yellow, to as dark as Tobacco juice colored metabolite type waste on the top of the tray. So long as it colonized nicely & the metabolite waste doesn't turn into a gusher. It's good to go. Been there & done that a few times, especially with big bulk trays that had a strong cow/poo mixture in them. The stuff is commonly called MYC PISS. If it's fully colonized, add a casing cover & go for it.

METABOLITES - There will be no live bacteria in the metabolites. They're acids and often ethylene based to kill bacteria and are produced in response to it. There may be bacteria in the grains, but not in the metabolites. That's why grain jars should be used at full colonization, not weeks later. The metabolites are the myceliums defense mechanism. I've used the metabolites from Hypsizygus ulmarium to kill bacteria and trichoderma on a Petri dish.

METABOLITES - It's metabolites since they're yellow. That is a sign of too much bacteria and/or excessive temperature. Is that uncased manure? I'd suggest gently dabbing the excessive off with a clean dry paper towel. The metabolites help to fight infections, but too much of a good thing isn't always good. Dry it off, and increase air exchange. You want high humidity, especially if fruiting uncased, but you also want lots of fresh air.

METABOLITES - The manure isn't eating the holes in the aluminum, the mushroom metabolites are. I have a mushroom that was sent for metals testing after harvesting from the tray pictured below. I should know within a few days if aluminum was conducted up into the fruit body. We know that heavy metals end up in the fruits, but as far as I know, nobody has ever had a fruit professionally tested for aluminum contamination.



METABOLITES - It sounds like metabolites and is often caused by excess temperature, which leads to bacterial contamination. Metabolites are antibiotic and are secreted in response to the bacteria or molds. Incubate at room temperature for best results and lowest contamination rate. I haven't even owned an incubator in ten years. They're not necessary and cause far more problems than they solve.

METABOLITES - The metabolites are generally produced in response to bacteria that are stimulated by high incubation temperatures. My rule of thumb is if you can see visible metabolites in the bottom of the jar, it's ok to spawn to bulk, but don't do a g2g with it, or the dormant bacteria will come back to life in the fresh grains. Next time, incubate your grains at room temperature.

METABOLITES - The excess moisture you see is metabolic discharges from the mycelium trying to fight off the contaminants, and/or metabolites from the molds trying to fight off the mushroom mycelium. Start over, and use a very light syringe, or better yet, prove your spores on agar, and transfer a proved, clean mycelium culture into your rye and watch it take off.

METABOLITES - A large amount of metabolites generally means a bit of bacteria in the jar. The metabolites are antibiotic secretions, so when they're in large amounts, it usually means something is up. High colonization temps will also lead to metabolite production, so remember to colonize jars at room temperature.

METABOLITES - Mycelia metabolites are not urine. They're antibiotic and much more like medicine than pee. In fact, they also help to break down the substrate for the mycelium, much like the saliva in our mouth (which is also not urine) helps break down our food, making it available to the mycelium.

CAUSES FOR METABOLITES - Elevated temperatures are a major cause of that. The high temperature stimulates bacteria, and then the mushroom mycelium must secrete antibiotic metabolites to deal with them. It's important to use room temperature for colonization, especially with larger substrates.

WHAT ARE METABOLITES - Antibiotic drugs such as penicillin are, and have been made from fungal metabolites for over fifty years. It is not a theory. I have used a syringe to draw metabolite from a grain jar and placed it on bacteria in a Petri dish. It kills the bacteria dead within hours.

METABOLITES - Antibiotics such as penicillin are made from fungi metabolites. They're a powerful anti-bacterial. They also help the mycelium to break down substrate materials. There are still a lot of unknowns to be researched, but they're not urine or feces, that's for sure.

METABOLITES - I'm convinced many growers who think they 'cut away lipstick mold' and succeeded, actually cut away harmless metabolites from their jars. Metabolites are produced by the mycelium in order to attack competitors. They're a weapon.

METABOLITES - Metabolites are a natural secretion of fungi both as a defense mechanism against competitors and to break down food sources. Molds produce as much or more metabolites than mushroom mycelium.

METABOLITES - It's just metabolites from the high temperature. NEVER use a jar with a lot of metabolites for grain-to-grain transfers, but you can use it to spawn to bulk or lay in a tray and case.

METABOLITES - They're actually antibiotic compounds used to neutralize competitor fungi and bacteria. That's why medical antibiotics are made from them.

METABOLITES - An excess of metabolites can point towards bacterial contamination, over-colonization of a substrate, or too high a temperature.

METABOLITES - Yes. Excessive heat will cause the mycelium to produce more, so if there's a lot of metabolite, try to reduce temperature.

METABOLITES - The metabolites will do no harm. You can leave the substrate soaking in it. They destroy contaminants, not cause them.

METABOLITES - A large amount of metabolites generally means a bit of bacteria in the jar.

METABOLITES - Actually, metabolites don't attract bacteria; they're a response to it.

LIGHTING

Light has absolutely NOTHING to do with telling the mycelium that it has reached the surface. The increased fresh air, with the corresponding drop in CO_2 levels sends the mycelium that message.
Light is also NOT just to establish the direction the fruits grow. In fact, air currents have a greater effect on direction of growth than light. If you doubt this, place a fan on your crop and watch.
A few seconds of light per day will NOT help to generate a good pinset. In fact, light is a secondary pinning trigger, but an important one. The difference between three or four pins, and hundreds of pins on a substrate can be directly correlated to the length, intensity, and frequency of the light applied, provided the primary pinning triggers have been fulfilled.
The light needs to be intense enough to penetrate 1/2" into the substrate. Not all pins form on the surface. Many originate from deeper in the substrate or casing layer.

Higher frequency light above a color temperature of 5,000 Kelvin will generate far more pins than a 'red' source of light such as incandescent lamps.
Fungi are a living organism that is much more closely related to mammals such as humans, than to plants. People need to quit looking at mycelium as a different kind of plant, which it isn't. Mycelium has been shown to have circadian rhythms just like mammals, and this is the reason that 12/12 light cycles work best. This planet, and all surface life on it are based on the 24-hour day. For best results, learn to work with nature rather than against it. Mycelium has an amazing ability to cope with less than optimal conditions, and will often fruit when a grower does everything wrong. However, do everything right and watch your performance go through the roof.

TMC FAULT, LIGHTING, WHY - Recent experiments (over the last 23 years) have shown the error of that statement in TMC. Many experiments have shown conclusively that fluorescent lamps in the 6500K range produce better pinsets and healthier, meatier fruits than other forms of light. Stamets himself does not repeat that 'flash of light' triggers pinning nonsense. In fact, he recommends fluorescent lamps in the 6,500-Kelvin range for 12/12 just as I do. In addition, there's a huge difference in saying something can result in 'pins', and helping to trigger a very nice flush.
Light, and the intensity/frequency of light is extremely important if one is interested in greater than mediocre performance. Many species, such as agaricus and P. cubensis, can pin in the total absence of light. That doesn't mean light isn't required for best results, especially with light sensitive species such as P. cubensis and P. ostreatus.

WHAT YOU WANT! - You want full spectrum light for best results. Indirect light from a window is fine. Hyphal knot formation is stimulated more by light at the higher end of the scale than at the lower end of the scale. A color temperature of around 6500K is just about perfect. This is the color produced by 'natural daylight fluorescent' tubes. For the geeks, I'll explain color temperature briefly. We all know when we heat a piece of metal, it first begins to glow red. We see this when we heat a syringe needle over a flame. If we continue to heat it, the metal will eventually glow white hot. As we heat it more and more the white color begins to take on a blue hue, provided the metal doesn't melt down into a puddle first. This is why tungsten in a vacuum is often used for light bulb filaments.
The Kelvin color temperature system is essentially the color a piece of dark metal will glow when heated to a specific temperature. The Kelvin scale starts at absolute zero, roughly -237C. This is Zero K. The scale follows the Celsius temperature scale and remains constant. Therefore, water freezes at 237K and boils at 337K. If you heat a piece of metal to a temperature of 4,763C, the resulting glow will have a color temperature of 5,000K. The color scale is used as 'corrected' color temperature when fluorescent or other gas type lighting fixtures are used. A 'natural daylight' fluorescent tube with a color temperature of 6500K would glow with the same color as a dark object heated to a temperature of 6,263C.
Color temperature is not an indication of the intensity of light, only its color. Mycelium forms fruits best with light at the 'blue' end of the spectrum, thus a higher color temperature is required for best performance. Look for lighting with a high color temperature such as fluorescent. Cool white fluorescent has a color temperature of 5,000K and natural daylight has a color temperature of 6,500K. Avoid UV light that is too high, and has been known to damage mycelium, as well as cause mutations, and cancer in humans.
Incandescent light bulbs by contrast, have a color temperature of around 3000K, which puts them in the 'red' end of the spectrum, and they are the worst choice for fruiting mushrooms.

LIGHTING - Many things. I've found the brightest light stimulates more pins. You need to look at pinning triggers like the instruments in a band. One instrument can be slightly off, and the band still plays the song. Often one instrument can be taken away and the music still sounds ok. However, if all are working together, it's awesome.
Perhaps the projects you remove from light after exposure are maintaining a higher humidity due to no heat from the lights. Humidity is a pinning trigger just like light. Maybe the ones you remove from the lights get better air circulation. Fresh air is a pinning trigger just like light.
For the record, light has no effect on colonizing mycelium, good or bad. The old advice of "incubate in total darkness" is bunk. Stamets wrote those words in TMC 20 years ago, and he disavows that advice today. I concur. The only real time that keeping in the dark has an advantage in my experience is during casing run, when the introduction of light after casing colonization can serve as one of the pinning triggers along with air exchange and proper humidity. Bare in mind, you want a constant rate of evaporation from your substrate to achieve the best pinset. If you're at 100% humidity, there will be little to no moisture evaporating from your

casing layer, and pinsets will suffer.
To repeat, light is a pinning trigger, but it isn't the only one, and it's greatly overrated. For the best pinsets, you have to balance several triggers at once. Screw up on any of them, and pinsets suffer, regardless of what you do with light.

LIGHTING - Normal room lighting has no effect on colonizing mycelium, either good or bad. This is one of the old myths perpetuated by stamets 'The Mushroom Cultivator', that was incorrect 20 years ago when it was written. He corrected his own mistake in GGMM, but fewer people have read that one because it centers more on edibles, than on psilocybe mushrooms. My own research says light doesn't make one whit of difference to colonizing mycelium in jars. The time to protect from light is during spawn run of bulk substrates and casing layers. During the initial colonization of grains or brf cakes, it doesn't matter. Light is required for primordia formation as well. Bulk substrate colonization is the last step prior to fruiting. The only reason for keeping a bulk substrate, and especially the casing layer dark during colonization is for the timing of the pinset initiation. It allows you to introduce all the major pinning triggers simultaneously, resulting in an explosion of pins. A bulk substrate will colonize just fine if exposed to light from day one, but then you aren't maximizing potential by synchronizing the pinning triggers.

TMC FAULTS LIGHTING - TMC is a classic and I still refer to it a lot. In the last twenty years we've learned a few things though. One, as hyphae said is the mycelium metabolites. Another is that colonizing mycelium need not be kept in total darkness. I think Paul fixed that one in GGMM, but I know at his beginners and masters seminars he points that out, and his own incubation rooms filled with hundreds of species, are under 8 to 12 hours per day of fluorescent lighting while work is being done. That has been my experience as well. Light doesn't become a significant pinning trigger prior to full colonization and the introduction of fresh air exchange. This one is probably nitpicking, but I don't like the TMC method of preparing grain jars which is add dry grain, add water and a pinch of gypsum, and PC. We now know that if you'll take the time to rinse the grains very well before cooking, they don't stick and clump up later. There's a couple of others I can't think of now. Nothing major though. It's a great reference work.

LIGHTING - While enough light to read by might give a minimum pinset, you want bright, high frequency light to induce a massive pinset. An hour or two in a window with even direct sunlight is great to kick start a pinset, but don't let the tub overheat. For the rest of the cycle, find a way to get the fluorescent to shine through the clear part of the tub. Put the light in front of or behind the tub. It doesn't have to come just from the top. The white lid will reflect side light down just fine. My entire greenhouse is lit from the back with fluorescent fixtures attached to the wall the greenhouse sits against. Cool white fluorescents produce 5000k, which is very close to natural sunlight. Incadescents are a much redder light and only produce at around 3200k, which is not nearly as effective. You want high frequency light for best results. The natural daylight fluorescents are the best, putting out light at around 7000k, but are much more expensive than cool white. Good luck.

LIGHTING FREQUENCIES, PLANT LIGHTS - Plants require much more light than mushrooms because they derive energy from the light source. In addition, most mj growers switch to a redder light at fruiting time, not the high frequency 'blue' light we get from our fluorescents. Perhaps you're confusing the Kelvin color temperature scale with intensity? My fluorescent fixture provides light to six shelves, each one eight feet long and three feet deep. That's 144 square feet, thus less than 1 watt per square foot of shelf space. The foil helps to prevent the trays in the back from being shaded by those in front. I challenge the best mj grower in the world to try to grow plants under that. Compact fluorescent bulbs work great as well for fruiting chambers and mini-greenhouses. In addition, LED technology has progressed considerably in the last few years. I'm sure it won't be long before LED fixtures are made with controllers to adjust color temperature.

LIGHTING - "Of course myc doesn't need dark but we use it to our advantage as a pinning trigger"
Exactly. After spawning the grains or brf or whatever into manure, it's a good idea to cover with foil to keep it in the dark during substrate colonization and casing colonization, and then remove the foil for light and sudden air/gas exchange to trigger pinning. However, I've found no benefit or harm from allowing the grain jars to be exposed to light from day one. If a few pins form in the grains, it is actually a good thing. Contrary to popular belief, a few pins in the grains can be spawned right into the manure or straw (or used in grain to grain transfers) and they do not rot or otherwise cause contamination. There is evidence they actually help to give a faster, more uniform pinset in the eventual flushes. Stamets believes it's the hormones or other

chemical triggers in the pins that do this.

LIGHTING - Light is very important after full colonization, when an increase in FAE is made. Enough light to 'see the tray' is absolutely NOT enough light unless you're happy with shitty pinsets. Brighter light is better. Higher frequency (blue) light such as is emitted by 'natural daylight fluorescent' tubes which produce light at 6500K are best from mine and Stamets tests. Cool white fluorescent tubes would be a second, lower cost choice and will work fine. Incandescent bulbs which emit 'red' light at 3000K are the worst choice. In addition, 24-hour light is extremely counter productive because hyphal knots form, and the fruit bodies seem to grow the most during the period of darkness. You can all prove that by simply measuring your growing mushrooms when you turn the light on, and again when you shut it off. You'll find growth is higher during the dark phase.

LIGHTING - Use full spectrum light, or a light that is in the higher frequency range. Don't use 'blue' lights or a 'blue' tub. Such is not in any way, shape, or form what the mycelium needs to perform well. The use of 'blue' led's or blue tubs is based on a misunderstanding of what Stamets was talking about in GGMM when he recommended high frequency lights, such as natural daylight fluorescent. This has all been covered ad-nauseam in previous light threads. It absolutely amazes me that people still repeat the 'any light will do' or 'if you can see, your mushrooms have enough light', or 'only a few minutes is enough' etc., etc. If one is satisfied with shitty pinsets, the above is true. If you're less than satisfied with shitty pinsets, use a light in the 6,500-Kelvin range. Incandescent grow lights are one of the worst possible choices.

LIGHTING - At full colonization, light becomes very important. The only real time you need to put your trays in the dark is during casing run. This allows the casing layer to colonize partially without the additional pinning trigger of light acting on it. At the proper time, you expose to light, increase FAE, and have full colonization all at the same time. This results in the best possible pinset. Read Hyphae's pinning strategy in his sig for more information on timing these events. There is no point in putting it into the dark now that it's already pinning. The fluoros you have will be plenty, but try to attach or hang them higher so they can give better direction to the fruits as they grow. It will also help hyphal knots to form if you'll have the light above the casing layer because it will penetrate deeper into it, thus helping to trigger knots. Good luck.

LIGHTING - Light is extremely important to good mushroom formation, and it's nothing to do with which way is up. Gravity takes care of that function. The post quoted above is only one of many times I've typed that. The problem is every time this question gets asked, people repeat the same 'stuff they've read' and thus if one of us fails to catch the misinformation, then somebody gets a grow compromised by using a desk lamp or some other less than desirable lighting source, rather than the best possible lighting. There's enough confusing points in mushroom growing to keep a board like this busy forever. Ask about things you're not sure of, or of the details you don't understand after searching. However, for the basic questions, the answers are all right here at your fingertips. Good luck to all. I'll try to be less pissy.

EXPOSING LIGHT FROM DAY ONE - In my experience, it's better to expose to light from day one. If you'll just let your bags or jars colonize on a shelf in a room of your house, they'll be exposed to normal room light. This will help to initiate pinning as soon as the substrate is ready to support fruitbodies. Colonizing your jars in the dark only delays pinning, and delay is not good in this hobby. Get light on it right away. I seriously disagree with keeping cubie mycelium in the dark at any time. I expose to light from the time the spores germinate on agar. Sometimes there are even a few pins in the jars when I break them up for the casing. That is no problem. Just mix them in and case it. If you give light from day one, your yields will go up, and you won't face overlay problems.

LIGHTING - Lighting is EXTREMELY important for a good pinset. Cubes will fruit in very low light conditions, but bright fluorescent light will help to trigger the pinsets the old timers show all the time that makes folks drool. Actually, you're probably right. The mushrooms don't care that much about light, but the mycelium sure as heck does. Lights, especially fluorescent, should be outside the terrarium, but near enough to flood the fruiting chamber in bright, high frequency light. Don't put the ballast outside and the lamps inside. The tombstones have a fairly high voltage potential across them, and wrapping a warm item in plastic in a wet environment is ...dumb. There isn't much more useless than 'blue' mood lights, especially from led's.

LIGHTING - There's a world of difference between 'blue spectrum' and what you get when a red light (incandescent) shines through blue plastic. (Dim) By 'blue' they mean high frequency light, such as would be

emitted by a metal halide bulb, or natural sunlight fluorescent. You'll want to get better lighting to get the best pinsets. It's better than nothing, but only ten percent of the electricity to run an incandescent is turned into light. The other ninety percent is turned into heat. Fluorescent fixtures are the opposite. 90% of the energy is turned into light and ten percent into heat. They're also closer to the frequency that is ideal for pinning.
http://www.shroomery.org/forums/showflat.php/Number/6611363#6611363

LIGHTING - All lights will produce heat. The light needs to be outside the fruiting chamber. Electricity and 100% humidity don't mix. Don't use blue Christmas lights. They're NOT the correct color temperature. By 'blue' we mean light at the high end of the spectrum. It will still look white to your eyes. As said, 6500 Kelvin fluorescent lights give the best bang for your buck. They're usually labeled 'natural daylight' on the package, as opposed to 'cool white' which are 5,000K and 'warm white' or 'kitchen and bath' which are 3000K, which is referred to as 'red' light, even though they still look white to our eyes. You can also simply place the terrarium in a room with a bright window and let the natural sunlight do the job.

LIGHTING - 2700K are awfully red. It might be nice for room light and for reading because it's 'warm', but you want light in the bluer end of the spectrum, so shoot for a frequency above 5,000 Kelvin. Lumens do matter to an extent. We're not deriving energy from the light, but it does need to be bright enough to penetrate into the casing layer. Bright fluorescent light from a 'daylight' type tube seems to help generate the best pinsets over a wide range of species. I have a four-tube 48" fluorescent fixture with 6500-Kelvin tubes in all four slots. This light is plenty for my mini-greenhouse. I have it hanging from the ceiling so it shines into the front of the greenhouse. Reflective foil is on the back wall of the GH.

LIGHTING - It sounds like something else growing in the area. MH is known to cause early pinning in jars because of the high frequency light output of MH. However HPS is more of a red light at the lower end of the spectrum, so it shouldn't be that bad. I'd still move the jars away from it. The heat could cause problems. There is no need to keep colonizing jars in the dark, but there is also no need to expose them to very bright lights either. When fruiting time comes, you'll probably do better to get a natural daylight fluorescent. The 6500K color temperature seems to stimulate primordia formation better than the lower color temperatures of lamps such as incandescent and HPS.

LIGHTING - You want bright light for 12 hours per day, not normal room light, which is usually at the red end of the spectrum if it's from incandescent bulbs, and is the worst possible choice. Incandescent bulbs produce light at 3000K. Cool white fluorescents are a higher frequency light and perform much better, with a color temperature of 5000K, and natural daylight fluorescent produce light at the 'blue' end of the spectrum with a color temperature of 6500K. You don't want blue lights. Light at the high (blue) end of the spectrum will look white to your eyes. You don't get high frequency light by using a bulb with a blue dye on the lens.

LIGHTING - Not at all. They will do best with 12 hours of light. I'd put them in the dark when they're about 90% colonized, then when they are at 100%, birth and begin giving them light at that time. This allows the four major pinning triggers of full colonization, steady rate of evaporation from the substrate, fresh air exchange, and light to all happen at the same time. Such has been shown to give the best pinsets. Light does not become a significant pinning trigger until the other factors have also been met. Many growers dunk at the time of birthing to pump the moisture content up for the first flush.

TMC FAULT, LIGHTING - Light has neither good nor ill effects on growing mushroom mycelium. It will not hurt, nor help, but there is no need to keep your jars in the dark. Stamets makes this clear in GGMC. He used to recommend incubation in total darkness (TMC), but he no longer recommends this. I concur. If you visit fungi perfect you will see he has 10,000 square feet of incubation space that is exposed to overhead fluorescent lights during the full workday. My jars sit on a shelf in an open room as said above and they're exposed to light from the day spores are started.

LIGHTING - The Kelvin scale refers to the color temperature of the light. Briefly stated, if you took a piece of white paper and looked at it under 2,000K such as you'd get from hps, it would look yellow. If you looked at it under 5,000K fluorescent tubes such as you'd find in an office or school classroom, it would look white. If you look at it under 7,500K fluorescent, it would have a blue tint to it. That's what is meant by 'blue' light. You can pick up an inexpensive fluorescent fixture and 7500K fluorescent tubes fairly cheaply at your local hardware store.

LIGHTING - My current setup is a larger fluorescent fixture that holds four 48" tubes, and I have it hanging vertically so it shines in from the front to bathe all five shelves in bright light. I have it about 12" from the door of the GH, so the farthest any substrate is from the light is about 36". The fruits tend to grow toward the light a bit, but that problem is fixed by rotating the trays 180 degrees every couple of days so growth is even. I'm glad to see you got the right frequency of light. 6500K are awesome. You'll never go back to silly night-lights or cool white fluorescent after using one of those. They really do make a difference in pinsets.

LIGHTING - I've still never seen a 150-watt cfl that small. At any rate, with multiple shelves or long shelves, tubes will spread the light out better, thus giving more coverage. I use 5 shelves in my mini-greenhouse, with a 48" fixture hanging vertically in front of the unit, which holds four fluorescent tubes with a color temperature of 6,500K. By hanging the light fixture vertically, the fixture lights the entire greenhouse between all shelves. With only one bulb, you're limited in coverage. They'd be great for tubs and the like, but there is no need for 250 watts. It will burn five or more times the electricity your projects require.

LIGHTING - They do care if they don't get air. You'll get a very poor pinset without several air exchanges per day at the very least. Four to five per hour are recommended. Water beads on the inside of the terrarium have NOTHING to do with humidity. They indicate a temperature differential, nothing else. You want your light outside the terrarium. Fluorescent ballasts generate a high voltage, and that doesn't go with near saturation humidity at all. In addition, a fluorescent ballast and light inside will heat your terrarium a lot. It will be over 90F in there within a few hours. Also, the heat will lower humidity, not raise it.

LIGHTING - Mushrooms grow towards the light. Very true. However, as an experiment, you can put the light above and a fan blowing from right to left. Watch what happens. In the absence of any wind, the mushrooms grow towards the light. You can also screw with your mushrooms if you're bored. Every morning, rotate your trays of pinning/fruiting mushrooms by 90 degrees, and leave them until the next morning, then rotate them an additional 90 degrees. They'll grow up in a spiral.

LIGHTING - You can't argue that light makes a big difference with growers that are happy with crappy pinsets. However, if you want the best pinset and growth you can get, and then use bright light with a color temperature of 5,000 Kelvin to 7500 Kelvin. Of course, there's other parameters that are just as important, if not more important than light. Failure to pay attention to ALL the pinning triggers is like trying to win the Indy 500 with a clogged up air filter or dirty spark plugs.

LIGHTING - It's true that they tend to grow more during the period of darkness, but that's only part of the equation. The other part is that pins for second, third, and future flushes often form during the time of first flush. If you go cheapie on the light after the first flush is set, you hinder primordia development for future flushes. Mushroom mycelium has circadian rhythms just like humans. Give them a day/night cycle and they'll be much happier over the course of several flushes.

LIGHTING - One, a 25W incandescent bulb only puts out the amount of light that a 2.5W fluorescent bulb would put out. Over 90% of the electricity used by a light bulb goes toward making heat, and only 10% of the electricity goes toward making light. With fluorescent, that ratio is reversed. In addition, incandescent bulbs put out light at the red end of the spectrum, and fluorescent lamps put out light near the blue end of the spectrum, which is much better for fungi.

LIGHTING - I've been saying for years that both light and total darkness are vastly overrated when it comes to mushroom growing. Some strains seem to be better at pinning in low light conditions, while others require much more. The other pinning triggers of full colonization, steady evaporation of moisture, and air exchange are much more critical than light. As a general rule however, pinsets will be better with bright, full spectrum lighting over dim/darker conditions.

LIGHTING - The reason intensity is important is because the light needs to penetrate the casing layer to the substrate below. Frequency is also important with light at the higher end of the spectrum, such as natural daylight fluorescent with a light temperature between 6,000K and 7,500K providing the best results. Cool white fluorescent tubes are generally in the 5,000 Kelvin range, and regular incandescent bulbs run about 3,000K, which is the worst possible choice.

LIGHTING - They need light for much more than to know which way is up. A lot has been written about this. Bright, intense light is going to stimulate a much better pinset than dim, low light. 12/12 has shown over the years to give the best performance. I don't even have my lights on a timer anymore unless I go out of town. I plug them in when I get up, and unplug them sometime in the evening. They rarely get exactly 12/12, but close.

LIGHTING - Bright, high frequency light at 12/12 will deliver the most prolific pinsets. You want maximum FAE, high humidity, and bright light, especially with cased substrates. The light needs to be bright enough to penetrate the casing layer for best results. 'Some' pins will form with low levels of light, but if you want the WOW factor, use bright fluorescent light or sunlight from a window. They do best with a period of darkness each day.

TMC FAULT, LIGHTING - Light has little to no effect on colonizing mycelium. I expose all jars to light from day one. I also incubate on a shelf in an open room at room temperature. If you visit fungi perfecti, you'll see that stamets has 10,000 square feet of incubation area, all of it exposed to fluorescent lights for 8 to 10 hours per day. He no longer recommends incubation in total darkness as he did 20 years ago when he wrote TMC. I concur.

LIGHTING - Two things. First, don't install lights inside a terrarium. Even a small light will create heat that causes other problems. Second, if it's incandescent, it's the wrong color temperature. You want a high frequency light such as natural daylight fluorescent for best results. Simply hang it above the terrarium. Bright, intense, high frequency light provides the best pinsets, so get a good one. I use four, 4' natural daylight fluorescent tubes.

LIGHTING - Many fluorescent tubes will have the light temperature stamped on them at the end. Cool white bulbs are in the neighborhood of 5000k while the kitchen and bath fluorescent tubes are warm white, and at 3000K, similar to regular light bulbs. The higher 'k' numbers will deliver better pinsets, because they match outdoor sunlight closer. Fortunately for us, cool white fluorescent which is superior, is also the least expensive.

UV LIGHTING - UV light strong enough to STERILZE will F/U your eyes, skin, cause cancer & other BS. If it is contained, as in well shielded..... it works great, but you still need filtration. Best is hepa filter run into UV light shielded in metal ductwork. Instance I refered to was UV light in metal ductwork behind filter, because it killed anything that got past the filter. The ductwork fed into a "clean" room area & it was fully sheilded.

LIGHTING - Natural Daylight fluorescent has been shown to produce the best results. Your milage will vary depending on the genetics of your strain using other types of lights. However, mushroom primordia seem to develop best in the 5,000 Kelvin to 7,500 Kelvin range which is exactly what is delivered by most fluorescent tubes. The Natural Daylight tubes are rated between 6,500 and 7,500 Kelvin depending on manufacturer.

LIGHTING - Brighter lighting will work better than dim, far away lighting. The light needs to penetrate the casing layer. Don't listen to those who say if you can see what's happening, there is enough light. That is incorrect. You can get small fluorescent fixtures intended for under kitchen cabinets for less than ten dollars. Put one a few inches above your plexiglass. Put it high enough that heat isn't transferred, but bright light is.

LIGHTING - The only reason for keeping a bulk substrate, and especially the casing layer dark during colonization is for the timing of the pinset initiation. It allows you to introduce all the major pinning triggers simultaneously, resulting in an explosion of pins. A bulk substrate will colonize just fine if exposed to light from day one, but then you aren't maximizing potential by synchronizing the pinning triggers.

LIGHTING - If you're going to use LED's, use white ones. Your mushrooms need full spectrum light, not mood light, and some evidence points to light at the higher end of the spectrum being somewhat better at setting primordia. Bright light will penetrate deeper into the casing layer, stimulating more pins than dim light. Avoid lights that produce excess heat such as incadescent or halogen.

LIGHTING - The color temperature (not light temperature) of any specialty bulb should be stamped on the package. Normal incandescents are in the 3000K range, which is too low. HPS is even worse, in the 2000K range. You want light at the other end of the spectrum. Cool white fluorescent is around 5000K and natural daylight fluorescent is 6500K, making it the best choice for the money.

LIGHTING - Use natural daylight fluorescent with a color temperature of 6,500 Kelvin for best results. I said use 6,500 Kelvin natural daylight fluorescent for best results. There is no contradiction. Mushroom cultivation was in its infancy 25 years ago. We've learned a lot since then. Lamps with a color temperature of 6,500 Kelvin are NOT low frequency-they're considered 'blue' light.

LIGHTING - Normal room light has no effect on colonizing mycelium, either good or bad. Usually, when mycelium stalls, it's due to lack of air exchange. If you have a verm filter, take the lid all the way off for a few minutes and then put it back on. If the mycelium starts to grow again, you know that was the problem. Make sure the inoculation/gas exchange holes are open.

LIGHTING - Correct. A 60 watt light bulb on the ceiling is enough to trigger a few pins. Failure to use proper lighting doesn't mean the entire project is going to fail. It simply means it will be less than what could be achieved by a tad more work. It's sort of like driving your car with one tire flat. You'll still get there, but not as fast, and people will point and giggle.

LIGHTING - Xmas lights have been used for years with poor to mediocre results. Don't put too much faith in the experiment done several years ago. Many, many tests since then have shown otherwise. Most any light will stimulate some pins to form, but the higher frequency lights in the 5,000 Kelvin to 7,500 Kelvin range will help to provide the best pinset possible.

LIGHTING - Yes you do. They require light right up until harvest. It provides direction for growth. In fact, many species such as oysters will turn into a mass of coral without adequate light. Shiitake won't grow at all. Cubes without light will twist around, not knowing which way to grow. Performance will suffer. 12/12 right up until harvest is the proper procedure.

LIGHTING - Even MH is at the 'red' end of the spectrum, just not as red as the old SV or HPS. MH has a color temperature of around 4,000K and HPS is around 2000K, but cool white fluorescent is 5,000K and natural daylight fluorescent is 6500K. Regular household light bulbs are around 3000K. The higher the color temperature in Kelvin, the more 'blue' the light is.

LIGHTING - I've measured many flushes of various species on a day to day basis and found that most mushrooms grow more during the period of darkness than during the period of light. The change in temperature caused by cycling the lights 12/12 is also positive. Mushrooms are not plants, but as said above, light does indeed have a major effect on them.

LIGHTING - The main pinning triggers are full colonization, an increase in fresh air that comes with the decrease in CO_2 levels, and a steady rate of evaporation from the substrate. Once those conditions have been met, light becomes a secondary pinning trigger. A few minutes of light will work, but 12/12 has been shown to produce superior product.

LIGHTING - That's why growers who use a very bright fluorescent light in the higher part of the color spectrum have much better pinsets and yields than those who use ambient room, or worse yet, only a few minutes a day of dim light. The light should be bright enough to penetrate well into the casing layer, which should also be loose and airy.

LIGHTING - Light is only a secondary pinning trigger, not the main one. Full colonization of the substrate, with an increase in air exchange are the two biggies. For best results, all the pinning triggers should be introduced at once. You'll have to say more than 'kit' to get help, and 'dirt' is what you get under your fingernails. Mushrooms don't grow on it.

LIGHTING - Light at the higher end of the spectrum is far superior to light at the low end of the spectrum. Incandescent light bulbs with a color temperature of 3,000 kelvin are considered 'red', and natural daylight fluorescent with a color temperature of 6,500 kelvin are considered 'blue' which is superior. Search the above terms for much more.

LIGHTING - Lots of people are satisified with 'less' light. It's just that if you want the best possible results, go with the best of all possible setups, which means best light, best substrate, best temperature, best humidity, etc. By all means if anyone is satisfied with less, go for it. Many of use raise growing to an artform, but not all. To each his own.

LIGHTING FRUITING - Just use a plain fluorescent bulb, and keep it above the terrarium, not inside it. Heat isn't an issue that way. As said, there's a big difference between short wavelength light(blue spectrum) and a light that makes your walls 'look' blue. However, the whole blue light thing is overrated. Use a full spectrum lamp.

LIGHTING - All you need to do is rotate your tubs every day or two to offset the light from an angle. Even if you don't, it's cool to see them grow towards the light. There's really no reason they need to grow straight up, and growing at an angle actually gives the caps more room to spread out without interferring with each other.

LIGHTING - What you're giving is great. There are no hard and fast rules. Some experienced folks give more light, some less, but all get great pinsets, so don't worry too much about light. A few hours a day is fine, so placing your project near a window where it gets diffused sunlight, but no direct sunlight is ideal.

LIGHTING - You want lights that are high in the color spectrum, thus a color temperature of 6500 to 7000 Kelvin works great. It will look bright white to your eyes. Christmas lights are a poor choice. They do have some full spectrum LED's out now, or you can use 'natural daylight' compact fluorescent lamps.

SMART FRUITING CHAMBER LIGHTING - If a light 'looks' blue to your naked eye, it means the blue has been filtered out of the spectrum. It's counterproductive. The blue light is at the high frequency end of the spectrum. The best source of blue light, if you want to experiment, is a Metal Halide lamp.

LIGHTING - Incandescent is never recommended for mushrooms. Incandescent lamps emit a red light that is at the opposite end of the spectrum from what mycelium prefers for primordia formation. Use fluorescent, preferably 'natural daylight' tubes with a color temperature above 5,000 Kelvin.

LIGHTING FC - Higher intensity light helps deliver a better pinset than lower intensity light. A few hours is cool, but most growers report better success with 12. The darkness time need not be total darkness. Turning on the light to see what you're during your mushies 'night' won't hurt anything.

LIGHTING - They never need total darkness at any time. Ambient light is fine. 'We' don't say mushrooms require only a small amount of light to grow however. Depending on the species, the results on pinset and performance from much brighter lights is well documented.

LIGHTS, IN OR OUT OF FC/MARTHA - The problem is when the lights are turned off, they will draw in moisture as they cool, then will be wet inside next time they're turned on. It's best to keep the lights outside of the terrarium or mini greenhouse unless they're battery operated.

LIGHTING - And natural daylight fluorescent takes it a step higher than cool white. They're the best of all. Warm white=3000K, cool white=5000K, and natural daylight fluorescent=6500K. The higher the light temperature in Kelvin, the higher the frequency, or closer to blue light.

LIGHTING - I use four 4' natural daylight 6500K fluorescent tubes for my mini greenhouse. It works like a charm. The important thing is to keep the humidity to as close to 100% you can get while still allowing plenty of air exchange. All three are important pinning triggers.

LIGHTING - I've found the brighter the better. You might even move the cakes to where they can get some diffused sunlight each day. Even direct sunlight for a few minutes is a good thing. You might try some damp verm on top of the cake too. That seems to help with pinsets.

LIGHTING - 5100K is fine. I think 6,500K to 7,500K is better, but when you compare to incandescent bulbs which burn at 3,000K, they're way better. Definitely, you don't want red. You also don't want any sort of colored cover over the bulb, and that includes blue.

LIGHTING - If it's a 'kitchen and bath' fluorescent, it probably has a color temperature of 3,000 Kelvin, just like incandescent. It will still work, but possibly not as well as 'natural daylight' fluorescent. Put it right up close to the fruiting chamber, but not inside.

LIGHTING - 12/12 is optimum, as is light at the high end of the spectrum. For the best bang for your buck, get natural daylight fluorescent tubes and run them 12/12. Mushrooms grow and hyphal knots form primarily in the period of darkness, so 24/7 is a mistake.

LIGHTING - To repeat, light is a pinning trigger, but it isn't the only one, and it's greatly overrated. For the best pinsets, you have to balance several triggers at once. Screw up on any of them, and pinsets suffer, regardless of what you do with light.

LIGHTING - Light has no effect on colonizing mycelium. The information from twenty to thirty years ago to keep them in the dark is just plain wrong. Light is not a pinning trigger until full colonization and a reduction in ambient CO_2 levels.

LIGHTING - You want bright fluorescent light in the high frequency range. Look for 'natural daylight' tubes or whatever they call them in your country. They should have a color temperature of 6,000 Kelvin to 7,000 Kelvin for best results.

LIGHTING - NEVER use 24 hour light. They grow and form primordia during the period of darkness. Attics are usually horrible places to grow due to wild temperature swings. Light is required for primordia formation as well.

LIGHTING - 12/12 from a high spectrum fluorescent, such as 'natural daylight' tubes with a color temperature of 6,500 Kelvin, will outperform other sources unless you have a bright south window. Avoid direct sun.

LIGHTING - Incandescent is the worst possible light for mushrooms. While it might 'work', you'll get much better performance and pinsets if you'll screw in a compact fluorescent instead of an incandescent light bulb.

LIGHTING - Cool white fluorescent gives the most bang for the buck in my experience. You'll definitely see an increase in pinning activity with metal halides, but they use a lot of energy and produce a lot of heat.

LIGHTING - CFLs use a tiny fraction of the electricity an incandescent bulb uses to produce the same amount of light. If you buy a CFL for mushroom growing, look for one that says 6,500 K on the packaging.

LIGHT - Light has absolutely NOTHING to do with telling the mycelium that it has reached the surface. The increased fresh air, with the corresponding drop in CO_2 levels sends the mycelium that message.

LIGHTING - Lighting is extremely important, and it's important to provide it at the right light temperature and intensity. Look for tubes with a light temperature above 5,000K.

LIGHTING - A 13 watt cfl does not produce 60 watts. It produces the lumens a 60 watt incandescent bulb does, but at a higher frequency, which is better for pin formation.

LIGHTING - I'd check the manufacturer website for that info. You can get a 6500K fluorescent fixture and tube for under twenty dollars at your local home megacenter.

LIGHTING - Diffused sunlight through a window is great. In fact, five to ten minutes of direct sunlight will often get a stubborn substrate to begin pinning.

LIGHTING - Bright light stimulates pinning. The light has to be bright enough to penetrate the casing layer. Dim light will result in poor performance.

LIGHTING - Warm white=3000K, cool white=5000K, and natural daylight fluorescent=6500K. The higher the light temperature in Kelvin, the higher the frequency, or closer to blue light.

LIGHTING - Fluorescent lighting is great. Look for a color temperature in the 5,000K to 7,000K range. UV light is bad for mushrooms.

LIGHTING - For those of you who have a project that 'just won't pin' try switching to natural daylight fluorescent and watch them take off.

LIGHTING - You don't need a light right on the tub. You can have it near a window(recommended), or use just a regular ceiling light.

LIGHTING - That would explain the no pins. You want a light at the other end of the spectrum. I'd suggest fluorescent tubes.

LIGHTING - I use four 4' natural daylight 6500K fluorescent tubes for my mini greenhouse. It works like a charm.

LIGHTING - You don't want blue. You want full spectrum. That means they will look white.

LIGHTING - Light is a secondary pinning trigger, once full colonization has been reached.

LIGHTING - Any cfl would be better than an incandescent light bulb.

LC/AGAR/CLONING/STERILE PROCEDURE/HELP/PROBLEMS/OTHER

AGAR - Put a lid on the jar that has been drilled and fitted with a filter. In other words, if you're using a jar, treat it like a grain jar. I use a whiskey bottle with a filter in the lid for agar because it's easier to pour. Pour the dishes after the agar has cooled, but before it's solidified. I wait until I don't need an insulated glove or pot holder to protect my hands from the heat. This will prevent condensation. Pour the dishes in a vertical stack, and then slip the sleeve back over them as protection while they cool. The agar will settle out until after pressure cooking. Just before pouring the plates, give it a stir. By the way, you can PC any sealed container, except some plastic bags. I routinely PC water in jars and also test tubes of agar that are tightly sealed. They don't blow up. Pressure inside the jar and outside is the same, therefore there is little to no differential between them. Just don't do something stupid like pop the weight off the PC at the end of the cycle and you can seal jars just fine. Agar being sterilized for Petri dishes in a jar or bottle should get a filtered lid, as I said above. You can use jars as Petri dishes, but you'll tire of it quickly. They're much more of a pain in the ass to work with than Petri dishes. Many growers new to agar use their jars, but once they switch to Petri dishes, they don't go back. A simple strain isolation series can easily generate fifty or more dishes working simultaneously, and that's a LOT of jars to keep stacked up.

AGAR - A few years ago, I ran several experiments to prove/disprove stamets' theory that if you clone very young healthy pins, the hormones that stimulate pinning are active, therefore the mycelium that grows from those pins will in turn produce better flushes with abundant primordia and fewer aborts. These pins were not sterile by any means, yet they were layed on the agar and the rapidly expanding mycelium simply overran any bacteria or molds that may have been present. You wouldn't get that same performance from a large fruit that was fully mature. Of course, I would never transfer those sections to grains because of dormant contaminant spores that may be present. Instead, a small piece of mycelium from the leading edge should be transferred to a new dish, which once grown out for a few days can then inoculate up to ten quart jars, or be transferred to LC to grow out the isolated strain for even larger inoculations. It was inconclusive on the hormone thing. This was already an isolated strain and an excellent performer. If anything, it may have pinned a day or two sooner, but there's too many other variables involved to be able to attribute it to just the hormones. Use pins. The pins grow very aggressively to eat for lunch any contaminant spores that might be on them, a large already slowed down fruit will not. I used Gentamicin Sulfate.

AGAR/ISOLATES - The hot agar is a way to isolate away from contaminants. It's mostly used when cloning wild mushroom tissue that is infused with bacteria and molds within the mushroom itself. You pour the piping hot agar over the contaminated culture until it's completely covered with agar, and then watch it carefully over the next few days. The bacteria and molds are 'pasteurized' by the hot agar, but in this case, the mushroom mycelium is more resillient and begins to grow up through the top layer of agar, reaching the surface in 48 hours or so. Shave off the mycelium with a scalpel as it appears on top without taking any of the agar. Do this with each growth that appears on top as soon as you see it, preferably within an hour or two of its appearance. This tek separates healthy mushroom mycelium from the contaminants. After the transfers, each dish is inspected under the microscope to identify perfect vs imperfect fungi. The molds are tossed out and the mushroom mycelium is kept.

AGAR - Do not turn them upside down. As workman said, keep temperature swings to a minimum. Keep the dishes in a vertical stack, and usually only the top one will have any condensation after a few days. It also helps if you wait to pour the Petri dishes until the agar has cooled enough that it starts to thicken. You won't need heat protection for your hands at this point either. This is the best way to avoid condensation. Always colonize agar at normal room temperature. You'll need to transfer away from contaminants as soon as they're noticed. Antibiotic agar will help with bacteria if you're attempting to clone outdoor wild mushrooms, but the antibiotics aren't needed when working with indoor clones or spores.You want to wrap Petri dishes with parafilm. It breathes, yet has a pore size that prevents contaminant spores from entering. Without parafilm, the slightest temperature variation will cause contaminants to be drawn into your dishes, where they might remain dormant until you spawn the agar to grains, at which time you'll wonder where all the green came from. I would imagine micropore tape would work also. Some growers use Glad cling wrap. I use Parafilm.

POURING AGAR - Don't disturb them unnecessarily. Over time, the excess water will replace moisture that evaporates from the dish. The moisture is caused from the inside of the dish being warmer than the outside.
When you pour agar, let it cool until it begins to thicken a bit. You want it to cool in the bottle you sterilize in, not the Petri dishes. When cool enough to pour without heat protection for your hands, fill your Petri dishes, and leave them stacked in a vertical pile. This will equalize the temperatures between the dishes and reduce condensation to a minimum. If you don't have a flowhood, you should slide the plastic cover back over the stack to enclose them as they solidify.
An excellent bottle for agar is a used whisky or other liquor bottle with a long neck and screw on lid. You can use polyfill or a synthetic filter disk cut to size in the lid. Just drill a 1/4" or larger hole in the lid. Cover with foil and PC. The filter will keep the agar from contaminating as the PC cools and until ready to pour. Don't remove the foil until just before you pour the dishes.

AGAR - In a glovebox you can easily get a tiny piece of good mycelium from that dish and move to a fresh one. Get the mycelium from the opposite side of the dish to the contaminant. Once you have the mycelium on a new dish, about two to three days later, you'll see the mycelium crawling off the wedge to the new agar. At this point, transfer a tiny piece of the fresh growth to a new plate. If you make the second transfer before the mold germinates, you now have a clean culture. If not, continue doing transfers until you get ahead of the mold. It's easy to clean up cultures from contamination on agar. You need to wrap your dishes to prevent contaminants getting under the lid. Remember, any time the air temperature in your room changes, the agar expands and contracts, forcing air in and out of the dish. This causes contamination if you don't have a gas permeable wrap around the edges such as parafilm. Some growers use cling wrap with success, but I stick with parafilm. At any rate, get the edges wrapped. Good luck.

AGAR - One swipe of spores on agar will yield hundreds of strains. By selecting a dozen or so of the best rhizomorphic strains and fruiting each one separately, you can find the super performer that will cover every spot of your casing layer with healthy pins. It might take hundreds of multispore grows to find that strain, if ever, because multispore inoculated substrates usually end up with only one or two strains by the time they fruit because they've all combined. (anastomosis). This means the good fruiting and potent strains combine with the poor fruiting and bunk strains. You never know what you're going to get. Isolate on agar, then fruit separately and test each strain. When you find the best one, you can keep master slants in the refrigerator and grow that isolate forever.

AGAR - The reason you don't see rhizomorphs early on is because there's so many substrains active, they cover each other up. It usually takes two or three transfers to begin to see rhizomorphic growth. I'd transfer a tiny piece from each sector to new dishes. I usually make the first transfers as soon as the spores begin to germinate, when the total growth is the size of a dime or less. Repeat the process a few times. Don't try to isolate 'one' rhizomorphic growth. Instead, isolate as many as you can, and then fruit each one. Once you determine the best isolate, you can store it in master culture slants to use for years to come without degradation.

AGAR/TRANSFER - A Petri dish that is fully colonized is not one that I'd use to inoculate grain masters with, even if the dish was wrapped with parafilm. I'd suggest taking a small piece of mycelium from the Petri dishes, and use it to inoculate fresh dishes. Allow that to grow for a few days, and then grab a very tiny piece of mycelium from the leading edge of the new growth. Transfer that fresh mycelium to a third dish and allow to grow 2/3 of the way across the dish. This clean mycelium can then be used to inoculate up to ten 1 quart/liter grain masters, which can each inoculate ten more via grain to grain transfers.

AGAR - You simply lift the lid of the grain jar and drop the agar wedge in. Prior to that, wipe the surfaces of the Petri dish and grain jar with alcohol, flame sterilize the scalpel, wear surgical gloves that have been washed with alcohol, and work as fast as possible, leaving the agar culture exposed for only a few seconds, and the grain jar lid open no more than 2 seconds. It may be stating the obvious, but the use of a glovebox or flowhood should be considered mandatory. Let the mycelium recover from the wedge into the grains for a few days before you shake.

ISOLATING ON AGAR - Sometimes, even with a clean sporeprint, you'll get a bit of contamination on the dish along with the mushroom mycelium. This is easy to transfer away from, by taking a small piece of mushroom mycelium and moving it to a new dish. Always take mycelium from the leading edge of the growth because this is the farthest away from the contaminant. We also transfer individual sectors away from each other so individual strains can grow out to determine the best fruiting ones. When cloning wild mushrooms, there's almost always molds and bacteria present, so it takes several transfers to get a clean culture.

AGAR - It often takes a few transfers from the initial spore swipe for strains to differentiate. Take a series of transfers of pieces of mycelium from the leading edge of the circle of growth and transfer to new plates. As these start to grow out, you'll probably see some sectoring. Transfer each sector to a new dish, and continue until you have single sector isolates, and then fruit each one to find a few stellar performers. Be sure to keep them properly labeled so when you fruit out a great one, you can go back to the original Petri dish that you've stored in the refrigerator, to get an earlier version of it to propagate and store in a culture slant.

AGAR - The purpose of agar is to be able to isolate mycelium away from contaminants, and to be able to isolate strains. By inoculating and leaving, if contaminants are present, they'll germinate and get a head start on the slower growing mycelium. I'd wait until you get back to inoculate. Often, bacteria and molds will be growing along with the mushroom mycelium, and you'll want to be there to make transfers. Agar isn't for expanding mycelium, so don't allow a dish to grow fully out.

AGAR - A single swipe of spores from a print, or a couple drops from a syringe might generate dozens or more sectors. I'd suggest transferring all of them to new dishes. You don't want to just isolate one strain, because it might be a dud. Isolate several promising looking strains and then grow each one out to determine the one(s) you want to keep for perpetuity in master culture slants.

AGAR - Cool the agar until just before it's too thick to pour. In addition, be sure to stack the dishes in a vertical configuration for colonization. Temperature differential causes condensation, so both the hot agar, and also the heat produced by the mycelium will cause condensation. Stacking the dishes helps prevent condensation from the latter by equalizing the temperature.

AGAR - You'll be much more likely to inoculate with molds and bacteria using powdered material. The dry tissue can also be grown out on agar without spores, but it takes a lot of transfers and patience. I'd suggest antibiotic agar. You can use up to 15mg of Gentamycin sulphate per liter of agar to help control bacteria. You'll just have to isolate away from the molds though.

AGAR/LC - Can you get DEXTROSE (straight corn sugar) & LIGHT DRY MALT powder? Both can be had at wine & beer (home brew) places. If so? Level teaspoon of each, into quart water. Simmer on stove to dissolve, filter, pour in jars, PC 5 to 8 minutes & you should end up with a fluid that is a light golden beer color (no chunks or flakes).

AGAR - We don't use agar to expand the mycelium so large dishes are worthless. We use agar to clean up our cultures from contaminants in the two dimensional space of a flat plane. Therefore, smaller dishes are most efficient because you shouldn't leave a culture growing more than ten days or so on a dish before doing something with it.

AGAR - Never use a warming plate with Petri dishes. Leave them in the bag they come in until they are IN your glovebox or in front of a flow hood. Wrap with parafilm, four squares per dish as soon as you inoculate. There is absolutely no reason to worry about keeping Petri dishes in the dark. Light has zero effect on agar or colonizing mycelium.

AGAR/SPORES - Unless the spores were from a cap that just dropped them an hour or two earlier, it takes a bit longer to see growth. You might see something if you put the dish under a microscope, but it takes a few days after germination for them to thicken up enough to see with the naked eye.

AGAR - Always mix the dry ingredients first, then add a small amount of room temperature water and swirl it around until the powder is dissolved. Don't shake, just swirl. Then add the rest of the water and sterilize. Pour the dishes before the agar cools below 100F or it will begin to solidify.

AGAR - If two drops or even three land, it won't kill your plate. One is usually enough though, especially if you're doing strain isolations. Just be sure to put one drop on each of a dozen plates so you can isolate out a LOT of strains to find the best performer(s).

AGAR - Antibiotics such as Gentmycin sulphate will help protect against bacteria, but do nothing to slow down fungi such as trichoderma or the other contaminants of mushroom culture. Sterile technique is the key to avoiding contaminants of all kinds in our art.

AGAR - When working with wild prints, I'll often use antibiotic agar, and mix it with less malt. If you buy pre-mixed agar powder from fp or sporeworks, you can mix it a bit weaker than recommended. This will keep from feeding the mold and bacteria quite so much.

AGAR - Agar is for germinating spores and isolating strains from each other and away from contaminants. You can use agar wedges to inoculate jars, which you then use for grain to grain transfers to expand the mycelium. Agar itself isn't used to expand mycelium.

AGAR TRANSFER - You want the Petri dishes open the least amount of time possible. I follow the 5 second rule. Never allow a Petri dish or jar lid to be open for more than five seconds at any time. Never have more than one Petri dish open at the same time.

WATER, AGAR - Lake water works fine, as does bottled or even tap water. I use regular tap water for everything except mixing agar. The organisms in the lake water won't help as they'll be 86'd by the PC.

AGAR - Fungi is perfect bacteriological agar made from the correct Petri types of agar, has malt/peptone/yeast which is the best combo, and has alot more then those packets you get from those 10 dollar packets.

AGAR - Normally, the term nutrient agar is used to refer to agar that has blood or other ingredients to tune it specifically to bacteria, which is what we are trying to tune against. I recommend MEA.

AGAR - I don't remove it from the pressure cooker until it's below 150F, and I then wait to pour until I don't need any heat protection for my hands. That's about 115F or perhaps less. If you pour it too hot, you'll get a lot of condensation on your Petri dish lids.

AGAR - The moisture on the lid is caused by the temperature differential. Don't store dishes upside down. Inoculate as soon as the agar cools. There is no need to wait.

AGAR - If not the pre-mix, you'd want to get some bacteriological grade, light malt extract, dextrose (optionally) nutritionally yeast, and peptone.

LC/AGAR - I use extra water in the PC when doing agar or LC so the pressure will drop more slowly due to the thermal mass of the extra water.

AGAR - Yes. You can also transfer healthy mycelium away from the contaminant, thus cleaning up the culture.

LC/AGAR - Extra light malt, dextrose, nutritional yeast, gypsum. Makes the strongest growth.

AGAR - One fruit body MAY contain multiple sub-strains of the same original. Look into agar.

AGAR - Gentmycin sulphate makes a great antibiotic because it's autoclavable.

AGAR/PETRI DISHES - Glad cling wrap instead of parafilm.

CLONING - Often, the reason later flushes produce only a few larger fruits is because the pinning surface has been torn up by previous picking, and the few remaining spots to pin from are all that's left...thus larger fruits form. Cloning these does not insure you'll get large fruits next time. That said, large fruits are not desirable. Smaller fruits have more active product per gram than larger ones, so try to produce larger flushes of smaller fruits. When cloning, select a young, rapidly growing fruit for best results. You want a fruit that is rapidly dividing cells, so it will take off quickly on agar. I prefer to clone from clusters, because they'll tend to produce clusters on future flushes, giving the volume desired, but with smaller and more desirable fruits.

CLONING TEK - Just so you take the tissue from the center of the stem after tearing it open with your hands. Use a flame sterilized blade. You can probably skip the alcohol. The air inside the bag should be still. I do similar when cloning wild mushrooms on backpacking trips. I take several Petri dishes sealed up in a baggie, a clear trash bag to use as a glovebox, and a scalpel and alcohol torch. The scalpel is flamed outside the bag, then stuck in while still hot. When it cools, the clone is taken. Don't forget to wear latex gloves.

CLONING - You can pour iodine over the stem to kill live bacteria on it, but it's really not necessary if you rip the stem lengthwise first to expose tissue that has never previously been exposed to air, thus generally free of contaminants. Outdoor mushrooms should be dipped in iodine no matter what before cloning, but with indoor grown ones usually it isn't necessary. Don't use alcohol on mushroom tissue.

CLONING - It won't affect your pinset because that's related to your technique, but it's well known that mycelium cloned from a cluster will produce mushrooms in clusters. That's not just cubes either. Edible growers have noted this for decades. The best oyster strains have been cloned from wild fruits that grew in clusters. In other words, clusters are a genetic trait.

CLONING - You can use iodine, or better yet, just tear the stem lengthwise to expose virgin tissue in the middle, and then cut a tiny piece out from there that has never been exposed to air. Use a flame sterilized needle or scalpel to get the tissue.

IODINE CLONING - I get iodine from a local drug store. It says "10% iodine solution" on the bottle. I like it for cloning because it kills bacteria without stressing out the mycelium the way peroxide does. When you're cloning, you want the mycelium to grow as fast as possible, and peroxide shocks it, and then it has to recover before it grows again. As we all know, molds grow faster than mushroom mycelium, so we don't want to do anything to slow down growth.

CLONING INDOOR FRUITS - I should also mention, when cloning clean indoor fruits, no iodine is needed. Simply split the stem as shown in the video, and scrape a touch of mycelium out of the center where it hasn't been exposed to air. The iodine/betadine is perfect for cloning wild outdoor mushrooms that have all sorts of bacteria and molds growing in conjunction with them.

CLONING STRAIN - Small, rapidly growing fruits make the best candidates for cloning. If the mushroom has already matured, the cells have stopped dividing, thus it's not a good candidate. If you like clusters of fruits, clone from a cluster. If you like individual fruits, clone a loner.

CLONING BLEACH - I've cloned wild mushrooms before by dipping in 10% bleach for up to fifteen minutes to kill bacteria before placing on agar. The bacteria is killed, but not the mushroom OR mold mycelium that might be along for the ride.

CLONING MUSHROOMS - I often dip wild mushrooms, and dry mushroom tissue into a ten percent bleach solution before cloning, to kill off bacteria. The fungi survives just fine, but it kicks the bacteria out.

STRAIN ISOLATION VS CLONING - As for cloning vs strain isolation, they're not related. By the time a substrate fruits, hundreds or perhaps thousands of strains have exchanged DNA, either weakening or strengthening the mass. What you get is a 'heinz 57' that may or may not be that great because the weaker genes and the stronger genes(mycelium) have all combined. An example would be mixed breed dogs. We've all seen good examples and others that are dumber then hell.
Strain isolation on agar begins when the spores first start to germinate. I make the first transfers as soon as I can see mycelium growing from the point of inoculation, long before sectoring can be detected. By doing this, and by continuing to separate each individual growth, you can isolate mycelium prior to the process of anastomosis combining dikaryons into a single mass.
You don't isolate looking for one super rhizomorphic strain. You isolate down to single sectors and then fruit out each one to determine the best performer. When you transfer mycelium to a grain master, the original Petri dish the mycelium was taken from is placed into a clean refrigerator. By doing this, when you find the best performing strain, you then go back to your well marked Petri dishes, thus your original P1 culture. This Petri dish can be used to inoculate a few test tube slants that can be incubated for a week, then placed in cold storage. Whenever you need mycelium, a tiny piece the size of a grain of rice can be taken from the test tube and put on agar to grow out, while the test tube is placed back into the refrigerator. These stored test tube cultures preserve the low P value of your isolated strain for years.
I have a complete video tek on strain isolation and master slant preparation and use already filmed. I'll release it when I get the rest of the teks filmed, and editing completed. Hopefully soon.

ISOLATING STRAINS - Right. You isolate every single strain you can, and then fruit them all. While they're fruiting, the 'master' from each strain is in the refrigerator. After you determine the best performers, you go back to the appropriate masters and get them out. Those are the ones you transfer to culture slants for long term storage. Rhizomorphic mycelium tends to fruit better than cottony mycelium, but a single swipe of spores on agar is likely to generate fifty or more individual sectors(strains), and half or so of those will be rhizomorphic. Those are the ones I keep for fruiting, and discard the cottony sectors.

ISOLATING - Don't wait for the first dish to fully colonize. As soon as it begins to grow, transfer mycelium away from the point of cloning to new dishes. This way, you can isolate healthy mycelium away from contaminants. You won't be doing strain isolation on a clone, so don't bother looking for rhizomorphs. Just get healthy mycelium.

STRAIN ISOLATION - For strain isolations, you can't beat the three section dishes. You're only letting the mycelium grow for a few days before making the next transfer, so you can do three times the amount of work on each dish. The four section dishes are great too. I don't even order the plain dishes anymore.

CLONING/ISOLATING - Cloning a fruit from within a cluster will provide a strain that will produce clusters. It matters not which fruit you choose from within the cluster, but you'll have better success if you'll clone while they're still small and rapidly growing.

STRAIN ISOLATES - It's extremely rare for rhizomorphic isolates to be none fruiting.

LIQUID CULTURE - 1000ML LC a.k.a Liquid Culture
1%=1.92Ts
2%=3.84Ts
3%=5.76Ts
4%=7.68Ts
1%=0.64TB
2%=1.28TB
3%=1.92TB
4%=2.56TB

LIQUID CULTURE - Throwing spores into honey or karo has to be the worst possible way to make a liquid culture and I'll be glad when this current fad passes and folks can get back to established techniques. Just inoculate some grains or brf in the standard way and you'll be miles ahead. For those who wish to make LC for inoculation, here's a way to get 100 syringes full of inoculant in two weeks: 1) Inoculate a quart jar of rye berries or wbs with your spores. Upon full colonization, shake the jar to loosen each individual kernel. Be sure to give it the smell test to make sure it smells like fresh mushrooms. 2) PC a quart of distilled water in a jar with a filter disk or tyvek, etc. In a glovebox or in front of a flowhood, pour 2/3 of the quart jar of sterilized water into your jar of shaken grains. 3) Shake well and then pour the now mycelium rich water back into whatever was left of your jar of sterilized water. Use the jar lid to hold back the grains themselves from pouring out. You now have a full quart of highly concentrated mycelium water that can then be used as is, or diluted two or three times again, and used to fill syringes. Because the grains were shaken first, the mycelium is ripped into shreds and will be sucked through even small needles easily, although larger needles always work better for this. Remember, mycelium grows poorly in water unless under constant stir which oxygenates it. With grains, they colonize in two weeks or less because oxygen is throughout the jar in the spaces between the kernels.

LIQUID CULTURE - A glovebox is not advanced equipment. One can be made free with stuff around the house, so there's no need for people to work in open air or fecal and mold infested bathrooms and kitchens. There is also no way to generate 100 full syringes of liquid mycelium in very small pieces within two weeks from injecting spores into honey or karo. I'm sure if people blindly used the grain method I described above, many would still have problems too, because they're inserting unproved and possibly contaminated spore solution into grains, which also isn't proper mycological technique. However, agar can easily be poured in a glovebox, and the Petri dishes used to isolate healthy mushroom mycelium away from any contaminants in less time than it takes to even know if a karo LC is contaminated or not. That agar wedge can then be used to inoculate the quart(or pint) jar of grains, that can then be turned into at least 100 syringes, or used for g2g transfer to get ten jars the old standard way. In addition, after the water is poured out of the grain jar, it can be placed back on the shelf to re-colonize, and the process can be repeated again. I just strongly feel new growers are doing themselves a disservice when they simply inject spores into honey water and then sit there waiting for something to happen. At the very least, inject directly to grains so you can visually inspect the process. Perhaps Agar's lids with injection ports will help those who have never used grains to get off to a good start.

LIQUID CULTURE - You might want to read more than the last paragraph. I described a method to generate ten times as much LC in a shorter period of time without contamination. I'm not against liquid culture. I use it all the time. I'm simply dead against the idea of squirting a syringe into a bottle of karo/water. I insist on having at least some verification my LC is good before I inject a bunch of jars. The analogy of a new growers greatest fear doesn't hold water. If his pf jars contaminated due to contaminated spores/syringe, it does no good to have even ten gallons of contaminated LC on hand. If they contaminated due to his sloppy procedure, he's likely to have used the same sloppy procedure making an LC. In my posts, I always try to show a way to have the greatest possible success rate, not necessarily the cheapest, easiest or laziest method.

LIQUID CULTURE - Sort of, but if you want liquid culture syringes, all you have to do is grow out a quart jar of rye berries, and then when it's fully colonized, shake it well, and pour nearly a full quart of sterilized water into the jar. Shake well again, and then draw the myceliated water back out into syringes. As an alternative, you can pour the quart of myceliated water into a sterile gallon of water to dilute the solution. You'll then have enough liquid culture to fill a few hundred syringes, and it only takes two to three weeks to get to this point from spores. In addition, after harvesting the mycelium from the surface of the grains as described above, you can then still use the left over grains to inoculate ten to twenty additional jars of grains via grain to grain transfer in the traditional method.

LIQUID CULTURE/COLONIZED SPAWN JAR - You want a fully colonized jar of grains to start with. Add sterilized distilled water to nearly fill up the jar, then shake well, and draw the now myceliated water back out. This is far faster and more dependable than making LC from spores because you can smell the rye jar before using to make sure it isn't contaminated. In addition, a jar of rye colonizes in two weeks, and will make at least 30 syringes. You won't get that performance from karo water.

LIQUID CULTURE - You can harvest liquid mycelium from the rye or wbs several times. After shaking the jar of grains to break them up, you can pour nearly a full pint of sterilized water into the jar, then shake again. Since there are nutrients in the grain juice/mycelium, you only need to pull a small amount of this solution into each syringe. Finish filling the syringe with sterilized water, and the mycelium will grow into it, expanding by several factors within a week.

LIQUID CULTURE - The more air to a liquid culture the better. That's why experienced growers always use a magnetic stirrer running 24/7. This ensures the entire LC is constantly oxygenated. I still don't understand why growers are slowing down their work so much trying to grow liquid cultures in mason jars. You can expand mycelium at least ten times faster in grains than in liquid, AND you'll know if it's contaminated before you use it.

LC CONTAMINANT EYE - If it's snow WHITE. It's right. FOR LC If you don't stir or agitate one every day, myc gets to the top & forms little islands that turn to thick pancakes. As, it has better gas exchange on the surface. How, I test for LC contams, is to STOP stirring one. If anything grows on the surface that isn't snow white. It isn't RIGHT. Most often contams show up as light gray / light blue growing on the surface.

LIQUID CULTURE - In addition, many growers waste valuable time by injecting spores into sugar water. Many times, you don't know you have contaminants present until you use your 'lc' to inoculate grains or brf. By then, you would have long ago discovered the contamination and replaced the contaminated jars, had you been growing on grains or brf directly.

LC JAR - Every tiny exposure to unfiltered air, increases the chance of a contam getting in. After jars are cool. With polyfil in one hole, simply stick syringe needle right through tape on other hole, inject & tape (with sterile tape) over the existing tape. That minimizes external air exposure.

LIQUID CULTURE - I sterilize the water that will be used for the LC syringe. In a separate pan I boil the syringe for at least half an hour. Put a lid on the pot and leave the syringe in the boiling water right up until you're ready to go to work.

STORING LC - You can store G-1 LC in 5, 50 or 100 vials of sterile water (years & years). Any time you want G-1 pull a tube out of the Fridge & go for it. Either start a new LC with it, or go to grains, then G2G.

LC - If you allow LC to go longer than five days post eberbach, the mycelium begins to grow into a solid organism which is not nearly as effective to inoculate with as a few million individual colonies.

LC - 1/2 teaspoon light dry malt, 1/2 teaspoon corn sugar to quart water, simmer, filter, add to jar, add lid w/filter, PC 15 minutes, innoc, store at around 82F.

DON'T USE MARBELS FOR LC - FOR LC...Marbles tend to break glass and not have that swirling tornado twirl when using.

LIQUID CULTURE - In fact, I have liquid mycelium cultures stored in the refrigerator for years that are still viable.

INOCULATING WITH LC WBS - Drain the WBS much longer, if you inoculate with LC. (rids WBS of excessive moisture).

LIQUID CULTURE - People have used bottled fruit juice for LC for years. It requires no sterilization.

LC - LC's are very prone to contamination, if ever exposed to open air.

FLAVOR OF MUSHROOMS - You won't add anything to the substrate to change the flavor. Mushrooms are NOT plants and don't have a circulatory system. Mushrooms grown on straw don't taste like straw and mushrooms grown on a bible don't taste like paper, and mushrooms grown on horse manure don't taste like horse manure...you get the point.

CONTAMINATED NATURE MUSHROOMS - In nature, thousands upon thousands of organisms can inhabit the same square inch of soil, thus each has his own niche and they all work together in harmony like instruments in a band.
Since we have no way to duplicate this indoors, we use sterile culture where the only organism allowed to grow is the mushroom mycelium.
It's a common misunderstanding that a contaminated substrate means a contaminated crop, which is incorrect. By that definition, all outdoor mushrooms would be toxic, yet they are not. If our sterile culture

becomes contaminated, the contamination might kill off our mycelium, but will be of little harm to us. Eating mushrooms from a cake with green mold will NOT hurt anyone.

MUSHROOMS FROM CONTAMINATED SUBSTRATES - Every mushroom that grows in the wild grows in conjunction with molds. In fact, I don't think I've ever picked an oyster mushroom from a log in the forest that didn't also have trichoderma growing on it. That's how common trich is. In fact, trichoderma inhabits nearly every cubic inch of soil on earth except extreme deserts and the arctic. On page one of Paul Stamets 'Mycelium Running', he starts with this sentence: "There are more species of fungi, bacteria, and protozoa in a single scoop of soil than there are plants and vertebrate animals in all of North America". However, we can pick wild boletes, chaneterelles, agaricus, matsutake, etc., etc., from this mold infested soil, and eat them without getting sick. We can pick Cubensis from a nasty pile of maggot infested cow shit and eat it without getting sick. If you put blue cheese salad dressing on your salad, you're eating huge chunks of the penicillium mold, because it's floating in the dressing. It never ceases to amaze me the fear that gets spread on these boards over harmless molds. If your fruits were covered with yellow or brown molds, I'd say toss them, as you would any moldy fruit or other food. Likewise if they were wet and became rotten from bacteria, because bacteria can cause food poisoning. However, as I've said for many years, just because there's a spot of mold on a cake, does not mean the fruits growing from that cake are contaminated. Mushrooms do not have vascular systems like plants, and do not suck up contaminant molds or bacteria from the substrate. If the fruit is fine and healthy, munch away. And, for those of you who don't know, please stop spreading myths and fear.

SPENT MUSHROOM MYCELIUM - Once your mushrooms have fruited a few times, the substrate is used up. You can't replace it with more fertilizer, because mushrooms are not plants that uptake water and nutrients to create energy in the leaves. Mushroom mycelium, which lives in the soil, eats its food, therefore after a few flushes, the food is gone. If you have a straw and dung loving species, you can bury the spent substrate into some horse or cow manure in a shady spot outdoors. Keep it slightly moist, and in a month or two, you'll probably see a nice flush. If you have a wood decomposing species, do the above, but with hardwood chips and sawdust.

COOKING WITH MUSHROOMS - Next time you have a bunch of fresh cubes, cut off the stems and set them aside for another day. Take the caps and rub a little blue cheese or ranch salad dressing into the gills. Rub olive oil on the outside of the cap. Add salt and pepper to taste, then grill outside on the bbq until done(gill side up), usually only a few minutes, when the dressing in the gills starts to boil, it's done. It's hard to beat cubes for good taste when cooked. When raw, they're nasty as hell, just like any raw mushroom. The heat will degrade them slightly, but not much. Cook up about 50 grams of fresh caps and you'll be happy.

MUSHROOMS FROM CONTAMINATED SOURCE - Mushrooms from a contaminated cake are safe to eat. They don't 'absorb' contaminants from the substrate or all wild mushrooms would be unsafe to eat. If the mold or bacteria is on the fruit itself of course, don't eat it. It's common in the commercial industry to harvest fruits from contaminated substrates and send them to market. There are no health regulations against it because it's not a risk factor.

EATING MUSHROOMS - Getting nausea and the shits from eating raw mushrooms is not a sign that they were contaminated. It's very hard for our systems to digest raw mushrooms, thus it's normal for the body to want to puke them out. Raw mushrooms are not digested, thus you excrete them in much the same form as you swallow them. Therefore, getting the shits a day after tripping is also common.

MUSHROOM SUBSTRATE NEED - What do mushroom nutriment needs? SUBSTRATE: carbon / nitrogen ratio <17:1, nitrogen 2.6%, phosphorus 0.2-0.5%, potassium 1.5-2.5%, calcium 1.5-2.5%, available boron <2 ppm, available ammonium <10 ppm, soluble salts 3.0-5.0 dS/m. This suffices from spawning to cropping.

SPENT MYCELIUM - The reason is it's probably not out of food. It's old. You can't take some 100 year old dude and if you keep feeding him, he'll keep on living. It doesn't work that way. Things live for a given time, then die. It's nature.

KEEPING MUSHROOMS FRESH - I've used a combination of CO_2, Argon, and Nitrogen gasses, and they still rot. You need to dry them though.

CONTAMINATED MUSHROOMS - Molds would be visible, and bacteria needs water to survive. If they were cracker dry, they're fine.

MUSHROOMS CAN'T SUCK UP SHIT LIKE PLANTS - Mushrooms DO NOT HAVE circulatory/vascular systems.

MUSHROOM GENETICS - Mushroom genetics are far different than plant genetics. With mj, one can plant seeds that will generally produce a crop similar to the parents. Such is not the case with mushrooms. Each mushroom produces millions, if not billions of spores. Each spore has a set of genetics unlike any other spore. 'Think fingerprints'. Now, another analogy. Humans breed fairly true because a male and female produce offspring, thus the child is a 50-50 cross. Following that analogy, understand that mushrooms can have 20,000 or more 'sexes' represented in those billion or so individually unique spores. Thus, the chances of a collection of mushroom spores breeding true to the parents is very low.

MUSHROOMS - It's not just nutrients, because mushrooms aren't plants. Mushrooms eat their food just like humans and produce body heat as they metabolise the food, just like humans. They also release the carbon in their food as CO_2 just like humans. Therefore, they need solid food, not just nutrients. Their preferred food in artificial cultivation seems to be grains, such as rye and rice. You can expand your harvest by using large amounts of less nutritious foods for the mycelium such as manure and coir. You won't find a 'nutrient' that you can add to the solid food that will enhance the crop much, if any at all.

MUSHROOMS - Nitrogen is for plants. Mushrooms eat their food. I speculate in a few years, you won't ever even hear the term 'nitrogen' in relation to fungi. Potency isn't related to substrate, so you can add all the junk you want and it won't make them more potent. You'll want to isolate for a strain on agar that is more potent, and then save it in master slants.

MUSHROOMS - You are correct. Mycelium doesn't have a vascular system. It's composed of long cells, stacked end to end to form a network. It doesn't take a circulatory system for heavy metals to be absorbed. Other substances are metabolized by the mycelium. That's why mushrooms can grow on manure, but we don't get e coli from eating mushrooms. However, according to stamets, if there's lead or mercury in the soil, they will absorb it. I've never personally tested for such.

MUSHROOMS - Mycelium does NOT absorb myco-toxins from other species such as molds and transmit them to the fruits! This is very well known in mycology. Every wild mushroom grows in conjunction with hundreds of other fungi, yeasts, and bacteria, yet who has ever been poisoned by wild morels, chanterelles, cubensis, etc?? However, it's best not to use them because the contaminant molds have already eaten some of the substrate that you want your mushroom mycelium to eat.

MUSHROOMS - Mushroom mycelium consumes oxygen and releases the carbon in its food as CO_2, just like humans. Plants do the opposite. Mushroom mycelium produces heat as it metabolizes its food, just like humans. Plants get energy from the sun, but mushroom mycelium gets energy from its food source, just like humans.

MUSHROOM SPORES - Mushrooms can have up to 23,000 'sexes', and millions of spores on a print, so it's always a crap shoot. If you want a particular set of genetics, you need to isolate strains down to single sectors, then keep master slants. Single sector isolates can be crossed with other single sector isolates by dikaryotic mating on agar as well.

MUSHROOMS - I haven't grown cubes in years. I grow legal edibles. We also harvest several hundred pounds per year of wild reishi. For those who are not aware, reishi brings $1,000 per kilo on the legal market. That takes a lot of drying space. Cubensis are a great way to learn the mushroom life cycle, but it only takes a few months to grow a lifetime supply. That's why most growers move on to other species, or lose interest in the hobby. I suggest to all to stop in at the gourmet and medicinal forum to exchange tips and ideas on legal edibles. Mushroom growing is great fun, and if you play your cards right, there's a lot of money to be made.

MUSHROOMS AND PLANTS - All fungi help to break down material in the soil, which in turn makes the nutrients more available to plant roots. In fact, our nemesis trichoderma is a very beneficial organism in the soil for that reason. I've noticed also that burying spent and/or contaminated cakes into houseplants or the garden benefits the plants. They always green up and look much better a month or two later.

ANASTOMOSIS MYCELIUM MUSHROOMS - Anastomosis is the pairing of dikaryotic mycelium with other dikaryotic mycelium. In other words, combining strains, but not species. For example, Penis Envy could combine with cambodian cubensis via anastomosis, but neither could combine with oyster, shiitake, or mold.

MUSHROOM MYCELIUMS LIFE - The mycelium runs out of food and/or it reaches the end of it's natural cell division life cycle. Both often occur at about the same time. Adding nutrients or more manure will be of little benefit, just as giving a steak dinner to a 100 year old man isn't going to make him 20 again.

MUSHROOMS/PLANTS - As for helping with the CO_2/O_2, forget it. The mycelium produces way more CO_2 than plants can metabolize, and the amount of plants that would fit in a mini-greenhouse won't do squat as far as helping with O_2 for the mushrooms.

LIFESPAN MYCELIUM - It's worse than a g2g because once a mycelial network flushes a few times, the natural cycle is to die back like a spawned out salmon. To get maximum growth, it's best to always use fresh spawn when going to bulk.

MUSHROOMS - Mushrooms depend on a LOSS of moisture from the substrate to fruit. If you saturate them, or keep a steady moisture level, they fruit poorly if at all. Mushrooms are not plants, which benefit from steady moisture levels.

MUSHROOMS - Mushrooms EAT their food, not drink it from blue water. Fungi is much more closely related to mammals than plants(fact). You wouldn't put miracle gro into your kids baby bottle would you?

MYCELIUM - I once saw a chanterelle lift a rock that weighed at least ten pounds out of it's way as if it wasn't even there. It's amazing how much hydraulic pressure mycelium can build when it needs to.

MUSHROOMS - Growing mushrooms is as much about water as 'nutrients'. In other words, a jar of brown rice won't fruit nearly as well as a jar with 1/3 rice flour and 2/3 verm. That's a fact.

MUSHROOM LIFE CYCLE - Hyphal knots are the very first stage of pinning. They're the size of the head of a pin. They develop into primordia, which then grow into pins.

MUSHROOMS - Growing mushrooms is part art, and part science, but it's not magic. Follow proper procedures, and you'll have success. Good luck.

MYCELIUM - Nice. Fungi in the soil helps to break down the manure, making it more available to the plants as well. Both species benefit.

MUSHROOMS - Mushrooms EAT their food, so you want to provide solid food. Don't use the liquid left over from soaking straw.

MUSHROOMS - Molds are fungi. I don't think there's an organism that can tell perfect from imperfect fungi.

MUSHROOMS - Plants and fungi rarely compete with each other, but often each benefits from the other.

MUSHROOMS - They're part and parcel of the same cell lines that colonize the substrate.

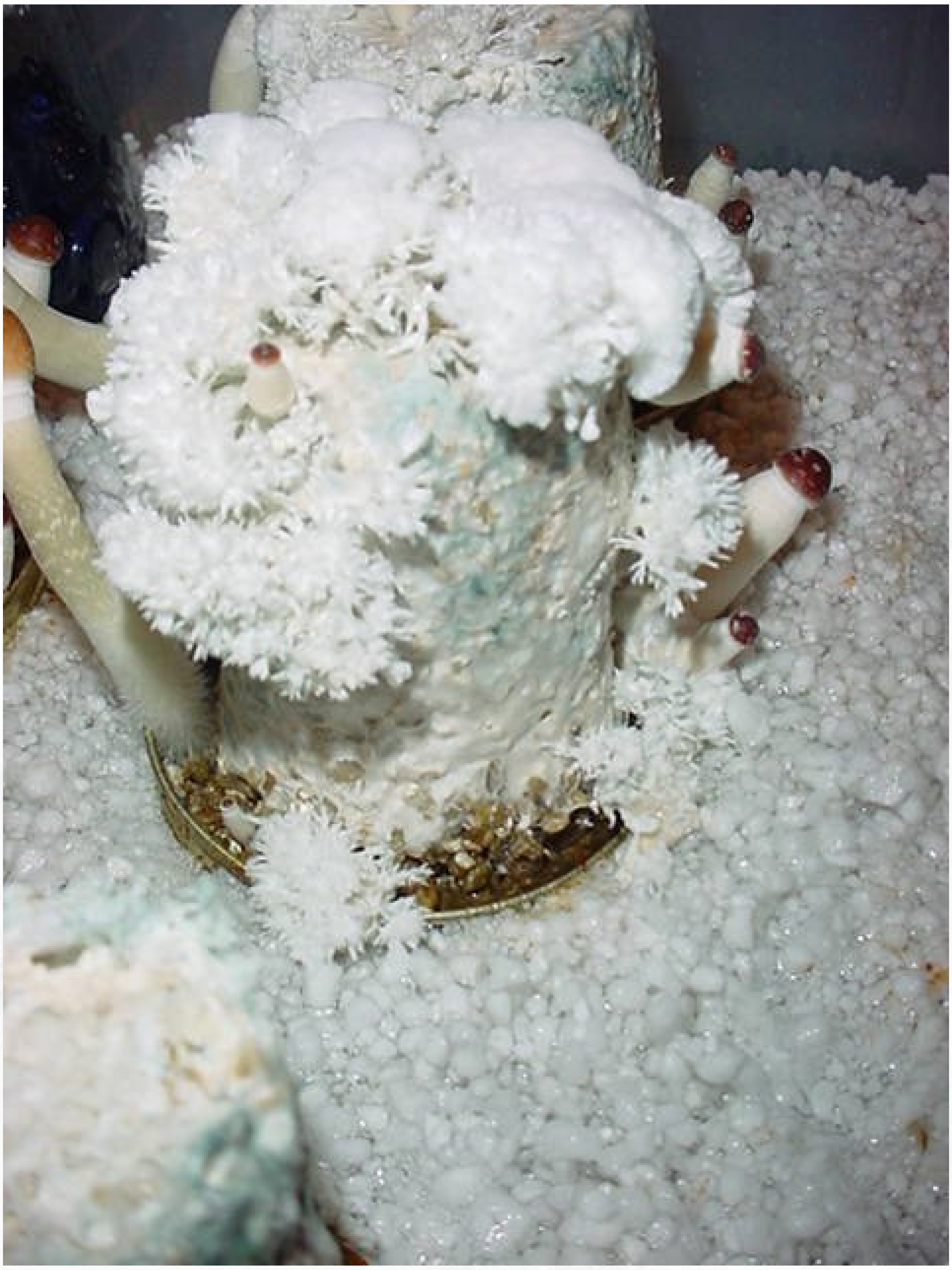
MUSHROOMS - Mushrooms don't 'suck up' toxins from a moldy substrate.

MUSHROOM - A Mushroom Viel is Made Of Tertiary Mycelium.

MYCELIUM - Mycelium is the vegetative part of a fungus consisting of a mass of branching threadlike hyphae that exists below the ground or within another substrate. It is through the mycelium that a fungus absorbs nutrients from its environment. It does this in a two stage process. Firstly the hyphae secrete enzymes onto the food source which breaks down polymers into monomers. These monomers are then absorbed into the mycelium by facilitated diffusion and active transport. Mycelium is also a vital component in many ecosystems in that it helps increase the efficiency of water and nutrient absorption of many plants and also is vital to the decomposition and breaking-up of plant material to form the organic part of soil and to release carbon dioxide back into the atmosphere.

MUSHROOMS/MYCELIUM - Mycelium grows by cell division. Primordia grows by cell division. Once they're fully formed mushrooms(ie pins), they grow by cell expansion, but not entirely. Basidia are single cells that produce spores at the ends of tube-like projections called sterigmata, and they're located on the gills. A larger cap will have more basidia, thus more spores. In other words, you'll get far more spores from a large cap than a small one. When we say mushrooms grow by cell expansion, it doesn't mean that no new cells are produced. It means these additional cells do not directly contribute to growth.

MYCELIUM - Aerial rhizomorphs, usually because they're searching for moisture from the air. You can tell from Road's pic above [see below] the cake is dry from the bluing. That's caused by the standing water in the perlite, which renders the perlite useless. Mycelium can be quite creative in finding ways to survive.



MYCELIUM - Fungi, including molds, grow mycelium. Most mycelium looks similar. With few exceptions, one can't tell what kind of mycelium it is by looking. An experienced cultivator on the other hand, can recognize the fragrance signature of different mycelia. Shiitake has a distinct smell, as does oysters. Ditto for morels. Cubensis has a distinct mushroomy scent. Trichoderma has a 'dirt' type smell to it. If I have an outbreak of trich, I can smell it when I open the greenhouse door, a few days before it's visible as a green spot when it sporulates.

MYCELIUM STORAGE - One last thing you might want to try is to take a piece of mycelium from the agar and drop it into a jar of sterilized distilled water. Be sure to cover the jar with a filtered lid. Sometimes, dry mycelium will recover in pure distilled water. Don't add any nutrients to the water that might also feed molds or bacteria. If the mycelium begins to grow that way, simply suck it up with a syringe and transfer to agar.

MYCELIUM - Mushrooms do not have roots OR root like structures. The mushroom fruiting body is mycelium, and it's genetically identical to the mycelium that is colonizing the substrate. No comparison can be made to plants/roots when discussing mycology. In fact, mycelium is a closer relative to humans and other mammals than it is to plants. That's a scientific fact.

MYCELIUM - Mycelium is much more closely related to humans than plants and that's a fact. Mycelium consumes O_2 and releases CO_2 as a waste product. Mycelium also produces body heat the way we do. I've often compared artificially increasing CO_2 levels to putting a bag over your head and trying to run a foot race. You'd run out of air, as will your mycelium.

MYCELIUM SMELL - If a jar smells sweet, sour, like vinegar, the kitchen garbage or stinky feet, toss it. All those are caused by various bacteria.

MYCELIUM - Hyphae from two compatible spores can exchange genetic information and become dikaryotic, thus able to fruit.

MYCELIUM - 'Fuzz' on the stems, contrary to popular myth is NOT a problem, and is NOT caused by high humidity.

MUSHROOM MYCELIUM - Most mushroom mycelium once 'mated' holds two nuclei in each cell.

MYCELIUM - Mycelium will suffocate and stall or die with no gas exchange, so I'd say it's very important.

MYCELIUM - I've generally found strains that poke spiky mycelium out end up being good fruiters.

MYCELIUM - The most aggressive mycelium I've worked with would be Morel.

MYCELIUM - Rhizomorphic mycelium is the type that forms primordia, so that's a good sign.

MYCELIUM - Mycelium has very little actives to extract.

ALCOHOL - First things first. 96% alcohol is a terrible sanitizer, but a pretty good fuel. For a cell to be destroyed by alcohol, the alcohol must be admitted into the cell via osmosis. However, cells are very good at keeping out substances that would kill them. That's why we mix water with the alcohol. The water 'tricks' the cell wall into admitting the alcohol, and then it kills the cell when it evaporates back out again. Use 70% alcohol for best results. However, alcohol will do nothing against the contaminants that are INside the needle, so you'd be injecting them right into your substrate. Use flame sterilization, and there is no need to wait for the needle to cool. It will cool enough on the way from the flame to the jar, and the first drop or two of solution will finish cooling the needle so that the rest can flow cleanly.

ALCOHOL - It's an explosion hazzard, a fire hazzard, and worthless against airborne contaminants because it settles out of the air too fast. The only way alcohol kills cells is when it penetrates the cell wall, and then evaporates back out. Alcohol by itself, if it doesn't penetrate the cell wall isn't toxic. That's why 70% alcohol works better than pure alcohol. The water 'tricks' the cell wall into admitting it, and then the alcohol evaporates back out from the inside, destroying the cell. Cells admit moisture by osmosis, and therefore exclude toxins such as alcohol unless water is mixed in with it.

ALCOHOL - No. Pure alcohol kills little. That's why it's mixed with water. The reason is that alcohol kills when it evaporates away from whatever it is in. Cells, including bacteria cells admit water through osmosis, but reject toxins. By mixing water into the alcohol, the cell is tricked into admitting it, then when the alcohol evaporates away, it kills the organism. Bacterial endospores are in grains, but we PC for those. The use of 70%

alcohol is great for tables, gloves, needles, etc.

ALCOHOL - 70% is preferred, but it has nothing to do with rate of evaporation. Cells admit water through their cell walls via osmosis. Cell walls are particularly good at preventing the entry of toxins, so by mixing water with the alcohol, it 'tricks' the cell wall into admitting the mixture, which then kills the cell as the alcohol evaporates back out. I'm sure one of our resident chemists can put it in more scientific terms, but that's the jest of it.

ALCOHOL - 99% alcohol is a poor sanitizer. The whole idea of using alcohol is to kill bacteria and mold spores. Cells don't admit substances without water. That's why up to 30% water is added to alcohol used to sanitize skin or other surfaces. It tricks the cell walls into admitting it, and then as the alcohol evaporates back out, it kills the cell.

ALCOHOL - Actually, the reason 70% is more effective is because living cells admit water through the cell membrane by way of osmosis. If there is water mixed in with the alcohol, it's admitted into the interior of the cell where it does the most damage. 99% alcohol can't penetrate the cell wall as effectively, therefore it's less effective.

DENATURED ALCOHOL - Use denatured alcohol from the paint department in your local hardware store. It doesn't create soot. Flame, then use while still hot. Don't cool the needle first. The first few drops of solution will cool the needle, allowing the rest to flow cleanly. Repeat between jars to avoid cross contamination.

ALCOHOL - Personally, I use 80% because it has enough water to penetrate cell walls of organisms, but not so much water it doesn't evaporate completely. The 70% takes too long to dry off my gloves or table when I wash them with it. I mix equal amounts of 91% and 70%. Works like a charm.

ALCOHOL - Just a note here too: 70% alcohol will do a better job of killing off contaminants than 90% or 99% alcohol. The reason is that the cell wall is tricked by the water in the alcohol into admitting it into the interior of the cell, where the cell is then destroyed as the alcohol evaporates back out.

WATER/ALCOHOL - The higher water content is what allows alcohol to penetrate the cells walls by imitating H_2O.

ALCOHOL - Alcohol is not a sterilizer. It is a sanitizer. Big difference.

BLEACH - Actually, bleach is approved for use in organic mushroom farms. I doubt seriously that the running water washed away the trich. It's possible it spread it even more, but only time will tell. Bleach also doesn't kill most fungi, including trichoderma. Good luck with that grow. I hope it works out. The trich sure won't impact your product or harvest, so if your second flush comes quickly, you'll be fine.

BLEACH - Bleach is not toxic to fungi, only spores. It's fine to clean out a glovebox or table if you mix it at ten percent, or also mixed at ten percent it can be used to disinfect a mini-greenhouse to kill flies and fly larvae between crop cycles. 30% bleach is too strong though. Don't go over ten percent or it isn't as effective.

BLEACH - Bleach doesn't harm mycelium much. I've soaked tissue for cloning for several minutes in a ten percent bleach solution. The bacteria is killed off, but the mycelium survives. Bleach seems to harm mycelium far less than peroxide.

DISINFECTANT - Alcohol is the recommended surface disinfectant. Some use lysol, but remember lysol is 80% alcohol and perhaps ten times the price of buying alcohol at the local drug store. To clean your table, just pour it out of the bottle, then wipe with a paper towel. Save the expensive windex for windows.

DISINFECTANT - Use alcohol for your surfaces and ozium for the air.

IODINE - You shouldn't need to do anything but clean the surface if you're using that tek. In fact, skip all the cleaners and just peel off a strip of mycelium like a banana peel, and then stick the needle into the freshly exposed flesh. Iodine is fine for cleaning the outside of the tissue, but use it at no more than ten percent.

LYSOL MUTATIONS - I want to scream every time I hear that. It's wrong. Lysol doesn't cause mutations. I can only catch it so many times, and this Lysol/mutant myth is spreading like a damn virus. Your new homework assignment is to spray Lysol near(not on) one of your fruiting cakes and report the results. Lysol is mostly alcohol and isn't good for mushrooms, but using it in the room isn't going to cause mutations. I spray the face of my flowhood with Lysol prior to transfers, so it's always blowing on something.

PEROXIDE - To avoid confusion, people should mention the percentage of hydrogen peroxide they USE. If you have 30 count peroxide such as it is measured in Europe, it is at ten percent. If you dilute it three to one, you have 3.33% peroxide. If you purchase it at a drug or grocery store in the US, it comes in 3% concentration. If you dilute it ten to one, you have roughly .3% after mixing. As I said above, peroxide is toxic to mycelium, all mycelium, therefore it is hated by mushrooms and mold alike. If you have an outbreak of Dactylium, you can spray the casing layer with it to wipe out the cobweb. This doesn't hurt the mushroom mycelium because Dactylium rarely colonizes over the top of mushroom colonized casing layers. I've found it's a mistake to use as a preventative measure because it sets the mushroom mycelium back and makes it less aggressive, then the faster recovering molds get the upper hand. Sterile technique will prevent molds in spawn, and fresh air exchange will prevent most molds in the growing environment, so go with that for best results.

PEROXIDE - The problem with peroxide on agar is it stunts the mycelium, and then oxidizes away to nothing, leaving the mycelium weak, but having no further effect on bacteria. For cloning, you can have far better results by dipping tissue into iodine before placing on agar. Gentamicin sulphate added to the agar will help prevent bacteria from growing, while not slowing down the mushroom mycelium at all. In all cases, strict attention to sterile procedure will outperform peroxide. I suppose that's what I meant to say, even if I was a bit harsh on ol' Rush.

PEROXIDE - Don't use peroxide on grains. Also, don't use tools to make the transfer. Peroxide will not sterilize spoons, forks, etc. Bang the unopened jar against a tire to break up the grains, and then pour the grains from the master jar to the receiving jars without touching them with anything.

PEROXIDE - Peroxide is toxic to fungi, all fungi. Personally, I no longer use peroxide in the humidifier, but I can assure you that isn't the problem. Peroxide in the humidifier only serves to help control molds within the humidifier itself.

PEROXIDE - Don't use peroxide in the mist water. Peroxide injures mycelium, so to use it for a preventative against contaminants might cause the very problem you're trying to avoid by stressing the mycelium, weakening it.

PEROXIDE - Peroxide does stress mycelium a great deal. We all know that. That doesn't mean it can't survive limited exposure, but it causes damage at the cellular level and that's a fact.

PEROXIDE - Don't use peroxide on your cakes for anything but cobweb control. Peroxide is highly toxic to mushroom mycelium and shocks it, allowing the faster growing trichoderma to take over.

PEROXIDE - Peroxide is no substitute for sterile procedure. Peroxide will wipe out cobweb mold on a casing layer, but it has little other use, imho of course.

PEROXIDE - Peroxide attacks mushroom mycelium too, so dunking in it can weaken the mycelium, making it more likely contaminants can get a foothold after the dunk while the mycelium is still weakened.

PEROXIDE - Don't assault your mycelium with peroxide. That's like throwing acid in your girlfriends face just to see if it sizzles.

PEROXIDE - Peroxide is toxic to fungi, all fungi. Some can tolerate it better than others, but none 'like it'.

OZIUM - Ozium air sanitizer is the best way to keep the air in your home or work space clean and smelling fresh. Ozium does not cover up the odors associated with sewer, pets, cooking and smoking - it eliminates them! . Ozium, the original air purifier, is a chemical agent that actually eliminates smoke and unpleasant odors and reduces airborne bacteria. Ozium actually cleanses the air through glycolized action. The Ozium glycolized formula acts directly on odor causing particles in the air. Ozium is distinguished from other products that simply mask odors. Ozium is an EPA registered air sanitizer and is safe to use residentially or commercially in homes, rental property, hospitals, nursing homes, hotels, veterinary clinics, restaurants, bars, laundry rooms, cars, mobil homes, offices, and just about anywhere there might be an odor problem. Do Not Breathe It Though!

MULTI SPORE INOCULATION - Every time you do multispore inoculation you mix hundreds, if not thousands of strains in the same jar. It makes absolutely NO difference if the spores come from the same print or from prints from halfway around the world. The definition of a strain is NOT the name some vendor put on a print he mailed out. The definition of a strain is two compatible hyphae 'mating' to form dikaryotic mycelium. Hyphae from a PR print are just as capable of mating with each other as with hyphae from a Tex or any other print. It's the same species so they're all compatible. There is NO competition between strains of the same species. Once they become dikaryotic, they continue to fuse by a process known as anastomosis, again with NO competition. Hybridization between 'strains' occurs in every single multispore project.

MULTISPORE - Every hyphal pairing makes a new 'strain' thus every grow is different and will have a different feel because there's millions of spores on each print and each spore has a unique genetic code. That's why there's far more variation in trip quality and macroscopic appearance from each crop from even the same print than there is difference between siblings of the same human or animal family for example. The 'cube is a cube' means just that. They have the same growth and nutritional/environmental requirements. Every trip will be different, so it matters little which named strain one chooses. You won't have the same trip twice, even from the same strain. In fact, you're very unlikely to have the same trip twice, even from fruits from the same substrate tray.

MULTISPORE - Multispore inoculation from a sporeprint is a roll of the dice. You can do ten grows from the same print and have ten crops that hardly resemble each other, other than being the same species. A fruit grown from multispore inoculation may or may not be an isolated strain. This is well known in the edible field. More than one substrain can be present in a single fruit. That's why clones from mushrooms grown from multispore inoculation do not always form single sector isolates on agar. I've seen this many times. However, if you isolate down to single sectors on agar, fruits from each single sector isolate will be genetically identical. However, if you fruit these and take sporeprints, you're back to square one.

MULTISPORE - What you're seeing is the effects of multi-spore inoculation. Often, several strains develop that are not compatible with each other, thus they don't form into a single organism via anastomosis. Therefore, more than one strain is fruiting on the same substrate. If you clone that big ol' choad, future flushes will have all choads, but whether you'll get enough of them to matter remains to be seen. I'd clone it, and then after you eat the thing, you'll know if it's a strain you want to keep or not.

MULTI-SPORE - When you grow from multispore inoculation, it matters little what the name on the syringe was. A cube is a cube and that's a fact. What this means is every grow will be different. When you buy a Cadillac, you can expect a luxury ride. When you buy a Ferrari, you can expect a fast car. When you buy a pickup truck, you can expect it to haul things. No such guarantees exist with cubes. Every multispore inoculation will be different, thus we say, "A cube is a cube".

MULTI SPORE - If you want to mix strains, do so. You can have multiple strains in the same terrarium, or for grins and giggles, you can inoculate a cake with four different strains, one strain per hole. You'll probably not notice anything different from any other multispore grow. This has all been covered hundreds of times, and the information is right here for searching. Strains of the same species are generally compatible.

MULTISPORE SYRINGE - Whoever made that syringe had no idea what he or she was doing. It's way too dark. Dark is bad. Fewer spores are better. That is a fact. A large number of spores is also going to have a large number of contaminants attached. Using too many spores is counter productive. That was known over twenty years ago when Paul Stamets wrote 'The Mushroom Cultivator' because he made that clear in the book.

MULTISPORE - Very often with multispore inoculation, what you have is many different types of mycelium growing together and one on top of the others. What is often mistaken for one type of mycelium is actually this pile of various types, or even the same type. If your cakes are in the FC and fuzzing up, they're good to go.

MULTISPORE - Sometimes with multispore inoculation you even end up with a non-fruiting strain. Other times, you end up with a poorly fruiting strain. Often, you end up with an awesome fruiting strain. It's all a dice roll.

MULTISPORE - If using multispores culture on both, you will have a different results no matter what and each sub-strain will have different properties/levels of chemicals within them..

MULTISPORE - The silly name on the syringe means nothing. Every grow from multispore inoculation is going to be different, just like every child born is different. It's all the same species.

MULTISPORE - In a spore print MULTISPORE = Millions of diff sub strains, within the strain you are using... Spores are like sperm, other then they mate with eachother

MULTISPORE - Multispore will produce different results everytime, because theres millions of genetics.

SPORE MIXING - Since multispore inoculation from a single print creates hundreds of strains, mixing two different prints would behave no differently. As has been said many times, a 'strain' is two compatible hyphae coming together to exchange genetic information, so it makes little difference how many prints go into making the multispore 'tea'. The mycelium doesn't give a darn what silly name somebody put on the print or syringe, it's only concerned with A and B mating types, and since all the cube 'strains' are the same species, hyphae from one spore will exchange information readily with hyphae from another compatible spore. Nobody can answer what the offspring will look like because nobody can say that mushrooms from GT will always be 'such and such' but PR's will always be 'this or that'. I've studied all types of spores under the microscope and I'm here to tell you, these so-called strains floating around with all the fancy names can't be identified either microscopically, or macroscopically from each other. That's why we stickied the strain thread up on top. It was to keep worthless discussion about 'strain' confined up there so it didn't litter the board with wasted bandwidth.

DARKER SYRINGES/SPORES - Darker syringes will result in more contamination problems. There is always going to be a certain percentage of contaminant spores on any print. Therefore, if you use more spores, you get more contaminants. In addition, when you use a massive spore inoculation, you force the mycelium to spend a lot of time and energy combining all the genetics into a common network. Many growers think that more spores results in faster colonization. What it results in is the substrate turning 'white' faster, but there is no evidence at all the project will actually fruit sooner. I'm a firm believer in using the minimum amount of spores necessary to achieve a crop. Clear(to the naked eye) syringes perform better than dark syringes. Nobody can see individual spores with their eyeballs. What you see is clusters of a few thousand that are stuck together. The spores in the center of these clusters are locked out of the moisture in the jars, so they rarely even get a chance to germinate.

VIABLE SPORES - I've ran several tests with the microscopes to determine spore viability. A brand new print will give about 1 spore in 100 that will germinate. After two weeks, that drops to about 1 spore in 500. At one month since taking the print, less than 1 spore in 1000 will germinate, and after one year, you're doing good to get 1 spore in 10,000 that is still viable and it drops even faster after one year. The thing to remember is take clean prints and store them properly. An old print will still work, but remember that you'll need to use many more spores to get the few that will germinate. Remember, when you use more spores, you also risk using more contaminant spores that may be hitch hiking along for the ride. Thus, fresh prints are better.

SPORES - Using more spores is counterproductive. I agree they will 'colonize' faster by using more spores, but the problem is that not all strains are going to be compatible, therefore by using an excess of spores, an excess of strains are going to be created, some of which won't unite to form a common whole. The result is you have several separate mycelial networks, none of which has access to the total amount of food(BRF) in the cake. The best fruiting results from multispore inoculation comes from using minimum spores. Even better, a single sector strain you've isolated on agar in a Petri dish.

SPORE INOCULATION - Using more spores to inoculate a grain or brf jar will result in faster colonization, but that's not always a good thing. You'll be left with many strains in the same substrate because not all are compatible enough to combine into a single organism by anastomosis. Therefore, each 'strain' will have a small piece of the substrate rather than being a single organism in control of the whole substrate, which is better for performance. That's why we practice strain isolation on agar prior to inoculating our grains.

SPORE LIFE PRINT - Actually, the life of spores on a print is three to five years, and less if the print was taken on acidic paper. In a syringe they last longer, provided the syringe was made properly. I have prints going back nearly 20 years, and even the ones I made four to five years ago won't germinate and grow anymore with very few exceptions. Good luck and check out "The Mushroom Cultivator" by Paul Stamets. You can get it from fungi.com or amazon.com.

SPORES - With multispore inoculation, it's common for two or more strains to make it to fruiting. They usually combine into a whole via the process of anastomosis, but some strains are incompatible and remain separate. They don't fight, being that they're the same species. Fruiting is not impaired either as you can see. The same often happens when someone injects one side of a cake with one strain, and another side of the cake with a different strain.

SPORES - I've been saying for many years, and Paul Stamets has been sayin for over 20 years(it's in TMC) not to use an excessive amount of spores. It's counter productive. Since no print is 100% clean, the more spores you use, the more contaminats you inject as well. Since molds and bacteria grow faster than mushroom mycelium, dark syringes give the advantage to contaminants over the mushrooms.

STORING MYC/SPORES - For live mycelium, I inoculate a test tube slant of agar. When the mycelium has colonized the agar in the test tube, I pour a small amount of distilled water over the top of the mycelium, then place the test tube in the refrigerator for long term storage. Once per year, take out the test tube and transfer the mycelium to a new test tube and repeat the process.

SPORES GERMINATING - With a powerful magnifying glass, you can sometimes see it on the second day. Using a microscope, I've observed fresh spores germinating within 20 minutes of swiping on wet agar. That blew me away. I never thought they'd germinate that fast. It can take four days to two weeks to be visible to the naked eye, with closer to four days the norm.

SPORES DROPPING - Spores drop due to internal pressures within the basidia that literally explode the spore away with force. Once dry, the process stops totally. To get more spores, put a drop of water on the cap so it stays wet longer. Nothing will speed it up, but lots of things can slow it down. You should have a readable print in three to four hours.

SPORES - It's genetics, and something else I've discovered, is there are often basidia on the gills producing clear spores. Check your prints under a microscope. You might have good prints, but just can't see them. The clear spores have a far lower germination ratio, but many still do germinate and grow, if used fresh.

SPORES DROPPING - There is some evidence that a heavy spore drop will inhibit future flushes. In addition, it makes a terrible mess, and furthermore it makes the fruits taste even worse than they normally would. Pick just before, or just after the veil breaks for best quality.

SPORES - Spores drop spores when the pressure in the basdidia reaches a crucial point, and then the spores are blown into the air with considerable force. You make a print by setting a freshly cut cap on paper, glass, foil, etc., and waiting for nature to do its thing.

STORING SPORE PRINTS - I think prints will definitely last longer on glass or aluminum foil. Refrigeration might help, but I'd make sure it's a dedicated lab frige. There's too much mold and bacteria in the kitchen refrigerator.

SAVING SPORES IN FREEZER..IF - Spores can be frozen without significant loss of viability by suspending in a 10% aqueous solution of sterilized glycerol (glycerin U.S.P.; available at most pharmacies).

SPORES - The spores will be fine since the water in the syringes didn't freeze solid. Freezing would likely destroy the cell walls of the spores, but just being very cold is fine.

STORING SPORES - Distilled water is the best method for storing spores or live mycelium. Spores stroked in distilled water don't dry out the way they do on a print.

SPORE PRINTS - After a year, they're down to less than one spore in a thousand that will germinate. It gets worse from there. Prints are best used when fresh.

FRESH SPORES - If done in a clean environment, spores can be scraped directly into grains or agar. They need not be re-hydrated first.

SPORES - Many minerals in tap water, and especially well water do effect the survival rate of spores in a syringe.

DROPPING SPORES - The big deal is it makes a horrible mess and makes the mushrooms taste even worse.

SPORE SOLUTION - That was enough for 4 jars. 2ml per jar is plenty.

SPORE PRINTING - I quit taking prints on paper. There's a lot of lime and other chemicals used in pulp production and papermaking. I don't know if that's the cause or not, but I've found prints taken on foil last MUCH longer than prints taken on paper. You can use the same methods, just with foil instead of paper. I'd tear a foot or so off the roll first, and save it for the kitchen, then use the clean foil beyond that point for your prints. I prefer to cover the printing cap with a tyvek sheet. I buy tyvek coveralls at the hardware store, and unzip them and do the printing on foil inside the torso area, then I zip it back up. You can tie knots in the arms and legs, and hood, so it totally seals your printing area up, yet still can breathe so bacteria is reduced. Heavy duty foil. It's several times the thickness of the cheap stuff. For immediate syringe making, you can use the non-stick foil. Spores slide right off it. They will slide right off the foil and into a shotglass still in the shape of the print.

SPORE PRINTING - If you're going to be streaking the spores onto agar, there's no need to be sterile in taking the print. I don't even put a glass or bowl over the cap. Just lay it on a piece of typing paper, and set a coffee filter over the top. After you streak the agar dish, watch it daily, and when the spores germinate and grow half a cm or so, take a small piece of mycelium from the FARTHEST away from the point of germination, and transfer it to a new Petri dish. Discard the original. This allows the mycelium to outrun the contams, and you can get clean cultures this way. Of course, doing it this way, you'd just drop the agar wedges into your grain, as opposed to making syringes. One Petri dish can innoc 10 quarts of rye or corn. Much faster/safer, imo.

SPORE PRINTING - If they're for printing, let the caps begin to drop spores prior to picking. Don't let the caps flatten all the way out because that wastes your spores and makes a mess all over your grow chamber. If they're for eating, pick just prior to veil tear for best overall quality. I agree that paper is a poor printing medium. Its porous surface attracts and holds contaminants, and the lime and acids used in production gives paper a wildly varied pH, which doesn't do much for the spores longevity. I use foil.

SPORE PRINTING - For printing, wait until the cap begins to flatten out, and you'll see spores on the stipe above the veil remnants as well. I disagree with the technique of printing under a glass. I'd suggest laying a sheet of tyvek over the printing caps. All you want is to keep dust off and restrict drafts. A glass can tend to keep the caps too wet, and bacteria may bloom.

SPORE PRINTING - Agreed, you don't need light. Personally, I don't let caps sit for more than 12 hours during printing because I don't want bacteria to be able to form in the stale air beneath the cap as it prints. The good news this way is you can get two prints from each cap. Although they will be lighter prints, they will work just fine.

SPORE PRINTS - Dark prints equal more spores, and since no print is completely clean, it also means more contaminant spores, which germinate and grow faster than mushroom spores.

SPORE PRINTING - After five years, especially if the print is on paper, there's little chance of success. It's not impossible, but less than one spore out of perhaps a million will still be viable.

SPORE SYRINGE GERMINATING - It doesn't make them germinate one second sooner. It just causes such a mass of mycelium you SEE it sooner. It's a horrible idea by the way because your mycelium spends needless energy combining cells(anastomosis) in order to become a single organism. You're much better off using a minimum of spores. Dark syringes or the over use of spores is also a good way to get contaminants. Remember, more mushroom spores also means more contaminant spores that hitch hike along for the ride. Since it takes longer for all those strains that germinate to combine, it gives the contaminants a better chance of getting the upper hand.

DARK SPORE SYRINGES - It becomes much worse when people make their own syringes and make them very dark. Some strains are not compatible, so when someone uses multispore inoculation, it's common to still have two or three strains active at fruiting. Each strain carves out its niche and holds it. Most strains combine into a single organism through the process of anastomosis, but the non-compatible ones don't, therefore you'll have several different substrains growing in the same tray.

SPORE SYRINGES - Having thousands of strains in the same jar may turn it white sooner, but in no way increases performance or yield. Time is spent combining all those pairings into a coherent whole. Fewer spores is much better, and in fact the clearest spore syringes often give the most massive flushes. The reason is that many strains are incompatible, so when you start off with a black syringe, there may be hundreds of incompatible strains at the end, greatly reducing harvest.

INOCULATING - 2CC's is plenty for quarts of grain. Shoot over to the side of the glass so the spore solution can run down. Don't shake until 20% or so colonized with mycelium.

INOCULATING - A torch lighter will leave the needle sterilized. Just make sure you get the needle to glow red hot. No need to wipe with alcohol afterward.

SPORE SYRINGE - A print should make up to ten or even more syringes, depending on size and darkness of the print.

SEX LUBE SPORE SYRINGES - Astroglide or Jet Dry.

INOCULATION - 'Inoculation' is the process of introducing spores to your substrate. 'Colonization' is the phase where the mushroom mycelium is working its way through the substrate, 'colonizing' it. 'Fruiting' is the stage you're at now.

STRAINS - Strains of the same species do NOT compete for nutrients and they do NOT fight it out. That's absolutely silly. Do the genes of a lady from Florida and a man from Texas fight it out when they make a baby? Of course not. Squirt as many different strains into the same jar or substrate as you want. It's no different than multispore inoculation from one print. It's all the same species. Everybody who's done it has reported the same results. A normal flush that looks just like any multispore inoculated flush. Most of the named 'strains' were simply named after the geographical location the print was collected from, as if a man made line in the sand changes the genetics of biological creatures. If a guy collects a print in Florida and names it treasure coast, and another guy collects a print in Georgia and names it hillbilly, are they really different? Both grew in the same region, under the same weather conditions, and spores from both mix freely in the wind. It's the same with all the SE Asia 'strains' in circulation. Lines on a map drawn by the British 50 years ago do not cause the mycelium that's been evolving for millions of years to suddenly morph into new strains, marketing considerations aside. They're all Cubensis. There are distinct strains such as Penis Envy, various albinos and fruits that drop slightly different spore coloring, but the rest is marketing, not mycology and they all mix and match easily. My point was that putting spores from several named 'strains' in the same substrate does not result in a hybrid, since there's no verifiable difference between them.

MIXING DIFFERENT STRAIN SPORES - Different strains do not fight it out. They do not compete for 'nutes', they don't make small fruits, they don't disrupt each others networks, and they don't get cut off from their own network. I speak from experience. Use the search feature and you'll see this issue comes up every couple of months at least, and this same disinformation gets repeated over and over again by those who have never done it. Here's a post I made in a similar thread several months ago with a picture showing two different strains fusing by anastomosis to create a third strain on a Petri dish.
http://www.shroomery.org/forums/showflat.php/Number/5545843#Post5545843Cubensis is easy to cross. Some

mycologists use the term hybrid, but I prefer 'cross', instead using the term hybrid to refer to cross-species matings. Every single multispore inoculation results in hundreds of 'strains'. Where is this fighting? Remember, a strain is born when two compatible hyphae exchange genetic information to become dikaryotic. It doesn't matter one whit whether the spores those hyphae came from originated from the same sporeprint, or sporeprints from the opposite sides of the world. Vendor named strains are just that-names. If the species is cubensis, they will combine normally. That is a fact.

STRAIN - Strain is irrelevant in mushrooms, unlike in mj cultivation where it's everything. A cube IS a cube. The long-time growers know this, thus the disreputable spore sellers constantly invent new names to stamp on the same old strains that have been around for years. Pick a strain from a shroomery vendor for your microscopy study. Sporeprints easily slide into a regular mail envelope. Cubes are cubes, and no named strain produces faster, more rhizomorphic, more potent, blah, blah, than any other on a continuing basis. Strain questions need to be in the strain thread at the top of the page please.

MIXING STRAINS - They may or may not share genetics(cross), but either way there is little to no harm in mixing vendor named strains because they're all the same species anyway. The chances are very high that they will combine into a single organism via anastomosis by the time fruiting comes. Search the posts. This has been asked and answered dozens of times in the last year or two. There's several grow logs in that forum where guys have mixed 'strains' in the same tray with no problems.

STRAINS - People, for the millionth time, the 'named strain' crap is completely irrelevant to growing. Cubes are a SPECIES, and they all grow under the same conditions in the same substrates, under the same temperatures, moisture contents, etc. It seems that everyone who makes a print these days gives it a name and calls it a new strain, which is total bullshit. As far as growing parameters are concerned, cubes are cubes, period.

WHAT IS A STRAIN? - Remember, a strain by definition is a pairing of two compatible hyphae into dikaryotic mycelium. The location the original print was taken from has no more to do with the size and shape of the fruits than being a human from New York or New Jersey or England has to do with how tall or how smart you are. Remember, cubes are all the same species, just like we humans are all the same species.

MUSHROOM STRAINS - Some strains just don't attach well to the substrate, therefore they tend to pick themselves by falling over. Other strains are so well attached they leave a huge divot when you pick them. Multispore inoculation will give one strain one time and the opposite the next. It's just the luck of the draw. It's not related to anything you're doing, except handling them. They prefer to be left alone.

MIXING STRAINS - Most likely, you'll end up with cubes. It matters little the name on the print. If it's a cube, it will grow cubes. If you mix spores from more than one print, you'll still grow cubes. Compare it to a human from Canada having a baby with a human from Mexico. The child will still be human. As long as they're the same species, the genes usually mix freely.

CROSSING STRAINS - Crossing one cube strain with another is quite easy actually. Dikaryotic mycelium readily exchanges genetic information with other dikaryotic mycelium. However, such is not a hybrid. It's a cross. This site operator has a long history and is not a vendor here for a reason. I won't repeat the whole step story here. Click.

SPORELESS STRAINS - I've had a few sporeless strains pop over the years. If they have the other qualities desired, it's a great trait since there's no mess if you wait until after work to harvest a flush. Sometimes, they're only half sterile, and you get zebra stripes on the gills,

STRAIN - PE is definitely slower to pin than other strains. Correct, the PE6 is a PE/Tx hybrid. Hope you guys enjoy it.

PRESSURE COOK TIMES - For larger jars or substrate bags, I've got a little different technique to know how long.
The bacterial endospores in grains need about 30 minutes @ 15 psi, at sea level, to ensure they're killed off. That does not mean 30 minutes from the time your PC reaches pressure, but 30 minutes from the time the interior of the jar or bag of grains reaches full temperature. The way to achieve this is to always use the

minimum stove setting that will hold 15 psi. If your PC rattles at 15, then use 14 so it doesn't rattle at all. Now, you'll notice after pressure is reached, for about 1/2 an hour or so, you'll have to constantly turn down the stove in order to prevent the weight rattling. Once you reach the point where you don't need to reduce the stove burner anymore, your substrate is fully heated all the way through. At this point, allow 1/2 hour to ensure the bacterial endospores in the very center of the substrate bag are killed off. If you're above 5,000 feet elevation, double the above time to one hour.

STERILIZATION JARS - Total sterilization would take at least 24 hours in the PC and your grains would come out as a sticky mush. The one to two hours we use for 'sterilization' gives us a window of opportunity to get the jars colonized before the contaminants that survived the pressure cooker can get a foothold. Don't wait three days. Instead, if you're having contamination problems, simply cook up a few extra jars and always keep a blank or two at each step that you don't inoculate. If you do a grain to grain transfer, keep one jar back that you don't use for g2g. If you experience contaminants and your blanks are contaminant free, the problem was in your sterile technique. If both the blank and the inoculated jar contaminate, the problem was in your sterilization process. By using blanks at every step, you can always narrow down the problem to exactly the step you went haywire on. Once you get your procedures down pat, you won't need to use blanks.

PRESSURE COOKING - You can remove the jars when the pressure cooker returns to zero pressure, but I'd still wait a little while. If you remove the jars while they're too hot, they can loose some of their moisture content to evaporation. Overnight is not necessary, but if you're going to let them sit anyway, the PC is a fine place to leave them. If you need to cook another batch, then there's no harm in removing them. Allow to cool to near room temp before inoculating.

PRESSURE COOKER - The biggest cause I see of dry jars is lifting the weight or relief valve to let pressure out faster at the end. That causes the grains that are at a temperature above the boiling point of water due to pressure, to suddenly loose all their moisture because the pressure that was holding the moisture in place disappears. Let the PC cool naturally until you can handle it without gloves or a pot holder before opening.

STERILIZATION - Sterilization is never complete because that would take overnight in the PC, which would turn the grains to mush. The hour or two we PC gives a window of opportunity for the mycelium to colonize and get a grip on the grains, but it's only a window.

PRESSURE COOKER - I use 90 minutes for quart jars at 15 psi. At 10 psi, go for two hours. I wouldn't attempt corn at ten psi. Corn sucks anyway as a spawn. Just use rye or wbs.

PC. TRICHODERMA - Trichoderma is killed at temperatures far below boiling, so there's no way it survived the

PASTERUIZATION - I can pasterize in a Crock Pot IF I can watch and control the temp!

PASTEURIZING - We pasteurize bulk substrates because molds are killed at very low temperatures that are below pasteurization temps, but some of the bacteria survive. Bacteria in manageable quantities are not a contaminant in bulk growing, but molds are. A sterilized substrate is a prime breeding ground for whatever lands on it, thus if you sterilize bulk substrates, you'll have a higher rate of contamination.

CLEAN MEANS - Sanitize means to reduce the number of contaminants to a safe or relatively safe level as may be judged by public health requirements.
Disinfect means elimination of all recognized pathogenic microorganism but not necessarily all microbial forms.
Sterilize means the destruction of all microbical life by use of chemical or physical procedure.

HOSPITAL SANITATION - Clean clothes & work-place, along with good sanitary procedures. AND Hair covering (net/cap), face mask, exam gloves & Lysol/Oust. ARE YOUR BEST FRIENDS. These are common-place inexpensive items, found at most local drug/pharmacy stores. Using these will cut down on contamination. I am amazed, why many don't use them. Then wonder why their jars/bags, syringes, prints or whatever get contaminated.

THE OVEN TEK - The oven will increase contaminants by stirring up turbulence that swirls contaminants around. The oven tek is bogus. You'd be better off in a still room in open air than using the oven. An air temp of 150 won't do squat to a contam spore in the two seconds it takes to swirl into your jar.

AIR SANITIZER - Lysol is a surface sanitizer. Get some Oust for the air. When you spray oust, it completely fogs up the room. I do about 30 seconds with a can in each hand, which really leaves a thick fog that kills airborne bacteria

OPEN AIR INOCULATION - Anyone who recommends open air inoculations can be compared to a drunk who recommends drinking and driving.

STERILE AIR - If you want sterile(relatively) air, get a laminar flow hood.

CONTAMINANTS BY HUMANS - Growers must realize that WE are the biggest source of contamination. I'll add to the above not to talk or sing, etc., while inoculating jars or doing other clean work. Your breath leaving your mouth is traveling faster even than a flow hood can blow it back. It's also perhaps the largest source of bacteria in our jars. The bests surgical masks will stop 99% of the bacteria leaving your mouth, but think about that 1% of several billion that gets through. That's a lot of bacteria even with a good medical, not dust mask. I hold my breath anytime a jar or Petri dish is open. Gloves are mandatory for consistent success. A box of them is less than the price of a single spore syringe. They'll save a lot of failures.

WASHING HANDS - Soap lifts the oil and bacteria skin cells and washes away with water. There is no true "anti-bacterial" soap that will kill it all (THIS IS A MYTH). Even soap/sanitizer can't even kill it all though. Skin is constantly shedding bacterial cells, You want the beneficial bacteria on your hands. True anti-bacterial soaps need to be left on for a couple minutes too.

FUNGICIDE IN CASING - They use Banrot 40WP. I ran several experiments with this fungicide a couple of years ago. It is so powerful you can soak rye grain in it, then PC, then leave the lid off the jar for 24 hours in an open room, and the grains won't contaminate. It can also be applied to casing material, and I guarantee that no trich or cobweb will grow on it.
It works by preventing spore germination, so it has to be inoculated with live mycelium, as nothing will happen if you try to inoculate with a spore syringe.
After determining that the Banrot 40WP works, I stopped the experiments because I see no reason to use chemicals to replace proper clean room procedure. A properly pasteurized, NOT sterilized casing layer will have no trouble surviving two flushes, which delivers 90% of the fruits you're going to get anyway. After two flushes, I recommend tossing the tray into your outdoor garden and replacing it with a fresh tray for the most effecient use of your growroom space. Thiophanate-methyl is approved by the FDA for use on mushroom crops and I ran some tests on it a few years ago. It's the active ingredient in Banrot 40WP. Banrot 40WP is so powerful you can put it in a jar of grains prior to sterilization, then leave it sitting out with the lid off in a dirty room and it won't grow mold, but if you put live mycelium into the jar it will grow unaffected. However, it's a chemical cure for laziness so I don't recommend it. Just use proper procedure, then toss out contaminated projects. It seems I used 1 tablespoon of Banrot per the several gallons I soaked the 10 cups of rye berries in overnight prior to PC'ing. It's been awhile, so you might search some more and find the posts that I wrote when my memory was still fresh on it.

FUNGICIDES - If fungicides have been used, they only effect spore germination. As long as you inoculate with live mycelium, there won't be a problem. You'll just have to do a test run.

RHODODENDRON LEAVES - Dried Rhododendron leaves are nearly as effective if someone is really having trouble with trich or cobweb. Simply dry them, then grind up in your hands and mix with the casing material at the rate of ten percent. Pasteurize and use. Fungus spores won't germinate in the presence of Rhododendron leaves.

BUG PROBLEM SOLVERS - You can also suck them out with a vacuum cleaner hose, which is kind of fun. They normally bread in your houseplant soil then fly out of your mycelium to feed. They can be killed off in the houseplant soil by soaking the entire pot from the soil line below in the sink for 24 hours. This drowns the adults and larvae. I use sticky paper. Works like a charm. Place it near the entrances to your grow area, and also on the inside. They're likely breeding in your houseplants too. A good cure for both houseplants and casings with fruit flies is dunking. A 24 hour dunk will drown them and their larvae. If you'll cut a lemon or lime in half and leave one of the halves near your grow, they'll congregate on the lemon rather than your mycelium. It's easy then to get them with the vacuum cleaner hose. Shot glass 1/4 full of wine are good traps. Glass with coco cola in it, they drown from the sticky ness. Fly Straps, they work great. I'm not talking about little pest strips, but 2' x 4' mats. You might try some DE to see if it works, but it only works when dry, and it won't stay dry for long on a substrate. Disposal is probably the best option. You could bury them into manure or compost in a shady spot outside to get a crop. They looooove stale beer and wine. Leave a half full bottle of either lying around for a couple of days, not more, and they'll crawl in and drown in the stuff. change the bottle every couple of days. You can use the yellow duct tape, but put a layer of vaseline on it so they stick to it. That's what a lot of the farms around these parts do. DE will help if it's dry. You can even sprinkle it around the shelves, or try baiting them with a bit of honey on a piece of wax paper, surrounded by DE. One needs to be careful handling nematodes and growing mushrooms. Many species are death to fungi, while other types of fungi can trap and kill the harmful nematodes.

GNATS - My favorite method is to cut a lemon in half and leave it near the grow area. The gnats are attracted to the lemon much more than to the mushroom mycelium. You'll see the lemon covered in gnats, and then you sneak up with the vacuum cleaner hose and suck them all up. Works like a charm.

GNATS - They avoid turbulence, but it's also likely to dry out your substrates. Try this if gnats are a problem. Cut a lemon in half and drop it into the bottom of a quart jar. Keep the lid next to the jar. The gnats will be attracted to the citrus, and when there's a bunch in the jar, quickly put the lid on before they can get away, and dispose of them.

BUG PROBLEM - Get a bag of DE from the garden center and sprinkle a thin layer on top of your casing. Completely cover the casing layer. The DE is extremely sharp to insects and will rip them to shreds when they crawl across it. DE is only effective until it gets wet, so you'll have to reapply it after misting. It's non toxic.

FRUIT FLIES BUG PROBLEM - They're attracted by the smell of mycelium for a snack. I've never seen them set up home and breed in a cake or other project. While an irritation to see in our FC's, they're for the most part harmless. I chase them down with the vacuum cleaner hose if their numbers get too large.

ANTS ATTACK - Another tip for ants is to put a bit of borax into a jar lid of honey or karo. The ants suck up the karo with the borax in it, then take it back to the nest to mix into the feed. Within two weeks, the entire colony including the queens is wiped out.

BUG PROBLEM? - Dung/straw based substrate draw gnats (fruit flies). Your infested - already...Get electric bug zapper.

FRUIT FLIES - Normally, they breed in your houseplant soil and then fly out to your mycelium to feed. They can be killed off in the houseplant soil by soaking the entire pot from the soil line below in the sink for 24 hours. This drowns the adults and larvae.

BUG PROBLEM - You can also get a bottle of red wine and drink all but the last inch in the bottom. Leave the bottle in the fruiting chamber as a trap. They're attracted to the wine, then can't get out of the bottle and drown.

KNAT PROBLEMS - Use 'Knock Out Knats' Bacillus Thuringiensis Thuricide to destroy gnats in your grow room.

UV LIGHT CANCER - Skin, or eye exposure to hard UV light is KNOWN to cause cancer. I have used then in air sterilization. But, they were enclosed in 16 gauge sheet metal duct work. Which, the air was forced through in a hepa filter housing. Just be careful, malignant melanoma skin cancer is NO FUN.

SURGICAL MASKS - The standard they're testing is how the mask protects the wearer, which we don't have a concern for. Our projects are not going to give us a fatal disease. Respirators are tight fitting around the cheeks, to prevent you from inhaling air from the edges that doesn't get filtered. This is important if you need protection from airborne pathogens. Surgical masks are open at the cheeks purposely to allow a low pressure route of escape for your exhaled bacteria(breath). What passes through the mask generally has 99% of the bacteria filtered out, depending on brand. Hospital operating rooms have HEPA filters in the ceiling that draw the room currents up and away from the patient. By having the doctor's breath leave in the direction of the ceiling, thus the filters, the patient is protected. This is our scenario as well. When the FDA says they don't test surgical masks, it means THEY don't test surgical masks. It doesn't mean they don't get tested. A surgical mask with the N95 rating is going to do our job just fine. However, a cheapie surgical mask works very well too. It's all I've used for years. The thing NOT to use is a construction type dust mask.

SURGICAL MASKS - Neither of the above. Go to a drug store and get surgical masks. They're designed to filter 99% of your exhaled bacteria. One of those above is only good for 97%, and the other one isn't even rated. You can do much better locally.

STERILE - Kitchens are the worst possible place to work. There is more fecal bacteria floating around a kitchen than in the bathroom right after you take a dump.
I've noticed the new growers that are saying it's ok to be nasty are also buying syringes from vendors so have their sterile lab work already done by someone else. That isn't mycology folks. When you learn to harvest a crop, take prints, germinate spores on agar, isolate strains, and produce a killer fruiting strain that blows you away with its potency, you'll understand what I mean.
Lab work isn't supposed to be clean. It's supposed to be laboratory sterile. No cut corners. When it comes to spawning a bulk substrate, who gives a shit if you pick your nose while working? It doesn't matter. If the grains were properly prepared and colonized in sterile conditions to full colonization, you can spawn to bulk outdoors if you want to. When you go to the Stamets seminars, you'll see Paul build a straw log or other project outside in the open air and it works fine. However, you can bet your ass the spawn wasn't produced outdoors in the open air.
Learn to be sterile where sterility is called for, and be clean where being clean is called for and you'll be fine. I live in a 40 year old condo building in a very damp climate and my entire building is infested with black mold, and it has wall to wall carpeting. It's unhealthy for us and we're trying to sell the damn thing so we can move, but every project I've done has been done in this mold infested place, yet I can grow successfully by following the advice given above, and even filmed my video DVD here, doing lab work and growing a dozen or more species from spores to the fruiting/harvest stage. Several of my terrariums sit within 18" of a wall that has black mold growing on it, yet it NEVER grows on my cakes.
For sterile work, surgical gloves are a must, surgical mask is a must(dust masks are for carpenters, not surgeons), a still air glovebox or laminar flow hood is a must. A closed, draft free room is a must especially if you're using a flowhood, and spray the air with oust at least two or three times before starting the flowhood. I let the flowhood run for at least an hour in that closed and oust sprayed room before beginning work, which gives me time to shower, wash my hair and brush my teeth, use mouthwash, etc.
Once your spawn jars are fully colonized, you can scratch your butt while you inoculate the coir if you want. Bacteria isn't a contaminant of bulk substrates. The important thing is to learn when it's important to be sterile. If someone else is doing your sterile work for you, then don't brag about how dirty you can be and get away with it. Anybody can be dirty and get away with it under those conditions.

STERILE AIR - There are up to 600,000 contaminants per cubic foot of air in a normal room. That's a lot of little nasties to stick to your needle or the top of your jar where it will get pushed into the substrate when you inject. A room also has normal circulation and all those nasties are moving around. You can see this on a bright day when the sun is shining in through a window. You'll see the larger of these dust particles, but there are hundreds of times that many smaller ones that you can't see. A still air box stops the movement of these particles, greatly reducing the chances they'll get on your jar lid or needle. You can also improve your chances by washing the glovebox and leaving the sides and bottom wet. The moisture will attract the dust/contaminants and then they'll stick, leaving the air within, not only still, but with much less contaminants floating. You don't want a filter and fan on a glovebox. The only suitable filters for mycology are several inches thick and require a plenum behind them to build static pressure, which gives the laminar flow. If you used a filter/fan in a glovebox, the turbulence would defeat the purpose. Where a glovebox really shines is when doing agar work or grain to grain transfers. They're not as good as a laminar flow hood by any means, but they're far better than open, turbulent air. Water or peroxide. A wet surface will make the contaminants adhere to it and stick, rather than floating into your jars.

STERILE - Opinions are like something else every one has, so unless somebody wishes to quote some scientific texts to back up claims, let's not be spreading flames over our opinions. I can easily see how water

10,000 feet below the surface of the earth can heat to well over 100C without boiling. After all, think of the weight(pressure) a 10,000 feet deep well of water will exert on the water at the bottom. That's a lot more pressure then the walls of our PC's can contain. However, I doubt seriously the walls of an oven bag can exert that much pressure. There's no way to get every molecule of air out of a bag of coir or manure, even if it soaks in water for a month. In addition, even if it did, you'd be handling a bomb when you open the microwave. My background is engineering, not chemistry, so we should wait for one of the member chemists to chime in. The overall point is mute though, because sterilized substrates are much more likely to contaminate than pasteurized substrates. One shouldn't heat substrate or casing material above about 170F, or the chances of contamination are increased rather than decreased.

STERILE SYRINGES - Flaming needles is to prevent cross contamination between jars. Syringes should always be boiled before re-use. This isn't a tek, it's simply stating what has been said over and over again for years. There is also no need or reason to PC a syringe. Plastic doesn't harbor bacterial endospores, so anything that might be on a syringe will be killed off by simply boiling. You still need to flame the needle between jars. As hyphae pointed out, you certainly don't need a separate syringe for each jar.

STERILE PROCEDURE - Nobody should ever recommend inoculations in open air, especially new growers that got started in the hobby during the winter when natural contaminant counts are low. In addition, the breath of the cultivator is the biggest source of bacterial contamination, and dust masks stop zero exhaled bacteria from reaching the work area. Dust masks are intended to stop the individual from inhaling large particles such as dust and dirt when mowing the lawn, but surgical masks are called for when doing mycology work. A surgical mask is designed to protect a patient from the surgeons exhaled bacteria, which is what we want to accomplish when doing sterile work.

STERILIZING - Actually, that's a terrible idea and I cringe everytime I see it repeated. 'Sterilization' is never complete, but only gives a window of opportunity to get the grains colonized. Wait until the jars return to room temperature, and then inoculate. Glass is an insulator, so if they were even slightly warm on the outside of the glass, your spores are probably cooked and doomed. It never pays to be in a hurry in this hobby. Waiting twelve hours to inoculate is the proper thing to do, and you don't gain anything by doing it sooner.

BOILING/STERILIZING SYRINGES - Boiling water IS enough to sterilize a syringe. Plastic does not harbor bacterial endospores, and fungi like trichoderma and cobweb are killed by temperatures far below boiling. I fill a pot with water and drop the syringe in. After the water has boiled for ten minutes, pull the syringe out and suck in the boiling water, swish it around and squirt it out. Do this a few times. The syringe will be sterile enough for mycology, I assure you. I've done it this way for years.

STERILE - I'd suggest an alcohol lamp to sterilize so you won't be anywhere near your kitchen during inoculations. Kitchens are full of molds and mold producing/carrying foods such as bread and cheese, vegetables, fruits, etc., not to mention all the bacteria that lives and breeds in the sink drain and in all those hard to reach to clean spaces. There's no need to wipe with alcohol after flaming the syringe. Wait two or three seconds and inject. Work in a glovebox of course.

STERILE INOCULATION - Swabbing the needle with alcohol does nothing for the contaminants that have become lodged in the interior of the needle. In addition, look at a needle under a microscope. There's many little holes and imperfections on the surface that alcohol is very likely to miss and thus the contaminant molds or bacteria survive. Always flame before first use, and flame again between each jar to prevent cross-contamination.

STERILIZING NEEDLE FOR INOCULATION - A bic lighter is fine. A butane type lighter is hotter and won't leave carbon on the needle, but as long as you get it red hot it's fine. Allow to cool for 2 seconds and use. The needle will still be hot, but not red hot, and the first half drop of solution will cool it off safely, allowing the rest to flow cleanly. Use a glovebox.

NEEDLE STERILIZATION - The problem is the alcohol doesn't penetrate to the inside of the needle. I suggest flaming the needle red hot, then using the first couple of drops from the syringe to cool it down. That way, you know the inside and outside of the needle are sterile. In other words, heat it red hot, then allow to cool for only a few seconds and use.

STERILIZING NEEDLE - If you flame sterilize, anything you do afterward will only make the needle 'dirtier'. Why not just flame and use? Forget the alcohol after flaming. There is no need to cool down the needle. Just use hot and let the first drop or two of solution cool the needle, so the rest can flow contaminant free.

STERILE - Alcohol does NOTHING to prevent the contaminants that are inside the needle being injected into the grains. The size of the interior of a needle to a contaminant is comparative to the size of a human in a subway tunnel. Needles should always be flame sterilized.

STERILE - Spraying Lysol into the air is a waste of a good surface disinfectant. It does no good whatsoever. Use Oust to clean the air, Lysol or plain iso alcohol to clean tabletops. Other than that, it should be OK. Keep your cotton filter dry at all times or it will mold.

STERILE - If you fail to flame between jars, you can easily cross-contaminate between them. Flame between each and every jar. Alcohol is good for the surface of the jars and tabletops, but flaming is the way to sterilize a needle or scalpel, inoculating loop, etc.

STERILIZING NEEDLE - 70% is more effective at killing organisms than 91%, but in my opinion, syringe needles should be flame sterilized. Alcohol on a cotton wad will do nothing for contaminants on the inside of the needle.

STERILIZATION - Sterilization kills all life forms. After sterilization, you need to keep the substrate under sterile conditions until fully colonized or it will contaminate. That's why we use filter patch bags or jars with filters.

STERILE PRINTS - There is always going to be a few contaminant spores on every print. There's no way to avoid them unless we grew on sterilized substrates in a hyperbaric chamber.

STERILE PROCEDURE - If you're not gloved up, wash like a surgeon with good soap, preferably something with exfoliant properties, and use hand sanitizer.

STERILE PROCEDURE - Alcohol your gloves and tyvek wrist sleeves, spawn jars, flame and alcohol transfer tools, scalpels, etc.

FLAMING SYRINGE NEEDLE - If you flame between each jar, you eliminate the possibility of cross contamination.

PASTEURIZATION - Pasteurization should not be longer than 90 minutes or too many of the beneficial organisms will be killed off, thus leaving the substrate open for contaminants later. Water is a much better conductor of heat than air, thus water or steam pasteurization the preferred method. Water or steam will conduct heat into the substrate fastest, thus allowing you to more precisely control the total amount of time at pasteurization temperature.

PASTEURIZATION DISCUSSION - Pasteurization of substrates doesn't take a few seconds. It takes an hour. The idea is to kill all of the mold spores, and some of the bacteria. The surviving bacteria keep the substrate 'alive', thus reducing the chances of molds forming. A few bacteria in a substrate will also improve fruiting, and some species simply will not fruit on a sterile substrate.

PASTERUIZATION - You'll want to get your material to the proper moisture content before loading into bags or jars. Let the substrate sit for half an hour, and then re-adjust to field capacity. Oven bags are for cooking turkeys in the oven. They're not suitable for stovetop pasteurization, so use jars or filter patch bags, which don't need to be sealed first.

PASTEURIZATION - Pasteurization only kills fungal spores, leaving the beneficial bacteria intact. After pasteurization, the substrate need not be kept sterile, so it's suitable for bulk substrates such as straw and manure that are too big for filtered jars.

PASTERUIZATION - You'd have an easier time if you divided it up into several smaller bags or jars rather than one large one. You want to maintain 140F to 160F in the center of the bag for one hour for pasturization.

PASTEURIZING - You should pasteurize the coir. Some, including me have used it unpasteurized with success, but additives such as compost and/or manure definitely need to be pasteurized, so just do it.

PASTERUIZATION - Open water pasteurization sucks, at least put it in a quart jar. Reason being, because it loses nutrients and the screws up the water content.

PASTERUIZATION - I can pasterize in a Crock Pot IF I can watch and control the temp!

PRESSURE COOKER - POINT OF A PRESSURE COOKER....IN GENERAL: Canning and cooking foods faster/ with less nutrition loss.....MYCOLOGY: Makes it so you don't lose juices and all in roasts and stuff too. Steam steralization at temps higher then boiling water can exhibit.

BEST PC BULK - If you are going to give it a SERIOUS go. All American PC is BEST PC EVER. Bigger the better. Build (at least) a GLOVE BOX. Better yet a HEPA FILTERED FLOW HOOD. FIND HORSE MANURE. Learn WBS & G2G. Learn PH of casing is important.

LEAVING JARS AFTER STERILIZATION - Leaving unsterilized grains in a closed jar is a breeding ground for contaminants. The more contaminants you have in a jar, the more are likely to survive the 'sterilization' process.

GLOVEBOX STILL AIR BOX - You rarely see the old hands using any sort of 'positve pressure' box. A glove box need not be sterile or have sterile air. There is absolutely no way that a dust mask or even a vacuum cleaner hepa filter on a sterlite container with a computer fan is going to deliver better performance than a simple container with two holes cut for your arms, but otherwise closed up.
What you want in a glove box is to have zero air movement. You can lightly mist the inside air of the box with plain water, and this will attract whatever contaminants are floating around in the box to the water droplets, where they will fall by gravity to the bottom of your glovebox. After that, simply do your work wearing latex gloves. I use tyvek sleeves on my wrists, pulled down over the surgical gloves. Wash the gloves with alcohol before working. I have nothing at all attached to the glovebox. Just two 4" holes for my arms to stick through. The loose fitting sleeves seal around the holes well enough, and allows me to pull my hands in and out with ease to use my alcohol torch. (I don't like to use the flame inside the box due to excessive heat) My success rate with the glovebox described above is equal to that of my laminar flow hood. I prefer the flowhood because it's easier to work in front of and you have more room to move around.
The problem with having a fan on your glovebox is it will cause turbulence inside the box, which will keep any contaminants in suspension where they are actually more likely to land on your project than without a fan. Best of luck.
A fan is the worst possible thing you can do to a glovebox. There is also no need to spray lysol or oust in a GB. Wipe it with a damp cloth and go to work. There is nothing sterile about a glovebox. STILL air is what you want.

STERILE TECHNIQUE GLOVEBOX - You can also cut the holes so they're fairly snug around your arms, then just wear latex gloves. Be sure to wash your hands and arms first, then put on a freshly laundered long sleeve shirt to cover the skin on your arms.(dead skin cells flake off all the time and they'll have bacteria) Remember, a glovebox does not have to be totally airtight or sterile. It only serves as a place for you to open or inoculate jars or Petri dishes in a draft free environment. I haven't used attached gloves in years because they're such a pain in the butt to work in. Latex gloves give you really good control. Of course, do your glovebox work in a very clean room with no fans or air conditioners etc running.

GLOVEBOX/STILL AIR BOX - If your box is draft free, then you can skip the mask and hairnet. Most of us use simple rubbermaid totes for gloveboxes, so breathing near the lid could get bacteria inside, so watch for that and either tape the seal or use a surgical mask. The air in the room doesn't need to be sterile by any means. As long as the glovebox has still air and you've sprayed inside with water, you'll be fine. Don't use flammable stuff in your glovebox. You can mist it with your regular mister with plain water, and whatever contaminants land on the floor or back and side walls, will stick there due to adhesion.

GLOVEBOX/STILL AIR BOX - The problem working bare armed is that several thousand dead skin cells per hour fall off each arm. That is a fact of human metabolism. In fact, the overwhelming majority of 'dust' in a house or on the furniture is actually dead skin cells. If you work bare armed, those skin cells that flake off your arms now have a chance to fall by simple gravity into a jar or Petri dish. With a freshly laundered long sleeved shirt, the shirt will catch the majority of those dead skin cells, thus protecting your project. The shirt does NOT need to be sterile, so please stop confusing the subject with this silly arguing.

GLOVEBOX VS AIR FILTER - A glovebox can never rival a flowhood, although one can certainly screw up a glovebox by placing fans and filters on it.
A still air glovebox can be used with the same success rate as a laminar flow hood, but is much more cramped to work in. A flowhood gives you a sterile work space that is big enough for your elbows to move around in.

GLOVEBOX - This is why I recommend soap and water only to clean a glovebox. Lysol and alcohol are both surface disinfectants, and you don't dump spores or mycelium on the floor of the glovebox anyway so they are of no use. Since all a glovebox does is prevent drafts that would blow contamination into your work, soap and water is all that is required to clean them.

GLOVEBOX - Glovebox Hands down beats oven box, too many contaminants in your oven also theres moving air coming in and out of it because it can't be closed unless you can fit inside it :p.

GLOVEBOX - Gloveboxes need not be sterile, and I never use lysol, etc., in mine. Fruiting chambers also need not be sterile.

STILL AIR BOX - I just use soap and water to clean the inside.

TIMERS - Cheap timers won't have the switching capacity to run an air conditioner. You'll need to get an intermatic timer in the metal box from an electrical supply. Sometimes you can get them at lowes or home depot, but make sure they have the 'amp' rating that matches or exceeds the nameplate 'amps' on your AC.

BOOKS - The Journal of Medicinal Mushrooms has as it's editor in chief, Mr. Solomon Wasser, and on the editorial board, another 'lay' person, Mr. Gaston Guzman. Perhaps you've heard of those two?
The issue I'm holding in my hand has articles from such 'lay persons and hobbyists' as Paul Stamets, Christopher Hobbs, John Holliday, Gaston Guzman, Toshihiro Hashimoto, Soloman Wasser, Gregory Plontnikoff, Daniel Winkler and others too numorous to mention.
I feel strongly on a board focused on mycology we should concentrate on mycology and not vulgarity, however, feel free to call it whatever you wish.

BOOKS - I'd recommend both of Paul's cultivation books. The Mushroom Cultivator for a good basic mycology course, and Growing Gourmet and Medicinal Mushrooms for some more advanced tips, correction of a few mistakes in TMC, and detailed descriptions and pictures of common contaminants. These are mushroom growing books, not specifically psilocybe growing books. Those I've seen that only show how to grow cubes are lame and inaccurate at best.

DAMAGED FRUITS - Anytime a spot forms on a cap from damage, it's there forever. It won't 'heal'. The fuzz on the stem is fine, and doesn't mean humidity is too high. It seems to happen with some strains/substrains. Look closely at what you see. Think about when you hit your own body on something and it bruises. The color you see is your actual skin color. That's bruising. Now think about when you get a bad scrape or cut and if forms a scab. The scab sits above your skin as a separate layer. A scab on your body corresponds to mold on your substrate. The mold will be a layer above the substrate.

DISTILLED WATER - Everybody knows about the pure distilled water in a clean, smooth container being able to be superheated slightly above 100C and remain liquid. There's dozens of demonstrations on youtube and others. However, coir or anything else mixed with water can NOT be heated above 100C without the water changing state to a gas. It doesn't matter if there's any air above the water or not.

EXPERIENCE - I found this "dust" of *Bacillus thuringiensis* for begetables. It was not labeled for fungus gnats, and it was not the substrate of this species indicated for controlling fungus gnats. It was really for chewing caterpillars, etc. It's called "Dipel 150 Dust." Five bucks for a pound. The values for treating soil are absurd (too low for me to apply to a casing) so I took a tea-straining teaspoon (one of those latch-and-strain teaspoons) and put it down in the container the bacillus dust and clipped it shut against the side of the container (while still inside) then brought it out and shook it over my casings. There was a layer of this dust that sort of looked like a fine, white snow. I applied this once, then a couple of days later again, then about a week later again. I applied it 3 or 4 times, and, as the bacillus thuringiensis propagated and interfered with the life cycle of the fungus gnats, the adult population began to wane. Over the course of around a month, I've gone from gnat-body-littered stickytape traps changed once a week or so, to, no visible adult gnats in the terrarium. It appears this particular product, though it takes a few weeks, will effectively disrupt and wipe out the fungus gnat life cycles on casings.

EXPERIENCE OF ROGERRABBIT - 36 years. In 1971, I brought home a cow pie that had cubes growing on it because I could see 'mushroom roots' covering the whole bottom of the patty. I mixed it into my compost pile and forgot all about it until the fall rains came when I found hundreds of cubes all around the base of the compost pile. I've been hooked ever since. It actually took me well over a year to learn that mushrooms don't have roots. There were no books on cultivation at the time, and of course no internet. The Dallas, Texas public library was my only source of information. I finally found Alexander Smith's field guide to western mushrooms in the mid 70's, and learned a lot about mushrooms from that, even though it's not a cultivation book.

FIRE FANG - Actinomycetis. It will also grow on coffee grinds if you store them for any length of time.

GNATS/FLIES INFO - They love the fruit bowls and anything else sweet. They're attracted to the smell of the mycelium, but they don't usually breed in our projects. They rarely cause much problem unless they're there by the thousands. I've never had a single contaminant that I could blame on them and I live in fruit fly/gnat heaven. Normally, they breed in your houseplant soil and then fly out to your mycelium to feed. Fruit flies have about a 20 to 30 day life span. They go from egg to larva to adult flies. The adult stage is about 7 to 10 days of the span & in that time, 1 adult can lay about 700 to 800 eggs. The flies do not lay eggs at temperatures below 54 F (12 C) or above 91 F (33 C).

HALF GALLON - Half gallon jars often go anaerobic in the centers. It's also harder for the CO_2 to escape the larger jars. Personally, I don't use anything larger than quarts, even though I have five or six cases of half gallon jars in storage. Try leaving the jars laying on their sides. Next grow, I'd suggest quarts for grains. In addition, the larger the container, the drier you make the grains. You'll use about 20% less water(per measure of grain) with half gallons than you'd use with quarts.

LAUNDRY BASKET TEK DISCUSSION - By Visions method if I remember correctly, you're not supposed to mist the sides. Let them dry out, and the dry straw serves as the contamination barrier. He poured water down from the top. I do it a bit different by placing in a bag or large tote with holes cut into it for gas exchange. This keeps the CO_2 levels higher during colonization, which actually prevents the mycelium from turning as much of the substrate carbon into CO_2, which reduces the size of the substrate greatly. About a week after full colonization, I introduce to the normal fruiting conditions of high humidity and lots of air exchange. I don't fruit them in open air unless it's the rainy season outdoors, in which case I set them on the back porch to fruit. You can see a short, low resolution preview video of the way I do it on my website.

LABELING - My system is to list the date first, parent species second, then strain third, and then each transfer beginning with the letter 'A' and going through the alphabet. Assume the species is Reishi, and the strain is my 'sheriff' (sherrif strain got its name because a dumbass sheriff gave me a bogus ticket the day I cloned it, but that's another story). A swipe of spores made today on agar would be labeled 042607RS. Assuming three days from now I make a series of transfers of the first mycelium to germinate from spores, they would be labeled 042907RS A1, B1, C1, D1, etc. As the strains differentiate, the next series of transfers would be labeled (date)RS-A1-A, (date)RS-A1-B, etc. From the second original dish, the second set of transfers would be (date)RS-B1-A, (date)RS-B1-B, etc and right on down the list. It's important to be consistant with your system all the way to fruiting because when you find that awesome fruiting strain three months from now, you want to be able to go back to the original dish in the refrigerator that corresponds to the fruiting tray, pull it out and make a master culture slant from it. That way, you preserve the genetics of a great strain from a very early time in its life before many cell divisions have occured.

LEARNING - Agreed. My bitch is that when people move to edibles/medicinals they have to un-learn all their bad habits, essentially starting the learning curve all over again. With cubes, they'll fruit on just about anything, regardless of how you prepare the substrate, so they're like learning to ride a bike with training wheels. However, if you don't learn to ride without those training wheels, you'll look awfully silly someday when you grow up and have to bolt them on your harley. That's why I suggest pasteurization of bulk substrates and casing material. However, this has all been covered before, so do a few searches and you'll find all you ever wanted to know from both sides of this coin.

LOOKING FOR A MICROSCOPE - If you want good pics, get ready to spend some bucks. I've got a few cheapies that just sit on the shelf, and never get used anymore. You won't get quality for less than $1,000 and that's the low end. A decent C-mount microscope camera is going to cost $2,000 just for the camera. In fact, the camera will cost more than the scope. You can pick up a pretty good scope for $1,000 whether you want zoom or light microscope. I actually use my zoom more than the light in mycology. The zoom microscope is great for looking at mycelium on Petri dishes, gills on mushrooms, and other stuff like that. If you want to see on the cellular level, you'll need a light microscope and a box of slides and covers. I had a whole section on microscopy filmed for my video, but had to cut it out because there just wasn't enough room on the 2 dvd set for it. Perhaps it will fit into one of the future releases. I'm already working on the next one. Stereo microscopes are for looking at something from the top. The lens and the light are on the same side of the object you're viewing. Stereo microscopes are for looking at gems, coins, bugs, and mycelium on a Petri dish to examine for contaminants, etc. A zoom microscope is a stereo microscope with an adjustment to vary the magnification without changing lenses. Maximum magnification with stereo-zoom and zoom microscopes is usually around 20X to 30X. I have a pretty high end zoom microscope that goes to 50X, but the field of view at that magnification is pretty darn small, defeating the purpose of using a stereo microscope in the first place. A light microscope has the light on the opposite side of the lens from the object you're viewing, thus you see the light that shines through the object. Laboratory and medical microscopes are the light type. If you want to examine the internal structure of spores, or view mycelium to look for the number of nuclei in each cell or to look for clamp connections, you'll want a light microscope. If you order a stereo microscope, be sure to get LED lights, even if they're more expensive. Coin collectors and jewelers can use the cheaper halogen that seems to be standard on stereo microscopes, but the heat will cook your mycelium, and if you look at something inside a Petri dish, the dish fogs up in three or four seconds from the heat, blocking your view. There's some pictures taken with a light microscope on my website on the introduction to mycology page http://www.mushroomvideos.com/1811640.html along with the mushroom gill shots which were taken with a zoom microscope, and the basidia pictures at the bottom of the page were taken with a scanning electron microscope. The pictures of verm and perlite in this thread:
http://www.shroomery.org/forums/showflat.php/Number/6610766#Post6610766 were taken with a stereo zoom microscope.

MUSHROOM FARMER - I know the owners of several local mushroom farms in my area and every single one of them got their start with growing magic mushrooms, then went into the legal business. They're business people and hard workers, but far from prudes. Just put down that you have experience and cautiously decline to talk about species during the interview and they'll get the point, but at the same time know you're being discrete. None of them will hire someone who brags about psilocybes because that could bring heat on them. That said, most of the jobs at mushroom farms are just labor. There's lots of compost to turn, trucks and tractors/forklifts to drive and floors to sweep and high pressure wash. Unless you get a job in the 'lab' it isn't going to be much to do with mushrooms unless you're a picker, and in that case you have to learn to work very fast, which is darned hard work, and stops being fun after the first fifteen minutes.

MUSHROOMS FALLING OVER - It's substrain related. Very good tendency in my opinion, because little damage is done to the casing layer when they fall over or are picked.

MYTH - Early mushroom growers followed on the agaricus farmers knowledge and grew their mycelium in the dark and had good results. Therefore, the wrote that mycelium should be 'incubated in total darkness' and that myth is being repeated thirty years later, even though it is just plain wrong.

MYTHS - Myth: If you can see the tray, it has enough light.
Reality: Bullshit. Bright, high frequency light is much better. Natural daylight fluorescent or metal halide will give the best pinsets.
Myth: You only need a few minutes of light per day.
Reality: Bullshit. 12/12 has been proved for years and years to be many times better.
You don't find the experienced growers making those silly statements. Fluorescent light.

NOOB SPEACH - Sure, you can half-ass the light and still get a crop. You can half-ass a substrate and still get a crop. You can half-ass a fruiting chamber and still get a crop. You can half-ass on air exchange and still get a crop. You can half-ass on humidity and still get a crop. However, if you skimp on all of them, you get nothing. If you work hard on every aspect of growing, you'll get spectacular results. That's why those of us who know try to advise on the best ways to get the results most of us are looking for.

NITROGEN - Don't use urea. If you feel you need a nitrogen boost, use chicken manure, but at no more than 5% of the total bulk substrate. Make sure the chicken manure has cured in the sun for at least a week or two and has zero smell. Otherwise, spread it out on cardboard in the sun until it's dry and odor free.

NITROGEN ONLY WHEN COMPOSTED - Don't use blood meal because it doesn't do much good unless it's been composted in a pile. Fish emulsion does no good at all. Remember, mushrooms are not plants and need to eat their food to get energy. They don't get energy from the sun, so fertilizers are useless.

NEMATODES - One needs to be careful handling nematodes and growing mushrooms. Many species are death to fungi, while other types of fungi can trap and kill the harmful nematodes.

PAN CYANS - Grow them exactly like cubes, except use a thinner substrate of horse or cow manure no more than 2 inches thick, and a 1/4" peat based casing layer. Other than that, don't do anything different. They're not as cold temperature tolerant as cubes, so try to keep fruiting conditions in the 75F to 85F range. They usually take a few days to a week longer to pin than cubes as well. Shotgun terrarium will work fine. I don't like them anymore. The trip always seemed a bit on the dark side, not pleasant at all in my experience. Good luck.

PENIS ENVY - PE's don't pin well unless you do strain isolations and find a really good fruiting isolate. What you have is about average pinset for multispore inoculation.

POPCORN - Colonizing twice as fast isn't necessarily a good thing. If the mycelium is starving, it will search for food. Since the vermiculite is inert, it won't find it. We see the same thing when people use popcorn for spawn. The jars colonize twice as fast as rye, but have only half or less as much mycelium per jar. There is no advantage.

PSILO - As we know, when mushrooms grow, they don't grow by cell division. The cells expand as they engorge with water. A small pin has all the cells it will have as a large mushroom. That's why a small fruit has nearly as much actives as a much larger fruit. The larger fruit is engorged with water, thus it's less potent by weight. That's a fact. Five grams of small mushrooms are far more potent than a single five gram fruit. That's also a fact. The picture of fahtsters above is in the pinning stage. Only a few of the caps have started to tear the veils. The picture from 24 hours later is on my video, and they're quite a bit larger. All bs aside, you don't compare the size of fruits from a four to six inch deep substrate to fruits from a half pint cake. This argument will be going on long after we're all dead and buried. I just won't have people trashing teks because they're unable to pull off grows with them. Ask any long-time grower who has used all methods, and most will tell you for large amounts of fruits, go with bulk substrates such as manure or coir. However, most of us aren't into selling mushrooms, and a few cakes are more than enough for personal use. There is no difference in potency between mushrooms from cakes and from bulk substrates, unless one lets the fruits from the bulk substrate get very large, at which time they're considerably weaker. Think of it like a balloon. If you blow it up bigger, you don't increase the amount of rubber in it.

SCLEROTIA - Sclerotia is a much better experience, and the taste doesn't gag you at all. I've found mexicana to be much more like acid than mushrooms. It's a cleaner trip, without the body numbing that makes it hard to move or communicate with cubensis. I've also found sclerotia to be a much more spiritual trip than cubes. In addition, it's shorter lasting, so it's not out of the question to do on a weeknight, when you have to be at work the next day. They're my favorite, along with ps cyans. I use rye berries, but they're simple as pie to clean up. Simply take a stone in your hands and rub the grains off with your fingers. The texture is similar to nuts, and the mushroom taste is mild and not unpleasant at all.

SPEACH - You want your grain master to be fully colonized, then bang it a few times against a fully inflated tire to separate the kernels. With the kernels separated, you can carefully pour the loosened grains from the

master to the receiving jar. Be sure your receiving jars have been prepared no more than 2/3 full, so that you can pour a tablespoon or two worth of grains from the master without overfilling the receiving jar. No jar should be filled more than 3/4 full after the g2g transfer, because you need room to shake it later.
Hopefully, you have a flow hood, but whether you're using a flowhood or glove box, try to get the transfer done within just a few seconds to limit the amount of time the lid is off each receiving jar. With time and practice you'll develop a technique where you twist the master jar as you pour so the grains will flow out smoothly.
Don't be distracted by the pictures of Paul doing g2g with bare hands. I cringe everytime I see those. Wear latex gloves and wipe them down with alcohol after putting them on. Also, wipe down the exterior of the master and receiving jars with alcohol before the transfer to limit the chances of contaminants from the exterior finding a way inside.

SPIDERS - Don't kill the spiders. They eat fungus gnats that WILL cause you problems. A grow chamber need not be sealed up, nor sterile. You want air exchange to prevent trich and cobweb, so naturally the gnats will get in, and so will the spiders. Spiders are our friends.

STORING REFRIGERATOR - Often, a grower puts a tray in the refrigerator, and a few days later gets pins. Thus, the connection is made that the drop in temperatures caused the pinning. It makes sense right? However, what if he had a tray that he exposed to a ten degree temperature rise and a few days later he got pins? Could he not make the same case that the increase in temperature caused the pinning? In fact, this is what happens in nature. A summer rain(thunderstorm) comes, which 'dunks' the substrate, and then when the sun comes out, the mushrooms pop up very fast, often in 80's and 90's degree temperature. One could make a very good case that in nature, it's the increase in temperature that stimulates the pinset. It's a survival mechanism. They need to spread spores before the mycelium dries out again. I've done both of the above scenarios dozens, if not hundreds of times to get to the bottom of this. That's the reason I say what I do that temperature drop does not play a part in the pinning strategy of tropical species. In fact, some of the best pinsets came when fruiting conditions were five degrees or more warmer than colonization temperature. Cold shocking is the signal that fall fruiting mycelium needs to begin producing fruits. Shiitake, P. cyanescens, P. nameko, etc., to name a few require a cold shock to fruit. Cubensis, H. ulmarium, Pan Cyanescens, etc., do not require a cold shock. The above is not to discourage experimenting in any way. However, get your ducks in a row, and have many duplicate projects made exactly the same way, and spawned, colonized, cased, etc., exactly the same way, and then cold shock some, and increase temps on others. Keep controls that fruit in exactly the temperature they colonize in. From my experience, if you do the above, your results will vary. Sometimes the cold shocked tray will fruit sooner, but other times later, often much later. Ditto for the other parameters. This is what has led me to my conclusions. The other pinning triggers of full colonization, increased air exchange, and near 100% humidity far outweigh temperature considerations. Good luck to all. Experimenting is how we learn. I store master slants in the refrigerator for years at a time. I've never had one single invitro mushroom from a tropical species ever form in a slant. Cause and effect can be tricky sometimes. For example, if you get drunk as snot and drive, you're more likely to get in a car accident. However, what if you have a cup of coffee in the morning and then get in an accident while sober? Did the coffee cause the accident, or was it just 'your time'? My experience says a tray that fruits after being put in the refrigerator was about to fruit anyway. The fridge probably delayed it by a day or so in fact. There used to be a mindset that mycelium could compare to weed, where (in the case of weed) changing the photo period would signal a change from vegetative growth to flowering. It was thought that a temp drop would change mycelium from vegetative growth to fruiting. However, after many side-by-side tests, I've personally ruled out such a phenomena, so I pass that info along. Feel free to experiment to either prove or disprove the above. In no way do I consider my experiences the last word on the subject. Mushroom cultivation, especially when compared to crop farming, is in its infancy and we're still learning.

STORAGE MYCOLOGY - Or, spend $99 and buy a dorm type refrigerator brand new, and never put anything but mycology projects and unopened cans/bottles of beer in it.

STIR BARS - Latex tubing can be used over magnetic bars in order to lower the noise of the magnet.

SUGARS - Dextrose and Karo are pretty much the same thing, Glucose.

TEMPERATURE - Water boils at 212F/100C. You can't boil at 300F without a LOT of pressure. It doesn't matter how hot your stove is or how rapidly the water is boiling, it will be at 212F/100C.

TERRA SORB WATER CRYSTALS - Terra-Sorb Terra-Sorb is a "water crystal" made from a synthetic polymer related to super glue. This brand is made from potassium and there are others made from sodium. The crystals can absorb 400 times their weight in water, and then release it slowly back into their surroundings. They have been tested and shown to be non-toxic and environmentally benign. They have been used in mushroom cultivation and shown to not incorporate themselves into the fruit at all. Over time they will just break down to carbon dioxide and water. They drastically reduce the need for misting a casing and in some instances will eliminate the need all together depending on the fruiting chamber. Just looking for anyone's experience first hand with this product. It is not a secret that it works or exists and given it's ability I would think many others before me would have tried it.

THE WAY IN - Mutlispore innoc, day six.
5 squirts, 1 each corner, 1 down center, about 2.5 cc per jar.
agar is GREAT, because you can tell if any culture is contam'ed - or not.
Liquid Culture (LC)is fastest - I ever had.
Matter of fact, once tried LC straight into pasturized compost substrate, supplemented with 25% PC'ed bulk WBS.
Worked GREAT (but, must have very aseptic enviro to incubate in).

TROPICAL SPECIES - It's well known that cold damages tropical species and thus they should never be 'cold shocked'.

BETTER, FASTER, CHEAPER......TRUE STORY - You cannot get

VOCABULARY - Spawn: Noun form: Grains, brf, etc., fully colonized with mushroom mycelium.
Spawn: Verb form: To mix the above defined colonized grains into a substrate.
Substrate: Manure, compost, coir, coffee grinds, etc. Substrate is the food the mushroom mycelium eats. In the case of brf cakes, the brf is both the spawn and the substrate.
Casing: The non-nutritious, moisture-holding layer we place on top of a substrate as a water reservoir to supply the substrate with the extra moisture it needs to support the developing flush of mushrooms.
Patching: Applying a small amount of casing material over the mycelium that is poking through the casing layer. This allows that mycelium to continue growing, while waiting for more mycelium to reach the surface of the non-patched areas. This results in a more even pinset.

WHAT IS - A pf jar for example is a substrate when fruited directly from the cake. However, a pf jar is spawn when used to inoculate manure or straw, etc.
Rye is a spawn when used to inoculate manure or straw, etc., but is a substrate when cased with peat-verm or verm-coir, although coir is better suited as a substrate than a casing material. If you mix the rye in as an inoculant, it's spawn, but if you lay it in a tray and apply a casing layer over the top of it, the rye becomes the substrate.
A bulk substrate is a large amount of material that supports mushroom growth that you spawn your mycelium into. Bulk substrates can be manure, straw, coir, worm castings, coffee grinds, etc. Grains can spawn to a bulk substrate, or serve as the substrate, but are never considered a 'bulk' substrate.

WHAT IS SPAWN - Spawn as a noun is the grains or other material such as brf cakes that are fully colonized with mushroom mycelium.
Spawn as a verb is the act of placing those fully colonized grains into another uncolonized substrate for the purposes of expanding mycelium mass.
Spawn as an adjective is used to qualify a noun. Thus when used as "the spawned substrate", substrate is the noun and spawned is the adjective form of the word spawn.

HARVESTING

HARVESTING - When harvesting your trying to get good food grade. Fruiting in the low 70's is perfect which benefits by giving better fruit quality. Harvesting your mushrooms should be easy on the casing and gentle. Gentle twist & pull is best. Object is to MINIMIZE casing cover damage. But, getting out clumps of shrooms, often leaves divots. Which you patch. Try not to leave any broken stem. Because that exposed tissue invites contaminates & rot. Better to have a divot in casing, which can be patched. Rather than leave torn stem tissue exposed. Good practice to pick those big fuckers, they take the uumph out of the rest of the flush. With practice, you'll develop a technique for twisting and pulling the mature fruits off that does very little damage. You can even hold a fork or spoon on the casing layer next to fruits you're picking to help hold the casing in place. Food quality is best just prior to the veil tearing. They just seem to go down easier, without that 'make you puke' horrible taste. When Picking A Flush: Remove the aborts, but leave any healthy looking pins. They'll start growing when you pick the present flush. You pick the fruits as they're ready. There is no reason to pick them all at once. You don't pick pins/primordia because they're required for the next flush. Air Dry! Then Put In Dehydrator They'll shrink a lot and let you put more into the dehydrator.

HARVESTING - Food quality is important. If you gag on every bite, then sit during your come-up time trying not to puke, it's no fun. There is no increase in the number of cells in a mushroom after the veil tears, therefore no new active compounds are made. The cells that are already there simply fill up with water. That means the actives that are in a freshly opened cap are the same actives that are in a huge, umbrella shaped, black spore covered cap, but you have to eat more to get them. When we say there is little to no loss of potency, that's what we mean. None was lost, but none was gained either. Only mass was gained, thus you gag more for the same amount. That's what I mean by poor food quality. As for developing allergies, mine have all come in the last few years as I've researched many species. I often have a few hundred jars and up to several hundred spawn bags going at any one time. This has been my full time job since I've been working on my dvd. I quit my job over a year ago, so I've been exposed to a lot of mushroom spores in that time. All of them legal edibles, by the way. The worst for causing allergic reactions is Hypsizygus ulmarium, but cubensis spores will clog up a humidifier filter in no time, and ruin the motor bushings as well. Cube spores will also foul hygrometers, and if you have a computer in the room with your grow, it will destroy the cooling fans, and if they get into the hard drive, will destroy it as well.

HARVESTING - Removing large chunks of substrate is from carelessness. You can easily back up the substrate with two fingers of one hand while twisting and pulling with the other. If the fruits are very well attached, simply do what the commercial farms do and cut the base off with a knife, then remove the stump later. Cut the stem off right at the substrate level and leave the stump there. Remember, mushroom tissue is mycelium. Anything below the substrate level doesn't need to be removed anyway. The strength of the mushroom/substrate connection is strain related, not casing/no-casing related. I have an isolated strain that the fruits fall over and unhook themselves from the substrate just as the veil tears, whether cased or not. That quality comes in really handy when I'm on an outside job working long hours.

AFTER A FLUSH HARVESTING - After picking a flush, allow the substrate to 'rest' for several days to a week. Let it dry out somewhat during this time. A substrate will not flush again right away. After the 'rest period', give it an overnight soak to bring the moisture content back up and place into fruiting conditions. Dunking right away is counterproductive because the mycelium is dormant for a few days and the dunk only supplies moisture to the contaminant molds that might be present, then it dries out before that moisture is actually needed for the next flush. Never leave a substrate that is flushing without air exchange. It will suffocate and die.

AFTER HARVEST - After harvest, it's a good idea to fill any divots created by picking with fresh casing material. Don't wait for it to colonize, because it rarely will. Don't re-case. Trays can be soaked for a few hours under running water. Just let the faucet fill up the tray and gently run over the sides and down the drain. Use jars of water or rocks to hold the substrate from floating. After four or five hours, most substrates will be re-hydrated. I like to wait up to a week after picking a flush before doing the above. During this rest time, allow the substrate to dry out a bit, and then soak as above and return to fruiting conditions.

DRYING - If you choose to use desiccant, it's best to fan or air dry for a couple of days first. When you use desiccant, be sure to have the desiccant lifted off the floor of the tupperware or other container, so that moisture that drips from the fruits can run through the desiccant to the bottom of the container to collect. This will prevent the premature saturation of your desiccant layer.If the fruits are for use within a few days or so, just leave them in front of a fan until then. Dehydrators and desiccant are mainly for when you wish to package them up for later and need to make sure they're especially dry to prevent molding.

HARVESTING - Pick all the mushroom tissue when you pick a flush. Don't leave pieces behind. You can fill the divots with fresh casing material but don't recase the whole thing because it won't colonize anyway. Your mycelium has already gone from colonization mode into fruiting mode. I like to let a cased substrate sit for a week after picking to 'rest'. The reason is that they rarely flush right away anyway, so by letting it sit for a few days to a week, then watering heavily or dunking, you get an immediate second flush. If you water it heavily right after picking, it just sits there wet, which can encourage molds.

HARVESTING - Do NOT pick all the pins from the casing layer. Often, pins for the first two or three flushes are set at time of first flush. Picking them ruins future flushes. You can't pick individual fruits from a cluster without using a knife. Simply grab and gently twist the whole cluster, and it will come off as one piece. Be careful that you don't also pull up a large chunk of your casing layer.

HARVESTING - Mushrooms that are picked small and immature will be more potent by weight than they would be if allowed to fully mature, and that's a fact. As the cells engorge with water, there's no evidence that they increase in potency as well. The 'veil tearing' is just a signpost along the way that indicates a good time to pick. It has nothing in and of itself to do with potency.

AFTER FLUSH - After picking a flush, it's a good idea to let the substrate sit idle for a week, and even to allow it to dry out a bit. After a week, soak it for six to twelve hours under water to re-hydrate. We refer to this as 'dunking'. After the soak, place it back into fruiting conditions, and the second flush usually pops fairly quick, provided the substrate has no contamination.

AFTER HARVEST - Nothing is set in stone, it's just something I've observed with lots of species. Most don't flush again for several days anyway, so during the time, let the substrate rest, and then give a soak to rehydrate and set back into fruiting. It more closely simulates natural the environment they evolved in, and helps to send out a stronger flush.

STORING - Cracker dry, then stored in vacuum sealed bags with oxygen absorber and food grade silica gel packets in each one. They'll keep for many years without degradation that way. I recently opened some from 1996, and there was NO degradation that could be detected after ten years of room temperature storage.

CASING AFTER HARVEST - Patching the divots is the right move, but the new casing material will not colonize, so don't wait for it to. After picking, I suggest letting the substrate sit untouched and dry for a week to recover, and then soaking for a few hours to rehydrate, then return to fruiting conditions.

HARVEST - You can pick individual mature fruits from a cluster by cutting them off just above the base with a sharp knife. Don't wiggle or otherwise stress the rest of the cluster. The aborts will sit there just fine until the remainder of the cluster is ready to harvest.

HARVESTING - The most bang for the buck comes from small fruits, prior to veil tearing. Even pins are great, and that's why you hear about aborts being so good. It's not because they aborted, but because they're at peak potency/gram at the pinning stage.

HARVESTING - With practice, you'll develop a technique for twisting and pulling the mature fruits off that does very little damage. You can even hold a fork or spoon on the casing layer next to fruits you're picking to help hold the casing in place.

DRYING FRUITS - I've never used a dehydrator. Lay your fruits on a piece of cardboard and put a large box fan in front of them. When dry, transfer to Tupperware with desiccant for 24 hours to finish up, and then seal in vacuum pac bags.

AFTER HARVEST/CASING - Fill in the divots with fresh casing material. Don't scratch or re-case the whole thing. The mycelium is in fruiting mode so won't colonize any casing material you add now.

HARVESTING - You pick the fruits as they're ready. There is no reason to pick them all at once. You don't pick pins/primordia because they're required for the next flush.

HARVESTING - When Picking A Flush: Remove the aborts, but leave any healthy looking pins. They'll start growing when you pick the present flush.

HARVEST - I prefer to pick just prior to the veil tearing. They just seem to go down easier, without that 'make you puke' horrible taste.

HARVESTING - Air Dry! Then Put In Dehydrator They'll shrink a lot and let you put more into the dehydrator.

HARVESTING - Good practice to pick those big fuckers, they take the uumph out of the rest of the flush.

DONE! I WANT THIS TO DISPUTE ANY BAD CULT ADVICE EVEN THOUGH THEIR ARE SOME MISINFORMATION OF SENTENCES AND OUTDATED INFO SO CHOOSE WISELY. PLEASE NO RATINGS. THIS IS SOMETHING I DID AND TOOK 3 MONTHS IN THE PROCESS.

Psilocybin Magic Mushrooms Growers Guide

by

O.T. Oss & O.N. Oeric

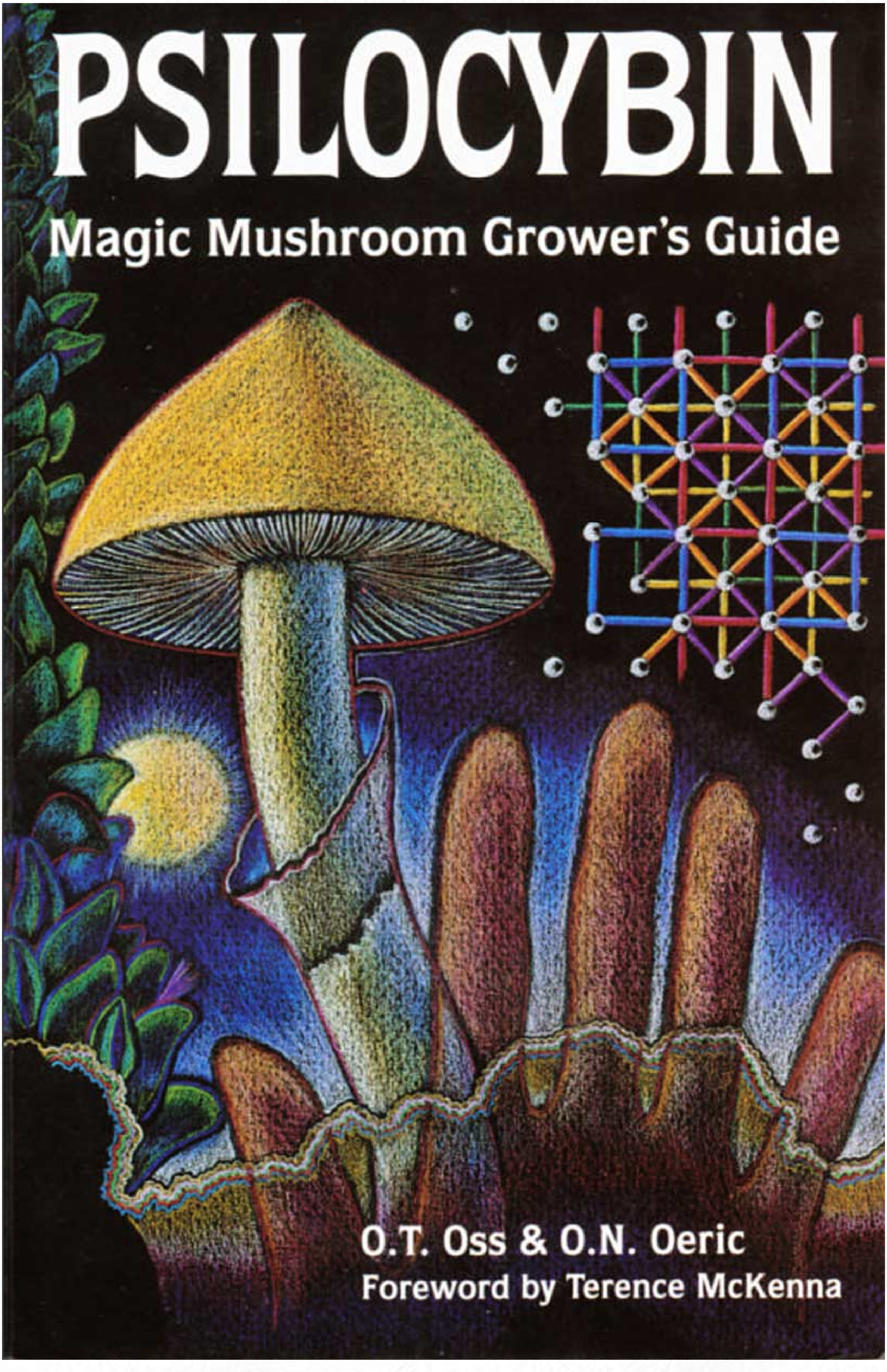
A Handbook for Psilocybin Enthusiasts

Drawings by Kat
Photography by Irimias the Obscure

original source: http://www.psilosophy.info/resources/Psilocybin.magic.mushroom.growers.guide.pdf

Table of Contents:

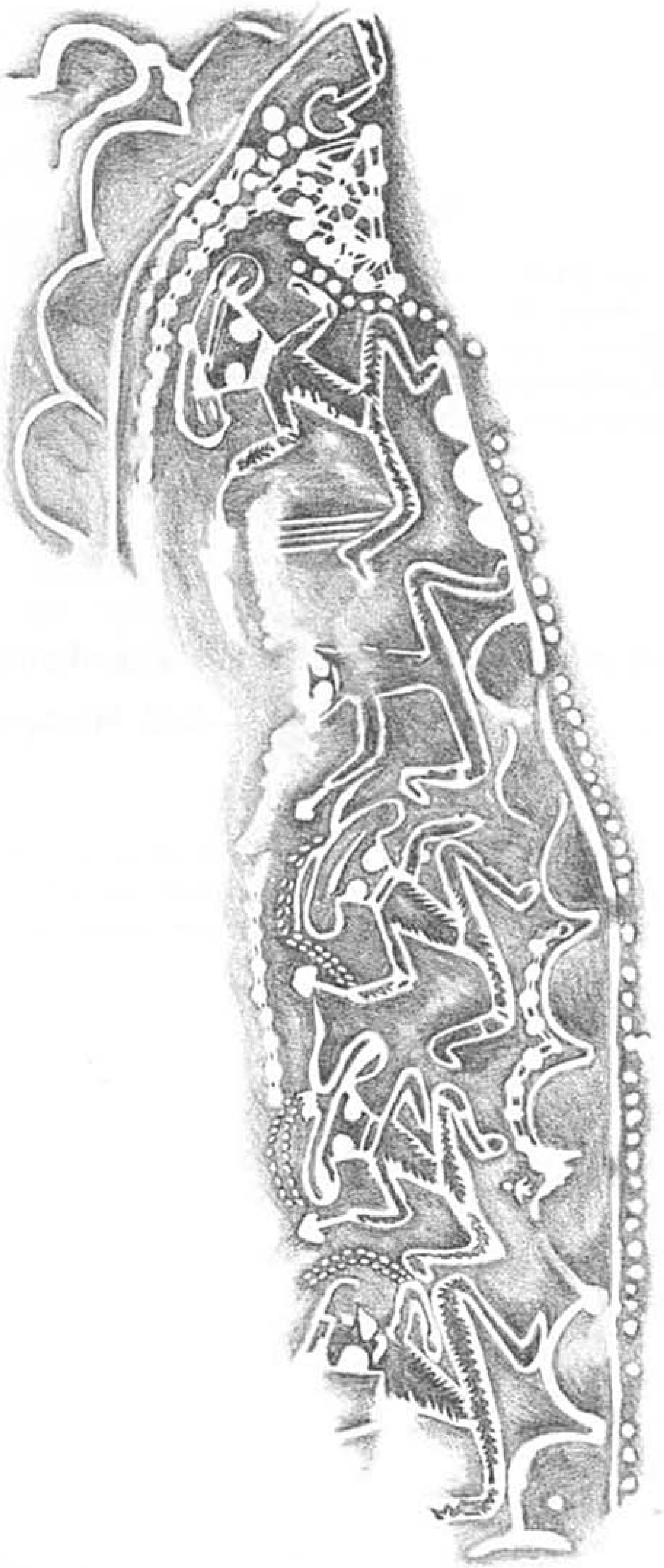
Preface to the Revised Edition
FOREWORD - by Terence McKenna
INTRODUCTION
STEP I - LOCATING AND IDENTIFYING THE FUNGUS: COLLECTING AND GERMINATING SPORES
STEP II - GROWING STOCK INOCULA
STEP III - GROWING ON STERILIZED RYE
STEP IV - CASING AND RECASING
STEP V - HARVESTING, PRESERVING, AND DOSAGE
AFTERWORD
CONVERSION TABLE
A CHRONOLOGY OF PSILOCYBIAN MUSHROOMS
BIBLIOGRAPHY
GLOSSARY



PSILOCYBIN

Magic Mushroom Grower's Guide

O.T. Oss & O.N. Oeric
Foreword by Terence McKenna



Rock painting from Tassili Plateau, Southern Algeria, circa 3500 B.C.

DEDICATION

This book is respectfully dedicated to R. Gordon Wasson
and Albert Hofmann, whose investigations of the botany
and chemistry of the
magic mushroom brought psilocybin to the world.

"At last you know what the ineffable is, and what ecstasy means."
R.G. Wasson, 1972

Preface to the Revised Edition

It is not often that something as fragile and culture-bound as a religious mystery can rise from the ashes of near extinction. Even the natural life of a religious mystery ends finally in erosion of connection to the mysterious driving power of some archetype. But few religious mysteries exist long enough to experience this decadence. Most are suppressed by dominant orthodoxies already in place or recently imported through conquest. This latter situation is an apt description of the status of the mushroom religion of Meso-America at the time of the Spanish Conquest.

In the case of Meso-American mushroom use, an ancient shamanic religion - of which we know next to nothing - confronted a Spanish Catholicism whose relatively advanced technology meant complete subjugation of the people, complete breakdown of the ancient gnosis. Practitioners of the mushroom cult were burned as heretics. The Indians' insistence on the mushroom as the "flesh of the gods" must have particularly excited the heretic-hunters and perhaps left them not a little uneasy as they went about their bloody business. After all, "flesh of the gods" is a claim explicitly made for the Christian Eucharist, yet it is not nearly so effective a visionary vehicle as the persecuted mushroom.

The use of the mushroom retreated to the remote mountainous peripheries of Spanish Mexico. The ritual itself was all but lost under a layer of Christianized associations. The mushrooms were called "Jesus" or "St. Peter" - their old names, names of the planetary gods of the Mayans, forgotten.

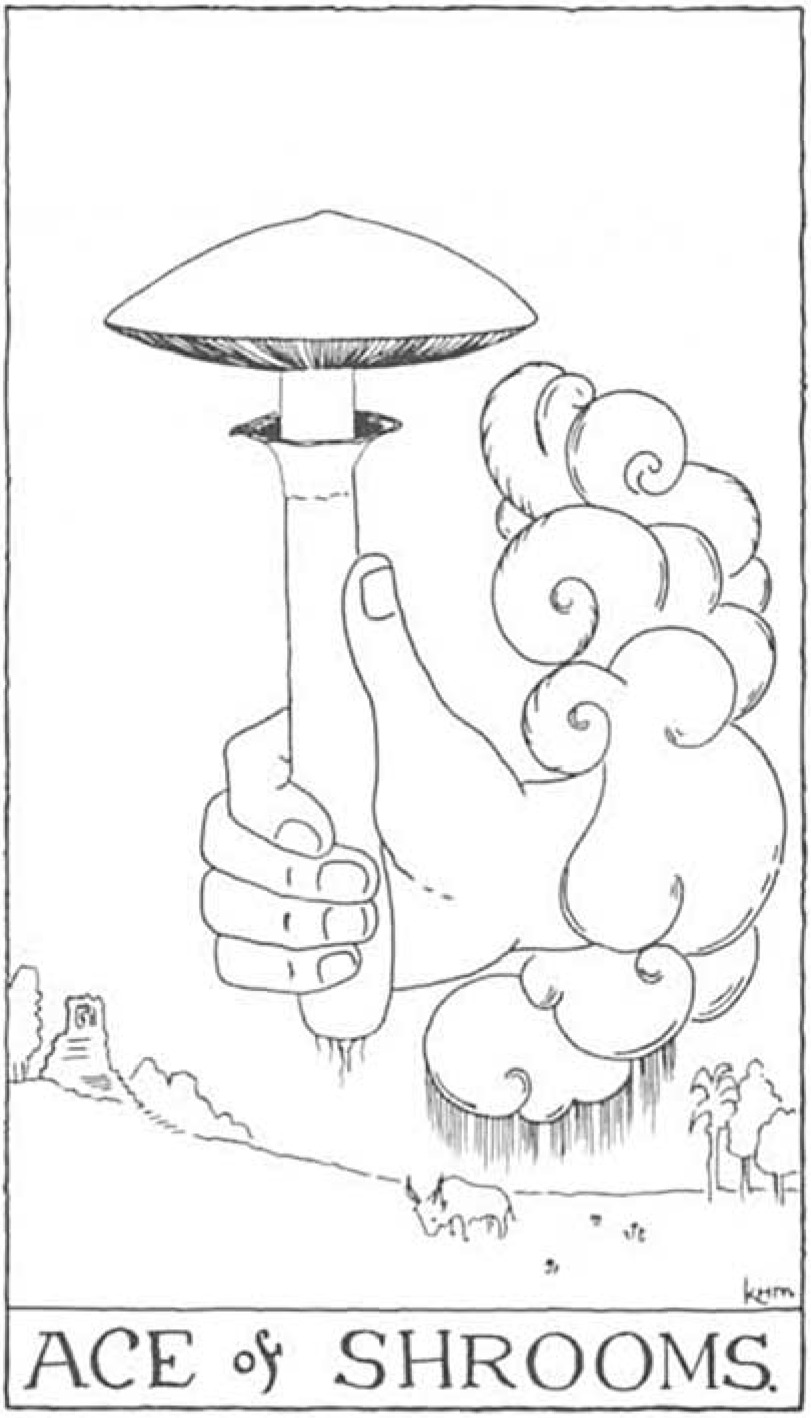
Thus the matter stood for centuries. In the 1950s Wasson made the initial discovery of the slumbering mystery, and more than two decades of mostly academic "ethnomycological" study followed. This book, first published in 1976, opened a new phase in the rebirth of the mushroom religion by placing the knowledge of cultivation into the body of publicly available information. More than a hundred thousand copies of this hook have been sold, it has spawned several imitations, and it continues to sell well. This means that there are now many thousands of mushroom cultivators in the world. It is reasonable to suppose that more people are now actively involved in a religious quest using psilocybin than ever before in history. This is a complete rebirth of a religious mystery and it has taken place in less than a decade! What are the implications of this emergence of a pagan mystery into the banal world of modernity? What are its implications for those closest to this decisive, historical shift, those who, by cultivating and teaching others how to cultivate, are making the change happen?

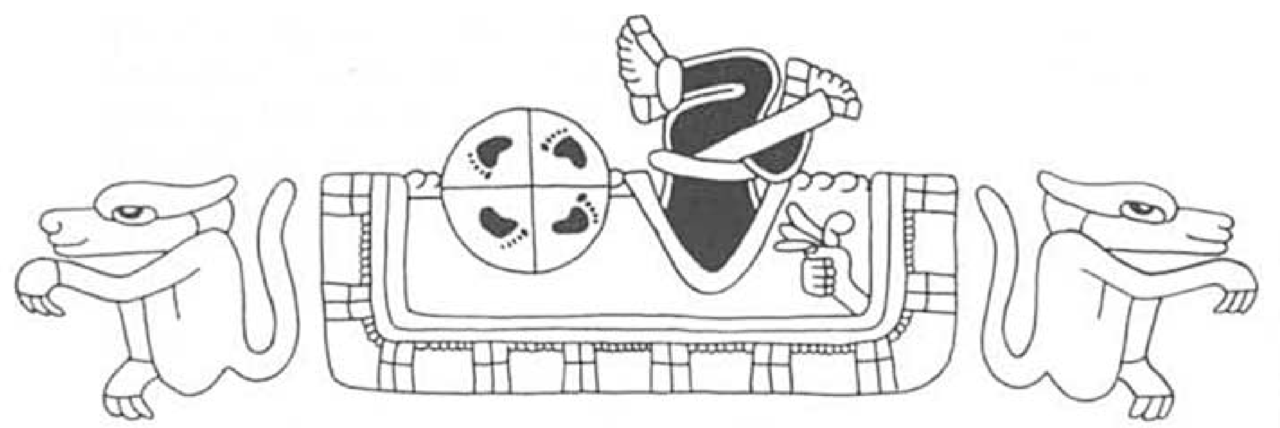
It is clear that pharmacology intends to provide the future with an ever-expanding repertoire of psychoactive chemicals. But I wonder whether what is needed are new drugs or the courage to shamanically apply the botanical hallucinogens already sanctioned by millenia of folk usage. Few of the productions of the laboratory will be found to be as somatically benign as psilocybin or to be so structurally analogous to those compounds naturally occurring in the human brain and responsible for "normal" consciousness.

Once one has actually grown the mushroom, it becomes obvious that the mushroom uses the same strategy whether it is enveloping a Petri dish or a society. A tiny part breaks away from the main body, it becomes a new center of radiative growth that expands until it reaches a critical limit, then it too spawns break-away particles with a life of their own. By this process - normally involving spores, but in cultivation involving propagation of mycelial strains, and on another level involving the teaching of cultivation techniques by one person to another - the mushroom makes its way in the world.

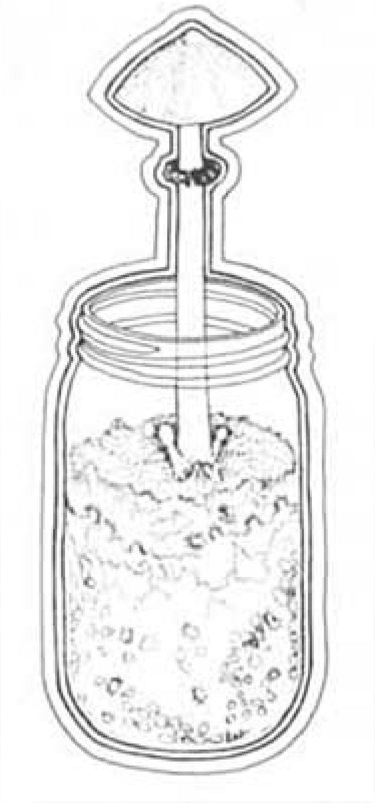
This implies an analogy: That knowledge of how to cultivate is spreading through society in the same way that the mycelium spreads through rye in a jar or a bed of compost. There is an apocalyptic corollary: When the technique is ubiquitous in society, "fruiting" will occur, meaning the real power and import of humanity's relationship to the mushroom will be suddenly revealed.

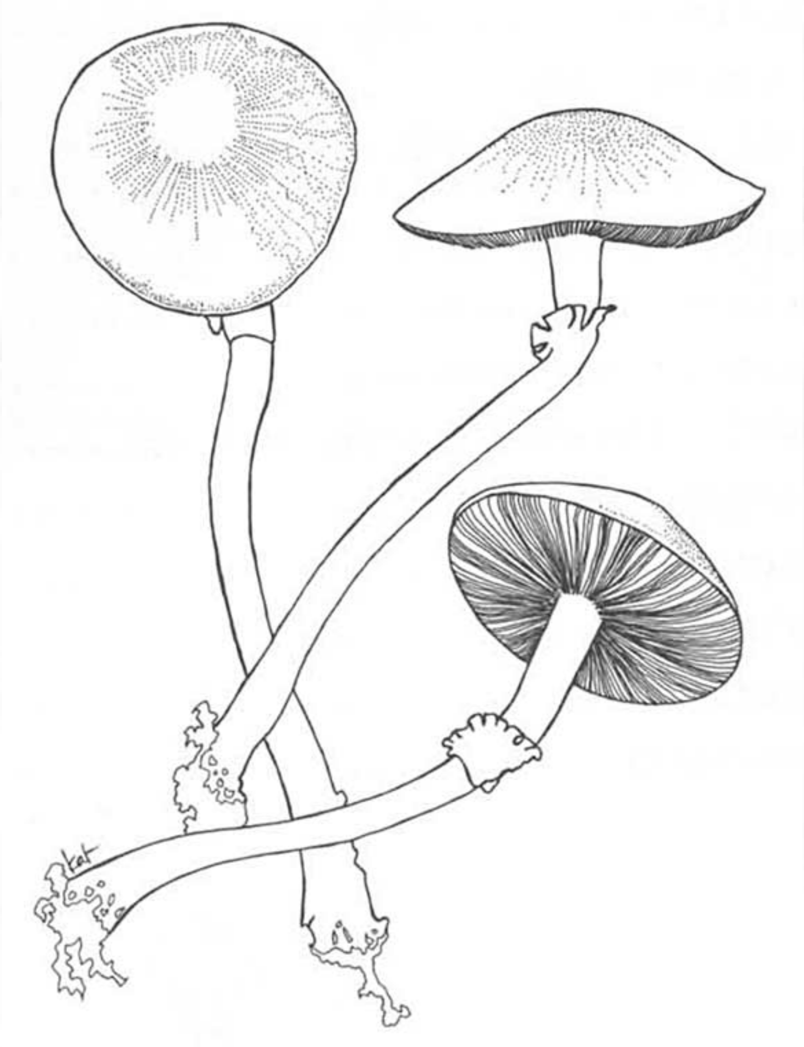
Terence McKenna, August 1985





The Mixtec representation of the psychedelic experience, from the *Codex Vindobonensis Mexicanus 1*.





FOREWORD - by Terence McKenna

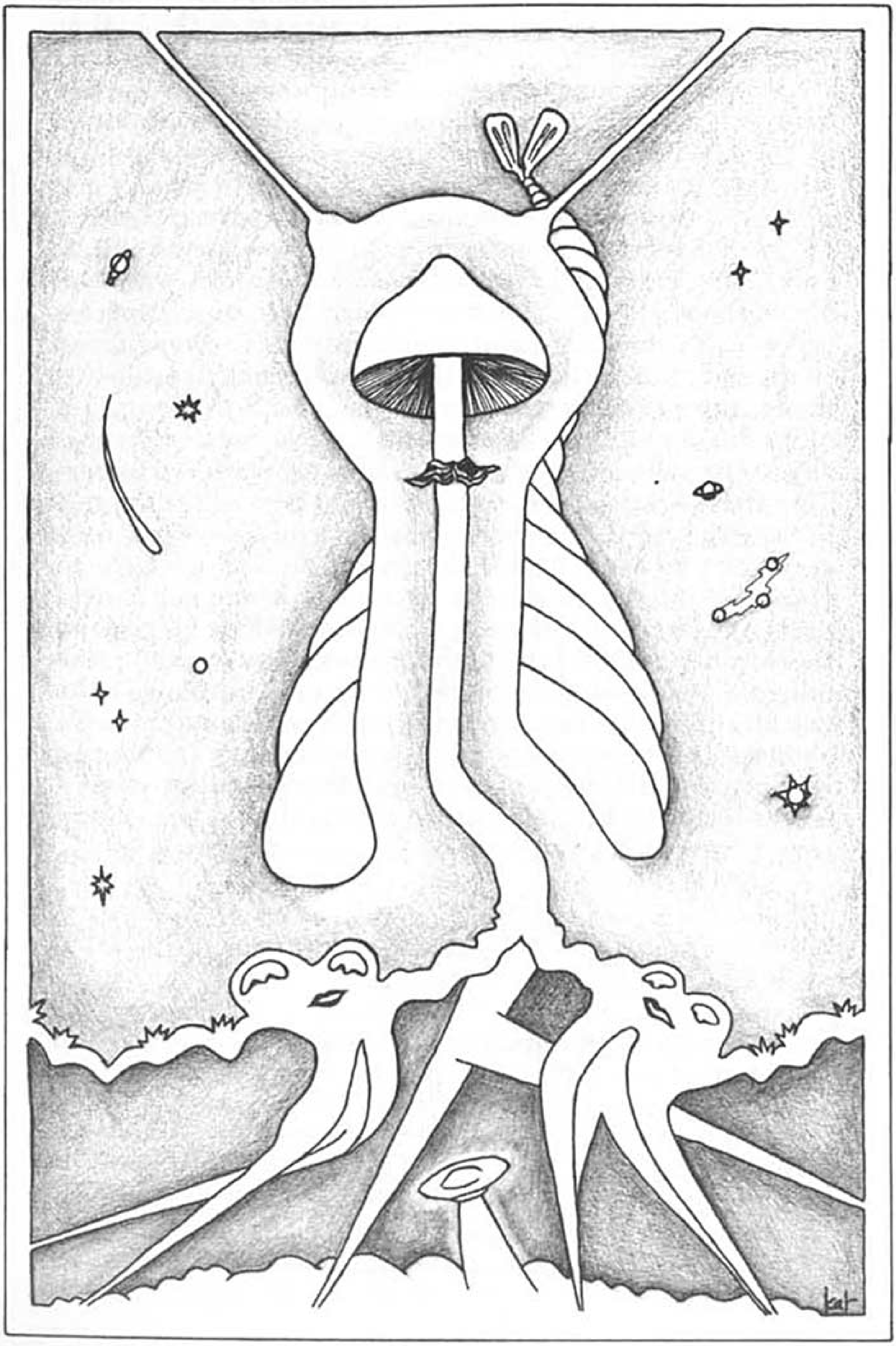
More than twenty-five years have passed since Albert Hofmann isolated and named the hallucinogen psilocybin. Hofmann's psilocybin was extracted from various species of mushrooms whose occurrence and ritual use in the mountains of Oaxaca had been discovered by Gordon and Valentina Wasson in the summer of 1953. Of the many species which were in use in Oaxaca, subsequent laboratory tests revealed that only one species was easily grown and able to fruit under a variety of artificial conditions. That one species is *Stropharia cubensis* - the starborn magic mushroom. This book is a path to this mushroom; how to grow it and how to place it in your life like the shining light that it is. The sections which follow give precise, no-fail instructions for growing and preserving the magic mushroom. We have made these instructions as clear and direct as possible; what is described is only slightly more complicated than canning or making jelly. These instructions can be adapted to undertakings of any size from a few jars to thousands.

But before all these details there should come a chat about just what this is really all about. We imagine that if you are avidly reading this book it is probably because you have taken dried mushrooms or been exposed to fresh ones in Latin America, so we do not begin with readers unfamiliar with the joys of mushroom tripping. Our instructions are a combination of research into other people's methods of cultivation and procedures which we developed, tested, and found useful ourselves. Nothing we recommend is untried by us. There may be other ways to carry on small-scale cultivation indoors but either they are variations on our method that are less direct or they are unknown to us. Cultivation of *Stropharia* outside on compost is possible in the U.S. if the local temperature is warm through the growing season. But compost cultivation is an art in itself and demands more space, more effort, and more public exposure than our indoor method. Getting involved in composting a ton of manure is not a necessary part of producing huge quantities of perfect magic mushrooms!

Our method is scientific but our opinions about *Stropharia cubensis* are not. Our opinions in this matter do not rest upon the opinions of others nor upon anything written in any book, instead they rest upon the experience of five dried grams of this psilocybin mushroom; at that level a peculiar phenomenon occurs. It is the emergence of an I-Thou relationship between the person taking the psilocybin and the mental state it evokes. Jung calls this "transference" and it was a necessary condition of early and primitive humanity's relationship to its gods and demons. The mushroom speaks, and our opinions rest upon what it tells eloquently of itself in the cool night of the mind:

I am old, older than thought in your species, which is itself fifty times older than your history. Though I have been on earth for ages I am from the stars. My home is no one planet, for many worlds scattered through the shining disc of the galaxy have conditions which allow my spores an opportunity for life. The mushroom which you see is the part of my body given to sex thrills and sun bathing, my true body is a fine network of fibers growing through the soil. These networks may cover acres and may have far more connections than the number in a human brain. My mycelial network is nearly immortal - only the sudden toxification of a planet or the explosion of its parent star can wipe me out. By means impossible to explain because of certain misconceptions in your model of reality all my mycelial networks in the galaxy are in hyperlight communication across space and time. The mycelial body is as fragile as a spider's web but the collective hypermind and memory is a vast historical archive of the career of evolving intelligence on many worlds in our spiral star swarm. Space, you see, is a vast ocean to those hardy life forms that have the ability to reproduce from spores, for spores are covered with the hardest organic substance known. Across the aeons of time and space drift many spore-forming life-forms in suspended animation for millions of years until contact is made with a suitable environment. Few such species are minded, only myself and my recently evolved near relatives have achieved the hyper-communication mode and memory capacity that makes us leading members in the community of galactic intelligence. How the hyper-communication mode operates is a secret which will not be lightly given to humans. But the means should be obvious: it is the occurrence of psilocybin and psilocin in the biosynthetic pathways of my living body that opens for me and my symbiots the vision screens to many worlds. You as an individual and Homo sapiens as a species are on the brink of the formation of a symbiotic relationship with my genetic material that will eventually carry humanity and earth into the galactic mainstream of the higher civilizations.

"Since it is not easy for you to recognize other varieties of intelligence around you, your most advanced theories of politics and society have advanced only as far as the notion of collectivism. But beyond the cohesion of the members of a species into a single social organism there lie richer and even more baroque evolutionary possibilities. Symbiosis is one of these. Symbiosis is a relation of mutual dependence and positive benefits for both of the species involved. Symbiotic relationships between myself and civilized forms of higher animals have been established many times and in many places throughout the long ages of my development. These relationships have been mutually useful; within my memory is the knowledge of hyperlight drive ships and how to build them, I will trade this knowledge for a free ticket to new worlds around suns younger and more stable than your own. To secure an eternal existence down the long river of cosmic time, I again and again offer this agreement to higher beings and thereby have spread throughout the galaxy over the long millenia. A mycelial network has no organs to move the world, no hands; but higher animals with manipulative abilities can become partners with the star knowledge within me and if they act in good faith, return both themselves and their humble mushroom teacher to the million worlds to which all citizens of our starswarm are heir."


kat

INTRODUCTION

It seems characteristic of our condition that human beings, in whatever environmental or existential milieu they find themselves, experience an urge to seek contact with the essential mystery underlying the fact of being. Indeed, the entire odyssey of our species, both phylogenetic and historical, can be seen as a groping toward some sensed transcendent fulfillment. The story of the human race - our art, science, philosophies, civilizations and religions - is largely the story of this quest for contact with the holy, numinous, and self-transcending. It is a quest at least as old as our species; evidence indicating that early humans possessed religious consciousness has been found dating back to the Middle Paleolithic. The archeological evidence shows clearly: Human beings were at home with the concept of the sacred long before the advent of writing, agriculture, civilization, or science; it is a concept that has abided in the human imagination guiding us forward since the earliest infanthood of humanity, contemporary with and possibly preceding the earliest use of tools, fire, even language itself.

The life of pre-literate people is one in which nature exists as the primary condition of existence; one is surrounded by it, one is immersed in it, one depends upon it for one's very survival. The quest for food and for the material necessities of life must be a constant and unending one for human beings in nature, a quest in which every plant and animal that one encounters comes under the scrutiny of a restless curiosity. Given this situation, it was inevitable that sooner or later in the search for food women and men would accidentally ingest certain plants containing compounds affecting the central nervous system - and find themselves suddenly transported to a realm of the profoundest rapture and strangeness. Indeed, the ethno-mycologist R. Gordon Wasson (1958, 1961) has suggested that the accidental ingestion of an hallucinogenic plant, probably a mushroom, constituted human beings' earliest encounter with the numinosum, and led directly to the formation of the concept of deity and the supernatural. This notion is not without a certain logical appeal: it stands to reason that the restless, roving eyes of human beings, scanning nature for potential sources of food, would quickly single out the lowly mushroom, so odd in appearance and so unlike the rest of the vegetation with which they were familiar. Given a few thousand years for random experimentation (a relatively short time in the scale of prehistory), they would eventually discover and ingest fungi containing centrally-active compounds, undergo the hallucinogenic experience and the connection with the numinosum would be established.

The scenario described is, of course, imaginary. We cannot know the exact circumstances under which humans first confronted the psychedelic experience. We do know, thanks to the work of Wasson and his colleagues in the 1950s (see V. P. & R.G. Wasson, 1957, R.G. Wasson & R. Heim, 1958, & Wasson, 1957), that a religious cult centered around the ritual ingestion of hallucinogenic mushrooms has existed in the highlands of Central Mexico at least since before the Conquest, and is very likely much more ancient than that, its real origins having been lost in the mists of prehistoric time. But the fact remains that, whether encountered through the ingestion of a fungus or some other plant, or through some spontaneously triggered altered state of consciousness, the direct experience of the transcendent has had and is having a profound impact on human history, perhaps even on human evolution. The urge toward the transcendent - and the dynamic tension that exists between the drive to transcend and the mundane necessities which impose themselves on the primary fact of biological being - is in a sense what all history, all religion, art, philosophy, discovery and science - in short, all of human thought and civilization - is about. The urge to reach beyond the known to what is unknown and unplumbed is irredeemably woven into the fabric of human history. It is this urge which built the pyramids, Stonehenge and the Gothic cathedrals. The same urge drove frail ships across the trackless oceans to the shores of a new world, and the same urge in our own time has driven us to fling a tiny bubble of light and air across the vast and howling abysses of space (that cosmic milli-micron) that separates our earth from its moon. It is the same urge that stirs the shiver along our spines when we gaze with wonder and longing at the star-dusted sky on a clear winter's evening.

Today, we stand on the threshold of the stars. Slowly it is emerging in mass consciousness that the next evolutionary step forward will so transform humanity that all that has gone before will seem but a prelude. We stand at the edge of history ready to accelerate our human experience out into the vast chasm of night which engulfs our planet, the lessons of our historical career still echoing down the corridors of time. We are about to embark on the greatest adventure we have ever known, one that will change our very notion of what it is to be human; yet we should not forget that between ourselves as we ascend the ramp of the starship and our mushroom munching ancestor gazing into his Paleolithic fire lie only seconds of cosmic time.

This book is essentially a how-to manual for those who have the interest, time, and patience required for cultivating "the magic mushroom" in their own homes. It is for people who feel that they still may be able to learn something by experiencing the primordial visions of their ancestors, and feel it strongly enough that they are willing to invest a little time, money and effort in order to realize that vision. By "magic mushroom" is meant those mushrooms which are members of the genus *Psilocybe*, and the closely related genera *Stropharia*, *Conocybe*, *Panaeolus*, and *Copelandia*. Certain members of these genera contain the compounds psilocybin (4-phosphoryloxy-*N,N*-dimethyltryptamine) and psilocin (4-hydroxy-*N,N*-dimethyltryptamine) as the active hallucinogenic agents (Fig. 1). These compounds contain the basic indole structure characteristic of most hallucinogens found in nature (see Schultes, 1973, p. 17 ff.) including various amides of lysergic acid (of which LSD is a semisynthetic representative), *N,N*-dimethyltryptamine, harmine and its analogues, and ibogaine. The most notable exception to this basic structure is mescaline, which chemically is 3,4,5-trimethoxyphenethylamine, and hence is in the same class as amphetamine (α-methylphenylethylamine).

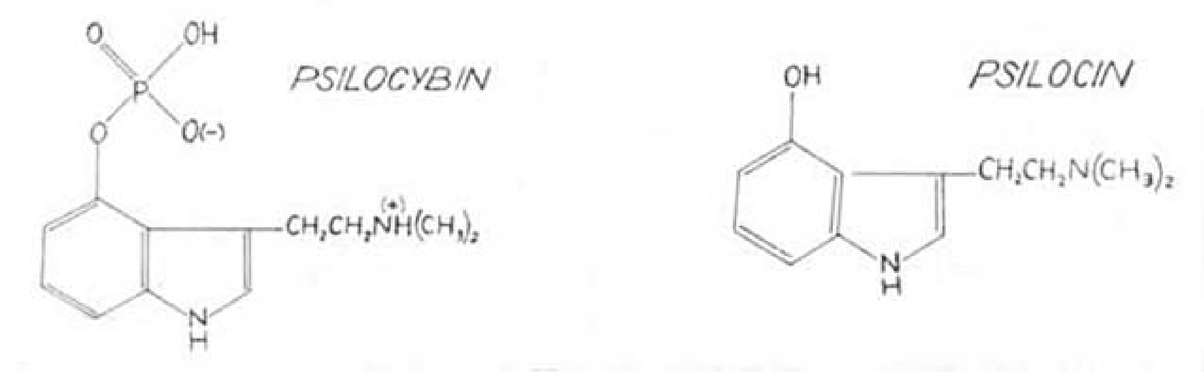
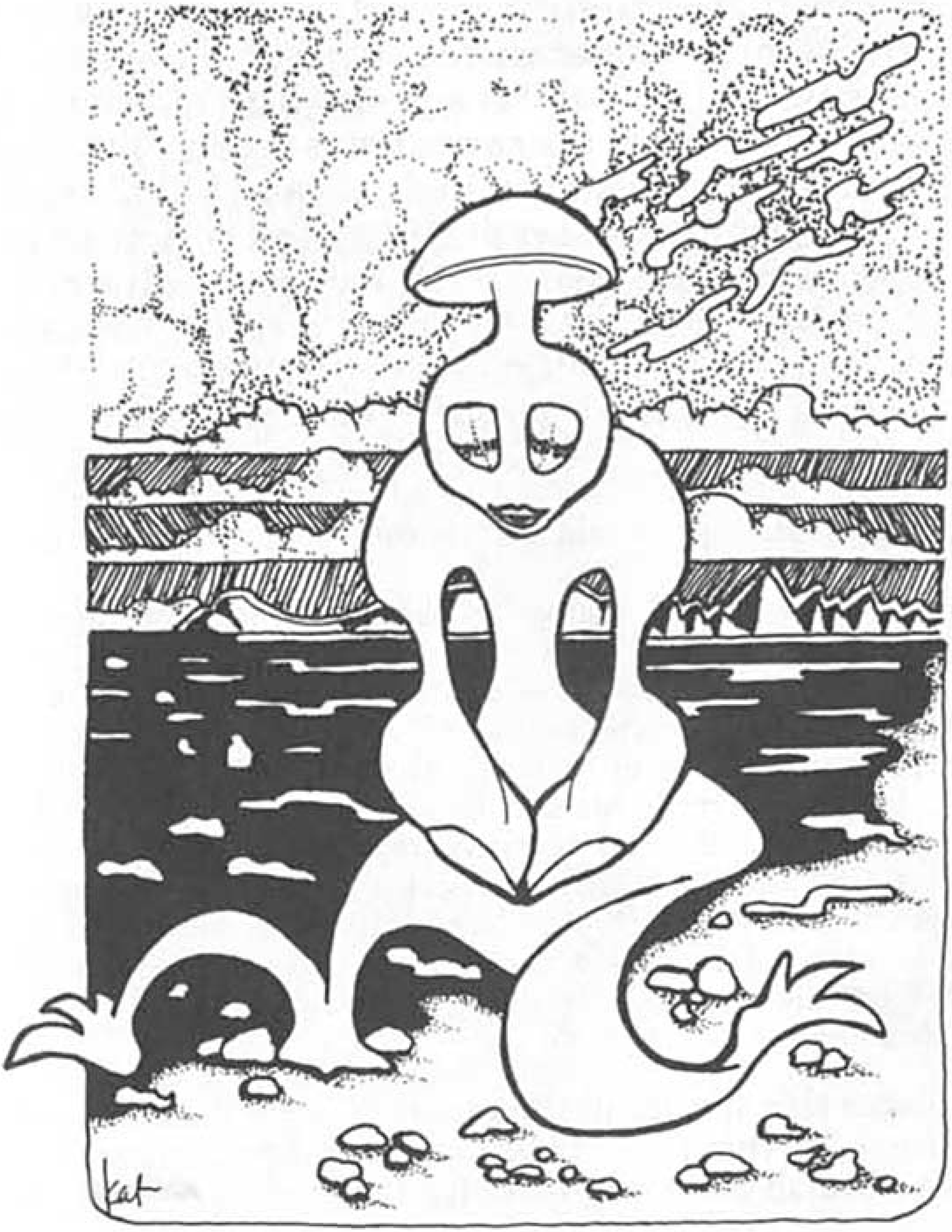


Fig. 1: Structural formulas for psilocybin and psilocin.

The cultivation information in this book pertains only to one species of magic mushroom, *Stropharia cubensis* Earle. (The mycologist Rolf Singer has recently reclassified this species into the genus *Psilocybe*. Hence in some references it is referred to as *Psilocybe cubensis* Earle ex. Singer.) It is probable that with appropriate adaptations the methods outlined here could be applied successfully to the cultivation of other species. Our experience has shown, however, that *Stropharia cubensis* is the easiest to cultivate. Those interested in the cultivation of other mushroom species should consult *The Mushroom Cultivator* by Stamets and Chilton, published by Agarikon Press, Olympia, Washington, 1983. Our limiting the discussion to one species, however, is not as unfortunate as it may seem since *Stropharia cubensis* is not only one of the strongest of the hallucinogenic mushrooms, but also one of the most widespread and readily obtainable. In nature, its habitat is cow-dung, and it can be found in pastures during rainy, warm parts of the year in regions as diverse as the Southeastern U.S. and Cambodia, Australia and Colombia. Unlike other psilocybin-containing genera, which with few exceptions are fairly restricted endemics, the distribution of the *Stropharia cubensis* is world-wide (Pollock, 1975). In fact, since its preferred habitat is cow-dung, its circumtropical distribution has doubtless been encouraged, if not caused, by the world cattle industry. Amusingly enough, the *Stropharia* could be said to exist as a "weed" on high-technology cattle-raising cultures. This intimate association with humans via domesticated cattle has probably existed for as long as humanity has possessed pastoral technology.

The procedures outlined in this book, if followed with care and persistence, will work for *Stropharia cubensis*. The procedures can be carried out by anyone in their own home, with just a minimum of equipment and a few supplies and common chemicals that are no more than moderately difficult to obtain. No special training in mycology or microbiology is necessary. What is necessary is to follow the instructions closely and carefully.

The procedure described herein consists essentially of four major steps. It begins with spores and describes step-by-step instructions for growing full-size mushrooms from spores within six weeks. The first step involves locating the fungus, collecting and germinating the spores, and isolating the mycelium, or fungal threads, obtained from the spores. The next step involves cultivating the mycelium on agar, a solid nutrient, in order to use it for inoculation. In the third step, mycelium grown on agar is then grown on a sterilized medium of whole rye grains. In the fourth and final step the rye-grown mycelium is *cased*, or covered with soil, a process that induces the production of mushrooms. This book describes each of these steps in detail, and can be put into practice by anyone able to read and carefully follow the instructions, provided that they can obtain spores or specimens of *Stropharia cubensis*.



STEP I - LOCATING AND IDENTIFYING THE FUNGUS: COLLECTING AND GERMINATING SPORES

In the New World, *Stropharia cubensis* can be found in appropriate habitats throughout the Southern U.S., all through the Coastal regions of Mexico, and throughout coastal and equatorial regions of South America. In the U.S., it has been reported from Texas, Louisiana, Alabama, Mississippi, Arkansas, Florida, Tennessee, and Georgia. Its distribution would probably be even greater were it not for the fact that its environmental requirements limit it to regions of mild temperatures and high humidity.

Because of its specific habitat and singular appearance, *Stropharia cubensis* is one of the easiest mushrooms to locate and identify. As already mentioned, it can be found growing out of cow-pies in pastures during rainy warm seasons. Other dung-growing mushrooms may also be found in the same pasture, but these bear little resemblance to *Stropharia*. The following botanical description of *Stropharia cubensis* is taken from *Mushrooms of North America* by Orson K. Miller, Jr.:

> Cap pale yellowish, viscid; persistent ring; blue-staining stalk.
>
> Cap 1.5-8 cm broad, conic, bell-shaped, convex in age, viscid, without hairs, whitish to pale yellow, light brownish in age, stains bluish in age. Flesh firm, white, bruises blue. Gills adnate (attached) to adnexed (notched), close, grey to violet-grey in age with white edges. Stalk 4-15 cm long, 4-14 mm thick, enlarging somewhat toward the base, dry, without hairs, white staining blue when bruised. Veil white, leaving a superior membranous ring. Spores 10-17 µ x 7-10 µ elliptical to oval in side-view, thick-walled, with a large pore at apex, purple-brown spore print. Cystidia (sterile cells) on gill edge club-shaped with rounded heads.

Miller places this species in the genus *Psilocybe*, after Singer.

The flesh of this mushroom exhibits the property of staining a bluish color when bruised or broken. This blue-staining reaction is apparently an enzymatic oxidation of psilocin to an indole diquinone (Bocks, 1967) and is a fairly reliable indicator of the presence of psilocybin, not only in *Stropharia cubensis*, but also in other closely related genera (members of the family *Strophariaceae*) (cf. Benedict, *et al*., 1967). Other mushrooms, such as members of the genus *Russula*, section Nigricantinae, and *Boletus*, exhibit a similar blueing. The blueing in these cases, however, is not due to the presence of indole substrates and these mushrooms otherwise bear no resemblance whatever to *Stropharia cubensis* or related species (Singer, 1958, p. 247).

Once one has located a specimen or specimens of *Stropharia cubensis*, and been satisfied as to its identity in all particulars, it is necessary to collect spores for cultivation. Spores can be easily collected in the following manner: Take one or more fresh specimens with the caps fully open; using a sharp knife, cut off the stipe as close to the gills as possible (see Fig. 3) and place the cap gillside down on a clean sheet of white paper, and leave for 24 hours. It doesn't hurt to cover the caps with a small bowl while taking the spore print in order to prevent dessication. When the caps are removed, a dark-purplish, radially symmetrical deposit of spores will remain on the paper where the gills contacted it. The paper should then be folded and sealed in an envelope in order to prevent further contamination by airborne spores of other species of lower fungi. A single spore-print contains tens of millions or spores, and is sufficient to make hundreds of spore germinations.

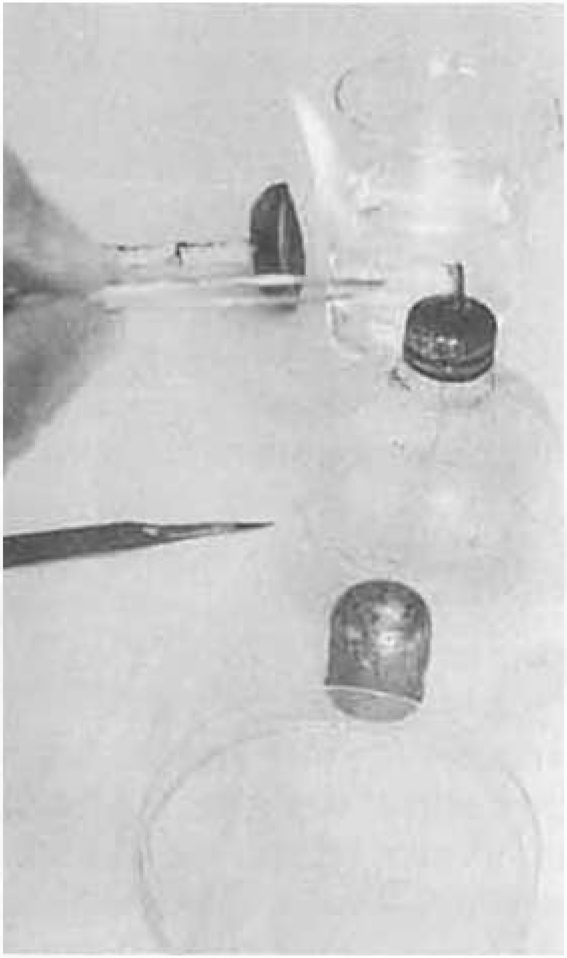


Fig. 2 - Sterilizing the slide.

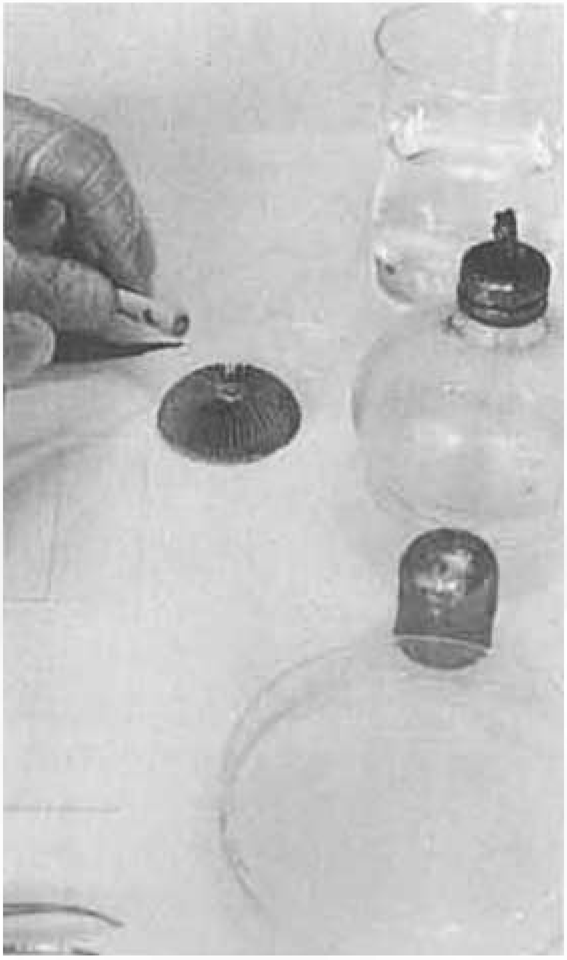


Fig. 3 - Decapitation.

The following variation on this method was suggested to us as a way of enhancing the sterility of the spore print: Take four standard flat microscope slides, swab with alcohol and flame in an alcohol flame or butane torch (Fig. 2). On a clean flat surface, such as a table-top swabbed with Lysol lay the slides side by side and end to end, so that they are arranged as in Fig. 3. Place the fresh cap in the exact middle of the slides so that approximately ¼ of the cap covers each slide (Fig. 4). Cover and wait 24 hours. When the cap is removed, the end of each slide will be covered with spores, and the slides can then be sealed, together or separately, in plastic or paper. One can easily substitute glass microscope coverslips for the slides to maximize compactness. Do not use plastic coverslips, since static electricity associated with them makes it difficult for the spores to adhere to them.

Once the spore-print has been collected, it is necessary to germinate some spores in order to begin the life cycle that will eventually culminate in the production of more mushrooms. Before we outline procedures for germinating the spores, a brief discussion of the stages in the life cycle of these higher fungi follows; readers who do not care to read this somewhat technical portion may skip the next three paragraphs.

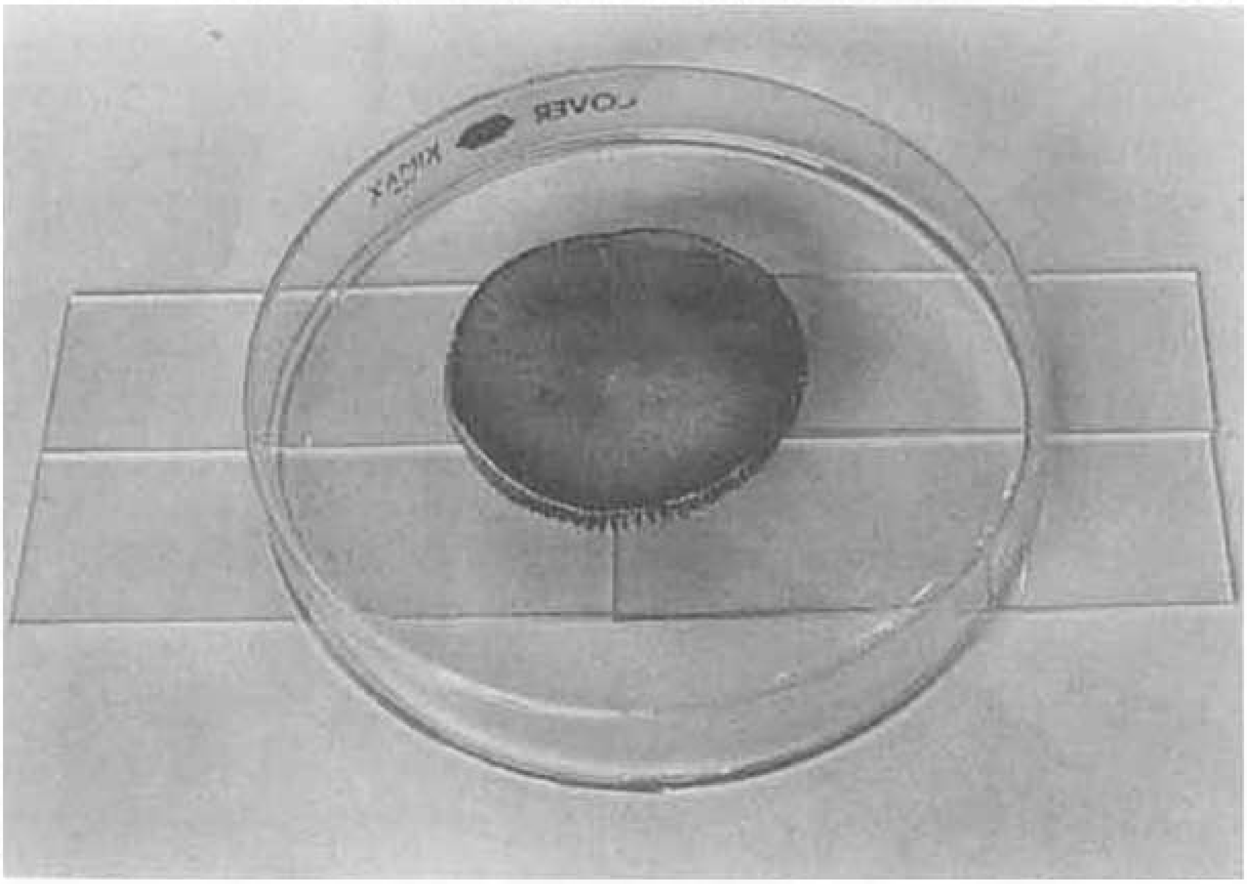
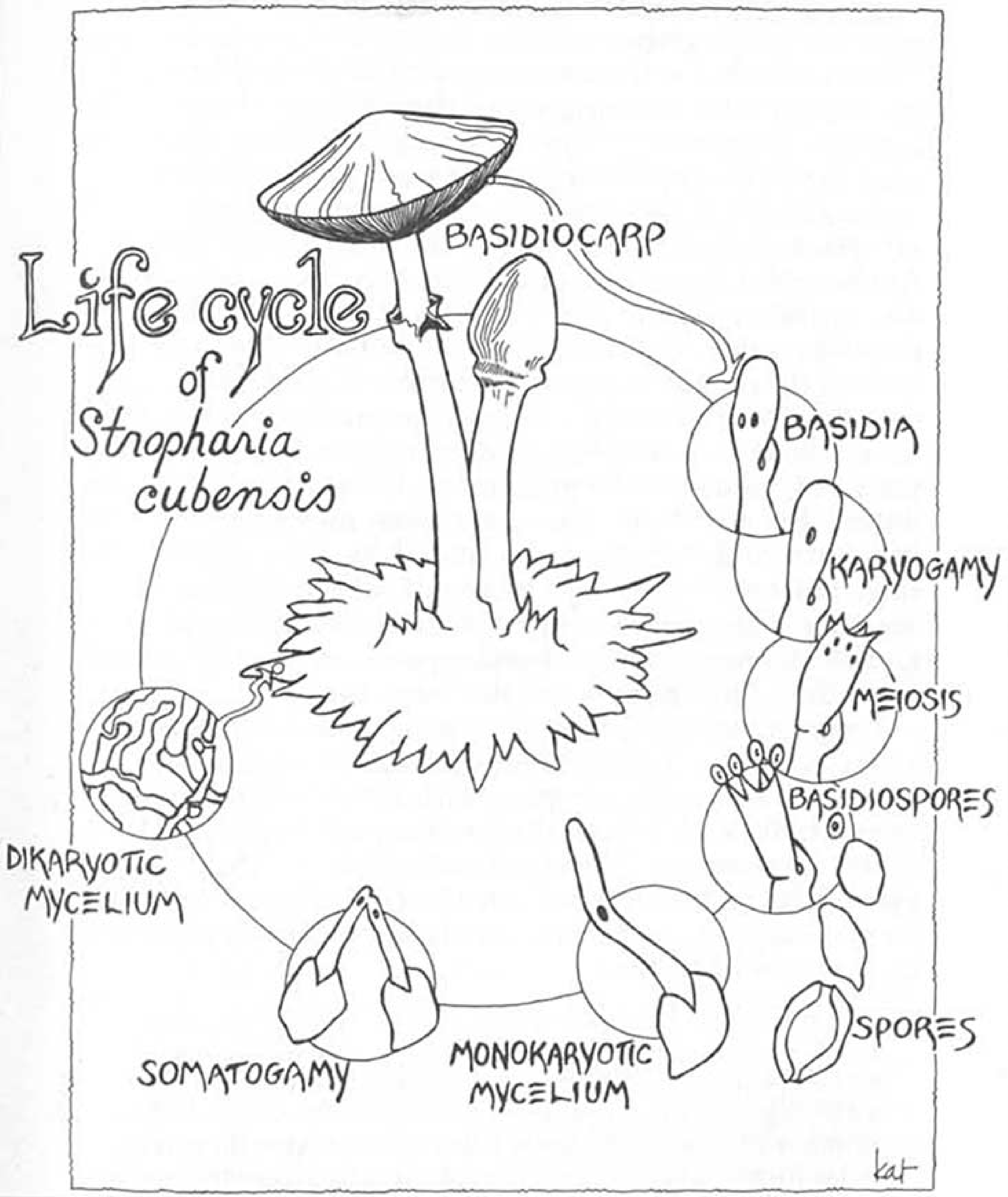


Fig. 4 - Making spore print (note slide arrangement).

All gilled fungi are members of the class Basidiomycetes, i.e., they are characterized by the production of spores on club-shaped appendages called *basidia*. Spores borne on basidia are called *basidiospores*. Most of the conspicuous fungi that one encounters, such as mushrooms, puffballs, and bracket fungi are members of the subclass Homobasidiomycetes. Of the members of this subclass, the gilled mushrooms are placed in the order *Agaricales*. The life cycle of a typical homobasidiomycete is illustrated on the facing page. The basidiospores germinate to form a monokaryotic hypha. A hypha is a tubular filament; an aggregation of these hyphae collectively comprise a mass of thread-like filaments referred to as the *mycelium*. The mycelium comprises the main body, or *thallus*, of the fungus. The stalked, capped structure which we call the mushroom is actually only the "fruiting body" or the spore-producing reproductive structure, and constitutes only a small portion of the total mass of the fungus; the great bulk of the organism exists underground in the form of a network of mycelium, which occasionally "fruits," or produces mushrooms, under appropriate conditions.

The basidiospores germinate to produce a *monokaryotic* mycelium, i.e., a mycelium having only one nucleus per cell. This mycelium grows out until it encounters another monokaryotic mycelium, germinated from another spore, that is a compatible mating type. If the monokaryotic mycelium does not contact a compatible monokaryotic mycelium, it eventually dies. In situations where two compatible monokaryotic mycelia do make contact, however, a process called *somatogamy*, or the fusing of the somatic cells of the two mycelia, takes place, *but fusion of the nuclei does not take place*. The result of somatogamy is the establishment of a *dikaryotic* mycelium, i.e., a mycelium possessing two nuclei, one from each of the monokaryotic mycelia, in each of its cells (see facing page). The dikaryotic mycelium stage is the most prolonged portion of the life cycle and is also the main assimilative stage of the fungus. The dikaryotic mycelium can propagate vegetatively indefinitely without going through a sexual (spore-producing) stage. Given appropriate conditions, however, the dikaryotic mycelium can be induced to "fruit": the undifferentiated mycelial thallus of the fungus begins to weave itself together into an articulated, spore-bearing "fruiting body," in this case, into a mushroom. The mushroom continues to enlarge and thrust above the ground, incorporating more and more mycelium while at the same time expanding by absorption of water. At a certain stage in the growth of the mushroom, or *basidiocarp*, club-shaped structures called *basidia* form on the underside of the gills. At this point, *karyogamy*, or fusion of the two nuclei of the dikaryotic mycelium takes place within the basidia (see preceding page). This is the only *diploid*, or 2n, stage in the life-cycle of the fungus, and is also the briefest stage, for meiosis, or reduction division of a diploid (2n) nucleus to 4 haploid (n) nuclei occurs immediately following karyogamy.

The result of meiosis is the production of four haploid nuclei within the basidium; these are then pushed out of the basidium and become surrounded by hard sheaths to form the basidiospores. The result is the basidium bearing four basidiospores on its outer surface as in the "Life Cycle" drawing. These basidiospores eventually detach from the basidium to begin the life cycle again.


Life cycle of Stropharia cubensis
BASIDIOCARP
BASIDIA
KARYOGAMY
MEIOSIS
BASIDIOSPORES
SPORES
MONOKARYOTIC MYCELIUM
SOMATOGAMY
DIKARYOTIC MYCELIUM
kat

Fungi of the family *Strophariaceae*, which includes *Stropharia cubensis* and most other psilocybin-containing genera, are genetically complex with respect to the mating compatibility of different monokaryotic mycelia. These fungi are *heterothallic* and *tetrapolar*, that is, their sexual cycle is dependent on the fusion of two compatible monokaryotic mycelia, and their sexual compatibility is governed by two sets of factors:

> In tetrapolar heterothallism, two sets of factors, the A's and B's, are involved. If a sexually reproducing thallus is to be established, somatogamy must occur between mycelia differing in both sets of factors - for example AB x ab. The number of mating classes is somewhat greater than in bipolar forms, since four types typically arise from spores of a single basidiocarp. Obviously these mating types, numbering in the hundreds in both bipolar and tetrapolar species, cannot be designated as sexes! (Scagel, *et al*., 1967, p. 69.)

Keeping this information pertaining to the sexual characteristics of these fungi in mind, let us return to the problem of spore germination; the relevance of our digression into the matter of life cycle and sexual compatibility will be seen shortly.

Once one has obtained a spore print from *Stropharia cubensis*, the monokaryotic mycelium can be easily obtained by germinating the spores on an appropriate solid nutrient medium, such as Potato Dextrose Agar or Malt Extract Agar. A more detailed discussion of various kinds of nutrient agars and how to prepare them will be given below in the section of Growing Stock Inocula. For the present, however, simply assume that one has several clean, sterile Petri plates which have been filled with an appropriate solid nutrient medium (see Fig. 5). Spores can be transferred most readily using a clean, sterile #11 scalpel, inoculating loop, or similar instrument. Flame the blade of the scalpel in an alcohol flame, then reach into the petri dish and cut a small square of agar (2-3 mm^2) from the center of the dish. Spear the agar square on the blade of the scalpel, and use it to lightly touch the surface of the paper or slide on which the spore-print is deposited. Replace the agar square on the medium close to the place it was cut. It is sometimes convenient to inoculate four agar squares in each dish, one in each quadrant. Care should be taken to do this as quickly as possible, keeping the cover off the Petri plate for the shortest time necessary, in order to minimize the chances of contaminating the plate with the airborne spores of contaminants. A variation on this method can also be used: Instead of scraping the spores directly onto the plate, they can first be scraped into about 10 ml of sterilized water. Shake this vigorously, then dilute to 100 ml by adding sterile water. Using a sterilized pipette or syringe, take up 2-3 ml of diluted spore solution, and point-inoculate the Petri plate by placing a drop of the solution at two or three separate points on the plate.

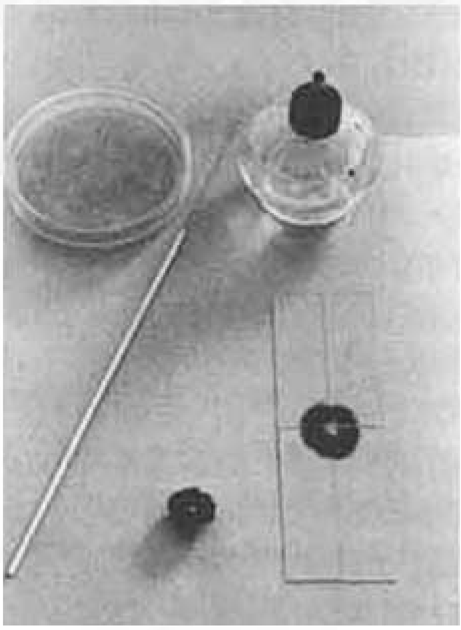


fig. 5 - Completed spore print and inoculating equipment.

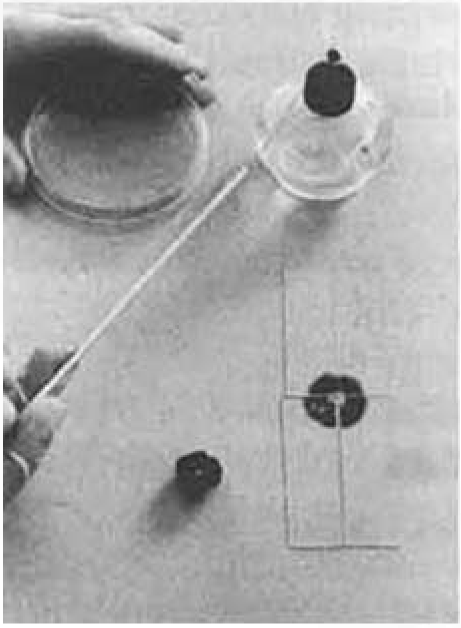


fig. 6 - Flaming the inoculating loop.

If possible, incubate the covered inoculated plate at 86 degrees F. for 24 to 36 hours. This will break dormancy and force the spores to germinate faster. Spores will germinate without this incubation, but may take up to 24 days. During this time, the spores will germinate and monokaryotic mycelium will grow radially outward from each point of inoculation. The plate should be left undisturbed until the mycelia from two different spores or two different points of inoculation have grown together and made contact. A few days after contact has occurred, one can be reasonably sure that somatogamy has taken place and that a dikaryotic mycelium has been established. Since in practice one transfers clumps of spores rather than single spores onto the plate, waiting for two different inoculation spots to make contact is not really essential; by the time mycelial growth is well established on the plate, one can be confident of isolating dikaryotic mycelium.

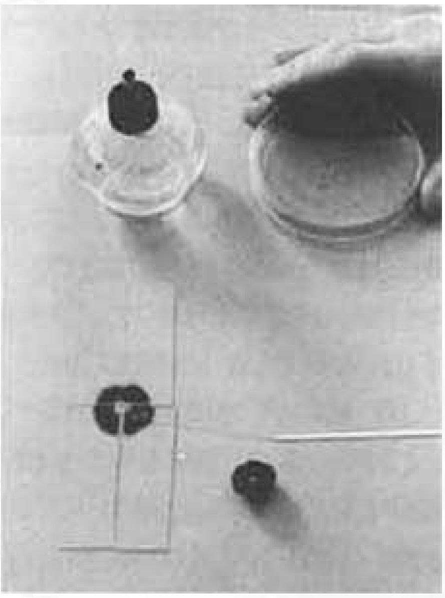


Fig. 7 - Touching inoculating loop to spore print.

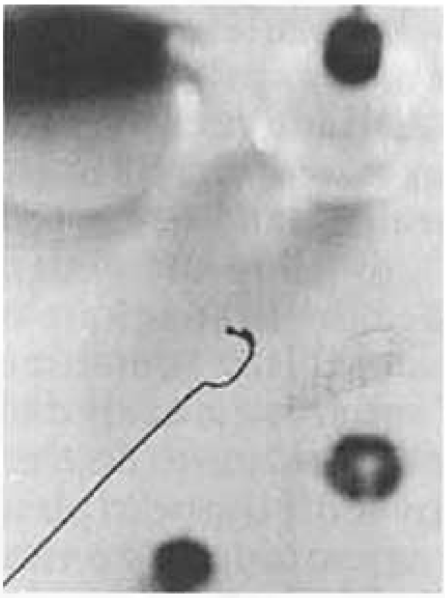


Fig. 8 - Hooked inoculating loop with adhering spores.

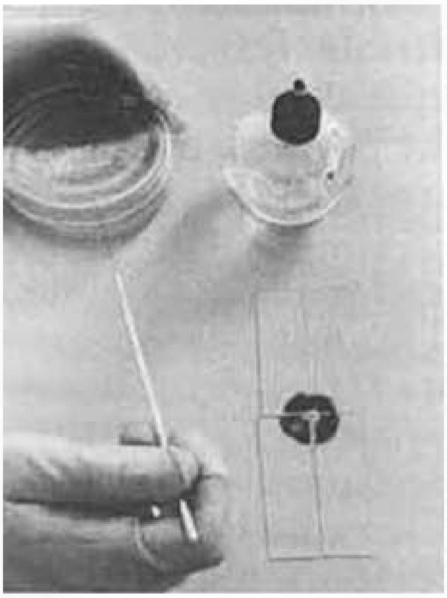


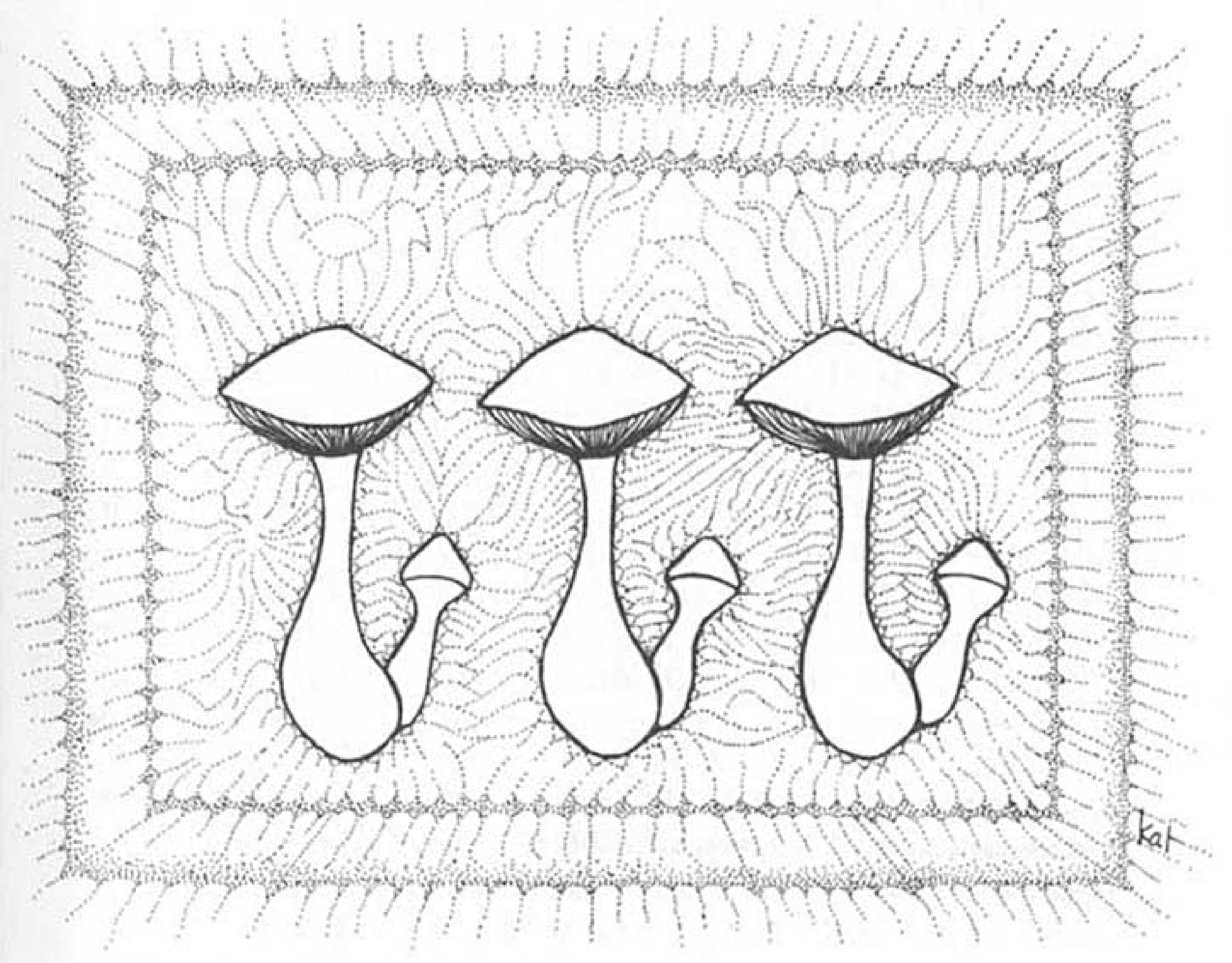
Fig. 9 - Inoculating Petri plate with spores.

In cultivating the fungus to the fruiting stage, one works primarily with a single strain of dikaryotic mycelium. However, because spores of several different mating types are produced by a single mushroom, a Petri plate inoculated with spores will have possibly several dozen different strains of dikaryotic mycelium growing on it. It is therefore necessary to isolate one of the strains so that one can grow out stock inocula from a single, uniform strain. This can be accomplished using a scalpel, dissecting needle or inoculating loop in which the loop has been bent to form a hook (Fig. 8). The implement is first sterilized in an alcohol flame; then the Petri plate is opened slightly and a very small piece of mycelial tissue is snagged on the end of the blade, needle, or hook, and transferred rapidly and deftly to a second clean sterile Petri plate containing an appropriate solid nutrient medium. Dikaryotic mycelium is isolated using exactly the same techniques as are used in transferring mycelium from one Petri plate to another; for figures illustrating this procedure, see Step II, Figs. 13-16. By selecting a very small piece of tissue in this way, one can be reasonably sure that only one strain of dikaryotic mycelium is being removed and isolated. In practice we find that both isolation of a dikaryon and plate-to-plate transfer of dikaryotic mycelium once isolated, can be most easily accomplished using a sterile #11 scalpel. Small agar squares can be cut from the edge of the mycelial thallus and transferred to fresh Petri dishes.

The dikaryotic mycelium thus isolated from the spore-germination plate will grow outward in all directions from the point of inoculation on the new plate and should cover most of the surface of the medium within 8-12 days. One can then go ahead and make further transfers to new plates with a fair degree of certainty that one is working with a single strain of dikaryotic mycelium.

It is probably advisable to isolate several different strains of dikaryotic mycelium onto separate plates by taking tissue from different sections of the spore-germination plate. Different strains isolated from a single spore-germination plate should be identified by labels and compared for vigor of growth and vigor of fruiting ability, so that, through observation and trial-and-error, the strain showing maximum vigor in both respects can eventually be identified and used exclusively thereafter. Isolating the most vigorous strain takes time and careful observation; however, this need not interfere with continuing on to the second and third steps of the process, since *any* dikaryotic mycelium that has been properly isolated from other strains should exhibit fruiting ability. After several strains have been put through several fruiting stages it should be apparent which strain is most vigorous. Our observations indicate that the most vigorous fruiting strains have a distinctly "ropy" morphology when growing in the mycelial stage. This stands to reason, since this ropy appearance is due to the formation of *rhizoids*, thick strands of hyphae, which are similar in structure to the rhizoids formed prior to and during the fruiting stage. Those rhizoids function in the transport of water and nutrients to the developing mushrooms (see Chang & Hayes, 1978, Chapter 8).

If one has fresh mushroom specimens, it is possible to employ another method of isolating dikaryotic mycelium without utilizing spores. This is the method of subcutaneous isolation (Enos, 1970). The operation should be performed with clean hands and implements. A pair of latex gloves sterilized by spraying with Lysol should be worn. Hold the fresh mushrooms by the stipe in one hand, and with the other hand swab the cap surface lightly with a sterile cotton swab dampened with tincture of iodine. Have ready a clean #11 scalpel and an alcohol lamp to sterilize it. Grasp the cap of the mushroom, top up, between the thumb and fingers until it splits open to reveal the interior whitish flesh. Flame the scalpel and remove a small piece of this subcutaneous flesh and transfer it to a sterilized nutrient plate. Several inoculations can be made from the interior flesh of a single cap. Since the flesh of the mushroom has been woven together out of dikaryotic mycelium, it will grow out across the plate in the same manner as mycelium isolated from a spore-germination plate. This procedure eliminates the step of having to isolate different dikaryotic strains, since mycelium isolated in this manner consists of only one strain. On the other hand, this procedure limits one to working with only one strain.



STEP II - GROWING STOCK INOCULA

Once one or more strains of dikaryotic mycelia have been successfully isolated, it is necessary to build up a stock of mycelial cultures grown on sterile agar media. The inocula from this stock will be used to inoculate the mycelium onto sterilized rye or other grain. Before proceeding to this step, however, it is advisable to have a good supply of inocula grown out of sterile agar media, so that one will have plenty of sterile inocula even if a few cultures should succumb to contamination. The information in this section therefore describes procedures for preparation, sterilization, and inoculation of solid nutrient media.

Most laboratory work with higher fungi, yeasts, molds, bacteria and so on involves growing the organism on a solid agar medium to which appropriate nutrients have been added. Agar is a pectin-like substance extracted from certain kinds of sea-kelp, which, when dissolved in boiling water and allowed to cool, solidifies to a gelatinous consistency. Agar is a standard item in all microbiological work, and is available from almost any scientific supply company. It is also stocked by many health-food stores and Oriental food stores as a dietary supplement. Fungi Perfecti (P.O. Box 7634, Olympia, WA 98507) offers a wide variety of mushroom-growing supplies and will send you a very helpful catalog for $2.50.

Potato Dextrose Agar (PDA) and Malt Extract Agar (MEA) are standard nutrient media suitable for cultivating the mycelia of most higher fungi, including *Stropharia cubensis*. Both types are commonly available in a premixed form from most scientific supply companies. The premixed type need only be dissolved in boiling distilled water. Usually about 15-20 g of pre-mixed agar medium per 1000 ml of water is used.

The appropriate proportions and mixing instructions are usually printed on the container of dried agar preparation. With very little trouble, one can also manufacture one's own PDA or MEA. Recipes for PDA, MEA, and a variation of MEA called MYP for Malt-Yeast-Peptone are given below. We have found MYP to be excellent for long term maintenance of vigorous mycelium.

P.D.A.
250 g potatoes
15 g agar
10 g dextrose
1.5 g nutritional yeast (or yeast extract)

Shred the unpeeled potatoes into a colander and then rinse them for thirty seconds with cold tap water. Combine the rinsed potatoes with one liter of water and gently boil for thirty minutes. Filter the resulting potato broth through muslin or cheesecloth and discard the potatoes. To the liter of potato broth add the agar, dextrose, and yeast which you have previously weighed out and mixed together in a baggie. While stirring gently add in the mixed powdered ingredients. Gently boil for ten minutes or until the solution is clear. Take care not to allow the solution to boil over. Add enough water to return the total volume of the solution to one liter. Pour the solution while still hot into Petri plates, baby food jars, or slant culture tubes (Fig. 11). Use just enough to cover the bottom of a plate or baby-food jar to a depth of about ¼ inch full. For convenience, the plates may first be placed in the bottom of the cooker before the medium is poured; then pour the medium, put the covers on the plates, then build a second stack on top of that; then pour, cover, and stack again, until a stack similar to Fig. 12 has been built. The solution may be allowed to cool or sterilized immediately. Sterilization procedures will be described shortly.

A recipe for Malt Extract Agar (MEA) follows.

To 1 liter of gently boiling water add a previously weighed and mixed powder containing:

20 g malt or malt extract (may be powder or syrup)
25 g agar
0.1 g potassium dibasic (K_2HPO)
0.1 g calcium carbonate ($CaCO_3$) (powdered oyster shell may be used)

The liquid malt extract sold in the syrup sections of most grocery stores is quite suitable for this medium. After the nutrients have been completely dissolved in the water, the hot solution is poured into plates in the same manner as the PDA.

MYP or Malt-Yeast-Peptone medium is a variation on MEA very useful for long term maintenance of desirable cultures. To 1 liter of gently boiling water add a previously weighed and mixed powder containing:

7 g malt extract (powder or syrup)
1 g peptone or soytone
0.5 g yeast extract
15 g agar

Soytone and Peptone are commercial brands of a protein hydrolysate and can be purchased from scientific or microbiological supply houses.

In the case of all three of these recipes, if some of the nutrient solution is left over after pouring the plates, the flask may be sealed and stored in the refrigerator indefinitely, or sterilized with the plates and stored on the shelf. When one wishes to make more plates, the medium can be reliquified over heat and reused.

The three types of media described above are quite easy to prepare and will be suitable for growing stock inocula. It is a good idea to mix up and have on hand at least two types of media, and to use them alternately in preparing batches of plates. In this way the fungus will not become accustomed to one type of medium and thus will be forced to use different parts of its genome in adapting to the different media. This will prevent the mycelium from succumbing to any "senescence factor" or tendency to age physiologically and thus to lose vigor after a period of time.

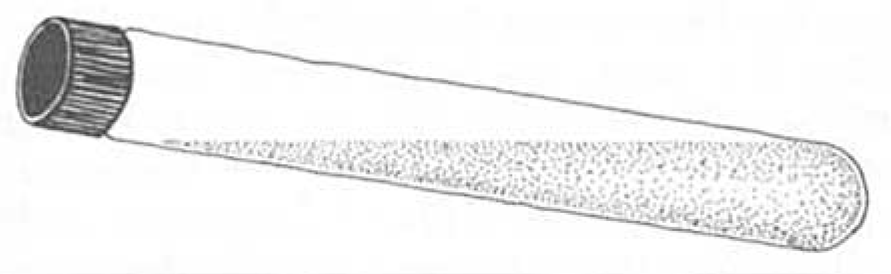
These three types of media are completely adequate for growing out one's stock inocula. From a purely practical standpoint, we have found them to be easily and readily prepared from a relatively few common ingredients. Unless one wishes to get involved in complex nutritional studies, it is unnecessary to bother with other recipes. Other types of media may be used, however, and those who do wish to get more deeply into this step of the process are urged to consult Neal, et. al. (1968).

Once one has prepared an agar medium and poured it into the Petri plates, baby food jars, slant culture tubes, or other suitable receptacles, it is necessary to sterilize the medium in the receptacles in order to kill the spores of bacteria, yeasts, and other molds which get into the medium from the air. This can be done via the following procedure: If a laboratory autoclave is not available, a standard home cooking or canning pressure cooker can be used. We use and recommend the All American 941½ pressure cooker, available from its manufacturer, The American Aluminum Foundry Co., P.O. Box 246, Manitowoc, Wisconsin 54220 (see Fig. 27). Place a small amount of water (approx. 1 liter) in the bottom of the cooker (tap water will do) so that the surface is covered. Place the receptacles containing the medium into the pressure cooker. Be sure to stack them carefully (see Fig. 12); a small enameled tray is useful for this. Note: If using pre-sterilized plastic plates, pour the medium into the plates *after* sterilizing; *do not autoclave plastic plates*.

It does not matter whether the medium is still hot and liquid, or whether it has been allowed to cool and solidify, since the heat of the sterilization process will reliquify the medium anyway. If baby food jars or culture tubes are used, *be certain that the lids are left loose, not screwed down tight*, when they are being sterilized. Seal the lid of the pressure cooker, *but leave the stopcock open*. Bring the cooker to a boil over high heat on a stove. When the water has begun to boil vigorously, a good head of steam will begin to vent through the stopcock; it should be closed at this point, and the pressure allowed to build up to between 15-20 lbs. Then reduce the heat just enough to maintain pressure at this level for 45 minutes to 1 hour. The standard sterilization time for solid media at these temperatures (250 degrees F.) and pressures (15-20 lbs.) is 15 minutes, but experience has shown that this is often insufficient to insure complete sterilization. Allowing a visible head of steam to build up in the pressure cooker before closing the stopcock is also important, for if it is closed prematurely, the pressure will rise but the water will be unable to vaporize, and dry heat requires much longer to accomplish sterilization.

After the medium has been sterilized at the correct pressure for 45-60 minutes, turn off the heat or carefully remove the cooker (remember that the medium is liquid at this point and can slosh around) and allow the cooker to cool to room temperature *before opening the stopcock*; otherwise, the sudden release of pressure will cause the medium to boil over.

When the cooker has cooled to room temperature or slightly above, wrap the column of the stopcock with an inch wide piece of paper toweling, then dampen it with an aerosol Lysol spray and then open the stopcock and allow any excess steam to escape. Remove the lid and carefully remove the receptacles containing the medium. Place the receptacles inside a pre-sterilized inoculating hood (see Fig. 10) or on a clean, smooth tabletop which has been wiped down with Lysol or similar strong disinfectant. As the receptacles cool further, the medium will solidify. If slant culture tubes are being used, they should be placed on an angle while the medium is still liquid, to provide maximum surface area for mycelial growth.



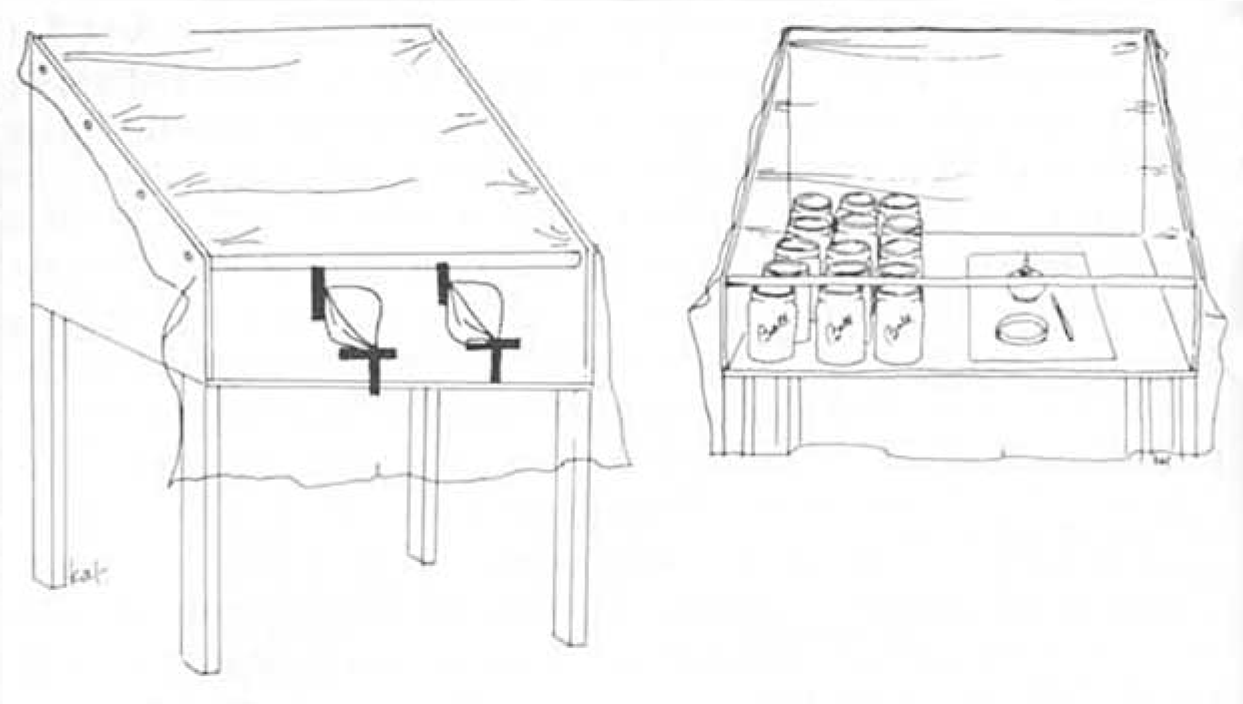


Fig. 10 - Two views of a homemade inoculating hood.

Note: PLASTIC PLATES CANNOT BE AUTOCLAVED! If using pre-sterilized plastic Petri plates, the medium should be sterilized in a flask sealed with tinfoil. The flask should be about ½ full, so it is best to sterilize two 1000 ml flasks with 500 ml each of medium. The procedure for pouring plastic plates is described below.

If pre-sterilized plastic plates are being used, one proceeds as follows: Allow the sterilized flasks to cool in the inoculating hood until they are warm to the touch - but can be handled easily. The medium is still liquid at this point, and is ready to be poured. Working with the usual sterile precautions (see below), one requires an alcohol flame and a stack of 20-40 plastic Petri plates. These commonly come packaged in rolls of twenty. Begin with a stack of about five plates. Carefully peel back the tinfoil from the lip of the flask of medium, and flame the flask lip briefly in the alcohol flame. Then, holding the flask in one hand, with the other carefully lift the lid from the bottom plate in the stack, keeping the other plates balanced on top of it. Hold the lip of the flask close to the edge of the Petri plate. Pour just enough medium to cover the bottom of the plate to a depth of about ¼ inch. Carefully replace the cover and then repeat the process with the next lowest plate and so on up the stack. After the plates have been poured, they should be stacked (carefully!) in columns of 10 or 20 in order to minimize condensation on the lids while cooling.

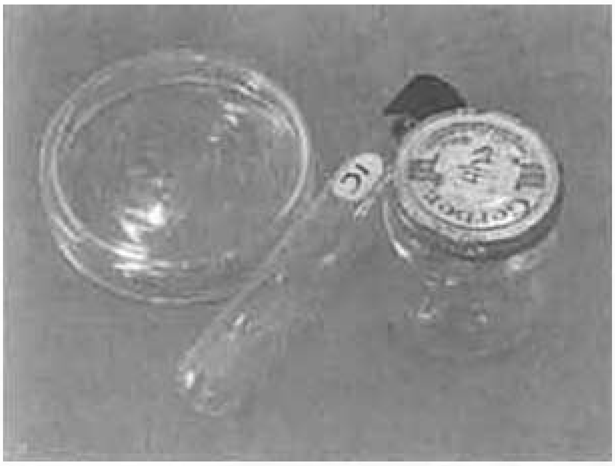


Fig. 11 - Three containers suitable for agar culture.

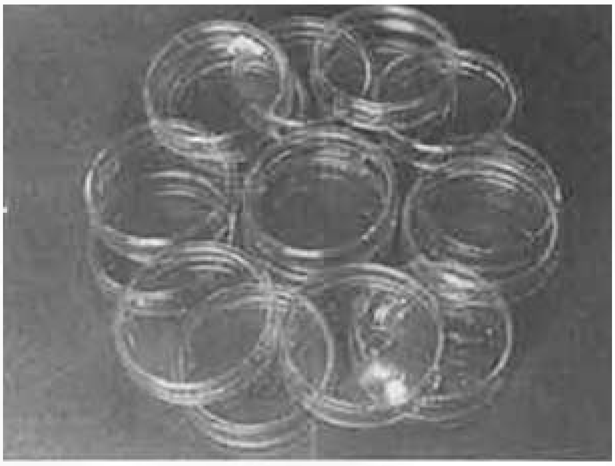


Fig. 12 - A simple stable stack of Petri plates.

When the receptacles have cooled completely to room temperature, and the medium is fully solidified, they are ready to be inoculated. If possible, inoculation should be carried out inside an inoculation hood such as that shown in Fig. 10. Commercial hoods are available, or a homemade hood can be constructed out of wood and all joints sealed with silicon caulking compound. Pre-sterilize the hood before introducing the culture receptacles by spraying all inside surfaces thoroughly with Lysol aerosol, or a mixture of 25% Clorox-distilled water solution, or both. If a hood is not available, inoculation can be carried out in the open air in a room in which the air is relatively still, i.e., a room without any drafts. The air of the room should be sprayed beforehand with 25% Clorox solution and the surface on which inoculation is to be done wiped down with a strong Lysol solution. All sterile procedures should always be done wearing latex gloves which have been sterilized by spraying with Lysol (Figs. 13 & 14). Never use aerosol Lysol spray in the presence of any flame. After spraying Lysol in the inoculating hood, wait a few minutes before introducing the alcohol lamp into the hood. **REMEMBER THAT SPRAY LYSOL IS HIGHLY FLAMMABLE**.

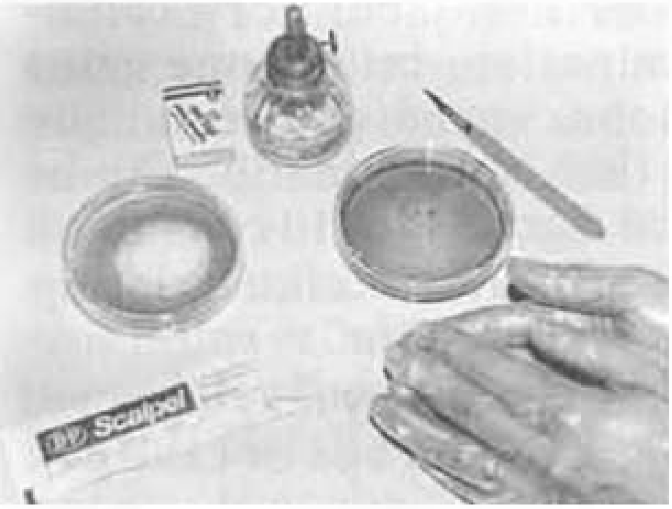


Fig. 13 - Materials for plate-to-plate inoculation.

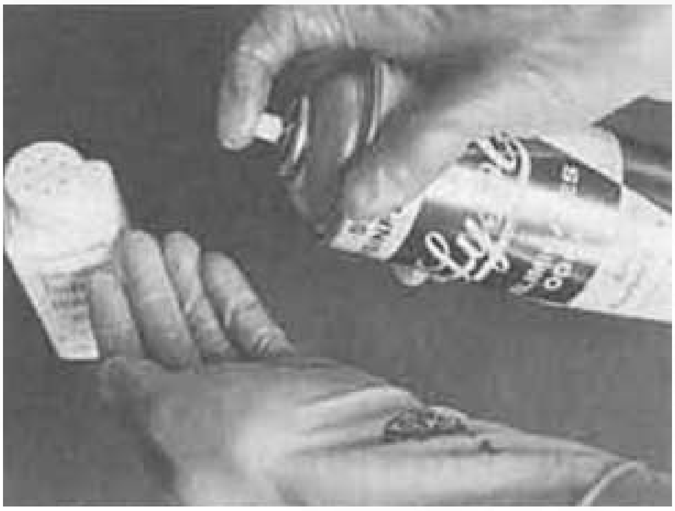


Fig. 14 - Disinfecting rubber gloves with Lysol.

Inoculation should be done using a disposable scalpel or an inoculating loop which has been opened to form a hook (Fig. 8), and can be carried out in essentially the same manner as was described for isolating dikaryotic mycelium from a spore germination plate. Select a completely sterile, vigorously growing culture from one's stock of dikaryotic mycelium isolated from spores. The mycelium of a vigorous culture should be pure white and ropey in appearance, and preferably less than 10 days old (cf. Fig. 13). Wash one's hands and arms thoroughly in soap and water before beginning work, then wipe down with alcohol. Wear thin latex gloves sprayed with Lysol or Clorox-water solution as added protection (Figs. 13 & 14); talcum powder can be sprinkled inside first to make them easy to slip on. Wear a short-sleeved or sleeveless shirt for the process to avoid introducing contaminants from one's clothes. Pass the scalpel or hooked inoculating loop through the flame of an alcohol lamp until the working tip has been heated to redness (Fig. 15). Allow it to cool for a moment or quench it in a Petri dish of sterilized agar sacrificed to this purpose. Open the culture just enough to insert the end of the loop, and snag a small piece of mycelial tissue or small plug of agar and transfer this rapidly to the freshly sterilized medium, again opening the lid just enough to insert the inoculum (Fig. 16). Withdraw the loop and replace the lid on the newly inoculated culture. If a scalpel is used instead of a loop, inoculation can be accomplished by cutting a small square (1 sq. mm) of mycelia-grown agar from the culture plate, and transferring this to the new plate. If using tubes or baby food jars, the lids should be left fairly loose to allow for aeration. Repeat this process for as many times as one has receptacles to inoculate. It is not necessary to use a new culture for each inoculation; a single culture is sufficient to inoculate dozens of fresh plates. After a batch has been inoculated, however, the culture used as the source of inocula should be discarded.

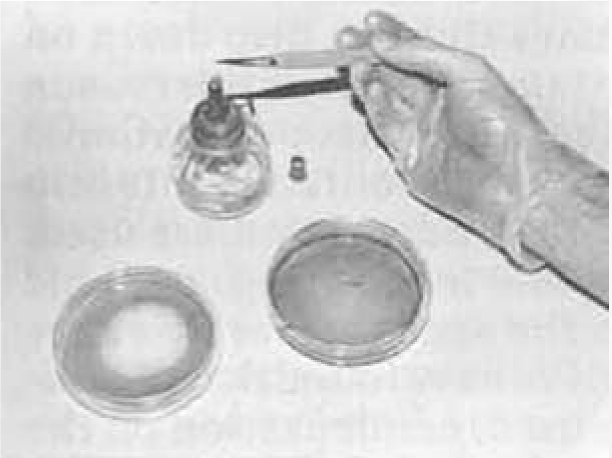


Fig. 15 - Flaming the inoculating scalpel.

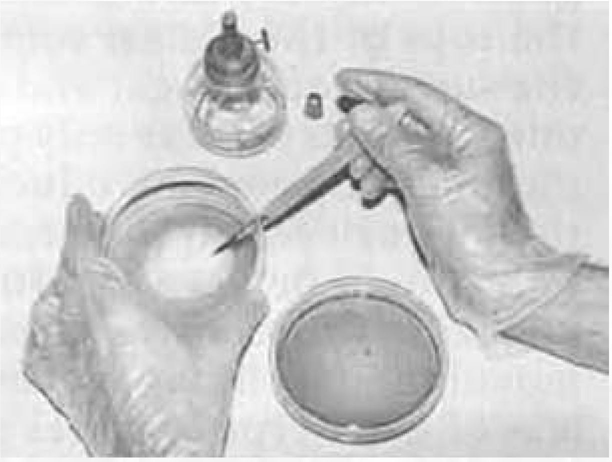


Fig. 16 - Inserting inoculum in fresh Petri plate.

Let the freshly inoculated medium stand at room temperature for 3-5 days. During this time the pure white, thread-like mycelium will spread radially across the surface of the medium, covering it completely within 7-20 days. Growth of the inoculum should be apparent by the fourth day after inoculation. Also apparent by about this time will be any contaminants that have gotten into the cultures during inoculation in spite of precautions. They usually appear as small white dots with blue-green centers, and grow much more rapidly than the mycelium. These are usually other molds, such as *Penicillium* and *Aspergillus*, *Neurospora* or various yeasts. Most are easy to distinguish from the mushroom mycelium, since the mycelium is pure white, occasionally with a slight tinge of blue, while the contaminants may be green, blue-green, black, yellow, dirty-gray, and so on, and otherwise do not resemble the mycelium. Any contaminated cultures should be discarded as soon as one is certain that contamination is present. It is normal to lose a few cultures to contamination, and one should not be discouraged by it. It is practically impossible, under non-laboratory conditions, to eliminate all contamination; but as one gains practice in making inoculations, speed and technique should gradually improve so that contamination can be held to a minimum. It would be a good idea to consult an introductory microbiology text for information relating to fast and efficient inoculating techniques.

After the plates have been inoculated, they may be stored while growing out in a sealed styrofoam box or cake box which has been sterilized by washing out with strong Clorox solution, then sprayed on all inside surfaces with Lysol. This will help to prevent contamination during growth. In very humid climates, water will condense on the tops of the plates; sometimes this can drip down on the surface of the agar and contaminate it. For this reason one should try to use only plates in which condensation is minimal, to avoid introducing unseen contaminants into the jars or rye; or, if plates with condensation are used, one should be very careful, while inoculating, to avoid knocking drops of water onto the agar surface when removing and replacing the cover. We have found that regardless of what type of plates are used, condensation on the cover can be eliminated by stacking the plates in taller (and more precarious) stacks of fifteen or more during the cooling down of the media.

STEP III - GROWING ON STERILIZED RYE

When a number of mycelial cultures have been successfully grown on solid agar medium, one is faced with a choice: It is possible to stop at this point, and concentrate on perfecting techniques for mycelial growth on agar. The mycelium itself contains psilocybin and can be ingested for hallucinogenic effects. The amount of psilocybin present in the mycelium is determined by the richness of the medium on which it is grown. Thus for an individual wishing only to obtain psilocybin from mycelium, there is a wide-open area for investigation; viz., to discover a suitable nutrient medium that gives a maximum yield of psilocybin per unit surface area of agar. If laboratory facilities are available, psilocybin can also be obtained from mycelium grown in liquid medium in shaken or submerged flask cultures. Since the necessary equipment for this is unavailable to most people, this approach is not discussed further here. Interested readers are urged to consult Catalfomo & Tyler, 1964.

The other choice at this stage involves moving on to the third step in the procedure, whereby mushrooms can be obtained by inducing the mycelium to fruit. In order for vigorous fruiting to take place, the mycelium must first be grown out onto sterilized rye, wheat, barley or other similar grain, so that a mass of mycelium weighing from 50-100 grams is obtained. The growing of mushroom mycelium on sterilized grain is a standard procedure in commercial mushroom culture that is used to produce "spawn" for inoculation into beds of horse-manure compost. The procedures described in this section are in fact adapted, with appropriate modifications, from a process originally developed by San Antonio (1971) for growing fruits of the common edible mushroom *Agaricus bisporus* under laboratory conditions. The steps involved in growing the mycelium onto rye-grain medium are described below.

While the mycelium will grow and fruit suitably on many types of grain, including rye, wheat, barley, triticale, oats, brown rice, sorghum, millet and even buckwheat, our experience is that rye works as good as any and is less expensive than most. Therefore we have primarily worked with rye in this stage. One must be certain, however, that the rye used is packaged for human consumption, and not grown as feed; feed rye has usually been treated with a fungicide.

At this stage, it is useful to construct a styrofoam box with a window in the lid such as illustrated in Figs. 17-20. These boxes can be obtained from pet stores and tropical fish dealers and can be used as a convenient modular system for incubating jars in a high-humidity, constant temperature environment. Jars may also be kept in an aquarium or a terrarium of suitable size. Such a case may be outfitted with a Grow-lux light and a timer set to a 13-hour light cycle to provide a nearly perfect growth environment. If one is working in an environment where temperature fluctuations are minimal and conditions are clean, the jars can simply be incubated on a shelf or table without any special containers.

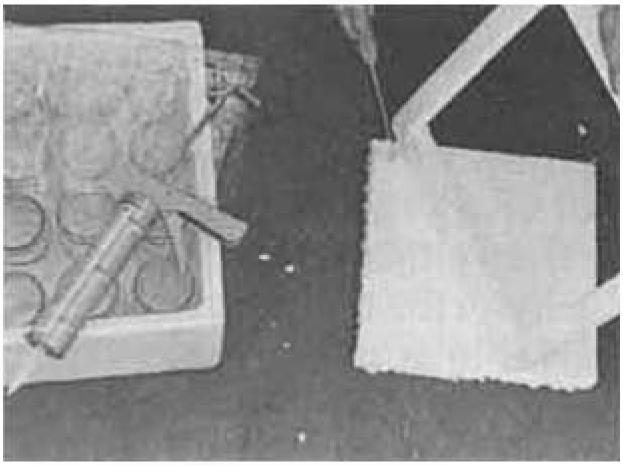


Fig. 17 - Making a box: cutting a window in the lid.

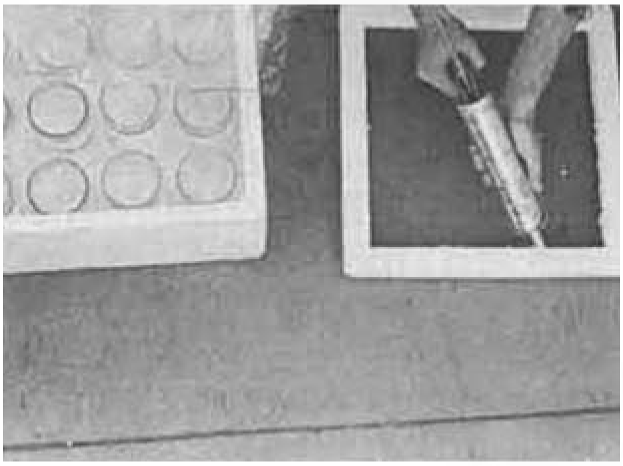


Fig. 18 - Applying silicone marine glue.

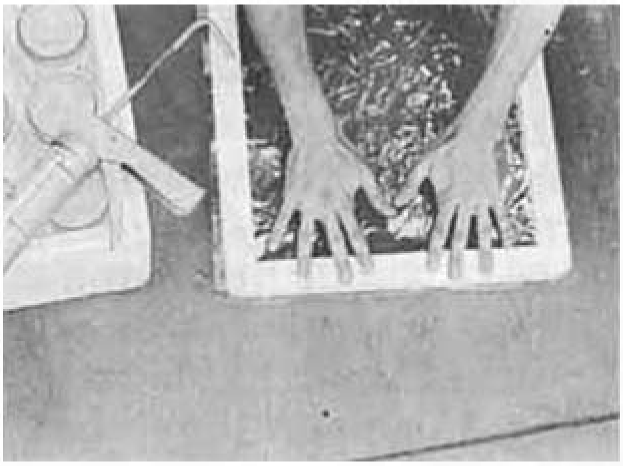


Fig. 19 - Clear plastic vinyl is glued over the window.

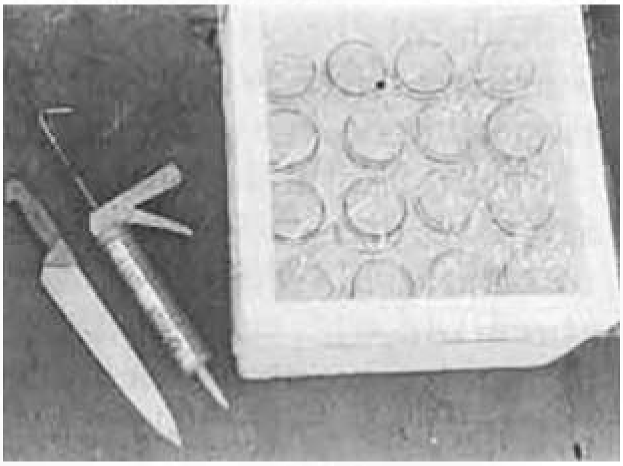


Fig. 20 - Completed box.

To prepare the rye medium, begin with a clean, wide-mouth quart Mason jar with a dome and ring lid. Add the following ingredients to the jar in these proportions:

160 ml rye berries (dry weight approx 150 g)
130 ml water (tap or distilled)
½ tsp. of calcium carbonate ($CaCO_3$)

The calcium carbonate, which is optional, need not be of great purity; powdered oyster shell, powdered limestone, or powdered chalk is suitable.

When the ingredients have been added to each jar in the proper proportions, the lids should be screwed *loosely* onto the jars, *with the rubber seal of the inner lids inverted* so that the jars will not seal during sterilization (Fig. 26).

Now the jars containing the rye can be sterilized. Add water to the pressure cooker; never use less than 1 to 1½ liters. Place the jars in the cooker, *making sure that the lids are loose* (Fig. 28). If one's pressure cooker is large enough to permit, jars can be stacked in two tiers without difficulty (Figs. 29 & 30). Seal the lid of the pressure cooker, but leave the stopcock open as before, until a head of steam begins to vent from the stopcock. Then close the stopcock, and bring to 15-20 lbs. pressure. Reduce heat when this pressure is reached so that pressure is maintained but does not increase. This is about medium heat on an electric stove. Sterilize at this pressure for one hour. Remove from the heat and allow the pressure to return to zero before opening the stopcock. Remember to wrap the stopcock column with a strip of Lysol-soaked paper toweling. Open the stopcock and allow excess steam to escape; then remove the lid from the pressure cooker. Remove one of the jars, tighten the lid down finger-tight, and carefully examine the jar for cracks and immediately discard any flawed jars (Fig. 31); then shake the remaining jars vigorously (Fig. 31). One can inscribe the jars with the date of inoculation or other suitable code-number (Fig. 32) in order to keep track of the schedule of shaking the jars. One will note on removing the jar that the rye has absorbed the water and swelled to several times its previous volume. After shaking, leave the lids tightened until the jars have cooled. Place the jars into the pre-sterilized inoculating hood (if available) or onto the clean, disinfected working surface (Fig. 10). Then let the jars cool for at least two hours or to room temperature.

When the jars have cooled completely to room temperature, and are no longer warm to the touch, they are ready to be inoculated. This step is best accomplished using a sterilized #11 scalpel (Fig. 33). These scalpels can be obtained from any medical supply house. Flame the blades of the scalpel over an alcohol lamp (Fig. 33). Insert the scalpel into an agar mycelial culture grown in a Petri plate or baby food jar, and cut a grid into the surface, so that small squares of agar of about 1-1.5 cm square are formed (Fig. 34). One can get about 9-20 small squares of agar from a single four-inch Petri dish in this way (Fig. 35). Cultures grown in slant tubes are obviously unsuitable for this step, because of difficulty in removing squares of agar from the tubes. At each transfer re-sterilize the scalpel blade by flaming, insert into the agar culture, and spear and remove one of the squares of mycelium-covered agar (Fig. 36) and transfer rapidly to one of the Mason jars, lifting the lid of the jar just enough to insert the inoculum (Figs. 37 & 38). Firmly tighten the lid and shake the jar vigorously to spread the inoculation points. Repeat this inoculation step for each jar.

An alternative method of inoculation was suggested to us by a friend, as possibly effective in increasing the sterility of the procedure and thus cutting down contamination. This method is a standard approach to fungal inoculations in mycological work, and so far seems promising, although we have not investigated it thoroughly enough to know if it is the answer to contamination problems.

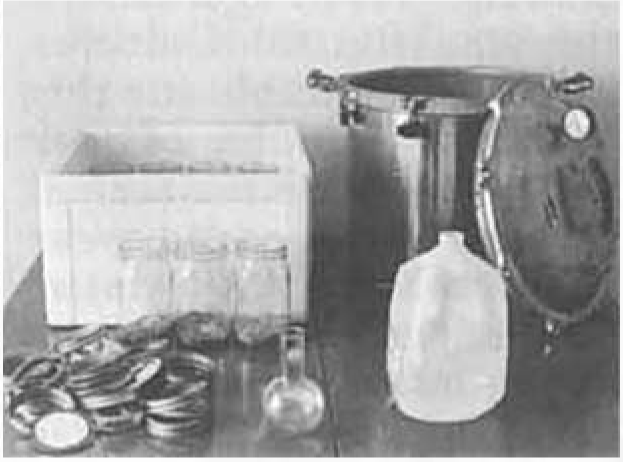


Fig. 21 - A set of jars to be filled and sterilized.

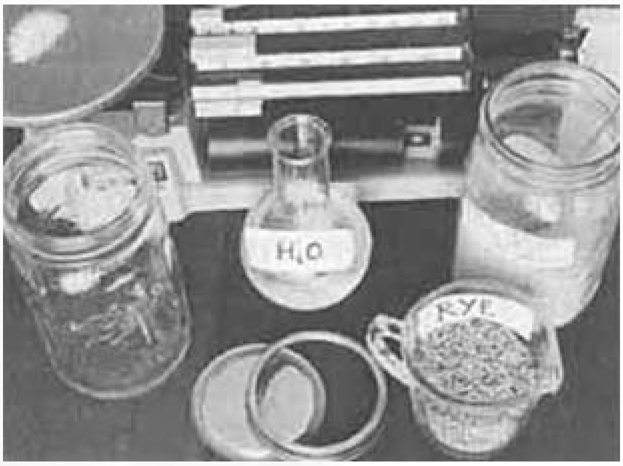


Fig. 22 - Materials for making the rye medium.

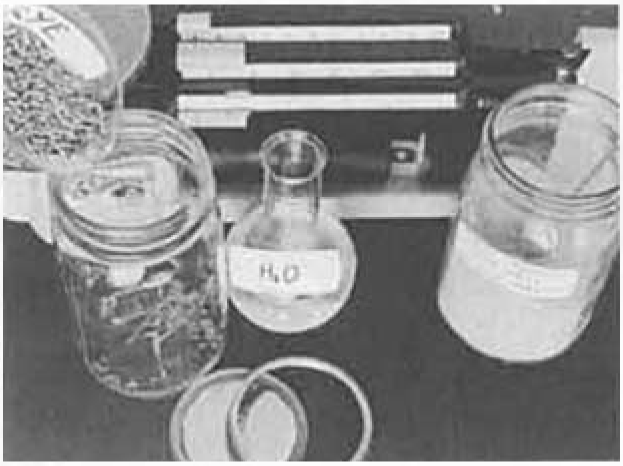


Fig. 23 - Adding weighed rye to the jar.

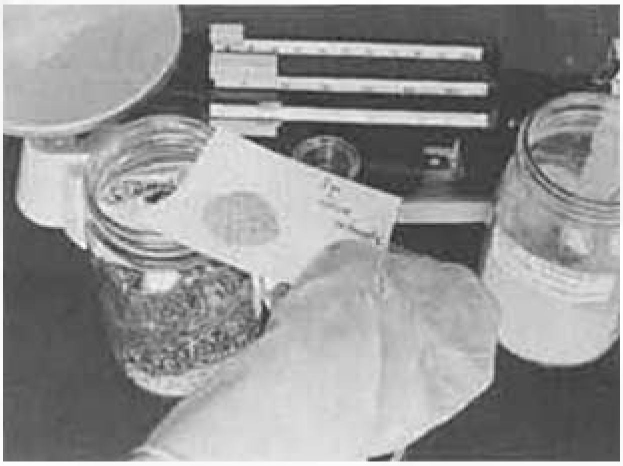


Fig. 24 - Two grams of powdered oyster shell ($CaCO_3$) are added.

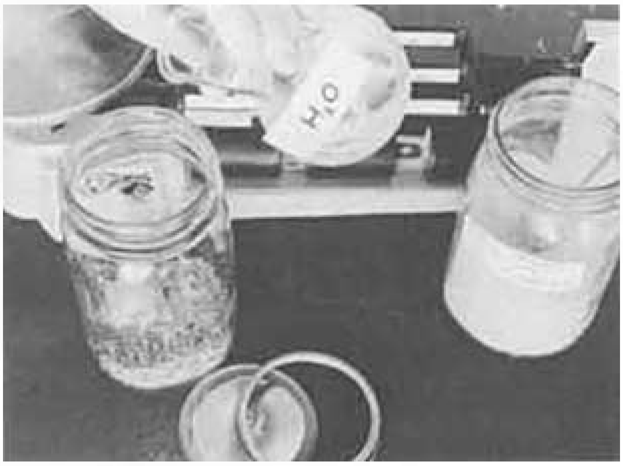


Fig. 25 - 150 milliliters of water are added.

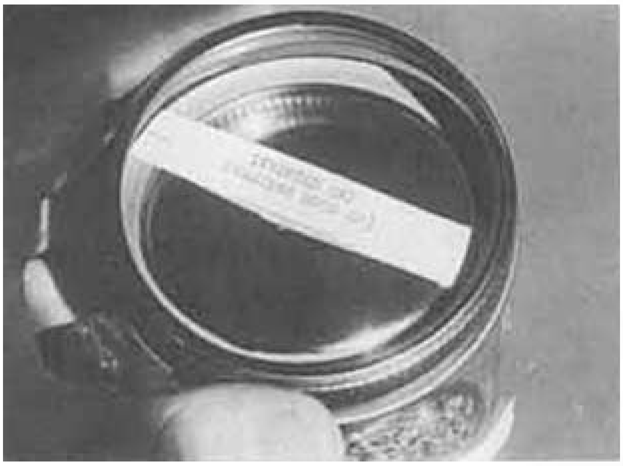


Fig. 26 - Mason jar lid with rubber edge up.

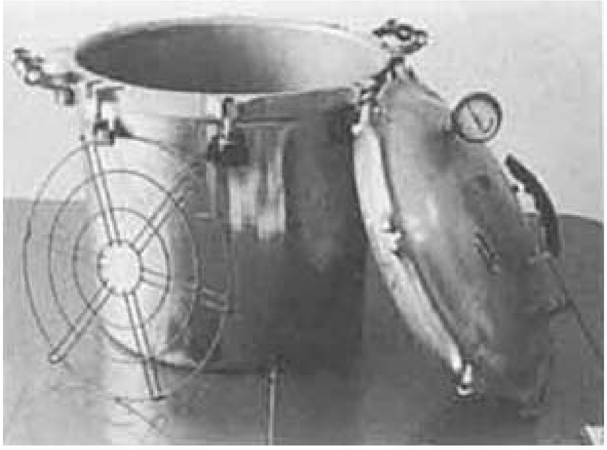


Fig. 27 - The All American 941½ pressure cooker.

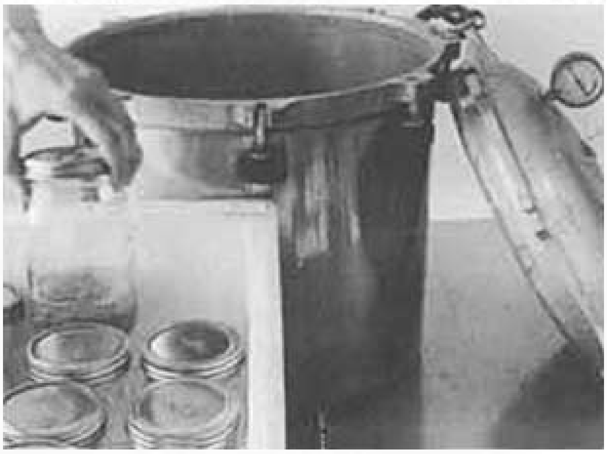


Fig. 28 - Loading the pressure cooker.

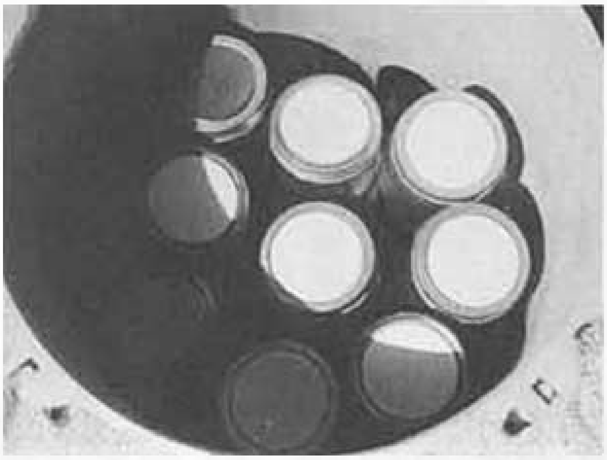


Fig. 29 - The first layer of jars.

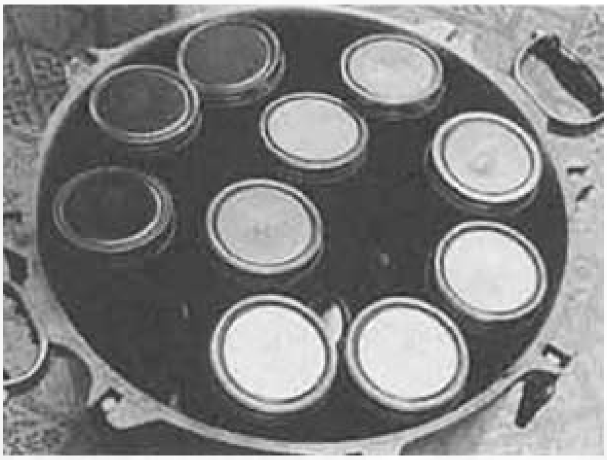


Fig. 30 - The second layer of jars.

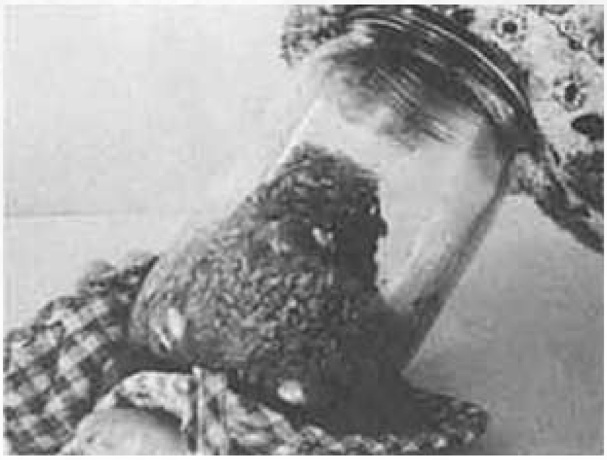


Fig. 31 - Sterilized jars are checked for cracks, then shaken.

Fig. 32 - Writing the date on the jars.

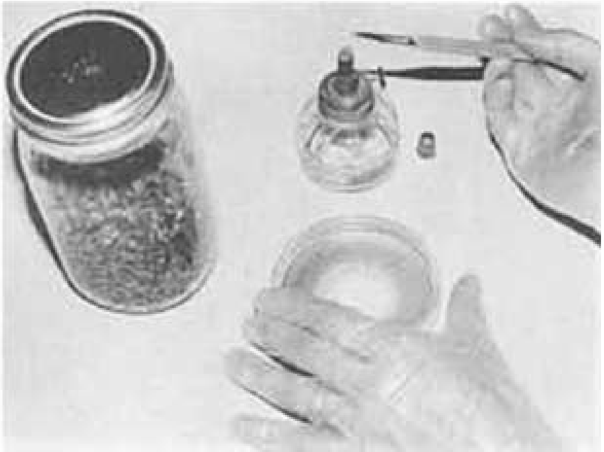


Fig. 33 - Flaming the scalpel.

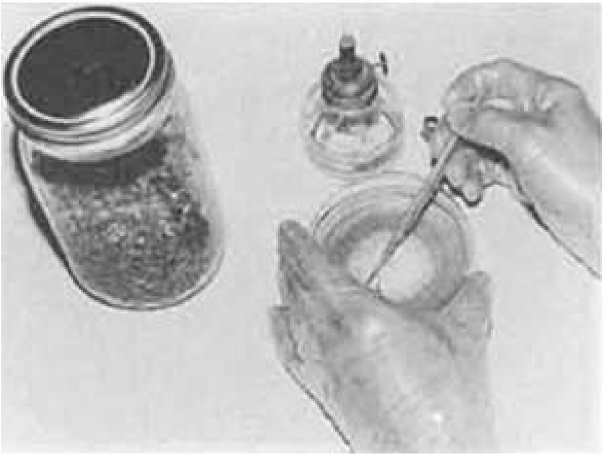


Fig. 34 - Mycelium on agar is cut into sections.

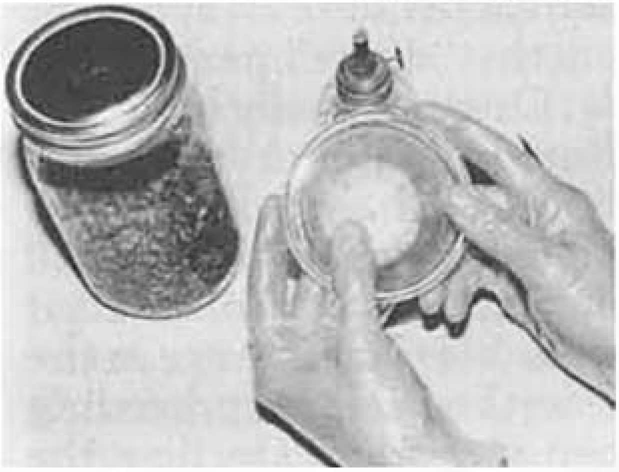


Fig. 35 - Plate of sections ready for use.

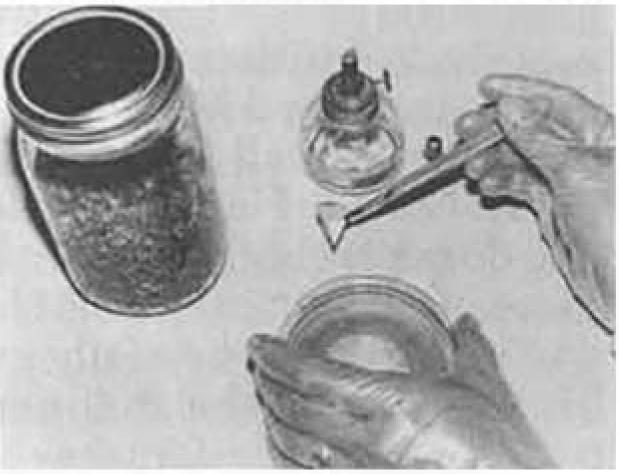


Fig. 36 - Agar block is speared with scalpel...

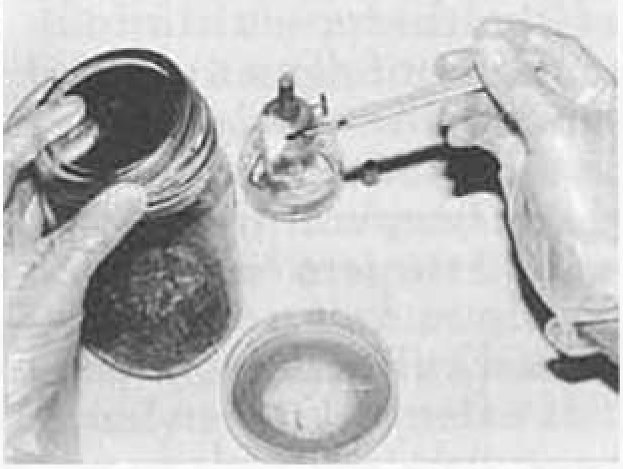


Fig. 37 - ... and transferred ...

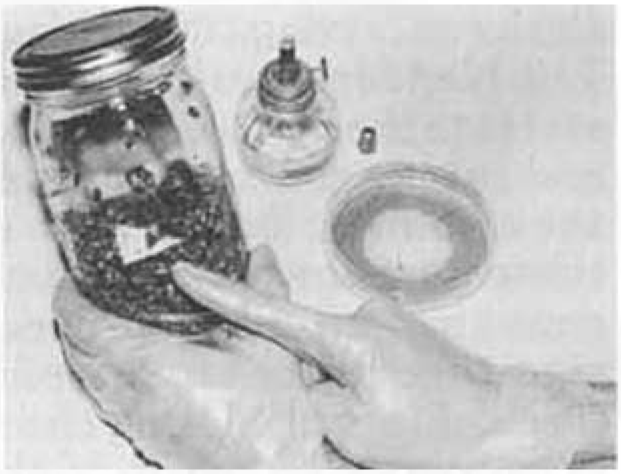


Fig. 38 - ... to a jar.

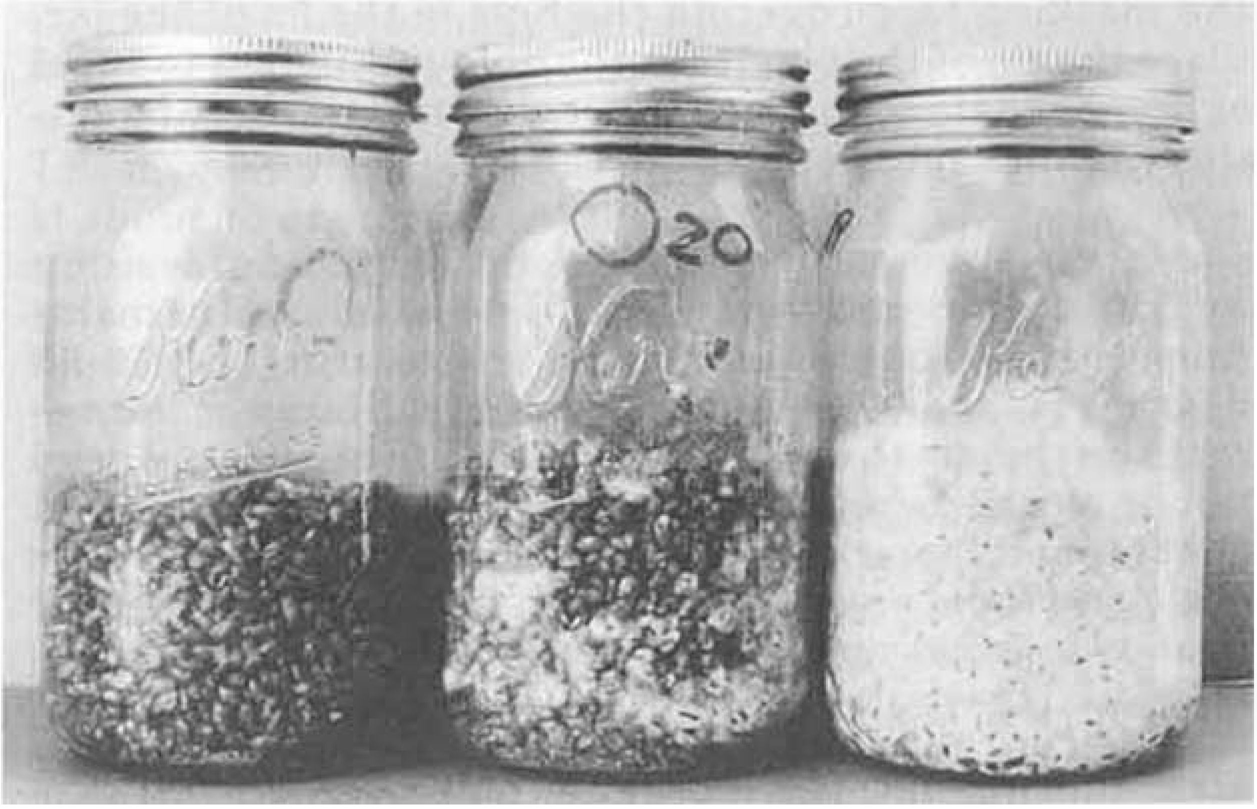


Fig. 39 - Jars at 4, 6, and 10 days after inoculation.

In order to use this method, one must bore an approximately ½-in. diameter hole in the "dome" part of the dome-and-band Mason jar lids. One can easily have this done for a small fee at a machine shop which has a drill press. NOTE: Have the holes bored with the white side of the dome facing up! Seal the hole in the lid with a small piece of masking tape that has been folded back on itself at one end so it can be easily grasped. Sterilize the rye in the Mason jars in the manner described in the preceding pages. After the jars have been sterilized, sterilize the following items for 45 minutes in the pressure cooker: one 50 ml Pyrex pipette (wrapped in tinfoil); the *glass part* of a standard household blender; one 250 ml Erlenmeyer flask containing 100 ml of water (seal the top with tinfoil). The blender should be covered with tinfoil on top; *do not* sterilize the plastic top of the blender! The metal propeller and rubber gasket of the blender need not be removed, as they will not be harmed by high temperatures. After these items have been sterilized and the jars have cooled enough to inoculate, proceed as follows: Select one or two vigorous, uncontaminated mycelial cultures from your stock of inocula. Using the flat of a flamed kitchen knife, cut around the edges of the agar disk in the plate, and empty the disk or disks into the blender. Add 100 ml of sterilized water, place the top on the blender and homogenize at high speed for 20 to 30 seconds. Suck up the homogenate in the sterile pipette. Grasp the free end of the masking tape covering the hole in the lid of the jar. Place the tip of the pipette in the hole and allow 5 to 10 ml of homogenate to fall into the jar. Reseal the hole by re-sticking the tape. Repeat for each jar.

After the rye has been inoculated, a period of waiting and careful observation follows. The jars should be maintained at a roughly constant temperature of 70-80 degrees F., and 95% relative humidity. Since the lids remain on the jars the humidity will tend to be high and need not be worried about. Maintaining the relatively high and constant temperature, however, is important to promote early and rapid mycelial growth. The mycelium gives off heat as it grows and a styrofoam box of the sort used by tropical fish wholesalers is ideal for holding this heat and thus self-incubating the jars. During the first three days after inoculation, the mycelium will grow off the agar inoculum and onto the rye. By the eighth to fourteenth day, depending on the temperature, the mycelium will have grown radially outward from the inoculum in all directions to form a mat of growth slightly smaller than a fifty-cent piece.

When mycelial growth has reached this stage, firmly tighten the lid and again shake the culture vigorously, to break up the mycelium and redistribute the inoculum throughout the rye. During the shaking process you will run across obviously contaminated jars; simply remove them and set them aside for washing out later. After shaking, allow the culture to stand for 3-4 days. At the end of this time mycelial growth from many different points in the rye should be apparent (Fig. 39). Shake the jars in this manner on the fourth, sixth, eighth, and, if necessary, on the tenth days after inoculation. Complete permeation of the rye should be observed anywhere from the eighth to the fourteenth day. At this time, the rye should be completely permeated by the snow-white mycelium, which may occasionally be lightly tinged with blue. If growth of any other color is observed, or if the rye is only partially permeated, then the culture is contaminated and should be discarded.

It should be noted that the time required for the mycelium to completely permeate the rye can vary widely according to individual circumstances. In some cases, permeation can take place in under eight days; in others, up to three weeks may be required. Our observations indicate that temperature of incubation of the jars is the single most critical factor governing permeation time. The mycelium of *Stropharia cubensis* has a growth optimum at about 80 degrees F. (Ames, 1958). We have found that cultures incubated at 80 degrees completed permeation in 11 to 13 days, while cultures incubated at 70 degrees required up to twice as long to complete permeation. A temperature of 68-70 degrees F. was, however, optimal for fruiting cultures after the casing step was carried out (see below). The degree of wetness of the rye medium also influenced permeation time, being slowed when the rye was too dry. We have found the best combination of rye and water to be approximately 160 ml rye to 130 ml water. We found these two factors, temperature and moisture, to affect permeation time significantly, while little discernable effect could be attributed to pH or the presence or absence of light. Even under optimum conditions, however, it is still necessary to shake the jars periodically to spread the inoculum through the medium and facilitate aeration. For the same reason one may also wish to loosen the lids of the jars (just a crack!) after the last shake.

When one or more jars of rye have been completely permeated by mycelium, the third step in the procedure is completed and one is ready to move on to the fourth step, casing. Before discussing this step, however, it is perhaps advisable to insert a word of caution with respect to the third step. This step, getting the mycelium to grow out and permeate the rye, seems to be the most difficult and discouraging step in the whole procedure. The peculiar headaches that one is faced with in this step can be summed up in one word: contamination. For some reason, contamination seems to be a much more serious problem at this stage than at the stage of growing on agar, probably because whole-grain rye is much more difficult to sterilize completely than is agar. Anyone attempting this step, in fact, is almost sure to receive a real education in the number of fungal and bacterial "weeds" that exist to plague the amateur mycologist. Our experience has been that two contaminants in particular are quite persistent and seemingly impossible to eliminate entirely. One is a crusty, rapidly-growing blue-green mold with a medicinal odor, probably a *Penicillium* or *Aspergillus*. The other is an unidentified bacteria that exudes a yellowish slime onto the side of the jar and that smells strongly of rotten apples. Spores of both of these organisms must be so commonly present in nature that they manage to contaminate some of the cultures despite the most careful inoculation procedures. The mold shows up rapidly and can be quickly spotted. Any culture seen to have this contaminant can be considered a loss. The bacteria takes longer to become obvious but with practice one can learn to spot it within a few days after inoculation. A sure give-away for presence of this contamination is to loosen the lid slightly and sniff at the crack: a strong yeasty or ferment-like odor indicates the presence of contamination. Uncontaminated cultures give off only a slight smell of cooked rye. Cultures contaminated with this organism are also almost impossible to salvage. The bacterium is anaerobic, that is, it can grow in the absence of oxygen. Our experience is that it seems indifferent to the presence or absence of oxygen, and grows in either situation. The mushroom mycelium is quite aerobic, in fact proper aeration is essential for its growth; therefore proper aeration can afford the fungus something of a competitive advantage against this organism.

Other contaminants will occasionally be seen, although not with the regularity of the two already mentioned. These may include black, olive green or sulphur-colored molds, and sometimes a dirty-grey, rapidly growing mold that is probably a *Rhizopus*.

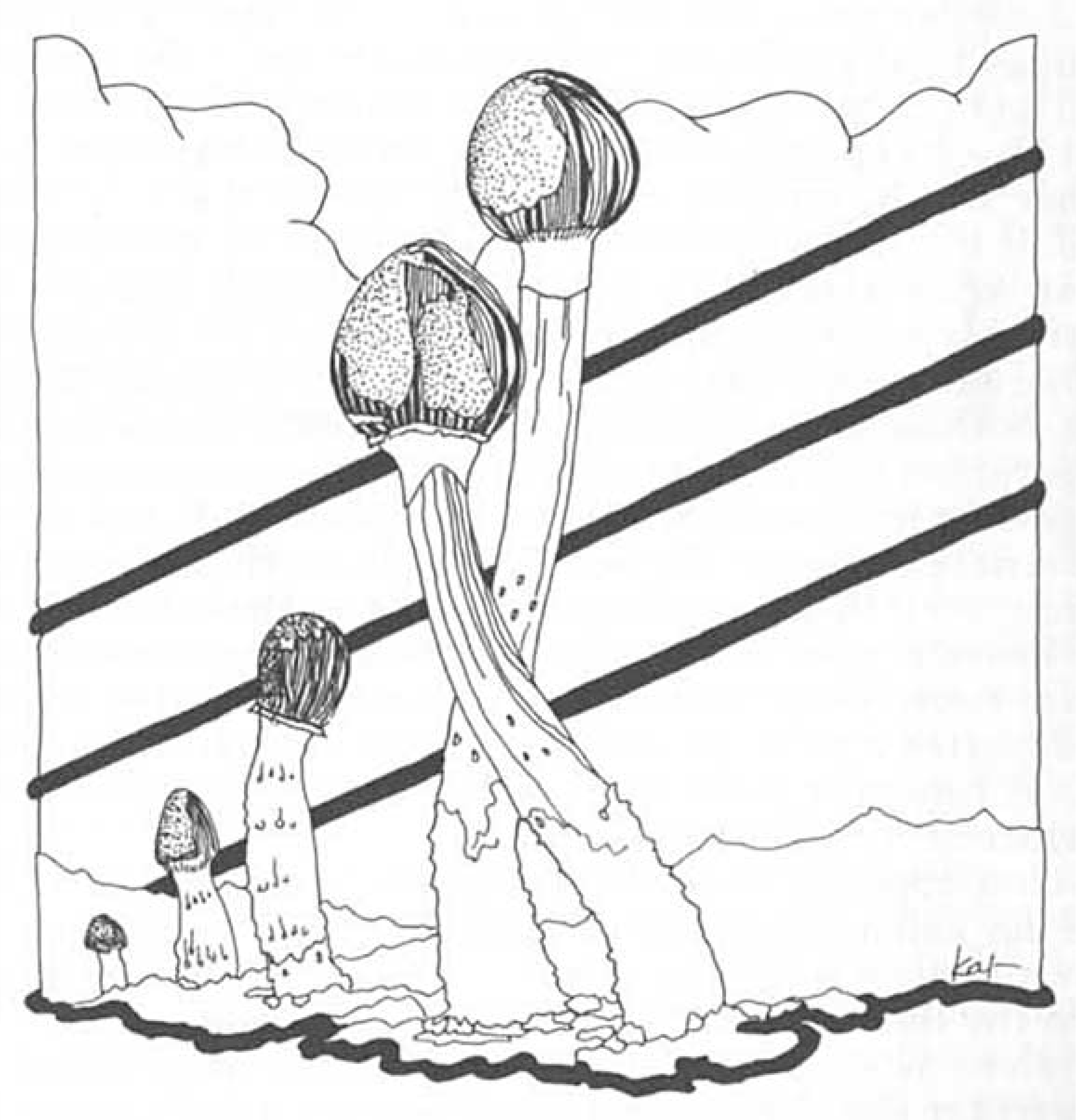
Three factors seem central to achieving a very low (5%) rate of contamination:

1. It is very important to let a good head of steam build up in the pressure cooker. If you are using the All American 941½ cooker, then it should vent clearly visible jets of steam for three to five minutes before the valve is closed and pressure allowed to build. 1500 ml of water should be covering the bottom of the 941 Vi at all times during the cooking of jars.
2. ***Lysol, while easily available, has serious drawbacks. It is highly flammable and if used in the presence of the alcohol lamp or any other open flame can explode. CAUTION: Mushroom growers have been severely burned in accidents involving Lysol***. Staphene is the commercial name of a strong water-based disinfectant that can be obtained from a scientific or medical supply house or ordered from the manufacturer, Vestal Labs, St. Louis, MO. Staphene cannot explode but should be treated with respect and handled with rubber gloves, as it is very toxic.
3. Petri dishes of inoculum should be used when the expanding circle of growing mycelium still retains at least a ¼ in. margin of undisturbed agar on all sides. Contaminants enter the dishes at the edges and most locate there. If inoculum is taken from "young" growth areas, very few even slightly contaminated dishes of inoculum enter the process of inoculating large batches of jars.

Jar Shifting: Once jars are cased it is important to check them for any possible contamination that may take hold in the casing soil itself. If a system of shelves is used, then each day the jars in the back of each row should be transferred to the front of the row. During the transfer, examine the jar for signs of contamination and excessive dryness or wetness. And mites. Done regularly, this process results in examination of all the jars every few days. Contamination can thus be caught in its early stages before it has a chance to spread. It is especially important to eliminate colonies of blue and green bacteria that are powdery.

Contaminants of any kind are not good and it is advisable to discard immediately any culture seen to be contaminated. Although the mycelium can co-exist with some of the slower-growing fungal contaminants, it is still best to discard any contaminated cultures in order to avoid spreading the plague. The cleaning of jars should be done as far away from the inoculation area as possible and should be done by someone who is not involved in making sterile inoculations. Jars that have been contaminated should be washed in a strong solution of Clorox and water before being reused. The best way to deal with contamination is to not allow it to become established in the first place, by being extremely meticulous about one's sterilization and inoculation procedures. Always make sure that the jars are sterilized with *wet* heat, not dry, by allowing a head of steam to build up in the pressure cooker before closing the stopcock. An inoculating hood, even if it is as simple as a cardboard box with clear plastic in one side, becomes almost indispensable at this stage. Always use sterile, uncontaminated agar cultures as the source of inoculation. Make sure that the working surface, and the inside of the inoculating hood, are thoroughly disinfected before inoculation.

The general working environment should also be kept as clean and dust-free as possible. One may wish to use an electrostatic air cleaner for this but it is not essential. Also make sure that hands and arms are clean before inoculating, and wear latex rubber gloves if possible. Spray your gloved hands with spray Lysol before reaching into the hood. ***Careful! Remember spray Lysol is flammable***. Use a sterilized scalpel for making inoculations, and be certain that it is absolutely clean for each batch to be inoculated. It does not hurt to swab it with alcohol beforehand. Be certain to flame the implement thoroughly in an alcohol flame before making each transfer. Practice making transfers as rapidly as possible, so that neither the receptacle containing the inoculum, nor the Mason jar are kept open longer than necessary. Finally, be absolutely ruthless in discarding contaminated cultures. Nothing less than complete permeation of the rye by the snow-white mycelium should be considered acceptable. If these procedures are followed rigorously, some cultures will undoubtedly still succumb to contamination, but the number can be held to a minimum.



STEP IV - CASING AND RECASING

When one or more jars have been completely permeated by mycelium, one can move on to the fourth step in the process that leads directly to the production of mushrooms. In commercial mushroom culture, this step is called casing. In the method outlined here, casing consists of removing the dome and band lid of the jar, and covering the surface of the permeated rye with about ½ to ¾ in. (½ cup for quart jars) of sterilized soil (Fig. 40 & 41). The soil should be premoistened to field capacity before being applied. The fastest way to do this is to spread the soil on a clean sheet of plastic and spray it lightly with the spray nozzle of a garden hose. Mix thoroughly. Field capacity can be gauged by the following rule of thumb: spray the casing soil just enough so that the soil is moistened throughout, but no water passes through the soil into the mycelium. In other words, moisten thoroughly, *but do not saturate* the soil. If the soil is to be sterilized, it should be moistened first. After sterilization, it can be conveniently stored in a double layer of plastic garbage bags, after it has cooled. Small amounts of casing soil may be dampened by putting two or three liters of casing soil in a large mixing bowl and moistening it with a pump sprayer. A large wooden spoon is perfect for folding the wet layers of soil into the dry. Alternate spraying the soil and stirring the dampness throughout the mix. When the casing soil has uniformly darkened in color and retains a shape when squeezed, it is ready to use. Once in the jar the soil should be shaken level and wetted a bit more with a fine mist sprayer (Fig. 42 & 43). A fine-mist spray must be used to avoid sealing the surface of the casing soil.

After applying and moistening the casing soil, discard the lids and maintain the cultures in a high humidity environment. A large styrofoam cooler with a window cut into the lid and covered with clear or translucent polyethylene is excellent for this (Fig. 17-20), so is a glass aquarium. If maintaining the jars in aquaria or styrofoam boxes, it is important to pay attention to proper aeration. Experience has shown that the daily transpiration/evaporation cycle is important if one is to have vigorous fruiting, healthy cultures. Maintaining the proper moisture balance and evaporation rate in the casing soil is actually a complex interplay among temperature, aeration, and evaporation. If either temperature or aeration is excessive, the soil will dry out. On the other hand, it should not become waterlogged, and a minimal amount of air movement should be present to facilitate a slow, even rate of evaporation from the casing soil. For this reason we recommend incubating the boxes with the lids partially or wholly removed after fruiting has begun. The temperature should be kept above 70 degrees F. Spray the cultures daily with a fine-mist spray just enough to make up for moisture lost through evaporation (Fig. 44). Each cased jar requires 2-3 good squirts of water per day to maintain continuous fruiting. Do not exceed field capacity. A good test for proper moisture content is that the surface of the soil should feel moist and spongy to the touch. Boxes of newly cased jars should be stored in chronological order.

Watering becomes a critical matter at this stage. If the correct water level is maintained in the casing soil, the first flush of mushrooms will be normal. But if jars are allowed to become too dry, then aborted fruiting or formation of many small mushrooms unable to grow to full maturity will occur. With proper watering and proper aeration, perfectly normal first flushes can be grown. What is a proper amount of moisture? The general tendency seems to be for beginning cultivators to keep jars too dry. Remember always to use premoistened casing soil. Make sure the distribution of the moisture is uniform. Once jars have been cased with pre-dampened soil, they ordinarily only need water once a day. The exceptions occur during and after periods of intense fruiting when slightly more water is required, or during spells of dry, hot weather. Strong drafts, especially warm drafts from floor heaters, can dry jars out very quickly. If one keeps jars on shelves that are open to the surrounding room part of the day, then it is especially important to keep the heaters from blowing directly on jars. Shelves can be enclosed in transparent polyurethane film in order to maintain high humidity and minimize contamination.

The other extreme to avoid is overwatering. The casing layer should be kept damp but not soaked. Any visible water accumulating between the rye covered mycelium and the walls of the jar indicates overwatering and a potential for contamination. Often if left unattended such jars become yellowish, indicating a more advanced stage of contamination. Such jars should be placed on a shelf together - separate from the other jars - and *all water should be withheld* until excess water in the jars recedes completely. Often, upon recasing, such jars seem to regain their equilibrium, and fruiting, though delayed, is normal.

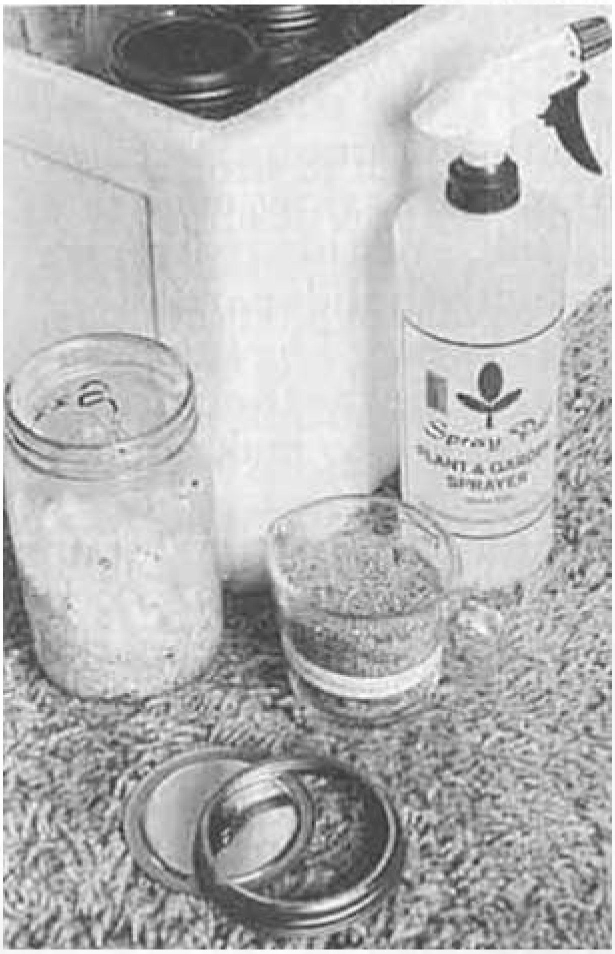


Fig. 40 - Open jar and soil ready for casing.

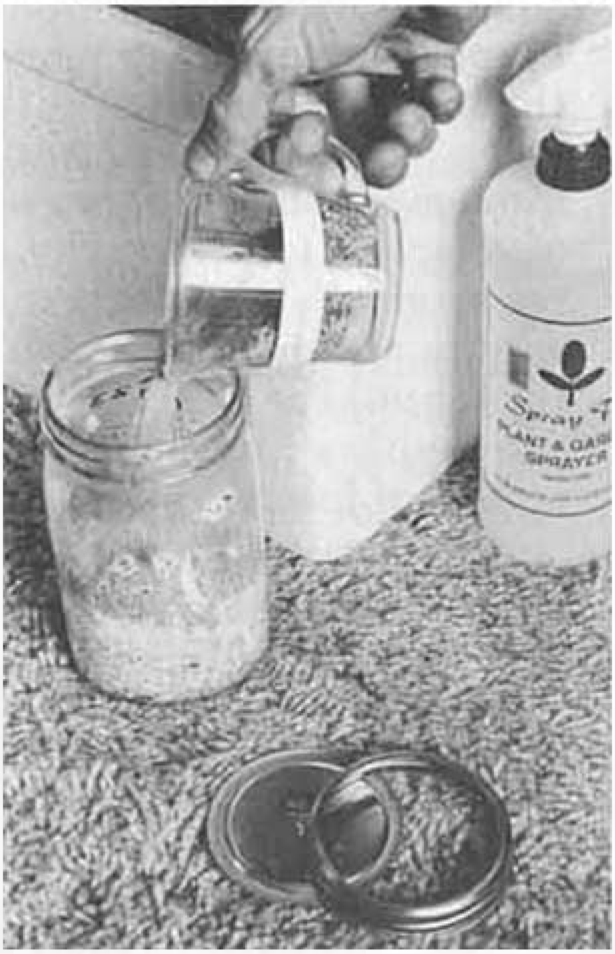


Fig. 41 - ½ cup casing soil is applied.

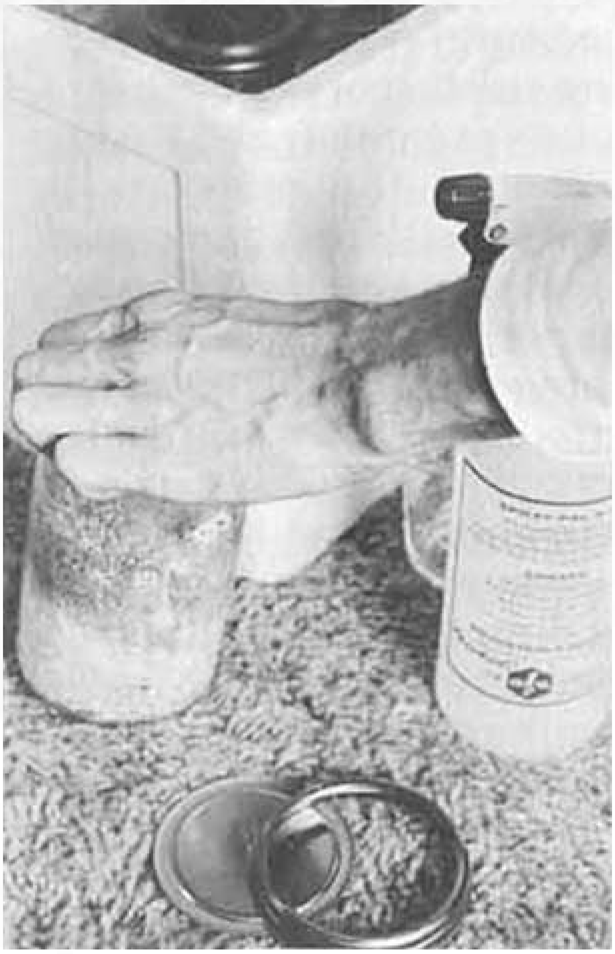


Fig. 42 - Casing soil is shaken to even it ...

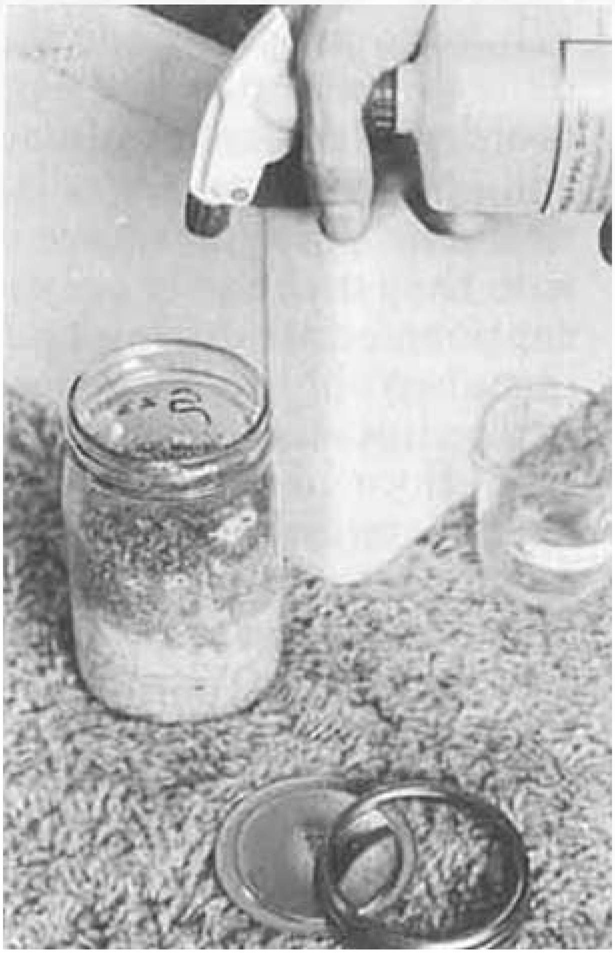


Fig. 43 - ... then sprayed, using a fine mist.

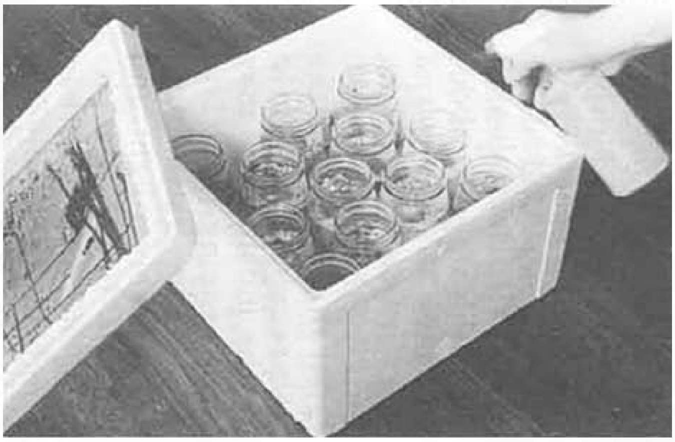


Fig. 44 - Spray cased jars daily.

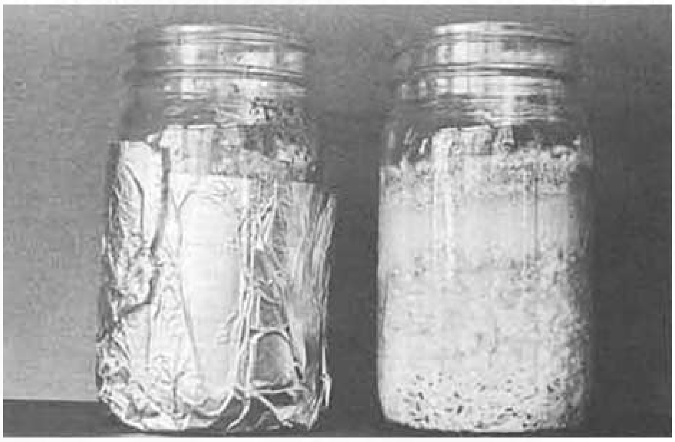


Fig. 45 - The mycelium grows through the casing soil.

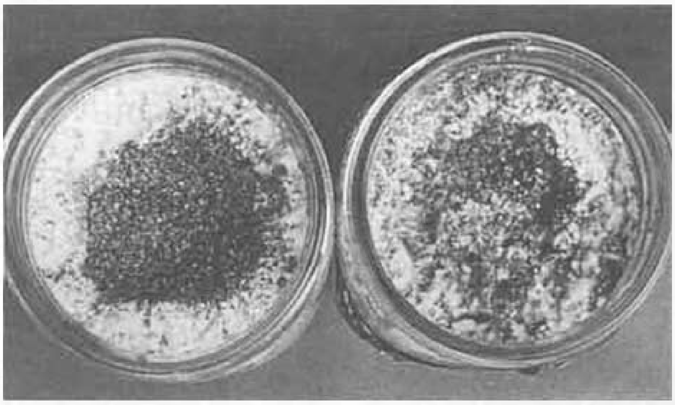


Fig. 46 - Mycelium will also grow on the surface.

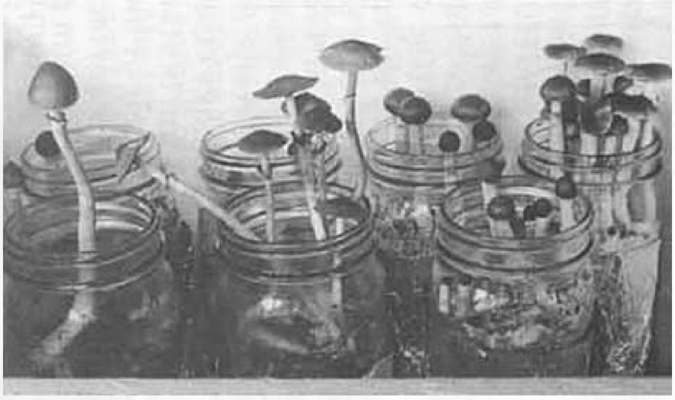


Fig. 47 - 25 days after casing, the first mushrooms appear.

During the next two to three weeks, the mycelium will begin to grow up into the casing soil, penetrating it to just beneath the surface (Fig. 45). The mycelium may occasionally break out onto the top of the soil and begin to spread across its surface, and part of the purpose of spraying daily is to keep this surface growth "knocked down" with the spray (Fig. 46). Excessive surface growth, in which the mycelium completely overgrows the casing soil and forms a thick spongy crust on the surface, is an indication that the mycelium is starved for air and that ventilation should immediately be increased. If you are under-watering your jars, this surface mycelium will turn blue with thirst. As the mycelium grows into the casing soil, it will begin to form a network of ropy strands visible at the interface of the soil and the glass. This network gradually gains more and more intersecting nodes, and by the 14th to 20th day after casing, these nodes have differentiated into tiny white dots distributed through the casing soil along the perimeter of the jar. These dots are the young mushroom primordia; gradually they enlarge and incorporate more mycelia, slowing taking on the appearance of tiny mushrooms with squat, fat stems and dark, brownish heads. This is the "pin" stage in the development of the mushroom and the primordia at this stage are about 1-2 mm in length. These pins continue to enlarge and some will begin to thrust above the surface of the casing soil, both at the sides and in the center of the jar. Once the young mushrooms have penetrated the surface of the casing soil, another five to ten days is required for them to reach full maturity. At maturity the mushrooms may be 2 to 9 inches tall and have caps ranging from 1 to 3 inches in diameter (Fig. 47 & 48). We have also found that these mushrooms do respond favorably to light, and that a daily 13-hour fluorescent or Grow-lux cycle results in mushrooms with larger caps and shorter stems than those grown without any special lighting. Probably it is not advisable, however, to place the cultures in direct sunlight for prolonged periods. While many mushrooms will grow to full size, approximately an equal number will grow to about half-size or less and then cease to grow; these "aborts" can still be plucked, dried, and used, although they are not as aesthetically appealing as the fully matured specimens. With practice one can learn to spot aborts early and remove them from the cultures. Aborted mushrooms left in the cultures are susceptible to attack by bacteria which quickly render them both ugly and unusable.

Excessive numbers of aborts are another indication of inadequate aeration. If the jars are being incubated in styrofoam boxes or aquaria, there is a possibility of accumulating carbon dioxide in the air space above the casing soil. This will inhibit fruiting and/or prevent fruits from reaching maturity. If this happens, increase aeration by leaving the lids off the box, or by using a small fan to enhance air movement over the surface of the jar. Be careful not to *over* aereate, however; too fast a rate of evaporation will cause the casing soil to dry out.

Occasionally mushroom primordia will form down toward the bottom of the jar and grow to maturity but will not break the surface of the casing soil. It is possible to inhibit this effect somewhat by wrapping jars with tinfoil to the top of the casing soil (Fig. 45). This effect, formation and development of primordia toward the bottom of the jar, is normally seen during the earliest mushroom "flush." After the first flush, the jars are recased for each subsequent flush (see below). We find that recasing will largely eliminate this problem for all flushes but the first one.

A variety of types of casing soils have been found to effectively promote fruiting. We have found the following mixture to be one of the best:

7.5 liters peat moss
3.5 liters fine vermiculite
4 liters washed fine sand
2 liters calcium carbonate (finely crushed oyster shell)

Powdered oyster shell is sold as a feed supplement by many feed companies. The calcium carbonate is an optional ingredient and can be left out without significantly affecting fruiting. It should be added if available, however, to buffer the soil and keep it from becoming too acidic. This factor *may* contribute to the growth of contaminants on the surface of the casing soil, and the calcium carbonate can inhibit or prevent this. For the same reason, one may also wish to water occasionally using a saturated solution of calcium carbonate. We have also found that a mixture of one part mica-peat (50/50 vermiculite-peat-moss mixture) to one part potting soil will work.

Sterilization of casing soil is usually recommended but we found it unnecessary when relatively sterile commercially bagged materials were used. If you wish you may sterilize casing soil before use at 15-20 lbs. pressure for 30 minutes. It should be wetted first to field capacity. Casing soil can be stored indefinitely in a tightly sealed large glass jar, or in a polyethylene garbage bag. If a glass jar is used, it can be sterilized with the casing soil in it. Remember to loosen the lid prior to sterilizing. After the first flush of mushrooms, the soil and mycelium-covered block of grain will shrink somewhat, leaving a space between the mycelium and the walls of the jar. Whenever this condition is noticed, it is time to recase. Recasing will greatly extend the life and fruiting capacity of your jars. It is a simple procedure which involves using a clean fork (one per jar, as this way contaminants are not spread from jar to jar) to scrape off all of the old casing soil and aborted mushrooms growing down along the sides of the jar. Then, using fresh casing soil prewetted as before, recover the mycelial block and use the fork to work the fresh casing soil down the sides of the jar around the block as well as covering the top. It will take your jars about two weeks to recover from this treatment but then they will do their best fruiting, producing clusters of large carpophores and behaving as if this recasing procedure had made them more resistant to contamination.

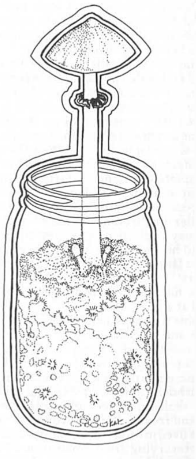
Instead of applying the casing soil to the mycelia-covered rye in the jars as described in the preceding pages, it is possible to adopt a somewhat different approach to the making of cased cultures. The steps involved in this method are described briefly below. The basic idea for this method was suggested to us by a friend, Paul Kroeger, and his contribution is gratefully acknowledged. In order to use this method, one begins by growing the mycelium out on the rye in the Mason jars in exactly the manner described above for the cased jar method. One may use plastic trays, glass baking pans, or one may manufacture a styrofoam box with a window of clear plastic in the lid as described above (Fig. 17-20). Sterilize the inside surface of the tray or box thoroughly by wiping down with a 25% Clorox solution followed by a Lysol spray. Cover the bottom of the container with a ¾-1 inch-deep layer of perlite or a 1:1 mixture of vermiculite and casing soil. Grow the mycelium on the rye medium in the Mason jars until it is fully permeated and ready to case. Instead of casing at this stage, however, shake the jars again. The mycelial block will be tightly woven together and may require a little extra effort in order to be shaken loose. After shaking, empty the contents of several jars into the container so as to form a layer of rye "spawn" about 1-1½ inch deep.

The number of jars required to do this will vary depending on the size of the container, but usually between five and ten jars are sufficient. Cover the rye layer with a second layer of moistened casing soil, to a depth of 1-1½ in. One has now created a 3-layered "sandwich" arrangement in the container: Perlite or vermiculite-casing soil forms the bottom layer and provides drainage; the second, rye and mycelium layer provides the nutritive substrate for the mycelium; the topmost, casing layer prevents the mycelium from becoming desicated or attacked by contaminants as well as functioning to induce the mycelium to fruit. Once the layers have been made, maintain the container in a humid environment and as close to 70 degrees F. as possible. If using styrofoam boxes, keep the lid on for the first two weeks following casing. Since the soil is moist and the mycelium produces water in its respiration, humidity will be high in the box (in fact, condensation on the transparent lid can usually be seen) and therefore one should not spray, or should spray only lightly and infrequently, during this stage.

Two weeks after casing, or approximately one week prior to the commencement of fruiting, the lids should be removed to prevent carbon dioxide accumulation in the containers. Daily watering with a fine mist can be started after the lids have been removed. The mycelium will continue to grow into the casing soil. Fruiting, at both the sides and center of the container, will commence 21-30 days after casing. The box or tray culture will fruit abundantly, producing many clusters of perfect large carpophores in various stages of maturity across the entire surface of the casing soil. As these clusters are plucked, the holes created in the casing soil should be plugged with fresh casing soil. Recasing as described for the jars is not necessary with this method. The container cultures will usually succumb to contamination (usually a green mold which shows up on the surface of the casing soil) more quickly than the jars. Containers fruit for 30 to 40 days as opposed to 60 to 80 days for jars, but the flushes produced during this time are so abundant that the overall total yield for trays and jars is comparable (approximately 10 grams dry weight of mushroom for every 100 grams dry weight of rye).

When your cultures are well established in the mature fruiting phase, it is a good idea to shift your awareness toward a new class of potential pests and carriers of contamination. These are insects, specifically flies and mites. The best way of controlling flies is by keeping your cultures in a screened room that flies are unable to penetrate. Even in the most tightly sealed environments flies do occasionally occur. It is therefore a good idea to use a slow acting insect killer of the vaporizing type, such as the "No-Pest Strip" in the growing area. Usually this is all the fly protection that is necessary. Mites are a more persistent and difficult pest to control. Massive reliance on applied insecticides is the commercial mushroom growers' approach to mite control. But we believe that application of insecticides to *Stropharia cubensis* should be undertaken only as a last resort.

The real key to mite control is early detection. Therefore, examine your jars very carefully. Mites are most visibly active in the middle and late afternoon, and are usually first spotted wandering around on the smooth rim of the jar. They are tiny specks, distinguished from tiny bits of casing material only by their motion. Jars with mites should be immediately isolated, or preferably removed entirely from the growing area. Once mites are detected, the grower must go to a state of high alert and check the jars every day to see if the plague is spreading. Removal of infested jars is the best course. The next best course is to spray only the infested jars with a ½-strength solution of Malathion. Malathion, though anathema to the anti-insecticide purist, is one of the least toxic and most rapidly degraded of commercial insecticides. It should not, however, be used on cultures within 6 days of fruiting. Under no conditions should the miticide Keldane be applied to cultures. Keldane is FATAL to *Stropharia cubensis*.



STEP V - HARVESTING, PRESERVING, AND DOSAGE

As the mushroom matures to full size, the cap will enlarge and become more globular in shape. The gills will at first be covered by a flap of tissue, called the *veil*, that connects the margin of the cap with the stipe. As the cap enlarges, this veil will detach from the cap margin to form an *annulus*, or ring of ruptured veil tissue, on the stem. The mushroom can be harvested as soon as the veil rupture has occurred. If a spore print is to be collected, however, the mushroom should be allowed to flatten out to an umbrella shape before harvesting.

Freshly harvested mushrooms can be eaten fresh, or can be dried and sealed in plastic bags for preservation. It is a simple matter to construct a small drying cabinet out of masonite or plywood. This consists essentially of a wooden box with a hinged door on the front and two or more screens or wire shelves which can slide in and out. A 150- to 200-watt electric light bulb can be mounted in the bottom as a heat source. We have found this type of drying cabinet completely suitable and trouble-free. It produces an even heat at about 120 degrees F. and will dry even large, thick-stemmed mushrooms completely within 48 hours; smaller mushrooms dry in 24 hours using this cabinet. They may be dried in a gas oven at low heat (140 F. or less) for 6-10 hours (Fig. 49 & 50). They may also be dried under a heat lamp, on a screen over a heating vent, or in a small electric food dehydrator. Mushrooms are fully dried when hard to the touch, like crackers, with no spongy feel at all (Fig. 51).

Mushrooms that have been dried at too high a heat will turn brown and be very bitter to the taste. Such mushrooms are substantially less psychoactive. To preserve maximum potency, dried mushrooms should be sealed in five gram increments in plastic bags from which the air has been withdrawn (Figs. 52-54), and this in turn placed in a tightly sealed glass vessel or other moisture-proof container, and frozen. We have found the polypropylene boiling bags used in food storage and preparation to be excellent for preserving dried mushrooms. Rolls of bagging material and the electric sealers used for sealing are sold commercially in department stores under the brand name "Seal-A-Meal" and "Seal & Save." Dried mushrooms left in the open air quickly lose their potency. Fresh mushrooms should not be frozen without drying first, as freezing them in this condition will turn them into a black, gooey mess. Fresh mushrooms can, however, be preserved in a plastic bag in the vegetable pan of the refrigerator for about a week to ten days. Fresh mushrooms older than this should either be eaten or dried to prevent spoilage.

The dried mushrooms contain from 0.2 to 0.4 percent psilocybin (Schultes, *et al.*, 1973) by weight. Some strains of *Stropharia cubensis* have been reported to contain as much as 0.5% psilocybin (Wasson & Heim, 1959, p. 260). Psilocin is present only in trace amounts. A dose of about 10-12 milligrams of psilocybin, or about 5 g dry weight of mushrooms, or 50 g wet weight, is sufficient to manifest the full spectrum of hallucinogenic effects in a 160 lb. adult. These effects include visual and auditory hallucinations, extreme hilarity, distortions of time and space perception, and a sense of emotional detachment from the environment. Less marked effects can be detected at doses as low as 2 mg, which is about 1-2 dried mushrooms. Fresh mushrooms seem to be somewhat stronger than dried ones. Psilocybin is one of the least toxic of all hallucinogens. A full, effective dose is 12 mg while mescaline, by comparison, has a minimum effective dose of 200 mg for an average-size adult, and a toxicity 2.5 times that of psilocybin (Aboul-Enein, 1974).

The state of mind induced by a full dose of mushrooms is one of euphoria and calm lucidity, with no loss of coherency or clarity of thought. The hallucinations seen with the eyes closed are colorful, hard-edged, and highly articulated, and may range from abstract geometrical forms to visions of fantastic landscapes and architectural vistas. These hallucinations are most intense when the mushroom is taken in the setting preferred by the Mazatecans: inside at night in complete darkness. On the other hand, if one is in a natural setting and directs the focus of the senses outward to the environment, one discovers that one's senses seem keyed to their highest pitch of receptivity, and finds oneself hearing, smelling and seeing things with a clarity and sensitivity seldom, if ever, experienced before. Although it should be clear to anyone who has read this far that cultivating these mushrooms is an endeavor requiring time, patience, care and humility, and one fraught with its own peculiar problems, once one has partaken of these wonderful gifts of nature and experiences the exalted consciousness that they can bring about, we think that they will agree with us that the effort involved provides its own ample reward.

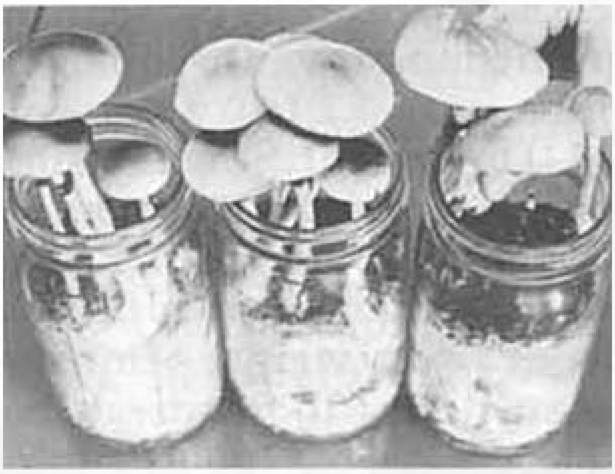


Fig. 48 - Grasp the stalks firmly when harvesting.

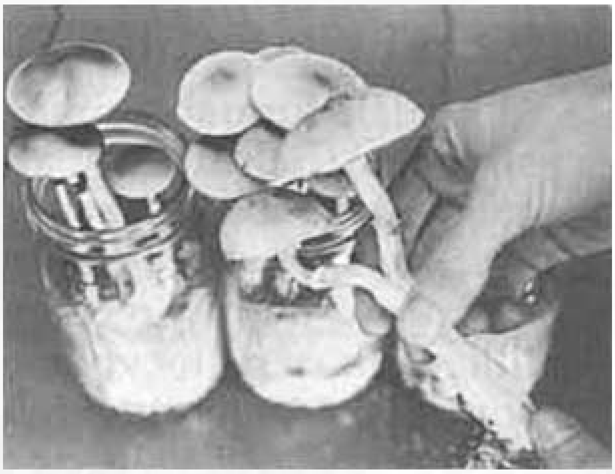


Fig. 49 - Remove the soil from the bottoms of the stems.

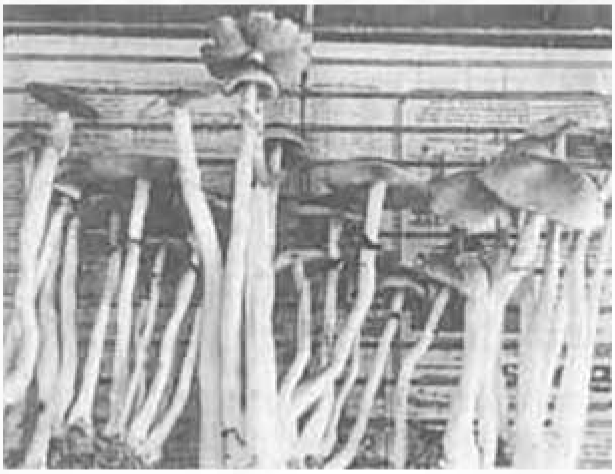


Fig. 50 - Mushrooms ready for oven-drying.

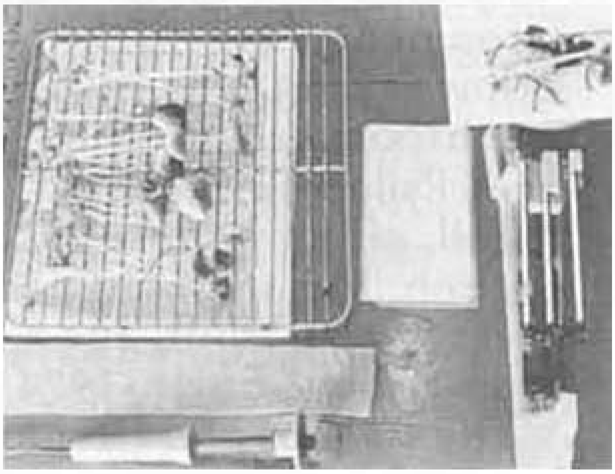


Fig. 51 - The dried mushrooms are weighed.

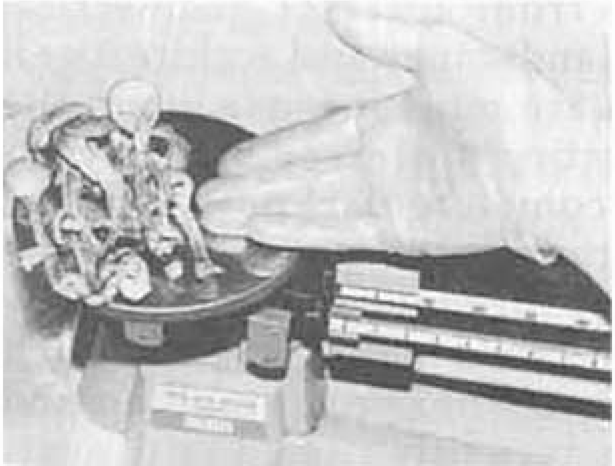


Fig. 52 - They are placed in plastic bags.

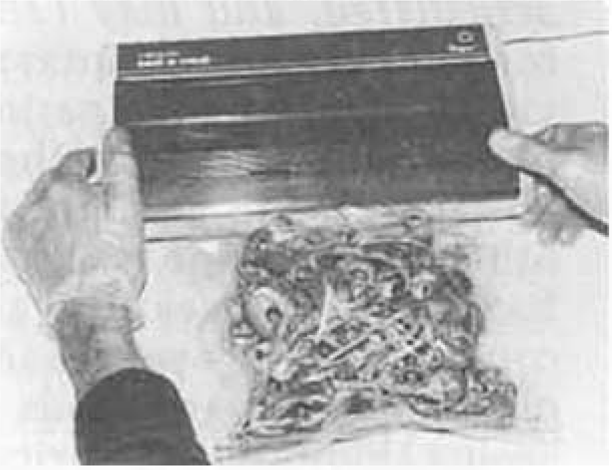


Fig. 53 - Bags are heat-sealed with a bag sealer.

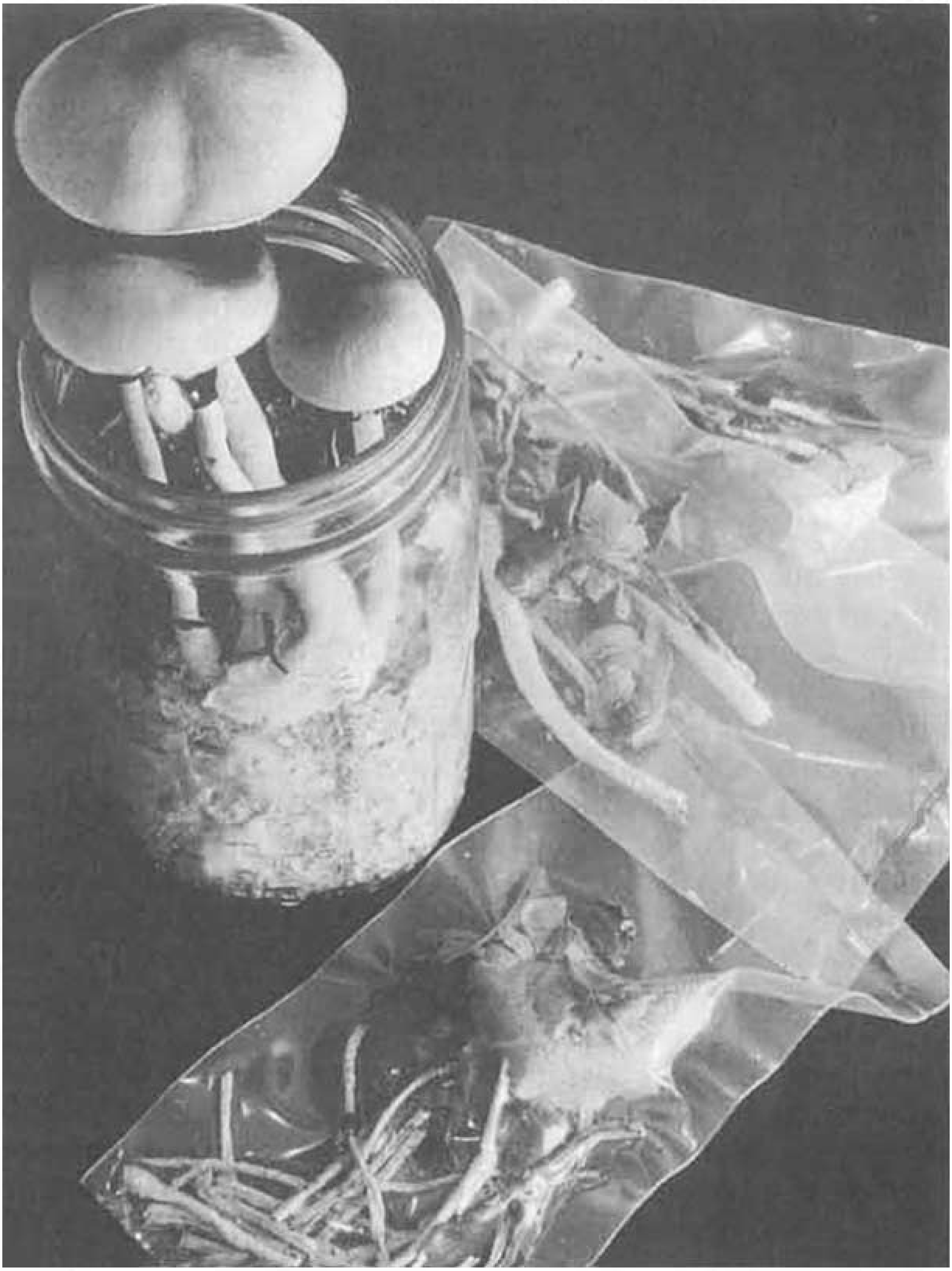
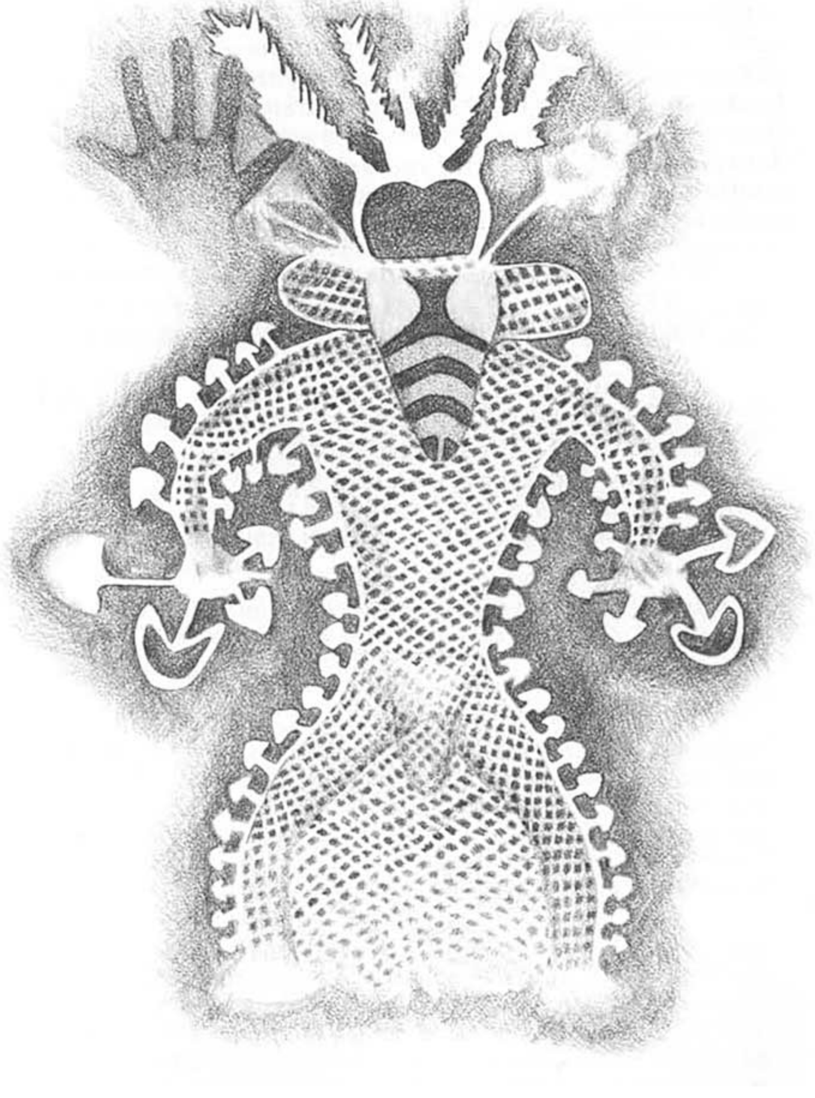


Fig. 54 - Fresh mushrooms and dried ones ready for freezing.

AFTERWORD

Approximately sixty days after you began the isolation of spores, the first harvest will be possible from your rye-filled jars. Mushroom growing is like alchemy in that there is a division of the work into practical effort and visionary reward. The organic psilocybin within the mushroom is quality controlled by the very stable and ancient genes of the *Stropharia*. You, as the propagator and spiritual friend of the mushroom, can form a deep relationship with the mycelial ally and again and again make far journeys into its visionary realms if you observe a few simple rules. Tolerance to psilocybin is easily acquired if trips are taken more often than once a week. If one does acquire a tolerance, it can be gone around by either upping the dose or by laying off for a couple of weeks to allow your body to recover its equilibrium. We recommend the latter course even though the toxicity of psilocybin is so low that raising the dose is a valid alternate course.

Now our little handbook closes. Advice from this point on can only come in generalities. Take the mushrooms that you have grown, take them in the darkness as the Indians of Mexico who have used them for centuries do. Smoke a lot of your favorite hash to synergize the behind-the-eyelids hallucinations and prolong them. Psilocybin is light shedding illumination on a landscape both within and without the mind and body of human beings and previously invisible to them. The exploration of this vast region by persons whose mental equipage is that of the modern West has only begun. Only a moment has passed since our culture has rediscovered, through the work of Wasson and others, the ancient and unplumbed relationship between the vision-causing mushrooms and our own strangely gifted species. You are a pioneer in a world whose future is undetermined and whose living organisms are full of singularities and surreal transforming promise.



Rock painting from Tassili Plateau, Southern Algeria, circa 3500 B.C.

CONVERSION TABLE

This conversion table is included for those who may lack scales or other equipment to make accurate measurements of required ingredients. Although one should always try to measure the ingredients as accurately as possible, and the purchase of an inexpensive scale and graduated cylinder is well worthwhile, this table can be useful in approximating measurements and calculating volumes if such equipment is unavailable.

160 ml dry rye weighs approximately 150 grams, &frac23; of a cup
2 g powdered oyster shell is a level ½ teaspoon
1 g yeast extract is a level ½ teaspoon
1 g Difco agar is 1 slightly packed level ½ teaspoon
1 liter (1000 ml) = 1 quart (1.057 quarts)
1 baggy (Glad type) weighs 1.5 g

A CHRONOLOGY OF PSILOCYBIAN* MUSHROOMS

Compiled by Irimias the Obscure & O.T. Oss

* "Psilocybian" in this context means any mushroom containing psilocybin.

c. 3500 B.C. Frescoes of dancing shamans holding mushrooms in the presence of white cattle are painted on the rock surfaces of the Tassili Plateau in Southern Algeria.**

** Special thanks to J. Ginsberg of Boulder, Colorado who was the first to notice the importance of the Tassili frescos for ethnomycology.

c. 2500 B.C. Aryan people with hallucinogenic mushroom use as a central part of their religion enter India. Wasson has argued for *Amanita muscaria* as the identity of the mysterious Soma. The question remains an open one. A psilocybian mushroom may well have been the source of Soma.

c. 1100-400 B.C. Eleusinian Mystery rites using ergotized rye (Wasson) or psilocybian mushrooms (Graves) focus the mystical aspirations of the Ancient World.

300-500 B.C. In the latter half of this century, "mushroom stones" were found in highland Guatemala dating back at least as far as 300-500 B.C.

c. 300 A.D. Frescoes have been found in central Mexico with mushroom designs indicating the existence of a mushroom cult at this time.

387 A.D. St. Augustine, formerly a follower of Mani, condemns Manichaeans for mushroom eating.

1502 A.D. Psilocybian mushrooms were served at the coronation feast of Moctezuma II and were used recreationally.

1547-1569 Fray Bernadino de Sahugun, A Spanish cleric, wrote *Historia de las Cosas de Nueva Espana* (also known as the *Florentine Codex*) which refers to "nanacatl" (= teonanácatl = flesh of the gods = psilocybian mushroom). Sahugun states that the mushrooms "are harmful and intoxicate like wine." Further, those who indulge "see visions, feel a faintness of heart and are provoked to lust."

1651 Dr. Francisco Hernández, a Spanish physician studying Central American Indian herbal medicine reported three types of mushrooms which were worshipped by Mexican natives. He reported that the ingestion of these caused "not death but a madness that on occasion is lasting, of which the symptom is a kind of uncontrolled laughter... these are deep yellow, acrid, and of a not displeasing freshness. There are others again, which without inducing laughter, bring before the eye all sorts of things, such as wars and the likeness of demons. Yet others there are not less desired by princes for their festivals and banquets, and these fetch a high price. With night-long vigils are they sought, awesome and terrifying. This kind is tawny and somewhat acrid."

1895 John Uri Lloyd publishes his fantasy-novel *Etidorpha* in which he makes it clear that he and his mycologist brother Curtis Gates Lloyd were aware of the hallucinatory properties of mushrooms other than *Amanita muscaria*. The Lloyds elected not to publish the botanical details of their findings.

1906 *Stropharia cubensis* is described by Earle in a Cuban agronomy journal.

1914 A.E. Merrill of Yale University published a paper in *Science* describing the hallucinogenic effects of ingesting *Panaeolus papilionaceus* from Oxford County, Maine. Although the identification of the mushroom may be in error, the effects described are very probably due to psilocybin and psilocin. Further, the article describes different reactions to this hallucinogenic mushroom which is compared to hashish and peyote in the text.

1915 American botanist William E. Safford attempted to identify the teonanácatl of the Aztecs. He claimed that sacred mushrooms had never existed, and that the teonanácatl referred to by the 16th century Spanish chroniclers were actually dried peyotl buttons. Safford's theory was widely accepted by the scientific community for the next three decades.

1915 American botanist William E. Safford attempted to identify the teonanácatl of the Aztecs. He claimed that sacred mushrooms had never existed, and that the teonanácatl referred to by the 16th century Spanish chroniclers were actually dried peyotl buttons. Safford's theory was widely accepted by the scientific community for the next three decades.

1919 Dr. Blas P. Reko, who had carried out extensive anthropological and botanical work in Mexico for more than 25 years, published an article in a Mexican anthropological journal stating that nanácatl (= teonanácatl) was a hallucinogenic mushroom. However, some of Reko's earlier work had been in error and this report was discounted.

1923 In a letter to the U.S. National Museum, Dr. Reko stated that teonanácatl "is actually, as Sahugun states, a fungus which grows on dung heaps and which is still used under the same old name by the Indians of the Sierra Juarez in Oaxaca in their religious feasts."

1936 Victor A. Reko (B.P.'s brother) publishes *Magischt Gifte*. In it, he wrongly suggests that teonanácatl might be a species of *Amanita*.

1936 Ing. Roberto J. Weitlaner obtained some teonanácatl in Oaxaca. He was the first white man in modern times to have done so. He sent the specimens to B.P. Reko, who sent them to Harvard, where they arrived in a decomposed state and thus escaped identification.

1938 Weitlaner's daughter, Irmgard, along with anthropologist Jean Basset Johnson and two others attended a mushroom rite in Huatla, Oaxaca. These were the first whites to attend a mushroom ceremony.

1938 Harvard botanist R.E. Schultes traveled to Oaxaca and obtained from native informants two specimens of two different genera: *Panaeolus campanulatus* var. *sphinctrinus*, and *Stropharia cubensis*. In his field notes, he described a third specimen: *Psilocybe caerulescens* var. *mazatecorum*.

1952-53 R. Gordon Wasson and his wife Valentina became aware of the existence of a mushroom cult in central Mexico. This ambitious couple set out to prove the theory that religion came directly from the use of hallucinogenic plants. The Wassons traveled to Mexico and were guided by Ing. Roberto J. Weitlaner to the mountainous village of Huautla de Jiménez in Oaxaca.

1955 R.G. Wasson and Allan Richardson became the first two Americans to attend a mushroom ritual and ingest the mushrooms. The mushrooms were taken under the supervision of Maria Sabina, Mazatec curandera. By 1957, news of this ritual had reached the world through articles in several popular magazines and the Wasson's book. *Mushrooms, Russia, and History*.

1956 Wasson invited Roger Heim, a French mycologist, to Oaxaca to research the use of the sacred mushrooms. Heim identified fourteen species and several subspecies belonging to three genera, *Psilocybe*, *Stropharia*, and *Conocybe*. Several of these species were new to mycology, but had been utilized as hallucinogens by the natives for centuries.

1957 Mycologist Dr. Rolf Singer and two young Mexican botanists, M.A. Palacios and Gastón Guzmán, arrived in Oaxaca to do taxonomic work on the mushrooms.

1958 Dr. Albert Hofmann, a Sandoz chemist from Basel, Switzerland, isolated two active agents and named them psilocybin and psilocin after the genus *Psilocybe*.

1960 While vacationing in Cuernavaca, Mexico, Harvard psychologist Timothy Leary ate a dose of the mushrooms. Later, he wrote "... it was the classic visionary voyage and I came back a changed man ... You are never the same after you've had that one flash glimpse down the cellular time tunnel. You are never the same after you've had the veil drawn."

1960 Dr. Leary and an associate, Dr. Richard Alpert, obtained a supply of synthetic psilocybin from Sandoz for use in an experiment with prisoners in Concord State Prison, Massachusetts. Initial results were very promising: prisoners released following an experience with psilocybin seemed less likely to be rearrested and returned for parole violations than other parolees.

1960 Aldous Huxley ingested 10 mg psilocybin in a group under the supervision of Timothy Leary. Huxley "sat in contemplative calm throughout; occasionally produced relevant epigrams; reported the experience as an edifying philosophic experience."

c. 1965-66 Laws against the sale, manufacture, and possession of LSD, mescaline and psilocybin are passed by paranoid legislatures after being persuaded by a hysterical press. The New York State legislature deferred hearings on one bill to outlaw hallucinogens until after the law was voted on and passed!

1966 By this time, several illicit labs were set up to manufacture hallucinogenic drugs in response to the growing demand by users.

1967 Reacting to erroneous tales of massive chromosome damage produced by LSD use, users began to demand organic drugs such as psilocybin and mescaline. Compared to LSD, hallucinogens such as these are relatively expensive to manufacture. Many unscrupulous dealers sold LSD as psilocybin. Most of the tabbed or capsulated psilocybin on the street from 1966-75 was actually LSD, or LSD cut with PCP.

1970 A Key to the North American Psilocybin Mushroom was published by Leonard Enos in California. This poorly-illustrated but well-written guide instructed laypersons where, when and how they could obtain psilocybian mushrooms in nature. The book also contained instructions for cultivating mycelium on agar.

1971 Due to popular demand for organic drugs, unscrupulous dealers began lacing commercial mushrooms with LSD and selling them as psilocybian mushrooms. These spurious psilocybian mushrooms appeared on the street drug market as late as 1975 and can be differentiated from most psilocybian mushrooms in that they (a) don't blue, and (b) their effects last much longer than the 4 to 7 hours characteristic of psilocybin.

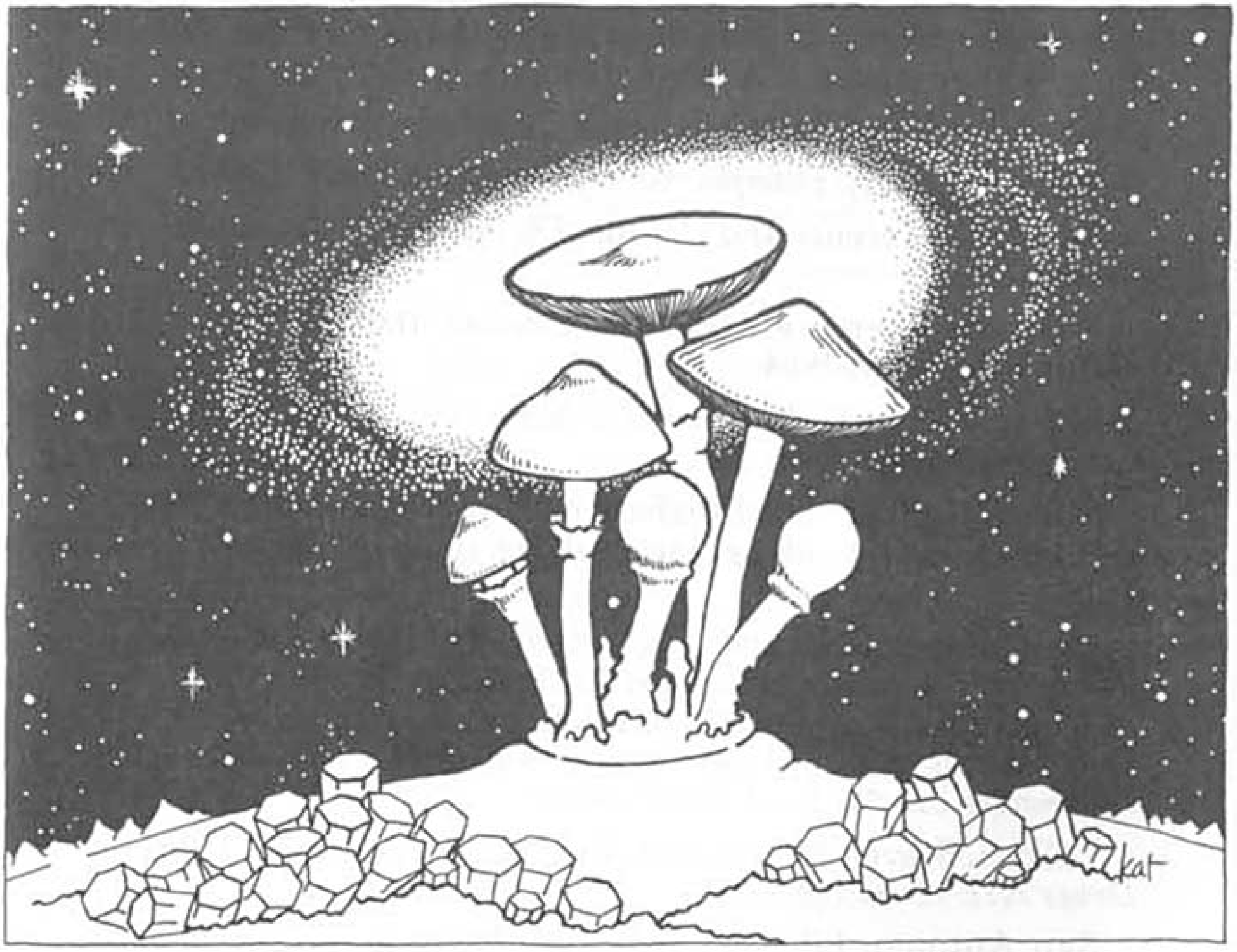
1975 The first living cultures of *Stropharia cubensis* were seen in limited numbers on the underground market.

1975 Oss and Oeric (in this volume) bravely risked ridicule to become the first to suggest the extraterrestrial origin of *Stropharia cubensis*.

1976 Technology developed by the authors (Oss & Oeric, 1976) is unleashed upon the world. The illicit hallucinogenic trade crumbles because of decentralization brought on by epidemic of home *Stropharia* cultivation. Invasion of North America by hallucinogenic mushrooms continues, leading shortly to metamorphosis of human beings into a symbiotic species.

1981 Over one hundred thousand copies of *Psilocybin: Magic Mushroom Grower's Guide* sold. Numerous imitations also flourish as an estimated five thousand North American mushroom growers work with love and dedication to make psilocybin *the* hallucinogen of choice in high-tech society.

1984 Heterodox Bengali Hindus announce identification of the Vedic intoxicant Soma as a psilocybian mushroom, *Stropharia cubensis*. A reform of Hinduism centered around recovery of the 6000-year-old Soma rite is begun.



BIBLIOGRAPHY

1. Aboul-Enein, Hassan Y. "Psilocybin: A Pharmacological Profile." *Am. J. Pharm.*, May-June, 1974: 91-95.
2. Ames, R.W. "The Influence of Temperature on Mycelial Growth of *Psilocybe*, *Panaeolus*, and *Copelandia*." *Mycopath. et Mycol. Appl*. 9:268-274 (1958).
3. Benedict, R.G., V .E. Tyler, & R. Watling. "Blueing in *Conocybe*. *Psilocybe* and a *Stropharia* Species and the Detection of Psilocybin." *Lloydia* 30 (2): 150-157 (1967).
4. Bocks, S.M. "The Oxidation of Psilocin by p-Diphenol Oxidase (Laccase)." *Phytochemistry* 6: 629-31 (1967).
5. Catalfomo, P., & V.E. Tyler. "The Production of Psilocybin in Submerged Culture by *Psilocybe cubensis*." Lloydia 27 (1): 53-63 (1984).
6. Chang, S.T. & W.A. Hayes, *The Biology and Cultivation of Edible Mushrooms*. Academic Press, New York, 1978.
7. Enos, Leonard. *A Key to the North American Psilocybin Mushroom*. Youniverse Productions, 1970.
8. Estrada, Alvero. *Maria Sabina: Her Life & Chants*. Ross-Erikson Inc., Santa Barbara, CA. 1981.
9. Graves, Robert. *Food for Centaurs*, Doubleday & Co., N.Y., 1957.
10. Lloyd, John Uri. *Etidorpha*. (1895), Amherst Press, 1985).
11. McKenna, Terence and Dennis. *The Invisible Landscape*. Seabury Press, 1976.
12. McKenna, Terence. *True Hallucinations* (talking book . Lux Natura, Berkeley, 1984.
13. Miller, Orson K. *Mushrooms of North America*. E.P. Dutton & Co., New York, 1972.
14. Munn, Henry. "The Mushrooms of Language" in *Hallucinogens and Shamanism*, ed. by Harner, Michael, Oxford Univ. Press, 1973.
15. Neal, J.M.,R.G. Benedict,* L.R. Brady. "Interrelationship of Phosphate Nutrition, Nitrogen Metabolism, and Accumulation of Key Secondary Metabolates in Saprophytic Cultures of *Psilocybe cubensis*. *Psilocybe cyanescens*, and *Panaeolus campanulatus*." *J. Pharmaceut. Sci*. 57: 1661-1667 (1968).
16. Pollock, Steven. "Psilocybin Mushroom Pandemic." *J. Psyched. Drugs* 7(1): 73-84 (1975).
17. San Antonio, J.P. "A Laboratory Method to Obtain Fruit from Cased Grain Spawn of the Cultivated Mushroom, *Agaricus bisporus*." *Mycologia* 63: 16-21 (1971).
18. Scagel, R.F., G.E. Rouse, JR. Stein, R.J. Bandoni, W.B. Schofield & T.M.C. Taylor. *An Evolutionary Survey of the Plant Kingdom*. Wadsworth Publishing Co., Belmont, CA, 1965.
19. Schultes, R.E. & Albert Hofmann. *The Botany and Chemistry of Hallucinogens*. Charles C. Thomas, Springfield, IL, 1973.
20. Singer, R. "Mycological Investigations on Teonanacatl, the Mexican Hallucinogenic Mushroom, Pt. 1," *Mycologia* 50: 239-261 (1958).
21. Stamets, P., *Psilocybe Mushrooms and Their Allies*. Homestead Book Co., Seattle, WA. 1978.
22. Stamets, P. & J.S. Chilton, *The Mushroom Cultivator*. Agarikon Press, Olympia, WA, 1983.
23. Wasson, R.G. "Seeking the Magic Mushroom." *Life* magazine, May 13, 1957.
24. Wasson, R.G., & V.P. Wasson. *Mushrooms. Russia and History*. Pantheon Books, New York, 1957 (out of print).
25. Wasson, R.G., "The Divine Mushroom: Primitive Religion and Hallucinatory Agents." *Proc. Am. Phil. Soc*. 102(3). June 24, 1958.
26. Wasson, R.G.,"The Hallucinogenic Mushrooms of Mexico: An Adventure in Ethnomycological Exploration." *Tans. NY Acad. Sci*., Ser. II, 21(4), February 1959.
27. Wasson, R.G., & R. Heim. *Les Champignons Hallucinogenes du Mexique: Etudes Enthologiques. Taxinomiques. Biologiques. Physiologiques el Chimiques*. Museum National d'Historie Naturelle, Paris, 1959.
28. Wasson, R.G., *Soma: Divine Mushroom of Immortality*. Harcourt, Brace, Jovanovich, 1968.
29. Wasson, R.G., *Maria Sabina and Her Mazatec Mushroom Velada*. Harcourt, Brace, Jovanovich, New York, 1974.
30. Wasson, R.G., C. Ruck & A. Hofmann, *The Road to Eleusis*. Harcourt, Brace, Jovanovich, New York, 1978.
31. Wasson, R.G., *The Wondrous Mushroom*. McGraw-Hill, New York, 1980.

GLOSSARY

adnate (of gills) - attached directly to the stalk.

adnexed (of gills) - notched just at stalk.

aerobic - requiring oxygen in order to live. Opposite of anaerobic.

annulus - ring-shaped remains of the partial veil which hangs on the stalk.

basidium (pl. basidia) - cell on which the spores of a Basidiomycete are borne.

basidiocarp - basidium-bearing structure or "fruiting body" of a Basidiomycete. Sometimes also called a *carpophore*.

basidiospore - spore formed exogenously on a basidium, generally following karyogamy and meiosis.

dikaryotic - a fungal hypha having two nuclei per cell.

diploid - having a single set of paired chromosomes (twice the number of chromosomes as in the gametes); 2n. Cf. *haploid*, having only one full set of *unpaired* chromosomes; n.

genome - the basic set of chromosomes (n) contributed by each parent.

genus (pl. genera) - the major subdivision of a family or subfamily of plants or animals; it usually consists of more than one species.

heterothallic - in Basidiomycetes, having thalli separable into two or more morphologically similar sexual strains, with conjugation occurring only when compatible mating types are paired.

hypha (pl. hyphae) - one of the tubular filaments composing mycelium.

indole - a white crystalline compound, C_8H_2N, having the same heterocyclic fused ring structure as the aminoacid tryptophane. The indole structure is incorporated into the structures of many hallucinogenic compounds.

inoculation - to implant microorganisms or fungal mycelium into a culture medium. The mycelium used for this is called the *inoculum* (pl. inocula).

inoculating loop - implement used for making inoculations, consisting of a long handle with a length of stainless steel or platinum wire attached to the end and usually bent into a loop at the tip.

karyogamy - fusion of the two nuclei of the dikaryotic mycelium. In the Basidiomycetes, karyogamy constitutes the only diploid (2n) stage in the life cycle.

meiosis - reduction division of a cell in which the number of chromosomes is reduced from the diploid (2n) to the haploid (n) state. Meiosis produces sexual cells or *gametes*.

milliliter (abbr. ml) - one-thousandth part of a liter. 1 ml = 1 cubic centimeter (cc) in volume.

monokaryotic - hyphal condition in which the cells contain a single haploid nucleus; e.g., the primary mycelium of Basidiomycetes.

mycelium (pl. mycelia) - the vegetative body of certain complex fungi, consisting of an aggregation of hyphae.

phylogeny - the evolutionary development of a species of plant or animal.

rhizoid - a rootlike filament composed of many strands of hyphae.

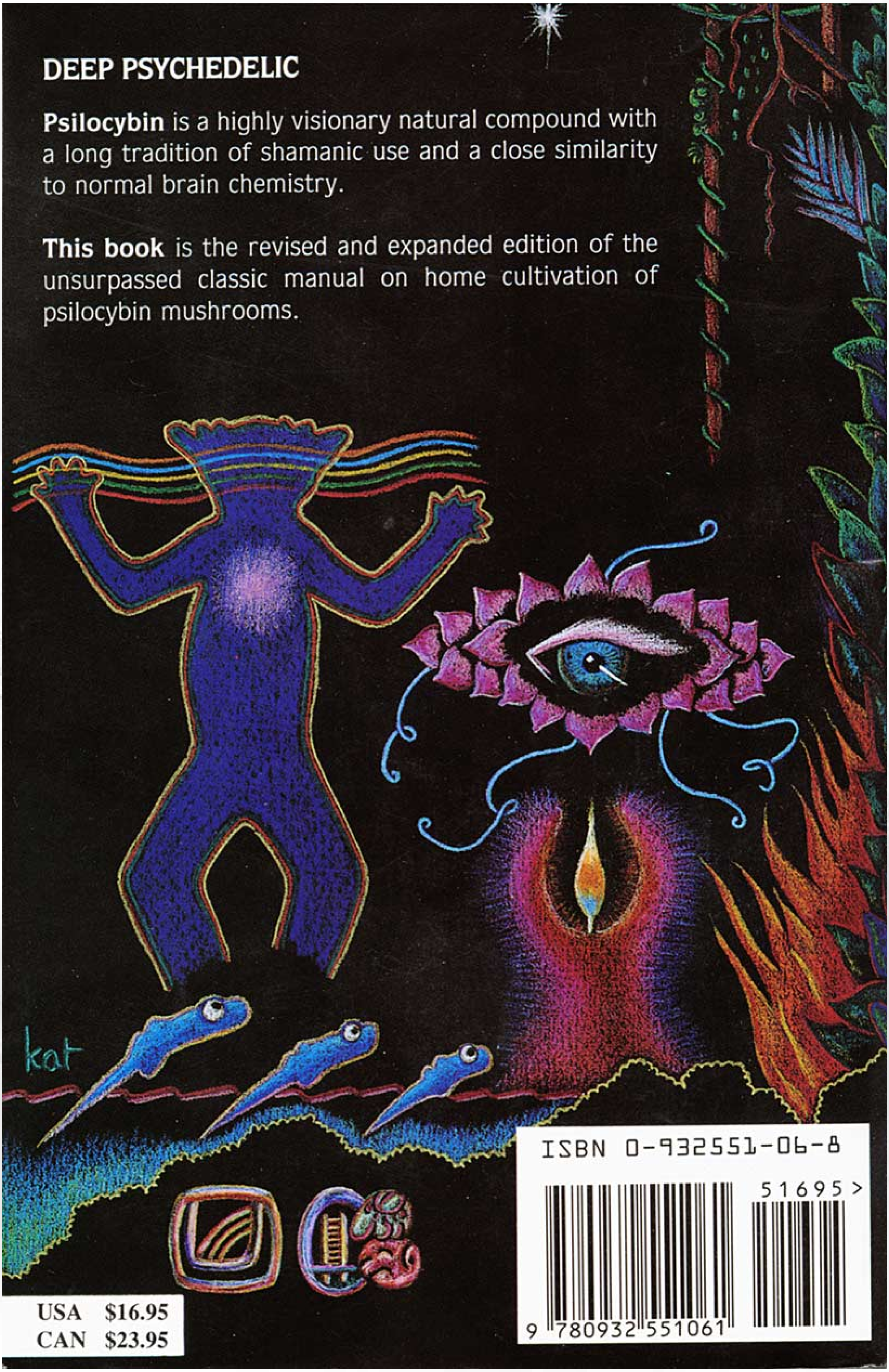
somatogamy - fusion of somatic (body) cells rather than differentiated sexual cells as in the Basidiomycetes; does not include karyogamy.

species - the major subdivision of a genus or subgenus; it is composed of related individuals that resemble each other and are able to breed among themselves but usually not with other species.

tetrapolar - condition referring to sexual compatibility of some Basidiomycetes in which two sets of factors are involved (such as A,a & B,b).

thallus (pl. thalli) - the undifferentiated body of the fungus; the mycelial mass.

veil - the *partial* veil is a covering that extends from the unopened margin of the mushroom cap to the stalk, and that ruptures to form the annulus; the *universal* veil is a tissue surrounding the entire developing mushroom, usually lost early in development. *Stropharia cubensis* has a partial and universal veil.



DEEP PSYCHEDELIC

Psilocybin is a highly visionary natural compound with a long tradition of shamanic use and a close similarity to normal brain chemistry.

This book is the revised and expanded edition of the unsurpassed classic manual on home cultivation of psilocybin mushrooms.

ISBN 0-932551-06-8
51695>
9 780932 551061

USA $16.95
CAN $23.95

Fungifun for Simple Minds

by

Anno

Table of Contents:

- Grain for Simple Minds
  - Basic rye recipe for 1 pint jar
  - Basic millet or birdseed recipe for 1 pint jar
  - Grains
  - Preparation
  - Preparing grain by simmering
- Polyfil filter lid for Simple Minds
- Homemade Tyvek filter discs test
- Pressure Cooker Use
  - Pressure cooker types
  - Pressure cooking step by step
  - Pressure cooker test
- Pouring Agar for Simple Minds
- Importance of Gas Exchange
- Cloning for Simple Minds
- Mycelium Inoculation Technique
- Spore printing

Grain for Simple Minds

original source: http://www.fungifun.org/English/Grain-For-Simple-Minds

These instructions will guide you through the process of preparing grain either to be used as spawn to inoculate bulk substrates or as mushroom substrate that can be directly cased.

There are 2 ways of preparing the grain, either by measuring grain and water, combining them in a jar and pressure cooking it, or first simmering the grain in order to achieve the proper water content, and then pressure cooking it. Both methods work similarly well. Try both, and see what works for you.

Presto 23-Quart Pressure Cooker/Canner

Basic rye recipe for 1 pint jar

- **100g** (**=**3.5 oz**~**125 ml**~**0.53 cup) **rye**
- **105g** (**=** 3.55 oz **=**105 ml**~**0.44 cup) **water**
- knife tip full of gypsum (optional)

For a quart jar, double the amounts.

Basic millet or birdseed recipe for 1 pint jar

- **100g** (3.5 oz~140 ml~0.59cup) **birdseed**
- **60-70g** (60-70 ml) **water**
- knife tip full of gypsum (optional)

Note: 1/4 qt(quart) = **½pt**(pint) = **1cp**(cup) = **236 ml**(milliliter) = **236cc**(cubic centimeter)
The cups, pints and quarts are in the US liquid measuring system.

The recipes above a basic guidelines. Other grains can be used as well, for instance wheat, barley, whole oats, tricale.... The exact measurements depend on the grain used, jar size and your pressure cooker.
You might find out, that a little less or more water gives you better results, thus experiment and vary the amounts a little after you have used the basic recipe, to find the optimum for your situation.
Keep notes on the amounts!

Grains

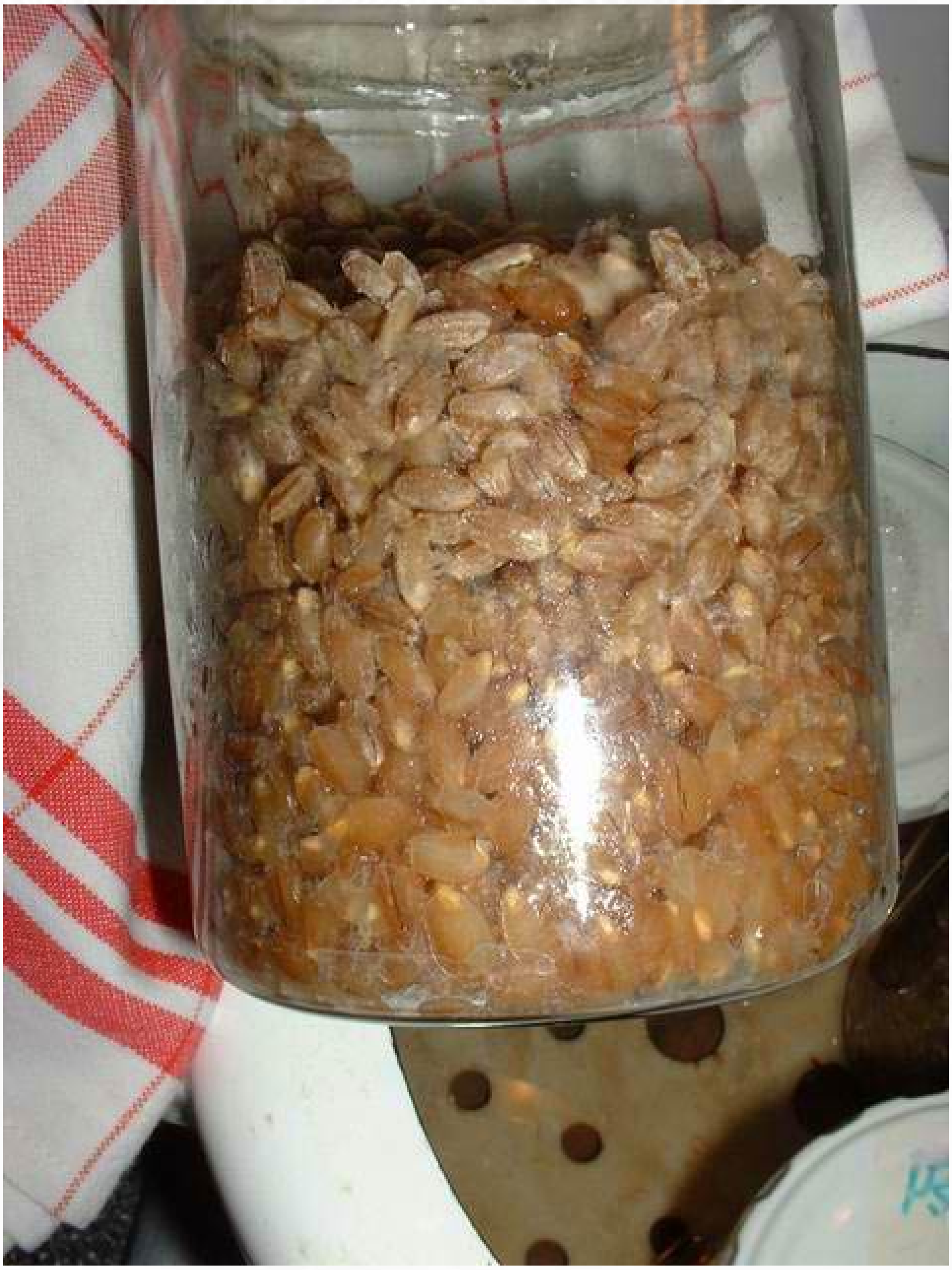
Rye

Birdseed

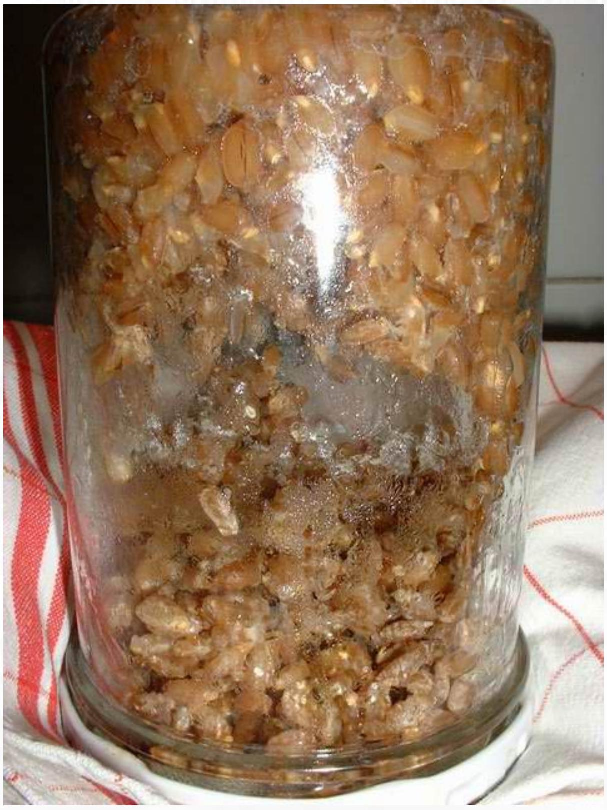
Millet

Preparation

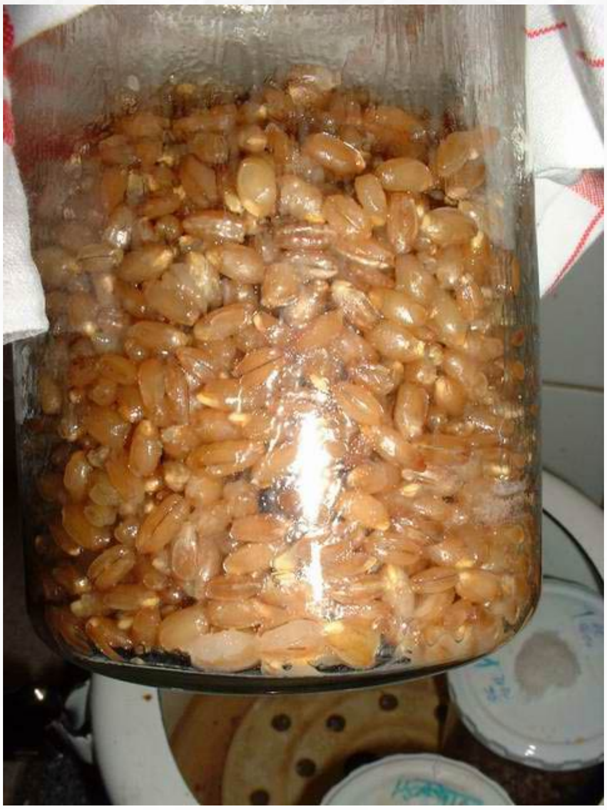
Fill both the measured amount of grain and the water into the jar, screw the lid fitted with a polyfill filter tight and pressure cook for 1 hour at 15 psi. If you don't know how to use a pressure cooker, check out this document about the correct pressure cooker use. The water absorption ability can vary depending on the grain quality and the type and the size of the pressure cooker. It's best to make a **batch of test jars** when one acquires a new grain for instance 100g rye and 100, 105, 110, 115 and 120g water. Then you'll see which water content provides the best result.



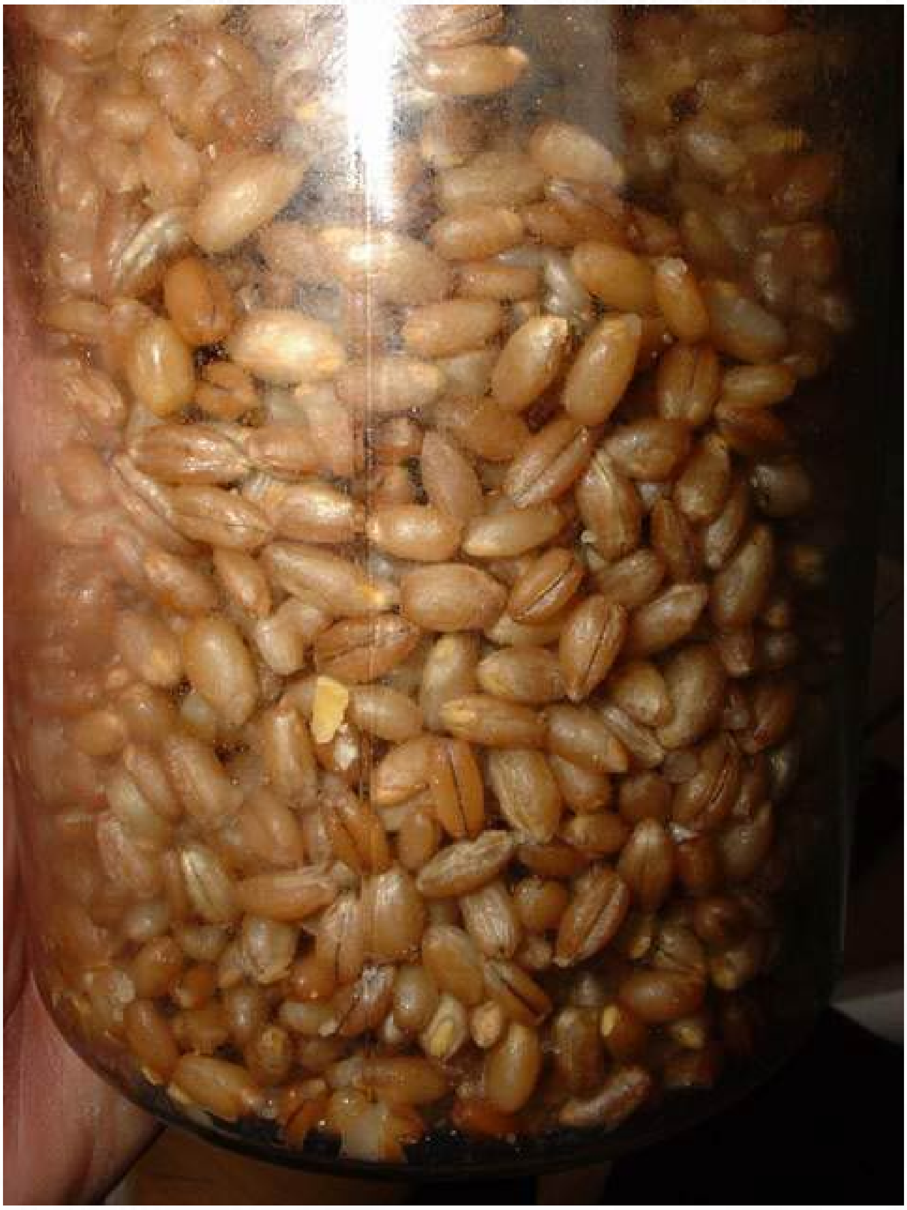
After the pressure has settled and the jars have cooled down a bit (~1 hour), take the still very hot jars out of the cooker using a towel and shake them well to mix the wetter and drier kernels.



If you turn the jar upside down, you can see the drier kernels separate from the wet kernels at the bottom.



After shaking the grains should appear wet, after a few days after inoculation they will loose this look and look more drier. Put the jars back in to the pressure cooker and let sit until completely cool. It has to be pointed out that the grain on this picture was meant to be directly cased after colonization, thus it is a bit on the wet side.



The grain used for spawn should look a bit drier, but still moist, and have less exploded kernels. The rye on this picture has been pressure cooked 48 hours ago with a rye/water ratio of 100g/100g.

Preparing grain by simmering

Alternatively you can prepare the grain by simmering in order to give it the correct water content. The procedure step by step:

1. Weigh out the amount of grain needed (~100g per pint jar).
2. Bring double the weight of water to a boil and put the grain in it. Start timing.
3. Reduce the heat so the water is barely moving. Stir the grain occasionally with a fork.
4. After ~30 minutes (for millet or birdseed) or after ~40 minutes (for rye) pour the now swollen grain through a strainer and let is drain for ~20 minutes. The exact simmer times depend on your grain, the size of the pot and other factors. For the start, follow the above times as closely as possible and then, if you see that the water content is not perfect, vary the times a bit.
5. Fill the of grain in the jars, screw the lid fitted with a polyfill filter tight and pressure cook for 1 hour at 15 psi. If you don't know how to use a pressure cooker, check out this document about the correct pressure cooker use.
6. After the pressure has settled, take the still very hot jars from the cooker (using a towel to protect your hands) and shake them well to mix the wetter and drier kernels.

Preparing rye grain by simmering - TEST RESULTS

(originally posted at the Shroomery)

I decided to test a rye grain for the water absorbing ability.

I weighed out 3 time 100 gram rye grain.

Experiments:
1. 100 g rye were dried in the oven at 140°C for 90 minutes.
2. 100 g rye were simmered in 500 ml of water for 30 minutes (rye grain put in boiling water).
3. 100 g rye were simmered in 500 ml of water for 40 minutes (rye grain put in boiling water).

Results:
1. The 100 g rye grain in the oven dried to 88 g -> 12% moisture content.
2. After 20 minutes of draining the grain weighted 190 g, nearly no exploded kernels ->(12g+90g)/190g = 54% moisture content.
3. After 20 minutes of draining the grain weighted 200 g, more exploded kernels, I'd say at the limit ->(12g+100g)/200g = 56% moisture content.

Conclusion:
Preparing grain by simmering it is a viable option. It shows that the amounts usually used when one mixes grain and water directly (100g grain and 100g-110g water) are similar (a little higher) as if one simmers the grain for around 40 minutes.

Polyfil filter lid for Simple Minds

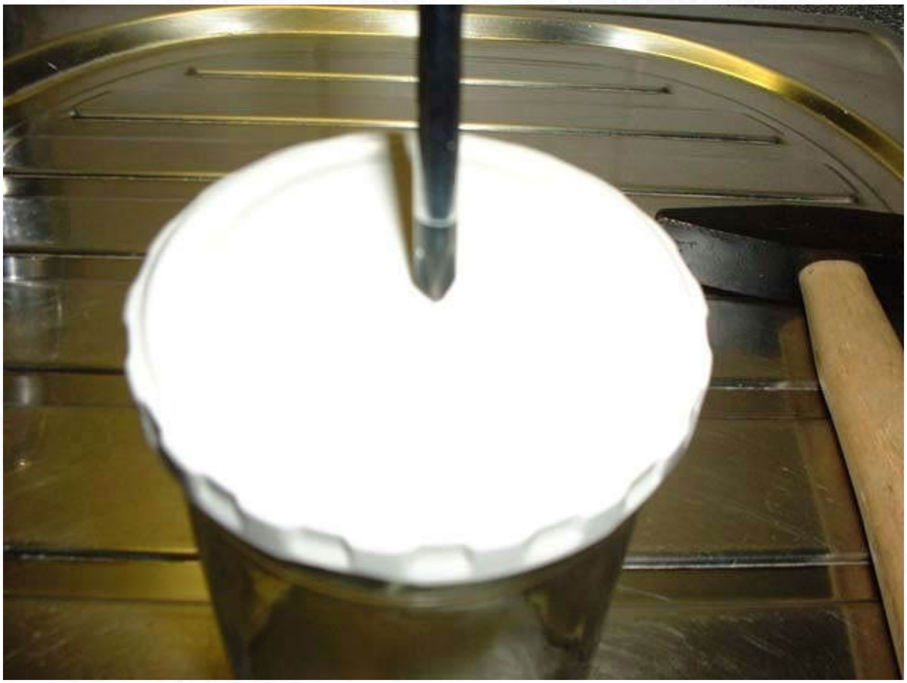
original source: http://www.fungifun.org/English/Polyfil

These instructions will guide you step by step through the process of making a very effective jar lid filter that will allow for fast colonization of shakeable substrates through better gas exchange without compromising their sterility.

Required materials:

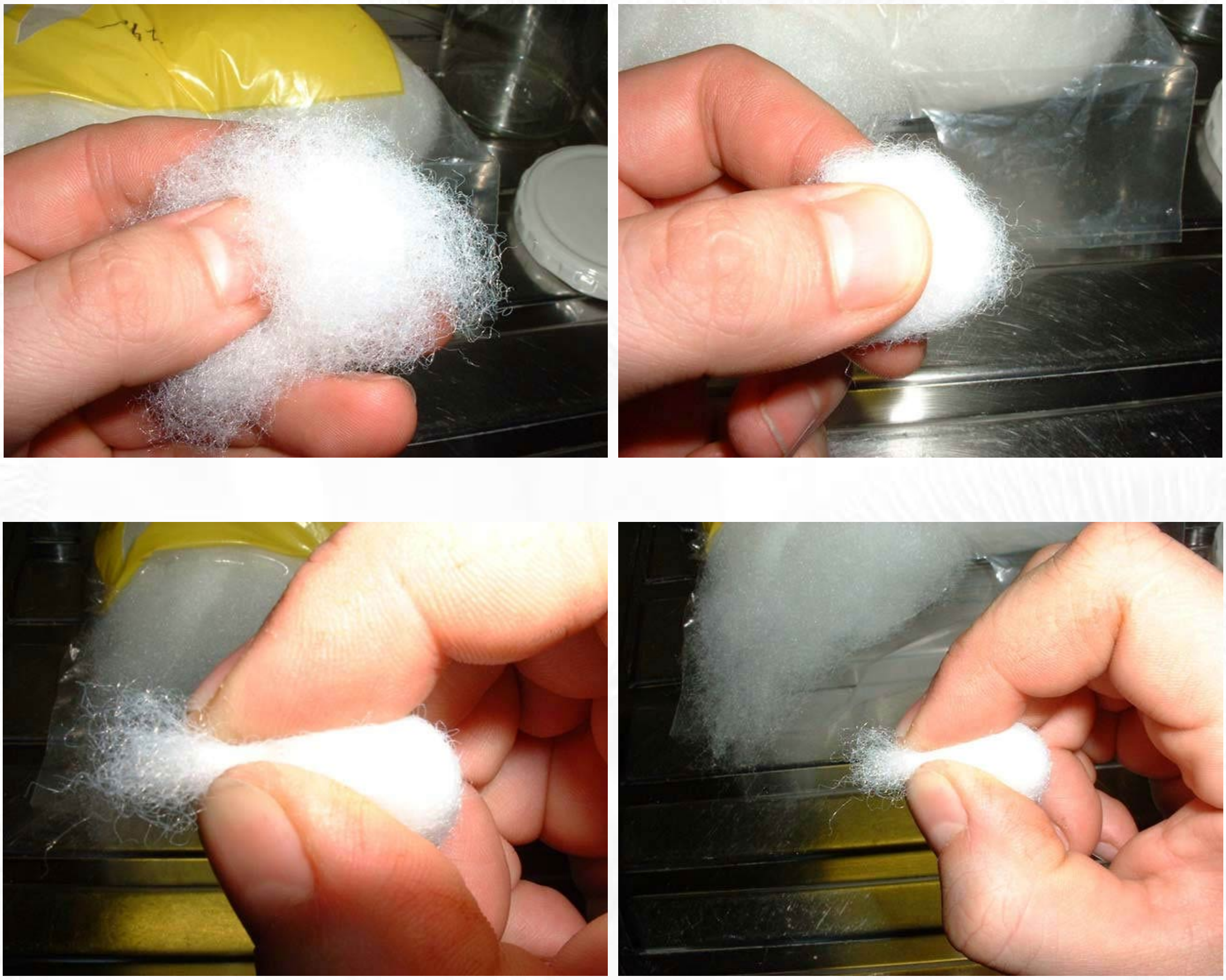
- pint or quart jar with lid
- Phillips screwdriver measuring app. 6mm (1/4in) in diameter
- hammer
- polyfil or polyester filter floss

Where can you get it? At Ebay (links above) you should easily find it.
Offline you get it at craft stores like Michaels or the craft section of Meijers or Walmart, when you ask at Walmart in arts and crafts department tell them that you are looking for pillow filling or batting.
It's also used as filter material for aquariums ("polyester filter floss"), thus aquarium and pet shops have it.

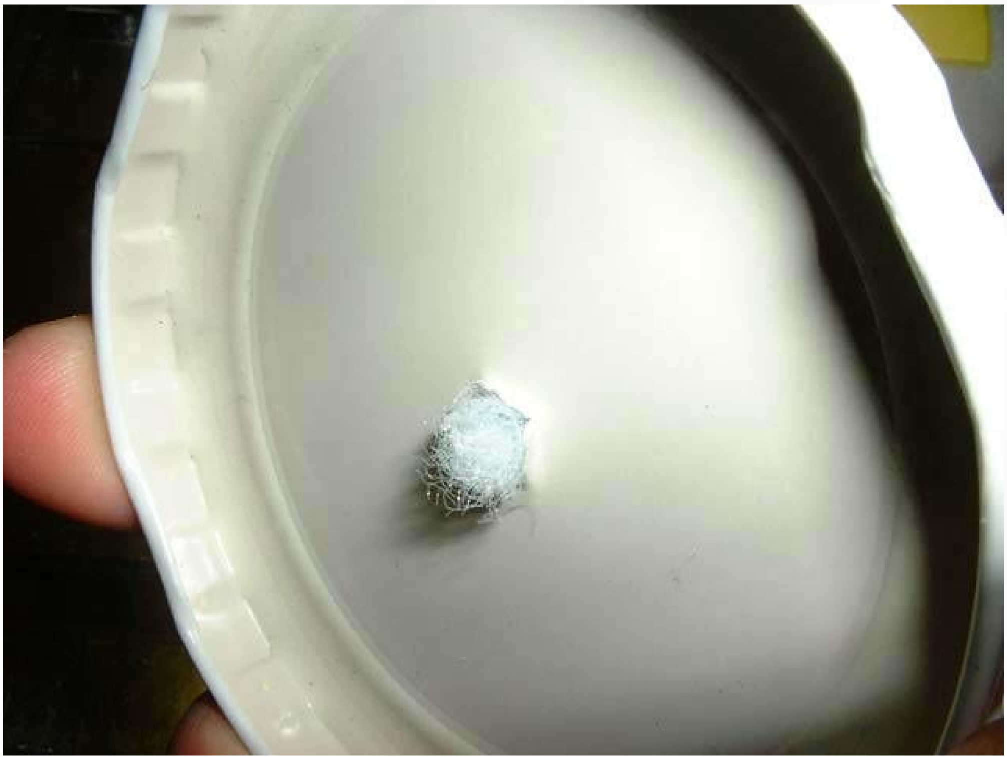


Screw the lid on the jar and punch a hole in the lid using the screwdriver and the hammer.

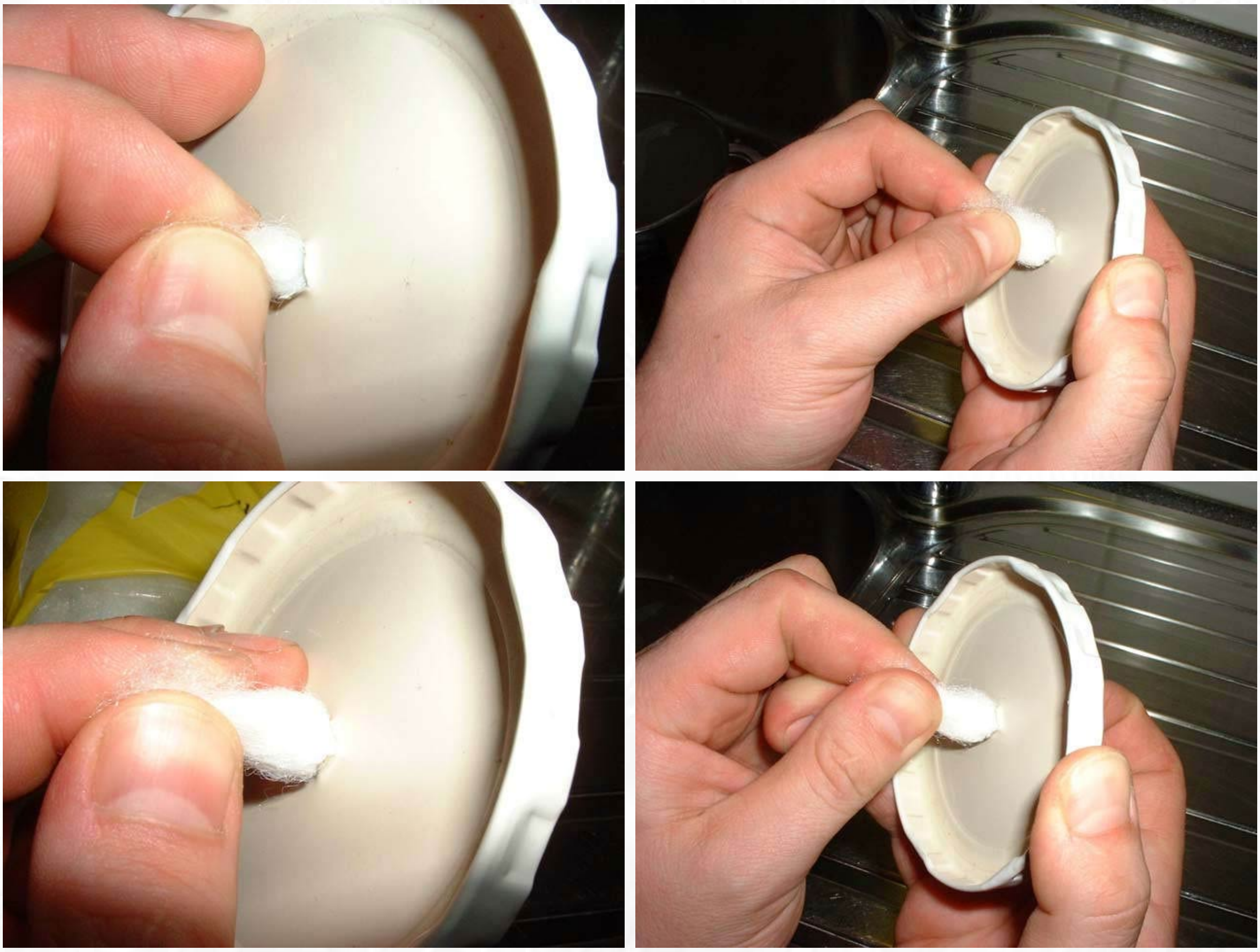
Take some floss and fold it to a small ball using both hands.

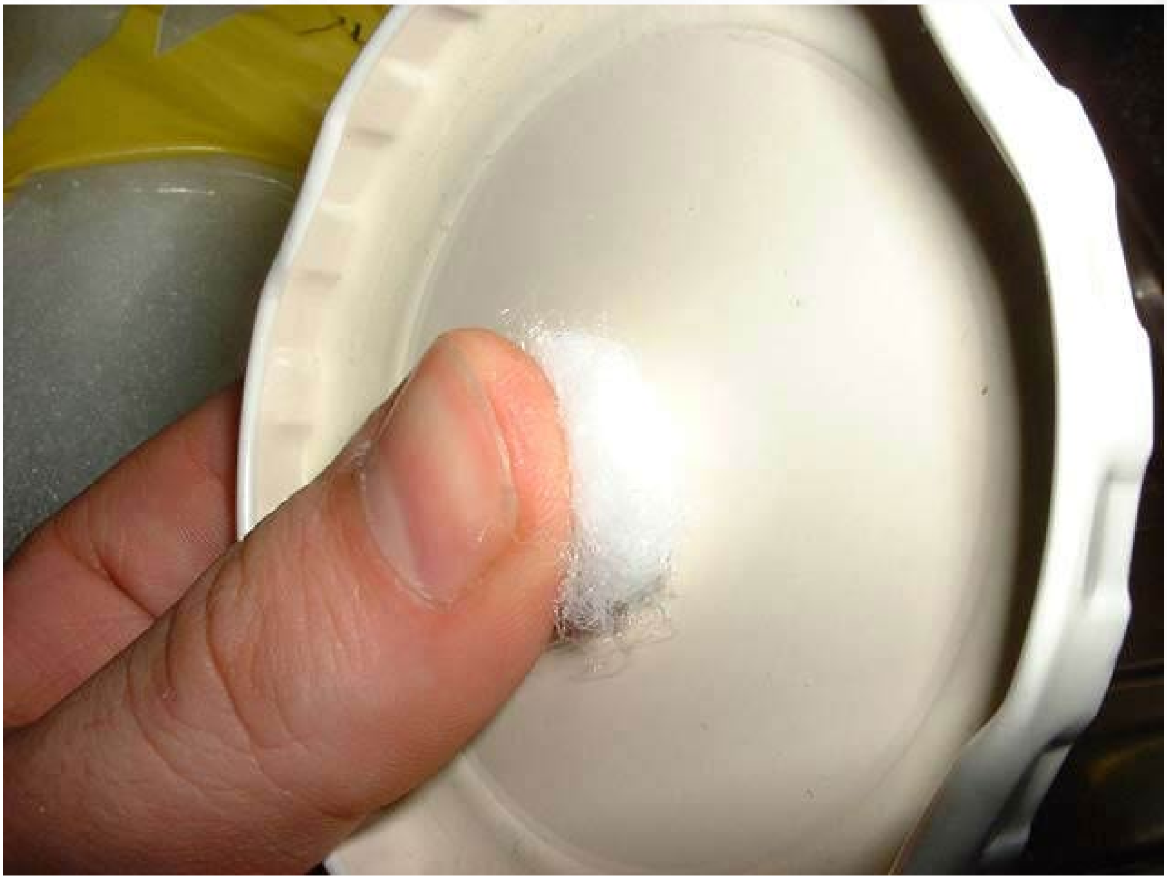


Make the ball having a tip at one end.

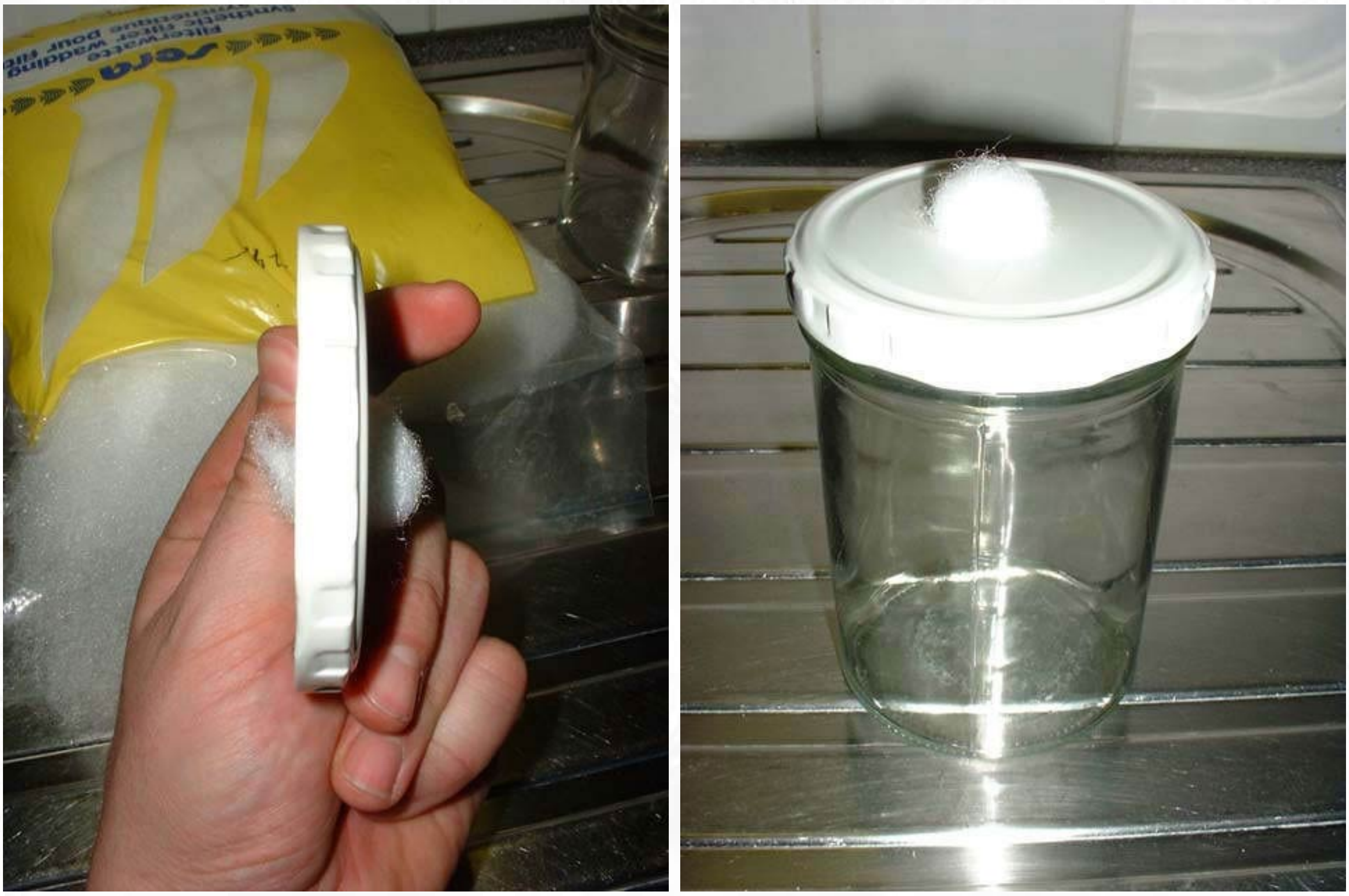


Put this end through the hole and pull it app. halfway through. It should form a relatively tight seat.
Be careful not to cut yourself on the sharp edges!





Push the floss back towards the edges. This will hold it in place.


sera
Filterwatte
synthetic filter wadding pour filtration

Ready.
You should replace the filter floss after using it 3-4 times just to make sure no substrate residuals collect on it which could support growth of contaminants.

Homemade Tyvek filter discs test

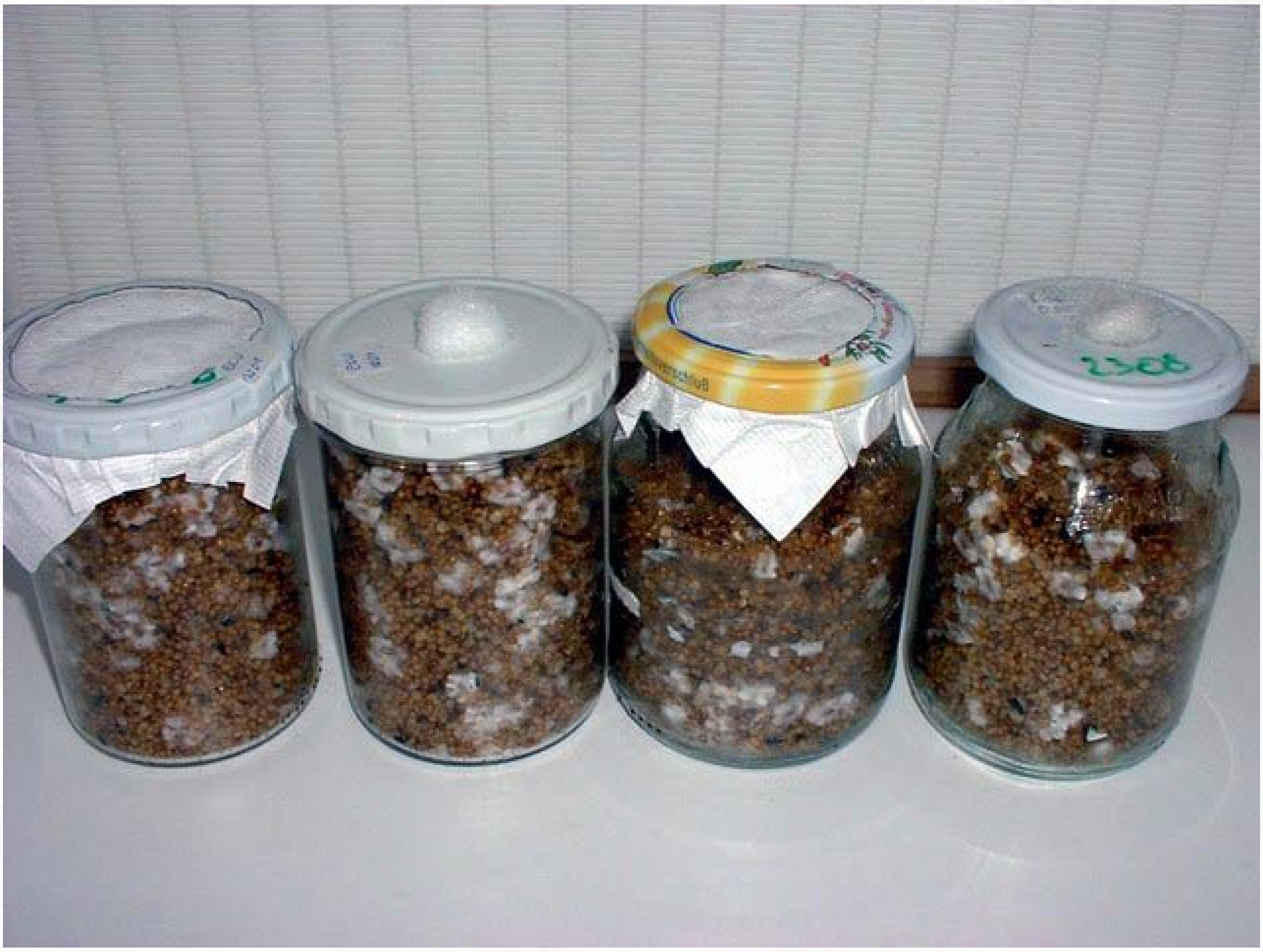
original source: http://www.fungifun.org/English/Tyvek

I conducted a test using filters made of Tyvek™ material.

I prepared 4 birdseed jars, 2 are covered with the polyfill lid like outlined in the Polyfil filter lid for Simple Minds, and 2 are covered with squares of Tyvek™ hold down by the rim of the lid. The variety of Tyvek was the thin Tyvek used in construction, "Tyvek house wrap".

I inoculated them with Ecuador rye grain spawn and incubate at 29°C.

After 2 days fresh growth was noticable both in polyfill filter jars and in Tyvek filter jars. I couldn't tell if the growth is faster in any of them.
The jars were shaken to distribute the newly colonized kernels and put back into the incubator.



After 3.5 days into colonisation the jars looked like this.

6 days after inoculation the jars were colonized.

If you look carefully you will notice, that the Tyvek filter jars have a thin layer of uncolonized, dry kernels on the top of the jar during the excessive gas exchange through the filter.

To counteract this one should make the hole in the lid smaller (about 1/2 inch in diamter) and thus only partially expose the filter surface.

No contamination problems were observed in jars with either kinds of filters.

All in all the test was a succes, proving that "Tyvek house wrap" is suitable for use as an filter in preparing of grain spawn.

Pressure Cooker Use

original source: http://www.fungifun.org/English/Pressure-Cooker-Use

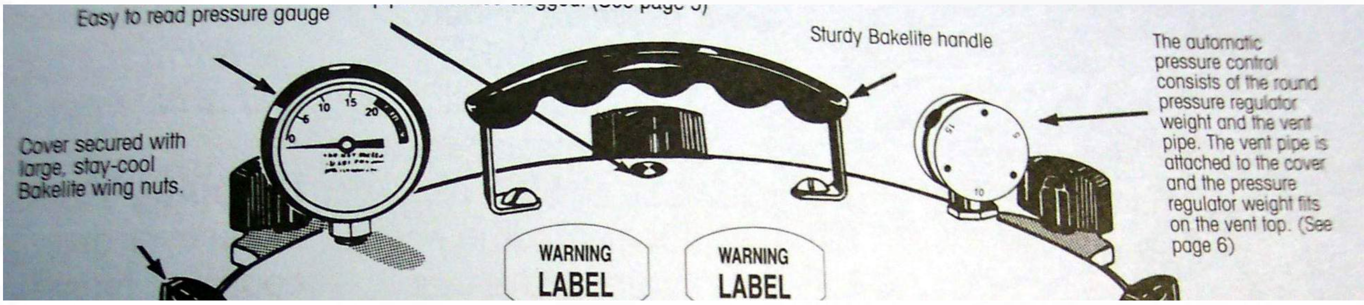
Pressure cookers and canner are important tools in mycological work. When used properly they guarantee the preparation of thoroughly sterilized mushroom growing substrates and tools.
In a pressure cooker the water reaches a higher temperature before boiling, and this higher temperature kills unwanted organisms more effectively and faster than normal cooking.

This document should give some answers on the correct use of pressure cookers.

Pressure cooker types

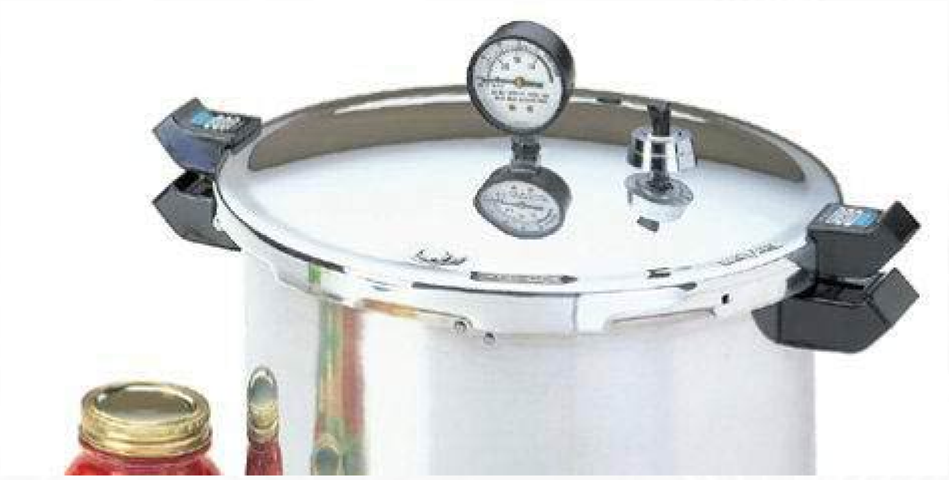
There are different ways of how a pressure cooker indicates and controls the operating pressure.

Pressure gauge + pressure regulator weight (All American Pressure Canner)


Easy to read pressure gauge
Sturdy Bakelite handle
The automatic pressure control consists of the round pressure regulator weight and the vent pipe. The vent pipe is attached to the cover and the pressure regulator weight fits on the vent top. (See page 6)
Cover secured with large, stay-cool Bakelite wing nuts.
5
10
15
20
WARNING LABEL
WARNING LABEL

The pressure regulator weight lets you select one of three pressure settings: 5, 10 and 15 PSI. You should select 15 PSI for mycological work. When the pressure cooker reaches the proper temperature, the pressure regulator weight will jiggle audibly, and you can see the steam being released. Additionally the pressure gauge will show that the pressure has been reached. It is normal that the pressure gauge shows 1-2 PSI less than what you selected on the pressure regulator weight. To maintain the proper temperature adjust heat lower to maintain a slow, steady rocking motion.

Pressure gauge + rocker (Presto Pressure Canner)



When the pressure cooker reaches the proper temperature, the rocker will jiggle audibly, and you can see the steam being released. Adjust heat lower to maintain a slow, steady rocking motion.

Rocker (Presto, Mirro, Hawkins....)

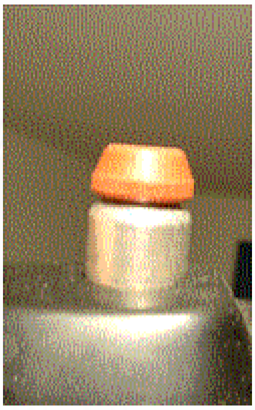
This is essentially the same as the above, just that they don't have a pressure gauge. When the pressure cooker reaches the proper temperature, the rocker will jiggle audibly, and you can see the steam being released. Adjust heat lower to maintain a slow, steady rocking motion.
To see if your pressure cooker reaches the desired temperature, you can do a pressure cooker test.

Spring system (T-Fal...)

Many new pressure cookers utilize a spring system.
A pin held by a spring is being forced out of the pressure cooker by the building pressure. The more the pin

comes out, the higher the pressure in the PC. After a certain point is reached steam is released with a hissing sound.
The operating point of those types of pressure cookers should be just before the steam is starting to get released, this means once you see the steam being released, you turn the heat down a bit.

In some types you can see the pin coming out:



(Gif animation not available in PDF version.)

WMF
PERFECT
PLUS
Made in Germany

In some types you don't:

In each case, the working point of those types of pressure cookers should be just before the steam is starting to get released.

Rack or trivet

Most pressure cookers come with a rack or trivet. Racks are made of aluminum of stainless steel. A rack keeps the jars from direct contact with the bottom of the pressure cooker. Some types of jars tend to crack if they are not on a rack.

More on racks at All About Pressure Cooker Racks and Trivets.

Pressure cooking step by step

1. Put 1 inch of cold water in the PC. Some pressure cooker manuals will tell you to use more water. You need to use as much water, that by the end of the pressure cooking there is still some water left at the bottom of the pressure cooker. If you are unsure, you can test drive the pressure cooker without jars first to see the 1 inch of water will fulfill this requirement or not. **Never let the pressure cooker run dry!** Place filled jars on the rack. Fasten PC lid securely.
2. Leave weight off vent port or open petcock. Turn the heat on at a setting from $^{2}/_{3}$ to the highest setting until steam flows from the petcock or vent port. You don't want the pressure cooker heat up too fast, since this can cause certain types of jars to break. Adjust the heat so that it takes around 15 minutes for the steam to begin to come out of the vent. The bigger the pressure cooker, and the more filled it is, the higher setting you can use.
3. Exhaust steam for 1 minute and then place weight on vent port or close petcock. The PC will pressurize during the next 5 to 15 minutes, depending on the size of the PC. (the bigger the PC, and the more jars are in it, the longer it will take).
4. Start timing the process, depending on the pressure cooker type
   - when the pressure reading on the dial gauge indicates that the recommended pressure has been reached **or**
   - when the weighted gauge begins to jiggle/rock **or**
   - when the valve comes up to the of second or third (last) ring **or**
   - when the steam is starting to get released from the pressure setting dial.
5. Adjust heat lower to maintain a slow, steady rocking motion, or the pressure indicator staying at the proper ring, or there is no steam coming from the pressure setting dial, depending on the pressure cooker type.
6. When timed processing is completed, turn off the heat, remove the PC from heat (if electric range), and let the PC de-pressurize at room temperature. (dial needle moves back to "0" or no steam escapes when weight is gently nudged). Do not force-cool the PC under water or force the steam out! The depressurazation can take anywhere from 5-20 minutes, depending on the size of the pressure cooker and the amounts of the jars in it.
7. After the PC is depressurized, remove the weight from the vent port or open the petcock.

If you are preparing whole grains (rye, millet, birdseed...), you will now want to wait around 30 minutes and then take the hot jars out and shake them to distribute the wetter and drier kernels.
If you are preparing PF jars it's best to leave them cool down in the pressure cooker over night.

Pressure cooker test

original source: http://www.fungifun.org/English/Pressure-Cooker-Test

A simple test to test if your pressure cooker is working properly:

Let a drop of water drop on the pressure cooker while sterilizing.
If the drop boils like underneath, the temperature is around 250°F (121°C) and the pressure cooker is working properly.

(Gif animation not available in PDF version.)

Why does this happen?

A pressure cooker operating under pressure is very hot, it is quite much hotter than the boiling point of water at 1 atmosphere (212°F=100°C). If the pressure cooker is of the "standard" kind, it will be at 250°F = 121°C.

If you put a small amount of water, a drop, on the surface of the lid of the pressure cooker while the pressure cooker is hot and under pressure, the drop of water will begin to boil vigorously and will evaporate in 2-3 seconds, since the surface of the pressure cooker is so much hotter than the boiling point of water at the atmospheric pressure.

If the pressure cooker doesn't work properly, i.e. if the pressure doesn't build up as it should, the pressure cooker temperature will be the same or only slightly above as the boiling point of water at atmospheric pressure. If you were to drop a drop of water on such a cooker, the drop would only sit there and slowly evaporate over the course of a longer time span.

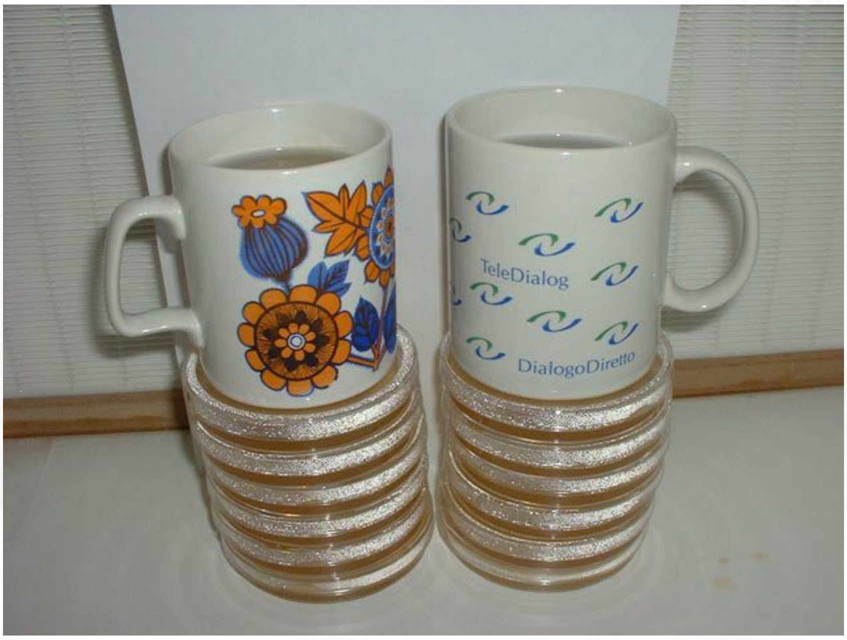
Pouring Agar for Simple Minds

original source: http://www.fungifun.org/English/Agar

These instructions will guide you through the process of pouring agar without having heavy condensation on the Petri dishes.

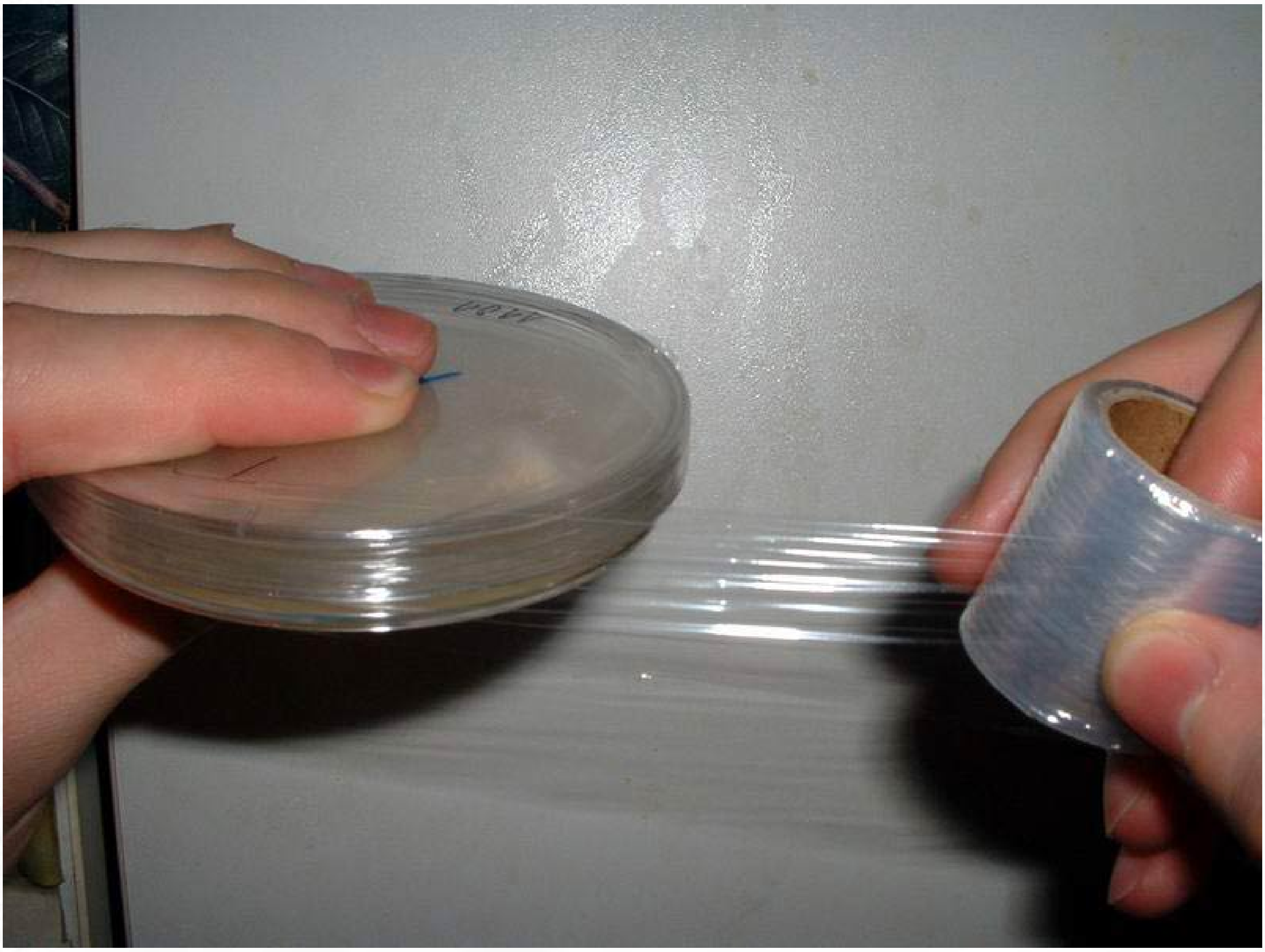
I stack the Petris in 5 or 6-piece stacks in front of the hood. Then I prepare some cups and boiling water.
I let the agar cool down to around 35°C, just before it solidifies. Then I pour the agar in the dishes, and immediately after a stack is finished I put a cup with the hot water on top of it.

What does this do? Water vapor condensates at cold surfaces. Now, when you stack the dishes, the top of each dish is kept warm by the bottom of the previous dish. Except the top one! Through the cold top one there is a temperature gradient and the top and to some extent also the dishes underneath get some condensation.



When you put a cup of hot water on the top dish, it prevents this condensation by heating the lid.
You will also notice I put a sheet of paper in front of the hood, so the dishes don't cool too fast from the side, which again contributes to less condensation.

I seal agar plates with a Glad Clingwrap, where I cut a small piece off the roll with a very sharp knife.
You can use any wrap, as long it's made from polyethylene. There are differences between brands though, some will work better than others.
Saran wrap is NOT suitable, since it's not made from polyethylene and is not gas permeable.
Sealing dishes prevents contaminants coming into the dish for whatever reasons, ads for easy handling since the both dish parts would otherwise come apart and allows gas exchange, since the polyethylene wrap is gas permeable.



GLAD
GLAD WRAP
600

Importance of Gas Exchange

original source: http://www.fungifun.org/English/Importance-Of-Gas-Exchange

When mushrooms digest a substrate, they produce carbon dioxide (CO_2), and consume oxygen (O_2).
This is a fairly important factor determining success or demise of a growth attempt.

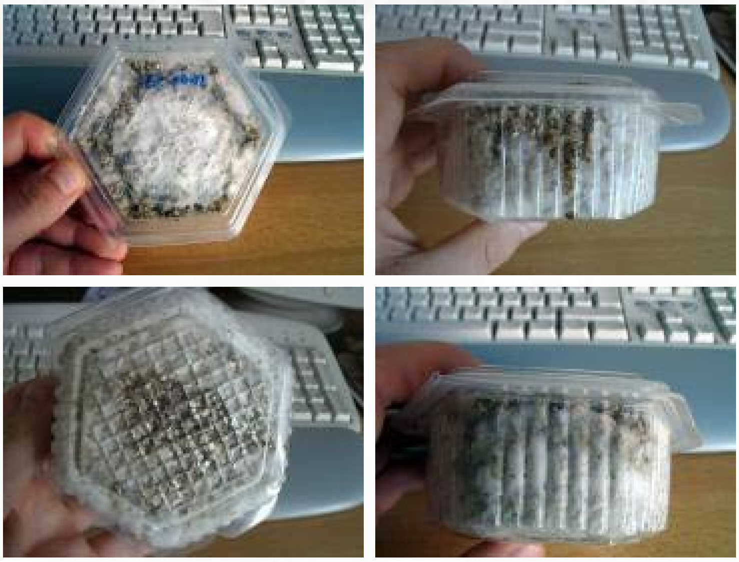
I prepared a few plastic containers with $^1/_2$ pint content with my standard substrate I use for PF tek jars. The plastic containers have a lid, that completely seals the container, so there is no gas exchange.

When I use the same substrate in jars with an aluminum foil lid, like described in the PF-Tek for Simple Minds I get full colonization in 8-12 days.

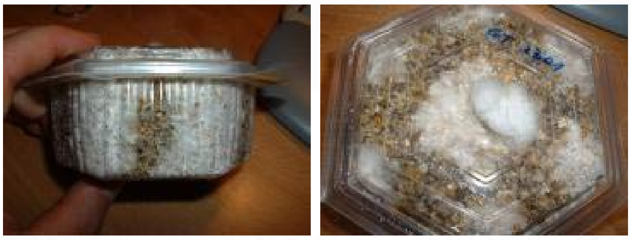
The spores germinated after 2 days and the colonization went fairly fast for another 3 days, then it suddenly stopped.

I left it then another week, and the colonization barely moved on.
Then I opened the container in front of a flow hood for a few seconds to provide some air.
The colonization again started, and again halted after a few days....
I repeated this another 2 times, and after 1 month into colonization, the substrate is still not completely colonized.
You can see at the pictures how the mycelium has a different appearance in some areas and it shows the different growth and stall phases.

The inoculation was at the sides and one inoculation point at the top of substrate. There is no vermiculite seal, but a thin vermiculite bottom layer.



TEST II :
This time I took the same plastic containers, but fitted them with a polyfill filter.
This is day 6 of colonization, look what a difference the air exchange makes!



One has to love polyfill!

Day 8:

I hereby declare this cake colonized.

FAQ

Why couldn't I put a few heat loving plants in my incubator at night to help with the exchange?
Plants convert CO_2 and water into oxygen and sugars....when they have light. This process is called photosynthesis.
The incubator shouldn't have light. So this woudn't really work well.
Plants need some oxygen for themselves too, btw.
Read
http://www.mcps.k12.md.us/departments/eventscience/EBS.OS1_RS~DF.html
http://www.hsv.k12.al.us/schools/middle/wtms/student/cell/cell_energy.html
http://www.saburchill.com/chapters/summary02.html

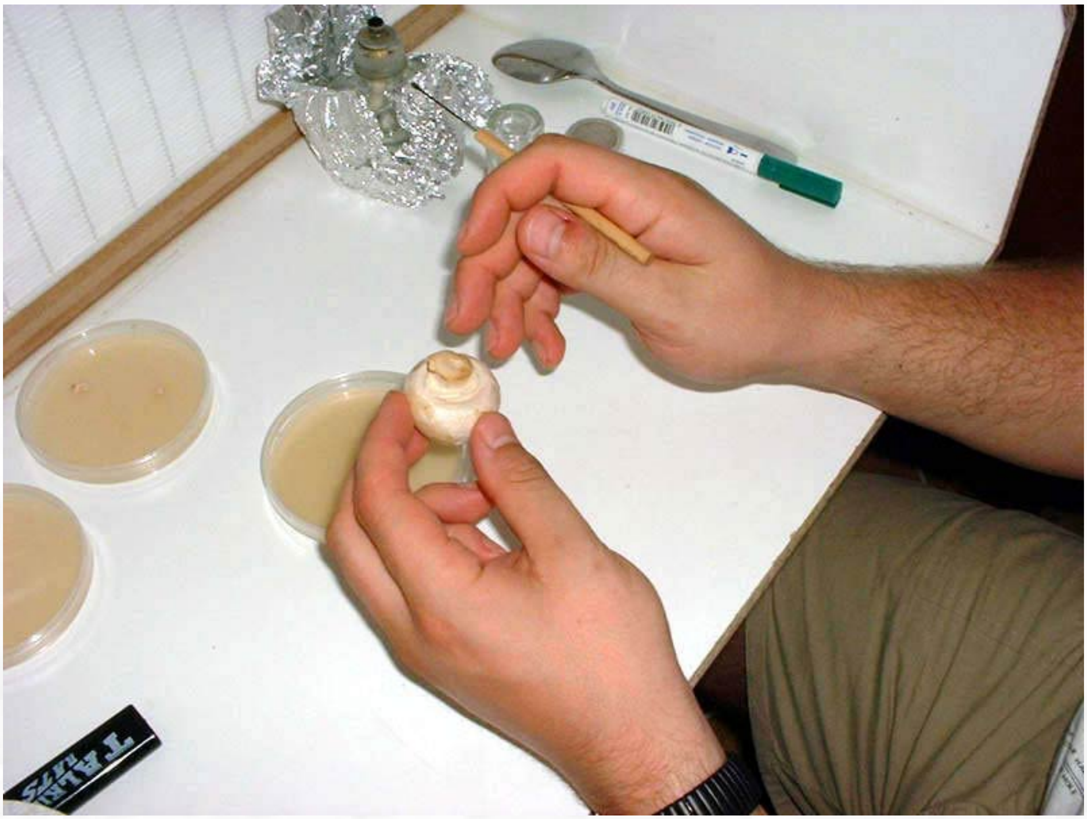
Besides, the point is not that the oxygen isn't available, it is there, in the normal air, to more than 20%, the problem is that it has to get to the mycelium, and it can't get there, if the jar is sealed.

I've found that the most tightly closed casings during regrow, turned out the best.
In the post casing - pre pinning phase the CO_2 levels should be high. This is best achieved by simply covering the casing container with aluminum foil or similar.
It will get some air exchange (same as the jars with the aluminum foil lid), but the CO_2 level will be high. That's what you want to achieve.

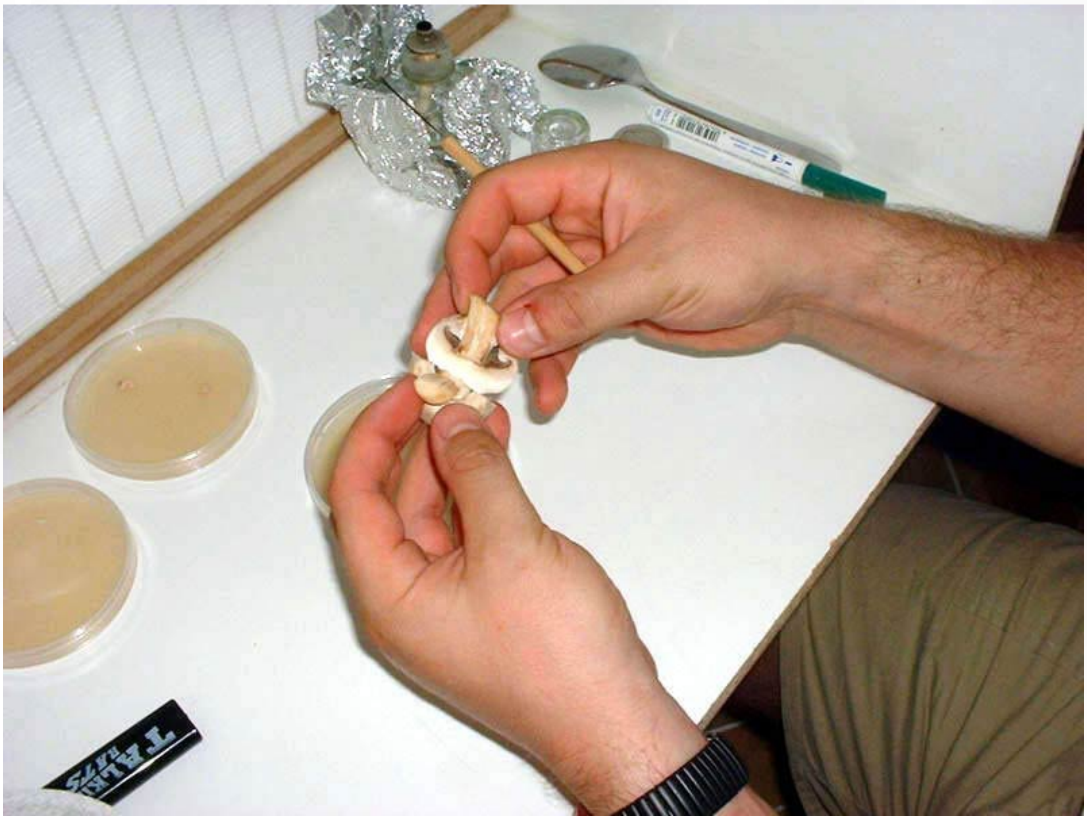
Cloning for Simple Minds

original source: http://www.fungifun.org/English/Cloning

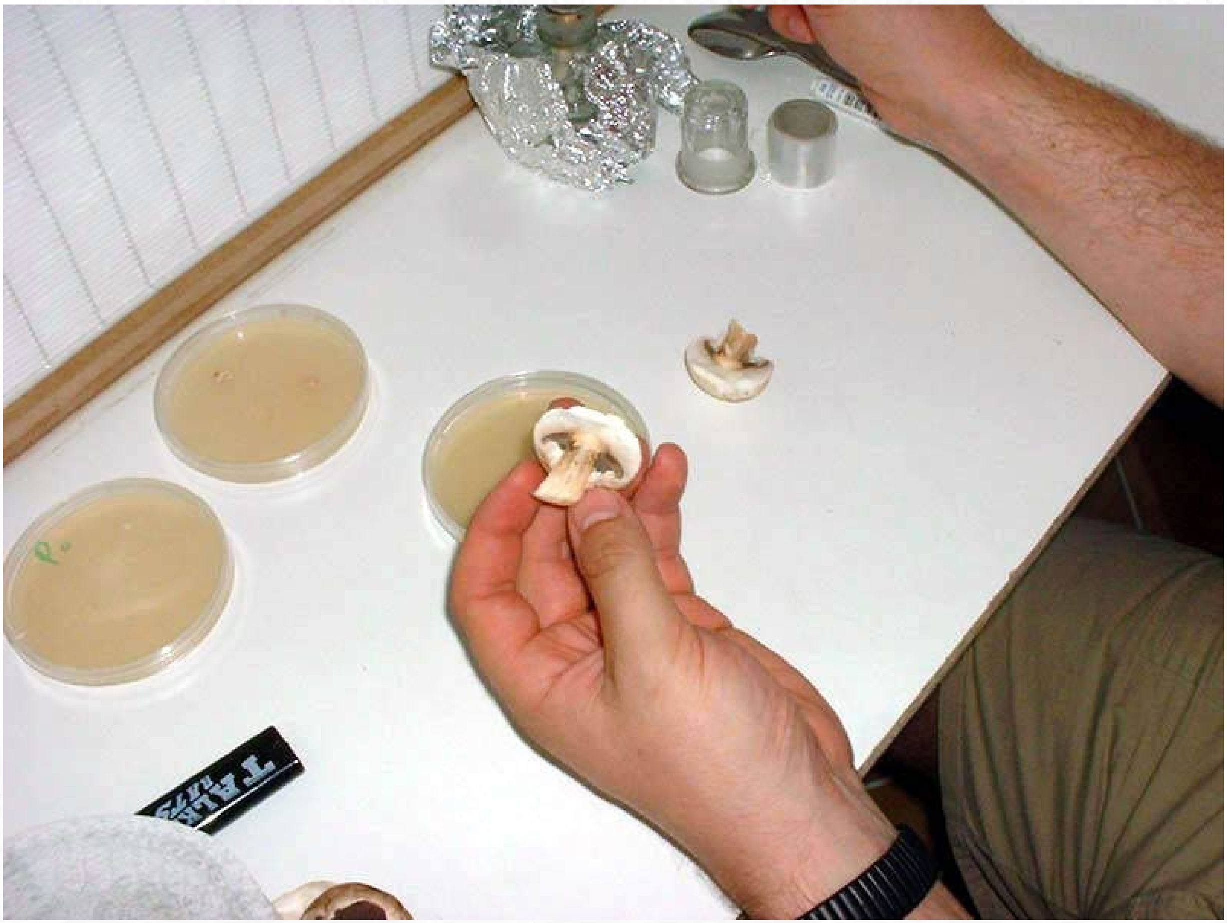
These instructions will guide you through the process of cloning a mushroom on agar.



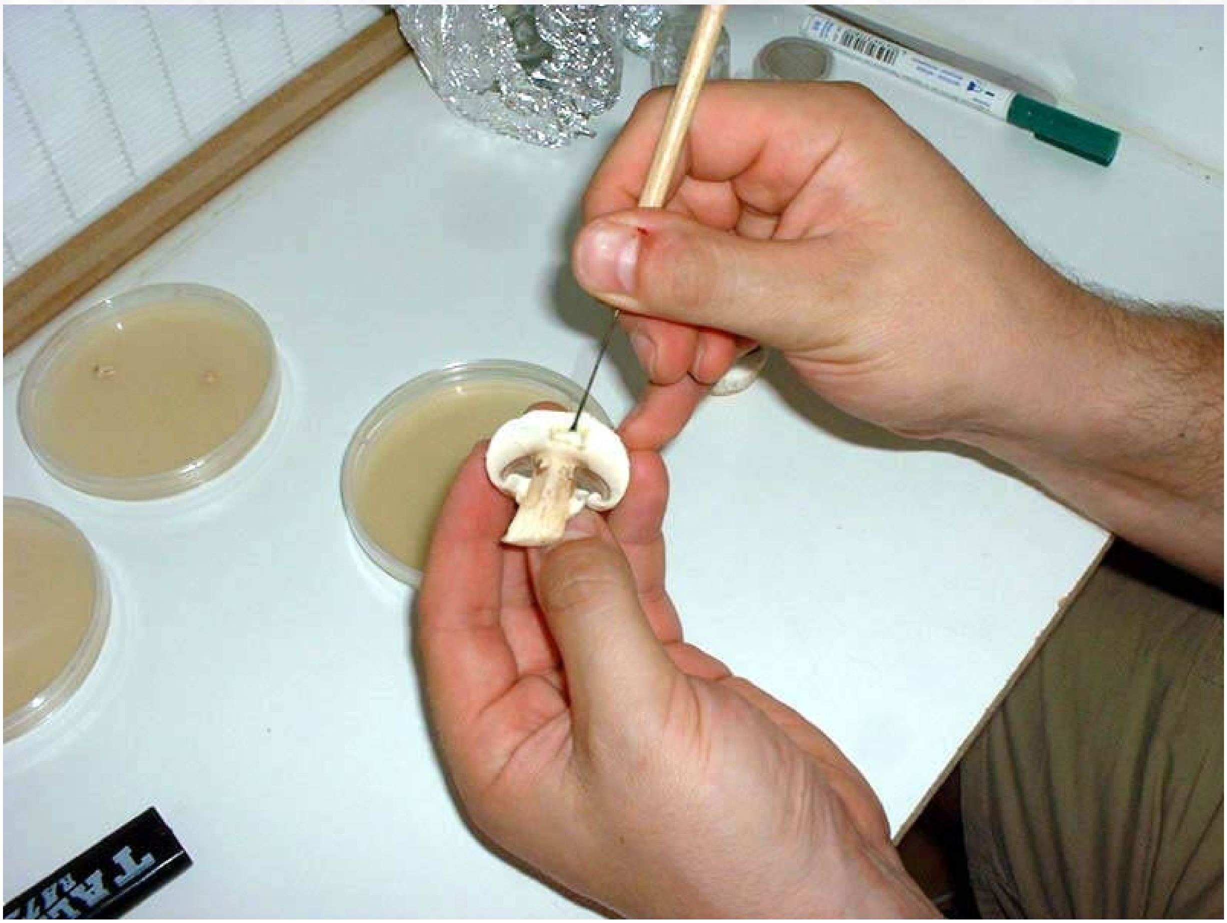
Take a nice, healthy mushroom.



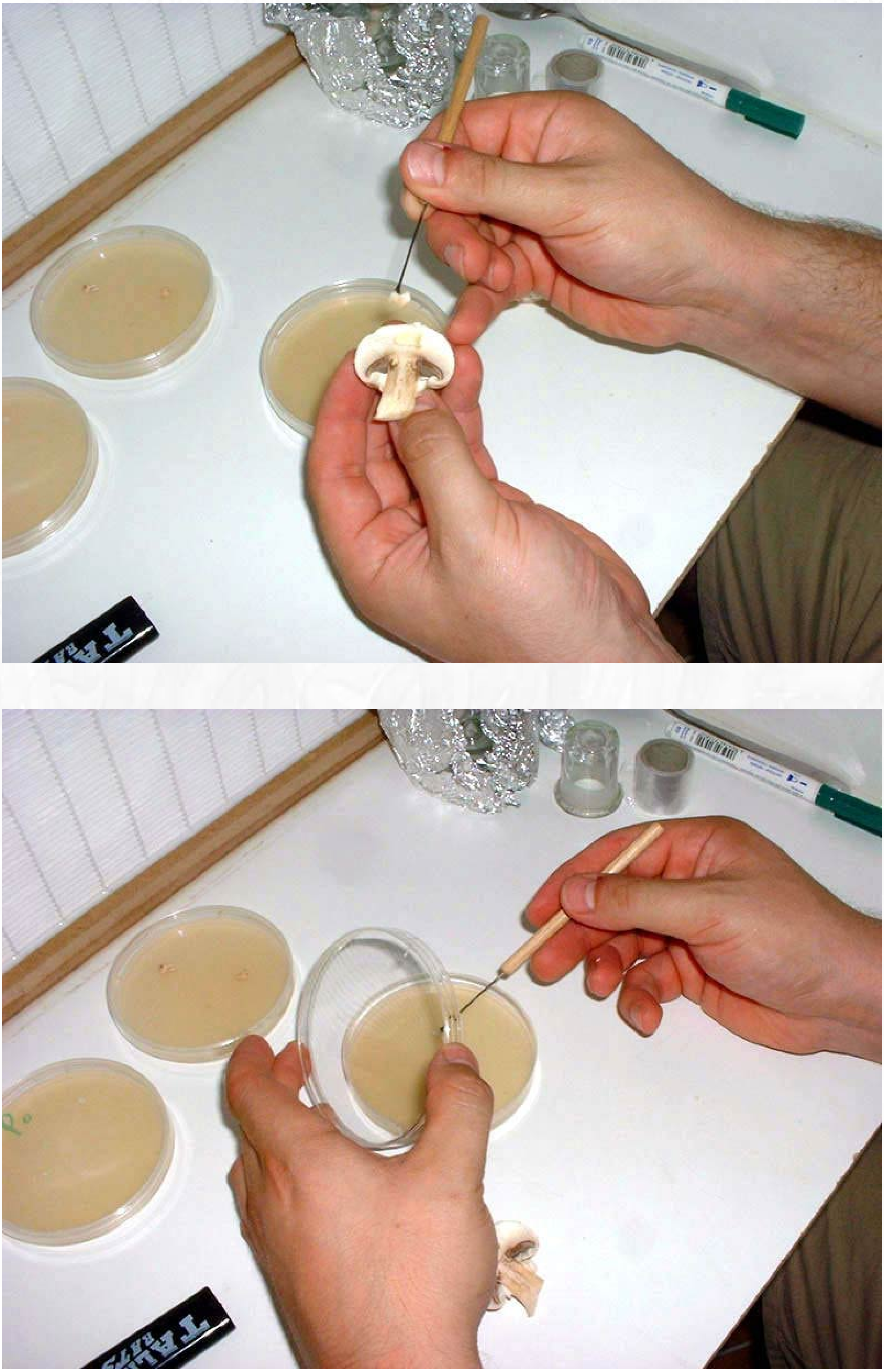
Tear the mushroom apart in the middle lenghtwise.



Flame the scalpell untill glowing red.
Let cool for a few seconds.



Cut a small chunk from the cap base, measuring around 2 x 2 x 2 mm.



Transfer to agar.

Mycelium Inoculation Technique

original source: http://www.fungifun.org/English/Mycelium

This is a significant add-on of the PF-Tek which enables you to grow virtually hundreds of PF-cakes with only one spore syringe! Also the primordia will appear in as little as 16 days after inoculation! The key is first to colonize a sterilized rye jar and then use this mycelium to make a mycelium syringe.

For the first part I basically use the The Foolproof Psilocybe cubensis Mycelial Culture Technique.

I use 100 g (3,2 ounces) rye + 105 g water + a knife tip of gypsum (optional) in a 450 ml (1 pint) jar.
For more detail on grain preparation read Grain for Simple Minds.

There is way to prevent airborne contamination entering the jars. Take a clean plastic bag and spray the inner side with Lysol or alcohol. Rub it from outside so the Lysol is evenly dispersed on the inner surface of the bag. When the sterilization time is over, wait a few minutes for the pressure to build down to ambient. Then take a clean, folded cloth or thick gloves, open the cooker and transfer the (careful, burning hot!) jars to the bag (shake the rye jars at this stage to distribute the dryer and wetter kernels!).

Roll the rest of the bag together, so you get it pretty airtight.
As the hot air in the jars is cooling down and its volume decreases, fresh (contaminated!) air from outside is drawn in. This setup will accomplish that the contaminants from the air set down on the wet bag surface and don't come into the jars!

The sterilization time should be 1 hour to assure complete sterilization. You should shake the rye jars immediately after spore inoculation and than once after 3-4 days and optionally again after 8 days. The optimum room temperature for incubation is about 27°C (80°F).

Now comes the best part!
After the rye jars are completely colonized you will need:

- At least one empty plastic syringe with needle, 10ml or more
- A small (app. 200 ml) jar with a screw lid (I take one from a spaghetti sauce)
- Tin foil
- Alcohol lamp
- A tea spoon

Punch a hole with a small nail into the middle of the lid. It has to be big enough for the needle of the syringe fits through. Fill the jar with app. twice the amount of water you will need to fill the syringes. (for instance when you have three syringes with each 10 ml to fill, use app. 60 ml water). Screw the lid on and cover with a double layer of tin foil, sterilize in a pressure cooker for 30 minutes and then handle according to the above tips.

After the water jar has cooled down to room temperature prepare everything for the transfer of the colonized rye to the water filled jar.
Wash your hands, clean the working surface, take the colonized rye jar, loosen the lid of the water jar, but don't take it off yet. Sterilize the already washed and Lysol-sprayed spoon over the flame of the alcohol lamp. I use to cool the hot spoon by dipping it in a small glass of alcohol, but you can also wait a few moments the spoon cools down. Then open the rye jar, the water jar and transfer 2 spoon full of colonized rye to the water jar. This should obviously best be done under sterile conditions (in front of a HEPA filter or in a glove box), but if you work fast and in a draft free room you should accomplish this without contaminating the whole jar. Replace the lids back and screw them tight. The rye jar can be kept in a fridge at least three months and be used over and over again.

Take the water jar, put a finger on the tin foil where the hole is and shake it vigorously at least 3 minutes until you see many tiny mycelium pieces swimming in the water. Take a clean, sterilized syringe, sterilize the tip of the needle over the flame and pull (holding the needle still in the flame) the plunger back 4 millimeters ($^1/_5$ inch). This will give you a little air bubble so later on you can shake the mycelium water prior to inoculation of the PF jars.

Remove the tin cover, hold the jar at an angle, insert the needle into water and pull the plunger until the syringe is full. Be careful the syringe needle is clean and sterilized or you will contaminate the mycelium water.

That's it! You can now use this syringe like you would use the spore-water one. You can keep the mycelium syringes in the fridge at least 2 months.

Spore printing

original source: http://www.fungifun.org/English/SporePrinting

Wash your hands and work in a clean environment to perform the following steps:

- take a clean material you want to print on (fresh typing paper, index cards, wax paper, tin foil, glass slides....)
- cut a opened, clean, mature cap off the stem as near to the gills as possible with a clean scalpel or knife
- place the cap on the printing material gills down
- cover the cap with a jar or glass or place the printing material in a plastic container (Tupperware...) with lid on.
- let sit for 12-24 hours at room temperature
- pick up the cap, cover again and let the print dry for around 24 hours
- when the print is dry fold the print and tape the edges or leave it as is and put into a clean plastic zip bag.
- label and store in a dark, cold and dry place.

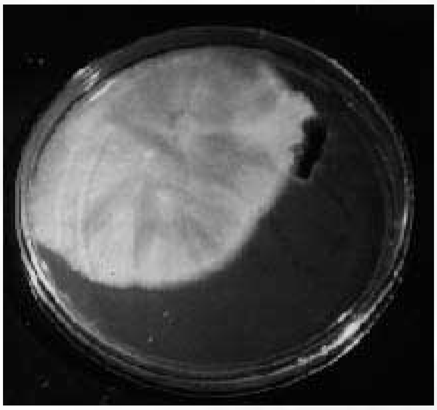
The Illustrated Mushroom Grower's Guide

original source: http://www.shroomery.org/8437/The-Illustrated-Mushroom-Growers-Guide

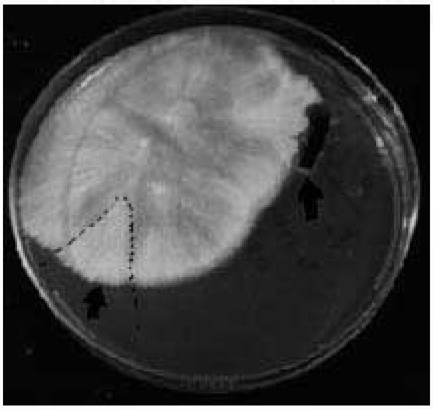
Not for the beginner, this cubensis cultivation method requires you to be fairly experienced with mushroom cultivation...and to have access to some basic laboratory equipment. It's got helpful illustrations.

Hey folks. Here is a detailed description of the method I use to grow Psilocybe cubensis. I have had very good success and have worked out most of the bugs so this method is guaranteed to produce lots of our little, happy friends. Unfortunately for most of you, I have access to laboratory equipment including an autoclave (for sterilization) and an incubator (for growing at constant temperatures) but I think you can substitute your own homemade stuff like a pressure cooker.
I start with Psilocybe cubensis mycelium which has been grown on an agar plate. The agar media I use is Potato dextrose agar (PDA) from Difco. This contains Potato dextrose broth and regular agar at 1.5 g/l. I am sure Malt extract agar would be just as good or even some home made version of PDA. The agar was autoclaved at 121°C, 15 psi for 30 min and was then cooled to 50°C. At this temperature, the agar was aseptically poured into Petri plates and allowed to cool and solidify. These plates can now be stored in a plastic bag in a cool location for as long as you want. If there was any contamination, it should show up after about 3-4 days at room temperature. If there is none, then the plates are good to use.

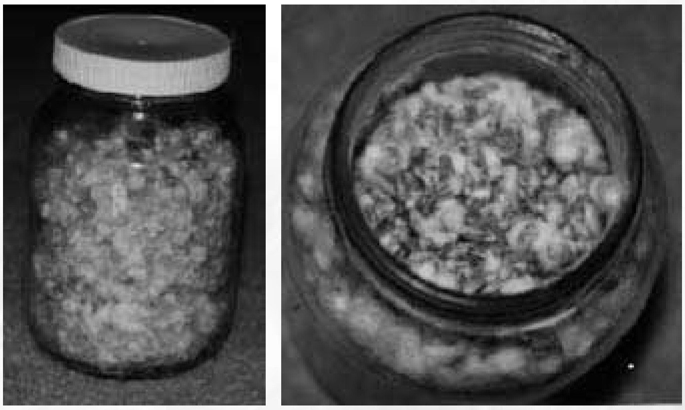
The Psilocybe cubensis strain I use was obtained from a local store and I was assured that it was a good one. Basically, the strain is dikaryotic and can be used directly to inoculate jars. I first aseptically transferred a small piece of mycelium containing agar to a few plates and grew them at 30°C for 1 week. Two of these plates were set aside as my stock cultures so that I did not have to go back to the original (and risk contamination) and were stored at 4°C (in the fridge) with some plastic wrap around them to keep in the moisture. They were also stored upside down so that any condensed water would collect on the lid and not on the surface of the agar. The other plate was used to inoculate a bunch of new plates with small pieces of mycelium containing agar. These new plates were grown at 30°C for one week. After this time, a nice white, kite string-like mycelium had grown. The kite string-like mycelium was actually only found in sectors on the plate and it was these areas that were used to inoculate jars of rye substrate.



Rye substrate was prepared using 130 g of rye seed combined with 100 ml's of water in a 500 ml (pint) jar. The jars I used had plastic screw-top lids which could be left partially unscrewed to allow air to enter. Also, mineral supplements like $CaCO_3$ could be added to the water but this was not found to be necessary. Once the rye and water was combined in the jar, the jars were autoclaved at 121°C, 15 psi for 1 hour. These were then allowed to cool to room temperature with the lids partially unscrewed in a sterile area overnight. The next day, two small pieces of mycelium containing agar (from a kite string-like sector), approximately 0.5 cm by 0.5 cm in size, were added to each jar aseptically and the jars were shaken. These jars were then incubated at 30°C in the dark for 2 weeks with shaking every 3-4 days to evenly distribute the mycelium. It is crucial that the lids of the jars be very loose at this stage so that air can get in to the growing mycelium.

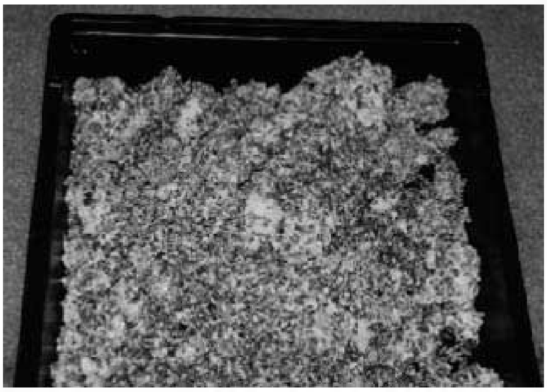


After 2 weeks of incubation and occasional shaking, the jars of rye were found to be fully colonized with white mycelium.

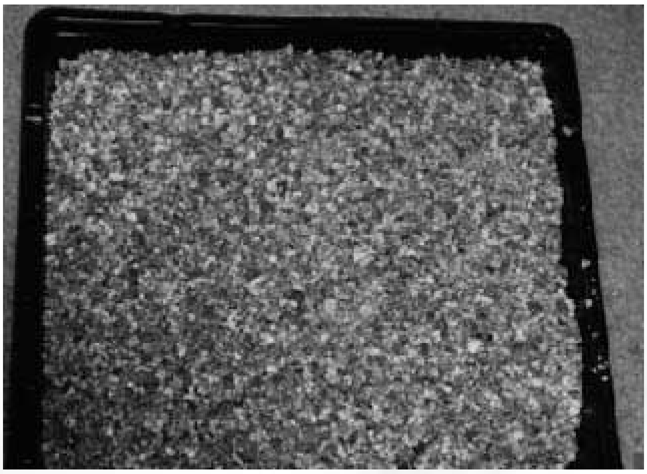


At this time, they have a very distinctive mushroomy smell. I have **never** had a jar contaminated and this is likely due to use of aseptic technique (sterile conditions). Five or six jars are dumped into plastic containers (about 2 ft by 1 ft by 5 inches) that also have clear plastic lids.

Small air holes should be punched into the lids to allow air into the container. No aseptic technique is required at this time as the rye should be fully colonized. The mycelium containing rye should be leveled off at the top to give a fairly flat surface.

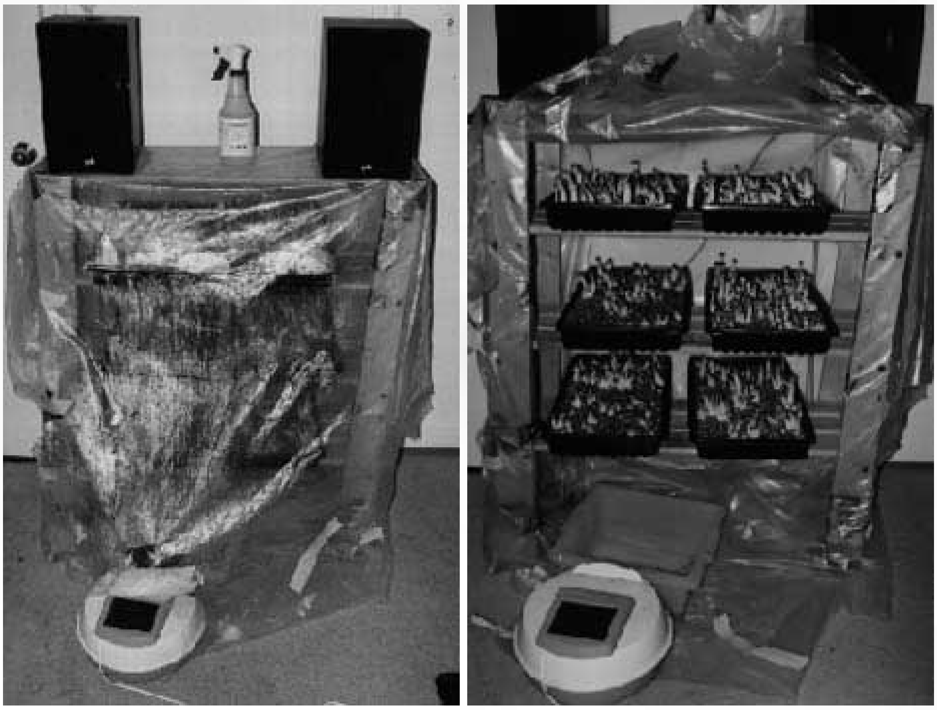


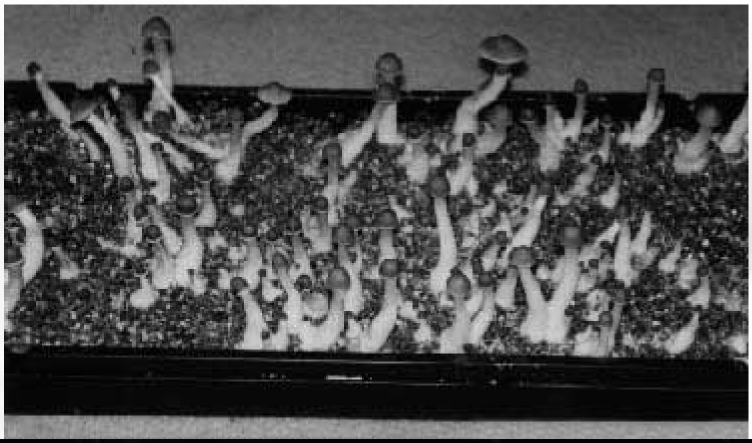
Now the rye should be cased with vermiculite. I have tried peat moss and a combination of vermiculite with peat moss but have found that vermiculite by far works the best. The vermiculite should be fully soaked in water and then the excess water wrung out. This is applied to the rye to a level of about 1-2 inches and then is leveled out.



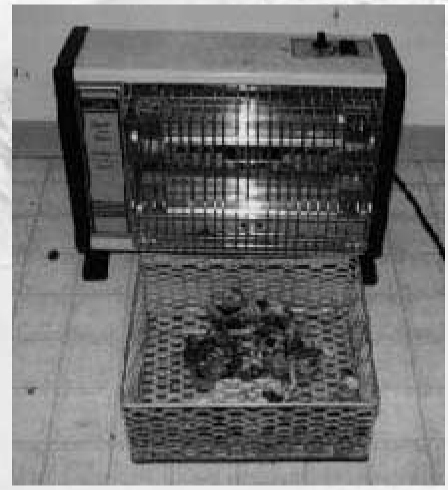
These trays of cased substrate should now be incubated in a humid environment, in the dark at 24-30°C for about 3-5 days. The trays can be kept moist by gentle misting with water at this time. Too much water is not good so don't overspray. During this time, I keep my trays in a plastic tent with no extra humidification. The tent is basically a small wooden shelving unit from IKEA which has been covered with clear plastic. A lot of water collects on the lids of the tray and this indicates that a very nice humid environment exists inside. Remember, at this stage nohumidification is required. Don't over water. After 3-5 days, white mycelium should be poking up through the vermiculite casing.

Once quite a bit of mycelium has poked up, but not too much, the temperature should be lowered to 20-24°C and the trays should be exposed to regular bursts of sunlight (i.e. open the curtains). At this time, mistings should be ended and the inside of the tent should be kept very humid using a humidifier. Be careful because over humidification can be a problem. This should continue for about 2 weeks. Small shrooms begin to appear in about 1 week and continue to grow over the remaining week.





Keep humidifying as the shrooms grow but not too much. Once the veils of the shrooms have broken, they should be carefully picked and dried immediately. For drying, I basically just use a heater that has a fan attached and I blow warm (not hot), dry air over the shrooms for about 2 days. At this time, the little guys are nice and dry and ready to be bagged and stored.



I usually get about 2-3 flushes and afterwards, I put the leftover substrate out in the garden. I found that in the late summer, many more mushrooms will grow in the garden from the spent substrate and these are very large with a more dark golden color. These garden grown shrooms are also **very** potent!

That's about it. Happy growing.

Indoor mushroom growing technique for the boil a bag

by

D.H Jarrold

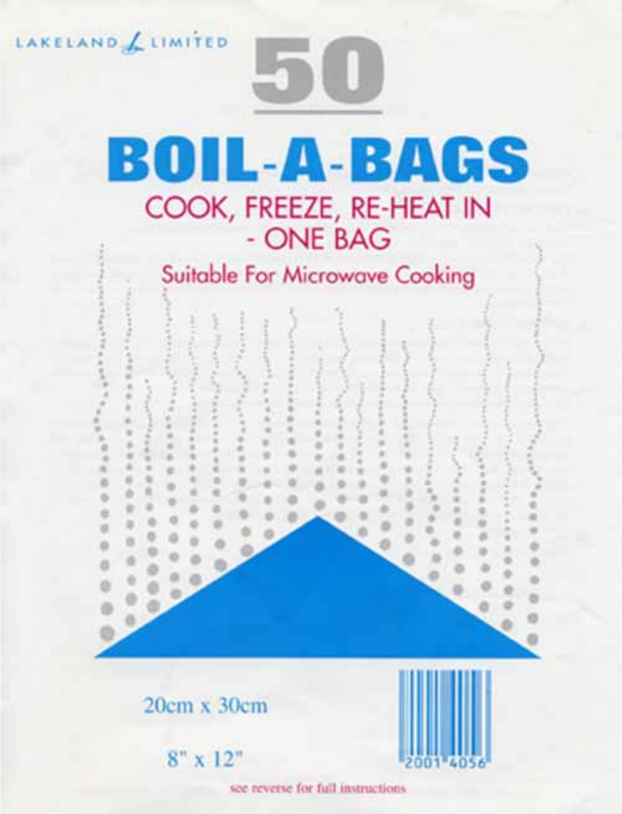
original source: http://files.meetup.com/1497456/Indoor Mushroom Growing Technique for the Boil-A-Bag by D H Jarr.pdf
backup source: http://www.psilosophy.info/resources/Indoor Mushroom Growing Technique for the Boil-A-Bag by D H Jarr.pdf

Table of Contents:

- Introduction
- Instruments you will need
- Making The filter can
- Preparing the Straw
- Filling the bags
- Sterilizing the bags
- Preparing bags for inoculation
- Preparing the spore syringe
- Inoculating the bags
  - *Short Needle Method*
  - *Long Needle Method*
- Keeping an eye on things
- Taking a spore print

Introduction

Firstly: Getting some "Boil a Bags" is all important in using this technique to grow your mushrooms. Boil a bags are plastic bags that can go in the pressure cooker or microwave without melting. the brand i use are made by a company called Lakeland Plastics, in packs of 50 at a size of 8 x 12 or that's 20cm by 30cm: cost is about £2.50p per pack of 50.


LAKELAND LIMITED
50
BOIL-A-BAGS
COOK, FREEZE, RE-HEAT IN - ONE BAG
Suitable For Microwave Cooking
20cm x 30cm
8" x 12"
see reverse for full instructions

Lakeland Plastics
Alexandra Buildings
Windermere
Cumbria
LA23 1BQ
UK TEL: 015394 88100
Barcode number : 2001 4056

Instruments you will need

Here are some essential instruments you will need to grow your mushrooms.

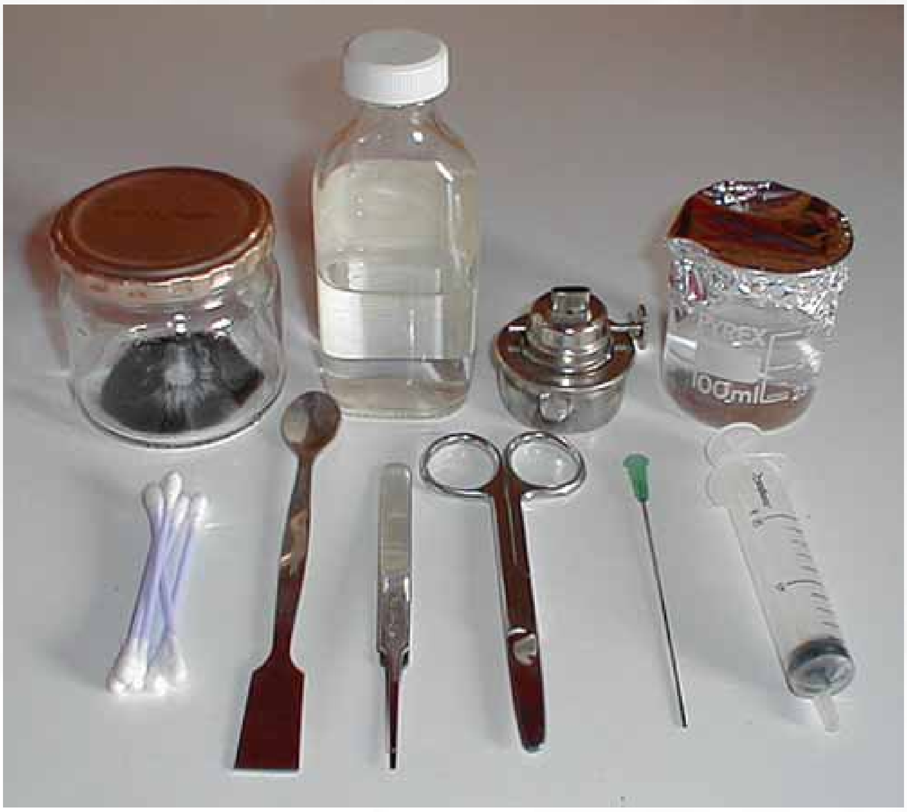
Top row left to right:

1. a spore print in a jar
2. propyl alcohol
3. spirit burner
4. glass pyrex container

Bottom row left to right:

1. some cotton wool buds
2. a flat edged metal scraper
3. metal tweezers
4. metal scissors
5. syringe needle
6. syringe

A long syringe needle can be easily made by removing the original needle from its green plastic holder with the use of a pair of grips & replacing with a thin piece of stainless steel tubing, obtainable from model and craft shops, or metal engineering companies. You may find it easier if you heat the tip of the steel tube before you insert it into the holder.



Making The filter can

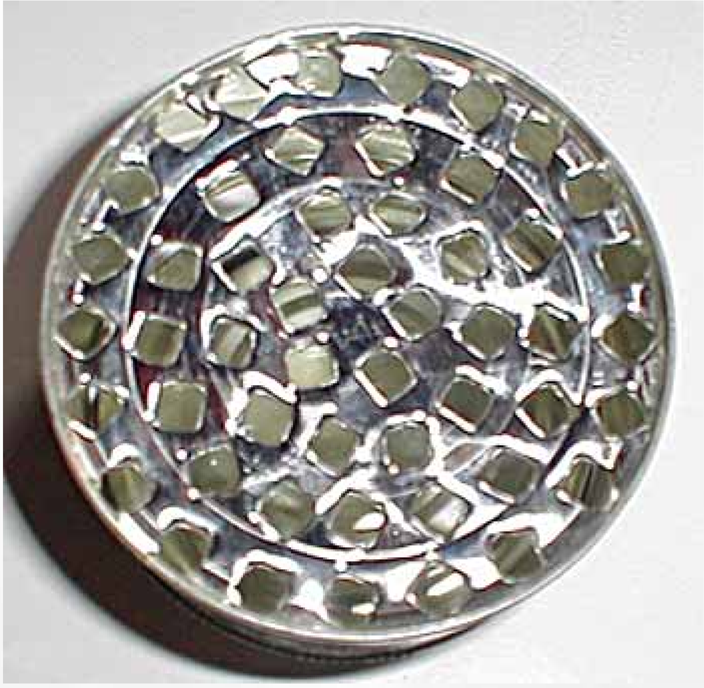


Fig 3. Get an empty cleaned 3 to 4 inch round food can "*when you first open the can, don't open all the way, leave the lid connected by an inch or so this will serve as an attached lid*". Now with a hammer and nail, make holes all over the bottom of the can, so that is has lots of breath holes.

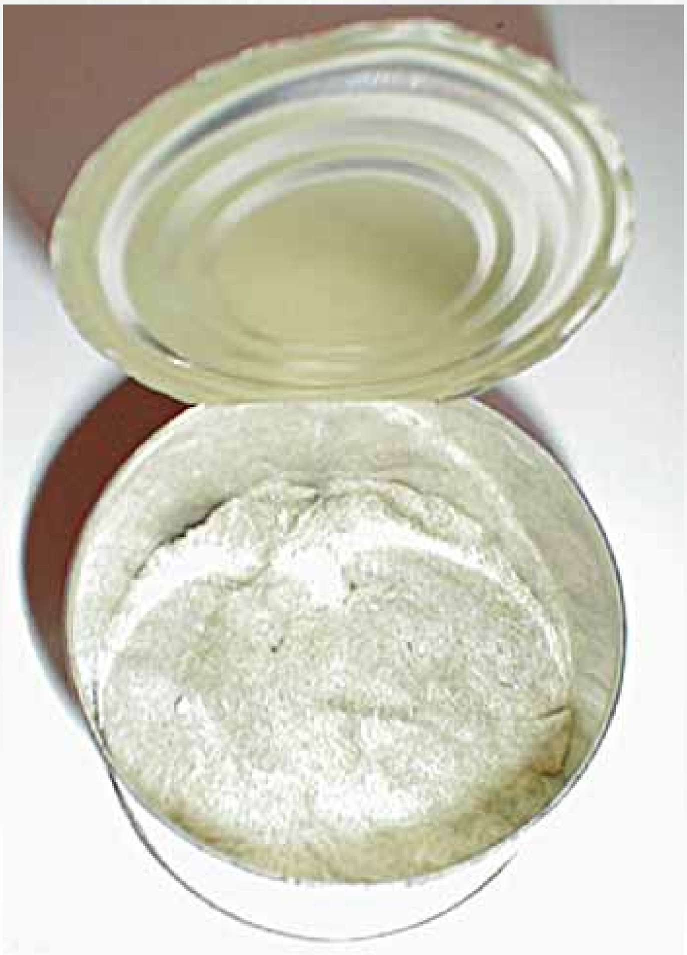


Fig 4. Line the bottom inside of the can with about 1cm of rock wool, or ordinary loft insulation fiber glass,

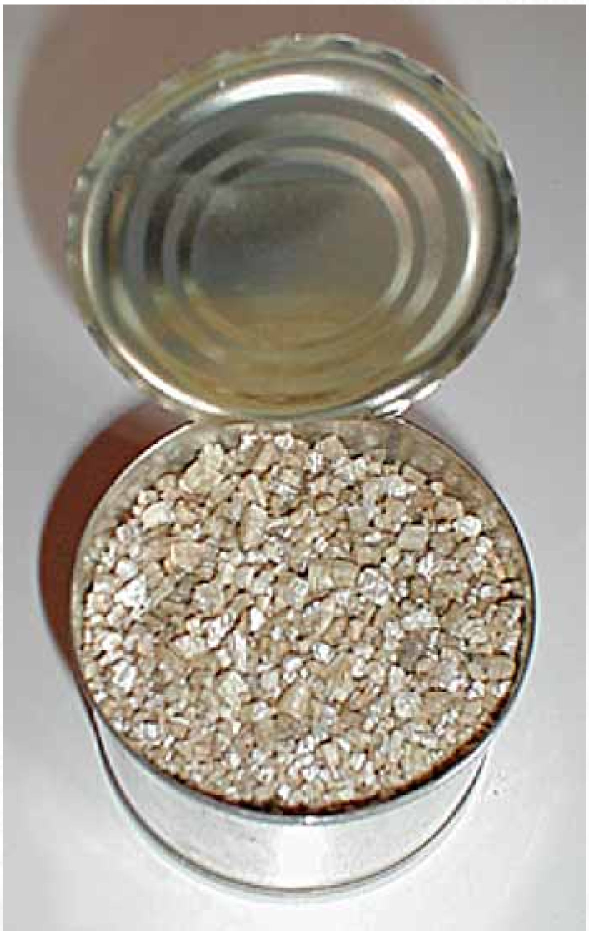


Fig 5. Fill the can with Vermiculite until you are 1cm from the top. Alternatively, instead of using vermiculite, Simply fill the can with small pieces of rockwool.

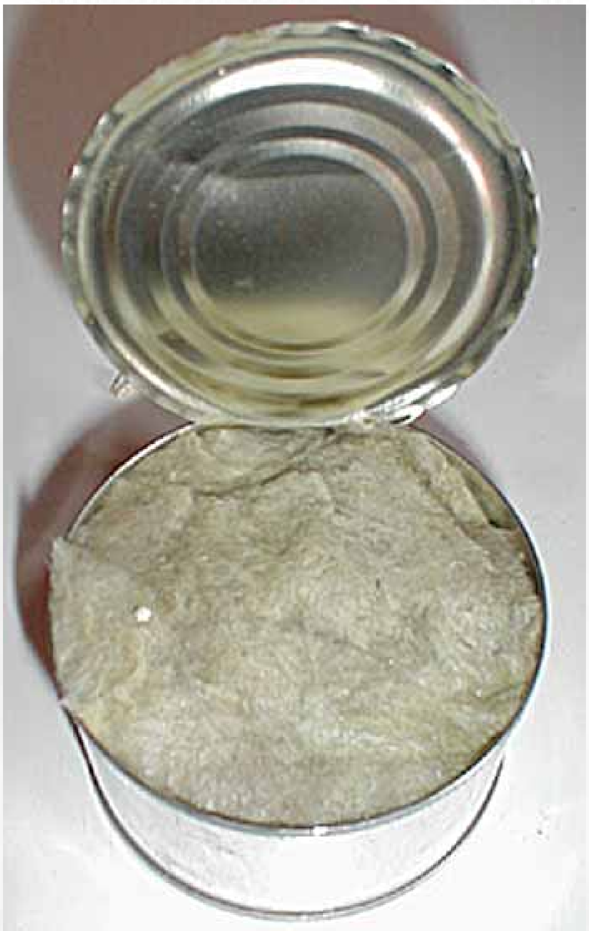


Fig 6. Top with a little more rock wool to hold in place. The filter is now completed & with the lid closed down is ready to be used.

Preparing the Straw

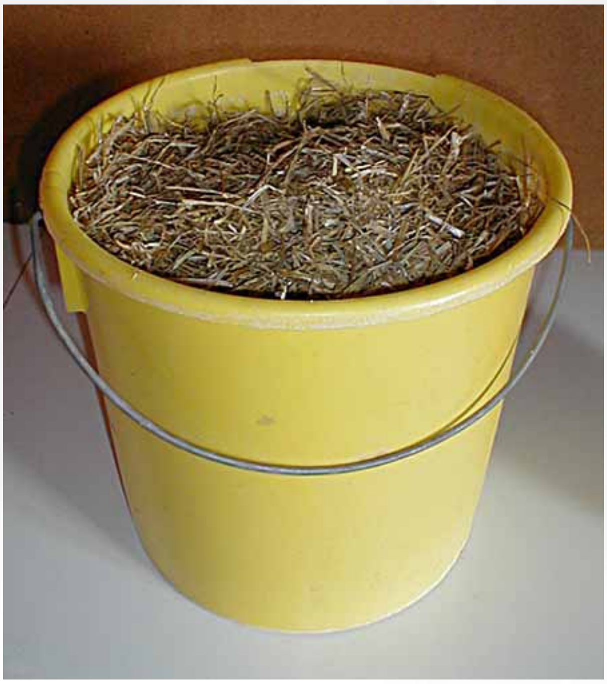


Fig 7. Chop some straw to be at 3 to 10cm lengths " you can buy straw pre cut to this length from many pet stores". Place as much of the straw as you need into a large water tight container.

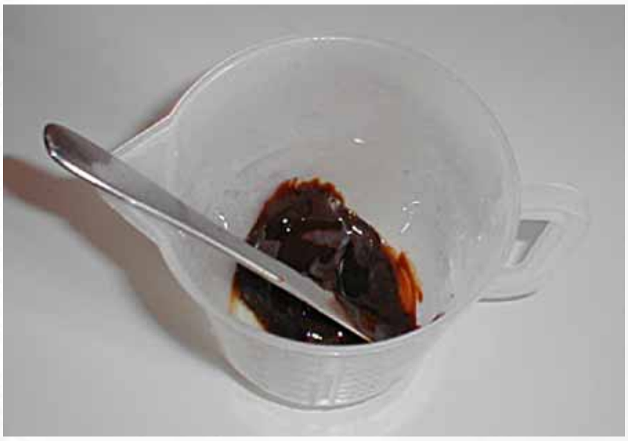


Fig 8. A heaped table spoon of marmite is added to a pouring jug. *Marmite, vegimite, or yeast extract is used to help quicken the germination time of the spores.*

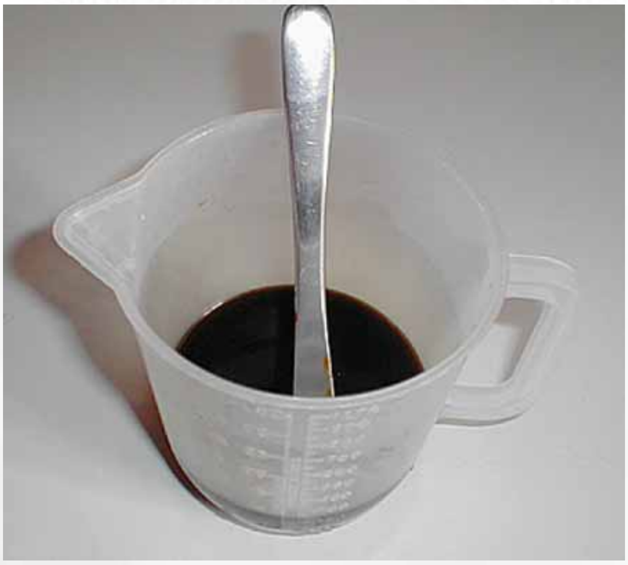


Fig 9. The marmite is dissolved in some boiling water. This is then poured into a bucket & an additional 6'ltrs of of boiling water is added.

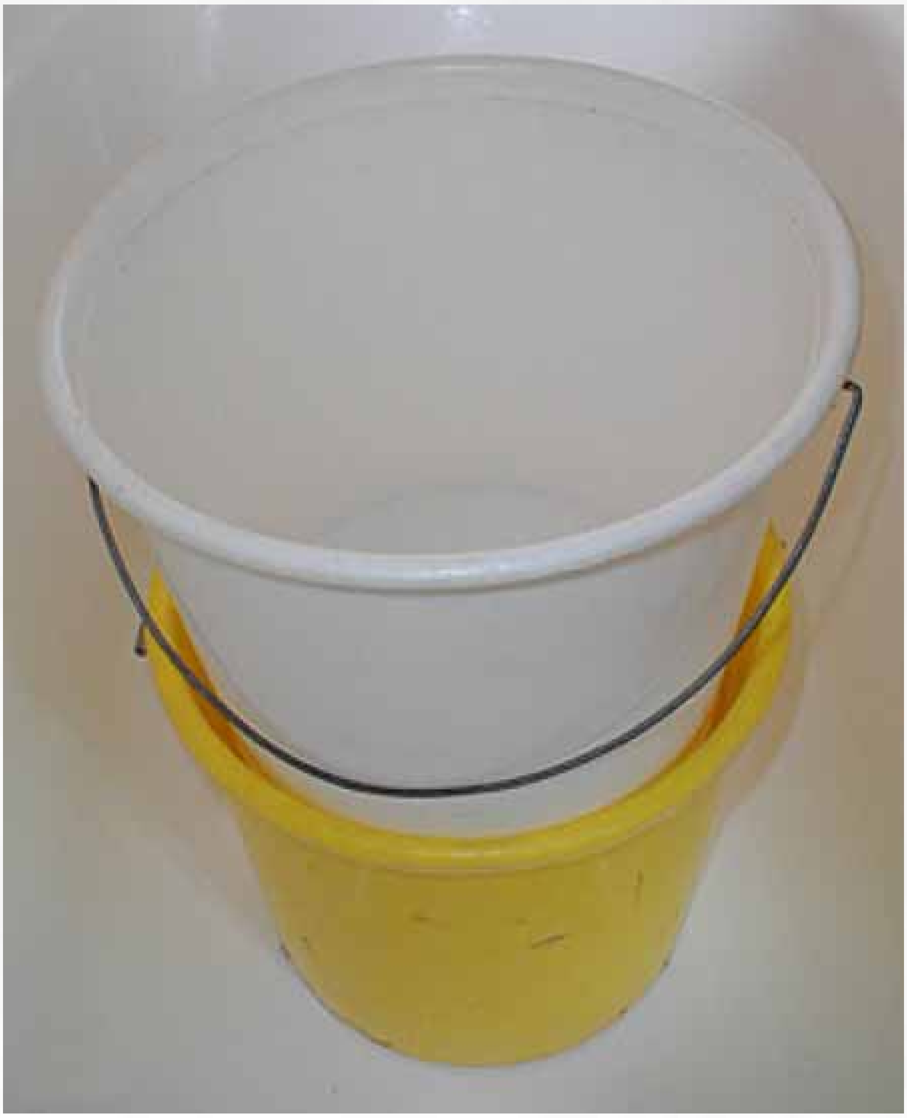


Fig 10. The marmite mixed boiling water is poured over the straw in the yellow bucket, the straw will now be weighed down by filling the white bucket with water. After an hour check to see how far the straw has been pushed down into the bucket & that the water level is still covering the straw. If needed add more boiling water & leave to soak for 1 more hour.

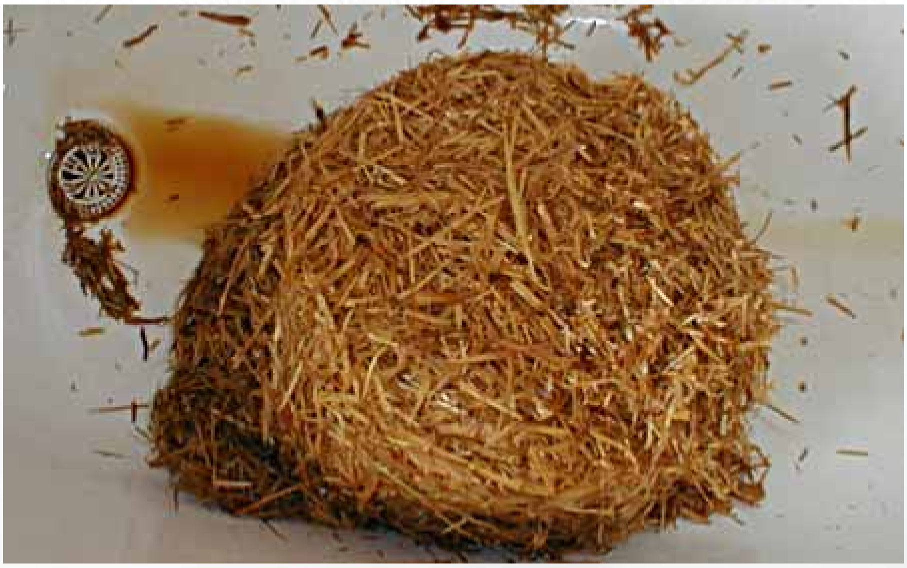


Fig 11. After the straw has been soaked, it is turned out in the bath tub & left for 1 hour to thoroughly drain.

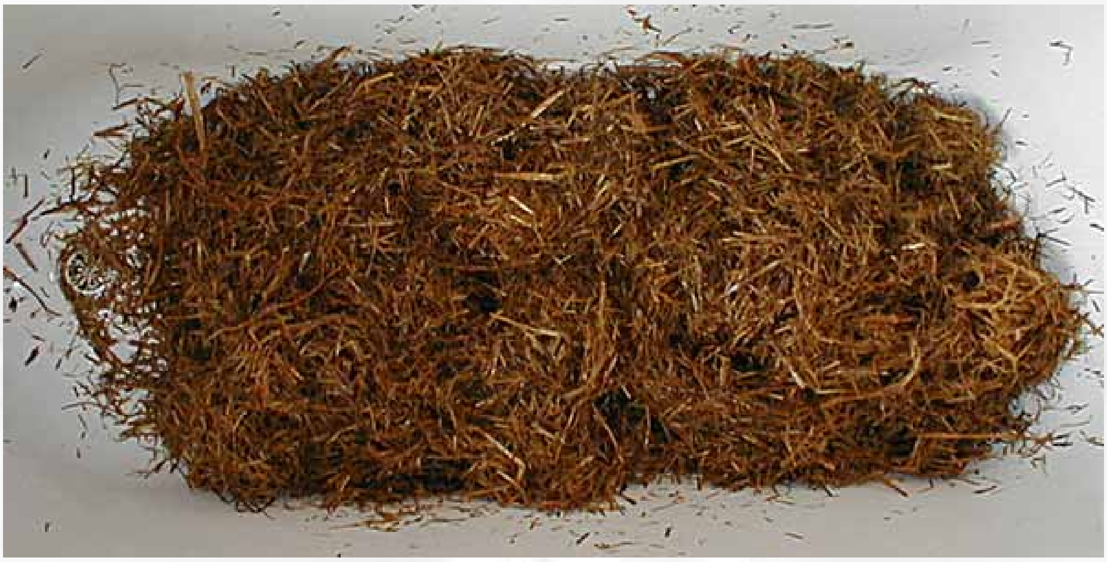


Fig 12. Evenly spread out the straw in the bath tub, if you find the straw is still to wet, then use your hands to squeeze out the surplus water.

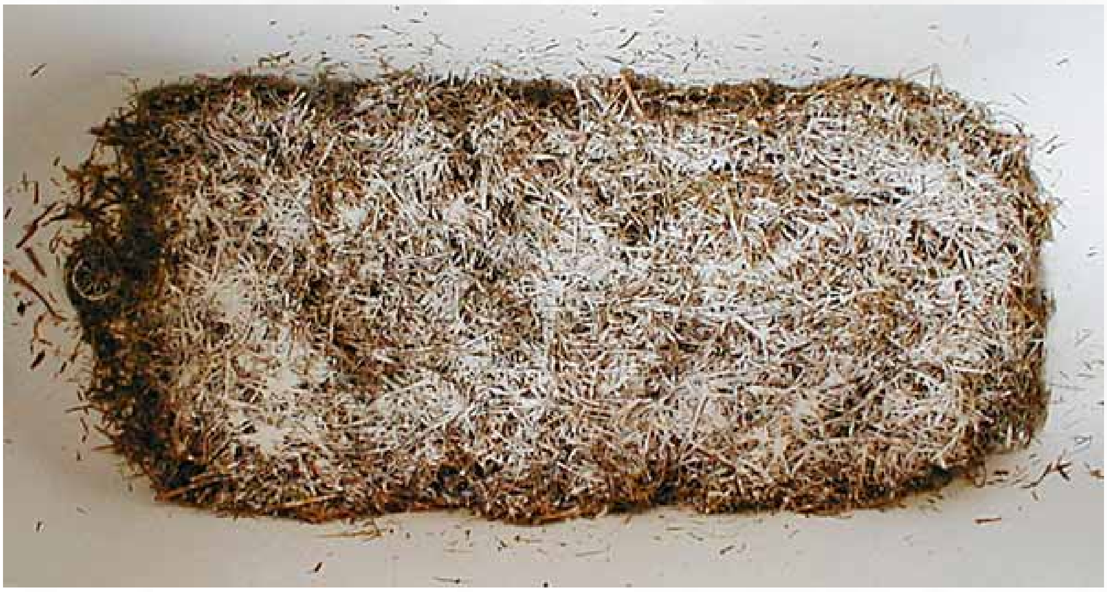


Fig 13. Some brown rice flour for extra food is sprinkled over the straw "*for 6 bags worth, Sprinkle around 3 to 4 handfuls*" then thoroughly mix in using your hands.

Filling the bags

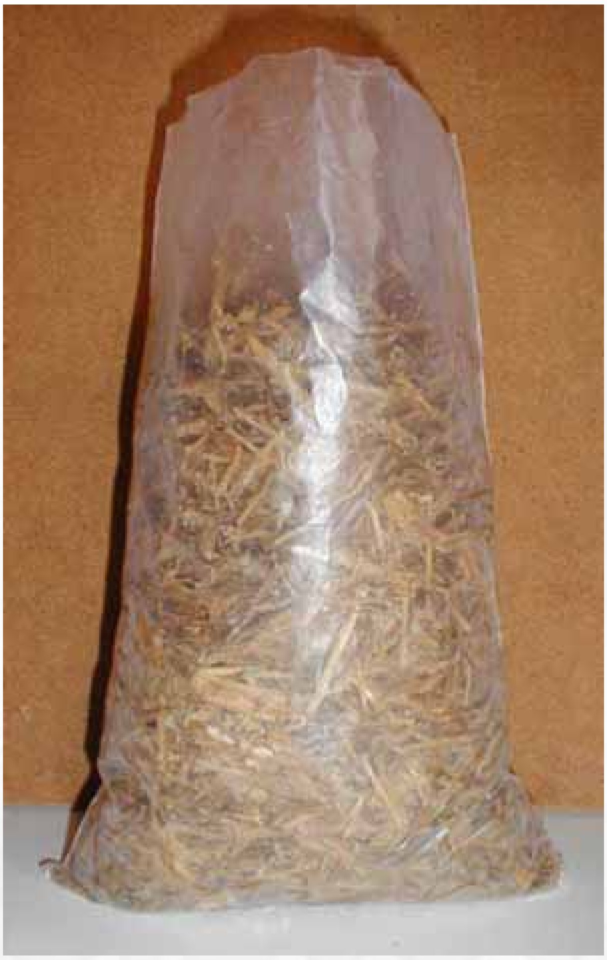


Fig 14. Firmly pack some straw mixture into the bags until they are almost full, leaving enough room to fit the filter can into the top of the bag.

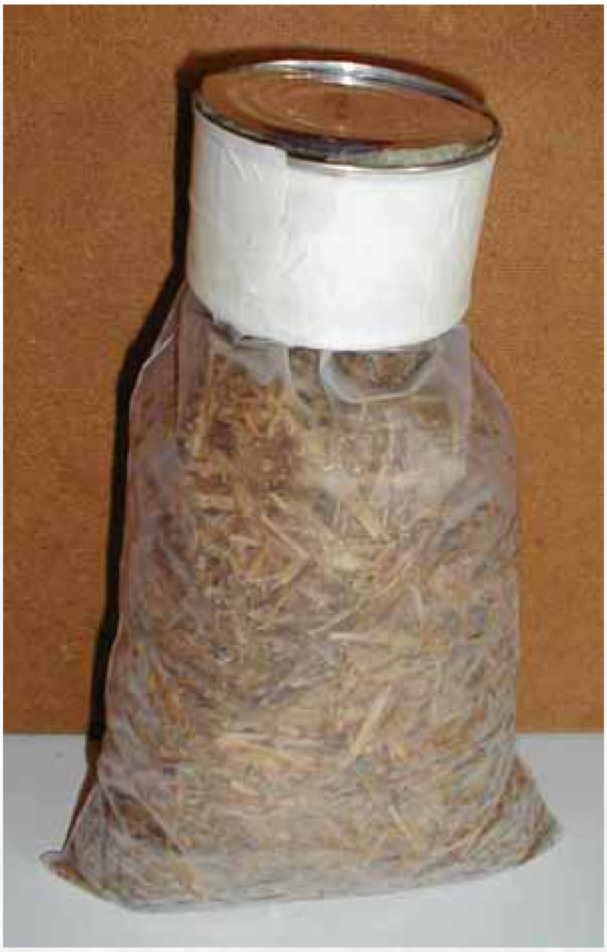


Fig 15. The filter can is fitted into the top of the bag & secured by going around the neck of the bag 3 times with wide masking tape, then firmly push the tape onto the can & bag.

Sterilizing the bags

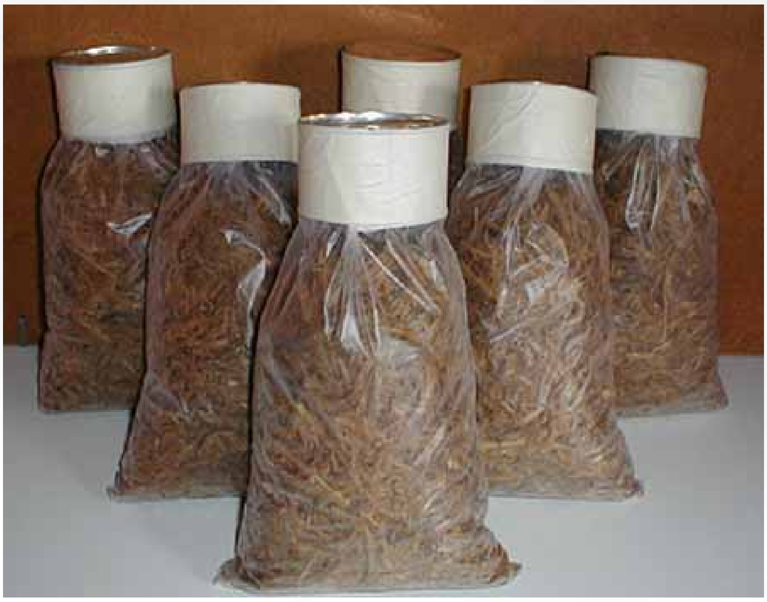


Fig 16. All 6 bags are now ready to be sterilized.

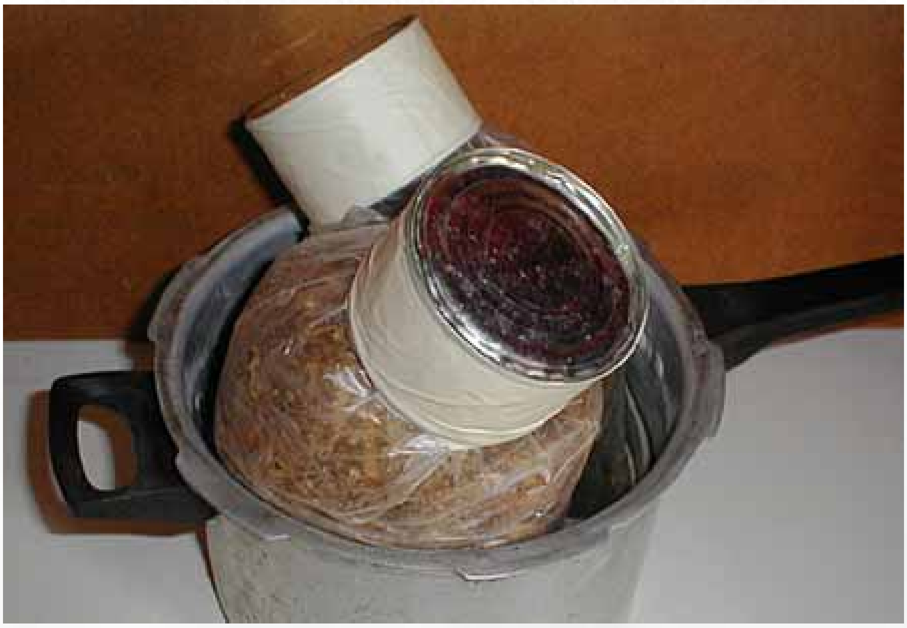


Fig 17. Two bags are placed into the pressure cooker "*Maybe only one, depending on the size of your cooker*" water is added & with the lid on, the bags are brought up to maximum pressure "15psi" for 60 minutes, You May find it favorable to do this in two' 30 minute stages.

Preparing bags for inoculation

If you are planning on using a standard 4cm long needle, then please follow this method for short needle inoculation.

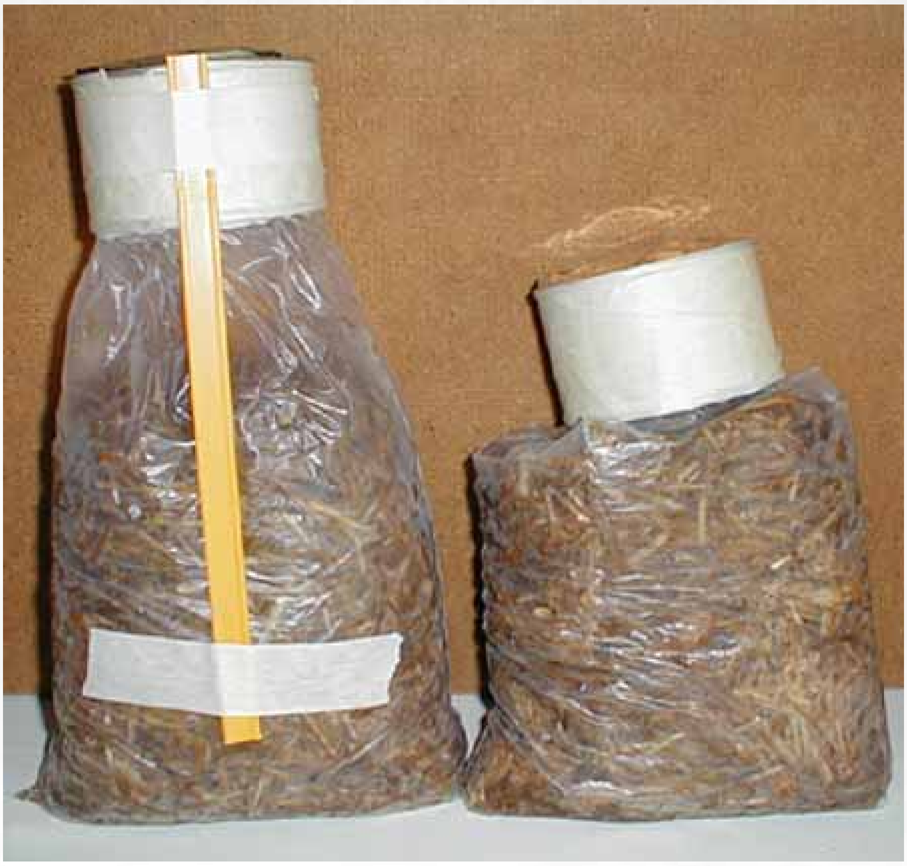


Fig 18. These 2 bags have just been sterilized & have thoroughly cooled down. Tape 2 supports, "*1 each side of the bag*" from can to bag base' as illustrated on the bag to the left.

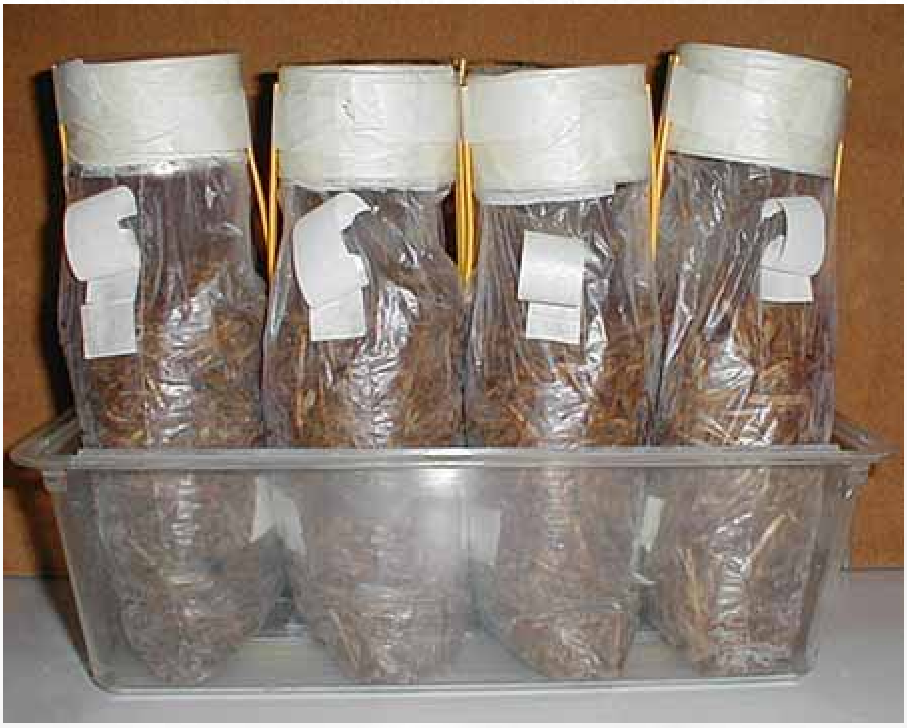


Fig 19. Here we see 4 bags that have had their supports added, it can be helpful to stand them in some kind of container, this will make things easier for you to prepare & inoculate them, it also makes sense at this point to add tape to the inoculation points, 1 on each side of the bag "2 inoculation Points per bag" "*this piece of tape stops the hole from enlarging upon inoculation*" an additional piece of tape is placed & looped back, so that when you have inoculated the bag, you can quickly roll the tape down over the hole as you remove the needle from the bag.

Preparing the spore syringe

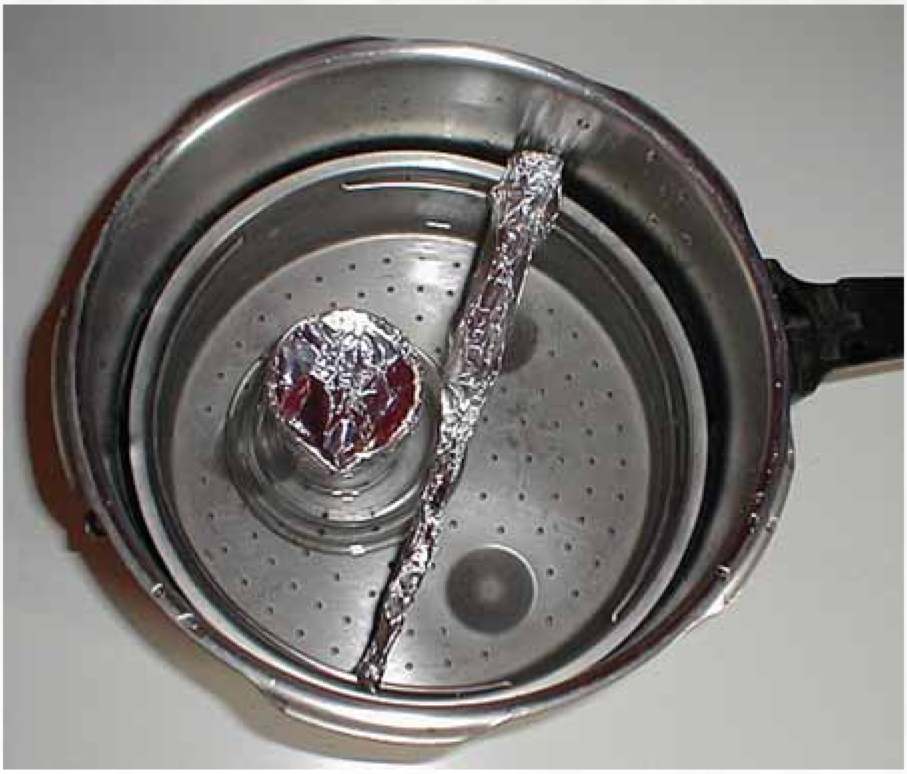


Fig 20. The syringe & its needle are connected & wrapped in tin foil, The pyrex jug in filled with 80ml of water & has a tin foil lid placed on top, The contents of the cooker is now brought up to full steam "15psi" for 20mins.

WARNING !

THE REST OF THE PROCESS WILL REQUIRE YOU TO WEAR A PROTECTIVE BREATHING MASK, OR A CLEAN HANKICHIEF COVERING YOUR NOSE & MOUTH.

THIS IS NOT FOR YOUR SAFETY, IT IS' SO THAT YOUR BREATH DOES NOT DIRECTLY INFECT THE SPORE SOLUTION.

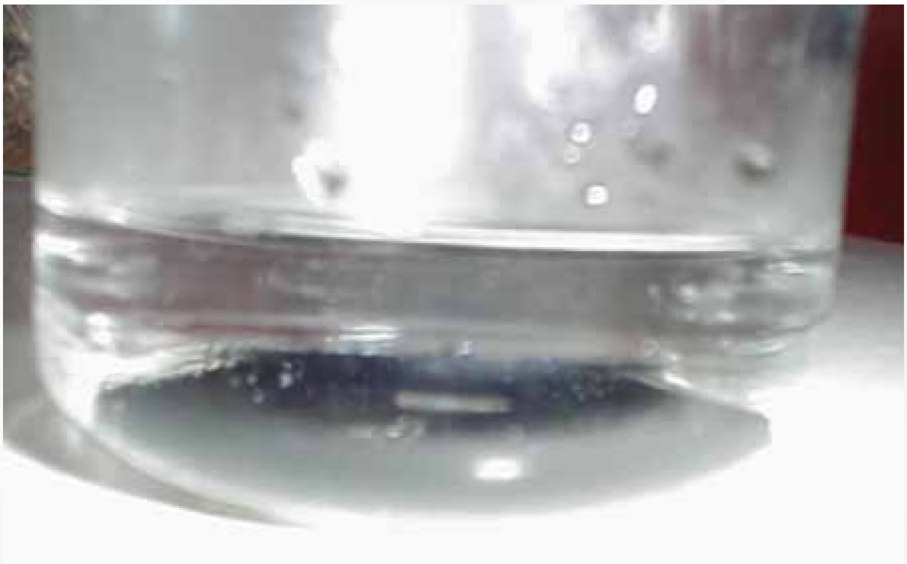


Fig 21. Now that the water has cooled, it can be added to the spore jar, But as you can see the spores do not readily mix with the water.

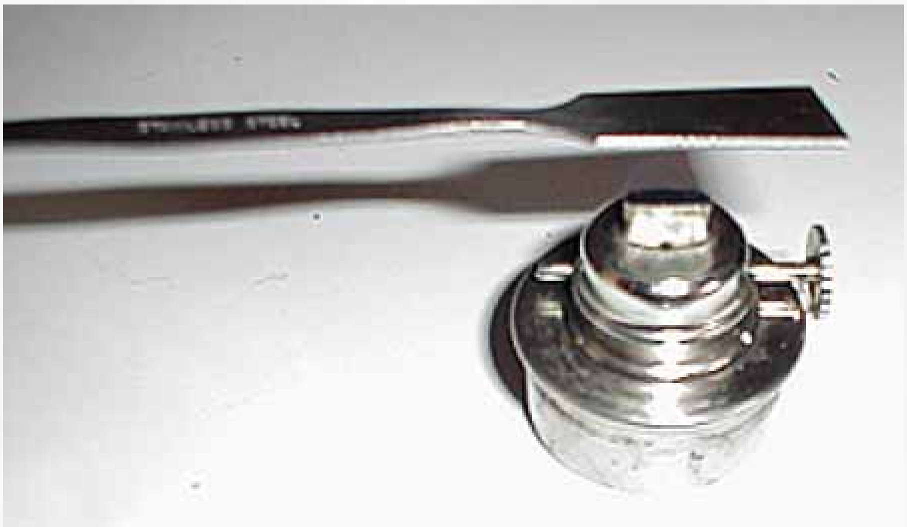


Fig 22. Add some methylated spirits to burner & flame sterilize the flat ended scraper.

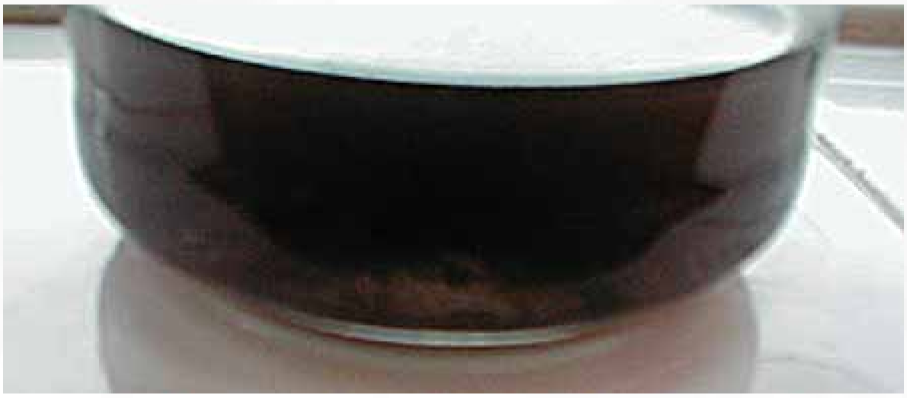


Fig 23. The scraper is then used to loosen the spores from the bottom of the jar, so that they disperse into the water & can then be easily loaded into the syringe.

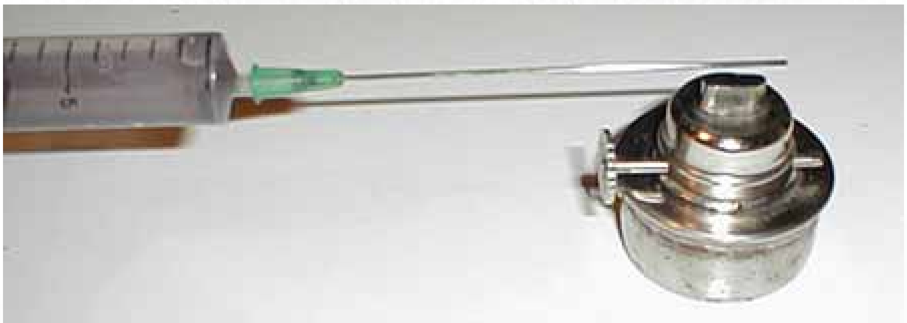


Fig 24. The syringe is passed through the flame to sterilize it, "*this is done every time before you refill from the spore jar or inoculate a bag ! And remember to replace the lid on the spore jar each time you refill the syringe !*"

Inoculating the bags

Short Needle Method

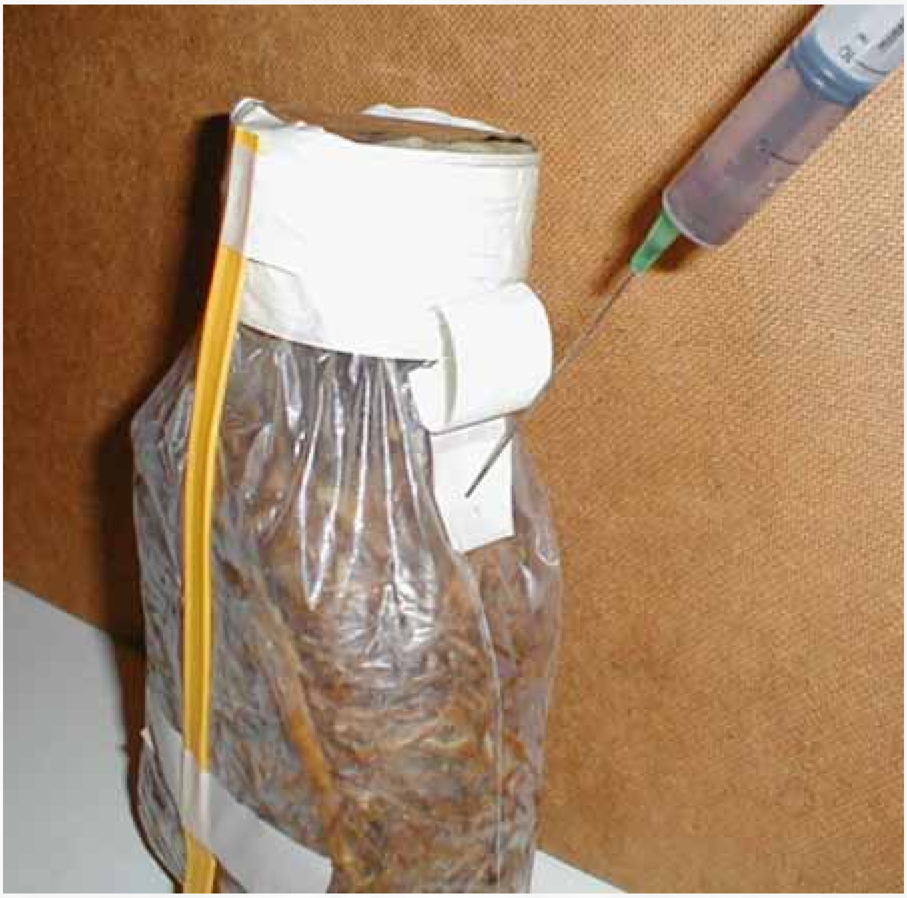


Fig 25. Here we see a bag about to be inoculated through the bag & bellow the filter level, this method is for short needles that cannot be passed all the way through the filter can for inoculation, there has also been a little preparation before this is done "see Fig 19". Using a cotton wool bud swab both inoculation points with propyl alcohol, now that the needle is fully flame sterilized.

"Again heat the needle tip only! Until it is Red, this will allow you to easily penetrate the bag".

Insert the needle all the way into the bag & release 5cc of the spores into each inoculation area, swiftly rolling down the tape as you remove the needle from the bag.

Long Needle Method

This Method is much easier, quicker & more trouble free than the short needle method.

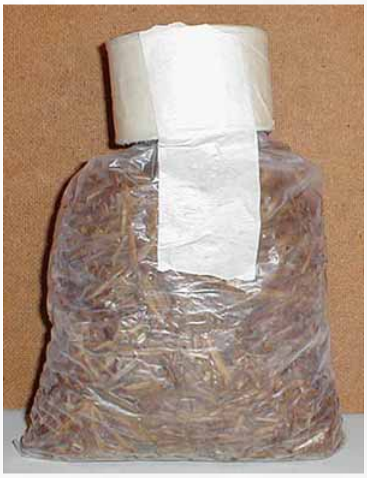


Fig 26. To secure it a sterilized & cooled bag has its filter can taped on both sides of the bag.

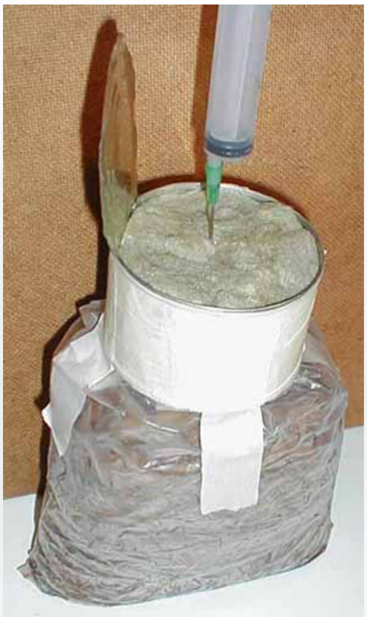


Fig 27. The lid of the filter can is lifted, the needle has been flame sterilized & is passed all the way through the can, & 10cc of spore solution is inoculated into the Straw, The needle is then removed & the lid of the can is closed down, if the lid keeps tending to lift up, then secure it with a small piece of tape. The bags can now be placed in a cardboard box & kept in a warm place for spore germination & mycelium growth.

Keeping an eye on things

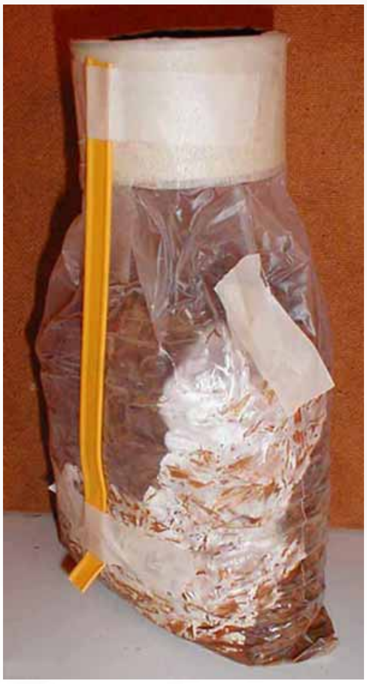


Fig 28. A few days after inoculation the mycelium growth is easily visible.

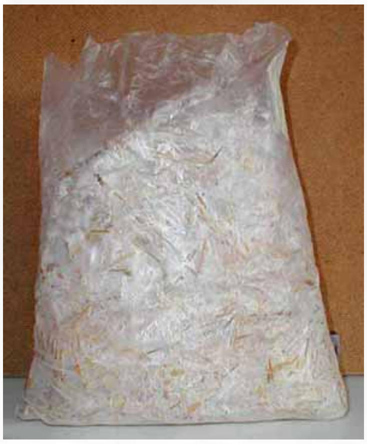


Fig 29. The Mycelium has totally colonized the bag, It is time to remove the filter & place them in the humidity chamber.

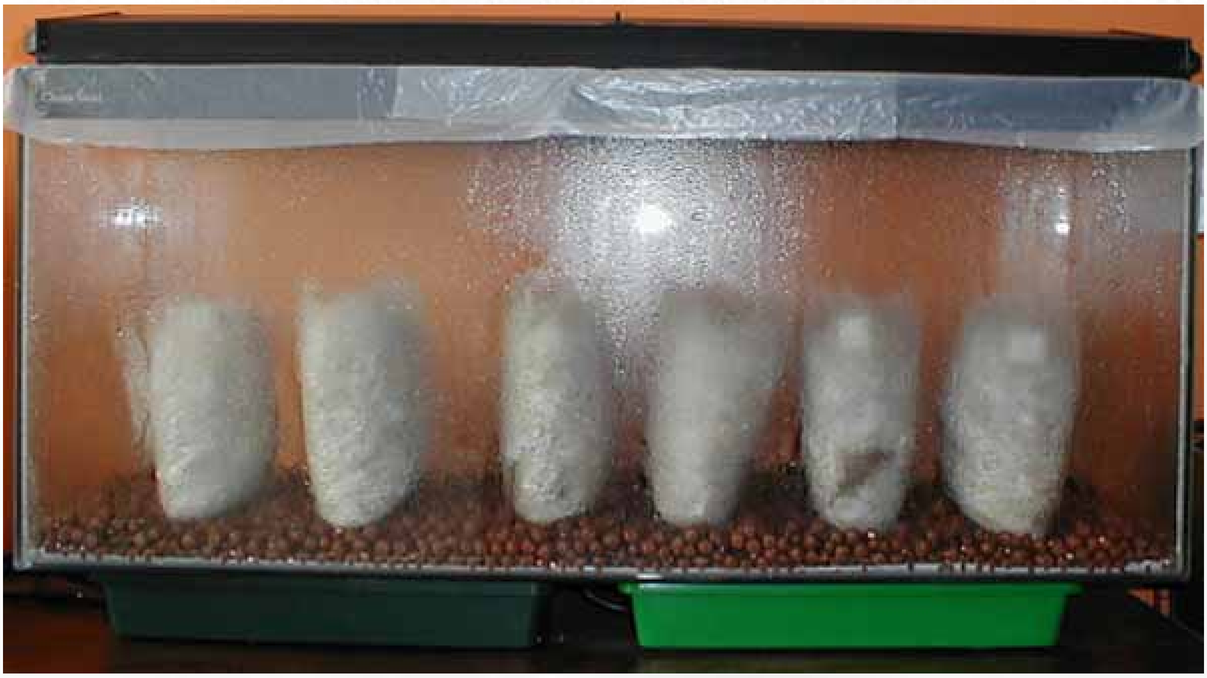


Fig 30. Place the bags into a humidity chamber, this is simply a 4ft by 2ft fish tank, also note that I have added a layer of soaked hydro pellets to the bottom of the tank, this will keep the interior nice & humid, there has also been a layer of plastic placed over the top of the tank to create a seal, so that none of the humidity escapes & no fly's can get in. All that needs to be done for the next few days is to fan some fresh air into the tank twice a day & keep an eye out for signs of forming mushrooms.

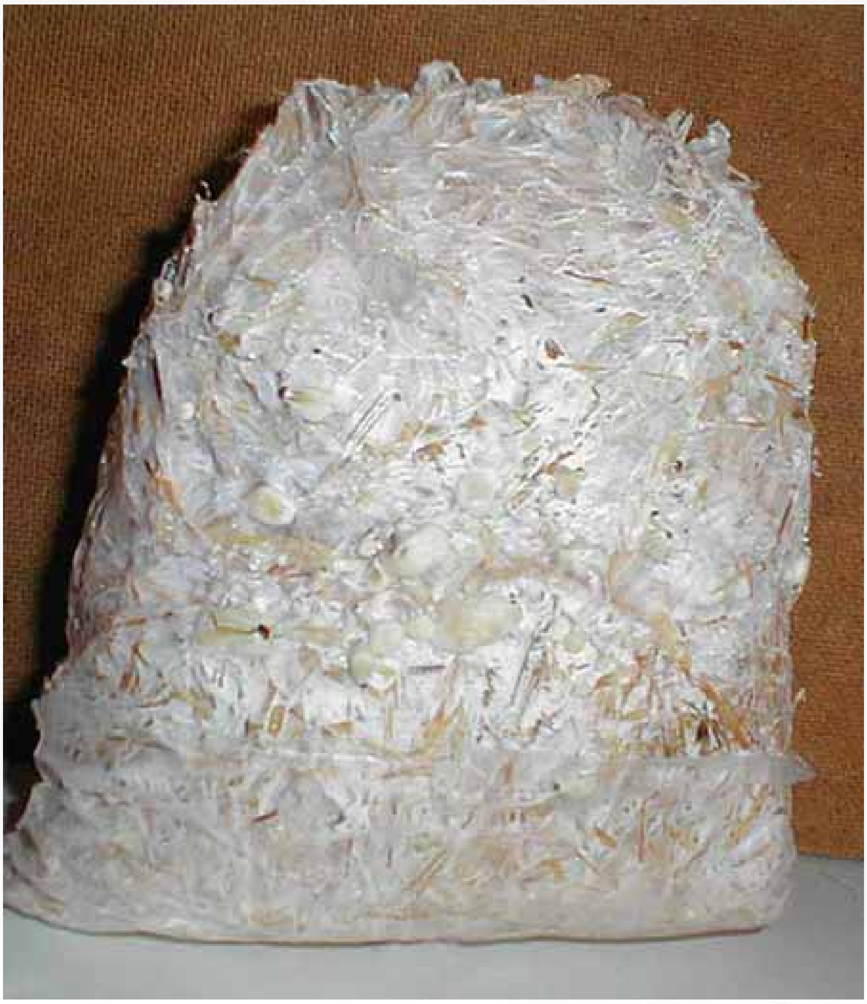


Fig 31. Here we see the first signs of mushrooms starting to form, it is time to cut the bag down the sides & remove as much of the bag as needed, I like to leave at least 2cm of the bottom of the bag intact, this allows me to stand the bags anywhere I like, without the worry of them getting to wet when they are standing in the humidity chamber.

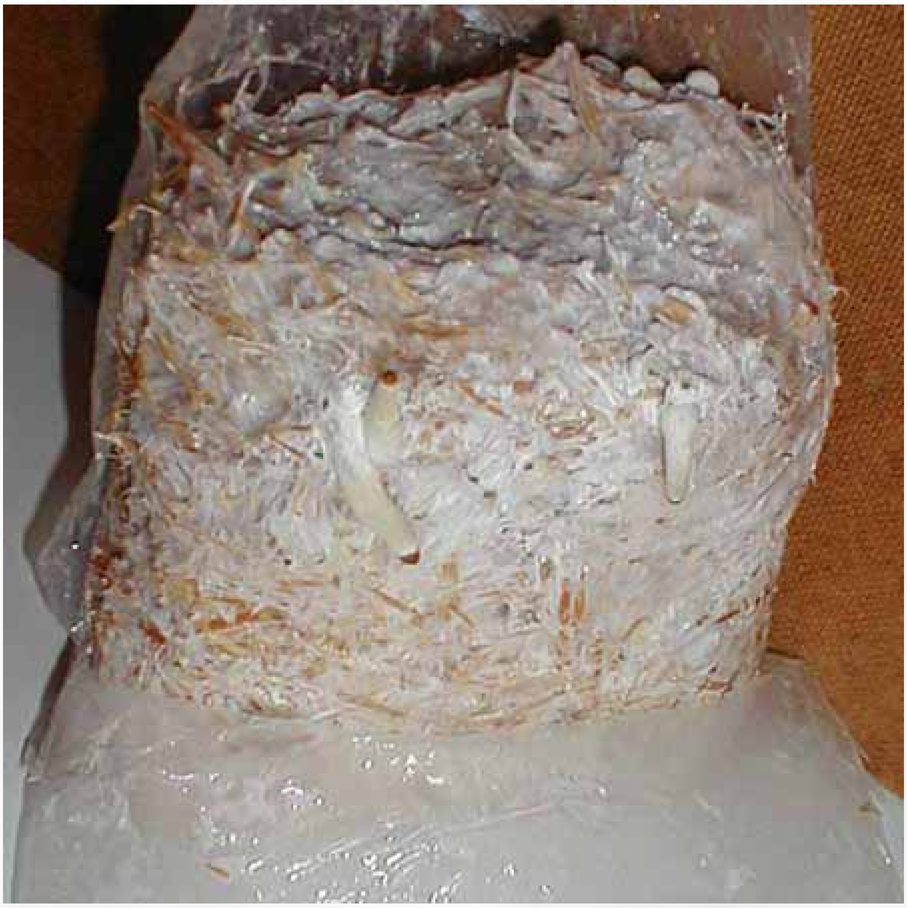


Fig 32. Here again we see the first signs of small mushrooms starting to form.

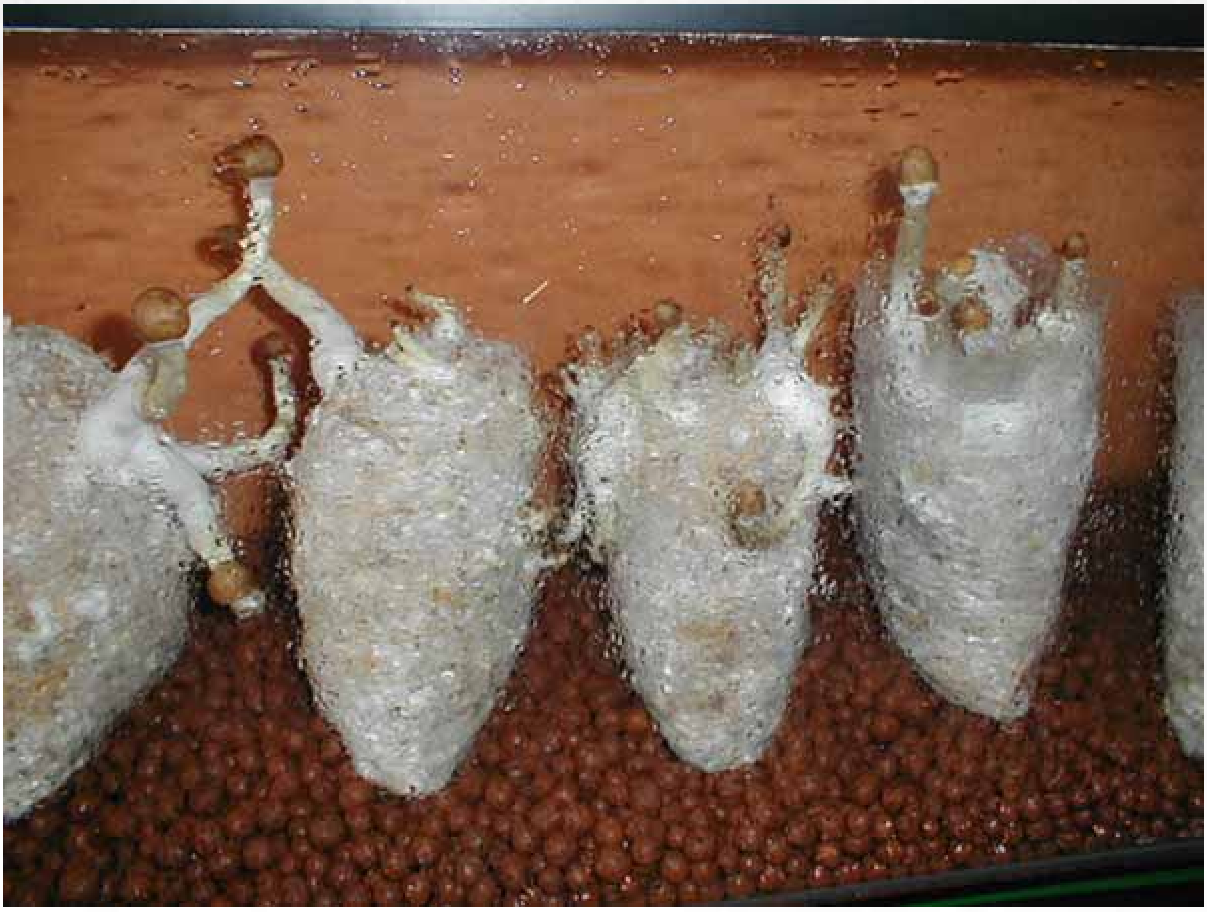


Fig 33. Mushroooms around halfway grown ! keep up the fresh air change of the tank twice a day !

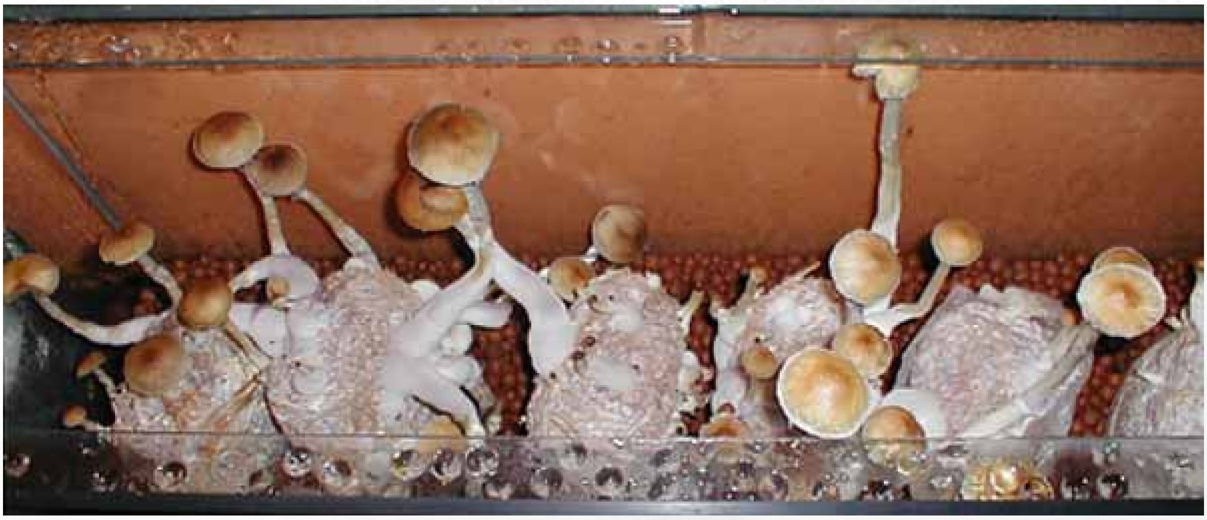


Fig 34. Mushrooms are now ready to pick ! or to take spore prints from.

Taking a spore print

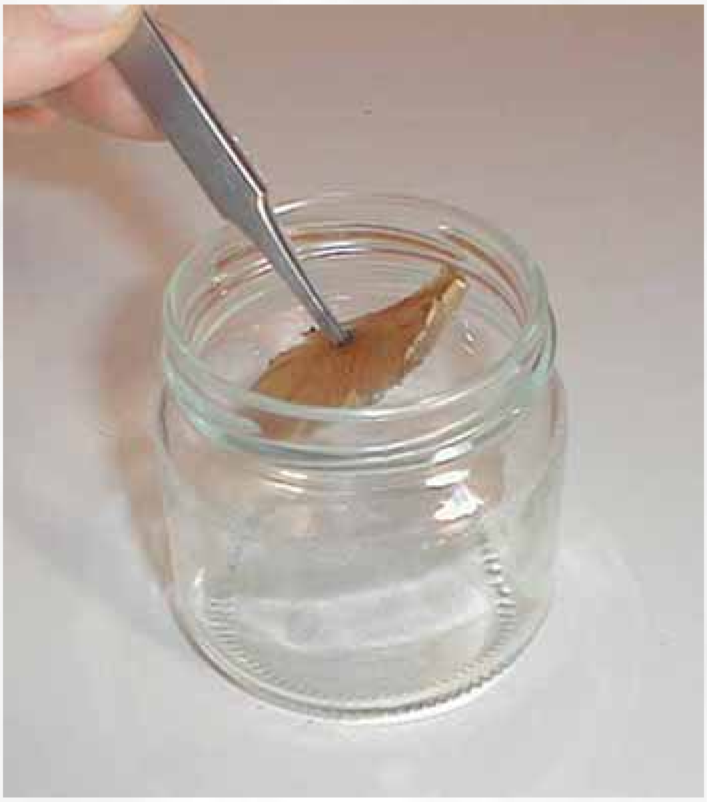


Fig 35. Now that you have grown some mushrooms, you will need to take some spore prints so that you can grow your next crops. First of all get some small clean glass jars with metal screw lids, take the lids off and lean them aside the jars & on a metal baking tray put them under the grill of your oven for 30mins at half the maximum heat so that they can be sterilized. When the jars have cooled, carefully go into the grill & place a lid loosely on each of the jars, now remove the tray from the grill & tighten the lids onto each of the jars.

Take your jars, tweezers, scissors & meths burner, to your mushroom growing tank !

FOR THIS PART OF SPORE PRINT TAKING WEAR YOUR BREATHING MASK.

Get one of the jars and unscrew its lid "but leave it on" Flame sterilize your tweezers & scissors. Gently push the tweezers into the top of an opened spore loaded cap & cut it from the stem with your scissors, now carefully place the cap gills down into the jar & immediately replace the lid ! but do not ! tighten it all the way, as any moisture in the jars or on the spores will need to naturally evaporate. see Fig 37.

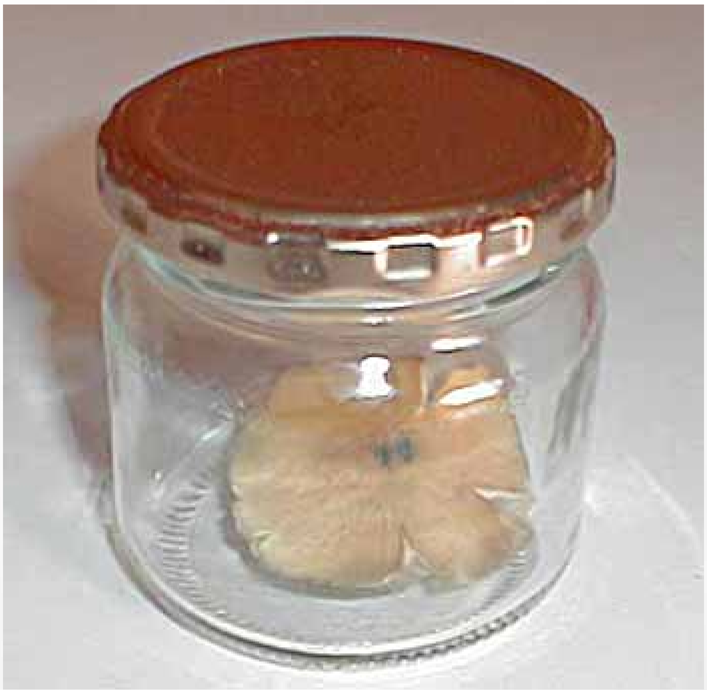


Fig 36. The cap has been carefully placed into the sterile jar & with the lid loose is left for at least 24 hours' for the spores to settle on the bottom of the jar.

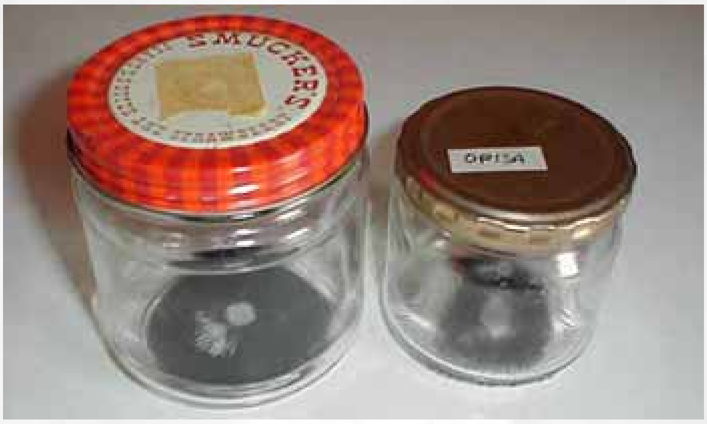
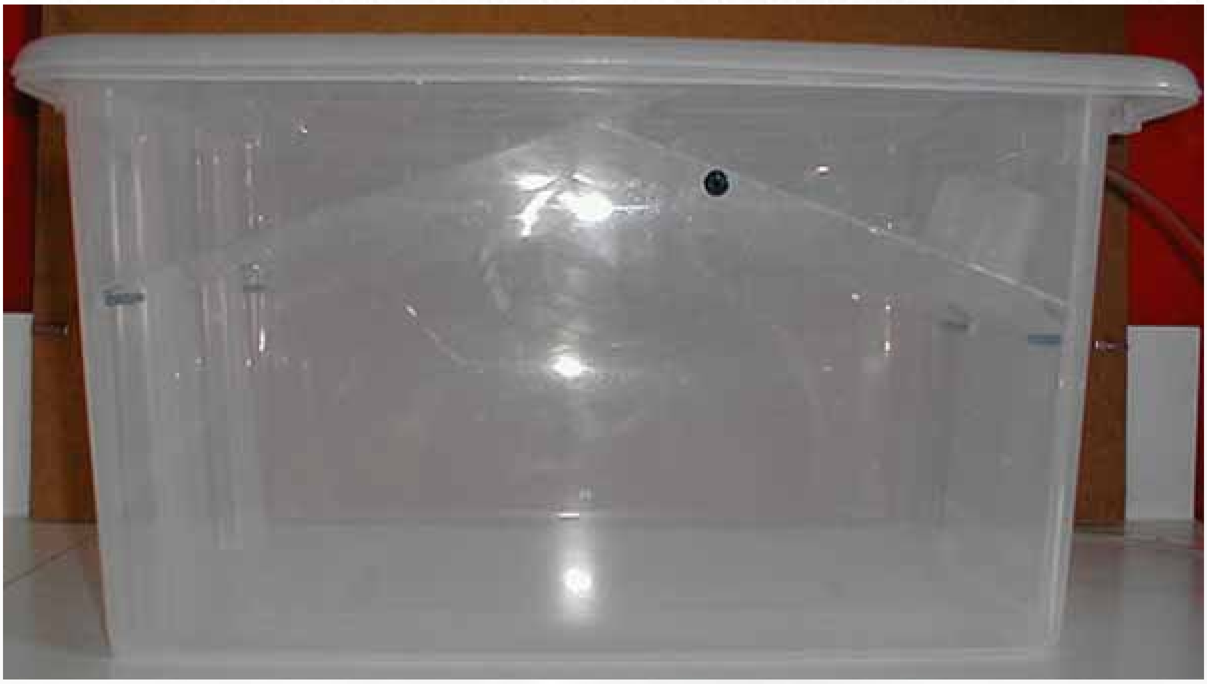


Fig 37. In this picture, using the tweezers the caps have been removed from the jars & for a further 24 hours have stood in a clean draught free area, so that the spores can loose their moisture, now this has been achieved the lids of the jars can be firmly tightened for later use.
The Circle Is Now Complete !



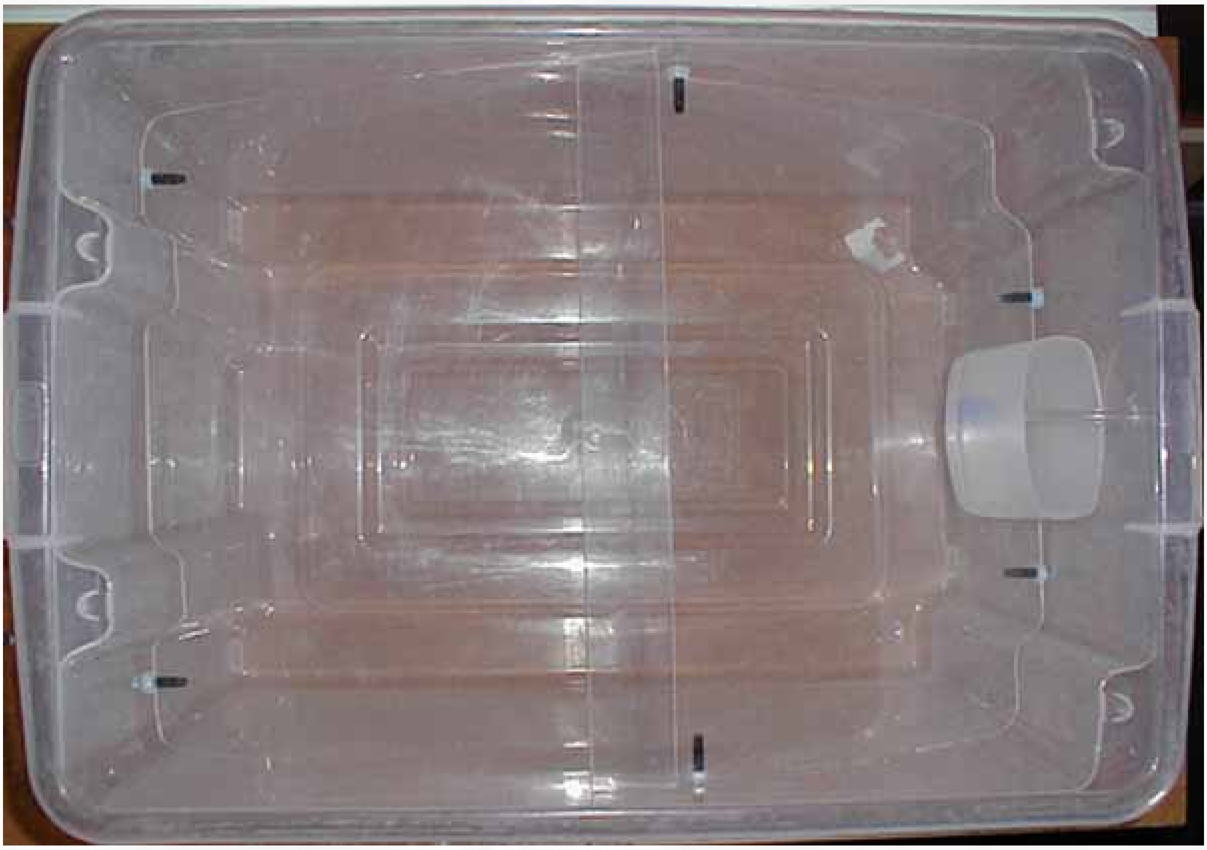
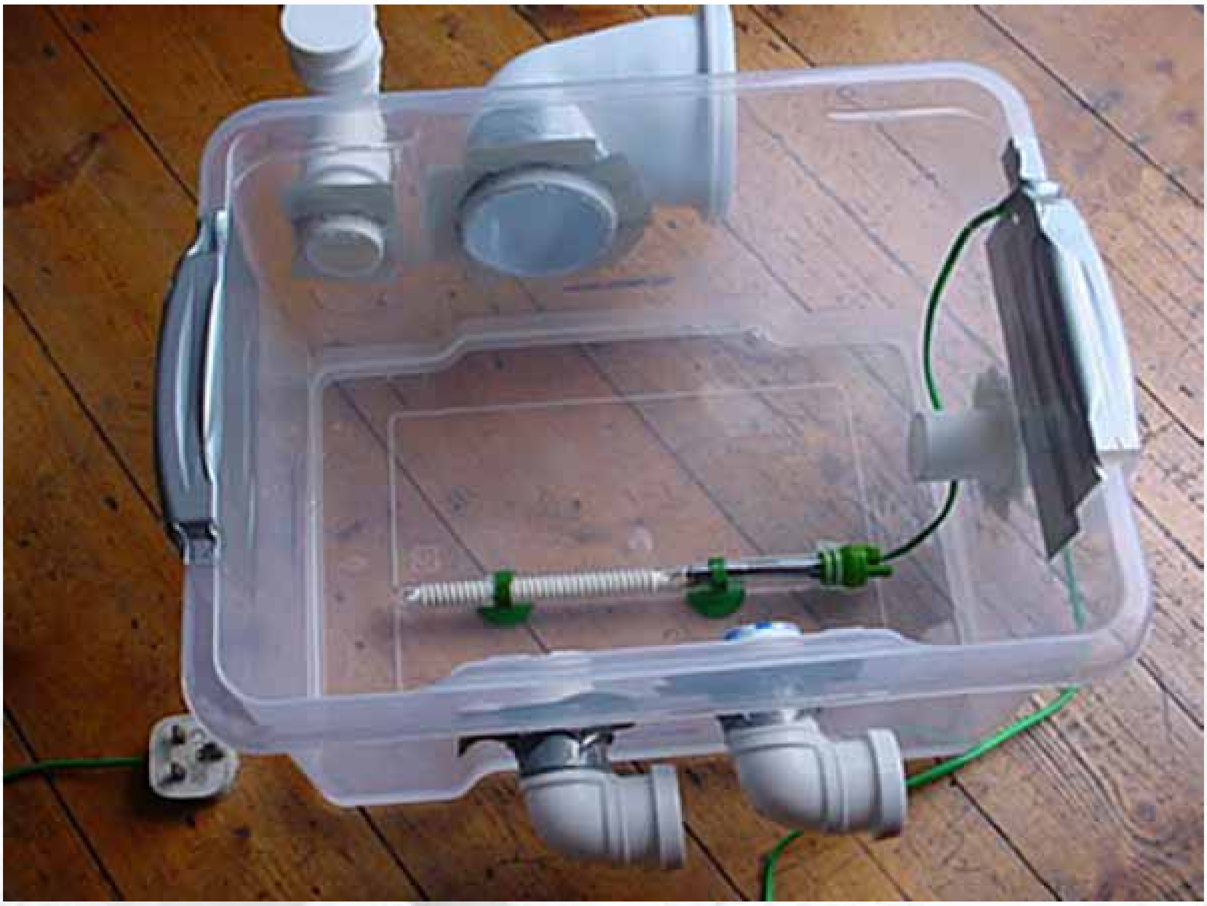


Fig 38 & 39. Here are some pictures to help you make an easy self humidifying chamber, most things to make the chamber can be obtained from local hardware shops & the plastic car registration plate nuts & bolts from car accessory shops. All that is needed to keep the tank humid is an air stone some tube & a small aquarium air pump, Simply make a small hole near the top of the tank & feed the pipe through to the water container, attach the air brick & pump. The inner angled drip lids are simply shaped 2mm plastic sheet.



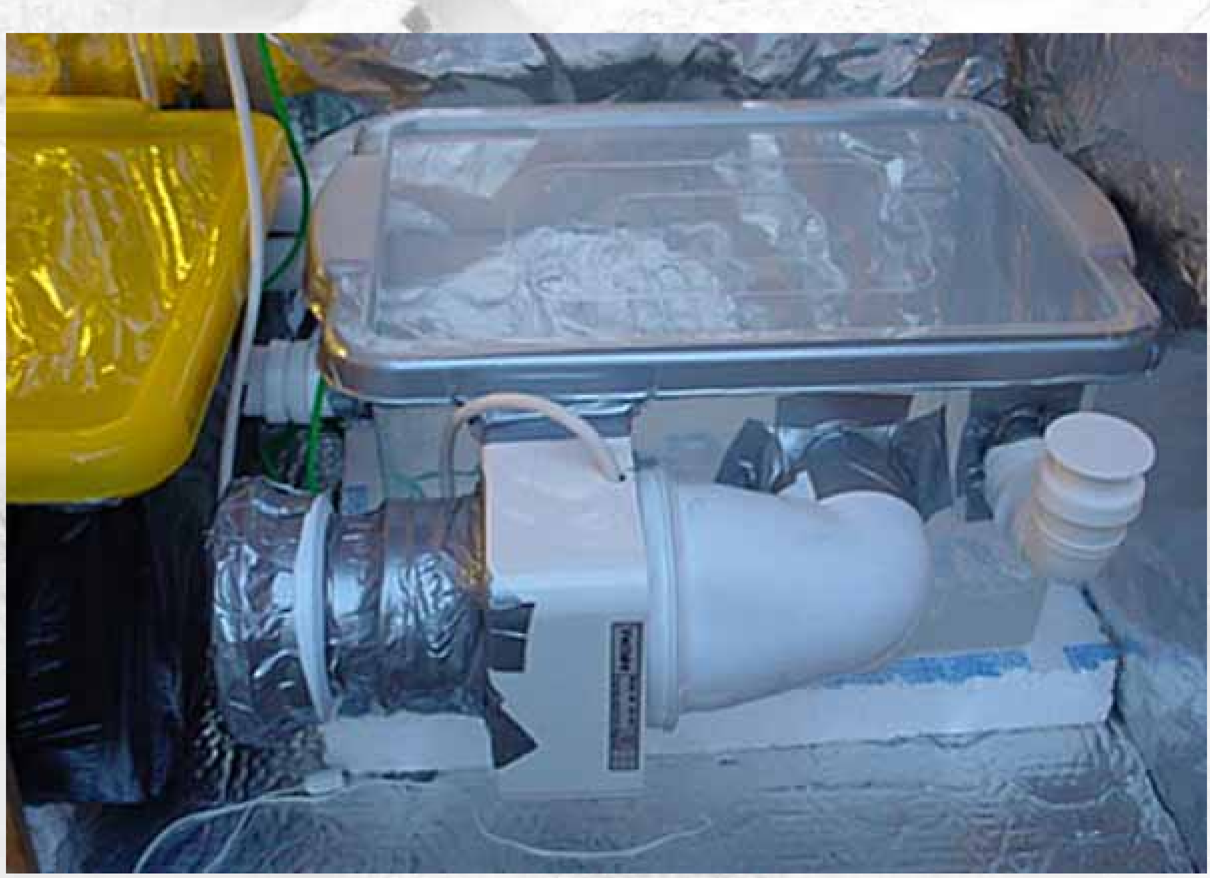


Fig 40 & 41. These two pictures show how to make a warm humid air delivery chamber, this is very useful for those who live in a cold climate, or want to grow at cold times of the year. All of the small connection ducts are potential outlets & the one large duct is the main input. The container is filled with a few Inches of water & with the lid & input fan fitted is ready to use, it may take you a few hours to set the water heaters timer to get the desired humidity temperature, when you have achieved this, plumb in the growing chambers & away you go !

Pasteurized Wheat Straw Prep TEK

by

hippie3

original source: http://mycotopia.net/archives/discus/messages/5/6714.html

Table of Contents:

- **Pasteurizing of wheat straw**
  - Introduction
  - Overview
  - Wheat Straw Preparation
    - *Procedure*
  - Chopping the straw
  - Pasteurization
    - *Draining water from straw*
- **Spawning Pasteurized Wheat Straw**
  - Overview of spawning
  - Initial Preparation
    - *Spawn Preparation*
  - Spawning Procedure
- **Small Wheat Straw Cake Preparation**
  - Overview of small cake preparation
  - Initial Preparation of small cake
- **Large Wheat Straw Cake Preparation**
  - Overview of large cake preparation
  - Initial Preparation of large cake

Pasteurizing of wheat straw

Introduction

The following procedure is a simple method for pasteurizing wheat straw and is ideal for the small-scale home cultivator. The number one benefit of working with a bulk substrate like Pasteurized Wheat Straw (as far as the small-scale cultivator is concerned) is the impressive boost that it offers in terms of overall performance and cropping yields. Fruitbodies grown out on WS are typically much larger than ones that are grown out on grain or flour. Colonization (or Spawn Run) times are also decreased which means that the mycelium grows more rapidly in straw than it does in grain or flour.

Wheat straw is an ideal substrate for these particular mushrooms and for this particular application. In fact, given its cleanliness, ease of preparation, and nutritional benefits; it may be the best alternative for any indoor cultivation app where these (or other similar mushrooms) are concerned.

The type of straw that we will be using is known as **Wheat Straw** and is commonly used amongst commercial grow-ops for creating composts to be used with edible mushrooms that require it. For small-scale apps, straw can be used as a primary substrate for this particular kind of mushroom.

Wheat straw can be purchased at any feed store for approximately $5 for 1 bale. One Bale weighs approximately 40 lbs dried. That is a lot of substrate for the price! Other places that are likely to carry wheat straw are; gardening centers or nurseries (frequently used for landscaping). You should be able to find straw at any one of these places with little effort.

Note: *Be sure not to use an Oat or Barley type straw. Make sure that you are purchasing "wheat" straw!*

Overview

Below is a list of all the items you will need to carry out this procedure:

Large pot for boiling water (5-7 Qt.)
2 lbs or more of wheat straw
A metal grate or a heavy weight (for holding the straw under water during pasteurization.)
1 Meat probe Thermometer
A pair of scissors for cutting up straw.
A large container (for holding the chopped straw)

Wheat Straw Preparation

Place the following items in your workspace:

Bag of Wheat Straw
2 large bowls or pans

Procedure

Before you begin, you will want to fill the large pot with water (about 1/2 - 3/4 full) with tap water like so.

Place the pot of water on the stove top and turn the stove on to begin the boiling process.

The water water should be allowed to boil for 20-30 minutes before adding straw. (This gives us plenty of time to chop the straw down to size in preparation of the pasteurization process).

Chopping the straw

The straw needs to be chopped down to a reasonable size so that it is easier to work with for our particular application. Generally, wheat straw should always be chopped down to 1-3 inch lengths which allows for a better substrate medium for both the cultivator and the mushrooms. The idea is to compact as much substrate mass as possible into a given area which increases your cropping efficiency while offering the mycelium a more ideal medium to colonize over. Cropping efficiency, in this case, is determined by how much substrate can be packed into a given area. This is essentially what determines the yield for a given substrate mass or "cake". In other words; a substrate/cake that is more compact or dense will produce greater yields than one that is less dense or compact.

Since we will be using such a small container to house our substrate/cakes, we will need to chop the straw down to the minimum possible length desirable. 1 inch is a good length for this particular application.

Start by grabbing a hand full of straw, and while working over your tray or bowl, begin cutting the loose pieces of straw off the end of the bushel like so.

Work your way down, one inch at a time, until you're able to get an even edge to work from (see pic above).

Continue to cut the bushel down to 1 inch lengths and repeat this procedure until you have at least 2.5 to 3 times the amount of mass that you plan to fill. Above is a picture of the final batch of straw ready for pasteurization.

NOTE: I FOUND A REGULAR BLENDER QUITE EFFECTIVE AT CHOPPING DRY STRAW, I USED A PLASTIC CUP AS A 'PUSH STICK' TO FEED THE STRAW TO THE BLADES.

Pasteurization

In order for pasteurization to be completed, Wheat straw is bathed in a pot of water at 160-170°F for a total of 30-45 minutes.

The pot of water should have had plenty of time to come to a boil and remain for 20-30 minutes.

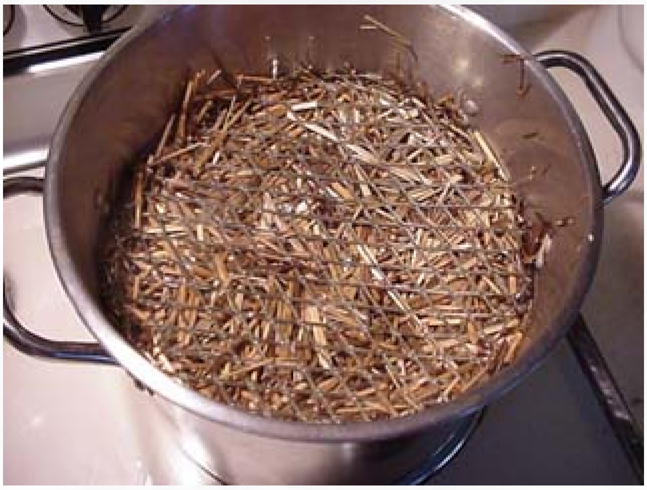
100
120
140
80
60
160
180
200
20
0
220
F

Before we can add the straw to the pot of water, we need to lower the temperature of the water to a point below boiling that is ideal for pasteurization to proceed. To do this; simply turn the stove dial down by 1/3 or 1/2. Using the Meat Thermometer Probe; periodically check the temperature of the water until it nears the ideal range for pasteurization (160-170°F).

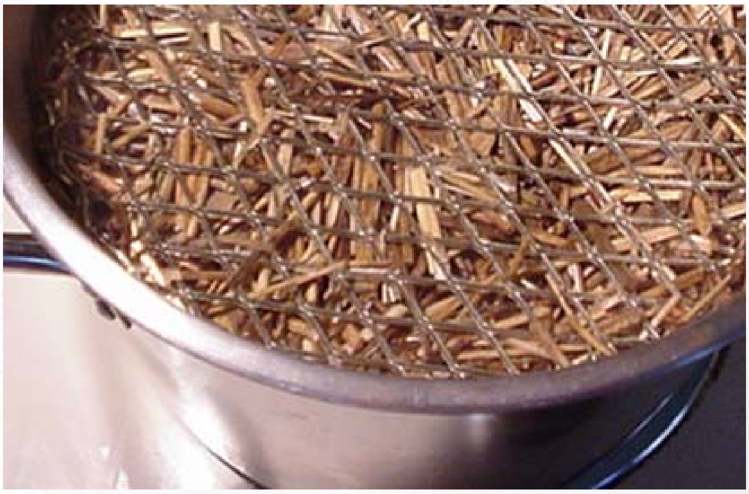
Once the water temperature is down within range; you can begin to add the straw into the water. This is the point where you should start your 30-45 minute countdown.

After filling the pot with a portion of dry straw, force the floating straw down under the water with a heavy-duty utensil for total submersion

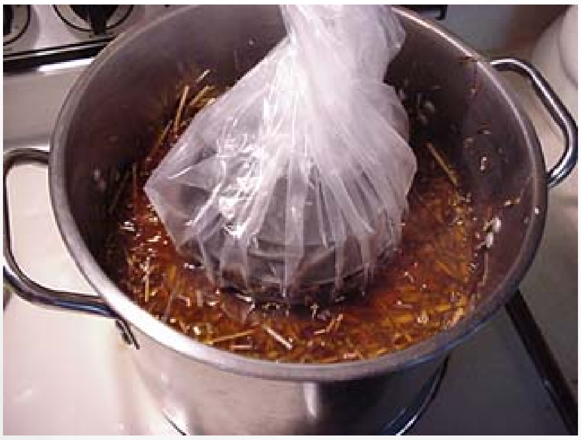
Repeat this procedure of filling and submerging the straw into the pot of water until you have added as much straw as necessary for your application (or as much as can possibly be contained in the pot your working with).



Using a grate (or some form of heavy-duty material that will allow you to hold the straw submerged under the water for the duration of the pasteurization process), force the straw down into the pot of water like so.



Here is a close up view of the type of grating that was modified to fit this pot for this particular purpose.



Now, you will need a heavy weight of some kind to place on top of the grate in order to keep the straw forced down into the pot of water. I used a couple of weights from a weight-lifting set and wrapped them in a heavy-duty plastic bag, like so.

Be sure to use the thermometer probe to gauge the temperature of the water. It's important to keep an eye on the gauge to make sure that the straw remains within the ideal range for the duration of the pasteurization process.

Draining water from straw

Once the straw has been fully submerged and pasteurized for the 30-45 minute time period, the stove should be turned off and allowed to cool down for about 10 minutes before draining the water out of the pot.

In the pic above, you can see how the leftover water from the pasteurization process was drained (and strained) into a 1 QT jar where it will be saved for another batch of grain.

Above is a picture of the final product of the drained wheat straw juice that will be used on the next batch of grain jars in place of bottled water, which will provide the spawn jar with a nutritional boost that will help to speed up the colonization cycle considerably.

Once the water has been drained from the pot, it's time to move the freshly pasteurized straw into a heavy-duty plastic bag where it can be allowed to cool down to room temperature before being spawned.

I recommend tying the bag up and poking about 20-30 holes into it with a clean nail or similar poking device and allowing it to hang for a 4-6 hour time period until it has had plenty of time to cool back down to room temperature. (see pic above).

Above is a picture of the final product after pasteurization and draining is completed.

Once the straw has cooled down to room temperature, you can proceed to the following TEK where you will find the necessary information for spawning the freshly pasteurized wheat straw with a pre-colonized jar of grain spawn.

Table of Contents

Spawning Pasteurized Wheat Straw

original source: http://mycotopia.net/archives/discus/messages/5/6734.html

Overview of spawning

Below is a list of all the items you will need to carry out this procedure:

Pasteurized Wheat Straw (cooled to room temp)
1 QT Jar of Grain Spawn (or colonized BRF)

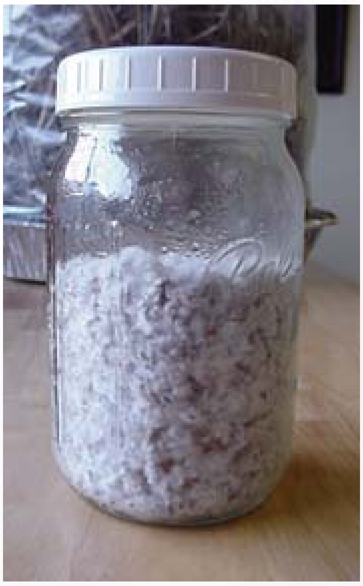
Initial Preparation

Before we begin, it's always a good idea to wash your hands and clean the work space that you will be working in before you get started. I recommend saturating a paper towel with rubbing alcohol and wiping your hands down thoroughly with it, paying close attention to your finger tips and nails where dirt can be easily trapped.

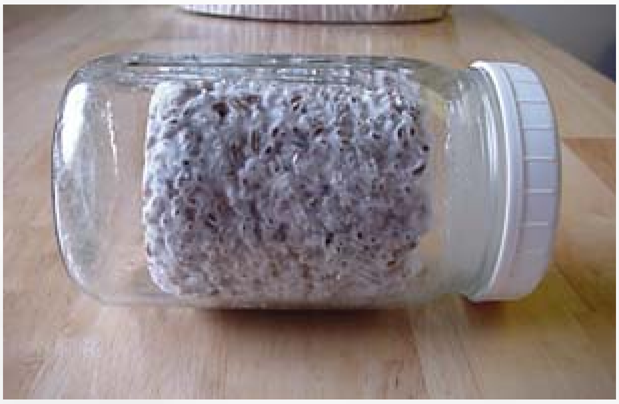
Spawn Preparation

The jar of grain spawn that you will be using to spawn the PWS with will need to be shaken first before applying to the prepared substrate. However, it is important that the grain is allowed to recover from the shaking for a 24 hour period before spawning takes place. The best time to shake the spawn jar is the day before pasteurization takes place. After 24 hours, the mycelium has had a chance to re-colonize and should be checked very closely for contamination before being used as spawn.

By doing this, you are allowing the mycelium to recover from the transitional state into an active state that will ensure rapid colonization of the wheat straw... which is very important. The mycelium needs to colonize the pasteurized wheat straw as rapidly as possible in order to beat the contaminations from taking over the substrate first. Once the mycelium has established itself in the substrate, it can easily fight off the contaminations that may be present. However, in it's transitional state, the mycelium is very vulnerable and has no way to protect itself from the competing contams that are present in the bulk substrate.

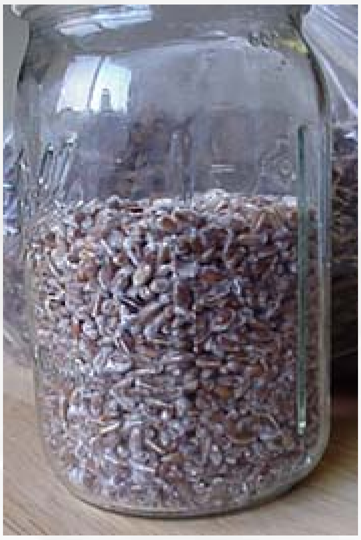


In the picture above, you can see the jar of colonized grain spawn ready to be shaken so it can be used to spawn our soon-to-be pasteurized wheat straw.



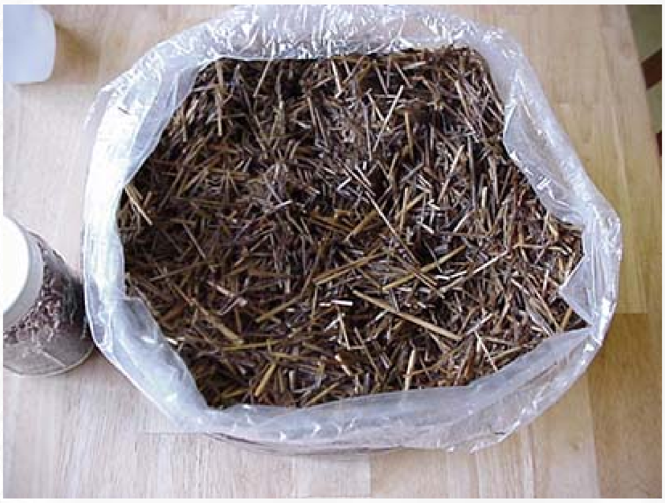
Above you can see how the colonized grain has bonded together so that when it is shaken considerably, it still remains in tact. It's important not to let a grain jar colonize much further beyond this point or you will likely never break it apart!

But, this spawn jar is right on schedule and as you can tell by the pic above, it gave in after a few good shakes.

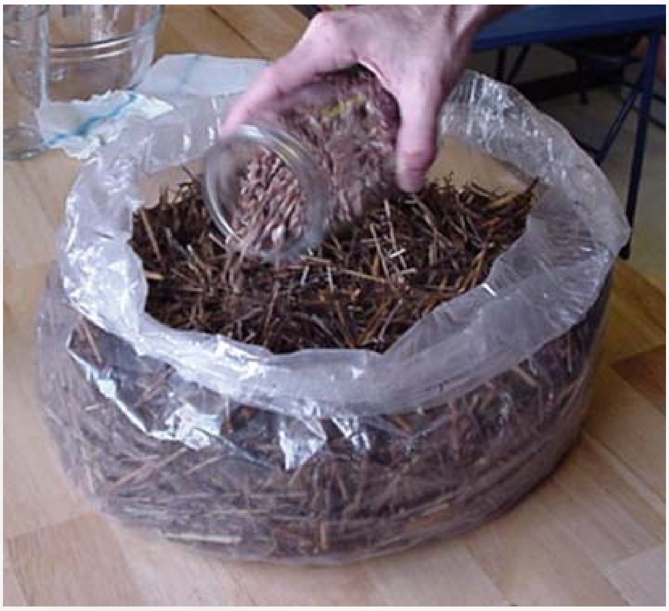


The picture above was taken directly after the spawn jar was shaken and is not ready to be transferred to the Wheat straw yet. It needs to be placed back into incubation for another 24 hour period so it can recover a little before it can be used as spawn for the wheat straw. Above is a picture of the spawn jar 24 hours after shaking and directly before being used as spawn for the wheat straw. As you can tell by the picture above, the jar of grain has had a chance to recover from the shaking that took place the day before and appears to be ready for spawning.

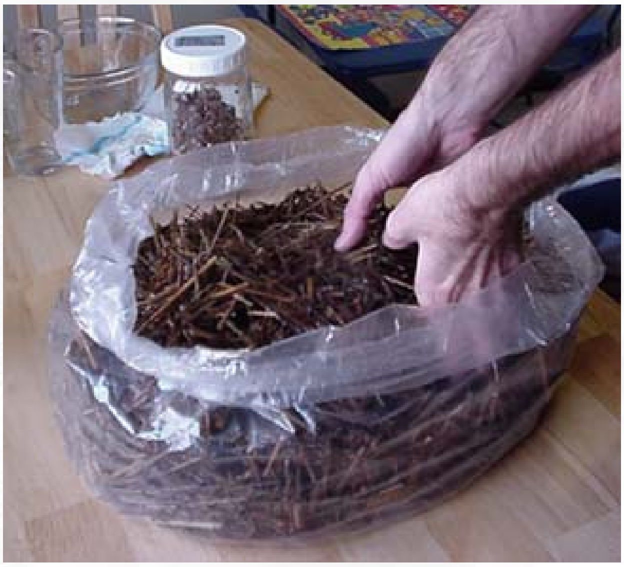
Spawning Procedure



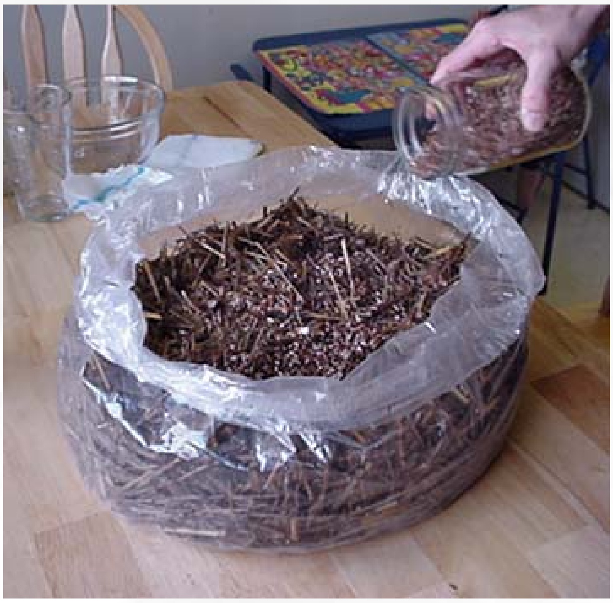
First, you will want to shake the bag of pasteurized straw and then open it up as wide as possible, like so.



Next, very lightly shake the recovering spawn jar just enough to break the kernels apart (being careful not to disturb the recovering mycelium anymore than necessary). Now open the jar up and pour about 1/5th of the grain spawn out over the surface of the straw, like so.



With clean hands (as described above); work the grain into the straw by turning it over so that the grain mixes well with the straw, like so.



Repeat the process of adding grain to the straw and mixing the two together until the entire jar of grain spawn has been added to the substrate, like so.

Once all the grain spawn has been added to the bag of straw, the bag should be tied and shaken thoroughly to ensure proper distribution of the grain kernels throughout the bag of straw.
Once this has been completed, the freshly spawned bag of Pasteurized Wheat Straw is now ready to make Wheat Straw Cakes which can be used in the terrarium.

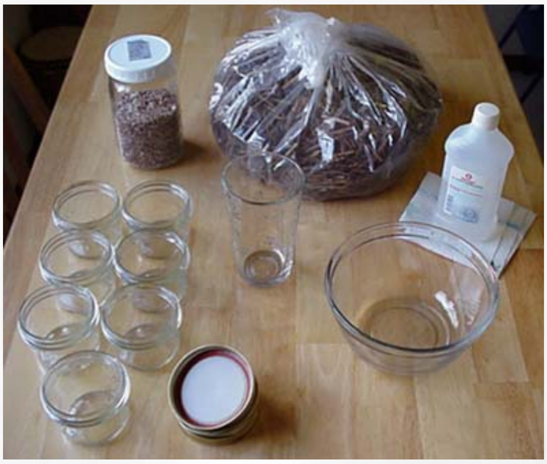
Table of Contents

Small Wheat Straw Cake Preparation

original source: http://mycotopia.net/archives/discus/messages/5/6767.html

Overview of small cake preparation

Below is a list of all the items you will need to carry out this procedure:



Spawned Wheat Straw
7 half-pint canning jars w/ lids
A bottle of Rubbing Alcohol
A paper towel
A drinking glass (optional)

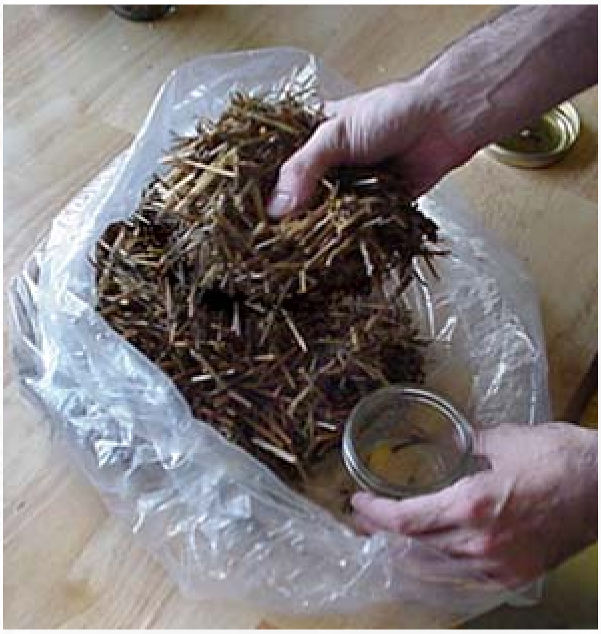
Note: The following items pictured above are not required for this TEK:
Jar of Grain Spawn
Large Glass Bowl

Initial Preparation of small cake

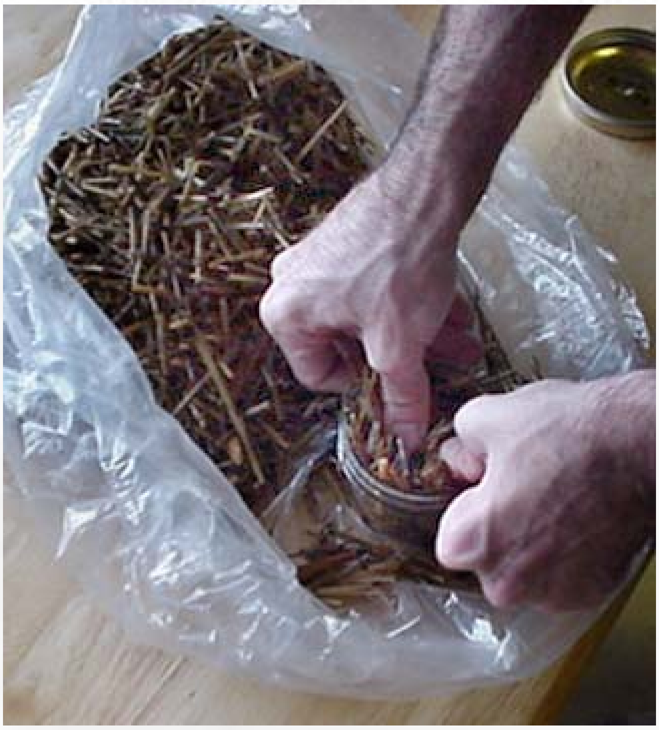
Before we begin; it's always a good idea to wash your hands and clean the work space that you will be working in before you get started. I recommend saturating a paper towel with rubbing alcohol and wiping your hands down thoroughly with it, paying close attention to your finger tips and nails where dirt can be easily trapped.

Start by saturating the paper towel with alcohol, like so.

Using the alcohol-saturated towel; wipe the glass jar clean (starting on the inside and continuing to the outside), like so.



Once the jar has had a moment to dry; it's time to begin adding the straw to it. Working over the bag of straw; start by adding a very large handful, like so.



After a large handful of straw is added; using both of your thumbs and working around the jar in a circular manner; press firmly down on the straw in order to compact it, like so.

Continue repeating this procedure of adding straw to the jar and compacting it with your hands, like so.

You'd be surprised at how much one of these half-pint jars can hold when you pack the #### out of one!
Note: A drinking glass can also be used to compress the straw down into the jar. (I prefer using my hands).

Continue adding and packing the straw until you end up over-filling the jar with straw to the point that it can't possible hold anymore. Now, it's time to add the lid to the jar. To do this, you will want to apply a lot of pressure to the lid as you tighten it to a close.

After the lid is tightened onto the jar, it's time to wipe it clean with the alcohol-saturated towel like so.

That's it! Just repeat the process until all the jars are filled, like so.

Once all the jars are filled and cleaned, they are now ready to be placed back into the incubation chamber so the mycelium can colonize them in preparation for the pinning/fruiting stage.

Note: *It's a good idea to shake the bag of straw and grain spawn up after each jar is prepared to help re-distribute the grain kernels back into the straw because the grain tends to fall through to the bottom of the pile as it gets handled.*

Table of Contents

Large Wheat Straw Cake Preparation

original source: http://mycotopia.net/archives/discus/messages/5/6744.html

Overview of large cake preparation

Below is a list of all the items you will need to carry out this procedure:

Spawned Wheat Straw
A 1.5 Qt capacity Glass Bowl
A bottle of Rubbing Alcohol
A paper towel

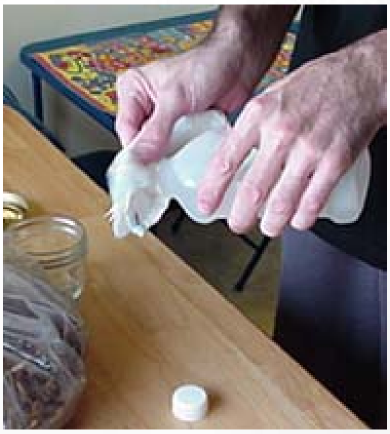
Additional Items required: (not pictured above)

A small sheet of Tin Foil
A small plate
A weight of some kind (needed to compress the straw down into the bowl)

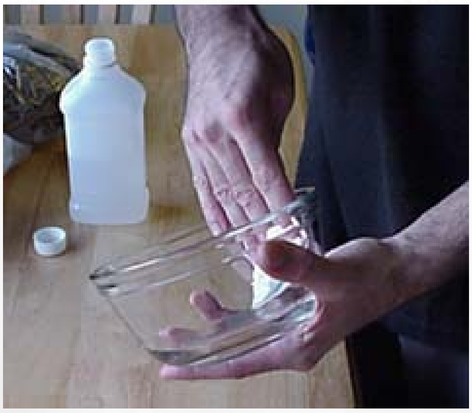
Note: The following items pictured above are ***not required*** *for this TEK:*
Jar of Grain Spawn
7 half-pint canning jars w/ lids
A drinking glass

Initial Preparation of large cake

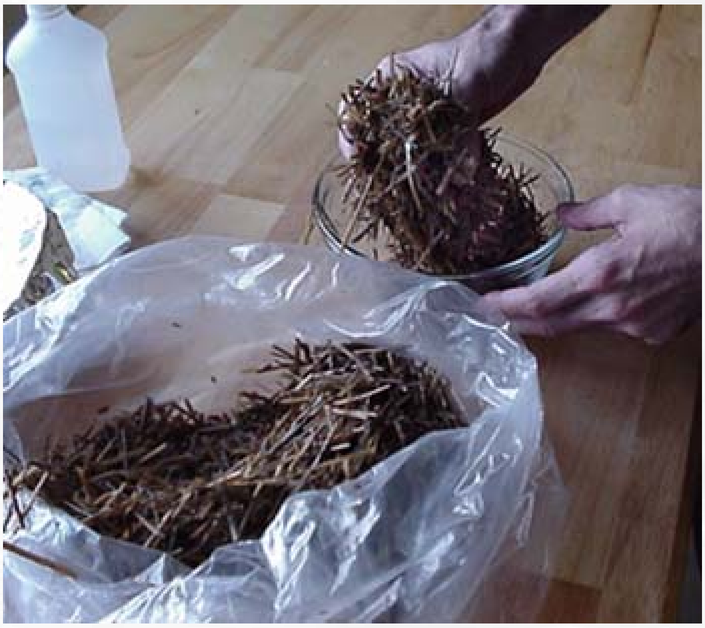
Before we begin; it's always a good idea to wash your hands and clean the work space that you will be working in before you get started. I recommend saturating a paper towel with rubbing alcohol and wiping your hands down thoroughly with it, paying close attention to your finger tips and nails where dirt can be easily trapped.



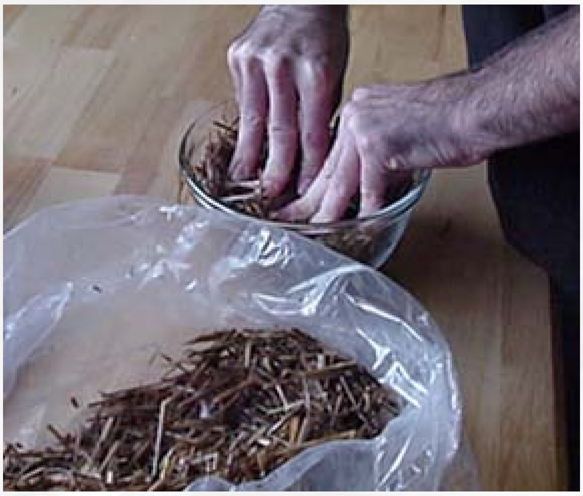
Start by saturating the paper towel with alcohol, like so.



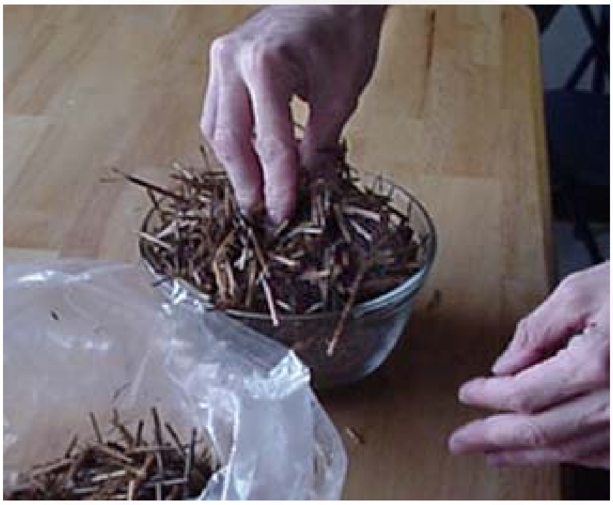
Using the alcohol-saturated towel; wipe the glass bowl clean (starting on the inside and continuing to the outside), like so.



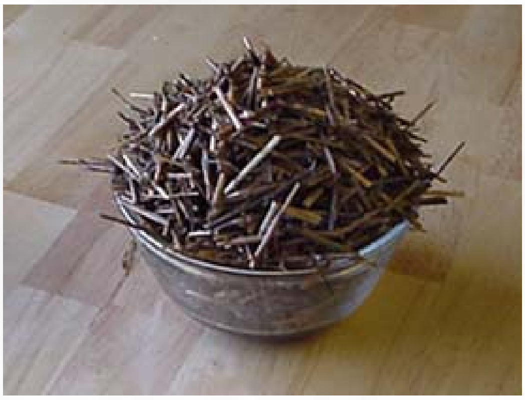
Once the bowl has had a moment to dry; it's time to begin adding the straw to the bowl. Start by adding a large handful, like so.



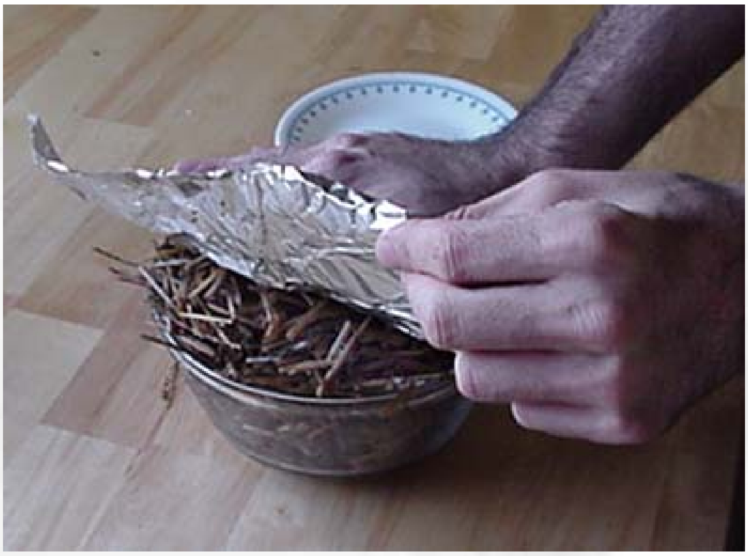
After a large handful of straw is added; use your fingers to press firmly down on the straw in order to compact it, like so.



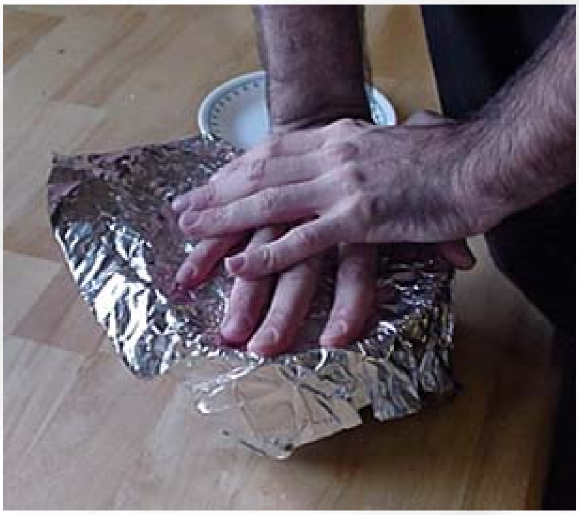
Continue repeating this procedure of adding straw to the bowl and compacting it with your hands, like so.



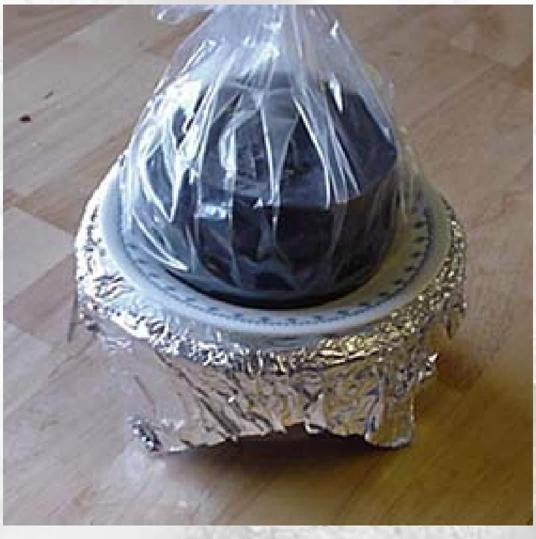
Continue adding and packing the straw until you end up overfilling the bowl with straw to the point that it can't possible hold anymore, like so.



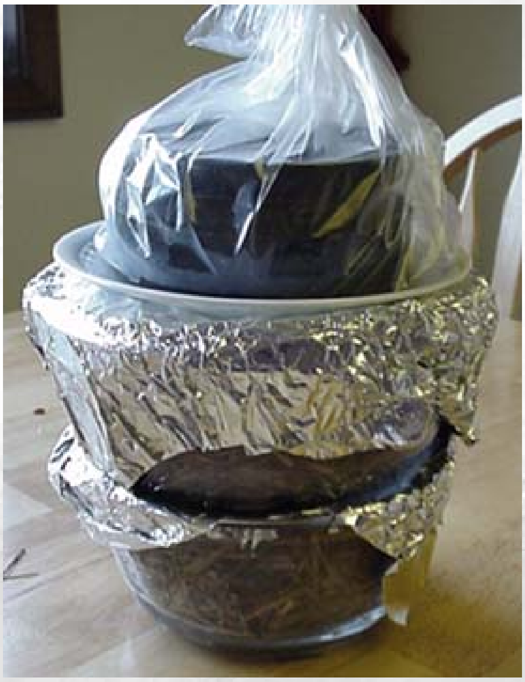
Now it's time to cover the straw with foil, like so.



After you have covered the straw with a sheet of tin foil; you will now want to press firmly down on the bowl of straw with both of your hands as best you can to compress the straw down into the bowl, like so.



Using a small plate like the one pictured above; place the plate over the tin foil-covered bowl of straw and place a weight over the top to help compress the straw down during the incubation phase.



If you are working with more than one bowl of straw, then you can stack them for efficiency, like so.

That's it! The cake is now ready to be placed back into the incubation chamber so the mycelium can colonize it in preparation for the pinning/fruiting stage.

Table of Contents

Cold Water Lime Pasteurization For Growing Mushrooms

Using lime and cold water to pasteurize substrates without heat

by

Tony & Tegan

© authors, 2019

original text: https://blog.freshcapmushrooms.com/learn/lime-pasteurization/

Table of Contents:

- **Intro**
- **What Is Hydrated Lime?**
  - ✘ What Type of Lime WON'T Work?
  - ✔ What Type of Lime WILL Work?
  - How Does Lime Work?
- **Cold Lime Step By Step**
  - What You Need
  - STEP 1: PREPARE STRAW
  - STEP 2: PREPARE WATER BATH
  - STEP 3: ADD STRAW AND SOAK
  - STEP 4: DRAIN AND INOCULATE
  - STEP 5: COLONIZE AND FRUIT
- **A Recent Grow With Hydrated Lime**
- **Other Low-Tech Methods**
  - Anaerobic Pasteurization
  - Laundry Detergent and Soap
  - Ash Pasteurization
- **Give Lime A Chance**

Intro

I'll admit, pasteurizing straw in hot water with a propane burner can be a bit of a pain.

You need a large burner, a full propane tank, and plenty of time to make sure the whole process goes smooth. Even more of a pain, it needs to be done outside or in a large shop - because you can't set up a propane burner in your living room!

Which leaves many new growers wondering...

"Isn't there another way to pasteurize large amounts of straw?"

Yes!

It's called **Cold Water Lime Pasteurization**, and it's a cheap and effective *low-tech* way to prepare substrates for growing mushrooms.

The process is simple. You basically just **soak straw for 12-24 hours in a bath of cold water** that has been treated with **hydrated lime**.

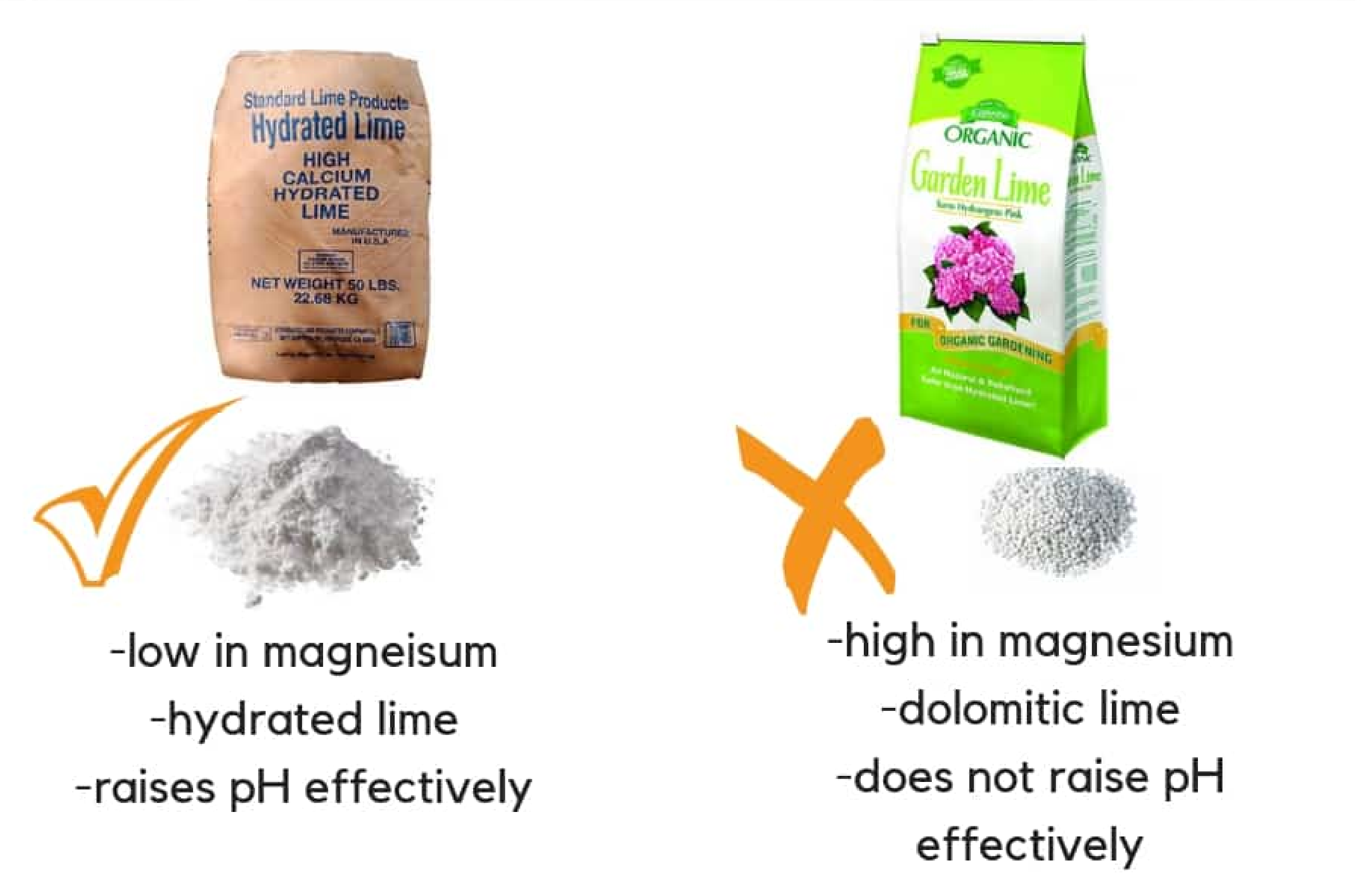
The lime will rapidly and *dramatically* increase the pH of the water, causing the mold spores, bacteria, and other contaminates in the straw to be killed off.

Once drained, the substrate can be inoculated with your mushroom spawn. The mycelium will then be able to grow in squeaky clean straw, unhindered by other competing organisms - for at least a little while!

What Is Hydrated Lime?

Hydrated Lime is basically just Calcium Hydroxide, chemically known as $Ca(OH)_2$, and is often used in industry for a whole whack of different reasons, from pickling cucumbers to treating sewage water.

This white powder is known by a many different names. BUT - not all Lime is created equal, and **some types will *not* work** for growing mushrooms.


Standard Lime Products
Hydrated Lime
HIGH CALCIUM HYDRATED LIME
NET WEIGHT 50 LBS. 22.68 KG
ORGANIC
Garden Lime
FOR ORGANIC GARDENING
-low in magneisum
-hydrated lime
-raises pH effectively
-high in magnesium
-dolomitic lime
-does not raise pH effectively

✘ What Type of Lime WON'T Work?

Make sure you don't get the type of lime that is used for treating garden soils, or buffering substrates. This is too weak! It is typically found at garden centers in pellet form or crushed stone.

This is **Calcium Carbonate Lime**. You might see it called a bunch of different names including dolomitic lime, garden lime, quicklime, limestone, chalk, and many more. This will not be effective in raising the pH high enough, or fast enough to kill the contamination. (check out wikipedia for a quick primer ('limer?) on pH)

Also, you want to make sure that the lime you use is **low in magnesium**, and high in calcium.

This type of lime is typically WAY high in magnesium. High concentrations of magnesium will retard the growth of mycelium, even after the substrate is drained and inoculated.

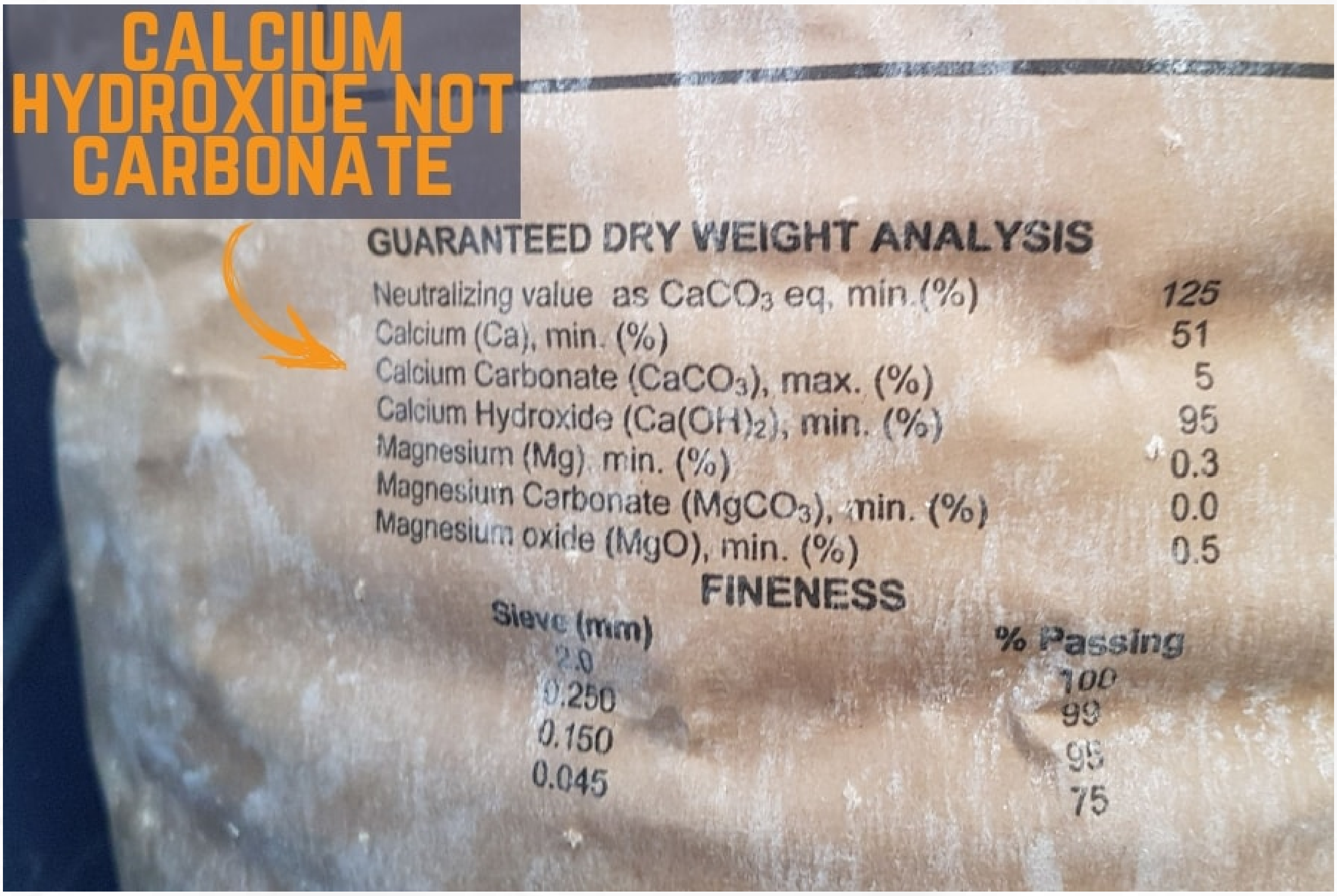
✓ What Type of Lime WILL Work?

The type lime you want is **Hydrated Lime** that is **low in magnesium**.

This white fluffy powder is manufactured by a process that treats "quicklime" with water, changing the chemical structure by converting *oxides* to *hydroxides*.

Keep in mind that it is possible to find garden variety "hydrated lime" that is high in magnesium. This will not work. Chances are, you'll need to go to an agricultural supply store or similar to find the correct type of lime. It isn't always easy to find, so if you have trouble trying to get some, don't be surprised!

The lime I used was picked up at a local UFA, and is the type typically used to treat drinking water on acreages.


CALCIUM HYDROXIDE NOT CARBONATE

GUARANTEED DRY WEIGHT ANALYSIS

Neutralizing value as $CaCO_3$ eq. min.(%)	125
Calcium (Ca), min. (%)	51
Calcium Carbonate ($CaCO_3$), max. (%)	5
Calcium Hydroxide ($Ca(OH)_2$), min. (%)	95
Magnesium (Mg) min. (%)	0.3
Magnesium Carbonate ($MgCO_3$), min. (%)	0.0
Magnesium oxide (MgO), min. (%)	0.5

FINENESS

Sieve (mm)	% Passing
2.0	100
0.250	99
0.150	95
0.045	75

How Does Lime Work?

Lime works by rapidly altering the pH of the water, making it extremely alkaline and killing off the contaminates in the substrate.

Once drained off, the substrate has a low concentration of living contaminates, giving mushrooms the upper hand.

I haven't tested it, but I'm guessing it's a combination between the substrate pH coming back down to earth after being drained AND the mycelium's natural ability to be resilient in high pH environments. Either way it works pretty well!

> **SAFETY FIRST**
> Hydrated Lime is potentially hazardous - so be careful when handling it.
>
> I like to wear gloves, safety glasses and a mask. Getting it on your skin can cause rashes and

burns, breathing it into your lungs can cause respiratory issues, and getting it in your eyes can be especially dangerous.

Always use protective equipment and don't say I didn't warn you!

Cold Lime Step By Step

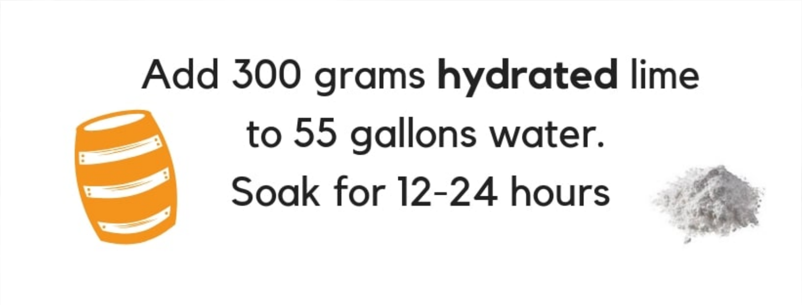
This type of substrate treatment is easy for most people to do at home.

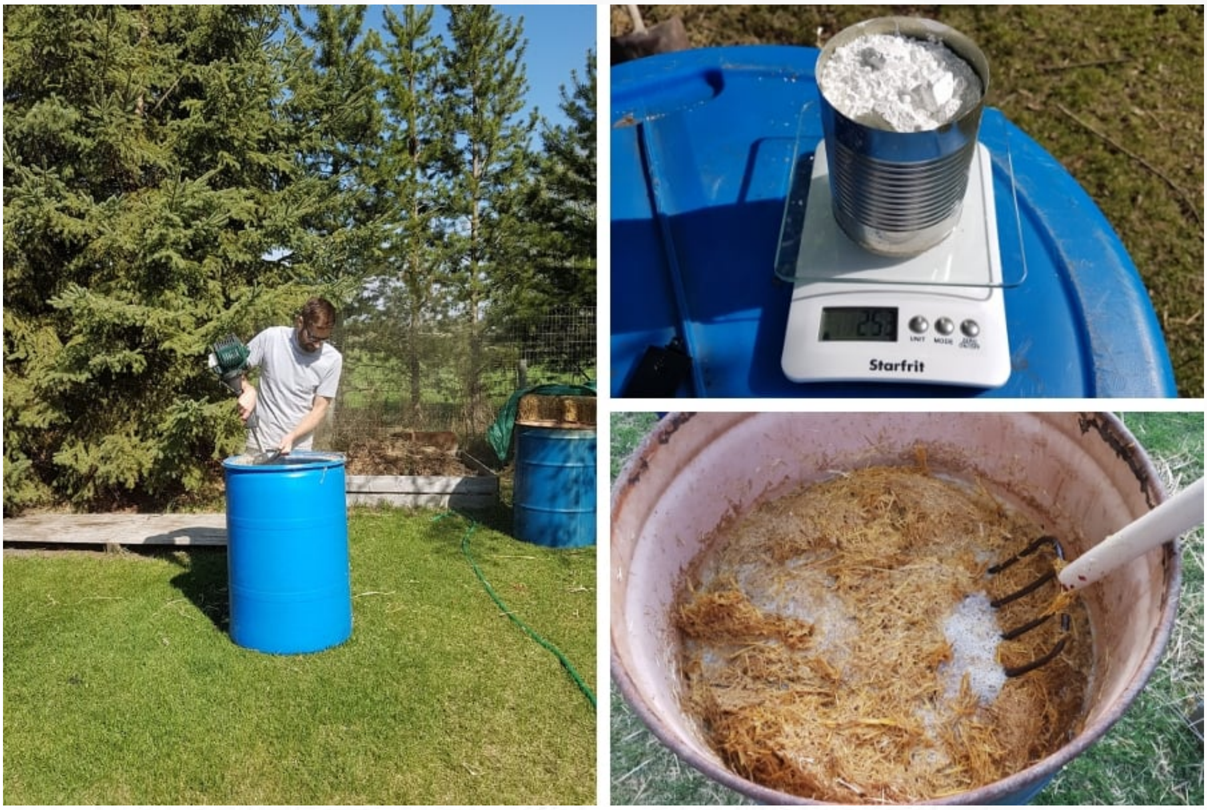
It's even used by some small-scale commercial mushroom growing operations that want a low-tech, cheap and effective way to pasteurize straw.

The overall process is very similar to growing mushrooms on straw with heat pasteurization, the only difference is to replace heat with lime.

What You Need

- Hydrated Lime (about 6 grams per gallon of water used)
- Water
- A 55 gallon drum, or large tote
- Straw (wheat straw or oat straw)
- Poly Tubing or Other Suitable Cropping Container
- Spawn, about 2.5lbs per 25 lbs wet substrate.


Add 300 grams **hydrated** lime
to 55 gallons water.
Soak for 12-24 hours



STEP 1: PREPARE STRAW

Chop your straw into 2-3" pieces. You can do this with shears if you have a small amount, or by whipping it up with a weed-whacker in a large drum.

This is not 100% necessary, but chopping the straw impacts how easily the mycelium can work it's way through the straw, and makes the nutrients in the straw more accessible.

The result of chopping is faster colonization, and very likely a **much bigger yield**.

STEP 2: PREPARE WATER BATH

Add the hydrated lime to the water in a large drum or tote.

A good rule of thumb is to use about **6 grams of hydrated lime for every 1 gallon of water**.

If you have a 55 gallon drum of water almost full (50-55 gallons of water), this equates to about 300-330 grams of lime. (*doesn't have to be exact*)

If you don't have a scale, you can estimate with volume and use about 1-1.5 cups lime per 55 gallons of water.

STEP 3: ADD STRAW AND SOAK

Add your straw and soak in the lime bath for 12-24 hours.

Ensure that the straw is evenly mixed though the water bath so that it is all treated equally. Straw floats, so you might want to place something heavy on top to ensure full submersion. I like to use a cinder block and a metal grate on top of the straw to hold it down.

STEP 4: DRAIN AND INOCULATE

After 12-24 hours of soaking, remove the straw and let it drain for 20 minutes of so. You don't want to leave it so long that new contaminates have a chance to settle in the substrate, but you also want to ensure that most of the water drains off so that the straw is not overly wet.

Inoculated the straw at a rate of 10-15%. You can either mix it all together, or place it down in layers. One of the best options for cropping container is poly-tubing. I like to use 14" lay flat diameter tubing, which makes straw logs that are about 9" in diameter.

Make sure that you cut holes in the poly tubing to allow for the mycelium to breath while colonizing. I like to use an arrow head and stab holes all around the log, every 4 inches or so. Make sure you also place holes in the bottom of the log so that any excess water can drain off.

STEP 5: COLONIZE AND FRUIT

The straw should colonize relatively quick, depending on the species and the spawn rate. The mycelium should start growing right away. Place the log in a room temperature environment away from direct sunlight. In 10-14 days, the log should be fully colonized and ready to be placed in fruiting conditions.

That's it! Again, it's very similar to the process for heat treated straw. Takes a little longer, but requires less work overall.

A Recent Grow With Hydrated Lime

I just finished up a grow using Cold Pasteurization of straw and had some pretty good results!

For this grow, I chose Blue Oyster (*Pleurotus columbinus*) and Yellow Oyster (*Pleurotus citrinopileatus*) because they're both fast growing, high yielding strains that typically do well on straw substrates.

I decided to fruit them outside, because the conditions were right, and because growing these species outside can produce some nice large fruits without too much hassle!

First step, I chopped the straw using a weed whacker in a large decommissioned rain barrel. I then soaked the straw for about **18 hours** in a **55 gallon drum** full of cold hose water and about **300 grams hydrated lime**.

The straw was then piled up on a large mesh screen for about 20 minutes to drain. It's surprising how much the color of the straw changes after the lime water bath!

It appears *so* much more yellow/gold from the treatment. At first, I thought the straw might have been fried in some way... but it turned out to be no problem at all!

Once drained, I stuffed the straw into poly tubing and inoculated it with grain spawn. Instead of mixing the spawn and straw *before* loading the tubes, I decided to add the spawn to the log in layers.

This involves grabbing handfuls of straw, stuffing it into the log, sprinkling a thin layer of spawn, and then repeating until you run out of straw or spawn. The result is a kind of "layer cake" of spawn and straw - which, believe it or not, will colonize just about as fast as if it were thoroughly mixed.

Keep in mind - If you decide to use this method, make sure that you really press down each layer as you are making it, so that there are no large air pockets or areas of loosely packed material.

Once the logs were stuffed, I stabbed the outside of the log with an arrowhead, about once every 4 inches or so. This included perforating the bottom of the log so that any excess water can drain off as the log colonized.

BLUE / PAST
05/14 w LIME

The logs were brought into a cool storage area, inside, so that they could colonize. After about a 7-10 days, the logs were fully colonized, and ready to be brought outside.

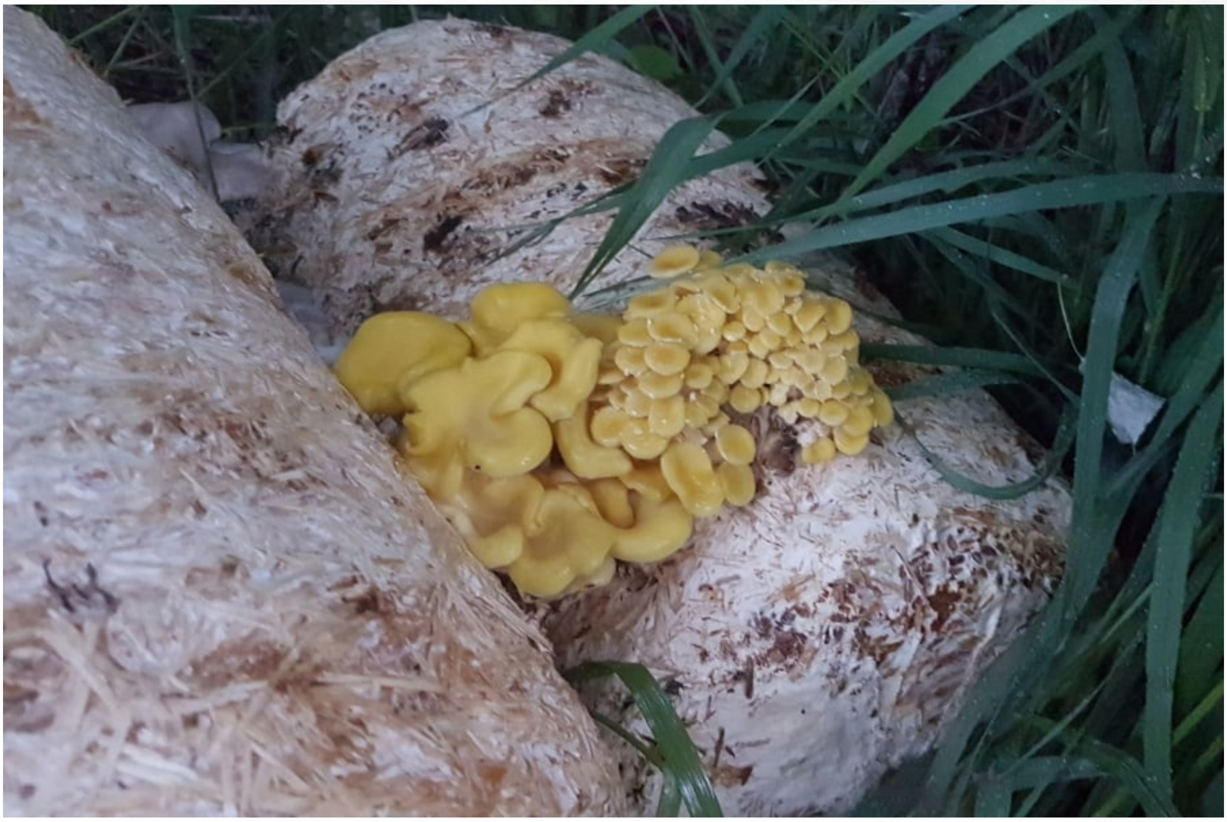
I hung these logs in a custom-made arbor, complete with a poly windscreen to help prevent the fruits from drying out. Oysters definitely need LOTS of fresh air, but if there is a constant wind, even just a slight breeze, the fruits will inevitably dry out and abort. You can usually remedy this by placing the log near the ground, deep enough into the trees, or simply draping it in poly sheeting.

The two logs fruited nicely!

The Blue Oyster, of course, had no problems producing some nice large cluster. I did however have to get 'em pretty early so that the bugs didn't take over.

The Yellow Oyster also fruited nice, although I didn't manage to snag any pictures.

That being said, once I thought the log was totally done, I stripped off the poly tubing and threw it in the compost pile... where it decided it wasn't done yet! This happens often, especially with Oysters, who just like to keep fruiting and fruiting and fruiting.



Other Low-Tech Methods

Of course, both heat pasteurization and lime pasteurization are effective, but they aren't the only way to treat your substrate. There are some other methods that are cheap and effective, that you might want to try for yourself.

Anaerobic Pasteurization

Although there are a million different types of bacteria and other contaminates that can affect your grow, you can divide them into two groups - **aerobic** (oxygen loving) and **anaerobic** (oxygen hating). Basically, some contaminates need oxygen to thrive, while others need a complete lack of oxygen in order to survive.

We can take advantage of this to manipulate conditions and pasteurize a substrate without heat, lime, or any other chemicals. The basic process involves soaking a substrate (such as straw or wood chips) in water, draining, and then placing in a **sealed** container. 5 gallon buckets work really well.

If properly sealed, the **aerobic** contaminates will eventually die off, and the **anaerobic** contaminates will proliferate.

Once the container is opened, and the substrate is exposed to the air, the anaerobic contaminates will die off, and there won't be any aerobic contaminates to worry about, at least for a little while. This gives the mushroom mycelium enough of a head start to take over the substrate.

This topic really deserves it's own post, hopefully I'll get to that soon!

Laundry Detergent and Soap

Some people have had success using **laundry detergent**, or even just regular dish soap.

I guess it makes sense, because soap is antibacterial and I'm sure laundry detergent is the same. Although I haven't tried this myself, the process involves soaking a substrate in cold water with laundry detergent for a day or so, in a very similar fashion to cold water lime pasteurization.

I imagine this might work OK for home and hobby growers, but is not something that would make much sense to do commercially.

Also, I would be a little concerned about the quality of the mushrooms if the substrate is pasteurized in this way.

Ash Pasteurization

Wood ash has also been used to successfully pasteurize substrates. It works in a similar way to hydrated lime, by raising the PH enough to kill off contaminates in the straw.

Some have reported that this method actually results in the **best yields of any method**, and considering it is a low cost material in many parts of the world, Wood Ash Pasteurization might be the best way to go for many growers.

Give Lime A Chance

I haven't run any strict trials, but many growers report that hydrated lime pasteurization actually has a much **higher Biological Efficiency** (BE) than steam pasteurization.

Some growers will actually calculate the exact amount of water needed, so there is no excess high pH water to get rid of. For example, if you had 25 lbs of dry straw, you would use about 10-12 gallons of water, most of which will be absorbed by the straw. This is much different than hot-water pasteurization, where you need to dispose of all the hot water.

All this and you don't need to wrestle hot straw, continuously monitor temperatures, and burn off expensive propane.

Don't you think it's worth giving lime a shot? I sure do!

Straw Log Tek

by

Skyypilot

original source: http://mycotopia.net/archives/discus/messages/5/26684.html

The inspiration for this Tek came from reading Paul Stamets book, Growing Gourmet and Medicinal Mushrooms. He describes a similar process for growing Oyster mushrooms on straw in vertical columns, where the fruits only form at holes you have previously punched. This works great if you're working with a strain of edible which will cooperate that way, but many mushroom strains simply want to fruit wherever they choose. It is for those strains of edibles that this Tek is intended. Although all edible and dung loving mushrooms love fruiting on pasteurized straw, the author wishes to make clear that this Tek is intended for the cultivation of legal, edible mushrooms only.

The Tek assumes the grower is familiar with grain spawn production, because building a 36" log, which we will be doing in this Tek, requires from 4 to 6 quarts of colonized rye or corn. If you're using smaller than quart (.9 liter) jars of colonized spawn, you'll have to do the math to figure how many to use. More spawn is better, as fast colonization of straw is essential. The pasteurization process doesn't kill all the contaminants; it only renders them harmless for approximately two weeks. If the mycelium hasn't colonized the substrate by then, contamination naturally will occur. The pasteurization process also spares the 'good bacteria' which help the mycelium to naturally fruit better, as well as to help fight off contaminants. If one were to put straw into a pressure cooker and sterilize it, harvests would be much lower as a result of killing these beneficial bacteria, and it would be considerably more susceptible to contamination. I've worked hard to put together what I think is the most concise and easy to follow directions for pasteurizing small amounts of straw on the net today.

Pictures accompany every step. Don't cut corners, and you'll be guaranteed success. I've tried to shrink the pictures as much as possible without sacrificing detail, to make downloads faster. I would recommend the reader print a copy of the Tek for future use.

1) Ok, the first step is to get a bale of straw from the local co-op or feed store. If you can find organic straw, it is preferable, because any contaminant or pesticide that is in the straw is likely to end up in the fruit bodies. The feed stores in my area carry organic barley straw and it works great. I know that wheat straw would also work.

2) Using whatever tools are at your disposal, chop the straw into 1-3 inch lengths. This is VERY important. The mycelium simply doesn't like to colonize straw if it can't get inside the hollow interior of the stems. Consider any length of straw longer than your pinky finger as too long. It's a pain in the neck, but don't cut corners here. Your project will fail.

3) Once the straw is cut, put it in a Sterlite or Rubbermaid container (or anything else similar, like a clean trash can) and cover it completely with hot tap water. I use the sink sprayer, to wet the straw evenly as the container fills. When you have enough water in the tub, place a screen and weight over the straw to push it down under the water. It needs to 'pre-soak' like this for at least an hour, but not longer than 2 hours. This is to hydrate the straw.

4) During the time the straw is hydrating, you need to get the pasteurization bath ready. You will need a container large enough to hold 14-16 gallons of water, plus the straw. Place one Sterlite or Rubbermaid container inside another for the insulation properties the dead air space between them provides. A very large insulated ice chest would also work well for this. The idea is that you want to hold the temperature of the pasteurization bath for an hour and a half. Without insulation of some sort, the bath will cool off before the time is up and not be effective.

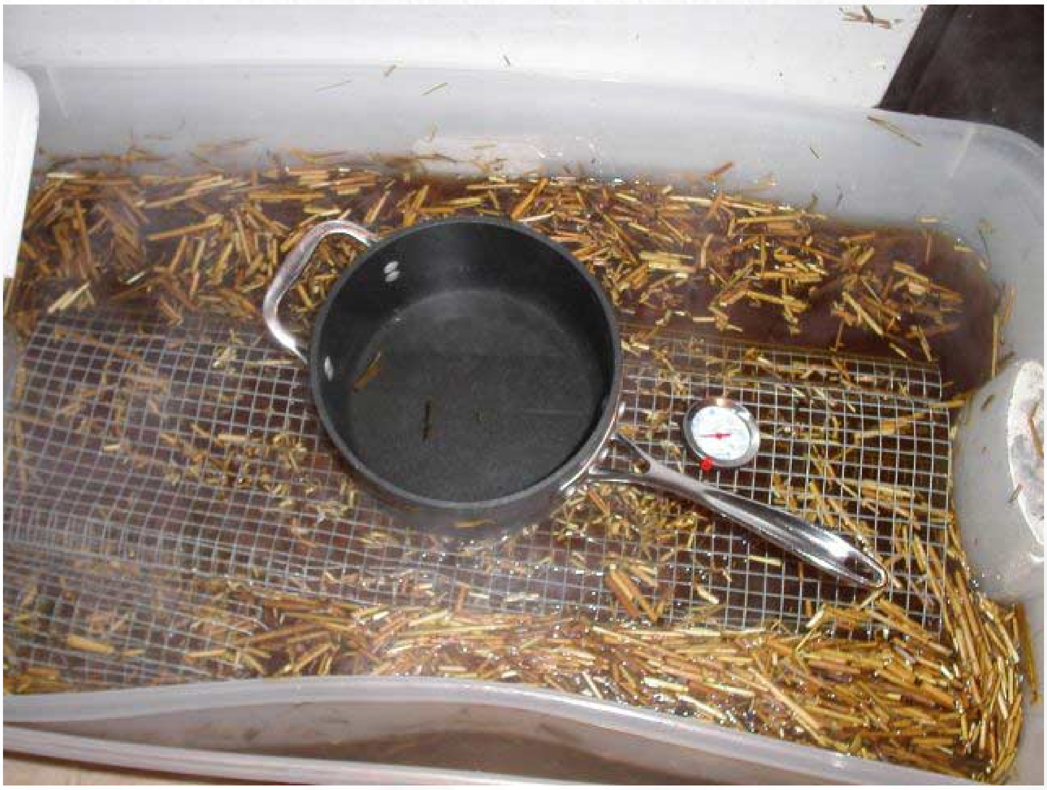
Don't start this process until the straw is soaking, or else the pasteurization bath will be ready before the straw is hydrated, and either you put the straw in too soon, while it's still dry, or the water cools off too much waiting on the straw. What you want is to have a temperature of 140F-160F, after you put the wet straw into the hot water bath. I've found the best way to do this is to heat up six gallons of water on the stove until it boils. The two pots you see in the picture add up to six gallons between them.

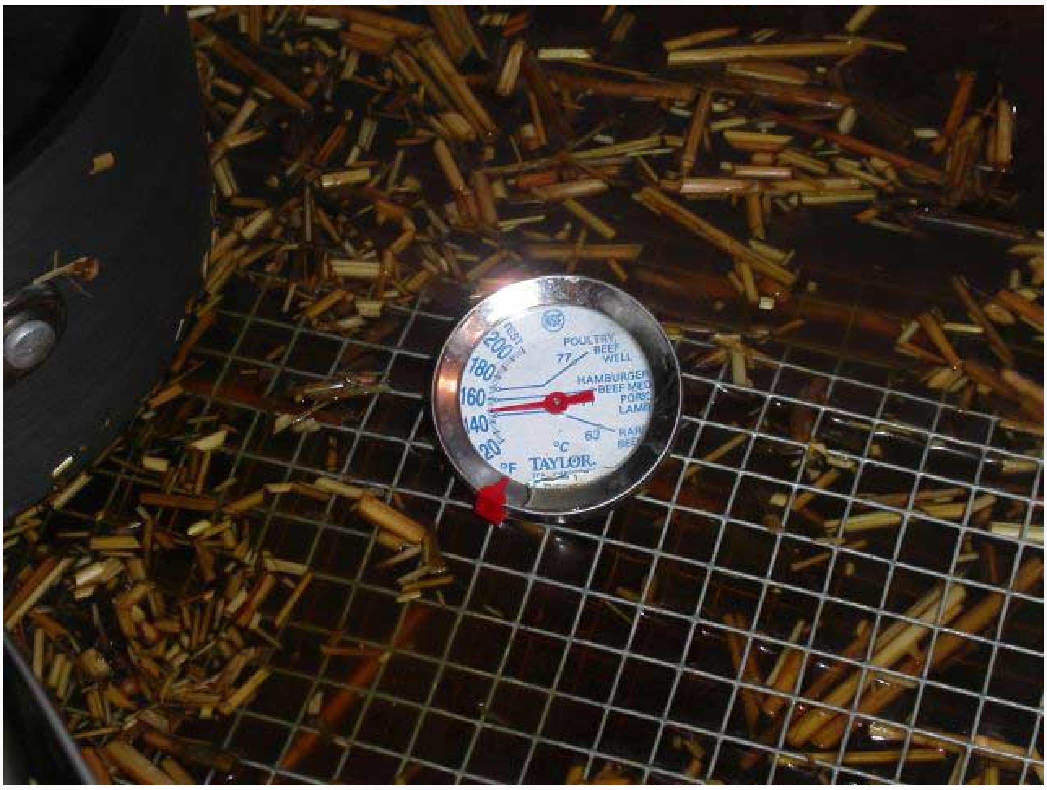
When you have six gallons of water on the stove boiling, place two gallons of plain hot tap water into the clean tub, before pouring the six gallons of boiling water into it. Immediately place the two lids on the container to hold the heat in. Refill the pots with another six gallons of water and set them on the stove to boil. When this water boils, it will make 14 gallons total so far. Just before pouring in the second batch of boiling water, it's a good time to add the lime. Use ½ cup of hydrated lime for this recipe which uses 14-16 gallons of water. Be sure to stir the lime into the water very well. If you're making a larger or smaller batch, adjust the lime accordingly. This will give the water a ph of 12-13 before the straw is added. This radical swing in ph, along with the heat will render the contaminants inactive for a couple of weeks.

Hoffman
Hydrated Horticultural
Lime
A hydrated lime that helps reduce soil acidity.
Satisfaction Guaranteed
Net Wt. 5 lbs.

5) Once you've added the second batch of water, it's time to put the wet straw into the pasteurization bath. At this time, the temperature of the bath will be around 180F, but as soon as you add the wet straw, it will cool it down to the proper range of 140F-160F. Simply use your hands to lift the straw out of the bath, let it drain briefly, then place it in the pasteurization tub.

Once all the straw is in the bath, stir it around gently to lift any lime that has settled on the bottom of the tub. Place a screen (hardware cloth works great) over the straw, and put whatever object you have handy on top to keep the straw submerged. Don't worry about a few floaters that escape the screen. They will pasteurize just fine floating on the surface. You don't want to mash it all the way to the bottom or pack the straw tight while in the bath, because you want the hot water to be able to circulate throughout the straw during pasteurization.





Now, put the double lid on the tub to hold the heat in, and leave it alone while you go clean up all the mess you just made. Make a note of the time. Check on it after 45 minutes, and if the temp is approaching 140F, go ahead and add a couple more gallons of boiling water to bring the temp back up. Don't worry about adding more lime. After an hour and a half, it's done. Don't go more than an hour and a half either, or you'll kill too much of the 'good bacteria'.

6) Ok, it's been an hour and a half and it's time to take the straw out of the pasteurization bath. Place the screen that was holding the straw submerged into the bottom of a clean tub, and transfer the straw to this new tub to drain/cool.

Cooling will take an hour or more. Don't waste all your hard work, by spawning hot straw. It will kill the mycelium. Leave the lid off the tub so air can get to it, and if it's cool outside, take it there. Don't worry about contaminants landing on your straw; Millions of them will, but with the high ph of the straw, they won't be able to grow for at least two weeks, and your log will be pinning by then anyway. By that time the mycelium will be strong enough to fight off all invaders.

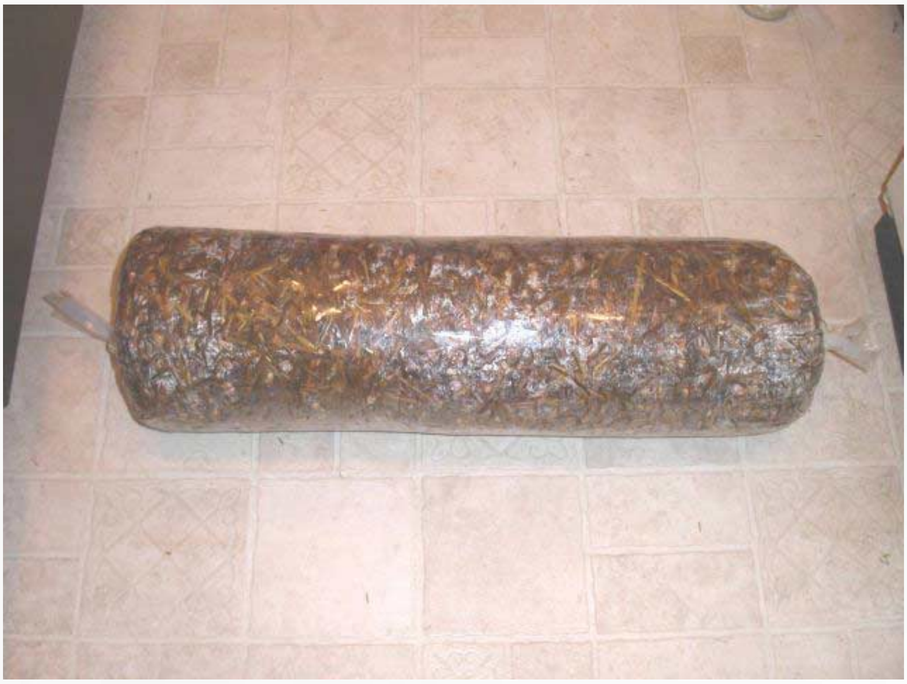
7) Now that your straw has cooled to room temperature, it's time to move it from the screen it's been draining on, to a clean tub for spawning. (You DID wash the pasteurization tubs while the straw cooled didn't you?) Don't squeeze it out or anything. The water that drains naturally while the straw cools will leave it at the right moisture content for spawning. At this time, cut your tubing to the appropriate length. We're making a 36" log, so cut it 18" longer than that.

Tie a knot in one end of the tube, and using a sharp kitchen knife, poke a few small holes in the plastic near the knot. These holes are to let the air escape as you pack the log. Take the 4-5 quarts of colonized grain or corn you have so carefully incubated, and beat them against a car tire to loosen up the kernels so they can be poured out into the tub of straw. I like to start with 2 quarts right on top of the straw.

Mix it into the top two to four inches only, before loading this top layer of spawned straw into your tube. Add another quart of spawn and mix it in, and continue the process until you reach the bottom of the tub, and your log is built. It seems to work better to thoroughly mix the spawn into the straw, as opposed to making a layer of straw, followed by a layer of spawn. This next part is VERY IMPORTANT. As you fill your log with straw, hold the straw in your hand, and gently sprinkle it down into the tubing, making sure it spreads evenly. You don't want big clumps of straw, with air cavities between them. After each handful or two of straw, stop and pack it down really tight with your hand.

Hold the tubing in one hand and pull up, while you stick the other hand down the tube and push down on the straw with all your might. I weigh close to 200 lbs., and I push down on the straw as hard as I can. It's very important that the straw is packed tightly into the tube. The mycelium can't colonize across large air gaps, so spread the straw out evenly, and push it down really good. Don't stand on it or use mechanical means to get it tighter. Just push as hard as you can with your hands, and that will be perfect.

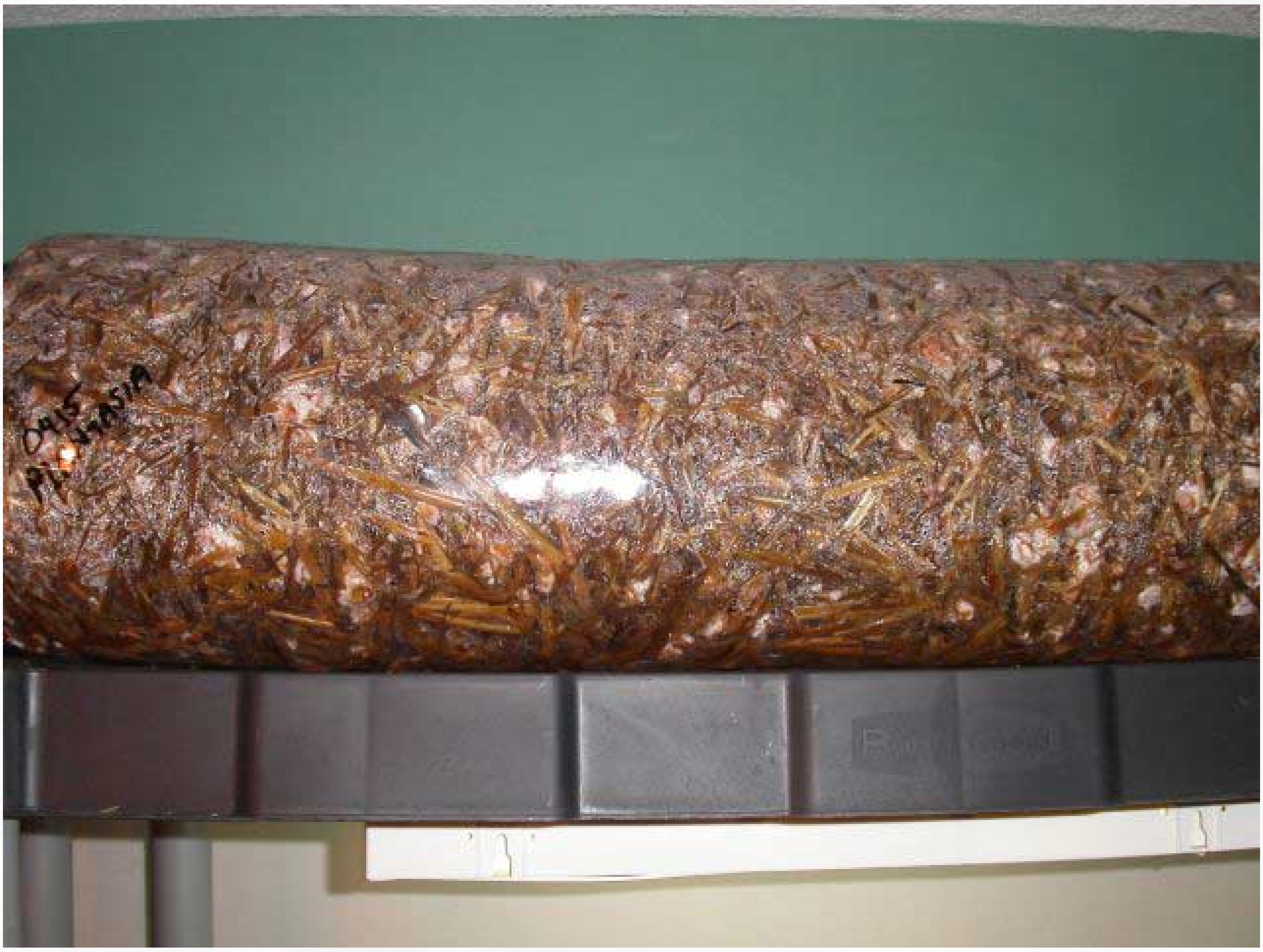
8) Now that you've filled up your tubing to within 9 inches of the top, it's time to tie the second knot, sealing the log. Push the straw down really tight, and squeeze the neck of the tubing against the straw. Holding the tubing with one hand, spin the log around with the other to wrap up the plastic tubing so you can tie a knot in it. Just make sure you tie the knot right against the straw, so the tubing keeps the straw tight. Now lay the finished (almost) log on the floor, and with both hands, roll it gently back and forth, to even up the surface. Roll it like a piece of dough, to get it very smooth on the outside surface.



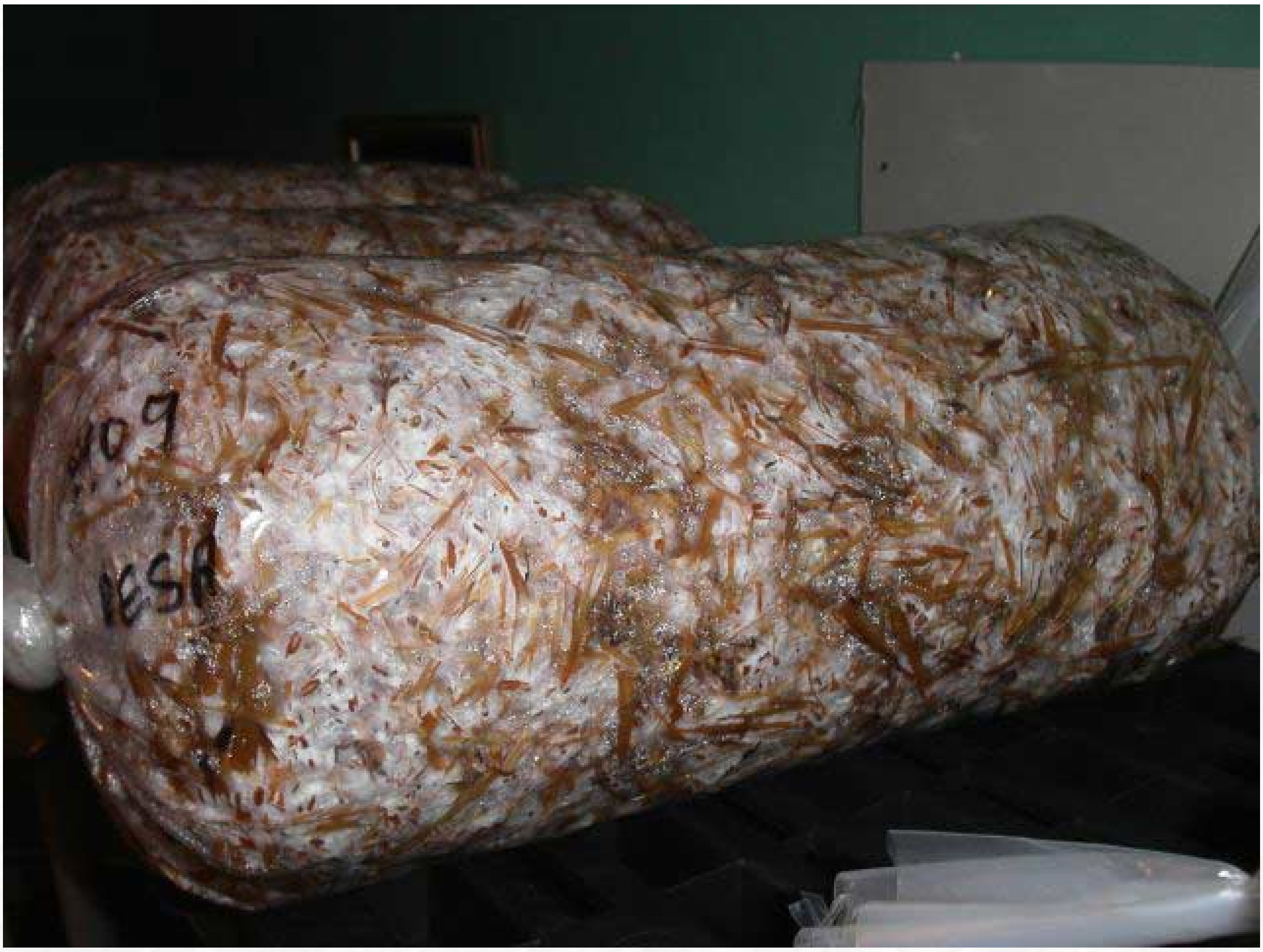
This is an important step to help achieve full colonization. Now, carefully take your log, and place it on the shelf you are going to incubate it on. Leave it alone for 3-5 hours, but not longer than 8 hours before doing this next step.

9) Almost done. Your log has been sitting for 3-5 hours now, so the moisture content has had a chance to equalize. All that packing during filling had pushed your moisture to the bottom of the bag. Some excess water may have run out the small slits you cut in the bottom of the tubing while you packed. That is good. Now, for the mycelium to colonize the straw, it needs a small amount of air exchange. It doesn't need a lot of air, just some. Also, you want to keep as much of the CO2 inside the log as you can during colonization. I use a hunting arrowhead to punch holes into the tubing. You can just as easily use a sharp knife, or box cutter. Cut slits in a + shape about every 2 to 3 inches all along and around the log. The slits only need to be half an inch or so long. Just make sure no place on the log is more than 3" from a vent. The idea is to have a small amount of air exchange, while maintaining moisture content. Now, put your log into its final fruiting location, and don't touch it again until you see pins forming invitro. This will be in two to three weeks. The growing mycelium HATES to be handled, so resist the temptation to pick up your log, or otherwise disturb it. Let it be exposed to normal room lighting during colonization, and don't let the temps get too high. Room temperature is fine. With a marking pen, record the date and strain on the end of the log.

The logs will produce more than casings, and much faster than casings, hands down. Yeild is hard to pinpoint, because so many other factors come into play, such as the age of your spawn (senescence), vitality of strain, temps and humidity, your ability to LEAVE THE LOGS ALONE to colonize, etc. Here's the catch 22; larger logs yeild much better, but they are more likely to get bruised by handling if you move them in any way. I found by experience that smaller logs don't bruise as easily, but they tend to dry out sooner, and the fruits are smaller. Here's an example of how fast this works. This picture is the 36" log built 24 hours ago to demonstrate this tek. As you can see, the corn is already growing out.



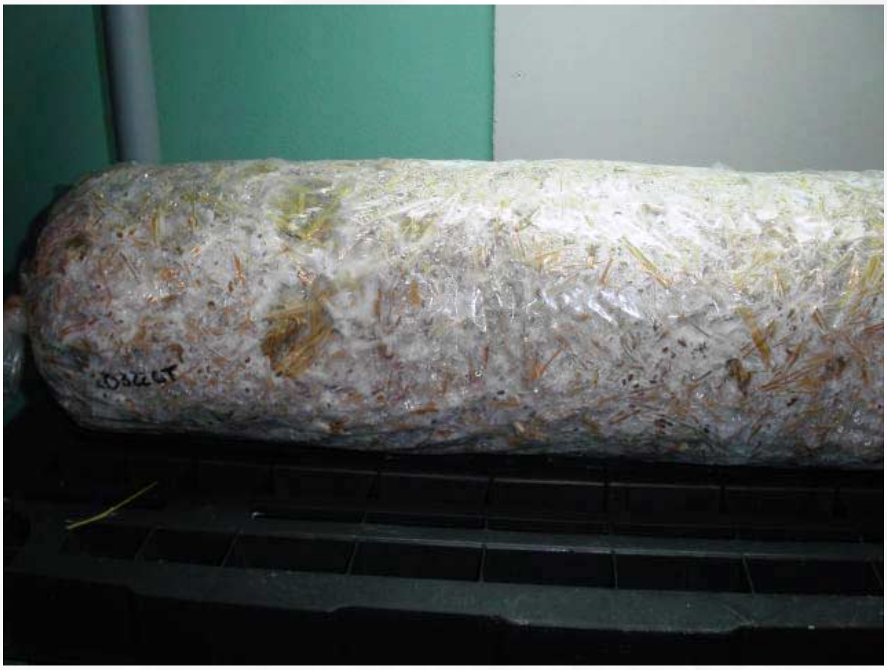
The picture below is a log spawned 7 days ago. Almost full colonization!



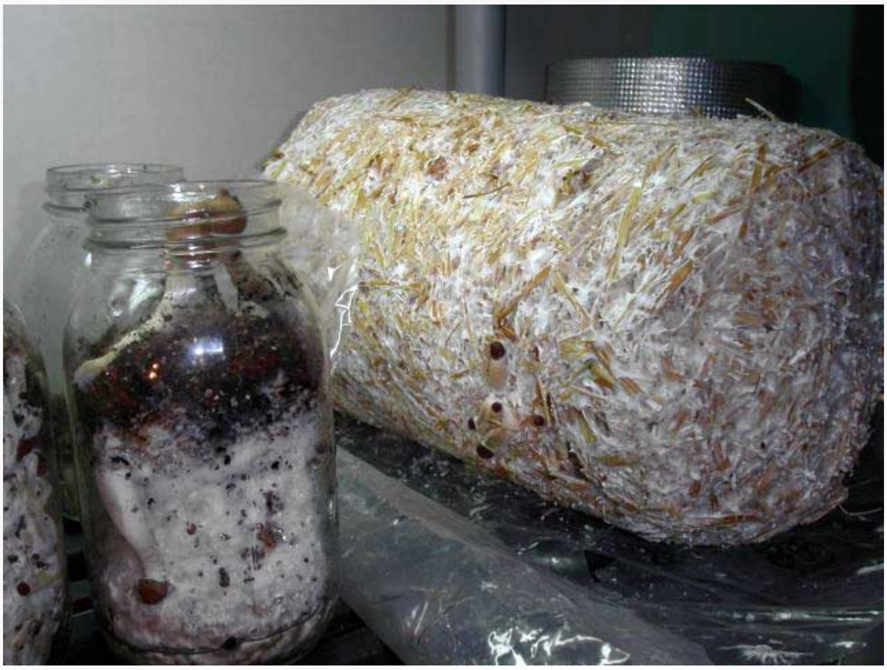
10) It's day fifteen, and you have pins! You've noticed for a few days already, that you had full colonization. It's time to birth your log. Try to do this without moving or disturbing the log in any way. Use sharp clean scissors to carefully cut the knots off both ends of the log. You'll have to cut a circle around the knot to get it off. You can't cut the whole knot off in one snip, because it's up against your log, and you'd bruise the mycelium. Once the knots are cut off, carefully cut the tubing lengthwise along the top edge of the log, trying not to touch the mycelium with the scissors. Peel the plastic down and away from the log, exposing the entire surface to air, then gently and loosely fold it back into place. There should be lots of air gaps around the log now. Once each day, fold the plastic back, then immediately replace it. This will stimulate a massive pinning. You can cut another length of tubing to go over the top of the log where the seam is, to keep it from drying out. Be sure to cut lots and lots of holes in this plastic. All you want to do is slow down the rate of evaporation, so you don't have to mist. You do want lots of constant air exchange. If you see a great deal of condensation forming on the plastic sheeting, make the holes a bit bigger. As your log fruits, the mushrooms will push the plastic away from the log as they grow. Don't worry about the fruits being in contact with the plastic. It won't hurt or bruise them. They'll love the humidity, and you'll love not having to constantly mist.

original source: http://mycotopia.net/archives/discus/messages/5/26705.html

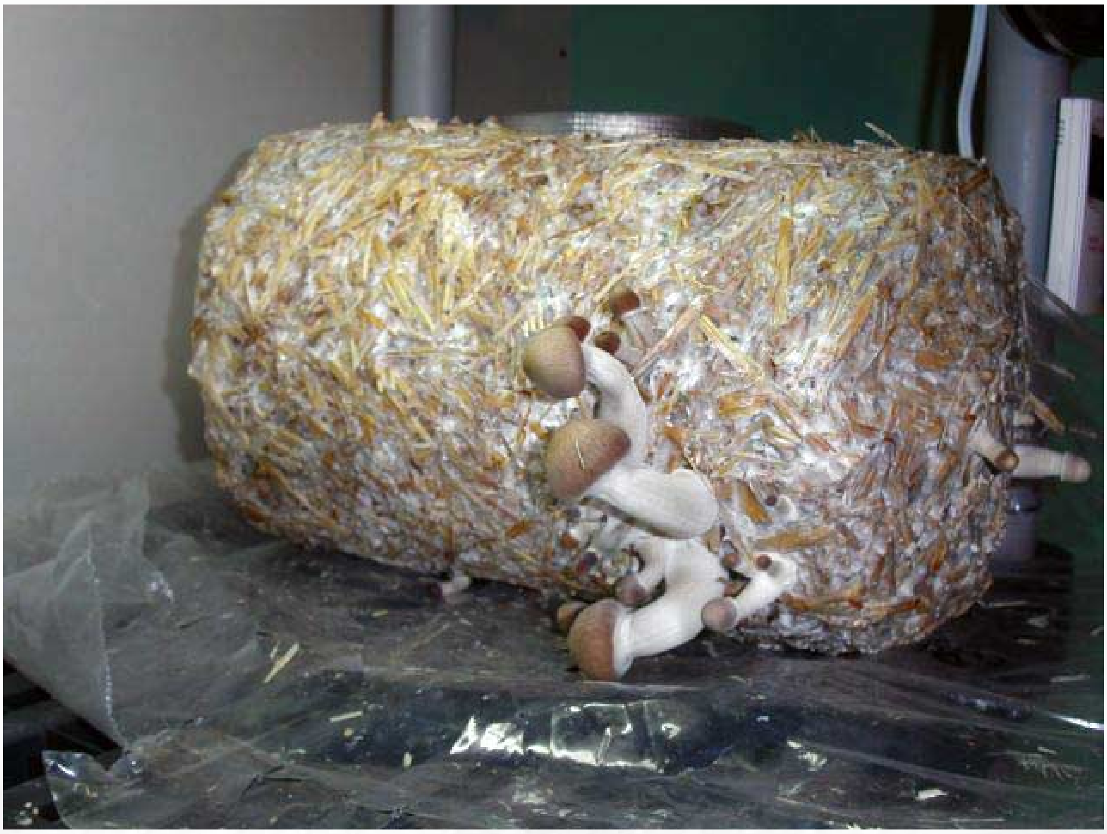
I've been working on this new TEK for a few months now, trying to perfect the process. I hope a bunch of you will try it and let me/us know how it goes. I think it's the next logical progression from the Laundry Basket TEK, because it completely eliminates the need to mist. The straw gets colonized inside a vented plastic tube, so the moisture and CO2 stays inside where it belongs. After the first few pins form (invitro), you cut the plastic off, and use it as a 'humidity tent' to allow air exchange while keeping the evaporation level under control, so the most awesome flushes can develop. I'll write the full TEK and post it here if anyone is interested. These straw logs produce the FASTEST and largest crops I've ever seen. The logs you see in the pix below were pinning on the 14th day after spawning with grain. The longest I've waited for pins to form was 18 days. Some were spawned with rye, and some with corn. I've made straw logs anywhere from 12" in length up to 72". The smaller ones are easier to handle, and I've stopped making them any longer than 24" for that reason. The six foot log weighed in at over 100LBS, and was very hard to move after full colonization without bruising the mycellium. The fruits form in a full 360 degrees around the log, so the yield is incredible. You don't case, don't fan, and don't mist! The 48" log you see below produced 17 lbs of fresh mushies, including the 74 gram fatty, on the first flush, from less than a dollars worth of straw. It was spawned with 6 quarts of either rye or corn, I forgot which. (I've even mixed rye and corn together in the same log) The 72" log 'only' produced 18 lbs, because I damaged it quite a bit getting the plastic off. After full colonization, they don't like to be moved, because if the log flexes, it bruises the mycellium. Try to let them incubate where they will fruit at. I incubate mine on a shelf in a 72F room. Enough heat is produced by the mycellium running through the straw, that if it was in much warmer of a room, it would overheat and kill the myc. The 12 inch log shown below has over 100 pins on it, so I think smaller logs are the way to go.



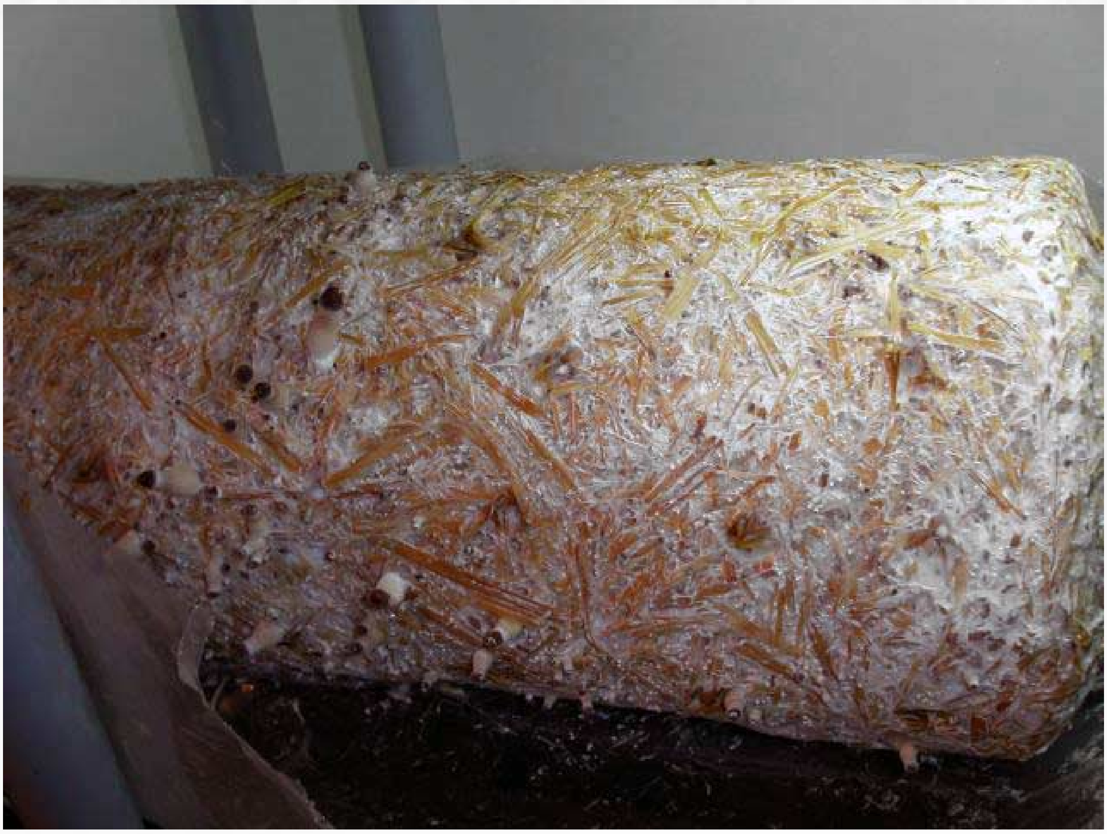
Full Colonization. Invitro pins forming. The two spots you see at the left that aren't fully colonized is where I didn't pack the straw tight enough in the tube. You want to really pack it with all your weight, so it's pressed tight against the plastic tubing.



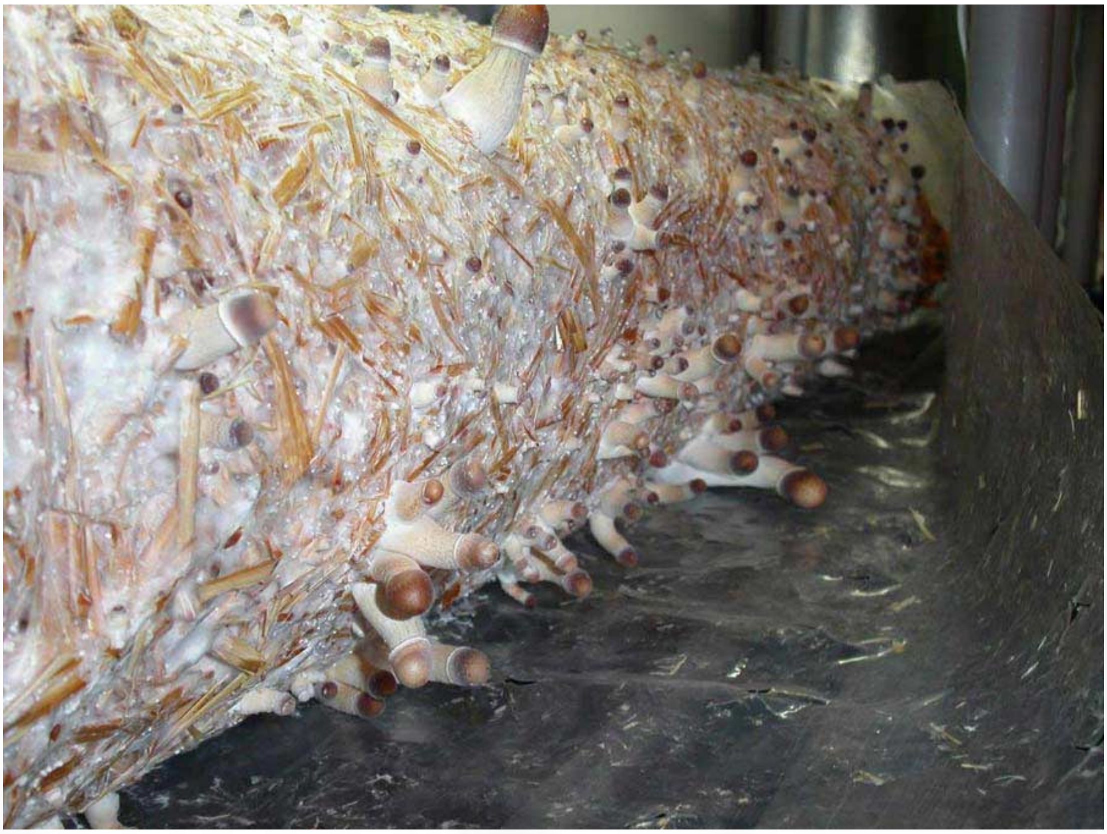
A 12 inch log that has just been 'birthed'. Use scissors to cut the tubing along the TOP edge of the log, and let it serve as a 'tray' for the log to sit on. (you can cut another piece of plastic to lay loosely over the top to keep the humidity up, just be sure to poke lots of holes in it for air exchange) Also if you HAVE to move the log, use the plastic so you don't touch the log.



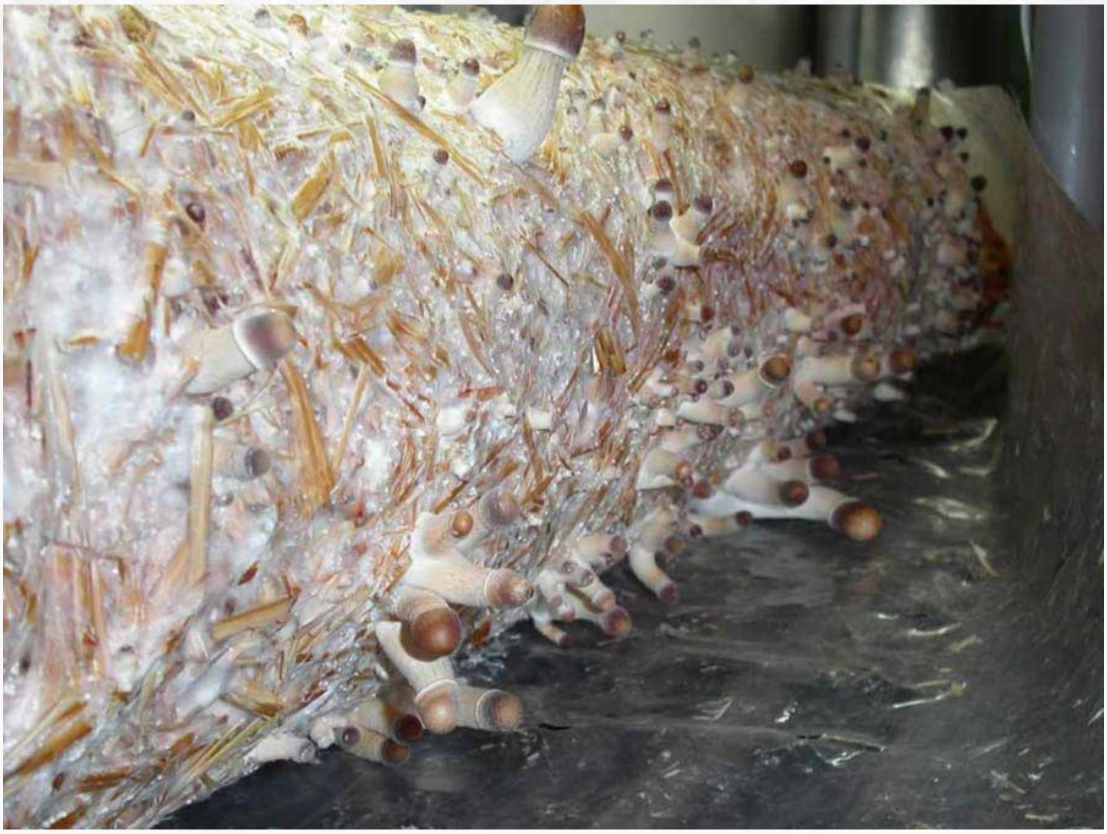
The same 12" log, 24 hours later.



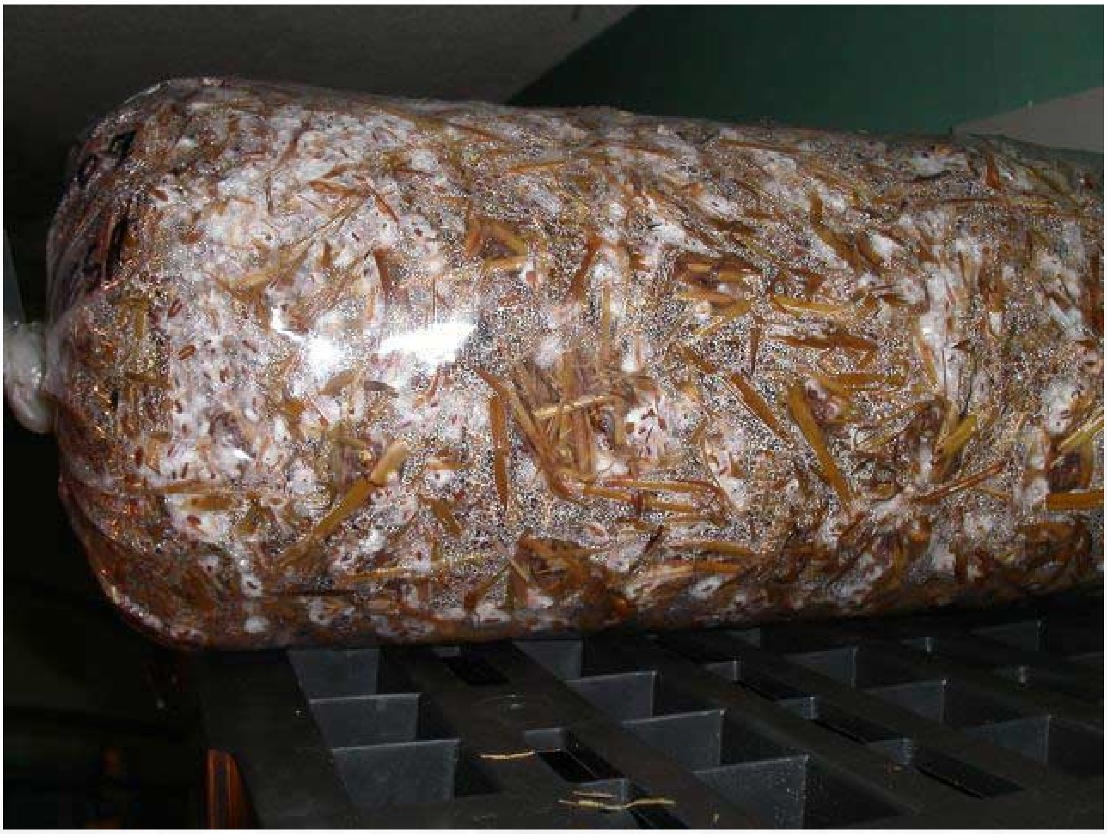
This is a 48" log, 24 hours after birthing.



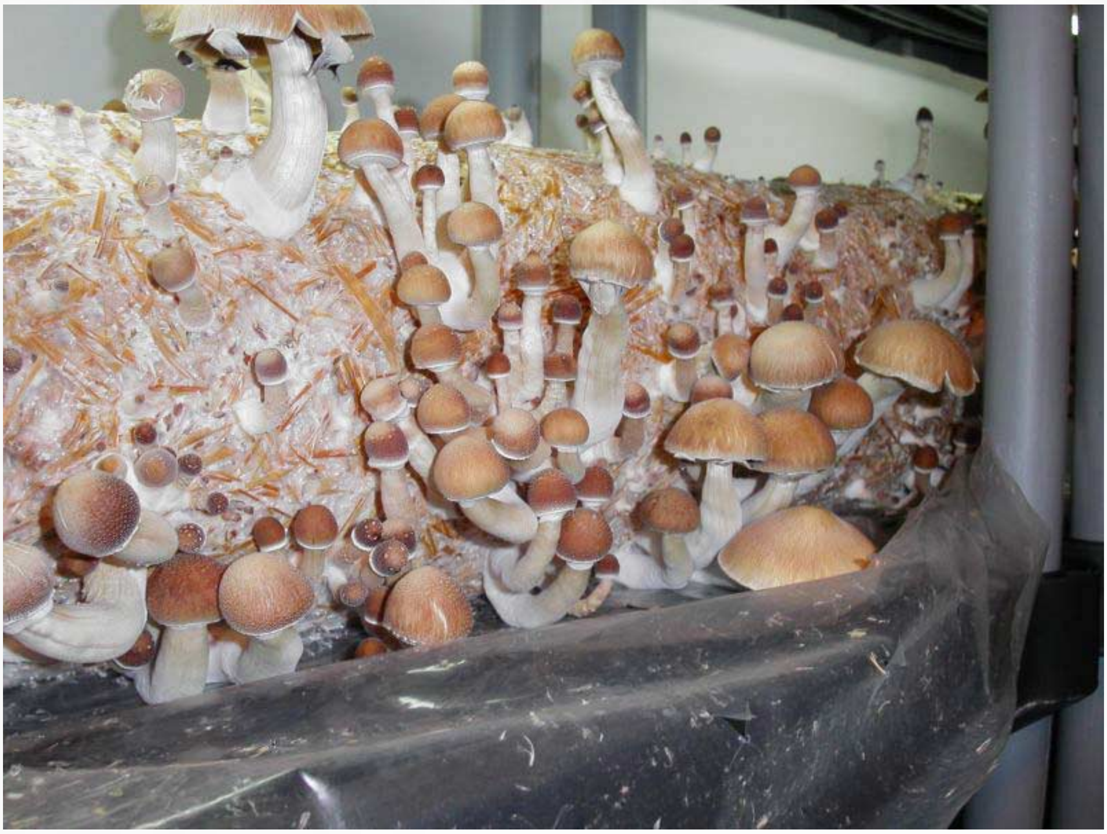
The same log, 48 hours later. Notice how the pins just exploded! I counted over 800 pins before I lost count. All on less than a dollar's worth of straw!



Here's a 24" log, on the second day after spawning. You can clearly see the mycellium growing out of the rye, and into the straw.



I've only pulled 5 aborts out so far! For some reason, they don't abort on the logs. I don't know why. I've had ZERO contams, probably because the straw colonizes so fast, and this is in a house with wall to wall carpet. Hell, I even build the logs on the kitchen floor. Can't think of a worse place, but it's all I have.



Hungry?

Mushroom Mans Sock Log Tek

by

Mushroom Man

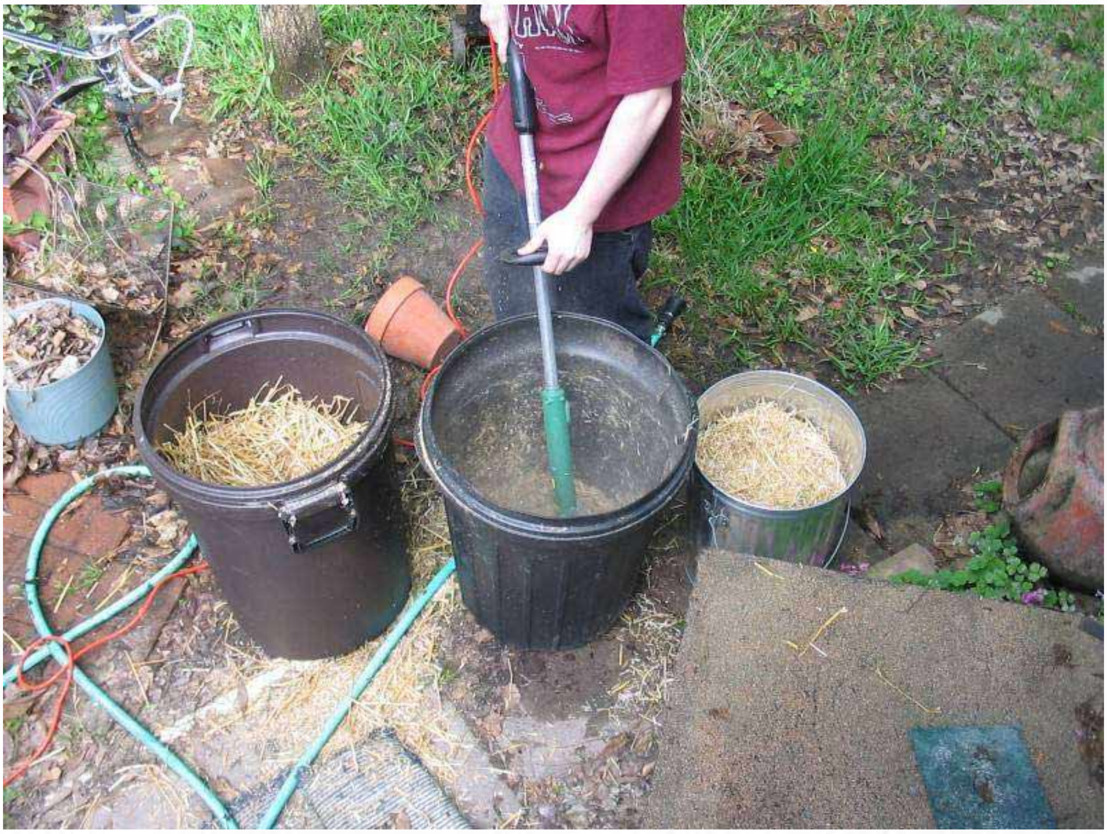
original source: http://mycotopia.net/archives/discus/messages/5/135826.html

I'll try to make this easy for ya, so i'm including this list of supplies you will need to get before doing this tek.

Supplies.

- Straw (Can be found at most feed stores for $4 a bale.)
- Something to chop the straw. (Scissors, weed eater, lawn mower, chipper/shredder)
- Colonized grain (You can use WBS, rye, or any other suitable grain)
- Drainsleeve Filter Fabric Sock for Perforated Drain Pipes (Home Depot $20 for 100ft)
- Insulated Cooler (For holding your pasteurizing straw)
- Form to pack straw in (4in PVC pipe, or wood frame.)
- Zipties (You can skip this one if you are good at tying knots)
- Vermiculite (Found at hydroponic stores and nurseries)
- Pillowcase (To hold straw while pasteurizing)
- Thermometer (So you don't overheat the straw)
- Craft Hoop(Used for stretching fabric in to stitch through. Can be found at craft stores)

The first step is to chop up your straw. You need to get the pieces of straw somewhere between 1 and 3 inches long. What I do is i use a weed eater to chop it in the bottom of a trashcan. It really shreds it, almost to the point of being straw flakes. Another way to chop it is by hand. Chopping by hand can become a real pain after a few logs. Another good way to chop it is with a lawnmower, or leaf shredder. Its not too important to get the straw the perfect size, just around the right size, you can have some long pieces here and there, doesn't matter. In the picture you see the unchopped straw on the left, the straw being chopped in the middle, and the chopped on the right.



The second step is to get the straw in a pillowcase and get it soaking in lukewarm water. You need to do a one hour soak before pasteurizing the straw. One pillowcase full of straw will be enough for 3 foot long logs. After the hour long soak, you take the straw out of the water and let it drain while you do the next few steps. First get a large insulated cooler with a lid, and pour a few large pots of boiling water in (enough to cover the straw thats draining). Then, use your thermometer to check the temperature of the water, when the temperature drops to 180, put the pillowcase of straw into the cooler, and close the lid. You might need something to hold down the straw while it pasteurizes. Once you put the straw in the cooler, you start a timer for 1 hour. After one hour, you open up the cooler and check the temperature with a thermometer. If the temperature is down to 155 or lower, add a pot of 180 degree water to bring the temp back up. If the temp is high enough, then just close the cooler and leave it for another hour to finish its full 2 hours of pasteurizing. Once the straw is done pasteurizing for 2 hours, take it out and let it drain until it cools. You can let it drain overnight if you want. Here is a picture of the straw during pasteurizing.

The next step is to toss the straw into a tub to do your mixing in, i recommend doing half a pillowcase at a time. After the straw is in the tub, you can throw in some vermiculite to add moisture, you can use anywhere up to 50% vermiculite for your logs without negatively effecting yield (it can actually yield more with verm). To get the vermiculite ready, bake it in an oven at 400F for about 30 mins, then rehydrate with water.

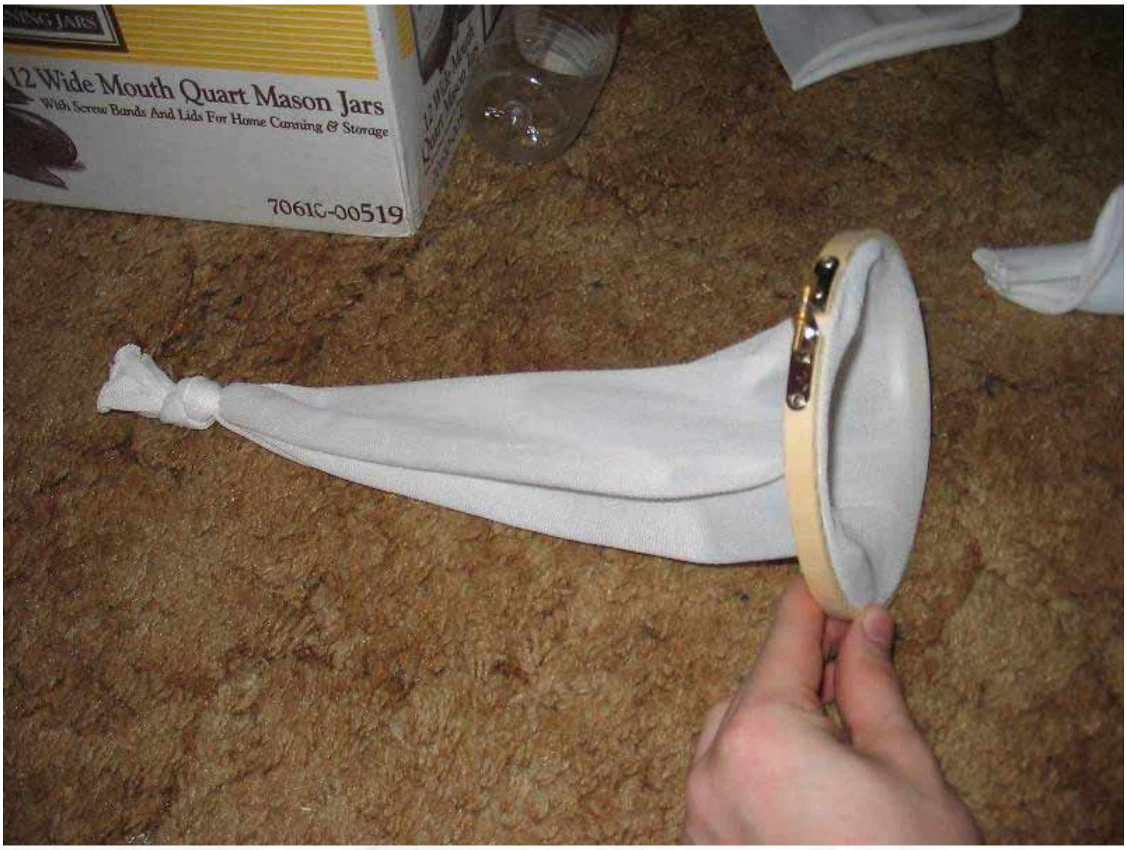
Then, toss in some colonized grain. For every full pillowcase, you need 2 quarts of grain, and half a pillowcase is 1 quart. Make sure the grain is good and crumbled up so it mixes in good.

Then, mix it all up. The grain usually falls to the bottom of the tub while mixing so make sure to grab the straw seed mix and roll it over and mix that around to get it evenly everywhere (you'll understand when you do it).

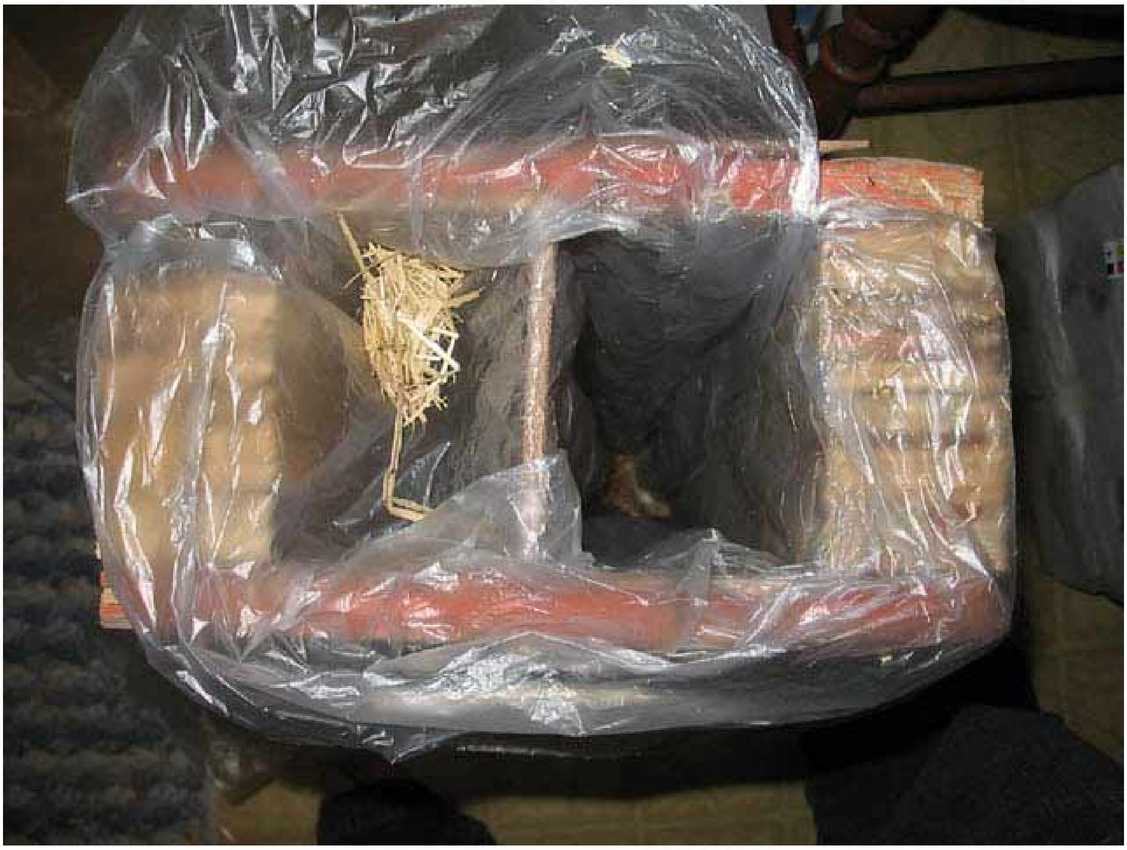
Okay, now that its mixed real good, you can start on getting the fabric tube ready. First, cut off a section about 1 1/2 feet long.

12 Wide Mouth Quart Mason Jars
Kerr
HOME CANNING JARS
12 Wide Mouth
Quart Ma
70610-0
70610-00519

Then tie one end, and put the hoop on the other.

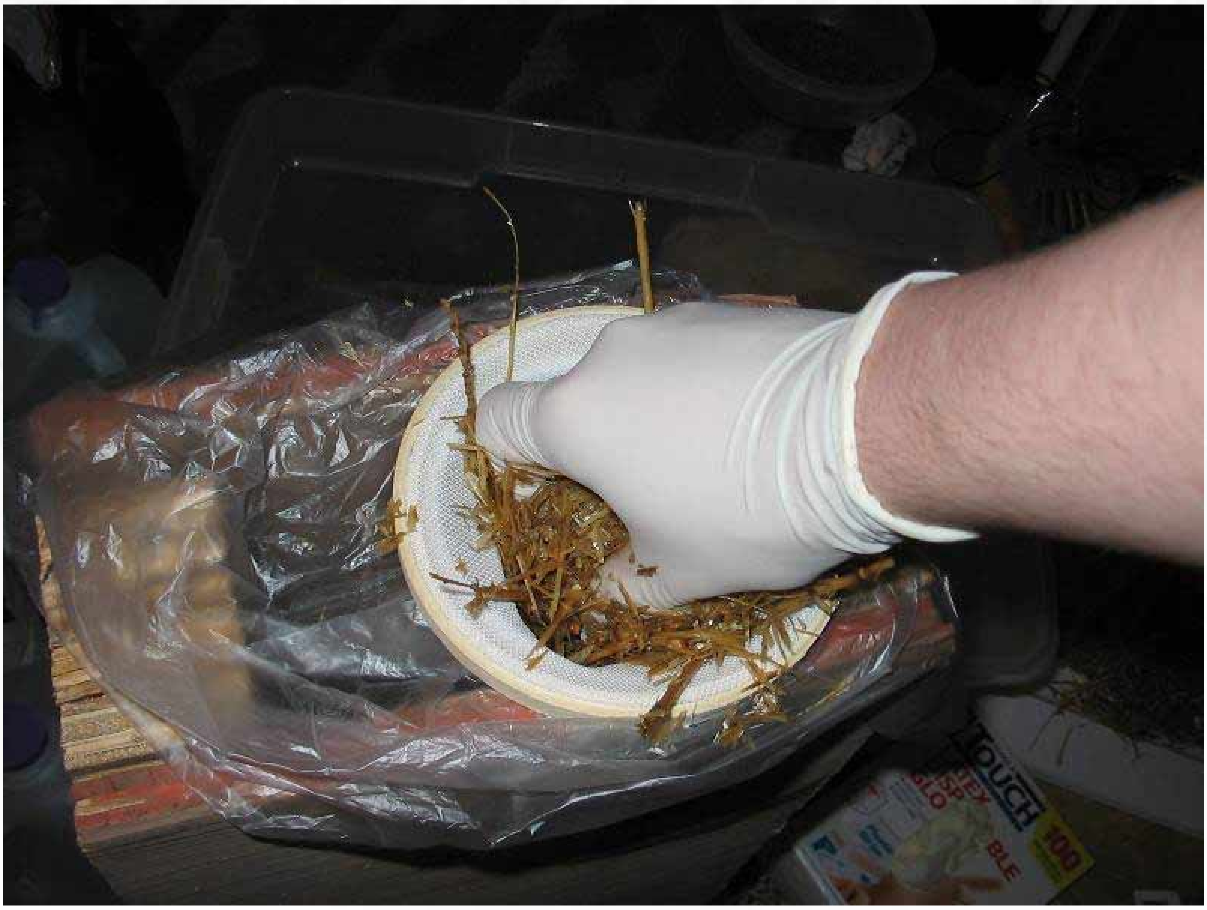

12 Wide Mouth Quart Mason Jars
With Screw Bands And Lids For Home Canning & Storage
70610-00519

The next step is to drop the fabric tube into some sort of form to hold it while packing. You can use 4in PVC pipe, or a wood form like i made. If you use a round form made of pvc pipe you can get a hoseclamp and clamp the fabric right onto the pipe instead of use the fabric hoop, it will work alot better. I used a layer of plastic with my form because i didn't want the fabric tube to touch the wood or catch on any splinters. Make sure to get the tube all the way down in the form.

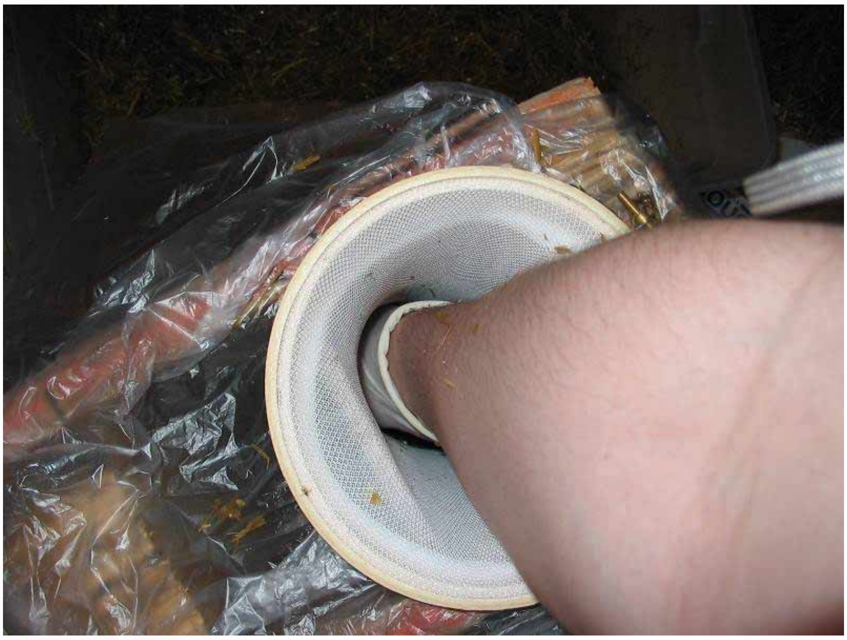


Next, grab a handfull of straw and ball it up as tight as you can.

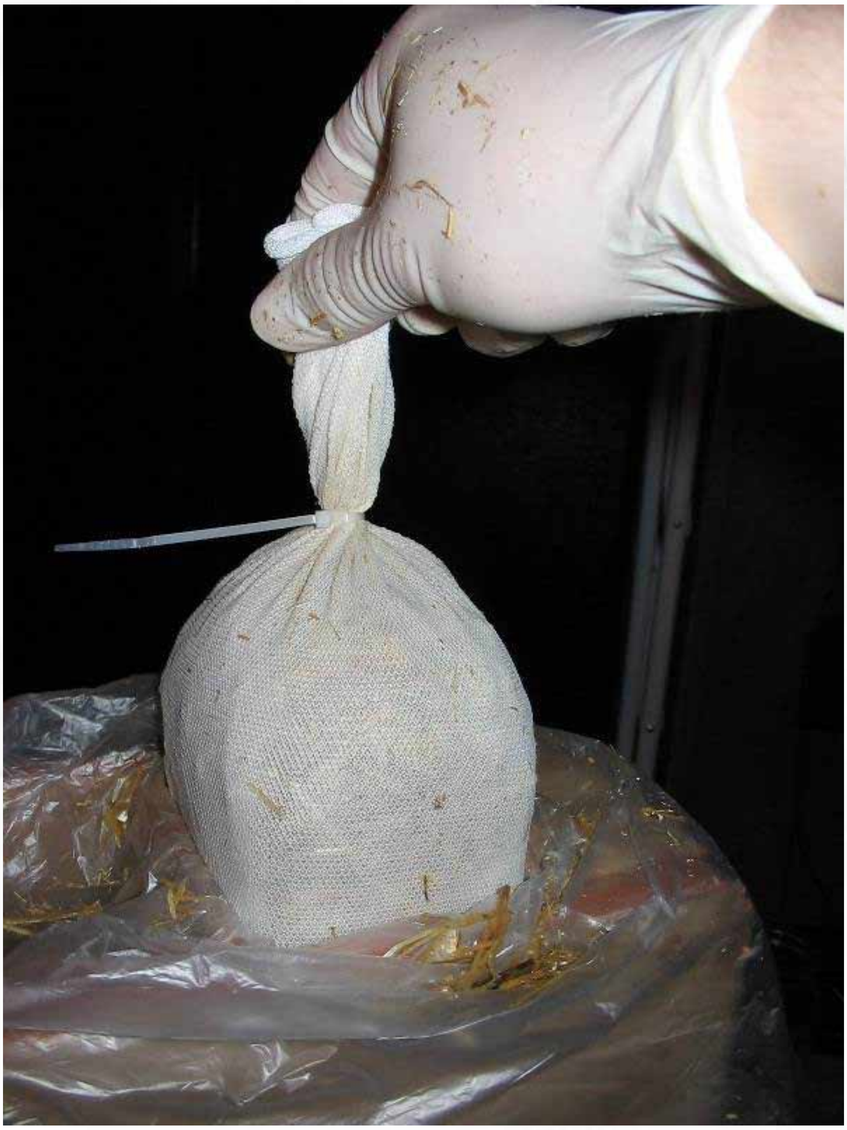
Then place the ball of straw in the opening of the tube.



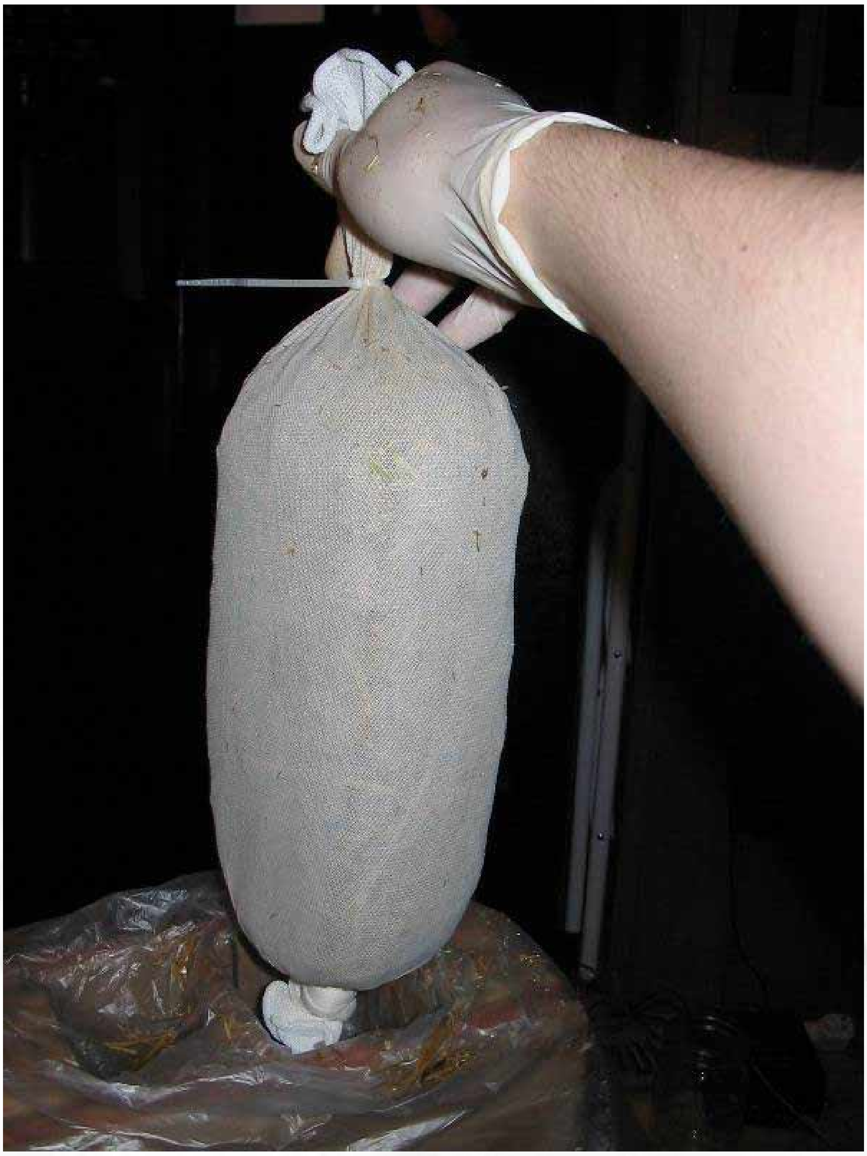
And shove it down as far as you can with your knuckles Make sure to push hard and get it packed really tight, then pack the straw to the sides with your fingertips to make sure its tight everywhere.



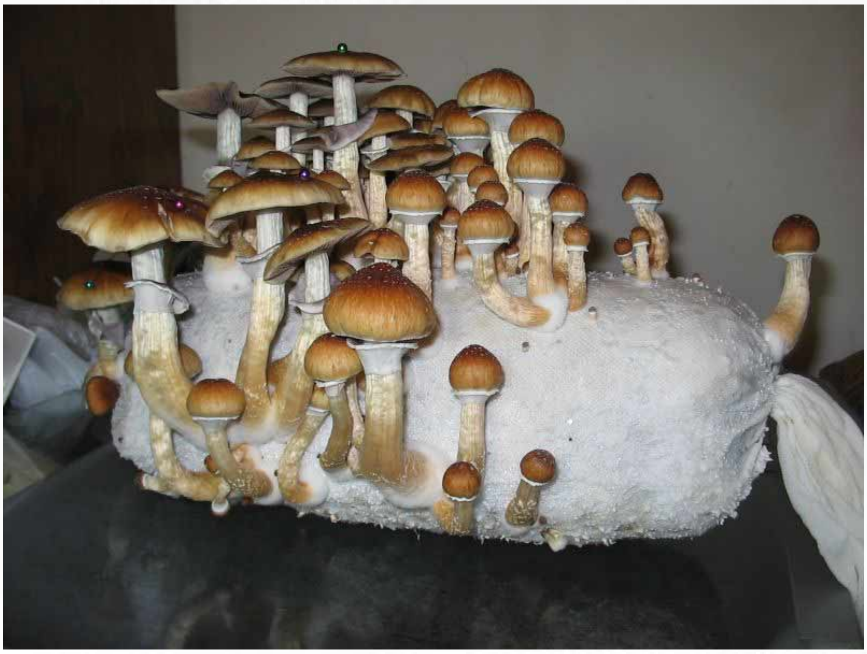
Keep packing straw until your are a few inches from the top, then take off the hoop, and pull the log out a little bit, twist up the end of the fabric and put a ziptie on the log.



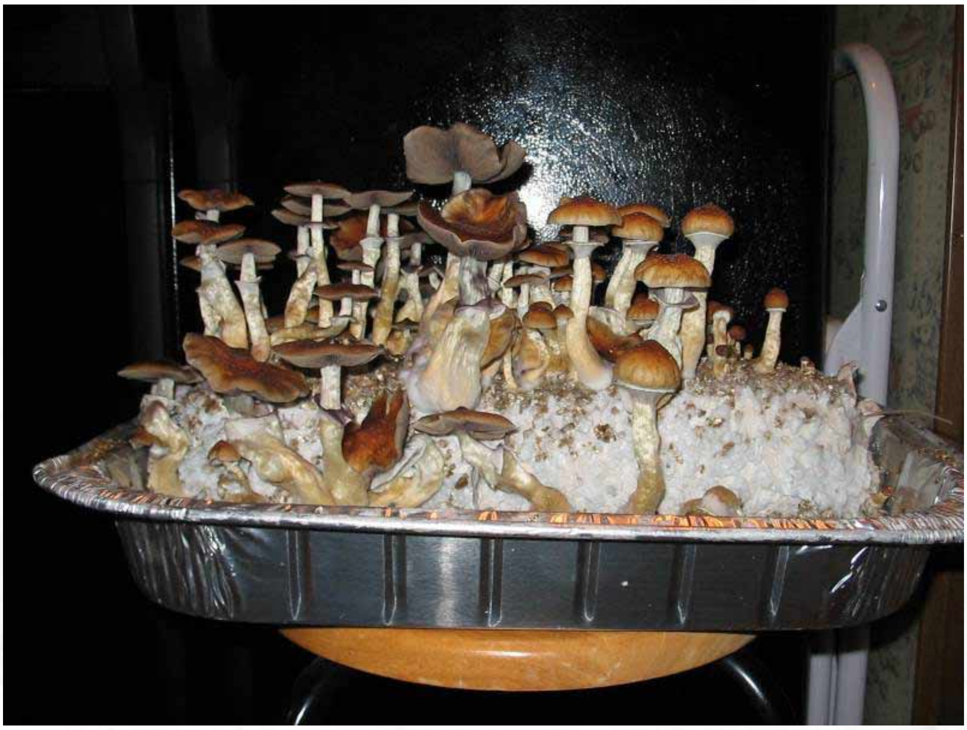
Pull it out, and you have just made your very first sock log. Congratulations!!! Now you can put the log into any terrarium for colonization.



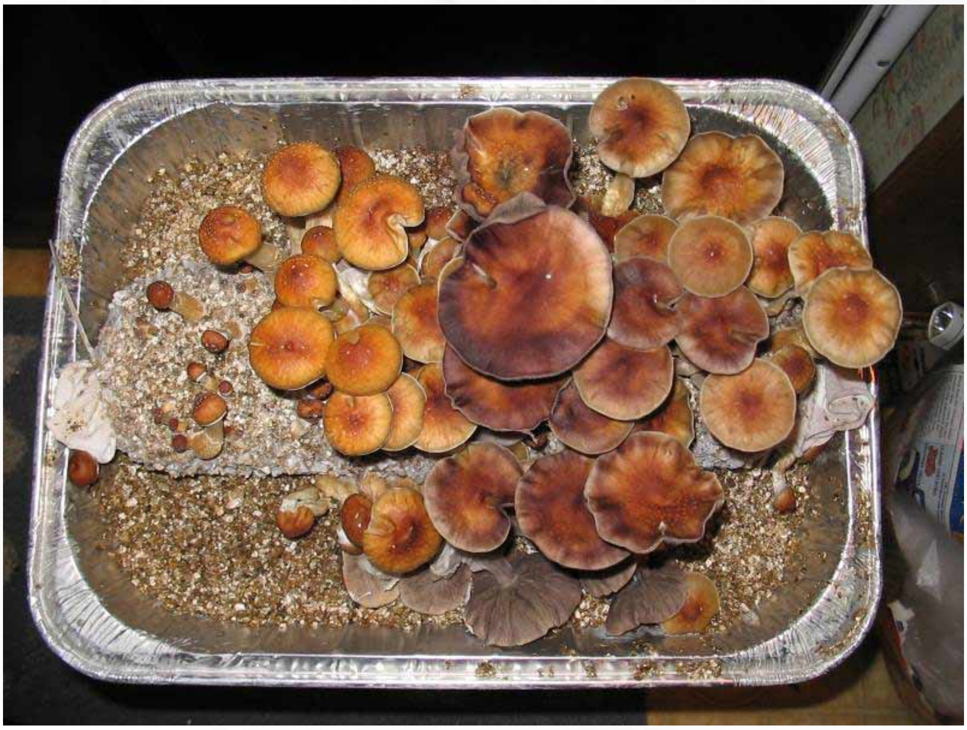
When its done, it should look something like this.



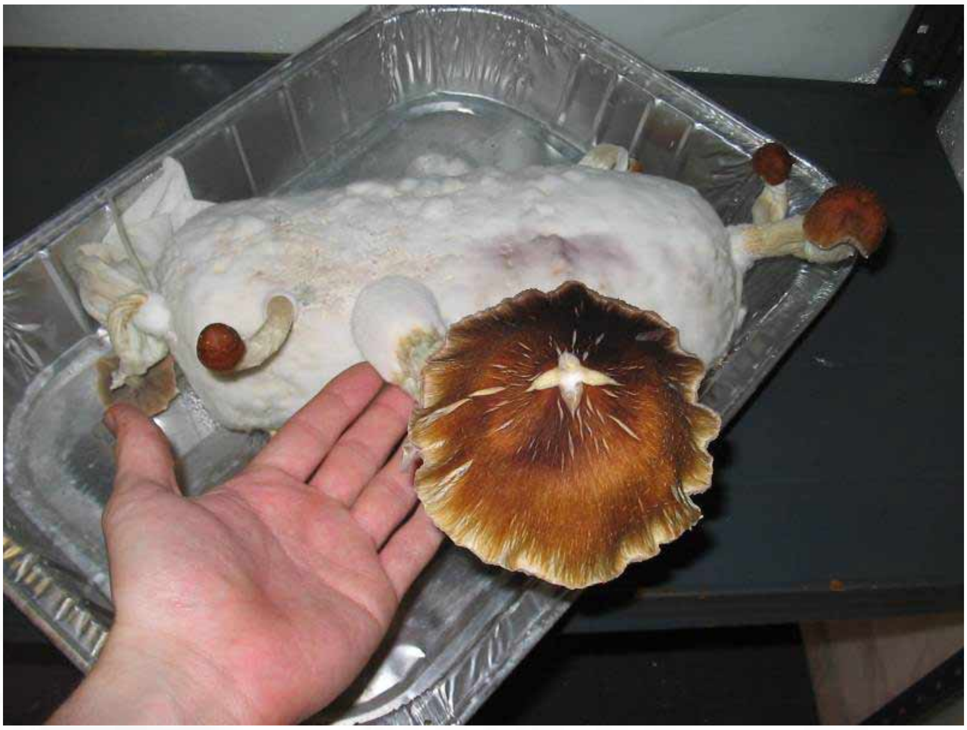
I'm back with a few updates. First, it seems that the sock logs need either vermiculite in them, or on them like a casing. I've done a side by side test of two logs, the cased one (not made with vermiculite in it) has finished flushing with a massive yield, and the uncased (no verm inside) has about 5 puny mushrooms on it. A good amount of vermiculite to use in the logs is somewhere between 10% and 45%. If you choose to case the logs instead, then a half inch works fine. The vermiculite content of the logs also seems to have an impact on how the log colonizes and fuzzes up. Without vermiculite in the straw mix, the mycelium grows through in long spikes, and does not like to pin, and with vermiculite, the fuzzing is even throughout. I think it is because the vermiculite fills in the gaps in the log, makes it more dense, and adds moisture content to the logs. Here is a picture of the square cased log I did, its yield is 671 g wet. Notice that it didn't pin on the sides where there wasn't any vermiculite. A little vermiculite added to the mixture will make it pin all over.



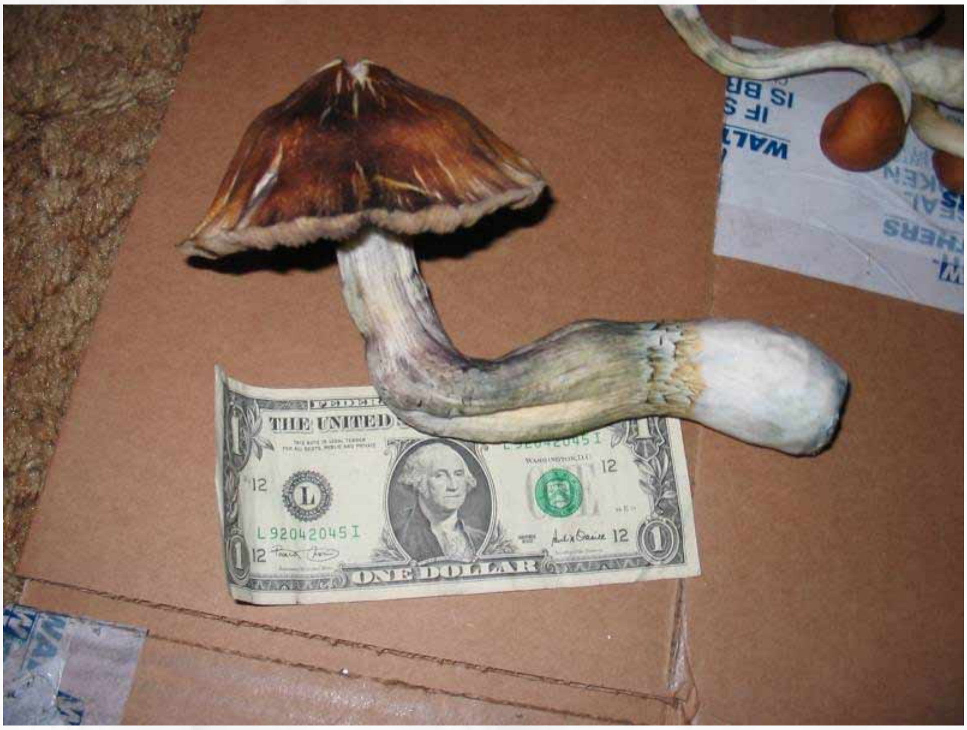
Top view. The log was birthed into an aluminum tin with vermiculite in it, and covered with about 1/4 to 1/2 an inch of vermiculite. [671g wet yield.]



As for the first sock log I made, it just finished its second flush. I never even dunked it. Its vermiculite content was about 45%. Here it is right before harvest.



Largest shroom from second flush. Isn't it beautiful. 120g wet. I had to break it in half to weigh it.



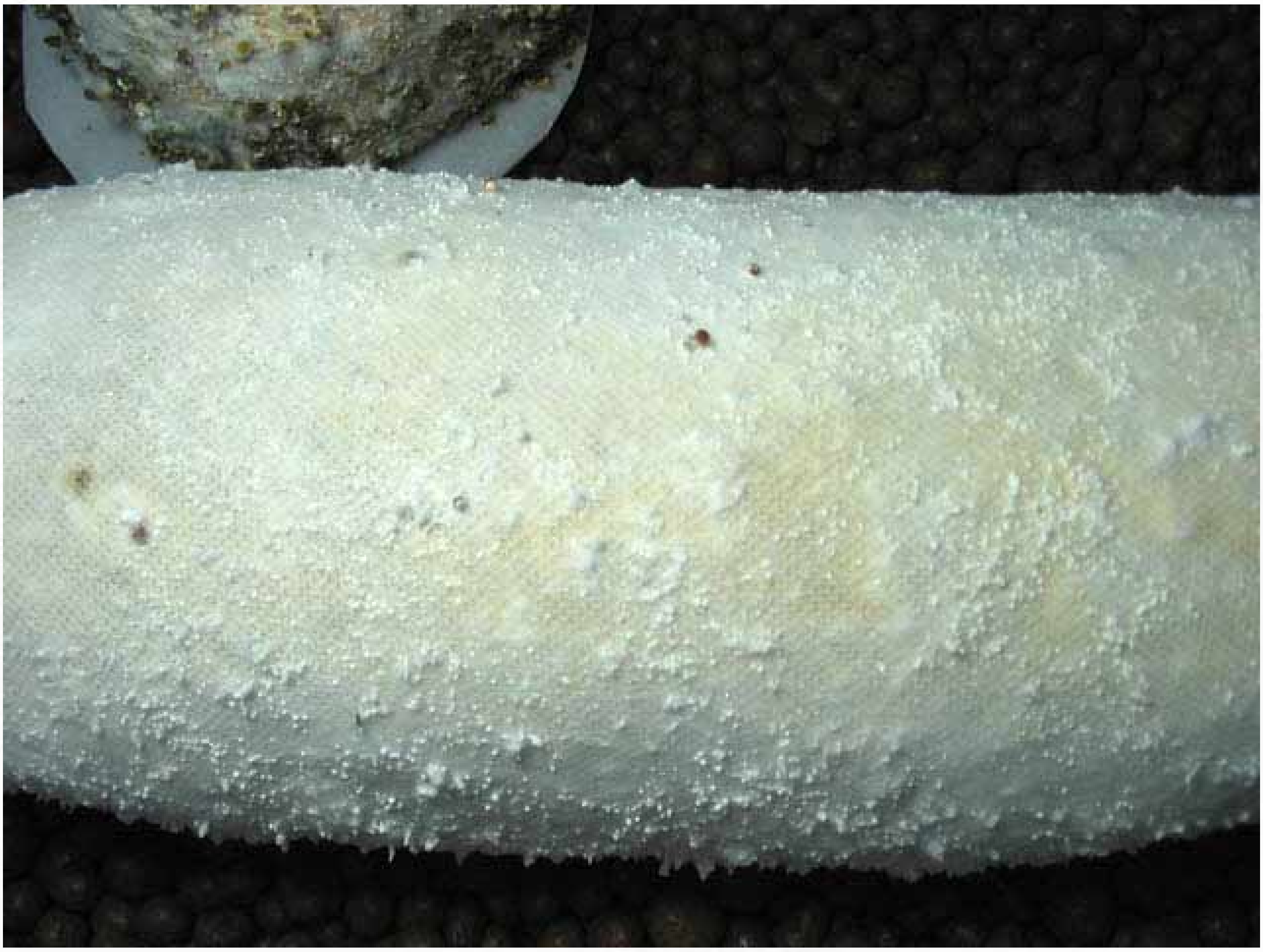
I should add that i'm currently trying a log with vermiculite in it, and on it. I'm also working on a form to make triangular logs (those should be neat). My hanging log is knotting up, so there should be results of that soon also.
I never really incubate the logs, they sit at room temperature which is about 78 most of the time. When its time to fruit the logs I crank up the AC and drop the room temp to about 70. I've always given my logs regular room lighting conditions, and regular temperatures. I've never really had that much of a problem with pinning. As for second flushes, there are always alot less shrooms. Soon i'll be adding dung to one of my logs to see how that works out. I've got a bag of worm castings, and i'm making some more logs tomorrow, so we may find out how that works out really soon. I'm going to try dunking the sock log and go for a third flush. I've got a nice

idea for dunking the logs by attaching hooks to the bottom of a tub and hooking the fabric to the bottom of the tub when its full of water. The logs float alot, and you could dunk quite a few logs that way.

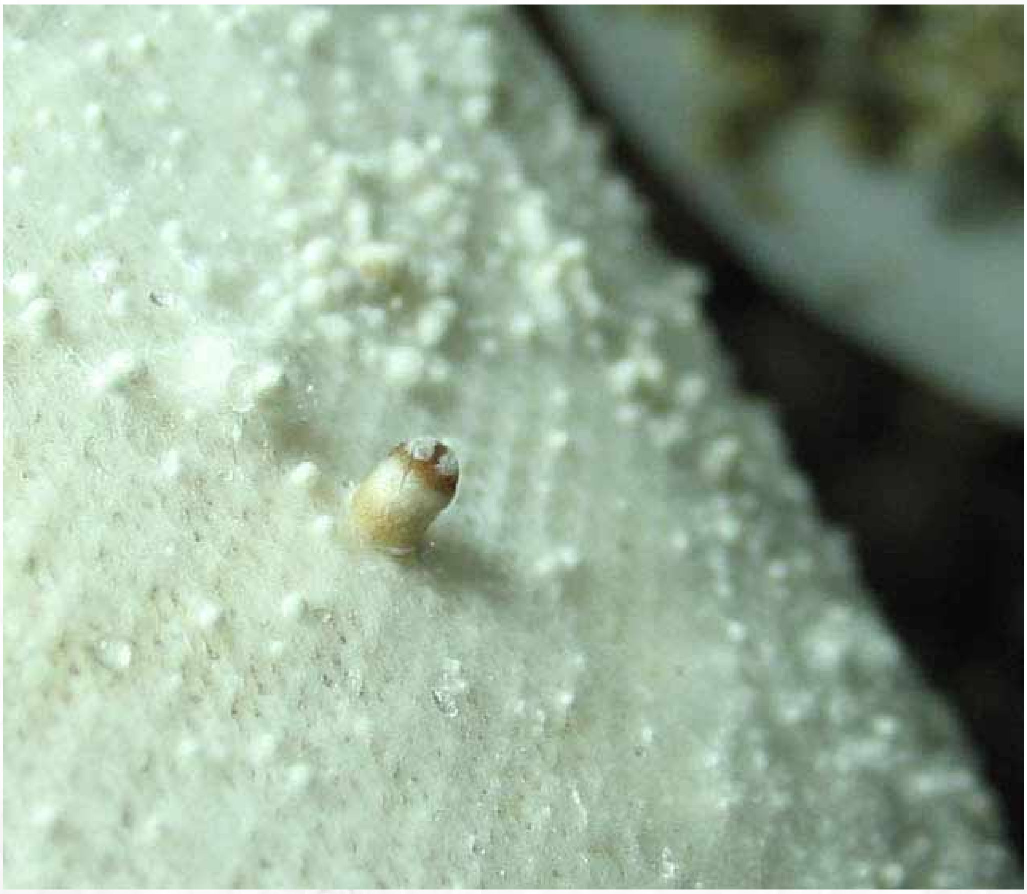
Skyypilot, the fabric is much too thin to be used as a casing itself, its actually see through. I have been thinking about the second fabric and vermiculite layer, but i'm going to put that off till later. I chop my straw really fine, almost like straw flakes, so thats why i like to use vermiculite, and it increases the weight of the flush alot, so far, it seems like mixing in vermiculite is the best way to go for ease and performance. The vermiculite on the outside is just there because those logs did not contain any vermiculite inside them, and i saw how poorly they performed, so it was pretty much an attempt to save them. The yield from my one foot long 4in wide logs is about 1.5 pounds wet, and about 6 logs produces one pound dry. I can guarantee that the straw is dense enough, i've packed them so hard, i've ripped the fabric and stretched the plastic tubing. One of my 4in wide foot long logs (without vermiculite) typically weighs in at 1000g right after i make it. Also, the purpose of the sock material isn't to hold moisture, but to hold things together. It makes things alot simpler, you don't have to worry about straw being stuck to the mushrooms, its really easy to pick,and they colonize a bit faster than polytube logs. I've tried larger logs without the sock material and I never seemed to get that much of a better yield per cubic inch of straw. Sorry if this doesn't make much sense, I haven't slept much lately.

original source: http://mycotopia.net/archives/discus/messages/5/136901.html

I've been working with the log tek for some time now, and i've been doing a few experiments. A few weeks ago i was at Home Depot and found some tubing made of fabric. The holes in it were small enough to hold straw, but also let mycelium grow through. So a few days after that, i made a log out of it. Here is what I have now.



You can see that the mycelium grew through the fabric and knotted up on the outside. The pins are on the outside just like i had hoped. Closeup of pin on outside of fabric.

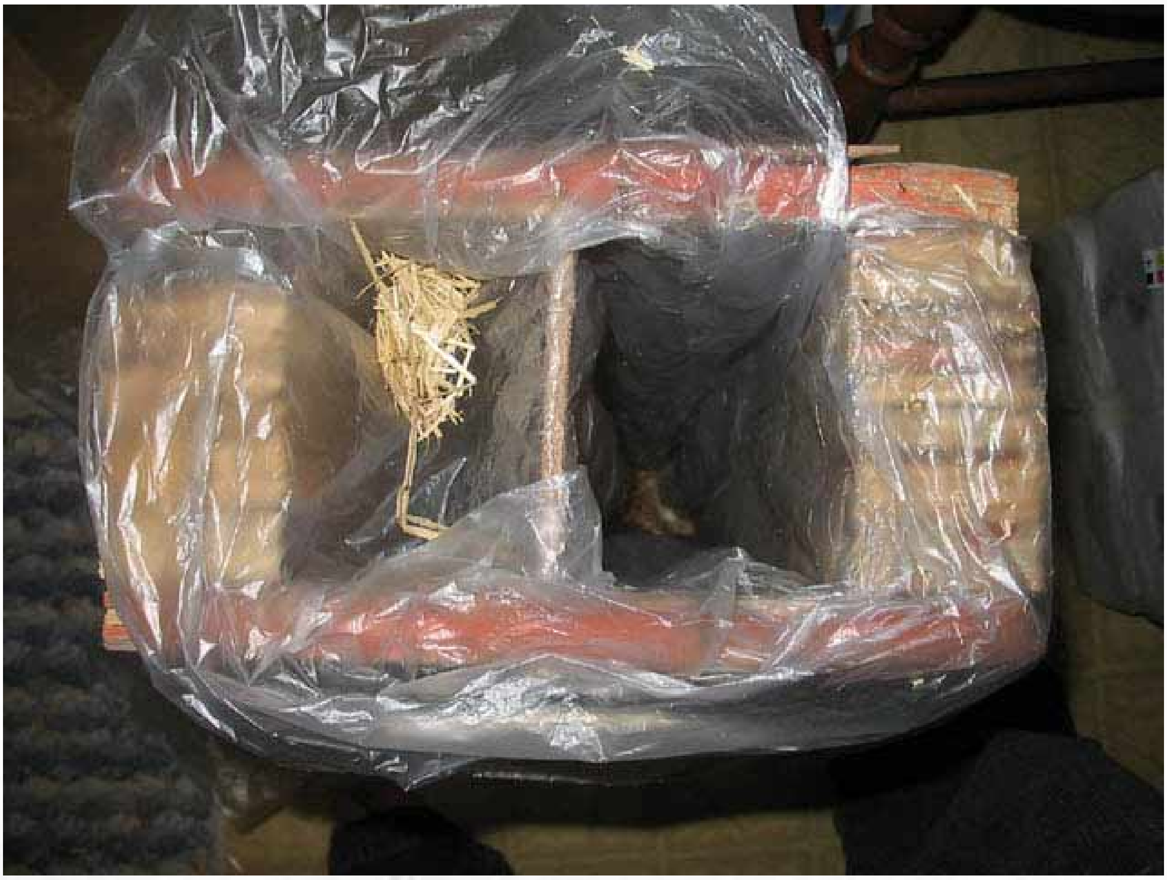


More pins.

I've been working on a few other ideas also. One is a rectangular prism shaped log. I got the idea from the straw biscuit. When its colonized enough i'm going to place it on a bed of verm, and cover the top with verm like a double end casing for a cake. A log with flat sides.

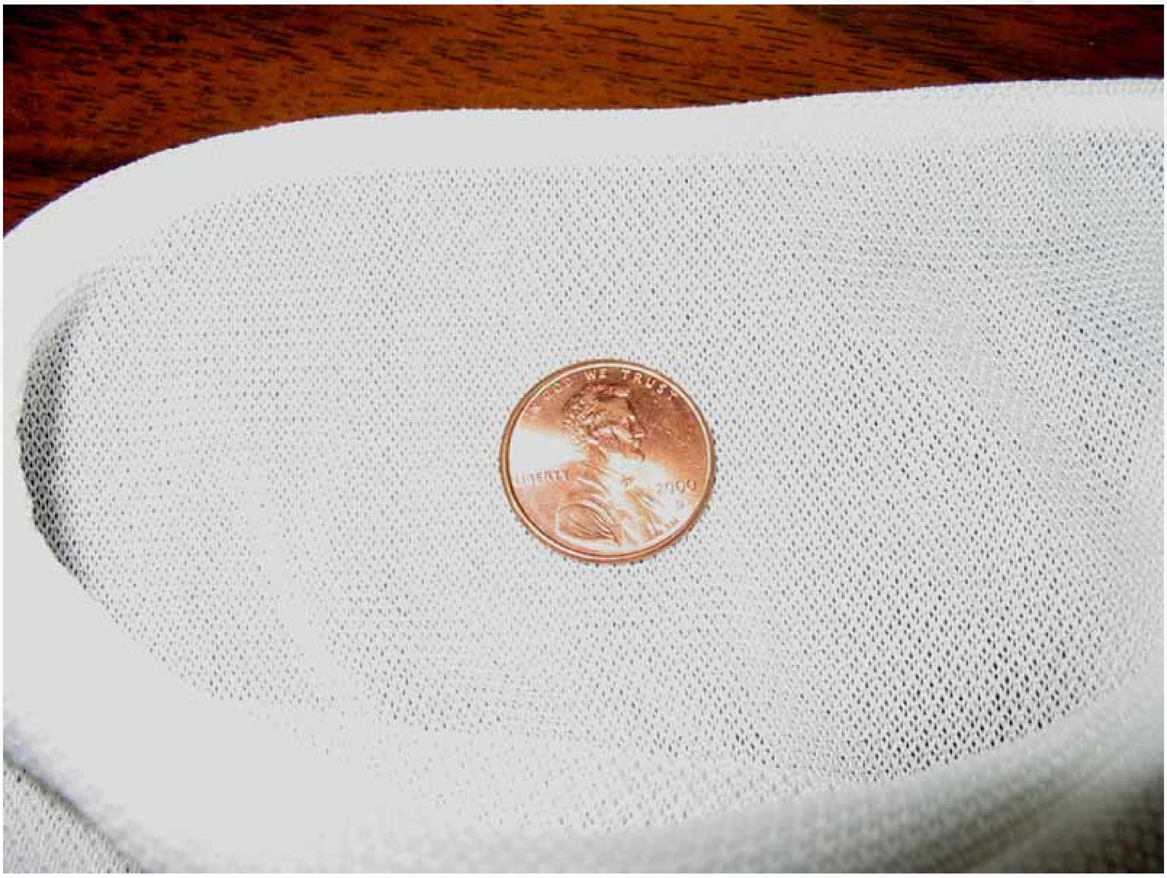
Another pic.

I made the logs square by packing the log inside of a form i made out of plywood.



How much for the tubing?

It was 20 bucks for a 100ft roll. **Its filter fabric sock tubing for septic tank drain lines,** here is a closeup of it.



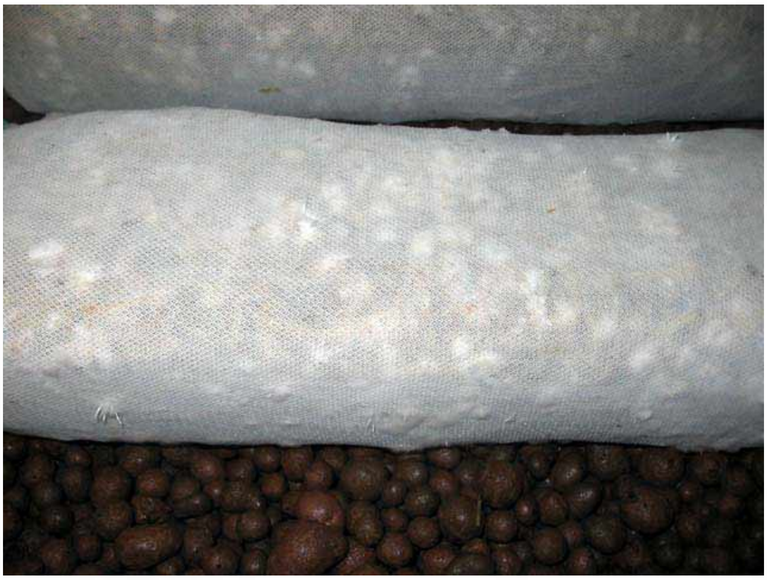
> rodger rabbit (Skyypilot) comment:
> The myc is definitely NOT colonizing that covering. It's synthetic.

I colonized the straw in a humidified environment. It colonized inside of the terrarium. The mycelium has totally grown through the fabric, and fuzzed up over the fabric, so there's no need to slit or do anything to it, its already covered in hyphal knots and the pins form on top of the fabric layer, so they shouldn't suffocate. I've been thinking about hanging the logs too, but it would be harder to case, but i have a way to make that easier too.

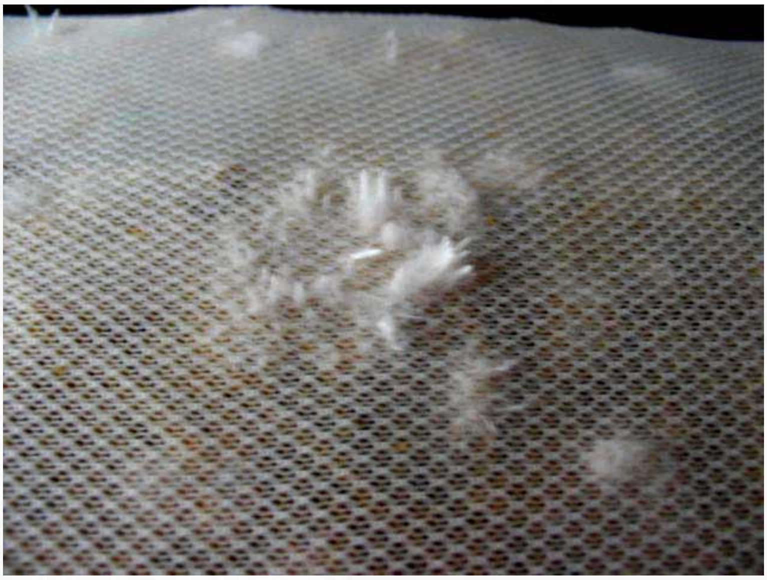
> rodger rabbit (Skyypilot) comment:
> Every vertical log I did was a disappointment. Gravity pulls water to the bottom where it drips out and is lost. The top of the log will dry out, because the mycelium isn't strong enough to pull water from the bottom by capillary action. If you hang them, build hanging shelves, and try to keep the logs horizontal.

I should also mention that this log is part of another experiment, the log is about 30% verm. I'm not sure how it will effect the yield. The flat sided logs are 100% straw.
The log drying out doesn't seem to be a problem as long as you have plenty of humidity. I weighed the log b4 and after colonization and its the same, so that eliminates moisture loss as a possibility. As for the fabric stretching, it does stretch, but in a weird way. If you make it wider, the tube gets shorter, its sorta like it pulls on itself. Thats why I used a form to stuff it, if I didn't, it would have come out all lumpy. You can also use 4" pvc for a form. Just tie the end, drop the fabric in the tube and stuff away.
This is a new log at 24 hours of colonization. See the fuzzy bits of mycelium sticking out. Very nice.

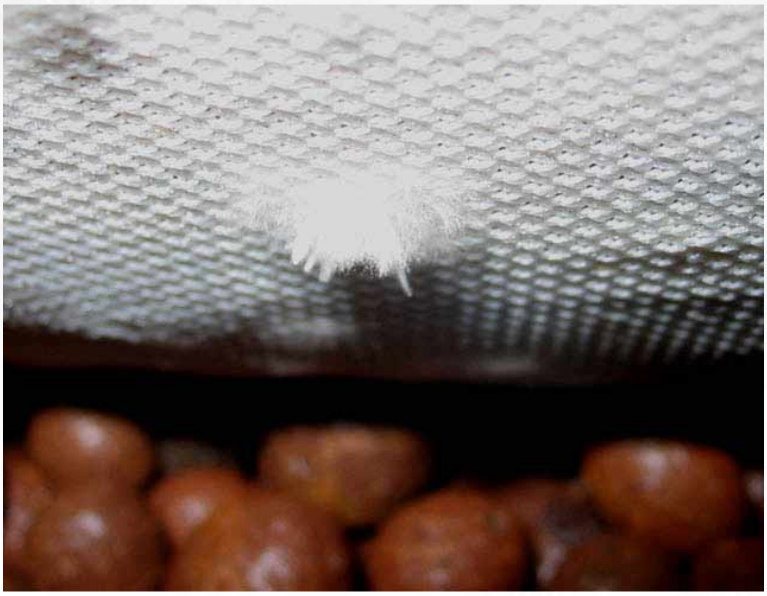
Here is another pic of the log.



Here is a closeup of the fuzz. You can tell it has great air exchange like this.

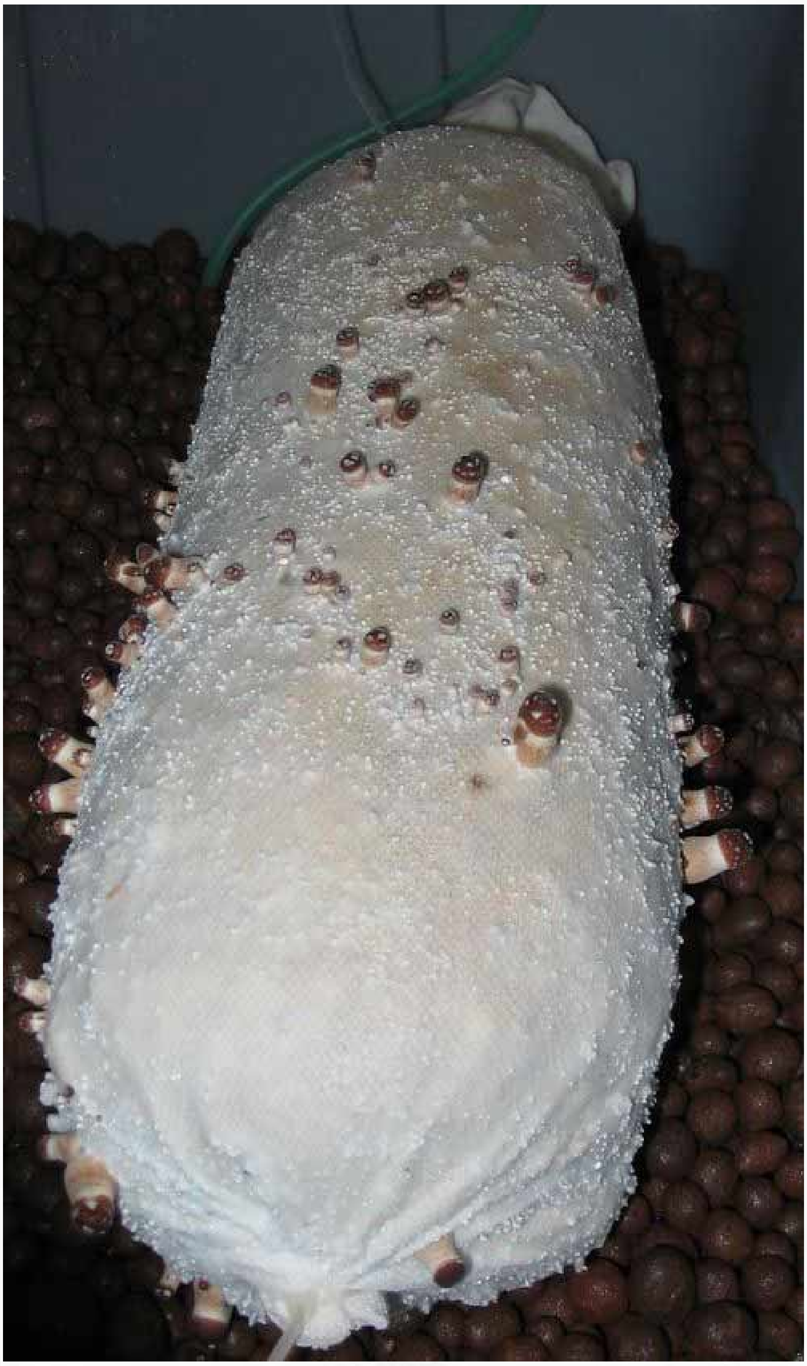


Another fuzz closeup.



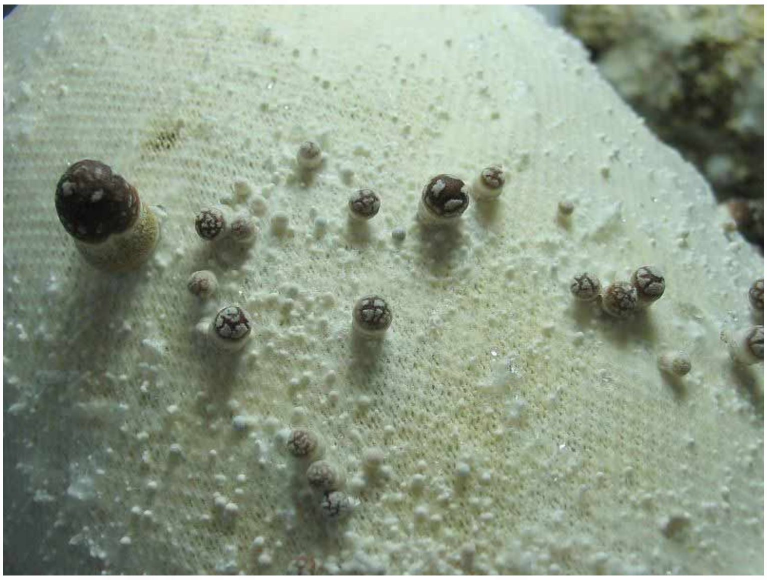
I birth the log directly on the geolite and leave them alone, Its like one of those "set it and forget it" ovens, you just birth and watch. Its incredibly low

UPDATE!!! The log is looking good. Still slow pinners as usual. Here are some pics i snapped a few mins ago.

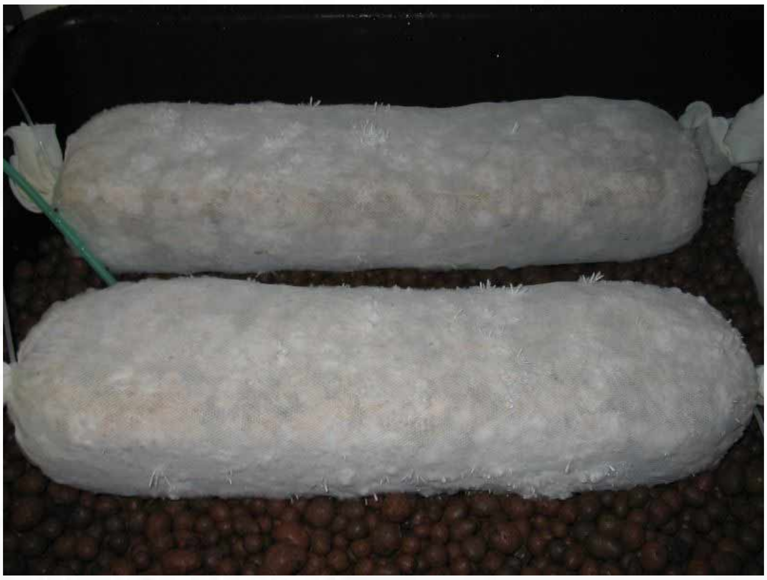


Another.

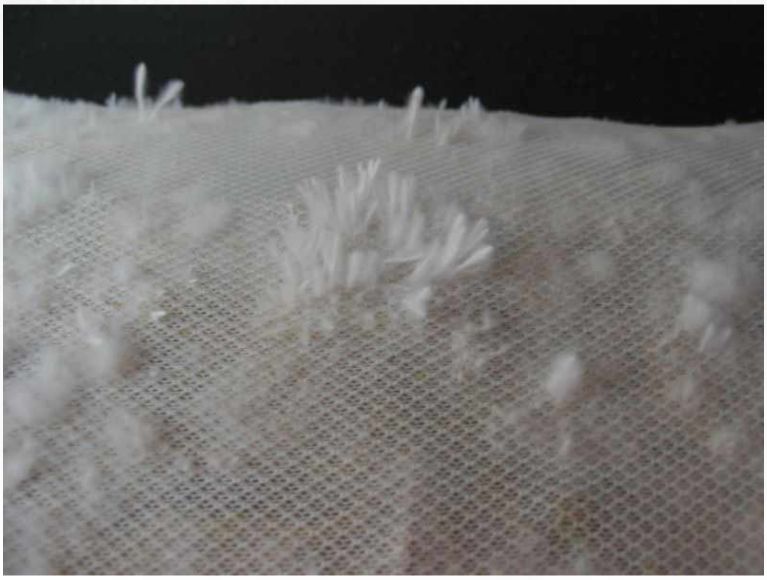
Here is a closeup pic of the knotting and pinning action.



Here is a pic of the logs that are colonizing. Amazing eh?

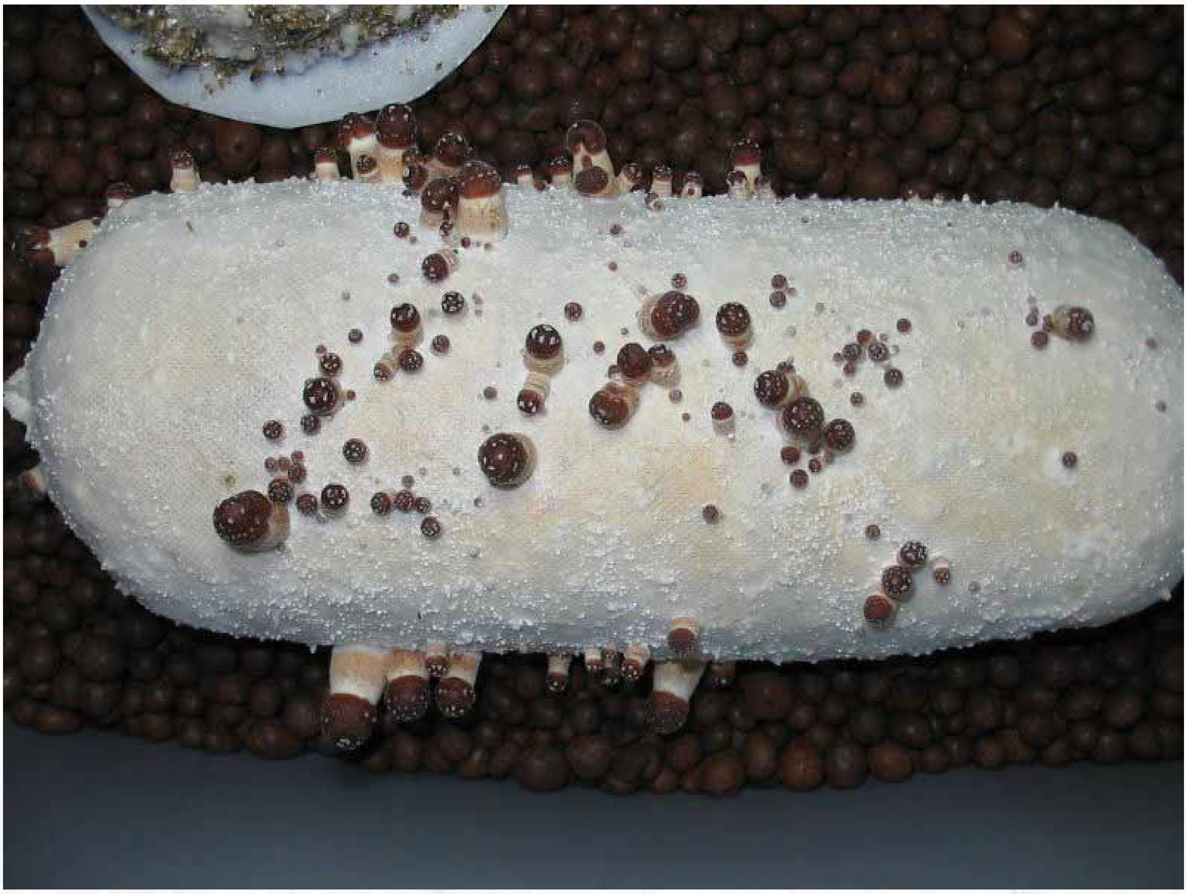


Closeup of the spikes of rhizomorphic mycelium coming through the fabric.



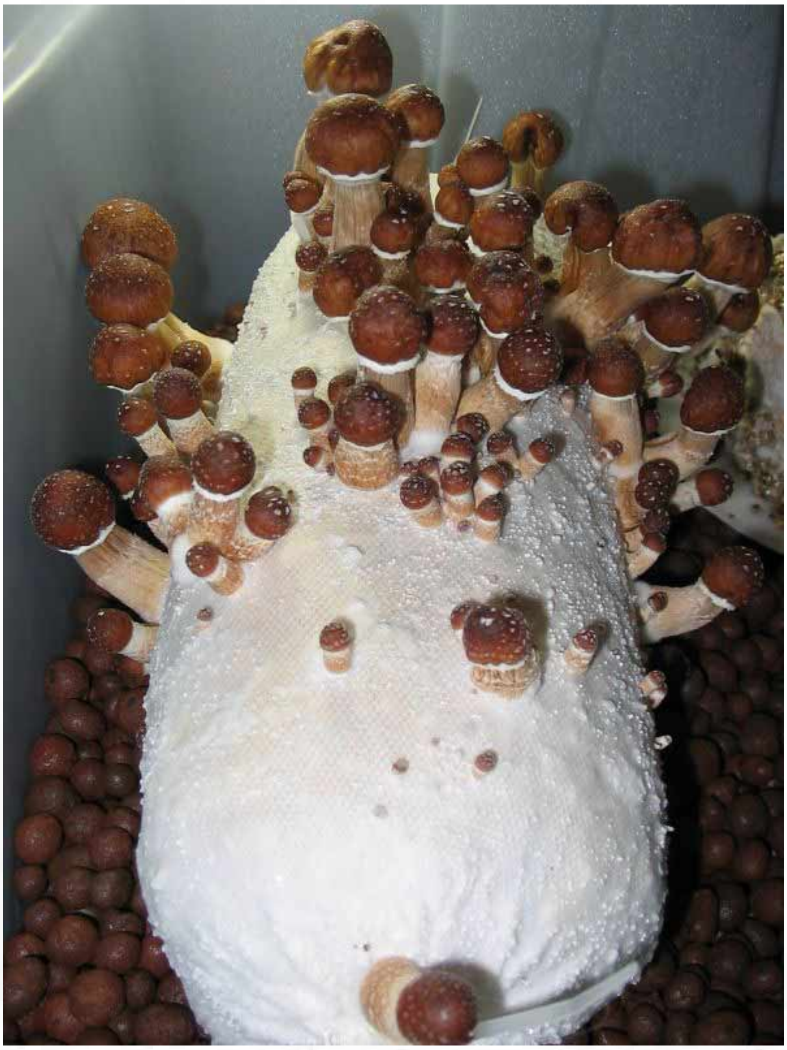
I use bottled water.

PINS!!!

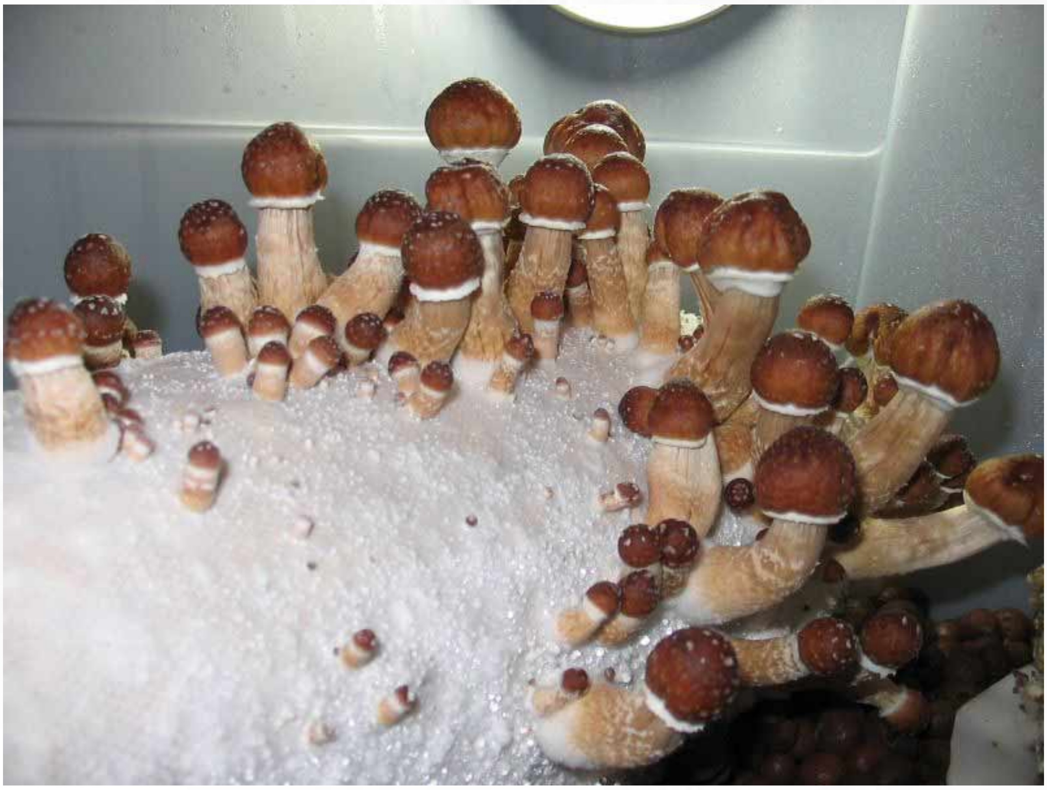


The colonizing logs are looking really nice.

Getting closer



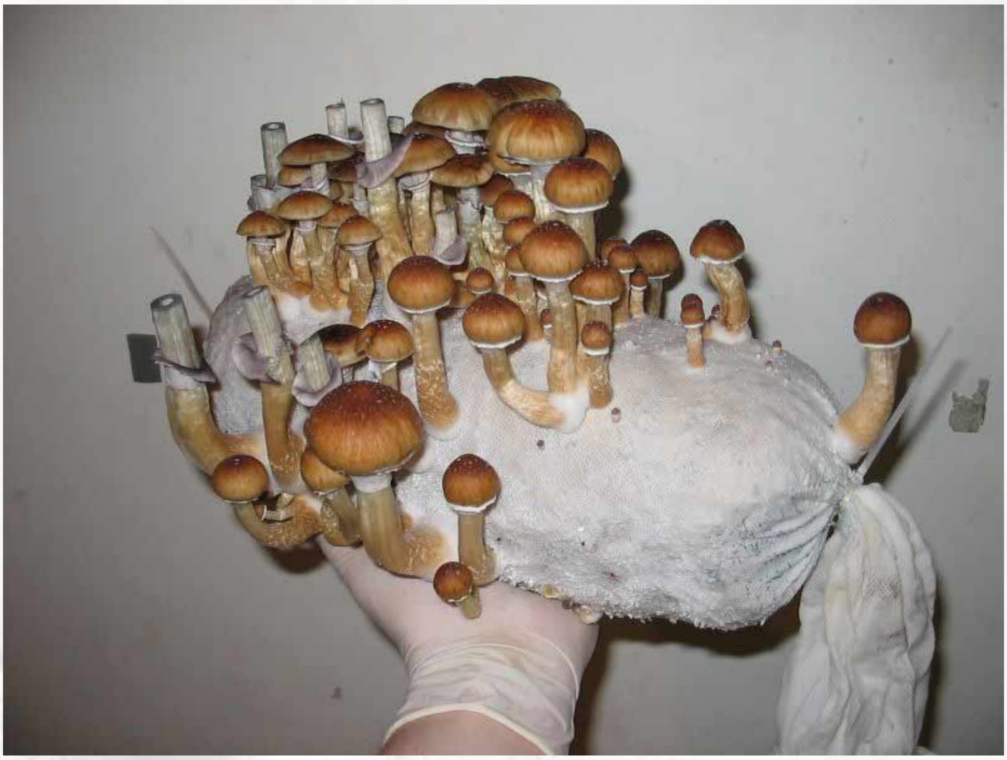
I like the looks of these pins, they're fat, should grow up big and strong.



I just got done harvesting the log and I figure i might as well tease you a little b4 posting the yield. Here is a little eyecandy from b4 i harvested.

Isn't it beautiful.

I love teasing you.



And the grand total yield is 414g wet, that should give a nice 41g dry. 3 logs will give you a quarter pound of dry shrooms, 12 will give you one whole pound of dry mushies.

Well, i'll get some pantyhose from my gf and give it a try. The tubing i use doesn't really stretch at all. I would suppose that if you used a form you could use panty hose, but i would think the straw would snag it and give it runs. We'll see. The logs don't really shrink like cakes, so there's no gap. It was really easy to harvest since i didn't have to clean one bit. Oh, BTW, those dots on the caps that look like bb's are pushpins. I use them to hook and move caps for printing.
I just weighed the caps i printed from the harvest, and they weighed 90 grams, add that to the yield, and you get a whopping 514g wet!!!

The Great Timothy Hay Cob Cubensis Method

by

Nanook

original source: http://mycotopia.net/archives/discus/messages/5/3001.html

First, you must obtain a clean culture of Psilocybe cubensis. I don't see any reason why multi-spore inoculation wouldn't work (presuming they'll germinate on hay) or why one couldn't use a multi-strain grain culture, but I used a pure culture I'd previously isolated. (Note: Don't be afraid! Agar work is much easier than you might think!)

Grow out some Grain Spawn. I use 'organic' whole rye grain steeped in near-boiling distilled water for an hour or so (as suggested by Stamets, produces uniform water content grain and minimized contaminants). Just before the grain is ready add some Gypsum to the pot and stir well (I use about a gram for every quart jar's worth of Rye Grain, but I don't know how important precision is...doesn't seem to matter much...). The gypsum helps keep the rye from sticking together post sterilization. Sticking frequently results in bacterial contamination. So use the gypsum (Try health food/herb co-ops).

Drain the grain, scoop into mason jars and sterilize at 15 lbs for 1 hour.
I use Autoclavable Filter Disks (from Fungi Perfecti and others) in lids with holes cut through, but I'm sure loosened jar lids would work fine. I Inoculate the sterilized, cooled-down grain with Mycelial Solution. Shake once after three days or so and perhaps once more several days later if needed, but the grain should be fully colonized within 10 days at most if liquid inoculum is used.

Get an "LM" brand "Timothy Hay Kob" from a pet store. Should cost $3-$4 for a package like a big bread loaf. (Note: I ended up cutting up the hay AFTER pasteurization, but you'll probably want to do this beforehand. Try and keep the pieces no longer than 4 inches or so. But don't worry about some bits being longer)

Place as much of 'cob' as possible in a large pot. Fill with distilled water (actually, I think I used a 50-50 mix of distilled and tap and it worked fine). You must be able to submerge the hay completely with a weight or a weighted lid.

Bring the water to a near boil and reduce heat to keep temp more or less stable. Pasteurize for one hour. Drain hay in a colander. Shake well.
Place hay in an "oven bag". These are special plastic bags used for cooking turkeys and so forth. They are heat resistant. Hold bag with hay upside down with bag open. Shake and squeeze to get rid of remaining excess water. Let hay cool in bag until it fully reaches room temperature.
Take fully colonized jar of grain spawn. Wash hands and rinse with rubbing alcohol. Air dry. These were the ONLY sterile precautions I used, but you may want to observe some more. Break up grain spawn and mix thoroughly with hay in bag. I used most of a quart spawn jar (figure one pint of spawn). Liquid mycelial inoculation would definitely work at least as well, spore inoculation is a possibility.

Let hay sit in bag for three-four days. The bag should be twisted loosely closed but not sealed or tied. You want to allow some respiration while retaining most of the moisture.

After 3-4 days the mycelium should be growing out vigorously onto the hay. Handling the hay through the outside of the bag, knead and pull at it between shakings. You want to break up the bigger mycelial mats and redistribute them throughout the hay. You can also open the bag and work it like a bellows to help exchange the air. You may find that the hay punctures numerous small holes in the bag. This is okay, and may help respiration.

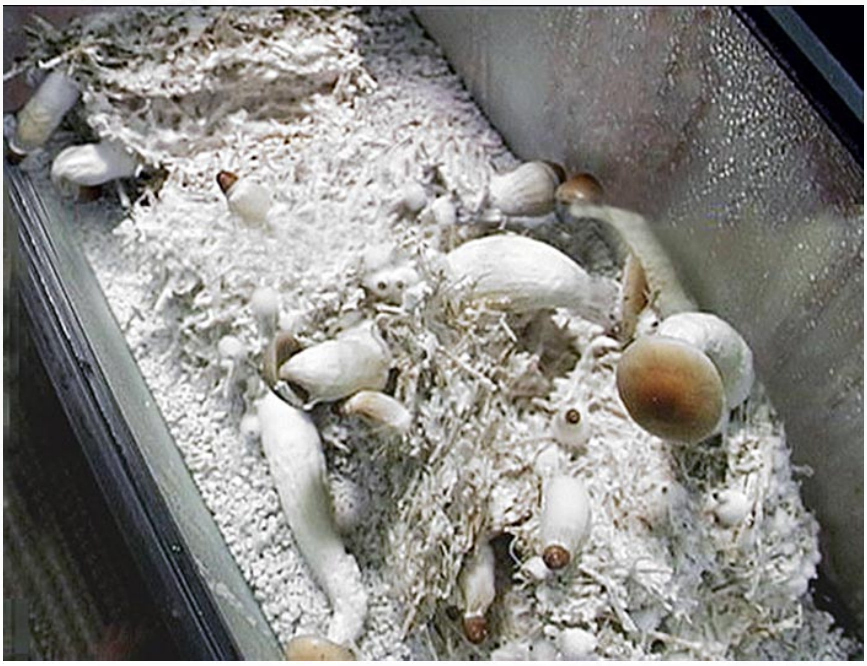
I gave the hay a couple of squirts of distilled mist at some point fearing that it might dry out. But I doubt this was necessary, despite the very dry climate.

Every few days, repeat the breaking, mixing, and aerating procedure.
DON'T worry about contamination. If you pasteurized the hay properly, you should have a couple of weeks before anything else really has a chance to compete with the mycelium.

When the hay looks like there's mycelium within an inch of any given spot of hay, leave it alone to complete colonization. The whole process should take a bit less than 14 days.

When there is at least wispy mycelium across all the hay (and if you've been mixing well, throughout it), it is ready to be laid out. You can use whatever terrarium setup you used for PF cakes, or use this low tech setup:

1. Get a big Rubbermaid storage container, a plastic drop cloth, and some chicken wire. Melt a hole in one of the bottom corners of the container. Wash it out well.
2. Cut a piece of chicken wire and fold over the ends and sides to make a platform that will stand at least an inch above the bottom of the container. Fit this down into the container. Spray the insides of the setup with lysol or the like and let completely dry.
3. Break up the colonized hay and lay it out on the chicken wire. It should be more or less evenly spread but don't go crazy breaking up the hay. Make it at least two inches deep. Don't know what the maximum depth would be...
4. No more than 3-1/2 to 4 inches. Unfold plastic drop cloth and drape over container. It will not make anything like a sealed environment BUT IT DOESN'T SEEM TO MATTER. Your mileage may vary so if you feel the need be more precise with environmental controls.
5. Let hay recuperate for a couple of days.
6. Twice per day, take off plastic tarp. Use lid of container to vigorously fan hay to exchange air. Replace tarp and lifting up one end stick spray bottle beneath and spray distilled water with the finest possible spray into the air. Experiment. I used only a few spritzes at first and more and more as the mushrooms grew. The lack of a drip shield doesn't seem to matter, though when I'd redrape the tarp I'd arrange it so that a piece without major condensation or water drops was above the hay. Redrape plastic. If necessary, tilt setup to allow excess water to drain out hole. Leave setup in a temperate place (mid to upper seventies to allow pinhead formation) with some light exposure. Any light is probably fine, a little natural light probably best. Don't overdue light. Very little is required.
7. In one to two weeks, the texture of the hay should begin to change dramatically, you may not realize that this is pinning, as it should appear that the entire service of the hay is turning to pins.
8. Keep up the fanning, spraying routine as the pins turn to primordia, and the primordia to carpophores. Enjoy the sight of dozens of large mushrooms springing forward.
9. Pick them just after or as the veil is breaking. While you won't have to clean off any vermiculite, you will want to pull off as much hay as possible. Some hay will be inside the stems. Don't worry about it.
10. Dry or eat fresh. Enjoy!!



SHOP AT McCRORY - McL

Hope this helps and encourages people to experiment!
Keep on Cultivating! And spread the word!!

Mushroom growing Invitro

by

Hyppie3

original source: http://www.mycotopia.net/archives/discus/messages/5/18237.html

Notes: This tek is primarily designed for anyone who, for whatever reason, cannot fruit in humidified terrariums. While the yield from each cake per flush is a bit less compared to some other methods, over time and multiple flushes the yield per cake can easily reach 7+ grams dry weight in mushrooms, particularly when the Dunk Tek is used between flushes. Some few strains are rather poor performers with this method so use them at your own risk. Pf's Classic aka Amazonian aka Matias is probably one of the best for this tek. The cakes can be left unattended for long periods of time, there is no need to do anything to them in between picking sessions. You can open the jars any time after full colonization to remove the cake for picking, drying out the jar, etc. The only real concern is to be alert to any sign of decay or rot on the fruit. If it turns black or appears slimy/wet then it's best to pick ASAP.

"Authority defied
Birthright defined
Life, liberty
The pursuit of happiness
The freedom of the mind
Emancipation of the soul
The courage for adventure
The safety of the secret
The unspeakable beauty
The birth, being, life and death
A surreal notion
The spark of revolution
The enforcer cannot get me from afar
I do it all
In one jar"
by Karna

invitro cambos at 5 weeks

invitro south americans, 2nd flush

1. get spores, preferably syringes. One good place to try is Fanaticus.com, whose PF TEK was the inspiration for my invitro method.

cambo print in gladware

home-made syringes, z strain

The PF Classic/MR is one of the strains best suited for this tek. But all strains can work, some better than others.

2. buy at least one dozen half-pint canning jars with lids. the half pint wide-mouth jars are the best for this method.

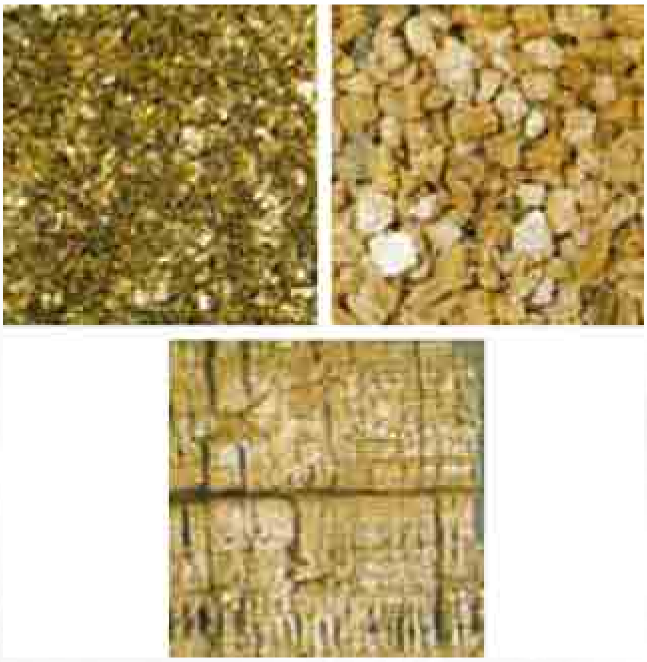
half pint wide-mouth jar

3. drill/punch-out 4 holes equidistant around the rim of each lid.

4. buy some brown rice and grind it into flour using a coffee grinder, blender, etc.

5. buy a bag of vermiculite at garden store. [note:there are very few good substitutes]

COUNTRY COTTAGE
HORTICULTURAL
Vermiculite



Verm. sizes/grades

6. buy a bottle of spring water at grocery store. [note:any water, even tap, can be used, in a pinch.]

7. pour 1/2 cup of the verm. in medium mixing bowl and level it out.

8. cover the vermiculite with 1/4 cup of the ground rice flour evenly.

9. sprinkle on 1/4 cup of spring water.

10. mix well.

11. load mixture into a jar, until level with the bottom of the lid's threads, discarding/recycling excess.

12. carefully clean the rim of jar of any material.

13. fill jar rest of way to rim with plain, dry vermiculite.

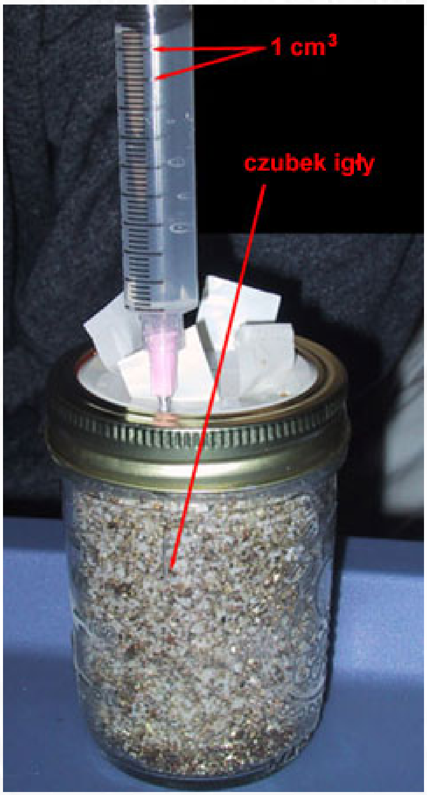
14. screw on lid, and cover holes/lid with aluminum foil.

15. repeat until you have all jars filled.

16. place jars into a large pot, add enough water to reach 1/3 up the jars' sides, cover with lid, and boil/steam 45 minutes.

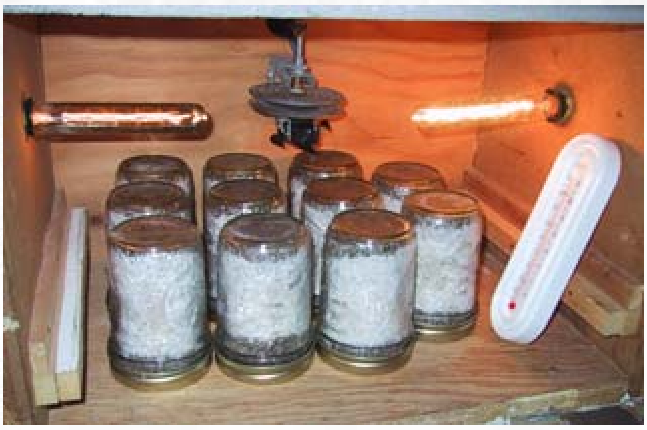
17. remove from heat and cool to room temperature.[note:overnight is safest]

18. inject 1 cc. from the spore syringe into each jar, splitting it evenly between the 4 holes.



inoculating jars

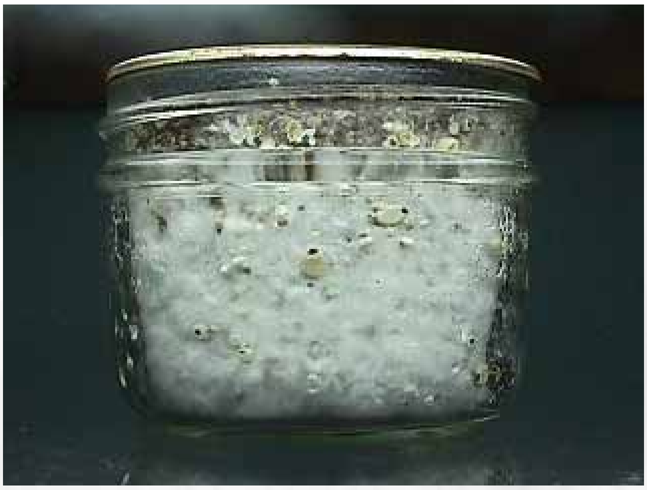
19. keep in warm, clean area for 2 weeks, or until the jar is completely covered with white growth. Meanwhile, from the very beginning if possible, expose to light several minutes a day, eventually you'll see little shroom-like growths called pins.

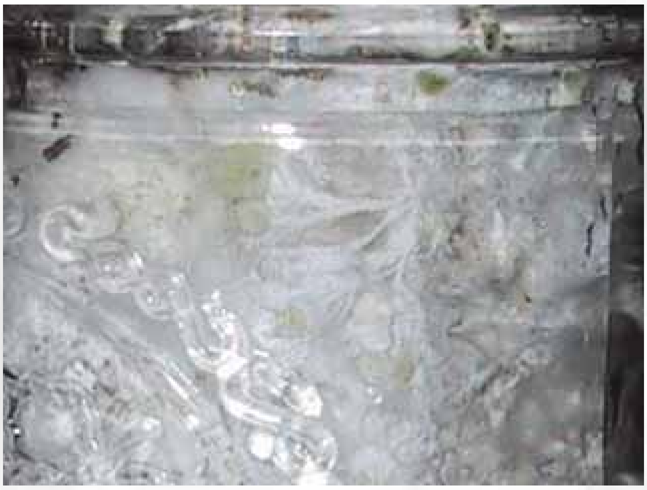


incubator

lamp

fully colonized jars

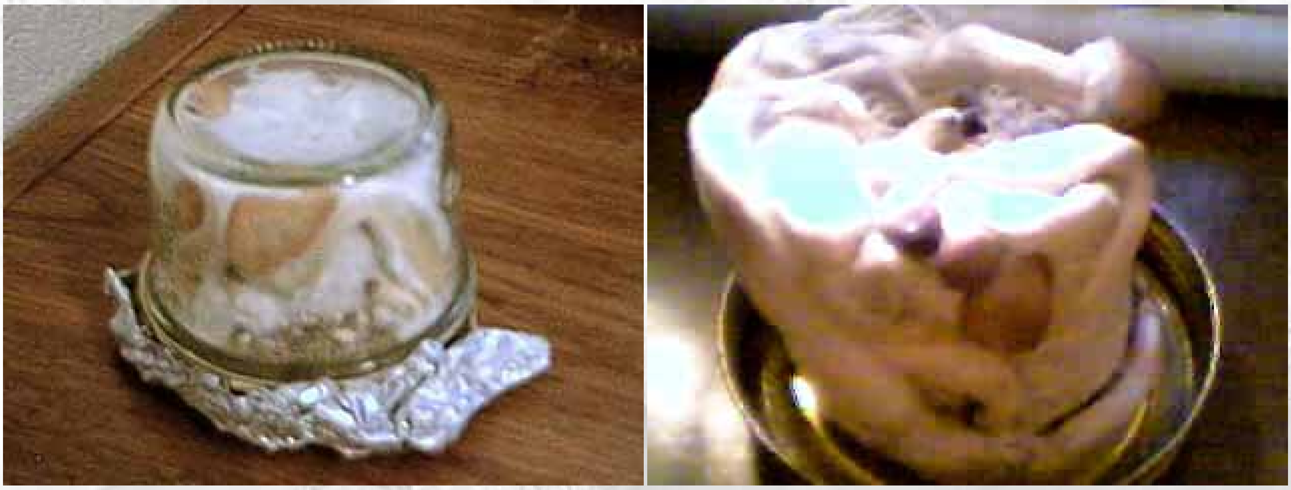

pins


invitro pinning

20. flip the jars over so the cakes rest on the lids.

21. pick shrooms when caps open and the veil under the cap tears. or when they quit growing, or turn dark in color.

22. dry them if you want, or eat them fresh. store un-picked but ripe invitro jars in the refrigerator for freshies all-the-time, year-round.



Detailed Grow Log-Tek - Penis Envy in a Monotub

by

monstermitch

original source: http://www.shroomery.org/forums/showflat.php/Number/6194327/fpart/1/vc/1

Table of Contents:

STAGE ONE: Liquid Culture Creation
STAGE TWO: Prepare and Inoculate Grain Spawn
STAGE THREE: Construct a Monotub and Prepare a Bulk Substrate
STAGE FOUR: Spawn and Substrate added to Monotub and Preparation of Casing Material
STAGE FIVE: Pasteurization and Application of Casing Material and Fruiting Parameters
STAGE SIX: Harvest, Dunking a Bulk Substrate and Later Flushes

This grow log isn't so much about one grow. It's about the process used for this kind of grow.
You'll notice many missing or incorrect pictures, yeah I'm not so much a camera guy, but in the future I'll clean it all up.
The point is to follow and understand the process and materials used to get from a spore syringe to healthy fruits using a simple method. Comments are very welcome. Any improvement suggestions are also welcome.

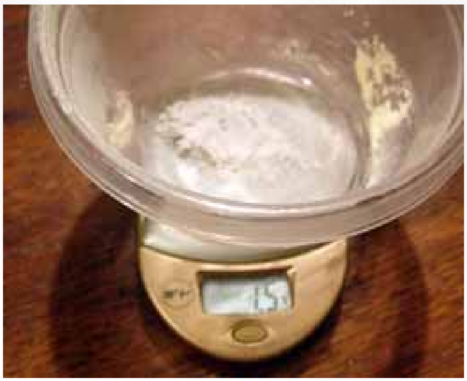
STAGE ONE: Liquid Culture Creation

First step was to order spores from a sponsor here at the shroomery.
While awaiting their arrival, I made a batch of liquid culture.

I started by making sure I had a new or very clean coffee pot. One of the ones that brews 12 coffee cups at a time. That equals roughly 1.8 liters.

I added to the basket: light dry malt, dextrose, gypsum, and activated charcoal.
I used one coffee filter fit for this type of machine.

15 grams each of dextrose and light dry malt

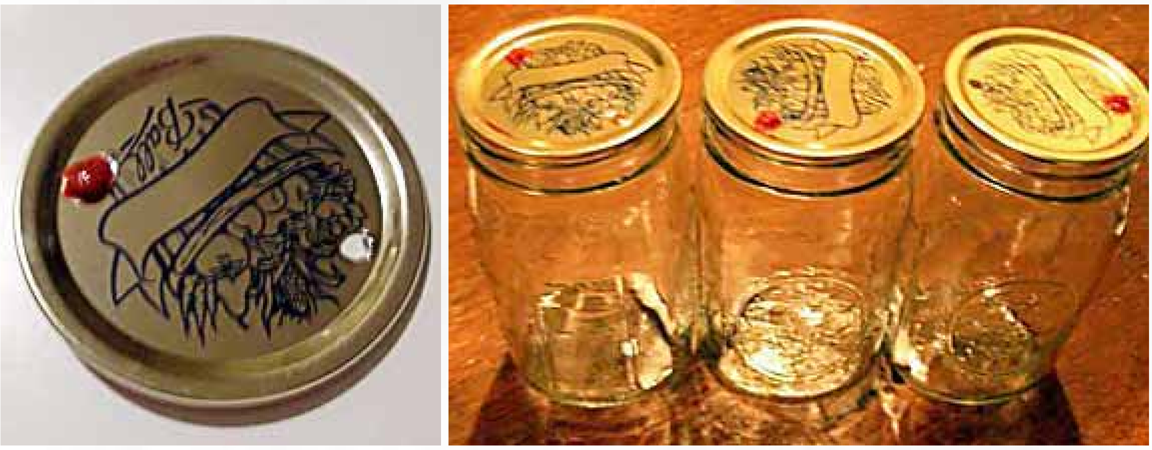


1.5 grams of gypsum flour, and a tiny amount of powdered activated charcoal.
No measurement, just look at the above picture for amount.

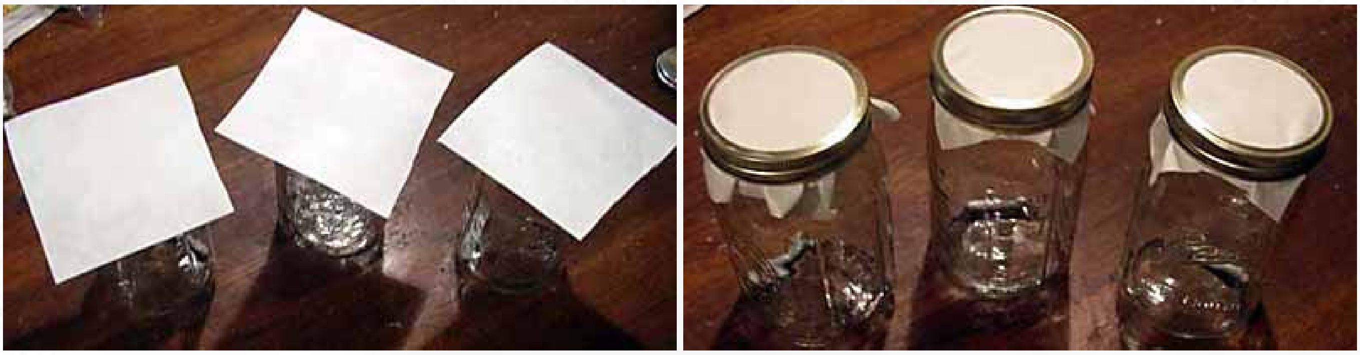
12
10
8
6
4
452

I filled the reservoir full with distilled water and brewed it as I would brew a normal pot of coffee.

I added a magnetic stir bar to each of three quart jars and I poured this solution into them up to the 600ml mark each.

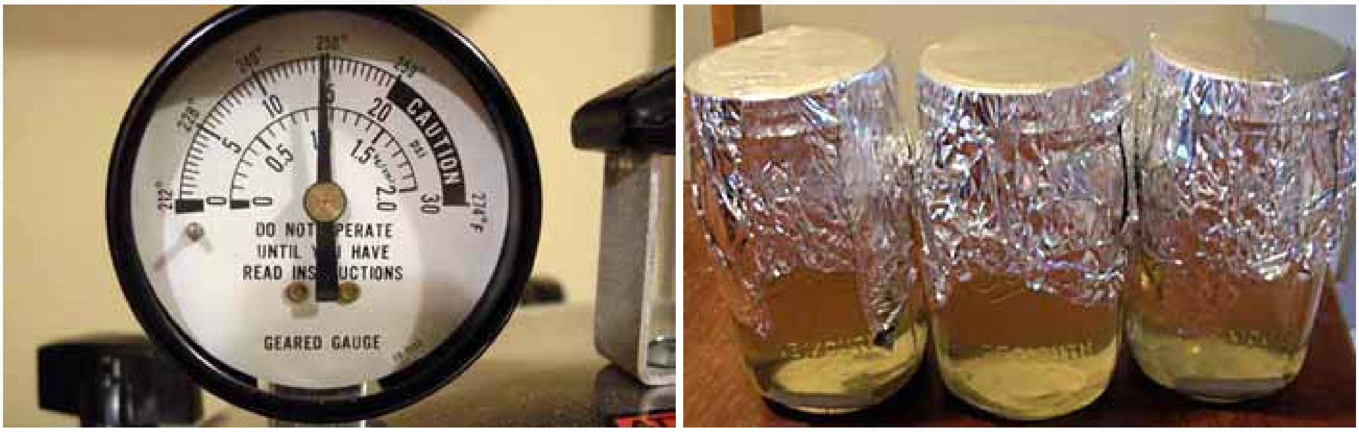


I added these lids to the jars, RTV port on one side, 1/4" hole on the other.



I covered the jars/lids with a piece of tyvek and tightened the band over the tyvek.

WARNING
ADVERTENCIA


CAUTION
DO NOT OPERATE UNTIL YOU HAVE READ INSTRUCTIONS
GEARED GAUGE

I covered the jars with aluminum foil and pressure cooked them at 15psi for twenty minutes.

I removed the jars and let them cool.
I removed the foil and cleaned the tyvek off.

For safety, I wrapped the lid/jar area with micropore tape.

And I added some coffee filters on top as dust covers. I can never be too safe with LC.

Truth be told, I pressure cooked the jars empty first to ensure they were clean when I began the process.

The spores arrived in the mail, and it was then time to move on to inoculation...

I inoculated a quart of liquid culture with some Penis Envy spores from a sponsor here.
This was the process:

I showered first and put on clean clothes.
I used listerine before and after brushing my teeth.

Apothecary Products
F405-603
NIOSH N95
Apothecary Products
F405-603
NIOSH N95

I wore an N95 mask and a shower cap.

I wore latex gloves and cleaned them well with 70% isopropyl. I wiped down the needle and jars with an isopropyl paper towel.

I sprayed the hell out of the air with oust brand air sanitizer. I gave the oust a minute to work and then I folded up a paper towel.

I soaked that paper towel with 70% isopropyl and folded it over the needle cover.

I removed the cover, keeping needle covered with the paper towel.

I shook the ever living hell out of the syringe, holding the needle tight.

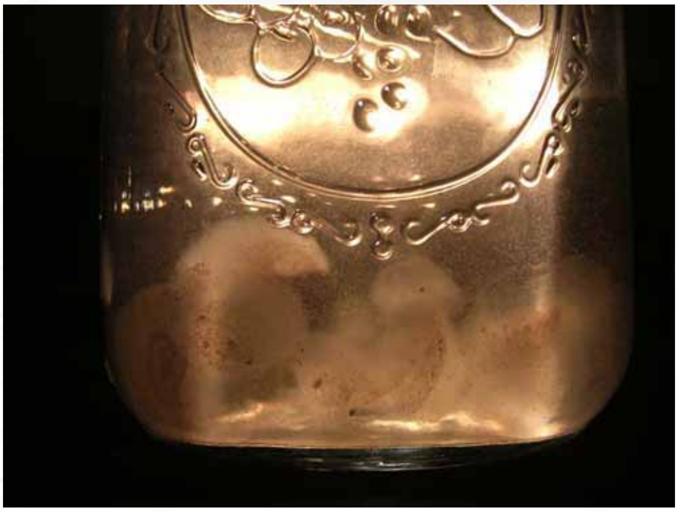
I inoculated each liquid culture jar with one half cc of spore solution.

I removed the needle, still keeping it in the paper towel and I applied a piece of micropore tape to the tyvek's hole.

This piece of tape was soaked in isopropyl prior to it's application.

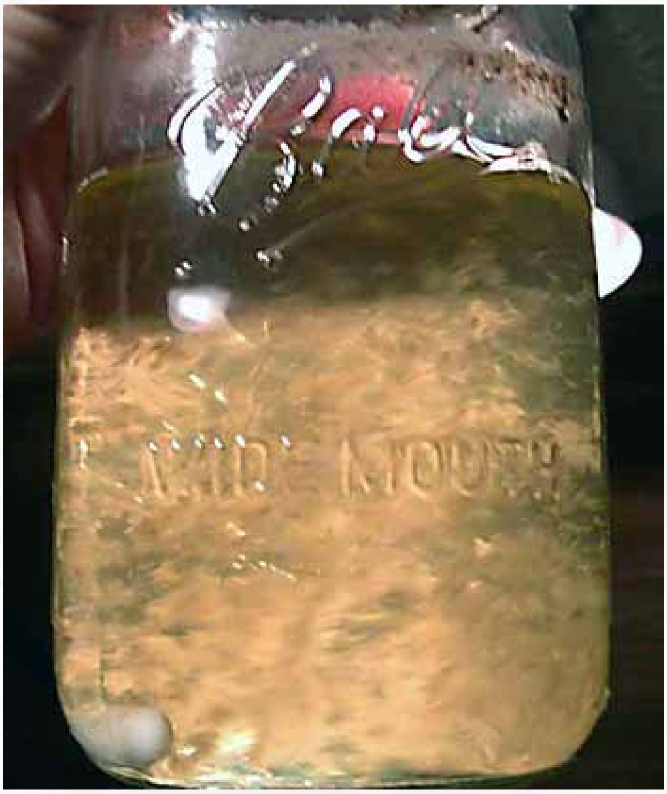
I re-covered the jars with the coffee filters and labeled them PE Spore LC.

These jars were left in a room that sits at 75 degrees steady for a couple of days.



Soon puff balls began to form and grow.

I used my magnetic stirrer to help colonization along.



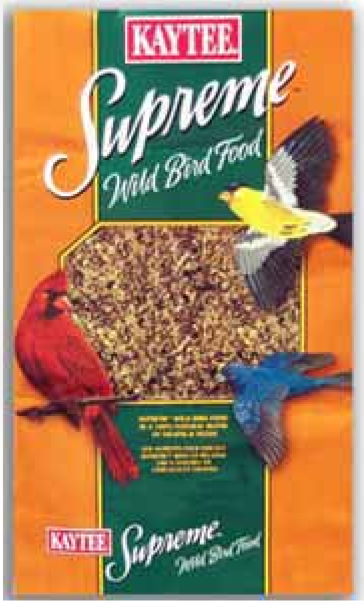
Soon I had a liquid culture that was ready to use.

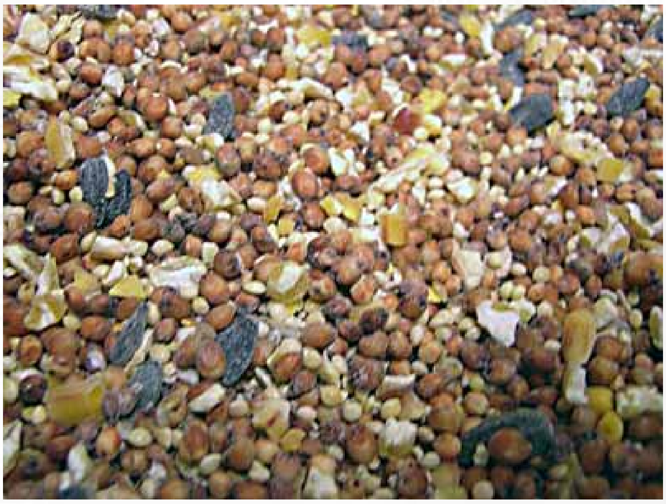
So I filled a big syringe with the finished LC, and got some grain together.

Table of Contents

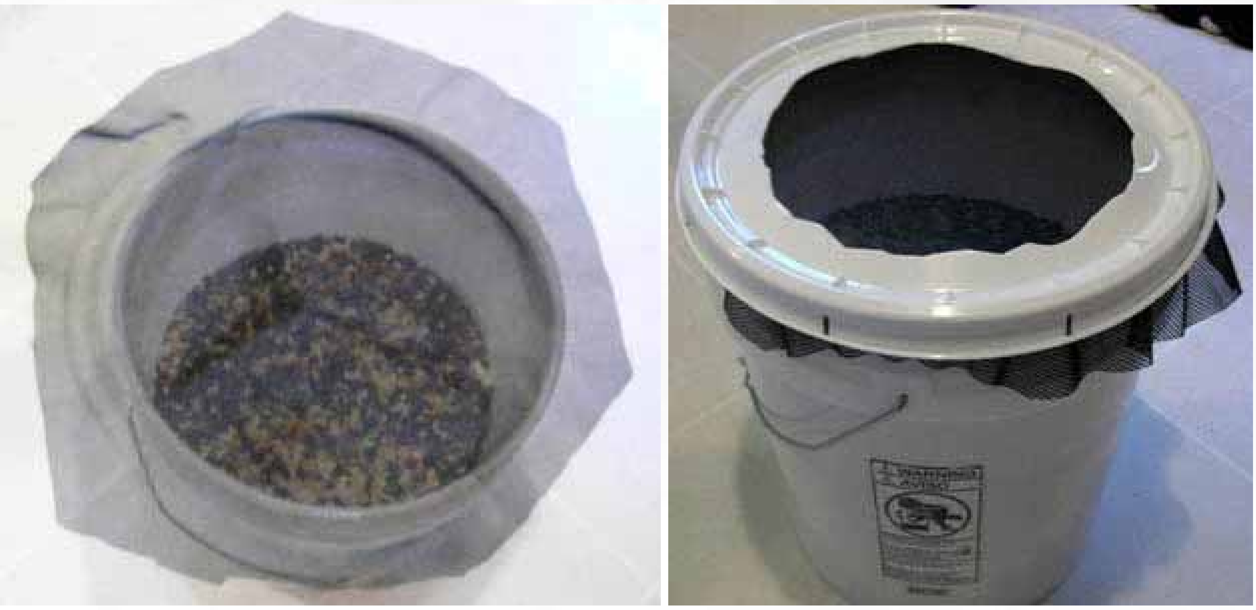
STAGE TWO: Prepare and Inoculate Grain Spawn

I chose this birdseed to use as my grain, I like it.


KAYTEE
Supreme
Wild Bird Food
KAYTEE
Supreme
Wild Bird Food

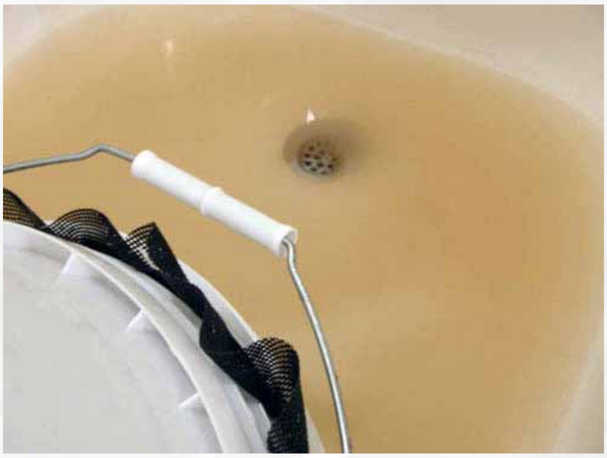


I filled a five gallon bucket with twenty pounds of birdseed.
That brought it to about 2/3 full.



I added a piece of house screen and a lid with a big hole to the bucket.

I filled the bucket with hot water, dumped it out, filled it, dumped it out... Until the water ran perfectly clear. This was like ten reps.



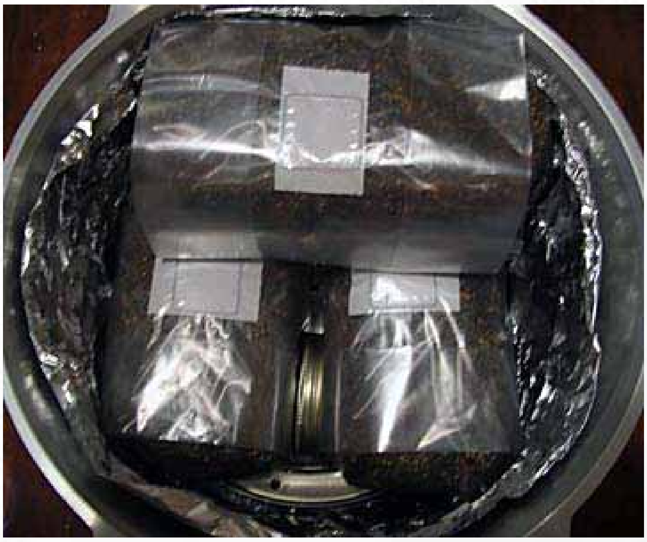
I opened the lid and took off the screen.
I added six cups of hot coffee and three tablespoons of gypsum to the birdseed.
I replaced the screen and lid, and filled the bucket up to within two inches of the top.
I set the bucket out of the way and left it alone for 24 hours.
After the 24 hour wait, I again dumped, filled, dumped, filled, dumped...
Until the water ran completely clear.
I used very hot water for the last couple of fill and dumps.

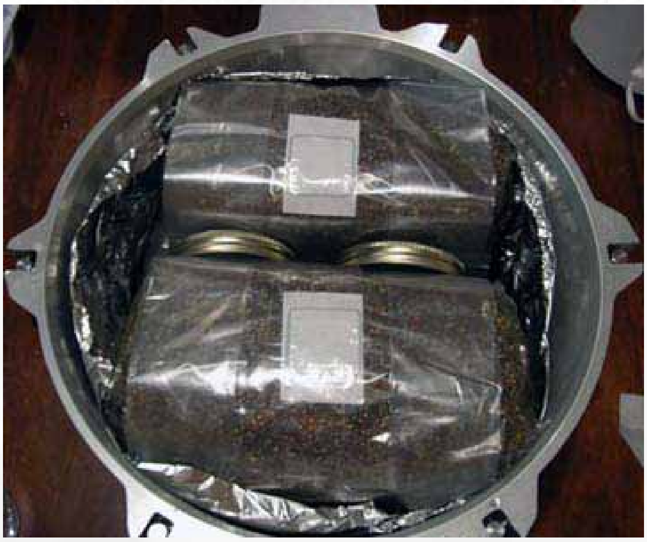
I inverted the bucket and let it drain through the screen for six hours.

After the drain, the birdseed was ready to be sterilized in filter patch bags.

Some of the following pictures show not just birdseed in the bags. They show a different substrate, this is because I suck at taking pictures.
So just visualize these bags always having birdseed in them.
There are other discrepancies too, like some bags not having RTV ports on them, again, just bare with me, at least there are pictures...

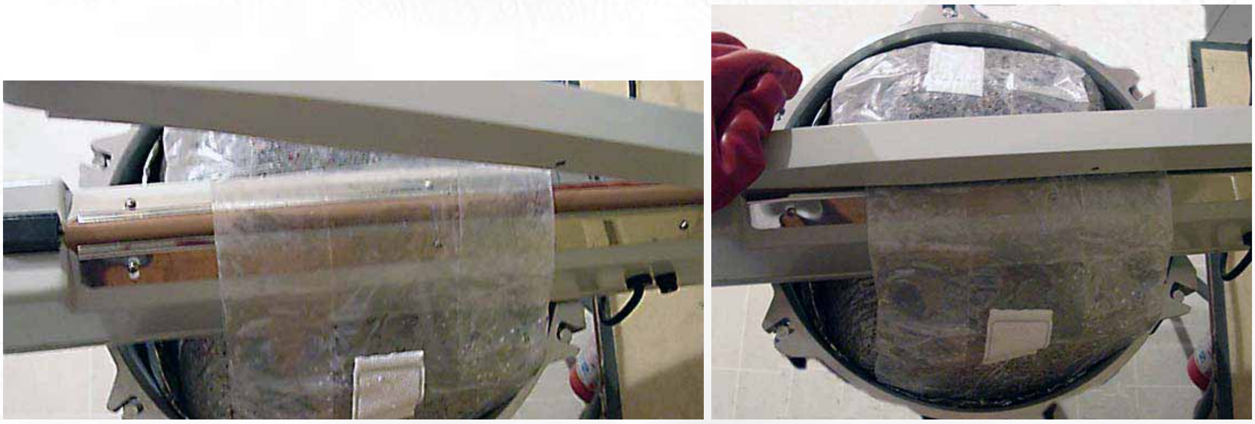
I put three full quarts of birdseed into each bag and folded the



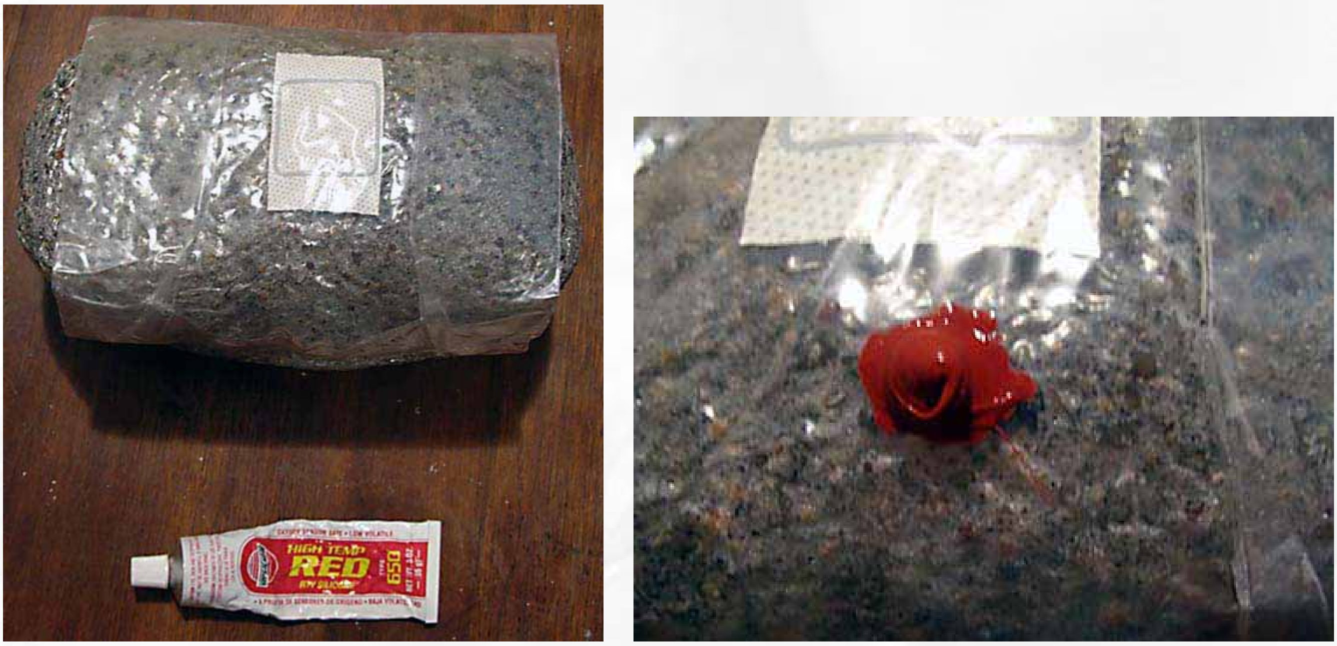


WARNING
ADVERTENCIA
CAUTION
DO NOT OPERATE
UNTIL YOU HAVE
READ INSTRUCTIONS
GEARED GAUGE

I loaded the bags into my AA-921 and pressure cooked them at 15psi for three hours. Four bags per batch.



After the pressure cooker cooled and de-pressurized, I opened it and impulse sealed the bags.

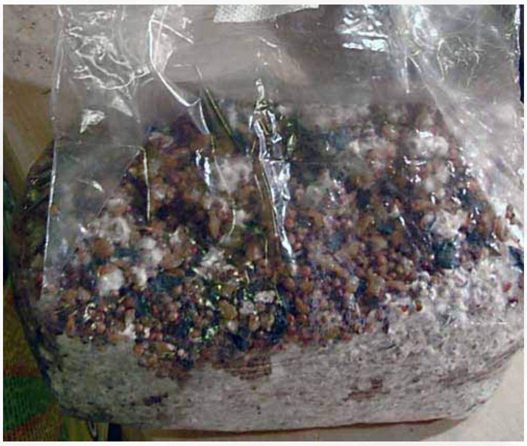


I then removed the bags and made some RTV ports on them. The ports went on the opposite side as the filter patch, below it.

I then hung the bags like so to cool and self-inflate.

I inoculated the grain bags with the PE LC and put them on wire shelves.

These were the bags, hanging out, colonizing.



Colonized to 25% or so, so time for massaging.

After massaging.

Growth began again quickly and took off.

Here they were, finished and ready to go.

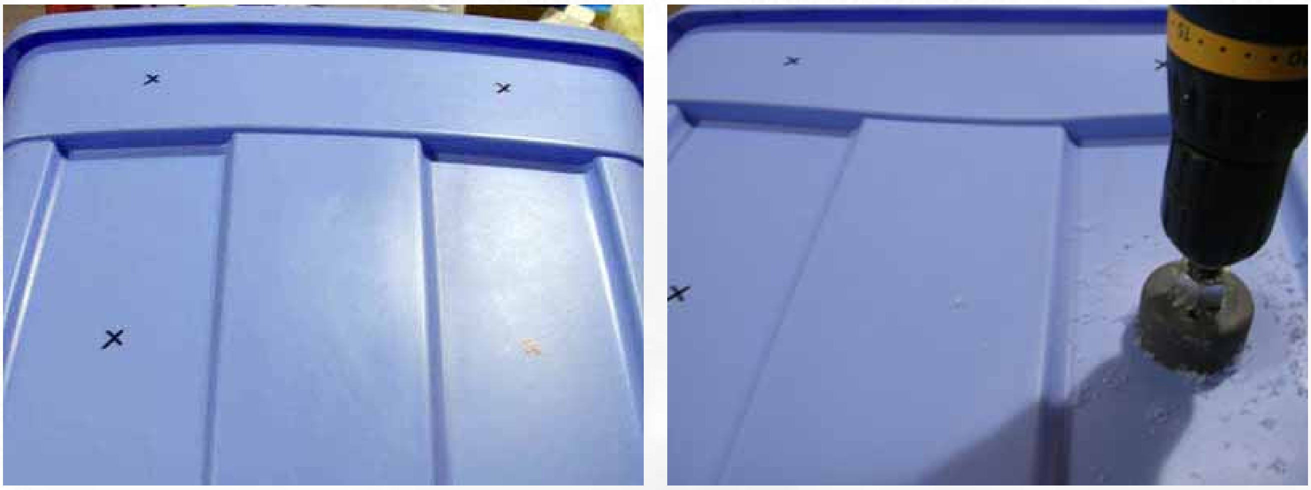
This grow log will follow the life of two of these bags and their try at it.

So I needed something to mix with this spawn...
What do I choose this time, so many options...

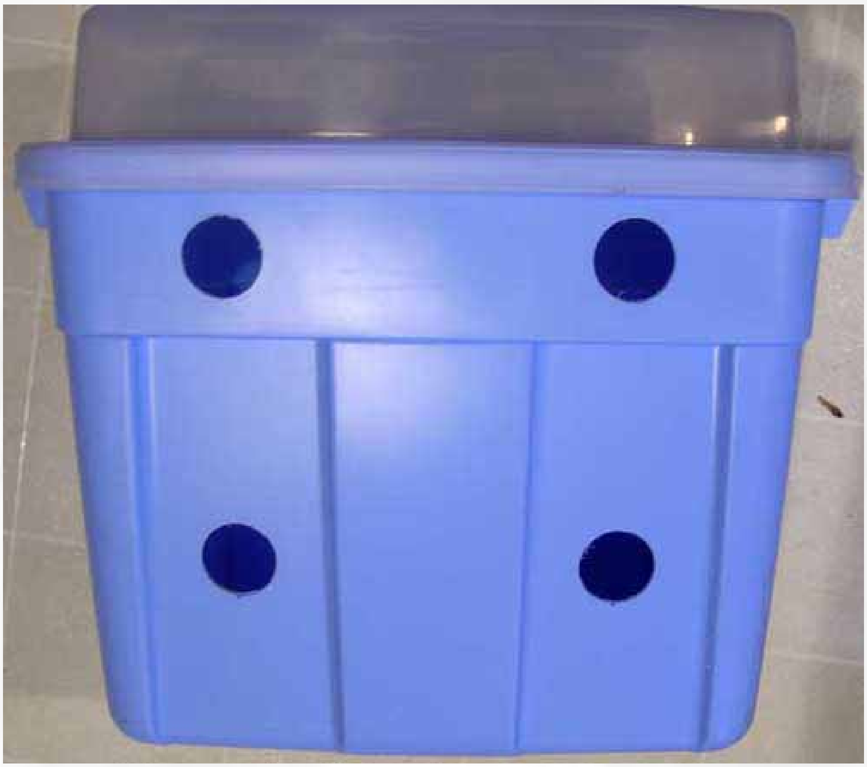
Table of Contents

STAGE THREE: Construct a Monotub and Prepare a Bulk Substrate

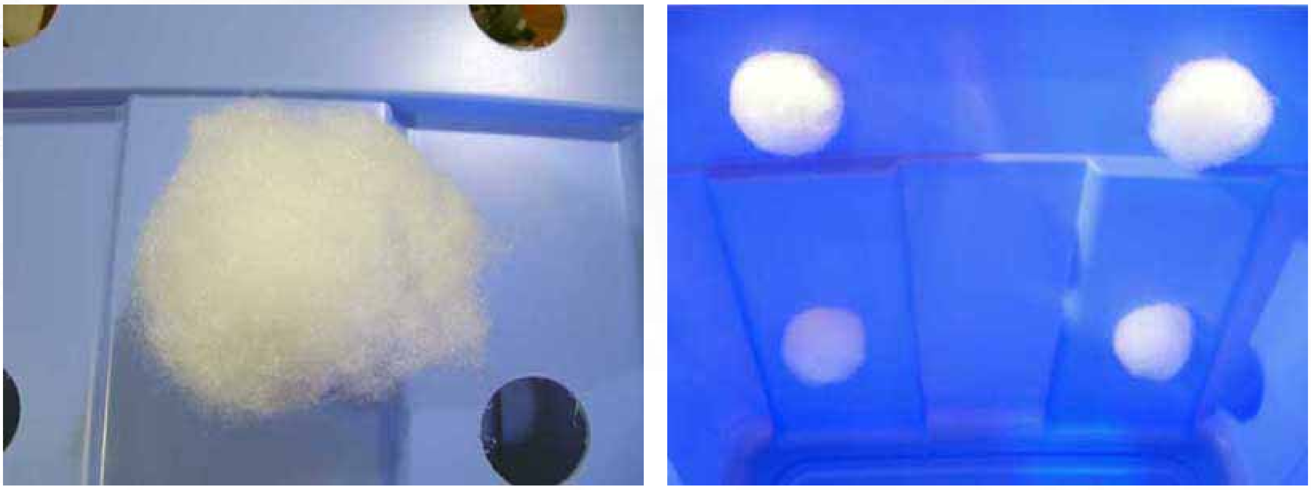
Following my monotub tek, I took two of these tubs and made them into monotubs.
These things are great, no plexi glass needed, the lid is clear(ish)!



I marked and drilled four 2" holes in each side.



The bottom holes are 5.5 inches from the bottom of the tub.
The top holes are 8 inches above the bottom ones.



I cleaned the tub well with vinegar and isopropyl and stuffed the holes with poly-fil.

I lined the bottom with a black trash bag, like with this tub.

Once complete, I just set these tubs aside to wait for use.

So I needed a bulk substrate to mix with the colonizing grain.
I was all out of horse manure, the other bags ate all of that.
Next best thing to horse manure in my house is...

BUY 2 GET 1 FREE!
ZOO MED
Can be Safely Composted or Recycled!
An Eco Friendly Product!
ECO EARTH
COMPRESSED COCONUT FIBER EXPANDABLE SUBSTRATE
Expands up to 8 times its size!

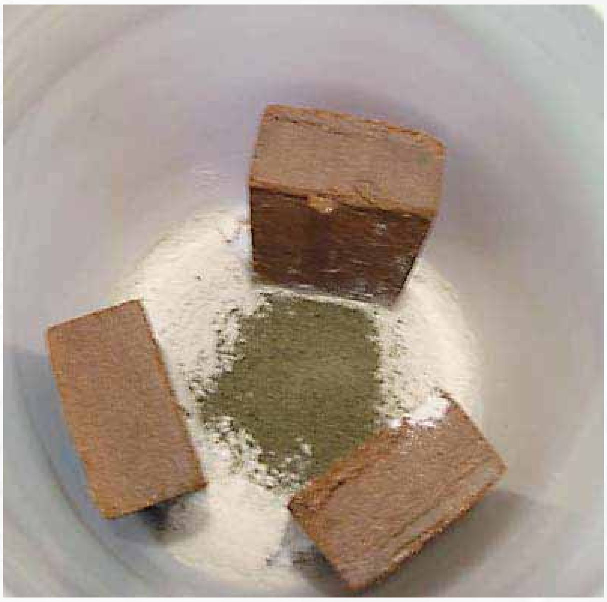
Coco Coir.

So three bricks went into a five gallon bucket.

distilled water
wardley
BULLSEYE
7.5
Basic pH REGULATOR

Three gallons of distilled water and three teaspoons of 7.5 pH regulator...

were heated on the stove to 150 degrees.



I added some hydrated lime, gypsum, kelp meal and blood meal to the bucket.

I added the three hot gallons of water and stirred well.
The stirring incorporated all of those powder additives into the water.
The coir then, in turn, absorbed that water and those additives.

A cover was placed on the bucket with a hole in it, and the coir bricks were allowed to expand for a half-hour.

After the half-hour, I opened the bucket to find three very expanded bricks.

I broke up the bricks very well using a knife at first. No big chunks at all left, all broken up.
These pictures suck, sorry, I suck with a camera. You can imagine though...

I dumped the coir into a mixing tub and added in the last little bit of tenn stud I had to the mix. But I wanted more...

Worm castings, diatomaceous earth, and maybe a touch of stevia leaf were added.

This was mixed very well until incorporated.
Some vegetable oil was added and mixed in.
And 7.5 pH regulated distilled water was added until the mix was field capacity.

PAINT
STRAINER
TRIMACO
5 GALLON
Elastic Top

A five gallon bucket was lined with a paint straining nylon bag.

The bag was filled 1/2 to 2/3 full with this finished substrate mix.

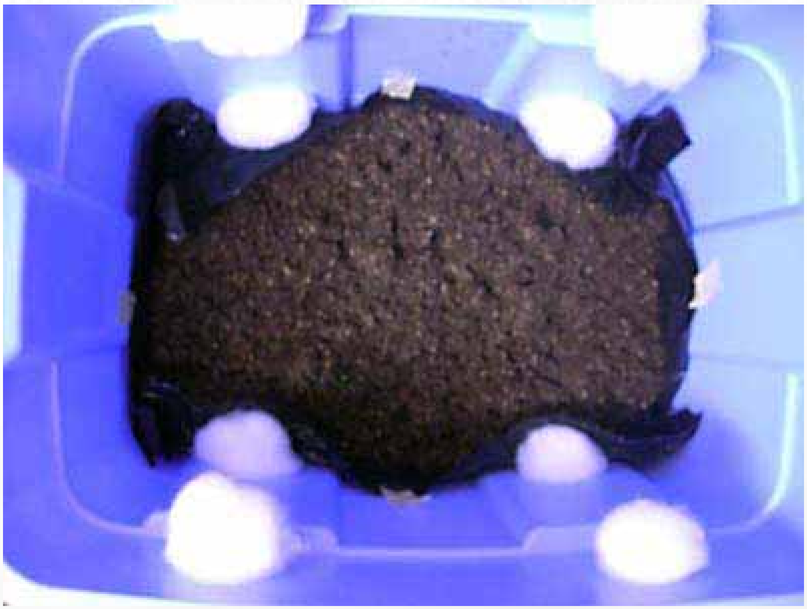
The bag was closed and cinched together with a rubber band.
This mix was enough to make two nylon bags full.

So the first one done was loaded into a five gallon bucket.
(I always place them on their side, they fit much better.)

And the second one was placed on top of the first, filling the bucket.

Sticking to my bulk substrate tek, I heated about 3 gallons of water to 175 degrees.

I filled the bucket with 175 degree water, covered it with a lid, and let it sit and pasteurize for two hours.



Once the two hours were over, I put the two bags into a clean tub to drain and cool.
I squeezed them fairly hard at first and then just let them sit.

Okay, now I had some colonized spawn and some pasteurized bulk substrate material.
It was time to put the two together into my newly constructed monotubs.

[Table of Contents](#)

STAGE FOUR: Spawn and Substrate added to Monotub and Preparation of Casing Material

I showered and put on clean clothes.
I used listerine before and after brushing my teeth.

Apothecary Products
F405-603
NIOSH N95
Apothecary Products
F405-603
NIOSH N95

I put on an N95 mask and a shower cap.

American Red Cross
100 ONE SIZE FITS ALL
HandHelpers
LATEX EXAM GLOVES
GUANTES LÁTEX PARA EXAMEN
• Non-sterile
• Ambidextrous
• Disposable
• Single use only
• Lightly powdered
• No esterilizados
• Ambidiestros
• Desechables
• Use sólo una vez
• Ligeramente entalcados
3 - 4.5% OF THE SALE PRICE SUPPORTS THE AMERICAN RED CROSS.
Officially Licensed Product of the American Red Cross.
ASTM

I wore latex gloves and cleaned them well with 70% isopropyl.

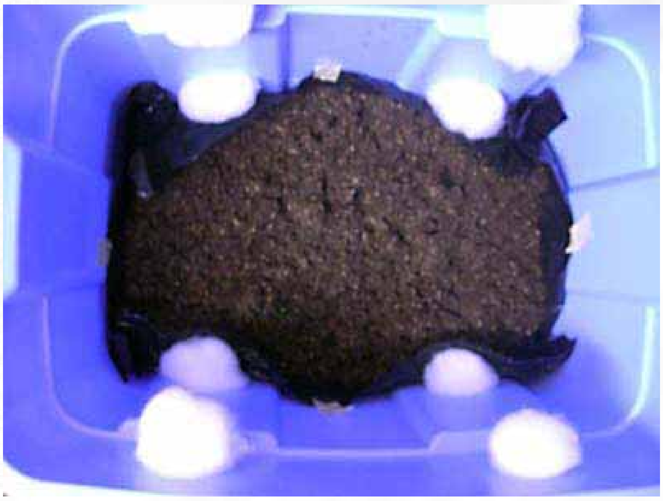
SWAN
70% ISOPROPYL RUBBING ALCOHOL
SWAN
70% ISOPROPYL RUBBING ALCOHOL

I put on latex gloves and cleaned them well with 70% isopropyl.
I wiped down the spawn bags and tubs with an isopropyl paper towel.

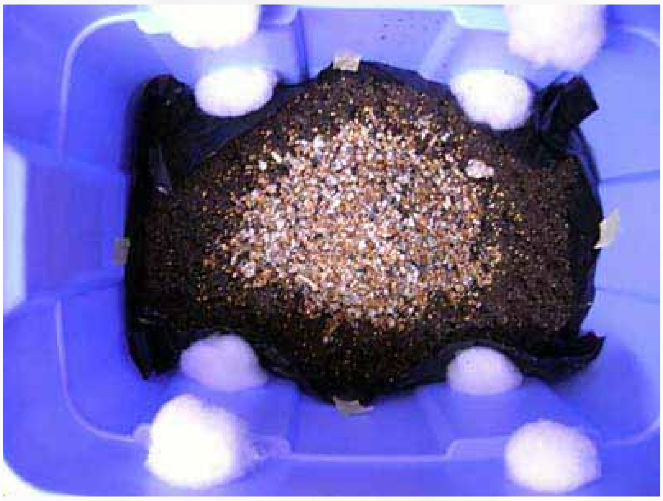
oust air
oust air
oust air
oust air

I sprayed the hell out of the air with oust brand air sanitizer.

I gave the oust a minute to work, then opened the first tub.

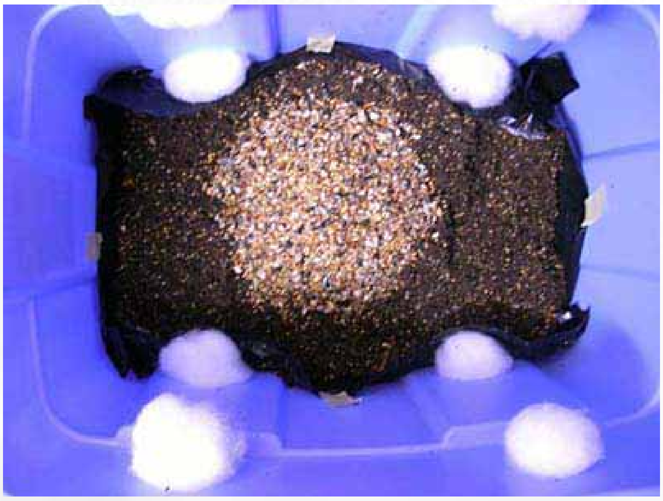


I emptied the bulk mix into the monotubs, leveling them out at around four and a half inches deep.
Sorry these pictures really suck in quality, I was trying to be clean.



I dumped the spawn on top of the substrate.
Each tub required one bag which was 3 quarts of birdseed spawn.

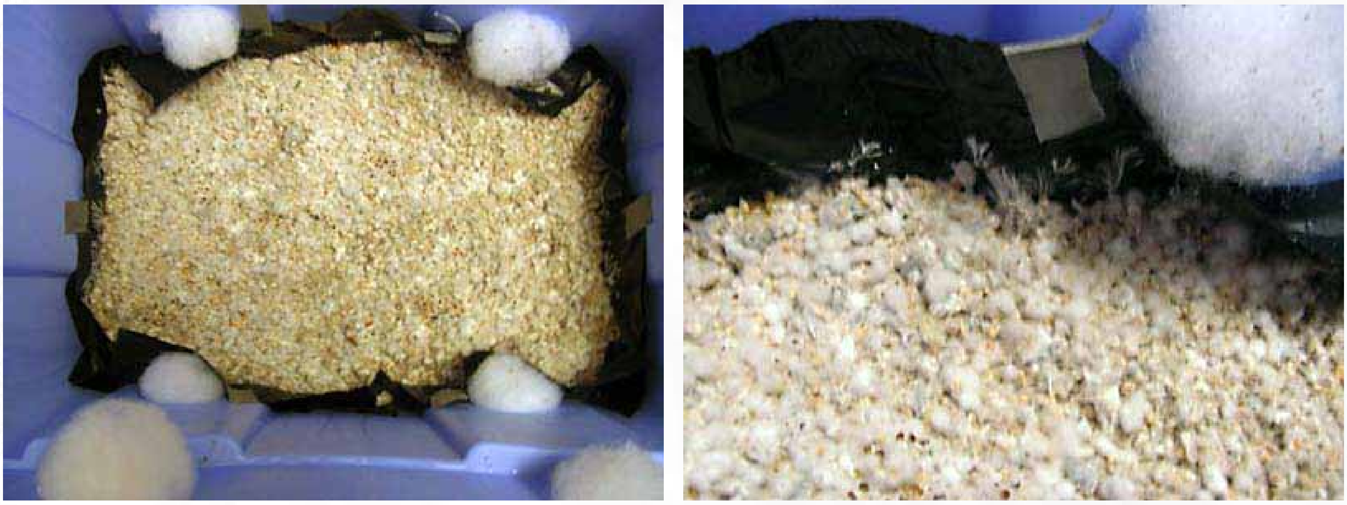
I mixed it in really well, especially the bottom.

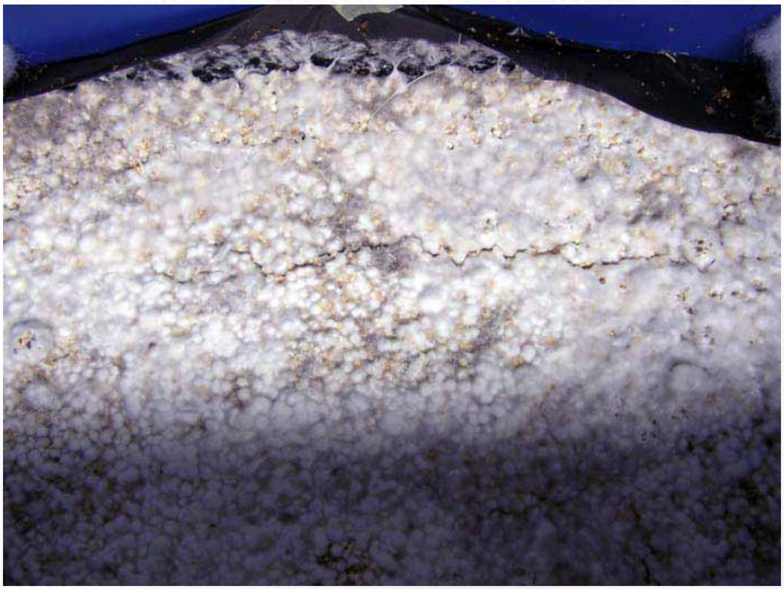


I added more spawn to serve as a spawn frosting layer.

I evened out the spawn frosting and closed up the tubs.

I placed the tubs under a blanket for about a week and a half.
74 degree room, blanket not too tight at all, allowing gas exchange still.




They colonized quite well and started to shoot up some rhizomorphs.

Now casing mix had to be made.
In recent past, I would make a traditional 50/50+ casing mix.
But this was more recent past, and I used a store-bought bagged product...

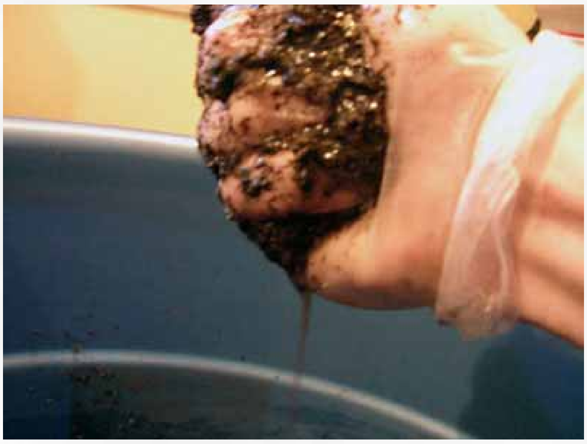
Grows Plants Twice As Big!
Miracle-Gro
Moisture Control
POTTING MIX
Feeds Plants up to 3 MONTHS!
8
Miracle-Gro Moisture Control Potting Mix.

I said this would be easy, and it is.
So I made up only six quarts of this stuff, because that's all I need for two of those monotubs.
I forgot to take pictures of this part, maybe I'll make more soon and remember to take some pictures...

Recipe I used for my casing mix:
38 cups of Miracle-Gro Moisture Control right out of the bag
(I removed sticks and large pieces)
1/4 cup of hydrated garden lime
1 cup of oyster shell flour
1 cup of food grade diatomaceous earth

I mixed this all very well before adding any water.

I added 7.5 regulator distilled water until field capacity.



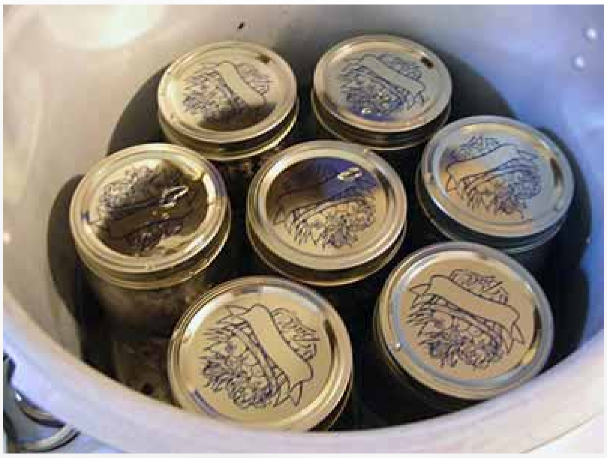
I tested the pH with my pH/Moisture probe and it was 7.5.
Perfect, now time to pasteurize the casing material on the stove.

Table of Contents

STAGE FIVE: Pasteurization and Application of Casing Material and Fruiting Parameters

I filled six quart jars full of casing material, NOT packed down tight.

I used new lids, not altered in any way and placed them on the jars.



I screwed the band down tight and loaded the jars into the Pressure Cooker.
(the middle jar is full of just water, to help keep the jars in place)
I filled the pressure cooker with cold water so the water was 2/3 up the side of the jars.

WARNING
ADVERTENCIA

I put the lid on the pressure cooker, but not the weight, and started the stove on high.

I let the heat build and the water boil.
I let steam escape the valve for five minutes and shut off the heat.

I let the pressure cooker just sit there and begin to cool for a half of an hour.

I turned the heat back on high and repeated the boil and five minutes of allow steam venting before shutting the heat off again.

This time the pressure cooker was allowed to cool for two hours.

I removed the jars and brought them to a room to cool to room temperature.
Casing mix was then complete and awaiting it's use.

I moved the tubs out of darkness and into the clean room with still air.
I showered and put on clean clothes.
I used listerine before and after brushing my teeth.

Apothecary Products
F405-603
NIOSH N95

I wore an N95 mask and a shower cap.

American Red Cross
100
ONE SIZE FITS ALL
Hand-Helpers.
LATEX
EXAM GLOVES
GUANTES LÁTEX PARA EXAMEN
Non-sterile
Ambidextrous
Disposable
Single use only
Lightly powdered
No esterilizados
Ambidiestros
Desechables
Use sólo una vez
Ligeramente entalcados
3 - 4.5% OF THE SALE PRICE SUPPORTS THE AMERICAN RED CROSS.
Officially Licensed Product of the American Red Cross.
SWAN
70% ISOPROPYL
RUBBING ALCOHOL
SWAN
70% ISOPROPYL
RUBBING ALCOHOL

I wore latex gloves and cleaned them well with 70% isopropyl.

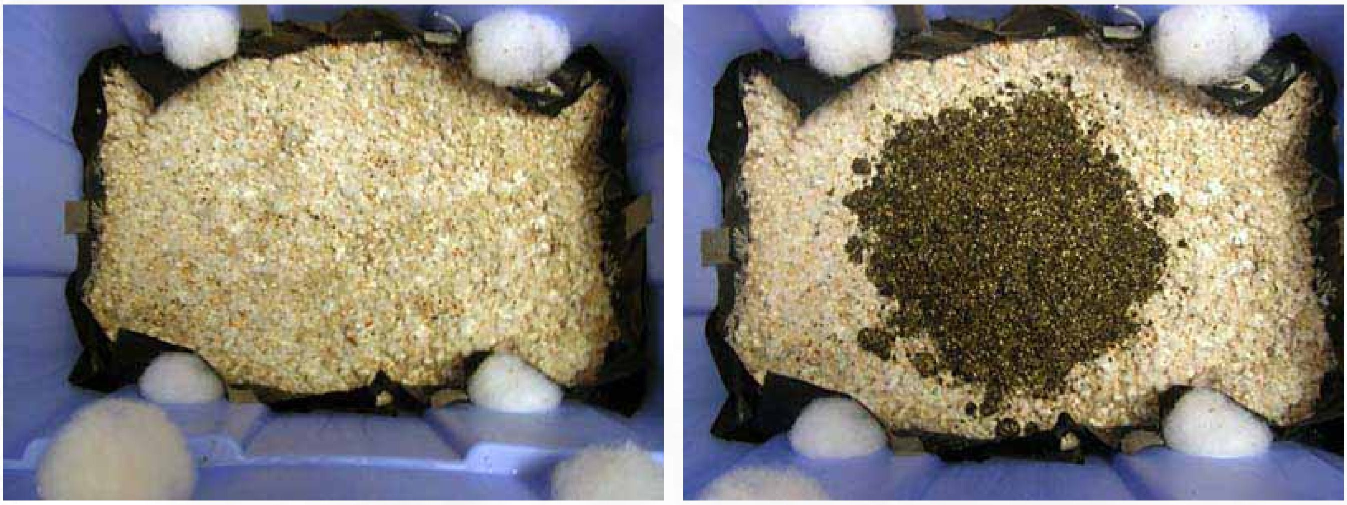
I removed the bands and wiped down the casing jars with an isopropyl paper towel.

oust
oust
oust
oust

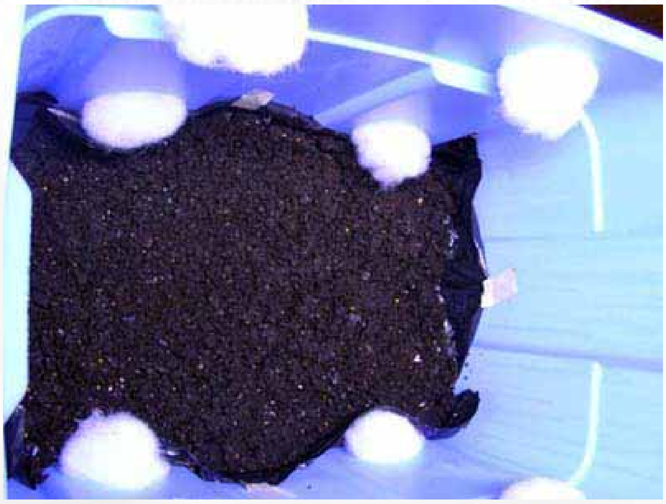
I sprayed the hell out of the air with oust brand air sanitizer.

I gave the oust a minute to work.

I shook each jar well then popped the vacuum seal and set it aside.



3 quarts of casing per tub were added and leveled out very evenly.



The tubs were closed immediately and put back into darkness.
After three days, the mycelium began to poke through and the tubs were taken from darkness and placed into their fruiting room.
Fruiting is super simple with monotubs.

Parameters the tubs were placed in:
74-76 degree room, whole room heated with a radiator-type space heater.
Box fan on a shelf high in one corner, running on medium.
Another small fan in the opposite corner, oscillating on medium.
Empty, inverted tubs or milk crates used to sit the tubs on.
A fluorescent light in the center of the room on the ceiling with cool white bulbs, set on a timer for 13 hours on and 11 hours off.

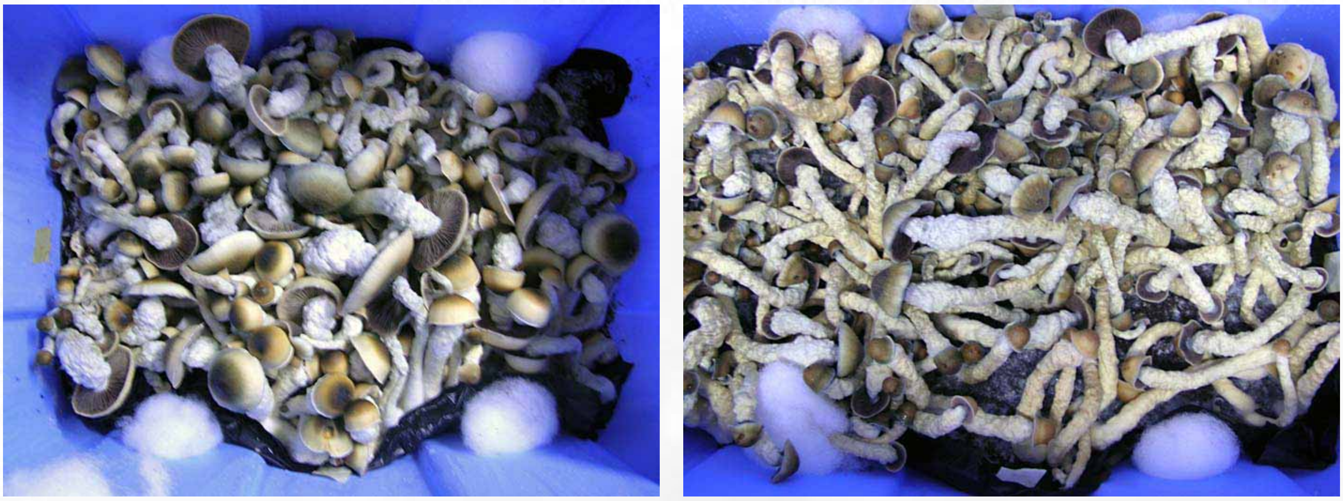
That's it.
No misting, ever.
No fanning, ever.
No patching or any opening of the tub at all, until harvest that is...
The holes are placed so as to promote swirling of air inside of the tub.
The poly-fil is used to trap humidity inside that the casing naturally produces.
It's a wonderful fruiting environment.

Table of Contents

STAGE SIX: Harvest, Dunking a Bulk Substrate and Later Flushes

Pinning is a problem to show you.
See these monotubs never opened, and I couldn't photograph the pinset.
The lids are translucent to start, and with a touch of condensation they turn pretty much opaque.
So sorry folks, right now I have no pinset shots of these tubs.
Let's just say the pinsets were acceptable, but not overwhelming.

Here are some pictures of the fruits:



Each tub on their first flush, nothing too special really.

Nice color on the gills on this one.

Typical flush for one tub, six ounces cracker dry.

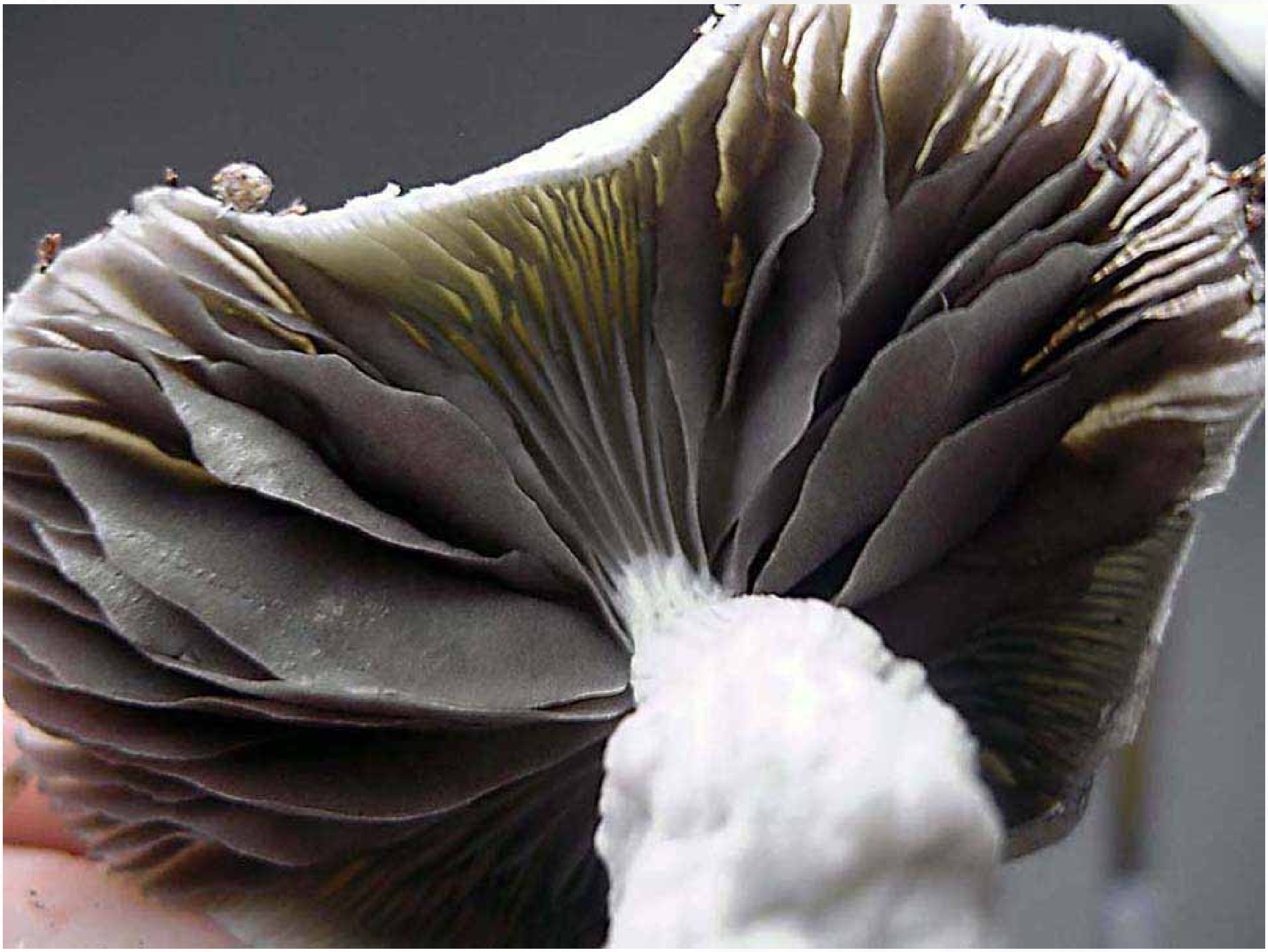
Some pictures of Second Flush Fruits for you:

A nice handful of solid fruits and a nice family of brothers and sisters.

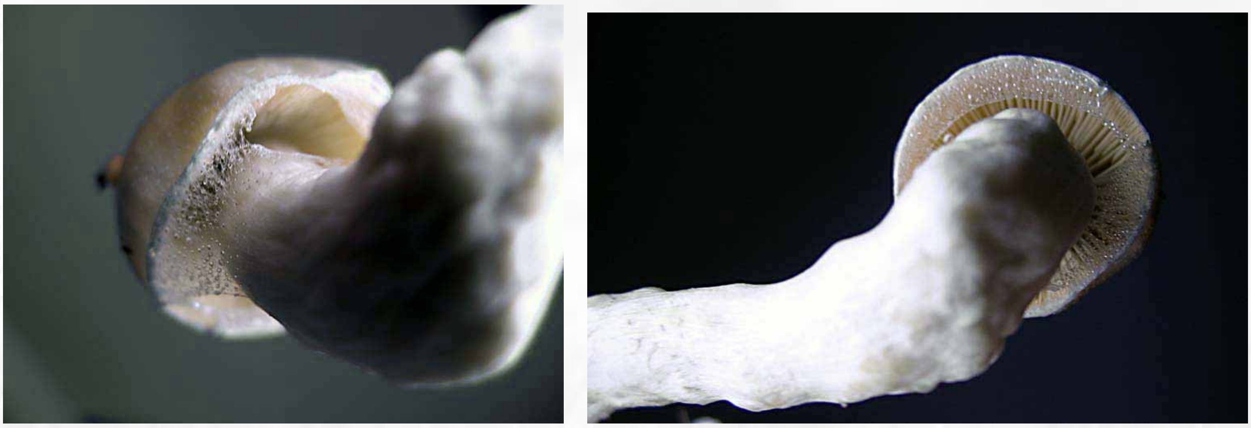
My dehydrator was laughing at me.

But I got them dry.

Other Penis Envy pictures of mine for you:



Gill mutation.



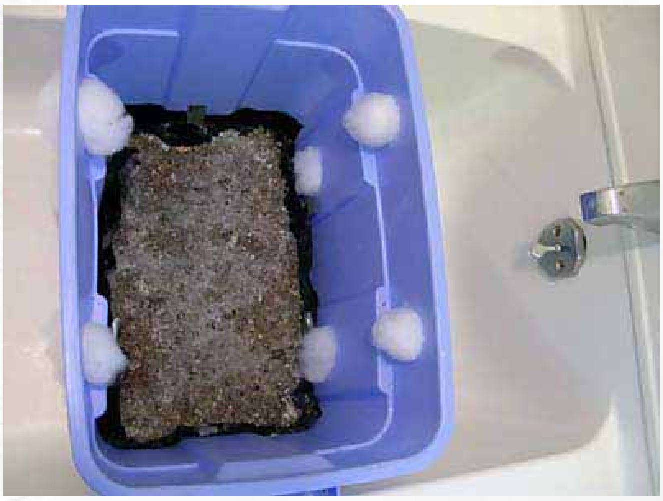
The minuscule veil.

The single and double penises.

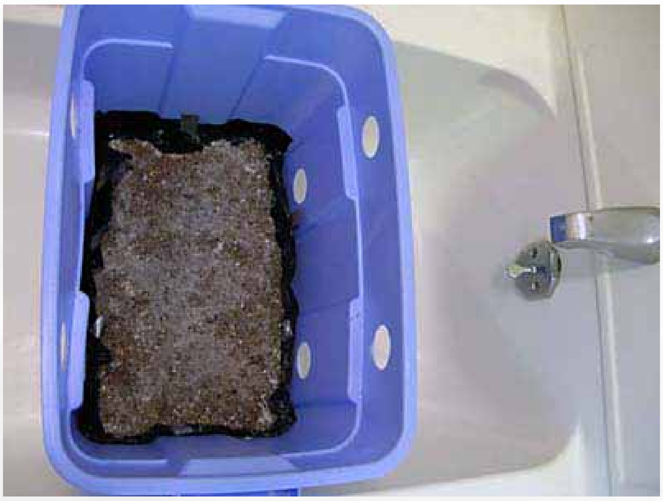
Super dense stipes on these pe pe's.

Nice shots from a bag.

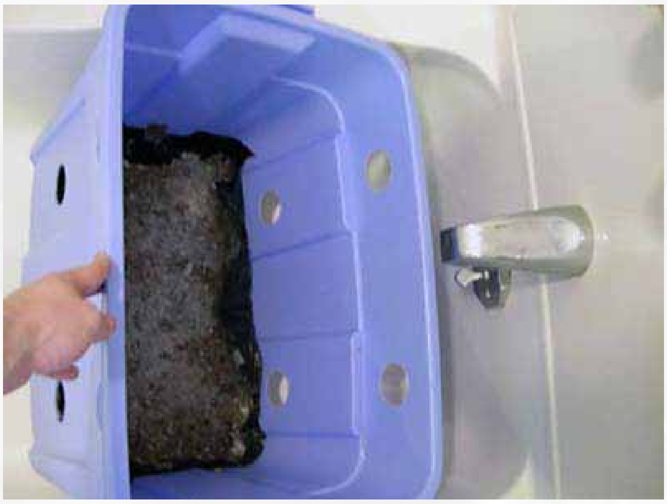
After the harvest, it was time to dunk the substrates and get them ready for a second flush, this is how I did that:



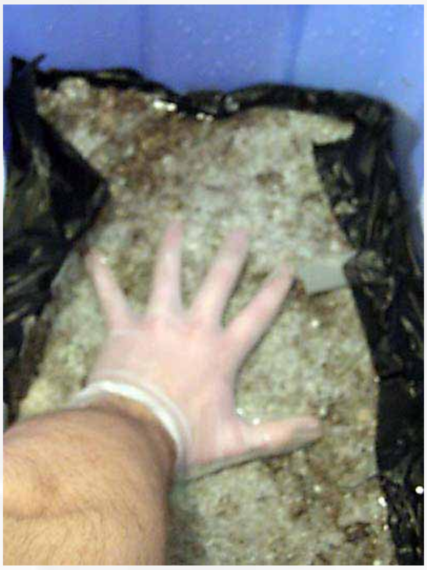
I placed the tub into the bathtub.



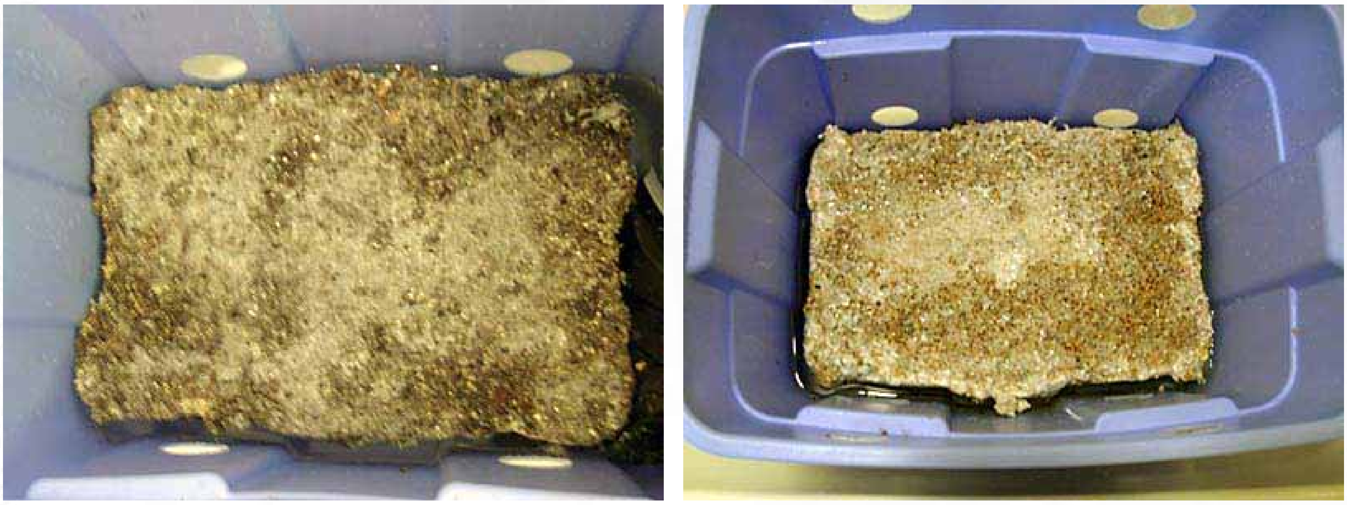
I removed the poly-fil from the holes and set it aside.



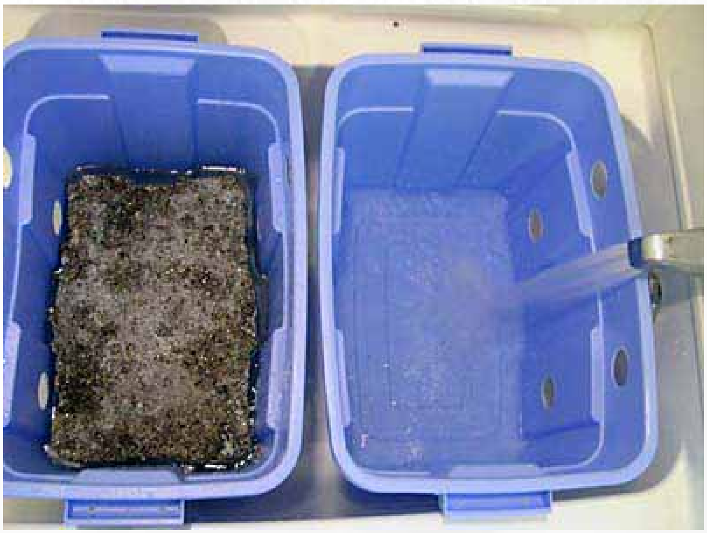
I tilted the tub and carefully filled it with water up to the holes.



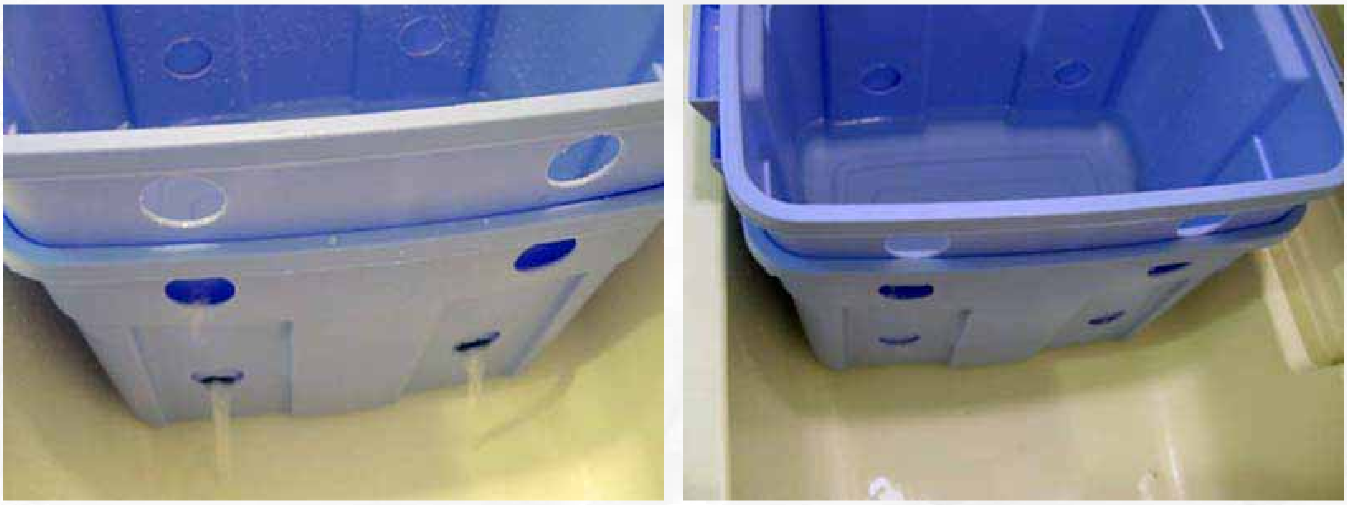
I gently submerged the substrate and loosened the bag around the sides.



I removed the bag gently.



I filled another tub with about two inches of water.



I carefully put the water filled tub on/in the tub with the substrate.
This top tub was an effective and even weight to hold the substrate under water.
Notice that some water ran out of the bottom holes, that was fine.

I positioned the tubs under the faucet and turned the water on slow.

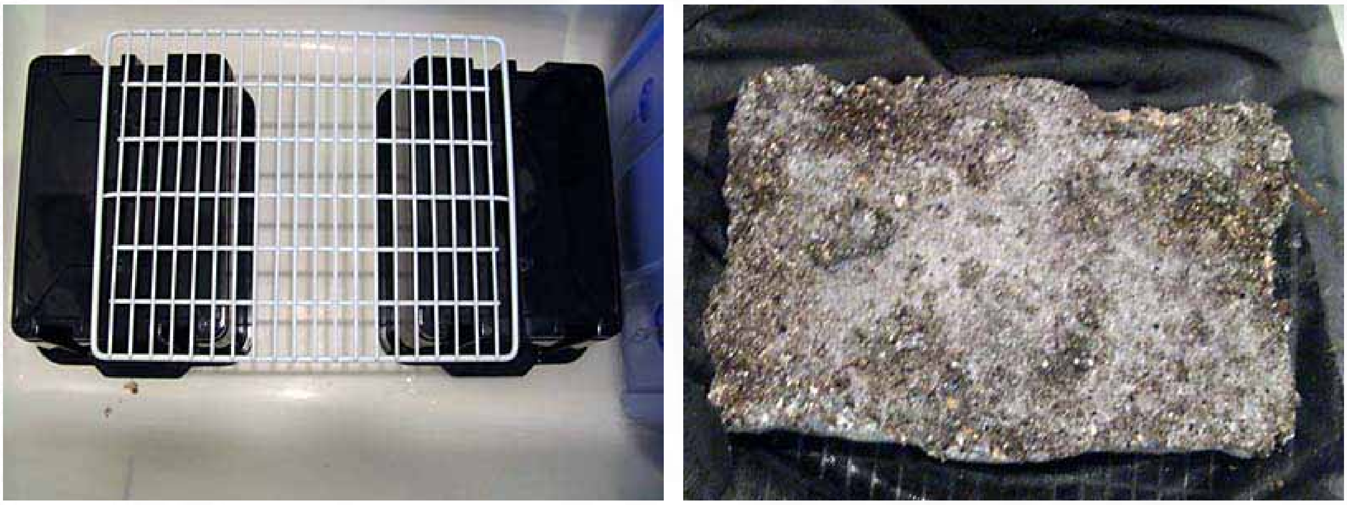
I let the water run into and out of the bottom tub for 4 hours.
After the four hour dunking, I shut the water off.
This used about as much water as a typical shower would have.

I very carefully removed the top tub as to not spill any water onto the substrate.

I emptied the top tub and set it aside.
Now it was time to remove and drain the substrate.

I taped two of the bottom holes with duct tape.
This would be temporary.

I tilted the tub again and filled it as much as I could.
I cut a piece of house screen six inches longer and wider than the substrate.
I used the screen to easily lift the substrate out of the bottom tub.



I placed the substrate and screen on to a wire shelf on top of some trays to drain.

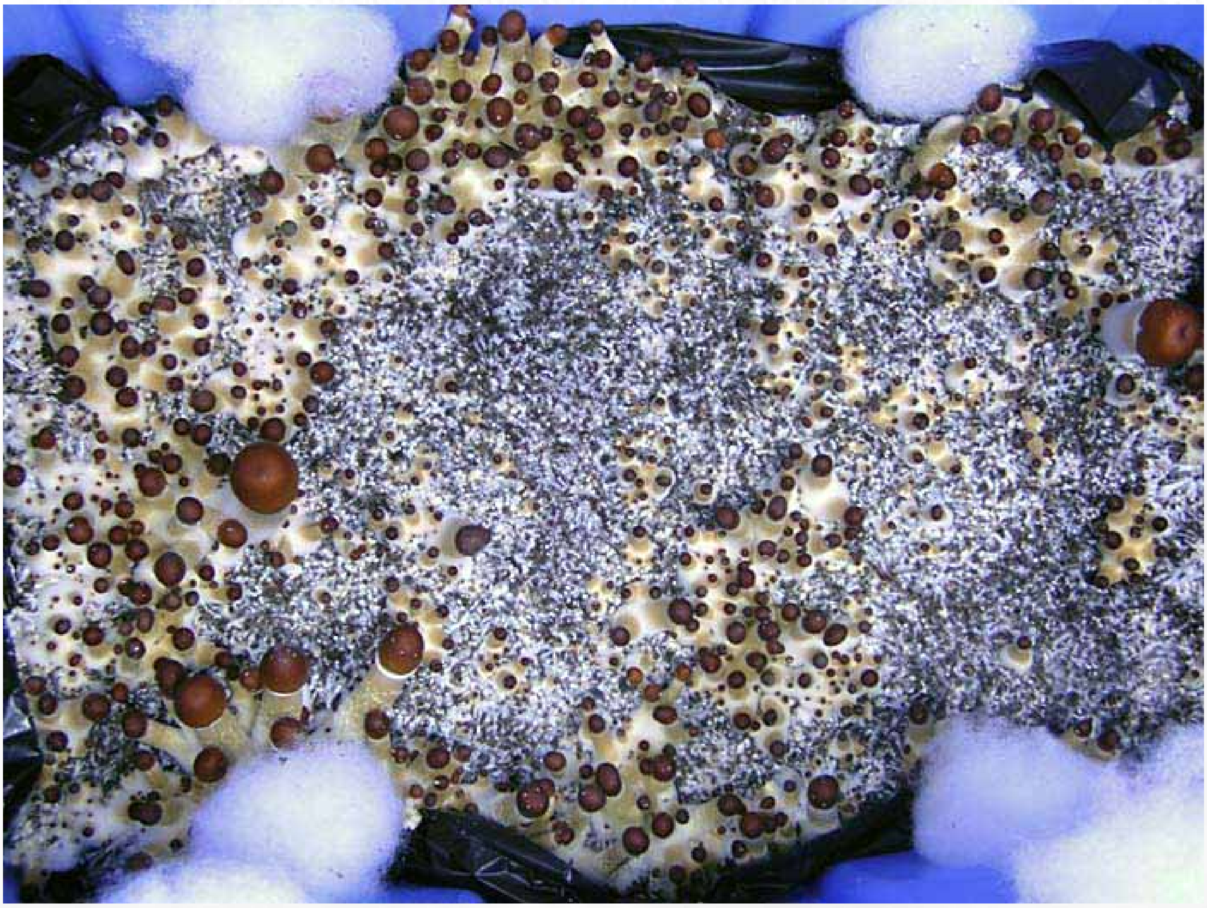
I let the substrate drain for four hours.

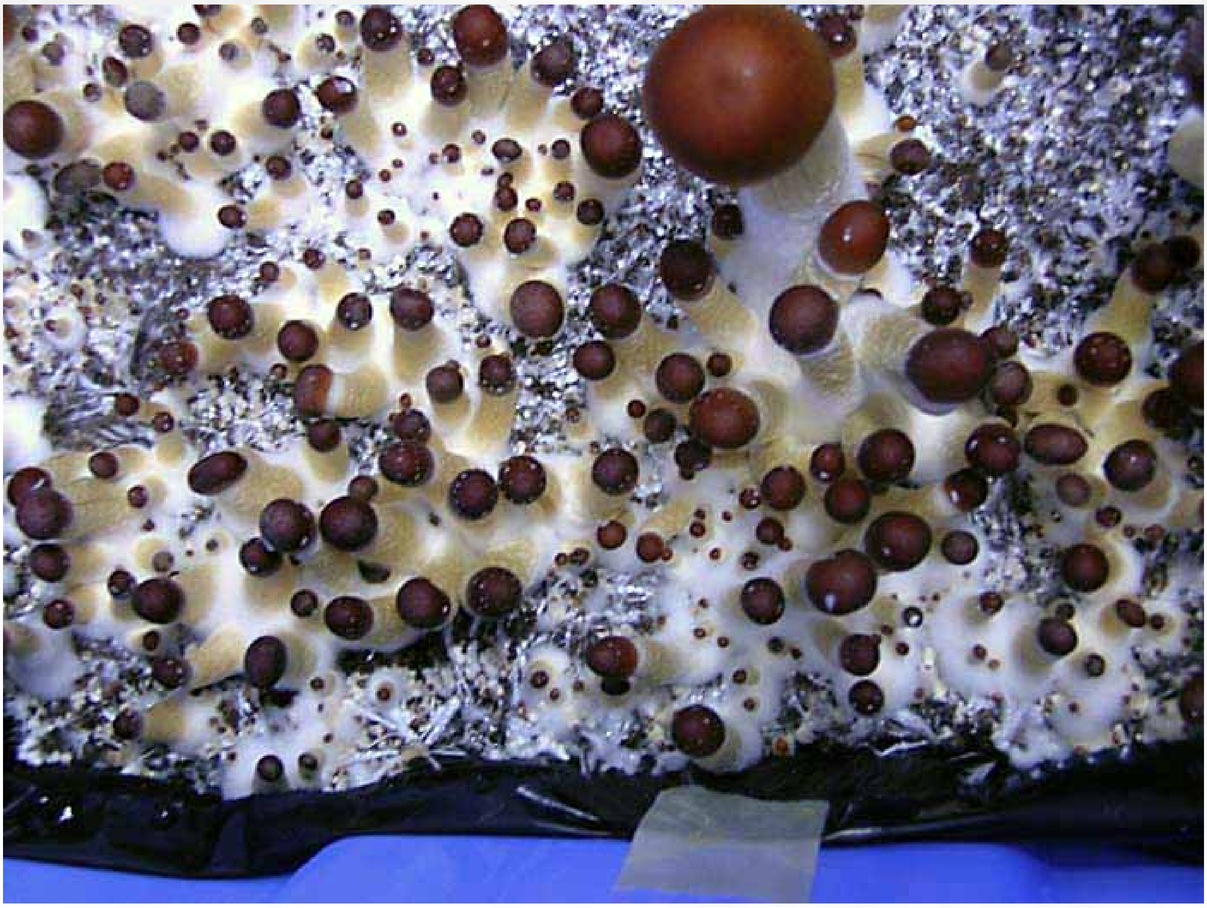
While the substrate was draining, I cleaned the monotub
very, very well and replaced the poly-fil in the holes.
I sealed the lid and set it by the bathtub for easy access when ready.

I slowly and easily shimmied a new plastic bag under and around the substrate.

I placed the substrates back into their clean monotubs and applied a fresh layer of brand new casing material to the substrates.
I then placed the monotubs back into the fruiting room and waited for a second flush.
And the grow is successfully completed.
What to do with the fruits? Make chocolates!

Works with any strain!!





Rye Grass Seed Bag Tek

by

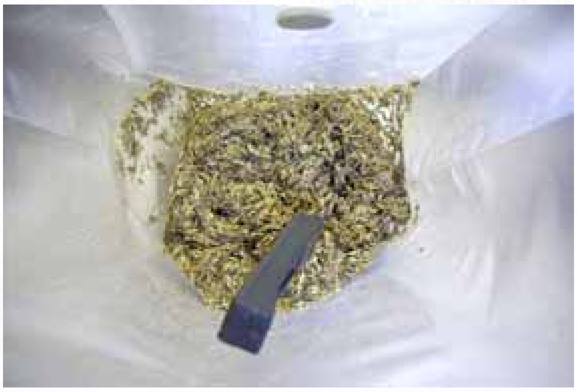
Compiler

original source:
http://cdn.preterhuman.net/texts/drugs/shroomery_grow_archive_2003_10_14/shroomery_grow/www.sporeworks.com/labnotes/ryebagtek.html

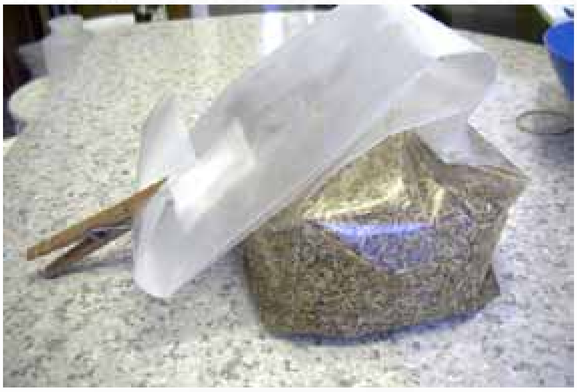
Below you will find instructions for the preparation of rye grass seed in Autoclavable Spawn Bags. The bags we are using for this demonstration contain filter patches and our new self-healing injector site. For these instructions we will be filling 3 bags and sterilizing them in a #915 All-American Pressure Cooker.

Fill 3 Autoclavable Spawn Bags with 500 gm of Rye Grass Seed.

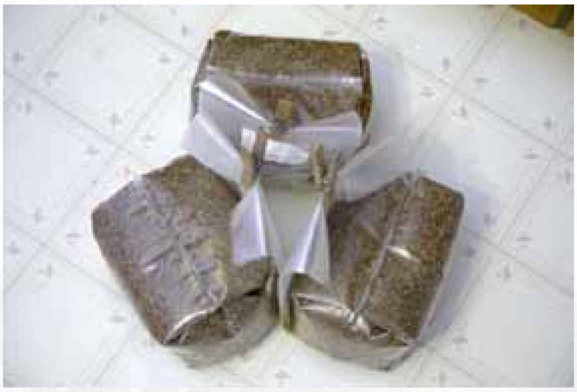
Add 500 ml of water to each bag.



Mix well.

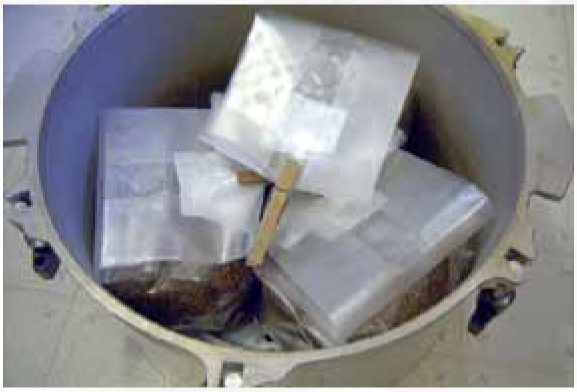


Fold over top of bags and hold closed with a clothespin.



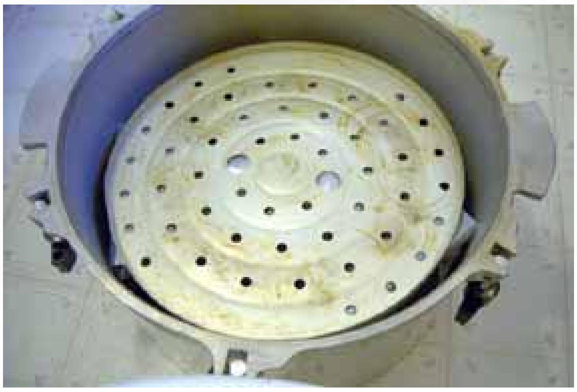
Flip bags over but keep opening at top like in photo to right.

Let sit like this for 8-10 hours or overnight. Rotate bags back to the normal upright position and fold the top down.



Now load 3 bags into a #915 All-American Pressure Cooker.

Add 3000 ml water to cooker.



Place extra bottom rack on top of the bags. This prevents the bags from blocking the vents of the cooker.

Put the lid on your cooker and secure. Turn on the heat to the range and set on high.

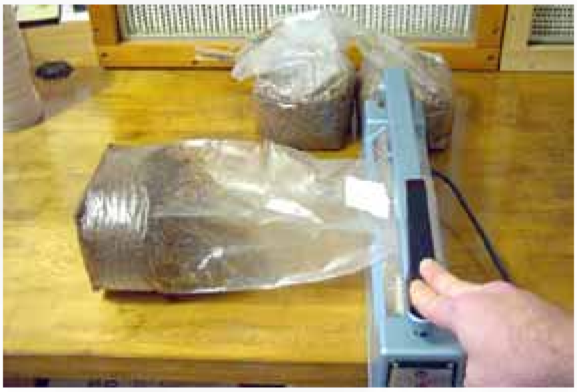
Let the steam vent until the pressure gauge is near 5 pounds pressure. This will ensure you that all air has been forced out of the unit.
Place the rocker on the vent pipe and turn down the heat to medium-high. This will vary with your particular range.

Pressure will slowly build until it reaches 15 pounds and then it will escape from the rocker. At this time turn the heat down to medium or so, just enough to maintain the pressure without making too much noise.
Once it reaches 15 pounds hold it there for 2 hours then turn off heat. Do not move the cooker. To many, 2 hours is overkill but I prefer double sterilization times for grain products.

Now is a good time to clean the work area where the bags are unloaded from the cooker. When the pressure has dropped to less than 5 pounds, the cooker can be moved, with care, to rest until opened.

This demonstration will be done in front of a HEPA (High Efficiency Particulate Air) filter system. A good still-air chamber or glove box will also work but contamination is more likely. It can be done.
Make sure you have washed your hands before proceeding.
Remove the rocker weight and open the pressure cooker.

Remove the 3 bags and let cool overnight or until less than 80 degrees (F).



Once cool the bags can be sealed with an impulse sealer.

The bags are now ready for inoculation.

Using your culture syringe, gently insert the needle through the small injector disk. Squirt approximately 2-4 ccs of spore solution into the rye grass seed. Slowly remove needle and the injection site will seal itself (If you are using bags without injector sites, insert needle through the side of the bag and tape over the hole once needle is removed).

Care for bags and store at proper incubation temps as species requires.

Late casing

The Method of Late Casing and Why it's a Good Idea

by

Fahtster

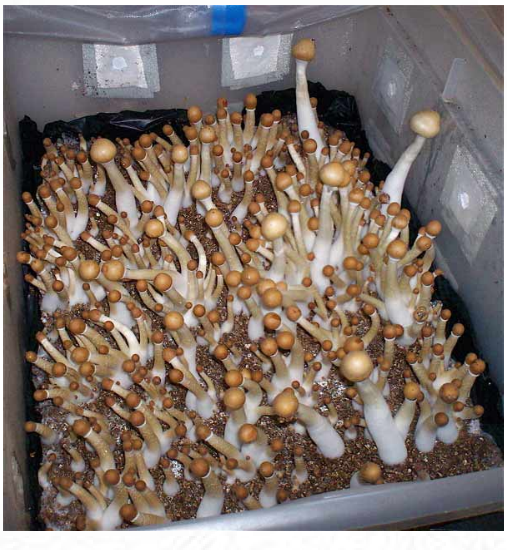
original source: http://www.shroomery.org/11382/Late-casing

I've been using a method called late casing... It's basically very simple and just how it sounds; applying the casing only after knotting has started and a few small pins start forming... so far it's been working great. I'm sure it'll have many rebuttals, but I say give it a try for yourself and see what ya think.. I know youz use hyphae's casing strategy and from what I can see, it also works great... this is just another way about it. Disclaimer: all of this is IMO and experience you can use whatever method you find fit, but I just want you to listen to why I think it's a good idea:

1. If you keep a casing layer off the top of the substrate and expose the sub to light from the time you lay it out, you are initiating knotting on the entirety of the top of the substrate. This will ultimately give you more fruits, at least some more fruits compared to the alternative. When you cover the sub with a casing layer, you are cutting off light penetration to some of the sub.

2. (a) The casing layer should not be colonized at all.. I don't care what anyone says.. that's not what it's for. It's not to hydrate the sub either, that just seems ridiculous to me. it does slow the release of evaporating water from the top of the substrate but while that's an important part it's a bit different than supplying the sub with hydration. The casing is to trap small air pockets of moist air to encourage developing pins and knots.. If the casing layer is colonized, the substrate cannot breathe like it should be able to.

(b) The substrate doesn't use the casing layer after the fruits have developed passed small pins. The fruits themselves act as the fruiting environment. If you think of an uncased bin, does it have a casing layer? The answer is actually yes; the entire rest of the bin is the fruiting environment... when you apply a casing layer, you are basically shrinking that fruiting environment down to the 1/2 inch directly above the substrate. This encourages the knots to form into pins and those pins to go on to develop into small mushrooms.. But then what happens after the fruits grow above the casing layer? That's when the fruits themselves become the fruiting environment for each other... kind of a one hand washes the other situation. I mean think about it.. if you put one cake in the middle of a 54 qt bin by itself, do you think that would do as well as if you put 24 cakes in that bin? no, because the cakes use the heat and perspiration of the cakes surrounding them as a fruiting environment. The same reason that the chronic tek works so well.. it's a cake in a small environment. Here's an example of what I mean...



notice in that pic how the casing layer is barely colonized if at all. The substrate at this point has stopped using the casing layer in the sense that the fruits are using it.. but the casing layer is using it in the sense that the casing is slowing the evaporation of water from the top of the substrate. And since the casing layer was added after the sub switched from the colonizing stage to the fruiting stage, the casing layer is not being consumed which helps the sub breathe. This also keeps the sub from spending vital energy on colonizing the casing. I know you've all noticed that once your bins' fruits reach a certain height, the bins are considerably warmer and moister inside. This is because the fruits are making that environment; basically helping themselves grow. So if you take a look at that pic, the actual casing layer (or fruiting environment) is from the top of the sub to about 4.5 inches above it.. the whole length of the fruits themselves. (sorry for the redundancy, just trying to really hit that home).

3. Another reason that this is a good idea is the length of time that the casing material is exposed to the substrate is greatly reduced. This in turns reduces the amount of risk the casing layer imposes on the substrate in harboring contamination. In example...

the amount of time it took this bin to get from here (right when the sub started pinning and the casing was applied)

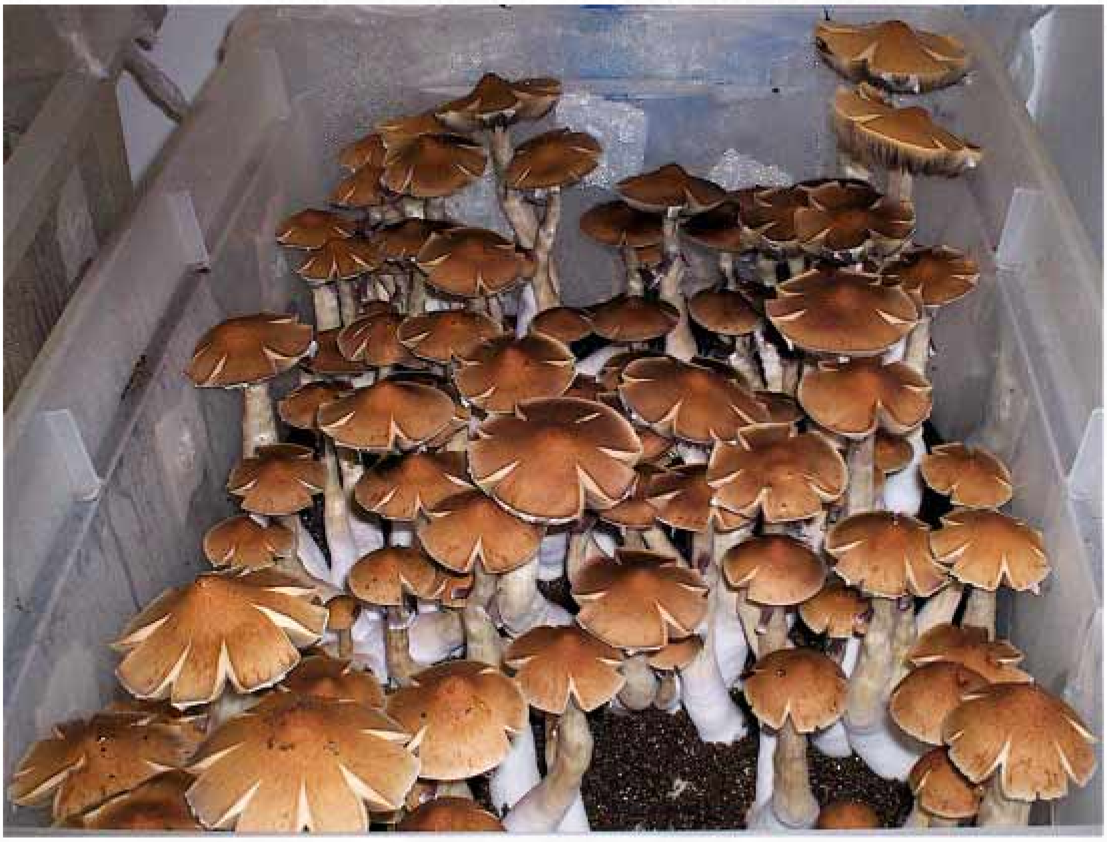
to looking like this...

was a mere four days. And since the time is so short, there should be no reason to add water to the casing after you first apply it.

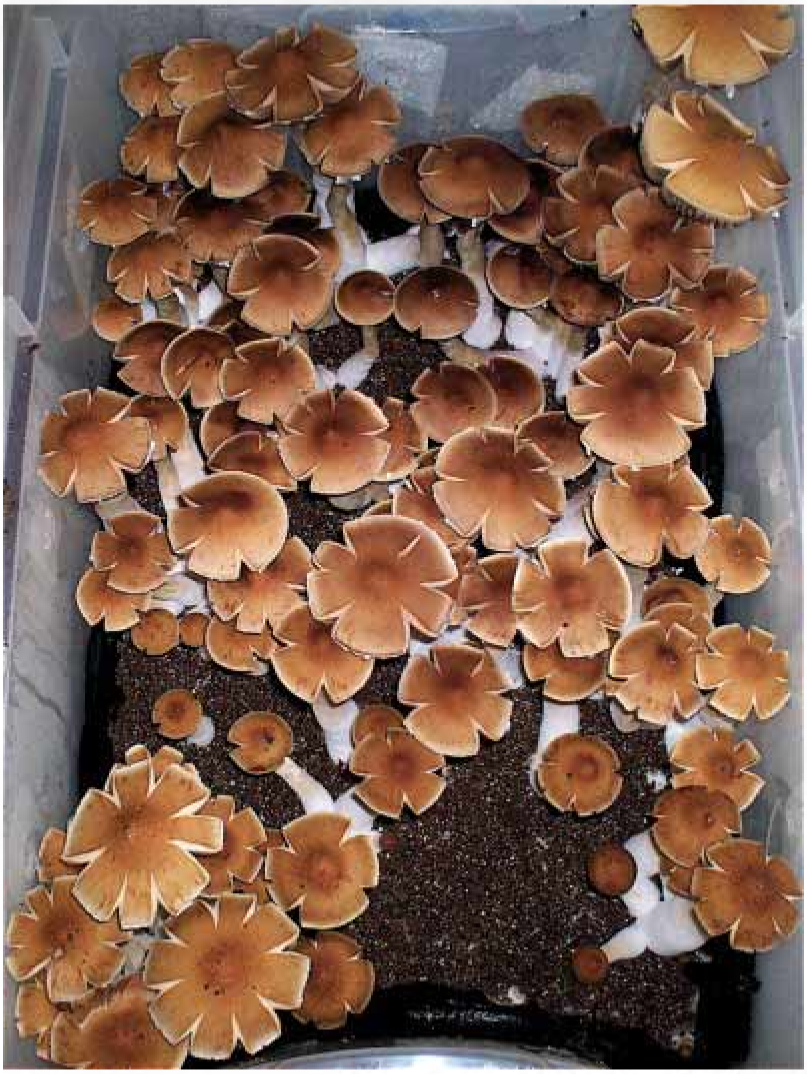
Here's other bins that have been late cased: all are 54 Qt bins except for the last tex bin, that's just a shorter version of the 54 qt.

that same bin in the first pic (SA's) only a couple days later...

The other two HB bins..



And a Tex popcorn verm rez bin that was also late cased...



Now, I'm strictly speaking of the bulk and grain casing methods and not for cakes. I actually do use the DECing's for water retention and cake hydration and not the usual method of a casing that the fruits grow "up" through.

I would love to hear any opinions and ideas about this and they are more than welcome. I just ask that you keep in respectful. Thanks for taking the time to check this out.

Here is also another thread you should check out on casing... it's the most standard way of casing... lots of good info here

Fahtster

Rez effect

by

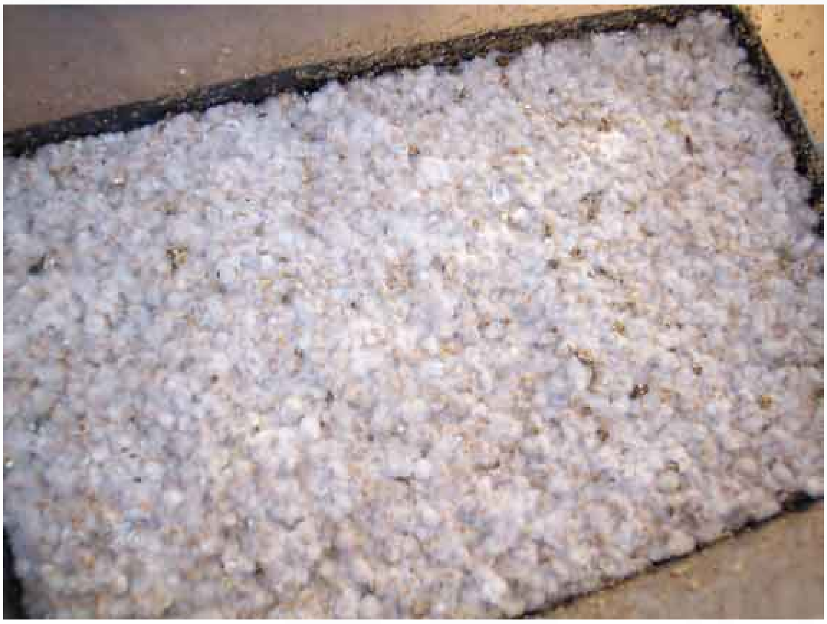
mockeylock

original source: http://www.rollitup.org/t/first-time-shroom-grower-pf-tek.107399/page-18#post-1651991

I know I'm new here and thanks for having me...I am rather experienced, however, and definitely know a thing or two about cultivation....
I've noticed just poking around, that most folks on this site are going with the PF tek. That's fine and all...it helps let you see the life cycle of cubes and gives you a good idea of how all this works.
But, man alive! Some of you are spending so much time, effort, and money setting up automated chambers with bubblers, humidity gauges, the whole works. With little to show for your efforts....
So I just wanted to give some ideas how to simplify and reap the benefits, so first off here's the Rez-Effect Tek which gives bulk-type results without pasteurization or anything besides wbs and vermiculite!
First off, get to know whole grains...so easy! They colonize faster since you can shake the qt. jars and you end up with way more spawn/substrate. This grow used 4 qts...this is 3 of 'em.

Next you simply mix into a Tupperware container (this is a 20qt'er) with about equal parts moistened vermiculite...

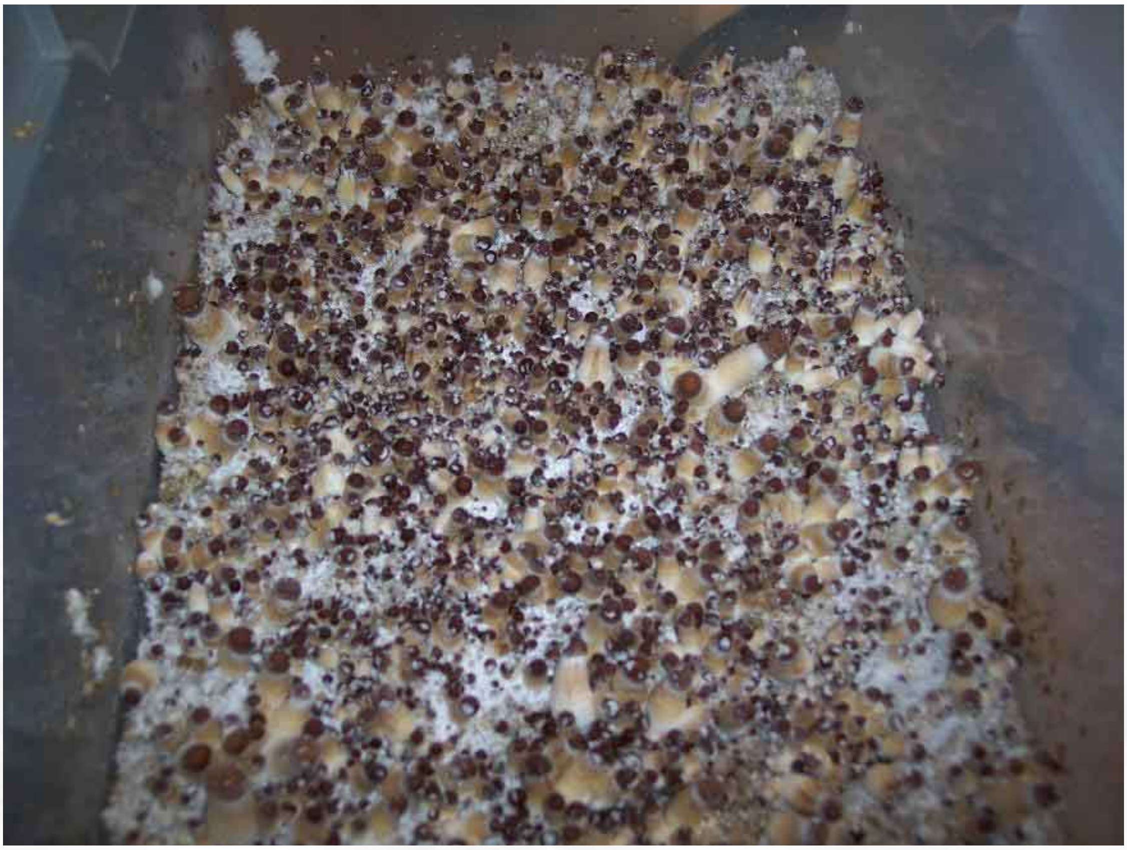
Next, cover with foil and incubate (we're talking about 3 days) until totally colonized.

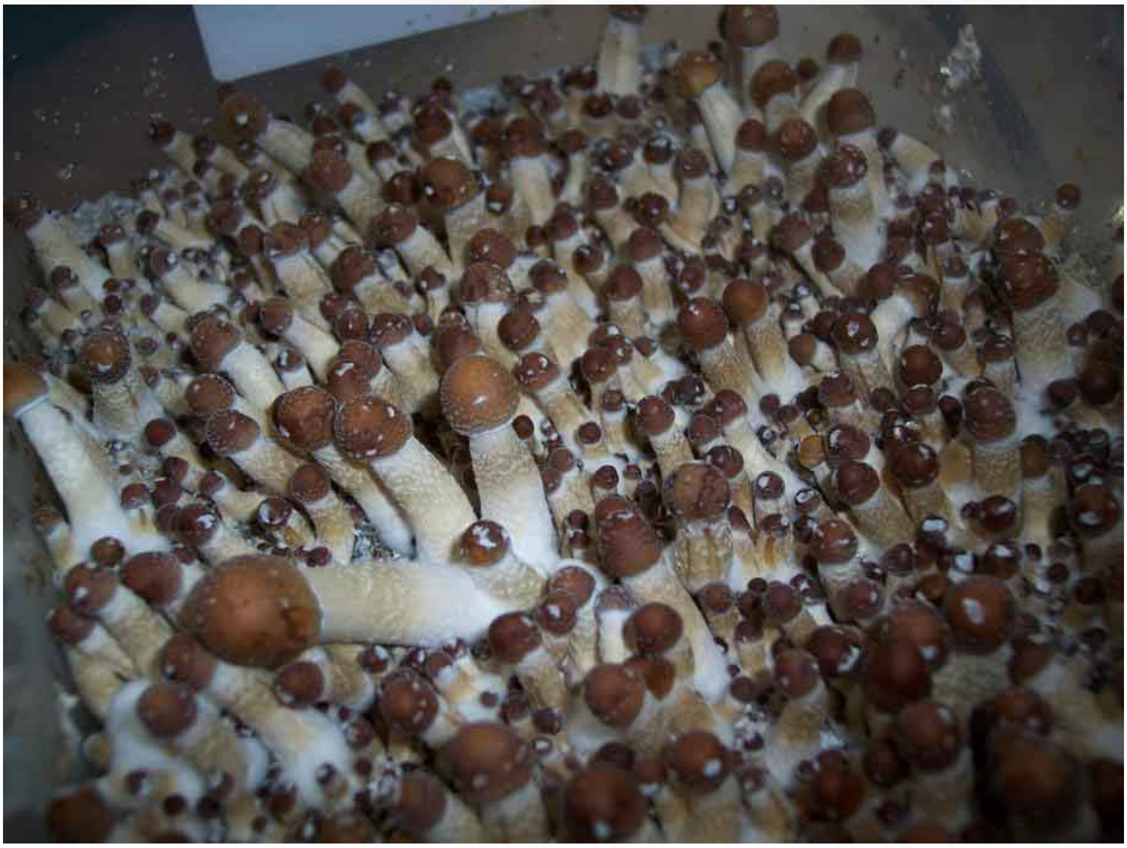


Now I've messed with a lot of casing mixtures. I've crushed Oyster shells with a hammer, lime, peat moss, coir, you name it.

You know what I use now? Vermiculite.

So case with whatever you like, recover, and let colonize a bit until you're ready to fruit. This time around it took forever to pin and the casing was 95% colonized. Bad news? Heh...just watch!





Just fanned a few times a day. This strain was S. American, btw....

From syringe to print using rye

by

Magash

original source: https://www.shroomery.org/8432/From-syringe-to-print-using-rye

Table of Contents:

- Making The Syringes
- Preparing the Grain and Jars
- Incubator Set Up
- Inoculation
- The Waiting Game
- Get The Casing Mix Together
- Making The Casing
- The Chamber
- Harvesting and Taking Prints
- FAQ

Making The Syringes

1. Well first I fill up a half pint jar with filtered water.
2. Then I like to add 2 or three drops of jet dry to the water (keeps spores from clumping and sticking to the sides of the syringe) and fill the syringes.
3. I put the syringes into a quart jar and put them in the pressure cooker so the needle tip faces up. (if they don't face up the water will shoot out when it boils.
4. I wrap 1 shot glass for each syringe in foil, put them in a quart jar and put them in the pressure cooker too.
5. I pressure cook at 15psi for an hour.
6. When it's all still hot as hell I load it all into a glove box that has had the living shit sprayed out of it with Lysol the night before. Spore prints to be used go in too.
7. This part is just a me thing but when it cools I unwrap and use one shot glass for each syringe. Flake off the print into the shot glass the amount of spores your going to use, shoot in the water from one of the syringes and suck it back up with the spores. The amount of spores used is up to you cause at this point I go overboard again.

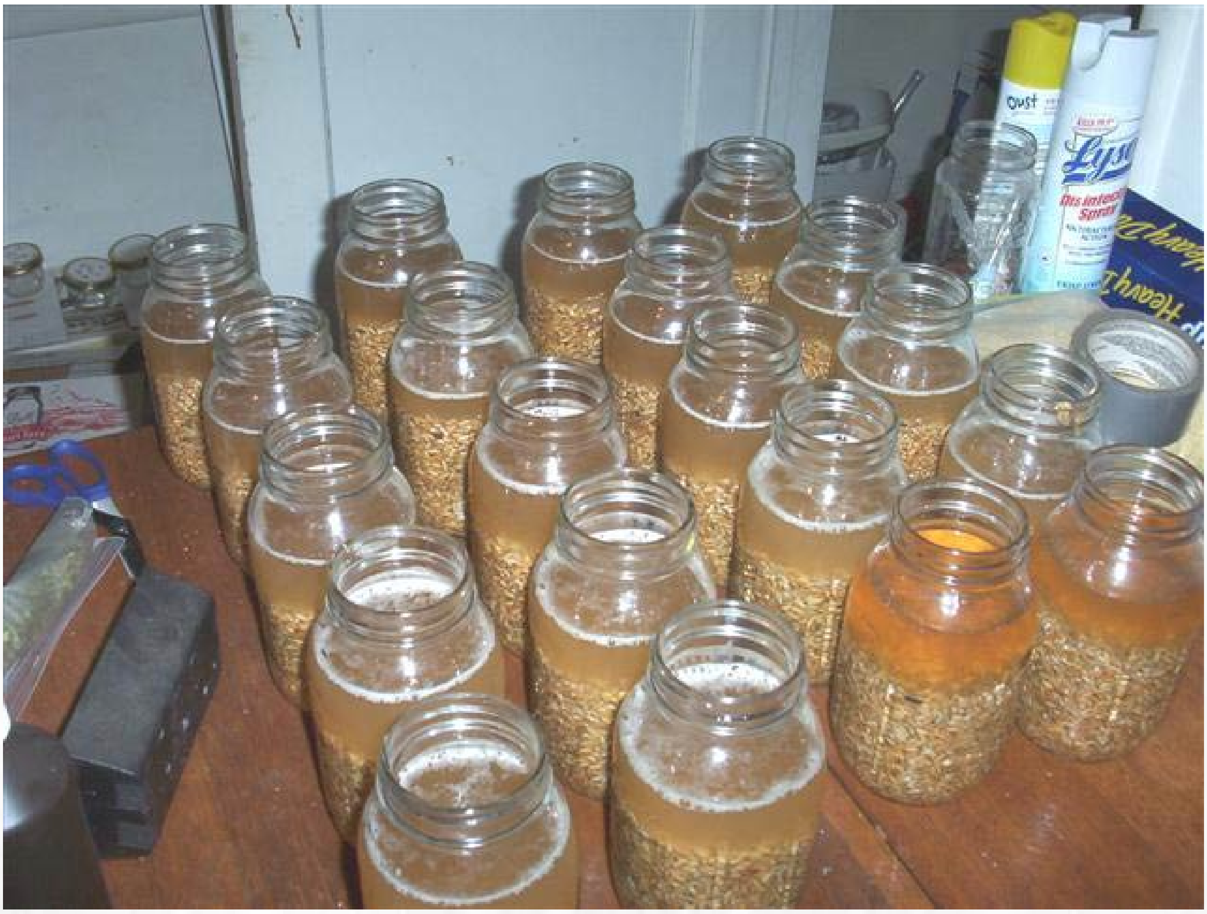
I know there is a lot of steps in this and it's a lot of overkill but it does leave little room for contaminations.

Preparing the Grain and Jars

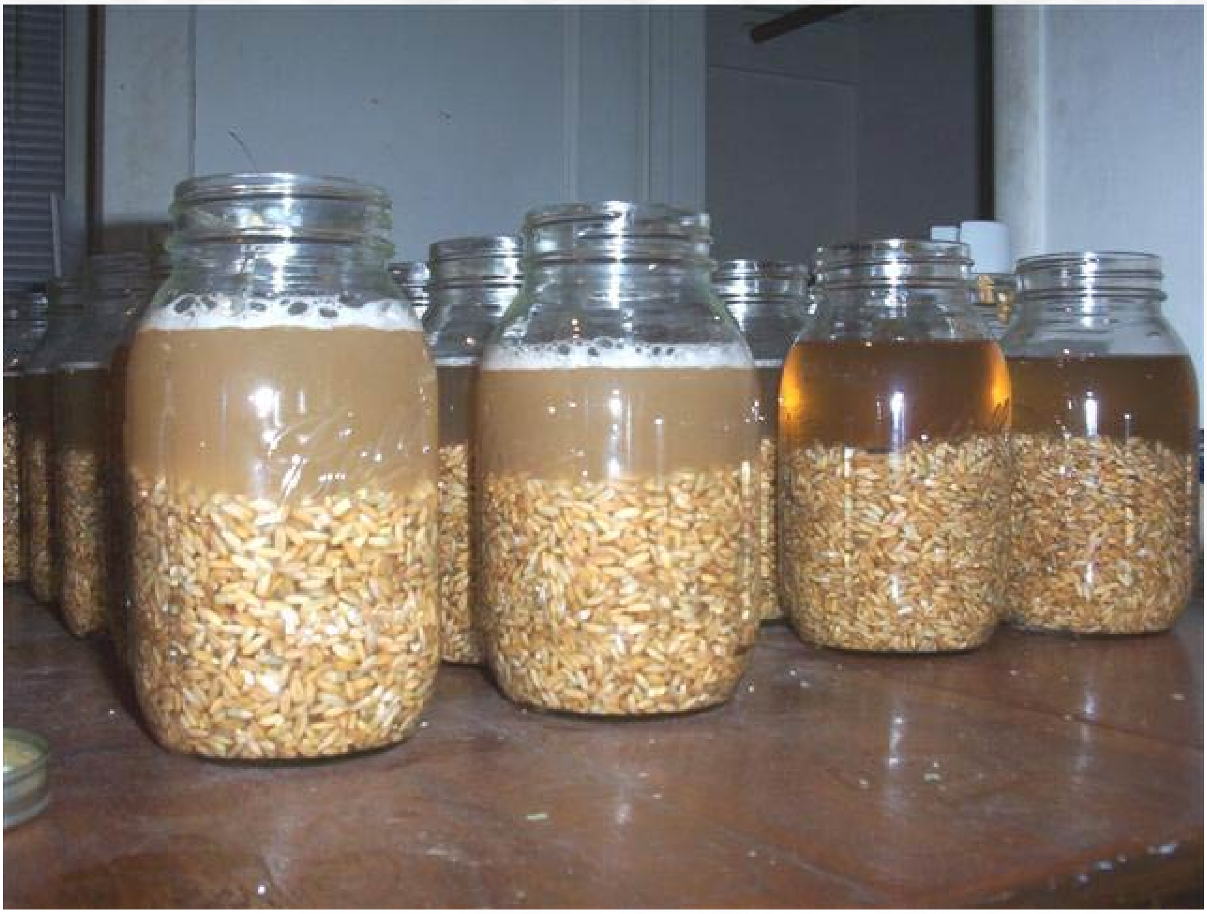
1. First thing I do is put one cup of rye in each quart jar.

2. Put in enough water for the soaking. Alternatively just measure out the grain and let it soak in a big pot (for instance the same pot you are going to use for the simmering later).

I like to soak for 24 hrs. Notice the difference in the color of the water after 24 hrs.



Bacteria endospores have started to germinate.

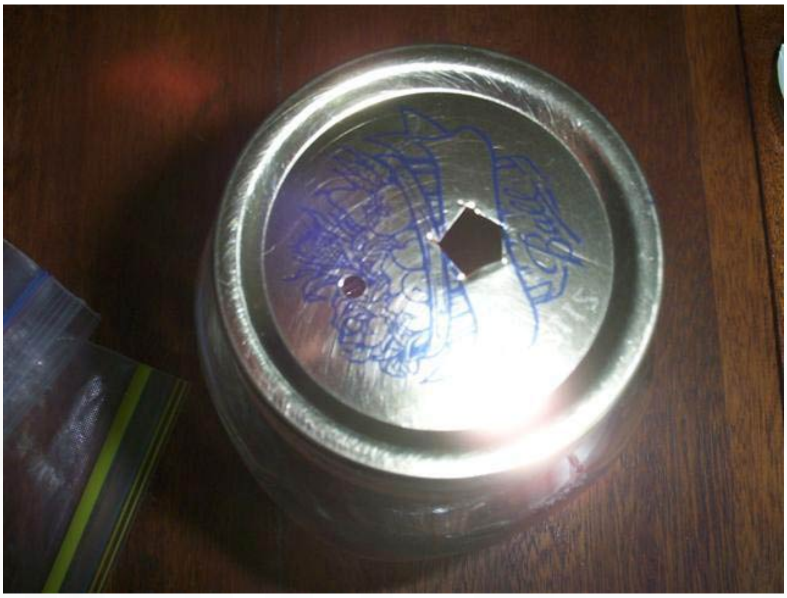


This is the reason we soak the grain. Many believe that this is where water is absorbed by the grain but this is only partially true since a substantial amount of water is absorbed by the grain when it is simmered. The main reason for the soaking is that we are germinating the bacterial endospores because they sometimes can survive the pressure cooking process. NOTE: In hot weather (summer) rye will sometimes begin to sprout before the 24 hour soak is over. This is NOT something you want to hapen. In this case shorten the soak time to 12 or 16 hours.

3. Strain the grain through a colander to get rid of the dirty water.
Put in a pot with plenty of fresh boiling water (roughly double the amount of the grain), reduce the heat and simmer for ~45 min, until the first rye kernels begin to open.

4. Strain the simered grain through a colander. I like to pour 6 gallons through the grain in order to get rid of the starch on the outside of the kernels. (no reason for 6 it's just a me thing). After the rinsing let the grain sit in the collander for ~10 minutes so the excess water can run off. The grain is now ready to be put into jars and pressure cooked.

5. Make 2 holes in the jar lids. One is a breather and one is for the syringe needle.

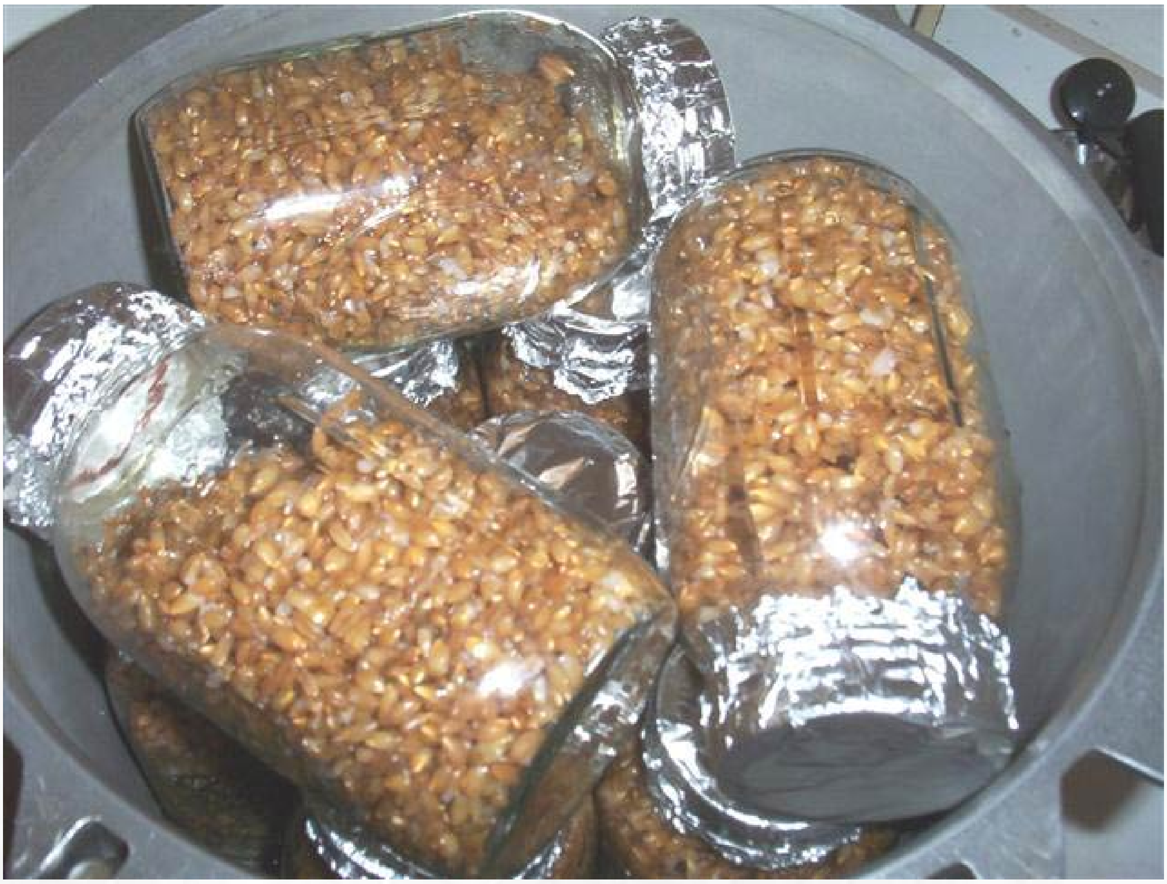


Put a piece of Tyvek over the top, add the ring and some foil and your ready to PC.

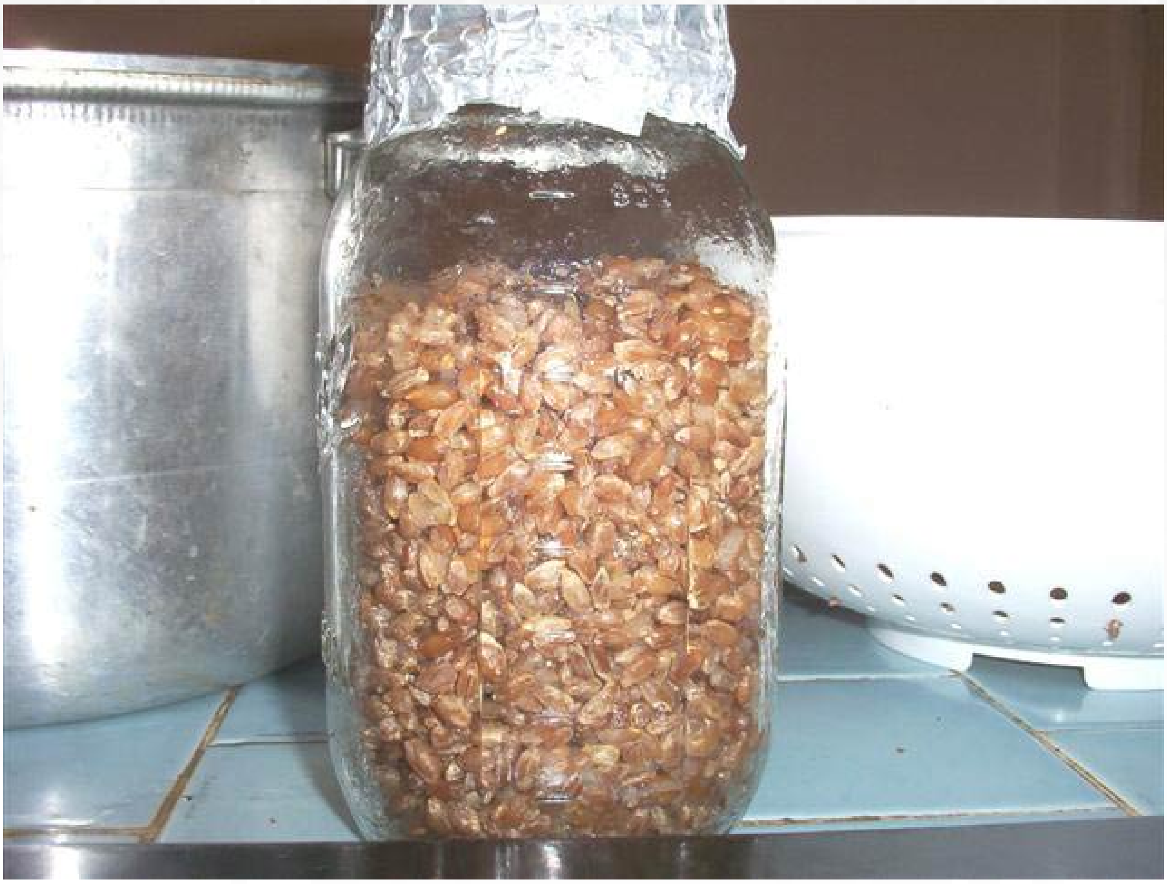
Be sure to leave room in the jars to shake the grain.

Be sure to leave
room at the top
so you can
shake the grain
around.

6. Load the jars into the PC



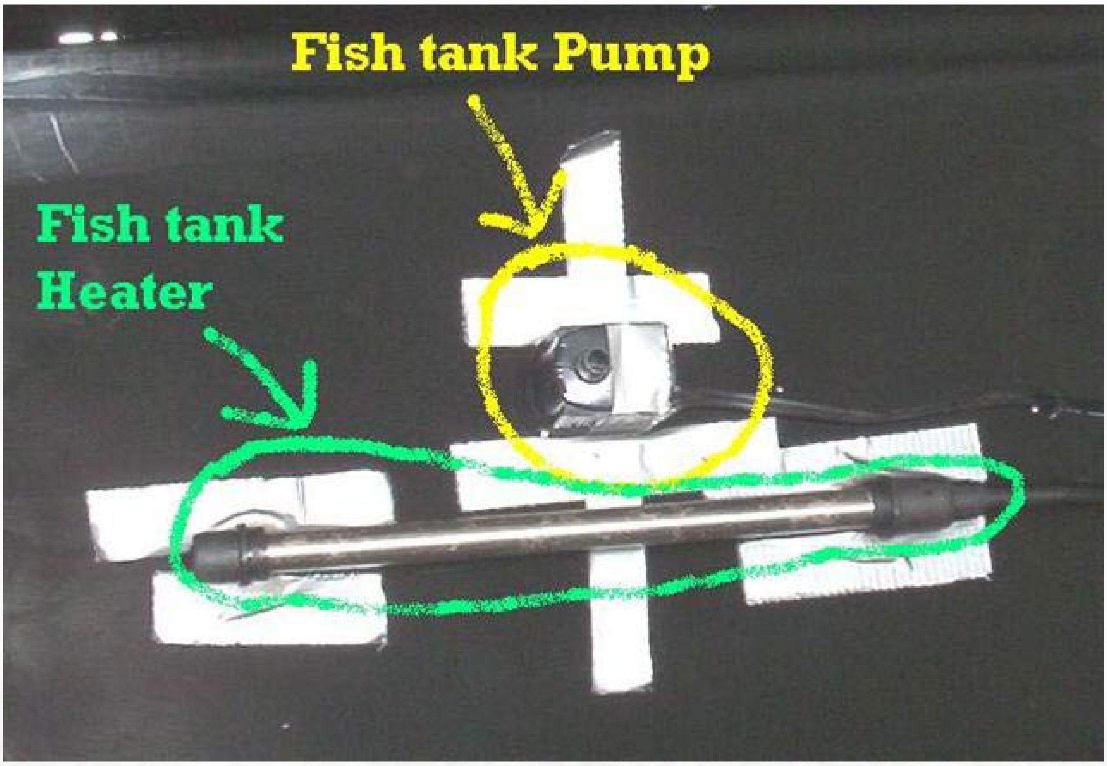
and pressure cook for 1 hour at 15 psi. Here is a finished jar.



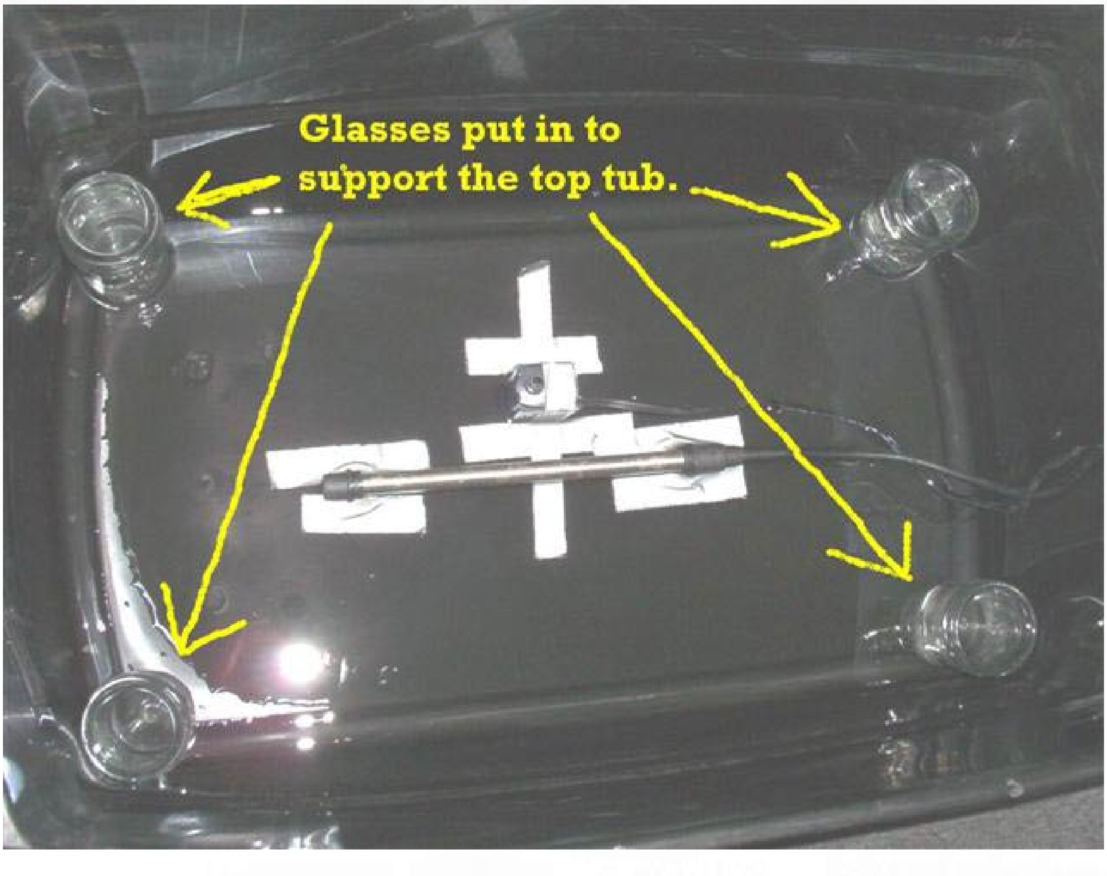
Now your ready for the next step.

Incubator Set Up

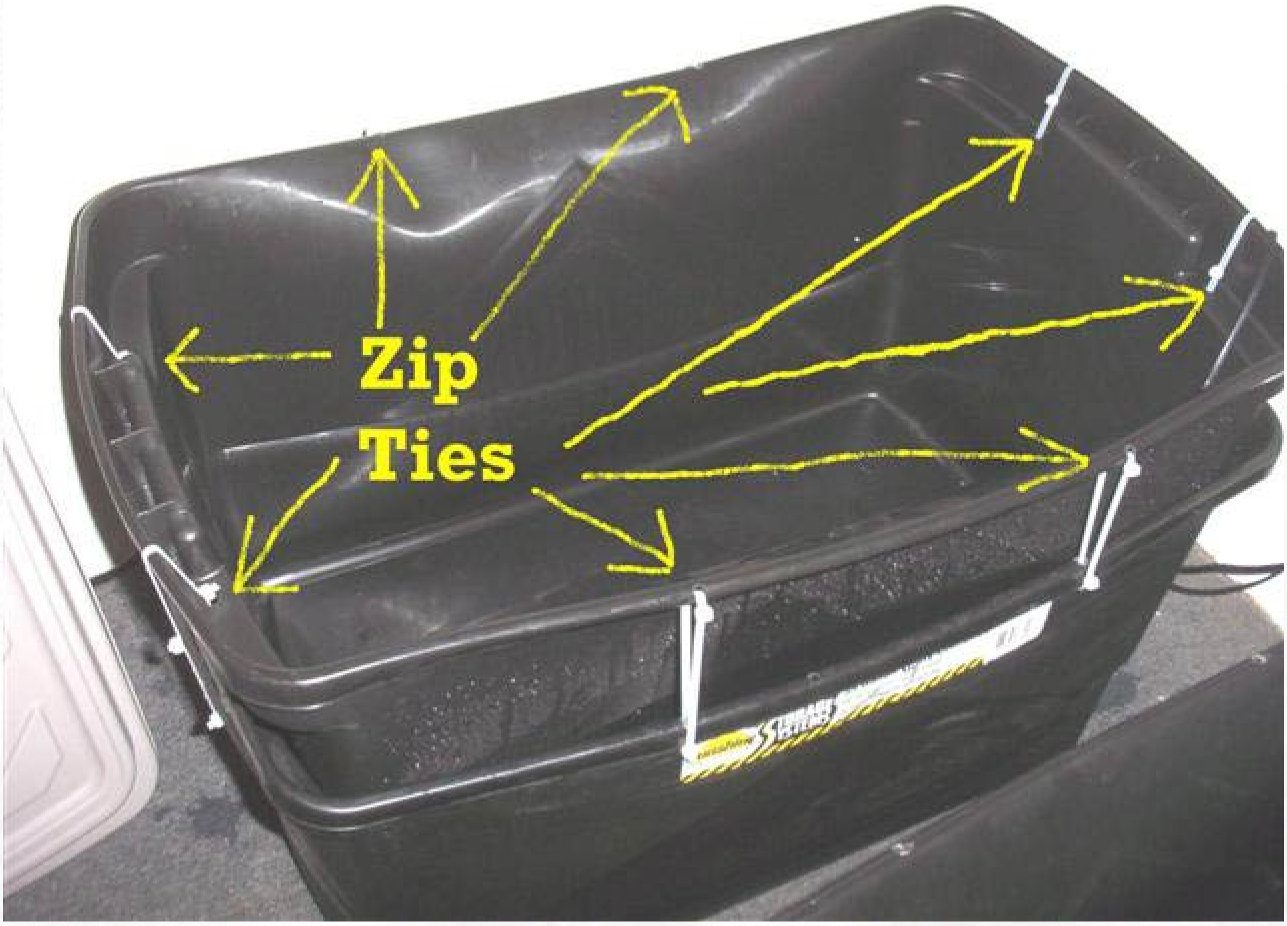
1. First thing get your bottom tub and put in your heater. I also add a water pump to mix the water that way it heats up more evenly but it isn't a necessary item. I got the tape from a boat shop and it has been working for some time. Good stuff for underwater.



2. Next put something (I used tall half pints) in each corner of the tub. This will keep the heater and pump safe from being smashed if I put in to many jars or do something stupid.

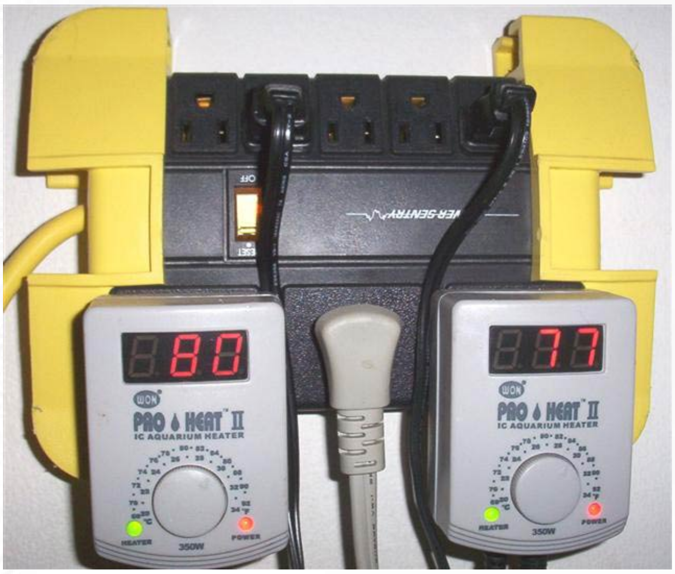


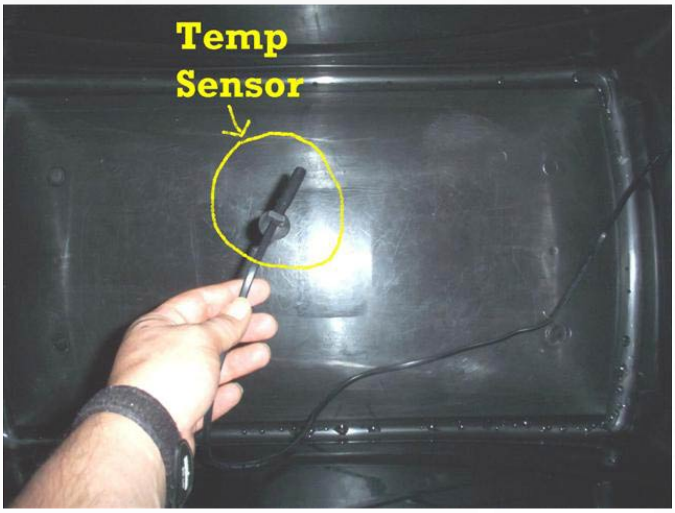
3. Now be sure to set the heater before you put on the top tub. I attach the top tub with zip ties cause the top tub will want to float.



4. Add the water. I like to add as much water as I can before it starts to spill out.

5. If you use the heaters with the external controls set them now to get ready for the jars. Mine use a dial and a sensor that gives the temp inside the chamber rather then the water. It also has a metal bulb rather then a glass one.

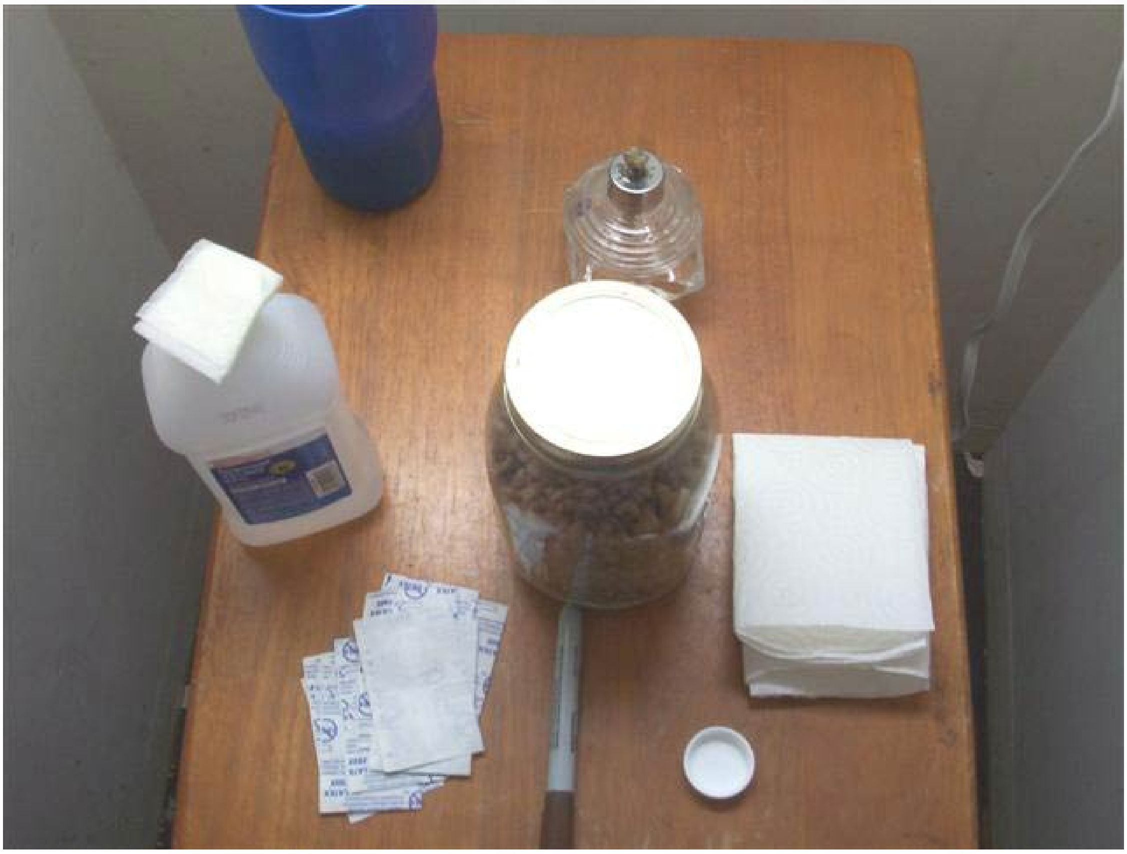

80
77
PRO HEAT II
IC AQUARIUM HEATER
PRO HEAT II
IC AQUARIUM HEATER


Temp
Sensor

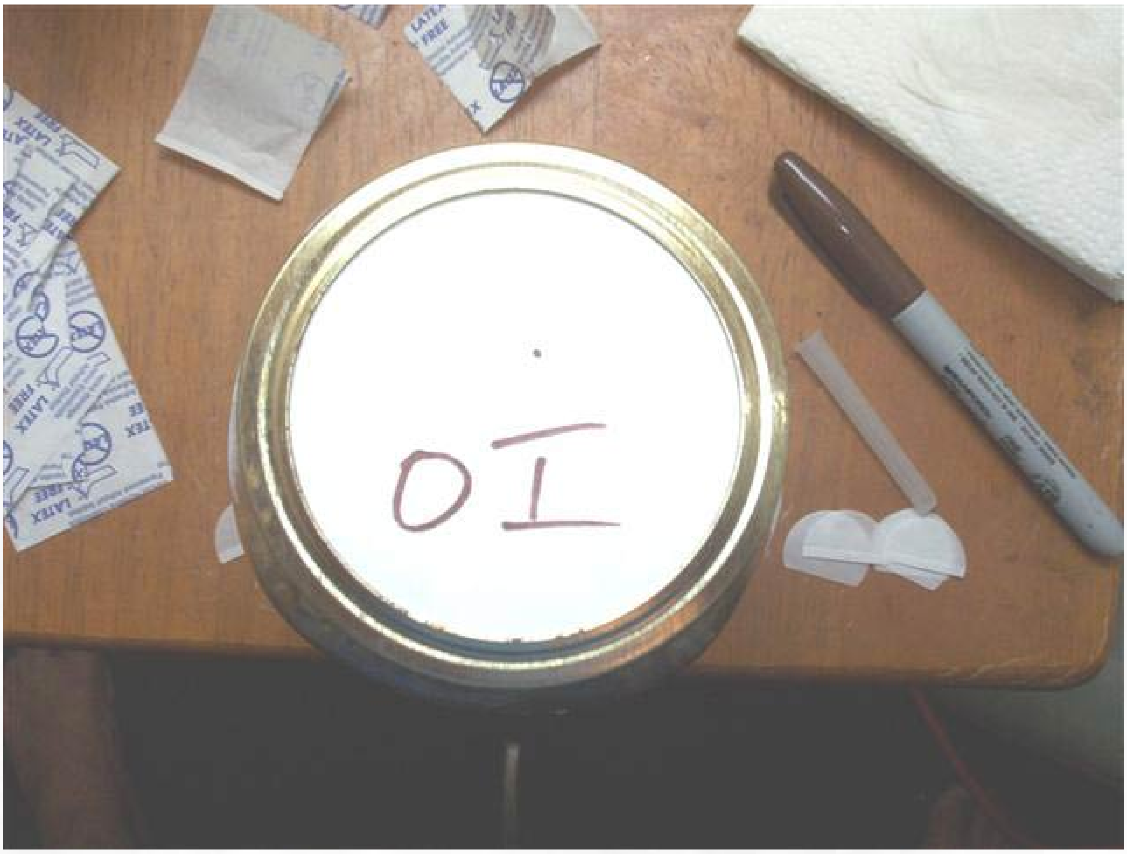
6. Finished.

Inoculation

1. First get your work area ready.



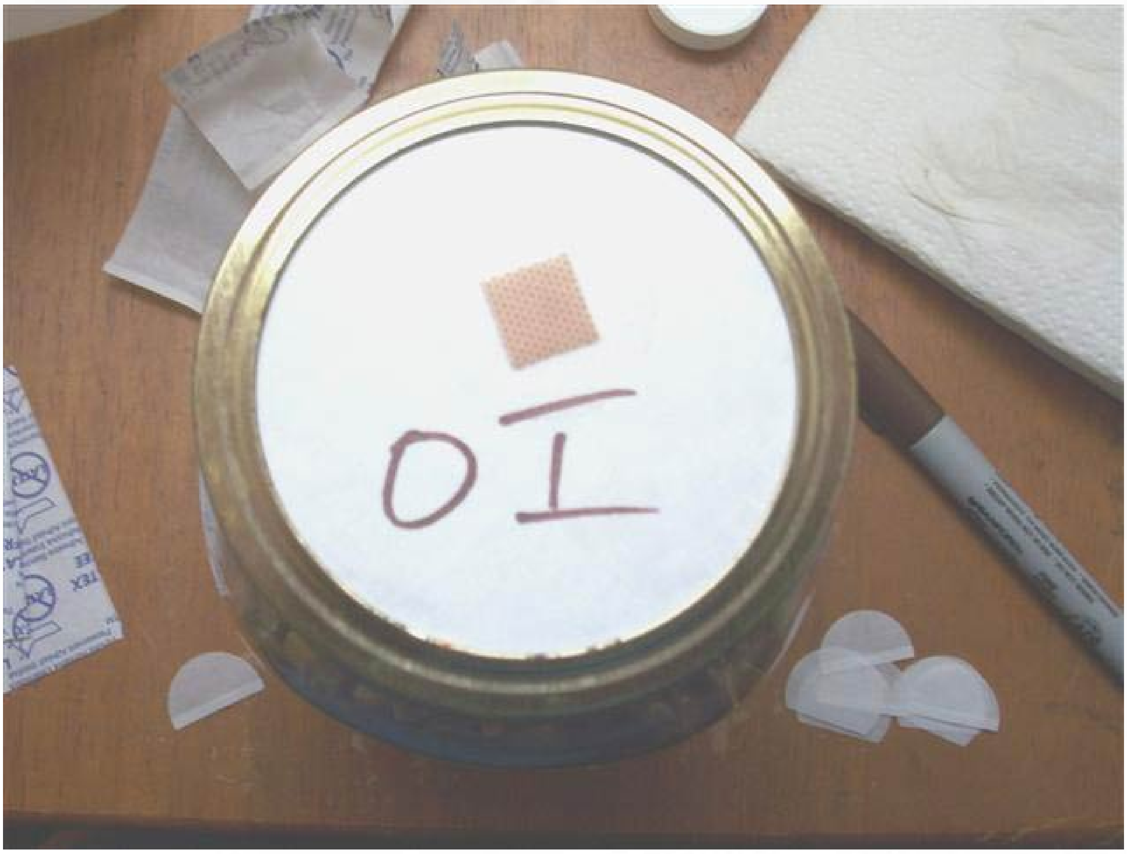
2. One of the reasons I like Tyvek is cause you can write on it



3. I like to heat the needle tip then cool it with a alcohol wipe.

4. Inoculate the grain. I like to use 2.5 cc per quart.

5. I like to cover the inoculation hole with a band-aid. I like em cause they come sterile.

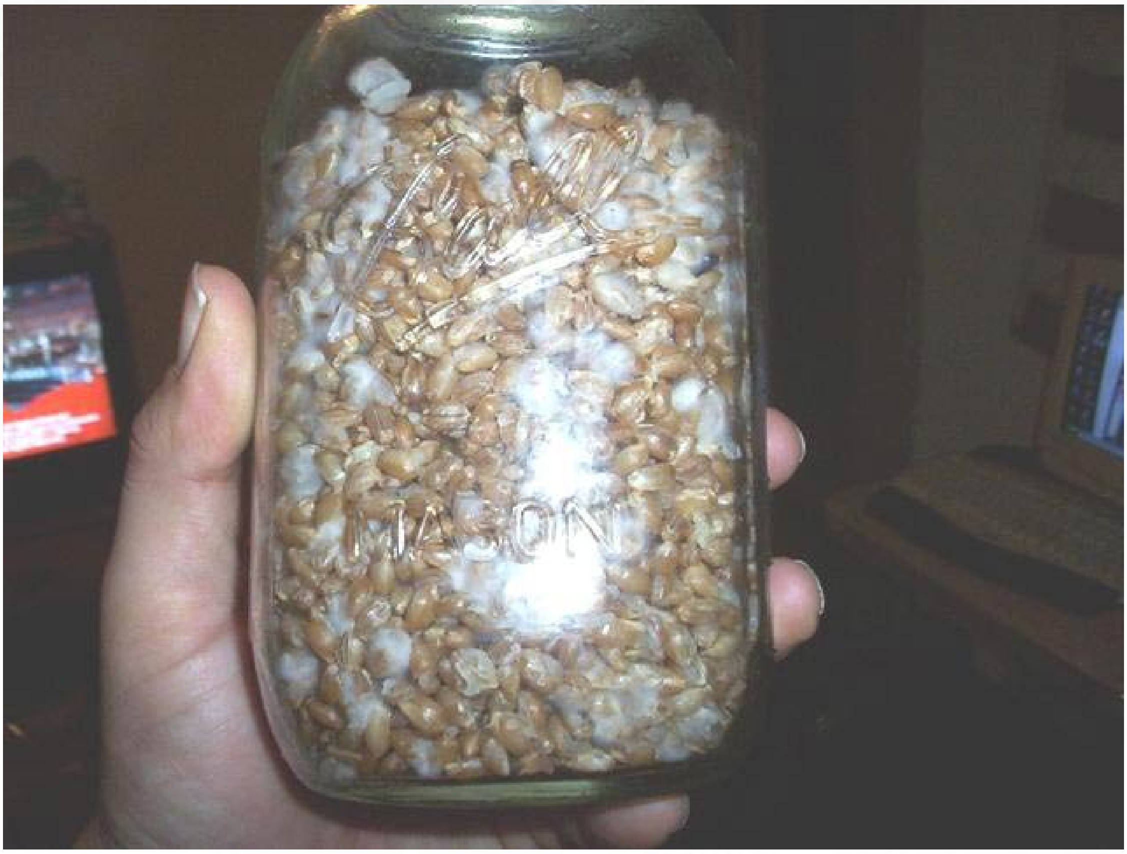


6. Shake up the jars real good and put em in a 82 F - 27.7C to 86F - 30C incubator.

7. I like to shake the jars again when they are about 25% colonized then once more at about 50% to 75% done.

The Waiting Game

1. This is the hard part, the waiting game. Here is a jar 3 ½ days after being shot up.

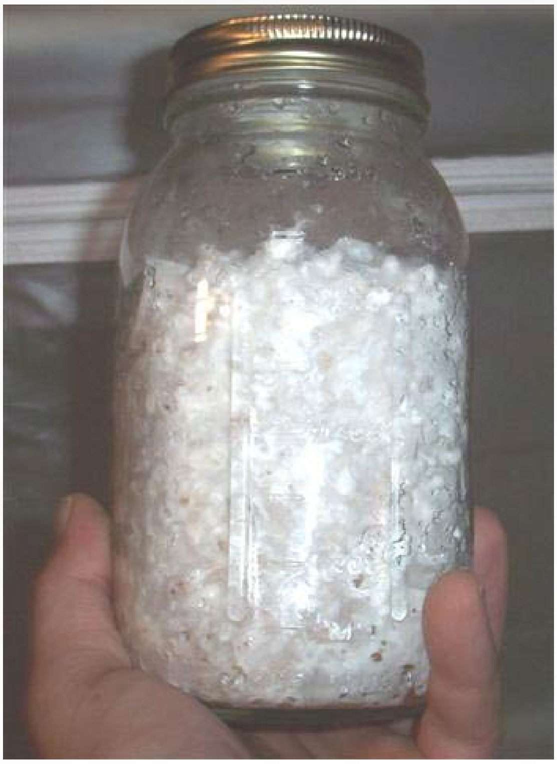


Few days later.

The first part of the waiting game is over time to

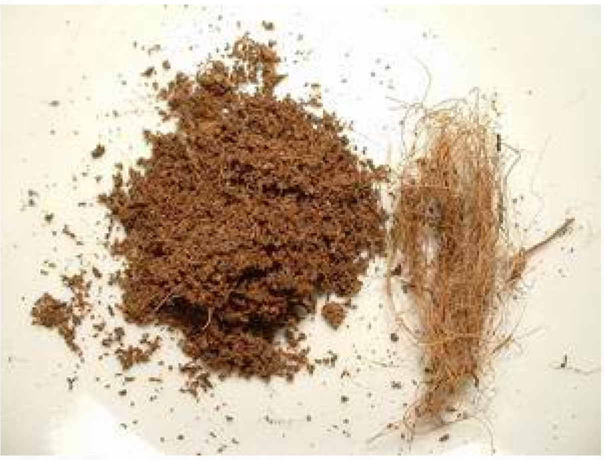
Get The Casing Mix Together

1. Well it's been exactly 9 days and the jars are done.



Time to get the casing supplies.

2. I like coco coir and vermiculite mix. Be sure you get coir and not fiber. Coir is on the left and fiber is on the right.



Coir in the package.

SAVE YOUR REPTILES
ZOO MED
ECO EARTH
BUY 2 GET 1 FREE!
1
2
3
30 Minutes
4

Vermiculite can be found all over the place and looks like this.

3. Add water to the coir as the directions say. Here is a brick.

Here is one with 4 quarts of water added.

4. Prepare your vermiculite. I just put it in a jar and fill it with water, let it soak,

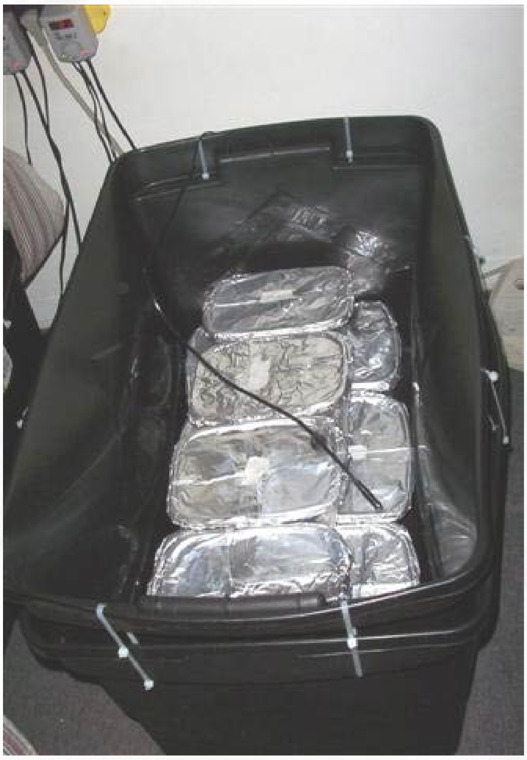
drain then add to a pot.

5. Now mix (I used 2 parts coir to 1 part vermiculite). Here it is when mixed.

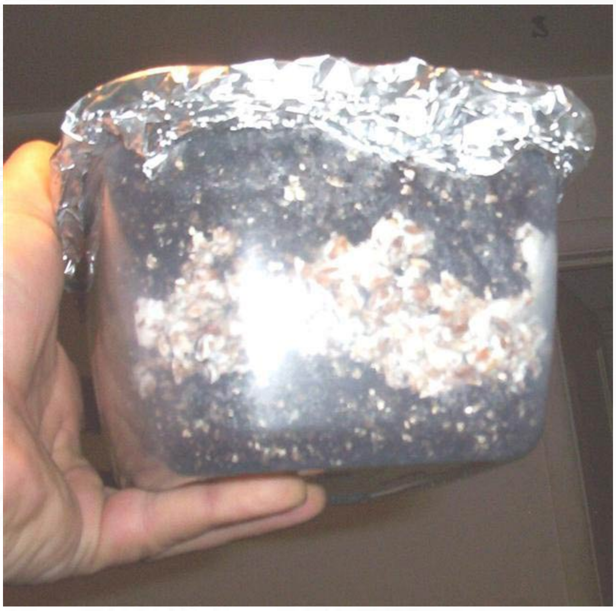
6. Put the mix into jars (I just use the grain jars) and pressure cook for 1 ½ hrs at 15 psi. (Once again just something I do)

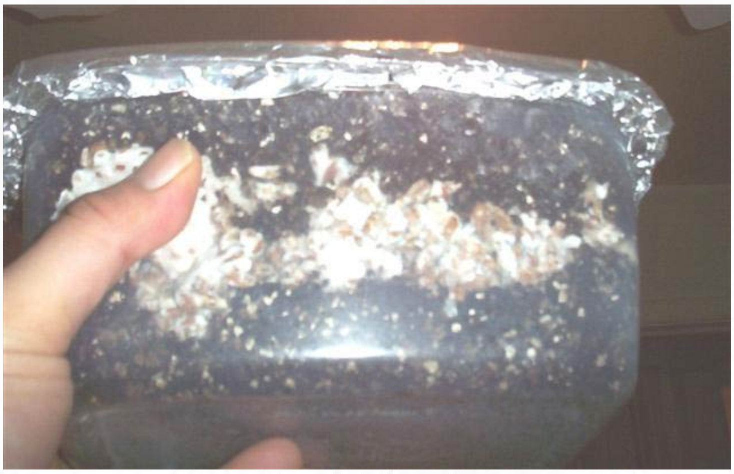
Making The Casing

1. I like to pressure cook everything. I pressure cook the casing layer, the casing containers, the foil that goes over the top, and the spoons and forks I use to do the work.
2. I like to do the work of putting the casing together in a walk in closest that I have. I spray the shit out of the air with oust and wait a few minutes then start the work. (With a face mask)
3. I pour a little (about a half inch) of the casing layer into the container.
4. Now scoop the mycelium out of your jar and put it in the container on top of the bottom casing layer that you put in. Once you have the amount of colonized substrate (these casings will be 1 quart each) that you want to use even it out so it's nice and flat on top.
5. Now add the top casing layer. (In this case ¼ to ½ inch of casing layer) A good rule of thumb is a top casing layer ¼ as thick as the substrate layer.
6. Now cover (I like to use foil) and put into the incubator.



Usually this last 4 to 7 days. A finished casing should look a little like this



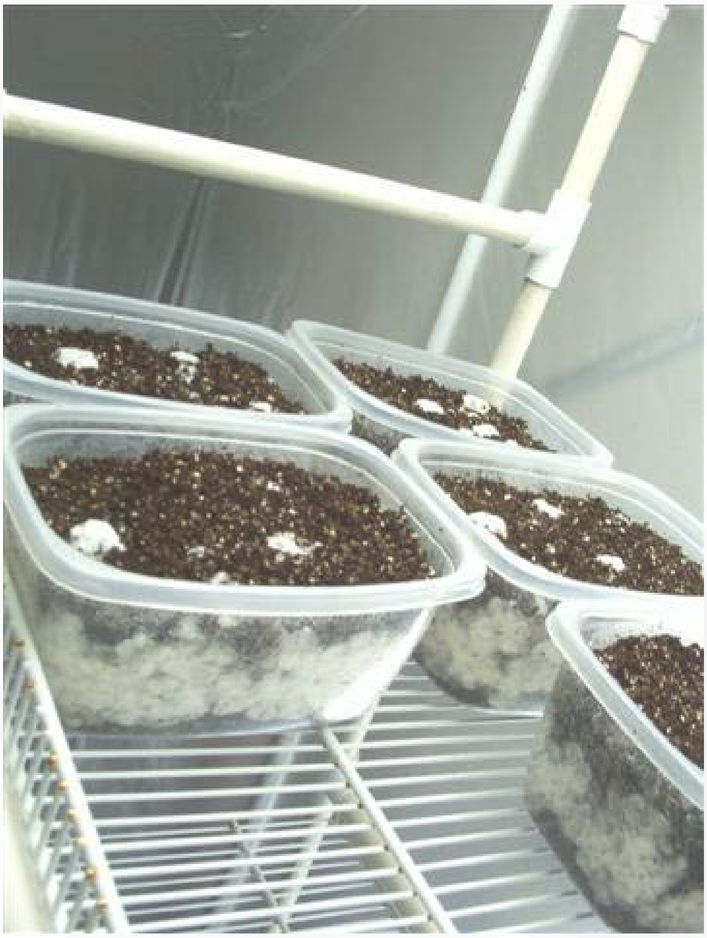


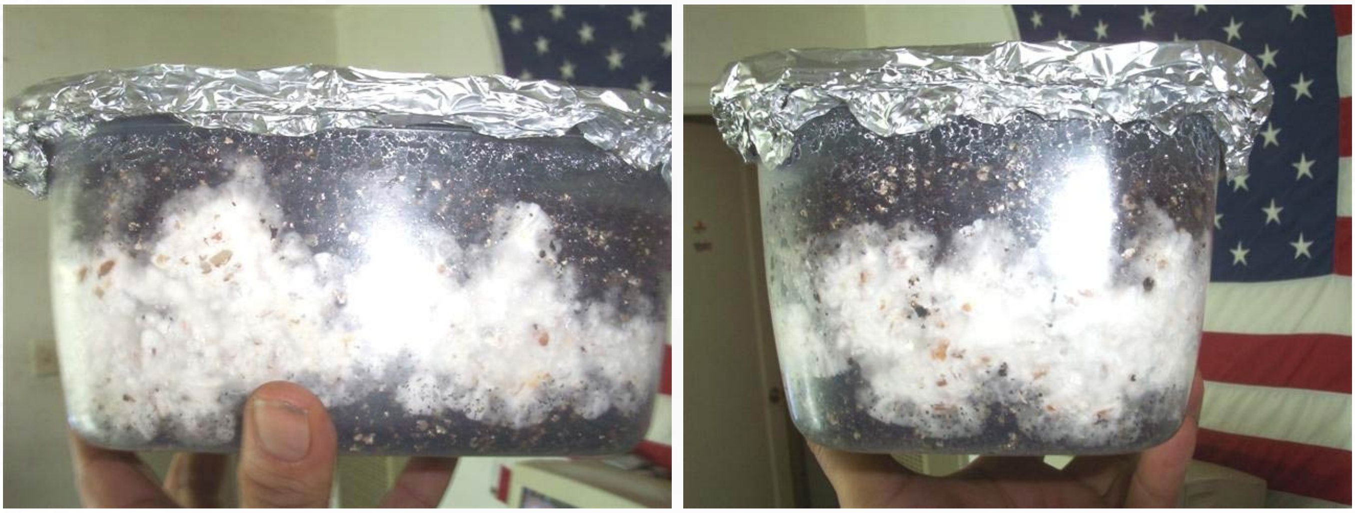
(I suggest covering the sides of clear containers to prevent side pinning. These will be left uncovered for pictures used in this post)

Time to put the casings in.

The Chamber

1. When the mycelium starts to break the casing surface is when I like to put them in the chamber.

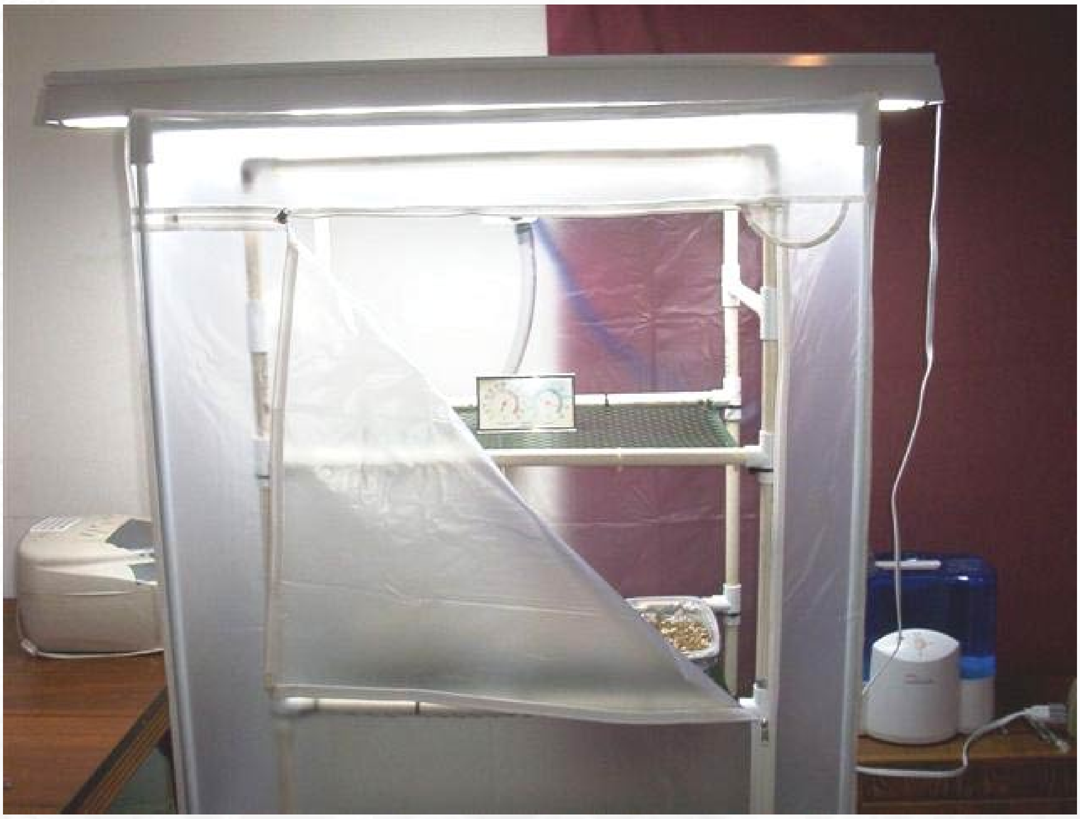




Lots of people like to patch at this time. Myself I've never been one for patching so in the chamber they go.

2. I like to use the tent style chamber that uses the cool mist running all the time and a ultrasonic that comes on every few hours for so many minutes.

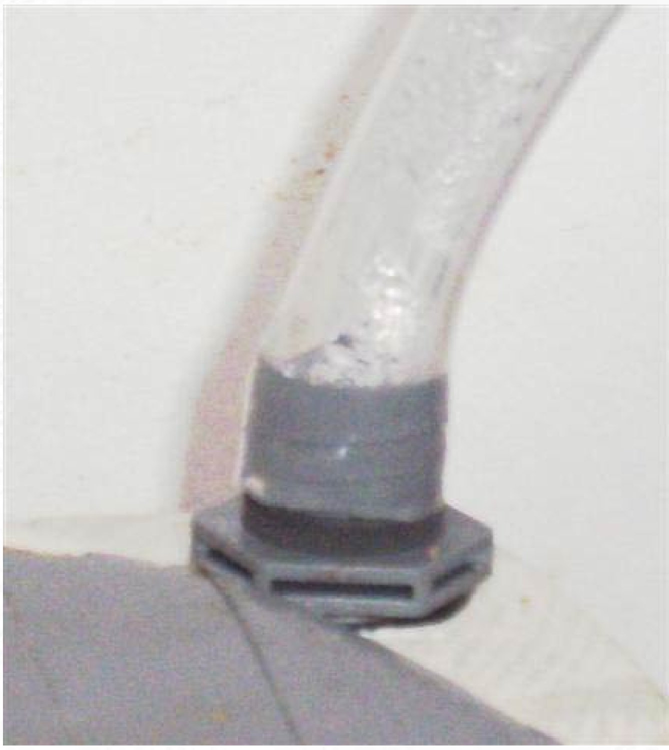
3. This is a Martha Stewart closet and hose set up.

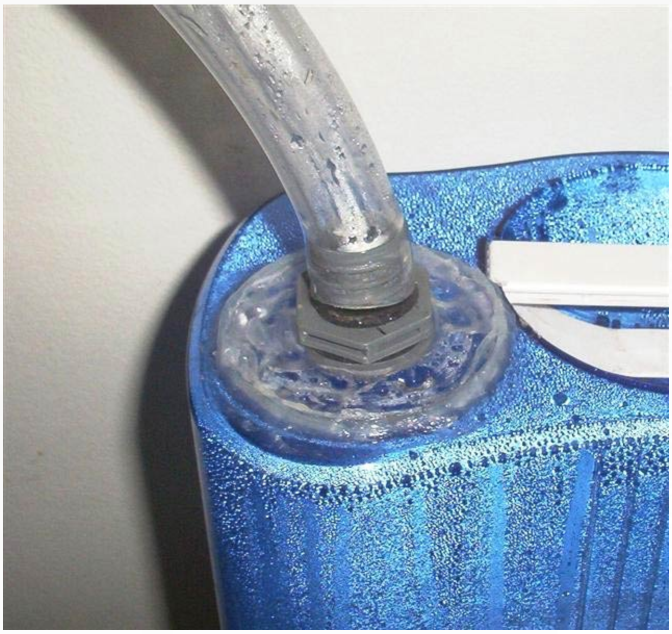


MARTHA STEWART
36"
STATIONARY
storage closet

I use the ultrasonic and cool mist. Very firm believer in air exchange.

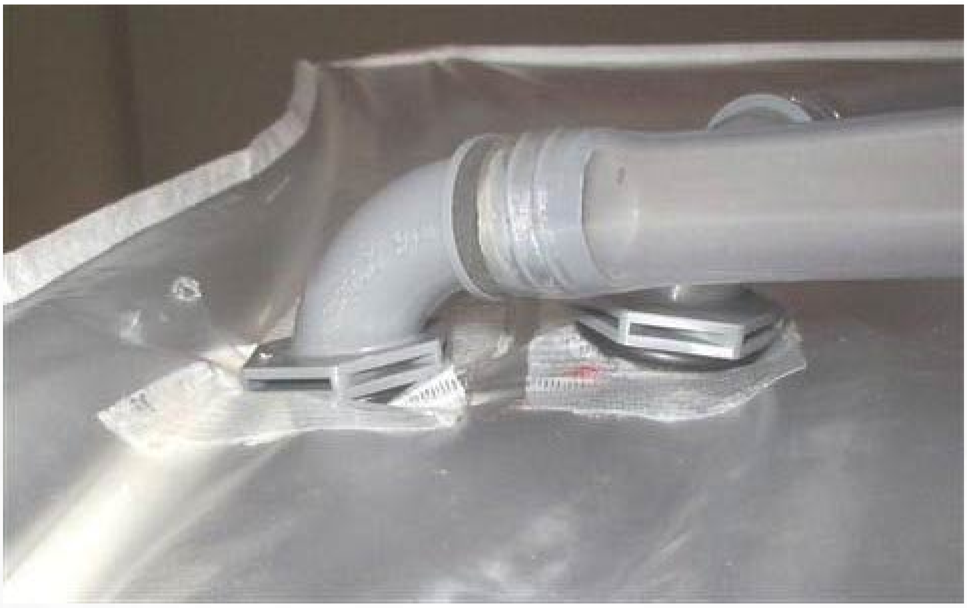
In the electrical Dept of the hardware store I find these.





and on the ultrasonic

Now on the back of the closet I cut the holes for the hose fittings and put tape over them and cut holes threw the tape for the fittings. The reason for the tape is to give the closet plastic a little extra strength when holding the hose weight.



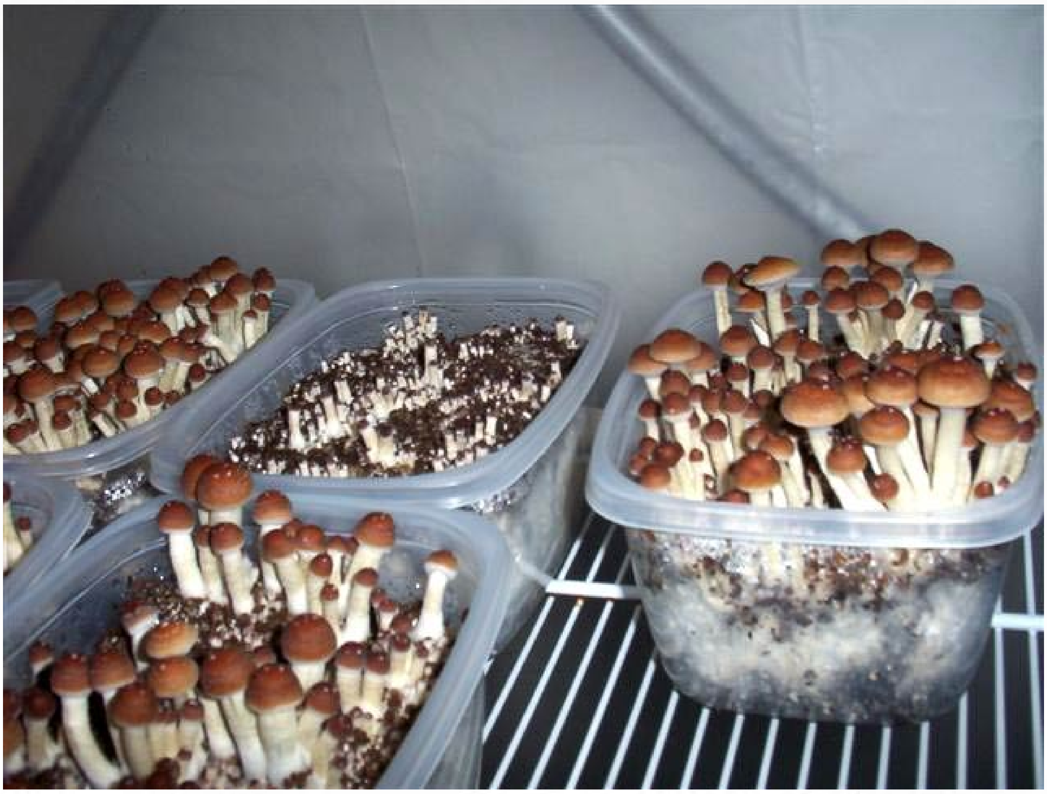
The outlet for the ultrasonic goes above the cool mist outlet that way the mist from the ultrasonic drops into the air stream of the cool mist and mixes better.

4. Now that the casings are in the chamber it's time to wait for pinning.

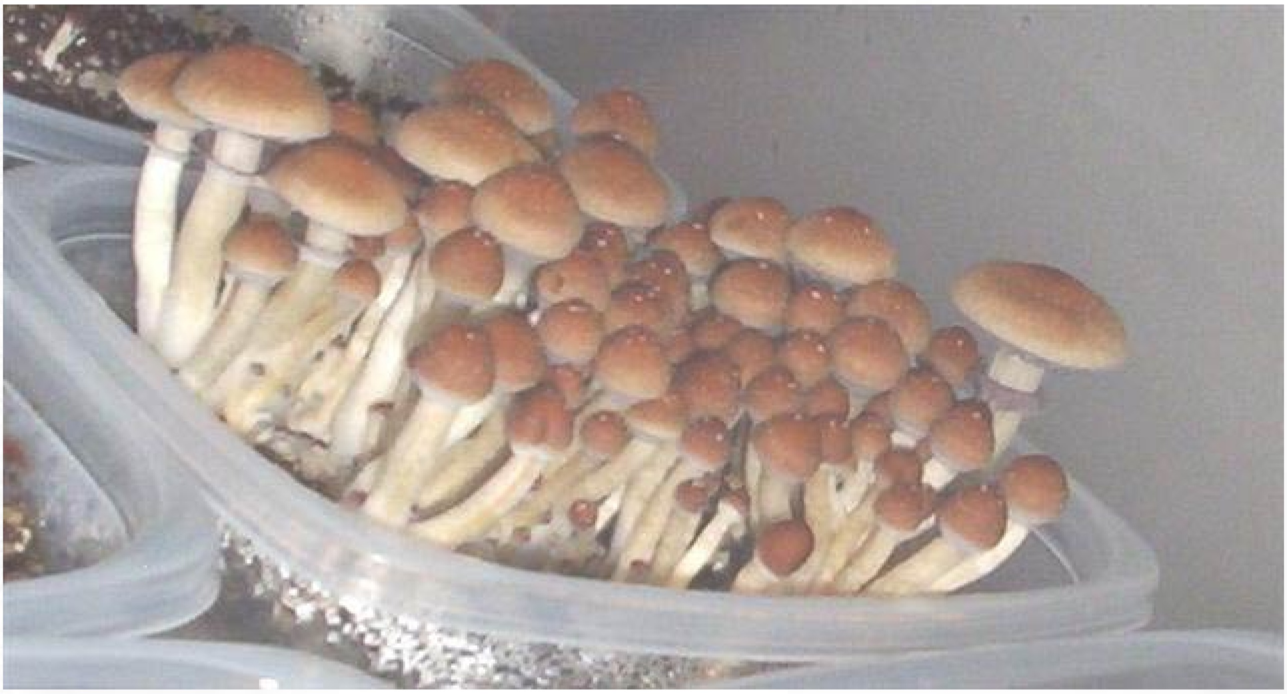
5. If the coir starts to get a little lighter in color it may be starting to get dry. Now is a good time to mist them with some sterile water, it's safe to mist up to the point of pinning.

Well it's been a week and pinning has started.

A few days later.



Well some of the veils are starting to tear



so it's time to think about.

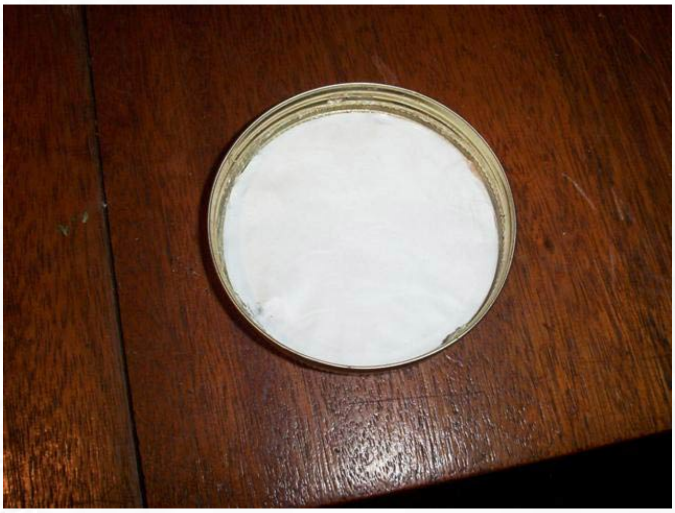
Harvesting and Taking Prints

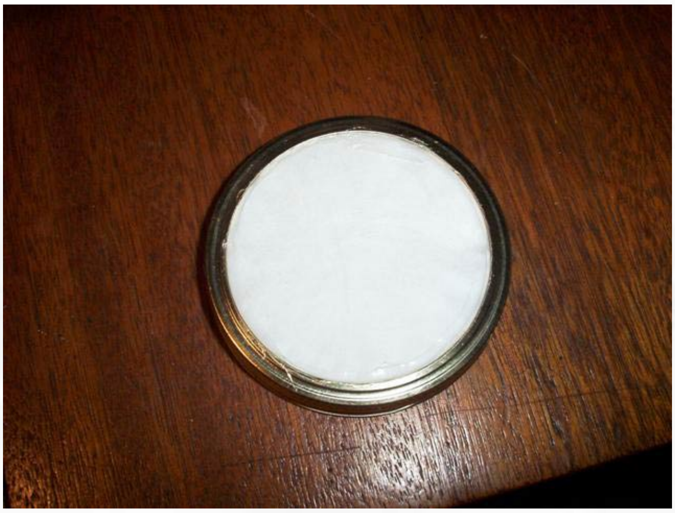
1. Harvesting is easy. Just be sure to remove the whole shroom and leave none behind to rot on the casing.
2. Cover the spots that show cause of the picked shrooms with casing material and spray it down real good with the water H_2O_2 mix.
3. If you dunk your casings now would be the time.

Now I suggest you take your own prints to use.
Well this is how I like to do it. I like to get my foil ready like this.

That way when the print is done you have these flaps to fold over.

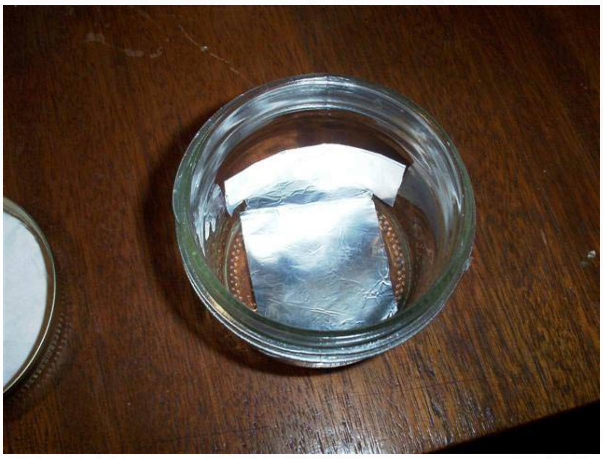
I then get a half pint jar (wide mouth) and prepare it like this. I ditch the disk and silicone in a Tyvek disk.





This will allow the cap to dry a little as sits in the jar. (Which causes more spores to drop and prevents the cap from rotting. Will also allow the prints to dry once the mushroom cap is removed.)

Next put in the foil and cover with the lid.



Put some foil on top and pressure cook for one hour at 15 psi.
Now uncover and wipe off and your little print chamber is ready.
Now take the jar to your mushroom chamber and loosen the top but don't remove it.
I like to put a pin in each of the mushroom caps I'm going to print.

Cut the shroom just below the cap and put it on the foil in the jar as fast as you can. Easy to do since the jar lid is loose.
Put it in a glove box or where you like to do your work.
In 24 hrs open up and take out the cap by the pin (now we know what the pin is for) and put the cap back on.
Let it sit for 24 hrs again to let the spores dry.
Once dry fold up foil and store in a cool dry place.

FAQ

Why do you wrap a shot glass for each syringe? This is more of a me thing but I like one glass for each syringe just in case there is a contamination I can keep it somewhat contained to one syringe.

Why do you soak the grain in separate jars? This is another one of those me things. I like to come by every once and a while and shake up the jars. No idea if it helps but it makes me feel better and I get a good look at all the grain being used.

Why do you pour out the water and fill and shake and pour that out after the grain has soaked? I like to be sure there is nothing bad like a endospore that may not have germinated and to rinse the water the grain was soaking in out of the jar.

When the grain is done simmering why do you rinse it with 6 gallons of water? Well 6 gallons was used for every 10 quarts of substrate prepared for this post. 6 gallons isn't needed but I do suggest rinsing off the grain.

Why do you leave room in the jars to shake the grain? The jars are shaken to spread the spores around and when the mycelium has started to grow to spread it out so colonization is done faster.

When you inoculate the grain you heat the needle tip then cool it with a alcohol wipe, is it needed to do both? No, if you like you can use one or the other.

When you prepare the vermiculite for the casing you soak it in a jar is that the only way to do it. No, that is just a easy way for me to do it. Anything that can hold the vermiculite and water will pretty much work. I like the vermiculite to have as much water in it as possible.

Is pressure cooking the casing layer the only way to sterilize it before using? No, that is just what I like to do and haven't had a contamination problem using it. There are several other ways to do it and they can be found here in the FAQ.

In the post when you put the casing together you have it in a clear container. Yes that was just done for the post. Light should be shielded from the sides of the casing.

When the mycelium starts to break the casing surface is when I like to put them in the chamber. What about patching? I'm not one that feels that patching is all that needed but many people do and how to do it is in the FAQ.

With your chamber you use two humidifiers, is this needed? I think so to get the most out of your shrooms. The cool mist exchanges the air while not dropping the humidity to much and every few hours the ultrasonic comes on to make sure the humidity is high enough. If you use only one, use the cool mist humidifier.

Your print tek uses a lot of steps are there other ways to do it? Yes look in the Grow section and you will find several ways to take prints.

The Azurescens Foundation - Growing Psilocybe azurescens

by

The Azurescens Foundation

original source: http://www.magic-mushrooms.net/growing-psilocybe-azurescens.pdf
backup source: http://www.psilosophy.info/resources/growing-psilocybe-azurescens.pdf

Table of Contents:

Materials
Preparation of Malt extract Agar
Germination of spores
Isolation of Pure Mycelium
Expansion of Mycelium on Wood Substrate
Preparation of an Outdoor Bed
The story of *Psilocybe azurescens* Stamets & Gartz

Materials

Mushroom spores

Pressure cooking pot

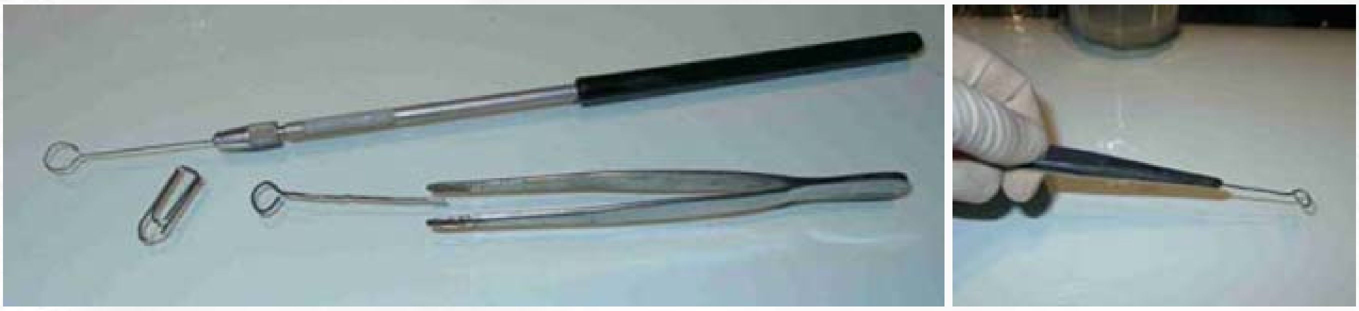
Glass jars

Agar

MALZEXTRAKT

Malt extract

Wood chips (beech, alder, hazelnut,...)

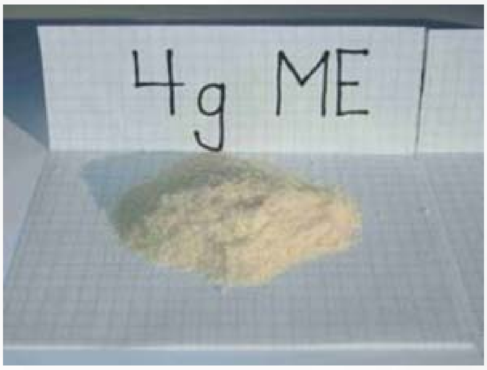


Inoculation instruments: Instead of a professional inoculation loop a pair of tweezers can be used, it is just a bit more tricky to handle.

Preparation of Malt extract Agar

Maltextract agar can easily be prepared in a common kitchen. The most expensive thing needed is a pressure cooking pot. The medium must be sterilised (autoclaved), or you will grow nothing but mold.

To 100 ml water add



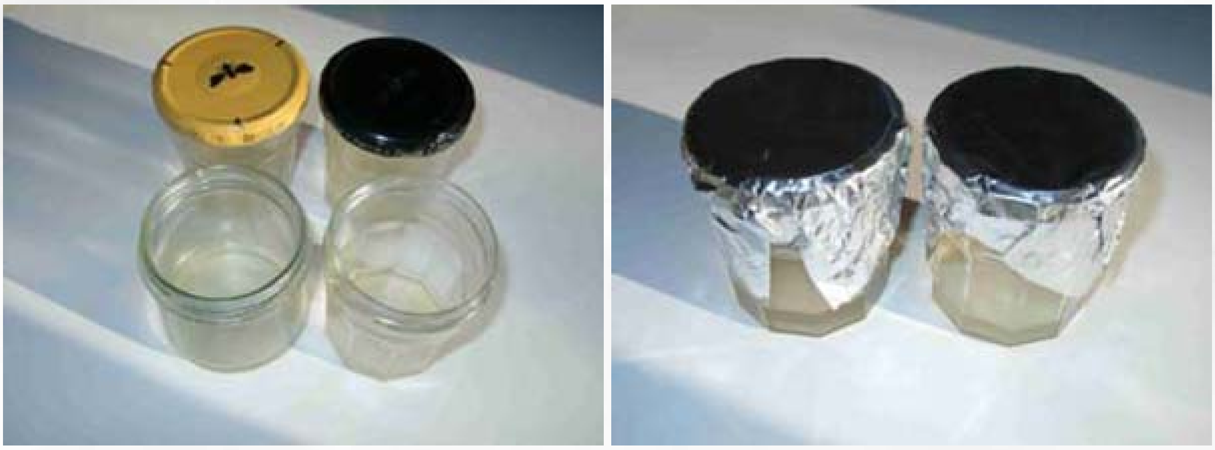
4g maltextract

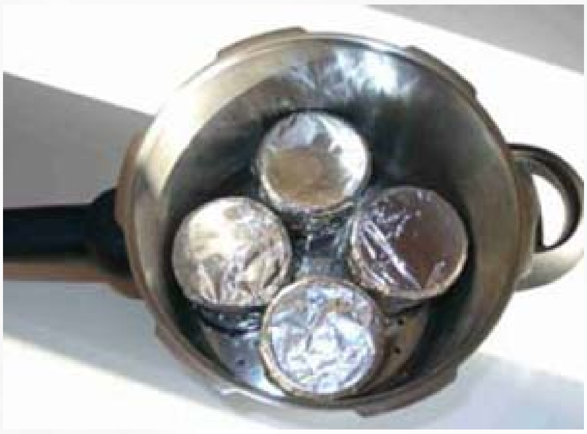
and 2g agar

Bring the liquid to boil to secure all solid particles are solved.

Fill the medium in suitable containers suck as jars of not more than 10cm height (the smaller the better to handle).

Pour about lcm of medium in the jars. The jars are covered with the caps, but do not screw them tight, or the jars will break during cooking!!! The caps can additionally be covered with tin foil to minimize the risk of airborne contamination.





The jars are placed in the pressure cooking pot filled with several cms of water.
Close the pot and slowly bring to boil. When the max. pressure is reached, the temperature in the pot is higher than 121°C.

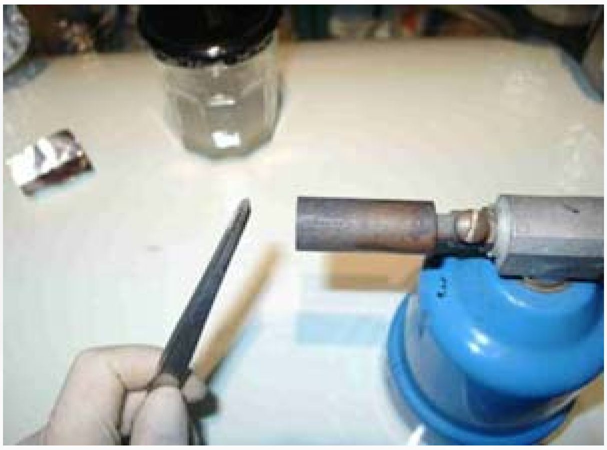
This is hot enough, if maintained for 20 minutes, to kill any spores of mold and bacteria. After this time period let the pot cool to room temperature.

Germination of spores

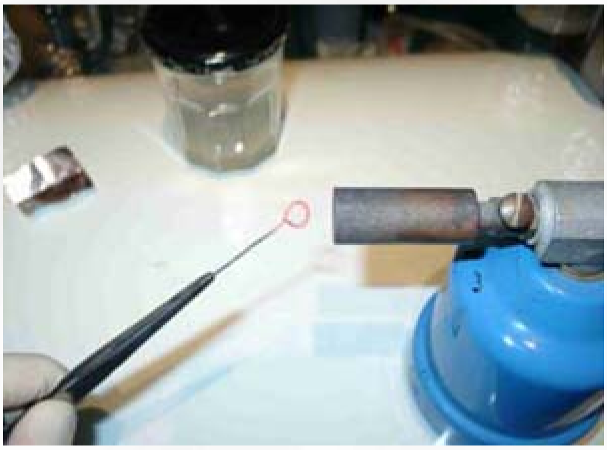
Short: Place some of the mushroom spores on sterile maltextract agar. Let the glass stand at room temperature (18 to 24°C/65 to 75°F). The spores will germ within a few days. Three weeks later the mycelium should be visible as cottony white hairs growing in all directions from where the spores had been placed.

How to transfer spores to maltextract agar in a sterile way:

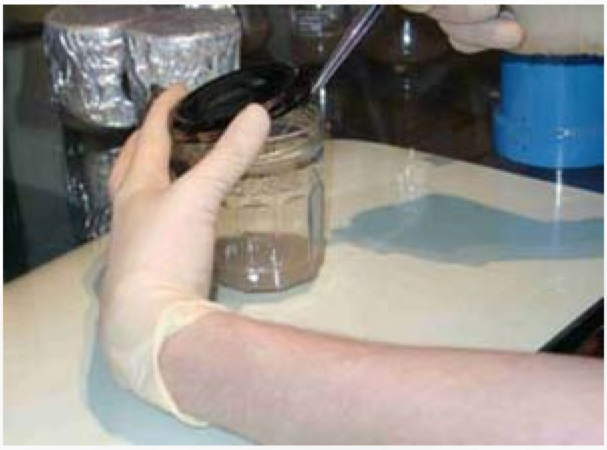
1) The working place is cleaned and sterilized with 70% ethanol.



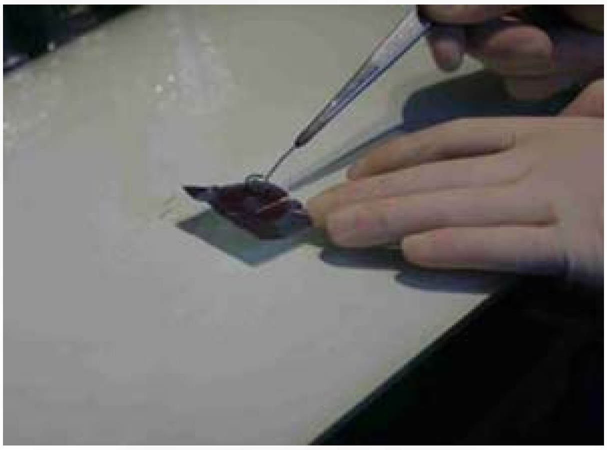
2) If tweezers are used, sterilize them in a gas flame.



3) Glow the inoculation loop, so it is sterile.



4) Cool the loop by placing it on the sterile agar. The spores will stick on the wet loop.

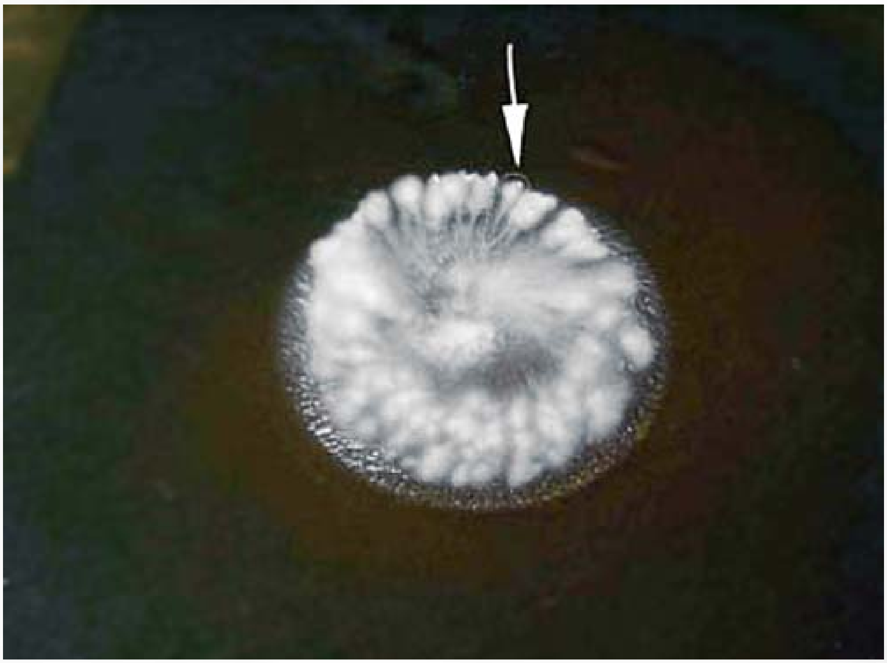


5) Spores are picked with the cooled inoculation loop and are

6) Transferred into the jar with maltextract agar.

Wait about three weeks for the spores to germinate and the mycelium to grow.

Isolation of Pure Mycelium



Mycelium of Psilocybe azurescens about 25 days after germination from spores.

Now it is time to take a little piece of white mycelium and put it in a fresh jar with agar medium.
Instead of an inoculation loop a lancet or similar can be used.
Yon should prefer thick filamentous structures (rhizomorphic mycelium).

Sometimes this isolation of pure medium has to be repeated several times until a really pure culture free of any contaminants is obtained A contamination is anything that grows on your medium that is not the mycelium.
When brought on new agar, the mycelium needs about one day to recover and until new growth can be seen.
Wet sterilized cardboard can be used as a much more selective medium, if serious problems occur in isolation of a pure culture on agar.

Expansion of Mycelium on Wood Substrate

From a pure culture the mycelium can be propagated further. A very good wood substrate are fresh hard wood chips presoaked in water.

Excellent for the expansion of *Psilocybe azurescens*:

Fresh cut hazelnut twigs

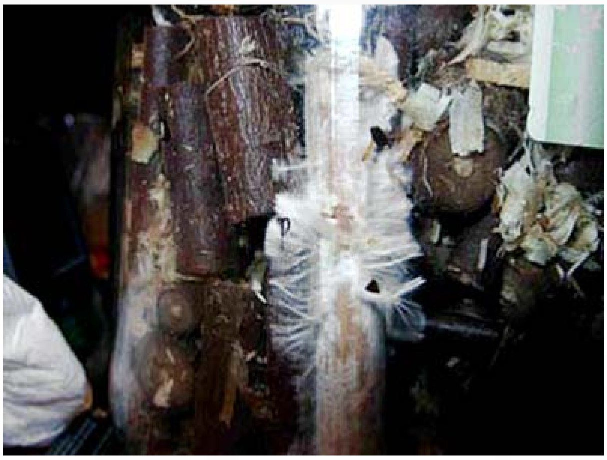
and/or hard wood chips.

Put them in as big glass jars as fit in your pressure cooking pot. The jars should only be filled to two third, this allows you to shake the wood chips in the jars.
The wood should not be sitting in water, and the ideal moisture content is 60 to 65%.

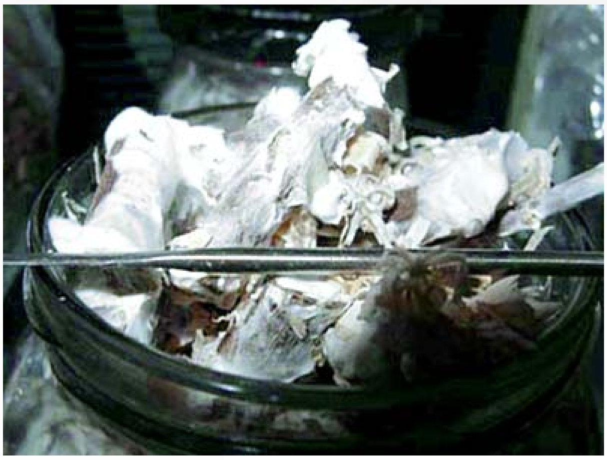
The procedure for sterilization is exactly the same as for the preparation of malt extract agar, except for the cooking time which must be increased to a full hour or more at max. pressure, depending on the container size.
Do not forget that the caps should not be screwed tight during sterilization!!!

As soon as the jars have cooled clown to room temperature they can be inoculated with several pieces of agar culture or if available wood spawn.
Shake the jars to even distribute the agar pieces.
After the shaking the caps are unscrewed a bit to ensure gas circulation and covered with tin foil to prevent airborne contamination.

A few days later growth of the mycelium should be visible.
The jars can then be shaken again to accelerate the expansion of the mycelium. The cultures are ready for the inoculation of more substrate, when they are completely grown through with mycelium.



Hazelnut chips inoculated with beech dowel.



Hazelnut chips ready for inoculation of more wood substrate.

The wood an a the mycelium form a compact mass of a white colour witch produces a characteristic mushroom odor when broken up. This mass of mycelium, suitable for the preparation of an outdoor bed, is called spawn.

Instead of jars, heat resistant polypropylene bags can be used to expand the mycelium to the wished volume, but the risk of contaminations is higher.

Do not use contaminated cultures to inoculate new Substrate!!!
If a jar or a Lag is contaminated, forget it or for the case there is only little contamination, place the spawn outdoor in a half shaded location and check in autumn for mushrooms.

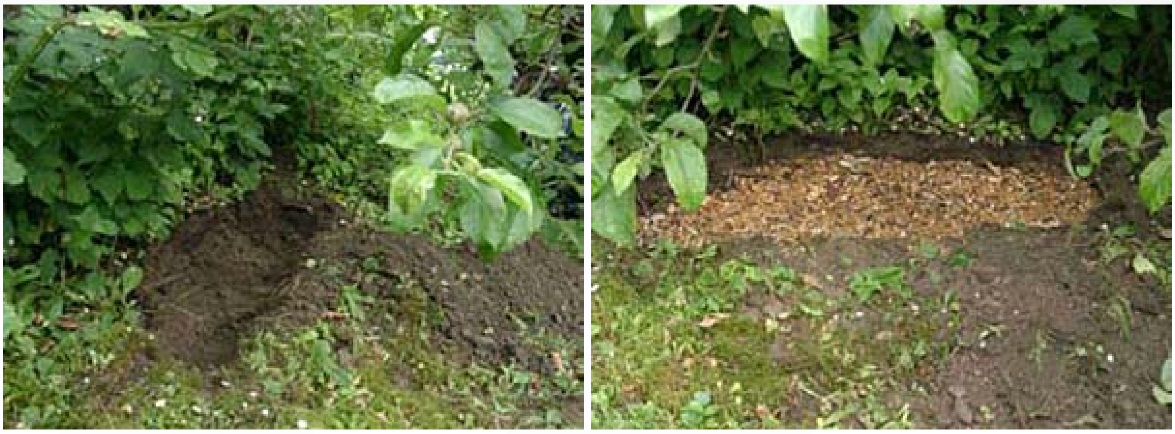
Preparation of an Outdoor Bed

An outdoor bed is nothing else than a 15 to 20cm deep bole m the soil filled with wood substrate.
Once a volume of one to several liters of mycelium on wood substrate has been obtained, the preparation of an outdoor bed is the final step, which will lead to beautiful mushrooms growing in your garden every year in late autumn and this for years.
A mushroom patch can be prepared at every time in the year except if the soil is frozen.
The chance for fructifications in autumn are excellent, if a bed is layed out in spring or even in autumn of the preceding year.
The bed on the pictures was layed out only three months before harvest season and it showed fructifications in the same year, but the result may have been better if the bed had been prepared earlier.
The later the patch is layed out, the more spawn has to be used to secure fructifications in autumn, and the later the mushrooms will appear.
Of course you can also prepare much smaller patches; I saw marvelous mushrooms growing from as little as 0,3 litres of contaminated spawn that bad been discarded in a garden near a compost pile.

Fresh chopped wood chips (preferable beech, alder, hazelnut...)

The wood spawn is added (at least l/5th of total volume) and mixed well with the chips.

A suitable place for the bed is a half shaded location below a shrub like this.

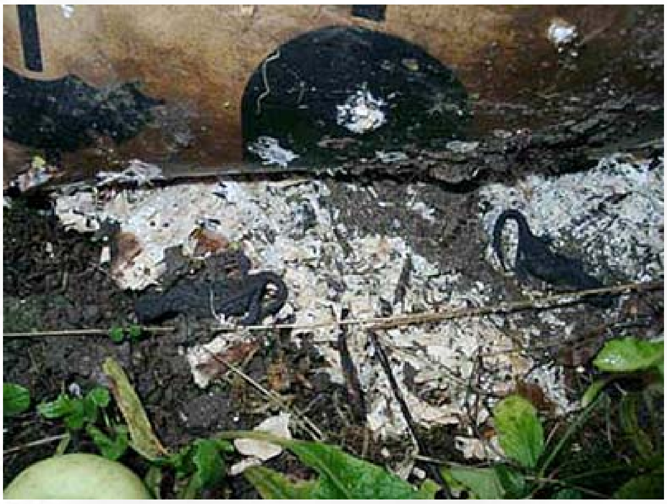


A 15 to 20 cm deep hole is opened and filled with the wood chips/spawn mixture.

The bed is watered with several liters depending on its size. The patch can additionally be covered with wet cardboard and perforated plastic or anything that keeps moisture high.

Do not give to much water! It is better to repeat watering a week later than to give too much first.

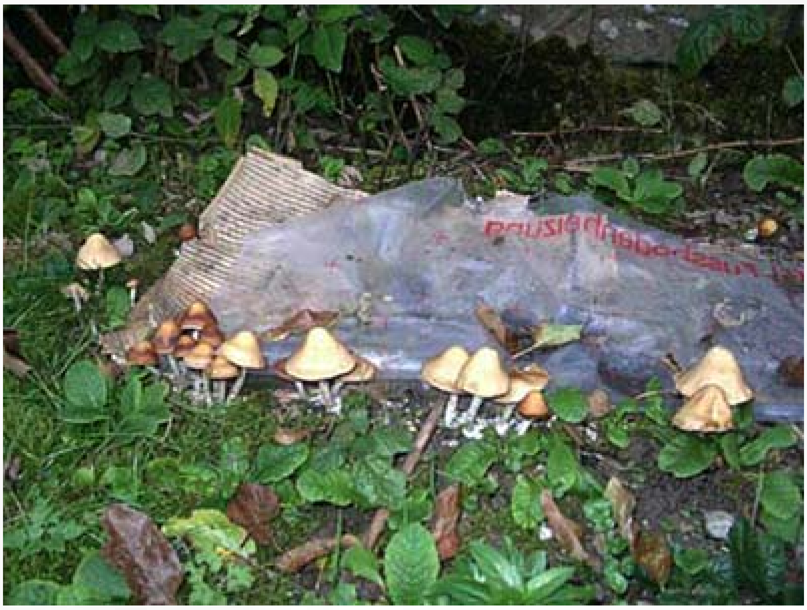
Make sure the bed is humid the first two weeks but not wet, then you will not have to give any more water until September. If you overwater during summer, the mycelium may grow aggressively, but you will probably see no mushrooms in late autumn.



That is the way a mushroom bed may look during summer: Note the white mycelium below and on the cardboard.

Not only mushrooms, but also amphibians like the humid environment.
Here you see ***Salamandra atra*** on a bed of ***Psilocybe azurescens***.

From September on keep the patch wet by watering once or twice a week.
This is not necessary if it is raining a lot, what is not unusual in this season.
In late September to early October, when the temperatures drop to 7°-10°C (45°-50°F), the first mushrooms can be expected, and they grow in usually two flushes about a month apart, until the temperatures drop below zero. Depending on the temperatures, mushrooms may even grow until January. By placing a tent over the bed, the fructification time can be prolonged.



The cardboard, the bed is covered with, is itself used by the mushroom as medium. A new bed of wood chips could be inoculated just by placing the infected cardboard on a small layer of wood chips at the bottom of the new bed, and by covering the cardboard with wood chips.

When the temperatures drop below 0°C the mushrooms stop growing. A layer of new wood chips can be worked in the top of the patch; this is the nutrition for the next year.

Treated that way, a mushroom bed may last for decades and zillions of spores will be set free.

The story of *Psilocybe azurescens* Stamets & Gartz

This species originates from the Columbia river basin near Astoria, Oregon and was first found in 1979. It grows in beds of hardwood or conifer chips in half shaded environments.

It belongs to the so called *Psilocybe cyanescens* complex. This means it is closely related to *Psilocybe cyanescens* and *Psilocybe cyanofibrillosa*.

Psilocybe azurescens is distinguished by its comparatively great size and some microscopic characteristics. But the most exclusive feature of this species is its production of secondary metabolites:

Typical analysis of dried ***Psilocybe azurescens*** (%) (Gartz l995):

mushroom	psilocybin	psilocin	baeocystin
1	1,40	0,31	0,28
2	1,56	0,30	0,32
3	1,68	0,28	0,38
4	1,71	0,34	0,41

These data make clear, that Psilocybe azurescens is able to accumulate as high levels of tryptamine alkaloids as 25 milligram, per gram of dried mushrooms.

With these values it is the mushroom with the highest alkaloid concentrations, of all psilocybin mushrooms known so far.

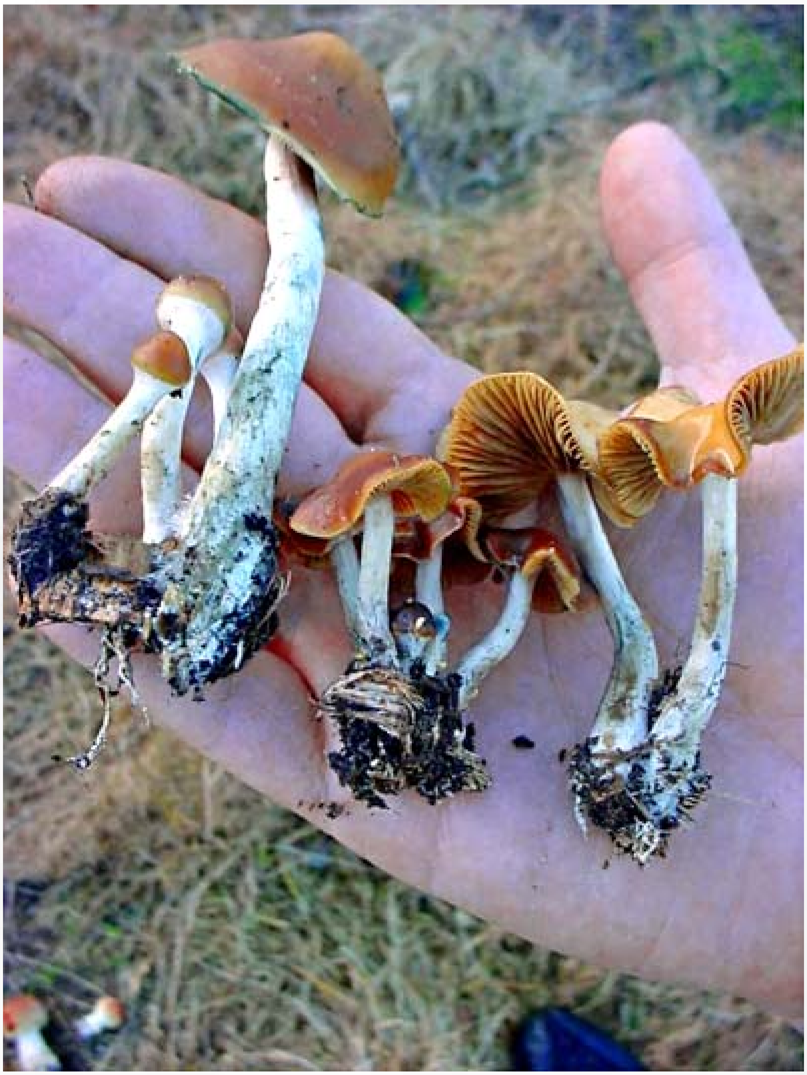
Latin description published by Stamets and Gartz in 1995:

Psilocybe azurescens Stamets & Gartz sp. nov.: Pileo ochreato-brunneo, hygrophano, viscido, pellicula separabili intructo, conico dein convexo, plano 30-100 mm lato, umbonato.
Lamellis sinuato-adnatis, pallidis vel brunneo.
Stipite albo, sricto elongato, 90-200 mm, fibrillis cum strigositate basis caerulescentibus.
Carne caerulescente.
Sporis 13-13.5 x 6.5-8.0 micron Cystidiis fusoid-ventricosis.
Cheilocystidiis 23-28 x 6.5-8.0 micron; pleurocystidiis 23-35 x 9-10 micron.

Cultivation of Caramel Cap Psilocybes with the PF TEK

original source: https://mycotopia.net/topic/7234-cultivation-of-caramel-cap-psilocybes-with-the-pf-tek/

Caramel Cap Psilocybes are mushrooms which belong to the Psilocybe cyanescens species complex: they are closely related to eachother and it is often difficult to separate those in species which exactly can be defined. All Caramel Caps grow on raw uncomposted plant matter, preferably fresh twigs or wood chips, and they typically fruit in the fall when temperatures drop to ten centrigrade and below. Psilocybe azurescens is the most popular Caramel Cap due to its agressive growth, large mushrooms and high alkaloid content.



Psilocybe azurescens (left) and Psilocybe cyanescens (right).

Caramel Caps are quite rare in the wild. In the Netherlands the Psilocybe cyanescens is even specifically listed as an endangered species. Caramel Caps are near to impossible to cultivate indoors but grow easily in semi wild conditions. It are great mushrooms to grow in a shady place in the garden. Until recently there was no good method available to grow these species from spores without the need for sophisticated laboratory equipment. With a few adaptations it is however possible to grow these mushrooms in "PF TEK" style, i.e. by using a spore syringe and without the need of agar cultures, a pressure canner, isolation box etcetera. Such a technique is presented here.

For the "outdoor" parts of this Caramel Caps cultivation technique the text heavily relies on an excellent pdf manual which was published on the internet by "The Azurescens Foundation" in June 2003. A similar technique with equally great pictures can be found at the Erowid site.

Method

For outdoor mushroom cultivation or larger scale cultivation it is recommended to germinate the spores on a substrate of whole grain kernels. The protocol is very similar to the production of "PF Substrate" from brown rice flour and vermiculite. The main difference is that it needs to be boiled two times (a process which is known as tyndallization).

Needed: brown rice, small woodchips (animal bedding), 250ml drinking glasses or jars, tinfoil.

Step 1: boil a cup of grains or brown rice according the directions on the box they came in. A cup of brown rice normally needs to be boiled for 15 minutes in two cups of water. Pour off the water;

Step 2: boil three or four times as much woodchips for half an hour. Pour off the water and mix the rice with the woodchips;

Woodchips plus brown rice substrate.

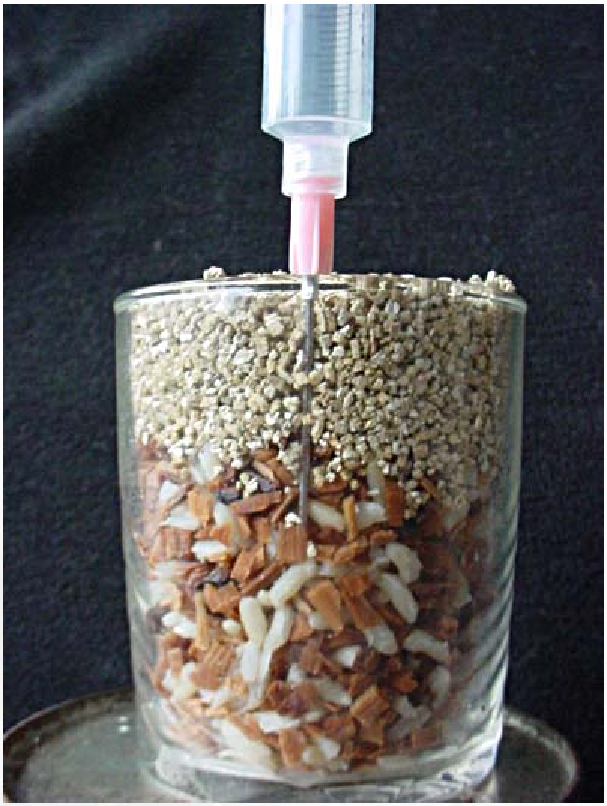
Step 3. Scoop the mixture of grains and woodchips in tall drinking glasses of 250ml until a distance of two fingers from the upper rim of each glass.

Step 4. WAIT 24 HOURS!
Important: the 24 hours waiting period is essential for the sterilization of whole grain mixtures without a pressure canner. This is because only living cells are immediately killed at the temperature of boiling water. But bacterial spores (endospores) are able to survive a boiling period when they are hidden in grains. They germinate in a few hours after the substrate mixture has cooled down. Therefore a double boiling period with a 24 hours pause in between kills contaminants, enables the contaminant spores to grow out (on the condition that the substrate is kept at roomtemperature) and then kills this second generation. This process is called "Tyndallization".

Step 5. Cover the glasses with tinfoil

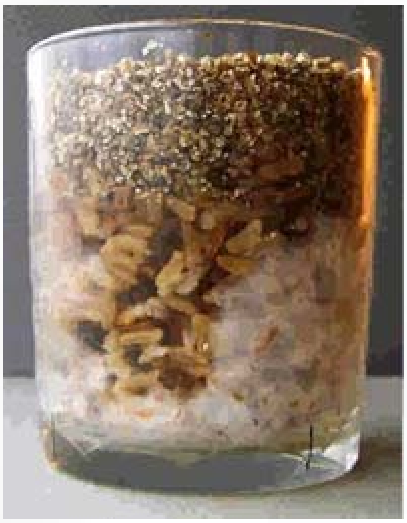
Pan with substrate jars. Photo: Azurescens Foundation.

Step 6: Put the glass(es) or jar(s) in a cooking pot with tight closing lid. Boil the containers in the same way but twice as long as PF Substrate jars: add cold water n the pot until the container(s) are halfway in the water and close the pan with a lid (or plate). Boil the water slowly for 60 minutes. Remove the pan from the gas stove.



Inoculation of rice/wood substrate.

Step 7: wait until the containers are cool to the touch and inoculate by using a spore syringe. The inoculation of azurescens spawn substrate is identical to the inoculation of riceflour substrate: lift the foil, inject the sporewater and replace the foil.



Colonization of rice/wood substrate.

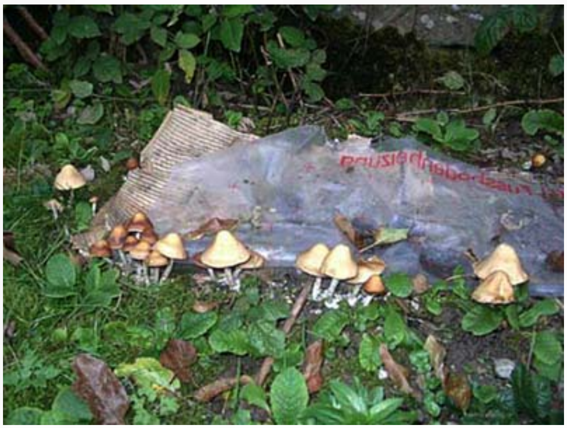
Step 8: again just as in the PF TEK for cubensis, store the inoculated substrate at room temperature. The mycelium will colonize the substrate in about a month (for this picture the tinfoil was temporarily removed).

Left: twigs, right: woodchips (photo: azurescens foundation).

Step 9: as soon as the Caramel Cap woodchip spawn cakes are colonized they can be crumbled and mixed with fresh woodchips (preferably outdoors). The best choice is a mixture of twigs, small chips and sawdust. A single 250ml glass of spawn is enough for several liters of woodchips.

An outdoor woodchips bed in the shade (photo: Azurescens foundation)

Step 10: preparation of an outdoor bed:
An outdoor bed is a 15 to 20cm deep hole in the soil filled with wood substrate. Once a volume of one to several liters of mycelium on wood substrate has been obtained, the preparation of an outdoor bed is the final step, which will lead to beautiful mushrooms growing in your garden every year in late autumn and this for years. A mushroom patch can be prepared at every time in the year except if the soil is frozen. The chance for fructifications in autumn are excellent, if a bed is laid out in spring or even in autumn of the preceding year.



Psilocybe azurescens fruiting and colonizing a sheet of cardboard (photo: Azurescens foundation)

The bed on the pictures was laid out only three months before harvest season and it showed fructifications in

the same year, but the result may have been better if the bed had been prepared earlier. The later the patch is laid out, the more spawn has to be used to secure fructifications in autumn, and the later the mushrooms will appear.
Of course you can also prepare much smaller patches; I saw marvelous mushrooms growing from as little as 0,3 litres of contaminated spawn that had been.
A suitable place for the bed is a half shaded location below a shrub like this.
A 15 to 20 cm deep hole is opened and filled with the wood chips/spawn mixture.
The bed is watered with several liters depending on its size. The patch can additionally be covered with wet cardboard and perforated plastic or anything that keeps moisture high. Do not give to much water! It is better to repeat watering a week later than to give too much first. Make sure the bed is humid the first two weeks but not wet, then you will not have to give any more water until September. If you overwater during summer, the mycelium may grow aggressiveley, but you will probably see no mushrooms in late autumn.

Psilocybe cyanescens fruiting on woodchips in freezing temperatures (photo: PFE)

From september on keep the patch wet by watering once or twice a week.
This is not necessary if it is raining a lot, what is not unusal in this season.
In late september to early october, when the temperatures drop to 7°-10°C (45°-50°F), the first mushrooms can be expected, and they grow in usually two flushes about a month apart, until the temperatures drop below zero. Depending on the temperatures, mushrooms may even grow until january. By placing a tent over the bed, the fructification time can be prolonged. The cardboard, the bed is covered with, is itself used by the mushroom as medium. A new bed of wood chips could be inoculated just by placing the infected cardboard on a small layer of wood chips at the bottom of the new bed, and by covering the cardboard with wood chips. When the temperatures drop below 0°C the mushrooms stop growing. A layer of new wood chips can be worked in the top of the patch; this is the nutrition for the next year. Treated that way, a mushroom bed may last for decades and zillions of spores will be set free.

Psilocybe azurescens fruits upon a thick mycelial mat.

Caramel Cap mycelium cleans up organophosphate pesticides

On October 28, 2004 , the world famous mushroom cultivator Paul Stamets filed a patent for the application of Caramel Cap mycelia for filtering wastewater, breaking down organopesticides and even cleaning up nerve gas residues from military sources(!). The latter two qualities are a directly related to the psilocybin producing capabilities of these species. In all cases the patented technique for the application of mushroom mycelia is quite simple: a wall of mycelium-colonized woodchips is placed around and/or mixed in the contaminated soil. The mushroom mycelium then excrete the phosphotase enzymes which rapidly break down the pollutants.

Paul Stamets writes: "Phosphorylated compounds such as the chemical warfare gases and many organophosphate pesticides have proven particularly resistant to breakdown and bioremediation, as few organisms are equipped with the appropriate dephosphorylating enzymes. Fungi, on the other hand, have a number of enzyme systems and paths for dealing with phosphorylated compounds and are therefore particularly suited for remediation of organophosphates. Preferred species include (...) agarics such as Psilocybe azurescens and Psilocybe cyanescens containing phosphorylated tryptamine compounds and their dephosphorylated analogs. (...) Since both Psilocybe azurescens and Psilocybe cyanescens can possess up to 1-2% psilocybin, a phosphorus rich molecule, and/or psilocin, the product of dephosphorylation of psilocybin, these species can be used to dephosphorylate toxins wherein phosphorus contributes to the toxicity of the pollutant (such as the phosphorylated chemical warfare gases above and organophosphate pesticides). Grassland species such as Psilocybe semilanceata, also rich in psilocybin, may also be preferably employed; such grassland species have the advantageous characteristic of acting as saprophytes, decomposing organic matter, or acting as ectomycorrhizal species, directly benefiting plants via symbiosis, depending upon circumstances. (...) The growth of algae in ponds and lakes can be directly attributed to the phosphorus-rich runoff from agricultural fertilizers and other industrial pollutants. Phosphorus is typically the 'limiting nutrient' of algae growth. By removing phosphorus using mycocloths, mycomats and mycoberms infused or spray hydroseeded with dephosphorylating fungi such as (...) Psilocybe azurescens (...) the over-growth algae can be limited in lakes and ponds, providing cost and ecological saving benefits to fishery ecologies and the watershed."

(United States Patent Application 20040211721, see: http://appft1.uspto....Juncus effusus

Psilocybe azurescens Cultivation Report

by

Skillet

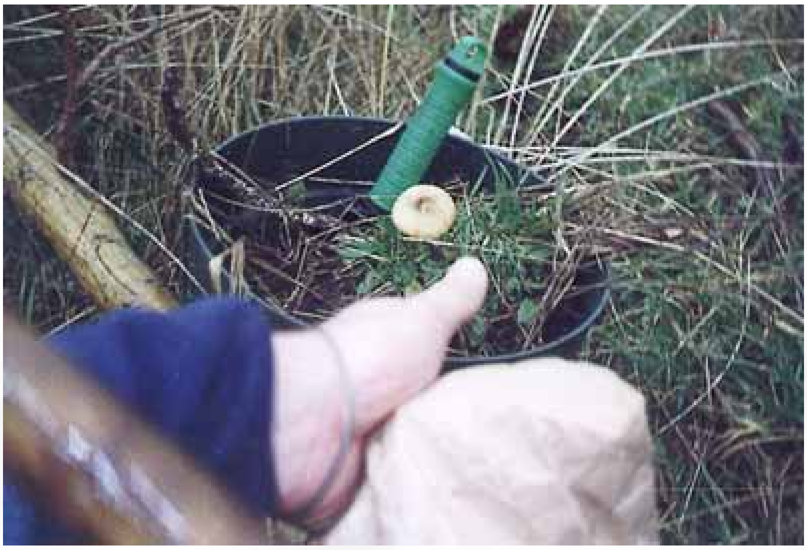
original report: https://www.erowid.org/plants/mushrooms/mushrooms_cultivation_az10.shtml

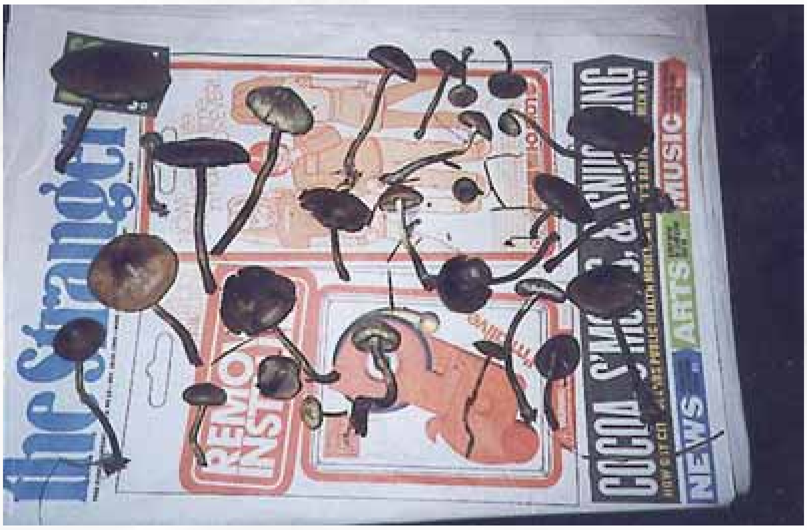
Table of Contents:

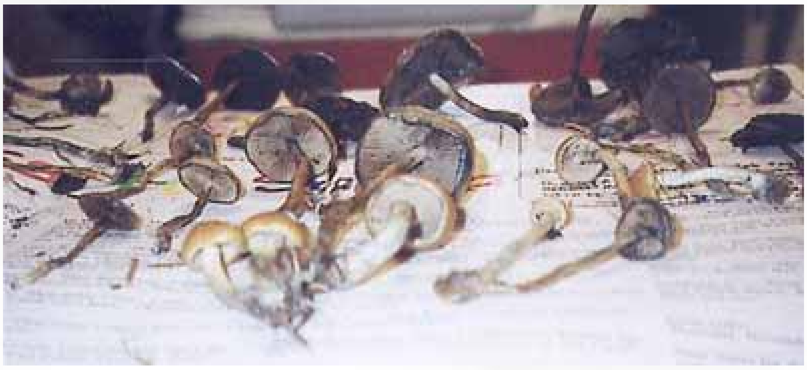
Psilocybe azurescens (Wild Astoria)
Psilocybe azurescens (Hammond)
Spore germination
Spawn media
Bulk substrate preparation
Preparation of outdoor beds
Establishment of beds
Pests!
Maintenance
Fruiting report

Psilocybe azurescens (Wild Astoria)

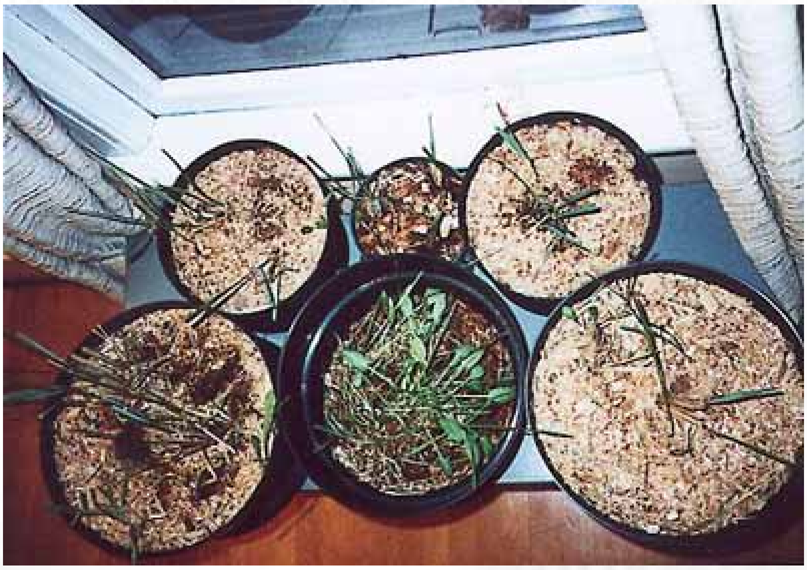
1. Patch collected in Astoria OR 12/19/99. Patch dug up and placed, along with grasses, into large flower pots.







2. Pots brought back to Seattle, WA. Patches were then cleaned up of extra debris and alder woodchips were added. Makeup of pots as follows: Pots filled 3/4 with beach/riparian sand/silt. dune grasses and other plants arranged on sand. Mycelial bits laid on sand surface around grasses. whole thing covered with alder chips and planings.



3. Each pot was watered deeply and placed in a south facing window sill. The pots were sprayed with distilled water every day. note: after two weeks, there were signs of black mold in one of the pots. I cleared the mold out with tweezers and stopped spraying the pots. I noticed lots of mycelium growing at the border between the sand and woodchips. The pots were then watered only once a week, allowing them to dry at the surface. The grass has taken off, as has the weeds. A coast lupine has sprouted as have lots of other weeds.

4. Three of the six pots were taken outside on 2/6/00, 7 weeks after starting. Daytime highs were in the mid-50's, lows in mid-40's. I hope to have Mushrooms growing in flowerpots by mid-March. They should make lovely pictures. After the last flush, the pots will be broken down and planted into prepared beds. These beds will be composed of pits dug out and filled with sand from a nearby river. I will try to recreate the environment of the West Oregon sand dunes and get the Azurescens to take to the Puget Sound environment. A portion of the patch will be dug up and moved every year to a location along the Puget Sound. There are places locally

with sand dunes containing dune grasses that the Azurescens will probably adapt to readily. Within ten years, Psilocybe Azurescens will be a predominant species in the Puget Sound Region.

5. A week after being put outside, a hard frost set in so I pulled the pots back into the house for a few weeks.(2/13/00-2/27/00) All the pots were put out on 2/28/00 along with a batch of P. Cyanescens. As of 4/7/00 there is no sign of activity from any of the pots. The weather has been 1/2 dry 1/2 rainy. Highs have been in the upper 50's to lower 60's, lows from the low 30's to mid 40's. With the weather warming (highs this weekend to near 70 degrees F.) I am fearing that any primordia may abort. Also, the pots go through a period of drying every week. I'll give it another month before I abort the mission and begin work on an outdoor patch. Psilocybe Azurescens.

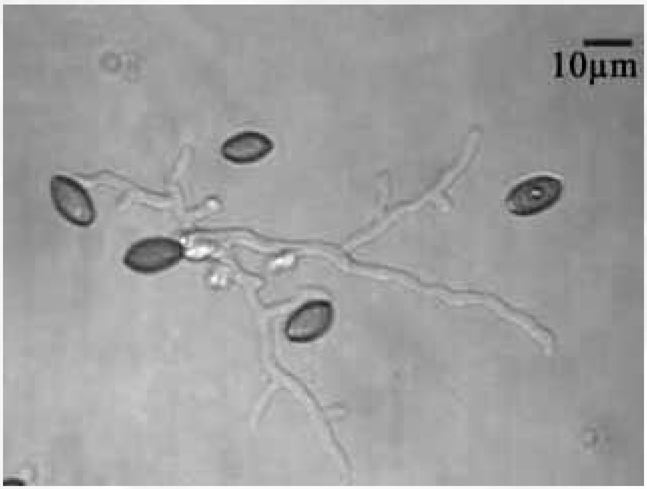
Psilocybe azurescens (Hammond)

by **Amanita**

original source: https://www.erowid.org/plants/mushrooms/mushrooms_cultivation_az2.shtml

Spore germination

Spores from a print were streaked out onto 2% malt agar and incubated in the dark at 25 °C. After 7 days, the healthiest looking rhizomorphic colonies were isolated and transferred to fresh plates, also cultured on agar slants in universal 1 oz glass bottles, for cold storage in the fridge (5.0 °C).



Spores germinating on agar media.

Spawn media

100 ml of organic rye grain and 80 ml of tap water was put in 1 pint glass jars, with synthetic filter discs fitted under the caps, and autoclaved for 20 minutes. Once cooled, 1cm wedges of mycelium were cut from the agar and transferred, 3 to each jar. Lids were replaced, and jars incubated at 25 °C for 7 days. Each jar was shaken to disperse the rapidly spreading mycelium, and then incubated for a further 7 days.

Bulk substrate preparation

Fully colonised grain spawn was then used to inoculate "filter patch spawn bags" . Each bag contained around 1 pound of mixed hardwood sawdust and alder wood shavings/chips. Enough boiling water was added to each bag to fully wet the substrate (approx. 5:4 substrate : water ratio). These substrate bags were left to soak overnight then autoclaved for 20 minutes, and allowed to cool. Around ½ pint of spawn was used to inoculate each bag of substrate and these were left to colonise in a dark cupboard for 2-3 weeks @ about 20 °C. An alternative method for an attempted indoor patch was using a plastic "washing-up" basin with a cased substrate consisting of wood shavings and wheat straw (#1). As you can see, the fungus loves this cellulose rich substrate.

Fully colonised wood/straw substrate.

Preparation of outdoor beds

Patches were placed in different areas of the garden, during the summer around June-July, 1999:

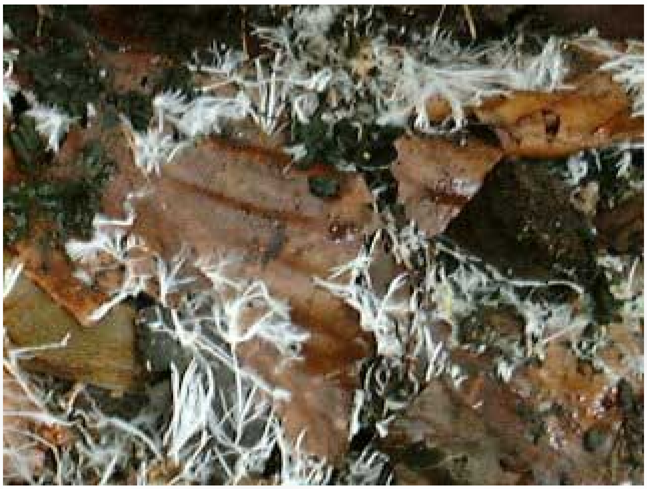
#1. Under Rhododendron bushes, next to grassy lawn
#2. Under a pear tree amongst weeds/shrubbery
#3. Under an ash tree with surrounding gooseberry bushes
#4. In rich woody soil next to a compost heap

Each site was prepared by digging trenches about 6 inches deep, around 2 square feet. The trenches were raked over and lined with a thin layer of moist, well rotted leaf litter/twigs. The colonised woody substrate was broken up and spread out (about 1 bag per patch). The spawn was then covered with another 2 inch layer of rotted leaves/twigs, and finally covered with a thin (1 inch) layer of soil.

Preparation of an outdoor patch (#1).

Establishment of beds

It has now been about 6 weeks since preparing the patches and they are all doing very well. Rhizomorphic mycelium can be observed creeping over leaves, and spreading out into the surrounding leaf litter which comprises the top 2-3 inches of the soil. The weather is cooling down now (August) and it's getting wetter.



Rhizomorphic mycelium spreading over leaf litter.

Pests!

Watch out for slugs, which like to eat mycelium. The best way of getting rid of them is to bait them with bread, and go out at night with a torch and remove them (wearing gloves!). Wood lice were also present and probably feasting on the mycelium. The other pests are squirrels, which discovered the grain and dug a few little holes in the patch under the pear tree (#2), soon after preparing the beds.

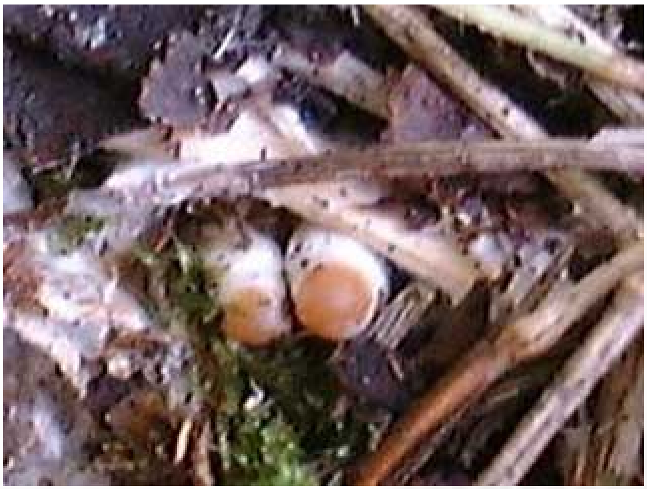
Maintenance

The patches were kept well-watered, mostly by rain, although they did encounter some dry periods, which implemented the use of a watering can. There was a light frost at the beginning of October, but the patches were snug under the leaf litter.

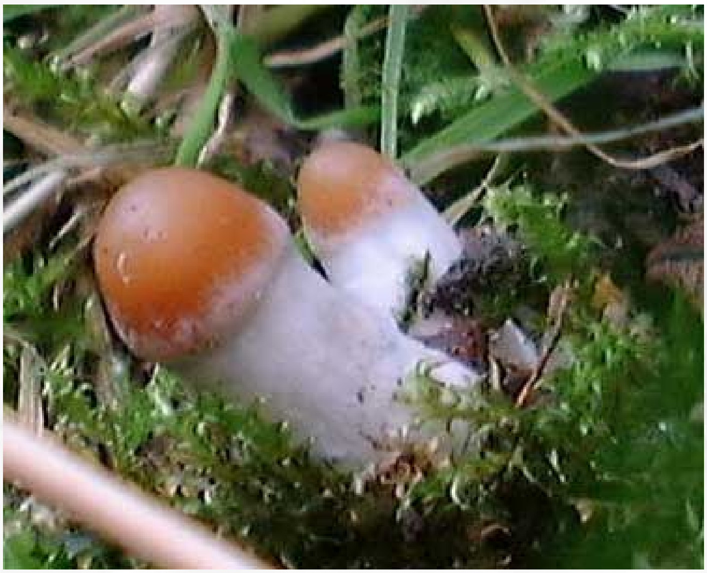
Fruiting report

- **#1** developed pinhead primordia, towards the end of October, This was mainly in the area which had been covered by a thin layer of moss, grass and leaves. The mossy turf had recovered and the mycelium could be seen around the grass roots. Over the following two weeks the primordia grew into mushrooms. Translucent caramel caps with whitish stems which have a very strong bluing reaction were bruised; truly an amazing species! They seem to grow very slowly at first, but accelerate as they got bigger.
- **#2** is sparsely colonised at the surface, and not looking very happy. Partially due to animals digging up the grain spawn, and the soil is very clay rich with is not much wood content. The soil might be too moist.
- **#3** under the ash tree, is still looking healthy, and there are plenty of thick rhizomorphic mycelium creeping out. It has a 2 inch covering of leaves, and seems to be retaining moisture well, but no sign of fruiting, yet.
- **#4** also hasn't started to fruit, but the woody ground is very well colonised. The patch was covered with a thin layer of mossy turf: this is keeping it moist, and there is a carpet of rhizomorphic mycelium.

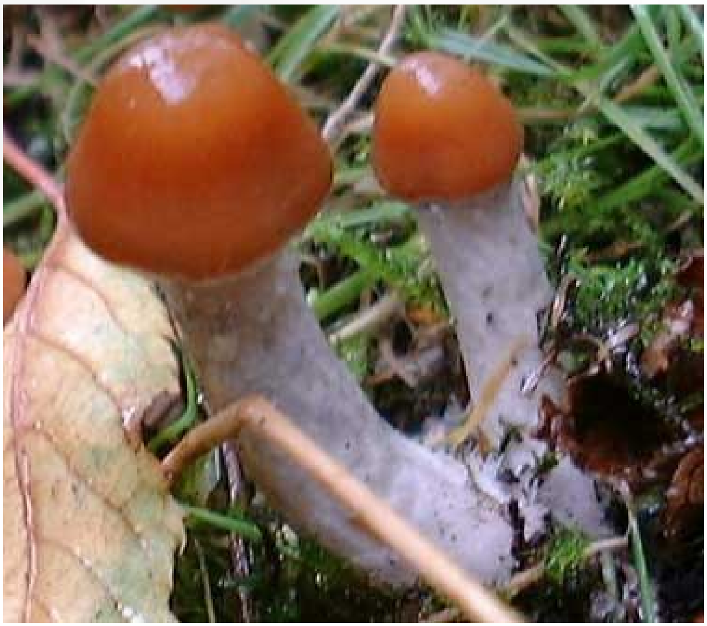
The following images show the development of primordia to "grown-up" mushrooms.



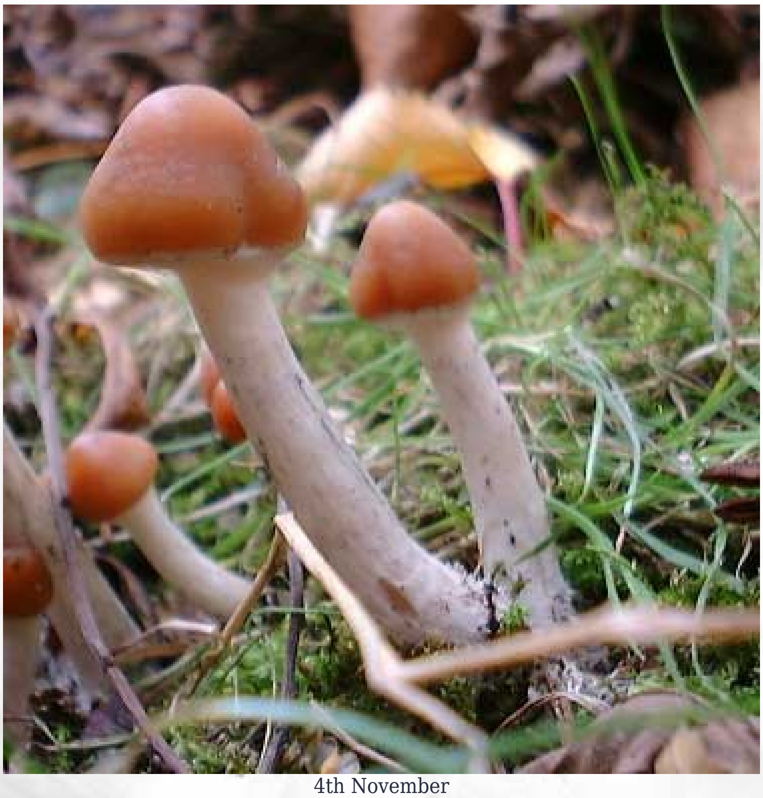
21st October



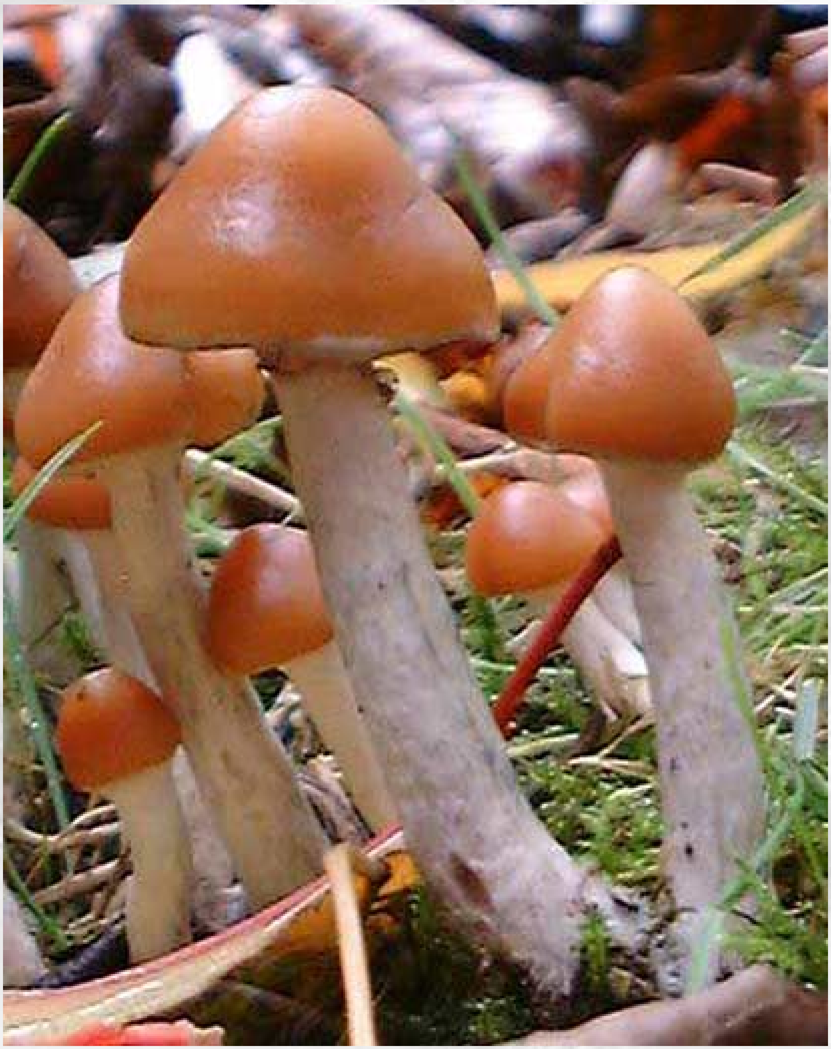
27th October



1st November



4th November



6th November

Psilocybe azurescens indoor cultivation

by

abert

original report: http://www.shroomery.org/8702/Psilocybe-azurescens-indoor-cultivation

First I have prepared mycelium on a sterilized wheat grain by inoculating it from mycelium on agar. After the grain was colonized I inoculated alder chips (not sterilized, soaked during 2-3 day in water) with this colonized grain.
The alder chips were dried chips, I bought them in a shop, they are used for smoking fish etc.

ОЛЬХОВАЯ ЩЕПА

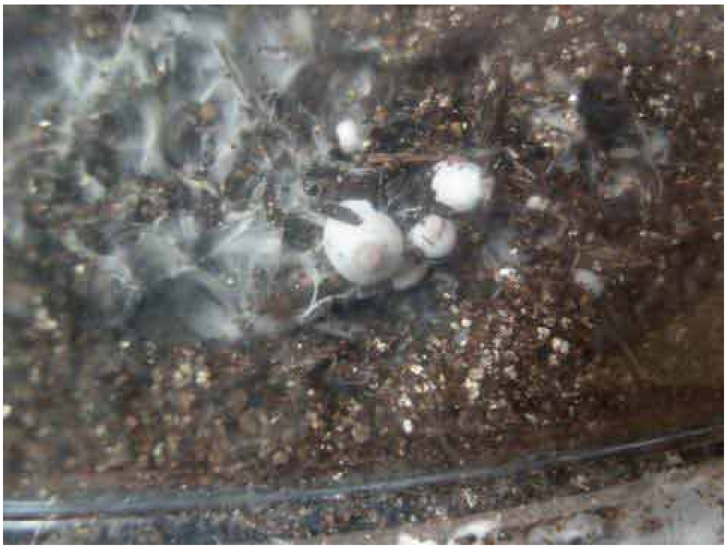
Alder chips were colonized by the mycelium within 1.5 months, at a temperature from 23-25°C. Then I placed the colonized alder chips in a plastic bottle (first case) and put a casing layer on.
The casing layer consisted of composted needles, foliage, sticks etc. from the woods. I removed large fragments so I was left with a homogeneous mass. The casing layer was not sterilized.

After mycelium appeared on the surface of casing layer (temp 23-25°C), I put a layer of wet vermiculite, and placed a bottle in a refrigerator (temp 6-8°C). (My refrigerator has a glass door and fluorescent lamp - such refrigerators are used as a display for wine bottles etc.).

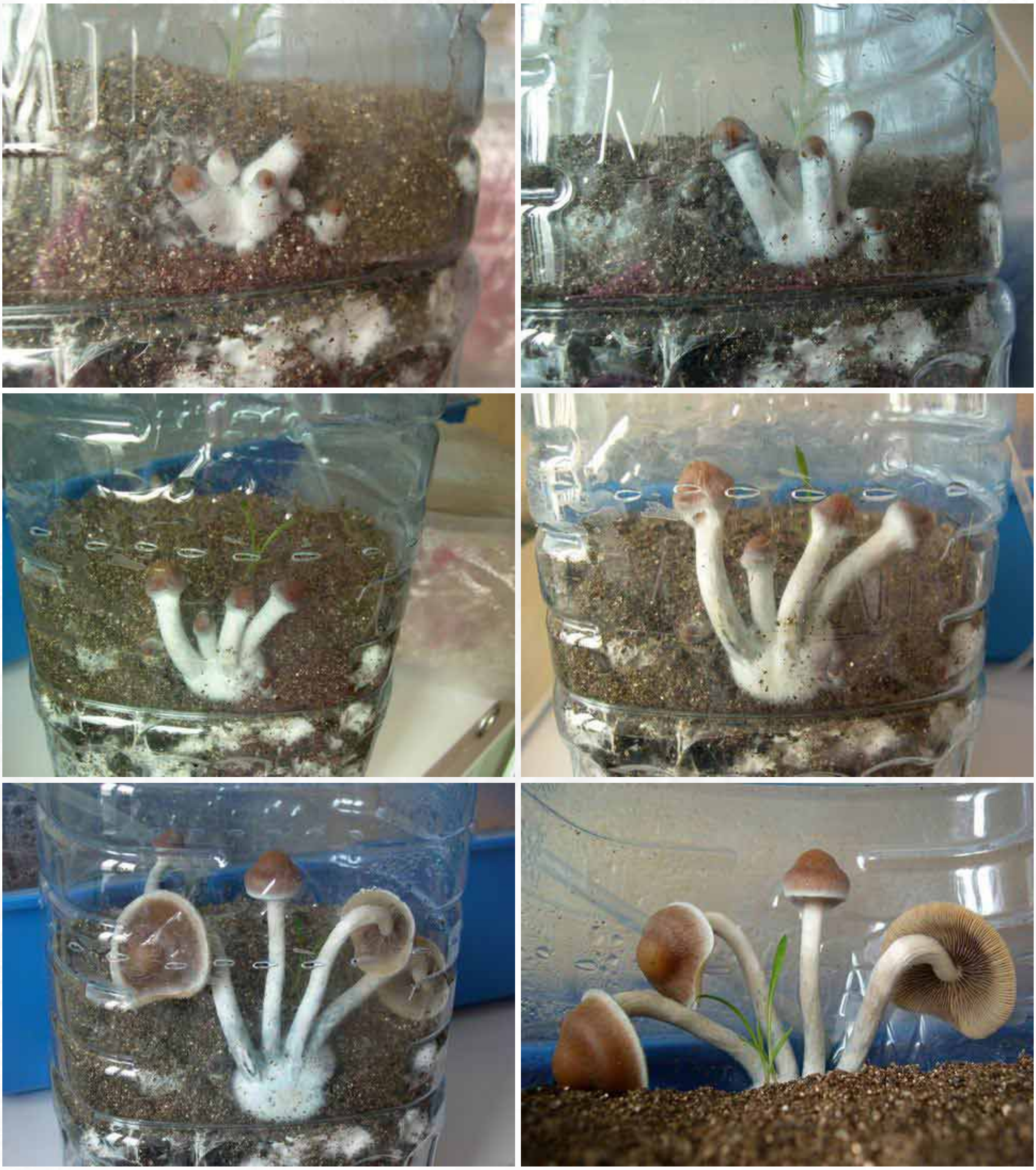
This is my refrigerator.

Regularly (two times per day) I aired and 1 time per 2 days humidified the bottle. 1.5 months later the first mushrooms have appeared.

The first mushrooms did not develop because of shortage of light (I used only natural illumination, through the glass door), but mushrooms on the second flush (that you can see in the pictures) developed normally. I used a fluorescent lamp for 16 hours per day. From occurrence of mushrooms up to harvest 28 days have passed.



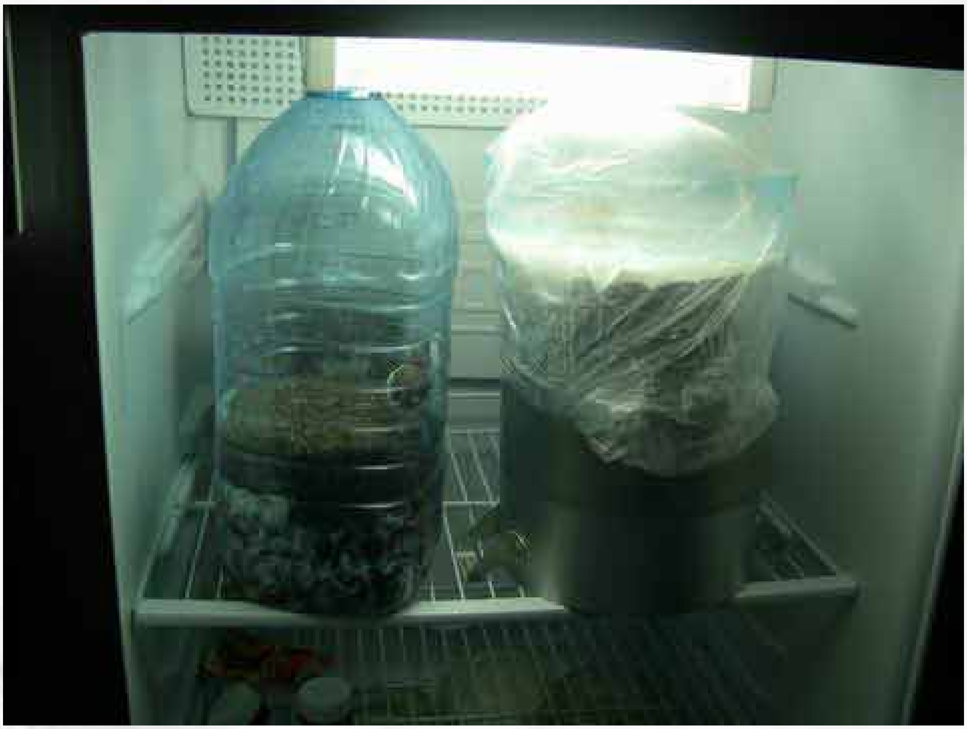
Development of the mushrooms in the bottle.



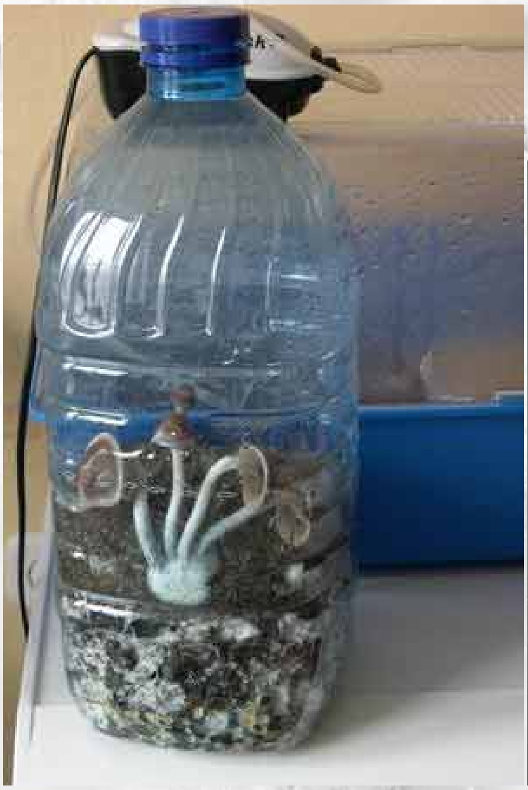
The second container was made in precisely the same way, only one month after the first. What you see in the pictures is the first flush. Using a light from the very beginning, and also having placed the container in the top part of a refrigerator (where temperature is little bit higher: 8-12°C), the development of the mushrooms could be reduced for 2-3 weeks. (2-3 weeks, because I noticed mushrooms when they have appeared above a surface of the casing layer, from this moment up to harvest have passed 2 weeks. But mushrooms needed some time to appear above a surface... let's consider 3-7 days.).

The second container (substrate and casing layer were the same as in the previous case).

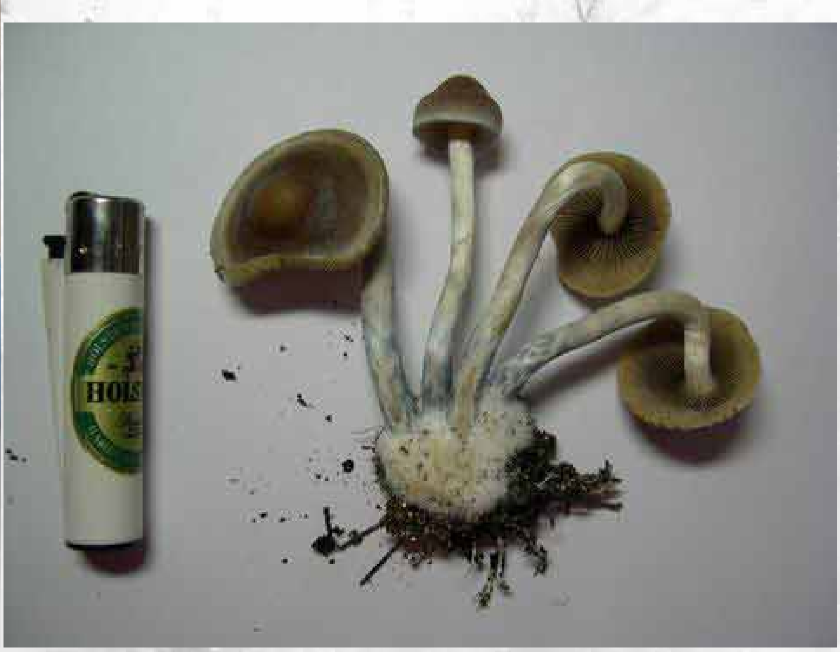
And some more pics.



Two containers, placed on the top shelf, (where it is warmer). Second container placed on a pan (in order to place it higher).



A plastic bottle with mushrooms inside (in full size).



And the harvest.

Growing Panaeolus Tropicalus and Panaeolus Cyanescens

Version 1.0

by

The Hawks Eye

original source: http://mycotopia.net/archives/discus/messages/5/1405.html

This is a document of collected knowledge from our own experience with pans and talking with other growers. Thank you everybody for your input over the years. More to come

Its well known this is not a very easy species of mushroom to grow, but it can be done, and is done quite often. Just count on a little extra work and some TLC.

Ok, for starters, if your using a spore syringe, inoculate your substrate jars of 3:5 ratio of ground brown rice to vermiculite or 2:1 of finch or birdseed to vermiculite. If your using agar with a spore print, then your obviously experienced and we don't need to go into much detail there. After your substrate is inoculated, you will see a very thin and wispy mycelium. Its not thick and rhizomorphic and healthy looking like cubensis mycelium. On agar, it actually looks like contamination its so strange looking. Sometimes very spongy looking, and wispy looking on agar. Strange stuff man. In jars, the mycelium is almost a light grey color, yet off white, and very thin. It almost looks like cobweb mold its so thin. At times it will even grow what appears to be primodorma and pins, but its not. Its just a very strange looking mycelium at this stage. So unless you start seeing strange colors other then white or a light grey, its ok, just go with it.

Typcial colonization of 1/2 pint jars is around 3-4 weeks. Sometimes faster, but allow them to sit a week after full colonization. You'll see why when you break open the jars and pull the substrate out. It breaks apart very easy. Once again its a weak mycelium. Be sure your handa are very clean, as this mycelium easily contaminates.

The next step is to use that substrate as spawn to colonize either dung or compost. Compost is your best bet. Dung is the next choice. A lot of old books recommends straw, well straw also works but it contaminates much easier on straw then dung or compost. This is not just our opinion, but from many growers we've talked with gave up on straw and pan species. So from here, either buy or make some compost, or go out to your local cow/horse/donkey/elephant field and shuck some patties. So you know how your always leaving your girlfriend at home while you go have fun? Well you need a helper, its time to bring her on a field trip This is a great cover up for where you go on those field trips when you disappear Doh!

If you can find farms that have straw or grain fed animals you have some prime realestate to grow those pans on. If you don't know what they are feeding the cows and are not aware of what they are eating, we recommend you kneel down and sniff the patty! A prime pile of dung will have a nice organic aroma to it.

Stay away from fresh steaming patties. You want the ones that are aging a bit. There are to many micro-organisms on the fresh patties that can kill the spores, plus they 're sticky and they stink. You don't want these. There are some great pictures on our website under the panaeolus species of some Manatee County Florida Panaeolus Cyanesecens growing on dung. These are the best pictures we've seen yet showing clarity of how old the dung is when these mushrooms are growing on them.

Ok, so you and your gal are out in the field under the full moon feeling romantic collecting dung. She's happy she's out of the house, your happy because your bucket is full of dung, time for a bud. Your choice, weiser or herb.

The next step is to prepare your dung. Usually its pretty hard when you pick it right. Toss it in a big bucket and poor in a gallon of purified water or more, so its covered in water, and let it sit for day to soften up. Next step, a day later is to pasturize your dung or compost.

Pasturizing is a form of sterilizing the compost or dung in less then boiling water to eliminate many non-beneficial bacteria unhealthy to mushroom mycelia. There are many methods of doing this, but here is what we recommend. Take your dung or compost and put it in an old pillow case, then tie it in a knot. Get a large pot, something like 22-30 quart and fill it with water. We always recommend againts tap water, spend $.50 cents and buy a gallon of filtered drinking water. Fill up your pot of water to about 8-10 inches from the top, turn up the heat on your stove. You want the water temp between 160F-180F, which usually is steaming heavily, but not boiling rapidly. Put in your mother-in-laws pillow case full of dung, push it down a bit, and let the hot water absorb into it. The temp of the water will drop for a while, wait it will build back up. When it does, let it pasturize for a good 45 minutes and turn off the heat. It will take a while to cool down. When its cool enough, take it outside and let it hang for a day to drip water and cool off. Not to worry, the outside air is good and healthy for it . You can let it sit there for several days if you don't have the time to get back to it. When your ready to work, here we go with the next step.

Ok, were assuming your have knowledge of casing your substrate. Take your dung or compost from your MIL's pillow case and take handfulls and squeeze it real hard until the water is barely dripping. You don't want a lot of water in it or it will be to soggy and contaminate to easily. Squeeze it until the water is barely dripping, and place it in your casing container. Get the desired amount for the space your working with. Take those jars of substrate and start gently crumbling them up with your pasturized compost or dung. Mix it well. We recommend about 3 to 4 1/2 pints of subtrate for every 10 lbs of compost. Or, a semi-full pillow of dung or compost, add about 2 1/2 pints of subtrate worth. After its mixed well, then add a casing layer. Pans seem to like hydrated lime in the soil. The 50/50+ mix works well. They grow well with the verm/peat/lime/oyster shell mix. Within 2-3 weeks of casing they should start fruiting. Now all the old school books say they like temps around 70F-75F, well, that is not written in stone. In the tropics where they grow, the temps are much warmer. We've seen them grow at a daytime high of 93F, which means substrate temps of 95-96F, and a LOW of 70-75F. There has not been a lot of information posted about this species that is updated, and we hope what we have given you helps. There is a lot more to come, this document will continue to grow and nothing is written in stone. This species is well worth the time and efforts because the experience from Panaelus species is PHENOMENAL !!!!

The Cultivation of Copelandia cyanescens

by

David Barlow

original source: http://jontrot.free.fr/champignons/Copelandia.pdf
backup source: http://www.psilosophy.info/resources/Copelandia.pdf

Table of Contents:

Introduction
Making an Inoculation Chamber
Horse Manure
Spore Germination
Grain Culture
Laying Out Spawn
Casing and Cropping
Spore Printing
Preserving Mushrooms
Making an Incubator
Mushrooms and the Law
A Cautionary Note
Resources
 Pressure Cooker
 Spawn Jars
 Spawn Jar Filters

Introduction

Copelandia cyanescens is fairly easy to grow and gives a reasonable yield. My specimens were grown from spores supplied by Pacific Exotic Spora. There are different opinions on the taxonomy of species in *Panaeolus* and some mycologists do not recognise *Copelandia* as a genus. The mycelium grows rapidly on malt dung agar (MDA) and fruits abundantly when horse manure is added to grain. Although the fruiting bodies are small they are extremely potent. The *Copelandia* casing layer eventually succumbs to blue mould and must be discarded although it should yield around 40 g of mushrooms (fresh weight) per 100 g rice/horse manure. *Panaeolus cyanescens* (spores from PES) is also very potent but has a weaker mycelium which gives smaller specimens and a much lower yield (10 g per 100 g rice/horse manure). The casing layer also succumbs to blue mould. These tropical species grow at similar temperatures to *Psilocybe cubensis*. Spores of *Copelandia cyanescens* and*Panaeolus cyanescens* are difficult to distinguish. Both are lemon shaped and give black deposits. *Copelandia cyanescens* measure around 9.5 x 11 µ while *Panaeolus cyanescens* are 11 x 12 µ and clump together less (each division in the photomicrograph below is 1.9 µm).

It is my personal view that Hawaiian *Copelandia cyanescens* offers the entheogen user a more enjoyable experience than the more easily cultivated *Psilocybe cubensis*. In fact I would place it in the *premier cru* of psychedelic plants, alongside the indigenous Liberty Cap (*Psilocybe semilanceata*) and the various DMT containing plants.

Making an Inoculation Chamber

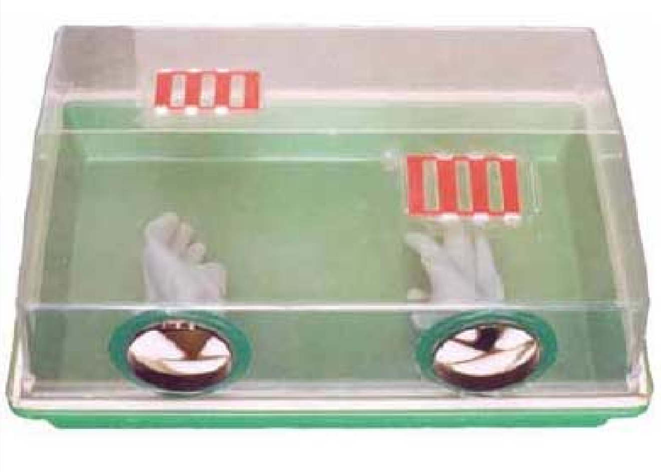
Mushroom mycelium has no hard protective skin, unlike flowering plants, so it is liable to attack by other micro-organisms. In nature each mushroom will produce millions of spores very few of which will reproduce. When working indoors we must therefore first construct an inoculation chamber to ensure sterile conditions. Mushroom laboratories use Laminar Flow Hoods where a powerful fan forces air through a large HEPA filter, but these are very expensive.

My inoculation chamber is based on an idea of Stephen Peele's (see FMRC). A 61 x 39 x 30 cm (24" x 15" x 12") glass aquarium is turned on its side. The exposed edges are rubbed with emery paper to make them less sharp and the narrow strips of glass at the top and bottom of the opening are removed. A sheet of polythene is Sellotaped to the front panel and the bottom left hanging for the operator to put his hands through. Alternatively two vertical slits can be cut in the polythene for this purpose. When exposed material is inside the bottom edge is held in place with tape (it need not be airtight). Hot sterilised items should be placed inside on a mat or plate rather than on the glass and the scalpel blade and tweezer tips must be flamed outside. An angle-poise lamp can be positioned over the aquarium.

A glass aquarium is preferable to a perspex one as it is superior optically and much harder to scratch. Although less portable and larger than necessary, I prefer large aquaria as they allow plenty of room for movement. The inside is misted with a few sprays of a 10% solution of thin (detergent free) bleach each time it is opened when working with exposed material. A plant or cosmetic spray bottle is ideal for this purpose. The spray bottle should be clearly labelled and kept in a safe place - if children are around it is safest to empty it between uses. Cosmetic spray atomisers may eventually block, even when deionised water is used for dilution, due to the chlorine. To extend its life it can be flushed through with water after each use. Gloves must be worn in the aquarium when bleach is present to protect the skin - thin rubber gloves with talcum powder work best. (I use a tissue for swabbing as cotton wool sticks to the rubber.) The inside surface of the aquarium can be wiped clear with the gloves. A mask with a charcoal filter should be worn as chlorine is very irritating to the mucous membranes. Avoid using the aquarium on quality furniture as the bleach spray causes staining of varnish and also stains clothing.

It is also possible to construct a glove box from a plant propagator tray with a perspex lid. Two holes are cut in the lid and washing-up gloves fitted. This model measures 56 x 37 x 22 cm (from B&Q stores). Although this glove box allows less air exchange than the aquarium design, I no longer use it as hand movement is very restricted and the height is inadequate for inoculating Kilner jars.

Aquarium



Glove Box

Horse Manure

Horse manure is a mixture of droppings, urine and straw which is allowed to rot down in a sealed plastic bag to preserve the nutrients. Common *Agaricus* mushrooms are grown commercially on composted horse manure. Various supplements are added and the process is rather complicated. Coprophilous (dung growing) species are less demanding. When used in the garden it is not unusual to see wild mushrooms growing on horse manure. While cubensis fruits abundantly on cased grain, copelandia and panaeolus grow poorly on this medium. Personal hygiene is essential when working with manure as some farm animals harbour the deadly strain of E coli which is frequently in the news. Avoid using kitchen utensils with unsterilised horse manure and wash hands after preparation. I sterilise a small quantity in a Kilner jar which I save for making the MDA below. Alternatively poultry manure pellets can be used.

Spore Germination

MDA (Malt Dung Agar)
For each 8 oz jar:

- 25 ml water
- 0.5 g agar agar
- 0.5 g malt extract (light dried or use 0.5 ml syrup)
- 0.25 g horse manure or poultry manure pellets - copelandia grows poorly on MEA (Malt Extract Agar)

The quantities are not critical but the solution must be contain at least 1.5% agar to solidify. Agar is made from seaweed and is sold as powder or flakes in Health Food shops. It is sometimes labelled "agar agar" to distinguish it from gelatine "agar" which is made from animal sources. Light dried malt extract is available from home brew outlets. Mycelial growth is less vigorous on dark malt extract syrup.

MDA Ingredients - Agar, Malt Extract, Horse Manure

Preparation

Agar Media before Sterilisation

Spraying Aquarium with Bleach Solution

STEP 1
Make up the media as above. Heat the liquid sufficiently in a saucepan to stir in the malt, or use a Pyrex mug in a microwave, then pour into 8 oz jars. It is important to have a reasonable depth of agar for inoculating grain jars later. Thin sections tend to stick to the jar side making inoculation more difficult. Ensure that any media is cleaned from the jar thread to avoid contamination entering later. If an accurate balance is available, it is more precise to add the ingredients separately to each jar as they are difficult to mix in a mug since the manure in not soluble. Add 500 ml of cold water to the pressure cooker. Pressure cookers are normally supplied with a basket and a rest to stand vegetables out of the water. Insert these or some similar utensil in the cooker and place the jars inside it. The lids should not be completely tightened.

STEP 2

Sterilise the jars for 20 minutes at 15 psi (1.05 kg/cm2).

STEP 3

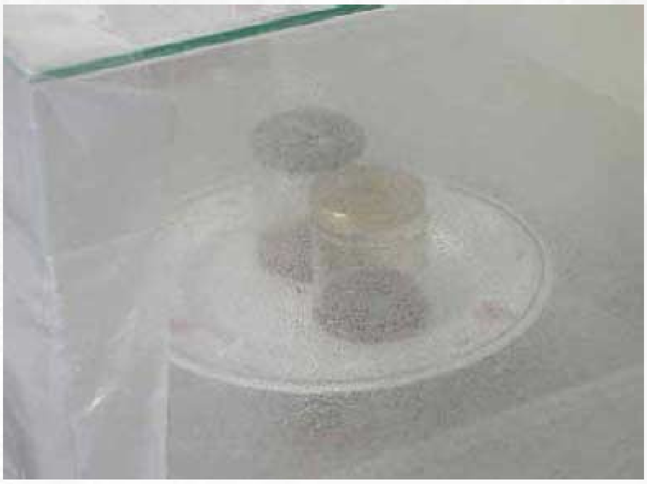
Close all doors and windows to prevent draughts and allow the pressure cooker to depressurise slowly. Depressurising rapidly will cause the media to boil excessively. Spray bleach solution into the aquarium. While wearing a thick pair of gloves remove the lid and place the jars on a plate in the aquarium. Spray more bleach solution. If any lids have come off the jars in the cooker they should be replaced immediately (usually they will be okay). If any lids become seized on by vacuum a flamed screwdriver tip should be used to lift the edge.

STEP 4

Once the media has solidified it can be inoculated (agar solution solidifies at 32°C). Swab a scalpel and tweezers with isopropyl alcohol or surgical spirit and flame the scalpel blade outside the aquarium. Rest them inside on something so that the blade and tweezer tips are not touching anything. Put on the gloves and mask and then pull the spore print partly out of its bag with tweezers inside the aquarium. While holding the print through the bag scrape the scalpel blade tip across the spores. If necessary the print can be placed on a saucer that has been swabbed with isopropyl alcohol (not surgical spirit which leaves a residue). The smallest speck can contain thousands of spores although some prints have to be scraped hard to remove them. Scrape the spores onto the surface of the agar in the centre of each jar. Always open lids as little as possible and close them quickly to reduce the risk of contamination. Do not allow any agar to remain on the spore print as it will attract contaminants. The lids are then tightened.

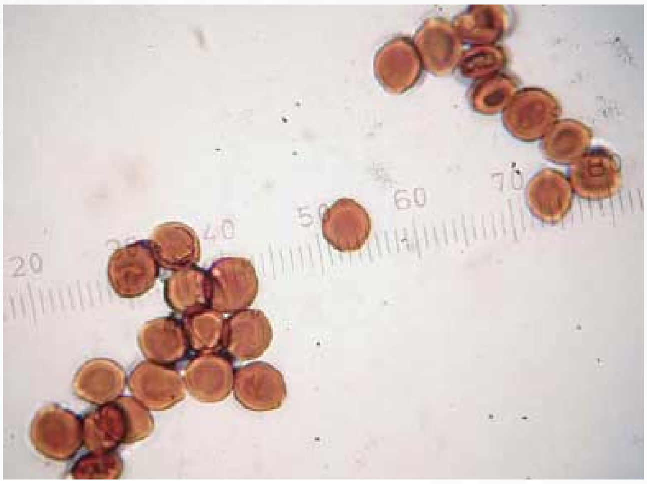
STEP 5

The jars are then incubated in a warm place (the top of an airing cupboard is ideal if you don't yet have a combi boiler). They should be stood upside down to keep moisture off the agar and can be heated up to 27°C. The temperature range can be checked over a period with a max/min thermometer to ensure it is not too hot.

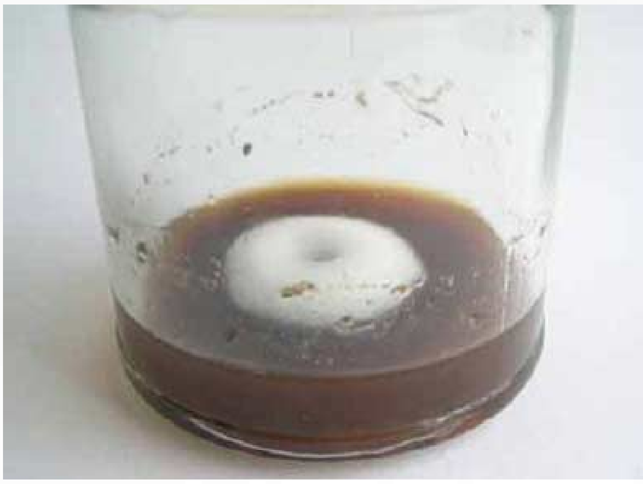


Agar Media Cooling

Scraping Spore Print



Copelandia cyanescens spores



Copelandia cyanescens mycelium on Malt Dung Agar

When working with more than one set of jars each should be labelled with a permanent marker or a Chinagraph pencil. Only write on the glass because permanent marker ink cannot be removed from some lids (ink can be removed from non-porous surfaces with meths). Fresh spores should germinate within a week although older spores can take up to three weeks. In the warm copelandia mycelium should fill a small jar about two weeks after inoculation, although it will not grow to the edge due to the lack of air exchange in the jars. For maximum growth the lids can be fitted with synthetic filter wool (from aquarium shops), although filters are never 100% effective. If liquid was present on the surface of the media the spores may be dispersed and germinate from different points. Any liquid present can be rolled around the side of the jar to remove condensation when viewing. It is essential to inoculate grain with fresh mycelium - in time it flattens and becomes less vigorous.

Copelandia mycelium is white and frequently develops a radial structure. Any coloured mycelia will be moulds from airborne spores. If these appear the media should be disposed of as spores will have been shed inside the jar. A slimy ring around the rim indicates bacterial contamination.

Grain Culture

For each litre Kilner jar:

- 180 g (dry weight) wholegrain rice
- 90 g thoroughly wetted horse manure (or 45 g poultry manure pellets and 45 ml extra water)
- 180 ml water
- 1 g gypsum

Some brands of rice are impossibly sticky. Rice can be tested by rinsing in hot water - if the water remains clear it is suitable. Easy cook rice, also known as parboiled rice, is pressure steamed to modify the starch. Any easy cook brown rice should be okay but Tesco American easy cook brown rice is ideal. Ensure that the ingredients are thoroughly mixed and heat immediately before the gypsum solidifies. The addition of gypsum (calcium sulphate) is particularly useful with rice grain to reduce clumping. Available from craft shops as Plaster of Paris.

STEP 1
Add 1 litre of cold water to the pressure cooker (the larger quantity of water is needed for the longer sterilisation time). Place the filters inside the plastic screw bands and tighten them on the Kilner jars (see Spawn Jar Filters in Resources section). Bring up to pressure with moderate heat and sterilise at 7 psi (0.5 kg/cm^2) maximum for 90 minutes. The pressure must be allowed to drop by itself as releasing it causes a sudden drop in temperature which can crack the jars. Shorter times do not give adequate sterilisation and higher pressure will crack the jars.

STEP 2
Remove the Kilner jars from the pressure cooker wearing thick gloves and check carefully that there are no cracks. Then shake the jars to separate the grains. The jars should be held upside down whilst shaking vigorously to dislodge the grain from the bottom (a little liquid may drip through the filters). It may be necessary to drop the jars upside down on to a floor mat from a couple of inches to dislodge rice grain. Only tighten the lids gently whilst hot as they will tighten as they cool. If the jars are allowed to cool without shaking they will need re-heating for a short period.

STEP 3
Allow the grain jars to cool completely before inoculating in the aquarium. A large section of agar must be used for grain in order to maximise the number of inoculations. I use two quarters of a small jar culture to inoculate each Kilner jar. Use bleach misting, gloves and mask. Cut the culture into quarters and spear them with a flamed scalpel to transfer them to the jars. One fully colonised small jar will adequately inoculate up to 4 Kilner jars - ideally all the jars should be inoculated at the same time. Open the jar lids as little as possible when transferring the media. Tighten the screw bands and shake the Kilner jars thoroughly in all directions to inoculate the grains. Label the jars with a permanent marker or Chinagraph pencil.

STEP 4
Incubate the grain jars in a warm place. They can be stored on their sides provided that the grain does not obstruct the filters, as mycelium grows quicker in less dense grain and it is less susceptible to Wet Spot. If the agar quarter has stuck culture side to the glass the jar may need re-shaking after the mycelium has grown through to the exposed surface. The mycelium will disappear on shaking but recover in a couple of days. In the warm the spawn should be ready in about a week. The grains will be stuck together with a fine white growth. A little moisture may be present as a waste product of the mycelium. Avoid re-shaking the jar if there are uncolonised patches (less likely with rice) as this encourages Wet Spot which thrives in anaerobic conditions. If green mould spots appear or the jar smells bad when the lid is removed due to Wet Spot, dispose of the grain. Wet Spot can often be smelt through the filter - filters are never 100% effective.

Laying Out Spawn

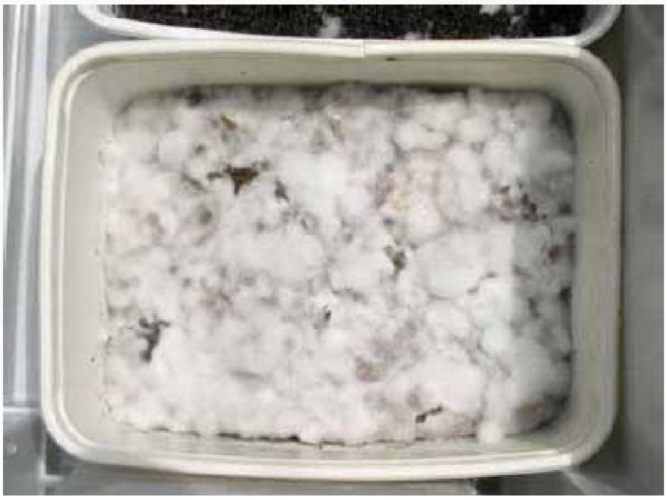
Some growers simply case the grain in the jars. This requires a large number of Kilner jars and the mushrooms are difficult to pick. Laying out the grain is more convenient and gives a better yield. A 2 litre ice cream tub (19 x 15 cm) or a similar sized sandwich box base makes a suitable container. This is then placed inside a larger container with water to maintain a humid atmosphere.

STEP 1
The tub should be stood for a half-hour in a warm bleach solution (keep the lid on to prevent fumes) and then rinsed before use. This will kill any mould spores surviving from previous use. Boiling water is also effective but deforms the tub.

STEP 2
A tablespoon should be placed in a mug of boiling water for a few moments, shaken dry and allowed to cool. The jars should be well shaken to separate the grains before pouring into the tub. Any large lumps should be put back into the jar with the spoon and re-shaken. The last grains may have to be dug out. The spawn is levelled off by pressing it with the spoon. Using the 2 litre ice cream tub should give about 40 mm depth of spawn. In hot weather the grain can sometimes dry out and not spawn after re-shaking. It may recover if the bottom of the tub is covered with a thin layer of wetted vermiculite.

STEP 3
A plastic box with transparent lid or cover should be bleached as above and rinsed. The bottom surface is covered with water and the tub stood inside it. (The water is changed every fortnight - always use cold tap water as the chlorine will help keep it fresh.) The lid is placed on the box to maintain high humidity - alternatively a polythene sheet can be taped over the top. Condensation will form on this lid. If too much condensation forms and drips onto the grain, the lid can be opened slightly to reduce the humidity. A fine white mycelium will completely cover the grain after a day or two with copelandia and cubensis. If a few grains remain uncolonised the spawn can still be cased normally. If the grain is cased before the mycelium reappears, foul smelling Wet Spot will develop and the spawn will be lost.

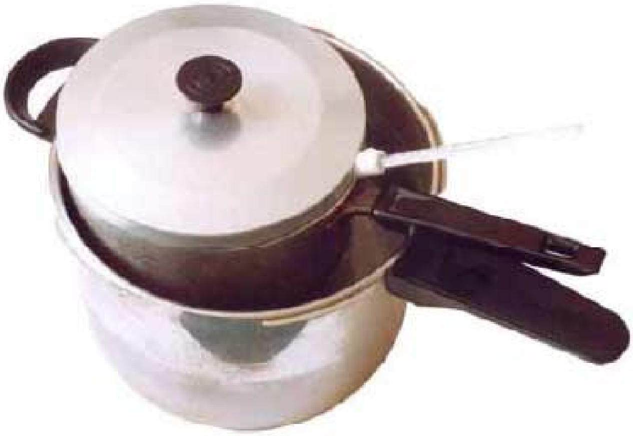
Copelandia cyanescens spawn on rice/horse manure



Spawn ready for casing

SPHAGNUM MOSS PEAT
GARDEN LIME

Casing Ingredients



Pasteurisation Apparatus

Casing and Cropping

Peat mixed with chalk (calcium carbonate) or lime (calcium oxide) is used for casing in *Agaricus* cultivation. Moss (Sphagnum) peat is the type preferred - the heavier sedge peat is unsuitable. It is usually sold in 60-80 litre or larger size bags. Moss peat has a low pH value that is too acidic to be used alone. It also has a low nutritive value. A quantity of chalk or lime is added to buffer the acidity, making the pH value more neutral. Moss peat and garden lime powder should be used in the ratio 2:1 by weight (8:1 by volume) for copelandia. For easy mixing the dry ingredients can be placed in a sealed container and shaken.

Moss peat compost makes an excellent casing for cubensis and unlike raw peat is available in small quantities. It is less acid than raw peat and has nutrients added. Garden retailers describe this product as compost although it has no connection with garden or mushroom compost.

Dry casing is sprayed to achieve an even moistness and then pasteurised. Pasteurisation is preferable to sterilisation because it preserves benign micro-organisms which delay contamination by the lower fungi. Sterilisation is adequate for copelandia although it is not recommended for slow growing species such as *Psilocybe cyanescens*. Untreated peat/lime and compost casings become contaminated very quickly by *Trichoderma*. I find that cubensis pins quicker and more abundantly on compost than on peat/lime. I use peat/lime with copelandia as I have found compost to be susceptible to Cobweb mould (*Dactylium*) when it is not rapidly colonised by mushroom mycelium.

STEP 1
Place sufficient pre-mixed peat/lime casing in a saucepan and wet until moist. I use a chip pan which has a gap in the lid for the basket handle, through which a winemaking/homebrew thermometer fits. The thermometer should touch the base of the saucepan and a piece of paper towel should be wrapped around it to prevent steam escaping from the hole. The pressure cooker base is filled with hot water so that the saucepan floats on the surface - see above. (Placing the thermometer in the water is adequate if a suitable saucepan is not available.) Alternatively the saucepan can be placed in any large pan. If it is too heavy to float, it can be stood on the pressure cooker's upturned perforated basket. The casing is pasteurised for an hour at 71-82°C (160-180°F). It is advisable to turn off the heat before the temperature reaches the lower limit as it will continue to rise for some time. If it reaches the upper limit the saucepan should be removed from the water and replaced when it drops to the lower limit. Once the system is stable, only occasional heat will be needed to maintain the casing between these temperatures.

OR

Place the moistened casing into a casserole dish with a lid and microwave until steaming hot.

STEP 2

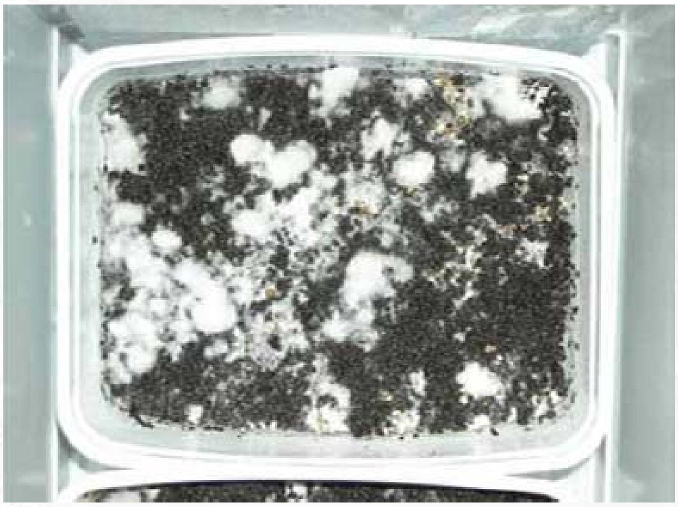
Apply the casing once it has completely cooled and replace in the plastic box with transparent lid. Use just enough to cover the spawn, no more than 10 mm depth. The casing should have an uneven open surface and should not be compressed. A little water should appear when the casing soil is squeezed between thumb and forefinger but it should not be saturated.

STEP 3

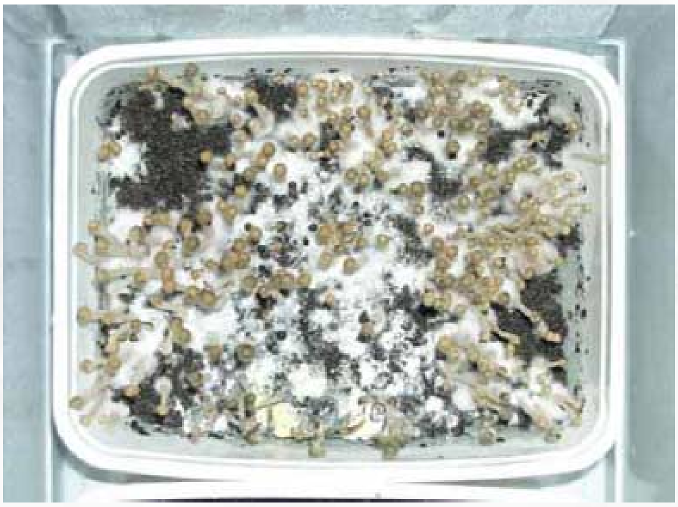
Mycelium should appear on the surface of the casing layer after a few days. If the casing starts to dry it should be sprayed regularly from a height with a fine mist so as not to damage the mycelium. If mycelium does not appear the casing should be completely ruffled up by scraping the surface of the spawn to allow air exchange. In the unlikely event that this fails the casing may need to be thinned. Once mycelium is visible the air should be changed regularly by fanning. Alternatively an aquarium pump tube can be placed inside the box to provide air exchange - place the tube into water to maintain humidity. Mushroom metabolites have a distinctive (not unpleasant) smell. Copelandia primordia (pins) should appear after a week. If the surface becomes completely overlaid with mycelium add more casing.

STEP 4

The stems of copelandia continue growing long after their caps have opened and are tenaciously attached to the casing. Scrape any casing from the bottom of the stems. You will see an instant bluing reaction on the stems after picking. Carefully tip out any liquid from the bottom of the tubs as this will encourage contamination.

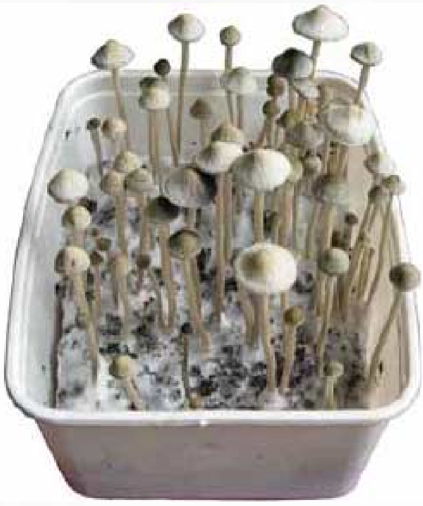


Copelandia cyanescens pins appearing



Six days later

Growing in Humid Box



Mature Specimens

Generally yields are larger in a humid environment. However if the humidity is too high black patches can appear on the caps due to Bacterial Blotch (*Pseudomonas*). Blotch should be wiped off the caps and the humidity reduced by raising or partly removing the lid. Excessive humidity stops the caps opening fully and reduces spore production. Keep the casing moist by spraying when necessary.

Copelandia succumbs to contamination much earlier than cubensis, the spawn and casing turning blue. Growing copelandia is particularly difficult in hot weather when daytime temperatures are much above 20°C. Small patches of contamination and the surrounding area can be sprayed with bleach solution. I have tried replacing contaminated casings in containers and in Kilner jars but they become re-infected because the spawn itself is contaminated.

Fungicides are used by commercial growers. These kill lower fungi while the higher fruiting fungi remain unaffected. Fungicide residues may present health risks so I avoid them. Spraying with pyrethrum is very effective if flies become a problem at fruiting. This natural insecticide is extracted from the pyrethrum daisy and is usually mixed with piperonyl butoxide to make the pyrethrins more effective. These compounds have very low toxicity and are used on edible crops and in medicine.

Airborne spores have been known to cause health problems in the mushroom industry. To reduce exposure the plastic box can be fanned outdoors or the mushrooms picked before the veil breaks. Boiling mushrooms for a few seconds and drinking the cooled water should avoid any allergic reaction - best to repeat to extract everything.

Spore Printing

Select a mature specimen on which the cap has fully opened and remove the stem - copelandia caps develop better when the humidity is reduced by raising or partly removing the lids. Place a strip of white paper on a saucer in the aquarium. Lay the cap onto the paper and cover with a glass, after spraying the inside of the glass with a fine mist. After 24 hours spores should be visible - leave for a couple of days to get a dense print. Remove the glass and cap and allow the print to dry. Once dried it should be folded, placed in a flat re-sealable bag and frozen. Frozen copelandia spore prints remain viable for many years, unlike cubensis, although mycelial cultures will only keep a few months on MDA in a fridge (see DSMZ, Medium 781 for a more elaborate media recipe).

Preserving Mushrooms

The simplest way to preserve mushrooms to dry them thoroughly and then freeze them. I lay them out on a plate in the top of the airing cupboard - psilocybin is destroyed in air at temperatures over 50°C. The mushrooms should be dried hard before being bagged and frozen. Copelandia loses far less potency than cubensis during drying.

Making an Incubator

The traditional home airing cupboard makes an ideal incubator. However they are fast becoming redundant as more efficient combination boilers are being installed which dispense with loft tanks and external boilers. So we can make an incubator by using a plastic box with a flat base and a clear lid, and placing it on a reptile heat mat or a demijohn heater. Inevitably there will be a temperature gradient between the base and top of the box so a spacer is used to prevent the jars touching the hot base and a 12V computer fan is suspended with string - using bolts with spacers looks more professional but is very noisy. The fan is connected to a mains adaptor and can be run at lower voltage to reduce noise further - be careful not to reverse the polarity as these fans have no diode protection. The jars are placed upside down to keep the media dry and a temperature probe is attached with White Tack. Kilner jars are placed on their sides ensuring that the filters are not blocked - the jars are far more susceptible to Wet Spot contamination when placed upright. Up to 27°C is ideal for copelandia agar and grain culture although cased copelandia spawn should not be heated above 21°C as it becomes more susceptible to blue mould - in this case water should be added to the plastic box to maintain high humidity and the fan should be set to its slowest speed to prevent the casing from drying out. Monitor the temperature and use a plug in dimmer or a thermostat, if required. A twin channel thermostat can be used enabling agar and grain to be kept at 27°C in one box while spawn tubs are kept at 21°C in a second box.

Mushrooms and the Law

The UK government has placed all psilocybin containing mushrooms under Class A of the Misuse of Drugs Act from 18 July 2005. Cultivation or sale now carries a maximum sentence of life imprisonment. Sadly our government has little interest in civil liberties and ignores the overwhelming evidence that mushrooms are less harmful for most users than tobacco or excessive drinking. Although no one has been sent to prison yet for mushrooms in the UK, I think it would be prudent to adopt a strategy to minimize our risk exposure. Here's mine:

- Avoid synthetic psychedelics as the risks to the manufacturers and distributors are enormous
- Never sell mushrooms to anyone - encourage them to grow their own
- Only grow and store small quantities
- Be aware that communications can be monitored - use PGP encryption (see PGP Guide) or a Hushmail account for sensitive emails

A Cautionary Note

Psilocybin mushrooms are very powerful. They are probably best avoided if one is not in good spirits as the experience can be overwhelming. They should also be avoided at times of illness as they may suppress the immune system. If you use mushrooms alone and encounter difficulties, an experienced companion can be helpful to sit or take a walk with. If you prefer to wander alone, I would recommend taking a mobile phone, a plastic water bottle and avoiding traffic. Obviously one should never drive or operate machinery whilst under their influence - it is best to avoid driving until the following day as one's own assessment can be deceptive. Be careful not to leave magic mushrooms anywhere where they might be eaten by children and do not use them during pregnancy.

Half a gram of dried copelandia should produce strong effects (dry weight is around 14% of fresh weight). If preferred, a liquid extract can be taken after boiling the mushrooms for a few seconds - best to repeat to extract everything. Taken on an empty stomach the full effects should be reached after an hour and a half and reasonable normality should return after four, although it may not return completely until the following day. Even with higher doses I haven't noticed that the effects last much longer. Taking mushrooms after food tends to cause indigestion and will delay the onset of effects.

In case of adverse effects, have drinking water handy in a plastic cup or bottle. Absolutely no glass. Caffeinated drinks should be avoided as should alcohol, cannabis or any other drugs. Psychotic symptoms can be overwhelming but should improve over time if the person is kept calm, ideally with the minimum of illumination. In this event any future experimentation should be undertaken at a reduced dose.

Resources

Pressure Cooker

Select a model having low and high pressure controls, usually 5 and 15 psi (0.35 and 1.05 kg/cm2), that can hold a pair of litre Kilner jars. I use an old Tower Rapide Chef 4305 which has 7 and 15 psi weights. Any 6 litre Tower model with dual weight settings should do (some only have a 15 psi weight), but check with your jars first for height. Prestige and Tower make larger High Dome aluminium pressure cookers which can be set between 5 and 15 psi by adjusting the heat, but they need watching when sterilising Kilner jars to ensure they don't go over pressure. Argos stores do a good selection. Cooking oil is rubbed around the gasket for lubrication. Large gasketless autoclaves are used commercially (the All-American range is available from Fungi Perfecti). Once sealed autoclaves don't emit steam. The pressure is read off a dial and adjusted by heat.

Spawn Jars

I use traditional preserving jars with filters which are inoculated with agar media. Spawn bags are also available with self healing injection patches for syringes. Buying spore syringes every time is expensive and making your own requires a lot of spore prints. Personally I find jars much easier to work with. (Preserving jars are known as canning jars in the US.) Use a preserving jar with a screw band - see the Kilner jar above. They should be sterilised at 7 psi (0.5 kg/cm2) maximum. At 15 psi they frequently crack. Kilner jars are no longer manufactured although Ball and Leifheit both make screw top preserving jars with the same size mouth. Of course you could use any jar with a metal screw top (PVC caps will deform when sterilised while polypropylene is indestructible). Make a few holes in the lid with a bradawl from the underside so that the burrs don't push against the filter (otherwise too much air would pass through the filter). Autoclave the filter to shrink it, allow to dry and trim with scissors to give a tight fit under the lid. Alternatively a single hole can be made in a metal lid and filled with synthetic filter wool (from aquarium shops).

Spawn Jar Filters

The spawn jars are fitted with autoclavable filters to allow air exchange without micro-organisms entering. I have also grown spawn by removing the rubber sealing rings from glass Kilner lids and tightening the plastic screw band over them to allow some air exchange. (In some American guides the metal sealing disc is inverted and the screw band tightened.) Although the resulting spawn looks healthy the casing becomes contaminated with *Trichoderma* very rapidly. Even if mushrooms are produced the disease free period will be reduced. I wasted a considerable amount of time with this method because the contamination present in the spawn is not visible to the naked eye.

Reusable wide mouth filter discs are available from Fungi Perfecti - they are advertised as 90 mm although the filters are 85 mm in diameter. Initially they are very tight under Kilner screw bands but shrink about 1 mm with use to give a perfect fit. They also fit Ball and Leifheit jars. The filters become stained with use and should be bleached between uses to keep them sterile (this does no harm as they are made from a synthetic material). I soak them in a mild solution in a Kilner jar until clean (use a lid to prevent fumes). The filters should have their surface area restricted to reduce evaporation from the jars. Draw a circle around a 5 pence piece (18 mm diameter) with a pencil and apply gloss paint to the outer area - see above. If the jars are used for slow growing species the filter aperture can be further restricted with tape to prevent the grain drying out prematurely, or the jars can be stored in a humid box.

Panaeolus Cyanescens - Liquid Culture to Fruits

by

Blue Helix

original source: http://www.shroomery.org/forums/showflat.php/Number/4872154

Table of Contents:

- What is all this about?
- How do they grow compared to cubensis?
- The Grow
  - *Stage 1 - The Liquid Culture*
  - *Stage 2 - The Spawn Bags*
  - *Stage 3 - Laying the trays, Casing, and Casing Incubation*
  - *Stage 4 - Fruiting*
- About the Harvest
- So, that's all fine and dandy, but how strong are they?

What is all this about?

This grow log is of my first try at Ausi Pan Cyans. The techniques I used in this grow are identical to my successful Ecuadorian cubensis grow of a few months back.

How do they grow compared to cubensis?

Like cubensis Pan Cyans are not too difficult to grow. I would call them a tiny bit more challenging than cubensis but not very much.

They grow slightly faster than cubensis in liquid culture, taking only 2 or 3 days to achieve a very high mycelium density cloud if continuously stirred and inoculated with a few ml of starter liquid culture whereas cubensis takes about 3 or 4 days.

Once in in grain or manure, they are close to the same speed as cubensis but can't hold the substrate as hard or dig through as well because they lack rhizomorphic features. When trying to colonize lots of grain, you really need to either keep shaking the grain every four days or use sufficient liquid culture so you don't need to shake because the mycelium can slow down, lacking the tenacity of cubensis mycelium. The same probably applies to spawning manure (i.e. use lots of spawn).

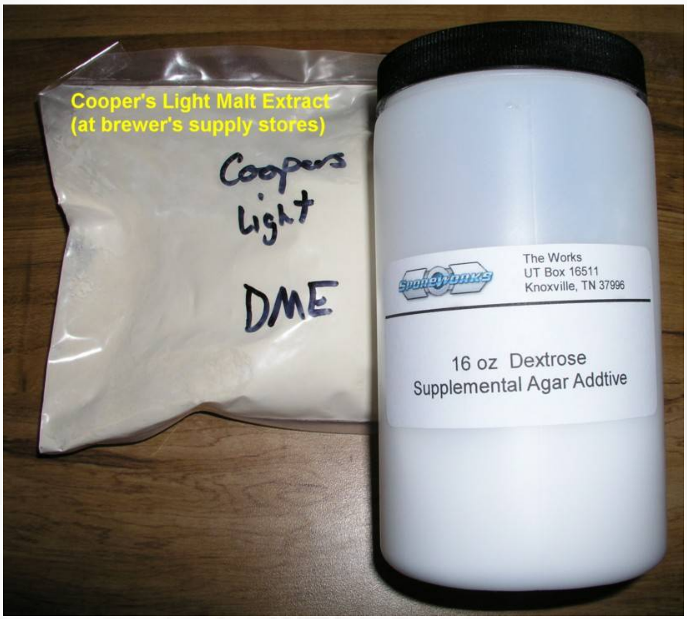
In the fruiting department, they like a between 75 to the low 80s, which is a little warmer than cubensis requires. The pins won't tolerate 100% relative humidity very well like cubensis can. The fruiting bodies are very tiny compared to cubensis, but there are tons of them. The fruits are much easier to dry than cubensis because they are smaller, but still the yield isn't as great. I believe one could achieve about 30% the yield of a perfect cubensis yield under ideal conditions.

In the strength department they make up for some of the yield shortfall. They will knock your socks off so be careful with these! I write a lot more about strength below, and I recommend you read it if you intend to trip on these. Tripping hard on anything can be dangerous, even deadly if you are in the wrong place, so take it easy at first.

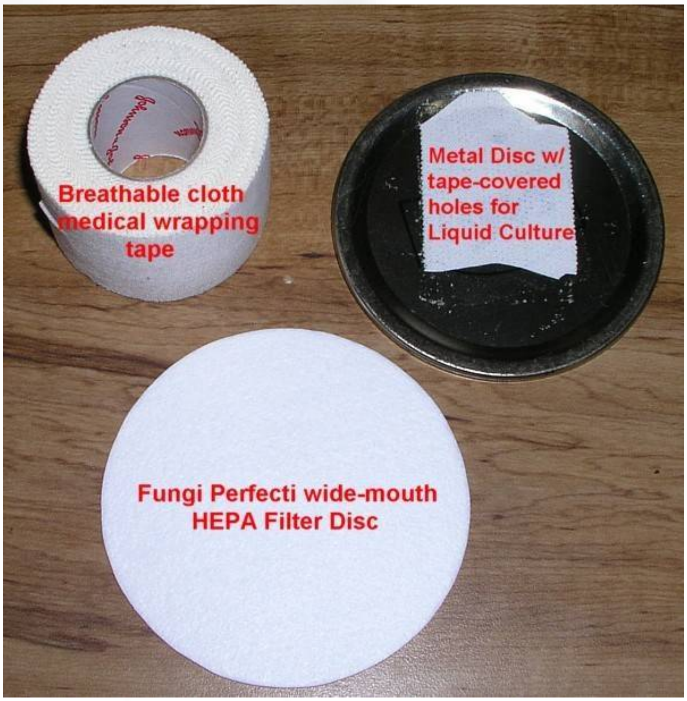
The Grow

Stage 1 - The Liquid Culture

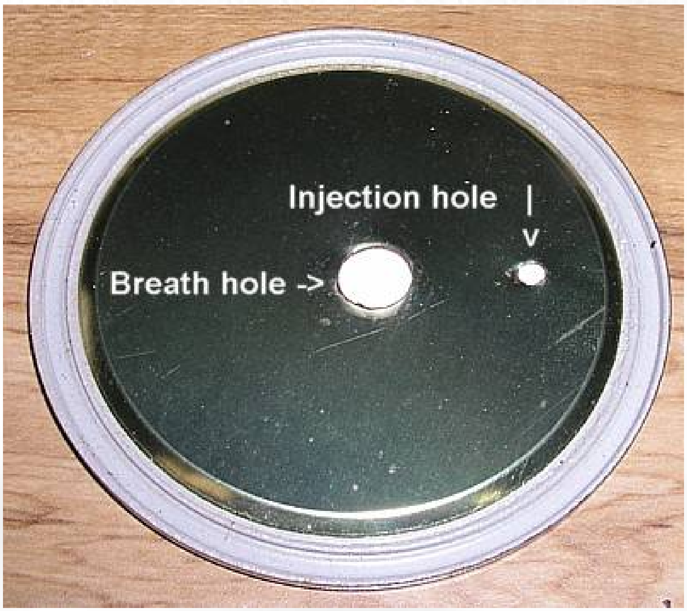
I started with a 4% by weight liquid culture solution. In my case I used 20 grams of sugars for the 500 ml of water. 10 grams of dextrose was added to 10 grams of light malt powder in a few coffee filters, which was then loaded in the coffee machine. I poured about 4 cups of water in the coffee machine, which steamed out about 2 of the cups and drained the other two through the sugars dissolving and filtering the liquid culture solution. The solution was covered with a metal disc lid with holes and cloth medical tape over the holes. Over that was placed a filter disc. I also dropped my Teflon magnetic stir bar in the quart jar and pressure-cooked the whole thing for 25 minutes. After it cooled, I inoculated with very few spores scraped off a spore print, and thus this liquid culture developed slowly given the minute amount of spores used. I have since seen Goliath Pan Cyans develop from 3ccs of liquid starter culture in only 48 hours, making them faster than cubensis. Below is the progression of the culture:


Cooper's Light Malt Extract
(at brewer's supply stores)
Coopers
Light
DME
The Works
UT Box 16511
Knoxville, TN 37996
16 oz Dextrose
Supplemental Agar Addtive

Liquid Culture (LC) Sugars.

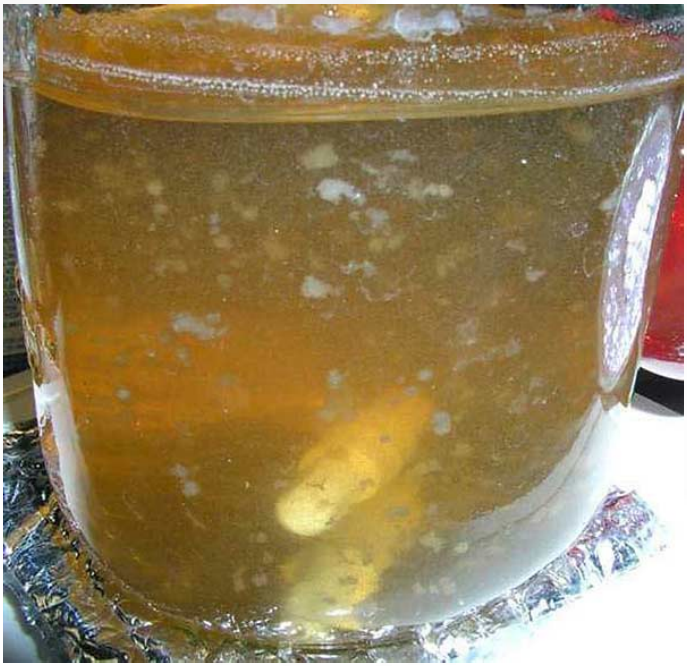

Breathable cloth
medical wrapping
tape
Metal Disc w/
tape-covered
holes for
Liquid Culture
Fungi Perfecti wide-mouth
HEPA Filter Disc

Making LC Lid.

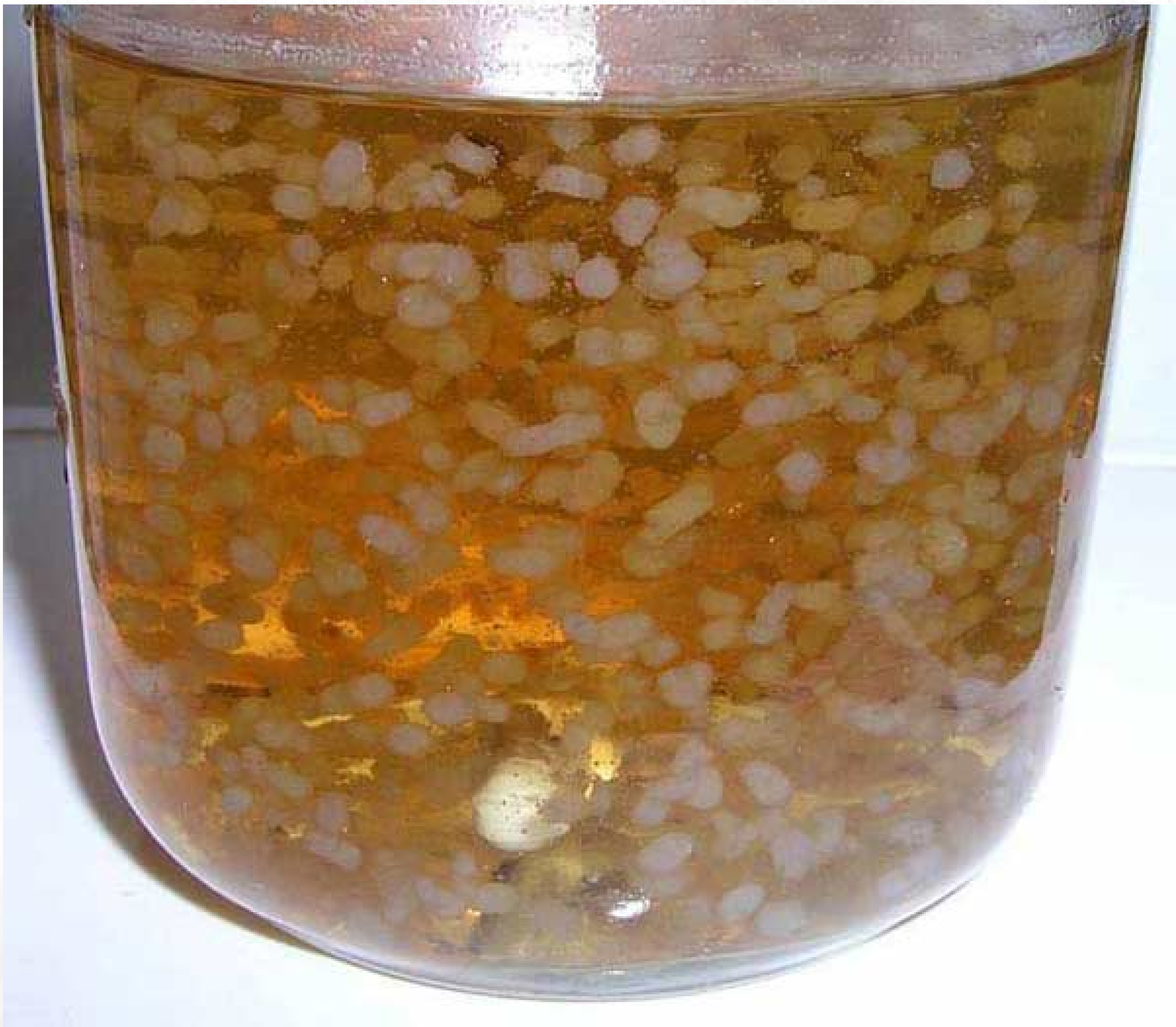


LC Lid Underside.

Liquid Culture - Day 3.



Liquid Culture - Day 5.



Liquid Culture - Day 7 (completion). Starting with a few mls of live culture rather than few spores can shorten this stage to around only 48 hours rather than 7 days.

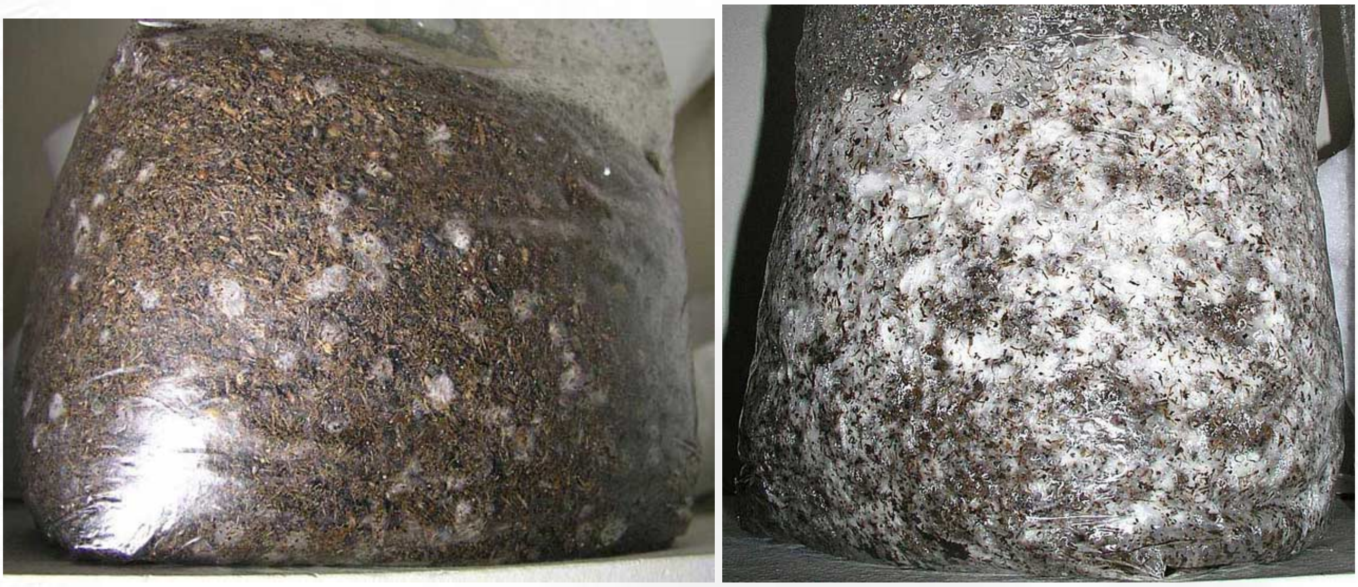
Stage 2 - The Spawn Bags

On the 7th day, the liquid culture was ready for inoculation directly into the fruiting substrate. I use spawn bags to colonize the final fruit out substrate rather than spawn because it's easier and faster. Using a couple or few large spawn bags, one has plenty of room for enough substrate for either small or large bulk grows, so why bother with creating grain spawn? A single large spawn bag holds about one gallon of substrate. In PF terms that about 20 half pins jars of substrate all prepared via a single large liquid culture injection rather than 80 small half pint jar injections.

The fruit out substrate was:

- 6.5 parts Agar's special mushroom compost (via dry weight)
- 2 parts WBS (via dry weight)
- 2 parts rye grass seed (via dry weight)
- 3% Stevia leaf (percentage via volume)
- 0.2% black mustard (percentage via volume)

All was mixed with water to the correct moisture content by feel and then loaded into large spawn bags. The WBS was loaded dry so as to absorb a little moisture during cooking, thus preparing the mix to absorb the liquid culture without getting too wet. I pressure cooked the bags for 4 hours. Once they cooled sufficiently to touch with gloves, I sealed them shut in a dirty bathroom without allowing air in the bag. I then hung the bags up from the top of the plastic in a closet using rubber-footed wood clamps to allow them to cool and draw air in via the filter patch. Once self-inflated and cool, they were removed from the clamps and injected through a tape reinforced area of the bag with 80 ml to 140 ml of liquid culture (I strongly recommend the 140 ml). I immediately sealed the hole with hot glue. Once the hot glue cooled, I kneaded the grains and manure through the plastic to mix in the inoculants and put the bags separated on a shelf to colonize. The bags were remixed one time on the fourth day, but mixing was not needed for the bag that had received the full 140 ml of liquid culture. All bags were well colonized by day 7. Below are pictures of the progression of the bag culture:



Fruiting Substrate Colonizing in Sterile Spawn Bag on Days 2... ...and 7 (completion)

Stage 3 - Laying the trays, Casing, and Casing Incubation

After cutting open the bags, I crumbled up the substrate as required to lay the trays about 2' deep and as evenly as possible. 12-quart dishwash trays are super cheap at Walmart and great for cubensis, but I do NOT recommend 12-quart trays for Pan Cyans. They are far too tall and will encourage air stagnation around the pins. I recommend using a 2' to 4" tall tray of some sort. For example, plant starter trays sold at garden stores would probably work well.

I used the classic 50/50 Tek casing with 10% to 15% coco coir (by volume) added. I laid the casing about 1/3rd inch thick. I do not recommend the addition of coco coir for this mushroom because it will encourage excessive overlay I think which seemed to reduce yields in the Ausi strain. Some folks also don't pH-balance Pan Cyan peat casings. I have no opinion about that as I haven't tried it, but I wouldn't doubt it would work fine. One thing is for certain; do not use hydrated lime for pH-balancing with this mushroom or any other. You are very likely to spike the pH way too high, and while cubensis can take that abuse, this one won't tolerate it. If you can't get pulverized limestone or powder calcium carbonate of some source, just don't use anything.

I put the laid trays in a closet for incubation. I covered the tray with plastic wrap and put a piece of 2" wide masking tape across the center length of the tray over the plastic. With a razor, I cut a slit the entire length of the tape and pulled it apart about 1/4th inch and covered with cloth medical tape. This is to allow some but not excessive gas exchange.

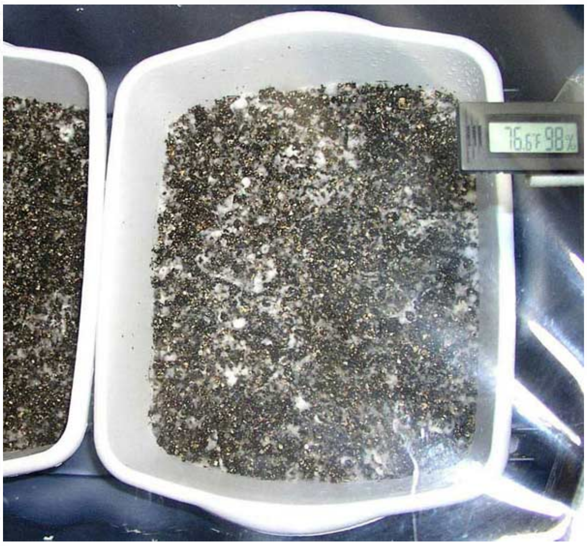
For cubensis with an inch casing, casing incubation is pretty much required, but Pan Cyans can rip through the casing in 24 hours because the casing is so thin. As a result, one can probably skip casing incubation all together with Pan Cyans, but it won't hurt anything. Below is a picture of the tray in the incubation closet. Notice the tray is raised off the shelf to help keep it from overheating. I raised the tray out of habit because with cubensis overheating can be a serious problem, but with Pan Cyans one probably doesn't need to worry about it as the substrate depth is only 2".

24-Hour Casing Incubation.

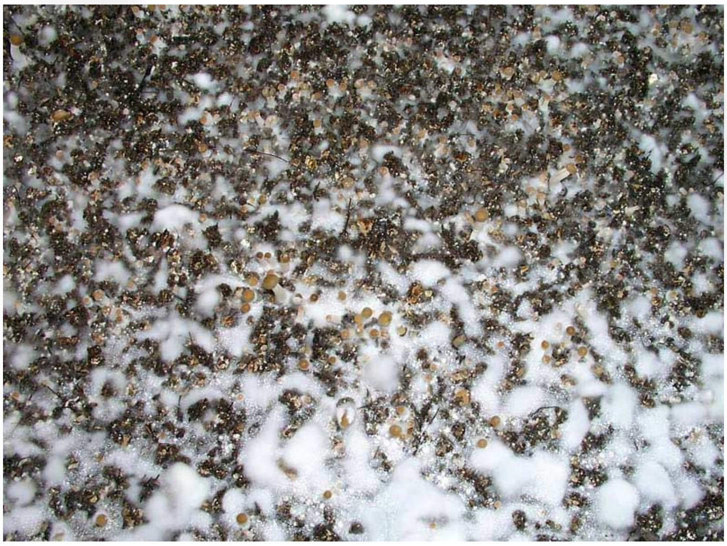
Stage 4 - Fruiting

I incubated the casing for 24 hours and we're off to fruit. At this point, I was only 2 weeks from the ***spore*** injection to the liquid culture, and already I was putting the tray in the fruiting chamber! Now try to beat that! Like I said Pan Cyans are faster than cubensis. Pan Cyans can fruit in the same environment as cubensis with some minor tweaks.

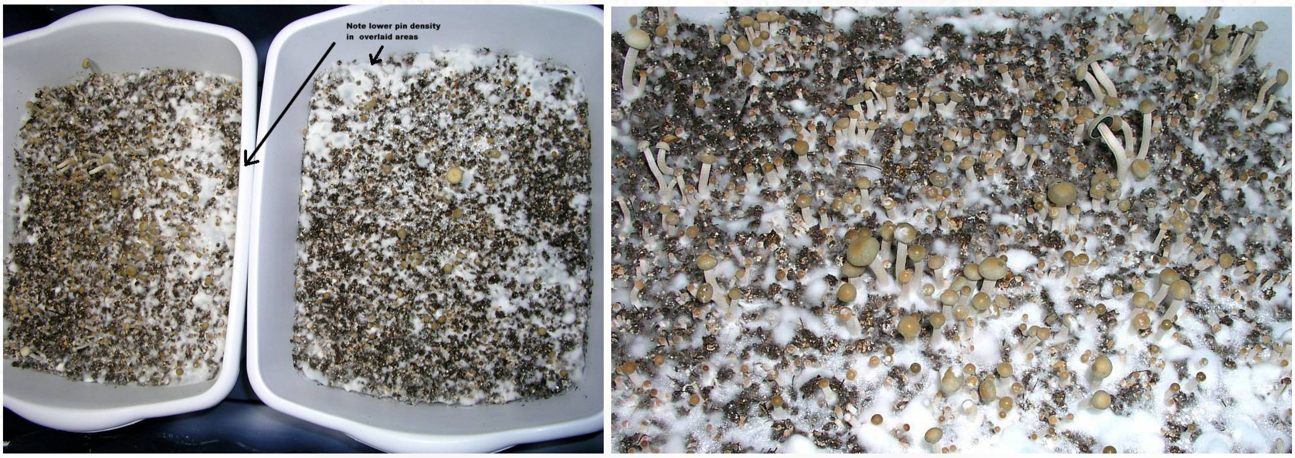
First, you can mist up to the pin formation, but you really must stop watering once the pins start to form. These pins abort easily and misting them will abort them. Once the pins are well set, one should try to reduce the humidity in the chamber to 85% to 95%. Don't allow it to stay up around 100% or else the pins won't mature as they should. Cubensis doesn't seem to mind near 100% humidity all the time--although you risk forming mold in your casing--but these don't like it and you also strongly risk forming mold in the casing. Just crack the lid a little open if you don't have any other way. Fresh air requirements are technically not more than cubensis but they tend to get super tall in high CO2 environments and less stocky. It all depends on what you want. Lastly, keep the chamber a little warmer than cubensis. I recommend 75F to 82F. Below is my fruiting chamber progression.



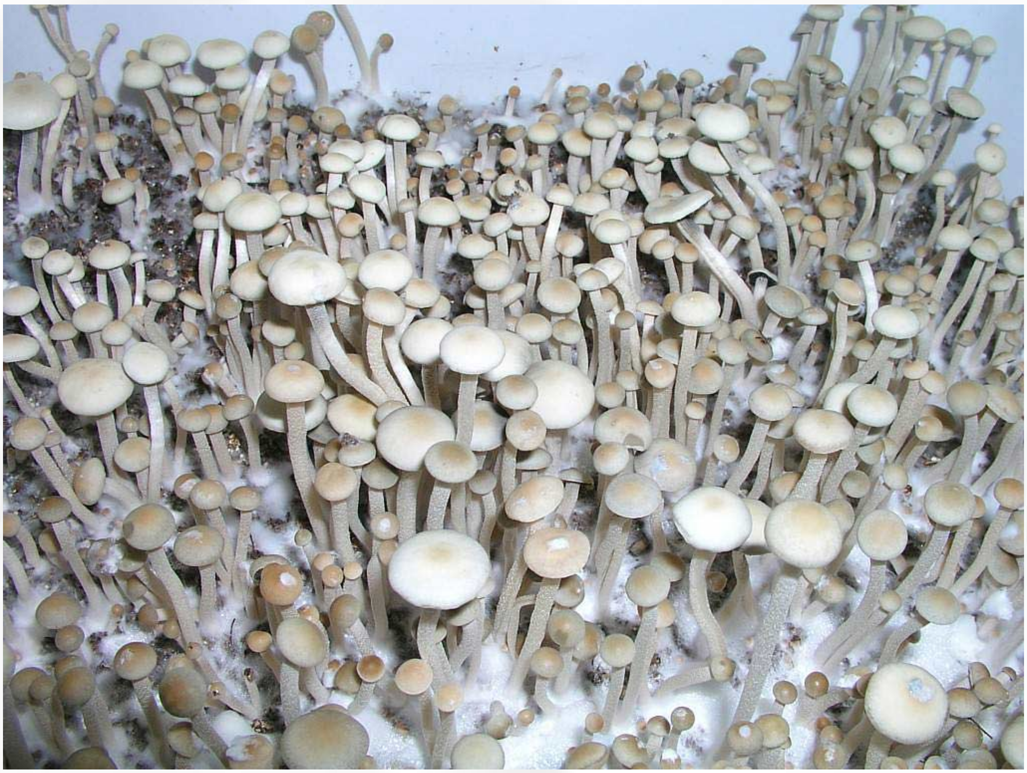
Day 3 in Fruiting Chamber.



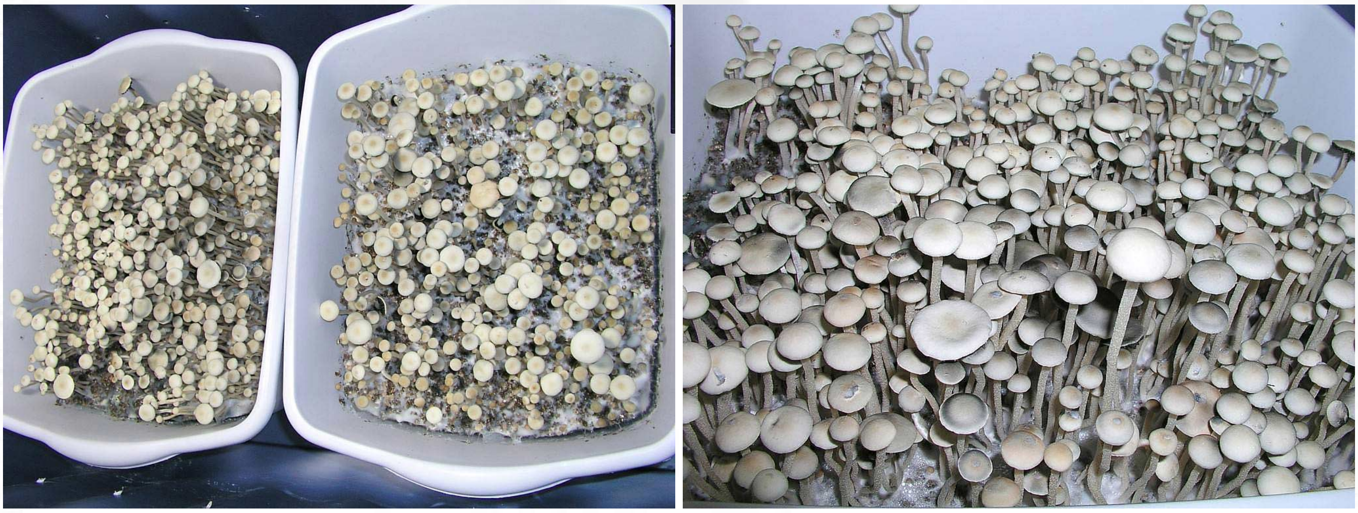
Day 8 in Fruiting Chamber.


Note lower pin density
in overlaid areas

Day 9 in Fruiting Chamber. (arrows: Note lower pin density in overlaid areas.)



Day 10 in Fruiting Chamber.



Day 11 in Fruiting Chamber and the Harvest Day!

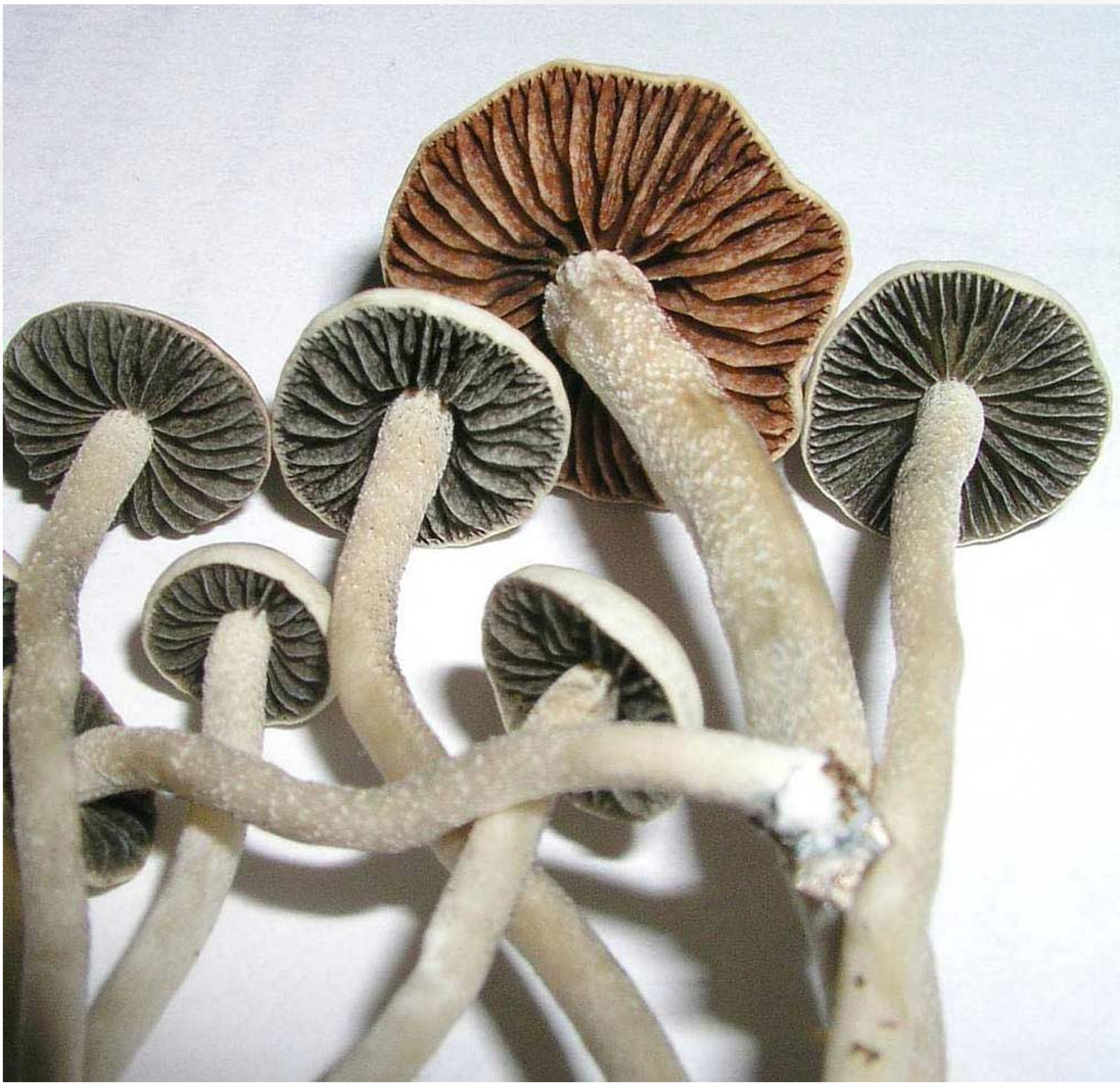
About the Harvest

I pulled that harvest on day 25 since the first spore was injected in the live culture. If I had used a few ml of a live culture to inoculate the live culture, I could have probably pulled the first flush off in 3 weeks! Now that is fast!

Although the pictures show the best trays, the trays did pretty well overall for a first timer. I estimate I harvested about 40% of a perfect first flush potential due to green mold which limited the yield. In fact I lost all of the trays after the first flush to green mold. It was all my fault too because I left town during the time the trays were in the fruiting chamber (that's why days 4 to 7 have no pictures) and the humidity and misting was way too high. The green mold formed on the soggy bottoms of the trays and extended up into the casing. Just don't over mist your trays! The fruits dried to exactly 10% their wet weight.

One thing that delighted me was the variation of this mushroom within the flush. Unlike cubensis, Pan Cyans show tremendous variation within a flush if one uses a multi-spore culture like I did. Some of the fruits were super tall, over 6 inches tall, and others were short (2 inches tall). Some had large caps (size of a quarter) and most had tiny caps (size of a nickel). The only thing that was consistent is that all the fruits were very small compared to cubensis. Indeed a single large third-flush cubensis can yield as much mass as half an entire tray of these!

One thing that really was a treat was the fact that about 1% or 2% of the caps had a light brown spore color while the others were grey. Here are some pictures of that fantastic phenomenon:



WOW! Isn't that beautiful?!?

So, that's all fine and dandy, but how strong are they?

Growing these over regular cubensis provides the grower a way to expand his or her cultivation skills to a new mushroom, but what about potency? Well, I have some firsthand experience to tell you, but first, let me preface this by saying that I am a seasoned cubensis tripper. I had my share of bad trips over the years. I know what it?s like to see both heaven and hell on shrooms, and hell always seems to come more often on stronger doses. I typically take about 3 grams on a cubensis trip, and I grow them strong on manure.

With these I decided to follow the dosage calculator here and take 10 fresh grams (would dry to 1 gram but is as strong as 1.35 grams dried). I was shooting for a level 3 experience. What I got was closer to a level 5 with total destruction of my ego.

I went from starting to see geometric patterns on the ground to tripping so hard that I couldn't even figure out how to put my Ipod's ear buds in my ears in less than 20 minutes! These shot off like a bomb in my brain way faster than anything I've taken, even cubensis tea doesn't hit that fast. I was so screwed up and it happened so fast that I had a massively terrible trip. I didn't know what the hell was going on. I won't go into details here, but let's just say I was heavily delusional in a negative sense and had trouble staying on my feet and not fainting. I am not a religious person, but basically I turned into a crazed religious schizophrenic for about 7 hours straight. The ordeal wore out my sitter--thank God I had one--big time. **I would equate those 10 wet grams to about 4 to 5 dried grams of extremely strong cubensis.**

I do not recommend taking over 1 dried gram until you know what you are dealing with. If you take them wet, you'd better start with no more than about 7 wet grams your first try. Now, I am serious here: these are not light weight mushrooms like cubensis! Like I said, **the batch I grew was at least 4 to 5 times as strong as any cubensis I have ever grown**, and I've grow lots of types on all sorts of stuff. Just be careful with them!

Spawn, Spawning and Spawn Growth

by

David M. Beyer & Vija L. Wilkinson

Mushroom Science & Technology Department of Plant Pathology

original source: http://extension.psu.edu/plants/vegetable-fruit/mushrooms/fact-sheets/general-information

Table of Contents:

History
Culture Maintenance
Cryogenic Storage
Obtaining A Culture
  Tissue Cultures
  Spore Cultures
  Culture Validation Cropping Trials
Sub Culturing (agar to agar transfer)
Spawn Production
  Spawning
  How Much Spawn?
  Spawn Growth
Substrate and Spawn Growth Management after Spawning
Measuring and Controlling Temperatures during Spawn Growth
Summary

The purpose of this fact sheet is to provide basic information on the process of seeding substrate and the management of the vegetative stage of growing the commercial mushroom, *Agaricus bisporus*. The process before this stage, substrate preparation and the processes after, casing and production, are discussed in other publications.

A mushroom is the fruiting structure of the fungus and consists of a cap and stem. The mycelium is the fine "root" system that grows in the composted substrate adsorbing nutrients and water. After fruiting is initiated and the mushroom matures, the cap opens and gills are exposed. These gills produce spores in huge quantities; for example, a three-inch mushroom produces 40 million spores per hour. In nature, spores germinate and grow very poorly; therefore, another method to seed the mushroom substrate is required. The mushroom mycelium (threadlike filaments that become interwoven) is propagated on a base of steam sterilized cereal grain (usually rye or millet). This cereal grain/mycelium mixture is called spawn. Most spawn is made with mycelium from a stored culture, rather than mycelium whose parent was a spore. This is because each spore is likely to yield a new strain and its performance would be unpredictable. Preparing spawn is highly technical task that is not practical for most mushroom growers to perform; therefore, it is mostly produced by specialized companies that supply growers with pure culture spawn. However, in some cases, it may be necessary for the growers to produce their own spawn. In such cases, access to cultures (cultivars) with proven productivity is a key component of a successful enterprise.

History

Spawn, spawning and spawn growth begin with a little fascinating history. Until the 20th century, mushroom growers used mill-track spawn to seed their substrate. Mill-track spawn was obtained from under the horses driven around a pole to provide power to the flour mills. Spawn from this source had uncertain varietal characteristics and was not free from pest and other competitors. Later "Flake Spawn" was developed. Flake spawn was the mushroom tissue or mycelium transferred to special substrate manure piles. When the spawn had thoroughly grown through this "Manure Spawn" was broken up and spread onto substrate in the house. England was the first to develop this "Manure Spawn" and when the Lambert brothers immigrated from Belgium to Minnesota, they brought the process to America. One brother, L. F. Lambert moved to Chester County Pennsylvania and began producing flat bricks of moist horse and cow manure that were stacked together with bits of mushroom mycelium.

Manure spawn was used worldwide until the 1930's, when a scientific breakthrough occurred in France and later in the United States. Researchers learned how to germinate spores on sterilized media. This procedure, which we all take for granted, allowed pure cultures to be maintained and then eventually used to make "Pure Culture" manure spawn. This spawn was usually made in a bottle that was stoppered with wool plug. The grower had to break the bottle to remove spawn for use. A practice that was probably fun for the kids, but messy and probably unsafe.

The next step in spawn history was "Tobacco Spawn", shredded dry stems of tobacco from Lancaster County, Pennsylvania. Tobacco spawn was more consistent than manure spawn, however the process of using reusable, screw top bottles was labor intensive and tedious. Tobacco spawn was used for about 10 years.

In 1930, Dr. James Sinden was assigned to the mushroom research project at Penn State. He needed a more consistent method of inoculating substrate for his research. He developed a method using sterilized grain inoculated with pure cultures of the mushroom mycelium. At first spawn, makers resisted its adoption, but by WWII grain spawn prevailed in the US. After 1950, it was introduced into Europe along with the process of thorough mixing of spawn into substrate, which was developed by Ms. Hauser and Dr. Sinden. Until 1926, cream-colored mushrooms were the only strains grown commercially. It was Chester County grower, named Downing that found a cluster of white mushrooms and realized its significance. He called L. F. Lambert from whom he had bought the spawn, who then made spawn from tissue cultures that grew only white mushrooms, hence the birth of the white strains.

Culture Maintenance

Maintenance of pure mycelial cultures is a necessity fo ultimate spawn preparation and spawn production. Once a culture is obtained, it is advisable to take note of the appearance of the mycelium, to observe the normal growth patterns of the specific lines. These observations are important to do, so that one will be aware of even the subtlest change that may lead to deleterious effects.

A desirable mycelial culture is one that is pure, free of contaminants and of sectoring of other abnormalities. Contaminants include other fungi, bacteria, or insects growing on or infesting the culture media along with the desired mycelial culture. When a culture is first obtained, by whatever means, it should be transferred several times to fresh media, to observe for any from of contamination.

Sectoring is any type of mycelial growth that differs in appearance, growth rate, color, or otherwise from the typical appearance of a given strain. Sectoring is often observed as a more rapidly growing area near the leading edge of growth, exhibiting a different growth habit from the rest of the culture. Other abnormalities that might appear in a culture are fluffy, aerial mycelium, thick or rubbery textures, of color changes such as browning or darkening of the mycelium. Sectors of other change in vegetative growth could affect the productivity of the culture. Therefore, it is very important to recognize and avoid propagation of abnormal mycelium to agar and further spawn production.

Cryogenic Storage

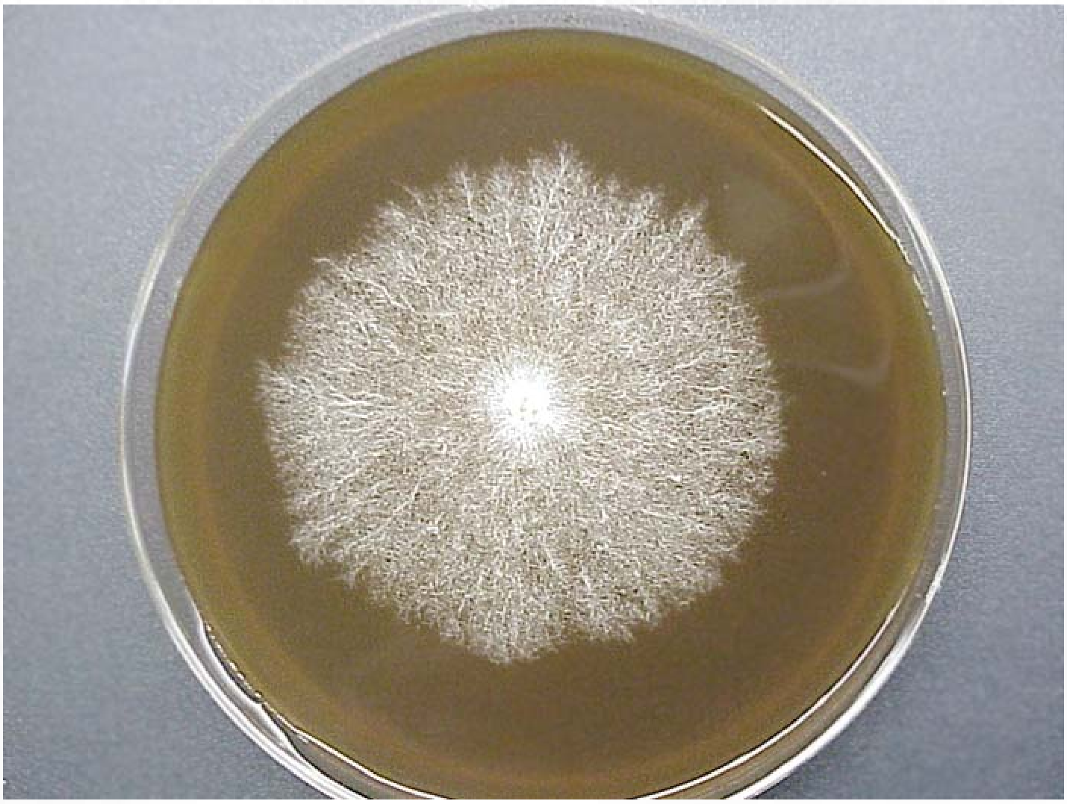
Storage of cultures in liquid nitrogen (LN2) is superior but expensive. It is the best long term culture storage method because mycelial growth is completely suspended at -196C. This method maintains a very stable mother culture for many years. Only the highest quality mycelial cultures are selected for long term storage - a culture's qualities will not improve with storage. Unfortunately it is also the most expensive. Initial equipment costs are high and liquid nitrogen is a continual monthly expense. The liquid nitrogen storage unit requires constant monitoring of the liquid nitrogen level in the chamber. The basic method is to fill a cryotube (special plastic tube designed for use in LN2) with a cryoprotectant and then to submerge a few mycelial plugs or spawn grains into the liquid. Then the filled cryotube is placed in a divided box or cane, then into rack and finally housed in the cryostorage unit. The purpose of the cryoprotectant it to protect the mushroom cells from damage during the freezing and thawing cycles.

Obtaining A Culture

Methods of obtaining a culture are: tissue culture, spore germination, or purchase of culture from a culture collection.

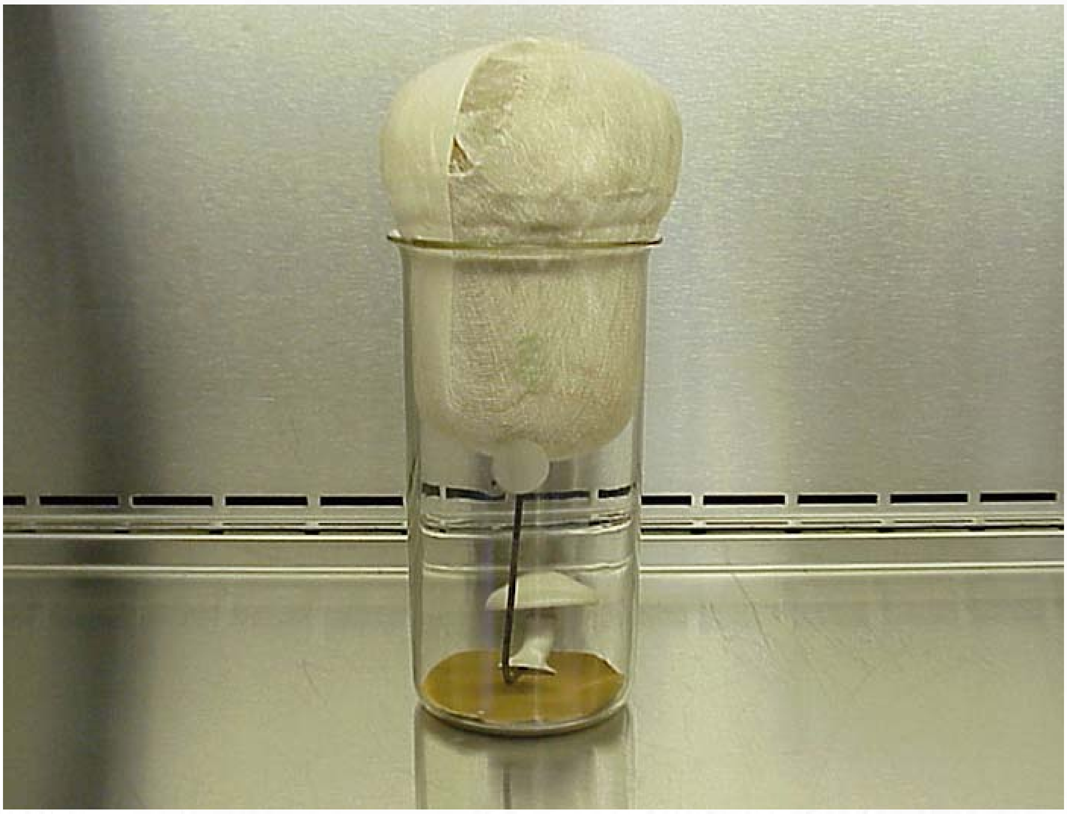
Tissue Cultures

Tissue cultures are the simplest way to obtain a mycelial culture. A tissue culture is essentially a clone of a mushroom. Clone is defined as an identical duplicate of an organism. The basic procedure is to sterilely remove a piece of the mushroom cap or stem, and place it on an agar plate. After a week to ten days, mycelium grows from the tissue and colonizes the agar. Great care should be taken to select a fruiting body of the highest quality, size, color, shape or any highly desired characteristic.



Spore Cultures

Mushroom spores are found on basidia lining the gills of the cap. To collect the spore, the cap is hung over sterile filter paper in a spore collecting chamber. Spore cultures differ genetically from tissue cultures. Cultures originating from spore germination are unpredictable. Spores germinate creating many different genetic combinations that are desirable when attempting to develop new strains, but undesirable when trying to maintain a specific strain. There is no way to predict if a culture's fruiting potential is similar to its parent other that to test many different lines obtained from spore germinations. Hundreds many be tested before obtaining a culture with good production potential.



Culture Validation Cropping Trials

There is no in-vitro test to determine a stock culture's validity. A series of cropping trials must be conducted on the mycelial stock culture to determine a culture line's value. Mushroom yield, size, color, cap shape and any other desired quality or growth factors are selected and then compared for each culture line.

Sub Culturing (agar to agar transfer)

Once a culture is obtained by whatever means, it needs to be maintained to preserve its viability. Agar to agar transfer (sub culturing) it the most popular culture maintenance method. Vegetative propagation of a mushroom culture is uncomplicated, but labor intensive. A small amount of mycelium from a mother culture is used to innoculate multiple fresh agar slants (these become the daughter cultures). The daughter cultures, after incubation at room temperature ~74F for 2 weeks. Are visibly screened for traits expressed in the mother culture. Then, one elected culture becomes the "new" mother culture. The new mother culture is stored in a refrigerator incubator at ~5C. After two months this culture is taken from refrigerator incubation and further transferred to freshly prepared agar slants repeating the cycle.

Spawn Production

The process of making spawn remains much the same as what Dr. Sinden first developed. The grain is mixed with a little calcium carbonate, then cooked, sterilized and the cooled. Small pieces of pure culture mycelium are placed in small batches of the grain. Once the small batch is fully colonized, it is used to further inoculate several larger batches of grain. This multiplying of the inoculated grain continues until the commercial size containers, usually a plastic bag with a breathable filter patch, are inoculated. During the colonization of each batch the containers are shaken every few days to further distribute the mycelium around. Temperatures are maintained where the mycelium is growing in a range of 75-76F . Uniformity of the air circulating around the bags is important to insure that all containers are keep at the desired temperature range. The mycelium is sensitive and its fruiting mechanism can be easily damaged at high temperatures.

Spawning

Before the spawning operation, attempts may be made to improve the substrate moisture. Sometimes water is applied or an pesticide application may be made. Farms with a historical problem of mummy disease may avoid water applications at spawning, because the free water improves conditions for the bacteria to reproduce and spread, thereby increasing the incidence of this disease. On bed farms spawn and supplement is broadcast over the surface of the substrate. Uniformity of the distribution is critical to achieve an even distribution and more even spawn growth and temperatures. On tray or bulk farms, spawn is usually metered into the substrate during the mixing operation. Some growers will bring the spawn brought to room temperature before mixing it into the substrate. Gypsum (1-2% of substrate dry wt.) can be added if substrate that is wet, little greasy and/or not completely conditioned.

Historically, three methods of spawning have been used. However, on most commercial farms the "Through Mixing" method prevails. "Broadcast" and "Ruffling In" spawning were the other two methods. Broadcast spawning consisted of covering the substrate surface with spawn. Whereas "Ruffling In" included the scratching the spawn into the top few inches of substrate.

"Through Mixing" spawning has many advantages over the other methods. Research has shown there are increases in yield. Because the mycelium does not have to grow far to colonize substrate, it reduces spawn-growing time, which is important because spawned substrate is exposed to various types of infection. Another advantage is that spawn grains act as supplemental nutrients for the mushroom mycelium. With through mixing spawning it is important that substrate must be cooled throughout the bed before spawning.

Spawning is the cleanest operation performed on a mushroom farm. All equipment, baskets, tools, etc. should be thoroughly cleaned and disinfected before spawning. Normally it is the first operation of the day when personnel have not been into any of the older houses. After spawning, the beds should be covered with plastic to protect the freshly spawned substrate from air borne contaminants and pest. Unfortunately, for any contaminants present before covering, the moist environment provides ideal conditions for germination and growth. Plastic sheeting is sometimes used to cover the substrate to help maintain substrate moisture.

How Much Spawn?

The amount of spawn used depends on the crop cycle and cost. The spawning rate can be expressed as a unit or quart per so many square feet of bed surface; 1 unit (~ 1 lb or 1 liter) per 6-8 ft. is considered a standard rate on a commercial farm. The rate is sometimes expressed based on spawn weight versus substrate weight; therefore, 2-3 percent spawning rate is equivalent rate. A low spawning rate is about 1 unit for every 12-15 sq. ft. (1-2% Dry Weight), whereas a high rate about 1 unit for every 4-5 sq. ft (>3% of Compost Dry Weight). The more spawn used the better, since it is a cheap supplement, increasing overall production; and the more initial growing points will provide a quicker and more efficient use of substrate nutrients. Both of these factors will improve the colonization of substrate, which also helps insure the mushroom will grow quicker than other fungal competitors. Furthermore, as the spawn rate is increased, more heat is generated and the heat surge occurs earlier during spawn growing period.

Spawn Growth

During the colonization of the substrate by the spawn (spawn run) is a good time to evaluate the crop and substrate. Spawn growth and the presence or absence of other molds helps to indicate how the substrate preparation process has been carried out. Problems with substrate formulation or process and Phase II composting or conditioning may first develop during the spawn-growing period. Weed and indicators molds may tell the grower how the composting process went and what nutrient was lacking or in excess. These molds may grow on compounds that have not been used by the microbes during the Phase II will often suggest a problem occurred.

Although the type of spawn growth depends on many factors, often it may user posted image indicate the nutritional and moisture level of the substrate. The spawn strain itself will vary in their inherent capacity for rapid or slow growth. This variation is a genetic characteristic; therefore, growers should be familiar with the characteristics of the different strains and the suppliers of spawn are a good source of this information. The other obvious important factor that determines the type of spawn growth is the substrate. Substrate element analysis is important but does not always correlate with growth or yield but should be monitored to determine trends in substrate preparation. The lab analysis should be used as guidelines and establishing trends from crop to crop. There is a direct correlation between substrate ammonia content and subsequent growth and yield of mushrooms. Substrate should have less that 0.05% ammonia, dry weight, at spawning time. By smelling, most growers can detect 0.1% ammonia levels, which will restrict spawn growth. Ammonia content above 0.2% will kill spawn. The substrate pH has little to no correlation to spawn growth or yield. Spawn can tolerate a pH in the range of 6.5 to 8.2 and normally it will decreases from 7.5 to 6.0 during cropping. When the substrate nitrogen content is analyzed at this time, it should be in a range of 2.0 - 2.5% on a dry weight basis. A positive correlation of substrate nitrogen and yield has been shown. The greater the nitrogen content, with no ammonia, the better the yield. Nitrogen content has no correlation with spawn growth, since rapid spawn growth has been observed in both high and low nitrogen composts. However, generally a high nitrogen substrate has a slower spawn growth, but fills out and becomes denser. The lipid (fats/oils) content of the substrate will influence both the rate and quantity of spawn growth. More nutritional substrate will support slower and finer texture spawn growth. It is suspected that the thinner strands of spawn are slowly adsorbing nutrients. In less nutritional substrate, spawn growth is more rapid and white with more rhizomorphs, suggesting the spawn is seeking nutrients.

Ideal substrate moisture at spawning varies according to the type of substrate. With horse manure substrate, moisture of 65-72% is normal. With synthetic composts a moisture range of 65-75% is normal. However, there are exceptions to these ranges where spawn growth and yield are better outside these ranges. Mushroom size and quality is affected directly by dry substrate, where dry substrate will produce smaller, off-color mushrooms.

Ventilation and environmental requirements for substrate are not well understood. It is assumed that little oxygen is required within the substrate. Carbon dioxide levels are kept high within the room or at least under the plastic that is used to cover the substrate after spawning. It is known that there is an increased spawn growth rate with increasing CO2 levels to 10,000 ppm. The desired relative humidity is 95% or more in order to preserve substrate moisture. Relative humidity within the room can be maintained by watering the walls and floors. Some high-pressure misting systems have been developed, but they are expensive to purchase and maintain. Steam can also be used to maintain humidity, however it is a source of heat and would increase energy cost and put more demands on the air conditioning system.

During the spawn-growing period, little outside ventilation is used, unless outside air is used as a supplemental source of cooling. During the warmer months outside air is not used, and the room air is re-circulated through the air conditioning units to be cooled. The higher humidity of the outside air requires more cooling capacity.

Substrate and Spawn Growth Management after Spawning

Substrate may lose about 5 F during spawning. During the summer, substrate may be warmer before spawn and therefore it is important to bring substrate temperature down to optimum temperature within 12-18 hrs after the spawning operation is completed. The mycelium within grain is slightly insulated; and this mycelium can survive in 90 F plus temperatures for a short time. However, with unfinished substrate it is usually better to be cooler than warmer when spawning, insuring the substrate temperature is brought down below the temperature range for mesophilic mold growth (> 85 F). The optimum spawn growth temperature is 75-76 F, however there is some indication that growth is faster at 73-75 F. Growers normally run substrate bed temperatures in the high 70's but most try not to exceed 80 F. At that temperature or higher the spawn growth becomes restricted and permanent damage to fruiting mechanism may occur. Spawn is killed at about 104 F.

Spawn growing temperatures should be maintained at a steady level. It is important to anticipate heat surges in substrate temperatures. Heat surges may occur early if the substrate is not conditioned properly. Spawn heat surges later in the growing period are a result of the spawn growth and dependent on the spawn and supplement type and rate. The initial first few days substrate activity should be minimal, unless substrate is unfinished and mesophilic microbes become active of the left over food. As tips of the spawn begin to contact each other and then fuse together (anastomose) more metabolic activity occurs. As the metabolic activity increases, more CO2, water vapor, other gases, and heat are produced. Gradually substrate temperature output will increase 6-9 days after spawning. Growers anticipate a heat surge at this time and will lower air temperatures before this heating occurs.

The removal of metabolic heat from the substrate involves conduction and other methods of heat transfer. Conduction is heat transfer by contact, like a touching a spoon in hot soup; eventually one feels the heat of the soup through the spoon. Metabolic heat is moves from one solid particle to another or water molecule to another. Therefore, tightly packed substrate with good moisture will help remove the heat from the substrate. Dense beds, less air spaces, its is easier for heat to be transfer to the surface and then removed. Loose, fluffy substrate is a harder to control more air spaces where heat transfer is slower. When the heat reaches the surface of the substrate heat it is removed by evaporative cooling and convection, heat transfer by circulation of currents from one region to another. Cooler air moving across the surface of the substrate removes the heat from the substrate. Evaporative cooling is the removal of heat when liquid phase turns to gas phase and occurs when dry air moves across the surface substrate moisture is lost and heat removed with it. Too much evaporative cooling is not good, since substrate will tend to dry out too much.

Measuring and Controlling Temperatures during Spawn Growth

The methods used to monitor and control temperatures vary at each farm. The quantity of thermometers used for a room may vary. One may use glass, dial thermometers, or use remote sensing thermocouples with computer control. At least two thermometers are usually placed into the substrate in most mushroom houses, and these are left in the same location throughout the entire spawn-running period.

Several factors should be considered when determining how to and how often one should monitor substrate temperatures. The cooling and volume capacity of the air handling units, substrate nutrition and dry weight are several factors that will determine how easily the spawn temperatures can be controlled during its most active period. At the beginning of spawn growth, when the substrate temperature is uniform, thermometers are usually left in the same location. One should monitor substrate temperature twice a day and during the accelerated spawn-growing period, more often is advisable.

These stationary thermometers are used to represent the range of temperatures encountered in all areas of a room. Probing of the substrate temperatures should be done to insure that the stationary thermometers represent that area of the substrate or room and provide another tool to monitor and control the crop temperatures. Most growers invest time every few days, if not daily, to probe all areas within each house, both upstairs and down, to monitor differences and changes in temperatures. Hand-held rapid response thermometers are inserted into as many spots of compost as possible to monitor temperatures. This probing determines the range of temperature within the substrate and areas of the room. However, it is important to have personnel available to spend the time probing the room. Probing can be done by any trained and culturally clean individual, not necessarily a grower. More uniformity in the substrate's moisture, nutrition and dry weight will reduce the need for extensive comprehensive probing. When the grower has enough experience about how the crop will react and can anticipate when and how much of a heat surge may occur, less probing may be required. After spawning, before the spawn heat surge, during heat surge and before casing are the most critical times to probe.

Probing and or stationary thermometer temperatures are usually averaged into a mean temperature for the room. This average substrate temperature is used to make decisions for raising or lowering the air temperature. Decisions on whether to lower the air temperature or to raise it should be based on both the average substrate temperature and the frequency or distribution of higher temperatures. If the majority of spots are a bit warm then air temperature should be lowered a degree or two. Conversely, if the majority of areas are a bit cool 68 - 72 F, either the air temperature or the volume of air should be decreased since both of these factors can affect the substrate temperature.

The varying air volume during spawn growing to control substrate temperature may be a new consideration for some mushroom growers. The use of air temperature to control substrate temperature is normally how substrate temperatures are controlled. By lowering the air temperature, the substrate temperature is decreased. It may also be obvious that the more air moved through a house, the greater the amount of heat removed from the air in the house and, indirectly, the substrate. If the air is dry, substrate moisture will evaporate and evaporation is a form of cooling. The greater air volume moving through a house and the drier that air, the greater the cooling effect on the substrate.

Substrate temperature control is also dependent of the cooling capacity of the air handling system. Most single-zone bed farms design their air conditioning systems on the requirements during spawn run. Tons of cooling that is required to maintain temperatures range from 2 to 5 tons per 1,000 sq. ft. of growing space. Cooling capacity is also dependent on the location of the farm and weather conditions. Cooling for spawn growth also depends on the air volume, movement and distribution within the room. Substrate density also determines to amount of cooling required, the more substrate dry weight the more cooling that is needed. The condition of the substrate will affect the amount of heating that occurs the first few days of spawn growth. When substrate is not conditioned well, other microbes have food to use and will tend to grow and produce a heat surge early is the spawn growing period. Substrate moisture also affects the temperature control during spawn run. The drier substrate the harder it is for the heat to be removed and substrate will tend to heat more rapidly and for longer time. While wetter substrate has less air in the pore spaces, and heat is conducted more easily, making substrate temperatures easier to control. When hot spots are found the plastic covering the bed should be removed. In addition, additional fans may be directed on the hot spots or one may dig a hole in the substrate and allow the heat to escape.

The spawn-growing period is normally 10-18 days. Longer spawn run times can reduce yield and substrate moisture, thus influencing fresh quality. A short growing time will create more heat production during the time after casing. This additional heat will require more cooling and increase the drying of the casing. The cooler air temperatures will slow the spawn growth into the casing, delaying the flush and first harvest. Spawn growing period is considered complete when the spawn has completely colonized the substrate and the metabolic heat surge is subsiding.

Summary

Important points to remember about spawning include the complete and thorough mixing of spawn into substrate. Spawn is a cheap nutrient supplement, therefore if economical; a high spawning rate is desirable. Spawning should be the cleanest operation the farm, often performed early in the workday. During the spawn run, it is a good time to evaluate the crop and substrate. Spawn growth and the presence or absence of other molds helps to indicate how the composting process has been performed. It is important to anticipate temperatures by monitoring temperatures often and by probing establishing crop variation and trends.

Spore printing pictorial

by

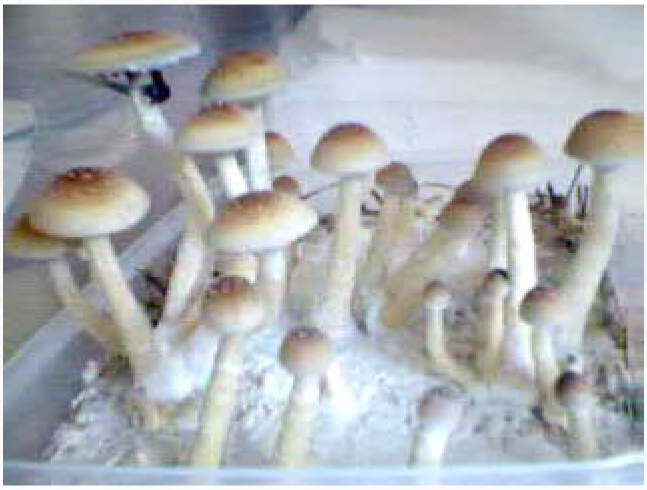
Shirley Knott

original source: http://www.shroomery.org/8404/Spore-printing-pictorial

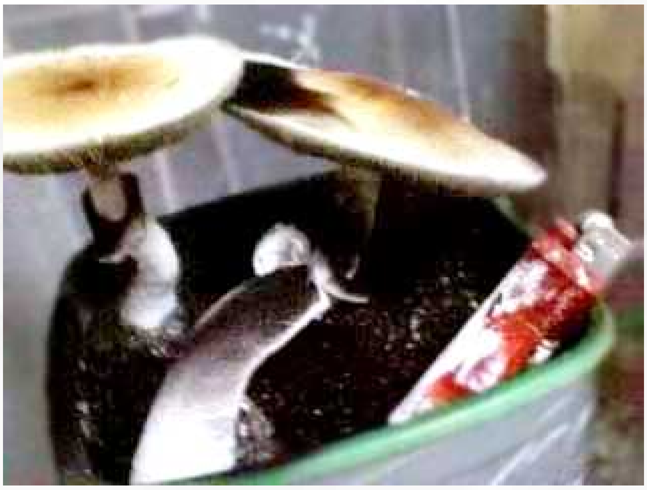
1. Get your stuff together:

- you'll need some foil,
- some rubbing alcohol (medical sterets work very well),
- a sterile blade,
- some thumbtacks with mini-handles,
- drinking glasses,
- a tray,
- two freshly laundered teatowels,
- and some ripe mushies, of course.

The mushrooms should have popped their veils, and formed a nice open cap that is nearly flat. it's best if you wait for the right time before printing, maybe another day or two past prime picking time.



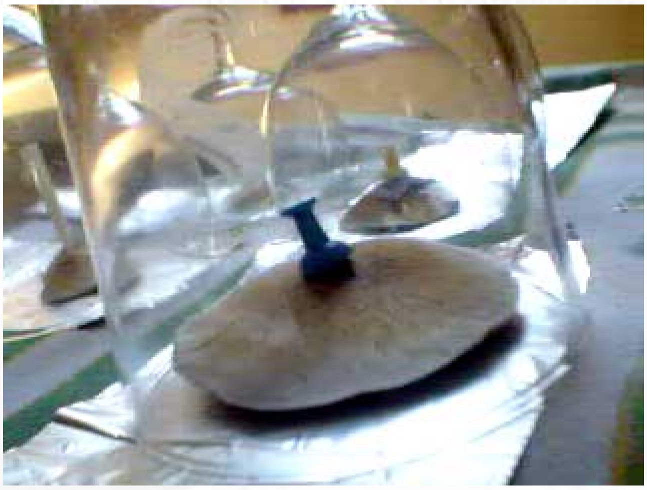
these are nearly ready



while these are probably a little late!
spores everywhere!

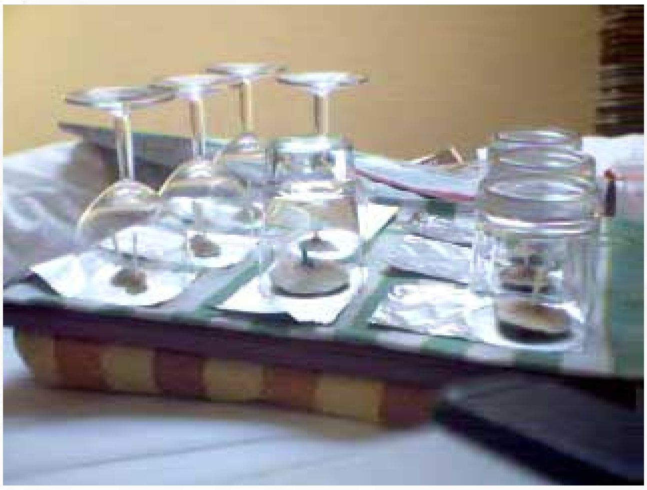
2. Clean your hands and wear a mask if you have one. lay one folded teatowel on the tray. Cut the foil into pieces maybe 15 x 8 cm. fold the foil pieces in half, then open then back up again (easier to fold later).
Swab them with alcohol. Swab the rims of some drinking glasses and put them on the foil. Don't put them on the fold, put them on one side of the fold only.

3. Now you're ready for action: clean your hands again, and open the terrarium lid. Choose your mushroom - one that has opened right up, and preferably has some purple spore dust on the stem, so you know it's already dropping. stick the pin in the middle of the cap. Holding the pin, cut off the cap as high up as you can with the sterile blade. Place cap gills-down on the foil, lifting glass briefly to do so. don't touch it with your fingers, they're filthy!



4. Position the glass carefully: make sure it does not completely seal the spore-dropping zone, so humidity can escape from a gap at the edge of the rim. either this, or make sure the foil is entirely enclosed within the glass: in at least one spot, the glass needs to rest on the teatowel, rather than creating an airtight seal (see on the right, in the pic above). The cap needs to be able to lose humidity slowly. As the cap dries, it sheds spores easier, like in nature. Otherwise the glass gets all sweaty and steamed up, and the spores just get stuck on the gills: Idoubt that many spores blow away on foggy days.

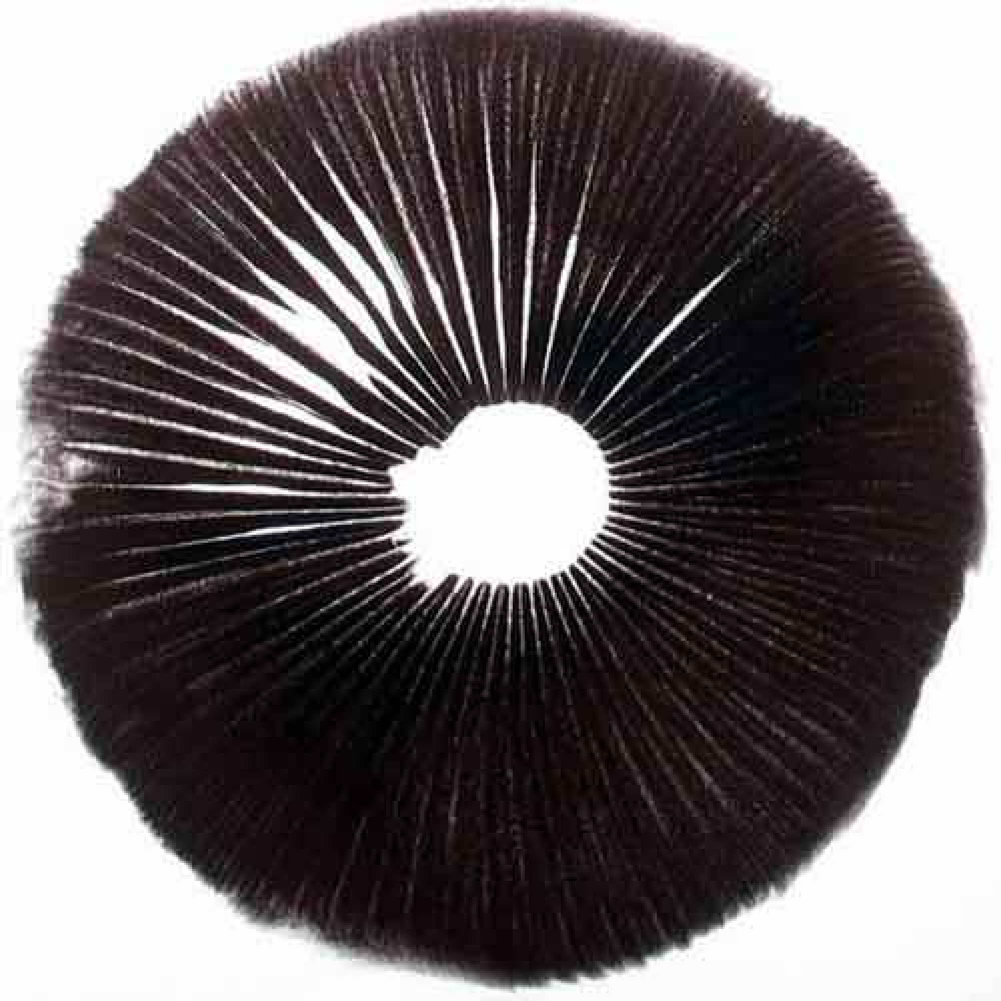
5. Repeat with the next mushroom, until the tray is full. Now cover the whole deal with the other clean teatowel, and put it out of harm's way in a dark cool drawer for a while, 12 - 24 hours.



6. When your chosen time is up (don't be mean, give them at least 12 hours), take out the tray and remove the top teatowel. If you look carefully through the glass, you should see a print laid down, where the edges of the cap have curled up as it dried.
Carefully remove glasses one by one, lifting out the cap and reswabbing the other foil-half and any sticking-out corners before folding over back along preformed fold. Now fold over two of the other three edges to form an envelope, with three closed sides and one open one. the caps can still be dried for consumption, or eaten on the spot if you're hungry!

Sorry, i haven't got a pic of the print - you want to get this covered asap, as any crap from the air that lands in the print (during photography, for example!) can spoil it. if these prints are for microscopy purposes, you want to keep them pristine. or if like me, you live somewhere that growing is legal, you'll be better off with a clean print as well. imagine if a contam spore landed in your print - you'd end up growing it!

Still, here is a picture of a print prepared on typing paper:



7. finally, give them a day in a sealed desiccant chamber for the print to dry before folding the fourth side and bagging the foil squares up individually. You wouldn't want the print to go mouldy after all that work! Here's an example of a desiccator chamber, without its lid:

FastFred's Media Cookbook

by

FastFred & ChesterKarma

(v0.97)

original source: http://www.shroomery.org/forums/showflat.php/Number/3077006

Table of Contents:

Section A. Classic Favorite Recipes
Potato Dextrose Agar (PDA)(FDA M127)
Potato Dextrose Yeast (PDY)
Malt Extract Agar (3%)(MEA)(General Microbiology)(FDA M93)
Malt Extract Agar with Yeast (2%)(MEAY)
Sabouraud's Dextrose Broth and Agar (SabDex)(FDA M133)

Section B. Special Blends
"Karo Water" (Corn Syrup Broth)
"Dextrose Tek" Liquid Media (Corn Sugar Broth)
Honey Water (Mycotopia Honey Tek)
Malt-Yeast-Peptone Agar (McKenna's MYP)
Malt Yeast Peptone Agar (Stamets MYP)
Grey Cardboard (instead of agar)
Oatmeal Flake Agar
Moonflower's Rice Malt-Alfalfa-Brewer's Yeast Agar
MycoPsycho's Liquid Mycelial Culture Broth
Ragadinks Liquid Medium
Amaranth Soy Agar
EntheoGenesis No.442

Section C: Food Based Recipes and Variations
Corn Meal Agar (CMA)
Cornmeal Dextrose Agar
Potato Flake Agar
Potato Starch Agar
Potato Flake Agar with Yeast
Potato-Carrot Agar
Barley Flour Malt Extract Agar
Barley Flour Modified Sabouraud's
Oatmeal Agar (OA)
Oatmeal Agar A
Oatmeal Agar B
V-8 Oatmeal Agar
V8 Medium
Bean Agar
Faba Bean Dextrose Agar (FDA)
Pea Agar
Cabbage Agar
Dr. Pollock's Modified [Dog Food] Agar

Section D. Other Media and Alternate Formulations
Potato-Glucose Agar 1
Potato-Peptone Medium
Potato-Peptone-Yeast Agar (PPYA)
Malt Agar (MA)(FDA M185)[aka 2% MEA]
Difco Malt Extract Broth (FDA M94)
Malt Extract Agar for Yeasts and Molds (MEAYM)(FDA M182)
Malt Extract Peptone Agar
Raper & Thom MEA (RTMEA)
ISP 2 Medium (Malt, Yeast, Glucose)
Yeast Extract Agar (YEA)(FDA M181)
Yeast Glucose Agar
Glucose and Yeast Extract Agar
Glycerin Yeast Agar
Manure Tincture
Manure Agar
Water Agar (aka Starved Agar)
Gelatin Agar (GA)(FDA M54)
Plate Count Agar (SMA)(aka Standard Methods Agar)(FDA M124)
Nutrient Agar (FDA M112)
Starch Agar (FDA M143)(Nutrient agar with starch)
Starch-Yeast Agar
1/5 Starch-Yeast Agar
Long-term Preservation Medium (FDA M85)
Peptone Meat Agar (Meat Water)

Section E. Common Solutions
Gentamicin Sulfate Solution (FDA M57)

Section F. Sources

Section A. Classic Favorite Recipes

Potato Dextrose Agar (PDA)(FDA M127)

200 g Potato infusion [dilute to 1L total, ~4g solids]
20 g Dextrose
20 g Agar
1 L Distilled water (dH2O)

To prepare potato infusion, boil 200 g scrubbed, sliced(unpeeled) potatoes in 1 liter distilled water for 30 min. Filter through cheesecloth, saving effluent, which is potato infusion (or use commercial dehydrated form). Mix in other ingredients and boil to dissolve. [Dilute to obtain 1 L final volume] Autoclave 15 min at 121°C. Dispense 20-25 ml portions into sterile 15 x 100 mm Petri dishes. Final pH, 5.6 ± 0.2.

Medium should not be re-melted more than once. Medium powder is available commercially but may require supplementing with extra agar to a final concentration of 20 g/liter. To BBL or Difco dehydrated medium, add 5 g of agar.

The broth is clear to slightly opalescent and yellowish in color.[1, 2]

Potato Dextrose Yeast (PDY)

200 g Potato, infusion from [dilute to 1L total]
20 g Dextrose
2 g Yeast extract

20 g Agar
1 L Distilled water (dH2O)

Gently boil for ten minutes or until the solution is clear.
Autoclave 15 min at 121°C.[13]

Malt Extract Agar (3%)(MEA)(General Microbiology)(FDA M93)

30 g Malt extract
20 g Agar
1 L Distilled water

Boil to dissolve ingredients. Avoid overheating, which causes softening of agar and darkening of medium color. Autoclave 15 min at 121°C. Dispense 20-25 ml into sterile 15 x 100 mm Petri dishes. Final pH, 5.5 ± 0.2.

This medium is recommended as a general maintenance medium.[1]

Malt Extract Agar with Yeast (2%)(MEAY)

20 g extra light malt extract
2 g yeast
15-20 g agar
1 L water[10]

Sabouraud's Dextrose Broth and Agar (SabDex)(FDA M133)

40 g Dextrose
10 g Polypeptone or neopeptone
1 L Distilled water

Dissolve completely and dispense 40 ml portions into screw-cap bottles. Final pH, 5.8. Autoclave 15 min at 118-121°C. Do not exceed 121°C.

For Sabouraud's dextrose agar, prepare broth as above and add 15-20 g agar, depending on gel strength desired. Final pH, 5.6 ± 0.2. Dispense into tubes for slants and bottles or flasks for pouring plates. Autoclave 15 min at 118-121°C.[1]

Sabouraud Dextrose (SabDex) Agar is used for the isolation, cultivation, and maintenance of saprophytic and pathogenic yeasts and fungi.

SabDex Agar is an excellent substitute for Malt or Potato Dextrose Agar, when used by mushroom cultivators to propagate mushroom mycelium.

Sabouraud Dextrose Agar was described by Sabouraud in 1892 and was used for the identification of fungi based on their morphological characteristics. Sabouraud Dextrose Agar is a standard medium used to support the growth of yeasts and molds. It supplies peptone as the protein source and dextrose as the carbohydrate source for nourishment. Bacterial suppression occurs due to the low pH. This media is especially suited for the primary isolation of fungi from normally sterile sites such as cerebrospinal fluid (CSF).

Later, Emmons modified the medium by decreasing the dextrose content and adjusting the pH closer to the neutral range. This modification enhances sporulation and is particularly useful for the subculture of fungi that so not develop fruiting structures on other media, and so is useful in their identification. It also serves as a good holding medium for stock cultures.[3]

Section B. Special Blends

"Karo Water" (Corn Syrup Broth)

1 Teaspoon Light Corn Syrup (Karo Syrup or store brand Light Corn Syrup)
100 ml Purified Water

Mix well until dissolved, sterilize for 20-30 minutes at 15 psi.[17]

"Dextrose Tek" Liquid Media (Corn Sugar Broth)

1 Teaspoon Powdered Dextrose (corn sugar)
75 ml water[17]

Honey Water (Mycotopia Honey Tek)

40 g Honey (or roughly 1 tablespoon per pint of water)
1 L Water

The correct mixture for optimum results is 4% sugars (honey) by weight and 96% water.
Water weighs 1 gram per cc/ml so if you use 100 ml as total weight, then 96 grams/ml/cc of water is mixed with 4 grams of honey, etc.
Sterilize for 30 min at 121°C (15 psi).[14]

Malt-Yeast-Peptone Agar (McKenna's MYP)

7 g malt extract (powdered or syrup)
1 g peptone or soytone
0.5 g yeast extract
15 g agar[11]

Malt Yeast Peptone Agar (Stamets MYP)

20 g extra light malt extract
1 g yeast extract
1 g peptone
15-20 g agar
1 L water[10]

Grey Cardboard (instead of agar)

Here are the detailed steps for making cardboard plates. Note that you can also use small jars in place of Petri dishes.

1) Measure about 100 mls. of tap water into a small jar.
2) For nutrients, measure another 100 mls. of tap water into a second jar and add one drop of ordinary soy sauce to the water, and a quarter teaspoon (1.25 mls.) of molasses or light malt powder.
3) Find some gray cardboard, the thicker the better, preferably gray on both sides. Trace a Petri plate onto the cardboard with a pencil and cut out several disks to fit into your plates.
4) Weigh one of your disks and record the weight. Multiply this weight by a factor of 1.3 as a rough guide (you may need to experiment with the amounts here), and add the resulting weight of tap water or nutrient solution to each disk in its Petri plate. (Remember, 1 ounce of water equals 28.35 grams; one gram equals one milliliter.) Example: Suppose my disks weighed 0.17 ounces each. Multiplying 0.17 by 1.3, I get 0.22 ounces. There are 28.35 grams in an ounce, so 0.22 ounces x 28.35 equals 6.3 grams. That means I'll add 6.3 milliliters

of solution to each disk.
5) Close up the disks in the plates, and let the water or nutrient solution soak in.
6) Pressure-sterilize the jar of plain water, and the Petri plates with moistened newsprint disks inside, for 10 minutes at 15 psi (allowing the cooker to equilibrate steam for 10 minutes before putting on the pressure regulator).
7) Cool the cooker, and remove the plates and jar of plain water.
8) When the water has cooled, add 3.3 mls. 3% peroxide to the jar, using a pasteurized pipette, to give you a final concentration of about 0.1% peroxide in sterile water.
9) Add about one third of the initial weight of the cardboard as 0.1% peroxide to each disk. Let the solution soak completely into the disks. They are now ready to use.[23]

Oatmeal Flake Agar

75 g Oatmeal flakes
20-25 g Agar
1 L water

Stir for 5-10 minutes then filter out the larger particles by pouring it through some mesh, save the broth. [Then add the agar]

This is the best medium for Panaeolus cyanescens I've ever encountered. Beware, this medium will be less firm than the other recipes so extra agar has to be added to compensate.[22]

Moonflower's Rice Malt-Alfalfa-Brewer's Yeast Agar

1 cup alfalfa, infusion from
2 cups rice, infusion from
1 standard dolomite (oyster shell-crushed) tablet
1 pkg of regular brewer's yeast

Prepare infusion using approx. 1 1/2 quarts of clean water. Mix in the alfalfa and rice, then allow to soak for 2 hours at room temp with occasional stirring. Filter or strain before adding the infusion.
Prepare yeast by activating in water for around 30 minutes, then strain out solid yeast grains.
Sterilize in pressure cooker for 20 minutes at 15lbs.
This media is reported to produce more "banding" than other media. Will support luxuriant mycelial growth, it is also more than sufficient for starting spores.[19]

MycoPsycho's Liquid Mycelial Culture Broth

1/2 tsp malt (2.5 ml)
3/4 cup water

1. procure a half-pint jar with lid & ring and also a spore syringe.
2. drill/punch a hole in the center of the lid large enough for the syringe.
3. mix 3/4 cup of water with 1/2 tsp.(2.5 ml.) malt.
4. put lid & ring on and put aluminum foil over the top of that and then Pressure Cook (PC) for 20 min. @ 15 psi. , when finished let cool to below 90 degrees F.
5. once cool, setup your sterile environment (flow hood, glove box or even your oven will work) with an alcohol lamp, extra alcohol in a dish, paper towels/napkins, small round bandaid and lastly the spore syringe.
6. remove the foil from the jar, shake the needle and then sterilize the point with the alcohol lamp (get it red hot), cool the needle with a wipe & some alcohol and then inject 1-2 cc/mil spore solution into the jar.
7. once injected wipe the needle with alcohol and put the guard back on it.
8. cover injection site with round bandaid (thanks for that tip magash!).
9. put the jars in your incubator set at 82-84 degrees F. for 4-14 days, you should notice growth by then.
10. sterilize empty syringes in your PC for 15-20 @ 15 psi.
11. remove the bandaid from the jar, sterilize your needle again and then suck myc solution into empty

syringe(s) for use on PF style jars or substrate bags.[15]

Ragadinks Liquid Medium

16.5 g dextrose
1.5 g yeast
500 ml tap water[16]

Amaranth Soy Agar

20 g amaranth flour
20 g soy flour
9 g agar
500 ml potable or distilled water
Sterilize for 20-30 minutes at 15 psi.[20]

EntheoGenesis No.442

10 g amaranth flour
10 g brown rice flour
10 g potato flour
10 g soy flour
2 g malted barley
9 g agar
500 ml potable or distilled water

Sterilize for 20-30 minutes at 15 psi.[20]

Section C: Food Based Recipes and Variations

Corn Meal Agar (CMA)

2 g Corn Meal, Infusion from [filter]
15 g Agar
1 L dH2O [4]

Cornmeal Dextrose Agar

25 g yellow cornmeal
3 g dextrose
9 g agar
500 ml potable or distilled water[20]

Potato Flake Agar

20.0 g Potato Flakes
10.0 g Dextrose
15.0 g Agar
1.0 L Demineralized Water

Potato Dextrose Agar and Potato Flake Agar are formulations developed to promote sporulation of fungi. The potatoes contained in these media provide nutritious bases for luxuriant growth of fungi. Both media contain dextrose as a growth stimulant.
pH 5.6 +/- 0.2 @ 25°C[7]

Potato Starch Agar

30 g potato starch, soluble
20 g dextrose/glucose
15 g agar, pure (omit for liquid media)
1000 mL (d)H2O

The pH is adjusted following autoclaving to prevent agar hydrolysis by acid.[20]

Potato Flake Agar with Yeast

20 g potato flakes
10 g glucose
1-2 g dried yeast
20 g agar
1 L water[18]

Potato-Carrot Agar

grated potato 20.0 g
grated carrot 20.0 g
Agar 20.0 g
Tap water 1000.0 ml

Boil potato and carrot in 1000.0 ml of water for 1 h, filter, add water to the initial volume, adjust pH to 7.0 - 7.1 and add agar.
Sterilize at 121°C for 30 min.[6]

Barley Flour Malt Extract Agar

40 g barley flour
2 g malt extract
1 g yeast extract (optional)
9 g agar
500 ml potable or distilled water

Sterilize for 20-30 minutes at 15 psi.[21]

Barley Flour Modified Sabouraud's

25 g barley flour
5 g dextrose
2 g Polypeptone or neopeptone (optional)
1 g yeast extract
9 g agar
500 ml potable or distilled water

Sterilize for 20-30 minutes at 15 psi.[21]

Oatmeal Agar (OA)

60.0 g Oatmeal [filter]
12.5 g Agar [may require more]
1.0 L dH2O

Cook oatmeal 5-10 minutes then filter the liquid into another container using cheesecloth or a metal strainer with a tight mesh. Dilute liquid to 1L, add agar, and heat with swirling until solids dissolve.

This is reported to be a good media for cultivating Panaeolus cyanescens.[5]

Oatmeal Agar A

Oatmeal 20.0 g
Agar 20.0 g
Tap water 1000.0 ml

pH 7.2.[6]

Oatmeal Agar B

Oats 30.0 g
Agar 15.0 g
Tap water 1000.0 ml

Keep oats on a water bath at 58°C for 1 h, filter through 2 layers of gauze, dilute to 1000.0 ml and add 15.0 g agar.[6]

V-8 Oatmeal Agar

50 ml V-8 juice
25 g Cream of oats
20 g Agar
1 L Water

Be careful to use a container much larger then the volume of medium, i.e., prepare a 500 ml medium in 2 liter flasks or it will tend to boil over no matter how slowly it is cooled down.[20]

V8 Medium

50 ml V8 Juice
.2 g $CaCO_3$
20 g of agar
1 L Water

The commercial V8 juice is occasionally used for tissue cultures of edible mushrooms. It should be noted that most mushrooms prefer neutral to slightly acid range of medium, that is, a pH of about 5.5 to 6.5. However the straw mushroom, Volvariella volvacea, prefers a high pH medium, 6.8 to 7.8. Therefore, it is important to make sure the acidity or pH of the medium is correct for a particular mushroom. Here be careful to use a container much larger then the volume of medium, i.e., prepare a 500 ml medium in 2 liter flasks or it will tend to boil over no matter how slowly it is cooled down. [20]

Bean Agar

Beans (peas or pulse) 100.0 g [infusion from (filter)]
K_2HPO_2 0.5 g
Sucrose 10.0 g
Agar 20.0 g
Water 1000.0 ml

Prepare infusion from beans. Sterilize at 121°C for 30 min.[6]

Faba Bean Dextrose Agar (FDA)

200 g faba bean seeds or 400 g of faba bean leaves [infusion from]
[autoclave and filter to obtain faba infusion]
20 g of dextrose
18 g agar
1 L water

Method:
a. Weigh out 200 g of faba bean seeds or 400 g of faba bean leaves in a 1.5 L flask. Add 1L of water, and autoclave at 15 psi. for 30 minutes.
b. Pass the autoclaved beans through a sieve, add 18 g of agar, heat, and stir till dissolved.
c. Add 20 g of dextrose, stir till dissolved, and make up the volume to 1 L with tap water. d. Autoclave at 15 psi. for 20 minutes, cool to about 40°C, and pour into Petri dishes (normally 40 Petri dishes/L).

This medium is used for propagation of B. fabae, A. fabae, and A. tenuis.[12]

Pea Agar

100 g Yellow peas
0.5 g K_2HPO_2
10.0 g Sucrose
20.0 g Agar
1.0 L Tap water

Boil peas in 1000.0 ml of water, filter through gauze, add water to the initial volume; add phosphate, sucrose, and agar. Sterilize at 121°C for 30 min.[6]

Cabbage Agar

Cabbage 50.0 g
glucose 20.0 g
Peptone 10.0 g
Agar 20.0 g
Tap water 1000.0 ml

Boil 50.0 g of cabbage in 1000.0 ml of water, filter cabbage, adjust the volume of broth to the initial value.[6]

Dr. Pollock's Modified [Dog Food] Agar

10 g dried dog food (ground to flour)
10 g amaranth flour
2 g dextrose or malt extract
9 g agar
500 ml potable or distilled water

Sterilize for 20-30 minutes at 15 psi.[20]

Section D. Other Media and Alternate Formulations

Potato-Glucose Agar 1

grated potato 200.0 g
glucose 20.0 g
Agar 20.0 g
Tap water 1000.0 ml

Boil potatoes for 1 h in 1 L of water, filter through gauze. Add water to the initial volume, add glucose and agar.
Sterilize at 105°C for 30 min.[6]

Potato-Peptone Medium

Potato decoction 200 ml [infusion from 200 g potato]
Yeast extract 1.0 g
Peptone 5.0 g
Agar 30.0 g
Distilled water 800.0 ml.[6]

Potato-Peptone-Yeast Agar (PPYA)

Potato decoction 200 ml [infusion from 200 g potato]
Peptone 5.0 g
Yeast extract 1.0 g
Agar 25.0 g
Distilled water to 1000.0 ml

pH 8.0.[6]

Malt Agar (MA)(FDA M185)[aka 2% MEA]

20 g Malt extract, powdered
20 g Agar
1 L Distilled water

Mix ingredients, steam to dissolve agar and sterilize for 15 min at 121°C. Temper medium to 45°C and pour plates under aseptic conditions.

This medium is recommended as a general maintenance medium.[1]

Difco Malt Extract Broth (FDA M94)

6.0 g Malt extract base
1.8 g Maltose, technical
6.0 g Dextrose
1.2 g Yeast extract
1.0 L Water

Final pH, 4.7 ± 0.2.[1]

Malt Extract Agar for Yeasts and Molds (MEAYM)(FDA M182)

20.0 g Malt extract, powdered

20.0 g Glucose
1.0 g Peptone
20.0 g Agar
1.0 L Distilled water

Mix ingredients, heat to dissolve agar and sterilize at 121°C for 15 min. Temper media to 45°C and pour plates under aseptic conditions. Dehydrated MA is commercially available, but since several MA formulas exist, check for the correct composition.
Final pH 5.4.[1]

Malt Extract Peptone Agar

30 g Malt extract
3 g Soya peptone
15 g Agar
1 L Distilled water

Adjust pH to 5.6. Sterilize at 121°C for 10 min.[8]

Raper & Thom MEA (RTMEA)

To 2% MEA add:
Glucose 10 g
Soy Peptone 5g.[9]

ISP 2 Medium (Malt, Yeast, Glucose)

Malt extract 10.0 g
Yeast extract 4.0 g
Glucose 4.0 g
Agar 15.0 g
Distilled water 1000.0 ml

pH 7.2.[6]

Yeast Extract Agar (YEA)(FDA M181)

10.0 g Proteose peptone
3.0 g Yeast extract
5.0 g NaCl
15.0 g Agar
1.0 L Distilled water

Adjust pH to 7.2-7.4. Autoclave at 121°C for 15 min.[1]

Yeast Glucose Agar

Yeast extract 5.0 g
Glucose 10.0 g
Peptone 5.0 g
Agar 20.0 g
Distilled water 1000.0 ml

pH 7.2. Sterilize at 121°C for 15 min.[6]

Glucose and Yeast Extract Agar

Glucose 20.0 g
Yeast extract 10.0 g
CaCO2 20.0 g
Agar 17.0 g
Distilled water 1000.0 ml[6]

Glycerin Yeast Agar

Yeast extract 5.0 g
Glycerin 50.0 g (also called glycerine or glycerol)
CaCO2 1.0 g
Agar 20.0 g
Distilled water 1000.0 ml[6]

Manure Tincture

Cow manure (fresh) 1.0 kg
Distilled water 3000.0 ml

Boil, squeeze through gauze into a bottle and dilute 3 to 1.[6]

Manure Agar

Horse manure 100-125 g
Agar 25.0 g
Distilled water 1000.0 ml

Boil manure in 1000.0 ml of water for 10 min, then keep for 16-20 h, filter through 1-2 layers of filter paper, adjust to the initial volume, add agar.
Sterilize at 121°C for 15 min.[6]

Water Agar (aka Starved Agar)

Agar 20.0 g
Distilled water 1000.0 ml

Sterilize at 121°C for 15 min.[6]

Gelatin Agar (GA)(FDA M54)

4 g Peptone
1 g Yeast extract
15 g Gelatin
15 g Agar
1 L Distilled water

Suspend ingredients with constant stirring to prevent scorching gelatin, and boil to dissolve gelatin and agar. Adjust to pH 7.2 ± 0.2. Autoclave 15 min at 121°C. Cool to 45-50°C. Pour plates.[1]

Plate Count Agar (SMA)(aka Standard Methods Agar)(FDA M124)

5.0 g Tryptone
2.5 g Yeast extract

1.0 g Dextrose
15.0 g Agar
1.0 L Distilled water

Heat to dissolve ingredients. Dispense into suitable tubes or flasks. Autoclave 15 min at 121°C. Final pH, 7.0 ± 0.2.

For viable yeasts and molds, dispense 20-25 ml portions into sterile 15 x 100 mm Petri dishes.[1]

Nutrient Agar (FDA M112)

3 g Beef extract
5 g Peptone
15 g Agar
1 L Distilled water

Heat to boiling to dissolve ingredients. Dispense into tubes or flasks. Autoclave 15 min at 121°C. Final pH, 6.8 ± 0.2.[1]

Starch Agar (FDA M143)(Nutrient agar with starch)

23 g Nutrient agar (FDA M112)
10 g Potato starch
1 L Distilled water

Heat to dissolve agar in 500 ml water. Dissolve starch in 250 ml water. Combine and dilute to 1 liter. Autoclave 15 min at 121°C.

Note: add 3 g agar to Difco's dehydrated starch agar.[1]

Starch-Yeast Agar

Yeast extract 2.0 g
Starch (soluble) 10.0 g
Agar 20.0 g
Tap water 1000.0 ml

pH 7.3.[6]

1/5 Starch-Yeast Agar

Yeast extract 0.4 g
Soluble starch 2.0 g
Agar 20.0 g
Distilled water 1000.0 ml

pH 7.3.[6]

Long-term Preservation Medium (FDA M85)

3 g Yeast extract, 0.3%
10 g Peptone
30 g NaCl
3 g Agar
1 L Distilled water

Heat to dissolve ingredients. Dispense 4 ml portions to 13 x 100 mm screw-cap tubes. Autoclave 15 min at 121°C. Cool and tighten caps for storage. No pH adjustment is necessary.[1]

Peptone Meat Agar (Meat Water)

Peptone 10.0 g
NaCl 5.0 g [optional]
Agar 20.0 g
Meat water 1000.0 ml

Preparation of meat water: comminute 500 g of meat free of bones, fat and tendons, add 1000.0 ml of tap water and leave for 12 h at room temperature or in a thermostat at 30°C, or for 2 h at 37°C. Then squeeze the meat through gauze or cloth and boil the filtrate for 5 min. The proteins are denatured. Filter the cooled down mass through a cotton-wool filter and add water to the initial volume. pH 7.2 - 7.4.
Sterilize at 121°C for 30 min.[6]

Section E. Common Solutions

Gentamicin Sulfate Solution (FDA M57)

5.00 g Gentamicin sulfate
1.00 L Distilled water

Sterilize by filtration through 0.20 µm membrane. Store at -20°C.[1]

Chloramphenicol 0.2g/liter of media survives autoclaving.

Section F. Sources

1. Bacteriological Analytical Manual, 8th Edition, Revision A, 1998.
2. EMD Chemicals [aka Merck]
3. PML Microbiologicals
4. Sigma Fine Chemicals
5. Sigma Fine Chemicals, instructions by FastFred
6. VKM Media Catalog 2003
7. remel
8. DSMZ-Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, Germany
9. Xenova Limited, UK
10. Paul Stamets (GGMM and/or TMC)
11. Terence McKenna
12. Screening Techniques for Disease Resistance in Faba Beans
13. FastFred
14. Mycotopia Honey Tek
15. MycoPsycho (Shroomery)
16. Ragadinks (Shroomery)
17. Nan (Nanook)
18. Pinback (Shroomery)
19. Moonflower (???)
20. Unknown (Shroomery)
21. Unknown (Shroomery) edited by FastFred
22. Unknown (Shroomery), comments by Una
23. Rush Wayne's Peroxide Manual Volume II (Via Hippie3)(Mycotopia)
24. USDA Complete Guide to Home Canning

Agar substitute

by

doc34

original report: http://www.shroomery.org/8514/Agar-substitute

Those of you who would like to study mycelium and can't find agar, can't afford it, or whatever your reason may be, can use this little technique.

This tek is very newbie friendly, cheap to prepare, and some seasoned cultivators may find it useful as well. Try it, you may enjoy it.

All of the ingredients combined = Total cost, $1.50 (current price of Rice). The Tyvek can be obtained at your local Post Office for freePriority Mail Envelopes.

Mahatma
BROWN RICE
PRIORITY MAIL

Ingredients:

- Brown Rice
- water
- 1/2 pint jars
- Tyvek
- foil
- coffee grinder

Preparation of media(for each jar):

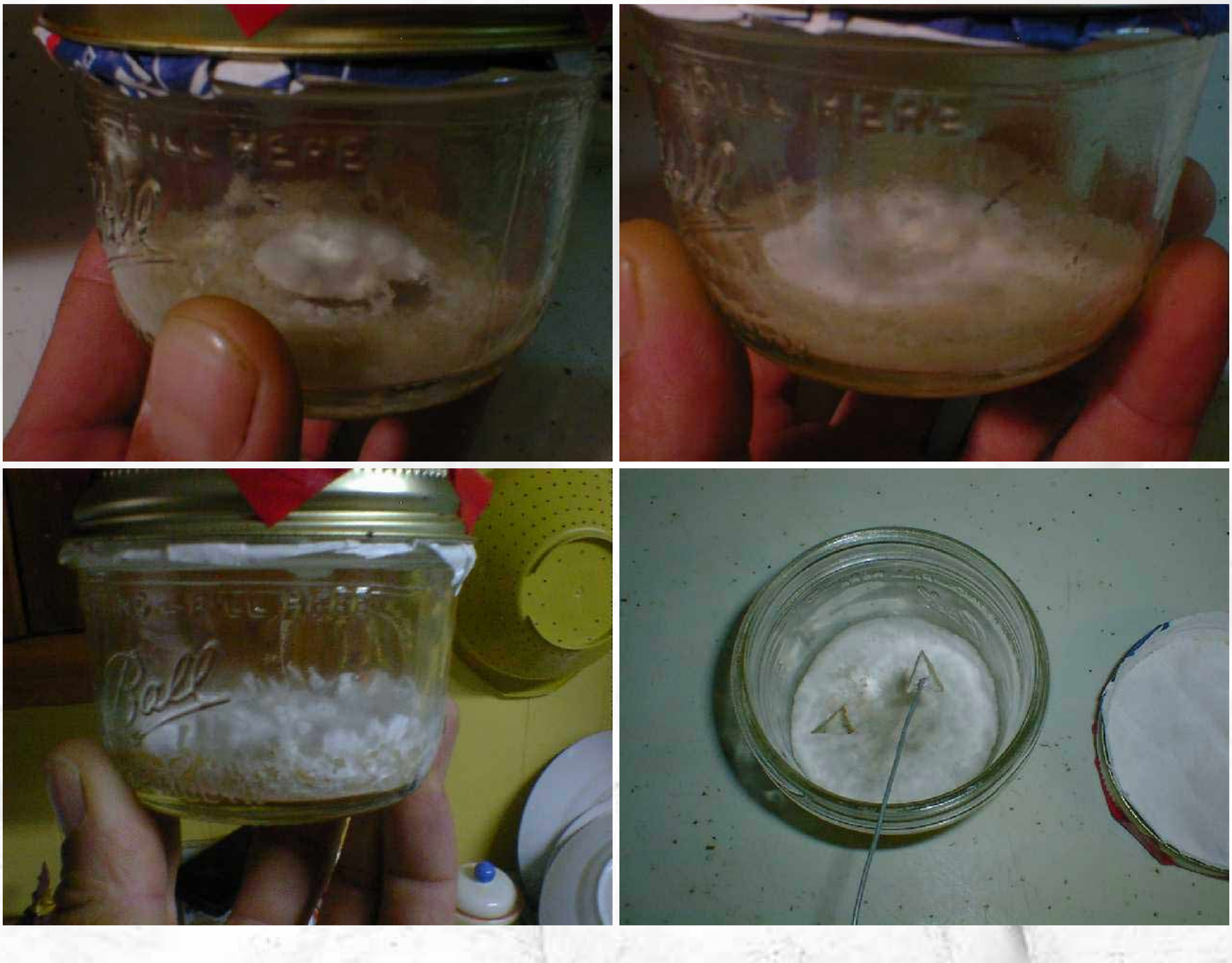
- 1->5 grams of Brown Rice ground into a fine powder.
- 2->16 ml (cc) of water.
- 3->place these ingredients in each jar you plan to use.
- 4->place Tyvek filter on jar, apply disc/polyfill filter and ring, cover with foil.
- 5->PC them for 15 minutes at 15 psi and allow to cool.

For a thinner layer:

- 2.5 grams of Brown Rice ground into a fine powder
- 8 ml (cc) of water

To inoculate with a spore syringe (multispore) simply flame needle, wipe with alcohol, and plunge syringe in through the polyfill, tyvek and inject 1 (one) drop of spore solution in the center of media.
Remove syringe, replace foil and incubate at 80°F - 85°F.

This colonizes 100% in about 2 weeks or less (less using the thin layer) .



Once you have the growth you are looking for you can transfer a wedge to the grain of your choice.

This is has worked well for me, and I hope you can find it useful.

Agar PDYA

Penn State Spawn Lab Procedure for Making PDYA

by

Vija L. Wilkinson

Research Support Technologist Department of Plant Pathology

original source: http://plantpath.psu.edu/facilities/mushroom/cultures-spawn/media-preparation

PDYA: POTATO DEXTROSE YEAST EXTRACT AGAR

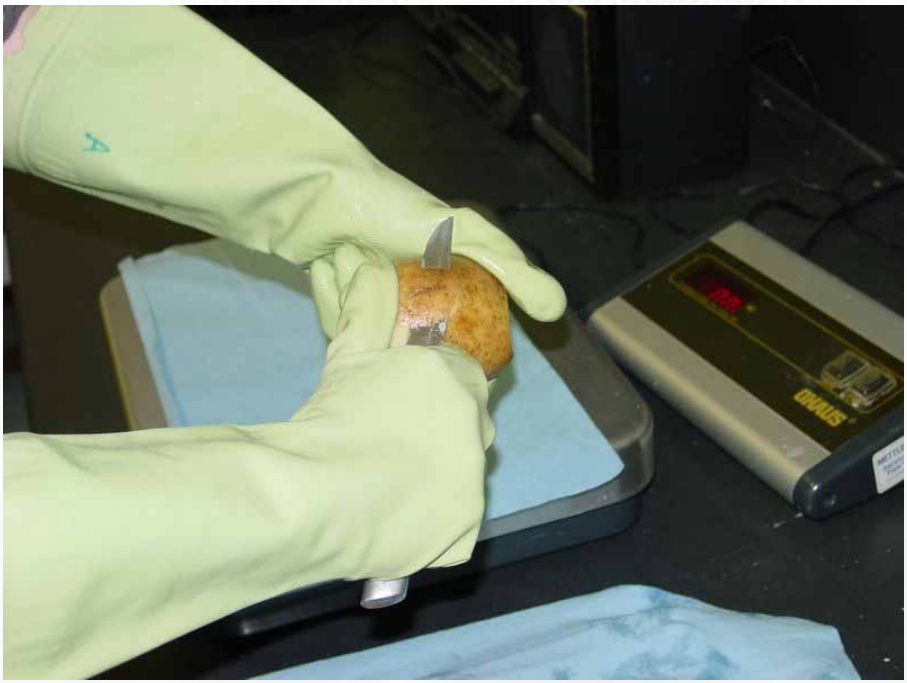
To Make 1 Liter:

- 250 grams potatoes; Do not peel. Scrub clean, cutting out eyes and bad spots.
- 20 grams Agar. Cut into 1/2" pieces.
- 10 grams Dextrose, Anhydrous.
- 1.5 grams Yeast Extract.

Rinse and drain cut potatoes twice with tap water and once with distilled water. Add 1 liter distilled water to the potatoes. Cook until potatoes are tender. Filter the potato broth through two layers of cheese cloth. Save the broth and discard potatoes. Add distilled water to broth bringing volume up to 1 liter. Heat the 1 liter of broth to a boil. While stirring slowly add agar, dextrose and yeast extract. Stir until dissolved, watch carefully or it will boil over.

Autoclave for 15 minutes at 121C.

Scrub potatoes clean.



Cut out eyes and bad spots.

Cut Potatoes into 1/2 inch Pieces.

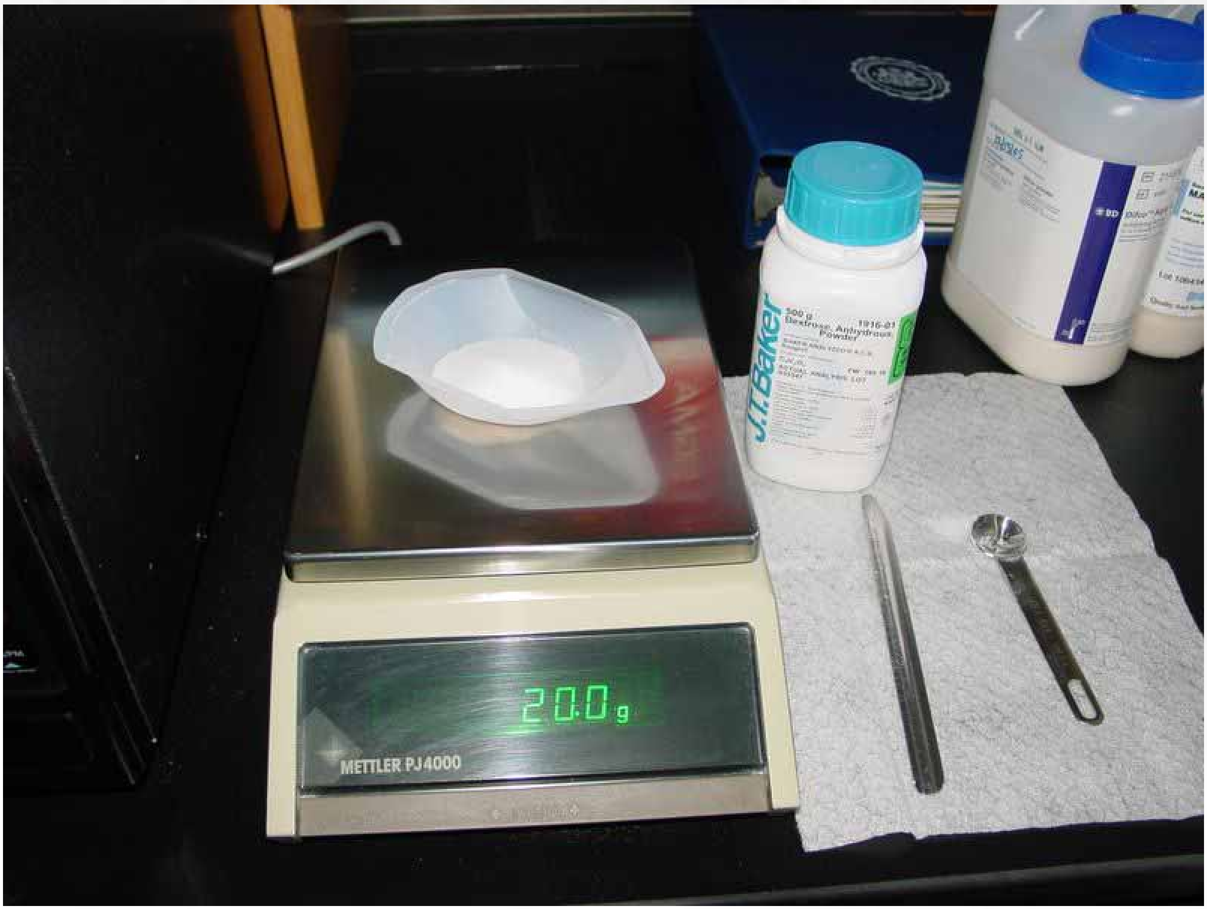
Potato Pieces.

Place Potatoes into large pyrex flask
Potatoes are rinsed twice with tap water, and a third time with distilled water.

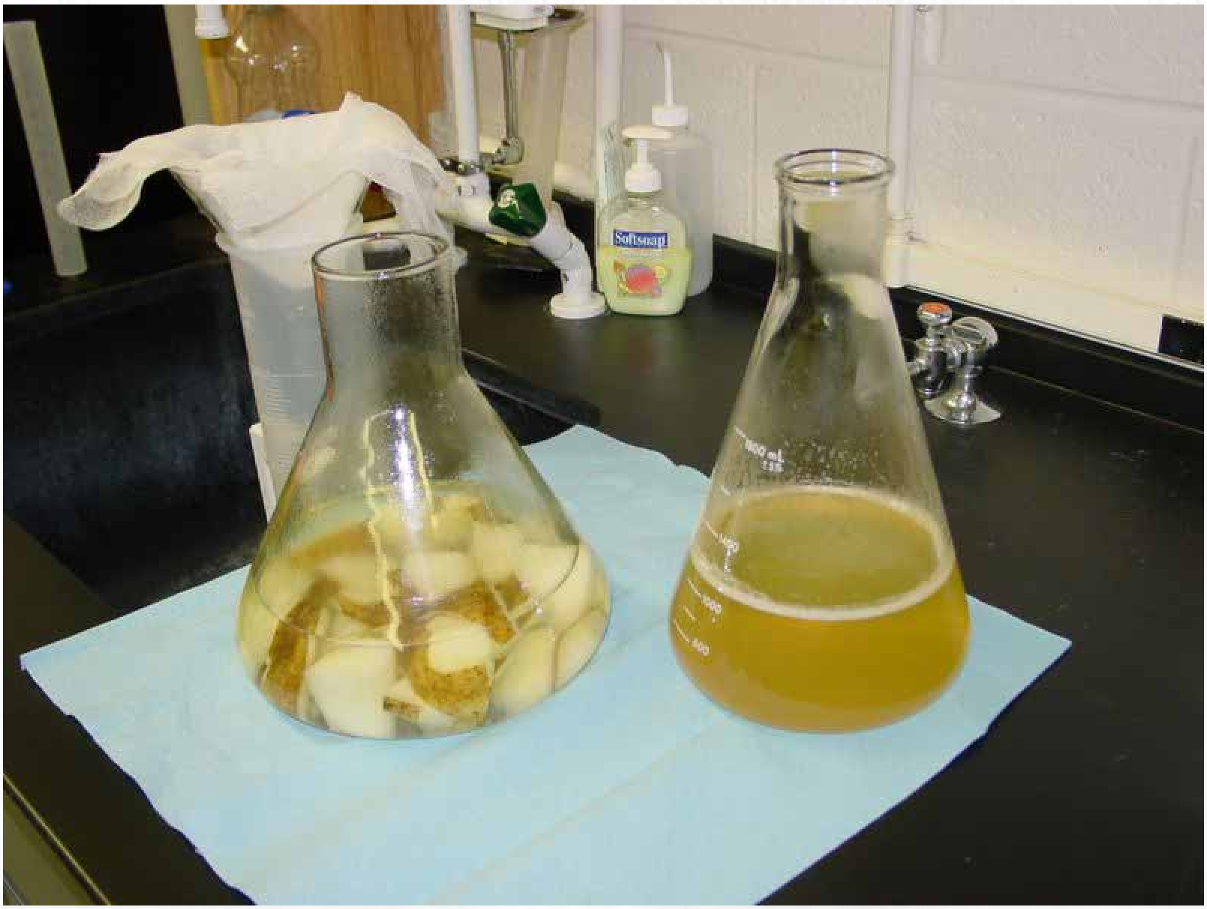
Adding Distilled Water
Add one liter of distilled water to the potato flask.

Prepare Agar
In a second flask, place 20 grams of Agar and one liter of distilled water. Place potato and Agar OPEN flasks in a metal pan.

Melt Agar and Cook Potatoes
Place the OPEN flasks (on a metal pan) in an autoclave. Autoclave on 'steam bypass' for 45 minutes. (Steam bypass - 100 C at 8 pounds pressure).

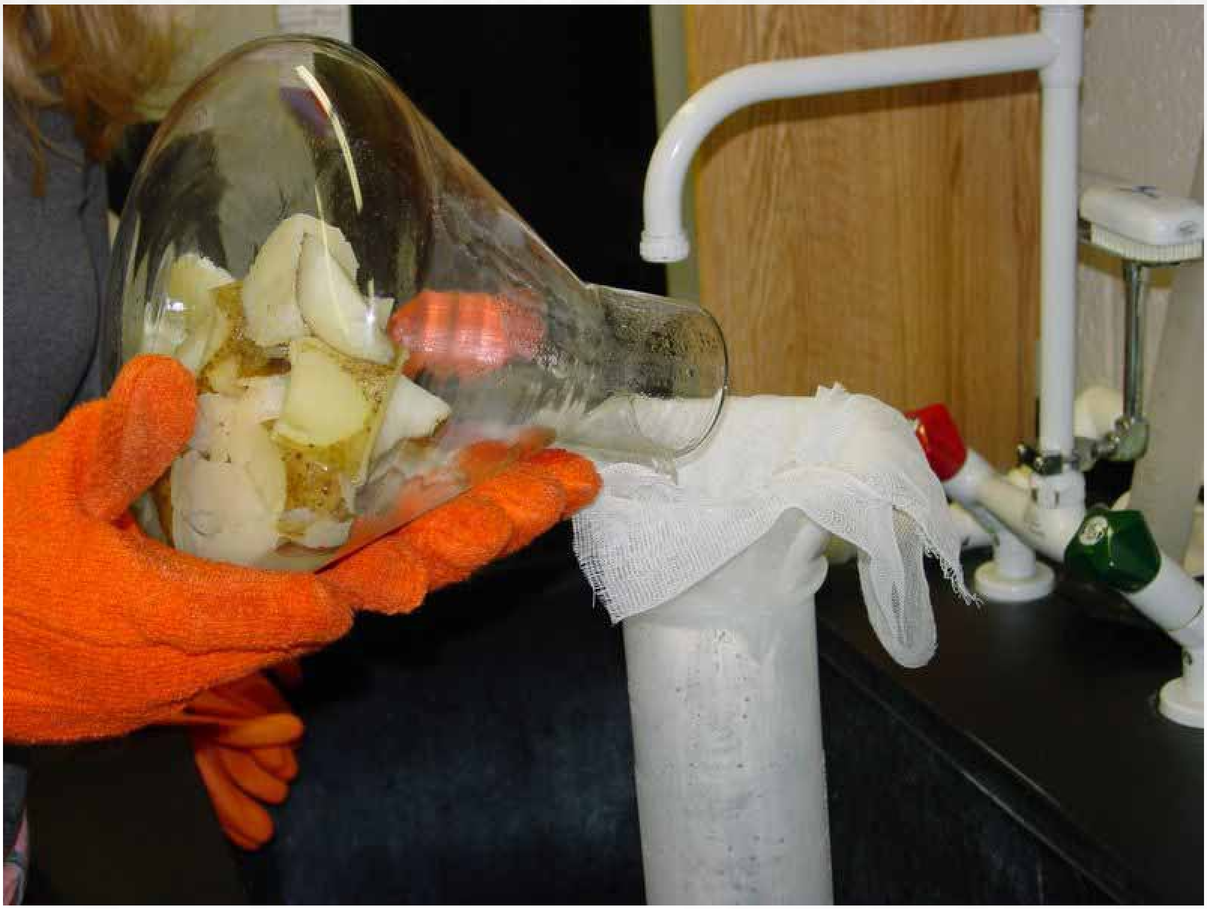

20.0 g
METTLER PJ4000
J.T.Baker
500 g
Dextrose, Anhydrous Powder

Measure ingredients
While potatoes and Agar are cooking, weigh out 10 grams of Dextrose and 1.5 grams of Yeast Extract.

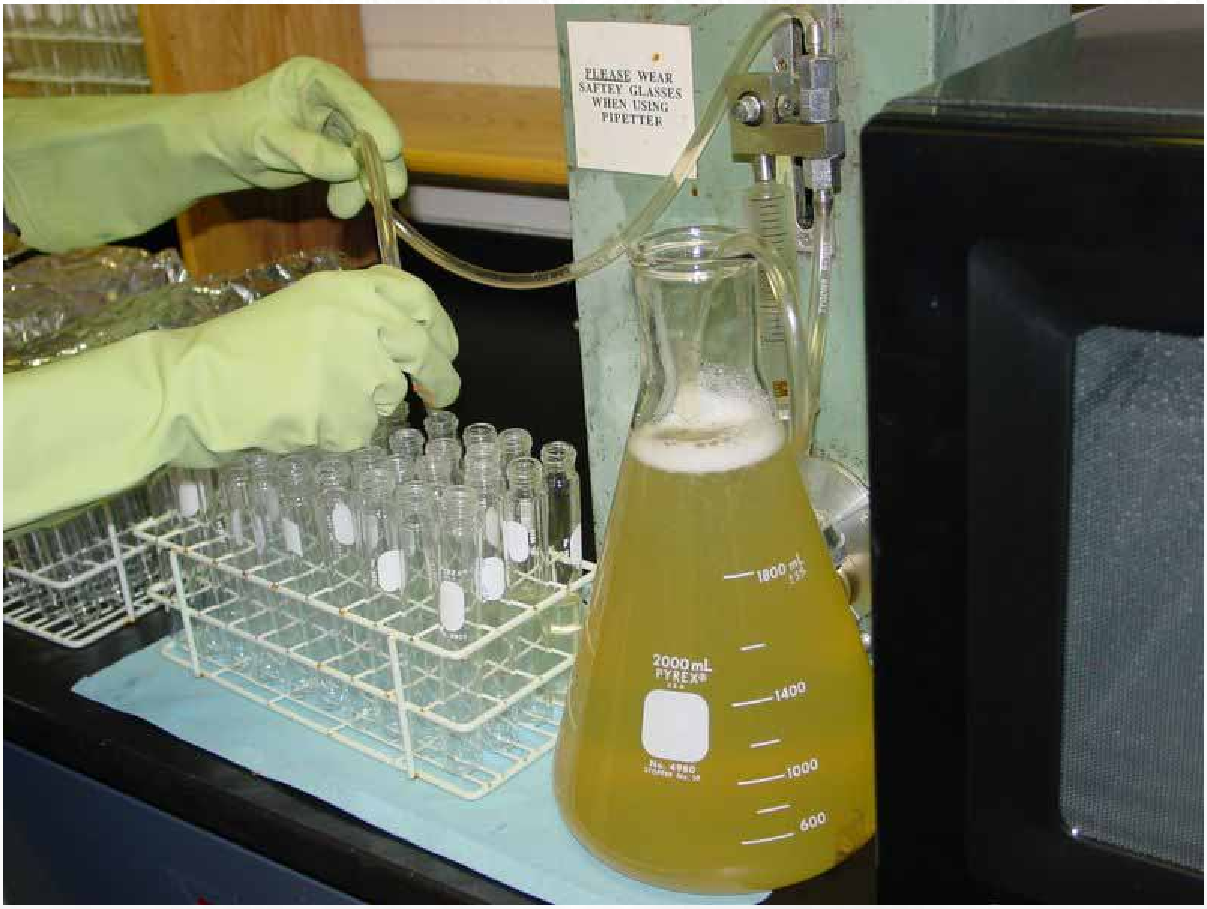


Cool Potatoes and Agar

Set up a 1 liter plastic cylinder with glass funnel lined with 2 layers of cheesecloth while potato broth is cooling.

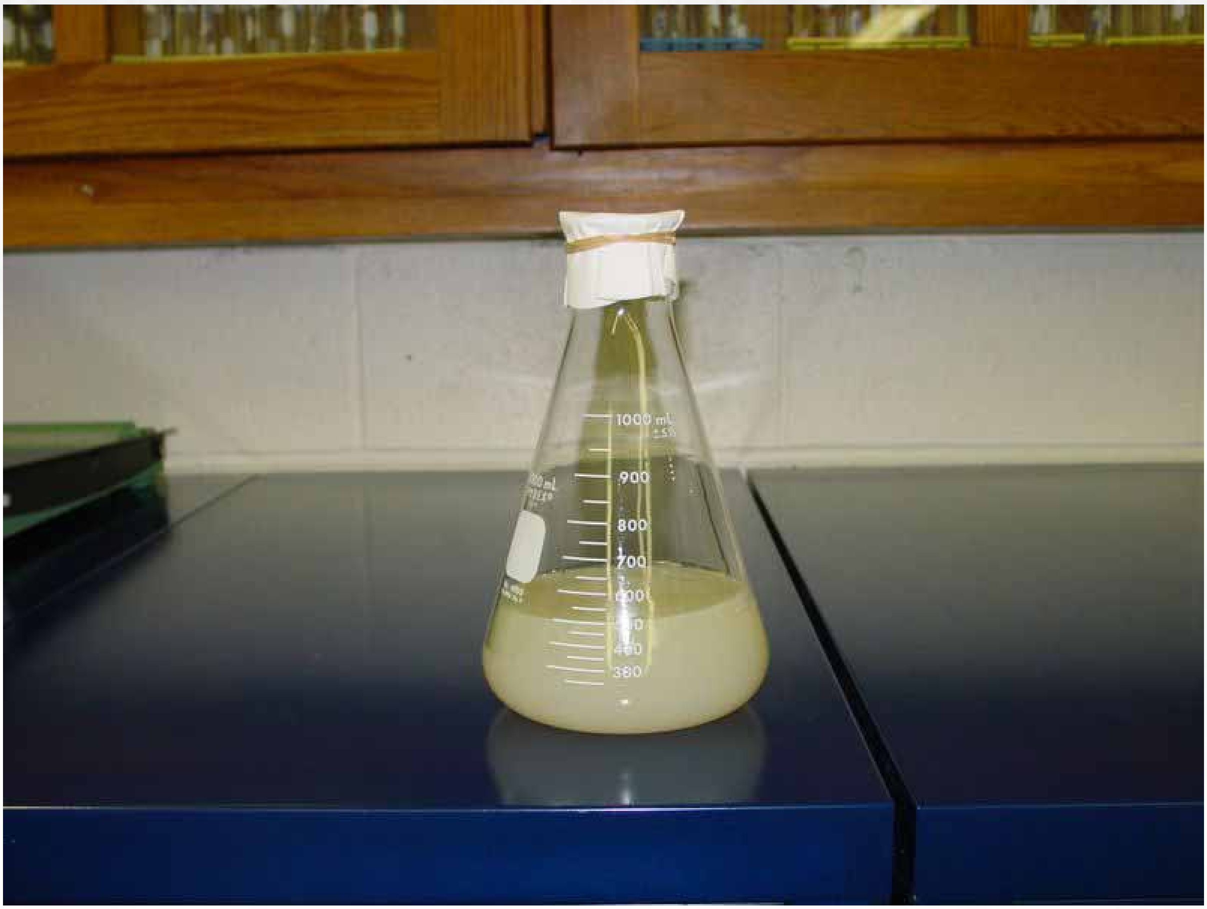


Filter the potato broth by pouring through the cheesecloth into the cylinder. Add distilled water if needed, to bring the volume in the cylinder to 1 liter. Add Dextrose and Yeast Extract to the melted Agar and swirl to mix. Mix filtered potato broth and Agar by pouring back and forth between the flask and the cylinder four times.


PLEASE WEAR
SAFTEY GLASSES
WHEN USING
PIPETTER
2000 mL
PYREX
1800 mL
1400
1000
600

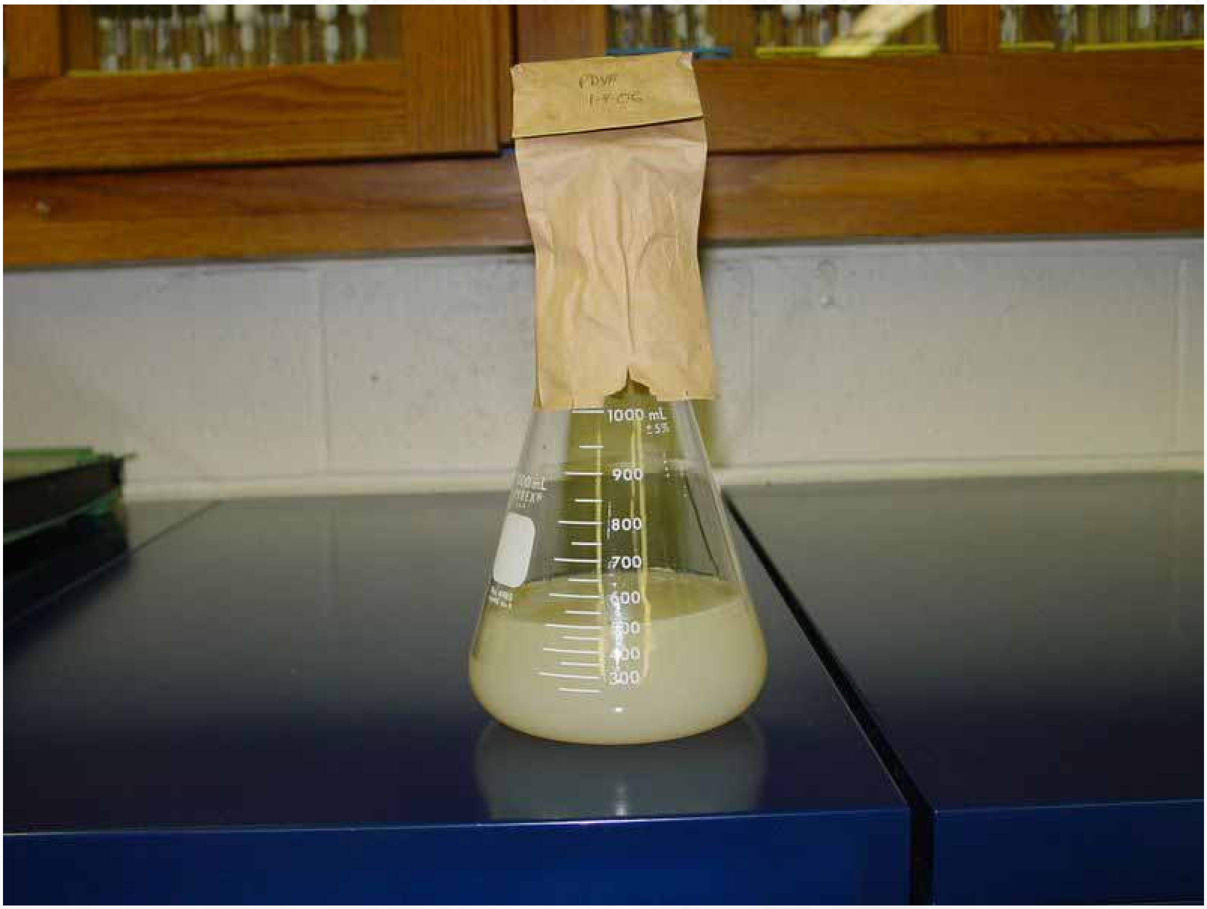
Pipet at once into Test tubes

If making test tubes, pipet at once using a pipeter. Make sure to flush pipeter with hot water when done.


1000 mL
900
800
700

OR For Making Plates

Place 500 ml of PDYA into 1-liter flask; cover with two sheets of filter paper and securing with a rubber band.


PDYA
1-7-06
1000 mL
±5%
900
800
700
600
500
400
300

Add Paper Bag
Cover the top of the flask with a small paper bag.

Sterilize
Autoclave test tubes and/or flask of PDYA for 15 minutes at 121 C. Slow exhaust.

Cooling Agar
Test tubes should be slanted on a slant board until set, about 3 hours. Plates can be poured once the PDYA flask is cool to the touch. For PDY Broth: made the same way but omitting agar. For Acide PDYA: add 1 ml Lactic Acid to liquid media just before pouring plates.

Honey Tek

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/honeytek.htm

This tek is a method for multiplying spore syringes by growing in liquid, specifically water mixed with honey. Honey is used because it is common and cheap, but substitution can be made of honey by malt extract/dextrose/corn sugar if available. The tek is flexible in that it can easily be done in different size jars as long as the proper ratio is maintained between the sugars and the water. The correct mixture for optimum results is 4% sugars {honey, malt} by weight and 96% water. Water weighs 1 gram per cc/ml so if you use 100 ml as total weight, then 96 grams/ml/cc of water is mixed with ~4 grams of honey, etc. (you must use dry sugar to be exact). See: Karo Tek

For those who figure that close is good enough, roughly 1 tablespoon of honey per pint will work.
The basic idea then is to get a jar with a good lid, canning jars like commonly used in pf tek work great.
The lid can be drilled and the hole covered with a filter disk or stuffed with polyfil to allow spores to be injected after the mix has been sterilized. Alternatively, one can use a glovebox and simply crack the lid a little to inoculate.

After the lid has been prepared, add the water and honey and stir until the honey dissolves. It's easier if warm water is used. Then tighten the lid and pressure cook or steam for 20 minutes. Don't overdo it because too much heat too long will ruin the mix by carmelizing the sugars.

After it cools to room temperature it is ready to be inoculated. Inject 1 or 2 cc's of spore solution into each jar. Alternatively, instead of spores, mycelial tissue from any part of any living shroom can be substituted.

Keep the inoculated jar warm in a clean environment. 86°F is ideal. Within several days, strands of mycelial tissue will appears and begin to grow. Allow it to grow at least several days then it is ready to use. You can draw up syringfuls through the polyfil/filter or open it inside a glovebox, etc. Try to get as much tissues as possible in the syringes, a nice thick mix will grow out very fast when used to inoculate jars, etc.
Store excess in clean refrigerator or discard within a few more days as the mix is best used fresh.
In the fridge, it can last until the sugar runs out, about a month or so, usually.

Liquid Culture Basics

original source: https://www.shroomery.org/9145/Liquid-Culture-Basics

Table of Contents:

Medium
Malt and Dextrose
Honey
Mixing
Vacu-tainers
Agitation
Microwave sterilization
Sediments
Aeration
Growth
Storage
Sugar carmelization
Boil sterilization
Notes

Liquid (tissue) cultures are used to expand mycelium into a liquid solution to inoculate your chosen substrate. Like a multi-spore syringe, except the spores have germinated into a network. Since the spores are already germinated; colonization times are substantially faster and inoculated substrates have an edge over contamination with speed.

In addition to the significant speed boost over MS (multi spore) inoculation, mycelium is not harmed by hydrogen peroxide (H_2O_2), so this can be added to your substrate to help reduce contamination. Normally you can not do this until the mycelium has started growing, because H_2O_2 kills the spores.

One spore syringe can be made into gallons of liquid culture. One spore print, agar culture and mushroom tissue can also make gallons.
Liquid cultures are economical, as 1cc from a spore syringe can supply you with a large volume of liquid inoculant which can be used on many jars/bags. Also if the liquid inoculant is a clone (generated from sectored agar or mushroom tissue), then each jar should show similar growth speeds and maturity.

Liquid cultures are normally at a 4% dilute solution of various sugars and other nutrients in water.This would be 4 grams of sugars per 96 ml/cc water. (Water weighs 1 gram per ml/cc.)

Medium

Some nutrient sources are:

- Karo (You want the clear one that has the red label; "Light with Vanilla". DO NOT get the dark Karo, such as the one containing brown sugar)
- Honey (Non-organic has been known to work, but organic honey is highly recommended.)
- Corn sugar
- Light malt extract (or extra light. The lighter the better, because it will make it easier to observe growth in the jar.)
- Dextrose (glucose)
- While only the above are recommended, because they have been tried and tested, other sources have been successfully used, such as organic maple syrup.

Household sugar (sucrose) shouldn't be used.

Dextrose alone is usually not recommended, but will work, due to the lack of additional nutrients its growth may be slower but due to its clarity it may be easier to spot contamination. Light malt extract and honey can be used alone. Additional nutrients can be added such as peptone, various flours could be used but it is much harder to determine the stage of mycelium growth due to cloudiness.

1 tablespoon of light malt extract and 1 tablespoon dextrose were weighed out. These are the weights;

1 tablespoon light malt extract = 10.3g
1 tablespoon dextrose = 10.1g
Give or take a point of a gram.

Malt and Dextrose

One member uses -
1 tablespoon dry malt extract or dextrose to 250ml (1 cup) water.

Another -
2% dextrose and 2% light malt extract.
This would equal close to 1/2 tablespoon dextrose and 1/2 tablespoon light malt extract per 250ml (1 cup) water.

Nanook from Nan's Nook uses -
1 level teaspoon dextrose (or light malt extract) to 75ml water.
-OR-
1 1/4 teaspoon dextrose (or light malt extract) to 100ml water.

Honey

4 cc/ml is the exact 4% ratio wanted. A syringe without the needle inserted is good to use as a measuring device. 1 teaspoon organic yellow honey to 100ml water is fairly close.

Note on ratio of solution

If your solution is a little off (3%-5%), don't worry. It'll still put out viable mycelium in most situations. It is better to be too weak a solution than too strong, too strong a sugar solution (around 10%) is toxic for the mycelium, and will not let anything grow in it (why jam is called preserve!)

Mixing

Once you have picked your method (which ever suits you best or is easiest to get) then its time to do some mixing.

Optionally, water can be hot or warm before adding sugars to allow for quicker dissolving.

Wrap top with aluminum foil and place jar in pressure cooker and slowly bring it up to 15 psi. for 15-20 min. Longer with Karo/Honey can cause carmelization.

Allow pressure cooker to cool before removing.

Vacu-tainers

You can bore a small hole big enough for a syringe needle in the top of a jar. (Half pints work best for this) Now put a blob of silicone sealant on it (preferable transparent) on both sides. Swirl it around to make sure it is a centimeter thick around the hole on each side. This is a self healing inoculation point so you can add spores and suck up inoculant without having to open the jar after sterilization. If you band the jar tight before pressure cooking, it will form a vacuum and suck in spores, so you must only prick the injection spot quickly. If you leave the band loose, you should tighten it right after the pressure cooker has cooled down, as it will not have a vacuum seal. You should always wipe your silicone injection spot and needle (flame sterilize before) with alcohol before inoculation.

Agitation

Some people add a piece of broken glass, a glass marble or a pebble to the jar before sterilization. Agitating allows you to cut up the mycellium which can form into an unsuckable clump in the jar. This is why wide (18 gauge or lower) needles are preferable.

A slightly more advanced method is adding a stir rod (or just a 1" piece of non-insulated wire) to the jar and using a magnetic stirring plate to agitate the mycelium. This is the preferred method of agitation because it doesn't have the potential to get your lid filter (polyfil for example) wet when you shake the jar, which can lead to contamination. Do it yourself (DIY) magnetic stirrers are pretty easy to make and there are a ton of guides available both on the Shroomery.org forums, and the Internet.

(TODO) Add links

Microwave sterilization

It is possible to sterilize honey/Karo in the microwave. Be sure to add more water to the mixture as it will boil off during heating leaving you with a more concentrated sugar solution (this does not occur in a pressure cooker). Do not use metal bands in the microwave. Plastic lids are sold next to the metal ones. Never put thin metal like tinfoil or syringe needles in the microwave. Bring the liquid to a boil, then turn to low/defrost for about 15 minutes. KEEP THE CAP LOOSE! Allow it to cool completely in the microwave for a few hours.

Sediments

Once removed, some sediments may be present.
To fix this, open up the jar and filter liquid through 2 coffee filters, stick liquid back in jar, cap with filter lid, and pressure cook again. If you have a lot of liquid you can decant it carefully into another jar leaving the sediment behind. (The sediments are not harmful but can be mistaken for mycelium growth, it is nicer to see clear growth) This should not be done with Karo/honey. After a few days with honey proteins may sink to the bottom or float around. After shaking these will re-mix.

Aeration

During sterilization/heating most of the oxygen will be driven out of the liquid. Shaking will help the network grow faster, but things like hooking up air flow to jars are not necessary. Be careful not to wet the filter patch (if using one) as this can cause contaminants to grow from the outside inwards through the filter.

Growth

Once inoculated by whatever means (spores, clone, agar), stick in a DARK place with a temp of 82-86F optimally, and room temperature if there is no incubator available. Signs of growth after one week max, and fully done at week 3 max. Some see growth in under a day and fully done in 3. Once growth has slowed down (done), either use immediately or store in a fridge.

Storage

Liquid cultures can be stored in a fridge for 6-8 months (or longer). Some add a little H_2O_2 (approx 1-3cc) at this point since the mycelium is able to handle it, this can help prevent contamination.

Sugar carmelization

With Karo and Honey, if you PC for too long your solution may turn yellowed. This is called caramelization and is over-baking of the sugars which may result in little or no growth at all. If this happens you can still try and grow a culture in the caramelized sugar jar, but if you are pressed for spores it is best to just start over. This is something you want to avoid. Liquids don't take very long to sterilize so you don't get any benefit from PCing for longer than 15-20 minutes max.

Boil sterilization

If you do not own a pressure cooker, boiling can also be used. Bring to a high rolling boil and boil your containers with water at least halfway up the jars for 20 minutes.

Notes

1 ml water weighs 1 gram.
1 tablespoon dextrose weighs ~10 grams. (may vary slightly)
1 tablespoon light malt extract weighs ~10 grams. (may vary slightly)
10 ml honey weighs 14 grams.
1 tsp (5 ml) honey = 7 g
1 tbsp (15 ml) honey = 21 g

The Effect of Light upon Basidiocarp Initiation in Psilocybe cubensis

by

E. R. Badham[1]

Department of Botany, University of Tennessee, Knoxville, Tennessee 37916

Mycologia, Vol. 72, No. 1. (Jan. - Feb., 1980), pp. 136-142.

Accepted for publication July 13, 1979

© E. R. Badham

original report:
https://psilosybiini.info/paperit/The%20effect%20of%20light%20upon%20basidiocarp%20initiation%20in%20Psilocybe%20cubensis%20(Badham,%201980).pdf
backup source:
http://www.psilosophy.info/resources/The%20effect%20of%20light%20upon%20basidiocarp%20initiation%20in%20Psilocybe%20cubensis%20(Badham,%201980).pdf

[1] Present address: Biology Department, Lehman College, Bronx, New York, 10468.

Table of Contents:

- **Summary**
- **Materials and Methods**
  - Culture isolate
  - Preparation of cultures
  - Light sources and filters
  - Scoring
- **Results**
  - Preliminary experiments
  - Dose-response experiments
  - Spectral-sensitivity experiments
  - Observations of cultures
- **Discussion**
- **Acknowledgments**
- **Literature Cited**

Summary

Formation of basidiocarp initials in *Psilocybe cubensis* occurred only when cultures were illuminated. Short durations of light (0.0025 sec of xenon-arc flash) were sufficient for initiation. Light-induced initiation was saturated at a dose of 0.345 x 10^4 ergs/cm^2 at 460 nm. UV and blue wavelengths of 370, 440, and 460 nm were the most effective. Green and red wavelengths greater than 510 nm were ineffective.

The requirement of light for basidiocarp initiation or development is well documented: Alasoadura, 1963; Lu, 1965; Manachière, 1970, 1978; Miller, 1967; Miller and Palmer, 1977; Plunkett, 1956, 1961. Chapman and Fergus (1973) found that the blue end of the spectrum at intensities above 1.5 x 10^4 ergs/cm^2/sec induced mature basidiocarp formation in *Coprinus domesticus* Fries, whereas green, red, and far red failed to induce initials. Kitamoto *et al*. (1970) studied initiation in *Favolus arcularis* (Fries) Ames and found that a half-maximal response is reached at 1.8 x 10^8 ergs/cm^2 (at 398 nm). Photoinduction was observed in the region between 350 and 560 nm and six peaks were described. Later Kitamoto *et al*. (1973) studied light-dependent pileus development in *Coprinus domesticus* and found the action spectra to be similar. Perkins and Gordon (1969) determined the action spectrum for basidiocarp initiation in *Schizophyllum commune* Fries. They showed that the dose response was linear up to a dose of approximately 1.1 x 10^5 ergs/cm^2 (at 440 nm). Spectral sensitivity peaked in the blue and UV. No light of wavelengths greater than 525 nm was photoinductive. Heim and Wasson (1958) reported that initials of *Psilocybe cubensis* (Earle) Sing. may be formed in darkness at elevated temperatures (27 C). Jackson and Alexopoulos (1976) stated that this species requires light for basidiocarp initiation (at 22-25 C).

The purpose of this study was to determine an action spectrum for basidiocarp initiation in *Psilocybe cubensis*.

Materials and Methods

Culture isolate

The isolate of *P. cubensis* used in this study was obtained during 1975 by allowing a basidiocarp to deposit basidiospores onto agar. A subculture was deposited with ATCC (#36359). The original basidiocarp is deposited in the University of Tennessee Herbarium (TENN 40476).

Preparation of cultures

An agar medium (Brodie, 1975) containing relatively low levels of sugars (maltose, dextrose, sucrose), asparagine, peptone, yeast extract, in addition to salts was used. Six ml of medium were poured and slanted in plastic test tubes (16 x 125 mm) giving a surface area of $3cm^2$. Inoculation of these tubes was made from stock cultures which were grown in the dark for 1 mo in plastic Petri plates (15 x 100 mm) with taped lids. One 3 x 3-mm cube was taken from these and placed in each slant tube. The slant tube caps were not tightly closed. These transfers were made under "safe" light (15-watt incandescent light filtered by a red filter, Carolina Biological Supply red, 650). The cultures were grown for 3 wk in well-ventilated but light-tight boxes. Both cultures and light sources were kept in a controlled temperature room at 21 C &plsmn; 2 and under relative humidity of 85% &plsmn; 15%. In most cases light treatments were given once per da for 5 da; the cultures were examined on da 6. Exposures were given at the same time each da. If manipulations were necessary they were accomplished under the same safe light described above.

Light sources and filters

Two preliminary experiments were conducted to determine: 1) the general wavelengths of importance for fruitbody initiation, and 2) the duration of light necessary for initiation. In the first of these, dark-grown cultures were illuminated for 12 h per da by Cool-white fluorescent lamps at 100 ft-c. filtered with broad-band filters: UV (Kodak 18-A) peak at 350 nm, blue (Carolina Biological Supply) peak at 450 nm, green (CBS) peak at 550 nm, and red (CBS) peak at 650 nm. In the second preliminary experiment the white light of a xenon-arc lamp (Honeywell photoflash) at 0.0005 sec per da was used to initiate fruitbodies.

Based on preliminary observations further experiments were conducted to determine: 1) the relative effectiveness of different doses of light, and 2) the relative effectiveness of different wavelengths of light. Both of these experiments used a 300-watt General Electric quartz-iodine projector lamp in conjunction with a 0.25-m Jarrell-Ash monochromater with 2-mm slits. The ½ band width was 15 nm. The lamp was placed 2.5 cm from the entrance slit and the cultures were placed at the exit slit. Using a spectroradiometer (International Light #783), equal light energies at different wavelengths were obtained by adjusting the voltage to the bulb. The light energy was adjusted to 23 ergs/sec/cm^2 at all wavelengths. Second-order spectra were eliminated for this calibration but were not eliminated when light was used to initiate cultures.

For dose-response experiments monochromatic light (460 nm) was used at eight different dosages to initiate fruitbodies. All cultures were illuminated once per da for 5 da and scored on da 6. For treatments providing doses greater than 0.345 x 10 ergs/cm^2 (23 ergs/sec/cm^2 per da for 5 da) an increase in the time of illumination was used to increase the dose. For treatments less than this amount neutral-density filters (Kodak) were used to decrease the dose. Ten cultures per treatment were used.

For spectral-sensitivity experiments approximately 30 cultures per light treatment were illuminated each da at 23 ergs/sec/cm^2 for 30 sec with monochromatic light of wavelengths from 370 to 510 nm and scored on da 5, 6, 7, or 8. Most replicates were scored on da 6 and those scored on other da were normalized to 6-da data for the interpretation of the results.

Scoring

For preliminary experiments cultures were scored for the presence of basidiocarp initials (here defined as the first "knots" of hyphae which are visible to the unaided eye and which can, under appropriate conditions, become basidiocarps). For further experiments an attempt was made to use a more precise method of scoring which involved: 1) the size and degree of development and 2) the number of initials per total area of the slanted tube. Numerical values for these categories were assigned as follows: size and degree of development - 0, rhizomorphs only, 1, flat aggregations of hyphae, 2, spherical initials 600 µm diam, 3, spherical initials 1,000 µm diam, 4, initials pyramidal in shape; for density of initials in the tubes - 1, 1-3 initials, 2, 4-8 initials, 3, 9-30 initials, 4, 31+ initials. A combination of these factors (the sum of the scores) was here termed the "degree of initiation" and was a useful quantitative index to the experimental induction of basidiocarp initiation.

Results

Preliminary experiments

When cultures were illuminated with light from Cool-white lamps filtered by broad-band filters only blue and UV-illuminated cultures formed fruitbody initials. When other cultures were illuminated with one 0.0005-sec flash/da for 5 da initials were present on the 6th da.

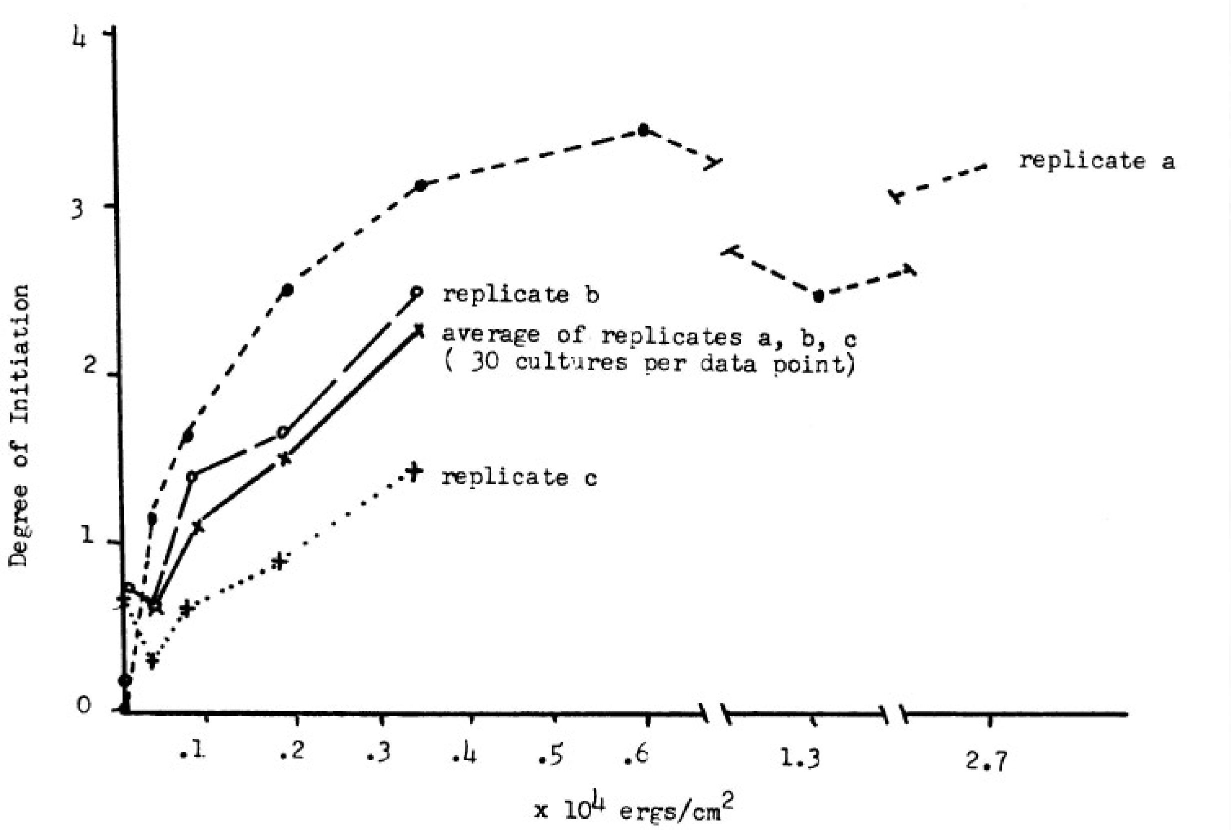


FIG. 1. Dose-response of *Psilocybe cubensis* to light. Eight different doses of monochromatic light (460 nm) used to initiate fruitbodies in dark-grown cultures. Average response approximately linear between 0.086 x 10^4 and 0.345 x 10^4 ergs/cm^2.

Dose-response experiments

This experiment was conducted to determine in what range of light doses a direct proportion exists between the light dose and the degree of initiation. Such a relationship, if it is linear, is called the Bunsen-Roscoe law of reciprocity. Proof of this relationship is essential to determination of action spectra because if, for example, a spectral-sensitivity study was conducted at doses above saturation all wavelengths would be equally active. As seen in FIG. 1 the average response is nearly linear in the range of 0.086 and 0.34 x 10^4 ergs/cm^2 at 460 nm. Also based on replicate "a," response is saturated at doses greater than 0.345 x 10^4 ergs/cm^2. Further studies concerning spectral sensitivity were conducted in the range of doses described above.

Spectral-sensitivity experiments

These experiments were used to determine the effect of different wavelengths of light on fruitbody initiation (action spectrum). The average degree of initiation at the various wavelengths is shown in FIG. 2.

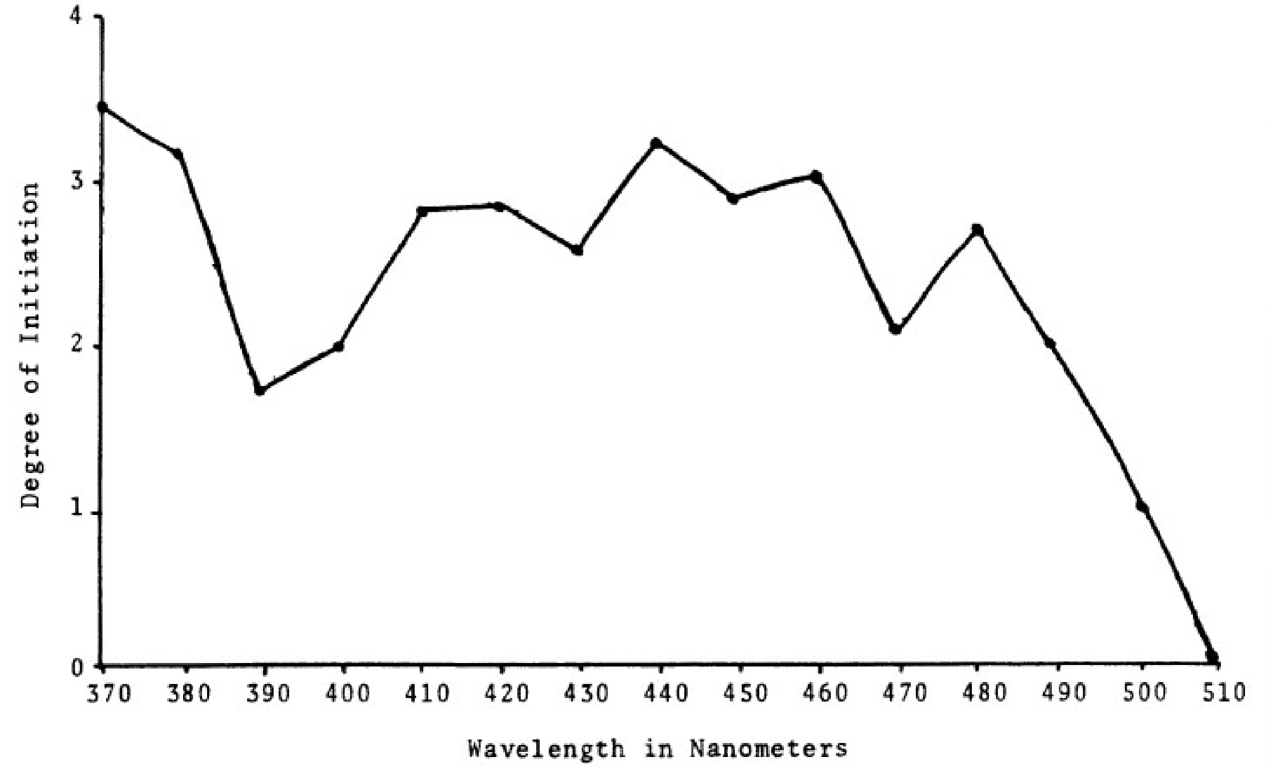


FIG. 2. Spectral sensitivity of photoinduction of basidiocarp initiation in *Psilocybe cubensis*.

Observations of cultures

Initiation did not occur in cultures that were not ventilated. Gases present in the atmosphere or those produced by metabolism may be responsible for this effect. Light has no effect on initiation before vegetative maturity is completed, i.e., the agar surface is covered by mycelium. In one case atypical initials were formed which increased in size as chestnut-colored spheres up to 5 mm diam. These structures contained spores and were grown at 10 C. In some sealed cultures one-celled conidia borne on clamped hyphae were noted (probably "ramifications acremoniformes," Heim and Wasson, 1958). Abnormalities in basidiocarp development were also noted, i.e., morchelloid forms (McKnight, 1971; Watling, 1971). Sometimes when primordia were developed under low levels of light a blue zone subtended the pileus. This zone is in the exact location of the phototrophic zone described by Plunkett (1961). The blue pigment has been related to the presence of hallucinogenic indoles (Singer, 1958) and its location might provide a clue to the role of these substances.

Discussion

This study provides another addition to the growing list of Basidiomycetes that require light for initiation or development. The low level of light necessary for initiation of basidiocarps in *Psilocybe cubensis* is in agreement with the requirements of other Basidiomycetes that have been studied and emphasizes the need for prudence in suggesting that certain mushrooms do not require light for fruitbody initiation (Heim and Wasson, 1958). Spectral-sensitivity studies show that at least two areas of the spectrum stimulate fruitbody initiation, the blue and the UV. This is characteristic for many photoresponses of fungi (Tan, 1978). Both action spectra determined for fruitbody initiation by Kitamoto *et al.* (1972) and Perkins and Gordon (1969) show relatively strong activity at 370 nm. Similarly strong activity at 440 and 480 nm (Kitamoto, 1972) and 420 and 480 nm (Perkins and Gordon, 1969) are in agreement with the present study. However, the peaks at 400 and 520 nm and the lack of activity at 460 nm (Kitamoto, 1972) are very unlike the results obtained in this study.

The observation that a lack of ventilation can inhibit basidiocarp initiation is well documented in the literature (Plunkett, 1956; Tschierpe, 1974). Additionally, the effect of maturity upon the ability of cultures to respond to photoinitiation has been previously reported (Lu, 1965).

Briggs (1976) suggested that the blue-light reactions in green plants and fungi are similar. If this is so then many of the known blue-lightmediated effects in green plants need to be reviewed for fungi. Of particular concern to this study is the connection between blue-light reactions and red-light reactions (phytochrome system) demonstrated by Chon and Briggs (1966). Since red light did not initiate fruitbodies it was considered appropriate as a "safe" light. This may be an incorrect assumption. Finally, although development after initiation seems to require light, it is not known if the action spectrum required is similar to that needed for initiation of basidiocarps.

Acknowledgments

I would like to thank Dr. Ronald Petersen, Dr. Larry Jones, and and Dr. Raymond Holton for guidance throughout this project. Also appreciation is extended to John Berg of the Ecology Department at the University of Tennessee for the use of the spectroradiometer. Dr. Abraham Held is acknowledged for his help in revision of the manuscript. This paper is part of a Master of Science Thesis submitted to the Botany Department at the University of Tennessee at Knoxville in March, 1978.

Literature Cited

1. Alasoadura, B. 0. 1963. Fruiting in *Sphaerobolus* with special reference to light. *Ann. Bot. (London)* 27: 123-145.
2. Briggs, W. R. 1976. The nature of the blue light photoreceptor in higher plants and fungi. Pp. 2-18. In: *The effect of light on higher plants*. Ed., H. Smith. Butterworths, Boston, Massachusetts
3. Brodie, H. J. 1975. *The bird's nest fungi*. Univ. of Toronto Press, Toronto, Canada. 198 p.
4. Chapman, E. S., and C. L. Fergus. 1973. An investigation of the effects of light on basidiocarp formation of *Coprinus domesticus*. *Mycopathol. Mycol. Appl*. 51: 315-326.
5. Chon, H. P., and W. R. Briggs. 1966. Effect of red light on the phototrophic sensitivity of corn coleoptiles. *PI. Physiol.* (*Lancaster*) 41: 1715-1724.
6. Heim, R., and G. Wasson. 1958. *Les champignons hallucinogenic du Mexique*. Museum National D'Histoire Naturelle, Paris. 322 p.
7. Jackson, R. E., and C. J. Alexopolous. 1976. *Psilocybe cubensis*, a comparison of Mexican and Texan types. *Southw. Naturalist* 21: 227-233.
8. Kitamoto, Y., A. Suzuki, and S. Furukawa. 1970. An action spectrum for light-induced primordium formation in a basidiomycete, *Favolus arcularis* (Fr) Ames. *Pl. Physiol.* (*Lancaster*) 49: 338-340.
9. Kitamoto, Y., A. Suzuki, and S. Furukawa. 1973. An action spectrum for photoinduction of pileus formation in a basidiomycete, *Favolus arcularis*. *Planta* 119: 81-84.
10. Lu, B. 1965. The role of light in the fructification of the basidiomycete, *Cyathus stercoreus*. *Amer. J. Bot.* 52: 432-437.
11. Manachère, G. 1970. Recherches physiologiques sur la fructification de *Coprinus congregatus* Bull. ex. Fr. *Ann. Sci. Nat. Bot. Biol*. 11: 1-95.
12. Manachère, G. 1978. Aspects photoperiodiques de la reproduction chez quelques champignons. *Bull. Soc. Bot. France* 125: 243-262.
13. McKnight, K. H. 1971. Cultural studies on *Psilocybe*. I Variation in a new species of the *P. coprophila* group. *Bull. Torrey Bot.* Club 98: 4-16.
14. Miller, O. K. 1967. The role of light in the fruiting of *Panus fragilis*. *Canad. J. Bot.* 45: 1939-1943.

15. Miller, O. K. and John G. Palmer. 1977. Effects of light quality on development of fruiting bodies of *Panus fragilis*. *USDA For. Serv. Res. Pap. FPL* 300: 1-20.
16. Perkins, J. H., and A. Gordon. 1969. Morphogenesis in *Schizophyllum commune*. II. Effect of monochromatic light. *Pl. Physiol.* (*Lancaster*) 44: 1712-1716.
17. Plunkett, B. E. 1956. The influence of factors of the aeration complex and light upon fruitbody form in pure cultures of an agaric and a polypore. *Ann. Bot*. (*London*) 20: 563-586.
18. Plunkett, B. E. 1961. The change in tropism in *Polyporus brumalis* stipes and the effect of directional stimulus on pileus differentiation. *Ann. Bot.* (*London*) 25: 206-223.
19. Singer, R. 1958. Mycological investigations on teconanacatl, the Mexican hallucinogenic mushroom: Part 1. *Mycologia* 50: 239-261.
20. Tan, K. K. 1978. Light induced fungal development. Pp. 334-357. *In: The filamentous fungi*. vol. 3. Eds., J. E. Smith and D. R. Berry. Edward Arnold, London.
21. Tschierpe, H. J. 1974. Environmental factors and mushroom growing. *Mushroom News* 22: 2-24.
22. Watling, R. 1971. Polymorphism in *Psilocybe medaria*. *New Phytol*. 70: 307-326.

Mushroom Composter Construction

How to generate superior compost for mushroom growing on a small scale

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/composter.html

Table of Contents:

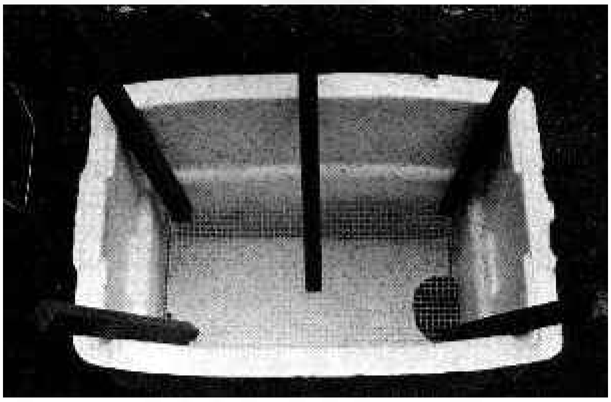
Materials needed to construct composter
Things to check for
To begin a compost run
Notes

This method uses a styrofoam picnic cooler with a steam humidifier and a common light dimmer (or variable transformer) to control the steam and compost temperature. The final product is about 3 gallons of pure pasteurized compost in just 6 to 7 days. Total cost for the bits and pieces to construct this composter should be no more than $30.

Materials needed to construct composter

- Styrofoam cooler
- Steam humidifier or vaporizer (VICKS Warm Mist or similar)
- Bottle, one gallon or larger
- Hose (2 feet) that will fit mouth/cap of the bottle
- Wooden sticks (5), each being 2 feet in length
- Single pole, solid-state dimmer switch
- Metal mesh screen (4 square feet with a 1/4" or 1/8" mesh size)
- Long stem thermometer, 120°C, scientific or kitchen (meat therm.)

The construction of the composter utilizes a styrofoam cooler, preferably one close to 14 inches by 22 inches by 15 inches deep in size. Six 3/4" holes, evenly spaced across the surface of the lid, are melted with a soldering iron or cut with a knife. Six more holes of the same size are melted or cut into the body of the cooler, three along each side, two inches up from the bottom edge. On the short sides of the cooler body, one hole is cut or melted on each side at the bottom edge. One of these holes is sized 1/2", and will serve for drainage. The other end has a hole cut just the right size to accommodate the steam output head or nozzle of the steam humidifier.



The bottom of the cooler is lined with aluminum foil, being careful to not obstruct the drain or steam inlet. A screen support is made from the 1/4" or 1/8"-mesh screen (sometimes called hardware cloth). The screen is cut 8 inches larger than the dimensions of the bottom of the cooler. 4 inches of screen are folded 90° at each edge to form supports, which hold the surface of the screen 4 inches above the bottom. The compost sits on the top surface of the screen so that the steam can flow evenly underneath the compost. This screen support should fit the bottom of the cooler without large gaps around the edges.

A single-pole solid-state dimmer is used to control the humidifier power. Good wiring and insulating procedures need to be followed. If you aren't knowledgeable about wiring, find someone who can help. It is important for safety that the wiring be correctly installed. The best method is to wire the dimmer switch (in a plastic electrical switch box) to both the power-cord of the humidifier (cut off the plug end[male]). Then take an extension cord (cut off the plug end[female]) and wire it to the dimmer switch.

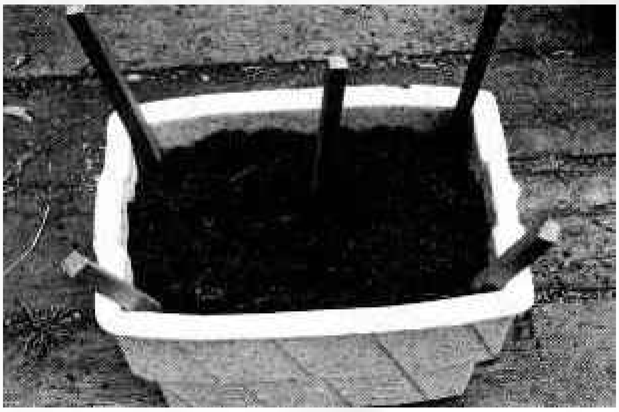
Things to check for

1. The maximum capacity of the dimmer switch (in Watts) should be greater than the load imposed by the humidifier. (almost all dimmers have the necessary rating)

2. The wiring methods should be well insulated and suitable for the damp environment it will be used in.

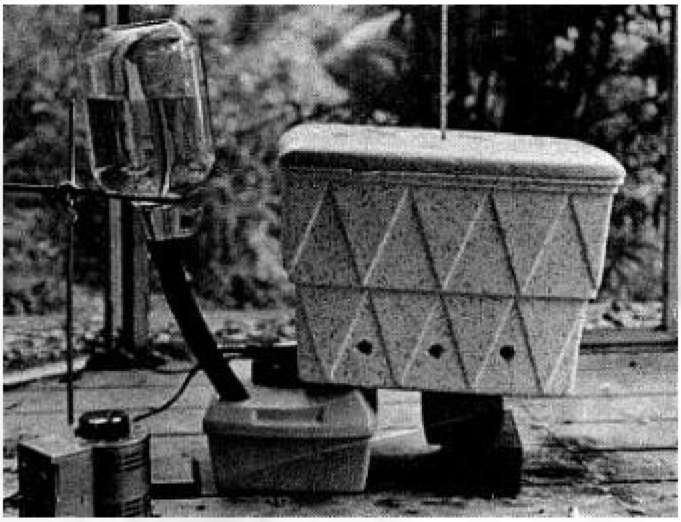
Finally, a water reservoir is constructed. Arrangements are made to secure a one-gallon or larger water bottle above the humidifier. A 1 and 1/2-inch hole is cut in the top surface of the humidifier body to accommodate the hose. The humidifier is filled with water to the "fill" line, and the hose is inserted so that the open end of the hose hangs 1/2-inch below the fill line. In this way a constant level of water is maintained in the humidifier, which makes the steam output constant for a given dimmer setting. It is important to maintain accurate steam/temperature settings during a composting run. During a run, the humidifier electrodes must be cleaned at least every other day, or output will be seriously effected. Using distilled water is a slightly expensive option to regular cleaning.

Before the first time a composter is used, it is best to set it up where in the final location, tape all the holes closed except the drain hole and the humidifier nozzle hole on the bottom, fill up the humidifier and reservoir jug with water and turn on the humidifier at full power dimmer setting allowing the cooler to steam for 4 hours or so to eliminate any plastic or chemical odors and to test your composter's operation.



To begin a compost run

Mix in a bucket, approximately 2 and 1/2-gallons of shredded straw with 1 gallon shredded dry fresh manure (cow or horse). Mix in 3 to 4 ounces cottonseed meal or 1 to 2 ounces blood meal (nitrogen sources, available at most plant nurseries). Add 3 and 1/2-quarts of hot water, preferably with a sprayer, and mix thoroughly. This warm mixture is loaded into the cooler without delay, loosely filling the cooler to within 1 to 2 inches of the top. Five sticks are placed in the cooler before adding the compost mixture, so that after the compost is loaded, 2-inch square ventilation shafts can be created by wiggling each of the sticks around. The sticks are withdrawn, and the lid put in place, all the vent holes are taped shut except the one on the lid furthest from the steam nozzle, and the dimmer set on maximum. The thermometer is placed through the untaped hole so that it is measuring the middle of the compost.



During the first phase of the run pasteurization occurs, killing all insect life. Note that this is opposite of how it is done at a commercial mushroom farm or in outdoor nature composting, where pasteurization is done at the end of a composting run. After about 2 hours of full power steaming, the temperature should rise to approximately 65°C (60° to 70°). Quoted temperatures are only a rough guide, try to maintain the temperatures within the given ranges. For this first phase it is necessary to reach a minimum of 60°C. Once the temperature reaches 60°C check the time and let the compost remain above 60°C. for 3 to 4 hours.

At the end of this time remove all the tape from the ventilation holes and leave the dimmer setting on full. Within a day ammonia will be noticeable in the exhaust steam and the temperature should be 55 to 65°C. Hold this temperature for 2 to 3 days. After the first day the ammonia odor should disappear. After this happens, white fire fang, or *actinomycete* fungi, will be apparent in the compost. It is best to allow the compost run to proceed undisturbed, but if you wish to check it is okay to briefly lift the lid and move the compost surface. Don't allow the compost to cool during any brief investigations. At the end of the 3 days *actinomycete* should be prominent and there should be no ammonia smell. If not, extend the high temperature phase for up to an additional day.

The dimmer setting is now lowered slowly so that the compost temperature drops 2° to 3° every 2 to 3 hours, until a temperature around 50°C is reached (45° to 55°). The compost is then held at this lower temperature for 3 to 4 days. At the end of this time the power is turned off and the compost is allowed to cool slowly inside the closed cooler. It is ready to lay out and spawn when the temperature cools to 24° to 28°C. It is best to spawn the compost immediately after it has cooled, although it can be stored for a few weeks if necessary.

The compost made in this way is usually excellent, comparable to the best commercial mushroom farm compost. An added benefit is that new compost recipes can be experimented with in small quantities and in short time frames. One extra is that the drain water makes an exceptional organic fertilizer for houseplants.

Notes

1. The formula for compost here is very basic. With trial and error many materials can be formulated into usable compost. In particular, it is important to mix for the correct carbon / nitrogen ratio (saccharides / protein). Any properly balanced mixture suitable for large scale composting is suitable for use in this composter. Very useful tables of compost ingredients are included in *The Mushroom Cultivator* and *Growing Gourmet and Medicinal Mushrooms*, both by Paul Stamets.

2. Some species of mushrooms culture well on ordinary pasteurized straw with no additions. This composter is ideal to pasteurize straw. It is much simpler and more accurate than immersion in hot water or other methods. Just load with shredded dried straw and pasteurize at greater than 60° for 4 to 6 hours. Allow to cool slowly covered, and spawn when the temperature is less than 28°C. Typically the straw will be at proper moisture content when unloaded.

Compost Tek

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/composttek.htm

Table of Contents:

Phase I: Making Mushroom Compost
Phase II: Finishing the Compost

This tek is for large scale composting but could be modified for a smaller scale operation.
Mushroom farming consists of six steps, and although the divisions are somewhat arbitrary, these steps identify what is needed to form a production system.

The six steps are Phase I composting, Phase II composting, spawning, casing, pinning, and cropping.
These steps are described in their naturally occurring sequence, emphasizing the salient features within each step.

Compost provides nutrients needed for mushrooms to grow. Two types of material are generally used for mushroom compost, the most used and least expensive being wheat straw-bedded horse manure.
Synthetic compost is usually made from hay and crushed corncobs, although the term often refers to any mushroom compost where the prime ingredient is not horse manure. Both types of compost require the addition of nitrogen supplements and a conditioning agent, gypsum.

The preparation of compost occurs in two steps referred to as Phase I and Phase II composting. The discussion of compost preparation and mushroom production begins with Phase I composting.

Phase I: Making Mushroom Compost

This phase of compost preparation usually occurs outdoors although an enclosed building or a structure with a roof over it may be used. A concrete slab, referred to as a wharf, is required for composting. In addition, a compost turner to aerate and water the ingredients, and a tractor-loader to move the ingredients to the turner is needed. In earlier days piles were turned by hand using pitchforks, which is still an alternative to mechanized equipment, but it is labor intensive and physically demanding.

Phase I composting is initiated by mixing and wetting the ingredients as they are stacked in a rectangular pile with tight sides and a loose center. Normally, the bulk ingredients are put through a compost turner. Water is sprayed onto the horse manure or synthetic compost as these materials move through the turner. Nitrogen supplements and gypsum are spread over the top of the bulk ingredients and are thoroughly mixed by the turner. Once the pile is wetted and formed, aerobic fermentation (composting) commences as a result of the growth and reproduction of microorganisms, which occur naturally in the bulk ingredients. Heat, ammonia, and carbon dioxide are released as by-products during this process. Compost activators, other than those mentioned, are not needed, although some organic farming books stress the need for an "activator."

Mushroom compost develops as the chemical nature of the raw ingredients is converted by the activity of microorganisms, heat, and some heat-releasing chemical reactions. These events result in a food source most suited for the growth of the mushroom to the exclusion of other fungi and bacteria. There must be adequate moisture, oxygen, nitrogen, and carbohydrates present throughout the process, or else the process will stop. This is why water and supplements are added periodically, and the compost pile is aerated as it moves through the turner.

Gypsum is added to minimize the greasiness compost normally tends to have. Gypsum increases the flocculation of certain chemicals in the compost, and they adhere to straw or hay rather than filling the pores (holes) between the straws. A side benefit of this phenomenon is that air can permeate the pile more readily, and air is essential to the composting process. The exclusion of air results in an airless (anaerobic) environment in which deleterious chemical compounds are formed which detract from the selectivity of mushroom compost for growing mushrooms. Gypsum is added at the outset of composting at 40 lbs. per ton of dry ingredients.

Nitrogen supplements in general use today include brewer's grain, seed meals of soybeans, peanuts, or cotton, and chicken manure, among others. The purpose of these supplements is to increase the nitrogen content to 1.5 percent for horse manure or 1.7 percent for synthetic, both computed on a dry weight basis. Synthetic compost requires the addition of ammonium nitrate or urea at the outset of composting to provide the compost microflora with a readily available form of nitrogen for their growth and reproduction.

Corn cobs are sometimes unavailable or available at a price considered to be excessive. Substitutes for or complements to corn cobs include shredded hardwood bark, cottonseed hulls, neutralized grape pomace, and cocoa bean hulls. Management of a compost pile containing any one of these materials is unique in the requirements for watering and the interval between turning.

The initial compost pile should be 5 to 6 feet wide, 5 to 6 feet high, and as long as necessary. A two-sided box can be used to form the pile (rick), although some turners are equipped with a "ricker" so a box isn't needed. The sides of the pile should be firm and dense, yet the center must remain loose throughout Phase I composting. As the straw or hay softens during composting, the materials become less rigid and compactions can easily occur. If the materials become too compact, air cannot move through the pile and an anaerobic environment will develop.

Turning and watering are done at approximately 2-day intervals, but not unless the pile is hot (145° to 170°F). Turning provides the opportunity to water, aerate, and mix the ingredients, as well as to relocate the straw or hay from a cooler to a warmer area in the pile, outside versus inside. Supplements are also added when the ricks are turned, but they should be added early in the composting process. The number of turnings and the time between turnings depends on the condition of the starting material and the time necessary for the compost to heat to temperatures above 145°F.

Water addition is critical since too much will exclude oxygen by occupying the pore space, and too little can limit the growth of bacteria and fungi. As a general rule, water is added up to the point of leaching when the pile is formed and at the time of first turning, and thereafter either none or only a little is added for the duration of composting. On the last turning before Phase II composting, water can be applied generously so that when the compost is tightly squeezed, water drips from it. There is a link between water, nutritive value, microbial activity, and temperature, and because it is a chain, when one condition is limiting for one factor, the whole chain will cease to function. Biologists see this phenomenon repeatedly and have termed it the Law of Limiting Factors.

Phase I composting lasts from 7 to 14 days, depending on the nature of the material at the start and its characteristics at each turn. There is a strong ammonia odor associated with composting, which is usually complemented by a sweet, moldy smell. When compost temperatures are 155°F and higher, and ammonia is present, chemical changes occur which result in a food rather exclusively used by the mushrooms. As a by-product of the chemical changes, heat is released and the compost temperatures increase. Temperatures in the compost can reach 170° to 180°F during the second and third turnings when a desirable level of biological and chemical activity is occurring. At the end of Phase I the compost should: a) have a chocolate brown color; b) have soft, pliable straws, c) have a moisture content of from 68 to 74 percent; and d) have a strong smell of ammonia. When the moisture, temperature, color, and odor described have been reached, Phase I composting is completed.

Phase II: Finishing the Compost

There are two major purposes to Phase II composting. Pasteurization is necessary to kill any insects, nematodes, pest fungi, or other pests that may be present in the compost. And second, it is necessary to remove the ammonia which formed during Phase I composting. Ammonia at the end of Phase II in a concentration higher than 0.07 percent is often lethal to mushroom spawn growth, thus it must be removed; generally, a person can smell ammonia when the concentration is above 0.10 percent.

Phase II takes place in one of three places, depending on the type of production system used. For the zoned system of growing, compost is packed into wooden trays, the trays are stacked six to eight high, and are moved into an environmentally controlled Phase II room. Thereafter, the trays are moved to special rooms, each designed to provide the optimum environment for each step of the mushroom growing process. With a bed or shelf system, the compost is placed directly in the beds, which are in the room used for all steps of the crop culture. The most recently introduced system, the bulk system, is one in which the compost is placed in a cement-block bin with a perforated floor and no cover on top of the compost; this is a room specifically designed for Phase II composting.

The compost, whether placed in beds, trays, or bulk, should be filled uniformly in depth and density or compression. Compost density should allow for gas exchange, since ammonia and carbon dioxide will be replaced by outside air.

Phase II composting can be viewed as a controlled, temperature-dependent, ecological process using air to maintain the compost in a temperature range best suited for the de-ammonifying organisms to grow and reproduce. The growth of these thermophilic (heat-loving) organisms depends on the availability of usable carbohydrates and nitrogen, some of the nitrogen in the form of ammonia.

Optimum management for Phase II is difficult to define and most commercial growers tend toward one of the two systems in general use today: high temperature or low temperature.

A high temperature Phase II system involves an initial pasteurization period during which the compost and the air temperature are raised to at least 145°F for 6 hours. This can be accomplished by heat generated during the growth of naturally occurring microorganisms or by injecting steam into the room where the compost has been placed, or both. After pasteurization, the compost is re-conditioned by immediately lowering the temperature to 140°F by flushing the room with fresh air. Thereafter, the compost is allowed to cool gradually at a rate of approximately 2° to 3°F each day until all the ammonia is dissipated. This Phase II system requires approximately 10 to 14 days to complete.

In the low temperature Phase II system the compost temperature is initially increased to about 126°F with steam or by the heat released via microbial growth, after which the air temperature is lowered so the compost is in a temperature range of 125° to 130°F range. During the 4 to 5 days after pasteurization, the compost temperature may be lowered by about 2°F a day until the ammonia is dissipated.

It is important to remember the purposes of Phase II when trying to determine the proper procedure and sequence to follow. One purpose is to remove unwanted ammonia. To this end the temperature range from 125° to 130°F is most efficient since de-ammonifying organisms grow well in this temperature range. A second purpose of Phase II is to remove any pests present in the compost by use of a pasteurization sequence.

At the end of Phase II the compost temperature must be lowered to approximately 75° to 80°F before spawning (planting) can begin. The nitrogen content of the compost should be 2.0 to 2.4 percent, and the moisture content between 68 and 72 percent. Also, at the end of Phase II it is desirable to have 5 to 7 lbs. of dry compost per square foot of bed or tray surface to obtain profitable mushroom yields. It is important to have both the compost and the compost temperatures uniform during the Phase II process since it is desirable to have as homogenous a material as possible.

Worm Composting

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/Worm_Compost.html

Table of Contents:

General information
How You Do It
What You Need
Harvesting Your Compost
Common Problems

General information

Worms can compost rubbish faster than any other type of composting method. Worms also are very efficient in digesting kitchen food wastes. Each day a worm eats half its weight in food. The care and feeding of worms take far less effort than maintaining an outdoor compost pile. Some of the benefits of keeping a worm bin include: recycling kitchen food waste, reducing waste disposal costs, producing soil amendments or fertiliser for house and garden plants, and having a ready supply of fishing worms.

worms

A worm bin is a self-contained system. As with any system, several components are involved.

Red worms are the most satisfactory worms to use in a home vermicomposting (composting with worms) system. The species of red worm best suited for a worm bin is Eisenia foetida pronounced "I see nee a fet id a." Eisenia Foetida is known by several common names: red worm, brandling worm, red wriggler, manure worm, and fish worm among others. Starter worms of this species for a worm bin may be found in old compost piles (ones that no longer generate any heat) or from local bait suppliers.

Once the worm bin is constructed, make bedding for the worms with shredded and moistened newspaper or cardboard. Maintain the system by burying food wastes throughout the bin on a rotational basis. Every three to six months move the compost to one side of the bin and add new bedding to the empty half. The worms will soon move to the new bedding. Harvest the compost and add new bedding to the rest of the bin.

How You Do It

This system is composed of a box to contain the worms (see back for a description of how to build a worm bin); the worms themselves; a controlled environment; and regular maintenance procedures. Worm compost is made in a container filled with moistened bedding and red worms. Add food waste and with assistance from micro-organisms, the worms will convert bedding and food waste into compost. Worm composting can be done year-round, indoors in schools, offices and homes. It is a natural method for recycling nutrients in food waste without odour. The resulting compost is a good soil conditioner for houseplants, gardens and patio containers.

What You Need

1. A container (made of wood or plastic)
2. Worms (500-2,000 red worms)
3. Bedding (shredded newspaper, corrugated cardboard and/or leaves)
4. Kitchen waste (fruit and vegetable waste)

1. The Container

Buy or build a container (see How to Make a Wormbin) or use an old dresser drawer, box or barrel. Wood containers are absorbent and good insulators for worms. Plastic containers do work but compost tends to get quite wet and may need more drainage. Raise the bin on bricks or wooden blocks for air circulation. Place a tray underneath to capture excess liquid, which can be used as liquid plant fertiliser. Some newer containers replace drainage holes in the bottom with a venting system higher in the container.

Worms like a moist, dark environment. Their bodies are 75 to 90 per cent water and worms' body surfaces must be moist for them to breathe. Cover the bin to conserve moisture and provide darkness. Indoors, place a sheet of dark plastic or burlap sacking on top of the bedding. Outdoors, use a solid lid to keep out unwanted scavengers and rain.

Worm bins can be located in a cellar, shed, garage or balcony. They need to be kept out of the hot sun, heavy rain and cold. When temperatures drop below 4 degrees C, bins should be kept in a frost-free place, heated or well insulated. The container can be heated with an electric heating cable placed in the bottom third of the container. To insulate, surround the container with (5 - 7.5cm.) rigid polystyrene, which can be bought from a builder's merchant.

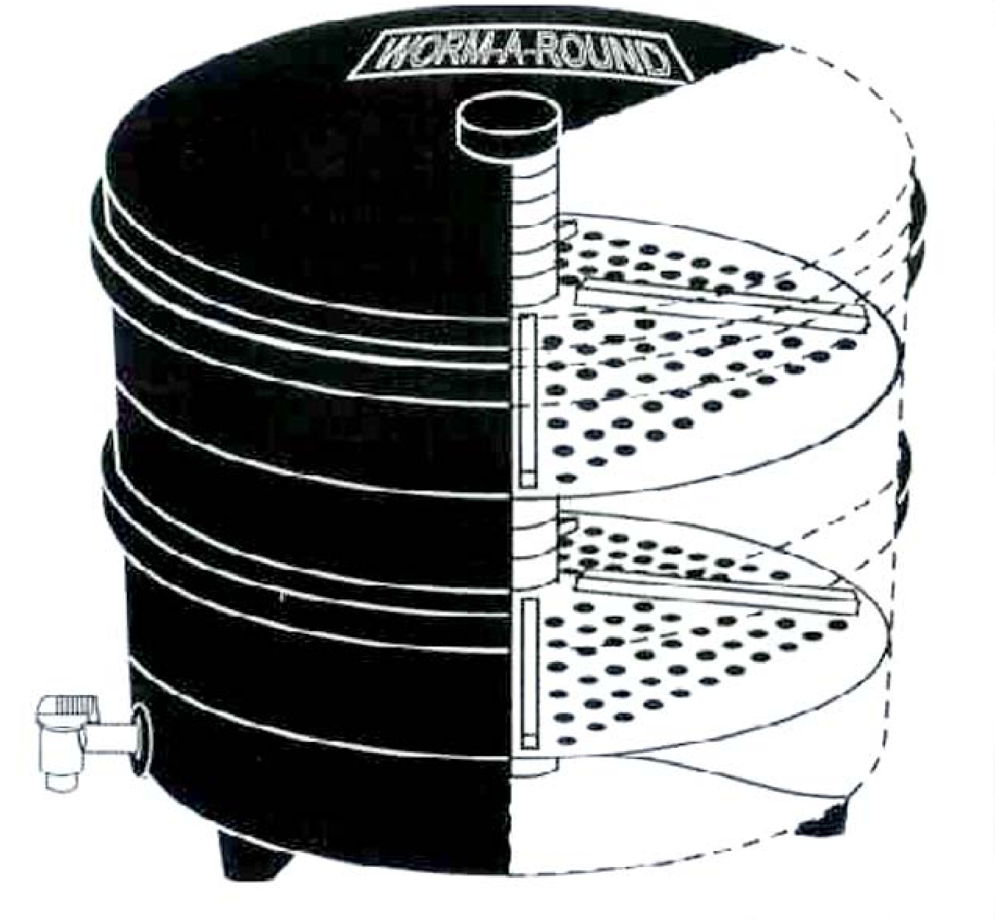
covering bedding with soil (previous compost) with worms

plastic container indoor

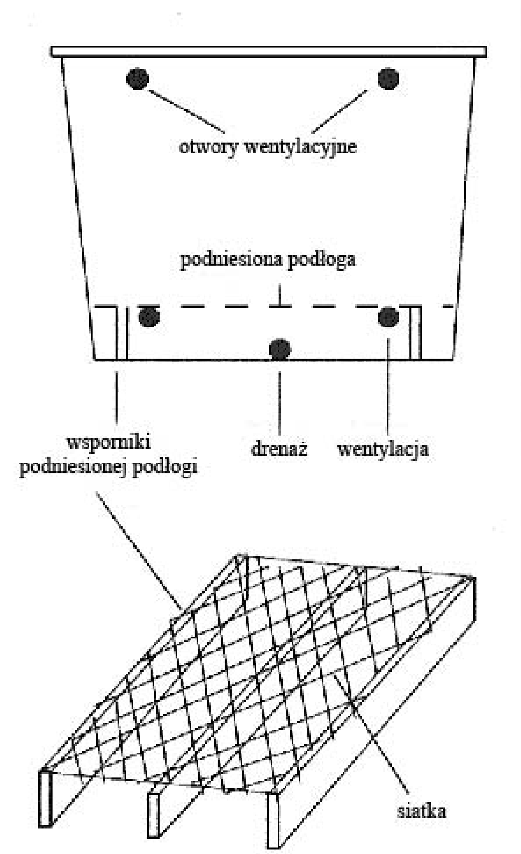
worm pals covering cement garden composter
at down right corner metal bucket

another worm pal with his garden composter

handy plastic container with ventilation holes


WORM-A-ROUND

drawing of special wormbin composter on a small scale


otwory wentylacyjne
podniesiona podłoga
wsporniki podniesionej podłogi
drenaż
wentylacja
siatka

schematic view of wormbin

2. The Worms

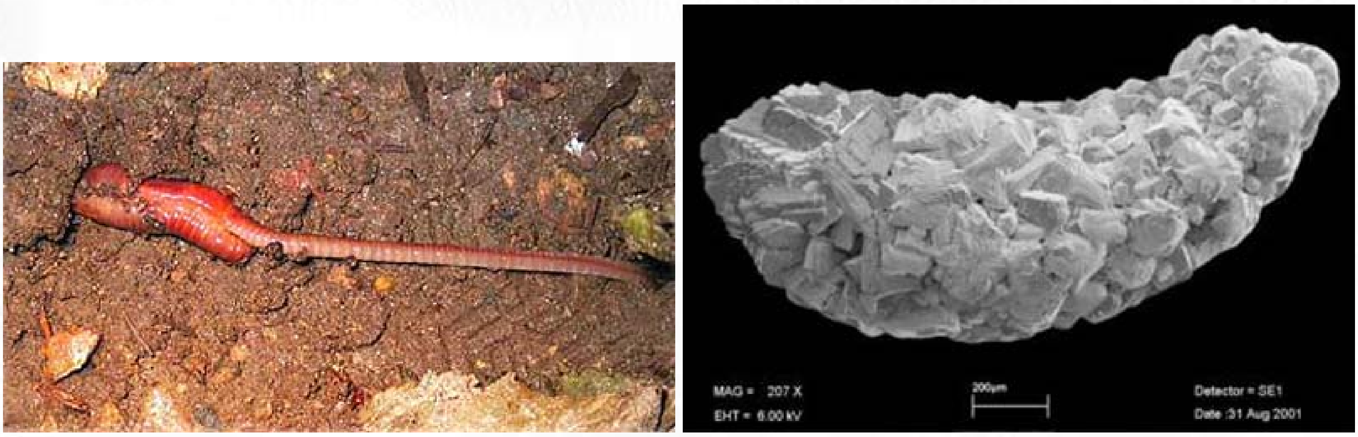
Red worms are best suited to worm composting. They are often found in aged manure, compost heaps, and piles of leaves. They are also known as red wriggler, brandling and manure worms. Their official names are Eisenia foetida and Lumbricus rubellus. Red worms are best suited for composting because they thrive on organic material, such as food waste. Earthworms, on the other hand, are better suited to life in the soil and shouldn't be used in a worm bin.
You can get your worms from an existing compost bin, purchase them or find a horse stable or farmer with an aged manure pile.

Red worms mature sexually in 60-90 days and can then produce cocoons, which take 21 days to hatch baby worms. Once they start breeding they can deposit two to three cocoons per week with two baby worms in each cocoon. The limits on their reproduction include availability of food and room to move and breed. So worm populations don't usually exceed the size of the container.

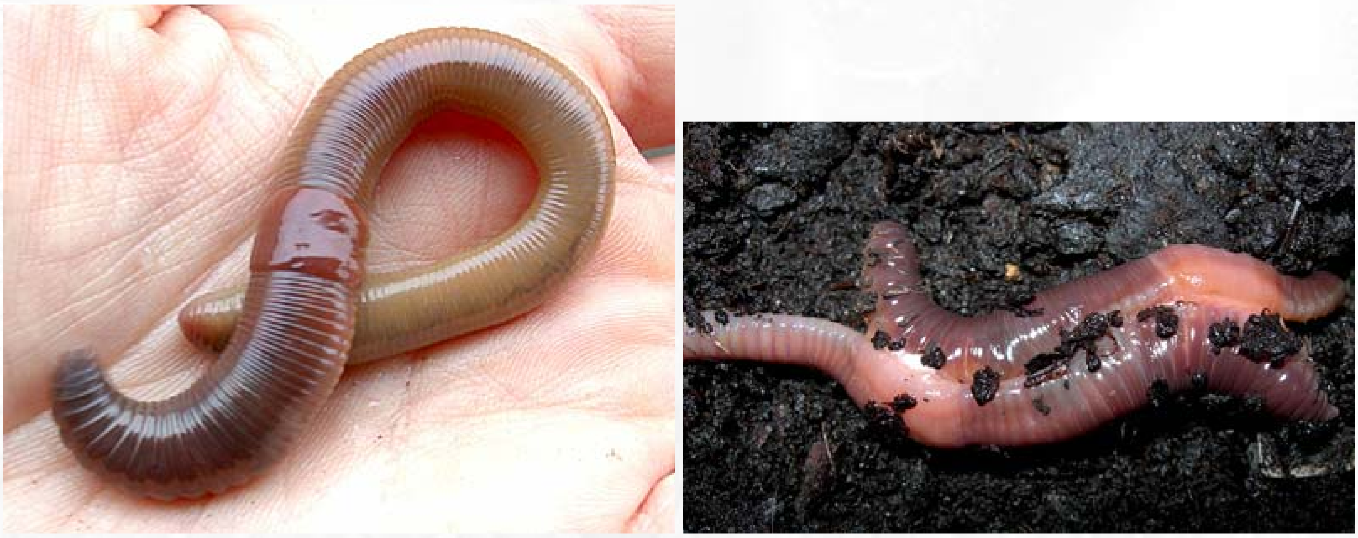
Eisenia foetida

3
4
5
6
7
8
1
10
cm

Lumbricus rubellus



Lumbricus rubellus and its cocoon



Lumbricus terrestris mating specimens at right

Lumbricus terrestris

3. The Bedding

Provide damp bedding. Suitable bedding material includes shredded newspaper and cardboard, shredded fall leaves, chopped-up straw and other dead plants, seaweed, sawdust, dried grass clippings, aged manure and peat moss. Peat moss is quite acidic and should be well soaked and combined with other bedding material. Vary the bedding in the bin to provide more nutrients for the worms and to create richer compost. Two handfuls of sand or soil will provide the necessary grit for worms' digestion of food.

Fill the bin with a mixture of damp bedding so the overall moisture level is like a "wrung-out sponge." Lift the bedding gently to create air spaces. This maintains aerobic activity, helps control odours and gives the worms freer movement.

4. The Food Waste

Your worms will eat any soft organic food scraps such as vegetable waste generated during food preparation, potato peelings, vegetable peelings, grapefruit and orange rinds, cantaloupe and watermelon rinds, outer leaves of cabbage and lettuce. Plate scrapings, spoiled food from the refrigerator, coffee grounds, tealeaves or eggshells are wastes that you may want to feed your worms.

To avoid potential rodent problems do not add cooked meats; decaying meat can produce offensive odours, dairy products, oily foods or grains.
Needless to say such things as glass, plastic, tin foil, wire ties, bottle caps, rubber bands and heavy shiny type paper should not be put in the wormbin.

For the first couple of weeks, collect food wastes in a container and weigh it. Do this for two weeks to get an estimate of average food waste. Your bin should provide one square foot of surface area for every pound of food waste per week. And you will need two pounds of worms for every pound of food waste per day. Once the worm colony has settled down and established itself, the waste can be put directly in the wormery.

Harvesting Your Compost

After six weeks, the bedding will be noticeably darker with worm castings. After two and a half months have passed, there will still be some of the original bedding visible in the bin plus brown and earthy-looking worm castings. Although food waste is being added regularly, the bedding volume will gradually decrease. As more bedding is converted into castings the worms will begin to suffer. It is time to decide whether you want to do "some fuss" or "more fuss" worm composting.

"Some Fuss" Harvesting
Some fuss worm composting involves moving the finished compost over to one side of the bin, placing new bedding in the space created, and placing food waste in the new bedding. The worms will gradually move over to the fresh bedding and food waste, and the finished compost can be harvested. Fill the space created with new damp bedding.

"More Fuss" Maintenance
If you want to use all of the compost at once, dump the bin's entire contents onto a large plastic sheet and make piles of material. Use sunshine or a hundred watt light bulb to drive the worms to the bottom of the piles. Worms don't like bright light because the single cells on the epidermis (skin) react to light. Scoop off the tops of each pile until all you have left is the worms. Most children love to help! Watch out for the tiny, lemon-shaped worm cocoons that contain the baby worms. Mix a little of the finished compost in with the new bedding of the next bin.

Show a Little Respect
We must act responsibly if we take worms out of their natural environment and place them in containers. They are living creatures with their own unique needs, so it is important to create and maintain a healthy habitat for them to do their work. If you supply the right ingredients and care, your worms will thrive and make compost for you.

Common Problems

Unpleasant Odours
Unpleasant odours may waft from your bin when it is overloaded with food waste. If this occurs, gently stir up the contents to allow more air in. Stop adding food waste until the worms and micro-organisms have broken down what food is already in the bin. Check the drainage holes to make sure they are not blocked and drill more holes if needed. If the moisture level seems right, the bedding may be too acidic from citrus peels and

other acidic foods. Adjust by cutting down on acidic wastes.

Fruit Flies

Fruit flies aren't harmful, but they are a nuisance, and a very common problem with worm bins. Discourage fruit flies by always burying the food wastes and not overloading the bin. Keep a plastic sheet; piece of old carpet or a lid on the compost's surface in the bin. Unfortunately there is no easy answer to the fruit fly problem but adding a spider or two helps reduce fruit flies. If flies persist, move the bin to a location where flies will not be bothersome.

shapely specimens of fruit flies

Culture source and cloning

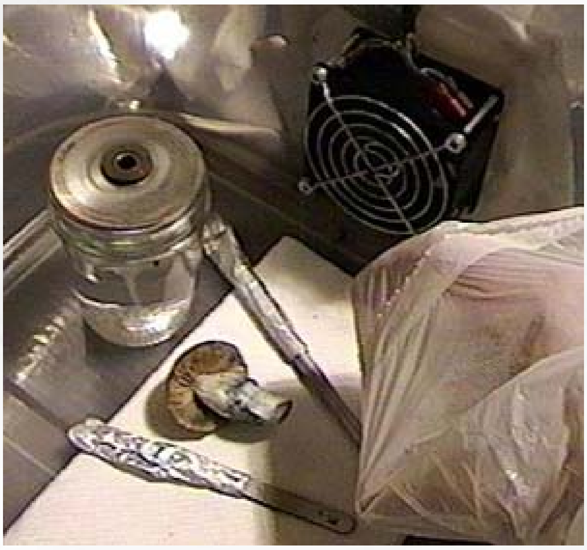
by

9er

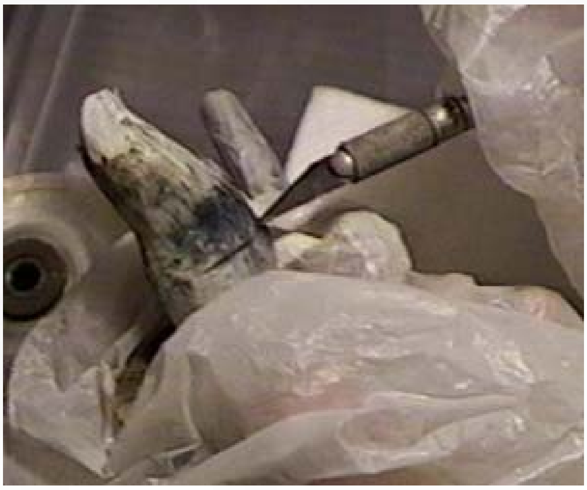
original source: http://mycotopia.net/archives/discus/messages/5/3384.html

Culture source:
Either acquire a spore syringe or get started from a fresh fruit body.
Spores can be injected into the whole grain recipe or the MMGG recipe.
It /seems/ that spores work better in the MMGG recipe, but more tests need to be made. After getting a strain started, you can farm it for a long time with the procedure below.

Cloning procedure:
Take a healthy mushroom for cloning around the time that the veil breaks. You want one that is still growing vigorously, not an abhort. Place it in the transfer chamber. Avoid fruit with brown streaks on the stem. Use a sterilized Xacto knife and tweezers to extract a clean chunk of stem to add to sterile water in a mason jar.

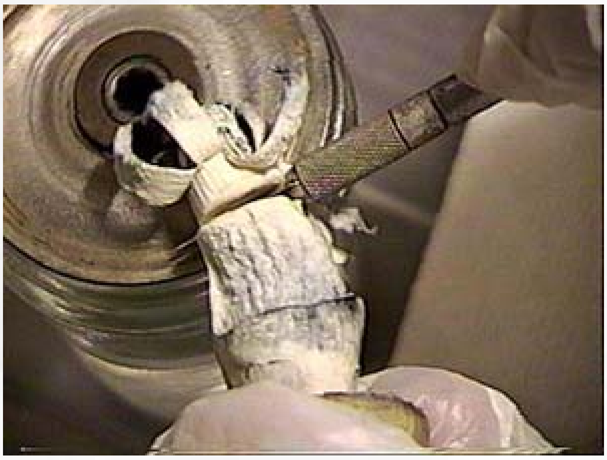


This is done by holding the freshly picked shroom near the cap, and using the sterile knife to cut a ring around the stem about 2" from the bottom. Only cut a little way into the stem.

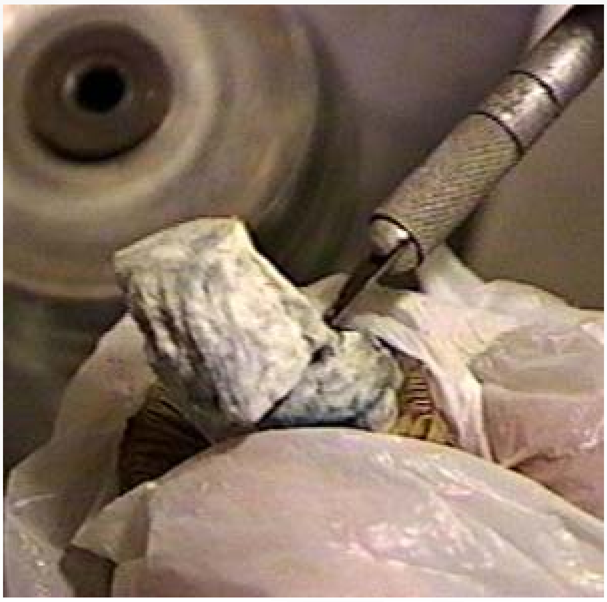


Use sterile tweezers to **grab and peel the surface layer back toward the base of the stem until it resembles a peeled banana.**

Then cut the stem just above the peels. Once you've removed the Al foil from the sterilized blade assembly and mason jar, You have a sterile table to work on for cutting off the stub.



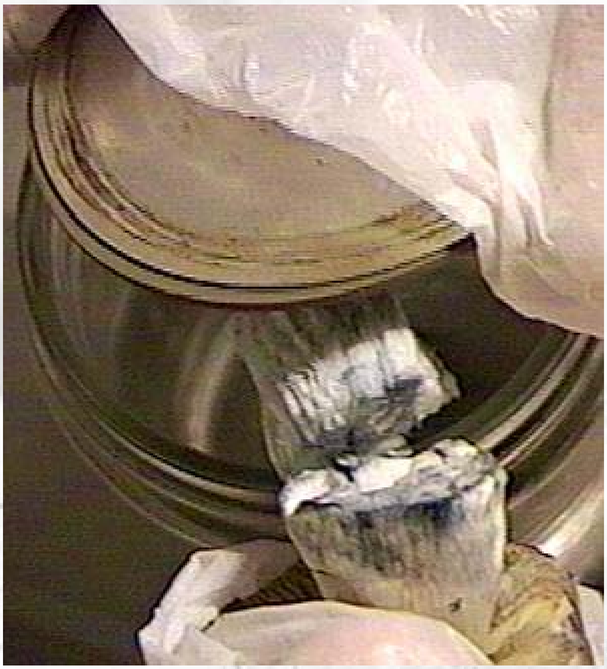
Then slice off the clean chunk and let it fall into a mason jar (8 oz regular mouth) 2/3 full of sterilized water. The jar is prepared by covering with the metal blade assembly and seal from the blender and that is covered with Al foil and sterilized. The transfer is done in the glove box. For more details see the "Blender Usage" page.



It turns out that a regular mouth mason jar has the same size and thread as the plastic blender container part from an Osterizer blender (probably other brands as well), so after dropping in the piece of stem, remove the jar from the chamber, then screw on the base of the blender and proceed to blend for about 3 or 4 seconds at the fastest speed. Allow to stop, then repeat. Be sure to hold the jar while blending. When done, remove the blender base, put the jar (w/seal and blades) in the chamber, remove the blades and seal, then immediately cover with a new baggie (in the transfer chamber). Then draw syringes of the inoculant water by piercing the plastic bag. This procedure has proved to be very effective. For pictures of the details of the blender parts and mason jar assembly go to the Blender Usage page.

Additional info/tips:
1) It is best to use a rubber band around the shroom water jar/baggie to keep out contaminants.

2) If one cuts the peeled chunk of stem almost all the way thru, then one can lift the blender parts just enough to stick the stem thru and finish severing the sterile chunk from the rest of the stem with the edge of the jar and the blender blade assy.



3) The shroom water has been stored for 1 week with no harm and it's gone bad in 2 days. I have no idea how long it can remain viable. It is MUCH better to make up the shroom water and use it immediately. The growth rates are incredible when the shroom water is fresh. One pint cakes (rice only) have been birthed 10 days after inoculation. 14 to 21 days is more common.

4) The knife and tweezers are sterilized in Al foil sheaths in the pressure cooker.

5) Eventually the cloned strain will lose stamina and stop producing and growing vigorously. It is a good idea to take a spore print and start a new culture every year or so (at least.) See the spore print procedure.

LC Cloning - Newbie friendly pictorial tek

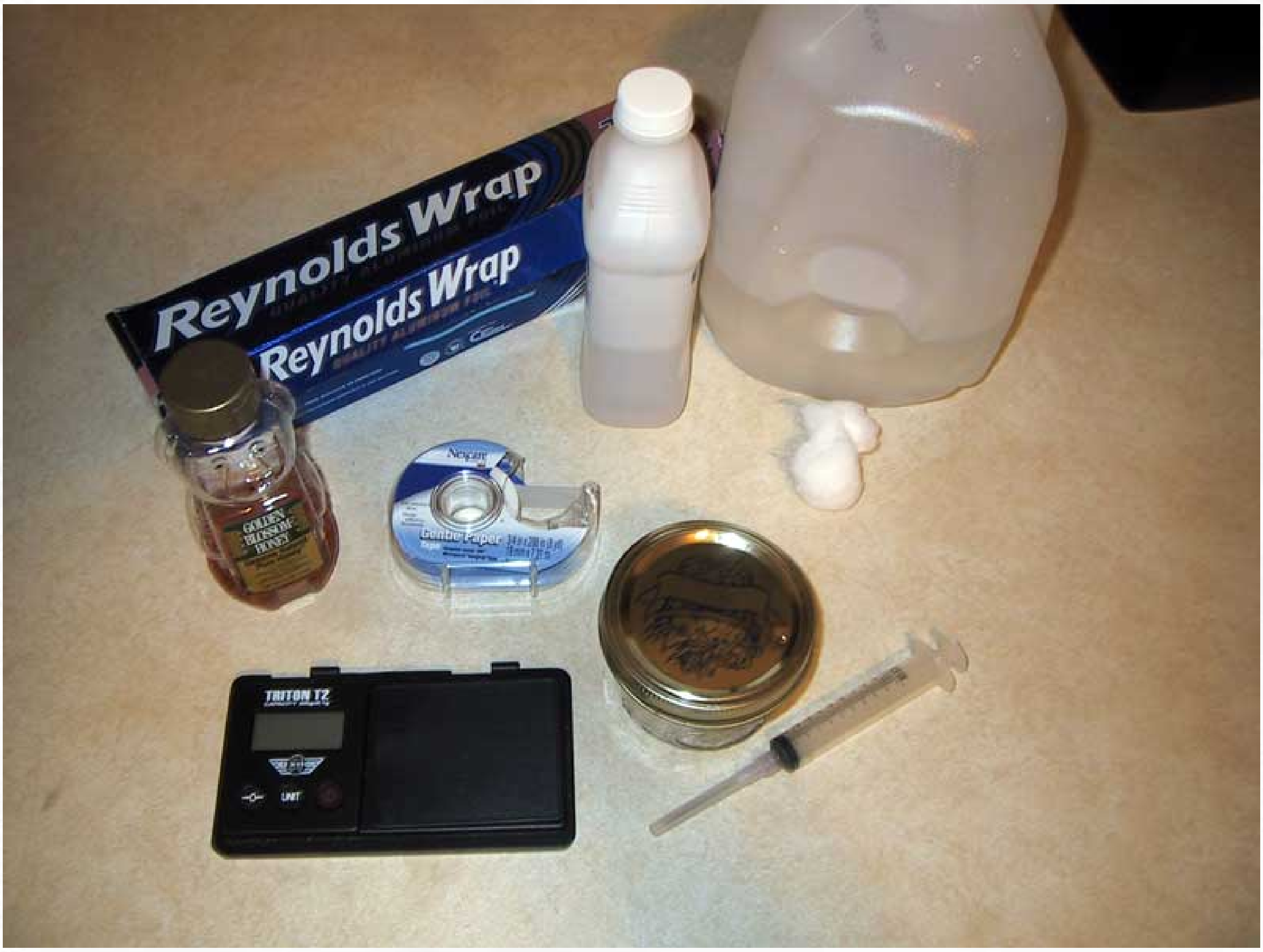
Cloning with liquid culture, the easy way

by

creamcorn

original source: http://www.shroomery.org/forums/showflat.php/Number/5874305

This is a tek on how to clone without the need for advanced methods, agar, gloveboxes, flowhoods, or even a pressure cooker. Its simple enough for a beginning pf-tek'er to complete. You'll probably also find some good LC tips here if you've been struggling with those. As always, comments, questions, suggestions, and kudos appreciated! I apologize if this is a little wordy, but I wanted to cover all the bases. I've been answering newbie questions long enough to anticipate them before they've even been asked, so hopefully I got everything covered.



Materials needed.

Step 1. Prepare a small liquid culture

For this, I am of the thinking that SIMPLE IS BEST. My liquid culture containers are simple jars, with a regular old metal lid and ring, with a single hole punched at the top. The hole should be big enough to accomodate your needle, with a little room to spare so that a vaccum is not created later when aspirating solution. The hole is covered with a piece of micropore tape, and then covered again either with a coffee filter and rubber band, or a piece of aluminum foil loosely crumpled, to act as a dust cover.

Jar with just a hole.

Recipe: Recipe is the same as any liquid culture; 4% media by weight. You may use any of the standard LC media, honey, caro, dex/malt will all work. Water quality is important to LC. I find that distilled works best, and gives the clearest solution. You may also use bottled spring water, or tap water filtered with a Brita pitcher or the like. (Your mileage may vary depending on the quality of your locality's tap water. In my area, I avoid it.) Honey quality also varies widely - I've found this particular variety works fantastic for me, and doesn't make any sediment in my LC's even without filtering. You may need to experiment with brands and types of honey to find one that works. For a sure thing, you can definitely use karo, and if you're industrious and willing to hunt down dextrose/malt, by all means use that. The honey I've got seems to outperform karo, so it works for me.

TRITON T2
CAPACITY 300gx0.1g
4.0
→0←
UNIT

Measure 4 grams of media per 100 ml of water.

When cloning, I generally start with a small half pint container. You'll see I've measured exactly 4 grams of honey. Water weighs 1 gram per 1 ml, so I'll fill it to the 100 ml point. I nuke this in the microwave for about 30 seconds, just to warm the water, allowing the honey to dissolve easier, and I stir it up. Obviously, when making larger LC's, just do the math to stay at that 4% mark.

This will be my "master" culture. From this culture, small samples are taken to start larger liquid cultures in quart jars that are my "working" culture that I use for inoculation. The remainder of the master culture can be refrigerated, where it will keep for several months. When I run out of working culture, it only takes a few drops of the master to start a whole quart of working culture all over again. Its important to take from the master each time, rather than go from working culture to working culture, so that each of your working cultures are "second generation."

Step 2. Sterilization

In my opinion there's only two acceptable ways to sterilize LC for consistent results: steaming, and pressure cooking. This gives those an option who don't own a PC. Microwaving works for some, but I don't trust it. If it works for you, fantastic, go with it.

In both cases, wrap the top of your jar in tinfoil as usual, and take a syringe about half full of water, and also wrap it in tinfoil. We'll sterilize them both at the same time.

Syringe with some water;

wrapped in foil and ready to sterilize.

Steam sterilization:
Place a cloth at the bottom of a pot with a tight fitting lid. Use an inch or two of water. Place your jar and syringe inside. Bring to a slow rolling boil. Once a boil has been achieved, start your timer for 30 minutes. At the end of 30 minutes, turn off the heat, walk away and don't even think about it for a few hours. Let it cool.

PC sterilization:
Use your PC as per its instructions with something to keep the items off the bottom of the pot (like a cloth, or a rack if you got one.) Slowly bring up to pressure. 10psi is plenty if that's all you got. 15psi is fine too. Do not exceed 15psi. Once at desired pressure, set your timer for 15 minutes. DO NOT exceed 15 minutes. When the time is up, cut your heat and walk away until its cooled.

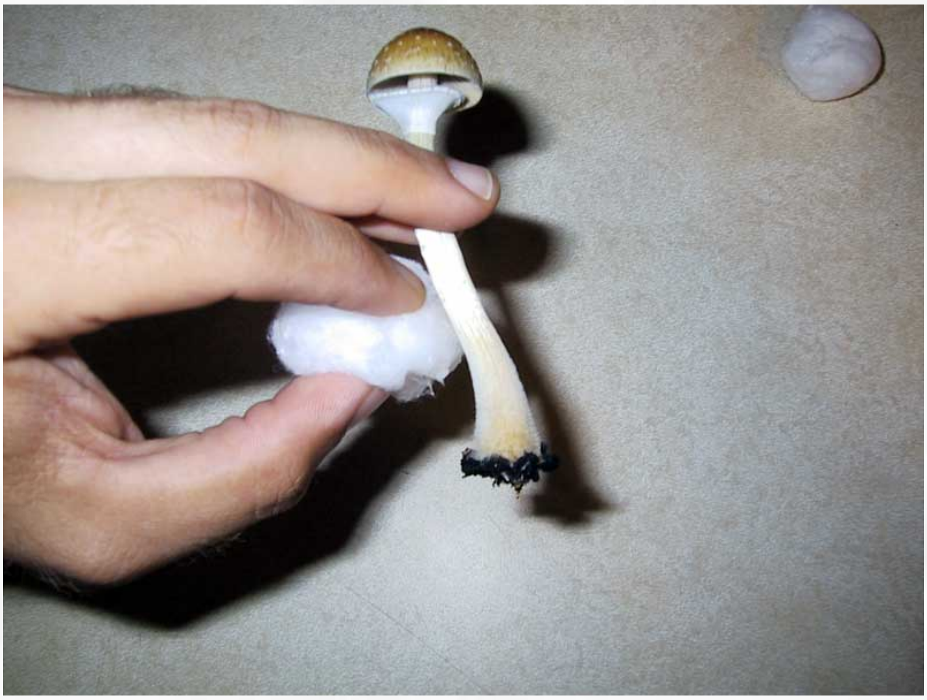
Step 3. Select specimen

Find a nice looking fruit! We want to clone desirable qualities. Many have different ideas as to which fruit to clone; ie. choosing the first one up might give you a speedy isolate to work with later, choosing a big one might give you a genetic predisposition towards large fruits; and so on. I believe that there's just so much variation in growing methods, even though we are taking a clone, we have no idea how closely its going to resemble its "parent" when grown out later - so I take a nice looking fruit and hope for the best. You'll find out in time if it was a good choice or not when you get your first crop of clones in, and can assess how long they took to grow, the yields you got, and of course, the potency after sampling some. If it didn't turn out as good as you were hoping, don't fret, you can try again from a different specimen from a different multispore grow. If it did turn out for you, treat that master culture like gold!

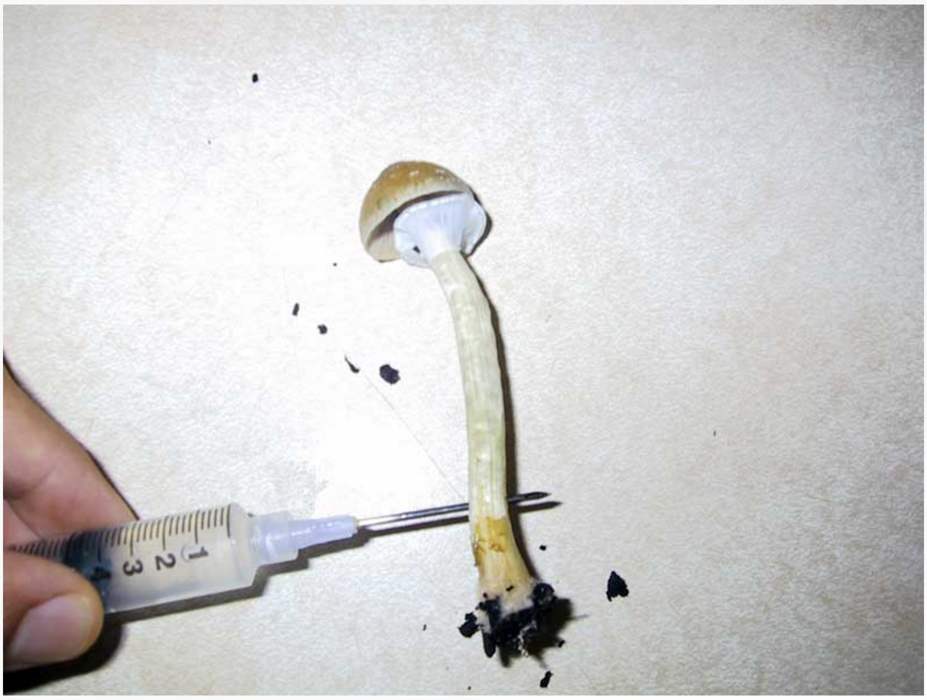
Step 4. The biopsy

Here's where you'll want to practice your sterile procedures. No need to go overboard, all I do is ensure there's no drafts, clean my work surface, wash my hands with antibacterial soap, and hit them a second time with some hand sanitizer. If spraying Oust into the air and washing everything with bleach or whatever makes you happy, knock yourself out.

Take your fruit, and clean the stem thoroughly with an isopropyl soaked cotton swab. Clean it all the way around. Do not touch any areas with your hand near the site of the biopsy. Quickly wipe your needle with iso (flame if desired, I don't bother - we did just sterilize it after all!) and stab it straight through the stem to the other side.

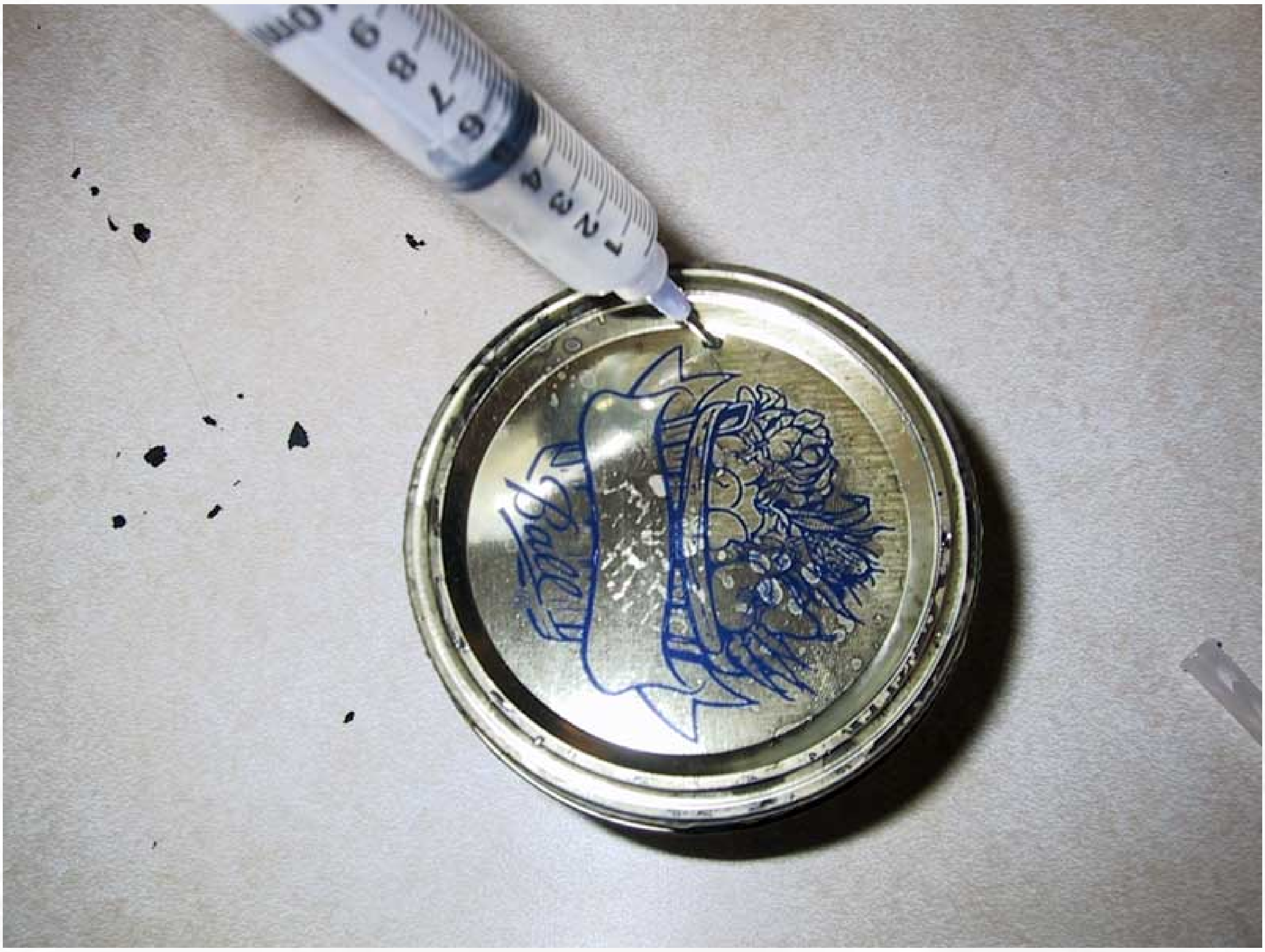


Swabbing the stem;



taking the biopsy. (This is where 3 hands would come in handy, somebody had to work the camera! You'll obviously want to hold the mushroom near the top and swab the bottom, and when taking a biopsy not allowing the mushroom to touch any surfaces.)

Remove the foil from your prepared LC jar. Using a dry cotton swab, clean up any condensation/moisture on the lid. Then using an alcohol soaked one, clean the lid again. Give the needle another wipe, insert into hole, and push the plunger. The water in the syringe will force the cross section of the stem out into your LC. Quickly cover the hole with a piece of micropore tape (if your lid is still wet with alcohol, that's fine, the tape will stick just fine once it dries) and cover with a dust cover of your choice.



Knock 'er up! You might need to push a little hard, but the liquid will force the piece of stem out.

You can sort of make out the piece of stem in there.
My solution really was clear I promise, this was without a flash to reduce glare
and hopefully get a picture of the piece inside.

Don't
forget
to
label!

Foil loosely back on as a dust cover, don't forget to label!

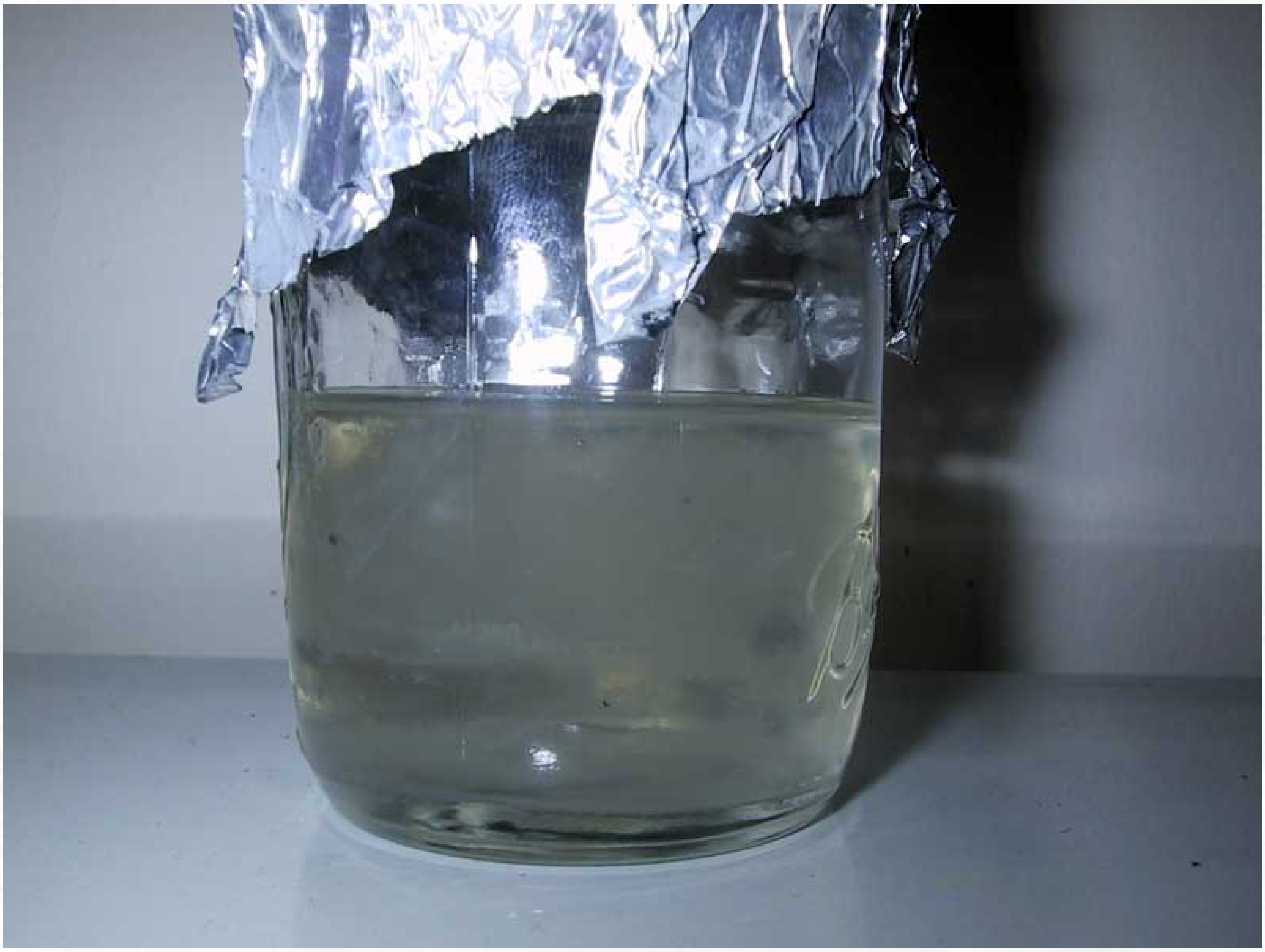
She's looking a little beat up after being stabbed!

Incubate, and wait.

7-10 days later you should have a nice looking cloud of mycelium.

As they do on the cooking show.... "here's one we've prepared earlier!" When doing all the above steps, you'll want to work quickly to avoid contamination. I obviously stopped to photograph everything so who knows if we got a clean sample here.

Here's a "master" culture, about 10 days colonizing. You'll notice some is already missing, as I've used some of the solution to inoculate larger LCs.



The master culture. Notice its very thick! Obviously my little micropore'd hole provides all the gas exchange you need.
You'll also note a few dark specs, that's leftover pieces of the stem. It kind of dissolves and breaks up to an extent.
It turns dark blue/grey, because you bruised it for sure when poking it with a needle!

Here's a working culture, this is 5 days old. It was started with about 4cc of solution from a master, and then constantly agitated on a magnetic stir plate. Use it (or make it) if you got it, but its not necessary. They'll colonize great without, it just takes a little longer. LC to LC is FAST no matter what.

Thermolyne
SYBRON
Type 17400 Stirrer
2
4
6
8
.15 Amps
120 Volts
50/60 Hz

Enough LC to kill a small army, from a few CC's of the master.

Some additional LC tips:
-Follow the measurements carefully. You'll get no growth or poor growth if you use too much media. When in doubt, use a little less than 4%.
-If your myc cloud is thick and can't be sucked up easily, suck up what you can, and squirt it back down into the cloud. It will break right up.
-To aspirate from my single-hole jars, I just tilt them on their sides, being very careful not to spill any out the hole. The needle reaches in just fine. I gently swirl it around and capture as much mycelium in the syringe as possible. The thicker the better!
-People often ask, "when is my LC done?" Well, its done when you want to use it! If there's enough mycelium floating around that you can capture a bunch in your syringe, go for it. The rest will continue to grow until the

nutrients have run out. When it doesn't seem to be growing any more, you can refrigerate it, and it lasts many months. (6 or more.)
-When I aspirate, I take an alcohol soaked cotton swab, and swab right over the piece of micropore tape. I then stick the needle right through the tape, and fill up my syringe. I quickly cap the syringe, and quickly replace the soggy piece of micropore tape with a fresh piece. You can certainly use any number of the fancy LC container teks out there, but it doesn't get much simpler than a hole with a piece of tape on it kids.
-LABEL EVERYTHING. Keep track of dates, strains, generation number, anything you feel relevant.
-A perfectly prepared karo or honey LC should be nearly crystal clear. Dex/malt will produce a yellowish solution. If your karo or honey solution turns yellow, you may have overcooked. Did you follow my sterilization directions to the T? Either way, a little overcooked will still work, its not the end of the world. Likewise, sediment from honey, or from malt/dex will not harm a thing - it just makes spotting possible contamination a little more difficult. Some take some pretty extreme measures to filter their solutions before sterilizing to get the sediments out, I'll leave it up to you.
-Unless you want cracked jars, heed my advice and allow them to cool gradually and naturally.

Quick Cloning FAQ:

Q: Why clone?
A: Cloning ensures the most efficient use of your substrate, the best possible yields, and once you've found a clone that has a desired potency, the most consistent potency! See, with a multispore inoculation, you end up with many many strains (each dikaryotic spore mating is technically its own strain). These strains sometimes grow side by side, and sometimes mate a second time by a process known as anastomosis. So in the end, you've got a cournicopia of genetic materials and strains. Not all of these are capable of fruiting! I think of these strains as "guy on the couch" strains - they'll gladly eat your food and drink your water, but never produce any fruits for you. By cloning an actual mushroom, we're dealing with one single isolated strain that's already proven itself as being able to fruit. Another benefit to cloning is nice even pinsets. When you're dealing with all the mixed strains of an MS inoculation, some parts of your substrate are going to be ready to pin before others. With clones, they're all going to be ready at nearly the same time, resulting in even, consistent pinsets, and more defined flushes.

Q: If I clone a large fruit, will the resulting fruits grown from it be large?
A: Maybe! If you have identical twin humans and one eats nothing but cheeseburgers and plays Nintendo all day, while the other eats a balanced diet and exercises regularly, are they going to be the same shape and size? Of course not. There's genetic predisposition of course, a large fruit obviously has the genetics needed to be capable of producing more large fruits - but conditions have to be right. Its nature AND nurture. Nurture is very, very important, so take care of your babies.

Q: If I clone a mutant, will the resulting fruits be mutants?
A: Again, maybe! It depends on why the mutation occurred. If there was a genetic problem that caused the mutation, then sure, it will carry over. You might not end up with the same exact mutations later, but you'll end up with some funky fruits. If the mutation occurred because the fruit came in contact with a harmful chemical while growing, that's not going to carry over - the result may very well be a healthy clone. Nature versus nurture again. Using the human analogy, if I cloned a person with 6 toes (yeah it happens), the resulting clone will be born with 6 toes. If I clone a human who broke their leg, of course the baby isn't going to be born with a broken leg! Got it?

Q: Where should I take my biopsy?
A: I've found that near the base of the stem works best. I can't tell you why, I don't know, just my experience.

Q: How mature should the mushroom be before cloning?
A: As the viel breaks, or just before. If it starts to sporulate, it will drop spores on the stem. You're likely to get spores mixed in with your biopsy, and guess what - its no longer going to be a clone! You want to avoid spores.

That's all for now, if anybody has any ideas for the little mini clone FAQ above, ask away, and I'll answer to the best of my knowledge (or maybe others can chime in and help out.) The only way I can make this any simpler is if I were to come to your house and do it for you - and unless you got boobies, and plan to pay travel expenses, it ain't happening. Thanks for reading, and good luck.

The Outdoor Cultivation of Psilocybe cubensis

by

Gerald Peppard

original source: http://mycotopia.net/archives/discus/messages/5/118001.html

We have seen a plethora of information on indoor cultivation. But what I find amazing is there is little or no information on outdoor cultivation of Psilocybe cubensis. Let me ask you a couple of questions: Are you tired of small mushrooms? Would you like a mushroom the size of a small dinner plate? Are frustrated by the number of steps involved? Are you always worrie about the posibility of contamination?

This species (P. cubensis) can be grown outdoors with a high rate of success and all with a limted amount of money and time. Eventhough P. cubensis is a warm sub-tropical mushroom, I believe it can be grown outdoors as far north as Canada. In order for a mushroom to grow it must have the right enviroment. As long as you meet the requirements, anybody can be succesfull.

Let's talk about a location for these wonderous creatures. Clumps of grass, yes that's right clumps of grass. You can look at a clump of grass as if it was a terrium. The grass will act like a barrier and keep humidity at a high level for well over 6 days. If the humidity level ever drops to low, take a hand mister and spray until the desired level of humidity is reached. The grass will then help with a couple of things by filtering the sun and absorbing CO2 during the day.

What substrate is suitable? Aged cow dung is best: but I would say horse dung might be a good subsitute. A good way to determine whether or not the dung is aged enough, is observing other fungi growing from the dung. Some of the species you might encounter are Psilocybe, Panaeolus, Coprinus, etc... Another way of determining whether dung is aged enough is checking it out. I like to take my walking stick and flip the pies upside down and then break it in half with my stick to check the moisture content. It should be the same consistency throughout the whole piece of dung, dry. After awhile you will be able to judge what is suitable and what is not. Once it is determined to be suitable, pick it up and place it in a collection bag. A good bag for collecting cow pies is an old pillow case. For those of you who are a little squeamish about handling cow dung, go buy a pair of RubberMaid kitchen gloves. Pick up all sizes of dung for your future endeavor.

Personally I don't pretreat my cow dung before use. The problem I see with pretreating the dung, is there is a chance you might kill some of the beneficial microbes. Besides that P. cubensis mycelium is known for its rapid and highly aggressive behavior. There are maybe a few other fungi whose mycelium can compete with P. cubensis in the wild. Here are a few suggestions for those of you who want to pretreat their dung. First take the dung and place it on a cookie sheet. Then place the dung in the oven at 150 degrees for 30 minutes. Second you can microwave 4 cups dung with a 1 cup of water for about 5 minutes.
Watering your homemade cow pie is not difficult, just water the pie every 3 to 5 days. How much water to apply depends on how big of a pie you made. Personally I like to collect rainwater for my pies; but tap water will do if you let it stand for 24 hours before use. Water the pies directly from the top with a watering can. Apply the water all over the pie while allowing at least 60% of the water to flow through the medium and loose substate. This will allow the water to transfer itself throughout the whole pie. Overwatering is not hard to do, so when the water comes rushing from out the pie you have overwatered. If you do overwater just add 1 to 2 days to your normal watering schedule before you water next.

Look around your yard and find a healthy clump of grass. An ideal clump of grass would be over 2 feet high with a diameter 2 to 3 feet. Clean out the middle of the clump to a diameter of 1 to 1 and a half feet. There should be nothing in the middle of the grass clump except bare ground. (fig 1)

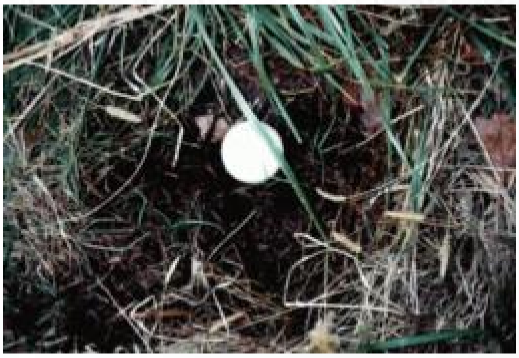


Figure 1

Now is a good time to separate the dung into three piles; large, medium, and small crumbled up pieces. (fig 2) If you don't have enough medium pieces break up some of your large pieces. The same goes with the small pieces just crumble up some medium or large pieces. Soak your dung at least 2 to 4 hours in a large container. When done soaking wring out the crumbled up dung to the point where it is moist; but not soaking wet.

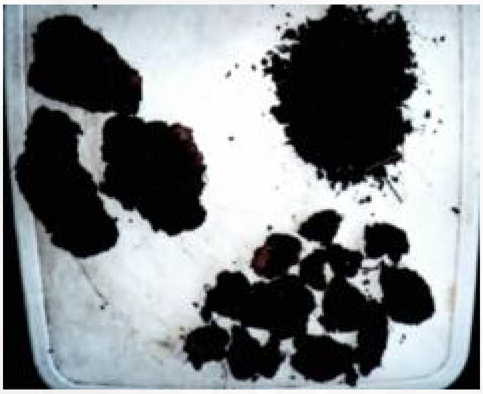


Figure 2

Fill in the area you had previously cleaned out with a 2 inch layer of the small substrate. (fig 3)

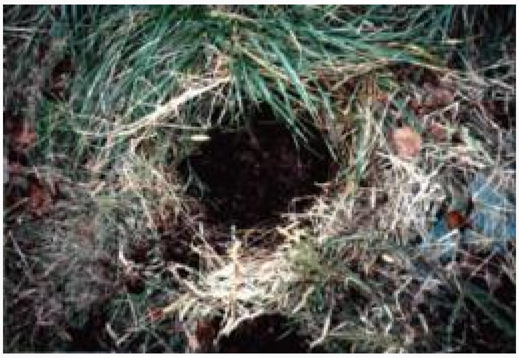


Figure 3

Take a print or a syringe and apply half of your spores on the exposed substrate. Place the larger pieces of substrate along the edge of the small substrate. (fig 4)

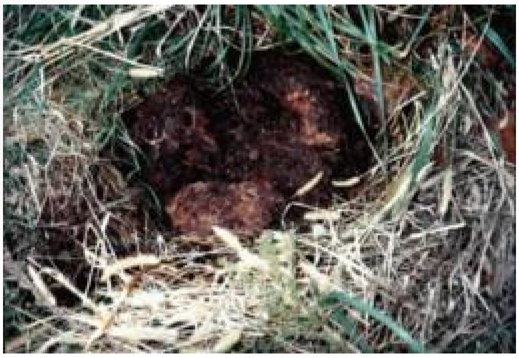


Figure 4

Fill in the inside with the medium substrate, and fill in the cracks and crevices with the small loose substrate. (fig 5) Use the rest of your spores and apply them to the top of your homade cow pie. Take the the grass that surrounds your homemade pie and fold it over. The idea is to make a dome, and not to have the grass lay flat on top of your substrate. Wait until your pie slightly dries up before you water the pie for the first time.

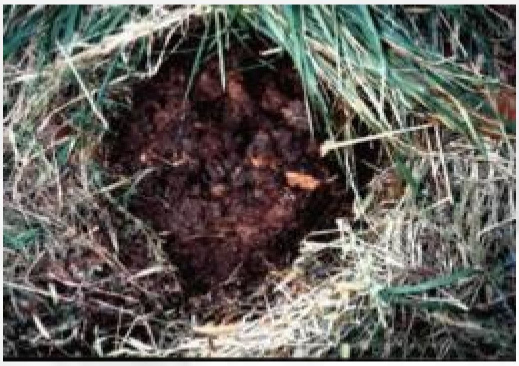


Figure 5

In Spring it would be best to wait until the night temps average in the mid 50's and the day temps were at least in the high 60's. The more you water the substrate the faster the mycelium will grow once it is established. Don't overwater because your mycelium can drown. When you are ready, let your substrate dry up somewhat and those cubes will begin to pop up. If you have the urge to water more when the caps start sprouting or the humidity level is to low use a hand mister. After a flush you may water the pie heavily again. Then just repeat the process through out the growing season. It is that simple and there is no worry of contamination or the use of sterile techniques.

A Comprehensive Sclerotia Cultivation Guide

by

stonesun

original source: http://www.shroomery.org/forums/showflat.php/Number/13431948

Table of Contents:

Intro
Grain/BRF Substrate Preparation (From Best to Least Optimal)
  BRF Preparation
  RGS Preparation (quart jar)
  WBS Preparation
  Rye Berries Preparation
Inoculation Methods
Harvesting the Stones
Fruiting Procedures
  Cased Grain Substrate
  Grains Spawned to Bulk Substrate
  Fruiting BRF Cakes
  Alternative Fruiting Method
Harvesting & Spore Printing

Intro

I've decided to put this guide together because there are numerous old threads and outdated information floating around regarding the cultivation of the sclerotia producing *Psilocybes*.
There are however some really great threads too, like the Easier than Cubes! or the Sclerotia FAQ
I'll try to cover the most popular and readily available species:

- *Psilocybe galindoi*/ATL#7
- *Psilocybe mexicana*/A
- *Psilocybe tampanensis*/Pollock
- *Psilocybe mexicana*/Jalisco

I have worked mainly with these four stone producers for the last year.
Section *Mexicanae* is my absolute favorite from the *Psilocybe* genus.
As you probably already know these species have the ability to produce sclerotia (stones) invitro and fruit bodies as well.
Most people cultivate them for stones only but hopefully after reading this thread they'll change their mind and give it a go at fruiting 'em too.
They aren't much harder to fruit than *Psilocybe cubensis* just require a thin casing layer and some extra TLC.
Let's get started!

Grain/BRF Substrate Preparation (From Best to Least Optimal)

- Rye Berries
- Rye Grass Seed (RGS)
- Wild Bird Seed (WBS)
- Brown Rice Flour (BRF)

I will not go into details with the BRF, WBS and RGS preparation, because these three methods are truly inferior to a perfectly prepped rye berries substrate.
Here's a short version of those three.

BRF Preparation

BRF cakes preparation is the regular formula (1/1/2 - BRF/water/verm)
but instead of 100% water use a 50% coffee/50% water solution.
Steam sterilize for 90 minutes or PC for 60 minutes @15psi.

Psilocybe tampanensis sclerotia forming on BRF substrate

RGS Preparation (quart jar)

300ml RGS
150ml coffee/water mix (50/50)
Pinch of gypsum.
Put RGS and gypsum in your jar, pour coffee/water on it.
Shake to distribute the liquid evenly and let sit for two hours. Then PC it for 60 minutes @15psi.

Psilocybe galindoi sclerotia on Rye Grass Seed

WBS Preparation

I hate WBS because it's messy and pretty difficult to clean the millet away from the sclerotia.
Use it however if for some reason rye or RGS is not available.
You can also prepare it at the same way like the rye berries below.

Psilocybe tampanensis colonizing on Wild Bird Seed

Rye Berries Preparation

As for the rye berries here's a detailed and pictured preparation method.

This is basically identical to RR's Rye Grain Preparation with the addition of coffee to the soak water.

I start it by brewing a full pot (2 quarts) of strong coffee.
In a large pot/kettle heat up 2-2.5 gallon of water and add the coffee.
Add a couple of teaspoons of gypsum and stir.

Prepping the coffee/water soak

On/Off
12:19
Program
Cuisinart
AUTOMATIC GRIND & BREW THERMAL™

While the water/coffee is heating measure out your rye.
Use a cup of rye for each quart jar.
Rinse the grains a few times to clean them from all the dirt/debris.
When the water runs clear drain it. Whenever the coffee/water is around 160F go ahead and shut off the stove and dump in the grains.
Stir it around, cover and let it sit for 4-24 hours.
I usually do this overnight, with a soaking time of 8-10 hours.

Rinsing the rye and adding it to the coffee/water

Your rye is soaked, now it's time to boil.
Bring it up to a full boil and let it go for 10-15 minutes.
Turn off the stove and strain the grains in to large colanders/strainers.
I like to put a fan on them and move them around a few times while drying.
Make sure that the surface of the kernels are completely dry!

Boiling, straining and drying the Rye Berries

Now they're ready to load into jars.
Use your favorite lids with your favorite filter (mine is synthetic filter disc).
Tyvek or polyfill will work too, but nothing beats the SFDs.
Screw on lids and put a layer of aluminum foil on them.

Filling the jars and fit them with lid & foil

Now you can load the jars in the pressure cooker.
PC them for at least 90 minutes (I like to go with 120...) @15psi.
As always let the PC completely cool before removing the jars.
Jars are room temperature and the foil is removed.
The grains are a little bit compacted so I like to shake them gently a bit now.
Ready to be inoculated!

Jars before & after sterilization

STONESUN
LATEX GLOVE

Inoculation Methods

So you have a spore print or syringe.
If you don't want to complicate things or just simply don't have the supplies/resources go ahead and inoculate the substrate with your spore syringe. If you have a print, well you know, just make a spore syringe...

Spore print and spore syringe of Psilocybe mexicana

ological S
es suspended
r microscop
silocybe mexic
r. M-4 04/10

If you are a bit advanced and make LCs for you cubensis, these species will do great in a DME (Dried Malt Extract) and DEX (Dextrose) LC.
Use your favorite recipe.
My preferred one is 1 tsp Malt Extract and 1/8 cup of Dextrose per quart.
The best and most advanced method however is to start your spores on agar.

Psilocybe galindoi mycelium on LME/DEX LC

ATL-#7
STIR
Cimarec® 2
Thermolyne

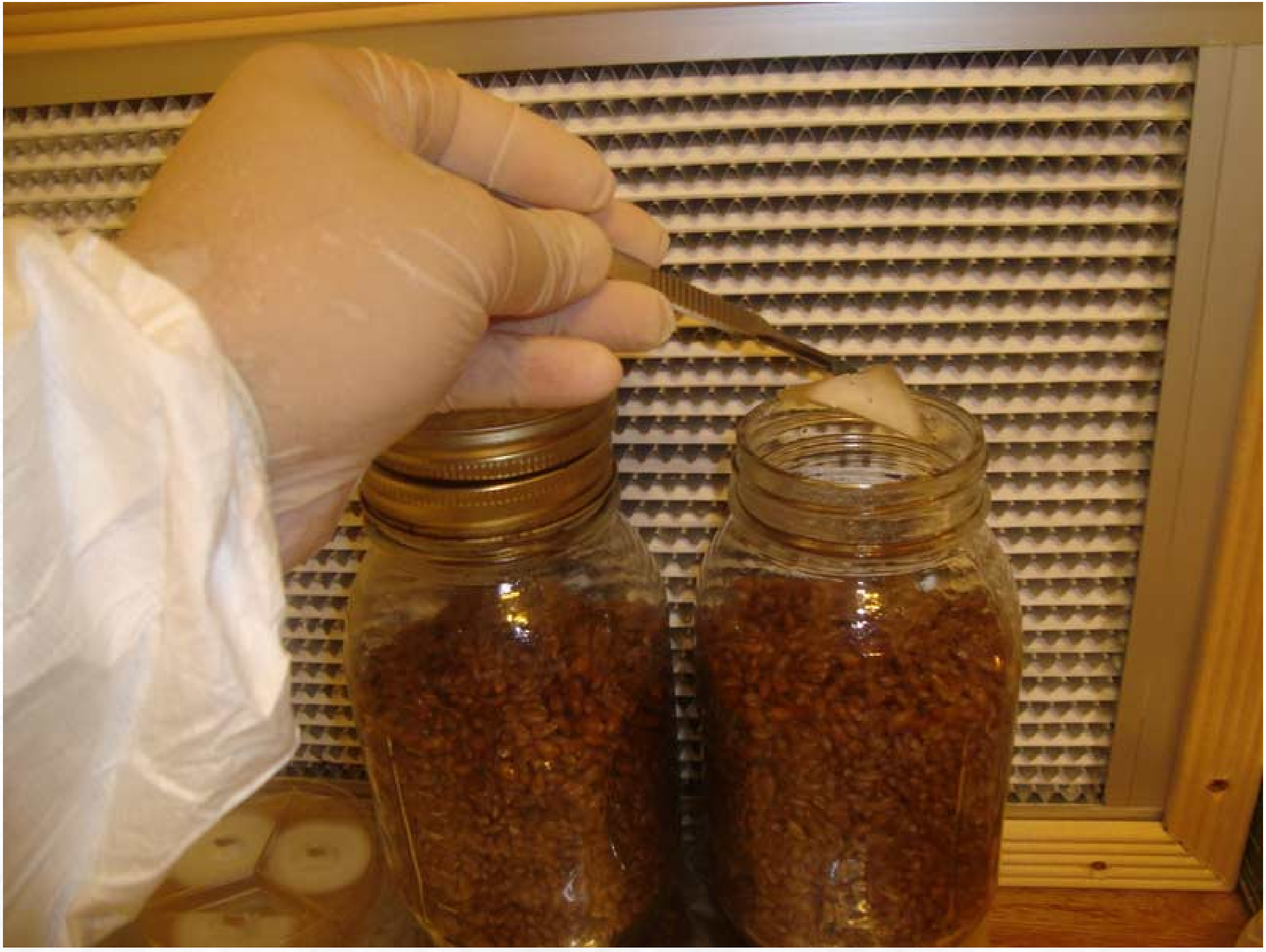
Cimarec® 2
Thermolyne

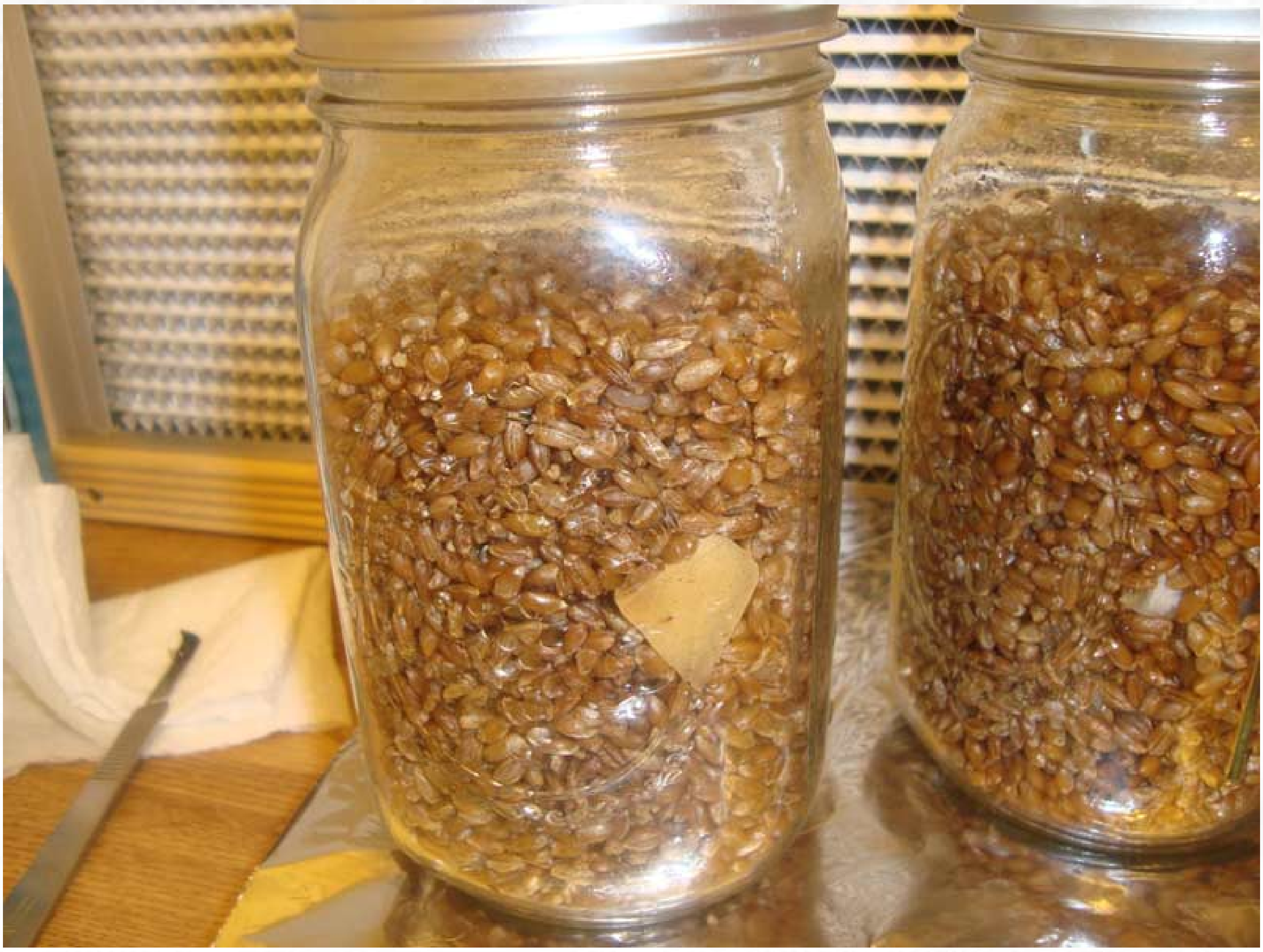
I use premixed MEA media and have never had germination issue.
When you have a nice healthy grow on your plate (not going into isolation…), you can inoculate your grain substrate or LC with a wedge.

Psilocybe galindoi and Psilocybe mexicana on agar

ATL #7
1/17/09
MEX -A
8/1/10

Rye inoculated with agar wedge

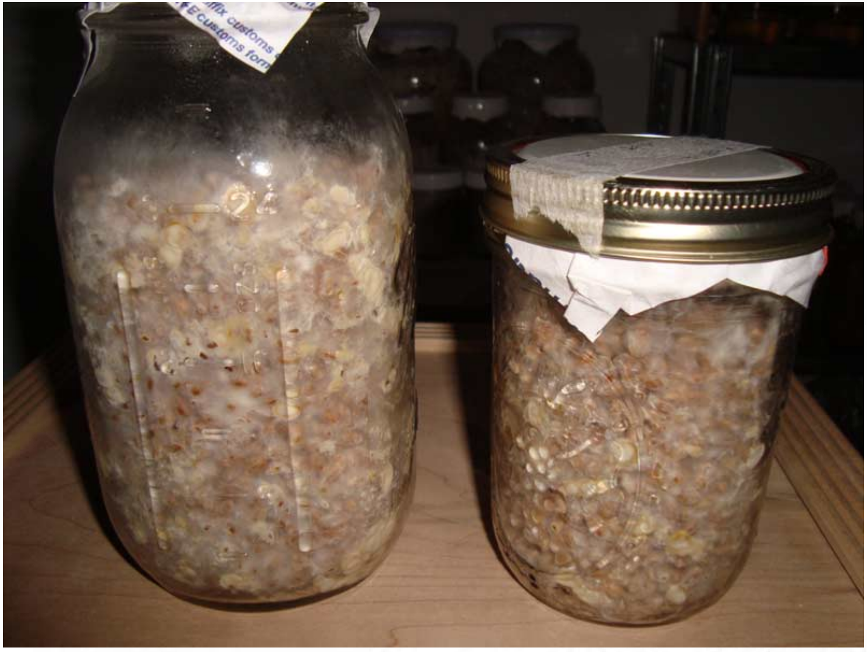




Now just set it and forget it!
Are you ready for some stones?!

Very often (especially with spore and agar wedge inoculation) sclerotia will form before full colonization of the substrate. This is perfectly normal.
If you inoculate with LC, the mycelium usually just rips through the substrate and stones will form after 100% colonization.
Either way you should see stones soon.

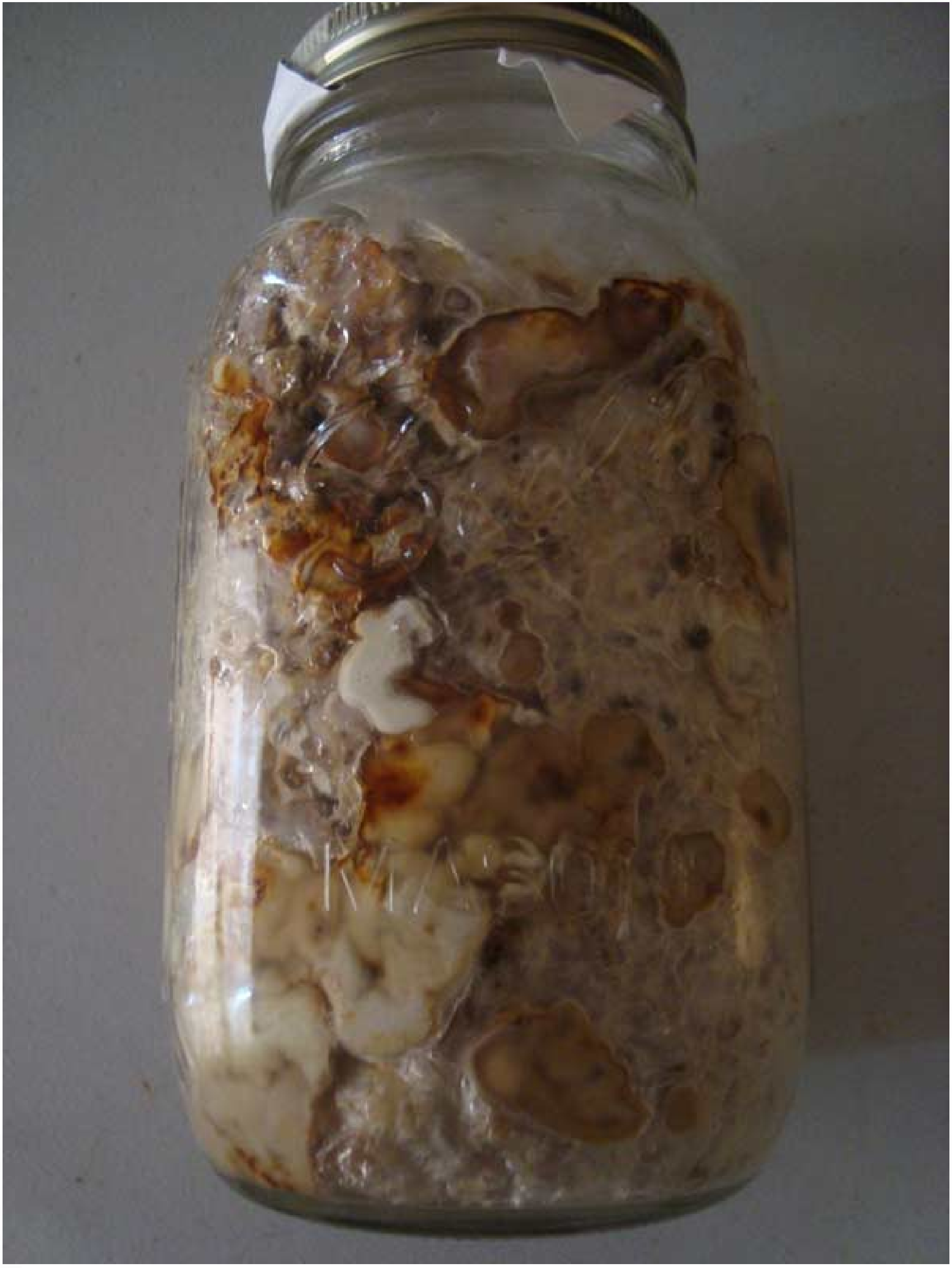
Some "young" jars (less than 30 days)



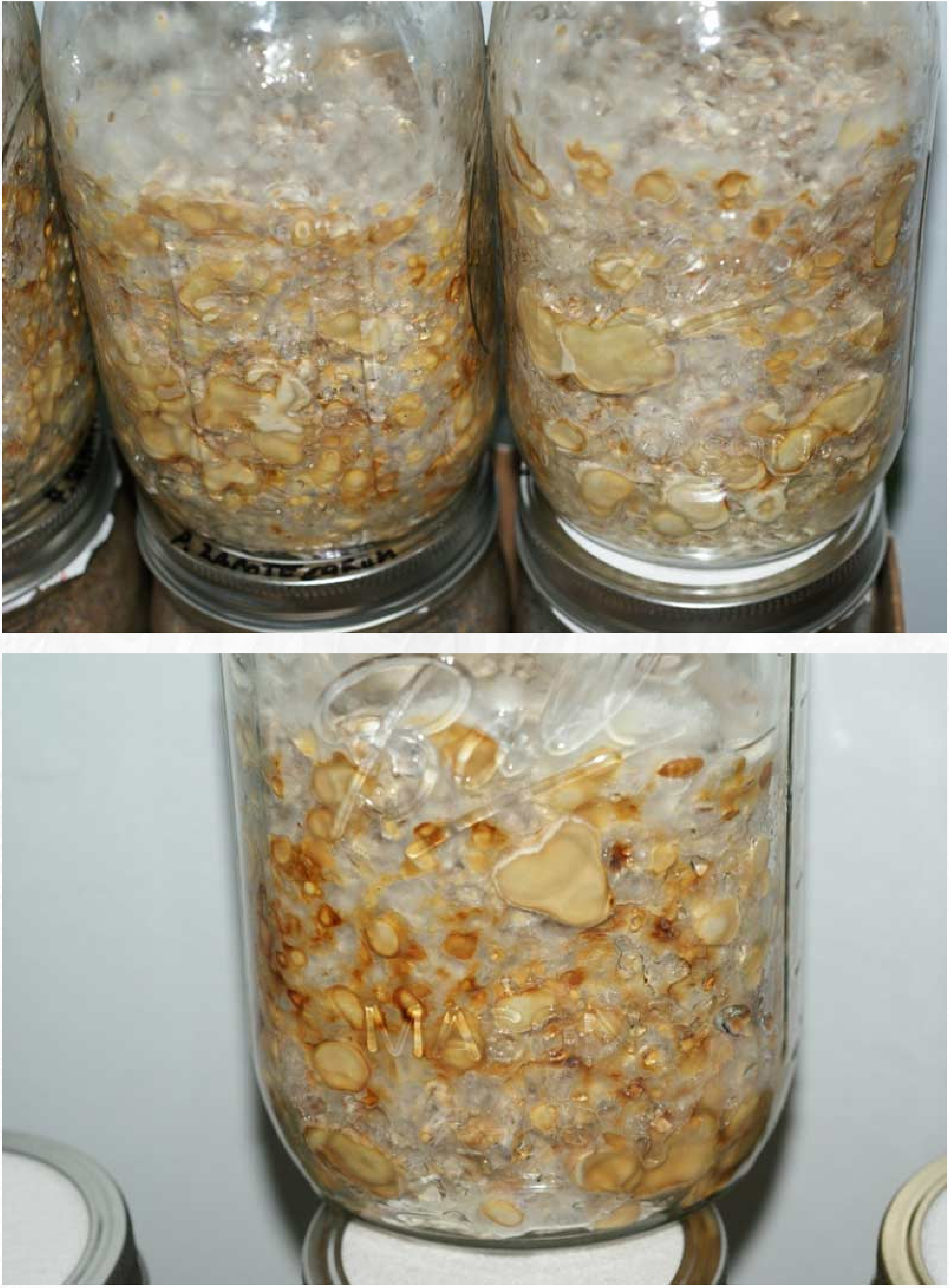
There's a controversy on shaking or not at the 20-30% stage of colonization.
Some say it's OK some say don't do it.
I've done it with success, but failed a few times too.
Therefore I don't shake anymore.

When I want to expand and plan on doing G2G transfers, the best method IME is to start with LC.
I use 3-4cc per jar and it's always done within a week.
Stones are not forming yet or if so, they are very tiny.
Just as usual, break up your colonized grain by shaking your jar, and transfer a small amount into new sterilized substrate jars.
However if you have a fair amount of LC, I'd rather go that way instead of G2G.

Psilocybe mexicana/A rye jars around 60 days



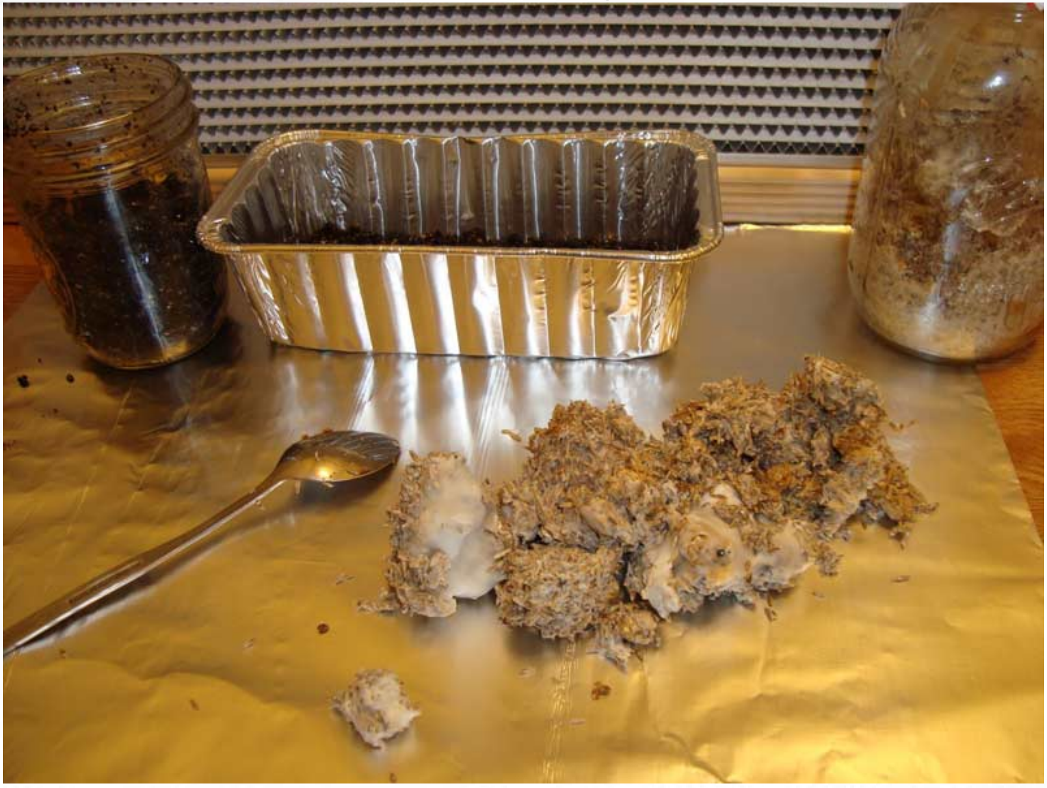
Psilocybe galindoi rye jars around 60 days



Harvesting the Stones

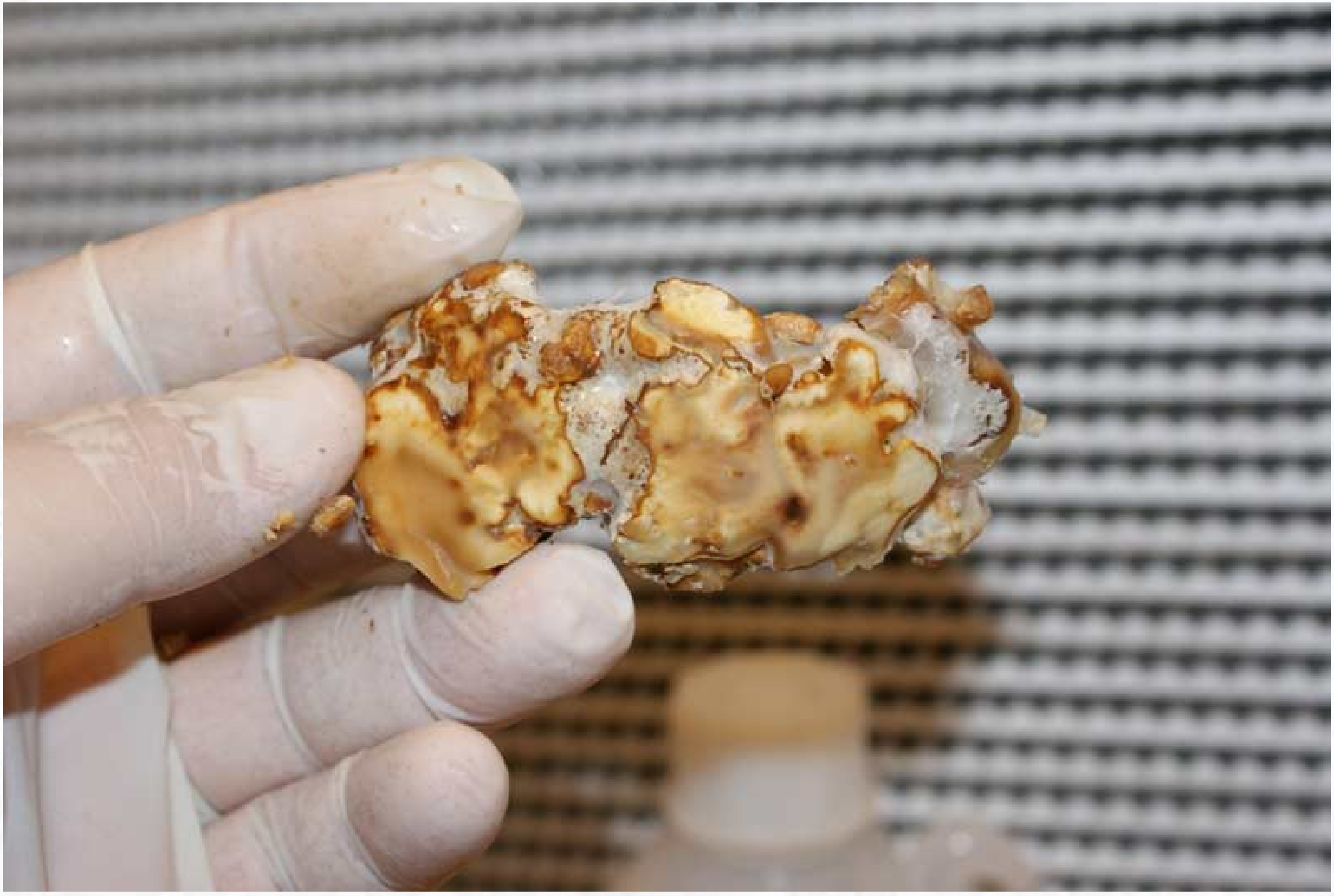
Well it is time to enjoy the first "fruits" of your labor.
When you're at this stage, your jars should be at least 2 months or older.
There's no point to harvest before 2 months and my latest harvest was 6 months.
Some leave it longer, but I always in need of jars/space.
Anyhow...
Get a spoon and sanitize it with alcohol.
Scrape out and separate the substrate and sclerotia on aluminum foil.
I have done this before in laminar air flow and totally open air.
Never ever get a contam with either method.

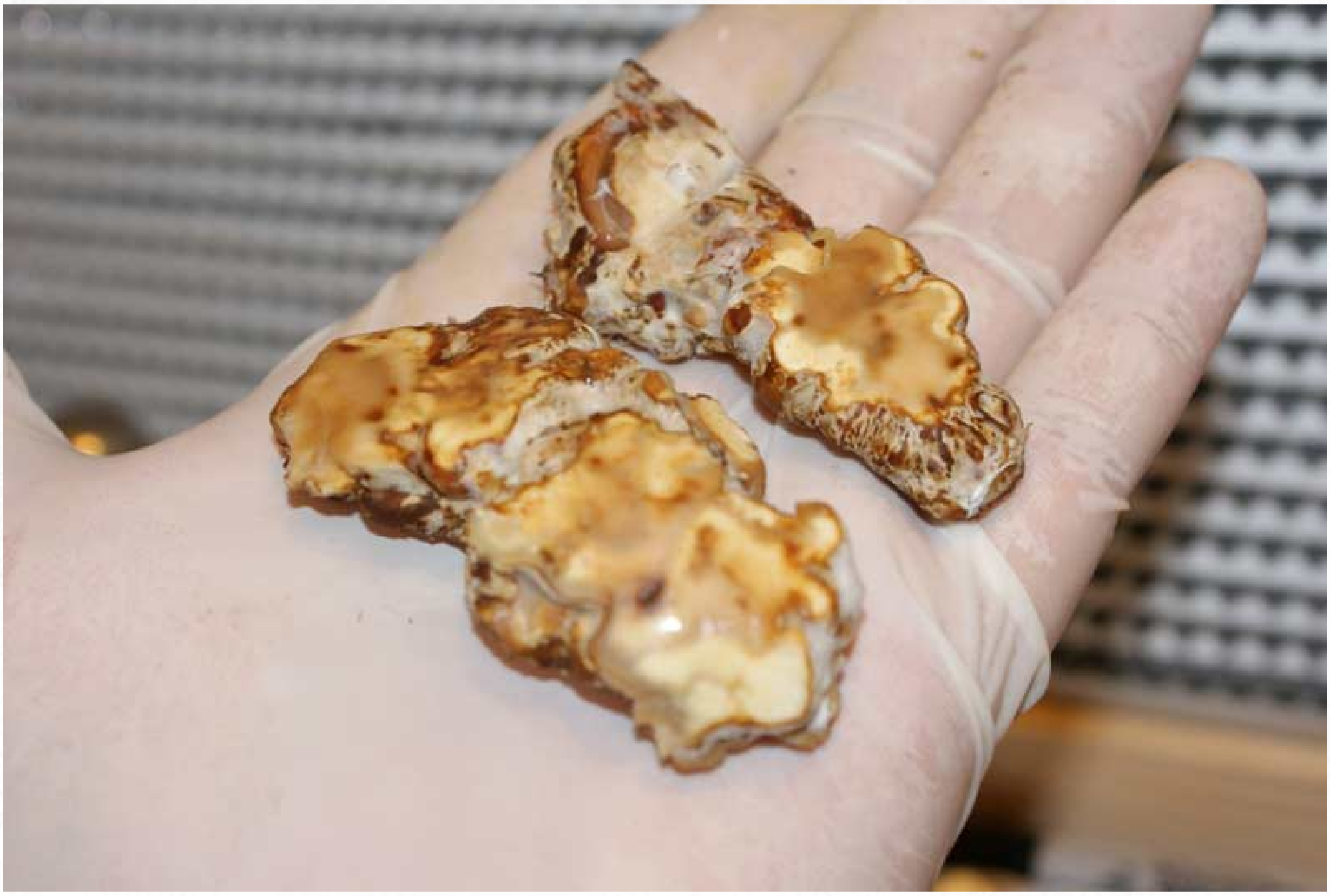
Stones harvested from RGS and rye berries substrate



Clean your stones with a brush and store them fresh in paper bags in the fridge for weeks or dehydrate and store them for months.

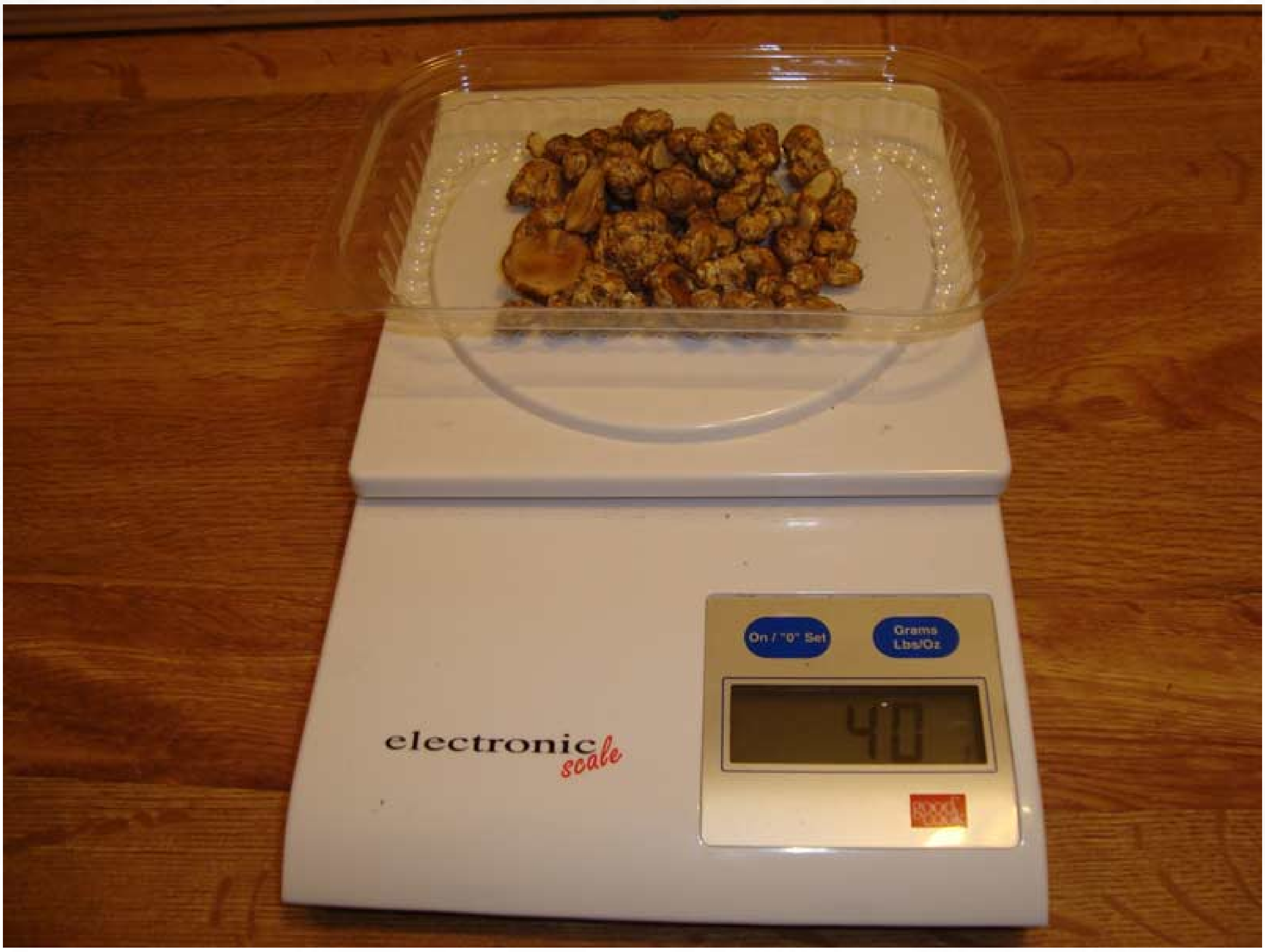
Psilocybe mexicana/A sclerotia harvested from rye



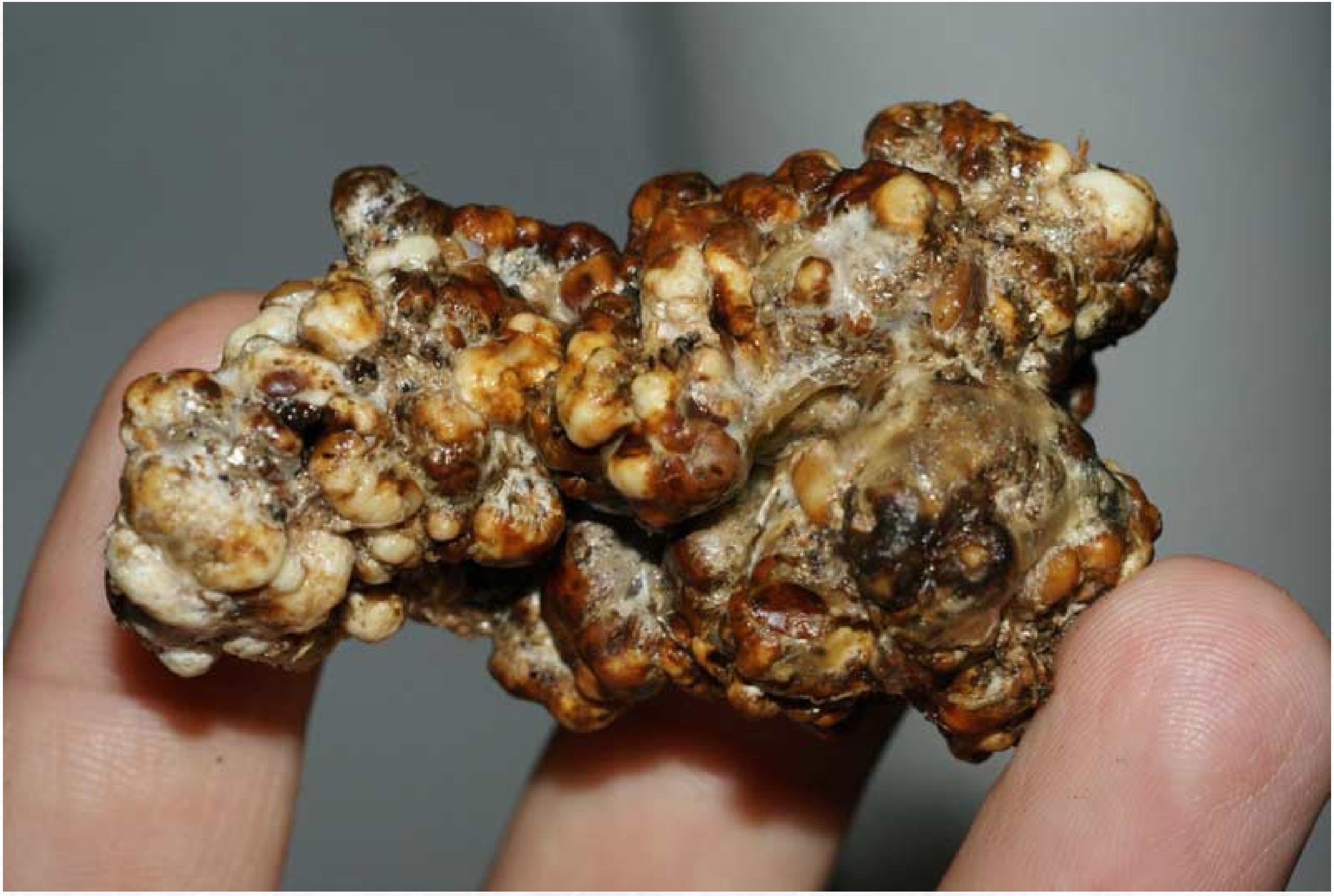


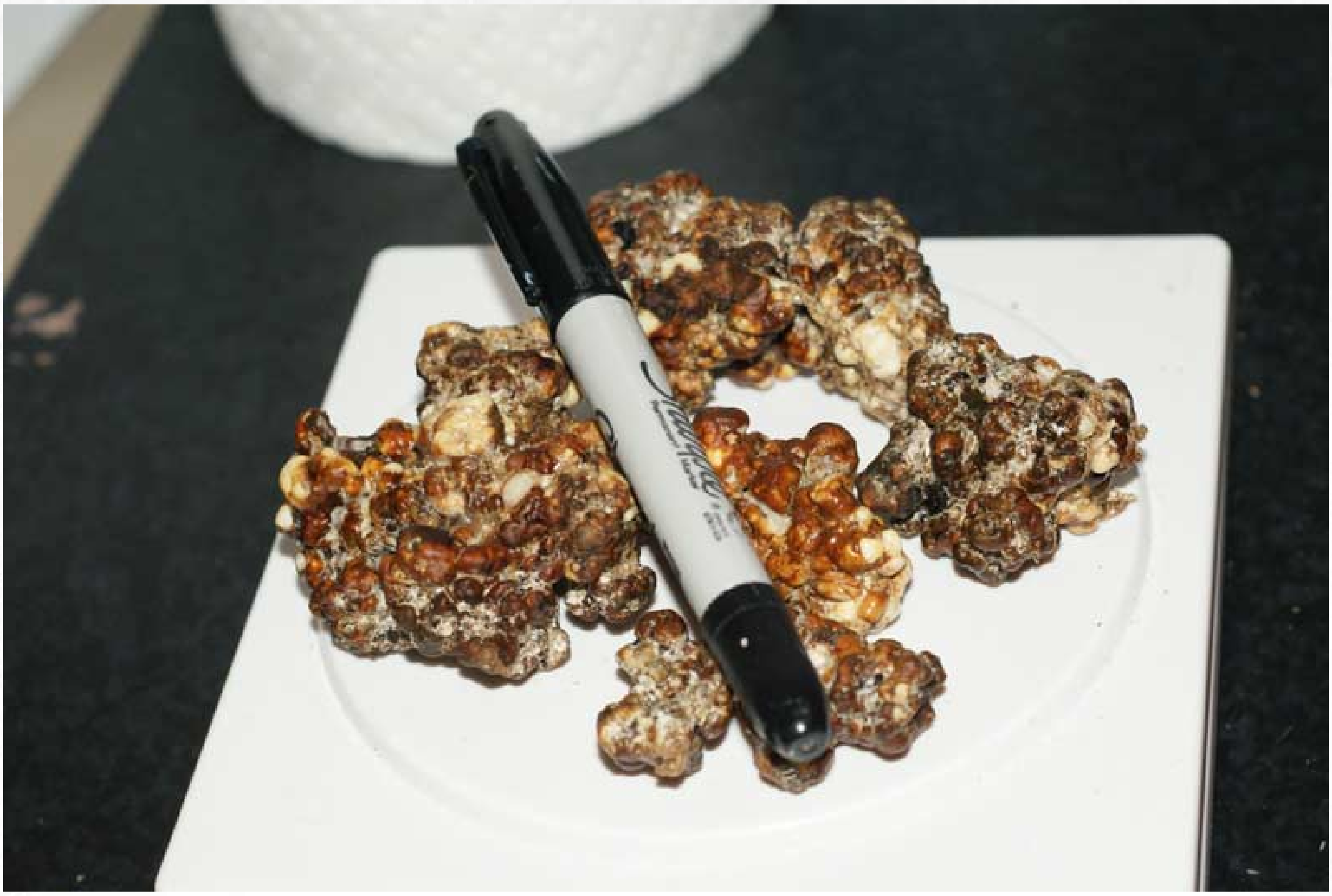
On / "0" Set
Grams Lbs/Oz
130
electronic scale

Psilocybe galindoi sclerotia from rye substrate


On / "0" Set
Grams Lbs/Oz
40
electronic scale

Psilocybe tampanensis sclerotia from manure based bulk substrate





On / "0" Set
Grams
Lbs/Oz
electronic scale
good cook

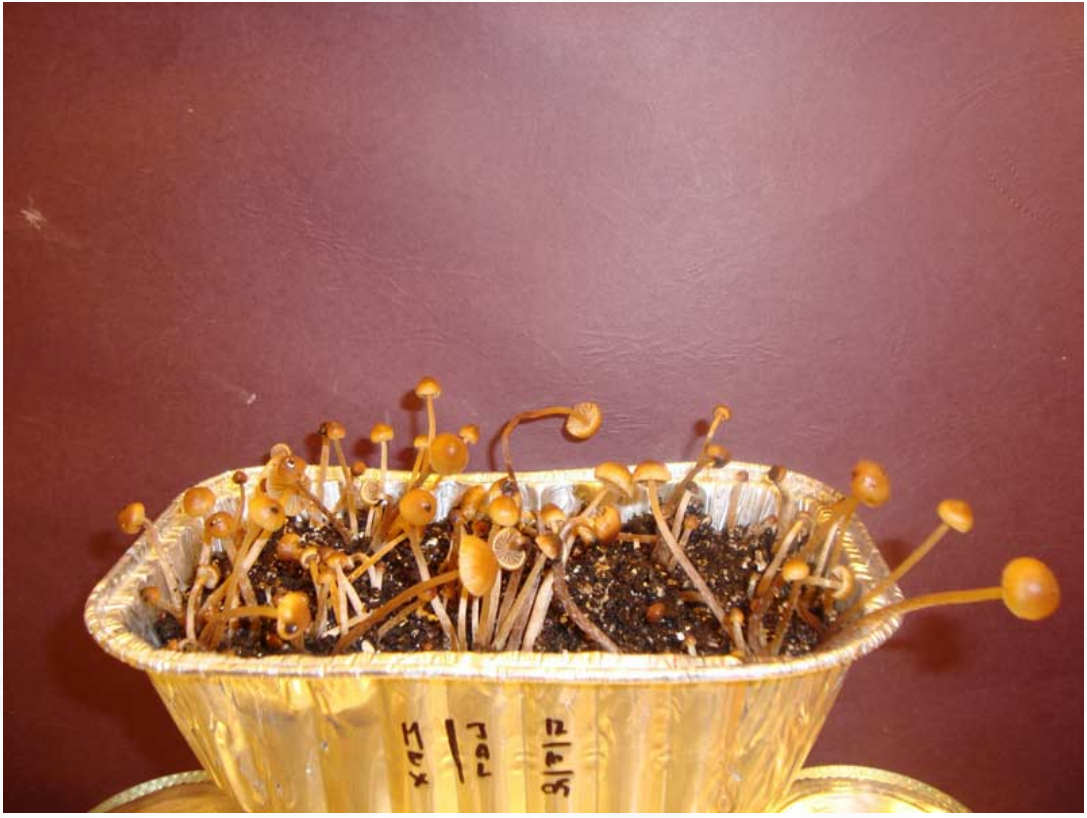
So now you have that leftover sub/very small stones mixture, ready to fruit.

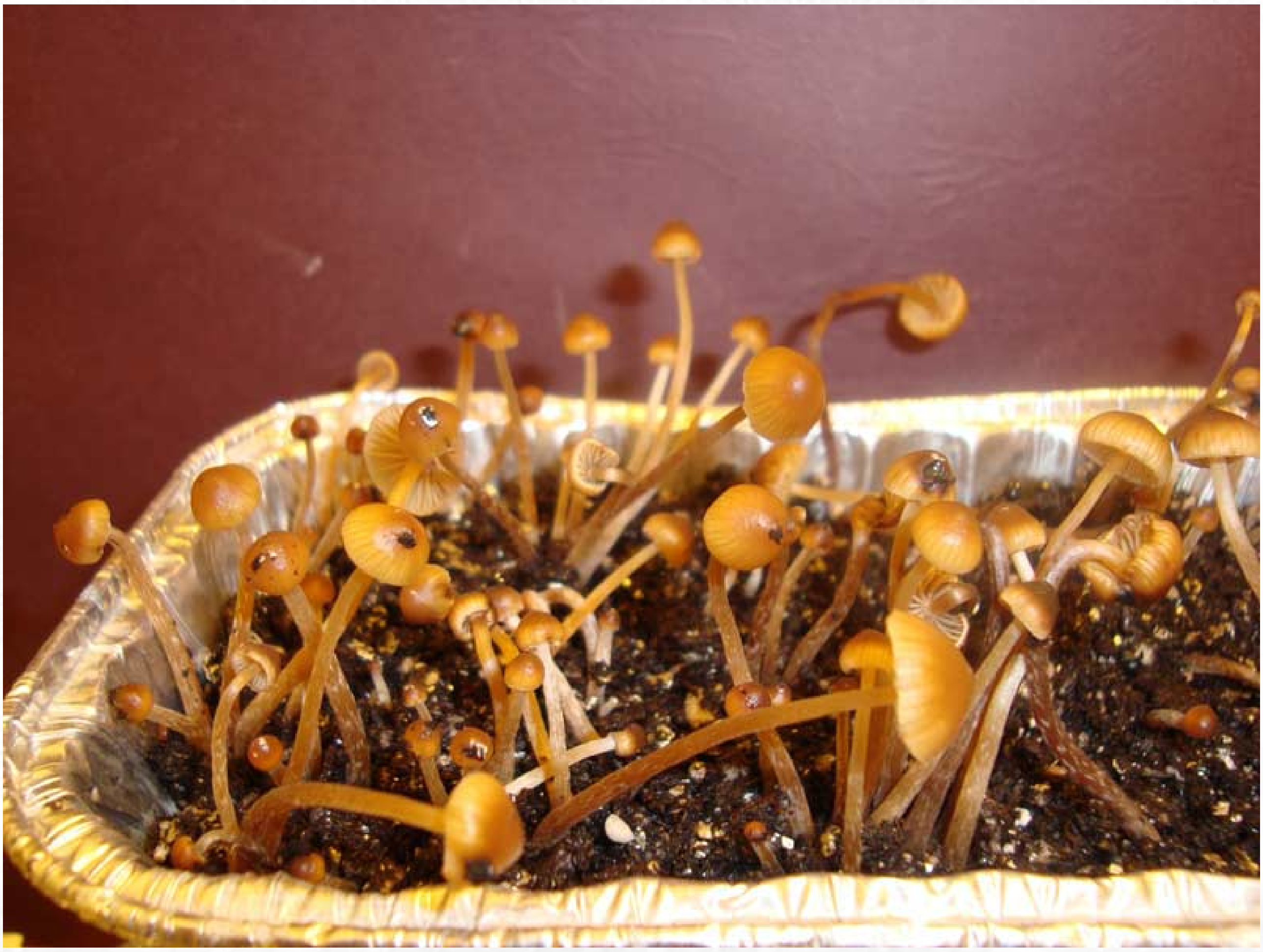
Fruiting Procedures

Cased Grain Substrate

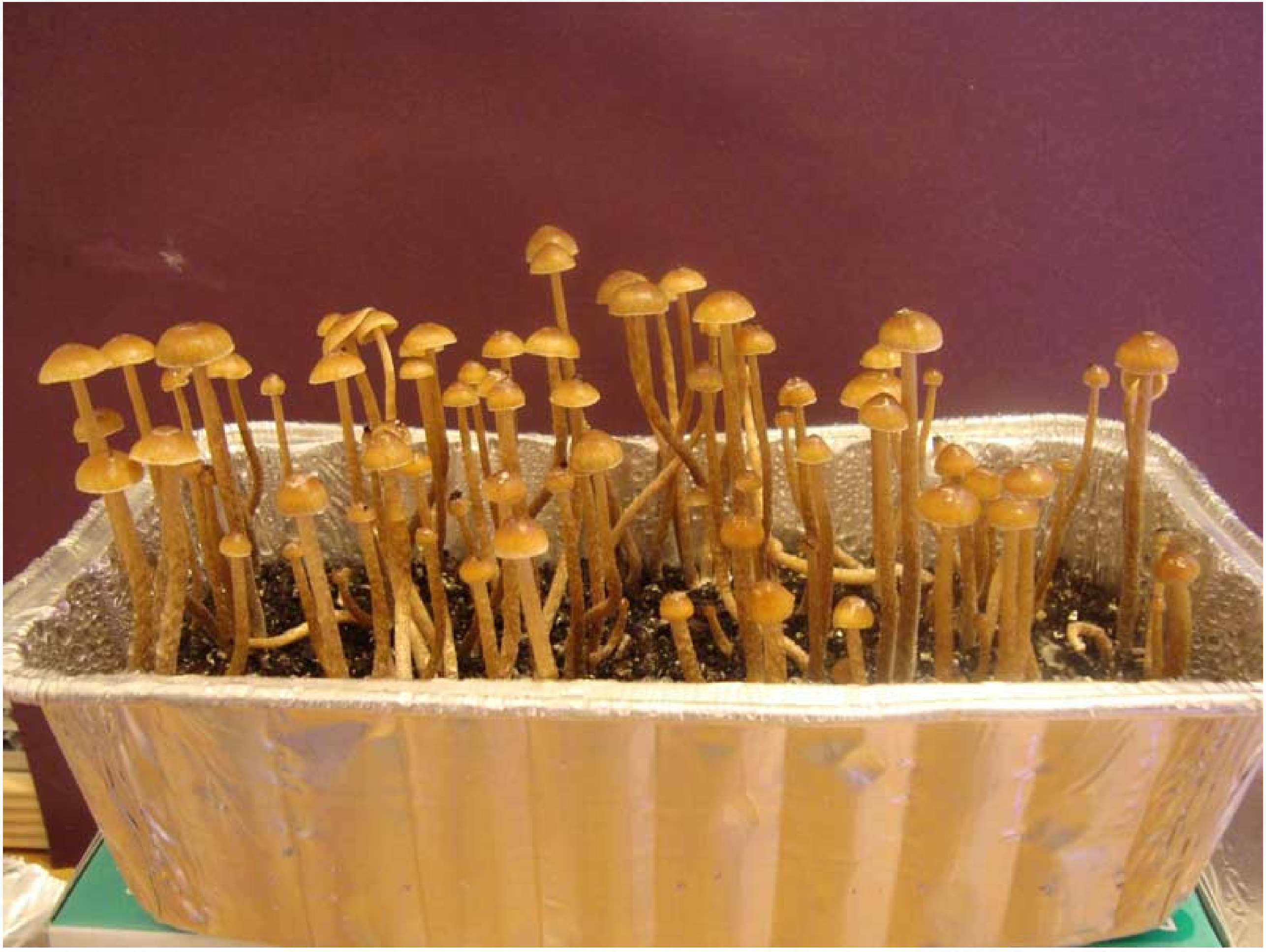
This is the easiest method to case the grains and fruit them as is.
I've had OK results by casing RGS.
Had great results by casing Rye.

Psilocybe mexicana/Jalisco fruiting on cased RGS

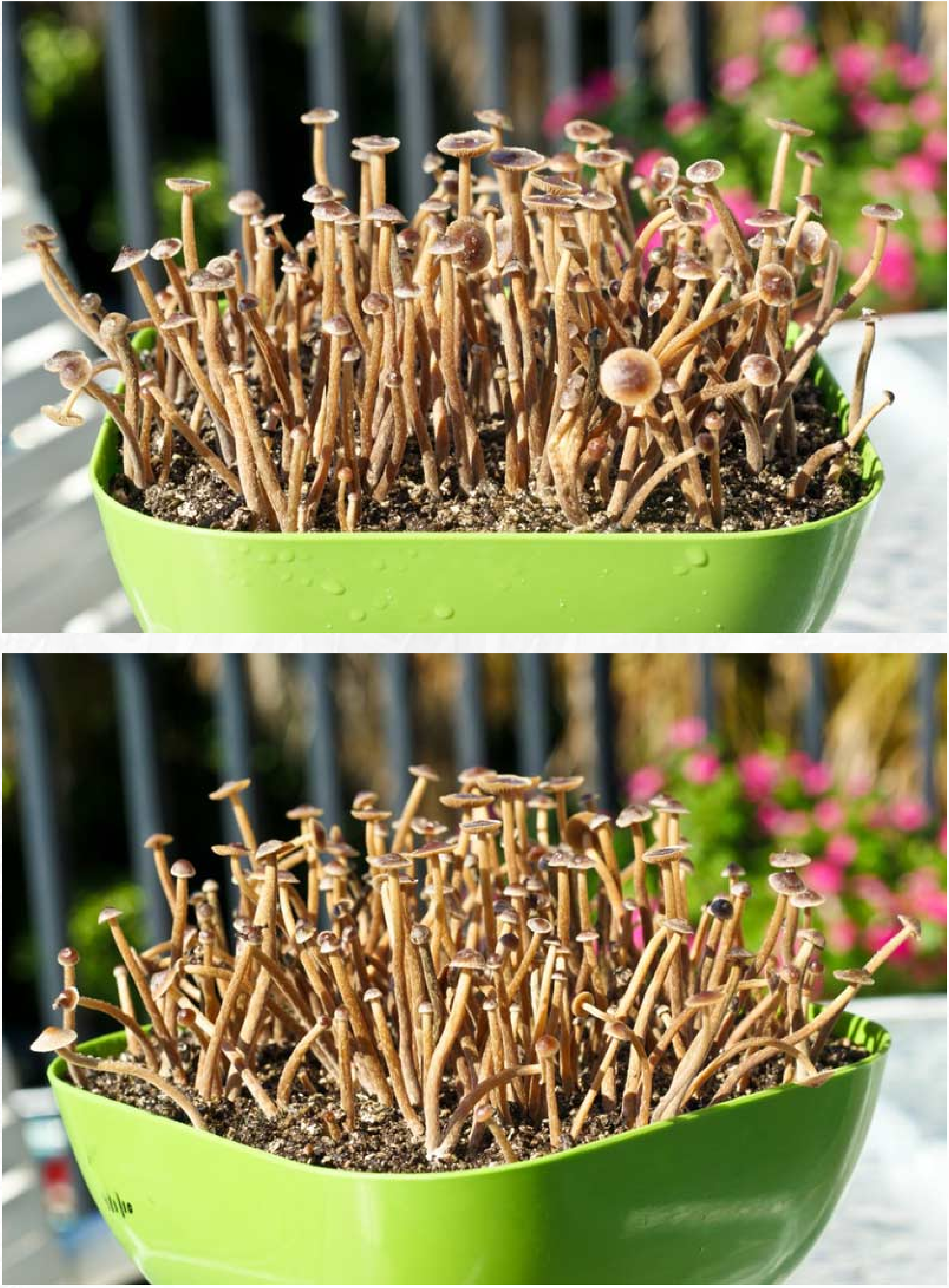




Psilocybe galindoi/ATL#7 fruiting on cased RGS



Psilocybe galindoi/ATL#7 fruiting on cased Rye Berries



They don't require a special casing layer, I've used pasteurized 50/50, 50/50+, Jiffy Mix and Plantation Seed Starter Mix with equally great results.
Make sure that you use a thin (~1/4") layer of your mix.

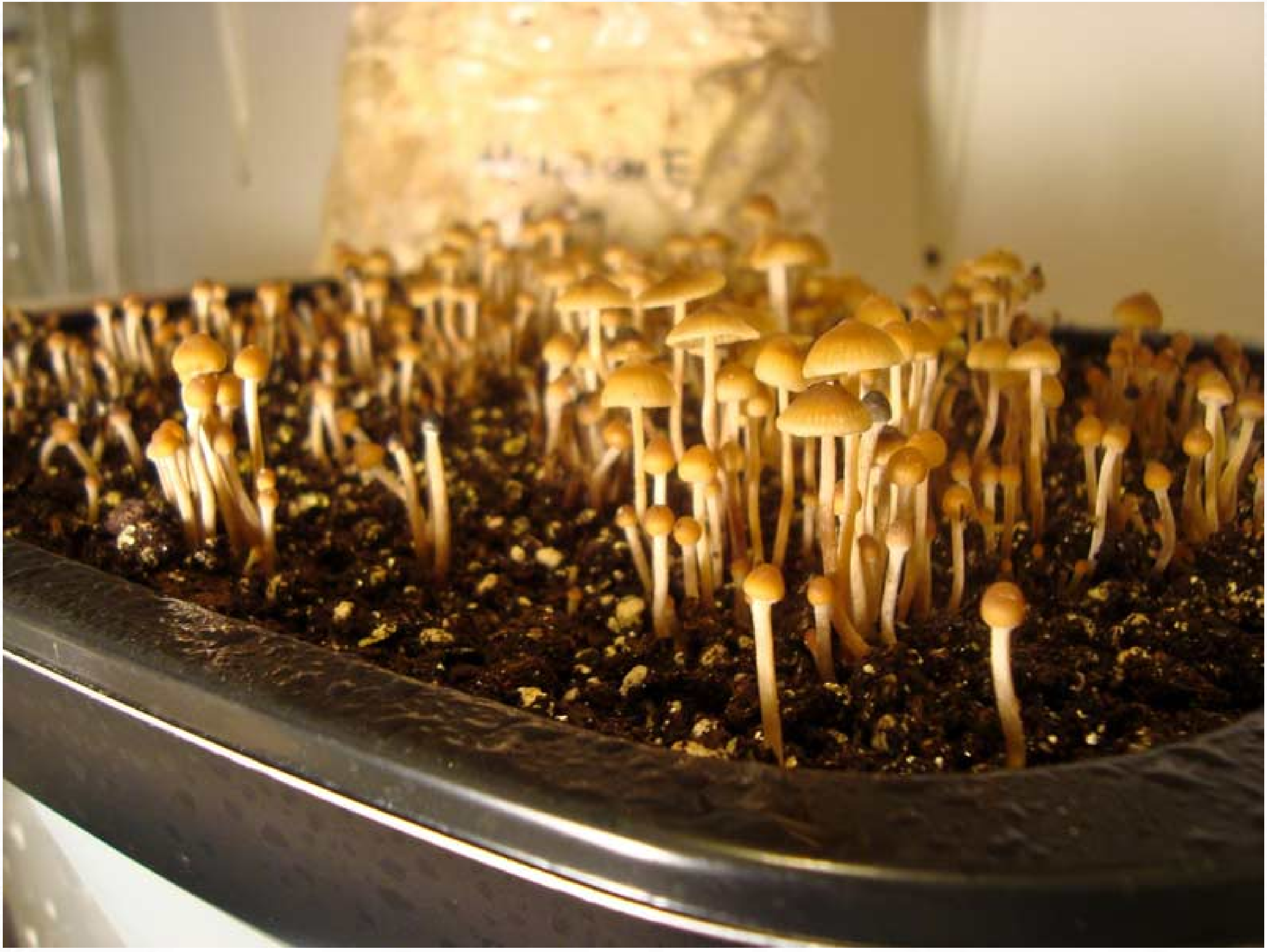
Spread it evenly on the top of the substrate and put it into your fruiting chamber.
I've used a SGFC and Greenhouse and they both perform good.
Keep high humidity and lots of FAE throughout the whole fruiting.
Keep your temperature between 65-80F.
I've had them to fruit on constant 65F and constant 80F and anywhere in between.
Light temperature of 6500K is preferred (although I experimented with a 8200K light too with good performance as well) with a cycle of 12/12.

Pins should appear within 10-14 days in optimal fruiting conditions.

Grains Spawned to Bulk Substrate

You can spawn your grains to any pasteurized manure or coir based bulk substrate.
My favorite mix is horse manure/straw/coir/vermiculite/gypsum (40/20/20/15/5).
Let your bulk colonize, case and fruit it as above.

Psilocybe mexicana/Jalisco rye berries spawned to pasteurized coir/coffee/verm/gypsum



Psilocybe tampanensis spawned to pasteurized horse manure/straw/verm/coir/gypsum

Fruiting BRF Cakes

With this method I don't harvest the sclerotia from the substrate.
After full colonization birth the cake and wash off the vermiculite barrier.
After this I like to dry the cakes out in the front of the flowhood or a fan.
Dry it for a few hours at least or overnight.

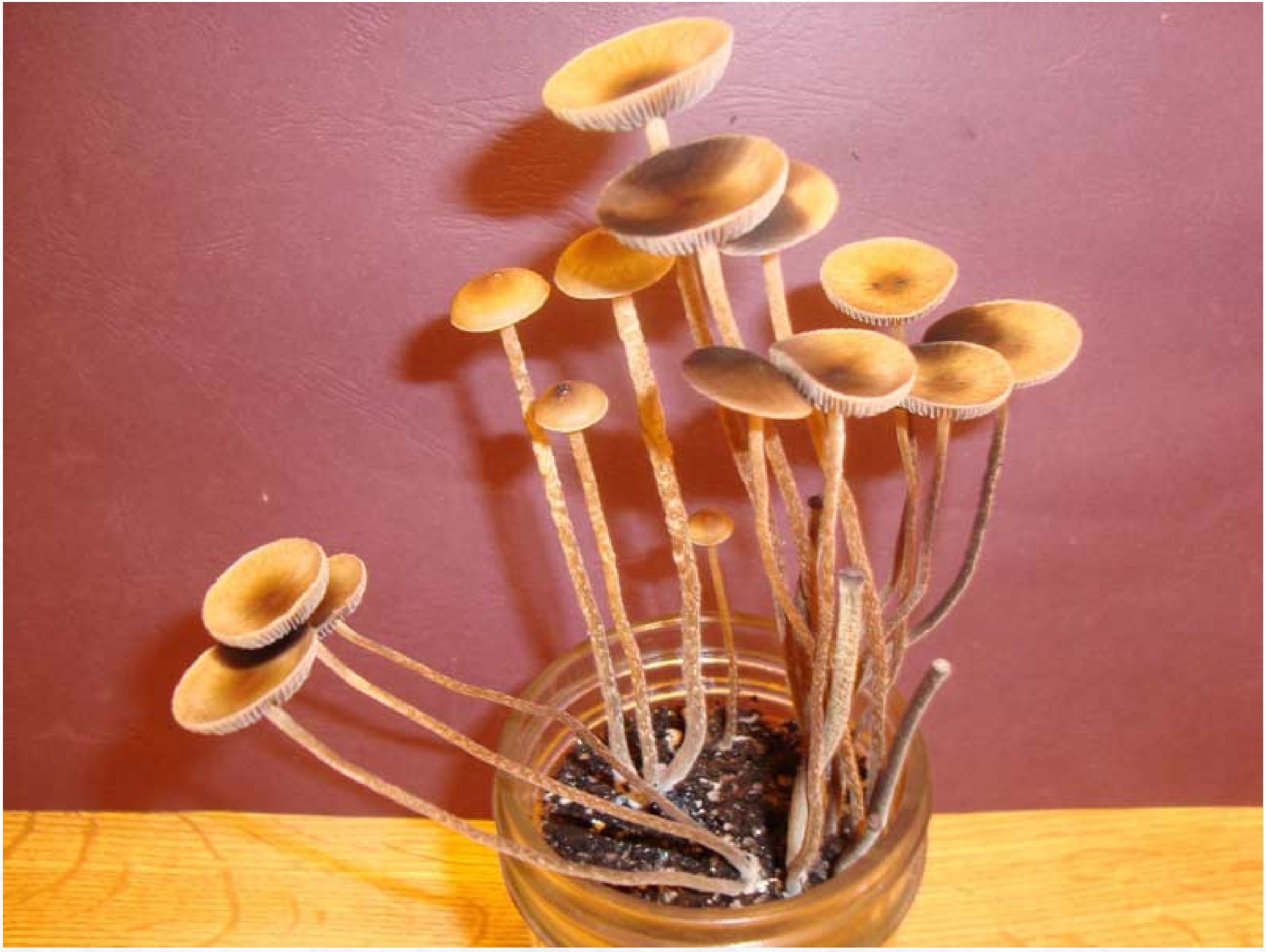
Psilocybe tampanensis cakes drying

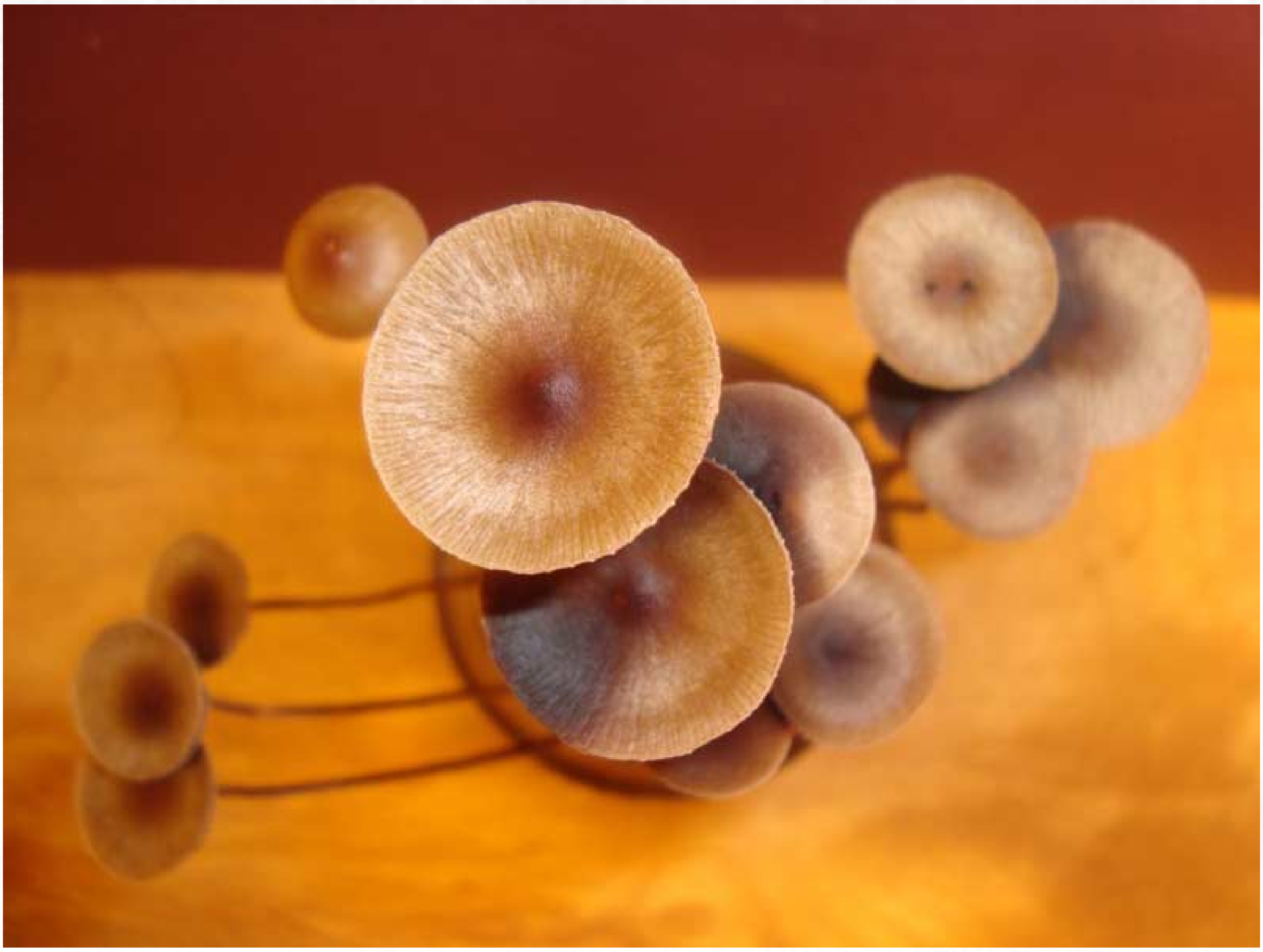
Please note that the above step is not necessary but IME it will give you a better flush/pinset.

Now that the cakes are dry you can go ahead and dunk them for 24 hours.
Put them back in the jars and case/fruit in the same manner as with grains (described above).

Psilocybe tampanensis cakes dunking and cased

Psilocybe galindoi fruits on BRF substrate





Alternative Fruiting Method

If you're after the fruits and don't care about sclerotia this is the TEK for you!
Prepare a bulk substrate mix in a spawn bag and sterilize it, then inoculate it directly with LC.
Here's how I prepare my bulk.

Shred the horse manure with a small food processor.
I can't believe that some people still breaking up manure with their hands...

Shredding the manure

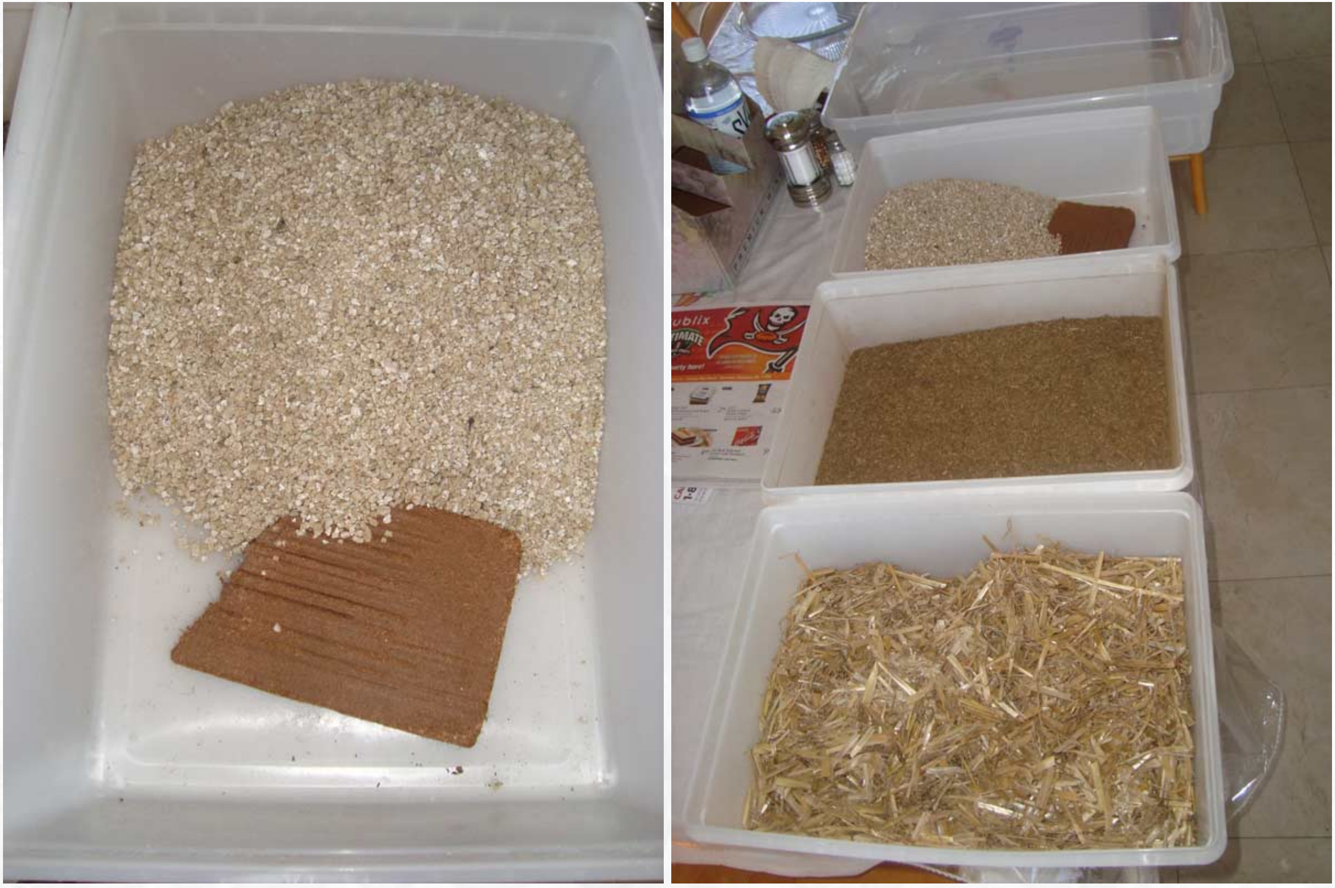
Ultimate Chopper

Chop up some wheat straw and submerge it in water for a couple of hours.

Prepping wheat straw

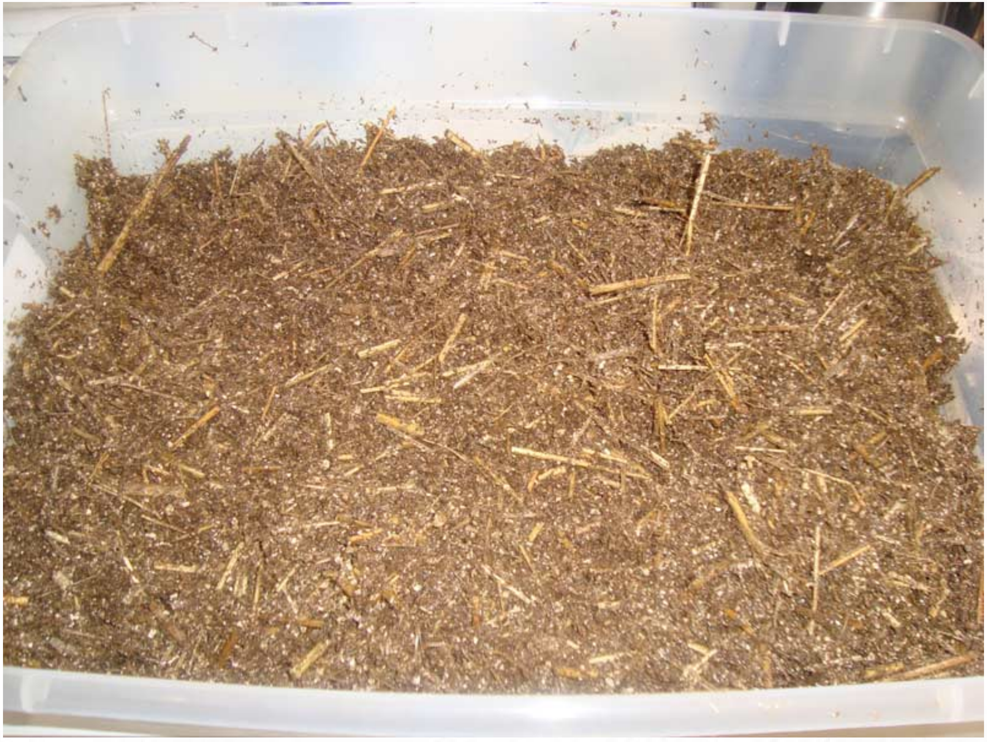
Hydrate some coir, and get the vermiculite & gypsum ready.
I don't measure anything exactly just eyeball it.
It's not that important, just be somewhere in the ballpark of the above mentioned ratio...

Ingredients for the substrate



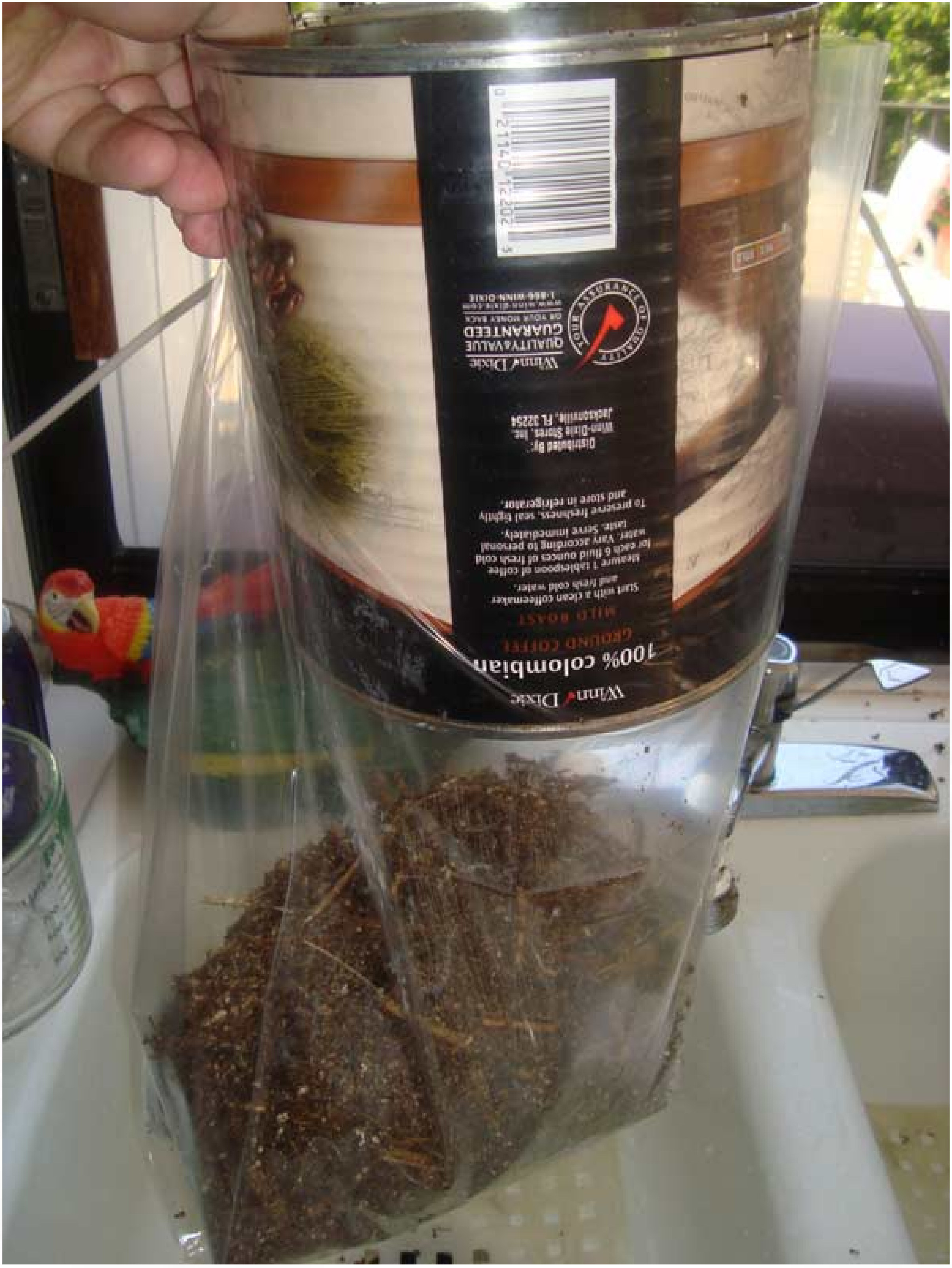
Now mix your dry ingredients (manure/verm/gypsum) then mix in coir and straw.
Hydrate the sub to field capacity and fill into gusseted spawn bags.
I fill the bags with 2-4 quarts of substrate.

Mixed and hydrated substrate



I love RRs idea with the tyvek sleeves inserted in the bags, you don't have to worry about contamination while your PC cools.

Prepping the spawn bags

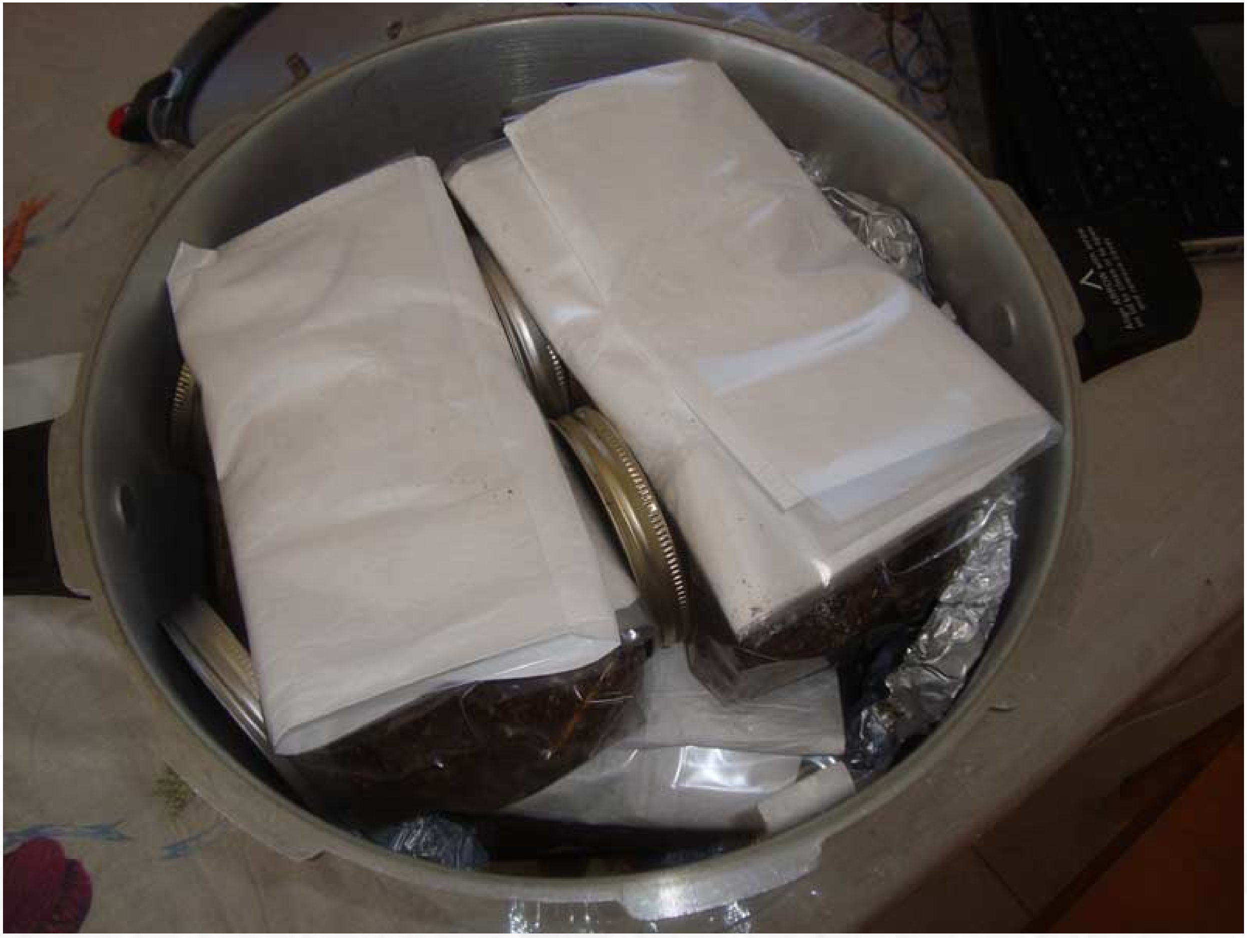


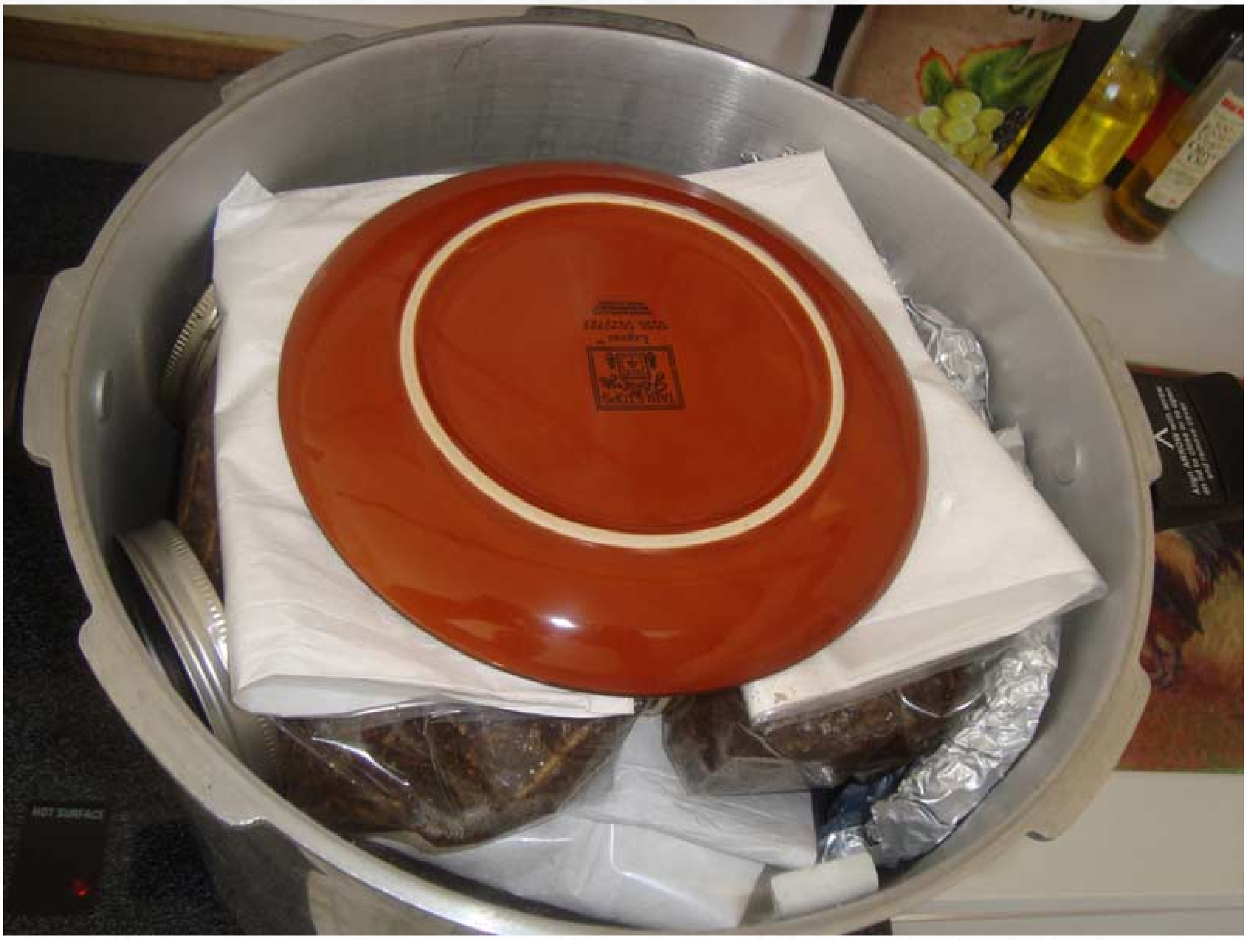
PREMIUM

PREMIUM

Fill your PC with the bags, and PC them for 120 minutes @15psi.

Bags before and after PCing

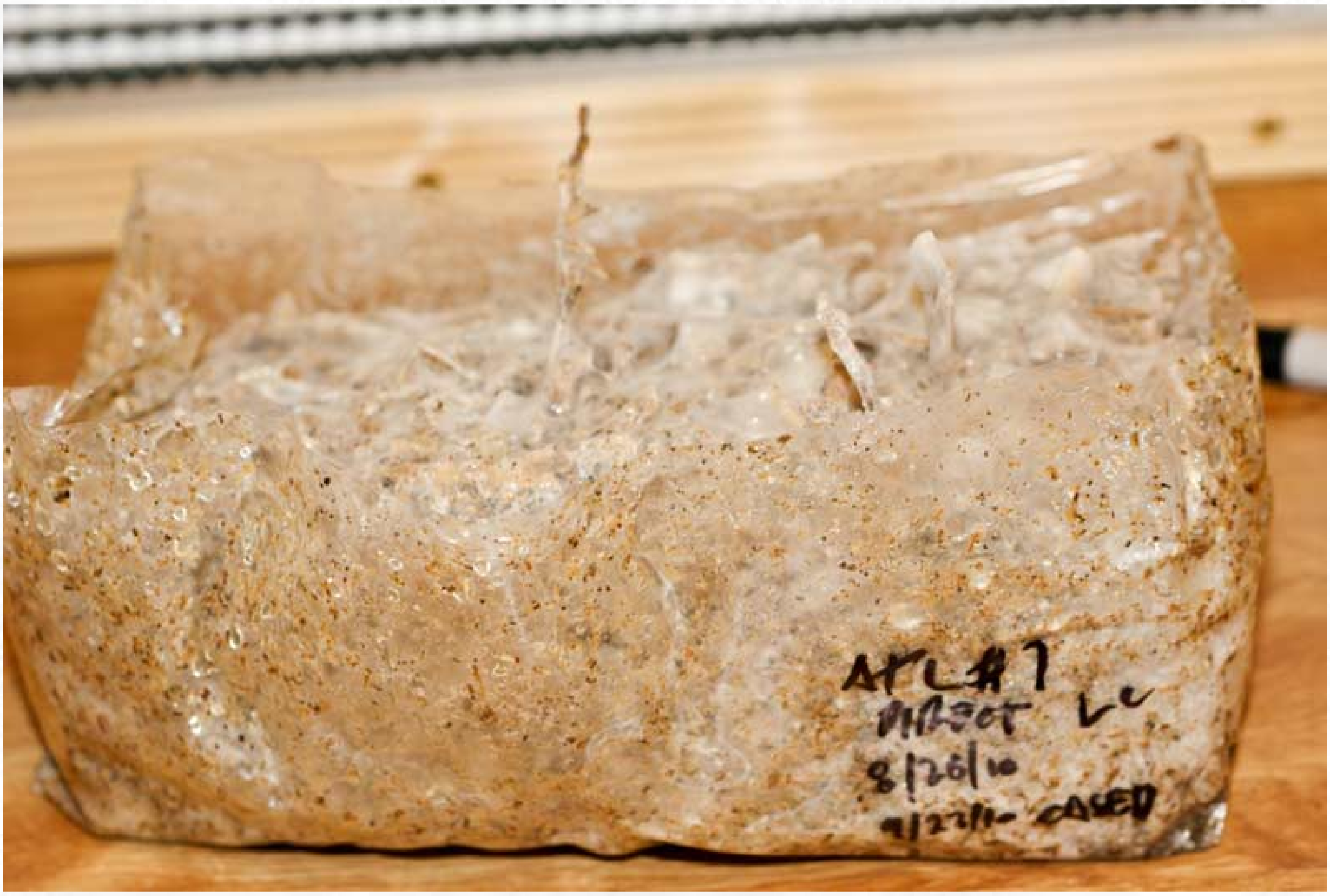




When the bags are cool I open them in the sterile laminar airflow and inoculate the bulk with 20-60cc of LC.
Inflate it with the sterile air and tie them up.
When fully colonized, cut the top of the bag just above the substrate level.
Case it thin with your favorite casing layer and fruit it.

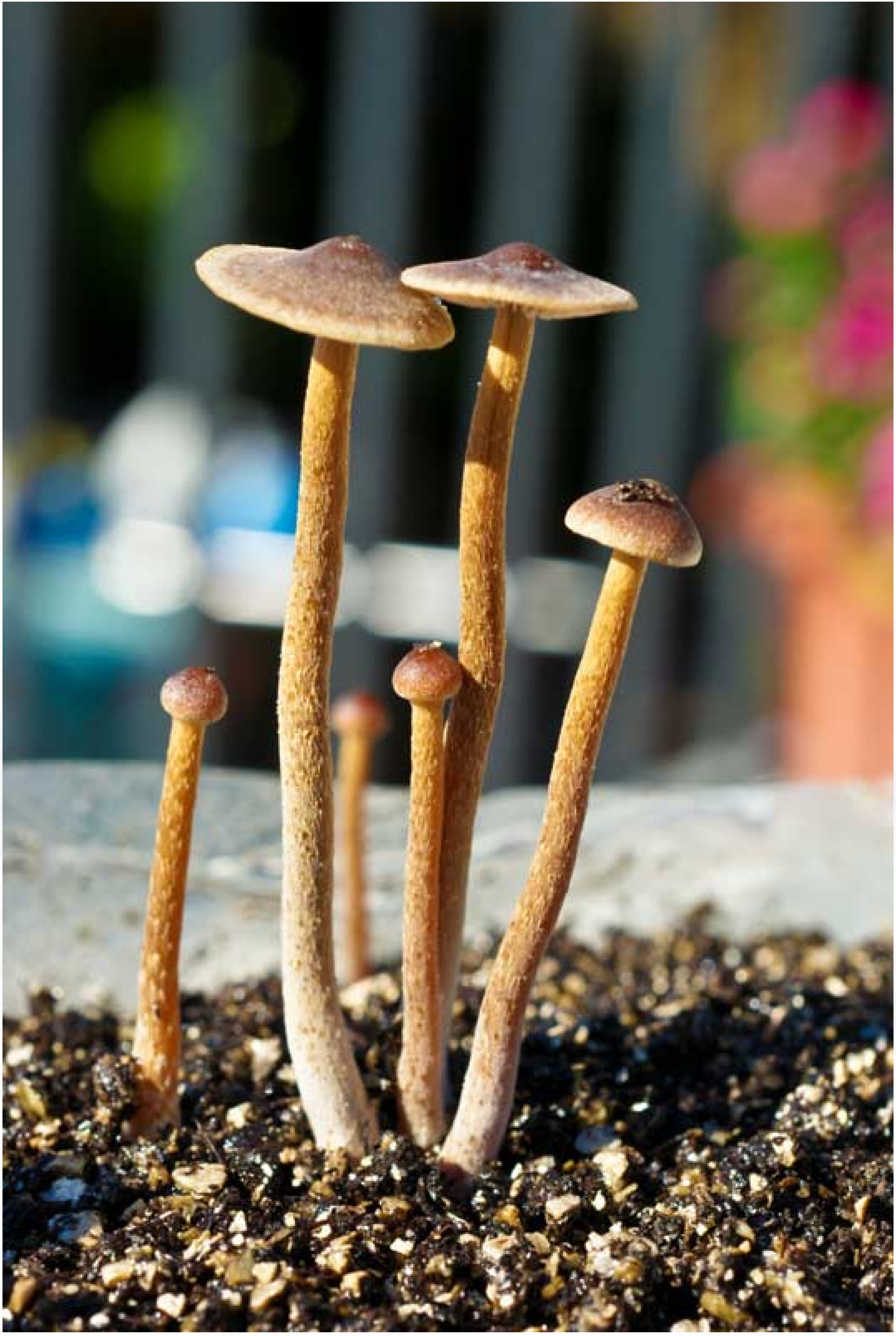
Psilocybe galindoi bag fully colonized, top cut off and cased

ATL#7
ATL#7
LC
8/20/10
9/27/10 CASED


ATL#7
DIRECT LC
8/26/10
9/22/10 CASED

ATL#7
DIRECT LC
8/26/10
9/22/10 CASED

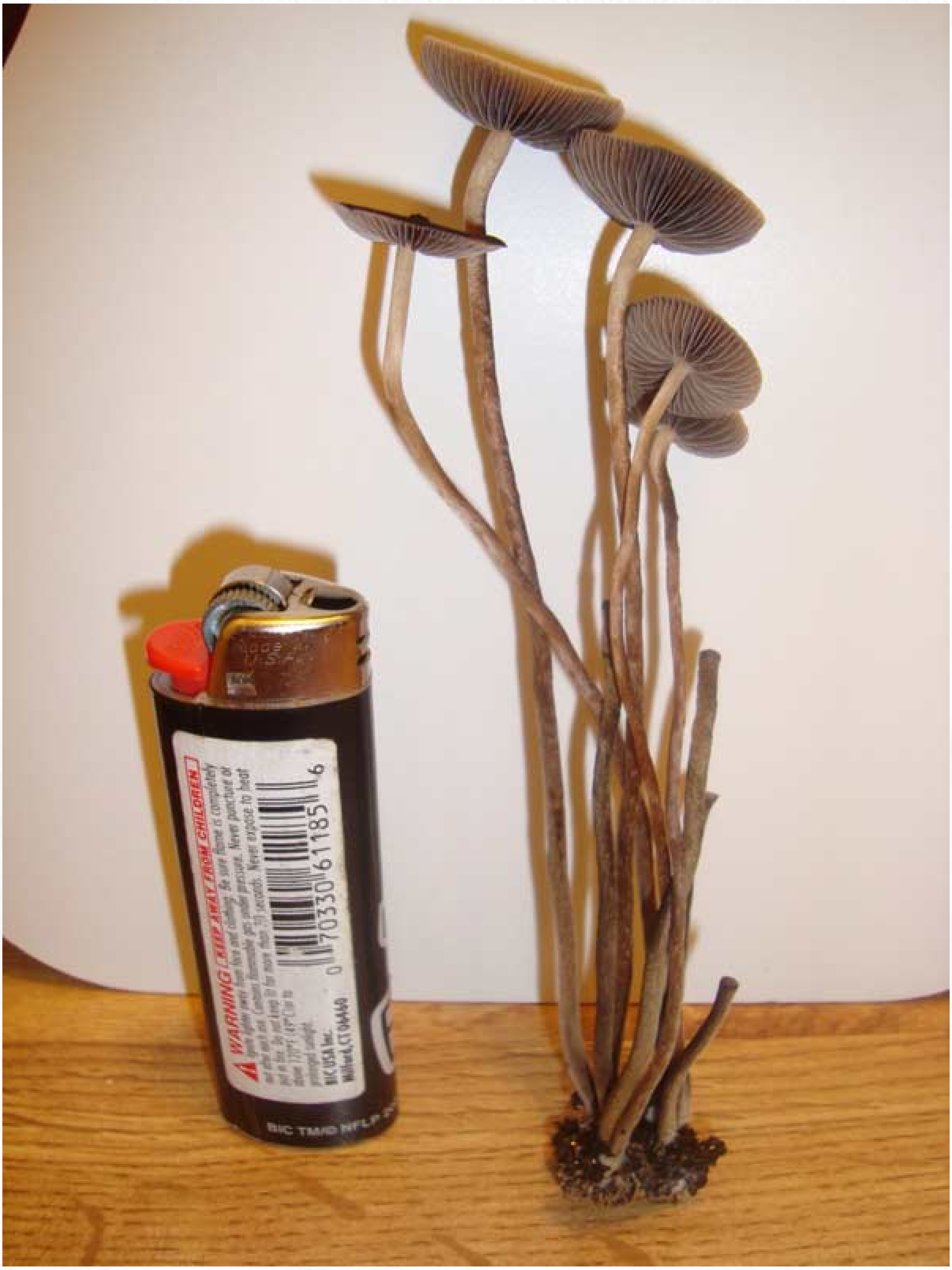
Psilocybe galindoi fruits on the above mentioned bag



Harvesting & Spore Printing

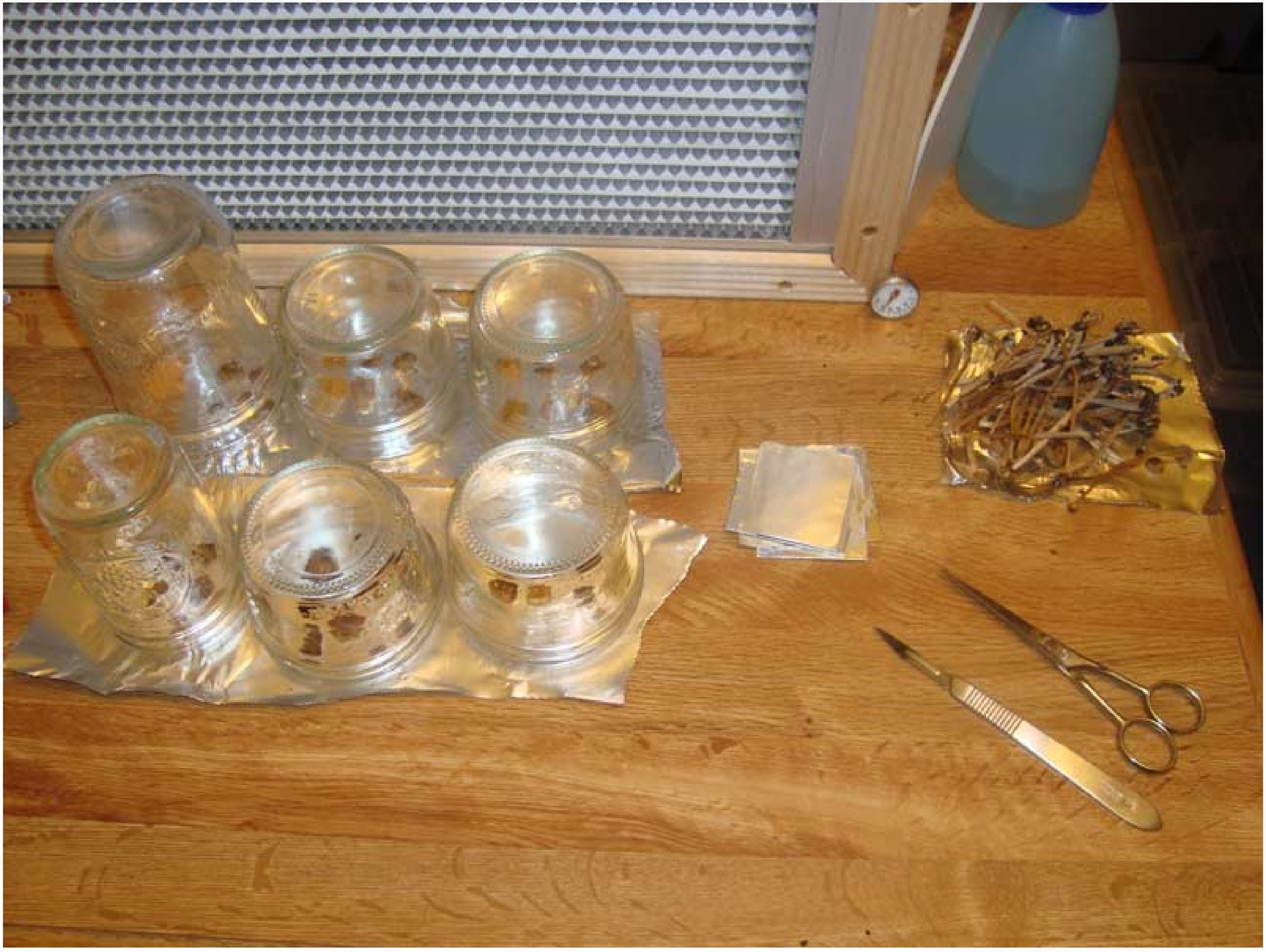
Now that the pins developed into mature fruits (anywhere between 5-10 days) you are ready to harvest them. This is the same as you would do with any other species of mushroom, but keep it in mind that these guys are pretty fragile.
Gently pull them off the substrate and set them aside.

Psilocybe galindoi harvest from BRF



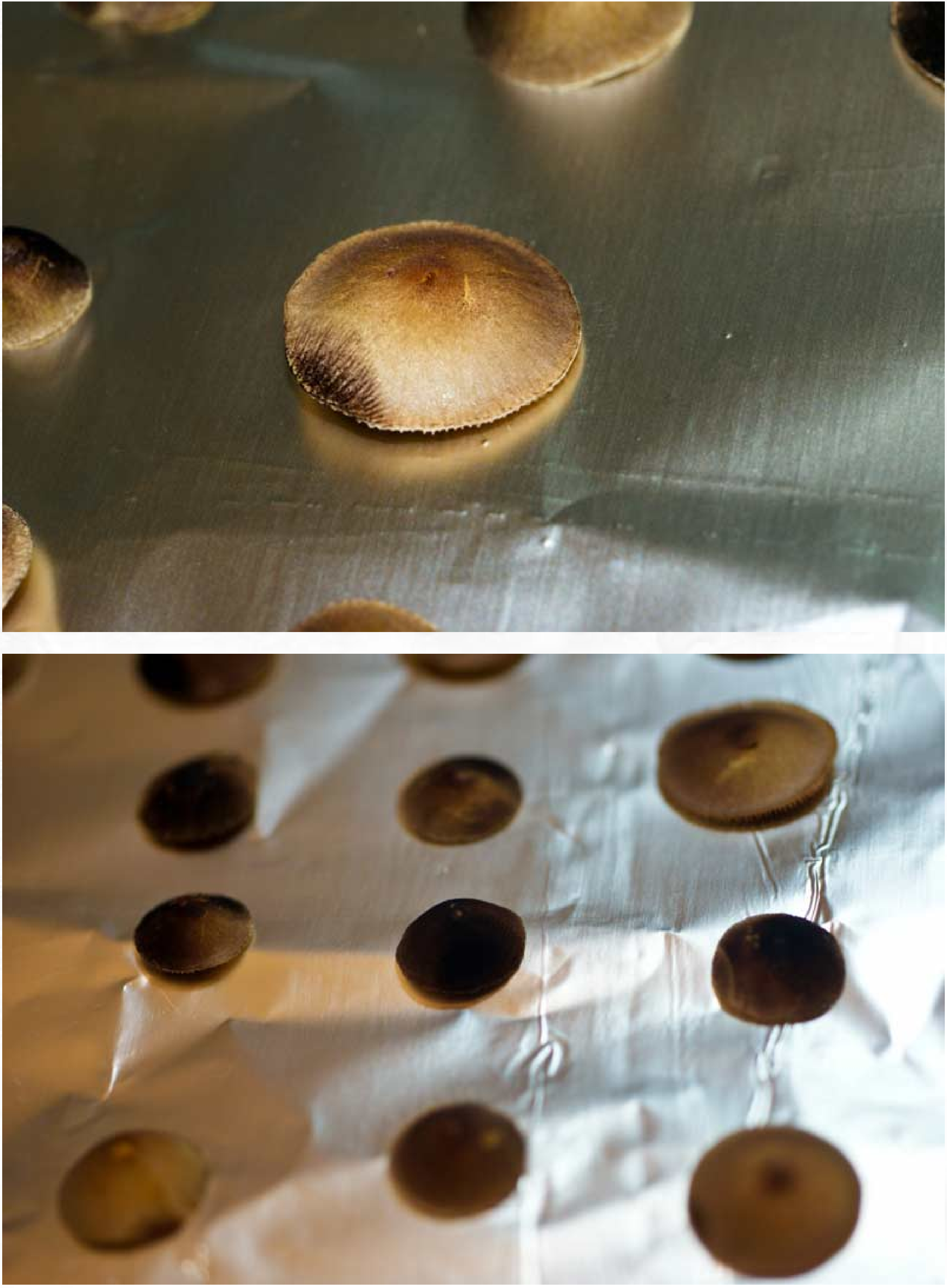
Cut the caps off the stipe as close as you can and place cap onto alcohol sanitized heavy duty aluminum foil. Do this in your glovebox or front of your flowhood.

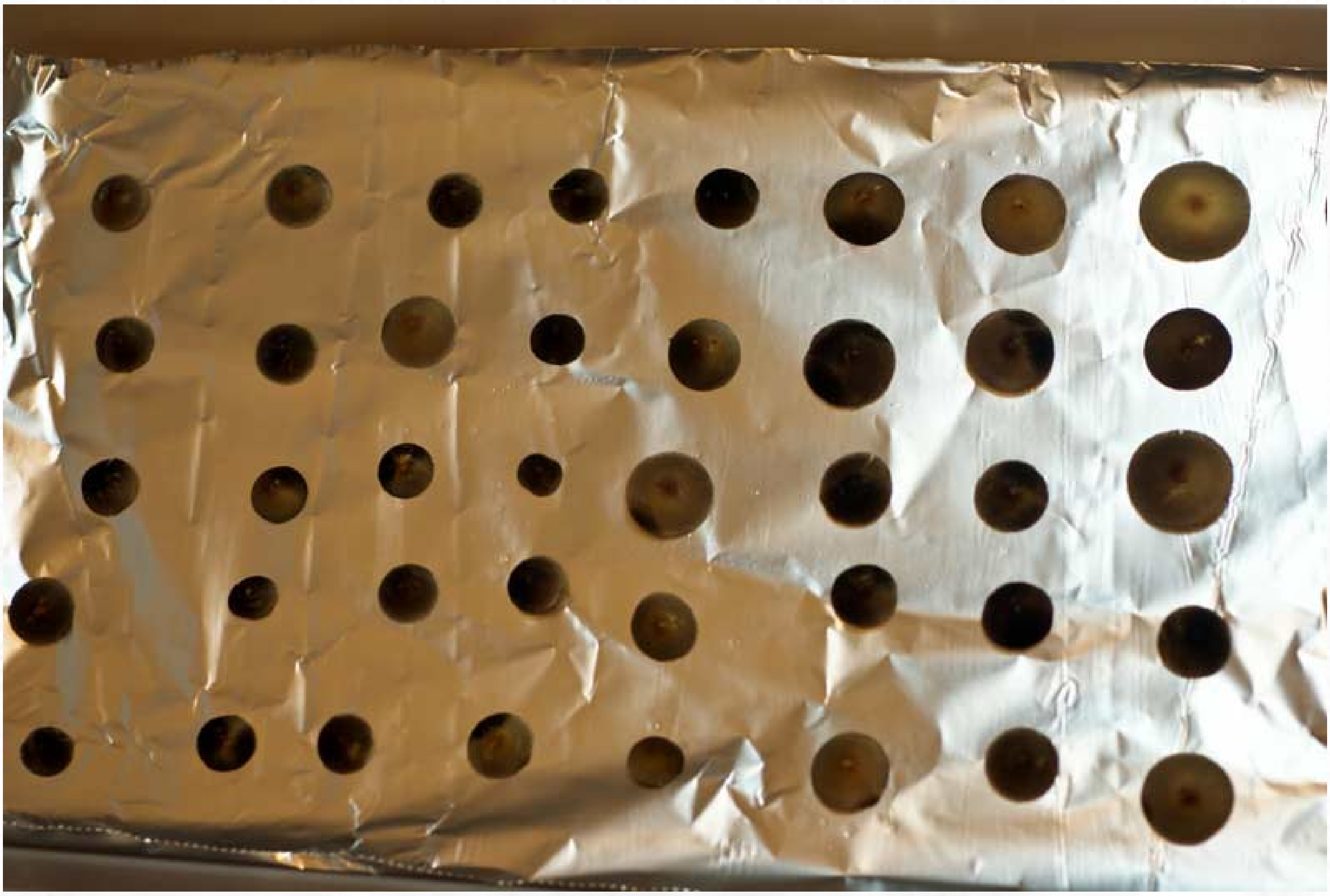
Psilocybe galindoi caps printing



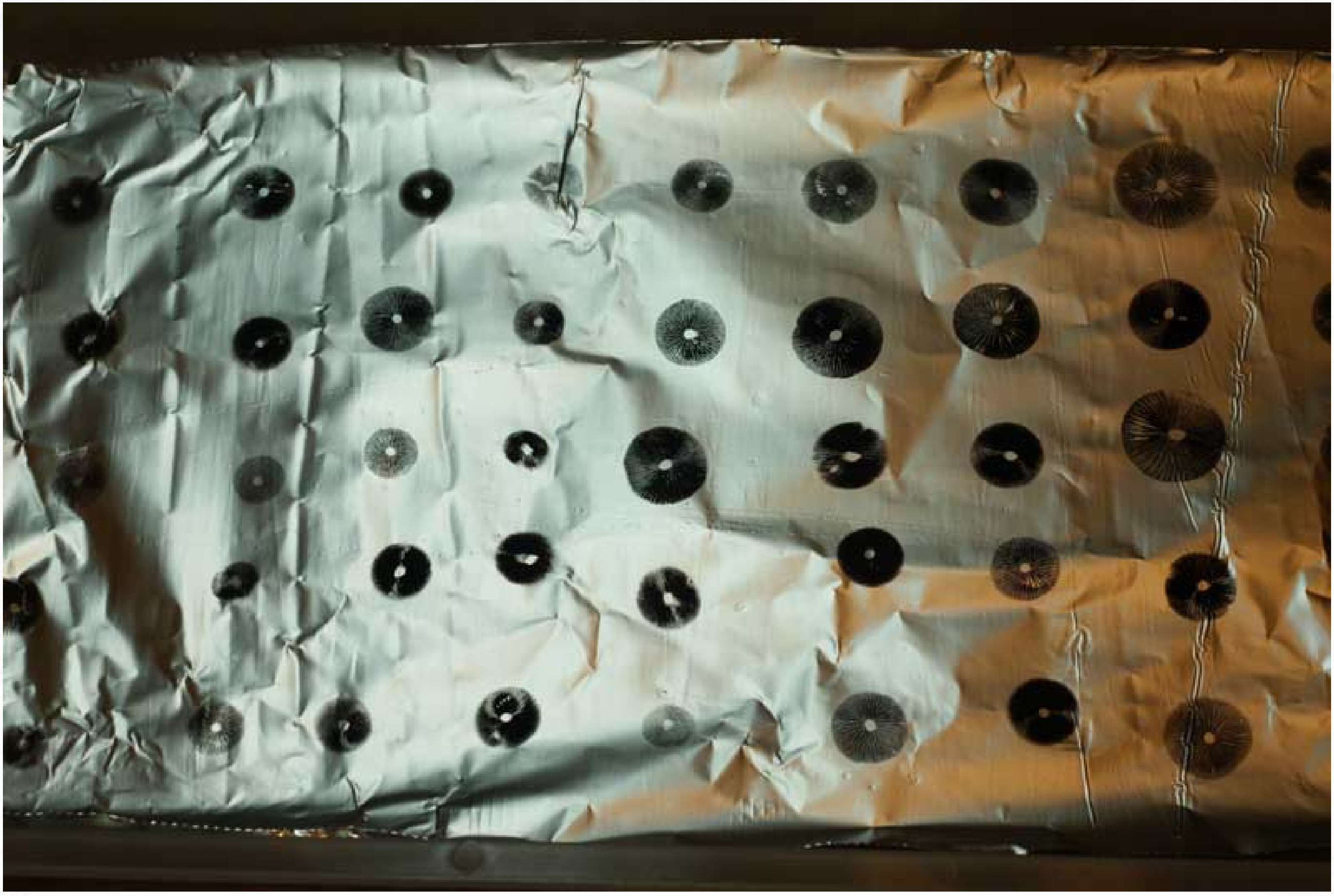
An other good method is to use a plastic shoebox.
Take the lid, and lay a sheet of sanitized foil in it.
Put the caps on the foil and place the bottom of the box on the top of the lid.
You'll have a nice sheet of good quality prints.

Psilocybe tampanensis caps mass-printing on foil in a shoebox





Finished prints of Psilocybe tampanensis



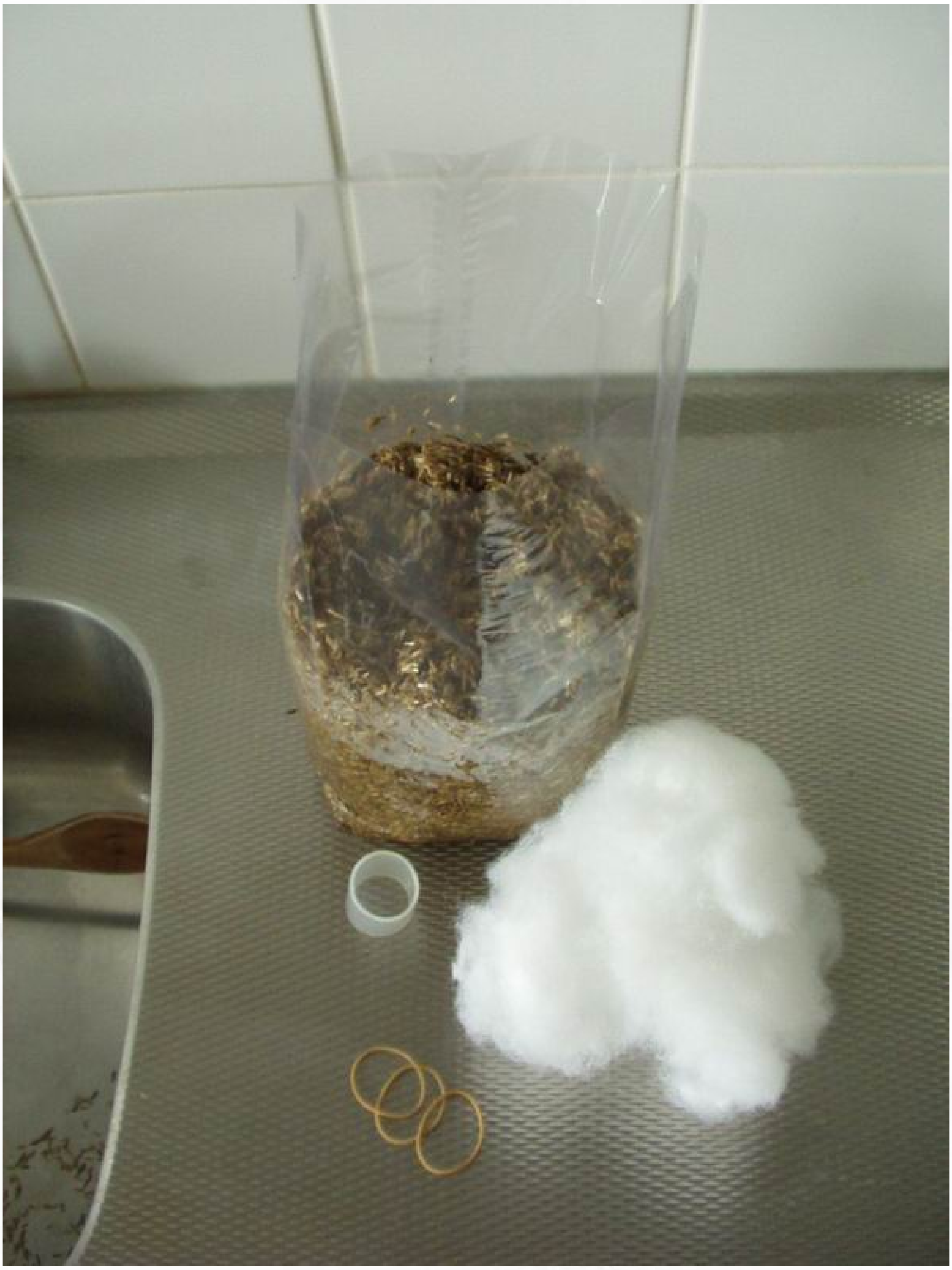
Thanks for reading.

Do it yourself - spawnbags

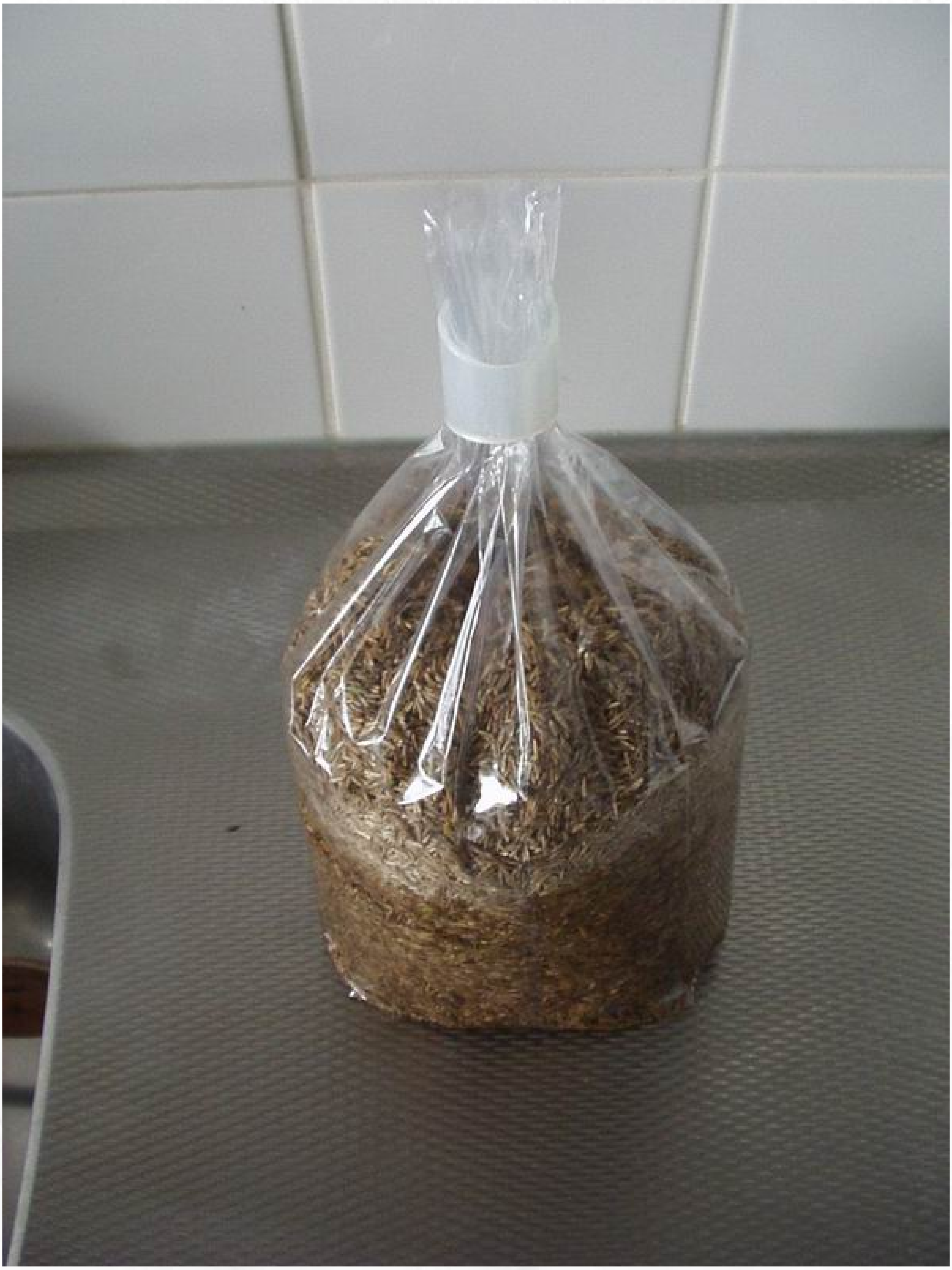
by

Una

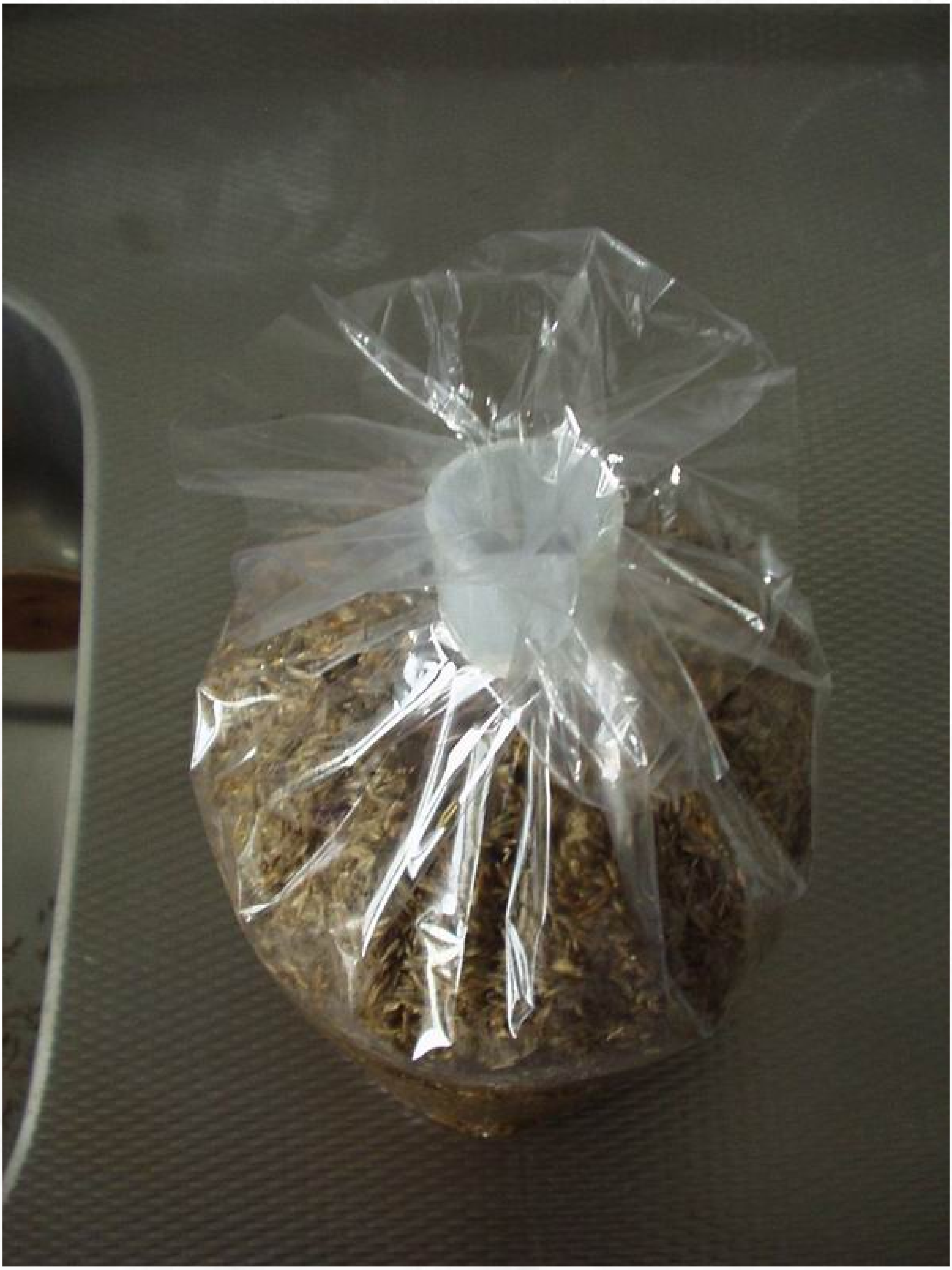
original source: http://www.shroomery.org/forums/showflat.php/Number/562556/fpart/all/vc/1



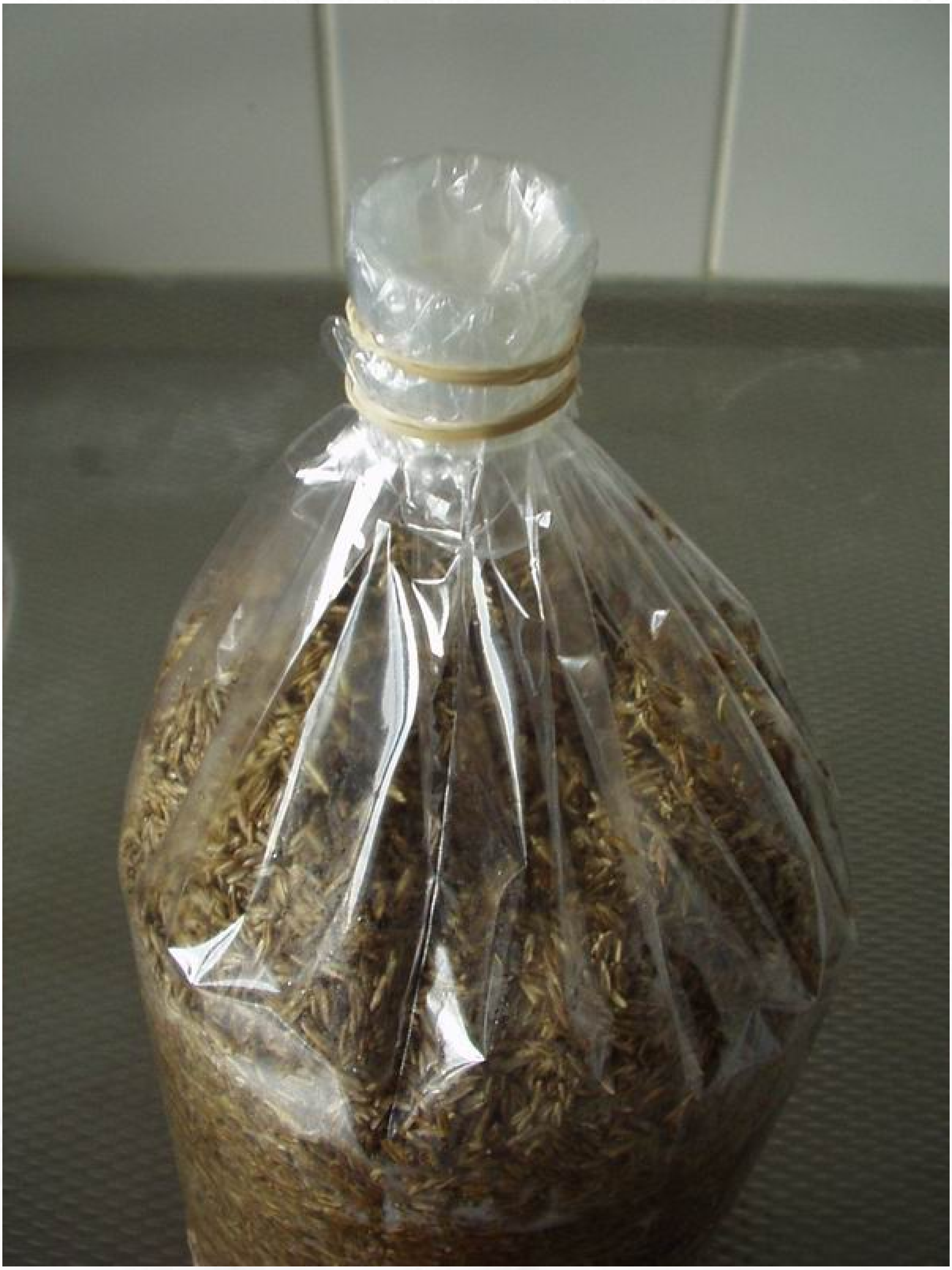
Grass seed (2 liter) and water (1 liter) combined in a polyproylene bag.



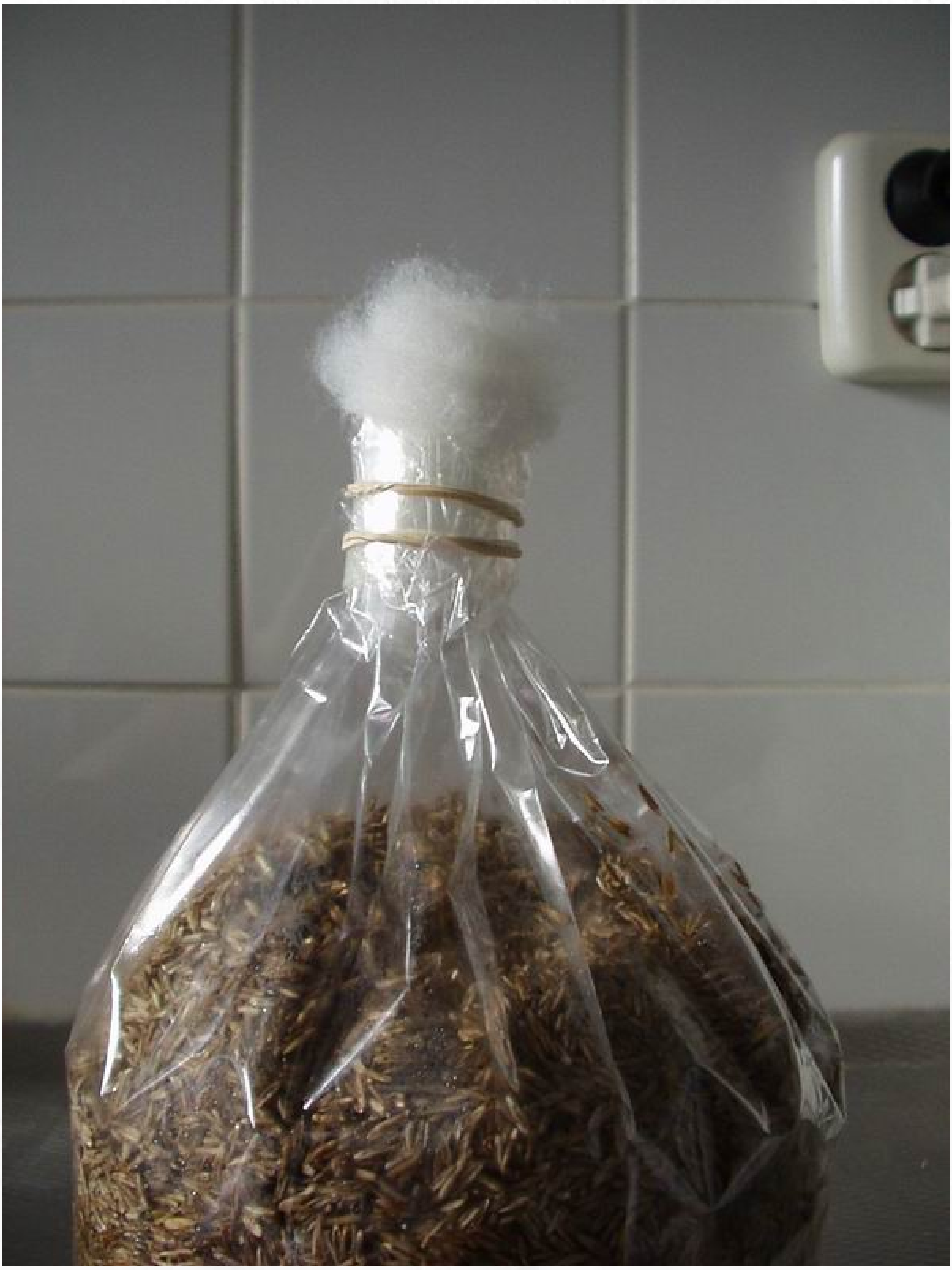
Bag is pulled thorugh a polypropylene ring (cut from a big syringe).



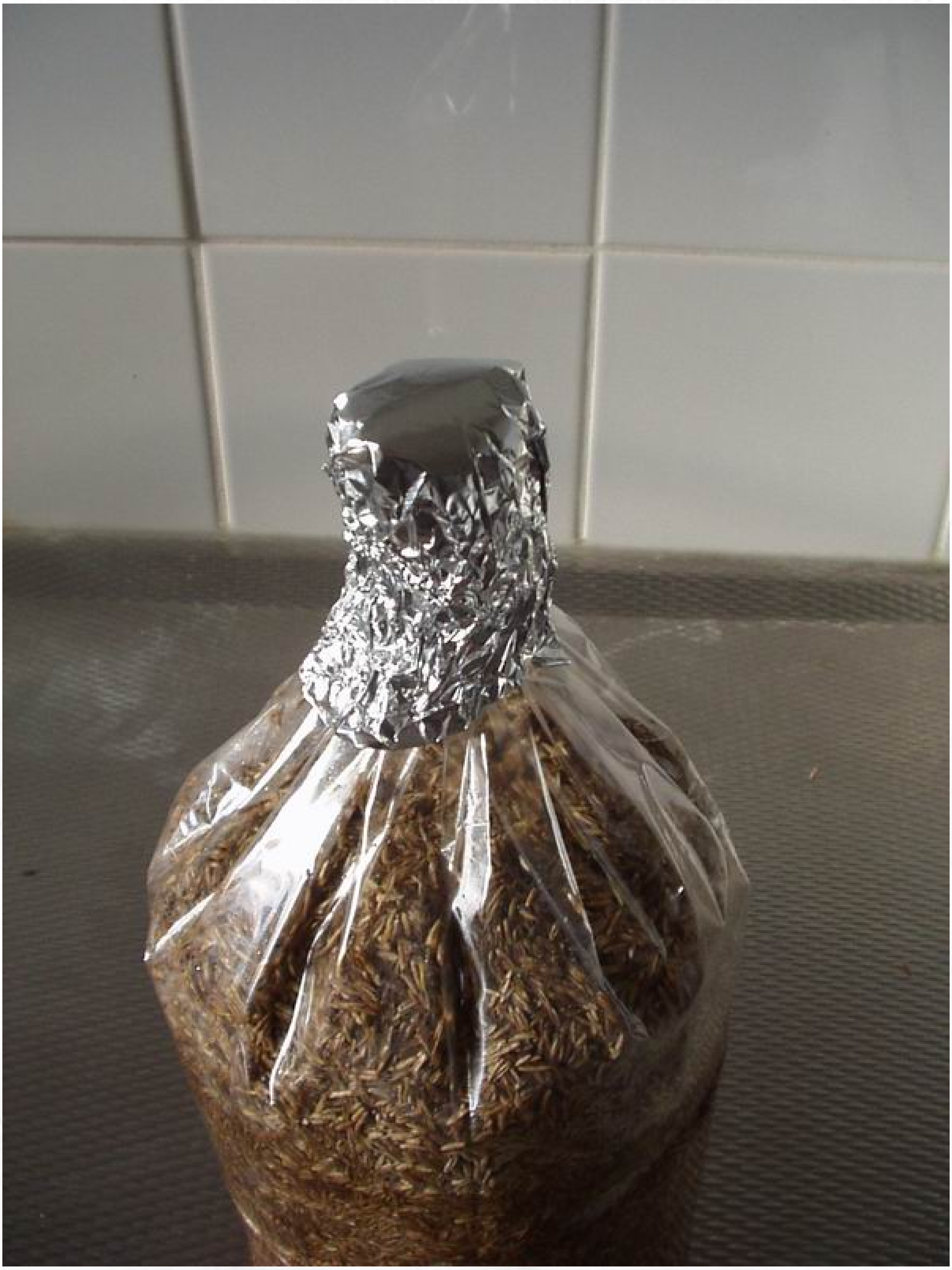
Bag is folded back...



...and secured with two rubber bands.

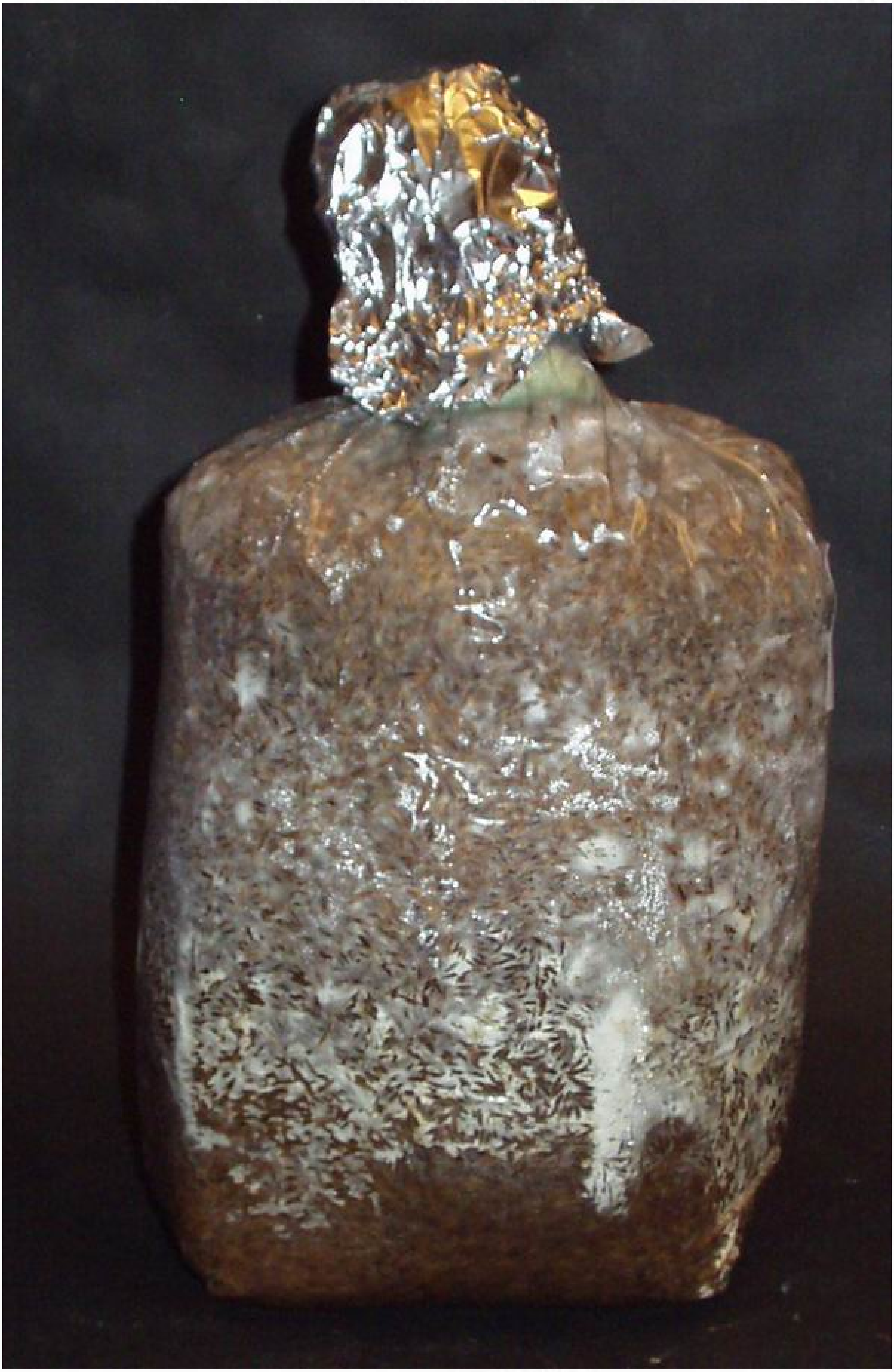


The openeing is stuffed with polyfill.

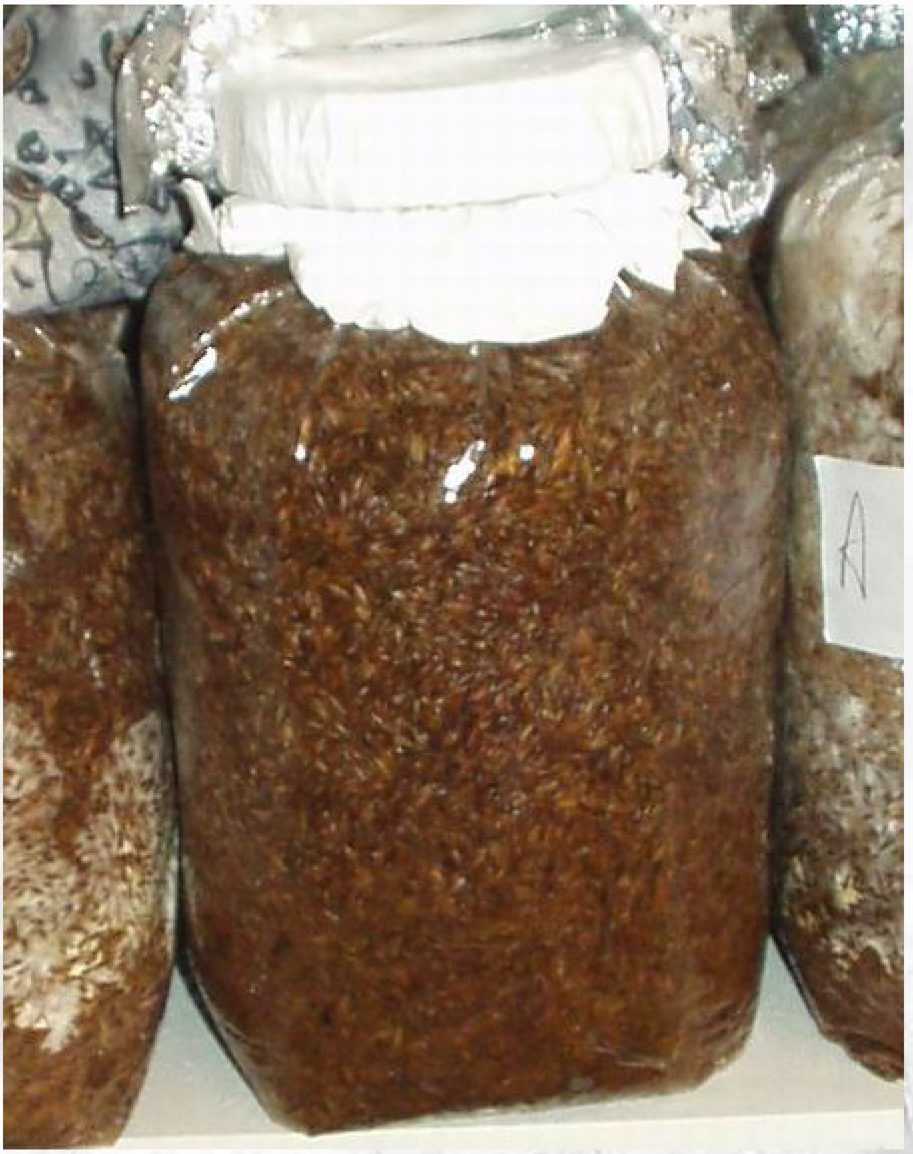


And this is covered with aluminium foil to prevent it from getting wet in the pressure cooker.

Bags after autoclaving (2 1/2 hours).



These bags should be inoculated with liquid mycelium since they cannot be shaken. Here's a picture of an (almost) fully grown bag, two weeks after inoculation. Some small scattered sclerotia are already starting to form.



Instead of using PVC pipe i used special cardboard rings that withstand autoclaving. Inoculation was done with 50 ml of mycelial suspension injected with a syringe through the tyvek filter. The hole was taped.

Magnetic stirrers

by

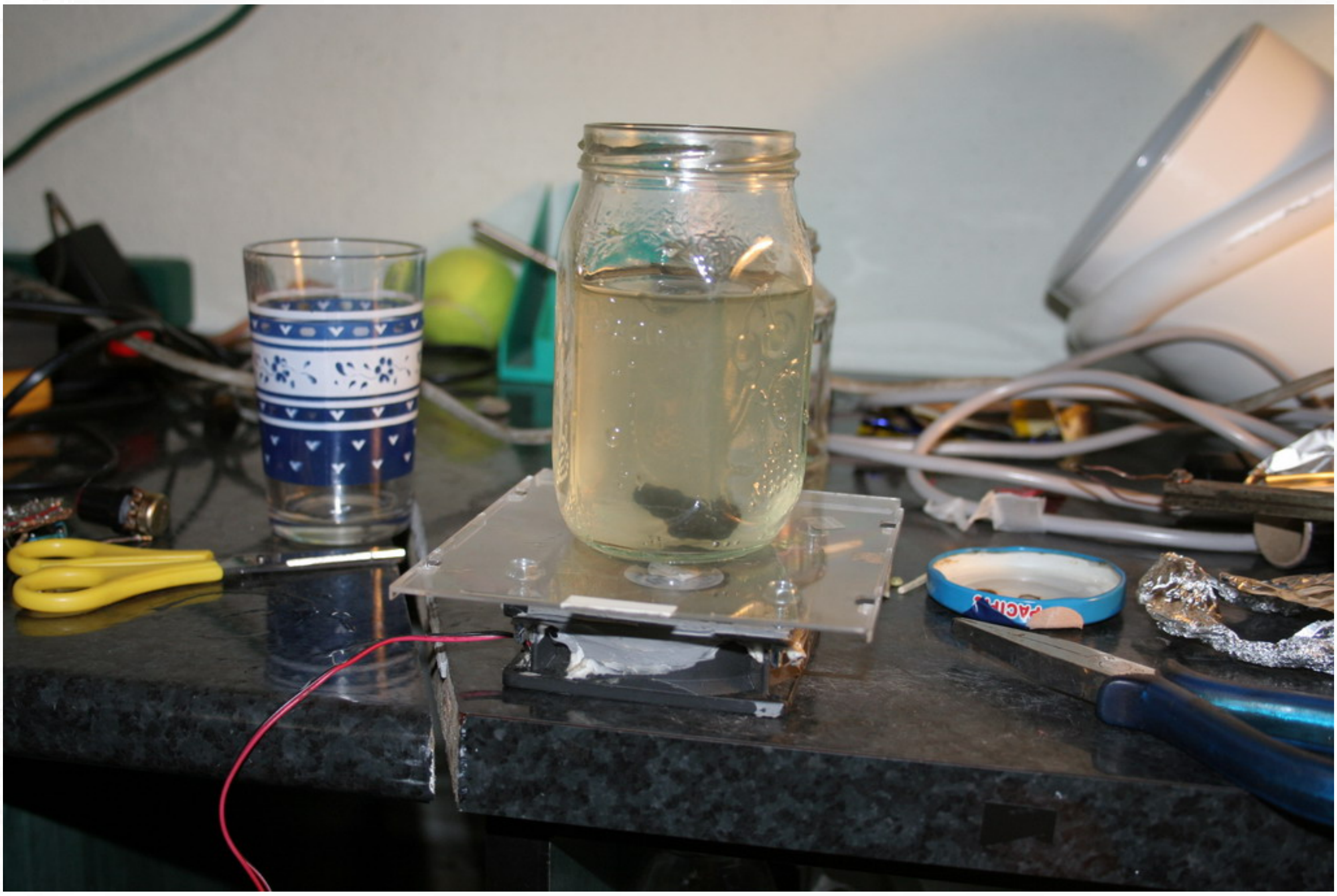
calavera, blacklabrat, splifner180

original source: https://www.shroomery.org/68/Do-it-yourself-magnetic-stirrers

by **calavera**:
http://www.shroomery.org/forums/showflat.php/Number/5585251

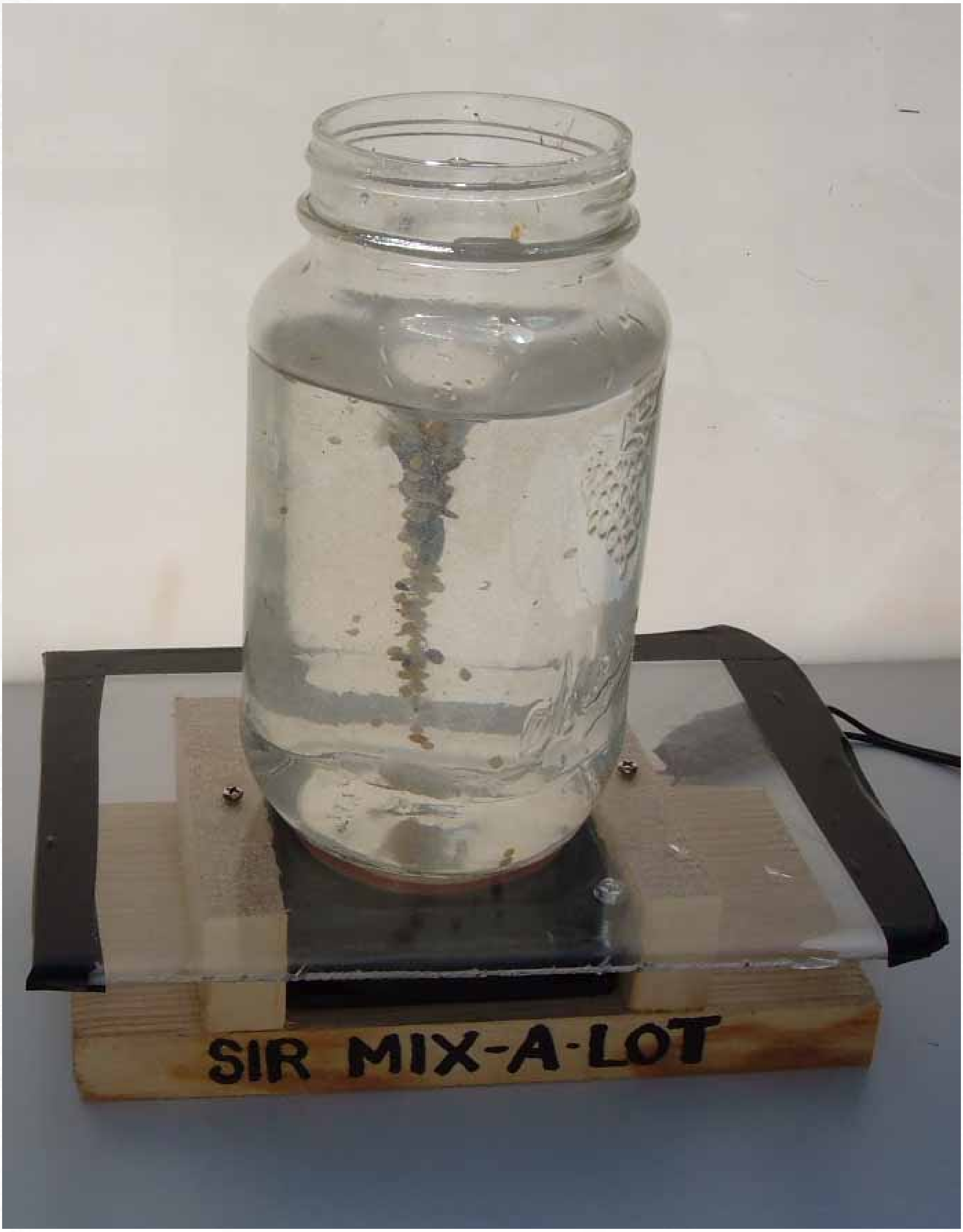
1 big computer fan with speed control
4 screws that fits in the fan's four hole
2 magnetic steerer stick's (original)
1 cd case
1 12v power supply for the fan
1 little piece of bluetech

stick one of your magnetic sticks on the center of the fan. screw in the 4 screws. the smaller part of the cd case goes on the top of the screws, adjust the screws until the cover is as close as possible, but not touching the case.



plug in, adjust the speed have fun!

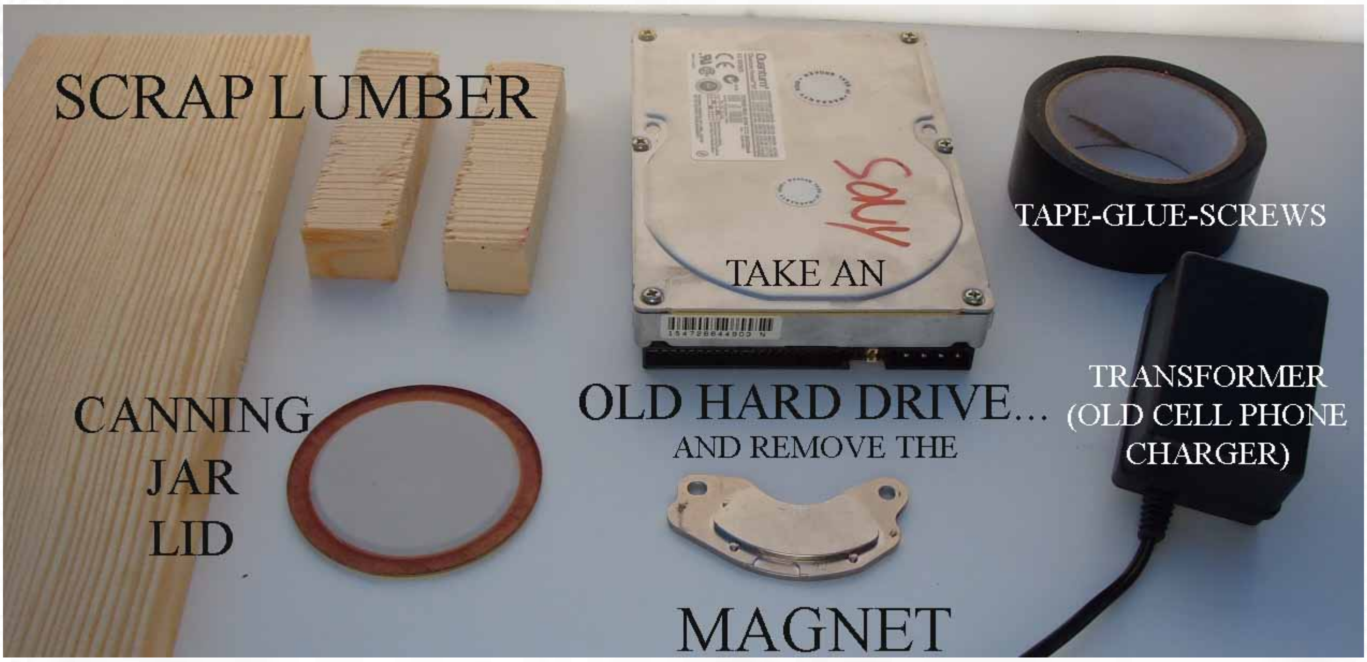
by **blacklabrat**:
http://www.shroomery.org/forums/showflat.php/Number/5568724 I would like to introduce my new little friend...........



SIR MIX-A-LOT.

OK, Right off the bat let me make it clear that I can take no credit for this. It is an idea that has been ripped off and inspired by several others who have done the DYI magnetic ***stirrer*** plate method. It works great, took me less than an hour to make and the best part...it didn't cost me a dime. FREE! Just scraped up a few items I had laying around the house.

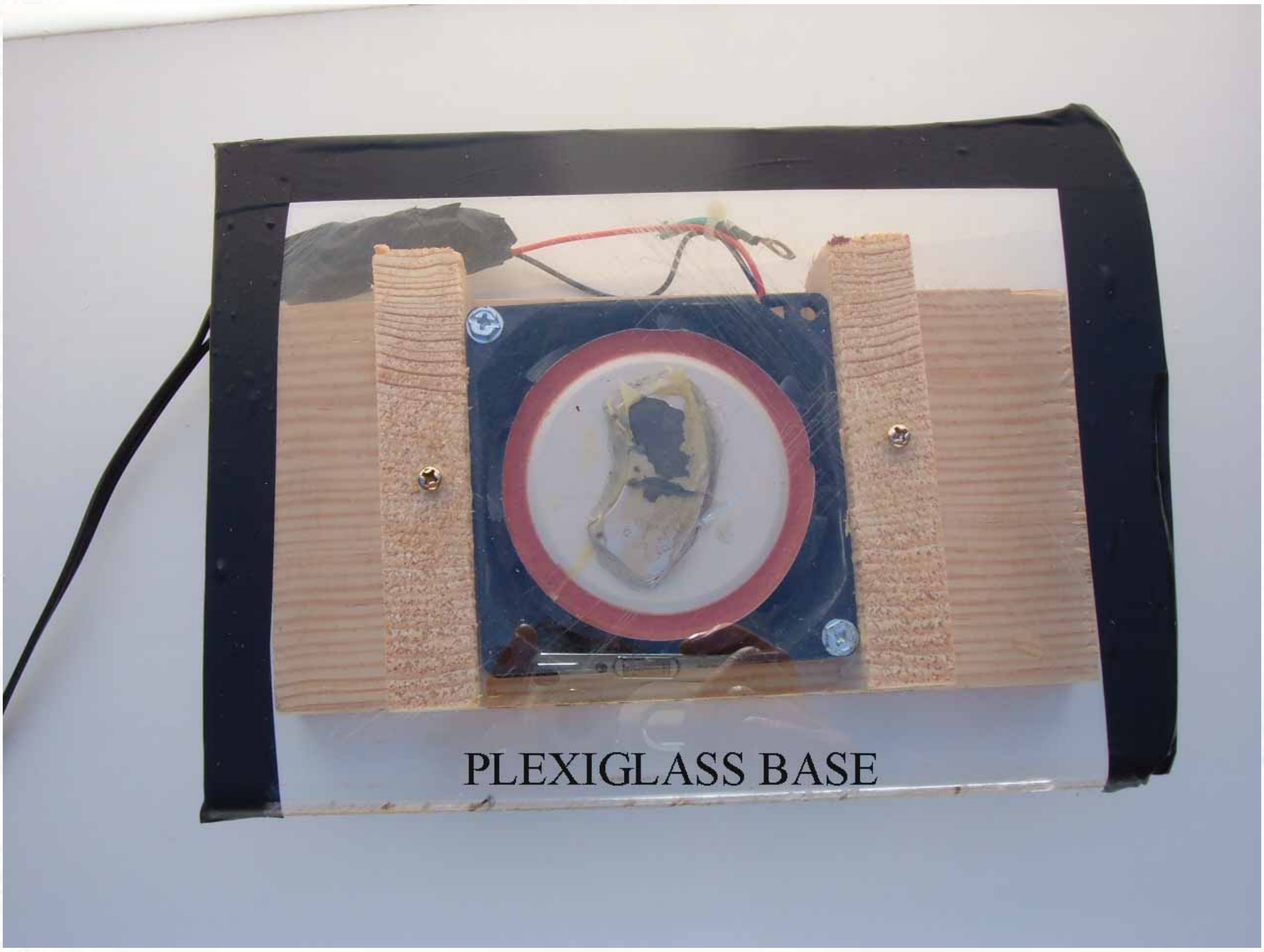
Here's how it was done:


SCRAP LUMBER
TAKE AN
OLD HARD DRIVE...
AND REMOVE THE
MAGNET
TAPE-GLUE-SCREWS
TRANSFORMER (OLD CELL PHONE CHARGER)
CANNING JAR LID

COMPUTER COOLING FAN
AAVID
THERMAL TECHNOLOGIES INC
MADE IN CHINA

~ Started off by mounting the fan to a block of scrap lumber. Connected the fan to the transformer. Originally I was going to add a dimmer switch, but after testing I deemed it unnecessary.

~ Next, I took a canning lid and hot glue gunned it to the top of the fan. Place the magnet in the center of the canning jar lid. Tested placement by plugging unit on to make sure there was no wobble. Hot glue gunned it once the magnet was properly centered.



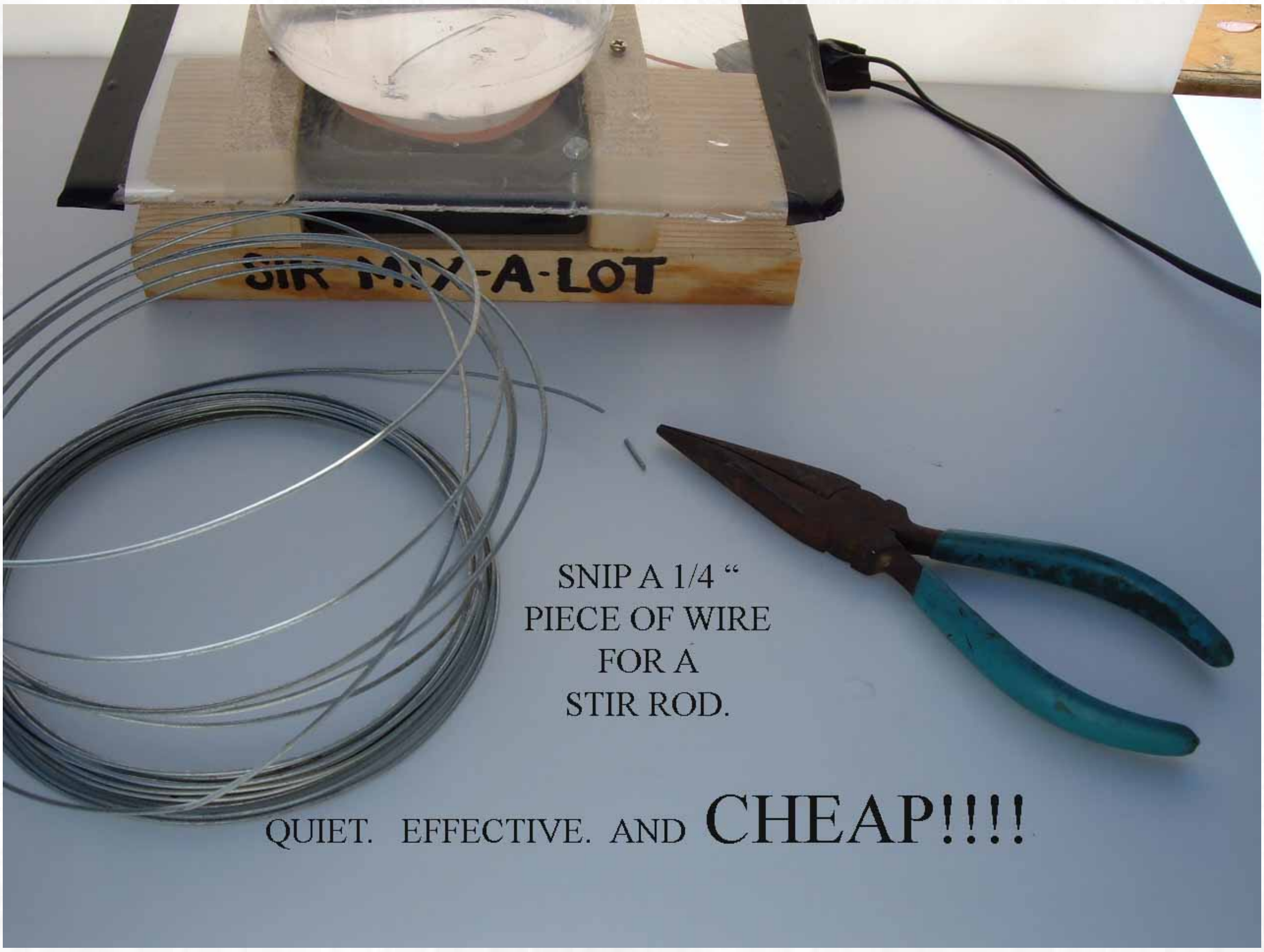
~Then I cut two blocks of lumber about 1/8" taller than the height of the fan/jar lid/magnet assembly. Mounted these to the side of the fan with glue and screws. Fixed a square of plexiglass to the blocks. This is the base surface where the LC jars sit.

Turned on to make sure that the fan was spinning freely.

Check. Everything is running quiet and smooth.

Now I need some stir rods................Hmmm. Ebay? Nah. Screw buying them!
I was now determined not to shell out any cash for this project. After playing around with several ideas, many which were too loud, slow or would require me spending some of my precious beer money.....

I was reminded how sometimes the simplest solutions are the most effective.



A small piece of wire about 1/4" long is quiet, effective and best of all CHEAP!

I tested it by placing a small piece of toilet paper in the jar w/ H2O and with in an hour it had broken it into small fibers.

Yeah yeah. I can hear it now. "Isn't the wire going to rust?"

Eventually. But not before the LC is done. They are essentially disposable, costing you about 10 cents per 100!

And there you have it.

How well does it work? Check out the first pic!

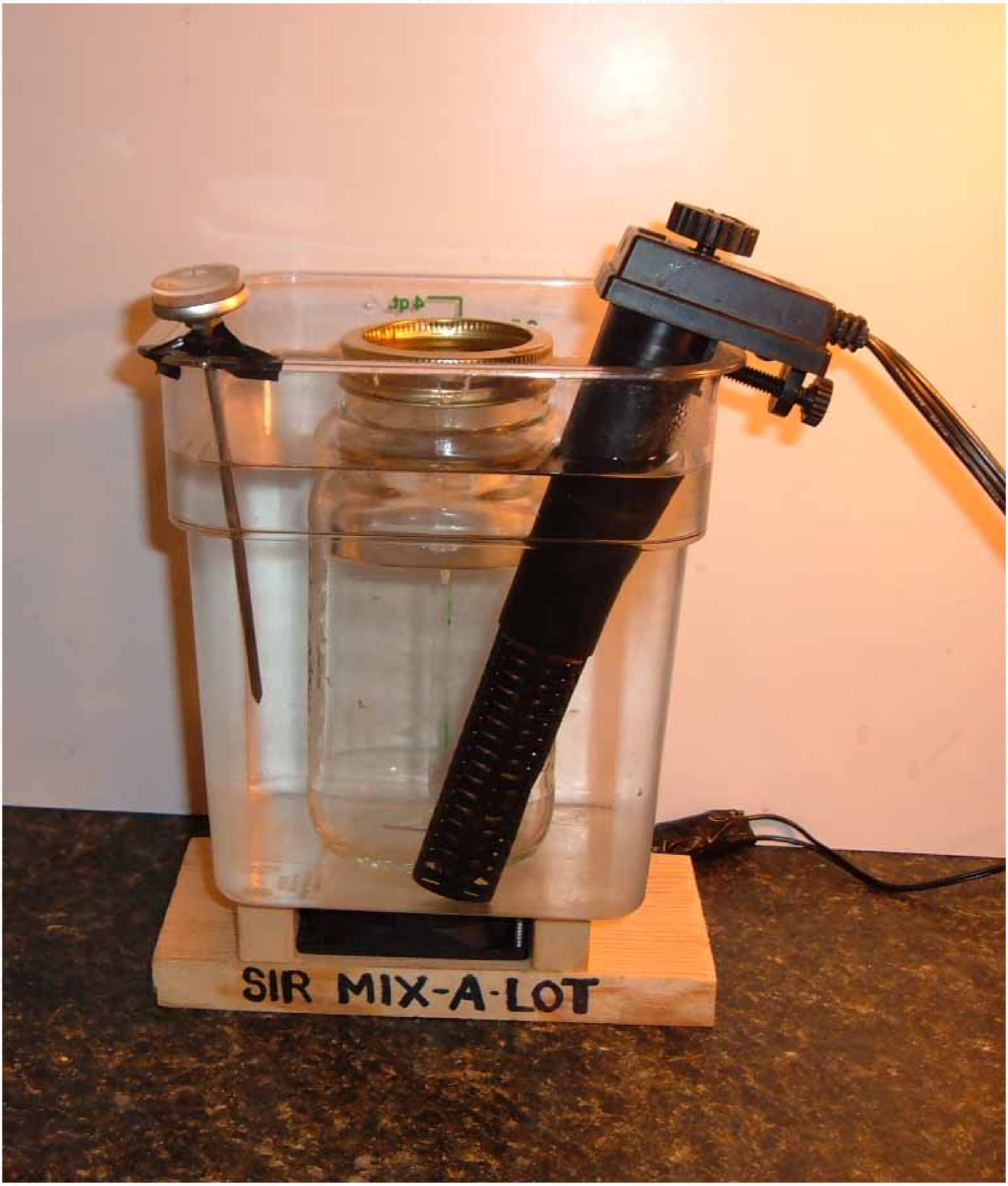
It spins like Dorthy in a tornado.

JUST ADDED

Need to warm up the temp of your LC? Try this:

Made one minor improvement to the Sir Mix-A-Lot magnetic ***stirrer***.

I usually do my LC in temps around the high 80s. Currently temps in my neck of the woods are about 20 degrees too cold & I'd rather not put the stir plate in the incubator, so........................



My solution:

I removed the plexiglass base plate and temporally replaced it with a 4 quart lexan tub. The tub is outfitted with a aquarium heater set to 87 degrees and a thermometer. (I realize that the heater is a little too large for this particular application..going to get a smaller one this weekend)
I can now dial in to the exact temp I need.

If you are not sure how to do this, or if you are unsure if the fan/transformer combo you have will work, don't ask me. I'm no electrician. Besides even if I was, you gonna trust an anonymous druggie electrician who posted some shit on the web with your life?

I suggest you read up, use google, use the shroomery search function and take a trip to Radio Shack or a hardware store and ask them. You don't want to go burning your house down or electrocuting yourself. There ain't no fungus worth that!

by **splifner180**:
http://www.shroomery.org/forums/showflat.php/Number/5567819

I should mention that this idea was stolen wholesale from blacklabrat and this thread. Five shrooms for him.

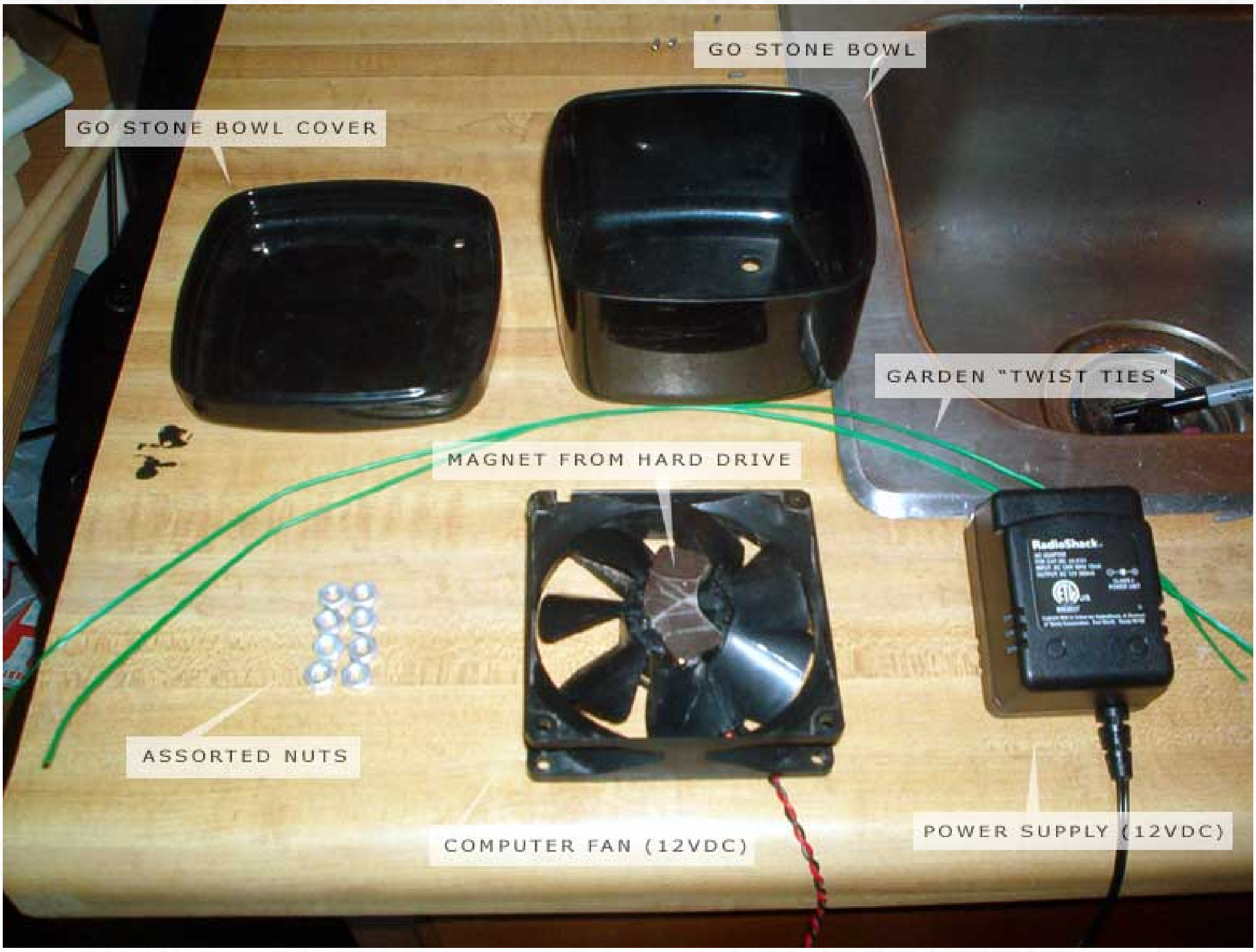
So I've been desperately wanting to have a magnetic stirrer but my $$ was tied up in necessary things like the PC, jars, etc. So when I read that thread I thought to myself "no frickin' way, I have at least five spare fans kicking around this room and probably twice as many power supplies."

And I was right.

So I made myself a working magnetic stirrer using only stuff I had kicking around the room. The only "exotic" thing used was a spare go stone "bowl" (though it's square-shaped). The whole thing from start-to-finish was roughly 30-40 minutes.

Obtaining the magnets are only a problem if you *aren't* someone who has spare hard drives kicking around as a matter of *principle*.

Ok, so here it is. The parts all in one spot:



There you can see the enclosure (go stone box), some arbitrary-length garden ties (use string if you want, doesn't matter), the computer fan with the magnet already attached, superglue (not shown), some washers (to stand off the fan from the work surface) and a 12v power supply pinched from a humungous box I have stuffed with such things.

The assembly was simple.

* Match fan up to lid. Use sharpie to mark four holes. Drill holes.

* Strip wires on both the fan and the power supply. Attach. If the fan spins in the "wrong direction" you have the wires hooked up backward but I don't think it'll harm anything if you do.

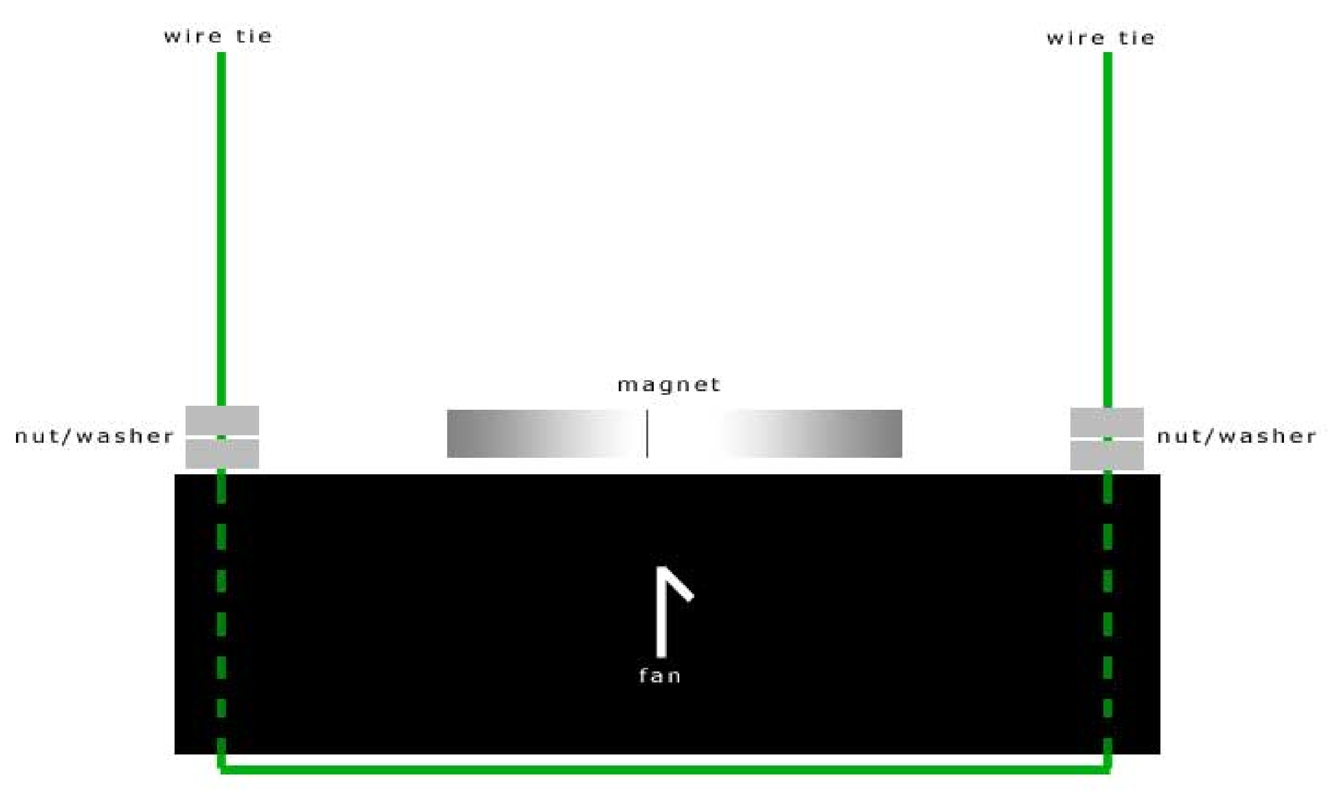
* Attach HD magnet to the fan. It should stick since it's an extremely powerful magnet and the fan has metal inside. Power up fan.

* The goal at this point is to find the "sweet spot" for the magnet, the placement that will cause the least wobble in the assembly. A millimeter can mean the difference between a kitten purr and the magnet being flung from the fan so make small adjustments.

* Once you find the sweet spot, superglue that mofo down. I didn't bother with the jar lid like blacklabrat did.

* With the fan pointed "up" (the magnet facing up), take one wiretie end and thread it through the fan holes from bottom to top. Take the other end of the wiretie and thread it through a parallel hole in the fan. The wire tie should look like the rope on a swing set and the fan/magnet should be the wood swing itself. The wire tie cradles the fan.

* Thread enough nuts unto the wire tie so that the spinning fan will not hit the lid when pressed against. Sorry no pics for this - my camera batteries died. Here's a drawing.



* Do the same through the other two holes. Now you'll have four wires cradling the fan with washers dropped over the wire to act as a standoff.

* Place the cover over the fan, threading the wires through the holes you drilled. Twist the ties together to secure the fan assembly to the lid.

* Place the lid over the box. Make a notch for the power wires if you want. I didn't.

That's it. All done. Here is the stirrer in action.

I should have taken multiple pictures. That one does it no justice. There is a righteous vortex in the container right now. The one in the picture is pretty small.

I should mention that there are TONS of ways I could have done this differently. I justed wanted to do it with the items I had on-hand and ...well ...these are the items I had on-hand. It's whisper quiet (calibrating the magnet is critical) and it's been running now for about 80 minutes without so much as a peep.

The stirring rod itself, like the other thread mentions, is just a 1" piece of ferrous (magnetic) metal. I just snipped a bit off a spool of ground wire I had kicking around. Heck, even a small nail might work perfectly. Tomorrow I'll pick up a bit of shrinkwrap to place around the rod. I tried different sizes (I think 1" is optimal) and I tried doing multiple bits of metal (it worked terrible for me, they all clumped together). Tomorrow I'll probably try to attach two bits of metal to polar ends of something non-magnetic, seal with shrink-wrap and see how that works. Who knows?

Chronic Invitro Tek

by

Chronic

original source: http://mycotopia.net/archives/discus/messages/5/7618.html
original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/6662.html

The Chronic Tek is a quart jar, mini terrarium technique that was developed to be as maintenance free as possible. It is a very simple tek that if followed properly will show the grower many of the benefits of a terrarium while eliminating the need for misting, fanning, and other such maintenance work.

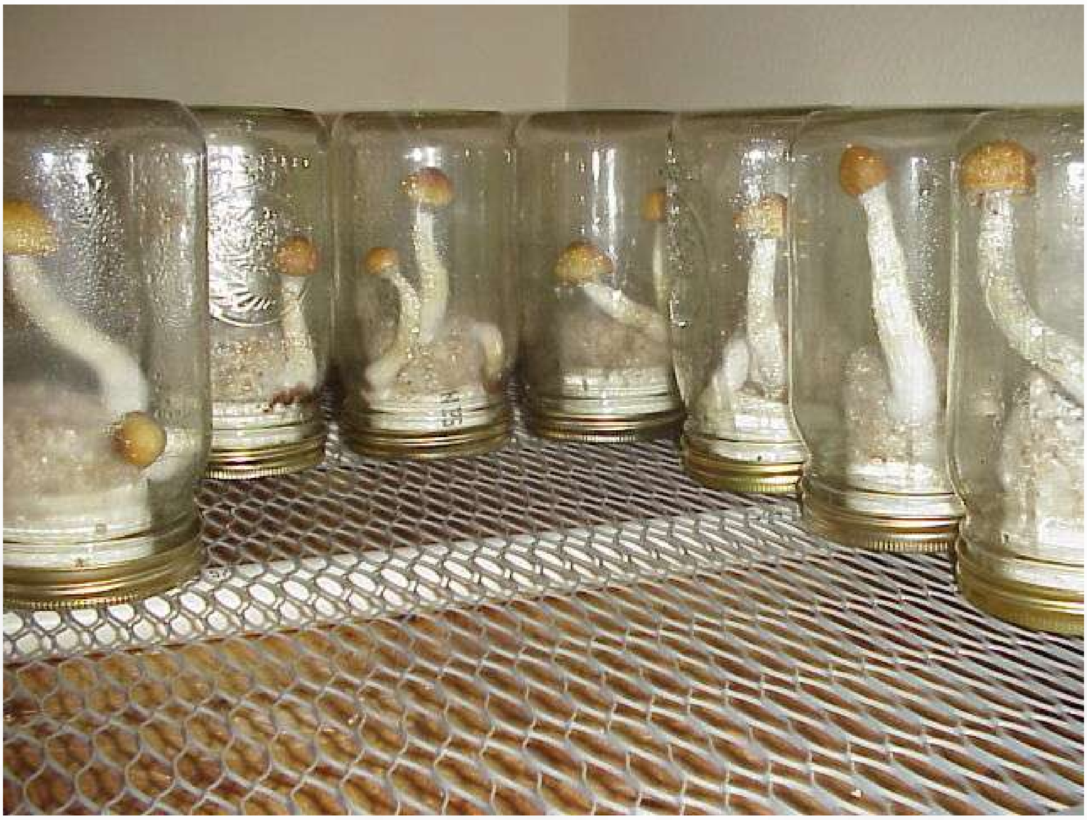
**keep in mind that this is a very open ended tek; the purpose for each piece of equipment will be noted and if you see fit to complete that piece's function with some other piece of equipment, that is your choice. I would however recommend completing this tek once as written before expanding as you will get a better feel as to how your mini terrariums will react to your changes.*

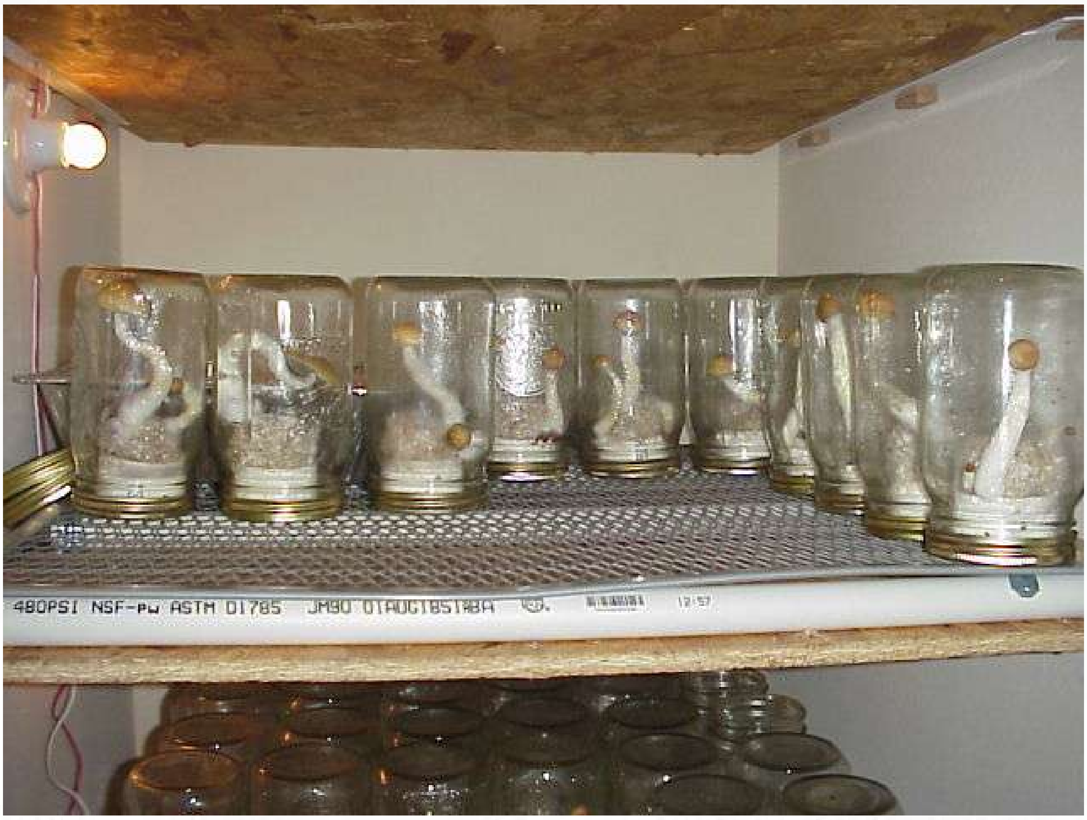
We will be making some very simple modifications to a quart jar that will enable the cake placed inside to create and maintain its own fruiting environment. The quart jars will also be acting as contamination buffer zones; holding contamination to one cake instead of spreading throughout the terrarium.

A few little things we will need:

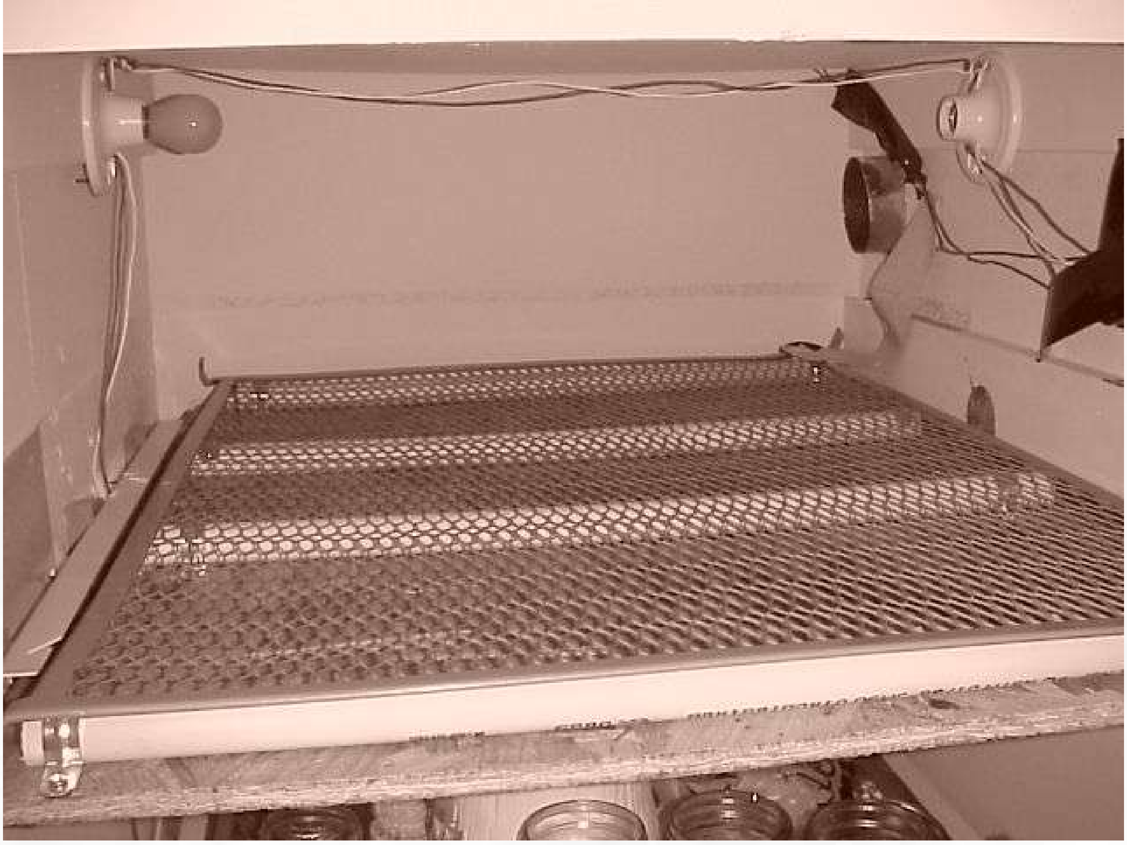
1. Wide mouth quart jar and normal dome lid with ring as used in PF jars.
2. Piece of 2" wide PVC pipe any length 2 or over will do.
3. A 1/8" thick nail.

OK, let's get started. First off our mini terrarium will be sitting upside down with the lid on tightly. To allow the cake to create a nice fruiting environment for itself we will allow airflow through four 1/8" holes equally placed around the lid. The temperature must be held as near to 76 degrees as possible for the proper fruiting environment to be maintained. I cannot stress this part enough folks; to hot and the cakes will dry out, to cold and you will not have proper humidity. Don't be fooled either, water condenses when humid air cools, this will give you the look of being humid but the water will be on the jar instead of in the air. **Keep it near 76 degrees and you will be happy**. The cake will be suspended on a 2" long by 2" wide riser to keep it out of pooling water and keep it from plugging our air exchange holes. Here is a quick picture of the finished product from the side so you can have a mental picture as I describe a few things more in depth.





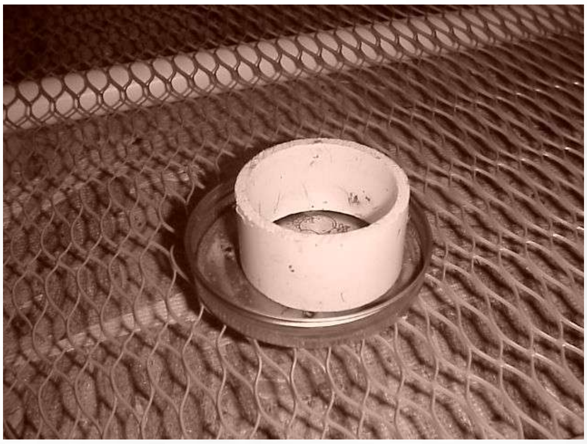
Here is an example of a shelf I place my jars on so that the holes are not plugged.



Well here is the fifth flush of a few of the cakes I displayed earlier in this thread. Not as awsome as the first few flushes and they definetly took longer to fruit but they're still giving it their all. They also straggle in at very different times when they get this old and wise. Bless their little hearts. I hate dumping cakes after they've worked so hard. Anyways someone asked what my contam rates were and how many flushes I got so here are the fifth flush girls.

The Lids: The screw on lid is the main factor in your mini terrarium that controls the environment inside. Many experiments were done with different hole sizes but 1/8" has most definitely proved to be the best. Four holes should be punched with your 1/8" nail around the dome lid just as in the PF TEK. If the holes are too large the jar will not be able to hold good humidity and the cake will dry out causing small and aborted fruits. If the holes are too small the cake will not be able to "breathe" efficiently and will begin graying and eventually die. As you can obviously tell by now the lids should be tight as air should only be entering or exiting through the holes. It is also very important to make sure the holes do not become covered which leads me right to the risers and surface on which your mini terrarium will be sitting.

Risers & Surface: The Risers we will be using to keep the cake from covering the holes will be 2" long pieces of PVC, cut from a 2" wide PVC pipe. The result will be a 2" long by 2" wide riser that will sit between the cake and the upside down lid of your mini terrarium. As well as keeping proper air flow throughout the jar, the riser will also be keeping the cake suspended from the water that will eventually pool inside the lid because of high humidity(*you may also get some dripping from the top of your terrarium, but I have never seen any significant negative results from this*). Do not worry if your PVC risers look as if they are covering your holes, the jagged edges from where you punched your holes will keep the riser from sitting flush on the lid and effectively blocking airflow (*this is why I prefer nails over drilling for making holes*). Having your jar lid sitting flush against a smooth shelf is equally as bad as having your cake sitting on the inside of the lid. Some sort of platform must be devised in order to allow airflow under your terrarium. You can get creative here, but as you can see from the picture below, the bottom part of a standard screen door works great when sitting on some horizontal 1/2" PVC pipe.

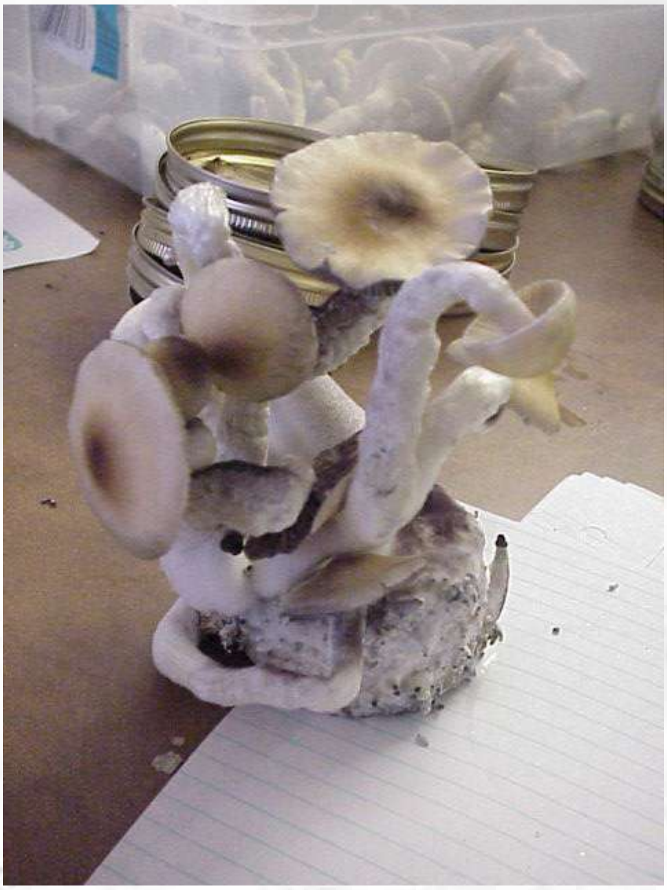


That is pretty much all there is to it. You can expect terrarium type yields with the ease of Hippie's Invitro tek (*The tek from which this one has evolved, great stealth tek*).

Now that you've built your mini terrarium it's time to test her out. So here are a few tips.

1. Dunking is a great tek. If you don't know anything about the dunk tek look it up and read away. I give a 16-20 hour dunk at birth and between every flush. Contamination is rarely a problem while using this tek so I just stack 3 cakes into one quart jar and throw a riser on top to hold the top cake under water and screw the lid on. Dunking is also great because your cakes have to be properly hydrated in order to create good humidity.
2. Keep temp as close to 76 degrees as possible. Hole sizes and all other factors are based off 76 degrees Fahrenheit.
3. If you are only doing a few jars PVC connector pieces can be bought as pre-made risers at Home Depot or other similar stores. If you plan on doing many jars cut your own to save money.
4. All pictures are of PF classics but remember your jars are mini terrariums and should work for all strains. I currently have Hawaiians doing great in my mini terrariums.
5. Give your PF cakes light through the entire colonization process to speed up fruiting. If you are inoculating 1 pint jars make sure to cut them in half before dunking and placing into mini terrariums since the ratio of air to space taken by cake in your jar is also a big factor.
6. I know cakes can be dunked safely with pins intact but I have realized greater success when cakes are scraped before being dunked right after birth. This may be just coincidence but you can find out for yourself.

Well that's all folks. You should be seeing results like the below picture in no time.



Have fun and be safe.

Cybers Martha Tek

by

Cyber

original source: http://www.shroomery.org/9664/Cybers-Martha-Tek

This setup was originaly done by Magash. As there was no TEK on it I decided to write one.

A Martha is a large fruiting chamber that maintains it's own humidity and air exchange, no fanning, no misting, just load it up add water and wait .

It was named for the Martha Stewart portable closet from K-Mart. This is what the first ones were made from.

Things you will need.

- 1 portable closet (Must be made of plastic)
- 1 COOL MIST humidifier
- 1 length of 3/4" ID hose (Hardware store)
- 1 90deg hose to pipe thread fitting (Hardware store)

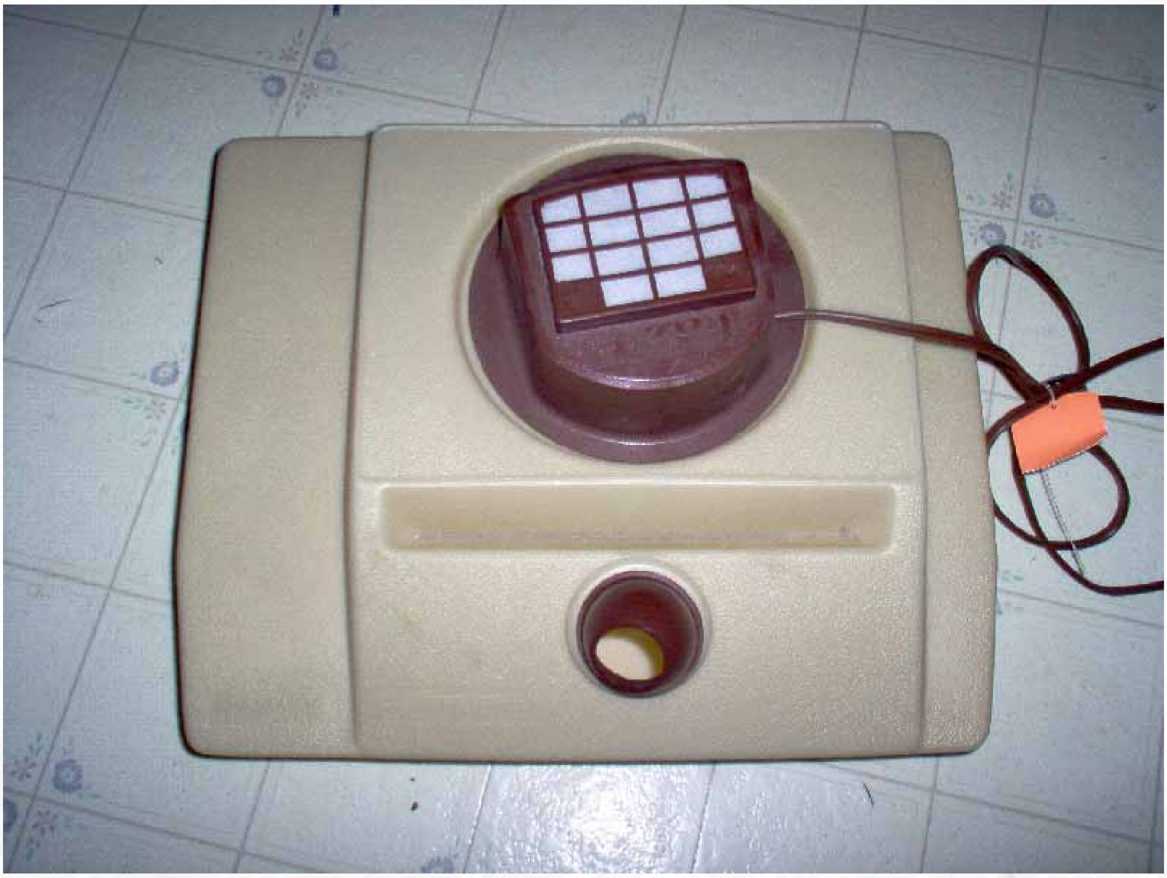
- 1 hose to 3/4" pipe thread fitting straight through (Hardware store)
- Other fittings to attach the hose to the humidifier (Hardware store)
- Duct Tape
- Some extra plastic.
- (The following is for the shelves. You can use anything you want)
- 4 pieces of chain
- 20 S-Hooks
- 4 36"x17" pieces of metal shelving

We start with the closet.

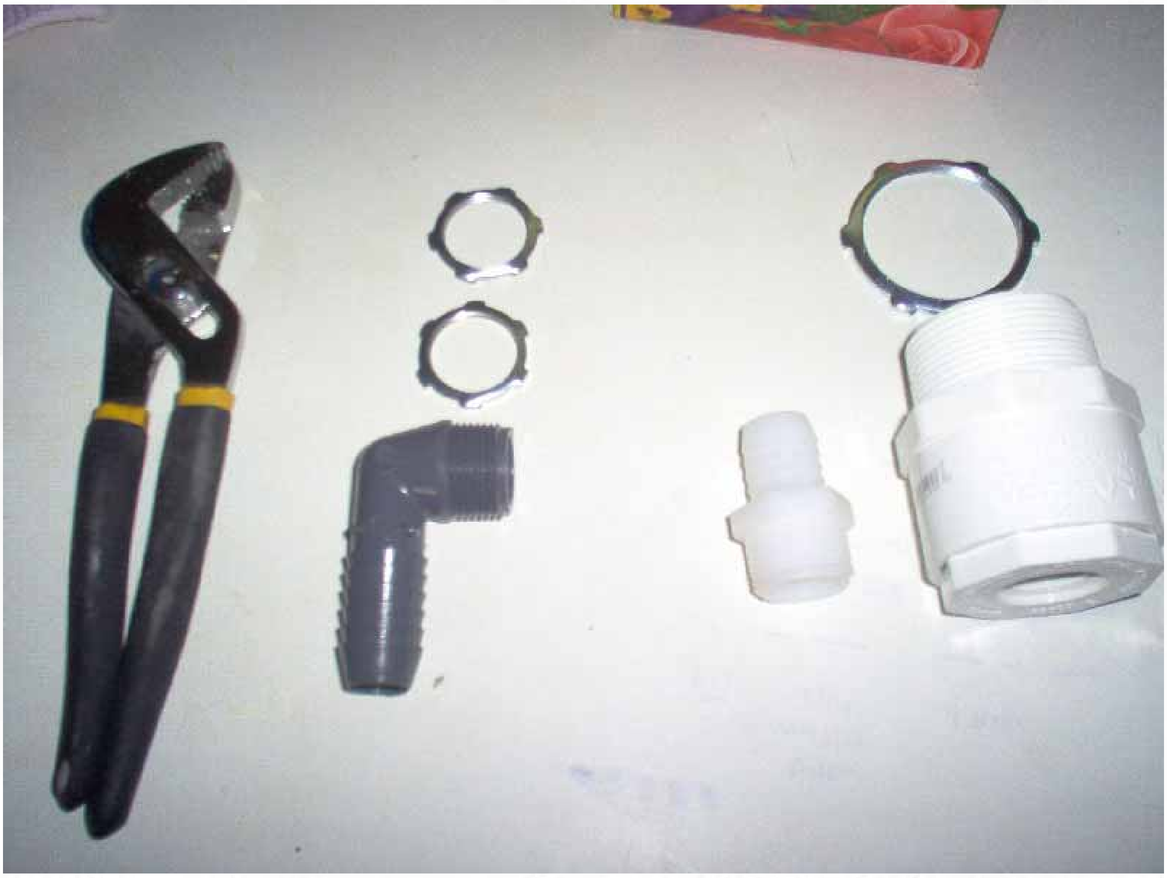
36" Clear
Storage Closet

I picked mine up at Bed, Bath, and Beyond for 30$ This model does not have a bottom, but we can fix that.

Next we get a humidifier. I picked this one up at the local thrift store for 3$.
I prefer the ones with the little round nozzle on them. It makes it essayer to fit the PVC fittings to them.

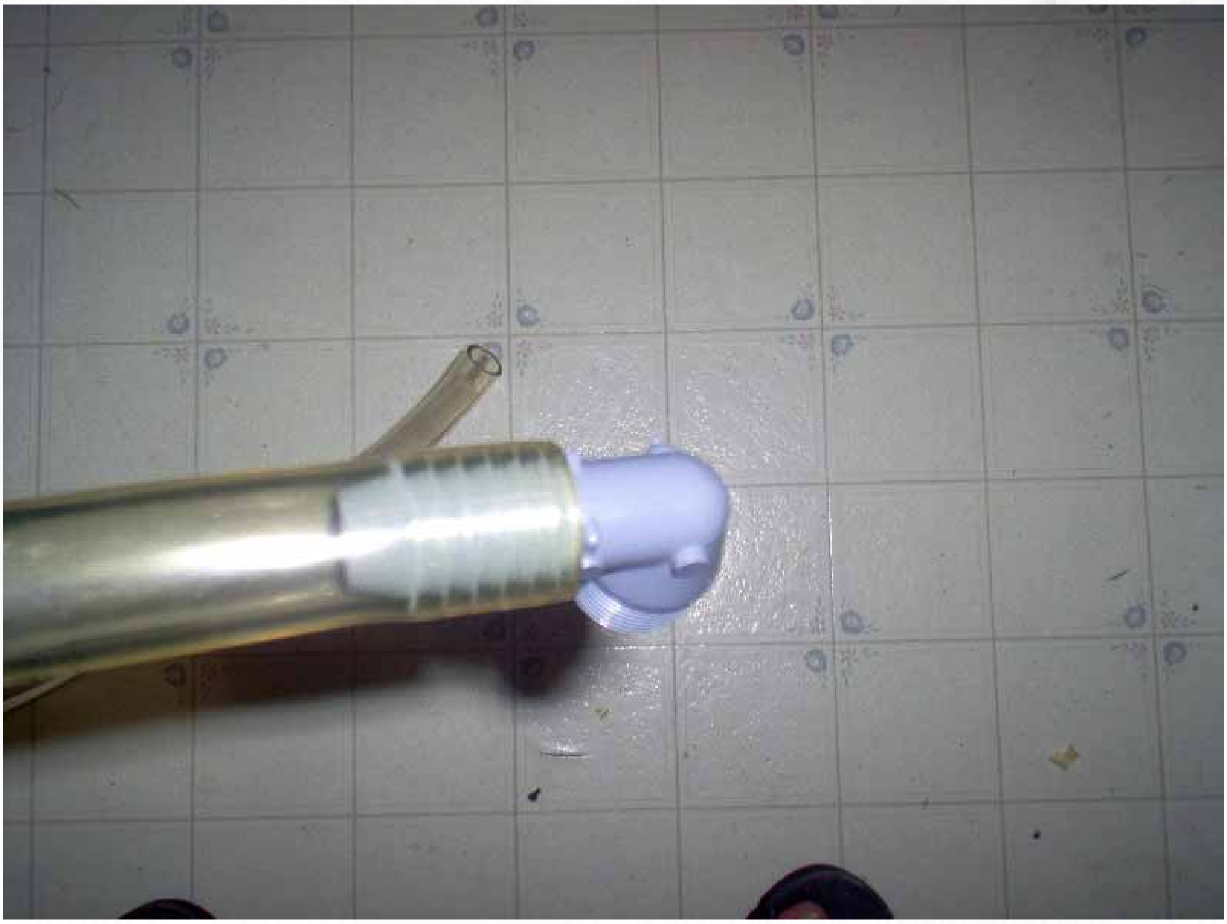


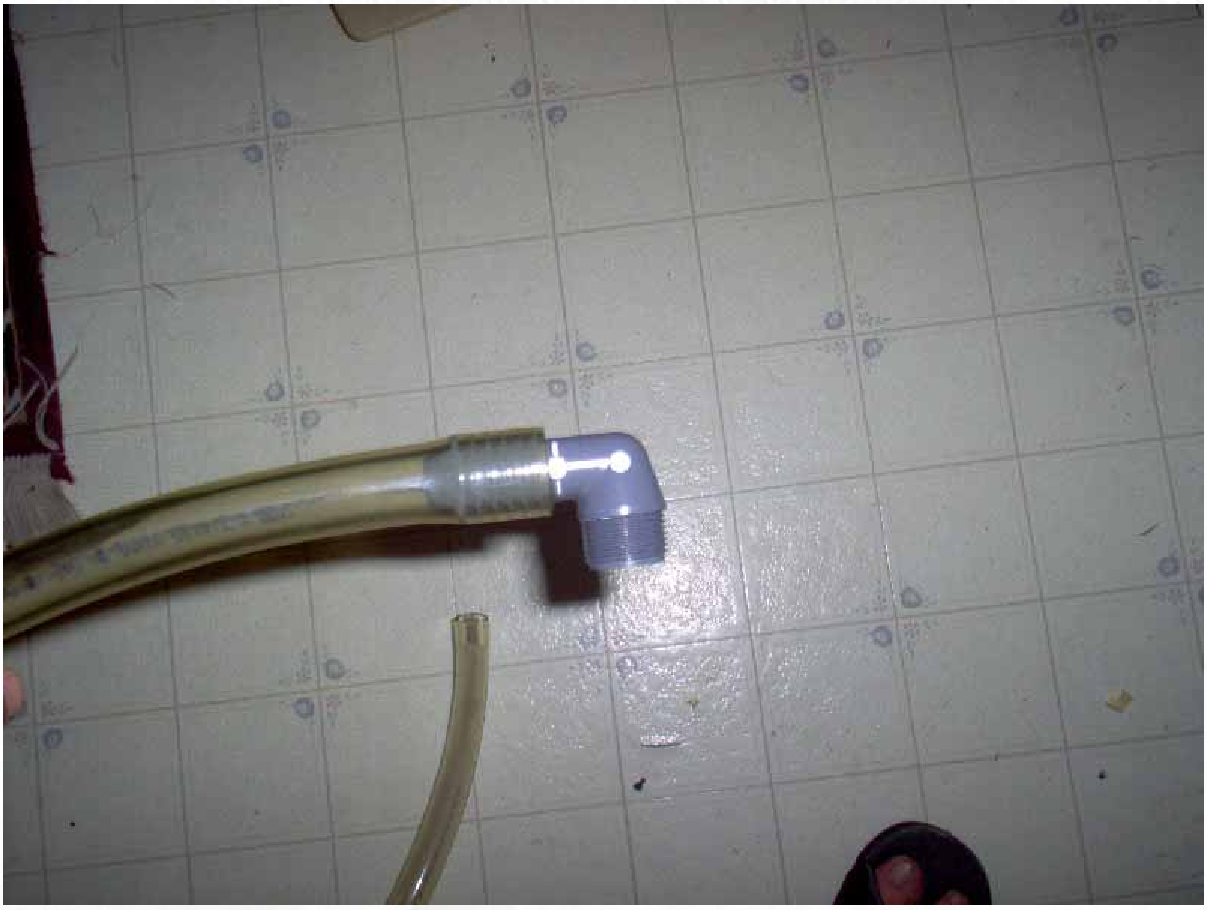
I have my tools and fittings.



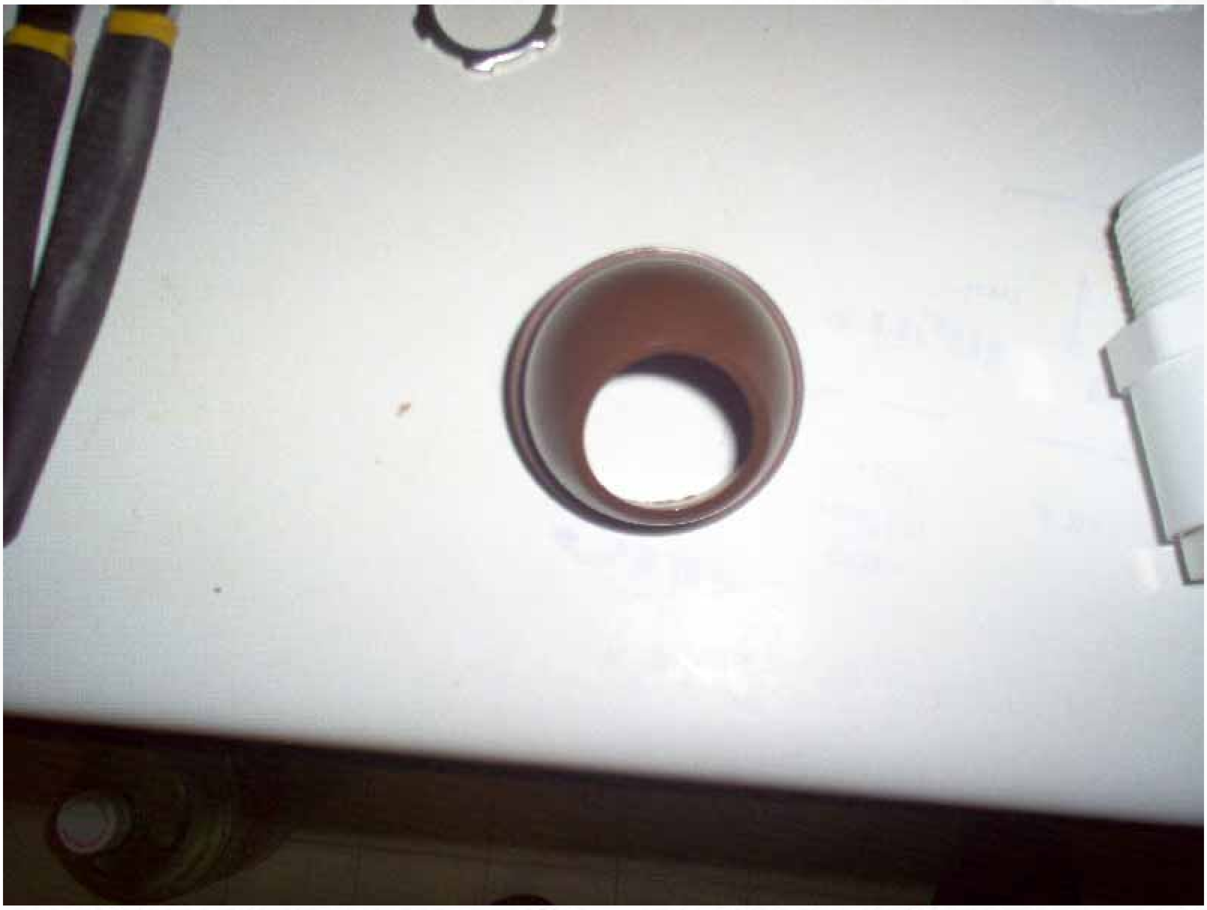
and my hose

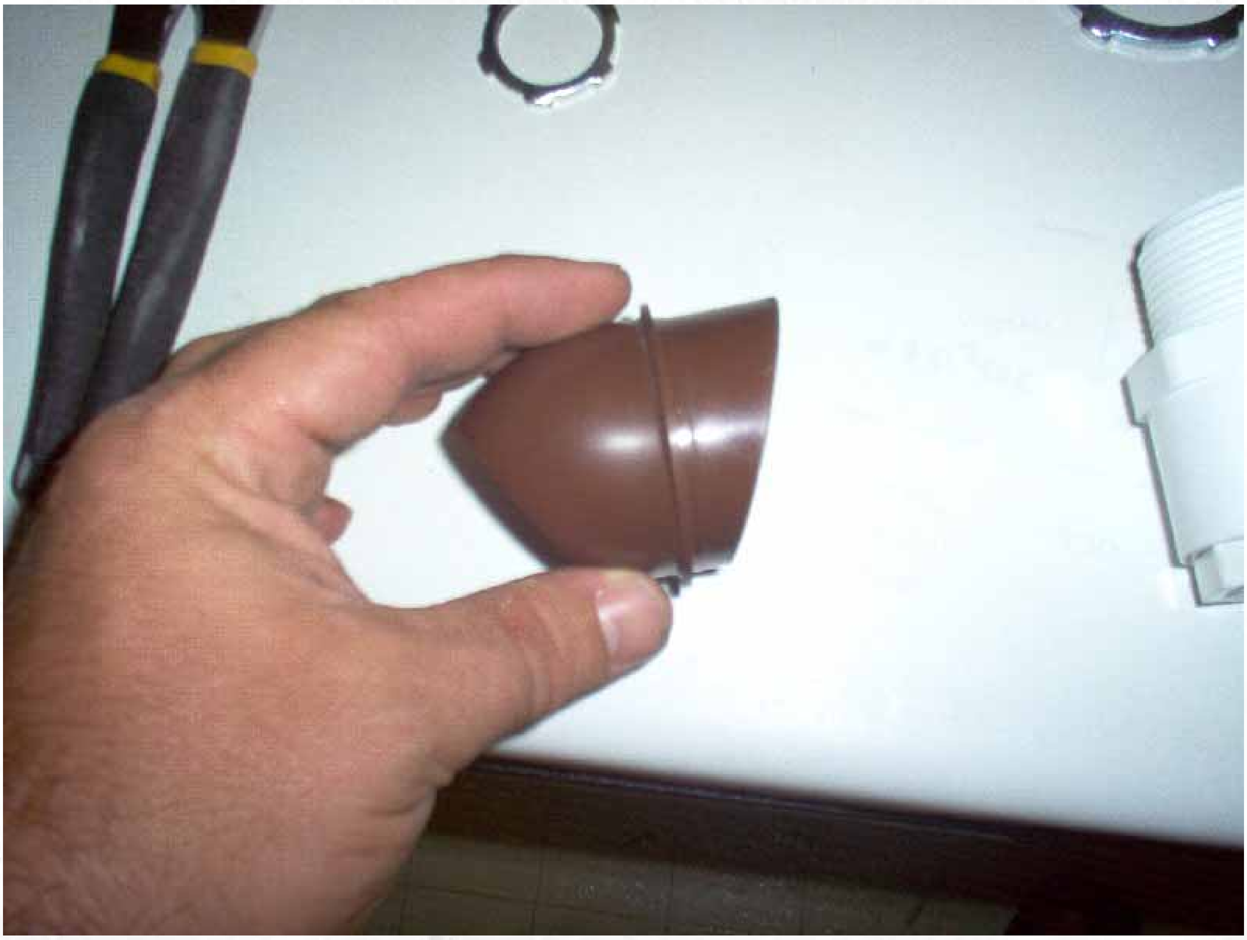
Put the fittings into the hose and get it ready



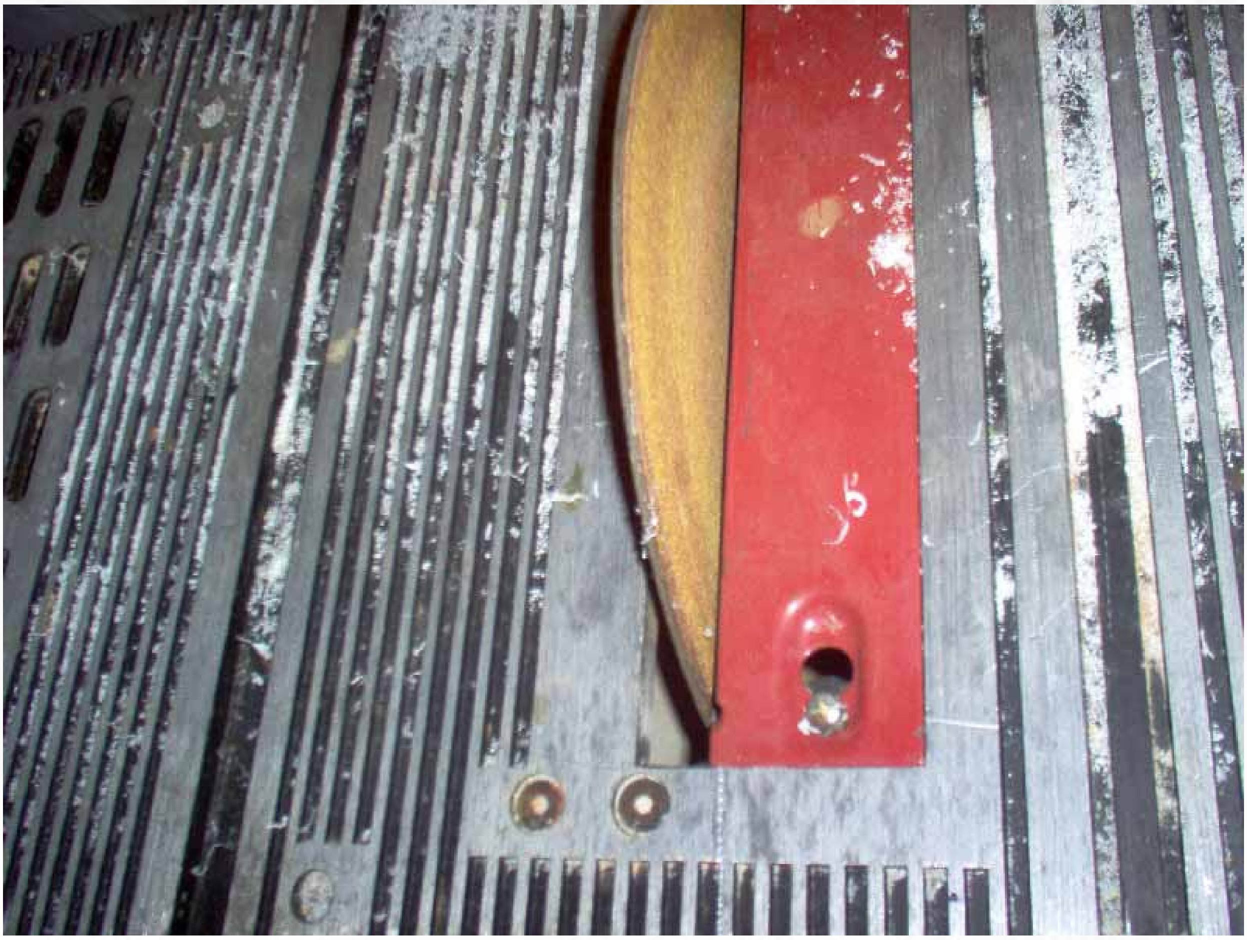


Now that the hose is ready, we move our attention to the largest fitting, I took the nozzle to the hardware store and put together a fitting that would go from the nozzle size to the threaded hose fitting. You will note that the nozzle is not a striate cut on the bottom. This allows it to catch the mist and direct it out the hole. We need to duplicate this on our replacement fitting.

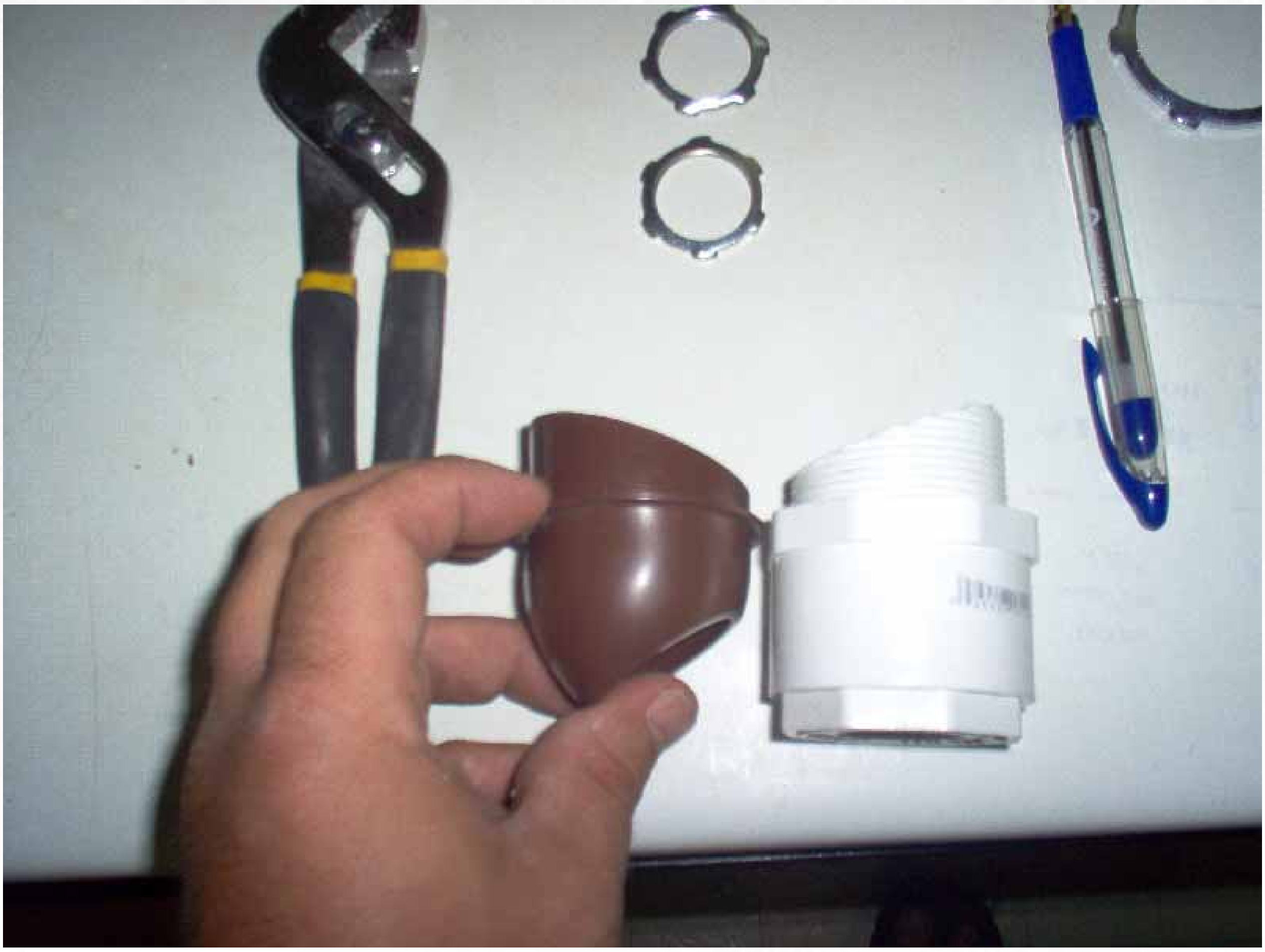




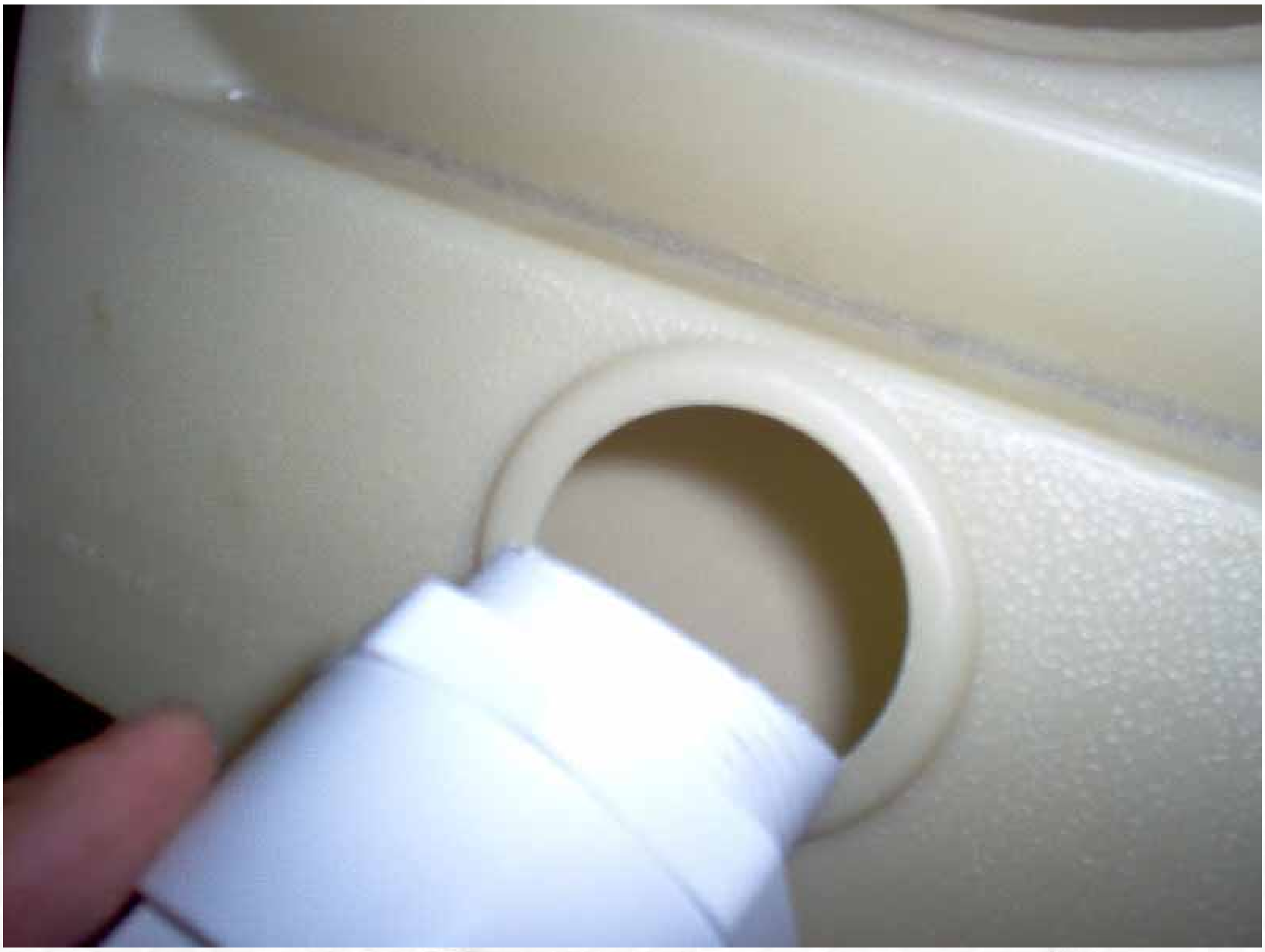
To duplicate this I used an 80 grit sanding disk in my table saw. If you do not have a table saw you can use a saw, drimmel tool, or anything else. (You could even get sandpaper and sand it by hand.)

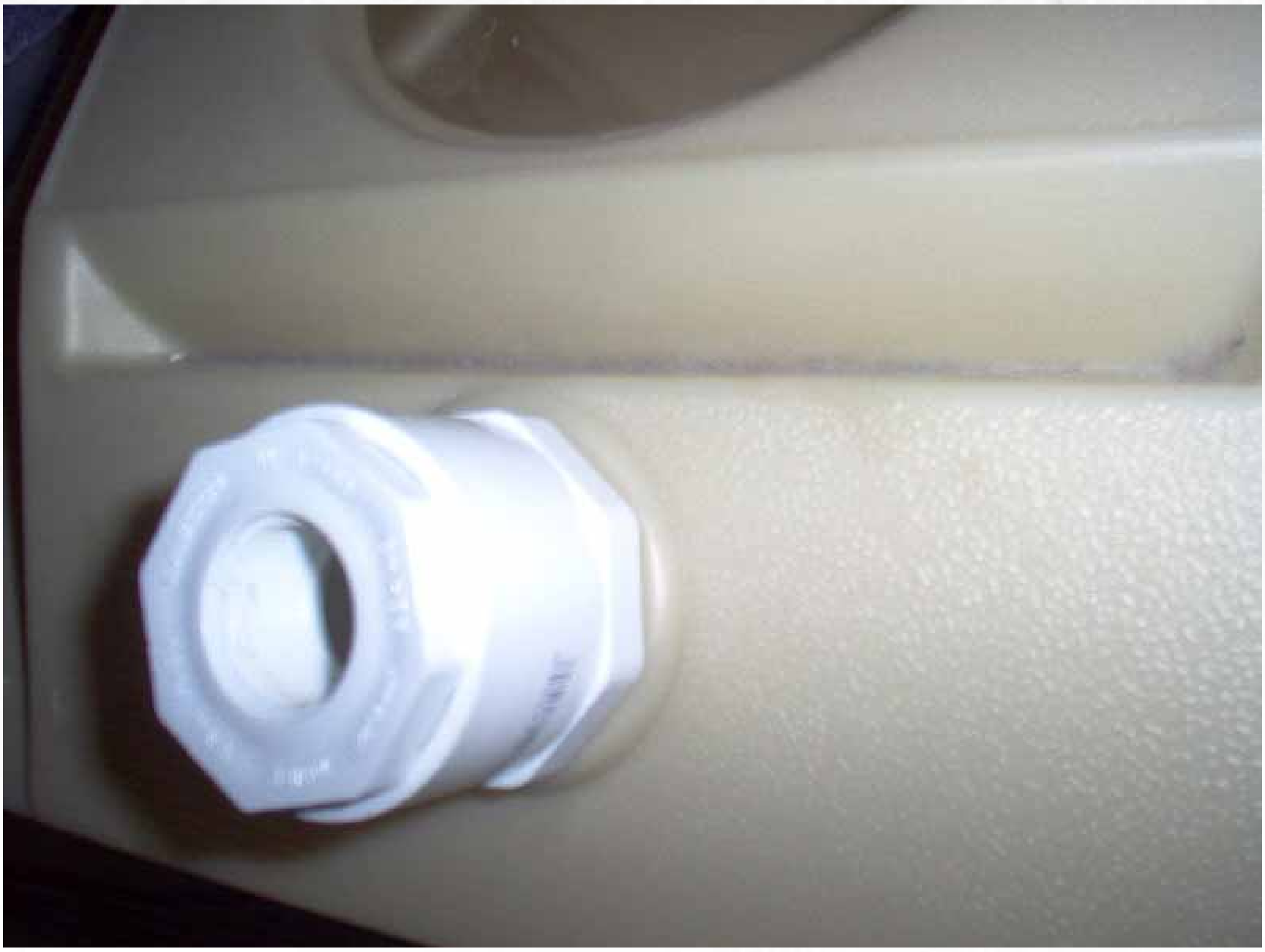


In the end you what it to be as close to the 45deg angle as you can get it.



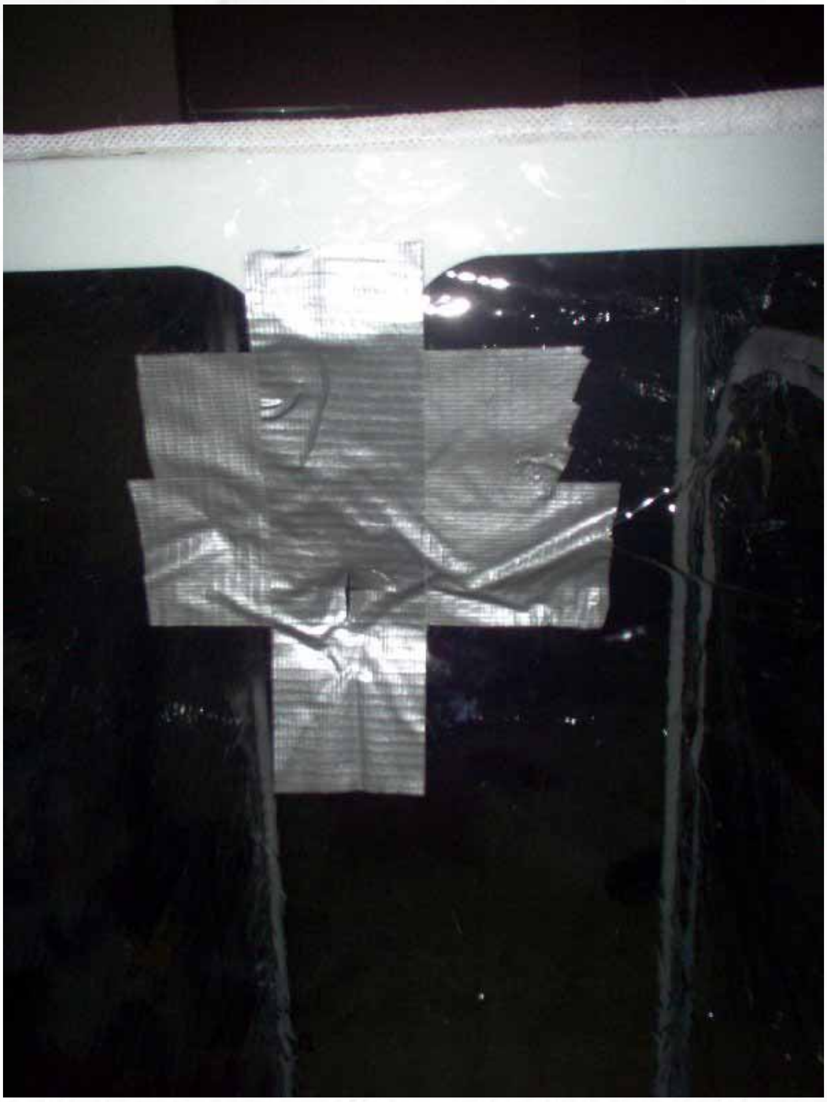
We now put the piece into the hole in the humidifier and use a galvanized nut to hold it in place.





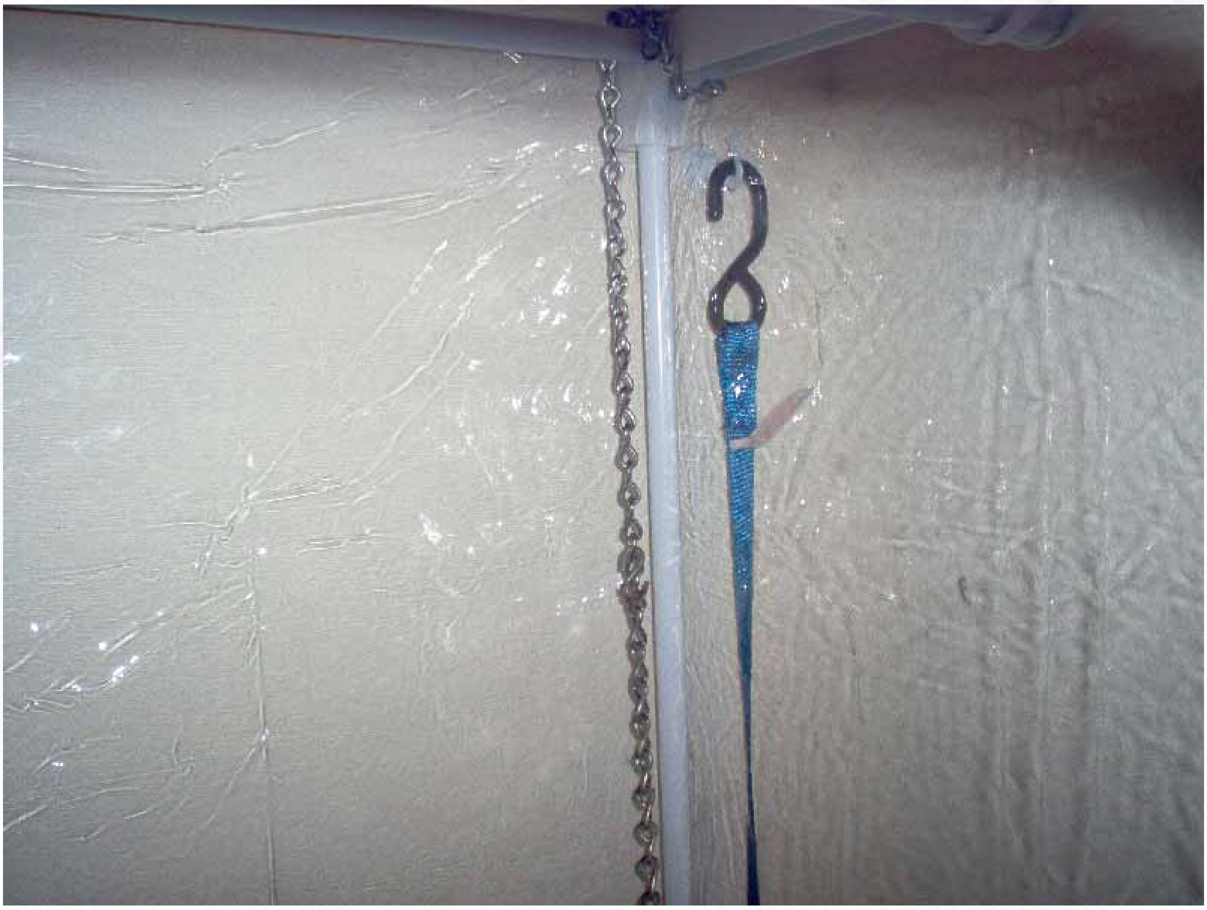
The closet I bought does not have a bottom so I will need to make one. You can use any plastic you can find. I have used plastic drop cloths, tarps, etc. This time I had some leftover black/white plastic from a grow room build so I used it. Just use some duct tape to hold it in place and seal it up.
Most of them have a "Breathable Bottom" on them. This means that the bottom is made of a fabrick. It works better if you can get one like that.

Now in the upper middle of the closet you want to put a couple of layers of duct tape (To re-enforce the plastic) and cut a hole big enough to put the hose fitting through.

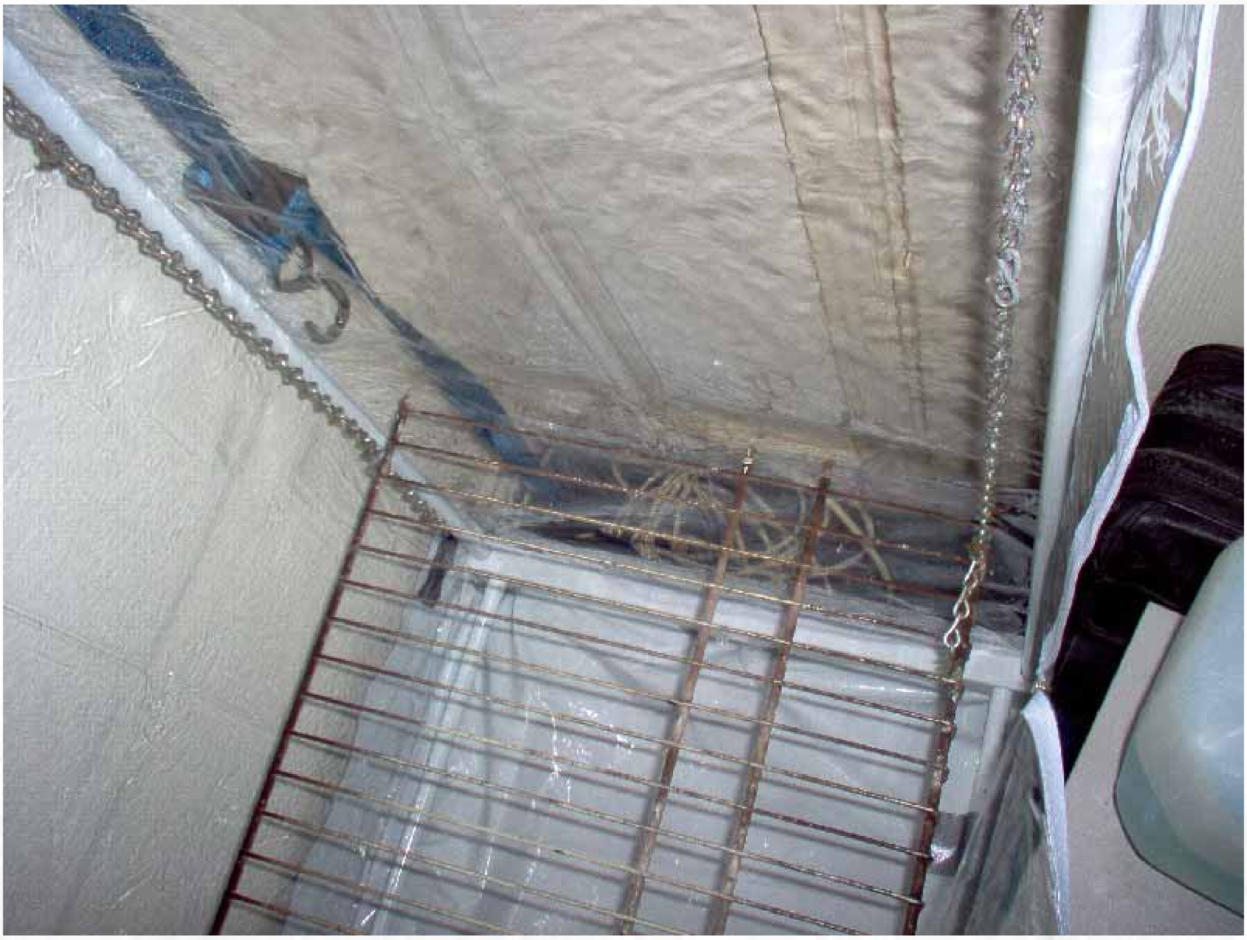


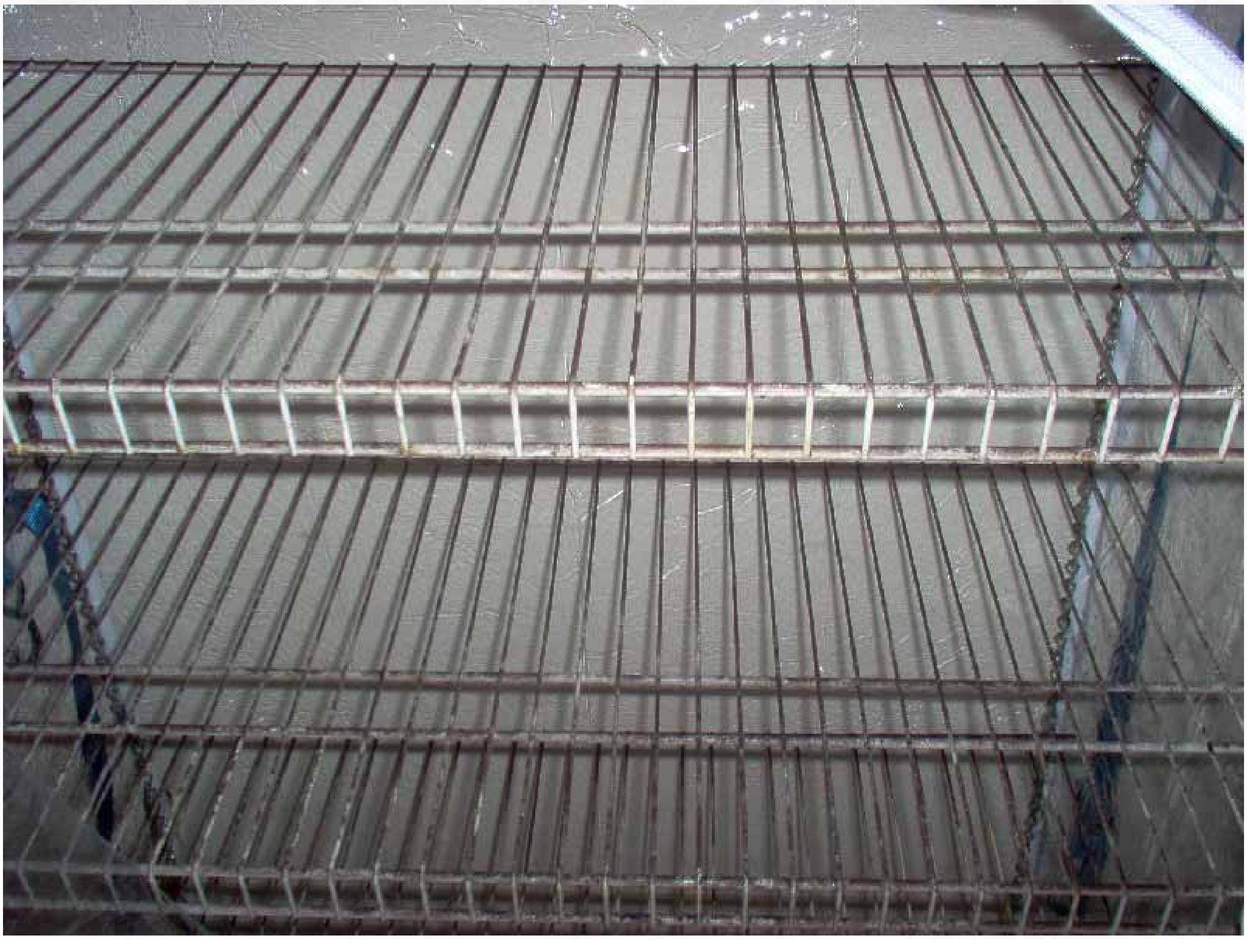
You can then move your Martha into place.

We then use the S-Hooks to hold the chains in the corners of the unit. This will be the points that the shelves connect to it.

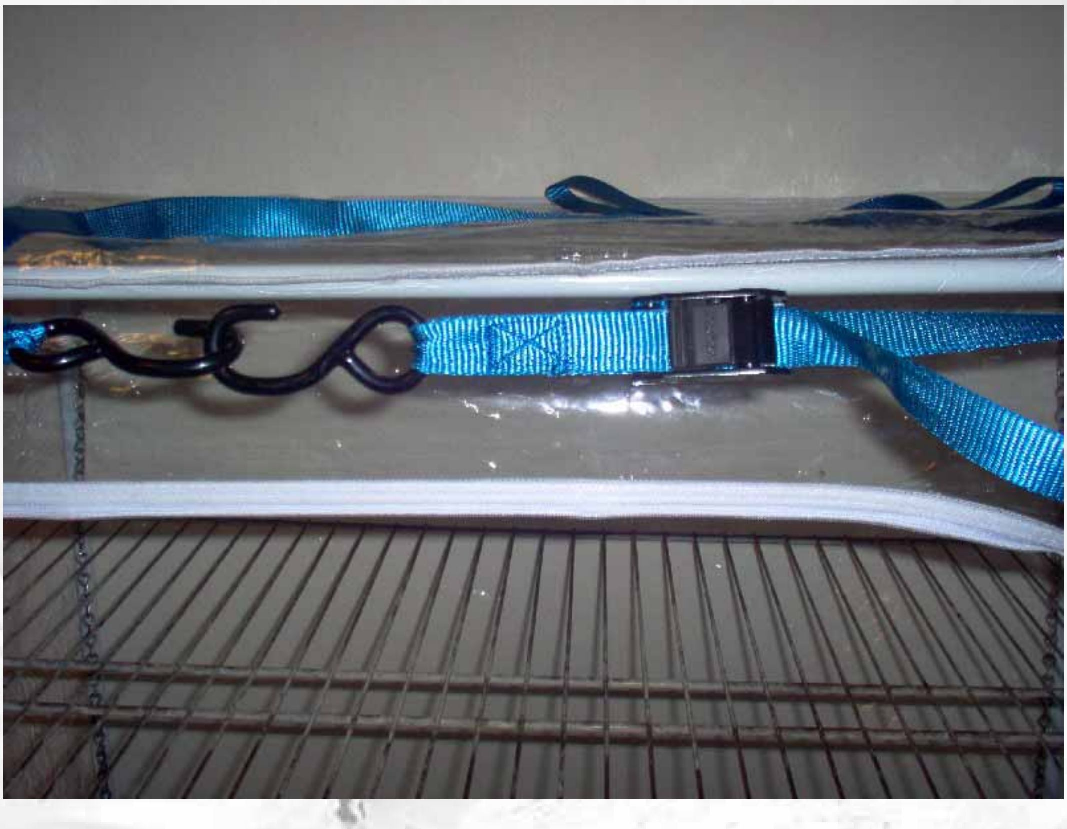


Then use the S-hooks to make hanging points for the shelves and attach the shelves to the chains. I start at the bottom and work my way up.

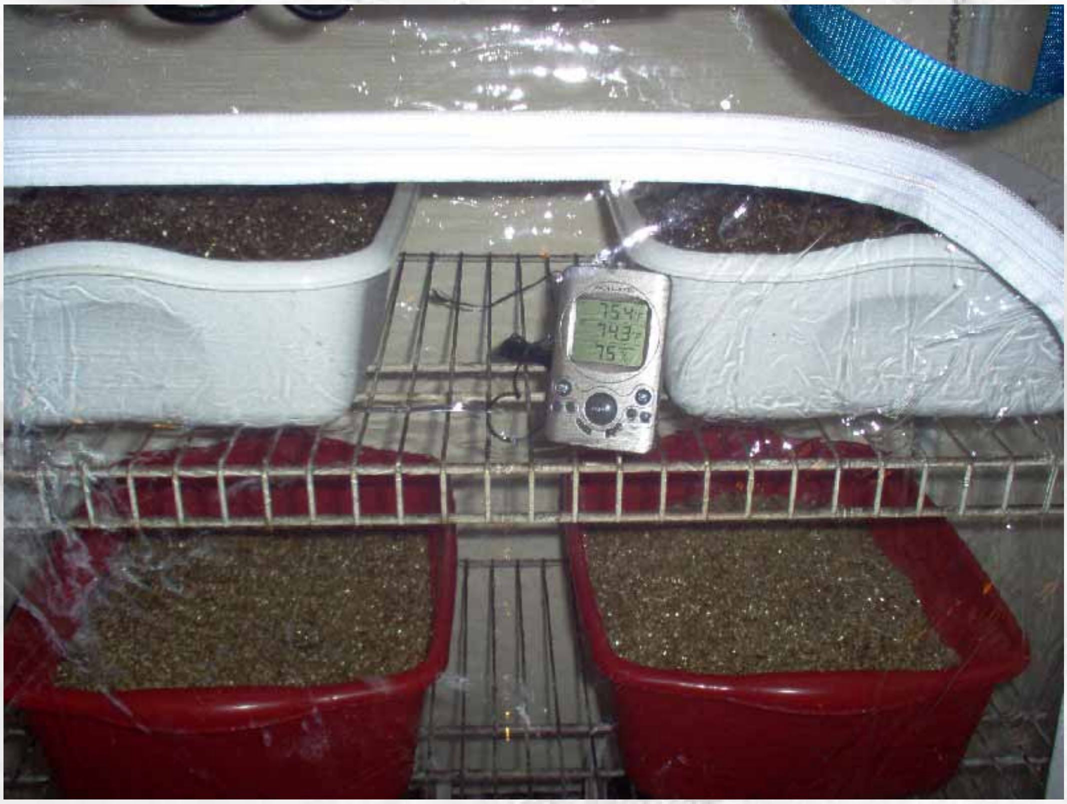




You may have noticed a set of hooks in the wall with straps on them, in the background of the pictures. I use these to hold the unit in place. I tend to load some weight into my and it leans if I do not have it secured to the wall.



Now we load the unit up, hook up the humidifier, and turn it on. Before long the humidity is up.



Some designs call for more than one humidifier on timers. I have found that mine can maintain it's humidity with just one cool mist on 24/7. You should get between 87 and 90% humidity which is perfect for fruiting. This unit, fully loaded, can produce 2lbs of dry mushroom every 35 to 40 days. This is enough for you and 75 of your closest friends to trip every weekend for a month!

A sterile transfer chamber

by

Oldtimer

original source: http://cdn.preterhuman.net/texts/drugs/nansnook3c/tek/otbox.htm

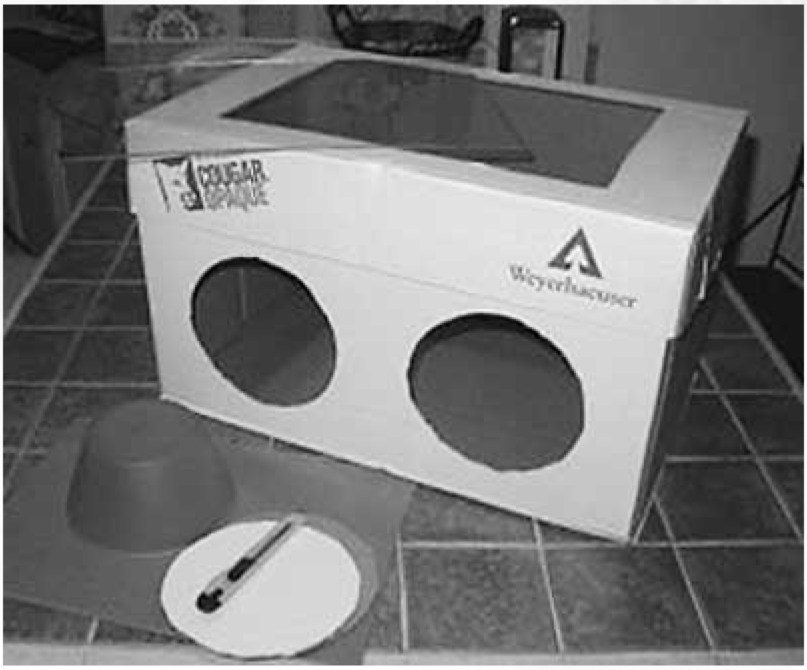
In order to achieve a good success rate when making transfers, you must first construct a transfer chamber or "glove box." This is simply an enclosed area that can be cleaned with disinfectants to keep out contaminants. Such a chamber can be designed in many ways and need not be elaborate to work well. Basically what you are striving for is an enclosure which provides a sterile, draft-free environment to work in while performing sterile culture work.

A good, inexpensive glove box can be constructed from a cardboard box, some aluminum foil and a sheet of plexiglass.

You will need the following materials:

- Clean, sturdy cardboard box.
- Razor knife or box cutter.
- Can of spray adhesive.
- Roll of heavy duty aluminum foil.
- Roll of duct tape.
- A piece of plexiglass cut to approximately 10" x 14".
- Clean dish towel.

Step I



Obtain a good, clean, sturdy cardboard box with a removable lid. The kind paper is shipped in is ideal and can be found at any printing shop or office supply company.

Use a small dish or bowl as a template and draw two circles about 5" in diameter on the front of the box. Cut out the two circular holes in the front side of the box (to allow you to insert your arms while making transfers). Also cut a square hole in the lid of the box slightly smaller than the sheet of plexiglass (approx. 9" x 13"). This hole will be covered with the sheet of plexiglass, effectively forming a "window" in the top of the box.

A razor knife or box cutter makes an ideal tool for cutting these holes in the box. Once you have the holes cut you can proceed to step II and prepare to apply the foil.

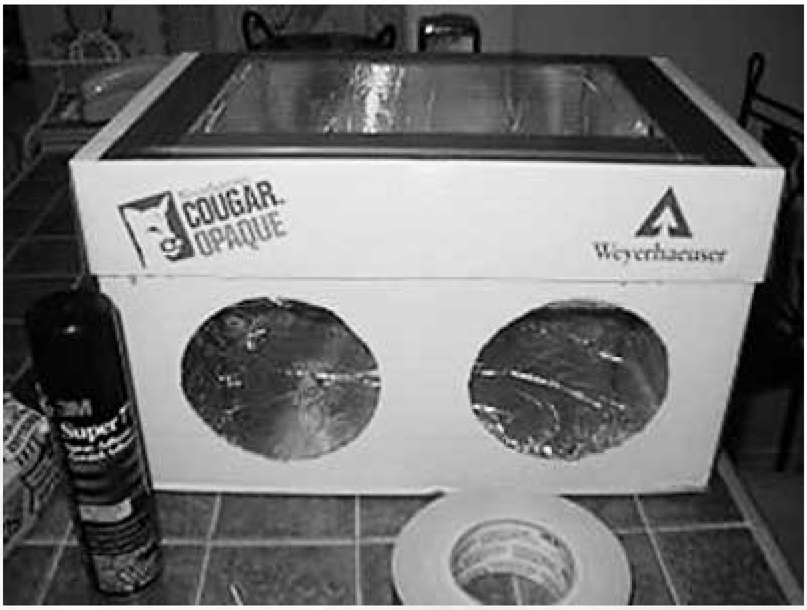
Step II

3M
Super
Spray Adhesive
Aerosol Ad

Wipe the inside of the box with alcohol and allow it to dry. After the alcohol dries liberally spray the entire inner surface of the box (sides, bottom and top) with the supplied Lysol aerosol. This kills any spores that are lying dormant on the surface of the cardboard. Once the Lysol has evaporated, spray a layer of adhesive in the bottom of the box and apply a sheet of aluminum foil to cover. Do not worry if the foil has a few wrinkles or creases. You just want to have a nonporous surface that is easy to clean and sterilize as well as being waterproof. Repeat this process on all sides of the inside of the box.

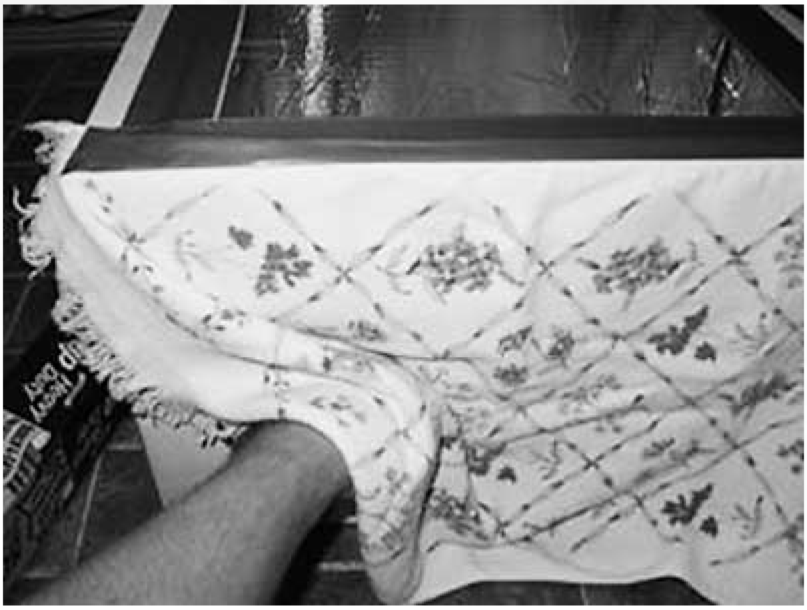
Step III

Fit the lid onto the box. Place the sheet of plexiglass over the hole in the lid of the box and tape each side to the box with duct tape. Be sure to seal each edge as you tape the plexiglass down to the box. This forms a nice, airtight "window" in the top of the box which will allow you see into the cabinet with no risk of contamination from airborne spores and bacteria.
Leave the lid of the box removable (do not tape) to allow easy access for placing your materials inside prior to performing sterile transfer work.



Step IV

Take a small, clean dishtowel and drape it across the top of the box so that it hangs down over the two hand holes in the front.
Run a strip of duct tape along the edge of the towel taping it to the lid of the box along the edge of the plexiglass.
The towel serves as a barrier to prevent drafts from entering the cabinet while you are working, effectively keeping contaminants out.
Do not tape the lid down. Leave the lid removable so it will be easier later when you need to load materials into and out of the sterile cabinet.



Note from Nan - I like a clean plastic sheet instead of cloth.

Congratulations! You now have a completed, fully functional sterile transfer cabinet that only cost a few bucks.... Spray inside of chamber with Lysol before each use but....ALLOW ALCOHOL FROM LYSOL to EVAPORATE COMPLETELY!!! before lighting any burners or lighters inside of box... unless you like the "hairless" look and don't mind your arms stinging like hell for a day or two!

> Note: You can save on the Plexiglas (which must be cut) but substituting some clear plastic film sheet (like a $2 plastic drop cloth) for the window and duct taping the plastic into place securely with no sags. I have done a lot of sterile work under draped plastic hoods and inside cardboard boxes; be clean in and around them and you can do intermediate mycology with only a few contam glitches.

HEPA filter flowhood

original source: http://www.fungifun.org/English/Flowhood

Table of Contents:

- Why you need one
- Getting started
- Sources for HEPA filters
- Match a blower to the filter
- Finding the correct blower
- Construction of the hood
- Some pictures of a similar design

Why you need one

A laminar flow hood is a piece of equipment which makes sterile working procedures in mushroom cultivation easier and reliable.

A flow hood consists of a coarse pre-filter, a blower and a very fine filter (the so called HEPA (High Efficiency Particulate Air) filter which filters particles from the air to a high degree.

This makes the air coming out of the HEPA filter nearly sterile which allows doing transfers in this stream of sterile air without worrying about contaminants entering from the air and contaminating the cultures.

Getting started

You should begin the construction by selecting a HEPA filter and a blower.

The HEPA filter size depends on how big you want to have your working space. The smallest filter size you can reasonably use (for home scale cultivation) is 1ft x 1ft, better though 1ft x 2ft or 2ft x 2ft if you are going to inoculate filter bags.

Sources for HEPA filters

www.aafeurope.com
(Austria, Belgium, Bosnia & Hercegovina, Bulgaria, Canada, China, Croatia, Czech Republic, Finland, France, Germany, Great Britain & Eire, Greece, Hungary, India, Italy, Luxembourg, Malaysia, Mexico, Middle-East, Netherlands, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Taiwan, Turkey, United Arab Emirates (UAE), USA)

www.filtrationgroup.com
(Australia, Austria, Belgium, Brazil, Canada, China, Columbia, Costa Rica, Denmark, Egypt, France, Germany, Great Britian, India, Indonesia, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Puerto Rico, Republic of Korea, Russia, South Africa, Spain, Sweden, Thailand, Turkey, United Arab Emirates (UAE), Ukraine, USA)

www.camfilfarr.com
(Australia, Austria, Belgium, Brasil, Canada, China, Danmark, Deutschland, España, France, Ireland, Italia, Malaysia, Netherlands, New Zealand, Polska, Schweiz, Singapore, Suomi, Sverige, United Kingdom, USA)

Australia
www.austair.com.au
www.aesenvironmental.com.au
www.biocabinets.com.au
www.hotfrog.com.au/Products/HEPA-filters

Austria
www.czech.at
www.vokesair.at

Bulgaria
www.eviss.bg

Canada
www.thefiltershop.com
www.tridim.ca

Czech republic
www.elfa-aaf.cz
www.filco.cz
ks-klima-service.czechtrade.us

Denmark
www.industrifilter.dk

France
www.aaf-sa.fr
www.climavent.fr

Germany
www.aaf-lufttechnik.de
www.atex-filter.de
www.camfil.de
www.cleanroom.de
www.luftfilterbau.de
www.euro-filter.de
www.filtega.de
www.het-filter.de
www.reinraum.de
www.spxairfiltration.eu
www.wieninger-filter.de
Filtertechnik-Deutschland

India
www.aeromechindia.com
www.multilab.biz

Israel
www.filt-air.com

Italy
www.altifilter.com
www.defil.it
www.eurofiltri.com
www.fcr.it
www.ma-in.com
www.mcleodrussel.it

Netherlands
www.mcleodrussel.nl

Norway
www.aafluftfilter.no

Russia
www.enveron.ru
www.ftov.ru

Slovenia
www.ecotip.si
www.hidria-imp-klima.si

Sweden
www.scandfilter.se

Switzerland
www.logicair.ch
www.sit.ch
www.tecnofil.ch
www.unifil.ch
www.vokes-air.ch
www.trion-elektrofilter.ch
www.wesco.ch

Turkey
www.aaf.com.tr
www.boytem.net
www.tekfil.com

United Kingdom (UK)
www.hepa.co.uk

USA
www.aafilters.com
www.airexco.com
www.airflotek.com
www.appliedairtechnology.com
www.cambridgefilterusa.com
www.cepatest.com
www.filtera-b2b.com
www.filterservicesil.com
www.fungi.com
www.hepa.com
www.hepafilters.com
www.laminaire.com
www.lascoservices.com
www.techrite.com
www.tridim.com
USA Filter search web site

Yugoslavia
www.interfilter.co.yu

Match a blower to the filter

Once you decided on the size of the HEPA filter, you have to match a suitable blower to this particular filter. This is a very important step, so make sure to study the directions thoroughly.

Every filter has a "resistance" when air blows through it at a certain speed, this resistance is called the "static pressure".

Press your hand against your mouth. Now try to blow through it. Dependant on how firm you press it against your mouth, you will have some difficulties blowing air out and you will feel some resistance, this is the static pressure.

Every filter has a different static pressure at the working point. The working point is where the amount of the air flowing through the filter is sufficient to meet the requirement of the laminar flow.

The static pressure is expressed in inch of water column in the English units, a typical value would be 1", the SI unit for pressure is Pa(Pascal).

1" water column is around 250 Pa. Each filter has a data sheet (consult the manufacturer if this is not the case with your filter) where the static pressure at the working point is entered. Before the air enters the blower it is usually pre-filtered by a furnace filter around 1"(2.5cm) thick placed in front of the blower to protect it and the HEPA filter from big particles like dust and hairs. It can be assumed that the static pressure for this prefilter at the working point is around 0.2"(50 Pa).

According to Stamets (**Paul Stamets and J.S.Chilton: The Mushroom Cultivator** p. 347 ff) the air speed of the air flowing from the filter surface should be (at least) **100 feet per minute(fpm)**. (around 30 meter per minute or 0.5 meter per second). Determining the correct blower for a filter consists of several steps:

1. Find out the area of your filter by **multiplying the width and the hight** in feet (for instance the smallest reasonably usable filter would be 2ft x 1ft):
2ft x 1ft = 2 ft^2

2. Multiply the required air speed(the one Stamets specifies, 100 ft/min) with the area of your filter:
100 ft/min x 2 ft^2 = 200 ft^3/min

So 200 ft^3/min(= cfm = "cubic feet per minute") is the amount of air your blower must deliver **at the sum of the STATIC PRESSURE of the HEPA filter + prefilter**.

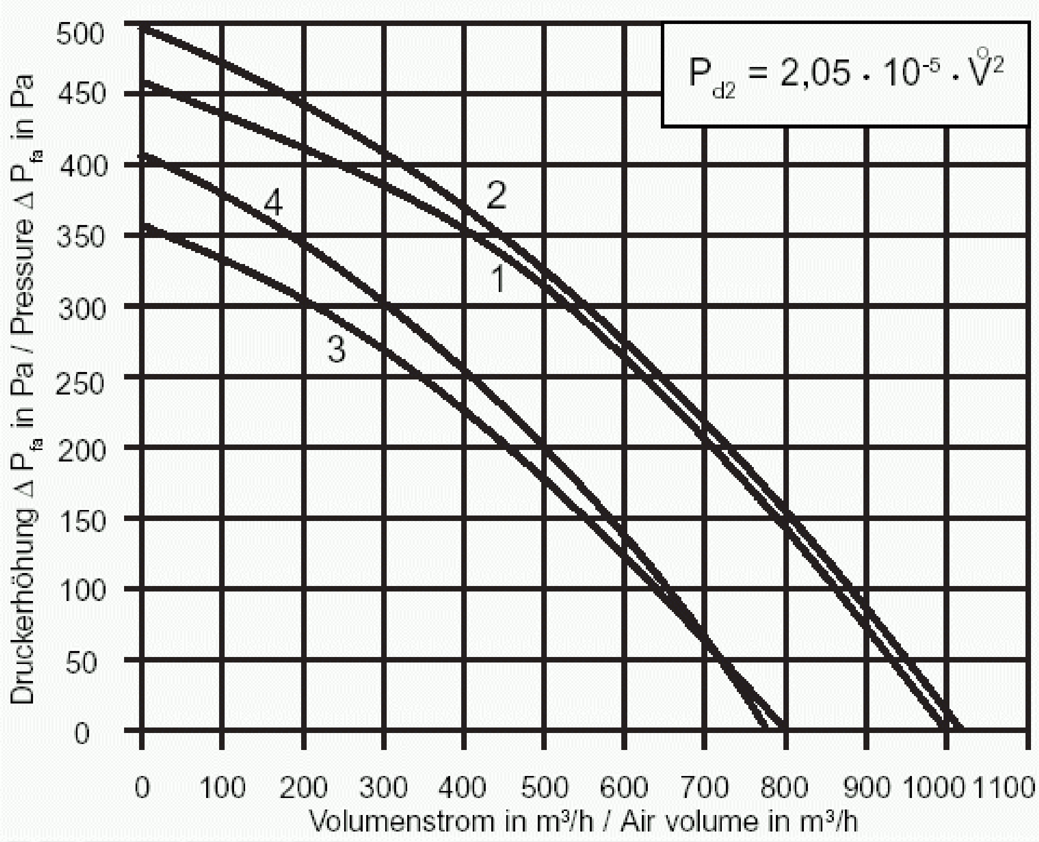
NOTE: 1 cfm= 1.7m^3/h

So if you use the above filter with 1"(250Pa) static pressure and a furnace prefilter with a static pressure of 0.2"(50Pa) your blower must deliver **200 cfm(340m^3/h) of air at a static pressure of 1.2"(300Pa).**

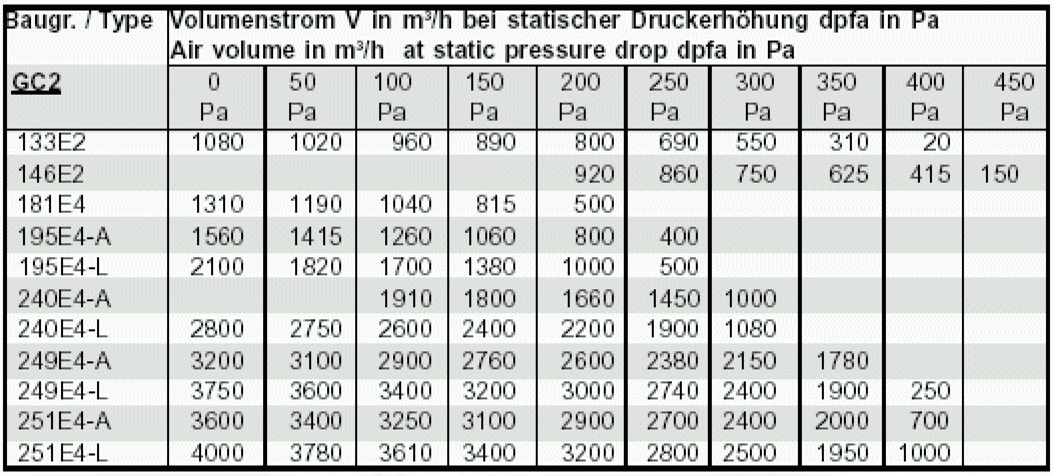
Finding the correct blower

Each blower has a data sheet (consult the manufacturer if this is not the case with your blower) where the correlation between the **volumetric flow** and the **static pressure** is represented by a graph or table.

Here is such a set of curves for 4 blowers (numbered 1-4).
NOTE: Each model of a blower has his own characteristic curve. This chart shows the curves for 4 different particular models of axial duct blowers.
What you can clearly see is that **the bigger the static pressure the less air the blower delivers**, up to the maximum static pressure where the air output is zero.



Sometimes these data are presented in form of a table.



Baugr. / Type	Volumenstrom V in m³/h bei statischer Druckerhöhung dpfa in Pa Air volume in m³/h at static pressure drop dpfa in Pa									
GC2	0 Pa	50 Pa	100 Pa	150 Pa	200 Pa	250 Pa	300 Pa	350 Pa	400 Pa	450 Pa
133E2	1080	1020	960	890	800	690	550	310	20	
146E2					920	860	750	625	415	150
181E4	1310	1190	1040	815	500					
195E4-A	1560	1415	1260	1060	800	400				
195E4-L	2100	1820	1700	1380	1000	500				
240E4-A			1910	1800	1660	1450	1000			
240E4-L	2800	2750	2600	2400	2200	1900	1080			
249E4-A	3200	3100	2900	2760	2600	2380	2150	1780		
249E4-L	3750	3600	3400	3200	3000	2740	2400	1900	250	
251E4-A	3600	3400	3250	3100	2900	2700	2400	2000	700	
251E4-L	4000	3780	3610	3400	3200	2800	2500	1950	1000	

By now you know how much your blower must deliver and at which static pressure. In our example it was $340m^3/h$ at 300Pa.
So what we do now is to go in this chart and find the value of 300Pa(**=1.2"**) at the vertical axis. Then you move to the right until you reach $340m^3/h$ (**=200cfm**).
Now, ideally there should be a curve of a blower going exactly trough this point, but this is not always the case.
So we have to choose a blower that best approximates our requirements.
In most cases we should choose a stronger blower, if it's not too strong.
How strong is too strong? I'd say the blower shouldn't deliver more that 20% more air than we calculated, so in our case the strongest acceptable blower would be around $400m^3/h$.
In this example we have a blower that delivers $300m^3/h$ (according to our calculation it should deliver $340m^3/h$ though). This is a difference of mere 10%. The next stronger blower in this chart delivers $530m^3/h$ at 300Pa, which is way too much.

In this case we go for the smaller(and cheaper) blower (Nr.4) instead of the much bigger one (Nr.1, which delivers 530m^3/h at 300Pa), despite the fact that it's generally recommended to take a stronger one.

NOTE: This chart is only an example for a set of 4 particular blowers. The curves of the blowers available to you may look a bit different, but similar.
Usually, if you search long enough, you will be able to find a blower that exactly matches your HEPA.

The design in this pictorial uses an in-line centrifugal fan, another good option (actually the one most commonly used for flow hoods) is a squirrel cage blower (also called shaded pole blower).

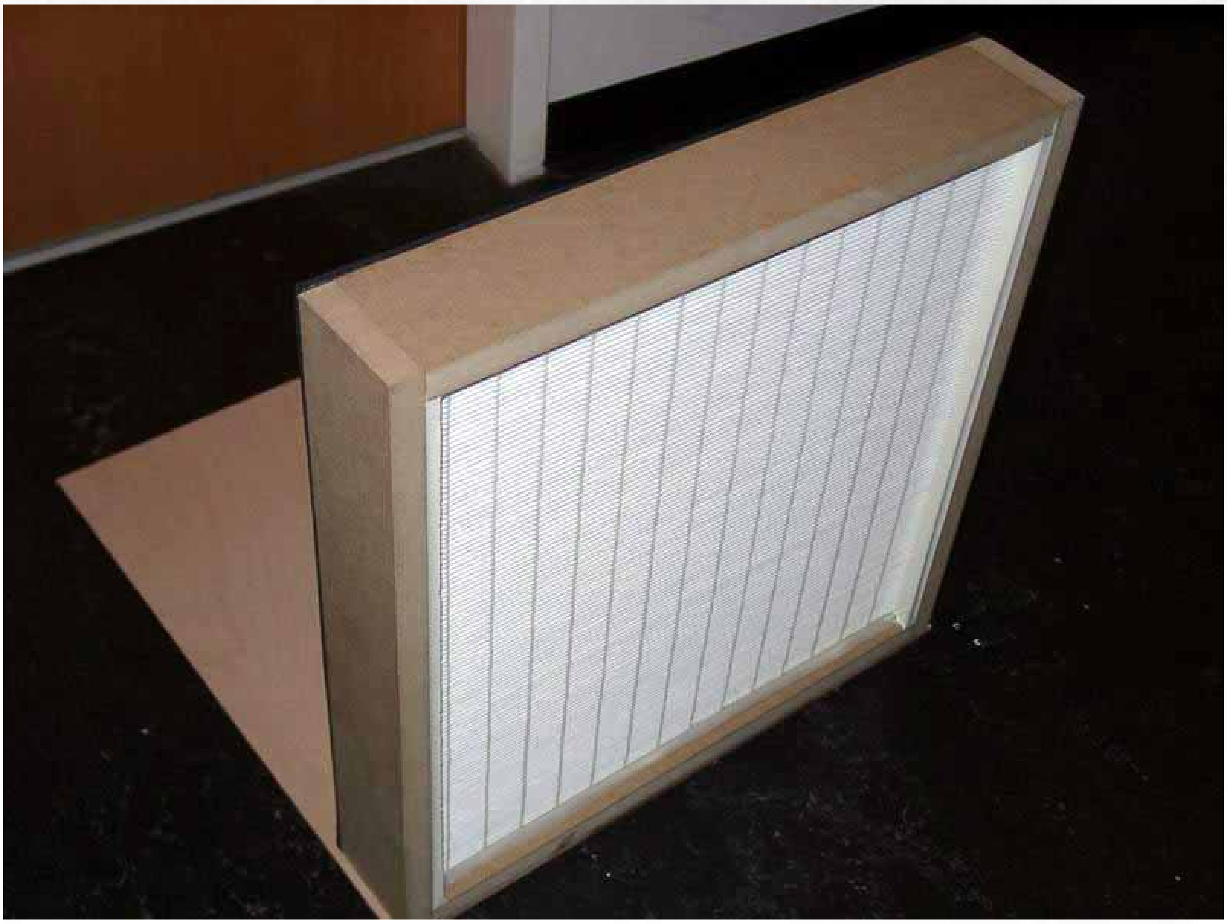
You can get many blowers at ebay.com, often at much cheaper prices than if you bought them directly.

Ebay offers
It is important to contact the seller in advance and inquire about the exact characteristics of the blower beforehand, so you don't end up with a too weak blower.

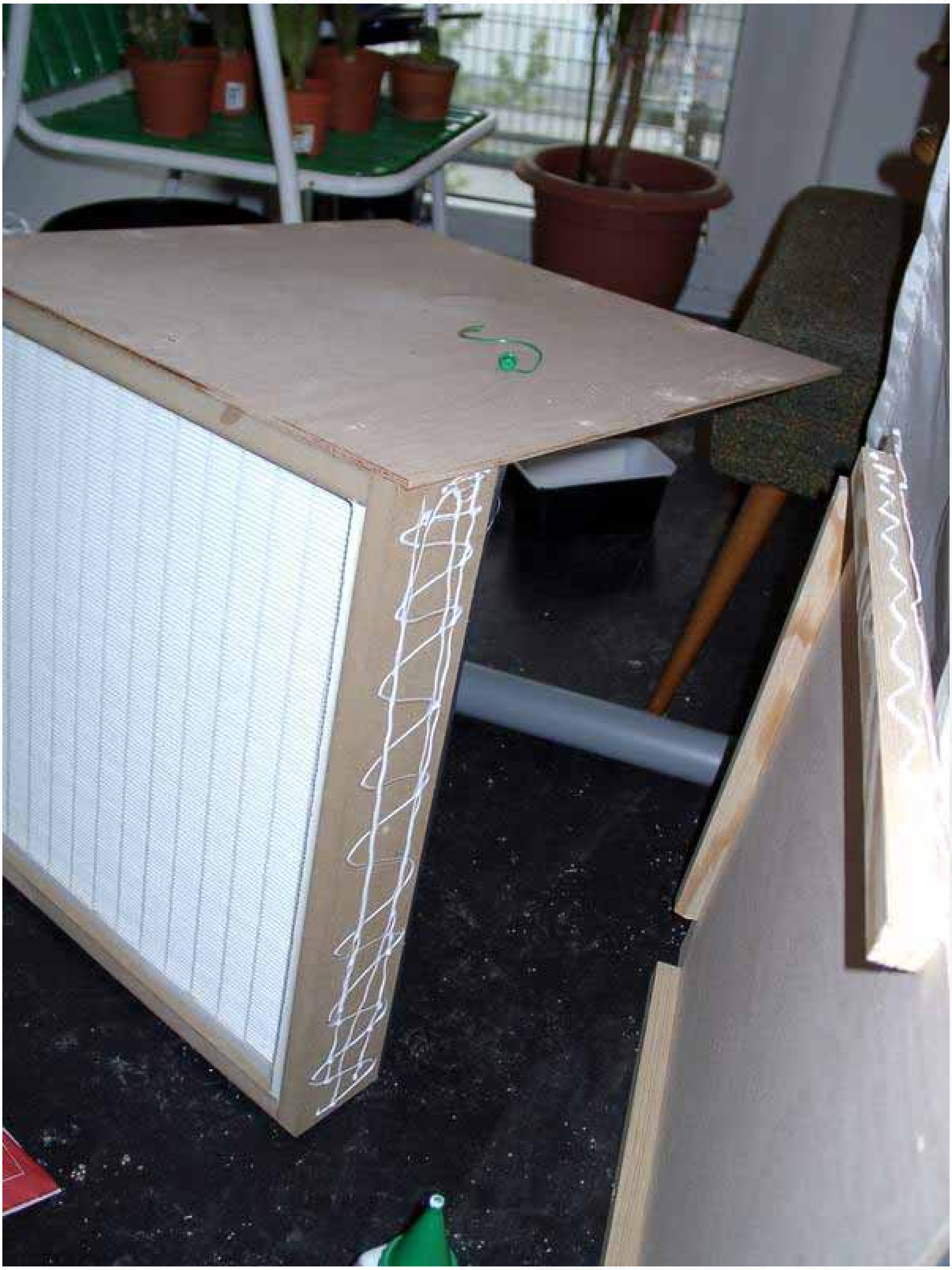
When in doubt, head for the more powerful blower, you can still regulate it down if necessary with a variable speed controller/regulator.

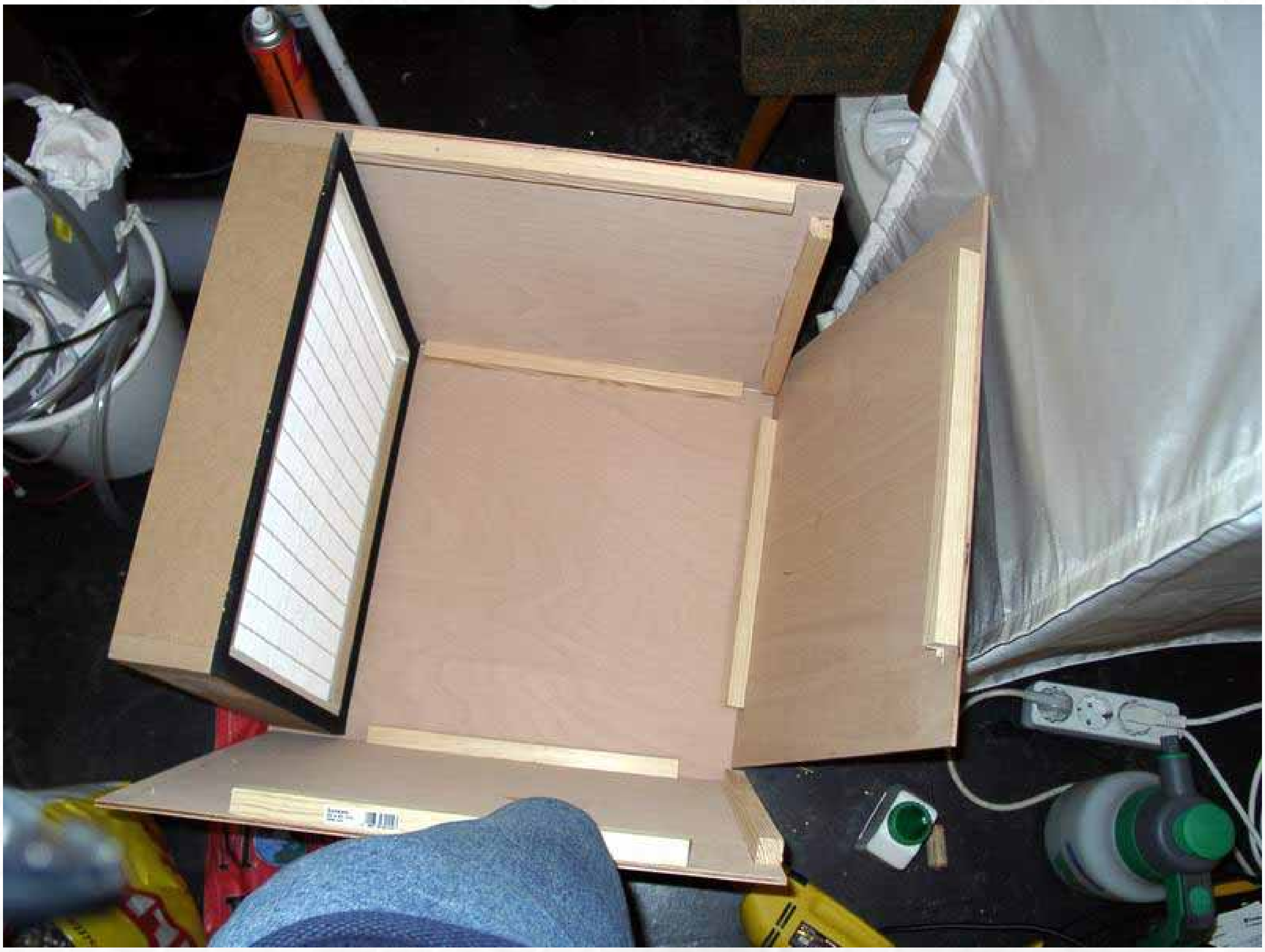
Construction of the hood

After you bought the HEPA filter and a matching blower, you have to get some materials for the construction of the box that will accommodate the above 2 components.
Basically you want to build a box, the front wall of the box will consist of the HEPA filter, and another wall will have the inlet of the blower with the pre-filter mounted. I had the material for the walls already cut to fit the size of the filter and the blower.
I begin by gluing and screwing the filter to the bottom wall.

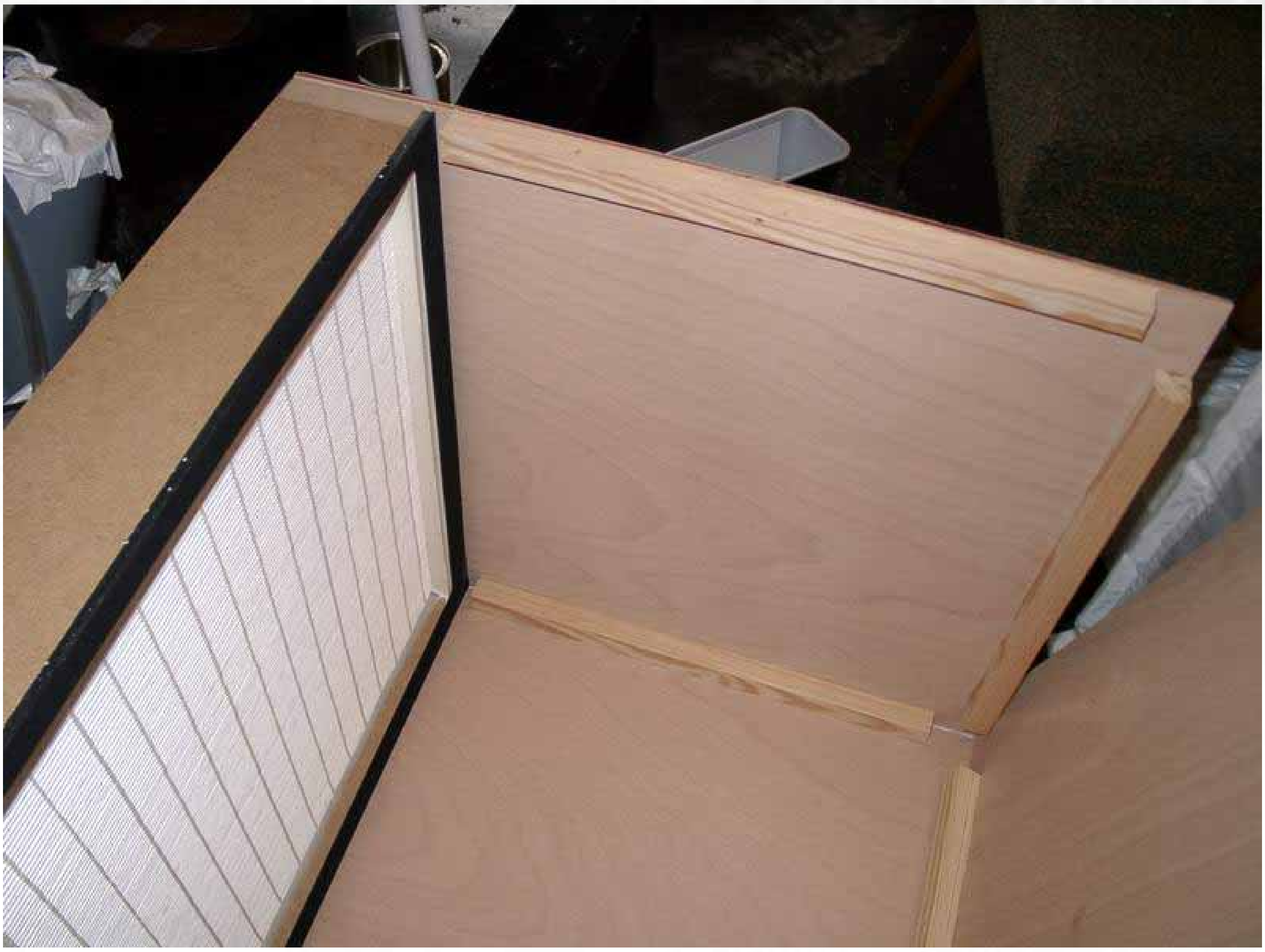


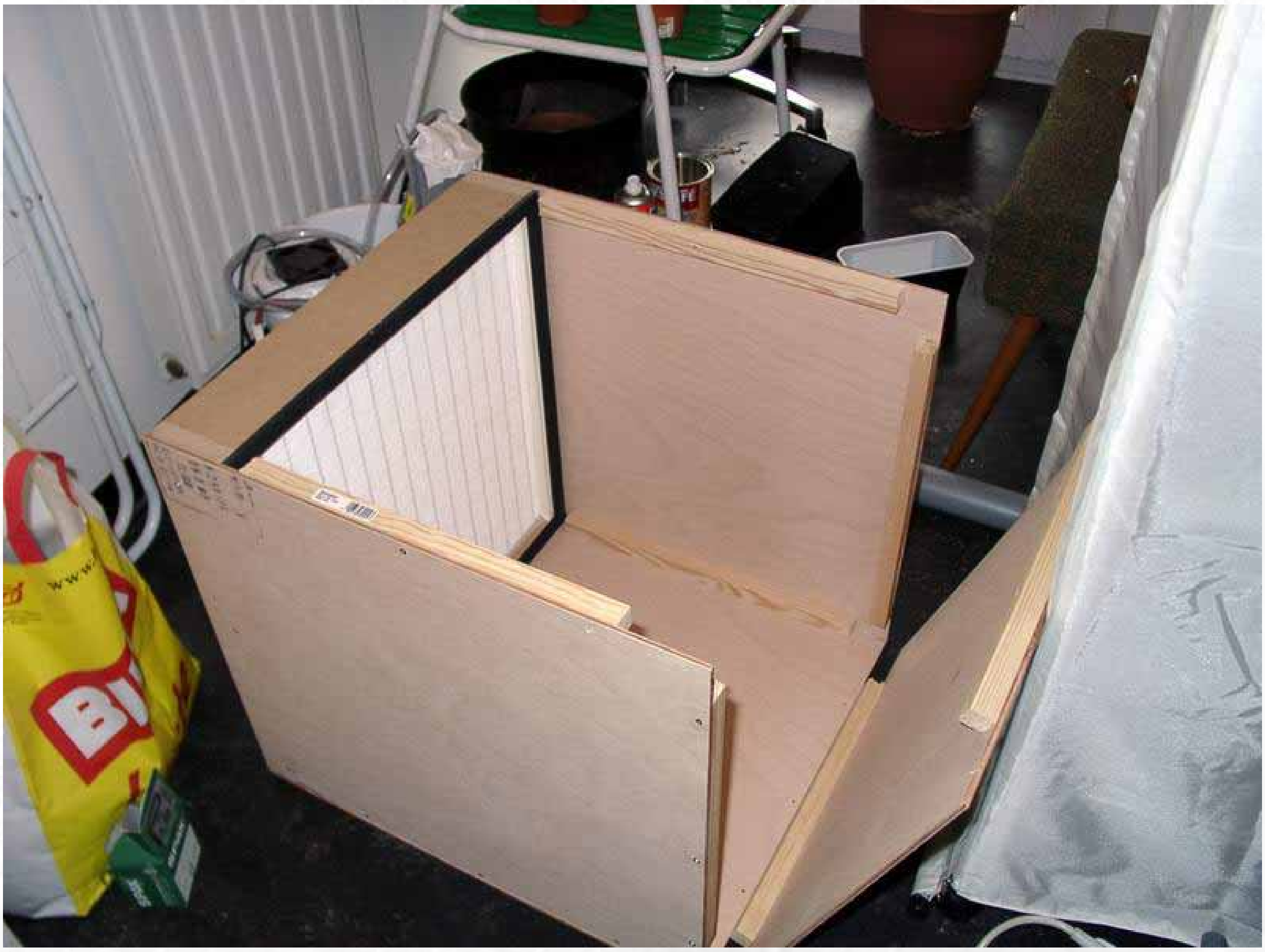
Then I add the side walls...



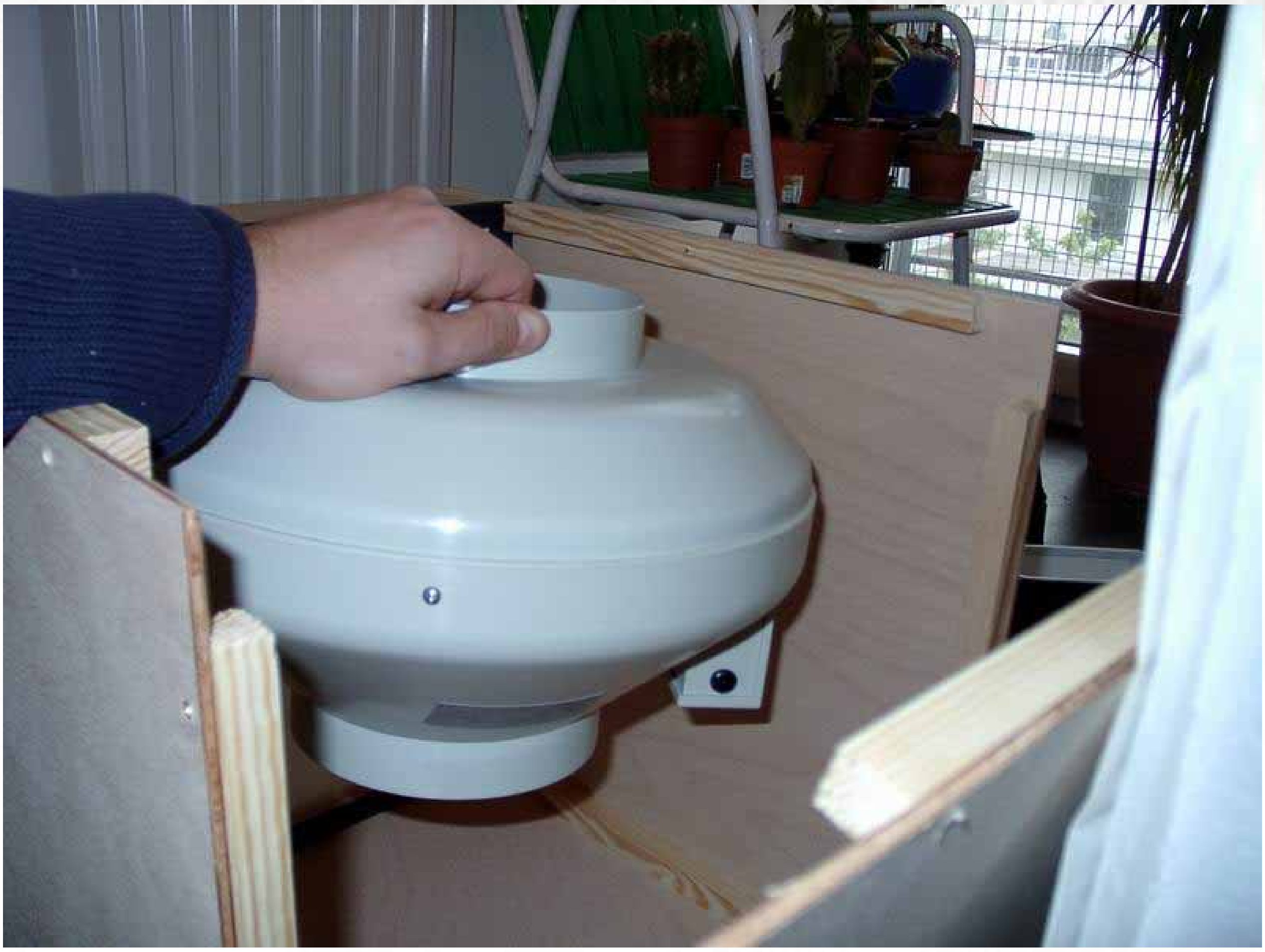


...and the back wall.

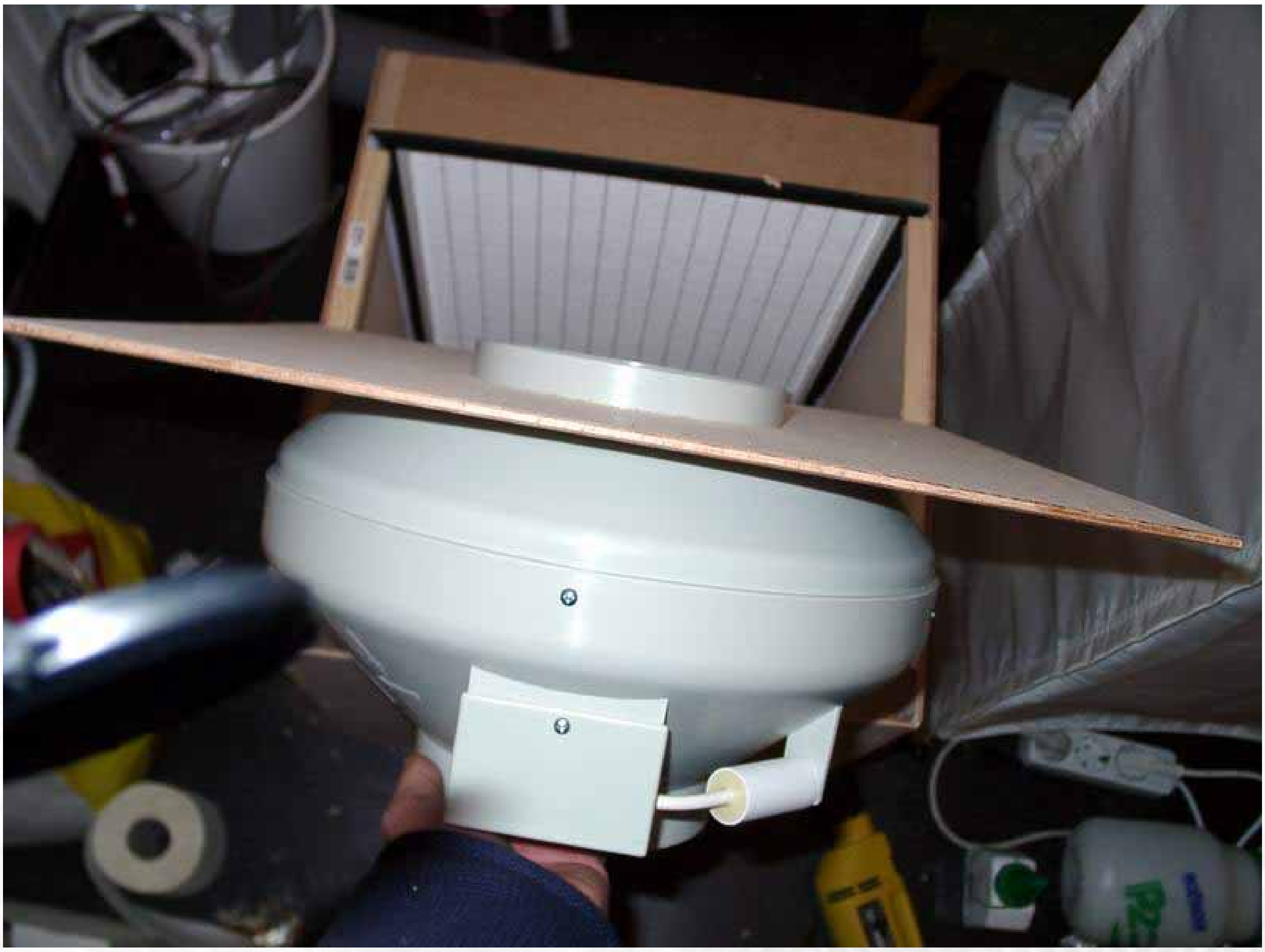


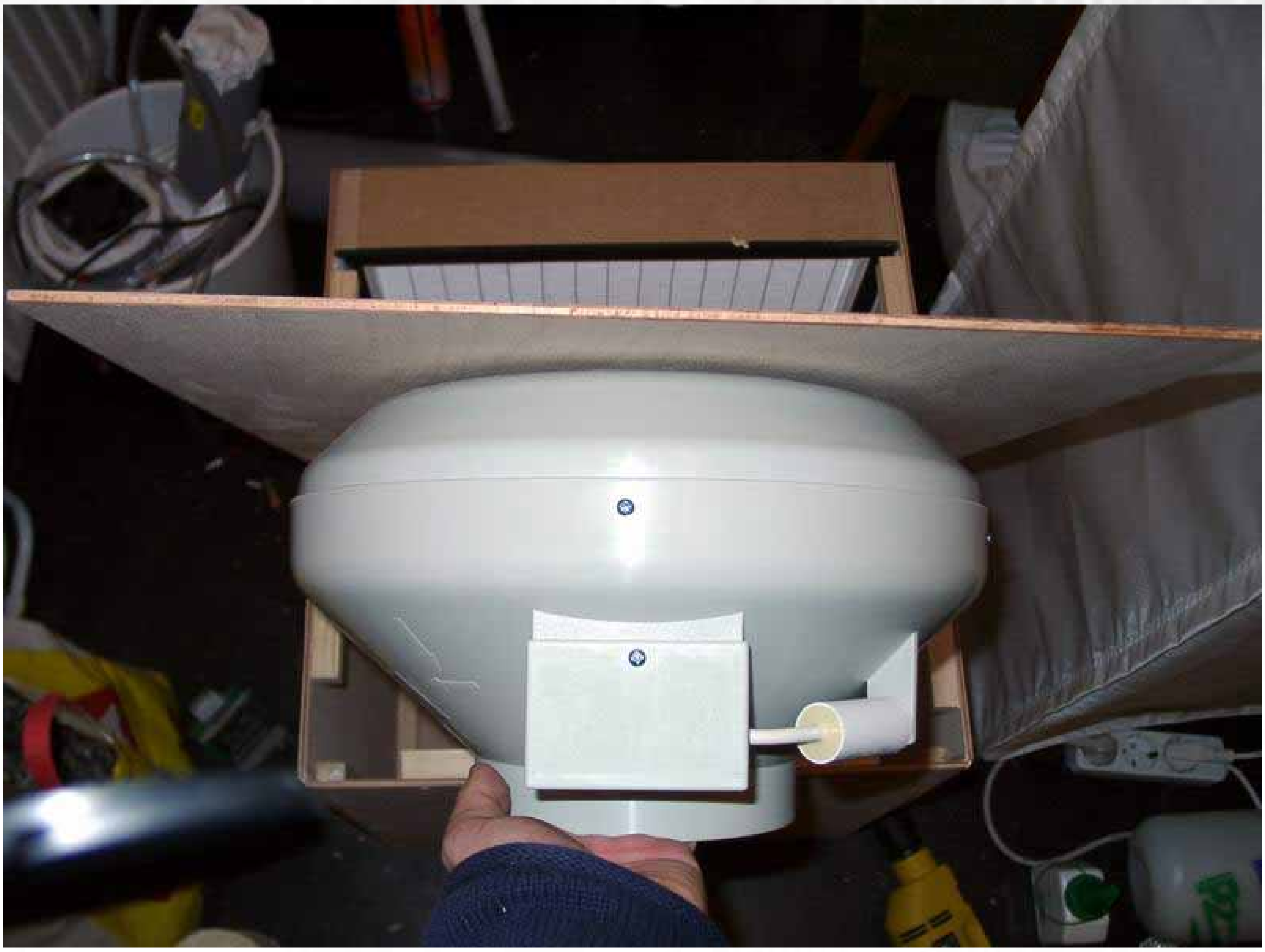


The blower will be mounted so the inlet is at the top.

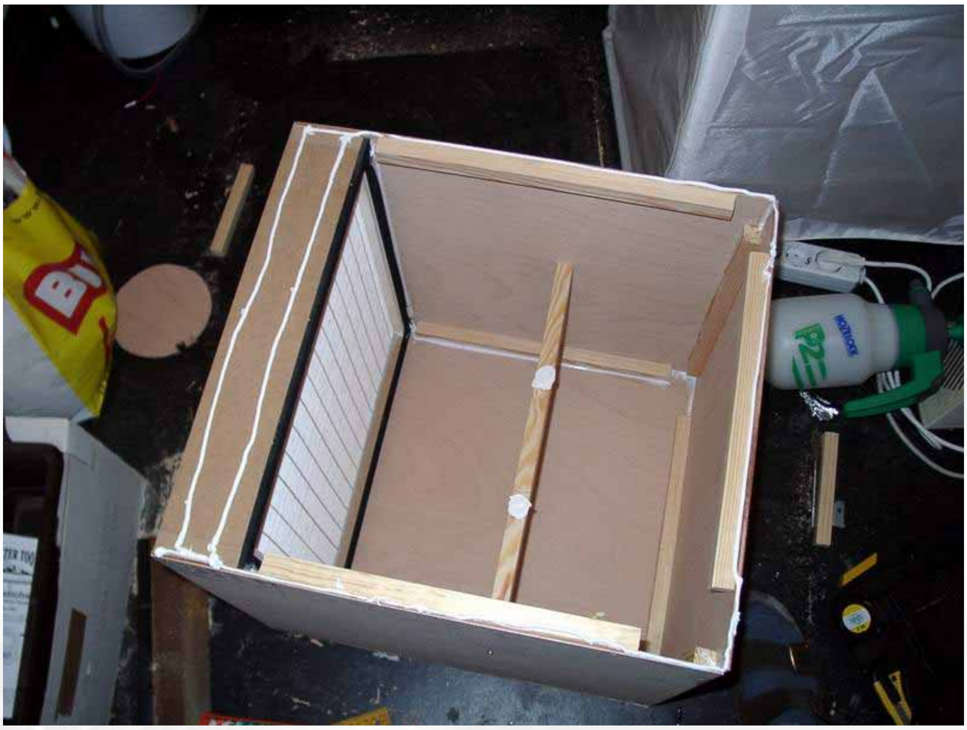


A hole is cut in the wall at the top to accommodate the blower inlet.

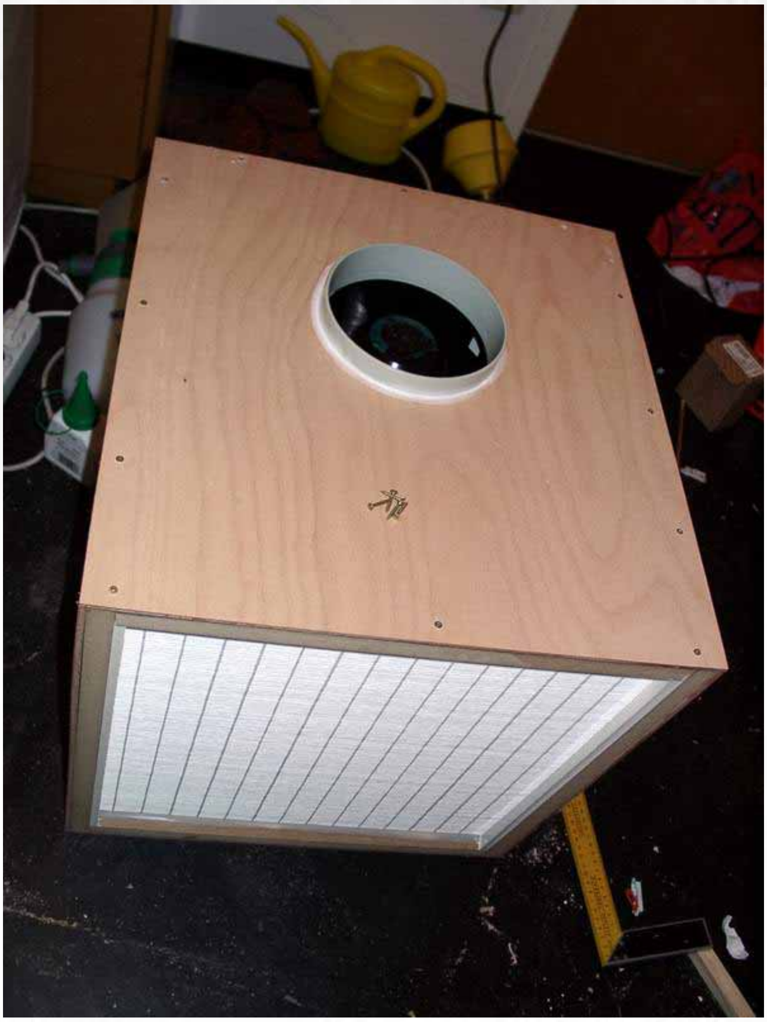




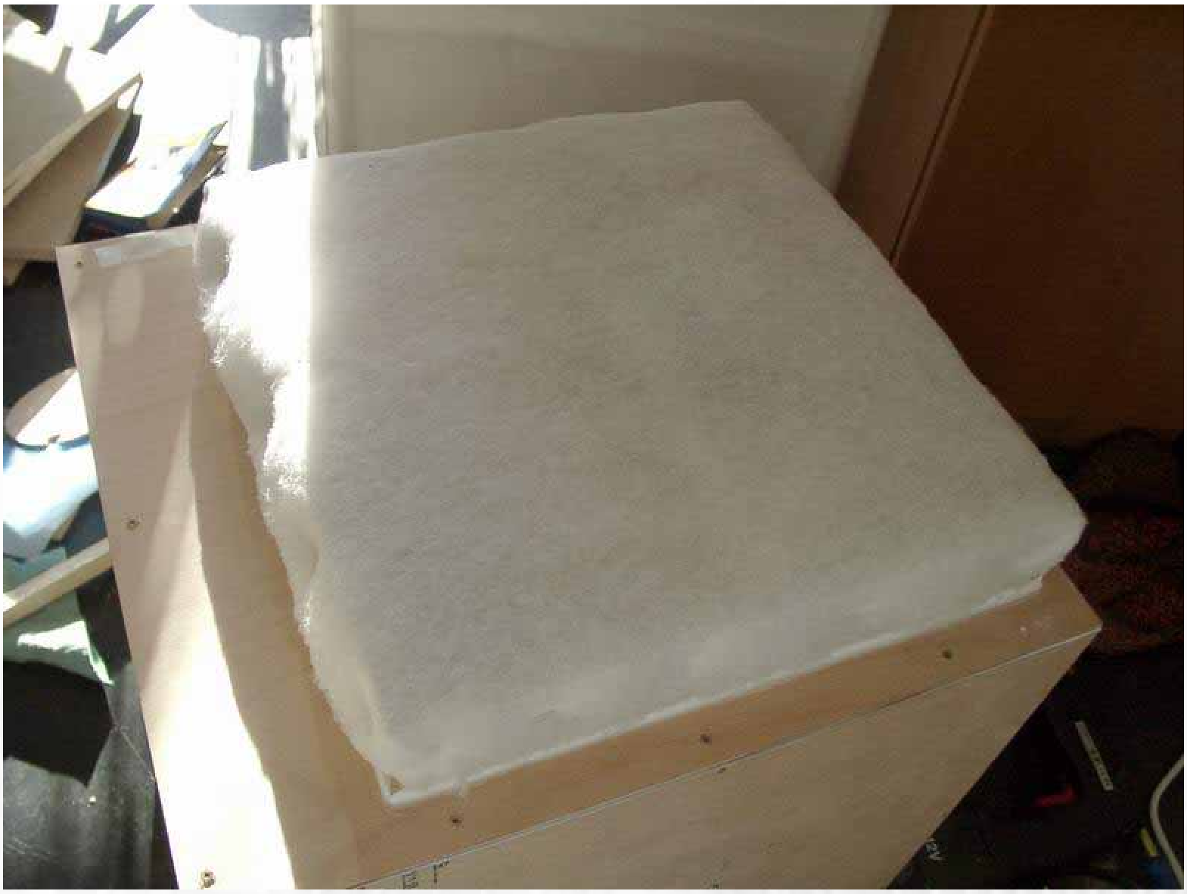
The blower rests on a bar mounted in the box. The white dots on the bar is some (already dried) silicone mass to provide some damping and lessens vibrations. All the joints are filled with silicone mass so the box is airtight.



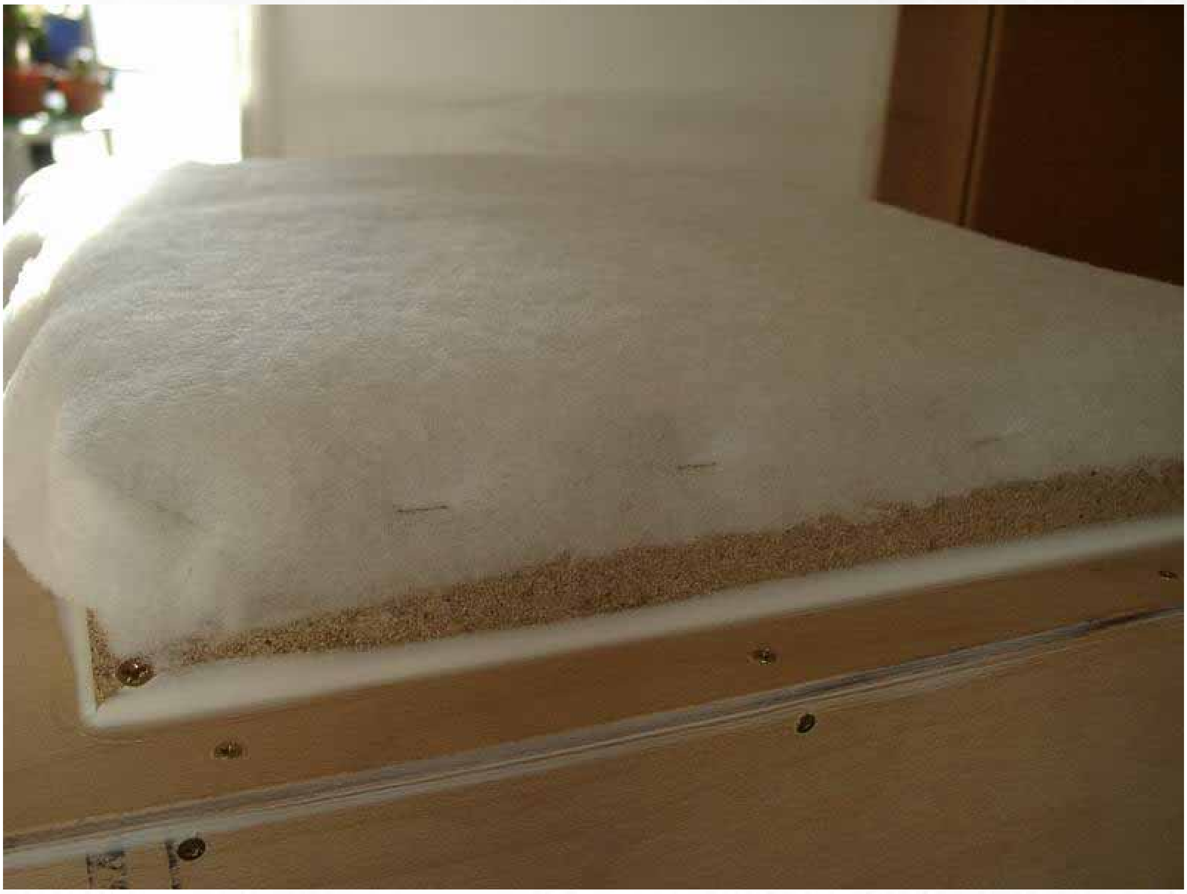
The top with the blower is screwed on the box. The space around the opening and all other cracks in the box are tightened with silicone mass.



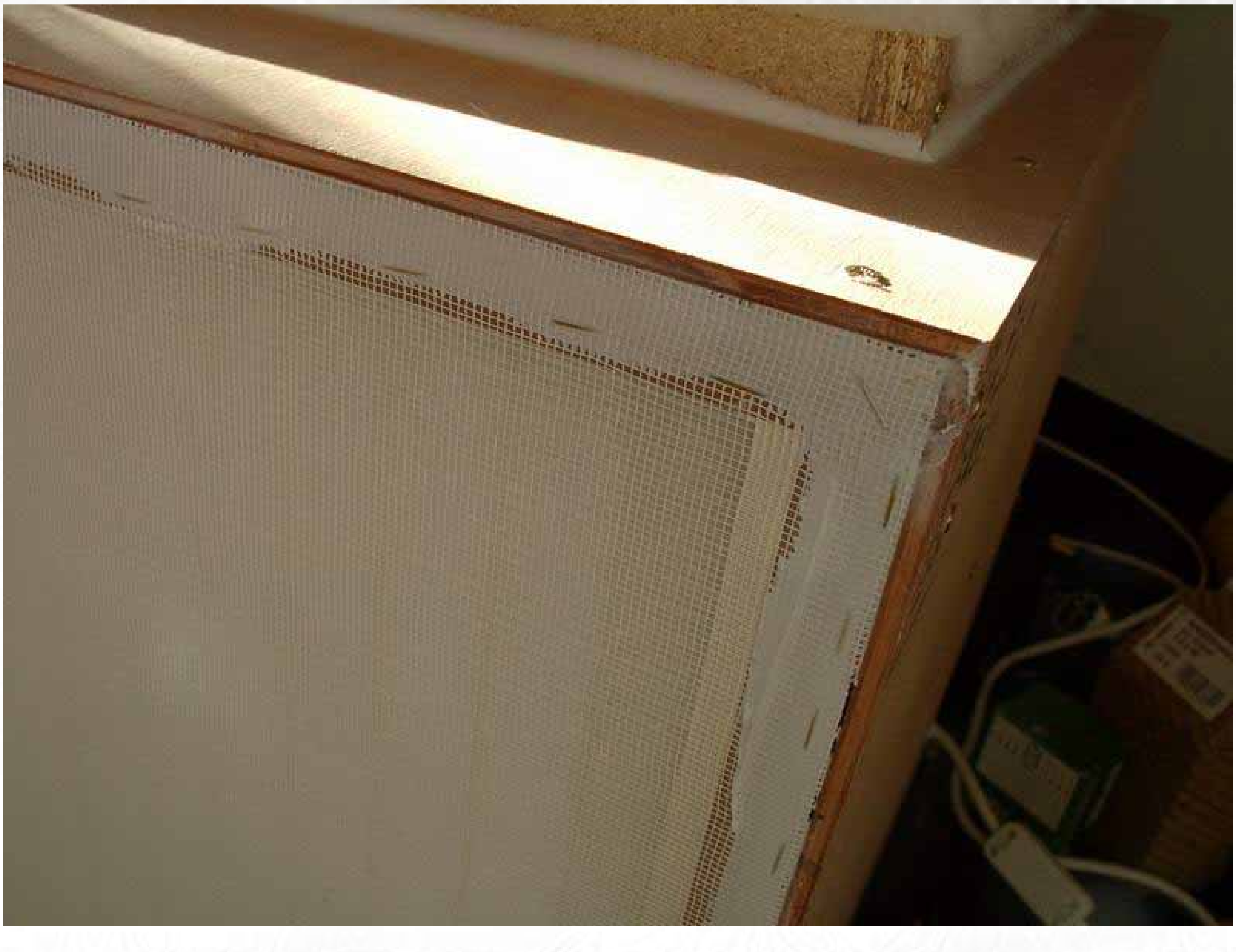
A pre filter is mounted atop of the blower. I use a furnace filter, you can also use other filers, like car air filters, just make sure they are large enough and that they don't have too much air resistance, otherwise you would need a larger blower.



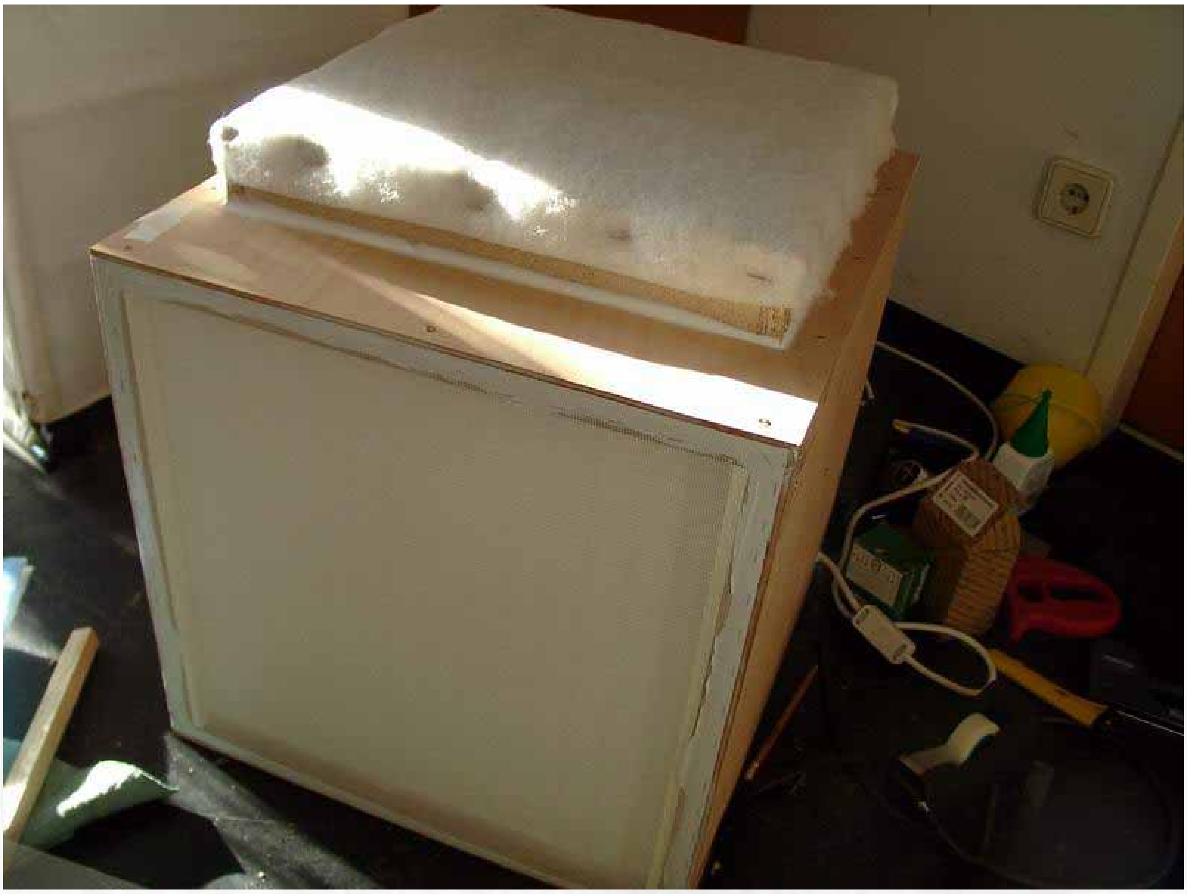
Detail of the pre-filter.



A net is tackered to the frame of the HEPA filter to prevent touching and harming the delicate filter.

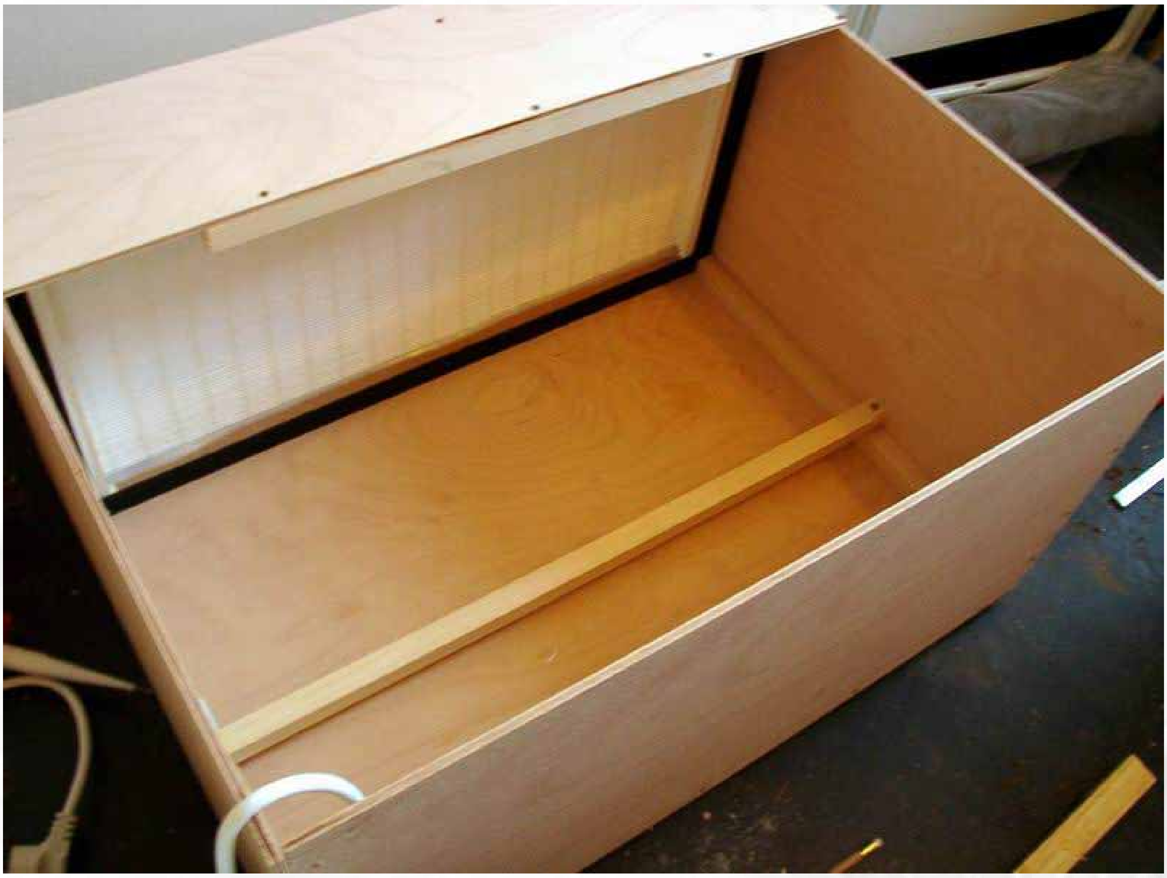


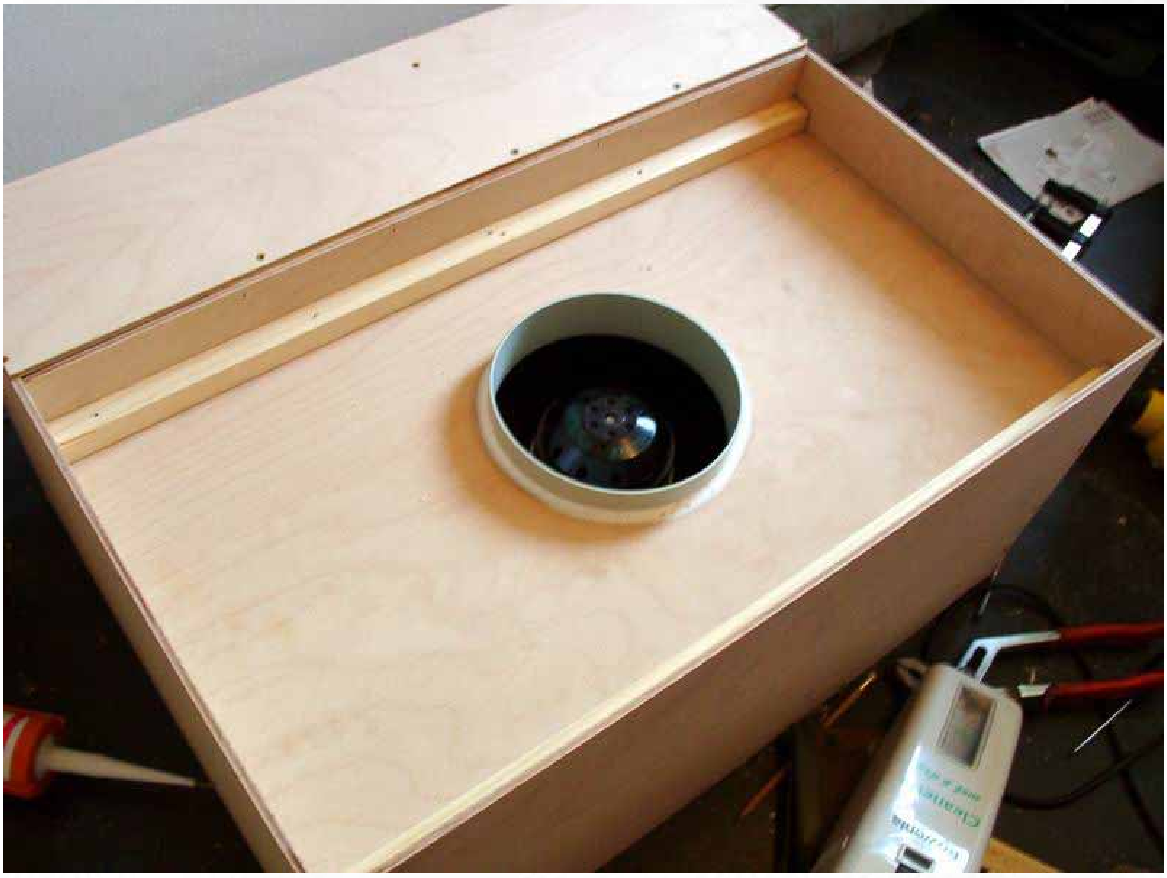
The finished flow hood.

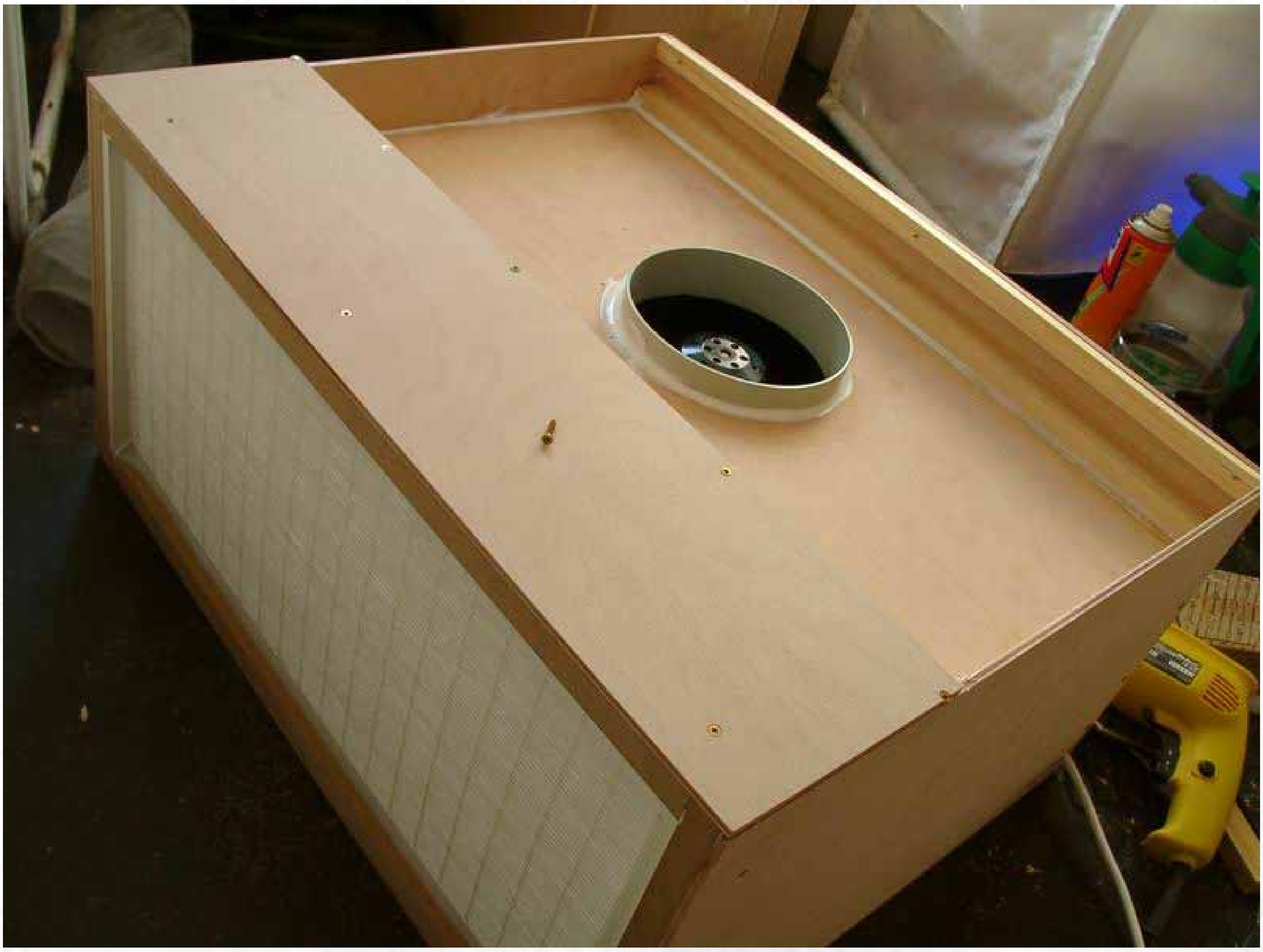


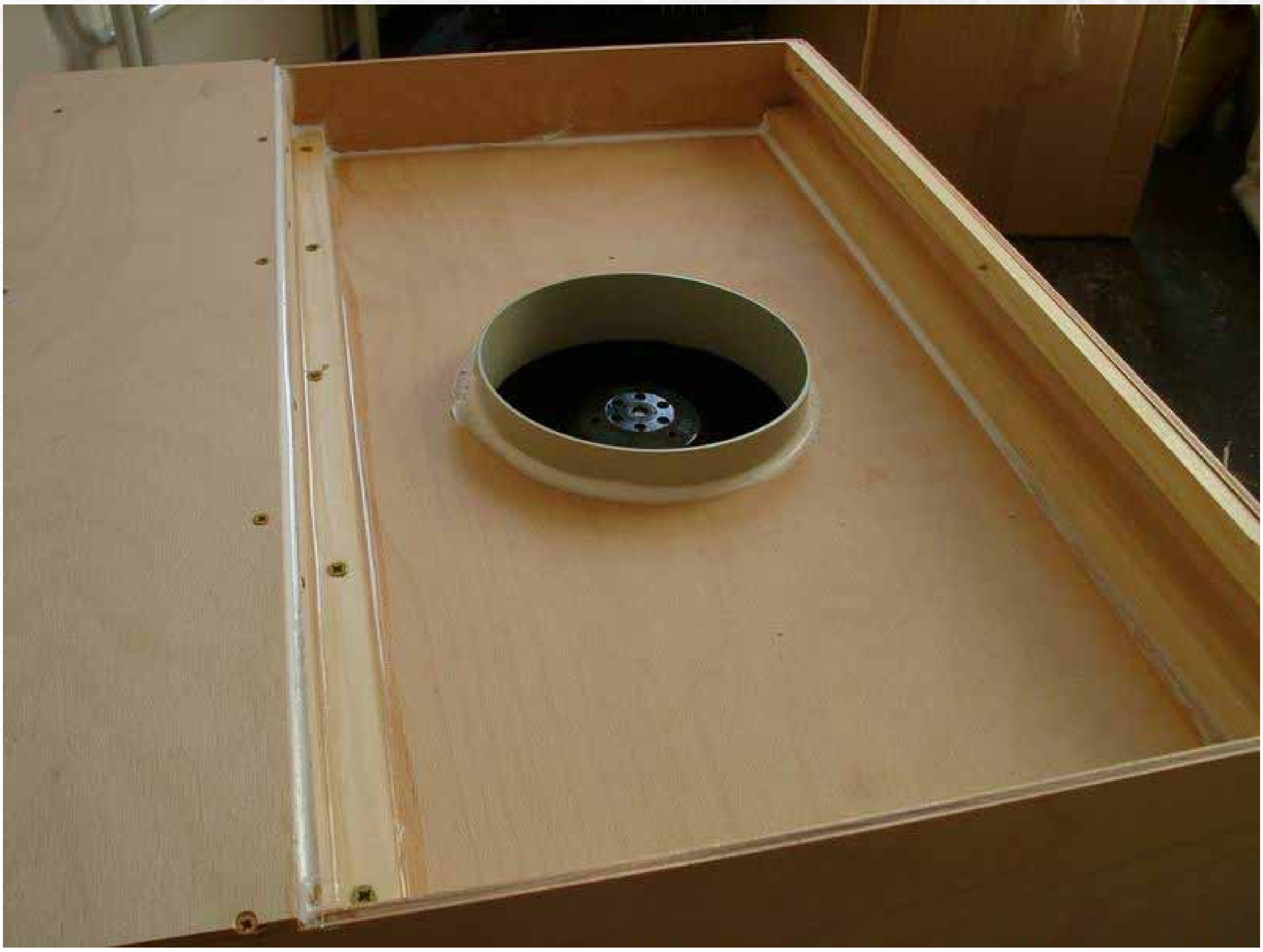
Some pictures of a similar design

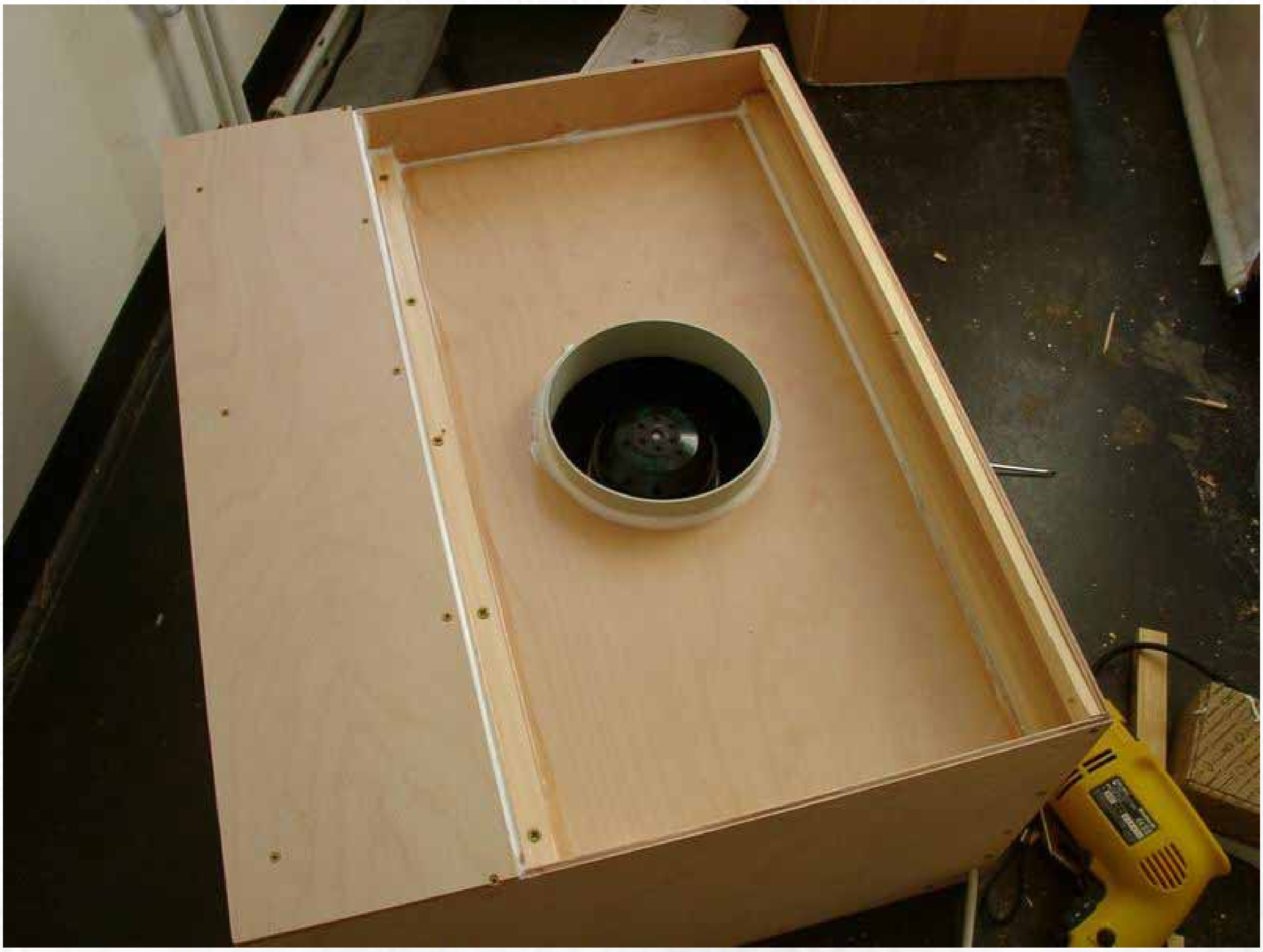
Some pictures of a similar design, the only difference is that the blower is mounted around 10 cm deeper, so the pre filer is in the same level as the rest of the box. Makes it more visually appealing and more compact this way.

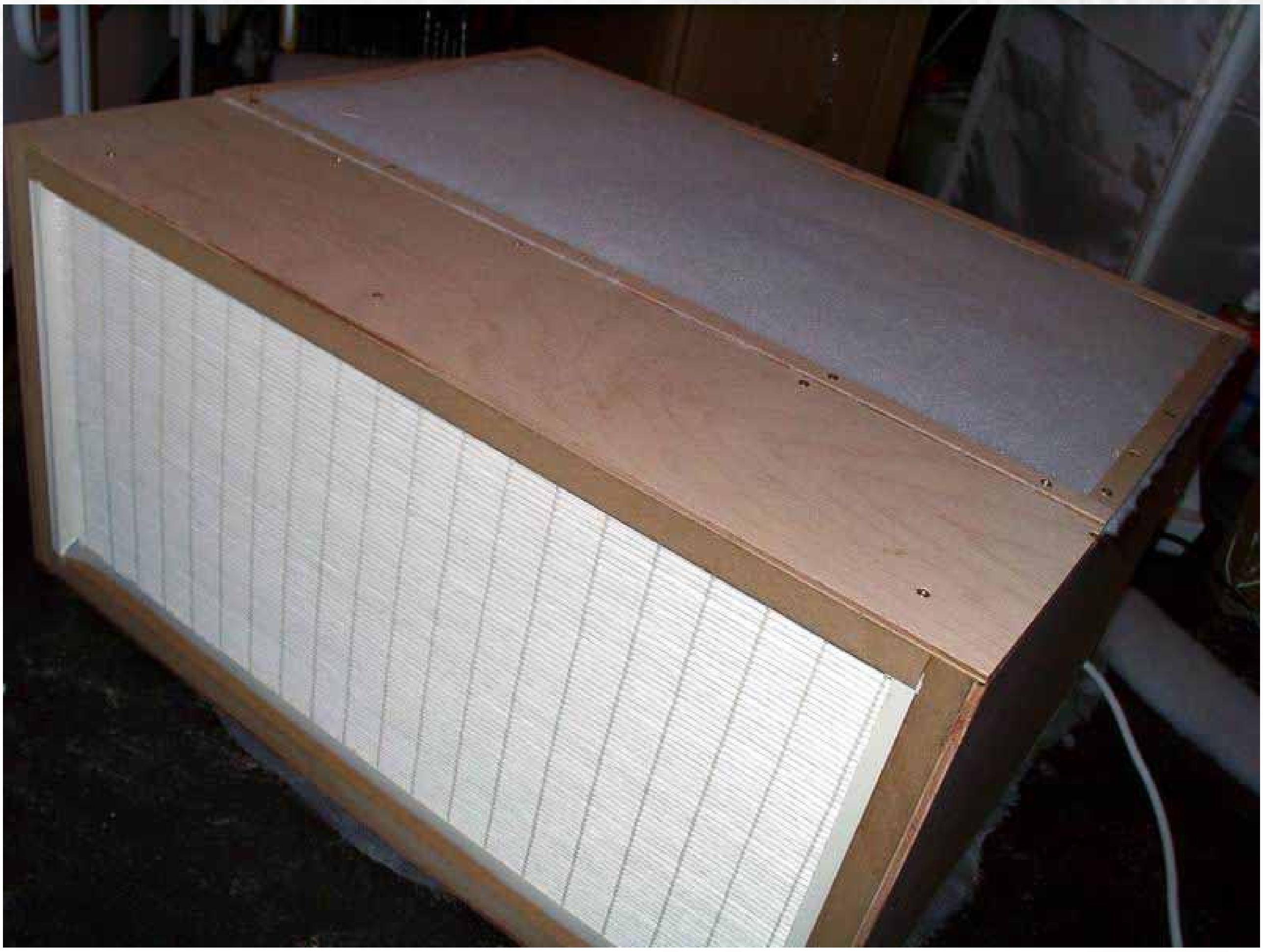


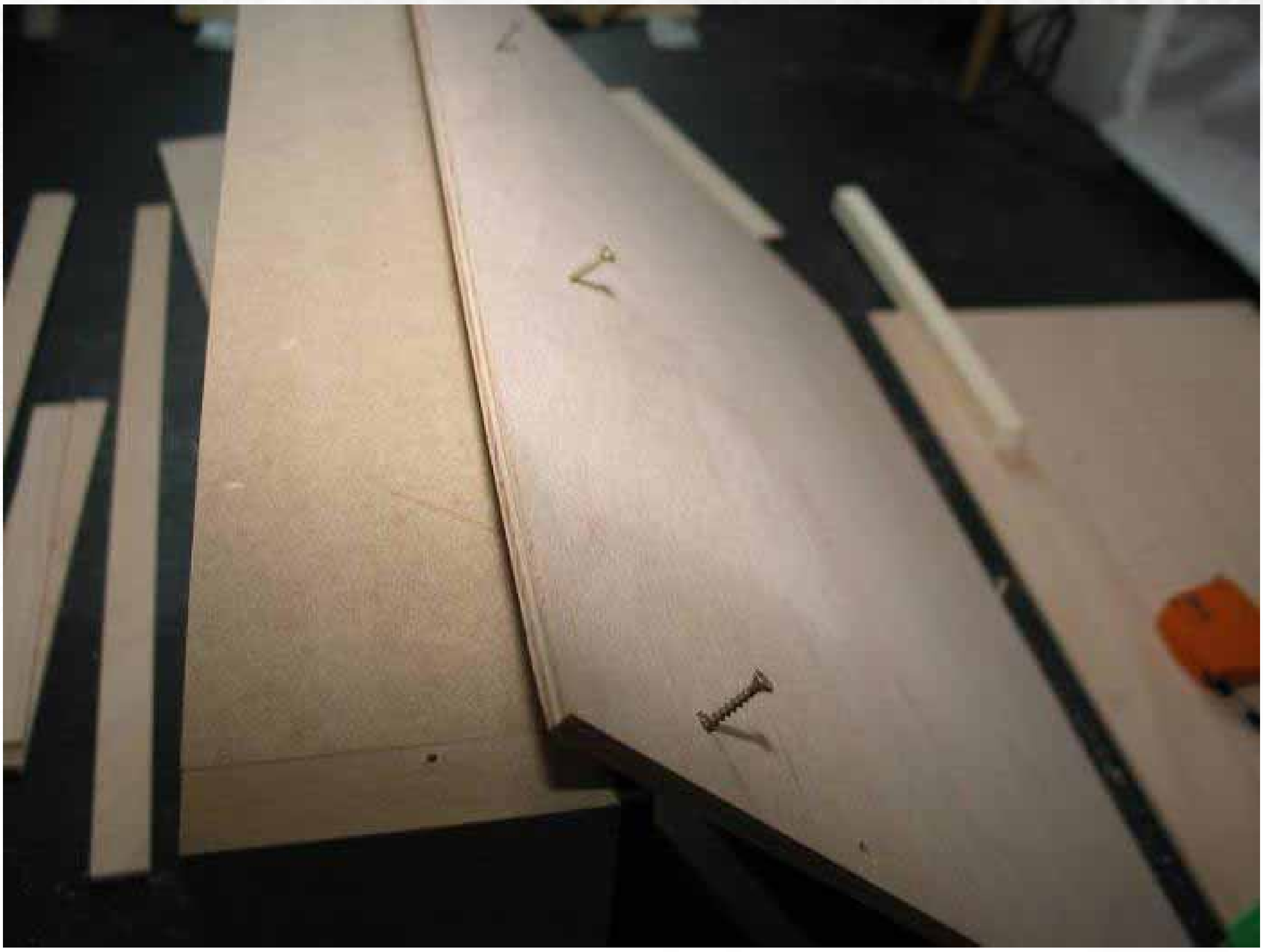


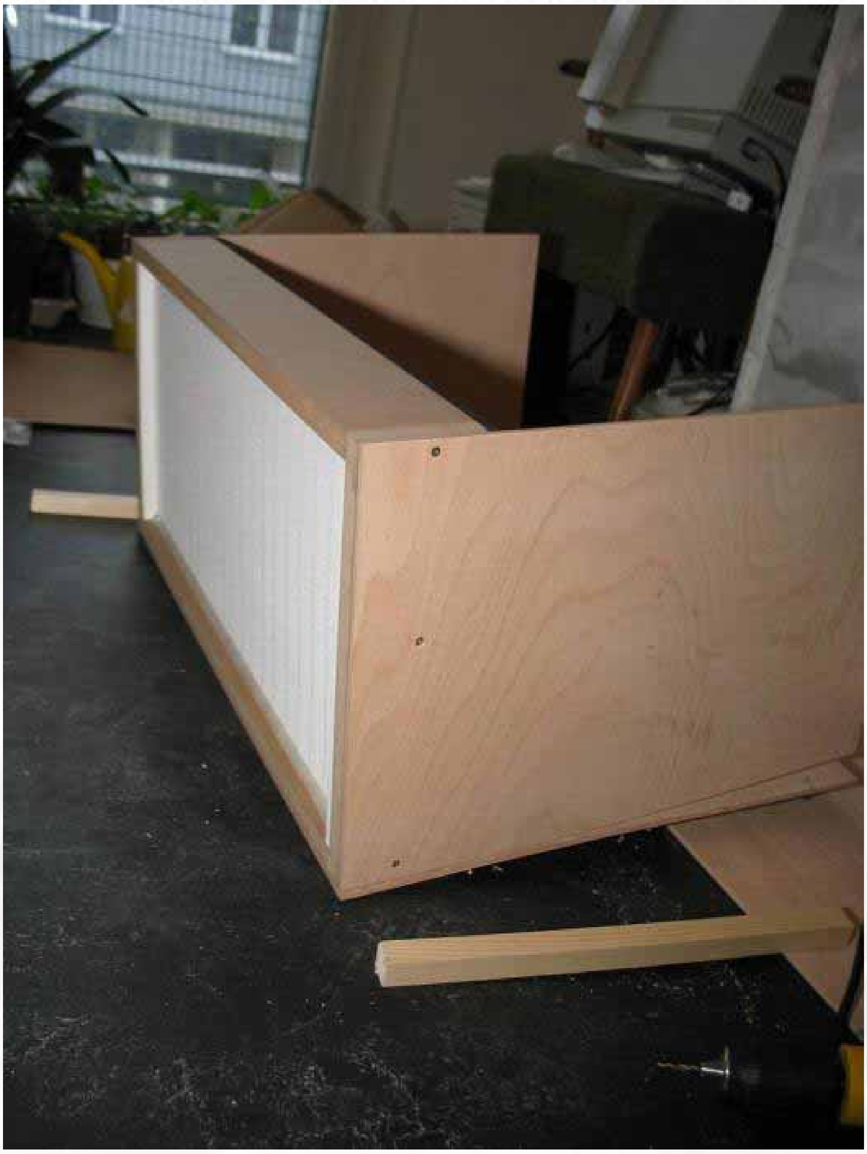


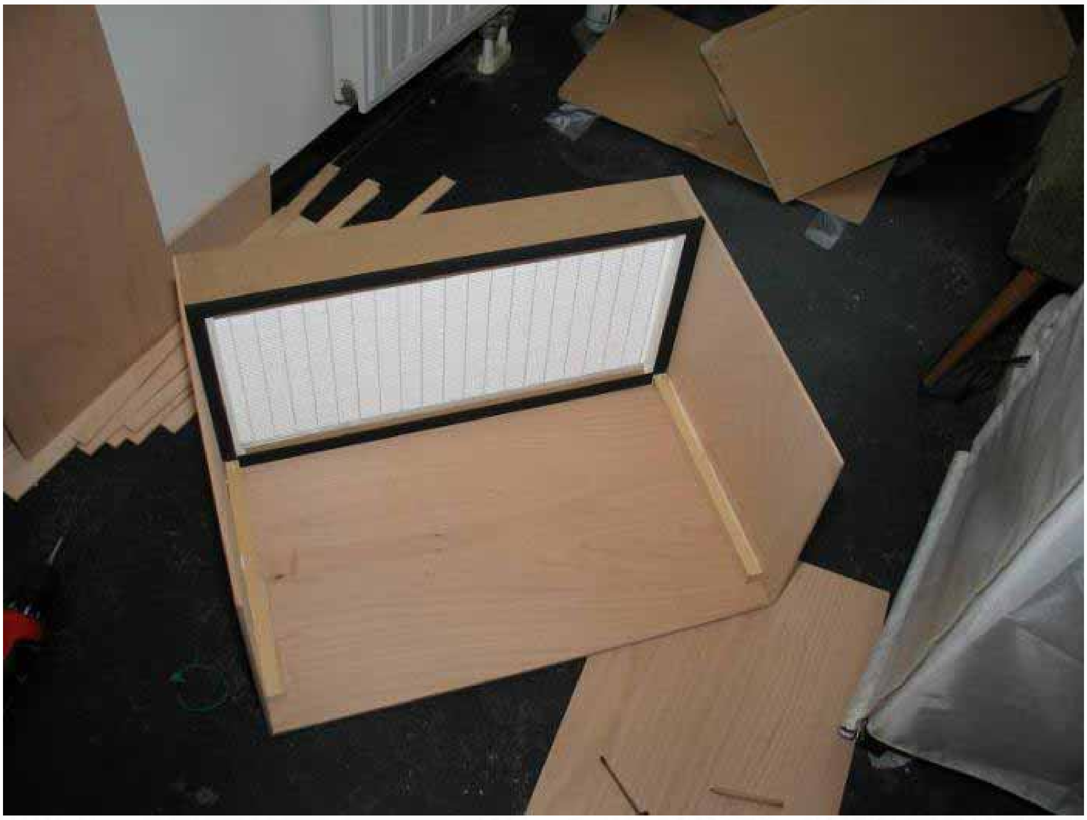


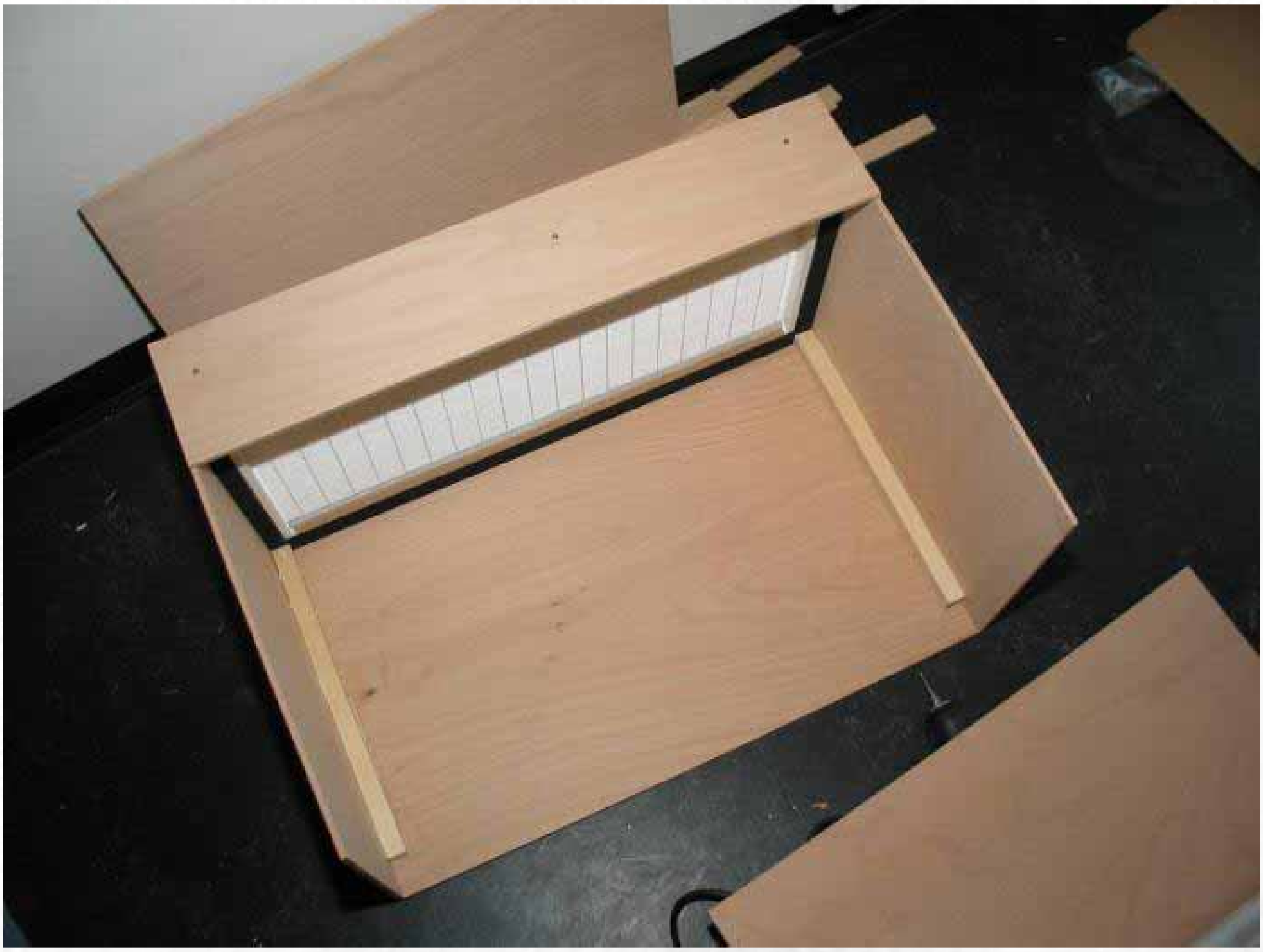


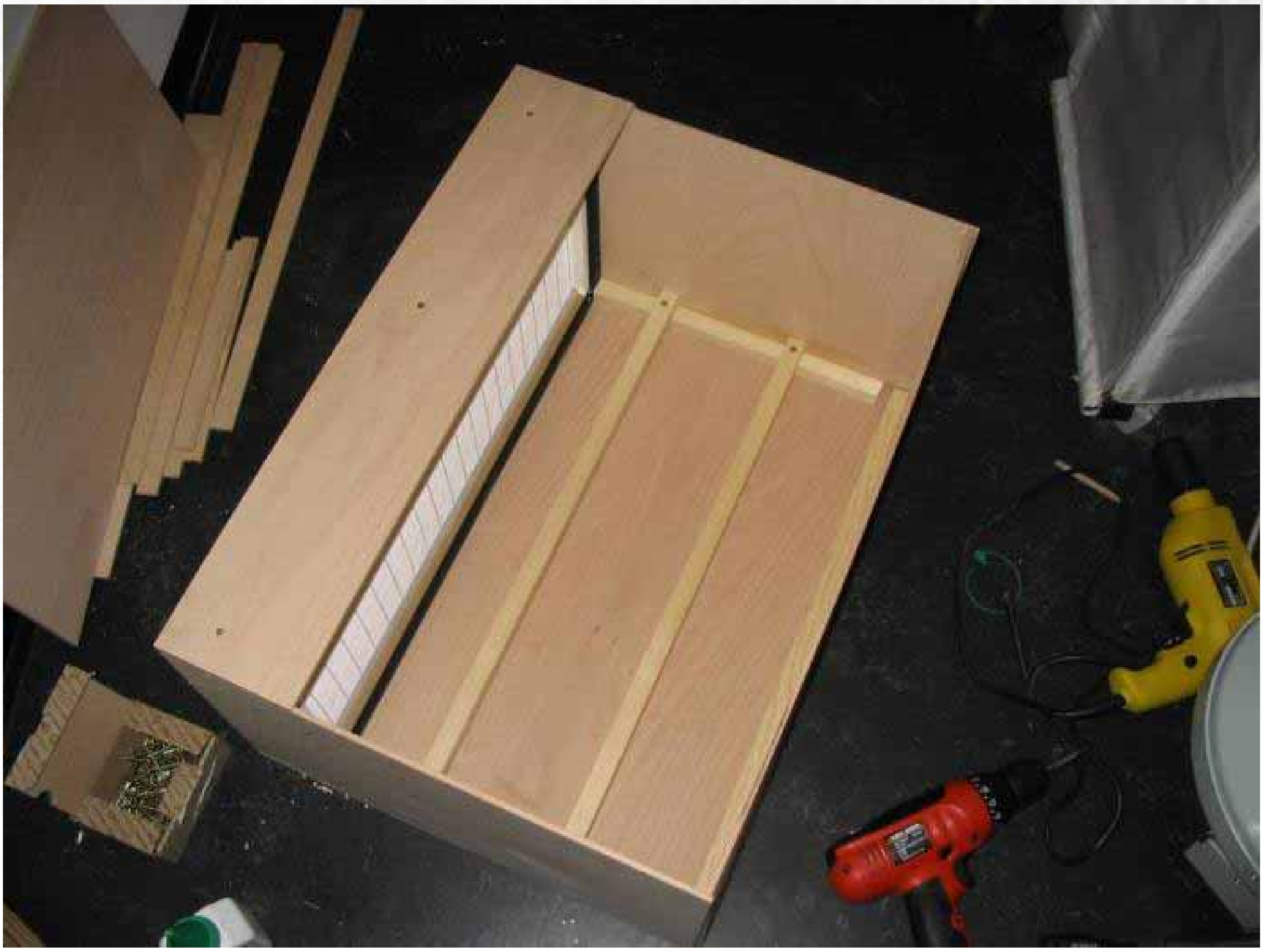


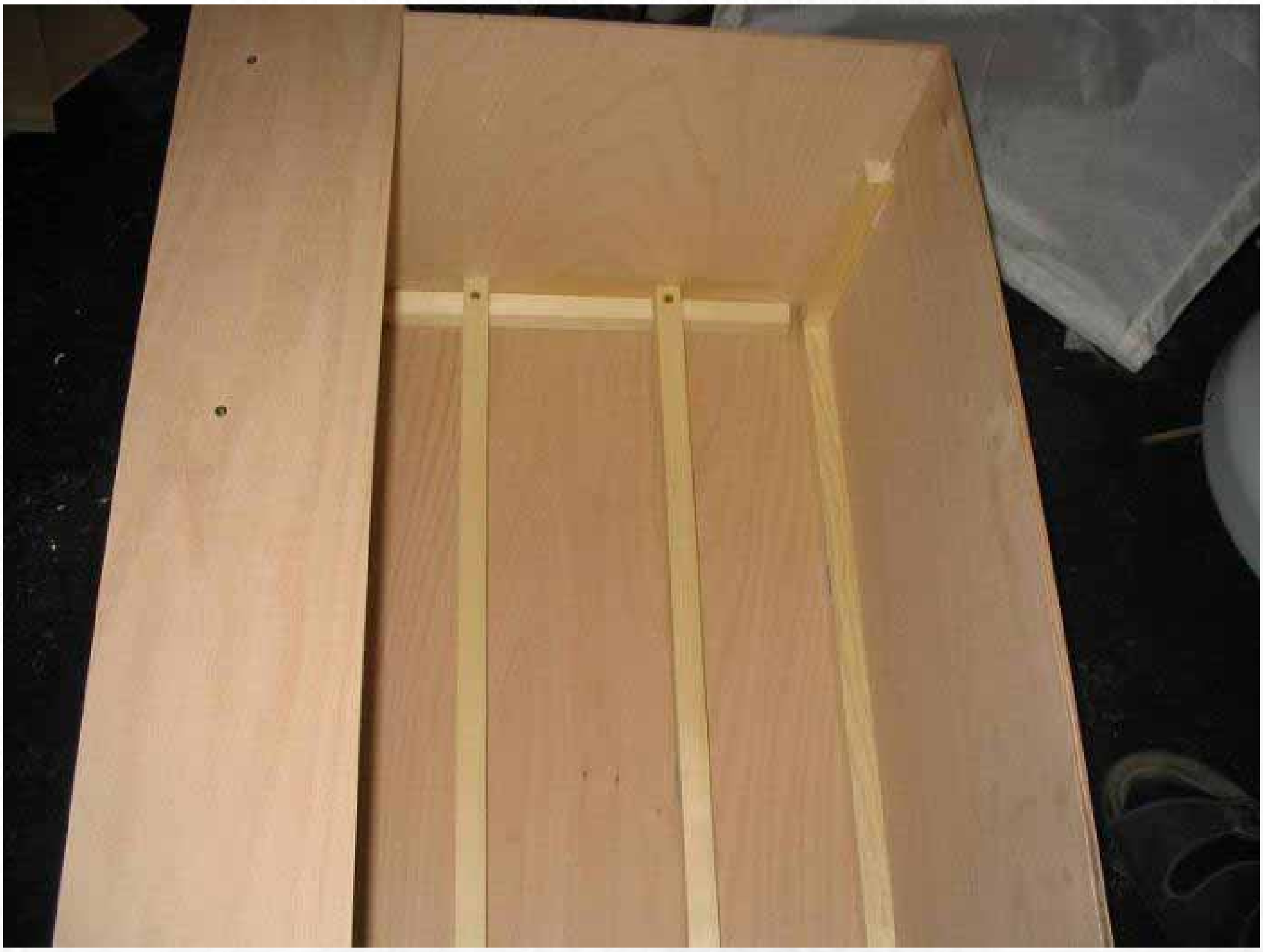


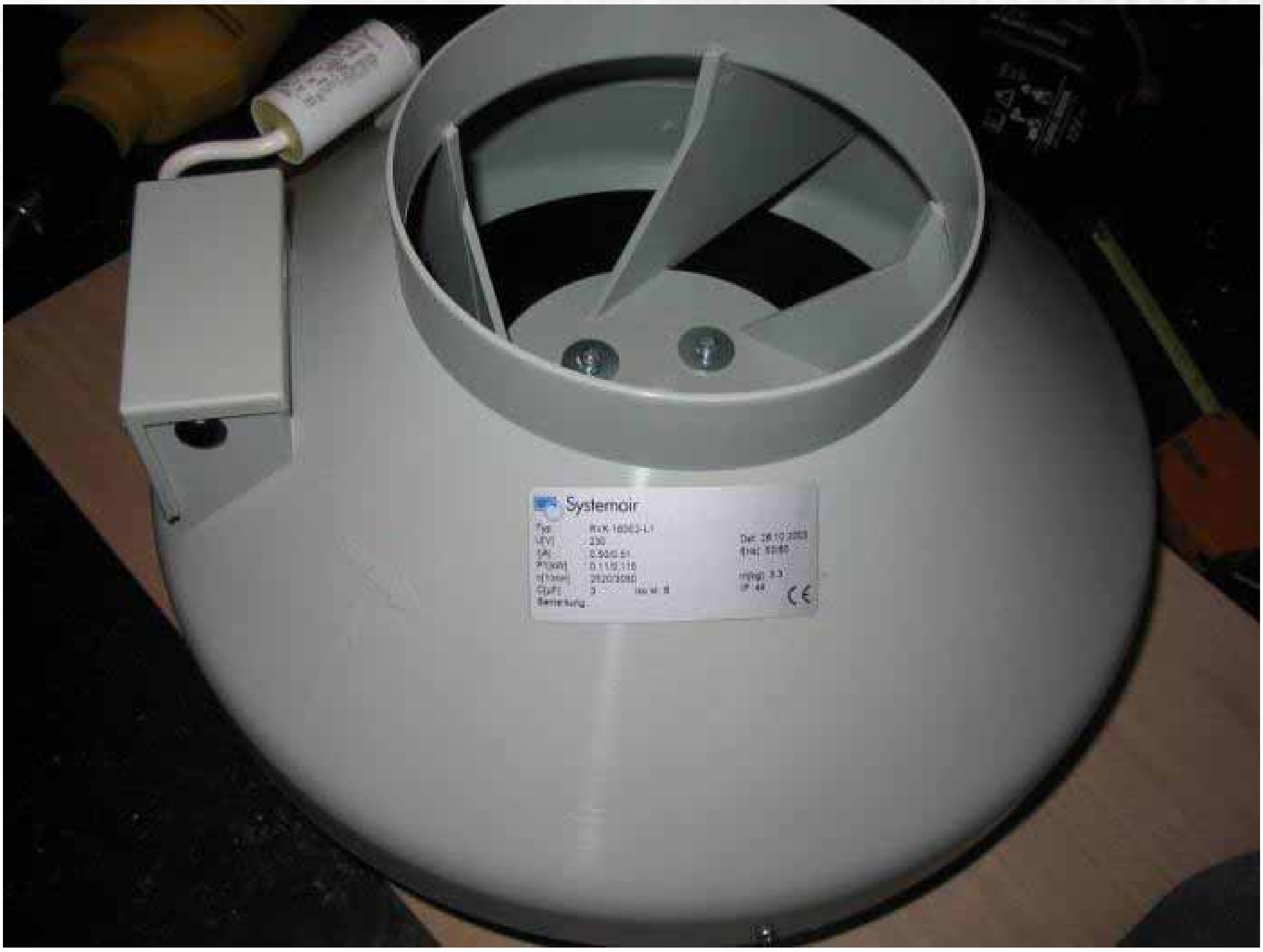


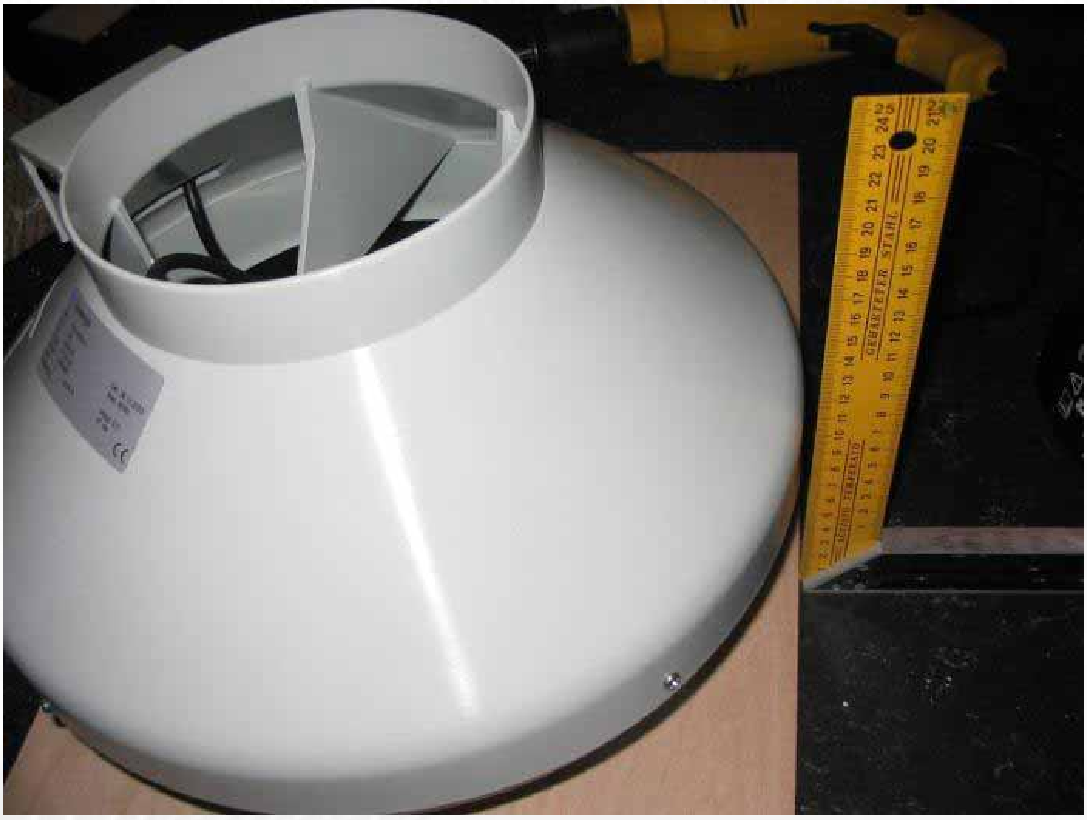


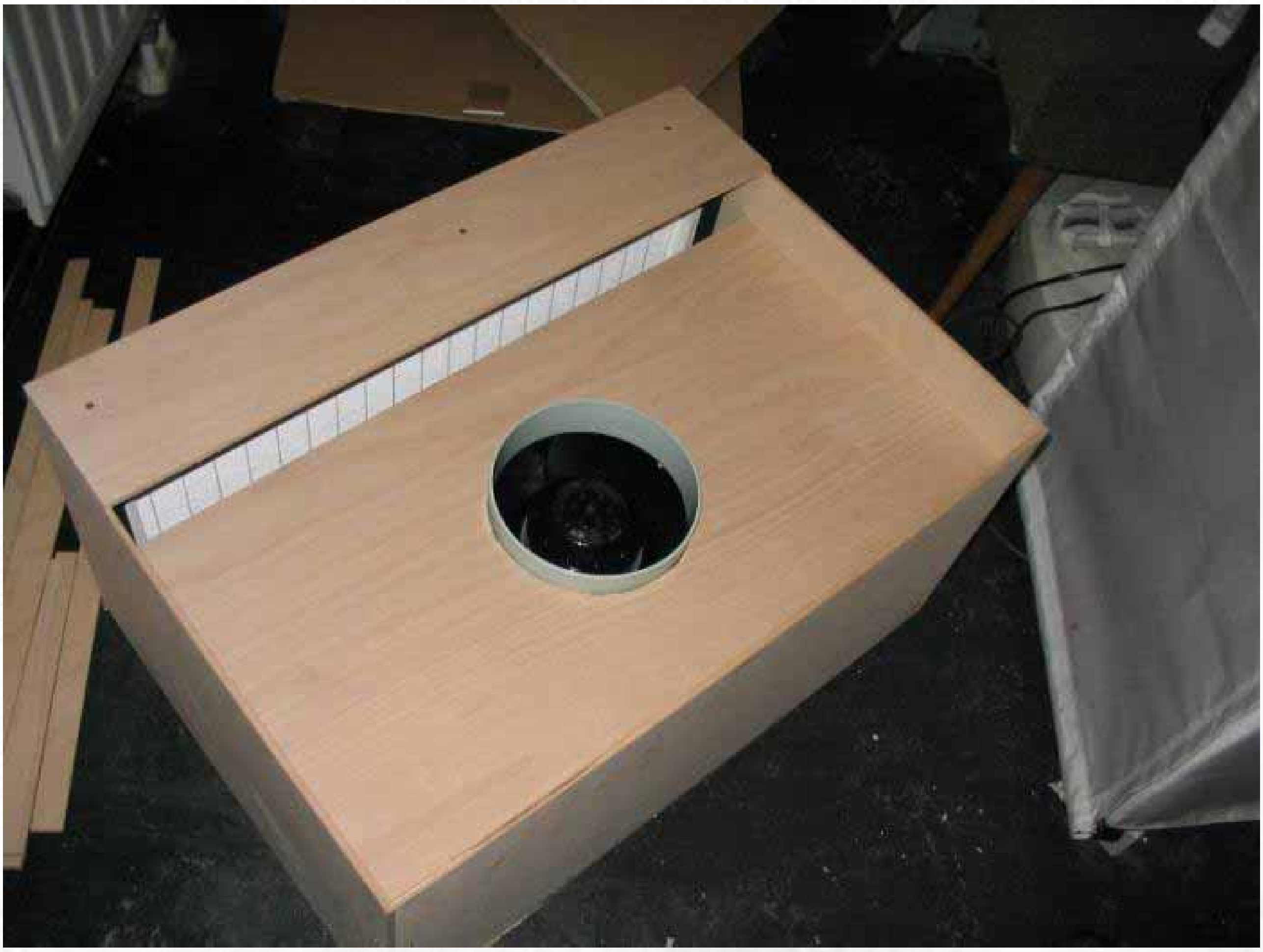




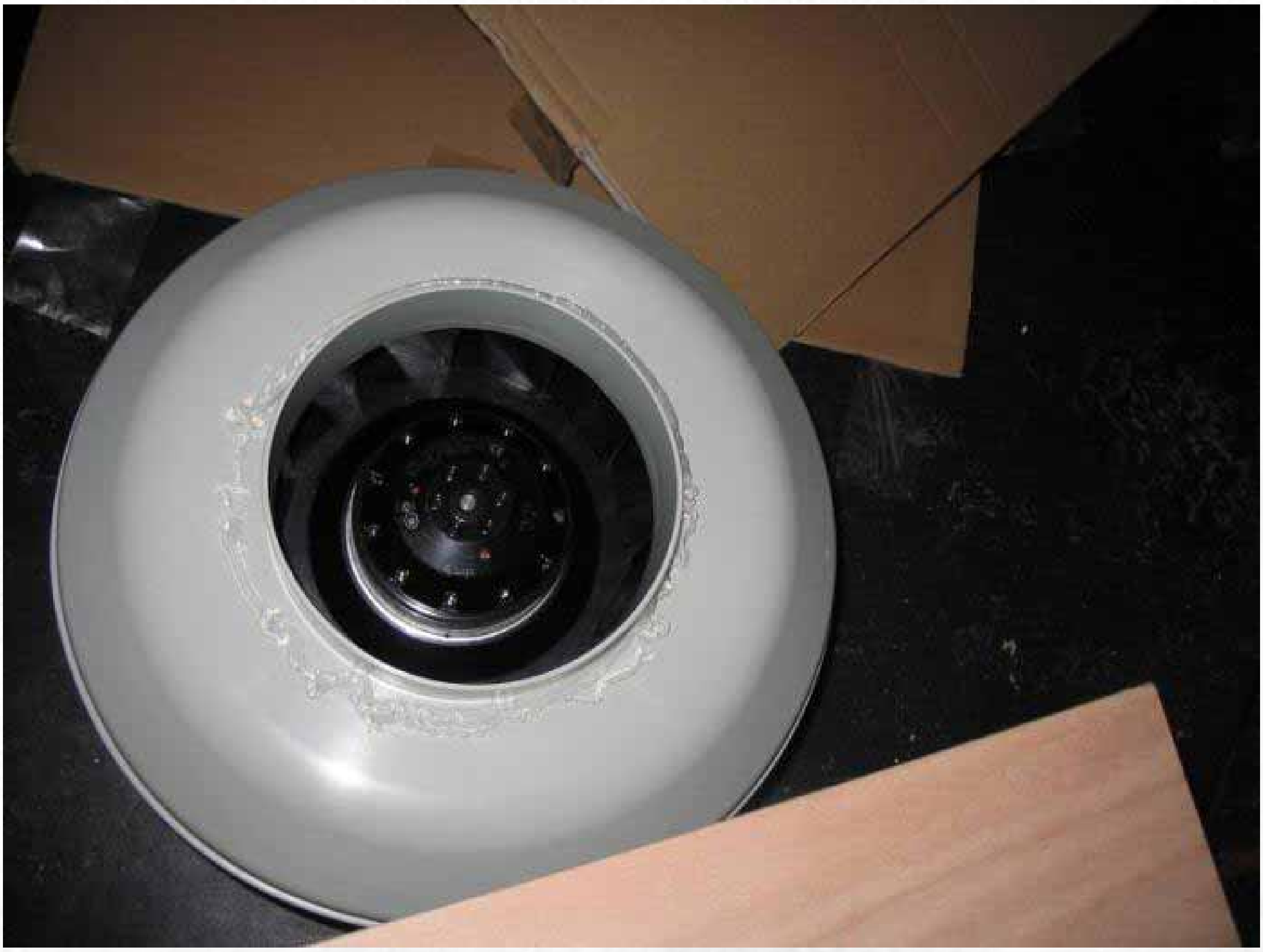


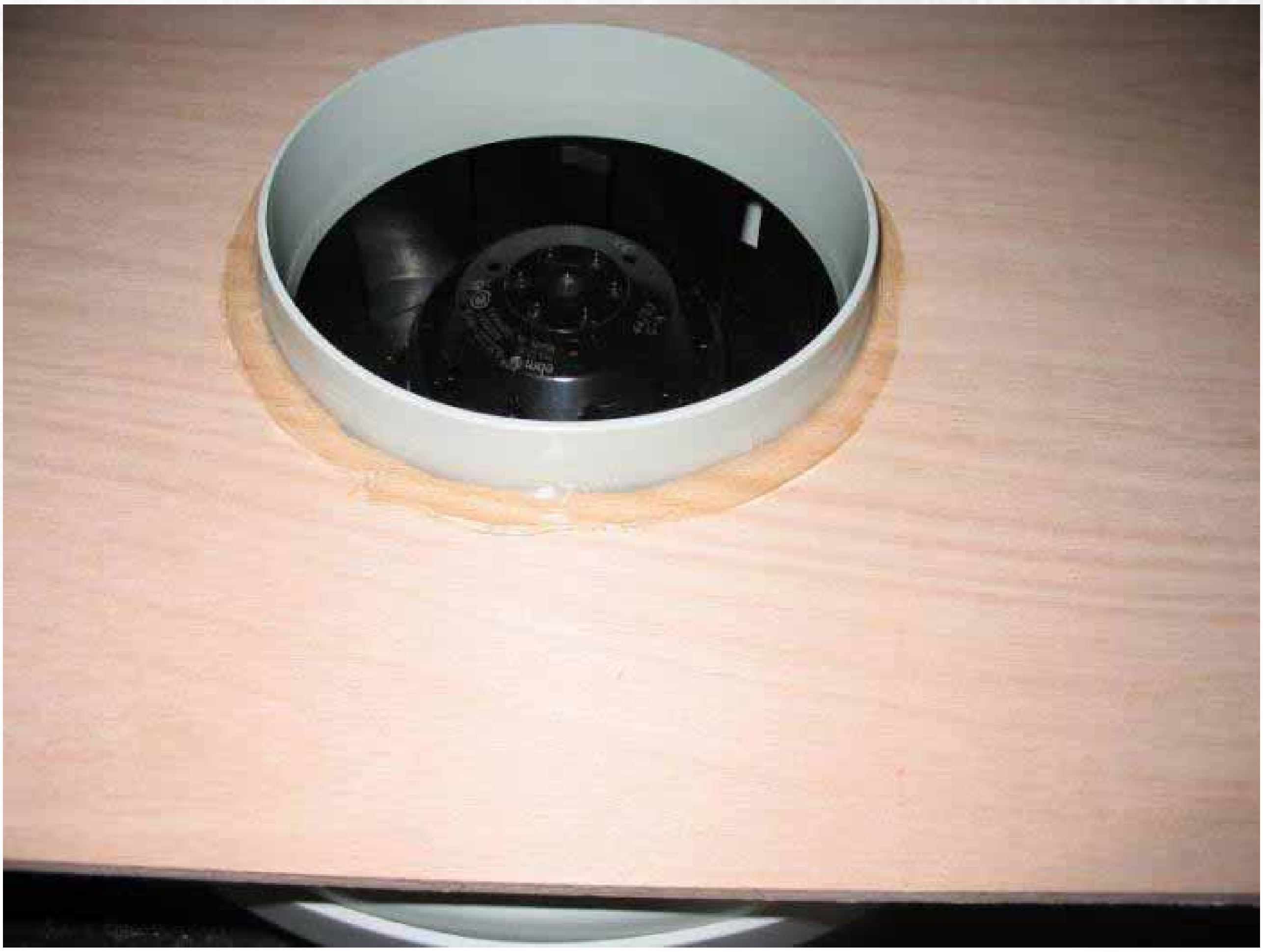

Systemair

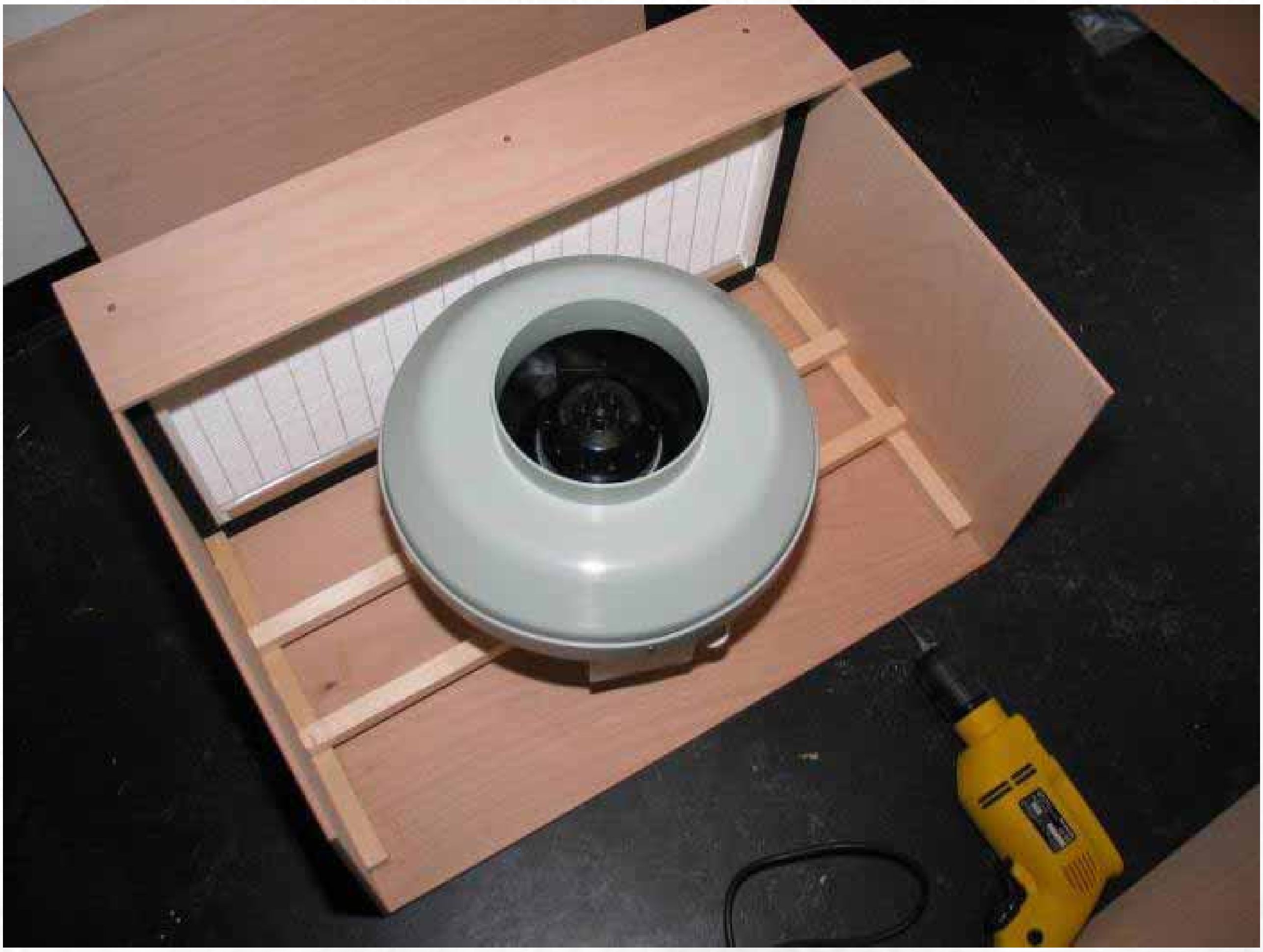


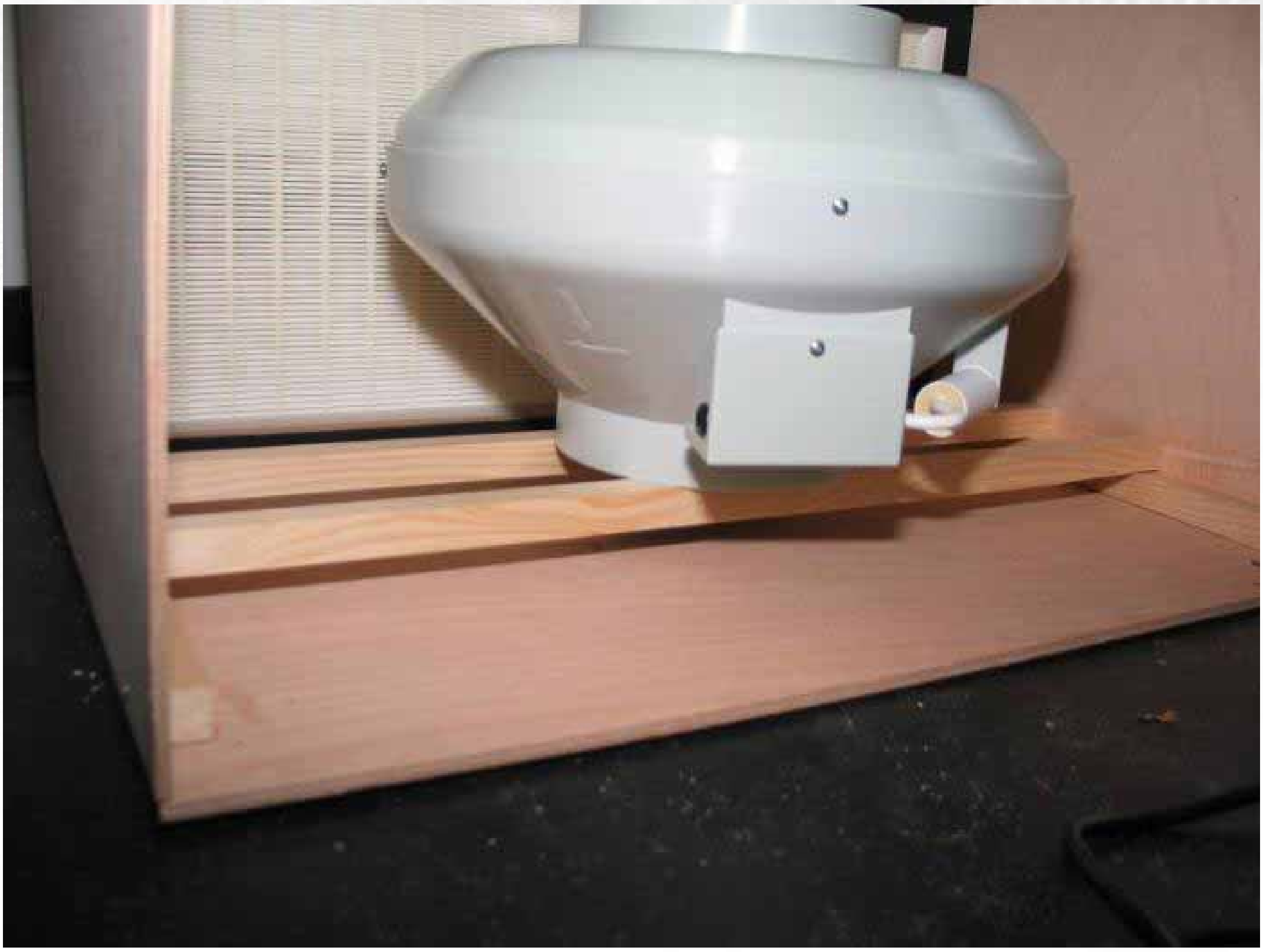


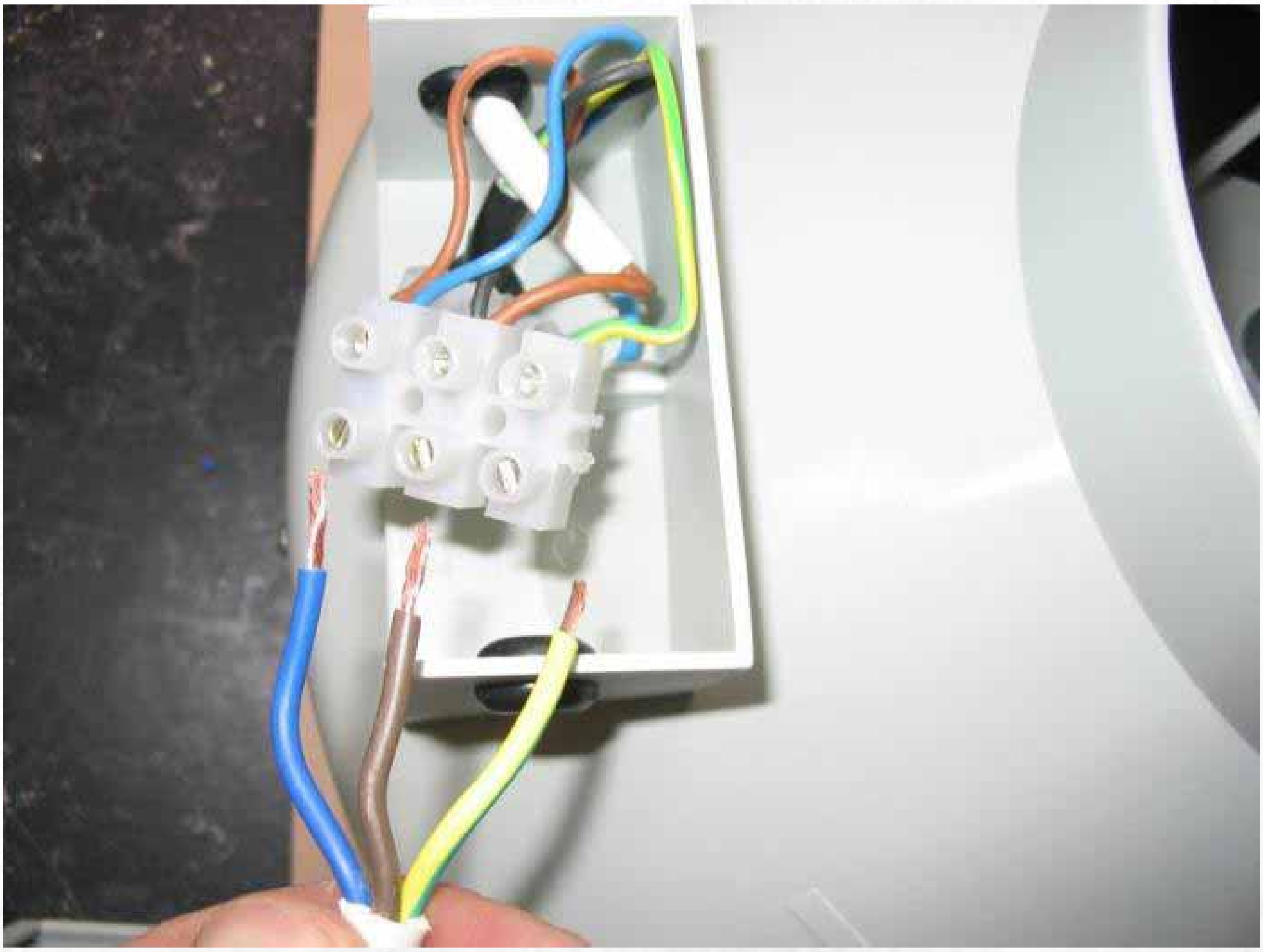
SILICONE-S

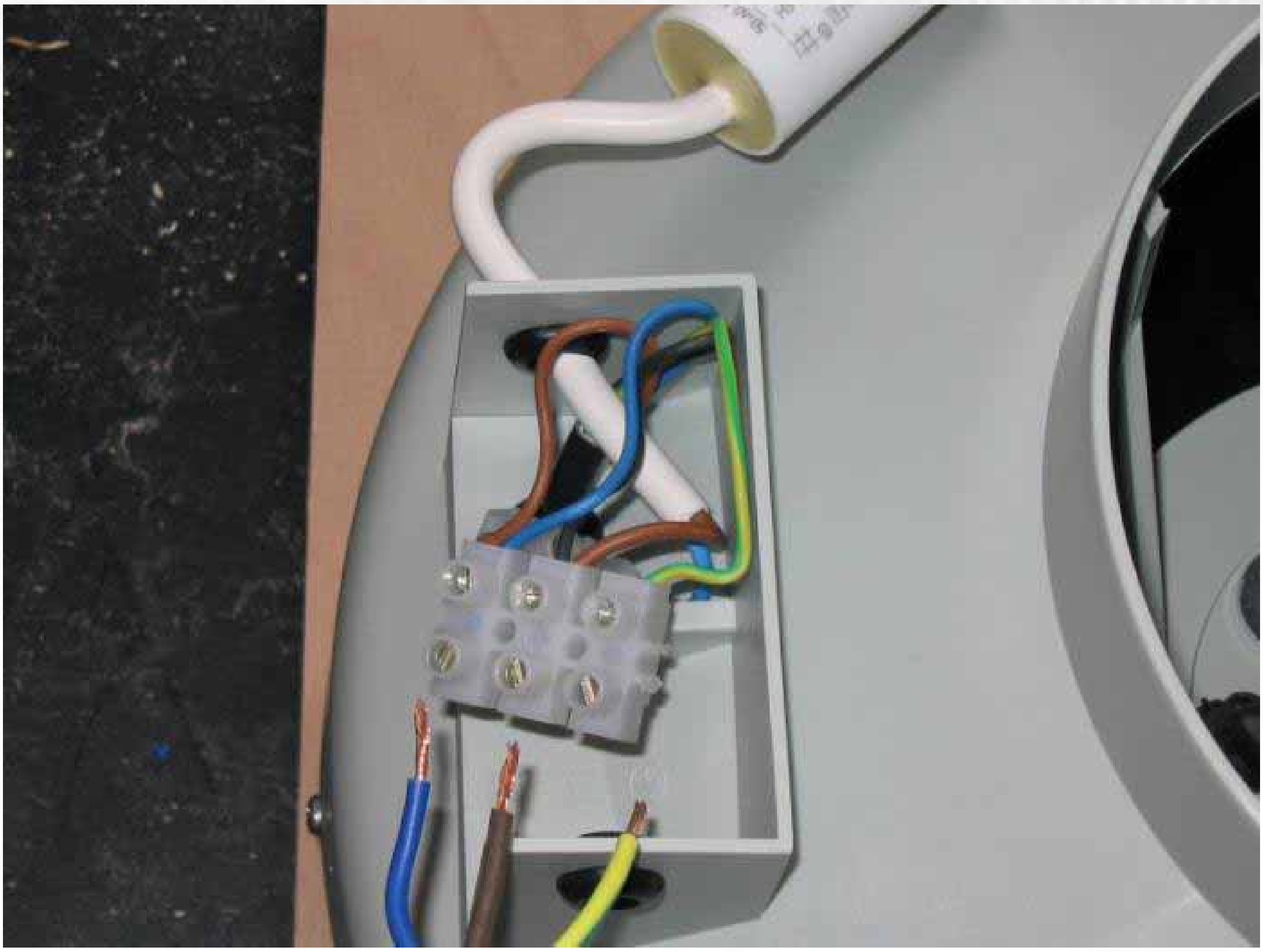


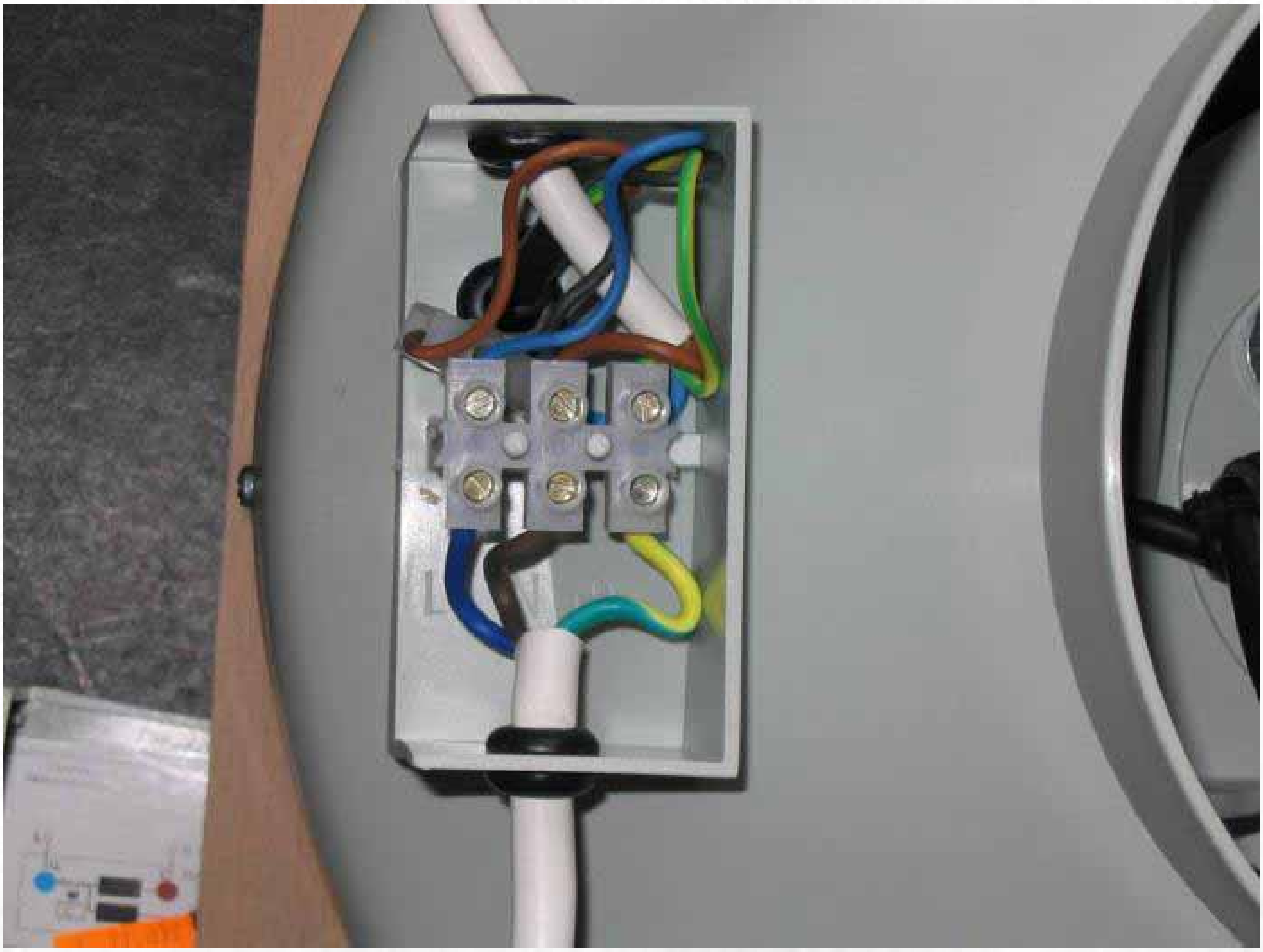


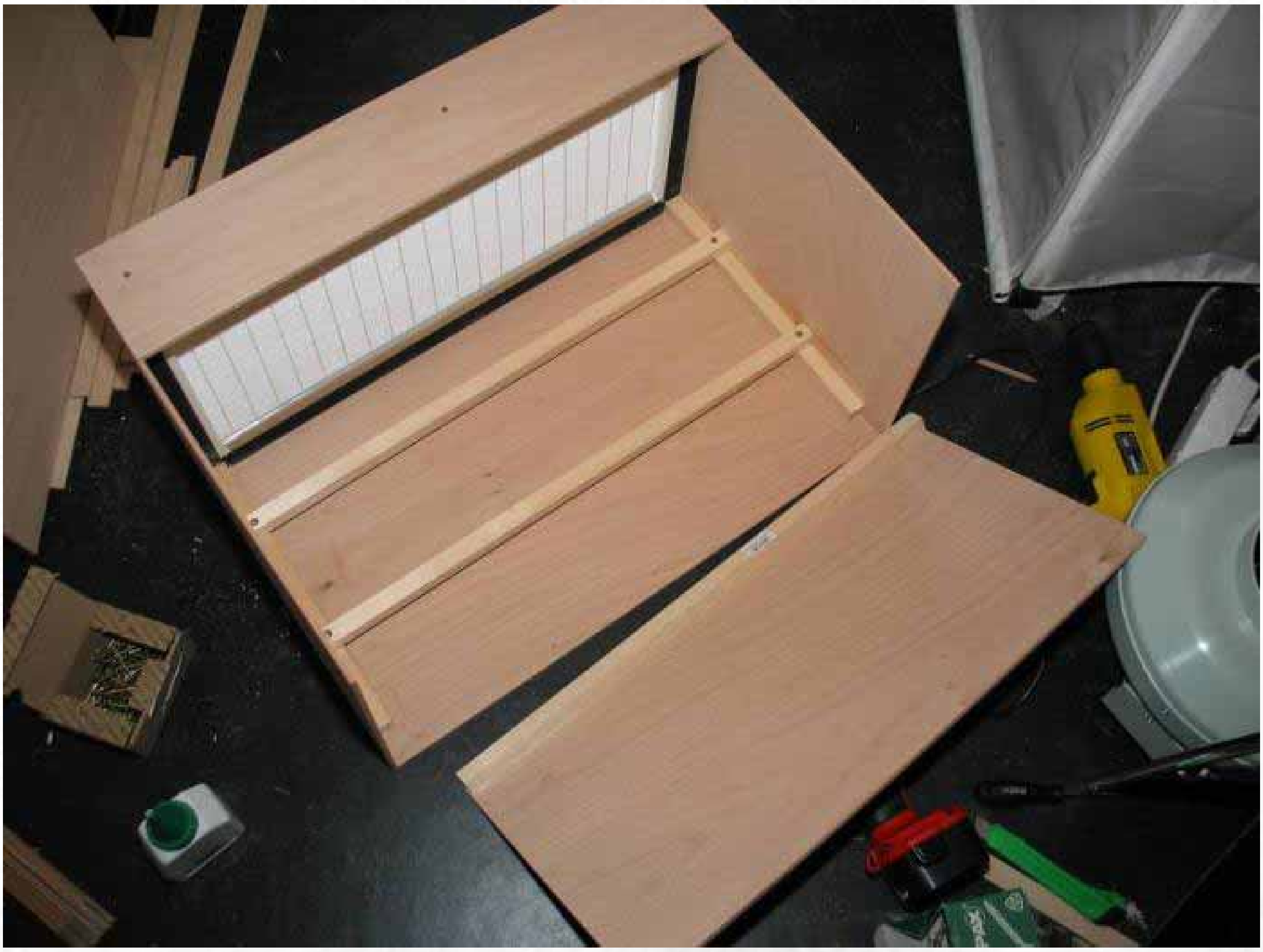


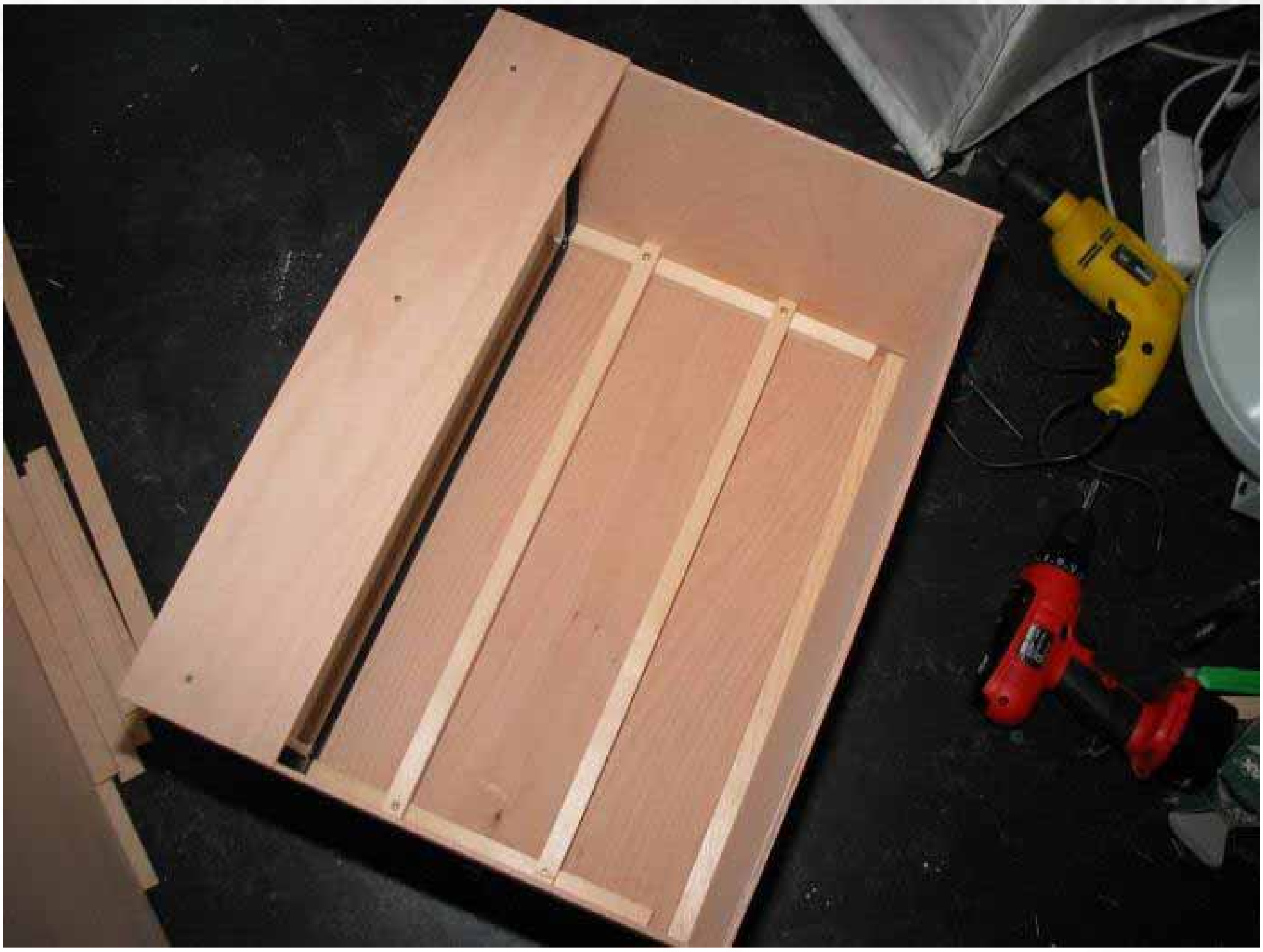


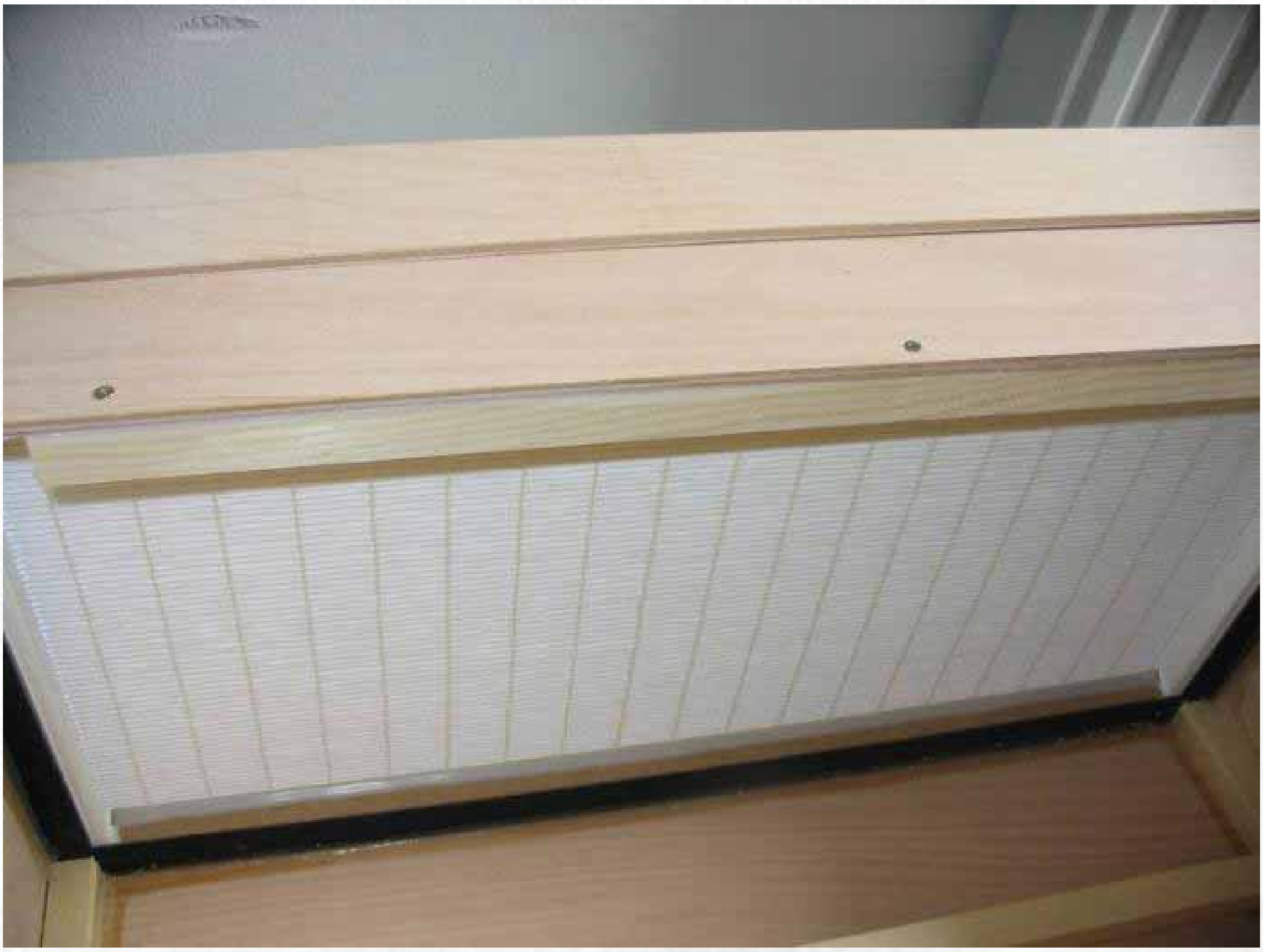


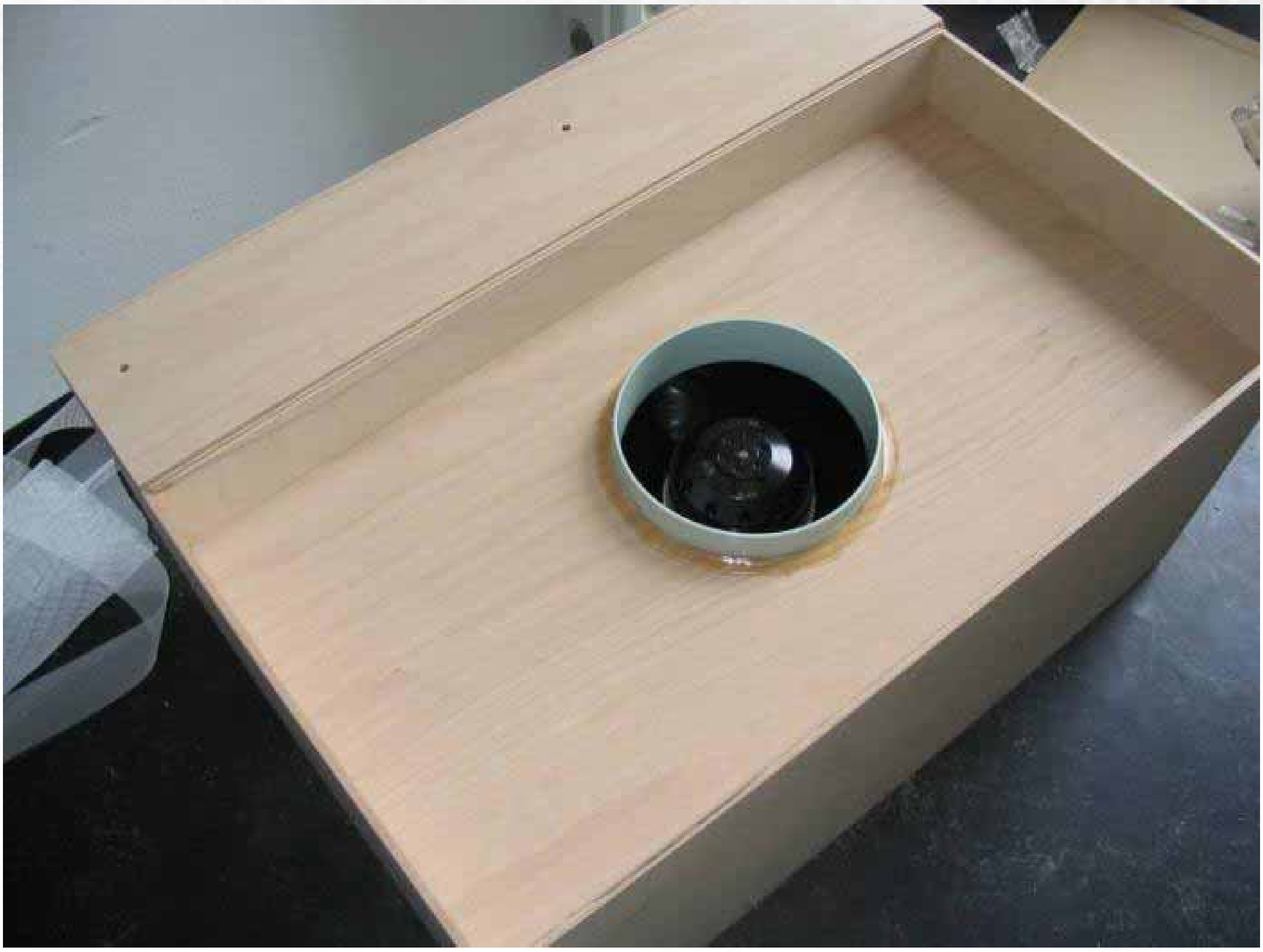


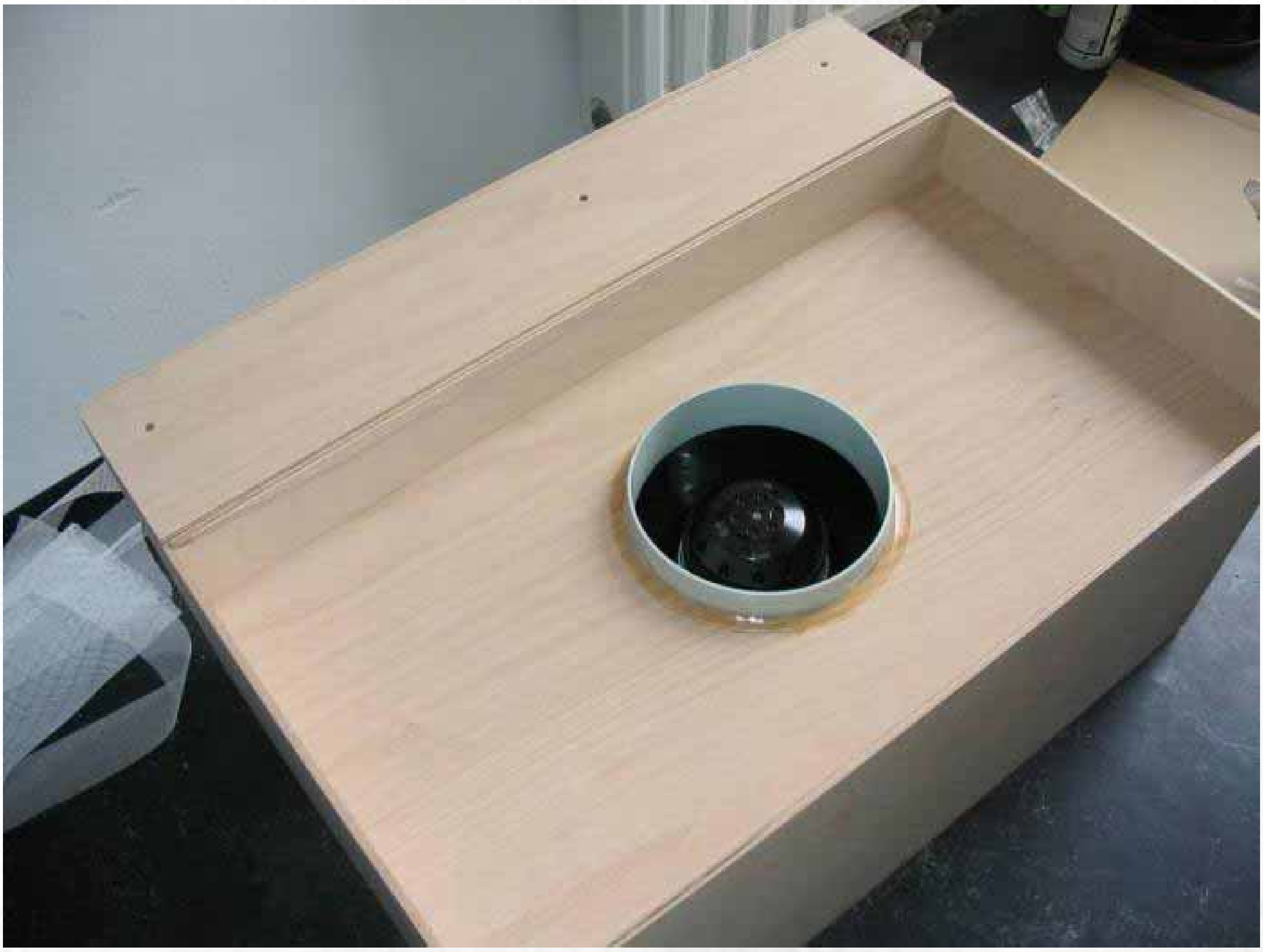


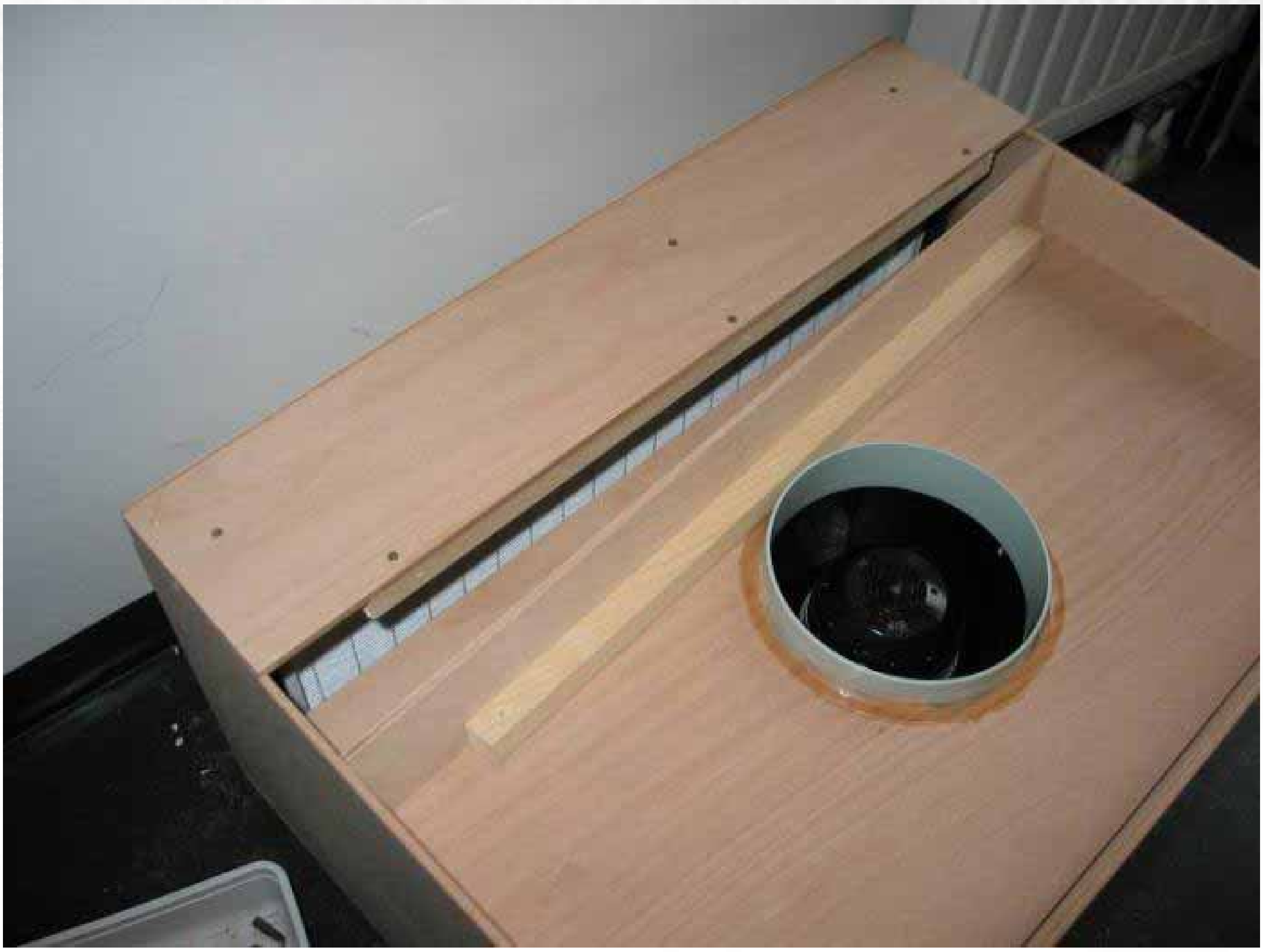


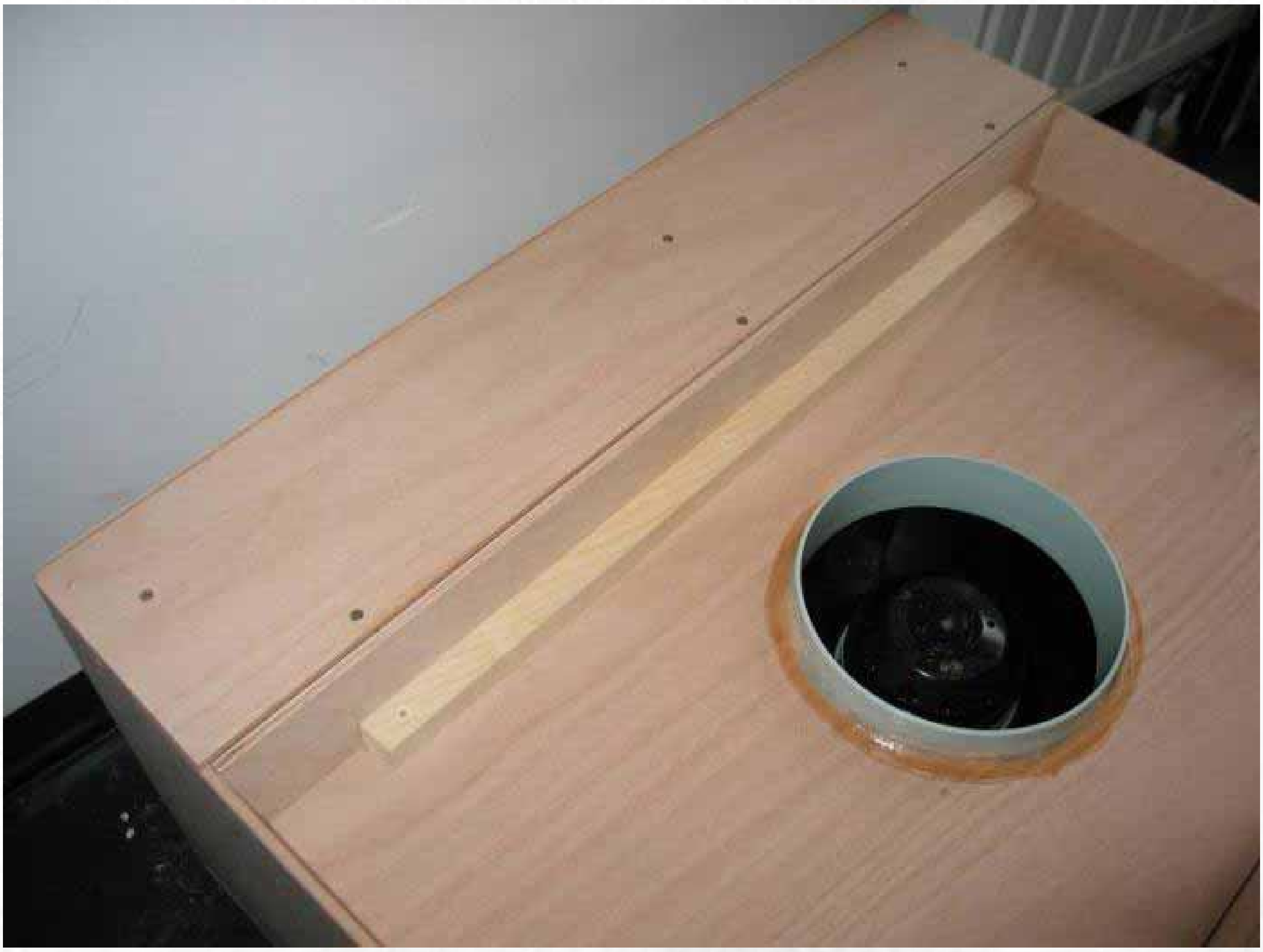


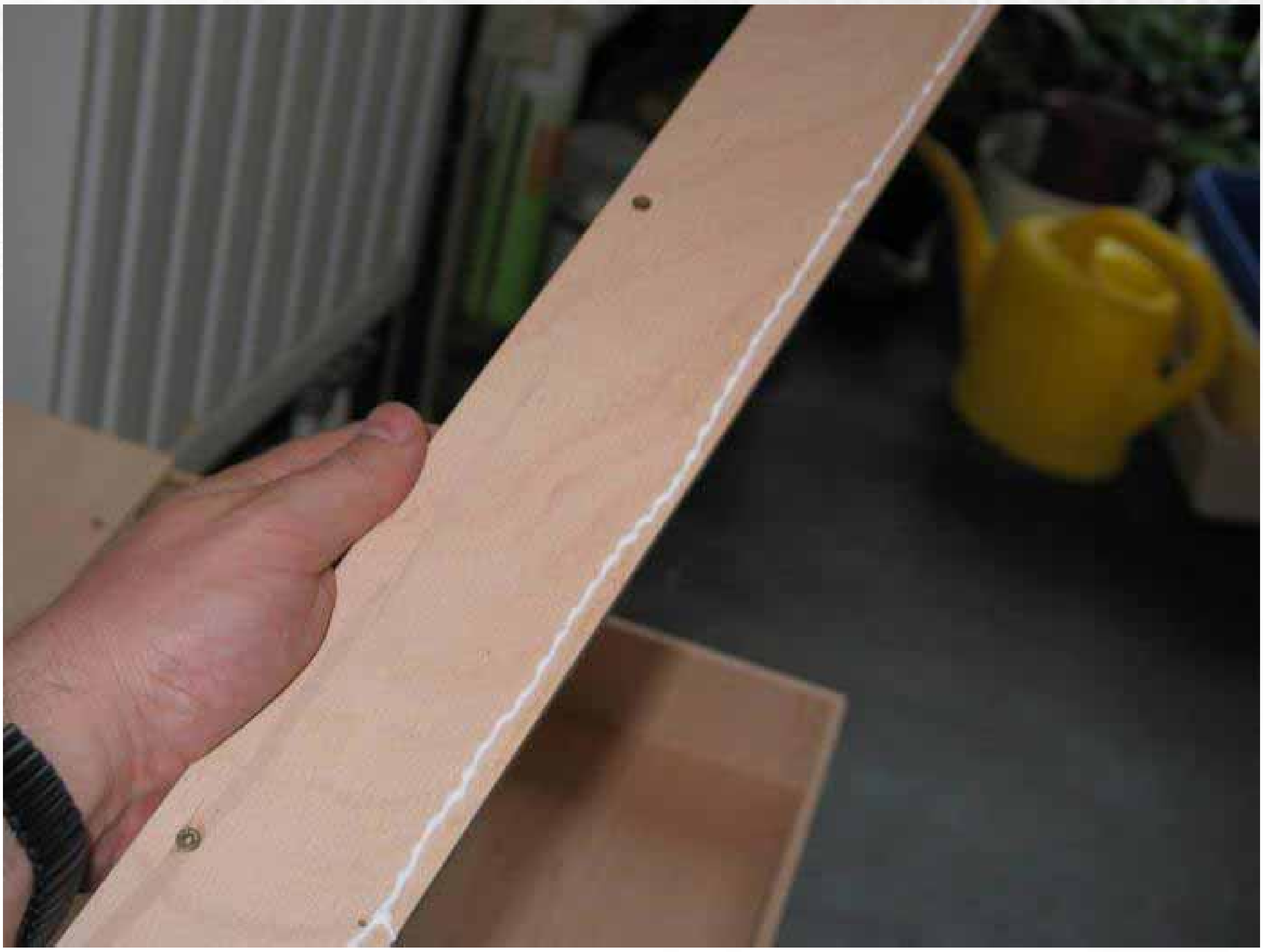


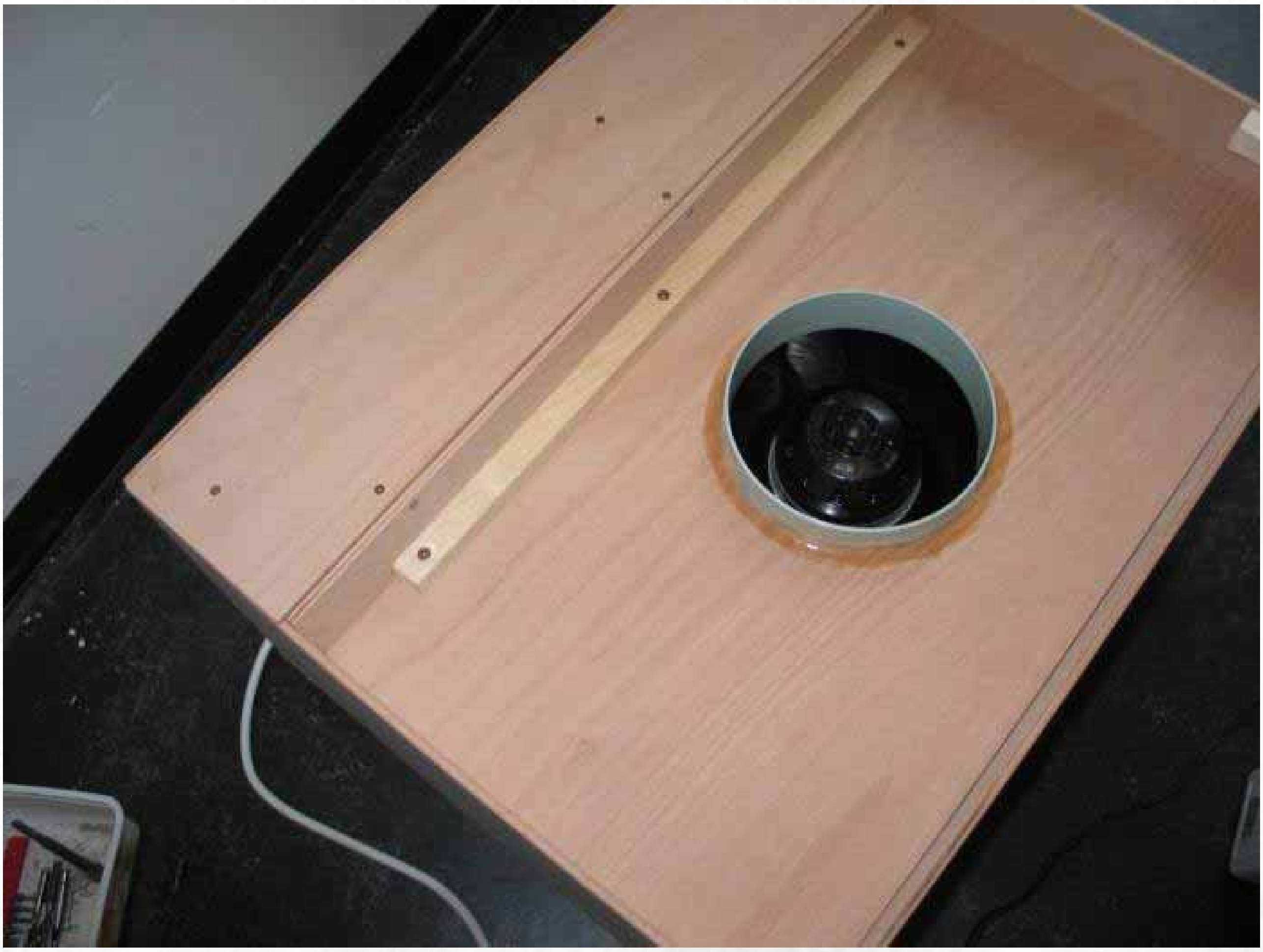


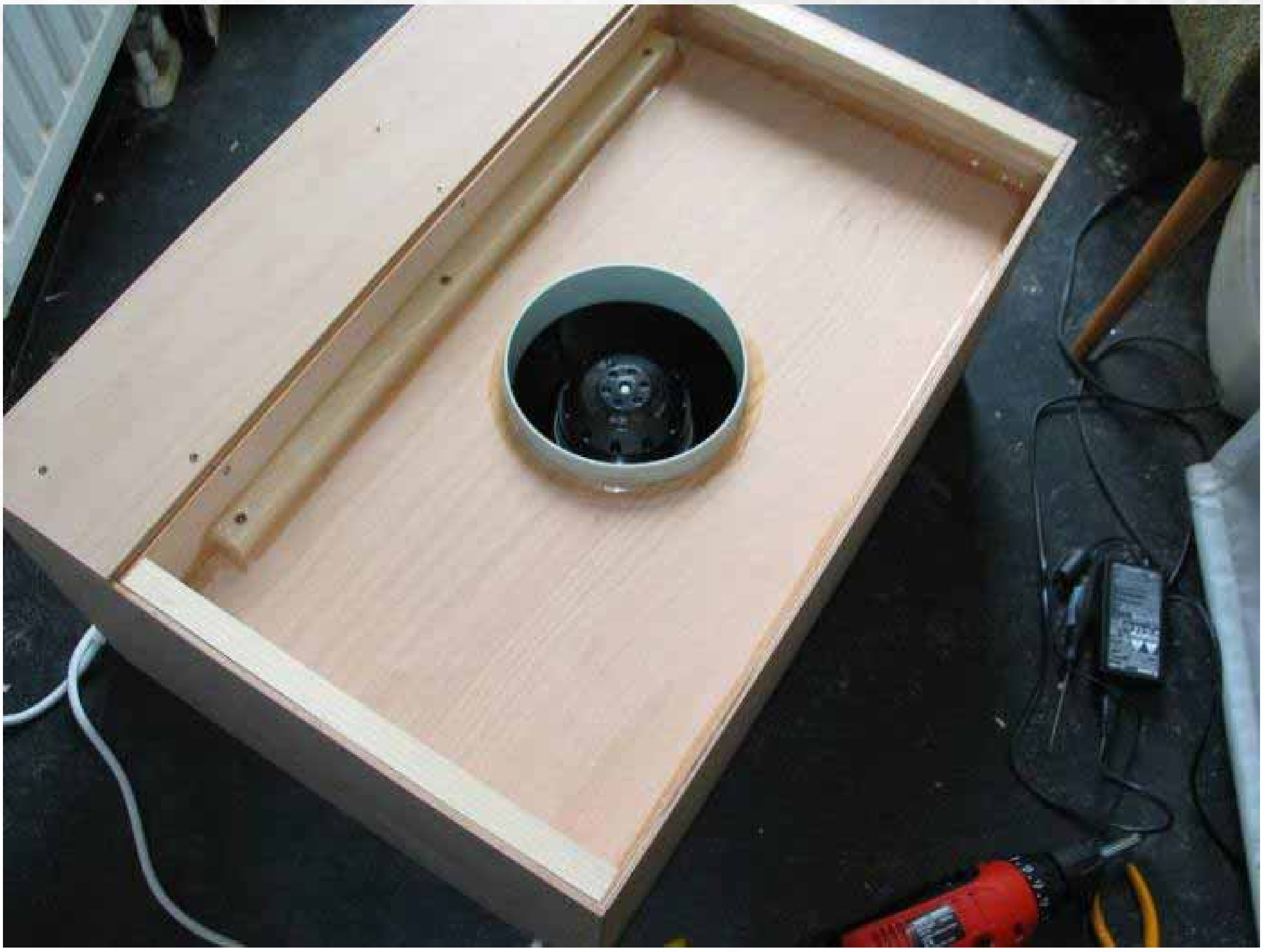


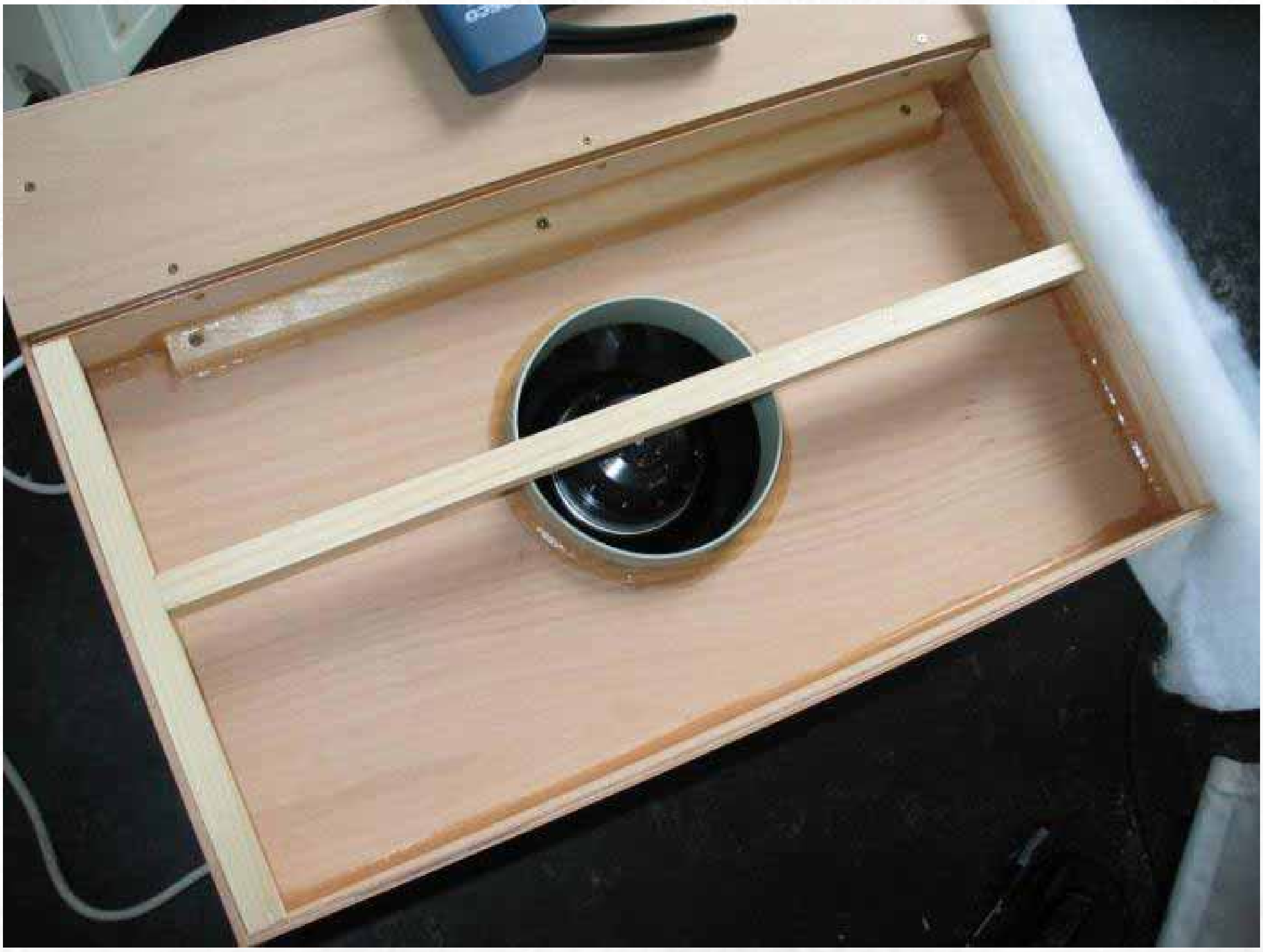


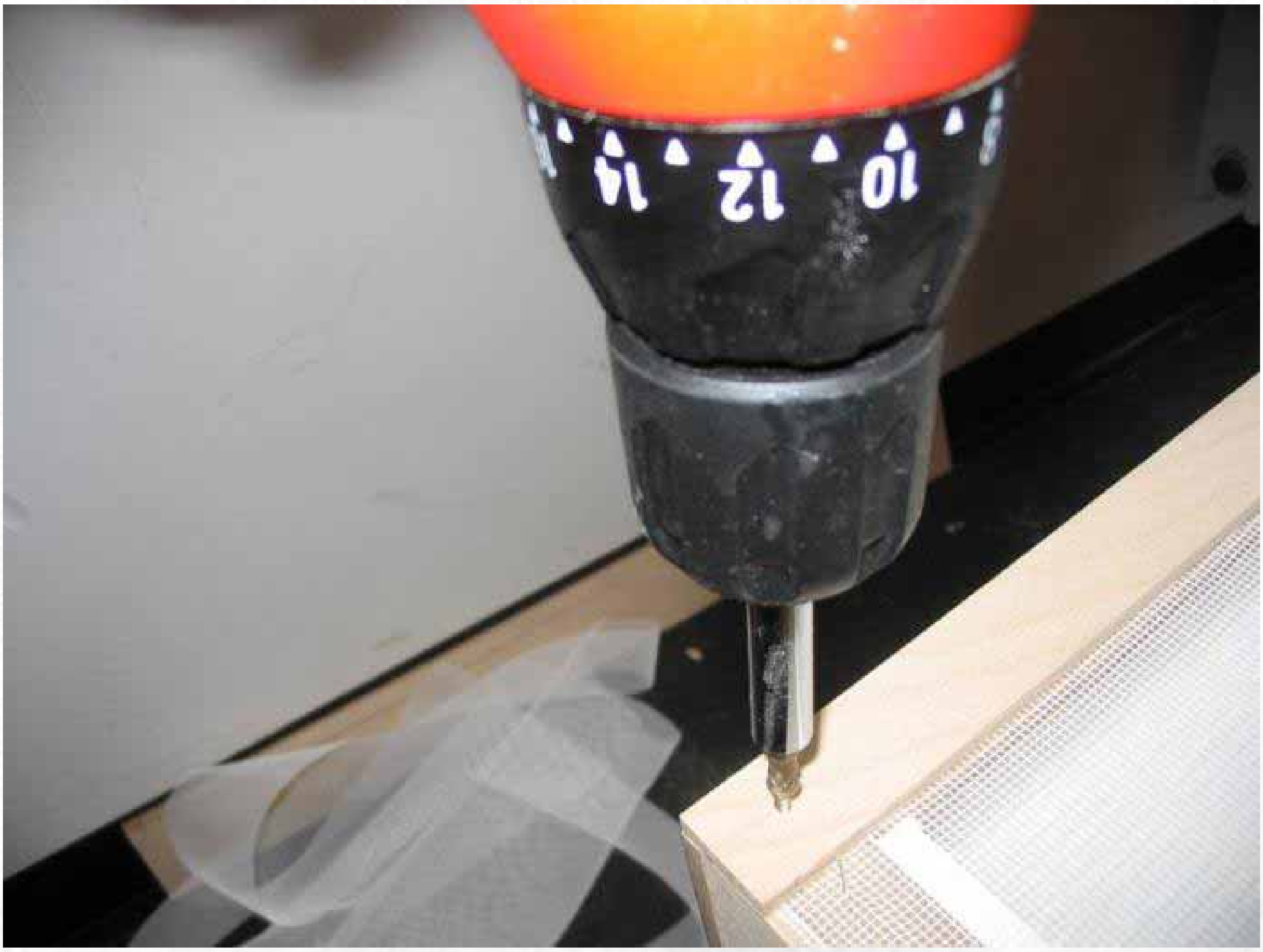


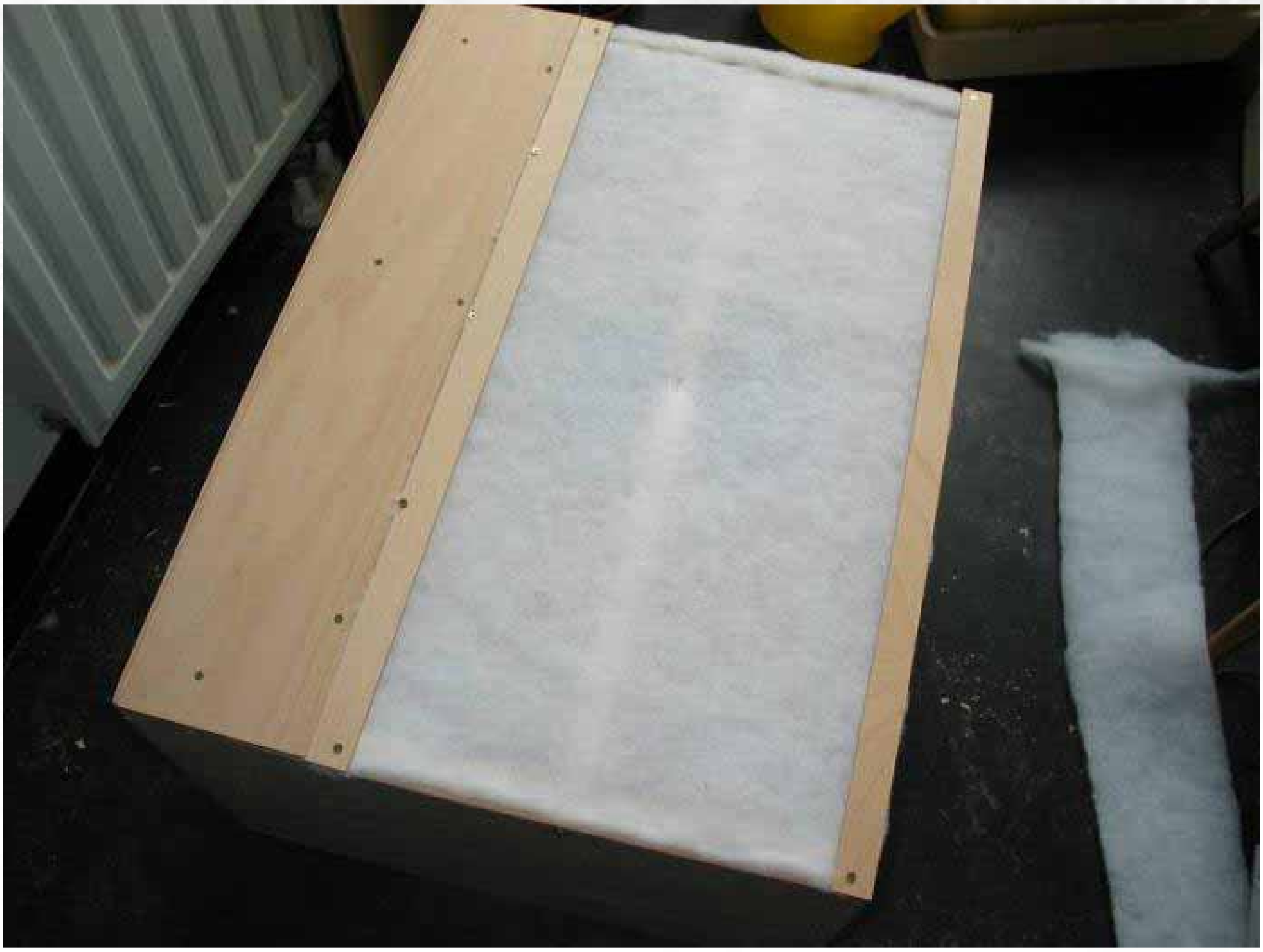




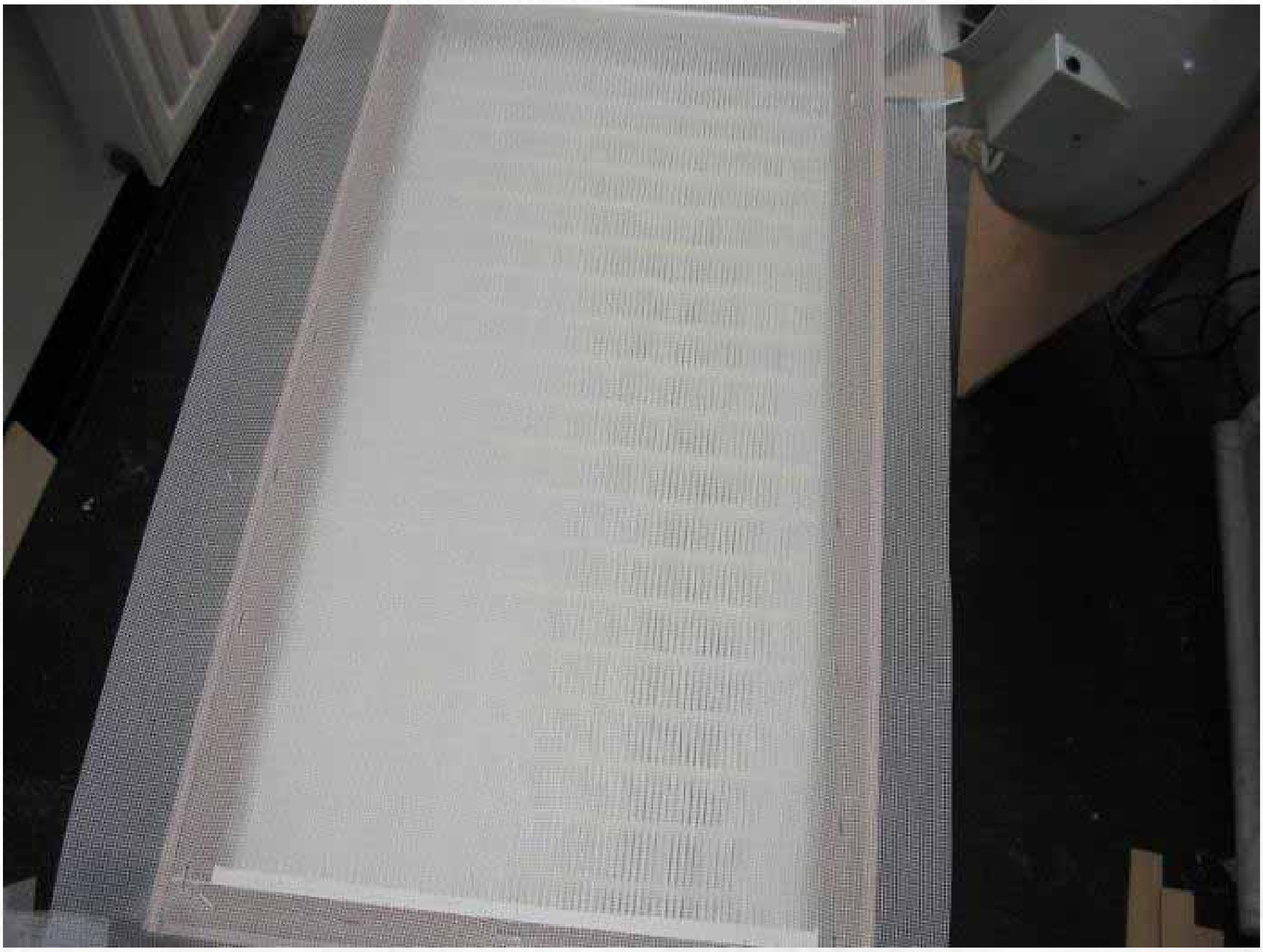


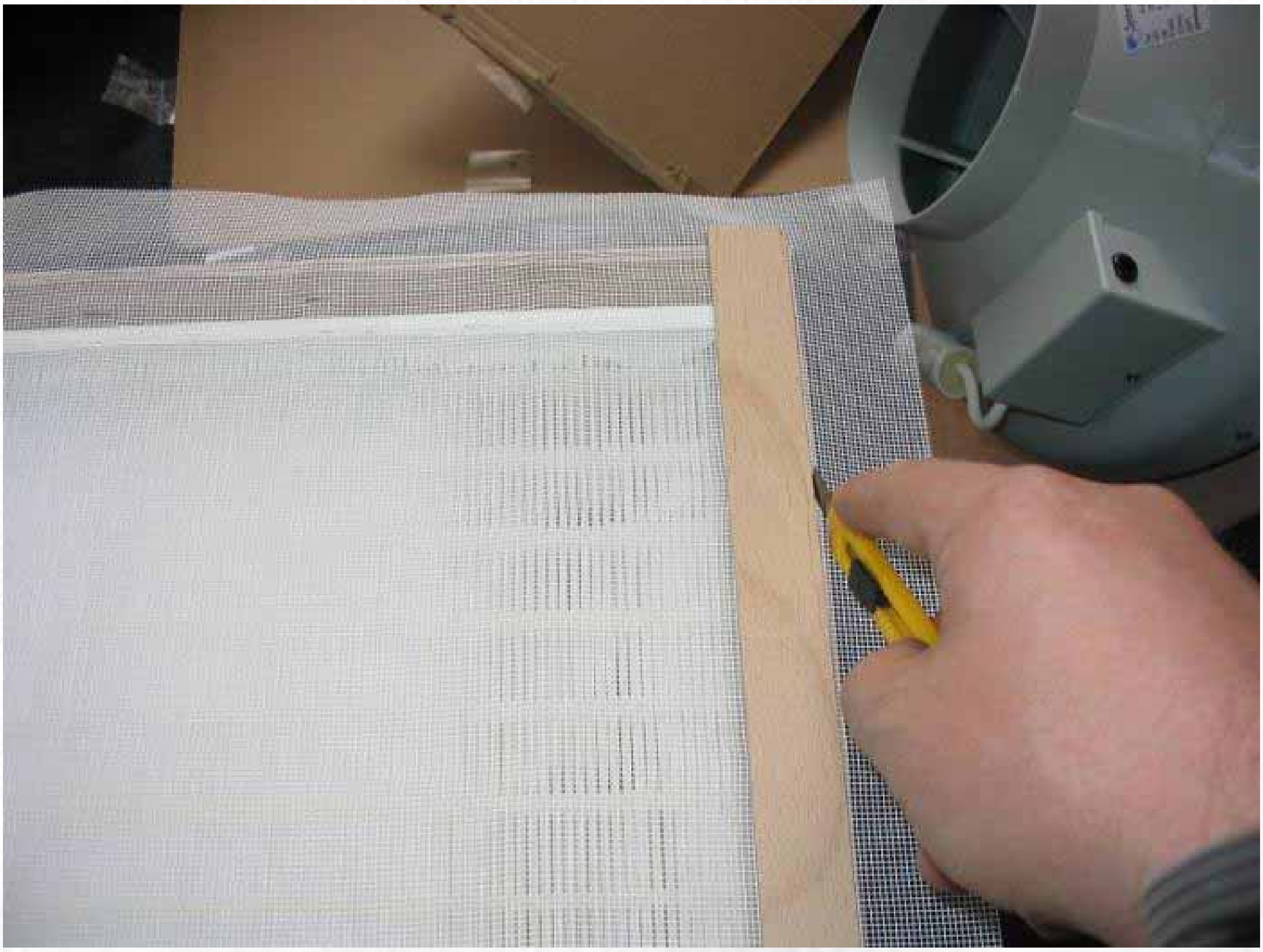


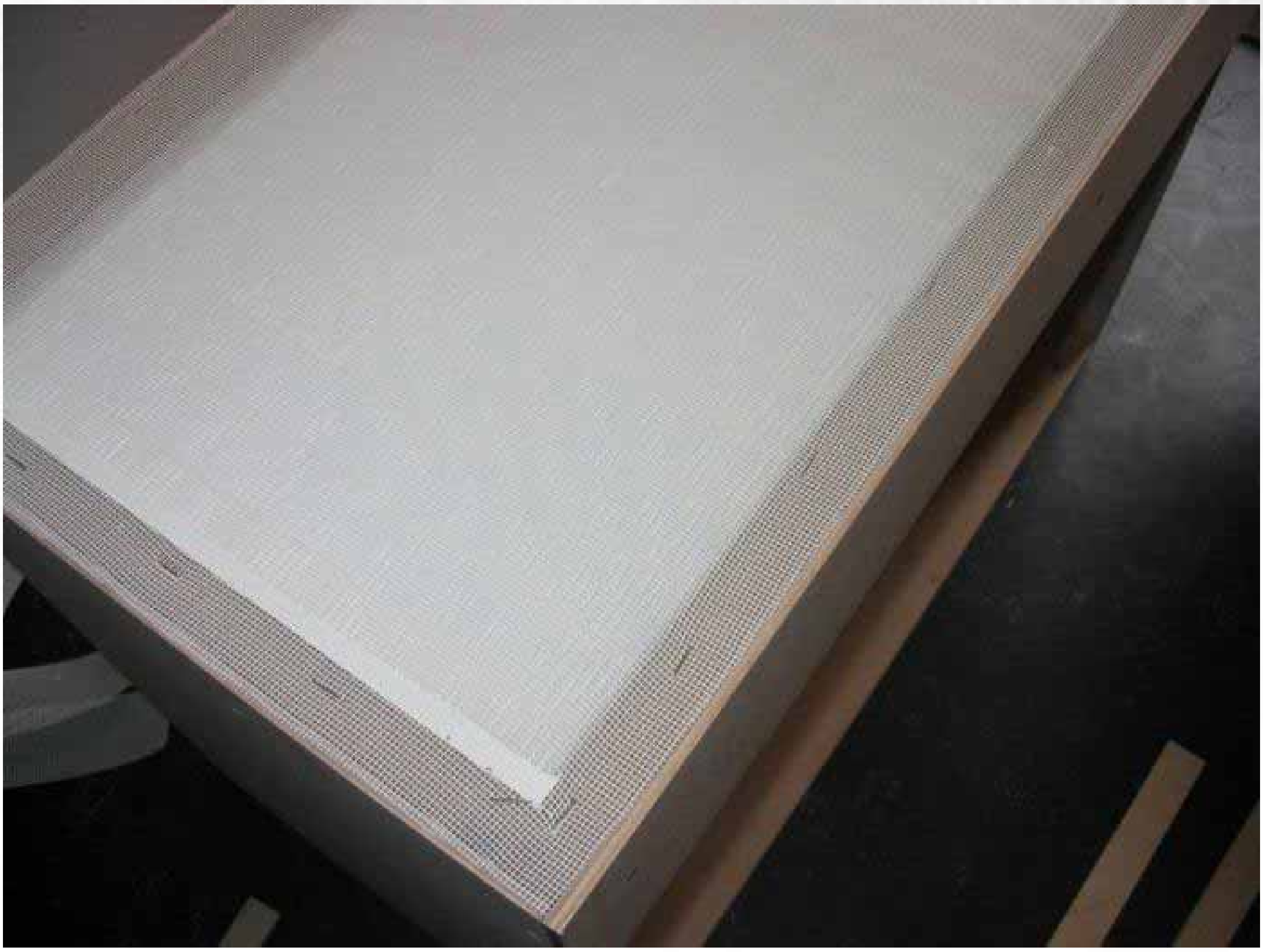

14
12
10

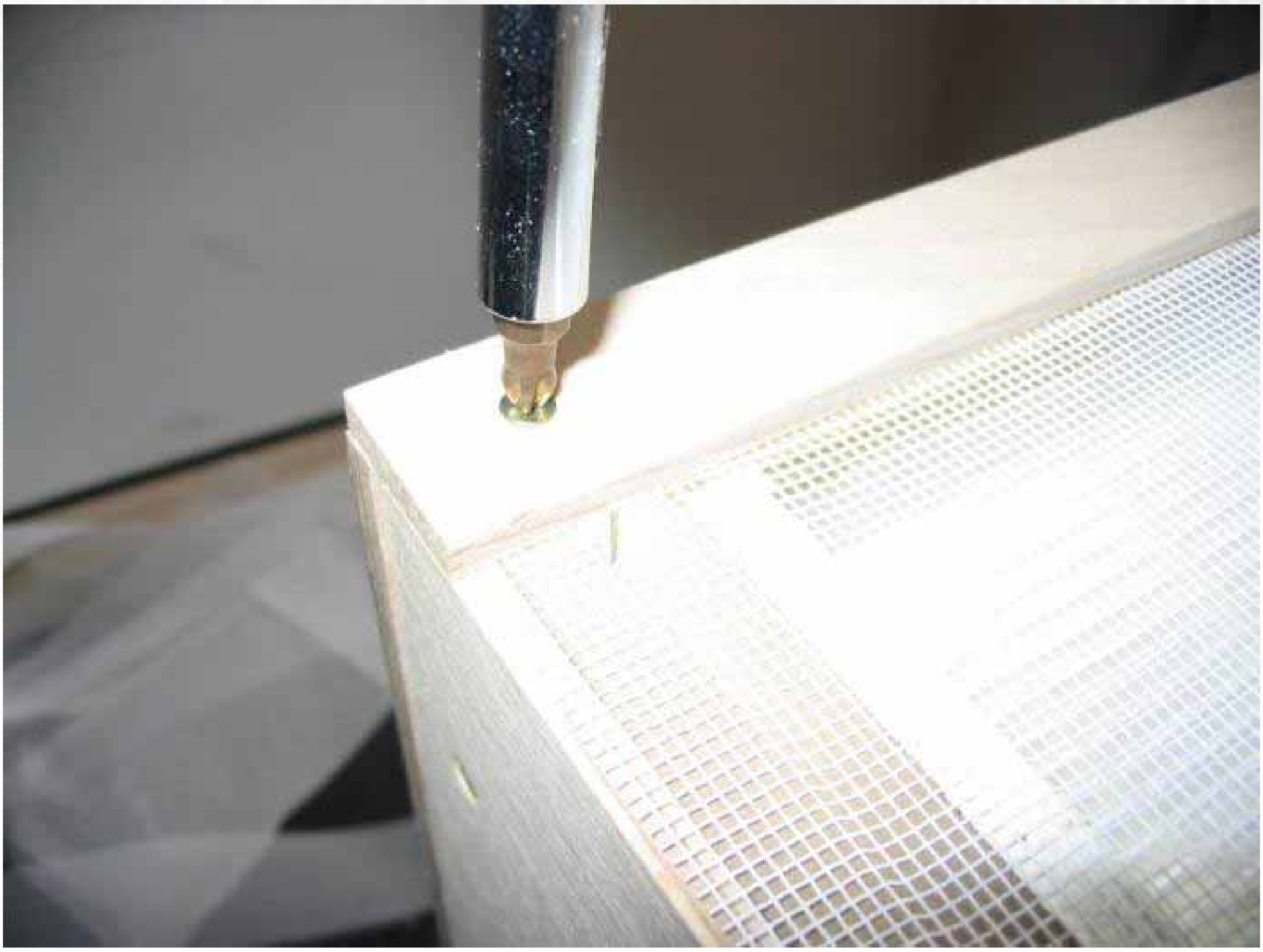


esco









HEPA Case for your Air Pump

by

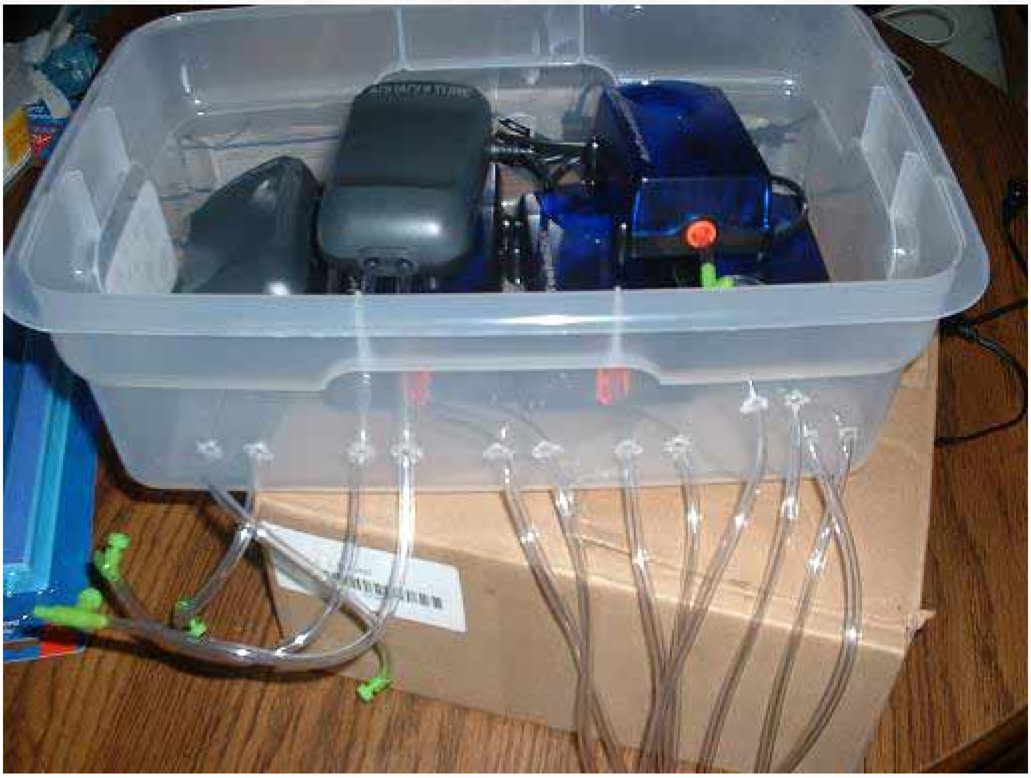
LiL_KuSsH

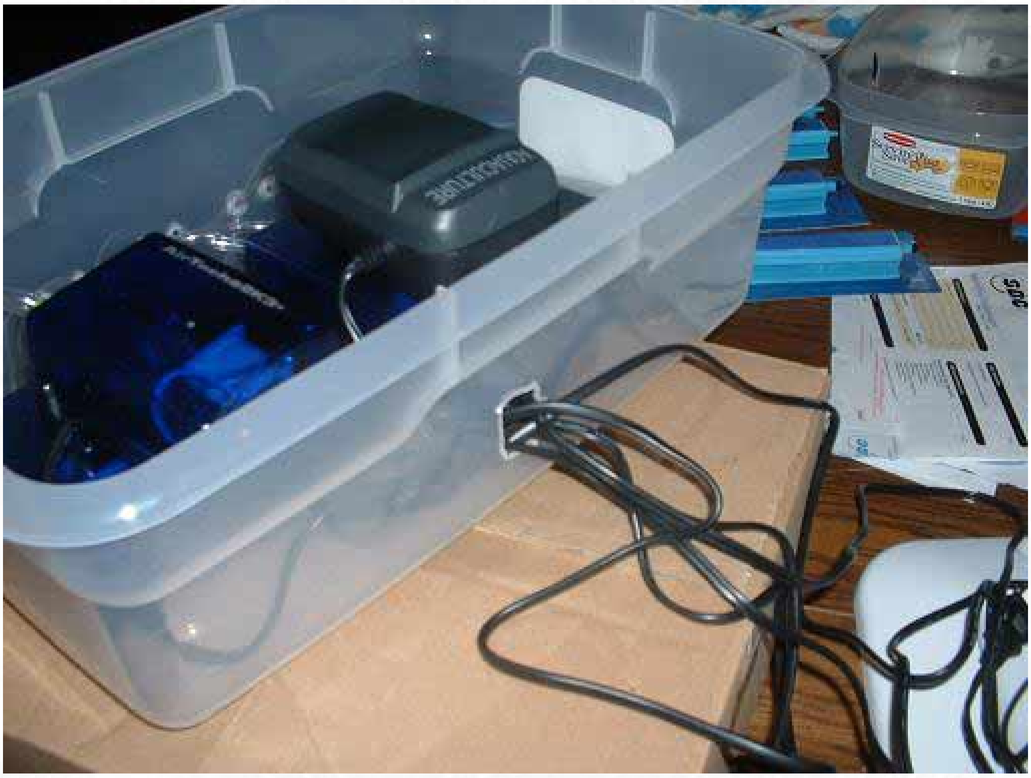
original source:
http://cdn.preterhuman.net/texts/drugs/shroomery_grow_archive_2003_10_14/shroomery_grow/www.shroomery.org/index/par/24205.htm

Materials Needed:

- A HEPA filter (any size, the bigger the better)
- A Tupperware container large enough to fit the pump(s) in Air line Hosing
- Pump (Or cool mist, just requires a larger container. Also I only suggest doing this for a cool mist if you are using it for air exchange and not having to add water to it.)
- A knife
- A heat source
- Silicon (I like duct tape HEHEHE)
- Lysol
- A screwdriver (phillips head large diameter)

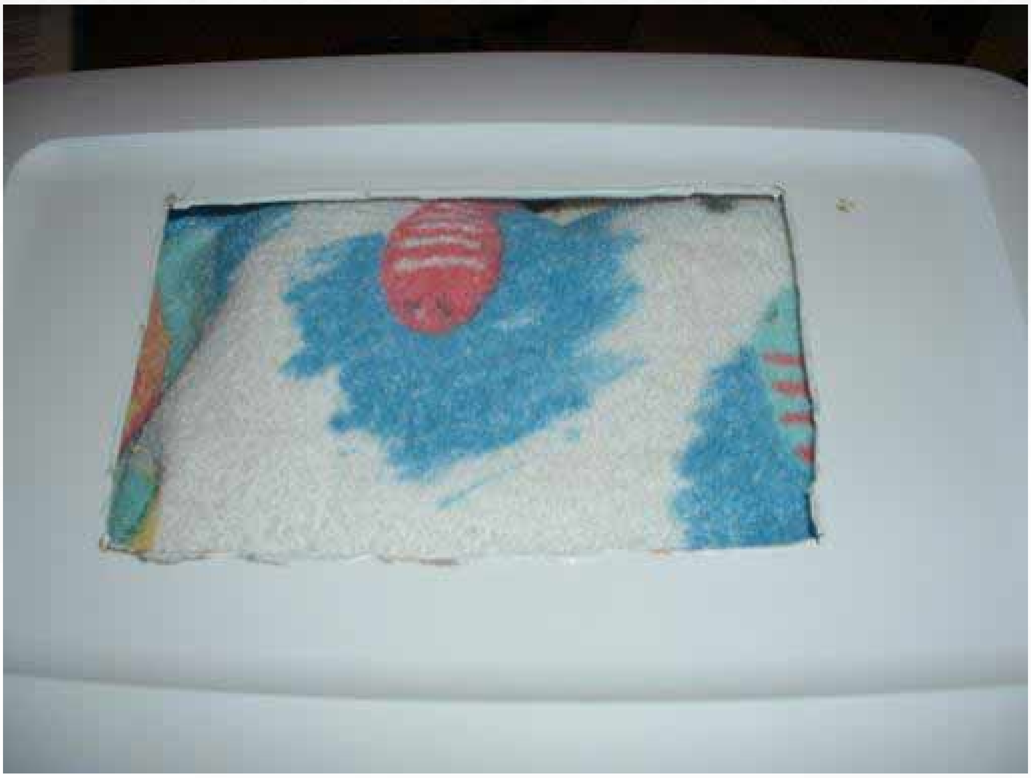
Turn your heat source on and heat the screwdriver till it's extremely hot. Then make two holes in the Tupperware container on the side. This is for the air lines to run through.
Next heat the butter knife till it's red hot. Then make a hole big enough to put the plug for the pump(s) through. Place the pump inside the Tupperware container and put the cord through the large hole. Now cut your desired length of tubing and feed it through the holes and connect it to the pump.
Should look like this :





Then take the knife and get it red hot again. (a utility knife can be substituted but its fun playing with fire). Taking you are knife cut a hole in the lid of the Tupperware container about 1/16th and inch smaller than the HEPA filter.

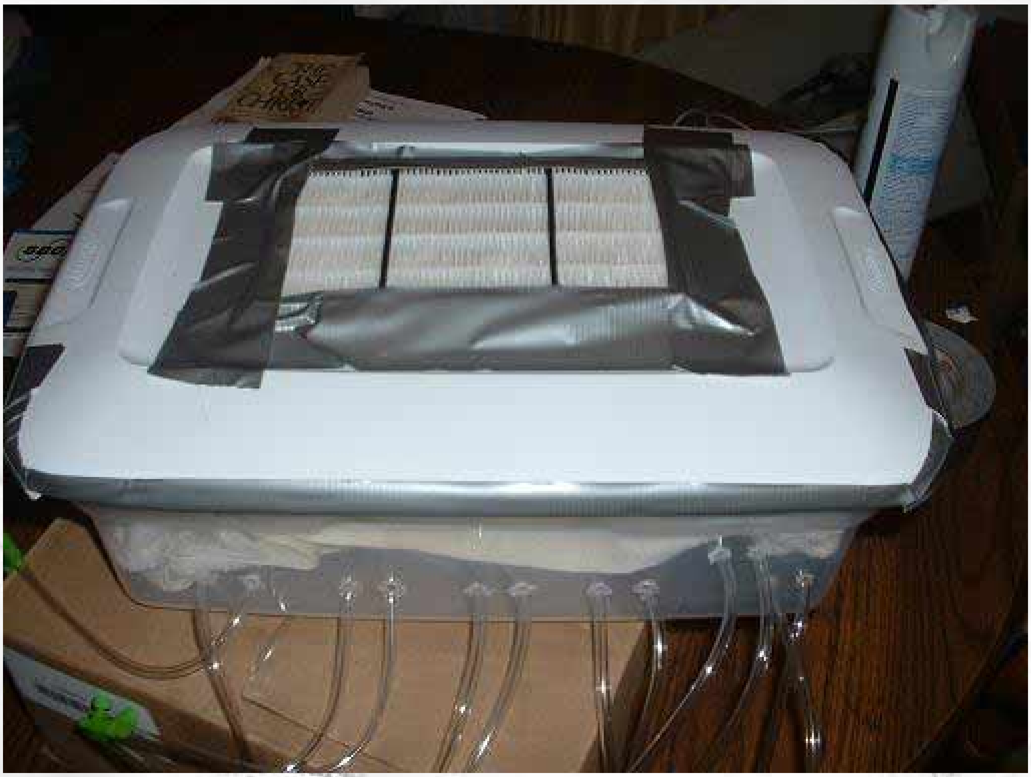
Should look like this...



Using the silicon seal the HEPA filter onto the top of the lid. Some HEPAs have certain sides intake and out put. Make sure the intake is facing up. ... then use your duct tape (I do this... doesn't mean you have to) and tape the sides of the HEPA to the lid.

Now silicon the holes closed that the hose is through. And silicon the hole with the plug through it closed nice and tight. Now place a towel inside the container and spray it down heavily with Lysol. Using the silicone run a bead around the edge of the container and place the lid on it. Now u have a sealed HEPA case. Let the silicon set in a ventilated area for 24 hours.

After its set run the unit for 12~24 hours to make sure the silicon vapors are completely out. BAM! Hepa Casing!



Have Fun and Be Safe!

Double Tub Pictorial

by

Carlito

original source: http://www.shroomery.org/9107/Double-Tub-Pictorial

Foreword:
I would like to first say that this tek is not mine. I am taking the time to document this for the benefit of our fellow members. Credit must be given to those that have pioneered this technique. Primary credit goes to Eatualive who had the courage to try this and bring it to light. There are others out there who have used this tek, Iamthewalrus, Mushroommark, many others and me of course.

Okay let's get started.

This tek will be written as a 'How to' manual. I will attempt to cover every facet of the growth and make references to those people who have coinciding information to aid in the final product.

First Things First:
The first phase in any tek is the planning. When using the Double Tub tek you must plan ahead. Failure to plan properly will result in wasted material. When assessing the needs of your grow there are a few key measures that must be taken into account before you do anything. These are:
1. The amount of colonized substrate you will use.
2. The amount of substrate after the spawn is mixed.
3. Having enough substrate to fill the area needed.
4. Leaving room for the casing layer.

Failure to address these key measures may result in too much spawn, too little, lack of height for CO2 expulsion, and finally no room for your casing layer.

Preparation does not have to be exact, but must account for the medium in which you are going to be growing in, in this case Double Tubs. For the purpose of this tek I will be referring to horse manure and WBS as the spawn mediums.

There are a couple of things to keep in mind. Do not to get wrapped up in exact specifications. This is not an exact science and a little imagination can go a long way.

There is no exact formula for mixing spawn. The difference between 2 quarts of WBS and 5 when spawning is time. The Double Tubs will keep the spawn contained in a contaminate free environment, as long as you keep the conditions reasonably clean. Allowing time to properly clean and sterilize all surfaces will go a long way and may mean the difference between 1 flush and 5.

Okay, now that we have those key points out of the way, let's move on.

Tools List:
The following are recommended tools for this tek, but are not required:
1. Drill (cordless or corded)
2. Hole-saw 1-1 1/2 inch
3. Tape measure

If you do not posses these tools, its okay, you can make your holes with a knife.

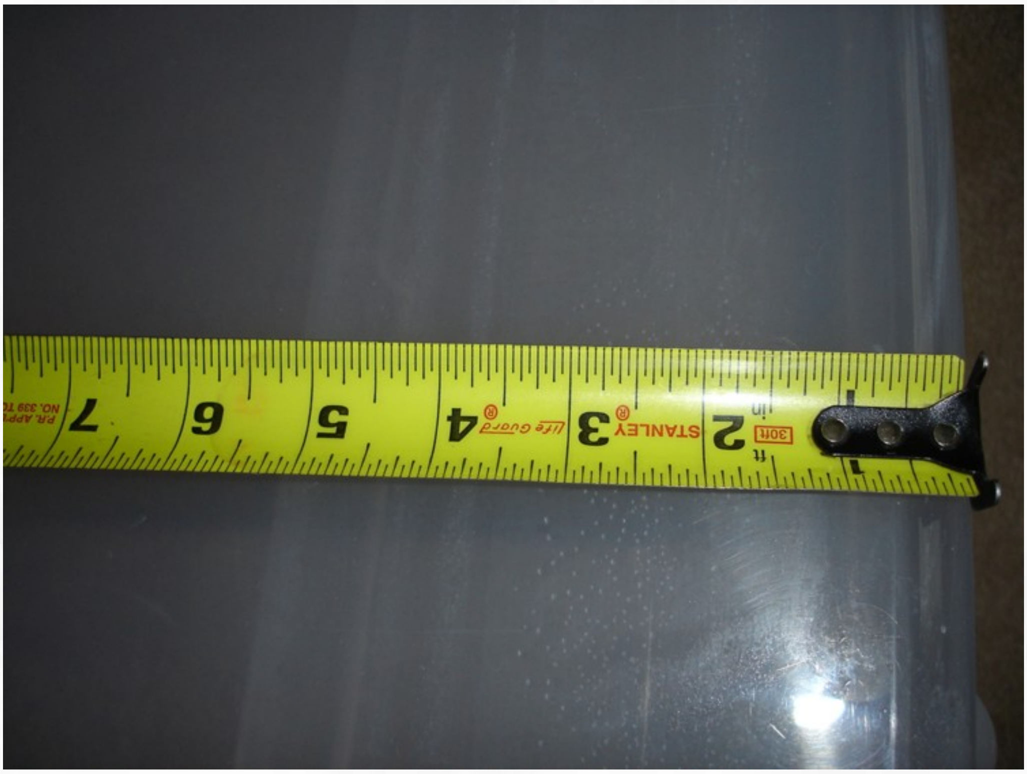
Materials List:
1. Sterlite or Rubbermaid tubs (19 qt minimum to 64 qt maximum) Qty. 2
2. Poly-fill 20 oz. Qty. 1 bag
3. Duct tape Qty. 1 roll
4. Black trash bags 30 gallon Qty. 2 bags
5. Alcohol Qty. 1 bottle

Now that we have our materials and tools in hand, it's time to start planning our hole placement. A total of 8 holes will be drilled for these containers (4 holes per container). 2 holes will be drilled approximately 4-5 inches from the bottom of the tub on each side, while the other tub will be drilled exactly the same.

When you are drilling the holes, place them semi-equally apart from one another by selecting the holes about 3-4 inches from the end of the sides. If you decide to use say 3 inches from the side and 4 inches up, do the same on the other side. Height placement is more important than side placement, as the holes should be fairly close to the substrate level.

Tip 1:
Remember to leave room for the casing layer. If you are going to have 4 inches of substrate and a 1/2 inch casing layer, it does you know good to have your holes drilled at exactly 4 inches. Where would the casing layer go? The bottom of the holes is where the measurement needs to take place.

As seen here:

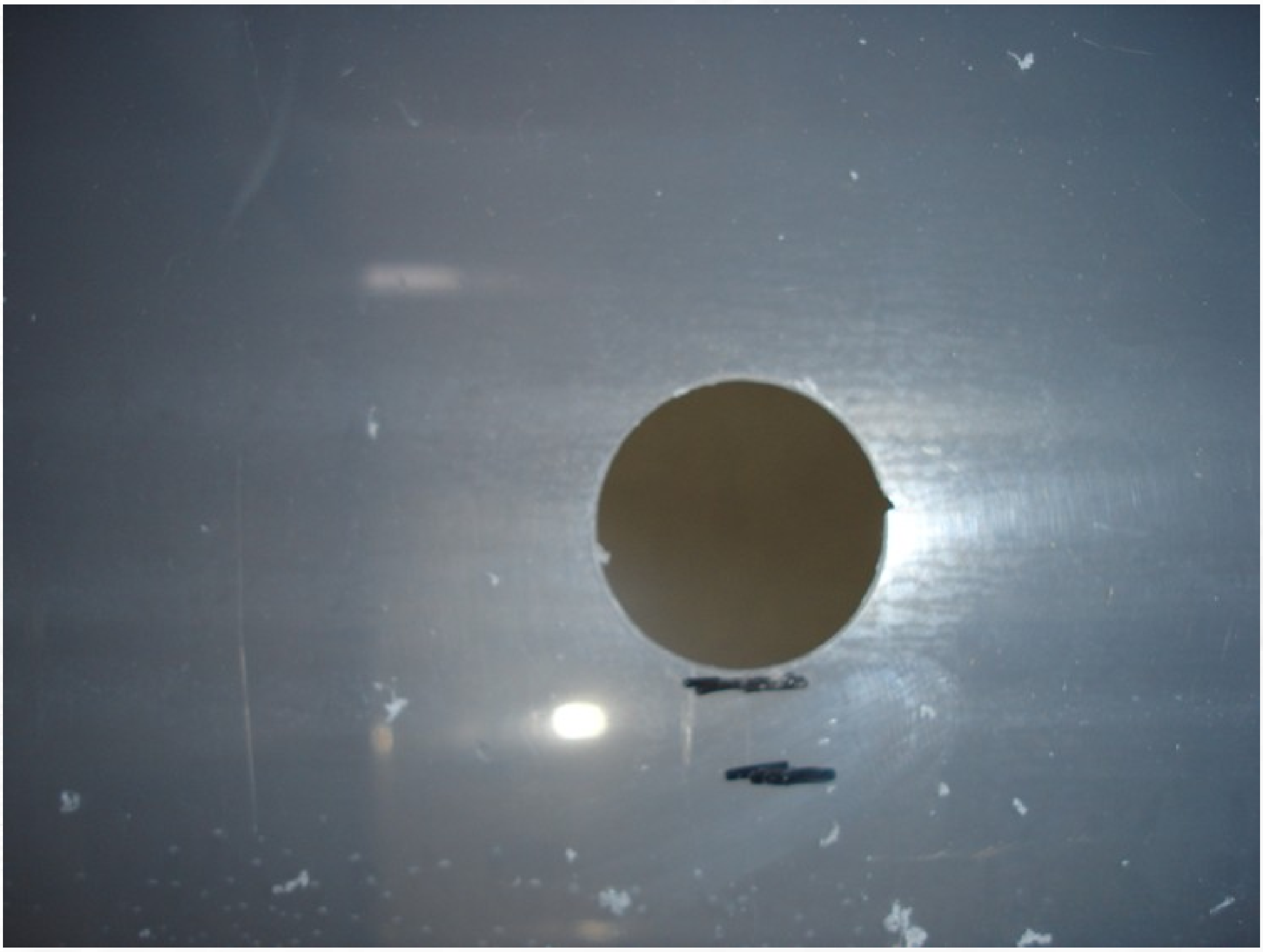


The reason why the two tubs will be drilled in the exact place is to avoid confusion on which tub is the top and which is the bottom. Remember that the tubs will be placed on top of each other, so the top tub, after it has been inverted, will be a considerable distance from the bottom holes.

What is the purpose of having holes at 4-5 inches on the bottom and way at the top for the top tub? I'm glad you asked. The lower holes, or holes at the substrate level, will aid in CO2 expulsion. The top holes will allow filtered air, filtered from the poly-fill, to enter the tub and provide air exchange.

The poly-fill is non-organic and not prone to habiting contaminates.

Now that that you have drilled your holes the container should look like this.

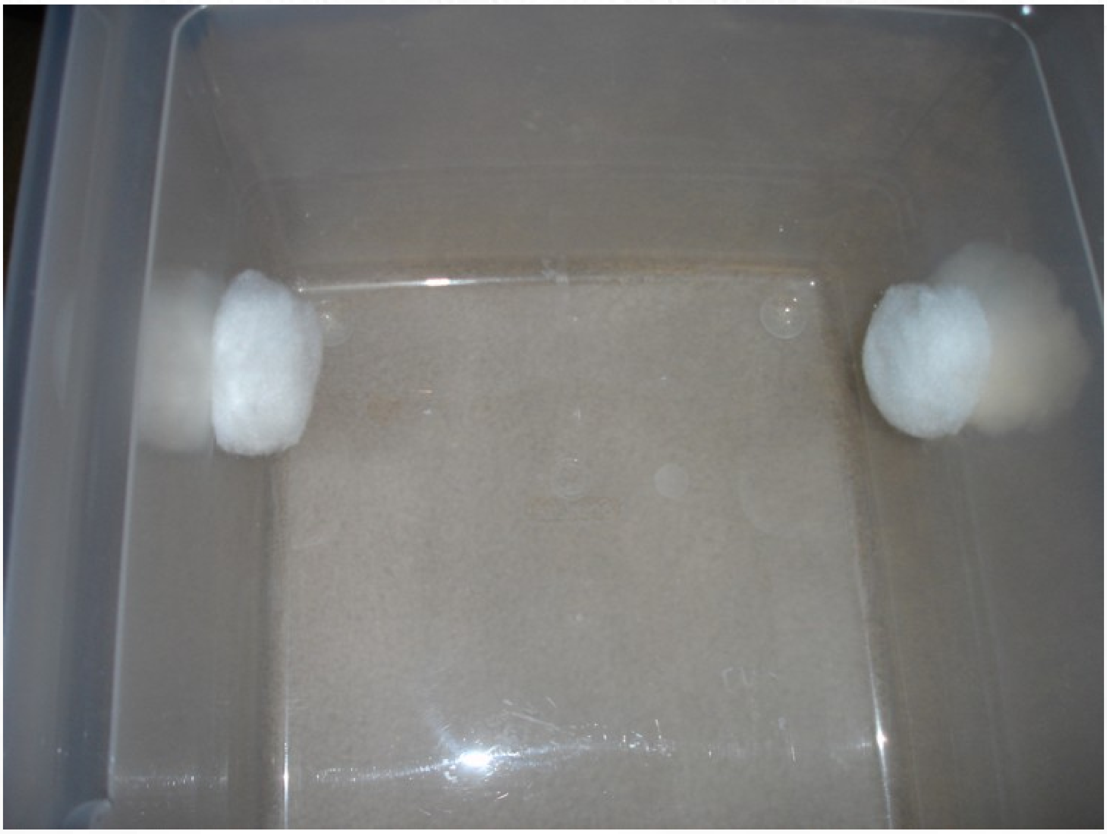


Notice how I planned my holes around where I want my substrate and final casing layer to be. I have plenty of room to even add a half inch of substrate if I choose, but I won't.

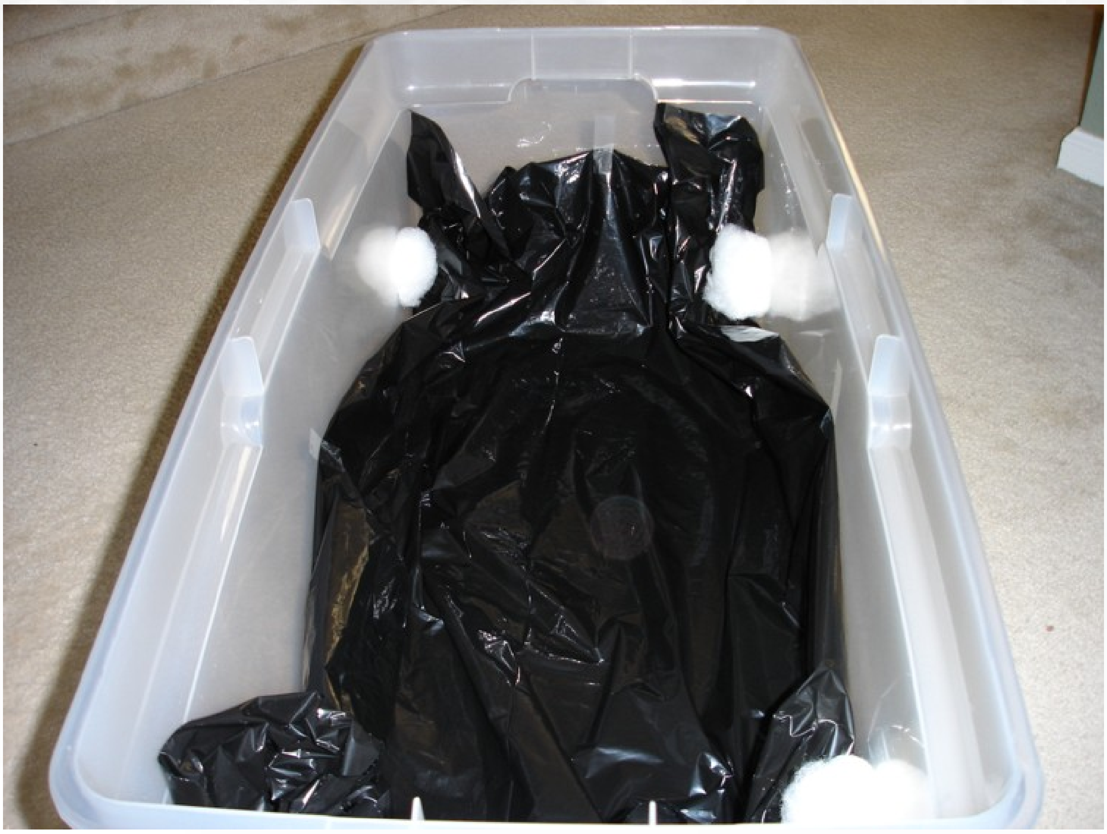
Tip 2:
Collect your horse manure and place in to the container dry. See how much you need to get up the holes, leaving room for a casing layer, and even it out. Now pull out the horse manure and weigh it. This is now the dry weight you need to grow every time for that container.

What about when you hydrate it and the weight changes? Good question. The answer is it doesn't matter. Hydrating horse manure increases the weight not the volume. In other words, the same horse manure dry, will take up roughly the same space wet. The wet horse manure simply weighs more than the dry.

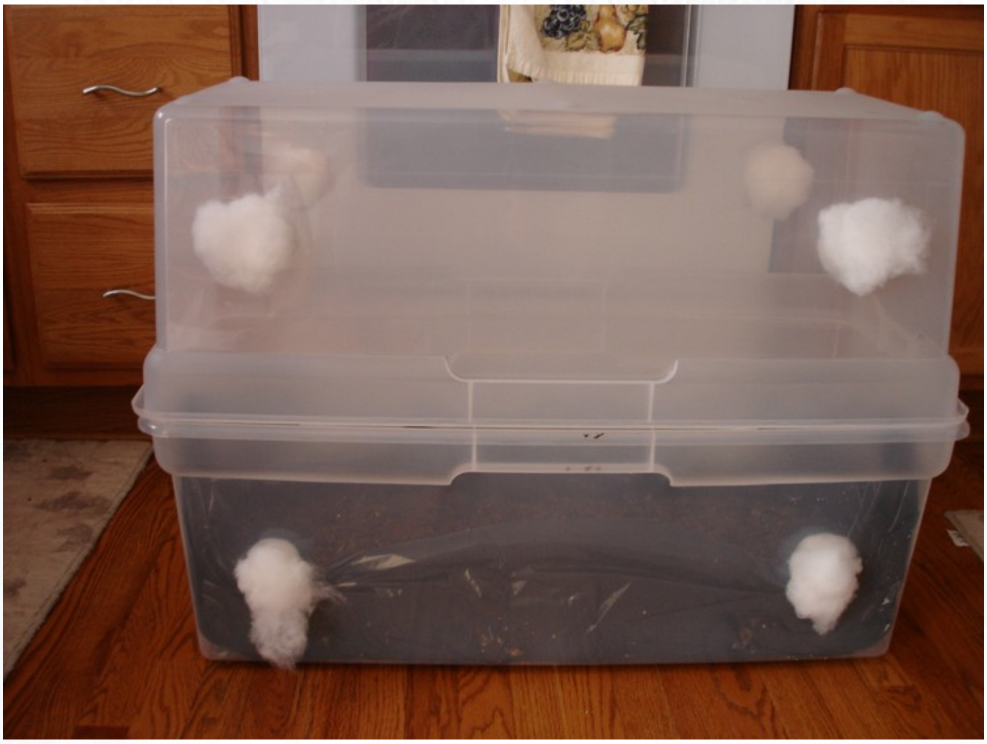
Once you have your holes drilled its time to pull some poly-fill out of the bag and stuff the holes. This does not need to be complicated. The best method for stuffing the poly-fill is to take a nice size wad and begin stuffing from the outside in. You want the poly-fill from the interior of the tub to look like large round cotton balls. This will avoid contact with the mushrooms during growth and looks neater. The poly-fill needs to be snug, but not so tight that the tub is deforming on you.



Okay, so we've stuffed all of our holes in both containers and now need to sterilize the containers. This can be accomplished by spraying some alcohol in the tub and thoroughly wiping the sides, rim, and bottom. Do not take your sweet time doing this. Get it done as quickly as possible. Place a trash bag or two on the bottom of the container that you are choosing to be the bottom. The trash bags should come up slightly higher than the poly-fill, by about a 1/2 inch, but not so high as to interfere with the fruiting.



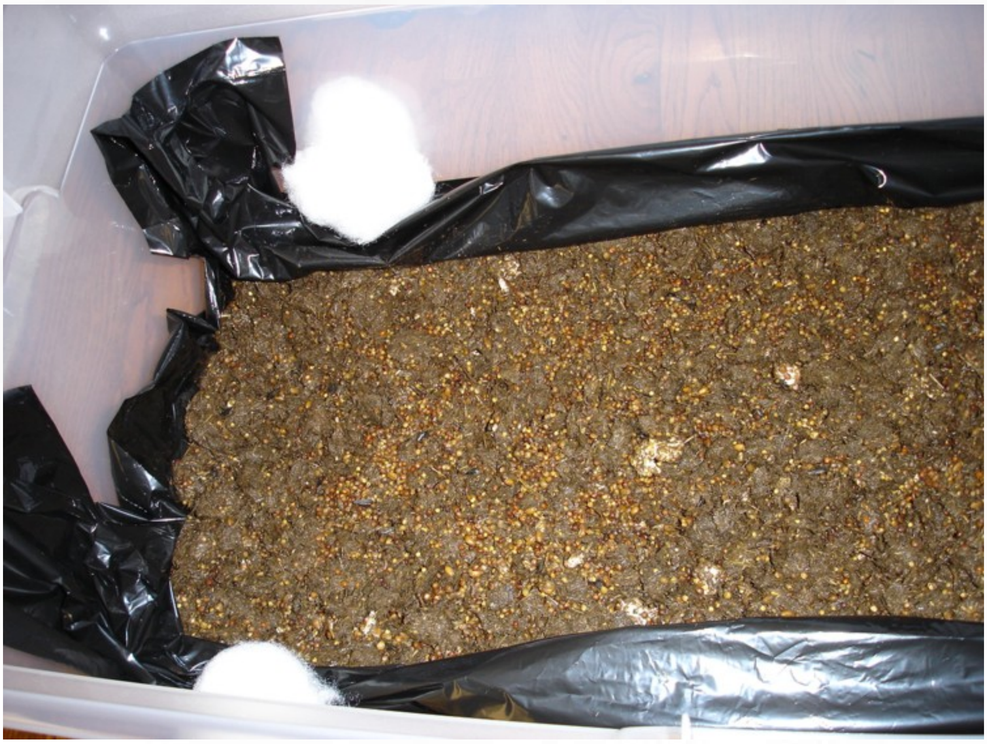
Once this is done, invert the chosen top tub and place on top of the bottom tub. Make sure the container lips are aligned with one another so you don't have anything floating in there from the open air.

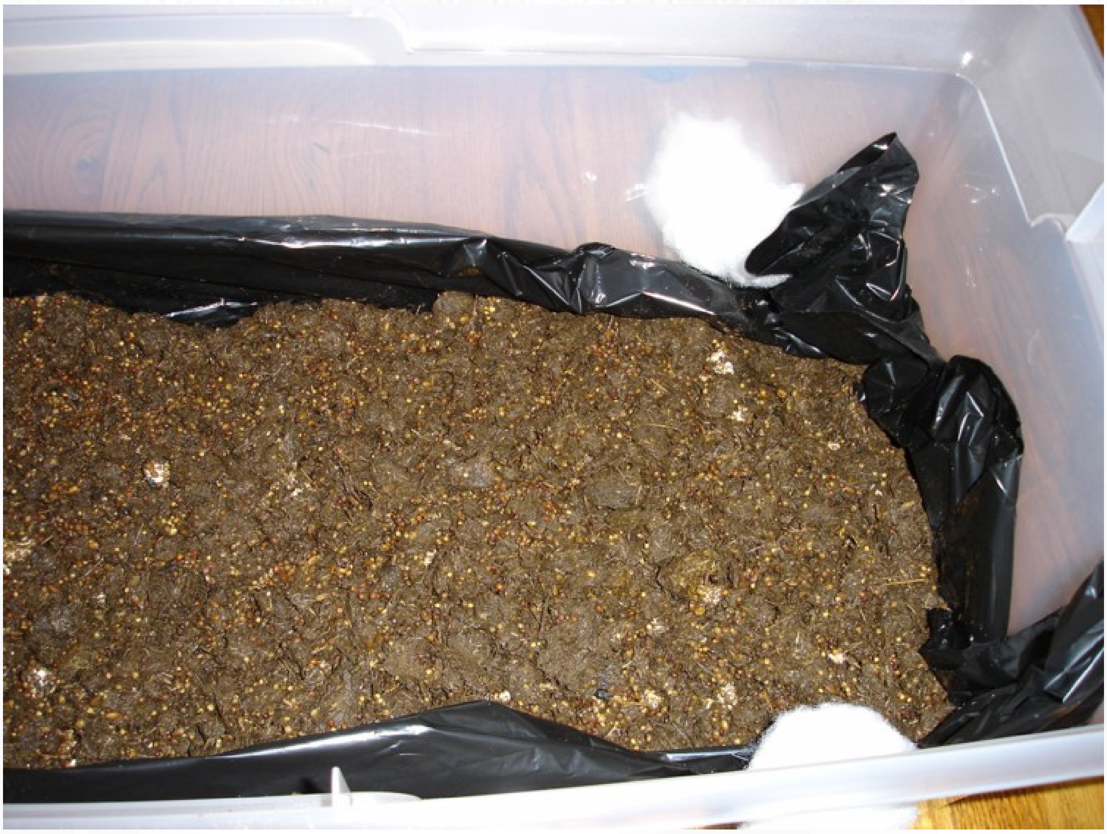


The next step is to take the materials for your spawn medium. You can use either Roadkill's horse manure tek or Agar's. Both work great.

In this case, I am using 7 quarts of PR WBS to about 12-15 lbs of dried horse manure in a 64 qt container. Place the horse manure into a sterilized container, preferably lined with a trash bag, and put your colonized substrate on top. In this case, I'm using WBS. Break up the WBS and begin mixing thoroughly. Once you have mixed up your spawn, place a lid onto the container with the spawn. Spray some Lysol into the air around the Double Tubs and wait for 10 minutes.

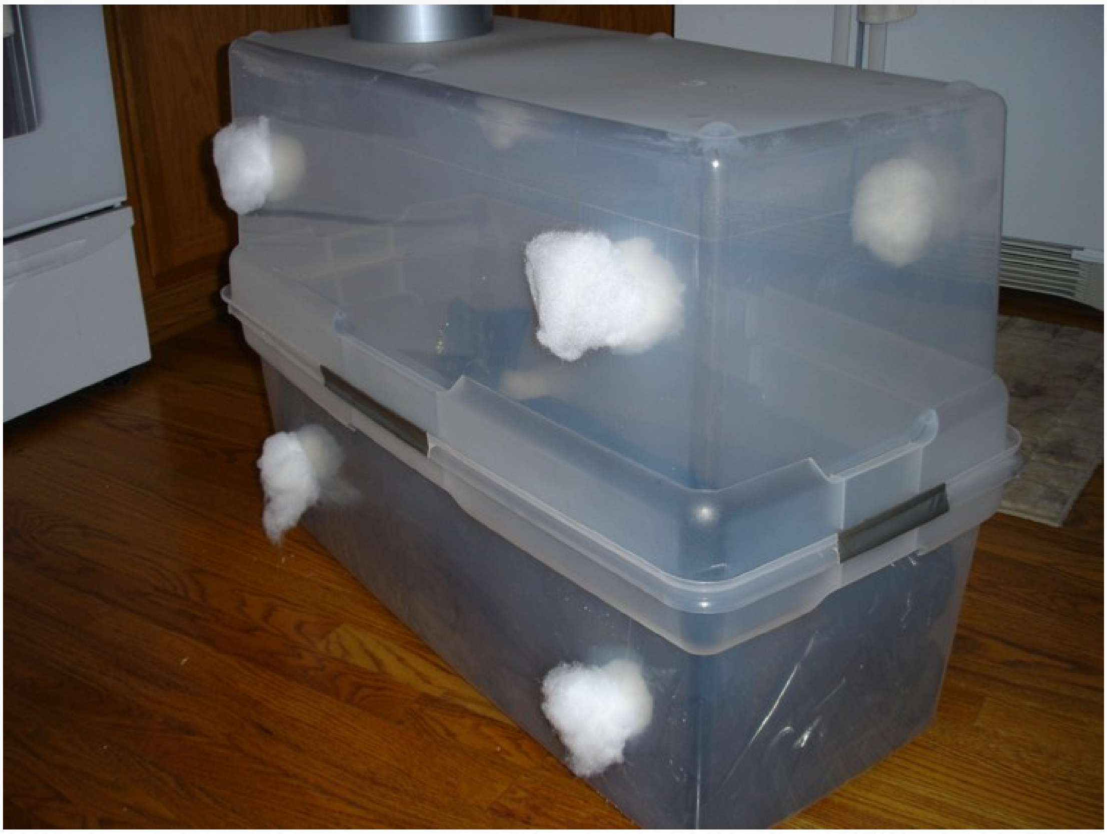
Now that I have mixed my spawn, I'm ready to place it into the bottom tub lined with the trash bag. Remember that your double tub should have closed during your spawn mix. Carefully place your mixed spawn into the bottom tub on top of the trash bag. You need to do this slowly, as you do not want the spawn to go down the sides of the trash bag, only inside the lined tub.





Now that you have your spawn in the tub, remove the tape you used to tack the trash bag in place and begin moving the bag so it is not covering the bottom holes. It may sag a little, but this is okay. Try and fold the sides of the bag towards the outside of the tub so they shorten in length. Remember, the water will drain down the sides, not onto the substrate.

Now that this is completed, you need to set the top tub onto the bottom tub, as seen below. To avoid knocking the top tub off the bottom, place duct tape between the lips of both tubs and seal in 4 places. If you want to be really cautious, you can seal the entire lip instead.



Place the double tub in your chosen room for incubation. A closet works very well for this, as the air does not circulate significantly, and the temps stay about the same. Ideal temps for the entire double tub grow are 68-74 degrees. Now that you have the container in your chosen room, place a black trash bag over the top of the tub so only the interior trash bag is visible. The bottom holes stuffed with poly-fill should be visible also.

The spawn needs to run for at least 5 days undisturbed. That means no peeking. After 5 days has passed, inspect your spawn by looking into the container, not opening it. If you are 100% colonized, prepare your casing mix. If you are not 100% colonized, leave the container in place and check every 2-3 days until you are complete.

Once you are complete, case the colonized substrate. I prefer the 50/50 mix. This can be found here.

It is very important to note that the tubs should only be opened to case and to harvest. There will be no misting or manually fanning. The only exception to this rule is when the double tubs are placed in a room that has stagnant air during the fruiting phase. If this is the case, you can use a personal size, oscillating fan to move air around the room. Do not point the fan directly at the tub, as you will dry out the casing and/or your growing mushrooms.

Once you have cased the substrate, it is time to incubate again for 5 days by placing back into the room where it began and placing the trash bag back on top. You will do no patching during the incubation phase for the casing. The substrate will colonize the casing layer evenly and you're ready to fruit.

You will see a bit of condensation on the sides of the container after the incubation of the casing layer. This is desired and will help in later flushes.

Depending on where you have your containers, you may need to place them in an area that has indirect sunlight. I place my tubs in my bathtub and crack my blinds. The course of the sun's natural rotation takes care of my lighting needs and affords about 12-14 hours of light. I also use a small personal size, oscillating fan in the room to move air around, but it is not required if air is coming in from an adjacent room.

At no time will you open the tubs, until the harvest. If you want to see the mushrooms growing, look through the top container. In about a week, you will start to see pins.

Once the mushrooms have completely matured and are ready for harvest, begin planning ahead. Set some time aside to complete the harvest. Have some Lysol on hand, alcohol, trays for mushroom collection, and pre-sterilized casing mix for patching. Before you remove the top tub, spray some Lysol into the air around the container and allow 5-10 minutes for everything to settle.

Spray some alcohol onto your hands and rub in thoroughly. Remove the duct tape from the lip of the two containers and have you collection tray/container ready for the mushrooms. This will be a monster flush, so try to avoid taking too much time doing the harvest. Once you have picked all of your mushrooms, grab your casing mix and lightly patch the areas you just pulled from.

Tip 3:
Avoid allowing the mushrooms to mature too much. Overly mature mushrooms will drop their spores and cause a big mess on you casing layer. You also want to keep printing in mind during your harvest planning. All mushrooms should be picked within 24 hours of each other. During the next 24 hours of the harvest, you will pick all of the mushrooms, including the aborts. Nothing will be left behind.

After you have completed the harvest and patched, place the top back onto the bottom container and seal with duct tape again. Very important: Do not mist the casing after you have patched or you will disturb the environment.

There it is. Eatualive's Double Tub tek revisited. I have made some modifications to this tek, namely the sealing of the tubs, details on hole placement, recommendations for temperatures, and tips to avoid trouble along the way.

Additional photos will follow as things progress so there is no confusion.

Thank you.

Carlito

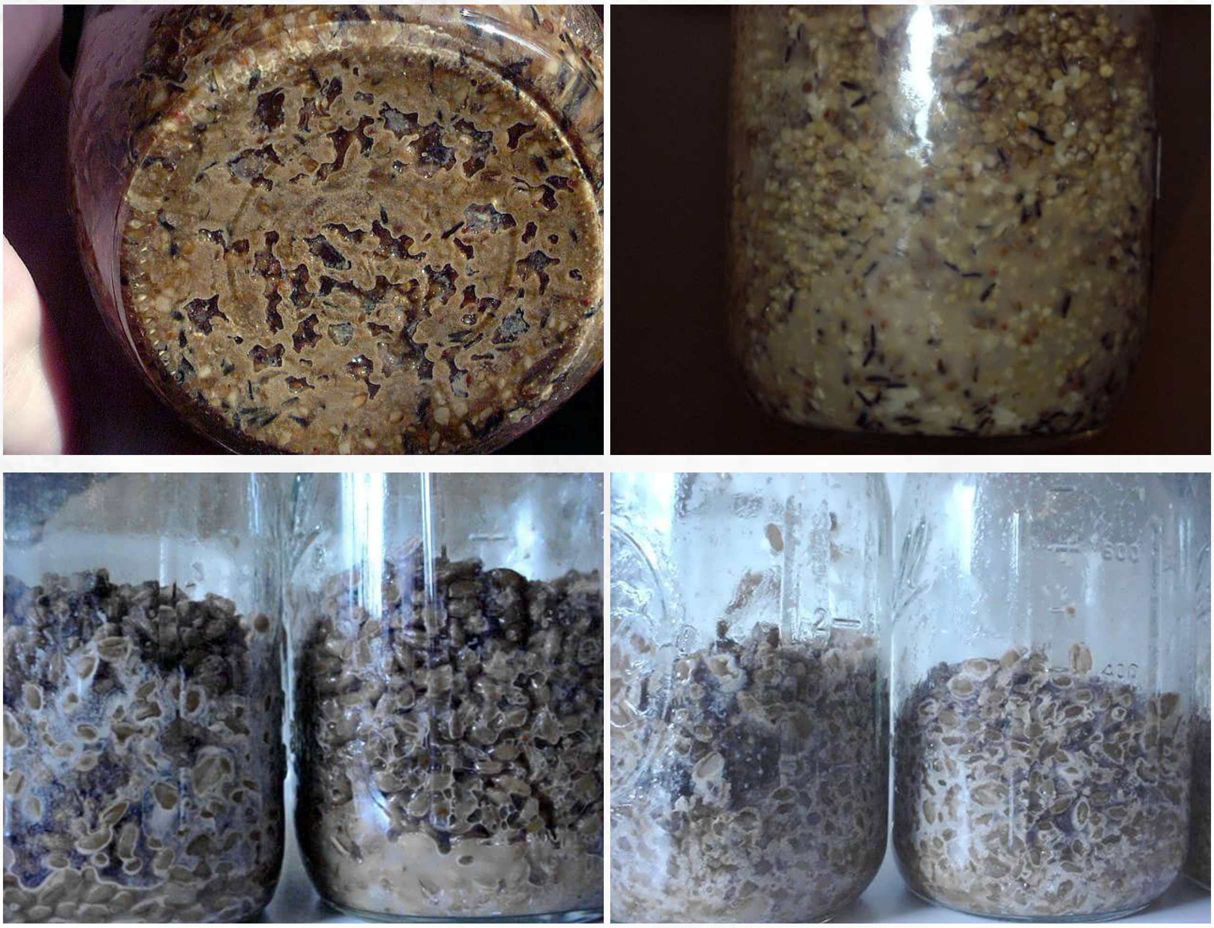
What are common contaminants of the mushroom culture?

original source: http://www.shroomery.org/5276/What-are-common-contaminants-of-the-mushroom-culture

Most specialty mushrooms are grown on sterilized substrates, and once a contaminant gets a foothold, it flourishes in the absence of competition from other contaminants. In nature, complex interactions among hundreds of other fungi, bacteria, nematodes, etc. maintain an ecological equilibrium. In a sterilized medium, the grower provides ideal conditions for the contaminant to prosper. In sawdust bags, contamination usually involves another fungus living off the waste products or on the remains of the cultivated fungus, or sometimes on the living mycelium or fruiting body of the cultivated fungus. The only competition for these contaminants is the cultivated fungus itself.

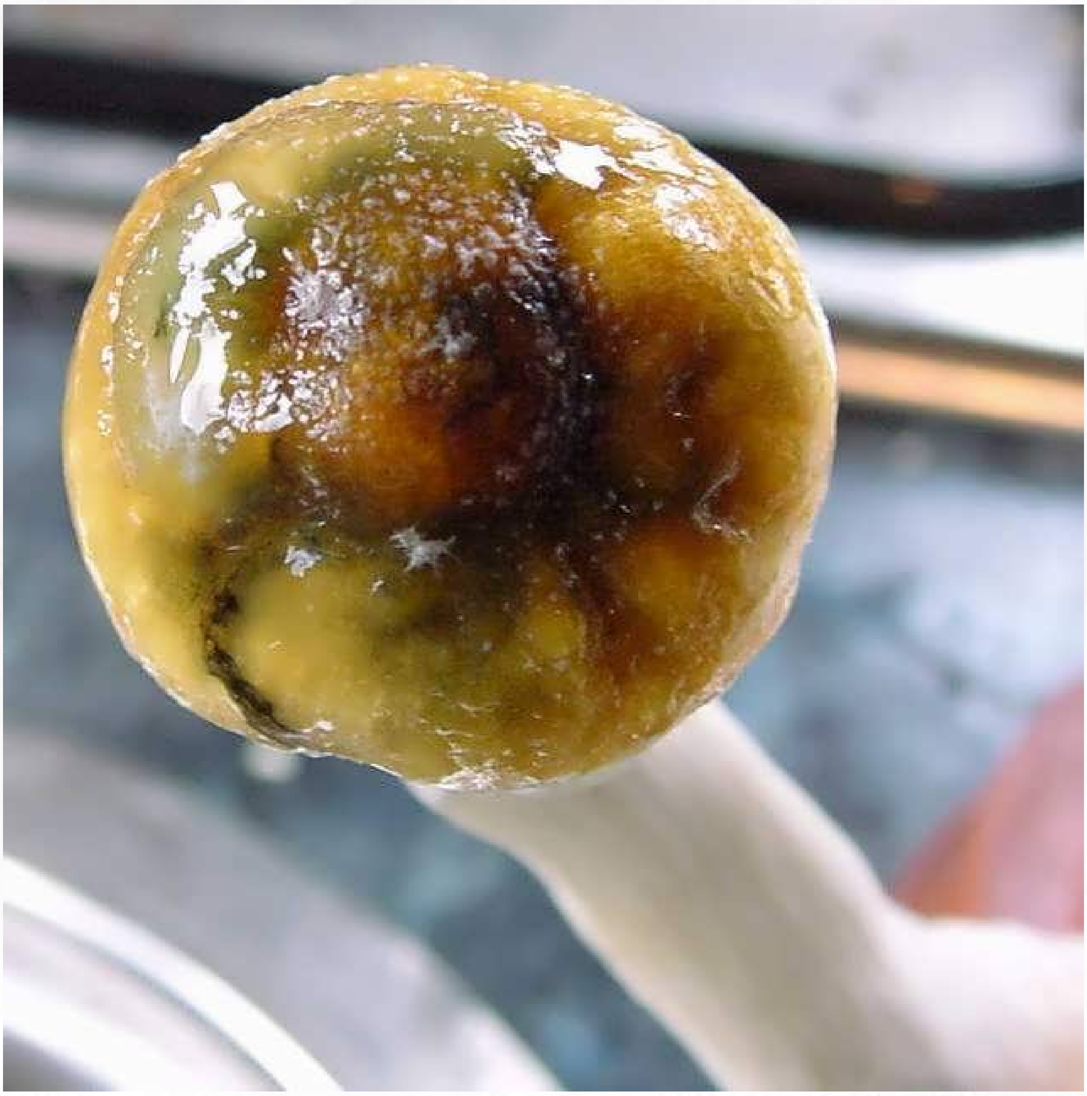
Wet Spot, Sour Rot - *Bacillus sp*

In grain spawn jars, one commonly encounters *Bacillus*, which sometimes survives the sterilization process as heat resistant endospores. A dull gray to mucus-like brownish slime characterized by a strong but foul odor variously described as smelling like rotting apples, dirty socks or burnt bacon. *Bacillus* makes uncolonized grain appear excessively wet, hence the name "Wet Spot". Pallid to whitish ridges along the margins of individual grain kernels characterize this contaminant. *Bacillus* primarily reproduces through simple cell division. In times of adverse environmental conditions, especially heat, a single hardened spore forms within each parent cell body - bacterial endospores, which can survive high temperatures for prolonged time.
The most practical method for eliminating bacterial endospores involves soaking the grain at room temperature 12 - 24 hours prior to sterilization. Endospores, if viable, will germinate within that time frame and then be susceptible to standard sterilization procedures. And, new endospores won't form in the moist environment of the resting jar of grain.



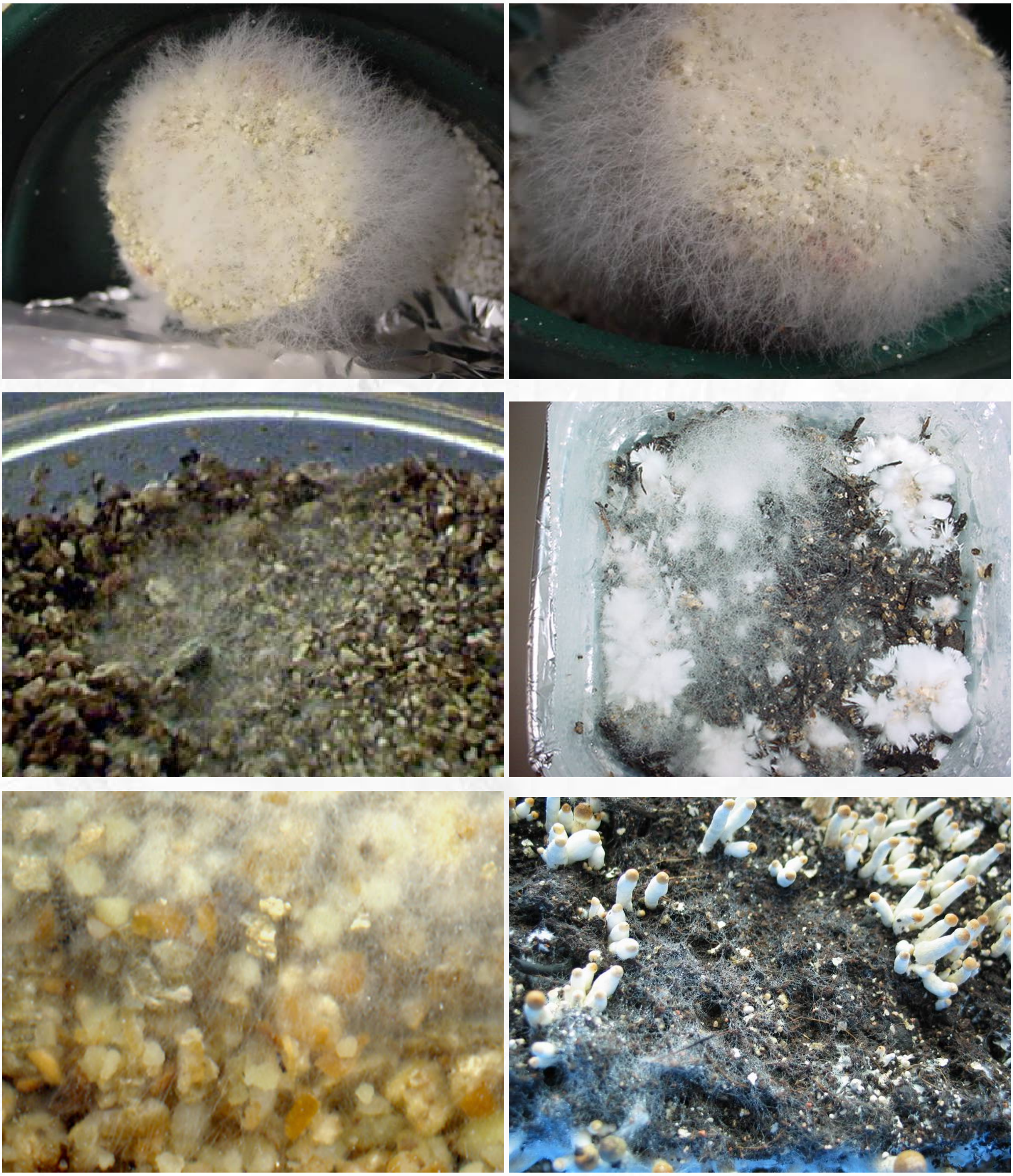
Bacterial Blotch - *Pseudomonas tolaasii (P. fluorescens)*

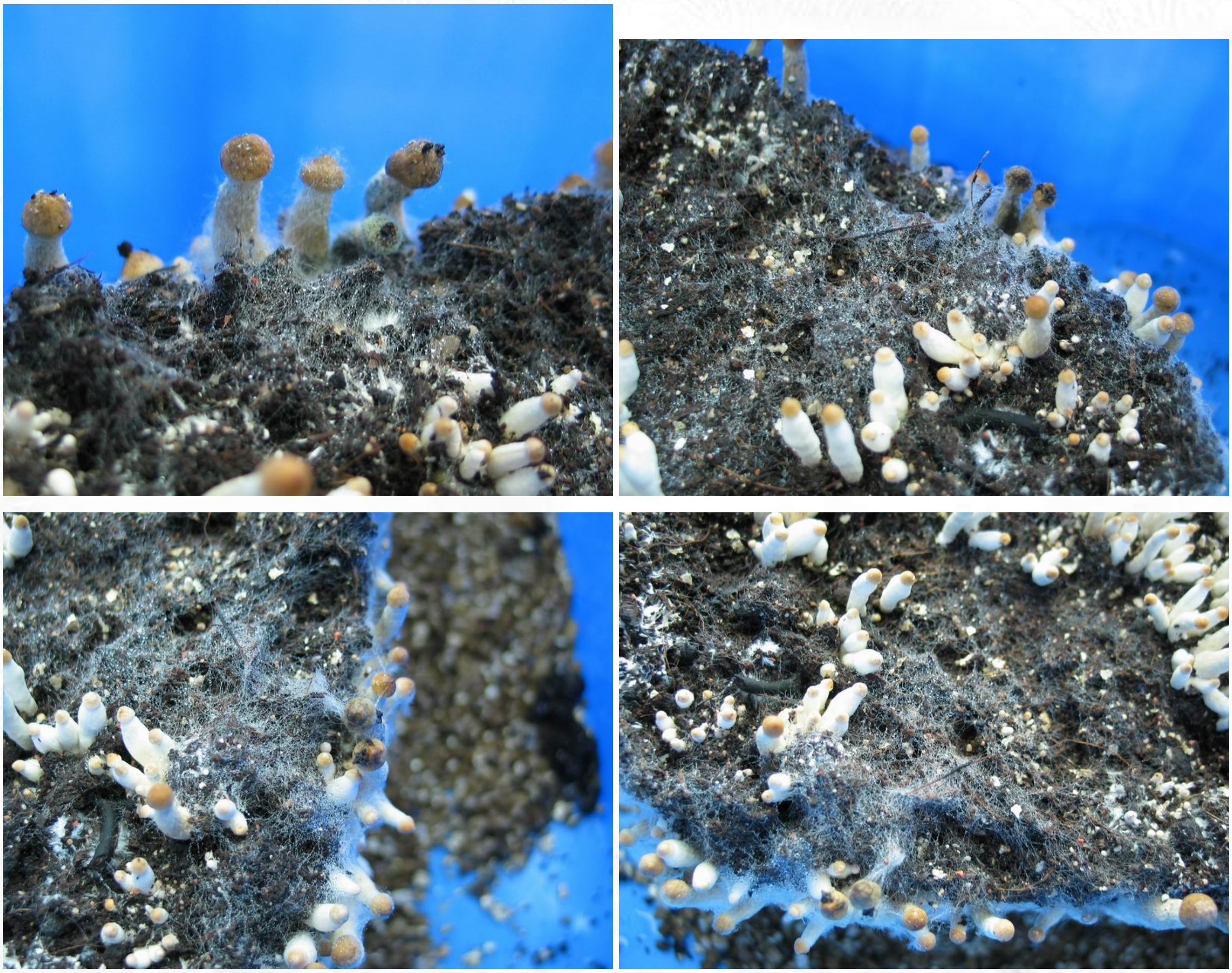
Yellow to brown lesions form on mushrooms. Typically, spotting occurs at or near the edge of mushroom caps. Blotch occurs when mushrooms remain wet for a period of 4 to 6 hours or longer after water has been applied. The bacterium is spread in air-borne soil particles. Controls include lowering humidity and watering with a 150 ppm chlorine solution (calcium hypochlorite products are used since sodium hypochlorite products may burn caps). If the mushroom stays wet, however, chlorine has little effect since the bacterial population reproduces at a rate that neutralizes the effect of the oxidizing agent. Shiitake caps are affected by a bacterial disease caused by *Pseudomonas gladioli* (*Burkholderia gladioli*). Sanitation is a critical component of control measures.



Cobweb mold or Dactylium Mildew - (*Hypomyces sp.*)

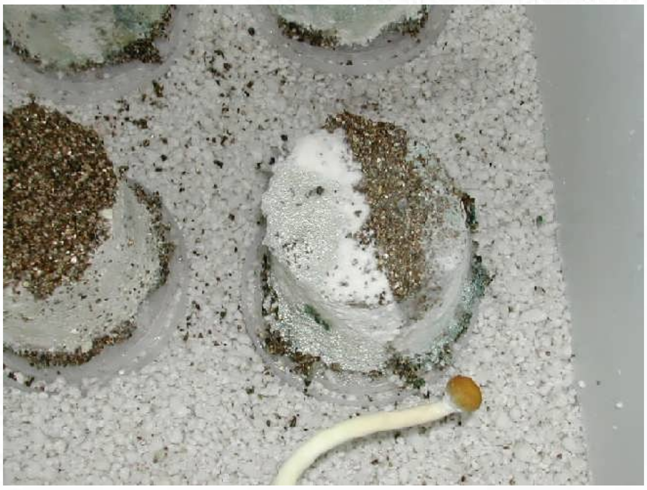
A cottony mycelium grows over casing. When it contacts a mushroom, the mycelium soon envelopes the mushroom with a soft mildewy mycelium and causes a soft rot. It is also a parasite of wild mushrooms.
Cobweb mold is darker than mycelium... almost grey as compared to white. The difference in color is sometimes hard to tell for somebody that hasn't seen them side by side before. Cobweb has several other indicators... the one that sticks out is the speed of growth. A small patch the size of a dime will spread to cover an entire jar/casing in just a day or two. Cobweb is also very very fine strands, while mycelium tends to be thicker ropes.
Cobweb mold is favored by high humidity. Control strategies include lowering humidity and /or increasing air circulation.

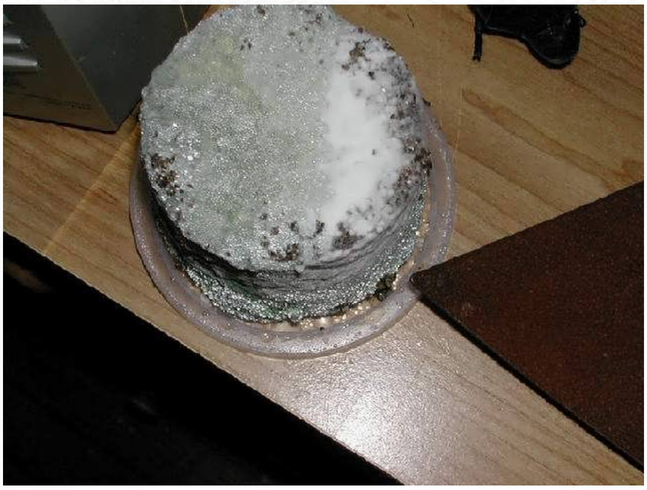


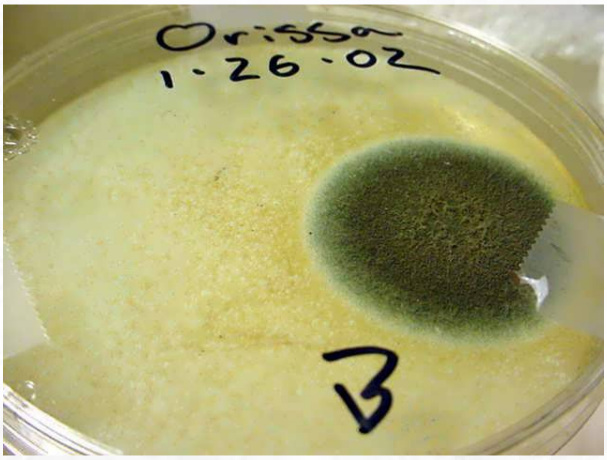


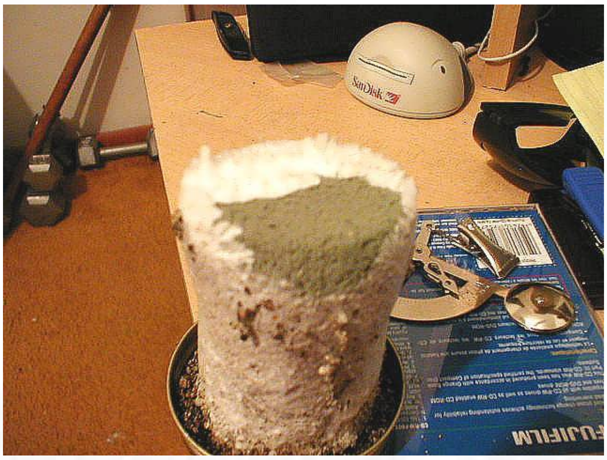
Green Mold - *Trichoderma harzianum, T. viride, T. koningii*

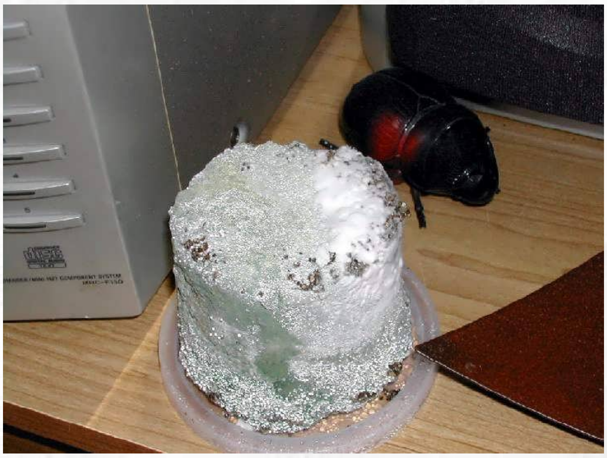
Green mold caused by *Trichoderma harzianum* is characterized by an aggressive, white mycelium that grows over the casing and onto mushrooms, causing a soft decay. Masses of spores that eventually form are emerald green. Heavily infested patches of compost are barren. This is currently the most important disease in the U.S. Agaricus industry. Many farms spread salt on the compost in affected areas when green mold is first recognized. Strict sanitation is essential. Shelving, trays, walls, floors, etc. may be surface disinfected as a matter of routine, but it is done with a sense of urgency following an outbreak of a disease. Many commercial products are available for cleaning surfaces. The base ingredients in these materials include chlorine, iodine, phenol, or quaternary ammonium, among others. Surface disinfectants are used farm-wide, from equipment sanitation to room washdowns to foot-dip solutions to picking basket pre-wash. Other Green Molds may be better defined as indicators since they don't seem to be as aggressive as *T. harzianum*. These species of *Trichoderma* also sporulate on the casing surface and may sporulate on infected mushrooms. These fungi indicate that carbohydrates are available, possibly due to inadequate nitrogen supplementation during Phase I or undercomposting. *T. viride* reportedly produce toxins that dissolve mushroom cells walls. A wet compost low in ammonia prior to pasteurization, flies, poor sanitation, anaerobiosis, and other factors influence green mold. These fungi are common in sawdust and commonly occur in the production of specialty mushrooms.
Trichoderma is often mistaken for Penicillium or Aspergillus molds (and vice versa), being that all three look very similar and are not easy to tell apart without the use of a microscope.
Some pictures underneath possibly show any of the three genuses out of the aforementioned reason.

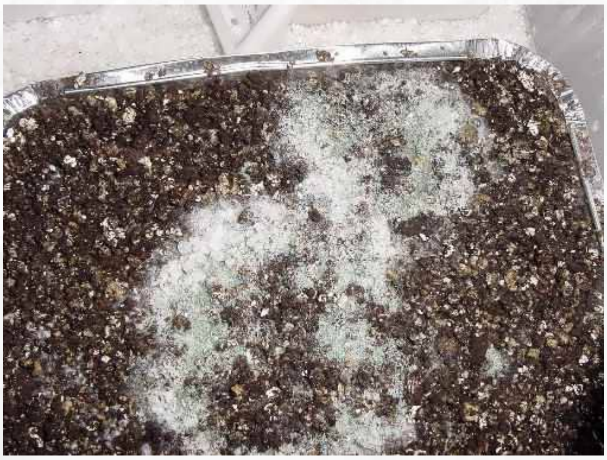


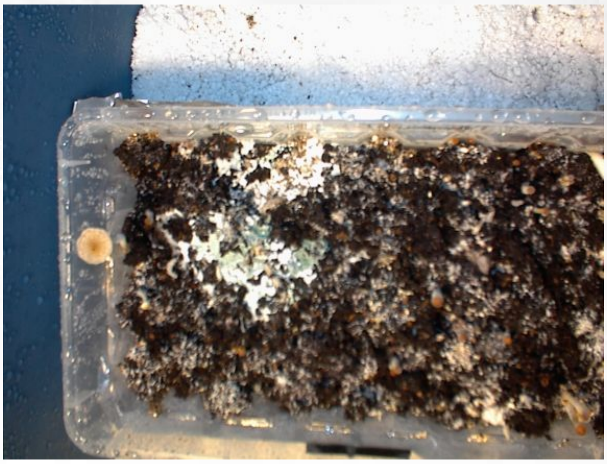


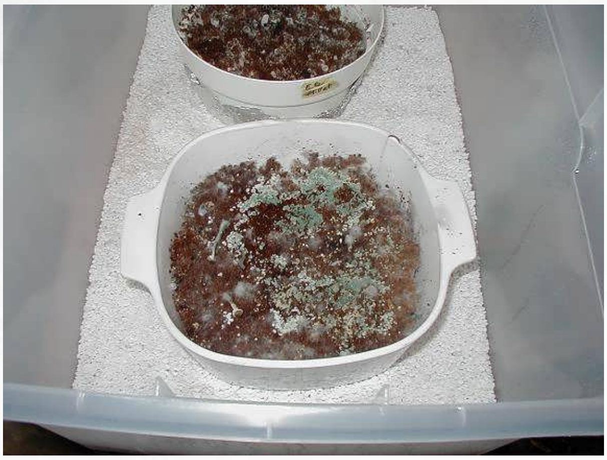

Orissa
1·26·02
B

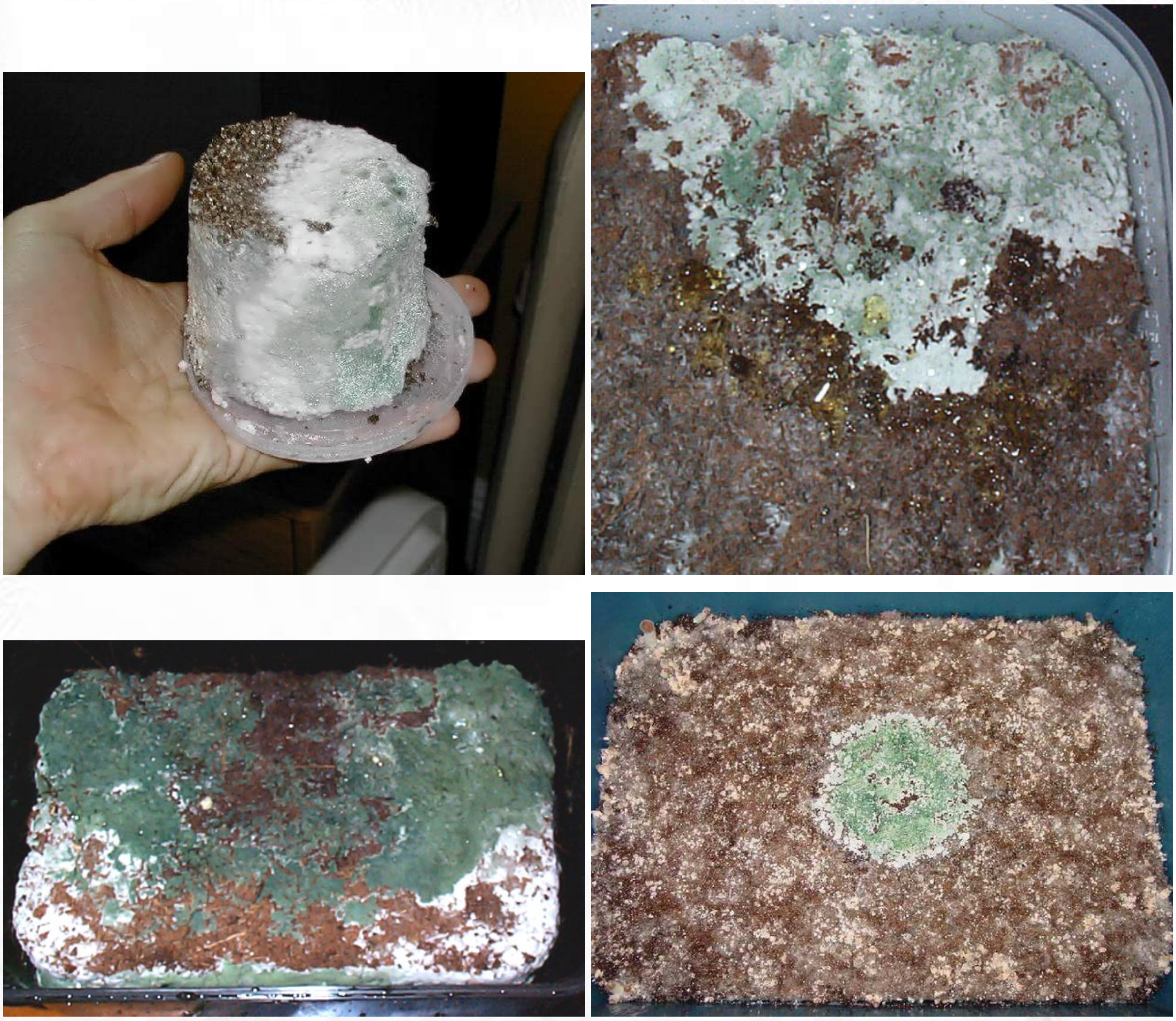

SanDisk
FUJIFILM











More:

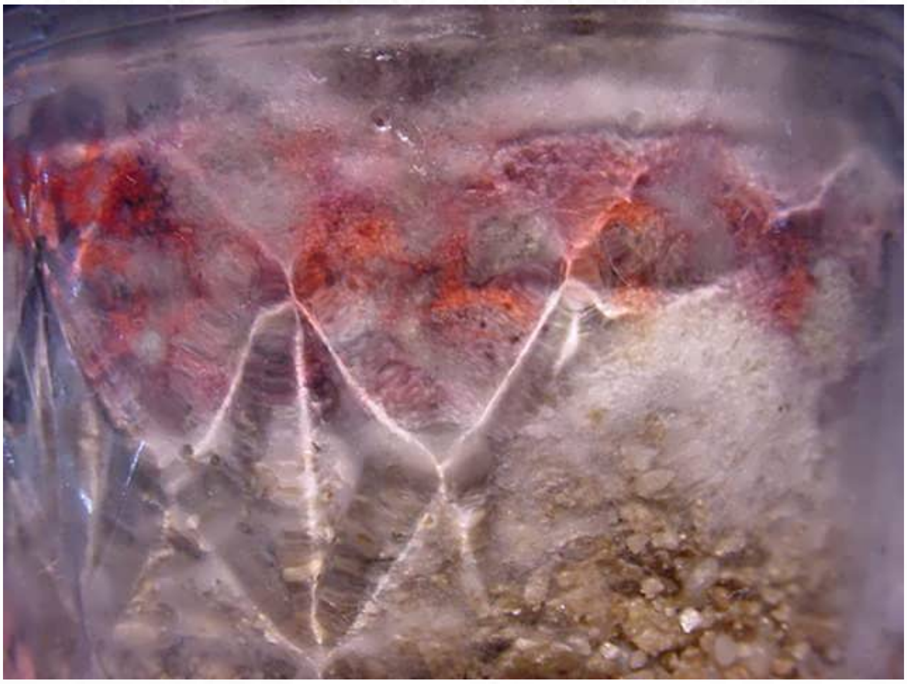
http://www.ppath.cas.psu.edu/MushGrowInfo/Trichoderma%20Green%20Mold.html

Cinnamon Brown Mold - *Chromelosporium fulva (Peziza ostrachoderma)*

The color of this mold ranges from yellow gold to golden brown to cinnamon brown. It grows rapidly in circular patches. It is very common in soil, and flourishes on damp wood. Areas in compost overheated during spawn run may be colonized. Improperly conditioned compost will also support growth, but it is most commonly known as a re-colonizer of overly pasteurized casing, possibly living on dead microorganisms. It often occurs on sterilized soil. Sexual fruiting bodies may appear several weeks after the first appearance of the mold. Spores are airborne.

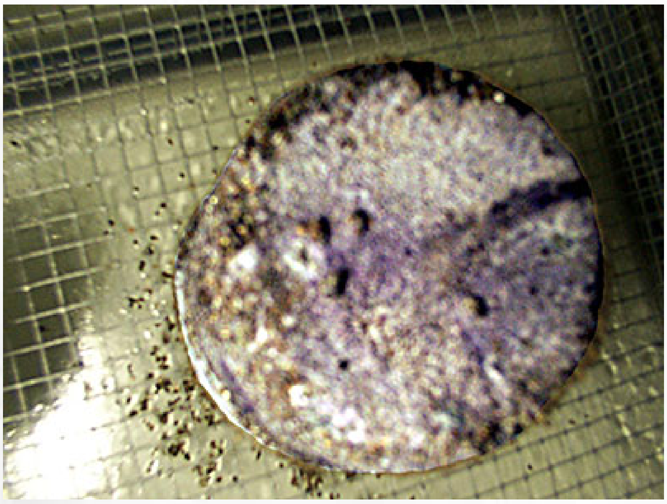
Lipstick Mold - *Sporendonema purpurescens (Geotrichum candidium)*

This fungus colonizes compost or casing. As spores mature, the color of the mold changes from white to pink, to cherry red, and finally to dull orange. It is slow growing. Spores spread in air, during watering, and on pickers. The lipstick mold utilizes certain fats in the compost. It is an uncommon problem. Control is centered around sanitation.



Pink Mold, Red Bread Mold - *Neurospora*

Commonly to occasionally seen on agar and grain. *Neurospora* is fast growing, sometimes taking only 24 four hours to totally colonize a media filled Petri dish. It is ubiquitous in nature, occurring on dung, in soils and on decaying plant matter. Since this fungus grows through cotton stoppers or filter discs, a single contaminated jar, though sealed, can spread spores to adjacent spawn jars within the laboratory. This condition is more likely if the filter discs or cotton plugs are the least bit damp; or if the external humidity is high. Furthermore, *Neurospora* spores germinate more readily at elevated temperatures. The pink mold seen in mushroom culture is most frequently *Neurospora sitophila*, a pernicious contaminant that is difficult to eliminate. All infected cultures should be removed as soon as possible from the laboratory and destroyed. A thorough cleaning of the laboratory is absolutely necessary. If contamination persists, remove all spawn and start anew.



Sepedonium Yellow Mold - *Sepedonium spp.*

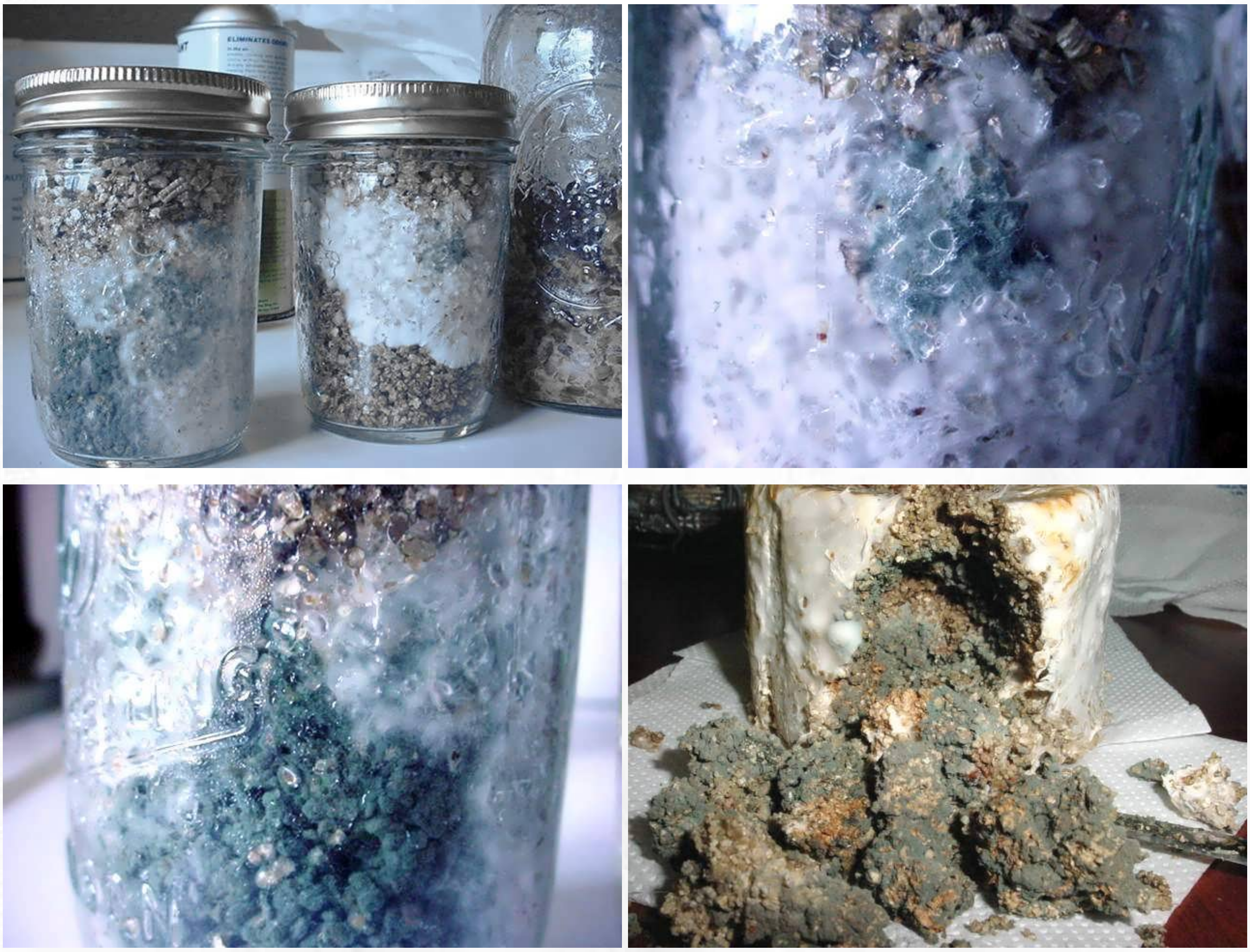
This white, sparse mold grows in the compost during spawn run. With age, it turns dull yellow to tan. Spores are airborne. Thick-walled spores may survive peak heat. The mold colonizes compost considered ideal for spawn growth.

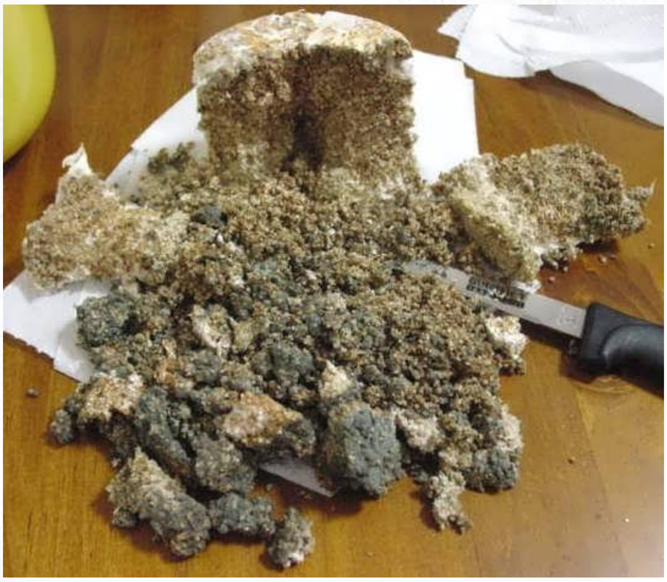
Black Whisker Mold - *Doratomyces spp.*

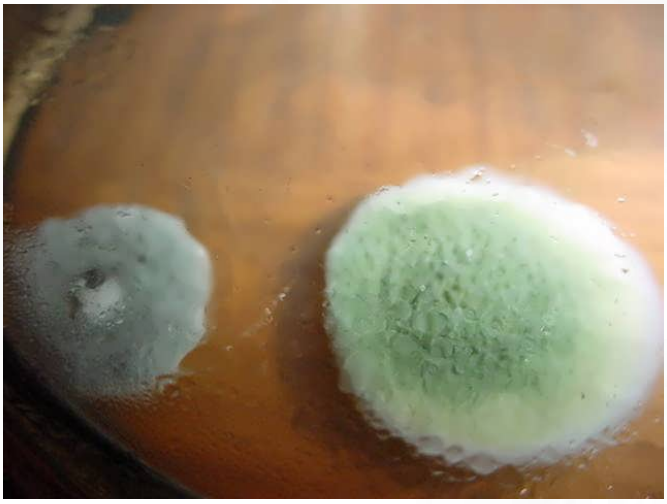
This fungus produces black powdery spores that appear as smoke when disturbed. This mold indicates the presence of certain carbohydrates in the compost at spawning time. It also indicates that the straw has been incompletely caramelized or underheated in Phase I (therefore, carbohydrates are in a form easily utilized). The proportion of carbohydrates, particularly cellulose, may be too high. The black whisker mold is also present in compost that overheated during spawn run. Simple carbohydrates are utilized by this fungus but it can also utilize lignin. *Doratomyces*, *Aspergillus*, and *Penicillium* produce copious numbers of spores and may cause respiratory problems (nasal and throat irritation, chest congestion, breathing difficulty, etc.).

Blue-green Molds - *Penicillium spp.*

Abundant blue-green spores are produced on the surface of the substrate. Similar to Aspergillus. Favorable conditions parallel those for the black whisker mold. *Penicillium spp*. utilize simple carbohydrates, as well as cellulose, starch, fat, and lignin. These fungi are very common on specialty mushrooms and are one of the chief concerns in agar and grain culture. Spores are airborne and ubiquitous.







Black Mold (also Yellow Mold and others) - *Aspergillus sp.*

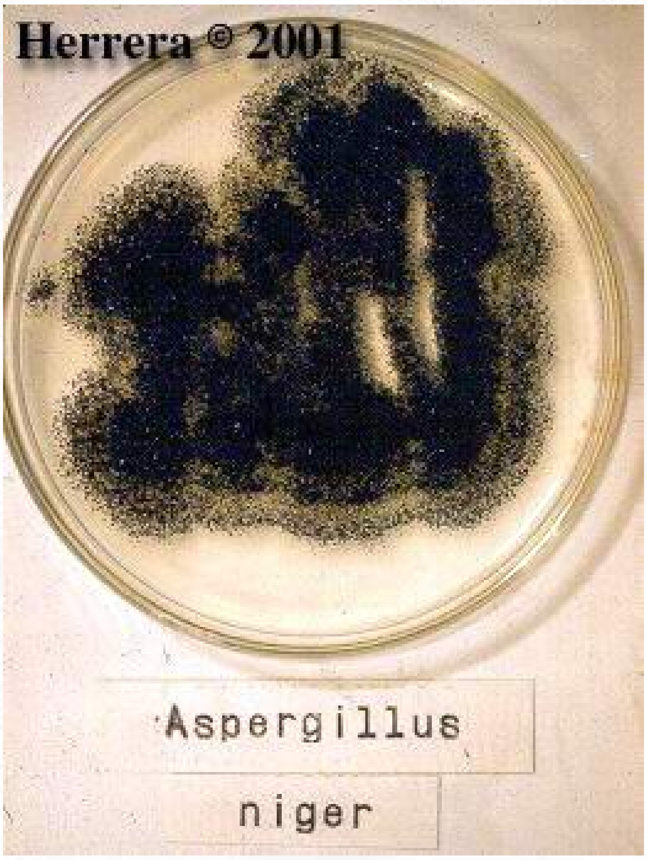
Very common in agar and grain culture, and in compost making. Found on most any organic substrate, *Aspergillus* prefers a near neutral to slightly basic pH. Well used wooden trays and shelves for holding compost are frequent habitats for this contaminant in the growing house. Species range in color from yellow to green to black. Most frequently, *Aspergillus* species are greenish and similar to *Penicillium*.

Aspergillus niger, as its name implies, is black; *Aspergillus flavus* is yellow; *Aspergillus clavatus* is blue-green; *Aspergillus fumigatus* is grayish green; and *Aspergillus veriscolor* exhibits a variety of colors (greenish to pinkish to yellowish). These molds, like many others, change in color and appearance according to the medium on which they occur. Several species are thermophilic.

Some *Aspergillus* species are toxic. *Aspergillus flavus*, a yellow to yellowish green species, produces the deadly aflatoxins. *A. flavus* attacks cottonseed meals, peanuts and other seeds high in oil that have been stored in hot, damp environments. Of all the biologically produced toxins, the aflatoxins are the most potent hepatocarcinogens yet found. The toxicity of this species was largely unknown until, in 1960, 100,000 turkeys mysteriously died from an outbreak of this disease in Great Britain.

Since *A. flavus* grows on practically all types of grain, this species is of serious concern to mushroom spawn producers. Careful handling of any molds, particularly those of the genus *Aspergillus*, should be a primary responsibility of all managers and workers in mushroom farms.

Aspergillus fumigatus and *Aspergillus niger*, two thermotolerant mesophiles, are also pathogenic to humans in concentrated quantities. The affliction is called aspergilliosis or "Mushroom Worker's Lung Disease". Spent compost is the most frequent source of *Aspergillus fumigatus*.


Herrera © 2001
Aspergillus
niger

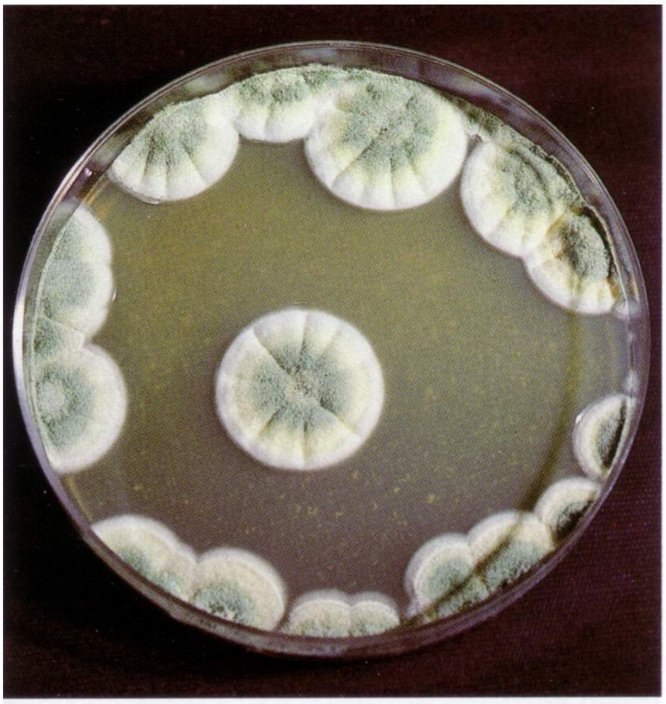
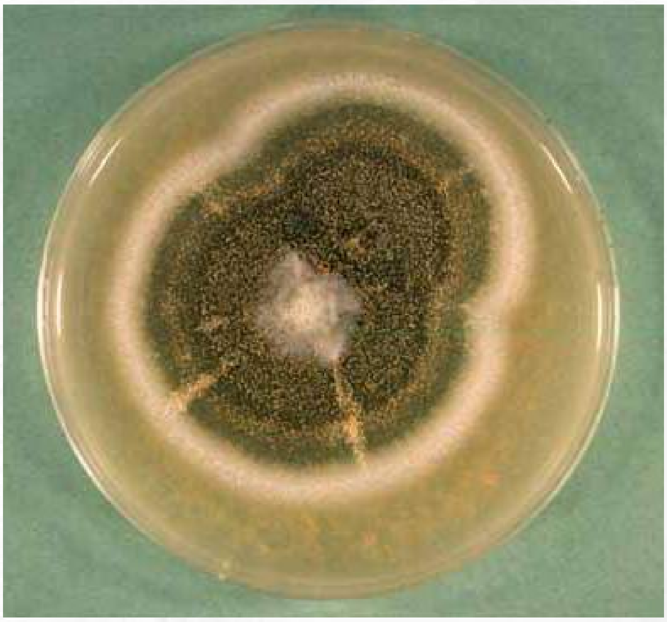
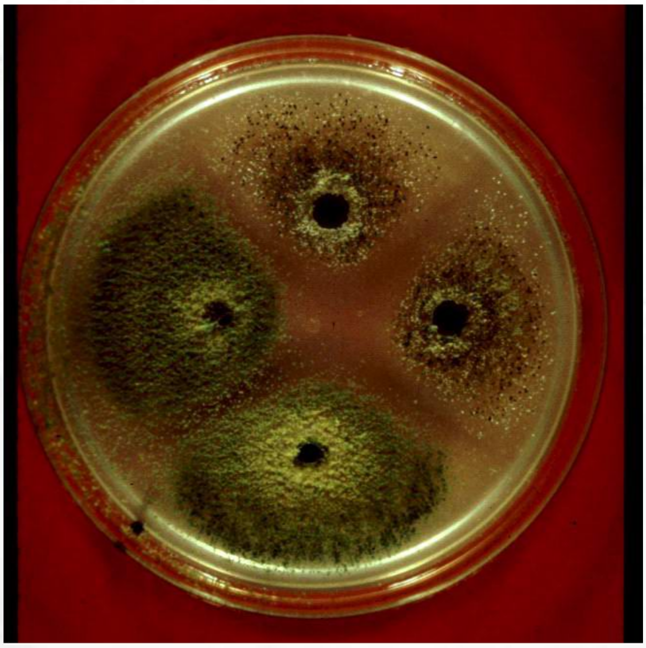


Plate 21 *Aspergillus,* the Green Mold, growing on malt agar media.

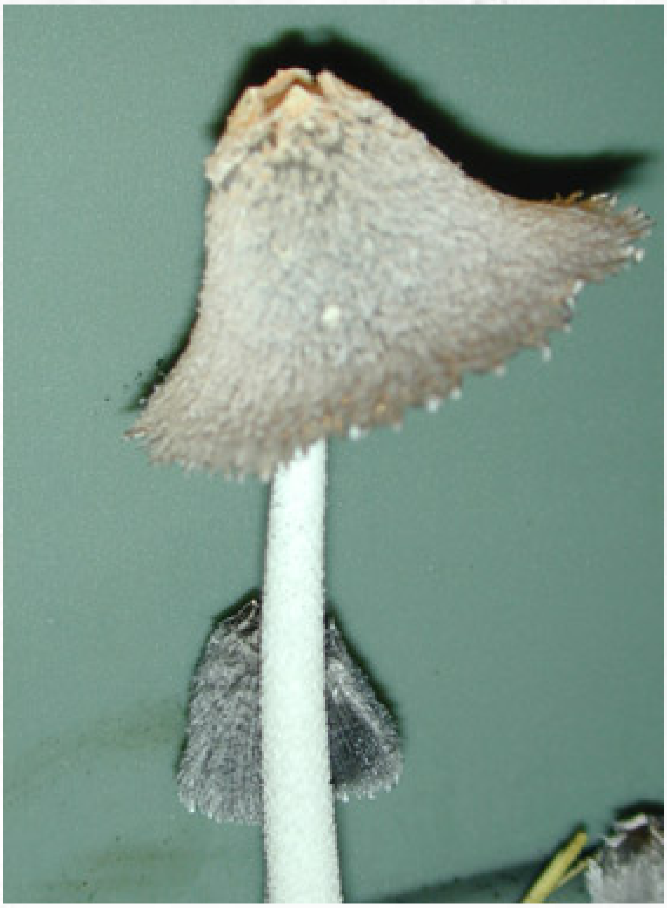


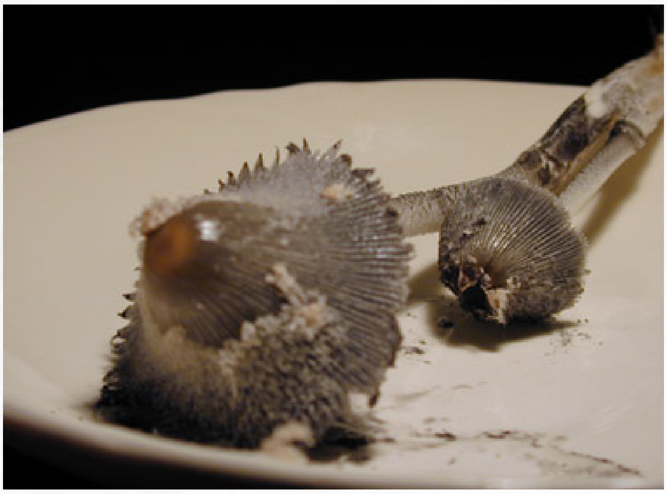


Herrera © 2001

Inky Cap - *Coprinus spp.*

These are evidence of free ammonia in the compost. Ammonia seems to be a nitrogen source. Their delicate gray caps autodigest quickly. Inky caps are indicators of nitrogen over-supplementation or a poorly managed Phase II compost. If there is too much residual ammonia, Phase II thermophilic microflora may be unable to convert all the ammonia into microbial protein. In addition, areas in the compost that did not remain within the range of 115 to 135 F from 72 to 96 hours after pasteurization may contain residual ammonia. This fungus is strongly cellulolytic.





Oedocephalum (Brown) Mold - *Oedocephalum spp.*

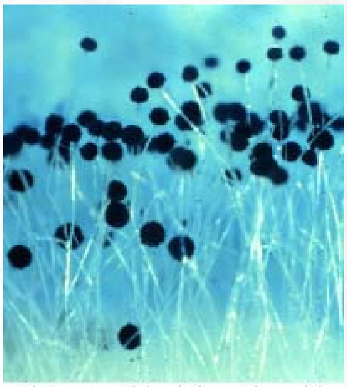
This mold makes light gray growth on compost surface, later becoming brown as the spores mature. It forms erect spore-bearing structures with spherical clusters of large spores at its top end. This mold indicates that ammonia and amines were not completely eliminated during Phase II (which might be the case when carbon sources are limiting and nitrogen can't all be converted into microbial protein). Its ecology is similar to *Coprinus*, and often occurs with it.

Olive Green Mold - *Chaetomium spp.*

Fruiting structures of this mold look like olive-green cockleburs - 1/16 inch in diameter - that develop on compost. Although its heat tolerant spores survive 140 F for 6 hours, the mold appears only in compost improperly managed during Phase II, especially where Phase II ventilation is inadequate. Lack of oxygen when compost temperatures are greater than 142 F permits formation of compounds produced in anaerobic conditions. These compounds are toxic to spawn growth but are utilized by the olive green mold. It is highly cellulolytic.

Pin Molds - *Rhizopus spp.*

A very fast growing fungus. Once it sporulates, it forms many tall aerial hyphae adorned with black-headed pins. It grows on readily available carbohydrates. Along with *Aspergillus* and *Penicillium*, species of this genus are the primary contaminants of grain spawn. It is also very common on straw.



Rhizopus -black bread mold

Plaster Molds and Flour Molds - *Papulaspora byssina, Thielavia thermophila, Botryotrichum piluiliferum, Trichothecium spp.*, and others

These molds develop when nitrogen sources (ammonical compounds and amines) from Phase I are not completely utilized by the microbes during Phase II and when the nitrogen is not converted into microbial protein. They are often seen in raw compost. Aerial hyphae aggregate on compost surface, resembling plaster of paris. White plaster mold (*Botryotrichum piluiliferum*) forms dense white colonies. *T. thermophila* is thermophilic (unique among the indicator molds), and may grow rapidly during the last days of Phase II. It indicates hot spots during spawn run, inhibiting spawn growth (resulting in black areas). Brown plaster mold (*Papulaspora byssina*) forms dense brown colonies on compost.

La France Disease - an isometric virus

Symptoms of this disease include a degeneration of the mycelium, suppression of fruiting, and rapid dying of mushrooms. In time, the mushroom mycelium disappears. Infected mushrooms are off-white and drum-stick shaped. Other fruitbody symptoms include dwarfing, premature opening of veil, development of an elongated spindly stem with a small cap, formation of a thickened stem with a thin flat cap, and malformed or absent gills. Mushrooms should be picked before the veil opens since spores may carry virus particles (75% infection rate of spores from infected mushrooms). Pasteurization of wood after the compost has been removed is essential. Initial sources include infected spores or mycelium in or on wood, compost, casing, people, and equipment. Wood should be cleaned, disinfected, and steamed. The virus may enter a mushroom farm from neighboring farms and from wild mushrooms. Controls include pasteurization (145 F for 6 or more hours) of compost, spawn, equipment and empty rooms), cleaning HEPA filters, and general sanitation. In 1962, Hollings first identified viruses in mushrooms, also the first report that fungi had viruses. Another virus with a lipid membrane is found in all hybrid spawn; its effect is unknown. PCR is now used by makers of spawn for early detection of viruses. An outbreak of viruses on a farm can be devastating.

More:
http://www.hri.ac.uk/isms/article4.htm

Mummy Disease - *Pseudomonas aeruginosa*

Symptoms of infected Button mushrooms include curved stems surrounded at the base by an overgrowth of mycelium. Internally, stems have water-soaked, longitudinal streaks. Caps are tilted and dwarf. Tissues become spongy and dry (mummified). Sanitation and reducing free water are control measures.

Pseudomonas aeruginosa colonies on agar

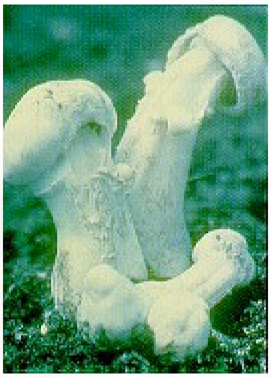
More:
http://www.shroomery.org/index.php/par/26841

Wet Bubble - *Mycogone perniciosa*

Symptoms include malformed mushrooms with swollen stipes and reduced or deformed caps. Undifferentiated tissue becomes necrotic and a wet, soft rot with an offensive odor may follow. An amber liquid appears on infected mushrooms. Mushrooms become brown in color. Bubbles may be as large as a grapefruit. The fungus is spread via airborne dust and contaminated casing. It is also a parasite of wild mushrooms. Controls include sanitation and in some countries the use of the compound Sporogone, which is also very effective against Verticillium. Wet bubble is the most important Button mushroom disease in China.

Dry Bubble - *Verticillium*

This disease is caused by Verticillium, a species which produces sticky spores.
The symptoms produced vary with the developmental stage of the mushroom at the time of infection. 'Early' infection at pin head formation results in the production of malformed pin heads, which turn a grey/brown colour and remain leathery. Infection at a later stage causes a thickening of the stipe especially at the base, and also a crooked mushroom with a tilted cap and backward peeling stalk. Cap infection can occur at a very late stage in the development of the mushroom, resulting in circular superficial spots, initially pale brown in colour which become grey with age.



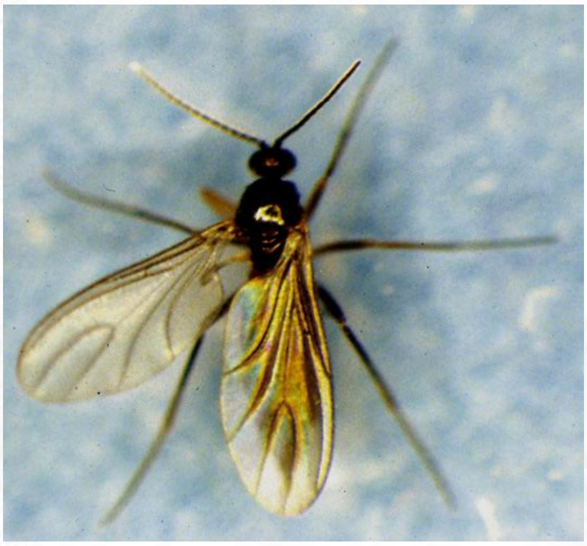
Verticillium sp. commonly occur in the soil which may be a primary source of the infection, however, it is more likely that they come with casing or by transfer of infection from house to house by pickers, flies or machinery. Spores can lie dormant until they come into contact with mushroom mycelium which stimulates them to grow. Because the spores are sticky the disease is spread on dust particles from the movement of earth or spent compost. This dust can contaminate fresh casing, or can enter through fans or doorways or be carried in by flies, pickers or even mites. The disease within the production house can be spread by water splash. The spores can also be spread on any other equipment used in an infected growing house. Appearance of the disease at pin head formation signifies infection at an early stage of development, probably at the time of casing. Development of the disease at later stages of the production cycle usually indicates infection has occurred from other cropping houses or from outside sources. Spread by water, flies and pickers can result in 30% of the crop being infected at the third flush and by the last flush virtually all of the crop. The highest standards of hygiene are essential for the control of Verticillium. Other methods of control are as follows:

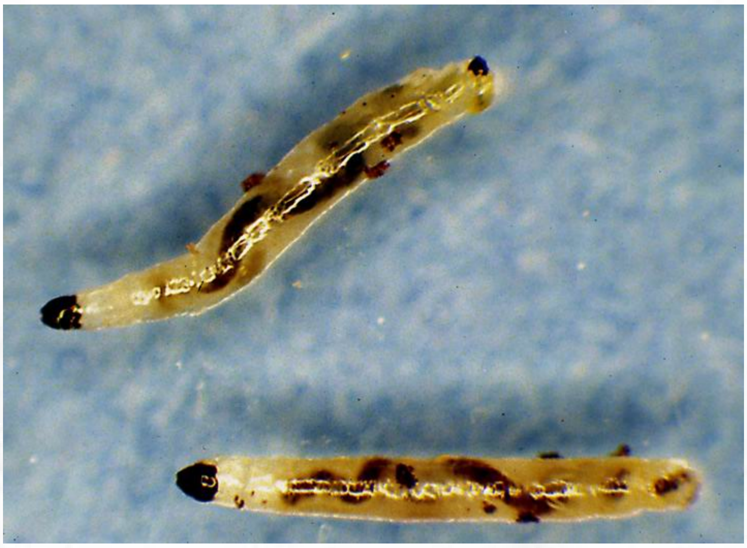
Control:
1. Avoid soil movement near mushroom houses especially on windy days. Take measures to avoid the accumulation of dust in the vicinity of mushroom houses and also dust movement into the vicinity of mushroom houses.
2. It is essential to control flies and every effort should be made to prevent their entry into cropping houses.
3. As diseased mushrooms appear they should be removed from the beds using a cloth or sponge soaked in disinfectant and then placed in a bucket containing disinfectant.
4. Table salt on top of tissue paper can be used to contain disease.

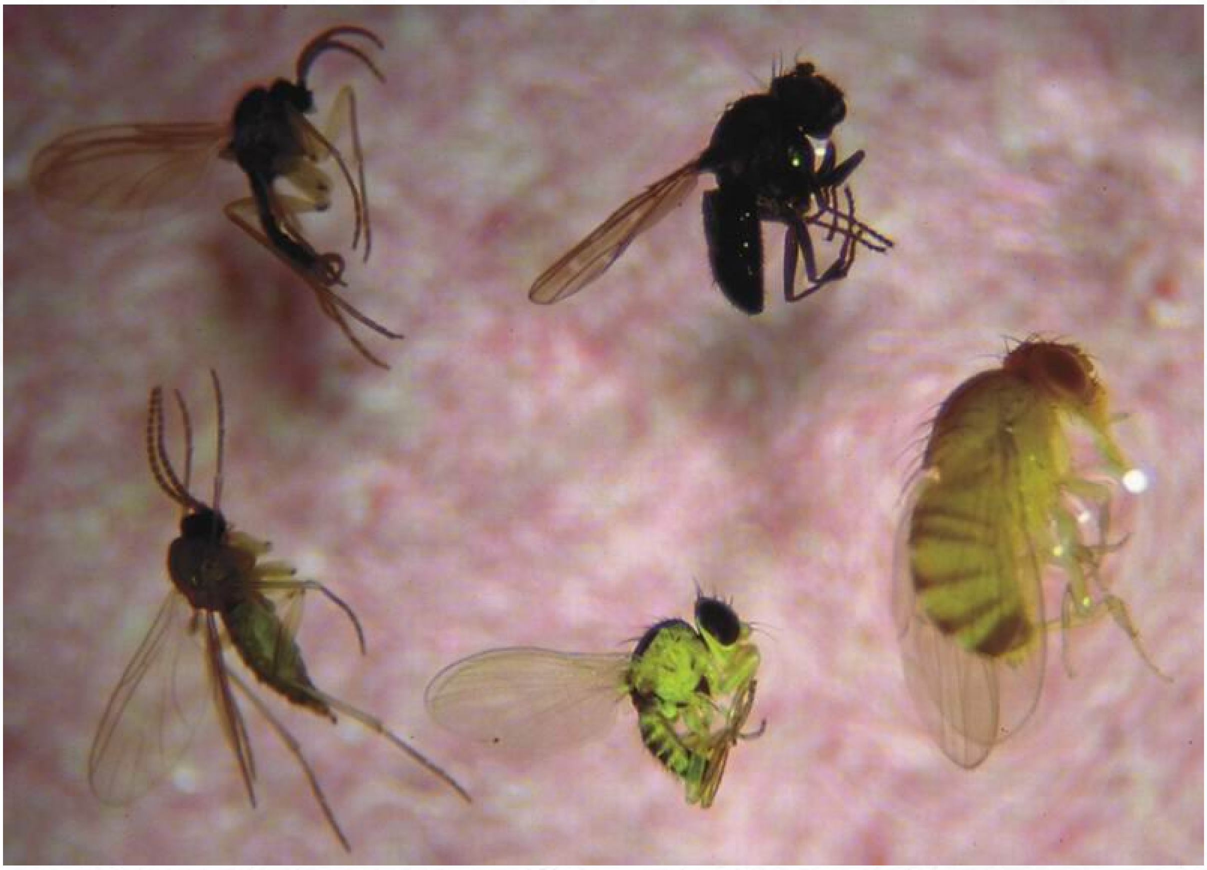
More:
http://mushgrowinfo.cas.psu.edu/Verticillium Dry Bubble.htm

Fungus gnats (Sciarids) - (*Lycoriella spp.*) and phorids (*Megaselia spp.*)

Adults are small (1/8 inch long), fragile grayish to black flies with long, slender legs and thread-like antennae. Their wings are clear or smoky-colored with no pattern and few distinct veins. Larvae are clear to creamy-white and can grow to about 1/4 inch long. They have shiny black head capsules.
They are attracted to the mushroom crop and their larvae feed directly on mycelium, swarm over the mushroom, and tunnel into the developing or developed mushroom. Tissues that have been physically damaged by flies often become colonized by bacteria which cause soft rot, thereby accentuating the problem. Controls include strict sanitation and general farm hygiene. For example, the grow room must be air tight. Fresh air that is used is filtered. Even a small crack will serve as an entry for the flies. Most farms use sticky tape or some other method that allows monitoring of populations. A biocontrol using nematodes offers effective control when populations of flies are low. In addition to the damage which fly larvae cause by eating mushroom mycelium or killing pins, the adults also carry diseases such as Verticillium, Mycogone and Cobweb.







Mites

Many mites are commonly found in straw and manure, most species are beneficial to mushroom growing as they feed on eelworms and other mites, although some can cause damage.
Mites, like fly larvae, may feed on mushroom mycelium and on the mushrooms, where they can cause surface discoloration. They may also live on other fungi (weeds and indicator molds) found in mushroom culture. One example is the red pepper or pygmy mite (*Pymephorus spp*.). These mites are commonly associated with *Penicillium* and *Trichoderma* molds, upon which they feed. Pygmy mites do not feed on *Agaricus*. These mites have the ability to change into an intermediate stage called a hypopus, wherein they develop flattened bodies and a sucker plate with which they attach to moving objects, like flies. Mites at this stage swarm on top of mushrooms.

1. Tarsonemid mite

> These mites are pale brown and are so minute that they are only visible with the aid of a microscope.
> They cause damage by feeding entirely on hyphae of mushrooms and the grower will know if he has these mites present, as the base of the stem of the mushroom will show a reddish brown discolouration. Where severe infestations occur the whole base of the mushroom may be detached from the growing surface.
>
> Control
> 1. As with eelworms little can be done when mites are present in the growing house, therefore efficient composting and peak heating must take place to ensure that they are killed during the pasteurization process.
> 2. Good hygiene should be practised around the farm, especially in the clearance of crop debris.

2. Tyroglyphid mites (*Tyrophagus spp*)

> These mites can be identified as they are slow moving, translucent, with long hairs on their bodies.
>
> If these mites are present in abundance they eat small pits in the caps and stalks. These pits then suffer from bacterial decomposition, which breaks down tissues just below the surface. This results in the skin collapsing which leaves an open pit. Tyroglyphids may also feed on mushroom mycelium, where they are present in large numbers, crop reductions can be caused.
> Mites usually gain entry into the compost by clinging onto Sciarid flies when the mites are the migratory stage. These migratory stages are normally produced when mites become overcrowded.
> The mites should not be a problem where efficient composting and peak heating takes place. Organic debris should not be allowed to accumulate around the farm as it provides a breeding ground for mites.

3. Red Pepper Mites (*Pygmephorous spp*)

> These mites are not regarded as primary pests, their presence is usually an indicator that Trichoderma (green mould) is present in the compost. These mites feed on various weed moulds but not mushrooms, thus their presence indicates that the compost is unsatisfactory.
> The mites are yellowish-brown in colour, 0.25 mm in length and have a flattened appearance, they also are capable of rapid rates of reproduction.
> As already stated these mites are secondary pets and they often swarm on the casing and mushroom surfaces. Where this happens their presence makes the mushrooms unsaleable. These mites can also spread spores of Trichoderma from bag to bag.

Nematodes - *Aphlelenchoides composticola* and *Ditylenchus myceliophagus*

These nematodes are common inhabitants of most agricultural soils. Symptoms include a degeneration of mushroom mycelium and failure of mushrooms to form. Normally, an infestation is noticed at the time of third break. Mycelium in affected areas is completely destroyed and as the compost decomposes, it turns black and a medicinal odor is detectable. An effective Phase II is the primary control.

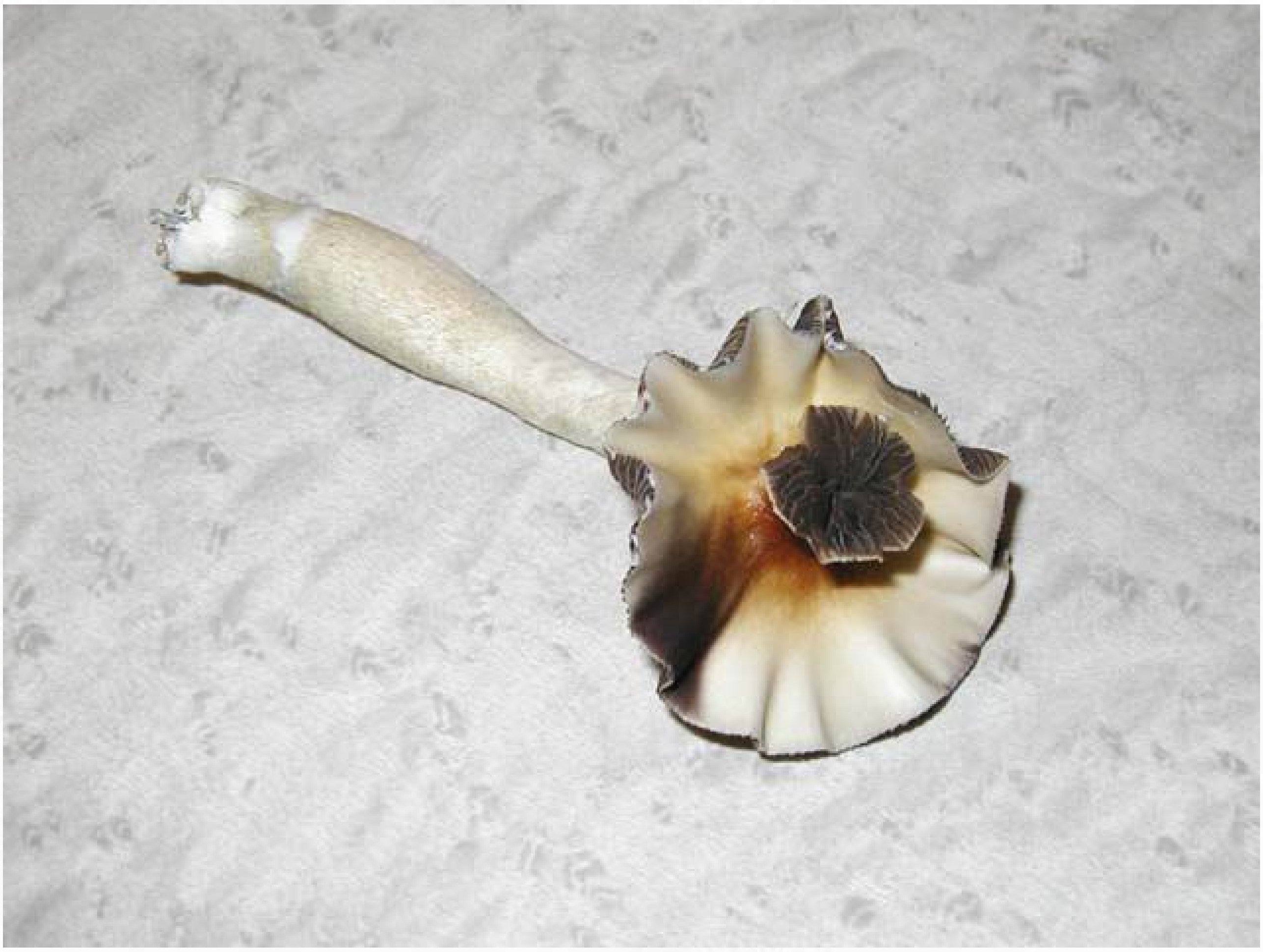
Abnormalities

Several disorders have abiotic origins. Common ones include:

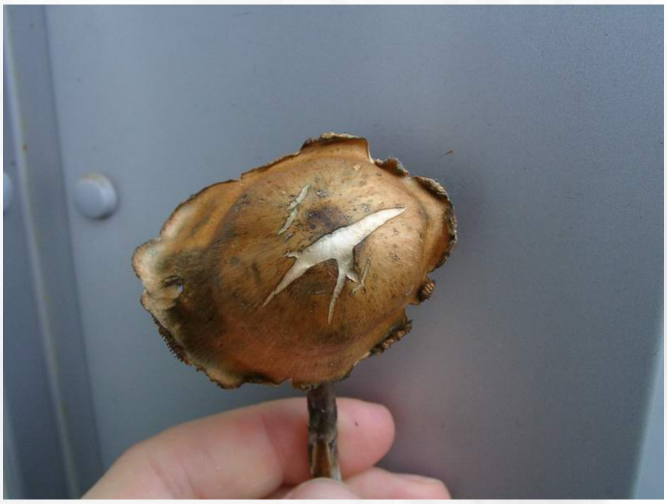
Browning - tyrosinase (phenolase) - Is the main enzyme responsible for browning in Agaricus. Calcium chloride in irrigation water decreases bruising by increasing the integrity of vacuole membranes (thus, tyrosinase is not released).

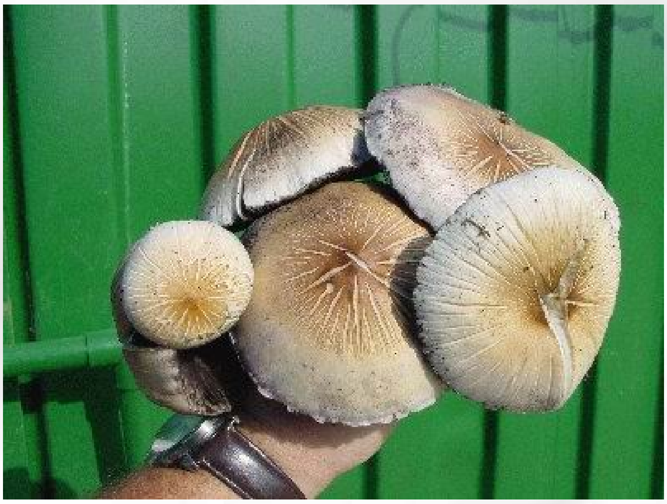
Flock, hardcap, and open veil - Physiologically induced malformation of cap and gill tissue. Cap opens prematurely. Causes include some diseases, petroleum based materials, and genetic abnormalities. Hollow core and brown pith - related to water stress, but exact factors unknown. Long stipes and small caps - insufficient light and/or fresh air.

Rosecomb - Condition where pink gill tissue, often with a porous appearance, develops on the surface of a mushroom cap. The cause has been attributed to contamination by petroleum based materials.

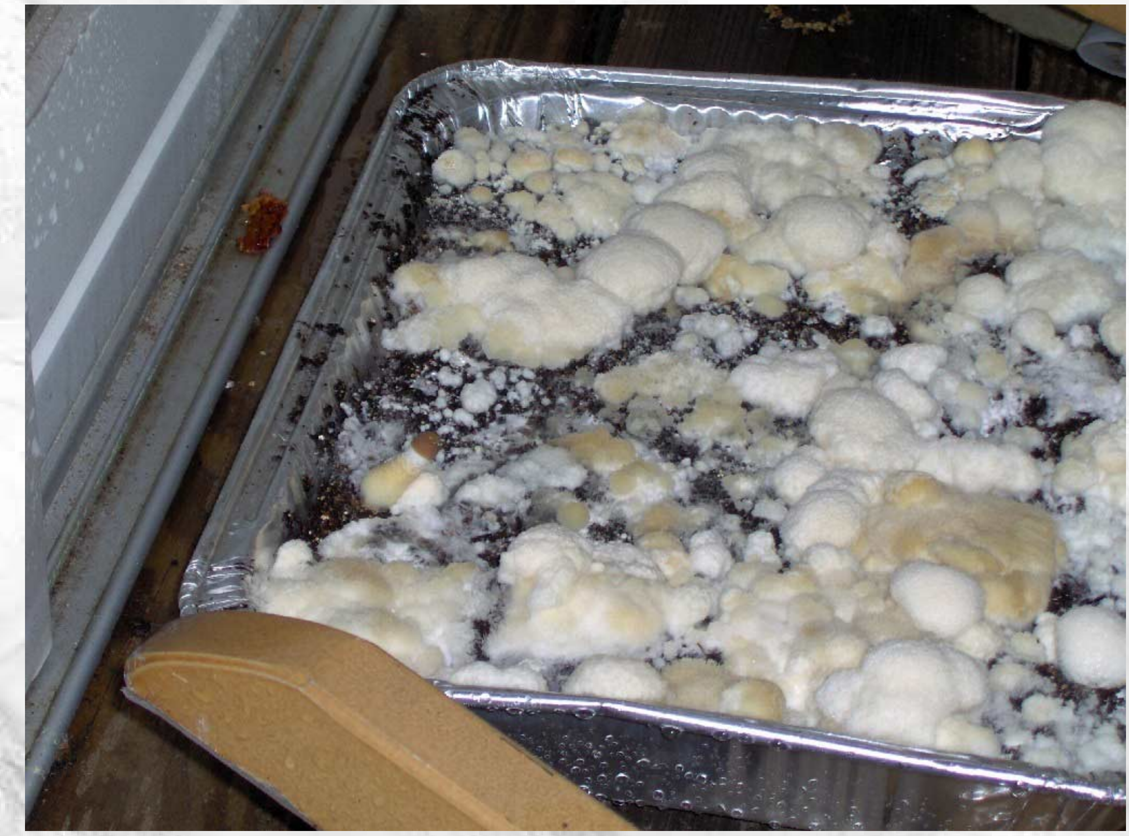


Scaling - The natural reaction of the mushroom cap to dry air.





Stroma - Dense mycelial growth without fruiting. Stroma occurs if spawn is mishandled or exposed to harmful petroleum-based fumes or chemicals. It also occurs in dry environments.



Weepers - Mushroom exudes water from cap. The cause is not known, but it is seen in low-moisture compost and high-moisture casing.

Literature sources:

- Plant Pathology 40, Edible Mushroom Cultivation Lecture/Lab 8 Pest, Diseases, and Weed Control; Abnormalities, February 26, 1999
- Mushroom Cultivator : A Practical Guide to Growing Mushrooms at Home, Paul Stamets, J.S. Chilton, 1984
- http://www.mold-help.org
- http://www2.truman.edu/~jherrera/colonies/colonies-genera.html
- http://www.hortips.co.uk/mush_2.htm

Moulds

Isolation, cultivation, identification

original source: http://website.nbm-mnb.ca/mycologywebpages/Moulds/Moulds.html

Table of Contents:

- **MOULDS AND THEIR CHARACTERISTICS**
- **HOW MOULDS ARE CLASSIFIED**
  - Chytridiomycota
  - Oomycota
  - Zygomycota
  - Ascomycota
  - Basidiomycota
  - Anamorphs
    - *Method of conidiogenesis*
    - *Locus of conidiogenesis*
    - *Sequence of conidiogenesis*
  - Other mould-like organisms
    - *Bacteria*
    - *Actinomycetes*
    - *Yeasts*
    - *Slime moulds*
- **WHERE MOULDS ARE FOUND**
  - Living plants
  - Dead plant material
    - *Herbaceous plants*
    - *Wood*
    - *Leaves*
  - Animals and humans
    - *Diseases*
    - *Predation*
  - Soil
  - Air
  - Dung
  - The human environment
    - *Food*
    - *Cellulose products*
    - *Other products*
    - *Moulds in the indoor environment*
- **HOW MOULDS CAN BE ISOLATED**
  - Direct isolation techniques
    - *Direct transfer*
    - *Moist chambers*
    - *Direct plating*
    - *Dilution plating*
  - Airborne fungi
  - Baits
  - Special techniques
    - *Stress techniques*
    - *Surface sterilization*
    - *Selective nutrients*
    - *Selective temperatures*
    - *Osmophily*

Spore printing
HOW MOULDS ARE GROWN
Media
Solid media
Liquid media
A few useful media
Synthetic
Semi-synthetic
Natural media
Preparation of media
Mixing
Sterilization
Cultivation
Sterile technique
Disposal of old cultures
PREVENTION AND TREATMENT OF CONTAMINATION
Contaminating agents
Prevention of contamination
Airborne contaminants
Contamination from natural sources
Decontamination
Mechanical methods
Chemical methods
MOULDS UNDER THE MICROSCOPE
Preparation of slides
Slide cultures
Mounting media
IDENTIFICATION OF MOULDS
Use of dichotomous keys
Keys to sixty common genera of moulds
The dichotomous or text keys
The picture keys
Keys to some common genera of moulds
Group I
Group II
Group III
Group IV
Group V
Picture keys to some common genera of moulds
Group I
Group II
Group III
Group IV
Group V
PICTORIAL INDEX OF MOULDS
INDEX TO THE DESCRIPTIONS AND ILLUSTRATIONS
Acremonium
Alternaria
Arthrinium
Arthrobotrys
Aspergillus
Aureobasidium
Bacteria
Beauveria
Bipolaris
Botrytis

Candelabrella
Candida
Cephalotrichum
Chaetomium
Chrysonilia
Chrysosporium
Circinella
Cladosporium
Dendryphiella
Diplodia
Yeasts
Echinobotryum
Epicoccum
Eurotium
Exophiala
Fusarium
Geniculifera
Geomyces
Geotrichum
Gliocladium
Gonatobotrys
Graphium
Gymnoascus
Leptographium
Microsphaeropsis
Monacrosporium
Mortierella
Mucor
Myrothecium
Nigrospora
Oedocephalum
Oidiodendron
Paecilomyces
Penicillium
Pestalotiopsis
Phialophora
Phoma
Pithomyces
Pyrenochaeta
Rhizopus
Scedosporium
Scopulariopsis
Sepedonium
Sporothrix
Stachybotrys
Stemphylium
Streptomyces
Talaromyces
Trichocladium
Trichoderma
Trichophyton
Trichothecium
Trichurus
Ulocladium
Verticillium
Wardomyces

Zygospores Mucorales

BIBLIOGRAPHY

MOULDS AND THEIR CHARACTERISTICS

Moulds, those dusty little spots often found spreading over bread, cheese, books, and other things in the home, cause the loss of millions of dollars to our economy every year and, even worse, may be a menace to your health. To deal with them successfully we must understand what moulds are and exactly what they are doing.

Moulds are microscopic, plant-like organisms, composed of long filaments called *hyphae*. Mould hyphae grow over the surface and inside nearly all substances of plant or animal origin. Because of their filamentous construction and consistent lack of chlorophyll they are considered by most biologists to be separate from the plant kingdom and members of the kingdom of fungi. They are related to the familiar mushrooms and toadstools,differing only in not having their filaments united into large fruiting structures. For our purposes here, we shall consider as moulds only fungi that are commonly encountered n the home and laboratory and that can be easily grown and studied.

When mould hyphae are numerous enough to be seen by the naked eye they form a cottony mass called a *mycelium*. It is the hyphae and resulting mycelia that invade things in our homes and cause them to decay.

Moulds reproduce by *spores*. Spores are like seeds; they germinate to produce a new mould colony when they land in a suitable place. Unlike seeds, they are very simple in structure and never contain an embryo or any sort of preformed offspring. Spores are produced in a variety of ways and occur in a bewildering array of shapes and sizes. In spite of this diversity, spores are quite constant in shape, size, colour and form for any given mould, and are thus very useful for mould identification.

The most basic difference between spores lies in their method of initiation, which can be either sexual or asexual. Sexually initiated spores result from a mating between two different organisms or hyphae, whereas asexual spores result from a simple internal division or external modification of an individual hypha. the recognition of a mating and subsequent spore formation is often difficult for an observer,and is usually reserved for patient specialists. However, for practical purposes one can learn to recognize certain indications of the sexual process, namely, the four kinds of sexually determined spores that appear in mould fungi: (1) oospores, (2) zygospores, (3) ascospores, and (4) basidiospores.

Oospores (Figure 1) are produced when male gametes (reproductive nuclei)enter a large spherical cell (*oogonium*) and fertilize the eggs within. The result, as seen in routine examination, is numerous oogonia containing one to several spherical and often brownish eggs. The oogonia are usually penetrated by one or more hyphae (*antheridia*) that give rise to the male nuclei.

Zygospores (Figure 2 and zygospore illustration) do not occur inside any kind of enclosing structure, but are produced by the direct fusion of two hyphal protrusions (*suspensors*) from neighbouring filaments. Usually zygospores are recognized as large,nearly spherical, often dark brown or black, rough-walled spores with two connecting hyphae, representing the two mating gametangia (figure 2C). Sometimes the zygospore may be surrounded by several finger-like extensions from the two gametangia.

Ascospores (Figure 3) are produced within spherical to cylindrical cells called *asci*, most often in groups of four or eight (figure 3A). Usually the asci are produced within some kind of enclosing structure and thus are not found exposed on the hyphae. In a few cases the asci may be borne among hyphae and resemble oogonia with eggs, but they will never be penetrated by any sort of fertilizing hypha. Fertilization occurs early in the life cycle and is not evident at the time ascospores are produced.

Basidiospores (Figure 4) are always produced externally on a structure called a *basidium*. Basidia come in a variety of forms, but those commonly encountered on moulds will be club-shaped and bear four or eight spores on sharp projections at the apex. At first it may be difficult to distinguish between a basidiospores and one of the asexually initiated spore types, but one should always suspect the presence of basidia when externally produced spores consistently occur in groups fo four or eight (figure 4). As with ascospores, basidiospores are the result of an early fertilization that is not easily observed.

Asexual spores usually occur either in sporangia or as conidia. *Sporangia* are modified hyphae or cells containing numerous spores (*sporangiospores*). They never have more than a single connecting hypha and the spores do not constantly occur in groups of four or eight as do ascospores.

Conidia are the most difficult group to characterize because of their great diversity of form. The only feature that most conidia have in common is that they occur externally on the cells that produce them. These conidium-bearing (*conidiogenous*) cells may occur within rather specialized or characteristic structures that resemble those that frequently bear asci, however, and it is often necessary to break them open to confirm that the spores are truly conidia and not ascospores. Conidia that are borne on the hyphae, without any kind of compound fruiting structure, are the most commonly encountered type. Structures that completely enclose the conidium-bearing cells are called *pycnidia*, and those resulting from a fusion of conidium-bearing cells are called *synnemata* if they are longer than they are broad or *sporodochia* if broader than long.

HOW MOULDS ARE CLASSIFIED

Strictly speaking, all fungi should be classified according to their method of sexual reproduction. In many cases this is possible, allowing us to recognize several groups of fungi. Fungi that are encountered most often or exclusively in the asexual condition create special problems and are discussed separately as *anamorphs*.

Chytridiomycota

The Chytridiomycota, or "chytrids" as they are commonly called, are a group of mostly unicellular fungi occurring in a variety of habitats ranging from soil and roots to the rumens of cows and deer. Asexual and sexual spores are produced in sporangia and escape as *zoospores* (swimming cells). Because of their basically non-hyphal nature and often unusual requirements for growth, the Chytridiomycota are seldom encountered as moulds.

The individual in the photograph above right is perched on top a grain of pine pollen. This is in fact an easy way to collect and examine chytrids. Many plants, including pine and other conifers, produce large amounts of pollen over a short period of time. This pollen can be gathered in small bottles and dried for later use. Sprinkle the pollen *very sparingly* over the surface of some pond water in a dish. Over the next few days examine the pollen under a microscope for evidence of chytrids.

Oomycota

Members of this group all reproduce by oogonia eggs. The hyphae have few or no cross-walls (*septa*) and thus appear as long, clear tubes. If a hypha is broken, most of the contents run out. Many oomycetes reproduce asexually by zoospores, which are motile and can swim quite rapidly. Because of their motile zoospores, oomycetes commonly require water for reproduction and are often encountered in water or wet soil.

An easy way to see oomycetes is to heat a few sesame seeds until they "pop" and then float three or four on the surface of some pond water in a dish. After a few days the oomycetes with form a thick white growth around the seeds. If you watch there carefully you may be able to observe the release of zoospores.

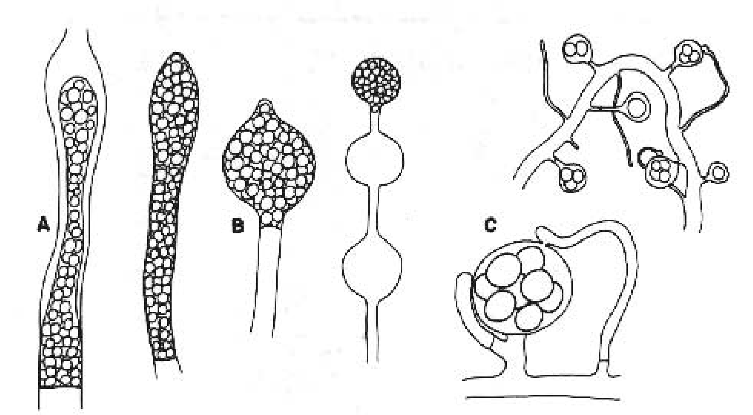
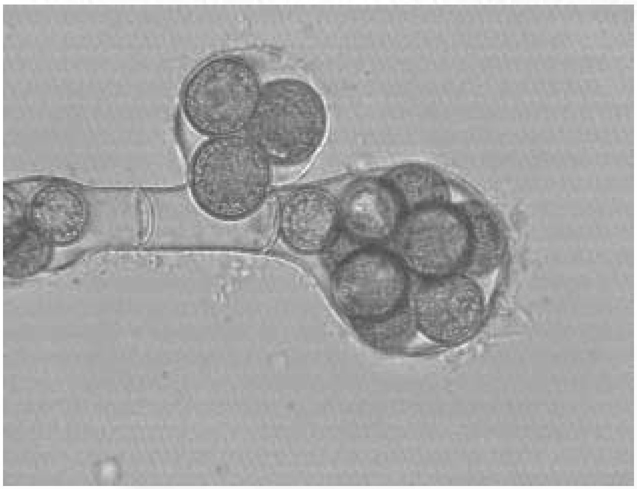


Figure 1 - Oomycota.
A: zoosporangia of *Saprolegnia* sp.
B: zoosporangia of *Pythium* sp.
C: oogonia and antheridia of *Saprolegnia* sp.



Oogonia of *Saprolegnia* sp., isolated from the Ramioul Cave in Belgium.

Zygomycota

As their name implies, these fungi all produce zygospores. They resemble the oomycetes in having hyphae that usually lack cross-walls or septa, but differ in lacking motile spores. Asexual reproduction is by sporangia or conidia. The members of this group are usually terrestrial and will be encountered only occasionally in aquatic conditions.

Zygomycetes are easy to observe. They will invariably grow if soil is sprinkled over strawberries or raspberries. Any attempts to isolate fungi from soil (see chapter on cultivation) will reveal numerous zygomycetes.

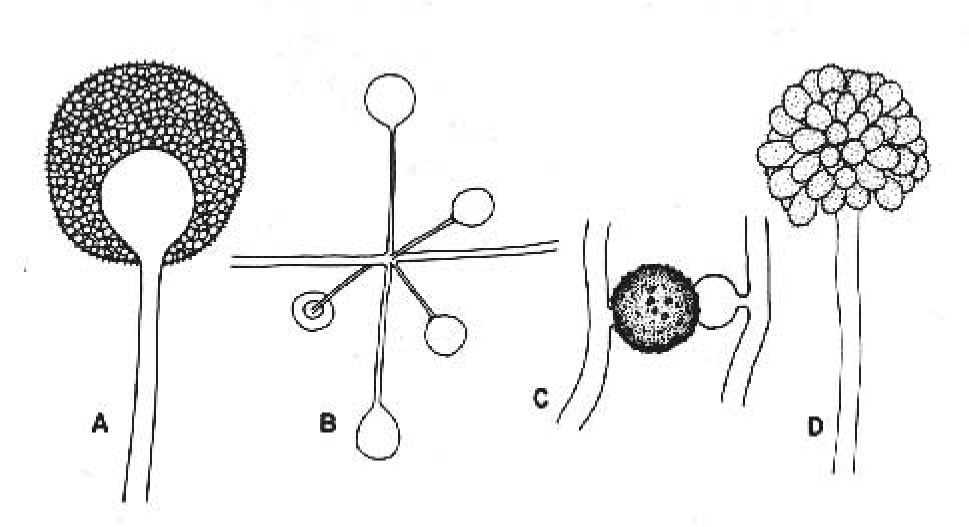


Figure 2a - Zygomycota
A: sporangia of *Mucor* sp.
B: whorl of sporangia of *Absidia* sp.
C: zygospore of *Zygorhynchus* sp.
D: sporangiophore and sporangiola of *Cunninghamella* sp.

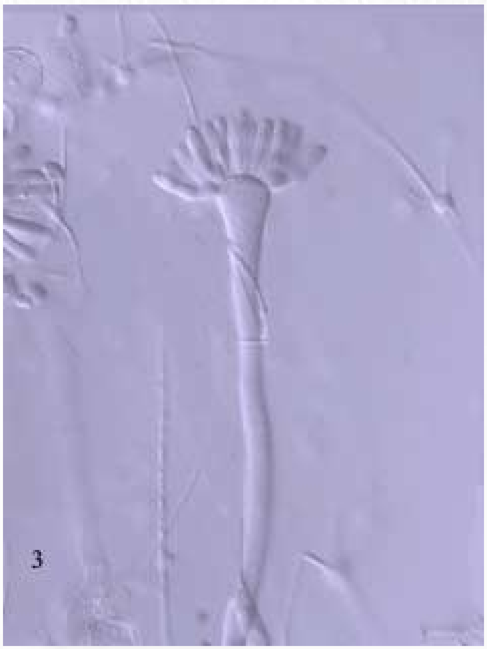


Figure 2b - *Syncephalis*, a member of the Zygomycota parasitic on other Zygomycota.

Ascomycota

All ascomycetes have ascospores borne inside asci. The hyphae always bear numerous septa. Asexual reproduction is by conidia that always lack motility. Although most ascomycetes are terrestrial, some occur in freshwater or marine habitats.

Ascomycetes are everywhere and can be collected year around. The minute black dots on rotting wood and leaves or the little cups on lichens will often prove to be perfect examples.

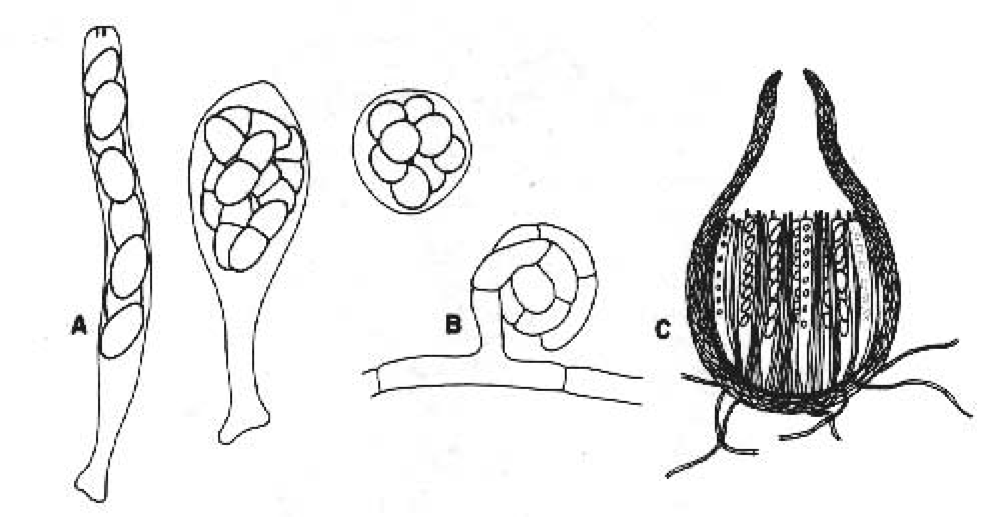


Figure 3 - Ascomycetes
A: three kinds of asci: cylindrical, clavate, and spherical.
B: initial phase of sexual reproduction.
C: cross-section of a flask-shaped perithecium bearing cylindrical asci.

Basidiomycota

This large group, which includes mushrooms and puffballs, is characterized by the presence of basidia and basidiospores. Like ascomycetes, to which they are related, basidiomycetes have hyphae with septa and lack motile spores. The hyphae of many basidiomycetes bear characteristic swellings, called *clamp connections*, that play a specialized role in nuclear migration. Asexual spores, when formed, are produced as conidia. Most basidiomycetes are terrestrial.

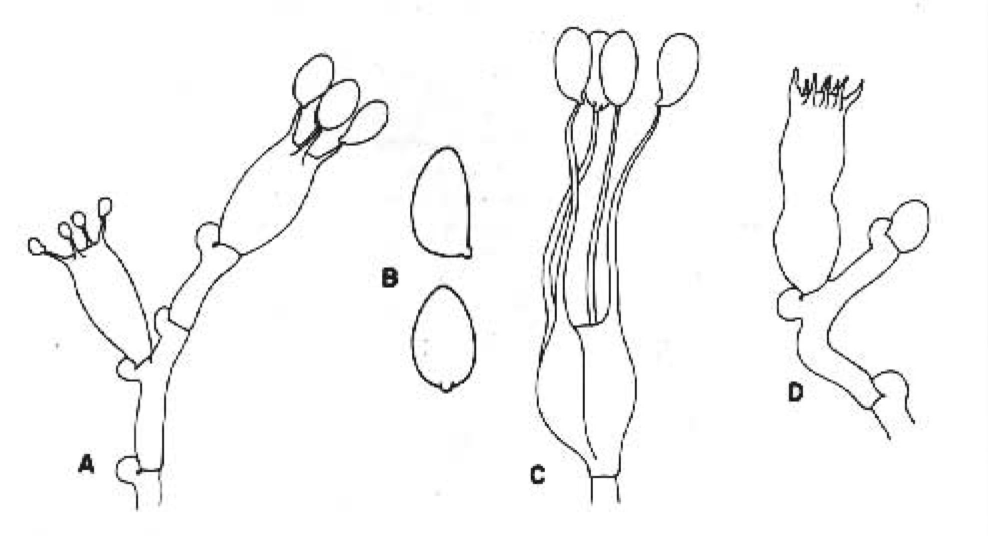
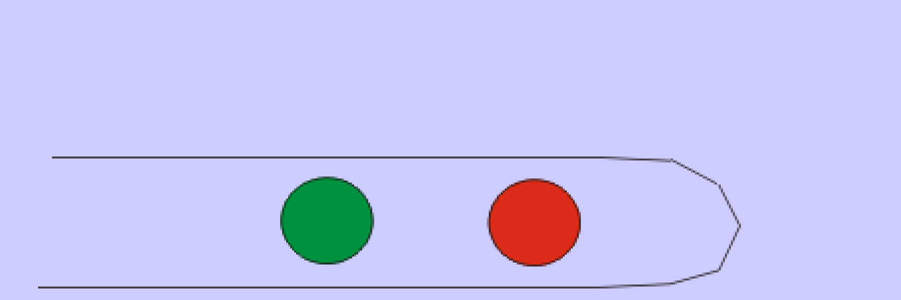


Figure 4 - Basidiomycetes A: four-spored undivided basidium (holobasidium); note the clamp connection at each cross-wall. B: two typical basidiospores, the upper one in side view and the lower in front view. C: a four-celled, cruciate basidium typical of many jelly fungi. D: eight-spored holobasidium typical of species of *Sistotrema*; the spores have been discharged.



The role of a clamp connection in facilitating nuclear migration.
(Gif animation not available in PDF version.)

Anamorphs

This group comprises the large number of fungi known to reproduce asexually by conidia and is by far the most important in a study of moulds. The asexually reproducing structures of a fungus are called *anamorphs*, which, together with the sexually reproducing structures or *teleomorphs*, make up the *holomorph* or whole fungus. Until the recent advent of a practical genetic methodology the numerous fungi known only as anamorphs could not be classified confidently with the ascomycetes or basidiomycetes to which they undoubtedly belonged. Mycologists have long used a system of classification that allows anamorphs to be named separately from the holomorph of which they form a part. As a consequence, many fungi could have two different names. For example, the name *Eurotium repens* pertained to a holomorph with both ascospores and conidia, whereas *Aspergillus repens* pertained only to the anamorph of the same fungus. Current advances in nucleotide sequencing now allow quite accurate taxonomic placement of species, and as of 1 January 2013 the dual system has come to an end. We now adhere to the more intuitive concept of "One Fungus - One Name". Digging out from more than a century of double names will take time and mycologists temporarily use the old system, but in an admittedly informal sense. Once all the doubly-named species have been sorted out mycologists can breathe a sigh of relief.

Anamorphs show considerable structural diversity and can be classified or described according to three attributes: (1) the method of conidium production (conidiogenesis), (2) the locus of conidiogenesis, and (3) the sequence of conidiogenesis (See Figures 5 and 6).

Method of conidiogenesis

Production of a conidium involves the transformation of part of a cell into a separable spore. Sometimes a hypha or cell becomes separated into one or more segments by septa. The separate cells then thicken, swell, and finally separate. This kind of conidiogenesis, where the septa appear before the conidium is initiated, is called *thallic* (Figure 5A,C). When the new conidium is initiated, begins to swell or thicken, and *then* is cut off by a septum, the conidiogenesis is called blastic (Figures 5B, D;6). When the wall of the conidium is continuous with the cell that produced it, it is called either *holothallic* (when thallic) (figure 5A) or *holoblastic* (when blastic) (figure 5B). When only the inner walls of the conidium-bearing cell are involved in conidiogenesis, the prefix "entero-" is used, resulting in the terms *enterothallic* (figure 5C) and *enteroblastic* (figure 5D). Although enterothallic types are rare, enteroblastic types are probably the most common of all and are represented by the ubiquitous phialide.

The following genera, illustrated at the end of this document, illustrate features of this section:

Holoblastic: *Botrytis*, *Geniculifera*, *Trichocladium*

Enteroblastic: *Acremonium*, *Bipolaris*, *Penicillium*

Holothallic: *Geotrichum*, *Oidiodendron*

Locus of conidiogenesis

Conidiogenesis usually can be traced to a particular point or locus on the conidiogenous cell. If this point remains stationary and gives rise to more conidia it is said to be *stable* (figure 5D). If subsequent conidia are produced at new points on the cell the conidiogenous locus is said to be *dynamic*. Dynamic loci may gradually elongate and be called *progressive* (figure 6C), or move toward the base of the conidiogenesis cell and be *retrogressive* (figure 6B). Usually it is necessary to examine several cells to "reconstruct" the loci of successive spore productions.

The following demonstrate types of loci:

Stable: *Aspergillus*, *Monacrosporium*

Dynamic-progressive: *Arthrobotrys*, *Scopulariopsis*, *Stemphylium*

Dynamic-retrogressive: *Arthrinium*, *Geotrichum*

Sequence of conidiogenesis

If only a single conidium is produced on a conidiogenous cell (figure 6A), we can hardly speak of a sequence. If, however, more than one is produced they can occur either *simultaneously* (figure 5A, B, C) or *serially* (i.e. one after another) (figures 5D; 6B, C).

The following illustrate sequence types:

Solitary: *Monacrosporium*

Multiple, simultaneous: *Botrytis*, *Oedocephalum*

Multiple, serial: *Cladosporium*, *Phialophora*, *Ulocladium*

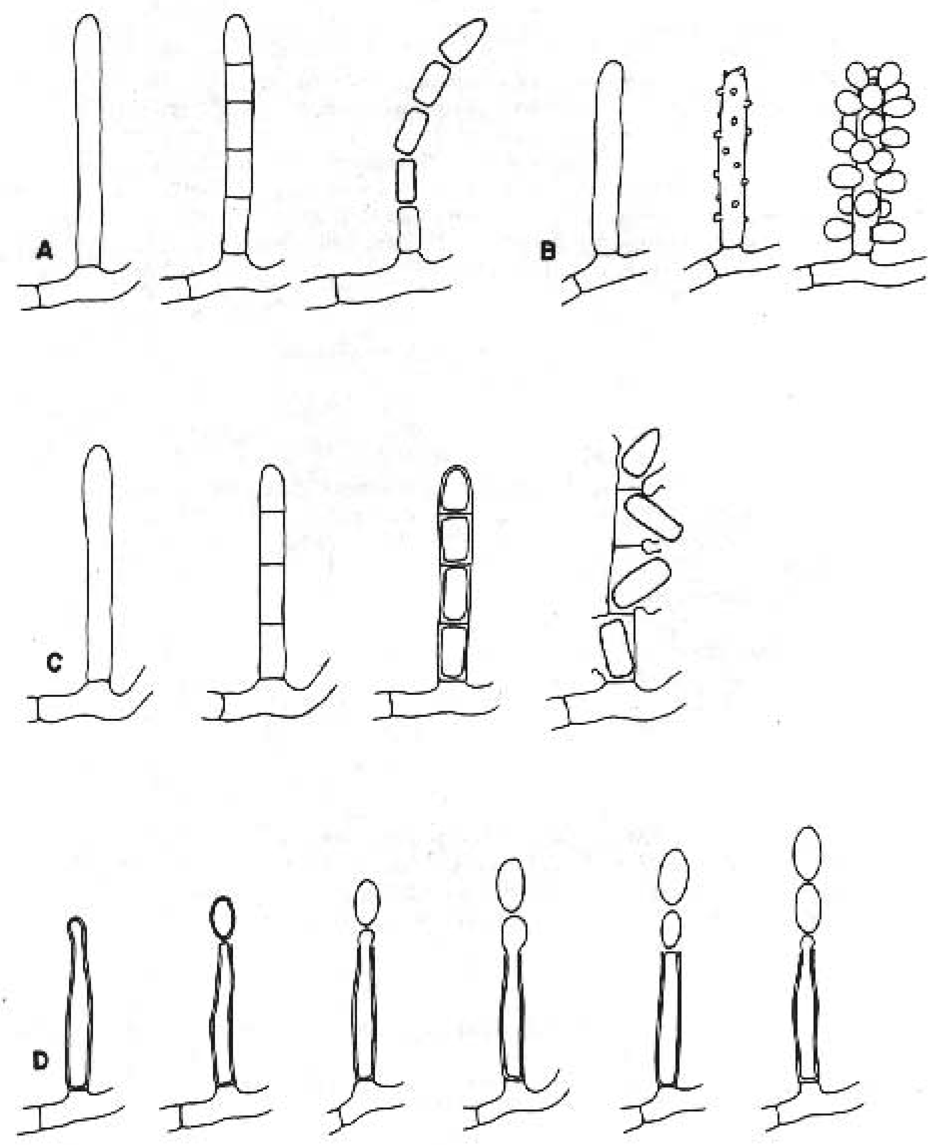


Figure 5 - Conidiogenesis 1.
A: holothallic; the multiple conidia are produced simultaneously.
B: holoblastic; the multiple conidia are produced simultaneously.
C: enterothallic; the multiple conidia are produced simultaneously.
D: enteroblastic; the multiple conidia are produced serially from a stablelocus.

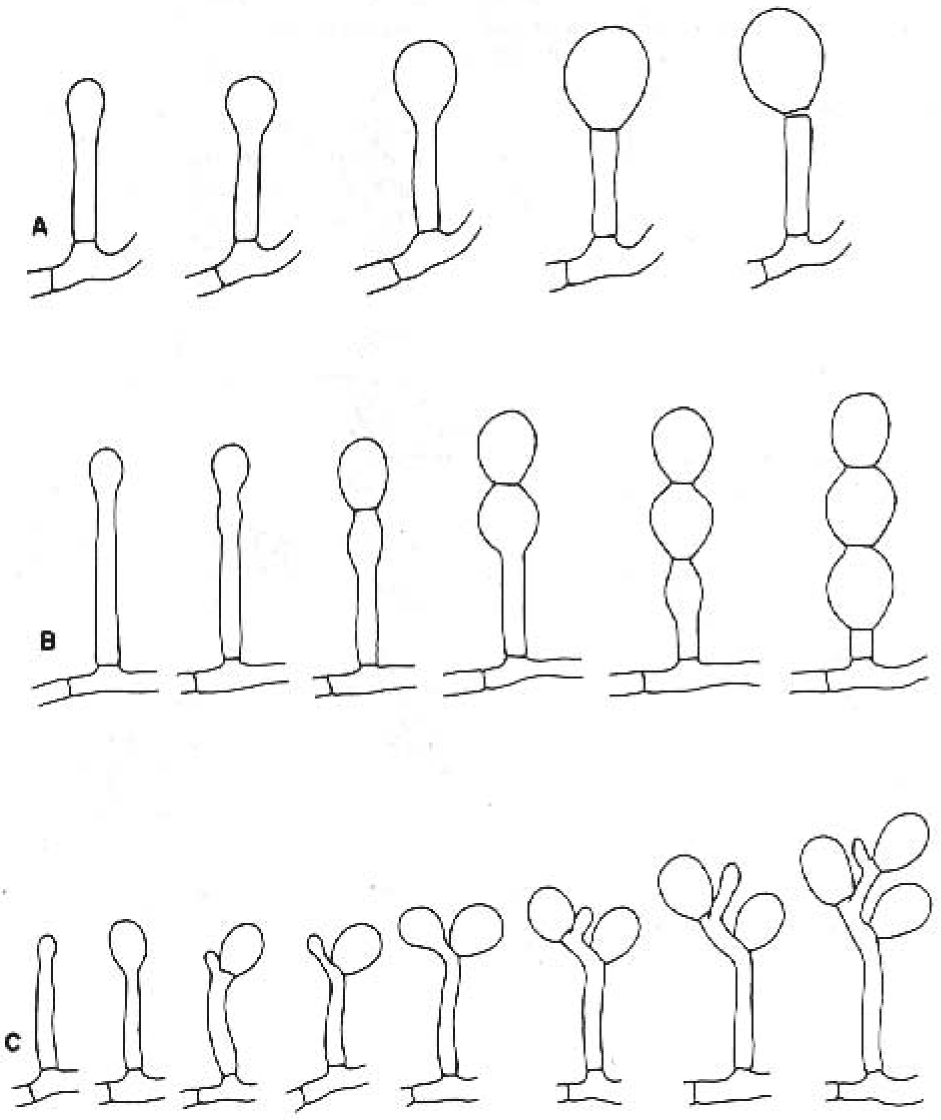


Figure 6 - Conidiogenesis II.
A: holoblastic; the conidium is solitary.
B: holoblastic; the multiple conidia are produced serially from a retrogressive locus.
C: holoblastic; the multiple conidia are produced serially from a progressive locus.

Other mould-like organisms

In routine work we often encounter organisms that are similar to moulds but do not fit our strict definition of the term. Either the organism is not filamentous or it is filamentous but not strictly a fungus. We can put four groups of organisms into this category; bacteria, actinomycetes, yeasts, and slime moulds.

Bacteria

Bacteria represent a very ancient group of organisms, perhaps as old as four billion years. Colonies of bacteria are composed of minute spore-like cells that together form a slimy mass. Such colonies never contain hyphae and are thus easily distinguished from those of true moulds. Bacterial cells, rarely more than 1 um in diameter, are difficult to examine, even with a good microscope, and are best seen when stained. Many bacteria are motile and swim vigorously.

Actinomycetes

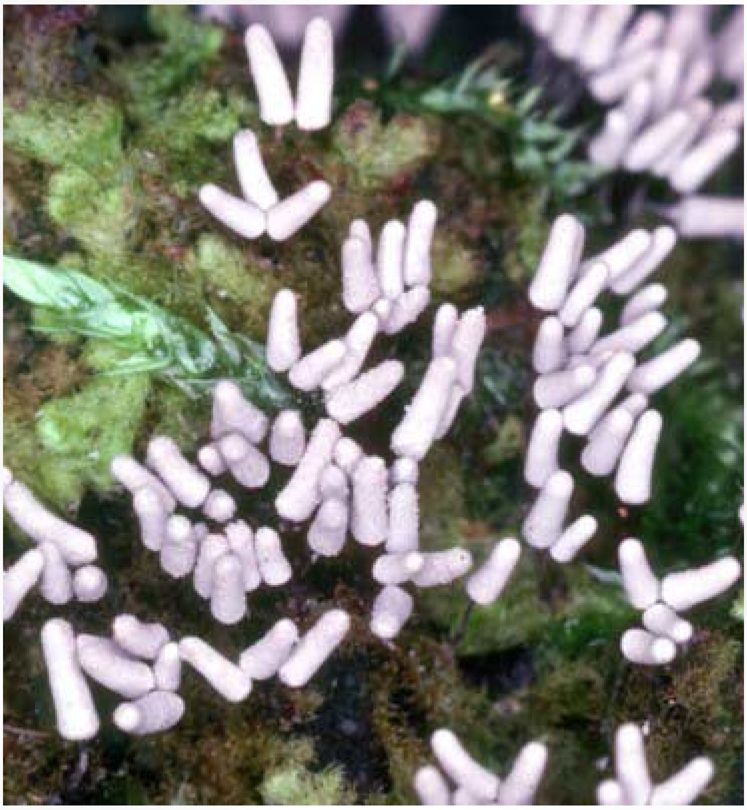
These organisms are usually classified as bacteria but have filaments like fungi. The filaments are seldom more than 1 um in diameter, however, and are thus considerably narrower than those of moulds. *Streptomyces*, the only actinomycete genus commonly encountered as a "mould", produces grey to brightly coloured powdery colonies, usually with a soil-like odour.

Yeasts

Yeasts are true fungi, but in lacking hyphae cannot be classed as moulds. They resemble bacteria in forming pasty or slimy colonies of spore-like cells, but differ in having these cells much larger, usually 2 um or more broad. Reproduction of yeasts is usually by budding, a process where a smaller cell appears to bubble slowly out of the parent cell.

Slime moulds

Slime moulds normally occur on logs and other natural materials but occasionally occur in the laboratory as "moulds". Cellular slime moulds, the most likely to appear in the laboratory, have creeping amoeba-like cells during part of the life cycle and sporangium-like structures in another. They most closely resemble members of the zygomycete genus *Mucor*, but differ in their complete lack of hyphae. Myxomycetes, another group of slime moulds, occur on rotting wood and vegetation in a great variety of habitats. The ones in the photograph at right were growing on an old moss-covered log.



WHERE MOULDS ARE FOUND

Almost any natural material, no matter how small, will support an indigenous population of moulds. Moulds are part of the economy of nature, quickly occupying dead or nearly dead materials and returning them to the basic building components of new organisms. As such, they are essential to what biologists call nutrient cycling, the process whereby nutrients never leave the realm of living things, but simply get used again and again; earth to earth, ashes to ashes, dust to dust.

While acknowledging that moulds are everywhere, it is useful to classify their habitats into a number of categories based on nutritional characteristics. Moulds have specialized nutritional requirements and usually do not range very far from their usual habitats: fungi that naturally decay seaweed on the beach will not be expected to occur on mouldy bread in the kitchen. The competition among moulds having similar nutritional requirements is intense and leaves no room for a mould adapted to another habitat.

Aside from nutritional and competitive barriers, other factors encourage habitat restriction among moulds. Most influential is spore dispersal. Although most moulds seem to produce astronomical numbers of spores, they are, in fact, practising a strict economy. In their highly competitive life there can be little waste; every minute bit of energy must be put to good use or a more efficient organism will prevail. Thus moulds will produce only enough spores to ensure reproduction of their species from year to year. If a mould were to put a disproportionate amount of energy into spore production, it would have to be at the expense of some other activity, such as rapid growth. Economy in spore production is best ensured by mechanisms of spore dispersal conferring a high probability of encountering suitable places to germinate and grow. Many different mechanisms exist and account for the great variety of spores and spore-producing structures found in moulds.

In many instances, moulds living together in particular habitats have similar methods of spore dispersal, even when the moulds themselves are not closely related, illustrating the idea that many structures in organisms are similar because of common ecological pressures rather than common ancestry. Thus we come again to a basis for subdividing habitats, and, as we shall see later, also a basis for applying certain techniques for the isolation and cultivation of moulds.

Living plants

Most plant diseases are caused by fungi. The largest group of plant parasites are the rusts, a highly specialized group of organisms that grow extremely slowly in the laboratory and are outside the usual definition of moulds. Powdery mildews, like the colonies of *Uncinula circinatum*parasitzing a maple leaf at right, have never been cultivated away from their plant hosts. Some plant disease fungi are less difficult to grow but are so specialized as parasites that they seldom occur in laboratories other than those of the plant pathologist. Many of these fungi have rather strict nutritional requirements to induce sporulation and are usually seen in cultivation only as sterile hyphae.

The plant disease fungi most commonly encountered as moulds are those having non-parasitic stages in their life-cycles. These fungi usually grow and sporulate well in the laboratory. Examples are species of *Phoma*, *Fusarium*, *Bipolaris*, *Graphium*, *Pestalotiopsis*, and *Monilia*.

Most parasitic fungi do not produce great numbers of spores and it is likely that they are transferred to uninfected plants by fairly specific means. Those having wet spore stages, such as species of *Phoma*, *Fusarium*, *Pestalotiopsis*, and *Ustilago* (a smut), are probably transmitted by insects or other arthopods, such as mites. Other fungi, such as *Cladosporium* and *Monilia*, produce large numbers of dry spores, and appear to be wind-dispersed.

Also conspicuous are fungi attacking plants weakened by senescence or disease. Such invaders are hardly parasites in the strict sense. Many of these fungi are now considered to be "endophytes", organisms that enter plant tissues while they are still healthy and remain there in a dormant state until the tissue is weakened or dies. Some ecologists now view these endophytes not as parasites but as the first arrivals in a long sucession of decay organisms. Many species of *Alternaria*, *Botrytis*, *Cladosporium*, *Fusarium*, and *Ulocladium* may belong here.

Dead plant material

Herbaceous plants

Moulds occurring on dead herbaceous plants are often the same species attacking dying ones. Thus we can again list *Alternaria*, *Cladosporium*, and others, as well as a few new ones such as *Epicoccum* and *Candida*. In temperate climates, where many plants die in the fall, there is a tremendous flush of mould activity in autumn. Because the dead plant material is so abundant, finely tuned dispersal mechanisms are not necessary and the moulds simply release their spores in the wind. The likelihood that a spore of *Cladosporium*, for example, will hit a dead plant part in the autumn is very great.

Nutritional specialization dictates that different plants will support different fungi, and we find, for example, dead grasses yielding a different flora of moulds than dead milkweeds or mustard, at least to a partial extent.

Wood

Dead wood is a good source of moulds and provides two distinct habitats, depending on whether it is covered with bark or not. Moulds occurring under the bark of fallen and standing trees cannot disperse their spores into the air and most often utilize insects and mites for their transmission. Although, as we might expect, many have wet spores ideal for sticking to the bodies of their dispersers, some have dry spores that appear to become trapped among the animals' body hairs. I have seen hundreds of the curved, dry ascospores of *Fragosphaeria purpurea* trapped among the bristles on the backs of mites under bark of maple trees in Ontario. Often the moulds under the bark of dead standing trees are different from those on fallen trees.

The surface of wood not covered with bark often has a distinct community of moulds. Although air dispersal of spores is possible in this situation and apparently often occurs, wet-spored moulds are still abundant. Again standing and fallen trees support different fungi. Freshly cut wood is a good source of moulds causing a phenomenon called blue stain. These moulds, common in lumber-yards as bluish to black discoloration on the wood, produce tall sporulating structures bearing wet drops of insect-transmitted spores. Closely related species occupy the tunnels and galleries formed by beetles under the bark of living and recently dead trees.

Leaves

Dead or dying leaves of trees support moulds similar to those from herbaceous plants, with some notable exceptions. However, tree leaves appear to support fewer *Alternaria* and *Cladosporium* colonies, thus often allowing a better chance to observe the more slowly growing or rarer fungi. For example, in Ontario fallen leaves of ash support a pin-sized mushroom called *Marasmiusminutus*, that never occurs on herbaceous plants.

Leaves submerged in water support a number of moulds with unusual spore forms. The spores may be needle-like, coiled like a watch-spring, or coiled into barrel-shaped structures that bob to the surface of the water and float away. Others have three or four narrow arms and look something like jacks with two or three of the arms missing. These moulds may be examined by submerging leaves in a bowl of water and stirring them vigorously. After a few minutes the spores will float to the surface, where they can be skimmed off in a drop of water. Best results are obtained with leaves likely to become submerged later in the natural habitat but have not yet become so.

Animals and humans

Diseases

A number of diseases of humans and animals are caused by mould and yeast-like fungi (Figure 7). Many are known only from this habitat and are quite specialized. Notable are the moulds called dermatophytes, the cause of a number of skin diseases such as ringworm and athletes' foot. The fungus grows on the outermost layer of skin, causing reddening of the surrounding tissues (zoophilic types) and sometimes scaliness (anthropophilic types). Dermatophytes do not normally attack deeper tissues; the symptoms are usually due to an allergic reaction. Because of their essentially non-parasitic nature dermatophytes are usually easy to grow in the laboratory. Many closely related species occur on substances similar to human skin, such as leather, feathers, hair, and horn, and are unable to grow on living animals or man. Probably the most commonly isolated dermatophytes are species of *Microsporum* (Figure 7A), *Trichophyton*, and *Epidermophyton*.

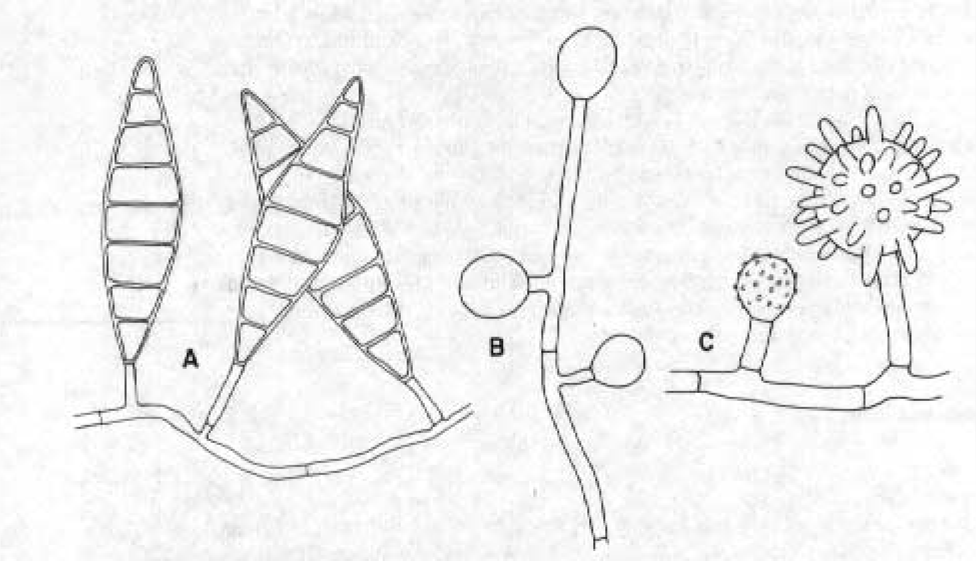


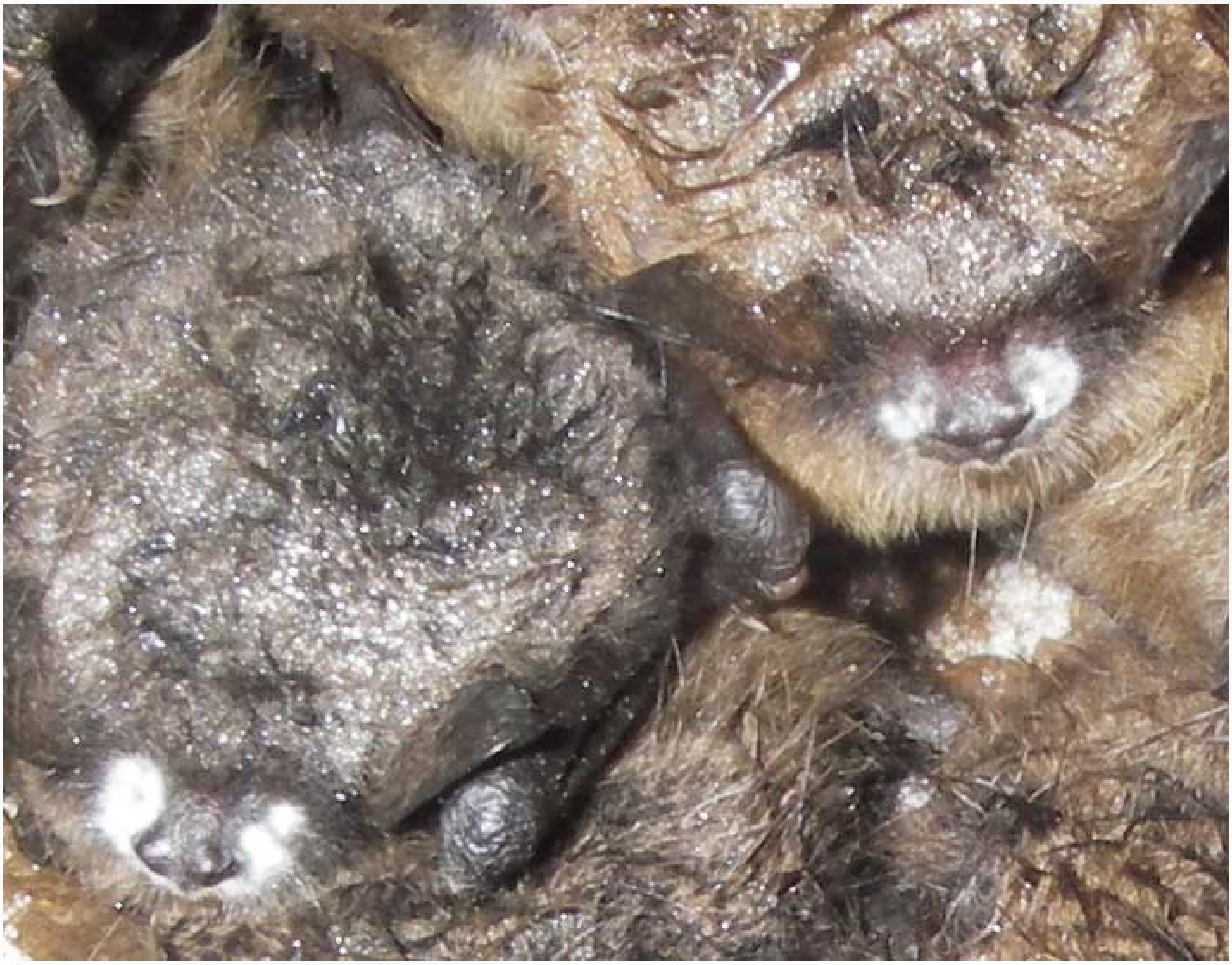
Figure 7 - Some fungi of medical importance.
A: Microsporum, causative agent of ringworm and other skin diseases.
B: Blastomyces dermatidis, causative agent of North American blastomycosis.
C: Histoplasma capsulatum, causative agent of histoplasmosis.

Several fungi can occur on living tissues and cause serious disease and even death. Many such organisms are known only from individuals who have low disease resistance, due to prior infection, AIDS, old age, or other factors. Most commonly, infections by these fungi occur when the normal bacterial populations of the body are eliminated by the use of antibiotics. Without competition from bacteria these fungi occupy the tissues and grow rapidly, often causing considerable damage.

Other fungi attack healthy living tissues without the aid of antibiotics, causing more localized but very serious infections. Histoplasmosis, a disease with symptoms similar to those of tuberculosis, is caused by *Histoplasma capsulatum* (Figure 7C), a mould associated with bird nests in nature. It is frequently reported in perfectly healthy people who have been exposed to the dust from nesting materials, such as while tearing down old barns.

The study of medically important fungi is beyond the scope of this book and will not be discussed further. There are several good books dealing with medical fungi from a *mycological* (rather than medical) point of view. Especially useful are Hoog and Guarro, 1995; McGinnis (1980) and St-Germain and Summerbell, 1996.

One of the most devastating animal diseases to have appeared in recent years is the "White Nose Syndrome" in hibernating bats. This disease, caused by *Geomyces destructans* is now known from a large part of eastern North America where it has drastically reduced the numbers of bats. Some scientists have suggested that species such as the little brown bat may become almost extirpated in much of its geographical range. The fungus appears on the hibernating bats during the winter, causing them to awaken several times. It is thought that when they wake up they burn of valuable fat reserves necessary to carry them through until the return of flying insects in the spring. Infected bats attempt to leave their caves to feed in late winter and freeze or starve to death. The photo at right shows two infected bats photographed in an old mine in New Brunswick, Canada. The fungus can be seen at white circles on each side of the animals' noses.



Predation

Some moulds actually trap small (usually microscopic) animals. Best known are those that trap eelworms or nematodes (see Barron [1977] for an excellent account of these fungi). The traps produced by these fungi are composed of loops, networks of filaments, or knobs and branches. Some are reminiscent of the well known

Venus' fly-trap, and are sprung upon contact with an eelworm. When the worm crawls into a ring of one of these fungi, the ring rapidly constricts, holding the eelworm tightly. At first the worm struggles violently, but it soon becomes still and is invaded by the filaments of the mould. In other species, the loops and branches are sticky and hold the eelworm fast as soon as it touches them.

A second group of eelworm catchers produces spores that are swallowed by the worm, germinating later in the gullet. At least one species has an elaborate injection mechanism that, when sprung, forces a small portion of the spore right into the tissues of the side of the eelworm.

Soil

Soil is one of the most commonly studied mould habitats. It is source of plant disease fungi, some human disease fungi, predacious fungi, and a host of forms that bring about the transformation of dead plant and animal material into soil.

Soil is not a uniform substance; in fact, it is so complex that a study of soil is a science in itself. Scientists recognize several layers in the soil, starting at the surface and working down. These are:

L layer: the layer at the soil surface composed of undecayed plant litter. The origin of the litter is clearly identifiable.

F layer: the layer with identifiable but partially shredded or decayed plant material.

H layer: the layer containing much material of plant origin, but with individual structures no longer recognizable.

A layer: the layer with plant or organic matter present but unrecognizable as such or well mixed with loam (a mixture of sand, silt, and clay).

B layer: a mineral layer containing little organic matter.

C layer: the parent rock from which the mineral layer is derived.

Naturally these layers are not always distinct, and grade more or less evenly on into the other. Some soils, especially agricultural ones, lack stratification altogether. Soils differ from one another in the kind of plant material falling into them; the relative proportions of sand, silt, and clay in the mineral components; the moisture content; the relative acidity or alkalinity (pH); and in many other characteristics.

Fungi, because they are highly specialized users of organic substances, vary from one soil to another and with depth in the same soil. They are entirely dependent upon the kind of material falling into the soil: a fungus specializing in oak leaves will probably not colonize a pine needle. This factor alone will account for many differences between the mould populations of two soils. In addition fungi may be sensitive to moisture levels, pH, competition from other organisms, and many other influences.

As a leaf falls into the soil it is shredded by arthropods and digested by microorganisms. Gradually it becomes buried under newer generations of leaves and thus moves down into the lower layers of soil. It undergoes continuous decay by moulds, bacteria and other organisms until it finally disappears (somewhere in the B layer). Fungi that first invade the leaf, often while it is still on the tree, will grow on it until the particular nutrient they need is exhausted and then die back, to be replaced by new fungi extracting what *they* need from the leaf. In this way, a leaf moving down through the layers of soil will have a series of moulds on it, each replacing a previous population. This transition of populations as the habitat ages and is modified is called *succession* and is the object of much study and discussion among ecologists.

Although we tend to think of soil fungi as decomposers of litter, they play a number of other roles as well. Many are associated with animals and animal products and may trap eelworms and other soil animals, or decay the dead bodies of insects and earthworms. Some invade cast-off feathers and hair, and at least one group specializes in old hooves and horns.

Through their roots, living plants offer an attractive habitat for soil-inhabiting fungi. Some live around the root and decay away the dead root layers or substances exuded by the root. Others invade the living root tissues and either cause plant disease or live in harmony with them. The latter situation involves a form of symbiosis called *mycorrhizae*, where the root and the fungi within each benefit the other, In fact, most mycorrhizal fungi and plants cannot live apart. Only a few species of plants are consistently free of this association.

Air

Air, of course, is not a habitat for moulds, though many disperse their spores by air currents and are encountered in routine work.

Fungi have a variety of mechanisms for getting their spores into the air. Simplest is that of exposing dry spore masses to air currents. Many moulds use this method, especially those that colonize exposed leaves and stems. Species of *Alternaria*, *Cladosporium*, and some of the basidiomycetes called smuts are conspicuous for this kind of dispersal. These species usually produce large numbers of spores, a necessary expenditure if at least a few randomly dispersed spores are to land on a suitable place to grow.

Ascomycetes and basidiomycetes are usually capable of shooting their spores away into the air. Asci are like popguns: the water pressure inside the ascus builds up higher and higher until the spores are fired out the end with considerable velocity. Ascospores can, in fact, be shot a distance of several centimetres from the end of the ascus, a prodigious feat considering the microscopic size of these mechanisms. The equivalent at our own scale would be to fire a 30-cm projectile a distance of 6 km, a feat necessitating a 105-mm howitzer! With such a mechanism, ascomycetes need not be exposed directly to the wind but may grow in places allowing entry to the air of their discharged spores. Thus ascomycetes are often found growing closer to the ground than other air-dispersed organisms.

Basidia discharge their spores from the tips of small projections called *sterigmata*. Such spores, sometimes called *ballistospores*, are not shot very far, only far enough to clear the surface of the basidium and the fruiting structure. The fruiting structures of basidiomycetes may be microscopic in size and bear only a few basidia or they may be very large, as in mushrooms and bracket fungi. These last fungi often continue to produce spores throughout the growing season and can produce a staggering number. One of the most prolific of these, the "artist's fungus", *Ganodermaapplanatum*, may disperse its airborne spores many kilometres from the woods where it grows. Related to the basidiomycetes are the mirror yeasts, a group of yeasts that produce ballistospores on solitary sterigmata. Most basidiomycetes are not normally encountered as moulds, and are really outside our interest here, but a few, such as *Sistotrema brinkmanii* may be encountered in the laboratory.

Some spores become airborne by a mechanism known as *droplet adhesion*, a process dependent upon the presence of tiny water droplets in the air. When one of these droplets, as on a foggy day, encounters a mould spore attached to a leaf, for example, the spore adheres to the droplet by surface tension and is carried off on it. It is then either deposited when the drop comes to earth, or becomes truly airborne when the drop dries out.

There are a few other mechanisms whereby spores become airborne, but these are rather more specific to one or a few species. Most are forcible discharge mechanisms and may involve various kinds of spring, water jet, or bellows devices. A discussion of these and other common mechanisms is found in the excellent book on dispersal in fungi by C.T. Ingold (1953).

Dung

Although people expect dung to be a rather disgusting material to study, many become so intrigued with the moulds and other organisms found there that they soon overcome their initial objections.

Many fungi found on dung are highly specialized for growth there and never occur anywhere else. They do not produce large numbers of spores and thus require a high probability of success in getting their spores from one dung pile to another.

The most commonly cited life-cycle in dung-inhabiting or coprophilous fungi is that shown by many ascomycetes. The spores of these ascomycetes are very heavy, sticky, and dark, and when they are shot from the ascus their weight allow them to travel a relatively great distance. Because of this weight, however, they do not usually remain in the air long, but follow a parabolic trajectory and land near the dung pile. Because they are sticky, often with rather elaborate slimy coverings or tails, they adhere to whatever they fall on, and because of their dark colours they are not greatly affected by the ultraviolet radiation in the sunlight to which they are exposed for an often considerable length of time. Eventually they may be eaten, if they have fallen on vegetation, by a grazing animal, ultimately to be packaged up in a new pile of dung. Many of these spores have a dormancy mechanism that prevents them from germinating on the vegetation but that can be broken when subjected to the processes of the animal's digestive tract. Most coprophilous ascomycetes are light-sensitive and aim their spore shots away from the dark-coloured dung, a first step in their journey to a new dropping.

Other coprophilous moulds present their spores to the environment in wet drops at the ends of stalks. When one of the many insects or mites attracted to dung brushes against these stalked spore drops they carry with them a few of the sticky spores. Later, perhaps on a new dung pile, the spores rub off and germinate to produce a new colony. Most insect-transmitted fungi lack dormancy mechanisms in their spores, and are unlikely to be away from dung for more than a few hours.

The variety of coprophilous fungi is large, and many occur in the laboratory as moulds. Included are several kinds of ascomycetes, some small mushrooms, slime moulds, zygomycetes, and many anamorphs. It is a particularly rewarding group for study by the beginning mycologist.

One warning must be issued. Dung may contain the eggs, larvae or adults of parasitic organisms. While most of these are of danger only to the species of animal producing the dung, some are able to parasitize humans. Because of this dung should never be handled with bare hands.

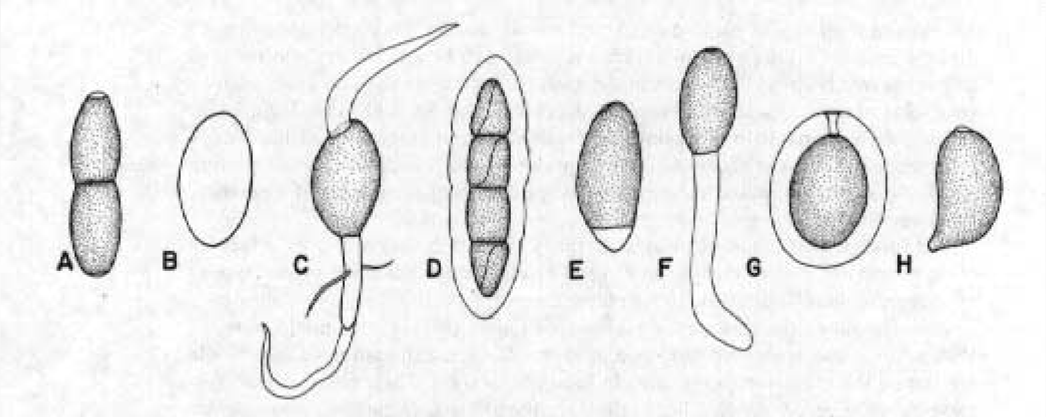


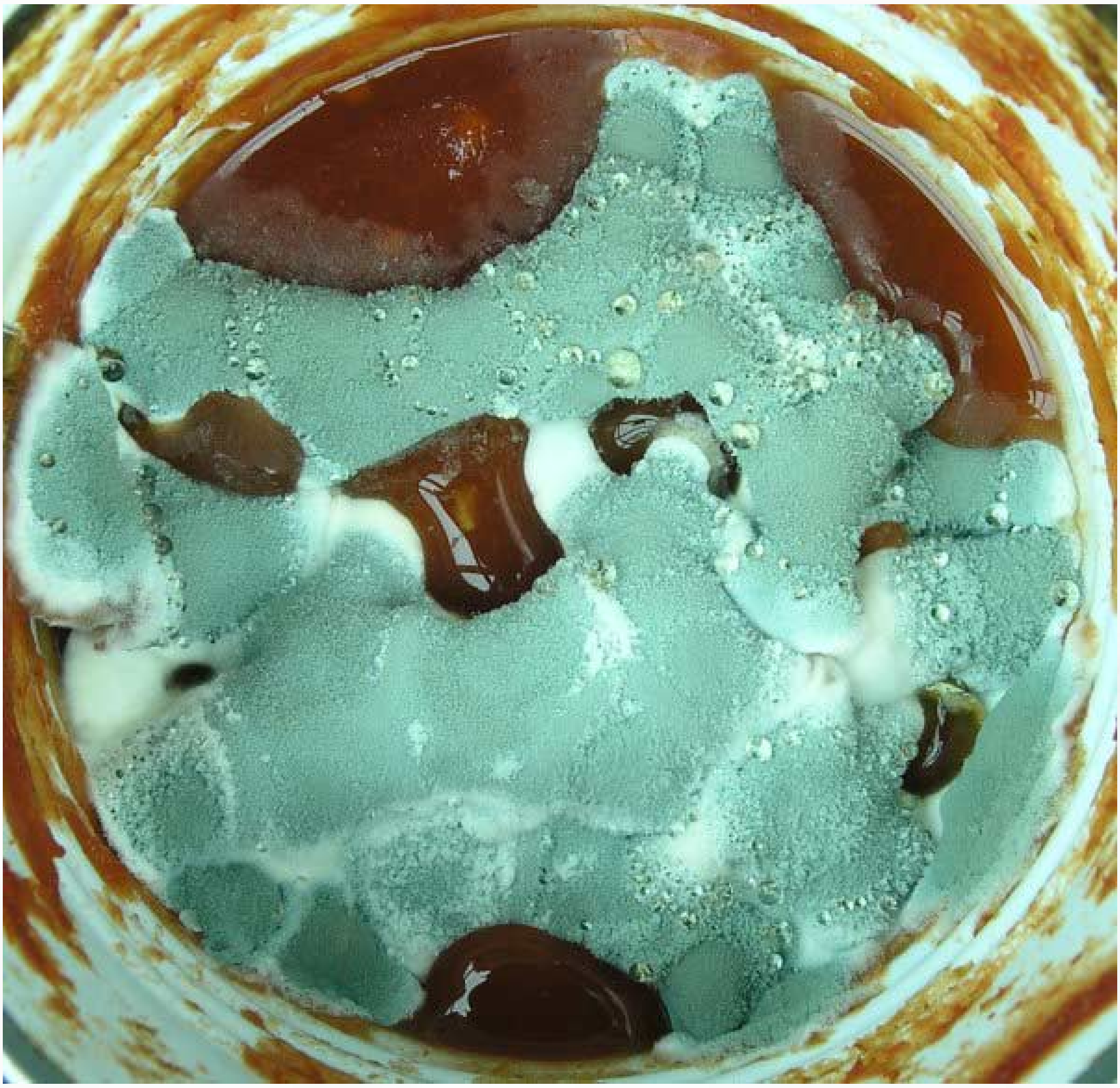
Figure 8 - Spores of some dung-inhabiting fungi.
A: *Trichodelitschia*.
B: *Thelebolus*.
C: *Podospora*.
D: *Preussia*.
E: *Triangularia*.
F: *Cercophora*.
G: *Sordaria*.
H: *Coprinus*.

The human environment

Food

Aside from their role in plant, animal, and human disease, many moulds enter directly into human affairs, in either a harmful or beneficial way. On the plus side is the involvement of moulds in the greatest contribution to medicine of all time, that of antibiotics. The discovery of penicillin by Sir Alexander Fleming in 1928 probably resulted in the saving of more lives than all other medical discoveries combined. Penicillin, a product of the common mould *Penicillium chrysogenum*, is still one of the safest and most widely used of antibiotics, in spite of a more than fifty-year search for others.

The foods we eat are as nutritional to many moulds as they are to us, a fact often put to use in the preparation of food products. For example, several types of cheese, such as Roquefort, Danish blue, Camembert, and Brie, owe their distinctive flavour to the presence of mould growing on them. If the mould were absent, these cheese would not ripen properly. Yeasts, although not really moulds, are among the most important fungi in food preparation. Their value, at least for some *Saccharomyces* species, lies in their ability to produce carbon dioxide and grain alcohol. In wine-making, where the production of alcohol is valued, yeast is added to the grape juice to bring this about. In bread-making, the important product is carbon dioxide, which is necessary in the rising process, and, again, yeast is added to the dough. In the production of beer, both alcohol and carbon dioxide, to produce carbonation, may be necessary, although today the carbon dioxide may be added later artificially.



In the Far East, a number of moulds are used in food preparation that remain unexploited in most of the world. Among these are species of *Aspergillus*, *Monascus*, and *Rhizopus*, used to process various rice, bean and soybean products.

To most of us, the negative aspects of moulds in foods are more noticeable than the positive. Few of us have failed to notice the pink, black, and green moulds growing on bread or the green or blue-green *Penicillium* rots of citrus fruits. Moulds are one of the reasons food manufacturers include preservatives in their products. The picture at right shows a species of *Penicillium*, growing over the surface of some tomato sauce left too long in the refrigerator. The yellowish drops of liquid, called exudate, resting on the surface of the mould, and its overall blue-green colour suggest it is *P. chrysogenum*. Microscopic examination revealed it had smooth conidiophores and conidia, also indicating it to be *P. chrysogenum*.

One of the most destructive activities of moulds in foodstuffs occurs in stored seeds and grains. Certain species of Aspergillus, Penicillium, and Eurotium are able to grow under particularly dry conditions and attack stored grains. To guard against this, the grain must be dried to very low moisture levels. Keeping grains dry in the humid tropics is particularly difficult if not, at times, nearly impossible. Not only do such fungi damage the grains or render them unpalatable, they may also excrete toxins that can cause illness or even death. Most famous of these are the aflatoxins - produced by *Aspergillus flavus* and other moulds - which are not only immediately toxic but are also known to be carcinogenic. *Aspergillus flavus* often grows on peanuts and was first discovered in peanut feed given to turkeys in Great Britain.

Some of the same species of Eurotium that attack stored grain commonly appear on the surface of jams, jellies, and syrups. These very sugary substances tend to prevent water from entering the cells of most fungi and thus create what amounts to a microbiological desert. Eurotium species, with their ability to grow under dry conditions, are ideally suited to such habitats. Some products, such as prunes and dried apricots, are so dry and so sugary that even Eurotium species are unable to cope with them. They still can be decayed by certain specialized moulds, however. Probably the most remarkable to these is *Xeromyces bisporus*, which cannot even grow at the sugar concentration used to grow Eurotium species. Laboratory cultures of this species are rather difficult to establish and require very special conditions.

Cellulose products

Cellulose is probably the most abundant material of biological origin on the earth and is a prime source of energy for many fungi. We have met some cellulose-decomposing fungi already in our discussion of moulds inhabiting dead and dying plant parts, notably Alternaria, Cladosporium and Epicoccum. While these fungi are common enough, there are several others that seem to become especially common on man-made cellulose products, such as paper, cotton, cardboard, and wood products. Many mould growths on paper and cotton are commonly called mildews, but this term really has little meaning. These fungi are able to dissolve the cellulose fibres in cotton and paper and thus cause the materials to disintegrate. The process is especially rapid under moist conditions, as occur in damp basements or in the tropics. Many species of moulds are involved in cellulose decomposition, but none are more widespread than species of the ascomycete genus Chaetomium. During the Second World War, countries fighting in the South Pacific and Southeast Asian areas lost a great deal of equipment to these species. The resulting increased interest in Chaetomium is reflected most notably in Ames's (1963) monograph on the Chaetomiaceae, published by the United States Army.

Sawdust contains many cellulose-utilizing moulds that may cause unwanted decomposition. Particularly undesirable are members of a group of moulds able to grow at high temperatures (up to 60? C). The growth of these moulds may actually cause the temperature of the sawdust to rise. Combined with bacteria having an even higher temperature tolerance and natural chemical activities these moulds may eventually lead to spontaneous combustion, a common cause of fire in lumber-yards.

Other products

Many other manufactured products are susceptible to mould attack. Painted walls, particularly in humid places such as showers, can become overgrown by certain fungi, notably species of Phoma and Exophiala. Wallpapers also serve as a source of nutrition for some moulds. Commonly cited are the Scopulariopsis species which have been reported to grow on wallpapers containing arsenic pigments and to release very poisonous gases. With modern wallpaper pigments, which contain no arsenic, this cannot happen.

Leather is mainly protein and serves as a convenient source of food for moulds. Some of the moulds that occur here are related to the dermatophytes that attack the outer layer of human skin; others belong to quite different groups.

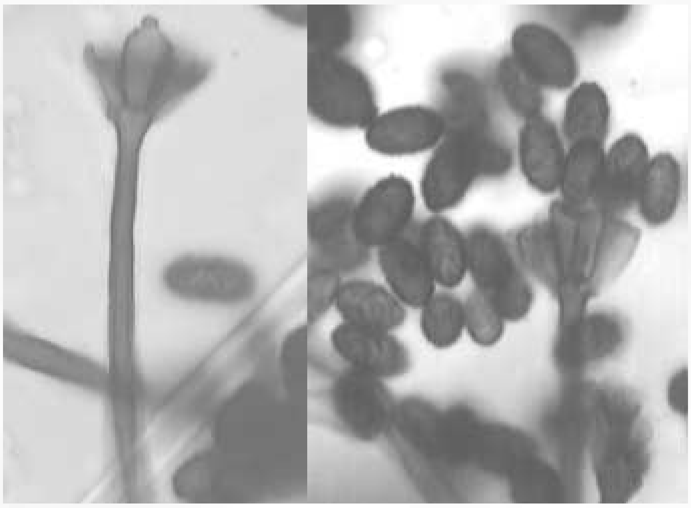
Some substances that seem to be entirely unlikely to support fungal growth may be found to be well colonized by these organisms. Exophiala species, for example, are found in syrupy solutions of polyvinyl alcohol. *Cladosporium (Amorphotheca) resiniae* often occurs on the surface of aircraft fuels in their tanks and can damage jet engines. *Penicillium ochrochloron* can be found in electroplating solutions that are extremely acid and contain very high levels of toxic copper salts. I was once involved in a search for the organism responsible for decaying inflatable life-rafts periodically soaked in seawater. The culprit eventually turned out to be a species of *Aspergillus*.

Moulds in the indoor environment

Increasing attention is becoming focused on fungi in indoor environments. Although most of the moulds occurring in human environments occur indoors, the interior of buildings are themselves a special habitat. It has long been known that indoor fungi cause allergies in sensitive persons, but only relatively recently have indoor moulds been linked to other health problems. While allergy sufferers generally react to substances in fungal spores, other health problems may be caused by voltile substances released by moulds into the air.

Virtually all buildings contain moulds, but some are mouldier than others. Indoor moulds can be remarkably tolerant of dry conditions but none can live without some moisture. Excessively mouldy buildings generally have a source of moisture leading to unusually heavy mould growth. The source of the moisture may be a leaky basement, a dripping pipe, a roof in need of repair or some other fairly obvious cause. In most cases the mould can be seen growing on walls or other materials in contact with the moisture. Sometimes the moisture can occur inside walls and not be apparent. A common but not obvious cause of moisture in cold climates is condensation inside north-facing walls. Severely mouldy buildings may have a musty smell, but not necessarily. Sometimes the only sign of a problem is persistant poor health of the occupants, such as headaches, nausea, respiratory symptoms, etc. It is now known that mouldy buildings can present a serious health risk to occupants. In fact, some infant deaths have been convincingly linked to indoor moulds. Any building with an apparent mould problem should be thoroughly investigated by qualified people.

Not all indoor moulds present a risk to human health, but an abundance of any mould is likely to be accompanied by others, including toxic ones. Species of *Stachybotrys* are particularly toxic. Obvious occurrences of *Stachybotrys* may be sufficient cause for a major "decontamination" by qualified technicians wearing special protective clothing. *Stachybotrys* species produce black colonies on dry wall, ceiling tiles and other materials containing cellulose. The easiest way to confirm the presence of *Stachybotrys* is to press a piece of cellulose tape against the mouldy spot and then examine it sticky side up on a slide under a microscope for the characteristic spore-bearing structures. The image at right illustrates conidiophores and conidia of a *Stachybotrys* species collected on tape from a basement in southern Quebec. Not all moulds are identifiable using this technique, but it works well for many, including *Stachybotrys*.



HOW MOULDS CAN BE ISOLATED

One of the joys of mycology is being able to go out into the field and isolate from among thousands of moulds a single interesting species. Almost any natural substance will have not one mould but a whole community of moulds growing on it. Each mould is distinct from all others and produces a characteristic colony when grown in pure culture. The isolation, or we might say domestication, of each is a challenge that never seems to lose its fascination.

A most difficult thing for the beginner is to come to terms with the small scale of mould communities. Even an area only 1 millimetre square can support more than one species of mould when nutrients are available. The only really practical way to get down to this scale is to work with a binocular dissecting microscope of sufficient magnification to allow spore-bearing structures to be seen. When this is possible, a sterile needle can be used to remove the spores of the particular mould that is to be isolated.

Isolation of fungi from natural sources is one of the basic skills in mycology that must be mastered by almost everyone concerned with moulds. Isolation techniques are numerous and often complex but can be quite effective in yielding just the mould one wants, while excluding all the others. Isolation techniques can be divided into two broad categories: (1) direct methods and (2) selective methods. Both are routinely used in mycology laboratories and can be further divided into a number of subtypes.

Direct isolation techniques

Direct transfer

The term "direct is applied to techniques involving the simple transfer of a mould from its natural habitat to a pure culture situation in the laboratory. At its simplest this is done by putting a piece of the habitat or substrate under a dissecting microscope so that the mould growth is easily visible. An inoculating needle is then heated until red hot, cooled, and used to transfer some of the spores into a sterile plate of culture medium. I find this easier to do if I first get a tiny piece of agar on the end of the needle for the spores to stick to. The piece of agar must be very small because it is often necessary to manoeuvre it into rather tight places where other moulds might easily contaminate it. An alternative is to moisten the needle with a slight amount of glycerine. Once the transfer has been made, it is only necessary to wait a few days for the mould to grow and form a colony.

The direct transfer technique is also used to obtain pure cultures of mushrooms and other large fungi. The fruiting body is broken open, without touching the newly exposed flesh, and some of the tissue is transferred to a sterile culture medium. If this has been done carefully, the tissue may give rise to a colony after a few days. For the beginner, the easiest large fungi to culture are those found inhabiting decaying wood. Most wood-inhabiting mushrooms and bracket fungi grow well on the semi-synthetic media listed in chapter 4, although few will form their large fruiting bodies in culture.

Moist chambers

Direct isolation of fungi is often more effective if the natural substrate has been kept moist for one to several weeks to allow moulds to grow and sporulate. The easiest method involves a container called a moist chamber (Figure 11). Moist chambers can take any number of forms, but are basically containers holding a material such as cotton, paper, cloth, sterile sand or soil, or peat moss that can be kept moist for several weeks. The specimen is placed on top of the moist material and left until moulds begin to grow on it. In my classes we use glass containers resembling very deep Petri dishes, and like Petri dishes they have loosely fitting lids. For the packing material we nearly always use peat moss, collected in the field and dried for later use. The container is filled with dry moss and then water is added. Peat moss is like a sponge in that it can absorb and hold a tremendous amount of water. When water is added to the moist chamber it soaks up into the moss. The excess can be poured off and the moss squashed down until it forms a moist layer no deeper than about one-quarter of the height of the container. We then place a single or double layer of filter-paper or paper towel over the moss layer so that the specimen does not come in contact with it. Thus prepared, the moist chamber is ready for the specimen.

In many areas peat moss, in its fresh form, is hard to obtain and it is necessary to find a substitute. Although many people use cotton for this purpose, I think that it is best avoided as it is a good substrate for mould growth itself. Instead, try using a layer of fine soil or very fine sand. Soil and sand will not hold water as well as peat, so watch carefully to make sure it does not dry out. But don't make it too wet or all you will get is mud!

When you are ready to add the specimen, moisten it slightly (unless it is already damp) and place it on top of the filter-paper. Cover the dish and leave it in a place where the temperature is reasonably constant.

Within a few days moulds will begin to appear on the specimen. Most beginners are unprepared for the extremely small size of many moulds and tend to overlook them completely. Invariably students using moist chambers for the first time complain that nothing is growing on their specimens, only to have an instructor point out at least half a dozen different moulds! Be sure to examine the material with a magnification of at least 15-20 times and with good bright illumination. Illumination is especially important and should be focused on the area of the specimen that is under examination. When something interesting is found, it can be removed for microscopic examination; but more about that part later.

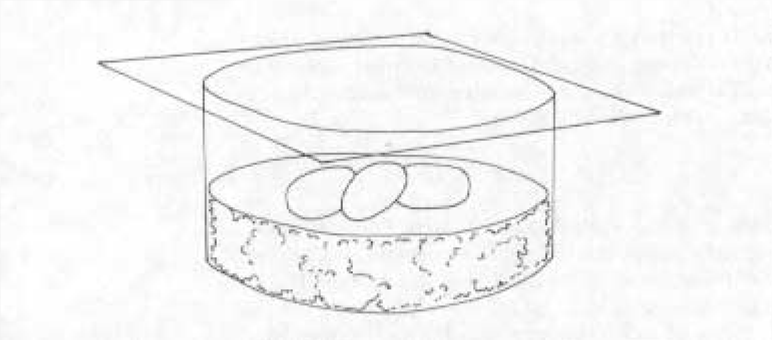


Figure 11 - A moist chamber containing three pieces of dung.

In order to obtain a pure culture of something in a moist chamber it is only necessary to follow the direct transfer procedure given above, making sure that the sterile needle picks up only the spores that are wanted. If the needle inadvertently touches the surface of the material in the moist chamber it will pick up all sorts of undesirable contaminants.

Moist chambers can be used for all kinds of materials. We have used them to incubate dung, wood, leaves, old stems, corn stalks, bark, seeds, fruits, old fungi, dead insects, and numerous other things. Natural materials are usually more productive than man-made ones, but sometimes old pieces of cloth or leather products can be good. You are only limited by your imagination. Moist chambers are also useful in mycological "detective work", to discover the cause of a particular decay. Placing the decayed material in a moist chamber often will result in abundant sporulation of the guilty organism in the area affected. This technique works well with diseased plant material as well as manufactural products.

With very small specimens, such as insect parts or seeds, it may be easier to use a Petri dish as a moist chamber. We sometimes simply put a few layers of filter-paper in a Petri dish, moisten them, and put the specimen on top. Such moist chambers may dry out very easily, however, and have to be tended closely. A better method is to make up a batch of water agar (a solution of 20 grams of agar in a litre of water), sterilize it, and pour it into sterile Petri dishes. Because the agar solution contains almost no nutrients it will support little mould growth and thus serves only as a water reservoir. The specimen can be placed on the agar surface and examined as in any other moist chamber. Agar media containing nutrients can be used here, but often they only become overrun by the fastest growing moulds at the expense of everything else.

Whether using a moist chamber or working with freshly collected material, one often discovers that moulds produce spores inside some kind of structure, such as a pycnidium. Direct transfer of these structures invariably leads to contamination by other moulds. To avoid the problem it is necessary to clean off the surface of the structure sufficiently that all foreign spores and bacteria are removed. I do this either by pushing the structure over, around, and through an agar medium for 10 minutes or more until it is clean, or by surface sterilizing it for about 60 minutes in a 10 per cent commercial chlorine bleach solution. The required times and concentrations of bleach in the latter technique will differ some what from one specimen to another; the technique is most effective if the treatment can be varied with several samples. The agar technique demands more dexterity but can be applied to a single specimen with predictable results.

Direct plating

Often it is most convenient to place materials that are of interest directly on a nutrient agar medium. As already noted, this technique encourages rapidly spreading moulds at the expense of other fungi but is nevertheless widely used. It is a simple technique, requiring the placing of small bits of the substance on the surface of the agar or the pouring of melted but cooled agar over the fragments. After a few days' incubation mould colonies appear on the surface, and can be transferred into pure culture.

The amount of material placed in the dish varies, depending upon how heavily it is infected with mould spores. This technique is commonly used in soil studies, requiring only a pinch of soil, evenly dispersed over the surface of the agar. It is difficult to apply any rules here, however, because a small amount of material may yield a different set of moulds from a large amount. If the amount of material is large, the result may be a combination of a plating technique and a moist chamber.

We find that Martin's Rose Bengal Medium is a good choice for direct plating, as the rose bengal dye and antibiotics in it slow down colony growth and keep the colonies from growing together at first.

Dilution plating

In this technique 1 gram (dry weight) of the material to be studied is ground up (if necessary) and dispersed in 9 ml of sterile water. One millilitre of this solution is transferred to a second tube containing 9 ml of sterile water, resulting in a 0.01 dilution of the spore mass in the original material. The process is repeated to yield dilutions of 0.001, 0.0001, and 0.00001 or even further if necessary. A 1-ml portion from each dilution is pipetted to a separate Petri dish, and cooled, melted agar medium poured over it. The plate should be moved gently on the table in a figure-of-eight motion to effect proper dispersion. Alternatively, the solution can be put on the surface of solidified medium and spread evenly throughout.

After a few days' incubation, colonies will appear in varying densities, depending upon the amount of dilution from the original material. The number of spores present in the original sample can be calculated roughly by selecting the plates showing 40-100 colonies and writing down the colony count. With this information the following calculation can be performed:

$$\textbf{Colonies per gram of original sample} = \frac{\textbf{Colony count}}{\textbf{Dilution factor}}$$

The accuracy of this technique is low when only one plate is counted. There are numerous contributing factors, including improper dispersion of spores during dilution, failure to break up spore masses, or mutual inhibition of growth by certain fungi. Greater accuracy is attained by doing several plates at the most desirable dilution, perhaps ten or more.

Dilutions are frequently used in studies on soil fungi. Although the technique has been criticized as not reflecting the "true" soil flora, it is probably the most commonly used method in this area of study. Even if the fungi isolated are not very representative of the whole flora, the technique does allow scientists to compare one soil with another on a statistical basis.

Airborne fungi

We have already discussed the subject of airborne fungi and have noted that certain moulds are more likely to get their spores into the air than others. Airborne mould spores can serve as an infective agent of plant disease and may also be allergenic. It is well known that allergy sufferers are sensitive to the spores of some moulds but not to others, and it is thus often helpful to know which mould species are present in the air at a particular time or place.

The sampling of airborne fungi is a subject that has attracted much attention in the last twenty years, resulting in the publication of several books. For a thorough treatment of this topic, see Gregory (1973). There are two approaches to air sampling, one that yields spores for microscopic examination and one that yields cultures. The former results in a lot of unidentifiable spores while the latter senses only those that can be cultivated (and many cannot).

It is well beyond my task here to go into all the different sampling techniques that are now in use. We can ignore the spore examination methods completely, as they deal only with spores, and concentrate on the cultural ones. The simplest culture techniques for airborne moulds involve the horizontal or vertical placement of Petri dishes containing a nutrient agar so that they trap any spores that fall on or blow into them. Usually 30 minutes to 3 hours out of doors is required for a good sample using this technique. Indoors the situation is more complicated and depends upon several factors, including the amount of traffic, the type of building, and its cleanliness. A good exposure time for an open Petri dish might be 1-2 hours, but only after testing can one be sure.

It has long been known that open Petri plates and other static spore traps have a rather low efficiency because of the layer of dead air on their surfaces. Any moving air, and its load of spores, will tend to pass over this layer and not reach the surface. To overcome the problem a number of devices have been invented that suck in air and force it against a sticky surface; one device, called an Anderson sampler, accommodates several Petri plates and will even sort spores out according to their size or mass. Such a machine is far more efficient than an open Petri plate but is bulky and is normally used only by specialists.

Baits

Many moulds have quite specific nutrient requirements and are specialized to use materials that other fungi use with difficulty or not at all. We can take advantage of this for the isolation of fungi by presenting a particular substance to the environment for colonization and then later recovering it for isolation of the fungi that occupied it. An example of a fungus sometimes recovered by baiting is the creosote fungus, *Amorphotheca resiniae*. To isolate it, some scientists coat matchsticks with creosote and place them on soil in Petri dishes for two or three weeks. *Amorphotheca*, a fungus particularly able to utilize creosote, grows from spores in the soil and invades the matchsticks, where it produces abundant hyphae and conidia. From here it is transferred into pure culture. Man inadvertently baits for this same fungus by allowing small amounts of water condensation to get into tanks containing jet fuel. The fungus grows in the water, utilizing the kerosene for energy, and ultimately forms mats of mycelium that can cause engine failure.

Other kinds of baits might be pieces of wood, insects, carrot chunks, plastics, hair, or anything else one can name. The bait can be submerged in a particular habitat in nature or in a moist chamber. To isolate dermatophytes, for example, it is customary to place hair on moist soil in a moist chamber and examine it periodically for sporulating moulds.

The most commonly baited habitat is water, both fresh and marine. Again, almost anything can serve as a bait and the water can be either naturally occurring or in a Petri dish. Good results can be obtained by putting some pond water in a Petri dish and floating on it a few sesame seeds that have been heated until they have popped. Within three or four days the seeds will be covered with oomycetes producing zoospores. Dead files, pollen, bits of apple or carrot, cellophane, and other materials are also productive baits. Since most moulds attracted this way are true aquatics it is necessary to purify them by transferring them to successive changes of distilled water containing new sesame seeds or other baits. When completely isolated into pure culture they can be transferred to solid media, but they may never sporulate there.

In the natural habitat it is interesting to submerge pieces of wood, whole carrots, apples, etc. on a string for several days or weeks and then bring them in for examination. Submerged wood blocks are one of the most commonly used materials for obtaining marine ascomycetes.

Special techniques

Aside from the rather broadly applicable techniques discussed above, there are many others that are quite specific in their effects. It is well beyond my purpose here to go into even a portion of these techniques, but a few are of particular interest and demonstrate some of the kinds of things that can be done to isolate a new set of moulds from a familiar habitat.

Stress techniques

All moulds are capable of withstanding environmental stresses, but eventually, when the stress is great enough, they will be killed. Not all moulds have the same tolerance to stress, however, and we can take advantage of this property by subjecting a material to just enough stress to kill some moulds but not others. The application of such techniques has turned up another interesting fact: that some moulds will not germinate *until* they have been subjected to conditions that kill most others. I have already mentioned one such group in my discussion of the dung-inhabiting or coprophilous fungi that produce spores that do not germinate until subjected to the rigours of the digestive tract of animals. Other fungi produce spores that germinate only after they are exposed to fires or freezing.

To explore these interesting adaptations we need only take a sample of soil, dung, wood, etc. and subject it to some kind ot treatment that we kill most fungi. We can steam the substance in an autoclave or steamer (without pressure), soak it in alcohol, acids, bases, or other chemicals, or alternately freeze and thaw it for several weeks. Almost any drastic treatment will yield a few fungal "holdouts" that might not otherwise appear. After treatment, the substance can be handled in any of the normal ways, such as plating, or moist chambers. Dr. De B. Scott (Scott 1968) outlined a method of this type for isolating species of *Eupenicillium* (an ascomycete) from soil. About 2 grams of soil were added to 18 ml of sterile water and heated in a water bath at 80°C for 30 minutes. After removal from the bath the soil suspension was treated according to the dilution plating technique described above.

Surface sterilization

In the section on direct isolation techniques I mentioned the method of sterilizing the surface of fungi with 10 per cent commercial bleach to kill adhering spores. Surface sterilization can also be used as a selective technique on a slightly larger scale. If we see a living leaf that has a dead circular spot on it we might guess that this is caused by a fungus. If we put the spot directly on the agar medium we will probably get some fast-growing fungus but not the causative agent. What we want is the fungus *inside* the leaf, not the surface adherents, and a good way to obtain it is to apply bleach long enough to kill the external organisms but not the internal ones. Although materials differ considerably, a sterilization time of about 1 hour in a 10% commercial bleach or 3% hydrogen peroxide will often work. If one is unsure, some longer and shorter times should be tried. Surface sterilization will also work for seeds, large fungi, wood, many man-made materials, dead insects, and other things.

Selective nutrients

This technique is essentially the same as the baiting methods discussed above. It differs only in that the substance to be sampled is added to the "bait" rather than vice versa. We might, for example. wish to isolate those moulds that can utilize cellulose. To select for these fungi we make a medium such as Czapek's, but using cellulose in place of sucrose. If a fungus is to grow well here it must make use of the cellulose; those that cannot will be excluded or grow only very poorly. The possibilities here are almost unlimited, except that when using agar media it is usually necessary to use a "synthetic medium" so that the nutrients that are being modified are known. Because of impurities in the agar, at least some growth of fungi not utilizing the specific ingredient will usually be obtained. These can often be recognized by their sparse growth.

Dr. Barron, in his highly interesting book on eelworm-trapping fungi (Barron 1977), describes a novel medium. He starts a culture of eelworms growing by feeding them dried pea soup and, when they became abundant, adds a little soil. Those fungi that can trap eelworms start to grow and finally dominate the plate. Here the eelworms are the selective nutrient upon which the soil is plated.

There are few organic substances that cannot be metabolized by at least one mould. We can thus prepare media with unusual substances and expect to isolate moulds. Several years ago I made a medium composed of little more than the amino acid tyrosine and isolated a fungus for which I had to describe a new genus and species! The substance one is interested in can be added directly to the medium or a water infusion of a particular substance can be made and agar then dissolved in it.

One commonly used infusion medium is prepared with hay. First 2.5 grams of dry hay are added to 1 litre of water and boiled for 15-20 minutes; then the mixture is strained through cheesecloth, 20 grams of agar are dissolved in the mixture, and it is sterilized as usual. The resulting medium is fairly weak and discourages many fungi that need a rich sugary medium, while encouraging those that are often reluctant to sporulate. Dung infusion agar is prepared in a similar way, but is instead made with 20 grams of dried horse or cow dung. Some materials, such as dead oak leaves or pine needles, will yield an infusion that is toxic to some fungi and not others, resulting in a medium that selects for fungi occupying those materials naturally.

Selective temperatures

Moulds that grow easily at room temperature are said to be *mesophilic*. Most fungi are mesophilic and are inhibited or killed at unusually high or low temperatures. There are some, however, that actually *require* unusual temperatures. Moulds requiring high temperatures (40°C or more) are said to be *thermophilic*, and those requiring low temperatures (15°C or less) are *psychrophilic*.

In searching for these fungi we simply incubate our plates or moist chambers at the appropriate temperature and isolate the moulds that develop; all isolates and subsequent transfers must be grown at their optimum temperature as well. Bird nests, for example, yield abundant thermophiles when incubated in a moist chamber at 45-50°C, while rabbit dung or compost materials produce several psychrophiles in moist chambers incubated at 0-5°C. The thermophilic forms are amazing for their rapid growth and are, in fact, the fastest growing of all fungi. Some psychrophiles can also grow quickly, however, proving that temperature is not the only factor contributing to rapid growth. Some thermophilic fungi, or at least those that can grow at 37°C, may cause serious infections in man and animals. In working with them, care should be taken to see that they are not exposed to air currents. I do not recommend the isolation of thermophilic fungi in situations involving large groups of students.

Osmophily

Many stored products, such as grain, museum specimens, and hides, undergo degradation by moulds. Most of us have also experienced mould growth on materials stored in damp places at home. Both phenomena are caused by fungi that can withstand unusually dry conditions. Such fungi are said to be *osmophilic*, a term that refers to their prevalence in environments of high osmotic potential. I have already discussed some of the osmophilic fungi in the section dealing with moulds on foodstuffs and will concentrate here on their isolation.

Osmophiles occur on relatively dry or sugary substances in the home. Most of the fungi encountered on old cloth or leather materials in the basement are osmophiles as are the moulds growing on the surface of jams and jellies. They are abundant enough in the home that they can be isolated simply by opening a Petri plate for 2 or 3 hours in the basement or kitchen. The critical thing is the medium within the Petri plate. Osmophilic fungi grow poorly on normal culture media and often sporulate abnormally or not at all. To isolate them the water actvities of media must be drastically decreased. This means increasing the sucrose in Czapek's Agar from 20 g per litre to 200-500 g per litre, or adding 200-500 g of maltose to each litre in Leonian's Agar instead of the usual 6.25 g. For the identification of osmophilic *Eurotium* species, most books will require them to be grown on Czapek's or malt agar with 40% sucrose or on media containing large quantities of glycerine.

Another excellent source of osmophilic fungi is dried fruit. Many producers, however, treat these products with non-toxic fungicides and effectively exclude most moulds. A sampling of dried fruit from several sources may be rewarding, since some may still be productive. As far as is known, the fungi on dried fruits do not produce toxins.

It appears that the seed caches of certain rodents may be good sources of osmophilic fungi, but this habitat has not yet been adequately explored.

Spore printing

Most ascomycetes and basidiomyces and some other moulds are able to eject their spores forcibly. We can take advantage of this property to isolate these fungi by suspending them over an agar surface and allowing the spores to be shot down on it. For mushrooms and bracket fungi a piece of the gill or tube tissue can be attached, perpendicular to the agar, on the lid of a Petri dish. The spores will then float down on to the agar surface and later germinate (if one is lucky). With large mushrooms it is sufficient to attach a single gill, flat side down, to the lid; with small ones the whole cap can be stuck on. We usually petroleum jelly as an adhesive in our laboratory, but other things, such as masking tape or an agar block, may work as well.

Ascomycetes, such as cup fungi, can also be suspended above an agar surface for spore printing. Some of them, however, are so small that they have to left attached to the material they are growing on and that stuck down as well. The problem of contamination from loose particles dropping down then arises, however, which can be avoided by turning the plate over and letting the spores shoot up. Most ascomycetes can shoot their spores far enough to reach the lid of a Petri dish, but basiomycetes cannot.

Suspending an open Petri dish over a moist chamber can be a good way to trap ascomycetes, particularly from dung. Be sure, though, that the agar does not touch the sides of the chamber of the material within. It is also wise to exclude any air currents that might carry spores upward to the agar.

Interesting isolations can be made from Petri plates that have been opened and inverted over soil, logs, and other materials in the field, if proper care is taken to exclude air currents.

HOW MOULDS ARE GROWN

Anyone who has to deal with moulds will sooner or later want to grow them. Identification of moulds most often depends upon observing their methods of spore production, which are not always obvious in the natural habitat. Often identification becomes so difficult that it is necessary to send a specimen to a distant university or government laboratory. Such specimens should preferably be sent as living colonies that can be grown out at the identifier's convenience. Even when the mould can be identified in its natural habitat one may still want to cultivate it - to get more material for study perhaps, or to learn something about its physiology.

Whatever one's reason for growing moulds, one needs to understand a few things about their nutritional requirements before starting. Moulds, like people, need a source of energy, a source of nitrogen, a few minerals, and sometimes vitamins. Some moulds are rather specific as to the source of these materials, and, like people, must have them in rather complete forms. In contrast, many fungi can supply all their nutritional needs from very simple materials and construct bit by bit all the highly complex molecules they need. If man has such abilities, he would be able to drink a paper cup full of a simple seawater solution, eat the cup, and go off to work confident that he had eaten a square meal!

Media

Whatever a particular mould needs, it must always be supplied with some form of organic carbon for energy, a source of nitrogen for protein and vitamin synthesis, and several minerals. The substance on which a mould is grown in the laboratory is called a *medium* and the mould growing on it, a *culture*. Culture media can be solid or liquid, depending on the sort of information one wishes to obtain. For the purposes of identification, solid culture media are usually more useful, as they allow the mould to sporulate more easily.

Solid media

Most culture media are prepared by dissolving the necessary nutrients in water, to obtain a balanced solution supplying everything the mould needs for growth. Preparation of solid media involves dissolving a solidifying agent in the solution that will harden to a gel upon cooling. In the past gelatin was used for this purpose, but is was soon found that gelatin, a protein, itself could serve as a nutrient for some fungi. As they grew on the gelatin, these fungi would cause it to liquefy, thus destroying the solidity of the medium.

Since the 1880s, a substance called *agar-agar* (or, more commonly, just agar) has been the solidifying agent of choice. Agar has the property of dissolving at a fairly high temperature (nearly that of boiling water) but solidifying at about 45°C. Thus, it can be poured over living fungi without killing them, yet can be used for organisms that grow at high temperature.

Agar is relatively stable and cannot be consumed by most organisms, aside from a few specialized bacteria. It is extracted from certain marine algae or kelp by a complex industrial process. It is fairly expensive these days, but extensively used in various food and industrial products, as an emulsifier, thickener, or jelling agent.

Most culture media fit into one of three categories: (1) synthetic, (2) semi-synthetic, and (3) natural. Synthetic media are composed of ingredients of known chemical composition and concentration. These media are useful in physiological or descriptive studies when it is necessary to duplicate exactly a previous batch of medium or to record the effects of the deletion or addition of a particular substance. Few fungi show their best growth on synthetic media; they must sacrifice speed in order to build their necessary cell components from relatively simple materials. However, many produce the sporulating structures necessary for identification more easily on synthetic media than on other kinds.

Semi-synthetic media resemble synthetic media in containing a known set of ingredients, but differ in that at least some of the ingredients are of unknown or variable composition. A synthetic medium, in which all ingredients are chemically defined, can be made semi-synthetic by adding a substance such as yeast extract. We know that the yeast extract contains thiamine and other vitamins, but we do not know the exact amounts or what else might be present. The result is a medium of quite predictable composition but one not completely known chemically. Semi-synthetic media are widely used in routine work and offer something of a compromise between synthetic and natural media.

Natural media are so called because they are partly or completely composed of natural materials, such as ground-up (or whole) plants or animals. A slice of potato is a natural culture medium, as is a piece of meat or bread. Some natural media may consist of a synthetic medium augmented by tomato juice, carrot strips, or plant stems. Natural media are often very good and allow sporulation in fungi that may otherwise remain sterile. Their major disadvantage is that they may differ considerably from batch to batch and thus not yield reliable experimental results. Nevertheless, natural media are widely used in laboratory work and cannot be replaced by any other kind.

Liquid media

Liquid media are employed in laboratory work when the entire colony must be recovered for weighing or chemical extraction. They are also useful when the culture medium itself is to be analysed for chemical changes. For identification purposes, liquid media are seldom chosen because few moulds sporulate well on them. The exception is in work with yeasts, a group of fungi especially adapted to liquid environments.

It has often been pointed out that any medium containing agar is at best a semi-synthetic medium. Agar contains numerous mineral elements and cannot conveniently be purified, even by repeated washings. Thus, for physiological studies, liquid media should be used.

A few useful media

The media described below have been chosen because they represent a sample of the variety of types used by mycologists. There are, however, many additional media; persons interested in pursuing this matter further should consult the more specialized literature.

Synthetic

Czapek's Solution Agar	
Sucrose	30 g
$NaNO_3$	3.0 g
K_2HPO_4	1.0 g
$MgSO_4 \cdot 7H_2O$	0.5 g
KCl	0.5 g
$FeSO_4 \cdot 7H_2O$	0.01 g
Agar	15 g
Distilled water	1000 ml

Czapek's Solution Agar is a synthetic medium widely used in mycological laboratories, particularly for the identification of species of *Aspergillus* and *Penicillium*. Many moulds produce very characteristic colonies on it and may also exude pigmented substances. Aerial growth is often suppressed and sporulation may be enhanced. Some moulds, however, grow poorly on this medium and may even fail to sporulate altogether, often because of their inability to synthesize vitamins. Many members of the Zygomycota are unable to process sucrose or nitrates and will do very poorly on Czapek's. The high glucose level may also cause problems. As noted above, the addition of agar to this medium makes it, in reality, a semi-synthetic one.

***Penicillium* Reference Medium**	
Glucose	9.1 g
Tris buffer, adjusted to pH 8.0 with HCl	606 mg
KNO_3	425 mg
KCl	485 mg
$MgSO_4 \cdot 7H_2O$	493 mg
$CaCl_2 \cdot 2H_2O$	44 mg
$NaH_2PO_4 \cdot H_2O$	28 mg
$FeCl_3 \cdot 6H_2O$ chelated with 8.5 mg of disodium salt of EDTA	6.2 mg
H_3BO_3	6.11 mg
$MnCl_2 \cdot 6\ H_2O$	366 Ág
$ZnSO_4 \cdot 7\ H_2O$	461 Ág
$Na_2MoO_4 \cdot 2H_2O$	14.5 Ág
$CoCl_2 \cdot 6H_2O$	23.8 Ág
$CuSO_4 \cdot 5H_2O$	20 Ág
Thiamine chloride	20 Ág
Biotin	1 Ág
Vitamin B_{12}	1 Ág
Agar	15 g
Distilled water	1000 ml

The medium is prepared as three stock solutions that can be stored and later combined to form the final mixture. The solutions are:

1. Major salts stock: 4.85 g KCl, 4.93 g $MgSO_4 \cdot 7H_2O$, 0.441 g $CaCl_2 \cdot 2H_2O$, 0.88 g NaCl in 1 litre

2. Buffer stock : 60.6 g/l Tris adjusted to pH 7.8 with HCl.

3. Micronutrients + vitamins stock: One litre stock prepared by mixing 5 ml each of 54.4 g/l $NaH_2PO_4 \cdot H_2O$, 12.6 g/l $FeCl_3 \cdot 6H_2O$ chelated with 17 g/l of disodium salt of EDTA, 12.2 g/l H_3BO_3, 732 mg/l $MnCl \cdot 6H_2O$, 922 mg/l $ZnSO_4 \cdot 7H_2O$, 29 mg/l $Na_2MoO_4 \cdot 2H_2O$, 47.6 mg/l $CoCl_2 \cdot 6H_2O$, 40 mg $CuSO_4 \cdot 5H_2O$, 40 mg/l thiamine chloride, 2 mg/l biotin, 2 mg/l vitamin B_{12}.

The complete mixture contains in a final volume of l litre: 15 g agar, 100 ml each of major salts and micronutrient stocks, and 10 ml of buffer stock.

This medium was formulated by Dr. I. Ahmad for the cultivation of *Penicillium* species. Although it appears at first glance to be a complicated and difficult medium it is usually prepared from three stock solutions and does not take as long as one might expect. It can be modified in several ways to assess the physiological activities of moulds. Most commonly different sources of carbon are substituted for glucose and different nitrogen sources for nitrate. As formulated above,with nitrate as a nitrogen source, it may be unsuitable for certain fungi, such as many Zygomycota, unable to utilize nitrates. In such cases it may be better to use ammonium salts, although this may result in dramatic plunges in pH. Again, to be truly "synthetic", the medium should be used without agar.

Semi-synthetic

Modified Leonian's Agar	
Maltose	6.25 g
Malt extract	6.25 g
KH_2PO_4	1.25 g
Yeast extract	1.0 g
$MgSO_4 \cdot 7H_2O$	0.625 g
Peptone	0.625 g
Agar	20 g
Distilled water	1000 ml

Leonian's medium was devised by the American mycologist L.H. Leonian, and was designed to promote sporulation in certain moulds. Later, at the University of Toronto, R.F. Cain found it to be more suitable for ascomycetes if it contained a little yeast extract; hence the term "modified" in its name. It is a good general purpose medium that will yield good growth with most fungi. Certain fungi, such as many mycorrhizal forms, will not grow on Leonian's Agar because they are unable to use maltose as an energy source. For these fungi we use Modified Melin-Norkran's medium, which has a glucose energy component.

Potato Dextrose Agar	
Thinly sliced, peeled white potatoes	500 g
Glucose	20 g
Agar	15 g
Distilled water	1000 ml

Heat potatoes at 60°C for 1 hour and filter through cheesecloth. Make up volume to 1000 ml and add other ingredients. Cook 1 hour and then sterilize.

Potato Dextrose Agar, or PDA, as it is usually called, is an old formula used by plant pathologists and many mycologists for general laboratory use.

Sabouraud's Agar	
Glucose	40 g
Peptone	10 g
Agar	15 g
Distilled water	1000 ml

This is the standard medium used in medical mycology. It is probably no better for these moulds than Leonian's or PDA but is simply the traditional choice and thus the medium that must be used if colonies are to be compared with those described by medical workers. It can be used as a general laboratory medium in place of Leonian's or PDA, although the amount of glucose is rather high and may suppress sporulation in some fungi.

Martin's Rose Bengal Agar	
Glucose	10 g
Peptone	5 g
KH_2PO_4	1.0 g
$MgSO_4 \cdot 7H_2O$	0.5 g
Streptomycin	30 mg
Rose bengal	30 mg
Agar	15 g
Distilled water	1000 ml

Ten millilitres of a 3.3 g/l stock solution of rose bengal is added to the medium after the other ingredients (except the streptomycin) have been dissolved. After sterilization, the streptomycin is added to the cooled medium.

This medium is useful in plating techniques (see below) when the aim is to slow down the growth of colonies in a mixed culture. It discourages the growth of bacteria and certain other organisms so that they will not swamp isolates from natural materials.

Dextrose-peptone-yeast extract Agar (DPYA)	
Glucose (dextrose)	5.0 g
Peptone	1.0 g
Yeast extract	2.0 g
NH_4NO_3	1.0 g
K_2HPO_4	1.0 g
$MgSO_4 \cdot 7H_2O$	0.5 g
$FeCl_3 \cdot 6H_2O$	0.01 g
Oxgall	5.0 g
Sodium propionate	1.0 g
Chlortetracycline	30 mg
Streptomycin	30 mg
Agar	20 g
Distilled water	1000 ml

DPYA is an excellent medium for isolating fungi from soil and other natural substrates. The oxgall and sodium propionate restrict the growth of some rapidly spreading fungi, while the chlortetracycline and streptomycin discourage bacteria. It can also be prepared as a more general-use medium by omitting these four inhibitory substances.

Natural media

V-8 Agar	
V-8 vegetable juice	200 ml
$CaCO_3$	3 g
Agar	20 g
Distilled water	1000 ml

The V-8 juice used in this medium probably contains many nutrients that fungi can use, but we have little idea what they may be. It is a medium that is used routinely in plant pathology and seems to be a good complement to Leonian's or PDA. Moulds that fail to sporulate on those media often sporulate heavily on V-8, or vice versa.

Weitzman and Silva-Hutner's Agar	
Alphacel cellulose powder	20 g
Pablum baby oatmeal	10 g
Hunt's tomato paste	10 g
KH_2PO_4	1.5 g
$MgSO_4$	1.0 g
$NaNO_3$	1.0 g
Agar	20 g
Distilled water	1000 ml

Weitzman and Silva-Hutner's medium was designed to enhance sporulation in certain medically important fungi, but is useful for a great many other moulds as well. I have found it to be a good (and often better) substitute for V-8 Agar and use it routinely in my laboratory. I grow most of my moulds on both Weitzman and Silva-Hutner's and Leonian's Agar and find very few that fail to sporulate on one or the other. Although the original formula calls for a final pH adjustment, I seldom do this and yet get good results.

Preparation of media

Mixing

Culture media are not hard to prepare, even under relatively primitive conditions. It is often easiest to dissolve the agar separately in hot water and then add the other ingredients. The agar burns easily when it is heated, so it is best to avoid putting it directly on the stove or hotplate. I usually put the agar in a flask of water and then immerse this in a boiling water bath. After an hour or so the agar will be dissolved and the solution will be clear. Some people do not worry very much about whether the agar is completely dissolved or not, but to avoid an uneven batch it is best to be patient.

Once the agar is dissolved the rest of the ingredients can be stirred in; they must be completely dissolved as well. Some ingredients, of course, do not dissolve and must be mixed in suspension as thoroughly as possible.

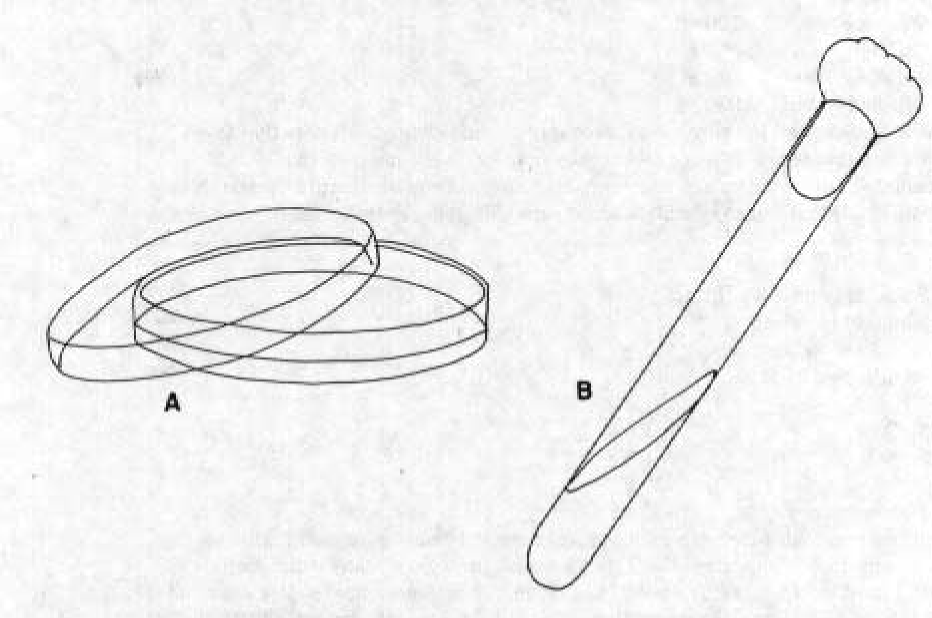


Figure 9 - Glassware for cultivating moulds.
A: Petri dish with lid partly removed.
B: test-tube with agar slant.

When the medium is completely mixed it must then be prepared for sterilization. Here one must stop and decide what use is to be made of the finished product. If fresh isolates are to be made from natural materials or some mould we already have is to be studied, we will probably want to use Petri dishes (Figure 9A). Petri dishes are small, round dishes, most commonly 9 cm in diameter, that have a bottom and a loosely fitting top that will admit air but discourage entry of foreign spores. They are the most commonly used vessels for growing moulds and are available either in permanent glass or disposable plastic form. The plastic plates are already sterile when bought, but the glass ones must be heated in the oven at 230°C (450°F) for 60 minutes, to kill all foreign organisms and spores, before they can be used. But more about Petri dishes later.

It is often necessary to save cultures for later use, or for mailing, in a way that they are less vulnerable to contamination by airborne spores. The conventional method is to use test-tube or bottle cultures that have only a narrow opening (Figure 9B). The culture medium is poured into the tubes, sterilized, and allowed to solidify at about a 30° angle. When cool, the agar inside has a smooth slanting surface for the colony to occupy. The tube or bottle is capped with a cotton plug that is just tight enough for the tube to be lifted without it coming out. In place of cotton a screw cap or one of several tube-capping devices can be used.

With the use of medium in mind, one can now proceed to prepare it for sterilization. If it is to be used in Petri plates it should be transferred into smaller containers that will make it easy to pour. It is impractical to sterilize filled Petri plates, so we pour them after sterilization. If the medium is to be used in tubes, they should be filled before sterilization and slanted afterwards. Sometimes it is advantageous to save sterilized medium in larger bottles and melt it down later to pour plates.

Sterilization

Sterilization is most often done in some kind of apparatus that will allow steaming at high pressures. In the laboratory we usually use a large sterilizer called an *autoclave*, but a simple pressure cooker works well, provided it has a pressure gauge. Most fungi and other organisms can be killed by boiling water, but there are a few, notably bacteria, that have highly resistant spores requiring sterner means. To be sure of killing *everything*, we sterilize at 121°C (250°F) for 20 minutes. To obtain this temperature the pressure must be raised to 1 kg/cm^2 (15 lb per $in.^2$ or 1 atmosphere).

When medium is sterilized in an autoclave it should not completely fill its container. Attempting to sterilize 1 litre of medium in a 1-litre flask will usually result in sudden and rather explosive boiling when it is removed from the autoclave. It is best not to fill the container more than half full. Inexperienced mycologists often assume that the 121°C for 20 minutes rule applies in all situations. However, not all materials will heat up enough to be sterilized in 20 minutes. It is an unpleasant surprise when a litre of medium becomes contaminated with bacteria because the person doing the sterilization attempted to do the whole batch in one container and barely managed to heat it to 100°C before the time was up.

After sterilization the medium is allowed to cool and solidify. Petri plates must be poured *before* the medium solidifies but while it is fairly cool. We usually test the medium by holding it against the inner side of the forearm; if it is cool enough to be poured it will not feel too hot. Beware, though of letting it cool too far, lest it solidify in the bottle! Pouring the medium when it is too hot results in unwanted condensation on the lid of the Petri dish.

Tubes, as stated above, should be left to solidify on a slant. Any agar medium that has solidified can be melted by heating in a boiling water bath. Melting of a 1/2-litre bottle of solidified medium will take about an hour if it is submerged well in boiling water. Petri plates dry up rather quickly, so it is often convenient to keep a number of bottles of solid sterilized medium that can be melted and poured when needed. When Petri plates are poured from melted agar, the neck of the bottle should always be heated over a flame first, either alcohol or gas, to kill any stray spore that may be on it.

Cultivation

Sterile technique

Once some Petri plates or tubes of sterile agar have been prepared, cultivation of one's moulds can begin. For the sake of simplicity, let us first suppose that a mould colony is already growing in a Petri dish and must be transferred to another. The essential thing to remember is that the air and all implements exposed to it are contaminated with mould spores and that these would germinate and grow if they got into the sterile plate. The steps we take to avoid this contamination constitute what is called *sterile technique*.

To transfer the culture we do the following:

1. Take an inoculating needle, usually a thin needle or wire at the end of a long pencil-like handle, and heat it in an alcohol or gas flame until it glows bright red (Figure 10A).
2. Allow the needle to cool for about 15 seconds. (A hot needle will kill the mould that is to be transferred).
3. Open the Petri dish containing the culture just wide enough to allow entry of the needle.
4. With the heat-sterilized needle, cut out a small portion of the colony margin. Hyphal tip transfers work best as they are usually the most active parts of the culture; in addition, transfers from the heavily sporulating central portions will result in spores being spread into the air. Especially in medical work,

hyphal tip transfers are essential. The excised colony margin should be only about 1 mm square (Figure 10B).

5. Transfer the square of colony margin to the sterile plate, making sure that the lid is opened only wide enough to admit the needle and make the transfer. Place the block at the centre, withdraw the needle and flame it until it is red hot, to kill all adhering spores and hyphae (Figure 10C,D).
6. Close the lid; label the plate with a marking pen, including name of culture and date. We usually wrap a thin strip of paraffin film around the sides of the plate to cover the opening, but this is not absolutely necessary; just a couple of pieces of masking tape to hold the lid down will do.
7. Leave the culture to grow in a protected place that has as little air movement as possible.

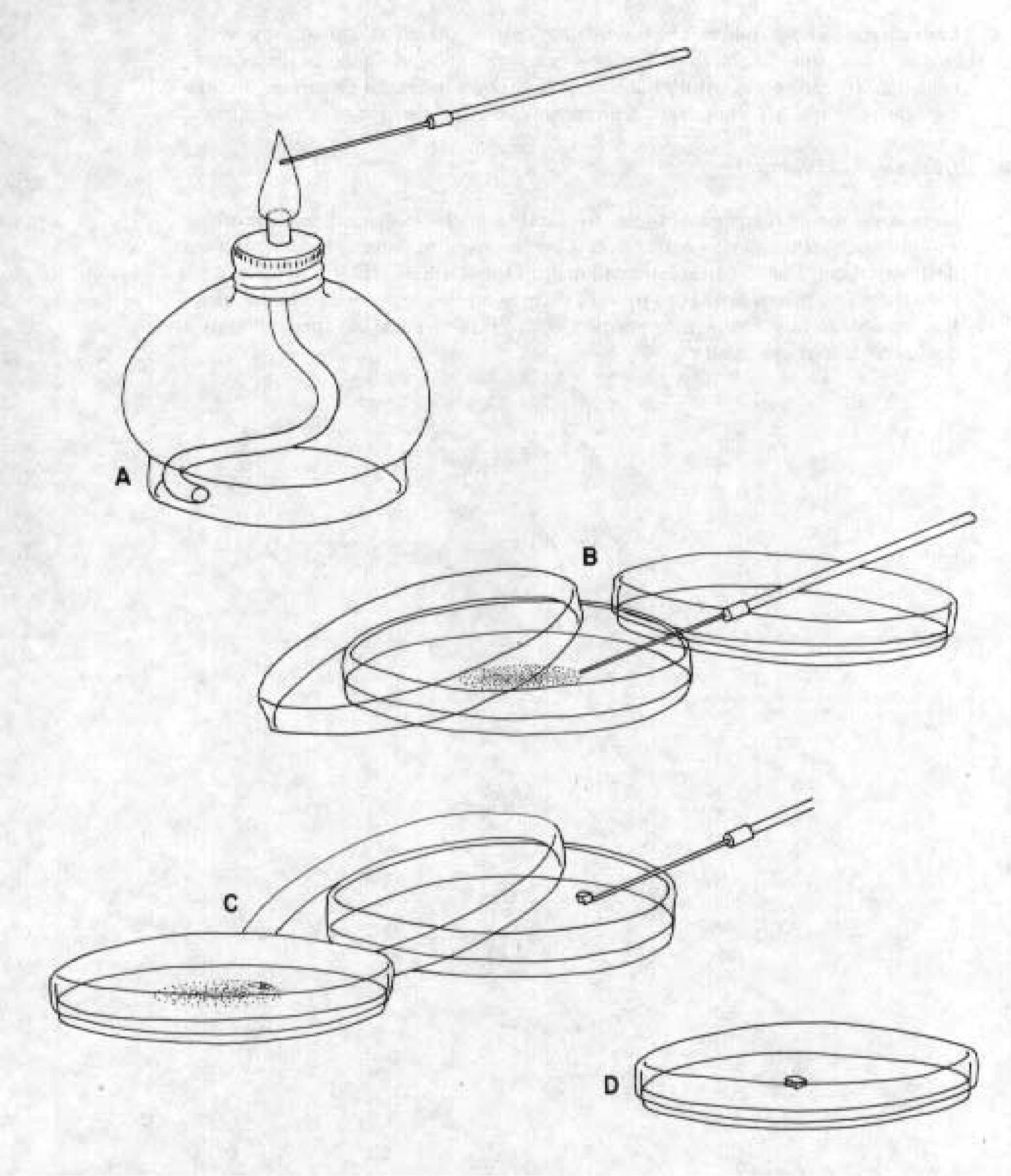


Figure 10 - Steps in sterile technique.
A: Inoculating needle is heated in an alcohol flame
B: Small piece of colony is removed from Petri dish
C: and transferred to a new dish of agar
D: yielding a plate containing a piece of the old culture at its centre.

Transferring from plates to tubes, tubes to plates, or tubes to tubes is done in a similar manner. When using tubes, always flame the mouth to kill any spores of airborne moulds. Never put the cotton plugs or lids of tubes on the table as they will pick up contamination.

The table itself should be clean and can be washed with water, alcohol, chlorine bleach, or other disinfectants. Some spores can survive long immersion in these substances, however, so one cannot thus expect to kill all spores on the table.

Many laboratories are now equipped with special inoculation chambers. Some, such as laminar flow chambers, have a layer of sterile filtered air flowing over the culture that excludes contaminating spores. Some models of such chambers, however, carry the air over the culture and into the worker's face. Such a device is a health hazard and should not be used. Other culture chambers consist only of an enclosed box, open at the front for the worker's hands, containing an ultraviolet light that kills all spores within the box. It is important here to be certain that the ultraviolet light is off while work is under way to avoid the risk of eye damage.

Disposal of old cultures

Since some moulds can cause human disease it is unwise to discard or wash tubes and dishes containing living cultures. It is best to sterilize them as before and then deal with them. Plastic Petri plates will melt in the sterilizer and it is necessary to keep them in a pan or bucket to prevent them from flowing over everything else. It is possible to buy non-melting plastic bags for this purpose, but these are only a convenience, not a necessity.

PREVENTION AND TREATMENT OF CONTAMINATION

The most exasperating problem confronting attempts to cultivate moulds is contamination by other moulds. Most mould spores are very light and easily transported by air. Even opening the lid of a Petri dish for a few seconds may allow the entry of contaminating organisms.

Contaminating agents

The worst contaminants are usually moulds, but bacteria and yeasts can also be a problem, especially when attempting to isolate from natural materials. The slimy or pasty bacterial and yeast colonies grow over the top of young cultures and simply smother them. Many bacteria are motile and "swim" along the mould hyphae, congregating at the end where they can share in the nutrients produced by the enzymatically active hyphal tips.

Actinomycetes may also invade cultures from time to time. In older cultures they may even grow on top of the mould colonies. Actinomycetes usually produce large numbers of spores and can be difficult to eliminate.

One of the worst causes of contamination is mites. Mites are small relatives of spiders and ticks that often feed on fungi. They crawl from one source of moulds to another and in the process carry spores of moulds and actinomycetes with them. Once they get into a culture collection they are extremely difficult to get rid of; usually one must go back and re-isolate all of one's cultures to purify them. The techniques for doing this may be difficult and extremely slow. Sometimes cultures may be lost altogether.

Mites are quite small, sometimes less than 1/10 mm long, and can come in a number of colours. The ones that most commonly get into cultures are white to cream-coloured and move rather slowly. Their eggs, also white, resemble tiny, smooth footballs scattered over the colony surface. All mites have eight legs, are usually covered with scattered bristles, and are often covered with spores.

If you find mites in one of your plates or tubes, separate it from the rest immediately and try to isolate the mould into a pure, mite-free culture. Setting the culture in an airtight box containing a dish of mothballs or paradichlorobenzene for several days will often kill the mites and spare the fungi, although the contaminants brought in with the mites will survive as well. If you have a duplicate culture or do not want the old one, sterilize the contaminated plate or tube, mites and all. I cannot emphasize strongly enough the necessity of keeping mites out of a collection.

Prevention of contamination

Airborne contaminants

The best way to avoid contamination is by cleanliness. Keep the work area as clean as possible, wiping down all surfaces with a 10% commercial bleach solution before starting to work. The major source of contaminants in pure cultures is airborne dust. While cleanliness is essential, it will not completely stop contamination; the cleanest of laboratories will still have problems. The number of airborne spores can be reduced drastically by eliminating as many air currents as possible. Fans, air-conditioners, and all kinds of traffic stir up dust continuously and should be avoided. At least an hour before beginning to work, shut the windows and doors, turn off fans and air-conditioners, and stay out of the room. Such precautions can be effective, even under difficult field conditions.

While transferring plate or tube cultures, open their lids for as short a time as possible. The less time allowed for entry of foreign spores the better. It is also wise to avoid opening Petri dish lids any wider than is needed for the accomplishment of the work in progress. I have seen many students open a Petri dish and put the lid down on the table. This habit is unnecessary and only invites contamination.

Spores sometimes stick to necks of tube cultures and can fall into the tube. For this reason it is wise to flame-sterilize the mouths of all tubes and bottles that one opens.

Contamination from natural sources

When a piece of natural material is put in a Petri dish a mixed culture of two to several organisms will often be obtained. Where one of these is a bacterium the culture can usually be purified by means of antibiotics. Media such as Martin's Rose Bengal Agar are especially designed for this purpose and nearly always inhibit the bacteria.

If moulds are a cause of contamination one of the selective isolation techniques discussed earlier will have to be followed or one of the "decontamination" procedures that follow.

In the initial isolation of fungi, the most important thing is to watch cultures closely as they first develop. Frequently the mould that is wanted will be accessible at first and easily transferred, but will be entirely overgrown by undesirable moulds later. In isolation from fresh material the first 12-72 hours are especially critical; cultures should not go unexamined for more than 15 hours at a time during this period.

Decontamination

The ability to purify mixed cultures is a skill that must be developed by everyone working with moulds. It is also one of the most difficult things to learn, as it requires a good knowledge of both the fungus one wants and those contaminating it. Although I will not be able to cover this subject in the detail required to purify *all* cultures, I can at least lay down some general guidelines.

Purifying cultures can be done in one of two ways: (1) mechanically or (2) chemically. In the first the organism one wants is physically separated from the rest while the second depends on the physiology of the organism. Often it may be useful to use both techniques simultaneously.

Mechanical methods

The simplest means of separating moulds is to spread their apart far enough that the colonies resulting from their germination will not grow together for a time. A common method is to place a spore mixture on the agar on one side of a Petri dish and streak it up and down that side until the spores are evenly spread along a line. The streaking is done with an inoculating wire having its tip bent into a loop so that it will not cut the surface of the medium. Sterilize the loop and do a second streak at right angles to the first along another side of the dish. This results in a second line bearing far fewer spores than the first. Repeat this a third time to yield another line. If it seems necessary, do it a fourth time, but be careful not to streak into the first line. After two or more days one of the streaks will be seen to contain several separate colonies that can be used for transferring. The previous streak will be too crowded and the subsequent one too sparse. This simple technique is the one I use most commonly for purification of mixed cultures (Figure 12).

A similar result can be obtained by using dilutions as described in the section dealing with isolation techniques. It will prove more useful than the streaking technique when the mould that is wanted is greatly outnumbered. Just take a mixture of spores and stir it up in about 10 ml of sterile water. Dilute this down several times and plate out each dilution separately. The ideal dilution will produce a plate containing about 60 colonies, of which at least some will be the desired mould.

When a mould is contaminated with yeasts or bacteria, dilution techniques usually work well. At times, though, yeast or bacterial cells so outnumber the spores of the desired fungus that dilutions are useless. Then it may be helpful to take advantage of the tunnelling or bridging abilities of fungus filaments. A technique sometimes used is to embed glass rings in the medium and surround the contaminated colony. A sterile glass ring, about 10 mm high and 15 mm in diameter, with three "feet" 2-3 mm in diameter glued or welded to the rim on the bottom, is placed on the bottom of a Petri dish. Sterile medium is then poured in to the usual depth, being careful not to overtop or wet the glass ring. After the medium has solidified, the mixed colony is inoculated into the glass ring. The mould filaments will be able to tunnel down under the ring and back up to the surface, while the bacteria or yeast, lacking the forward pressure of hyphae, will be confined to the ring.

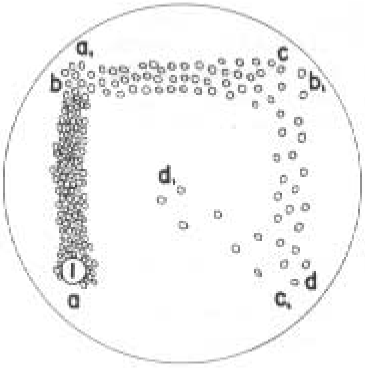


Figure 12 - Streaking technique to separate mould or bacterial colonies. An inoculum of spores is placed on the agar surface at point I and is streaked along the line a-a1 with a sterile wire loop. A second streak b-b1 is made at approximately right angles to the first streak and is followed by a third right-angle streak at c-c1. A fourth streak d-d1 is made into the centre. Each successive streak contains fewer spores and resulting colonies than the one preceding it, finally yielding at d-d1 several widely separated colonies.

The apical growth of mould hyphae can be used to bridge gaps in the medium insurmountable to bacteria and yeasts. A good method to follow is to make a small moist chamber by putting a few layers of wet filter-paper in a Petri plate. Then flame-sterilize a microscope slide, put a square of agar medium near the edge of it, inoculate the agar with the mixed culture, and put the whole thing in the moist chamber. After a few days the hyphae of the desired mould may extend out into the air from the agar block. If they do, place another agar block on a second sterile slide and move it close enough to the first block to contact the aerial hyphae but not the block itself. If one is successful, the hyphae will grow into the new block, leaving the yeast or bacteria behind.

Chemical methods

In some cases, mechanical purification techniques just don't seem to work. If they don't one can take advantage of the chemical or nutritional differences between micro-organisms. The most basic technique is to use antibiotics to discourage bacteria. Most bacteria are sensitive to antibiotics, although no antibiotic will work for all of them. In routine isolation work we use a mixture of antibiotics, most often streptomycin and chlortetracycline at a concentration of 30 and 2 mg/l respectively. Few bacteria are able to grow in such a medium, while most fungi are unaffected. In fact, fungi are so tolerant of these substances that we sometimes just sprinkle a little of the powdered antibiotic right on the agar surface in a Petri plate.

In the formula for Martin's Rose Bengal medium, given in the previous chapter, the rose bengal dye is added because it acts as an inhibitor to the growth of bacteria and many moulds. It can be added to any medium and is often useful in helping to separate otherwise rapidly spreading colonies. Oxgall, used in the formulation of DPYA, serves a similar function.

Most moulds have at least some nutritional preferences that distinguish them from other moulds. These preferences can be used in the purification of cultures if the physiology of the organisms involved is known. Zygomycetes, for example, grow rapidly on glucose or maltose media such as Leonian's and will overgrow everything, but cannot grow on some complex compounds like cellulose. Thus a medium such as Czapek's, with cellulose substituted for sucrose, will put zygomycetes at a distinct disadvantage.

The use of selective media for purification of cultures is so dependent on experience with moulds that it is difficult to generalize. A beginner should experiment with several media to see what will happen. The section on selective nutrients in chapter 5 offers suggestions about specific substances.

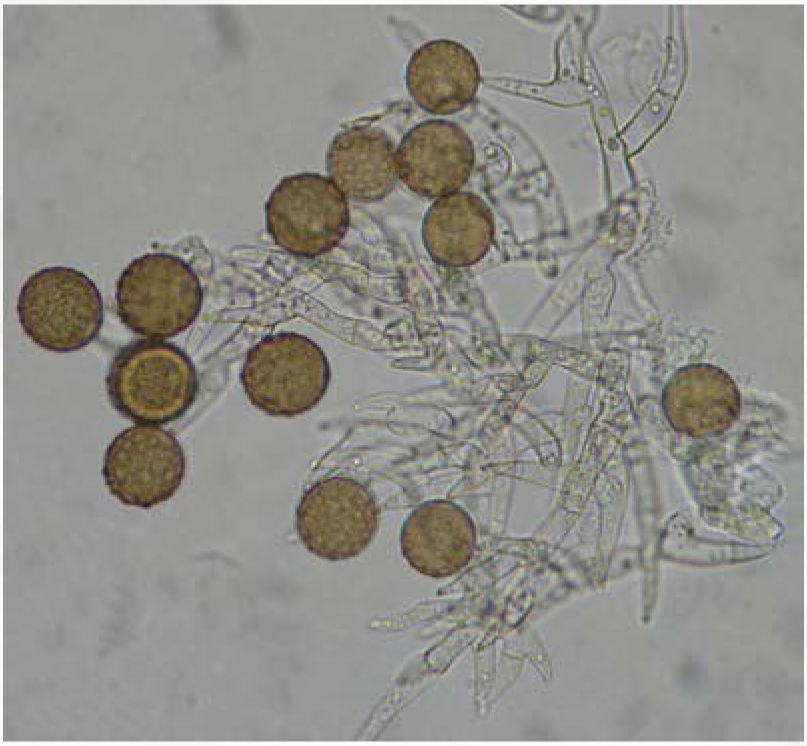
MOULDS UNDER THE MICROSCOPE

There are many good texts on the theory and use of the microscope and I am thus going to assume the reader either has some knowledge of microscopy or can find it. My main interest here is with the particular skills necessary for microscopic examination of moulds.

Preparation of slides

Most beginners find moulds difficult to prepare for microscopic examination. Often preparations seem to contain only spores or mycelium, or structures that are so unlike any of the illustrations available that they are unidentifiable. Most of these problems can be overcome with a little practice and will, in time, seem trivial.

The first rule to remember in mould studies is to examine young, actively growing material. Older parts of colonies or moulds on natural material will often be partially decomposed or so covered with spores as to be unrecognizable. The best way to begin is to examine the growth from the margin of the colony where spores are being actively produced. It may require two or three attempts before the area of active sporulation is located, but when it is all the features of spore production necessary for identification can be seen. If the colony has been in Petri plate with other moulds for several weeks and is no longer actively spreading it will not yield good material for examination.



To make a good microscopic preparation from a mould colony, start by putting a *small* drop of mounting medium on a microscope slide. Microscope mounting media come in a variety of types and will be discussed separately; at the beginning, use water. Then, using a sterilized dissecting or inoculating needle remove a small (no more than 2 mm square) portion of the colony near the margin, taking with it a very thin layer of the agar surface. If the colony is thick and woolly, it may not be necessary to take the agar, but in the more appressed type it is essential. Place the piece of colony in the mounting medium, and, with a second needle, tease it out so that the filaments are well spread. A mount that has not been teased out will appear as an opaque lump yielding little information. Place a cover-slip over the mount, lowering one edge to the slide before the other so that air bubbles can escape. The remaining air bubbles can be removed from the mount by *gently* heating it over an alcohol flame. If it is heated too vigorously, the cover-slip will pop off explosively, splattering fungus and medium into one's face, so it is *essential* to heat it only until its steams slightly, *not* until it boils. The picture of *Harzia verrucosa* above was made from a simple water mount and photographed through the eyepiece of a microscope using a point-and-shoot digital camera. This is usually all that is needed to see what you want.

An interesting technique used by some mycologists for preparing microscope mounts involves sticking the mould to a bit of cellophane tape. The tape is pressed lightly against the colony so that some of the hyphae and spores stick to it. This is then placed *sticky side up* in a drop of mounting fluid (see below) on a microscope slide and covered with a cover slip. This technique is not restricted to colonies in Petri dishes; it works well on naturally occurring colonies in most habitats. The cellophane tape technique is commonly used for sampling moulds in indoor environments.

Slide cultures

Most moulds will yield good results if prepared as outlined above, but a few present extra difficulties. The most problematic are those that tend to disintegrate as soon as they are mounted. Species of *Cladosporium*, *Monilia*, and *Alternaria* have spores connected in very fragile chains that can fall apart at the slightest movement of air. Mounts of these fungi invariably reveal only loose spores and a network of hyphae. To overcome this problem it is useful to set up slide cultures (figure 13). Slide cultures are made by setting up a small Petri dish moist chamber containing a V-shaped piece of glass tubing resting on several layers of moistened filter-paper. A sterile block of agar medium about 1 cm square is placed on a flame-sterilized microscope slide and the slide is then set in the moist chamber on the tubing. The fungus is inoculated near the four edges of the agar block and a sterile cover-slip is put over it. After a few days the slide can be mounted on a microscope, and the undisturbed mould structures viewed as they are growing. Later, if desired, the agar block can be removed from slide and cover-slip and two conventional slide mounts made from them. If they are allowed to dry before this is done, the mould structures are less likely to break apart.

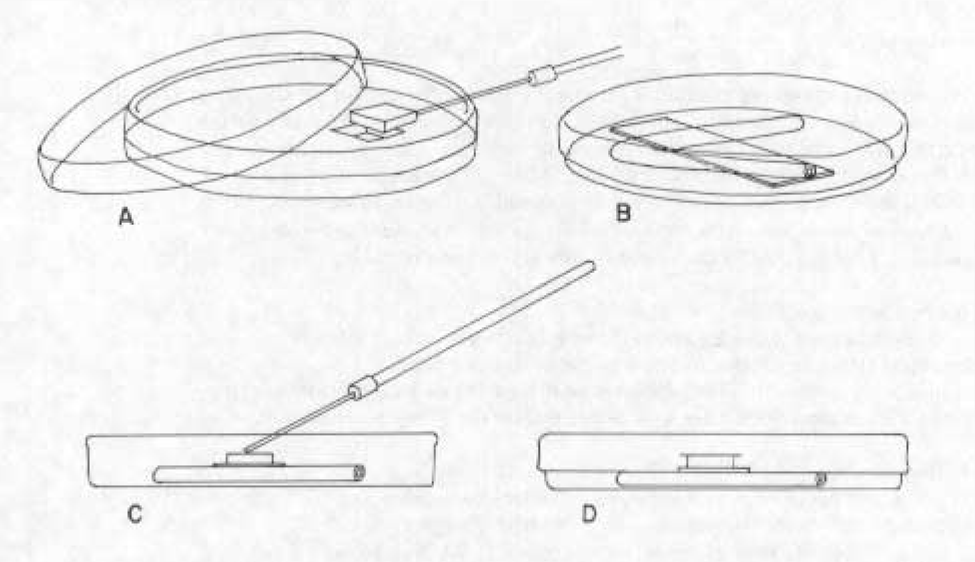


Figure 13 - Slide culture technique. A block of sterile agar is cut out of a Petri dish (A) and is placed upon a sterile slide resting on a bent glass tube within a sterile Petri dish (B). A few spores of a fungus are inoculated at the edges of the sterile agar block (C) and topped with a cover-glass (D) for incubation. A disc of moist filter-paper in the dish maintains humidity for the culture.

Mounting media

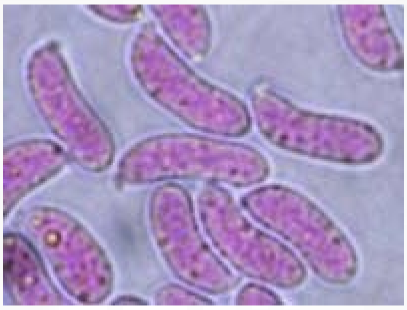
Using water as a mounting medium is easy and is often sufficient for satisfactory preparations. Water mounts dry up quickly, however, and do not allow any particular structures to be seen better than others. To overcome these problems, many different mounting media have been devised. Although the preparation and use of mounting media is a specialized and rather personal matter, there are a few that are in routine use in most laboratories because they offer distinct and well-known advantages. I offer below formulas and comments on some of these.

Water + wetting agent	
Distilled water	100 ml
Wetting agent	A few drops

Several products intended to be used as a photographic wetting agents can be used, eg. Kodak Photo-Flow or Edwal Kwik-wet.

This mounting medium has the advantage of preventing air bubbles from sticking to many fungus structures. I sometimes use it in place of water for making mounts of particularly dry moulds. Many fungi are difficult to "wet", even when a wetting agent is used. For these, I suggest putting them in a drop of 95% ethyl alcohol for a few seconds and then, before the alcohol is completely dried out, adding a drop of the required mounting medium. This often works wonders with the dryest of moulds.

KOH + phloxine	
Solution 1	
Phloxine (a pink dye)	0.025 g
Distilled water	100 ml
Solution 2	
KOH	10 g
Distilled water	10 g



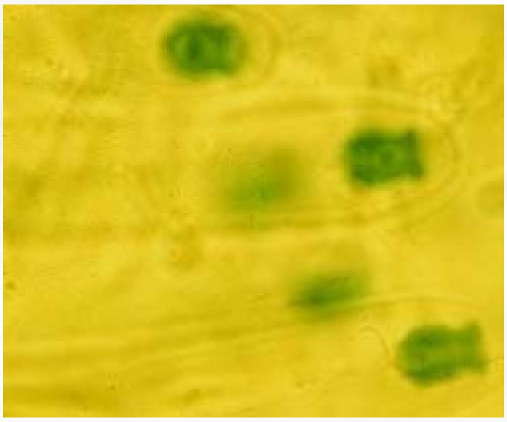
The two solutions are kept in separate dropper bottles. A drop of each is put on a microscope slide and mixed with a needle just before use.

This is a useful staining medium for basidiomycetes and other fungi with compact and difficult-to-spread tissues. The mould hyphae are stained a bright pink colour and are thus more easily seen than in water mounts. It is best to draw as much liquid out from under the cover-slip as possible so that the background colour will be much paler. The picture at right is of basidiospores of *Dacrymyces lacrymalis* mounted in KOH + phloxine.

Lacto-fuchsin	
Acid fuchsin (a pink dye)	0.1 g
Lactic acid (pure)	100 ml

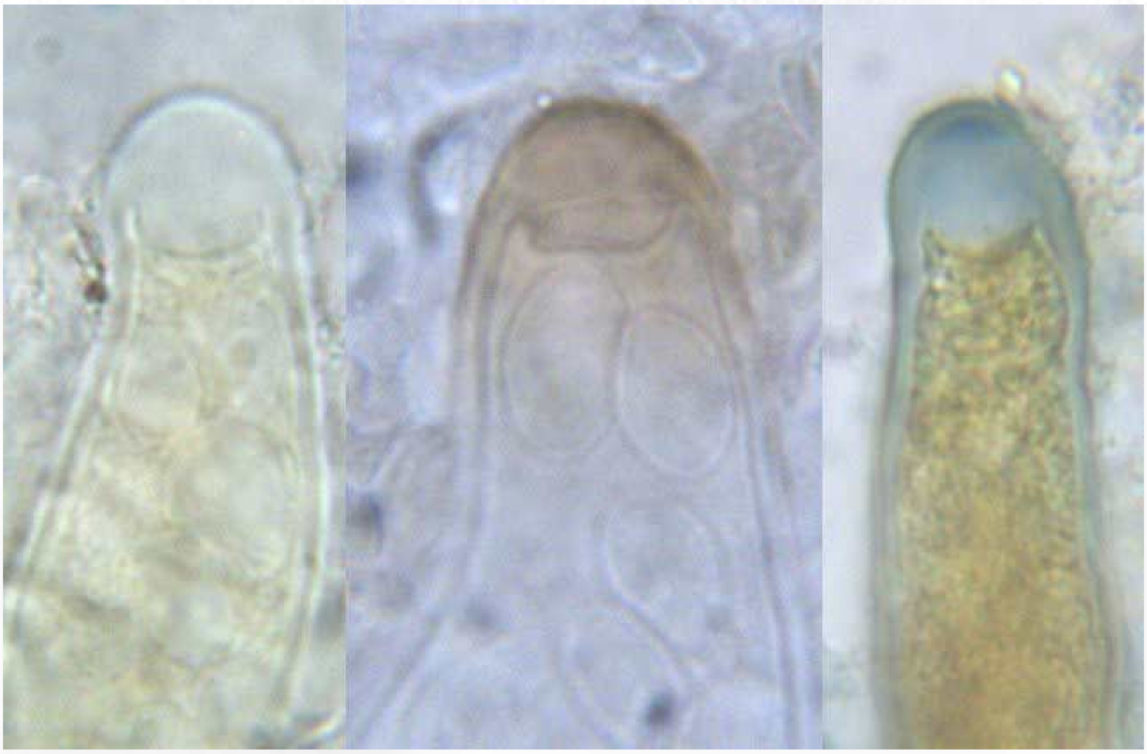
Lacto-fuchsin will not dry up on the slide for several weeks and is thus useful if a slide must be saved for awhile. Drying can be prolonged even further by sealing the edges of the cover-slip with clear nail polish. Lacto-fuchsin is a strong stain that is especially useful for mounts of anamorphs and other easily spread structures.

Melzer's Solution	
Chloral hydrate	100 g
Potassium iodide	5.0 g
Iodine	1.5 g
Distilled water	100 ml



This mounting medium is used extensively in mycology. Certain tissues turn blue to blackish in it and are said to be *amyloid*; others stain red or dark orange and are called *dextrinoid*. In the illustration at right the asci of *Ustulina vulgaris* were treated with Melzer's Solution. The ordinarily clear ascal plugs have stained blue. Melzer's Solution is a good general mounting medium that clears the material somewhat and allows particularly brilliant resolution with a microscope. For good resolution and colour in photographs through the microscope, I make up Melzer's Solution without the iodine, which yields a very clear solution. WARNING: Chloral hydrate should be handled with care as it is toxic. In addition it may be listed as a controlled substance in some jurisdictions, requiring special permission for purchase and possession.

Some mycologists prefer to use iodine-containing mounting media without chloral hydrate. Lugol's Solution (0.5 g iodine, 1.5 g potassium iodide, 100 ml distilled water) and IKI (1.0 g iodine, 3.0 g potassium iodide, 100 ml distilled water) are both substitutes for Melzer's Solution and will produce an amyloid or dextrinoid reaction in many fungi. In fact lichenologists (people who study lichens) routinely use Lugol's and only rarely use Melzer's. The amount of iodine can be varied according to the sensitivity of the group of fungi being studied. Although arguments have been made in favour of all of these media, using them in combination will probably yield the most information.



The photo above shows three asci of *Agyrium rufum*, a fungus commonly encountered on dry branches in sunny locations. The one at left was mounted in Melzer's Solution and yielded no colour changes. The one in the middle was placed in heated 5% KOH solution and then transferred to Melzer's, giving a brown reaction to the ascus tip (perhaps due more to the KOH than to the Melzer's). The one at right was mounted in Lugol's Solution and shows an amyloid apex and dextrinoid contents. This illustration seems to indicate that Lugol's Solution is the best treatment to use, but it's not that simple: many structures can be strongly amyloid in Melzer's alone, as seen in the picture of *Ustulina vulgaris*, or in Melzer's with KOH pretreatment, so only using all three techniques will give a complete profile.

Shear's mounting medium	
Potassium acetate	6 g
Glycerine	120 cc
Ethanol 95%	180 cc
Distilled water	300 cc
Ink Blue	0.1-0.2% by weight

A very good, all-purpose mounting medium that does not dry upon the slide for several weeks. As with Lacto-fuchsin, it can be sealed in with nail polish for even longer life. Ink Blue was not a part of the original formula but is useful as a stain for the walls of certain fungi. The picture at right shows an ascus of a *Claussenomyces* species mounted in Shear's Mounting Medium with Ink Blue. The ascospores and ascus contents have become stained blue while the walls of the ascus remain unstained.

Certain mounting media, such as lacto-phenol, are widely used in mycological laboratories but are very toxic and offer no particular advantages over those listed above.

IDENTIFICATION OF MOULDS

Identification of moulds is based almost entirely on the structures bearing spores and on the spores themselves. Therefore it may be useful for the reader to go back to the beginning and reread the sections in chapters 1 and 2 describing the different kinds of moulds and their anatomy. The process of identification usually involves keys, specialized flow-charts leading to the name of the organism at hand. There are many kinds of keys in use; we present two here, dichotomous keys and picture keys.

Use of dichotomous keys

The most common means of identifying moulds is by the use of a *dichotomous key*, a very clever device presenting a series of alternatives for consideration. A glance at any of the keys that follow will serve as a demonstration. In the key for Group I, for example, there are two choices at number 1, two at number 2, two at number 3, etc., on up to number 14. Each pair of choices represents a decision to be made about the mould which is under examination. In number 1 one has to decide whether the mould's spores are composed of one cell or divided by cross-walls into two or more cells. If they are one-celled, the key sends one on to consider the choice in number 2; if they are more than one-celled, one must go to 12. Eventually the series of decisions will lead to a name.

Most books the reader may wish to use will have dichotomous keys that work in the same way as the ones here. But beware; some authors introduce a third or even fourth, fifth, or sixth choice in their keys that may not be noticed as first!

It is difficult to recommend one or even a few books on identification. The best I can do is direct the reader to a few texts as a good starting points. Ainsworth, Sparrow, and Sussman (1973) and Arx (1981) offer keys to most of the groups of fungi you are likely to encounter. If the mould under examination appears not to be an ascomycete, basidiomycete, or zygomycete, try starting with Barron (1968), Barnett and Hunter (1987), or Carmichael *et al*. (1980). Fungi forming spores in pycnidia can be identified in Nag Raj (1993) and Sutton (1980). For zygomycetes, start with O'Donnell (1979). Domsch *et al*. (1980), a monumental work treating all fungi known to occur in soil, includes keys, illustrations and extensive literature citations. It is an indispensible book for anyone doing serious work with moulds. De Hoog and Guarro (1995), Gravesen *et al*. (1994), Samson, *et al*. (1995), and St-Germain and Summerbell (1996) are beautifully illustrated books, the first and last dealing with fungi of medical interest and the others with fungi found on foods and other human-associated materials. Wang and Zabel (1990), dealing with fungi isolated from utility poles, is a very useful reference for wood-inhabiting fungi. It contains extensive keys and illustrations.

Keys to sixty common genera of moulds

Two approaches are taken to identification in this section: a set of dichotomous keys and a set of picture keys. Which you choose depends upon your individual preference. Some people are verbal in nature and do best when everything is written out; these people usually prefer dichotomous or other types of textual keys. Others are visual and prefer to match what they see to an image. You may even find you do best with a combination of the two.

The dichotomous or text keys

The dichotomous keys are designed to work like the mind of an experienced mycologist, eliminating the most common or most expected fungi first and relegating the less common ones to the end. These are composed of keys to several *groups* of genera. Group I contains the most commonly encountered genera, group II those that are a little less common, and group III those that are less common yet, and so on down to the end. To use the key, start with the key to group I. If you are satisfied that the fungus you are trying to identify is not there, try the key to group II. If that does not work, go to Group III, and so on. The chances are greatest, of course, that the mould you want to identify is in group I, since these are the commonest of all moulds. If your fungus is not among the 60 genera in the whole key, you will have to turn to more complete or specialized books, such as those listed above or in the bibliography.

It should be pointed out that all identifications should be checked against the appropriate description and illustration following the key. It may also be necessary to turn to the references given there. Fungi from one group may be identified incorrectly in the key to another group and only the description and illustration will reveal the mistake. For example, *Paecilomyces* of group II will key out to *Penicillium* in group I, but this problem will only be discovered when checking the descriptions and illustrations.

Go on to the text key for: Group I, Group II, Group III, Group IV, Group V.

The picture keys

These keys are arranged in the same way as the dichotomous keys: that is, the first set of pictures illustrates the most comonly encountered moulds. Those in the second set are also common, but not quite as common as those in the first group. To use the keys, browse over the first group to see if your unknown specimen matches one of the pictures. If you think it fits one of them, click on the picture for further information. If the fit is not very good, go back and try again. If the unknown is not in Group I, go on to Group II.

Go on to the picture key for: Group I, Group II, Group III, Group IV, Group V.

Keys to some common genera of moulds

Group I

1. Spores 1-celled 2.

1. Spores with more than one cell 12.

Usually this is obvious. Occasionally spores may have darkened areas resembling septa, but these will not be visible in optical section when you focus on the centre of the spore.

2. (1) Colonies, spores, and other tissues colourless or brightly coloured 3.

2. Colonies, spores, and/or other tissues dark coloured 8.

The dark colour is either brown or black. The best indication of dark colours comes from looking at the culture itself, either directly or with a dissecting microscope. Under the compound microscope many brown structures will appear nearly colourless.

3. (2) Spores produced in chains 4.

Often chains of spores break apart thoroughly when placed in a water mount. In many species of *Aspergillus* and *Penicillium* a few spores will remain together in a group, so that you can assume that they were originally in chains. On the other hand, species of *Cladosporium* produce chains of spores that completely disassociate on contact and leave no clue about their original orientation. The easiest way to check this is to examine the colony under the 10X objective of a compound microscope, being careful not to get spores on the lens.

3. Spores not produced in chains 6.

4. (3) Conidiophores with a swollen head or vesicle bearing bottle-shaped phialides -»

Aspergillus.

4. Conidiophores not swollen at apex 5.

5. (4) Spores in unbranched chains, borne from clusters of cylindrical to bottle-shaped phialides; colonies usually green -» *Penicillium*.

Compare with *Paecilomyces* (Group II), *Gliocladium* (Group III), *Scopulariopsis* (Group III), and *Talaromyces* (Group IV).

5. Spores borne in branching chains from undifferentiated conidiophores; colonies often very fast growing and pink -» *Chrysonilia*.

6. (3) Spores borne in a sporangium with a columella; often with only the columella evident as a swollen hyphal tip; hyphae not septate -» *Mucor*.

Compare with *Rhizopus* (Group I), *Mortierella* (Group II), *Absidia*, *Circinella* (Group V), and *Zygorhynchus*.

6. Spores produced externally; hyphae septate7.

7. (6) Conidiophores well-developed and usually with a central axis; very fast growing and with conidiophores usually produced in small cushions of hyphae; often green -» *Trichoderma*.

Compare with *Verticillium* (Group II), *Gliocladium* (Group III).

7. Conidiophores poorly developed or lacking; phialides produced singly along the vegetative hyphae; hyphae often aggregated into "ropes"; seldom or never green -» *Acremonium*.

Compare with *Verticillium* (Group II), *Sporothrix* (Group IV), and *Phialophora* (Group IV).

8. (2) Spores in chains, produced externally (9).

8. Spores not in chains, produced inside sporangia or fruiting bodies (pycnidia)Spores not in chains, produced inside sporangia or fruiting bodies (pycnidia) (10).

9. (8) Conidiophores with a swollen head or vesicle bearing bottle-shaped phialides; conidial chains unbranched -» *Aspergillus*.

9. Conidiophores lacking a swollen apex; spore chains often branched; spores often both 1- and 2-celled -» ***Cladosporium***.

10. (8) Spores produced inside a fruiting body (pycnidium) with a cellular wall; hyphae septate -» *Phoma*.

Compare with *Pyrenochaeta* (Group IV), *Microsphaeropsis* (Group IV), and also be sure that asci are not present at a very early stage.

10. Spores produced within a sporangium with a columella, often with only the columella evident as a swollen hyphal tip; hyphae not septate 11.

11. (10) Sporangiophores with rhizoids (branched "roots") at base -» *Rhizopus*.

Compare with *Absidia* (Figure 2B).

11. Sporangiophores lacking rhizoids -» *Mucor*.

Compare with *Mortierella* (Group II), *Absidia* (Figure 2B), *Circinella* (Group V), and *Zygorhynchus* (Figure 2C).

12. (1) Spores with transverse septa only 13.

12. Spores with both transverse and vertical septa 14.

13. (12) Spores dark, produced in branched chains -» *Cladosporium*.

13. Spores colourless or brightly coloured, mostly with more than two cells, often canoe-shaped, usually produced in slimy masses; colonies often pink -» *Fusarium*.

Compare with *Cylindrocarpon* (not treated here), *Candelabrella*, *Monacrosporium* (both Group III), and *Trichophyton* (Group V).

14. (12) Spores usually in chains, usually club-shaped; colonies grey to brown -» *Alternaria*.

Compare with *Ulocladium* and *Stemphylium* (Group II).

14. Spores in clusters but not in chains, usually spherical; colonies often (but not always) bright orange or yellow and purplish in reverse -» *Epicoccum*.

Compare with *Stemphylium* (Group II).

Group II

1. Colonies composed of hyphae, or at least with some hyphae present 2.

1. Colonies lacking hyphae; short chains of "budding" cells may be produced 16.

2. (1) Spores 1-celled 3.

2. Spores with more than one cell 14.

3. (2) Spores and hyphae colourless or brightly coloured 4.

3. Spores and/or hyphae dark coloured 10.

4. (3) Spores produced in chains 5.

4. Spores not produced in chains 7.

5. (4) Spores produced from small clusters of tapering phialides, often rather pointed at the ends -» *Paecilomyces*.

Compare with *Penicillium* (Group I), *Talaromyces* (Group IV) and *Verticillium* (Group II).

5. Spores produced by the simple fragmentation of hyphal segments into individual cells 6.

6. (5) Colonies very slow growing (slower than 5 mm/week), often grey, often with a strong earthy odour; hyphae usually less than 1 µm in diameter -» *Streptomyces*.

6. Colonies growing faster, with a fruit-like odour or odourless, hyphae larger -» *Geotrichum*.

Compare with *Geomyces* (Group IV).

7. (4) Spores produced in sporangia, with sporangia often broken and represented only by simple blunt sporangiophores (no swollen columella); colonies often velvety in texture and pink to brown -» *Mortierella*.

Compare with *Mucor* (Group I) and *Absidia* (Figure 2B).

7. Spores produced externally 8.

8. (7) Spores produced in large numbers and completely covering the surface of large terminal cells; cells of conidiophores often flattening in alternating planes as they dry; colonies often producing black stony sclerotia -» *Botrytis*.

Compare with *Chromelosporium* (not treated here).

8. Spores produced at the tips of terminal cells and never covering them; cells of the conidiophore

not flattening characteristically upon drying 9.

9. (8) Conidia produced in small round masses at the tips of phialides; phialides in whorls, tapering gradually to a very narrow tip -» *Verticillium*.

Compare with *Acremonium* (Group I).

9. Conidia produced singly at the ends of short branches; or in short chains, not on phialides; spore-producing cells not in whorls -» *Chrysosporium*.

Sepedonium and *Trichophyton* (both Group V) and *Geomyces* (Group IV) are similar.

10. (3) Spores produced in sporangia or in fruiting bodies 11.

10. Spores produced externally 12.

11. (10) Spores produced within densely hairy fruiting bodies (perithecia), very dark; asci present when young -» *Chaetomium*.

11. Spores produced in sporangia (Go back to 7).

12. (10) Conidiophores united to form large synnemata that have a sterile base and a spore-bearing upper part, often accompanied by spores of *Echinobotryum* (Group V), -» *Cephalotrichum*.

Compare with *Trichurus* and *Graphium* (both Group III).

12. Conidiophores never united to form such structures 13.

13. (12) Spores arising in dense masses directly from swellings on the vegetative mycelium; colonies usually rather flat and moist -» *Aureobasidium*.

Compare with *Exophiala* (Group III).

13. Spores completely covering the terminal cells of erect conidiophores; colonies cottony and rather dry; black sclerotia often present -» *Botrytis*.

14. (2) Spores with transverse walls only, colourless; colonies white to pink; often associated with eelworms -» *Orbilia*.

Compare with *Trichothecium* (Group V). Species formerly referred to *Arthrobotrys*, *Candelabrella*, *Dactylella*, *Geniculifera*, and *Monacrosporium* also belong here.

14. Spores with transverse and vertical walls, dark brown 15.

15. (14) Conidiophores more or less straight because of their elongation directly through the scar of the previous spore, bearing only one spore at a time -» *Stemphylium*.

Compare with Pithomyces (Group IV).

15. Conidiophores often with a slight zigzag appearance due to new growth from just below the tip, often bearing a spore at each bend -» *Ulocladium*.

Compare with Pithomyces (Group IV) and *Curvularia* (not treated here).

16. (1) Cells very small, seldom more than 1-2 µ in diameter, dividing by simple fission into two equal-sized daughter cells, sometimes containing a single internal spore -» Bacteria.

16. Cells usually larger than 1-2 µ in diameter, dividing by budding, with the daughter cell seen as a small "bubble" arising from the wall of the parent cell, sometimes containing one or more internal spores (ascospores) -» Yeasts.

Compare with Aureobasidium (Group II), Candida and Exophiala (both Group III).

Group III

1. Spores 1-celled 2.

1. Spores with more than one cell 10.

2. (1) Conidiophores united into complex synnemata with a sterile base and fertile upper part 3.

2. Conidiophores solitary, never forming complex structures, sometimes not present 4.

3. (2) Spores produced in a large colourless drop of fluid at the tip of the synnema -» *Graphium*.

Compare with *Pesotum* (not treated here).

3. Spores produced along the sides of the upper part of the synnema, dry, interspersed with loosely coiled hairs -» *Trichurus*.

4. (2) Spores produced in chains 5.

4. Spores not produced in chains 6.

5. (4) Spores brown, produced from a cluster of strongly swollen cells (phialides) -» *Memnoniella*.

(see Stachybotrys)

5. Spores usually grey, tan, or colourless, produced from clusters of bottle-shaped cells (annellides) -» *Scopulariopsis*.

Compare with Penicillium (Group I) and Scedosporium.

6. (4) Spores produced in small clusters at several "nodes" along the length of erect conidiophores

-» *Gonatobotrys*.

6. Spores apical or conidiophores not obviously well-developed 7.

7. (6) Spores borne along the length of the hyphae from apparently undifferentiated cells; colonies white, moist, and flat -» *Candida*.

7. Spores produced at the apex of distinct conidiophores or phialides; colony appearance various 8.

8. (7) Conidiophores small and inconspicuous, usually consisting of short cells or branches functioning as annellides; colonies often black and yeast-like; spores collecting in wet masses at the apex of the conidiophores, sometimes budding -» *Exophiala*.

8. Conidiophores large and conspicuous; colonies never yeast-like 9.

9. (8) Conidiophores unbranched or rarely very simply so; spores arising from an apical cluster of swollen cells (phialides) -» *Stachybotrys*.

9. Conidiophores highly branched; spores borne from clusters of narrow cells (phialides), produced in a slimy mass -» *Gliocladium*.

Compare with *Leptographium* (Group V), *Penicillium* (Group I), and *Scedosporium*.

10. (1) Spores dark brown, rather large, several-celled -» *Bipolaris*.

Compare with *Pithomyces* (Group IV) and *Trichocladium* (Group V).

10. Spores colourless; usually associated with eelworms. Anamorphs of Orbiliaceae go here 11.

11. (10) Spores solitary at the tip of a long unbranched to weakly branched conidiophore -» *Orbilia*.

Species formerly referred to *Arthrobotrys*, *Candelabrella*, *Dactylella*, *Geniculifera*, and *Monacrosporium* also belong here.

11. Several spores on each conidiophore 12.

12. (11) Spores produced along the length of an elongating and more or less zigzag conidiophore -» *Orbilia*.

Species formerly referred to *Arthrobotrys*, *Candelabrella*, *Dactylella*, *Geniculifera*, and *Monacrosporium* also belong here.

12. Conidiophores producing a series of short branches from a single locus (candelabrum-like), with each branch bearing a spore -» *Orbilia*.

Species formerly referred to *Arthrobotrys*, *Candelabrella*, *Dactylella*, *Geniculifera*, and *Monacrosporium* also belong here.

Group IV

1. Spores 1-celled 2.

1. Spores with more than one cell 11.

2. (1) Spores produced within a distinct fruiting body having a hyphal or cellular wall 3.

2. Spores borne externally 6.

3. (2) Fruiting bodies or spore mass brown or black 4.

3. Fruiting bodies and spore mass colourless or brightly coloured 5.

4. (3) Spores brown; fruiting bodies (pycnidia) lacking spines -» *Microsphaeropsis*.

Compare with *Myrothecium* (Group V).

4. Spores colourless or brightly coloured; fruiting bodies (pycnidia) with spines around the apical opening -» *Pyrenochaeta*.

5. (3) Fruiting bodies (cleistothecia) composed of hyphae; usually with an abundant brush-like anamorph -» *Talaromyces*.

Compare with *Gymnoascus* (Group V) and *Arachniotus* (not treated here).

5. Fruiting bodies (cleistothecia) with a distinctly cellular wall; usually with a conspicuous anamorph characterized by bottle-shaped philides borne on a swollen apical vesicle -» Teleomorphs of *Aspergillus*.

Species of *Penicillium* may have similar teleomorphs.

6. (2) Spores distinctly dark brown or black 7.

6. Spores colourless or quite pale 8.

7. (6) Spores usually spherical and roughened, with two hyphal connections; hyphae mostly not septate -» Zygospores of Mucorales.

Usually associated with *Absidia*, *Mucor*, *Rhizopus*, *Zygorhynchus* (similar to *Mucor*), etc. Read about Zygosporangia for a more detailed discussion of how these structures are formed.

7. Spores discoid or egg-shaped, often with a colourless band, usually smooth, with only one connection to the conidiophore; hyphae septate -» *Arthrinium*.

Compare with *Wardomyces* and *Nigrospora* (both Group V).

8. (6) Spores in chains (sometimes interrupted by sterile cells) 9.

8. Spores not in chains 10.

9. (8) Spore chains often characterized by an alternating series of spores and narrow sterile cells (bead-like in appearance); filaments never dark -» *Geomyces*.

Compare with *Chrysosporium* (Group II).

9. Spore chains composed of uniformly cylindrical spores, never with alternating sterile cells; conidiophores often dark -» *Oidiodendron*.

10. (8) Spores borne from the apex of flask-shaped phialides with a flaring collar -» *Phialophora*.

Compare with *Exophiala* (Group III).

10. Spores borne at the tips of somewhat jagged conidiophores -» *Sporothrix*.

11. (1) Spores borne in fruiting bodies (pycnidia), 2-celled -» *Diplodia*.

11. Spores borne externally, with more than two cells -» *Pithomyces*.

Compare with *Trichocladium* (Group V).

Group V

1. Spores 1-celled 2.

1. Spores with more than one cell 11.

2. (1) Spores borne in dense masses within some kind of structure 3.

2. Spores produced externally, never from any kind of compound structure 5.

3. (2) Spores produced inside thin-walled sporangia that are recurved on short hooks -» *Circinella*.

Compare with *Mucor* (Group I).

3. Spores never produced in recurved sporangia 4.

4. (3) Fruiting structure a sporodochium containing a layer of conidiophores; spores in slimy masses, very dark green -» *Myrothecium*.

4. Fruiting structure a cleistothecium containing asci (when young) and ascospores; spores dry at maturity; never associated with phialides -» *Gymnoascus*.

5. (2) Spores brown to black 6.

5. Spores brightly coloured or colourless 8.

6. (5) Spores roughened, with a prolonged apical snout; often associated with *Cephalotrichum* (Group II) -» *Echinobotryum*.

6. Spores smooth 7.

7. (6) Spores usually borne in small clusters, usually egg- or bullet-shaped, with a narrow colourless band (germ slit); may be associated with *Scopulariopsis* (Group III) -» *Wardomyces*.

7. Spores solitary, usually spherical to somewhat flattened spherical, often with a germ slit -» *Nigrospora*.

8. (5) Conidiophores dark brown, densely branched at the apex and bearing the colourless spores in a drop of fluid -» *Leptographium*.

Compare with *Phialocephala*, *Thysanophora*, and *Verticicladiella* (not treated here).

8. Conidiophores colourless 9.

9. (8) Spores completely covering a large swelling at the apex of an erect conidiophore -» *Oedocephalum*.

Compare with *Cunninghamella*.

9. Conidiophores not well-developed and lacking a terminal swelling 10.

10. (9) Spores relatively large, usually spherical, roughened -» *Sepedonium*.

Several fungi produce large sphaerical scultured spores. Important among these are *Histoplasma capsulatum* and some *Mortierella* species. *Histoplasma capsulatum* is a serious human pathogen; if you believe that it is present in your culture; **do not open the lid**.

10. Spores quite small, usually egg-shaped, smooth; often causing skin infections in animals, including humans -» *Trichophyton*.

11. (1) Spores dark (at least some of the cells) 12.

11. Spores colourless 13.

12. (11) Spores with long appendages at the apex, borne in sporodochia -» *Pestalotiopsis*.

12. Spores lacking appendages, not in sporodochia -» *Trichocladium*.

Compare with *Dendryphiella*.

13. (11) Spores 2-celled, produced in chains from the apex of erect conidiophores -» *Trichothecium*.

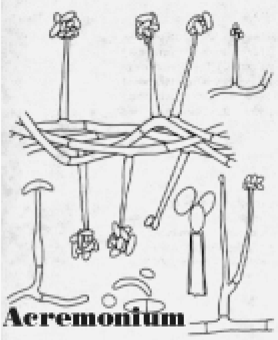
13. Spores usually with more than 2-cells or irregularly 1- to several-celled, not arising from distinct conidiophores; often causing skin infections in animals, including humans -» *Trichophyton*.

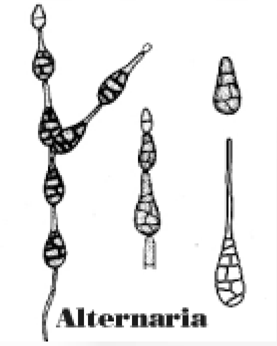
Compare with *Microsporum*.

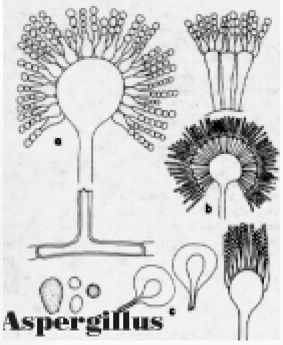
Picture keys to some common genera of moulds

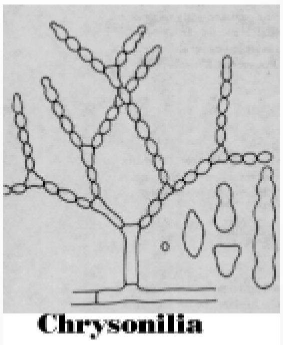
Group I

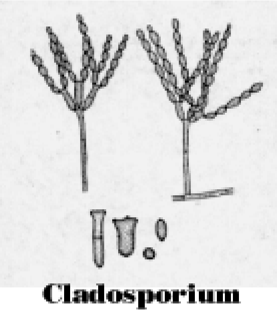
These are the most common moulds you will encounter
Click on the image for more information

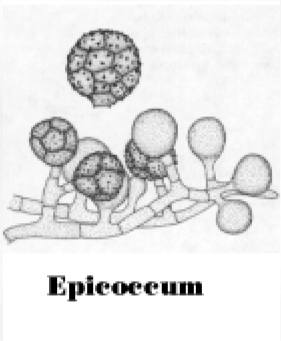

Acremonium

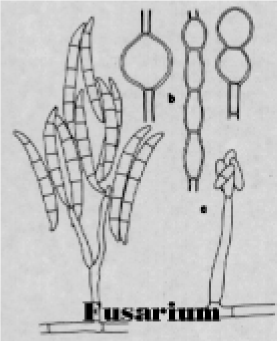

Alternaria

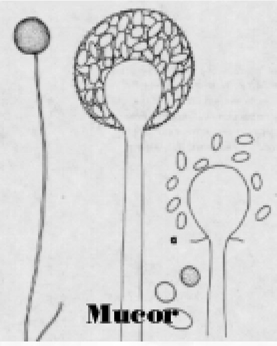

a
b
c
Aspergillus

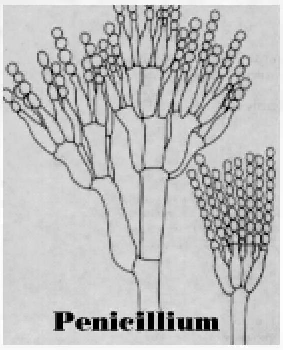

Chrysonilia

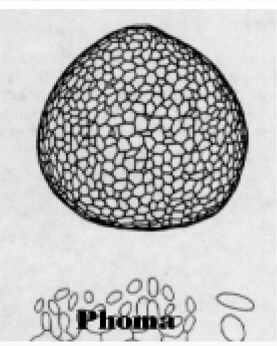

Cladosporium

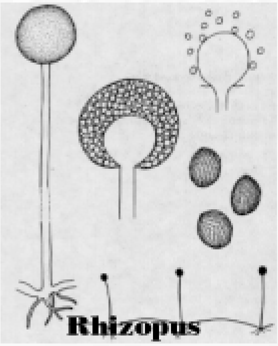


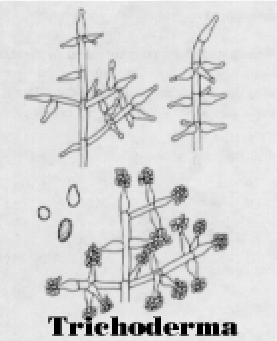

b
a
Fusarium




Penicillium

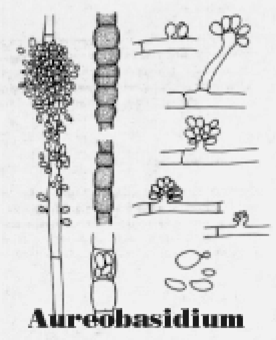


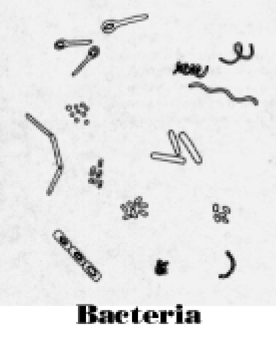


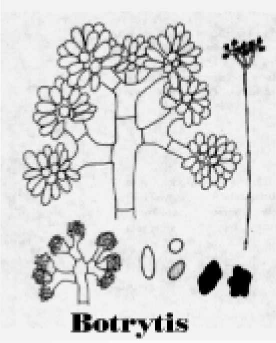

Trichoderma

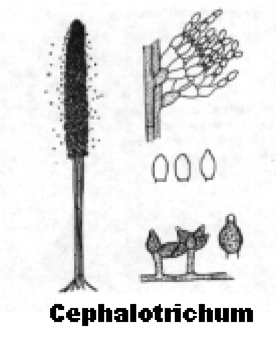
Group II

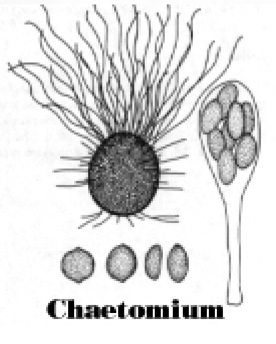
These are the second most common moulds you will encounter
Click on the image for more information

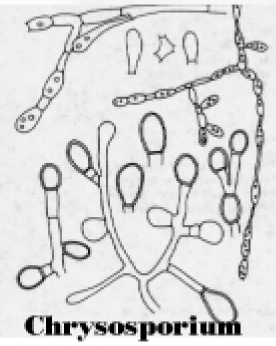

Aureobasidium

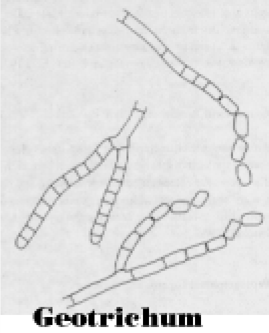

Bacteria

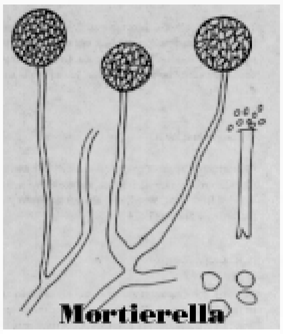

Botrytis

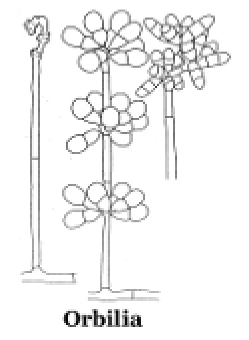

Cephalotrichum

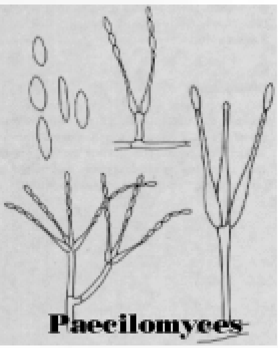

Chaetomium

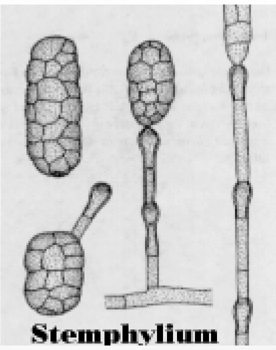

Chrysosporium

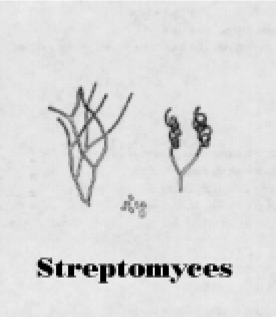

Geotrichum

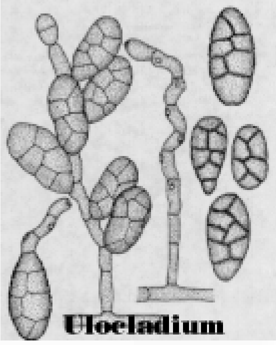

Mortierella

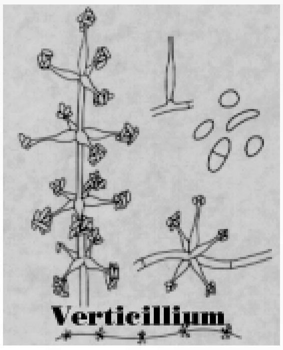

Orbilia

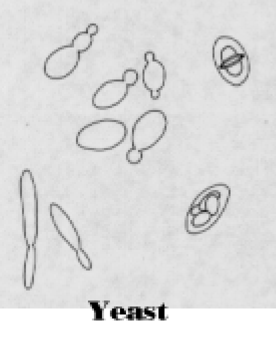

Paecilomyces


Stemphylium


Streptomyces

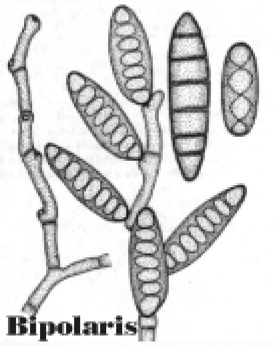

Ulocladium

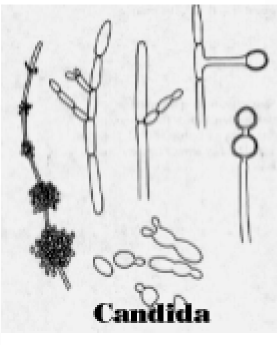

Verticillium

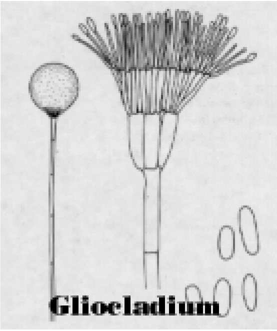

Yeast

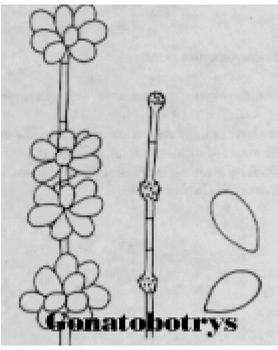
Group III

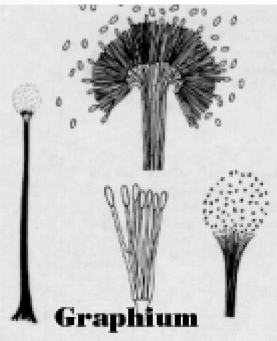
These are the third most common moulds you will encounter
Click on the image for more information

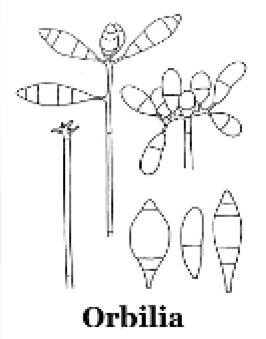


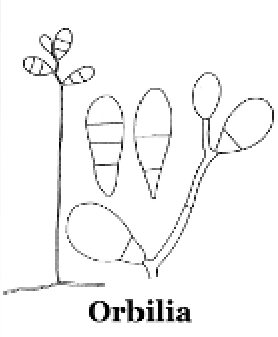


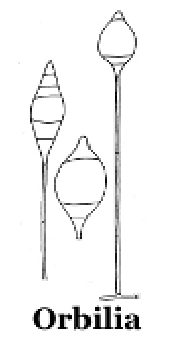

Gliocladium

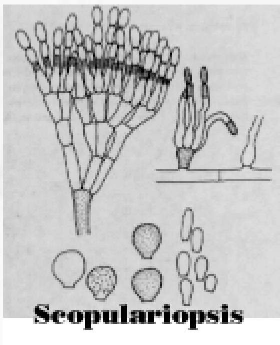

Gonatobotrys

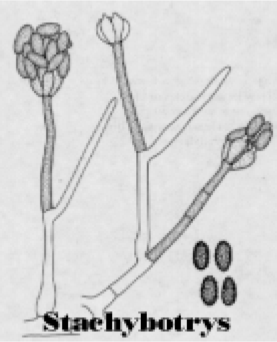


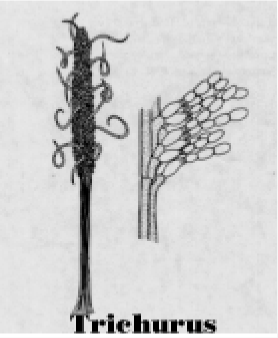






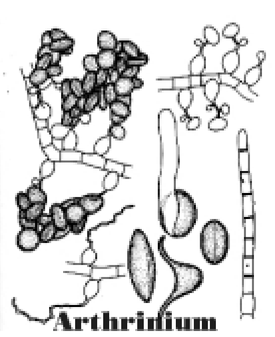

Scopulariopsis

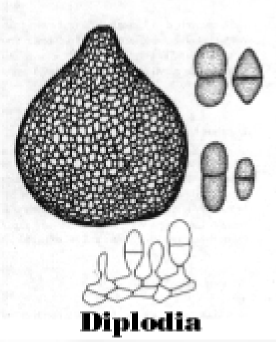

Stachybotrys

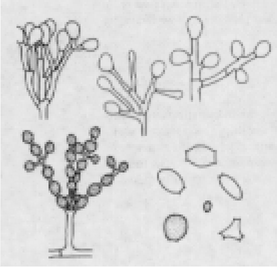


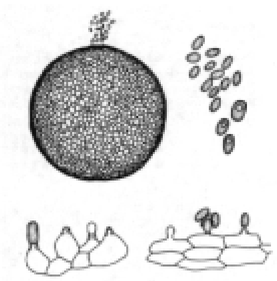
Group IV

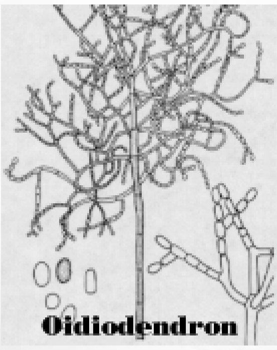
These are the fourth most common moulds you will encounter
Click on the image for more information

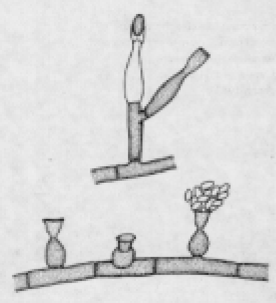

Arthrinium

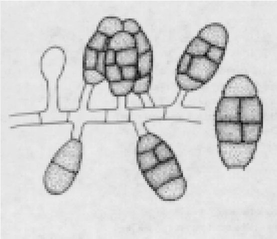

Diplodia

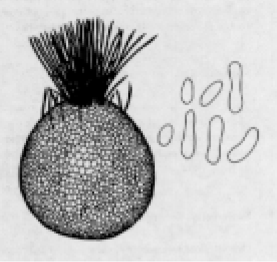

Geomyces

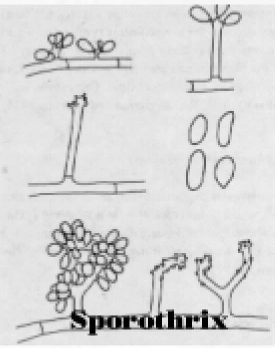

Microsphaeropsis

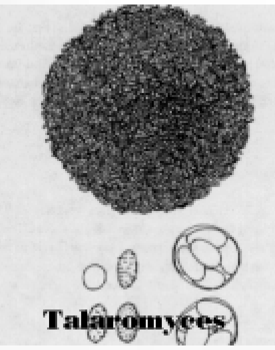

Oidiodendron

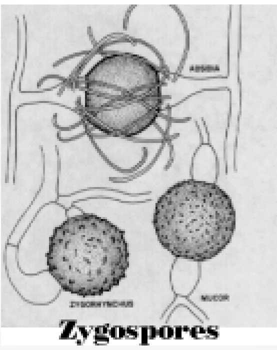

Phialophora


Pithomyces

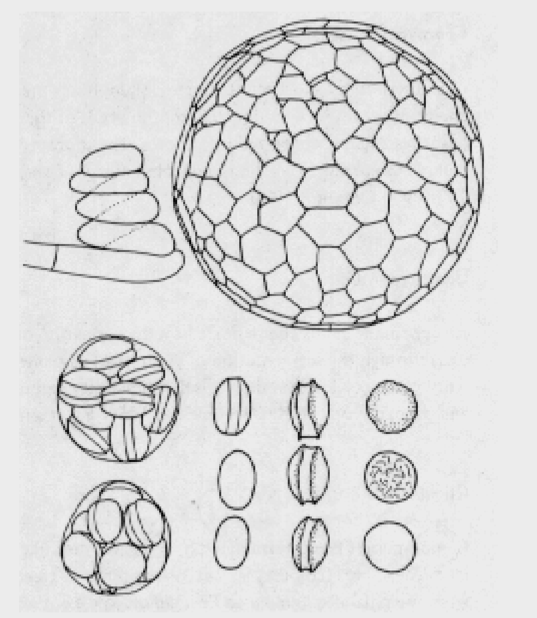

Pyrenochaeta


Sporothrix


Talaromyces

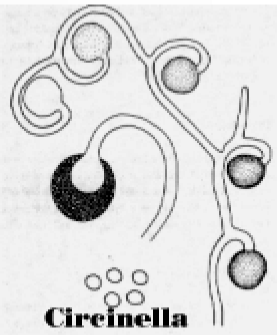


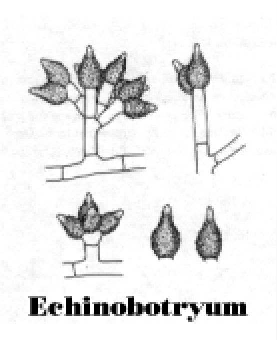
Zygospores

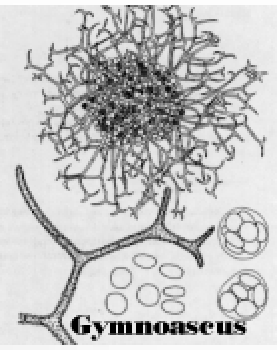

Teleomorphs of *Aspergillus*

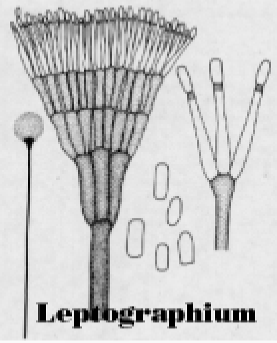
Group V

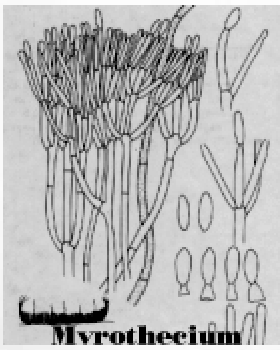
These are the fifth most common moulds you will encounter
Click on the image for more information

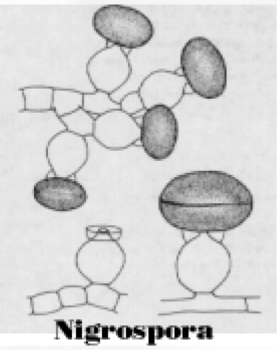

Circinella

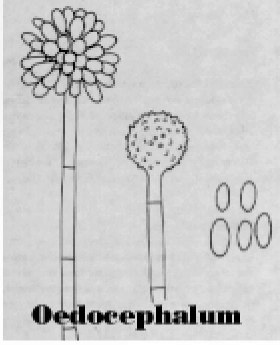

Echinobotryum

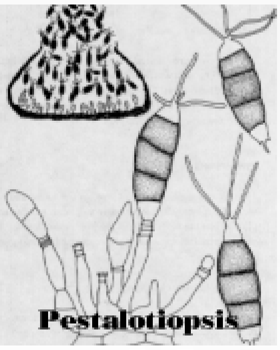

Gymnoascus

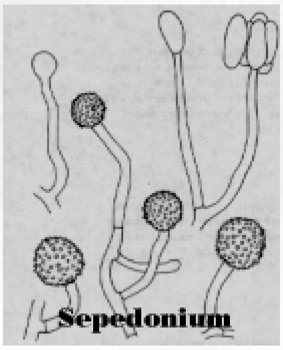

Leptographium

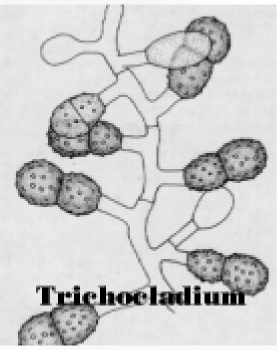

Myrothecium

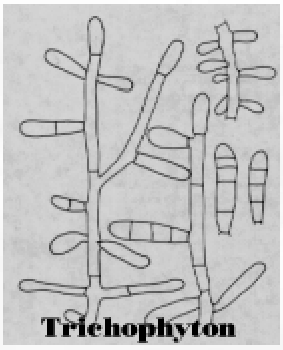

Nigrospora

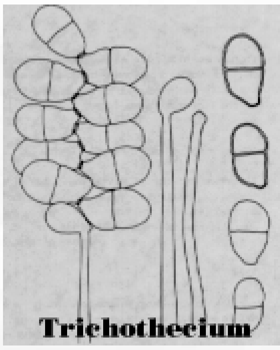

Oedocephalum

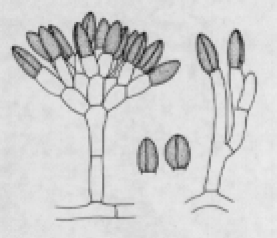

Pestalotiopsis


Sepedonium

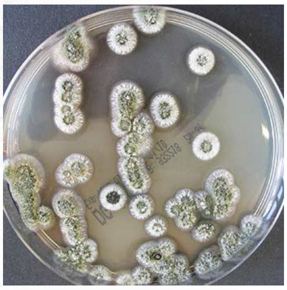

Trichocladium

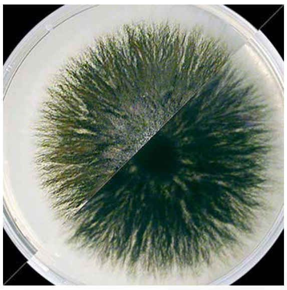

Trichophyton

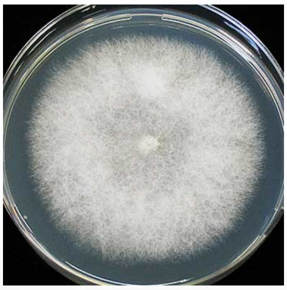

Trichothecium

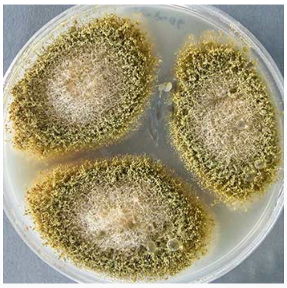

Wardomyces

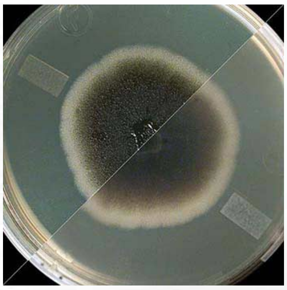
PICTORIAL INDEX OF MOULDS

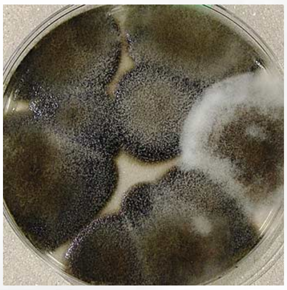

Acremonium murorum

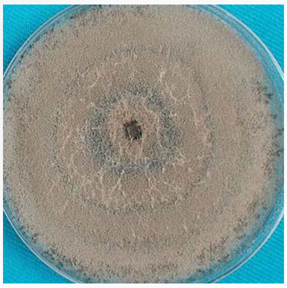

Alternaria alternata


Arthrinium phaeospermum

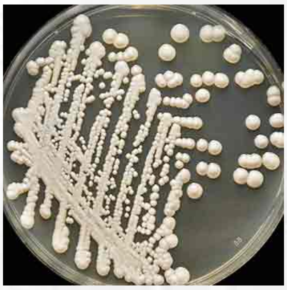

Aspergillus tamarii


Aureobasidium pullulans

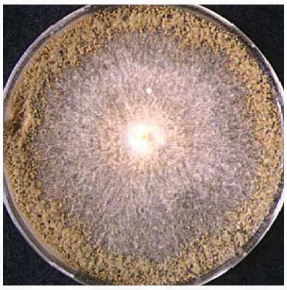

Bipolaris

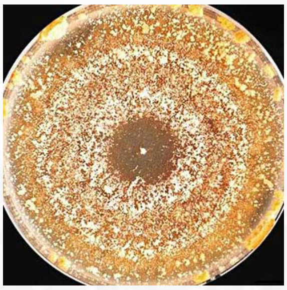

Botrytis cinerea

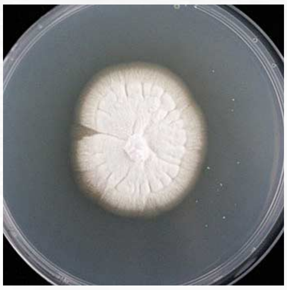
Candelabrella - no image

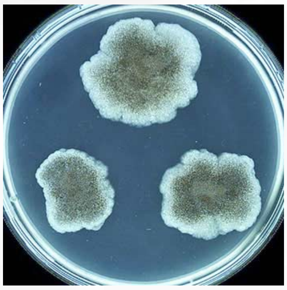

Candida albicans

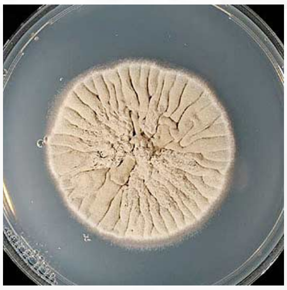
Cephalotrichum - no image


Chaetomium globosum

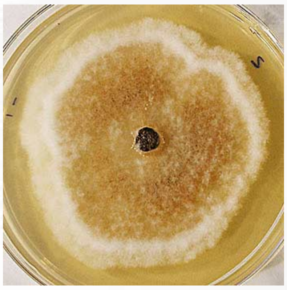

Chrysonilia sitophila


Chrysosporium pannorum

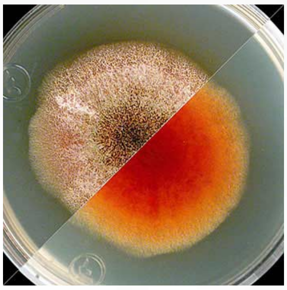

Circinella muscae

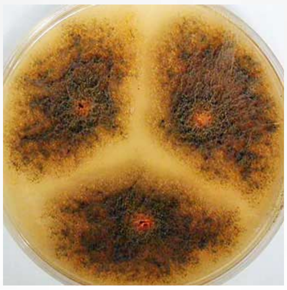

Cladosporium herbarum

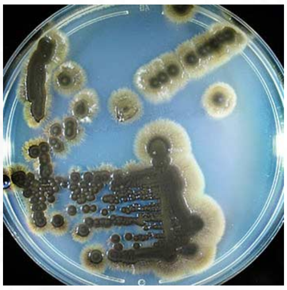
Dendryphiella - no image

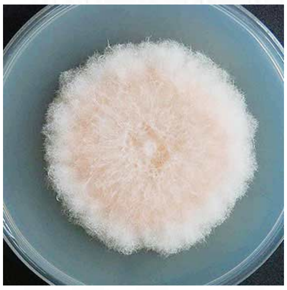

Diplodia mutila

Echinobotryum - no image

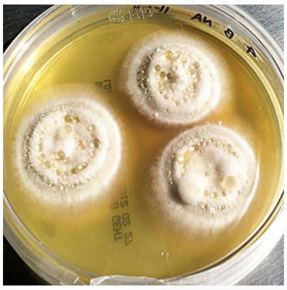

Epicoccum purpurascens

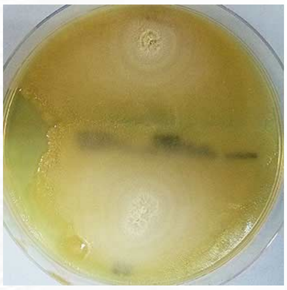

Eurotium rubrum

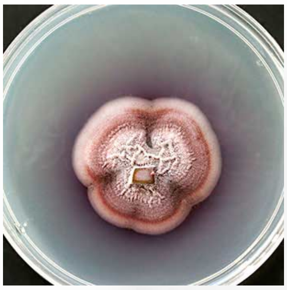

Exophiala dermatitidis


Fusarium equiseti

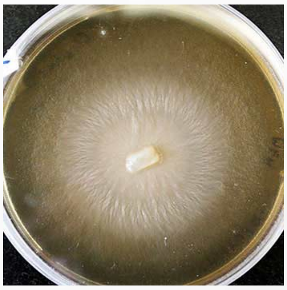
Geniculifera - no image

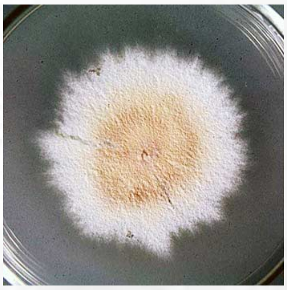

Geomyces destructans

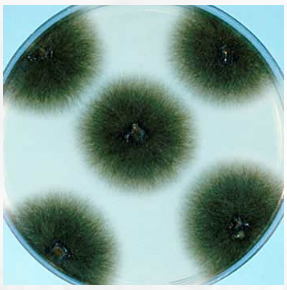

Geotrichum candidum


Gliocladium roseum

Gonatobotrys - no image

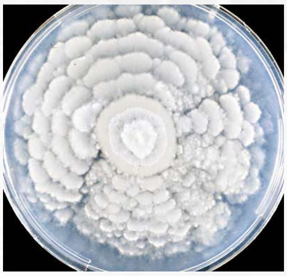

Graphium ulmi

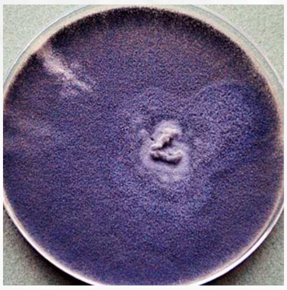

Gymnoascus gypseus

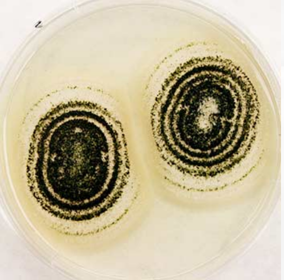

Leptographium procerum

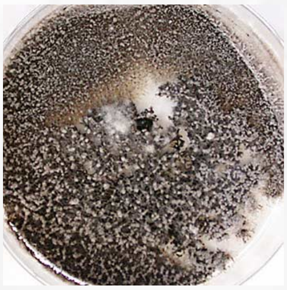
Microsphaeropsis - no image

Monacrosporium - no image


Mortierella wolfii

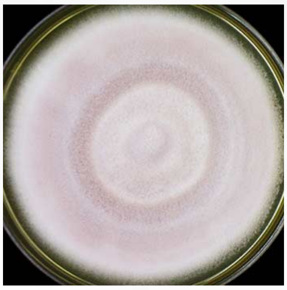

Mucor circinelloides

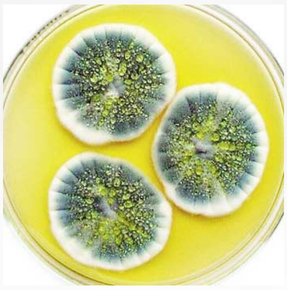

Myrothecium roridum

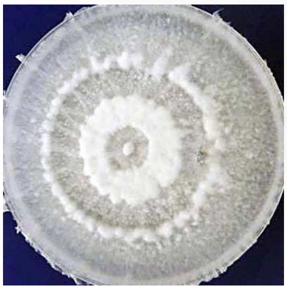

Nigrospora

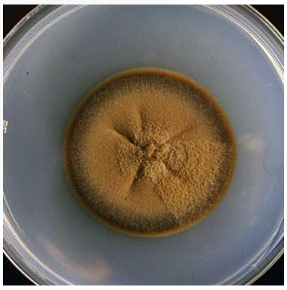
Oedocephalum - no image

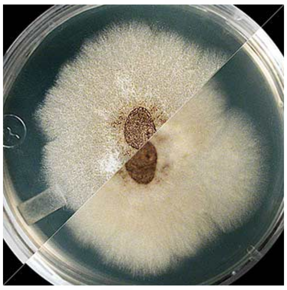
Oidiodendron - no image

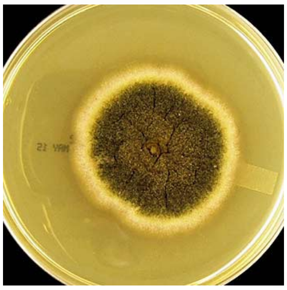

Paecilomyces lilacinus

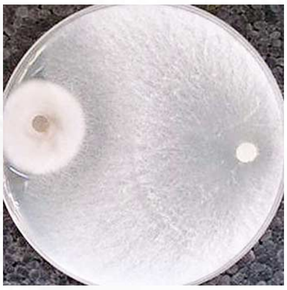

Penicillium chrysogenum

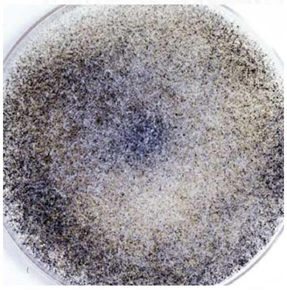

Pestalotiopsis microspora

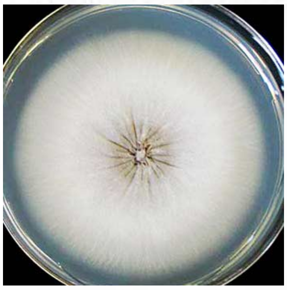

Phialophora verrucosa

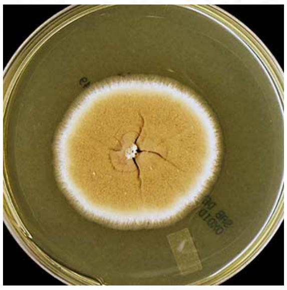

Phoma glomerata

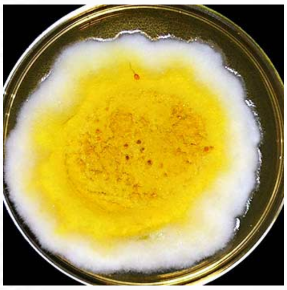

Pithomyces

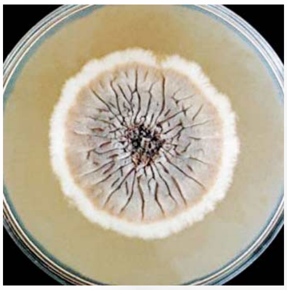

Pyrenochaeta lycopersici

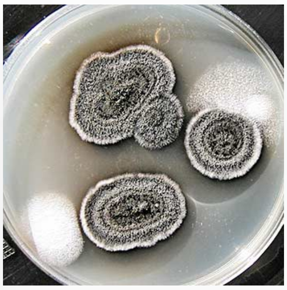

Rhizopus oryzae

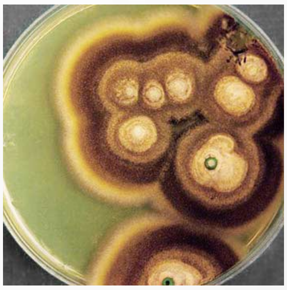

Scedosporium prolificans

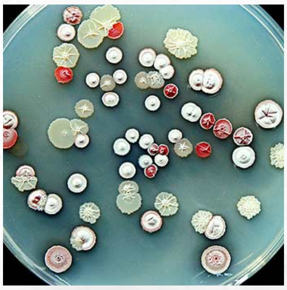

Scopulariopsis brevicaulis

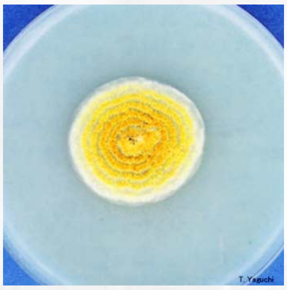

Sepedonium


Sporothrix schenckii

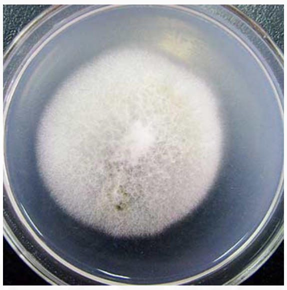

Stachybotrys

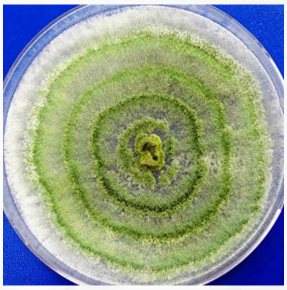

Stemphylium botryosum

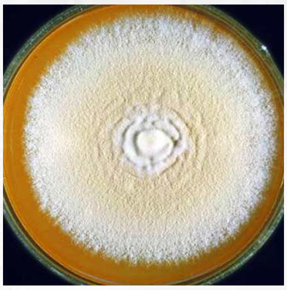

Streptomyces coelicolor

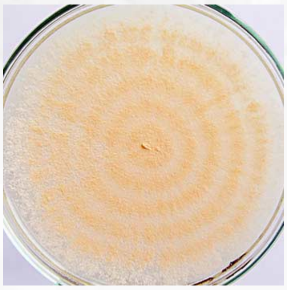


Talaromyces wortomannii

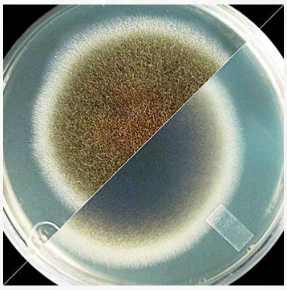

Trichocladium

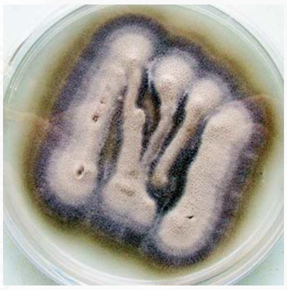

Trichoderma viride

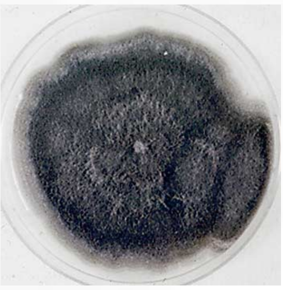

Trichophyton mentagrophytes

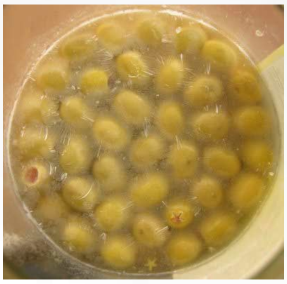

Trichothecium roseum

Trichurus - no image


Ulocladium chartarum


Verticillium theobromae

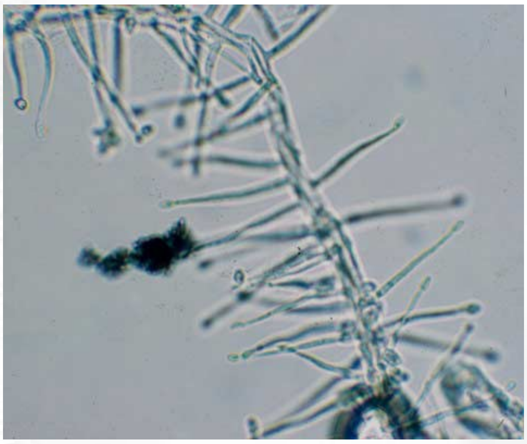
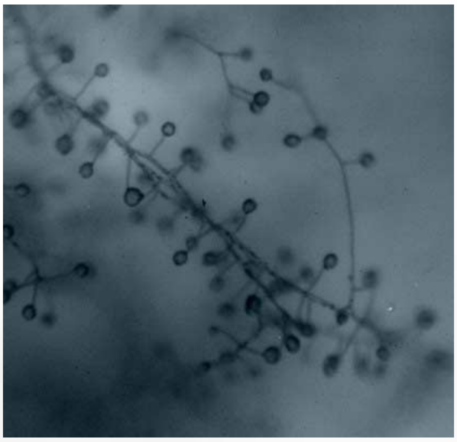
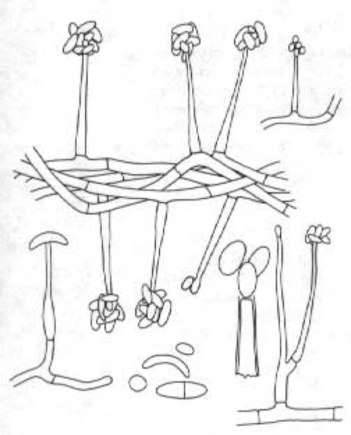

Wardomyces anomala

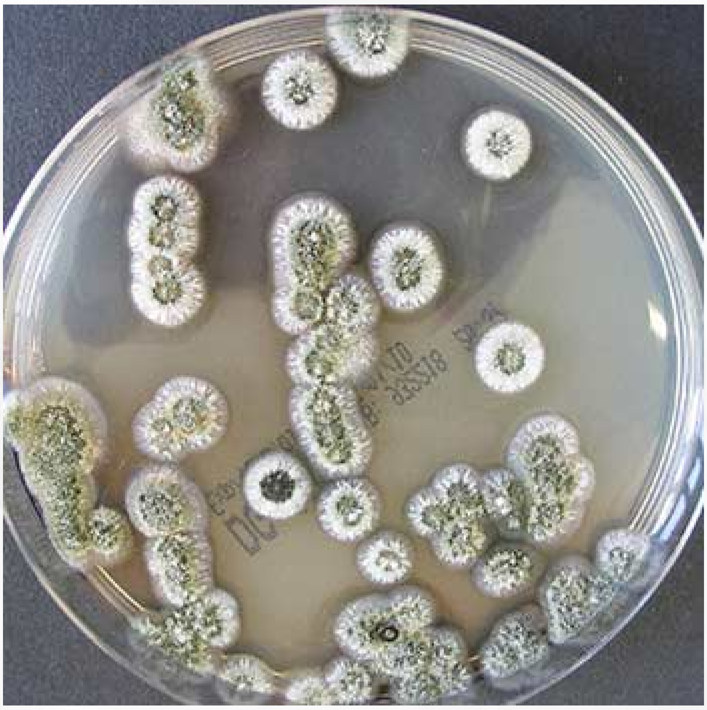

Dro¿d¿e

INDEX TO THE DESCRIPTIONS AND ILLUSTRATIONS

Acremonium
Alternaria
Arthrinium
Arthrobotrys
Aspergillus
Aureobasidium
Bacteria
Beauveria
Bipolaris
Botrytis
Candelabrella
Candida
Cephalotrichum
Chaetomium
Chrysonilia
Chrysosporium
Circinella
Cladosporium
Dendryphiella
Diplodia
Yeasts
Echinobotryum
Epicoccum
Eurotium
Exophiala
Fusarium
Geniculifera
Geomyces
Geotrichum
Gliocladium
Gonatobotrys
Graphium
Gymnoascus
Leptographium
Microsphaeropsis
Monacrosporium
Mortierella
Mucor
Myrothecium
Nigrospora
Oedocephalum
Oidiodendron
Paecilomyces
Penicillium
Pestalotiopsis
Phialophora
Phoma
Pithomyces
Pyrenochaeta
Rhizopus
Scedosporium
Scopulariopsis
Sepedonium
Sporothrix
Stachybotrys
Stemphylium
Streptomyces
Talaromyces
Trichocladium
Trichoderma
Trichophyton
Trichothecium
Trichurus
Ulocladium
Verticillium
Wardomyces
Zygospores of Mucorales

Acremonium



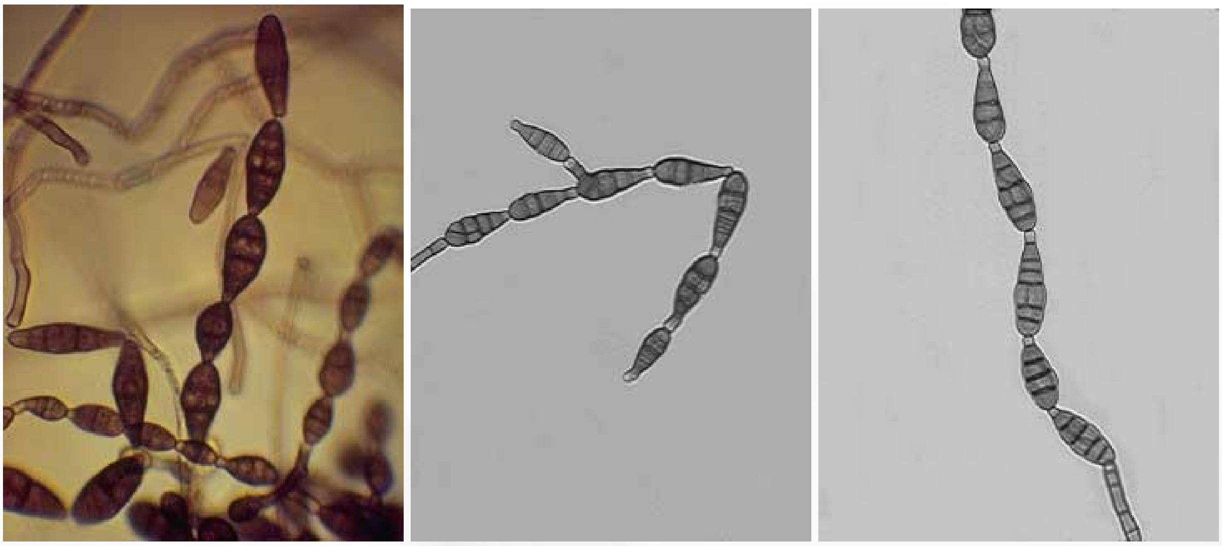
Acremonium murorum

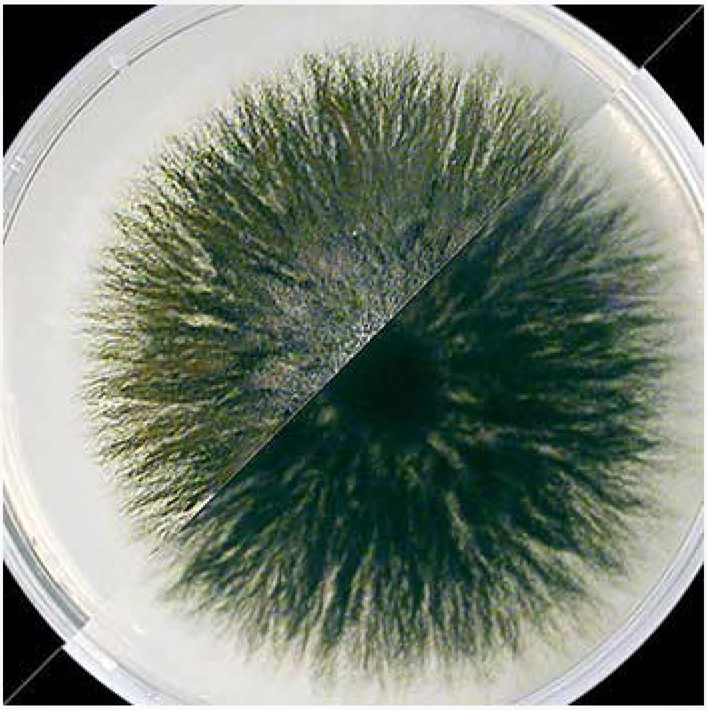
Species of *Acremonium* are recognized by solitary to weakly branched, tapering phialides arising from vegetative filaments and bearing a wet cluster of mostly 1-celled spores (conidia). The filaments are sometimes bound together into "ropes" several cells in diameter. The illustrations here present *Acremonium* in its narrower sense, but a great variety of species have been included in the genus at one time or another. Almost any species bearing colourless or brightly-coloured conidia on rather simple unpigmented phialides might be referred to *Acremonium*. Seifert *et al.* (2011) present a key to no fewer than 50 genera that might be confused with *Acremonium*. Even when taken in its narrowest sense, species of *Acremonium* are nearly impossible to identify without the use of molecular methods.

Common in soil, plant debris, rotting mushrooms, etc. Some appear to be parasitic on living fungi.

Classification: in a narrow sense of *Acremonium* the species are mostly members of the Hypocreomycetidae.
Holomorphs: *Emericellopsis*, *Hapsidospora*, *Leucosphaerina*, *Nectria*, and many others.
Ref: Domsch *et al*, 1980,; Gams 1971.

Alternaria



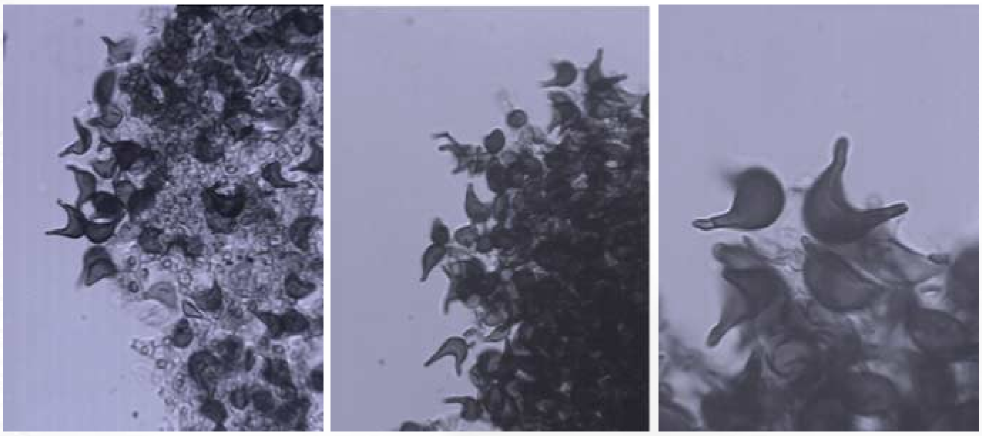


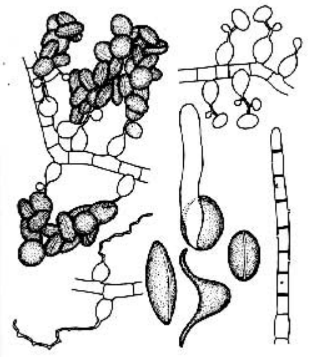
Alternaria alternata - top/bottom

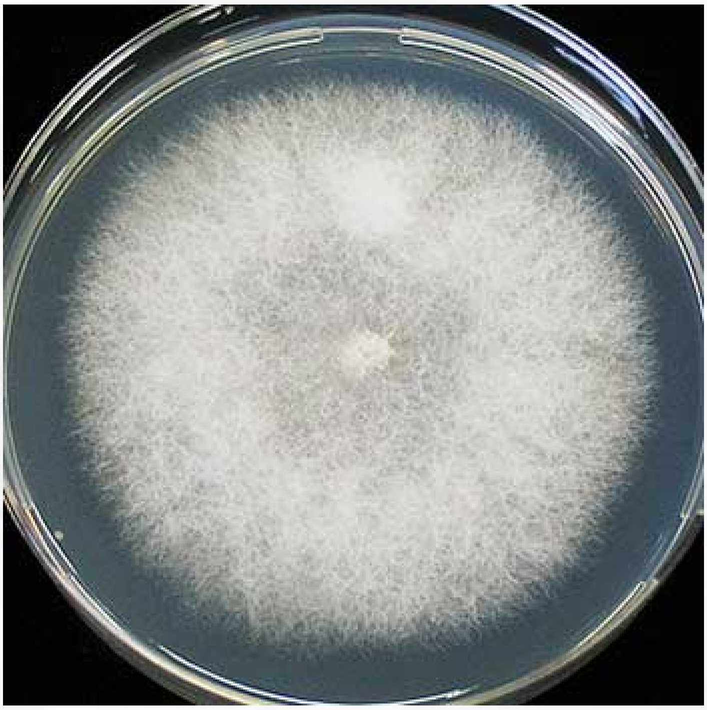
The dark brown spores are borne in simple or branched chains from the tips of simple dark conidiophores and are divided into several cells by transverse and vertical walls. New spores are produced by the extrusion of wall material through a pore at the tip of the previous spore. Commonly isolated from decaying plant materials; also causing plant diseases. Spores of *Alternaria* species are dispersed by air currents and are usually abundant in outdoor air.

Classification: Pleosporales.
Holomorphs: *Clathrospora*, *Comoclathris*, *Leptosphaeria*, *Lewia*.
Refs: Ellis 1971, 1976; Joly 1964; Simmons, 1967, 1981, 1982a, 1982b, 1986a,1986b, 1986c, 1990, 1993a, 1993b, 1993c, 1994a, 1994b, 1995, 1996a, 1996b, 1997, 1998, 1999, 2000.

Arthrinium





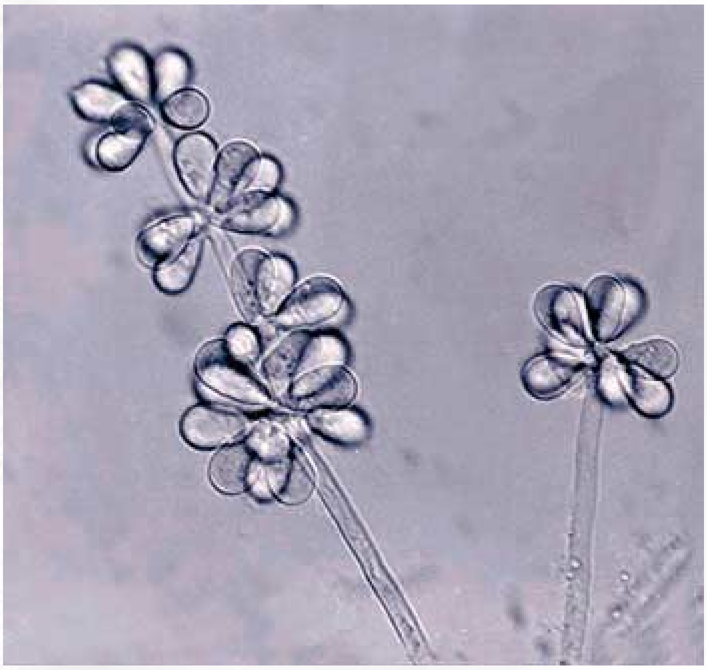


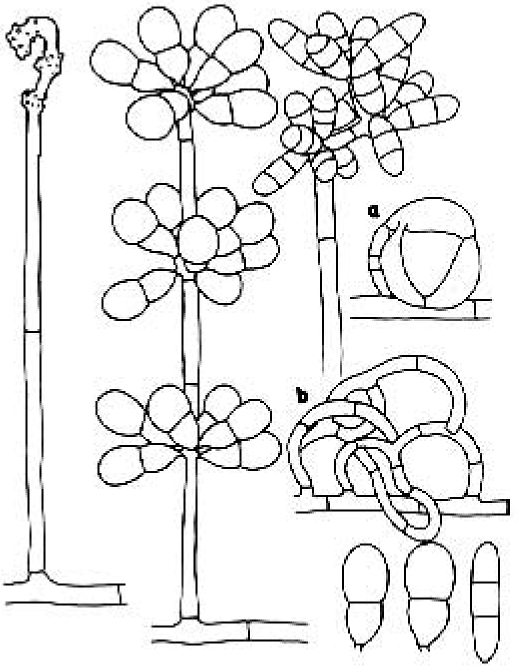
Arthrinium phaeospermum

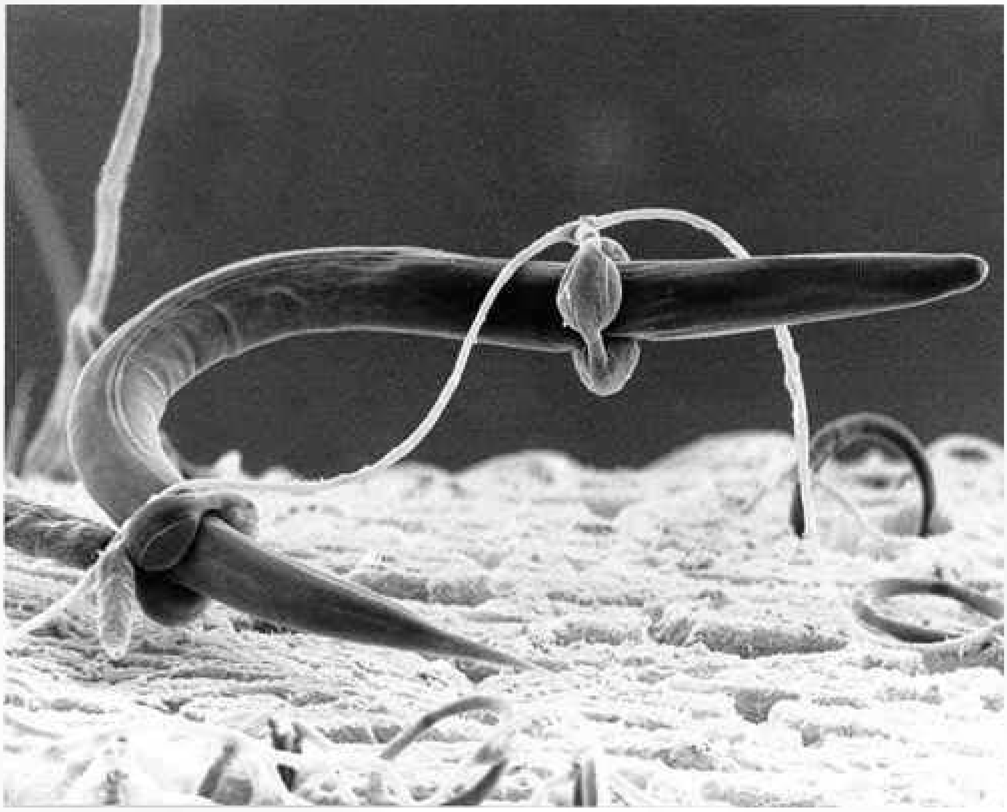
The spores (conidia) are dark brown and usually occur in grape-like masses on white woolly colonies. The spores are flattened and have a colourless line at the edge. When germinating they break along the line in the manner of a clam shell. In some species the filaments have dark cross-walls. Common on dead plants, especially grasses and sedges, and often isolated from air near grassy places in the autumn. The drawing at right illustrates several species. The photographs are of *Arthrinium cuspidatum* found growing on dead grass stems in a salt marsh in St. Andrews, New Brunswick.

Classification: Apiosporaceae (Sordariomycetidae).
Holomorphs: *Apiospora*, *Physalospora*, *Pseudoguignardia*.
Ref: Ellis 1971.

Arthrobotrys







Arthrobotrys anchonia chwyta nicienia

Characterized by tall, colourless conidiophores bearing clusters of spores (conidia) at the tip and often at several swollen points below. The conidia are pale, 2- to 3-celled, and leave conspicuous scars on the conidiophore when released.

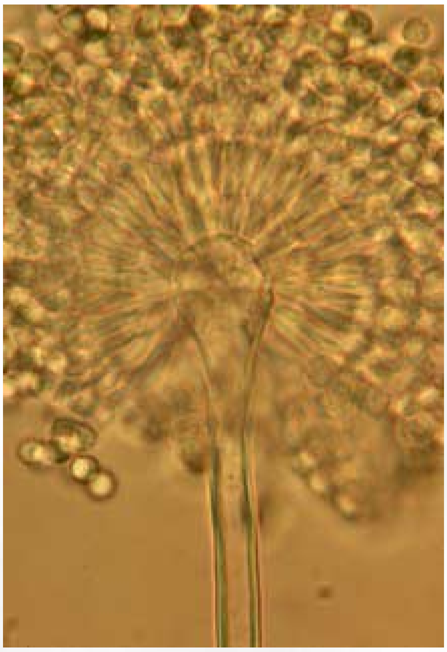
Species of *Arhrobotrys* are probably all predators on eelworms (nematodes). They employ several devices to capture these microscopic worms, including (a) constricting rings and (b) sticky networks of loops. Constricting rings work something like the well-known Venus' fly trap. When a nematode, intent upon searching for bacteria and other small edible particles, enters one of the rings, the cells of the ring suddenly inflate and the nematode becomes entrapped. The constricting action of these rings is so powerful that the nematode is almost cut in half. Sticky networks are less theatrical than constricting rings, yet they have their own brand of terror. When a nematode enters the network of loops it is held by a very strong "glue" and is unable to escape. In both cases, the captured worm first struggles wildly and then seems to become comatose. The fungus then sends its filaments into the worm and digests it. When it has obtained sufficient nutrients from its prey the fungus reproduces by producing clusters of conidia at the tops of long conidiophores.

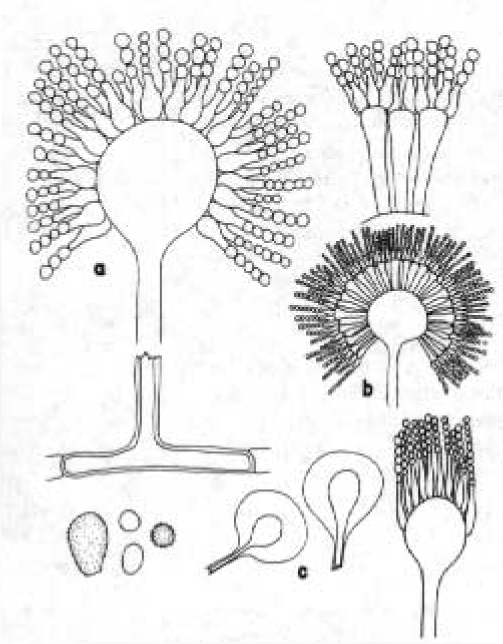
Thanks to the groundbreaking research of Drs. Donald Pfister and Michael Liftik (Pfister, 1994, 1997; Pfister and Liftik, 1995) we now have a much better understanding of the life histories of *Arthrobotrys* species. These authors provided convincing evidence that *Arthrobotrys* species are the asexual expression of the well-known discomycete genus *Orbilia*, a group of ascomycetes commonly found on dead wood, decomposing plant materials, soil and dung. Although species of *Orbilia* were previously thought to be simple decomposers we now realize they can be active predators.

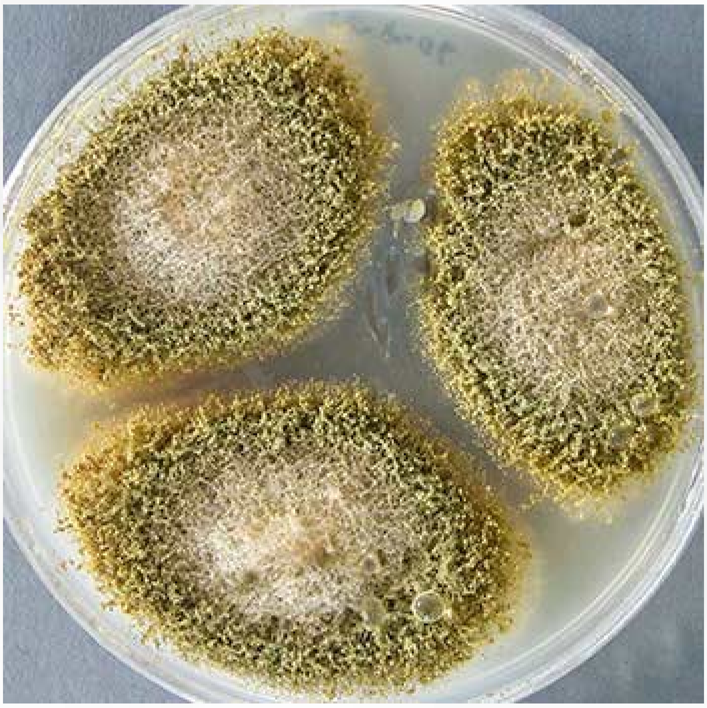
Arthrobotrys species are undoubtedly important in controlling numbers of nematodes, including those causing damage to agricultural crops. To study them it is necessary to first have a culture of nematodes. We maintain them on a weak medium spread with yeast or bacteria. Dehydrated pea soup mix also seems to be good food for nematodes. To see *Arthrobotrys*, a pinch of soil is introduced into the nematode culture. After a few days the traps will become abundant.

Classification: Orbiliaceae. Although the sexual stages resemble one of the inoperculate discomycetes, they may not be closely related. Dr Joey Spatafora, writing on The Tree of Life website assigns them to the Class Orbiliomycetes, a group of discomycetes distinct from both the Leotiomycetes and Pezizomycetes.
Holomorphs: *Orbilia*.
Ref: Haard 1968, van Oorschot, 1985, and Rubner, 1996.

Aspergillus







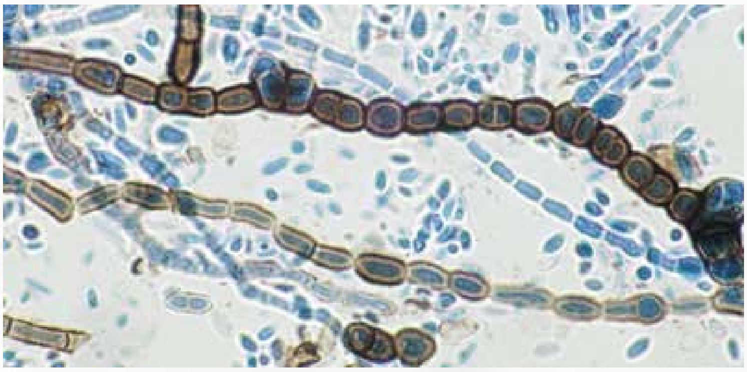
Aspergillus tamarii

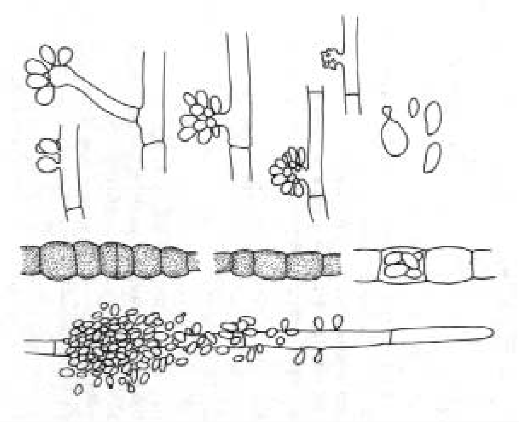
Recognized by its distinct conidiophores arising from a well-defined "foot cell" and terminated by a swollen vesicle bearing flask-shaped phialides. The phialides may be borne directly on the vesicle (a) or on intervening metulae (b). Some species may form masses of thick-walled cells called "hülle cells" (c). The spores come in several colours, depending upon the species, and are produced in long chains from the ends of the phialides. Commonly isolated from soil, plant debris, and house dust; sometimes pathogenic to man.

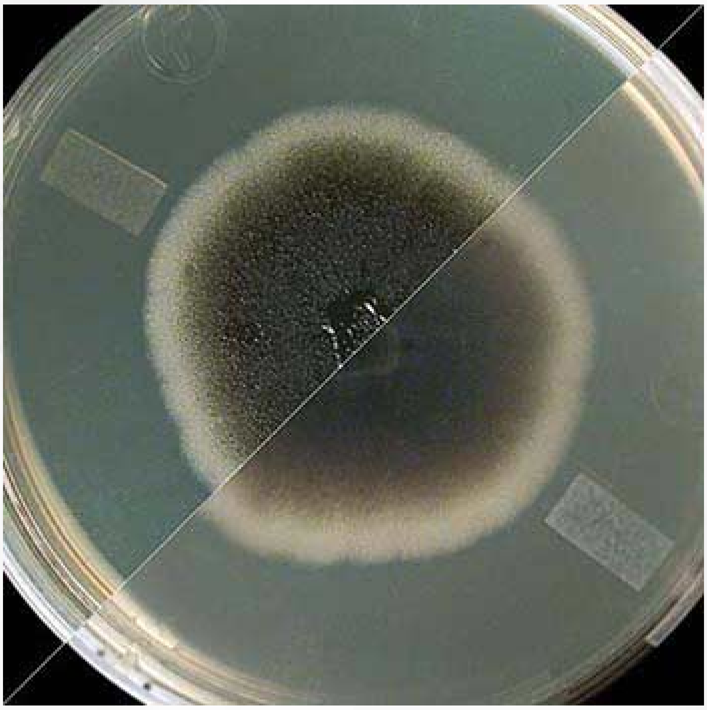
Classification: Trichocomaceae (Eurotiales).
Holomorphs: *Emericella*, *Eurotium*, *Neosartorya*, and others.
Refs: Klich, 2002; Klich and Pitt, 1988; Raper and Fennell 1965; Samson 1979; Samson and Varga, 2007; Samson *et al*., 2011; Seifert, 2000. Samson *et al* (2004) have a excellent presentation with a key, illustrations, discussions and descriptions of the species commonly found on foods and indoor environments. This will work

very well for most species of *Aspergillus* found in indoor environments, but will be less useful for outdoor habitats, especially in the tropics.

Aureobasidium





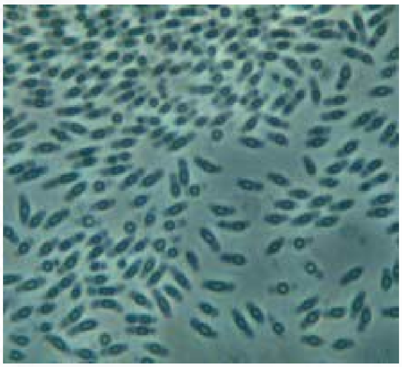


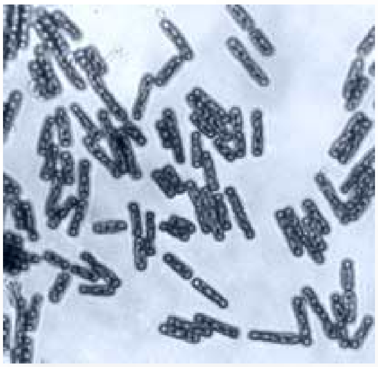
Aureobasidium pullulans - top/bottom

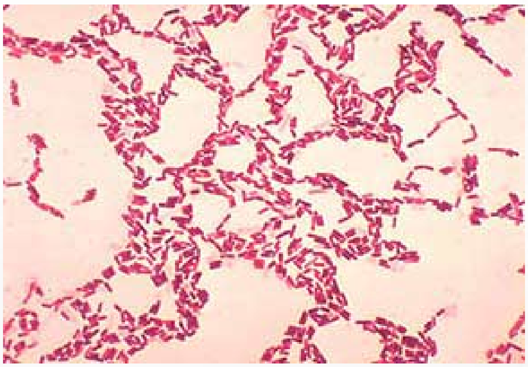
This is one of several genera of "black yeasts", characterized by mostly slow-growing, black, pasty colonies. The spores are produced in great masses along the filaments and occur on short lateral branches or pegs. When the spores are released they leave minute roughened scars. Exophiala species are similar but the spores do not leave rough scars as in *Aureobasidium*. Black yeasts occur in many habitats; some species of *Exophiala* may even cause human disease. *Aureobasidium pullulans*, the most frequently reported and possibly only species of *Aureobasidium* is a common inhabitant of the phylloplane (leaf surfaces) but is also frequently reported from soil, wood, rocks stone monuments and human skin. Stone buildings that have become black over the years often have abundant growth of *A. pullulans*.

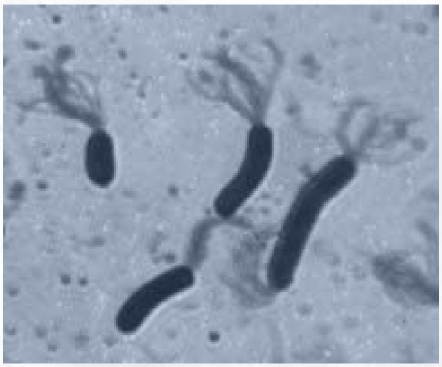
Classification: Dothioraceae (Dothideales).
Holomorphs unknown.
Ref: Hoog and Hermanides-Nijhoff 1977; Hoog and Yurlova, 1994; Takeo and Hoog, 1991.

Bacteria

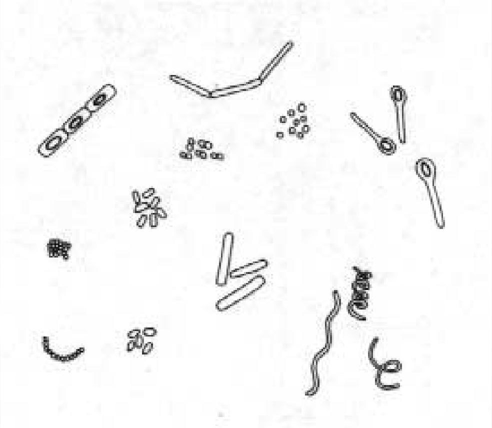

Bacillus


Bacillus aureus


Bacillus coagulans


Spirillum

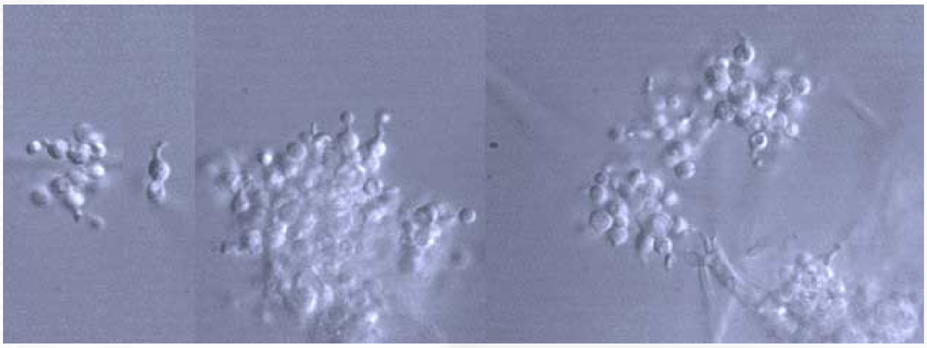
Escherichia coli

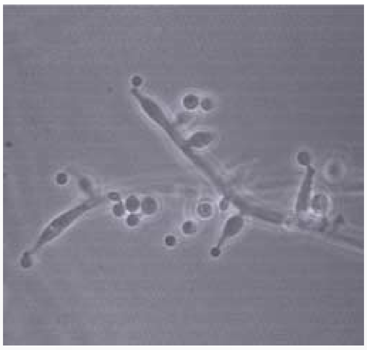


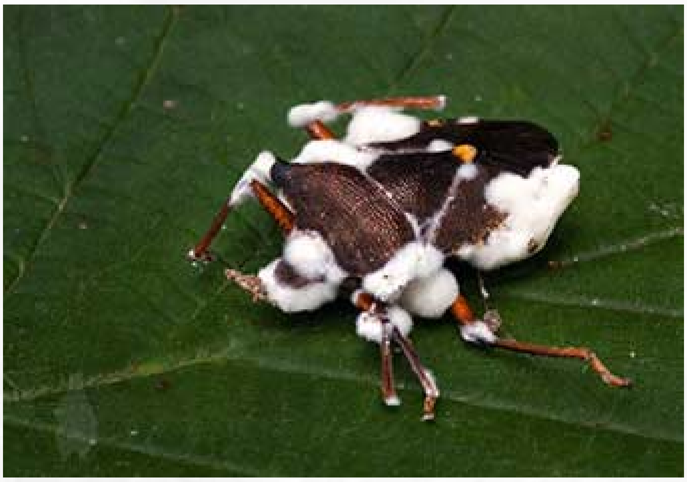
Bacteria are not fungi and are included here only because they will always be found where fungi occur. They form wet or slimy colonies, often with rather bright colours and unpleasant odours. The cells are nearly always *very* small and take a variety of shapes including the well-known rods (bacilli), spheres (cocci) and helices (spirilla). Some species, such as those of *Streptomyces* and related genera can form multicellular filaments. Many bacteria are motile, swimming freely around a microscope slide or wet Petri plate. The photographs above illustrate several features of bacteria. At left is a colony of a species of *Bacillus*, photographed in a sample of pond water. Each of the rod-shaped cells contains a thick-walled endospore. At top-center is a group of rods of *Bacillus aureus*, a species that can be isolated from certain foods such as fried rice and which can cause diarrhea in humans. *Escherichia coli*, at bottom-center, is a normal inhabitant of the human intestinal tract that occurs in both benign and beneficial forms. Because *E. coli* is always in the intestinal tract, its presence in water and other materials is a good indicator of fecal contamination. The organism at bottom-left is a species of *Spirillum*, common in nutrient-rich ponds. Note the curved shape that will become a loose helix in larger cells and the fasicle of flagella at the end of each cell. Flagella, which may occur singly or in clusters, are the main means of bacterial locomotion. Bacteria must be handled with great care as some are pathogenic to humans.

The routine identification of bacteria requires specialized facilities not normally available to mycologists. Although morphology can play a role in identification it is also necessary to utilize a battery of nutritional and physiological tests as well. Taxonomic studies based on nucleic acid homologies have shown that the traditional methods for classifying bacteria are often at odds with genetic evidence. Present-day bacteriologists still rely on traditional methods, but these are quickly being replaced by more reliable methods using genetic sequences. The basic reference for traditional methods is the 9th edition of Bergey's Manual of Determinative Bacteriology (Holt, 1994).

Beauveria







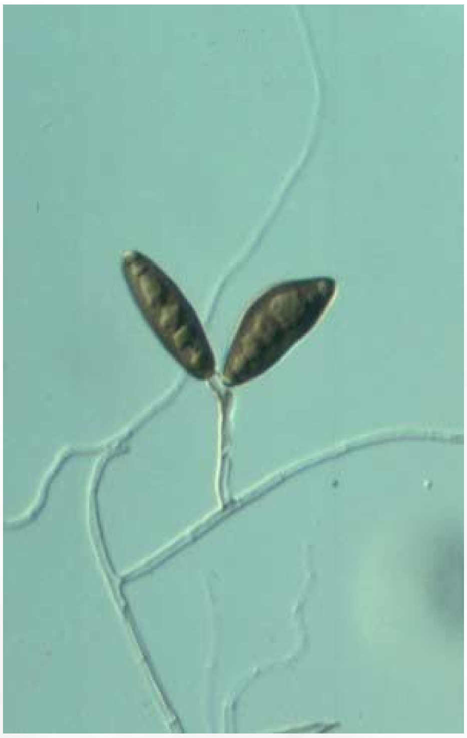
Beauveria bassiana

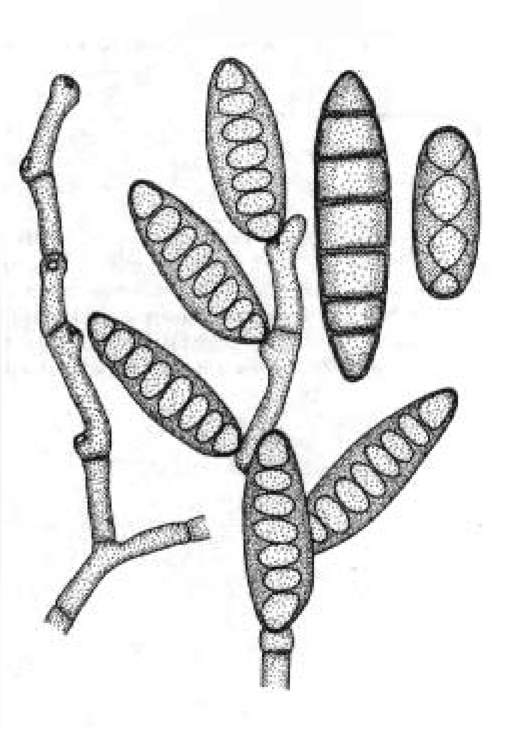
Species of *Beauveria* produce rather slow-growing white cottony colonies. Reproduction is copious and the conidia are easily detached, a condition often leading to scattered colonies when you thought you had carefully transferred only one. The one celled colourless conidia are borne along a thin filament that elongates in a zig-zag fashion as the conidia are produced. The conidia are produced on short spikes or denticles, giving the conidiogenous cells a spiny appearance. Species of *Tritirachium* are similar to some *Beauveria* species in having zig-zag conidiogenous cells, but differ in lacking denticles on their conidiogenous cells and in producing yellow brown to purple colonies. *Beauveria* species are commonly found associated with insects or habitats supporting insects. They commonly occur in private dwellings, where they probably decompose the dead bodies of insects, spiders and mites. They may also attack living insects and cause small epidemics. *Beauveria bassiana*, the best-known member of its genus, has been investigated widely as a potential agent for the biological control of harmful insects.

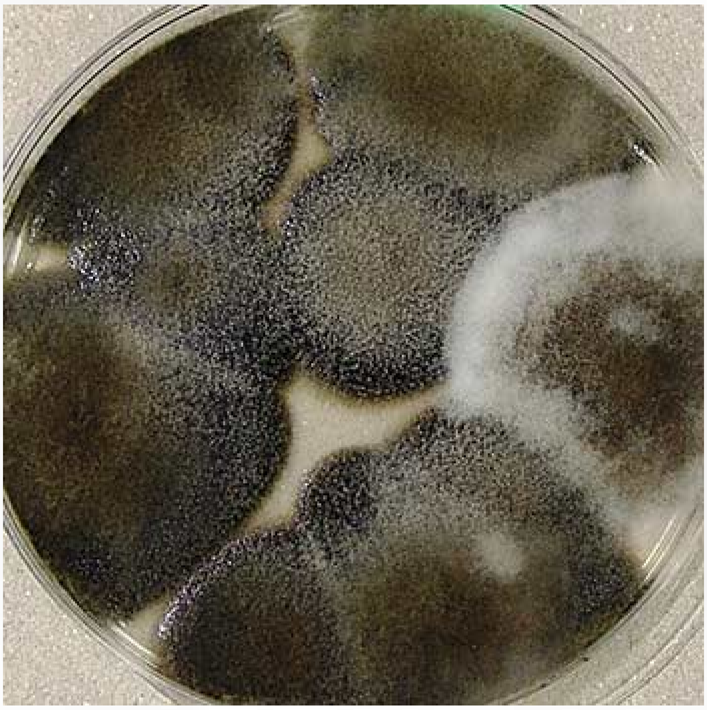
Glare and Inwood (1998) and Rehner and Buckley (2005) carefully examined cultures of *B. bassiana, B. amorpha, B. brongniartii, B. caledonica* and *B. vermiconia* as well as certain strains of *B. bassiana* that did not fit the concept of that species very well. They utilized traditional as well as molecular tools in their analysis and concluded that all of these species fall into distinct clades. This suggests that all are therefore "good" species. Unfortunately neither of these papers supplies identification keys, although Glare and Inwood did provide a chart of spore measurements that might be some aid in determination.

Classification: Cordycipitaceae.
Holomorph: *Cordyceps*.
Refs.: Domsch *et al*, 1980; Hoog, 1972.

Bipolaris





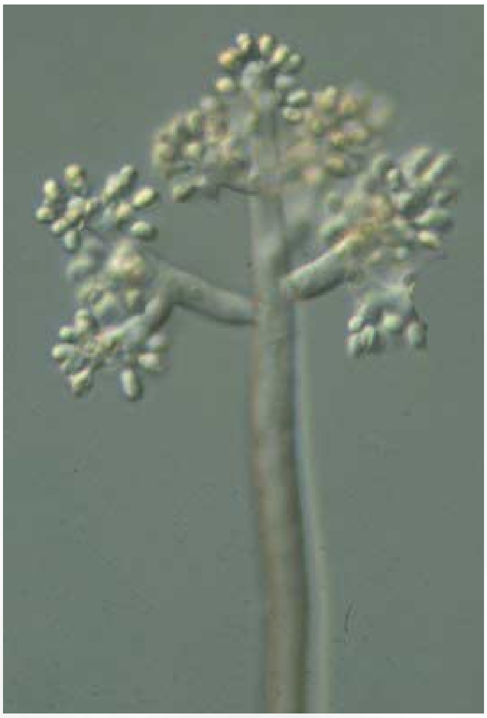


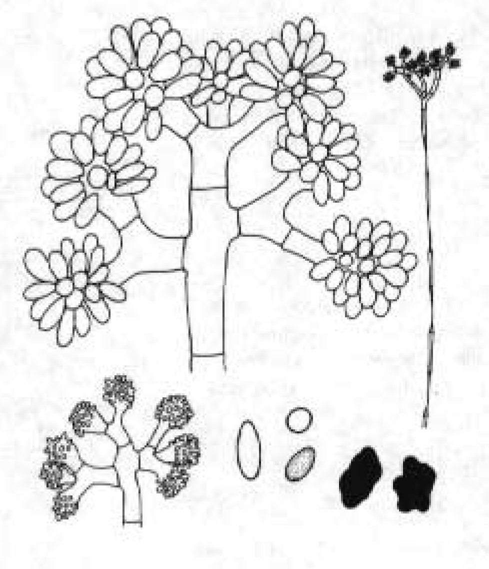
Bipolaris

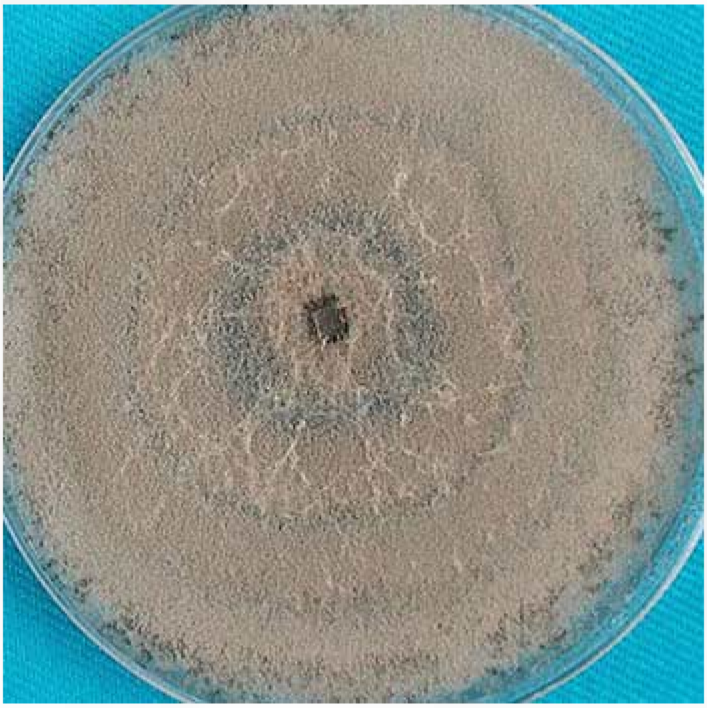
In species of *Bipolaris* the large, dark, multicellular spores are produced from pores along a gradually elongating, dark conidiophore. Often the cells of the spores appear to be very thick walled. Germination occurs only through the two end cells (and hence the generic name). *Drechslera* species differ in having spores that germinate through any cell. Species of *Curvularia* are similar, but the spores never appear very thick walled. Common on dead or dying plant material, especially grasses.

Classification: Pleosporaceae (Pleosporales).
Holomorph: *Cochliobolus*.
Ref: Ellis 1971, 1976 (with Drechslera).

Botrytis





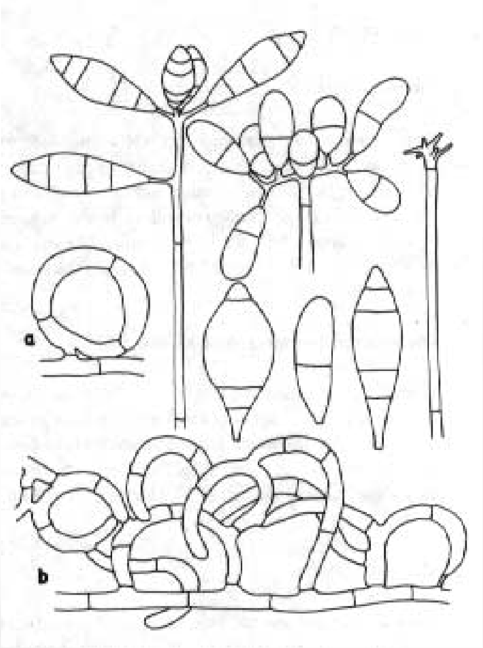


Botrytis cinerea

Species of *Botrytis* produce coarse, brown conidiophores with branched tops. The spores (conidia) cover the ultimate branches and are produced synchronously. As the colonies begin to dry, the cells of the conidiophore often flatten in alternate planes from each other. Many isolates produce black stone-like sclerotia. Often isolated from dead or living plants and frequently causing plant disease. Rotting of stored fruits and vegetables by *Botrytis* species is a major problem. Jarvis (1977) wrote an important overview of *Botrytis* that discusses many aspects of this economically important genus, although it cannot be used for identification of species.

Classification: Sclerotiniaceae (Sclerotiniales).
Holomorphs: *Botryotinia*, *Ciboria*, *Sclerotinia*.
Ref: Ellis 1971; Hennebert 1973.

Candelabrella

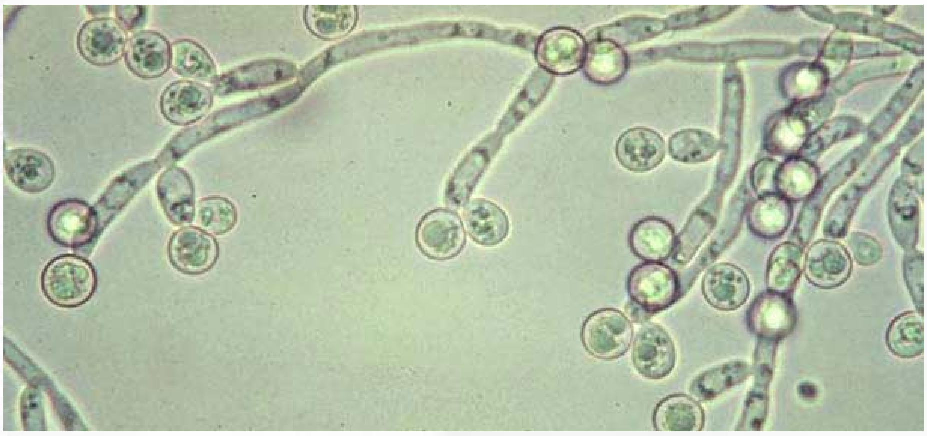


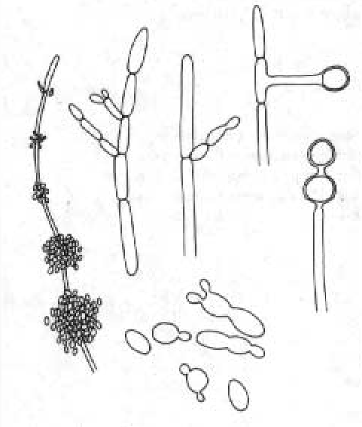
no image

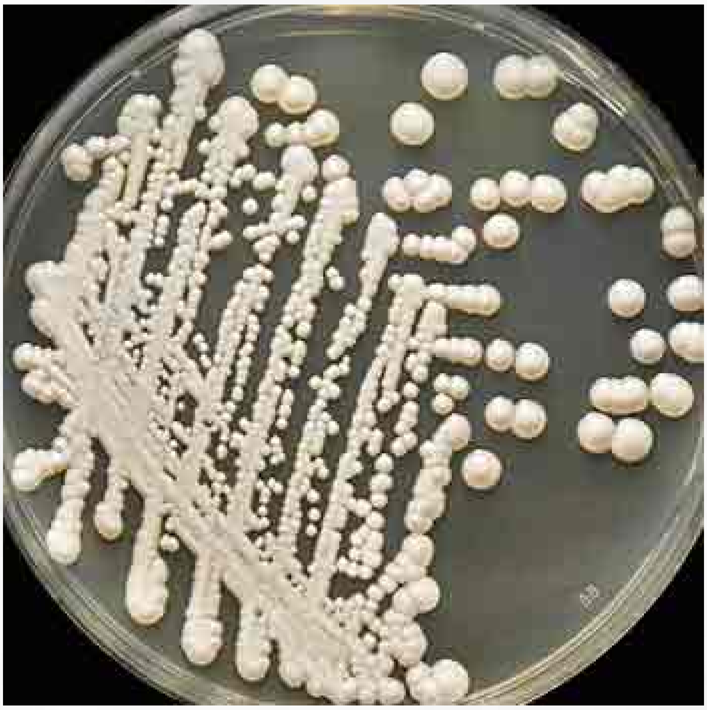
Conidiophores tall and bearing colourless 2- to 5-celled spores (conidia) at the tips of short apical branches. As the name implies, the branching is like that of a candelabrum. The species are predacious on eelworms and catch them in constricting rings (a) or sticky networks (b). *Arthrobotrys* species are similar but do not have conidiophores with branched tips. Some authors consider the two genera to be indistinguishable.

Classification: Orbiliaceae. Although the sexual stages resemble one of the inoperculate discomycetes, they may not be closely related. Dr Joey Spatafora, writing on The Tree of Life website assigns them to the Class Orbiliomycetes, a group of discomycetes distinct from both the Leotiomycetes and Pezizomycetes.
Holomorph unknown.
Ref: Cooke 1969; Rifai and Cooke 1966; Rubner, 1996.

Candida





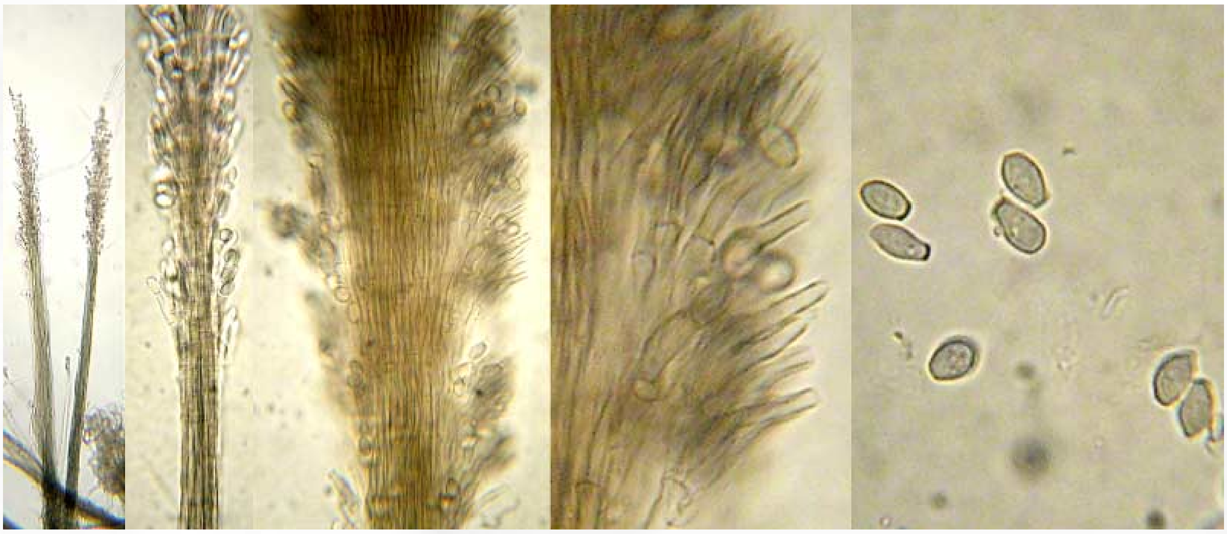


Candida albicans

Although often appearing to be mould-like, species of *Candida* are really yeast fungi, differing from filamentous fungi in some rather fundamental ways. The cells of their hyphae are usually rather loosely attached and will fragment when disturbed. The spores are produced along the "hyphae" and become so numerous that the filaments can be entirely obscured. The spores can reproduce themselves by "budding". The abundance of spores can give the colony a pasty or slimy appearance. Species of *Candida* are common in soil and organic debris and can also cause human disease. Although these organisms often live on the bodies of humans and other mammals causing little harm, if the immune system becomes compromised by immunosuppresant drugs or disease they can cause serious infections or even death. People infected with HIV are often at risk of contracting candidiasis, the name of the disease caused by *C. albicans*. Not all species of *Candida* cause disease in humans, many occur in association with plants or insects and never affect humans at all.

Classification: Saccharomycetales, one of the so-called Hemiascomycetes or yeasts.
Holomorphs: *Entelexis, Hyphopichia, Issatchenkia, Metschnikowia, Saccharomycopsis, Stephanoascus.*
Ref: Barnett and Pankhurst 1974; Lachance *et al*, 2011.

Cephalotrichum

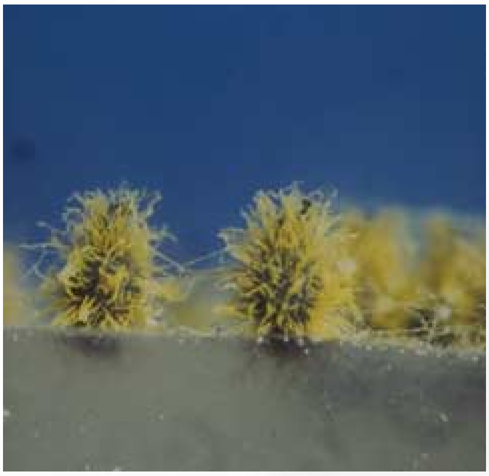


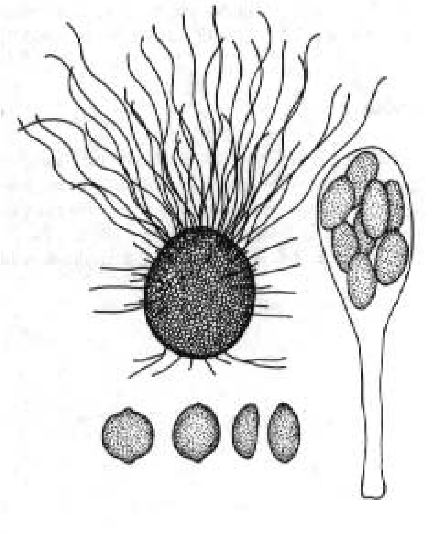
no image

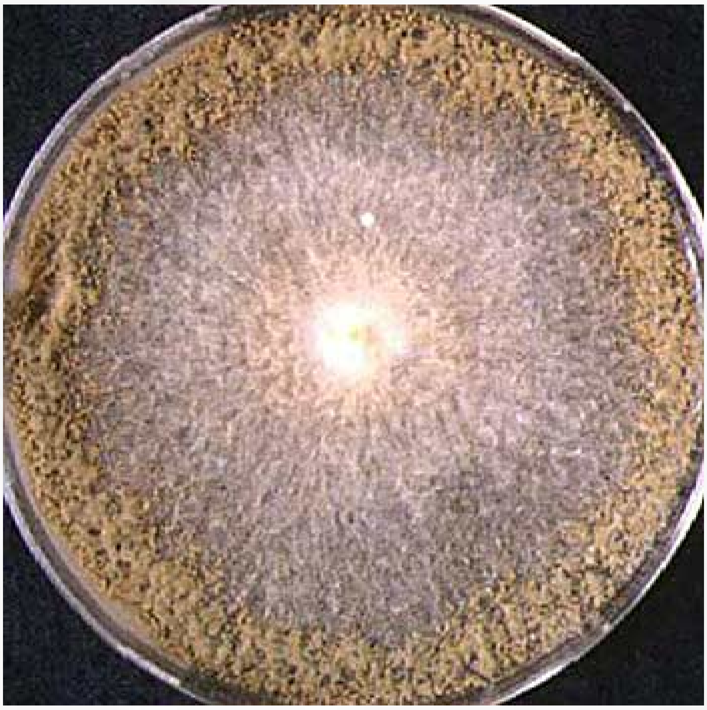
The dark brown conidiophores are united in a fascicle to form a long compound fruiting structure (synnema). The upper half of the synnema is covered with flask-shaped annellides giving rise to chains of grey-brown spores (conidia). In *C. stemonitis* there is an accessory *Echinobotryum* spore form arising from the stalks of the synnemata and on the surrounding hyphae. Other species, such as *C. microsporum*, pictured at right, have only one spore form. *Trichurus* species are similar, differing in having straight to coiled hairs arising among the annellides. Young synnemata of *Trichurus* species may not have well developed hairs and may be mistaken for a species of *Cephalotrichum*. Related to *Scopulariopsis*. Many of the species were placed in *Doratomyces* in the older literature. Common in soil, dung, and decaying plant materials.

Classification: Microascaceae.
Holomorph unknown.
Ref: Morton and Smith 1963.

Chaetomium





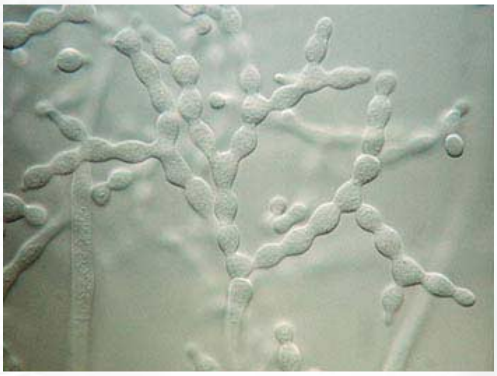


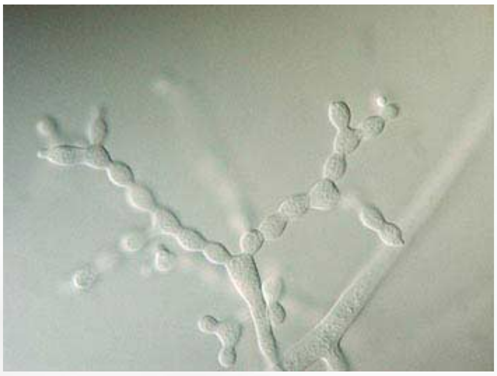
Chaetomium globosum

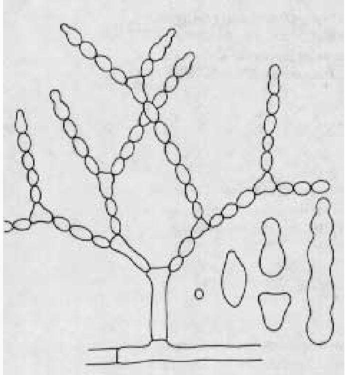
Characterized by densely hairy, egg-shaped fruiting bodies (perithecia) containing asci, which in turn enclose 4-8 brown spores (ascospores). The perithecial hairs can take a variety of forms, depending upon the species. The ascospores collect in a dense mass outside the perithecium. Most species are strong decomposers of cellulose and occur wherever this substrate is abundant, such as in soil, dung, or rotting plants.

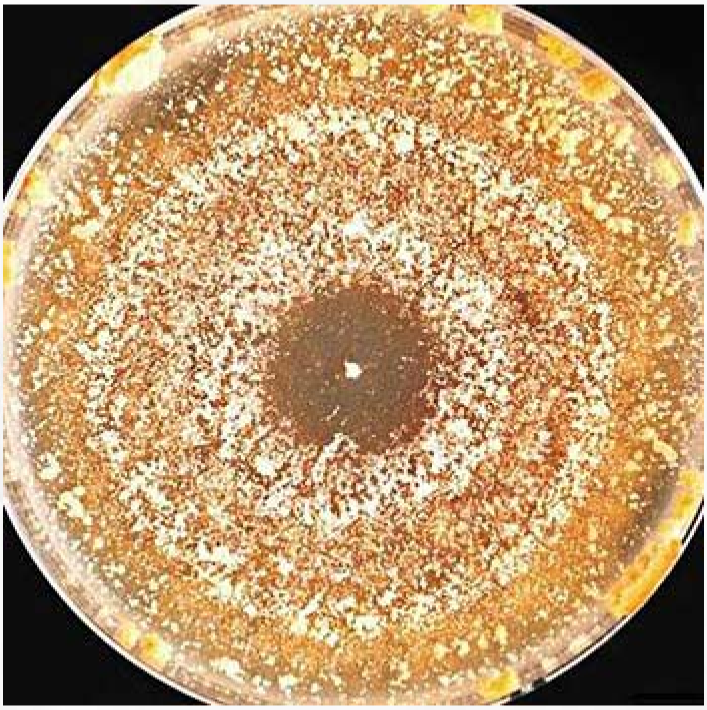
Classification: Chaetomiaceae (Sordariomycetidae).
Anamorphs: *Acremonium*, *Botryotrichum*, *Chrysosporium*, *Scopulariopsis*, *Trichocladium*, or lacking.
Ref: Ames 1963; Arx *et al.*, 1986; Seth 1970

Chrysonilia









Chrysonilia sitophila

Recognized by its branched chains of light or brightly coloured spores (conidia) arising from inconspicuous conidiophores. Spores are produced by "budding", with the youngest ones at the tips of the chains.

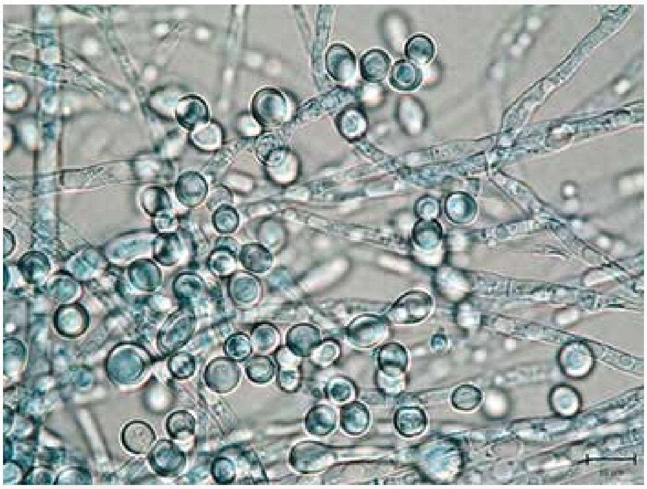
Species of *Chrysonilia*, including *C. sitophila*, the red bread mould, produce very fast growing pink colonies and numerous spores. The spores are dry and easily detached from one another. Because they combine rapid growth and prolific reproduction, species of *Chrysonilia* can contaminate other laboratory cultures very rapidly. In the school or university laboratory where many students may be cultivating fungi at the same time these fungi can cause lab-wide epidemics, ruining every culture they contact. The best strategy is to discard all rapidly growing, pink, powdery cultures without opening them.

Neurospora, the holomorph of *Chrysonilia* species, is widely used as an experimental organism. More is known about the physiology and genetics of *Neurospora* than any other fungus. The ascospores of *Neurospora* species resist germination until they encounter certain kinds of physical or chemical stimulant. In nature, the ascospores occur in soil and are activated by heat. Thus the species *Neurospora* and their associated *Chrysonilia* anamorphs can often be found on the surface of soil following forest or grass fires. They can also appear on the surface of soil that has been partially sterilized in the greenhouse. They can be isolated from soil by first treating the sample with alcohol or heat (see discussion of stress techniques in Chapter 4.

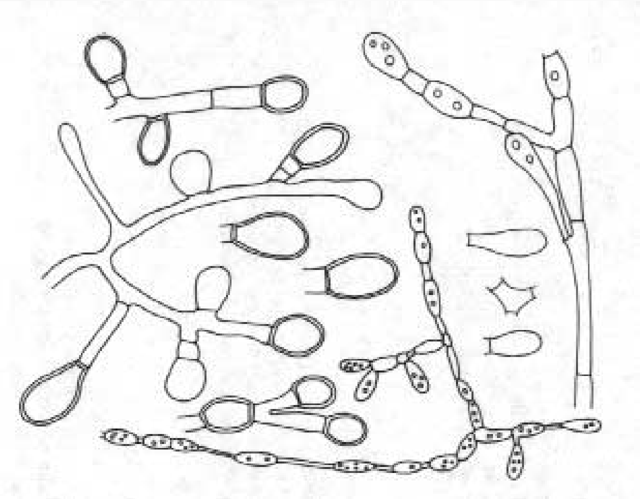
Many texts still treat *Chrysonilia* species in the genus *Monilia*. However, *Monilia* species are plant parasites, commonly causing a soft brown rot of stone fruits (peaches, apricots, etc.), and are not closely related to *Chrysonilia*. Common in soil, homes, fruits, and as a laboratory pest.

Classification: Sordariaceae (Sordariomycetidae).
Holomorph: *Neurospora*.
Ref: Samson *et al*, 2004.

Chrysosporium



Chrysosporium fastidium



Chrysosporium pannorum

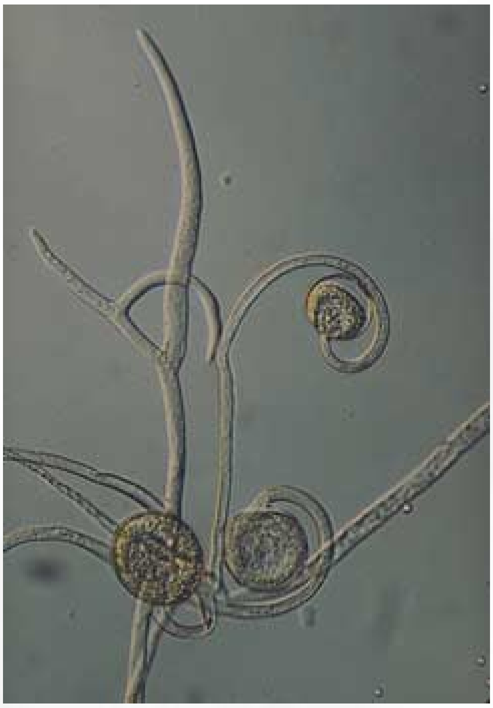
Spores (conidia) are produced along the vegetative filaments by a swelling of the wall and subsequent isolating by a cross-wall. The conidia can be terminal on the filament or at various sites along its length. Chains of conidia may occur and are sometimes separated by empty cells. Most species are entirely colourless to yellow.

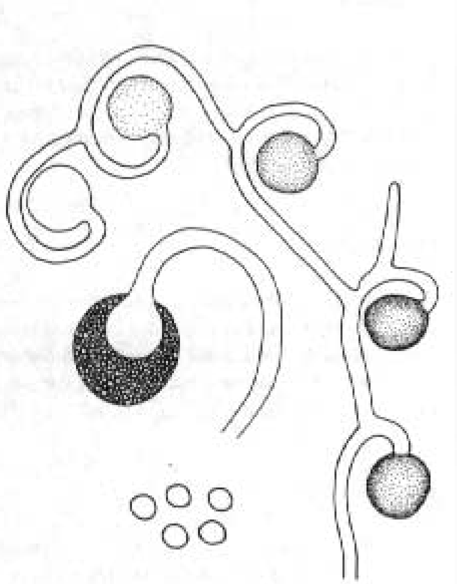
Species of *Chrysosporium* have been shown to be anamorphs of many different fungi (see below), suggesting that they are not a group with a unique ancestor but are instead polyphyletic. Their ecology reflects these diverse origins; some species are psychrotolerant (able to grow at low temperatures) while others, in contrast, are thermotolerant (able to grow at high temperatures). As well, some are osmotolerant (tolerating dryness or osmotic stress) while others are not. Although the species are often not physically complex or highly characteristic, their physiological diversity is a great help in their identification.

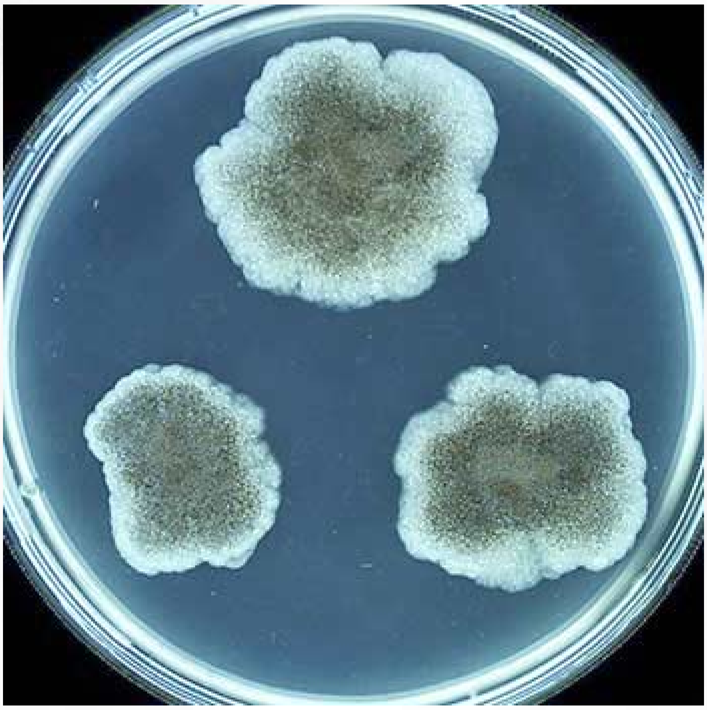
Growing in soil, dung, and decaying plant material. Some are able to decompose hair, hoofs, and leather.

Classification: Onygenaceae (Onygenales).
Holomorphs: *Aphanoascus*, *Apinisia*, *Arthroderma*, *Bettsia*, *Chaetomium*, *Gymnoascus*, *Pectinotrichum*, *Psathyrella*, *Renispora*, *Rollandina* and others.
Ref: Carmichael 1962; Van Oorschot 1980.

Circinella





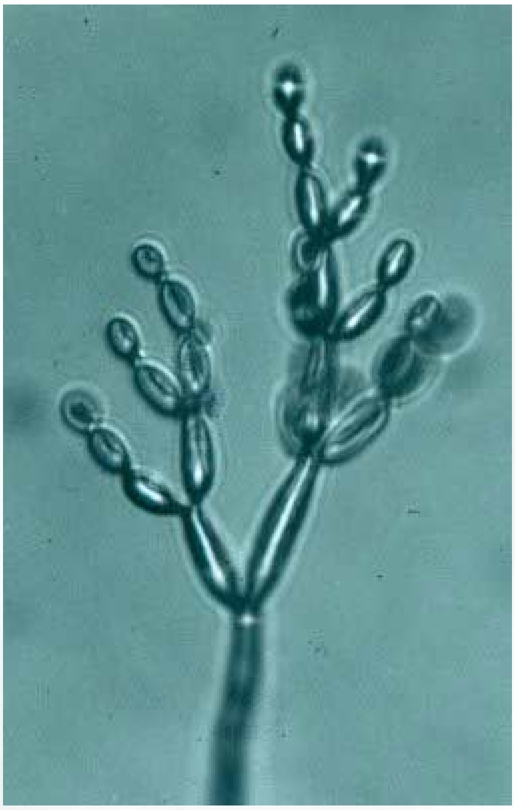


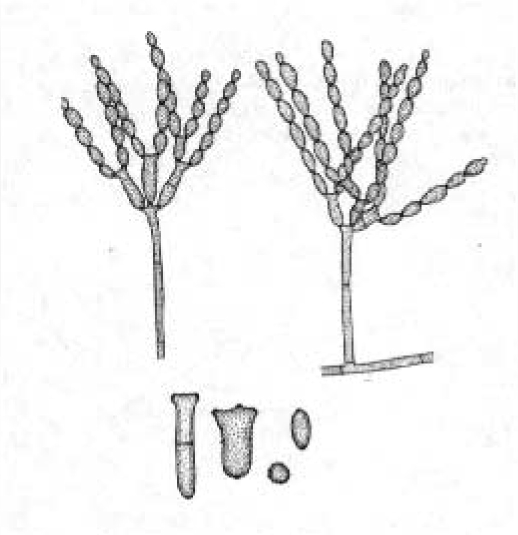
Circinella muscae

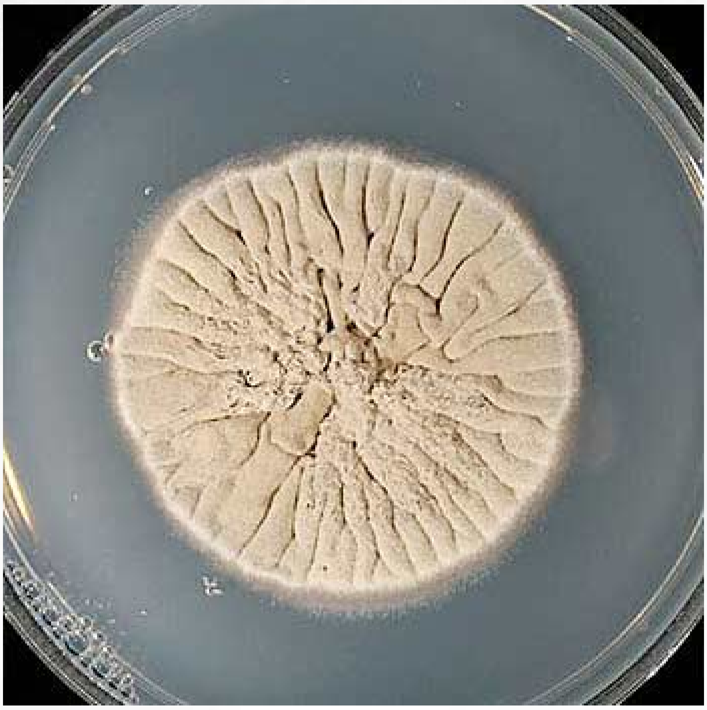
Colonies rather coarse and fast-growing. Spores produced within dark spherical sporangia that are borne along the length of sporangiophores on strongly curved or hooked branches. The filaments have few cross-walls and thus resemble long, hollow tubes. The most characteristic feature is the strongly hooked sporangial branch. Occurring in soil, dung, and decaying nuts.

Classification: Mucoraceae (Zygomycota).
Ref: Arambarri and Cabello, 1996; Hesseltine and Fennell 1955; Zycha and Siepmann 1970.

Cladosporium







Cladosporium herbarum

Colonies dark greenish to black, black in reverse, and relatively slow-growing. The dark spores are 1- or 2-celled and occur in long, branching chains that arise from a dark conidiophore. The youngest spore is at the top of the chain. The slightest movement will disrupt the chains, making microscope mounts of the whole structure nearly impossible. The best way to recognize the genus is by the prominent scars on the spores where the adjacent ones were attached. Very common on decaying plants and fungi; the fungus most commonly isolated from air, both indoors and outdoors.

It has always been difficult to identify species of *Cladosporium*. Most isolates from air and from habitats associated with humans have been referred to one of three species, distinguished by the following key:

1. Spores usually ellipsoidal in shape, only rarely spherical - 2.

1. Spores often nearly spherical -» *Cladosporium sphaerospermum*.

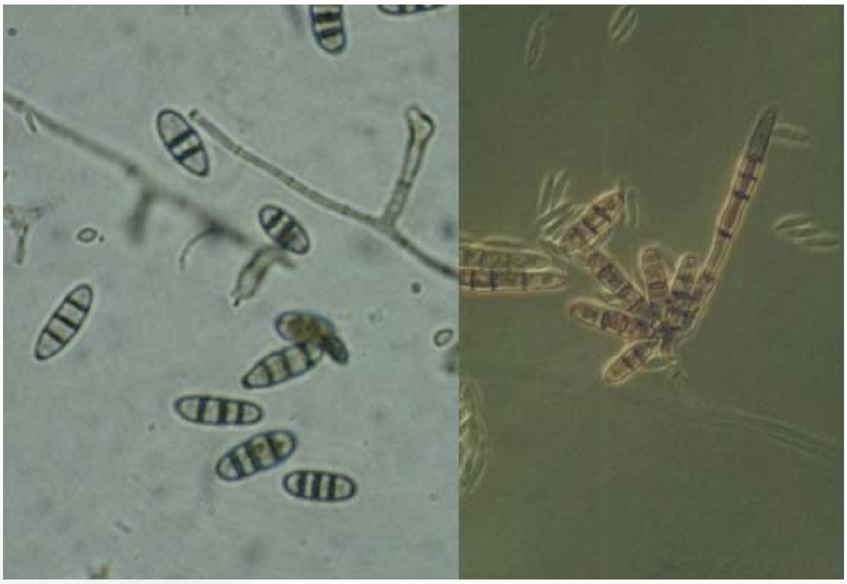
2. Spores smooth -» *Cladosporium cladosporioides*.

2. Spores warty -» *Cladosporium herbarum*.

Unfortunately the taxonomic reality is that there are many more species of *Cladosporium*, perhaps hundreds more, than these three. Many are known from specific plants or particular geographic areas. Many have not yet been grown in culture and many remain undescribed. The recent book on *Cladosporium* edited by Crous *et al* (2007) addresses this difficult genus in several ways and provides keys, descriptions and illustrations to aid in identification. It is a major advance in the taxonomy of *Cladosporium* and one that will undoubtedly stimilate further research.

Classification: Davidiellaceae (Capnodiales).
Holomorph: *Davidiella, Mycosphaerella* and *Venturia*.
Ref: Bensch *et al.*, 2012; Crous *et al*, 2007; Ellis 1971, 1976; de Vries 1952; Wang, 1990.

Dendryphiella



no image

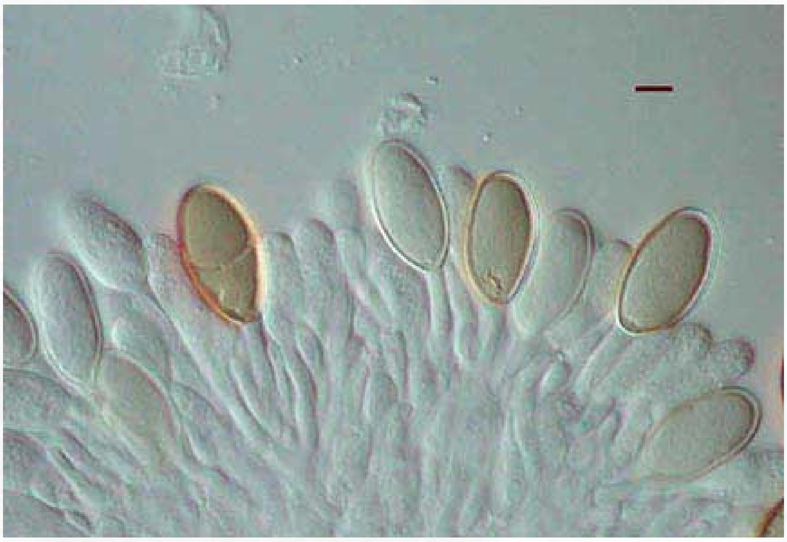
Dendryphiella species are not among the most common of fungi but any isolations from ocean beaches will turn them up in abundance. Two species are known in this habitat, *D. arenaria*, at left, and *D. salina*, at right. Both are common but often not overlapping in their ranges, with *D. salina* found in cool climates and *D. arenaria* in warm ones. Other species, including the type, occur on decomposing plants in terrestrial situations. Species of *Dendryphiella* are recognized by their sympodially developing conidiogenous cells producing dark poroconidia with several transverse septa.

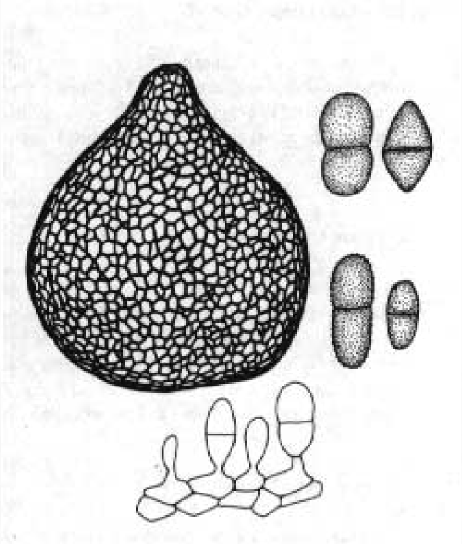
Mycologists have long debated whether the two marine species belong in the genus *Dendryphiella* or *Scolecobasidium*. They are very similar morphologically, so the distinction really boils down to some very obscure features. Dela Cruz *et al* (2006) finally laid the controversy to rest by presenting molecular evidence that *D. arenaria* and *D. salina* are closely related to one another and only very distantly related to species of *Scolecobasidium*. Of course there is one futher issue left to resolve; the genus *Dendryphiella* was typified (created specifically) for *Dendryphiella interseminata* (Berk. & Ravenel) Bubák, a species orginally described from *Phytolacca decandra* (=*Phytolacca americana*), American pokeweed and *Cicuta maculata*, Spotted cowbane. It is not yet known whether *D. interseminata* is closely related to the two marine species or not. If not, our two beach inhabitants will have to find a home in yet another genus.

Habitat: decaying stems and marine algae.

Classification: Pleosporaceae (Pleosporales).
Holomorphs unknown.
Refs.: Kohlmeyer and Volkmann-Kohlmeyer, 1991 (for marine species), Ellis, 1976 (as species of *Scolecobasidium*).

Diplodia



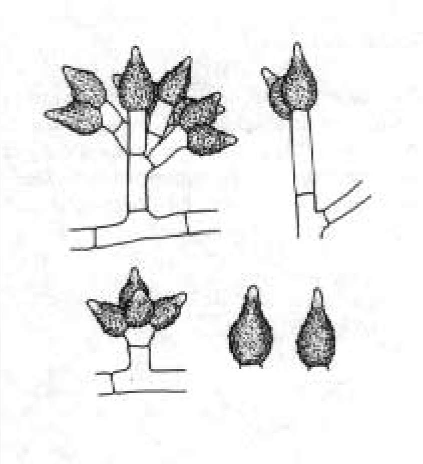


Diplodia mutila

The spores (conidia) are brown, 2-celled, and are borne within more or less round fruiting structures (pycnidia). Conidial production occurs (probably holoblastically) on short cells that line the inner walls of the pycnidium. There are a number of similar genera that are distinguished on the basis of pycnidial and spore structure. Most species occur on living or dead plants.

Classification: Botryosphaeriaceae (Botryosphaeriales).
Holomorphs: *Botryosphaeria*, *Cucurbitaria*, *Eutryblidiella*, *Massarina*, and others.
Ref: Sutton, 1980; Zambettakis 1954, 1955.

Echinobotryum

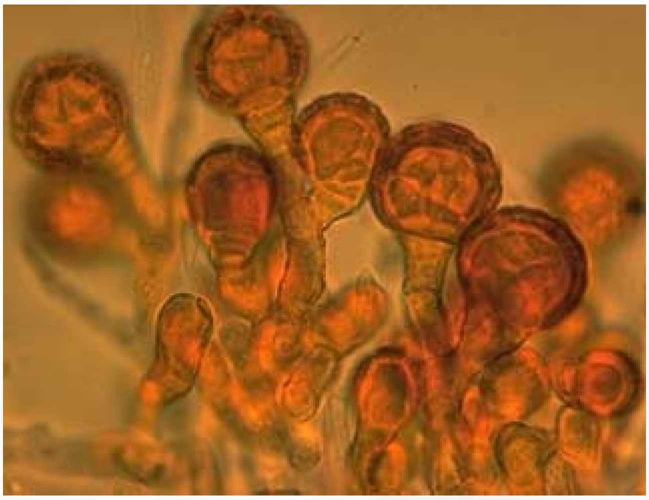


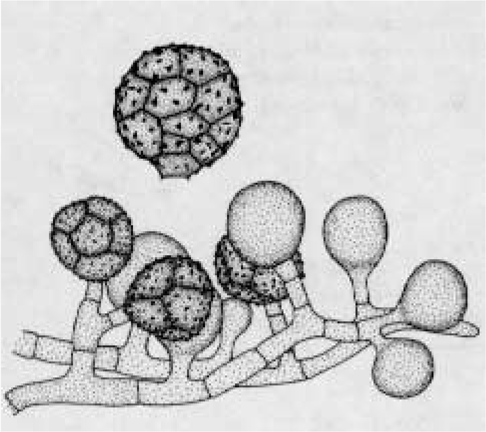
no image

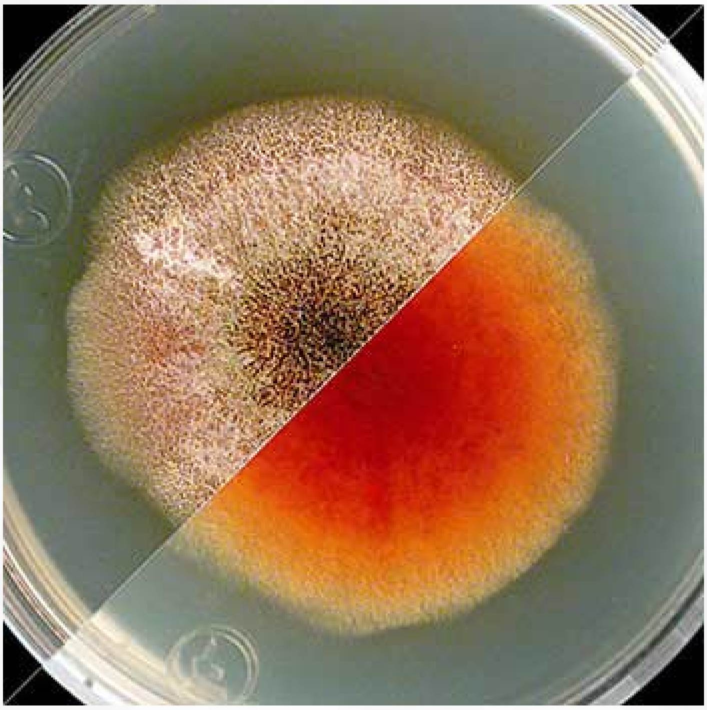
Characterized by small clusters of pear-shaped, beaked, roughened, brown spores (conidia) borne on short, branched or simple conidiophores. Usually occurring as an "accessory form" at the synnematal bases and surrounding hyphae of *Cephalotrichum stemonitis*. Fairly common on dung, soil, and plant debris.

Classification: Microascaceae.
Holomorph unknown.
Ref: Hennebert 1968

Epicoccum





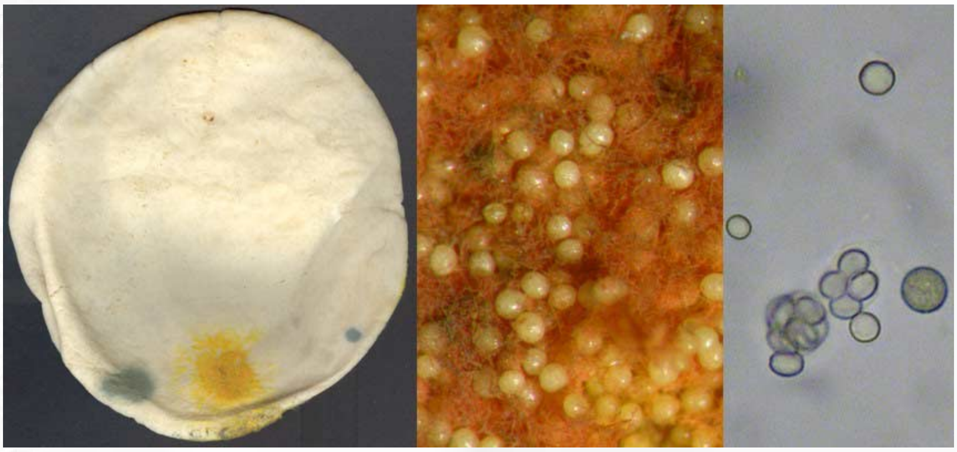


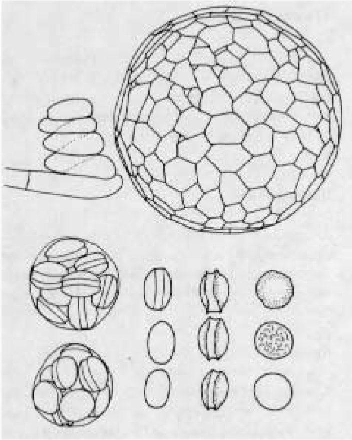
Epicoccum purpurascens - top/bottom

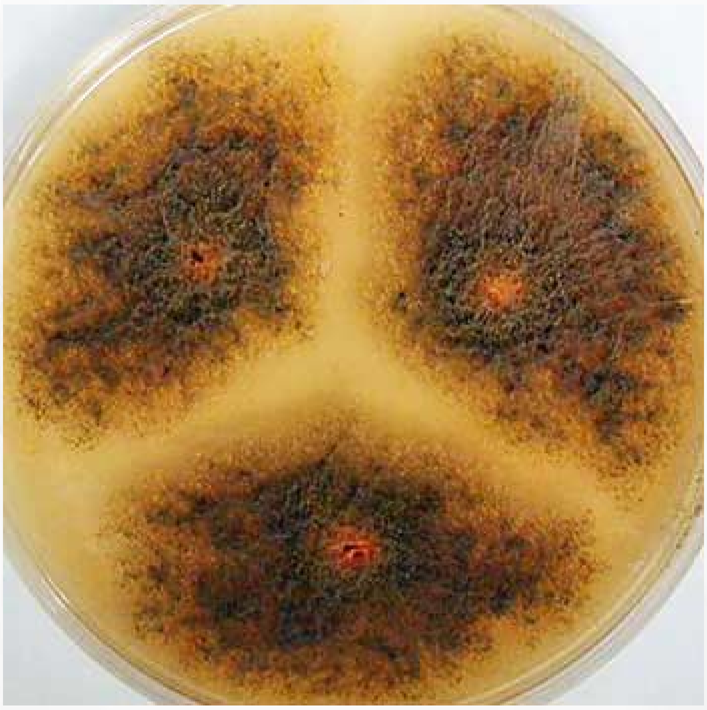
Easily recognized by its nearly spherical spores (conidia) that are several-celled and strongly roughened. The conidia are usually produced in dense masses from clustered conidiophores (sporodochia). Identification may be difficult at first because isolates often fail to produce conidia in culture. Experienced mycologists easily recognize it by its fast-growing, red, orange or yellow colonies. Heavily sporulating colonies are sometimes encountered but these are less common than the more lightly sporulating or non-sporulating strains. Very common on dead or dying plants; frequently isolated from both outdoor and indoor air.

Classification: Pleosporaceae (Pleosporales).
Holomorph unknown.
Ref: Schol-Schwarz 1959.

Eurotium







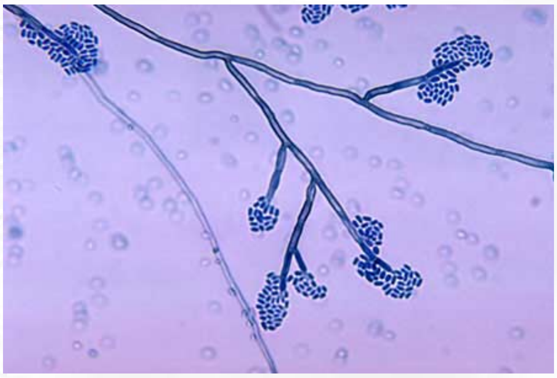
Eurotium rubrum

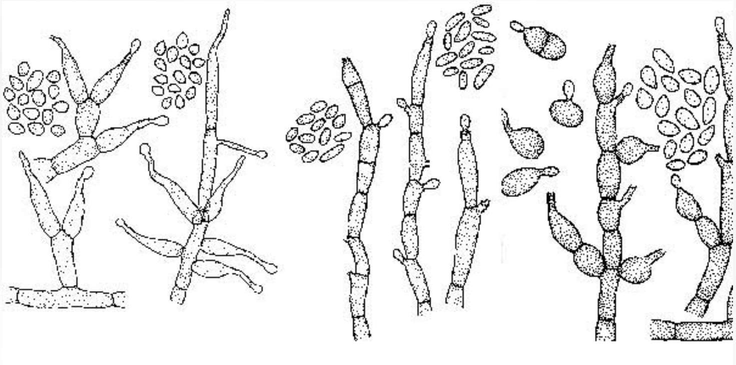
An ascomycete characterized by whitish to bright yellow spherical fruiting bodies (cleistothecia) containing spherical asci which in turn each enclose eight colourless ascospores. The ascospores are oblate (like a flattened sphere) and may have equatorial ridges, thus resembling pulleys. Species of *Eurotium* grow best in dry situations and are usually cultivated on media high in sucrose or glycerine. They are common in homes, stored grains, and rodent dwellings.

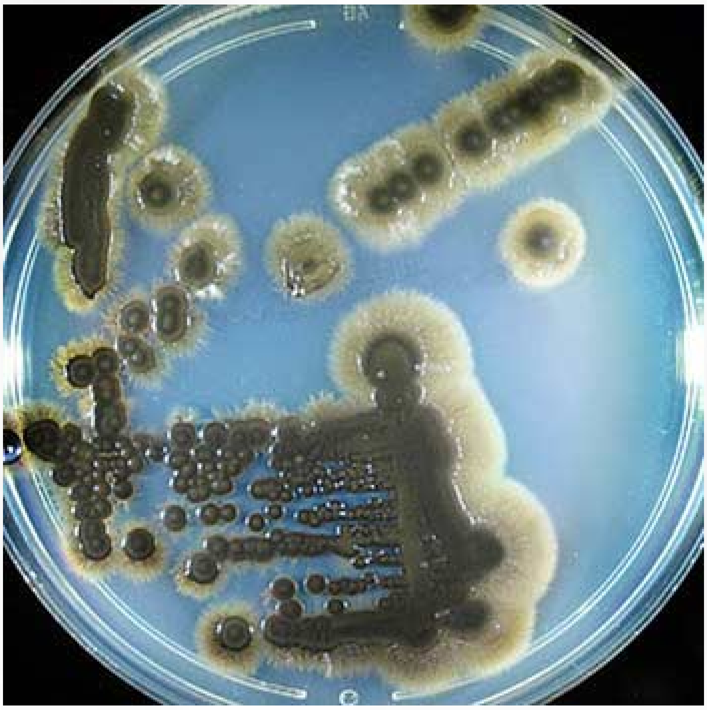
The three photographs at top are of a strain of *Eurotium rubrum* found growing on an old pita bread in a New Brunswick home. The bright yellow-orange colony is typical of *Eurotium* species where the bright yellow cleistothecia greatly outnumber the green masses of conidia. The green colony at left is a species of *Penicillium*, probably *P. chrysogenum*. The middle panel is an enlargement of the colony showing the yellow cleistothecia nestled among the red hyphae characteristic of *E. rubrum*. The right panel shows a group of spores. The darker, roughened spores at the right and top of the picture are conidia of the *Aspergillus* anamorph of the fungus. The rest of the spores are ascospores, which are shaped like minute hamburgers. In common with hamburgers, ascospores of *Eurotium* species tend to come to rest on a top or bottom rather than on a side. Thus most of the ascospores look circular. However, two of these are lying on their side and thus have the elliptical outline of a hamburger as viewed by someone about to bite into it. The group of ascospores that are slightly out of focus are still inside an ascus, although the ascal wall cannot be seen. All of these features can be seen more clearly in the drawing at right. The coiled structure in the drawing is an ascogonial coil, discussed in greater in the discussion of the Sordariomycetes.

Classification: Trichocomaceae (Eurotiales).
Anamorph: *Aspergillus*.
Ref: Blaser 1976; Klich and Pitt, 1985; Raper and Fennell 1965.

Exophiala







Exophiala dermatitidis

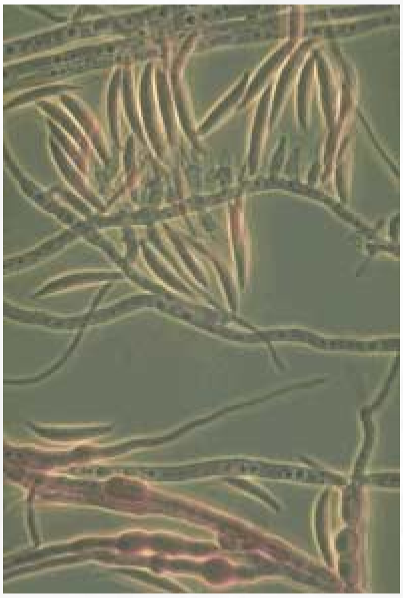
Exophiala species are usually included among the fungi called "black yeasts". Conidia are typically borne at the tips of short annellides produced along the vegetative hyphae. The annellides are often difficult to see and to determine that they actually *are* annellides. Species of *Phialophora* are similar but produce their conidia on phialides rather than annellides. Species of *Aureobasidium*, another genus of black yeasts, produce conidia holoblastically on minute peg-like extensions of short hyphal branches or directly along the hyphae themselves.

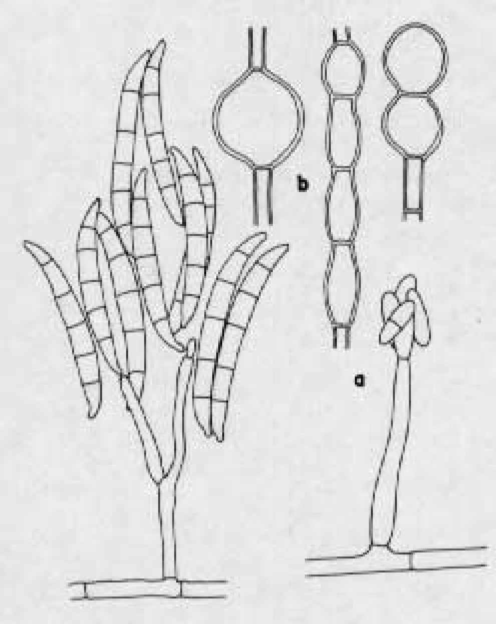
Some species of *Exophiala* are known to cause a subcuaneous disease in humans and other vertebrates. Although not normally life-threatening, these infections must be removed surgically or they may continue to grow for years. In handling these fungi, care must be taken not to accidentally inoculate oneself with contaminated instruments.

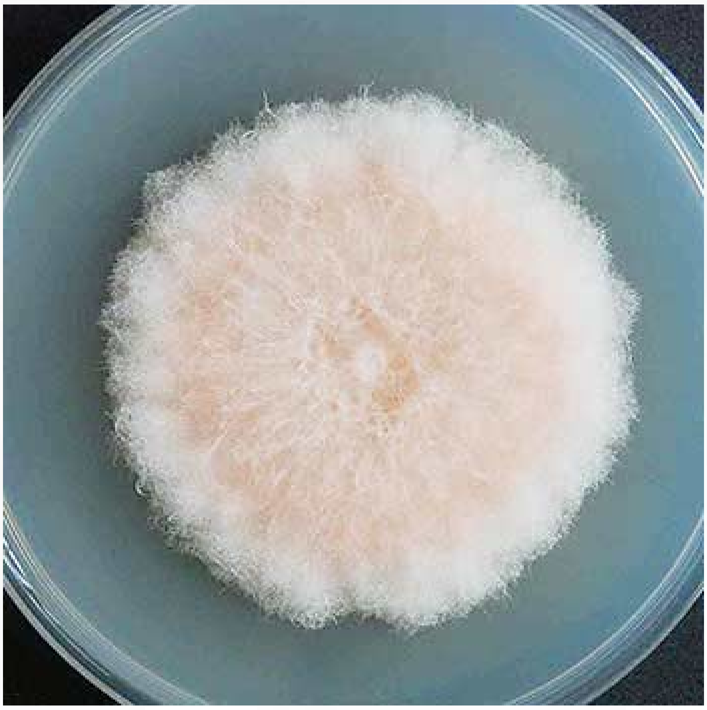
The natural habitats of *Exophiala* species are hard to pin down. They can be isolated from decaying plant material, wood, sewage sludge, soil, tree exudates and many other sources. They sometimes appear in unlikely places, such as in syrup-like solutions of polyvinyl alcohol. They are often most easily found by locating the small perithecia of the *Exophiala* holomorphs.

Classification: Herpotrichiellaceae (Eurotiomycetes).
Holomorph: *Capronia*.
Refs: Hoog and Hermanides-Nijhoff, 1977; Untereiner, *et al.,* 1995. The drawings used here are from the Ph.D. thesis of Wendy Undereiner.

Fusarium





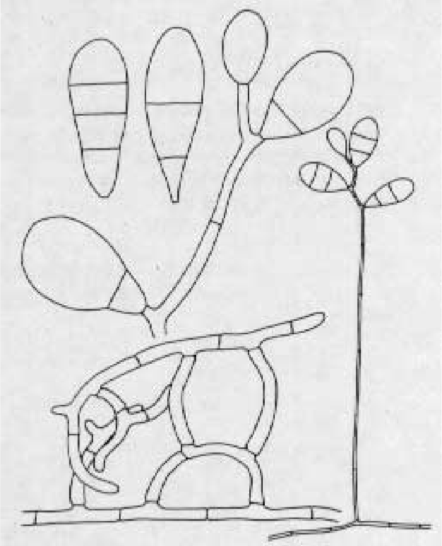


Fusarium equiseti

Most characteristic are the colourless spores (conidia), which are canoe-shaped in side view, have a distinct "foot cell" at the lower end, and are divided by several cross-walls. The conidiophores are often clustered to form sporodochia and produce large pasty masses of spores from tapered phialides. Two other spore forms may occur, microconidia (a) resembling spores and phialides of *Acremonium*, and chlamydospores (b), thick-walled swellings along the filaments. Cultures may be brightly coloured. Common in soil and dead or living plants; often causing plant disease.

Classification: Nectriaceae.
Holomorphs: *Albonectria*, *Coralomycetella*, *Gibberella*, *Haematonectria*, and possibly others.
Ref: Booth 1971b, 1977; Burgess, *et al*., 1988; Gerlach and Nirenberg, 1982; Nelson, *et al*., 1983.

Geniculifera

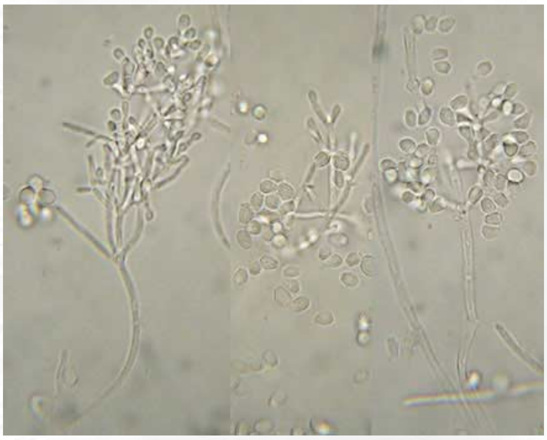


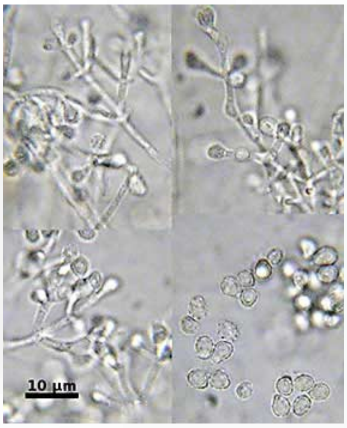
no image

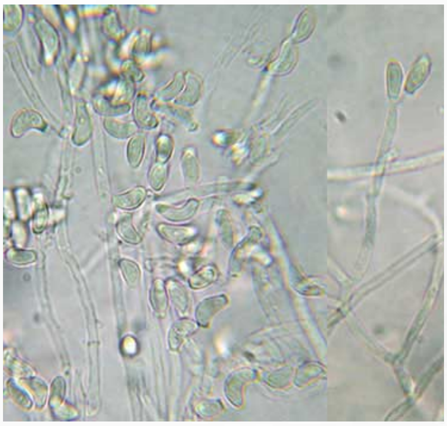
The 2- to 4-celled colourless spores (conidia) are produced at the "joints" of more or less zigzag or geniculate conidiophores. The youngest conidium is at the top and new growth of the conidiophore then originates just below it and pushes it to one side. Considered by some authors to be indistinguishable from *Arthrobotrys*. Predacious on eelworms, which they trap in sticky networks of loops. Occurring in soils high in organic material.

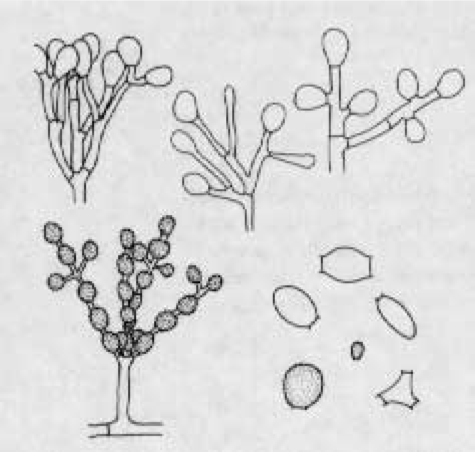
Classification: see *Arthrobotrys*.
Holomorph unknown.
Ref: Rifai 1975; Rifai and Cooke 1966; Rubner, 1996.

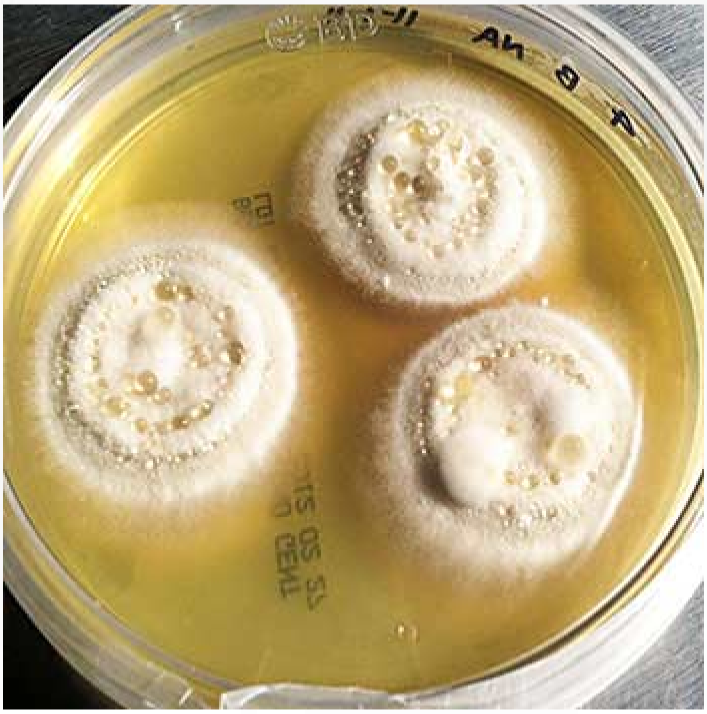
Geomyces











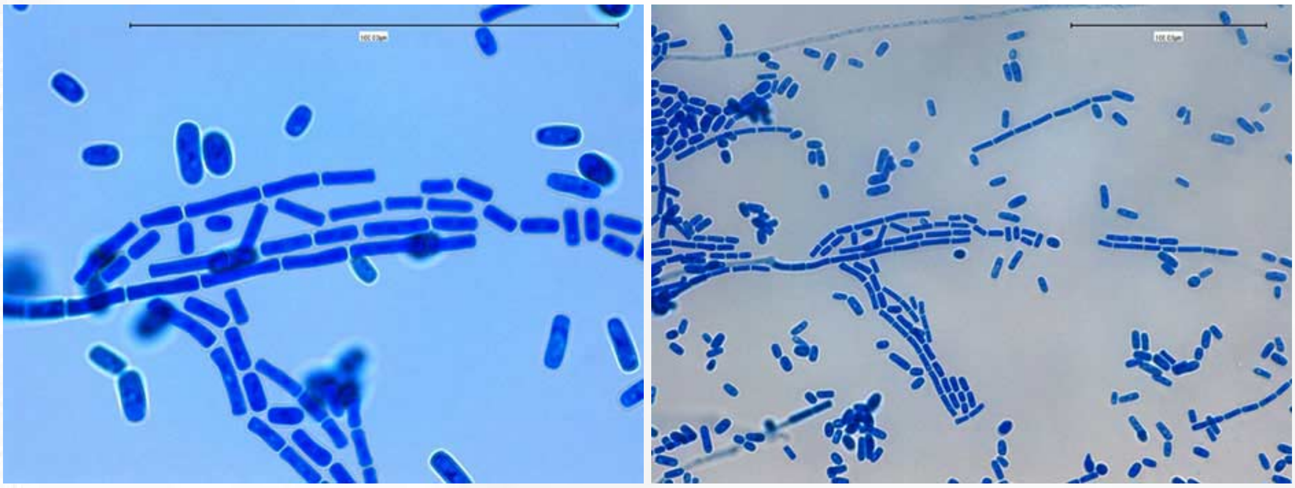
Geomyces destructans

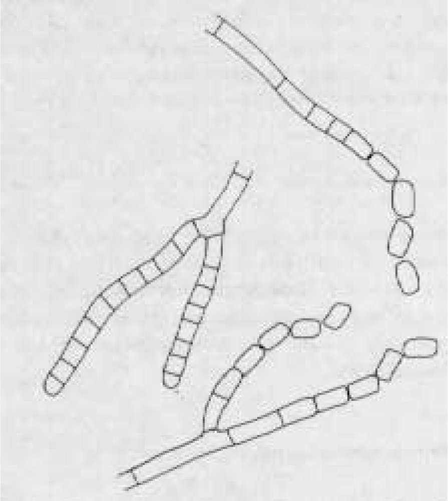
Characterized by short but distinct conidiophores that are branched above and which bear chains of spores formed directly from the cells of the branches. Often only the tips of the branches become converted into spores. The spores (conidia) are 1-celled and may be white or yellow.

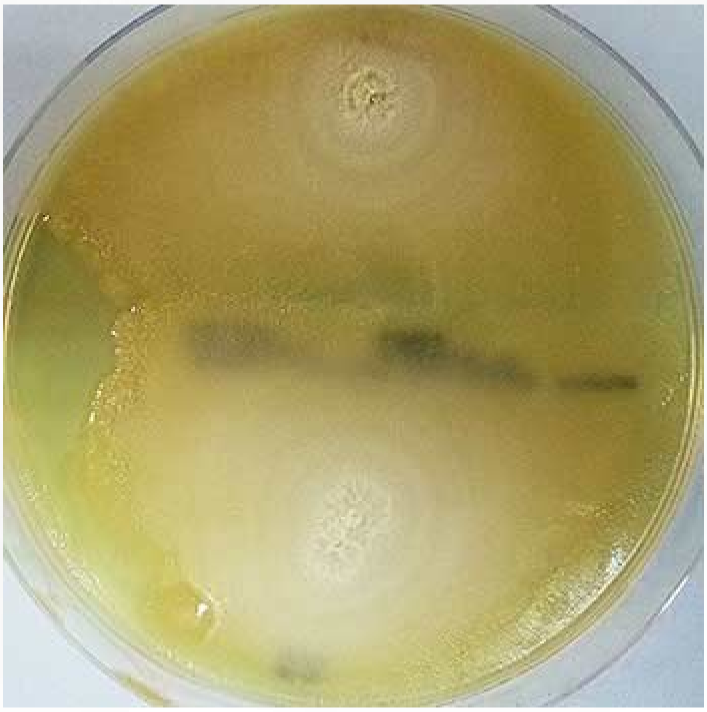
Species of *Geomyces* are generally found in relatively cool habitats, although many can grow well at room temperature. Some species are psychrophilic, that is they are adapted to cold conditions and cannot tolerate temperatures above the mid-teens celsius. These psychrophiles are often abundant in soils at high latitudes or in cold habitats such as mines and caves. *Geomyces destructans*, cause of white-nose syndrome in bats, thrives on hibernating bats in caves where the year-around temperature remains below 10 degrees C. The picture at right-middle shows the curved conidia characteristic of *G. destructans*. Occurring in soil, leaf litter and animal materials such as dung and decomposing tissues.

Classification: Myxotrichaceae (Myxotrichales).
Holomorph: Pseudogymnoascus.
Ref: Hayes 2012; Sigler and Charmichael 1976; Van Oorschot 1980.

Geotrichum





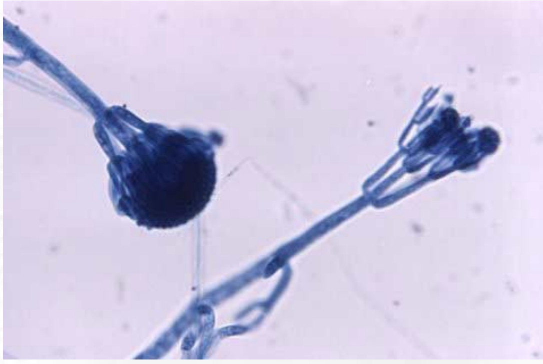


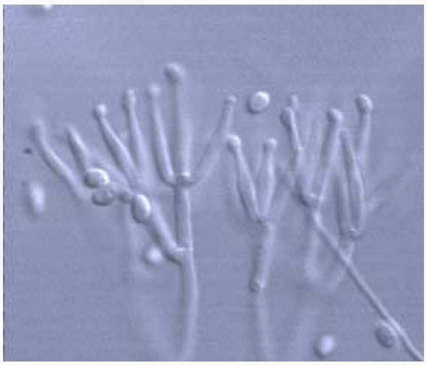
Geotrichum candidum

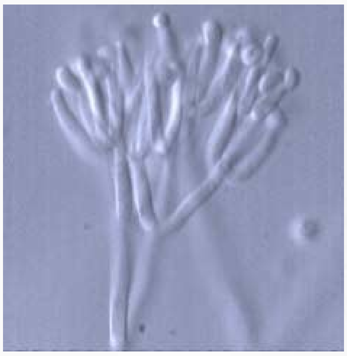
A very simple genus characterized by the formation of chains of colourless, slimy spores (conidia) through the segmentation of vegetative filaments. Some with strong odours. Common in dairy products, fruits, slime fluxes, and sometimes soil. Suh and Blackwell (2006) described three new species from the guts of living insects.

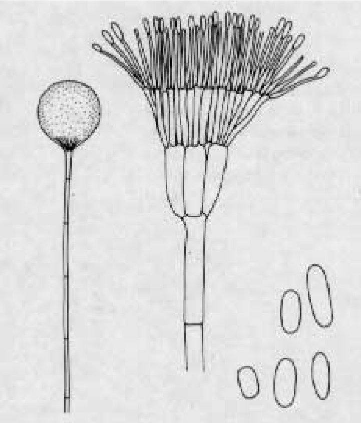
Classification: Dipodascaceae (Saccharomycetales), one of the so-called Hemiascomycetes or yeasts.
Holomorph: *Galactomyces*.
Ref: Carmichael 1957; Hoog *et al.*, 1986; Hoog and Smith, 2011; Sigler and Carmichael 1976.

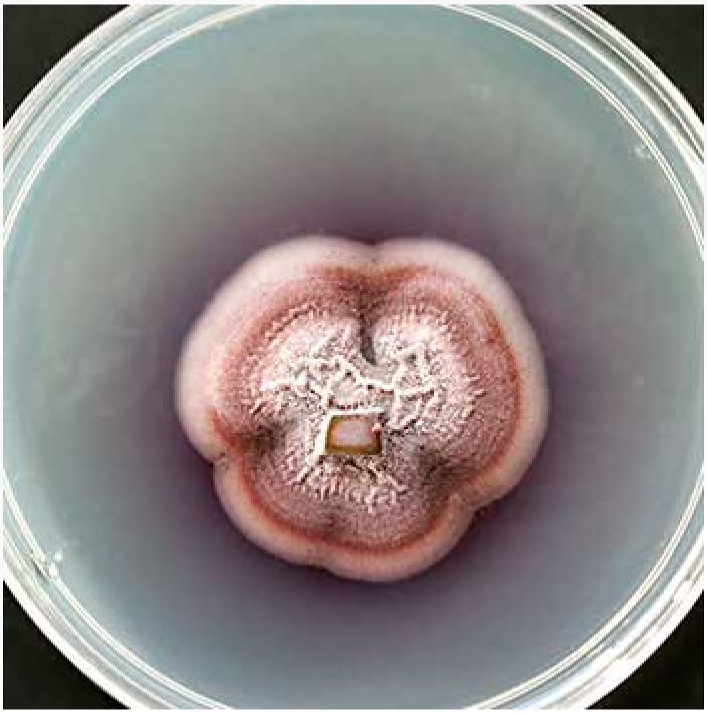
Gliocladium











formerly *Gliocladium roseum*

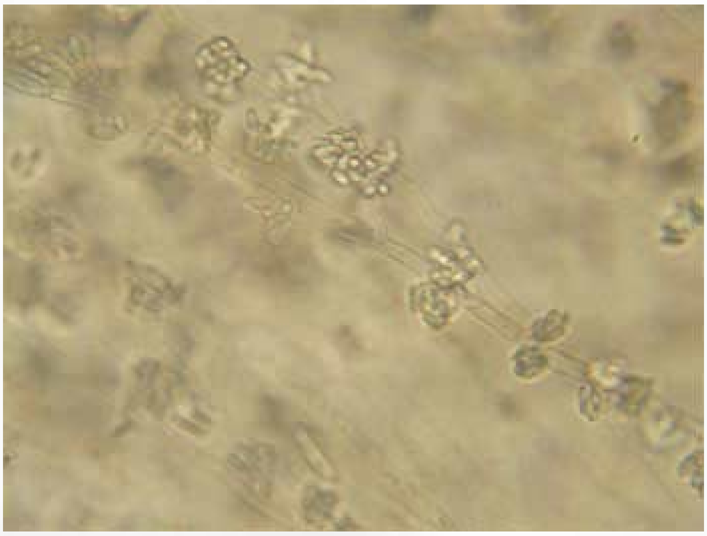
Conidiophores erect, terminated by a dense brush-like branching system bearing tapered phialides. The spores (conidia) are colourless, or green and are produced in a dense wet mass from the phialides. The spore-bearing structures are fairly large and complex as in the illustration of *G. penicillioides* at left. Species of *Gliocladium* are similar to those of *Penicillium* but with conidia collecting in wet rather than dry masses.

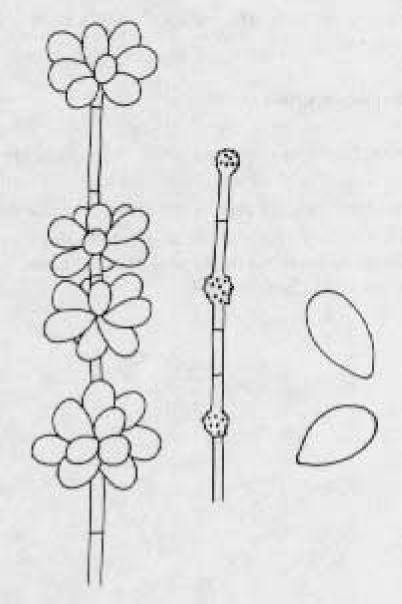
For many years *Clonostachys rosea* (two photos at right) was maintained in *Gliocladium* as *G. rosum* but is now known to be a member of the Bionectriaceae as an anamorph of *Bionectria* and *Roumegueriella* species.

Species of *Gliocladium* occur in soil or decaying plant matter where they frequently are reported as parasites of other fungi. Some can become pests in petri dish cultures, overrunning the colonies of other fungi.

Classification: Hypocreaceae.
Holomorphs: *Sphaerostilbella*, *Hypocrea* and other Hypocreales.
Refs: Domsch, Gams and Anderson, 1980; Morquer *et al.*, 1963; Raper and Thom, 1949.

Gonatobotrys



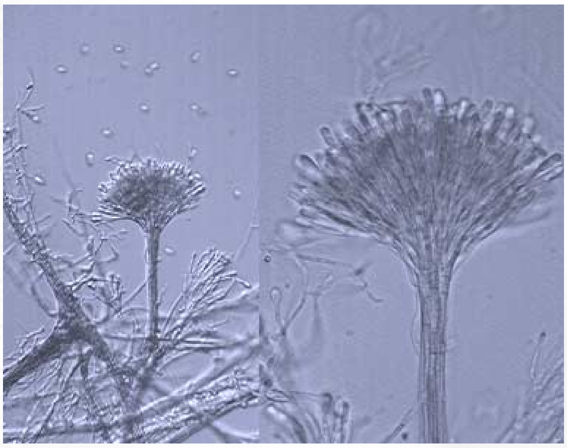
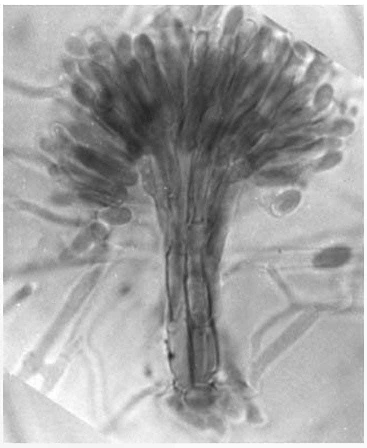
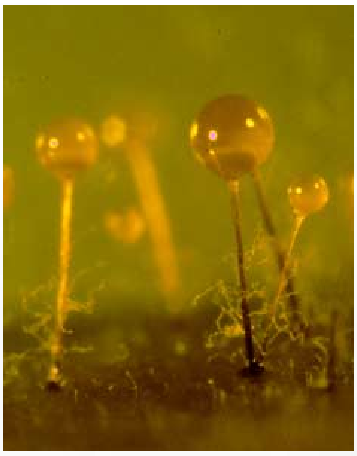
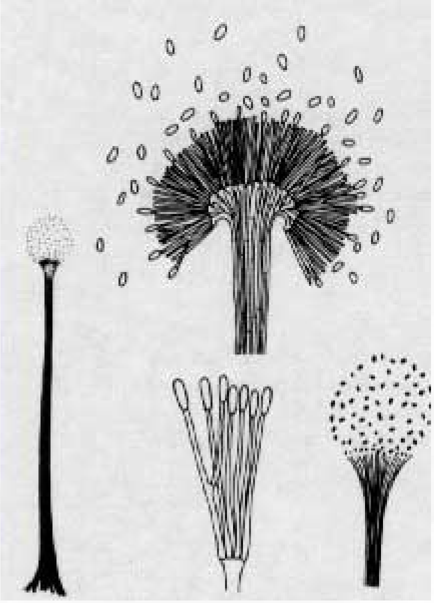


no image

Consisting of an erect conidiophore with several roughened swellings along its length. The colourless 1-celled spores (conidia) are borne in grape-like clusters around each swelling. Similar to *Arthrobotrys* but the spores are never more than 1-celled. Parasitic on other fungi by means of small sucker-like structures called contact cells. Common on dead or dying plant parts, especially those not yet fallen to the ground.

Classification: Ceratostomataceae (Hypocreales).
Holomorph: possibly *Melanospora*.
Refs: Matsushima 1975; Sutton 1973.

Graphium

Graphium ulmi

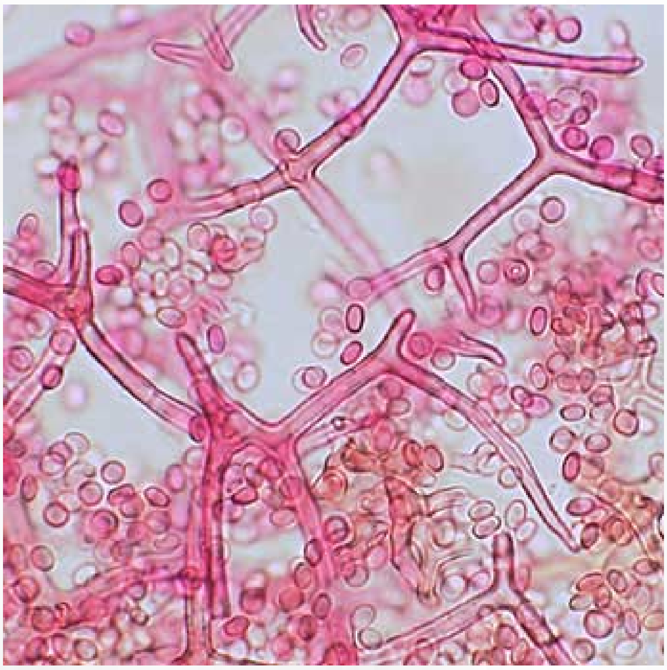
Fruiting structure a synnema, composed of fused dark conidiophores terminating in a droplet of liquid containing conidia. The colourless 1-celled spores are produced continuously from annellides, phialides or sympodially occurrring holoblastic loci, and collect in a large drop of fluid. The synnemata can be quite stout and up to 5 mm high.

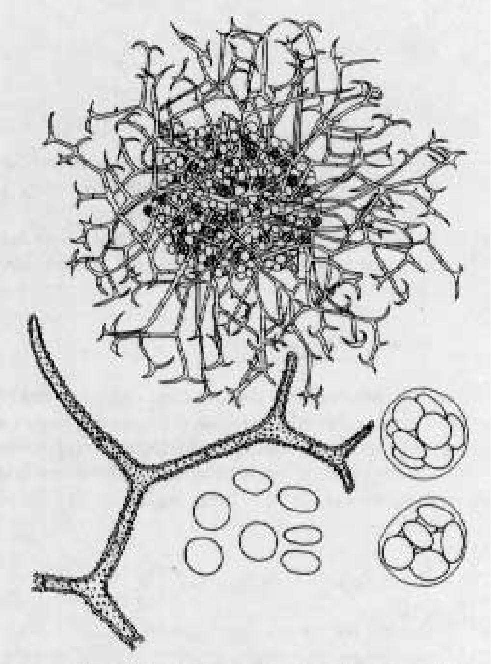
The two panels in the leftmost photo were taken from a culture isolated from seeds of canola, an edible rapeseed. It is a typical *Graphium* anamorph of *Kernia*, *Microascus*, *Petriella* and *Pseudallescheria*, all members of the ascomycete family Microascaceae. A few non-synnematous (mononematous) structures can be seen in the photograph at left; strictly speaking, these should be called *Scedosporium* because they are not synnematous. However, many strains are highly synnematous when first isolated but become mononematous after a few transfers. Some species of *Scedosporium* cause disease in humans and should be handled with great care. The second photo is the *Graphium* anamorph of *Kernia pachypleura*. This species produces distinct but much smaller synnemata with more compact annellides. The picture at right-middle is a macrophoto of synnemata growing on an agar surface.

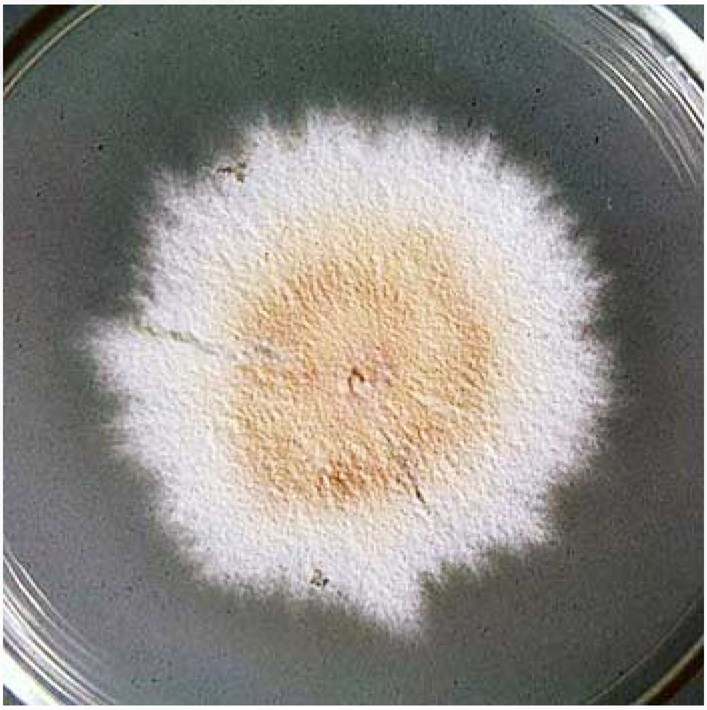
Occurring on wood, dung, seeds, and plant debris.

Classification: Microascaceae.
Holomorphs: *Kernia*, *Microascus*, *Petriella*, and *Pseudallescheria*.
Ref: Ellis 1971; Seifert and Okada, 1993.

Gymnoascus







Arthroderma gypseum (syn. *Gymnoascus gypseus*)

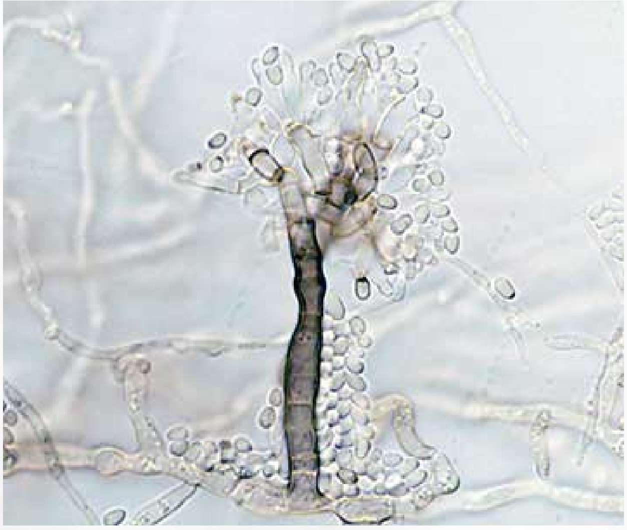
An ascomycete characterized by loose, light-coloured, bramble-like fruiting structures (gymnothecia) containing spherical asci which in turn each enclose eight spores (ascospores). The ascospores are colourless to yellow, smooth, and oblate (a flattened sphere). The gymnothecia usually bear some sort of hooked or recurved spines.

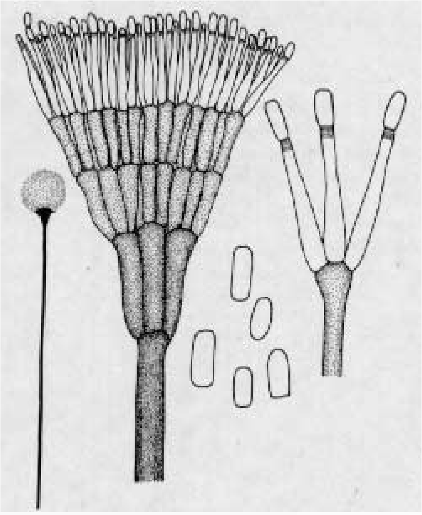
Several other genera of ascomycetes, all treated and discussed by Currah (1985, 1988), are similar to *Gymnoascus*. *Gymnoascus* species differ from all of these in having a combination of oblate, smooth ascospores and gymnothecia composed of distinctive hyphae forming a complete network around the mass of ascospores.

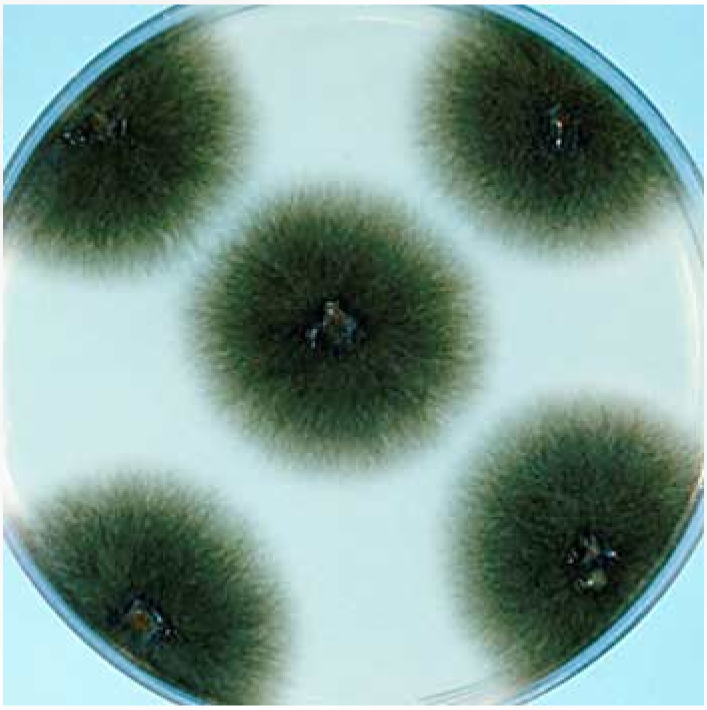
Occurring in soil, dung, or other habitats where hair or feathers are decaying.

Gymnoascaceae (Onygenales).
Anamorph: lacking.
Ref: Currah, 1985, 1988; Orr, Kuehn, and Plunkett 1963.

Leptographium





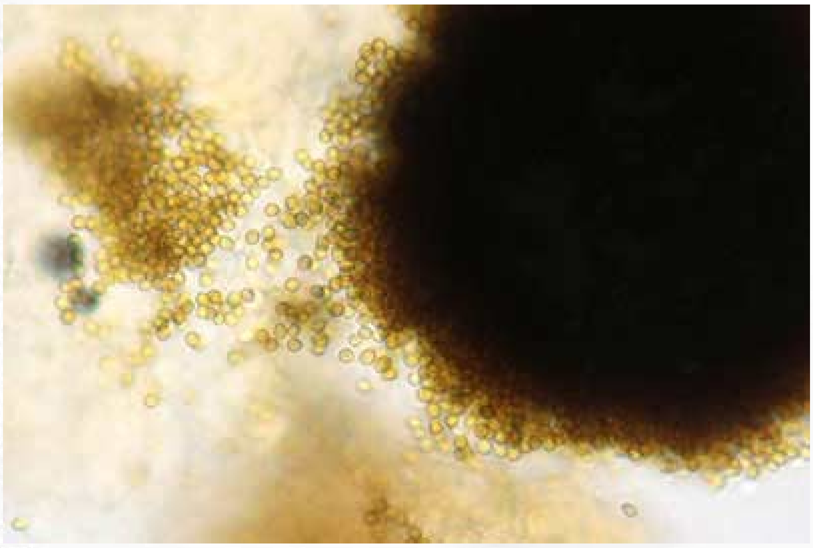


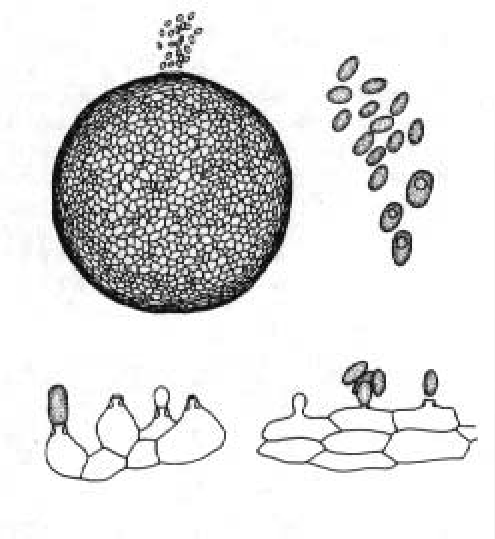
Leptographium procerum (syn. *Gymnoascus gypseus*)

Conidiophores very dark and stout, bearing a brush-like apical branching structure that is terminated by tapered annellides. The colourless 1-celled spores (conidia) are produced continuously from the tips of the annelides and collect in a large drop of fluid. *Phialocephala* species are related but differ in having phialides. Species of *Thysanophora* are similar but have conidiophores with short swollen branches bearing phialides in a manner strongly reminiscent of *Penicillium* species. On wood and conifer needles.

Ophiostomataceae (Ohiostomatales, Sordariomycetidae).
Holomorph: *Grossmannia*, *Ophiostoma*.
Ref: Ellis 1971.

Microsphaeropsis



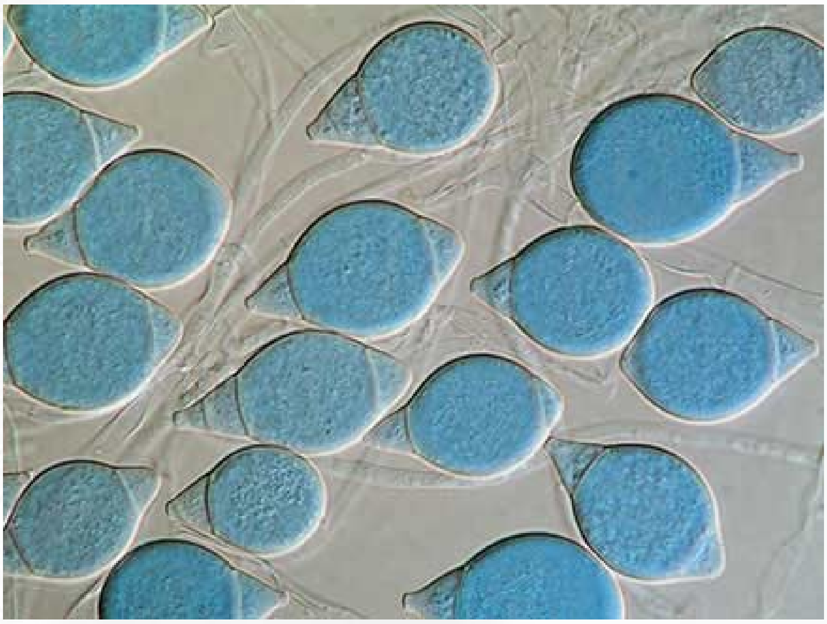


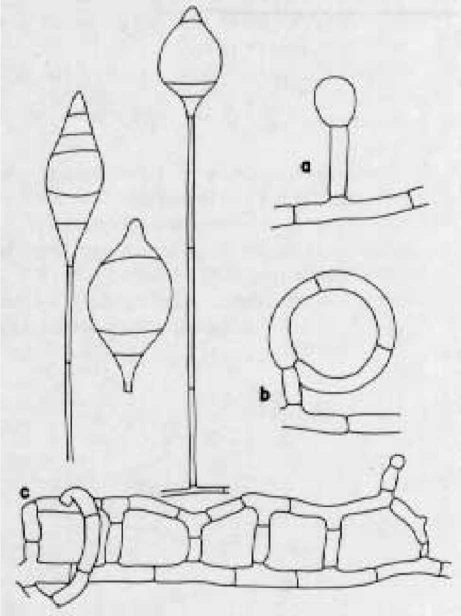
no image

The dark spores (conidia) are borne within cellular, more or less round fruiting structures (pycnidia) and are produced on small flask- or peg-like cells (annellides). Usually the spores are extruded through an opening at the top of the pycnidium and collect in a droplet of fluid. The species occur on living or dead plants.

Classification: Pleosporales.
Holomorphs: *Cucurbitaria*, *Didymosphaeria*, *Leptosphaeria*, *Pleospora*, and related genera.
Ref: Bestagno *et al.*, 1958; Sutton, 1980.

Monacrosporium



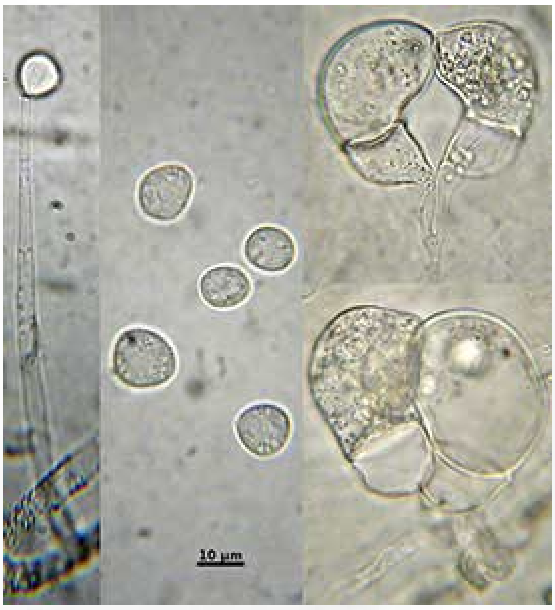


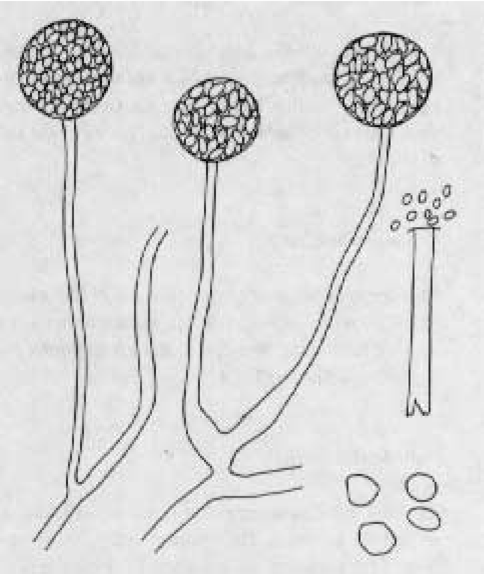
no image

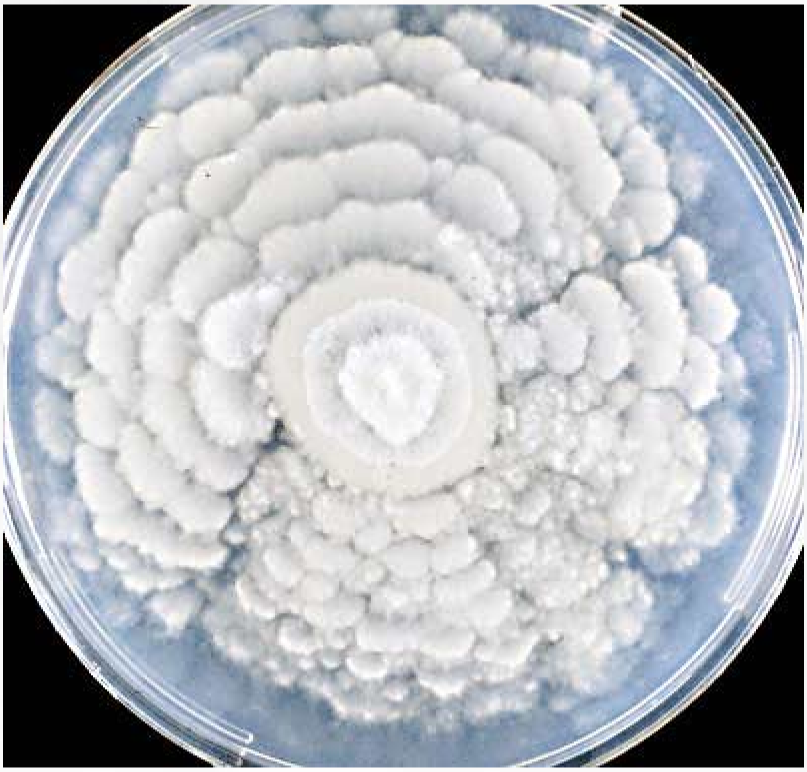
Conidiophores colourless, erect, bearing a single terminal spore (conidium). The conidia have 2 to several cells, are colourless, and have one cell larger than the others. Because of the large cell, the conidia are strongly spindle-shaped. Rubner (1996) recognized 39 species. Predacious on eelworms, which they catch by means of sticky knobs (a), rings (b), or adhesive networks (c). Closely related or possibly synonymous with *Arthrobotrys*. Occurring in soil, dung, and decaying plant matter.

Classification: see *Arthrobotrys*.
Holomorphs unknown.
Ref: Cooke 1967; Cooke and Dickenson 1965; Cooke and Godfrey 1964; Rubner, 1996.

Mortierella







Mortierella wolfii

Mortierella colonies are relatively fast-growing and often spread in overlapping "waves" or lobes. Some have a peculiar odour suggesting garlic. Many species produce a white oily substance in large drops among the aerial hyphae. One group of species, characterized by velvety, odourless colonies, is included with *Mortierella* in the older literature but is now segregated into the separate and unrelated genus *Micromucor*. The spores (sporangiospores) of *Mortierella* species are produced inside spherical sporangia at the tips of sporangiophores and are colourless to brownish. A columella is usually lacking or very poorly developed (compare with *Mucor* for this feature).

The photograph at left illustrates a species of *Mortierella*, possibly *M. verticillata*, isolated by museum technician Karen Vanderwolf from the surface of a hibernating bat in a New Brunswick cave. The leftmost panel shows a sporangiophore with a single spore at its apex. In fact, the sporangial wall had already broken and the spore is one of three or four that were originally there. The middle panel depicts several sporangiospores from broken sporangia. Typical of *Mortierella* species the spores are irregular in size and shape. The rightmost panel illustrates two pairs of gametangia in the midst of mating. The contents of one will move into the other, where the nuclei of the two will fuse, producing temporarily diploid nucei (zygotes). The gametangium containing the diploid nuclei will dvelop into a zygosporangium.

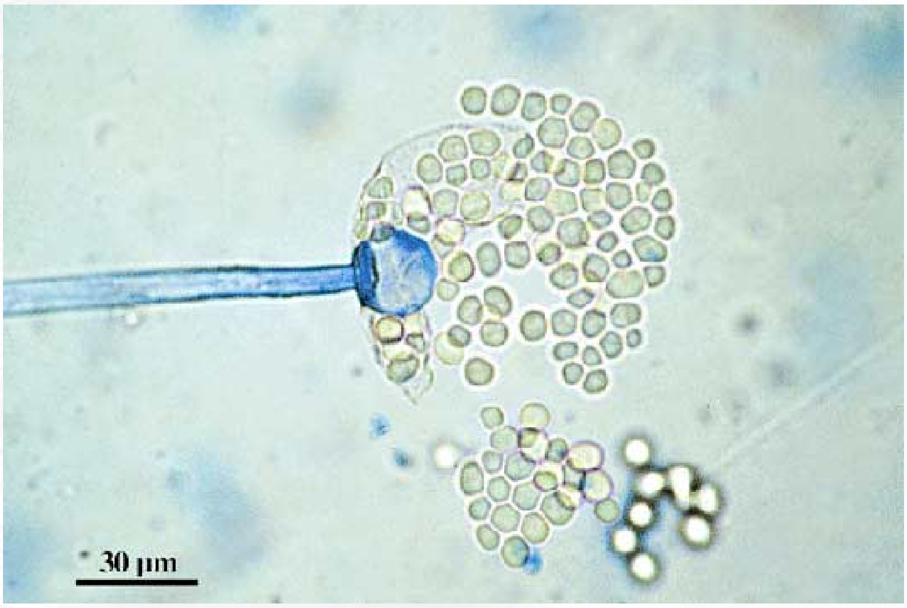
Mortierella species often fail to reproduce under normal laboratory conditions. We have obtained good sporulation by growing the colonies on water agar (agar media containing no nutrients) and incubating at 5-10°C. Growth is slow but sporangia are often abundant. Apparently cold and starvation triggers reproduction.

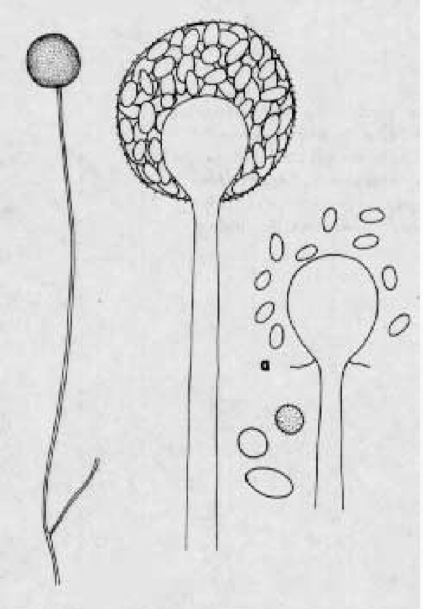
Some species, such as *M. polycephala*, produce spherical "chlamydospores". These spores can be large in some species and may be variously roughened. In culture, the chlamydospores may be more conspicuous than the sporangia; in fact sporangia may be absent at first. Similar spores are produced by *Histoplasma capsulatum*, cause of a serious disease in humans, and by species of *Sepedonium*.

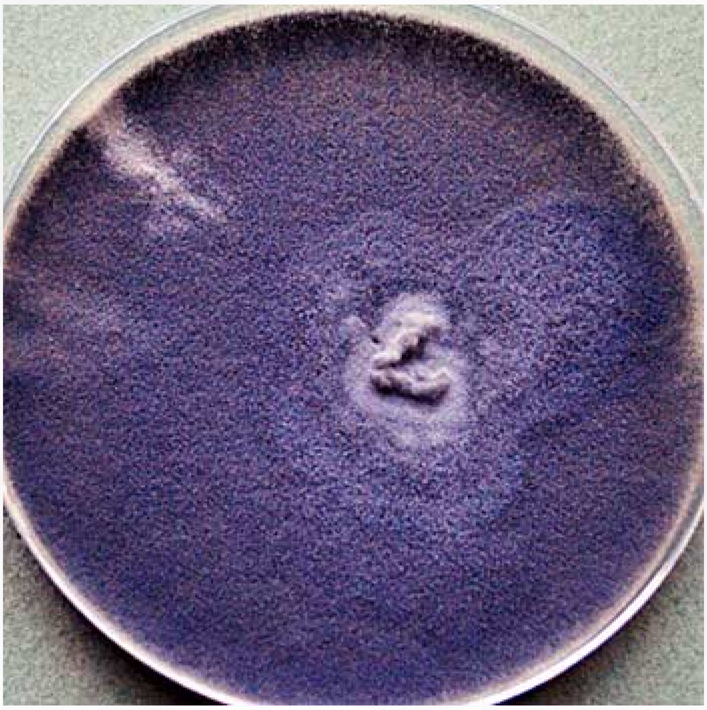
Common in soil and dung.

Classification: Mortierellaceae (Mucorales, Zygomycota).
Ref: Gams 1969, 1977; Zycha and Siepmann 1970.

Mucor





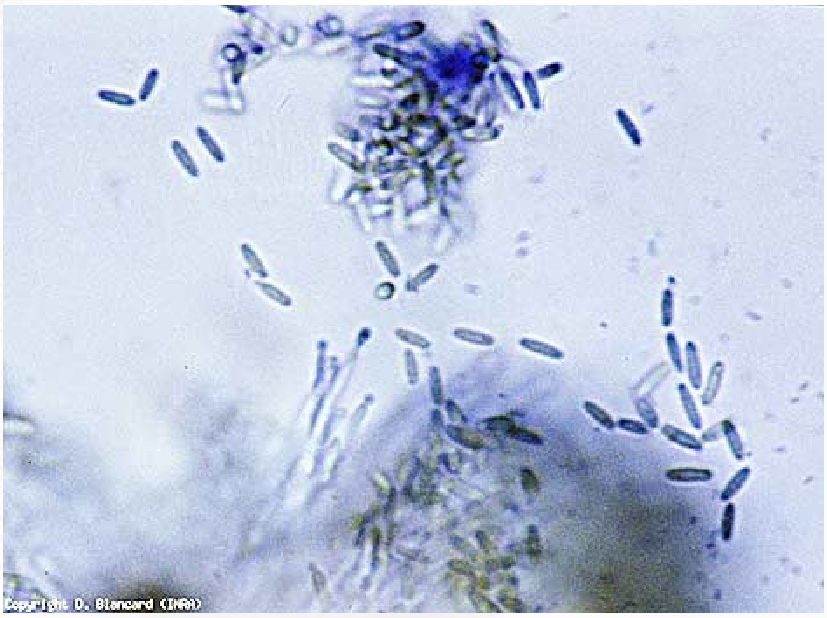


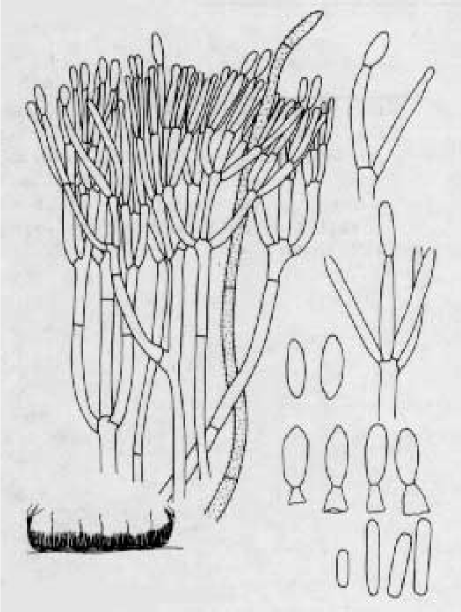
Mucor circinelloides

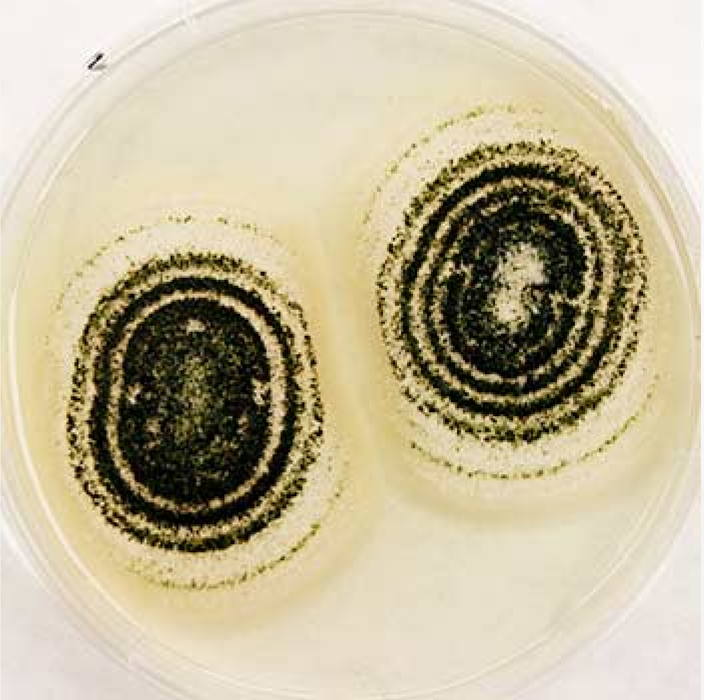
Colonies fast-growing, whitish to greyish, usually thick owing to the abundant upright sporangiophores. Spores (sporangiospores) produced inside spherical sporangia at the tips of the sporangiophores, brownish. Always with a large columella that remains after the sporangial wall is broken (a). Large dark zygospores may be produced. Common almost everywhere fungi occur.

Classification: Mucoraceae (Mucorales, Zygomycota).
Ref: Schipper 1978.

Myrothecium





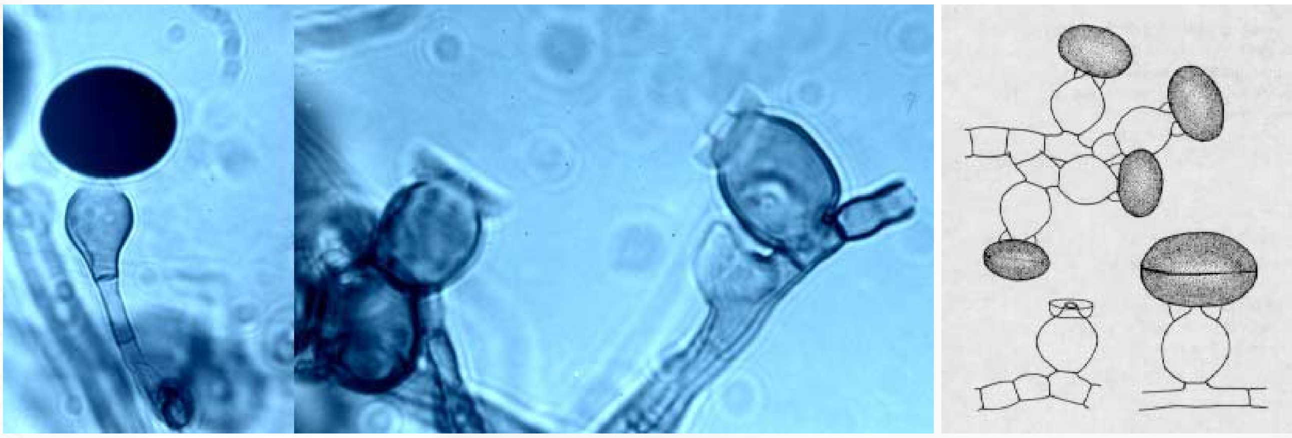


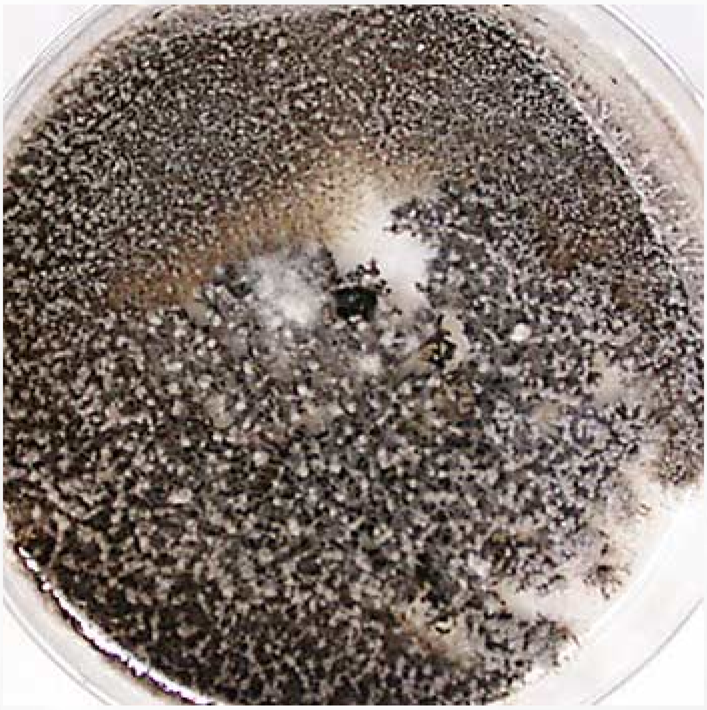
Myrothecium roridum

The conidiophores are united together to form fruiting structures (sporodochia) which are usually flat but may be on a stalk. The spores (conidia) are borne from the tips of the long phialides which are in turn borne on densely branched and brush-like conidiophores. The mass of dark green conidia collect in large green to blackish wet drops. In soil and decaying plant debris.

Classification: Hypocreales (Hypocreomycetidae), but its family placement is still unclear.
Holomorphs: unknown.
Ref: Domsch *et al.*, 1980; Tulloch 1972.

Nigrospora



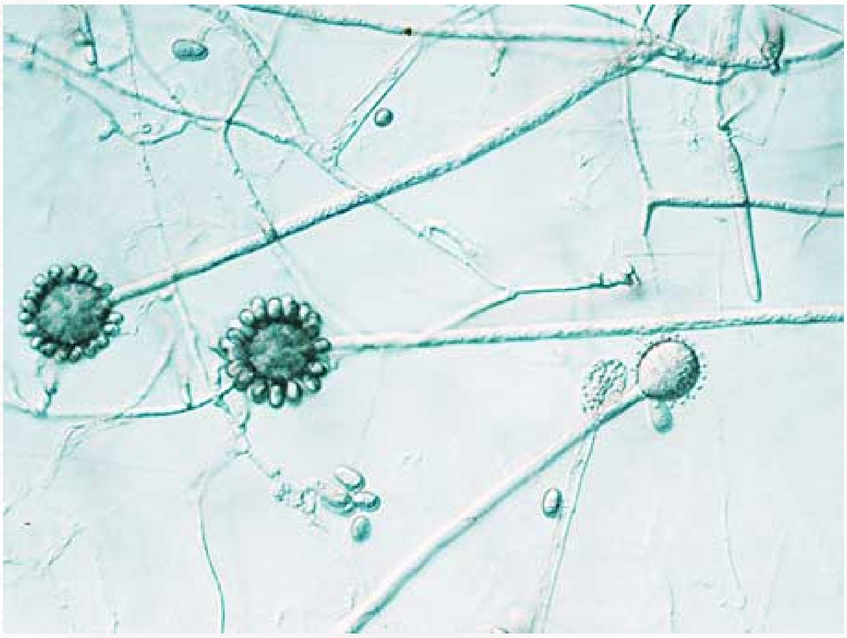


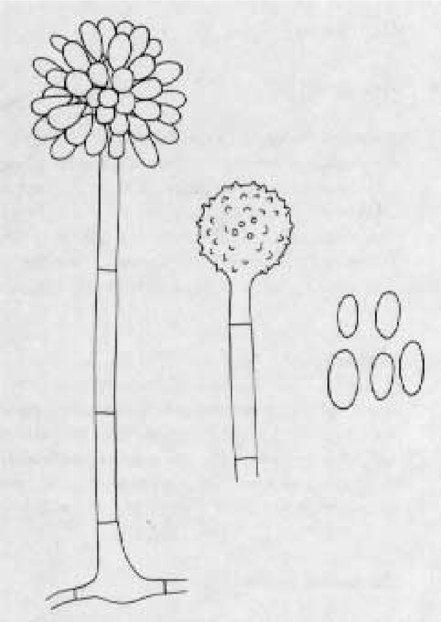
Nigrospora

The white woolly colonies grow fairly rapidly. Spores (conidia) are produced singly on swollen urn-shaped conidiophores and are egg-shaped to flattened-spherical, black, and often have an equatorial colourless line or germ slit. Occurring as parasites on living grasses but also present on dead ones; easily isolated from dead lawn grass in the autumn.

Classification: Trichosphaeriales (Sordariomycetidae).
Holomorph: *Khushkia*.
Ref: Ellis 1971.

Oedocephalum



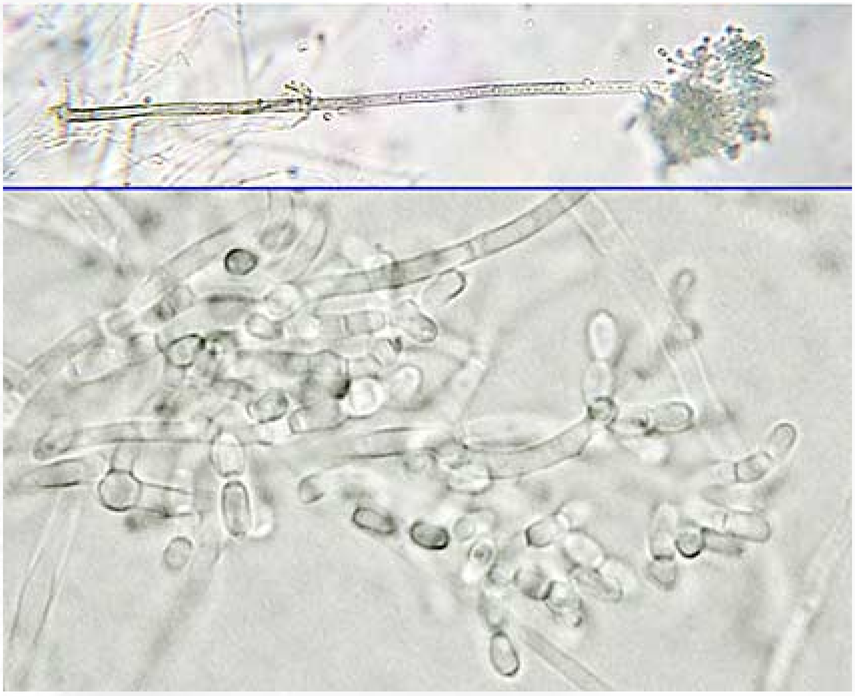


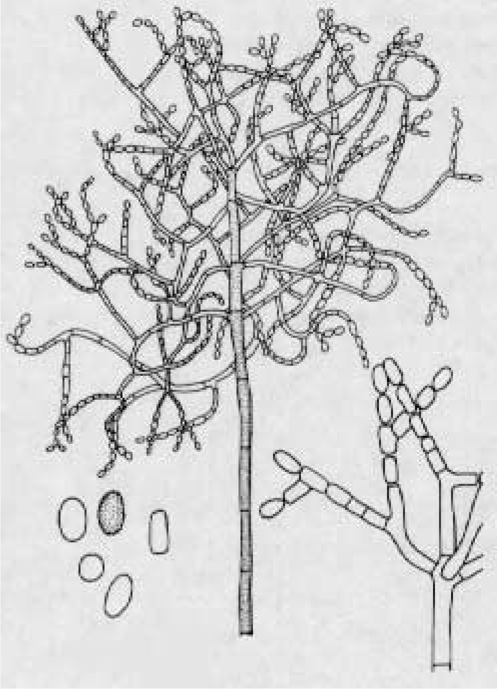
no image

Characterized by erect colourless conidiophores with a terminal swelling or vesicle. The spores (conidia) are colourless, 1-celled, and are borne in a single layer on the surface of the vesicle. Isolated from dung, wood, soil, and decomposing plant matter.

Classification: Pezizaceae.
Holomorphs: *Iodophanus*, *Peziza*.
Ref: Stalpers 1974.

Oidiodendron



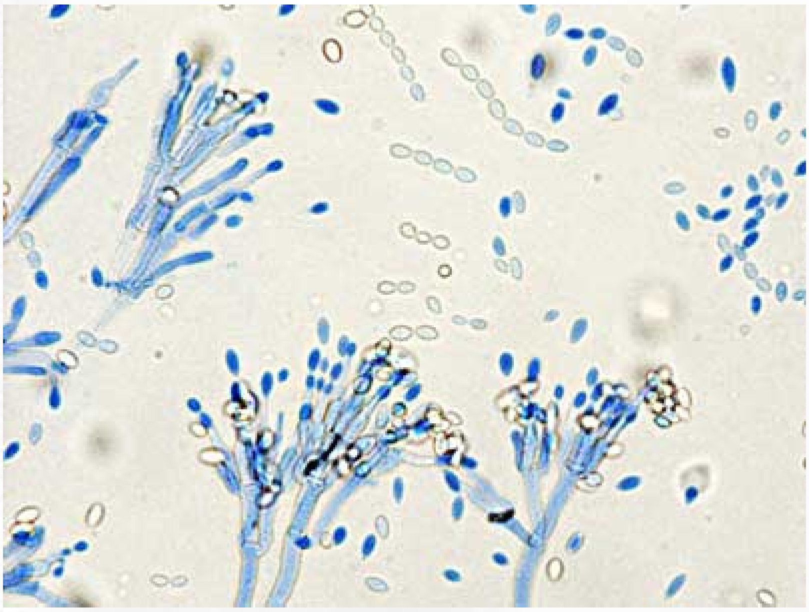


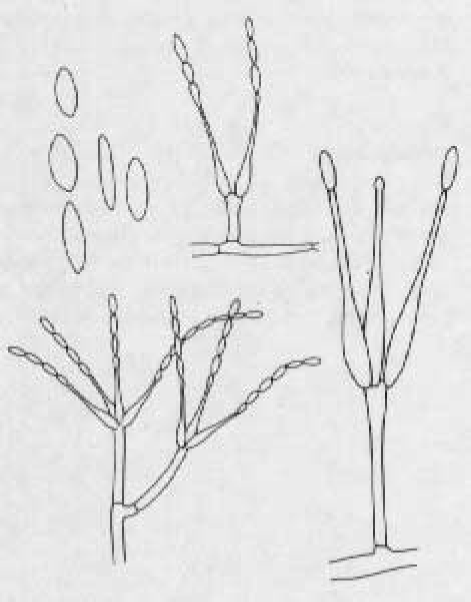
no image

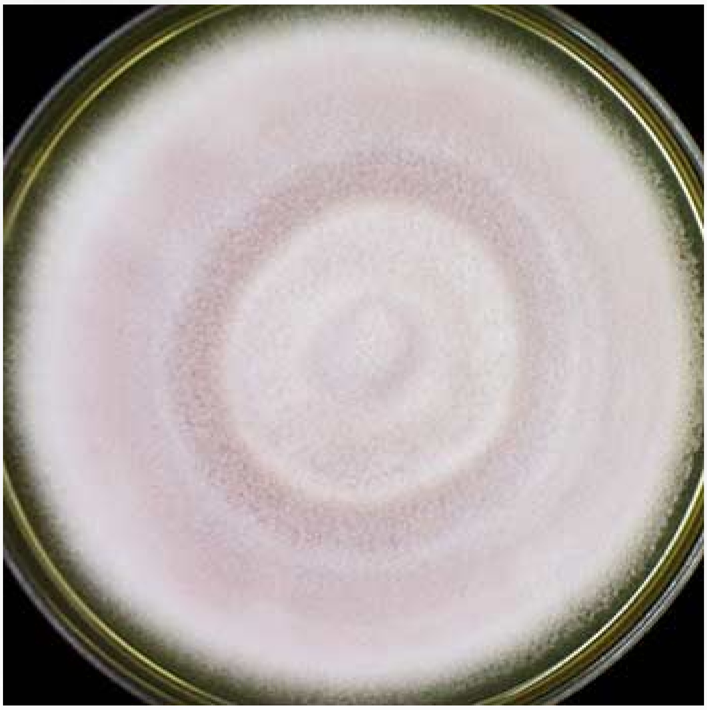
The dark conidiophores are erect, usually tall, and are terminated by a rather irregular system of tree-like branches. The brown to colourless spores (conidia) are produced by the fragmentation of the conidiophore branches. Occurring in soil and organic debris.

Classification: Myxotrichaceae (*Myxotrichales*).
Holomorphs: *Byssoascus*, *Myxotrichum*.
Ref: Barron 1962; Morrall 1968; Rice and Currah, 2005; Tokumasu 1973.

Paecilomyces





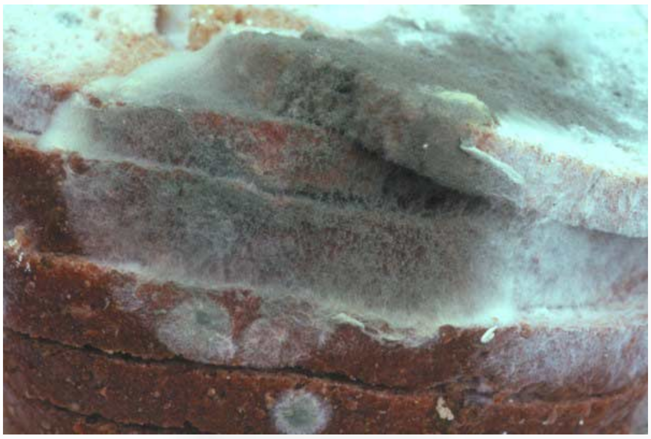


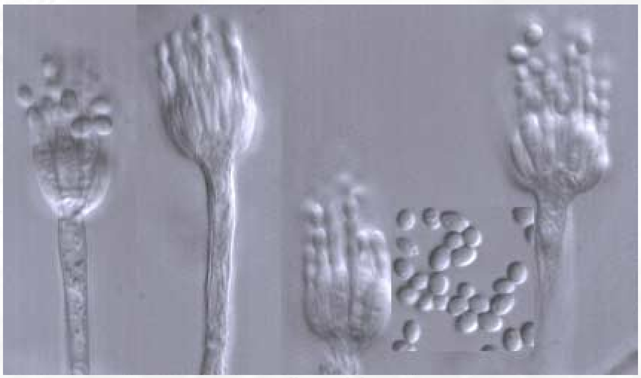
Paecilomyces lilacinus

Colonies with more or less well developed, colourless, simple or branched conidiophores bearing two to several phialides. The phialides are characteristically swollen at the base and gradually narrowed into a long beak. The spores (conidia) are produced in chains from the tips of the phialides, are colourless or brightly pigmented, and are usually rather narrow. Similar to *Penicillium*, but the chains of spores tend to be widely divergent in *Paecilomyces* and more parallel in *Penicillium*.

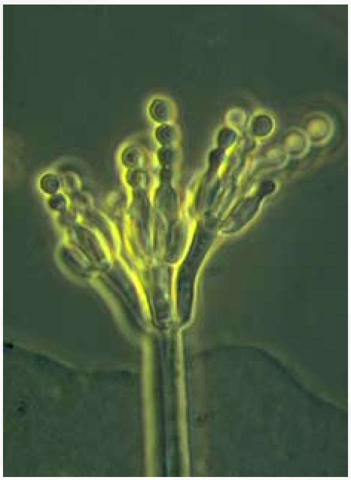
Classification: Thermoascaceae (Eurotiales).
Holomorphs: *Byssochlamys*, *Talaromyces*, *Thermoascus*.
Ref: Bissett 1979; Samson 1974.

Penicillium

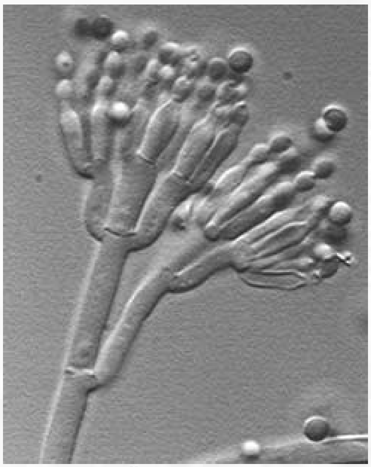




Penicillium glabrum



Penicillium



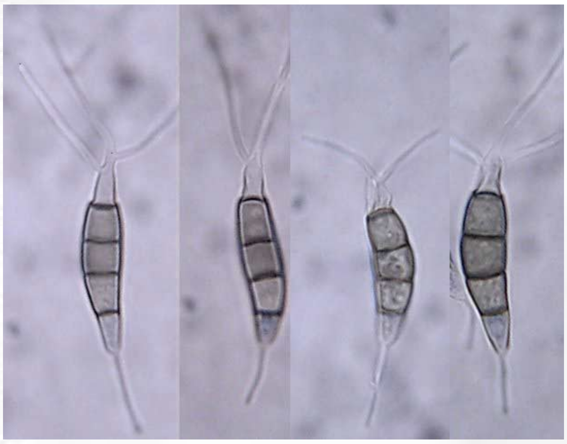
Penicillium atramentosum

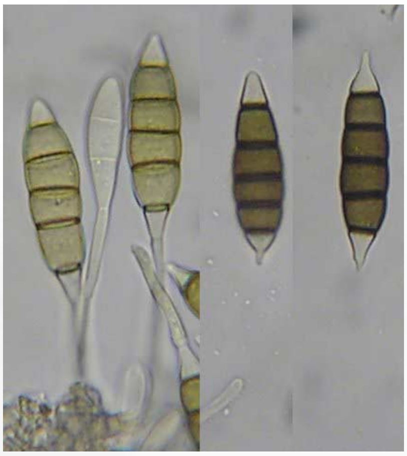
Species of *Penicillium* are recognized by their dense brush-like spore-bearing structures. The conidiophores are simple or branched and are terminated by clusters of flask-shaped phialides. The spores (conidia) are produced in dry chains from the tips of the phialides, with the youngest spore at the base of the chain, and are nearly always green. Branching is an important feature for identifying *Penicillium* species. Some, such as *Penicillium glabrum* at left, are unbranched and simply bear a cluster of phialides at the top of the stipe. Others (middle photo) may have a cluster of branches, each bearing a cluster of phialides. *Penicillum atramentosum*, at right, represents a third type haing branches that bear a second order of branches, bearing in turn a cluster of phialides. These three types of spore bearing systems (penicilli) are called monoverticillate, biverticillate and terverticillate respectively. *Penicillium* is a large and difficult genus encountered almost everywhere, and usually the most abundant genus of fungi in soils.

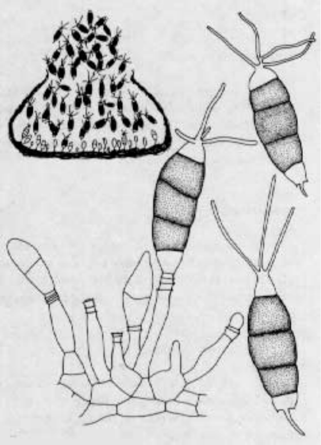
The common occurrence of *Penicillium* species in food is a particular problem. Some species produce toxins and may render food inedible or even dangerous. It is a good practice to discard foods showing the development of any mould. On the other hand some species of *Penicillium* are beneficial to humans. Cheeses such as Roquefort, Brie, Camembert, Stilton, etc. are ripened with species of *Penicillium* and are quite safe to eat. The drug penicillin is produced by *Penicillium chrysogenum*, a commonly occurring mould in most homes.

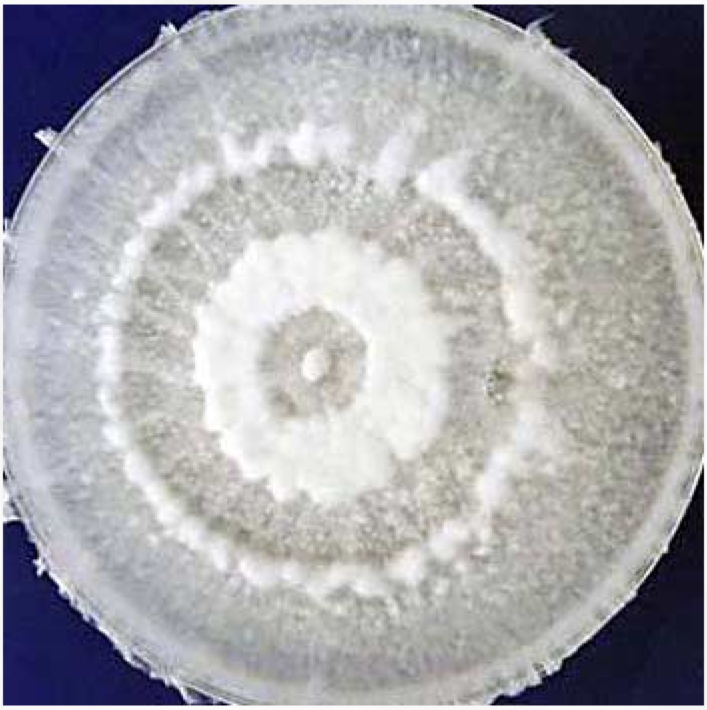
Classification: Aspergillaceae (Eurotiales).
Holomorphs: *Eupenicillium*, *Hamigera*, *Talaromyces*, *Trichocoma*.
Ref: Kulik 1968; Pitt, 1980, 1985; Raper and Thom 1949; Ramirez, 1982; Samson and Frisvad, 2004; Samson and Houbraken, 2011; Samson, Stolk, and Hadlok 1976; Stolk and Samson, 1972, 1983.

Pestalotiopsis









Pestalotiopsis microspora

Conidiophores (annellides) produced within compact fruiting structures (aecervuli or pycnidia). Spores (conidia) 4- to 5-celled, with the two or three central cells dark brown, and with two or more apical appendages or hairs; collecting in a wet mass outside the aecervulus.

Pestalotiopsis is just one of a complex group of fungi. For example the photo at top-center is of *Seiridium abietinum*, a species found on dead branches of balsam fir in Atlantic Canada. It differs from species of *Pestalotiopsis* in having conidia with a single apical appendage rather than several. The following key may be some help in distinguishing these difficult genera. However, anyone seriously interested in identifying a member of this group should consult the monumental work on coelomycetes with appendaged conidia by T. R. Nag Raj (Nag Raj, 1993).

Simplified key to *Pestalotiopsis* and related genera

1. Conidia with a single apical branched or unbranched appendage 2.

1. Conidia with appendages arising at more than one point on the apical cell 10.

2. (1) Basal appendages always lacking 3.

2. Basal appendage present in some of the spores 6.

3. (2) Apical appendage laterally branched, comb-like -» *Labridella*.

3. Apical appendage unbranched or with branches regularly produced on more than one side 4.

4. (3) Apical cell with a single unbranched appendage produced at a nearly right angle to the axis of the spore -» *Bleptosporium*.

4. Apical cell with appendage(s) branched or arising at several points 5.

5. (4) Branches of the apical cell arising at one point or nearly so -» *Hyalotiella*.

5. Branches of apical appendage arising at several points -» *Truncatella*.

6. (2) Conidia without appendages commonly occuring among those with appendages -» *Seimatosporium*.

6. Conidia consistently appendaged 7.

7. (6) Basal appendage arising from the basal septum of the conidium, often visible inside the conidiogenous cell before the conidium has broken off 8.

7. Basal appendage arising from the lateral wall of the basal cell, usually visible alongside the conidiogenous cell before the conidium has broken off 9.

8. (7) Conidia with four or five cells, euseptate, with normally thickened or relatively thin septa -» *Monochaetia*.

8. Conidia with six cells, disto-septate, with inner walls greatly thickened and often with conspicuous septal pores -» *Seiridium*.

9. (8) Apical appendage lateral, branched -» *Doliomyces*.

9. Apical appendage unbranched -» *Sarcostroma*.

10. (1) Conidia disto-septate, with inner walls greatly thickened and often with conspicuous septal pores -» *Pestalotia*.

10. Conidia euseptate,with normally thickened or thin septa 11.

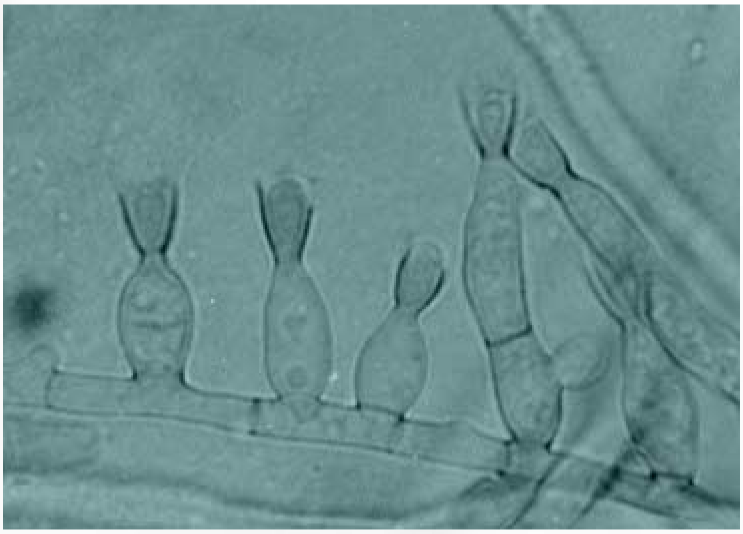
11. (10) Median (coloured) cells of the conidia thin, smooth-walled and pale, occasionally nearly colourless; apical appendages consist of one obliquely bent terminal appendage giving the spore a hummingbird-like appearance and one or more lateral appendages borne on the convex side of the apical cell -» *Zetiasplozna*.

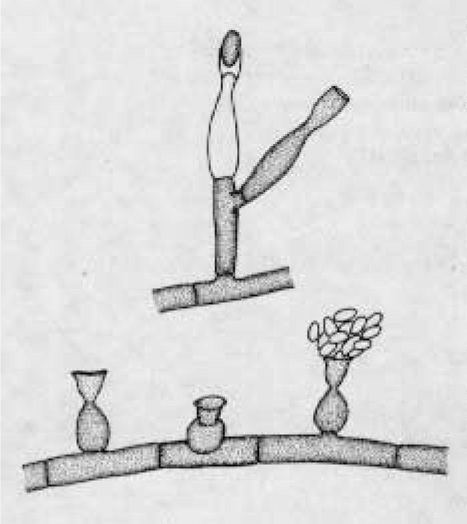
11. Median cells of the conidia thick-walled, dark and sometimes roughened; apical appendages less regular in configuration -» *Pestalotiopsis*.

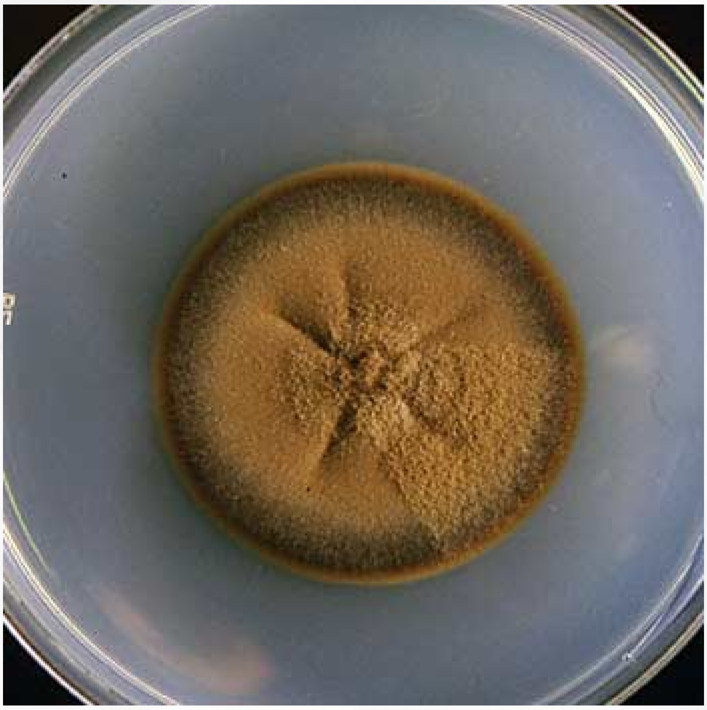
Parasitic or endophytic on living leaves and twigs but are often isolated from dead plant matter and even soil.

Classification: *Pestalotiopsis* species, and those of related genera, are anamorphs of members of the ascomycete family Amphisphaeriaceae (Sordariomycetidae). Members of the Amphisphaeriaceae and their anamorphs include *Amphisphaeria* (*Bleptosporium*), *Blogiascospora* (*Seiridium*), *Broomella* (*Pestalotia* and *Truncatella*), *Discostroma* (*Seimatosporium*), *Ellurema* (*Hyalotiopsis*), *Griphosphaerioma* (*Labridella*), *Lepteutypa* (*Seiridium*), *Neobroomella* (*Pestalotia*), and *Pestalosphaeria* (*Pestalotiopsis*). *Doliomyces*, *Monochaetia*, *Sarcostroma* and *Zetiasplozna* have not yet been found associated with a holomorph.
Ref: Guba 1961, Kang, *et al* 1999, Nag Raj, 1993.

Phialophora







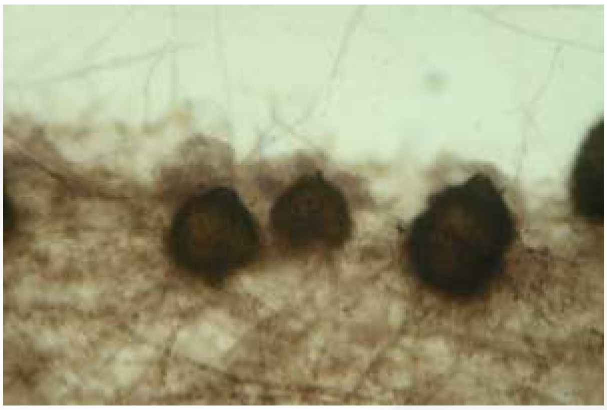
Phialophora verrucosa

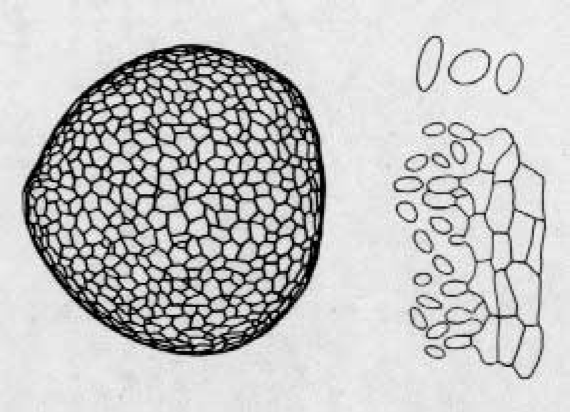
Characterized by brown to black colonies bearing phialides directly on the vegetative filaments or on short branches. The phialides are dark, flask-shaped, and have a collar-like or flared apex. The colourless to brown 1-celled spores (conidia) are produced successively from the apex of the phialides. Some species may produce dark brown holoblastic conidia along the vegetative hyphae or at the tips of short branches. Species of *Exophiala* are similar and are separated from those of *Phialophora* mainly on the basis of producing annellides rather than phialides. The differences between the two are subtle in some instances. There are numerous other fungi not closely related to *Phialophora* as strictly defined. Seifert *et al.* provide a key written by the eminent Dutch mycologist Dr. Walter Gams to 36 genera that could be confused with *Phialophora*.

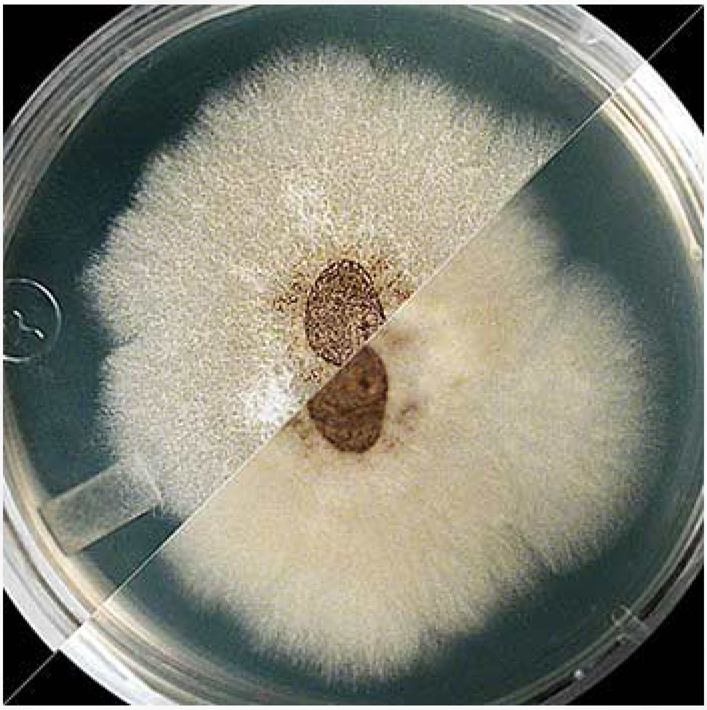
Phialophora species have been isolated from soil, water, dung, wood and plant debris.

Classification: Herpotrichiellaceae (Eurotiomycetes).
Holomorphs: *Capronia*.
Ref: Cole and Kendrick 1973; Ellis 1971, 1976; Schol-Schwarz 1970; Wang, 1990.

Phoma







Phoma glomerata

Recognized by its cellular and more or less round fruiting structures (pycnidia) containing masses of 1-celled colourless to yellow or pink spores (conidia). The conidia are borne from inconspicuous peg-like phialides lining the inner wall of the pycnidium. Species of *Phoma* having spines or setae on their pycnidia are sometimes confused with those of *Pyrenochaeta.* However, the two genera can be distinguished on the basis of their conidium-bearing structures: conidia of *Phoma* species are produced from simple phialides while those of *Pyrenochaeta* arise from phialides ocurring along the sides of elongated conidiophores.

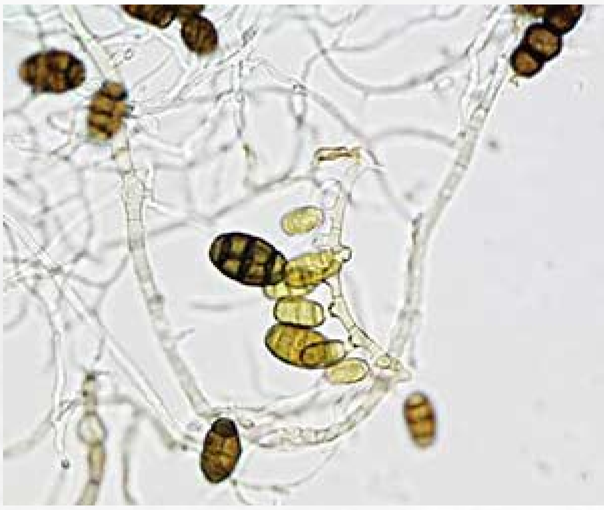
Phoma is a taxonomically difficult genus and is still under study. Species identification is often difficult. Much of our present knowledge has come from the work of Dr. G.H. Boerema and his colleagues in The Netherlands. Boerema (in Aa, *et al.*, 1990) divided *Phoma* into five sections, extended in 2004 (Boerema *et al.*, 2004) to nine in a comprehensive identification manual.

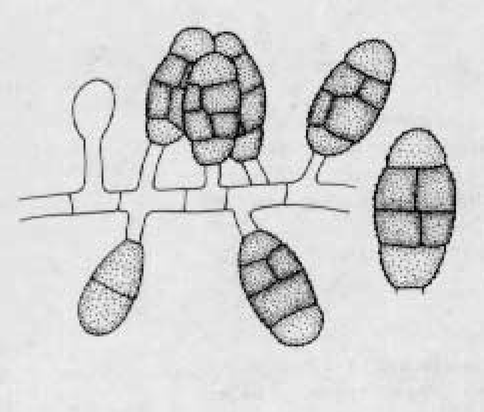
Aveskamp *et al.*, (2010) have studied the genetic relationships of fungi referrable to *Phoma* and have found, as Boerema himself suspected, that the genus is highly polyphyletic; that is, its species belong to a number of distinct families within the *Pleosporales.*, including the Cucurbitaceae, Didymellaceae, Leptosphaeriaceae, Phaeosphaeriaceae, Pleosporaceae, and Sporormiaceae. While these authors agree that Boerema's classification is useful for practical identification the sections do not really reflect natural relationships.

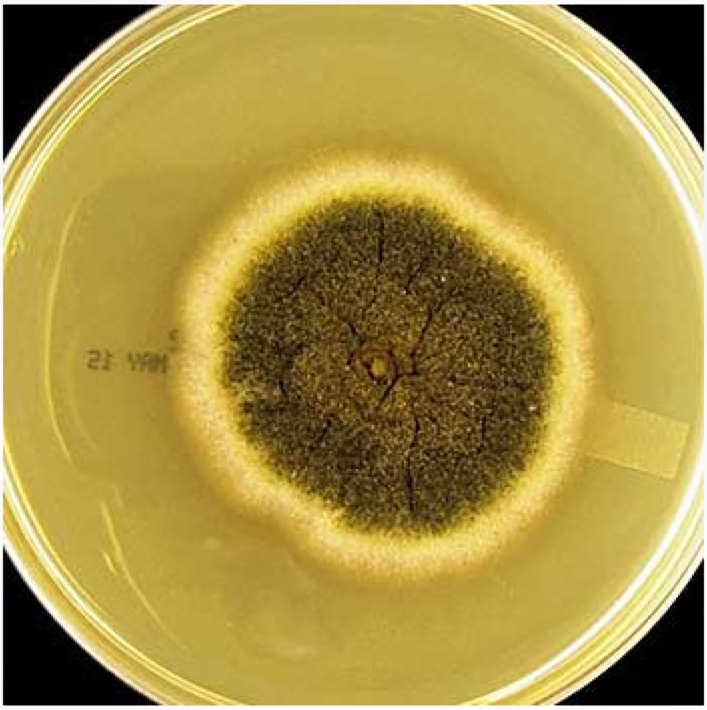
Species of *Phoma* are frequently encountered in indoor environments. In fact, in an intensive study of the dust in 369 homes in western Ontario, Dr. James Scott found the species *Phoma herbarum* to be in nearly 30% of the homes and to be the 14th most common mould overall (Scott, 2001). This study is available online at Dr. Scott's Sporometrics website. *Phoma herbarum* is the type species of the genus *Phoma*, meaning that it is the species upon which the genus is based. It is therefore undisputedly a 'good' species of *Phoma*. Beside being found in indoor environments species of *Phoma* are common in soils, dung, and both living and dead plants.

Classification: In the true genetic sense, based on its type species *P. herbarum*, *Phoma* belongs in the Didymellaceae (Pleosporales). In a broader and less evolutionary sense it can be located in all of the families listed above.
Holomorphs: many genera of ascomycetes, for example, *Didymella* and *Leptosphaeria*.
Ref: Aa *et al*, 1990; Aveskamp *et al.*, 2010; Boerema, 1993; Boerema *et al.*, 1994; Boerema *et al.*, 2004; Boerema and Dorenbosch 1973; Dorenbosch 1970; Gruyter and Noordeloos, 1992.

Pithomyces







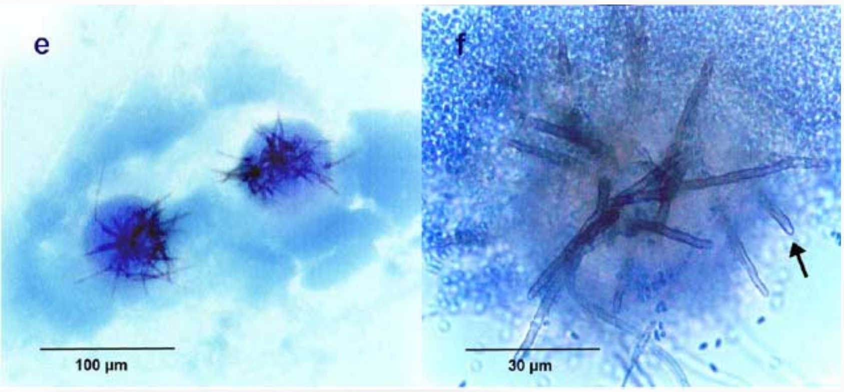
Pithomyces

Spores (conidia) produced at the apex of short side branches of the vegetative filaments, dark brown, 2- to several-celled. When the spores are released they retain a small portion of the cell that produced them. The spores of *P. chartarum*, the most commonly isolated species, have both longitudinal and transverse walls.

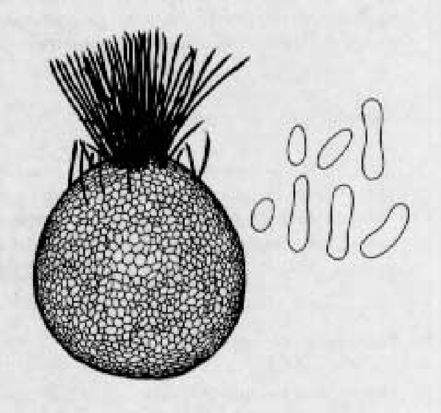
Growing on decaying plants, especially grasses.

Classification: Pleosporaceae (Pleosporales).
Holomorph: *Leptosphaerulina*.
Ref: Ellis 1971, 1976.

Pyrenochaeta



Pyrenochaeta unguis-hominis

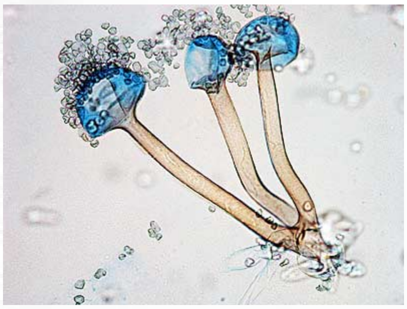


Pyrenochaeta lycopersici

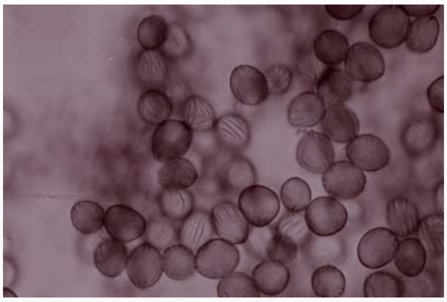
Fruiting structures (pycnidia) more or less round and ornamented, at least on the upper part, with stiff spines. The colourless to yellowish 1-celled spores (conidia) are borne from phialides produced along the length of elongated conidiophores lining the inner walls of the pycnidium. Some species of *Phoma* also have pycnidial spines, but differ in having simple phialides borne dirctly from the walls of the pycnidium. Isolated from soil and plant debris.

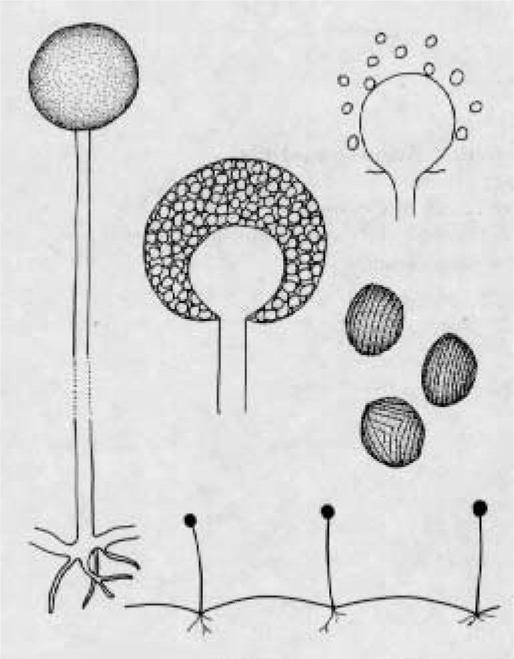
Classification: Cucurbitariaceae (Pleosporales) according to Gruyter *et al.*, (2010).
Holomorphs: *Cucurbitaria*, *Herpotrichia*.
Ref: Dorenbosch 1970; Gruyter *et al.* 2010; Schneider 1979.

Rhizopus



Rhizopus microsporus var. *rhizopodiformis*



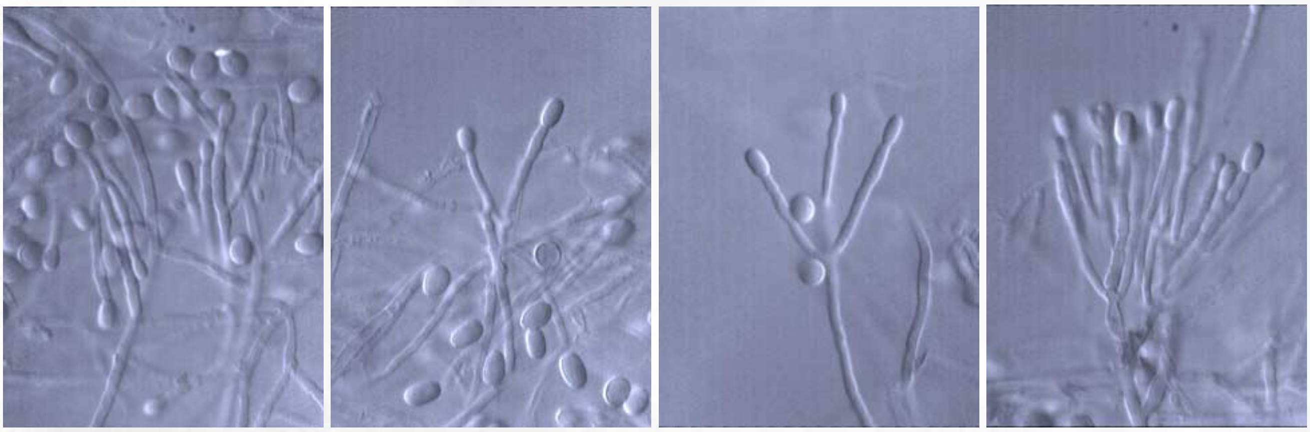


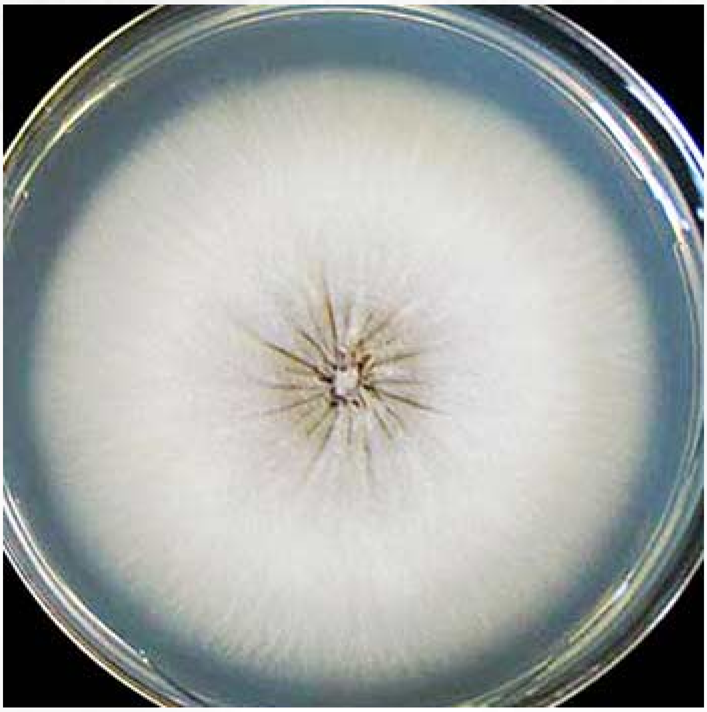
Rhizopus oryzae

Colonies very fast growing and coarse. Characterized by dark sporangia containing dark to pale spores and a large columella. At the base of the sporangiophores are root-like rhizoids. Often spreading by means of aerial, creeping stolons. *Rhizopus* species are often a pest in the laboratory. Because of their rapid growth and dry, easily airborne spores they can take over all the cultures in the lab in a few days. One species is capable of transforming soy beans into edible products and is much used in some Asian countries. Common on decaying fruits, soil, and house dust.

Classification: Mucoraceae (Mucorales, Zygomycota).
Refs.: Schipper, 1984; Schipper and Stalpers, 1984.

Scedosporium





Scedosporium prolificans

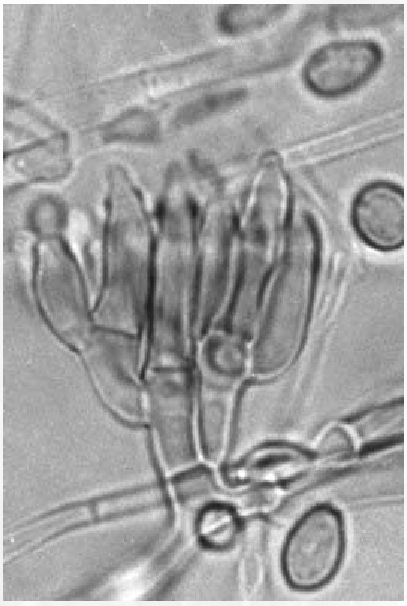
Spore-bearing cells may be solitary or united into more complex brush-like structures. Conidia are borne at the apices of cells with irregularly elongated necks and widely separated annellations. The conidia are generally flattened at the point of attachment and occur in wet masses. The spore-bearing structures are sometimes united into complex synnemata referrable to the genus *Graphium*.

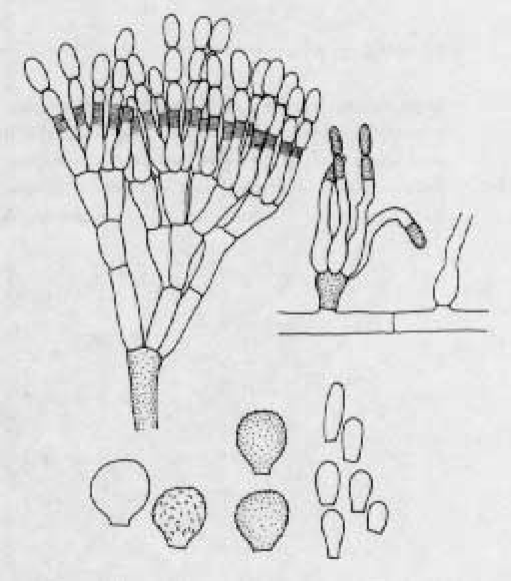
Species of *Scedosporium* can cause a variety of diseases in humans. Mostly they affect people with compromised immune systems, but healthy individuals may also become infected. Cultures of all *Scedosporium* species should be treated with caution.

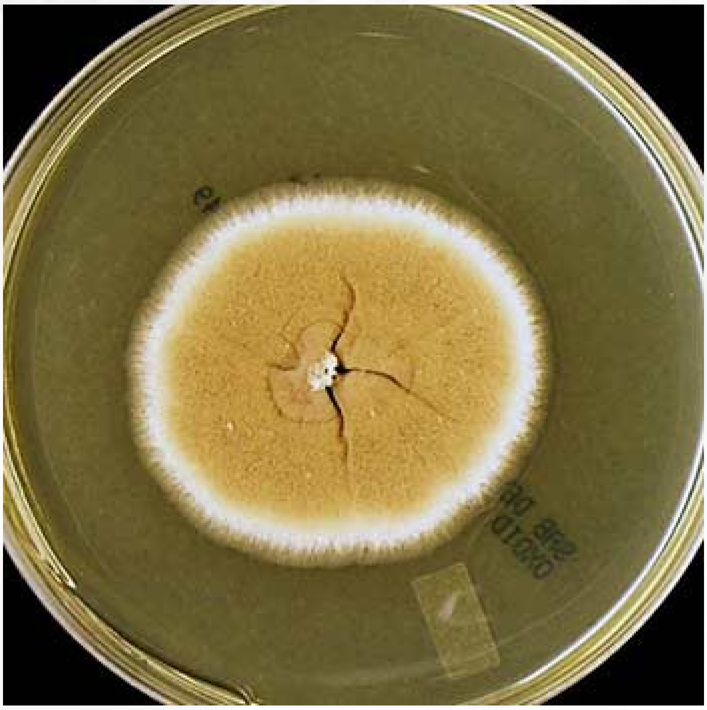
The species occur in soil, decaying plant matter or dung. They can become exceedingly abundant in some situations, such as in piles of feed-lot manure.

Classification: Microascaceae.
Holomorphs: *Petriella* and *Pseudallescheria*.

Scopulariopsis





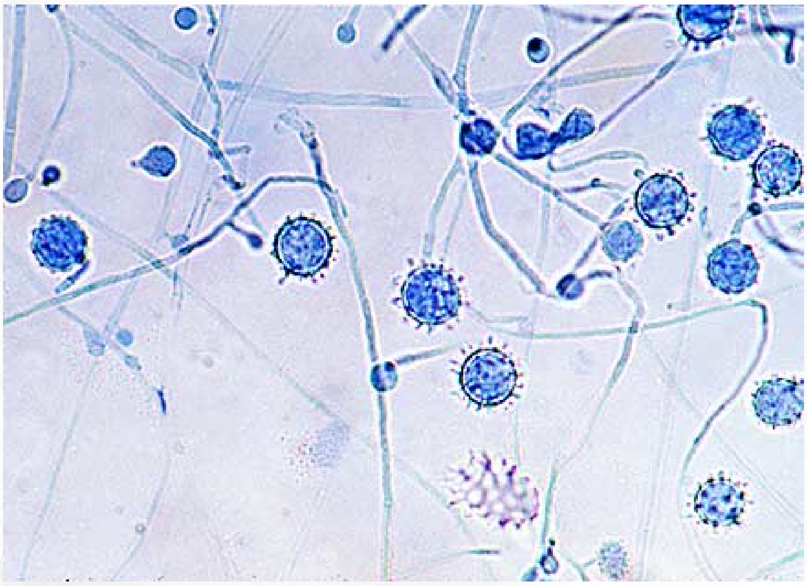


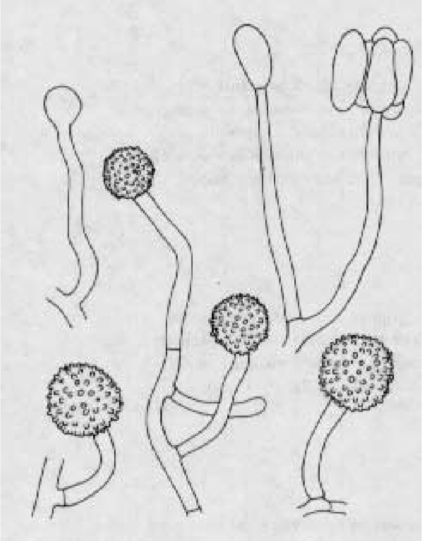
Scopulariopsis brevicaulis

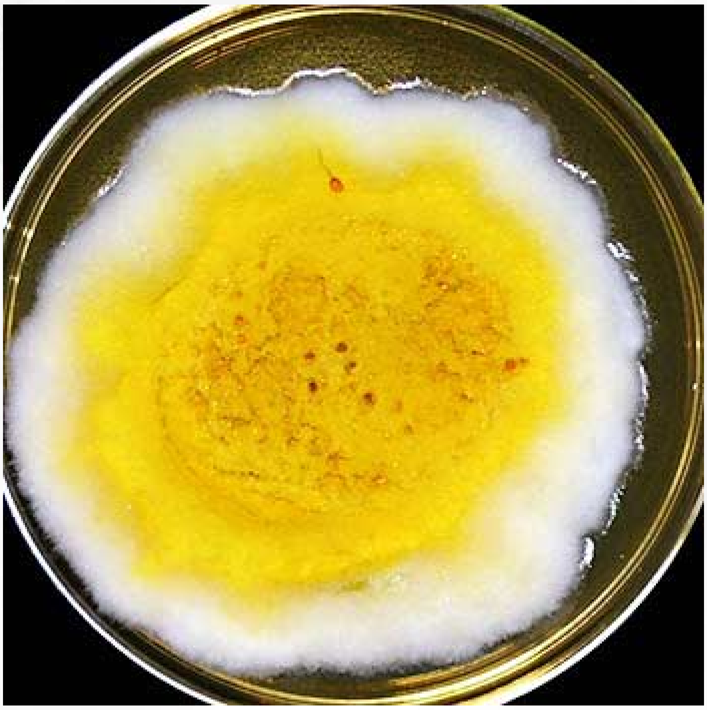
Conidiophores dark, usually highly branched and terminating in a brush-like complex bearing flask-shaped annellides. The colourless to dark 1- or 2-celled spores (conidia) are borne in chains from the tips of the annellides and usually have a flattened base where they were originally connected. Occurring in soil, dung, decaying plant debris, and house dust.

Classification: Microascaceae.
Holomorphs: *Kernia*, *Microascus*, *Petriella*.
Ref: Domsch *et al.*, 1980; Morton and Smith, 1963.

Sepedonium





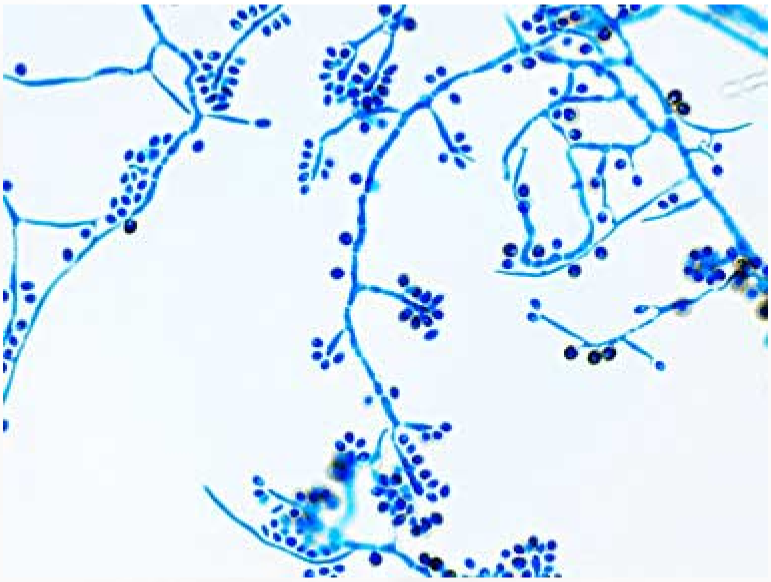


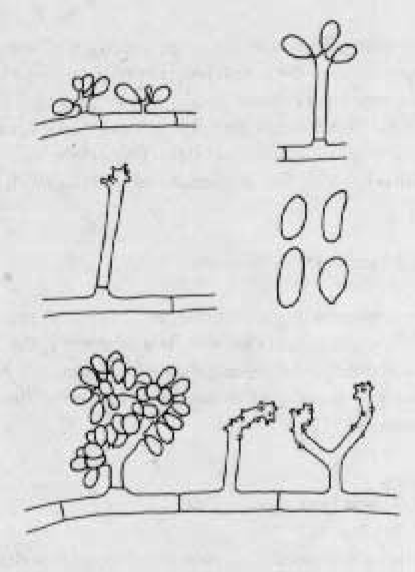
Sepedonium

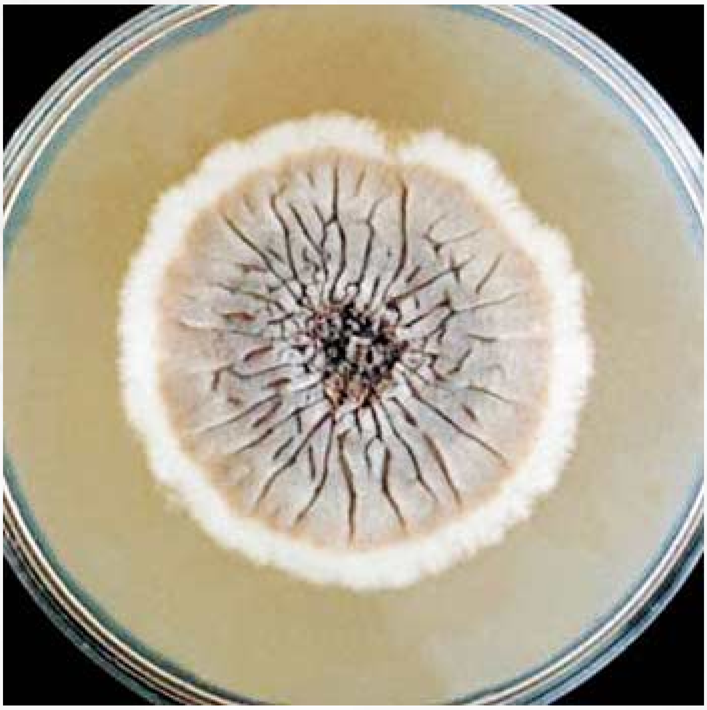
Most easily recognized by the spores, which are colourless to yellow, spiny, round, 1-celled, and produced singly at the ends of short filaments. Sometimes phialides of the Acremonium or *Gabarnaudia* type may also occur. A few species of Mortierella, as well as the human pathogen Histoplasma capsulatum, produce spores resembling those of *Sepedonium*. Isolated from soil, but most commonly parasitized boletes.

Classification: Hypocreaceae.
Holomorph: *Hypomyces*(*Apiocrea*).
Ref: Gilman 1957.

Sporothrix







Sporothrix schenckii

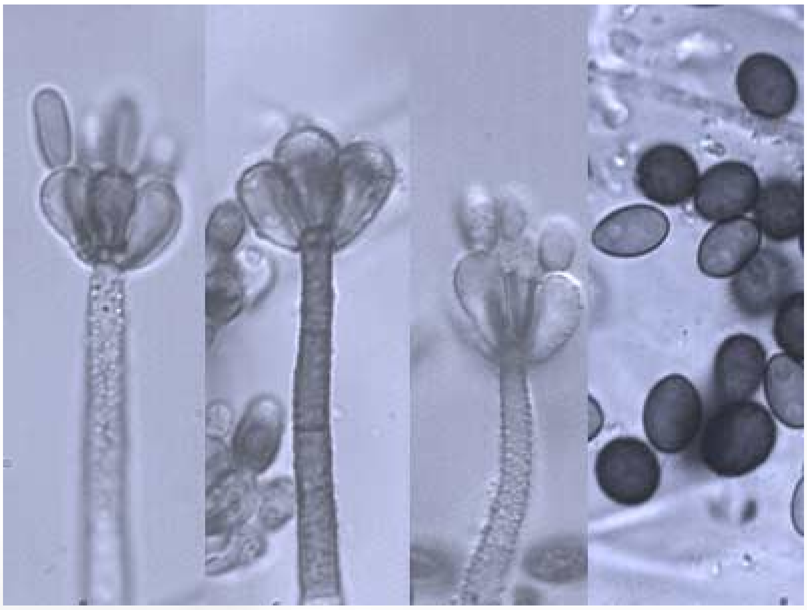
The 1-celled colourless spores (conidia) are produced on short roughened or toothed branches of the vegetative filaments. Occasionally more distinct conidiophores may develop.

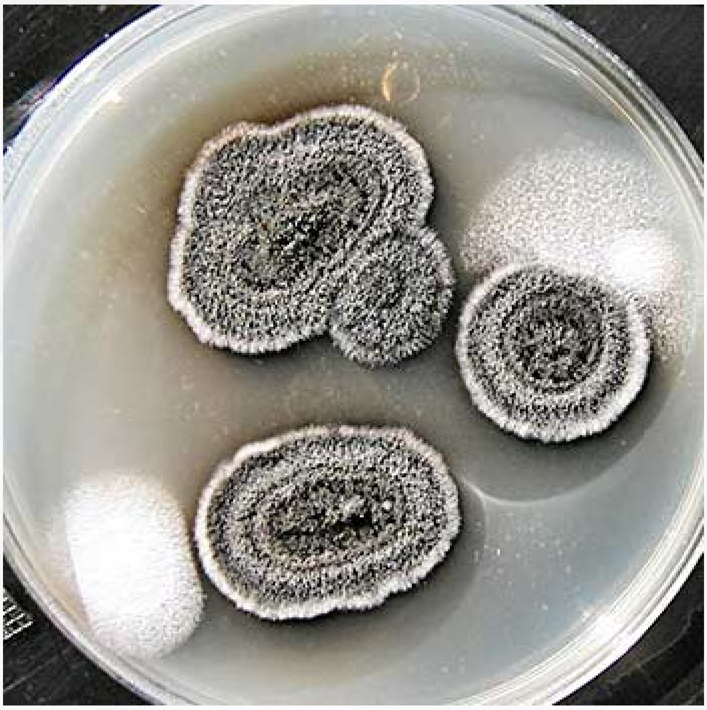
According to de Hoog (1993), species of *Sporothrix* have been reported as anamorphs of both ascomycetes and basidiomycetes. However, he believes the name should be restricted to those with ascomycetous relationships and refers the basidiomycetous ones to the genus *Cerinosterus*. Unfortunately, distinguishing *Sporothrix* from *Cerinosterus* with certainty requires an electron microscope or advanced biochemical techniques.

Isolated from soil, decaying plant materials, other fungi, insects, and air. Sometimes causing human disease.

Classification: Ophiostomataceae (Sordariomycetidae) in a strict sense, but found in other families of ascomycetes as well.
Holomorphs: *Cephaloascus*, *Ophiostoma*, *Valsonectria*, and others.
Ref: de Hoog 1974, 1993.

Stachybotrys





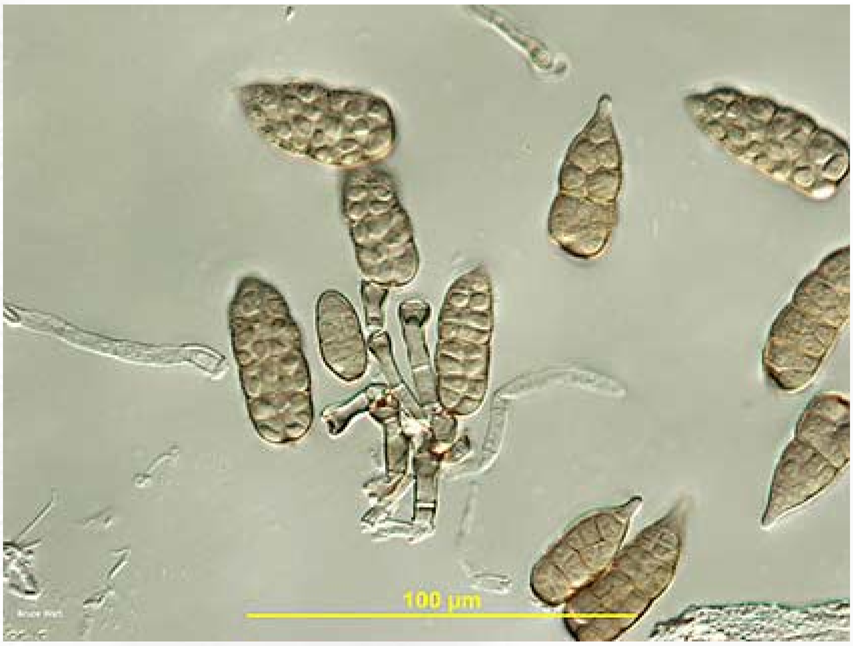
Stachybotrys

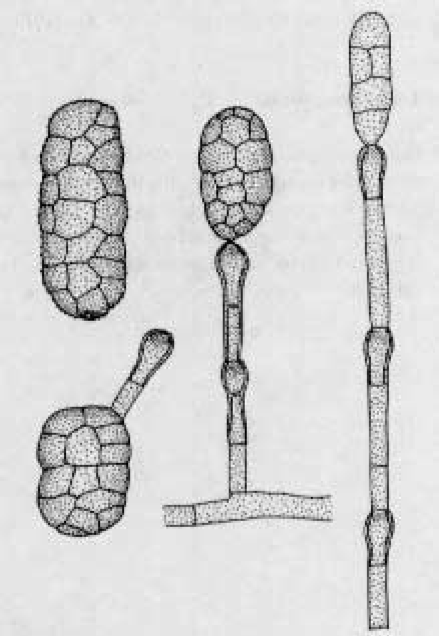
Characterized by clusters of colourless to brown swollen phialides at the tips of colourless to brown, sometimes branched, conidiophores. The dark brown 1-celled spores (conidia) are produced successively from the tips of the phialides and collect in wet masses. Species with spores in chains are referred to *Memnoniella*. A strong decomposer of cellulose and thus usually associated with decaying plant materials.

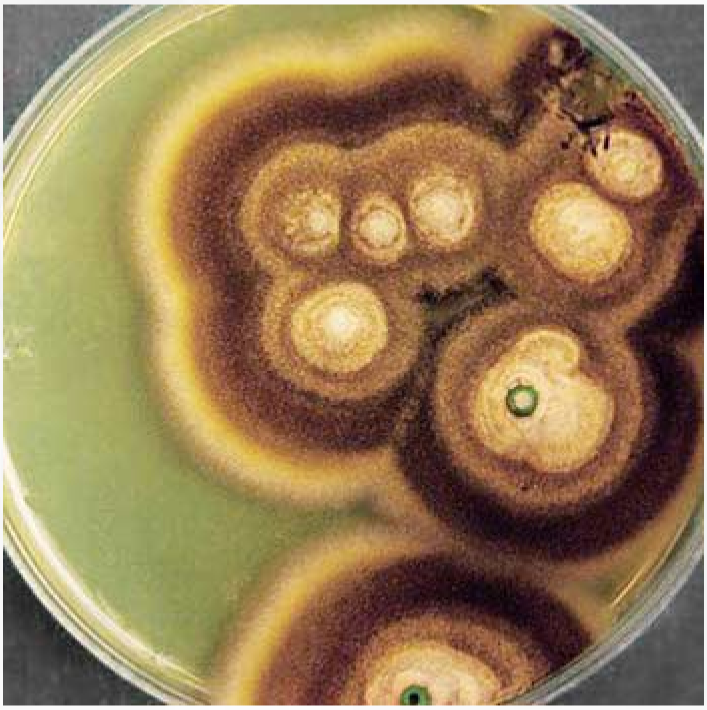
Species of *Stachybotrys* have earned a considerable notoriety in recent years due to their production of potent toxins in indoor environments. They have been linked to some cases of infant death in mouldy buildings. Rarely pathogenic for man.

Classification: Chaetosphaeriaceae (Hypocreomycetidae).
Holomorph: *Melanopsamma*.
Ref: Ellis, 1971; Jong and Davis 1976.

Stemphylium



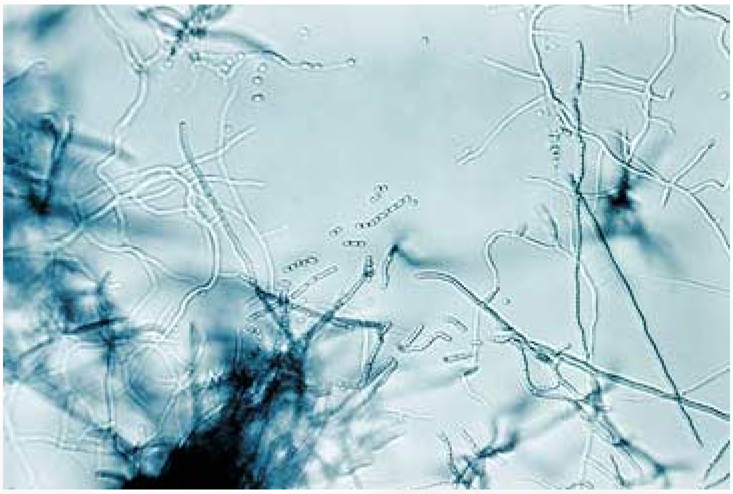


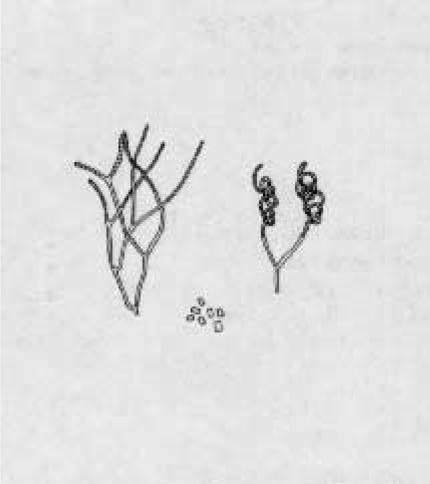

Stemphylium botryosum

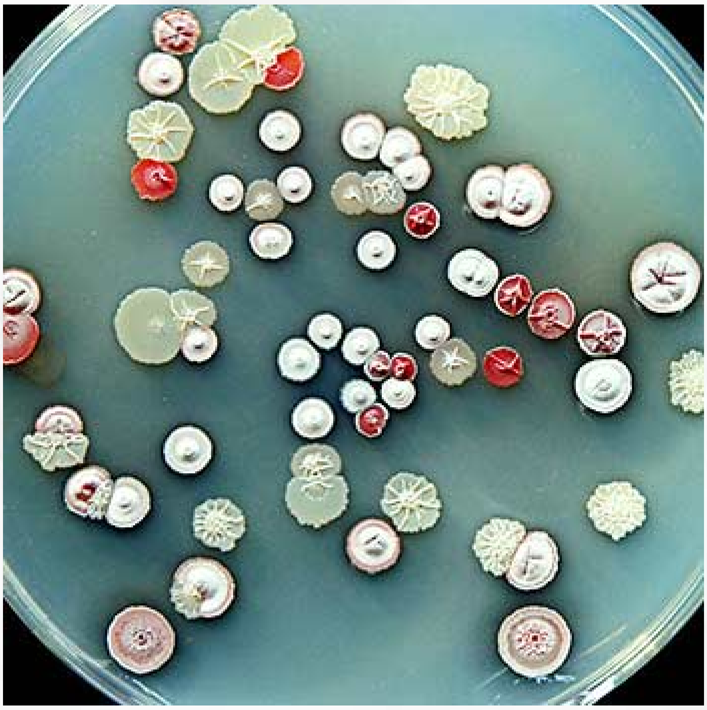
The dark conidiophores produce a single apical spore (conidium) through a pore and then continue to grow through the pore, thus dislodging the spore. Successive periods of spore production and regrowth give the conidiophore a noded appearance. The spores are dark brown and are divided by several longitudinal and transverse walls. Occurring on decaying and living plants and in soil.

Classification: Pleosporaceae (Pleosporales).
Holomorphs: *Pleospora*.
Ref: Ellis 1971.

Streptomyces





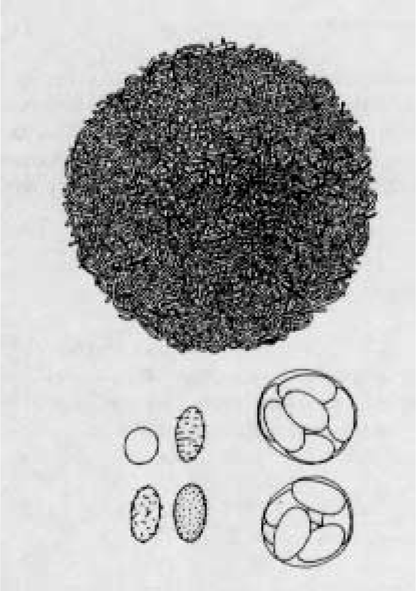


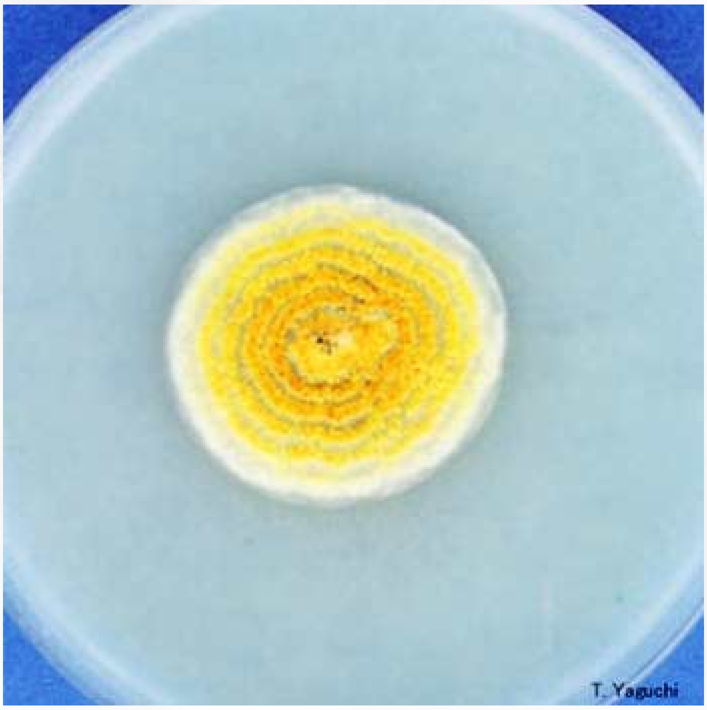
Streptomyces coelicolor

Streptomyces species are filamentous Gram-positive bacteria (actinobacteria), not fungi, and are thus out of place here. However, they occur in the same habitats as fungi and are superficially similar. The filaments and spores are very small (usually 1 µm or less in diameter). The spores are formed by the fragmentation of the filaments and are borne in straight, wavy, or helical chains. The colonies are slow-growing and often have a soil-like odour. Common in soil, plant debris, dung, house dust, and many other habitats.

Classification: Streptomycetaceae.
Ref: Buchanan and Gibbons 1974; Holt, 1994; Waksman 1961.

Talaromyces



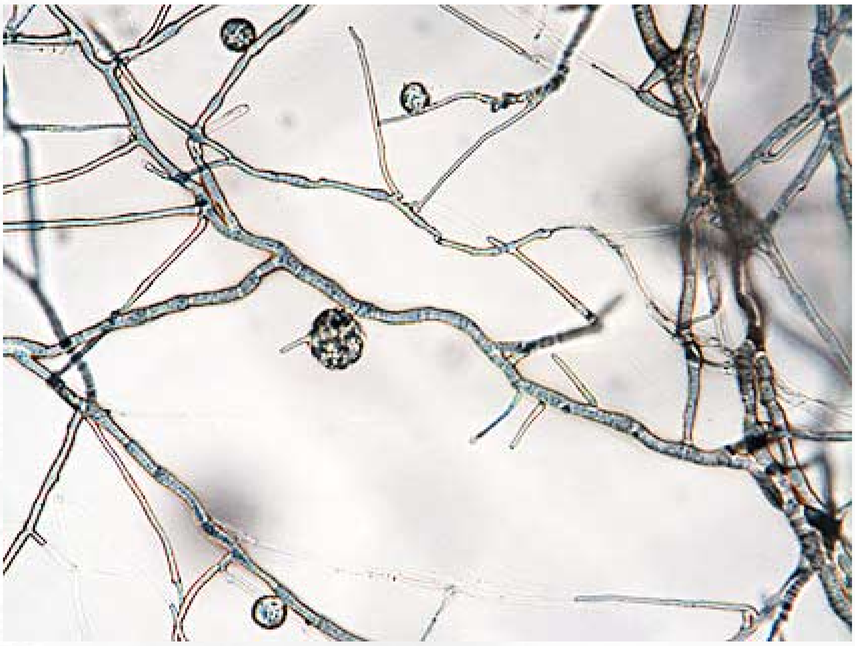


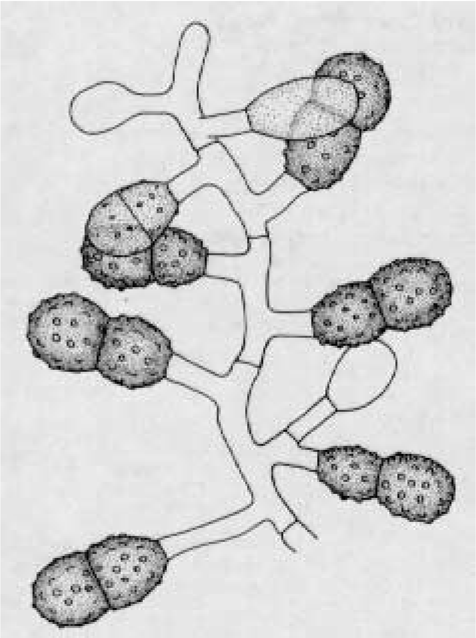
Talaromyces wortomannii

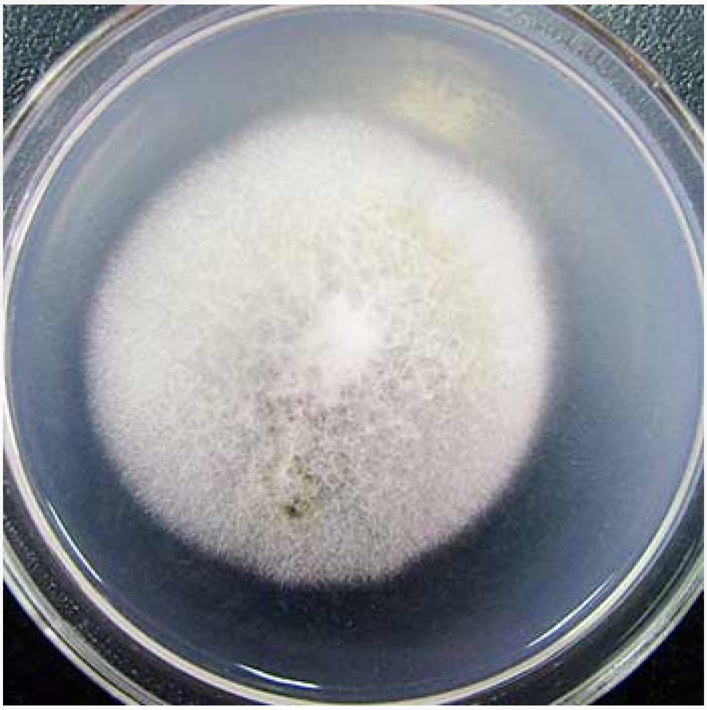
Ascomycetes characterized by loose hyphal fruiting bodies (gymnothecia) containing spherical asci, which in turn each enclose 8 ascospores. The ascospores are colourless to yellow, spherical to disc-shaped, and 1-celled. The whole fungus is either colourless or brightly coloured. Anamorphs are strongly like those of *Penicillium* and are often difficult to distiguish from them. Their most characteristic features are highly symmetrical spore-bearing structures (penicilli) and elongated and rather lance-like phialides. Conidia are often sharply fusoid. In soil, dung, or decaying plant material. The species can be quite aggressive in culture with other fungi, often completely overrunning other colonies, suggesting some level of parasitism may be involved.

Classification: Trichocomaceae (Eurotiales).
Anamorphs: *Penicillium*-like.
Refs: Pitt, 1980, 1985; Samson and Houbraken, 2011; Stolk and Samson, 1972.

Trichocladium





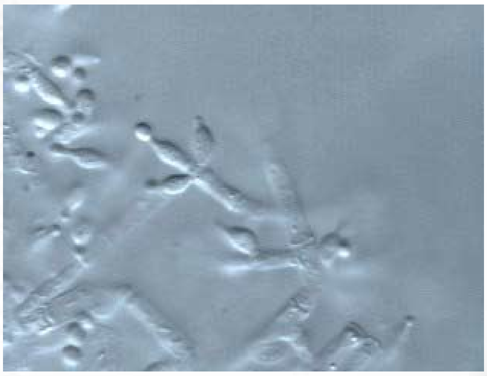


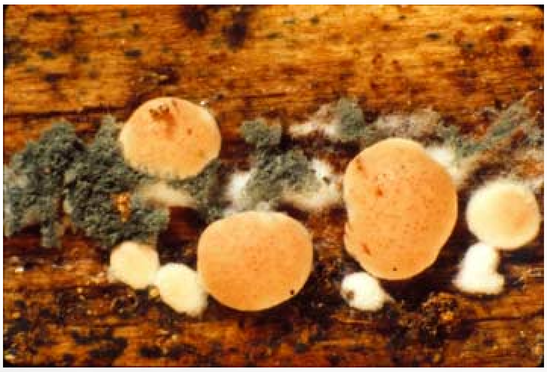
Trichocladium

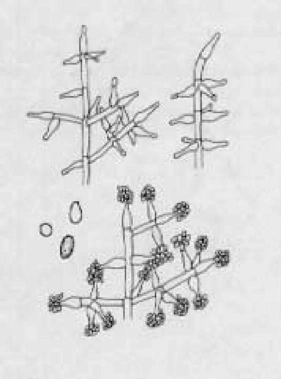
The dark brown 2- to several-celled spores (conidia) are produced by the swelling and subsequent delimitation of the terminal portion of short branches of the vegetative filaments. The most common species, *T. asperum*, has 2-celled, roughened spores. In soil and plant debris, including wood.

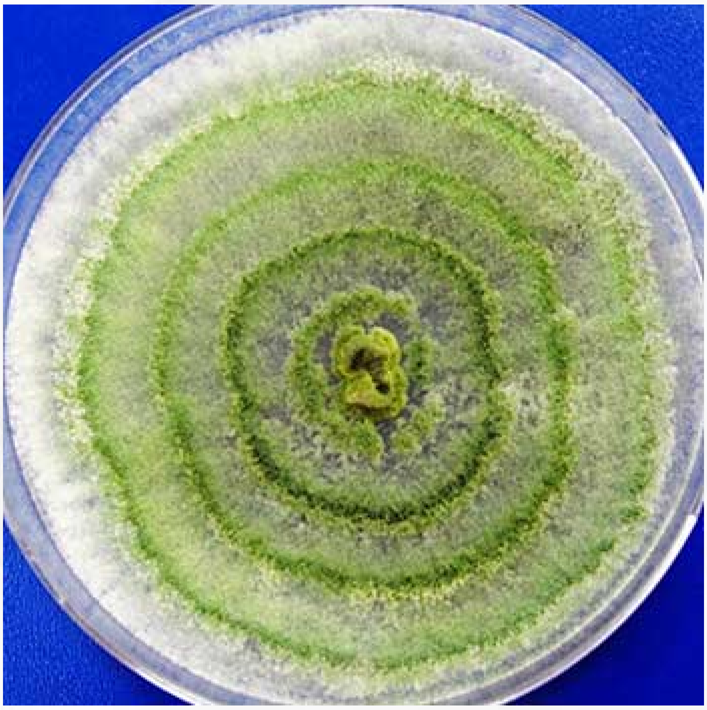
Classification: Chaetomiaceae (Sordariomycetidae).
Holomorph: *Chaetomium*.
Ref: Ellis 1971.

Trichoderma









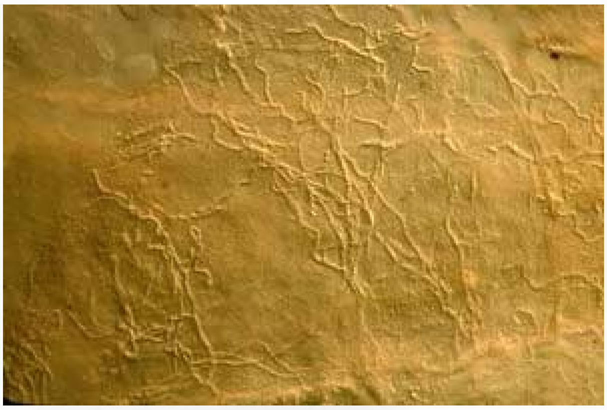
Trichoderma viride

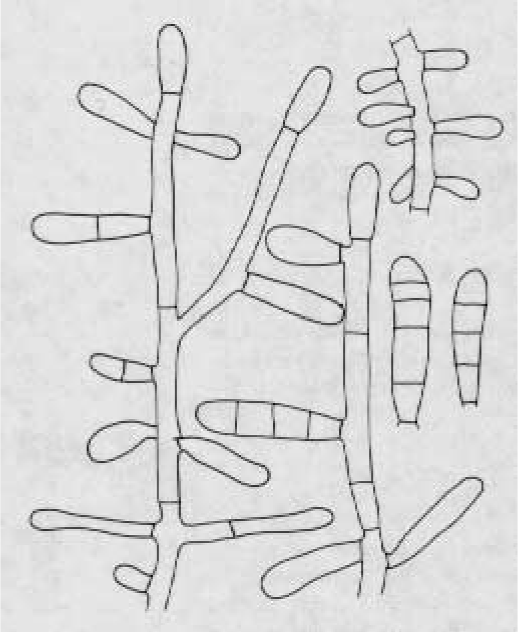
Usually recognized by fast-growing colonies producing white, green, or yellow cushions of sporulating filaments. The fertile filaments or conidiophores produce side branches bearing whorls of short phialides. The 1-celled spores (conidia) are produced successively from the tips of the phailides and collect in small wet masses. The photograph at left, and the drawing, show a species of *Trichoderma* as seen with a microscope, but *Trichoderma* species are also very conspicuous in the field, especially under the dead bark of trees. The photo at top-center shows a species of *Trichoderma* producing its green conidia among the nearly mature cushion-shaped stromata of its teleomorph.

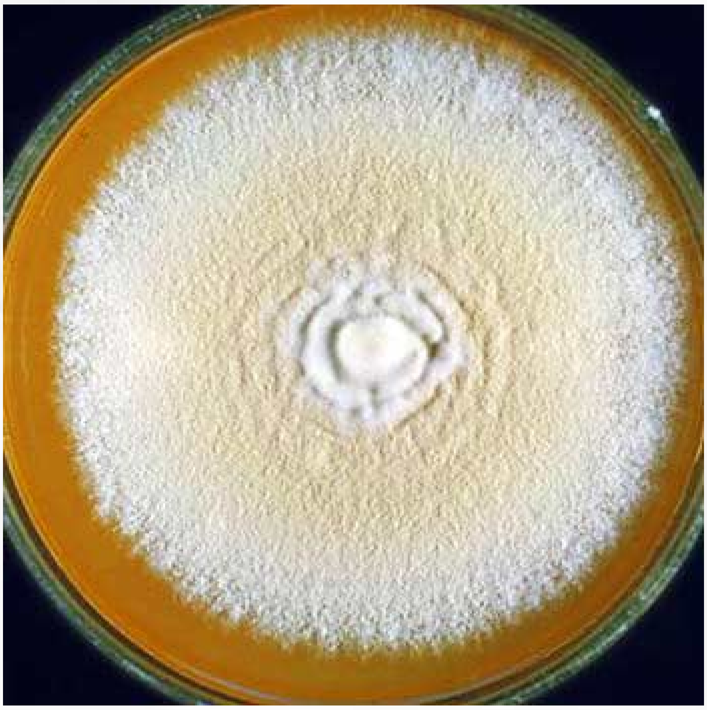
Trichoderma species are strongly antagonistic to other fungi. The exact nature of this relationship is still not clear, but it appears that they kill other fungi with a toxin and then consume them using a combination of lytic enzymes. This suggests they are actually microbial predators. This antagonistic behaviour has led to their use as agents of biological control of some fungi causing plant disease. On the other hand, they can be serious pests in cultivated mushroom beds. Species of *Trichoderma* are common in soil (especially water-logged soil), dung, and decaying plant materials.

Classification: Hypocreaceae.
Holomorphs: *Hypocrea*, *Podostroma*.
Ref: Bissett, 1984, 1991a,b,c; Chaverri and Samuels, 2003; Gams, 2006; Rifai 1969; Samuels *et al.*, 1998.

Trichophyton





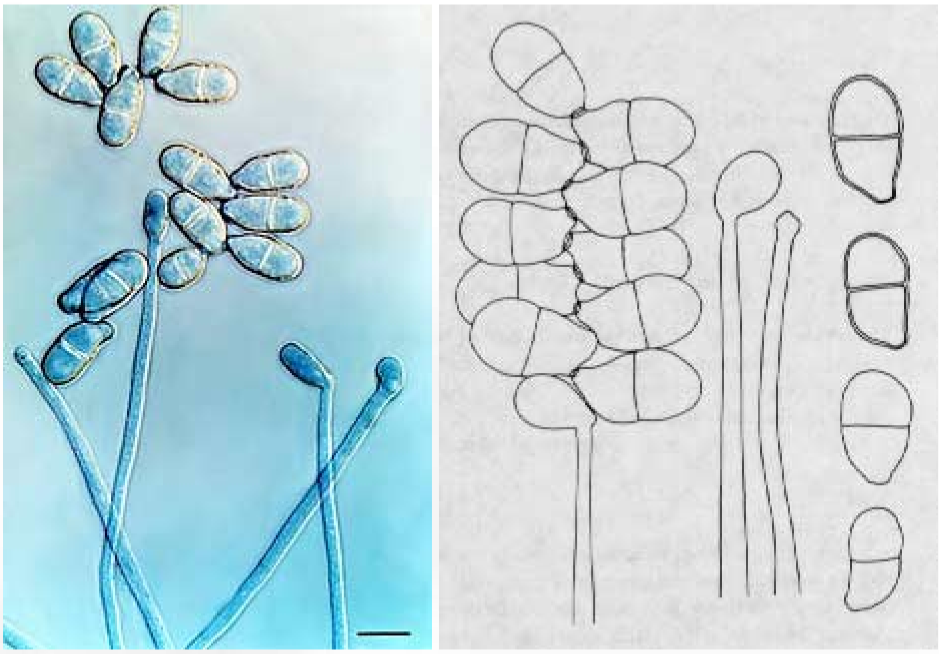


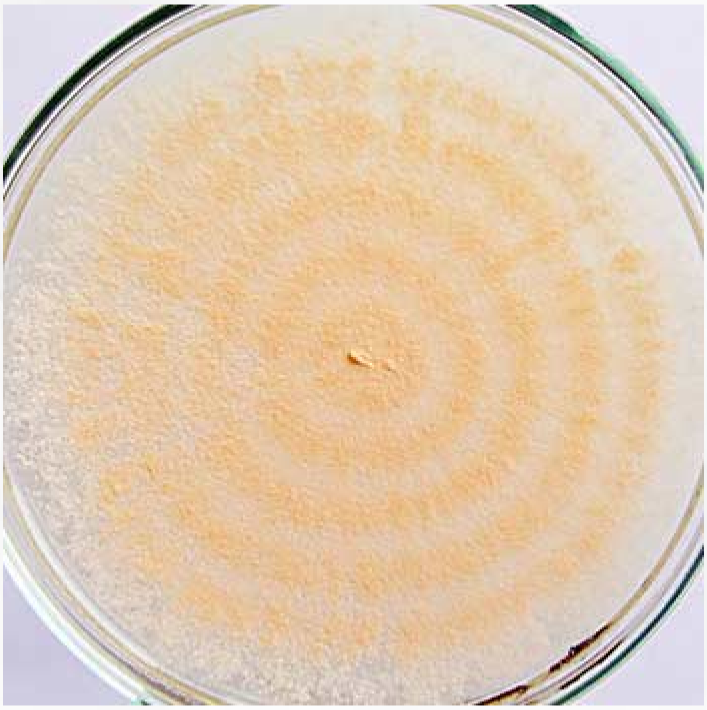
Trichophyton mentagrophytes

Characterized by colourless spores (conidia) that are nearly sessile and usually produced at right angles to the fertile filament, or as terminal swellings. Most conidia are 1- or 2-celled (micro-conidia) but at least a few are more than 2-celled (macroconidia). Similar to *Chrysosporium*. Usually occurring as a skin parasite on man and animals but occasionally isolated from soil, leather, feathers, etc. The picture at top-left shows hyphae of *T. rubrum* growing within a flake of dead skin scraped from an infected patient. The picture at top-right shows conidia as they are seen in pure culture.

Classification: Arthrodermataceae (Onygenales).
Holomorph: *Arthroderma*.
Ref: Ajello, 1968; Ajello, Georg, Kaplan, and Kaufman 1963; Beneke 1958; Rebell and Taplin 1970.

Trichothecium



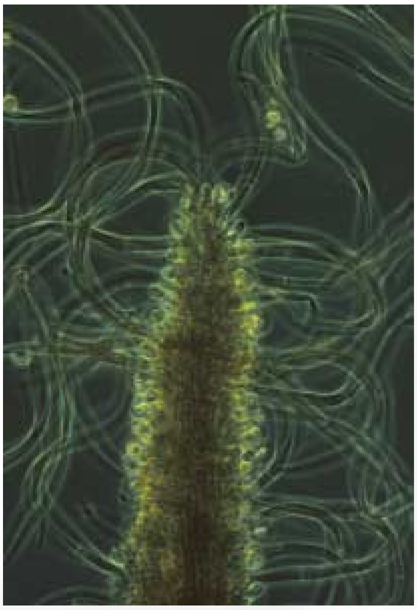


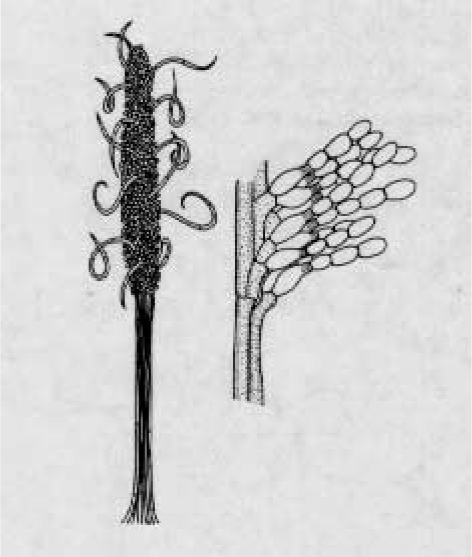
Trichothecium roseum

The 2-celled colourless to pink spores (conidia) are bilaterally symmetrical and are produced retrogressively in long chains from the unbranched conidiophores. The youngest spore is at the bottom of the chain and is always attached at an oblique angle to the conidiophore. Occurring in soil and decaying plant materials, often found as an epiparasite on black knot of cherry.

Classification: Bionectriaceae (Hypocreales).
Holomorph: *Hypomyces*.
Ref: Rifai and Cooke 1966.

Trichurus





no image

The brown conidiophores are united to form large complex cylindrical structures (synnemata) bearing a dense layer of annellides on the upper half. Curved to straight sterile hairs project out from among the annellides. The spores (conidia) are colourless to brown and are produced in chains from the tips of the annellides. Similar and possibly congeneric with Cephalotrichum.

Shoemaker and Kokko (1977) discussed four species and Udagawa *et al* (1985) added a fifth, *T. dendrocephalus*. These species can be distinguished with the following key:

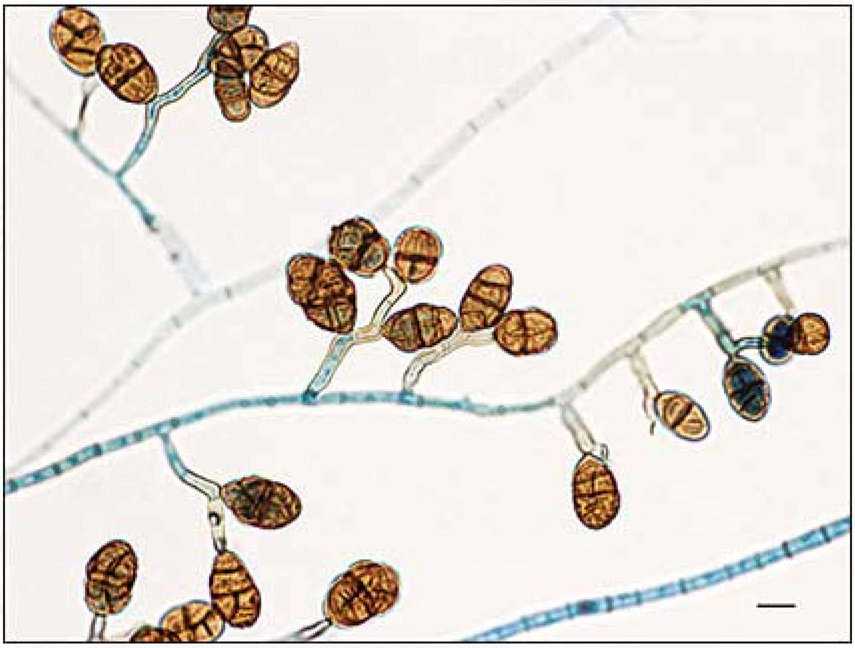
1. Sterile hairs straight - 2.
1. Sterile curved or definitely wavy - 3.
2. Sterile hairs usually unbranched. Spores 4-9 x 3 µ - *Trichurus cylindricus*.
2. Sterile hairs forked. Spores 3.0-6.0 x 2.0-3.5 µ - *Trichurus terrophilus*.
3. Sterile hairs branched - *Trichurus dendrocephalus*.
3. Sterile hairs unbranched - 5.

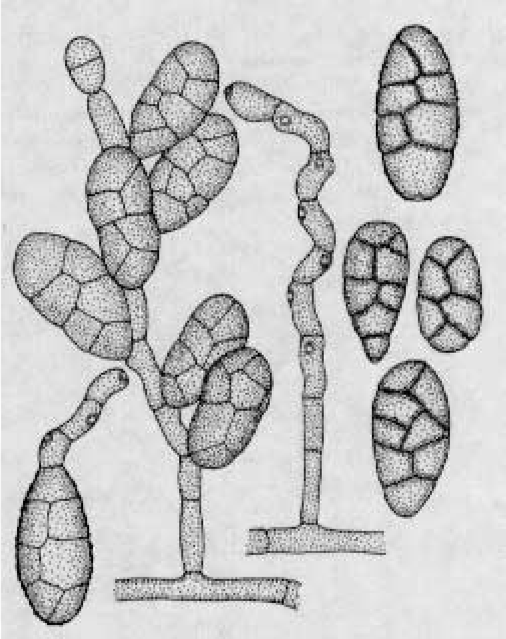
4. Spores ashy grey in mass - *Trichurus gorgonifer*.
4. Spores yellow-brown in mass - *Trichurus spiralis*.

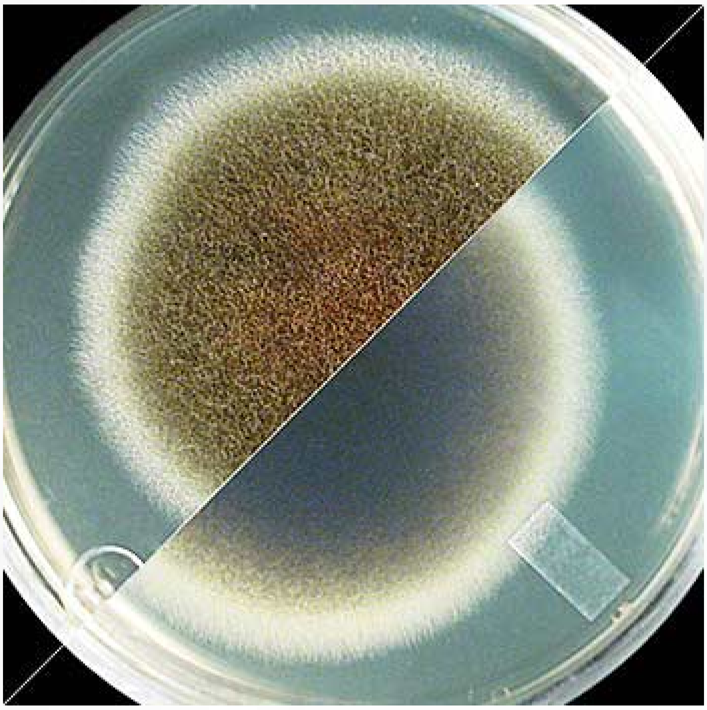
Occurring in soil, dung, and plant debris.

Classification: Microascaceae.
Holomorph unknown.
Ref: Ellis 1971; Shoemaker and Kokko 1977; Swart 1964; Udagawa *et al* 1985.

Ulocladium





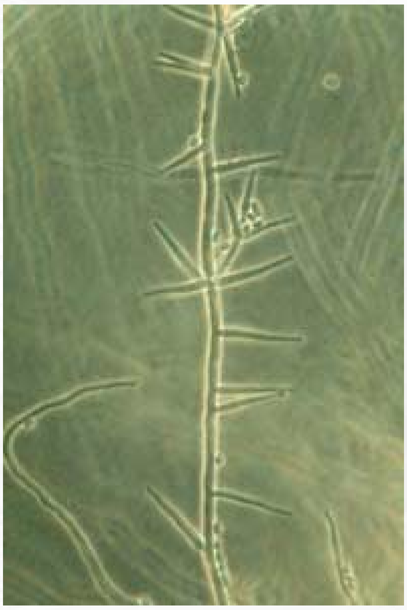


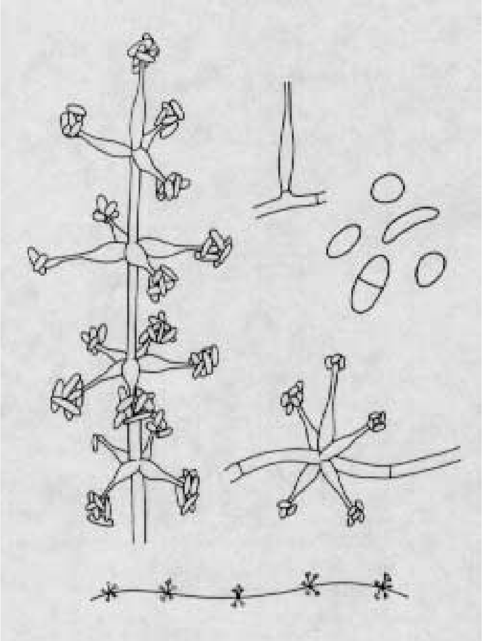
Ulocladium chartarum

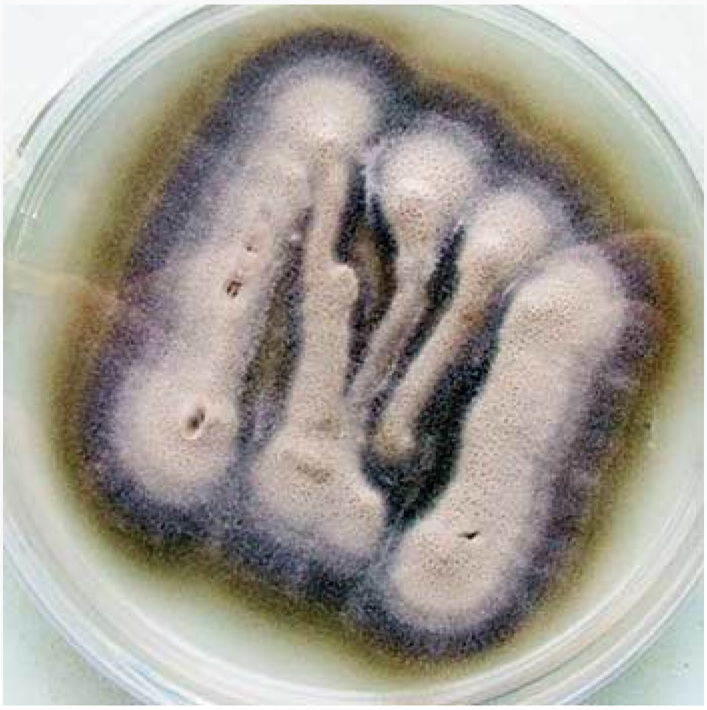
Characterized by dark conidiophores bearing conidia through a pore at several points along their length. The conidia are dark brown, more or less egg-shaped to cylindrical, and divided into several cells by transverse and longitudinal walls. Occurring in soil and dead or dying plants.

Classification: Pleosporaceae (Pleosporales).
Holomorph: Although no teleomorphs in the Pleosporaceae have been linked to species of *Ulocladium*, Dr. Lee Bonar, a pioneering California mycologist, published evidence that *Lasiobotrys affinis*, a member of the Venturiaceae (Pleosporales) produced a *Ulocladium* anamorph in culture (Bonar, 1928). He had made this observation on several occasions and published excellent illustrations. His evidence seems credible and should be examined further.
Ref: Ellis 1971, 1976; Simmons 1967.

Verticillium





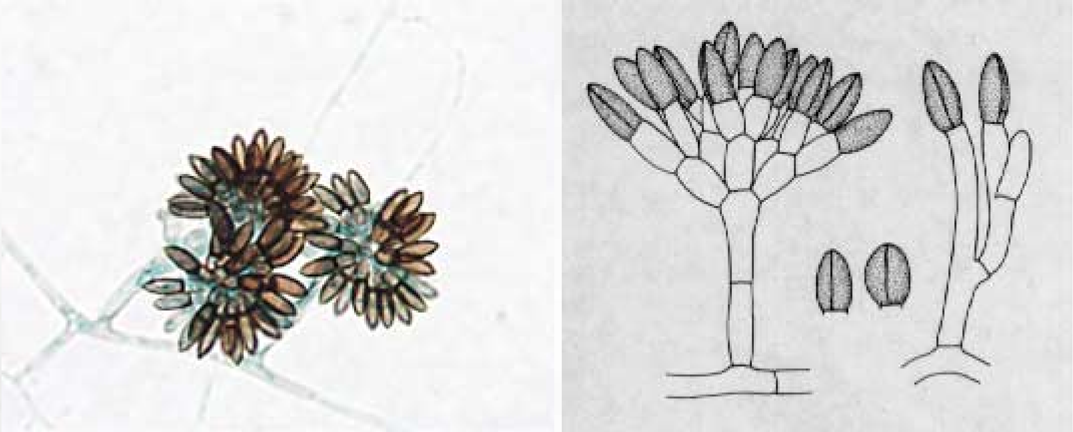


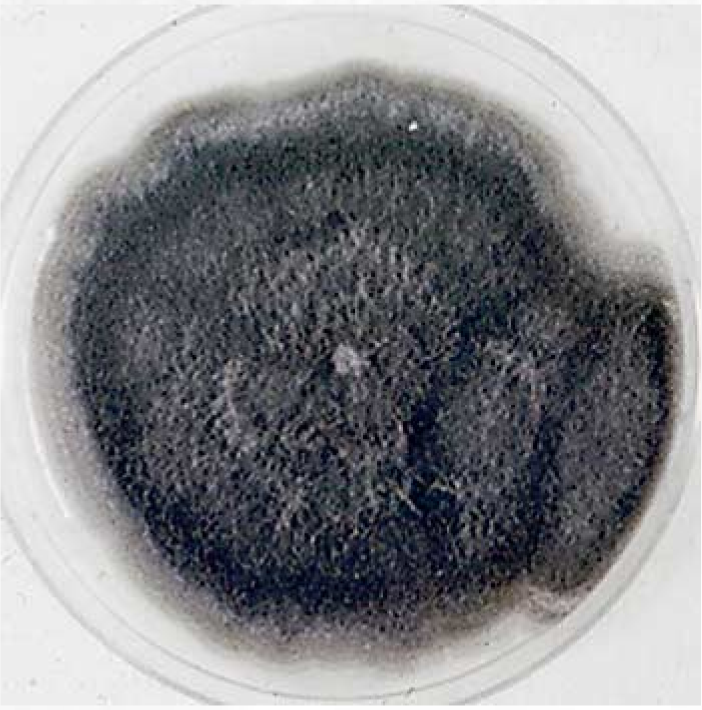
Verticillium theobromae

Characterized by whorls of phialides produced along the length of undifferentiated filaments or on conidiophores. The colourless to brightly coloured 1- or 2-celled spores (conidia) collect in small wet masses. Common in soil and decaying plant matter; also causing plant disease. Some species, such as *V. lecanii* in the above photos, are parasites on other fungi.

Classification: Plectosphaerellaceae (Sordariomycetidae).
Holomorphs: According to Seifert *et al.* (2011) no holomorphs have been identified with *Verticillium* in a more strictly defined sense. However, as more broadly and, as here, more commonly defined *Verticillium*-like anamorphs are known in *Cordyceps*, *Nectria*, *Torrubiella*, and perhaps other genera of the Hypocreomycetidae.
Ref: Gams 1971.

Wardomyces





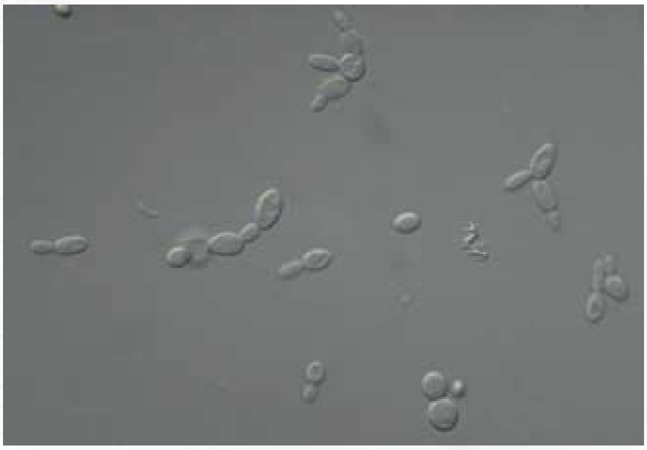
Wardomyces anomala

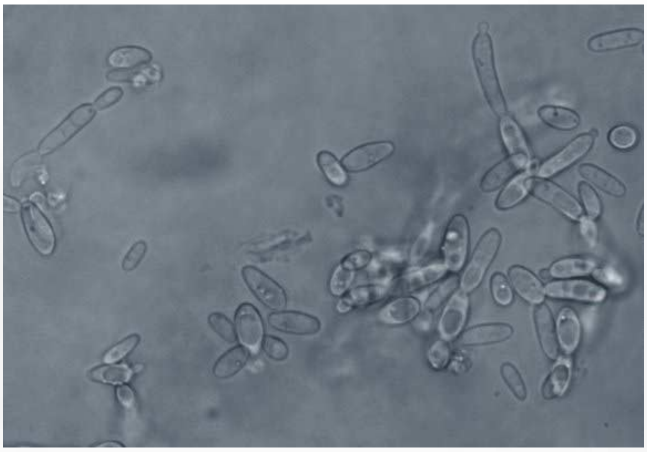
The conidia are the most distinctive feature, being 1- or 2-celled, dark brown, bullet-shaped to egg-shaped, flat at the base, and with a colourless line or germ slit on one side. They are borne on upright, branched conidiophores. Occurring on dung, soil, and meat in cold storage.

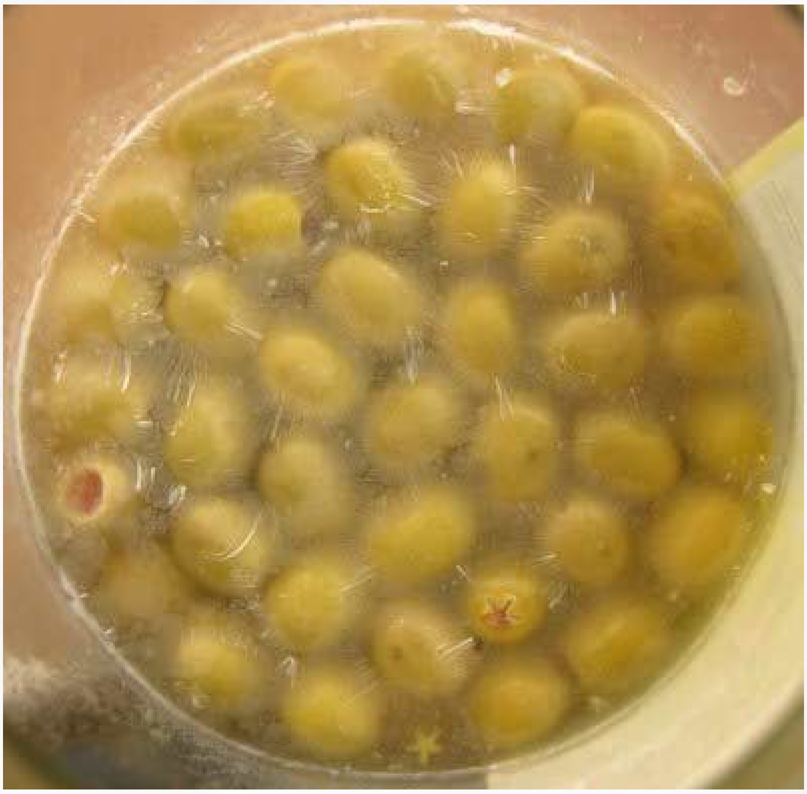
Classification: Microascaceae.
Holomorph: *Microascus*.

Ref: Ellis 1971, 1976.

Yeasts





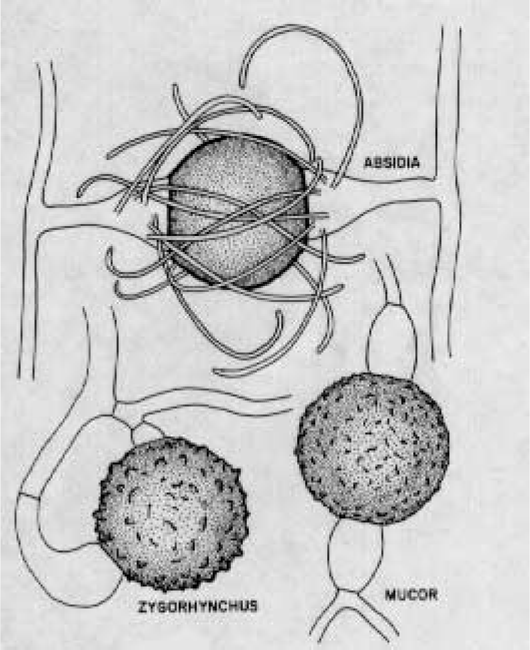


A complex group of fungi resembling one another in existing as single cells that "bud" directly to form new cells. The colonies are pasty in appearance. Some yeasts may form ascospores within their cells. Common in moist habitats and often able to grow at reduced oxygen levels. See the discussion of yeasts under the broader topic of fungal growth.

The pictures above left illustrates *Saccharomyces cerevisiae*, a yeast used for the rising of bread and the brewing of beer. The one at right is probably *Pichia membranaefaciens*, a species found in a variety of habitats. It often colonizes stored foods where it may form a thin film over the surface. The picture above shows a jar of olives colonized by *P. membranaefaciens*.

Holomorphs: various and not necessarily related to one another.
Ref: Arx, Rodrigues de Miranda, Smith, and Yarrow 1977; Kurtzman *et al.*, 2011.

Zygospores



These structures represent the sexually reproductive spores of several genera of Mucorales. They are usually dark, roughened, 1-celled, and connected to the filaments by short cells called suspensors. They rarely occur apart from asexual fruiting structures and are not normally used exclusively for identification purposes.

Classification: Mucorales (Zygomycota).
Ref: Schipper, Samson, and Stalpers 1975; Zycha and Siepmann 1970.

BIBLIOGRAPHY

Specialized reference books are often necessary for identifying fungi. The bibliography presented here contains many such references. Unfortunately, many of these cannot be found in smaller community libraries and must be sought in university and government collections. Some of these large libraries can be visited by anyone, but many others are generally inaccessible. The best way to see a specialized publication is to ask your librarian to request an interlibrary loan. Interlibrary loans may take a few weeks but are usually available.

---

1. Aa, H.A. van der, M.E. Noordeloos and J. de Gruyter. 1990. Species concepts in some larger genera of the Coelomycetes *in* W. Gams K. A. Seifert, H. A. van der Aa and R. A. Samson. Developments in the taxonomy of anamorphic fungi. CBS Stud. Mycol. 32.
2. Ainsworth, G.C. 1971. Ainsworth and Bisby's Dictionary of the Fungi. Commonwealth Mycol. Inst., Kew
3. Ainsworth, G.C., F.K. Sparrow, and A.S. Sussman. 1973. The Fungi: An Advanced Treatise, vol. IVa and IVb. Academic Press, New York
4. Ajello L. 1968. A taxonomic review of the dermatophytes and related species. Sabouraudia 1968; 6:147-159.
5. Ajello, L., L.K. Georg, W. Kaplan, and L.Kaufman. 1963. Laboratory Manual for Medical Mycology. U.S. Publ. Health Serv. Publ. 994
6. Ames, L.M. 1963. A Monograph of the Chaetomiaceae. U.S. Army Res. Dev. Ser. 2
7. Arambarri, A.M. and M.N. Cabello. 1996. *Circinella lacrymispora* sp. nov. A new mucoral isolated from Argentine soils. Mycotaxon 57: 145-149.
8. Arx, J.A. von. 1981. The Genera of Fungi Sporulating in Pure Culture. J. Cramer, Vaduz
9. Arx, J.A., J. Guarro and M.J. Figueras. 1986. The ascomycete genus *Chaetomium*. Nova Hedwigia Beiheft 14: 1-162.
10. Arx, J.A. von, L. Rodrigues de Miranda, M.T. Smith, and D. Yarrow. 1977. The Genera of Yeasts and Yeast-like Fungi. C.B.S. Stud. Mycol. 14
11. Aveskamp M., Gruyter H. de, Woudenberg J., Verkley G., Crous P.W. 2010. Highlights of the Didymellaceae: A polyphasic approach to characterise *Phoma* and related pleosporalean genera. Stud. Mycol. 65: 1-60.
12. Barnett, H.L., and B.B. Hunter. 1987. Illustrated Genera of Imperfect Fungi. MacMillan Publ. Co., New York.
13. Barnett, J.A., and R.J. Pankhurst. 1974. A New Key to the Yeasts. North Holland Publ. Co., Amsterdam

14. Barron, G.L. 1962. New species and new records of *Oidiodendron*. Can. J. Bot.40: 589-607
15. Barron, G.L. 1968. The Genera of Hyphomycetes from Soil. Williams and Wilkins, Baltimore
16. Barron, G.L 1977. The Nematode-Destroying Fungi. Canadian Biol. Publ., Guelph, Ontario
17. Beneke, E.S. 1958. Medical Mycology Laboratory Manual. Burgess Publ. Co., Minneapolis
18. Bensch, K, U. Braun, J.Z. Groenewald, and P.W. Crous. 2012. The genus *Cladosporium*. Stud. Mycol. 72, 401 pages.
19. Bestagno Biga, M.L., R. Ciferri, and G. Bestagno. 1958. Ordinamento artificiale delle specie del genere *Coniothyrium*. Sydowia 12: 258-320
20. Bissett, J. 1979. *Mariannaea* and *Paecilomyces*. Fungi Canadenses 151-60. Canada Agric., Ottawa
21. Bissett, J. 1984. A revision of the genus *Trichoderma*. I. Section *Longibrachiatum* sec. nov. Can. J. Bot. 62: 924-931.
22. Bissett, J. 1991a. A revision of the genus *Trichoderma*. II. Infrageneric classification. Can. J. Bot. 69: 2357-2372.
23. Bissett, J. 1991b. A revision of the genus *Trichoderma*. III. Section *Pachybasium*. Can. J. Bot. 69: 2373-2417.
24. Bissett, J. 1991c. A revision of the genus *Trichoderma*. IV. Additional notes on section *Longibrachiatum*. Can. J. Bot. 69: 2418-2420.
25. Blaser, P. 1976. Taxonomische und physiologische Untersuchungen über die Gattung *Eurotium* Link ex Fr. Sydowia 28: 1-49
26. Boerema, G.H. 1993. Contribution toward a monograph of *Phoma* (Coelomycetes) - II. Section *Peyronellaea*. Persoonia 15: 197-221.
27. Boerema, G.H., J. de Gruyter and H.A van Kesteren. 1994. Contribution toward a monograph of *Phoma* (Coelomycetes) - III. 1. Section *Plenodomus*: taxa often with a *Leptosphaeria* teleomorph. Persoonia 15: 431-487.
28. Boerema G.H., J. de Gruyter, M.E. Noordeloos, and M.E.C. Hamers. (2004). *Phoma* identification manual. Differentiation of specific and infra-specific taxa in culture. CABI publishing, Wallingford, U.K.
29. Boerema, G.H., and M.M.J. Dorenbosch. 1973. The *Phoma* and *Ascochyta* Species described by Wollenweber and Hochapfel in Their Study on Fruit-Rotting. C.B.S. Stud. Mycol. 3
30. Bonar, L. 1928. Studies on Some California Fungi. Mycologia 20: 292-300
31. Booth, C. 1971a. Fungal culture media. *In* C. Booth (ed.),Methods in Microbiology, vol. 4. Academic Press, New York
32. Booth, C. 1971b. The genus *Fusarium*. Commonwealth Mycol. Inst., Kew
33. Booth, C. 1971c. Methods in Microbiology, vol. 4. Academic Press, New York
34. Booth, C. 1977. *Fusarium*. Laboratory Guide to the Identification of the Major Species
35. Burgess, L. W., C. M. Liddell and B. A. Summerell. 1988. Laboratory manual for *Fusarium* research, 2nd ed. University of Sydney, Sydney.
36. Carmichael, J.W. 1957. *Geotrichum candidum*. Mycologia 49: 820-830
37. Carmichael, J.W. 1962. *Chrysosporium* and some other aleuriosporic hyphomycetes. Can. J. Bot. 40: 1137-73
38. Carmichael, J.W., W.B. Kendrick, I.L. Connors, and L. Sigler. 1980. Genera of Hyphomycetes. Univ. Alberta Press, Edmonton
39. Chaverri, P. and Samuels, G.J. 2003. *Hypocrea/Trichoderma* (Ascomycota, Hypocreales, Hypocreaceae): species with green ascospores. Stud. Mycol. 48: 1-116.
40. Cole, G.T., and B. Kendrick. 1973. Taxonomic studies of *Phialophora*. Mycologia 65: 661-88
41. Cooke, R.C. 1967. *Monacrosporium globosporum* sp. nov. and other network-forming nematode-trapping species. Trans. Brit. Mycol. Soc. 50: 515-18
42. Cooke, R.C. 1969. *Candelabrella cylindrospora* sp. nov. and notes on the taxonomy of nematode-trapping species of *Dactylaria*. Trans. Brit. Mycol. Soc. 53: 475-8
43. Cooke, R.C., and C.H. Dickinson. 1965. Nematode-trapping species of *Dactylella* and *Monacrosporium*. Trans. Brit. Mycol. Soc. 48: 621-9
44. Cooke, R.C., and B.E.S. Godfrey. 1964. A key to the nematode-destroying fungi. Trans. Brit. Mycol. Soc. 47: 61-74
45. Crous, P.W., U. Braun, K. Schubert and J.Z. Groenewald (eds.). 2007. The genus *Cladosporium* and similar dematiaceous hyphomycetes. CBS Stud. Mycol. 58.
46. Currah, R.S. 1985. Taxonomy of the Onygenales: Arthrodermataceae, Gymnoascaceae, Myxotrichaceae and Onygenaceae. Mycotaxon 24: 1-216.
47. Currah, R.S. 1988. An annotated key to the genera of the Onygenales. Systema Ascomycetum 7: 1-12.
48. Dela Cruz, T.E., B. Schulz, M. Komon-Zelazowska and I. Druzhinina. 2006. Conidial morphology: homology or homoplasy? The analysis of molecular data shows that marine *Dendryphiella* species do not belong to the genus *Scolecobasidium*. Proc. of 8th International Mycological Congress", Cairns, pg. 7.
49. Domsch, K. H., W. Gams and T.-H. Anderson. 1980. Compendium of Soil Fungi. Academic Press, London. Vol. I, 859 p. and II, 405 p.
50. Dorenbosch, M.M.J. 1970. Key to nine ubiquitous soil-borne *Phoma*-like fungi. Persoonia 6: 1-14
51. Dring, D.M. 1971. Techniques for microscopic preparation. *In* C. Booth (ed.), Methods in Microbiology, vol. 4. Academic Press, New York
52. Ellis, M.B. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycol. Inst., Kew
53. Ellis, M.B. 1976. More Dematiaceous Hyphomycetes. Commonwealth Mycol. Inst., Kew
54. Fuller, M.S. (ed). 1978. Lower Fungi in the Laboratory. Univ. Georgia Press,Athens
55. Gams, W. 1969. Gliederungsprincipien in der Gattung *Mortierella*. Nova Hedw.18: 30-44
56. Gams, W. 1971. *Cephalosporium*-artige Hyphomyceten. G. Fisher, Stuttgart
57. Gams, W. 1977. A key to the species of *Mortierella*. Persoonia 9: 381-91
58. Gams, W. (Ed.). 2006. *Hypocrea and Trichoderma* studies marking the 90th birthday of Joan M. Dingley. Stud. Mycol. 56: 1-177.
59. Gerlach, W. and H. Nirenberg. 1982. The genus *Fusarium* - a pictorial atlas. Mitt. Biol. Bund. Land-Forst. 209.
60. Gilman, J.C. 1957. A Manual of Soil Fungi. 2nd ed. Iowa State Coll. Press,Ames
61. Glare TR, Inwood AJ. 1998. Morphological characterization of *Beauveria* spp. from New Zealand. Mycol Res 102: 250-256.
62. Gravesen, S., J.C. Frisvad and R.A. Samson. 1994. Microfungi. Munksgaard, Capenhagen.
63. Gregory, P.H. 1973. The Microbiology of the Atmosphere. Leonard Hill, Aylesbury, UK.

64. Gruyter, J. and M.E. Noordeloos. 1992. Contribution toward a monograph of *Phoma* (Coelomycetes) - I. 1. Section *Phoma:* taxa with very small conidia in vitro. Persoonia 15: 71-92.
65. Guba, E.F. 1961. Monograph of *Monochaetia* and *Pestalotia*. Harvard Univ.Press, Cambridge, Mass.
66. Haard, K. 1968. Taxonomic studies on the genus *Arthrobotrys*. Mycologia 60: 1140-59
67. Hayes, M.A. 2012. The *Geomyces* fungi: ecology and distribution. BioScience 62: 819-823.
68. Hennebert, G.L. 1968. *Echinobotryum*, *Wardomyces* and *Mammaria*. Trans. Brit.Mycol. Soc. 51: 749-62
69. Hennebert, G.L. 1973. *Botrytis* and *Botrytis*-like genera. Persoonia 7: 183-204
70. Hesseltine, C.W., and D.I. Fennell. 1955. The genus *Circinella*. Mycologia47: 193-212
71. Holt, J.G. (ed.) 1994. Bergey's manual of determinative bacteriology, 9th edition. Williams and Wilkins, Baltimore.
72. Hoog, G.S. de. 1972. The Genera *Beauveria*, *Isaria*, *Tritirachium* and *Acrodontium* gen. nov. C.B.S. Stud. Mycol. 1
73. Hoog, G.S. de. 1974. The Genera *Blastobotrys*, *Sporothrix*, *Calcarisporium* and *Calcarisporiella* gen. nov. C.B.S. Stud. Mycol. 7
74. Hoog, G.S. de. 1993. *Sporothrix*-like anamorphs of *Ophiostoma* species and other fungi, *in* Wingfield, M.J., K.A. Seifert, and J.F. Webber. *Ceratocystis* and *Ophiostoma*: taxonomy, ecology and pathogenicity. APS Press, St. Paul, Minnesota.
75. Hoog, G.S. de and J. Guarro. 1995. Atlas of clinical fungi. C.B.S., Baarn, The netherlands.
76. Hoog, G.S. de, and E.J. Hermanides-Nijhoff. 1977. The Black Yeasts and Allied Hyphomycetes. C.B.S. Stud. Mycol. 15
77. Hoog, G.S. de, M.TH. Smith and E. GuÚho. 1986. A revision of *Geotrichum*. C.B.S. Stud. Mycol. 131
78. Hoog, G.S. de and M.TH. Smith. 2011. *Geotrichum* Link: Fries (1832) *in* Kurtzman, C.P., Fell, J.W. and Boekhout, T. (Eds). The yeasts: a taxonomic study, fifth edition. Vol. 2: 1279-1286. Elsevier, Amsterdam.
79. Hoog, G.S. de, Yurlova, N.A., 1994. Conidiogenesis, nutritional, physiology and taxonomy of *Aureobasidium* and *Hormonema*. Antonie van Leeuwenhoek 65, 41-54.
80. Ingold, C.T. 1953. Dispersal in Fungi. Oxford Univ. Press, London
81. Inui, T., Y. Takeda, and H. Iizuka. 1965. Taxonomical studies on genus *Rhizopus*. J. Gen. Appl. Microbiol. 11, suppl.
82. Jarvis, W.R. 1977. *Botryotinia* and *Botrytis* species: taxonomy, physiology and pathogenicity. Agriculture Canada, Monograph No. 15.
83. Joly, P. 1964. Le genre *Alternaria*. Encyle. Mycol. 33
84. Jong, S.C., and E.E. Davis. 1976. Contibution to the knowledge of *Stachybotrys* and *Memnoniella* in culture. Mycotaxon 3: 409-85
85. Kang, J.C., K.D. Hyde, and R.Y.C. Kong. 1999. Studies on Amphisphaeriaceae: The Amphisphaeriaceae (*sensu stricto*). Mycol. Res. 103: 53-64.
86. Klich, M.A. 2002. Identification of common *Aspergillus* species. CBS, Utrecht.
87. Klich, M.A. and J.I. Pitt. 1988. A laboratory guide to the common *Aspergillus* species and their teleomorphs. CSIRO, North Ryde, Australia. 116 pages.
88. Kohlmeyer, J. and B. Volkmann-Kohlmeyer. 1991. Illustrated key to the filamentous higher marine fungi. Botanica Marina 34: 1-61.
89. Kulik, M.M. 1968. A compilation of descriptions of new *Penicillium* species. U.S. Dept. Agric. Handb. 351
90. Kurtzman, C.P., Fell, J.W. and Boekhout, T. (Eds). 2011. The yeasts: a taxonomic study, fifth edition. 3 Vols. Elsevier, Amsterdam.
91. Lachance, M.-A., Boekhout, T., Scorzetti, G., Fell, J.W. and Kurtzman, C.P. 2011. *Candida* Berhkout (1923) *in* Kurtzman, C.P., Fell, J.W. and Boekhout, T. (Eds). The yeasts: a taxonomic study, fifth edition. Vol. 2: 987-1278. Elsevier, Amsterdam.
92. Lilly, V.G. 1965. The chemical environment for fungal growth. I. Media, Media, macro- and micro-nutrients. *In* G.C. Ainsworth, and A.S. Sussman (eds.), the Fungi: An Advanced Treatise, vol. I. Academic Press, New York
93. McGinnis, M.R. 1980. Laboratory Handbook of Medical Mycology. Academic Press, New York
94. Marx, D.H. 1969. The influence of ectotrophic mycorrhizal fungi on the resistance of pine roots to pathogenic infections. I. Antagonism of mycorrhizal fungi to root pathogenic fungi and soil bacteria. Phytopathol. 59: 153-63
95. Matsushima, T. 1975. Icones Fungorum A Matsushima Lectorum. Publ. by the author, Kobe, Japan
96. Morquer, R., G. Viala, J. Rouch, J. Fayret, and G. Bergé. 1963. Contributiona l'étude morphogénique du genre *Gliocladium*. Bull. Soc. Mycol. France 79: 137-241
97. Morrall, R.A.A. 1968. Two new species of *Oidiodendron* from boreal forest soils. Can. J. Bot. 46: 203-6
98. Morton, F.J., and G. Smith. 1963. The Genera *Scopulariopsis*, *Microascus* and *Doratomyces*. Mycol. Pap. Commonwealth Mycol. Inst. 86
99. Nag Raj, T.R. 1993. Coelomycetous anamorphs with appendage-bearing conidia. Mycologue Publications, Waterloo, Ontario, Canada.
100. Nelson, P. E., T. A. Toussoun and W. F. O. Marassas. 1983. *Fusarium* species, an illustrated manual for identification. Pennsylvania State University, University Park and London.
101. O'Donnell, K. 1979. Zygomycetes in Culture. Dept. of Botany, Univ. of Georgia
102. Orr, F.G., H.H. Kuehn, and O.A. Plunkett. 1963. The genus *Gymnoascus* Baranetzky. Mycopathol. Mycol. Appl. 21: 1-18
103. Pitt, J. 1980. The Genus *Penicillium*. Academic Press, New York
104. Pitt, J. 1985. A aboratory guide to common *Penicillium* species. CSIRO, North Ryde, Australia. 185 pages.
105. Ramirez, C. 1982. Manual and Atlas of the Penicillia. Elsevier Biomedical Press, New York.
106. Raper, K.B., and D.I. Fennell. 1965. The Genus *Aspergillus*. Williams and Wilkins Co., Baltimore
107. Raper, K.B., and C. Thom. 1949. A. Manual of the Penicillia. Williams and Wilkins Co., Baltimore
108. Pfister, D.H. 1994. *Orbilia fimicola*, a nematophagous discomycete and its *Arthrobotrys* anamorph. Mycologia 86:451-453.
109. Pfister, D.H. 1997. Castor, Pollux and Life Histories of Fungi. Mycologia 89:1-23.
110. Pfister, D.H., and M.E. Liftik 1995. Two *Arthrobotrys* anamorphs from *Orbilia auricolor*. Mycologia 86:451-453.
111. Rebell, G., and D. Taplin. 1970. Dermatophytes: Their Recognition and Identification. Univ. Miami Press, Coral Gables
112. Rehner, S.A and Buckley, E. 2005. A *Beauveria* phylogeny inferred from nuclear ITS and EF1-{alpha} sequences: evidence for cryptic diversification and links to *Cordyceps* teleomorphs. Mycologia, 97(1), 2005, pp. 84-98.
113. Rice, A.V. and R.S. Currah. 2005. *Oidiodendron*: A survey of the named species and related anamorphs of *Myxotrichum*. Stud.

Mycol. 53:83-120.

114. Rifai, M.A. 1969. A Revision of the Genus *Trichoderma*. Mycol. Pap. Commonwealth Mycol. Inst. 116
115. Rifai, M.A. 1975. *Geniculifera* nom. nov. Mycotaxon 2: 214-16
116. Rifai, M.A., and R.C. Cooke. 1966. Studies on some didymosporous genera of nematode-trapping hyphomycetes. Trans. Brit. Mycol. Soc. 49: 147-68
117. Rubner, A. 1996. Revision of predacious Hyphomycetes in the *Dactylella-Monacrosporium* complex. C.B.S. Stud. Mycol. 39.
118. Samson, R.A. 1974. *Paecilomyces* and Some Allied Hyphomycetes. C.B.S. Stud.Mycol. 6
119. Samson, R.A. 1979. A Compilation of the Aspergilli Described since 1965. C.B.S. Stud. Mycol. 18
120. Samson, R.A. and Frisvad, J.C. (Eds.) 2004. *Penicillium* subgenus *Penicillium*: new taxonomic schemes, mycotoxins and other extrolites. Stud. Mycol. 49. i-vi + 1-251.
121. Samson, R.A., Hoekstra, E.S. and Frisvad, J.C. 2004. Introduction to Food - and Airborne Fungi, Seventh Edition. CBS, Utrecht
122. Samson, R.A. and Houbraken, J. (Eds.). 2011. Phylogenetic and taxonomic studies on the genera *Penicillium* and *Talaromyces*. Stud. Mycol. 70, 183 pages.
123. Samson, R.A., A.C. Stolk, and R. Hadlok. 1976. Revision of the Subsection Fasciulata of *Penicillium* and Some Allied Species. C.B.S. Stud. Mycol. 11
124. Samson R.A. and J. Varga. 2007. *Aspergillus* systematics in the genomic era. CBS Stud. Mycol. 59.
125. Samson, R.A., Varga, J. and Frisvad, J.C. (Eds.) 2011. Taxonomic studies on the genus *Aspergillus*. Stud. Mycol. 69. 96 pages.
126. Samuels, G.J., Petrini, O., Kuhls, K., Lieckfeldt, E. and Kubicek, C.P. 1998. The *Hypocrea schweinitzii* complex and *Trichoderma* sect. *Longibrachiatum*. Stud. Mycol.: 41: 1-54.
127. Schipper, M.A.A. 1978. On certain species of *Mucor* with a key to all accepted species. C.B.S. Stud. Mycol. 17
128. Schipper, M.A.A. 1984. A revision of the genus *Rhizopus*. I. The *Rhizopus stolonifer*-group and *Rhizopus oryzae*. Stud. Mycol. 25:1-19.
129. Schipper, M.A.A., R.A. Samson, and J.A. Stalpers. 1975. Zygospore ornamentation in the genera *Mucor* and *Zygorhynchus*. Persoonia 8: 321-8
130. Schipper, M.A.A., and Stalpers, J.A. 1984. A revision of the genus *Rhizopus*. II. The *Rhizopus microsporus*-group. Stud. Mycol. 25:20-34.
131. Schneider, R. 1979. Die Gattung *Pyrenochaeta* De Notaris. Mitt. Biol. Bundesanst. Land-Forstw. Berlin-Dahlem 189: 1-73
132. Schol-Schwarz, M.B. 1959. The genus *Epicoccum*. Trans. Brit. Mycol. Soc.42: 149-73
133. Schol-Schwarz, M.B. 1970. Revision of the genus *Phialophora*. Persoonia 6: 59-94
134. Scott, De B. 1968. The Genus *Eupenicillium* Ludwig. CSIR Res. Rep. 272(Pretoria, S. Africa)
135. Scott, J.A. 2001. Studies on indoor fungi. Ph.D. Thesis, University of Toronto.
136. Seaver, F.J. 1951. The North American Cup Fungi (Inoperculates). Publ. by the author, New York
137. Seifert, K.A. 2000. ASP45, a synoptic key to common species of *Aspergillus in* Samson, R.A. and J.I. Pitt. Integration of modern taxonomic methods for *Penicillium* and *Aspergillus*. Harwood Academic Publishers, Amsterdam.
138. Seifert, K.A. and G. Okada. 1993. *Graphium* anamorphs of *Ophiostoma* species and similar anamorphs of other ascomycetes, *in* Wingfield, M.J., K.A. Seifert, and J.F. Webber. *Ceratocystis* and *Ophiostoma*: taxonomy, ecology and pathogenicity. APS Press, St. Paul, Minnesota.
139. Seifert, K.A., G. Morgan-Jones, W. Gams and B. Kendrick. 2011. The Genera of Hyphomycetes. CBS-KNAW Biodiversity Centre, Utrecht. 997 pages.
140. Seth, H.K. 1970. A Monograph of the Genus *Chaetomium*. Beih. Nova Hedw. 37
141. Shoemaker, R.A., and E.G. Kokko. 1977. *Trichurus spiralis*. Fungi Canadenses 100. Canada Agric., Ottawa.
142. Simmons, E. G. 1967. Typification of *Alternaria*, *Stemphylium*, and *Ulocladium*. Mycologia 59:67-92.
143. Simmons, E. G. 1981. *Alternaria* themes and variations. Mycotaxon 13:16-34.
144. Simmons, E. G. 1982a. *Alternaria* themes and variations (7-10). Mycotaxon 14:17-43.
145. Simmons, E. G. 1982b. *Alternaria* themes and variations (11-13). Mycotaxon 14:44-57.
146. Simmons, E. G. 1986a. *Alternaria* themes and variations (14-16). Mycotaxon 25:195-202.
147. Simmons, E. G. 1986b. *Alternaria* themes and variations (17-21). Mycotaxon 25:203-216.
148. Simmons, E. G. 1986c. *Alternaria* themes and variations (22-26). Mycotaxon 25:287-308.
149. Simmons, E. G. 1990. *Alternaria* themes and variations (27-53). Mycotaxon 37:79-119.
150. Simmons, E. G. 1993a. *Alternaria* themes and variations (54-62). Mycotaxon 46:171-199.
151. Simmons, E. G. 1993b. *Alternaria* themes and variations (63-72). Mycotaxon 48:91-107.
152. Simmons, E. G. 1993c. *Alternaria* themes and variations (73). Mycotaxon 48:109-140.
153. Simmons, E. G. 1994a. *Alternaria* themes and variations (74-105). Mycotaxon 50:219-270.
154. Simmons, E. G. 1994b. *Alternaria* themes and variations (106-111). Mycotaxon 50:409-427.
155. Simmons, E. G. 1995. *Alternaria* themes and variations (112-144). Mycotaxon 55:55-163.
156. Simmons, E. G. 1996a. *Alternaria* themes and variations (145-149). Mycotaxon 57:391-409.
157. Simmons, E. G. 1996b. *Alternaria* themes and variations (150). Mycotaxon 59:319-335.
158. Simmons, E. G. 1997. *Alternaria* themes and variations (151-223). Mycotaxon 65:1-91.
159. Simmons, E. G. 1998. *Alternaria* themes and variations (226-235). Mycotaxon 70:263-323.
160. Simmons, E. G. 1999. *Alternaria* themes and variations (236-243). Mycotaxon 70:325-369.
161. Simmons, E. G. 2000. *Alternaria* themes and variations (244-286). Mycotaxon 75:1-115.
162. Sigler, L., and J.W. Carmichael. 1976. Taxonomy of *Malbranchia* and some other hyphomycetes with arthroconidia. Mycotaxon 4: 349-488
163. Simmons, E.G. 1967. Typification of *Alternaria*, *Stemphylium* and *Ulocladium*. Mycologia 59: 67-92
164. St-Germain, G. and R. Summerbell. 1996. Identifying filamentous fungi: a clinical laboratory handbook. Star Publ. Co., Belmont, California.
165. Stalpers, J.A. 1974. Revision of the genus *Oedocephalum* (Fungi Imperfecti). Kon. ned. Akad. Wetens. Ser. C, 77: 383-401
166. Stevens, R.B. (ed.). 1974. Mycology Guidebook. Univ. Wash. Press, Seattle

167. Stolk, A.C., and R.A. Samson. 1972. The Genus *Talaromyces*. Studies on *Talaromyces* and Related Genera. II. C.B.S. Stud. Mycol. 2
168. Stolk, A.C., and R.A. Samson. 1983. The ascomycete genus *Eupenicillium* and related *Penicillium* anamorphs. C.B.S. Stud. Mycol. 23.
169. Sugita, T. 2011. *Trichosporon* Behrend (1890) *in* Kurtzman, C.P., Fell, J.W. and Boekhout, T. (Eds). The yeasts: a taxonomic study, fifth edition. Vol. 3: 2015-2062. Elsevier, Amsterdam.
170. Suh, S. and M. Blackwell. 2006. Three new asexual arthroconidial yeasts, *Geotrichum carabidarum* sp. nov., *Geotrichum histeridarum* sp. nov. and *Geotrichum cucujoidarum* sp. nov., isolated from the guts of insects. Mycol. Res. 110: 220-228.
171. Sutton, B.C. 1973. Hyphomycetes from Manitoba and Saskatchewan, Canada. Mycol. Pap. Commonwealth Mycol. Dist. 132
172. Sutton, B.C. 1980. The Coelomycetes. Commonwealth Mycological Institute, Kew.
173. Swart, H.J. 1964. A study of the production of coremia in three species of the genus *Trichurus*. Antonie van Leeuwenhoek 30: 257-60
174. Takeo, K., Hoog, G.S. de, 1991. Karyology and hyphal characters as taxonomic criteria in Ascomycetous black yeasts and related fungi. Antonie van Leeuwenhoek 60, 35-42.
175. Tokumasu, S. 1973. Notes on Japanese *Oidiodendron*. Trans. Mycol. Soc. Japan 14: 246-55
176. Tulloch, M. 1972. The genus *Myrothecium*. Mycol. Pap. Commonwealth Mycol.Inst. 130
177. Udagawa, S.-I., Y. Horie and S.K. Abdullah. 1985. *Trichurus dendrocephalus* sp. nov. from Iraqi soil. Mycotaxon 23: 253-259.
178. Untereiner, W.A., N.A. Straus and D. Malloch. 1995. A molecular-morphotaxonomic approach to the systematics of the Herpotrichiellaceae and allied black yeasts. Mycol. Res. 99: 897-913.
179. Van Oorschot, C.A.N. 1980. A Revision of *Chrysosporium* and Allied Genera. C.B.S. Stud. Mycol. 20
180. Van Oorschot, C.A.N. 1985. Taxonomy of the *Dactylaria* complex, V. A review of *Arthrobotrys* and related genera. C.B.S. Stud. Mycol. 26.
181. Vries, G.A. de. 1952. Contribution to the Knowledge of the Genus *Cladosporium*. Hollandia Press, Baarn
182. Waksman, S.A. 1961. The Actinomycetes, vol. II. Williams and Wilkins Co., Baltimore
183. Wang, C.J.K. Microfungi *in* Wang, C.J.K. and R.A. Zabel (Eds.). 1990. Identification manual for fungi from utility poles in the eastern United States. American Type Culture Collection, Rockville, Md.
184. Wang, C.J.K. and R.A. Zabel (Eds.). 1990. Identification manual for fungi from utility poles in the eastern United States. American Type Culture Collection, Rockville, Md.
185. Zambettakis, C. 1954. Recherches sur la systÚmatique des Sphaeropsidales-Phaeodidymae. Bull. Soc. Mycol. France 70: 219-350
186. Zambettakis, C. 1955. Recherches anatomiques et biologiques sur Sphaeropsidales-Phaeodidymae des Fungi Imperfecti. Arch. Mus. Nation. Hist. Nat. 7 Ser., 3: 41-146
187. Zycha, H., and R. Siepmann. 1969 (1970). Mucorales. Eine Beschreibung aller Gattungen und Arten dieser Pilzgruppe, mit einem Beitrag zur Gattung *Mortierella* von G. Linnemann. J. Cramer, Lehre

The Truth About Cobweb

by

Kizzle

original text: https://www.shroomery.org/forums/showflat.php/Number/18642418

This has been long overdue, I'll start by explaining what led me to post this. I've been growing mushrooms for a good 4+ years but not until fairly recently, after assisting with the cultivation of *Agaricus bisporus*, did I start to suspect that what I had always considered cobweb mold may actually be something else. Unlike the competitor molds you're used dealing with cobweb mold is a mushroom pathogen. It's occurrence is in no way linked to contaminated spawn and is rarely a problem in bulk substrates. To ignore that and misidentify other molds as cobweb is counterproductive to determining the source of contamination problems and what to do about them. In trying to make sense of contradicting information I've read a huge amount of information from books, published studies, experiments, etc and thought I'd share some of it.

Just to clarify things up front, the term cobweb mold is often used loosely to refer to any kind of thin wispy grey mold and that's not what I'm referring to. Hopefully I can help distinguish the difference between these molds and the specific mold that causes cobweb disease.

To start, cobweb mold could be defined as a group of closely related species capable of causing cobweb disease in mushrooms. Many of these species are so similar they can only be properly identified from each other through genetic testing. They've been reclassified over the years, and as is often the case in taxonomy not necessarily with complete agreement among mycologists, so you may hear different species or names mentioned. In the US *Dactylium* or the species *Dactylium dendroides* is usually referred to as the causative agent. In eastern countries you'll more commonly hear them referred to as various *Cladobotryum* spp. I also note the Shroomery main site mentions *Hypomyces* sp. which is also correct. In fact *Dactylium*, for the most part, is synonymous with *Hypomyces rosellus*.

Cobweb mold grows on casing layers and mushrooms. Although in theory it could occur on any uncolonized substrate so long as a suitable host is present, it's been shown experimentally that neither spores or mycelium fragments added to spawn will result in development of cobweb disease, nor does adding them to the surface of bulk substrate during spawning, even when a casing layer is then added over it.

Cobweb mold spreads quickly. This is absolutely true, but it's rarely mentioned that the primary reason for this is it's ability to fragment and start growing from multiple points on the casing layer and not solely from the growth speed of a single colony. The growth rate is closely tied to the environmental conditions it is growing in. This is important for two reasons. A slower growth rate may be wrongfully assumed to rule out cobweb during identification. It's also important because changing these conditions can assist in dealing with an outbreak assuming the mushroom species being cultivated is able to tolerate the changes. Lowering temperature and/or RH can slow the growth of cobweb mold or even inhibit it completely.

Cobweb is usually seen in later flushes. IMO this is important to consider both in terms of identification and in finding the source of the contamination. Cobweb proliferates mostly by means of spore. Even high amount of spores added directly to a casing layer requires weeks before the first sign of cobweb disease occurs. With that in mind any the appearance of actual cobweb mold in earlier flushes is most likely the result of mycelium fragmentation and that strongly implies a nearby source. This appears to be true despite the fact that the mold spores can germinate much more quickly on an actual fruit body.

Mushroom stumps are a common point of origin. Now before anyone freaks out and reverts to twist-and-pull, this has nothing to do with the stumps rotting. A cobweb infected mushroom, whether apparent or not, may leave behind a cobweb infected stump.

Aborts are an even more common point of origin. This does not mean aborts need to be picked immediately but they should always be removed while harvesting your other mushrooms. That can be a painstaking task if there is a very large amount of aborts.

This is really open to interpretation. There's definitely a correlation between cobweb disease and aborts but it's hard to say if the aborts are cause of the mold or if the mold is the cause of the aborts. Considering the same conditions that can lead to a lot of aborts can lead to mold contamination...

There are many look-alikes. I find it frustrating how quick people are to identify any fuzzy or grey mold as cobweb mold regardless of where or how it's growing. Pin molds, called that because of the black pins which they may produce, are commonly misidentified as cobweb. In contrast to cobweb, which occurs in the casing laying, pin molds are very common contaminants in spawn and some bulk substrates. In ideal conditions some species can grow at rates matching or surpassing those of cobweb. Despite their somewhat similar appearance these molds are far more difficult to treat and misidentification has apparently left some with the impression that actual cobweb mold is hard to treat.

Cobweb is easily treatable. A common misconception is that hydrogen peroxide only affects cobweb mold. Peroxide will react in some way or another with pretty much any fungus, including mushroom mycelium. The most common reaction to fungi is fizzing caused by the rapid conversion of h202 into water and oxygen bubbles. The fact that cobweb grows solely on the casing surface is what makes it easier to treat than other molds.

On a personal note, despite claims I find it increasingly hard to believe peroxide could be an effective treatment of actual *Cladobotryum* considering it's ability to grow inside the mushroom. It certainly doesn't match my own experiences nor have I seen any studies to support it nor any claim accompanied by documentation showing the mold could indeed be positively identified (visible spores, cobweb disease present). Whether this is due to misidentification or just differences in tolerance between strains/species I'm uncertain.

However I confirm in cases where cobweb disease is present it can be controlled by placing a damp paper towel over the growth and pouring salt over it, and by removing mushrooms showing spotting symptoms. Some may be hesitant to try this, just keep in mind you're salting the casing layer, the damage to the mushroom mycelium is relatively small and there plenty of other areas for mushrooms to develop. That's part of the reason BTW *Trichoderma* almost always reoccurs once it's been growing in the spawn, Trich originating on a casing layer is much easier to treat.

Of course no rambling of this nature would be complete without a RR quote.

> "Cobweb mold is the only thing you can totally kill and eliminate with peroxide. Nobody has lost a project to cobweb mold who has made searches here to find the cure. You're supposed to spray it until wet three times at 12 hour intervals. Spray until all the cobweb mycelium has 'melted' and disappeared. Repeat twice at 12 and 24 hours after the first spray whether you see any cobweb or not."
> RR

Overall cobweb disease does not appear to be particularly common with Cubensis, certainly not as common as many believe. Probably because most Cube cultivators do not use casing layers or use pasteurized casing layers. Spores of *Dactylium* are killed when exposed to 115-122°F. for only 1/2 hour making it extremely unlikely to survive pasteurization. It's uncommon but possible for mushrooms to get the disease even without a casing layer. It such a situation the mold mycelium will not grow on the fully colonized substrates surface but may still be seen spreading to nearby pins and mushrooms directly.

Some miscellaneous info:
A particular species may produce different or no symptoms of the disease depending on the mushroom species being grown.

According to one source *Cladobotryum dendroides* produces a noticeable odor while *Cladobotryum mycophilum* does not.

Spores will not become airborne early on in it's development unless the colony is physically disturbed, like while misting.

Spores are relatively massive. In the presence of typical air currents most spores will have settled after 15 minutes.

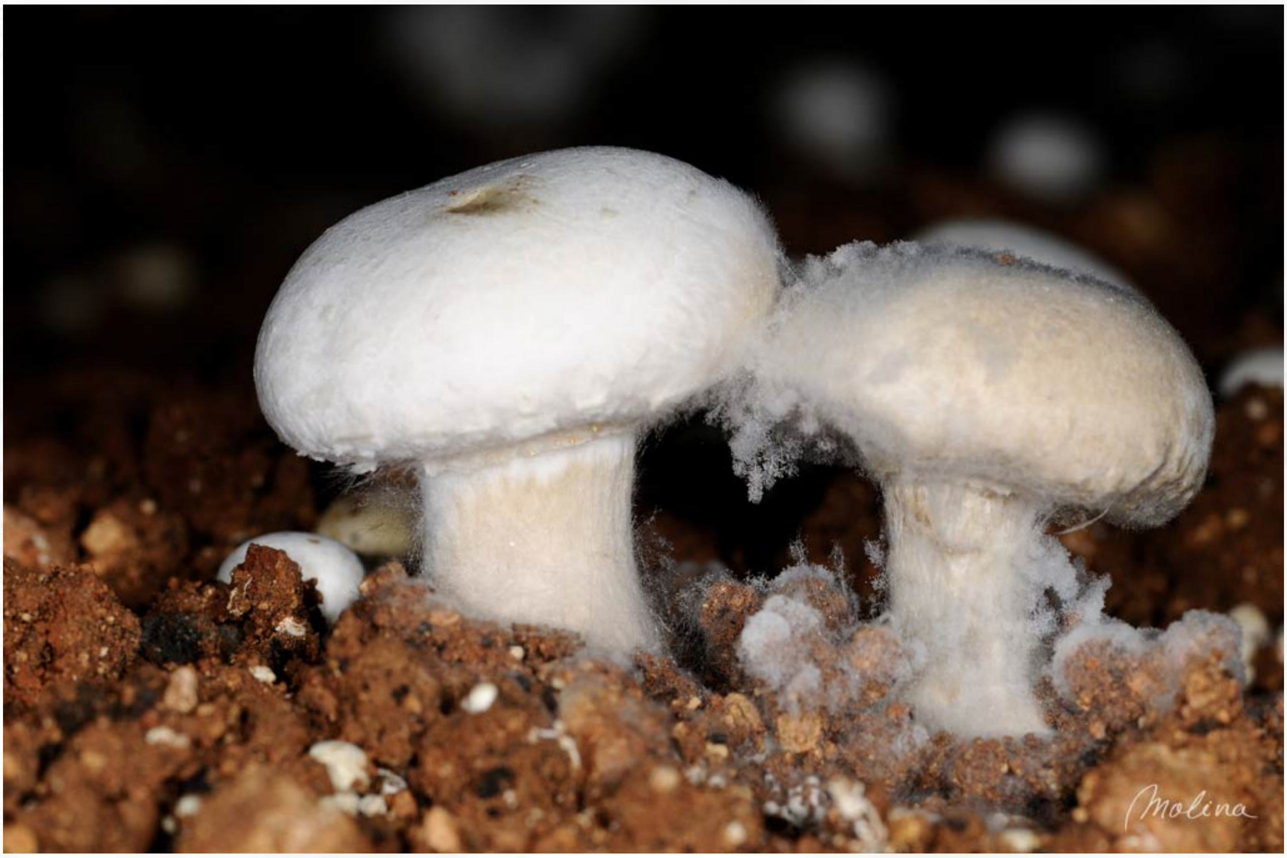
Spores survive a maximum of 7 days in sterile water.

Heavy spore production occurs usually occurs near and on infected mushrooms.

In time, some species produces metabolites which turn the mycelium and/or substrate a pink or yellow color.

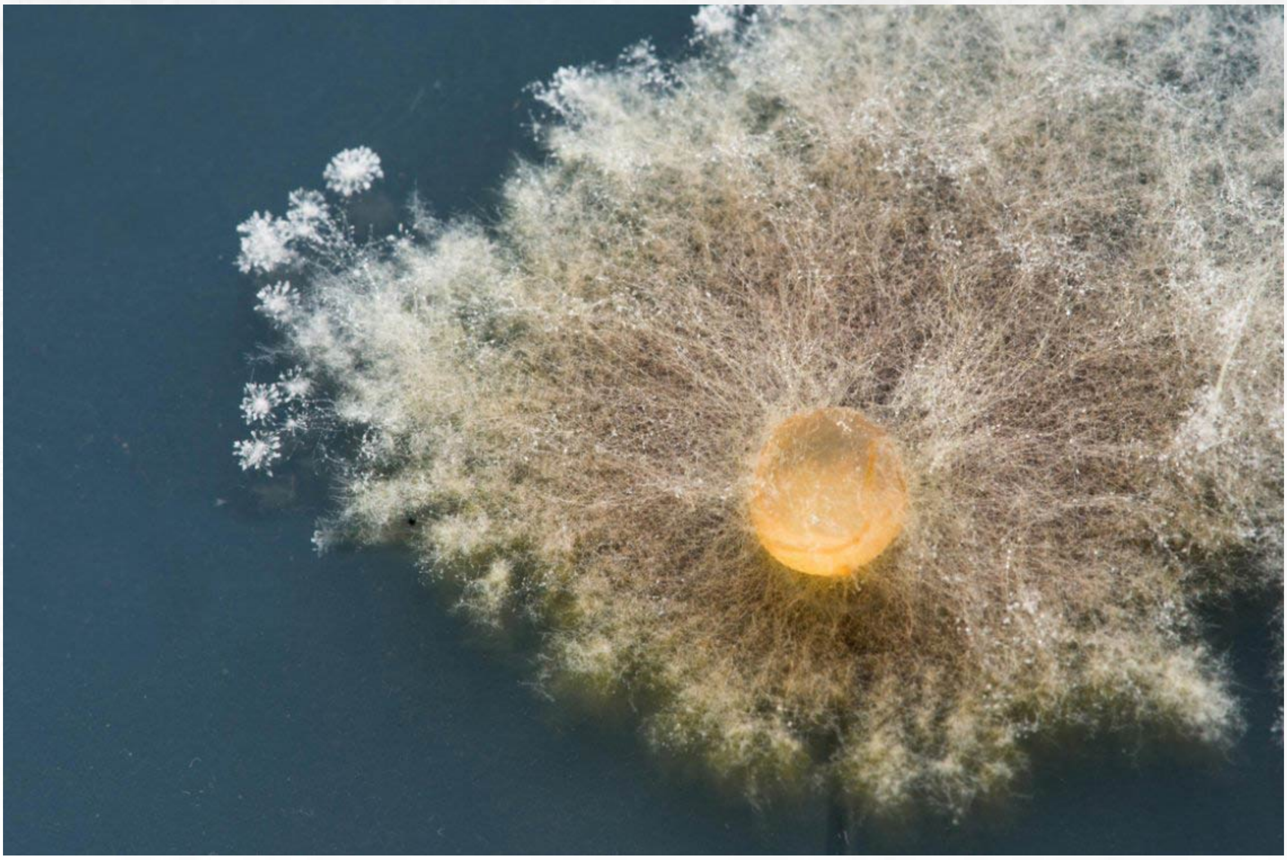
When the disease is allowed to progress the mycelium will take on a powdery appearance from the produced spores.

The following are pictures positively identified by reliable sources.

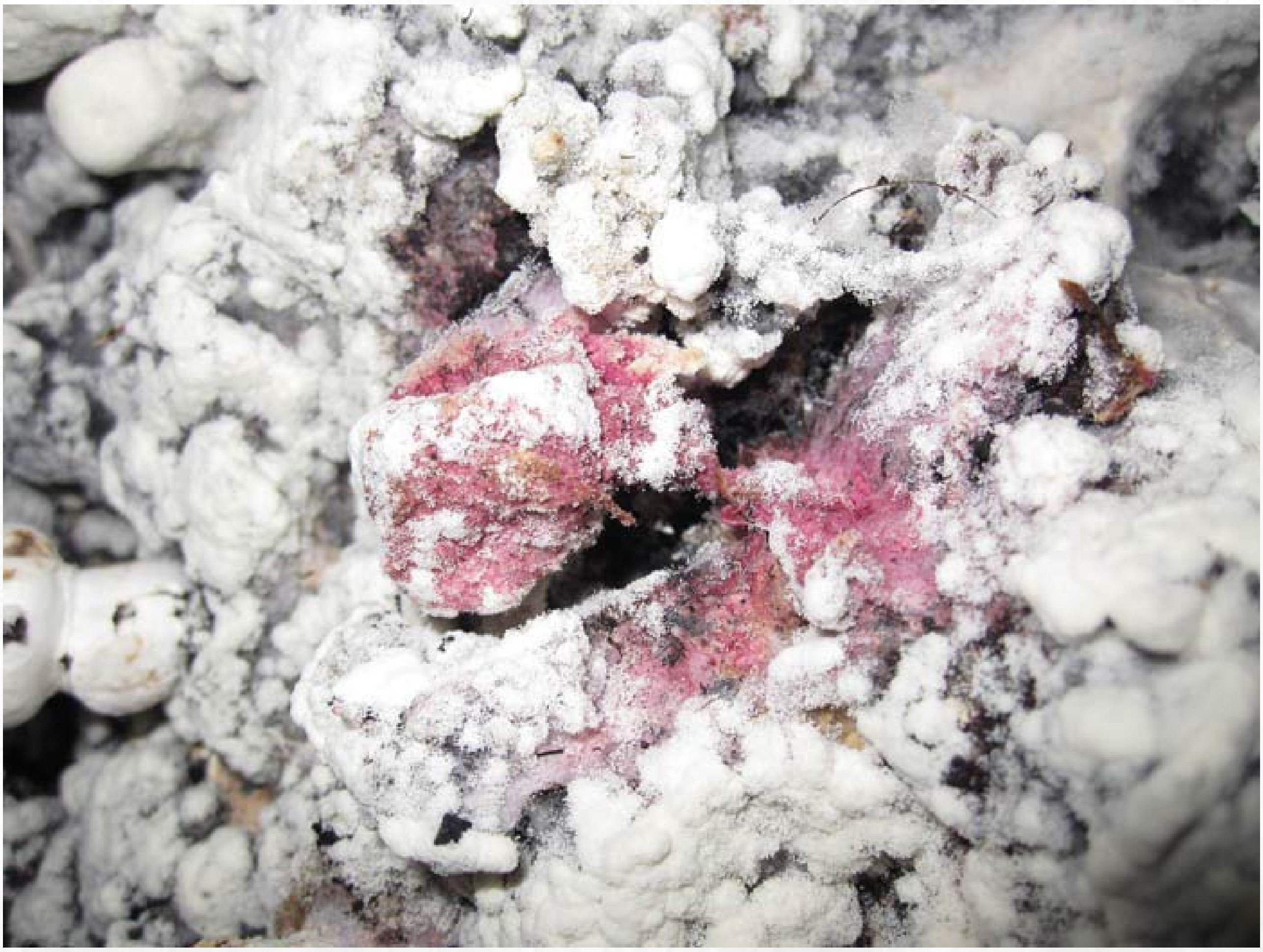


Spore production on 2 cobweb infected mushrooms.

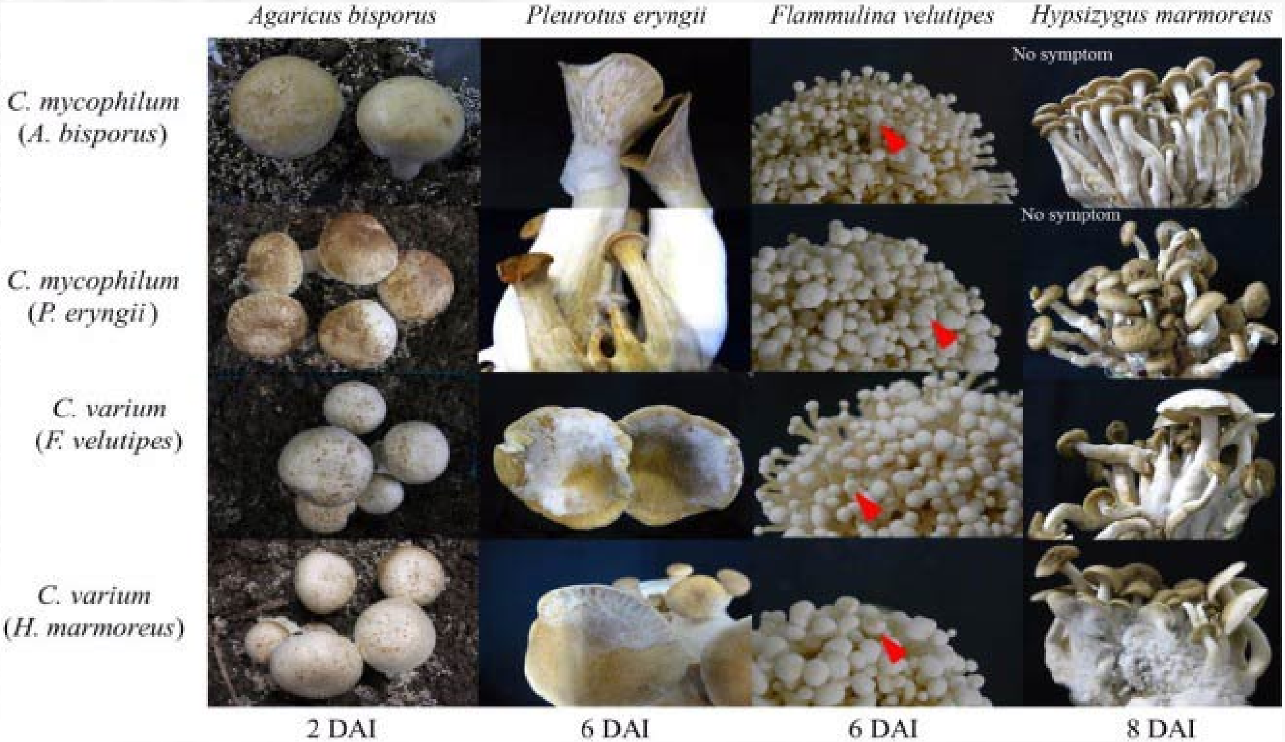
Another good one.



A culture of *Cladobotryum mycophilium*. Spore are visible here as well on the top left.

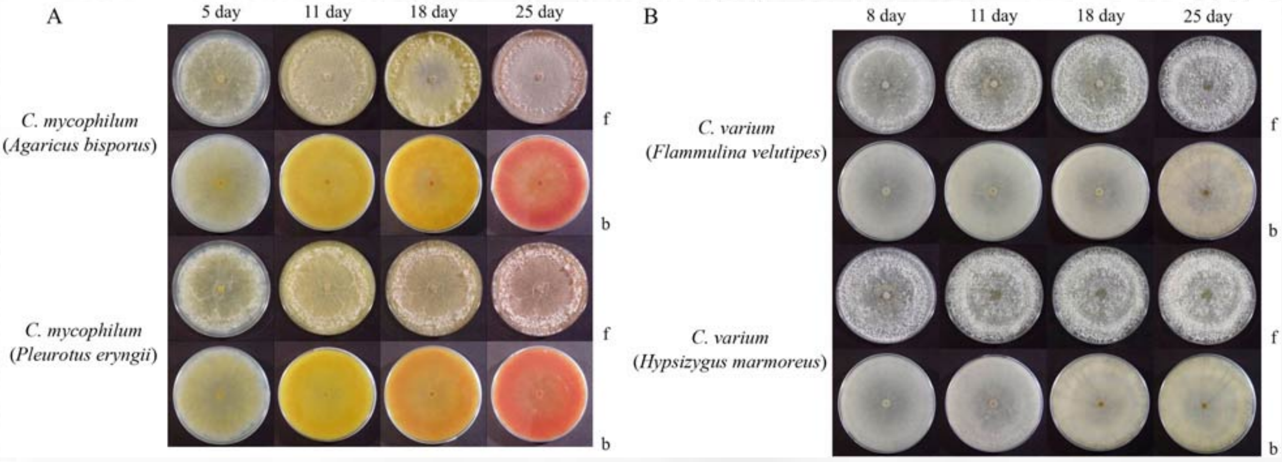


An untreated outbreak in the late stage.

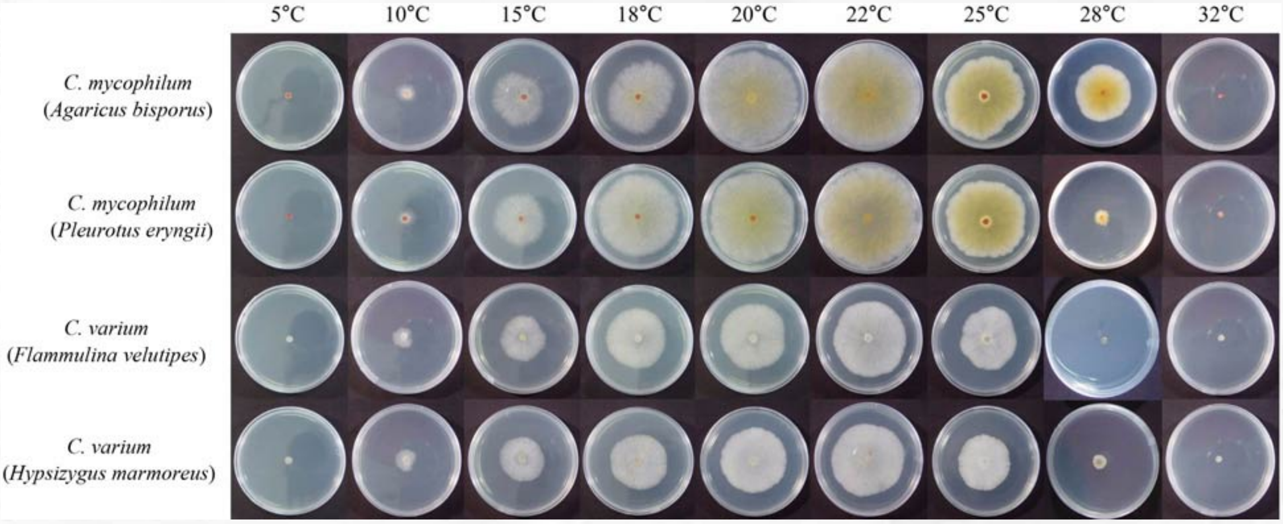


Agaricus bisporus
Pleurotus eryngii
Flammulina velutipes
Hypsizygus marmoreus
C. mycophilum (A. bisporus)
C. mycophilum (P. eryngii)
C. varium (F. velutipes)
C. varium (H. marmoreus)
No symptom
No symptom
2 DAI
6 DAI
6 DAI
8 DAI

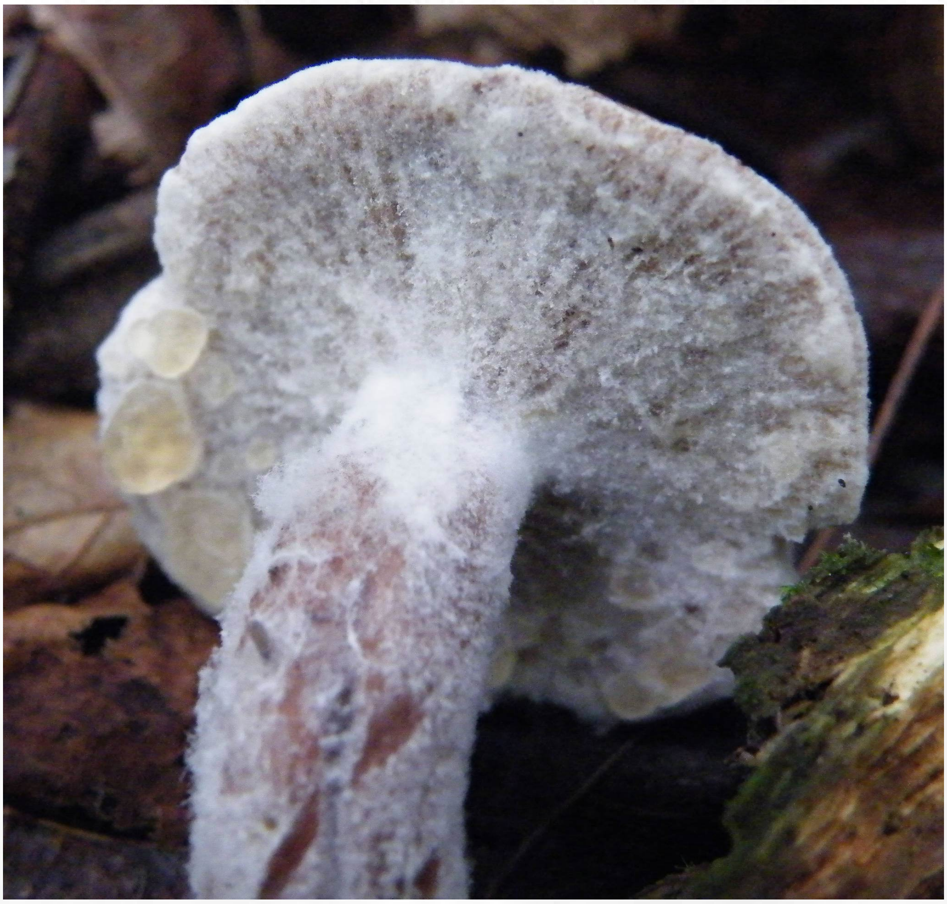
This was from a study although the quality limits it's usefulness. The symptoms of 2 different species cobweb isolated from 4 different source inoculated into 4 different mushrooms species.


A
5 day
11 day
18 day
25 day
C. mycophilum (Agaricus bisporus)
C. mycophilum (Pleurotus eryngii)
f
b
f
b
B
8 day
11 day
18 day
25 day
C. varium (Flammulina velutipes)
C. varium (Hypsizygus marmoreus)
f
b
f
b

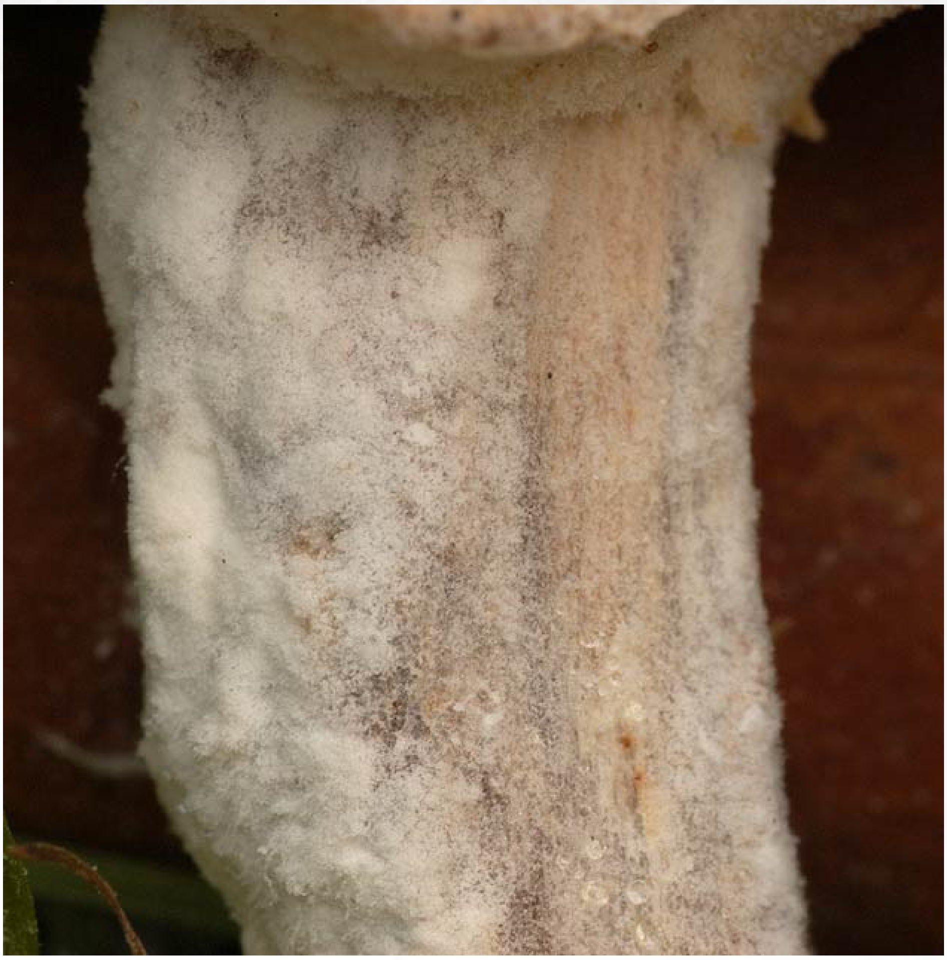
The appearance on agar of 2 different cobweb species isolated from 4 different mushrooms.


5°C
10°C
15°C
18°C
20°C
22°C
25°C
28°C
32°C
C. mycophilum (Agaricus bisporus)
C. mycophilum (Pleurotus eryngii)
C. varium (Flammulina velutipes)
C. varium (Hypsizygus marmoreus)

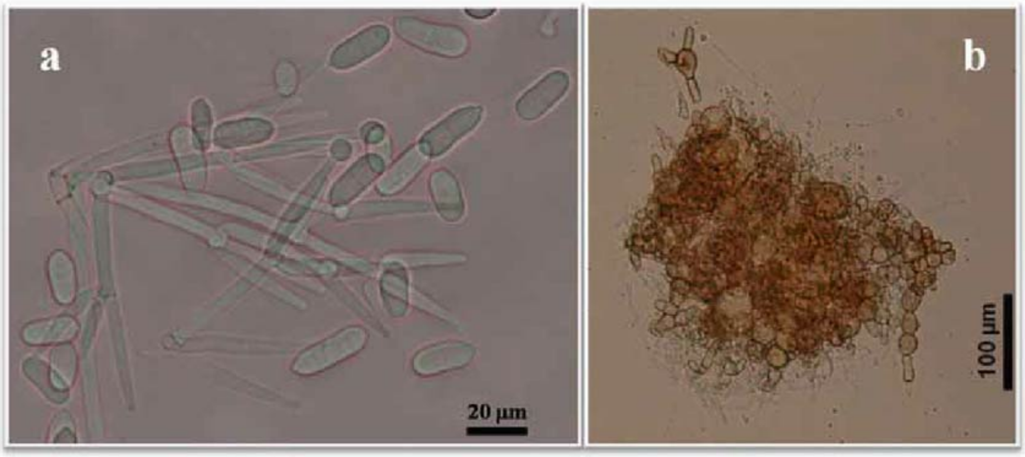
The effects of temperature on growth.



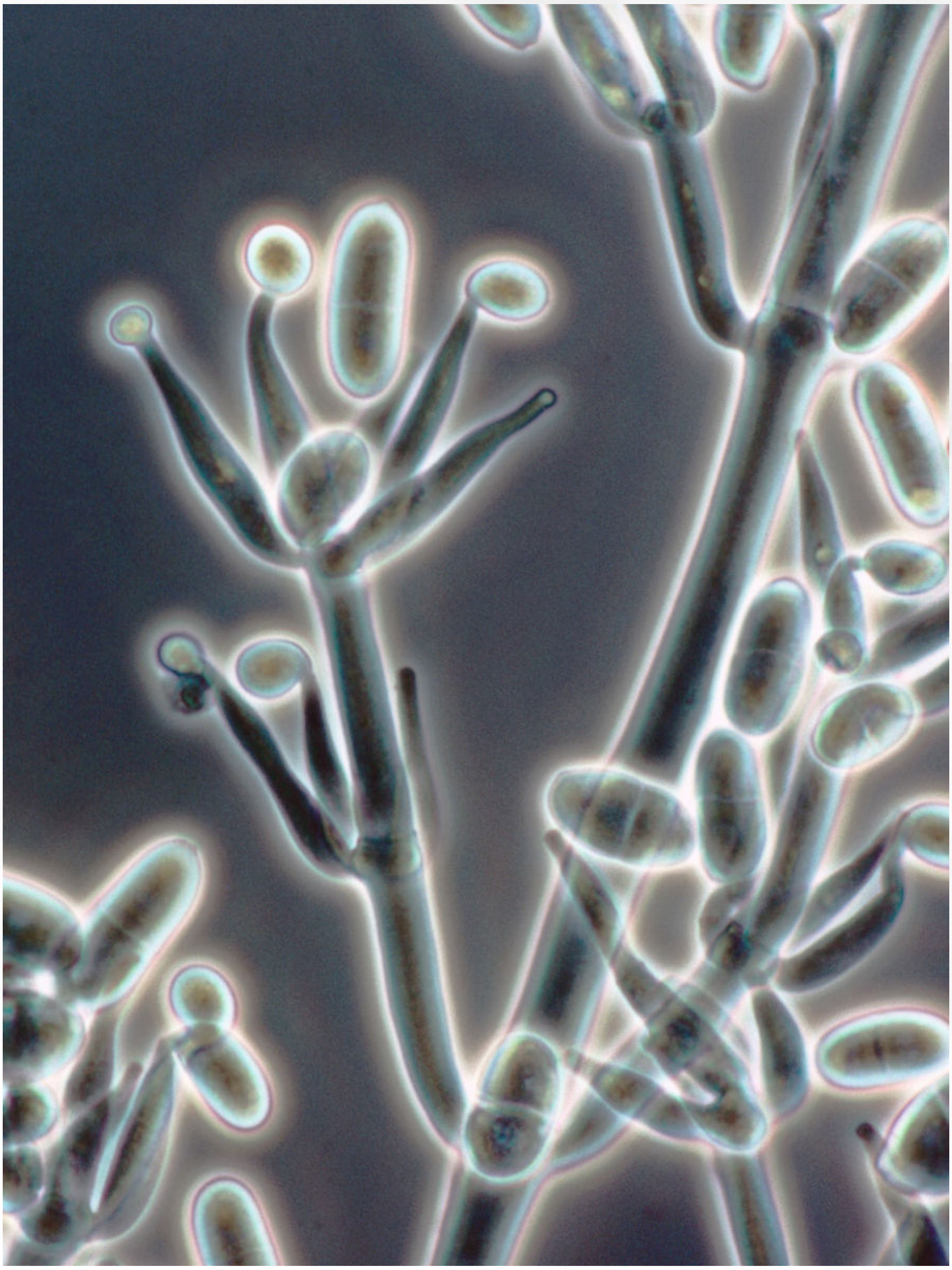
Infected mushroom.



Close up of stem.

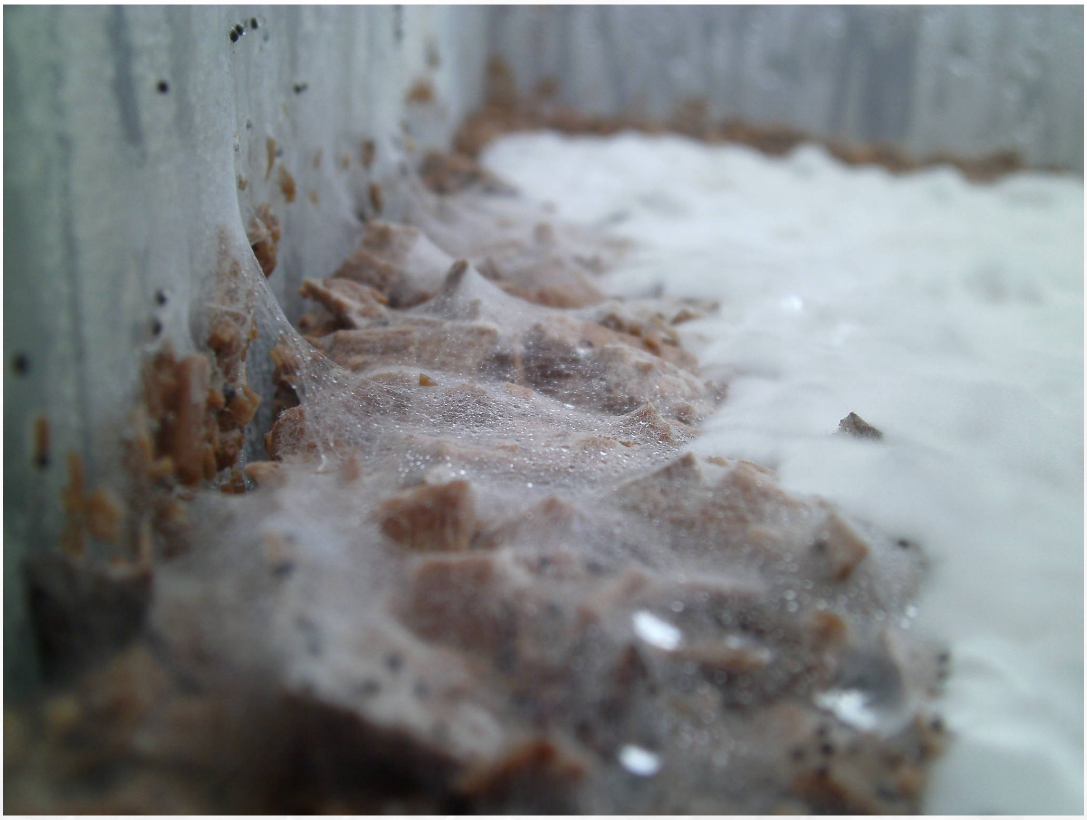


Cladobotryum mycophilum

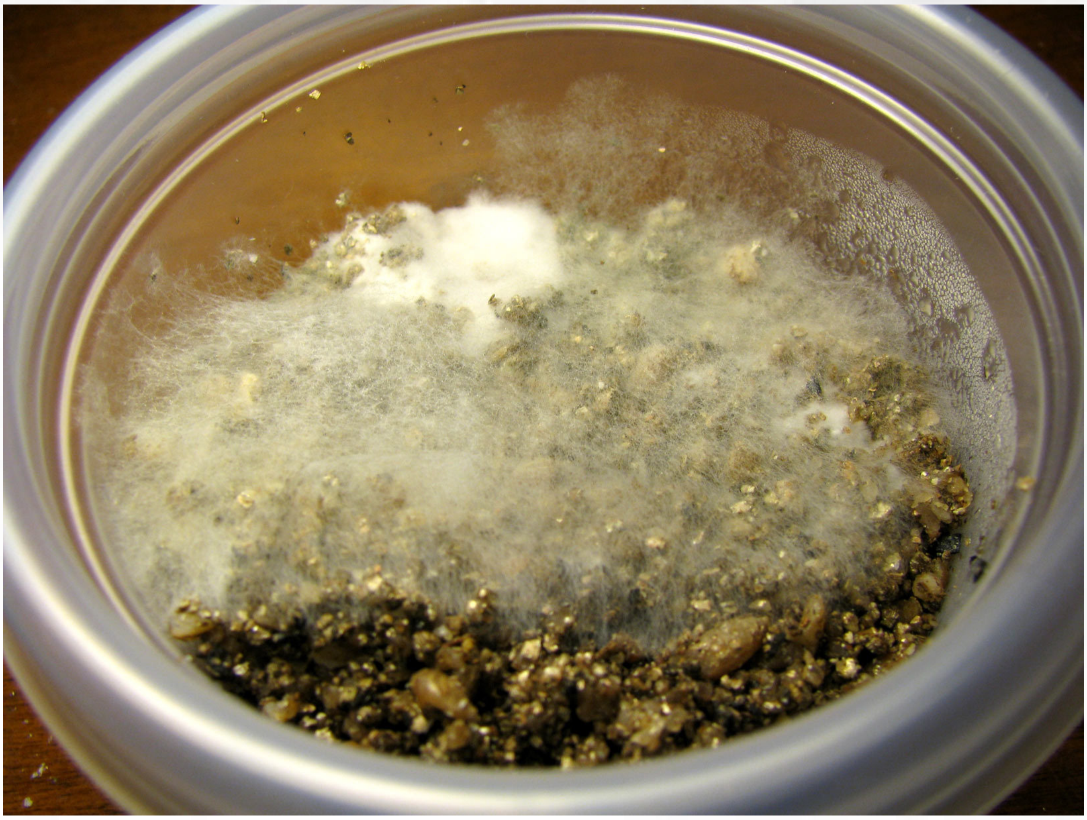


Cladobotryum variospermum

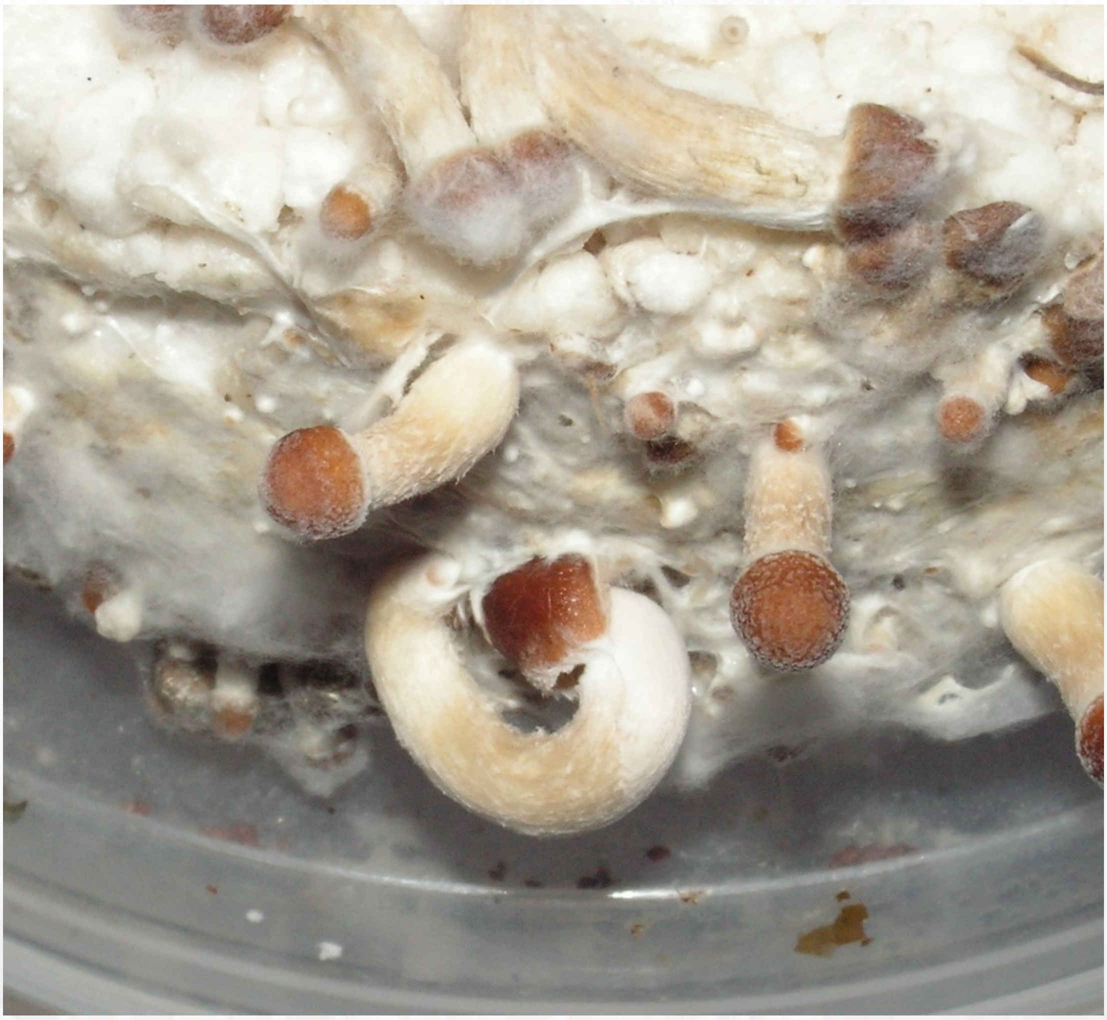
Here are some pictures of cobweb on Cubensis which I should mention to my knowledge have not been identified beyond all doubt.



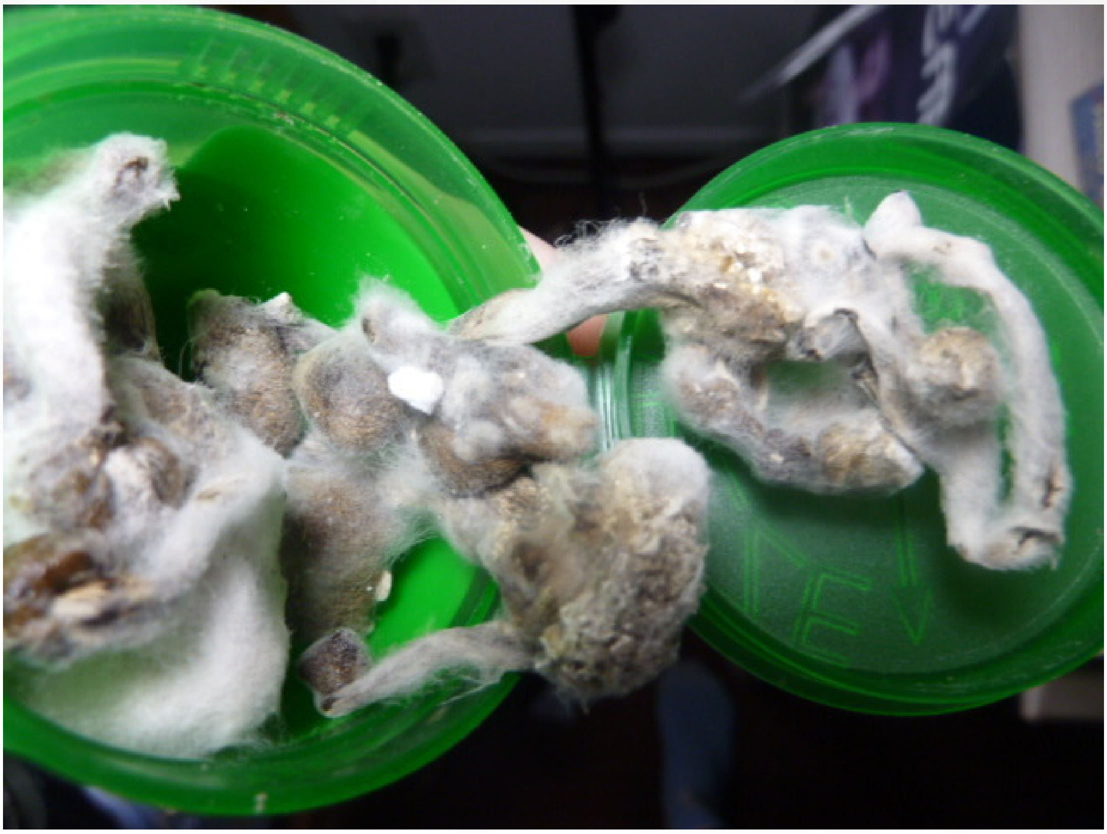
Possible cobweb on partially colonized substrate. It's growing completely over the substrate and not over the mycelium.



Cobweb on the (supposed to be) dry verm layer of a BRF cake. It's no coincidence that it didn't appear until the mushroom mycelium had grown through. That is a necessary for any visible growth on a casing layer, or in this case the equivalent of a casing layer. You can see the powdery of what appears to be spore formation.

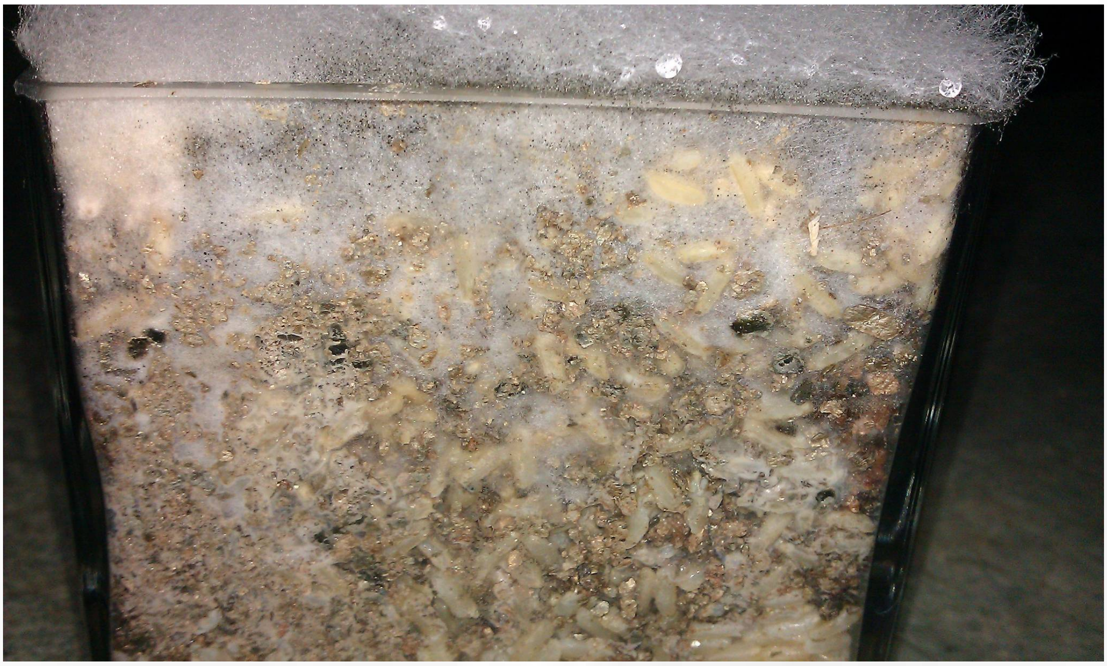


You can't even see them all anymore but there are pins and primordia under all those patches towards the bottom. However no spores for confirmation.

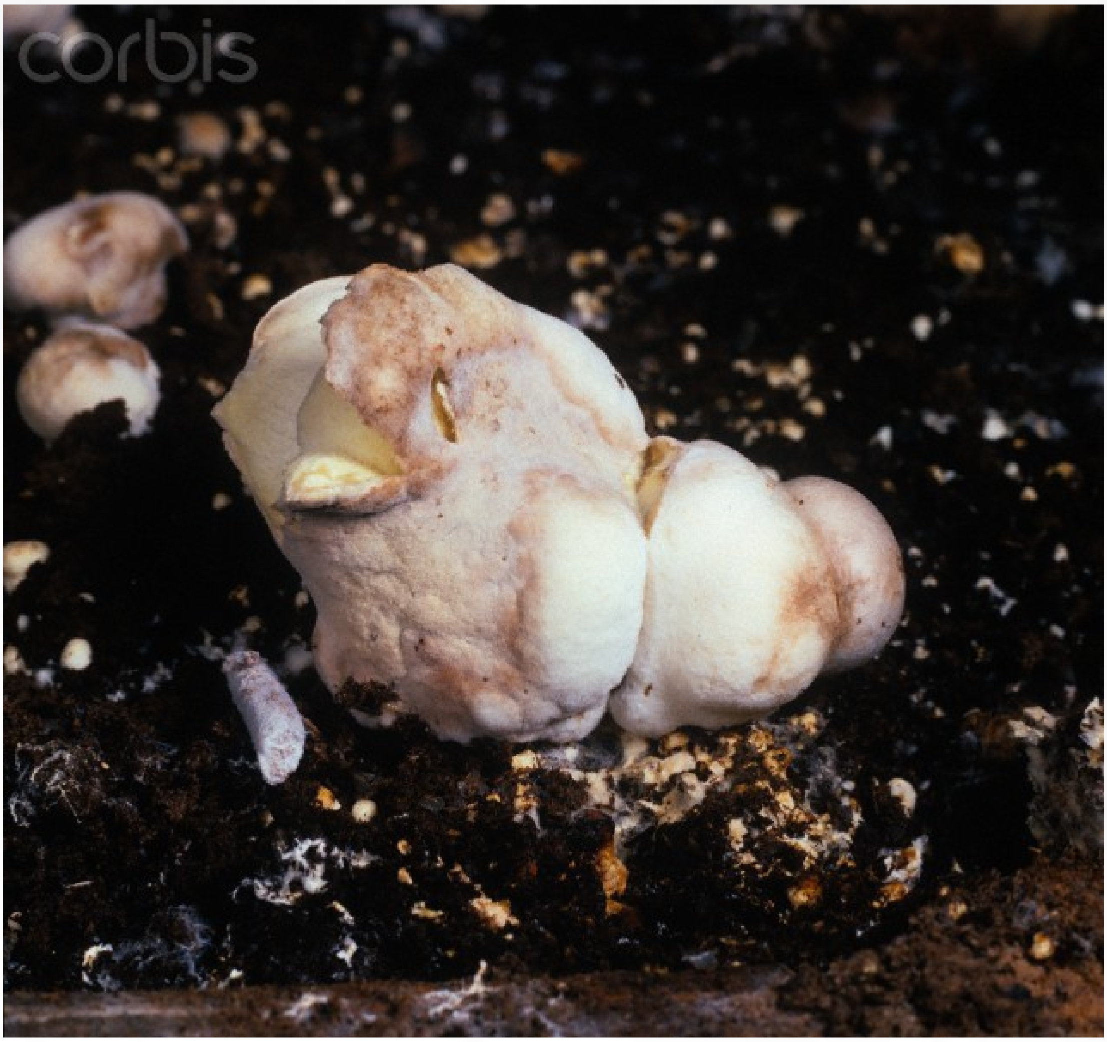


Cobweb on harvested mushrooms.

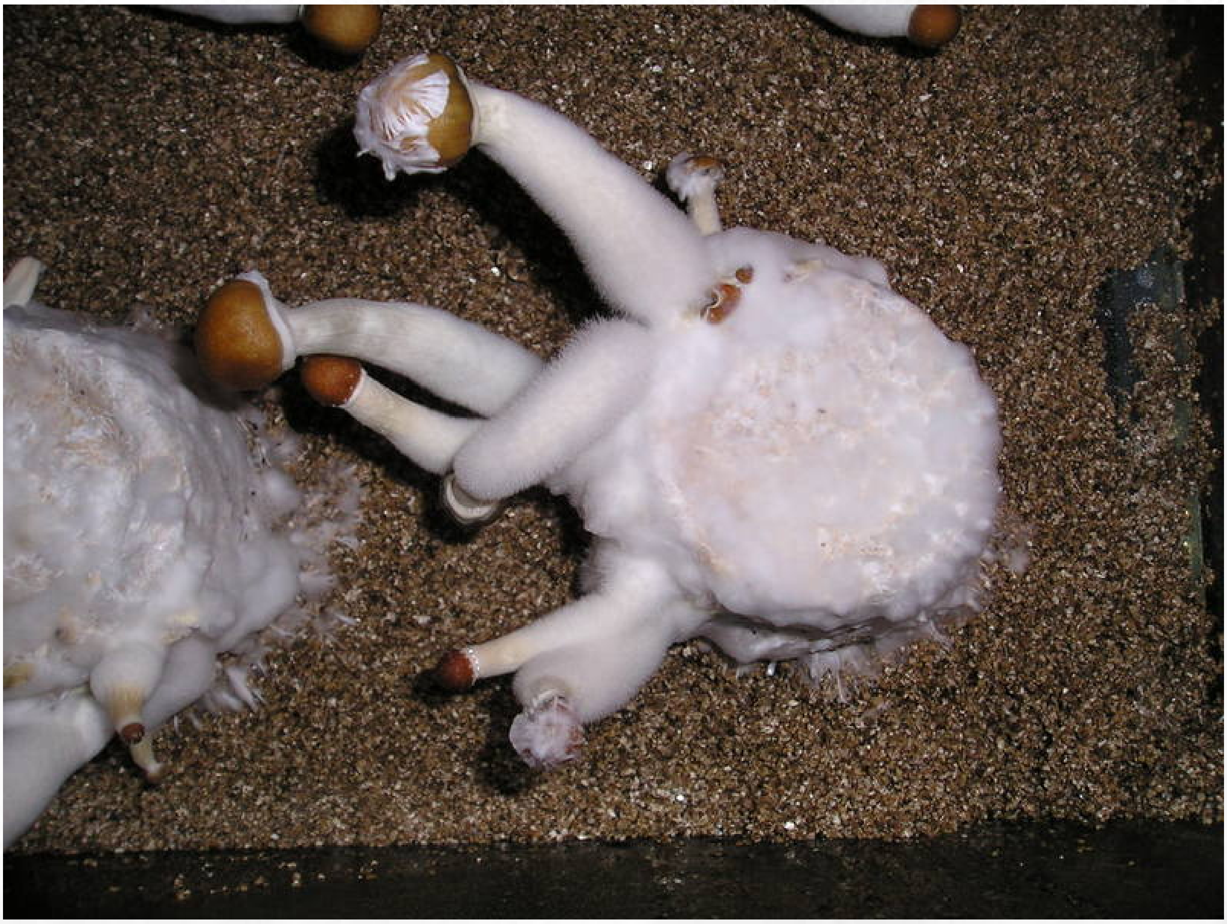
Some things that are NOT cobweb.



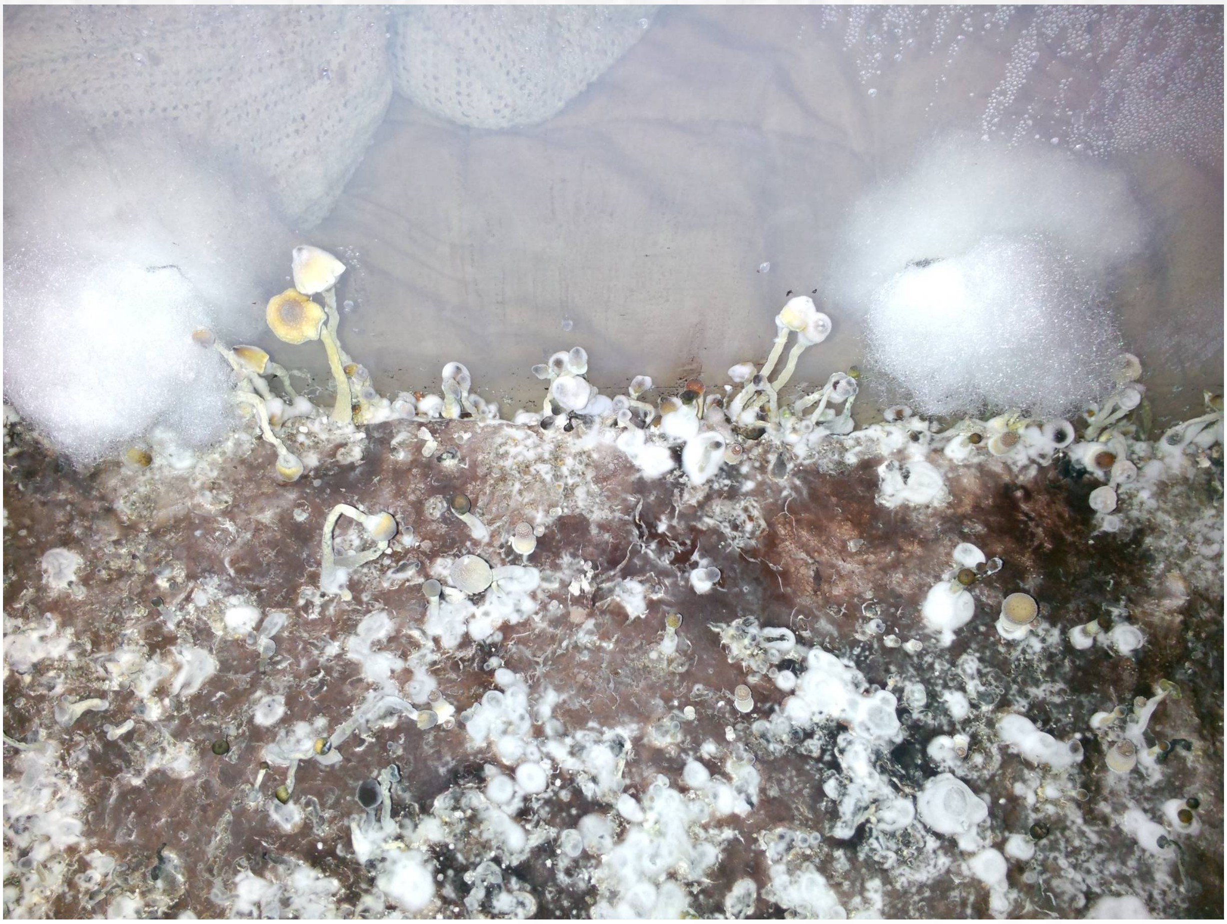
A perfect example of a pin mold which was thought to be cobweb despite the obvious presence of the black pins, and the immature white pins.



Verticillium infected mushroom.



Mushroom mycelium (fuzzy feet).



Old mushrooms and stumps although if there was cobweb there I don't think anyone would notice.

UPDATE: It's been a while since I posted this. I think I can say without a doubt now that actual *Dactylium* is not killed by 3% hydrogen peroxide. I have however discovered there are a couple *Mucorale* (pin molds) species that are when growing in anaerobic conditions. Or in other words they grow when gas exchange is lacking or when the substrate is oversaturated with water. They also do not sporulate under those conditions so if you're seeing the black pins they've establish themselves well enough to compete with the mushroom mycelium even after conditions are fixed and you've most likely already lost the opportunity to fix the problem.

Pilot Study of Psilocybin Treatment for Anxiety in Patients With Advanced-Stage Cancer

by

Charles S. Grob MD, et al.

Alicia L. Danforth, MA; Gurpreet S. Chopra, MD; Marycie Hagerty, RN, BSN, MA; Charles R. McKay, MD; Adam L. Halberstadt, PhD; George R. Greer, MD

PUBLISHED ONLINE SEPTEMBER 6, 2010

original source: http://enteogenios.com/wp-content/uploads/2011/10/2010_Grob_23136_1.pdf
backup source: http://www.psilosophy.info/resources/2010_Grob_23136_1.pdf

Author Affiliations: Departments of Psychiatry (Drs Grob and Chopra) and Internal Medicine (Dr McKay), Harbor-UCLA Medical Center and Los Angeles Biomedical Research Institute, Torrance (Drs Grob and McKay and Mss Danforth and Hagerty) and Department of Psychiatry, University of California, San Diego, La Jolla (Dr Halberstadt); and Heffter Research Institute, Santa Fe, New Mexico (Dr Greer).

Table of Contents:

- **Preface**
- **Methods**
  - *Assessment measures*
  - *Instruments*
    - Beck Depression Inventory
    - Profile of Mood States
    - State-Trait Anxiety Inventory
    - Brief Psychiatric Rating Scale
    - 5-Dimension Altered States of Consciousness Profile
  - *Data analysis*
- **Results**
  - *Cardiovascular function*
  - *Psychological measures*
- **Comment**
- **References**

PREFACE

Context: Researchers conducted extensive investigations of hallucinogens in the 1950s and 1960s. By the early 1970s, however, political and cultural pressures forced the cessation of all projects. This investigation reexamines a potentially promising clinical application of hallucinogens in the treatment of anxiety reactive to advanced-stage cancer.

Objective: To explore the safety and efficacy of psilocybin in patients with advanced-stage cancer and reactive anxiety.

Design: A double-blind, placebo-controlled study of patients with advanced-stage cancer and anxiety, with subjects acting as their own control, using a moderate dose (0.2 mg/kg) of psilocybin.

Setting: A clinical research unit within a large public sector academic medical center.

Participants: Twelve adults with advanced-stage cancer and anxiety.

Main Outcome Measures: In addition to monitoring safety and subjective experience before and during experimental treatment sessions, follow-up data including results from the Beck Depression Inventory, Profile of Mood States, and State-Trait Anxiety Inventory were collected unblinded for 6 months after treatment.

Results: Safe physiological and psychological responses were documented during treatment sessions. There were no clinically significant adverse events with psilocybin. The State-Trait Anxiety Inventory trait anxiety subscale demonstrated a significant reduction in anxiety at 1 and 3 months after treatment. The Beck Depression Inventory revealed an improvement of mood that reached significance at 6 months; the Profile of Mood States identified mood improvement after treatment with psilocybin that approached but did not reach significance.

Conclusions: This study established the feasibility and safety of administering moderate doses of psilocybin to patients with advanced-stage cancer and anxiety. Some of the data revealed a positive trend toward improved mood and anxiety. These results support the need for more research in this long-neglected field.

Trial Registration: clinicaltrials.gov Identifier: NCT00302744

Arch Gen Psychiatry. Published online September 6, 2010. doi:10.1001/archgenpsychiatry.2010.116

In recent years, there has been a growing awareness that the psychological, spiritual, and existential crises often encountered by patients with cancer and their families need to be addressed more vigorously.[1-4] From the late 1950s to the early 1970s, research was carried out exploring the use of hallucinogens to treat the existential anxiety, despair, and isolation often associated with advanced-stage cancer.[5-15] Those studies described critically ill individuals undergoing psychospiritual epiphanies, often with powerful and sustained improvement in mood and anxiety as well as diminished need for narcotic pain medication. Despite these promising results, there has been no follow-up research.

Today, the medical value of hallucinogens is again being examined in formal psychiatric settings. One substance under investigation is psilocybin, 4-phosphoryloxy-N,N-dimethyltryptamine, which occurs in nature in various species of mushrooms. Psilocybin is rapidly metabolized to psilocin, which is a potent agonist at serotonin $5\text{-HT}_{1A/2A/2C}$ receptors, with 5-HT_{2A} receptor activation directly correlated with human hallucinogenic activity.[16] Psilocybin was studied during the 1960s to establish its psychopharmacological profile; it was found to be active orally at around 10 mg, with stronger effects at higher doses, and to have a 4-to 6-hour duration of experience. Psychological effects were similar to those of lysergic acid diethylamide (LSD), with psilocybin considered to be more strongly visual, less emotionally intense, more euphoric, and with fewer panic reactions and less chance of paranoia than LSD.[17,18]

Recent clinical examinations of psilocybin have indicated that it is not hazardous to physical health.[19] Positron emission tomographic studies demonstrated that psilocybin produces a global increase in cerebral metabolic rate of glucose, most markedly in the frontomedial and frontolateral cortex, anterior cingulate, and temporomedial cortex. These changes were correlated with measures of psychological state and consistent with potential neurobiological substrates of major mental illnesses.[20]

In one recent study, 36 healthy volunteers received a high dose (30 mg/70 kg) of psilocybin with no sustained deleterious physiological or psychological effects. The investigators corroborated previous findings that psilocybin could reliably catalyze mystical experiences leading to significant and lasting improvements in quality of life.[21] In another study, the effects of psilocybin were examined in patients with severe, refractory obsessive-compulsive disorder. Researchers concluded that psilocybin is safe and well tolerated in subjects with obsessive-compulsive disorder and may be associated with "robust acute reductions" in core obsessive-compulsive disorder symptoms, although there was no clear dose-response relationship.[22]

During the first wave of hallucinogen research from the 1950s through the early 1970s, investigators who administered hallucinogens to patients with end-stage cancers reported results that included improved mood and reduced anxiety, even in those with profound psychological demoralization.[23-26] The present study is the first in more than 35 years to explore the potential utility of a psilocybin treatment model for patients with reactive anxiety associated with advanced-stage cancer.[27]

METHODS

Twelve subjects with advanced-stage cancer and a *DSM-IV*[28] diagnosis of acute stress disorder, generalized anxiety disorder, anxiety disorder due to cancer, or adjustment disorder with anxiety were recruited into a within-subject, double-blind, placebo-controlled study to examine the safety and efficacy of psilocybin in the treatment of psychological distress associated with the existential crisis of terminal disease. Participants were recruited through Internet postings, flyer distribution, presentations at local hospitals and wellness centers, oncologist referrals, and study registration on clinicaltrials.gov and by contacting local patient support agencies and health care providers. Medical and psychiatric screening including brain magnetic resonance imaging, communication with treating oncologists, formal psychiatric diagnostic interviews, and informed consent were required for enrollment into the study. Subjects were not paid for their participation. The institutional review board of the Los Angeles Biomedical Research Institute, Harbor-UCLA Medical Center, Torrance, California, approved the protocol and monitored the study.

Of the 12 subjects, 11 were women. Subjects' ages ranged from 36 to 58 years. Primary cancers included breast cancer in 4 subjects, colon cancer in 3, ovarian cancer in 2, peritoneal cancer in 1, salivary gland cancer in 1, and multiple myeloma in 1. All subjects were in advanced stages of their illness. The duration of their primary cancers ranged from 2 months to 18 years. Eight subjects completed the 6-month follow-up assessment, 11 completed at least the first 4 months of assessment, and all 12 completed at least the first 3 months of follow-up. Two subjects died of their cancer during the follow-up period, and 2 others became too ill to continue participating. The study was conducted from June 2004 to May 2008. By the time of submission of this report in 2010, 10 of the 12 subjects had died.

Exclusion criteria included central nervous system involvement of the cancer, severe cardiovascular illness, untreated hypertension, abnormal hepatic or renal function, diabetes, lifetime history of schizophrenia, bipolar disease, other psychotic illness, and anxiety or affective disorders within 1 year prior to the onset of cancer. Medication contraindications included active cancer chemotherapy, antiseizure medications, insulin and oral hypoglycemics, and psychotropic medications in the previous 2 weeks. Subjects also were asked to refrain from taking any medications the day of and the day after the experimental treatment sessions, except for prescription or over-thecounter nonnarcotic pain medications at any time and narcotic pain medications up to 8 hours before and 6 hours after administration of the experimental medicine.

Four subjects had no prior hallucinogen experience. Of the remaining 8, 4 had hallucinogen experience more than 30 years ago. Two had their last experience more than 5 years ago, and the other 2 had taken a hallucinogen within the year prior to their participation in the study. Hallucinogens taken included LSD (7 subjects), hallucinogenic mushrooms (5 subjects), peyote (2 subjects), and ayahuasca (2 subjects).

Subjects met with study staff to review the purpose and intention of participation in the study, the treatment goals, the structure of the experimental treatment sessions, and critical issues to be examined during the course of the treatments. Subjects were informed of the range of emotional reaction that might be experienced while under the influence of psilocybin, including challenging psychological issues that might arise, and were informed that the purpose of the investigation was to determine whether psilocybin could ameliorate the anxiety associated with their advanced-stage cancer. Additional goals of these meetings included establishing a comfortable level of rapport and trust between the patient and research personnel, reviewing significant life issues in the patient's history, and the nature and status of present relationships and concerns.

All experimental sessions took place in a hospital clinical research unit in a room decorated with fabric wall hangings and fresh flowers to provide a pleasing and comfortable environment. Subjects were admitted on the afternoon of the day prior to treatment. A Holter cardiac monitor was attached for 24 hours beginning at admission. Following medical and nursing evaluations, the treatment team met with the subject to review the procedure for the treatment session (described later), confirm the subject's personal intentions, and answer any additional questions. Subjects spent the night in the room on the research unit and were provided dinner and a light breakfast before 06:30 hours. On the morning of treatment, the therapeutic team met with the subject to administer presession instruments, attend to patient comfort, and review treatment procedures for the session one final time.

Each subject acted as his or her own control and was provided 2 experimental treatment sessions spaced several weeks apart. They were informed that they would receive active psilocybin (0.2 mg/kg) on one occasion and the placebo, niacin (250 mg), on the other occasion. Psilocybin and placebo were administered in clear 00 capsules with corn starch and swallowed with 100 mL of water. A niacin placebo was chosen because it often induces a mild physiological reaction (eg, flushing) without altering the psychological state. The order in which subjects received the 2 different treatments was randomized and known only by the research pharmacist. Treatment team personnel remained at the bedside with the subject for the entire 6-hour session.

Psilocybin or placebo was administered at 10:00 hours. The subject was encouraged to lie in bed wearing eye shades during the first few hours as well as to put on headphones to listen to preselected music. Subjects were allowed to remain undisturbed until each hour point, when treatment staff checked to inquire how they were doing. Contact was generally brief; subjects had been advised that there would be ample opportunity after the session and in subsequent days, weeks, and months to discuss the content of the experience. During hourly check-ins, heart rate (HR) and blood pressure (BP) measurements also were taken. Noncaffeinated clear liquids or juices were permitted.

At the conclusion of the 6-hour session, subjects discussed the subjective aesthetic, cognitive, affective, and psychospiritual experiences they had during the session and completed rating instruments. Various self-report inventories and questionnaires were administered from 2 weeks prior to the first treatment session to up to 6 months after the second. Treatment team personnel maintained contact with subjects for the entire 6-month follow-up period, including regularly scheduled monthly telephone calls to update data on adverse events, concomitant medications, and evolving medical and psychological status.

ASSESSMENT MEASURES

Subjects' BP and HR were measured 30 minutes before drug ingestion, immediately before drug administration, and at hourly intervals for the next 6 hours. Temperature was measured just prior to drug administration and 6 hours later at the conclusion of the session.

The following psychological measures were administered the day before each of the experimental sessions: the Beck Depression Inventory (BDI), Profile of Mood States (POMS), and State-Trait Anxiety Inventory (STAI). The POMS, STAI, 5-Dimension Altered States of Consciousness profile (5D-ASC), and Brief Psychiatric Rating Scale were administered at the conclusion of the experimental sessions. The day after the session, the BDI, POMS, and STAI were readministered. Finally, the BDI, POMS, and STAI were administered again 2 weeks after each session and at monthly intervals for 6 months after the final session.

INSTRUMENTS

Beck Depression Inventory

The BDI consists of a series of questions developed to measure the intensity, severity, and depth of depression.[29]

Profile of Mood States

The POMS describes feelings individuals have, with the subject indicating his or her mood during the past week, including the present day. The POMS Brief, used for this study, is a shorter version of the original POMS Standard.[30] Subjects were instructed to fill out the POMS and BDI in reference to their feelings during the past week.

State-Trait Anxiety Inventory

The STAI Form Y is a widely used self-report instrument for assessing anxiety in adults. It includes separate measures of state and trait anxiety.[31] The STAI evaluates the essential qualities of feelings of apprehension, tension, nervousness, and worry. The STAI differentiates between the temporary condition of state anxiety and the more general and long-standing quality of trait anxiety. The STAI state anxiety sub-scale asks for feelings at the moment of filling out the questionnaire, and the STAI trait anxiety subscale asks subjects to indicate how they generally view themselves.

Brief Psychiatric Rating Scale

The Brief Psychiatric Rating Scale provides clinician assessment of the level of symptoms such as hostility, suspiciousness, hallucination, and grandiosity.[32]

5-Dimension Altered States of Consciousness Profile

The 5D-ASC rating scale measures alterations in mood, perception, experience of self in relation to environment, and thought disorder.[33] The ASC items are grouped into 5 sub-scales comprising several items, including the following:
(1) *oceanic boundlessness*, measuring derealization and depersonalization accompanied by changes in affect ranging from elevated mood to euphoria; (2) *anxious ego dissolution*, measuring ego disintegration associated with loss of self-control, thought disorder, arousal, and anxiety; (3) *visionary restructuralization*, including hallucinations, pseudohallucinations, synesthesia, changed meaning of perceptions, and facilitated recollection and imagination; (4) *auditory alterations*, with acoustic alterations and alterations of auditory experiences; and (5) *reduction of vigilance*, associated with drowsiness, reduced alertness, and related impairment of cognition. Subjects filled out the 5D-ASC at the conclusion of the session.

DATA ANALYSIS

Raw BDI, POMS, and STAI data were analyzed using 2-way analysis of variance (ANOVA) with drug as the within-subject factor and day as a repeated measure. When the 2-way ANOVA detected significant main effects of drug or interactions between day and drug, post hoc pairwise comparisons were performed by 1-way ANOVA for each day. The 5D-ASC data were analyzed using 1-way ANOVA with drug as a within-subject factor. Item clusters comprising the oceanic boundlessness, anxious ego dissolution, and visionary restructuralization dimensions also were analyzed using 1-way ANOVA.[34] The Brief Psychiatric Rating Scale data were analyzed using 1-way ANOVA with drug as a within-subject factor. The HR and BP data were analyzed using 2-way ANOVA with drug as a within-subject factor and time as a repeated measure. When the 2-way ANOVA detected significant main effects of drug or interactions between time and drug, pairwise post hoc comparisons were performed by 1-way ANOVA at each time. For the measures listed earlier, significance was demonstrated by surpassing an α level of .05. Paired t tests were used to assess whether niacin placebo and psilocybin produced effects on HR and BP compared with the predrug time, and significance was demonstrated for these multiple comparisons by surpassing an α level of .025. For the BDI, POMS, and STAI, data from each of the 6 follow-up times were compared with the baseline value obtained on the day before the first treatment session, using t tests. For the follow-up data, significance was demonstrated by surpassing an α level of .05.

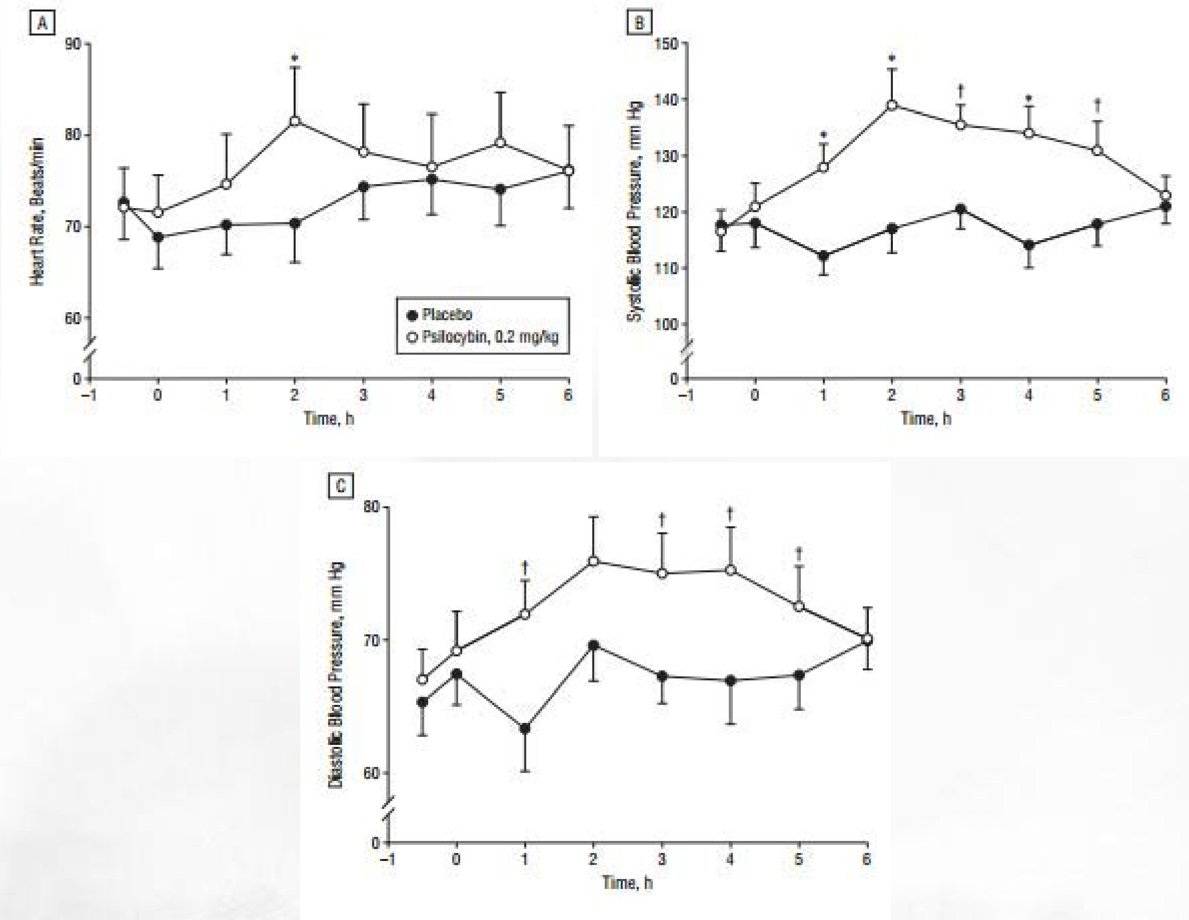


Figure 1. Effect of psilocybin or niacin placebo on mean (SEM) heart rate (A), systolic blood pressure (B),and diastolic blood pressure (C). Psilocybin or niacin placebo was administered at 0 hours. *P<.01, †P<.05 for psilocybin vs niacin placebo control (1-way analyses of variance were used to compare niacin and psilocybin effects at individual times).

RESULTS

CARDIOVASCULAR FUNCTION

The administration of psilocybin at a dose of 0.2 mg/kg induced a mild but statistically significant elevation of HR (psilocybin x time interaction: $F_{7,70}$=2.40, P=.03), systolic BP ($F_{1,11}$= 25.39, P<.001), and diastolic BP ($F_{1,11}$=5.94, P=.03) when compared with niacin placebo. Elevation of HR peaked 2 hours after psilocybin administration, with a mean (SEM) peak effect of 81.5
(5.8) beats/min, which was statistically significant ($F_{1,11}$=11.31, P<.007) compared with 70.4 (4.3) beats/ min during placebo sessions (Figure 1A).

Blood pressure also peaked at the 2-hour point, with mean (SEM) peak systolic BP during psilocybin sessions measuring 138.9 (6.4) mm Hg (compared with 117.0 [4.3] mm Hg during niacin placebo sessions) (Figure 1B) and mean (SEM) peak diastolic BP of 75.9 (3.4) mm Hg during psilocybin sessions (compared with 69.6 [2.7] mm Hg during niacin placebo sessions) (Figure 1C). Holter monitor recordings during the psilocybin sessions showed no sustained tachyarrhythmias or heart block and were consistent with findings during active placebo sessions. Compared with the predrug time, niacin modestly depressed diastolic BP 1 hour after administration (Figure 1C) with a rebound over the next hour but had no effect at other times.

PSYCHOLOGICAL MEASURES

The 5D-ASC demonstrated marked subjective differences between the psilocybin and placebo experiences. Psilocybin particularly affected the oceanic boundlessness ($F_{1,11}=33.12$, $P<.001$) and visionary restructuralization ($F_{1,11}=18.95$, $P=.001$) dimensions (Figure 2A). Psilocybin had smaller but significant effects on anxious ego dissolution ($F_{1,11}=4.91$, $P=.049$) and auditory alterations ($F_{1,11}=5.93$, $P=.03$). The item clusters with marked differences between the subjective states produced by psilocybin and niacin included a significant increase (P<.05) in psilocybin-invoked states of positive derealization, positive depersonalization, altered sense of time, positive mood, manialike experiences, elementary hallucinations, visual pseudohallucinations, synesthesia, changed meaning of percepts, facilitated recollection, and facilitated imagination. Subscales with no appreciable differences between intrasubjective states induced by the 2 treatments included anxious derealization, thought disorder, delusion, fear of loss of thought control, and fear of loss of body control (Figure 2B).

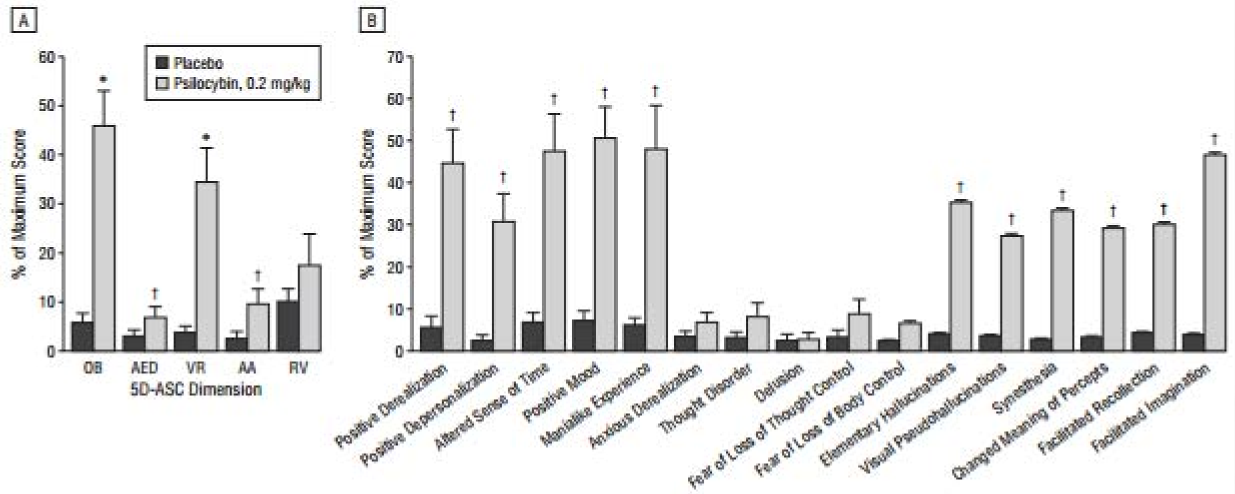


Figure 2. Subjective effects of psilocybin as measured by the 5-Dimension Altered States of Consciousness profile (5D-ASC). A, Five main 5D-ASC dimensions are shown: oceanic boundlessness (OB), anxious ego dissolution (AED), visionary restructuralization (VR), auditory alterations (AA), and reduced vigilance (RV). B, Item clusters comprising the OB, AED, and VR dimensions are shown. Values are the mean (SEM) percentages of the total possible score. *$P<.01$, †$P<.05$ for psilocybin vs niacin placebo control (1-way analyses of variance were used to compare niacin and psilocybin effects on individual 5D-ASC dimensions and 5D-ASC item clusters).

For the BDI, there was an overall interaction of psilocybin and day that approached but did not attain statistical significance ($F1,11=3.75$, $P=.08$). There was no appreciable change from 1 day prior to placebo administration to 2 weeks after experimental treatment, whereas a trend was observed after psilocybin administration, from a mean (SEM) score of 16.1 (3.6) one day before treatment to 10.0 (2.7) two weeks after treatment (Figure 3A). As shown in Figure 3B, BDI scores dropped by almost 30% from the first session to 1 month after the second treatment session ($t_{11}=-2.17$, $P=.05$), a difference that was sustained and became significant at the 6-month follow-up point ($t_7=2.71$, $P=.03$).

The POMS similarly revealed a trend for reduced adverse mood tone from 1 day before treatment with psilocybin to 2 weeks later, a difference that was not seen after placebo (drug x time interaction: $F_{3,33}=2.71$, $P=.06$) (Figure 4A). Paired post hoc tests revealed that mean (SEM) POMS scores were elevated ($F_{1,11}=7.48$, $P=.02$) 1 day before psilocybin treatment (11.3 [3.1]) compared with 1 day before placebo (4.5 [2.0]) and demonstrated that this difference disappeared 6 hours after psilocybin administration. Improvement of mood, indicated by reduced POMS scores, was observed in 11 subjects after administration of psilocybin. The elevation of POMS scores 1 day before psilocybin treatment occurred regardless of whether the subjects were treated with placebo or psilocybin first (ie, there was no interaction between treatment order and drug). As shown in Figure 4B, POMS scores were not altered during the 6 months of follow-up compared with the day before the first treatment session.

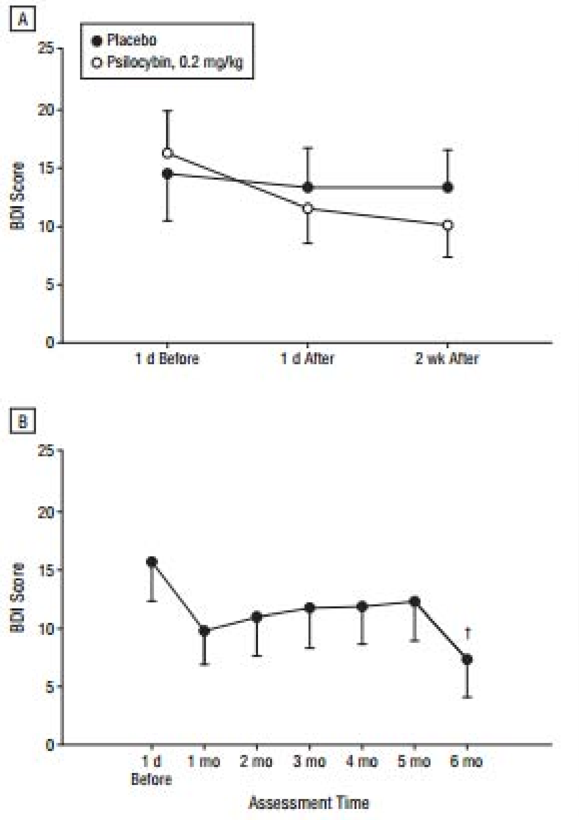


Figure 3. Beck Depression Inventory (BDI) scores. A, Mean (SEM) BDI scores 1 day before, 1 day after, and 2 weeks after administration of psilocybin or niacin placebo are shown. B, Six months of mean (SEM) BDI follow-up data are shown. The BDI was administered at monthly intervals for 6 months after the second treatment session, and the 6 sets of monthly follow-up data were compared with the scores obtained the first time the participants filled out the instruments (ie, 1 day before the first treatment session). †P<.05 for psilocybin vs the value from 1 day before the first treatment session (*t* tests were used to compare individual monthly follow-up values with values on the day before the first session).

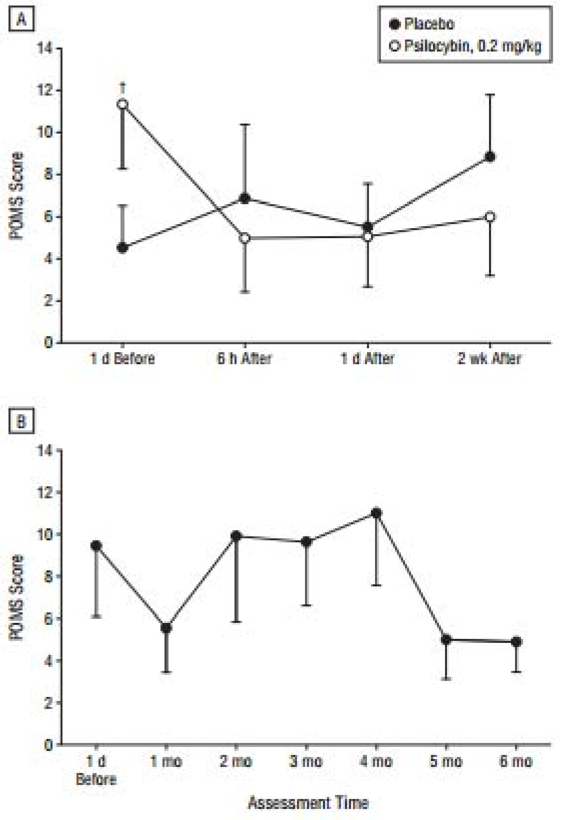


Figure 4. Profile of Mood States (POMS) scores. A, Mean (SEM) POMS scores 1 day before, 6 hours after, 1 day after, and 2 weeks after administration of psilocybin or niacin placebo are shown. B, Six months of mean (SEM) POMS follow-up data are shown. The POMS was administered at monthly intervals for 6 months after the second treatment session, and the 6 sets of monthly follow-up data were compared with the scores obtained the first time the participants filled out the instruments (ie, 1 day before the first treatment session). †P<.05 for psilocybin vs niacin placebo control (1-way analyses of variance were used to compare niacin and placebo effects at individual times).

The STAI revealed no significant changes from 1 day before to 2 weeks after treatment, although a substantial but nonsignificant decrease was evident for the state anxiety subscale 6 hours after psilocybin administration, which was not observed after placebo (Figure 5A and C). Although minimal change was observed in the STAI state anxiety score for follow-up data, a sustained decrease in STAI trait anxiety was observed for the entire 6-month follow-up, reaching significance at the 1-month (t_{11}=4.36, P =.001) and 3-month (t_{10}=2.55, P = .03) points after the second treatment session (Figure 5B and D).

The Brief Psychiatric Rating Scale at the end of the experimental session revealed no appreciable difference between psilocybin and placebo administration.

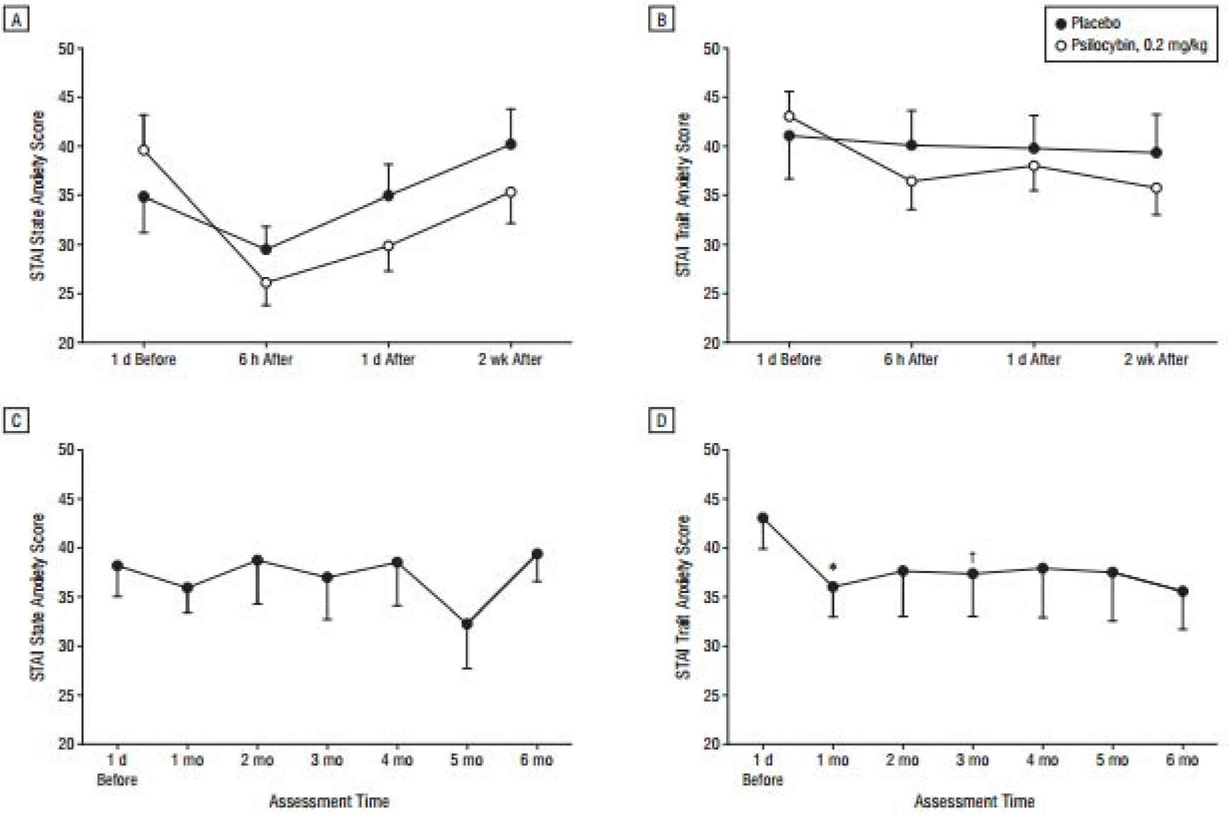


Figure 5. Mean (SEM) State-Trait Anxiety Index (STAI) state anxiety scores (A) and trait anxiety scores (B) 1 day before, 6 hours after, 1 day after, and 2 weeks after administration of psilocybin or niacin placebo are shown. Six months of mean (SEM) STAI state anxiety follow-up data (C) and trait anxiety follow-up data (D) are shown. The STAI was administered at monthly intervals for 6 months after the second treatment session, and the 6 sets of monthly follow-up data were compared with the scores obtained the first time the participants filled out the instruments (ie, 1 day before the first treatment session). *$P<.01$, †$P<.05$ for psilocybin vs the value from 1 day before the first treatment session (*t* tests were used to compare individual monthly follow-up values with values on the day before the first session).

COMMENT

The initial goals of this research project were to establish feasibility and safety for a hallucinogen treatment model in patients with advanced-stage cancer and anxiety. Following discussion with federal and state regulatory agencies as well as hospital institutional review board and research committees, a modest 0.2-mg/kg psilocybin dose was chosen. Although not comparable to higher doses of hallucinogens administered in the past to severely ill patients, the dose used here was still believed capable of inducing an alteration of consciousness with potential therapeutic benefit while optimizing patient safety. Determining safe parameters with this novel treatment paradigm is critical to establishing a strong foundation for this field of study that would allow for future investigations.

Consistent with previous research, we found no untoward cardiovascular sequelae in our subject population.[19] Minor HR and BP elevations after psilocybin administration were evidence only of a mild sympathomimetic effect. Holter monitoring did not identify increased cardiac arrhythmias in comparison with niacin placebo, even in subjects who presented with some baseline cardiac arrhythmia. Niacin may acutely lower BP through vasodilation[35] but had minimal effects on BP and HR in our subjects, except for a reduction in diastolic BP that was noted 1 hour after administration of niacin. This transient effect may have contributed to our detection of a significant psilocybin effect at that time but cannot explain the significant effects of psilocybin over the subsequent intervals because the initial niacin-induced reduction of diastolic BP did not persist. We also observed no adverse psychological effects from the treatment. All subjects tolerated the treatment sessions well, with no indication of severe anxiety or a "bad trip." The fact that psilocybin produced only modest effects on the anxious ego dissolution scale of the 5D-ASC confirmed this conclusion.

When hallucinogens were administered to patients with terminal cancer in the 1960s and early 1970s, the occurrence of a profound psychospiritual experience was correlated with therapeutic outcome.[10,12] Such transcendent states of consciousness are usually associated with higher doses of hallucinogens, so our expectation of demonstrating efficacy was limited.[21] Common themes reported by subjects included examining how their illness had impacted their lives, relationships with family and close friends, and sense of ontological security. In addition, subjects reported powerful empathic cathexis to close friends and family members and examined how they wished to address their limited life expectancy. In monthly follow-up discussions, subjects reflected on insights and new perspectives gained during their psilocybin treatment. However, the frequency of these reports was not quantified.

Although past researchers reported more pronounced therapeutic effects with a higher-dose model, even the lower dose of psilocybin used in the current study gave some indication of therapeutic benefit in quantitative psychological evaluations. In particular, we found that the STAI trait anxiety subscale demonstrated a sustained reduction in anxiety that reached significance at the 1-and 3-month points after treatment. This reduction might reflect a reduced level of stress and anxiety over time. Although the state anxiety on the STAI showed a modest elevation at 6 months, the change was not statistically significant and might have resulted from the deteriorating medical status of most subjects over time.

Mood also improved for 2 weeks after treatment with psilocybin, with sustained improvement on the BDI reaching significance at the 6-month follow-up point. The POMS scores also reflected improved mood 2 weeks after receiving psilocybin. Although not statistically significant, there was a trend toward positive outcome. With a larger cohort of subjects and use of a higher dose of psilocybin, it seems possible that significant results would be obtained on these measures.

Compared with placebo sessions, POMS scores were elevated in subjects immediately prior to psilocybin administration. The reasons for this difference in POMS scores 1 day before administration are not entirely clear. Subject expectations were unlikely to have played a role in the elevation of the POMS scores on the day before treatment because the elevation occurred regardless of treatment order. The most likely explanation for the elevation of POMS scores prior to treatment with psilocybin may be that subject randomization was not complete with regard to this instrument. Nonetheless, POMS scores declined after administration of psilocybin in 11 of 12 subjects, suggesting that psilocybin produces mood-elevating effects that persist after the acute effects of the drug.

Another focus of the study was the effect of a 0.2mg/kg psilocybin dose on somatic symptoms, particularly pain perception. In contrast to previous investigations, we did not find robust reductions in pain perception or lessened need for narcotic pain medication. In the 2 weeks following experimental treatment sessions, several subjects reported lessened pain, whereas others did not. There was no apparent difference between subjects treated with psilocybin and those treated with placebo (data not shown). Although this modest dose of psilocybin was not observed to impact pain, given the impressive reports of earlier researchers,[6] this measure would certainly be indicated for study with higher doses.

Although we used a within-subject, double-blind, placebo-controlled design, the drug order was almost always apparent to subjects and investigators whether the treatment was psilocybin or placebo. In fact, one consistent subject critique of the study was that the placebo sessions were perceived as far less worthwhile than those with psilocybin. Many of the subjects suggested that future protocols provide the opportunity for a second psilocybin session several weeks after the first. The general consensus among subjects was that a follow-up experience with psilocybin would reinforce and extend the perceived therapeutic effects of the initial session.

Future studies also will need to address the issue of controlling for a placebo effect that might otherwise be attributed to the active treatment. Given the subjects' grave prognosis and limited life expectancy, we decided to provide all subjects with an opportunity to experience the experimental medicine and to serve as their own control. Although we believed that to be the ethical course to take, given the life circumstances subjects were encountering, the protocol design contains some inherent limitations. A better experimental design might incorporate an independent control group, receiving only either placebo treatment or a conventional psychopharmacological intervention. Although there is no question that the extensive attention paid to the subjects influenced outcomes, the unique qualities of the psilocybin experience in facilitating strong therapeutic bonds and ameliorating underlying psychological demoralization are important factors worthy of further exploration.

Another limitation of this study was variability in the extent of contact with subjects after treatment. A minimum contact of 1 hour monthly was established, but variability in additional ad hoc communication depended on the needs and wishes of the subjects, some of whom were near death compared with others who were more functional.

Despite the limitations, this study demonstrates that the careful and controlled use of psilocybin may provide an alternative model for the treatment of conditions that are often minimally responsive to conventional therapies, including the profound existential anxiety and despair that often accompany advanced-stage cancers. A recent review from the psilocybin research group at Johns Hopkins University describes the critical components necessary for ensuring subject safety in hallucinogen research.[36] Taking into account these essential provisions for optimizing safety as well as adhering to strict ethical standards of conduct for treatment facilitators, the results provided herein indicate the safety and promise of continued investigations into the range of medical effects of hallucinogenic compounds such as psilocybin.

Submitted for Publication: August 17, 2009; final revision received June 28, 2010; accepted July 4, 2010. Published Online: September 6, 2010. doi:10.1001 /archgenpsychiatry.2010.116 Correspondence: Charles S. Grob, MD, Department of Psychiatry, Harbor-UCLA Medical Center, Box 498, 1000 W Carson St, Torrance, CA 90509 (cgrob@labiomed .org).

Author Contributions: Dr Grob had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Financial Disclosure: Drs Grob and Greer are on the board of directors of the Heffter Research Institute. Dr Greer had no approval/disapproval authority over either the manuscript or the reported data.

Funding/Support: This work was supported by the Heffter Research Institute; the Betsy Gordon Foundation; the Nathan Cummings Foundation, with the support and encouragement of James K. Cummings; and grant M01RR00425 from the National Institutes of Health to the Harbor-UCLA General Clinical Research Center. Previous Presentation: These findings were presented at the annual meeting of the Royal College of Psychiatrists; June 4, 2009; Liverpool, England. Additional Contributions: Ira Lesser, MD, David Nichols, PhD, Mark Geyer, PhD, and Roland Griffiths, PhD, provided comments on the manuscript.

REFERENCES

1. Breitbart W, Gibson C, Poppito SR, Berg A. Psychotherapeutic interventions at the end of life: a focus on meaning and spirituality. *Can J Psychiatry*. 2004: 49(6):366-372.
2. Breitbart W, Rosenfeld B, Pessin H, Kaim M, Funesti-Esch J, Galietta M, Nelson CJ, Brescia R. Depression, hopelessness, and desire for hastened death in terminally ill patients with cancer. *JAMA*. 2000;284(22):2907-2911.
3. Chochinov HM. Psychiatry and terminal illness. *Can J Psychiatry*. 2000;45(2):143-150.
4. Rousseau P. Spirituality and the dying patient. *J Clin Oncol*. 2000;18(9):2000-2002.
5. Kast EC. The measurement of pain, a new approach to an old problem. *J New Drugs*. 1962;2:344-351.
6. Kast EC. Pain and LSD-25: a theory of attenuation of anticipation. In: Solomon D, ed. *LSD: The Consciousness-Expanding Drug*. New York, NY: GP Putnam; 1966: 239-254.
7. Kast EC. LSD and the dying patient. *Chic Med Sch Q*. 1966;26(2):80-87.
8. Kast EC. Aconcept of death. In: Aronson B, Osmond H, eds. *Psychedelics: The Uses and Implications of Hallucinogenic Drugs*. Garden City, NY: Anchor; 1970: 266-381.
9. Kast EC, Collins VJ. Study of lysergic acid diethylamide as an analgesic agent. *Anesth Analg*. 1964;43:285-291.
10. Pahnke WN. The psychedelic mystical experience in the human encounter with death. *Harv Theol Rev*. 1969;62(1):1-21.
11. Grof S. *LSD Psychotherapy*. Pomona, CA: Hunter House; 1980.
12. Grof S, Goodman LE, Richards WA, Kurland AA. LSD-assisted psychotherapy in patients with terminal cancer. *Int Pharmacopsychiatry*. 1973;8(3):129-144.
13. Richards WA, Grof S, Goodman LE, Kurland AA. LSD-assisted psychotherapy and the human encounter with death. *J Transpers Psychol*. 1972;4(2):121-150.
14. Fisher G. Death, identity and creativity. *Voices: Art Sci Psychother*. 1969;5:36-39.
15. Fisher G. Psychotherapy for the dying: principles and illustrative cases with special reference to the use of LSD. *Omega*. 1970;1(1):3-15.
16. Presti D, Nichols D. Biochemistry and neuropharmacology of psilocybin mushrooms. In: Metzner R, ed. *Teonanacatl: Sacred Mushroom of Vision*. El Verano, CA: Four Trees; 2004:89-108.
17. Passie T, Seifert J, Schneider U, Emrich HM. The pharmacology of psilocybin. *Addict Biol*. 2002;7(4):357-364.
18. Passie T. A history of the use of psilocybin in psychotherapy. In: Metzner R, ed. *Teonanacatl: Sacred Mushroom of Vision*. El Verano, CA: FourTrees; 2004:109-134.
19. Hasler F, Grimberg U, Benz MA, HuberT, Vollenweider FX. Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. *Psychopharmacology (Berl)*. 2004;172(2):145-156.
20. Vollenweider FX, Leenders KL, Scharfetter C, Maguire P, Stadelmann O, Angst J. Positron emission tomography and

fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology*. 1997;16(5):357-372.

21. Griffiths RR, Richards WA, McCann U, Jesse R. Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology (Berl)*. 2006;187(3):268-283, discussion 284-292.
22. Moreno FA, Wiegand CB, Taitano EK, Delgado PL. Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J Clin Psychiatry*. 2006;67(11):1735-1740.
23. Grinspoon L, Bakalar JB. *Psychedelic Drugs Reconsidered*. New York, NY: Basic Books; 1979.
24. Grob CS. Psychiatric research with hallucinogens: whathave we learned? *Heffter Rev Psychedelic Res*. 1998;1:8-20.
25. Grob CS, ed. *Hallucinogens: A Reader*. New York, NY: Tarcher/Putnam; 2002.
26. Walsh R, Grob CS, eds. *Higher Wisdom: Eminent Elders Explore the Continuing Impact of Psychedelics*. Albany: State University of New York; 2005.
27. Grob CS. The use of psilocybin in patients with advanced cancer and existential anxiety. In: Winkelman MJ, Roberts TB, eds. *Psychedelic Medicine: New Evidence for Hallucinogenic Substances as Treatment*. Westport, CT: Praeger; 2007: 205-216.
28. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed, text revision. Washington, DC: American Psychiatric Association; 2000.
29. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry*. 1961;4(6):561-571.
30. Cella DF, Jacobsen PB, Orav EJ, Holland JC, Silberfarb PM, Rafla S. Abrief POMS measure of distress for cancer patients. *J Chronic Dis*. 1987;40(10):939-942.
31. Spielberger CD, Gorsuch RL, Lushene R, Vagg PR, Jacobs GA. *State-Trait Anxiety Inventory*. Menlo Park, CA: Mind Garden; 1970.
32. Overall JE, Gorham DR. The Brief Psychiatric Rating Scale. *Psychol Rep*. 1962; 10:799-812.
33. Dittrich A, Lamparter D, Maurer M. *5D-ABZ: Fragebogen zur Erfassung Aussergewöhnlicher Bewusstseinszustände: Eine kurze Einfürhung*. Zürich, Switzerland: PSIN Plus; 1999.
34. Vollenweider FX, Csomor PA, Knappe B, Geyer MA, Quednow BB. The effects of the preferential 5-HT2A agonist psilocybin on prepulse inhibition of startle in healthy human volunteers depend on interstimulus interval. *Neuropsychopharmacology*. 2007;32(9):1876-1887.
35. Bays HE, Rader DJ. Does nicotinic acid (niacin) lower blood pressure? *Int J Clin Pract*. 2009;63(1):151-159.
36. Johnson MW, Richards WA, Griffiths RR. Human hallucinogen research: guidelines for safety. *J Psychopharmacol*. 2008;22(6):603-620.

Treatment of Childhood Schizophrenia Utilizing LSD and Psilocybin

by

Gary Fisher, Ph.D.

original source: http://www.maps.org/news-letters/v07n3/07318fis.html

Table of Contents:

- Hypothesis
- Ward Conditions
- New Behavior
- Patty's First Session
  - *The Second Session*
  - *The Third Session*
- Timmy
- Jenny
- Stevie
- Floyd
- Nancy
- Jeannie
- The Work Ends
- Acknowledgment
- References

> *Now that the FDA has permitted research with LSD and psilocybin to resume, we feel it is important to share examples of a remarkable experiment, the results of which were not sufficiently taken into account because this line of research was prematurely halted in the mid-sixties due to political considerations. Childhood schizophrenia is still a difficult problem to treat and causes much suffering. It is a terrible shame that research done 35 years ago is still the last word on the use of psychedelics to treat these conditions. - Ed.*

Hypothesis

The working hypothesis of this study is that psychosis is a massive defensive system of repression-avoidance-denial in the service of protecting the individual from experiencing early childhood trauma. The repression is so massive that the individual ceases to experience himself with any validity. The individual exists isolated in a world without feelings and this world becomes meaningless. One of our little patients told me that he lived in a world of "no nothingness." It was hypothesized that the psychedelic drugs could break through this massive repression wherein the child would re-experience these traumatic events and release the pain bound to those experiences. He or she would acknowledge his own history. Furthermore, through experiencing the loving attention of the staff in a milieu of total acceptance, the child could begin to experience himself as a positive and valid person. The team consisted of a psychiatrist (who chose not to have an LSD experience but was medically responsible for the research), four psychology graduate students and three psychiatric nursing technicians. The author acted as lead therapist of this group. For any one session there were usually three to four staff, relieving each other throughout the day as the sessions were extremely intense and required very active participation by the staff. All staff had had their own experience with LSD and psilocybin, as it is accepted practice that in order to understand what was going on with the children one had to have had personal experiences with the drugs. As we progressed with the work it emerged that one staff person would become the primary therapist for each patient. Each session was continuously recorded for the verbalizations and behavior of the patient. Besides spending time with the patient during the treatment session itself, a total program had to be developed for each patient and that program communicated to all ward personnel to attempt consistency in the therapeutic approach. We were careful to include ward personnel who were not part of the treatment team in the ongoing progress of each patient and to enlist their cooperation in the development of a consistent attitude. As the ward personnel began to see the remarkable changes occurring in the children, they became involved and supportive in the ongoing care of each child.

Ward Conditions

The ward in which these children lived was in a state of constant pandemonium. The ward housed some sixty children ranging in age from four to twelve who were the most severely disturbed children of a larger hospital population. There was constant screeching, fighting and destructive behavior. Many children were destructive towards the environment, to each other, to the staff and to themselves. The primary duty of the ward personnel was damage control. The noise level was always high, as many of the children were extremely hyperactive and vocal. Other children were very withdrawn, involved in repetitious physical motions and when interfered with would lash out at the intruder. There was little interactive or parallel play and any toys or material brought into the ward were soon destroyed. Feces smearing and random urinating were a constant problem. To say the least the environment was not conducive to good mental health.

New Behavior

After nine months of the program and fifty-eight treatment sessions it was decided to continue the program with five patients of the initial twelve. The children discontinued from the program were characterized by a lack of speech and infantile autism and were the least responsive to treatment. They were extremely withdrawn and had no ability to relate to other children or adults. In spite of their severe limitations, all of them did have some marked response to the treatments. During the sessions they showed little responsiveness although some of them became hyperactive and were obviously having some sensory experiences and more interaction with the staff. One girl had a prolonged fear response. Marked changes occurred in the days following the sessions. They showed much more interest in relating to the treatment staff, became animated and playful and remarkably less withdrawn. One girl evidenced extreme frustration at not being able to verbally communicate as she had no language development. The youngest (four years old) and least developed child kept trying to lead a treatment staff person down to the room where we did sessions. They all had interest in making physical contact with the treatment staff and one very autistic child became quite demanding to be held. This was all new behavior for these children. Consequently they all had behavior changes but their potential in relation to other patients was much more limited and we had limited time available to treat them.

Among the children with whom we discontinued treatment, one twelve year old girl had progressed so remarkably that she was able to attend public school during the day and return to the hospital in the evenings. It was felt that she had sufficiently improved, was functioning satisfactorily in the school system and that further treatment was not crucial. Patty was the only patient who was not psychotic. She responded to the treatments more rapidly than the more disturbed patients. A short summary of her treatment will help illustrate the work.

Patty's First Session

Patty had three sessions over a period of three months. Dosage for the sessions were 100 micrograms of LSD, 100 micrograms of LSD with 10 milligrams of psilocybin, and 200 micrograms of LSD. She was hospitalized because of her inability to function at home, in the school or in the community. Her behavior fluctuated from being withdrawn and uncommunicative to very aggressive and sadistic towards smaller children. She stole food and other items from other smaller children and when thwarted in her behavior had violent temper tantrums and had to be physically restrained and isolated. Although her IQ was tested at 72, her low functioning seemed to be caused by severe personality problems and it was estimated that her potential was near the normal range. During the first session she spent the entire seven hours regressing to an infantile oral state. She incessantly repeated, "I'm hungry" and when asked what she was hungry for, she did not reply but only restated her hunger. During the entire session she chewed and sucked on her clothes or others, her fingers, arms and anything or anyone she could reach. She was given an empty baby bottle with cotton stuffed in the nipple and she chewed and sucked on this for hours. It was clear that she was trying to draw nourishment from anything in her environment. During the session one staff member would sit with her, holding her hand or arm and gently hugging her or stroking her. We gave her constant tactile care. For about two hours she aggressively bit the nipple, stretching it and gnawing on it. She finally appeared to become exhausted and uncommunicative for almost an hour. In the latter stages she held hands with staff and smiled quietly without verbalizing. She appeared to be making genuine interpersonal contact.

The Second Session

In the month following her treatment Patty was much more subdued and did not want to talk a great deal about the first session. During the second session she spent a great deal of time sucking on the baby bottle but this time she said she wanted milk in it and we complied. She then went into a panic-like state and talked a great deal of her fear of being rejected by her parents. She insisted that we call them immediately and have them come and take her home. She was extremely anxious that she would be abandoned by them and at one time sadly said of her mother, "She doesn't love me." After some three hours of constant turmoil concerning her familial relationships and her severe agitation over the rejection by her parents, she slipped into a quiet state for a period of time. She then suckled on the milk bottle and when she took it out of her mouth she would repeat, "I am loved." After some four hours she said "I love my mother, my father, my brothers and my sisters, I never felt this way before. I love them." She said that she had never felt that she was loved and the feeling of being loved and loving that she was now experiencing was new to her. She then went into a state for about two hours which is best described as a deep trance state. She was completely still with no movement whatsoever, and was unresponsive to all verbal or tactile stimuli. She finally came out of it and started smiling but still remained unresponsive to any of our inquiries. After about another hour she got up and wanted to go for a walk outside. She was happy and smiling and occasionally would laugh out loud.

Following this session Patty again was much more subdued, her behavior changed remarkably in that her temper tantrums ceased and she was relaxed and content. She interacted with new maturity toward the staff and had a very positive relationship (it looked like adolescent adoration) with one of the male psychology students. They spent a good deal of time with each other.

The Third Session

The third session, two months later, was initially characterized by more oral regressive behavior. She asked for the baby bottle with milk and spent over two hours, biting on it, suckling it trying to swallow the whole bottle, but this behavior did not have a desperate quality to it. She seemed to be more playing with it, enjoying it, and her demeanor was quiet and content. She suckled for long periods and would drift off into a peaceful, tranquil state, completely relaxed, smiling at the sitters when making eye contact. She wanted to be quiet and we were quiet with her - touching her, hugging her, holding her hand when she reached out. She responded to visual stimulation such as a rose with delight and amazement. She thoroughly enjoyed the attention and affection of the staff. Again following the session she was much more mature, interested in relating to adults and wanted to go to school with kids her own age. Her temper tantrums and rage reactions and her stealing behavior had completely ceased. It was felt she was ready to try school off hospital grounds. She was excited about this new situation and did not have any relapses. Patty did not seem to experience fear of the new situation but was excited about the opportunity to be in new surroundings and she did very well. She continued to stay at the hospital after school hours and continued her supportive relationship with the staff. She became a very affectionate and loving child and her personality was fairly subdued and quiet.

Timmy

One ten year old severely autistic boy was continued on the program more as a challenge, as he was very resistant to abandoning his psychotic defenses. He was given a series of ten sessions over a period of ten months, with dosages up to 400 micrograms of LSD. Before treatment he was highly encapsulated, repeating a few phrases and displaying repetitive and catatonic posturing. His only contact with people was looking up their sleeves, he seemed to be checking if and how arms were attached. He would not allow himself to be touched and had no interaction whatsoever, other than attacking other children if they approached or touched him. His treatment sessions were characterized by agitation, fear, panic and anxiety. Occasionally he could relax and allow staff to hold him, rub him and gently feed him. He had long periods where he was totally out of contact with his surroundings. During a later session after some two hours of being out of contact, he sat up rather suddenly, his eyes widened with astonishment and he whispered, "I saw God." During later sessions he evidenced a much larger vocabulary and abandoned his echolalia and repetitive speech.

Timmy's first four sessions were almost exclusively devoted to biting, chewing and aggressive oral behavior. We observed this with all patients, evidencing extreme oral rage. In later sessions patients would attempt to eat us and everything in sight to fill the emptiness they felt. In spite of us not witnessing a lot of what we could identify as conflict resolution during the sessions, his behavior underwent a marked change. His physical attacking behavior subsided and he became interested in relating to other boys his age as well as the treatment staff. He wanted physical contact, became playful and enjoyed himself. His parents began taking him home for weekends due to these behavioral changes and they repeatedly told us that they were amazed at his improvement.

Jenny

This nine year old girl had eight sessions over a period of six months. Her IQ at age five was eighty-two. She had good verbal ability. Her behavior was impulsive, erratic and unpredictable. She was often very aggressive to other children, especially smaller ones, and attacked them viciously without provocation. When she attacked it was often with very flat affect, not associated with anger or retaliation. She was very oral, eating anything she could obtain and attempted to eat inedible objects. She would make sexual advances to adult males. She was socially isolated, did not participate with others, and showed a pronounced inability to make any meaningful relationship with anyone, children or adults.

Jenny's sessions were characterized by her reliving sexual abuse and her fear and alarm and ambivalence over the attention given her. She regressed back to her early infancy and gave repeated evidence of her neediness from her mother and her anger at not being properly cared for (both parents were alcoholics). She was extremely orally aggressive and had to be restrained a good deal as she acted out her anger by biting, scratching, pinching, kicking and attacking staff. Much of the time that she was acting out her affect was quite flat, other times she would be screaming and there was a great deal of conflict over toilet training and power struggles related to this event.

In later sessions Jenny became much more stabilized and she started verbally expressing her hatred of both males and females and wanted to kill babies and children. Behavior changes on the ward were significant. The affect became much more appropriate and she developed a buddy relationship with another one of the female patients, a twelve year old girl. Her erratic, aggressive behavior towards younger children completely subsided; she became much more interested in doing activities with her friend and interacting with adult ward personnel. She began to see herself as more grown up and took pleasure in her new identity. She went to school and was able to function satisfactorily in that setting. Her changes were remarkable and she became quite functional and was no longer a management problem.

Stevie

This nine year old, very small boy had a total of thirteen sessions over a ten month period. Prior to treatment Stevie was extremely withdrawn and isolated and responded to no one. He vacillated between extreme catatonia and excited catatonic rage reactions. He would become assaultive and destructive and especially physically aggressive towards younger and more helpless children. During these times he had to be placed in camisole (full straight-jacket) and seclusion. He never spoke to anyone, made no eye contact and lived exclusively in his own world. What was unique about this boy's psychedelic experiences was his ability to enjoy sensory experiences that are commonly experienced by the normal person. During the first two hours he would delight in the visual and auditory experiences and constantly comment about what he was experiencing.

We soon discovered Stevie had an extensive vocabulary which he never used in his usual state. He would say such things as "the music is following the designs," he would laugh and say, "I love you, designs. Heart designs, ahhh, what a beautiful lady, a whole house full of changes." He rhythmically moved his body very gracefully to the music. He became extremely animated, smiling, sometimes giggling and appearing very much enchanted by his experiences. The long duration of this type of reaction was most unusual with these children. He would also become extremely quiet and peaceful, radiating a serene countenance that is witnessed when individuals are experiencing transcendental states. After the first few sessions he became very excited when told that he was going to have another session. He would run down to the treatment room and participate in preparing it by setting out the things that we would typically bring - fruit, cookies, flowers, pictures, record albums and so forth. When the room was set up he would take a wash cloth, dampen it with cool water, fold it and lay down on the couch and cover his eyes with it, a ritual we would frequently use in attempting to get patients to travel inwardly. He would then want the music started. He was acting like a typical normal person in preparing themselves for a session.

In the second phase he would exhibit intense turmoil, conflict, fear and agitation. He indulged in the entire gamut of behaviors and emotions, biting, spitting, profuse and prolonged swearing and extreme hyperactivity, destructiveness and total catatonic withdrawal. He would carry on extended dialogues between two or possibly more people, evidencing conflict between his mother, father and himself. There was a great deal of anal and genital content to his conversation, with endless repetitions about "shit, piss, penis, nasty, black BM, death, black hearts, throw up, black breasts, black diarrhea, chew it, afraid, burn it hurts." He would interrupt these dialogues by going to the bathroom, standing in front of the toilet, turning in a few circles and then urinating and when he ran out of urine he would continue this behavior twenty to twenty-five times. After an exhausting three to four hours he would appear very beaten up and would allow staff to sit with him, touch him and hold him, feed him and nurture him.

Touching moments would often occur with these small patients, near the end of one session a male sitter was sitting beside Stevie, holding his hand and Stevie opened his eyes and said, "Will you talk to me, David?," David said, "Yes Stevie" and after a moment said, "I don't know what to say?" to which Stevie replied, "Just talk to me with your eyes." This coming from a child who in his usual state was either catatonic or wildly destructive. Very often we had no idea how to interact with the children when they were obviously back in time wrestling with the demons of their pasts. They would be unaware of our presence and often the most we could do was to sit it out with them. Remarkable changes occurred with this boy. He started to relate to treatment staff and wanted to be touched and held. His manic and destructive behavior disappeared and he started relating to boys of his own age and older ones and struck up a bond with another boy on the program. They became good buddies. He became well enough to attend school and was able to function well in that setting. His parents were amazed at the changes and started to visit him and then began taking him home every weekend. He was very verbal, became very playful with the treatment staff and was behaving like a normal boy.

Floyd

This ten year old boy had a total of sixteen sessions over a period of eleven months. He had a history of extreme deprivation. His mother was an extremely agitated, narcissistic woman who made no effort to relate to him at all. For the first two years of his life, he was confined to a crib without any toys or any kind of stimulation. Prior to treatment he was constantly hyperactive and agitated, not wanting contact with others. He spent his days in the yard being completely involved in finding and looking at small bugs. When not in the yard he looked at two books which were about insects and bugs. When staff attempted to interact with him, he would only ask repetitive questions about bugs but was uninterested in any one responding to his questions. He appeared to be actively hallucinating much of the time. He would not carry on a verbal exchange.

In his first session Floyd had a remarkable response to the drug. Within thirty minutes he was obviously experiencing sensory changes and became relaxed and smiled a genuine human smile. His first words were, "What did you do with me? He's not dead yet." He looked at pictures in his book and said, "I'm not making it real, no I'm not." A staff member said "You're alive, aren't you?" to which he replied, "No, no, no, I can't be alive, this is too good." He looked back at the book and said, "Okay, it can't be, turn it off, turn it off, who's doing it." Looking at one of the staff he said, "Oh Judy, don't be real, don't be real." He touched another staff member, looked in his eyes and said, "Don't be real, don't be real, I've got to get out of here. I don't want to be alive, I am afraid of me, turn that off. Tom, don't be real. I'm not real no more. I'm blind. No, no, no, I can see." He then relaxed, looked at various staff members and said, "How come we are all the same?" He didn't ask this in an inquiring way but more as in a declarative way. He then drifted off, listening to the music and went into interior experiences. This lasted for some five hours. Finally, he started to become aware of his present time, became agitated and tense and started to cry, and sadly said, "I want outside." He kept repeating this phrase which we took to mean that the expanded experience he had was receding and he did not want to go back into his isolated world. This was a very painful time for the staff as well and we didn't know how to help him stay alive. This was a unique experience for us in that Floyd had such an immediate response and was able to leave his psychotic defensive posturing and experience himself as a real living being.

During the next session, a month later, there was a similar reaction to the drug. After he started experiencing sensory changes he asked, "Is it real? Is the music real?" then incredulously stated, "We're real, are the feelings doing it?" He was told that having feelings made life real. He then repeatedly asked, "Is it real?" to which we gave affirmation. He then drifted off and started smacking his lips and making lots of movements with his tongue and lips. He said, "I am with Mommy, Daddy is here too, why don't you love me?" His speech then became incoherent and he remained in this state for two hours. Finally he desperately started crying and said, "I want out. I want outside. I want out of here. Please, please, help me open the door, help me, help me, I'm real, I'm Floyd and I'm real. My own little boy." He then looked at staff and said, "Give me some more, please give me some more." We asked more of what and he replied, "Pills. Just give me some more, I want to get out." Staff told him that essentially he had to make himself real, that the pills let him know that he was real but that the pills wouldn't do it, that he had to do it. Floyd finally settled down out of this agitation and became very pensive and very, very sad looking. He went to a window, looked out and quietly said to himself, "Fountain View State Hospital. What a funny place to come back to." Obviously this was incredibly touching and the staff were tearful. The empathy we felt for him was deep, as we all had had the same feeling after coming out of a profound experience back to our usual normative reality.

The next four sessions were very similar to each other and markedly different from the earlier two. These sessions were characterized by his regression to earlier experiences where he had been physically abused and threatened. He repeatedly called the phrases, "I'll be good from now on. I'm sorry. I promise, don't hurt me, stop, stop, help me, help me." He frequently yelled, "Oh, oh, ouch, it hurts," and was physically trying to get away from being beaten. He would also have periods when he would attempt to strike out at the staff, smash himself against the wall and plead to be left alone. He was also very orally fixated and we gave him a baby bottle which he could suck, chew on and then violently fling away.

The seventh session was markedly different in that he did not appear to regress but rather stayed in contact with staff but became very belligerent, aggressive and sexually provocative. He would want to be cuddled by a female, rest his head on her breast and then make an aggressive biting gesture at her breast or suddenly start pounding her breast. He would also climb on a female, make undulating hip movements on her body and would attempt take his pants off. He would also approach a male, be sensual and want to be held and cuddled and then aggressively grab at the male's genitalia or scratch or bite his face. He would run around the room attempting to slap and punch everyone. He would growl and make guttural sounds, howl and become feral and aggressive.

The following three sessions were similar in many respects in that he acted out alternately oral aggression and his need to orally take in good things in the universe. At one time he took the author's fingers, sucked them, opened his mouth as wide as he could and attempted to swallow my hand. He put his hand on my elbow and pushed it in an attempt to eat my hand and arm. I said, "You are so empty you want to swallow me completely." His eyes became very wide and he vigorously nodded his head affirmatively acknowledging that's exactly what he wanted to do. He would also swing into seductive sexual behavior and alternate between being tender towards staff and then biting and trying to eat us. In subsequent sessions, he became obsessed with wanting to be taken to our homes. He would verbalize this precisely saying, "I am very unhappy here, I want to go to your home. I want you to take me to your house." Various staff would take him home after a session and he invariably was very calm, serene, extremely happy to be there and behaved admirably. He was affectionate, ate well, went to bed when told and evidenced none of his hyperactive, anxiety-ridden behavior. He also totally abandoned all preoccupation with bugs and stopped asking endless, meaningless questions.

After a number of these home visits a lot of Floyd's session time was spent in trying to convince staff to let him live with them permanently. He started to attend school and was also able to function well in that setting. He developed a positive relationship with his teacher and developed intense relationships with three of the treatment staff and wanted to dominate their time. However, when they were with other patients he did not become aggressive to the other patients as he had earlier but patiently waited his turn. It was very painful for staff not to be able to meet all of his needs. He did start to relate to other children his age and had meaningful interaction with another boy his age but always preferred to be with the attending staff. His withdrawn, isolated behavior never reoccurred. He attended school and was well behaved on the ward, always looking out for staff to be with and to talk to.

Nancy

This eleven year old girl was the most difficult and challenging person we treated. When first introduced to me, she was in complete restraints twenty-four hours a day. She was in full camisole and her legs were tied to the bed. This was necessary due to her extreme self destructive behavior. If her hands were free, she would gouge out her eyes, hit herself in the head as hard as possible, bite her fingers, tear out her tongue. She was totally emaciated, covered with swellings and bruises, black eyes in sunken sockets. She was incontinent and refused to eat. She was IV fed, she looked like a beaten up, starved, wild, eighty year old woman. She made no eye contact, did not respond to any physical stimuli, attempted to make guttural noises and spit, but unsuccessfully, as she was so exhausted. The attending physician felt that she would probably die. All known drugs had been tried. It was frightening to treat her with LSD, as my concern was her extremely frail physical condition and that she might die during a session.

Nancy was to be our first patient to treat and the physician's attitude was essentially that she was going to die anyway so we may as well attempt LSD as nothing else was available. I was fearful that this would be our first and last LSD session. She was given 200 micrograms of LSD. The session was very long and tumultuous. After thirty minutes she started intense screaming. She briefly stopped, muttered very softly, "I'm sorry" and went back to screaming. She looked Petrified, made rocking motions, furtively looking around as though she were trying to avoid being attacked. She began to verbalize "Gary, hold on tight, hold on tight, hold me." She would scream, "Mummy, ow, oh, hurt, oh." She would go in and out of contact with her surroundings. She remained extremely agitated and frightened, alternating vehement screaming with animal growling. After about seven hours of this violent behavior and screaming, out of exasperation and exhaustion I said to her, "How long are you going to scream?" She stopped flailing about, became very quiet and still, looked at me very directly in the eyes and said very quietly, "I am going to have to hurt for a very long time, so just leave me alone." She then proceeded to flail around, resuming her screaming.

In the following session she was markedly different. She developed a voracious appetite, was very talkative with the staff and required no restraints. As she went by the dining room she stopped, looked in and said with amazement, "My God look at that, they're eating, that's nice." She then regally flourished her hand and said, "Let them eat." Later in the day she told one of the staff, "We went to see Dr. Fisher, Gary, didn't we? I had a camisole test. It was good." The next session, a week later, she was looking forward to the session, telling me in the early morning, "Let's get the test now." She was much more verbal and a great majority of the time was spent in regressing back to conflict with her grandfather. It was obvious she was reliving a sexual trauma, wailing and screaming, "No Grandpa, no, I can't stay like this. I can't do it, hurt Grandpa, hurt, bye Grandpa bye, I don't have to." She would moan and wail. She then began to attack herself and had to be restrained.

The following few sessions were characterized by extreme conflict over pleasure and pain, much of it sexual in nature. In her regressions she would evidence marked sensual/sexual pleasure, laughing, giggling and saying "Don't do it. Oh Honey, no fair. Oh Honey let go, let go. They will kill us. No more. Love me, love me." She would then alternate to fear and anguish, become agitated, start lashing out at herself. When physically held by staff she would bite, spit, claw and scratch at them. This alternation between indulgence and conflict went on hour after hour.

After five sessions, Nancy's ward behavior was totally different. She wanted lots of interaction with the treatment staff, became very demanding of attention and was jealous of other children getting attention. She became bossy, started ordering other children around and took on an "I'm in charge here" attitude. She wasn't hurtful to them, only making it clear that they were inferior and that she knew what was best for everyone. When another child was going to have a session, she would attempt to maneuver her way to the treatment room and when removed became verbally, but not physically, angry. When told one day that she couldn't have a "test" (her word for the session) whenever she wanted it, she said, "Oh, then let's talk. Let's go down to the visitor's room (where sessions were held) and talk." Once there she would lay down on the couch, close her eyes and tell us to be quiet. I went over, pulled her up and sat her in my usual chair and I lay down on the couch. She got quite indignant and told me, "You don't need help, I do. I want the test." She began evidencing behavior which indicated she considered having a session a privilege. She went on her best behavior when informed she was going to have the next session - helping other children, being polite and neat, smiling and being very charming. Prior to her seventh session one of the ward staff, Van, asked her what she was going to see during her next "test," she replied, "God and Van." He laughed and asked her how she could tell the difference. Very seriously she replied, "I'll show you. You'll be there and I'll show you." Van asked, "Where will that be?" She replied incredulously, "Why, in the visitor's room. That is the only place you can see God."

During the next few sessions, Nancy's behavior became quiet, she was always wanting to be in physical contact with one of the staff and especially with one of the males. She would pet and stroke his arm, softly caress his face, smile and sing softly. She wanted to be cuddled and not interrupted in her pleasure. Coming out of the session was usually stressful, she would cry and occasionally revert to soft biting. When told she couldn't bite, she would lick and kiss.

After five months of treatment the focus became on her self-destructive behavior. It was felt that she was no longer psychotic and was using her hitting herself as a way of manipulating and controlling staff for whatever she happened to want at that moment. This was a sure way of getting attention, it was very clear that she wanted to be the sole focus of staff's love, attention and care. We decided that everytime she hit herself we would pinch her, step on her toes, and if we were outside, grab her and run her until she was exhausted. She was extremely indignant about this and gave up most of her self-destructive behavior. One day in a fit of pique she said, "Well I can't fool the A.M. staff anymore but I can still fool the P.M. staff." I looked at her directly and her mouth dropped open as in, "Oh, oh, I shouldn't have given that one away." That evening I met with the P.M. staff, made Nancy sit in the meeting, told them what she had said and clearly outlined how they all had to behave, just like the A.M. staff. She looked daggers at me but she knew that she had been nailed. She then took to placing small pieces of paper on her hands, telling us that the paper prevented her from hitting herself. When we saw her with a piece of paper we would go over and knock it out of her hand and dare her with our stares, to do anything about it. She would often mutter, "God damn" and either pick the paper up or walk away. She then gave up the paper and started to carry kleenex around with her. When we would see this kleenex she would say, "Oh, I've got a cough" or "My nose is running and I need it," we would just look at her and mutter, "oh yea, I bet" and look at her with a message "How dumb do you think I am?" Soon she gave up the Kleenex routine.

The staff person who was primarily working with Nancy left at the end of the fifth month and she was badly shaken by his departure. Her response was amazingly mature, she became depressed, sad and mournful and cried a great deal. She did not act out against herself or others. Another male student from the treatment staff, whom she knew well, took his place and she was grateful for his attention. She would become frustrated at her lack of sufficient language in trying to describe her feelings to him. Sometimes she just held him and sobbed about her loss.

She began to attend school on half days and was able to adjust to the setting. It was hard for her to share adult attention and other children her age did not have her sophistication. She was very bright and didn't miss a thing. She had become affectionate and warm, loved to be physically touched, and smiled happily a great deal of the time. She had given up her self-destructive behavior and wanted to identify with the treatment staff and to be included in the grown-up world. Unfortunately she was often bored because there was a gross lack of stimulation available for her in the ward setting.

Jeannie

Jeannie was a girl who, when initially seen, lived in a totally encapsulated world. Her behavior consisted of hyperactive twirling, yelling a meaningless "word-salad," screaming, and violent attacks towards anyone who came within her personal space. She would work herself up into such manic frenzy that she would collapse in physical exhaustion. During her treatment course with psychedelic therapy Jeannie experienced a number of transcendental phenomena which established the core recovery from her psychosis.

In spite of being blind, burdened with congenital dislocation of hips and knees and raised by a completely psychotic mother, this girl overcame horrendous madness in a devastatingly sterile and chaotic environment of a state hospital ward, to become one of the most tender, loving, compassionate and courageous persons the author has ever known. If Jeannie had had the opportunity to continue her sessions in a benign, safe and nurturing environment, she would have become a functionally superior human being. Our experience with this one girl was all the proof that was needed to attest to the dramatic usefulness of psychedelic drugs in treating the most seemingly intractable psychotic states.

It is most noteworthy to report that at least four of the children had identifiable transcendental experiences and were capable of communicating such experiences to us. It may be that some of the other children had similar experiences but were unable to communicate to us. However, given the age and degree of psychopathology of these children we were amazed that these spiritual experiences occurred.

The Work Ends

Our work was cut short by the political climate that developed after LSD hit the streets. Our project was closed down very quickly in mid 1963 and the staff associated with the project soon left. The abandonment of these children was an extremely painful experience for all of us. We were very surprised and touched with how supportive and accepting the children were of our departure when we said our good-byes. A follow-up was attempted ten years later but proved to be futile. The administration of the hospital was extremely agitated that the media would learn that LSD therapy was done there in the early sixties, as in the early seventies the political landscape around LSD was still very volatile.

To separate out the contribution of the drugs from our intense, devoted and caring commitment to these children was not an issue with which we struggled, although it was an issue often raised by other professionals. The author had worked for over four years with psychotic children in these same settings without drugs with very minimal success. The psychiatric technicians on staff had worked with these same children for many years, again without any significant results. It is only through personal experience with these compounds does one appreciate the potential they offer. However, a strong cautionary word is offered. These materials are so potent that a person interested in using them must have very clear his intention and needs to have guides attend him who are experienced travelers in the realms of consciousness that are unfolded and revealed. We used to say that the most important ingredient in LSD was the person taking it. The second most important ingredient is the guide who sits with that person.

One issue that is generally not addressed in the literature is the vulnerability the psychedelic therapist feels which is inherent in this work. Often included in the expanded state of awareness achieved by the drug-taker is intimate knowledge of the therapist and his state of grace - or lack thereof. The therapist cannot hide from being "seen." Experienced therapists know this well (and hence the emergence of counter-transference) and one's vulnerability is total when sitting with a psychedelic voyager. We had not anticipated this phenomenon to occur with these children as they all appeared to be so disturbed and out of contact with "reality." We were amazed when, in sessions, they would tease us by mimicking us, sorely hitting our most vulnerable and protected spots. Happily, this was done with compassion, humor and acceptance, but nevertheless we got the message. Our humanity and humility were often tested and we were stunned by the children's perceptiveness and their ability to embrace us in our shame - we had so much and they had so little.

Acknowledgment

Invaluable work of the dedicated treatment staff is gratefully acknowledged: Con Cowan, Dave Dion, Bob Haynes, Phyllis Mesker, Tom Parsons, Ethel Pett, Suni Strom. The donation of LSD and psilocybin for the study by Sandoz Pharmaceuticals is also gratefully acknowledged.

References

1. Fisher, G; The psycholytic treatment of a childhood schizophrenic girl. International J. of Social Psychiatry; 1970, 16, 112-130.
2. Fisher, G; Psychotherapy for the dying: principles and illustrations with special reference to the utilization of LSD. Omega, 1970, 1, 3-16.
3. Fisher, G and Martin, Joyce; The psychotherapeutic use of psychodysleptic drugs. Voices: The Art and Science of Psychotherapy; 1970, 5, 69-72.
4. Fisher, G; Some comments concerning dosage levels of psychedelic compounds for psychotherapeutic experiences. The Psychedelic Review, 1963, 1, 208-218.
5. Fisher, G; Psychedelic drug usage: socio-political and psychological consideration. California School Health, 1968, 4, 40-54.
6. Blewett, DB and Chwelos, N; Handbook for the therapeutic use of LSD-25: Individual and Group Procedures. Unpublished manuscript; Regina, Saskatchewan, 1959.

Gary Fisher, Ph.D.
1750 E. Ocean Blvd. #705
Long Beach CA 90802

The psycholytic treatment of a childhood schizophrenic girl

by

Gary Fisher

University of California, Los Angeles

Int J Soc Psychiatry 1970 16: 112
DOI: 10.1177/002076407001600204

© Gary Fisher

original report: https://sci-hub.se/10.1177/002076407001600204

Table of Contents:

Introduction
The Setting
The Treatment Team and Approach
The Patient
Excerpts From Session Number One
Evaluation of Session No. 1
Excerpts From Session Number Two
Evaluation of Session No. 2
Excerpts From Session Number Three
Evaluation of Session No. 3
Session No. 4
Session No. 5
Session No. 6
Session No. 7
Sessions 8, 9 and 10
Session No. 11
Sessions No. 12
Session No. 13
Sessions 14, 15 and 16
Discussion
Five-year Follow-up
Other Research Utilizing Psychedelic Drugs With Autistic Schizophrenic Children
Acknowledgment
References

Introduction

This paper is a description of a psychotic child's experiences with psychedelic drugs and some judgments as to what these experiences were about. We believe that there was considerable value in utilizing these psychedelic drugs in the psychotherapeutic, treatment of this child who was schizophrenic. Our position is not one of simple broad endorsement of LSD and other psychedelics in the treatment of children grouped in this classification. If there is anything to be learned from this treatment attempt it is that little of what may be called health or growth can occur without intimate and honest relationships between people. The drugs were, however, in our judgment, of extreme importance in making the psychotherapeutic experience.

The hypothesis used in the research and treatment program involving Jeannie and eleven other children diagnosed as childhood schizophrenics is that psychosis is a massive defensive system of repression-avoidance-denial in the service of protecting the individual from experiencing his feelings. The experiences which have aroused such painful and frightening feelings are repressed and the feelings denied existence. The tendency to deny and to defend generalizes to more and more stimuli such that a great part of all experience is either denied or misinterpreted to fit delusional explanations of experiences. The individual exists isolated in a world of no feeling and meaninglessness and this renders him unable to meet social expectations and to relate with other people. The individual has committed psychological suicide - he lives but in the solution of massive retreat he has virtually died.

The rationale behind the use of psychedelic agents with psychotic children was that these drugs have the capacity to activate or chemically energize various areas of the brain to an extreme degree resulting in vivid experiencing in the area of perception, emotion, memory and feeling. In addition, these agents seem to inhibit the higher brain centers which are considered responsible for such functions as inhibition, intellectual abstractions and cognition. The psychedelic drugs tend to release experiences of phenomena normally repressed or denied or not considered essential in meeting the demands of one's own and others' egos. Experiences and feelings ordinarily denied awareness receive proportionately more energy causing them to break into a statue of consciousness which is less strongly dominated by the usual defenses and values which one has developed. Without the usual complicated defensive structures and censures, the individual is able to re-experience himself in a far less distorted way and to re-evaluate the worthiness of his essential self.

The Setting

The present case is a report of one of twelve autistic and schizophrenic children who were experimentally treated with lysergic acid diethylamide and psilocybin in a research study which began in early 1962 and terminated in mid-1963. The setting was a large state institution for the mentally retarded and the population included many severely emotionally disturbed children. All the children in the study were on one ward, a ward which housed some sixty acutely psychotic and behavior problem children and young adolescents. All the children were management problems and the atmosphere of the ward could be described as constant pandemonium. There were all the usual problems of a large state institution-inadequate staff, high staff turnover, overcrowding, insufficient clothing and laundry problems, constant and inadequate physical repairs and the constant need of medical attention because of the hyperactive, destructive and assaultive nature of the children. The ward was bleak and barren as it was impossible to maintain any furnishings due to the wanton destructiveness. As well as the hyperactive, screaming, assaultive, feces-smearing children, there were of course the severely withdrawn, totally autistic children who seldom moved and who lay dotted throughout the ward. An atmosphere little conducive to stimulating mental health.

The Treatment Team and Approach

The writer acted as the head of the treatment team and the ward psychiatrist was the responsible physician. Since none of the staff had any previous experience with psycholytic treatment, the first phase of the program was to train the staff. This consisted of having them become familiar with the then-available literature, having extensive group discussions on the nature and philosophy of the psychedelic experience and then having one (and on occasion, two) psychedelic treatment session themselves. This session was followed up by both individual and group meetings. Consequently there developed a team of co-therapists who worked together closely, intimately, and with amazingly little friction. The team consisted of one nurse, three nurses' aides, and four graduate students in psychology. A detailed account of the development of the treatment approach cannot be given here. However, at the time of the study we had no prior knowledge of effective techniques to utilize with this patient population and consequently we tried various techniques. In our initial sessions we utilized techniques which had proven successful with alcoholics (e.g., Chevelos and Blewett, 1959) but soon discovered that we had to become much more active in the treatment, utilizing interpretation, role playing, and very directive measures. Because the treatment sessions were often excessively long (some lasting to fifteen hours) and often physically arduous and exhausting, we utilized multiple therapists. About midway in the research program we decided to intensely treat the six most responsive of the patients and one team member was assigned as responsible therapist for that child, being assisted by other staff members in the actual treatment sessions. In some very difficulty sessions, we would "go through" (or wear out) all six or seven of the treatment team members.

The Patient

The patient is a twelve year old girl who was diagnosed as a childhood schizophrenic. She was born prematurely after a seven month pregnancy. Birth weight was two pounds, thirteen ounces. Retrolental fibroplasia was diagnosed early as was a congenital dislocation of the hips and knees and a congenital heart murmur. Her early development was slow - she held her head up and sat alone at six months and walked at four years. Single words were spoken at nine months but shortly after this time she discontinued speech until four years. At age three she broke her collar bone and at age five she suffered a head injury from a fall down a flight of stairs. At age five she was hospitalized for a "nervous breakdown," the record showing no details of this episode. From age five on she was,taken to several hospitals, institutions and clinics and was given a variety of diagnoses including CNS pathology, childhood schizophrenia, mental retardation, severe emotional disturbance and severe brain injury from birth. Her behavior from age six, as described by these various diagnostic centers, was characterized as being bizarre, grossly regressive, retarded, hyperactive, assaultive, erratic and destructive. She never attended school because of her severe disturbance although special classes were attempted unsuccessfully at age seven.

She was evaluated for state institutionalization at age ten and was described as indulging in loud screaming, wild jumping about, impersonating a baby through a doll she carried and involving herself in a hectic interplay of scolding with the doll. The intake worker described the patient as reaching a state of physical exhaustion caused by her constant hyperactivity. It was not possible to obtain the patient's cooperation on any examination or testing procedures. She was admitted to the institution seven months later, at age eleven.

Jeannie's mother had her first psychotic episode eight years prior to Jeannie's birth, and presumably following her husband's accidental death. She has had several miscarriages and only two successful deliveries, the patient and a boy who was born when Jeannie was five years old (the age at which she was hospitalized for a nervous breakdown). The brother died at age three years due to strangulation following an acute bronchial disorder. The mother has had several hospitalizations for paranoid schizophrenia since Jeannie's birth and has had extensive somatic treatment (ECT and IST). The father is a career Army officer and reportedly seen as a stable individual.

Hospital treatment for Jeannie had consisted of a number of drugs and a series of ten ECT treatments, none of which had resulted in any improvement.

When Jeannie was seen for evaluation for psycholytic treatment, she was acutely psychotic and had virtually no contact with anyone. She was a rather large girl for her twelve years, quite blind, apparently only able to see very little when she held an object within a couple of inches of one eye. When she moved, she bounded, with a pronounced lurch and limp and it was amazing she had as few fall and crashes as she did. Her hair was rather long, oily and stringy and her skin was covered with severe acne. She always appeared dishevelled and was quite an ugly sight. Her typical day was spent sitting in a corner of the ward with two major activities, one was protecting herself from the assaults of other children and the second was twirling bits of paper in her long fingers, constantly rocking herself, masturbating, and talking word-salad almost incessantly. When other children would come within range she somehow detected them and swung out with her arm to hopefully knock,them flying. If a child would be too persistent in his attack, she would resort to screaming belligerently and make some greater effort to locate him and physically assault him. At times she had a transistor radio which she held right against her ear. However, the radio never functioned too often. She apparently was having hallucinatory experiences, mostly auditory although it was difficult to specify the girl's experiences. She repeatedly talked of riddles and her phrases were often meaningless - when spoken to she would often repeat the last few words of the examiner or else ignore him. On one occasion she said that Tide means "to live," Fels Naptha means "to die" and Blue Cheer means "sick." She often was seen to shout at unseen persons and become distressed by them. She often used a number of pitches in her voice in order to carry on conversations among a number of people although these conversations lacked continuity or meaning. She was able to feed herself, toilet herself and dress herself.

Psychedelic Treatment Regimen			
Treatment No.	*Date*	*Days betweeen Sessions*	*Drugs Utilized*
1	7-24-62		100 mcg. LSD
2	10-2-62	70	100 mcg. LSD
3	10-16-62	14	200 mcg. LSD
4	11-14-62	28	10 mg. Librium; 5 mg. Methedrine; 10 mg. Psilocybin; 200 mcg. LSD
5	12-3-62	18	10 mg. Librium; 5 mg. Methedrine; 300 mcg. LSD
6	1-7-63	35	200 mcg. LSD
7	1-21-63	14	300 mcg. LSD
8	2-4-63	14	10 mg. Psilocybin
9	2-18-63	14	30 mg. Psilocybin
10	3-4-63	14	200 mcg. LSD
11	3-11-63	7	200 mcg. LSD
12	3-18-63	7	50 mcg. LSD
13	4-12-63	24	200 mcg. LSD
14	5-13-63	31	10 mg. Librium; 200 mcg. LSD
15	5-22-63	9	25 mg. Librium; 200 mcg. LSD
16	6-24-63	33	200 mcg. LSD

Excerpts From Session Number One

(*J is patient; F is male therapist; S is female therapist.*)

9.30 a.m.: Drug administered.

9.50 a.m.: Drug appears to have taken effect. J is becoming giddy, silly and hyperactive; talks about the Scribble Head Riddle. J asks with profound seriousness, "How can you make me talk better?" Starts laughing, bounces on couch with great vigor; begins to hold her fingers close to her eyes, move her fingers and laugh and smile at her finger movements. Is becoming very hyperactive and finally yells, "Hold me, hold me," to which F responds by holding her very tightly.

10.20 a.m.: J is pinching and scratching F; F responds by returning the same treatment and J becomes very angry. J says, "My finger nails like you."

10.30 a.m.: J hyperactive and aggressive; F attempts to quietly hold her, reassures her and suggests that she relax and listen to the music. J continues to struggle and F is persistent in his attempting to quiet and soothe J, telling her repeatedly to lie down, relax and listen to the music. J finally gives up her bodily struggles, lies back and softly begins to sob. Her crying becomes more intense. While crying deeply she says, "I'm very sad; I want to go home." Her crying eases somewhat and she holds F and asks with intense feeling, "Why do you make me like this?" She again begins to sob and cry and is full of tremendous anguish and sorrow. She repeats, over and over again, "Leave me alone; leave me alone; leave me alone." This crying anguish with these words interspersed frequently, lasts for about one hour. She is emotionally exhausted.

11.30 a.m.: S enters room and J says, "Mommy," and then says therapist's name. J reaches out to S, holds her and sobs incessantly. She cries, "I'm afraid - I can't see. I'm afraid - I can't see." When J becomes extremely agitated she releases S and goes into a fetal position. This quietens her and she then returns to holding S and crying.

12.15 a.m.: Beginning to moan but appears more relaxed and less desperate. Begins to say, "Scribble Head Riddle." Begins to relax and rest although still crying, but softly.

12.30 p.m.: Beginning to move around again; some gentle pinching; moaning and groaning; says, "I don't feel good."

1.00 p.m.: Becoming much more agitated; begins to yell - no content, just yelling. Now crying in an aggressive manner. This starts a new sequence; she is becoming excited and angry; starts to scratch T's and after she has done so, bites her own hand; lies on her side and begins her first rocking movements; her speech now becoming disorganized and deteriorative; grabs towel and starts to stuff it into her mouth; rocks vigorously with towel stuffed in her mouth. She now gets up and moves about room; finds some food and gobbles it down; starts picking up any item and attempts to eat it; she demands food which we give her; eats voraciously. Gradually relaxes after eating. F sits with her and holds her quietly. F asks, "Why did you cry, J?" to which she replied, "Because my poor little mother made me."

Evaluation of Session No. 1

Attempts to prepare the patient for the experience were probably of no benefit as it was impossible to get her attention in any sustained way or to establish any communication. The first indication that she was having any reaction was an increase in motor and verbal behavior. She bounced around the couch, giggled and laughed, and appeared to be delighted and excited with perceptual changes. Her first words were, "How can you make me talk better?" This is the question to which J has returned so many times and the eventual understanding of its meaning has helped us a great deal in understanding her psychotic process. It appears that for J talking and thinking are one and the same, and she thinks if she could only organize her speech in a satisfactory, coherent or better way, she could then think coherently and thereby control the confusions she experiences. This is one reason why she is constantly talking and trying to master by voice imitation such significant persons or images as the baby, the child, the mother and the father; for it is these figures which cause her painful feelings. It is through organized speech and therefore organized thinking that J hopes she can understand and control her impulsive chaotic feelings. And it is her thinking that is a defense against these feelings which she cannot accept.

J's excitement with her new perceptual experiences progressively increased and she cried out, "Hold me, hold me," expressing her desire for physical contact and probably control over these new sensations. After an hour or so she became anxious, her movements and gestures became exaggerated with a restless driven quality and quickly mounted to hyperactive behavior. Later she scratched the therapists. J's hyperactive, behavior was a result of a preconscious awareness of overwhelming anger. Her hyperactive behavior served as a way of shaking her attention and deterring threatening wishes from becoming manifest and at the same time allowed her to release this tension in a less incriminating way. In later sessions J frequently expressed herself with hyperactive behavior and we were later able to confirm this as being both a defense against, and a released of, her aggressive feelings.

J was encouraged to lie down and listen to the music. She quieted down and began to cry with great anguish. She said, "I'm very sad; I want to go home." Her crying and grief continued periodically for more than four hours and the depth and the honesty of her self pity and anguish surpassed all our expectations for we did not anticipate that J would experience feelings so profoundly. She began referring to her mother and it appeared that she was re-encountering and struggling with this relationship. She asked F sobbingly, "Why do you make me like this?" and later cried out repeatedly, "Leave me alone, leave me alone." These sentences appeared not to refer to F but to her mother and communicated to us J's great burden of her mother - both the guilt she felt over her rage toward her mother and her desire that her mother release her. At these times, J's social conscience arose more powerfully than we would have guessed and engulfed her hostility causing her this experience of intense guilt and self pity. When the emotionality became exhausting, she assumed the fetal position and became quiet.

Later in the afternoon as the power of the drug receded, she again became hyperactive, scratched the therapists and then turned her aggression inwards and bit her own hand. Her speech regressed and deteriorated and she indulged intensively in oral activity. She stuffed a towel into her mouth and at other times tried to eat nearly everything in sight. This oral regressive behavior was interpreted as an attempt to do something about her tremendously unfulfilled oral needs. In the days following the session, some attempts were made to have J communicate about her experiences. The day following the session J told us that in her session she had visited the real Scribble Head Riddle and that the Scribble Head Riddle hated her mother and loved her father. Further, she said that the Scribble Head Riddle's mother was dead and then asked, "Is my mother dead?"

When asked where she had gone, she replied, "Into the dark." When asked if it was all dark, she said, "No, it was light too. The Scribble Head Riddle likes the light." She was able to discuss, with some appropriateness, parts of her session where she had laughed or cried and was able to be minimally reflective about those experiences. One week later she appeared to be better, the rocking movement which was almost constant had ceased. She seemed very anxious to talk but started to talk word-salad and "nonsense." When told that the therapist wanted to talk to her but would only talk about sensible things, she immediately stopped and asked, "What's sensible." When asked what she thought was sensible she began to name concrete items and topics. She then tried to make comments about items or topics. She asked what the word "relation" meant and then attempted to verbally categorize and specify relationships between items. Her speech and affect were noticeably improved and she demonstrated such a serious attempt to be sensible. She gave up her word-salad barrage and her constant reference to the Scribble Head Riddle. She very much wanted the contact with the therapist and was quite anxious to lean how to relate and talk to him.

Excerpts From Session Number Two

9.00 a.m.: Drug administered.

9.30 a.m.: J: "Will I lose my voice? Will my voice go away? I want my voice!" J is rolling around on couch, fairly agitated. She was assured she could keep her voice if she wanted to.

9.40 a.m.: "I feel retarded." J herself and the rest of us laugh as the tone was humorous. J: "I want a peanut butter sandwich." (Such sandwiches are the big treat on the ward.) J takes F's hand, holds it, feels it thoroughly and, the says, "Your hand feels retarded." Again J and staff laugh. She seems to be in a sophisticated humorous mood.

9.50 a.m.: J starts mimicing other patients' symptoms, including stereotypic and repetitive speech, hand movements, gesturing, posturing, etc. She does this in a rather light hearted, laughing and humorous manner, identifying the patients she is mimicing. (We are surprised that she knows all this as we had assumed she was too blind to see such phenomena and too withdrawn to observe or be interested in them.)

10.00 a.m.: J begins to kiss her own hands. This activity increases to kissing her arms. She appears to be becoming agitated. F asks, "What's happening, J?" to which she yells back, "Nothing!" She now begins to cry and as she becomes more sad, she starts kissing herself more frantically and as she kisses herself more, she sobs louder and deeper. She then starts moaning, "I'm a girl, I'm a girl." J begins to rub her face, mouth and head. She then holds her mouth open as wide as it will go and starts jamming her hands into her mouth - throughout all this activity she cries with great anguish and depth. She uses great force in getting her hands inside her mouth and staff is afraid she will injure herself. Female therapist (S) takes J into her arms and J clutches onto S and cries intensely. With great grief J cries, "I didn't do anything." F: "What did Mamma do?" J: "She left me." F: "Was it your fault she left you?" J yells, "Love, love love, love." F: "What was it you put into your mouth?" J: "Nothing, nothing." F: "What did you want?" J: "Food, food." F: "No one fed you." J: "I want to feed myself now." F: "Jeannie, you were never fed. Mamma never fed you. Now you want to gabble up the whole world. You're mad because you never got what you wanted." J yells, "No, no," and wildly lurches out to strike at F. After striking him, she looks shocked and says, "I'm sorry, I'm sorry," and strokes him. She then says, "I know," and F asks, "What?" and J replies, "Oh, ice cream bars, and everything." She then begins to cry again and her crying is full of anger, self pity and anguish.

11.00 a.m.: J seems quite distressed in a diffuse, agitated manner. F: "Why are you so unhappy?" J: "I'm not unhappy. I'm happy." F: "No, you're not happy. What happens when you don't like yourself?" J: "You die!" (with emphasis.) F: "Do you like it that way?" J: "No." F: "What can you do about it?" J: "Stay alive." F: "How can you come alive?" J: "I don't know. I don't know." At this point she returns to stuffing her hands into her mouth, pulling and probing, begins to cry. F: "What would you like to be?" J: "A boy and a girl." F: "Then what?" J: "Be sick." F: "Do people love you more when you're sick?" J: "Yeah, yeah." Again many minutes of wailing wand crying. J: "Boy, boy, boy." F: "Who wanted a boy?" J: Yells, "Nobody!" F: "Did they want a boy?" J: "Boy, boy, I'm a boy, I'm a boy. I want to be a boy." Now she becomes extremely agitated, starts lurching and screaming, "No, no." She continues this extreme agitation and yells, "I'm a girl, Mommy, I'm a girl. No, I'm a boy, I'm a boy. Mommy, mommy. I'm a girl, Mommy. No, no, mommy, I'm a boy." This repetitious material continues for some time. The therapists attempt to intervene and have J accept her mother's rejection of her. This appears to increase her agitation. She begins to becomes disorganized and her psychotic defenses begin to appear. She begins calling out ward numbers, begins to bang her fist on the wall, and stuff her hands into her mouth.

12.30 p.m.: Patient is yelling and screaming,. It is difficult to understand what she is saying. She laughs loudly and falsely. She attempts to cry but can't make it. She calls out, "Scribble Head Riddle, Scribble Head Riddle, I want to feel funny."

1.00 p.m.: Suddenly she stands up, throws her fist into the air and screams with anger, "Oh, I'll kill you, mother." F: "You want to kill mother." J: "No, no, no, I love my mother," and as she says this she smashes the wall fiercely with her fist. She then goes into a flurry of mumbling and ward naming which continues for some time. She is very agitated. After this, she begins to growl like an angry animal. She screams, "I want to stay alive." F: "Did you kill your mommy?" J: "I killed my mommy. The Scribble Head Riddle killed my mommy. Ward 33 killed my mommy. I'm 12 and I'm a ward. I want to kill ward 18. Ward 31 is God. Ward 14 is the Devil. I'm going to kill Ward 18's parents, and Ward 17's parents. Oh, I love Ward 3. I'm going to kill Ward 11's mother." She then became very quiet and very soft and says, "Ward 31 is God. I hate Ward 31. I love Ward 31. It's the Riddle, It's the Riddle." She then goes into a frenzy of activity and this continues for two and one-half hours. Finally she is becoming exhausted, as are the therapists - and 50 mg. of thorazine is administered IM which begins to quieten her. She rambles on incoherently for another hour, is fed, and put to bed and she goes to sleep.

Evaluation of Session No. 2

J was apprehensive at the beginning of the session and expressed serious concern over the possibility that LSD would change her voice or take it away entirely. This statement refers not only to her anxiety over losing her speech-thinking defense mechanisms, but also suggests that she was afraid of losing her only means of relating with others, for loss of speech to J also means total isolation.

We were rather amazed to see J's sense of humor - she was able to feel and relate in a very human way in,the beginning of the hour and it was quite startling to observe this. The bulk of the session was devoted to her conflict over being a girl and being rejected by her mother. She began to experience her rage against her mother but had tremendous difficulty in admitting to that rage. When she would begin to deny her rage she would immediately start indulging in her psychotic behavior. It was also of interest to get a hint of some of the meaning of the "Scribble Head Riddle." Part of that riddle has to do with her both loving and hating something, probably most notably her mother, at the same time. When commenting on this, her tone was one of quiet perplexity.

Excerpts From Session Number Three

9.00 a.m.: Drug administered.

9.30 a.m.: J is tense; she wants to talk to us but we insist she be quiet and listen to the music; she begins to cry and rub her hand on her forehead and mouth. She moans and sighs and is distraught - cries, kisses her hand and says, "I want to like myself" - repeats this numerous times. Occasionally she bounds off,the couch and smashes her fist against the wall.

10.00 a.m.: J: "I'm a girl, I'm a girl." Alternately cries and laughs. Growls and whines. Stuffs a rag into her mouth. Occasionally screams out "No!" When staff try to touch her, she withdraws and says, "No, leave me alone."

10.40 a.m.: J: "My chest feels like I'm the Scribble Head Riddle, I'm not! Hey, S, I want this to go away. I don't like it like this." She then begins to carry on one of her dual conversations about wards, then stops herself and says: "No, you're not supposed to talk like two persons. I'm not going to talk too much."

10.50 a.m.: "I'm well now. I feel different. I feel like a girl. S, please help me." S moves to her and takes her hand. J responds by trying to communicate with S. J: "A girl and a boy. S, is this different or is it the same? How come I have to be a girl? Why do I have to talk this way? Am I supposed to act this way? I'm gonna do just what I want when I feel this way. I have feelings and they're stupid. I guess I could get out of bed for awhile. I'm just not gonna talk two persons any more." J holds S closely and with great affection, kisses her occasionally. Her speech is slow and soft, not driven and harsh as is usual. J appears to go into a reverie-like state which is characterized by calmness. J: "I want to be the mother. Why do I feel this way, S? I'm gonna be a mother. I have a good mouth. I grow back into a girl now, S. Let me try and do something different.. Now, love, that's me and S loving each other. I feel so good. I can't make things start over again." She now becomes very soft and gentle, speaks as though she is speaking gently to herself - "I could feel this way if I like. I love to get along with people. I'm a girl and a good one. I'm making the things I'm not supposed to feel, feel this way. Oh, I feel like I'm supposed to feel! I'm not going to do what I did last time! I feel like I'm a new baby. Turn on the gas - no, no - I didn't mean that (a little agitated). I feel different. I feel good and I can help other people too. Oh, I wish I was sick." F asks: "What's bad?" J: "I feel good." F: "Is there such a thing as bad?" J. "No!" (with great emphasis.) She then laughs and asked: "Would it feel good if I died?" to which S replied, "Yes." J: "I want to die." J then laid down with a deep sigh, closed her eyes, relaxed and stopped talking. She becomes extremely peaceful looking and maintains this state for about twenty minutes. She then mutters softly, "Yeah, this is it, this is it." She strokes S's hand softly and smiles, and says, "I'm a girl." Her expression is positively beatific. She takes S's head in her hands and whispers, "I love you." There is a remarkable grace to her hand and body movements. F: "Did you get to die?" J: "Yes, and I came back alive, see?" Ten minutes later she said, "That's the way it's supposed to be. I can be anything I want." She then becomes quiet and repeats the word "See?" in a questioning manner, to mean "You see, now do you understand."

1.00 p.m.: J begins to talk about good and bad wards - a flurry of rambling speech - in the middle of this she suddenly stops and says, "I want to die again." She then appears to become a little anxious and says, "I can do anything I want to do. See, I'm a good girl." F: "Let's be bad for awhile." J: "Why? I'm a good girl." Appears to be a little agitated with this suggestion. J: "Shall I die? It's fun." D: "What do you want?" J: "To be a good girl." D: "What does that mean?" J: "To get along with everyone." D: "What would happen if you didn't get along with someone." J: "I'd die." Later J says, "Scribble Head's mother is dead," and proceeds to go into an autistic discussion of all the wards in the hospital. She then becomes agitated, talks intermittently about being good or bad and about whether she is a boy or a girl. She proceeds on this track and our attempts at intervention are to no avail.

Evaluation of Session No. 3

In this session, J reached a state of deep acceptance and experienced profound feelings of love and personal integration. At the beginning of the session she was visibly tense and less talkative than usual. There was an almost grave aspect to her feeling tone in contrast to her usual loose, uninhibited and inappropriate behavior. Soon after taking the drug she tried to engage us in conversation but we thwarted these attempts viewing them as a method of hanging on to the world she knows and her defensive psychotic posturing. For two hours, J quietly cried and smiled, engaged in familiar oral activity, expressed anger and kissed herself. Then her feeling tone changed. She became happy, relaxed and full of warmth - she appeared to be overwhelmed with feelings of compassion and love for herself and for us. J was expressing wonder and delight and her voice was relaxed and her words spoken softly and slowly as contrasted witch her usual rapid tense mode of speech. Her warmth of feeling increased dramatically, and she reacted to these feelings and physically and verbally expressed love for herself and for S. She has never behaved this way before. We interpret much of what she said to mean that she was experiencing feelings of love and acceptance for the first time and she was quite amazed at this. Her fear had always been that would annihilate herself and others if she expressed her feelings because the primary feelings that she knew at some level were her tremendously angry ones. We felt that she had been able to achieve a significant state of self-acceptance and love during this session. Her whole manner, speech, feeling tone, bodily movements and appearance was one of profound self-acceptance and peace. This was a very dramatic experience to observe and was very similar to experiences observed, during psychedelic states, with mature and stable adults.

Later in the day she became very much involved with good and bad; and then we asked her to try being bad for a while. She seemed to become anxious at this suggestion and repeated that she had to get along with everyone and than she wasn't so bad. Her anxiety increased and she began a discussion of what one should or should not do; she became increasingly anxious and attempted to define and control her experiences and feelings in the context of good or bad.

After the session, pronounced and quite sudden changes occurred in her behavior and perceptions of her world. Her entire delusional system solidified into an absolute clear-cut dichotomy of good and bad and their respective proponents, God and the Devil. God was good and stood for every socially acceptable value J had ever heard of. He told her to help the staff, to love everyone, not to talk crazy and to do what she was supposed to do, which, as far as we could determine, meant doing what everyone told her to do, staff as well as every patient. She saw the Devil pretty much as an evil temptor who, if she did not resist him, was somehow able to make her do bad things, such as break windows, say bad words, hit other children, scream and yell, get mad, roll her head on the bench and so on. J was never at a loss to tell us how she hated the Devil, which in truth was the strongest part of her. It appeared that in one dramatic act J had chopped her self in half trying to affirm the good, the socially acceptable and the "should" while denying her tremendous anger and antisocial impulses, projecting them to an external force, the Devil. Actually the good was also externalized, for a J told us herself, she was not good unless every one thought she was good. She had reduced herself to a mechanism capable of certain responses which hopefully would elicit reward and approval from others. There was very little Jeannie Drake involved at all. She vehemently emphasized that if someone, any one in the world, did not love her, she would kill herself, choke herself, turn on the gas and die, tear off her spout (vagina), rip open her stomach, etc. Needless to say, her behavior was painstakingly and horribly good. In the battle between her hostility and her cruel, immature conscience (based on her fantasies of mother and her inability to accept the fact of an unloving mother) her conscience was victorious because she so needed mother's love to verify that she herself was worthy. She was incessantly besieged with feelings of worthlessness and evil and directed her death wishes onto herself while at the same time trying to find a way to get out from under the superego's relentless attack. Thinking that she was evil, she attempted to eradicate all traces of herself as a person and externalize her battle between good and evil to God and the Devil. She took a totally passive attitude and was at the mercy of the world. Everyone in the world stood in judgment of her and she undertook the most tremendous task of all, a control of the world. She had to control everyone's attitude towards her. The slightest kind of disapproval from anyone excited feelings of such failure and worthlessness that she wanted to die. At the same time, the expression of hostility on the part of other patients launched her into a frenzy for this caused her to experience dreadful impulses to aggress which threatened the betrayal of her delusional system, thus setting up her ultimate destruction.

We viewed this "personality adjustment" favorably and as a change which included more of reality than she could previously recognize. In part she was attempting to isolate her rage and to become socialized. She did realize that her day to day behavior had something to do with her being where she was psychologically and environmentally, and she started to take initiative in helping around the ward. A couple of weeks later she established a consistent and friendly relationship witch a female patient a few years younger than herself. This attempt to "adjust" on her part was a courageous effort to again face reality, and attempt to understand something in life and to establish a new spot for herself. If she did express any hostility, she blamed it on the Devil. (Later we realized that in her fantasy life she gained "a lot of satisfaction by having the Devil and the Scribble Head Riddle "kill people's parents." She would then "bring them back alive" and would thus maintain an immaculate image of herself.)

Session No. 4

During the initial phases of this session J experienced genuine grief and sorrow and cried. In response to these feelings she frequently extended her arms upwards and said she wanted " to go up" and "Ito go up there, to heaven" which meant that she did not want to experience her sorrow but wanted only feelings of comfort and happiness. She further verbalized this desire by saying, "I am trying to kill hell," and "I am trying to love myself." She then began to devote her time to bring about pleasant and good feelings through the use of her voice and intellect. She repeated hundreds of times, "I am trying to find out why" and "I am trying to make me love myself." She was caught up in such perseverative patterns off and on for the rest of the day. At the end of the day she became very violent and tried to choke herself and others and had to be restrained.

Session No. 5

In this session J was completely unable to tolerate any affect induced by arousal of unconscious material and drove herself into an acute psychotic state involving perseverative manic-like verbal defense and frenzied motor activity. It was impossible to make ourselves known to her and she was completely out of control and encapsulated and isolated by her defense. An additional dosage of 100 mcg. LSD around noon served only to intensify the ongoing reaction.

Session No. 6

During she initial phases of this session J talked much as she had before, saying tat she was going to try to love herself and learn things. She appeared to be looking forward to this experience and was extremely anxious to cooperate. It was important for her to follow our instructions and she seemed to feel that we could help her. All this behavior had been J's way of relating to everyone ever since her third session. What was significant for us was that during the session when she began to get anxious and talked in a defensive manner she would stop herself and say, "No, I'm supposed to lie down and listen;to the music," and would do just that. One might argue that we were only reinforcing and encouraging her "be good" game but we feel that her ability to resist her usual defensive methods even for someone else was excellent progress for her. After the first hour she remained quiet and still for almost three hours. It appeared that she was allowing herself new experiences. She laughed loudly and with genuine gusto, which we had never seen her do before, and for long periods of time she simply appeared very relaxed, calm, quiet and happy. During the latter phases of she session her compulsive controls reemerged and she was anxious and agitated. We felt,that this appeared to be provoked by her difficulty in reentering her more usual state of consciousness. We felt that it was quite significant that she was able to cooperate with the therapists, follow our directions to become quiet, to listen to the music and to learn, and that she was able to surrender these defenses and allow herself new experiences.

The quality of the quietness of the session was also significant in that this type of behavior usually indicates that the individual is exploring internal phenomena, and the quality of the session was in marked contrast to the two previous ones wherein she was extremely defensive and psychotic.

Session No. 7

Throughout most of the morning J was relaxed and content to remain quiet and still. The few times she did speak she launched into a typical discussion of good and bad, God and the Devil. Some two hours later she began referring to apparently traumatic sexual oral events to which she had alluded from tie to time. Although this material was not made precise, it appeared that she had been subjected to forced oral copulation. She appeared to be choking and then spitting vehemently. In addition she moved so as to try to remove her mouth from some presenting object. We directly interpreted the symbolism she presented in this connection but we received little response from her. Soon after this, however, she became anxious and told us "I am trying to think."

In the afternoon her perseverative behavior dwindled and she began to whine and plead apologetically which grew to great and genuine grief over "killing" people. It seemed that she had been confronted with her hostility and death wishes and that these wishes had come true for her. Thus, she was forced to abandon her denial of hostile wishes and was now suffering the consequences. This to us was an important step forward for her. We attempted to communicate to her that she need not be ashamed of her wishes and that in truth she had killed no one. She did not respond to this "support" and continued to grieve and crucify herself for these murderous deeds.

Significantly, she identified these wishes with the past and was unable to accept that these wishes still existed. She begged for forgiveness and pleaded, "Hurry, mother, come back alive," and would deny the existence of any hostility at the present time. However, we felt that this session was a significant one for her.

Sessions 8, 9 and 10

J's 8th, 9th and 10th sessions were quite different from those previous ones and were so similar that they can be described together. In general she remained quiet and still, spoke only when spoken to and experienced little anxiety at any time. We were somewhat dismayed over this change and wondered if perhaps she had found a way to shut off the drug effects and prevent herself from getting herself involved in any significant material. Yet the absence of any defensive behavior suggested that she was having little difficulty tolerating her experiences, whatever they were, and thins was encouraging. The specific content that did emerge was related to her relationship with her mother. She discussed, rather quietly, that it was not good to get mad at her mother and how sorry she would be if her mother got hurt. In describing mother, J said, "Mother is crying, mother is mad, mother thinks I'm lying, mother is crazy." She said that if she hated her mother, she herself would die. She was able to talk about her mother's threat to leave her and the ambivalence she felt about it. She also said that she wanted to leave her mother, but that would be a terrible thing to do. She continued to deny her mother's rejection of her saying tat if she died, then her mother would die, because her mother loved her so much. At one time J said, "I hate my mother when she cries and gets mad at me." D: "Tell her that." J: "Mother, I want to tell you something.... No, I don't, mother, I love you." In retrospect, it appeared that she had indeed done some productive working through for in her 11th session there was a significant breakthrough in her defensive maneuvers and she experienced freedom.

During the month in which thee three sessions occurred she was more quiet, demonstrated little hyperactive behavior, head rolling or bizarre behavior. She sat quietly by herself and very infrequently indulged in her perseverative speech patterns.

Session No. 11

J lay quietly for some three hours and appeared to be experiencing more pleasure and delight than she had since her third session some five months previously. At about noon she appeared very much in contact with her surroundings and still very accepting of her experiences. We began to communicate to her our interpretation of her delusions. She made no remarkable response to these interpretations so we stopped. Soon, however, she began spontaneously to verbalize and we suddenly witnessed her description of the destruction of her psychotic world. J: (in a loud booming voice) "I love the Devil! I am the real Devil and I am the real Scribble Head Riddle! The Devil and the Scribble Head Riddle are my imagination and I am really the Devil and the Scribble Head Riddle!" She stood up and walked around the room, laughing in amazement and continued to say, "I've been bad and I don't care. I.think it is just great." She repeated, ''I think it is just great," at least fifty times. She reenacted many past scenes with her mother, taking both parts. Taking the part of mother, she would whine and say, "Jeannie, are you being a good girl?"and in a booming response, J would yell, "Hell, no, hell, no hell no!" She told us she could say all the bad words she wanted to and proceeded to do so with great passion. She began to toy with her fear of death as reprisal for the expression of her feelings. She said, "I hate mother and God and everybody," and then dramatically fell to the floor as if struck dead and,then leapt back,to her feet, announcing, "I have just died and I don't care and this is just great!" Many times she compulsively repeated the sequency of expression of hostility, death, and the rebirth. Finally, she said, "Let's not have any more of this goody, goody stuff." On several occasions she berated the staff and imitated us in humorous and unflattering ways.

This type of material went on for four hours. Near the end of the day she began mentioning concern over her "good things" and pretended to carry,them about in her hand asking for a safe place to keep them. When questioned as to what these good things were, she stated tat they were the nice things that happened to her, the good feelings she had, and the future. From what we surmised, her good things were her insights which she wanted to salvage from the wreckage of her good and bad world. Perhaps the destruction of that which she had previously tried to maintain caused her to feel there was little with which she could start over. We assured her that her good things would not leave her, only her useless, crazy things but she remained in doubt over thins matter. We took her back to)the ward early win the evening-she was a tired, dazed and happy girl clutching her "good things,." It is an understatement to say we felt a lot had been accomplished.

The next day she was extremely anxious to talk, and we talked to her about her session. She knew that we knew all about her and she was happy. Still she made some feeble references to the Devil, but laughed when we reminded her of events in her session. She laughed with great warmth and genuineness, saying, 'The Devil and the Scribble Head Riddle-yeah, they're me alright!" It appeared that on a very superficial level she wanted to continue with her old ways, but at a deeper level, however, she was ready to drop her psychosis and learn something new.

Sessions No. 12

This session was almost entirely spent in J's reenacting out traumatic events with her mother. This included many scenes which were painful for J and she compulsively and repetitiously went through them, perhaps trying to abreact all the affect out of these events. Her affect would change as she repeated these events and often she would go through one in a light-hearted and humorous manner. When she had finished with one scene, she would start another different one. She also spent considerable time being mischievous and bad and she enjoyed this tremendously. She also indulged in alternately beating and loving a large air-filled rubber mannikin which she identified as mother. She also attempted to nurse on,the mannikin. Several sessions earlier when the therapist had verbalized his hate for his mother, J had become terribly concerned, rushed over to him, placed her hand over his mouth so he couldn't speak and said, "Oh, you must never say that." When he also hit the mannikin and screamed, "I hate you, mother," this also sent J into a panic and she physically controlled the therapist from hitting the mannikin. Now, in this session, she was acting out this ambivalence toward mother, through the mannikin, both verbally and physically. She also continued to hold she "good things" in her hands and seemed,to suck and nurse on these things. She said there was nothing really in her hands but yet these were things that she liked to have that made her feel good. She had difficulty verbalizing the nature of these good thing, but when pressed, named a number of things she liked, including candy, peanut butter sandwiches, staff members, a boy patient she had recently taken to associating with, and money.

Session No. 13

In she first two hours of this session, J lay quietly and made no movements or verbalizations. She then sat up and in a perplexed manner said, "Why do you sometimes get hit by a truck when you go out on the highway of life?" After this she lay quietly for a short time and then started to become agitated. She tried to allay this agitation by trying to express positive feelings for the therapists but soon the shallowness of this attempt was obvious as she started to become aggressive, angry and assaultive. She ended up by screaming desperately, "I want to go out on the highway and get killed." She then would become frightened and yell, "No, no, I don't want to be killed." Perhaps in some existential manner, she was dealing with the question: should I give up my living death (psychosis) and take my chances with the world of reality,? It seems that the resolution of the "Riddle" the pressure of positive and negative feelings (of good and evil, the Devil and God) in oneself and the acceptance of that seeming paradox was the key to her entering "the highway of life." In this dilemma, J is not alone and facing such existential questions is often the core work of the psychedelic experience. When transcendance of the ego-state is achieved, the paradox is resolved and the seeming contradiction of conditions is experienced as a unified state. We feel that J had had glimpses of this unified state, but as with everyone except the saints, the human perception of opposition conditions maintained itself and conflict resulted.

Sessions 14, 15 and 16

J's mother had been released from the hospital. and came to see her. This apparently was exceedingly stressful for J and she became very disturbed. During the 14th session she became totally involved with fear of punishment and reverted back to trying to be good. This undoubtedly was related to the conflict over her rage being activated by having to see her mother. She became manic in her massive denial during this session and it was felt to be very unproductive. During the 15th and 16th sessions, she was excessively quiet, somewhat morose but did have long periods where she appeared to be in a very tranquil and peaceful state. During this time, she spoke softly and gently, only to herself, saying-"Yes, yes, this is it. It's alright." During this period of time we were preparing J for discontinuation of drug sessions as the project was being terminated. She also knew that two of the staff that she had been closest to were leaving and this was distressing to her.

Discussion

The experimental project came to an end at the time when drug laws were enacted which necessitated a long and difficult procedure to obtain these drugs. Consequently, we were forced to tell J that she would no longer be able to have any sessions with these drugs. The conversation that ensued was as follows: F: "J, because of certain problems we're not going to be able to get any more of the drugs we have been giving you and so we are going to have to do without them." J: "Isn't there any more of those drugs?" F: "Well, yes, there's still more of,the drugs but we're not able to get them." J: "Why not?" F: "Well, it's a very long and difficult story but we just aren't going to be able to get any more." J: "Do you know who has any?" F: "Yes." J: "Who has it?" F: "Well, the man who distributes it is called H.A. and he is a representative of the drug company and he lives in San Francisco." J: "Well, just go there and tell him that you need some more drugs." F: "That just won't work." J: "Why not?" F: "He just wouldn't give it to us." J: "Well, just hit him over the head and take them." F: "Then the police would come and get us." J: (In a serious and determined, yet pleading voice) "Well, just go to the man and tell him that Jeannie Drake *says* that she *really* needs it and can't she *please* have some."

One question that is most often asked concerning the results we obtained with these psychotic children is-"But wouldn't you get the same results without the drugs by just giving the time and devotion you gave to these children?" As can be seen, J evaluated the drugs as being an important aspect of her psychotherapy and the writer concurs with J's judgment. The writer had spent over two years experimenting with psychotherapeutic techniques with this type of child and the results were negligible. If one is very familiar with the severity of she problems encountered in these very psychotic children, one can more realistically judge the results of this present work. One extremely important factor which came to be of paramount importance was the constant chaotic and physically stressful environment to which these children were constantly subjected. They had to survive on a sterile ward with sixty other acutely disturbed and acting-out psychotic children. How anyone could maintain a trace of sanity under these conditions is a mystery. The writer often thought that a psychotic withdrawal would be a healthy reaction to having to live in such an environment.

It was obvious that J became much better. She ceased her isolated, autistic behavior to a very large degree-she no longer sat in a corner,.twisting papers, masturbating and talking word-salad. She had chores which she did on the ward. She talked to people rationally and helped with the smaller children. Her comments about other patients, and sometimes staff, were painfully accurate. She tried to learn but found it almost impossible because of her blindness. She did go to the hospital's rehabilitation department and the music instructor discovered, within one hour, that J could learn to play piano "by ear." He was overwhelmed and enthusiastic and highly recommended she be given this chance to learn to play. Nothing came of it. She was able to carry on very sensible conversations with staff, gave intense and undivided attention to her co-therapist when they met between sessions and was able to describe her concerns, reactions and finally, her own dynamics. She developed a very meaningful and intense relationship with the co-therapist. They had a totally gratifying experience with each other, the co-therapist describing J as "one of the most human, one of the best people I know." When the therapist and co-therapist left, they had much more difficulty in the separation than she and it was quite amazing the depth of acceptance she had concerning the necessity of terminating the project and her relationship with both the therapist and the co-theparist. In fact, she was very reassuring and supportive to them and seemed to exquisitely sense their deep feelings of guilt and shame at the abandonment of her and she rest of the children. In short, she carried on in a rather remarkable fashion and with a maturity that literally awed us.

Five-year Follow-up

The patient was discharged in June, 1968 to her parents who had moved to another state. She has not been seen by the writer since May of 1963 and the distance mitigated a personal follow-up. The patient's chart at the state institution was made available and was searched for progress notes for that five-year period. Unfortunately, the record was scanty but it was possible to glean some indication of her psychological condition.

The first notation in the chart was at the termination of the treatment in June, 1963. The psychiatrist's progress report read, "Patient is in good contact with reality; she has fairly good insight; requires no regular medication; cares for all of her own needs and is no management problem; definite improvement."

The writer left the institution in May of 1963 and the co-therapist left a few weeks later. Within three months the majority of the treatment staff had left. Consequently, the patient had virtually no one with whom to continue her therapeutic work.

In February, 1964 a notation was made that she asked one of the ward workers, "When will my craziness wear out?" She also offered the information that she must be happy with her craziness as she didn't want it to leave. In August, 1964 a student worker had Jeannie in a group therapy situation with a number of adolescent girls. There is no data as to the length of time these sessions had occurred but a progress evaluation by the student therapist reveals the following information: "Jeannie loves attention and acceptance and is very pleased when praised; she is a big help to me when I take the group off the ward. It seems as if she is living another life in her mind. She told me, "I'm out to see the world-but how many are there?" She also told me, "Everything is a thousand years old and everything is getting better and better." She converses with herself a lot and in these conversations she is usually mad at herself and talks of her mother.She shows concern about being sick and dying. As we were walking the other day, she very intently told me to listen to her talk and then to answer the questions. One day when she was talking to herself, I went over to her and asked her what she was concerned about. She laughed and answered, "Oh, don't bother, I'm just talking!"

In May of 1966 a progress report indicates that she was not a behavior problem but that her behavior oscillated between hyperactivity and withdrawal. A notation was made that she verbalized concern over fear of drying, of evil, and commented that cleanliness was good.

In October of 1967 she was presented to a consultant psychiatrist who interviewed her before a staff. He noted that she was in good psychological contact "despite her rocking motion." He felt that there had been improvement following her LSD treatment and suggested a manic-depressive psychosis diagnosis based on her alternating between hyperactive and withdrawal moods.

At the time of her discharge in June, 1968 she was described as making rocking movements, that she might be having hallucinatory experiences and that often when eating she would stuff her mouth. She was also noted to participate well in the ward activities, that she did her ward chores, that she spoke coherently and well and that she was a co-operative patient. A final note was that "Jeannie is an enjoyable person."

Unfortunately, the follow-up information is scant and meager. It would appear from these notes that Jeannie generally maintained the progress she had made in her treatment but that she had not resolved her essential conflicts. Apparently she was able to live somewhat in two worlds-,the world of her psychotic preoccupation which was dominated by her impulse of rage toward her mother and the world of external reality. This conclusion is based on her ability to interact appropriately with demands made upon her by ward personnel, her ability to communicate reasonably, her participation in activities and work and the fact that she was seen as not only human, but as an "enjoyable" human. While wrestling with her own stated craziness, she was also able to relate and participate in the real world. This degree of integration is certainly a far superior one to that which she possessed prior to her treatments.

The writer feels that it was Jeannie's great determination to know and to become more powerful than her "craziness" and that was the key facet in her maintaining some degree of sanity. She would actively seek out people and make attempts to understand her chaotic world and had a belief that she was going to get some answers one way or another. Her attitude towards her unintegrated and confused psychic state was one of tolerance with an unrestrained determination to overcome. The writer often feet, very deeply, that this was one very courageous human being.

Other Research Utilizing Psychedelic Drugs With Autistic Schizophrenic Children

Mogar and Aldrich (in press) have recently reviewed the literature on the use of psychedelic drugs with schizophrenic children. They review the work of Bender, Goldschmidt and Sankar (1962); Bender, Faretra and Cobrinik (1963); Freedman, Ebin and Wilson (1962); Peck and Murphy (in Abramson, 1960); Rolo, Krinsky, Abramson and Goldfarm (1962) and Simmons, Leiken, Lovaas, Schaffer and Perloff (1966), as well as some preliminary unpublished data from our own work. Of the total of 91 children treated with psychedelics, 55 were treated by Bender, who gave daily dosages over a relatively long term period (45 to 60 days) but without attempting to conduct psychotherapeutic sessions. The primary purpose of the studies by Rolo *et al*. and Simmons *et al*. was explicitly methodological whereas Freedman *et al*. were attempting to study the schizophrenic process and did not have any therapeutic intent. Our own work was the only one which attempted to create an atmosphere which would optimize the therapeutic process. Mogar and Aldrich state: "Inconsistent findings become much more understandable if the psychedelic experience is viewed as a dynamic configuration of intimate patient-therapist-milieu transactions. In short, the administration of LSD is inextricably embedded in a large psychosocial process which should be optimized in accordance with particular treatment goals."

Despite the diversity along major dimensions known to influence drug response and treatment effectiveness, Mogar and Aldrich make the following conclusions based on their evaluation of the results of the seven studies reviewed. (1) all children were refractory to all other forms of treatment; (2) only slight differential responsiveness as a function of age, diagnosis, duration or severity of illness; (3) most effective results were obtained with at least 100 mcg. doses given daily or weekly over relatively extended periods of time; (4) greater therapeutic benefit was related to (a) the degree of active therapist involvement, (b) an opportunity to experience meaningful objects and interpersonal activities, (c) congenial settings that were free of artificiality, experimental or medical restrictions and mechanically administered procedures; (5) the most consistent effects of psychedelic therapy included: (a) improved speech behavior in otherwise mute children, (b) increased emotional responsiveness to other children and adults, (c) an elevation in positive mood including frequent laughter, (d) decreases in compulsive ritualistic behavior; (6) although differences in patient attributes, treatment techniques, research design and other non-drug factors seemed to effect the *frequency* and *stability* of favorable outcome the types of improvement found were essentially the same in each study.

The reviewers conclude that the collective findings argue strongly for more extensive applications of psychedelic drugs in the treatment of this type of child.

Acknowledgment

The writer wishes to acknowledge, with great admiration, the contribution of this patient's co-therapist, David Dion, M.S.

References

1. Abrahamson, H. A. (ed.): *The Use of LSD in Psychotherapy*. New York: Josiah Macy Foundation, 1960.
2. Bender, L., Faretra, G., and Cobrinik, L.: "LSD and UML treatment of hospitalized disturbed children." *Recent Advances in Biological Psychiatry*, 1963, 5, 84-92.
3. Bender, L., Goldschmidt, L, and Sankar, S. D. V.: "Treatment of autistic schizophrenic children with LSD-25 and UML-491." *Recent Advances in Biological Psychiatry*, 1962, 4, 170-177.
4. Blewett, D. B. and Chwelos, N.: *Handbook for the Therapeutic Use of LSD-25: Individual and Group Procedures*. Unpublished Manuscript, Regina, Saskatchewan, 1959.
5. Freedman, A. M., Ebin, E. V., and Wilson, E. A.: "Autistic schizophrenic children: An experiment in the use of d-lysergic acid diethylamide (LSD-25)." *Archives of General Psychiatry*, 1962, 6, 203-213.
6. Mogar, R. E. and Aldrich, R. W.: "The use of psychedelic agents with autistic schizophrenic children." *International Journal of Neuropsychiatry*, in press.
7. Rolo, A., Krinsky, L. W., Abramson, H. A., and Goldfarm, L.: "Preliminary method for study of LSD with children." *International Journal of Neuropsychiatry*, 1965, 1, 552-555.
8. Simmons, J. Q., Leiken, S. J., Lovaas, Q. I., Schaffer, B., and Perloff, B.: "Modification of autistic behavior with LSD-25." *The American Journal of Psychiatry*, 1966, 122, 1201-1211.

The Use of Psychedelic Agents with Autistic Schizophrenic Children

by

Robert E. Mogar & Robert W. Aldrich

from Psychedelic Review Number 10, 1969

original source: http://www.druglibrary.org/schaffer/lsd/autism.htm

Table of Contents:

- Patient characteristics
- Rationale and hypotheses
- Drug regime
- Physical and psychological milieu
- Results
- Summary and conclusions
- References

Evidence from seven independent studies indicates LSD may help free the most severely imprisoned minds.

In recent years, a number of exploratory investigations have been reported involving the administration of psychedelic agents to young children suffering from severe forms of psychological disturbance (Abramson, 1960; Bender, *et al*., 1962; Bender, *et al*., 1963; Fisher & Castile, 1963; Freedman, *et al*., 1962; Rolo, *et al*., 1965; Simmons, *et al*., 1966). As either therapeutic or experimental undertakings, these studies are extremely fragmentary and suffer gross shortcomings. As a case in point, wide diversity along major dimensions known to influence drug response and treatment effectiveness characterize this work. These include the agent employed, dosage level, number and frequency of administrations, therapist expectations and previous experience with psychedelic drugs, and finally the setting and circumstances surrounding the drug-induced state. With regard to patient characteristics, the children treated were demographically varied and covered a broad age range. More importantly, the samples were markedly heterogeneous with respect to the nature, severity, and duration of modal symptoms. The major experimental shortcomings included small samples, subjective and vague criteria of drug effects and improvement, and grossly inadequate follow-up.

Despite their diversity and severe limitations, these seminal explorations in an extremely complex area of research seem worthy of wider reportage and more serious attention than they have hitherto received. Almost without exception, these reports have appeared in obscure publications or remain unpublished. A more significant reason for their relative neglect has been the polarized controversy surrounding psychedelic agents which has all but completely curtailed publicly-sanctioned research.

In this critique of the use of psychedelic agents with severely disturbed children, the various studies conducted thus far will be comprehensively reviewed and integrated. Particular attention will be given to their similarities and differences along known relevant dimensions in order to detect communalities and possible reasons for inconsistent findings. While some attempt will be made to resolve seemingly contradictory results, the heuristic value of this work will be emphasized rather than its conclusiveness . Hopefully, the tentative conclusions derived from these initial efforts will point the way for more definitive studies into the therapeutic efficacy of psychedelic agents with childhood disorders.

Patient characteristics

A fairly exhaustive search of clinical and research reports revealed a total of 91 severely disturbed children who have been administered one or more psychedelic agents for experimental and/or therapeutic purposes. As detailed in Table 1 this collective group of patients ranged from five to fifteen years of age, with the large majority between six and ten years of age. Careful examination of the seven independent studies disclosed little basis for assuming a significant relationship between age and drug response. However, tentative relationships were suggested by both Bender (1963) and Fisher and Castile (1963). Bender noted that in contrast to pre- adolescents, younger children manifest consistently different reactions to a variety of medical and pharmacological treatments. For this reason, she hypothesized that her older patient group (12-15, N = 8) would not show the dramatic positive changes obtained with the younger children. Contrary to expectations, comparable favorable effects were found irrespective of age differences. Fisher and Castile, on the other hand, concluded that older children were better candidates for psychedelic therapy because verbal communication was possible and also because they tended to be less withdrawn, more schizophrenic than autistic, and displayed more blatant symptomology. While these patient features were obvious advantages for the particular therapy technique employed by Fisher and Castile, it is unlikely that this symptom picture consistently distinguishes older from younger psychotic children. Thus, on the basis of the available evidence concerning the immediate and subsequent effects of psychedelic drugs on children, age per se appears to be an inconsequential variable.

All of the patients treated in these studies were described as severely and chronically disturbed with a primary diagnosis of autism or childhood schizophrenia. With regard to duration of illness, most had been hospitalized for periods ranging from two to four years. Many were afflicted since birth. An apparent exception was the single patient studied by Rolo and his co- workers (1965). This twelve year old boy had been hospitalized for four months. No estimate of the duration of his illness was reported. At the opposite extreme, the twelve children treated by Fisher and Castile were probably the most severely disturbed with an average illness duration of 7.6 years.

The modal symptoms characterizing the majority of children given psychedelic treatment were well summarized by Simmons and his coworkers (1966): (1) preoccupation with and stereotyped manipulation of objects (toys, etc.); (2) isolation of the self from contact with animate objects (including minimal eye contact); (3) failure to acquire general social behaviors (including speech); and (4) bizarre rhythmic repetitive motor patterns. This syndrome conforms closely to the classical picture of infantile autism (see e.g., Rimland, 1964). As suggested earlier, the symptoms picture of the older children treated by Bender and by Fisher and Castile resembled adult schizophrenia more than infantile autism. This was also true of Rolo's single patient. Although autism was invariably present, the "schizophrenic" children were less withdrawn and manifested a greater variety of symptoms including overt aggression, hallucinations, paranoid delusions, and psychosomatic disturbances. Almost without exception, long-standing mutism was characteristic of all 91 patients prior to psychedelic treatment.

Despite these significant communalities among the seven groups of children studied, individual differences in patient characteristics extended over a fairly broad range. Without discounting the possible importance of individual differences, there is little indication in the work reviewed here of differential response or benefit as a function of age, diagnosis, duration or severity of illness. As will become apparent in subsequent sections of this paper, the failure to detect such relationships seems partly due to fragmentary patient data and the crude estimates available of drug response and subsequent changes in behavior. Consistent with this hypothesis, the differential findings reported by Fisher and Castile appear to reflect their more detailed assessment of personal history information and individual differences in both pre- and post- treatment symptomology. They also applied more stringent criteria of improvement than the other investigators.

Rationale and hypotheses

Explicit hypotheses or theoretical bases for administering psychedelic drugs to disturbed children are almost completely absent in these exploratory studies. The lack of a definite rationale is hardly surprising when one considers the enigma surrounding both schizophrenic behavior in children and response to psychedelic drugs. Despite great diversity in expectations and technique, there was one point of departure shared by all investigators, namely, that all known forms of treatment had been attempted without success. Thus, the use of a potent experimental drug with the particular chronic patients selected seemed justified.

With regard to the purpose of these studies, all were to some extent exploring the therapeutic potential of psychedelic drugs rather than their psychotomimetic properties. This was least true of Freedman and his coworkers (1962) who viewed LSD primarily as a means of studying the schizophrenic process by "intensifying pre-existing symptomology." This orientation contrasted sharply with Bender's view. Noting that withdrawn children became more emotionally responsive while aggressive children became less so, she hypothesized that psychedelic drugs "tend to 'normalize' behavior rather than subdue or stimulate it." This basic difference in expectations seems at least partially responsible for Bender's extremely favorable outcomes and Freedman's rather poor results. Regarding all forms of psychotherapy, it has become a truism that " where there is no therapeutic intent, there is no therapeutic result" (Charles Savage in Abramson, 1960, p. 193).

Consistent with their explicit therapeutic intent, Bender, Fisher, and Simmons each offer essentially the same hypothesis based on a psychological interpretation of childhood schizophrenia: "The working hypothesis of this study is that the psychosis is a massive defensive structure in the service of protecting and defending the patient against his feelings and affectual states" (Fisher & Castile, 1963). Psychedelic drugs were viewed as a powerful means of undermining an intractable defense system and thereby making the patient more receptive to contact and communication with others. In attempting to explain the predominantly positive results in this area of research (see Table 1), it is worth emphasizing that the collective work of Bender, Fisher, and Simmons accounts for over 75 per cent of the 91 children treated with psychedelic drugs. Although their techniques differed considerably, these investigators shared a psychological conception of autistic symptoms and a psycho-therapeutic orientation to drug treatment.

Although Freedman was prompted to use LSD primarily as an experimental device to study psychosis, he did mention that he was influenced to some extent by the dramatic improvement in autistic children reported by Peck and Murphy (in Abramson, 1960) and by the apparent success of Cholden, Kurland, and Savage (1955) in their work with adult mute catatonic patients. As will become apparent in the discussion of results, a partial and often transient alleviation of mutism by LSD treatment has been one of the most consistent effects reported in the children studies.

A final secondary objective worth mentioning is that the more recent studies (Rolo, *et al*., 1965; Simmons, *et al*., 1966) were influenced by Bender' s earlier reports of successful LSD treatment. These studies were attempts to replicate Bender's findings using various control measures and other methodological refinements.

Drug regime

As indicated in Table 1, LSD-25 has been by far the most frequently employed psychedelic agent in work with psychotic children. An exception was Benders s second study (1963) in which she gave one-half of her patients LSD-25 and the other half UM L491. The experimental drug UML-491 was described as a more potent serotonin inhibitor without the psychedelic properties associated with LSD-25. Based on a variety of biochemical indices and observations of differential behavior changes, Bender reported no apparent differences between the action or effectiveness of the two drugs.

Fisher and Castile employed LSD-25 and psilocybin at times singly and at times simultaneously. These investigators were unique in using a variety of dosage level drug combinations both with the same patient on different occasions and with different patients on the same occasion. The specific drug regime adopted for a given session was determined by clinical criteria of the patient' s particular defense structure and his expected resistance to psychedelic drugs. Stated differently, Fisher and Castile were the only investigators who attempted to optimize the psychedelic experience for a given patient rather than mechanically administering a constant dosage of the same agent to all patients. This feature of their method was consistent with the greater attention paid to individual patient differences and their general orientation to psychedelic therapy as a psychopharmacological process.

Concerning dosage level, most investigators settled on 100 micrograms as optimal. Although this was the average dosage used by Bender, she differed from the others by starting treatment at a relatively low level (50 mcgs.) and gradually increasing the amount to as high as 150 mcgs. As suggested earlier, Fisher and Castile usually administered multiple agents and employed a wide range of dosage levels (with LSD, 50 to 400 mcgs.). As their work progressed, they developed a definite preference for the prolonged high dose psychedelic experience, especially with older schizophrenic children. Their most effective results were obtained with pre-treatment medication of 10 mg. Librium, 10 to 15 mg. of Psilocybin given approximately one-half hour later, followed by 250 to 300 mcg. of LSD administered twenty minutes later. In addition, Fisher and Castile often gave "boosters" during the session itself ranging from 25 to 100 mcg. of LSD. Boosting was considered beneficial " (a) when the patient seemed to be caught up in a problem area which he could not break through; (b) when the patient kept defending himself from new experiences; (c) when the patient increased his defensive, stereotyped behavior and the psychotic controls became intensified."

With regard to frequency and total number of treatments, the seven studies varied widely - from Freedman's single session per patient to Bender's daily sessions over periods as long as one year. Although more frequent and prolonged treatment was often impossible for non-clinical reasons, Fisher' s group averaged five sessions per patient given preferably at two week intervals. With both Rolo' s single patient and Simmons' pair of identical twins, experimental requirements precluded an optimal therapeutic regime. Both investigators attempted double-blind procedures and more objective observational methods. Rolo administered 100 mcg. LSD on 28 consecutive days while Simmons gave a total of nine 50 mcg. LSD treatments, approximately two per week, interspersed with inert placebo sessions and control (no-drug) trials.

After citing extensive evidence indicating rapid tolerance of LSD-25, Freedman concluded that repeated administrations would be ineffective with psychotic children. Bender, on the other hand, found little indication of either rapid or sustained tolerance to LSD using her method of continued daily administrations over extended periods. With her relatively large group of patients, Bender did observe a leveling off of reactivity after several weeks or months of uninterrupted treatment. She considered it unlikely, however, that this effect was due to physiological drug tolerance. The impressive improvement rates obtained by Bender in contrast to Freedman's results offer support for a high frequency regime of moderately large doses. It is worth noting that Fisher and Castile arrived at a similar conclusion without knowledge of Bender's work. Parenthetically, the significance of a possible drug tolerance effect is further lessened by the findings of more recent experiments indicating that tolerance to LSD diminishes almost as rapidly as it develops (Hoffer, 1965).

Physical and psychological milieu

It should be emphasized that the findings obtained in these studies are the result of an interrelated set of determinants, only one of which is the ingestion of a particular chemical agent. The significance of seemingly contradictory results has often been obscured by the persistent search for static, " drug-specific" reactions to LSD. Inconsistent findings become more understandable if the psychedelic experience is viewed as a dynamic configuration of intimate patient therapist-milieu transactions. In short, the administration of LSD is inextricably embedded in a larger psychosocial process which should be optimized in accordance with particular treatment goals.

Even a cursory examination of the work with autistic children clearly reveals that at least some important aspects of the physical and psychological milieu were considerably less than optimal. In the seven studies reviewed here, only Fisher and Castile attempted to create a specifically non-medical atmosphere that was minimally threatening to the patient. Modeled after the widely-adopted Saskatchewan technique (Blewett & Chwelos, 1959; Hoffer, 1965), the procedure developed by Fisher and Castile included the following key features: (1) a high dose, 7 to 10 hour session; (2) the use of a variety of therapeutically-meaningful or aesthetically-pleasing stimuli (music, flowers, pictures, food, etc.); (3) a positive patient-therapist relationship formed prior to the session itself; (4) the presence of both a male and female therapist who "had thorough acquaintance with the phenomena of the drug through personal experience"; and (5) active therapist involvement with the patient including role-playing (e.g., father, mother). Importantly, these conditions have repeatedly been found to significantly enhance the personal value of psychedelic experiences.

In each study, the circumstances under which the session was conducted were consistent with the purpose and expectations of the investigator. Consistent with his psychotomimetic orientation, Freedman' s patients were supervised by a familiar psychiatrist primarily for the purpose of careful observation and note-taking. No attempts to relate to the children or personal experience with the drug were reported. The same applies to Bender's group although the intent in this case was clearly therapeutic. She apparently administered LSD as a conventional daily medication that did not require any special conditions of preparation, therapist involvement, or setting. However, her reports are replete with descriptions of spontaneous interactions between staff and children. Supervision of Bender' s patients was performed mainly by ward attendants. The adults present in the sessions conducted by both Rolo and Simmons were also ward attendants.

The primary purpose of the studies reported by Rolo and Simmons was explicitly methodological. Both research projects employed the double-blind method and attempted to follow a predetermined, uniform procedure during each experimental and control session. As means of standardizing the sequence of events and increasing objectivity, both investigators systematically presented various playing objects, games, and tasks to the child. Rolo's single patient was encouraged to engage in quite simple, familiar activities such as throwing a baseball or playing cards. Simmons, on the other hand, created a far more elaborate series of game-like situations that were novel and intrinsically interesting, requiring sustained patient-adult interactions, and importantly were specifically designed to simulate or elicit normal social behavior and emotional responsiveness.

A number of probable effects of the physical and psychological milieu are suggested in these studies that bear a significant relationship to the investigator' s orientation, on the one hand, and differences in benefit or outcome, on the other. As indicated earlier, the expectations of a particular research team seem highly related to various aspects of both drug regime and setting. With regard to differential improvement rates, a major determinant seems to be the degree of active therapist-patient interactions permitted during the drug-induced state. Secondly, greater therapeutic benefit seems to occur in congenial settings offering some opportunity to experience meaningful objects and interpersonal activities. Finally, psychedelic therapy with psychotic children seems most effective in natural, flexible settings that are reasonably free of artificiality, experimental restrictions on spontaneous behavior, and mechanically administered procedures. Conversely, barren medical or laboratory environments seem clearly anti- therapeutic.

Results

As emphasized previously, each of these exploratory studies suffered major shortcomings either as therapeutic or experimental undertakings. Almost without exception, the findings reported consist mainly of observational data obtained during the acute phase of drug reactivity. The use of pre-treatment baselines against which to measure change either during or after psychedelic therapy were generally absent. In most cases, follow-up data was not obtained. Although caution in interpreting results is certainly indicated, it should be pointed out that these limitations are shared by the bulk of research on drug- and psycho-therapies. Furthermore, objective evaluation of improvement in severely disturbed children presents unique problems due to the nature of autistic symptoms, especially the ubiquity of mutism. Even the few cases not suffering from a complete absence of speech were untestable by standard psychological assessment methods.

In their initial study, Bender and her coworkers (1962) administered the Vineland Maturity Scale at the beginning of treatment and again three months later. At the followup testing, ratings were qualitatively higher for all children. In the second study (Bender, *et al.*, 1963), the Rorschach, Draw-A-Person, and Bender-Gestalt tests were given to the ten verbally responsive children on at least two occasions; before treatment and again after a three to eight month interval. In these aggressive, overtly psychotic patients, Bender reports that "there were two major changes observed: (1) There was a decrease in personalized ideation and a corresponding gain in accuracy of response; and (2) An inhibition of strongly emotional or 'feeling' reactions to the cards." Other favorable changes reported included decreases in hallucinations, negativism, and regressive defenses with a corresponding increase in reality-contact. Similar types of improvement were found in the older children treated by Fisher and Castile.

With regard to her major group of young autistic children, Bender reported significant improvement in speech and verbal communication:

> "...the vocabularies of several of the children increased after LSD or UML; several seemed to be attempting to form words or watched adults carefully as they spoke; many seemed to comprehend speech for the first time or were able to communicate their needs... Very few of these changes in communication had been noted previously in such a large number of children, and at such a relatively rapid rate" (1963, p. 91).

Since mutism is a cardinal symptom of autistic children and probably the major impediment to successful therapy, it is worth emphasizing that at least temporary speech improvement has been one of the most frequently reported effects of LSD in the work conducted thus far. Other communalities include an elevated mood, less compulsive ritualistic behavior, and increased interaction with others. All investigators reported some favorable change in these major areas with the exception of Rolo' s single patient . Rolo's group abandoned the attempt to estimate improvement since their judges could not distinguish between LSD and non-LSD trials. Bender, on the other hand, made the following observations:

> "They appeared flushed, bright eyed, and unusually interested in the environment... They participated with increasing eagerness in motility play with adults and other children... They seek positive contacts with adults, approaching them with face uplifted and bright eyes, and responding to fondling, affection, etc." (1962, pp. 172- 3). "There is less stereotyped whirling and rhythmic behavior... They became gay, happy, laughing frequently... Some showed changes in facial expression in appropriate reactions to situations for the first time" (1963, pp. 90-91).

As indicated earlier, Simmons' patients were subjected to a uniform sequence of game-like situations that evoked a variety of measurable responses. During each LSD session and non-LSD session, a total of 20 specific behavioral measurements were taken by a recorder observing the patient through a one-way, screen. The behaviors recorded included physical contact with the adult present, vocalizations, destructive acts, laughter, stereotyped movements, and eye-to-eye contact. In contrast to non-LSD trials, the most pronounced and consistent changes observed during LSD sessions were: "(1) An increase in social behaviors manifested by increased eye to face contact and increased responsiveness to adults, (2) An increase in smiling and laughing behavior generally considered an indication of a pleasurable affective state, and (3) a decrease in one form of non-adaptive behavior demonstrated by a reduction of self-stimulation."

Considering the wide diversity in these studies, the major findings of Bender, Fisher and Castile, Freedman, and Simmons are remarkably similar. Differences in orientation, patient attributes, drug regime, setting, treatment technique, research design, etc. seem to affect the frequency and stability of favorable outcomes (see Table 1). The types of improvement, when and if they occur, appear to be essentially the same in each study. In short, when LSD is effective with autistic children, it is effective in characteristic ways.

The influence of non-drug factors is well illustrated in the work of Fisher and Castile. Although they optimized the physical and psychological milieu, their patients were the most severely disturbed and displayed the greatest variety of symptoms. Furthermore they made conservative estimates of improvement based on the extent and stability of favorable changes after treatment was terminated. In contrast, most of the findings reported by the other investigators concerned the immediate effects of treatment. These differences account in part for the relatively modest improvement rates reported by Fisher and Castile.

The lack of even short-term follow-up data on the majority of children treated with psychedelic drugs has been a major limitation of the work reviewed here. Follow-up information is particularly crucial because the available evidence strongly suggests that when used alone, LSD produces only transient alleviation of symptoms. In order to bring about enduring improvement, the drug induced state requires active therapist patient interaction and/or subsequent psychotherapy. In this connection, Simmons noted that:

> "Therapeutic intervention in severely retarded or regressed children utilizes to a great extent close physical interaction to which the child must respond. In the usual state it is often difficult to intrude upon the child because of a general lack of responsiveness... The results of our experiments clearly demonstrate changes in exactly these areas with increased attendance to

> physical and face contact with an attending adult and concomitant reduction of competing self-stimulatory behavior... Thus, two possible criteria for the successful intervention into autistic children are met... A third piece of data which must be considered is the increase in smiling and laughing behavior. . ." (1966, p. 1207).

The collective work reviewed here supports the main conclusion reached by Simmons and his co-workers and argues strongly for more extensive and systematic applications of psychedelic drugs in the treatment of autistic schizophrenic children: "LSD-25 appears to offer a useful adjunct to psychotherapy because of its positive effect in the areas described which are closely related to the process of psychotherapy."

Summary and conclusions

1. Seven independent studies are reviewed involving a total of 91 autistic schizophrenic children who had been given psychedelic drugs for therapeutic and/or experimental purposes.
2. The large majority of children treated in these studies were between six and ten years of age and were completely refractory to all other forms of treatment.
3. There was only slight indication of any differential response or benefit as a function of age, diagnosis, duration or severity or illness.
4. A variety of psychedelic agents, dosage levels, frequency of administrations, and treatment schedules were employed. The most effective results were obtained with at least 100 microgram doses of LSD-25 given daily or weekly over relatively extended periods of time.
5. Concerning the physical and psychological milieu, greater therapeutic benefit was related to: (a) the degree of active therapist involvement with the patient; (b) an opportunity to experience meaningful objects and interpersonal activities; and (c) congenial settings that were reasonably free of artificiality, experimental or medical restrictions, and mechanically administered procedures.
6. The most consistent effects of psychedelic therapy reported in these studies included: (a) improved speech behavior in otherwise mute children; (b) increased emotional responsiveness to other children and adults; (c) an elevation in positive mood including frequent laughter; and (d) decreases in compulsive ritualistic behavior.
7. Differences in patient attributes, treatment technique, research design, and other non-drug factors seemed to effect the frequency and stability of favorable outcomes. The types of improvement found were essentially the same in each study.
8. Although each of these studies contained serious therapeutic and experimental flaws, it was concluded that the collective findings argue strongly for more extensive applications of psychedelic drugs in the treatment of autistic children.

Table 1
Summary of Patient Samples, Drug Regime, and Improvement Estimates

Reference	Patients	Age	Agent	Dose (mcg)	Treatments	Schedule	Excel. (a)	Good	Poor
Abramson 1960	6	5-14	LSD	40	3-6	weekly	5	-	1
Freedman 1962	12	6-12	LSD	100	1	-	-	5	7
Bender 1962	14	6-10	LSD	100	45 (b)	daily	7	7	-
Bender 1963	44	6-15	LSD, UML	50-150, 4-12mg	60 (c)	daily	20	21	3
Fisher i Castile 1963	12	6-15	LSD, psiloc.	50-400, 10-20mg	1-11 (d)	biweekly / monthly	4	4	4
Rolo 1965	1	12	LSD	100	28	daily	-	-	1
Simmons 1966	2	5	LSD	50	9	twice weekly	2	-	-
total	91					totals	38	37	16

References

1. Abramson, H.A. (Ed.). The Use of LSD in Psychotherapy. New York: Josiah Macy Foundation, 1960.
2. Bender, L., Faretra, G., & Cobrinik, L. LSD and UML treatment of hospitalized disturbed children. Recent Advances in Biological Psychiatry, 1963, 5, 84-92.
3. Bender, L., Goldschmidt, L., & Sankar, S.D.V. Treatment of autistic schizophrenic children with LSD-25 and UML-491. Recent Advances in Biological Psychiatry, 1962, 4, 170-177.
4. Blewett, D.B., and Chwelos, N. Handbook for the Therapeutic Use of LSD-25: Individual and Group Procedures. Unpublished Manuscript. Saskatchewan, 1959.
5. Cholden, L., Kurland, A., & Savage, C. Clinical reactions and tolerance to LSD in chronic schizophrenia. J. nervous and mental disease, 1955, 122, 211-216.
6. Fisher, G. & Castile, D. Interim report on research project: An investigation to determine therapeutic effectiveness of LSD-25 and Psilocybin on hospitalized severely emotionally disturbed children. Unpublished Manuscript, Fairview State Hospital, Costa Mesa, California, February 10, 1963.
7. Freedman, A.M., Ebin, E.V., & Wilson, E.A., Autistic schizophrenic children: An experiment in the use of d-lysergic acid diethylamide (LSD-25). Archives of General Psychiatry, 1962,6, 203-213.
8. Hoffer, A. LSD: A review of its present status. Clinical Pharmacology and Therapeutics, 1965, 183, 49-57.
9. Rimland, B. Infantile Autism: The Syndrome and Its Implications for a Neural Theory of Behavior. New York: Appleton-Century Crofts, 1964.
10. Rolo, A., Krinsky. L.W., Abramson, H.A., & Goldfarb, L. Preliminary method for study of LSD with children, International Journal of Neuropsychiatry, 1965, 1, 552-555.
11. Simmons, J.Q., Leiken, SoJ., Lovaas, Q.I., Schaffer, B., & Perloff, B. Modification of autistic behavior with LSD-25. The American Journal of Psychiatry, 1966,122, 1201-1211.

The Effects of Consciousness-Expanding Drugs on Prisoner Rehabilitation

by

Timothy Leary

These articles by Dr. Timothy Leary are part of his book "High Priest",
published 1968, New American Library. Reprinted by permission.

original report: http://www.maps.org/research-archive/psychedelicreview/n10/n10029lea.pdf
backup source: http://www.psilosophy.info/resources/n10029lea.pdf

The first of two articles describing the Harvard-Concord Prison Project, in which the author's own version is flanked by official reports and newspaper accounts of the same story.

During the Fall and the Winter of 1960, much of my time and energy was going into the study of the effects of the psychedelic mushrooms. I was also carrying on an active program of lecturing, teaching, and field work in Clinical Psychology in the Harvard Graduate School. I had been brought to Harvard in 1959 in order to introduce existential-transactional methods for behavior change. After 15 years of doing research on psychotherapy, I had come to the conclusion that there was very little that one person called a doctor could do for another person called a patient by talking to him across a desk, or listening to him as he lay on a couch.

I developed a lot of theories and a lot of methods on how behavior change could be brought about in ways more effective than the standard clinical interview method. There are two main points to the theories I developed; first, (transactional) I was convinced that the doctor had to throw away his role and status as a doctor, had to join the other person actively and collaboratively in figuring out the solution to his problem As much as possible, the doctor had to turn over the responsibility to the who knew most about the problem at hand, namely, the patient. I developed many techniques for getting patients to help each other.

The second point in my theory (existential) was that the doctor has to leave the safety of his consulting room and get out there in the field where the so-called patient is having his unique problems and where he is going to solve his problems. I saw the role of the doctor as that of a coach in a game in which the patient was the star player. The coach can help, can point out mistakes, can share his wisdom, but in the last analysis, the guy who does the job is the guy out there in the field, the so-called patient.

I was enthusiastic about these theories because they worked, and because there is no joy in teaching that can equal that thrill which comes when you watch someone who's been hung up, and blocked, and confused, and making a mess of things suddenly learn how. All this had started happening before I got involved in the drug research, and I had already become a controversial figure around the Boston area, because everything that I was saying made a tremendous amount of sense to patients, but the doctors, the psychiatrists, the social workers, the psychologists, were not so quick to accept these theories. You see, I was asking them to give up the status and the omniscient position which they felt their training entitled them to. I asked them to turn over the authority and the star role in the game to the patient.

I was taking one day off a week to drive down to New Bedford, Massachusetts with two or three graduate students where we were working in an orphanage teaching social workers and nuns to set up groups in which older kids would help younger kids, and in which children at every age level were encouraged to take more responsibility for running the school and planning their lives.

We set up another project in a slum housing district in a Boston suburb. Here were hundreds of people who were bogged down socially and psychologically. They couldn't afford psychiatric help and there was none available for them. With another group of graduate students, I used to go down there one night a week with tape recorders and blackboards. We set up headquarters in one of the slum apartments and started teaching groups of the neighbors how they could help each other and become psychiatrists for each other and develop some facility for solving their own problems.

All this, of course, was very déclassé at Harvard. Universities are supposed to be research institutes and if you get too involved in service functions or helping people, you're considered a bleeding heart. I was able to justify the work in the orphanage, the work with alcoholics, the work in the slum projects, by using the phrase methodology. We weren't really trying to help these people. No sir, not us. We were trying to develop new techniques and scientific methods for changing psychotherapeutic theory. Of course, if people enjoyed it and got help, that was an interesting by-product which supported the method and the theory. It was all experimental, you see. It became a tradition in the center where I worked that any time they got a call from a do-good social service agency requesting Harvard's help in curing any sort of social disease, the request was likely to get bucked to me because they knew that this was my vice and my eccentricity.

One day I got a note in my box saying that two men from the Department of Legal Medicine were interested in enlisting Harvard's help in the psychological rehabilitation of prisoners. Now prison work is considered to be the least interesting, lowest status work you can do in the field of psychology, psychiatry, and sociology. The problems are hopeless. Criminals never change. The atmosphere is dreary and the academic rewards are slim. But when I found this little piece of paper in my box requesting an appointment from two officials from the Department of Legal Medicine, I let out a big grin and chuckled all the way to my office because this was just the chance I was looking for.

By this time, we had given the psychedelic mushrooms to about 100 people in a wide variety of circumstances and we had learned a lot about the process. In spite of the bungling, and the confusion, and our ignorance, we still hadn't caused any damage to anyone and there were a lot of mistakes that we'd never make again. By this time, we had learned a few things about how to run the sessions. About 90 percent of the people who were taking the magic mushrooms were reporting the most ecstatic and educational experience of their lives. The problem was, there was no way to get any measurement as to how much good we were doing. There was no way to keep score.

That of course, is the main problem in the field of psychotherapy. You can develop a completely effective method of treating people's psychological problems and there is no way you can prove it. you can work with 1.000 people and help every one of them change their way of thinking and their way of acting, but there are no statistics like hits, runs, and errors to tabulate your score. The problem is that half the people you help are going to get better jobs, and half of them are going to quit the jobs they have. Half of them may increase the intimacy and closeness and meaning in their marriages, but the other half may leave their wives. Changing a person's psyche is one thing, but measuring results in an observable way is another thing. Because who's to say which behavior reflects growth and change.

Here's where the prison came in. The prison is the ideal place to do a study in psychotherapy behavior change because when you try to rehabilitate prisoners you've got an iron-clad statistic you can work against. It's called the recidivism rate. When you are working with people outside, they may quit their job and join the Peace Corps, or they may quit their job and join the ministry, or they may quit the ministry and take up guitar, and you know about the growth of this person, but who else will believe it? But when you work with prisoners and you think you've helped them change, grow, and become more effective people, there's an easy way to tell. Where are they a year after you've finished with them? Are they back in jail, or are they making it on the outside. Prisoner rehabilitation presents the most effective check for someone who claims he can bring about change in behavior. In the prisons of Massachusetts the recidivism is about 70 percent. Seven out of every ten men who leave prison, return. If you develop a new and sure-fire way of changing man's mind, the prison presents the toughest and cleanest test of your effectiveness. Can you keep him out of jail? That's why I wanted to get into the prison.

Now, the reason why the prison psychologists wanted to get into Harvard is because everyone in any academic or professional activity in the Boston area has one way of measuring his success. Can he get on the Harvard payroll? The word Harvard in the Boston area is a powerful status symbol that operates at every level of society. There are several thousand janitors around the Boston area, but if you are a janitor at Harvard, you're a prince among custodians. The same with a cook, a gardener, and a psychologist.

A week later, I found myself host at a corner table in the Harvard Faculty Club with two officials from the Massachusetts Prison System. What they wanted was simple. They wanted to have Harvard graduate students assigned to the prisons as psychology interns with a possible long-range hope of getting themselves clinical professorships at Harvard. And what I wanted was to get Harvard graduate students into the prisons because that's where I felt that all embryonic psychologists should be - out in the field, dealing with real people and real problems. But there was something else I wanted - and that was the chance to show that we could rehabilitate criminals by using the sacred mushrooms. And so the deal was made. I agreed to get Harvard approval to send graduate students to internships in the prison and they agreed that if I could get the approval of the warden and the prison psychiatrists, I could give psychedelic mushrooms to prisoners.

About a week later I drove out to the prison. I wore my Harvard tweed suit and my button-down shirt. The warden was impressed and pleased. It wasn't often that Harvard professors came out to the prison proposing to do research and training with Harvard graduate students. But the whole thing hinged on the approval of the psychiatrists, because the sacred mushrooms were DRUGS and to work with DRUGS you had to have the medical O.K. So, we walked down the hallway to the metal cage that let us into the prison. We opened up the first steel door and we stood in the anteroom. Then we rang a bell, a slot opened, and a guard looked at us and opened up the second metal door. We walked into the middle of the guard room, across the prison yard to the hospital where we rang the bell and got peered at through the slot, heard the metal hinges creak, and walked into the prison hospital. We walked down the corridor to the psychiatrist's office and knocked on the door.

After a minute, out walked one of the most entertaining and interesting men in American psychiatry. The first thing that struck me about the prison psychiatrist was that he was the best-dressed man I had ever seen. He was short, graceful, like a ballet dancer. The first negro psychiatrist I had ever met. I spent an hour talking with Dr. Madison Presnell. He was no intellectual; he mispronounced some of the polysyllabic words, but he had a light in his eye and a wise, cool way of looking at you which told you he was a man who had seen a lot, and suffered a lot, and was still looking for the funniest and wisest part of everyone he came in contact with.

In sizing up Dr. Presnell, I could say to myself a word which I had heard used quite often in recent months. He was "hip." I was obvious too, that he had had some experience with psychedelic drugs. Which ones he didn't make clear. He could have had LSD in medical school, or mescaline in psychiatric research, or maybe pot in the Village, but he knew what I was talking about.

A few days later Dr. Presnell came over to Harvard to meet some of my bosses, and the following Sunday, he brought his beautiful and intelligent wife and his two lovely children over to my house for cocktails. It was on a Sunday afternoon. We had a straightforward and hones discussion. He sat down on a chair in my study, thought for a minute and said, The plan you propose to get the psychedelic drug to prisoners is the best idea I've ever heard for dealing with an impossible problem. If you're smart enough and dedicated enough to know how to do it, this could be the best plan for the treatment of prisoners I've hear proposed. There's one chance in a hundred you can pull it off, but if you do, you will have accomplished more for American society and for prisoners rehabilitation than has been done in the last four thousand years since the code of Hammurabi. But, it's risky business. You're bound to run into trouble. As a matter of fact, the more successful you are, the more trouble you're going to stir up. Because one thing I've learned as a prison psychiatrist is that society doesn't want the prisoner rehabilitated and as soon as you start changing prisoners so that they've discovered beauty and wisdom, God, you're going to stir up the biggest mess that Boston has seen since the Boston Tea Party. I'll give you medical coverage and I'll be glad to serve as psychiatric consultant and I'll back you up all the way with the wardens, with the guards, with the mental health department, but sooner or later as soon as they see the thing you do working, they're going to come down on you - the newspaper reporters, the bureaucrats, and the officials. Harvard gives drugs to prisoners! And you're going to gave to do the impossible - you're going to have to cure prisoners with you left hand, and that's something that's never been done before and you're going to have to hold off the entire bureaucracy of the state of Massachusetts with you right hand and that's never been done before, not even by Kennedy. So, I'll back you all the way, until you make a mistake, and when you make that mistake, and they all start coming down at you, exactly at that point, I'm going to walk out because I'm not you. I'm not the new Freud and I have no ambitions to play that game. I'm a negro from the South with a degree from a second-class medical school, with a wife and two kids whom I'm trying to support and educate in an insane society, and I'll help you all the way to win, but I'm not going to lose with you.

And so it was settled. Dr. Presnell would line up volunteers in the prisoner population for the sacred mushroom project and I would go back to Harvard and get graduate students who would volunteer their time and energy and their nervous systems to take drugs with maximum security prisoners at the penitentiary.

A few days later, I was in my office when a knock came on the door, and I was visited by a graduate student named Ralph Metzner. Metzner had a reputation for being one of the smartest students in the department. He was a graduate of Oxford, an experimentalist, a precise, objective, and apparently very academic young man. He said he had heard about the prison project and he wanted to work with me on it. My first reactions were that Metzner was too academic, too dainty-British, too bookish, too ivory tower, to walk into a prison and roll up his sleeves, and take drugs that would put him out of his mind, with rough and tumble prisoners. Metzner said he wanted to learn how. Then I said, Before you can give drugs and take drugs with anyone else, you have to have some experiences yourself. Are you ready to take mushrooms? He was ready. As a matter of fact, that's exactly what he wanted to do, to have a session.

And so it happened that on March 12, 1961, at my home in Newton, Massachusetts, I ran a session for Dr. Presnell and his beautiful wife, for Ralph Metzner and his girl friend, another graduate student, and Gunther Weil and his wife, Karen. This was the 52nd time I had taken psilocybin with other people. The notes on the session say, This training session was designed to introduce several new subjects to the sacred mushroom experience under supportive circumstances.

The session took place in my study. Since this was an exploratory training session, I told the participants that they should relax, have a good time, be entertained, and learn what they could. Dr. Presnell was the dominating factor in this session. His joking and warm attitude created a benign atmosphere. Each new subject had his spouse or a trusted friend present. After a long period of happy relaxed giggling, the joking became more and more philosophic. Members of the group would leave the room periodically to be by themselves or to talk in pairs, but my study operated as the center for the session. There were no discordant notes, no anxiety, depression, or friction. We were finally getting to the point where we knew how to set up a pleasant session. Each member of this six-person group reported a deep ecstatic, educational experience.

A few days after this session, Ralph Metzner, Gunther Weil, and I drove out to the concrete prison and met with the six volunteers who had been selected by Dr. Presnell. Sitting around a table in a dreary hospital room, with grey walls, black asphalt floor, bars in the windows, we told six sceptical and suspicious men about an experience that could change their lives.

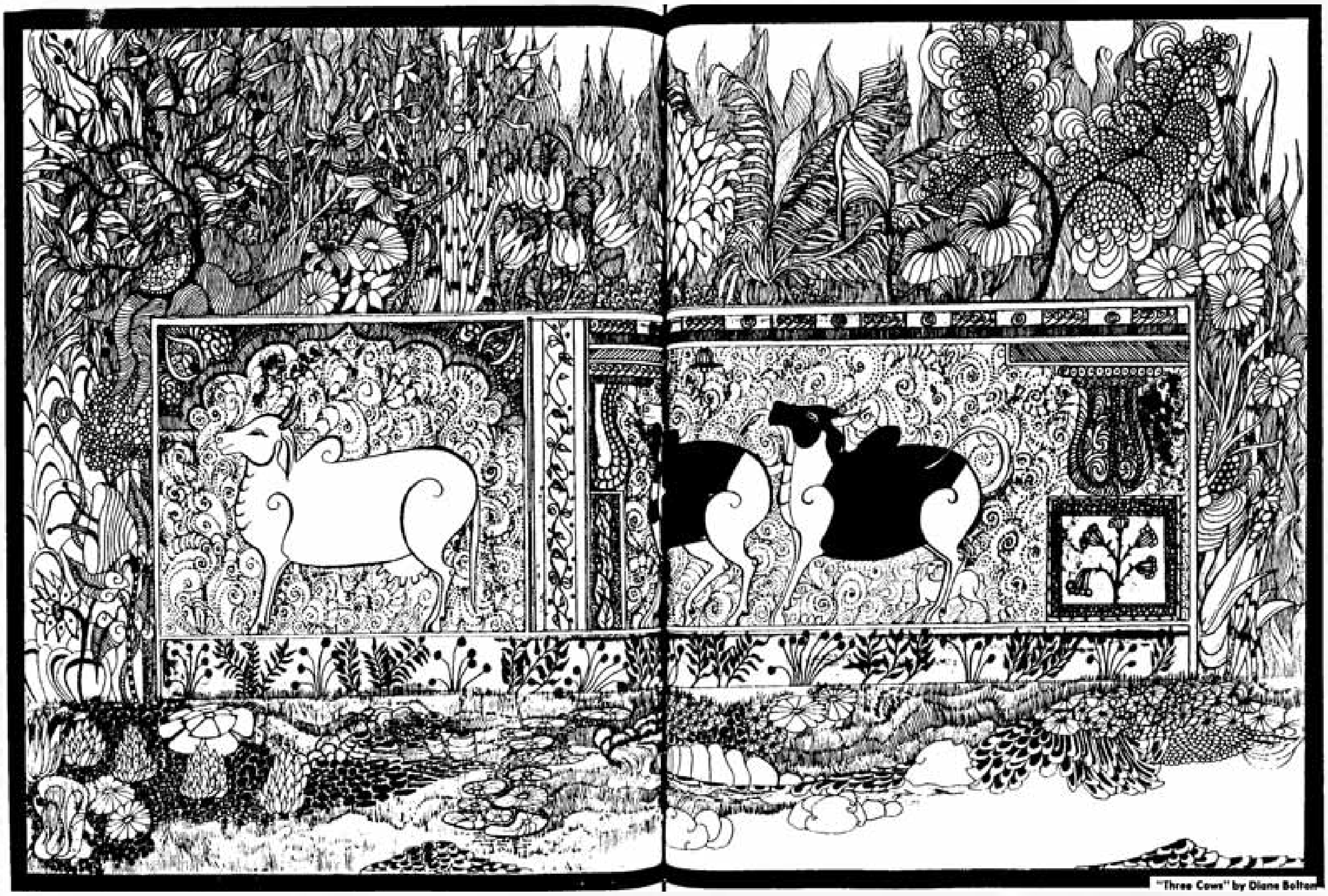
The first psychedelic session in the prison was well-planned. The first thing we did was to tell the prisoners as much as we could about the psychedelic experience. We brought in books for them to read, reports by other subjects, articles that described both the terrors, as well as the ecstasies of the experience. We spent most of the time describing our own experiences and answering groping questions. We made it very clear to the prisoners that this was nothing we were doing to them. There was no doctor-patient game going here. We would take the drugs with them. We were doing nothing to them that we wouldn't willingly, happily have done to us.

We also made a research contract with the prisoners. We said something like this, "We want to find out how and how much you change during this experience. For this reason, we want you to take a battery of psychological tests before you eat the mushrooms. Then, after three or four sessions with the sacred mushrooms, we'll give you the tests again. The aim here is to find out how you change, like you weigh yourself on a scale before and after you go on a diet. But, after you've taken the tests before and after the sessions, we'll give you the results. We'll go over the tests with you and explain how you were before and how you changed. Nothing in this project is going to be a secret. We've told you everything know about the drugs before you take them and we'll tell you everything we know about you after you finish your sessions." That sounded like a good deal to them and the following week, each prisoner was administered a long and complicated battery of psychological tests.

And so it happened that on March 27, 1961, in the large ward room in the prison infirmary in Concord, Massachusetts, five prisoners and three Harvard psychologists met for a trip. In the morning I would turn-on with three convicts and the two other prisoners and the two graduate students would act as observers. Then in the afternoon, Gunther Weil and Ralph Metzner from Harvard and the two observing prisoners were to take the drug and the rest of us were to act as guides.

We brought a record player, tape recorder, and some books of classical art with us. Otherwise the room was bleak in decor with four couches, a large table, and a few chairs. At 9:35 in the morning the bowl of pills was placed in the center of the table. I was the first one to turn-on in the prison project. I reached over, took fourteen milligrams of psilocybin. Then I handed the bowl to the prisoner next to me and he took twenty milligrams and passed it on to the guy next to him who took twenty and the next man. Then we pushed the pills into the middle of the table and sat back to see what would happen.

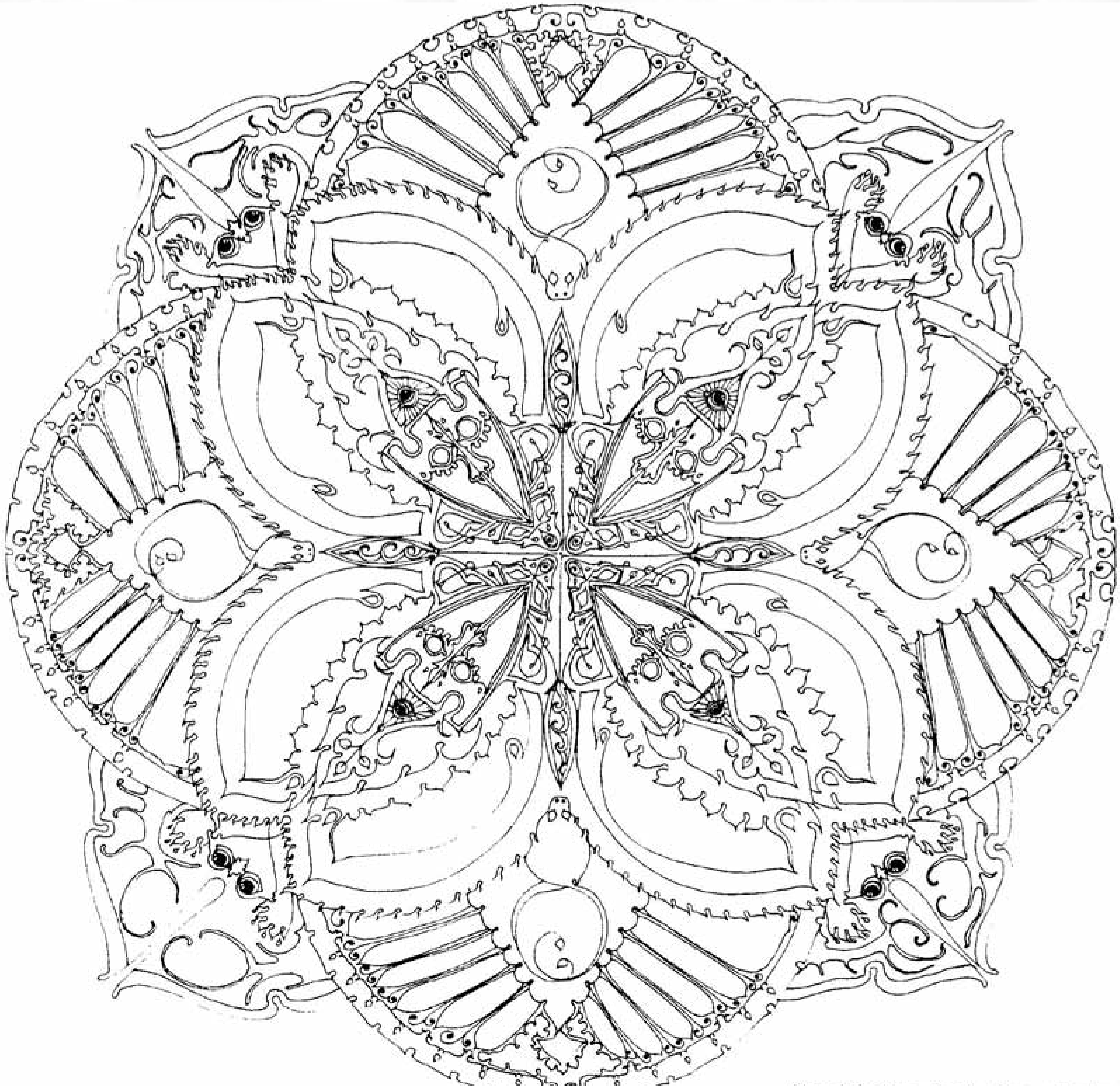
I'll never forget that morning. After about half an hour, I could feel the effect coming up, the loosening of symbolic reality, the feeling of humming pressure and space voyage inside my head, the sharp, brilliant, brutal intensification of all the senses. Every cell and every sense organ was humming with charged electricity. I felt terrible. What a place to be on a gray morning! In a dingy room, in a grim penitentiary, out of my mind. I looked over at the man next to me, a Polish embezzler from Worcester, Massachusetts. I could see him so clearly. I could see every pore in his face, every blemish, the hairs in his nose, the incredible green-yellow enamel of the decay in his teeth, the wet glistening of his frightened eyes. I could see every hair in his head, as though each was as big as an oak tree. What a confrontation! What am I doing here, out of my mind, with this strange mosaic-celled animal, prisoner, criminal?



"Three Cows" by Diane Bolton

I said to him, with a weak grin, How are you doing, John? He said, I feel fine. Then he paused for a minute, and asked, How are you doing, Doc? I was about to say in a reassuring psychological tone that I felt fine, but I couldn't, so I said, I feel lousy. John drew back his purple pink lips, showed his green-yellow teeth in a sickly grin and said, What's the matter, Doc? Why you feel lousy? I looked with my two microscopic retina lenses into his eyes. I could see every line, yellow spider webs, red network of veins gleaming out at me. I said, John, I'm afraid of you. His eyes got bigger, then he began to laugh. I could look inside his mouth, swollen red tissues, gums, tongue, throat. I was prepared to be swallowed. Then I heard him say, Well that's funny Doc, cause I'm afraid of you. We were both smiling at this point, leaning forward. Doc, he said, why are you afraid of me? I said, I'm afraid of you, John, because you're a criminal. He nodded, I said, John, why are you afraid of me? He said, I'm afraid of you Doc because you're a mad scientist. Then our retinas locked and I slid down into the tunnel of his eyes, and I could feel him walking around in my skull and we both began to laugh. And there it was, that dark moment of fear and distrust, which could have changed in a second to become hatred, terror. We'd made the love connection. The flicker in the dark. Suddenly, the sun came out in the room and I felt great and I knew he did too.

We had passed that moment of crisis, but as the minutes slowly ticked on, the grimness of our situation kept coming back in microscopic clarity. There were the four of us turned-on, every sense vibrating, pulsating with messages, two billion years of cellular wisdom, but what could we do trapped within the four walls of a gray hospital room, barred inside a maximum security prison? Then one of the great lessons in my psychedelic training took place. One of the four of us was a Negro from Texas, jazz saxophone player, heroin addict. He looked around with two huge balls of ocular white, shook his head, staggered over to the record player, put on a record. It was a Sonny Rollins record which he'd especially asked us to bring. Then he lay down on the cot and closed his eyes. The rest of us sat by the table while metal air from the yellow saxophone, spinning across copper electric wires bounced off the walls of the room. There was a long silence. Then we heard Willy moaning softly, and moving restlessly on the couch. I turned and looked at him, and said, Willy, are you all right? There was apprehension in my voice. Everyone in the room swung their heads anxiously to look and listen for the answer. Willy lifted his head, gave a big grin, and said, Man, am I all right? I'm in heaven and I can't believe it! Here I am in heaven man, and I'm stoned out of my mind, and I'm swinging like I've never been before and it's all happening in prison, and you ask me man, am I all right. What a laugh! And then he laughed and we all laughed and suddenly we were all high and happy and chuckling at what we had done, bringing music, and love, and beauty, and serenity, and fun, and the seed of life into that grim and dreary prison.



Mandala Drawing by Susan Frahm

Well, the session went on and on. There were high points and low points, ecstasies and terrors. My friend John, the Polish man, got sick and vomited. We all got pretty thoughtful. Why are there prisons? Why do some men put the warm cellular envelopes of their fellowmen in metal cages? What were we doing here? Then after a few hours, Ralph and Gunther and the two remaining convicts turned-on. Gunther was silly and acting like a hipster, and Ralph fell down on the bed and experienced visions of Blakean terror. Two prisoners came and held his hand and guided through. Dr. Presnell would check in every now and then, walk around the room like a dainty, graceful cat, not saying much, but taking it all in. And the guards came in bringing metal trays of food which we all looked at with disbelief, the way you'd look at a plate of worms or a pot of sawdust served up to you on a plate, and someone said, Man, do they call that food? Since we Harvard people weren't allowed to eat prison food at the expense of the state, Dr. Presnell went out and got milkshakes and sandwiches which we all shared, and we had never tasted food so good.

Then at five o'clock, there was a bang on the door, and we opened it and the guards came in and said, Time is up, men. Back to the prison ward. Ralph, Gunther, and I went with the five prisoners back to the lockup part of the hospital and sat there on beds, and smoked, and laughed, and compared notes on what we'd seen, and where we'd been. Then it was time for us to go. We shook hands, said we'd be back tomorrow, and Ralph and Gunther and I walked out of the prison, across the dark yard, rang the bell, and waited until the iron doors opened into the guardroom, and then across the guardroom, through the two metal doors, and down the metal stairs, past clanking, steaming, old-fashioned radiators, and then we were outside. Ralph and Gunther got into their car and drove back to Cambridge, and I got in my car and drove to Newton.

As I rode along the highway, the tension and the drama of the day suddenly snapped off and I could look back and see what we had done. Nothing, you see, is secret in a prison, and the eight of us who had assembled to take drugs together in a prison were under the gaze of every convict in the prison and every guard, and within hours the word would have fanned through the invisible network to every other prison in the state. Grim Walpole penitentiary. Gray, sullen-walled Norfolk.

Did you hear? Some Harvard professors gave a new drug to some guys at Concord. They had a ball. It was great. It's a grand thing. It's something new. Hope. Maybe. Hope. Perhaps. Something new. We sure need something new. Hope.

> In the evaluation of the dominant moods of any historical period it is important to hold fast to the fact that there are always islands of self-sufficient order - on farms and in castles, in homes, studies and cloisters - where sensible people manage to live relatively lusty and decent lives: as moral as they must be, as free as they may be and as masterly as they can be. If we only knew it, this elusive arrangement is happiness. But men, especially in periods of change, are swayed by alternating world moods which seem to be artificially created by the monopolists and manipulators of an era's opinions, and yet could not exist without the highly exploitable mood cycles inherent in man's psychological structure. The two most basic alternating moods are those of carnival and atonement: the first gives license and leeway to sensual enjoyment, to relief and release at all cost; the second surrenders to the negative conscience which constricts, depresses, and enjoins man for what he has left unsolved, uncared for, unatoned. Especially in a seemingly rational and informed period like our own, it is obvious how blithely such moods overshadow universally available sets of information, finding support for luxurious thoughtlessness at one time, for panicky self-criticism at another. Thus we may say that beside and beyond a period's verifiable facts and official doctrines, the world image "breathes". It tends to expand and contract in its perspectives, and to gain or lose solidity and coherence.
>
> **Erik Erikson**

Second Annual Report: Psilocybin Rehabilitation Project.

All the professional work on this project was volunteer. The expenses for clerical assistance and salaries for ex-inmate workers were covered by generous donations from the Uris Brothers Foundation, New York, Eileen Garrett, President.

Applications to three offices of the U.S. Public Health Service requesting support for continuing his project were refused.

Exactly two years ago the Harvard psilocybin project initiated a research program at Massachusetts Correctional Institution, Concord, designed to test the effects of consciousness expanding drugs on prisoner rehabilitation.

The project was designed as a pilot study - necessarily exploratory - since little was known about the long range application of the substances.

The key issue was the use of a consciousness-expanding drug; but equally important was the philosophy underlying the research, which emphasized:

Democratic Collaboration:

Inmates were given responsibility for planning and evaluating the work. This was seen as preparation for assuming roles as responsible citizens in a democratic society.

Sharing of Information:

The inmates were given all information relevant to their treatment. This was seen as a necessary step in increasing trust and self-respect.

Spiritual Insight:

The transcendental experience provided by the drugs propels the subject beyond space, time, ego, culture, etc. The implications of this visionary experience were utilized in the program.

Interpersonal Trust and Closeness:

Evidence shows that when subjects share in ego-shattering experience together they develop strong positive emotional bonds.

Self-help and Mutual Help:

The most successful rehabilitation methods (A.A., Synanon, Group Dynamic "T" Groups, etc.) seem to those which turn over responsibility to the subjects themselves and which stimulate them to help each other. The drug experience facilitates this tendency.

Emotional and Practical Support:

The model used was not doctor-patient or expert-client but that of human beings who believe in each other and want to help each other.

The project developed the model of friends who are available to help group members stay out of trouble and maintain a responsible role in society. In our research we helped inmates get jobs, purchase union cards, made small loans and spent hours in friendly advising interaction.

Procedures

Since its initiation, the project has operated under the medical and psychiatric supervision of Dr. W. Madison Presnell.

Inmates received on the average four doses of psilocybin. Dosage ran from 20 mg in early sessions to 70 mg. Now we employ 30 mg as a standard, moderate dose.

Inmates were given personality tests before and six months after the program began. Significant decreases in hostility, cynicism, social delinquency and irresponsibility were registered.

There seems to be general agreement that the effects of the program in-the-institution were quite dramatic. The behavior and attitude of the project members became more mature and social.

The post-release events, however, involved a different set of factors and required several revisions in the program.

Post-Release Program:

The main conclusion of our two year pilot study is that institutional programs, however effective, count for little after the ex-convict reaches the street. The social pressures faced are so overwhelming as to make change very difficult.

We recognized very early in our work the advantages of a post-release program.

Our philosophic and theoretical orientation led us to encourage inmates to plan and execute their own program.

We fondly hoped for a halfway house run by ex-inmates along the lines of the successful Synanon program.

In June 1961 a non-profit organization, Freedom Center, was set up to administer the post-release program.

Our hopes for a convict-run halfway house did not materialize.

We had too few men in the Boston area and they were to caught up in the desperate struggle to survive, to spare time to help others.

In 1961 as a beginning step towards a halfway house, we began "Project Contact." The purpose of this project was to keep in regular contact with all group members.

By these means we were able to reach ninety-one percent of ex-inmates living in Massachusetts.

A newsletter and personal letters also kept up contact and seemed to be effective in helping the rehabilitation spirit stay alive.

But increased contact only strengthened our convictions than an A.A. type organization of ex-convicts is necessary.

The initial step of finding the small nucleus of men who are ready to make the dedication needed has not yet taken.

As a possible solution we hope to be able to send two ex-inmates to spend a month living at Synanon House, Santa Monica.

The director of Synanon, Mr. Chuck Dederich has expressed interest in this project.

The next step of selecting two ex-inmates to make the trip is waiting to be taken.

Upon their return, Freedom Center is prepared to offer its resources to support a local self-help residence program.

Results:

Plans and hopes are one thing but the actual score card of accomplishments provides the crucial evidence. What are the available results?

Psilocybin is safe:

Thirty-five inmates and ten Harvard staff members have had group Psilocybin experiences at Concord.

There were 131 inmate ingestions and 37 staff ingestions, a total of 168 experiences. There were no episodes of violence, lasting disturbances or negative after-effects.

Physically and psychologically there is clear cut evidence that in a supportive environment the drug effect is safe and positive.

Those interested in using psilocybin for research or therapy purposes can proceed with confidence if their program is open, supportive, collaborative.

Psilocybin produces temporary states of spiritual conversion, interpersonal closeness and psychological insight.

Forty-five percent of the entire inmate group clearly underwent a mystical, transcendent, death-rebirth experience.

This figure should be modified, however. The results for running sessions improved so that 100% of our recent groups were undergoing transcendent experiences.

The life changing therapeutic effects of the psilocybin experience do not last for more than 72 hour unless the subject is in a situation which encourages him to maintain his emotional and spiritual insights.

Therefore, psilocybin must be used in on-going programs of therapy or self-help. When employed in such programs psilocybin is a dramatically useful, educational and rehabilitative instrument.

If the subject shares time and space subsequently with those who have had the experience his chances of maintaining ths insights are increased.

The actual score board is difficult to interpret. The aims of this project were: 1) to help keep men on the street and 2) to help them in constructive contact with each other.

Result Percentages:
January 15, 1963
Percentage of men released who are now on street 73
Percentage of men now back for technical parole violation 19
Percentage of men now back for new crimes 8

If ex-convicts who have had a psilocybin experience in a supportive environment meet regularly after release (these statistics suggest one a month) the chances of their remaining on the street will be dramatically improved.

The Harvard staff members - Dr. Ralph Metzner, Gunther Weil, Dr. Ralph Schwitzgebel, Johnathan Clark, David Kolb, Michael Hollingshead, Kathy Harris, Dr. Timothy Leary - who contributed several thousands of hours each to this work cared deeply and suffered keen disappointments as they witnessed the failures.

But the results summarized in this report offer some consolation that the time shared in psilocybin experiences, and the meetings in and out of Concord were educational and somewhat effective.

Summary

Thirty-one inmates of MCI Concord participated in a rehabilitation program combining:
-Psilocybin administered in a supportive setting, and
-volunteer contact of inmates after release.

The evidence after two years of operation suggests that the drug is safe, that the experience temporarily provides personal and spiritual insight, and has some effect in keeping inmates out of prison.

A listing of the major mistakes and improvements in method will be found ind two publications, one in press and one in preparation.

Convicts gains cited by study.

Insight drugs called boon.

IFIF is the Internal Federation for Internal Freedom, a non-profit organization involving the use of consciousness-expanding drugs.

The supply of the drug has, temporarily at least, been cut off because the medical supervision required by Federal regulation in the administration of drugs for research has been withdrawn.

Backing withers.

But troubles or no, IFIF and the zealous psychologists dedicated to the proposition that widespread use of drugs such as psilocybin will pretty much cure the intellectual ills of mankind are news.

And the group has been asked to vacate the medical building in Charles River Park for lack of medical affiliation.

In addition, the supportive backing at the academic level, principally at Harvard, has been withering.

The latest concerns a study made on the religious impact the drug ingestion made on some 33 convicts at the Concord Reformatory in which eight Harvard psychologists worked on the pilot program.

Dr. Timothy Leary, one of the co-founders of IFIF, wrote the report on the pilot program which began in mid-March of 1961 and continued for almost two years.

Beginning with six convicts a senior investigator and two graduate students, the study came to include 33 convicts and eight psychologists. All participated in the drug ingestion.

In Dr. Leary's opinion, the experiment was an unqualified success. Ingestion of the drugs produced "sudden insight that one has been living in a narrow space-time-self context."

"It's all a game, Doc, cops and robbers - we're such tough guys," he quotes one convict as saying. "We take it all so seriously as though that's all there is to life."

He reports also of frequent mystical insight among the convicts, particularly the death-rebirth experience.

"I felt helpless and wanted to murder you guys who did it to me; then I realized it was my own mind doing it; it's always been my own mind imagining troubles and enemies," he quotes one convict.

Return rate drops.

Over half the hardbitten convicts displayed a sudden swing towards increased religious understanding and need, according to the study report.

More important, perhaps, in the long run is the fact that the recidivism rate among the convicts who have been discharged dropped sharply.

"Seventy-five percent are holding their own against stiff winds and treacherous currents," Dr. Leary says.
The expected return rate of ex-convicts to the Concord Reformatory would be between 50 and 70 percent.
But even in his claimed success among the convicts, Dr. Leary runs up against a Doubting Thomas in the Reformatory Superintendent Edward Grennan.

Control questioned.
Grennan feels that study was done without a control and was therefore unscientific.
"These men received an extremely high degree of personal attention," he said. "The psychologists even set up a kind of criminal AA for the paroled prisoners in Cambridge. They made themselves available to them around the clock."
"I feel that the same rate of recidivism might have been achieved if the same concentration and attention were given to any parolee by highly-placed members in any community."
Commenting on the religious aspects of the survey, Prof. Walter Houston Clark of the Andover-Newton Theological Seminary had this to say:
"The student of religious behavior who studies phenomena such as those described in the study cannot but be struck by the similarities to intense religious groups of an evangelistic nature."
"As with them, the experience tends to be dramatic; individuals are changed as to their life goals and the experience tends to be individualized, for while some are greatly helped, there are others on whom the experience seems to have very little permanent effect."

Similarities noted.
"However, it may not be without significance that 62 percent of one group, as indicated in the study, reported their lives were changed for the better; for studies have indicated that roughly the same percentage find help in MRA and AA."
On the basis of the study report, Prof. Clark hinds the psilocybin experience to be mystical in nature. As such, and administered with proper setting and preparation, he feels it may release latent religious sensitivities to make possible an experience closely akin to a truly religious experience with a profound change in attitudes and values resulting.
He sees the drugs as useful also in the form and rehabilitation of convicts (and all others) to more wholesome life aims, a factor which religion could not ignore. But he ends on a note of caution.
"We have been speculating quite freely, basing our speculations largely on the experiences of a few convicts. But enough has been done to suggest creative possibilities in the drugs, the most constructive seemingly to lie in the field of religion and moral regeneration. The use of the substance, however, is very much in the experimental stage, and must have medical and scientific psychological supervision. But its results cannot be ignored by scholars, theologians or leaders of organization.
Such, then, is the latest triumph of the IFIF oriented group. Or are the naysayers correct in holding to their deep doubts?

Dr. Leary's Concord Prison Experiment - A 34 Year Follow-Up Study

by

Rick Doblin

Originally published in Journal of Psychoactive Drugs; Oct-Dec 1998; 30, 4.

original source: http://www.maps.org/research-archive/1998_Doblin_ConcordPrisonFollow-up.pdf
backup source: http://www.psilosophy.info/resources/1998_Doblin_ConcordPrisonFollow-up.pdf

Table of Contents:

Abstract
Background
Design of the original experiment
Reported outcome of the original experiment
Genesis of the follow-up study
Research objectives
Methodology
Limitations of the data set
Reanalysis of the reported short-term recidivism success
Parole violations or new crimes?
Longer-term recidivism rates
Follow-up interviews
Leary's reflections
A higher standard
Conclusion
Notes
References

Abstract

This study is a long-term follow-up to the Concord Prison Experiment, one of the best known studies in the psychedelic psychotherapy literature. The Concord Prison Experiment was conducted from 1961-1963 by a team of researchers at Harvard University under the direction of Timothy Leary. The original study involved the administration of psilocybin-assisted group psychotherapy to 32 prisoners in an effort to reduce recidivism rates. This follow-up study involved a search through the state and federal criminal justice system records of 21 of the original 32 subjects, as well as personal interviews with two of the subjects and three of the researchers, Timothy Leary, Ralph Metzner and Gunther Weil. The results of the follow-up study indicate that published claims of a treatment effect were erroneous. This follow-up study supports the emphasis in the original reports on the necessity of embedding psilocybin-assisted psychotherapy with inmates within a comprehensive treatment plan that includes post-release non-drug group support programs. Despite substantial efforts by the experimental team to provide post-release support, these services were not made sufficiently available to the subjects in this study. Whether a new program of psilocybin-assisted group psychotherapy and post-release programs would significantly reduce recidivism rates is an empirical question that deserves to be addressed within the context of a new experiment.

Keywords: psilocybin, psychedelic, psychotherapy, recidivism, Leary, Concord Prison Experiment

Background

This paper reports on the results of a long-term (34 year) follow-up study to the Concord Prison Experiment, one of the best known studies in the psychedelic psychotherapy research literature.[1] The Concord Prison Experiment was originally conducted during 1961-1963 by a team of Harvard researchers under the direction of Timothy Leary (Leary 1963; Leary *et al*. 1965; Leary & Metzner 1968; Leary 1969; Riedlinger & Leary 1994).

The Concord Prison Experiment arose out of preliminary research into the subjective effects of psilocybin (Leary, Litwin & Metzner, 1963). Leary and associates found that 88% of their subjects in the preliminary study reported that they learned something of value about themselves and the world, while 62% claimed that the experience of psilocybin changed their lives for the better. In some subjects, the administration of psilocybin produced a "mystical" or "transcendent" experience similar to experiences of religious conversion. Based upon the preliminary evidence, Leary speculated that psilocybin experiences might be powerful catalysts of behavior change in subjects with criminal records.

Research evaluating the use of psychedelic psychotherapy in subjects with criminal records was also being conducted around the same time by Tenenbaum, who administered LSD to criminal sex offenders while they were incarcerated in Atascadero State Hospital, California (Tenenbaum 1961), and, in the Netherlands, by Arendsen Hein, who administered a series of doses of LSD to twenty-one chronic criminal offenders (Arendsen Hein 1963). These studies generated promising results but focused on measuring symptom, behavior and personality changes rather than recidivism, the return to prison post-release for parole violations or new crimes.

Design of the original experiment

The Concord Prison Experiment was designed to evaluate the use of a form of psilocybin-assisted group psychotherapy in the reduction of rates of recidivism. As described by the researchers, the form of treatment was "a collaborative group program; we avoid the traditional doctor-patient, researcher-subject, professional-client roles (Leary *et al*. 1965)."

The subjects in the study, all volunteers, were incarcerated in Massachusetts Correctional Institute Concord, located outside of Boston not far from Cambridge, where Harvard University is located. Subjects were limited almost entirely to prisoners nearing their possible parole dates, with just a few subjects released more than a year after the experiment concluded. Leary thought that recidivism would be an objective measure of behavior change that would more persuasively demonstrate the effects of psychedelic-assisted psychotherapy than subjective self-report questionnaires and tests. Differences between pre- and post- values of standardized tests of psychological functioning were also evaluated. Among the tests administered were the Minnesota MultiPhasic Personality Inventory (MMPI), the Thematic Apperception Test (TAT), and the California Personality Inventory (CPI).

The experimental treatment was administered in the context of group therapy, with each group composed of about four subjects and two members of the experimental team. The treatment generally took place over six weeks of bi-weekly meetings which included two administrations of psilocybin. The treatment involved a combination of an initial battery of tests, twice a week non-drug preparation sessions over the course of two weeks at which the test results were discussed and preparations were made for the first psilocybin experience, a day-long group experience of psilocybin with doses ranging from 20-70 mg., several post-psilocybin sessions devoted to discussion and integration of the initial psilocybin experience and preparation for the second and usually final administration of psilocybin, followed by several more non-drug sessions. After the final session, the identical battery of personality tests was readministered with the results again fed back to the subjects. This cycle was repeated over the course of two years for a total of 32 subjects.

In most treatment groups, one subject who had completed the cycle of treatment was included so as to give the new subjects exposure to a peer who had already been through the psilocybin experience. As a further method of providing emotional support to the subjects for their frequently challenging psilocybin experiences, one of the group leaders usually self-administered psilocybin as a demonstration of solidarity and trust in the healing potential of psilocybin.[2]

Once subjects who had completed the treatment process had been approved for parole, additional group meetings were held to address the details of trying to create a new life outside of prison. Though no post-release group meetings were originally planned, they were soon considered necessary to support the efforts of the subjects to live within the law and remain out of prison. Substantial effort was expended by the experimental team to remain in contact with subjects post-parole so as to provide continuing emotional support and leads on jobs and housing. A non-profit organization, Freedom Inc., was created to coordinate post-release efforts. However, Leary noted, "This phase (post-parole) of our program was never fully developed. We now realize that it is necessary to set up a halfway house where members can meet regularly and discuss mutual problems along Alcoholics Anonymous lines. For practical and material reasons, we were limited to irregular individual contacts with group members (Leary *et al*. 1965)."

Reported outcome of the original experiment

The Concord Prison Experiment is generally accepted to have had somewhat beneficial results (Grinspoon & Bakalar 1979) or to have been an astonishing success (Stafford 1979; Lee & Shlain 1985, Stevens 1987) in reducing recidivism rate. In addition, some of the psychological measures showed changes that would be expected to support the development of more positive behaviors.[3]

Recidivism rates of the experimental group were initially measured on January 15, 1963, when 28 of the 32 subjects had already been released from one to eighteen months, with an average ten months post-release. At this first follow-up, Leary reported in two papers that the recidivism rate was 32%, slightly more than half of what Leary claimed was the expected 56% recidivism base rate for inmates at Concord Prison (Leary & Metzner 1968, Riedlinger & Leary 1994). In a slight discrepancy, Leary reported in another paper that the recidivism rate as of January 15, 1963 was just 27% (Leary 1969). In his autobiography, Leary reported that, "We had kept twice as many convicts out on the street as the expected number." (Leary 1968). The recidivism base rates were generated through a review of the records of all 311 prisoners who had been discharged or paroled from Concord in 1959. This recidivism base rate study was conducted by Metzner and Weil, both of whom were graduate students affiliated with the Harvard Social Relations Department and co-investigators with Leary on the prison project (Metzner & Weil 1963).

The longest period of follow-up reported was from data gathered as of July, 1964, when 27 subjects were reported to have been evaluated at from 18-26 months post-release (Leary *et al*. 1965). As of July, 1964, the total recidivism rate of the experimental group was reported by Leary to be no different than the expected base rates, with 41% of the experimental group who had been released reportedly still out of prison and 59% having been reincarcerated.[4]

Despite the lack of a reduction in overall recidivism rates, Leary still claimed that the experimental treatment had a significantly positive influence. Leary reported that in the control data gathered in the base rate study, the recidivism rate was due equally to new crimes and parole violations. However, in the experimental group, 52% were reported to have been returned on parole violations while only 7% were incarcerated for new crimes. With a total recidivism rate of 59%, Leary stated that the expected percentage of subjects reincarcerated for new crimes would have been 29.5% and the expected percentage of subjects reincarcerated for parole violations would also have been 29.5%. The discrepancy between the expected and actual numbers of subjects reincarcerated for parole violations compared to new crimes was reported to be significant at the .01 level.

The difference between recidivism for ostensibly less serious parole violations as compared to new crimes was considered a sign of the continued, though limited, success of the experimental treatment. Leary hypothesized that the higher rate of recidivism in the experimental group attributable to parole violations rather than new crimes might have been the result of the experimental group being more closely supervised than other parolees, resulting in an increased number of technical parole violations of a minor nature. As Leary wrote, "The main conclusion can be stated as follows: One and one half years after termination of the program, the rate of new crimes has been reduced" (Leary, 1965).

Genesis of the follow-up study

Recognizing the historical importance of the Concord Prison Experiment, the Massachusetts Department of Corrections had preserved many of the original records of the experiment. Michael Forcier, a researcher with extensive experience conducting research for the Department of Corrections, was aware of the continued existence of a collection of papers from the Concord Prison experiment. These papers included an uncoded list of the names of the subjects in the experiment, a series of progress reports by Leary, correspondence between Leary and the Department, and some personal accounts written by the subjects about their subjective experiences under the influence of psilocybin.

In 1991, Forcier read an op-ed article about the author of this paper's previously published twenty-five year follow-up study to the Good Friday Experiment, the other major psilocybin experiment that Leary sponsored during his time at Harvard (Doblin 1991). Conducted in 1962 by Walter Pahnke, M.D., then a Ph.D. student working under the direction of Leary, the Good Friday Experiment was designed to evaluate the potential of psilocybin to catalyze religious experiences when taken by religiously inclined people in a religious setting. After reading about the follow-up to the Good Friday experiment, Forcier contacted this author and offered to assist with a long-term follow-up study to the Concord Prison Experiment. After quite a lengthy process, approval was obtained for the Concord follow-up study from the office of then-Governor William Weld.

Research objectives

This follow-up study was conducted in order to measure the impact of the experimental treatment on recidivism rates from both parole violations and new crimes at 2.5 years post-release, the longest point in time for which base rate statistics for a control group had been gathered, and also to review the records of the criminal behavior patterns of the subjects over a 34 year period. A secondary aim was to seek to interview some of the original subjects in order to determine what they felt were the long-term consequences of their participation in the experiment and to gather information on any reported linkages between the subjects' experiences under the influence of psilocybin and the nature of subsequent behavior change.

Due to the importance of the Concord Prison Experiment in the psychedelic literature, the long-term follow-up also offered the opportunity to raise awareness in a new generation of students and researchers about what this author believed at the beginning of this follow-up was a successfully proven approach to behavior change. It was also hoped that this follow-up might help to catalyze additional research extending and expanding on Leary's pioneering study and its reportedly promising results.

Methodology

The follow-up experiment was designed primarily as a search of the criminal histories of the subjects, using both Massachusetts and Federal data bases. A supplemental part of the experiment was planned to include interviews with any subjects who were located and willing to be interviewed. The readministration of the same set of psychological measures used by Leary was considered but rejected since there was no way to link any newly obtained results to the initial scores, which were reported only as group averages.

Limitations of the data set

The criminal histories of the subjects in the Concord Prison Experiment for the time period of the experiment and several years thereafter are contained only in file folders in storage at the Department of Corrections. The Concord Prison Experiment took place well before the records of the Department were computerized, thereby necessitating the follow-up study to be conducted primarily through physical examination of the records on site at the downtown Boston offices of the Department of Corrections. Federal records were accessed via computer.

Although a list of the names of 32 subjects who participated in the experiment was among the papers retained by the Department of Corrections, file folders could be located for only 21 of the original subjects. As a result, there is no way to determine the exact recidivism rate of the entire experimental group for periods of time longer than previously reported by Leary. Nevertheless, the total recidivism rate as of July, 1964 for the sample of 21 subjects whose files were located is quite similar to the rates reported by Leary for the entire experimental group, demonstrating that the lost folders are likely to form a random subset of the entire cohort. As a result, the recidivism rate for the subsample of 21 subjects at 2.5 years post-release is likely to be similar to that of the entire sample. Furthermore, by comparing the cumulative records from the smaller sample of 21 subjects as of July,1964 to that of the larger sample as reported by Leary, also as of July, 1964, it is possible to calculate both lower and upper bounds for the recidivism rate of the entire group of 32 subjects at the timepoint of 2.5 years post-release.

Reanalysis of the reported short-term recidivism success

Leary claimed a remarkable reduction of recidivism rates in the short-run, at the date of the first follow-up as of January, 1963. A careful review of all the source documents, including the base rate study, prove that claims of an initial treatment effect were false. Leary's report of a dramatic treatment effect was the result of a misleading use of the base rate data.

To show an initial treatment effect as of January, 1963, Leary compared the recidivism rates of his experimental group after they had been out of jail an average of ten months (32%) with the recidivism rates of men who had been out of Concord Prison an average of 30 months (56%). The difference between the two rates was called the treatment effect. However, the appropriate comparison should have been between recidivism rates of the experimental and control groups at similar periods of time post-release. Recidivism is, among other factors, a function of how long someone has been out of prison, with rates rising over time since more time presents more opportunities for criminal behavior and police apprehension. Leary's flawed comparison has not been criticized to date, in part because in all the papers in which Leary reported data from the January, 1963 follow-up, he failed to mention that the base rate study figure used for comparison was for recidivism rates at 30 months. Perhaps another factor is that the base rate study was published in a journal that is not widely available.

Also unreported by Leary, the base rate study contained a graph indicating the recidivism rate as a function of time. It was thus easily possible for Leary to have compared recidivism rates at identical periods of time post-release. When the appropriate comparison between the experimental and control group is made for the identical period of 10 months post-release, the recidivism rate for the control group turns out to be 34.3%, compared to 32% for the experimental group. This results in a 2.3% reduction over the base rates, not the 23% reduction reported by Leary. The 2.3% reduction is not significant and is the same as a finding of no treatment effect.

Parole violations or new crimes?

As of the July, 1964 follow-up, Leary reported that only two subjects were returned to jail for new crimes, while 14 were returned as parole violators.[5] The disproportionate rate of recidivism due to supposedly technical parole violations instead of new crimes is the basis of Leary's claim that the Concord Prison experiment was still a success as of July, 1964 despite there being no reductions in overall recidivism rates as compared to the base rate control group. Leary claimed that many of his subjects were returned to prison for minor technical parole violations. He hypothesized that these technical parole violations were due to the extra supervision the subjects received as a result of having been in the psilocybin experiment. Unfortunately, the results of this follow-up do not confirm Leary's claim that virtually all of the subjects in his study who were returned to prison were returned merely for technical parole violations.

Through comparing the findings of the follow-up with Leary's reported results, it was possible, with some difficulty, to discern Leary's method of categorization between new crimes and parole violations. Leary's method involved counted only the reason for the first reincarceration post-release, ignoring everything occurring after that first reincarceration. As of July, 1964, 12 out of the 18 subjects in the subsample of 21 subjects who had been released prior to this date had been returned to prison. By Leary's counting method, only one of these 12 had been returned for a new crime, while 11 had been returned for parole violations. Of the 15 out of 21 subjects who were returned to prison within 2.5 years post-release, only one was returned for a new crime while 14 were returned for parole violations.

Leary's method, using only the reason for the first reincarceration to determine whether a subject was returned to prison for a new crime or a parole violation, isn't as straightforward as it initially appears. For example, many of the experimental subjects were arrested for a new crime while on parole, immediately or shortly thereafter returned to prison as a parole violator because of the new arrest, then subsequently convicted and sentenced for the new crime, all within the follow-up period. By Leary' s counting rules, these subjects were considered parole violators because they were first returned to prison for a parole violation. They were not counted as having committed a new crime despite the fact that they had, in fact, committed a new crime that directly resulted in a rapid return to prison (but initially for violation of parole), followed by a subsequent conviction for the new crime. As another example, several subjects were first returned to prison for a parole violation that was not linked to an arrest with subsequent conviction for a new crime and were subsequently released within the follow-up period. They were then later arrested for a new crime, convicted and returned to prison again for that new crime, all within the follow-up period. These subjects were also counted as having been reincarcerated for parole violations and not new crimes since their first reincarceration was for a parole violation.

It may be true that Leary's subjects were more closely monitored than other parolees. If that were the case, the result of this intensive monitoring would have resulted in a rapid violation of parole for new crimes that had been committed but for which the criminal justice system needed more time to arrive at a conviction. Parolees who were less intensively monitored may not have been returned to prison until they were actually convicted for new crimes. The rapid link between arrests for new crimes and parole violations prior to new convictions, combined with Leary's counting rules, resulted in the illusory appearance that fewer new crimes and more technical parole violations had been committed by the subjects in this experiment. The results look quite different when recidivism due to a new crime is defined as a return to jail during the period of the follow-up for any incident that later resulted in a conviction for a new crime (regardless if the subject was first returned to prison for a parole violation), and a parole violation is defined as a return to prison for anything short of an incident that led to a new conviction (such as not reporting in to the parole officer, not keeping a job, associating with known criminals, or suspicion of or arrest for a new crime but no new conviction). These definitions represent reasonable criteria; the present author is not certain that these are the exact definitions used in the base-rate study.

Using the above definition of a return to prison for the commission of a new crime, it turns out that of the 18 subjects who had been released prior to July, 1964, seven (39%) had been returned to prison for a new crime, five (28%) had been returned for parole violations, and six (33%) had not returned to prison. Of the seven returned to prison due to new crimes, one subject was first returned to prison for a new crime while six had been returned to prison as a result of parole violations linked to incidents that subsequently resulted in convictions for new crimes. Of the five subjects who had been returned for parole violations, two were returned for parole violations linked to a suspicion of a new crime but without conviction. Only three were returned for technical parole violations, in each case due primarily to problems related to the use of alcohol.[6]

Of all 21 subjects evaluated at 2.5 years post-release, eight (38%) had been returned to prison for a new crime, seven (33%) had been returned to prison for parole violations, and six (29%) had not returned to prison. Of the eight returned for new crimes, one was returned first for new crimes and seven were returned for parole violations that were associated with incidents that later resulted in convictions for new crimes. Of the seven returned for parole violations, four were returned for parole violations linked to a suspicion without conviction of a new crime and only three were returned for a technical parole violation, in each case due primarily to problems related to the use of alcohol.[7]

Neither as of the July, 1964 follow-up nor at 2.5 years post-release were a disproportionate percentage of the subjects returned to prison for parole violations as compared to new crimes, when parole violations are defined as returns to prison not linked to convictions for new crimes and new crimes are defined as returns to prison for incidents linked to new crimes. Only a small minority of subjects who were sent back to prison were returned for technical parole violations, just three of 12 (25%) as of July, 1964 and only three of 15 (20%) as of 2.5 years post-release. Regardless of whether the results of the Concord Prison experiment were somehow an improvement on the ratio of new crimes to parole violations in the base rate study, the distinction between parole violations and new crimes is largely meaningless since the majority of what Leary considered "parole violations" were caused by incidents that later led to convictions for new crimes.

Longer-term recidivism rates

Of the 21 psilocybin subjects for whom records could be searched, the actual recidivism rate at 2.5 years (30 months) post-release was 71%, with 15 out of 21 of the subsample having been returned to prison. The bounded range of possible recidivism rates for 2.5 years post-release for the entire experimental group of 32 subjects is 56%-88%.[8]

The 71% recidivism rate of the sample of 21 is just one percentage point below the mid-point of the range of possible values (72%), again suggesting that the subsample is likely to be a random sample of the entire group. The range of possible recidivism rates is similar to the expected recidivism base rate of 56% at 2.5 years post-release, and to the previously reported recidivism rate as of July, 1964 of 59%. There is thus no treatment effect, in terms of reduced recidivism rates, at the longest point in time for which base rate statistics for a control group are available. The finding of no treatment effect at 2.5 years post-release is not surprising, given the lack of such an effect as of July, 1964, with subjects from 18-26 months post-release.

From 30 months post-release to the time when this long-term follow-up was conducted (an additional 31.5 years), the total recidivism rate was 76%. One of the six subjects who stayed out of jail for the first 2.5 years post-release was returned to jail after that period of time for the commission of a new crime, while the remaining five subjects were not reincarcerated.

Follow-up interviews

Only three subjects were able to be located and contacted by phone. Two agreed to be interviewed and one declined. Of the two subjects who agreed to be interviewed, one had returned to prison after participating in the experiment while the other had not. A special meeting was arranged at which the author of this paper brought the two subjects willing to be interviewed to the home of Leary for an emotional reunion and tape-recorded interview. The meeting took place on January 20, 1996, just several months before Leary died. Gunther Weil, one of Leary's co-investigators on the experiment, also participated in the meeting.

Both experimental subjects expressed their gratitude at being able to participate in the experiment. Both felt that they had benefited personally from their psilocybin experiences and did not suffer any long-term negative problems linked to their psilocybin experience. Both had vivid memories of their psilocybin experiences. Neither had taken a psychedelic drug on their own after the experiment.

The subject who returned to prison spoke about a remarkable experience he had while under the influence of psilocybin. He described it as, "being back in the womb I'm seeing a movie, it's my two older brothers and they're saying, 'Mom, can we go out and play?' 'Sure, Bob, sure, Al, you can go out.' I'm saying, 'Wait for me, I want to go out, too.' She says, 'You can't go out.' And I said, 'Why?' And she says, 'Because you're not even born yet.' It was a funny sensation."

He reflected on the experience and commented, "I firmly believe that I would never have gone back to prison if I had had help [post-release], if someone would have guided me, taken an interest. Who the hell wants to do time?" After his final release from jail, he said he became more responsible, got married and became a father. He reported that his son also had served time in jail, and commented that he wished his son could have a psilocybin experience because it might have helped him see his life options in a new, more responsible manner.

The subject who did not return to jail speculated that he was able to stay out of jail primarily because he had a family to return to post-release. The crime for which he went to jail had been committed six years prior to his arrest, which he said came about because he told someone about his earlier crime who then told the police. This subject credited the psilocybin experiences with helping him to stay out of jail, saying, "I know this thing [the psilocybin experience] was great for me in my life for about two years after I had taken it. You know, my wife and I would discuss it every once and a while, and she'd ask me, 'How do you feel?' And I'd say, ' I feel great you and I are together, so I got something out of it.'" He reflected on the content of his psilocybin experience by saying, "You tear your life down and you put it back together."

Leary's reflections

Leary, though weakened by terminal illness, thoroughly enjoyed the meeting with the ex-prisoners. He reminisced about the elation he frequently felt leaving the prison after a successful experimental session, realizing that he had brought a degree of mental freedom to people behind bars.

Leary also mentioned several elements of the experimental design other than the use of psilocybin that he thought were important but might easily be overlooked. The main point he wanted to make was that, "There were no secrets. We gave you guys all the power" The prisoners were given the results of all the psychological tests that were administered, they could decide on the dose they wanted to take, and they even played a role in deciding which other prisoners could participate in the experiment. At that time, this degree of openness was rare but Leary chose to be democratic about information and procedures in order to empower the subjects to take greater control over their lives.

Leary elaborated on the theme of relinquishing control. "Giving full disclosure, no secrets, but one of us [the experimental team] would always be in control, we would trade off. Once I really lost it. At one point, I was sitting there talking to the group and it was like a hypnotic thing. Everybody was like really into it, I was really into it, and suddenly I had this flash like you were all in my web, like a spider. I got into a whole control thing, and I felt really shameful about that. The next minute I collapsed. I kind of woke up and I was on a cot and you guys were all looking at me like mom. I was completely vulnerable, but everybody was so kind and sensitive. It was tremendous."

When asked what changes in the experimental design he would implement if he were to try to replicate the experiment, the first and only change he noted was, "One thing would be to set up the halfway house system.. A support system is really needed." The lack of post-release support was the most important weak link in the therapeutic intervention. This was recognized early on and the experimental team devoted a substantial amount of time keeping in touch with the subjects post-release, trying to find them living arrangements and jobs, and offering emotional support. The establishment of a half-way house was, however, beyond the means of the experimental team.

A higher standard

When Leary left Harvard, he left science behind and focused on becoming a cultural change agent of the most controversial nature. Until now, it has been generally assumed that all his scientific contributions were reliable. Indeed, this author's Good Friday Experiment follow-up study confirmed the basic findings of that Leary-sponsored experiment, although the author did uncover the unreported fact that one of the subjects in the Good Friday experiment had had a difficult reaction and was administered a major tranquilizer during the course of the experiment (Doblin 1991; Roberts & Jesse 1998). Whatever his motivations, Leary's misleading reports about the success of the Concord Prison experiment serve as an object lesson in what not to repeat. With the current renewal of research into the therapeutic use of psychedelic drugs after three decades of almost total prohibition, psychedelic researchers must hold themselves to the highest ethical standards in order to retain a measure of trust with regulators and the general public.

Conclusion

The failure of the Concord Prison Experiment to generate a reduction in recidivism rates should not be interpreted as proof of the lack of value of psychedelics as adjuncts to psychotherapy in criminals. Rather, the failure of the Concord Prison Experiment should finally put to rest the myth of psychedelic drugs as magic bullets, the ingestion of which will automatically confer wisdom and create lasting change after just one or even a few experiences. Personality change may be made more likely after a cathartic and insightful psychedelic experience, though only sustained hard work after the drug has worn off will serve to anchor and solidify any movement toward healing and behavior change. Psychedelic drug experiences are not sufficient in and of themselves to produce lasting change. Leary, who wrote about the importance of set and setting, knew this as well as anyone, and wrote, "The main conclusion of our two year pilot study is that institutional programs, however effective, count for little after the ex-convict reaches the street. The social pressures faced are so overwhelming as to make change very difficult." (Leary 1969).

Leary took the time during the follow-up interview, conducted shortly before his death, to reiterate what he had previously claimed was the major lesson of the Concord Prison experiment; the key to a long-term reduction in overall recidivism rates might be the combination of the pre-release administration of psilocybin-assisted group psychotherapy with a comprehensive post-release follow-up program modeled on Alcoholics Anonymous groups to offer support to the released prisoners.

Of course, it is likely that post-release programs would be of some benefit to all people released from prison, regardless of whether they had received psilocybin-assisted group psychotherapy, drug abuse counseling, vocational training, non-drug psychological treatment, any other program intended to reduce recidivism, or even no treatment at all. As a result of the profound psychological effects of psilocybin, a post-release program for subjects who had received psilocybin might differ in both content and importance from programs for subjects who had received other interventions. Whether a new program of psilocybin-assisted group psychotherapy and post-release programs would significantly reduce recidivism rates is an empirical question that deserves to be addressed within the context of a new experiment.

Notes

1. This article has benefited from extensive critique by Ralph Metzner as well as thoughtful review by Rick Strassman, Tom Riedlinger, Gunther Weil, Charles Grob, and Bob Forte.

2. Experiential accounts by project leaders can be found in High Priest (Leary 1968), and in the account by Metzner, "From Harvard to Zihuatanejo," in the Leary Festschrift Timothy LearyOutside Looking In, edited by Robert Forte, published by Inner Traditions, New York.

3. These personality changes are discussed in detail in Leary et. al. 1965, and Leary & Metzner 1968. In the California Personality Inventory, significant changes were noted in 12 of 18 scales (including sociability, sense of well-being, socialization, tolerance and intellectual efficiency.) There were generally no significant changes in the MMPI with the exception of the D-scale going down from test one to test three.

4. Some confusion may result from the fact that the first journal article that Leary published about the Concord Prison experiment (Leary *et al*. 1965) contains information about recidivism rates as of July, 1964, which showed no overall reduction. Leary's subsequent books and journal articles (Leary 1969; Leary 1968; Leary & Metzner 1968) and historical reviews written by authors to whom Leary spoke (Stevens 1987; Lee & Shlain 1985; Stafford 1979), report recidivism rates only as of January, 1963, which Leary claimed did show a dramatic reduction, and do not even mention that there had been a later follow-up as of July, 1964 which showed no overall reduction. The normal expectation is that later papers and reports contain the most up-to-date information. As a result of being first exposed to the later papers and reports, this author, as well as many other people, initially obtained the mistaken impressions that there had been no follow-up to the Concord Prison Experiment after January, 1963, and that the experiment had succeeded in reducing recidivism rates. Only in one post-1965 paper did Leary ever mention again that there had been a follow-up after January, 1963 in which the recidivism rates were not lower than expected. Leary was not the lead author in that paper, which was written after almost three decades had passed since the 1965 paper (Riedlinger & Leary 1994).

5. Leary's report of two people returned to prison for new crimes as of July, 1964 conflicts with his report as of January 15, 1963, 18 months earlier, when he claimed that three people had already been returned to prison for new crimes. Subject #9 was returned to prison for parole violations linked to a new crime for which he was not convicted, was released after serving additional time, and then returned for parole violations linked to subsequent convictions for new crimes.

6. Subjects #2, #9, #13, #17, #19, and #21 were returned to prison for parole violations for incidents that subsequently resulted in new criminal convictions. Subject #4 was returned to prison for a new crime. Subjects #5 and #10 were suspected of committing new crimes but were not convicted, while Subjects #12, #15, and #20 were returned for problems related to their use of alcohol.

7. Between the July, 1964 follow-up and 2.5 years post release, three additional subjects were released from

Concord. Subject #3 was returned to prison for skipping parole but was not suspected of committing any new crimes. Subject #6 was returned for a parole violation related to suspicion of involvement in an armed robbery for which he was not convicted. Subject #7 was returned to prison for a parole violation linked to suspicion of involvement in theft, was released after serving additional time, and then returned for a conviction of armed robbery.

8. As of July, 1964, Leary reported that 27 out of the 32 subjects had been released from prison. Of the 27 who had been released, 16 had returned to prison and 11 had not, for a recidivism rate of 59%. In the subsample of 21 subjects, 18 had been released from prison prior to July, 1964. Of those 18 who had been released, 12 had returned to prison and six had not, for a recidivism rate of 67%. Thus, out of the nine subjects who had been released as of July, 1964 and whose file folders were not located, simple subtraction indicates that four must have been returned to prison (16 minus 12) and five were not (11 minus 6). There were also five subjects who had not been released from prison as of July, 1964. In the subsample of 21 subjects, three were released only after July, 1964. Of that three, two were returned to prison for parole violations within 2.5 years post-release while the third was returned to prison for a new crime, but not until after 2.5 years post-release. Therefore, the best possible outcome at 2.5 years post-release would be 56% (18/32; 12 subjects from the subsample of 21 who went back to prison before July, 1964, four subjects from the missing files who Leary reported went back to prison by July, 1964, and two subjects from the subsample of 21 who were released from prison after July, 1964 and who returned to prison within 2.5 years post-release). This lower bound of 56% is exactly what the base rate statistics were for 2.5 years post-release. The worst possible outcome at 2.5 years post-release would be 88% (28/32).

References

1. Arendsen Hein, G.W. 1963. *LSD in the Treatment of Criminal Psychopaths.* London: Charles C. Thomas.
2. Doblin, R. 1991. The Good Friday Experiment - A twenty-five year follow-up and methodological critique. *Journal of Transpersonal Psychology* 23 (1): 1-28.
3. Grinspoon, L. & Bakalar, J. 1979. *Psychedelic Drugs Reconsidered*. New York: Basic Books.
4. Leary, T. 1969. The effects of consciousness-expanding drugs on prisoner rehabilitation. *Psychedelic Review* 10: 20-44.
5. Leary, T. [1968] 1995. *High Priest*. Berkeley: Ronin Press.
6. Leary, T. 1963. Report on the Harvard Psilocybin Project. Unpublished. January 15, 1963.
7. Leary, T. & Metzner, R. 1968. Use of psychedelic drugs in prisoner rehabilitation. *British Journal of Social Psychiatry* 2: 27-51.
8. Leary, T.; Metzner, R.; Presnell, M.; Weil, G.; Schwitzgebel, R. & Kinne, S. 1965. A new behavior change pattern using psilocybin. *Psychotherapy: Theory, Research and Practice* 2 (2): 61-72.
9. Leary, T.; Litwin, G. & Metzner, R. 1963. Reactions to psilocybin in a supportive environment. *Journal of Nervous and Mental Diseases* 137:561-73.
10. Lee, M. & Shlain, B. 1985. *Acid Dreams: The CIA, LSD and the Sixties Rebellion*. New York: Grove Press.
11. Metzner, R. & Weil, G. 1963. Predicting recidivism: Base rates for Massachusetts Correctional Institute, Concord. *Journal of Criminal Law, Criminology and Police Science* 54 (3): 307-16.
12. Riedlinger, T. & Leary, T. 1994. Strong medicine for prisoner reform: The Concord Prison Experiment. *MAPS Bulletin* 4 (4): 22-25.
13. Roberts, T. & Jesse, B. 1998. Recollections of the Good Friday Experiment: An interview with Huston Smith. *Journal of Transpersonal Psychology* 29(2): 99-104.
14. Stafford, P. 1979 . *Psychedelics Encyclopedia. 3rd Ed*. Berkeley: Ronin Press. Third Edition, 1992.
15. Stevens, J. 1987. *Storming Heaven: LSD and the American Dream*. New York: Atlantic Monthly Press.
16. Tenenbaum, B. 1961. Group therapy with LSD-25. *Diseases of the Nervous System* 22: 459-92.

Reflections on the Concord Prison Project and the Follow-Up Study

by

Ralph Metzner, Ph.D.

from Journal of Psychoactive Drugs Vol 30(4)

original source: http://www.maps.org/research-archive/ralphmetzner_concord_follow-up.pdf
backup source: http://www.psilosophy.info/resources/ralphmetzner_concord_follow-up.pdf

Rick Doblin has provided a valuable service to the field of psychedelic research by conducting critical follow-up studies to the Good Friday study of religious experiences as well as the study discussed here on a "behavior change" program for convicts at Concord Prison. I was probably more deeply involved in the project and in the writing-up of the results than anyone besides Leary. I spent the better part of two years out of my four-year graduate program on this project, and though it was not the area in which I did my thesis research, I did also do a clinical internship in Concord prison supervised by Dr. Madison Presnell (who was also the supervising psychiatrist for the psilocybin project).

It is disconcerting, of course, to discover 35 years after the fact that a research project I was involved in and wrote about made quantitative errors and reported erroneous conclusions. As I read Rick Doblin's findings, and re-read our original papers, it did give me occasion to reflect on that period, and what was called the Harvard Psilocybin project - and to come to the depressing conclusion that none of it did any better than chance (as far as one could tell from the tests). Leary was, at that time, a respected, experienced and committed research scientist, who had spent a decade doing statistical evaluations of psychotherapy. The graduate students in the project, such as Gunther Well and myself, were equally committed to doing exacting and rigorous demonstrations. Well and I, for example, spent most of a summer in the archives of the State Department of Corrections, poring through hundreds of prisoner files and assembling the data we needed to calculate an appropriate recidivism base-rate, against which any behavior change program could be measured.

The two dominant paradigms in the Department of Social Relations at Harvard (of which the Center for Research in Personality was a part) were behaviorism and Freudian psychoanalysis. For this reason, Tim Leary was particularly pleased with the prospect of trying the psychedelic insight treatment with convicts. Having just shown that the subtle personality changes that psychotherapists feel sure happen, can't be demonstrated to happen, he pointed out that in the recidivism rate (the rate of return to prison after being released on parole) we had the perfect in controvertible behavioral index of personality change. Personality tests would also be given before and after the therapy, but they were secondary.

It was therefore with some dismay that the members of our project realized, after almost a year of running dramatic, seemingly life-changing psilocybin sessions with convicts in the prison, that we (and the prisoners) didn't have a clue as to what to do for them once they got out of the prison and how to help them make it in society. In the 1965 paper published in *Psychotherapy: Theory, Research and Practice*, which I mostly drafted, I remember sharing the disappointing conclusion that our group's recidivism rate was not different from the base-rate. We did find and report significant changes in several scales on the California Psychological Inventory, and one on the MMPI; as well as some inconclusive behavioral ratings changes. And that is the way I have held the study in my mind ever since - deep personality changes occurred, but in order to maintain changed behavior outside of the prison, some kind of half-way house or rehab program is essential.

This conclusion was stated clearly in our reports. Leary actually devoted a tremendous amount of time and energy to finding ways that our project could somehow help the paroled convicts who had been through our program, "make it" on the outside, i.e., trying to help them find jobs, places to live, and offering them companionship. I remember trips to Boston bars to meet with some of the men, just to keep in touch. Leary has described (in chapter 10 of *High Priest*) his extreme and almost comical efforts on behalf of an uneducated, unskilled, lower class, alcoholic petty thief who was the first to graduate from our program - including eventually giving him a job at the Center for Personality Research (the "job" being to find another job) and renting him a room in his family home, with his kids.

Thirty-five years is a long time from which to recall details of a statistical research project. Although I wrote up the results of the final and longer follow-up in the 1965 paper. I have to say at this point I have no idea how Leary came up with the "finding" that the return rate for parole violations Was up and for new crimes down (hence the over- all rate unchanged). This "finding," which has now turned out to be erroneous, was of course the kind of result we wanted to find - it enabled us to maintain a positive, enthusiastic attitude in talking about this project. We fell victim to the well-known "halo effect," by which researchers tend to see their data in as positive a light as possible. I have myself, in later years, sometimes forgotten the basically negative result we reported in the study, and talked about the project as if we lowered the recidivism rate.

In this sense, I'm grateful to have this late opportunity to acknowledge a chastening correction. Rick Doblin's analysis of the situation shows that most prisoners who were actually returned for parole violations had also committed new crimes - so that the distinction itself is an artifact. Similarly, I have at this time no idea where the 10-month follow-up figure of 32% recidivism in our group came from. In the article in the *British Journal of Social Psychiatry*, which he apparently wrote before the project was completed(though it was not published until 1968), Leary (erroneously) compared this 32% figure to the 30-month base rate figure - thereby arriving at a significant overall reduction. He stated these as "extremely tentative" results, subject to further analysis. Nevertheless, they are clearly inconsistent with our own results (reported in the 1965 article) of no difference in overall rate of return. As Doblin points out, Leary was able to get this seemingly positive finding only by using the wrong control figure. In the paper from *Psychedelic Review*, which was excerpted from the then forthcoming *High Priest*, he repeated the same mistake - and I, as editor, didn't catch it. Clearly we were both under the "halo-effect." Leary was also by this time no longer playing what he called "the scientist game."

Whether Leary made these mistakes consciously, faking the results that he wanted, or whether they were unconscious mistakes of carelessness, motivated by overenthusiasm, is impossible to say at this point. I tend to favor the latter alternative, if only for the reason that our own results clearly show the inconsistencies. Our basic finding remains, then as now: that with psychedelics (and other programs) profound experiences of insight and personality change can be brought about, but criminal behavior patterns take a much more concerted system of rehabilitation and community support to change. The interviews done 30 years later with two of the men document this in a direct and touching way.

The one statement of Doblin's that I would still question is the need for a "higher standard" or "highest ethical standards in order to regain a measure of trust from regulators." In my opinion, the existing accepted standards of honesty and truthfulness are perfectly adequate. We have those standards, not to curry favor with regulators, but because it is the agreement within the scientific community that observations should be reported accurately and completely. There is no proof in any of this re-analysis that Leary unethically manipulated the data. Careless mistakes were made, no doubt; mistakes that made the data look more like we wanted them to look. But to make mistakes is neither unethical nor unscientific. It's an integral part of the scientific method that when mistakes are found, they are reported and corrected. In this sense, I appreciate the better understanding that comes. from this more complete and accurate review of the Concord prison project.

Selective Enhancement of Specific Capacities Through Psychedelic Training

by

Willis W. Harman and James Fadiman

From: PSYCHEDELICS, The Uses and Implications of Hallucinogenic Drugs

Bernard Aaronson and Humphrey Osmond, editors, Doubleday & Company, 1970

© Aaronson & Osmond, Harman & Fadiman

original source: http://www.druglibrary.org/schaffer/lsd/harman.htm

Table of Contents:

Rationale Behind the Creative Problem-Solving Study
Procedure
Subjective Reports
Results: Subjective Ratings
Results: Psychometric Data
Long-term Results
Comments and Speculations

> (This article discusses exploratory work that was interrupted early in 1966 when the Food and Drug Administration, as a strategy in combating the illicit-use problem, declared a moratorium on research with normal human subjects. In view of the preliminary nature of the work, it would not under ordinary circumstances have been submitted for publication. However, because of the significance of the hypotheses, and because they are consistent with experience gained in a previous study of four hundred subjects who received psychedelics in a therapy context, and because of the hope that when it is again possible to resume psychedelic research the non-medical applications will get long-overdue attention, the decision was made to release these results in their present, unfinished form.)

Amid much controversy over the place of psychedelic chemicals in contemporary culture, we have quietly entered a third phase of the research on human uses of these agents.

The first phase, typically identified in the literature by the use of the adjective "psychotomimetic," was characterized by dominance of *a priori* structured models. Seriously underestimating the effects that such preconceptions might have on the content and aftereffects of the subjective experience, researchers variously reported that psychedelics mimicked mental illness (when given in a setting that provoked it), illuminated Freudian theory (when administered by a competent Freudian), evoked Jungian archetypes (when administered by a sensitive Jungian), substantiated the tenets of behavior therapy (by increasing suggestibility and modifiability), and demonstrated the soundness of the existential approach.

The second phase, adopting Osmond's neologism "psychedelic," was characterized by an emphasis on allowing the drug session to run its natural course, in an attempt to minimize the influence of the conceptions and interpretations of the therapist or monitor. Care was taken to provide such expectations, rapport, and environment that the experience would be as non- threatening as possible. Opinions varied as to what constitutes optimum set and setting, and subjects and experimenters varied. As a consequence, reported effects range from ecstasy to psychosis, from community to isolation, from greatly enhanced mental and perceptual abilities to greatly impaired abilities. From this work emerged a variety of psychotherapeutic applications, well summarized by Hoffer (1965), as well as widespread, mainly illicit, use with sensual, philosophical, and transcendental goals.

Growing out of this informal experimentation and clinical research, largely as a consequence of suggestive spontaneous occurrences, the possibility gradually emerged that specific kinds of performance might be selectively enhanced by deliberate structuring of psychedelic-agent administrations. Thus a third phase of psychedelic research began. Whereas, in the first phase, experiences tended to be controlled and delimited-never mind if inadvertently-by preconceptions of experimenter and subject, and in the second phase they tended to be more uncontrolled and wide-ranging in scope, now the emphasis was to be on deliberate selection of specific aspects of the psychedelic experience and of specific parameters of functioning.

As these experiments on specific performance enhancement through directed use of the psychedelics have gone on in various countries of the world, on both sides of the Iron Curtain, and as, furthermore, some, at least, of the informal exploration has been in defiance of existing laws governing use of the psychedelic agents, publicly available information on results is scant and scattered. In the remainder of this chapter we shall discuss one pilot study in which the particular type of performance chosen for attention was creative problem-solving ability. The implications of the work are, we believe, much broader than this particular application. Indeed, the basic assumption underlying setting up the project, and not negated by any of our observations during the course of the research, is that, *given appropriate conditions, the psychedelic agents can be employed to enhance any aspect of mental performance, in the sense of making it more operationally effective*. While this research was restricted to intellectual and artistic activity, we believe the assumption holds true for any other mental, perceptual, or emotional process. The psychedelic agent acts as a facilitator, an adjunct to the situation it facilitates, neither good nor evil, efficacious nor powerless, safe nor dangerous.

Rationale Behind the Creative Problem-Solving Study

Reports in the literature on psychedelic agents that deal with effects on performance are inconclusive or contradictory. Changes in performance levels have been intensively investigated, both during and after the drug session. Instrumental learning has been found to be impaired during the drug experience in some studies, enhanced in others. Similarly, contradictory results have been noted for color perception, recall and recognition, discrimination learning, concentration, symbolic thinking, and perceptual accuracy (Mogar, 1965a).

In some of the research, where impairment was reported, the drug was used as a stresser with the intention of simulating psychotic performance-impairment. Practically all of the formal research in which improved performance was claimed subsequent to the drug experience has been in a clinical context. Performance enhancement during the drug experience has been sporadically reported in both experimental and clinical research, but not in general where the psychotomimetic orientation was dominant.

Our experience in clinical research (Mogar and Savage, 1964; Fadiman 1965; Savage *et al*., 1966) had been amply convincing with regard to the possibility of long-term performance enhancement through employment of the psychedelic agents in a clinical setting. We also had much evidence with regard to the subtlety and pervasiveness of the influence of set and setting. Furthermore, although they had not been deliberately sought, there were numerous spontaneous incidents of what appeared to be temporarily enhanced performance during the drug experience itself. These observations led us to postulate the following propositions:

1. Any human function, as generally elicited, can be performed more effectively. This amounts to an acknowledgement that we do not function at our full capacity.
2. The psychedelics appear to temporarily inhibit censors that ordinarily limit the mental contents coming into conscious awareness. The subject may, for example, discover his latent ability to form colored imagery, to hallucinate, to recall forgotten experiences of early childhood, to generate meaningful symbolic presentations, etc. By leading the subject to expect enhancement of other types of performance-creative problem solving, learning manual or verbal skills, manipulating logical or mathematical symbols, sensory or extrasensory perception, memory and recall-and by providing favorable preparatory and environmental conditions, it may be possible to improve the level of functioning in any desired respect.
3. Both objective and subjective indicators of mental performance are appropriate to use in establishing whether there has indeed been an improvement (or impairment) of performance.

As Table 1 indicates, commonly observed characteristics of the psychedelic experience seem to operate both for and against the hypothesis that the drug session could be used for performance enhancement. In this research we attempted to provide a setting that would maximize those characteristics that tend toward improved functioning, while minimizing those that might hinder effective functioning.

TABLE 1
SOME REPORTED CHARACTERISTICS OF THE PSYCHEDELIC EXPERIENCE
(as found in the literature and in subjects' reports)

Those supporting creativity	Those hindering creativity
1. Increased access to unconscious data.	1. Capacity for logical thought processes diminished.
2. More fluent free association; increased ability to play spontaneously with hypotheses, metaphors, paradoxes, transformations, relationships, etc.	2. Ability to consciously direct concentration reduced.
3. Heightened ability for visual imagery and fantasy.	3. Inability to control imaginary and conceptual sequences.
4. Relaxation and openness.	4. Anxiety and agitation.
5. Sensory inputs more acutely perceived.	5. Outputs (verbal and visual communication abilities) constricted.
6. Heightened empathy with external processes, objects, and people.	6. Tendency to focus upon "inner problems" of a personal nature.
7. Aesthetic sensibility heightened.	7. Experienced beauty lessening tension to obtain aesthetic experience in the act of creation.
8. Enhanced "sense of truth," ability to "see through" false solutions and phony data.	8. Tendency to become absorbed in hallucinations and illusions.
9. Lessened inhibition, reduced tendency to censor own by premature negative judgment.	9. Finding the best solution seeming unimportant.
10. Motivation heightened by suggestion and providing the right set.	10."This-worldly" tasks seeming trivial, and, hence, motivation decreased.

For several reasons we chose to focus our efforts on creative problem solving. One was its obvious utility, an important consideration at that juncture because of the increasing pressure for stricter regulation of the psychedelics by those who doubted that they were good for anything at all. Another factor was that many of the observed spontaneous occurrences had been of this sort. Finally, because of extensive recent research activity in the field of creativity, a number of relevant objective measures were available for use. Interest centered on three questions:

1. Can the psychedelic experience enhance creative problem-solving ability, and if so, what is the evidence of enhancement?
2. Can this result in enhanced production of concrete, valid, and feasible solutions assessable by the pragmatic criteria of modern industry and positivistic science?
3. Working with a non-clinical population and with a non-therapy orientation, would there nevertheless result demonstrable long-term personality changes indicative of continued increased creativity and self-actualization?

Procedure

The subjects in these experiments were twenty-seven males engaged in a variety of professional occupations (sixteen engineers, one engineer-physicist, two mathematicians, two architects, one psychologist, one furniture designer, one commercial artist, one sales manager, and one personnel manager). Nineteen of the subjects had had no previous experience with psychedelics. The following selection criteria were established:

1. Participant's occupation normally requires problem-solving ability.
2. Participant is found to be psychologically stable as determined by psychiatric interview-examination.
3. Participant is motivated to discover, verify, and apply solutions within his current work capacity.

Each group of four subjects met one another during an evening session several days before the experimental day. (In one of the groups, one subject had to be eliminated, which left only three.) The proposed sequence of events during the experimental session was explained in detail. This initial meeting also served the function of allaying apprehension and establishing rapport and trust among the members and the staff.

Subjects were told that they would experience little or no difficulties with distractions such as visions, involvement with personal emotional states, and so on. The instructions emphasized that the experience could be directed as desired. Direct suggestions were made to encourage mental flexibility during the session. An excerpt from those instructions is quoted below:

> Some suggestions on approaches:
>
> Try identifying with the central person, object, or process in the problem. See how the problem looks from this vantage point.
>
> Try asking to "see" the solution, to visualize how various parts might work together, to see how a certain situation will work out in future, etc.
>
> You will find it is possible to scan a large number of possible solutions, ideas, data from the memory etc., much more rapidly than usual. The "right" solution will often appear along with a sort of intuitive "knowing" that it is the answer sought. You will also find that you can hold in conscious awareness a number of ideas or pieces of data processes simultaneously, to an uncommon extent.
>
> You will find it is possible to "step" back from the problem and see it in new perspective, in more basic terms; to abandon previously tried approaches and start afresh (since there is much less of yourself invested in these earlier trials).
>
> Above all, don't be timid in the ambitiousness with which you ask questions. If you want to see the completed solution in a three-dimensional image, or to project yourself forward in time, or view some microscopic physical process, or view something not visible to your physical eyes, or re-experience some event out of the past, by all means ask. Don't let your questions be limited by your notion of what can and what cannot happen.

Approximately one hour of pencil-and-paper tests were administered at this time. Subjects were told that they would take a similar battery during the experimental session. To insure that the problems to be worked on were appropriate for the purpose, each participant was asked to present his selection briefly. By the end of the preparation session, participants were generally anticipative and at ease. They had been given a clear picture of what to expect, as well as information on how to cope with any difficulties that might arise.

The session day was spent as follows:

8:30 Arrive at session room
9:00 Psychedelic material given. Mescaline sulphate (200 mg).
9-12 Music played, subjects relaxed with eyes closed
12-1 Psychological tests administered
1-5 Subjects work on problems
5-6 Discussion of experience; review of solutions.

Participants were driven home after this. They were given a sedative, which they might take if they experienced any difficulty in sleeping. In many cases, however, they preferred to stay up until well after midnight, continuing to work on insights and solutions discovered earlier in the day.

Each subject wrote a subjective account of his experience within a week after the experimental session. Approximately six weeks after the session, subjects were administered questionnaires that related to (1) the effects of the session on post-session creative ability and (2) the validity and acceptance of solutions conceived during the session. These data were in addition to the psychometric data comparing results of the two testing periods.

Subjective Reports

The literature on creativity includes analytical description of the components of creative experience, the personal characteristics of creative individuals, and the distinguishing features of creative solutions. From the participants' reports, it was possible to extract eleven strategies of enhanced functioning during the session. The relationship of these strategies to enhanced functioning should be self-explanatory. Those readers interested in the relationship of these aspects to current research and theory on creativity can refer to the detailed technical discussion in Harman, McKim *et al*. (1966).

The factors are listed below with representative quotations from the subjects' reports.

1. Low Inhibition and Anxiety:
"There was no fear, no worry, no sense of reputation and competition, no envy, none of these things which in varying degrees have always been present in my work."
"A lowered sense of personal danger; I don't feel threatened any more, and there is no feeling of my reputation being at stake."
"Although doing well on these problems would be fine, failure to get ahead on them would be threatening. However, as it turned out, on this afternoon the normal blocks in the way of progress seemed to be absent."

2. Capacity to Restructure Problem in Larger Context:
"Looking at the same problem with (psychedelic) materials, I was able to consider it in a much more basic way, because I could form and keep in mind a much broader picture."
"I could handle two or three different ideas at the same time and keep track of each." "Normally I would overlook many more trivial points for the sake of expediency, but under the drug, time seemed unimportant. I faced every possible questionable issue square in the face."
"Ability to start from the broadest general basis in the beginning ..."
"I returned to the original problem. ... I tried, I think consciously, to think of the problem in its totality, rather than through the devices I had used before."

3. Enhanced Fluency and Flexibility of Ideation:
"I began to work fast, almost feverishly, to keep up with the flow of ideas."
"I began to draw ... my senses could not keep up with my images ... my hand was not fast enough ... my eyes were not keen enough ... I was impatient to record the picture (it has not faded one particle). I worked at a pace I would not have thought I was capable of."
"I was very impressed with the ease with which ideas appeared (it was virtually as if the world is made of ideas, and so it is only necessary to examine any part of the world to get an idea). I also got the feeling that creativity is an active process in which you limit yourself and have an objective, so there is a focus about which ideas can cluster and relate."
"... dismissed the original idea entirely, and started to approach the graphic problem in a radically different way. That was when things started to happen. All kinds of different possibilities came to mind. ..."
"And the feeling during this period of profuse production was one of joy and exuberance. ... It was the pure fun of doing, inventing, creating, and playing."

4. Heightened Capacity for Visual Imagery and Fantasy:
"Was able to move imaginary parts in relation to each other."
"... it was the non-specific fantasy that triggered the idea."
"The next insight came as an image of an oyster shell, with the mother-of-pearl shining in different colors. I translated that in the idea of an interferometer-two layers separated by a gap equal to the wave length it is desired to reflect."
"... As soon as I began to visualize the problem, one possibility immediately occurred. A few problems with that concept occurred, which seemed to solve themselves rather quickly. ... Visualizing the required cross section was instantaneous."
"Somewhere along in here, I began to see an image of the circuit. The gates themselves were little silver cones linked together by lines. I watched the circuit flipping through its paces. ..."
"I began visualizing all the properties known to me that a photon possesses and attempted to make a model for a photon. ... The photon was comprised of an electron and a positron cloud moving together in an intermeshed

synchronized helical orbit. ... This model was reduced for visualizing purposes to a black and white ball propagating in a screw-like fashion through space. I kept putting the model through all sorts of known tests."

5. Increased Ability to Concentrate:
"Was able to shut out virtually all distracting influences."
"I was easily able to follow a train of thought to a conclusion where normally I would have been distracted many times."
"I was impressed with the intensity of concentration, the forcefulness and exuberance with which I could proceed toward the solution."
"I considered the process of photoconductivity. ... I kept asking myself, "What is light?" and subsequently, "What is a photon?" The latter question I repeated to myself several hundred times till it was being said automatically in synchronism with each breath. I probably never in my life pressured myself as intently with a question as I did this one." "It is hard to estimate how long this problem might have taken without the psychedelic agent, but it was the type of problem that might never have been solved. It would have taken a great deal of effort and racking of the brains to arrive at what seemed to come more easily during the session."

6. Heightened Empathy with External Processes and Objects:
"... the sense of the problem as a living thing that is growing toward its inherent solution."
"First I somehow considered being the needle and being bounced around in the groove."
"I spent a productive period ... climbing down on my retina, walking around and thinking about certain problems relating to the mechanism of vision."
"Ability to grasp the problem in its entirety, to 'dive' into it without reservations, almost like becoming the problem." "Awareness of the problem itself rather than the 'I' that is trying to solve it."

7. Heightened Empathy with People:
"It was also felt that group performance was affected in ... subtle ways. This may be evidence that some sort of group action was going on all the time."
"Only at intervals did I become aware of the music. Sometimes, when I felt the other guys listening to it; and it was a physical feeling of them listening to it."
"Sometimes we even had the feeling of having the same thoughts or ideas."

8. Subconscious Data More Accessible:
"... brought about almost total recall of a course that I had had in thermodynamics; something that I had never given any thought about in years."
"I was in my early teens and wandering through the gardens where I actually grew up. I felt all my prior emotions in relation to my surroundings."

9. Association of Dissimilar Ideas:
"I had earlier devised an arrangement for beam steering on the two-mile accelerator which reduced the amount of hardware necessary by a factor of two. ... Two weeks ago it was pointed out to me that this scheme would steer the beam into the wall and therefore was unacceptable. During the session, I looked at the schematic and asked myself how could we retain the factor of two but avoid steering into the wall. Again a flash of inspiration, in which I thought of the word "alternate." I followed this to its logical conclusion, which was to alternate polarities sector by sector so the steering bias would not add but cancel. I was extremely impressed with this solution and the way it came to me."
"Most of the insights come by association."
"It was the last idea that I thought was remarkable because of the way in which it developed. This idea was the result of a fantasy that occurred during Wagner [Note: the participant had earlier listened to Wagner's 'Ride of the Valkyries.']. ... I put down a line which seemed to embody this [fantasy]. ... I later made the handle which my sketches suggested and it had exactly the quality I was looking for. ... I was very amused at the ease with which all of this was done."

l0. Heightened Motivation to Obtain Closure:
"Had tremendous desire to obtain an elegant solution (the most for the least)."
"All known constraints about the problem were simultaneously imposed as I hunted for possible solutions. It was like an analog computer whose output could not deviate from what was desired and whose input was continually perturbed with the inclination toward achieving the output."

"It was almost an awareness of the 'degree of perfection' of whatever I was doing."
"In what seemed like ten minutes, I had completed the problem, having what I considered (and still consider) a classic solution."

11. Visualizing the Completed Solution:
"I looked at the paper I was to draw on. I was completely blank. I knew that I would work with a property three hundred feet square. I drew the property lines (at a scale of one inch to forty feet), and I looked at the outlines. I was blank.
Suddenly I saw the finished project [Note: the project was a shopping center specializing in arts and crafts]: I did some quick calculations ... it would fit on the property and not only that ... it would meet the cost and income requirements ... it would park enough cars ... it met all the requirements. It was contemporary architecture with the richness of a cultural heritage ... it used history and experience but did not copy it."
"I visualized the result I wanted and subsequently brought the variables into play which could bring that result about. I had great visual (mental) perceptibility; I could imagine what was wanted, needed, or not possible with almost no effort. I was amazed at my idealism, my visual perception, and the rapidity with which I could operate."

Results: Subjective Ratings

As mentioned above, several weeks after the experimental session all participants were asked to complete a brief questionnaire. Here they rated their experience with respect to nine characteristics relevant to enhanced functioning. Items were rated on a five-point scale from MARKED ENHANCEMENT (+2) through NO CHANGE (O) to MARKED IMPAIRMENT (-2). The average ratings are listed in Table 2. These data, too, seem to substantiate the hypothesis of enhancement of both verbal and non-verbal skills.

TABLE 2
MEAN SUBJECTIVE RATINGS OF FACTORS
RELATED TO ENHANCED FUNCTIONING
(all ratings refer to behavior during the session) n = 27

Values	Mean	S.D.
1. Lowering of defenses, reduction of inhibitions and anxiety	+1.7	0.64
2. Ability to see the problem in the broadest terms	+1.4	0.58
3. Enhanced fluency of ideation	+1.6	0.69
4. Heightened capacity for visual imagery and fantasy	+1.0	0.72
5. Increased ability to concentrate	+1.2	1.03
6. Empathy with external processes and objects heightened	+0.8	0.97
7. Empathy with other people heightened	+1.4	0.81
8. Data from "unconscious" more accessible	+0.8	0.87
9. Enhanced sense of "knowing" when the right solution appears	+1.0	0.70

Results: Psychometric Data

Test-retest scores on some of the measures used showed dramatic changes from normal to psychedelic-session conditions. Most apparent were enhanced abilities to recognize patterns, to minimize and isolate visual distractions, and to maintain visual memory in spite of confusing changes of form and color. Specific tests used included the Purdue Creativity, the Miller Object Visualization, and the Witkin Embedded Figures. This last test has been reported to be stable under a variety of experimental interventions including stress, training, sensory isolation, hypnosis, and the influence of a variety of drugs (Witkin *et al.*, 1962). With these twenty-seven subjects, enhancement was consistent ($p<.01$), and in some cases improvements were as great as 200 percent. (For a fuller description of the psychometric evaluation, see Harman *et al.*, 1966.)

Long-term Results

The practical value of obtained solutions is a check against subjective reports of accomplishment that might be attributable to temporary euphoria. The nature of these solutions varied; they included: (1) a new approach to the design of a vibratory microtome, (2) a commercial building design, accepted by the client, (3) space probe experiments devised to measure solar properties, (4) design of a linear electron accelerator beam-steering device, (5) engineering improvement to a magnetic tape recorder, (6) a chair design, modeled and accepted by the manufacturer, (7) a letterhead design, approved by the customer, (8) a mathematical theorem regarding NOR-gate circuits, (9) completion of a furniture-line design, (10) a new conceptual model of a photon, which was found useful, and (11) design of a private dwelling, approved by the client.

Table 3 outlines the initial results of attempting to apply the solutions generated in the experimental sessions back into the industrial and academic settings of the subjects. (These data were obtained by questionnaire and follow-up interview six to eight weeks after the session.) A quote for a follow-up report written several months after the session is typical of the relative usefulness and validity of the session-day solutions: "In the area of ionospheric source location and layer tilt analysis, I was able in the weeks following the session to build on the ideas generated to the extent of working out the mathematics of the schemes proposed, and of making them more definite. The steps made in the session were the correct ones to start with ... the ideas considered and developed in the session appear as important steps, and the period of the session as the single most productive period of work on this problem I have had in the several months either preceding or following the session."

TABLE 3
OUTCOME OF PROBLEMS ATTEMPTED IN EXPERIMENTAL SESSION
ONE MONTH AFTER SESSION DATE

new avenues for investigation opened	20
working model completed	2
developmental model to test solution authorized	1
solution accepted for construction or production	6
partial solution obtained being developed further or being applied	10
no further activity since session	1
no solution obtained	4
total number of problems attempted*	44

* Many subjects attempted more than one problem during the session.

Many subjects in the follow-up interview reported changes in their modes of functioning that were continuous with the enhancement reported for the session itself (e.g., continuing visualization ability). Table 4 lists the result of a questionnaire dealing with changes in work effectiveness.

TABLE 4
WORK PERFORMANCE SINCE SESSION (n=16)

key	-2	-1	0	+1	+2
1. Ability to solve problems	0	0	8	8	0
2. Ability to relate effectively to others	0	0	8	5	3
3. Attitude toward job	0	0	7	8	1
4. Productivity	0	0	9	5	2
5. Ability to communicate	0	0	10	5	1
6. Response to pressure	0	0	7	8	1

key: -2 marked impairment; -1 significant impairment; 0 no change;
+1 significant enhancement; +2 marked enhancement

The results given in Table 4 indicate that approximately half the subjects reporting were still noticing some change in their performance level several months after the experimental session. These results are particularly interesting in view of the relatively low dosage and the fact that no suggestion was made at any time that continuing changes of this nature were expected. The deliberate anticipation of enhanced performance level, the incitement to a high degree of motivation, and use of a sheltered and non-critical atmosphere-none of these were directly suggestive of long-term personality changes or permanent therapeutic benefit. Yet a certain amount of such change seems to have occurred. One implication is clear: We are dealing with materials and experimental situations that have long-term effects; it would be foolhardy and irresponsible to treat this kind of research as if it were isolated from the fabric of the subjects' lives.

Comments and Speculations

We had originally intended to follow this pilot study with a controlled experiment employing a double-blind design, in which a fraction of the subjects receive an active placebo. This would have addressed the question of whether suggestion alone could account for the performance enhancement. Because of interruption of the research program by government fiat, this extension was never carried out. The need for controlled hypothesis-testing research in this perplexing area of chemical facilitation of mental functioning has become a common plea, and rightly so. But equally needful of furthering is the exploratory sort of research that aims at invention of conceptual models and hypothesis construction. Because of the controversy surrounding use of the psychedelic agents, this latter type of research is even more likely to be slighted.

In the research described, we employed naive subjects. There are clear methodological virtues accruing from the use of untrained subjects. However, when the central question is not one of pharmacological effects, but rather the degree to which certain processes can be facilitated, the more experience the subjects can gain the more we are likely to learn about the process. Thus we would urge the desirability of further investigations employing a series of sessions for each subject.

A similar comment holds with regard to selection of subjects. Clinical studies already referred to indicate that those subjects who are more stable and productive beforehand 4 tend to "benefit considerably from the psychedelic experience along the lines of self-actualization, richer creative experience, and enhancement of special abilities and aptitudes" (Savage *et al.*, 1966). Subjects for this pilot study were deliberately selected to be persons with known reputations as creative individuals. In general, we would expect the outcomes of this kind of research to be more fruitful with gifted rather than "merely normal" subjects.

In contrast with reports of other researchers, we experienced little difficulty in getting subjects to work on psychological tests. Many studies seem to indicate a temporary debilitating effect of psychedelics on higher cortical processes. It seems to us that variables that affect results on these kinds of tests include attitude and motivation as well as ability. We found that discussing this problem with subjects in the preparatory meetings eliminated any tendency in the experimental session to shrug off the tests as meaningless or to resist them as disconcerting. In short, on the tests, as well as in problem solving, by establishing an anticipation of improved performance, we seemed to obtain results that support it.

Assuming that these findings are eventually substantiated by additional research, they find their most obvious application to problem solving in industry, professional practice, and research. Here the procedure could play a role similar to that played by consultants, brainstorming, synectics, and other attempts to augment and "unstick" the problem solver's unsuccessful efforts. A quote from one of our subjects illustrates the possibilities:

"I decided to drop my old line of thinking and give it a new try. The 'mystery' of this easy dismissal and forgetting did not strike me until later in the afternoon, because I had many times before this session indulged in this line of thinking and managed to work up the whole thing into an airtight deadlock, and I had been unable to break, much less dismiss, this deadlock. The miracle is that it came so easy and natural."

A much more important application in the long run, we believe, is the use of the psychedelic agents as training facilitators to gradually upgrade the performance level of already effective personnel. This would require establishment of accepted training procedures and certification provisions for those qualified to use them. This may seem to be a utopian projection from our present state, but we live in an age of rapid change, and it is perhaps not out of the question within a decade.

Among consequences of this line of exploration, the most significant of all, in our estimation, is the gaining of new knowledge of the mysterious higher processes of the human mind, the framing of new and more productive research questions, and the eventual effect on our image of man-of what he can be, and of what he is, of the vast potentialities he has seemingly only begun to tap.

Implications for psychedelic-assisted psychotherapy: a functional magnetic resonance imaging study with psilocybin

by

R. L. Carhart-Harris, R. Leech, T. M. Williams, D. Erritzoe, N. Abbasi, T. Bargiotas, P. Hobden, D.J. Sharp, J. Evans, A. Feilding, R. G. Wise oraz D. J. Nutt

The British Journal of Psychiatry 1-7. doi: 10.1192/bjp.bp.111.103309

original source: http://bjp.rcpsych.org/content/bjprcpsych/early/2012/01/18/bjp.bp.111.103309.full.pdf
backup source: http://www.psilosophy.info/resources/bjp.bp.111.103309.full.pdf

Table of Contents:

Method
 Design
 Participants
 Derivation of autobiographical memory cues
 Scanning procedure and drug administration
 Functional paradigm
 Subjective ratings
 Imaging analysis
Results
 Subjective ratings
 fMRI results
  Activations to memories
  Correlations with subjective ratings
  Effect of psilocybin on activations to memories
  Follow-up ratings of well-being
Discussion
 Relevance to previous studies
 Subjective experiences
 Medial temporal lobe involvement in 'relivings'
 Implications for psychedelic-assisted psychotherapy
 Limitations
 Implications
Funding
Acknowledgements
References

Background

Psilocybin is a classic psychedelic drug that has a history of use in psychotherapy. One of the rationales for its use was that it aids emotional insight by lowering psychological defences.

Aims

To test the hypothesis that psilocybin facilitates access to personal memories and emotions by comparing subjective and neural responses to positive autobiographical memories under psilocybin and placebo.

Method

Ten healthy participants received two functional magnetic resonance imaging scans (2 mg intravenous psilocybin v. intravenous saline), separated by approximately 7 days, during which they viewed two different sets of 15 positive autobiographical memory cues. Participants viewed each cue for 6 s and then closed their eyes for 16 s and imagined re-experiencing the event. Activations during this recollection period were compared with an equivalent period of eyes-closed rest. We split the recollection period into an early phase (first 8 s) and a late phase (last 8 s) for analysis.

Results

Robust activations to the memories were seen in limbic and striatal regions in the early phase and the medial prefrontal cortex in the late phase in both conditions ($P<0.001$, whole brain cluster correction), but there were additional visual and other sensory cortical activations in the late phase under psilocybin that were absent under placebo. Ratings of memory vividness and visual imagery were significantly higher after psilocybin ($P<0.05$) and there was a significant positive correlation between vividness and subjective well-being at follow-up ($P<0.01$).

Conclusions

Evidence that psilocybin enhances autobiographical recollection implies that it may be useful in psychotherapy either as a tool to facilitate the recall of salient memories or to reverse negative cognitive biases.

Declaration of interest

None.

Psilocybin is a classic psychedelic ('mind-manifesting') drug, pharmacologically related to the prototypical psychedelic, lysergic acid diethylamide. Psychedelic drugs were used extensively in psychotherapy in the 1950s to lower psychological defences and facilitate emotional insight.[1] In cognitive terms, the 'lowering of defences' may be thought of as a decrease in top-down emotional control. There are several reports in this literature of spontaneous autobiographical recollections or 'relivings' under psychedelics[2] - similar in some respects to the dream-like sequences seen on stimulation of the medial temporal lobes[3] or to the flashback phenomena seen in post-traumatic stress disorder (PTSD).[4] In a previous psilocybin functional magnetic resonance imaging (fMRI) study by our group,[5] one individual reported a striking reliving under the drug, further motivating us to test this phenomenon in a controlled manner. We also observed large decreases in resting state activity in the medial prefrontal cortex after psilocybin.[5] The medial prefrontal cortex is known to exert top-down inhibitory control over limbic activity,[6] so a psilocybin-induced deactivation of the medial prefrontal cortex - leading to a disinhibition of limbic activity - may explain the occurrence of spontaneous recollections in the psychedelic state.

Thus, the present study sought to test the hypothesis that psychedelic drugs facilitate autobiographical recollection, using psilocybin and a blocked fMRI paradigm involving personal memory cues. Spontaneous relivings under psychedelics are often explicitly linked to past traumata;[2] however, we used only positive memory cues in order to minimise the risk of adverse reactions. We predicted that psilocybin would augment subjective and neural responses to personal memories. Based on previous studies implicating medial temporal and visual association regions in vivid autobiographical recollections,[7-9] we predicted that psilocybin would increase activations in these specific regions.

Method

Design

This was a placebo-controlled cross-over study approved by a local National Health Service research ethics committee and research and development body, and conducted in accordance with good clinical practice guidelines. A Home Office licence was obtained for storage and handling of a schedule 1 drug. The University of Bristol sponsored this research.

Participants

Fifteen healthy individuals were recruited, all via word of mouth. However, only 13 completed the behavioural component of the fMRI study because of presentation software failure for 2 individuals after administration of psilocybin, and three further data-sets were removed because of scanner artefacts, rendering the functional data unusable. Of the ten remaining participants, nine were male, all were physically and mentally healthy, with a mean age of 31 years (s.d.= 7.5), and all had used psilocybin before (average 16.4 uses, s.d.= 27.2), but not within 6 weeks of the study. Participants attended a screening visit during which their mental and physical health was assessed. This included a brief psychiatric interview, routine blood analysis, electrocardiogram, blood pressure and heart rate, and a neurological examination.

Derivation of autobiographical memory cues

After enrolment, participants were given at least 2 weeks to provide 30 or more personal memories for use in the fMRI behavioural paradigm. They were instructed that these should refer to specific life events, and not general periods of time, and that they should be especially positive and emotionally salient. To avoid embarrassment, individuals were advised to encrypt especially personal memories so that they could only be understood by themselves. Cues were abridged to one sentence (e.g. 'Remember being at the altar getting married'). To control for recency effects, participants were asked to estimate the approximate age they were at the time of the event, and to rate the emotionally potency of the memory on a scale of 0-3, with 3 being 'especially potent' (i.e. capable of eliciting a strong emotionally response and/or vivid recollection). The 30 most potent memories were split into 2 groups of 15 memories and balanced for recency and potency. Each group was randomly assigned to either the psilocybin or placebo condition.

Scanning procedure and drug administration

Participants attended two scanning sessions, separated by at least 7 days. Psilocybin (2 mg in saline) was received on one day, and placebo (saline only) on the other, in a balanced order across participants. Solutions (10 ml) were administered during scanning, as 60 s intravenous infusions.

Participants were cannulated and screened for magnetic resonance compatibility. Prior to functional scanning, we obtained an initial three-dimensional SPGR structural scan in an axial orientation, with field of view 256 x 256 x 192 mm and matrix 256 x 256 x 192 mm to yield 1 mm isotropic voxel resolution (repetition time (TR)/echo time (TE) 7.9/3.0 ms; inversion time 450 ms; flip angle 20°). All scanning was performed on 3 T GE HD x MR system.

Blood oxygen level-dependent (BOLD)-weighted fMRI data were acquired using a gradient echo-planar imaging sequence, TR/TE 3000/35 ms, field of view 192 mm, 64 x 64 acquisition matrix, parallel acceleration factor 2, and flip angle 90°. Fifty-three oblique-axial slices were acquired in an interleaved fashion, each 3 mm thick with zero slice gap (3 x 3 x 3 mm voxels). An initial task-free, eyes-closed, resting state scan took place for 12 min in total. The data from these scans will be presented in a separate publication. Sixty-second manual infusions of either psilocybin or placebo began 6 min after the start of the resting-state scan and the behavioural scan began 7.5 min after the start of the infusion. The subjective effects of intravenous psilocybin (2 mg) peak a few minutes after infusion and persist for approximately 25-30 min (online Fig. DS1 and Carhart-Harris *et al.*[10]); thus, the subjective effects of psilocybin were robust throughout the behavioural scan.

The total duration of the behavioural scan was 18.5 min (370 whole brain volumes).

Functional paradigm

Fifteen memory cues were presented in a blocked paradigm, interleaved with rest and an auditory attention task. The attention task was designed to investigate hypotheses unrelated to autobiographical memory and so the results are not included here. For the memory task, participants were instructed to close their eyes and to open them when cued by a loud auditory tone played through stereo headphones. Individuals were instructed to allow their memories to come back to them during a period of eyes-closed recollection, and not to resist any associated thoughts. Visual stimuli were projected onto a screen behind them which was viewed through a mirror attached to the head coil.

Participants performed the autobiographical memory condition with their eyes closed in order to aid recollection; eyes were also closed in the rest blocks to provide an unbiased baseline state, matched for sensory input. In the rest trials, individuals were first presented with an auditory tone and the visual instruction 'relax', which remained on the screen for 6 s followed by 'close your eyes'. Participants closed their eyes for 16 s before hearing an auditory tone which signalled for them to open their eyes. They were then presented with their first memory cue (e.g. 'Remember playing Oliver in the school play'), which was shown for 6 s before the instruction 'close your eyes'. Individuals were given 16 s to recollect the event before hearing an auditory tone signalling for them to open their eyes. They were then presented with the instruction 'count the beeps', which was shown for 6 s, followed by 'close your eyes' and the onset of the attention task. This task consisted of a sequence of auditory tones of different pitch playing in either ear in a random order. Each participant had to decide whether more tones occurred in their left or right ear and gave their response via button press at the end of the 16 s. There was always one more tone in either the left or the right ear. The fixed sequence of rest-memory-attention was repeated 15 times in total. The rationale for the fixed order was to minimise carry-over effects from the memory trials to the rest trials by using the attention paradigm to distract participants from sustained recollection of the memories.

Subjective ratings

Memory ratings were given after the participants exited the scanner. Each memory was rated for vividness ('How vivid was the memory, if 10 is extremely vivid - i.e. as if you are there experiencing it again?'), emotional intensity ('How strong was the emotion you felt, with 10 being extremely intense?'), valence ('How positive was the memory, if 10 is extremely positive, 5 is neither positive or negative, and 0 is extremely negative?') and visual imagery ('How visual was the memory, if 10 is extremely visual, as if you can see it again?'). Ratings were always given on a 0-10 scale. Descriptive statistics were derived and *t*-tests were performed for between-condition comparisons. Participants were followed up 2 weeks after their scans and asked to rate any changes in their subjective well-being or life satisfaction on a scale of +3 (decreased very much) to +3 (increased very much), with 0 as 'no change'.

Imaging analysis

All imaging analysis was carried out using FSL (www.fmrib.ox. ac.uk/fsl). In the first-level analysis, a general linear model with four regressors was fitted to each participant. There was a regressor for the 16 s of eyes-closed attention to beeps and a regressor of no interest for the periods when the task instructions were presented and for when task responses were required. Previous imaging work on autobiographical recollection has found that different neural systems are engaged immediately after the memory cue compared with a few seconds later.[9] Therefore, two regressors were used for the 16 s memory recollection period - one for the first 8 s after the memory cue (early phase) and one for the remaining 8-16 s (late phase). The two primary contrasts of interest were the early memory period *v.* rest, and the late memory period *v.* rest. The regressors were convolved using a double gamma response function, a temporal derivative was added and temporal filtering applied. Data were high-pass filtered with a cut off of 100 s. The functional data were spatially smoothed (6 mm) and registered to each participants' T_1-weighted high-resolution (1 x 1 x 1 mm) structural scan which was itself registered to the Montreal Neurological Institute standard brain (1 x 1 x 1 mm) using non-linear registration.

The results of fitting this model at the first level were combined in a higher-level within-participants analysis to compare brain activation under psilocybin with activation under placebo. A mixed-effects analysis was performed to produce group statistics. Statistical parametric maps were cluster thresholded and a whole-brain cluster significance threshold of $P<0.05$ was used. To determine the mean activation maps for recollection *v.* rest under psilocybin and placebo, group means were derived for each condition. FSL fMRI Expert Analysis Tool (FEAT) query was used to compute BOLD per cent signal change for specific contrasts. Pearson's correlations were used to compare regional BOLD changes with subjective ratings - and specific variables were chosen on a hypothesis-driven basis. Given that recollection and emotion is typically thought to involve medial temporal lobe and limbic structures, anatomical regions of interest were created for bilateral parahippocampal gyrus and the amygdala based on the Harvard-Oxford probabilistic atlas.

Results

Subjective ratings

Memories were rated as more vivid, visual, emotional and positive under psilocybin than placebo (Fig. 1). Individually, only ratings of vivid (*t*-test, $P= 0.049$, two-tailed) and visual (*t*-test, $P = 0.041$, two-tailed) were significantly different, but if the four parameters (which were highly correlated) are grouped, ratings were significantly higher under psilocybin than placebo (*t*-test, $P = 0.0003$, two-tailed).

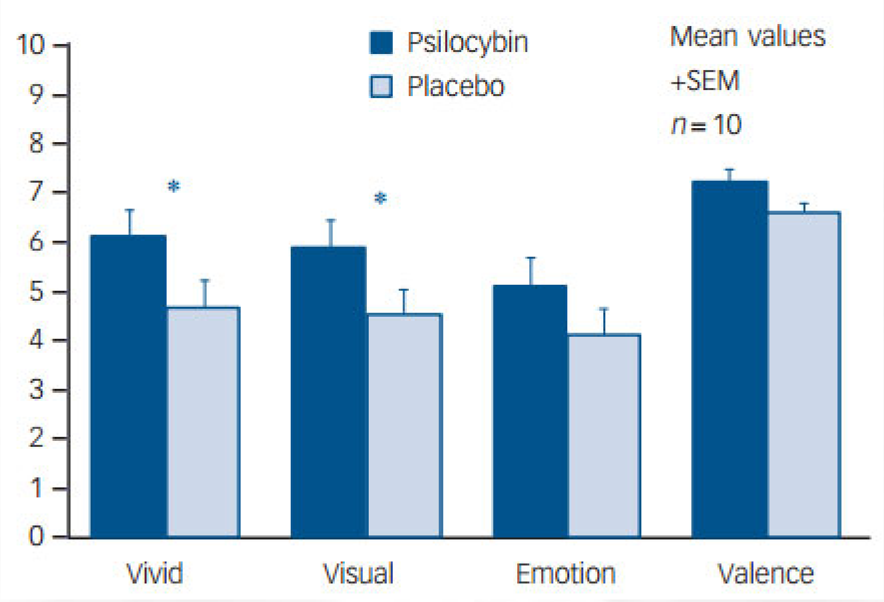


Fig. 1 - Memory ratings after psilocybin and placebo.

Ratings were significantly higher after psilocybin than placebo for the items 'How vivid was the memory?' and 'How visual was the memory?' (two-tailed *t*-test, $*P<0.05$) and when all four were grouped ($P = 0.0003$).

fMRI results

Activations to memories

Robust activations were observed during cued autobiographical recollection v. rest under both placebo and psilocybin, even with a stringent threshold of $Z = 2$ (whole brain cluster corrected, $P<0.001$; Fig. 2). The contrasts were split up into an early phase recollection period versus rest (orange clusters) and a late phase recollection period *v.* rest (dark red clusters); these were the first and last 8 s of the 16 s recollection period. The early activations were generally more subcortical - and were especially significant in limbic/medial temporal lobe (e.g. amygdala and hippocampus) and striatal regions (e.g. the putamen and nucleus accumbens), as well as the mid-cingulate cortex, pre-sensorimotor area and precuneus. Late activations were seen in limbic (e.g. the amygdala) and paralimbic regions (e.g. the subgenual cingulate cortex and pre-sensorimotor area) and the temporal pole, but there were also large activations in the medial prefrontal cortex and frontal pole that were notably absent in the early recollection period.

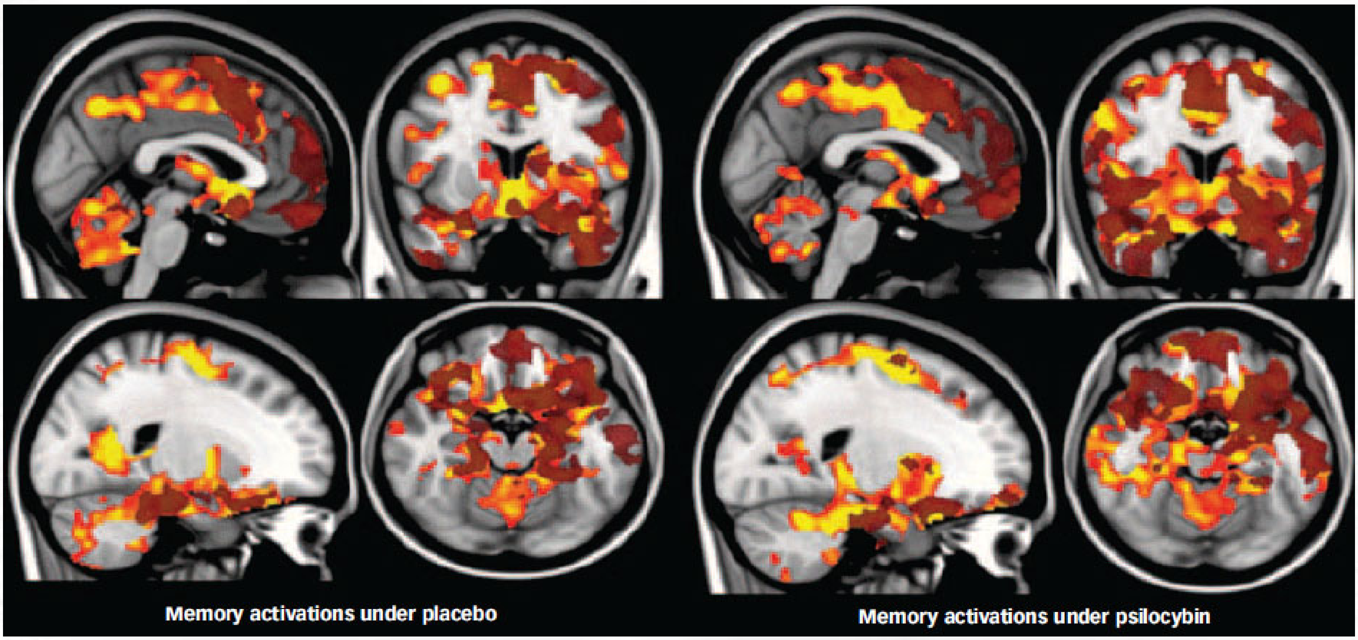

Memory activations under placebo
Memory activations under psilocybin

Fig. 2 - Activations during autobiographical recollection v. rest under placebo and psilocybin.

Early phase activations are shown in orange and late phase activations in translucent dark red. Cluster threshold $Z = 2$, whole brain corrected $P<0.001$. The left hemisphere is shown on the right.

Correlations with subjective ratings

Combining the data from each individuals' two scans, there was a significant positive correlation between 'emotion' scores and late phase bilateral parahippocampal activations (Fig. 3, left; $r = 0.4$, $P = 0.04$, one-tailed). There was also a trend-level positive correlation between 'vividness' scores and late phase anterior bilateral parahippocampal activations ($r = 0.35$, $P= 0.07$, one-tailed).

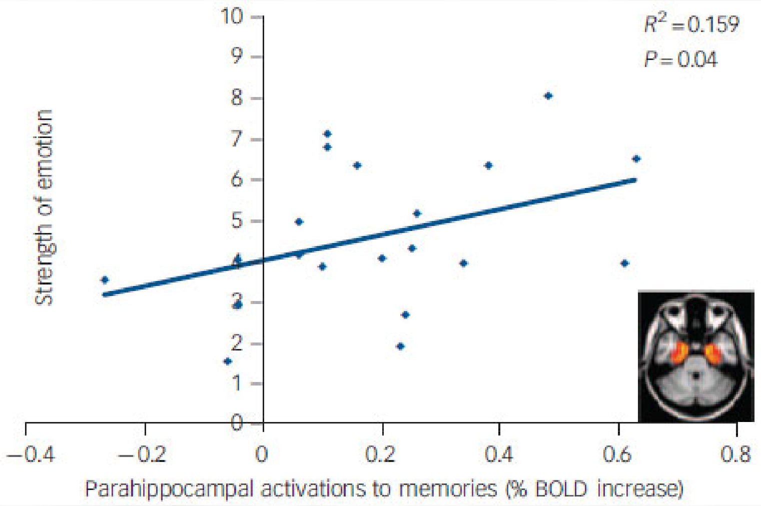


Fig. 3 - Late phase parahippocampal (right) activations correlated positively with how emotional the memories were.

BOLD, blood oxygen level-dependent. Pearson's correlation, $P<0.05$, one-tailed.

Effect of psilocybin on activations to memories

There were no significant differences between early phase activations to memories under psilocybin *v.* placebo. However, there were significantly greater late phase activations under psilocybin than placebo (Fig. 4). These were found in three large clusters, a left occipital pole and visual association region cluster (Fig. 3) and left and right hemisphere clusters that included the mid-insula and primary and secondary auditory cortex, the temporal pole, primary and secondary somatosensory cortex and superior parietal regions (e.g. the superior parietal lobule and supramarginal gyrus). Contrary to prior hypotheses, there were no between-condition differences in medial temporal lobe activations.

Since secondary sensory and high-level attention areas are typically deactivated during periods of introspection,[11] we considered the possibility that the putative activations in these regions under psilocybin were in fact deactivations under placebo. To assess this, we looked at the first-level results for both conditions and calculated the mean percentage BOLD signal change to memories *v.* rest in the three above-mentioned clusters (Fig. 4). One cluster was in the left occipital pole and visual association regions (red in Fig. 4), one was in the left primary and secondary auditory cortex and left somatosensory and superior parietal areas (blue in Fig. 4), and one was in the right primary and secondary auditory cortex and right somatosensory and superior parietal areas (green in Fig. 4). After calculating the mean signal changes in each cluster, large deactivations were evident in the left and right hemisphere clusters under placebo (blue and green, Fig. 4), but true activations under psilocybin were found for all of the clusters - especially the visual one (red, Fig. 4), confirming that visual and other sensory regions are activated by memory cues under psilocybin.

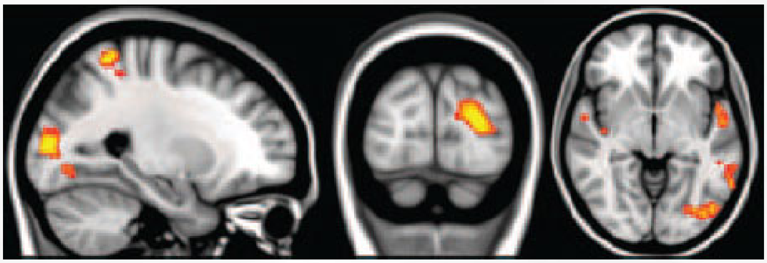


Fig. 4 - Greater late phase activations during autobiographical recollection under psilocybin than placebo.

Cluster threshold $Z = 2$, whole brain corrected $P<0.05$. The left hemisphere is shown on the right.

Follow-up ratings of well-being

When data from the complete sample were analysed ($n = 15$, mean age 30.5 years (s.d.= 7.7), 2 females), reports of well-being 2 weeks after each scan were significantly higher after psilocybin than placebo ($P = 0.03$, two-tailed). To test the hypothesis that participants with the most pronounced subjective responses to positive memories have the largest increases in well-being after psilocybin, we plotted scores of memory vividness against scores of increased well-being post-psilocybin for the 13 participants that completed the memory task in both conditions (Fig. 5). One outlier was removed owing to an explicit non-drug-related event causing him to report an anomalous decrease in well-being post-psilocybin. A significant positive correlation was found between vividness ratings and improved well-being post-psilocybin ($r = 0.72$, $P= 0.004$, one-tailed).

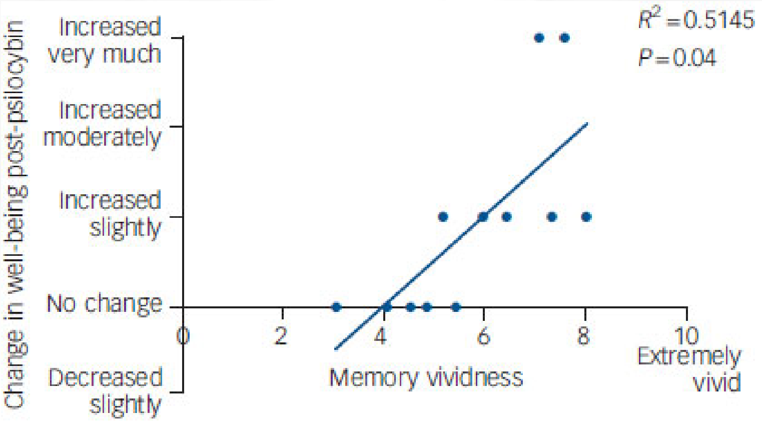


Fig. 5 - Significant positive correlation between ratings of increased well-being post-psilocybin and ratings of memory vividness.

$r = 0.72$, $P = 0.004$, one-tailed.

Discussion

This study sought to test the hypothesis that psychedelics facilitate the neural processes underlying autobiographical recollection using fMRI and the classic psychedelic psilocybin. Robust activations to autobiographical memory cues were found after both placebo and psilocybin, but greater late phase sensory activations and more intense subjective effects were seen after psilocybin. Greater activations were observed in the bilateral auditory cortex, somatosensory cortex, superior parietal cortex, left visual association regions and the occipital pole after psilocybin, and *post-hoc* tests confirmed that visual and other sensory regions were uniquely activated under psilocybin (Fig. 6). This switch in sensory function from a pattern of deactivation under placebo to activation under psilocybin is important and may explain why memories can be felt as especially vivid or 'real' under psychedelics).[2,12,13]

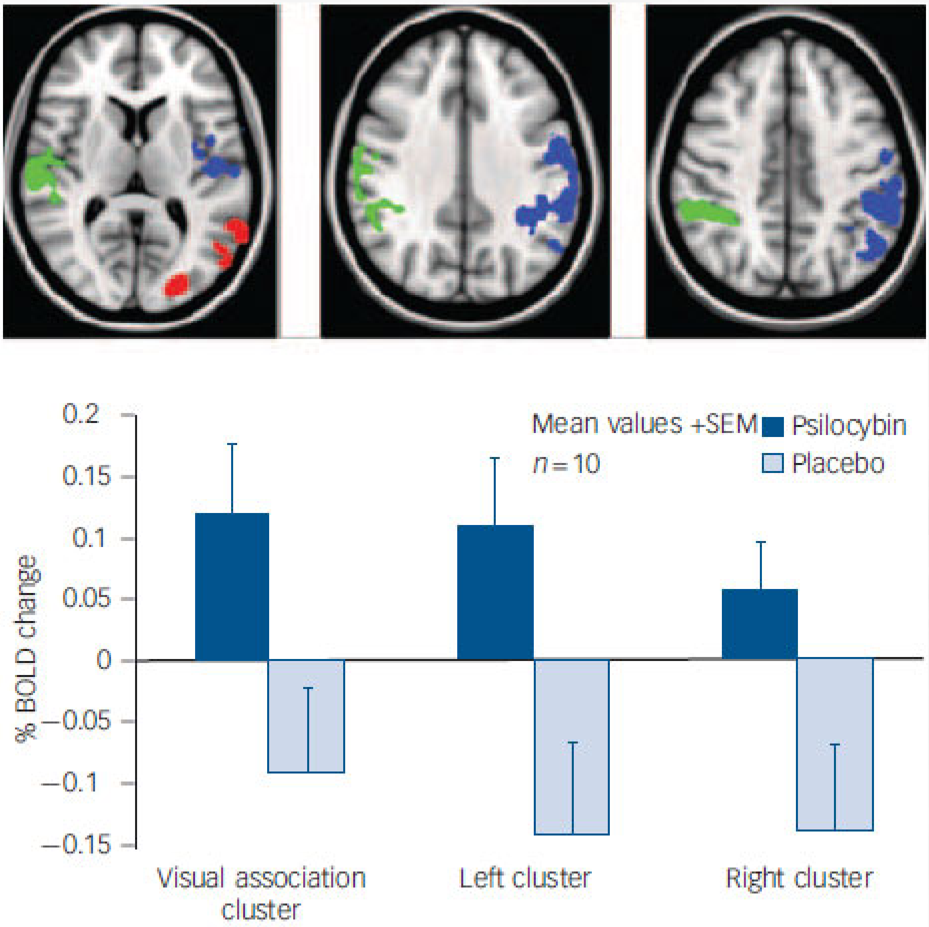


Fig. 6 - Mean per cent blood oxygen level-dependent (BOLD) signal changes to memories v. rest under psilocybin (blue) and placebo (grey).

The left hemisphere is shown on the right.

Relevance to previous studies

Memory activations in both conditions were similar to those found in previous studies. Medial temporal activations are a relatively reliable finding in autobiographical recollection paradigms[6] and have also been shown to correlate with emotional intensity[7] (as shown in Fig. 3). Moreover, early limbic activation followed by a late medial prefrontal component is entirely consistent with previous findings.[9] The early limbic activations are thought to reflect memory retrieval and initial hedonic sensations and the delayed cortical activations are thought to reflect memory elaboration and reliving.[9] Indeed, detailed visual imagery is a hallmark of vivid reliving,[14] and visual cortical activations have been found to correlate positively with ratings of 'reliving' in previous studies.[9] Thus, the greater visual activations in the late recollection phase, when visual imagery becomes more pronounced, plus the reports of more visual and vivid recollections under psilocybin, support the hypothesis that psilocybin augments the neural processes underlying autobiographical recollection.

Subjective experiences

To give a sense of the qualitative difference between the recollective experiences in each condition, one participant commented after his second scan (placebo scan): 'I was focusing on my memories, but there wasn't the same kind of emotional engagement, and I didn't visualise them as realistically as I had done last week [under psilocybin].' When asked whether this meant that he was using his imagination more this time, he said:

> 'I think my imagination had a lot to do with it last time, but it seemed more vivid and real ... I was more attached to the images and putting myself in the scenario than I was today. Today it was like ... I was thinking about it, it was nice, but it was nothing special - nothing new came out of it.'

A number of participants also commented on the brevity of the recollection period and how memories only became more vivid towards the end of the 16 s under psilocybin. For example: 'I think the memories could develop more with more time - you could go deeper with more time'.

Medial temporal lobe involvement in 'relivings'

Despite these positive findings, there were some important negative findings in this study. None of our participants reported anything like the dramatic relivings that are described in the literature on psychedelics.[2,12] We also did not find the hypothesised augmentation of medial temporal lobe responses under psilocybin - despite there being some compelling reasons to expect this: medial temporal lobe activations have been found during flashbacks in patients with PTSD,[15] but the most compelling evidence for a medial temporal lobe involvement in relivings comes from invasive procedures. Wilder Penfield was the first to demonstrate that electrical stimulation of the temporal cortex could produce vivid recollections and reliving,[16,17] and subsequent work has shown that the medial temporal lobes are especially sensitive to this effect.[18] That medial temporal lobe stimulation can generate complex visual imagery is interesting and implies the occurrence of a spreading activation from the site of stimulation to posterior sensory regions. Evidence for this was found in a simultaneous stimulation-depth electroencephalography study, in which stimulation of the anterior medial temporal lobes produced complex visual imagery and a spreading activation to visual association regions in the theta frequency.[19] Thus, our failure to find an exaggerated medial temporal lobe response under psilocybin may explain the absence of relivings, but it would be interesting to explore this issue further with connectivity analyses. For example, using dynamic causal modelling,[20] we might predict an increased medial temporal lobe input to the visual cortex during recollection under psilocybin. We might also predict that connections from the medial prefrontal cortex to medial temporal lobe regions are decreased during recollection under psilocybin. Rostral anterior cingulate cortex blood flow was found to decrease during PTSD flashbacks (and to increase during dissociation),[21] and in a previous psilocybin fMRI study by our group, we found an immediate, marked and sustained drop in medial prefrontal activity after intravenous psilocybin.[5] The medial prefrontal cortex is known to exert a top-down inhibitory control over medial temporal lobe regions;[6] thus, a decrease in medial prefrontal cortex activity may lead to a medial temporal lobe disinhibition.[22]

There are some likely explanations for why we did not observe the predicted relivings in this study. For example, in our efforts to minimise negative drug responses, we used only positive memory cues, but relivings are often linked to painful or conflict-laden memories.[2] An improved design could use conflict-laden memory cues in patients in dynamic psychotherapy, so that any upsetting reactions could be worked through post-session. This would properly test the hypothesis that psychedelics facilitate emotional insight by lowering psychological defences. Also, increasing the duration of the recollection periods would allow a deeper level of introspection. However, despite these limitations, our decision to use only positive memory cues was not without reward; the primary hypothesis that psilocybin augments subjective and neural responses to positive autobiographical memory cues was supported and the experience was well tolerated by all of the participants. Indeed, consistent with previous studies,[23] our sample reported significant improvements in subjective well-being after their psilocybin experience. Moreover, a positive correlation was found between ratings of subjective well-being and memory vividness. The following report from one participant testifies to this:

> 'It being February and having endured the harsh months of a long British winter, I guess I'd been feeling a little blue lately, but right now I feel invigorated, recharged and inspired by the

> experience … What seems to be fuelling my optimism isn't just the drug experience, but the combination of it with refreshing my own memories; it's like I've been reminded of the affirmative aspects of my life.'

Implications for psychedelic-assisted psychotherapy

The primary finding of this study was that psilocybin switched autobiographical memory activations in visual and other sensory regions from a pattern of deactivation to activation (Fig. 6). Participants also reported more vivid and visual recollections under psilocybin - which is consistent with the increased sensory activations. These effects may have implications for the use of psilocybin in psychotherapy. For example, psilocybin could be combined with positive memory cues as a treatment for depression - facilitating the recall of positive life events so to reverse pessimistic mind-sets. Support for such an idea comes from findings of decreased depression scores in patients with anxiety 6 months after a single psilocybin treatment[24] and improvements in well-being and trait openness persisting in healthy volunteers up to 2 years after a single high dose of psilocybin.[23,25] Further supporting the case for psilocybin as a treatment option for depression, we recently observed marked decreases in medial prefrontal cortex activity after psilocybin.[5] Hyperactivity in the medial prefrontal cortex in depression and its normalisation after effective treatment is a highly reliable finding.[26]

Limitations

The sample size in this study ($n = 10$) was small and may have encouraged false negatives. For example, we failed to find significant correlations between between-condition differences in brain activations and subjective ratings, which may have emerged in a larger sample. Another limitation was the self-selecting nature of the sample, which may have biased outcomes. Participants were required to have used psychedelics before, and many held prior assumptions about the positive value of these drugs. This may have contributed to the positive memory ratings, the reports of improved well-being post-administration, and the positive relationship between them (Fig. 6). Importantly, however, such biases cannot easily explain the increased brain activations to memories after psilocybin.

Implications

This study found increased subjective and neural responses to autobiographical memory cues under psilocybin. Greater activations were evident in visual and other sensory regions, which may explain why recollections were rated as more vivid and visual under psilocybin. Psychedelic drugs have a history of use in psychotherapy, linked to the hypothesis that they lower defences to facilitate access to salient emotions and memories. The results of this study provide initial support for this idea and a potential neurobiological mechanism is proposed: decreased medial prefrontal cortex activity leading to disinhibited limbic and sensory activity. We propose that psilocybin may be used in combination with cognitive strategies designed to reverse cognitive biases in depression - and we also suggest that it may be used in more classic dynamic therapy to assist the exploration and understanding of salient emotional themes.

Funding

This study received financial and intellectual support from the Beckley Foundation and financial support from the Neuropsychoanalysis Foundation, Multidisplinary Association for Psychedelic Studies (MAPS) and Heffter Research Institute.

Acknowledgements

We thank Eleanor Maguire, Karl Friston, Alison Diaper, Ann Rich, Sue Wilson, Andrea Malizia and David Jessop.

R. L. Carhart-Harris, PhD, Imperial College London, Neuropsychopharmacology Unit, and University of Bristol, Academic Unit of Psychiatry; **R. Leech**, PhD, Imperial College London; **T. M. Williams**, MD, University of Bristol, Academic Unit of Psychiatry; **D. Erritzoe**, MD, Imperial College London, Neuropsychopharmacology Unit; **N. Abbasi**, MD, University of Bristol, Academic Unit of Psychiatry; **T. Bargiotas**, MD, Oxford Health NHS Foundation Trust, Warneford Hospital, Oxford; **P. Hobden**, PhD, Cardiff University Brain Research Imaging Centre (CUBRIC), School of Psychology, Cardiff University; **D. J. Sharp**, MD, Imperial College London; **J. Evans**, PhD, Cardiff University Brain Research Imaging Centre (CUBRIC), School of Psychology, Cardiff University; **A. Feilding**, The Beckley Foundation, Beckley Park, Oxford; **R. G. Wise**, PhD, Cardiff University Brain Research Imaging Centre (CUBRIC), School of Psychology, Cardiff University; **D. J. Nutt**, MD, Imperial College London, Neuropsychopharmacology Unit, and University of Bristol, Academic Unit of Psychiatry, UK

Correspondence: R. L. Carhart-Harris, Imperial College London, Neuropsychopharmacology Unit, 5th Floor, Burlington Danes Building, 160 Du Cane Road, London W12 0NN, UK. Email: r.carhart-harris@imperial.ac.uk

First received 19 Sep 2011, final revision 21 Nov 2011, accepted 30 Nov 2011

References

1. Cohen S. *The Beyond Within - The LSD Story*. Atheneum, 1964.
2. Sandison RA. *A Century of Psychiatry, Psychotherapy and Group Analysis: A Search for Integration*. Jessica Kingsley, 2001.
3. Halgren E, Walter RD, Cherlow DG, Crandall PH. Mental phenomena evoked by electrical stimulation of the human hippocampus formation and amygdala. *Brain* 1978; 101: 83-117.
4. Hagenaars MA, van Minnen A, Hoogduin KA. Reliving and disorganization in post-traumatic stress disorder and panic disorder memories. *J Nerv Ment Dis* 2009; 197: 627-30.
5. Carhart-Harris RL, Erritzoe D, Williams T, Stone JM, Read LJ, Colasanti A, et al. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 2012, in press (doi: 10.1073/pnas.1119598109).
6. Milad MR, Quirk GJ. Neurons in medial prefrontal cortex signal memory for fear extinction. *Nature* 2002; 420: 70-4.
7. Greenberg DL, Rice HJ, Cooper JJ, Cabeza R, Rubin DC, LaBar KS. Co-activation of the amygdala, hippocampus and inferior frontal gyrus during autobiographical memory retrieval. *Neuropsychologia* 2005; 43: 659-74.
8. Addis DR, Moscovitch M, Crawley AP, McAndrews MP. Recollective qualities modulate hippocampal activation during autobiographical memory retrieval. *Hippocampus* 2004; 14: 752-62.
9. Daselaar SM, Rice HJ, Greenberg DL, Cabeza R, LaBar KS, Rubin DC. The spatiotemporal dynamics of autobiographical memory: neural correlates of recall, emotional intensity, and reliving. *Cereb Cortex* 2008; 18: 217-29.
10. Carhart-Harris RL, Williams TM, Sessa B, Tyacke RJ, Rich AS, Feilding A, et al. The administration of psilocybin to healthy, hallucinogen-experienced volunteers in a mock-functional magnetic resonance imaging environment: a preliminary investigation of tolerability. *J Psychopharmacol* 2011; 25: 1562-7.
11. Raichle ME, MacLeod AM, Snyder AZ, Powers WJ, Gusnard DA, Shulman GL. A default mode of brain function. *Proc Natl Acad Sci USA* 2001; 98: 676-82.
12. Grof S. *Realms of the Human Unconscious*. Souvenir Press, 1975.
13. de Araujo DB, Ribeiro S, Cecchi GA, Carvalho FM, Sanchez TA, Pinto JP, et al. Seeing with the eyes shut: neural basis of enhanced imagery following ayahuasca ingestion. *Hum Brain Mapp* 2011; Sep 16. Epub ahead of print (doi: 10.1002/hbm.21381).
14. Rubin DC, Schrauf RW, Greenberg DL. Belief and recollection of autobiographical memories. *Mem Cognit* 2003; 31: 887-901.
15. Vermetten E, Schmahl C, Southwick SM, Bremner JD. Positron tomographic emission study of olfactory induced emotional recall in veterans with and without combat-related post-traumatic stress disorder. *Psychopharmacol Bull* 2007; 40: 8-30.
16. Penfield W, Perot P. The brain's record of auditory and visual experience. A final summary and discussion. *Brain* 1963; 86: 595-696.
17. Penfield W, Jasper S. *Epilepsy and the Functional Anatomy of the Human Brain*. Brown and Co., 1954.
18. Bancaud J, Brunet-Bourgin F, Chauvel P, Halgren E. Anatomical origin of déjàvu and vivid "memories" in human temporal lobe epilepsy. *Brain* 1994; 117: 71-90.
19. Barbeau E, Wendling F, Régis J, Duncan R, Poncet M, Chauvel P, et al. Recollection of vivid memories after perirhinal region stimulations: synchronization in the theta range of spatially distributed brain areas. *Neuropsychologia* 2005; 43: 1329-37.
20. Friston KJ, Harrison L, Penny W. Dynamic causal modelling. *NeuroImage* 2003; 19: 1273-302.

21. Hopper JW, Frewen PA, van der Kolk BA, Lanius RA. Neural correlates of reexperiencing, avoidance, and dissociation in PTSD: symptom dimensions and emotion dysregulation in responses to script-driven trauma imagery. *J Trauma Stress* 2007; 20: 713-25.
22. Carhart-Harris RL, Friston KJ. The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. *Brain* 2010; 133: 1265-83.
23. Griffiths R, Richards W, Johnson M, McCann U, Jesse R. Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 2008; 22: 621-32.
24. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstadt AL, et al. Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 2011; 68: 71-8.
25. MacLean KA, Johnson MW, Griffiths RR. Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. J Psychopharmacol 2011; 25: 1143-61.
26. Hamani C, Mayberg H, Stone S, Laxton A, Haber S, Lozano AM. The subcallosal cingulate gyrus in the context of major depression. *Biol Psychiatry* 2011; 69: 301-8.

Mescaline, LSD, Psilocybin and Personality Change

by

Sanford M. Unger, Ph.D

from: *Psychiatry: Journal for the Study of Interpersonal Processes*
Vol. 26, No. 2, May, 1963

© The William Alanson White Psychiatric Foundation

original source: http://www.druglibrary.org/schaffer/lsd/unger.htm

Table of Contents:

The Equivalent Action of Mescaline, LSD-25, and Psilocybin
Invariant Drug Reactions
The "Psychotomimetic" Label
Variable Drug Reactions and Extradrug Variables
Rapid Personality Change
Examples Not Associated with Drugs
Drug-Associated Personality Change: A "New Concept" in Psychotherapy
Explanatory Concepts
References
Acknowledgments

> ... our normal waking consciousness ... is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens, there lie potential forms of consciousness entirely different.... No account of the universe in its totality can be final which leaves these ... disregarded. How to regard them is the question-for they are so discontinuous with ordinary consciousness.
> William James.[1]

In recent years, how to regard the "forms of consciousness entirely different" induced by mescaline, LSD-25, and psilocybin has posed a seemingly perplexing issue. For articulate self-experimenters from Mitchell to Huxley, mescaline has provided many-splendored visual experiences, or a life-enlarging sojourn in "the Antipodes of the mind"[2]. For Stockings, it may be recalled, mescaline produced controlled schizophrenia[3] - a thesis which earned the Bronze Medal of the Royal Medico-Psychological Association and apparently inaugurated, in conjunction with the advent of LSD-25, a period of concerted chemical activity in the exploration and experimental induction of "model psychoses"[4]. In counterpoint, this same so-called "psychotomimetic" LSD has increasingly found use as a purposeful intervention or "adjuvant" in psychotherapy[5]. The recently arrived "magic mushroom," psilocybin, has been similarly equivocal - "psychotogenic" for some, "mysticomimetic" for others[6]. The present paper will review the literature on drug experience - paying particular attention to the effects of *extradrug* variables, for the realization of the extent of their potential influence has only recently crystallized, and promises to reduce some of the abundant disorder in this area.

The phenomenon of drug-associated rapid personality or behavior change will be discussed in some detail. For example, a number of different alcoholic treatment facilities, especially in Canada, have reported, for many of their patients, complete abstinence after a single LSD session[7]. More generally, neurotic ailments over the full range have been described as practically evaporating[8]. Given this picture, and the present state and practice of the therapeutic art, it is not surprising to find at least one psychiatrist envisioning "... mass therapy: institutions in which every patient with a neurosis could get LSD treatment and work out his problems largely by himself"[9]. James would have been much attracted by the "spectacular and almost unbelievable results"[10] reported on the modern drug scene; and, in fact, their resemblance to the "instantaneous transformations" attendant on "mystical" religious conversions - which he discussed so eloquently - may well be more than superficial and seems worthy of attention.

The Equivalent Action of Mescaline, LSD-25, and Psilocybin

Since the evidence and testimony accumulated over the years on the separate drugs will be treated interchangeably, this raises a preliminary point of some importance. Although the conclusion was delayed by both dissimilarities in their chemical structure and differing modes of introduction to the scientific community, it is now rather commonly adjudged that the subjective effects of mescaline, LSD-25, and psilocybin are similar, equivalent, or indistinguishable. Both Isbell and Abramson have administered LSD and psilocybin in the same study; Wolbach and his co-workers have administered all three. All have found that their subjects were unable to distinguish between the drugs[11].

The reported equivalence in subjective reactions seems quite consistent - or at least not inconsistent - with present pharmacodynamic knowledge. Studies of radioactively tagged mescaline and LSD indicate that the compounds largely disappear from the brain in relatively short order - in fact, at about the same time that the first "mental phenomena" make their appearance[12]. Hence, it has been tentatively suggested that the characteristic effects, which persist for a relatively long period, are to be attributed not to the action of the drug itself but to some as yet unidentified aspect of the chain of events *triggered* by drug administration. Isbell, observing the "remarkably similar" reactions to LSD and psilocybin, hypothesized "some common biochemical or physiological mechanism" to be responsible for the effects - that is, that the various compounds share a final common path[13]. The most direct support for this inference of biological identity in ultimate mechanism of action has come from cross-tolerance studies wherein subjects rendered tolerant to one drug - that is, nonreactive after repeated administrations - have then been challenged by a different drug. Present indications are that cross-tolerance among the drugs does in fact develop[14].

This is not intended to suggest that a drug experience is invariable among subjects - quite the contrary has been the case. In fact, experiences even for the same subject differ from one session to the next[15]. But when relevant extradrug variables are controlled, the within-drug variance is apparently coextensive with between-drug variance, and is attributable to ubiquitous personality differences; in other words, while a range of reactions is reported to *all* of the drugs, there is no reaction distinctively associated with any particular drug. Extradrug variables, which have been uncontrolled and largely unrecognized until recently, are apparently responsible for much of the variance erroneously attributed to specific drug action.

Invariant Drug Reactions

By common consent, the drug experience is paranormal - that is, beyond or outside the range of the normal, the everyday. Exclamations of "indescribable" recurrently appear in the literature. However, whenever descriptions are essayed, there is relative unanimity about certain features. These, it may be said, are attributable to the drug administration, per se, independent of the personality of the subject, the setting, or the experimenter's or subject's expectations. A sampling from the literature of subjective reports and testimony may communicate, or at least transmit the flavor of, these invariant reactions.

First, and perhaps most easily conveyed, is the characteristic of the drug experience called by Ellis a "saturnalia" or "orgy" of vision[16]. Subsequent authors have been only slightly more restrained:

> The predominance of visual experiences in the picture is striking - not only on account of the persistent hallucinations and illusions, but by the impressiveness of seen real objects, their shape and color....[17]
>
> There is a great intensification of light; this intensification is experienced both when the eyes are closed and when they are open.... With this intensification of light there goes a tremendous intensification of color, and this holds good of the outer world as well as of the inner world[18].
>
> When I closed my eyes ... I experienced fantastic images of an extraordinary plasticity. These were associated with an intense kaleidoscopic play of colors[19].

> Changes in the perception of visual form occur in virtually everyone.... Consistently reported [are] the plasticity which the forms of the visual world assume ... the emphasis upon play of light and color, as though light were alive[20].

A second invariant set of drug reactions, more difficult to characterize or communicate, has been called, variously, depersonalization, dissociation, levitation, derealization, abnormal detachment, body image distortion or alteration, and the like:

> There is an awareness of an abnormal distance between the self and what happens in its consciousness; on the other hand, the experience of an abnormal fusion of subject and object[21].

> My ideas of space were strange beyond description. I could see myself from head to foot as well as the sofa on which I was lying. About me was nothingness, absolutely empty space. I was floating on a solitary island in the ether. No part of my body was subject to the laws of gravitation[22].

> What happens in the LSD experience? ... the universe is overtly structured in terms of an identification between the perceiver and the thing perceived. You hear the music way off down in a cavern, and suddenly it is you who is way down in the cavern. Are you now the music, or is the music now at the mouth of the cavern? Did you change places with it? And so on?[23]

> Some degree of depersonalization probably occurs during every LSD experience ... the detachment of the conscious self, a sort of detached ego. This self is in touch with reality and is in touch with the self experiencing the psychic phenomena[24].

Regardless of whatever else a drug experience may be reported to include, alterations in visual experience and in experience of self, as detailed above, may be predicted with considerable confidence[25].

In connection with the so-called dissociation phenomenon - and in view of the connotations of the "psychotomimetic" and "intoxicant" labels - it may be well to emphasize that drug experiences, at least for most nonpsychotic subjects, do not seem to approximate delirium:

> The mescal drinker remains calm and collected amid the sensory turmoil around him; his judgment is as clear as in the normal state....[26]

> It is difficult to classify the state of consciousness during the intoxication which allows such self-observation and, at times, seems to foster detachment and self-scrutiny[27].

> ... in a state of clear consciousness [the subject] ... is able to describe in detail the manifold mental changes daring drug intoxication[28].

The nondelirious condition of normal volunteers, at least with low to moderate drug dosage, has been objectively attested by their ability to perform psychological tests. The most exhaustive series of investigations along this line has been carried out for LSD by Abramson and his associates[29]. Generally, although not consistently, subjects show slight decrements in performance - at least some of which may well be attributable to an altered state of attention-motivation-affect. However, the test setting itself seems to contaminate the drug experience; Savage, among others, has noted "a less profound effect when subjects are kept busy doing psychological tests...."[30]

Another and final set of seemingly invariant reactions concerns the retrospective impressiveness of the drug experience. The succession of testimonials to this effect is a striking and salient feature of the history of research with these compounds:

> In some individuals, the "ivresse divine" is rather an "ivresse diabolique." But in either case ... one looks "beyond the horizon" of the normal world and this "beyond" is often so impressive or even shocking that its after-effects linger for years in one's memory[31].

> The experience of the intoxication, as Beringer also observed, makes a particularly deep

> impression.... The personality is touched to its core and is led into provinces of psychic life otherwise unexplored; light is shed on boundaries otherwise dark and unrevealed and in this some aid may be given to Existenzerhellung (illumination of existence)[32].
>
> ... most subjects find the experience valuable, some find it frightening, and many say that it is uniquely lovely.... For myself, my experiences with these substances have been the most strange, most awesome, and among the most beautiful things in a varied and fortunate life[33].
>
> To be shaken out of the ruts of ordinary perception ... this is an experience of inestimable value to everyone and especially to the intellectual ... the man who comes back through the Door in the Wall will never be quite the same as the man who went out[34].
>
> ... the whole experience is (and is as) a profound piece of knowledge. It is an indelible experience; it is forever known. I have known myself in a way I doubt would have ever occurred except as it did[35].

The "Psychotomimetic" Label

After the above renditions, a querulous reader may be concerned about the appellation "psychotomimetic drugs." So are many contemporary researchers and therapists, too numerous to mention. Holliday has provided a trenchant analysis of "how the semantics in the field of psychopharmacology became so confused and generally misleading"[36]; here, only a few points will be noted.

Early mescaline investigators clearly tempered their comparisons between the mescal-induced state and the hallucinations and dissociations of endogenous psychosis. As far back as 1930, it was found that when chronic schizophrenics suffering from persistent hallucinations were given mescal, they distinguished the mescal phenomena, remarked on their appearance, and usually blamed them on the same persecutors who had molested them before[37]. Kluver, though he foresaw and extensively discussed the "model" values of mescal, persisted in calling it "the divine plant"[38]. It was apparently difficult to consider a sacramental substance - "the comfort, healer, and guide of us poor Indians ... the great teacher"[39] - as unequivocally psychotomimetic.

With LSD, a laboratory-born drug having no history to contend with, the situation changed. The adventurous Hofmann, on that fateful day in 1943, started his self-experiment with 250 micrograms of LSD, thinking, as he put it, that such a small amount would probably be harmless. His response to this quite large dose - in terms of present-day experimental standards - was as follows:

> I noted with dismay that my environment was undergoing progressive change. Everything seemed strange and I had the greatest difficulty in expressing myself. My visual fields wavered and everything appeared deformed as in a faulty mirror. I was overcome by a fear that I was going crazy, the worst part of it being that I was clearly aware of my condition. The mind and power of observation were apparently unimpaired[40].

Hofmann went on to list, as his most marked symptoms, visual disturbances, motor restlessness alternating with paralysis, and a suffocating sensation, and added: "Occasionally I felt as if I were outside my body. My 'ego' seemed suspended in space. ..."[41]

Stoll, who in 1947 reported experimental confirmation of Hofmann's experience, is widely reputed to have warned informally of a case of suicide as the aftermath of an experimental trial. The most common accounts thereafter had a psychotic female subject committing suicide two weeks after the administration; or, in another version, a subject committing suicide after the drug had been administered without her knowledge. At any rate, this story, though itself never appearing in print, is referred to in one form or another in nearly all of the early work with LSD; it apparently influenced experimenter attitudes for a number of years.

For many and varied reasons, too involved to trace here, the initial formulation of the "model psychosis" properties of LSD engendered enormous investigative enthusiasm. In this climate, latent reservations on the score of psychotomimesis tended to go unvoiced. In the more recent, postenthusiasm era, however, reservations have been more or less vigorously expressed - for example:

> There are considerable differences between LSD-induced and schizophrenic symptoms. The characteristic autism and dissociation of schizophrenia are absent with LSD. Perceptual disturbances due to LSD differ from those due to schizophrenia and, as a rule, are not true hallucinations. Finally, disturbances of consciousness following LSD do not resemble those occurring in schizophrenia[42].

Many alternatives to the "psychotomimetic" characterization of "hallucinogenic" agents have recently been proposed. In 1957, Osmond offered, among others, "psychelytic" (mind-releasing) and "psychedelic" (mind-manifesting)[43]. Other investigators have proposed consciousness-expanding, transcendental, emotionalgenic, mysticomimetic, and so forth. It becomes ever more apparent, though, that old labels never die[44].

Variable Drug Reactions and Extradrug Variables

It may probably be stated as a pharmacopoeias commonplace that the effects of a drug administration of any kind are likely to be compounded by factors other than specific pharmacologic action. Often this is attributed to "personality," to individual differences[45]. However, though there have been as yet very few controlled investigations in the case of the drugs considered here, it has become abundantly clear from the *systematic* variability reported in subject and patient reactions - in both the affective and ideational dimensions of drug experience - that factors other than "personality" are also at issue.

Affective reactions attendant on a drug administration have varied, according to reports, all the way from hyperphoric ecstasy to unutterable terror - though not with all investigators. The opinion leader Hoch, through a decade of observations, consistently maintained:

> LSD and mescaline disorganize the psychic integration of the individual....[46]

> ... mescaline and LSD are essentially anxiety-producing drugs... .[47]

The following interchange was recorded at the 1959 conference on the use of LSD in psychotherapy held under the auspices of the Josiah Macy, Jr. Foundation:

> *Hoch*: Actually, in my experience, no patient asks for it [LSD] again.
> *Katzenelbogen*: I can say the same.
> *Denber*: I have used mescaline in the office ... and the experience was such that patients said, "Once is enough." The same thing happened in the hospital. I asked the patients there if, voluntarily, they would like to take this again. Over 200 times the answer has been "No"[48].

Subsequently, Malitz also stated:

> None of our normal volunteers wanted to take it [LSD] again[49].

In contrast, DeShon and his co-workers reported the results of the first LSD study done with normal subjects in this country as follows:

> ... anxiety was infrequent, transient, and never marked.... All subjects were willing to repeat the test[50].

The experience of other investigators has been similar:

> During the past four years we have administered the drug [LSD] hundreds of times to nonpsychotics in doses up to 225 micrograms... . Those who have participated in these groups are nearly always definitely benefited by their experiences. Almost invariably they wish to return and to participate in new experiments[51].

> ... few patients discontinue treatment, in fact, enthusiasm and eagerness to continue are among the features of LSD patients[52].

The rapidly expanding use of LSD in psychotherapeutic contexts has provided highly revealing clues to the patterning of extradrug variability. Busch and Johnson were the first to report administering LSD to neurotic patients whose therapy had "stalled" and whose prognosis was "dim." The result was "a reliving of repressed traumatic episodes of childhood," with "profound" influence on the course of therapy[53]. Sandison and his colleagues also found that LSD "produces an upsurge of unconscious material into consciousness"[54], and that "repressed memories are relived with remarkable clarity"[55] - with therapeutically beneficial consequences.

Since these early reports, whenever psychoanalytically oriented therapists have employed LSD, practically without exception the patient relives childhood memories. The interesting point is that this phenomenon has practically *never* been noted in the experimental literature!

Jungian therapists, on the other hand, have repeatedly found that their patients have "transcendental" experiences - a state beyond conflict - often with rapid and dramatic therapeutic results. As a matter of fact, in an amusing and somewhat bemused account, Hartman has described his LSD-using group comprised of two Freudians and two Jungians, in which the patients of the former report childhood memories, while those of the latter have "transcendental" experiences. In addition, for Jungian patients, the transcendental state is associated with "spectacular" therapeutic results, while for Freudians, should such a state "accidentally" occur, no such spectacular consequence is observed[56].

While not from a therapeutic setting, the reports which have emanated from Harvard are noteworthy on the score of ideational content. Under psilocybin, Harvard subjects do not relive their childhood experiences, but grapple with age-old paradoxes:

> ... the problem of the one and the many, unity and variety, determinism and freedom; mechanism and vitalism; good and evil; time and eternity; the plenum and the void; moral absolutism and moral relativism; monotheism and polytheism and atheism. These are the basic problems of human existence.... We need not wonder that the Indians called the mushroom sacred and gave it a name which means "the flesh of the god"[57].

Without multiplying or belaboring divergences further, it should be apparent that affective reactions and ideational content may be *systematically* variable dimensions of drug experience; in addition, the possible therapeutic uses or consequences, however these are conceived, seem clearly variable. Once these "facts" are arrayed, in Baconian fashion, they nearly speak for themselves. At the Josiah Macy conference, the emerging consensus was perhaps best expressed by Savage:

> This meeting is most valuable because it allows us to see all at once results ranging from the nihilistic conclusions of some to the evangelical ones of others. Because the results are so much influenced by the personality, aims, and expectations of the therapist, and by the setting, only such a meeting as this could provide us with such a variety of personalities and settings. It seems clear, first of all, that where there is no therapeutic intent, there is no therapeutic result... . I think we can also say that where the atmosphere is fear-ridden and skeptical, the results are generally not good.... This is all of tremendous significance, for few drugs are so dependent on the milieu and require such careful attention to it as LSD does[58].

The same conclusion has come from experimental quarters as well - for example:

> [The effect] of hallucinogens is not limited to any single agent since, in addition to psilocybin, we have seen it with LSD-25 and mescaline. The environmental setting in which the drug is administered ... affects the emerging behavior pattern. This factor may account for variations in results with different investigators. Our hospital setting, with the subject, a paid volunteer, receiving an unknown agent, in an experimental framework surrounded by unfamiliar doctors and nurses, differs markedly from the mystical setting which Wasson observed.... Only one of our subjects reported what might be described as a transcendental experience.... The differences in expectation and setting between these two grossly divergent groups may account in part for the disparity in their responses[59].

More specifically, anxiety in the therapist or experimenter about administering the drug, about "inducing psychosis," seems likely to render the experience anxiety-ridden for the subject. Abramson has flatly declared:

"The response of the subject ... will depend markedly upon the attitude of the therapist.... In particular, if the therapist is not anxious about the use of the drug, anxiety in the patient will be much decreased"[60]. Hyde has reported that "impersonal, hostile, and investigative attitudes" arouse hostile and paranoid responses[61]. Sandison has observed that the occurrence of anxiety seems largely to depend on "what the patient is told beforehand [as well as] rumors and myths current among patients and staff, or even in the press, about hallucinogenic drugs"[62]. Huxley had intimated this before it became clarified in the psychiatric literature:

> ... the reasonably healthy person knows in advance that, so far as he is concerned, mescaline is completely innocuous. ... Fortified by this knowledge, he embarks upon the experience without fear - it: other words, without any disposition to convert an unprecedented strange and other than human experience into something appalling, something actually diabolical[63].

That the positive or negative character of the experience can be systematically directed, overriding even personality factors, seems now to have been fairly conclusively demonstrated. With "adequate" preparation - that is, with the specific intent of rendering drug experiences "positive" - approximately 90 percent of the subjects or patients, in each of the two most recent studies, reported at least a "pleasant" or "rewarding" session, and nearly as many called it "an experience of great beauty" or something equally superlative[64].

In content, as in affect, subjects apparently respond to the implicit or explicit suggestion or expectation of the therapist or experimenter. The Harvard subjects were prepared for their metaphysical binges, it may be noted, with such assigned readings as the "Idols of the Cave" parable in Plato's *Republic* and passages from *The Tibetan Book of the Dead*. The preparation of psychotherapy patients hardly needs specification.

Finally, what may be said about therapeutic implications? - given the fact that the compounds under discussion may induce a powerful paranormal experience whose affective and ideational content can be guided. Only perhaps that the extent to which the experience can serve as a useful adjunct to traditional interview therapies, or vice versa, or even as a "compleat therapie" would seem to depend on the particular practitioner of the art - his conceptions of therapeutic gains and consequences, his philosophy and enthusiasm, and his orientation toward "placebo" or "faith" cures[65]. Schmiege has summarized the current state of affairs as follows:

> Those using LSD in multiple doses as an adjunct to psychotherapy feel that it is so useful because of its ability to do the following: (1) It helps the patient to remember and abreact both recent and childhood traumatic experiences. (2) It increases the transference reaction while enabling the patient to discuss it more easily. (3) It activates the patient's unconscious so as to bring forth fantasies and emotional phenomena which may be handled by the therapist as dreams. (4) It intensifies the patient's affectivity so that excessive intellectualization is less likely to occur. (5) It allows the patient to better see his customary defenses and sometimes allows him to alter them. Because of these effects, therapists feel that psychotherapy progresses at a faster rate. Of course this poses the age old problem of what is the essence of psychotherapy.

There are many reports of patients receiving meaningful insight about themselves in an LSD experience without the intervention, participation or even presence of a therapist.... Those who administer lysergic acid in a single dose have as their goal, in the words of Sherwood, *et al.*, an overwhelming reaction "in which an individual comes to experience himself in a totally new way and finds that the age old question 'Who am I?' does have a significant answer." Frequently, this is accompanied by a transcendental feeling of being united with the world.... Some spectacular, and almost unbelievable, results have been achieved by using one dose of the drug[66].

Rapid Personality Change

An increasing number of subjects, patients, experimenters, and psychiatrists - spontaneously or with priming - have declared their drug experiences to be transcendental, mystical, cosmic, visionary, revelatory, and the like. There seems to be difficulty in finding the right name for the experience, even among the professional so-called "mystics":

> There is no really satisfactory name for this type of experience. To call it mystical is to confuse it

> with visions of another world, or of god and angels. To call it spiritual or metaphysical is to suggest that it is not also extremely concrete and physical, while the term "cosmic consciousness" itself has the unpoetic flavor of occultist jargon. But from all historical times and cultures we have reports of this same unmistakable sensation emerging, as a rule, quite suddenly and unexpectedly and from no clearly understood cause[67].

Whatever this type of experience is called, however, a growing body of "expert" testimony apparently confirms the possibility of its induction by drugs. Watts, the dean of current Western Zen scholars, has recently described "cosmic consciousness," courtesy of LSD, in exquisite detail[68]. Seminary students and professors in the Boston area are said to have definitely concluded that their contact with psilocybin was "mystico-religious" (as to whether or not it was "Christian," however, they are still in doubt)[69]. Huxley has been most outspoken about the capacity of the drugs to induce "traditional" mystical-visionary states:

> For an aspiring mystic to revert, in the present state of knowledge, to prolonged fasting and violent self-flagellation would be as senseless as it would be for an aspiring cook to behave like Charles Lamb's Chinaman, who burned down the house in order to roast a pig. Knowing as he does (or at least as he can know, if he so desires) what are the chemical conditions of transcendental experience, the aspiring mystic should turn for technical help to the specialists....[70]

Nearly invariably, whenever dramatic personality change has been noted following the use of these drugs, it has been associated with this kind of experience - that is, one called transcendental or visionary - with the particular name the experience is given seemingly most dependent upon whether the investigator focuses on affect or content. These experiments in drug-induced behavior change will shortly be reviewed in detail.

Examples Not Associated with Drugs

Since accounts of behavior transformations attendant on paranormal experience are not without precedent, it may be helpful to set the stage for present developments by citing some examples not connected with drugs. James reported on the phenomenon in its most familiar and perhaps prototypic context:

> In this lecture we have to finish the subject of conversion, considering it first through striking instantaneous instances of which St. Paul's is the most eminent, and in which, often amid tremendous emotional excitement or perturbation of the senses, a complete division is established in the twinkling of an eye between the old life and the new.

After adducing numerous examples, James continued:

> I might multiply cases almost indefinitely, but these will suffice to show you how real, definite, and memorable an event a sudden conversion may be to him who has the experience. Throughout the height of it he undoubtedly seems to himself a passive spectator or undergoer of an astounding process performed upon him from above. There is too much evidence of this for any doubt of it to be possible. Theology, combining this fact with the doctrine of election and grace, has concluded that the spirit of God is with us at these dramatic moments in a peculiarly miraculous way, unlike what happens at any other juncture of our lives. At that moment, it believes, an absolutely new nature is breathed into us, and we become partakers of the very substance of the Deity[71].

One may also recall to mind the "vision-seeking" American Indians whom Ruth Benedict immortalized. Adapting Nietzsche's designation "Dionysian" to characterize their cultural pattern, she portrayed its fundamental contrast with the "Apollonian" Zuni-Pueblo way of life. The Dionysian "seeks to attain in his most valued moments escape from the boundaries imposed on him by his five senses, to break through into another order of experience." He values "all means by which human beings may break through the usual sensory routine"[72].

Widespread among the western Indians (except in the Pueblos) was what Benedict called the "Dionysian dogma and practice" of the vision-quest - sought by fasting, by torture, and by drugs. The point of interest, of course, is that when the vision came, it could apparently trigger large-scale behavior alterations which had the stamp and reinforcement of social approval.

> ... on the western plains men sought these visions with hideous tortures. They cut strips from the skin of their arms; they struck off fingers; they swung themselves from tall poles by straps inserted under the muscles of their shoulders. They went without food and water for extreme periods. They sought in every way to achieve an order of experience set apart from daily living.
>
> On the western plains they believed that when the vision came, it determined their life and the success they might expect. If no vision came, they were doomed to failure.... If the experience was of curing, one had curing powers; if of warfare, one had warrior's powers. If one encountered Double Woman, one was a transvestite, and took woman's occupations and habits. If one was blessed by the mythical Water-Serpent, one had supernatural power for evil, and sacrificed the lives of one's wife and children in payment for becoming a sorcerer[73].

The final example which will be noted here of rapid personality change not induced by drugs has emerged quite recently from Maslow's studies of "self-actualization." Maslow reports that the occurrence of a dramatic "peak experience" - defined or alternatively described as a "cognition of being," or as "mystic" or "oceanic" - is a major event in the life histories of his "self-actualizing" subjects. Maslow avers "unanimous agreement" among his subjects as to the "therapeutic" after-effects of such peak experiences - for example, that they were so profound as to remove neurotic symptoms forever; or were followed by greater creativity, spontaneity, or expressiveness; or produced a more or less permanently changed, more healthy world-view or view of self, and so on[74].

Drug-Associated Personality Change: A "New Concept" in Psychotherapy

It is an intriguing historical accident that, on the one hand, anthropological studies of the Native American Church (Peyotism) consistently record the peyote-associated reformation of alcoholic and generally reprobate characters[75], and, on the other hand, LSD has been increasingly utilized in the treatment of the white man's "fire-water" ills. LSD was first systematically administered to non-Indian alcoholics in order to explore a putative similarity between the so-called model psychosis and delirium tremens. Two independent undertakings along this line, one in the U.S. and one in Canada, resulted in highly unexpected and sudden "cures"[76].

Investigators in Saskatchewan pursued this serendipitous result aggressively. The outcome, with lately-evolved refinements in technique, has been an explicitly formulated "new concept" in psychotherapy[77]. The following narrative, pieced together from Hoffer's statements at the Macy LSD conference, describes the conditions under which the rapid change phenomenon seems first to have occurred in sizeable numbers:

> ... we have what we call the "businessman's special," for very busy people, the weekend treatment.... They come in because the police or Alcoholics Anonymous or others bring them in. They come in on day *one*. They know they are going to take a treatment, but they know nothing about what it is. We take a psychiatric history to establish a diagnosis. That is on day *one*. On day *two*, they have the LSD. On day *three*, they are discharged.
> Our objective [in using 200-400 gamma doses] is to give each patient a particular LSD experience.
> The results are that 50 per cent of these people are changed [that is, they stop drinking or are much improved].... As a general rule ... those who have not had the transcendental experience are not changed; they continue to drink. However, the large proportion of those who have had it are changed[78].

The only other investigators to report a "weekend treatment" are Ball and Armstrong[79]. They describe a small series of "sex perverts," at least two of whom had had, over a number of years, "a variety of forms of psychotherapy, including psychoanalysis ... [resulting in] no improvement whatever." The large-dose LSD experience, however, is said to have had "remarkable, long-lasting remedial effects"[80].

MacLean and his co-workers in British Columbia, Canada have reported on a series which included 61 alcoholics and 33 neurotics (personality trait disturbance and anxiety reaction neurosis)[81]. Each patient was carefully and intensively prepared for the 400-1500 gamma, "psychedelic LSD-day" - which was jointly conducted by a psychiatrist, a psychologist, a psychiatric nurse, and a music therapist. Their follow-up data (median follow-up was for 9 months) were interpreted to yield a "much improved" or "improved" rating for over 90 percent of the neurotics and 60 percent of the alcoholics, with just under 50 percent of the alcoholics found at follow-up to have remained "totally dry"[82]. The results of this single LSD session with the alcoholic cases seem most impressive, in view of the picture provided:

> These were considered to be difficult cases; 59 had experienced typical delirium tremens; 36 had tried Alcoholics Anonymous and were considered to have failed in that program. The average period of uncontrolled drinking was 14.36 years. The average number of admissions to hospital for alcoholism during the preceding 3 years was 8.07[83].

Since Hoffer's account, procedures in Saskatchewan have apparently been modified to incorporate considerable "psychotherapy" - as an adjunct to, and preparation for, the LSD experience. In a recent report, Jensen has described a greatly expanded treatment method and its results:

> The treatment program includes three weekly A.A. meetings. The patients are strongly encouraged, but not forced, to attend. There are also 2 hours of group psychotherapy, in the course of which those who are not already familiar with the A.A. program are indoctrinated mainly by the other patients' discussion.... Because of the fairly short time available, the group therapy is superficial in nature and primarily educational.
> Toward the end of hospitalization (which averaged 2 months), the patients were given an LSD experience. They routinely received 200 gamma of the drug....[84]
> Of 58 patients who experienced the full program, including LSD, and were followed up for 6 to 18 months, 34 had remained totally abstinent since discharge or had been abstinent following a short experimental bout immediately after discharge; 7 were considered improved, i.e., were drinking definitely less than before; 13 were unimproved; and 4 broke contact.
> Of 35 patients who received group therapy without LSD, 4 were abstinent, 4 were improved, 9 were unimproved and 18 were lost to follow-up.
> Of 45 controls, consisting of patients admitted to the hospital during the same period who received individual treatment by other psychiatrists, 7 were abstinent, 3 improved, 12 unimproved, and 23 lost to follow-up[85].

Among the reservations that might be expressed about Jensen's study, two are outstanding. First, there is some ambiguity about the assignment of patients to the different treatment conditions - it does not seem to have been entirely random. Second, Jensen's assumption that patients who broke or refused follow-up contact with the hospital staff are safely categorized, for statistical purposes, as "treatment failures" would seem somewhat overweening. At any rate, on his count, the difference in percentages of patients "abstinent or improved" between the "full program-LSD" group (41 out of 58, or 71 percent) and the "individual psychotherapy" group (10 out of 45, or 22 percent) was highly statistically significant.

The present "official policy" of the Saskatchewan Department of Public Health may be of interest. A recently issued document, which reviews the results of four such follow-up studies as Jensen's, concludes with the directive that the single, large-dose LSD treatment of alcoholism is to be considered "no longer as experimental," but rather, "to be used where indicated"[86].

There seem to have been only two efforts in the U.S. to explicitly and systematically follow the Canadian model. In quite different contexts, both are reported as at least "doing well." Leary and his co-workers at Harvard, over the last two years, have conducted a research and treatment program at Massachusetts Correctional Institution, Concord, "designed to test the effects of consciousness-expanding drugs on prisoner rehabilitation"[87]. This undertaking, which emphasizes the crucial importance of drug-induced "far-reaching insight experiences" - prepared for, supported, and reinforced by group therapy sessions - has resulted in a recidivism rate considerably reduced from actuarial expectation. The number of post-treatment cases on which this evaluation is based, however, is only 26. The program is ongoing[88].

In a much more familiar setting, a group of workers on the West Coast has been treating the full range of garden-variety neuroses. The patients are intensively prepared over a two- to three-week period for a large-dosage, "transcendental" drug session. The stated intent is to induce a "single overwhelming experience ... so profound and impressive that ... the months and years that follow become a continuing growth process"[89]. Thus far, in over 100 treated cases, at least "marked improvement" in the condition for which treatment was sought has been reported in about 80 percent - after one so-called overwhelming experience[90].

It is a commonplace that new psychiatric treatments seem to effect remarkable cures - at least for a short time and in the hands of their originators. In raising the spectre of the powerful placebo effect[91], it need hardly be pointed out that the results reviewed above should be regarded with healthy skepticism. On the other hand, they are more than merely trifling.

Explanatory Concepts

In addressing a recent international assemblage at Copenhagen, Leary asserted:

> The visionary experience is the key to behavior change. [In its wake] change in behavior can occur with dramatic spontaneity ...[92].

Van Dusen, who bids fair to become the psychologist-philosopher of the "new concept" movement, puts the issue as follows:

> There is a central human experience which alters all other experiences ... not just an experience among others, but ... rather the very heart of human experience. It is the center that gives understanding to the whole.... It has been called satori in Japanese Zen, moksha in Hinduism, religious enlightenment or cosmic consciousness in the West.... Once found life is altered because the very root of human identity has been deepened ... the still experimental drug d-lysergic acid diethylamide (LSD) appears to facilitate the discovery of this apparently ancient and universal experience[93].

Although reminded on all sides of the incommunicableness of "the transport," as James called it, of its ineffability, one may, before following him in the descent toward "medico-materialistic" explanation, inquire further of its nature. James proffered the traditional demurrer "... it is probably difficult to realize [its] intensity unless one has been through the experience one's self ..."[94]. He then proceeded, with seeming aplomb, to describe it:

> The central [characteristic] is the loss of all worry, the sense that all is ultimately well with one, the peace, the harmony, the *willingness* to be....
> The second feature is the sense of perceiving truths not known before ... insight into depths of truth unplumbed by the discursive intellect.... The mysteries of life become lucid ... illuminations, revelations, full of significance and importance, all inarticulate though they remain....
> A third peculiarity ... is the objective change which the world often appears to undergo. "An appearance of newness beautifies every object" ... clean and beautiful newness within and without ...[95].

In James' view, "melting emotions and tumultuous affections" were the constant handmaiden of "crises of change"[96]. Also Benedict, in the context of the vision-quest, remarked on "... very strong affect, either ultimate despair or release from all inadequacy and insecurity"[97]. Chwelos and his co-workers, describing the transcendental drug experience as "mainly in the sphere of emotions or feeling"[98], exemplify this by quoting an alcoholic patient:

> I was swept by every conceivable variety of pleasant emotion from my own feeling of well-being through feelings of sublimity and grandeur to a sensation of ecstasy[99].

Finally now, turning from the poetry of phenomenal experience to medico-materialism, how did James approach the matter of explanation?

> If you open the chapter on Association, of any treatise on psychology, you will find that a man's ideas, aims, and objects form diverse internal groups and systems, relatively independent of one another.... When one group is present and engrosses the interest, all the ideas connected with other groups may be excluded from the mental field.... Our ordinary alterations of character as we pass from one of our aims to another, are not commonly called transformations ... but whenever one aim grows so stable as to expel definitively its previous rivals from the individual's life we tend to speak of the phenomenon and perhaps to wonder at it, as a "transformation."
> Whether such language be rigorously exact is for the present of no importance. It is exact enough, to recognize from your own experience the fact which I seek to designate by it.
> Now if you ask of psychology just *how* the excitement shifts in a man's mental system, and *why* aims that were peripheral become at a certain moment central, psychology has to reply that although she can give a general description of what happens, she is unable in a given case to account accurately for all the single forces at work.
> In the end we fall back on the hackneyed symbolism of mechanical equilibrium. A mind is a system of ideas, each with the excitement it arouses, and with tendencies impulsive and inhibitive, which mutually check or reinforce one another.... A new perception, a sudden emotional shock ... will make the whole fabric fall together, and then the center of gravity sinks into an attitude more stable, for the new ideas that reach the center in the rearrangement seem now to be locked there, and the new structure remains permanent[100].

More modern discussions of rapid personality change seem, in large part, to be variations on the theme of "melting emotions and tumultuous affections." There have been two relatively recent efforts to deal with rapid change associated primarily with conversion. Wallace, who attempted an heroic amalgam of Selye's "stress" theory and cultural anthropology, summed this up as follows:

> ... the physiologic events of the general adaptation syndrome [in situations of massive emotion] establish a physicochemical milieu in which certain brains can perform a function of which they are normally incapable: a wholesale resynthesis that transforms intellectual insight into appropriate motivation, reduces conflict by partial or total abandonment of certain values and acceptance of others, and displaces old values to new, more suitable objects[101].

Sargant has linked along an axis of abnormal "anger, fear, or exaltation" such "abrupt total reorientations" in personality as attend religious and political conversion experiences - as well as violent abreactions in therapy, spontaneous or narcosynthetic. His explanatory scheme derives directly from Pavlov - in the final analysis, sudden alterations in behavior are attributed to "paradoxical" and "ultraparadoxical" brain processes, and the like, induced by extreme emotion[102].
To return to LSD-related developments, Ditman and his coworkers have reviewed a whole range of considerations and theories which might "rationalize" the sudden change phenomenon - including a highly libidinized psychoanalytic formulation[103].

It remains to raise just one final query. Rapid personality change, translated into language more congenial to behavioral psychology, could be taken to describe a situation in which formerly dominant or high-probability responses, overt or mediational, were suddenly greatly reduced in frequency of occurrence; and, vice versa, uncommon responses, or those formerly *low* in a hierarchy, appear with greatly elevated frequency. The only experimental results which even approximate this order of events seem to be those which have arisen with the aid of direct intracranial electrical stimulation. With response-contingent reinforcement of this kind - that is, with electrical "trains" delivered to the hypothalamic, so-called pleasure or reward centers - the repertoires of many rats and monkeys have been dramatically altered in a very few moments: Utterly new behaviors have been shaped, old responses eliminated[104]. The degree to which such "artificially induced" learning has been sustained has been a function, as with all behavior, of the ebb and flow of environmental contingencies. Thus, to point the issue: Do transcendental experiences at the human level, however they are interpreted, tread in this area of *super* reinforcement - with a potential for radically altering the probability of occurrence of "heuristic" mediating processes (for example, positive rather than negative self-concepts) which might channel behavior, at least temporarily, in new directions, toward a "new beginning"?

With Ruth Benedict's "Apollonian" Zuni, the tendency of the modern West is to regard paranormal experiences, indiscriminately and often with little idea of their nature, as "pathological" - to be distrusted, feared, avoided. The Zuni Indian, said Benedict, "finds means to outlaw them from his conscious life... . He keeps the middle of the road, stays within the known map, does not meddle with disruptive psychological states"[105]. It would seem unfortunate were this *Zeitgeist* to unduly prejudice the exploration of therapeutic potential in the drugs here discussed.

In conclusion, let it be noted that the public health implications of drug-associated rapid personality change, should this phenomenon prove not to be a will-of-the-wisp, are apparently great. Intensive investigation would seem a reasonable order of the day. The procedures and time involved are manifestly economical - in truth, there seems little to be lost.

Acknowledgments

Grateful acknowledgment is made of the substantial contributions of Miss Judith C. Marshall and the assistance of Mrs. Linda B. J. P. Moncure in the preparation of this paper.

References

1. *The Varieties of Religious Experience* New York: Modern Library, 1902; pp. 378-379.
2. S. Weir Mitchell, "The Effects of Anhelonium Lewinii (the Mescal Button)," *Brit. Med. J.* (1896) 2:1625-1629. Aldous Huxley, "Mescaline and the Other World," pp. 46-50, in *Proceedings of the Round Table on Lysergic acid Diethylamide and Mescaline in Experimental Psychiatry,* edited by Louis Cholden. New York: Grune & Stratton, 1956; see p. 47.
3. G. Tayleur Stockings, "Clinical Study of the Mescaline Psychosis with Special Reference to the Mechanisms of the Genesis of Schizophrenia and Other Psychotic States," *J. Mental Science* (1940) 86:29-47.
4. For example, see Max Rinkel, Editor, *Chemical Concepts of Psychosis.* New York: McDowell, Obolensky, 1958.
5. For example, see Harold A. Abramson, Editor, *The Use of LSD in Psychotherapy: Transactions of a Conference.* New York: Josiah Macy, Jr., Foundation Publications, 1960.
6. Max Rinkel, C. W. Atwell, Alberto DiMascio, and J. R. Brown, "Experimental Psychiatry, V: Psilocybin, a New Psychotogenic Drug," *New England J. Med.* (1960) 262:293-299. Stephen Szara, "Psychotomimetic or Mysticomimetic?," paper presented at NIMH, Bethesda, Md., Nov. 14, 1961.
7. For examples, see: Nicholas Chwelos, Duncan Blewett, Colin Smith, and Abram Hoffer, "Use of LSD-25 in the Treatment of Alcoholism," *Quart. J. Studies on Alcohol* (1959) 20:577-590. J. Ross MacLean, D. C. MacDonald, Ultan P. Byrne, and A. M. Hubbard, "The Use of LSD-25 in the Treatment of Alcoholism and Other Psychiatric Problems," Quart. J. Studies on Alcohol (1961) 22:3445. P. O. O'Reilly and Genevieve Reich, "Lysergic Acid and the Alcoholic," *Diseases Nervous System* (1962) 23:331-34.
8. For examples, see: Charles Savage, James Terrill, and Donald D. Jackson, "LSD, Transcendence, and the New Beginning," *J. Nervous and Mental Disease* (1962) 135:425-439. John N. Sherwood, Myron J. Stolaroff, and Willis W. Harman, "The Psychedelic Experience - A New Concept in Psychotherapy," *J. Neuropsychiatry* (1962) 3:370-375.
9. C. H. Van Rhijn, "Introductory Remarks: Participants," in footnote 5; p. 14.
10. Gustav R. Schmiege, "The Current Status of LSD as a Therapeutic Tool - A Summary of the Clinical Literature," paper presented to the Amer. Psychiatric Assn., Toronto, Canada, May 8, 1962 (in press, *New Jersey Med. Soc. J.*, 1963).
11. Harris Isbell, "Comparison of the Reactions Induced by Psilocybin and LSD-25 in Man," *Psychopharmacologia* (1959) 1:29-38. Harold A. Abramson, "Lysergic Acid Diethylamide (LSD-25): XXX, The Questionnaire Technique with Notes on Its Use," *J. Psychology* (1960) 49:57-65. A. B. Wolbach, E. J. Miner, and Harris Isbell, "Comparison of Psilocin with Psilocybin, Mescaline and LSD-25," *Psychopharmacologia* (1962) 3:219-223.
12. For examples, see: Max Rinkel, "Pharmacodynamics of LSD and Mescaline," *J. Nervous and Mental Disease* (1957) 125:424-426. T. J. Haley and J. Rutschmann, "Brain Concentrations of LSD-25 (Delysid) after Intracerebral or Intravenous Administration in Conscious Animals," *Experientia* (1957) 13:199-200.
13. See Isbell, in footnote 11: p. 37.
14. For examples, see: Antonio Balestrieri and Diego Fontanari, "Acquired and Crossed Tolerance to Mescaline, LSD-25, and BOL148," *Arch. General Psychiatry* (1959) 1:279-282. Harris Isbell, A. B. Wolbach, Abraham Wikler, and E. J. Miner, "Cross-Tolerance Between LSD and Psilocybin," Psychopharmacologia (1961) 2:147-151.
15. T. W. Richards and Ian P. Stephenson, "Consistency in the Psychologic Reaction to Mescaline," *Southern Med. J.* (1961) 54:13191320.
16. Havelock Ellis, "Mescal, a New Artificial Paradise," pp. 537-548, in *Annual Reports Smithsonian Institution,* 1897; p. 547.
17. W. Mayer-Gross, "Experimental Psychoses and Other Mental Abnormalities Produced by Drugs," *Brit. Med. J.* (1951) 57:317-321; p. 318.
18. See Huxley, in footnote 2; pp 47-48.
19. From Albert Hofmann's laboratory report, translated and quoted in H. Jackson DeShon, Max Rinkel, and Harry C. Solomon, "Mental Changes Experimentally Produced by LSD," *Psychiatric Quart.* (1952) 26:33-53; p. 34.
20. Frank Barron, "Unusual Realization and the Resolution of Paradox When Certain Structural Aspects of Consciousness Are Altered," paper read at the Amer. Psychological Assn., New York, September, 1961.
21. E. Guttman and W. S. Maclay, "Mescaline and Depersonalization: Therapeutic Experiments," *J. Neurol. Psychopath.* (1936) 16: 193-212; p. 194
22. Translated from a subject's account in K. Beringer, Der Mcskalinrausch; Berlin, Springer. 1927; and quoted in Robert S. DeRopp, *Drugs and the Mind*. New York: Grove, 1957; p. 51.

23. Gregory Bateson, "Group Interchange," in footnote 5; p. 188.
24. Ronald A. Sandison, A. M. Spencer, and J. D. A. Whitelaw, "The Therapeutic Value of Lysergic Acid Diethylamide in Mental Illness," *J. Mental Science* (1954) 100:491-507; p. 498.
25. Electrophysiological investigations have shown definite alterations in firing at a number of points in the visual system (also in auditory evoked potentials) and in the functioning of cortico-cortical (transcallosal) connections. However, in concluding an extensive review of electrophysiological results, Evarts warned: "... it does not appear that we have reached the point of being able to assign any particular psychological effect ... to a demonstrated disturbance of the electrical activity of the nervous system." See Edward V. Evarts, "A Review of the Neurophysiological Effects of LSD and Other Psychotomimetic Agents," *Annals N. Y. Acad. Science* (1957) 66:479495; p. 489. Speculation on this issue may best be tempered by consulting Evarts' most thoughtful summation and evaluation.
26. See footnote 16; p. 547.
27. See footnote 17; p. 319.
28. Paul H. Hoch, "Experimental Psychiatry," *Amer. J. Psychiatry* (1955) 111:787-790; p. 787.
29. For example, see A. Levine, Harold A. Abramson, M. R. Kaufman, and S. Markham, "Lysergic Acid Diethylamide (LSD-25) : XVI The Effect of Intellectual Functioning as Measured by the Wechsler-Bellevue Intelligence Scale." *J. Psychology* (1955) 40:385-395.
30. Charles Savage, "The Resolution and Subsequent Remobilization of Resistance by LSD in Psychotherapy," *J. Nervous and Mental Disease* (1957) 125:434-436; p. 436.
31. Heinrich Kluver, *Mescal: The Divine Plant and Its Psychological Effects*. London: Kegan Paul, 1928; pp. 105-106.
32. See footnote 21; p. 195.
33. Humphry Osmond, "A Review of the Clinical Effects of Psychotomimetic Agents," *Annals N. Y. Acad. Science* (1957) 66:418-434; p. 419.
34. Aldous Huxley, *The Doors of Perception*. New York: Harper, 1954; pp. 73, 79.
35. 35. Philip B. Smith, "A Sunday with Mescaline," *Bull. Menninger Clinic* (1959) 23:20-27; p. 27.
36. Audrey R. Holliday, "The Hallucinogens: A Consideration of Semantics and Methodology with Particular Reference to Psychological Studies," pp. 301-318, in *A Pharmacologic Approach to the Study of the Mind,* edited by R. Featherstone and A. Simon. Springfield, 111.: Thomas. 1959; p 301.
37. See footnote 17, p. 320, for a review of the findings of K. Zucker, *Z. ges. Neurol. Psychiat.* (1930) 127:108.
38. See footnote 31.
39. James S. Slotkin, *Peyote Religion.* Glencoe, III.: Free Press, 1956;; pp. 76-77.
40. Translated from Albert Hofmann's laboratory report, and quoted in "Discovery of D-lysergic Add Diethylamide - LSD ' *Sandoz Excerpta* (1955) 1:1-2: p. 1.
41. See footnote 40; p. 2. For the record, it may be noted not only that Hofmann recovered, and subsequently synthesized psilocybin, but that he has recently written of the use of "psychotomimetics" in psychotherapy: "... these substances are new drug aids which ... enable the patient to attain self-awareness and gain insight into his disease." See Albert Hofmann, "Chemical, Pharmacological and Medical Aspects of Psychotomimetics," *J. Exper. Med. Science* (1961) 5:31 - 51 p. 48.
42. Translated from B. Manzini and A. Saraval, "L'intossicazione Sperimentale da LSD ed i Suoi Rapporti con la Schizofrenia, *Riv. Sper. Freniat.* (1960) 84:589; and quoted in *Delysid (LSD-25), Annotated Bibliography, Addendum No. 3*, mimeographed, Sandoz Pharmaceuticals, 1961; p. 307.
43. See footnote 33; p. 429.
44. In taking issue with the "psychotomimetic" label, it had best be emphasized that the present intent is hardly to transmit a cavalier attitude toward drug administrations; these are obviously potent agents. On the other hand, they are also apparently "safe" when used with reasonable precaution. For a survey of the outcome of 25,000 administrations, see Sidney Cohen, "LSD: Side Effects and Complications," *J. Nervous and Mental Disease* (1960) 130:30-40.
45. For example, see Joseph Zubin and Martin M. Katz, "Psychopharmacology and Personality," presented at the Colloquium on Personality Change, Univ. of Texas, Austin, Texas, March 9, 1962 (in press).
46. See footnote 28; p. 788.
47. Paul H. Hoch, "Remarks on LSD and Mescaline," *J. Nervous and Mental Disease* (1957) 125:442444; p. 442.
48. Paul H. Hoch, Solomon Katzenelbogen, and Herman C. B. Denber, "Group Interchange," in footnote 5; p. 58.
49. Sidney Malitz, "Group Interchange," in footnote 5; p. 215.
50. See footnote 19; p. 50.
51. Harold A. Abramson, "Some Observations on Normal Volunteers and Patients," pp. 51-54, in *Proceedings of the Round Table on Lysergic Acid Diethylamide and Mescaline in Experimental Psychiatry,* in footnote 2; see pp. 5253.
52. Ronald A. Sandison, "The Clinical Uses of LSD," pp. 27-34, in *Proceedings of the Round Table on Lysergic Acid Diethylamide and Mescaline in Experimental Psychiatry*, in footnote 2; see p. 33.
53. Anthony K. Busch and Walter C. Johnson, "LSD-25 as an Aid in Psychotherapy (Preliminary Report of a New Drug)," *Diseases Nervous System* (1950) 11:241-243; pp. 242-243.
54. Ronald A. Sandison, "Psychological Aspects of the LSD Treatment of the Neuroses," *J. Mental Science* (1954), 100:508-515; p. 514.
55. See footnote 24; p. 507.
56. Mortimer A. Hartman, "Group Interchange," in footnote 5; p. 115.
57. See footnote 20.
58. See Charles Savage, "Group Interchange," in footnote 5; pp. 193194.
59. Sidney Malitz, Harold Esecover, Bernard Wilkens, and Paul H. Hoch, "Some Observations on Psilocybin, a New Hallucinogen, in Volunteer Subjects," *Comprehensive Psychiatry* (1960) 1:8-17; p. 15.
60. See footnote 51; p. 52.
61. Robert W. Hyde, "Psychological and Social Determinants of Drug Action," pp. 297-312, in *The Dynamics of Psychiatric Drug Therapy,* edited by G. J. Sarwer-Foner. Springfield, III.: Thomas, 1960.

62. Ronald A. Sandison, 'Group Interchange," in footnote 5; p. 91. Any remaining skeptics on the score of expectation and attitude may want to take note of Cohen's caveat: "Invariably, those who take hallucinogenic agents to demonstrate that they have no value in psychiatric exploration have an unhappy time of it. In a small series of four psychoanalysts who took 100 gamma of LSD, all had dysphoric responses." See footnote 44; p. 32.
63. See footnote 34; p. 14.
64. Ralph Metzner, George Litwin, and Gunther Weil, "The Relation of Expectation and Setting to Experiences with Psilocybin: A Questionnaire Study," dittoed, Harvard Univ., 1963. Charles Savage, Willis Harman, James Fadiman, and Ethel Savage, "A Follow-up Note on the Psychedelic Experience," mimeographed, International Foundation for Advanced Study, 1963.
65. It may be noted that only slightly lower figures have been reported *without* explicit preparation of the subjects - though with an "atmosphere" that was enthusiastic and supportive. See Keith S. Ditman, Max Hyman, and John R. B. Whittlesey, "Nature and Frequency of Claims Following LSD," *J. Nervous and Mental Disease* (1962) 134:346352.
66. For example, see Jerome D. Frank, Persuasion and Healing: A Comparative Study of Psychotherapy. Baltimore, Johns Hopkins Press, 1961. More specifically, see Colin M. Smith, "Some Reflections on the Possible Therapeutic Effects of the Hallucinogens," *Quart. J. Studies on Alcohol* (1959) 20:292-301.
67. See footnote 10.
68. Alan W. Watts, *This is IT.* New York: Pantheon, 1960; p. 17.
69. Alan W. Watts, *The Joyous Cosmology.* New York: Pantheon, 1962.
70. Timothy Leary, "The Influence of Psilocybin on Subjective Experience," paper presented at NIMH, Bethesda, Md., May 29, 1962.
71. Aldous Huxley, *Heaven and Hell.* New York: Harper, 1956 p. 63.
72. See footnote 1; pp. 213-222.
73. Ruth Benedict, *Patterns of culture.* New York: New American Library, 1934; pp. 72-73.
74. See footnote 72: pp. 74-75
75. Abraham H. Maslow, "Cognition of Being in the Peak Experience," *J. Genetic Psychology* (1959) 95: 43-66.
76. See footnote 39.
77. Keith S. Ditman and John R. B. Whittlesey, "Comparison of the LSD-25 Experience and Delirium Tremens," *Arch. General Psychiatry* (1959) 1:47-57. Colin M. Smith, "A New Adjunct to the Treatment of Alcoholism: The Hallucinogenic Drugs," *Quart. J. Studies on Alcohol* (1958) 19:1931. By the way, the LSD experience and delirium tremens were found to be distinctly dissimilar in most respects.
78. See Sherwood and co-workers, in footnote 8.
79. Abram Hoffer, "Group Interchange," in footnote 5; pp. 59, 114-115.
80. J. R. Ball and Jean J. Armstrong, "The Use of L.S.D. 25 in the Treatment of the Sexual Perversions," *Canadian Psychiatric Assn. J.* (1961) 6:231-235. 80. See footnote 79; p. 234.
81. See MacLean and co-workers, in footnote 7.
82. A personal communication (1963) from J. Ross MacLean indicates sustained success in 270 additional postpublication cases of "psychedelic treatment."
83. See MacLean and co-workers, in footnote 7; p. 38.
84. The preparation of the subject and the conduct of the 12-hour session were patterned along the lines described by Blewett and Chwelos. See Duncan B. Blewett and Nicholas Chwelos, *Handbook for the Therapeutic Use of Lysergic Acid Diethylamide-25, Individual and Group Procedures;* to be published.
85. Sven E. Jensen, "A Treatment Program for Alcoholics in a Mental Hospital," *Quart. J. Studies on Alcohol* (1962) 23:315-320; pp. 317-319.
86. "Apparent Results of Referrals of Alcoholics for LSD Therapy," Report of the Bureau on Alcoholism, Saskatchewan Department of Public Health, Regina, Saskatchewan, Dec. 31, 1962; p. 5.
87. Timothy Leary, Ralph Metmer, Madison Presnell, Gunther Weil, Ralph Schwitzgebel, and Sara Kinne, "A Change Program for Adult Offenders Using Psilocybin," dittoed, Harvard Univ., 1962.
88. Timothy Leary, "Second Annual Report: Psilocybin Rehabilitation Project," dittoed, Freedom Center, Inc., 1963.
89. See Sherwood and co-workers, in footnote 8; p. 370.
90. See footnote 89 and Savage and co-workers in footnote 64.
91. See David Rosenthal and Jerome D. Frank, "Psychotherapy and the Placebo Effect," *Psychol. Bull.* (1956) 53:294-302.
92. Timothy Leary, "How to Change Behavior," pp. 50-68, in *Clinical Psychology, XIV International Congress of Applied Psychology,* Vol. 4, edited by Gerhard S. Neilsen; Copenhagen, Munksgaard, 1962; p. 58.
93. Wilson Van Dusen, "LSD and the Enlightenment of Zen," *Psychologia* (1961) 4:11-16; p. 11.
94. See footnote 1; p. 242.
95. See footnote 1; pp. 242-243.
96. See footnote 1; p. 195.
97. See footnote 72; p. 78.
98. See Chwelos and co-workers, in footnote 7; p. 583.
99. See footnote 7; p. 584.
100. See footnote 1; pp. 190-194.
101. Anthony F. C. Wallace, "Stress and Rapid Personality Changes," *Internat. Record Med.* (1956) 169: 761-774; p. 770.
102. William Sargant, *Battle for the Mind: A Physiology of Conversion and Brain-washing.* Garden City, N,Y.: Doubleday, 1957.
103. See Ditman and co-workers, in footnote 64.
104. For example, see Daniel E. Sheer, Editor, *Electrical Stimulation of the Brain.* Austin: Univ. of Texas Press, 1961.
105. See footnote 72; p. 72.

Values and Beliefs of Psychedelic Drug Users: A Cross-Cultural Study

by

Michael Lerner, Michael Lyvers

© Michael Lerner and Michael Lyvers 2006

original source: http://epublications.bond.edu.au/cgi/viewcontent.cgi?article=1130&context=hss_pubs

Table of Contents:

- **Abstract**
- **Method**
  - Subjects
  - Materials
    - *Drug Use Questionnaire*
    - *Life Values Inventory*
    - *Emotional Empathic Tendency Scale*
    - *Mystical Beliefs Questionnaire*
    - *Sense of Coherence Scale*
  - Procedure
- **Results**
  - Mystical Beliefs
  - Life Values
  - Empathy
  - Coping Ability
- **Discussion**
- **References**

Values and Beliefs of Psychedelic Drug Users: A Cross-Cultural Study

Michael Lerner, B.A.(Honours), & Michael Lyvers, Ph.D.
Department of Psychology
Bond University
Gold Coast, Queensland 4229 Australia
Address correspondence to:
Associate Professor Michael Lyvers
Phone (61) (75) 595 2565
Fax (61) (75) 595 2672
e-mail: mlyvers@staff.bond.edu.au

Abstract

Psychedelic drugs such as LSD and psilocybin are often claimed to be capable of inducing lifechanging experiences described as mystical or transcendental, especially if high doses are taken. The present study examined possible enduring effects of such experiences by comparing users of psychedelic drugs (n = 88), users of non-psychedelic illegal drugs (eg., marijuana, amphetamines) (n = 29) and non-illicit-drug using social drinkers (n = 66) on questionnaire measures of values, beliefs and emotional empathy. Samples were obtained from Israel (n = 110) and Australia (n = 73) in a cross-cultural comparison to see if values associated with psychedelic drug use transcended culture of origin. Psychedelic users scored significantly higher on mystical beliefs (eg., oneness with God and the universe) and life values of spirituality and concern for others than the other groups, and lower on the value of financial prosperity, irrespective of culture of origin. Users of non-psychedelic illegal drugs scored significantly lower on a measure of coping ability than both psychedelic users and non-illicit-drug users. Both groups of illegal drug users scored significantly higher on empathy than non-illicit-drug users. Results are discussed in the context of earlier findings from Pahnke (1966) and Doblin (1991) of the transformative effect of psychedelic experiences, although the possibility remains that present findings reflect pre-drug characteristics of those who chose to take psychedelic drugs rather than effects of the drugs themselves.

Psychedelic drugs are claimed to have the potential to induce profoundly spiritual or mystical experiences (e.g., Bakalar, 1985; Hasler *et al*., 2004; Hofmann, 1983; Horgan, 2003; Huxley, 1956; Maslow, 1964; Leary, 1965; Pahnke, 1966; Shanon, 2003; Strassman, 2001; Watts, 1965). Presumably because of such effects, plant psychedelics such as *psilocybe* mushrooms, peyote, and ayahuasca have been central to the traditional spiritual and healing ceremonies of some indigenous cultures of the Americas. Even today, the Native American Church is permitted to use peyote legally for religious purposes in the United States, and the syncretist religious group União Vegetal is allowed legal use of ayahuasca for similar purposes in Brazil (Shanon, 2002). The most potent of all psychedelics, the semisynthetic ergot derivative LSD, was initially regarded as an agent that induces a "model psychosis" but subsequently LSD was utilized sporadically in depth psychotherapy and alcoholism treatment in the 1950s and 1960s (Grinspoon & Bakalar, 1979; Grof, 2001). Before all use of psychedelics was made illegal in most countries, there were two main models of LSD psychotherapy: "Psycholytic" psychotherapy administered frequent low doses of LSD to facilitate the emergence of material from the personal unconscious and was based on a psychoanalytic paradigm, whereas "psychedelic" psychotherapy administered a limited number of high doses with the goal of inducing a transpersonal, mystical experience that would have longlasting transformative effects on behavior (such as alcohol abstinence in alcoholics). However, clinical research on the efficacy of LSD or other psychedelic agents for psychotherapeutic purposes was generally marred by poor research design (Ludwig, 1970).

In the only published controlled experiment on the spiritual potential of psychedelics in humans, Pahnke (1966) tested claims that psychedelics are capable of inducing religious experiences. In a Boston chapel on Good Friday, drug-naïve divinity students were given either a high dose of psilocybin or an active placebo in double-blind fashion. Most subjects in the psilocybin group reported profound spiritual insights with transformative effects that persisted for decades, according to a follow-up study by Doblin (1991). However, one subject who received psilocybin suffered a psychotic reaction during the experiment, highlighting one of the major risks of psychedelic drug use. Although psychedelics are not addictive, and frequent use is rare due to the intensity of effects (Grinspoon & Bakalar, 1979), these drugs can be dangerous due to the unpredictable and overwhelming mental changes they may induce. Time slows down or stands still, brilliantly colored visions unfold in the mind's eye, and emotions may range from terror and panic to spiritual ecstasy and transcendence. Normal reality may be left far behind as the user seems to enter another dimension, and near-death type experiences are not uncommon. Users often claim to encounter God, to merge with the Cosmos and undergo death and rebirth during a high-dose psychedelic experience.

Reports from some users resemble classic Buddhist or Hindu descriptions of self-realization or enlightenment (Grinspoon & Bakalar, 1979; Horgan, 2003; Watts, 1965). This mystical experience is said to have a universal aspect that transcends cultural context and may cause lasting and profound changes in the user (but see Horgan, 2003, for a critical discussion of this claim). If psychedelic drugs can sometimes induce mystical experiences, as often claimed, then the values and beliefs of psychedelic users should differ in crucial respects from those endorsed by users of other illicit drugs such as marijuana, amphetamines or heroin, as well as those endorsed by non-users of illegal drugs. Further, to be truly universal, the values and beliefs of psychedelic users should transcend cultural context. The present exploratory study examined these hypotheses by comparing users of psychedelic drugs with users of non-psychedelic illegal drugs (as a control for correlates of illicit drug use in general) and non-users of illegal drugs on values, beliefs, coping ability and empathy. Samples were drawn from two culturally distinctive countries, Israel and Australia. We predicted that certain characteristics of psychedelic drug users would distinguish them from the other two groups across the two different nationalities. Mystical beliefs such as oneness with God and the universe, empathy (commonly presumed to follow from such beliefs), confidence in one's ability to handle life stress, and life values such as spirituality, creativity, humility, concern for others, and concern for the environment were all expected to differentiate psychedelic users from the other groups, irrespective of cultural background. Psychedelic users were also expected to be less concerned with financial prosperity and achievement than the other groups, reflecting a less materialistic value orientation. Two values, belonging and loyalty to group, were expected to be higher in Israelis than in Australians irrespective of drug use, on the basis of the presumed ethnic/religious group identification of Israelis.

Method

Subjects

A total of 183 volunteers participated in this study. There were 41 Israeli and 47 Australian users of psychedelic drugs (LSD, psilocybin, mescaline), 18 Israeli and 11 Australian users of other illegal drugs (10 marijuana only, 17 marijuana + amphetamines, 1 amphetamines only, 1 marijuana + heroin) who had never tried psychedelics, and 51 Israeli and 15 Australian non-illegal-drug-using social drinkers. Mean age was 35 years (range 21-70 years). For purposes of this study, participants were classified as psychedelic users only if they reported having had at least one overwhelming high-dose psychedelic experience. This was because some recreational drug users today take low doses of a psychedelic drug (eg., 50 mcg LSD, 1 gm of *psilocybe* mushrooms) to enhance their appreciation of the music and social scene at dance clubs or "rave" venues. As low dose psychedelic use is unlikely to induce a mystical experience, prospective participants who only reported this type of psychedelic use were excluded from the study. For similar reasons, use of marijuana or "entactogens" such as MDMA (Ecstasy) or MDE, which are sometimes considered mild psychedelics, was not sufficient for classification into the psychedelic user group. Use of dissociatives such as ketamine or PCP likewise did not qualify as psychedelic drug use in the context of the present study, as the "psychedelic" category was conservatively restricted to the "classic" serotonergic agonist hallucinogens - the drugs most widely cited as capable of inducing mystical experiences. This study was approved by the Bond University Research Ethics Committee and was funded by a grant from the Multidisciplinary Association for Psychedelic Studies (MAPS).

Materials

Drug Use Questionnaire

Drug Use Questionnaire (DUQ; Barker & Lyvers, 2002). The DUQ assesses personal history of use of alcohol and illegal drugs such as cannabis/marijuana, MDMA/Ecstasy, cocaine, amphetamines, heroin/opiates, and psychedelics (LSD, psilocybin, mescaline), as well as demographic information. A short qualitative section was added asking if the psychedelic user has ever had a profound or overwhelming high-dose psychedelic experience; an affirmative response was necessary for inclusion in the psychedelic user group (see above).

Life Values Inventory

Life Values Inventory (LVI; Brown & Crace, 1996). The quantitative section of the LVI used in this study measures 14 life values by means of 42 items rated for importance to one's life on four-point Likert scales. For purposes of the present study, only 9 of the 14 values were analyzed as they were deemed most relevant to the psychedelic experience and/or to cultural differences between Israel and Australia: Spirituality, Concern for Environment, Concern for Others, Financial Prosperity, Creativity, Belonging, Loyalty to Family or Group, Achievement, and Humility.

Emotional Empathic Tendency Scale

Emotional Empathic Tendency Scale (EETS) (Mehrabian, 1994). The EETS measures one's perceived ability to identify and feel the emotions of others, using 33 items rated on a five point Likert scale.

Mystical Beliefs Questionnaire

Mystical Beliefs Questionnaire (MBQ). Based on Pahnke's (1966) Peak Experience Profile, the MBQ is a 21-item scale developed for the present study. Five point Likert scales are used to rate mystical beliefs such as universal soul, the unity of all things, having no fear of death, the illusory nature of physical existence, the existence of a transcendental reality, and oneness with God, nature and the universe. Cronbach's alpha coefficient in the present study was .94, indicating high internal consistency of this exploratory measure.

Sense of Coherence Scale

Sense of Coherence Scale (SOCS; Antonovsky, 1987). The SOCS measures subjective coping ability in terms of beliefs that stressful events are comprehensible and that one has the resources necessary to cope with them. We expected that psychedelic users would score higher on this than the other groups, due to the presumed buffering effect of a mystical or spiritual perspective against stress. There are 29 items rated on a seven point Likert scale.

Procedure

Participants were recruited by posters in counterculture areas frequented by members of contra-cultural groups and drug users and by word of mouth (snowball method) in Israel (Tel Aviv, Haifa, Jerusalem) and Australia (Nimbin, Byron Bay, Melbourne, Gold Coast). Interested persons contacted the researcher, who sent them a questionnaire packet and a self-addressed stamped envelope for return of the completed forms. Of 212 packets initially returned, 14 were discarded as incomplete, and 22 were discarded because although psychedelic use was reported the respondent denied ever having had an overwhelming or high-dose experience.

Results

Initial examination of groups revealed differences in gender and age composition. There was a significant association between drug group and gender, X^2 (2, N = 183) = 10.15, $p = .006$. There were relatively more males in the psychedelic group (51 males, 37 females) compared to the users of other illegal drugs group (9 males, 20 females) and the non-user group (24 males, 42 females). There were also group differences in age, $F(2, 178) = 4.21$, $p = .016$. Tukey's HSD post-test ($p < .05$) revealed that the non-psychedelic illegal drug user group was younger on average (M = 30 yr) than the psychedelic group (M = 36 yr) and the non-user group (M = 38 yr). Therefore age and gender were used as covariates in all analyses reported below.

Mystical Beliefs

Two-way (drug group X nationality) analysis of covariance (ANCOVA) indicated a significant effect of drug group on the MBQ, $F(2,171) = 73.33$, $p = .000$. As predicted, psychedelic drug users scored significantly higher on the MBQ ($M = 64.22$) than non-psychedelic illegal drug users ($M = 34.84$) and non-users ($M = 34.05$), as revealed by pairwise comparisons using the Bonferroni correction. There was no difference between Israelis and Australians on the MBQ, and no interaction.

Life Values

MANCOVA indicated an overall multivariate effect of nationality on the LVI, $F(9, 164) = 2.51$, $p = .01$. Univariate analyses were significant for Belonging, $F(1, 172) = 6.70$, $p = .01$, Humility, $F(1,172) = 5.72$, $p = .02$, and Loyalty to Family or Group, $F(1,172) = 5.82$, $p = .02$. On Belonging, Israelis ($M = 10.80$) scored significantly higher than Australians ($M = 9.59$). Israelis also rated the value of Humility more highly ($M = 9.59$) than Australians did ($M = 8.71$). Further, Israelis scored higher on Loyalty to Family or Group ($M = 10.80$) than Australians did ($M = 9.74$). There was an overall multivariate effect of drug group on the LVI, $F(18,328) = 4.73$, $p = .000$. Univariate analyses revealed significant effects of drug group on Spirituality,

$F(2,172) = 21.29$, $p = .000$; Concern for Environment, $F(2,172) = 7.72$, $p = .001$; Concern for Others, $F(2,172) = 7.04$, $p = .001$; Creativity, $F(2,172) = 3.42$, $p = .03$; and Financial Prosperity, $F(2,172) = 7.35$, $p = .001$. Pairwise comparisons using the Bonferroni correction revealed that psychedelic users scored significantly higher on Spirituality and Concern for Others, and lower on the value of Financial Prosperity, than the other groups (see Table 1). Psychedelic users also scored significantly higher than users of other illegal drugs on Concern for Environment and Creativity, but only marginally ($p < .10$) higher than non-users on these values (see Table 1).

Table 1. Life Values of Psychedelic Drug Users Compared to Non-Psychedelic Illegal Drug Users and Non-Users of Illegal Drugs.

Life Value	Users of -		
	Psychedelics	Other Drugs	Non-users
Spirituality	12.15	7.59	9.28
Environment	12.16	10.24	11.40
Concern for others	12.25	11.38	11.58
Creativity	11.97	10.59	10.97
Financial Prosperity	8.68	10.38	10.92

Empathy

ANCOVA indicated significant effects of the covariate gender, $F(1, 172) = 62.12$, $p = .000$, and drug group, $F(2, 172) = 14.99$, $p = .000$, on emotional empathy as measured by the EETS. As expected based on past research, females scored higher overall on emotional empathy ($M = 45.87$) than males ($M = 24.96$). According to pairwise comparisons using the Bonferroni correction, psychedelic users scored non-significantly higher ($M = 44.92$) on empathy than users of other illegal drugs ($M = 36.53$), with both groups of drug users scoring significantly higher than non-users ($M = 24.42$). There was no effect of nationality and no interaction.

Coping Ability

SOC total scores were subjected to a two-way (drug group X nationality) ANCOVA. The main effect of drug group was significant, $F(2, 173) = 6.47$, $p = .002$. Post-test (Bonferroni) showed that users of non-psychedelic illegal drugs scored significantly lower on the SOC ($M = 116.78$) than both users of psychedelics ($M = 133.73$) and non-users ($M = 130.88$). Neither the main effect of nationality nor the interaction were significant.

Discussion

The findings, though tentative due to the self-selected nature of the samples, were largely consistent with predictions based on the notion that many users of psychedelic drugs have undergone a mystical or transcendental experience that led to major changes in orientation. Regardless of culture of origin, users of psychedelic drugs scored significantly higher than users of other illegal drugs and non-users on mystical beliefs, such as oneness with God and the universe, the illusory nature of physical existence, and the presence of a transcendental reality. Psychedelic users also scored higher on emotional empathy than the other groups, although only the comparison with non-users was significant. The higher mean empathy score of psychedelic users was consistent with predictions based on the compassionate qualities attributed to those who have had enlightenment experiences according to the mystical traditions of Buddhism and Hinduism. Nevertheless, such claims should be tempered by the fact that, as Horgan (2003) noted, no obvious "psychedelic saints" have yet emerged from the counterculture. Life values that are said to naturally follow from mystical experience - spirituality and concern for others - were rated significantly more highly by psychedelic users than both of the other groups, and concern for the environment and creativity were rated significantly more highly by psychedelic users than by users of other illegal drugs. The value of financial prosperity was rated significantly lower by psychedelic users than by the other groups, indicating a less materialistic orientation in the psychedelic users. However, contrary to predictions, differences were not found on the values of humility or achievement between psychedelic users and the other groups. On the SOC, a measure of belief in one's ability to cope with life stress, users of non-psychedelic illegal drugs such as marijuana and amphetamines scored significantly lower than both users of psychedelics and non-users of illegal drugs. This suggests that in contrast to psychedelic drug use, non-psychedelic illegal drug use may be in part motivated by escapism or as an attempt to cope with stress. Alternatively, use of such drugs may impair the subjective coping ability of some users.

A question that naturally arises from the present findings is whether the above characteristics of psychedelic drug users preceded psychedelic use or resulted from such use. Those who decide to take a psychedelic drug may in some cases do so as part of a personal spiritual quest, based on the reputation such drugs have for inducing mystical experiences; thus the tendency to endorse more spiritual, less materialistic values may have preceded use of psychedelics. However, present results are generally consistent with the earlier findings of Pahnke (1966) and Doblin (1991) of a profound and enduring spiritual influence of the psychedelic experience. The most likely possibility, in our interpretation, is that both pre-drug factors and psychedelic drug effects may have contributed to the distinctive characteristics of psychedelic drug users observed in the present study. That is, people on a spiritual quest may be more inclined to use psychedelics as part of that quest, but in addition the drugs themselves may on occasion have powerful effects on values and spirituality even in those who did not initially take psychedelics for spiritual purposes. Present findings also suggest that the effects of psychedelic drugs may be more important than the cultural differences between Israel and Australia in influencing the life values and spirituality of drug users in these two countries, consistent with the claim of a universal aspect to psychedelic mystical experiences. As predicted, Israelis scored higher on Belonging and Group Loyalty than Australians overall, but also on the value of Humility, which was not predicted.

In recent years a "psychedelic renaissance" seems to be underway, both at the societal level and in terms of renewed scientific interest in these remarkable compounds. In the early 1960s, psychedelics were regarded by many as miracle drugs with the potential to positively transform individuals and society. But the ensuing controversies and problems associated with uncontrolled use quickly led to the illegalization of psychedelics and cessation of scientific research on their clinical and spiritual potential. Given the recent resurgence of scientific interest, and government approval of limited human studies of psychedelic effects (e.g., Strassman, 2001), a less hysterical assessment of psychedelics is likely to emerge in the coming years.

References

1. Antonovsky, A. (1987). *Unravelling the mystery of health: How people manage stress and stay well*. San Francisco: Jossey-Bass.
2. Bakalar, J.B. (1985, Fall). Social and intellectual attitudes toward drug-induced religious experience. *Journal of Humanistic Psychology*, 24, 45-66.
3. Barker, B., & Lyvers, M. (2002). *Neuropsychological performance in human ecstasy users: A test of the serotonin neurotoxicity hypothesis*. Presented at the 2002 Convention of the Australian Psychological Society, Gold Coast, Qld., September 2002.
4. Crace, R.K., & Brown, D. (1996). *Life values inventory*. Ann Arbor, MI: Aviat.
5. Doblin, R. (1991). Pahnke's "Good Friday Experiment": A long-term follow-up and methodological critique. *Journal of Transpersonal Psychology*, 23 (1), 1-28.
6. Grinspoon, L., & & Bakalar, J.B. (1979). *Psychedelic drugs reconsidered*. New York: Basic Books.
7. Grof, S. (2001). *LSD psychotherapy* (3rd edition). Sarasota, FL: MAPS.
8. Hasler, F. , Grimberg, U., Benz, MA., Huber, T., & Vollenweider, F.X. (2004). Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. *Psychopharmacology (Berlin)*, 172, 145-156.
9. Hofmann, A. (1983). *LSD: My problem child*. Los Angeles: Tarcher.
10. Horgan, J. (2003). *Rational mysticism: Dispatches from the border between science and spirituality*. Boston: Houghton Mifflin.
11. Huxley, A. (1956). *The doors of perception/Heaven and hell*. New York: Harper.
12. Leary, T. (1965). The religious experience: Its production and interpretation. In G.M. Weil, R. Metzner & T. Leary (Eds.), *The psychedelic reader* (pp. 191-216). Secaucus, NJ: Citadel Press.
13. Ludwig, A.M. (1970). LSD treatment in alcoholism. In J.R. Gamage & E.L. Zerkin (Eds.), *Hallucinogenic drug research: Impact on science and society*. Beloit, WI: Stash Press.
14. Maslow, A. (1964). *Religions, values and peak experiences*. New York: Viking Press.
15. Mehrabian, A. (1994). *Manual for the Emotional Empathic Tendency Scale (EETS)*. Available from Albert Mehrabian, 1130 Alta Mesa Road, Monterey, CA 93940.
16. Pahnke, W. (1966). The contribution of the psychology of religion to the therapeutic use of psychedelic substances. In Abramson, H. (Ed.), *The use of LSD in psychotherapy and alcoholism* (pp. 629-49). NY: Bobbs-Merrill.
17. Shanon, B. (2003). *The antipodes of the mind: Charting the phenomenology of the ayahuasca experience*. Oxford: Oxford University Press.
18. Strassman, R. (2001). *DMT: The spirit molecule*. Rochester, VT: Park Street Press.
19. Watts, A. (1965). *The joyous cosmology*. New York: Random House.

Hallucinogenic Drugs and Plants in Psychotherapy and Shamanism

by

Ralph Metzner

(published in: *Journal of Psychoactive Drugs*, Vol 30, No. 4, Oct-Dec 1998, special issue on: Therapeutic Use of Hallucinogens.)

California Institute of Integral Studies

original source: http://www.psychonautdocs.com/docs/Metzner - Hallucinogenic Plants.pdf
backup source: http://www.psilosophy.info/resources/Metzner - Hallucinogenic Plants.pdf

Table of Contents:

Abstract
Psychotherapy within the Standard Western Paradigm
Shamanic Rituals of Healing and Divination
Syncretic Folk Religious Ceremonies
Hybrid Shamanic Therapeutic Rituals
References

Abstract

Western psychotherapy and indigenous shamanic healing systems have both used psychoactive drugs or plants for healing and obtaining knowledge (called "diagnosis" or "divination" respectively). While there are superficial similarities between psychedelic-assisted psychotherapy and shamanic healing with hallucinogenic plants, there are profound differences in the underlying worldview and conceptions of reality. Four paradigms are reviewed: (1) psychedelic psychotherapy within the standard Western paradigm - here the drug is used to amplify and intensify the processes of internal self-analysis and self-understanding; (2) shamanic rituals of healing and divination, which involve primarily the shaman or healer taking the medicine in order to be able to "see" the causes of illness and know what kind of remedy to apply; (3) syncretic folk religious ceremonies, in which the focus seems to be a kind of community bonding and celebratory worship; and (4) the "hybrid shamanic therapeutic rituals," which incorporate some features of the first two traditions. There are two points in which the worldview of the shamanic and hybrid shamanic ceremonies differs radically from the accepted Western worldview: (1) the belief and assumption (really, perception) that there are multiple realities ("worlds") that can be explored in expanded states of consciousness; and (2) the belief that "spirits," the beings one encounters in dreams and visions, are just as real as the physical organism.

Keywords - hallucinogens, psychedelics, psychotherapy, shamanism, states of consciousness.

By way of introducing a comparative overview of the role of psychoactive drugs in psychological healing practices, a brief personal note might be permitted. As a psychologist, I have been involved in the field of consciousness studies, including altered states induced by drugs, plants and other means, for over 35 years. In the 1960s I worked at Harvard University with Timothy Leary and Richard Alpert, doing research on the possible therapeutic applications of psychedelic drugs, such as LSD and psilocybin (Leary, Metzner & Alpert 1964). During the 1970s the focus of my work shifted to the exploration of nondrug methods for the transformation of consciousness, such as those found in Eastern and Western traditions of yoga, meditation and alchemy (Metzner 1971). I also studied intensively the newer psychotherapeutic methods, many deriving from the work of pioneers such as Wilhelm Reich, that involve deep altered states induced by breathwork and bodywork. During the 1980s I came into contact with the work of Michael Harner (1980, 1973), Joan Halifax

(1982), Peter Furst (1976, 1972), Terence and Dennis McKenna (1975) and others, who have studied shamanic teachings and practices around the globe. These shamanic traditions involve non-ordinary states of consciousness induced by a variety of methods including ingesting hallucinogenic plants, but also drumming, fasting, wilderness vision questing, use of sweat lodges and others.

Realizing that there were traditions reaching into prehistoric times of the respectful use of hallucinogens for shamanic healing and divination, I became much more interested in the plants and mushrooms that have a history of such use. Indigenous people are known to have a profound knowledge of plants and herbs and their effects on the body and mind; they are well able to distinguish harmful from beneficial medicines. For this reason the vision-inducing plants that have a tradition of shamanic usage are much more likely to be safe, in contrast to newly discovered and synthesized drugs, the use of which may often involve unknown long-term risks.

It became clear to me, as a result of these explorations, that while Western psychotherapy and indigenous shamanism may sometimes use the same or similar psychoactive substances for healing and obtaining knowledge (called diagnosis in the West and divination in traditional cultures), there are profound differences between them in underlying worldview and assumptions about the nature of reality. In this article I propose to compare the use of psychoactives, as well as the underlying worldviews, in four systems of consciousness transformation: (1) psychotherapy within the standard Western paradigm, (2) shamanic rituals of healing and divination, (3) syncretic folk religious ceremonies, and (4) what I call hybrid therapeutic-shamanic rituals, which represent a blending of indigenous shamanic and Western psychotherapeutic approaches.

A note on terminology: I use the terms "psychedelic," "hallucinogenic" and "entheogenic" interchangeably. "Psychedelic," the term coined by Humphrey Osmond and Aldous Huxley and popularized by Leary and the Harvard group, means "mind-manifesting." "Hallucinogenic" is the term most often used in the psychiatric research literature for these substances. The main objection to the term hallucinogenic is that these drugs and plants do not in fact induce hallucinations, in the sense of "illusory perceptions." But the term hallucinogen deserves to be rehabilitated. The original meaning of the Latin *alucinare* is to "wander in one's mind"; and traveling or journeying in inner space are actually quite appropriate descriptive metaphors for such experiences, which are referred to colloquially as "trips." The term "entheogen," proposed by R. Gordon Wasson and Jonathan Ott, has the same root as "enthusiasm," and means "releasing or expressing the divine within" (Ott 1995).

Psychotherapy within the Standard Western Paradigm

When the fantastically potent mind-altering qualities of LSD were first discovered, at the height of World War II in a Swiss pharmaceutical lab, they were characterized as "psychotomimetic" and "psycholytic." The prospect of unhinging the mind from its normal parameters for a few hours to simulate madness interested a small number of daring psychiatric researchers as a possible training experience. Predictably, this possibility also intrigued the military and espionage agencies of both superpowers, especially the Americans. Considerable research effort and expense was devoted for about 10 years to determining the most effective surreptitious delivery systems to unsuspecting enemy soldiers, agents or leaders, for maximum confusion, disorientation or embarrassment (Lee & Shlain 1985). Ironically, and fortunately, it was the capacity of LSD to tap into the hidden mystical potentials of the human mind that ruined its applicability as a weapon of war. Rather than making subjects predictably submissive to mind-control programming, LSD had the unnerving propensity to suspend the existing mental programming and thereby release one into awesome worlds of cosmic consciousness. The military was not prepared to have soldiers or espionage agents turn into mystics.

The first research papers that came out of the Sandoz labs, where Albert Hofmann had synthesized LSD and accidentally discovered its astounding properties, described it as bringing about "psychic loosening or opening" (*seelische Auflockerung*). This was the *psycholytic* concept that became the dominant model for LSDassisted psychotherapy in Europe. In psycholytic therapy, neurotic patients suffering from anxiety, depression, or obsessive-compulsive or psychosomatic disorders were given LSD in a series of sessions at gradually increasing doses, while undergoing more or less standard analytic interactions using a Freudian perspective (Passie 1997; Grof 1980). The rationale was that through the *psycholysis*, the loosening of defenses, the patient would become more vividly aware of his or her previously unconscious emotional dynamics and reaction patterns (presumably acquired in early family interactions), and such insight would bring about a resolution of inner conflicts. The Czech psychiatrist Stanislav Grof, working within this model, made the startling discovery that in such a series (involving increasing doses) there could be an even deeper psychic opening - to birth and prebirth memories. After resolving the conflicts stemming from the Freudian dynamics of early childhood, patients would find themselves reliving the significant sensory-emotional features of their birth experience - patterns to which Grof gave the name *perinatal matrices* (Grof 1985).

More or less simultaneously with the psycholytic approach being developed in Europe, the *psychedelic* model became the preferred approach in Anglo-American psychological and psychiatric circles. The English psychiatrist Humphrey Osmond, who worked in Canada with Abram Hoffer on the treatment of alcoholism with LSD (and who provided Aldous Huxley with his first mescaline experience, immortalized in *The Doors of Perception* (Huxley 1954), introduced this term in an exchange of letters with Huxley. First used in the treatment of alcoholics, where it was thought to simulate the often life-changing "bottoming out" experience, psychedelic therapy usually involved one or a small number of high-dose sessions, during which the contents of the unconscious mind would be manifested in the form of vivid hallucinatory imagery, leading to insight and transformation (Passie 1997). A second center for psychedelic therapy and exploration developed in the early sixties in Southern California, where Sidney Cohen, Oscar Janiger and others began providing psychedelic experiences to their clients in the Hollywood film, arts and media community (Novak 1997) - work that brought considerable publicity and notoriety to psychedelics.

The term "psychedelic" was adopted by Timothy Leary, Frank Barron, Richard Alpert and the Harvard research project, which did one of its first research studies on the production of behavior change in convicts, and started publishing the *Psychedelic Review*. Apart from the prison project, Leary's work focused not so much on treatment or therapy, but rather on exploring the possibilities and values of the psychedelic experience for "normals" (mostly graduate students) as well as artists, musicians, poets and writers, when provided in a relatively unstructured but supportive, home-like setting. The concept of "consciousness expansion" was introduced for these experiences, which could be usefully contrasted with the contracted, fixated awareness characteristic of narcotic addictions, as well as obsessions and compulsions in general (Metzner 1994). Leary was also responsible for introducing and popularizing what became known as the "set and setting" hypothesis, according to which the primary determinants of a psychedelic experience are the internal set (intention, expectation, motivation) and the external setting or context, including the presence of a guide or therapist (Leary, Litwin & Metzner 1963).

The psychological research on psychedelics, as well as the psycholytic and psychedelic psychotherapy applications, have been well summarized and reviewed by Lester Grinspoon and James Bakalar (1979/1997) in their book *Psychedelics Reconsidered*. The history of the introduction of LSD and other hallucinogens into American culture with its many extraordinary and unforeseen social and political consequences has been described by Jay Stevens (1987) in his book *Storming Heaven*. Leary's own story of these events in which he was centrally involved is told in his own unique, provocative and tricksterish style in his several autobiographies, most particularly in *High Priest* (1968/1995) and *Flashbacks* (1983).

A significant extension of the field of psychoactive-assisted psychotherapy occurred with the discovery by chemist Alexander Shulgin of a variety of phenethylamines, such as MDA, MDMA, 2-CB and others, which bring about an expansion and centering of awareness primarily on the emotional or heart-level, with minimal or no perceptual changes or other-worldly consciousness (Shulgin & Shulgin 1991). For this reason, to distinguish them from the classical hallucinogens, some have suggested the name *empathogens* ("generating a state of empathy") for this class of substances. In particular, MDMA (which also became known as Ecstasy or E, and as such has come to play a central role in the hugely popular rave culture) was used with impressive success in psychotherapy - often facilitating a significant opening of relationship communication and helping in the healing of disabling trauma (Saunders 1993; Eisner 1989; Adamson & Metzner 1988).

Despite the seeming theoretical and practical differences between the psycholytic and psychedelic approaches, there are a number of significant fundamental conclusions and directions which they share, and which I would now like to summarize. These are all features of psychoactives-assisted psychotherapy that distinguish this modality from other uses of mood-altering drugs such as tranquilizers or antidepressants, in which the patient or client takes a pill and goes home:

1. It is recognized that psychotherapy with hallucinogens invariably involves an experience of a profoundly *expanded state of consciousness*, in which the individual can not only gain therapeutic insight into neurotic or addictive emotional dynamics and behavior patterns, but may come to question and transcend fundamental self-concepts and views of the nature of reality.
2. It is widely accepted in the field that *set and setting* are the most important determinant of experiences with psychedelics, while the drug plays the role of a catalyst or trigger. This is in contrast to the psychiatric or other psychoactive drugs (including stimulants, depressants and narcotics) where the pharmacological action seems paramount, and set and setting play a minor role. The set-and-setting model can also be extended to the understanding of other modalities of altered states of consciousness, involving nondrug triggers such as hypnosis, meditation, rhythmic drumming, sensory isolation, fasting, and others (Metzner 1989).
3. Two analogies or metaphors for the drug experience have been repeatedly used by writers both in the psycholytic and psychedelic paradigms. One is the *amplifier analogy*, according to which the drug functions as a nonspecific amplifier of psychic contents. The amplification may occur in part as a result of a lowering of sensory thresholds, a "cleansing of the doors of perception," and in part be due to not-yet-understood central processes involving one or more neurotransmitters. The other analogy is the *microscope metaphor*: it has repeatedly been said that psychedelics could play the same role in psychology as the microscope does in biology - opening up to direct, repeatable, verifiable observation realms and processes of the human mind that have hitherto been largely hidden or inaccessible.
4. Again in contrast to the use of other psychiatric or psychoactive drugs, it is widely recognized that the *personal experience of the therapist* or guide is an essential prerequisite of effective psychedelic psychotherapy. Without such prior personal experience, communication between the therapist and the individual in a psychedelic state is likely to be severely limited. This principle implies also that a significant role for psychedelic experience could be in the training of psychotherapists. The vast majority of psycholytic and psychedelic therapists would of course not sanction the taking of the drug by the therapist together with the client.
5. *Access to transcendent, religious or transpersonal dimensions of consciousness* can be attained. That mystical and spiritual experiences can and often do occur with the use of psychedelics was recognized early on by most researchers in this field, thereby posing both challenge and promise to the psychological disciplines and professions. Albert Hofmann has testified that his ability to recognize the psycholytic properties of the LSD experience was based on its similarity to his childhood mystical experiences in nature (Hofmann 1979). Stanislav Grof found that after resolving biographical childhood issues, and then the perinatal traumata, individuals would often find themselves in realms of consciousness completely transcendent of time, space and other parameters of our ordinary worldview (Grof 1985). He gave the name "transpersonal" to these realms of consciousness and "holotropic" ("seeking the whole") to the predominant quality of consciousness in these realms, as well as to other means of accessing these realms, such as certain breathing methods (holotropic breathwork).

Timothy Leary, stimulated by his association with Aldous Huxley, Huston Smith and Alan Watts, devoted considerable time and energy to exploring and describing the spiritual and religious dimensions of psychedelic experience. This work resulted in adaptations of the Tibetan Buddhist *Bardo Thödol* (Leary, Metzner & Alpert 1964) and the Chinese Taoist *Tao Te Ching* (Leary 1997) as guidebooks for psychedelic experience. Based on his initiating experience with Mexican magic mushrooms, it would also be true to say that Leary was the first person to recognize and articulate that the fundamental mystical vision that emerges in these states is an *evolutionary remembering* - an experience of reconnecting with our biological and cosmological evolution. In other words, he realized the experience went beyond the personal and cultural developmental issues that usually concern psychologists, and that the language of mystics and shamans in our time was basically going to be the scientific language of evolution.

Shamanic Rituals of Healing and Divination

Synchronistically with the revelations and insights emerging from psychedelic research in psychology and religion, a generation of students and researchers in anthropology and ethnobotany was inspired to explore the roots of humankind's involvement with psychoactive plants in shamanism. These works ranged from Wasson's rediscovery of the pre-Columbian magic mushroom cult, and Harner's early work on the role of hallucinogens in European witchcraft-shamanism, to the work of sober researchers like Weston LaBarre, Richard Evans Schultes, Claudio Naranjo and Peter Furst, as well as the more fantastic and imaginative writings of Carlos Castaneda and Terence McKenna. It is fascinating to realize, in hindsight, that the two texts which seemed to lend themselves most readily to psychedelic adaptation (the *Bardo Thödol* and the *Tao Te Ching*) come from religious traditions in which shamanic elements were strong. In Tibetan Buddhism, as in Chinese Taoism, practices of connecting with spirits of nature through special visionary states were integrated into the teachings concerning spiritual development and liberation.

If we accept the idea, growing out of scientific research, that set and setting are the crucial determinants of the content of a hallucinogenic experience, then the use of these substances in a ritual setting, with careful attention paid to conscious intention, is in fact the logical as well as the traditional approach. Shamanic rituals involving hallucinogens are the intentional arrangement of the set and the setting for purposes of healing and divination. Traditional Western psychotherapy, with or without psychedelics, can also appropriately be seen as a ritual - i.e., an experience formally structured according to the intention of healing or problem-solving. The traditional *shamanic ceremonial* form involving hallucinogenic plants is a carefully structured experience, in which a small group of people (six to 12) come together with respectful, spiritual attitudes to share a profound inner journey of healing and transformation, facilitated by these powerful catalysts. A "journey" is the preferred metaphor in shamanistic societies for what we call an "altered state of consciousness."

There are three significant differences between shamanic entheogenic ceremonies and the typical psychedelic psychotherapy session. One is that the traditional shamanic rituals involve very little or no talking among the participants, except perhaps during a preparatory phase or after the experience to clarify the teachings and visions received. The second is that singing, or the shaman's singing, is invariably considered essential to the success of the healing or divinatory process; furthermore the singing typical in entheogenic rituals usually has a fairly rapid beat, similar to the rhythmic pulse in shamanic drumming journeys (widespread in shamanistic societies of the Northern Hemisphere in Asia, Europe and America). Psychically, the rhythmic chanting, like the drum pulse, seems to give support for moving through the flow of visions, and minimizes the likelihood of getting stuck in frightening or seductive experiences. The third distinctive feature of traditional ceremonies is that they are almost always done in darkness or low light - which facilitates the emergence of visions. The exception is the peyote ceremony, done around a fire (though also at night); here participants may see visions as they stare into the fire. I should point out that the hybrid therapeutic forms that have been developing in the past few decades (to be discussed below) have incorporated these three features from the shamanic model.

As mentioned above, psychotherapists working within the psycholytic and psychedelic model quickly came to the consensus that the therapist working with these substances had to have prior experience with them. This is so widely assumed in shamanic societies that it is hardly even discussed. Typically, a shamanic healer working with entheogenic plants undergoes a lengthy initiation and training (sometimes lasting years) under the guidance of an experienced elder before working with others.

I will briefly mention some of the variations on the traditional rituals involving hallucinogens. In the peyote ceremonies of the Native American Church in North America, participants sit on the ground in a circle around a blazing central fire in a tipi. The ceremony lasts all night and is conducted by a "roadman," with the assistance of a drummer, a firekeeper and a cedar-man (for purification). A staff and rattle are passed around and participants sing the peyote songs, which involve a rapid, rhythmic beat. The peyote ceremonies of the Huichol Indians of Northern Mexico also take place around a fire, with much singing and story-telling, after the long group pilgrimage to find the rare cactus (Pinkson 1995; Myerhoff 1974; La Barre 1964).

The ceremonies of the San Pedro cactus in the Andean regions are sometimes also done around a fire, with singing; but sometimes the *curandero* sets up an altar, on which are placed different symbolic figurines and objects representing the light and dark spirits which one is likely to encounter (Calderon *et al*. 1982).

The mushroom ceremonies (*velada*) of the Mazatec Indians of Mexico involve the participants sitting or lying in a very dark room with only a small candle. The healer, who may be a woman or a man, sings almost uninterruptedly throughout the night, weaving into his or her chants the names of Christian saints, spirit allies and the spirits of the Earth, the elements, animals and plants, the sky, the waters and the fire (Estrada 1981; Wasson 1980).

Traditional Amazonian Indian or mestizo ceremonies with ayahuasca also involve a small group sitting in a circle, in semidarkness, while the initiated healers sing the songs (*icaros*), through which the healing and/or diagnosis takes place. These songs also have a fairly rapid rhythmic pulse, which keeps the flow of the experience moving along. Shamanic "sucking" methods of extracting toxic psychic residues or sorcerous implants are sometimes used (Luna & Amaringo 1991; Dobkin de Rios 1984).

The ceremonies involving the African *iboga* plant, used by the Bwiti cult in Gabon and Zaïre, involve an altar with ancestral and deity images, and people sitting on the floor with much chanting and some dancing. Often, there is a mirror in the assembly room, in which the initiates may "see" their ancestral spirits (Samorini 1995; Fernandez 1982).

Certain common elements can be found in the anthropological literature on the experiences of shamanistic indigenous societies with hallucinogenic plants. These features are also found in accounts of shamanic journey experiences with other modalities, such as drumming, vision questing, or conscious dreaming. It is clear that these experiential features imply the existence of a radically different worldview (than the Western) in entheogenic shamanic practitioners. I will simply list these features, since there is not the space here to document them extensively.

1. The role of the guide, *curandera* or healer is always described as central and essential. This must be a person with extensive personal experience in the use of these medicines, who agrees to provide an initiatory experience to a seeker or training to an apprentice. In virtually all entheogenic rituals, the guide or shaman does much or all of the singing, and this singing profoundly shapes the quality and content of the experience.
2. The experience can be *healing* on physical, psychic and spiritual levels (although traditional shamanic healers do not make such analytic distinctions). Shamanic healing experiences, with entheogens or other means, have three main variations: one is the extraction of a toxin that may have been implanted by means of sorcery; the second is the retrieval of a split-off psychic fragment or "soul"; and the third is the experience of being dismembered or destroyed, and then reconstituted with a healthier, stronger "body."
3. The experience can provide *access to hidden knowledge* - this is the aspect of divination, "seeing," prophecy, intuition or visioning. If the intention or context is healing, then the divination would be equivalent to what Western medicine calls diagnosis - e.g., determining from where and from whom the particular toxic implant came, where has the soul-fragment been "lost," what particular herbs should be used for the person's illness, etc. It is said that there is an intelligence associated with the plant medicine that communicates in an interior way to the person who ingests the medicine. Indigenous healers refer to the entheogenic plants as "plant teachers."
4. There is a feeling and perception of *access to metaphysical realms or worlds*. Such realms have, in shamanic, esoteric or magical traditions, been referred to variously as the "inner world," "spirit world," "upper or lower world," "faerie world," "dreamtime" or "otherworld." Some anthropologists, including Michael Harner, refer to them as "nonordinary reality." The access to these other-worlds may come through a kind of journey to that world, perhaps traveling on the back of an animal or being carried by a large bird. Alternatively, one may feel that one can see into the spirit world without moving, while still aware of the ordinary present world of time-space as well. Scenery and beings of the other world may appear in our world. In any event, the usual boundaries between the worlds seem to become more permeable during such experiences.
5. The experience may involve the *perception of nonmaterial, normally invisible, spirit beings or entities*. Such spirits are recognized as being associated with particular animals (e.g., a serpent or jaguar), certain plants, trees or fungi, certain places (e.g., a river or rainforest), deceased ancestors, and other nonordinary entities (e.g., extraterrestrials or elves). It can include the experiences of actually becoming or identifying with that spirit (e.g., the experience of becoming a jaguar or a serpent). The healing and divination is experienced as being done by or with the assistance of such spirits, also referred to as "allies," "power animals," "guardians" or "helpers." In some healing rituals, there may also be contact with bad or malevolent spirits that need to be exorcised or neutralized in some way.

In comparing Western psychoactive-assisted psychotherapy with shamanic entheogenic healing rituals, we can see that the role of an experienced guide or therapist is equally central in both, and the importance of set (intention) and setting is implicitly and explicitly recognized in both. Healing and insight may take place with both approaches, though the underlying paradigms of illness and treatment are completely different. There is a great deal of as-yet-poorly or not-at-all understood about the processes of illness and healing.

The role of divination is implicitly acknowledged in the Western models through the amplifier analogy and the microscope metaphor. The two elements in the shamanic traditions that pose the most direct and radical challenge to the accepted Western worldview are the existence of multiple worlds and of spirit beings - such conceptions are considered completely beyond the pale of both reason and science. However, we shall see that in the hybrid shamanic-therapeutic rituals and practices, the recognition of multiple dimensions and of the reality of spirit beings is becoming quite common.

Syncretic Folk Religious Ceremonies

The distinction I am drawing here between entheogen-based shamanic rituals and folk religious ceremonies involving plant entheogens is in some ways arbitrary - there is, rather, a continuum of ritual forms and practices. The emphasis in shamanic practices is healing and divination, and they are usually conducted in small groups of around a dozen participants, or sometimes just with one or two afflicted individuals and with apprentices. The folk religious ceremonies often involve fairly large groups of 20 to 40 participants, and in the case of the Brazilian *hoasca* churches several hundred. Here the aspect of healing and divination or visioning tends to recede more into the background, and the primary focus is on group worship and celebration with singing and prayer. Instead of a shaman or healer there are priests and officiants. There is very little or no discussion or sharing of visions or insights, as there would be in the context of a shamanic healing or divination.

The groups coalescing around such entheogenic folk ceremonies in an urban or village society have usually organized themselves into recognized churches, providing their members with a certain degree of social cohesion and protection. An important social function of these religious ceremonies is to strengthen community bonds and give members a sense of participation and belonging. Participation in the Native American Church in the United States, as well as the *hoasca* churches in Brazil, tends to reduce the incidence of alcoholism and drug addiction (McClusky 1997; Grob *et al*. 1996). As has been noted by some anthropologists, a further societal function of these churches is to provide a protective shield of traditional lore against the encroachments of Christian missionaries and the seductions of Western consumer culture in general (Taussig 1987; Fernandez 1982).

The use of peyote by the Huichols of Mexico follows more the traditional shamanic healing model, involving careful and lengthy apprenticeships for the *curanderos*, and a group pilgrimage to the sacred land of Wirikuta to find the sacred cactus. The actual ceremonies are accompanied by much singing and telling of creation myths and other sacred stories (Pinkson 1995; Myerhoff 1974). Native American tribes in the United States legally incorporated the Native American Church (NAC) as an organized religion that uses the peyote cactus as a sacrament. Though their legal protection has been eroded in recent court decisions, for most of this century the NAC has enjoyed legal access to the entheogens in most of the Western states (Peregoy, Echo-Hawk & Botsford 1995). Native American Church ceremonies follow a fairly consistent format, with a "roadman" presiding, and with almost constant singing of traditional peyote songs throughout the night. There is virtually no discussion of healing processes or "visions" during or after the ceremony, although individual participants may of course have healing or visionary experiences. NAC ceremonies are legally limited to persons with 25% or more Indian ancestry, although some ceremonial leaders have opened up their ceremonies to non-Indians as well.

In Brazil there are no less than three organized churches in which ayahuasca is the main sacrament: the Santo Daime, Uniao de Vegetal (UDV) and Barquinia. Each was founded by rubber tappers working in the Amazon region in the 1950s, who came into contact with the hallucinogenic vine through mestizo or Indian *ayahuasceros*. The founder of each of them reported a significant vision which instructed them to organize a church using the brew or "tea" as the principal sacrament. Members of the churches come from all walks of life and both urban and rural environments in Brazil. Each has by now several thousand members in Brazil, and two of the churches have significant satellite centers in North America and Europe. The churches are officially recognized and the use of the ayahuasca is legal in Brazil within that framework.

Typically, the ceremonies are held weekly in specially-built temples, and may range in size from 20 or 30 to several hundred participants. Each of the churches has some differences of emphasis and ceremonial form. The UDV, the largest, is also the most formal: participants sit in rows in straight-backed chairs during the ceremony, listening to sermons and songs given by the *maestres* who sit around a table in the center; there is also a question and answer period. Sometimes testimonials of life-transformations are offered by longer-term members, reminiscent of AA confessions. The Santo Daime, which was founded by a Brazilian of African descent, involves the singing of hymns by the entire congregation, led by a small group of women singers. Some of the Santo Daime ceremonies also involve dancing, in simple rhythmic, swaying steps - the whole somewhat reminiscent of African-American gospel services. The Barquinia church, less well known outside of Brazil, has incorporated elements of Umbanda, an Afro-Brazilian religious movement that involves contact with deceased ancestors and deities known as *orixas*. These ceremonies also involve both singing and dancing. The research of Charles Grob, Dennis McKenna and others has confirmed that membership in these churches and long-term drinking of the tea is associated with no adverse health effects - and indeed with a reduction of addictions and other psychopathologies (Grob *et al*. 1996).

The Bwiti cult among the Fang people in Gabon and Zaire involves the use of the powerful hallucinogen iboga or eboka, from which ibogaine is derived. The use of iboga, like peyote in North America, exists in both shamanic and syncretic religious ceremonial forms. Originally, the Fang, who are village dwellers, say they learned about the iboga brew from the Pygmies, the deep forest dwellers. Initiates are taken through a powerful death-rebirth experience, in which their "head is opened up," after which they are able to converse with their ancestor spirits, who can guide them in their lives. The Bwiti ceremonies are held in temples, with an altar and officiating priests, where the initiate men and women, daubed with white mud, sit and sing in lengthy ceremonies. (Samorini 1995; Fernandez 1982). Pharmacological research has indicated that ibogaine may have a specific action on the receptor sites for cocaine in the brain, raising the possibility that it may be a chemical antidote to addiction (Lotsof 1995). The more plausible assumption is that all the "consciousness-expanding" hallucinogens, including LSD, peyote, ayahuasca and others, can serve to counteract the consciousness-contracting and fixating effect of the addictive narcotics or stimulants (Halpern 1996).

These syncretic religious movements, particularly the ayahuasca churches in Brazil, have brought the use of entheogenic plant substances out of the context of shamanic healing rituals, where only a very limited number of people came into contact with them. They have made profoundly spiritually transforming experiences with entheogenic plant medicines accessible to a large number and wide spectrum of people in all walks of life. As such, we may be seeing the beginnings of a broader cultural transformation movement with significant impact.

Hybrid Shamanic Therapeutic Rituals

There are numerous kinds of set-and-setting rituals using hallucinogens in the modern Western world, ranging from the casual, recreational "tripping" of a few friends to "rave" events of hundreds or thousands, combining Ecstasy (MDMA) with the continuous rhythmic pulse of techno music. My own research has focused on what might be called neoshamanic medicine circles, which represent a kind of hybrid of the psychotherapeutic and traditional shamanic approaches. In the past dozen years or so I have been a participant and observer in over 100 such circle rituals, in both Europe and North America, involving several hundred participants, many of them repeatedly. Plant entheogens used in these circle rituals have included psilocybe mushrooms, ayahuasca, San Pedro cactus, iboga and others. My interest has focused on the nature of the psychospiritual transformation undergone by participants in such circle rituals (Metzner 1999).

In these hybrid therapeutic-shamanic circle rituals certain basic elements from traditional shamanic healing ceremonies are usually kept intact:

- the structure of a circle, with participants either sitting or lying;
- an altar in the center of the circle, or a fire in the center if outside or in tipi;
- the presence of an experienced elder or guide, sometimes with one or more assistants;
- a preference for low light, or semidarkness; sometimes eye-shades are used;
- use of music: drumming, rattling, singing or evocative recorded music;
- dedication of ritual space through invocation of spirits of four directions & elements; and
- cultivation of a respectful, spiritual attitude.

Experienced entheogenic explorers understand the importance of set and therefore devote considerable attention to clarifying their intentions with respect to healing and divination. They also understand the importance of setting and therefore devote considerable care to arranging a peaceful place and time, filled with natural beauty and free from outside distractions or interruptions.

Most of the participants in circles of the kind that I witnessed were experienced in one or more psychospiritual practices, including shamanic drum journeying, Buddhist *vipassana* meditation, tantra yoga and holotropic breathwork, and most have experienced and/or practiced various forms of psychotherapy and bodyoriented therapy. The insights and learnings from these practices are woven by the participants into their work with the entheogenic medicines. Participants tend to confirm that the entheogenic plant medicines, when combined with meditative or therapeutic insight processes, function to amplify awareness and sensitize perception, particularly amplifying somatic, emotional and instinctual awareness.

Some variation of the *talking staff* or *singing staff* is often used in such ceremonies: with this practice, which seems to have originated among the Indians of the Pacific Northwest, and is also more generally now referred to as "council," only the person who has the circulating staff sings or speaks, and there is no discussion, questioning or interpretation (as there might be in the usual group psychotherapy formats). Some group sessions, however, involve minimal or no interaction between the participants during the time of the expanded state of consciousness.

In preparation for the circle ritual there is usually a sharing of intentions and purposes among the participants, as well as the practice of meditation, or sometimes solo time in nature, or expressive arts modalities, such as drawing, painting or journal work. After the circle ritual (sometimes the morning after), there is usually an integration practice of some kind, which may involve participants sharing something of the lessons learned and to be applied in their lives.

The majority of Westerners who have developed an ongoing practice of working with entheogenic plant substances seem to have expanded their belief systems beyond the boundaries of the conventional materialistic paradigm of Western science and psychology. While accepting the validity of many Western psychological insights, including those of Freud, C.G. Jung and Wilhelm Reich, they have come - like indigenous people and devotees of Asian and Western esoteric traditions - to accept the reality of nonmaterial spirit beings and to recognize that we live in multiple worlds of consciousness.

Western psychology may, through such explorations, be finally coming around to the views expressed by William James, after his personal research with the psychedelic anesthetic nitrous oxide, almost 100 years ago:

> Our normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens, there lie potential forms of consciousness entirely different... . No account of the universe in its totality can be final which leaves these other forms of consciousness quite disregarded (James 1901/1958: 228).

References

1. Adamson, S. & Metzner, R.1988. The nature of the MDMA experience and its role in healing, psychotherapy and spiritual practice. *ReVision*. 10 (4): 59-72.
2. Calderon, E.: Cowan, R.; Sharon, D. & Sharon, F.K. 1982. *Eduardo el Curandero: The Words of a Peruvian Healer*. Berkeley: North Atlantic Books.
3. Dobkin de Rios, M. 1984. *Hallucinogens: Cross-Cultural Perspectives*. Albuquerque: University of New Mexico Press.
4. Eisner, B. 1989. *Ecstasy- The MDMA Story*. Berkeley, California: Ronin Publishing.
5. Estrada, A. 1981. *Maria Sabina- Her Life and Chants*. Santa Barbara, California: Ross-Erikson.
6. Fernandez, W.J. 1982. *Bwiti: An Ethnography of the Religious Imagination in Africa*. Princeton, New Jersey:Princeton University Press.
7. Furst, P. 1976. *Hallucinogens and Culture*. San Francisco: Chandler & Sharp.
8. Furst, P. (Ed.) 1972/1990. *Flesh of the Gods*. Prospect Heights, Illinois: Waveland Press.
9. Grinspoon, L. & Bakalar, J. 1979. *Psychedelic Drugs Reconsidered*. New York: Basic Books.
10. Grob, C.S.; McKenna, D.J.; Callaway, J.C.; Brito, G.S.; Neves, E.S.; Oberlaender, G.; Saide, O.L.; Labigalini, E.; Tacla, C.; Miranda, C.T.; Strassman, R.J. & Boone, K.B. 1996. Human psychopharmacology of hoasca, a plant hallucinogen used in ritual context in Brazil. *Journal of Nervous and Mental Disease* 184 (2):86-94.
11. Grof, S. 1985. *Beyond the Brain: Birth, Death and Transcendence in Psychotherapy*. Albany, New York: State University of

New York Press.
12. Grof, S. 1980. *LSD Psychotherapy*. Pomona, California: Hunter House.
13. Halifax, J. 1982. *Shaman - Wounded Healer*. New York: Crossroad Publishing Co.
14. Halpern, J. 1996. The use of hallucinogens in the treatment of addiction. *Addiction Research* 4 (2): 177-89.
15. Harner, M. 1980. *The Way of the Shaman*. San Francisco: Harper & Row.
16. Harner, M. (Ed.) 1973. *Hallucinogens and Shamanism*. New York: Oxford University Press.
17. Hofmann, A. 1979. *LSD - Mein Sorgenkind*. Stuttgart: Klett-Cotta.
18. Huxley, A. 1954. *The Doors of Perception*. New York: Harper & Row.
19. James, W. 1901/1958. *Varieties of Religious Experience*. New York: New American Library.
20. La Barre, W. 1964. *The Peyote Cult*. Hamden, Conncticut: Shoestring Press.
21. Leary, T. 1997. *Psychedelic Prayers and Other Meditations*. Berkeley, California: Ronin Publishing Co.
22. Leary, T. 1968/1995. *High Priest*. Berkeley, California: Ronin Publishing Co.
23. Leary, T. 1983. *Flashbacks*. Los Angeles: J. P. Tarcher.
24. Leary, T.; Litwin, G. & Metzner, R. 1963. Reactions to psilocybin administered in a supportive environment. *Journal of Nervous and Mental Disease* 137:561-73.
25. Leary, T.; Metzner, R. & Alpert, R. 1964. *The Psychedelic Experience - A Manual Based on the Tibetan Book of the Dead*. New Hyde Park, New York: University Press Books.
26. Lee, M. & Shlain, B. 1985. *Acid Dreams*. New York: Grove Weidenfeld.
27. Lotsof, H.S. 1995. Ibogaine in the treatment of chemical dependence disorders: Clinical perspectives. *MAPS Bulletin* V (3): 16-27.
28. Luna, L.E. & Amaringo, E. 1991. *Ayahuasca Visions - The Religious Iconography of a Peruvian Shaman*. Berkeley, California: North Atlantic Books.
29. McClusky, J. 1997. Native American Church peyotism and the treatment of alcoholism. *MAPS Bulletin* VII (4): 3-4.
30. McKenna, T. & McKenna, D. 1975. *The Invisible Landscape*. New York: Seabury Press.
31. Metzner, R. (Ed.) 1999. *Ayahuasca - Human Consciousness and the Spirits of Nature*. New York: Thunder's Mouth Press.
32. Metzner, R. 1994. Addiction and transcendence as altered states of consciousness. *Journal of Transpersonal Psychology* 26 (1): 1-17.
33. Metzner, R. 1989. States of consciousness and transpersonal psychology. In: R.Vallee & S. Halling (Eds.) *Existential and Phenomenological Perspectives in Psychology*. New York: Plenum Press.
34. Metzner, R. 1988. Molecular mysticism - The role of psychoactive substances in shamanic transformations of consciousness. *Shaman's Drum* 12:15-21.
35. Metzner, R. 1971. *Maps of Consciousness*. New York: Collier-Macmillan.
36. Myerhoff, B. 1974. *Peyote Hunt - The Sacred Journey of the Huichol Indians*. Ithaca, New York: Cornell University Press.
37. Novak, S.J. 1997. LSD before Leary - Sidney Cohen's critique of 1950s psychedelic drug research. *Isis* 88: 87-110.
38. Ott, J. 1995. *The Age of Entheogens & The Angels' Dictionary*. Kennewick, Washington: Natural Products Co.
39. Passie, T. 1997. *Psycholytic and Psychedelic Therapy Research - 1931-1995*. Hanover: Laurentius Publishers.
40. Peregoy, R.; Echo-Hawk, W. & Botsford, J. 1995. Congress overturns Supreme Court's peyote ruling. *NARF Legal Review* 20 (1): 1-25.
41. Pinkson, T.S. 1995. *Flowers of Wiricuta*. Mill Valley, California: Wakan Press.
42. Samorini, G. 1995. The Buiti religion and the psychoactive plant *Tabernanthe iboga* (Equatorial Africa). *Integration* 5:105-13.
43. Saunders, N. 1993. *E for Ecstasy*. London: Self-Published.
44. Shulgin, A. & Shulgin, A. 1991. *PIHKAL - A Chemical Love Story*. Berkeley, California: Transform Press.
45. Stevens, J. 1987. *Storming Heaven - LSD and the American Dream*. New York: Atlantic Monthly Press.
46. Taussig, M. 1987. *Shamanism, Colonialism and the Wild Man - A Study in Terror and Healing*. Chicago: University of Chicago Press.
47. Wasson, R.G. 1980. *The Wondrous Mushroom*. New York: McGraw-Hill.

Psychointegration - The Physiological Effects of Entheogens

by

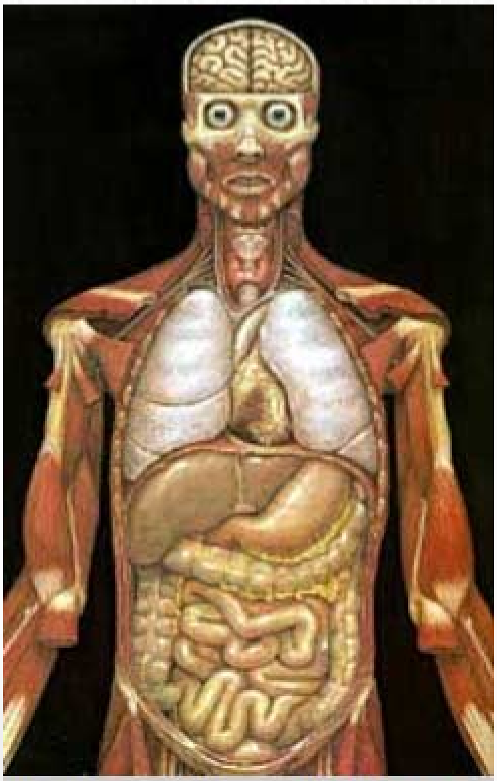
Michael Winkelman

original source: http://www.public.asu.edu/~atmxw/psychointegration.pdf
backup source: http://www.psilosophy.info/resources/psychointegration.pdf

Table of Contents:

Introduction
Cross-Cultural Patterns in Societal Responses to Entheogens
Societal Differences in the Use of Psychointegrative Plants
Botanical, Chemical Experimental, and Neurological Approaches to Entheogens
Neurological Perspectives on Psychointegrators
Psychointegrators and Neurotransmitter Functions and the Brain
Psychointegrators, Altered States of Consciousness, and the "Divine Other"
Conclusions: Systemic Integration of Brain Function
Notes
References

Vision inducing plants, commonly referred to as entheogens, hallucinogens, and psychedelics, have played important roles in the therapeutic and religious practices of many societies. Cross-cultural research indicates that their common effects include the induction of powerful emotional, cognitive and therapeutic reactions and interpretations, suggesting these are consequences of similar psychophysiological properties of the substances. Neurophysiological studies illustrate the common physiological effects of entheogens involve psychointegrative effects through intervention in the serotonergic neurotransmitter systems. Psychointegration underlies the entheogens' cross-cultural use as sacred and therapeutic agents. The effects of psychointegrators upon neural, sensory, emotional, and cognitive processes illustrate their adaptive effects in the stimulation of integrative information processing and enhancement of access to lower structures of consciousness. Psychointegrative effects derive from the disinhibition of emotional and social processes and the stimulation of systemic integration of brain functions, particularly the integration of limbic system processes with neocortical processes. Psychointegrators couple nonlinguistic behavioral and social-emotional dynamics with rational processes and functionally integrate different systems of the brain while enhancing spiritual and transcendent experiences by stimulating brain operations supporting basic structures and functions of consciousness (self, other and affect/attachment).



Alex Grey, *Viscera* (detail), 1979.
Oil on linen (84" x 46")

Introduction

The plants with entheogenic effects have played important roles cross-culturally and across history. Where used, they generally have been viewed as central sources of spiritual experience and religious participation, providing inspiration for the institutionalization of religious sentiments and activities (e.g. see Dobkin de Rios 1984, Schultes and Hofmann 1979, Winkelman and Andritzky 1996). These plants are important in understanding cultural and religious development. As La Barre (1972) pointed out, understanding the pharmacological effects illuminates their central roles in many cultures as sources of religious and spiritual inspiration, shamanic ecstasy and visionary experience. An integration of laboratory studies of entheogens' neurophysiological effects and neurotransmitter interactions with ethnographic and cross-cultural studies on their social and therapeutic uses illustrates why they have important personal and cultural functions. Such substances may be also seen as dangerous agents and demonic influences to be prohibited. Understanding why these substances evoke such powerful social reactions requires knowledge of their biophysiological, cognitive and psychosocial effects.

This paper develops a neurophenomenological perspective (e.g. see Laughlin d'Aquilli and McManus 1992; Winkelman 2000) on the institutionalized cultural use of entheogenic plants, addressing their biochemical mechanisms to enhance understandings of their psychodynamic and phenomenal effects upon human experience. This interdisciplinary synthesis provides the rationale for the term "psychointegrator" to refer to the central effects of entheogens, and contributes to a "neurotheological" perspective on the biological mechanisms of sacred experiences (e.g., d'Aquili and Newberg, 1999; Joseph, 2001; Winkelman, 2000). The cross-cultural social and therapeutic uses of entheogens are based in their neurophysiological effects upon the serotonergic neurotransmitter systems. This is the basis for their characterization as "psychointegrators", enhancing processing of fundamental information regarding self, emotions, social relations, attachments, and the overall integration of information in the brain. The neurological foundations explain the widespread common patterns of use of these plant substances in religious and therapeutic practices. Entheogenic plants are generally used along with other means of inducing altered states of consciousness (ASC) in shamanistic healing practices that reflect the universal institutionalization of the psychobiological potentials of ASC (Winkelman 1986a & b, 1990, 1992). This use of ASC is functional, based upon physiological changes that facilitate healing and cognition through a number of physiological and psychological mechanisms (Winkelman

1992, 2000). Shamanic ASC are the quintessential spiritual experience of "ecstasy", providing a neurological basis for the role of chemical agents as sources of spiritual experience.

Cross-Cultural Patterns in Societal Responses to Entheogens

The cross-cultural use of entheogens is consistently associated with the fundamental principles reflected in the etymology of the term - the belief that they are powerful spiritual forces that provide access to internal sacred worlds and have simultaneous therapeutic applications (see Dobkin de Rios 1984; Emboden 1972, 1989; Furst 1972, 1976; Riedlinger 1990; Schultes 1972; Schultes and Hofmann 1979; Wasson 1980; Wasson *et al*. 1974, 1986; Winkelman 1996). Entheogens not only dramatically alter experience, shifting self-awareness to an "other-worldly" sacred or spiritual domain; they also have important applications as therapeutic agents. Furthermore, there are ubiquitous interpretations of these plants' effects, a universal social psychology that involves: personal relations with an animistic world (especially power animals); participation in a mythical time which reaffirms cultural values and beliefs; contact with a spiritual source of power and self identification; ego dissolution and transformation; healing and divination; and enhancement of social solidarity and identity, and interpersonal and community relations (Winkelman 1996).

Alex Grey, *Ayahuasca Visitation*, 2001. Colored pencil and acrylic on paper (11 3/4" x 16 1/4")

Other cross-cultural patterns of entheogen use involve the context of initiation. Grob and Dobkin de Rios (1992) point to the cross-cultural pattern of managed use of these substances in contexts where elders employ them in re-socialization rites. These often constitute collective puberty or initiation rites that channel the individual in transition to adult status. Entheogens are also widely used in the context of shamanic initiation and training (Harner 1973, Furst 1976, Winkelman 2000) and may have contributed to their origins.

The worldwide interpretation of these substances as having simultaneous religious, spiritual and medicinal roles reflects their effects upon basic structures of consciousness. McKenna (1992) documents the worldwide pre-historic practices of using mushrooms as a central part of a cultural ethos relating to the earth and mysteries of nature. He suggests that the mushrooms provoke enhanced self-awareness and a sense of contact with a "Transcendent Other." This reflected an experience of the sentience and intelligence of nature, and an intimate awareness of our interconnectedness with nature, the earth, and the universe.

Societal Differences in the Use of Psychointegrative Plants

Though very widespread, the societal use of entheogens is not universal but varies as a function of social conditions. Different types of societies make varying assessments of their value and potentials. Differences in their use is reflected in the dramatically larger number of hallucinogenic plants used in the New World in comparison to the Old World cultures (LaBarre 1970). This variation has been attributed to cultural factors, since there are many entheogens present but not considered religious in the Old World (Schultes and Hofmann 1979, LaBarre 1970, Furst 1972). Institutional political factors are also responsible for the lack of use of these psychointegrator plants. Hallucinogenic plant use is not typically institutionalized in complex societies (Dobkin de Rios and Smith 1977; Winkelman 1991c). Increasing social and political complexity leads to reduction in the use of psychointegrator plants, with the societal use of hallucinogens negatively correlated with the levels of political integration (Winkelman 1991c). This negative relation to political integration reflects the dynamics of their psychocognitive effects and their inherent conflicts with the political needs of the leadership of hierarchical societies.

The repression of, and restrictions on, the use of entheogens (as a function of increasing political integration) reflects their patterns of use and their effects upon social relations and personal interpretations of the world. Dobkin de Rios and Smith (1977) suggest that hallucinogenic plants are typically repressed in state level societies because they constitute a potential threat to the religious authority and interpretations of those who hold social and religious power. These substances are typically employed in social settings where local idiosyncratic interpretations derived from the set and setting (personal expectations and the local situational influences) play powerful roles in shaping interpretations of the experiences. Local interpretation of the experiences could pose a threat to the centralized hierarchical control of religious consciousness and political authority, and undermine control in religious, political and social arenas. These conflicts could be expected to result from the typical cross-cultural patterns of use of these plants in small group community settings, where they enhance group cohesion and reaffirm immediate values and beliefs (Dobkin de Rios and Smith 1977). They consequently reinforce a traditional community based mythos and social order rather than hierarchical ideological and political ideologies.

The social contexts associated with the use of entheogens also suggest that they are used to provide means of facilitating psychosocial adaptations to social change. Entheogens appear to be most intensely used under conditions of rapid social change, where they serve as a means of facilitating adaptation to changing psychosocial circumstances (e.g. see Andritzky 1989, Aberle 1966), facilitating mediation between conceptual systems. The widespread use of the Banisteriopsis genus (ayahuasca) in the Amazonian basin in collective rituals which strengthen social cohesion and group identity also assist in the management of acculturation problems by mediating between the indigenous world view and the European derived systems (Andritzky 1989). The symbolic synthesis of traditional and new beliefs that facilitate psychosocial adjustment is achieved through the images that appear while under the influence of the plants. Similar dynamics are reported for the selective adoption of the Peyote Religion (Native American Church) among the Navaho (Aberle 1966). The historical development of the Peyote Church illustrates its role in psychosocial adjustment. The early Navajo adherents were primarily those who experienced the greatest relative deprivation due to federally imposed livestock reduction programs. The Native American Church provided a new ethical code that facilitated an adjustment of the Navajo values of collectivism to the broader society's emphasis on individualism. The burgeoning use of hallucinogens in American culture was also associated with periods of rapid social change in the U.S. (i.e., 1960's and 1990's).

Botanical, Chemical Experimental, and Neurological Approaches to Entheogens

The (pre) historical and cross-cultural commonalities in the uses of entheogens, and in particular their similar social and therapeutic utilization patterns, reflect underlying biological mechanisms and require a neurobiological explanation. The specific physiological mechanisms of the general and specific effects of entheogens are derived from the physiological properties of these substances. The commonalities in the experiences induced by entheogens suggest that they should share a common botanical and chemical classification. But there is no single botanical grouping or chemical classification for the diverse plants and substances that produce entheogenic effects, occurring in nearly 100 species and a wide range of genera and families (Schultes and Hofmann 1979). Traditionally, classification of a substance as a hallucinogen was based in non-toxic subjective effects upon human experience, the ability to produce visions, voices, and alterations of perceptions and mood (Siegel 1984).

Because of the subjective basis of the classification of these substances and their effects, social and cultural factors have dominated the labeling of these substances. This is manifested in the medical definition of hallucinogens, which characterizes them as false perceptions and disturbances of thought, experiences without a basis in reality. Similarly, the early psychiatric term "psychomimetic" implies a psychotic and delusional basis for the experiences, but does not reflect their central phenomenological experiences. The cross-cultural use and interpretations of these substances instead reveals that they invoke perceptions of a spiritual realm, a veridical source of important information, in direct contrast with the implications of delusions emphasized by traditional nomenclature.

Recognition of the shortcomings of the medical terms and traditional definitions has prompted the development of new terminology.

The term "psychedelic" developed mainly in the context of LSD experiences, referring to the extraordinary conceptual ("mind-manifesting") impact upon human experience and understanding. The general connotations associated with the term psychedelic, derived as they are from the closely-associated counter-cultural movement, has made the term undesirable to many. The focus on the mental also fails to capture the significant emotional and therapeutic effects. Grof (1989) proposed the term holotropic to reflect the psychodynamic actions of these substances in forcing an orientation towards wholeness. Holotropic does reflect global effects, but does not explicitly emphasize the salient spiritual, emotional, and cognitive elements central to the experiences induced by psychointegrators.

Shultes and Hofmann (1979) referred to these substances as "plants of the gods," reflecting the referents often embodied in indigenous terms for these plants. Many religions throughout history and prehistory and around the world have viewed their practices as inspired by the indwelling spiritual influences of certain sacred plants. In light of these ubiquitous beliefs, Ruck, Wasson, Staples, Bigwood, and Ott (1979) introduced the term entheogen from the Greek *entheos*, referring to "the god within," and gen, "action of becoming." Entheogen reflects many cultural perceptions of these substances and is very appropriate for classification of their beliefs. It can be argued, however, that the concept of entheogen does not reflect other personal and cognitive dynamics of these plants' effects, and implies a strictly spiritual basis that may alienate some who wish to take a more agnostic/scientific approach to the study of these substances.

I have suggested the term psychointegrator as being based both upon the neurological and experimental effects of these substances (Winkelman 1996). Cross-cultural data on traditions utilizing these substances and the neurobiological research on their mechanisms of action concur in seeing these substances as producing psychointegration. Psyche reflects not only the mind, but also the soul and spirit (the broader bases to which psyche once referred), thus it encompasses the spiritual dimensions emphasized in the term entheogen. Psychointegrator implies the stimulation of the mind, emotions, soul and spirit to integrative development (Winkelman 1996) in that they stimulate mental and emotional catalyzing processes, and encourage a holistic developmental integration of the mind, spirit and soul.

The neurotransmitter actions of these substances involve a number of psychointegrative effects and provide a basis for explaining their cross-cultural similarities. Beginning with neurotransmitter processes, and continuing upward, across hierarchical levels of complexity in the brain and mind, psychointegration reflects the effect of entheogens upon processes from neurotransmitter activity, through physiological, behavioral, emotional, cognitive and psychological levels. The basis of an entheogen's activity derives from its intervention in the serotonergic neurotransmitter system, a "neuromodulatory" system whose properties and effects exemplify psychointegration. That is, the modulating effects of serotonin have an overall integrating effect on the dynamics of the neurotransmitter systems.

The introduction of the term psychointegrator is not intended to replace all other terms for sacred plants, nor to preclude further terminological differentiation (e.g., Naranjo 1996, Stafford 1992). Rather, the intent is to supercede inaccurate and value-laden terminology and to provide a neurological basis for explaining the commonalities in the effects of these substances. Such neurological effects can also provide an explanation for the roles of entheogens, activating brain processes that enhance fundamental aspects of sacred experiences. A fundamental aspect of entheogenic and sacred experiences is the generation of a sense of connectedness, oneness and psychological health and healing - perceptions that reflect the effects of psychointegration.

Neurological Perspectives on Psychointegrators

The effects of entheogens upon neurotransmission are responsible for the cross-cultural similarities in physical, emotional, cognitive and sacred experiences and their therapeutic applications. Neurological studies indicate that the major entheogens have common effects upon neurotransmitters (Jacobs 1984a, Mandell 1985). Their effects upon brain function in humans and other animals have been extensively investigated, particularly in the case of LSD (Jacobs 1984a; Mandell 1985). Most of these substances (i.e., indoleamines like psilocybin and LSD, and the phenethylamines like mescaline) have effects that generalize to one another, reflecting similar neurochemical mechanisms of action (Mandell 1985) and global properties involving effects upon serotonin pathways and mechanisms (Jacobs 1984, Aghajanian 1994).

Alex Grey, *Ohio Song*, 2001. Oil on linen (11" x 14")

Laboratory studies of LSD effects have provided diverse findings, derived from various procedures, dosages, phase effects, and "set and setting" factors (Freedman 1984). The basic mechanisms of their action, however, are well recognized, and the LSD-like entheogens are well understood in terms of their effects upon brain mechanisms (Mandell 1985). The primary neurotransmitter system affected by LSD-like entheogens is serotonin. The entheogens most similar to serotonin are: LSD and lysergic acid amide (LSA, e.g., morning glories); psilocybin (e.g., from mushrooms of the genera Psilocybe, Conobybe, Panaeolus and Stropharia; harmine and harmaline from Banisteriopsis caapi and Peganum harmala; and DMT (dimethyltryptamine) and similar substances from the Virola genus and species of Anadenanthera. Mescaline (from peyote) and similar synthetic drugs (STP, DMA, MMDA) resemble norepinephrine, but have end effects similar to the LSD-like substances.

Entheogens' effects upon sensory, behavioral, emotional, cognitive and psychodynamic experience illustrate their stimulation of integrative information processing, providing the rationale for their characterization as psychointegrators. Their systemic effects upon the autonomic nervous system include the induction of limbic system discharge patterns that enhance interhemispheric synchronization and coherence, and limbic-frontal cortex integration (Mandell 1980, 1985; Winkelman 1996). These substances evoke an integration of brain functioning from neurophysiological through cognitive levels, stimulating the integration of pre-linguistic social, emotional and behavioral processes with the frontal cortex's linguistic and egoic functions. The therapeutic roles of psychointegrators derive from the activation of emotional and personal processes of the limbic system and paleomammalian brain that underlie personal identity, attachment and social bonding, emotion, conviction (in beliefs), and their integration with neocortex processes.

Entheogens stimulate the integration of the brain's behavioral and social-emotional processing output with language based ratiomentation, egoic representations, and personal identity. This activation is reflected in the theta wave linkages between the limbic-emotional and the behavioral brain that send ascending impulses into the frontal cortex. These biochemically based physiological effects may produce awareness of repressed memories, integration of emotional and rational processes, and the resolution of conflicts through integration of various functional systems of the brain. I have introduced the term psychointegrator in order to refer to the systemic integrative effects of these substances.

Psychointegrators and Neurotransmitter Functions and the Brain

Neurotransmitters act through a number of mechanisms, exercising inhibitory or excitatory effects and modulating the effects of other neurotransmitters. Entheogens have these roles in the serotonergic system, substituting for neurotransmitters in some receptor locations, and, in others, functioning as antagonists (or blockers) that prevent the normal response.[1] These actions[2] upon neurotransmission mediate their profound effects upon human experience and consciousness.

There are at least four different types of CNS serotonin receptors with different kinds of effects in different parts of the brain.[3] The LSD-like psychointegrators interact with serotonergic neurotransmitters across all major levels of the brain, generally augmenting normal processes in these structures.

Basic commonalities of the LSD-like indole-based psychointegrators involve the blockage of serotonin re-uptake, enhancing action of the brain's serotonergic systems (Mandell 1985). Another mechanism of psychointegrators' effects upon serotonin action is the decreased action of target neurons in the forebrain; LSD exercises a blocking effect upon these serotonin neurons, resulting in the disinhibition of their typical repression. The limbic system's emotional processing areas and the visual areas of the cortex have the most intense disinhibition and therefore greatest activity, resulting in intense visual and emotional experiences. This disinhibition of the structures of the mesolimbic temporal lobe manifests as synchronous high voltage activity in the hippocampus, and as synchronous discharges in the temporal lobe limbic structures (Mandell 1980, 1989; Fink 1978, Aghajanian 1982; Hoffmeister and Stille 1982). Synchronous brainwave patterns result which drive impulses into the frontal cortex, replacing its characteristic desynchronized fast-wave activity with slower, more coherent wave patterns. In turn, these coherent systematic discharges produce synchronous, slow-wave patterns (3-6 cps theta) in the frontal lobes, and ultimately interhemispheric synchronization of the cortex (Fairchild, Alles, Jensen and Mickey 1967, Mandell 1980).

Mandell (1980) suggests that the common neurobiochemical pathway is based in biogenic amine-temporal lobe interaction involving high voltage slow wave EEG activity in the hippocampal-septal area of the limbic system. The limbic system discharge pattern induced by entheogens produces inter-hemispheric synchronization and coherence, limbic-cortical integration, and the synthesis, integration and coherence of thought and emotion (Mandell 1980, 1985; Winkelman 1986a, 1992). Thus the effects of biochemical psychointegration include increases in the coherence of brain discharges, an enhanced integration of feelings and thoughts, and the catalization (of often profound) personal-psychological insights. Driven by the underlying limbic functions, entheogens stimulate the brain to process information in this integrated fashion.

Psychointegrative results derive from a range of biochemical mechanisms upon brain function. These effects on neurotransmission enhance brain activity by reducing habitual repressions while simultaneously stimulating processes that are normally dissociated (such as simultaneous dreamlike mentation with ego awareness). Psychointegrators increase activity of the raphe and reticular formations of the brain stem area, the limbic system, (particularly the hippocampus and amygdala), and the visual and auditory areas of the frontal cortex. This results in the stimulation of memory, emotions, motivation, cognitive processes, attention, awareness and environmental orientation.

Such synthesis of whole brain function enhances the regulation of the autonomic nervous system and the integration of emotions and visual-cognitive representations (Winkelman 1996, 2000). LSD-like compounds also increase arousal, heightening sensory receptivity and responsiveness, which induce a more thorough and random examination of a given environment. This phenomenon, which is almost universal at lower does, again demonstrates the reduction of typical response patterns, habitatuation, which often leads to new behavior patterns and perspectives. High dosages tend to lead to withdrawal (i.e., 'incubate') and a focus upon the internal environment, where limbic activity forces material from the sub- or unconscious into awareness. Elevation of repressed/forgotten memories into consciousness permits catharsis and abreaction, allowing conflicts to be confronted and resolved. The tendency of these substances to elicit distressing personal material (i.e. unresolved conflicts, repressed experiences, and unintegrated aspects of ones psyche) suggests that the stimulation of the limbic system provokes the release of such unresolved issues as it is related to the sense of self and social attachments.

The limbic-frontal driving induced by psychointegrators also produces interhemispheric synchronization, producing integration of unconscious material into the cerebral cortex. This results in an integration of feelings with thoughts, enhancing insight. With an enhanced awareness of repressed memories, personal emotional liability increases, disrupting habitual behavior patterns and dissolving problematic egocentric fixations and repressions. Thus stimulating psyche-dynamic reprogramming by permitting the conscious consideration and expression of repressed aspects of the self.

Psychointegrators primarily enhance the activation of the aspects of the brain that MacLean (1990, 1993) refers to as the R-complex and the paleomammalian brain, or limbic system. The R-complex is a "behavioral" brain that manages motor activities and their routinization, coordinating basic social interaction. The paleomammalian brain manages processes associated with self, identity, species survival, family and social relations, learning and memory, and sexual and aggressive emotions as well as their behavior integration. Entheogens (and ASC in general) enhance systemic integration of the psyche by producing heightened arousal and awareness, and by interfering with habituated behavioral routines. The paleomammalian brain and limbic system provide the social and emotional mentation and behavior. These fundamental cognitive processes involve nonverbal communication, and forms of mental and social representation that manage processes of emotional and social life.

By inducing experiences through the evocation of these underlying structures of consciousness and brain function, entheogens produce experiences that are interpreted and defined as spiritual. Grof 's (1975, 1980, 1992) many years of clinical research with LSD and holotrophic procedures has resulted in new models of the nature of human consciousness. Based on these experiences and research, he has identified the transbiological realms: the perinatal domain of (pre-) birth experiences and the transpersonal domain, of archetypal and mystical structures. The transpersonal domain reveals dimensions of human consciousness that lie beyond the easily encapsulated egoic identity, and provide fundamental or 'primary' spiritual experience. Grof's work on the personal biographical level of the perinatal (domains of-OUT) experience has demonstrated the effectiveness of entheogens in bringing the memories and conflicts embedded at this level into consciousness, and permitting their integration. Naranjo's (1996) studies suggest that entheogens activate "Kundalini phenomena," high levels of organismic self-regulation as a consequence of ego suspension and the activation of mental structures.

The inherent potential of entheogens to induce psychosocial psychointegration is reflected in the wide typology of LSD experiences. These differences result from effects mediated by "set and setting" and the personal, social or transpersonal expectations for the experience. "Set" refers to these beliefs, attitudes, and expectations that one inevitably brings with them, while "setting" refers to the consequences of situational influences upon the experience. Such effects are manifested in the different medical paradigms on the effects of LSD: which include the psychomimetic, psycholytic, and psychedelic (Yensen 1985; Bravo and Grob 1989). The different paradigms of LSD-effects are attributed to extrapharmacological factors derived from expectations and situational circumstances. It is illustrative at the "psychointegrative" effect that the subjects' experiences are understood to also reflect expectations of the researchers.

Psychointegrators, Altered States of Consciousness, and the "Divine Other"

The disinhibition of the serotonergic neurotransmitters systems and the resulting loss of their inhibitory effects upon the mesolimbic temporal lobe structures underlies the common effects of entheogens in producing altered states of consciousness (ASC) and the associated transcendental or transpersonal experience. Systematic changes in brain processes are common to many means of inducing ASC2 (Winkelman

1986a, 1992, 2000) or "transcendent state" (Mandell 1980, 1985) and the basis for the universal application of ASC in healing practices (Winkelman 1986b, 2000). The common psychophysiological changes associated with diverse ASC involve the replacement of normal waking EEG by cortical synchronization (produced by high-voltage, slow-wave discharges originating in the limbic system), which links the levels of the brain with coherent synchronized brain wave patterns. ASC generally replace the normal waking physiological patterns, characterized by the external orientation of attention, with an internally oriented parasympathetic dominant state.

Alex Grey, *Collective Vision*, 1995. Oil on linen (84" x 46")

Elsewhere I have shown that various ASC constitute different means of accessing a common mode of consciousness that represents an optimized homeostatic balance among different functional systems of the brain, permitting the emergence of integrative psycho-physiological operations. This integrative mode of consciousness is as fundamental to human psychobiology as the dream, deep sleep, and waking, and underlies the universality of shamanic healing practices. Since ASC's exemplify the kinds of experiences produced by entheogens, we must conclude that their dynamics be understood in the broader context of ASC experiences.

The fundamental cultural roles of entheogens are shared with other methods of altering consciousness, being represented in shamanism and related ASC based healing practices found in all cultures (shamanistic healers), a universal institutionalization of the psychobiological potentials of ASC (Winkelman 1986a, 1986b, 1990, 1992). Entheogens often serve as a primary means for inducing ASC in the training of shamanic healers and in community rituals for healing. Most shamanic practices do not use entheogens, although these healers still serve the same cultural goals of healing and providing spiritual experiences. The role of these ASC lies in their functional effects, inducing the physiological changes that facilitate healing and divination through the stimulation of integrative brain functioning from the neurophysiological through cognitive levels. This suggests that the cultural roles of entheogens be understood also in the broader context of institutionalized practices for producing spiritual experiences through ASC.

The primary effects of entheogens and ASC are elucidated in reference to the nature of spontaneous religious experience (Stark 1997) and the brain systems elicited by psychointegrators (Winkelman 1996, 2000). Spontaneous religious experiences involve sensations, perceptions and feelings that include some sense of contact with a 'divine' agency that can provide interactive communication with the subject. Religious experience, as essentially a sense of contact with a "Divine Other," and means of developing an enhanced awareness of the divine aspects of self, is found universally because it results from the function of innate brain structures, operators and modules (Winkelman 2000; cf. D'Aquili and Newberg 1996, Joseph, 2001).

The areas of the brain primarily responsible for managing self and external awareness are based in the paleomammalian brain (MacLean 1990). This "emotional brain" is also a "social brain," effecting fundamental aspects of attachment with, and reference to, others. The emotional bonding that first emerged with the paleomammalian brain, evolved to include attachment to others - kin, community, and the unknown spiritual "Other". The major effects of psychointegrators on the paleomammalian brain (and its fundamental processes) provide a basis for an enhanced sense of awareness of self and other (i.e. Buber's 'I and Thou'), which is basic to religious and entheogenic experience. Thus neurophenomenological perspective suggests that the properties of entheogens derive from a general enhancement of specific aspects of brain function that have a role in managing self, other, affect and conviction about beliefs.

Conclusions: Systemic Integration of Brain Function

Spontaneous mystical experiences and those induced by entheogens have similar qualitative and quantitative effects upon both subjective experience and brain functioning. These parallels reflect the manipulation of similar brain processes and aspects of consciousness, indicating that such experiences are endogenous to brain structures and are not dependent on the unique properties of entheogens. Therefore our understanding of entheogens should be placed in the broader context of ASC and integrative mode consciousness models. Conforming to the fact that entheogens derive their characteristic properties from their effectiveness as psychointegrators and from their influences upon the innate structures and modules of the brain (Winkelman 2000, 2002).

The worldwide uniformity of the use of ASC reflects underlying psychobiological potentials. While cross-cultural variation exists in ASC phenomena, this reflects social influences upon the adaptation of these underlying biochemical potentials for ASC (Winkelman, 2000). The psychobiological basis of both shamanic experience and other "natural" ASC derived from the use of entheogens has resulted in the continued re-manifestation of these practices in the contemporary world. This is seen in numerous religio-therapeutic and Neo-shamanic groups active today, as well as the resurgence of indigenous shamanic traditions, the widespread adoption of peyote religion among Native Americans over the past century, most recently the development of a vast international "rave" culture, and the worldwide resurgence in entheogenic religions.

The impact on, and importance of, entheogenic plants in human cultures confirms their important role in facilitating psychointegration, helping to meet needs through the elevation and activation of innate structures, and the stimulation of integrative processes. Humanity's innate drive to seek out ASC's, manifests in a recurrent cycle of "rediscovery" of ASC, within societies. This illustrates a persistent need within all cultures to provide safe and legitimate access to these experiences. The lack of formal societal structures that instruct and accommodate ASC will only assure that the spontaneous discovery and exploration will continue as counter-cultural, (as was seen in the 60's LSD movement and the raves of the 90's).

Cross-cultural patterns of entheogen use illustrate their potential role in meeting a range of psychodynamic needs, in addition to their application for psychointegration. Psychointegration plays a critical therapeutic role in managing the needs of developmental change and crises induced problems that require the integration of conscious, pre-conscious and unconscious processes. This applies particularly to the integration of behavioral routines and socioemotional dynamics into a new gestalt. The conjunction of healing with spirituality reflects an integration of psychophysiological and psychocultural dynamics and has been a fundamental adaptation found universally within traditional societies in the form of shamanistic healing practice. A recurrent emphasis upon entheogens as an important means of achieving this adaptation reflects the need of modern cultures to dramatically reorient psychocultural dynamics to account for the many changes that have occurred in social and cosmological dynamics, producing new patterns of psychointegration. The use of these substances will continue in the rapidly changing world and requires that societies take informed and rational approaches to their managed use (c.f. Winkelman 2001).

Notes

1. Serotonin 5-HT_{1A} receptors in the raphe system mediate responses of the serotonergic neurons with respect to their own transmitters (Aghajanian 1994: 138). These receptors show a strong sensitivity to LSD-like substances (Aghajanian 1994: 140), inhibiting their firing in the raphe area and depressing neuronal firing in lower areas of the brain (the dorsal hippocampus, hypothalamic suprachiasmatic nucleus, amygdaloid cell, caudate-putamen, substantia nigra, trigeminal nucleus, spinal-cord interneurons, spinothalamic-tract neurons and the mesencephalic reticular formation) (Aghajanian 1981: 165). LSD effects the hippocampus by blocking or suppressing the typical depressant functions of serotonin, creating responses conditions similar to dreaming and contributing to production of the typical visual or hallucinatory experiences by disinhibiting postsynaptic neurons in the limbic and visual areas.
   Indoleamine and phenethylamines cause greater activation of 5-HT_2 serotonin receptors relative to other serotonin receptors (Aghajanian 1994). Primary effects of LSD-like psychointegrators are through the action on the 5-HT_2 serotonergic neurons (Glennon 1990: 43). Large concentrations of serotonin 5-HT_2 receptors are in the limbic system in the hypothalamus and basal ganglia; these sensory processing functions are antagonized by LSD (Kruk and Pycock 1991). LSD-like psychointegrators also affect the cerebral cortex and the locus coeruleus 5-HT_2 receptors (Aghajanian 1994). LSD affinity for 5-HT_{2A} and 5-HT_{2C} receptors facilitates the functioning of the locus coeruleus, which receives numerous somatosensory and visceral inputs and projects diffusely to most of the brain (Miller and Gold 1993). These 5-HT_2 serotonin sites play a role in the control of anxiety and reduction of schizophrenic symptomology (Ribeiro 1991).
   LSD-like psychointegrators activate the serotonergic neurons in the locus coeruleus, which serves as a nodal point for convergence of somatosensory and visceral information. The locus coeruleus projections innervate most areas of the neuraxis, principally the thalamus, hypothalamus, cerebellum, basal forebrain, hippocampus and neocortex (Aghajanian 1994, Role and Kelly 1991). LSD-like psychointegrators effect the somatodendritic region of the serotonin autoreceptors in the raphe neuron sites, inducing a selective and potent inhibition of the tonic firing of the dorsal raphe nucleus. This also results in a disinhibition of forebrain targets (Aghajanian 1981, 1982, 1994: 137). LSD-like psychointegrators release the tonic inhibitory serotonin influences upon postsynaptic neurons and increases activity in the lateral geniculate nucleus and amygdala. Jacobs' (1984b) expands the dominant model of presynaptic action of LSD upon serotonergic systems with consideration of the postsynaptic excitatory influences. LSD-like psychointegrators, potentiate serotonin's excitatory effects upon the brain stem and spinal cord (Jacobs 1984b), resulting in excitatory effects on brain stem and spinal cord areas receiving serotonergic input results in excitatory effects at the postsynaptic neurons in the cerebral cortex and brain stem (Jacobs 1984b: 188).
2. The systemic effects of these substances upon neurotransmitters as discussed here is derived from Aghajanian (1994), Jacobs and Gelperin (1981), Jacobs (1984a), Kruk and Pycock (1991), McKim (1991), and Ryall (1989).
3. Derived from Aghajanian (1981, 1993), Glennon (1990), Kruk and Pycock (1991: 121-122), Ribeiro (1991), and Schmidt and Perovtka (1989).
4. A wide variety of agents, procedures, and psychophysiological conditions produce this pattern of limbic driven cortical synchronization. In addition to the entheogens, these include: auditory stimulation such as singing, chanting and clapping; extensive running or other motor behavior; hunger, thirst, and sleep loss; intense sensory stimulation such as physical austerities or temperature extremes; sensory deprivation; sleep states and meditation; and a variety of psychophysiological imbalances or sensitivities resulting from hereditarily transmitted nervous system liabilities, or from epileptic-like states resulting from injury, disease, or other trauma to the central nervous system (summarized from Winkelman 1986a, 1992, 1997, 2000).

References

1. Aberle, D. 1966. The Peyote Religion Among the Navaho. Chicago: Aldine Pub.
2. Aghajanian, G. 1981. The Modulatory Role of Serotonin at Multiple Receptors in Brain. In: Serotonin Neurotransmission and Behavior, Jacobs, B. and A. Gelperin, eds. Cambridge, Mass.: MIT Press.
3. Aghajanian, G. 1982. Neurophysiologic Properties of Psychotomimetics. In: Psychotropic Agents III, F. Hoffmeister and G. Stille, eds. pp.89-109. New York: Springer-Verlag.
4. Aghajanian, G. 1984. LSD and Serotonergic Dorsal Raphe Neurons: Intracellular Studies in Vivo and in Vitro. In: Hallucinogens: Neurochemical. Behavioral and Clinical Perspectives, Jacobs, Barry, ed. New York: Raven Press.
5. Aghajanian, G. 1994. Serotonin and the Action of LSD in the Brain. In: Psychiatric Annals 2463:137-141.
6. Andritzky, W. 1989. Sociopsychotherapeutic Functions of Ayahuasca Healing in Amazonia. In: Journal of Psychoactive Drugs 21(1):77-89.
7. Bravo, G. and C. Grob. 1989. Shamans, Sacraments and Psychiatrists. In: Journal of Psychoactive Drugs 21(1):123-128.
8. d'Aquili, E. and A. Newberg. 1999. The Mystical Mind: Probing the Biology of Religious Experience. Minneapolis: Fortress Press.
9. Dobkin de Rios, Marlene. 1984. Hallucinogens: Cross-Cultural Perspectives. Albuquerque: Univ. New Mexico Press.
10. Dobkin de Rios, M., and D. Smith. 1977. Drug Use and Abuse in Cross-Cultural Perspective. In: Human Organization 36(1):14-21.
11. Embodden, W. 1972. Narcotic Plants. New York: Macmillan.
12. Embodden, W. 1989. The Sacred Journey in Dynastic Egypt: Shamanistic Trance in the Context of the Narcotic Water Lily and the Mandrake. In: Theme Issue on Shamanism and Altered States of Consciousness. M. Dobkin de Rios and M. Winkelman, eds. Journal of Psychoactive Drugs, pp.61-75.
13. Fairchild, M.D., G.A. Alles, D.J. Jensen, and M.R. Mickey. 1967 The Effects of Mescaline, Amphetamine and Four Ring Substituted Amphetamine Derivatives on Spontaneous Brain Electrical Activity in the Cat. In: International Journal of Neuropharmacology 6:151-167.
14. Fink, M. 1978. Psychoactive Drugs and the Waking EEG 1966-1976. In: Psychopharmacology, M. Lipton, A. Dimascio and K. Killam, eds. New York: Raven Press. pp.691-98.
15. Freedman, D. 1984. LSD: The Bridge from Human to Animal. In: Hallucinogens: Neurochemical. Behavioral and Clinical Perspectives, Barry Jacobs, ed. New York: Raven Press. pp.203-226.
16. Furst, P., ed. 1972. Flesh of the Gods. New York: Praeger.
17. Furst, P., ed. 1976. Hallucinogens and Culture. San Francisco: Chandler and Sharp.
18. Glennon, R. 1990. Serotonin Receptors: Clinical Implications Neuroscience and Biobehavioral Reviews 14:35-47.
19. Grob, C., and M. Dobkin de Rios. 1992. Adolescent Drug Use in Cross-Cultural Perspective. In: Journal of Drug Issues 22(1):121-138.
20. Grof, S. 1975. Realms of the Unconscious: Observations from LSD Research. New York: Viking Press.
21. Grof, S. 1980. LSD Psychotherapy. Pomona, Ca: Hunter House.
22. Grof, S. 1989. Beyond the Brain: New Dimensions in Psychology and Psychotherapy. In: Gateways to Inner Space. C. Ratsch, ed. Bridport, Dorset: Prisim Press. pp.55-71.
23. Harner, M., ed. 1973a. Hallucinogens and Shamanism. New York: Oxford University Press.
24. Harner, M. 1973b. The Role of Hallucinogenic Plants in European Witchcraft. In: Hallucinogens and Shamanism. Harner, M. ed. New York: Oxford University Press. pp.125-150.
25. Hoffmeister, F. and G. Stille (eds). 1982. Psychotropic Agents III. New York: Springer-Verlag.
26. Jacobs, B. and A. Gelperin, eds. 1981. Serotonin Neurotransmission and Behavior. Cambridge, Mass.: MIT Press.
27. Jacobs, Barry, ed. 1984a. Hallucinogens: Neurochemical. Behavioral and Clinical Perspectives. New York: Raven Press.
28. Kruk, Z. and C. Pycock. 1991. Neurotransmitters and Drugs. London: Chapman and Hall.
29. La Barre, W. 1970. Old and New World Narcotics: A Statistical Question. In: Economic Botany 24:368-373.
30. La Barre, W. 1972. Hallucinogens and the Shamanic Origins of Religion. In: Flesh of the Gods, P. Furst, ed. New York: Praeger. pp.261-278.
31. Laughlin, C., J. McManus and E. d'Aquili. 1992. Brain, Symbol and Experience Toward a Neurophenomenology of Consciousness. Boston and Shaftesbury: Shambhala.
32. MacLean, P. 1990. The Triune Brain in Evolution. New York: Plenum.
33. MacLean, P. 1993. On the Evolution of Three Mentalities. In: Brain, Culture and the Human Spirit Essays from an Emergent Evolutionary Perspective, James Ashbrok, ed. Lanham, Md.: University Press of America. pp.15-44.
34. Mandell, A. 1980. Toward a Psychobiology of Transcendence: God in the Brain. In: The Psychobiology of Consciousness, D. Davidson and R. Davidson, eds. New York: Plenum.
35. Mandell, A. 1985. Interhemispheric Fusion. In: Journal of Psychoactive Drugs 17(4):257-266.
36. McKenna, T. 1992. Food of the Gods: The Search for the Original Tree of Knowledge A Radical History of Plants, Drugs and Human Evolution. New York: Bantam Books.
37. McKim, W. 1991. Drugs and Behavior An Introduction to Behavioral Pharmacology. Englewood Cliffs, N.J.: Prentice-Hall.
38. Miller, N. and M. Gold. 1993. LSD and Ecstacy: Pharmacology, Phenomonology and Treatment. In: Psychiatric Annals 24(3):131-134.
39. Naranjo, C. 1996. The Interpretation of Psychedelic Experience in Light of the Psychology of Meditation. In M. Winkelman & W. Andritsky (Eds.), Sacred Plants, Consciousness and Healing (pp. 75-90). Yearbook of Cross-Cultural Medicine and Psychotherapy, 5. Berlin: Verlag.
40. Ribeiro, C. 1991. Pharmacology of Serotonin Neuronal Systems. In: Human Psychopharacology 6:37-51.
41. Riedlinger, T., ed. 1990. The Sacred Mushroom Seeker. Historical, Ethno- & Economic Botany Series Volume 4. Portland: Dioscorides Press.

42. Role, L. and J. Kelly. 1991. The Brain Stem: Cranial Nerve Nuclei and the Monoaminergic Systems. In: Principles of Neural Science. E. Kandal, J. Schwartz and T. Jessell, eds. New York: Elsevier.
43. Ryall, R. 1989. Mechanisms of Drug Action on the Nervous System. Cambridge: Cambridge University Press.
44. Schmidt, A. and S. Peroutka. 1989. S-Hydroxytryptamine Receptor "Families." Neuropsychopharmacology 3:2242-2249.
45. Schultes, R. 1972. An Overview of Hallucinogens in the Western Hemisphere. In: Flesh of the Gods, P. Furst, ed. New York: Praeger. pp.3-54.
46. Schultes, R. and A. Hofmann. 1979. Plants of the Gods Origins of Hallucinogenic Use. New York: McGraw-Hill (Reprinted 1992 by Healing Arts Press, One Park Ave., Rochester, Vermont.)
47. Siegel, R. 1984. The Natural History of Hallucinogens In: Hallucinogens: Neurochemical. Behavioral and Clinical Perspectives. Barry Jacobs, ed. Raven Press: New York. pp.1-18.
48. Staffford, P. 1978. Psychedelics Encyclopedia. Berkeley: Ronin Press. Stark, R. 1997. A Taxonomy of Religious Experience. In The psychology of religion: Theoretical approaches, eds. B. Spilika. and D.N. McIntosh. Boulder, CO: Westview Press.
49. Wasson, R. G., S. Kramrisch, J. Ott and C. Ruck. 1986. Persephone's Quest Entheogens and the Origins of Religion. New Haven: Yale University Press.
50. Wasson, R., F. Cowan and W. Rhodes. 1974. Maria Sabina and her Mazatec Mushroom Velada. New York: Harcourt, Brace Jovanovich.
51. Wasson, R. G. 1980. The Wondrous Mushroom: Mycolatry in Mesoamerica. New York: McGraw Hill.
52. Weil, A. 1992. Forward. In: Psychedelics Encyclopedia, P. Stafford. Berkeley: Ronin Press.
53. Winkelman, M. 1986a. Trance States: A Theoretical Model and Cross-Cultural Analysis. In: Ethos 14(2):174-203.
54. Winkelman, M. 1986b. Magico-Religious Practitioner Types and Socioeconomic Conditions. In: Behavior Science Research 20:17-46.
55. Winkelman, M. 1990. Shaman and Other "Magico-Religious" Healers: A Cross-Cultural Study of Their Origins, Nature, and Social Transformations. In: Ethos 18:308-352.
56. Winkelman, M. 1992. Shamans, Priests and Witches. A Cross-Cultural Biosocial Study of Magico-religious Practitioners. Anthropological Research Paper #44. Arizona State University.
57. Winkelman, M., & Andritzky, W. 1996. Sacred Plants, Consciousness and Healing. Yearbook of Cross-Cultural Medicine and Psychotherapy, 5. Berlin: Verlag.
58. Winkelman, M. 1996. Psychointegrator plants: their roles in human culture and health. In Sacred Plants, Consciousness and Healing, eds. M. Winkelman & W. Andritzky. Yearbook of Cross-Cultural Medicine and Psychotherapy, 5. Berlin: Verlag, 1996, pp. 9-53.
59. Winkelman, M. 2000. Shamanism: The Neural Ecology of Consciousness and Healing. Westport, CT: Bergin & Garvey.
60. Winkelman, M. 2001. Alternative and Complementary Medicine Approaches to Substance Abuse: A Shamanic Perspective. International; Journal of Drug Policy 12:337-351.
61. Winkelman, M. 2002. Shamanism and Cognitive Evolution. Cambridge Archaelogical Journal. (forthcoming 12:1)
62. Yensen, R. 1985. LSD and Psychotherapy. In: Journal of Psychoactive Drugs 17(4):267-277.

Psychointegrators: Multidisciplinary Perspectives on the Therapeutic Effects of Hallucinogens

by

Michael Winkelman

Arizona State University
Tempe, AZ

Complementary Health Practice Review 2001; 6; 219

DOI: 10.1177/153321010100600304

original source: https://wiki.dmt-nexus.me/w/images/7/70/Psychointegrators_multidisciplinary_approach.pdf
backup source: http://www.psilosophy.info/resources/Psychointegrators_multidisciplinary_approach.pdf

Table of Contents:

Psychointegration: Hallucinogens' Actions upon Serotonergic Transmission
Cross-Cultural Patterns of Psychointegrator Use
- Societal Differences in Use of Psychointegrator Plants
- Variation in Therapeutic Applications
- Clinical Paradigms in Research on LSD
- Psychointegrators and Neurotransmitter Functions
- The Serotonergic System
  - *Serotonin Receptors*
- Effects of LSD-like Psychointegrators on Serotonergic Receptors
  - *Psychointegrators and Systemic Brain Function*
  - *Psychointegrator Effects Upon Behavior*
  - *Cognitive Dynamics: Interhemispheric Fusion*
  - *Altered States of Consciousness*
- Contemporary Applications
- Research Applications

Conclusions
Note
Biographical Data
References

Vision-inducing plants ("hallucinogens") are important in many societies, evoking powerful emotional, psychological, cognitive, religious, spiritual, therapeutic and political reactions. These substances' psychophysiological properties shape cross-cultural similarities in patterns of use and experiences, while political factors shape their cultural desirability. Neurological studies illustrate that common effects are based in intervention in serotonergic neurotransmission. Effects upon neural, sensory, emotional, and cognitive processes stimulate integrative information processing, justifying a new term-"psychointegrators." Psychointegrators disinhibit sensory and emotional processes. They stimulate systemic integration of brain information-processing functions, enhancing integration of limbic system self and emotional dynamics with neocortical processes. Their therapeutic applications are reviewed from perspectives of cross-cultural and clinical studies.

The use of hallucinogens or psychedelics as therapeutic and religious agents is reported in many cultures (Dobkin de Rios,1984; Furst, 1972,1976; Harner, 1973; Rdtsch, 1989; Schultes & Hofmann, 1979; Stafford, 1992; Winkelman & Andritzky, 1996). Although broadly prohibited for private and therapeutic use by U.S. and international law in the late 1960s, these substances have a continued importance illustrated by the recent increases in self-application (Beck, 2000; Gold, 1994a & 1994b; Miller & Gold, 1993; Schuster, Lieb, Lamertz

& Wittchen, 1998; Werner, 1993; Zoccolillo, Vitaro, & Trimblay, 1999) and the governmental decisions to renew limited human subject studies (Mathias, 1993). These substances are often viewed as sources of spiritual inspiration, mystical participation and personal transformation, but also as dangerous agents to be controlled or prohibited.

This article integrates ethnographic, cross-cultural, clinical and neurophysiological data to develop a neurophenomenological perspective (Laughlin, d'Aquilli, & Mc- Manus, 1992) for explaining psychotherapeutic and sociocultural patterns of use of these substances. Cross-cultural similarities in social and therapeutic use derive from their effects upon serotonergic neurotransmission, enhancing brain wave coherence (synchronization), emotional processing, and self- and information integration. A review of physiological and psychological data justifies the term "psychointegrator" as more accurately characterizing these substances' effects, avoiding misleading implications and inaccurate assumptions associated with commonly employed terms such as hallucinogen. A cross-cultural review of the use of these substances illustrates similarities in effects and interpretations, and political conditions predicting their use and prohibition. Diverse therapeutic applications attested to cross-culturally are related to different clinical paradigms of the effects of LSD. These are shown to reflect effects upon serotonergic transmission and sensory, emotional, behavioral and cognitive processes. The article concludes with a brief consideration of psychointegrators' continued therapeutic and research applications.

Psychointegration: Hallucinogens' Actions upon Serotonergic Transmission

Cross-cultural similarities in uses and effects of psychointegrators suggest a common botanical and chemical basis for these substances. The so-called hallucinogenic substances do not share a single common botanical or chemical classification, being found in nearly 100 species and a wide range of genera and families (Schultes & Hofmann, 1979). Although hallucinogenic plants are principally fungi and angiosperms, angiosperms are the principal group of plants on the earth, and most are not hallucinogenic (Schultes, 1972; Schultes & Hofmann, 1979). Similarly, most hallucinogenic chemicals are alkaloids, but most alkaloids do not have hallucinogenic effects. Classification as a hallucinogen (or psychedelic) has not been based upon specific chemistry or physiology, but upon effects on human experience, producing visions, voices and effects upon perception, mood, and thought in *non-toxic doses* (Siegel, 1984). This distinguishes them from substances that produce hallucinations because of toxicity.

In spite of the absence of a botanical grouping or chemical classification for these notable plant substances, there are common neurophysiological effects of many of these substances. Lysergic acid diethylamide (LSD), phenylethylamine (e.g., mescaline) and indolealkylamines (e.g., psilocybin) differ in terms of their potency but otherwise have virtually identical clinical effects (Aghajanian, 1994; Hollister, 1984; Jacobs, 1984a; Mandell, 1985). Most[1] substances classified as hallucinogens (e.g., indoleamines such as psilocybin and LSD, phenylethylamines such as mescaline, and tetrahydrocannabinols) have similar neurochemical mechanisms of action involving intervention in serotonin pathways and mechanisms (Aghajanian, 1994; Jacobs, 1984b). Their effects provoke limbic discharge patterns that produce enhanced interhemispheric synchronization and increased communicative interaction between the frontal hemispheres, and between the lower brain areas and frontal cortex (Mandell,1980, 1985). The psychointegrators most similar to serotonin and interacting with it are as follows: LSD, other ergot compounds, and lysergic acid amide found in morning glories (*Ipomoea spp.*); psilocybin (e.g., from mushrooms from the genera *Psilocybe*, *Conocybe*, *Panaeolus*, and *Stropharia*); and DMT (dimethyltryptamine) and similar substances from the genus *Virola* and species of *Anadenanthera*. Mescaline (from peyote), similar synthetic drugs (STP, DMA, MDA, MMDA), and myristicin and elemicin from the genus *Myristica* (e.g., nutmeg) resemble norepinephrine, but their end effects are similar to LSD-like substances.

Because of its availability, standardization and potency, LSD has been the most extensively investigated psychointegrator. Recognition of a primary role of the serotonergic system in the effects of LSD-like substances resulted in extensive studies of their serotonergic interactions. The effects of LSD on neurotransmitters besides serotonin have not been as extensively investigated; although it appears to affect dopamine and norepinephrine systems, the primary effects of LSD do not appear to be mediated by these systems (Freedman, 1984; Jacobs, 1984b). LSD does have significant interactions with other neurotransmitter systems (e.g., GABAergic) (Carlsson, Waters & Carlsson, 1999). Since they interact with serotonin, a neuromodulator with effects on many neurotransmitter systems, psychointegrators affect other systems as well.

Although these substances share physiological and experiential effects, questions have been raised as to the basic nature of the effects and the appropriateness of the terms used. Medical and lay characterizations of their effects as "hallucinations," and therefore false and delusional, are inaccurate and point to the need for new terms. Psychedelic is politicized for many, and its meaning of "mind manifesting" is limited. Grof (1975) proposed *holotropic*, reflecting the psychodynamic actions of these substances in forcing an orientation toward wholeness. Holotropic reflects central experiential effects of these substances, but without emphasizing the spiritual, emotional, and mental experiences. The term *entheogen* was introduced as an alternative, with "*entheos*" referring to the "god within" and "*gen*," "the action of becoming" (Wasson, Kramrisch, Ott & Ruck, 1986). Entheogen accurately reflects the views of many cultures on these substances' effects, but its exclusive focus on the spiritual alienates the scientific and clinical approaches needed to understand these substances.

Common systemic effects of these substances include the stimulation of mental and emotional processes in an integrative personal and spiritual experience. The experiential effects of integration are mirrored in the neurophysiology of the substances, suggesting that *psychointegrator* is a more appropriate characterization. Psyche reflects the meanings of mind emphasized more recently, and the broader and older meanings of *soul* and *spirit* central to the interpretations of these effects in other cultures. Psychointegrator reflects the integration of mind, soul, and spirit as attested to by laboratory, clinical, and cross-cultural research. The term psychointegrator does not preclude further terminological differentiation of the variable effects of these substances (e.g., Naranjo,1996; Stafford, 1992). "Psychointegrator" supersedes valueladen terminology and misconceptions with a neurophenomenological grounding. The justification for this term is provided by the following examinations of cross-cultural, clinical, and neurophysiological data.

Cross-Cultural Patterns of Psychointegrator Use

Cross-cultural use of psychointegrator plants is associated with the belief that they are powerful spiritual forces, provide access to spiritual realities, and have religious and therapeutic applications (see Dobkin de Rios, 1984; Furst, 1972, 1976; Harner, 1973; Schultes & Hofmann, 1979; Winkelman, 1996). Psychointegrators dramatically alter experience, shifting self-awareness to what is interpreted as an "other worldly" sacred or spiritual domain of important personal and social significance. The ubiquitous aspects involve the following: personal relations with the supernatural world; participation in a mythical time; spiritual relationships with animals as a source of power and self-identification; ego dissolution, resurrection and transformation; healing and divination; and promotion of social solidarity and community relations (Dobkin de Rios, 1984). The interpretations of these plants as having therapeutic, religious, and spiritual roles have implications for understanding human consciousness, mystical and spiritual experiences (Smith, 2000), and the pre-historical origins of religion. La Barre (1972) called attention to their potential to stimulate visions and supernatural experiences, giving rise to religious traditions.

Societal Differences in Use of Psychointegrator Plants

Therapeutic use of psychointegrator plants is not universal but varies as a function of social conditions. Different types of societies make different assessments of their value, adaptive functions and potentials. Major regional differences in their use have been reported, with dramatically larger number of hallucinogenic plants used in the indigenous cultures of the Americas in comparison to pre-Christian Eurasian cultures (La Barre, 1970). These differences have been attributed to cultural factors, since many hallucinogens are present but not used in Eurasia (Furst, 1972; La Barre, 1970). Increasing political complexity leads to reduction in the use of psychointegrator plants, which are not typically institutionalized in healing and religion in complex societies (Dobkin de Rios & Smith 1977; Winkelman, 1991). Changes in society and the institutionalized bases and functions of religious healing (Winkelman, 1986b, 1990, 1992) are responsible for cross-cultural differences in institutionalization of psychointegrator plants. Cross-cultural data show their ritual use is negatively correlated with levels of political integration (Winkelman, 1991). The negative relation with political integration reflects inherent conflicts of the needs of hierarchical politically integrated societies with the psychosocial and cognitive dynamics produced by psychointegrators.

Dobkin de Rios and Smith (1977) suggest hallucinogenic plants are typically repressed in state-level societies because they constitute a threat to the interpretations of those who hold social and religious power. Psychointegrators are typically used in social contexts where influences derived from the set and setting (personal expectations and the local situational influences) play powerful roles in shaping the experiences and interpretations. These local set and setting influences on interpretation can pose a threat to the centralized hierarchical control of religious consciousness, and undermine control in religious, political and social arenas. In contrast, typical cross-cultural use of psychointegrators for therapeutic purposes is in small-group community settings, where they enhance group cohesion and reaffirm local social and cultural values and beliefs rather than the state-level ideological and political orders (Dobkin de Rios & Smith, 1977). Repressive legislation enacted against these substances in the 1960s reflects this pattern of political control of threats to the established hierarchy and cosmological orders.

The social context of contemporary psychointegrator use cross-culturally suggests it facilitates psychosocial adaptations required by rapid social change and changing psychosocial circumstances (Aberle, 1966; Andritzky, 1989; Dobkin de Rios, 1984). Psychointegrator plants play a role in mediation between conceptual systems. Ayahuasca is widely used in the Amazonian basin in collective rituals that strengthen social cohesion and group identity and assist in the management of acculturation problems by mediating between indigenous world views and the imposed European systems (Andritzky, 1989). The psychointegrators are used in rituals that serve as a means for mediating between the individual and the cultural systems, integrating the ancient traditions into current adaptations.

The historical adoption of the Peyote religion (Native American Church, NAC) among the Navajo as reported by Aberle (1966) also illustrates its role in psychosocial adjustment, as the early Navajo adherents were primarily those who experienced the greatest relative deprivation due to federally imposed livestock reduction programs. The NAC ethical code facilitated an adjustment of the Navajo values of collectivism to the American society's emphasis on individualism. The NAC fostered resistance to colonizing influences, maintaining socially valued community experiences and religious consciousness (Calabrese, 1997).

Variation in Therapeutic Applications

Review (Schultes & Winkelman, 1996) of therapeutic uses among the indigenous cultures of the Americas of psychointegrators of the families *Strophariaceae*, *Myristicaceae*, *Leguminosae*, *Malpighiaceae*, *Cactaceae* and *Convolvulaceae* illustrates quite a variable action. These substances are used for both physical and spiritual illness, mediation of conflict, treating dysfunctions in social or sexual relations, and directing healing energies. They evoke a range of emotional experiences, including terrifying visions and cathartic reactions. Psychointegrators may be used to prophesize the future, to send messages to others, to contact distant relatives, to discover enemies' plans, and to assist in learning myths, chants, and dances. They are used for all sorts of physical problems, including stomach, bladder, intestinal worms, hemorrhoids, malaria, mouth sores, rheumatism, cuts and wounds, and childbirth difficulties. Diagnostic applications include determination of: the cause of illness, death or other problems; the means of treatment; direction in life; and the meaning of dreams. Social uses include annual harvest festivals, fertility rites, cremation ceremonies, ancestor worship, and inter-village alliances. They are used to treat culture-bound syndromes (e.g., hexes, soul/spirit loss, witchcraft, spirit affliction and exorcisms) and for protection against witches and ghosts. They provide control of emotions and release from guilt and illness caused by resentment and envy, balancing spiritual and natural forces in the patient's life to overcome misfortunes and find peace and harmony.

Highly developed traditional healing systems selectively use variations across species, varying admixtures of species, different doses and routes of administration, and ritual processes to obtain a range of effects. Variable effects also reflect their functions as nonspecific amplifiers of pre- and unconscious content (Metzner, 1998; Riedlinger & Riedlinger, 1994). These substances' effects integrate pharmacotherapy and psychotherapy through interactions of biological and social factors.

Clinical Paradigms in Research on LSD

Since the same plant is used for a variety of purposes, this suggests the same substance can produce a variety of effects. Clinical research revealed a range of effects from LSD (see Bliss, 1988; Bravo & Grob, 1989; Grof, 1975, 1980; Lukoff, Zanger & Lu, 1990; Riedlinger & Riedlinger, 1994; Yensen, 1985, 1996). Legal prohibitions enacted in the late 1960s severely reduced clinical research, but earlier (e.g., see Abramson, 1967) and limited subsequent research (Passie, 1997) provides evidence of the therapeutic effects of LSD. A primary finding is that effects differ as a function of expectations, producing several different medical paradigms-psychotomimetic, psycholytic, and psychedelic (see Bravo & Grob, 1989; Yensen, 1985, 1996;). The different paradigms reflect "set and setting" influences, extra-pharmacological factors derived from expectations and situational circumstances. "Set" refers to personal beliefs, attitudes, and expectations, while "setting" refers to the situational influences upon the experience. These are considered the primary determinants of the psychointegrator's effects.

The psychotomimetic perspective emphasized that LSD induces effects such as dizziness, weakness, tremor, nausea, hallucinations, depression, depersonalization, psychotic reactions, and delusions. This clinical profile better represents side effects rather than the phenomenologically and personally most relevant experiences. While psychosis and disturbed cognitive functioning may occur, particularly under adverse set and setting influences, psychointegrators typically produce positive outcomes, inducing new ways of perceiving and understanding ordinary experience. Induced emotional liability can lead to changes in sense of self, including powerful mystical experiences of union with the universe and oceanic feelings (Cohen, 1971).

These realizations lead to the psycholytic approach, which viewed LSD as a "mind dissolving" agent that facilitates psychoanalytic therapy by altering the relationship between the conscious and unconscious (Yensen,1985). LSD was used as a therapeutic aid for weakening psychological defenses, eliciting conflicts and emotional impulses, releasing unconscious or blocked material, and increasing awareness and emotional responsiveness. The ability to activate and deepen psychoanalytic processes helped shorten psychotherapy, facilitating restructuring of the personality and accelerating the maturation process (Passie, 1997). The psycholytic approach is reflected in the NAC, where peyote plays a role in meaning therapy involving therapeutic emplotment and reinterpretation (Calabrese, 1997).

The last pre-prohibition development in LSD-assisted therapy was the psychedelic approach, based on the recognition that the greatest benefits occurred when mystical experiences resulted. The psychedelic approach used large doses to evoke mystical experiences which produced major personality changes. LSD activated repressed memories, evoking catharsis, enhancing self-awareness, and providing an opportunity for life changes. A significant application of the psychedelic approach was in the treatment of alcoholism and pain and end-of-life management for terminal cancer patients (see Abramson, 1967; Kurland, 1985).

In summary, the cross-cultural patterns in social, religious, and therapeutic applications of psychointegrators and their psychocognitive effects reflect both biological mechanisms and psychosocial effects (set and setting). Even the same substance can induce quite varied experiences since cultural traditions provide integral inputs through ritual, song, myth and other symbolic elements that shape experiences, reactions and outcomes. Cross-cultural commonality in uses of psychointegrator plants in therapeutic activities, and the similarities in experiences and interpretations, nonetheless reflect biological mechanisms and require a neurobiological explanation. The specific neurotransmitter mechanisms through which general and specific effects are achieved illustrate why these pharmacological agents should be called psychointegrators and why they have such important therapeutic applications.

Psychointegrators and Neurotransmitter Functions

The effects of psychointegrator constituents upon neurotransmission produce cross-cultural similarities in physical, emotional, and cognitive experiences. Neurotransmitters act through at least four known mechanisms: stimulating neurons, creating inhibitory or excitatory effects, altering the responsiveness of neurons to other neurotransmitters, and modulating the effects of other neurotransmitters. Psychointegrators interact with neurotransmitters through initiating responses in receptors (agonists) by substituting for neurotransmitters, and by diminishing their effectiveness by functioning as antagonists (or blockers), preventing normal response of a receptor. Studies on these effects in humans have been limited in recent decades, but psychointegrator effects (particularly LSD) upon brain function in humans and other animals have been extensively investigated (Jacobs, 1984a; Mandell, 1985). These studies provide diverse and apparently contradictory findings, derived from different procedures, dosages, phase effects, and set and setting factors (Freedman, 1984). Basic mechanisms of action of LSD-like psychointegrators are fundamentally the same across mammalian species (Jacobs, 1984a; Jacobs & Gelperin, 1981) and are one of the best understood of psychoactive substances (Mandell, 1985). The primary neurotransmitter affected by LSD-like psychointegrators is serotonin (Aghajanian, 1994; Jacobs, 1984b; McKim, 1991). The following section briefly reviews the serotonergic system and effects of LSD-like substances upon neurotransmission. The information about the systemic effects of psychointegrators upon neurotransmitters is primarily derived from Aghajanian (1994), Jacobs (1984a), Jacobs and Gelperin (1981), Kruk and Pycock (1991), McKim (1991), and Ryall (1989).

The Serotonergic System

Serotonin (5-HT) is the most extensive monoaminergic neurotransmitter system in the brain (Role & Kelly, 1991), performing a wide range of functions (Fischbach, 1992; Kruk & Pycock, 1991; Ribeiro, 1991). Serotonin plays an important role in regulating sleep, arousal, thermoregulation, vasoconstriction, blood pressure, growth hormones, hunger, pain, smooth muscles, perception, sensory processing, vigilance, learning, memory, moods, motor activity, cognition, and decision making (Glennon, 1990, p. 39; Kruk & Pycock, 1991, pp. 122-123). Serotonergic dysfunctions are associated with fear, anxiety, depression, sleep disturbances, schizophrenia, pain dysfunctions and psychosomatic complaints (Ribeiro, 1991, p. 37).

The central importance of serotonin in many different processes reflects its role as a modulatory neurotransmitter, a mediator of processes, receiving sensory and internal information, and modulating the strength of responses. The serotonergic neurotransmitter cells are primarily located in the reticular formation, the limbic system and the basal ganglia, with descending projections into the spinal cord and ascending projections to the forebrain; the limbic system and visual areas have the highest levels of serotonin fibers (Ribeiro, 1991). The primary projections are ascending and exert diffuse influences on neuronal systems. The primary concentrations of serotonin neurons in the central nervous system (CNS) are in the midline area of the brain stem, particularly the raphe nuclei; its upward projections into the thalamus, hypothalamus and amygdala of the limbic system; the corpus striatum and basal ganglia; and frontal cortex (Kruk & Pycock, 1991; Parent,1981). The projection systems of the raphe (and reticular activating) systems of the midbrain carry sensory input from axons to the cortex. Interconnected nuclei of the limbic system are responsible for mediating emotion and motivation. Serotonin input to the cortex mediates integration of sensory information and coordination of bodily movements.

Serotonin Receptors

There are at least four different types of CNS serotonin receptors that mediate different kinds of effects in different parts of the brain (Aghajanian, 1981, 1994; Glennon, 1990; Kruk & Pycock, 1991; Ribeiro, 1991; Schmidt & Peroutka, 1989). Serotonin 5-HT$_{1A}$ receptors are primarily in the raphe system and limbic region; they mediate responses of the serotonergic neurons with respect to their own transmitters and have a strong sensitivity to indoleamines (Aghajanian, 1994, p. 140). Primary effects of LSD upon serotonergic systems are on 5-HT$_2$ neurons (Aghajanian, 1994), for which they have a high affinity (Glennon, 1990). 5-HT$_2$ receptors are concentrated in the limbic system in the hypothalamus and basal ganglia, and play a role in the control of anxiety and reduction of schizophrenic symptomology (Ribeiro, 1991). Primary effects of LSD-like psychointegrators upon the cerebral cortex, the locus coeruleus, and other areas of the brain are mediated by the 5-HT$_2$ receptors of postsynaptic neurons (Aghajanian, 1994). LSD has a high affinity for 5-HT$_{2A}$ and 5- HT$_{2C}$ receptors (Miller & Gold, 1993), facilitating the functioning of the locus coeruleus, which receives numerous somatosensory and visceral inputs and projects them diffusely to most of the brain.

Effects of LSD-like Psychointegrators on Serotonergic Receptors

Serotonergic effects of the LSD-like psychointegrators are complex and variable because: the modulatory functions of serotonin are a function of other neural conditions; serotonin has different actions and effects in different areas of the brain, including presynaptic, axon terminal and postsynaptic sites; psychointegrators have different actions upon different types of serotonergic neurons; and psychointegrators have dose-and phase-dependent effects (Aghajanian, 1994, Hamon, 1984; Hollister, 1984). Psychointegrators may act as agonists (serving in the place of serotonin) and as an antagonist, blocking its action. LSD induces sustained hyperpolarization of some serotonergic neurons, but with prolonged effects beyond maximal levels induced by serotonin (Aghajanian, 1984). Uptake and binding of LSD is primarily in postsynaptic serotonin receptors in the visual and auditory areas of the cerebral cortex, and the amygdala, hippocampus, hypothalamus and striatum of the limbic system (Hamon, 1984). Jacobs suggests action at postsynaptic (rather than presynaptic) serotonergic sites is central to hallucinogenic effects. The focus upon hallucinations may undervalue the importance of other effects, such as the stimulation of systemic information integration.

LSD-like psychointegrators' effects upon the serotonin autoreceptors in the raphe neuron sites induce a selective and potent inhibition of the tonic firing of the dorsal raphe nucleus, and results in a dysinhibiting of forebrain neuron targets. LSD blocks the activating effects of the serotonin neurons in the reticular formation and in the cortex, which releases the tonic inhibitory serotonin influences upon postsynaptic neurons, and increases activity in the lateral geniculate nucleus and amygdala. LSD-like psychointegrators also facilitate or potentiate serotonin's excitatory effects upon areas of the brain stem and spinal cord, resulting in excitation of target cells (Jacobs, 1984b, p. 188). Psychointegrators activate serotonergic neurons in the locus coeruleus, a nodal point for convergence of somatosensory and visceral information from all regions of the body. The locus coeruleus' projections innervate most areas of the neuraxis, principally the thalamus, hypothalamus, cerebellum, basal forebrain, hippocampus, and neocortex (Aghajanian, 1994; Role & Kelly, 1991). LSD affects the hippocampus by blocking or suppressing the typical depressant functions of serotonin. This stimulates mesolimbic temporal lobe structures by dysinhibiting postsynaptic neurons in the limbic and visual areas (Mandell, 1985), releasing the habitual blocking on emotional and visual centers, and contributing to production of visual experiences similar to dreaming.

LSD-like psychointegrators interact with the serotonergic system in the brain stem, limbic system, and frontal cortex. They both stimulate and suppress the effects of serotonin, substituting for it in neurotransmission, and blocking it, reducing habitual repressions and stimulating processing centers. Psychointegrators effect: reactivity of the raphe and reticular formations of the brain stem area; the limbic system, particularly the hippocampus and amygdala; and the visual and auditory areas of the frontal cortex. Psychointegrators have effects on: attention, awareness and environmental orientation; motivation, memory, emotions and cognitive processes; visual conceptualization and cognitive representation; and synthesis of information from the entire brain. An effect of serotonin is to depress the action of target neurons in the forebrain; consequently, the blocking effect of LSD upon serotonin neurons is a dysinhibition of their typical repression. This dysinhibition results in synchronous brain-wave patterns that drive impulses into the frontal cortex, replacing the normal desynchronized fast wave activity characteristic of the frontal cortex with slower, more coherent wave patterns. These coherent systematic discharges drive synchronous slow-wave patterns (3-6 cps theta) into the frontal lobes, synchronizing the cortex (cf., Aghajanian, 1982, 1984; Mandell, 1980).

Psychointegrators and Systemic Brain Function

Psychointegrators enhance activation of brain systems that MacLean (1990) refers to as the R-complex (reptilian brain) and the paleomammalian brain (limbic system). Stimulation of the R-complex provides an enhanced integration of information across all areas of the brain, producing heightened arousal and awareness and interference with habituated behavioral routines that the reptilian brain manages. The paleomammalian brain provides social and emotional influences on mentation and behavior involved in species survival, sex, aggression, family and social relations, learning and memory, and self-identity. The activation of the paleomammalian brain and its functions by the psychointegrators (and ASC in general) enhances systemic integration of the psyche through cognitive processes based in nonverbal communication, mentation and social representations that manage processes of emotional and social life.

Psychointegrator Effects Upon Behavior

The macro-level effects of psychointegrators include a range of sensory, behavioral, emotional and cognitive effects (Freedman, 1984; see Winkelman, 1996 for discussion). Psychointegrators heighten sensory receptivity, increasing arousal and responsivity to the environment. They also reduce or reverse habituation of typical response patterns, forcing the organism into new patterns of behavior. While low dosages lead to a more thorough, random and complete examination of the environment, high dosages tend to lead to withdrawal and a focus upon the internal imagetic, emotional, and cognitive environment. The internal focus, alteration of consciousness, and limbic activation forces material from the sub- or unconscious into awareness and brings repressed memories into consciousness where through catharsis and abreaction they are resolved and integrated. Their tendency to elicit distressing personal material, unresolved conflicts, repressed experiences, and un-integrated aspects of self and behavior suggests that psychointegrators provoke manifestations of conflicts and traumas not yet integrated into long-term stable memories. Psychointegrators stimulate emotions and interpretations related to one's sense of self and social attachments.

Cognitive Dynamics: Interhemispheric Fusion

Psychointegrators' neurophysiological effects produce general integration of information from all parts of the body, enhancing significance and meaning, and producing insight and new understandings. The focus on internal experience is often accompanied by an enhanced clarity of consciousness (Freedman, 1984, p. 209) and the maintenance of intact memories subsequent to the experiences that permits reflection and integration. This also reflects activation of paleomammalian brain functions that subserve memory functions and provide the basis for our sense of certainty and conviction (MacLean, 1990). The characteristic cognitive integration found with psychointegrators reflects an "interhemispheric fusion" (Mandell, 1985), a result of the increased coupling (bilateral coherence) in hemispheric oscillations that improves information exchange and integration between the two frontal hemispheres. This integration of the specialized roles in cognition and affect (thought and emotion) of left and right hemispheres, respectively, improves the integration of feelings and thoughts, the right hemisphere intuition and left hemisphere rationality. This underlies the insight experiences and perceptions of wholeness and oneness associated with psychointegrators. The integration of feelings with thoughts enhances insight. Integrative experiences are produced physiologically through high voltage synchronous brain waves generated by hippocampal-septal discharges in the mesolimbic temporal lobe structures (Fink, 1978; Hoffmeister & Stille,1982; Mandell, 1980) that drive synchronization of the cortex. The limbic-frontal driving and interhemispheric synchronization integrates unconscious material into the cerebral cortex. These common patterns have general therapeutic effects, permitting expression and reprogramming of repressed aspects of the self. Enhanced awareness of repressed memories, increased emotional lability, disruption of habitual behavior patterns, and dissolution of egocentric fixations permit an alteration of psychodynamic processes.

Altered States of Consciousness

Dysinhibition of the serotonergic system and the resulting loss of inhibitory effects upon mesolimbic temporal lobe structures underlies common effects of psychointegrators and other means of producing ASC or "transcendent states" (Mandell, 1980). Systematic changes in brain functioning are common to many means of inducing ASC (Winkelman, 1986a, 1992) and the basis for universal shamanistic healing practices (Winkelman, 1986b, 1990). Therapeutic use of psychointegrators reflects the effects of ASC in healing (Winkelman, 1986a, 1992). Healers using ASC are found in all cultures, reflecting the biological basis of ASC and its functional effects that produce physiological changes facilitating healing (Winkelman, 2000). Diverse ASC constitute different means of accessing a common mode of consciousness that represents an optimized homeostatic balance among functional systems of the brain, permitting the emergence of integrative operations. This integrative mode of consciousness is as fundamental to human psychobiology as the dream, deep sleep, and waking modes of consciousness (Winkelman, 2000). Integrative consciousness is manifested in the common patterns associated with ASC (e.g., limbic-frontal integration, interhemispheric synchronization, parasympathetic dominance). It has general therapeutic effects, both physiological and psychological (Winkelman, 2000). ASC in general permit expression of repressed aspects of the self, enhancing right hemisphere processes by inhibiting critical screening by the left hemisphere, permitting expression and reprogramming of normally repressed aspects of brain functioning. These conditions of consciousness are known around the world in contemplative traditions (Laughlin *et al.*, 1992), reflecting high levels of integrative functioning. Psychointegrators are a means of providing experiences within this integrative mode of consciousness, but do not substitute for the rigorous mental discipline necessary for sustained functioning in these conditions of consciousness (Naranjo, 1996).

In summary, the LSD-like psychointegrators have global effects upon awareness, behavior, emotions and cognition. They heighten sensory receptivity, arousal and responsiveness to the environment, reducing or reversing habituation of typical behavior patterns. They force new perspectives and patterns of behavior, phasicly moving from a more random and complete examination of the environment to withdrawal and focus upon internal emotional and cognitive material from the sub- or unconscious. The blocking effect of LSD upon serotonin neurons, whose function is to depress the action of target neurons in the forebrain, results in a dysinhibition of typical repression and therefore more activity. The greatest activity is in the densest serotonin axon terminals in the limbic system's emotional processing areas and the visual areas of the cortex. The dysinhibition of the mesolimbic temporal lobe structures drives synchronous slow-wave impulses into the frontal cortex, replacing the normal desynchronized fast-wave activity with coherent theta wave discharges from the limbic system. The limbic-frontal driving also produces interhemispheric synchronization and an integration of unconscious material into the cerebral cortex. This results in an integration of feelings with thoughts, enhancing insight. Activation of repressed memories permits catharsis and abreaction, facilitating resolution of psychodynamic and interpersonal conflicts. This enhanced awareness, increased emotional lability, disruption of habitual behavior patterns, and dissolution of egocentric fixations permits an alteration of psychological relationships and processes and psychodynamic reprogramming.

Contemporary Applications

The application of these substances as therapeutic agents might seem a mute question given their general illegality. Current classification of many psychointegrators in the Schedule I category inhibits their legitimate use as therapeutic agents. This classification implying no recognized medical use and high abuse potential ignores the substantial clinical and cross-cultural data on their therapeutic applications.

The continued and increasing use of hallucinogens, particularly in the form of new "designer" drugs such as "ecstasy" (MDMA) that have reported adverse consequences, indicates a need for therapists to be able to provide education for their patients. The widespread reports of organic and cognitive dysfunction, brain damage and fatalities associated with "ecstasy" use (e.g., Burgess, O'Donohoe & Gill, 2000; Parrott, Sisk & Turner, 2000) indicate the need for cautionary advice beyond that regarding secondary side-effects (e.g., dehydration). Serotonergic neurotoxicity may result from prolonged and frequent use, a pattern contrary to the sporadic use in traditional societies. Physiological risks may be exaggerated, however, as reports linking hallucinogen use to organic damage and dysfunction lack controls for confounding factors such as comorbidity and polydrug abuse, rendering their conclusion suspect (Halpern & Pope, 1999). There are clear contra-indications for use of psychointegrators (particularly monoamine oxidase inhibitors) with serotonin re-uptake inhibitors (Callaway & Grob, 1998). Serious psychiatric impairments probably should be considered a contraindication.

Clients who use these substances, or have needs that may be served by their use, can benefit from the therapist as educator. Therapists need to be aware that their own attitudes will affect the experiences induced. Clients need to be advised of the need for qualified guidance and appropriate set, setting, goals and support. Traditional patterns of use in non-Western societies provide the richest database for guiding therapeutic use (see Metzner, 1998 for summarization). These traditional approaches have been adapted for the guidance of contemporary people (e.g., see Leary, 1997). Traditional use involved administration by shamanistic healers in periodic sessions, often involving the entire community. This use involved a significantly different worldview and focus than psycholytic and psychedelic therapies (Metzner, 1998).

Information about these substances and their uses and specific effects are widely available (cf., Ott, 1993,1994; Shulgin & Shulgin, 1991; websites at psychedeliclibrary.org, maps.org, geocities.com/psychedelics101, drugtext.org, and csp.org). The pre-prohibition research and limited subsequent clinical studies, particularly in Europe (Passie, 1997), also provide indications of potential applications. The psycholytic approach has usefulness at the beginning of therapy to reduce fear-induced inhibitions and repressions, facilitate communication, and accelerate the formation of therapeutic alliances (Riedlinger & Riedlinger, 1994). Psycholytic therapy has greatest applicability for those with: psychic rigidity and rigid defenses; sexual and severe character neuroses; anxiety, depression, and chronic compulsions; and alcoholism. The ability to overcome strong defensive structures may provide success for those with whom classic psychoanalysis was unsuccessful (Kurland, 1985; Metzner, 1998; Passie, 1997; Zanger, 1989). Users may find benefits through assistance in placing fears and emotional traumas in a more realistic perspective (Greer & Tolbert, 1998). Riedlinger and Riedlinger's (1994) examination of the relationship of serotonergic disorders and depression suggests that the success of psychointegrators reflects effects upon serotonergic mechanisms similar to those of other 5-HT uptake inhibitors used in treating mood disorders, anxiety, aggression, panic and obsessive compulsive disorders (OCD). This may parallel traditional antidepressants' "down-regulation" of serotonin receptors and the normalization of serotonin transmission (Ribeiro, 1991). The usefulness of psychointegrators in treatment of OCD is well enough indicated to warrant clinical trials (Delgado & Moreno, 1998). Earlier work with oncology patients indicates further use is warranted.

Treatment of alcoholism and other forms of drug dependence is a promising area for use of psychointegrators, which often are integrated in non-Western ethnomedical treatments of substance dependence (Heggenhougen, 1997; Jilek, 1994). The incredulity that this suggestion might raise is unsubstantiated since these substances in general appear to be non-addictive (McKim, 1991). Psychointegrators' effectiveness is exemplified in the widespread consensus among Native American rehabilitation counselors that the NAC is the only effective tool against alcoholism in Indian country. Bill Wilson considered his LSD experiences to have had an importance equal to the conversion experience that led to his co-founding of Alcoholics Anonymous (AA) (Smith, 2000). His efforts to have AA endorse LSD as a source of the spiritual experiences for treating alcoholism were, however, rejected by the board. The role of LSD in treating alcoholism and other drug dependence (Abramson, 1967; Kurland, 1985) indicates the use of the psychedelic approach and its large doses for inducing transcendent peak or mystical experiences. Treatment of substance dependence with the psychedelic approach remains inadequately examined in clinical populations (Mangini, 1998), but evidence for its effectiveness continues to accumulate (e.g., see ; Alper, Lotsof, Frenken, Luciano & Bastiaans, 1999; Mabit, Giove & Vega, 1996; Sanchez-Ramos & Mash, 1996).

There is widespread recognition that psychointegrators enhance self-healing effects by allowing a purge of negative affects and memories and activating inherent capacities for psychological integration. There may also be immune system enhancement (Roberts, 1999, 2000). Contemporary applications of psychointegrators typically combine psycholytic and psychedelic approaches, using large doses to induce transformative experiences and a series of low doses in psycholytic sessions for processing psychodynamic material (Passie, 1997).

Research Applications

Psychointegrators induce experiences that facilitate study of the general principles of the brain and consciousness. Grof's clinical research with LSD (1975, 1980, 1992) provided new models of the nature of human consciousness. Psychointegrators elicit experiences in what Grof labels the transbiological realms, the perinatal and transpersonal domains of experience. The transpersonal domain includes the archetypal and mystical structures, dimensions of human consciousness and identity beyond egoic identity. Grof has shown that these substances help elucidate the operations of the brain and mind. They accentuate certain processes (e.g., emotional harmony, connection and integration with nature and humanity, joy and euphoria, alternate identities and sense of self), revealing natural cognitive domains and symbol systems (Shannon, 2000). Naranjo (1996) suggested psychointegrators activate "Kundalini phenomena" (high levels of organismic self-regulation) as a consequence of ego suspension and the activation of latent mental structures. These substances have also been considered a source of veridical mystical and spiritual experiences, as attested to in the recent book by the acclaimed expert on world religions, Huston Smith (2000).

Conclusions

The roles of psychointegrators in many cultures point to their important functions in meeting human needs. Although Western societies have held negative views of these substances and most ASC, they represent responses to innate drives (Siegel, 1990). The innate basis of the drive to seek ASC raises questions about the consequences for a society that views such behavior as aberrant and pathological and attempts to repress it. The recurrent societal "discovery" of ASC (e.g., "ecstasy" and its use at group parties known as raves) illustrates the persistent need to address these issues, as ignoring and prohibiting them has not led to their demise. The numerous biological and chemical sources of these substances with powerful psychological effects suggest that their use will continue. Societies need to take informed approaches to their managed use rather than excluding them to a counter-culture producing ethos. Failure of societies to provide legitimate avenues of access, and instead outlawing these experiences, increases the likelihood that their utilization will contribute to antisocial tendencies.

Typical cross-cultural patterns of psychointegrator use involve management of developmental change or crises-induced problems. Psychointegrators integrate conscious, pre-conscious and unconscious processes into a new gestalt or understanding. Their institutionalized use involves healing and spiritual integration, a "wholing" of the individual. This integrative stimulation is a rationale for the term "psychointegrator" to refer to their functions and effects, reflecting the coupling of the soul or spirit with the mind and emotions. This conjunction of healing with the spiritual reflects an integration of psychophysiological and psychocultural dynamics, a fundamental adaptation found in all human societies in shamanistic healing practices. The use of psychointegrator substances as a means of achieving this psychobiological and psychosocial adaptation reflects the need to reorient psychocultural dynamics to changes in social and cosmological relations. Humanity has many millenniums of use of these substances, and legal prohibitions have not stopped this human drive to experience therapeutic alterations of consciousness. They are, however, powerful and potentially dangerous; only adequate education can help prevent abuse and destructive effects.

Note

[1] Many different plants are loosely classified as hallucinogens because they produce hallucinations through toxic effects upon the body. The plants of the family Solanaceae such as mandrake (*Mandragora officinarum*), deadly nightshade (*Atropa belladonna*), henbane (*Hyoscyamus niger*), and the genus *Datura* (e.g., jimson weed) may be inappropriately classified as hallucinogens. Anticholinergics such as atropine, hyoscyamine, and scopolamine (hyoscine), block acetylcholine's muscarinic receptor sites (McKim, 1991) and can cause cardiac arrhythmia, arrest and death through a reduction in heart rate and contractions, blocking of neurotransmission, and interference with the parasympathetic nervous system (Kruk & Pycock, 1991). This produces delirium, clouded consciousness, interference with basic life-support functions, and possible death, conditions not typically associated with the indoleamine compounds. Deaths due to use of these substances are reported every year in the U.S., but shamanistic traditions have apparently found ritual ways to use these plants safely (Jacobs, 1996).

Biographical Data

Michael Winkelman, PhD, is a Senior Lecturer in the Department of Anthropology at Arizona State University, where he is Director of the Ethnographic Field School, Baja California, Mexico. His research interests are in shamanism, shamanistic healing, altered states of consciousness and ethnomedicine; and in cross-cultural adaptation and inter-ethnic relations. He is the author of *Shamanism: The Neural Ecology of Consciousness and Healing* (Westport, CT: Bergin and Garvey, 2000), *Shamans, Priests and Witches: A Cross-cultural Study of Magico-religious Practitioners* (Anthropological Research Papers #44. Tempe, AZ: Arizona State, 1992), *Ethnic Sensitivity in Social Work and Ethnic Relations in the US: A Sociohistorical Cultural Systems Approach* (1999, 1998, Eddie Bowers Publishing, Dubuque: Iowa). He is also the co-editor of *Sacred Plants, Consciousness and Healing*, and *Divination and Healing* (*Yearbook of Cross-cultural Medicine and Psychotherapy, Volumes 6 & 9*, Berlin: Springer Verlag).

References

1. Aberle, D. (1966). *The Peyote religion among the Navaho*. Chicago: Aldine.
2. Abramson, H. (Ed.). (1967). *The use of LSD in psychotherapy and alcoholism*. Indianapolis, IN: Bobbs-Merrill.
3. Aghajanian, G. (1981). The modulatory role of serotonin at multiple receptors in brain. In B. Jacobs & A. Gelperin (Eds.), *Serotonin neurotransmission and behavior*. Cambridge, MA: MIT Press.
4. Aghajanian, G. (1982). Neurophysiologic properties of psychotomimetics. In F. Hoffmeister and G. Stille (Eds.), *Psychotropic agents III* (pp. 89-109). New York: Springer Verlag.
5. Aghajanian, G. (1984). LSD and serotonergic dorsal raphe neurons: Intracellular studies in vivo and in vitro. In B. Jacobs (Ed.), *Hallucinogens: Neurochemical, behavioral and clinical perspectives* (pp. 137-141). New York: Raven Press.
6. Aghajanian, G. (1994). Serotonin and the action of LSD in the brain. *Psychiatric Annals*, 2463, 137-141.
7. Alper, K., Lotsof, H., Frenken, G., Luciano, D., & Bastiaans,J. (1999). Treatment of acute opioid withdrawal with ibogaine. *American Journal on Addictions*, 8(3), 234-242.
8. Andritzky, W. (1989). Sociopsychotherapeutic functions of ayahuasca healing in Amazonia. *Journal of Psychoactive Drugs*, 21(1) , 77-89.
9. Beck, J. (2000). MDMA in the USA: An epidemiological overview. In C. Ratsh & J. Baker (Eds.), *Yearbook for Ethnomedicine and the Study of Consciousness*, 6/7, 127-136.
10. Bliss, K. (1988). LSD and psychotherapy. *Contemporary Drug Problems*, 519-563.
11. Bravo, G. & Grob, C. (1989). Shamans, sacraments and psychiatrists. *Journal of Psychoactive Drugs*, 21(1), 123-128.
12. Burgess,C., O'Donohoe,A. & Gill, M. (2000). Agony and ecstasy: A review of MDMA effects and toxicity. *European Psychiatry*, 15(5), 287-94.
13. Calabrese, J. (1997). Spiritual healing and human development in the Native American Church: Toward a cultural psychiatry of peyote. *Psychoanalytic Review*, 84(2), 237-255.
14. Callaway, J. & Grob, C. (1998). Ayahuasca preparations and serotonin reuptake inhibitors: A potential combination for severe adverse interactions. *Journal of Psychoactive Drugs*, 30(4), 367-369.
15. Carlsson, A., Waters, N. & Carlsson, M. (1999). Neurotransmitter interactions in schizophrenia-therapeutic implications. *European Archives of Psychiatry*, 249(4), 37-43.
16. Cohen, S. (1971). Theories on the effects of psychomimetics. In L. Madow & L. Snow (Eds.), *The psychodynamic implications of physiological studies of psychomimetic drugs* (pp. 3-10). Springfield, IL: Charles Thomas.
17. Davis, W. (1985). *The serpent and the rainbow*. New York: Simon & Schuster.
18. Delgado, P. & Moreno, F. (1998). Hallucinogens, serotonin and obsessive-compulsive disorder. *Journal of Psychoactive Drugs*, 30(4), 359-366.
19. Dobkin de Rios, M. (1984). *Hallucinogens: Cross-cultural perspectives*. Albuquerque, NM: University of New Mexico.
20. Dobkin de Rios, M. & Smith, D. (1977). Drug use and abuse in cross-cultural perspective. *Human Organization*, 36(1), 14-21.
21. Fink, M. (1978). Psychoactive drugs and the waking EEG 1966-1976. In M. Lipton, A. Dimascio, & K. Killam (Eds.), *Psychopharmacology* (pp. 691-698). New York: Raven Press.
22. Fischbach, G. (1992, September). Mind and brain. *Scientific American, Special Issue, Mind and Brain*, 48-57.
23. Freedman, D. (1984). LSD: The bridge from human to animal. In B. Jacobs (Ed.), *Hallucinogens: Neurochemical, behavioral, and clinical perspectives* (pp. 203-226). New York: Raven Press.
24. Furst, P. (Ed.). (1972). *Flesh of the gods*. New York: Praeger.
25. Furst, P. (Ed.). (1976). *Hallucinogens and culture*. San Francisco, CA: Chandler and Sharp.
26. Glennon, R. (1990). Serotonin receptors: Clinical implications. *Neuroscience and Biobehavioral Reviews*, 14, 35-47.
27. Gold, M. (Ed.). (1994a). The new psychedelic subculture. *Psychiatric Annals*, 24(3).
28. Gold, M. (1994b). The epidemiology, attitudes and pharmacology of LSD use in the 1990. *Psychiatric Annals*, 24(3), 124-126.
29. Greer, G., & Tolbert, R. (1998). A method of conducting therapeutic sessions with MDMA. *Journal of Psychoactive Drugs*, 30(4), 371-379.
30. Grob, C., & Dobkin de Rios, M. (1992). Adolescent drug use in cross-cultural perspective. *Journal of Drug Issues*, 22(1), 121-138.
31. Grof, S. (1975). *Realms of the unconscious: Observations from LSD Research*. New York: Viking Press.
32. Grof, S. (1980). *LSD psychotherapy*. Pomona, CA: Hunter House.
33. Grof, S. (1992) *The holotropic mind*. San Francisco: Harper Collins.
34. Halpern, J. & Pope, H. (1999). Do hallucinogens cause residual neuropsychological toxicity? *Drug & Alcohol Dependence*, 53(3), 247-256.
35. Hamon M. (1984). Common neurochemical correlates to the action of hallucinogens. In B. Jacobs (Ed.), *Hallucinogens: Neurochemical, behavioral and clinical perspectives* (pp. 143-170). New York: Raven Press.
36. Harner, M. (Ed.). (1973). *Hallucinogens and shamanism*. New York: Oxford University Press.
37. Heggenhougen, C. (1997). *Reaching new highs: Alternative therapies for drug addicts*. Northvale, NJ: Jason Aronson.
38. Hoffmeister, F. & Stille, G. (Eds.). (1982). *Psychotropic agents III*. New York: Springer Verlag.
39. Hollister, L. (1984). Effects of hallucinogens in humans. In B. Jacobs (Ed.), Hallucinogens: Neurochemical, behavioral and clinical perspectives (pp. 203-226). New York: Raven Press.
40. Jacobs, B. (1984a). (Ed.). *Hallucinogens: Neurochemical, behavioral, and clinical perspectives*. New York: Raven Press.
41. Jacobs, B. (1984b). Postsynaptic serotonergic action of hallucinogens. In B. Jacobs (Ed.), *Hallucinogens: Neurochemical, behavioral, and clinical perspectives*, (pp. 183-202). New York: Raven Press.
42. Jacobs, B., & Gelperin, A. (Eds.). (1981). *Serotonin neurotransmission and behavior*. Cambridge, MA: MIT Press.
43. Jacobs, B. & Trulson, M. (1981). The role of serotonin in the action of hallucinogenic drugs. In B. Jacobs & A. Gelperin (Eds.), *Serotonin neurotransmission and behavior*. Cambridge, MA: MIT Press.
44. Jacobs, D. (1996). The use of Datura in rites of transition. In M. Winkelman & W. Andritsky (Eds.), *Sacred plants,*

consciousness and healing (pp. 341-351). *Yearbook of cross-cultural medicine and psychotherapy*, 5. Berlin: VWB.
45. Jilek, W. (1994). Traditional healing and the prevention and treatment of alcohol and drug abuse. *Transcultural Psychiatric Research Review, 31*, 219-258.
46. Kruk, Z. & Pycock, C. (1991). *Neurotransmitters and drugs*. London: Chapman and Hall.
47. Kurland, A. (1985). LSD in the supportive care of the terminally ill cancer patient. *Journal of Psychoactive Drugs*, 17 (4), 279-290.
48. La Barre, W. (1970). Old and New World narcotics: A statistical question. *Economic Botany*, 24, 368-373.
49. La Barre, W. (1972). Hallucinogens and the shamanic origins of religion. In P. Furst (Ed.), *Flesh of the gods* (pp. 261-278). New York: Praeger.
50. Laughlin, C., McManus, J. & d'Aquili, E. *Brain, symbol and experience toward a neurophenomenology of consciousness*. New York: Columbia University Press.
51. Leary, T. (1997). *Psychedelic prayers and other meditations*. Berkeley, CA: Ronin Publishing Co.
52. Lukoff, D., Zanger, R. & Lu, F. (1990). Transpersonal psychology research review: Psychoactive substances and transpersonal states. *Journal of Transpersonal Psychology*, 22(2), 107-147.
53. Mabit, J., Giove R. & Vega J. (1996). Takiwasi: The use of Amazonian shamanism to rehabilitate drug addicts. In M. Winkelman & W. Andritzky (Eds.), Sacred plants, consciousness and healing. *Yearbook of Cross-Cultural Medicine and Psychotherapy*, 5 (pp. 257-85). Berlin: VWB.
54. MacLean, P. (1990). *The triune brain in evolution*. New York: Plenum.
55. Mandell, A. (1980). Toward a psychobiology of transcendence: God in the brain. In D. Davidson and R. Davidson (Eds.), *The psychobiology of consciousness* (pp. 379-464). New York: Plenum.
56. Mandell, A. (1985). Interhemispheric fusion. *Journal of Psychoactive Drugs*, 17(4), 257-266.
57. Mangini, M. (1998). Treatment of alcoholism using psychedelic drugs: A review of the program of research. *Journal of Psychoactive Drugs*, 30(4), 381-418.
58. Mathias, R. (1993). NIDA research takes a new look at LSD and other hallucinogens. *NIDA Notes*, 8(1), 6-11.
59. McKim, W. (1991). *Drugs and behavior: An introduction to behavioral pharmacology*. Englewood Cliffs, NJ: Prentice-Hall.
60. Metzner, R. (1998). Hallucinogenic drugs and plants in psychotherapy and shamanism. *Journal of Psychoactive Drugs*, 30 (4), 333-431.
61. Miller, N. & Gold, M. (1993). LSD and ecstasy: Pharmacology, phenomenology and treatment. *Psychiatric Annals*, 24(3), 131-134.
62. Naranjo, C. (1996). The interpretation of psychedelic experience in light of the psychology of meditation. In M. Winkelman & W. Andritsky (Eds.), *Sacred plants, consciousness and healing* (pp. 75-90). *Yearbook of Cross-Cultural Medicine and Psychotherapy*, 5. Berlin: VWB.
63. Ott, J. (1993). *Pharmacotheon*. Kennewick, WA: Natural Products.
64. Ott, J. (1994). *Ayahuasca analogues*. Kennewick, WA: Natural Products.
65. Parent, A. (1981). The anatomy of serotonin-containing neurons across the phylogeny. In B. Jacobs & A. Gelperin (Eds.), *Serotonin neurotransmission and behavior*. Cambridge, MA: MIT Press.
66. Parrott, A., Sisk, E., & Turner, J. (2000). Psychobiological problems in heavy "ecstasy" (MDMA) polydrug users. *Drug & Alcohol Dependence*, 60(1), 105-110.
67. Passie, T. (1997). *Psycholytic and psychedelic therapy research, 1931-1995: A complete international bibliography*. Hannover, Germany: Laurentius Publishers.
68. Praag, H. (1991). The present and future of serotonergic drugs. *Human Psychopharmacology*, 6, 513-519.
69. Rätsch, C. (Ed.). (1989). *Gateway to inner space, sacred plants, mysticism and psychotherapy*. Bridgeport, Dorset: Prisim Press.
70. Ribeiro, C. (1991). Pharmacology of serotonin neuronal systems. *Human Psychopharacology*, 6, 37-51.
71. Riedlinger, T. & Riedlinger, J. (1994). Psychedelic and entactogenic drugs in the treatment of depression. *Journal of Psychoactive Drugs*, 26(1), 41-55.
72. Roberts, T. (1999). Do entheogen-induced mystical experiences boost the immune system? Psychedelics, peak experiences, and wellness. *Advances in Mind-Body Medicine*, 11395-14,7.
73. Roberts, T. (Ed.). (2000). *Psychoactive sacraments*. San Francisco: Council on Spiritual Practices.
74. Role, L., & J. Kelly. (1991). The brain stem: Cranial nerve nuclei and the monoaminergic systems. In E. Kandal, J. Schwartz & T. Jessell (Eds.), *Principles of neural science*, (pp. 683-699). New York: Elsevier.
75. Ryall, R. (1989). *Mechanisms of drug action on the nervous system*. Cambridge, UK: Cambridge University Press.
76. Sanchez-Ramos, J., & Mash, D. (1996). Pharmacotherapy of drug dependence with ibogain. In M. Winkelman & W. Andritzky (Eds.), *Sacred plants, consciousness and healing. Yearbook of Cross-Cultural Medicine and Psychotherapy, 5*, 353-367. Berlin: VWB.
77. Schmidt, A., & Peroutka, S. (1989). S-Hydroxytryptamine Receptor "Families." *Neuropsychopharmacology*, 3, 2242-2249.
78. Schultes, R. (1972). An overview of hallucinogens in the western hemisphere. In P. Furst (Ed.), *Flesh of the gods*, (pp. 3-54). New York: Praeger.
79. Schultes, R., & Hofmann, A. (1979). *Plants of the gods origins of hallucinogenic use*. New York: McGraw Hill. (Reprinted 1992 by Healing Arts Press, Rochester, Vermont)
80. Schultes, R., & Winkelman, M. (1996). The principal American hallucinogenic plants and their bioactive and therapeutic properties. In M. Winkelman & W. Andritsky (Eds.), *Sacred plants, consciousness and healing* (pp. 205-239). *Yearbook of Cross-Cultural Medicine and Psychotherapy*, 5. Berlin: VWB.
81. Schuster, P., Lieb, R. Lamertz, C. & Wittchen, H. (1998). Is the use of ecstasy and hallucinogens increasing? Results from a community study. *European Addiction Research*, 4(1-2),75-82.
82. Shannon, B. (2000). Cognitive psychology and the study of Ayahuasca, In C. Ratsch & J. Baker (Eds.), *Yearbook for Ethnomedicine and the Study of Consciousness*, 6/7, 77-94.
83. Shulgin, A., & Shulgin, A. (1995). *Phikal*. Berkeley, CA: Transform Press.

84. Siegel, R. (1984). The natural history of hallucinogens. In B. Jacobs (Ed.), *Hallucinogens: Neurochemical, behavioral and clinical perspectives* (pp. 1-18). Raven Press: New York.
85. Siegel, R. (1990). *Intoxication: Life in pursuit of artificial paradise*. New York: Dutton.
86. Smith, D., & Seymour, R. (1994). LSD: History and toxicity. *Psychiatric Annals, 24*(3), 145-147.
87. Smith, H. (2000). *Cleansing the doors of perception: The religious significance of enthenogenic plants and chemicals*. New York: J. P. Tarcher.
88. Stafford, P. (1992). *Psychedelics encyclopedia*. Berkeley, CA: Ronin Press.
89. Wasson, R., Kramrisch, S., Ott, J. & Ruck, C. (1986). Persephone's quest: Ethnogens and the origins of religion. New Haven, CT: Yale University Press.
90. Wasson, R. (1980). *The wondrous mushroom: Mycolatry in Mesoamerica*. New York: McGraw Hill.
91. Werner M. (1993) Hallucinogens. *Pediatrics in Review*, 14(12), 466-472.
92. Winkelman, M. (1986a). Trance states: A theoretical model and cross-cultural analysis. *Ethos*, 14(2), 174-203.
93. Winkelman, M. (1986b). Magico-religious practitioner types and socioeconomic conditions. Behavior Science Research, 20, 17-46.
94. Winkelman, M. (1990). Shaman and other "magico-religious" healers: A cross-cultural study of their origins, nature, and social transformations. *Ethos*, 18, 308-352.
95. Winkelman, M. (1991). Physiological, social and functional aspects of drug and nondrug altered states of consciousness. In W. Andritzky (Ed.), *Yearbook of cross-cultural medicine and psychotherapy, 1990* (pp. 183-198). Berlin: VWB-Verlag.
96. Winkelman, M. (1992). *Shamans, priests and witches. A cross-cultural study of magico-religious practitioners* (Anthropological Research Papers #44). Arizona State University.
97. Winkelman, M. (1996). Psychointegrator plants: Their roles in human culture and health. In M. Winkelman & W. Andritzky (Eds.), *Sacred plants, consciousness and healing. Yearbook of cross-cultural medicine and psychotherapy, 5* (pp. 9-53). Berlin: VWB.
98. Winkelman, M. (2000). *Shamanism: The neural ecology of consciousness and healing*. Westport, CT: Bergin & Garvey.
99. Winkelman, M., & Andritzky, W. (Eds.). (1996). *Sacred plants, consciousness and healing. Yearbook of cross-cultural medicine and psychotherapy, 5*. Berlin : VWB.
100. Yensen, R. (1985). LSD and psychotherapy. *Journal of Psychoactive Drugs*, 17(4), 267-277.
101. Yensen, R. (1996). From shamans and mystics to scientists and psychotherapists. In M. Winkelman & W. Andritzky (Eds.), *Sacred plants, consciousness and healing. Yearbook of cross-cultural medicine and psychotherapy* (Vol. 5, pp. 109-128). Berlin: VWB.
102. Zanger, R. (1989). Psycholytic therapy in Europe. *Newsletter: The Albert Hoffman Foundation, 1*(2).
103. Zoccolillo, M., Vitaro, F., & Tremblay, R. (1999). Problem drug and alcohol use in a community sample of adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 38*(7), 900-907.

Effects of psilocybin on time perception and temporal control of behaviour in humans

by

Marc Wittmann, Olivia Carter, Felix Hasler, B. Rael Cahn, Ulrike Grimberg, Philipp Spring, Daniel Hell, Hans Flohr, Franz X. Vollenweider

Journal of Psychopharmacology 21(1) (2007) 50-64

© 2007 British Association for Psychopharmacology

original source: http://visionlab.harvard.edu/Members/Olivia/publications/Wittmann_psilo&Time(2007).pdf
backup source: http://www.psilosophy.info/resources/Wittmann_psilo&Time(2007).pdf

Table of Contents:

- **Abstract**
- **Introduction**
- **Methods and Materials**
  - Subjects
  - Time measures
    - *Temporal reproduction*
    - *Sensorimotor synchronization*
    - *Tapping speed*
  - Cognitive test
    - *Spatial Span test*
  - Psychometric measures
    - *5D-ASC*
    - *AMRS*
  - Experimental procedure
    - *Substance and dosing*
  - Study design
  - Statistical analysis
- **Results**
  - Temporal reproduction
  - Sensorimotor synchronization
    - *Asynchrony (Mean)*
    - *Asynchrony (standard deviation)*
    - *Per cent missed synchronization*
  - Personal tapping speed
  - Maximum tapping speed
  - Spatial span task
  - Altered States of Consciousness rating scale (5D-ASC)
  - Adjective Mood Rating Scale (AMRS)
  - Correlations between working-memory performance, time measures and psychometric scores
- **Discussion**
- **Acknowledgments**
- **References**

Marc Wittmann - Generation Research Programme, Human Science Centre, Ludwig-Maximilian University Munich, Bad Tölz, Germany.
Olivia Carter - Vision Touch and Hearing Centre, University of Queensland, Brisbane, Australia. Heffter Research Centre, University Hospital of Psychiatry, Zürich, Switzerland.
Felix Hasler - Heffter Research Centre, University Hospital of Psychiatry, Zürich, Switzerland.
B. Rael Cahn - Department of Neurosciences, University of California at San Diego, La Jolla, USA. Heffter Research Centre, University Hospital of Psychiatry, Zürich, Switzerland.
Ulrike Grimberg - Heffter Research Centre, University Hospital of Psychiatry, Zürich, Switzerland.
Philipp Spring - University Hospital of Psychiatry, Zürich, Switzerland.
Daniel Hell - University Hospital of Psychiatry, Zürich, Switzerland.
Hans Flohr - Brain Research Institute, University of Bremen, Bremen, Germany.
Franz X. Vollenweider - Heffter Research Centre, University Hospital of Psychiatry, Zürich, Switzerland. University Hospital of Psychiatry, Zürich, Switzerland.

Abstract

Hallucinogenic psilocybin is known to alter the subjective experience of time. However, there is no study that systematically investigated objective measures of time perception under psilocybin. Therefore, we studied dose-dependent effects of the serotonin $(5\text{-HT})_{2A/1A}$ receptor agonist psilocybin (4-phosphoryloxy-*N,N*-dimethyltryptamine) on temporal processing, employing tasks of temporal reproduction, sensorimotor synchronization and tapping tempo. To control for cognitive and subjective changes, we assessed spatial working memory and conscious experience. Twelve healthy human volunteers were tested under placebo, medium (115 µg/kg), and high (250 µg/kg) dose conditions, in a double-blind experimental design. Psilocybin was found to significantly impair subjects' ability to (1) reproduce interval durations longer than 2.5 sec, (2) to synchronize to inter-beat intervals longer than 2 sec and (3) caused subjects to be slower in their preferred tapping rate. These objective effects on timing performance were accompanied by working-memory deficits and subjective changes in conscious state, namely increased reports of 'depersonalization' and 'derealization' phenomena including disturbances in subjective 'time sense.' Our study is the first to systematically assess the impact of psilocybin on timing performance on standardized measures of temporal processing. Results indicate that the serotonin system is selectively involved in duration processing of intervals longer than 2 to 3 seconds and in the voluntary control of the speed of movement. We speculate that psilocybin's selective disruption of longer intervals is likely to be a product of interactions with cognitive dimensions of temporal processing - presumably via 5-HT_{2A} receptor stimulation.

Keywords: psilocybin, 5-HT_{2A} receptor, temporal processing, sensorimotor synchronization, altered states of consciousness, working memory, human study

Introduction

Events are perceived over time, and motor actions evolve over time. The brain, therefore, has to process temporal information adequately for the control of perception and action. Evidence to date suggests that different temporal-processing mechanisms are implemented in distinct circumscribed neural circuitries that can be affected by brain injury and pharmacological treatments (Harrington and Haaland, 1998; Rammsayer, 1999; Wittmann, 1999). Accuracy and precision of time estimation and the exact timing of motor behaviour are intimately linked to overall cognitive functioning. Basic timing processes (internal clocks) are an integral part of the whole cognitive system (Steinbüchel and Pöppel, 1993; Wearden, 2004). Patients with structural damage to the brain such as with right-hemispheric focal brain lesions following a stroke (Kagerer *et al*., 2002) or with traumatic brain injury dominantly affecting frontal areas (Pouthas and Perbal, 2004), patients with dysfunctions related to the dopaminergic system of the brain such as in Parkinson's disease (Pastor *et al*., 1992) or in schizophrenia (Elvevag *et al*., 2003), but also healthy older adults (Block *et al*., 1998) can show substantial impairments in temporal processing. Specifically, these populations show more variability and deviate more strongly from target durations during tasks involving time estimates and the timing of motor acts. These findings are discussed in relation to alterations on several information-processing stages related to time processing, specifically a clock, memory and decision stage (Wearden, 2004) as well to attentional mechanisms (Zakay and Block, 1996). Specifically, recent studies report that schizophrenic patients show deficits in discriminating temporal durations (Volz *et al.*, 2001; Davalos *et al.*, 2002; 2003; Elvevag *et al.*, 2003) as well as recognizing the temporal order of visual and acoustic stimuli (Braus, 2002; Tenckhoff *et al.*, 2002).

Recent research into the pharmacological mechanism of hallucinogens (LSD, psilocybin) and dissociative anesthetics (PCP, ketamine) suggests that a dysbalance between serotonin, glutamate and dopamine neurotransmitter systems may be critical to psychotic symptom formation (Vollenweider, 1998). Specifically, there is increasing evidence that the serotonin 5-HT$_{1A/2A}$ receptor systems are involved in psychotic symptom formation as well as the cognitive and behavioural deficits of schizophrenia (Mita *et al.*, 1986; Arora and Meltzer, 1991; Ngan *et al.*, 2000; Bantick *et al.*, 2001; Roth and Hanizavareh, 2004). Receptor binding studies in rats have shown that psilocin (4-Hydroxy-*N*,*N*-dimethyltryptamine), the pharmacologically active metabolite of psilocybin (Hasler *et al.*, 1997), primarily binds to 5-HT$_{2A}$ receptors (Ki=6 nM) and with a lower affinity also to the 5-HT$_{1A}$ sites (Ki=190nM) (McKenna *et al.*, 1990). Psilocybin induces a model psychosis which mimics certain aspects of acute and incipient stages of schizophrenia (Gouzoulis-Mayfrank *et al.*, 1998; Klosterkötter *et al.*, 2001; Vollenweider, 2001; Vollenweider and Geyer, 2001) and causes deficits in sustained and spatial attention (Gouzoulis-Mayfrank *et al.*, 2002; Umbricht *et al.*, 2003; Hasler *et al.*, 2004). In addition, it is well established, based on early phenomenological and psychological studies, that psilocybin and related serotonergic hallucinogens produce a strongly altered experience of time (reviewed in Heimann, 1994), notably a feeling of slowing down of the passage of time and a subjective overestimation of time intervals expressed in reports that 'minutes appear to be hours' or even that 'time is standing still' (Kenna and Sedman, 1964; Fischer *et al.*, 1966).

To date, alterations in time perception and performance in humans have been linked primarily to the dopamine system (O'Boyle *et al.*, 1996; Rammsayer, 1999), specifically to the cortico-basal ganglia-thalamic-cortical loop representing the neuronal clock (Meck, 1996). Pharmacological studies on animals and humans also support the general hypothesis that fronto-striatal circuits are critical for temporal processing. Dopaminergic antagonists (like haloperidol) that affect the meso-striatal dopamine system disrupt temporal processing in healthy subjects (Rammsayer, 1999). Moreover, animal studies indicate that both dopaminergic agonists and antagonists influence timing processes, presumably by increasing and decreasing clock speed, respectively (Meck, 1996). Patients with Parkinson's disease, who have decreased dopaminergic function in the basal ganglia, and particularly depleting input to the putamen, not only show deficits in motor timing but also in the discrimination of temporal intervals (O'Boyle *et al.*, 1996; Hellström *et al.*, 1997). Thus, intact dopamine neurotransmission within striatal and fronto-cortical sites is important for temporal processing, which is consistent with the notion that a cortico (SMA)-striato-thalamo-cortical system is involved in sensorimotor timing (Harrington *et al.*, 2004). The basic idea in these models is that a pacemaker generates pulses and that the number of pulses represents the subjective estimate of an elapsed interval. The higher the clock rate (presumed to be dependent on the effective dopamine level) the better the temporal resolution will be and the longer subjective estimates of duration (Church, 1984; Matell and Meck, 2004; Harrington *et al.*, 2004; but see Ivry, 1996, who proposes the dominant role of cerebellar mechanisms). Recently, the association of dopaminergic gene loci with endophenotypes of cognitive functioning such as attention and the speed in motor timing was shown (Reuter *et al.*, 2005). Pharmacological manipulations of the serotonin system, applying 5-HT agonists and antagonists, however, have also been shown to affect duration discrimination abilities in humans. Duration discrimination of small intervals with a base duration of 50 ms even improved slightly (Rammsayer, 1989). Given the impairments of patients with schizophrenia in timing tasks, the alterations in subjective time perception in psilocybin model psychosis, and the rather unknown role of the serotonin system in modulating basic timing mechanisms, we designed the present study to elucidate the contribution of the serotonin system to time perception and temporal behaviour. Indications exist that intervals below a time unit of approximately 2 to 3 seconds are processed differently from longer intervals (e.g. Woodrow, 1951; Fraisse, 1984; Pöppel, 1997; Wittmann, 1999). Typically, intervals up to 2 to 3 sec are reproduced accurately, whereas longer intervals tend to be underestimated (Kagerer *et al.*, 2002). Subjects can accurately synchronize their motor actions to a sequence of tones presented with a frequency of approximately 1 to 2 Hz. The ability to synchronize these tones becomes more difficult with increasing inter-tone intervals and finally breaks down when intervals exceed durations of about 2 sec (Mates *et al.*, 1994). Therefore, in the present study we aimed to investigate dose-dependent effects of psilocybin on temporal control of motor performance in sensorimotor tasks on time ranges below and above 2 to 3 seconds. We hypothesized that psilocybin would affect performance on the longer time ranges given the known elicited deficits in attention and working memory and the importance of working memory in longer duration temporal behaviour. Given the lack of any previous data on the phenomena in question, we did not know what to expect regarding possible decrements of timing performance at shorter time ranges which would indicate fundamental influence on the more basic proposed central pacemaker/accumulator mechanism.

For this double-blind, placebo-controlled experimental study of healthy volunteers, sensorimotor tasks were selected that are standard experimental tools in timing research and have proven to be sensitive measures of behavioural differences between brain-injured patient groups and controls. We employed the tasks of sensorimotor synchronization (Mates *et al*., 1994), temporal reproduction of time intervals (Kagerer *et al*., 2002), and personal and maximum tapping speed (Wittmann *et al*., 2001). Concerning the latter tapping tasks, neuropsychological studies point to a specialization of distinct brain networks associated with either voluntarily-chosen speed or with movements at maximum pace (Wittmann *et al*., 1999, 2001). This is the first systematic study of timing tasks performed in pharmacological models of psychoses in healthy human subjects. Former studies on time perception in LSD- or psilocybin-induced states in humans reporting the subjective experience of the passage of time (Kenna and Sedman, 1964), each used a single temporal-processing task to assess time-related psychomotor performance. In the study conducted by Fischer *et al*. (1966) self-paced tapping rate during an 8-minute recording period increased in the two subjects exposed to 115 µg/kg psilocybin as compared to the performance of the same subjects on the next day without the drug. Significantly shortened pause durations between the articulations of words were recorded in 12 volunteers who were under the influence of 123 to 174 µg/kg psilocybin. This result was interpreted as evidence for an increase in the speed of a physiological clock (Tosi *et al*., 1968). However, in a duration identification task with a time range between 300 and 1000 ms, LSD did not affect performance of four subjects (Mitrani *et al*., 1977). Distinct from these limited measures of timing used previously, our study aims to systematically assess timing performance by investigating the impact of psilocybin on standardized measures of temporal processing. Following from this approach, basic neuropharmacological mechanisms of time perception in the normal brain as well as in psychotic disorders may be elucidated.

Methods and Materials

Subjects

Subjects were students from the University of Zürich and a technical college. Volunteers were supplied with oral and written information about the aim of the study and the effects and possible risks of psilocybin administration. All provided written informed consent. Eligible subjects had to have normal or corrected-to-normal vision, no hearing problems, were healthy according to medical history, physical examination, clinical-chemical blood analysis and electrocardiogram. Participants were right handed and instructed to use their dominant hand in all experimental tasks. They were also deemed by psychiatric interview to have no personal or family (first-degree relatives) history of a major psychiatric disorder or evidence of regular alcohol or substance abuse. Subjects were also diagnosed according to the DIA-X computerized diagnostic expert system (Wittchen and Pfister, 1997). Administration of psilocybin to healthy subjects was authorized by the Swiss Federal Office of Public Health, Bern. The study protocol was approved by the Ethics Committee of the University Hospital Zürich. Twelve young volunteers (six men and six women; mean age 26.8 years, SD 3.6) were recruited. Six of these participants reported having had previous experience with psilocybin through the ingestion of psilocybe mushrooms (no more than three times) and seven had used cannabis sporadically. All subjects were reimbursed for their time and were informed that they were free to withdraw from the study at any time without reprisal.

Time measures

Temporal reproduction

Subjects were instructed to reproduce the duration of a sound at 500 Hz that was presented at comfortable loudness via earphones. Six different standard intervals of 1500 ms, 2000 ms, 2500 ms (short intervals), and 4000 ms, 4500 ms, 5000 ms (long intervals) were used. Each interval was presented randomly eight times, resulting in 48 trials per subject. A trial started with the presentation of a randomly-selected standard interval.

After the tone had ended, a fixed-pause interval of 2000 ms duration followed. Then the tone was presented again. Subjects were instructed to reproduce this duration by pressing a key to switch off the stimulus when they believed that the duration corresponded to the previously presented standard interval. After completion of the reproduction phase, a new standard interval was presented. Thus, presentation phases always alternated with reproduction phases. Mean reproduced intervals and the standard deviation of reproduction were calculated over the eight trials per standard interval.

Sensorimotor synchronization

Through headphones subjects heard a regular sequence of tonal stimuli that had to be synchronized precisely by tapping the index finger on a key. The intervals between tone onsets were constant. Four different durations of inter-onset intervals were presented in different trials: 700 ms, 1000 ms, 2000 ms and 4000 ms. The number of tones in each trial was varied to achieve a constant trial duration of 56 sec: 80 (700 ms), 56 (1000 ms), 28 (2000 ms), and 14 (4000 ms). Tones had a frequency of 500 Hz and duration of 100 ms. A software program (Mates, 1990) controlled the stimulus presentation and the registration of the inter-tap intervals, as well as recording the asynchrony between the tone onset and the tap onset. As a measure of accuracy of synchronization, the mean asynchrony between tap and tone onset per trial was registered. As a measure of impaired synchronization ability the number of reactions to the tones per trial was calculated. A reaction to a tone or 'missed synchronization' was defined as a tap onset following a tone with an interval of at least 120 ms. If recorded human reaction times to acoustic stimuli occur less than approximately 120 ms after a stimulus has been presented, they are considered as 'false start', e.g., they were initiated before the stimulus actually occurred (Najenson *et al.*, 1989). Therefore, we defined positive asynchronies (taps occurring after the tone) of more than 120 ms as reactions to the stimulus, that is, as failed attempts to anticipate and synchronize with the repeatedly occurring tone.

Tapping speed

Subjects were instructed to tap constantly on a key with the index finger in a personally chosen constant tempo that was neither too fast nor too slow (personal tapping tempo). Then, in a second task, subjects had to tap at maximum speed (maximum tapping tempo). The program by Mates (1990) registered every single inter-tap interval and terminated the program after 20 taps in each task. The median inter-tap interval per trial is calculated as the measure of tapping speed and a coefficient of variance (Interquartile/ Median x 100) per trial is taken as a measure of stability of the tapping performance for each person and tapping task.

Cognitive test

Spatial Span test

Spatial working memory was assessed using the spatial span (SSP) test taken from the Cambridge Neuropsychological Test Automated Battery (CANTAB) (Robbins *et al.*, 1994). The spatial span test is a computerized version of Corsi's block tapping task measuring the spatial working memory span. For this test, up to nine white boxes arranged irregularly on a black background were presented on a touch screen. During each trial a set number of the boxes were sequentially highlighted by a change in their colour, before returning back to white. Each box was highlighted for the duration of 3 sec. The period between each subsequent box highlighting was 0.5 sec. For each trial the subject was instructed to remember the order in which the boxes were highlighted and then reproduce these changes at the end of the trial by touching the respective boxes in the appropriate sequence. Subjects were initially presented with a sequence of two boxes. After this trial one additional box was added to the sequence after every correct response, up to a maximum of nine boxes. When the subject made a mistake the following trial would repeat the previous number of boxes in a different sequence. After three incorrect responses on any number of boxes, the test was terminated. The final number of boxes that the subject was able to accurately reproduce (Span Length) was recorded.

Psychometric measures

The Altered State of Consciousness rating scale (5D-ASC) (Dittrich, 1998) and the Adjective Mood Rating Scale (AMRS) (Janke and Debus, 1978) were used to assess the subjective effects under placebo and psilocybin. Both the AMRS and 5D-ASC have previously been shown to be sensitive to the psychological effects of psilocybin in humans (Vollenweider *et al*., 1997, 1998, 1999; Hasler *et al*., 2004).

5D-ASC

The Altered States of Consciousness rating scale 5D-ASC (Dittrich, 1998; Dittrich *et al*., 1999) consists of 94 items that are visual-analogue scales of 10 cm length. These items measure alterations in mood, perception, experience of self in relation to environment, and thought disorder. Scores of each item range between zero ('No, not more than usually') and ten ('Yes, much more than usually'). The ASC items are grouped into five main factors comprising several items. (1) 'oceanic boundlessness' (OB) measures derealization and depersonalization accompanied by changes in affect ranging from heightened mood to euphoria and/or exaltation as well as alterations in the sense of time. The corresponding item clusters are 'positive derealization', 'positive depersonalization', 'altered time sense', 'positive mood', and 'mania-like experience'. (2) 'anxious ego dissolution' (AED) measures ego disintegration associated with loss of self-control, thought disorder, arousal, and anxiety. The item clusters are 'anxious derealization', 'thought disorder', 'delusion', 'fear of loss of thought control', and 'fear of loss of body control'. (3) 'visionary restructuralization' (VR) includes the item clusters 'elementary hallucinations', 'visual (pseudo-) hallucinations', 'synesthesia', 'changed meaning of percepts', 'facilitated recollection', and 'facilitated imagination'. (4) 'auditory alterations' (AA) refers to acoustic hallucinations and distortions in auditory experiences and (5) the dimension 'reduction of vigilance' (RV) relates to states of drowsiness, reduced alertness, and related impairment of cognitive function.

AMRS

The Adjective Mood Rating Scale (AMRS) (Janke and Debus, 1978) consists of 60 adjectives representing different mood states. Subjects were instructed to rate the extent to which each adjective was applicable to their current mood from the options: 'not at all' (1), 'a little' (2), 'quite' (3) and 'strongly' (4). The AMRS consists of the following main factors: 'concentration', 'inactivation,' 'tiredness,' 'dazed state', 'introversion', 'heightened mood', 'emotional excitability', 'anxiety,' 'depressiveness,' and 'dreaminess.'

Experimental procedure

Substance and dosing

Psilocybin (4-phosphoryloxy-*N,N*-dimethyltryptamine) was obtained through the Swiss Federal Office of Public Health, Bern. Psilocybin capsules (1 mg and 5 mg) were prepared at the Pharmacy of the Cantonal Hospital of Aarau, Switzerland. Quality control comprised tests for identity, purity and uniformity of content. Psilocybin and lactose placebo were administered in gelatine capsules of identical appearance. After oral uptake, psilocybin is rapidly transformed to the pharmacologically active metabolite psilocin (Hasler *et al*., 1997; Lindenblatt *et al*., 1998). Usually, first subjective effects of psilocybin are perceived 20 to 40 min after oral administration and peak at about 60 to 90 min to last for another 60 to 120 min. All psilocybin-induced symptoms usually wear off 6 to 8 hours after drug administration (Vollenweider *et al*., 1997; Hasler *et al*., 2004).

Study design

We conducted a double-blind, placebo-controlled, within-subject design with three experimental arms: placebo, medium and high doses of psilocybin were administered with a counterbalanced order of administration. Subjects were tested on 3 days separated by at least 14 days to avoid carry-over effects. The medium dose (MD) psilocybin (115 µg/kg; mean body weight of subjects 70.3±12.5 kg; absolute doses 8.2±1.4 mg psilocybin) and the high dose (HD) psilocybin (250 µg/kg; absolute doses 17.6±3.2mg psilocybin) were selected for this study due to observations from a previous investigation (Hasler *et al.*, 2004). These selected doses produced perceptual alterations without producing profound thought disturbances or complete loss of ego control. One week ahead of the first experiment, subjects underwent a somatic and psychiatric examination and were familiarized with the sensorimotor tasks. Subjects arrived at the research unit of the University Hospital of Psychiatry at 8.30 AM on each experimental day, and psilocybin or placebo capsules were administered at 10.00 AM.

Performance on the sensorimotor tasks was assessed just prior to administration of drug/placebo (t_0; baseline measures), at 90 minutes during the anticipated peak effects (t_1), and 240 minutes after drug intake (t_2), when effects had decreased substantially. Subjects also underwent psychometric measurements using the AMRS (at 0, 80 and 280 min after drug/placebo administration) and the 5D-ASC (at 110 min). The SSP of the CANTAB battery was accomplished at 0, 100 and 360 min after drug/placebo intake. Subjects were examined by the principal investigator approximately 7 to 8 hours after drug intake and released from the hospital only when the psychotropic effects had completely subsided. The presented results are part of a study that also comprised tests of binocular rivalry (sampled at 100 min, 180, 270 and 360 min), these results are reported separately (Carter *et al.*, 2005).

Statistical analysis

Psychometric data were analysed using a one-, two- or three-way repeated measures ANOVA. Analysed factors were (1) treatment (placebo, MD psilocybin, HD psilocybin), (2) time of measurement (t_0, t_1, t_2) and - where applicable - (3) measures or subscales (different temporal intervals in a timing task or subscales on a questionnaire). The interaction of treatment x time of measurement was considered as the main source of information since the effect of psilocybin should occur at t_1 and to a lesser degree at t_2, in contrast to the placebo condition. In cases where a significant interaction effect was observed, simple *a priori* contrasts compared differences between placebo and both MD and HD psilocybin. These drug dose effects were considered in respect to changes over time from both t_0 to t_1 and t_0 to t_2 (four contrasts). In some cases we looked at the three treatment conditions separately. Then, time of measurement (t_0, t_1, t_2) was the main factor in three drug conditions followed by two contrasts each (t_0 to t_1 and t_0 to t_2). Pearson's correlation analysis was used to compare relative change in performance on the temporal-processing tasks, the spatial span working memory test and the 5D-ASC rating scale. Only those correlations found to be significant at both medium and high doses were considered. For these cases, the low and high dose data were pooled to calculate a single Pearson's r value for that measure.

To minimize the possible effects of non-normal distribution in the data sets, we transformed all data prior to analysis by applying a natural log transform. In the case that negative values had to be transformed, a constant was added to the variable to make sure that all values were positive. Additionally, Greenhouse-Geisser adjustment of degrees of freedom was applied to the data set when, according to the Mauchly test, sphericity of the sample distributions could not be assumed. Significance levels were set to values of $p<0.05$. However, since multiple comparisons were planned for each measure, the risk of Type I error increases (incorrect rejection of null hypothesis). To ensure overall protection level, only those planned contrasts associated with the decisive interaction for hypothesis testing (e.g. time of measurement x treatment) on each measure are reported. Nevertheless, we adjusted the alpha level for each measure to the amount of contrasts that were applied (e.g. two contrasts: $p<0.025$, four contrasts: $p<0.0125$) as well as for the number of ANOVAs that were calculated for different subscales of a task.

Results

Temporal reproduction

To test for an effect of psilocybin on temporal reproduction, three-way repeated measure ANOVAs were calculated separately for the short (1500 ms, 2000 ms, 2500 ms) and the long intervals (4000 ms, 4500 ms, 5000 ms). The three main factors included were interval duration (three intervals for the short and the long intervals, respectively), measurement time (t_0, t_1, t_2) and treatment (placebo, MD and HD psilocybin). For the short intervals, interval duration was the only factor to show a significant effect [F(2,16)=600.2, *p*<0.001], reflecting a linear increase in reproduction intervals as a function of the presented interval duration (see Figs 1a-1c). No other main factors or interactions showed significant differences. For the long intervals, significant main effects of interval duration [F(2,16)=130.0, *p*<0.001] and measurement time [F(2,16)=6.9, *p*=0.007] were revealed. The interaction treatment x measurement time, the decisive interaction to reveal differential drug effects between peak and baseline, proved to be significant [F(4,32)=3.2, *p*=0.025]. No other interaction revealed a significant effect.

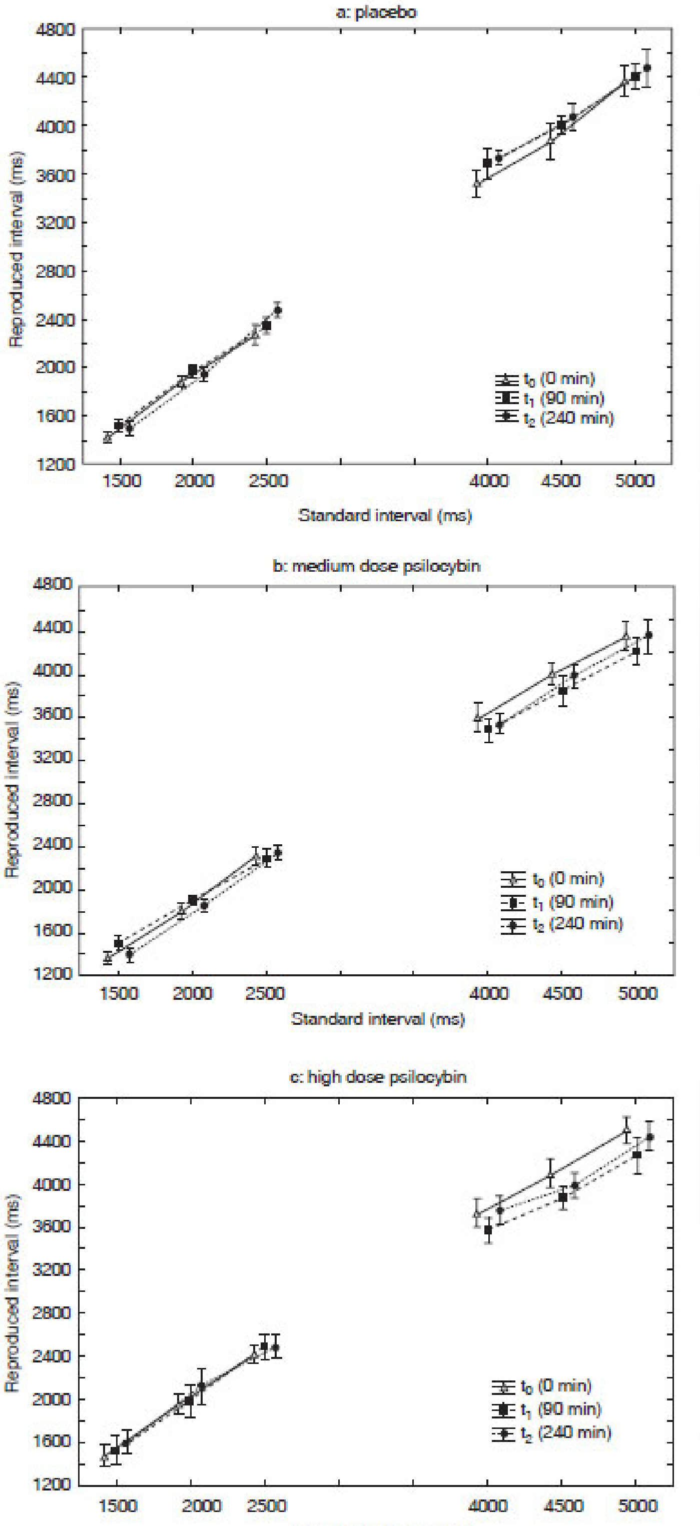


Figure 1 - Mean reproduced intervals ± SE for six different stimulus durations over three measures (t(0) = baseline, t(1) = peak effect 90 min after drug intake, t(2) = post-peak effect) are compared for the conditions of high dose psilocybin (250 µg/kg), medium dose psilocybin (115 µg/kg) and placebo.

To discern the treatment x measurement-time interaction at the long intervals, we looked separately at the three treatment conditions that were tested at the three measurement times. For every treatment condition, a two-way ANOVA with the interval duration (4000 ms, 4500 ms, 5000 ms) and measurement time (t_0, t_1, t_2) was calculated. In the placebo condition (Fig. 1a), we found a significant difference for the factor interval [$F(1,8)=98.1$, $p<0.0001$], but no significant effect of measurement time and no significant interaction of measurement time x interval duration. A similar result was obtained for MD psilocybin (Fig. 1b): a significant difference was only revealed for the factor interval [$F(2,20)=122.7$, $p<0.0001$] and measurement time did not reach the significance level ($p<0.1$). The interaction between interval duration and measurement time also revealed no significant effect. In the treatment condition HD psilocybin (Fig. 1c), however, the ANOVA revealed significant effects for both main factors, interval duration [$F(2,22)=49.5$, $p<0.001$] and measurement time [$F(2,22)=7.0$, $p=0.004$]; no significant interaction effect was found. As depicted in Fig. 1c, temporal reproductions at the long intervals showed a stronger tendency toward underestimation at peak time of HD psilocybin as compared with baseline. Contrasts for the effect of measurement time in the HD-psilocybin condition showed significant differences for the contrast between t_1 and t_0 [$F(1,11)=13.0$, $p=0.004$] but no significant difference between t_2 and t_0 [$F(1,11)=0.36$, $p=0.561$]. Thus, HD psilocybin leads to a significant under-reproduction of time intervals of 4 seconds and longer.

To assess the stability of performance, we compared the standard deviation of the reproduced interval for the three factors: interval, measurement time and treatment. A three-way ANOVA for the short intervals did not reveal any significant effects. For the long intervals, measurement time showed a significant effect. However, for both, the long and short interval durations, the treatment x measurement time interaction failed to reach the significance level.

Sensorimotor synchronization

Asynchrony (Mean)

To assess the subjects' ability to temporally synchronize to a regularly occurring external stimulus, a three-way ANOVA with the main factors: treatment, measurement time and interval (700 ms, 1000 ms, 2000 ms, 4000 ms) was calculated for the dependent variable asynchrony. Whereas the effect of treatment failed to reach significance [$F(2,22)=3.0$, $p=0.069$], measurement time [$F(2,22)=10.1$, $p=0.001$] and interval [$F(1.2,13.5)=16.7$, $p<0.001$; Greenhouse-Geisser adjusted] showed significant differences. Moreover, the measurement time x treatment interaction was found to be significant [$F(4,44)=3.9$, $p=0.009$]. The interaction between interval and measurement time failed to reach significance [Greenhouse-Geisser adjusted]. The interaction of interest (measurement time x treatment) only tended towards significance for the contrast between HD psilocybin and placebo between t_1 and t_0 [$F(1,11)=4.5$, $p=0.057$] but a significant difference was observed for the contrast between MD psilocybin and placebo between t_1 and t_0 [$F(1,11)=14.5$, $p=0.003$].

To take a closer look at the treatment x measurement-time interaction, we calculated two-way ANOVAs separately for the three treatment conditions with the two main factors: measurement time and interval. In the placebo condition, only the main factor interval [$F(1.2,13.2)=13.6$, $p=0.01$; Greenhouse-Geisser adjusted] proved to be significant. No significant differences were found for either measurement time or the interval x measurement-time interaction (Fig. 2a). In the MD-psilocybin condition both factors interval [$F(1.27,33)=12.4$, $p=0.002$; Greenhouse-Geisser adjusted] and measurement time [$F(2,22)= 10.2$, $p<0.001$] revealed significant differences, but not the interaction of the two. Contrasts for the effect of measurement time in the MD-psilocybin condition showed a significant difference for the contrast between t_1 and t_0 [$F(1,11)=16.9$, $p=0.002$] but no significant difference between t_2 and t_0 [$F(1,11)=0.669$, $p=0.431$] (Fig. 2b). In the HD psilocybin condition, interval [$F(1.4,15.9)=9.9$, $p=0.003$; Greenhouse-Geisser adjusted] and measurement time [$F(2,22)=8.1$, $p=0.002$] as well as the interval x measurement-time interaction [$F(2.5,27.7)=4.7$, $p=0.012$; Greenhouse-Geisser adjusted] reached the significance level. Contrasts for the effect of measurement time in the HD-psilocybin condition revealed only a marginally significant difference (adjusted p value) for the contrast between t_1 and t_0 [$F(1,11)=5.5$, $p=0.039$] and no significant difference between t_2 and t_0 [$F(1,11)=1.844$, $p=0.202$] (Fig. 2c). It is to note that the smaller mean asynchrony between tap and tone onset does not reflect a more precise synchronization ability but instead an increase in reaction times, that is, more missed synchronizations (see below).

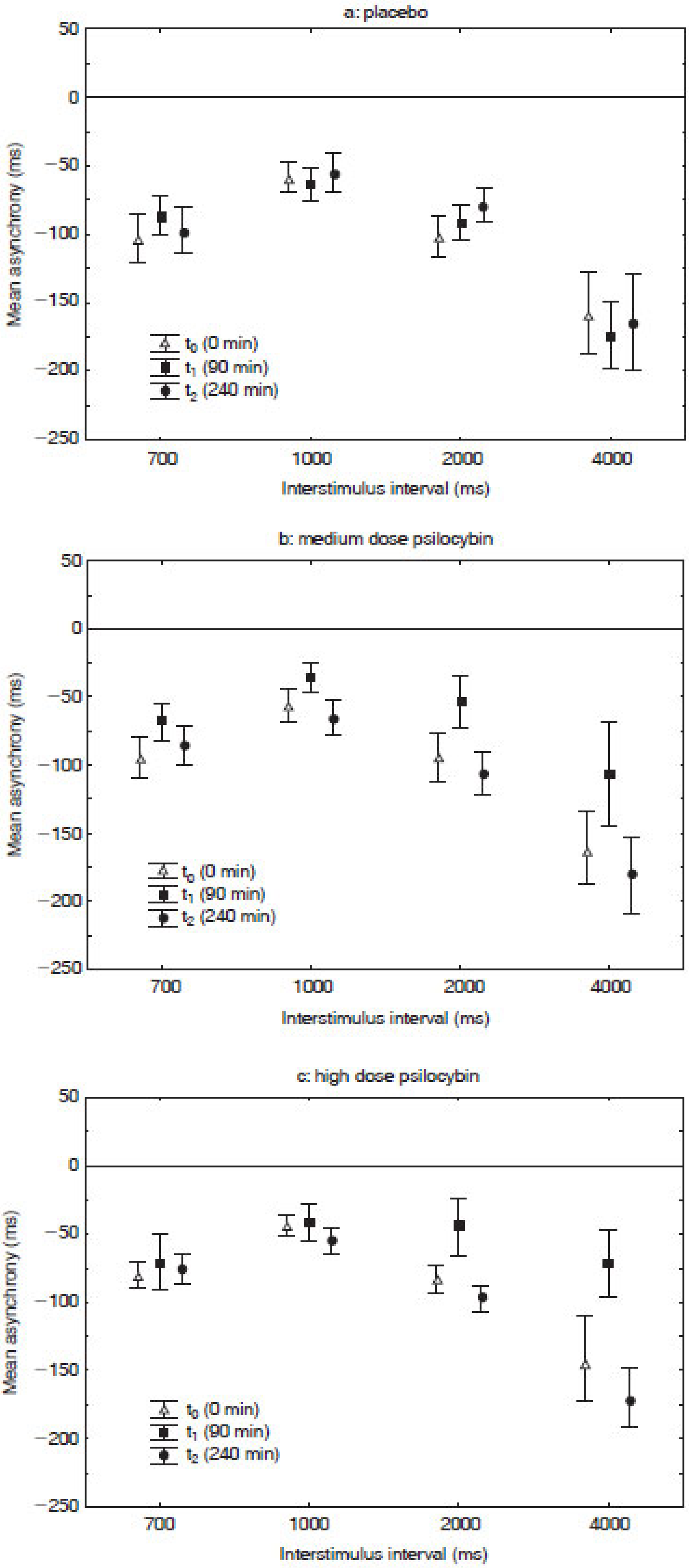


Figure 2 - Mean asynchrony (± SE) between motor response (tap onset) and tone onset over four different interstimulus intervals in the sensorimotor synchronization task over three measures (t(0)= baseline, t(1) = peak effect 90 min after drug intake, t(2) = post-peak effect) are compared for the conditions of high dose psilocybin (250 µg/kg), medium dose psilocybin (115 µg/kg) and placebo.

Asynchrony (standard deviation)

To measure the stability of synchronization performance, the standard deviation of the asynchrony between the tap and the tone was taken as the dependent variable in a three-way ANOVA with the main factors: treatment, measurement time and interval. Treatment [F(2,22)=1.4, *p*=0.874] and time of measurement [F(2,22)=1.6, *p*=0.229] showed no effect on performance. The length of the inter-beat interval had a significant influence on tapping variability [F(3,33)=227.5, *p*<0.001] - the standard deviation getting bigger with increasing intervals. However, the important interaction measurement time x treatment [F(4,44)=1.4, *p*=0.268] was not significant.

Per cent missed synchronization

As can be seen in Fig. 3a-c, it was only for the 2- and 4-seconds intervals that a considerable amount of reaction time asynchronies (> 120 ms) were detectable. Therefore, only these two intervals were taken for further calculations. A three-way ANOVA comparing the per cent missed synchronization for the factors - treatment, measurement time and interval (2000 ms, 4000 ms) - showed a significant main effect only for treatment [F(2,22)=4.9, *p*=0.018] and interval [F(1,11)=16.5, *p*=0.002]. The interaction in focus of our hypotheses treatment x measurement time showed not to be significant [F(4,44)=1.1, *p*=0.37] although - descriptively - subjects show more reaction times under psilocybin at peak-time than at baseline or at post peak (see Fig. 3a-c).

Personal tapping speed

A two-way ANOVA (treatment and measurement time) revealed that psilocybin significantly slowed tapping tempo. There was a main effect of measurement time [F(2,20)=3.5, *p*=0.05], treatment [F(2,20)=4.9, *p*=0.019], and the measurement time x treatment interaction [F(4,40)=3.1, *p*=0.026]. Subjects tapped slower during peak effects of HD psilocybin (949.0 ms, SD: 390.0) than at baseline (692.2 ms, SD: 274.6) and post-peak effects of drug (772.1 ms, SD: 280.7). Following a one-way ANOVA with the factor measurement time in the HD condition [F(2,20)=8.7, *p*=0.002], subsequent contrasts reveal a significant difference between t_1 and t_0 [F(1,10)=13.6, *p*=0.004] but no significant difference between t_2 and t_0 [F(1,10)=2.7, *p*=0.133]. No effect of measurement time was seen in the MD condition [F(2,20)=1.5, *p*=0.247]. The coefficient of variance, the measure for tapping stability in the personal tempo, revealed a significant main effect of measurement time [F(2,20)=5.7, *p*=0.01], but no effect for treatment or the interaction of the two main factors.

Maximum tapping speed

Over the different experimental conditions, subjects' maximum tapping speed was registered with mean inter-tap intervals of approximately 150 ms. Two-way ANOVA for the factors measurement time [F(2,22)=10.9, *p*=0.001] and treatment [F(2,22)=4.3, *p*=0.026] showed significant main effects. However, the important measurement time x treatment interaction was not significant. Since the main effect of treatment includes the t_0 and t_2 measurement times in addition to the t_1 measurement time, the treatment effect was probably due to by chance different performance on the psilocybin administration day. Furthermore, a two-way ANOVA on the coefficients of variance for the inter-tap interval showed no significant main effects or interaction, suggesting that tapping stability at maximum speed is unaffected by psilocybin.

Spatial span task

Two-way ANOVAs (factors treatment and measurement time) were calculated to elucidate the effects of psilocybin on the spatial span length. We found no overall effect for treatment [F(2,22)=1.33, n.s.], a significant effect to measurement time [F(2,22)=4.05, *p*=0.032], and - decisive for the question of concern - a significant interaction effect [F(2,22)=4.66, *p*=0.003]. A priori contrasts (alpha level adjusted to *p*<0.0125 for four contrasts) revealed a significant difference only for the contrast between placebo and HD psilocybin between t_1 and t_0 (*p*<0.011). Thus, at the peak of effects, HD psilocybin (and not MD psilocybin) impaired spatial span task (SSP) performance as indexed by span length (see Fig. 5).

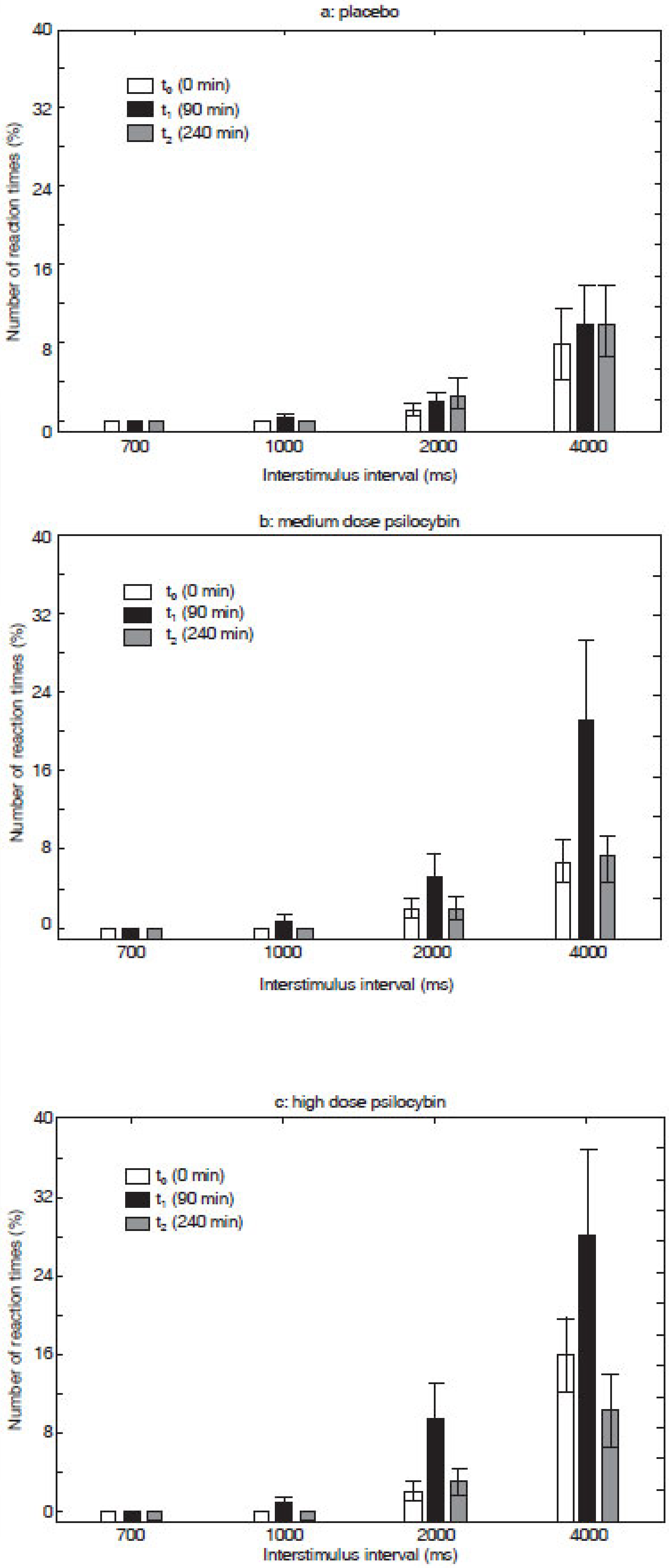


Figure 3 - Mean number of reaction times (in per cent; ± SE) of four different interstimulus intervals in the sensorimotor synchronization task over three measures (t(0) = baseline, t(1) = peak-effect 90 min after drug intake, t(2) = post peak effect) are compared for the conditions of high dose psilocybin (250 µg/kg), medium dose psilocybin (115 µg/kg) and placebo.

Altered States of Consciousness rating scale (5D-ASC)

As shown in Fig. 4, psilocybin increased the scores of the 5D-ASC dimensions (as assessed at peak time) in a dose-dependent manner. There was a main effect of treatment [F(2,22)=14.2, *p*<0.001]. The main effect for subscale did not reach the significance level [F(2.22,24.2)=4.38; *p*=0.064; Greenhouse-Geisser adjusted] but the treatment x subscale interaction did [F(8,88)=2.53, *p*=0.016]. Subsequent one-way repeated measures ANOVAs comparing the three treatment conditions at peak time were performed for each of the five subscales (adjusted alpha level for five comparisons is *p*<0.01). A significant effect of treatment could be seen in all five subscales: OB [F(2,22)=13.54; *p*<0.001; contrast for MD psilocybin vs placebo: *p*=0.01; contrast for HD psilocybin vs. placebo: *p*<0.001], AED [F(2,22)=7.08; *p*=0.004; MD psilocybin vs. placebo: *p*=0.046 (n.s.); HD psilocybin vs placebo: *p*=0.005], VR [F(2,22)=11.2; *p*<0.001; MD psilocybin vs placebo: *p*=0.006; HD psilocybin vs placebo: *p*=0.003], AA [F(1.368,15.05)=9.79; *p*=0.004; Greenhouse-Geisser adjusted; MD psilocybin vs placebo: *p*<0.167 (n.s); HD psilocybin vs placebo: *p*=0.007], RV [F(2, 22)=7.67; *p*=0.003; MD psilocybin vs placebo: *p*=0.004; HD psilocybin vs placebo: *p*=0.003].

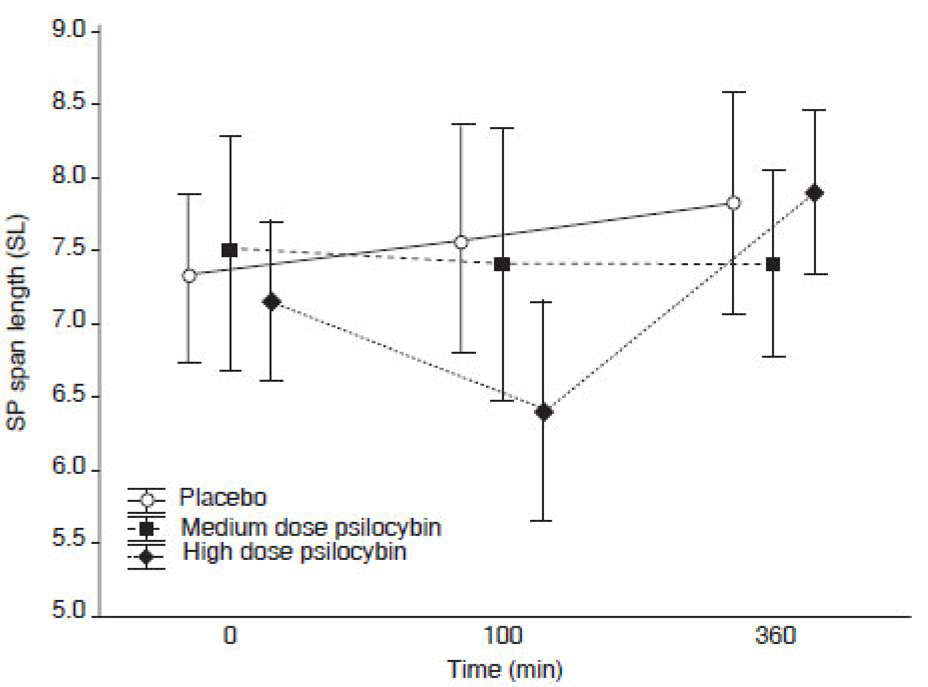


Figure 4 - Dose- and time-dependent effects of psilocybin on working memory performance as indexed by spatial span length (SL; mean ± SE).

A subsequent exploration of the ASC item clusters in each subscale revealed that the increase in OB after high-dose psilocybin was mainly due to moderate increases in (positive) 'derealization phenomena' (30.8±18.7% of scale maximum), 'heightened mood' (30.1±18.9%) and 'mania-like symptoms' (26.0±18.5%). The item of special interest, 'altered time sense', also showed a significant effect of psilocybin [F(1.33,14.61)=7.9; *p*=0.009; contrast for MD psilocybin vs placebo: *p*=0.083 (n.s.); contrast for HD psilocybin vs placebo: *p*=0.017]. The increase in AED was attributable to moderate 'thought disturbances' (45.0±29.8% of scale maximum) followed by slight increases in 'loss of body control' (20.1± 21.0%), 'loss of thought control' (15.9±28.5%) and 'anxious derealization' (15.0±23.4%). Furthermore, the analysis of the VR item-cluster revealed that only the high dose, but not the medium dose of psilocybin significantly produced 'complex hallucinations' and increased 'facilitated recollection and imagination,' and that increase in VR after medium dose of psilocybin was mainly due to visual illusions and elementary hallucinations, such as light flashes or geometric figures.

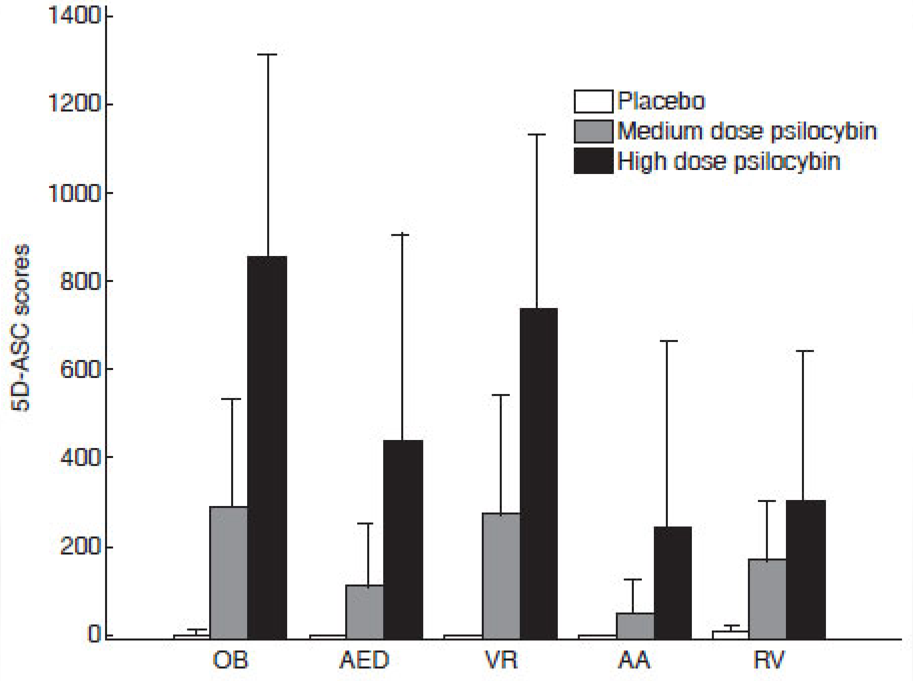


Figure 5 - Mean scores ± SE of the Altered States of Consciousness Rating Scale (5D-ASC) during the peak effect of high dose psilocybin (250 µg/kg) compared to medium dose psilocybin (115 µg/kg) and placebo (*n* = 12). OB= oceanic boundlessness, AED=anxious ego dissolution, VR = visionary restructuralization, AA= auditory alterations, RV = reduction of vigilance.

Adjective Mood Rating Scale (AMRS)

Two-way repeated measures ANOVAs were performed for each of the ten subscales (adjusted alpha level: $p<0.005$). A significant interaction between treatment and measurement time, was found for the subscales of inactivation [F(4,44)=7.89, $p=0.001$; significant contrast for MD psilocybin vs placebo between t_0 and t_1 ($p<0.001$) as well as between HD psilocybin and placebo between t_0 and t_1 ($p=0.019$)], tiredness [F(4,44)=6.6, $p<0.001$; MD psilocybin vs placebo between t_0 and t_1 ($p<0.001$)], dazed state [F(4,44)=6.51, $p<0.001$; MD psilocybin vs placebo between t_0 and t_2 ($p<0.001$)], introversion [F(4,44)=9.84, $p<0.001$; MD psilocybin vs placebo between t_0 and t_2 ($p<0.001$)], emotional excitability [F(4,44)=5.36, $p<0.001$; MD psilocybin vs placebo between t_0 and t_1 ($p=0.015$)], and dreaminess [F(4,44)=12.4, $p<0.001$; MD psilocybin vs placebo between t_0 and t_1 ($p=0.009$) as well as t_0 and t_2 ($p<0.001$)]. A tendency for a treatment x measurement-time interaction was found for the subscale of 'concentration' [F(4,44)=4.12, $p=0.006$]. No significant interaction effect appeared for the subscales of heightened mood, anxiety and depressiveness. The effects of psilocybin on the AMRS mood scales during peak time, comparing the three treatment conditions, are presented in Fig. 6.

Correlations between working-memory performance, time measures and psychometric scores

Correlational analyses revealed no significant correlation between spatial span length and temporal reproduction for the longer intervals (4000, 4500, 5000 ms; where significant drug effects were found) (*r* ranged from -0.17 to 0.16). However, there was a strong negative correlation between spatial span length and the OB subscore (r=-0.73, $p<0.001$). Further multiple regression analysis revealed that the two OB items 'depersonalization' and 'altered time sense' contributed most to this effect (r=-0.83, $p<0.0001$ and r=-0.69, $p<0.001$, respectively). Importantly, the other factors on the 5D-ASC did not show significant correlations with spatial span length, indicating that this effect was specific and not a generalized association between the drug-induced altered state of consciousness and working-memory decrement. There were no significant correlations between any of the temporal-processing measures and the 5D-ASC subscales, however a trend towards correlation between the OB subscore and the time reproduction underestimation at longer time intervals was found. Specifically, the item 'altered time sense' showed moderate correlation coefficients with the longer time intervals in temporal reproduction at peak time under the influence of MD and HD psilocybin: the larger the underestimation of the 4500 and 5000 ms interval, the higher the score on the 'altered time sense' item (*r* between 0.4 and 0.6). However, these associations failed to reach the significance level.

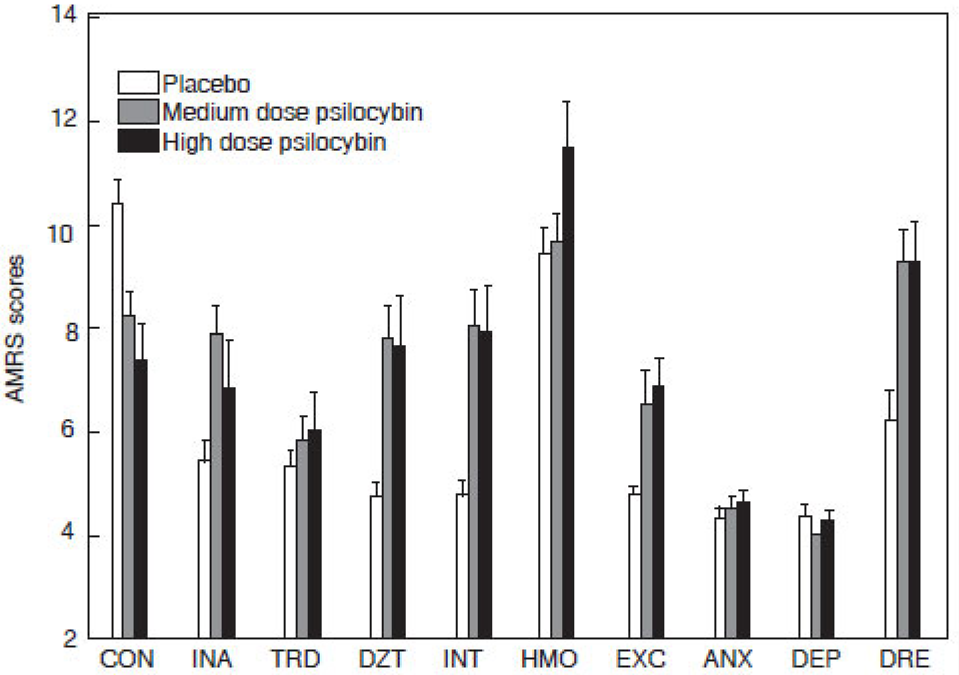


Figure 6 - Mean scores ± SE of the Adjective Mood Rating Scale (AMRS) during the peak effect of high dose psilocybin (250 µg/kg) compared to medium dose psilocybin (115 µg/kg) and placebo (*n* = 12). CON = concentration, INA = inactivation, TRD = tiredness, DZT = dazed state, INT = introversion, HMO = heightened mood, EXC = emotional excitability, ANX = anxiety, DEP = depressiveness, DRE = dreaminess.

Discussion

Our investigation clearly revealed that the 5-HT$_{2A}$/5-HT$_{1A}$ mixed agonist psilocybin alters time perception and temporal control of behaviour in humans. These results confirm self-reports that hallucinogens cause strong alterations in spatial and temporal perception (Vollenweider *et al*., 1997; Hasler *et al*., 2004) and extend these psychometric findings by showing the specific ways in which objective measures of temporal processing can be affected. Psilocybin was found to affect an individual's capacity to accurately reproduce interval lengths longer than 3 seconds, synchronize a motor response (finger tap) to regular auditory beats with intervals longer than 2 seconds, and to slow down the personal tapping tempo (preferred tapping rate). No impairment of performance was observed for shorter lengths on the sensorimotor synchronization and the reproduction task. This indicates that the effects found at the longer intervals were likely a product of interactions with cognitive dimensions of temporal processing instead of interactions with the proposed basic pacemaker/accumulator mechanisms of the brain (Rammsayer, 1999; Wearden, 2004).

Several studies on timing point to a temporal-integration interval of approximately 2 to 3 sec that can be found in perception and motor performance (for reviews, see Fraisse, 1984; Pöppel, 1997; Wittmann, 1999). Durations of temporal intervals in the temporal-reproduction task are estimated precisely with intervals up to approximately 2 to 3 sec, whereas longer intervals are substantially underestimated (Kagerer *et al*., 2002). A temporal limitation of anticipatory planning is also observed in the sensorimotor synchronization task. The ability to synchronize accurately becomes substantially weaker when the inter-stimulus interval is longer than 2 sec (Mates *et al*., 1994). Our pharmacological approach contributes to these findings, as psilocybin mildly affects only those intervals of longer duration in each task. One of the few time perception studies under LSD in humans adds to our results (Mitrani *et al*., 1977): subjects did not show distortions in the ability to identify durations of visual stimuli in the range between 300 ms and 1 sec although they reported changes in the subjective passage of time.

In respect to the current model of timing with multiple processing stages (Wearden, 2004), the disturbed timing abilities for sensorimotor synchronization and duration reproduction we show here could reflect impairments of short-term memory, attention or decision-making mechanisms (Zakay and Block, 1996; Pouthas and Perbal, 2004), rather than the alteration of the pacemaker-accumulator clock (the basic internal timing mechanism). This is especially supported by the concurrent deficits observed in working memory in the present study. Converging evidence exists for the involvement of working memory in temporal reproduction. Processing of a secondary task that influences working-memory capacity interferes with the encoding and reproducing of durations in the domain of seconds (Fortin and Rousseau, 1998). Miyake *et al*. (2004) showed that a secondary working-memory task affected the accuracy of synchronization only with inter-stimulus intervals above 2 seconds. With inter-stimulus intervals below 2 seconds the memory task had no influence on performance. In a group of elderly subjects, working memory capacity correlated with performance in a temporal reproduction task with durations of 5 and 14 seconds (Baudouin *et al*., 2006). Frontal regions known to be closely linked with working-memory function, particularly dorsolateral and frontomedial cortices (Postle *et al*., 2000; Cabeza and Nyberg, 2000; Owen, 2000) are active during temporal reproductions of time intervals of a few seconds (Elbert *et al*., 1991; Volz *et al*., 2001; Monfort and Pouthas, 2003). Given the selective effect of psilocybin on the longer duration intervals in both the temporal reproduction and sensory synchronization tasks it seems that the temporal disturbance observed is induced through interference with cognitive processes like attention and working memory. The fact that no correlations were found between performance on the working-memory and temporal-processing tasks, should not be considered as evidence against this hypothesized role of working memory in the observed timing impairments. Rather it is likely to reflect the small sample size combined with the relatively small effect sizes seen in both the timing measurements and the working memory. In fact, the small impairments observed for the timing measures may reflect a relative insensitivity of working memory performance to psilocybin, a claim supported by the finding that psilocybin had no significant effect on working memory at either the median dose used in this study (115 µg/kg) or a higher dose (215 µg/kg) used in a separate study (Carter *et al*., in press). However, further studies are warranted to corroborate this interpretation. Moreover, it is also possible that other working-memory functions such as verbal working memory might be more significantly associated with the timing tasks.

Whereas the maximum-tapping speed was unaffected by psilocybin, the tapping tempo in a voluntarily chosen tempo was significantly slower during peak effects of HD psilocybin as compared to baseline and post-peak time of that condition. This finding is consistent with several lines of evidence showing that the control of motor speed can basically be characterized by two distinct sensorimotor processes functioning with different frequencies. For example, movements with a frequency of 1 to 2 Hz are under voluntary control and allow the collection of somatosensory information (feedback control), while movements at maximum speed with frequencies of 5 Hz and above require only coarse pre-attentive control (feed-forward control) (Peters, 1989; Kunesch *et al*., 1989; Wittmann *et al*., 1999). These two sensorimotor modes appear to be controlled by distinct neural networks. Injury of the cerebellum can lead to dysdiadochokinesia, the inability to alternate agonist and antagonist muscles with maximum speed (Dichgans, 1984). In contrast, metabolic dysfunction of the basal ganglia such as in Parkinson's disease can lead to the inability to tap at a slower pace, patients showing the so-called hastening phenomenon (Nakamura *et al*., 1978). In another study, tapping in a self-paced tempo was slowed down in patients with left-hemispheric lesions to the brain, whereas maximum-tapping speed was not influenced by lesions in either side of the cortex (Wittmann *et al*., 2001). The effect of HD psilocybin on personal tapping tempo, leading to a slower pace of the regular finger taps at peak time, could be the result of the drug influencing cortical sites of the brain, including those of the left hemisphere. In partial support of such a hypothesis we have previously found that psilocybin caused left-over-right sided dorsolateral overactivation that significantly correlated with depersonalization phenomena using FDG-PET imaging (Vollenweider *et al*., 1997; Vollenweider, 2001).

Psilocybin-induced dose-dependent changes to subjective measures of conscious state, i.e. the loosening of ego boundaries, changes in affect and perceptual distortions as previously reported in detail (Vollenweider *et al*., 1997; Hasler *et al*., 2004), included the expected changes in time perception as indexed by the 5D-ASC item 'altered time sense'. Although we found no correlation between working-memory deficits and the objective timing measures used, we did find significant correlations between working-memory impairment and subjective measures of altered time sense and depersonalization experiences measured by the OB subscale of the 5D-ASC. The trend towards correlations for the duration underestimation above 3 seconds and the OB item 'altered time sense' merits further studies seeking to investigate the relationship between alterations in temporal processing and experiences of self.

The pharmacological basis of the experience of time and temporal processing is only vaguely understood.

Pharmacological manipulations in animal and human studies indicate that dopaminergic agonists and antagonists influence timing processes - supposedly by increasing and decreasing (respectively) clock speed (Rammsayer, 1989; Cevik, 2003). The detrimental effect of the DA antagonist haloperidol on duration discrimination with base intervals of 50 ms has been interpreted as resulting from a slowing down of the clock rate (Rammsayer, 1989). Studies in patients with Parkinson's disease show that dopaminergic agonists can improve motor timing (O'Boyle *et al.*, 1996). It appears that dopaminergic neurotransmission within striatal and cortical sites is strongly connected to temporal processing, leading to the postulation of a cortico-striato-thalamo-cortical system involved in sensorimotor timing (Matell and Meck, 2004). The present results indicate that the serotonin system is also involved in temporal processing, either directly as a component of one of the basic processing stages in the model of timing or indirectly by influencing dopaminergic or glutaminergic transmission as we have previously shown in PET studies of psilocybin model psychosis (Vollenweider *et al.*, 1999). When taking into account the different levels of the timing model that are an integrative part of the cognitive system (Pouthas and Perbal, 2004), several neurotransmitter systems play a decisive role in temporal processing in the range of seconds. Rammsayer (1999), for example, discovered that the dopamine receptor antagonist haloperidol as well as benzodiazepine midazolam had detrimental effects on duration discrimination of intervals ranging around 1 second whereas processing of 50-ms intervals was only affected by haloperidol. These results were discussed as influences via disruption of transmitter-guided cognitive processes such as attention and working memory. The author concluded that any pharmacological treatment that affected working-memory capacity would interfere with temporal processing of intervals in the longer time range. It has to be noted that we did not find effects of psilocybin on durations below 2 seconds. This discrepancy can only be resolved in future studies that consider task-specific and pharmacological factors. In addition to comparing possible task-related differences between the duration discrimination task and the sensorimotor tasks used in our study, selective effects of individual pharmacological substances will probably be accounted for by the inconsistencies found over different studies. In the study presented here, the 5-HT$_{2A/1A}$ receptor agonist psilocybin affected time intervals in sensorimotor synchronization and temporal reproduction only above 2 to 3 seconds and only self-paced tapping (and not maximum tapping). These effects can also be interpreted as following the disruption of cognitively mediated temporal-processing stages. Moreover, as we are reporting the specific effects of the drug concerning the time domain, we can rule out the possibility that a generally decreased capacity of subjects to interact with the environment or a decreased interest for the experimental task produced the effects shown.

Our main goal was to elucidate whether psilocybin induced specific effects on temporal control of behaviour and, if so, whether these would be a function of the duration of the processed time interval - an effect we did find. In future studies the possible relationship between duration processing and underlying cognitive functions including different aspects of working memory - for example, taking into account differences between spatial and verbal working memory - needs to be further investigated by concurrently probing other dimensions of attention and working memory. Further studies with specific 5-HT$_{1A}$, 5-HT$_{2A}$ and dopamine receptor antagonists are needed to tease out the relative contribution of each of these receptor systems to the observed effects. In respect to the use of psilocybin in modelling endogenous psychosis, temporal processing deficits have been observed in chronic medicated schizophrenics at both short and long intervals (Davalos *et al.*, 2002, Davalos *et al.*, 2003, Elvevag *et al.*, 2003) whereas our current findings indicate that only longer interval processing is affected by psilocybin. It would be of interest to see whether the use of the same paradigm in healthy subjects with psilocybin and unmedicated acute schizophrenic subjects would show the same disparity of effects. Moreover, as some effects could be seen on a descriptive level but differences failed to reach the significance level it would be interesting to investigate whether increasing the number of participating subjects may yield further effects of the psilocybin intervention.

Acknowledgments

This study was supported by the Heffter Research Institute, Santa Fe, NM, USA, and the Swiss Federal Office of Public Health (BAG contract No. 00.001023) through grants to FXV. The authors especially thank G. Greer, MD, for critical comments on the manuscript.

References

1. Arora R C, Meltzer H Y (1991) Serotonin2 (5-HT2) receptor binding in the frontal cortex of schizophrenic patients. J Neural Transm Gen Sect 85: 19-29
2. Bantick R A, Deakin J F W, Grasby P M (2001) The 5-HT1A receptor in schizophrenia: a promising target or novel atypical neuroleptics? J Psychopharmacol 15: 37-46
3. Baudouin A, Vanneste S, Isingrini M, Pouthas V (2006) Differential involvement of internal clock and working memory in the production and reproduction of duration: A study on older adults. Acta Psychologica 121: 285-296
4. Block R, Zakay D, Hancock P (1998) Human aging and duration judgments: a meta-analytic review. Psych Aging 13: 584-596
5. Braus D F (2002) Temporal perception and organisation, neuronal synchronization and schizophrenia. Fortschr Neurol Psychiatr 70: 591-600
6. Cabeza R, Nyberg L (2000) Imaging cognition II: an empirical review of 275 PET and fMRI studies. J Cog Neurosci 12: 1-47
7. Carter O L, Burr D C, Pettigrew J D, Wallis G M, Hasler F, Vollenweider F X (n.d.) Using psilocybin to investigate the relationship between attention, working memory and the Serotonin1A/2A receptors. J Cog Neuroscience (in press)
8. Carter O L, Pettigrew J D, Hasler F, Wallis G M, Liu G B, Hell D, Vollenweider F X (2005) Modulating the rate and rhythmicity of perceptual rivalry alternations with the mixed 5-HT2A and 5HT1A agonist psilocybin. Neuropsychopharmacology 30: 1154-1162
9. Cevik M Ö (2003) Effects of methamphetamine on duration discrimination. Behavioral Neuroscience 117: 774-784
10. Church R M (1984) Properties of the internal clock. In Gibbon J, Allan L (eds), Annals of the New York Academy of Sciences Vol. 423: Timing and Time Perception. New York Academy of Sciences, New York
11. Davalos D, Kisley M, Ross R (2002) Deficits in auditory and visual temporal perception in schizophrenia. Cog Neuropsychiat 7: 273-282
12. Davalos D B, Kisley M A, Ross R G (2003) Effects of interval duration on temporal processing in schizophrenia. Brain Cogn 52: 295-301
13. Dichgans J (1984) Clinical symptoms of cerebellar dysfunction and their topodiagnostical significance. Human Neurobiol 2: 269-279
14. Dittrich A (1998) The standard psychometric assessment of altered states of consciousness (ASCs) in humans. Pharmacopsychiat 31: 80-84
15. Dittrich A, Lamparter D, Maurer M (1999) 5D-ABZ: Fragebogen zur Erfassung aussergewöhnlicher Bewusstseinszustände. Eine kurze Einführung. PSIN Plus, Zürich
16. Elbert T, Ulrich R, Rockstroh B, Lutzenberger W (1991) The processing of temporal intervals reflected by CNV-like brain potentials. Psychophysiology 28: 648-655
17. Elvevag B, McCormack T, Gilbert A, Brown G D, Weinberger D R, Goldberg T E (2003) Duration judgements in patients with schizophrenia. Psychol Med 33: 1249-1261
18. Fischer R, England S M, Archer R C, Dean R K (1966) Psilocybin reactivity and time contraction as measured by psychomotor performance. Arzneimittelforschung 16: 180-185
19. Fortin C, Rousseau R (1998) Interference from short-term memory processing on encoding and reproducing brief durations. Psychol Res 61: 269-276
20. Fraisse P (1984) Perception and estimation of time. Ann Rev Psych 35: 1-36.
21. Gouzoulis-Mayfrank E, Habermeyer E, Hermle L, Steinmeyer A M, Kunert H J, Sass H (1998) Hallucinogenic drug induced states resemble acute endogenous psychoses: results of an empirical study. Eur Psychiatry 13: 399-406
22. Gouzoulis-Mayfrank E, Thelen B, Maier S, Heekeren K, Kovar K-A, Sass H, Spitzer M (2002) Effects of the hallucinogen psilocybin on covert orienting of visual attention in humans. Neuropsychobiology 45: 205-212
23. Harrington D L, Haaland K Y (1998) Neural underpinnings of temporal processing: a review of focal lesion, pharmacological, and functional imaging research. Rev Neurosci 10: 91-116
24. Harrington D L, Boyd L, Mayer A, Sheltraw D, Lee R, Huang M, Rao S (2004) Neural representation of interval encoding and decision making. Cog Brain Res 21: 193-205
25. Hasler F, Bourquin D, Brenneisen R, Baer T, Vollenweider F X (1997) Determination of psilocin and 4-hydroxyindole-3-acetic acid in plasma by HPLC-ECD and pharmacokinetic profiles of oral and intravenous psilocybin in man. Pharm Acta Helv 72: 175-184
26. Hasler F, Grimberg U, Benz M A, Huber T, Vollenweider F X (2004) Acute psychological and physiological effects of psilocybin in healthy humans. A double-blind placebo-controlled dose-effect study. Psychopharmacology 52: 145-156
27. Heimann H (1994) Experience of time and space in model psychoses. In Pletscher A, Ladewig D (eds), 50 Years of LSD. Current Status and Perspectives of Hallucinogens. The Parthenon Publishing Group: New York
28. Hellström A, Lang H, Portin R, Rinne J (1997) Tone duration discrimination in Parkinson's disease. Neuropsychologia 35: 737-740
29. Ivry R (1996) The representation of temporal information in perception and motor control. Curr Opin Neurobiol 6: 851-857
30. Janke W, Debus G (1978) Die Eigenschaftswörterliste (EWL-K) - Ein Verfahren zur Erfassung der Befindlichkeit. Hogrefe, Göttingen
31. Kagerer F, Wittmann M, Szelag E, Steinbüchel von N (2002) Cortical involvement in temporal reproduction: evidence for differential roles of the hemispheres. Neuropsychologia 40: 357-366
32. Kenna J C, Sedman G (1964) The subjective experience of time during lysergic acid diethylamide (LSD-25) intoxication. Psychopharmacologia 5: 280-288
33. Klosterkötter J, Hellmich M, Steinmeyer E M, Schultze-Lutter F (2001) Diagnosing schizophrenia in the initial prodromal phase. Arch Gen Psychiatry 58: 158-164
34. Kunesch E, Binkofski F, Freund H-J (1989) Invariant temporal characteristics of manipulative hand movements. Exp Brain Res 78: 539-546

35. Lindenblatt H, Kraemer E, Holzmann-Erens P, Gouzoulis-Mayfrank E, Kovar K A (1998) Quantitation of psilocin in human plasma by highperformance liquid chromatography and electrochemical detection: comparison of liquid-liquid extraction with automated on-line solidphase extraction. J Chromatogr B Biomed Sci Appl 709: 255-263
36. McKenna D J, Repke D B, Lo L, Peroutka S J (1990) Differential interactions of idolealkylamines with 5-hydroxytryptamine receptor subtypes. Neuropharmacology 29: 193-198
37. Matell M, Meck W (2004) Cortico-striatal circuits and interval timing: coincidence detection of oscillatory processes. Cog Brain Res 21: 139-170
38. Mates J (1990) A system of personal computer control programs for tapping experiments. Comp Meth Prog Biomed 33: 43-48
39. Mates J, Radil T, Müller U, Pöppel E (1994) Temporal integration in sensorimotor synchronization. J Cog Neurosci 6: 332-340
40. Meck W (1996) Neuropharmacology of timing and time perception. Cog Brain Res 3: 227-242
41. Mita T, Hanada S, Nishino N, Kuno T, Nakai H, Yamadori T, Mizoi Y, Tanaka C (1986) Decreased serotonin S2 and increased dopamine D2 receptors in chronic schizophrenics. Biol Psychiatry 21: 1407-1414
42. Mitrani L, Shekerdjiiski S, Gourevitch A, Yanev S (1977) Identification of short time intervals under LSD25 and mescaline. Activ Nerv Sup 19: 103-104
43. Miyake Y, Onishi Y, Pöppel E (2004) Two types of anticipation in synchronous tapping. Acta Neurobiol Exp 64: 415-426
44. Monfort V, Pouthas V (2003) Effects of working memory demands on frontal slow waves in time-interval reproduction tasks in humans. Neurosci Lett 343: 195-199
45. Najenson T, Ron S, Behroozi K (1989) Temporal characteristics of tapping responses in healthy subjects and in patients who sustained cerebrovascular accident. Brain Bahav Evol 33: 175-178
46. Nakamura R, Nagasaki H, Narabayashi H (1978) Disturbances of rhythm formation in patients with Parkinson's disease. Percept Mot Skills 46: 63-75
47. Ngan E T, Yatham L N, Ruth T J, Liddle P F (2000) Decreased serotonin 2A receptor density in neuroleptic-naïve patients with schizophrenia: a PET study using [(18)F]setoperone. Am J Psychiatry 157: 1016-1018
48. O'Boyle D J, Freeman J S, Cody F W J (1996) The accuracy and precision of timing of self-paced, repetitive movements in subjects with Parkinson's disease. Brain 119: 51-70
49. Owen A M (2000) The role of the lateral frontal cortex in mnemonic processing: the contribution of functional neuroimaging. Exp Brain Res 133: 33-43
50. Pastor M A, Artieda J, Jahanshahi M, Obeso J A (1992) Time estimation and reproduction is abnormal in Parkinson's disease. Brain 115: 211-225
51. Peters M (1989) The relationship between variability of intertap intervals. Psych Res 51: 38-42
52. Pöppel E (1997) A hierarchical model of temporal perception. TICS 1: 56-61
53. Postle B R, Berger J S, Taich A, D'Esposito M (2000) Activity in human frontal cortex associated with spatial working memory and saccadic behavior. J Cogn Neurosci 12(suppl.): 2-14
54. Pouthas V, Perbal S (2004) Time perception does not only depend on accurate clock mechanisms but also on unimpaired attention and memory processes. Acta Neurobiol Exp 64: 367-385
55. Rammsayer T (1989) Dopaminergic and serotoninergic influence on duration discrimination and vigilance. Pharmacopsychiatry 22(Suppl. 1): 39-43
56. Rammsayer T (1999) Neuropharmacological evidence for different timing mechanisms in humans. Q J Exp Psych 52B: 273-286
57. Reuter M, Peters K, Schroeter K, Koebke W, Lenardon D, Bloch B, Hennig J (2005) The influence of the dopaminergic system on cognitive functioning: a molecular genetic approach. Behav Brain Res 164: 93-99
58. Robbins T W, James M, Owen A M, Sahakian B J, McInnes L (1994) Cambridge Neuropsychological Test Automated Battery (CANTAB): a factor analytic study of a large sample of normal elderly volunteers. Dementia 5: 266-281
59. Roth B L, Hanizavareh S M (2004) Serotonin Receptors represent highly favorable molecular targets for cognitive enhancement in schizophrenia and other disorders. Psychopharmacology 174: 17-24
60. Steinbüchel von N, Pöppel E (1993) Domains of rehabilitation: a theoretical perspective. Behav Brain Res 56: 1-10
61. Tenckhoff A, Tost H, Braus D F (2002) Altered perception of temporal relations in schizophrenic psychoses. Nervenarzt 73: 428-433
62. Tosi O, Rockey M A, Fischer R (1968) Quantitative measurement of time contraction induced by psilocybin. Arzneimittelforschung 18: 535-537
63. Umbricht D, Vollenweider F X, Schmid L, Grubel C, Skrabo A, Huber T, Koller R (2003) Effects of the 5-HT2A agonist psilocybin on mismatch negativity generation and AX-continuous performance task: implications for the neuropharmacology of cognitive deficits in schizophrenia. Neuropsychopharmacology 28: 170-181
64. Vollenweider F X (1998) Advances and pathophysiological models of hallucinogenic drug actions in humans: a preamble to schizophrenia research. Pharmacopsychiatry 31(Suppl. 2): 92-103.
65. Vollenweider F X (2001) Brain mechanisms of hallucinogens and entactogens. Dialog Clin Neurosci 3: 265-279
66. Vollenweider F X, Geyer M (2001) A systems model of altered consciousness: integrating natural and drug-induced psychoses. Brain Res Bull 56: 495-507
67. Vollenweider F X, Vontobel P, Hell D, Leenders K L (1999) 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man: a PET study with [11C]raclopride. Neuropsychopharmacology 20: 424-433
68. Vollenweider F X, Vollenweider-Scherpenhuyzen M, Bäbler A, Vogel H, Hell D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 9: 3897-3902
69. Vollenweider F X, Leenders K L, Scharfetter C, Maguire P, Stadelmann O, Angst J (1997) Positron emission tomography and fluoro-dexyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. Neuropsychopharmacology 16: 357-372
70. Volz H P, Nenadic I, Gaser C, Rammsayer T, Hager F, Sauer H (2001) Time estimation in schizophrenia: an fMRI study at adjusted levels of difficulty. Neuroreport 12: 313-316
71. Wearden J H (2004) Decision processes in models of timing. Acta Neurobiol Exp 64: 303-317
72. Wittchen H U, Pfister H (1997) DIA-X-Interview. Swet Test Services: Frankfurt

73. Wittmann M (1999) Time perception and temporal processing levels of the brain. Chronobiol Int 16: 17-32
74. Wittmann M, Kagerer F, Pöppel E (1999) Wie, wann und was können wir lernen? Zeitliche und räumliche Merkmale sensomotorischer Koordination. Zbl Chir 124: 876-883
75. Wittmann M, Steinbüchel von N, Szelag E (2001) Hemispheric specialisation for self-paced motor sequences. Cog Brain Res 10: 341-344
76. Woodrow H (1951) Time Perception. In Stevens S S (ed.), Handbook of Experimental Psychology. J Wiley, New York
77. Zakay D, Block R (1996) The role of attention in time estimation processes. In Pastor M A, Artieda J (eds), Time, Internal Clocks and Movement. Elsevier Science, Amsterdam

Preliminary report on the experience with psychosomimetic drugs in the treatment of alcoholism

by

Z. Rydzyński, S. Cwynar, L. Grzelak, W. Jagiełło

Psychiatric clinic of Military Medical Academy, Łódź

original report: http://www.beckleyfoundation.org/bib/doc/ah/1968/1968_rydzynski_4745_1.pdf
backup source: http://www.psilosophy.info/resources/1968_rydzynski_4745_1.pdf

Encouraged by the world literature reports on good effects of therapy of alcoholics with help of psychosomimetic drugs we started to use this method in 1965. We used two drugs: Psylocybin and Delysid, both produced by Sandoz. In two years and a half we treated 14 men aged 25 do 55. All of them had been treated previously as out- or in-patients, with no results. They belonged to a group of excessive chronic drinkers, majority in conflict with their nearest families and strongly connected with the "alcoholic environment" of their town. We injected psylocibin intramuscularly in doses of 9 mg and so we did with LSD-25, depending on the patient's tolerance and on his body weight, in doses of 100 to 800 µ. As a rule we started the cure with psylocibin, next LSD was used, and then for every 3 delysid injections we gave a psylocibin one. It seems to prevent from getting used to the same drug and allows to avoid increasing the dosage during cure. Psychosomimetic shocks were given, as a rule, one a week, exceptionally twice weekly. Towards the end of the procedure, in 3-4 hours time after the drugs were injected, the doctor taking care of the group had some exploratory talks with the patients during the first 2-4 sittings, later talks took the form of individual psychotherapy. On the days when no drugs were given, individual psychotherapy was systematically continued and half the patients had a group - psychotherapy one the day succeeding the psychosomimetic sitting. The leisure time of the patients was continually organized (work therapy, amusements, etc). Attempts were also made at improving their family relationships. During the hospitalization the patients received 6-8 psychosomimetic shocks. Thereafter all of them were offered to continue the cure as out-patients. Only 4 of them accepted it; they received totally 30 shocks.

The results are the better when the number of shocks is greater. The effects of 6-8 shocks were as follows: 2 men without any improvement, 7 with moderate improvement (they returned to addiction in 3-6 months), 3 with good improvement (ret. to the addiction in 12-18 months) and 2 have not returned to the addiction, for 18 months.

Beneficial effect of psychosomimetic drugs depend on 1st - their transforming influence upon the structure of personality, 2nd - making easier the psychotherapeutic contact with the doctor, 3rd - remission already after 2-3 shocks of the craving for drinking. Really good effects can be obtained by giving 30 or more psychosomimetic shocks in out-patient clinic at intervals of 1-2 weeks. Shorter treatment do not assure remission longer than half a year.

Usually, already after the first two shocks and before the leading doctor starts active psychotherapy, the alcoholic changes his cynical attitude to the environment, loses his desire for drinking, begins to believe in the possibility of getting rid of his habit and to accept attentively the doctor's suggestions.

We have not seen any somatic nor psychic complications.

Human hallucinogen research - guidelines for safety

by

MW Johnson, WA Richards, RR Griffiths

original source: http://www.maps.org/research-archive/mdma/mt1_docs/johnson_2008_human_hal_study_des.pdf
backup source: http://www.psilosophy.info/resources/johnson_2008_human_hal_study_des.pdf

MW Johnson Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA.
WA Richards Johns Hopkins Bayview Medical Center, Baltimore, Maryland, USA.
R Griffiths Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; Department of Neuroscience, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA.

Table of Contents:

- **Abstract**
- **Introduction**
- **Relevant history**
  - Hallucinogen use by indigenous cultures
  - Early clinical research
- **Unique risks of human hallucinogen research**
  - Physiological toxicity
  - Abuse and dependence
  - Acute psychological distress and dangerous behaviour during hallucinogen action
  - Prolonged psychosis
  - Lasting perceptual abnormalities
- **Guidelines for safety**
  - Selection of volunteers
  - Study personnel
  - Physical environment
  - Preparation of volunteers
  - Conduct of hallucinogen administration sessions
  - Post-session procedures
- **Concluding remarks**
- **Acknowledgements**
- **References**

Abstract

There has recently been a renewal of human research with classical hallucinogens (psychedelics). This paper first briefly discusses the unique history of human hallucinogen research, and then reviews the risks of hallucinogen administration and safeguards for minimizing these risks. Although hallucinogens are relatively safe physiologically and are not considered drugs of dependence, their administration involves unique psychological risks. The most likely risk is overwhelming distress during drug action ('bad trip'), which could lead to potentially dangerous behaviour such as leaving the study site. Less common are prolonged psychoses triggered by hallucinogens. Safeguards against these risks include the exclusion of volunteers with personal or family history of psychotic disorders or other severe psychiatric disorders, establishing trust and rapport between session monitors and volunteer before the session, careful volunteer preparation, a safe physical session environment and interpersonal support from at least two study monitors during the session. Investigators should probe for the relatively rare hallucinogen persisting perception disorder in follow-up contact. Persisting adverse reactions are rare when research is conducted along these guidelines. Incautious research may jeopardize participant safety and future research. However, carefully conducted research may inform the treatment of psychiatric disorders, and may lead to advances in basic science.

Key words: 5-HT$_{2A}$ agonists; adverse reactions; DMT; entheogens; hallucinogens; human research; LSD; mescaline; psilocybin; psychedelics; safety guidelines

Introduction

After several decades of dormancy, research involving the administration of classical hallucinogens to humans has been recently renewed (Sessa, 2005; Frecska and Luna, 2006; Harvard Mental Health Letter, 2006; Lancet, 2006; Morris, 2006; Winkelman and Roberts, 2007). Although nonhuman animal research during the intervening decades has substantially advanced our understanding of underlying neuropharmacological mechanisms of the hallucinogens, the fact that human research with this historically important and widely used class of compounds remained inactive is remarkable (Nichols, 2004). Renewed human administration research began with the work of Rick Strassman, who initiated research on the effects of *N,N*-dimethyltryptamine (DMT) at the University of New Mexico in the early 1990s (Strassman, 1991, 1996, 2001; Strassman and Qualls, 1994; Strassman, *et al.*, 1994, 1996). Subsequently, investigators both in the USA and in Europe have developed human research programmes with hallucinogens. This new research has included basicscience studies that have administered hallucinogens as tools for investigating cognitive neuroscience and perception (Gouzoulis-Mayfrank, *et al.*, 1998a; Gouzoulis-Mayfrank, *et al.*, 2002; Umbricht, *et al.*, 2003; Carter, *et al.*, 2004; Carter, *et al.*, 2005a,b), time perception (Wittmann, *et al.*, 2007), hallucinogen pharmacokinetics and metabolism (Hasler, *et al.*, 1997, 2002), model psychosis (Vollenweider, *et al.*, 1997, 1998, 1999, 2007; Gouzoulis-Mayfrank, *et al.*, 1998a; Vollenweider and Geyer, 2001; Gouzoulis-Mayfrank, *et al.*, 2005, 2006), and, recently in our laboratory, hallucinogens' reported facilitation of experiences having enduring personal meaning and spiritual significance (Griffiths, *et al.*, 2006). Recent clinical studies have administered hallucinogens to evaluate their safety and efficacy in the treatment of psychiatric disorders: specifically, anxiety related to advanced-stage cancer (Grob, 2005) and obsessive-compulsive disorder (Moreno, *et al.*, 2006). In addition, several studies have examined the effects of *ayahuasca* (also known as *hoasca* or *yagé*; an admixture containing DMT) in human volunteers outside of the USA (Grob, *et al.*, 1996; Riba, *et al.*, 2001). Because the United States Supreme Court has recently ruled in favour of the União do Vegetal (UDV; a syncretic Brazilian church that uses *ayahuasca* in the context of religious ceremonies) in their claim that the UDV's use of *ayahuasca* is protected under the Religious Freedom Restoration Act (Gonzales v. O Centro Espirita Beneficiente União do Vegetal, 2006), *ayahuasca* use within this church setting may receive increased scientific investigation within the USA.

We use the word 'hallucinogen' herein to refer to the classical hallucinogens, sometimes called 'psychedelics', 'psychotomimetics' or 'entheogens' (Grinspoon and Bakalar, 1979; Ruck, *et al.*, 1979; Ott, 1996; Metzner, 2004). Admittedly, the term 'hallucinogen' is not ideal for these substances, because perceptual changes are only one domain of their effects, and the typical perceptual changes engendered by hallucinogens at typical doses rarely include frank hallucinations (Grinspoon and Bakalar, 1979; Nichols, 2004; O'Brien, 2006). However, we use this term because it is the most widely used in the scientific literature. Although the term 'psychedelic' is widely used, it has the disadvantage of carrying considerable cultural connotation (i.e. its use as a descriptor of a style of music or art associated with Western counter-culture of the 1960s). The terms 'psychotomimetic' (emphasizing model psychosis) and 'entheogen' (emphasizing mystical-type experiences, i.e. phenomenologically indistinguishable from classically described mystical experiences) highlight only a single aspect (which may not occur reliably) of the much broader range of hallucinogen effects.

Hallucinogens can be divided structurally into two classes of alkaloids: the tryptamines, including psilocybin (prodrug constituent of *Psilocybe* and several other mushroom genera), the semi-synthetic d-lysergic acid diethylamide (LSD), and DMT; and the phenethylamines, including mescaline (principle active constituent of peyote) and certain synthetic compounds (Grinspoon and Bakalar, 1979; Shulgin and Shulgin, 1991, 1997; Metzner, 2004, Nichols, 2004). The effects of these substances are primarily mediated by agonist action at 5-HT$_{2A}$ receptors (Glennon, *et al.*, 1984; Nichols, 2004; González-Maeso, *et al.*, 2007) and produce a generally similar profile of subjective effects (Hidalgo, 1960; Hollister and Hartman, 1962; Wolbach, *et al.*, 1962a,b; Shulgin and Shulgin, 1991, 1997). Other classes of substances have sometimes been identified as 'hallucinogens', including 3,4-methylenedioxymethamphetamine or MDMA [perhaps more appropriately labelled an entactogen (Nichols, *et al.*, 1986) or empathogen (Metzner, 1985)]; dissociative anaesthetics such as ketamine, phencyclidine and dextromethorphan; and anticholinergic agents such as scopolamine and atropine (Nichols, 2004). However, this paper uses the term 'hallucinogen' to refer specifically to classical hallucinogens.

The purpose of this paper is to provide guidance in the safe administration of high doses of hallucinogens (e.g. ≥25 mg psilocybin or 200 μg LSD). Some aspects of these recommendations may also apply to studies employing lower doses, although, as with other drug classes, the likelihood of potential adverse effects will be related to dose. Similarly, some aspects of these recommendations may also apply to studies administering the other drug classes mentioned in the preceding paragraph: entactogens, dissociative anaesthetics and anticholinergic agents. However, the clinical effects and mechanisms of action of these agents are sufficiently different from the classical hallucinogens that safety recommendations concerning their administration are beyond the scope of this manuscript.

First, so that the historical context in which current human hallucinogen studies are conducted will be clear, we will briefly discuss the history of sacramental hallucinogen use by indigenous cultures, and the history of human hallucinogen research before it became dormant in the 1970s. The decades-long virtual dormancy of human hallucinogen research stands as a unique case in the history of modern clinical pharmacology. It is important for researchers going forward to understand the role that safety factors, as well as sociological and political factors, played in the history and cessation of human hallucinogen research. Moreover, because of the historical legacy of sensationalism surrounding hallucinogens, researchers should appreciate the precarious position of current human hallucinogen research, and recognize that very high safety standards will help to ensure that human research continues into the decades to come. Next, we will provide a detailed description of the unique risks of hallucinogen administration. We will then present the proposed guidelines for conducting high-dose hallucinogen research in each of several domains, including volunteer selection, study personnel, physical environment, preparation of volunteers, conduct of sessions, and post-session procedures.

Relevant history

Hallucinogen use by indigenous cultures

Hallucinogens have been used by indigenous cultures for millennia (Schultes, 1969; Lowy, 1971; Schultes, *et al.*, 2001). These cultures have restricted hallucinogen use to sacramental and healing contexts, with these two often being inseparably intertwined. Remarkably, apparently without exception, such cultures view hallucinogenic plants and fungi as being of divine origin (Schultes, *et al.*, 2001). Given this orientation, it is not surprising that their ingestion is often tightly restricted, with use controlled by ceremonial guidelines, including taboos against improper use (Schultes, *et al.*, 2001; Weil, 2004). Indigenous cultures restrict use of hallucinogens to highly ritualized, sacred ceremonies such as those designed to serve as rites of passage, or to set the occasion for divination and spiritual or physical healing. Even in cases in which certain use extends beyond the shaman and may be more recreational in nature (e.g. use of the DMT-containing *epená* by the Waiká cultures of Brazil and Venezuela), the hallucinogen is prepared and taken in a highly ritualized context (Grinspoon and Bakalar, 1979; Schultes, *et al*. 2001; Weil, 2004). Modern, urban syncretic religions, such as the UDV, which have developed in South America and have been influenced by indigenous use of ayahuasca, also incorporate a high degree of structure and guidance into their *ayahuasca* use, which may minimize adverse reactions (Gonzales v. O Centro Espirita Beneficiente União do Vegetal, 2006).

However, indigenous cultures should not be regarded as absolute role models in the clinical use of hallucinogens for at least two reasons. First, some of these cultures also engaged in practices considered unethical in our culture. For example, the Aztecs, who used psilocybin mushrooms and morning glory seeds (containing LSD-related agents), practiced human sacrifice, and even incorporated hallucinogen use into sacrificial rituals (Ott, 1996). As another example, the Jivaro in Ecuador who use *ayahuasca* practice sacramental headhunting, and *ayahuasca* may be used by the shaman in that society for malevolent intent (i.e. bewitching) as well as for healing (Harner, 1962, 1968; Grof, 1977). Second, risk/benefit tradeoffs that may be acceptable in various religious contexts may fall short of what is expected in the domain of contemporary scientific research with human participants.

Nonetheless, some important themes have emerged in the use of hallucinogens by indigenous cultures that may have bearing on the appropriate use of hallucinogens in clinical research. Indeed, some of the safeguards developed for clinical hallucinogen research and expressed in the guidelines presented herein are similar to important aspects of hallucinogen use by indigenous cultures. These common themes are structured use (expressed as ritual in indigenous use), restrictions on use including the need for guidance and appreciation of hallucinogens' powerful psychological effects (expressed as reverence in indigenous use). We believe that these commonalities are more than coincidence. The unique pharmacology of classical hallucinogens may have shaped convergent practices across independent cultures. Likewise, the guidelines expressed herein for human clinical research with hallucinogens may also be viewed as having been developed in reaction to these same aspects of hallucinogen pharmacology. As an example, some of the unique effects and safety concerns for hallucinogens may be related to their ability to set the occasion for deeply meaningful, even spiritual experiences (Richards, 2003, 2005). Novak (1997) hypothesized that Western intellectuals in the mid 1950s such as Aldous Huxley and Gerald Heard merely redefined the subjective effects resulting from hallucinogen administration as a spiritual experience, thereby popularizing such an association in western culture. However, the observation that indigenous cultures that ingest classical hallucinogens almost invariably do so under sacramental contexts (Schultes, *et al*., 2001), along with the findings from double-blind clinical studies demonstrating that under supportive conditions, hallucinogens occasion mystical-type experiences with high frequency (Pahnke, 1963; Griffiths, *et al*., 2006) suggests that the association of hallucinogens with spiritual experience relates to the pharmacology of these agents rather than being based entirely on cultural suggestion.

Early clinical research

In the 1950s and 1960s, thousands of research participants were administered hallucinogens in the context of basic clinical research or therapeutic clinical research, resulting in hundreds of publications (Grinspoon and Bakalar, 1979; Grob, *et al*., 1998; Strassman, 2001; Nichols, 2004). During this time, the United States Army investigated classical hallucinogens as incapacitating agents in soldiers, and the United States Central Intelligence Agency conducted clandestine research investigating classical hallucinogens as interrogation agents in which civilians were administered hallucinogens without knowledge or consent. Eventually, both groups ceased to focus on classical hallucinogens in favour of non-classical 'hallucinogens' such as the synthetic anticholinergic compound quinuclidinyl benzilate (BZ), which showed greater promise as a warfare agent than LSD because its effects were marked by greater immobility, delirium, amnesia and duration (Lee and Shlain, 1992). Very early academic research on classical hallucinogens was designed without considering the powerful influences of set (psychological state) and setting (environment) (Malitz, *et al*., 1960; Rinkel, *et al*., 1960; Hollister, 1961; Rümmele and Gnirss, 1961; Leuner, 1962). Subsequent research, which included more preparation and interpersonal support during the period of drug action, found fewer adverse psychological reactions, such as panic reactions and paranoid episodes, and increased reports of positively valued experiences (Chwelos, *et al*., 1959; Leary, 1964; Leary, *et al*., 1963, 1964; Metzner, *et al*., 1965; Pahnke, 1969).

One major area of early research focused on the comparison of hallucinogen effects with the symptoms of psychosis (e.g. Stockings, 1940; Hoch, *et al*., 1953; Hoffer and Callbeck, 1960; Leuner, 1962; Kuramochi and Takahashi, 1964). Although the study of hallucinogens as models for the psychosis observed in schizophrenia eventually fell out of favour in psychiatry (Grinspoon and Bakalar, 1979; Snyder, 1988; Strassman, 2001), a renewed interest in this area is emerging, in part due to modern brain imaging techniques and neuropharmacological findings that have supported hallucinogens as a model of at least certain aspects of acute psychosis (Vollenweider, *et al*., 1997; Gouzoulis-Mayfrank, *et al*., 1998a; Vollenweider and Geyer, 2001; Gouzoulis-Mayfrank, *et al*., 2005, 2006).

Other areas of early human research included investigations of therapeutic applications of hallucinogens in treatment of psychological suffering associated with cancer and in the treatment of substance dependence. Anecdotal observations and non-blind studies in cancer patients suffering from anxiety and depression suggested that LSD administration resulted in an ability to openly discuss existential fears and be at peace with approaching death, and that this reorientation often outlasted the acute drug effects (Kast and Collins, 1964; Cohen, 1965; Kast, 1967). Follow-up investigations involved the administration of a high dose of a hallucinogen to carefully prepared patients under highly supportive interpersonal conditions, with the patient wearing eyeshades and listening to classical music through headphones during the course of pharmacological action, a model known as 'psychedelic peak therapy' or 'psychedelic therapy' (Kurland, *et al.*, 1969; Pahnke, *et al.*, 1969; Richards, et al, 1972; Grof, *et al.*, 1973; Kurland, *et al.*, 1973; Grof and Halifax, 1977; Richards, *et al.*, 1977, 1979; Grof, 1980; Richards, 1980; Kurland, 1985). Unfortunately, these early studies did not include the stringent control conditions or groups that now have become standard in modern clinical psychopharmacology research. The results suggest, however, that these compounds may have improved psychological well-being in the face of anxiety and depression secondary to cancer.

Another focus of study was hallucinogen-facilitated therapy in the treatment of alcoholism and other forms of substance dependence (e.g. Smart, *et al.*, 1966; Hollister, *et al.*, 1969; Ludwig, *et al.*, 1969; Kurland, *et al.*, 1971; Savage and McCabe, 1973). While some studies prepared patients and utilized supportive conditions (e.g. Kurland, *et al.*, 1971; Savage and McCabe, 1973), others drastically departed from the 'psychedelic therapy' model (and from the guidelines herein), and involved the administration of high doses to unprepared, restrained patients (e.g. Smart, *et al.*, 1966). Results across studies were ultimately inconclusive due to such variations in methods and a lack of modern controls and experimental rigour (Abuzzahab and Anderson, 1971; McGlothlin and Arnold, 1971; Halpern, 1996; Mangini, 1998). Similarly, some therapists reported that hallucinogens administered under supportive contexts could accelerate psychotherapy for a variety of psychological disorders (e.g. Abramson, 1960, 1963; Crochet, *et al.*, 1963; Mogar and Aldrich, 1969; Rhead, 1977). However, these reports were largely based on anecdotal clinical accounts rather than controlled studies.

Escalation in recreational hallucinogen use, primarily LSD, in the 1960s, led to considerable sensationalism concerning these drugs in media coverage. Adding to the controversy was the publicized departure and termination of Timothy Leary and Richard Alpert from Harvard University in 1963 following charges of unorthodox methods in hallucinogen research (Grinspoon and Bakalar, 1979; Lee and Shlain, 1992; Novak, 1997; Strassman, 2001). Leary's subsequent irresponsible advocacy of hallucinogen use by youth further undermined an objective scientific approach to studying these compounds. The growing controversy and sensationalism resulted in increasing restrictions on access to hallucinogens throughout the 1960s (ultimately resulting in the placement of the most popular hallucinogens into Schedule I of the 1970 Controlled Substances Act in the United States), creating substantially greater regulatory barriers for researchers to conduct human trials. The negative publicity also resulted in withdrawal of federal research funds, which had previously supported much of the human research, and in the professional marginalization of clinical investigators interested in pursuing research with hallucinogens. Human research with hallucinogens in the USA became virtually dormant when the last trials were published in the early 1970s. Commenting on the unusual evolution of psychiatric research with hallucinogens, Strassman (2001) mused, "They began as 'wonder drugs,' turned into 'horror drugs,' then became nothing" (p. 28).

Unique risks of human hallucinogen research

Hallucinogen administration in humans results in a unique profile of effects and potential adverse reactions that need to be appropriately addressed to maximize safety. Different risks are associated with different drug classes, and human research with each class requires procedures to be in place to address those particular risks. For example, because high doses of certain opioids and sedative/hypnotics can cause respiratory depression (Gutstein and Akil, 2006; Charney, *et al.*, 2006), when conducting research with high doses of these drugs, respiration rate and/or blood oxygen are monitored, and mechanical breathing assistance and appropriate rescue medications are readily available. As another example, administration of high doses of psychomotor stimulants, such as cocaine, can cause cardiac stress (O'Brien, 2006). Therefore, electrocardiogram (ECG) readings taken at screening are scrutinized carefully, pulse and blood pressure are monitored during sessions, and rescue medication for acute hypertension is immediately available. Similarly, human hallucinogen administration entails its own unique risk profile. Unlike opioids, sedative/hypnotics or psychomotor stimulants, the primary safety concerns with hallucinogens are largely psychological rather than physiological in nature.

Physiological toxicity

Hallucinogens generally possess relatively low physiological toxicity, and have not been shown to result in organ damage or neuropsychological deficits (Strassman, 1984; Gable, 1993, 2004; Halpern and Pope, 1999; Hasler, *et al.*, 2004; Nichols, 2004; Halpern, *et al.*, 2005). Nonhuman animal studies have shown MDMA (structurally similar to some classical hallucinogens, but with a substantially different pharmacological mechanism of action) to have neurotoxic effects at high doses, although MDMA has been judged to be safe for human administration in the context of several therapeutic and basic human research studies. In contrast, there is no evidence of such potential neurotoxic effects with the prototypical classical hallucinogens (i.e. LSD, mescaline and psilocybin). Some physiological symptoms may occur during hallucinogen action, such as dizziness, weakness, tremors, nausea, drowsiness, paraesthesia, blurred vision, dilated pupils and increased tendon reflexes (Isbell, 1959; Hollister, 1961; Nichols, 2004). In addition, hallucinogens can moderately increase pulse and both systolic and diastolic blood pressure (Isbell, 1959; Wolbach, *et al.*, 1962b; Strassman and Qualls, 1994; Gouzoulis-Mayfrank, *et al.*, 1999; Passie, *et al.*, 2000; Griffiths, *et al.*, 2006). However, these somatic effects vary and are relatively unimpressive even at doses yielding powerful psychological effects (perceptual, cognitive and affective) (Metzner, *et al.*, 1965; Passie, *et al.*, 2000; Metzner, 2004).

Although a full discussion of special physiological toxicity concerns for medical patient populations is beyond the scope of this manuscript, a few observations are worthy of note. The early literature examining hallucinogens in the treatment of anxiety and depression secondary to cancer indicated that the classical hallucinogens LSD and *N,N*-dipropyltryptamine (DPT) were physiologically well-tolerated. The physical adverse effects of these agents observed in cancer patients were manageable and similar to effects observed in physically healthy individuals. These researchers noted that any other symptoms experienced during sessions with cancer patients were symptoms already associated with their existing illness (Richards, *et al.*, 1972; Kurland, *et al.*, 1973; Kurland, 1985). Early clinical research also safely administered LSD to chronic alcoholics and cancer patients with 'considerable liver damage', suggesting hepatic concerns are 'negligible unless the dysfunction is of a critical degree' (Grof, 1980, p. 164).

Participants and review committees may be concerned that LSD or other hallucinogens are associated with chromosomal damage. These concerns stem from an anti-LSD media campaign by the USA government in the late 1960s that was based on and followed soon after initial reports (Cohen, *et al.*, 1967a,b; Irwin and Egozcue, 1967), suggesting that LSD caused chromosomal damage in human leukocytes (Ott, 1996; Weil, 2004). This campaign included pictures of deformed children (Grinspoon and Bakalar, 1979) at a time when the thalidomide tragedies of a decade earlier were relatively fresh in the public's memory (Ott, 1996). However, many follow-up investigations soon squarely refuted the hypothesis that LSD use in humans was a significant risk for chromosomal damage or carcinogenic, mutagenic or teratogenic effects (e.g. Bender and Siva Sankar, 1968; Tjio, *et al.*, 1969; Dishotsky, *et al.*, 1971; Long, 1972).

Abuse and dependence

Like many classes of psychoactive drugs, hallucinogens are sometimes used in a manner that jeopardizes the safety or well-being of the individual or others (e.g. driving while impaired; a pattern of use that interferes with work, school or relationships). Under such circumstances, hallucinogens are said to be 'abused'. However, hallucinogens are not typically considered drugs of dependence in that they do not engender compulsive drug seeking (National Institute on Drug Abuse, 2001, 2006; O'Brien, 2006), consistent with the observation that they are not reliably self-administered in nonhuman animals (Poling and Bryceland, 1979; Griffiths, *et al.*, 1980; Fantegrossi, *et al.*, 2004). Furthermore, they are not associated with a known withdrawal syndrome (O'Brien, 2006). Therefore, there is little risk that exposing human volunteers to hallucinogens will leave participants physically or psychologically dependent on these compounds. This low dependence potential allows for the possibility of administering these compounds to hallucinogen-naïve volunteers when blinding issues are critical (e.g. Griffiths, *et al.*, 2006). However, in certain situations it may be advantageous to study hallucinogen-experienced participants (e.g. brain imaging studies requiring the participant to remain immobile).

Acute psychological distress and dangerous behaviour during hallucinogen action

Although hallucinogens have relatively low physiological toxicity and are not associated with compulsive drug seeking, there is still concern that they may pose other psychological risks. The most likely risk associated with hallucinogen administration is commonly known as a 'bad trip' and is characterized by anxiety, fear/panic, dysphoria, and/or paranoia. Distressing effects may be experienced in a variety of modalities: sensory (e.g. frightening illusions), somatic (e.g. disturbing hyperawareness of physiological processes), personal psychological (e.g. troubling thoughts or feelings concerning one's life) and metaphysical (e.g. troubling thoughts or feelings about ultimate evil forces) (McCabe, 1977; Grinspoon and Bakalar, 1979; Strassman, 1984). Because emotional experience is often intensified when under the influence of a hallucinogen, in unprepared individuals or uncontrolled situations any of these effects may potentially escalate to dangerous behaviour. For example, fear and paranoid delusions may lead to erratic and potentially dangerous behaviours, including aggression against self or others (Strassman, 1984). Although very rare, in hazardous and unsupervised conditions, individuals under the influence of hallucinogens have ended their lives by such acts as jumping from buildings (Keeler and Reifler, 1967; Reynolds and Jindrich, 1985; Reitman and Vasilakis, 2004; O'Brien, 2006). We recognize that even under unsupervised and unprepared conditions, reactions to hallucinogens involving violence and self-destructive behaviour are rare, and our intention is not to create an unrealistic account of the dangers of hallucinogens. Nonetheless, even infrequent reports of such dangers require that investigators take seriously such risks and take steps to avoid their occurrence.

Prolonged psychosis

Another potential risk of hallucinogen administration is provoking the onset of prolonged psychosis, lasting days or even months (Strassman, 1984). Although determining causation is difficult, it appears that individuals who experience such reactions have premorbid mental illness before taking hallucinogens. However, it is unknown whether the precipitation of psychosis in such susceptible individuals represents a psychotic reaction that would have never occurred in the absence of hallucinogen use, or whether it represents an earlier onset of a psychotic break that would have inevitably occurred (Grinspoon and Bakalar, 1979; Strassman, 1984). Unlike acute psychological distress, these cases will be extremely rare in well-selected and well-prepared participants. In a survey of investigators who had administered LSD or mescaline, Cohen (1960) reported that only a single case of a psychotic reaction lasting more than 48 h occurred in 1200 experimental (non-patient) research participants (a rate of 0.8 per 1000). Notably, the individual was an identical twin of a schizophrenic patient and thus would have been excluded under the proposed guidelines. Prolonged reactions over 48 h were slightly more frequent in patients undergoing psychotherapy than in experimental non-patient participants, but still relatively rare, occurring at a rate of 1.8 prolonged reactions per 1000 patients. Cohen (1960) also reported that suicide attempts and completed suicides occurred at a rate of 1.2 and 0.4, respectively, per 1000 patients. The causal link between hallucinogen exposure and suicide or suicide attempt was only clear for a portion of these cases in patients, and no suicides or suicide attempts were noted for the 1200 non-patient, experimental participants. However, it is important when evaluating these data to consider that only 44 of the 62 researchers queried by Cohen returned survey results (Cohen, 1960; Novak, 1997). Although Cohen and Ditman (1962) subsequently expressed misgivings over the increased incidence of adverse effects due to the increasing recreational use of LSD and some questionable clinical practices, they maintained that when used under the proper guidelines, LSD was an important tool for use in human research (cf. Novak, 1997). McGlothlin and Arnold (1971) reported one case out of 247 individuals who received LSD in either experimental or psychotherapeutic studies in which an LSD-related psychotic reaction lasting more than 48 h occurred. That single case was a patient who received repeated LSD administrations in a psychotherapeutic context. Although very rare, care must be taken to minimize the risks of such an episode. The volunteer selection guidelines, addressed in a later section, will be the key factor in minimizing the risk of prolonged psychosis in human hallucinogen research studies.

Some clinical observations suggest the possibility that unconscious psychological material may be activated during hallucinogen sessions, and that such material, if not properly worked through and psychologically integrated, may lead to psychological difficulties of a non-psychotic nature, such as negative emotions and psychosomatic symptoms, lasting beyond the session (e.g. McCabe, 1977; Grof, 1980). Although these observations have not been examined experimentally, they deserve consideration. As suggested in our subsequent discussion of volunteer-monitor interactions, we believe that the strong interpersonal support from session monitors before, during and following sessions will minimize any enduring untoward psychological effects.

Lasting perceptual abnormalities

Another potential risk of hallucinogen administration is hallucinogen persisting perception disorder (HPPD). In order to meet DSM-IV-TR criteria for this disorder, a hallucinogen user must re-experience perceptual effects similar to those experienced under acute hallucinogen action after cessation of hallucinogen use, these effects must be clinically distressing or impair functioning, and the effects must not be caused by a medical condition or be better explained by another psychiatric disorder or hypnopompic hallucinations (American Psychiatric Association, 2000). The incidence of HPPD is unknown, although it is thought to be very uncommon given the relatively few cases reported out of the millions of hallucinogen doses consumed since the 1960s (Halpern and Pope, 2003). Although the term 'flashback' is sometimes used interchangeably with HPPD, the former term is often used to describe any brief perceptual effects reminiscent of acute hallucinogen effects but occurring beyond acute hallucinogen use, usually in the absence of clinical distress or impairment (Lerner, *et al.*, 2002). Indeed, many illicit hallucinogen users report some brief visual abnormalities occurring after acute hallucinogen effects, but only for a small minority of users are these effects troubling or impairing enough to be considered clinically significant or warrant the diagnosis of HPPD (Lerner, *et al.*, 2002; Baggott, *et al.*, 2006). Many illicit users regard such sub-clinical effects as benign and pleasurable (Strassman, 1984; Lerner, *et al.*, 2002; Frecska and Luna, 2006). Importantly, the incidence of HPPD or other perceptual abnormalities appears to be much lower in therapeutic or research contexts with careful screening and preparation than in the context of illicit recreational use, which may include the confounds of polydrug use and unscreened psychiatric disorders (Cohen, 1960; McGlothlin and Arnold, 1971; Strassman, 1984; Halpern and Pope, 2003). Because such perceptual abnormalities are poorly understood, researchers administering hallucinogens to human volunteers should probe for perceptual disturbances in follow-up contact.

Guidelines for safety

The guidelines that follow are intended to support the safe administration of high doses of hallucinogens to human volunteers while minimizing potential adverse reactions. Although a previous paper outlined methodological issues relevant to the study of hallucinogens in humans (Gouzoulis-Mayfrank, *et al.*, 1998b), safety issues were not the primary focus of that paper. The present paper substantially complements this previous work by providing a more detailed discussion of safety concerns. Issues relevant to the conduct of human research with drugs of abuse in general have been well described (Fischman and Johanson, 1998). The present guidelines extend and complement the recommendations of Fischman and Johanson (1998) for high-dose hallucinogen research. For some domains, such as volunteer selection, volunteer preparation, and the interactions between the volunteer and study personnel, the proposed criteria are substantially more extensive than those presented by Fischman and Johanson (1998) and those routinely used in human behavioural pharmacology because these domains appear to require even greater attention for hallucinogens than for other classes of psychoactive drugs. Although particular aspects of the proposed guidelines may be debatable, it is hoped that this paper will encourage such discussion while conveying the general themes and major domains of concern in human hallucinogen research. The proposed guidelines may serve as a helpful starting point for investigators planning to conduct human hallucinogen research.

Selection of volunteers

There are two main domains of consideration for volunteer selection. First, selection criteria may be methodological in nature and involve the specific research questions being explored. Second, which is the focus of this manuscript, is safety-related selection criteria. In our studies at Johns Hopkins, participants must be in good general health as assessed by detailed medical history, physical examination, 12-lead ECG, blood chemistry profile, haematology and urinalysis. Pregnant women or those not practicing effective means of birth control are excluded. Relevant to general medical screening, classical hallucinogens moderately increase pulse and both systolic and diastolic blood pressure (Isbell, 1959; Wolbach, *et al.*, 1962b; Strassman and

Qualls, 1994; Gouzoulis-Mayfrank, *et al.*, 1999; Passie, *et al.*, 2000; Griffiths, *et al.*, 2006). Therefore in our studies of psilocybin to date, volunteers have been excluded if resting blood pressure exceeded 140 systolic and 90 diastolic (mmHg), averaged across four assessments on at least two separate days. Using these screening parameters with 54 participants to date, no psilocybin session has resulted in blood pressure increases considered medically dangerous, and we have never needed to administer an anti-hypertensive medication in response to psilocybin effects. Modification of these limits may be considered in future studies if safety continues to be observed under these parameters.

Certain medications may alter the effects of a hallucinogen and, therefore, individuals taking these medications should be excluded from participation. Specifically, chronic administration of tricyclic antidepressants and lithium (Bonson and Murphy, 1996), and acute administration of serotonin reuptake inhibitors (Fiorella, *et al.*, 1996) and the antipsychotic medication haloperidol (Vollenweider, *et al.*, 1998) have been shown to potentiate hallucinogen effects, and therefore participants' use of these represents a safety concern. Chronic administration of serotonin reuptake inhibitors (Stolz, *et al.*, 1983; Strassman, 1992; Bonson, *et al.*, 1996) and monoamine oxidase inhibitors (Bonson and Murphy, 1996) have been shown to decrease sensitivity to hallucinogens, and therefore participants' use of these represents a scientific concern. We also advise investigators to include questions concerning over-the-counter dietary supplements in addition to prescription medications when probing medication history, and to exclude those taking potentially problematic substances (e.g. 5-hydroxytryptophan and St John's Wort may affect serotonergic function, and, therefore, it is appropriate to exclude individuals currently or recently taking these products). It should also be noted that administration of *ayahuasca* (which contains monoamine oxidase inhibitors in addition to DMT) to individuals taking serotonin reuptake inhibitors may lead to a severe serotonin syndrome reaction (Callaway and Grob, 1998).

Psychiatric screening criteria are important for minimizing the already low chances of precipitating a longer term psychotic reaction by hallucinogen administration. Thorough psychiatric interviews (e.g. SCID; First, *et al.*, 2001) should be conducted to identify contraindicated psychological functioning or history. In our research, individuals are excluded who have a current or past history of meeting DSM-IV criteria for schizophrenia or other psychotic disorders (unless substance-induced or due to a medical condition), or bipolar I or II disorder, which are the most important conditions to exclude for ensuring safety. We also exclude those with a first or second-degree relative with these disorders. There is considerable evidence from family, twin and adoptive studies that genetic factors make a robust contribution to the aetiology of schizophrenia, with genetic factors established as relevant to some, perhaps all cases (Buchanan and Carpenter, 2005). In fact, data indicate that there is approximately a six-fold greater chance of developing schizophrenia in second-degree relatives of individuals with schizophrenia (Patel, *et al.*, 2003). Other investigators have also excluded individuals scoring high on the personality traits of rigidity and emotional lability on the grounds that these have been significantly associated with negative experiences during hallucinogen action and during non-pharmacologically induced altered states of consciousness (Dittrich, 1993; Hasler, *et al.*, 2004).

Depending on the nature of the study, it may be appropriate to exclude those with other psychiatric disorders as well. Unless the research study is designed to specifically address a question relevant to a specific psychiatric disorder, our advice is to select a population that is psychiatrically healthy. This strategy is warranted because the effects of hallucinogens may potentially interact with various psychiatric disorders. Furthermore, including volunteers with psychiatric disorders may increase the chances that symptoms from such disorders may inadvertently be misattributed to hallucinogen action. For example, our recent studies with healthy volunteers have excluded volunteers with a current or a recent past history (e.g. within the last 5 years) of alcohol or drug dependence (excluding caffeine and nicotine) or major depression, and volunteers with current obsessive-compulsive disorder, dysthymic disorder, panic disorder, dissociative disorder, anorexia nervosa or bulimia nervosa.

Recent and current studies have investigated therapeutic applications of psilocybin for psychiatric disorders (Grob, 2005; Moreno, *et al.*, 2006). Because preliminary reports have suggested safety, studies examining therapeutic indications are likely to continue. These studies target for participation volunteers with disorders that would normally be excluded from non-treatment studies. Therefore, additional considerations are appropriate for such studies. For example, in a study of hallucinogen-assisted therapy for depression or anxiety, individuals should be excluded whose symptoms of depression or anxiety are sufficiently severe to warrant immediate treatment with medication (e.g. due to suicidal ideation). In addition, clinical treatment studies may choose to lift restrictions on relatively minor non-target psychiatric disorders that would be excluded in studies with healthy volunteers. For example, a study of hallucinogens in the treatment of anxiety related to cancer might choose to allow the inclusion those with comorbid dysthymic disorder or mild obsessive-compulsive disorder. Investigators should examine the relevant evidence when considering lifting specific exclusions, proceed cautiously, and implement any supplemental safeguards that might be appropriate for such exceptions.

Study personnel

It is difficult to overemphasize the importance of the interpersonal atmosphere created by study staff in influencing a volunteer's response to a hallucinogen. Most critically, this applies to the interpersonal environment created by the actual session monitors (Leary, *et al*., 1964; Masters and Houston, 1966). We use the term 'monitor' to refer to the staff members, who will be with the participant in the session room during the course of hallucinogen action. The monitors should be knowledgeable about the medical and psychological markers of potential adverse reactions to the drug. Furthermore, monitors should have significant human relation skills and be familiar with descriptions of altered states of consciousness induced by hallucinogens. Personal experience with techniques such as meditation, yoga or breathing exercises may also prove to be helpful in facilitating empathy for volunteers who experience altered states of consciousness during hallucinogen action. The lead monitor for each participant in the Johns Hopkins studies to date has been a clinical psychologist or a clinical social worker. However, we believe that clinical sensitivity (e.g. empathy, respect) is likely more important than formal degrees when considering monitor qualifications.

We recommend the presence of at least two monitors during hallucinogen administration sessions so that the volunteer will never be alone should one monitor need to briefly leave the session room (e.g. to the restroom). For each participant in the Johns Hopkins studies, we have specified a primary monitor (who takes the lead in participant interactions) and an assistant monitor, with differing required levels of involvement for the two monitors during volunteer preparation (see Preparation of volunteers section below). In prior research into potential treatment applications of hallucinogens, the presence of both genders in the monitoring team has been recommended (Grof and Halifax, 1977; Grof, 1980; Kurland, 1985). Having both genders present may foster feelings of security. In the Johns Hopkins studies, we have followed this recommendation when possible, but also have conducted sessions in which the primary and assistant monitors were of the same gender as the volunteer. We would counsel against both members of the monitoring team being the opposite gender of a volunteer, unless there is a staff member of volunteer's gender who has established some rapport with the volunteer in advance, and who can quickly be summoned to assist should support be needed in the restroom. For studies that are intended to maximize the potential for mystical-type experience during hallucinogen administration, an additional valuable monitor characteristic may be her or his ability to interact with and relate to the participant concerning spiritual issues (e.g. Moss and Dobson, 2006; Council on Spiritual Practices, 2001).

Although the volunteer's interactions with the monitors are of paramount importance, all individuals at the study site having contact with the volunteer on or before the session day may influence a volunteer's reaction to a hallucinogen. Pre-session negative mood consisting of anxiety or depression has been shown to significantly predict anxious or other negative experiences during the session (Metzner, *et al*., 1965). Strassman (2001) reported that a visiting medical student's unexpected interaction with a volunteer before the session may have contributed to an adverse event resulting in the volunteer leaving the study site under the influence of psilocybin. To the degree possible, investigators should work with all personnel that the volunteer may encounter (e.g. receptionist, building security, nurses) to ensure that volunteers are treated with courtesy and respect. For example, in the Johns Hopkins studies, a research staff member other than the study monitors meets with the volunteer in the morning and administers a few pre-session questionnaires and manages other logistics. This staff member should be friendly, welcoming and compassionate, as he or she inquires as to the volunteer's current emotional and physical well-being (e.g. recent sleeping history, interpersonal or work stressors, anticipation of session, adherence to study dietary and medication/drug restrictions). The staff member should maintain a positive social rapport with the volunteer to reduce the likelihood of adverse psychological reactions during the session and to gain accurate information on the volunteer's condition so that other study staff may be notified if there is any potential reason to postpone or cancel the session (e.g. if the volunteer is experiencing a particularly stressful life event or is feeling ill). If any staff member treats the volunteer disrespectfully or coldly (i.e. 'like a guinea pig'), this may negatively influence the volunteer's psychological state and subsequent hallucinogen experience. We recognize that treating volunteers respectfully is an ethical imperative for all human research. However, with hallucinogen administration research, the importance of this mandate is even more compelling given the powerful influence of set and setting on hallucinogen effects. Therefore, we recommend providing additional attention to volunteer rapport beyond what is customary in general human behavioural pharmacology practice.

Physical environment

The physical environment during hallucinogen sessions is extremely important for ensuring safety for volunteers in two respects. First, an aesthetically pleasing environment may decrease the probability of acute psychological distress. The Johns Hopkins hallucinogen research projects use a living room-like setting (Figure 1). The furniture is comfortable and is atypical for a research laboratory or medical office setting. An overly 'clinical' environment with an 'antiseptic' look (e.g. white walls, extraneous medical equipment, personnel in white lab coats) may increase anxious reactions. Strassman (2001) noted that the medically oriented environment in which his DMT studies were conducted may have contributed to volunteers having unpleasant subjective experiences. For example, some volunteers reported vivid and realistic experiences of being medically examined by extraterrestrials. It has also been noted that many of the potentially unpleasant physical reactions to hallucinogens (e.g. subjective changes in temperature, difficulty in breathing, various bodily sensations) might be in part psychosomatic in nature (Blewett and Chwelos, 1959), and therefore possibly more likely in settings evocative of medical conditions (Masters and Houston, 1966). Some protocols may require videotaping of sessions for scientific purposes. Although there might be concern that videotaping could increase self-consciousness or paranoia, we have no evidence that this has occurred in the Johns Hopkins studies, in which videotaping of sessions is routine.

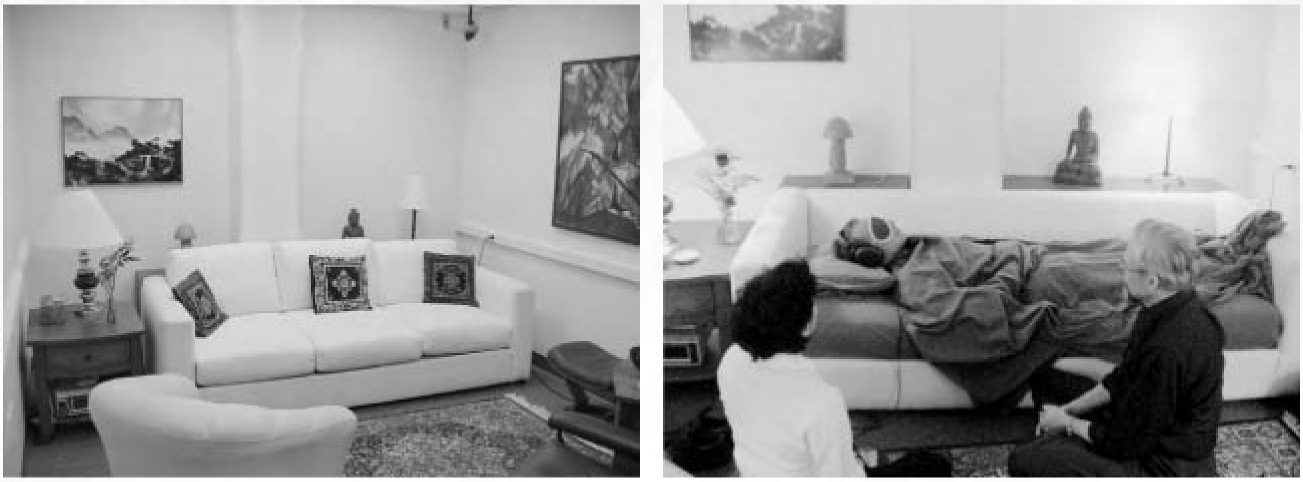


Figure 1. The living room-like session room used in the Johns Hopkins hallucinogen research studies. Aesthetically pleasing environments such as this, free of extraneous medical or research equipment, in combination with careful volunteer screening, volunteer preparation and interpersonal support from two or more trained monitors, may help to minimize the probability of acute psychological distress during hallucinogen studies. For studies that investigate potential therapeutic effects or the phenomenology of introspective hallucinogen experiences, the use of eyeshades and headphones (through which supportive music is played) may contribute to safety by reducing the distractions of environmental stimuli and social pressures to verbally interact with research personnel.

Beyond the psychological importance of a comfortable, relaxing environment, attention must be paid to the physical safety of the environment. The environment should be designed keeping in mind the perceptual changes and disorientation that can occur under the influence of hallucinogens. Thus, any potentially dangerous objects (e.g. furniture with sharp corners; glass lamps) should be avoided. If there is a window in the room, the investigators need to be confident that the volunteer could not exit the window if in a delusional state. Additionally, the session room should not have a telephone, and the participant should surrender her or his cellular telephone before the session. Not only may an incoming telephone call be distracting or alarming while under the influence of a hallucinogen, but it may also represent a safety risk, as Strassman (2001) has reported a case in which a participant used a session room telephone to call a companion, which culminated in the two fleeing the study site. Having a private restroom located near the session room would be ideal for volunteer use during the session. A shared restroom may be used if the monitors ensure that the volunteer does not interact with non-study personnel while going to the restroom (more details under the section: *Conduct of hallucinogen administration sessions*). Of course, most research laboratories do not provide the ideal physical environment. Thus, resourcefulness and ingenuity may be necessary to convert a less than ideal location into a relaxing and secure environment.

Preparation of volunteers

As with any human research with psychoactive drugs, volunteer preparation at the earliest stages must include a thorough review of the consent form, which should include in plain language the range of experiences that may result from hallucinogen administration, including changes in perception, sense of time and space, and emotion (possibly including anxiety, fear, panic and paranoia). Relative to other drug classes, the subjective effects of hallucinogens are likely more difficult to describe to a naïve volunteer; therefore, additional time may be necessary to fully discuss these potential effects with volunteers. The consent form should also include the approximate timecourse of the drug, the state of knowledge concerning its toxicity profile, and its status as an experimental drug. In addition, the consent form should state that there is a relatively small risk of adverse effects that last for hours to days after the hallucinogen session. These include mood disorders (such as depression), psychotic disorders and anxiety disorders. It should also state that there are rare reports in which hallucinogen exposure appears to cause, accelerate or precipitate the onset of significant or lasting psychiatric illnesses such as psychoses and intermittent or persisting visual perceptual abnormalities ('flashbacks', HPPD).

The next step in volunteer preparation is to conduct a series of meetings between the monitors and volunteer to build rapport and trust. The relationship between the monitors and the volunteers should be well established by the time of the first session (Masters and Houston, 1966). In the Johns Hopkins studies, there are at least eight contact hours over the course of at least four meetings, usually over a 1-month period. One of these preparatory meetings should be conducted in the room in which the hallucinogen is to be administered, to familiarize the participant with the physical environment. The primary monitor meets with the volunteer during all of these meetings, while the assistant monitor is required to be present on at least one occasion. It is important that the assistant monitor, in addition to the primary monitor, has developed a trusting relationship with the volunteer because this assistant monitor will be the only person in the session room with the volunteer if the primary monitor needs to leave briefly.

During these preparatory meetings, the monitors discuss meaningful aspects of the volunteer's life. The main purpose of the participant-monitor meetings is to develop rapport and trust, which we believe helps minimize the risk of fear or anxiety reactions during the hallucinogen session. This typically includes discussions of the volunteer's childhood, romantic life, current relationships with family and friends, and the volunteer's philosophical and/or spiritual beliefs. Reviewing personal history and feelings may be important for two reasons. First, this discussion helps establish a significant level of trust. The interaction should convey that all aspects of the person are welcome, from the petty to the noble, from embarrassments to achievements and from sorrow to joy. By the time of the hallucinogen session day, the volunteer will ideally feel completely comfortable with the monitors, reducing the likelihood of paranoia (e.g. feeling that the monitors are trying to control her or his mind, or have deceived the volunteer about the nature of the study). Second, related personal material may 'emerge' under the effects of the hallucinogen. That is, the volunteer may experience intense thoughts, feelings and visions related to his or her personal history or world-view. Knowing about the volunteer's life will allow the monitors to better understand her or his session experience and help the monitors in providing interpersonal support should strong emotions arise. If it is felt that sufficient rapport and trust have not developed during these monitor meetings, then either additional contact hours should be provided, or the volunteer's participation should be cancelled. A high dose of a hallucinogen should not be administered to a volunteer if sufficient trust has not been established. As with other forms of human research involving the development of rapport and trust (e.g. clinical trials involving psychotherapy), investigators should be careful that this rapport and trust does not create a situation in which the volunteer feels obligated to remain in the study. Volunteers and monitors should be clear that participation is voluntary, and that the participant will be fully supported if her or his decision is to quit the study.

At some point during preparatory meetings, time must be devoted to explain the study logistics. These should include the timing of the session (e.g. what time to arrive at the laboratory if an outpatient study, what time the session is likely to end), any restrictions on diet or contraindicated medicines, drugs or nutritional supplements (e.g. if fasting or a low-fat diet is required the morning before session), and any requirements of other people (e.g. if a family member or friend is to pick up the participant at the end of the session).

This discussion should also include thorough descriptions of study procedures, to the degree allowable by blinding issues. For example, if cognitive or memory tests are to be performed, or questionnaires are to be answered, the participants should be aware of these requirements. If physiological measures, such as blood pressure, are to be taken during the time of drug action, this also should be explained. The activities during hallucinogen action will naturally depend on the scientific questions under investigation. Whatever the nature of the experiment after hallucinogen administration, the scenario should be thoroughly discussed with the volunteer in preparation. In some cases, such as with brain imaging research, it may be helpful for volunteers to be run through a preliminary research session to familiarize them with the equipment and procedures. Some studies have conducted an initial non-blind hallucinogen administration session in which safety measures are assessed before subsequent blinded sessions to, among other reasons, acquaint volunteers with the effects of the drug before the introduction of additional, potentially anxiety provoking measures (e.g. blood draws) (Strassman and Qualls, 1994; Strassman, *et al.*, 1994, 1996).

The preparation of the volunteer should involve a detailed discussion of the possible range of experiences that may be encountered after hallucinogen administration. This includes the typical onset and duration of the drug(s) under investigation. Preparation involves discussion of the various potential physical sensations, such as nausea or heightened awareness of physiological processes, such as breathing and heartbeat. Volunteers are encouraged to trust that their bodies will continue to function properly regardless of such sensations, and that these bodily processes will continue without the volunteers' volitional control.

The major categories of potential psychological experiences during hallucinogen action should be discussed with the participant. The range of subjective experience under hallucinogens can be remarkably broad (Blewett and Chwelos, 1959; Richards, 1980; Masters and Houston, 1966; Strassman, 2001; Nichols, 2004; Stolaroff, 2004). This range of experiences includes perceptual changes, such as visual illusions, intensification of colours, proprioceptive changes (e.g. one's body may feel gigantic or tiny), and synesthesia (e.g. seeing sounds or hearing colours). Another type of possible experience is the alteration of emotions, such that emotions of either a positive or negative nature may be greatly intensified, yielding experiences that may range from euphoria to despair. Another category of possible effects involves changes in the sense of time and space. At the extremes, time and/or space may be experienced as infinite or nonexistent. Other experiences may include thoughts, feelings or insights concerning one's personal history (e.g. revisiting childhood memories) or current life circumstances (e.g. relations with loved ones), highly symbolic experiences (e.g. involving religious symbols, animals, etc.), and experiences described by some to be of a mystical or spiritual nature. Importantly, it should be emphasized that these experiences may consist of much more than the participant subjectively observing internal and external events. Rather, the effects may involve a profound change in one's sense of self, such that one feels as if he or she is merging into the surrounding environment or the entire universe (Schultes, *et al.*, 2001). The individual may temporarily experience a complete loss of subjective self-identity, a phenomenon sometimes referred to as 'ego loss' or 'ego death' (e.g. Leary, *et al.*, 1964; Grof and Halifax, 1977; Grof, 1980). While a detailed discussion concerning the range of possible hallucinogen effects will enhance safety by psychologically preparing the participant for the unique and often intense effects of a hallucinogen, it may also serve to undermine the blind. That is, such preparation may train the participant on how to identify a hallucinogen by its effects. Nonetheless, the primary concern must be the participant's safety. Therefore, researchers must minimize the potential for unblinding by manipulating other aspects of the experimental design, such using hallucinogen-naïve participants or the use of an active placebo (e.g. Griffiths, *et al.*, 2006).

The volunteers should be given guidance on how to handle difficult hallucinogen experiences. Whether the disturbance consists of frightening illusions or internal imagery, difficult thoughts and feelings about some past or present personal issue, or anxiety related to a radical change in sense of self (e.g. temporary loss of self-identity), the volunteer is encouraged to mentally surrender to the experience, trusting that her or his usual state of consciousness will return when the drug effects resolve (Blewett and Chwelos, 1959; Masters and Houston, 1966; McCabe, 1977). For example, if the participant experiences disturbing internal imagery of a demon or monster, he or she is encouraged to mentally approach the figure and interact with it (e.g. imagine asking the figure why it has appeared), rather than attempt to flee from the disturbing imagery. The participant should be alerted that sometimes people experience extremely convincing sensations of dissolving, melting, exploding and so forth, and that the best way to deal with all such situations is to surrender to the experience, subjectively allowing oneself to dissolve, melt or explode. Similar advice applies to physical symptoms such as nausea; for example, participants may be encouraged to 'dive in' to their stomachs, which may alleviate the nausea, as it has been suggested anecdotally that nausea and other somatic discomforts may in part be of a psychosomatic nature (Blewett and Chwelos, 1959; Masters and Houston, 1966).

The preparation of volunteers for hallucinogen administration will require balancing the ethical requirements to prepare the volunteer for the potentially powerful psychological effects of hallucinogens, with the scientific concern not to bias the volunteer with respect to the dependent variables. This is especially true because classical hallucinogens have been shown to increase suggestibility in an experimental model involving body sway (Sjoberg and Hollister, 1965; Middlefell, 1967), and suggestibility has been proposed as a potential mechanism of the possible therapeutic efficacy of hallucinogens (Dobkin de Rios, *et al*., 2002; Barbosa, *et al*., 2005). That is, one could argue that examples conveyed during preparation are then experienced during the session only due to an increased level of suggestibility during hallucinogen action. Increased suggestibility would seem to be of greatest concern as a confound when investigating the phenomenology of subjective hallucinogen-occasioned experience (e.g. the study by Griffiths, *et al*. (2006), demonstrating that psilocybin can occasion mystical-type experiences under supportive conditions). In the study by Griffiths, *et al*. (2006), although experiences of a spiritual variety were included among the range of possible effects conveyed in preparation, the monitors emphasized that these experiences were not the only variety of interesting or valuable effects that might occur. Specific categories of mystical-type experience to be assessed in measures were not discussed. In the Johns Hopkins studies, we have not encouraged participants to read the diverse and widely varying published accounts of hallucinogen effects as part of their preparation, because this may introduce compelling idiosyncratic expectations. Our research has proceeded safely by delivering all such preparatory information to participants verbally during presession meetings with monitors. Researchers will need to design studies such that a maximum amount of preparation is provided for safety reasons, while not confounding the particular hypotheses being studied. Furthermore, controlled studies should ensure that the unique preparation methods and research environment qualities described herein are in place, under double-blind conditions, for both hallucinogen and placebo groups (or conditions). For example, in the study by Griffiths, *et al*. (2006), the use of identical procedures under double-blind conditions for psilocybin sessions and the active placebo (a high dose of methylphenidate) sessions permitted a reasonable degree of control over suggestibility.

Conduct of hallucinogen administration sessions

As with research with many other psychoactive drugs, a physician should be available during hallucinogen sessions, should any untoward medical complications arise. Furthermore, medication for the treatment of acute hypertension (e.g. intravenous labetalol) should be immediately available in the event that blood pressure exceeds predetermined safety parameters.

Adverse psychological reactions to hallucinogens will be minimized when studies are conducted under conditions that provide strong interpersonal support to the participants (Blewett and Chwelos, 1959; Chwelos, *et al*., 1959; Pahnke, 1969; Masters and Houston, 1966). The monitors should carefully observe the participant and be vigilant for signs of psychological distress. If the volunteer needs to walk to complete study tasks or to go to the rest room, the monitors should stand close by to assist by gently holding an arm or shoulder. Even with high doses of hallucinogens, individuals do not typically show substantial motor impairment, and will likely be able to ambulate without considerable difficulty (with the exception of hallucinogens such as parenteral DMT with abrupt effects and short duration of action). However, perceptual and proprioceptive effects may make walking disorienting, which is why gentle guidance may be helpful. One of the monitors should always be present in the session room with the participant. Because the session monitors will have developed rapport and trust with the participant, they should be the only people to interact with the volunteer during the course of hallucinogen action, barring any non-routine event (e.g. fire alarm, medical intervention by a specialist). Individuals who are anticipated to have contact with the volunteer during the course of hallucinogen action (e.g. nurse, physician) should have at least met with the volunteer once prior to session to develop some degree of rapport and trust.

For all but the shortest acting hallucinogens (e.g. parenteral DMT), the participant is likely to need to use the restroom at some point while experiencing hallucinogen effects. If a private restroom is not available, then study staff should escort the volunteer to assure that no one is in the restroom. Either the restroom door needs to have no lock, or study staff should have a key readily available if needed. Cohen (1960) reported a case in which a depressed patient who had been administered LSD barricaded himself into a room to attempt suicide. In the Johns Hopkins studies, sessions are conducted in a room located on the third floor of a research facility. The session room itself has a private restroom just outside of the session room. During sessions, the volunteer is closely escorted to the restroom and a session monitor waits just outside the restroom to be available if the volunteer should encounter any difficulties. Furthermore, waiting in this area outside the restroom allows the monitors to ensure that the volunteer does not exit the research site. Any attempt by a disoriented volunteer to leave the session area would be met with compassionate but firm direction to return to the session room.

Serious attention must be devoted to the possibility of volunteers trying to leave the study site under the influence of a hallucinogen. Walter Pahnke's (1963) dissertation study (known as the 'Good Friday Experiment') examined the ability of a high dose of psilocybin to occasion mystical experiences by administering either psilocybin or placebo (randomly assigned) to seminary students in a small, basement chapel into which a Good Friday service from the main sanctuary was broadcast. A retrospective investigation conducted over 25 years after the original experiment revealed that two volunteers left the chapel under the influence of psilocybin (Doblin, 1991). One of these volunteers reported feeling imprisoned in the chapel and left the chapel during a portion of the experiment. The other volunteer abruptly left the chapel believing that God had chosen him to immediately announce to the world the dawning of an age of peace (Roberts and Jesse, 1997; Smith, 2000). This volunteer was apprehended by the research staff and administered the antipsychotic agent chlorpromazine after efforts to calm him were unsuccessful (Doblin, 1991; Roberts and Jesse, 1997; Smith, 2000). Strassman (2001) also reported an incident in which a participant experiencing the full effects of a high dose of psilocybin evaded the research staff and left the research site. Fortunately, the participant's spouse monitored the participant and no one was injured.

The risks of allowing a research volunteer experiencing the effects of a hallucinogen to leave the study site are significant. For example, in a bewildered or delusional state, the person might walk into traffic or attempt to drive. Although many hallucinogen users maintain reasonable control while under the influence of hallucinogens, panic or delusional reactions to hallucinogens have in rare circumstances resulted in tragic consequences, such as jumping out of windows (Keeler and Reifler, 1967; Reynolds and Jindrich, 1985; Reitman and Vasilakis, 2004; O'Brien, 2006). Interestingly, the volunteer who fled Strassman's (2001) study site on psilocybin was a carefully screened, experienced LSD user. Therefore, it is imperative for safety reasons that the study site environment, session procedures and participant preparation all minimize the chance of a volunteer leaving the study site.

Strategies for handling non-routine scenarios should be considered. For example, how are study monitors and the volunteer expected to respond in the event of a fire alarm or fire? On the single occasion at Johns Hopkins in which a fire alarm sounded during a session, the two study monitors closely escorted the volunteer outside, making sure to minimize contact with other individuals. The three of them walked to a nearby quiet area with an attractive landscape and enjoyed the scenery until the volunteer and monitors could return to the building. The monitors encouraged the participant to view the occasion as an opportunity to enjoy the natural world outdoors (something normally unavailable during sessions), rather than as an impediment to having a successful session. If any non-routine events occur, the monitors should maintain contact with the volunteer throughout.

If participants become anxious during the course of hallucinogen action, it is now widely recognized that the appropriate first response is to provide strong personal support and reassurance (O'Brien, 2006). This primarily includes interacting with the volunteer in a comforting and reassuring manner. If the volunteer is behaving anxiously and a negative psychological reaction seems to be escalating, the monitors should convey a solid sense of security and calm, while empathizing with what may be an incredibly intense and unpleasant experience. Attempts to 'talk down' the participant (i.e. the use of reality-defining techniques to distract the participant from or attenuate the altered state of consciousness) may be counterproductive and aggravate a difficult reaction (McCabe, 1977). Instead, participants should be reminded to surrender to the experience.

Appropriate forms of reassurance may include a supportive touch to the arm or shoulder with verbal reminders that the participant is in a research study, has taken the hallucinogen, and that he or she will return to normal consciousness in 'a few minutes' or 'a few hours' (or whatever the appropriate estimate may be, depending on the specific drug under study and when it was administered). During an intense hallucinogen-occasioned experience when verbal interactions may be of limited help, a powerful form of reassurance (sometimes called 'interpersonal grounding') is simply holding the hand of the participant (McCabe, 1977). Many volunteers report that during such experiences, a reassuring hand provides an incredible sense of stability and connection. Monitors should demonstrate this practice during preparation to normalize hand holding during sessions.

If volunteers have been appropriately screened and the guidelines herein followed, reassurance should be sufficient to diffuse acute psychological distress in the vast majority of cases. For example, in recent studies in our laboratory, in which we have administered high doses of psilocybin to 54 volunteers, reassurance has been sufficient to handle all cases of acute psychological distress that have arisen. Although pharmacological intervention is a last resort and should rarely, if ever, be needed, medications should be readily available for use if the need arise. For cases in which acute psychological distress is insufficiently managed with reassurance alone, treatment with a benzodiazepine anxiolytic is the pharmacological intervention of choice (Abraham and Aldridge, 1993; Frecska and Luna, 2006; O'Brien, 2006). In these cases, we recommend a 10 mg oral dose of diazepam (Grinspoon and Bakalar, 1979), although oral doses of 15-30 mg per hour or every few hours as needed have been recommended for pharmacological treatment of 'bad trips' that do not respond to reassurance in emergency department settings (Ungerleider and Frank, 1976). Because of its high lipid solubility, diazepam has a more rapid onset, a shorter time until peak plasma concentration and a shorter duration of therapeutic action than many other benzodiazepines including lorazepam, despite the fact that lorazepam has a shorter elimination half-life (Greenblatt and Shader, 1985; Funderburk, *et al.*, 1988). Although the intravenous route may be considered, the oral route is preferable because intravenous injection procedures may further exacerbate the participant's anxiety. Moreover, antipsychotic medications (e.g. risperidone, olanzapine) should be available in the event that an adverse reaction escalates to unmanageable psychosis. However, experienced clinicians have suggested that although antipsychotic medications may reduce psychotic behaviour through sedation, their use may be problematic because the effects may be abrupt, unpleasant and intense and their use may result in subsequent psychological problems (McCabe, 1977; Grinspoon and Bakalar, 1979; Grof, 1980). Furthermore, pretreatment with the antipsychotic haloperidol has been shown to exacerbate the psychosis-like effects of psilocybin (Vollenweider, *et al.*, 1998), suggesting that haloperidol should not be used as a rescue medication. Although not approved for use in the USA, ketanserin (a 5-HT$_{2A}$ antagonist) pretreatment has been shown to attenuate psilocybin effects (Vollenweider, *et al.*, 1998), suggesting possible use as a rescue medication for hallucinogen administration. Ultimately the decision to medicate will depend on whether the monitors and responsible physician judge that they are capable of maintaining the safety of the volunteer and others without medical intervention. Bringing the participant to the emergency department represents an ultimate 'last resort' in the treatment of a very difficult (i.e. psychotic) reaction. However, medical evaluation by well-meaning emergency department personnel, who are inexperienced with hallucinogen effects can readily escalate and prolong an adverse reaction. Therefore, all possible efforts should be made to treat a difficult experience in the session context, even if pharmacological intervention is required.

The conduct of the session will largely be based on the particular research topics being studied. The research requirements of many types of studies will require the participants to adhere to regimented testing conditions (e.g. cognitive tests, memory tests, brain scans). In such investigations, interference with procedures may be minimized by judiciously selecting dose and the hallucinogen experience level required of volunteers. Adverse reactions will generally be more likely at higher hallucinogen doses; however, adverse reactions can potentially occur at any dose level. Experienced hallucinogen users may be particularly appropriate participants for studies involving challenging conditions, such as remaining immobile for long periods in a confining brain imaging scanner. Regardless of experience level and dose, however, the possibility of psychological adverse reactions exists whenever a hallucinogen is administered. To the degree possible, investigators should attempt to implement their scientific protocols as planned. However, monitors should always be vigilant for potential adverse psychological reactions. In the event of a significant adverse psychological reaction, interpersonal support should be provided even if it interferes with data collection. Clearly, volunteer safety must take priority over scientific procedures. In studies such as ours, in which participants are encouraged to focus their attention inward by wearing eyeshades and listening to music through headphones, our advice is for monitors to occasionally probe the volunteer's psychological well-being (e.g. ask the volunteer, 'Would you like to describe where you find yourself?') to ensure that the volunteer is not experiencing significant anxiety and is in need of support.

For studies that investigate potential therapeutic effects or the phenomenology of hallucinogen experiences (i.e. studies that do not require participants to engage in research tasks during the session), the employment of eyeshades and headphones (through which supportive music is played) may contribute to safety by reducing the distractions of environmental stimuli and social pressures to verbally interact with research personnel. This may be especially important for volunteers who are experiencing the effects of a hallucinogen for the first time. Typically, we have kept eyeshades and headphones in place for most of the session. In the latter hours of the session some time is spent with the volunteer sitting on the couch, interacting without eyeshades and headphones, although music may still be played through speakers to provide nonverbal structure and continuity. As a whole, we encourage our participants to 'collect experiences' to discuss after the drug effects have abated, and discourage attempts to analyse material or communicate excessively while the atypical states of consciousness are still occurring.

After the effects of the hallucinogen have resolved, the participant should either be released into the care of a friend or family member or required to stay overnight at the research site for monitoring. If participants are released from the study site after the session, they should be instructed not to drive an automobile or engage in any other potentially dangerous activity for the remainder of the day. At Johns Hopkins, volunteers are released into the care of a friend or family member, who has been appropriately oriented by our staff to be available to emotionally support the participant, but also to provide space (i.e. be in another room) if the participant feels the need to be alone. We have also given the participant the primary monitor's pager number to call if he or she feels the need for support that evening. Of the 54 volunteers tested at a high psilocybin dose to date, no one has paged the monitor, although volunteers do seem to appreciate this opportunity for additional support.

Post-session procedures

After the session, safety monitoring should continue in the form of one or more post-session meetings (typically the next day) between the primary monitor and participant to ensure psychological stability and provide an opportunity for the volunteer to discuss thoughts or feelings from the session. As with any acute, intense positive or negative emotional experience, participants often feel the need for, and seem to benefit from, additional time for reflecting on the novel thoughts and feelings that may have arisen in the session. Given the potentially intense and unusual psychological nature of hallucinogen effects, the volunteer may have difficulty discussing the experience with others in her or his life. Because the monitors were present during the session when the hallucinogen effects were experienced and have knowledge of a broad range of reported phenomena during drug action, the volunteer may feel more comfortable discussing her or his experience with the monitors than with others. This follow-up contact also allows the assessment of any potentially persisting adverse effects, including perceptual abnormalities. More than one post-session meeting may be necessary if the volunteer is experiencing psychological difficulty concerning thoughts and feelings encountered during the session. Of the 54 volunteers tested with a high dose of psilocybin at Johns Hopkins to date, none has shown evidence of persisting psychosis or psychological problems related to their sessions, and all have returned to their normal daily activities. If the primary session monitor is not a clinically trained psychologist or psychiatrist, it is prudent for research teams to have available for consultation a clinically trained psychologist or psychiatrist familiar with altered states of consciousness, who can work with patients who appear to have developed psychological difficulties stemming from hallucinogen administration.

Concluding remarks

After a decades-long period of dormancy in response to the sensationalism surrounding the nonmedical use of hallucinogens during the 1960s, human hallucinogen research has resumed in the USA and Europe, and is now beginning to address a variety of important basic research questions as well as potential therapeutic applications (Nichols, 2004). In light of the unusual history of restriction on human research with this class of compounds, it is critical for investigators to implement appropriate and conservative safeguards. With such safeguards this class of compounds can be studied safely in humans. Careless research that lacks attention to the unique risk profile of hallucinogens may not only endanger the safety and well-being of the research participants, but may also jeopardize future human research with these scientifically fascinating compounds. On the other hand, carefully conducted research that respects hallucinogens' unique and often powerful psychological effects may potentially inform the treatment of various psychiatric disorders, as well as lead to significant advances in our understanding of perception, cognition, behaviour, the psychology of religion and the biological underpinnings of consciousness.

Acknowledgements

Support for preparation of this manuscript was provided by grants from NIH (R01 DA03889), the Council on Spiritual Practices and the Heffter Research Institute. We thank George Greer, MD, Charles Grob, MD, Robert Jesse, Annie Umbricht, MD and Franz Vollenweider, MD for helpful comments on previous versions of this manuscript. We also thank the staff of the Johns Hopkins psilocybin research studies, whose insights have contributed to these guidelines, including Mary P. Cosimano, MSW and Brian D. Richards, Psy.D. for their roles in screening volunteers and monitoring sessions, and Lawrence P. Carter, PhD, Ryan K. Lanier, PhD, Benjamin McKay, Chad J. Reissig, PhD, and Ryan G. Vandrey, PhD for their assistance in monitoring sessions.

References

1. Abraham, HD, Aldridge, AM (1993) Adverse consequences of lysergic acid diethylamide. Addiction *88*: 1327-1334.
2. Abramson, HA (ed) (1960) The Use of LSD in Psychotherapy. New York: Josiah Macy Jr. Foundation Publications.
3. Abramson, HA (ed) (1963) The Use of LSD in Psychotherapy and Alcoholism. New York: Bobbs-Merrill.
4. Abuzzahab, FS, Anderson, BJ (1971) A review of LSD treatment in alcoholism. Int Pharmacopsychiatry *6*: 223-235.
5. American Psychiatric Association (2000) DSM-IV-TR: Diagnostic and Statistical Manual of Mental Disorders, Text Revision. Fourth ed. Washington, DC: American Psychiatric Association.
6. Baggott, MJ, Erowid, E, Erowid, F, Robertson, LC (2006) Chronic visual changes in hallucinogen users: a web-based questionnaire. Poster presented at the 2006 meeting of the College on Problems of Drug Dependence, Scottsdale, AZ.
7. Barbosa, PC, Giglio, JS, Dalgalarrondo, P (2005) Altered states of consciousness and short-term psychological after-effects induced by the first time ritual use of *ayahuasca* in an urban context in Brazil. J Psychoactive Drugs 37: 193-201.
8. Bender, L, Siva Sankar, DV (1968) Chromosome damage not found in leukocytes of children treated with LSD-25. Science *159*: 749.
9. Blewett, DB, Chwelos, N (1959) Handbook for the Therapeutic Use of Lysergic Acid Diethylamide-25: Individual and Group Procedures. http://www.erowid.org/psychoactives/guides/handbook_lsd25.shtml [accessed 9.10.07].
10. Bonson, KR, Buckholtz, JW, Murphy, DL (1996) Chronic administration of serotonergic antidepressants attenuates the subjective effects of LSD in humans. Neuropsychopharmacology *14*: 425-436.
11. Bonson, KR, Murphy, DL (1996) Alterations in responses to LSD in humans associated with chronic administration of tricyclic antidepressants, monoamine oxidase inhibitors or lithium. Behav Brain Res *73*: 229-233.
12. Buchanan, RW, Carpenter, WT (2005) Concept of Schizophrenia. In: Sadock, RJ, Sadock, VA (eds), Kaplan and Sadock's Comprehensive Textbook of Psychiatry, vol. 1, eighth ed. Philadelphia: Lippincott, William, Wilkins, pp. 1329-1345.
13. Callaway, JC, Grob, CS (1998) *Ayahuasca* preparations and serotonin reuptake inhibitors: a potential combination for severe adverse interactions. J Psychoactive Drugs *30*: 367-369.
14. Carter, OL, Burr, DC, Pettigrew, JD, Wallis, GM, Hasler, F, Vollenweider, FX (2005a) Using psilocybin to investigate the relationship between attention, working memory, and the serotonin 1A and 2A receptors. J Cogn Neurosci *17*: 1497-1508.
15. Carter, OL, Pettigrew, JD, Burr, DC, Alais, D, Hasler, F, Vollenweider, FX (2004) Psilocybin impairs high-level but not low-level motion perception. Neuroreport *15*: 1947-1951.
16. Charney, DS, Mihic, SJ, Harris, RA (2006) Hypnotics and sedatives. In: Brunton, LL, Lazo, JS, Parker, KL (eds), Goodman & Gilman's The Pharmacological Basis of Therapeutics, eleventh edition. New York: McGraw-Hill, pp. 401-427.
17. Chwelos, N, Blewett, DB, Smith, CM, Hoffer, A (1959) Use of d-lysergic acid diethylamide in the treatment of alcoholism. Quart, J Stud Alcohol *20*: 577-590.
18. Cohen, MM, Hirschhorn, K, Frosch, WA (1967a) In vivo in vitro chromosomal damage induced by LSD-25. N Engl J Med *277*: 1043-1049.
19. Cohen, MM, Marinello, MJ, Back, N (1967b) Chromosomal damage in human leukocytes induced by lysergic acid diethylamide. Science *155*: 1417-1419.
20. Cohen, S (1960) Lysergic acid diethylamide: side effects and complications. J Nerv Ment Dis *130*: 30-40.
21. Cohen, S (1965) LSD and the anguish of dying. Harpers Mag *231*: 69-78.
22. Cohen, S, Ditman, KS (1962) Complications associated with lysergic acid diethylamid (LSD-25). JAMA *181*: 161-162.
23. Council on Spiritual Practices (2001) Code of ethics for spiritual guides (appendix B). In: Roberts, TB (ed), Psychoactive Sacramentals: Essays on Entheogens and Religion. San Francisco: Council on Spiritual Practices, pp. 250-251.
24. Crochet, R, Sandison, R, Walk, A (eds) (1963) Hallucinogenic Drugs and Their Psychotherapeutic Use. Springfield, IL: Thomas.
25. Dishotsky, NI, Loughman, WD, Mogar, RE, Lipscomb, WR (1971) LSD and genetic damage. Is LSD chromosome damaging,

carcinogenic, mutagenic, or teratogenic. Science *172*: 431-440.
26. Dittrich, A (1993) Psychological aspects of altered states of consciousness of the LSD type: measurement of their basic dimensions and prediction of individual differences. In: Pletscher, A, Ladewig, D (eds), Fifty years of LSD Concurrent status and perspectives of hallucinogens. New York: Parthenon, pp. 101-118.
27. Dobkin de Rios, M, Grob, CS, Baker, JR (2002) Hallucinogens and redemption. J Psychoactive Drugs *34*: 239-248.
28. Doblin, R (1991) Pahnke's "Good Friday Experiment": a long-term follow-up and methodological critique. J Transpers Psychol *23*: 1-28.
29. Fabing, HD (1955) New blocking agent against the development of LSD-25 psychosis. Science *121*: 208-210.
30. Fantegrossi, WE, Woods, JH, Winger, G (2004) Transient reinforcing effects of phenylisopropylamine and indolealkylamine hallucinogens in rhesus monkeys. Behav Pharmacol *15*: 149-157.
31. Fiorella, D, Helsley, S, Rabin, RA, Winter, JC (1996) Potentiation of LSD-induced stimulus control by fluoxetine in the rat. Life Sci *59*: PL283-PL287.
32. First, MB, Spitzer, RL, Gibbon, M, Williams, JBW (2001) Structured clinical interview for DSM-IV-TR Axis 1 Disorders Research Version Patient Edition (SCID-I/P) Biometrics Research. New York: New York State Psychiatric Institute.
33. Fischman, MW, Johanson, CE (1998) Ethical and practical issues involved in behavioral pharmacology research that administers drugs of abuse to human volunteers. Behav Pharmacol *9*: 479-498.
34. Frecska, E, Luna, LE (2006) The adverse effects of hallucinogens from intramural perspective. Neuropsychopharmacol Hung *8*: 189-200.
35. Funderburk, FR, Griffiths, RR, McLeod, DR, Bigelow, GE, Mackenzie, A, Liebson, IA, *et al*. (1988) Relative abuse liability of lorazepam and diazepam: an evaluation in 'recreational' drug users. Drug Alcohol Depend *22*: 215-222.
36. Gable, RS (1993) Toward a comparative overview of dependence potential and acute toxicity of psychoactive substances used nonmedically. Am JDrug Alcohol Abuse *19*: 263-281.
37. Gable, RS (2004) Comparison of acute lethal toxicity of commonly abused psychoactive substances. Addiction *99*: 686-696.
38. Glennon, RA, Titeler, M, McKenney, JD (1984) Evidence for 5-HT_2 involvement in the mechanism of action of hallucinogenic agents. Life Sci *35*: 2505-2511.
39. Gonzales, VO Centro Espirita Beneficiente União do Vegetal 546 US (2006). US Supreme Court, no 04-1084, decided 21 February 2006.
40. González-Maeso, J, Weisstaub, NV, Zhou, M, Chan, P, Ivic, L, Ang, R, *et al*. (2007) Hallucinogens recruit specific cortical 5-HT(2A) receptor-mediated signaling pathways to affect behavior. Neuron *53*: 439-452.
41. Gouzoulis-Mayfrank, E, Heekeren, K, Neukirch, A, Stoll, M, Stock, C, Daumann, J, *et al*. (2006) Inhibition of return in the human $5HT_{2A}$ agonist and NMDA antagonist model of psychosis. Neuropsychopharmacology *31*: 431-441.
42. Gouzoulis-Mayfrank, E, Heekeren, K, Neukirch, A, Stoll, M, Stock, C, Obradovic, M, *et al*. (2005) Psychological effects of (S)-ketamine and *N,N*-dimethyltryptamine (DMT): a double-blind, cross-over study in healthy volunteers. Pharmacopsychiatry *38*: 301-311.
43. Gouzoulis-Mayfrank, E, Heekeren, K, Thelen, B, Lindenblatt, H, Kovar, KA, Sass, H, *et al*. (1998a) Effects of the hallucinogen psilocybin on habituation and prepulse inhibition of the startle reflex in humans. Behav Pharmacol *9*: 561-566.
44. Gouzoulis-Mayfrank, E, Schneider, F, Friedrich, J, Spitzer, M, Thelen, B, Sass, H (1998b) Methodological issues of human experimental research with hallucinogens. Pharmacopsychiatry *31*: 114-118.
45. Gouzoulis-Mayfrank, E, Thelen, B, Habermeyer, E, Kunert, HJ, Kovar, KA, Lindenblatt, H, *et al*. (1999) Psychopathological, neuroendocrine and autonomic effects of 3,4-methylenedioxyethyl amphetamine (MDE), psilocybin and d-methamphetamine in healthy volunteers Results of an experimental double-blind placebo-controlled study. Psychopharmacology (Berl) *142*: 41-50.
46. Gouzoulis-Mayfrank, E, Thelen, B, Maier, S, Heekeren, K, Kovar, KA, Sass, H, *et al*. (2002) Effects of the hallucinogen psilocybin on covert orienting of visual attention in humans. Neuropsychobiology *45*: 205-212.
47. Greenblatt, DJ, Shader, RI (1985) Clinical pharmacokinetics of the benzodiazepines. In: Smith, DE, Wesson, DR (eds), The Benzodiazepines: Current Standards for Medical Practice. Lancaster, PA: MTP Press, pp. 43-58.
48. Griffiths, RR, Bigelow, GE, Henningfield, JE (1980) Similarities in animal and human drug-taking behavior. Adv Subst Abuse *1*: 1-90.
49. Griffiths, RR, Richards, WA, McCann, U, Jesse, R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology *187*: 268-283.
50. Grinspoon, L, Bakalar, JB (1979) Psychedelic Drugs Reconsidered. New York: Basic Books.
51. Grob, CS (2005) Psilocybin research with advanced-stage cancer patients. Multidisciplinary Association for Psychedelic Studies (MAPS). Bulletin *15(3)*: 8.
52. Grob, CS, Greer, GR, Mangini, M (1998) Hallucinogens at the turn of the century: an introduction. J Psychoactive Drugs *30*: 315-319.
53. Grob, CS, McKenna, DJ, Callaway, JC, Brito, GS, Neves, ES, Oberlaender, G, *et al*. (1996) Human psychopharmacology of hoasca, a plant hallucinogen used in ritual context in Brazil. J Nerv Ment Dis *184*: 86-94.
54. Grof, S (1977) Perinatal roots of wars, totalitarianism, and revolutions: observations from LSD research. J Psychohist *4*: 269-308.
55. Grof, S (1980) LSD Psychotherapy. Pomona, CA: Hunter House.
56. Grof, S, Goodman, LE, Richards, WA, Kurland, AA (1973) LSD-assisted psychotherapy in patients with terminal cancer. Int Pharmacopsychiatry *8*: 129-144.
57. Grof, S, Halifax, J (1977) The Human Encounter with Death. New York: EP Dutton.
58. Gutstein, HB, Akil, H (2006) Opioid analgesics. In: Brunton, LL, Lazo, JS, Parker, KL (eds), Goodman & Gilman's The Pharmacological Basis of Therapeutics, eleventh ed. New York: McGraw-Hill, pp. 547-590.
59. Halpern, JH (1996) The use of hallucinogens in the treatment of addiction. Addict Res *4*: 177-189.
60. Halpern, JH, Pope, HG (1999) Do hallucinogens cause residual neuropsychological toxicity. Drug Alcohol Depend *53*: 247-256.
61. Halpern, JH, Pope, HG (2003) Hallucinogen persisting perception disorder: what do we know after 50 years. Drug Alcohol Depend *69*: 109-119.

62. Halpern, JH, Sherwood, AR, Hudson, JI, Yurgelun-Todd, D, Pope, HG (2005) Psychological and cognitive effects of long-term peyote use among Native Americans. Biol Psychiatry *58*: 624-631.
63. Harner, MJ (1962) Jivaro Souls. Am Anthropol *64*: 258-272.
64. Harner, MJ (1968) The sound of rushing water. Natural History Magazine, *77*: 28-33, 60-61.
65. Harvard Mental Health Letter (2006) Reviving the study of hallucinogens (editorial). Harv Ment Health Lett *23*: 5.
66. Hasler, F, Bourquin, D, Brenneisen, R, Bär, T, Vollenweider, FX (1997) Determination of psilocin and 4-hydroxyindole-3-acetic acid in plasma by HPLC-ECD and pharmacokinetic profiles of oral and intravenous psilocybin in man. Pharm Acta Helv *72*: 175-184.
67. Hasler, F, Bourquin, D, Brenneisen, R, Vollenweider, FX (2002) Renal excretion profiles of psilocin following oral administration of psilocybin: a controlled study in man. J Pharm Biomed Anal *30*: 331-339.
68. Hasler, F, Grimberg, U, Benz, MA, Huber, T, Vollenweider, FX (2004) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology *172*: 145-156.
69. Hidalgo, WT (1960) Estudio comparativo psicofisiologico de la mescalina, dietilamida del acido D-lisérgico y psilocybina. Acta Med Venez *8*: 56-62.
70. Hoch, PH, Pennes, HH, Cattell, JP (1953) Psychoses produced by administration of drugs. Res Publ Assoc Res Nerv Ment Dis 32: 287-296.
71. Hoffer, A, Callbeck, MJ (1960) Drug-induced schizophrenia. J Ment Sci *106*: 138-159.
72. Hollister, LE (1961) Clinical, biochemical and psychologic effects of psilocybin. Arch Int Pharmacodyn Ther *130*: 42-52.
73. Hollister, LE, Hartman, AM (1962) Mescaline, lysergic acid diethylamide and psilocybin: comparison of clinical syndromes, effects on color perception and biochemical measures. Compr Psychiatry *3*: 235-241.
74. Hollister, LE, Shelton, J, Krieger, G (1969) A controlled comparison of lysergic acid diethylamide (LSD) and dextroamphetamine in alcoholics. Am J Psychiatry *125*: 1352-1357.
75. Irwin, S, Egozcue, J (1967) Chromosomal abnormalities in leukocytes from LSD-25 user. Science *157*: 313-314.
76. Isbell, H (1959) Comparison of the reactions induced by psilocybin and LSD-25 in man. Psychopharmacologia *1*: 29-38.
77. Kast, E (1967) Attenuation of anticipation: a therapeutic use of lysergic acid diethylamide. Psychiatr Q *41*: 646-657.
78. Kast, EC, Collins, VJ (1964) Lysergic acid diethylamide as an analgesic agent. Anesth Analg *43*: 285-291.
79. Keeler, MH, Reifler, CB (1967) Suicide during an LSD reaction. Am J Psychiatry *123*: 884-885.
80. Kuramochi, H, Takahashi, R (1964) Psychopathology of LSD intoxication; Study of experimental psychosis induced by LSD-25: description of LSD symptoms in normal oriental subjects. Arch Gen Psychiatry *11*: 151-161.
81. Kurland, AA (1985) LSD in the supportive care of the terminally ill cancer patient. J Psychoactive Drugs *17*: 279-290.
82. Kurland, A, Savage, C, Pahnke, WN, Grof, S, Olsson, JE (1971) LSD in the treatment of alcoholics. Pharmakopsychiatr Neuropsychopharmakol *4*: 83-94.
83. Kurland, AA, Grof, S, Pahnke, WN, Goodman, LE (1973) Psychedelic drug assisted psychotherapy. In: Goldberg, IK, Malitz, S, Kutscher, AH (eds), Patients With Terminal Cancer Psychotheramacological Agents for the Terminally Ill and Bereaved. New York: Columbia University Press, pp. 86-133.
84. Kurland, AA, Pahnke, WN, Unger, S, Savage, C, Goodman, E (1969) Psychedelic psychotherapy (LSD) in the treatment of the patient with a malignancy. In: Cerletti, A, Bove, FJ (eds), The Present Status of Psychotropic Drugs: Pharmacological and Clinical Aspects. Amsterdam, Holland: Excerpta Medica, pp. 432-434.
85. Lancet (2006) Reviving research into psychedelic drugs (editorial). Lancet *367*: 1214.
86. Leary, T (1964) The religious experience: Its production and interpretation. Psychedelic Rev *1*: 324-346.
87. Leary, T, Litwin, GH, Metzner, R (1963) Reactions to psilocybin administered in a supportive environment. J Nerv Ment Dis *137*: 561-573.
88. Leary, T, Metzner, R, Alpert, R (1964) The Psychedelic Experience: A Manual Based on the Tibetan Book of the Dead. New York: Citadel Press.
89. Lee, MA, Shlain, B (1992) Acid dreams: The Complete Social History of LSD: The CIA, the Sixties, and Beyond, Revised Edition. New York: Grove Press.
90. Lerner, AG, Gelkopf, M, Skladman, I, Oyffe, I, Finkel, B, Sigal, M, *et al*. (2002) Flashback and hallucinogen persisting perception disorder: clinical aspects and pharmacological treatment approach. Isr JPsychiatry Relat Sci *39*: 92-99.
91. Leuner, H (1962) Die Experimentelle Psychose. Berlin: Springer.
92. Long, SY (1972) Does LSD induce chromosomal damage and malformations? a review of the literature. Teratology *6*: 75-90.
93. Lowy, B (1971) New records of mushroom stones from Guatemala. Mycologia *63*: 983-993.
94. Ludwig, A, Levine, J, Stark, L, Lazar, R (1969) A clinical study of LSD treatment in alcoholism. Am J Psychiatry *126*: 59-69.
95. Malitz, S, Esecover, H, Wilkens, B, Hoch, H (1960) Some observations on psilocybin: a new hallucinogen in volunteer subjects. Compr Psychiatry *1*: 8-17.
96. Mangini, M (1998) Treatment of alcoholism using psychedelic drugs: a review of the program of research. J Psychoactive Drugs *30*: 381-418.
97. Masters, REL, Houston, J (1966) The Varieties of Psychedelic Experience. New York: Holt, Rinehart & Winston.
98. McCabe, OL (1977) Psychedelic drug crises: toxicity and therapeutics. J Psychedelic Drugs *9*: 107-121.
99. McGlothlin, WH, Arnold, DO (1971) LSD revisited A ten-year follow-up of medical LSD use. Arch Gen Psychiatry *24*: 35-49.
100. Metzner, R (1985) Forward. In: Adamson, S (ed). Through the Gateway of the Heart: Accounts of Experiences with MDMA and other Empathogenic Substances. San Francisco: Four Trees Press.
101. Metzner, R (2004) Introduction: visionary mushrooms of the Americas. In: Metzner, R, Darling, DC (eds), Teonanácatl: Sacred Mushroom of Visions. El Verano, CA: Four Trees Press, pp. 1-48.
102. Metzner, R, Litwin, G, Weil, G (1965) The relation of expectation and mood to psilocybin reactions: a questionnaire study. Psychedelic Rev *5*: 3-39.
103. Middlefell, R (1967) The effects of LSD on body sway suggestibility in a group of hospital patients. Br J Psychiatry *113*: 277-280.
104. Mogar, RE, Aldrich, RW (1969) The use of psychedelic agents with autistic schizophrenic children. Psychedelic Rev *10*: 5-13.

105. Moreno, FA, Wiegand, CB, Taitano, EK, Delgado, PL (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. J Clin Psychiatry *67*: 1735-1740.
106. Morris, K (2006) Hallucinogen research inspires "neurotheology". Lancet Neurol *5*: 732.
107. Moss, EL, Dobson, KS (2006) Psychology, spirituality, and end-of-life care: an ethical integration? Can Psychol *47*: 284-299.
108. National Institute on Drug Abuse (2001) Hallucinogens and dissociative drugs. National Institute on Drug Abuse, Research Report Series NIH Publication No 01-4209.
109. National Institute on Drug Abuse (2006) LSD, NIDA Infofacts. Rockville, MD: National Institute on Drug Abuse.
110. Nichols, DE (2004) Hallucinogens. Pharmacol Ther *101*: 131-181.
111. Nichols, DE, Hoffman, AJ, Oberlender, RA, Jacob, P, Shulgin, AT (1986) Derivatives of 1-(1,3-benzodioxol-5-yl)-2-butanamine: representatives of a novel therapeutic class. J Med Chem *29*: 2009-2015.
112. Novak, SJ (1997) LSD before Leary: Sidney Cohen's critique of 1950s psychedelic drug research. Isis *88*: 87-110.
113. Ott, J (1996) Pharmacotheon: Entheogenic Drugs, their Plant Sources and History. Kennewick, WA: Natural Products Co.
114. O'Brien, CP (2006) Drug addiction and drug abuse. In: Brunton, LL, Lazo, JS, Parker, KL (eds), Goodman & Gilman's The Pharmacological Basis of Therapeutics, eleventh ed. New York: McGraw-Hill, pp. 607-627.
115. Pahnke, W (1963) Drugs and mysticism: an analysis of the relationship between psychedelic drugs and the mystical consciousness. Thesis presented to the President and Fellows of Harvard University for the PhD in Religion and Society.
116. Pahnke, WN (1969) Psychedelic drugs and mystical experience. Int Psychiatry Clin *5*: 149-162.
117. Pahnke, WN, Kurland, AA, Goodman, LE, Richards, WA (1969) LSD-assisted psychotherapy with terminal cancer patients. In: Hicks, RE, Fink, PJ (eds), Psychedelic Drugs: Proceedings of a Hahnemann Medical College and Hospital Symposium. New York: Grune & Stratton, pp. 33-42.
118. Passie, T, Seifert, J, Schneider, U, Emrich, HM (2000) The pharmacology of psilocybin. Addict Biol 7: 357-364.
119. Patel, JK, Pinals, DA, Breier, A (2003) Schizophrenia and other psychoses. In: Tasman, A, Kay, J, Lieberman, JA (eds), Psychiatry, Vol. 2. Second ed. New Jersey: John Wiley & Sons, Ltd, pp. 1131-1206.
120. Poling, A, Bryceland, J (1979) Voluntary drug self-administration by nonhumans: a review. J Psychedelic Drugs *11*: 185-190.
121. Reitman, J, Vasilakis, A (2004) The lost freshman. Rolling Stone Magazine, *944*: 62-66.
122. Reynolds, PC, Jindrich, EJ (1985) A mescaline associated fatality. J Anal Toxicol *9*: 183-184.
123. Rhead, JC (1977) The use of psychedelic drugs in the treatment of severely disturbed children: a review. J Psychedelic Drugs *9*: 93-101.
124. Riba, J, Rodriguez-Fornells, A, Urbano, G, Morte, A, Antonijoan, R, Montero, M, *et al*. (2001) Subjective effects and tolerability of the South American psychoactive beverage *Ayahuasca* in healthy volunteers. Psychopharmacology *154*: 85-95.
125. Richards, WA (1980) Psychedelic Drug-assisted psychotherapy with persons suffering from terminal cancer. J Altered States Conscious *5*: 309-319.
126. Richards, WA (2003) Entheogens in the study of mystical and archetypal experiences: Research in the Social Scientific Study of Religion. Brill *13*: 143-155.
127. Richards, WA (2005) Entheogens in the study of religious experiences: current status. J Religion Health *44*: 377-389.
128. Richards, WA, Grof, S, Goodman, LE, Kurland, AA (1972) LSD-Assisted psychotherapy and the human encounter with death. J Transpers Psychol *4*: 121-150.
129. Richards, WA, Rhead, JC, DiLeo, FB, Yensen, R, Kurland, AA (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. J Psychedelic Drugs *9*: 1-10.
130. Richards, WA, Rhead, JC, Grof, S, Goodman, LE, Di Leo, F, Rush, L (1979) DPT as an adjunct in brief psychotherapy with cancer patients. Omega *10*: 9-26.
131. Rinkel, M, Atwell, CR, DiMascio, A, Brown, J (1960) Experimental Psychiatry, VPsilocybine: A New Psychotogenic Drug. N Engl J Med *262*: 295-299.
132. Roberts, TB, Jesse, RN (1997) Recollections of the Good Friday Experiment: an interview with Huston Smith. J Transpers Psychol *29*: 99-104.
133. Ruck, CA, Bigwood, J, Staples, D, Ott, J, Wasson, RG (1979) Entheogens. J Psychedelic Drugs *11*: 145-146.
134. Rümmele, W, Gnirss, F (1961) Untersuchungen mit Psilocybin, ein psychotropen Substanz aus Psilocybe Mexicana. Schweiz Arch Neurol Neurochir Psychiatr *87*: 365-385.
135. Savage, C, McCabe, OL (1973) Residential psychedelic (LSD) therapy for the narcotic addict: a controlled study. Arch Gen Psychiatry *28*: 808-814.
136. Schultes, RE (1969) Hallucinogens of plant origin. Science *163*: 245-254.
137. Schultes, RE, Hoffman, A, Rätsch, C (2001) Plants of the Gods: Their Sacred, Healing, and Hallucinogenic Powers, Revised Edition. Rochester, VT: Healing Arts Press.
138. Sessa, B (2005) Can psychedelics have a role in psychiatry once again. Br J Psychiatry *186*: 457-458.
139. Shulgin, AT, Shulgin, A (1991) Pihkal: A Chemical Love Story. Berkeley, CA: Transform Press.
140. Shulgin, AT, Shulgin, A (1997) Tihkal: The Continuation. Berkeley, CA: Transform Press.
141. Sjoberg, BM, Hollister, LE (1965) The effects of psychotomimetic drugs on primary suggestibility. Psychopharmacologia *8*: 251-262.
142. Smart, RG, Storm, T, Baker, EFW, Solursh, L (1966) A controlled study of lysergid in the treatment of alcoholism: The effects on drinking behavior. Quart J Stud Alcohol *27*: 469-485.
143. Smith, H (2000) Cleansing the Doors of Perceptions: The Religious Significance of Entheogenic Plants and Chemicals. New York: Penguin Putnam Inc.
144. Snyder, SH (1988) Psychotogenic drugs as models for schizophrenia. Neuropsychopharmcology *1*: 197-199.
145. Stockings, GT (1940) A clinical study of the mescaline psychosis, with special reference to the mechanism of the genesis of schizophrenia and other psychotic states. J Mental Sciences *86*: 29-47.
146. Stolaroff, MJ (2004) The Secret Chief Revealed: Conversations with Leo Zeff, Pioneer in the Underground Psychedelic Therapy Movement. Multidisciplinary Association for Psychedelic Studies (MAPS), Sarasota, FL.
147. Stolz, J, Marsden, C, Middlemiss, D (1983) Effect of chronic antidepressant treatment and subsequent withdrawal on [^{3}H]-5-

hydroxytryptamine and [^{3}H]-spiperone binding in rat frontal cortex and serotonin receptor mediated behaviour. Psychopharmacology *80*: 150-155.

148. Strassman, RJ (1984) Adverse reactions to psychedelic drugs: a review of the literature. J Nerv Ment Dis *172*: 577-595.
149. Strassman, RJ (1991) Human hallucinogenic drug research in the United States: a present-day case history and review of the process. J Psychoactive Drugs *23*: 29-38.
150. Strassman, RJ (1992) Human hallucinogen interactions with drugs affecting serotonergic neurotransmission. Neuropsychopharmacology *7*: 241-243.
151. Strassman, RJ (1996) Human psychopharmacology of N,Ndimethyltryptamine. Behav Brain Res *73*: 121-124.
152. Strassman, RJ (2001) DMT: The Spirit Molecule. Rochester, VT: Park Street Press.
153. Strassman, RJ, Qualls, CR (1994) Dose-response study of N,Ndimethyltryptamine in humans: neuroendocrine, autonomic, and cardiovascular effects. Arch Gen Psychiatry *51*: 85-97.
154. Strassman, RJ, Qualls, CR, Berg, LM (1996) Differential tolerance to biological and subjective effects of four closely spaced doses of *N,N*-dimethyltryptamine in humans. Biol Psychiatry *39*: 784-795.
155. Strassman, RJ, Qualls, CR, Uhlenhuth, EH, Kellner, R (1994) Doseresponse study of *N,N*-dimethyltryptamine in humans II: subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry *51*: 98-108.
156. Umbricht, D, Vollenweider, FX, Schmid, L, Grubel, C, Skrabo, A, Huber, T, *et al*. (2003) Effects of the 5-HT$_{2A}$ agonist psilocybin on mismatch negativity generation and AX-continuous performance task: implications for the neuropharmacology of cognitive deficits in schizophrenia. Neuropsychopharmacology *28*: 170-181.
157. Ungerleider, JT, Frank, IM (1976) Management of acute panic reactions and drug flashbacks resulting from LSD ingestion. In: Bourne, P (ed), Acute Drug Emergencies. New York: Academic Press, pp. 133-138.
158. Tjio, JH, Pahnke, WN, Kurland, AA (1969) LSD and chromosomes, A controlled experiment. JAMA *210*: 849-856.
159. Vollenweider, FX, Csomor, PA, Knappe, B, Geyer, MA, Quednow, BB (2007) The effects of preferential 5-HT$_{2A}$ agonist psilocybin on prepulse inhibition of startle in healthy human volunteers depend on interstimulus interval. Neuropsychopharmacology *32*: 1876-1887.
160. Vollenweider, FX, Geyer, MA (2001) A systems model of altered consciousness: integrating natural and drug-induced psychoses. Brain Res Bull *56*: 495-507.
161. Vollenweider, FX, Leenders, KL, Scharfetter, C, Maguire, P, Stadelmann, O, Angst, J (1997) Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. Neuropsychopharmacology *16*: 357-372.
162. Vollenweider, FX, Vollenweider-Scherpenhuyzen, MFI, Bäbler, A, Vogel, H, Hell, D (1998) Psilocybin induces schizophrenia-like psychosis in humans via serotonin-2 agonist action. Neuroreport *8*: 3897-3902.
163. Vollenweider, FX, Vontobel, P, Hell, D, Leenders, KL (1999) 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man - a PET study with [^{11}C]raclopride. Neuropsychopharmacology 20: 424-433.
164. Weil, A (2004) The Natural Mind: A Revolutionary Approach to the Drug Problem, Revised Edition. Boston, MA: Houghton Mifflin Co.
165. Winkelman, MJ, Roberts, TB (eds) (2007) Psychedelic Medicine: New Evidence for Hallucinogenic Substances as Treatments. Westport, CT: Praeger.
166. Wittmann, M, Carter, O, Hasler, F, Cahn, BR, Grimberg, U, Spring, P, *et al*. (2007) Effects of psilocybin on time perception and temporal control of behaviour in humans. J Psychopharmacol *21*: 50-64.
167. Wolbach, AB, Isbell, H, Miner, EJ (1962a) Cross tolerance between mescaline and LSD-25 with a comparison of the mescaline and LSD reactions. Psychopharmacologia *3*: 1-14.
168. Wolbach, AB, Miner, EJ, Isbell, H (1962b) Comparison of psilocin with psilocybin, mescaline and LSD-25. Psychopharmacologia *3*: 219-223.

The Contribution of the Psychology of Religion to the Therapeutic Use of the Psychedelic Substances

by

Walter N. Pahnke, M.D., PH.D*

* Resident Psychiatrist, Massachusetts Mental Health Center.

original source: http://www.psilosophy.info/resources/1967_Pahnke_2132_1.pdf

Table of Contents:

Introduction
Examination of the Claim that Psychedelic Drug Experience May Resemble Mystical Experience
Category I: Unity
Category II: Transcendence of Time and Space
Category III: Deeply Felt Positive Mood
Category IV: Sense of Sacredness
Category V: Objectivity and Reality
Category VI: Paradoxicality
Category VII: Alleged Ineffability
Category VIII: Transiency
Category IX: Persisting Positive Changes in Attitude and/or Behavior
Implications for Therapeutic Use
Discussion
Summary
Polemics

Introduction

There have been two major methods employed in the use of psychedelic or mind-opening drugs (LSD, psilocybin, and mescaline, to name the major ones) in order to obtain the maximal therapeutic effect in psychiatric patients. The first method involves a small dose technique (25 to 100 mcg of LSD) in weekly or bi-weekly sessions to facilitate the release of unconscious material and aid psychotherapy or group therapy. This method is the predominant one used by LSD therapists in Europe.

Sandison and Spencer[1] pioneered this method and are continuing their work which stresses abreaction. Spencer[2] has recently written a review of modifications. Ling and Buckman[3] in their book have outlined their technique and have given representative case histories. Martin[4, 5] has employed LSD in the framework of a psychoanalytic approach. Leuner[6, 7] in Germany has been a leader on the continent. Van Rhijn[8] and Hein[9, 10] have been continuing and expanding their interest in LSD therapy in Holland. In Belgium, Aguilar[11] has used psilocybin with in-patients who receive intensive supervision and psychotherapy before, during, and after drug sessions. Alhadeff[12] in Switzerland has also found psilocybin useful as an adjunct to psychotherapy. In Sweden, Kaij[13] has employed an LSD technique which is similar to that used by Sandison and Spencer in England. Alnaes[14] has compiled a bibliography of the Danish and Norwegian LSD literature. Although not so much work is currently in progress in the United States, there have been clinicians who have advocated a similar approach with some modifications in technique.[15, 16, 17, 18]

The second method involves a much smaller number of psychedelic drug sessions or even a single one, but at a higher dosage in order to produce an experience with such an overwhelming impact as to change radically the patient's view of the world and himself in a healthful and therapeutic manner. Descriptions of this method have been written by Chwelos and coworkers,[19] MacLean and coworkers,[20] and Sherwood and coworkers.[21] See also Unger's excellent review article[22] and his description of the English language literature.[23] The striking similarity of some of these drug experiences to the reports given by mystics from many varying cultures and epochs has led some investigators to consider the possible use of this kind of drug experience as an aid in psychotherapy. Research in the psychology of religion may be of value in illuminating the second approach. Data from such research will be presented as an example of this possibility.

Examination of the Claim that Psychedelic Drug Experience May Resemble Mystical Experience

There is a long and continuing history of the religious use of plants which contain psychedelic substances. Scholars such as Osmond,[24] Schultes,[25] and Wasson[26] have made valuable contributions to this intriguing field. In some instances, such natural products were ingested by a priest, shaman, or witch doctor to induce a trance for revelatory purposes; sometimes they were taken by groups of people who participated in sacred ceremonies. For example, the dried heads of the peyote cactus, whose chief active ingredient is mescaline, were used by the Aztecs at least as early as 300 B.C. and are currently being employed by over 50,000 Indians of the North American Native Church as a vital part of their religious ceremonies. Both *ololiuqui*, a variety of morning glory seed, and certain kinds of Mexican mushrooms (called *teonanacatl*, "flesh of the gods") were also used for divinatory and religious purposes by the Aztecs. These practices have continued to the present among remote Indian tribes in the mountains of Oaxaca Province in Mexico. Modern psychopharmacological research has shown the active chemicals to be psilocybin in the case of the mushrooms, and several compounds closely related to LSD in the case of *ololiugui*. *Amanita muscaria*, the mushroom which has been used for unknown centuries by Siberian shamans to induce religious trances, does not contain psilocybin. The most important psychologically active compound from this mushroom has not yet been isolated, but promising work is in progress. Other naturally occurring plants used by various South American Indian tribes in a religious manner for prophecy, divination, clairvoyance, and the tribal initiation of male adolescents, or sacred feasts, are cohoba snuff made from the pulverized seeds of *Piptadenia*, the drink, *vinho de Jurumens*, made from the seeds of *Mimosa hostilis*, and the drink, caapi, made from *Banisteriopsis*. These last three products contain various indolic compounds closely related to psilocybin, both structurally and in their psychic effects (bufotenine, dimethyltryptamine, harmine). Both LSD and psilocybin contain the indolic ring, and mescaline may be metabolized to an indole in the body.

An empirical study, designed to investigate in a systematic and scientific way the similarities and differences between experiences described by mystics and those induced by psychedelic drugs, was undertaken by the author.[27] First, a phenomenological typology of the mystical state of consciousness was carefully defined after a study of the writings of the mystics themselves and of scholars who have tried to characterize mystical experience. Then, some drug experiences were empirically studied, not by collecting such experiences wherever an interesting or striking one might be found and analyzed after the fact, but by conducting double-blind, controlled experiments with subjects whose religious background and experience, as well as personality, had been measured *before* their drug experiences. The preparation of the subjects, the setting under which the drug was administered, and the collection of data about the experience were made as uniform as possible. The experimenter himself devised the experiment, collected the data, and evaluated the results without ever having had an experience with any of these drugs.

A nine-category typology of the mystical state of consciousness was defined as a basis for measurement of the phenomena of the psychedelic drug experiences. Among the numerous scholars of mysticism, the work of W. T. Stace[20] was found to be the most helpful guide for the construction of this typology. His conclusion that in the mystical experience there are certain fundamental characteristics which are universal and not restricted to any particular religion or culture (although particular cultural, historical or religious conditions may influence both the interpretation and description of these basic phenomena) was taken as a presupposition. Whether or not the mystical experience is "religious" depends upon one's definition of religion and was not the problem investigated. Our typology defined the universal phenomena of the mystical experience, whether considered "religious" or not.

The nine categories of our phenomenological typology may be summarized as follows:

Category I: Unity

Unity, the most important characteristic of the mystical experience, is divided into internal and external types, which are different ways of experiencing an undifferentiated unity. The major difference is that the internal type finds unity through an "inner world" within the experiencer while the external type finds unity through the external world outside the experiencer.

The essential elements of internal unity are loss of usual sense impressions and loss of self without becoming unconscious. The multiplicity of usual external and internal sense impressions (including time and space) and the empirical ego or usual sense of individuality, fade or melt away while consciousness remains. In the most complete experience this consciousness is a pure awareness beyond empirical content, with no external or internal distinctions. In spite of the loss of sense impressions and dissolution of the usual personal identity or self, the awareness of oneness or unity is still experienced and remembered. One is not unconscious, but rather very much aware of an undifferentiated unity.

External unity is perceived outwardly with the physical senses through the external world. A sense of underlying oneness is felt behind the empirical multiplicity. The subject or observer feels that the usual separation between himself and an external object (inanimate or animate) is no longer present in a basic sense, yet the subject still knows that on another level, at the same time, he and the objects are separate. Another way of expressing this same phenomenon is that the essences of objects are experienced intuitively and felt to be the same at the deepest level. The subject feels a sense of oneness with these objects because he "sees" that at the most basic level all are part of the same undifferentiated unity. The capsule statement, "all is one," is a good summary of external unity. In the most complete experience, a cosmic dimension is felt so that the experiencer feels, in a deep sense, a part of everything that is.

Category II: Transcendence of Time and Space

This category refers to loss of the usual sense of time and space. This means clock time but may also be one's personal sense of his past, present, and future. Transcendence of space means that a person loses his usual orientation as to where he is during the experience in terms of the usual three-dimensional perception of his environment. Experiences of timelessness and spacelessness may also be described as an experience of "eternity" or "infinity."

Category III: Deeply Felt Positive Mood

The most universal elements (and, therefore, the ones which are most essential in the definition of this category) are joy, blessedness and peace. Their unique character in relation to the mystical experience is that their intensity marks them as being at the highest levels of the human experience of these feelings, and they are valued highly by the experiencers. Tears may be associated with any of these elements because of the overpowering nature of the experience. These feelings may occur at the peak of the experience or during the "ecstatic afterglow" when the peak has passed, but its effects and memory are still quite vivid and intense. Love may also be an element of deeply felt positive mood, but does not have the same universality as joy, blessedness, and peace.

Category IV: Sense of Sacredness

This category comprises the sense of sacredness which is evoked by the mystical experience. The sacred is here defined broadly as that which a person feels to be of special value and capable of being profaned. The basic characteristic of sacredness is a non-rational, intuitive, hushed, palpitant response of awe and wonder in the presence of inspiring realities. No religious "beliefs" or traditional theological terminology need necessarily be involved, even though a sense of reverence or a feeling that what is experienced is holy or divine may be included.

Category V: Objectivity and Reality

This category has two interrelated elements: (1) insightful knowledge or illumination felt at an intuitive, non-rational level, gained by direct experience, and (2) the authoritativeness of the experience, or the certainty that such knowledge is truly real, in contrast to the feeling that the experience is a subjective delusion. These two elements are connected because the knowledge through experience of ultimate reality (in the sense of being able to "know" and "see" what is really real) carries its own sense of certainty. The experience of "ultimate" reality is an awareness of another dimension not the same as "ordinary" reality (the reality of usual, everyday consciousness), yet the knowledge of "ultimate" reality is quite real to the experiencer. Such insightful knowledge does not necessarily mean an increase in facts, but rather intuitive illumination. What becomes "known" (rather than only intellectually assented to) is intuitively felt to be authoritative, requires no proof at a rational level, and has an inward feeling of objective truth. The content of this knowledge can be divided into two main types: (a) insights into being and existence in general, and (b) insights into one's personal, finite self.

Category VI: Paradoxicality

Accurate descriptions and even rational interpretations of the mystical experience tend to be logically contradictory when strictly analyzed. For example, in the experience of internal unity there is a loss of all empirical content in an *empty* unity which is at the same time *full* and complete. This loss includes the loss of the sense of self and dissolution of individuality, yet something individual remains to experience the unity. The "I" both exists and does not exist. Another example is the separateness from, yet at the same time unity with, objects in the experience of external unity (essentially a paradoxical transcendence of space).

Category VII: Alleged Ineffability

In spite of attempts to tell or write about the mystical experience, mystics insist that words fail to describe it adequately or that the experience is beyond words. Perhaps the reason is an embarrassment with language because of the paradoxical nature of the essential phenomena.

Category VIII: Transiency

Transiency refers to duration and means the temporariness of the mystical experience in contrast to the relative permanence of the level of usual experience. There is a transient appearance of the special and unusual levels or dimensions of consciousness which are defined by our typology, with eventual disappearance and return to the more usual. The characteristic of transiency indicates that the mystical state of consciousness is not sustained indefinitely.

Category IX: Persisting Positive Changes in Attitude and/or Behavior

Because our typology is of a healthful, life-enhancing mysticism, this category describes positive, lasting effects which are the result of the experience. These changes are divided into four groups: (1) toward self, (2) toward others, (3) toward life, and (4) toward the mystical experience itself.

(1) Increased integration of personality is the basic inward change in the personal self. Undesirable traits may be faced in a way that enables them to be dealt with and finally reduced or eliminated. Issuing from personal integration, the sense of one's inner authority may be strengthened, and the vigor and dynamic quality of a person's life may be increased; creativity and greater achievement efficiency may be released; there may be an inner optimistic tone with consequent increase in feelings of happiness, joy and peace. (2) Changes in attitude and behavior toward others include more sensitivity, more tolerance, more real love, and more authenticity as a person by being more open and more one's true self with others. (3) Changes toward life in a positive direction include philosophy of life, sense of values, sense of meaning and purpose, vocational commitment, need for service to others, and new appreciation for life or the whole of creation. Life may seem richer. The sense of reverence may be increased, and more time may be spent in devotional life and meditation. (4)

Positive change toward the experience means that it is regarded as valuable and that what has been learned is thought to be useful. The experience is remembered as a high point, and an attempt is made to recapture the experience, or if possible, to gain new experiences as a source of growth and strength; mystical experiences of others are better appreciated and understood.

The purpose of the experiment in which psilocybin was administered in a religious context was to gather empirical data about the state of consciousness experienced. In a private chapel on Good Friday, twenty Christian theological students, ten of whom had been given psilocybin one and one-half hours earlier, listened over loud speakers to a two and one half hour religious service which was in actual progress in another part of the building, and which consisted of organ music, four solos, readings, prayers, and personal meditation. The assumption was made that for experiences most likely to be mystical, the atmosphere should be broadly comparable to that achieved by tribes who actually use natural psychedelic substances in religious ceremonies. The particular content and procedure of the ceremony had to be applicable (familiar and meaningful) to the participants. Attitude toward the experience, both before and during, was taken into serious consideration in the experimental design. Preparation was meant to maximize positive expectation, trust, confidence, and reduction of fear. Setting was planned to utilize this preparation through group support and rapport, friendship, an open and trusting atmosphere, and prior knowledge of the procedure of the experiment in order to eliminate, if possible, feelings of manipulation which might arise.

In the weeks before the experiment, each subject participated in five hours of various preparation and screening procedures which included psychological tests, medical history, physical examination, questionnaire evaluation of previous religious experience, intensive interview, and group interaction. The twenty subjects were graduate-student volunteers, all from a middle-class Protestant background and from one denominational seminary in the free-church tradition. None of them had ever taken psilocybin or related substances before this experiment. The volunteers were divided into five groups of four students each on the basis of compatibility and friendship. Two leaders who knew from past experience the positive and negative possibilities of the psilocybin reaction met with their groups to encourage trust, confidence, group support, and fear reduction. The method of reaction to the experience was emphasized (to relax and cooperate with, rather than to fight against, the effects of the drug). Throughout the preparation, an effort was made not to suggest the characteristics of the typology of mysticism. The leaders were not familiar with the typology which had been devised.

Double-blind technique was employed in the experiment so that neither the experimenter nor any of the participants (leaders or subjects) knew the specific contents of the capsules which were identical in appearance. Half of the subjects and one of the leaders in each group received 30 mg of psilocybin. Without prior knowledge of the effects, the remaining subjects and the other leader received 200 mg of nicotinic acid, a vitamin which causes transient feelings of warmth and tingling of the skin, in order to maximize suggestion for the control group.

Data were collected during the experiment and at various times up to six months afterwards. On the experimental day, tape recordings were made both of individual reactions immediately after the religious service and of the group discussions which followed. Each subject wrote an account of his experience as soon after the experiment as was convenient. Within a week all subjects had completed a 147-item questionnaire, designed to measure the various phenomena of the typology of mysticism on a qualitative numerical scale. The results of this questionnaire were used as the basis for a one and one half hour, tape-recorded interview which immediately followed. Sixth months later, each subject was interviewed again, after completion of a follow-up questionnaire in three parts with a similar scale. Part I was open-ended; the participant was asked to list any changes which he felt were a result of his Good Friday experience and to rate the degree of benefit or harm of each change. Part II (52 items) was a condensed and somewhat more explicit repetition of items from the post-drug questionnaire. Part III (93 items) was designed to measure both positive and negative attitudinal and behavioral changes which had lasted for six months and were due to the experience. The individual descriptive accounts and Part I of the follow-up questionnaire were content-analyzed with a qualitative, numerical scale by judges who were independent from the experiment and knew only that they were to analyze twenty accounts written by persons who had attended a religious service.

Prior to the experiment, the twenty subjects had been matched into ten pairs on the basis of data from the pre-drug questionnaires, interviews, and psychological tests. Past religious experience, religious background, and general psychological make-up were used for the pairings in that order of importance. The experiment was designed so that by random distribution one subject from each pair received psilocybin and one received the control substance, nicotinic acid. This division into an experimental and control group was for the purpose of statistical evaluation of the scores from each of the three methods of measurements which used a numerical scale: the post-drug questionnaire, the follow-up questionnaire, and the content analysis of the written accounts.

A summary of percentage scores and significance levels reached by the ten experimentals and ten controls for each category or subcategory of the typology of mysticism, is presented in Table 1.

The score from each of the three methods of measurement was calculated as the percentage of the maximum possible score if the top of the rating scale for each item had been scored. The percentages from each method of measurement were then averaged together. A comparison of the scores of the experimental and control subject in each pair was used to calculate the significance level of the differences observed by means of the non-parametric Sign Test. As can be seen from Table 1, for the combined scores from the three methods of measurement, *p* was less than .020 in all categories except deeply felt positive mood (love) and persisting positive changes in attitude and behavior toward the experience where *p* was still less than .055.

Table 1
Summary of percentage scores and significance levels reached by the experimental versus the control group for categories measuring the typology of mystical experience.

% of Maximum Possible	***Category Score for 10 Ss***		
	Exp	**Cont**	***p* <**
I. *Unity*	62	7	.001
A. Internal	70	8	.001
B. External	38	2	.008
II. *Transcendence of time and place*	84	6	.001
III. *Deeply felt positive mood*	57	23	.020
A. Joy, blessedness and peace	51	13	.020
B. Love	57	33	.055
IV. *Sacredness*	53	28	.020
V. *Objectivity and Reality*	63	18	.011
VI. *Paradoxicality*	61	13	.001
VII. *Alleged ineffability*	66	18	.001
VIII. *Transiency*	79	8	.001
IX. *Persisting positive changes in attitude and behavior*	51	8	.001
A. Toward self	57	3	.001
B. Toward others	40	20	.002
C. Toward life	54	6	.011
D. Toward the experience	57	31	.055

Although this evidence indicates that the experimentals as a group experienced, to a statistically significant degree, a higher score in each of the nine categories than did the controls, the degree of completeness or intensity must be examined.

In terms of our typology of mysticism, ideally the most "complete" mystical experience should have demonstrated the phenomena of all the categories in a maximal way. The evidence (particularly from the content analysis and also supported by impressions from the interviews) showed that such perfect completeness in all categories was not experienced by all the subjects in the experimental group. In the data the various categories and subcategories can be divided into three groups in regard to the degree of intensity or completeness as shown in Table 2.

Table 2
Relative completeness* of various categories in which there was a statistically significant difference between experimental and control groups

(a) Closest approximation to the most complete and intense expression.	(b) Almost, but not quite as complete or intense as (a).	(c) Least complete or intense, though still a definite difference from the control group.
Internal unity	External unity	Sense of sacredness
Transcendence of time and space	Objectivity and reality	Deeply felt positive mood (love)
Transiency	Alleged ineffability	Persisting positive changes in attitude and behavior toward others and the experience.
Paradoxicality	Deeply felt positive mood (joy, blessedness, and peace)	
Persisting positive changes in attitude and behavior toward self and life.		

* Based on qualitative score levels and agreement among the three methods of measurement.

Criteria were the percentage levels and the consistency among different methods of measurement. The closest approximation to a complete and intense degree of experience was found for the categories of internal unity, transcendence of time and space, transiency, paradoxicality, and persisting positive changes in attitude and behavior toward self and life. The evidence indicated that the second group had almost but not quite the same degree of completeness or intensity as the first group. The second group consisted of external unity, objectivity and reality, joy, and alleged ineffability. There was a relatively greater lack of completeness for sense of sacredness, love, and persisting positive changes in attitude and behavior toward others and toward the experience. Each of these last eight categories or subcategories was termed incomplete to a greater or less degree for the experimentals, but was definitely present to some extent when compared with the controls. When analyzed most rigorously and measured against all possible categories of the typology of mysticism, the experience of the experimental subjects was considered incomplete in this strictest sense. Usually such incompleteness was caused by results of the content analyses.

The control subjects did not experience many phenomena of the mystical typology, and even then only to a low degree of completeness. The phenomena for which the scores of the controls were closest to (although still always less than) the experimentals were: blessedness and peace, sense of sacredness, love, and persisting positive change in attitude and behavior toward others and toward the experience.

The meaningful religious setting of the experiment would have been expected to have encouraged a response of blessedness, peace, and sacredness. In the case of love and persisting changes toward others and toward the experience, observation by the controls of the profound experience of the experimentals and interaction between the two groups on an interpersonal level appeared, from both post-experimental interviews, to have been the main basis for the controls' experience of these phenomena.

The experience of the experimental subjects was certainly more like mystical experience than that of the controls who had the same expectation and suggestion from the preparation and setting. The most striking difference between the experimentals and controls was the ingestion of thirty mg of psilocybin which, it was concluded, was the facilitating agent responsible for the difference in phenomena experienced.

After an admittedly short follow-up period of only six months, life enhancing and life-enriching effects, similar to some of those claimed by mystics, were shown by the higher scores of the experimental subjects when compared to the controls. In addition, after four hours of follow-up interviews with each subject, the experimenter was left with the impression that the experience had made a profound impact (especially in terms of religious feeling and thinking) on the lives of eight out of ten of the subjects who had been given psilocybin. Although the psilocybin experience was unique and different from the "ordinary" reality of their everyday lives, these subjects felt that this experience had motivated them to appreciate more deeply the meaning of their lives; gain more depth and authenticity in ordinary living; and rethink their philosophies of life and values. The data did not suggest that any "ultimate" reality encountered had made "ordinary" reality no longer important or meaningful. The fact that the experience took place in the context of a worship service, whose symbols were familiar and meaningful to the participants, appeared to provide a useful framework within which to derive meaning and integration from the experience, both at the time and later.

The relationship and relative importance of psychological preparation, setting, and drug were important questions raised by our results. A meaningful religious preparation, expectation, and environment appeared to be conducive to positive drug experiences, although the precise qualitative and quantitative role of each factor was not determined. For example, everything possible was done to maximize suggestion, but suggestion alone cannot account for the results because of the different experience of the control group. The hypothesis that suggestibility was heightened by psilocybin could not be ruled out on the basis of our experiment. An effort was made to avoid suggesting the phenomena of the typology of mysticism, and the service itself made no such direct suggestion.

Implications for Therapeutic Use

The data presented above suggests that indeed the basic psychological characteristics of the mystical experience can be facilitated and studied by the use of psychedelic drugs. The most important therapeutic implication is suggested by the ninth category, persisting positive changes in attitude and behavior, which were measured after six months. Although normal subjects were used and the changes measured were not removal of symptoms, the direction of change was toward more integrated, self-actualizing attitudes and behavior in life. Although the mystical experience has been called by many names - psychedelic, conversion, transcendental, peak, or one of cosmic consciousness - this realm of human experience should not be rejected as outside the realm of serious scientific study if it can be shown that a practical benefit can result. This can be tested. Our data would indicate that such an overwhelming experience, in which a person existentially encounters basic values such as the meaning of his life (past, present, and future), deep and meaningful interpersonal relationships and insight into the possibility of personal behavior change, can be therapeutic if approached and worked with in a sensitive and adequate way.

First, what have we learned about the best way to facilitate the mystical experience out of the variety of forms which a psychedelic drug experience may take? Preparation would seem to be very important. Who the patient is must be considered. In a sense, his whole life has been part of his psychological preparation, but the nature of his expectations, fears, etc., at the time of his drug session, may radically determine the direction his reaction takes. (The more the patient can trust his doctor the better his chances for a beneficial experience.) The establishment of a firm and trustful therapeutic relationship is essential, as in any productive psychotherapy.

The therapist or person who will be present or easily available at all times during the drug session should carefully plan the procedure with the patient in advance. Special attention should be paid to the environment in which the drug is given and to the stimuli to be introduced during the session. Beautiful surroundings are in general beneficial, but the setting must be adapted to the individual patient. An orthodox religious setting, while helpful to deeply religious persons such as ministers or theological students, might detract from the most meaningful experience of someone else. Music which intuitively appeals to the individual can be helpful, in general, smooth, peaceful, and majestic music is best (Brahms' *Requiem*, or other classical music, especially with a chorus of human voices). Flowers, candlelight, and beautiful objects may also be used to set a general feeling-tone of peace and trust; confusion and unexpected stimuli definitely should be avoided.

The dosage level and route of administration also profoundly affect the kind of drug experience obtained. There are many interesting effects (such as visual changes and hallucinations) from psychedelic drugs even at low dosages, but the mystical type of experience appears to be best facilitated by the higher doses. Perhaps more of the drug is needed to make material available from the deeper levels of the unconscious. The very powerfulness of the experience helps patients, with proper preparation and encouragement, to go along more easily with the drug effects and not waste psychic energy fighting or resisting the drug. Certainly there is a dose-related effect in regard to the level of consciousness reached with sodium amytal interviews or general anesthesia. An adequate dose of LSD would be 4 mcg/kg; for psilocybin, .6 mg/kg; and for mescaline, 10 mg/kg. The speed of onset of action of the drug may influence the kind of experience, perhaps because of the effect of surprise with a sudden overwhelming of resistance. This is especially true of I.M. psilocybin which acts in a powerful manner within two minutes after injection. It is interesting that I.M. mescaline and LSD do not have this immediate kind of action. In the case of LSD, the I.M. route takes almost as long to act as the oral (about 30 minutes). The duration of action may be of importance; there is less time in the drug reaction with psilocybin (4-5 hours) than with LSD (8-10 hours) or mescaline (10-12 hours); this may be an advantage or disadvantage, depending on the time available. If the patient has a mystical experience, it is generally most beneficial for the work of integration to let the reaction run its course without interruption by barbiturates or chlorpromazine, which are used sometimes routinely to terminate the effect after a predetermined time. The positive mystical experience can generate an afterglow effect which can be very rewarding.

Secondly, what are the most effective ways in which to aid the therapeutic work of integration? Adequate time should be provided by the patient to work through the experience. The next day should be quiet, peaceful, and free from the duties and responsibilities of normal routine activities, so that the patient can think about and work on what was learned. The patient should be encouraged to put into words or pictures the significant parts of his experience.

Any therapist who wants to use psychedelic drugs should be trained under the supervision of those who are skilled in the administration of these drugs. If the therapist has not taken the drug himself, he should familiarize himself with the possible effects by talking to many patients who have had the experience and by sitting with and observing patients who are undergoing the treatment. This helps by making the therapist sensitive to the areas of content which may be brought into awareness by the drug experience. His own frame of reference will undoubtedly influence the interpretation and even the content of his patient's experiences through suggestion.

If the therapist is sensitive and familiar with the characteristics of the mystical experience, he can be of more help in making therapeutic use of the insights gained from such an experience. His emphasis should be on integration and application of the experience to everyday life. A danger can be that the patient may tend to view the experience as so much of another reality that it may seem a pleasant escape from his problems. The therapist can work against this possibility in the preparation before, in the support given during, and in the work of integration after the session.

If more than one patient has a session on the same day, even if the sessions are separate a group discussion and sharing after the drug effects are over serve to illuminate the meaning of the various experiences and to provide an effective means of group therapy; communication, closeness, and group solidarity are enhanced to a striking degree. Group therapy can supplement the individual therapy which is needed to help integrate the experience over a longer period of time.

Thirdly, what are the frequency and number of sessions needed when mystical experiences occur? It has been observed that the patients themselves are reluctant to repeat a mystical experience too soon; perhaps this is because of the characteristic of sacredness. The release of a large amount of unconscious material no doubt needs time to be adequately integrated. The hope is that relatively fewer large-dose drug sessions would be needed to accomplish the same result as the more frequent and numerous low-dose multiple sessions. By the very nature of the impact of mystical experience, more time would be needed between sessions for the work of integration. The possibility arises that such sessions might be most useful at selected points during regular therapy when progress was blocked, but certainly only after a strong relationship of trust had been established.

Discussion

These three questions - the best way to facilitate the mystical experience; the most effective means by which to aid the therapeutic work of integration; the optimal number and frequency of sessions - all can be tested experimentally. They are all facets of a much more basic question: can the mystical experience be therapeutic? Much research needs to be done in this area and perhaps the place to do it would be at a center where the best insights and trained personnel are available from psychiatry, clinical psychology and religion. An in-patient facility would be essential so that patients could be adequately prepared and then observed and helped afterwards as necessary. Screening could be done by medical history, psychiatric interview, and psychological testing; religious background and experience may also be an important variable and should not be ignored.

Theoretically there should be no reason why a patient could not be referred to such a specialized center for intermittent psychedelic drug sessions. The therapist might want to be present during the session but, if not, he could use the material obtained in his ongoing therapy with the patient. The therapist's attitude toward the treatment would play a crucial role not only in the patient's expectation and preparation for the treatment but also in the kind of experience obtained. Whether such an arrangement would work out satisfactorily could be tested experimentally.

Not all types of patients may do well if mystical experiences are facilitated through the use of the high-dose technique. For some, the small-dose, multiple-session method may be better. Research is needed to answer this question as well.

With such powerful agents, the possible dangers must never be forgotten. As with any potentially pleasant experience, psychological habituation is possible. The possible deleterious effects from continual use over a long period of time are not known. This consideration would argue in favor of fewer treatments of maximal effectiveness and impact. If the supply of these drugs is administrated only through psychiatrists trained in their use, the danger of habitual use is minimized. Pre-psychotic or borderline individuals with weak ego-structure may be disintegrated and become prolongedly psychotic if given these drugs; proper screening should eliminate such patients. Most psychotic episodes evoked by these drugs are temporary; the incidence and severity of such reactions can be reduced by proper preparation before and handling during a drug session.

Summary

Data were presented to show that psychedelic drug experience can be very similar to if not identical with the experiences described by mystics. A nine-category typology of mystical experience was defined and a double-blind controlled experiment was described in which normal subjects were given psilocybin in a supportive, religiously meaningful setting. The experiences of the experimental subjects were more like the mystical typology than those of the controls at a significance level well below expectation. The therapeutic implications of this kind of psychedelic drug experience were discussed in regard to the best way to facilitate mystical experience, the most effective means by which to aid the work of integration, and the optimal number and frequency of sessions. The challenging possibilities of future research in this area were suggested, and the possible dangers mentioned.

Polemics

Dr. Osmond: Dr. Pahnke, I want first to congratulate you upon your contribution. Then I want to make one very serious criticism and one minor criticism. The serious criticism is this: looking through the bibliography and seeing your Alma Mater, I see with great sorrow that the name of the greatest American psychologist who contributed most heavily to this field, and the man who introduced Freud to this country, has been omitted; and I do urge that this should be repaired. I don't think that a paper on this subject should appear, especially a good paper and a paper with such fascinating data, without William James's name being attached to it. That is, James would have delighted in this. He was at Harvard; I am certain he would have participated in this conference, and he would have been one of the first to do so. As you know, it was unfortunate that his weak stomach prevented him from enjoying peyote, and this was the only reason that he did not himself undertake this work; and I hope that you will repair this. Now, the next thing, regarding the idea of the one-shot experience: I think this is a mistake, although perhaps to some extent I may have been partly responsible for this. The actual evidence from the whole mystical literature, from which some of this is derived, was the fact that the idea was, as Aldous Huxley pointed out, that it is a free grace, as it were, for which you are then expected to do some work. You might say it is insight bought on the hire-purchase system, but you are expected to do something afterwards; and I'm sure that this has really been in everyone's mind. But I do hope that you will take my only serious criticism to heart, because I think it would be a great shame if James's name were not there.

Dr. Pahnke: I would agree one hundred percent with all of your comments. This work formed the basis for my Ph.D. thesis at Harvard, and in my thesis I give James full due. You probably agree no more strongly than I do with James, but I didn't want to include all my references to the mystical literature and to those scholars who have been interested in mysticism. I perhaps relied more heavily on Stace than on James.

Dr. Eisner: I think it's a beautiful job, and I'm particularly glad to see you break down the different categories, because it helps me; it helps resolve in my mind something that's bothered me. That's the invalid or pseudo-mystic or pseudo-cosmic experience. There are a couple of people who use LSD in Los Angeles, and when they first started using it, all of us in the area used to meet together for staff meetings. I would sit there with open mouth and hear how everyone and his patients were having the cosmic experience every time they had LSD. I couldn't figure it out. But their patients didn't change; this was the thing! And then they started telling me the way they would invoke these experiences by tricks and gimmicks. They might have them imagine they were in Belsen, and there were S.S. guards and their bodies were being destroyed by the flames. Then it would put them into a kind of cosmic state. I couldn't then understand why; but I see now, here, that this change in behavior is a very important variable to add to the mystic experience.

Dr. Baker: Could I ask about the terminology? I guess the people were given the material double-blind. But as the experience went on and as the follow-up goes on, it is no longer double-blind, is it? We don't want to make a mistake.

Dr. Pahnke: It was double-blind as far as is possible, but probably more blind from the standpoint of the subjects rather than the experimenter. I think we all know, and anyone who has worked with these drugs knows, that it is very difficult to keep fooling yourself once the drug reaction starts. The subjects were not ever told, though, and in the six-month follow-up, even at the one-week follow-up, many of them said, "I want to talk about what I think I had," and I said, "I don't want to hear about it," and kept it that way. But my own guesses all turned out to be right, and the subjects were all one hundred percent right as well.

Dr. Cohen: I'd like to hear again what instruction or statement you made to the subjects, for giving them the drug before the service.

Dr. Pahnke: These subjects were all males; they were between the ages of twenty-one and thirty-five; most of them were first-year theological students; we recruited them at one particular seminary. We had one group meeting initially with all the subjects and gave them the California Psychological Inventory and a questionnaire which measured past religious experience and background. These data were used to match the twenty subjects into ten matched pairs, but the subjects did not know about any of this. They were told only that they would have the chance to participate in an experience in which we were going to give them psilocybin, so they did know what drug they were going to get. They were also told that some of them would not get psilocybin. This was to decrease any sense of suspicion, distrust, and experimental manipulation which might have led to paranoid reactions, and also provide a more uniform expectation. I wasn't at all sure that it was even possible to facilitate the mystical experience, but I was doing everything I could to try to get it. Then there were two more meetings: one, an individual meeting with me when I took a medical history, gave each one a physical exam, and talked in more detail about his past religious experience; there was also a meeting in groups of four with their two guides, to give them a feeling of group solidarity for extra support. The main thing told to them at that time was what I have already indicated, about trusting, not being afraid, and surrendering, but the experience itself was not described.

Dr. Cohen: So the expectation was that they would receive psilocybin, a name with which they had some familiarity.

Dr. Pahnke: This was in 1962, and at that time there had not been the mass sensationalism and publicity that later emerged. Most of the subjects had not heard much about either LSD or psilocybin.

Dr. Cohen: Were there any adverse effects in the control group, great disappointment or whatever?

Dr. Pahnke: These were people who all wanted to have the psychedelic experience, so I told them at the time of recruiting that the control group, six months later, after the study was over, would be able to have the experience. This decreased the disappointment at the time of the experiment, but in the meantime there was much upheaval at Harvard, as I guess you all know, and I was not able to continue. Therefore, I could not offer the experience after the six-month follow-up. Then there was much disappointment; I was sorry about this.

Dr. Hoffer: I just wanted to ask Dr. Pahnke if he is ready to let me have his mystical experience questionnaire.

I'd like to use it on all my patients.

Dr. Pahnke: Yes, I'd be glad to. I have extra copies, and it's also in my thesis, which is on file at the Widener Library at Harvard University.

Dr. Savage: Do you think that this experience makes a better or worse minister? Do people give up the ministry? Or do they become more devoted, or do they stay about the same as they were before? Would you hazard a guess on that?

Dr. Pahnke: My guess is that the people who stay in the ministry would become better ministers if they have the drug reaction under conditions which allow for having a positive experience. Now, let me tell you what happened. I have done follow-up studies on these people to see what's happened to them in the intervening three years. At the time of the experiment, one boy from Georgia who came from a very fundamentalistic background was struggling with himself over whether he should go into the ministry, whether he should stick it out; he had just about decided to leave the seminary. After this experience he realized that he did have a deep interest in religion, and that he did want to go on and get his B.D. degree. This enthusiasm carried into the next fall, but at that time he again reconsidered and decided to drop out of the seminary. After one year he went back and got a master's degree at the same seminary and is now the assistant dean of a college in the South, doing religious counseling, and feels that he's much happier with this. So he feels that the experience helped him to get his bearings and to do what he really wanted. One person in the control group and two persons in the experimental group left the seminary before the end of training. This is not a statistically significant difference.

Dr. Ketchum: In view of the outstanding way in which this experiment was designed and carried out, and the seemingly highly useful nature of the results, I'd be interested now in hearing comments from the people who stated that controlled or double-blind experiments were, in general, not necessary or not useful.

Dr. Abramson: Psychotherapy was not involved.

Dr. Fremont-Smith: You're asking for comments from others. I regret that this must remain the only comment from others; we've got to go back to the discussion of this paper.

Dr. Unger: This is not an answer, but I think there has been a somewhat irrational bias that has reverberated throughout this meeting. But that's because most of the people here are involved in and pressured by clinical responsibilities and duties, whereas Dr. Pahnke was not. He was doing a piece of research, patient research that took time and opportunity. I don't think that there is a fundamental conflict that can't be resolved; I think, though, that many people who are involved in clinical work should be made aware of the necessity and the desirability of doing certain systematically controlled research, and not feel that we should come to the point where we consider it impossible to carry it out, because that's where much criticism of LSD research arises. Careful, controlled experiments are possible, but they involve the availability of enough time, proper facilities, and adequate training. Otherwise, such studies just cannot be done.

Dr. Pahnke: I might add that I did have full time to do this, and it took me a year and a half of solid effort to perform the experiment, analyze the results, and write it all up, because I had to do it all myself. I didn't have a grant, and it is time-consuming.

Dr. Rinkel: Professor Houston Smith of the Massachusetts Institute of Technology made a comment something like this: drugs appear able to induce religious experience. It is less evident that they can produce religious lives; but, although religion cannot be equated with religious experience, neither can it long survive its absence.

Dr. Pahnke: In my experiment, it was a very helpful thing that these students had a framework from which they came and to which they returned. They used their religious background as a way of interpreting the experience and utilizing the insights. I think the fact that they were going into religion professionally was a great help to them for integrating the experience in a useful way.

Dr. Ling: I'd like to ask the speaker to what extent this was a fair sample. You say it's a sample, you think, of the average religious student, but at the same time they volunteered for this. You do not think, perhaps, that volunteers are self-selective, and that's why they volunteered to answer their own problems? And, secondly, you stated that in order to get this experience you must produce a background that is symbolic and significant. Clearly a church is significant for a group of religious students, but would this carryover to, say, a law court, and how would it apply to an ordinary group of students?

Dr. Pahnke: This is the kind of experiment that would be useful to do in the future. Take a comparable group of people who are not professionally religious or even particularly interested in religion and give them the drug in a uniform setting. Another factor in the set could be controlled by comparing this group with another group of theological students or ministers. Then we could see whether both groups get the same experience. Now, the first point about the students being volunteers was true - they all volunteered. But remember, they were matched, and then randomly assigned to control group or experimental group, so I would assume that a fairly comparable population was assigned to the experimental and control group.

Dr. Ling: The only point I raised was that I have a counter-belief that volunteers volunteer for unconscious reasons.

Dr. Pahnke: Well, that may be so, but what I was trying to prove was whether it was possible to facilitate this experience or not, and in the control group these categories definitely were not present; in the experimental group they were. That was all I was trying to prove.

Dr. Dahlberg: Youmight have just answered my question, but I was wondering whether there were any of the people in the control group who did get the religious experience, perhaps through suggestion or influence by the people around them.

Dr. Pahnke: Suggestion was the same for both through preparation and during the experiment. Then, as I pointed out, when I analyzed the data with the three methods separately, the content analysis showed no significant difference in the sense of sacredness. You might expect this, because, in the control group, these people were ministers, too; they were in a Good Friday service; and they did have a higher score on sacredness than any other category for the control group, but they didn't have things, for example, like unity, or transcendence of time and space, or as intensive an experience of deeply felt mood as did the experimental group.

Dr. Dahlberg: I'm not talking about statistics now, I just wondered

Dr. Fremont-Smith: Did any of them have the experience, in the control group?

Dr. Pahnke: If you want to look at it that way, first you have to decide how many of the categories are to be considered necessary to the mystical experience.

Dr. Fremont-Smith: What's your definition of the experience, then? It's got to have the unity, and so forth?

Dr. Pahnke: Well, in order to decide which group had an experience which was more mystical, you must look at the statistics. You must compare one group against another, and you see whether by categories they have statistically-significant higher scores, one group or the other. Now if you want to break it down another way and consider subjects primarily, rather than categories, eight out of ten of the experimental subjects experienced at least seven out of nine of the categories. None of the control group, when each individual was compared to his matched partner, had a score which was higher; but some of the control group had scores which came up high enough to make the results not significantly different for some categories. Such statements really are not too significant unless you use groups of subjects compared statistically.

Dr. Fremont-Smith: Well, then, to the crude question, semi-crude question asked, whether any of the control group would be considered as having had -

Dr. Pahnke: Then you have to think about how high a score for each category you have to have in order to consider an experience mystical. If you look at Table 1, you will see, for each group, the percentage of the maximum possible for each score category. You can see what the control group score is and what the experimental group score is.

Dr. Fremont-Smith: Can we pull you away from the tables?

Dr. Pahnke: To take an individual case, there was one control subject who scored fairly high on sacredness and sense of peace and that...

Dr. Fremont-Smith: Did he think he'd had an unusual or...

Dr. Pahnke: ... And he himself, in his written account, said, "It was a very meaningful experience, but in the past I've certainly had one that was much more so."

Dr. Fox: The book by Maslow, called "The Psychology of Being," describes the transcendental experience as occurring without any drugs at all and, of course, he quotes James. It is what Freud called the oceanic experience. I have this quite often reported by my patients, particularly the artistic kind of person, and many of them use just the same phrases that you've been using. I know that, although such an experience may occur only once in a lifetime, it really is extremely important to that particular individual; he feels it with great conviction.

Dr. Pahnke: In a personal conversation with Professor Maslow, he said that he is, frankly, much more interested in these experiences at the lower level of the continuum. He said that spontaneously occurring peak mystical experiences certainly exist, but that they are so rare that he does not really find too many of them. He has studied mostly the ones that are still on the continuum, but at the lower end, like the woman who, during childbirth, has an ecstatic experience. I think I have demonstrated that, with psilocybin, it is possible to study the more rare, mystical experiences under controlled conditions.

Dr. Abramson: I would just like to return to the question of the double-blind procedure to amplify what I mentioned in connection with Dr. Unger's position. Major Ketchum, I think, thought that some of us here opposed controlled experiments, double-blind experiments, and the usual scientific procedures. I don't think that's true. I think what was meant by Dr. Fremont-Smith and myself and several others is that there are certain systems which are inherently incapable at present, because of poor methodology, of exploring with double-blind procedure. To reduce it to an absurd example, let's take one of Bridgman's problems: if you were to measure the distance from here to the moon by the velocity of light and by a yardstick, would the two agree? Well, you just can't do it, and I just don't think you can set up double-blind, controlled systems, if you're psychoanalyzing a patient. We just don't want to see poor methodology applied to systems where it cannot be applied. For example, I felt like attacking, just for the fun of it, the MMPI. And I've used that test for many years and published a few papers on it. When I started to use it, it was looked upon as a most disreputable test, because it was not projective. Now it suddenly has become so respectable that nearly everybody accepts it here. And I'm wondering why has this non-projective test suddenly assumed the cloak of respectability? Is it because it lends numerical elegance to physicians without clinical acumen? So, please bear with the clinician, as there are systems where you can't use the double-blind technique or the controls. Within-subject studies are certainly significant and cannot be avoided. Certainly in my work on normal test subjects I've done nothing but use single-blind and double-blind techniques, as well as everything possible, such as repeated placebo studies, to make certain I wasn't getting hysterical reactions. But in psychoanalyzing the patient, at present, unless one uses within-subject data, the data are inherently incapable of being tested.

Dr. Fremont-Smith: Could I add one phrase? And that is, it's not the question of applying poor scientific method to a difficult problem; it's a question of applying a good scientific method to a problem which is not appropriate to this method.

Dr. Ketchum: Well, I'd like to say that I'm glad Dr. Abramson and Dr. Fremont-Smith made these remarks. Actually, in a sense, I suppose I was playing devil's advocate because I do believe that double-blind procedures are either totally impossible or inappropriate to most of the problems under discussion. But I wanted this brought out because I think most of the people here feel the same way.

Dr. Fremont-Smith: Thank you very much. Now, Dr. Pahnke, would you like to close?

Dr. Pahnke: I feel that this area of psychology and religion is an area for serious scientific study, especially with these drugs. I feel that my experiment was only a first step. Who knows what the implications might be just for the one discipline that was mentioned - the training of ministers? I think this is an area where we need the best brains and insights and sensitivity not only from psychiatrists, but also from philosophers, theologians, and psychologists. I think that in doing further work, the various factors can be isolated and tested for their influence - for example, factors of set, setting, preparation, expectation and, last but not least, experimenter bias. I think these things can be done with carefully controlled studies; if they're not double-blind, at least they should have some kind of controlled comparison group, as Dr. Levine mentioned yesterday. I'd like to say that, in one sense, I agree with Dr. van Rhijn in his point that perhaps we should keep moving ahead to gain clinical experience with a drug which seems to show therapeutic promise in difficult cases, and not be stopped by the lack of double-blind studies; but on my trip to Europe last year, when I visited most of the centers where LSD is being given, I was struck by the lack of control groups of any kind in Europe. They do have control groups in the sense that a patient can be his own control, but you can never be sure that these patients might not have gotten better spontaneously. Now I think my paper has been an introduction to the paper to follow, because the work that has been going on at Spring Grove State Hospital is an effort to try to work with the psychedelic, mystical experience in alcoholics and utilize the positive implications of this experience.

Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population

by

Peter S Hendricks[1], Christopher B Thorne[1], C Brendan Clark[2], David W Coombs[1] and Matthew W Johnson[3]

Journal of Psychopharmacology 1-9

© The Author(s) 2015

original report:
http://www.ouramazingworld.org/uploads/4/3/8/6/43860587/2015-hendricks-classic_psychedelic_use_is_associated_with_reduced_psychological_distress_and_suicidality_in_the_united_states_adult_population.pdf
backup source:
http://www.psilosophy.info/resources/2015-hendricks-classic_psychedelic_use_is_associated_with_reduced_psychological_distress_and_suicidality_in_the_united_states_adult_population.pdf

1. Department of Health Behavior, University of Alabama at Birmingham, Birmingham, AL, USA
2. Department of Psychiatry and Behavioral Neurobiology, University of Alabama at Birmingham, Birmingham, AL, USA
3. Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Corresponding author:
Peter S Hendricks, 227L Ryals Public Health Building, 1665 University
Blvd., Birmingham, AL 35294, USA.
Email: phendricks@uab.edu

Table of Contents:

Abstract
Introduction
Methods
 Data analysis
Results
Discussion
Conclusion
Acknowledgements
References

Abstract

Mental health problems are endemic across the globe, and suicide, a strong corollary of poor mental health, is a leading cause of death. Classic psychedelic use may occasion lasting improvements in mental health, but the effects of classic psychedelic use on suicidality are unknown. We evaluated the relationships of classic psychedelic use with psychological distress and suicidality among over 190,000 USA adult respondents pooled from the last five available years of the National Survey on Drug Use and Health (2008-2012) while controlling for a range of covariates. Lifetime classic psychedelic use was associated with a significantly reduced odds of past month psychological distress (weighted odds ratio (OR)=0.81 (0.72-0.91)), past year suicidal thinking (weighted OR=0.86 (0.78-0.94)), past year suicidal planning (weighted OR=0.71 (0.54-0.94)), and past year suicide attempt (weighted OR=0.64 (0.46-0.89)), whereas lifetime illicit use of other drugs was largely associated with an increased likelihood of these outcomes. These findings indicate that classic psychedelics may hold promise in the prevention of suicide, supporting the view that classic psychedelics' most highly restricted legal status should be reconsidered to facilitate scientific study, and suggesting that more extensive clinical research with classic psychedelics is warranted.

Keywords: Psychedelic, hallucinogen, lysergic acid diethylamide, psilocybin, mescaline, mental health, suicide, prevention

Introduction

Almost half of a billion people worldwide suffer from mental health problems, at substantial cost to society (World Health Organization, 2001). Suicide is among the many deleterious consequences of poor mental health and accounts for approximately one million deaths across the globe annually (Hawton and van Heeringen, 2009). Despite advances in mental health treatment over the past 60 years, suicide rates have not significantly declined in much of the world during this time (Varnik, 2012), suggesting the need for more innovative and effective mental health treatments. In response to this trend the National Institute of Mental Health has called for research on novel interventions that address the mechanisms underlying suicidal phenomena (National Action Alliance for Suicide Prevention: Research Prioritization Task Force, 2014). Treatments involving classic psychedelics may represent one such approach.

Classic psychedelics can occasion mystical-type experiences and have been used in sacramental healing contexts across cultures since time immemorial (Johnson *et al.*, 2008; Nichols, 2004). Among the most prominent of these substances are dimethyltryptamine (DMT; widespread in the plant kingdom), the semi-synthetic lysergic acid diethylamide (LSD; derived from the ergot fungus), mescaline (the primary active constituent of peyote and other cacti), and psilocybin (the primary psychoactive constituent of *Psilocybe* and other mushroom genera), with primary effects caused by their action as agonists on serotonin 2A (5-HT_{2A}) brain receptors (Vollenweider and Kometer, 2010). Western science devoted significant attention to classic psychedelics from the 1950s through the early 1970s, and though a lack of modern methodological rigor complicates interpretation, results suggested that classic psychedelics might potentiate psychotherapeutic effectiveness (Johnson *et al.*, 2008; Nichols, 2004; Vollenweider and Kometer, 2010). To the dismay of responsible investigators, sensationalized media coverage of recreational classic psychedelic use in the 1960s led to the most severe legal restrictions, which all but eliminated the possibility of future study that might have yielded more conclusive findings. These legal restrictions were enacted in the absence of a compelling medical or scientific rationale, and contemporary analysis suggests that classic psychedelics are among the least harmful of misused drugs, with limited dependence potential (Nutt *et al.*, 2007, 2010).

The past three decades have witnessed a gradual return to research on classic psychedelics. Though limited in number, these studies indicate that classic psychedelics may warrant the attention they received five decades ago, not least in part because they appear to target a number of factors that modulate suicide risk. For instance, affective disturbance is one of the most prominent contributors to suicidality (Hawton and van Heeringen, 2009). Under carefully controlled conditions, a single administration of psilocybin can occasion profoundly meaningful experiences that bring about persisting elevations in mood among healthy, hallucinogen-naïve volunteers (Griffiths *et al.*, 2006, 2008, 2011). In a pilot trial among individuals with advanced-stage cancer a single dose of psilocybin was associated with long-term reductions in anxiety and depression (Grob *et al.*, 2011), and in a pilot trial among individuals with life-threatening diseases two administrations of LSD produced lasting reductions in anxiety (Gasser *et al.*, 2014; in press). Substance misuse also is robustly related to suicide risk (Borges *et al.*, 2000; Britton and Conner, 2010; Center for Substance Abuse Treatment, 2008; Hawton and van Heeringen, 2009; Wilcox *et al.*, 2004), and several lines of research suggest that classic psychedelics have anti-addictive effects (Bogenschutz and Pommy, 2012). For example, a recent meta-analysis of six randomized clinical trials of treatment for alcoholism conducted between 1966-1970 found that a single dose of LSD reduced the probability of alcohol misuse almost two-fold relative to comparison conditions (Krebs and Johansen, 2012). Furthermore, a single-arm trial of smoking cessation involving up to three administrations of psilocybin yielded abstinence rates of 80% at long-term follow-up, more than doubling abstinence rates typical of approved contemporary tobacco dependence interventions (Johnson *et al.*, 2014). Moreover, naturalistic hallucinogen use predicted a reduced likelihood of recidivism among more than 25,000 individuals under community corrections supervision with a history of substance involvement (Hendricks *et al.*, 2014). Additional prominent suicide risk factors include impulsive-aggressive personality characteristics and early traumatic life events (Hawton and van Heeringen, 2009). Psilocybin may occasion enduring improvements in inner peace, patience, good-natured humor/playfulness, interpersonal regard, anger, and compassion (Griffiths *et al*., 2006, 2011), and may facilitate processing of prior trauma by enhancing recall of autobiographical memories (Carhart-Harris *et al*., 2012a). Finally, classic psychedelics may boost spirituality (Bogenschutz and Pommy, 2012; Griffiths *et al*., 2011), which has been shown to protect against suicidality (Rasic *et al*., 2009, 2011; Weber and Pargament, 2014). Although sample sizes in recent medical administration studies have been limited, no serious adverse events were reported, consistent with historical data indicating that these substances can be administered safely in medical contexts by using appropriate safeguards (Johnson *et al*., 2008).

Neurobiological experiments echo clinical findings, adding further evidence to suggest that classic psychedelics may modify processes implicated in suicidality. Increased 5-HT$_{2A}$ receptor density in the prefrontal cortex is associated with suicide risk factors (e.g. major depression) and suicidal behavior, and may reflect compensatory up-regulation of 5-HT$_{2A}$ receptors stemming from dysfunctional serotonergic transmission (Bhagwagar *et al*., 2006; Carballo *et al*., 2008; Meyer *et al*., 2003; Shelton *et al*., 2008). Classic psychedelic use down-regulates 5-HT$_{2A}$ receptors in the prefrontal cortex which may, in turn, normalize limbic hyperactivity associated with affective disturbance (Baumeister *et al*., 2014, Kraehenmann *et al*., in press; Vollenweider and Kometer, 2010). Reduced neuroplasticity (i.e. expression of brain-derived neurotrophic factor) is also associated with affective disturbance and suicide, and classic psychedelic use may elicit neuroplastic adaptation via glutamatergic transmission (Baumeister *et al*., 2014; Bogenschutz and Pommy, 2012; Dwivedi, 2010; Dwivedi *et al*., 2003; Vollenweider and Kometer, 2010). Furthermore, the default mode network (DMN) is hyperactive and hyperconnected among those with affective disorders, a state that may underpin negative rumination and rigid pessimism characteristic of these conditions (Carhart-Harris *et al*., 2014; Whitfield-Gabrieli and Ford, 2012). Classic psychedelics may normalize the DMN, thereby reducing this cognitive fixedness (Carhart-Harris *et al*., 2012b; Carhart-Harris *et al*., 2014; Muthukumaraswamy *et al*., 2013; Roseman *et al*., 2014; Tagliazucchi *et al*., 2014). In support of this view, a single dose of psilocybin increased personality openness 14 months post-administration (MacLean *et al*., 2011). Some studies show that openness may protect against suicide in older adults, though findings are mixed (Segal *et al*., 2012). Finally, emerging evidence suggests that classic psychedelics might reduce markers of central nervous system inflammation that are implicated in a host of mental health conditions and suicidal behavior (Black and Miller, in press; Szabo *et al*., 2014).

Despite evidence suggesting safety and efficacy, the legal status of classic psychedelics has not changed since 1971. Classic psychedelics remain Schedule I substances (designated as having a high potential for abuse, no currently accepted medical use, and a lack of accepted safety under medical supervision), rendering clinical research with these drugs extremely difficult to conduct (Nutt *et al*., 2013). Consequently, an understanding of the impact of classic psychedelics on mental health and suicidality remains incomplete. Given the regulatory difficulty associated with administering classic psychedelics to humans, population-based survey studies represent one means for examining the relationships of classic psychedelic use with mental health and suicidality. What population-based survey studies sacrifice in internal validity afforded by experimental methodology, they gain in external validity provided by large samples, minimal inclusion and exclusion criteria, and assessment of subjects in real-world settings (Kelley *et al*., 2003). To our knowledge, only one prior investigation has evaluated the population-level associations of classic psychedelic use with mental health. Using data drawn from 2001-2004 of the National Survey on Drug Use and Health (NSDUH), Krebs and Johansen (2013) tested the relationships of lifetime classic psychedelic use with worst month of the past year psychological distress, past year mental health treatment use, and past year *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; American Psychiatric Association, 1994) symptom indicators among over 130,000 USA adults. They found that lifetime classic psychedelic use was largely unassociated with these outcomes, though some findings indicated that lifetime classic psychedelic use was associated with a decreased likelihood of certain mental health indices (e.g. past year mental health treatment utilization). The purpose of the current study was to examine the relationships of lifetime classic psychedelic use with past month psychological distress and past year suicidality using data drawn from the last five available years of the NSDUH at the time of analysis (2008-2012). Considering multiple lines of research indicating that classic psychedelics may be protective with regard to mental health problems and suicidality, we hypothesized that lifetime classic psychedelic use would be associated with a decreased likelihood of past month psychological distress, past year suicidal thinking, past year suicidal planning, and past year suicide attempt.

Methods

The NSDUH survey of the Substance Abuse and Mental Health Services Administration of the United States Department of Health and Human Services is conducted annually to estimate the prevalence of substance use and mental illness in the general USA civilian non-institutionalized population using a complex, probability sampling design (United States Department of Health and Human Services, 2009, 2010, 2011, 2012, 2013). NSDUH interviewers met with individuals in their homes, who listened to prerecorded survey questions on headphones and provided responses via computer. Participants in the current study were adult (≥18 years old) respondents of the NSDUH survey pooled across years 2008-2012 with valid data on the primary independent variable (lifetime classic psychedelic use) and all covariates (see below). These cross-sectional data were pooled across years 2008-2012 because standardized assessment procedures introduced in 2008 yielded the same variables for analysis. Weighted interview response rates were approximately 75%. Detailed information on NSDUH methodology is available elsewhere (https://nsduhweb.rti.org/respweb/homepage.cfm). The NSDUH survey was approved by the institutional review board of the Research Triangle Institute and the current analyses were approved by the institutional review board of the University of Alabama at Birmingham.

Data analysis

A unique identifier was created for each unique NSDUH respondent from years 2008-2012 using the Cantor pairing function. Respondents reporting they had ever, even once, used DMT (code 616 from variables HALNEWA, HALNEWB, HALNEWC, HALNEWD, or HALNEWE=1), ayahuasca (a South American drink that contains DMT; code 6103 from variables HALNEWA, HALNEWB, HALNEWC, HALNEWD, or HALNEWE=1), LSD (variable LSDFLAG=1), mescaline (variable MESC2=1), peyote or San Pedro (cacti that contain mescaline; variable PEYOTE2=1 or code 6077 from variables HALNEWA, HALNEWB, HALNEWC, HALNEWD, or HALNEWE=1), or psilocybin (variable PSILCY2=1) were coded as positive for lifetime classic psychedelic use; those indicating that they had never used any of these substances were coded as negative. We considered coding individuals who responded in the affirmative to a query concerning use of DMT, alpha-methyltryptamine (AMT), and 5-methoxy-*N,N*-diisopropyltryptamine (5-MeO-DIPT) ("Have you ever, even once, used any of the following: DMT, also called dimethyltryptamine, AMT, also called alpha-methyltryptamine, or Foxy, also called 5-MeO-DIPT?"; variable TRYPTM=1) as lifetime classic psychedelic users, but since DMT use in particular could not be determined from this query, and because the classification of AMT and 5-MeO-DIPT as classic psychedelics is inconclusive, this query was not used to classify lifetime classic psychedelic users (post-hoc analyses determined that doing so contributed only 362 additional individuals to the group of lifetime classic psychedelic users and had no meaningful impact on the results). A single variable corresponding to lifetime classic psychedelic use (yes=1 or no=0) was the primary independent variable in analyses.

The primary outcome variables included past month psychological distress (variable SPDMON; yes=1 or no=0) as measured by the widely used and well-validated Kessler Psychological Distress Scale (K6; Kessler *et al*., 2002, 2010; Khan *et al*., 2014), past year suicidal thinking ("At any time in the past 12 months... did you seriously think about trying to kill yourself?"; variable MHSUITHK; yes=1 or no=0), past year suicidal planning ("During the past 12 months, did you make any plans to kill yourself?"; variable MHSUIPLN; yes=1 or no=0), and past year suicide attempt ("During the past 12 months, did you try to kill yourself?"; variable MHSUITRY; yes=1 or no=0). Multivariate logistic regression was used to test the associations between lifetime classic psychedelic use and the primary outcomes while controlling for the following covariates: age in years (18-25, 26-34, 35-49, 50-64, or 65 or older); gender (male or female); ethnoracial identity (non-Hispanic White, non-Hispanic African American, non-Hispanic Native American/Alaska Native, non-Hispanic Native Hawaiian/Pacific Islander, non-Hispanic Asian, non-Hispanic more than one race, or Hispanic); educational attainment (5th grade or less, 6th grade, 7th grade, 8th grade, 9th grade, 10th grade, 11th grade, 12th grade, freshman college year, sophomore or junior college year, or senior college year or more); annual household income (less than $20,000, $20,000-$49,999, $50,000-$74,999, or $75,000 or more); marital status (married, divorced/separated, widowed, or never married); self-reported engagement in risky behavior ("How often do you like to test yourself by doing something a little risky?"; never, seldom, sometimes, or always) and lifetime illicit use of cocaine, other stimulants, sedatives, tranquilizers, heroin, pain relievers, marijuana, 3,4-methylenedioxymethamphetamine (MDMA)/ecstasy, phencyclidine (PCP), and inhalants (each aforementioned drug category coded as separate covariates). All analyses were conducted in SAS version 9.3 using PROC

SURVEYLOGISTIC and accounted for the complex study design variables and sampling weights as recommended by the NSDUH.

Results

Of the 191,382 respondents, 27,235 reported lifetime classic psychedelic use (13.6% weighted). Of these, 391 reported lifetime DMT use (0.1% weighted), 26 reported lifetime ayahuasca use (0.008% weighted), 18,152 reported lifetime LSD use (10.2% weighted), 4687 reported lifetime mescaline use (3.5% weighted), 3540 reported lifetime peyote or San Pedro use (2.4% weighted), and 20,274 reported lifetime psilocybin use (8.9% weighted). In addition, 12,657 of the respondents reported past month psychological distress (4.8% weighted), 10,445 reported past year suicidal thinking (3.8% weighted), 3157 reported past year suicidal planning (1.1% weighted), and 1716 reported past year suicide attempt (0.5% weighted).

Table 1. Characteristics of lifetime classic psychedelic users versus non-lifetime classic psychedelic users.

Feature	Lifetime classic psychedelic users Weighted %	Non-lifetime classic psychedelic users Weighted %	*p* value
Age, years			<0.0001
18-25	13.6	14.9	
26-34	21.3	14.9	
35-49	33.7	26.3	
50-64	29.4	24.4	
65 and older	2.0	19.4	
Gender			<0.0001
Male	62.8	46.0	
Female	37.2	54.0	
Race			<0.0001
Non-Hispanic White	83.3	65.2	
Non-Hispanic African American	3.9	12.7	
Non-Hispanic Native American/Alaska Native	1.1	0.4	
Non-Hispanic Native Hawaiian/Pacific Islander	0.2	0.4	
Non-Hispanic Asian	1.3	5.2	
Non-Hispanic more than one race	2.0	1.1	
Hispanic	8.3	15.0	
Education			<0.0001
5th grade or less	0.3	1.6	
6th grade	0.1	1.5	
7th grade	0.2	0.6	
8th grade	1.0	1.8	
9th grade	2.0	2.5	
10th grade	3.2	2.9	
11th grade	4.8	4.5	
12th grade	28.1	30.9	
Freshman college year	10.1	8.7	
Sophomore or junior college year	20.0	16.4	
Senior college year or more	30.3	28.7	
Annual household income			<0.0001
Less than $20,000	16.9	18.5	
$20,000-$49,999	30.0	33.3	

$50,000-$74,999	17.8	17.2	
$75,000 or more	35.3	31.0	
Marital status			<0.0001
Married	47.3	54.5	
Divorced/separated	18.3	13.1	
Widowed	1.8	6.7	
Never married	32.6	25.7	
Self-reported engagement in risky behavior			<0.0001
Never	27.8	55.6	
Seldom	44.1	32.4	
Sometimes	25.3	11.0	
Always	2.8	1.0	
Lifetime illicit substance use			<0.0001
Lifetime cocaine use	71.4	7.5	<0.0001
Lifetime other stimulant use	37.1	3.7	<0.0001
Lifetime sedative use	17.9	1.2	<0.0001
Lifetime tranquilizer use	37.5	5.0	<0.0001
Lifetime heroin use	10.6	0.4	<0.0001
Lifetime pain reliever use	46.5	9.5	<0.0001
Lifetime marijuana use	97.7	36.2	<0.0001
Lifetime MDMA/ecstasy use	33.0	2.1	<0.0001
Lifetime PCP use	18.0	0.4	<0.0001
Lifetime inhalant use	39.5	3.8	<0.0001

All percentages were rounded to the nearest 0.1%. Rao-Scott chi-square tests were used to examine the characteristics of lifetime classic psychedelic users versus nonlifetime classic psychedelic users. MDMA: 3,4-methylenedioxymethamphetamine; PCP: phencyclidine.

Table 1 displays the characteristics of lifetime classic psychedelic users versus non-lifetime classic psychedelic users. Lifetime classic psychedelic use was concentrated among 26-64 year olds and rare among those aged 65 years and older. Furthermore, lifetime classic psychedelic use was more common among men, non-Hispanic Whites and Native Americans/Alaska Natives, those with greater educational attainment and income, individuals who were divorced/separated or who had never been married, those with greater self-reported engagement in risky behavior, and those who reported lifetime illicit use of each of the other substances. Among lifetime classic psychedelic users, only 240 (0.9% weighted) reported never having used any other illicit substance whereas among non-lifetime classic psychedelic users, 85,601 (58.2% weighted) reported never having used any other illicit drug. Figures 1-4 show the results of multivariate logistic regression models predicting past month psychological distress, past year suicidal thinking, past year suicidal planning, and past year suicide attempt. As shown in these figures, lifetime classic psychedelic use was associated with a decreased likelihood of past month psychological distress (weighted OR=0.81 (0.72-0.91), p=0.0002), past year suicidal thinking (weighted OR=0.86 (0.78-0.94), p=0.001), past year suicidal planning (weighted OR=0.71 (0.54-0.94), p=0.01), and past year suicide attempt (weighted OR=0.64 (0.46-0.89), p=0.008). Conversely, lifetime illicit use of other substances was either not related with or associated with an increased odds of these outcomes, with odds ratios (ORs) for all relationships exceeding 1.0 except lifetime PCP use and past month psychological distress, and lifetime MDMA/ecstasy use and past year suicidal thinking, past year suicidal planning, and past year suicide attempt (no OR significantly different than 1.0).

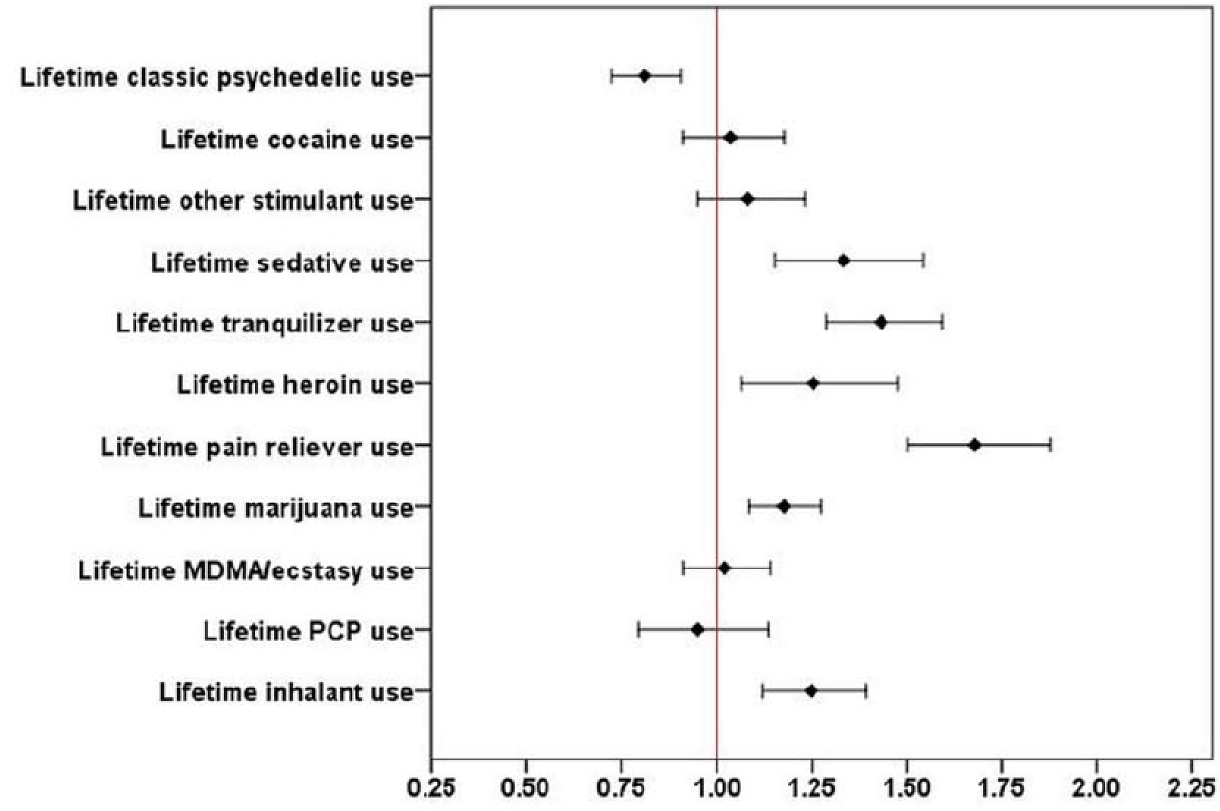


Figure 1. Result of multivariate logistic regression model predicting past month psychological distress. Diamonds are weighted odds ratio point estimates and error bars are 95% confidence intervals. Associations of demographic variables and self-reported engagement in risky behavior with psychological distress are not presented. *n*=191,369 due to missing data on the dependent variable. MDMA: 3, 4-methylenedioxymethamphetamine; PCP: phencyclidine.

Discussion

The objective of the current study was to evaluate the associations of classic psychedelic use with psychological distress and suicidality in a large sample generalizable to the USA adult population. Consistent with hypotheses, lifetime classic psychedelic use was associated with a 19% reduced likelihood of past month psychological distress, a 14% reduced likelihood of past year suicidal thinking, a 29% reduced likelihood of past year suicidal planning, and a 36% reduced likelihood of past year suicide attempt. These findings comport with the accumulating literature indicating that classic psychedelics may remediate a number of risk factors associated with suicide. Indeed, if the current results reflect a direct causal chain between classic psychedelic use and decreased suicidality, the mechanisms described in the introduction may have explanatory value. By contrast, lifetime illicit use of all other substances was by and large associated with an increased likelihood of psychological distress and suicidality at or above the trend level. These results align with data indicating that non-psychedelic substance use is a suicide risk factor (Borges *et al*., 2000; Britton and Conner, 2010; Center for Substance Abuse Treatment, 2008; Hawton and van Heeringen, 2009; Wilcox *et al*., 2004).

An obvious limitation of the current research is its reliance on self-report. Biases in responding may have obscured the true relationships of classic psychedelic use with psychological distress and suicidality. Also, analyses were restricted to the available data, which precluded testing more nuanced associations (e.g. dose-response relationships). Furthermore, as with any cross-sectional study, the associations reported here may not necessarily indicate causation. Population survey studies cannot control for all possible sources of confounding and therefore we cannot rule out that a shared underlying factor may have contributed to both classic psychedelic use and decreased psychological distress and suicidality. Psychedelic drug users commonly report autognostic (Móró *et al*., 2011), "mind expansion," spiritual, and curiosity motives for such use (Lyvers and Meester, 2012). Although these interests may be lasting effects of classic psychedelic drug use, they may also represent predrug characteristics among classic psychedelic users that might protect against suicide as well (e.g. openness, curiosity, and spiritual tendencies; Carhart-Harris *et al*., 2014; Kashdan *et al*., 2004; Rasic *et al*., 2009, 2011; Weber and Pargament, 2014). Lerner and Lyvers (2006) found that classic psychedelic users reported less materialistic values and greater mysticism, spirituality, and concern for others than non-classic psychedelic drug users, and speculated that both predrug factors and classic psychedelic drug effects contributed to group differences. This too may be the case with regard to the present findings. However, as classic psychedelic use was associated with self-reported engagement in risky behavior and illicit substance use, some who use classic psychedelics may also have a premorbid liability for suicidality. The picture is undoubtedly complex. Nevertheless, future research should attempt to delineate longitudinal predictors of classic psychedelic use that also relate to mental health and suicidal behavior.

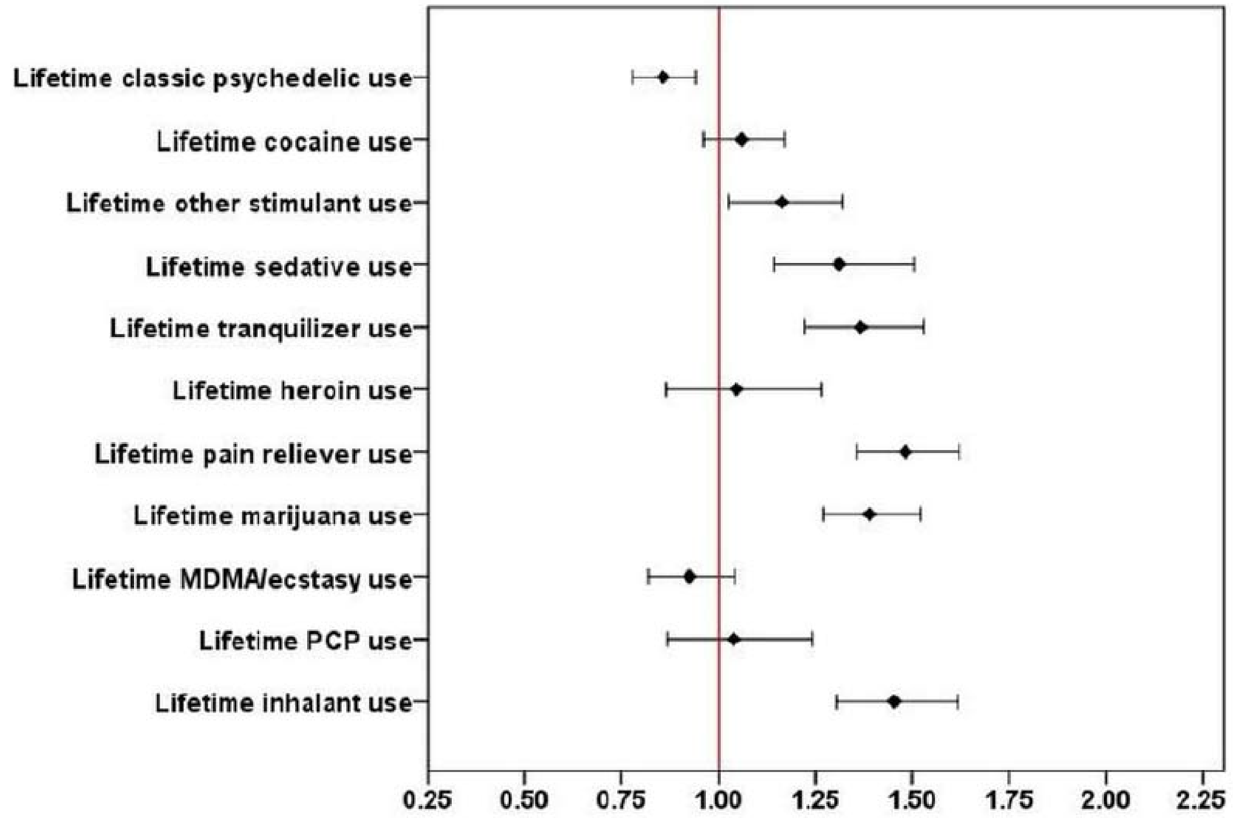


Figure 2. Result of multivariate logistic regression model predicting past year suicidal thinking. Diamonds are weighted odds ratio point estimates and error bars are 95% confidence intervals. Associations of demographic variables and self-reported engagement in risky behavior with suicidal thinking are not presented. *n*=190,728 due to missing data on the dependent variable. MDMA: 3, 4-methylenedioxymethamphetamine; PCP: phencyclidine.

We also cannot rule out the possibility that classic psychedelic use may have caused harm at the individual level. Indeed, classic psychedelic use may exacerbate schizophrenia or other psychotic disorders, can be dangerous in hazardous physical environments, and can sometimes elicit feelings of anxiety, fear, panic, and paranoia (Johnson *et al.*, 2008). Nevertheless, the associations reported here suggest that if individual-level harms occurred, they failed to obscure the apparent protective effect of classic psychedelic use on psychological distress and suicidality at the population level. Considering that carefully controlled conditions are ideal in the administration of classic psychedelics (Johnson *et al.*, 2008), it is noteworthy that naturalistic classic psychedelic use demonstrated evidence of benefit. Not only could classic psychedelic users have used in suboptimal settings, they could have ingested substances of unknown purity and/or at sub- or supratherapeutic doses. If the results do reflect salubrious effects of classic psychedelic use, these may very well be potentiated in specialized treatment settings designed to maximize safety and efficacy (Johnson *et al.*, 2008).

Given the grave and chronic nature of suicide (Hawton and van Heeringen, 2009; Varnik, 2012) and the call for research on innovative treatments that target suicide pathogenisis (National Action Alliance for Suicide Prevention: Research Prioritization Task Force, 2014), the current findings set the stage for more extensive clinical research with classic psychedelics. Despite millennia of use in sacred healing rituals, and accruing scientific evidence suggesting safety and efficacy when administered in clinical settings with appropriate safeguards (Johnson *et al.*, 2008), classic psychedelics remain Schedule I substances. Accordingly, evaluating the clinical application of classic psychedelics remains an arduous challenge secondary to regulatory hurdles and scarce funding, among other obstacles (Nutt *et al.*, 2013). The present results reinforce the perspective that the designation of these substances should be reconsidered to allow further scientific inquiry. Regardless, priorities for future investigation include evaluating the efficacy of classic psychedelics in treating suicidality as well as pathologies associated with increased suicide risk including affective disturbance, substance misuse, dysfunction marked by impulsive-aggressive personality traits, trauma sequelae, and neurocognitive deficits. Mediators of classic psychedelics' effects should be carefully evaluated so as to better understand their mechanisms of action. Elucidating such mechanisms is critical to optimizing the benefits of classic psychedelics and their concomitant psychotherapeutic components.

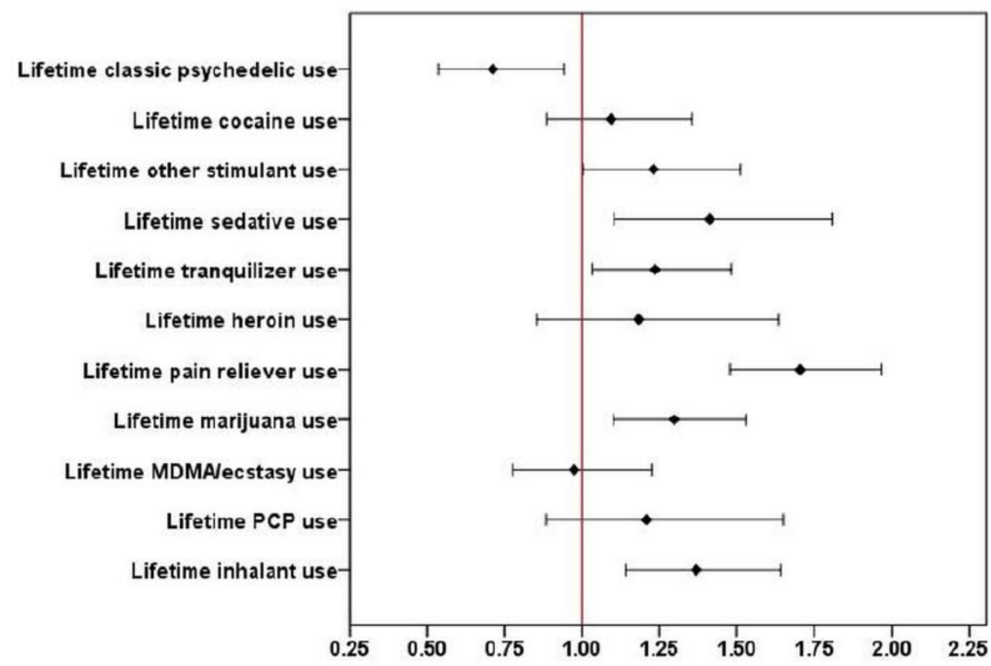


Figure 3. Result of multivariate logistic regression model predicting past year suicidal planning. Diamonds are weighted odds ratio point estimates and error bars are 95% confidence intervals. Associations of demographic variables and self-reported engagement in risky behavior with suicidal planning are not presented. *n*=190,713 due to missing data on the dependent variable. MDMA: 3,4-methylenedioxymethamphetamine; PCP: phencyclidine.

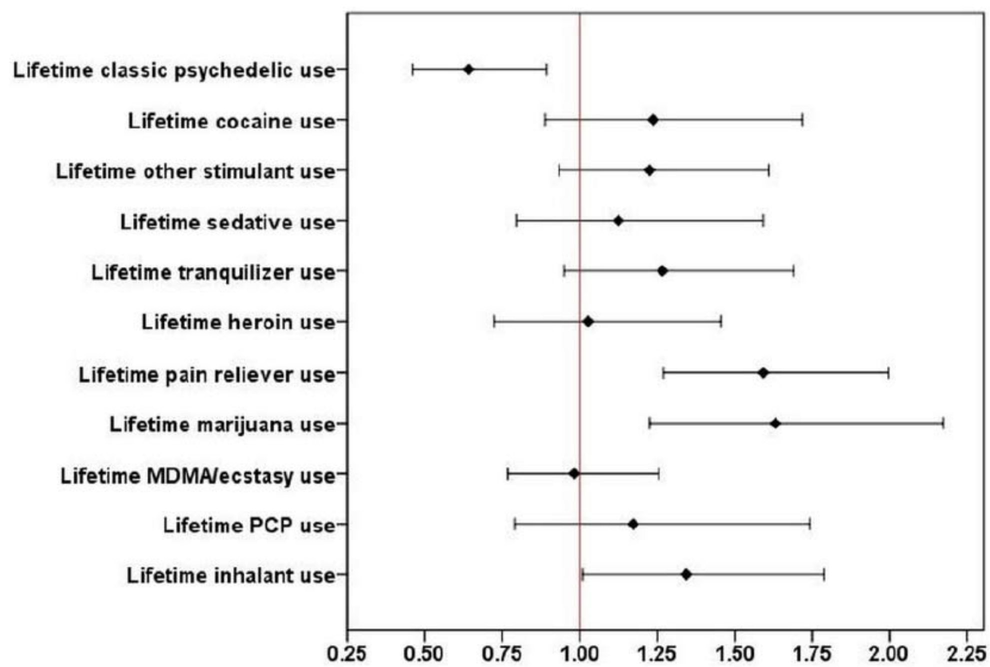


Figure 4. Result of multivariate logistic regression model predicting past year suicide attempt. Diamonds are weighted odds ratio point estimates and error bars are 95% confidence intervals. Associations of demographic variables and self-reported engagement in risky behavior with suicide attempt are not presented. *n*=190,709 due to missing data on the dependent variable. MDMA: 3,4-methylenedioxymethamphetamine; PCP: phencyclidine.

Conclusion

Classic psychedelics carry a contentious recent history and barriers to their clinical evaluation remain. Growing evidence including the present research suggests that classic psychedelics may have the potential to alleviate human suffering associated with mental illness. Further rigorous research is warranted to better understand these substances, with the ultimate goal of taking full advantage of their latent therapeutic capacity.

Acknowledgements

NSDUH data are available to the public and archived at http://www.icpsr.umich.edu/icpsrweb/SAMHDA/series/64. The authors thank Mallory Cases, Michael Scott Crawford, Noah Wiles Sweat, and Jacqueline Upp for their work on the project.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. American Psychiatric Association (1994) *Diagnostic and statistical manual of mental health disorders*. 4th ed. Washington, DC: American Psychiatric Association.
2. Baumeister D, Barnes G, Giaroli G, *et al*. (2014) Classical hallucinogens as antidepressants? A review of pharmacodynamics and putative clinical roles. *Ther Adv Psychopharmacol* 4: 156-169.
3. Bhagwagar Z, Hinz R, Taylor M, *et al*. (2006) Increased 5-HT_{2A} receptor binding in euthymic, medication-free patients recovered from depression: A positron emission study with [11C] MDL 100,907. *Am J Psychiatry* 163: 1580-1587.
4. Black C and Miller JM (in press) Meta-analysis of cytokines and chemokines in suicidality: Distinguishing suicidal versus non-suicidal patients. *Biol Psychiatry*. doi: 10.1016/j.biopsych.2014.10.014 Available online 30 October 2014
5. Bogenschutz MP and Pommy JM (2012) Therapeutic mechanisms of classic hallucinogens in the treatment of addictions: From indirect evidence to testable hypotheses. *Drug Test Anal* 4: 543-555.
6. Borges G, Walters EE and Kessler RC (2000) Associations of substance use, abuse, and dependence with subsequent suicidal behavior. *Am J Epidemiol* 151: 781-789.
7. Britton PC and Conner KR (2010) Suicide attempts within 12 months of treatment for substance use disorders. *Suicide Life Threat Behav* 40:14-21.
8. Carballo JJ, Akamnonu CP and Oquendo MA (2008) Neurobiology of suicidal behavior. An integration of biological and clinical findings. *Arch Suicide Res* 12: 93-110.
9. Carhart-Harris RL, Erritzoe D, Williams T, *et al*. (2012b) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci U S A* 109: 2138-2143.
10. Carhart-Harris RL, Leech R, Williams TM, *et al*. (2012a) Implications for psychedelic-assisted psychotherapy: Functional magnetic resonance imaging study with psilocybin. *Br J Psychiatry* 200: 238-244.
11. Carhart-Harris RL, Leech R, Hellyer PJ, *et al*. (2014) The entropic brain: A theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front Hum Neurosci* 8: 20
12. Center for Substance Abuse Treatment (2008) *Substance abuse and suicide prevention: Evidence and implications - A white paper.* DHHHS Pub. No. SMA-08-4352. Rockville, MD: Substance Abuse and Mental Health Services Administration.
13. Dwivedi Y (2010) Brain-derived neurotrophic factor and suicide pathogenesis. *Ann Med* 42: 87-96.
14. Dwivedi Y, Rizavi HS, Conley RR, *et al*. (2003). Altered gene expression of brain-derived neurotrophic factor and receptor tyrosine kinase B in postmortem brain of suicide subjects. *Arch Gen Psychiatry* 60: 804-815.
15. Gasser P, Holstein D, Michel Y, *et al*. (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202: 513-520.
16. Gasser P, Kirchner K and Passie T (in press) LSD-assisted psychotherapy for anxiety associated with a life-threatening disease: A qualitative study of acute and sustained subjective effects. *J Psychopharmacol* 29: 57-68.
17. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: Immediate and persisting doserelated effects. *Psychopharmacology* 218: 649-655.
18. Griffiths RR, Richards WA, Johnson MW, *et al*. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632.
19. Griffiths RR, Richards WA, McCann U, *et al*. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-283.
20. Grob CS, Danforth AL, Chopra GS, *et al*. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage

cancer. *Arch Gen Psychiatry* 68: 71-78.

21. Hawton K and van Heeringen K (2009) Suicide. *Lancet* 373: 1372-1381.
22. Hendricks PS, Clark CB, Johnson MW, *et al*. (2014) Hallucinogen use predicts reduced recidivism among substance-involved offenders under community corrections supervision. *J Psychopharmacol* 28: 62-66.
23. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al*. (2014) Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
24. Johnson MW, Richards WA and Griffiths RR (2008) Human hallucinogen research: Guidelines for safety. *J Psychopharmacol* 22: 603-620.
25. Kashdan TB, Rose P and Fincham FD (2004) Curiosity and exploration: Facilitating positive subjective experiences and personal growth opportunities. *J Pers Assess* 82: 291-305.
26. Kelley K, Clark B, Brown V, *et al*. (2003). Good practice in the conduct and reporting of survey research. *Int J Qual Health Care* 15: 261-266.
27. Kessler RC, Andrews G, Colpe LJ, *et al*. (2002) Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med* 32: 959-976.
28. Kessler RC, Green JG, Gruber MJ, *et al*. (2010) Screening for serious mental illness in the general population with the K6 screening scale: Results from the WHO World Mental Health (WMH) survey initiative. *Int J Methods Psychiatr Res* 19: 4-22.
29. Khan A, Chien CW and Burton NW (2014) A new look at the construct validity of the K6 using Rasch analysis. *Int J Methods Psychiatr Res* 23: 1-8.
30. Kraehenmann R, Preller KH, Scheidegger M, *et al*. (in press) Psilocybininduced decrease in amygdala reactivity correlates with enhanced positive mood in healthy volunteers. *Biol Psychiatry*. doi:10.1016/j. biopsych.2014.04.010 Available online 26 April 2014
31. Krebs TS and Johansen PØ (2012) Lysergic acid diethylamide (LSD) for alcoholism: Meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
32. Krebs TS and Johansen PØ (2013) Psychedelics and mental health: A population study. *PLoS One* 8: e63972.
33. Lerner M and Lyvers M (2006) Values and beliefs of psychedelic drug users: A cross-cultural study. *J Psychoactive Drugs* 38: 143-147.
34. Lyvers M and Meester M (2012) Illicit use of LSD or psilocybin, but not MDMA or nonpsychedelic drugs, is associated with mystical experiences in a dose-dependent manner. *J Psychoactive Drugs* 44: 410-417.
35. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
36. Meyer JH, McMain S, Kennedy SH, *et al*. (2003) Dysfunctional attitudes and 5-HT$_2$ receptors during depression and self-harm. *Am J Psychiatry* 160: 90-99.
37. Móró L, Simon K, Bárd I, *et al*. (2011) Voice of the psychonauts: Coping, life purpose, and spirituality in psychedelic drug users. *J Psychoactive Drugs* 43: 188-198.
38. Muthukumaraswamy SD, Carhart-Harris RL, Moran RJ, *et al*. (2013) Broadband cortical desynchronization underlies the human psychedelic state. J Neurosci 33: 15171-15183.
39. National Action Alliance for Suicide Prevention: Research Prioritization Task Force (2014) *A prioritized research agenda for suicide prevention: An action plan to save lives*. National Institute of Mental Health and the Research Prioritization Task Force, Rockville, Maryland.
40. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101: 131-181.
41. Nutt DJ, King LA and Nichols DE (2013) Effects of Schedule I drug laws on neuroscience research and treatment innovation. *Nature Rev Neurosci* 14: 577-585.
42. Nutt DJ, King LA and Phillips LD (2010) Drug harms in the UK: A multicriteria decision analysis. *Lancet* 376: 1558-1565.
43. Nutt D, King LA, Saulsbury W, *et al*. (2007) Development of a rational scale to assess the harm of drugs of potential misuse. *Lancet* 369: 1047-1053.
44. Rasic DT, Belik SL, Elias B, *et al*. (2009) Spirituality, religion and suicidal behavior in a nationally representative sample. *J Affect Disord* 114: 32-40.
45. Rasic D, Robinson JA, Bolton J, *et al*. (2011) Longitudinal relationships of religious worship attendance and spirituality with major depression, anxiety disorders, and suicidal ideation and attempts: Findings from the Baltimore epidemiologic catchment area study. *J Psychiatr Res* 45: 848-854.
46. Roseman L, Leech R, Feilding A, *et al*. (2014) The effects of psilocybin and MDMA on between-network resting state functional connectivity in healthy volunteers. *Front Hum Neurosci* 8: 204.
47. Segal DL, Marty MA, Meyer WJ, *et al*. (2012) Personality, suicidal ideation, and reasons for living among older adults. *J Gerontol B Psychol Sci Soc Sci* 67: 159-166.
48. Shelton RC, Sanders-Bush E, Manier DH, *et al*. (2009). Elevated 5-HT $_{2A}$ receptors in postmortem prefrontal cortex in major depression is associated with reduced activity of protein kinase A. *Neuroscience* 158: 1406-1415.
49. Szabo A, Kovacs A, Frecska E, *et al*. (2014) Psychedelic N,N-dimethyltryptamine and 5-methoxy-N,N-dimethyltryptamine modulate innate and adaptive inflammatory responses through the sigma-1 receptor of human monocyte-derived dendritic cells. *PLoS One* 9: e106533.
50. Tagliazucchi E, Carhart-Harris R, Leech R, *et al*. (2014) Enhanced repertoire of brain dynamical states during the psychedelic experience. *Human Brain Mapp* 35: 5442-5456.
51. United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality (2009) *National Survey on Drug Use and Health, 2008*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research.
52. United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality (2010) *National Survey on Drug Use and Health, 2009*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research.
53. United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration.

Center for Behavioral Health Statistics and Quality (2011) *National Survey on Drug Use and Health, 2010*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research.

54. United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality (2012) *National Survey on Drug Use and Health, 2011*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research.
55. United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality (2013) *National Survey on Drug Use and Health, 2012*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research.
56. Varnik P (2012) Suicide in the world. *Int J Environ Res Public Health* 9: 760-771.
57. Vollenweider FX and Kometer M (2010) The neurobiology of psychedelic drugs: Implications for the treatment of mood disorders. *Nature Rev Neurosci* 11: 642-651.
58. Weber SR and Pargament KI (2014) The role of religion and spirituality in mental health. *Curr Opin Psychiatry* 27: 358-363.
59. Whitfield-Gabrieli S and Ford JM (2012) Default mode network activity and connectivity in psychopathology. *Annu Rev Clin Psychol* 8: 49-76.
60. Wilcox HC, Conner KR and Caine ED (2004) Association of alcohol and drug use disorders and completed suicide: An empirical review of cohort studies. *Drug Alcohol Depend* 76: S11-S19.
61. World Health Organization (2001) *The World health report 2001: Mental health: New understanding, new hope*. Geneva, Switzerland: World Health Organization.

Psychedelics not linked to mental health problems or suicidal behavior

A population study

by

Pål-Ørjan Johansen[1] and Teri Suzanne Krebs[2]

Journal of Psychopharmacology 1-10

© The Author(s) 2015

original source:
http://www.emmasofia.org/wp-content/uploads/2015/02/Psychedelics-not-linked-to-mental-health-problems-or-suicidal-behavior.pdf
backup source: http://www.psilosophy.info/resources/Psychedelics-not-linked-to-mental-health-problems-or-suicidal-behavior.pdf

1. EmmaSofia, Oslo, Norway
2. Department of Neuroscience, Norwegian University of Science and Technology, Trondheim, Norway

Corresponding author:
Teri Suzanne Krebs, Department of Neuroscience, Norwegian University of Science and Technology, Trondheim, N-7489, Norway.
Email: krebs@ntnu.no

Table of Contents:

- **Abstract**
- **Introduction**
- **Materials and methods**
  - Source, population and data
  - Use of psychedelics
  - Mental health indicators
  - Control variables
  - Data analysis
- **Results**
  - Lifetime psychedelic use
  - Specific psychedelic use
  - Stratified subgroups
- **Discussion**
  - Lack of associations with mental health or suicidality
  - The idea of 'flashbacks' and 'hallucinogen persisting perceptual disorder'
  - Psychedelics and personally significant experiences
  - Limitations
  - Lack of association with suicidal behavior
  - Comments on the history of national and international control of psychedelics
- **Conclusions**
- **Acknowledgements**
- **References**

Abstract

A recent large population study of 130,000 adults in the United States failed to find evidence for a link between psychedelic use (lysergic acid diethylamide, psilocybin or mescaline) and mental health problems. Using a new data set consisting of 135,095 randomly selected United States adults, including 19,299 psychedelic users, we examine the associations between psychedelic use and mental health. After adjusting for sociodemographics, other drug use and childhood depression, we found no significant associations between lifetime use of psychedelics and increased likelihood of past year serious psychological distress, mental health treatment, suicidal thoughts, suicidal plans and suicide attempt, depression and anxiety. We failed to find evidence that psychedelic use is an independent risk factor for mental health problems. Psychedelics are not known to harm the brain or other body organs or to cause addiction or compulsive use; serious adverse events involving psychedelics are extremely rare. Overall, it is difficult to see how prohibition of psychedelics can be justified as a public health measure.

Keywords: Psychedelic, hallucinogen, epidemiology, public health, suicide

Introduction

The classical psychedelics lysergic acid diethylamide (LSD), psilocybin (magic mushrooms) and mescaline (peyote and other cacti) have their primary mechanism of action at the serotonin 2A (5-HT_{2A}) receptor, elicit similar, often indistinguishable effects and show cross-tolerance (Bonson, 2012). Over 30 million adults in the United States (US) have tried psychedelics (approximately one in six adults aged 21-64 years) (Krebs and Johansen, 2013a).

Psychedelics are not known to harm the brain or other body organs or to cause addiction or compulsive use (Halberstadt, 2015; Bonson, 2012). Psychedelics are well known for inducing profound effects on the mind, which sometimes include confusion and emotional turmoil (McWilliams and Tuttle, 1973). Both the European Monitoring Center for Drugs and Drug Addiction (EMCDDA) and the health authorities in the Netherlands, where hundreds of thousands of servings of psilocybin mushrooms are legally sold in shops each year, report that serious injuries related to psychedelics are extremely rare (EMCDDA, 2011; CAM, 2007). Furthermore, Dutch police report that legal sale of psilocybin mushrooms has not led to public order problems (van Amsterdam *et al.*, 2011). Approximately 0.005% of emergency department visits in the US involve LSD or psilocybin (US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality 2013; Centers for Disease Control and Prevention (CDC), 2014). Drug abuse experts consistently rank LSD and/or psilocybin mushrooms as much less harmful to the individual user and to society compared to alcohol and other controlled substances (Nutt *et al.*, 2007, 2010; Taylor *et al.*, 2012; van Amsterdam *et al.*, 2010). Controlled studies have not linked either clinical administration or regular use of psychedelics in religious ceremonies to lasting health problems (see Krebs and Johansen, 2013b).

Psychedelics often elicit deeply personally and spiritually meaningful experiences and sustained beneficial effects (Carhart-Harris and Nutt, 2010; Griffiths *et al.*, 2008, 2011; Morgan *et al.*, 2010). Common reasons for using psychedelics include mystical experiences and personal development (Hallock *et al.*, 2005). Indeed, in many countries, including the US, select groups have protection from prosecution on grounds of freedom of belief or religion. People have used psychedelics for at least 5700 years (Bruhn *et al.*, 2002), pre-dating the major organized religions. Modern antipsychedelic legislation began 100 years ago when members of rival religious groups campaigned against Native American peyote use, calling peyote addictive and an 'insidious evil' that causes users to 'withdraw from the churches and become "peyote worshipers"' (Newberne and Burke, 1922). Eventually, concerned scientists defended peyote users, using evidence-based reasoning and human rights arguments (Collier, 1952; La Barre *et al.*, 1951; Le Farge, 1960); this led to legal exemptions for specific groups. However, laws and cultural biases against peyote remained in place and were later extended to include other psychedelics. Concerns have been raised that the ban on use of psychedelics is a violation of the human rights to belief and spiritual practice, full development of the personality, and free time and play (United Nations General Assembly, 1948; Walsh, 2014).

There is increasing interest in the therapeutic use of psychedelics, especially for alcoholism (Krebs and Johansen, 2012), smoking cessation (Johnson *et al.*, 2014), depression and other mental health problems (Baumeister *et al.*, 2014; Bogenschutz, 2013; Hendricks *et al.*, 2014). David Nutt and colleagues have explained how national and international regulations have impeded scientific research and medical treatment development with psychedelics and other highly controlled 'Schedule I' substances (Nutt *et al.*, 2013). Prohibition has also obviously had negative consequences for the millions of individuals who find it worthwhile to use these substances in various cultural settings outside of the clinic.

Our previous population study failed to find evidence for a link between psychedelic use (lifetime use of LSD, psilocybin, mescaline, or peyote, past year use of LSD) and past year serious psychological distress, receiving or needing mental health treatment, or symptoms of eight psychiatric diagnoses, including major depression, anxiety disorders, mania and psychosis, or visual hallucinations (Krebs and Johansen, 2013b). Here, using a new large data set, which included data on suicidal thoughts and suicide attempt, we again examine the associations between the use of psychedelics and mental health.

Materials and methods

Source, population and data

The annual National Survey on Drug Use and Health (NSDUH) collects data on substance use and mental health from a random sample representative of the US civilian non-institutionalized population (http://oas.samhsa.gov/nsduh.htm). We pooled data from respondents aged 18 years and over from survey years 2008-2011. Half of year 2008, earlier survey years and younger respondents were not pooled due to questionnaire differences (including no questions on suicidal behavior). The response rate was 78%. In addition, approximately 10% of participants were excluded from the public use data file, either because of excessive missing data on drug use or because they were excluded at random in order to increase anonymity. The sample consisted of 135,095 respondents, of whom 19,299 (13.6% weighted) reported lifetime use of a psychedelic substance. Our previous study examined NSDUH years 2001-2004 (Krebs and Johansen, 2013b).

Use of psychedelics

We counted participants as having any lifetime psychedelic use if they reported use of LSD, psilocybin, mescaline or peyote. LSD, psilocybin and mescaline are all classical serotonergic psychedelics with main mechanism of action at the 5-HT$_{2A}$ receptor (Halberstadt, 2015). We combined mescaline and peyote (mescaline-containing cactus) use into one variable but also examined peyote use separately. Data on past year use was available only for LSD.

Mental health indicators

We examined 11 self-reported indicators of past year mental health problems. Past year mental health indicators also used in our previous study (Krebs and Johansen, 2013b) were serious psychological distress during the worst month of the past year, assessed with the K6 scale (Kessler *et al.*, 2003a), mental health treatment, including treatment for substance disorders (inpatient, outpatient, psychiatric medication prescription, felt a need for but did not receive mental health treatment). The remaining mental health indicators from our previous study, such as psychosis symptoms, were not available in this data set. Past year mental health indicators new to this study were suicide thoughts, suicide plan, suicide attempt, symptoms of major depressive episode (assessed with a questionnaire adapted from the National Comorbity Survey (Kessler *et al.*, 2003b), which was different from the depression questionnaire in our previous study), physician diagnosis of depression, and physician diagnosis of an anxiety disorder.

The K6 scale provides a valid assessment of general psychological distress during the worst month of the past year. It covers types of psychological distress that are common to a broad range of psychiatric disorders and has strong accuracy in discriminating between people with and without one or more diagnoses from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (American Psychiatric Association, 1994; Kessler *et al.*, 2010).

Control variables

Control variables consisted of a variety of sociodemographic, psychological and drug use variables (Figure 1, Tables 1 and 2). The control variables were selected on the basis of associations with mental health in previous research, and were the same as those used in our previous study, with two differences: depressive episode before age 18 was now available to be included as a control variable in this study, and lifetime exposure to an extremely stressful event was not available to be included.

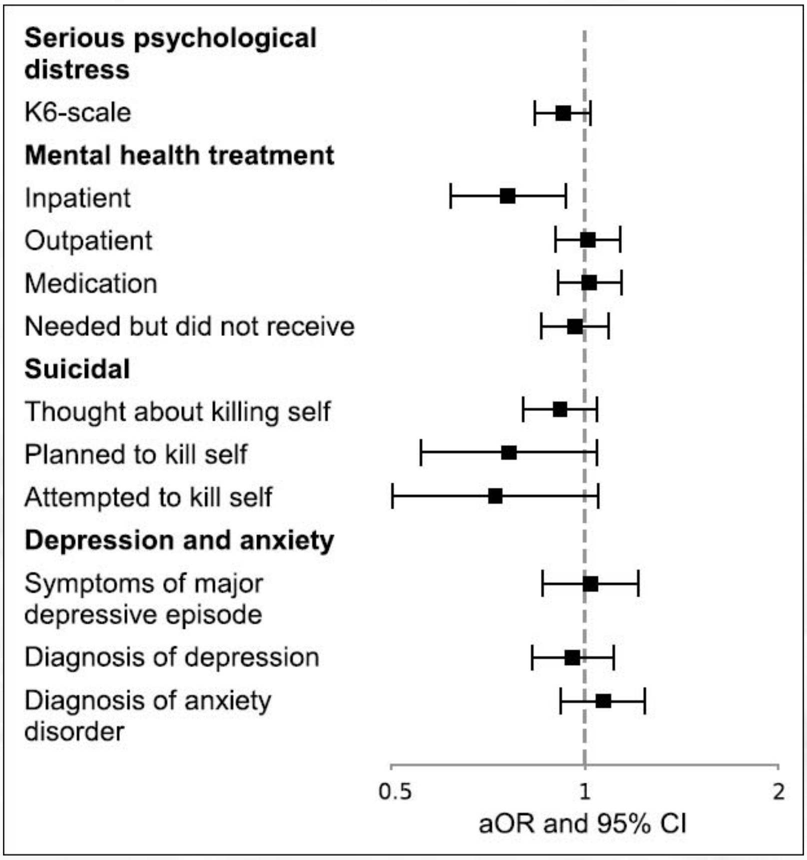


Figure 1. Association between psychedelic use and mental health. aOR: adjusted odds ratio. Values less than 1.0 indicate lower likelihood among people with lifetime psychedelic use, adjusted for age (11 categories, treated as a continuous variable), gender (male, female), race/ethnicity (white, Hispanic, black, Asian, Native American, Native Hawaiian or Pacific Islander, more than one), household income (less than US$20,000, US$20,000-49,999, US$50,000-74,999, US$75,000 or more), education (not high school graduate, high school graduate, some college, college graduate), marital status (unmarried, married), likes to test self by doing risky things (never, seldom, sometimes, always), depressive episode before age 18 years (no, yes), and 10 types of lifetime drug use (cannabis/marijuana, opiates, cocaine, sedatives/tranquilizers, stimulants, MDMA/ecstasy, inhaled anesthetics, amyl nitrates, other inhalants, phencyclidine); CI: confidence interval.

Participants with missing data were excluded; including participants with missing values had no effect on statistical significance. All calculations accounted for the NSDUH weighting variables and complex sample design. We used SPSS/PASW Statistics (version 18.0.3).

The control variables were age at interview (11 categories, treated as a continuous variable), gender (male, female), race/ethnicity (white, Hispanic, black, Asian, Native American, Native Hawaiian or Pacific Islander, more than one), household income (less than US$20,000, US$20,000-49,999, US$50,000-74,999, US$75,000 or more), education (not high school graduate, high school graduate, some college, college graduate), marital status (unmarried, married), likes to test self by doing risky things (never, seldom, sometimes, always), depressive episode before age 18 years (no, yes), and 10 types of lifetime drug use (cannabis/ marijuana, opiates, cocaine, sedatives/tranquilizers, stimulants, MDMA/ecstasy, inhaled anesthetics, amyl nitrates, other inhalants, phencyclidine). Additionally, in the analyses of past year use of LSD we also included as control variables past year use of the other drugs listed above, but with only one variable for any past year inhalant use because data on specific inhalants were not available.

Data analysis

We used multivariate logistic regression to calculate adjusted odds ratio (aOR) associations between mental health variables and lifetime use of any psychedelics, lifetime use of the specific psychedelics (LSD, psilocybin, mescaline/peyote, peyote) and past year use of LSD. We also calculated associations between mental health and use of any psychedelics in subgroups stratified on sex, age (18-25 years, 26 or older), past year illicit drug use and depressive episode before age 18.

All unstratified analyses had 25 or more events per control variable, and all stratified analyses had eight or more events per control variable (Vittinghoff and McCulloch, 2007). For all control variables the variance inflation factors were under 2.5, indicating little multi-collinearity.

Table 1. Sociodemographic and psychological variables

	Ever used psychedelics		Never used psychedelics		% used psychedelics
	wt%	N	wt%	N	wt%
Total	100%	19,299	100%	115,796	13.6%
Age					
18-25 years	13.8%	8609	14.9%	58,284	12.7%
26 years or older	86.2%	10,690	85.1%	57,512	13.7%
Sex					
Male	63.0%	11,625	45.9%	51,625	17.7%
Female	37.0%	7674	54.1%	64,171	9.7%
Race/ethnicity					
White	83.7%	15,556	65.5%	70,327	16.7%
Hispanic	8.1%	1705	14.9%	19,285	7.9%
Black	3.8%	531	12.7%	16,234	4.5%
Asian	1.3%	239	5.1%	4792	3.8%
Native American	1.0%	484	0.4%	1545	27.4%
Native Hawaiian or Pacific Islander	0.2%	46	0.4%	568	7.2%
More than one	1.9%	738	1.1%	3045	22.2%
Household income					
Less than US$20,000	16.5%	4613	18.6%	30,113	12.3%
US$20,000-49,999	30.1%	6638	33.3%	39,898	12.4%
US$50,000-74,999	18.2%	3127	17.2%	18,355	14.3%
US$75,000 or more	35.2%	4921	31.0%	27,430	15.2%
Education					
Not high school graduate	11.3%	2833	15.3%	19,407	10.4%
High school graduate	28.1%	6001	31.0%	38,256	12.5%
Some college	30.5%	6207	24.9%	33,361	16.2%
College graduate	30.0%	4258	28.8%	24,753	14.1%
Marital status					
Not married	52.5%	13,129	45.4%	74,077	15.4%
Married	47.5%	6163	54.6%	41,697	12.0%
Likes to test self by doing risky things					
Never	27.6%	4278	55.6%	53,388	7.3%
Seldom	44.7%	8258	32.4%	41,114	17.9%
Sometimes	25.0%	5871	11.0%	18,742	26.4%
Always	2.7%	871	1.1%	2266	28.3%
Depressive episode before age 18					
No	92.5%	17,067	97.1%	108,628	13.0%
Yes	7.5%	1961	2.9%	5923	29.2%
wt%: weighted percentage					

Results

Psychedelic users were more likely than non-users to report a depressive episode before age 18. They were also more likely to be younger, male, white, unmarried, with somewhat more education and income, to like doing risky things and to have used other drugs (Tables 1 and 2).

Table 2. Lifetime illicit drug use variables.

	Ever used psychedelics		Never used psychedelics		% used psychedelics
	wt%	N	wt%	N	wt%
Total	100%	19,299	100%	115,796	13.6%
Psychedelics					
LSD	74.9%	12,806	0%	0	100%
Psilocybin	66.7%	14,438	0%	0	100%
Mescaline/peyote	33.0%	4595	0%	0	100%
Peyote	17.6%	2512	0%	0	100%
Other drugs					
Cannabis	97.8%	18,899	36.0%	48,411	29.9%
Opiates	49.7%	11,223	9.5%	15,371	45.2%
Cocaine	71.3%	13,092	7.5%	8499	60.0%
Tranquilizers and sedatives	43.5%	8688	5.6%	7446	55.1%
Stimulants	37.5%	7109	3.7%	5092	61.4%
MDMA	32.9%	8407	2.0%	4119	32.9%
Inhaled anesthetics	28.6%	5893	1.5%	2515	74.4%
Alkyl nitrites	16.0%	2401	1.1%	1155	70.1%
Other inhalants	12.3%	2524	1.7%	2931	53.3%
PCP	17.7%	2567	0.4%	404	17.7%

wt%: weighted percentage

Lifetime psychedelic use

Lifetime psychedelic use was not associated with any of the indicators of mental health problems (aOR range 0.7-1.1). Rather, lifetime psychedelic use was associated with a lower likelihood of past year inpatient mental health treatment (aOR 0.8, 95% confidence interval (CI) 0.6-0.9, p=0.01) (Figure 1, Table 3). In our previous study this association was not statistically significant (aOR 0.9, 95% CI 0.7-1.2, p=0.53). Including respondents with missing data (with missing values set to the most common response) or excluding Native Americans (who may use peyote in a religious setting) did not substantially change the results.

Specific psychedelic use

Among the specific psychedelics (lifetime use of LSD, psilocybin, mescaline/peyote or peyote; past year use of LSD), we found 10 associations with a lower likelihood and one association with a greater likelihood of mental health problems (Table 4). Four of these associations were also statistically significant in our previous population study.

Associations between psilocybin use and lower likelihood of past year serious psychological distress, inpatient mental health treatment and psychiatric medication prescription were statistically significant both in this study (aOR 0.9, p=0.007; aOR 0.7, p=0.0004; aOR 0.8, p=0.002, respectively) and in our previous study (aOR 0.8, p=0.009; aOR 0.8, p=0.04; aOR 0.8, p=0.00008, respectively) (Krebs and Johansen, 2013b). Past year use of LSD was, with weak statistical significance, associated with lower likelihood of serious psychological distress (aOR 0.8, *p*=0.04); this was also consistent with our previous study (aOR 0.7, *p*=0.009).

Mescaline/peyote use was, with weak statistical significance, associated with a greater likelihood of past year symptoms of major depressive episode (aOR 1.2, *p*=0.02); however, mescaline/peyote use was not associated with diagnosis of depression (aOR 1.0, *p*=0.59) and peyote (mescaline-containing cactus) use was not associated with either symptoms of major depressive episode or diagnosis of depression (aOR 1.1, *p*=0.24; aOR 0.9, *p*=0.60, respectively). Furthermore, in our previous study, neither mescaline/peyote use nor peyote use was associated with past year symptoms of major depressive episode (aOR 0.9, *p*=0.14; aOR 0.9, *p*=0.67, respectively).

Table 3. Association of psychedelic use with mental health.

	Ever used psychedelics	Never used psychedelics	aOR[a] (95% CI)	*p*
	N	*N*		
Serious psychological distress in worst month of past year				
K6 scale	4165	15,525	0.9 (0.8-1.0)	0.12
Mental health treatment in past year				
Inpatient	694	1349	**0.8 (0.6-0.9)**	**0.01**
Outpatient	3108	8343	1.0 (0.9-1.1)	0.87
Medication	3472	11,282	1.0 (0.9-1.1)	0.77
Needed but did not receive	2534	6990	1.0 (0.9-1.1)	0.56
Suicidal thought and behavior in past year				
Thought about killing self	1748	5533	0.9 (0.8-1.0)	0.19
Planned to kill self	527	1654	0.8 (0.6-1.0)	0.09
Attempted to kill self	266	904	0.7 (0.5-1.0)	0.09
Depression and anxiety in past year				
Symptoms of major depressive episode	2446	8178	1.0 (0.9-1.2)	0.81
Diagnosis of depression	2352	7648	1.0 (0.8-1.1)	0.55
Diagnosis of an anxiety disorder	2095	5747	1.1 (0.9-1.2)	0.39

aOR: adjusted odds ratio (values less than 1.0 indicate lower likelihood); CI: confidence interval.
Bold text indicates $p < 0.05$.
[a] Adjusted for age (11 categories, treated as a continuous variable), gender (male, female), race/ethnicity (white, Hispanic, black, Asian, Native American, Native Hawaiian or Pacific Islander, more than one), household income (less than US$20,000, US$20,000-49,999, US$50,000-74,999, US$75,000 or more), education (not high school graduate, high school graduate, some college, college graduate), marital status (unmarried, married), likes to test self by doing risky things (never, seldom, sometimes, always), depressive episode before age 18 years (no, yes), and 10 types of lifetime drug use (cannabis/marijuana, opiates, cocaine, sedatives/tranquilizers, stimulants, MDMA/ecstasy, inhaled anesthetics, amyl nitrates, other inhalants, phencyclidine)

Stratified subgroups

In the stratified subgroups there were eight associations between psychedelic use and a decreased likelihood of various past year mental health problems, most with weak statistical significance, and none consistent with the stratified subgroups in our previous population study (Table 5). Notably, among people with a history of childhood depressive episode (before age 18 years), psychedelic use was associated with a lower likelihood of suicidal thoughts (aOR 0.8, *p*=0.01) and suicidal plan (aOR 0.5, *p*=0.002). Data on childhood depression and past year suicidal behavior were not available in our previous population study.

Table 4. Association between use of LSD, psilocybin, mescaline and peyote and mental health.

	LSD		Psilocybin		Mescaline/peyote		Peyote		LSD past year	
	aOR[a] (95% CI)	*p*	aOR[a] (95% CI)	*p*	aOR[a] (95% CI)	*p*	aOR[a] (95% CI)	*p*	aOR[b] (95% CI)	*p*
Serious psychological distress in worst month of past year										
K6-scale	0.9 (0.8-1.1)	0.38	0.9 (0.8-1.0)	**0.007**	0.9 (0.8-1.1)	0.37	0.8 (0.7-1.0)	0.05	**0.8 (0.6-1.0)**	**0.04**
Mental health treatment in past year										
Inpatient	0.8 (0.6-1.0)	0.02	0.7 (0.5-0.8)	**0.0004**	0.7 (0.6-0.9)	0.01	0.7 (0.5-1.0)	0.03	**0.5 (0.3-0.8)**	**0.002**
Outpatient	0.9 (0.8-1.0)	0.09	0.9 (0.8-1.1)	0.27	1.0 (0.9-1.2)	0.50	1.0 (0.8-1.2)	0.94	**0.7 (0.5-0.9)**	**0.01**
Medication	1.0 (0.9-1.2)	0.69	0.8 (0.7-0.9)	**0.002**	1.0 (0.9-1.1)	0.67	0.9 (0.8-1.1)	0.32	0.9 (0.6-1.2)	0.36
Needed but did not receive	0.9 (0.8-1.1)	0.21	1.0 (0.9-1.1)	0.835	1.1 (0.9-1.3)	0.28	0.9 (0.7-1.1)	0.35	0.9 (0.7-1.2)	0.59
Suicidal thought and behavior in past year										
Thought about killing self	0.9 (0.8-1.0)	0.07	1.0 (0.8-1.2)	0.95	1.0 (0.8-1.3)	0.78	0.9 (0.7-1.1)	0.31	0.9 (0.6-1.3)	0.68
Planned to kill self	0.8 (0.6-1.0)	0.06	0.9 (0.7-1.3)	0.71	1.0 (0.7-1.5)	0.79	0.7 (0.5-1.1)	0.12	1.1 (0.7-1.7)	0.80
Attempted to kill self	0.8 (0.5-1.2)	0.25	0.9 (0.6-1.3)	0.44	1.0 (0.7-1.6)	0.83	0.7 (0.4-1.2)	0.21	0.6 (0.2-1.7)	0.35
Depression and anxiety in past year										
Symptoms of major depressive episode	1.0 (0.8-1.2)	0.94	1.0 (0.8-1.2)	0.70	**1.2 (1.0-1.5)**	**0.02**	1.1 (0.9-1.4)	0.24	1.1 (0.8-1.4)	0.75
Diagnosis of depression	0.9 (0.8-1.1)	0.29	**0.8 (0.7-1.0)**	**0.01**	1.0 (0.8-1.1)	0.59	0.9 (0.8-1.2)	0.60	0.9 (0.6-1.3)	0.60
Diagnosis of an anxiety disorder	1.1 (0.9-1.3)	0.30	0.9 (0.8-1.1)	0.51	1.1 (0.9-1.4)	0.21	0.9 (0.7-1.1)	0.37	1.1 (0.7-1.5)	0.78

aOR: adjusted odds ratio (values less than 1.0 indicate lower likelihood); CI: confidence interval.
Bold text indicates $p < 0.05$.

[a] Adjusted for age (11 categories, treated as a continuous variable), gender (male, female), race/ethnicity (white, Hispanic, black, Asian, Native American, Native Hawaiian or Pacific Islander, more than one), household income (less than US$20,000, US$20,000-49,999, US$50,000-74,999, US$75,000 or more), education (not high school graduate, high school graduate, some college, college graduate), marital status (unmarried, married), likes to test self by doing risky things (never, seldom, sometimes, always), depressive episode before age 18 years (no, yes), and 10 types of lifetime drug use (cannabis/marijuana, opiates, cocaine, sedatives/tranquilizers, stimulants, MDMA/ecstasy, inhaled anesthetics, amyl nitrates, other inhalants, phencyclidine).

[b] Adjusted for above variables plus nine types of past year drug use (cannabis/marijuana, opiates, cocaine, sedatives/tranquilizers, stimulants, MDMA/ecstasy, inhalants, phencyclidine).

Table 5. Association of psychedelic use and mental health in stratified subgroups. Only results with $p < 0.05$ are shown.

Subgroup	Past year mental health indicator	aOR[a] (95% CI)	*p*
Female	Inpatient mental health treatment	0.7 (0.5-0.9)	0.01
Age 18-25	Serious psychological distress	0.9 (0.8-1.0)	0.008
Age 18-25	Psychiatric medication	0.8 (0.7-1.0)	0.03
Age 18-25	Attempted to kill self	0.7 (0.6-1.0)	0.03
Age 26 or older	Inpatient mental health treatment	0.8 (0.7-1.0)	0.04
No past year illicit drug use	Attempted to kill self	0.5 (0.2-0.9)	0.04
No depression before age 18	Inpatient mental health treatment	0.8 (0.6-0.9)	0.02
Depression before age 18	Thought about killing self	0.8 (0.6-0.9)	0.01
Depression before age 18	Planned to kill self	0.5 (0.4-0.8)	0.002

aOR: adjusted odds ratio (values less than 1.0 indicate lower likelihood); CI: confidence interval

[a] Adjusted for age (11 categories, treated as a continuous variable), gender (male, female), race/ethnicity (white, Hispanic, black, Asian, Native American, Native Hawaiian or Pacific Islander, more than one), household income (less than US$20,000, US$20,000-49,999, US$50,000-74,999, US$75,000 or more), education (not high school graduate, high school graduate, some college, college graduate), marital status (unmarried, married), likes to test self by doing risky things (never, seldom, sometimes, always), depressive episode before age 18 years (no, yes), and 10 types of lifetime drug use (cannabis/marijuana, opiates, cocaine, sedatives/tranquilizers, stimulants, MDMA/ecstasy, inhaled anesthetics, amyl nitrates, other inhalants, phencyclidine).

Discussion

Lack of associations with mental health or suicidality

We failed to find any associations between lifetime use of psychedelics and past year serious psychological distress, receiving or needing mental health treatment, depression, anxiety, or suicidal thoughts or behavior in the past year. Rather, lifetime use of psychedelics was associated with decreased inpatient psychiatric treatment. In addition to not being significantly different from no association, in all cases the calculated aORs were small (for all, psychedelic use aOR < 1.2).

Stratifying by age, gender, past year illicit drug use or childhood depressive episode did not substantially change the results of any of the logistic regression analyses. Likewise, lifetime use of LSD, psilocybin, mescaline or peyote, or past year use of LSD was not associated with a higher rate of mental health problems.

Most claims about the harms from psychedelics have been based on theoretical assumptions and case reports, which should be evaluated with caution. See our earlier population study of mental health among psychedelic users for further discussion about case reports and previous studies (Krebs and Johansen, 2013b).

The idea of 'flashbacks' and 'hallucinogen persisting perceptual disorder'

In particular, our previous population study (Krebs and Johansen, 2013b) did not support either the idea of 'flashbacks', described in extreme cases as recurrent psychotic episodes, hallucinations, or panic attacks, or the more recent 'hallucinogen persisting perceptual disorder' (HPPD), described as persistent visual phenomena with accompanying anxiety and distress, since lifetime use of psychedelics and past year use of LSD was not associated with past year symptoms of visual phenomena ('seeing something others could not'), panic attacks, psychosis or overall serious psychological distress. Recent randomized controlled trials with psilocybin have not reported any cases of flashbacks or persistent visual phenomena (Griffiths *et al.*, 2008, 2011; Studerus *et al.*, 2011). Interviews with over 500 regular participants in Native American peyote ceremonies did not identify anyone with flashbacks or persistent visual symptoms (Halpern *et al.*, 2005). Occasional visual phenomena are common in the general population, and all of the symptoms included in the purported HPPD are also present in people who have never used psychedelics. A recent study of 120 US adults troubled by HPPD-like persistent visual symptoms found a lower than average rate of psychedelic use (Schankin *et al.*, 2014). Overall, the validity of the HPPD diagnosis remains scant. HPPD may fit within the somatic symptom disorders. For further discussion, see Krebs and Johansen (2013b).

Psychedelics and personally significant experiences

Our results might reflect beneficial effects of psychedelic use, relatively better initial mental health among people who use psychedelics or chance 'false positive' findings. However, it is well documented that psychedelics elicit spiritual experiences. Indeed, long-term psychological benefits have been reported in several clinical trials of LSD, for example, 'About half of the total sample felt they had achieved more understanding and acceptance of themselves and a broader tolerance of the view points of others via the LSD experience' (McGlothlin and Arnold, 1971). In a recent randomized controlled trial of psilocybin, most of the participants (67%) regarded the experience as one of the most personally significant moments in their lives (comparable to the birth of a first child) (Griffiths *et al.*, 2006) and, furthermore, most of the participants (64%) reported improved wellbeing or life satisfaction 14 months later (Griffiths *et al.*, 2006, 2008; MacLean *et al.*, 2011). People often report long-term benefits from LSD use (Morgan *et al.*, 2010). No serious adverse events have been reported in recent randomized controlled trials of psilocybin, demonstrating that psychedelics can be administered safely in medical contexts (Griffiths *et al.*, 2008, 2011; Johnson *et al.*, 2008; Studerus *et al.*, 2011). Case-control and longitudinal studies have not found evidence of increased mental health problems among people who have used traditional psychedelics (peyote or ayahuasca) hundreds of times in legally recognized religious ceremonies (Bouso *et al.*, 2012; Halpern *et al.*, 2005).

Limitations

This study had a retrospective, cross-sectional design, making it impossible to draw causal inferences. Many potentially important risk factors, such as family mental health history, were not available. Longitudinal data were not available on mental health or other factors before psychedelic use. We cannot exclude the possibility that use of psychedelics might have a negative effect on mental health for some individuals or groups, which might be counterbalanced at a population level by a positive effect on mental health for others. People who choose to use psychedelics might have better initial mental health before using psychedelics, and people who experience problems apparently related to psychedelics may choose to not use them again. We did not adjust for multiple comparisons, so some of the associations with weak statistical significance are likely due to chance. Screening questions, rather than diagnostic interviews, were used as symptom indicators. We did not have data on setting of use or factors that might influence the experience of psychedelics. The study also relied on self-reports of drug use. Participants' answers to the questions on behaviors and mental health could be influenced by memory errors and under-reporting; however, a 14-year longitudinal study reported good consistency over time in reporting of LSD use (Johnston and O'Malley, 1997). Use of dimethyltryptamine (DMT), found in the shamanic brew ayahuasca, could not be determined from the data set; however, recent studies of people who have used ayahuasca hundreds of times have not detected evidence of problems (Bouso *et al.*, 2012). Dosage and purity of street drugs is often unknown and, in particular, substances sold as mescaline often contain LSD or other substances (Laing and Siegel 2003). A small group (< 2%) of US adults in prison, hospital or military service was not included in the NSDUH sampling.

Lack of association with suicidal behavior

This study did not find any associations between psychedelic use and increased likelihood of past year suicidal thoughts, plans or attempts. Rather, among people with childhood depression, those who had used psychedelics had lower likelihood of past year suicidal thoughts and plans.

There is little evidence linking psychedelic use to later suicide. A study of 178 adolescents with psychosis reported that suicide attempt was more likely among those who had used LSD, but there was no adjustment for other factors and it was not recorded whether the suicide attempt occurred before or after LSD use (Shoval *et al.*, 2006). A case-control study of 96 adolescents with depression reported that suicide attempt was more likely among those with hallucinogen abuse or dependence, but 'hallucinogen' was not defined and likely included drugs such as MDMA and PCP, there was little adjustment for other factors, and it was not recorded whether the suicide attempt occurred before or after hallucinogen use (Kelly *et al.*, 2002).

In the past, some people seem to have assumed that taking psychedelics, or indeed engaging in any introspective practice, could lead to depression and suicide because of the supposedly disturbing and disappointing nature of self-knowledge (Evang, 1968); however, there now seems to be greater acceptance of introspective practices (such as 'mindfulness' or meditation) among the public and mental health professionals. In a small number of publicized cases, relatives or anti-psychedelic campaigners have blamed an individual's suicide on prior psychedelic use, without evidence of any clear connection. For instance, in 1909 a Native American peyote church member killed himself (Stewart, 1987), and his death was then cited as evidence against peyote; in the 1960s there were a few cases where relatives blamed a suicide on prior LSD use (Mikkelson and Mikkelson, 2005). In surveys of US, Canadian and British physicians who administered LSD to thousands of psychiatric patients in the 1950s, 1960s and 1970s, a small number of suicides and suicide attempts were reported (in people with prior suicide attempt or serious mental illness) in the year or so after taking a dose of LSD (Canada Department of National Health and Welfare, 1973; Cohen 1960; Malleson 1971; US Senate, Committee on Government Operations, Subcommittee on Executive Reorganization, 1968). Based on these and other studies, the rate of adverse events following clinical treatment with LSD was considered to be similar to that expected among psychiatric patients in general, and overall LSD was considered to have acceptable safety for clinical use (Canada Department of National Health and Welfare, 1973; Home Office, Department of Health and Social Security, 1970; US Senate, Committee on Government Operations, Subcommittee on Executive Reorganization, 1968).

When evaluating case reports of suicide in psychedelic users, it is important to note that suicide is one of the most common causes of death in the general population: approximately two out of every 100 people in the US will die by suicide (CDC, 2013). Cases of suicide or death due to other causes during the direct effects of psychedelics are extremely rare, despite the fact that millions of doses are consumed annually (EMCDDA, 2011). It is of note that many of the stories from 50 years ago about death or injury of people while on LSD appear to be unsubstantiated urban legends (Siff, 2008).

Comments on the history of national and international control of psychedelics

Concern about psychedelic use seems to have been based on media sensationalism, lack of information and cultural biases, rather than evidence-based harm assessments. As examples of cultural biases, a 1967 case series of five university students with 'prolonged adverse reactions' to peyote consisted of a homosexual student who started a relationship with another male student, a student with pre-existing depression who wanted to travel to India and study Eastern religions, a student who left school and became a 'beatnik', a student who was prompted to seek psychotherapy for pre-existing social anxiety and paranoia about homosexuals, and an engineering student who had visions while falling asleep and eventually took a break from school to do volunteer work (Kleber, 1967). There was a common view in the early 20th century that mystical or transcendent experiences were, almost by definition, delusional and anti-scientific, and that self-exploration without the supervision of a trained therapist was dangerous (Evang, 1968; Hayman, 1964). While discussing psychedelics, psychiatrist Max Hayman wrote, 'The practices of the Christian mystics constitute one of the most tragic chapters of human history... Science is the path we have chosen to aid in man's growth and development, and mysticism in whatever guise is a contaminant of the scientific attitude' (Hayman, 1964). In an influential 1966 *Time* magazine interview, psychiatrist Sidney Cohen, one of the most prominent critics of the emerging psychedelic culture, commented on his own LSD experience: 'I got a massive jolt that I'll never forget. I got a chance to really look at myself, and I didn't like some of the things I saw' (*Time*, 1966).

The original World Health Organization (WHO) assessment of psychedelics, prepared for the 1971 Convention on Psychotropic Substances, claimed that psychedelics caused a list of problems; however, the references cited included no evidence of harm from psilocybin, mescaline or DMT, and only a small number of case reports and anecdotes of possibly LSD-related adverse effects (Isbell and Chrusciel, 1970; WHO Expert Committee on Drug Dependence, 1969). Central to the argument for international restrictions on psychedelics was the claim that psychedelics caused a special 'LSD-type' dependence, defined as 'periodic' use amongst 'arty-type' people (Eddy *et al.*, 1965; Isbell and Chrusciel, 1970; WHO Expert Committee on Drug Dependence, 1969). Psychedelics were claimed to have 'high abuse potential' simply because there were reports of their use (Isbell and Chrusciel, 1970). The WHO report acknowledged that LSD and other psychedelics 'are usually taken in the hope of inducing a mystical experience leading to a greater understanding of the users' personal problems and of the universe' and that people diagnosed with mental disorders following psychedelic use 'are generally believed to have been persons who were "predisposed" to psychiatric disease' (Isbell and Chrusciel, 1970).

As noted recently by the British Medical Association (BMA), 'The cultural and social attitudes surrounding illegal drugs mean that their classification and legal status do not directly relate to the health risks they pose to users and communities' (BMA, 2012). A 1970 assessment of LSD by the UK Home Office acknowledged that use of LSD and other psychedelics was a sincere spiritual practice, noting, 'We have been content to accept the sincerity of those of our witnesses who claimed that some people have reached a greater awareness and insight into their own problems and, indeed, into the meaning of life itself, through their use of LSD'. The UK assessment explained that 'there is a presumption in favour of allowing adult men and women to consume whatever substances they please, but this presumption must be overridden in circumstances in which such freedom results in a serious danger to public health... [Evidence for which] would have to be kept under continual review in the light of rapidly developing scientific knowledge and accelerating social change' (Home Office, Department of Health and Social Security, 1970). The only epidemiological data on non-clinical use of LSD included in the UK assessment was a table showing that 127 people who were admitted to UK psychiatric hospitals in 1966-1968 had reported having tried LSD at some point, not necessarily related to the hospital visit (Home Office, Department of Health and Social Security, 1970); these cases were a surely a tiny fraction of total psychiatric admissions or total LSD users at that time. We failed to find, in this study or in our previous population study, evidence linking past year LSD use to increased likelihood of inpatient mental health treatment (Krebs and Johansen, 2013b).

A 1975 report from the US National Institute of Mental Health noted that people who use LSD 'repetitively in a social pattern' 'cannot be characterized by any specific psychiatric label' and called for more 'scientific study of hallucinogen-derived mystical experiences... described as powerful and sometimes transforming' (Segal, 1975). A 1968 US Senate report on LSD policy noted that all expert witnesses were opposed to criminalizing LSD use and concluded: 'The tardy reaction of the Government was rash and excessive, resulting in the termination of almost all research... As protector of the public safety and supporter to medical research, the Government had an obligation to maintain a balanced perspective concerning LSD at a time of public tumult. It failed to do so' (US Senate Committee on Government Operations, Subcommittee on Executive Reorganization, 1968). LSD, psilocybin, mescaline and several other psychedelics are included in Schedule I of the US Controlled Substances Act of 1970; these substances were simply placed in Schedule I by Congress without an evidence-based assessment to determine whether LSD and other psychedelics met criteria to be added to Schedule I. There may have been a political rather than public health rationale behind the criminalization of psychedelic users. It is deeply troubling to read an interview with John Ehrlichman, advisor to US President Richard Nixon, in which he explains that the War on Drugs was 'really about' hurting 'the antiwar Left, and black people', and openly admits, 'Did we know we were lying about the drugs? Of course we did' (Baum, 2012).

Conclusions

The results of this study are consistent with our previous population study, early and recent randomized controlled trials, studies of regular participants in legally recognized psychedelic religious ceremonies, drug education materials from public agencies and recent expert assessments of drug harms (Krebs and Johansen, 2013b). There is little evidence linking psychedelic use to lasting mental health problems. In general, use of psychedelics does not appear to be particularly dangerous when compared to other activities considered to have acceptable safety. It is important to take a statistical perspective to risk, rather than focusing on case reports and anecdotes: 'Nothing in life is free from risk - risk is simply impossible to avoid... Even ordinary activities - eating breakfast, watching television, walking the dog - carry risks, however minor' (BMA, 2012). As Steven Pinker recently noted, 'In a free society, one cannot empower the government to outlaw any behavior that offends someone just because the offendee can pull a hypothetical future injury out of the air' (Pinker, 2008). Overall, it is difficult to see how prohibition of psychedelics can be justified from a public health or human rights perspective.

Acknowledgements

The Substance Abuse and Mental Health Data Archive provided the public use data files from the National Survey on Drug Use and Health, which was sponsored by the Office of Applied Studies of the Substance Abuse and Mental Health Services Administration.

Declaration of Conflicting Interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: TSK is board leader and PØJ is a board member of EmmaSofia, a non-profit organization based in Oslo, Norway, working to increase access to quality-controlled MDMA and psychedelics (www.emmasofia.org). PØJ is also a board member of the Association for a Humane Drug Policy, Oslo, Norway (www.fhn.no).

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Research Council of Norway (grant number 185924).

References

1. American Psychiatric Association (1994) *Diagnostic and Statistical Manual of Mental Health Disorders*, 4th edn. Washington DC: American Psychiatric Association.
2. Baum D (2012) Truth, lies, and audiotape. In: Smith L (ed), *The Moment: Wild, Poignant, Life-Changing Stories from 125 Writers and Artists Famous & Obscure*. New York: Harper Perennial.
3. Baumeister D, Barnes G, Giaroli G, *et al*. (2014) Classical hallucinogens as antidepressants? A review of pharmacodynamics and putative clinical roles. *Ther Adv Psychopharmacol* 4: 156-169.
4. BMA (2012) Risk: What's your perspective? Available at: http://bmaopac.hosted.exlibrisgroup.com/exlibris/aleph/a21_1/apache_ media/YIVHJTLF47Q118N114JPHDHV6RU6GP.pdf (accessed 1 November 2014).
5. Bogenschutz MP (2013) Studying the effects of classic hallucinogens in the treatment of alcoholism: Rationale, methodology, and current research with psilocybin. *Curr Drug Abuse* Rev 6: 17-29.
6. Bonson KR (2012) Hallucinogenic drugs. In: *eLS*. Chichester: John Wiley & Sons. epub ahead of print DOI: 10.1002/9780470015902. a0000166.pub2.
7. Bouso JC, González D, Fondevila S, *et al*. (2012) Personality, psychopathology, life attitudes and neuropsychological performance among ritual users of ayahuasca: A longitudinal study. *PLoS ONE* 7: e42421.
8. Bruhn JG, De Smet PA, El-Seedi HR, *et al*. (2002) Mescaline use for 5700 years. *Lancet* 359: 1866.
9. CAM (Coördinatiepunt Assessment en Monitoring nieuwe drugs) (2007) *Aanvullende informatie paddoincidenten in Amsterdam* [Additional information on mushroom incidents in Amsterdam]. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu. Available at: www.rivm.nl/bibliotheek/digitaaldepot/cam_paddo_aanvulling.pdf (accessed 1 November 2014).
10. Canada Department of National Health and Welfare (1973) Final report of the Commission of Inquiry into the Non-Medical Use of Drugs. Ottawa: Information Canada. p. 376.
11. Carhart-Harris RL and Nutt DJ (2010) User perceptions of the benefits and harms of hallucinogenic drug use: A web-based questionnaire study. *J Subst Abuse* 15: 283-300.
12. CDC (2013) Deaths and mortality. Available at: www.cdc.gov/nchs/fastats/deaths.htm (accessed 1 November 2014).
13. CDC (2014) Emergency department visits. Available at: www.cdc.gov/nchs/fastats/emergency-department.htm (accessed 1 November 2014).
14. Cohen S (1960) Lysergic acid diethylamide: Side effects and complications. *J Nerv Ment Dis* 130: 30-40.
15. Collier J (1952) The peyote cult. *Science* 115: 503-504.
16. Eddy NB, Halbach H, Isbell H, *et al*. (1965) Drug dependence: Its significance and characteristics. *Bull World Health Organ* 32: 721-733.
17. EMCDDA (2011) Drug profiles: Lysergide (LSD). Available at: www.emcdda.europa.eu/publications/drug-profiles/lsd (accessed 1 November 2014).
18. Evang K (1968) LSD: New menace to youth. *UNESCO Courier*, May, 18-20
19. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology (Berl)* 218: 649-665.
20. Griffiths R, Richards W, Johnson M, *et al*. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632
21. Griffiths RR, Richards WA, McCann U, *et al*. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology (Berl)* 187: 268-283.
22. Halberstadt AL (2015) Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behav Brain Res* 277: 99-120.
23. Hallock RM, Dean A, Knecht ZA, *et al*. (2013) A survey of hallucinogenic mushroom use, factors related to usage, and perceptions of use among college students. *Drug Alcohol Depend* 130: 245-248.
24. Halpern JH, Sherwood AR, Hudson JI, *et al*. (2005) Psychological and cognitive effects of long-term peyote use among Native Americans. *Biol Psychiatry* 58: 624-631.
25. Hayman M (1964) Science, mysticism and psychopharmacology. *Calif Med* 101: 266-271.
26. Hendricks PS, Clark CB, Johnson MW, *et al*. (2014) Hallucinogen use predicts reduced recidivism among substance-involved offenders under community corrections supervision. *J Psychopharmacol* 28: 62-66.
27. Home Office, Department of Health and Social Security (1970) *The amphetamines and lysergic acid diethylamide (LSD)*. Report by the Advisory Committee on Drug Dependence. London: Her Majesty's Stationery Office.
28. Isbell H and Chrusciel TL (1970) Dependence liability of 'non-narcotic' drugs. *Bull World Health Organ* 43 (Suppl): 5-111.
29. Johnson M, Richards W and Griffiths R (2008) Human hallucinogen research: Guidelines for safety. *J Psychopharmacol* 22: 603-620.
30. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al*. (2014) Pilot study of the 5-$HT_{2A}R$ agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
31. Johnston LD and O'Malley PM (1997) The recanting of earlier reported drug use by young adults. *NIDA Res Monogr* 167: 59-80.
32. Kelly TM, Cornelius JR and Lynch KG (2002) Psychiatric and substance use disorders as risk factors for attempted suicide among adolescents: A case control study. *Suicide Life Threat Behav* 32: 301-312.
33. Kessler RC, Barker PR, Colpe LJ, *et al*. (2003a) Screening for serious mental illness in the general population. *Arch Gen Psychiatry* 60: 184-189.
34. Kessler RC, Berglund P, Demler O, *et al*. (2003b) The epidemiology of major depressive disorder: Results from the National Comorbidity Survey Replication (NCS-R). *JAMA* 289: 3095-3105.
35. Kessler RC, Green JG, Gruber MJ, *et al*. (2010) Screening for serious mental illness in the general population with the K6 screening scale: Results from the WHO World Mental Health (WMH) survey initiative. *Int J Methods Psychiatr Res* 19 (Suppl

1): 4-22.

36. Kleber HD (1967) Prolonged adverse reactions from unsupervised use of hallucinogenic drugs. *J Nerv Ment Dis* 144: 308-319.
37. Krebs TS and Johansen PØ (2012) Lysergic acid diethylamide (LSD) for alcoholism: Meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
38. Krebs TS and Johansen PØ (2013a) Over 30 million psychedelic users in the United States. *F1000Res* 2: 98.
39. Krebs TS and Johansen PØ (2013b) Psychedelics and mental health: A population study. *PLoS ONE* 8: e63972.
40. La Barre W, McAllester DP, Slotkin JS, *et al*. (1951) Statement on peyote. *Science* 114: 582-583.
41. Laing R and Siegel JA (eds) (2003) Hallucinogens: *A Forensic Drug Handbook*. Waltham, MA: Academic Press.
42. Le Farge O (1960) Defining peyote as a narcotic. *Am Anthropologist* 62: 687-689.
43. McGlothlin WH and Arnold DO (1971) LSD revisited. A ten-year follow-up of medical LSD use. *Arch Gen Psychiatry* 24: 35-49.
44. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
45. McWilliams SA and Tuttle RJ (1973) Long-term psychological effects of LSD. *Psychol Bull* 79: 341-351.
46. Malleson N (1971) Acute adverse reactions to LSD in clinical and experimental use in the United Kingdom. *Br J Psychiatry* 118: 229-230.
47. Mikkelson B and Mikkelson DP (2005) Death of Diane Linkletter. *Urban Legends Reference Pages*. Available at: www.snopes.com/horrors/ drugs/linkletter.asp (accessed 1 November 2014).
48. Morgan CJ, Muetzelfeldt L, Muetzelfeldt M, *et al*. (2010) Harms associated with psychoactive substances: Findings of the UK National Drug Survey. *J Psychopharmacol* 24: 147-153.
49. Newberne RE and Burke CH (1922) Peyote: *An Abridged Compilation from the Files of the Bureau of Indian Affairs*. Washington DC: US Government Printing Office. Available at: http://archive.org/details/peyoteabridgedco00unit (accessed 1 November 2014).
50. Nutt DJ, King LA and Nichols DE (2013) Effects of Schedule I drug laws on neuroscience research and treatment innovation. *Nat Rev Neurosci* 14: 577-585.
51. Nutt DJ, King LA, Phillips LD; Independent Scientific Committee on Drugs (2010) Drug harms in the UK: A multicriteria decision analysis. *Lancet* 376: 1558-1565.
52. Nutt D, King LA, Saulsbury W, *et al*. (2007) Development of a rational scale to assess the harm of drugs of potential misuse. *Lancet* 369: 1047-1053.
53. Pinker S (2008) The stupidity of dignity. *New Republic* 28 May 2008. Available at: http://pinker.wjh.harvard.edu/articles/media/The%20Stupidity%20of%20Dignity.htm (accessed 1 November 2014).
54. Schankin CJ, Maniyar FH, Digre KB, *et al*. (2014) 'Visual snow' - a disorder distinct from persistent migraine aura. *Brain* 137: 1419- 1428.
55. Segal J (ed) (1975) *Research in the service of mental health*. Report of the Research Task Force of the National Institute of Mental Health. Washington, DC: US Government Printing Office.
56. Shoval G, Sever J, Sher L, *et al*. (2006) Substance use, suicidality, and adolescent-onset schizophrenia: An Israeli 10-year retrospective study. *J Child Adolesc Psychopharmacol* 16: 767-775.
57. Siff SI (2008) *Glossy visions: Coverage of LSD in popular magazines, 1954-1968* (electronic thesis or dissertation). Available online at: http://etd.ohiolink.edu/ap/10?0::NO:10:P10_ACCESSION_ NUM:ohiou1225818399 (accessed November 1 2014).
58. Stewart OC (1987) *Peyote Religion: A History*. Norman, OK: University of Oklahoma Press, p. 168.
59. Studerus E, Kometer M, Hasler F, *et al*. (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: A pooled analysis of experimental studies. *J Psychopharmacol* 25: 1434-1452.
60. Taylor M, Mackay K, Murphy J, *et al*. (2012) Quantifying the RR of harm to self and others from substance misuse: Results from a survey of clinical experts across Scotland. *BMJ Open* 2. DOI: 10.1136/ bmjopen-2011-000774.
61. *Time* (1966) An epidemic of acid heads. Time, 11 March 1966, p.56.
62. United Nations General Assembly (1948) Universal declaration of human rights. Available at: www.refworld.org/docid/3ae6b3712c. html (accessed 1 November 2014).
63. US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality (2013) Drug Abuse Warning Network (DAWN), 2010. ICPSR34083-v2. Report, Ann Arbor, MI: InterUniversity Consortium for Political and Social Research.
64. US Senate, Committee on Government Operations, Subcommittee on Executive Reorganization (1968) *Organization and Coordination of Federal Drug Research and Regulatory Programs: LSD*. Washington, DC: US Government Printing Office. p. 7.
65. van Amsterdam J, Opperhuizen A, Koeter M, van den Brink W (2010) Ranking the harm of alcohol, tobacco and illicit drugs for the individual and the population. Eur Addict Res 16: 202-7. doi: 10.1159/000317249.
66. van Amsterdam J, Opperhuizen A, Koeter M, *et al*. (2010) Ranking the harm of alcohol, tobacco and illicit drugs for the individual and the population. *Eur Addict Res* 16: 202-207.
67. Vittinghoff E and McCulloch CE (2007) Relaxing the rule of ten events per variable in logistic and Cox regression. *Am J Epidemiol* 165: 710-718.
68. Walsh C (2014). Beyond religious freedom: Psychedelics and cognitive liberty. In: Labate BC and Cavnar C (eds) *Prohibition, Religious Freedom, and Human Rights: Regulating Traditional Drug Use*. Berlin: Springer, pp. 211-233.
69. WHO Expert Committee on Drug Dependence (1969) Sixteenth report. Technical Report Series 407. Vienna: United Nations. Available at: http://whqlibdoc.who.int/trs/WHO_TRS_407.pdf (accessed 1 November 2014).

Psilocybin-assisted treatment for alcohol dependence

A proof-of-concept study

by

Michael P Bogenschutz[1], Alyssa A Forcehimes[1], Jessica A Pommy[1], Claire E Wilcox[1], PCR Barbosa[2] and Rick J Strassman[1]

Journal of Psychopharmacology 1-11

© The Author(s) 2015

original report:
http://www.ouramazingworld.org/uploads/4/3/8/6/43860587/2015-bogenschutz-psilocybin-assisted_treatment_for_alcohol_dependence-_a_proof-of-concept_study.pdf
backup source:
http://www.psilosophy.info/resources/2015-bogenschutz-psilocybin-assisted_treatment_for_alcohol_dependence-_a_proof-of-concept_study.pdf

[1] Department of Psychiatry, University of New Mexico Health Sciences Center, Albuquerque, NM, USA
[2] Departamento de Filosofia e Ciencias Humanas Ilheus, Universidade Estadual de Santa Cruz, Bahia, Brazil

Corresponding author:
Michael P Bogenschutz, Department of Psychiatry, Center for Psychiatric Research, University of New Mexico Health Sciences Center, MSC11 6035, 1 University of New Mexico, Albuquerque, NM 87131-0001, USA. Email: mbogenschutz@salud.unm.edu

sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/0269881114565144

Table of Contents:

- **Abstract**
- **Introduction**
  - Biological mechanisms
  - Psychological models of psychedelic treatment
- **Methods**
  - Study design
  - Participants
  - Interventions
    - *Psychosocial intervention*
    - *Dosing and administration of study medications*
  - Assessments
    - *Medical evaluation*
    - *Psychiatric and substance use disorder diagnoses*
    - *Acute hallucinogen effects*
    - *Substance use and consequences*
    - *Psychological assessments*
    - *Safety assessment*
  - Statistical analysis and power
- **Results**
  - Participants
  - Treatment exposure and follow-up
  - Acute effects
  - Clinical outcomes
  - Relationships between acute effects and treatment response

Treatment-related adverse events
Discussion
Acknowledgements
References

Abstract

Several lines of evidence suggest that classic (5-HT$_{2A}$ agonist) hallucinogens have clinically relevant effects in alcohol and drug addiction. Although recent studies have investigated the effects of psilocybin in various populations, there have been no studies on the efficacy of psilocybin for alcohol dependence. We conducted a single-group proof-of-concept study to quantify acute effects of psilocybin in alcohol-dependent participants and to provide preliminary outcome and safety data. Ten volunteers with DSM-IV alcohol dependence received orally administered psilocybin in one or two supervised sessions in addition to Motivational Enhancement Therapy and therapy sessions devoted to preparation for and debriefing from the psilocybin sessions. Participants' responses to psilocybin were qualitatively similar to those described in other populations. Abstinence did not increase significantly in the first 4 weeks of treatment (when participants had not yet received psilocybin), but increased significantly following psilocybin administration ($p < 0.05$). Gains were largely maintained at follow-up to 36 weeks. The intensity of effects in the first psilocybin session (at week 4) strongly predicted change in drinking during weeks 5-8 ($r = 0.76$ to $r = 0.89$) and also predicted decreases in craving and increases in abstinence self-efficacy during week 5. There were no significant treatment-related adverse events. These preliminary findings provide a strong rationale for controlled trials with larger samples to investigate efficacy and mechanisms.
TRIAL REGISTRATION: NCT02061293

Keywords: Addiction treatment, alcoholism, hallucinogens, psilocybin, clinical trial, motivational interviewing

Introduction

In the 1950s through early 1970s there was extensive research on the use of LSD and other classic (5-HT$_{2A}$ agonist or partial agonist) hallucinogens in the treatment of addiction (Abuzzahab and Anderson, 1971; Dyck, 2006; Grinspoon and Balakar, 1997; Halpern, 1996; Mangini, 1998), existential distress in dying patients (Grof *et al.*, 1973; Pahnke *et al.*, 1969; Richards, 1975; Richards *et al.*, 1977), pain (Kast, 1966; Kast and Collins, 1964), and other conditions (Grinspoon and Balakar, 1997; Grof, 2008). A recent meta-analysis (Krebs and Johansen, 2012) examined the six published randomized trials (Bowen *et al.*, 1970; Hollister *et al.*, 1969; Ludwig *et al.*, 1969; Pahnke *et al.*, 1970; Smart *et al.*, 1966; Tomsovic and Edwards, 1970) of LSD treatment of alcoholism. A total of 325 participants received active treatment with LSD, and 211 received control treatment. At the first post-treatment follow-up (ranging from 1 month to 12 months) the odds ratio for improvement was 1.96, favoring LSD (95% confidence interval 1.36-2.84, $Z = 3.59$, $p=0.0003$).

The past decade has seen a rapid growth of interest in potential clinical applications of the classic hallucinogen psilocybin (Bogenschutz, 2012; Burdick and Adinoff, 2013; Carhart-Harris *et al.*, 2012, 2013; Garcia-Romeu *et al.*, 2013; Grob *et al.*, 2011; Kometer *et al.*, 2012; Nichols, 2014). Using a double-blind, cross-over design, Grob *et al.* administered psilocybin 0.2 mg/kg vs. placebo to 12 patients with anxiety related to advanced cancer (Grob *et al.*, 2011). Participants showed significant improvement with time, and there were statistical trends suggesting a positive effect of psilocybin on mood. Additional clinical trials in cancer patients are currently nearing completion at Johns Hopkins University and New York University (Nichols, 2014). A recent pilot study of psilocybin as an adjunct in smoking cessation treatment resulted in remarkable rates of abstinence (80% point abstinence at 6-month follow-up) (Johnson *et al.*, 2014). Extensive clinical research with the classic hallucinogens (LSD, psilocybin, DMT, mescaline) has established their relative safety within a clinical research setting when subjects are carefully screened, supervised, and followed up (Strassman, 1984). A number of articles and chapters have reviewed the literature on the use of hallucinogens in the treatment of addictions (Abuzzahab and Anderson, 1971; Dyck, 2006; Grinspoon and Balakar, 1997; Halpern, 1996; Mangini, 1998), with the recent addition of two reviews that incorporate current research on the effects of classic hallucinogens more generally and discuss possible mechanisms of action (Bogenschutz and Pommy, 2012; Ross, 2012).

Biological mechanisms

Although classic hallucinogens bind to many serotonin receptor subtypes and other receptors (Ray, 2010), the psychoactive effects of all classic hallucinogens appear to depend primarily on their actions at 5-HT$_{2A}$ receptors (Nichols, 2004; Vollenweider and Kometer 2010; Vollenweider *et al*., 1998). Administration of classic hallucinogens in rat models has been shown to induce down-regulation of 5-HT$_{2A}$ receptors, particularly those in the anterior cingulate and frontomedial cortex, likely accounting for the rapid development and reversal of behavioral tolerance to most classic hallucinogens (Buckholtz *et al*., 1990; Gresch *et al*., 2005).

The behavioral correlates and effects of 5-HT$_{2A}$ receptor activity are complex. Increased 5-HT$_{2A}$ receptor binding has been found in relation to pathological conditions in humans including depression (Shelton *et al*., 2009), impulsive aggression (Rosell *et al*., 2010), neuroticism (Frokjaer *et al*., 2008), borderline personality disorder (Soloff *et al*., 2007), and suicide (Anisman *et al*., 2008). The relationship of 5-HT$_{2A}$ receptor binding/activity and alcoholism or alcohol exposure is less clear. Family history of alcoholism may be associated with lower 5-HT$_{2A}$ binding (Underwood *et al*., 2008), and alcoholism is not consistently associated with change in 5-HT$_{2A}$ receptor levels (Thompson *et al*., 2012; Underwood *et al*., 2008). Among alcoholics, one small post-mortem study reported that higher impulsivity was associated with increased 5-HT$_{2A}$ receptor binding (Thompson *et al*., 2012). In animal models, alcohol exposure has been associated with region-specific increases (Akash *et al*., 2008) and decreases (George *et al*., 2010) in 5-HT$_{2A}$ receptors binding. Studies indicate that increased activity in 5-HT$_{2A}$mediated pathways relative to 5-HT$_{2C}$ activity increases cue response and impulsivity in rat models of cocaine addiction (Cunningham and Anastasio, 2014). 5-HT$_{2A}$ antagonists suppress alcohol consumption in animal models (Johnson, 2008). However, two large trials of the 5-HT$_{2A}$ antagonist ritanserin failed to demonstrate beneficial effects in people with alcohol dependence (Johnson *et al*., 1996; Wiesbeck *et al*., 1999).

Animal studies suggest mechanisms by which acute activation of 5-HT$_{2A}$ receptors could activate intracellular signaling pathways resulting in persisting changes in cellular structure and synapses. The classic hallucinogen DOI increases expression of glial cell line-derived neurotrophic factor (GDNF) mRNA in glioiblastoma cells by a 5-HT$_{2A}$-dependent mechanism (Tsuchioka *et al*., 2008). Through its action on 5-HT$_{2A}$ receptors, DOI has also been shown to increase levels of mRNA for brain-derived neurotrophic factor (BDNF) in rat parietal cortex and other neocortical regions, with decreases in the hippocampus and no change in piriform cortex (Vaidya *et al*., 1997). These findings are relevant because levels of BDNF and GDNF are inversely related to alcohol consumption and conditioned place preference in animal models (Ghitza *et al*., 2010). DOI activates intracellular signaling cascades associated with dendritic spine remodeling on rat pyramidal cells, and transiently increases the size of dendritic spines on cortical neurons (Jones *et al*., 2009).

Psychological models of psychedelic treatment

Clinical work with classic hallucinogens has emphasized the central role of the altered state of consciousness experienced during the drug's acute effects (Grof, 2008; Hoffer, 1967; Masters and Houston, 2000; Pahnke *et al*., 1970; Sherwood *et al*., 1962). The "psycholytic" model of treatment emphasized the use of classic hallucinogens to enhance the process of psychodynamic psychotherapy by making unconscious material more accessible (Leuner, 1967). The "psychedelic" treatment model on the other hand emphasized the use of relatively high doses of classic hallucinogens (usually LSD) to occasion a "peak-psychedelic" or mystical experience of ego loss, often likened to psychological death and rebirth (Kurland *et al*., 1967). The latter model was used in most of the clinical studies conducted in North America using LSD in the treatment of addiction or existential anxiety in the dying. The concept of a singular transformative experience leading to lasting behavior change is consistent with classic descriptions of religious conversion (James, 1902), "spiritual awakening" in the context of Alcoholics Anonymous (Forcehimes, 2004), and spontaneous Quantum Change experiences (Miller and C'de Baca, 2001). Recent studies have demonstrated that the self-reported "mystical" dimension of the psilocybin experience (feelings of unity, sacredness, ultimate reality, transcendence of time and space, deeply felt positive mood, and ineffability (Pahnke, 1963)) significantly predicts the lasting personal significance of the experience (Griffiths *et al.*, 2008) and personality change (Maclean *et al.*, 2011) in normal volunteers receiving psilocybin.

The evidence summarized above provides a convincing rationale for investigating whether a classic hallucinogen can improve treatment response among patients with alcohol dependence. In spite of the accumulating evidence that psilocybin has clinically relevant effects and is safe under controlled conditions, there are no prior studies of psilocybin in the treatment of alcohol dependence. We therefore undertook a proof-of-concept study which aimed to quantify the psychoactive effects and tolerability of oral psilocybin in alcohol-dependent participants, and to evaluate outcomes during and after completion of treatment.

Methods

Study design

The study employed a single-group, within-subjects design. Participants received a 12-week, 14-session manualized intervention including two open-label psilocybin sessions in which psilocybin was administered: the first after 4 weeks of psychosocial treatment, the second after 8 weeks. Outcome data were collected for a total of 36 weeks.

Participants

Participants were recruited from the community using advertisements in local media and flyers. They were males and females age 25-65 with a diagnosis of active alcohol dependence, ascertained using the Structured Clinical Interview for DSM-IV (SCID) (First *et al.*, 1996), and at least two heavy drinking days in the past 30 days, who were concerned about their drinking and not currently in treatment. Participants were excluded if screening showed them to have exclusionary medical or psychiatric conditions; family history of schizophrenia, bipolar disorder, or suicide; cocaine, psychostimulant, or opioid dependence; or history of using hallucinogens more than 10 times (or any use in the past 30 days). Participants were required to be abstinent and not in alcohol withdrawal at the time of the psilocybin sessions. Participants provided written informed consent, and all study procedures were reviewed and approved by the IRB of the University of New Mexico Health Sciences Center.

Interventions

Psychosocial intervention

The psychosocial intervention comprised a total of 12 sessions: seven sessions of Motivational Enhancement Therapy (MET: a structured approach using the principles of motivational interviewing (Miller and Rolnick, 2013)), three preparation sessions, and two debriefing sessions. Four sessions occurred before the first psilocybin session, four sessions between the first and second psilocybin sessions, and four sessions after the second psilocybin session. The psychosocial intervention was conducted by a team of two therapists. One performed the seven MET sessions focused on changing drinking behavior, while the other was responsible for preparation before, support during, and debriefing after the psilocybin sessions. Both therapists were present for the preparation and debriefing sessions, as well as the psilocybin sessions. Three of the authors (MB, AF, CW) served as study therapists. Therapy sessions were audiorecorded. The first and third MET sessions were coded using the Motivational Interviewing Treatment Integrity (MITI 3.1) coding system (Moyers *et al.*, 2005) by a rater trained to reliability.

Dosing and administration of study medications

On the morning of the psilocybin sessions, participants were required to be afebrile, non-hypertensive, non-tachycardic, abstinent from alcohol for at least 24 hours, and without evidence of alcohol withdrawal. Urine drug screens were negative for cocaine, psychostimulants, and opioids, and breath was negative for alcohol.

The psilocybin sessions took place in a room that was specially prepared to provide a living-room-like environment for the sessions. Individualized doses of psilocybin (based on participant weight) were prepared by the study pharmacist on the morning of the session, and placed in a single gelatin capsule. Participants ingested the psilocybin capsule followed by 4 ounces of water. They were instructed to lie on a couch wearing eyeshades and headphones (providing a standardized program of music), and to direct their attention toward their internal experience. Participants remained under observation for at least 8 hours following psilocybin administration. Both therapists were present throughout the session. Interactions with the participants were supportive and non-directive. Medications were available for administration if needed to treat hypertension (sublingual nitroglycerin 0.4 mg), anxiety (lorazepam 1-2 mg PO/IM), or acute psychosis (ziprasidone 10-20 mg PO/IM). Beginning 7 hours after drug administration, participants completed questionnaires and assessments, and a brief clinical interview was performed, including mental status exam. Participants were escorted home at the end of the session by a family member or friend, who stayed with the participant overnight.

For the first psilocybin session, participants received a dose of 0.3 mg/kg. For the second session, the dose was increased to 0.4 mg/kg unless the participant (i) was unwilling to increase the dose; (ii) experienced adverse effects during the first session which suggested that a higher dose would pose significant risk; or (iii) reported a "complete" mystical experience during the first session (Griffiths *et al.*, 2006), indicating very strong effects from 0.3 mg/kg.

Assessments

Medical evaluation

Medical screening consisted of medical history and physical examination, ECG, liver function tests, complete blood count, blood chemistries, urinalysis, serum pregnancy test, and body mass index. Women of childbearing potential completed a menstrual calendar at each assessment visit, and urine pregnancy tests were completed prior to each drug administration session. The Clinical Institute Withdrawal Scale - Alcohol, revised (CIWA-Ar) (Sullivan *et al.*, 1989) was used to assess alcohol withdrawal at screening and before the psilocybin sessions.

Psychiatric and substance use disorder diagnoses

The SCID (First *et al.*, 1997) was used to diagnose DSM-IV Axis I disorders including substance abuse and dependence diagnoses.

Acute hallucinogen effects

Self-report scales (administered 7 hours after drug administration) and monitor ratings (0-6 hours after drug administration) were used to quantify acute subjective effects. The Intensity subscale of the Hallucinogen Rating Scale (HRS) (Strassman *et al.*, 1994) was used as a global measure of the intensity of the drug experience. The 5-Dimensional Altered States of Consciousness Scale (5D-ASC) (Dittrich, 1998) has 94 items using the visual analog scale format, yielding five primary dimensions: "Oceanic Boundlessness," "Dread of Ego Dissolution," "Visionary Restructuralization," "Auditory Alterations," and "Altered Vigilance." The States of Consciousness Scale is a 100-item questionnaire which has been used extensively to measure states of consciousness in hallucinogen administration experiments (Griffiths *et al.*, 2006; Pahnke, 1963, 1969; Richards *et al.*, 1977; Turek *et al.*, 1974). This scale contains the 43 items of the Pahnke-Richards Mystical Experience Questionnaire (MEQ) (Griffiths *et al.*, 2006). The Addiction Research Center Inventory (ARCI), 49-item version (Martin *et al.*, 1971) was also administered following each drug administration session. In addition, a Monitor Session Rating Form (Griffiths *et al.*, 2006) was completed by both monitors at intervals during the psilocybin sessions to provide ratings of participants' behavior and affect during the session.

Substance use and consequences

The Time-Line Follow-Back (TLFB) (Sobell and Sobell, 1992, 1995) procedure was used to assess drinking behavior at baseline (covering the 12 weeks preceding enrollment) and follow-up visits. Heavy drinking days were defined as days during which participants consumed five or more standard drinks if the participant was male, or four or more standard drinks if the participant was female, a standard drink being defined as 14 g of alcohol. Drinking days were defined as days during which participants consumed any amount (even a sip) of an alcoholic beverage. The Short Inventory of Problems (SIP) (Miller *et al*., 1995), past 3 month version, was used to measure consequences of alcohol use. Breath Alcohol Concentration (BAC) was measured at each visit, but was used to ensure safety of treatment and validity of assessments rather than as an outcome measure.

Psychological assessments

The Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES 8A) (Miller and Tonigan, 1996) was used as a measure of motivation. The Alcohol Abstinence Self-Efficacy Scale (AASE) (Diclemente *et al*., 1994) was used as a measure of self-efficacy to abstain from drinking. The Penn Alcohol Craving Scale (PACS) (Flannery *et al*., 1999) was used to assess craving. The Profile of Mood States (POMS) (Mcnair *et al*., 1981) was used as a measure of mood. Additional measures of persisting psychological effects obtained but not discussed in this publication were the Hood Mysticism Scale (Hood *et al*., 2001), the Persisting Effects Questionnaire (Griffiths *et al*., 2006), the ASPIRES Spiritual Transcendence Scale (Piedmont, 1999), the Brief Multidimensional Measure of Religiousness/Spirituality (Fetzer Institute, 1999), the NEO Personality Inventory 3 (NEO-PI-3) (Mccrae *et al*., 2005), and the Schwartz Value Survey (Schwartz, 1992, 2006).

Safety assessment

Vital signs were obtained at each visit and measured frequently during psilocybin sessions: every half hour for the first 2 hours, then hourly for the next 4 hours, with more frequent readings as needed. Adverse events (AEs), when present, were collected on an AE case report form at the end of the psilocybin sessions and at all subsequent visits, including assessment of clinical significance and relatedness to treatment.

Statistical analysis and power

Statistical analyses for this open-label pilot study were primarily descriptive, but two *a priori* hypotheses were tested. To test for changes in drinking behavior (percent heavy drinking days and percent drinking days), consequences of drinking, and psychological outcomes, scores at follow-up time points were contrasted with baseline and week 4 values using paired t-tests, and effect sizes (Cohen's d) (Cohen, 1988) were computed with correction for correlation between time points (Morris and Deshon, 2002). The primary drinking outcome was percent heavy drinking days, and the primary contrast was baseline vs. weeks 5-12. With a sample size of $n = 10$, the study had power of 0.803 to detect pre-post changes of effect size $d = 1.0$, with $\alpha = 0.05$ (2-tailed) prior to correction for multiple comparisons. For drinking outcomes, the Benjamini-Hochberg procedure (Benjamani and Hochberg, 1995) was used to control the false discovery rate at the 0.05 level.

Results

Participants

In total 70 individuals were screened for the study, of whom 10 were included in the study (Figure 1). Participants were four women and six men with DSM-IV alcohol dependence. Two participants were Native American/Alaska Native, one was African American, four were Hispanic, and three were white non-Hispanic. Four were single, three were married, and three were divorced. Four were working full-time, five part-time, and one was unemployed. Mean household income was $47,023 (SD $35,262). Participants averaged 15.1 (SD 3.7) years of education (12 years representing graduation from high school), and three were college graduates.

Mean age was 40.1 years (SD 10.3, range 25-56), and mean duration of alcohol dependence was 15.1 years (SD 11.5, range 4-32). Participants had a mean of 5.0 dependence criteria (SD 1.2, range 3-7). Eight out of 10 had evidence of physical dependence (tolerance or withdrawal), but none had alcohol withdrawal symptoms requiring treatment during the trial.

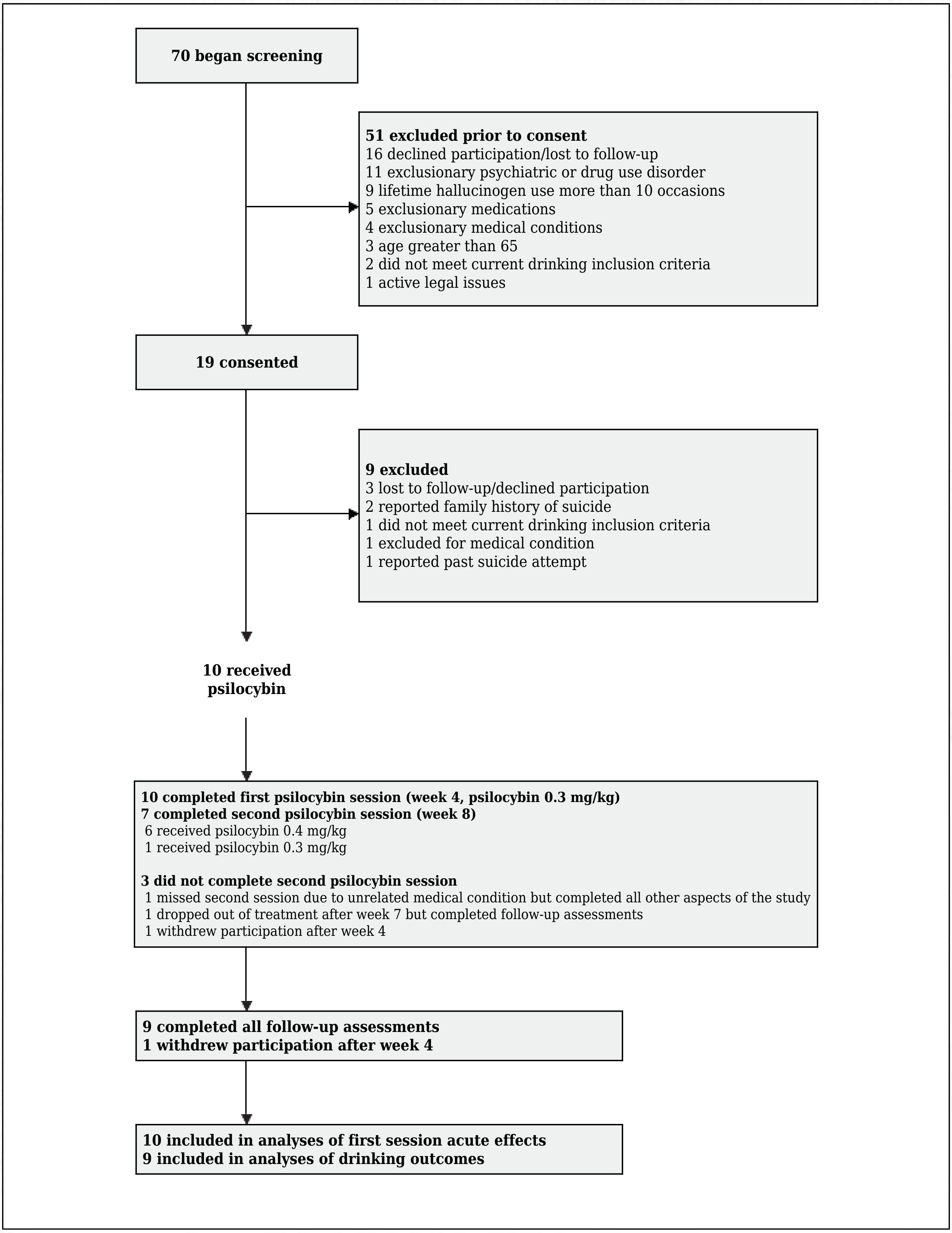

70 began screening
51 excluded prior to consent
16 declined participation/lost to follow-up
11 exclusionary psychiatric or drug use disorder
9 lifetime hallucinogen use more than 10 occasions
5 exclusionary medications
4 exclusionary medical conditions
3 age greater than 65
2 did not meet current drinking inclusion criteria
1 active legal issues
19 consented
9 excluded
3 lost to follow-up/declined participation
2 reported family history of suicide
1 did not meet current drinking inclusion criteria
1 excluded for medical condition
1 reported past suicide attempt
10 received psilocybin
10 completed first psilocybin session (week 4, psilocybin 0.3 mg/kg)
7 completed second psilocybin session (week 8)
6 received psilocybin 0.4 mg/kg
1 received psilocybin 0.3 mg/kg
3 did not complete second psilocybin session
1 missed second session due to unrelated medical condition but completed all other aspects of the study
1 dropped out of treatment after week 7 but completed follow-up assessments
1 withdrew participation after week 4
9 completed all follow-up assessments
1 withdrew participation after week 4
10 included in analyses of first session acute effects
9 included in analyses of drinking outcomes

Figure 1. Participant flow.

Treatment exposure and follow-up

Figure 1 summarizes participation in treatment and follow-up. Ten participants completed the first psilocybin session. Of the seven participants completing the second psilocybin session, six received psilocybin 0.4 mg/kg and are included in analysis of second session effects. One received psilocybin 0.3 mg/kg due to meeting criteria for "complete mystical experience" in the first session. Nine participants completed all follow-up assessments and are included in outcome analyses. One participant discontinued participation shortly after the first psilocybin session and did not provide usable outcome data. A total of 14 MET sessions were coded for fidelity using the MITI 3.1. Mean (SD) global scores ranged from 4.43 (0.76) to 5.00 (0.00), well above the proficiency benchmark of 4.0.

Acute effects

Figure 2 illustrates physiologic effects and monitor ratings during the first psilocybin session, in which all participants received psilocybin 0.3 mg/kg, and during the second psilocybin session for the six participants who received psilocybin 0.4 mg/kg. Systolic or diastolic blood pressure was modestly but significantly increased from 30 minutes to 180 minutes in one or both conditions. Heart rate (not shown) did not change significantly. Monitor ratings of global drug effect and "distance from ordinary reality" peaked between 120 and 180 minutes, and were significantly elevated at most time points. Differences in these measures between the two doses were not statistically significant (paired *t*-tests, df = 5).

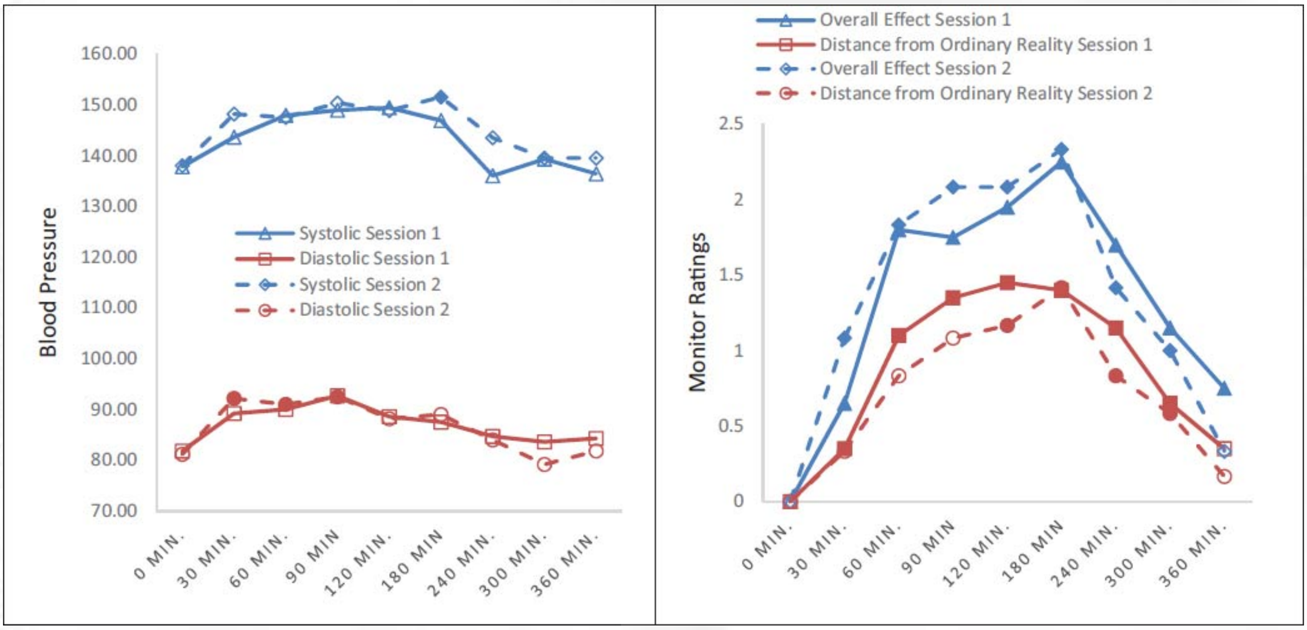


Figure 2. Within-session objective effects. Blood pressure (mm Hg) monitor ratings (0-4 Likert Scale).
Means are shown for 10 participants receiving psilocybin 0.3 mg/kg in the first session (solid lines), and the six participants who received psilocybin 0.4 mg/kg in the second session (*n* = 6, dashed line) during the 6 hours following drug administration. Solid markers indicate significant difference from baseline value.

Table 1 shows mean scores on self-report measures of subjective experience obtained 7 hours following administration of psilocybin 0.3 mg/kg in the first session and for the six participants who received psilocybin 0.4 mg/kg in the second session. Intensity of effects varied markedly from patient to patient. On average, acute effects on the MEQ and HRS are numerically lower in magnitude than those seen at comparable doses in normal volunteers (Griffiths *et al*., 2011). For the six participants who received psilocybin 0.4 mg/kg in the second session, subjective ratings were not significantly different between the two sessions (paired *t*-tests, df = 5), but were strongly correlated between the sessions for most of the scales intended to measure hallucinogen effects.

Table 1. Acute effects of psilocybin 0.3 mg/kg and 0.4 mg/kg.

	0.3 mg/kg Session 1 ($n = 10$)				0.4 mg/kg Session 2 ($n = 6$)				r	Sig.
	Mean	(SD)	Min.	Max.	Mean	(SD)	Min.	Max.	(n=6)	
ASC OBN	960.4	(518.8)	91	1798	785.0	(977.3)	79	2107	0.649	0.163
ASC DED	499.6	(515.8)	38	1515	340.1	(445.2)	26	1021	0.808	0.052
ASC VRS	923.5	(396.8)	61	1516	610.2	(543.5)	188	1462	0.670	0.145
ASC AUA	302.5	(380.9)	26	1166	182.0	(288.5)	18	766	0.960	0.002
ASC VIR	394.2	(268.1)	49	819	244.4	(333.0)	36.5	883	0.828	0.042
G-ASC	2383.5	(1347.7)	235	4628	1735.3	(1761.1)	337.5	4590	0.827	0.042
MEQ total	0.473	(0.217)	0.016	0.768	0.387	(0.347)	0.011	0.924	0.843	0.035
HRS intensity	2.43	(1.03)	0	3.5	2.00	(1.14)	0.25	3.25	0.902	0.014
ARCI PCAG	8.00	(3.06)	3	12	5.50	(4.04)	1	12	0.287	0.581
ARCI BG	5.40	(1.58)	3	8	5.83	(2.99)	2	11	0.167	0.752
ARCI A	4.78*	(2.37)	0	8	4.50	(2.88)	2	9	0.198	0.707
ARCI MBG	5.33*	(3.61)	4	12	6.33	(4.55)	2	13	0.388	0.448
ARCI LSD	8.10	(3.21)	1	13	8.17	(2.99)	4	12	0.405	0.425

Shown are scores for all 10 participants in session 1, scores for the six participants who received psilocybin 0.4 mg/kg in the second session, and correlations between scores for the two sessions for these six participants.
*n = 9 due to incomplete questionnaire from one participant.
ASC: 5-Dimensional Altered States of Consciousness Scale; OBN: Oceanic Boundlessness subscale; DED: Dread of Ego Dissolution subscale; VRS: Visionary Restructuralization subscale; AUA: Auditory Alterations subscale; VIR: Vigilance Reduction subscale; G-ASC: summary score (sum of OBN, DED, and VRS); MEQ: Mystical Experience Questionnaire; HRS Intensity: Intensity subscale of the Hallucinogen Rating Scale; ARCI: Addiction Research Center Inventory; PCAG: Phenobarbital, Chlorpromazine, Alcohol Group subscale (sedation); BG: Benzedrine group subscale (stimulant); A: Amphetamine subscale (stimulant); MBG: Morphine-Benzadrine group subscale (euphoria); LSD: LSD subscale (dysphoria). Instruments are described in Methods section.

Clinical outcomes

Percent heavy drinking days decreased during weeks 5-12 relative to baseline (mean difference (SD) = 26.0 (22.4), 95% CI 8.7-43.2, t(8) = 3.477, p=0.008), and also decreased relative to weeks 1-4 (during psychosocial treatment but prior to psilocybin) (mean difference (SD) = 18.2 (20.0), 95% CI 2.8-33.5, t(8) = 2.723, p=0.026). Percent drinking days also decreased during weeks 5-12 relative to baseline (mean difference (SD) = 27.2 (23.7), 95% CI 9.0-45.4, t(8) = 3.449, p=0.009) and relative to weeks 1-4 (mean difference (SD) = 21.9 (21.8), 95% CI 5.1- 38.6, t(8) = 3.010, p=0.017). Figure 3 illustrates change in percent heavy drinking days and percent drinking days over the course of the study. Improvement is not statistically significant during the first 4 weeks of participation, when participants received weekly counseling but had not yet received psilocybin. Following the first psilocybin session, percent heavy drinking days and percent drinking days are significantly lower than baseline at all follow-up points. Further, these measures are significantly decreased relative to weeks 1-4 with the exception of heavy drinking days during weeks 9-12 (p = 0.059). Fifteen out of 16 contrasts were significant at the nominal 0.05 level, and all of these remained significant at a false discovery rate of 0.05. Effect sizes are large (greater than 0.8) with one exception, Cohen's d ranging from 0.75 to 1.38. Table 2 summarizes additional outcomes for study participants. Significant improvement relative to baseline and/or week 4 is noted at multiple time points for drinking consequences, craving, self-efficacy, and motivation. Changes in POMS scores were not significant with one exception (increased Vigor at week 24 relative to baseline).

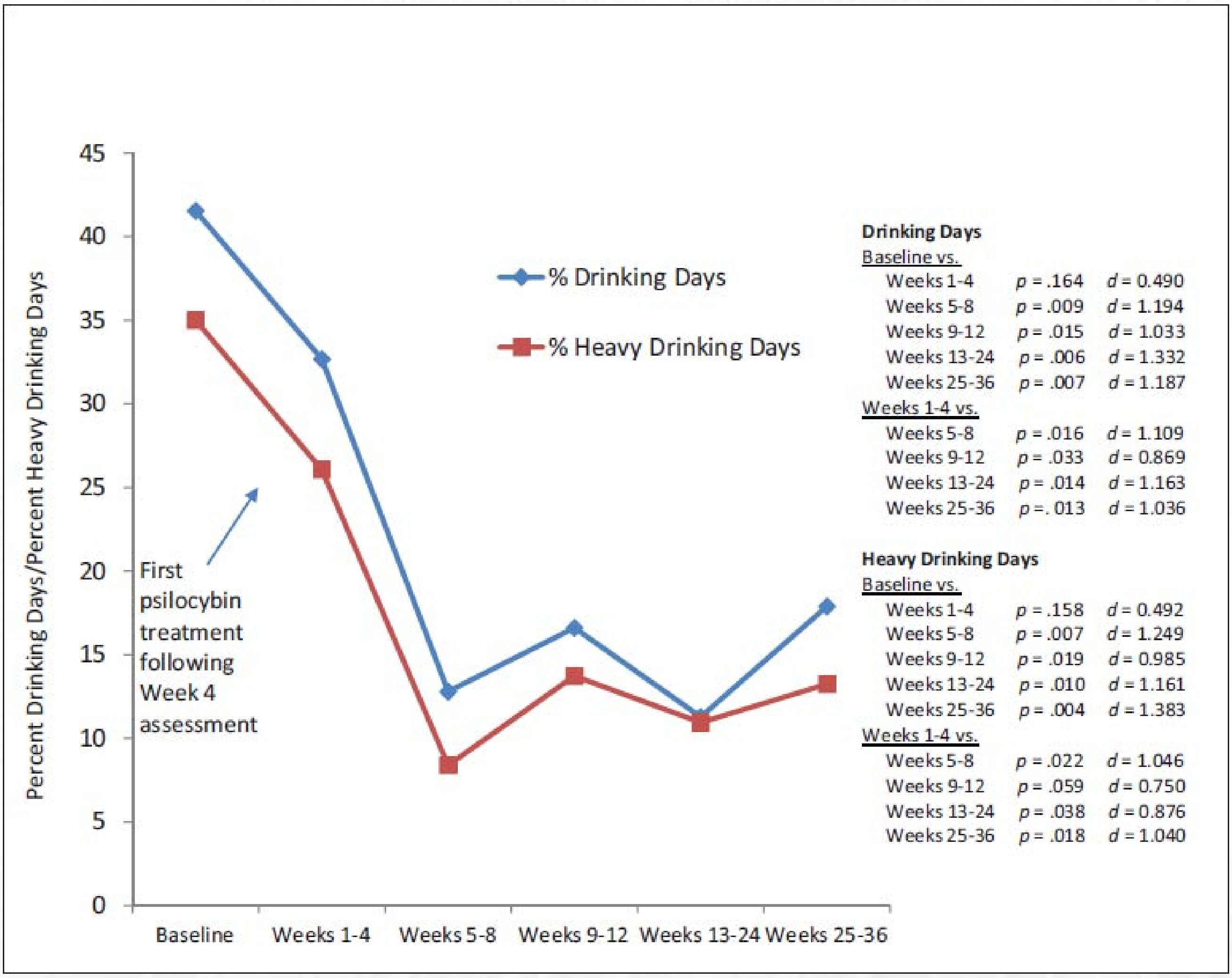


Figure 3. Drinking outcomes and effect sizes.
Means shown are for all available data (*n* = 10 at baseline, *n* = 9 at all other time points). p-values are from paired *t*-tests (df = 8). Cohen's *d* is shown for the contrast between baseline or weeks 1-4 and each follow-up time point.

Table 2. Secondary outcomes.

	Baseline Mean (SD)	Week 4 Mean (SD)	Week 5 Mean (SD)	Week 8 Mean (SD)	Week 9 Mean (SD)	Week 12 Mean (SD)	Week 24 Mean (SD)	Week 36 Mean (SD)
SIP								
Physical	4.60 (2.27)					4.89 (3.14)	2.78 (2.95)	2.78 (3.35)
Interpersonal	4.80 (2.57)					4.44 (3.17)	2.56 (3.05)**	2.56 (2.88)**
Interpersonal	7.30 (1.70)					6.00 (3.12)	3.89 (3.76)*	3.67 (3.74)*
Impulse control	2.90 (1.29)					3.89 (2.47)	2.56 (2.24)	2.56 (3.05)
Responsibility	4.50 (2.37)					4.22 (3.46)	3.67 (3.81)	2.67 (2.87)
PACS	16.00 (5.59)	14.10 (7.17)	11.89 (8.64)	11.56 (5.85)*	10.00 (6.61)**,§	12.11 (8.28)*	13.00 (9.59)	8.11 (9.16)***,§
AASE								
Temptation	38.30 (12.80)	38.10 (18.17)	28.11 (18.86)	32.78 (21.09)	24.56 (16.80)*,§	32.56 (21.67)	26.63 (18.70)*	27.22 (21.86)§
Confidence	40.10 (12.58)	40.30 (16.66)	55.56 (10.88)*,§§	49.00 (11.90)	53.67 (12.76)§	50.00 (13.21)	50.44 (13.09)	54.00 (19.87)§
SOCRATES								
Recognition	31.80 (3.22)	31.10 (5.26)	31.11 (5.33)	31.78 (5.89)	31.89 (5.33)	30.38 (8.02)	28.67 (7.89)	26.78 (9.56)
Ambivalence	15.70 (3.65)	13.90 (5.93)	14.22 (5.31)	14.56 (5.81)	13.11 (6.13)	13.00 (6.48)	12.00* (5.20)	11.56* (4.90)
Taking Steps	32.30 (3.20)	34.00 (5.03)	36.33 (2.65)*	36.33 (2.65)**	37.33 (3.46)**,§	35.78 (3.80)*	36.00 (4.12)*	33.78 (5.36)
POMS								
Tension	7.20 (5.27)	6.22 (3.42)	4.67 (3.54)	5.78 (4.44)	5.89 (4.88)	8.00 6.06	5.78 (5.97)	5.33 (6.04)
Depression	6.50 (5.60)	3.40 (4.45)	4.89 (6.41)	4.44 (3.50)	3.22 (4.38)	6.78 7.45	6.11 (6.11)	5.00 (4.58)
Anger	4.40 (4.09)	2.40 (3.13)	4.67 (4.61)	3.89 (4.62)	2.22 (2.64)	4.50 (6.61)	3.56 (5.48)	4.56 (6.46)
Vigor	5.60 (4.01)	6.50 (3.34)	8.56 (4.61)	8.11 (5.46)	9.00 (5.85)	7.75 4.10	9.56 (4.90)*	7.50 (2.78)
Fatigue	8.70 (5.79)	6.60 (5.78)	6.22 (6.44)	5.44 (4.75)	5.56 (4.28)	7.67 6.28	6.67 (5.96)	6.89 (4.08)
Confusion	6.10 (2.69)	3.90 (1.79)*	4.67 (2.96)	5.33 (3.71)	5.56 (3.43)	5.13 3.36	5.56 (2.19)	4.44 (2.51)

SIP: Short Inventory of Problems; PACS: Penn. Alcohol Craving Scale; AASE: Alcohol Abstinence Self-Efficacy; SOCRATES: Stages of Change Readiness and Treatment Eagerness Scale; POMS: Profile of Mood States
*Different from baseline, $p < 0.05$; **Different from baseline, $p < 0.01$; ***Different from baseline, $p < 0.001$; §Different from week 4, $p < 0.05$; §§Different from week 4, $p < 0.01$.
$n = 10$ at baseline and 4 weeks, and $n = 9$ at weeks 5-36 with the following exceptions due to missing questionnaire items: $n = 9$ for PACS baseline; $n = 8$ for SOCRATES Recognition week 12, AASE Confidence week 12, AASE Temptation week 24, POMS Anger week 12, POMS Confusion week 12, POMS Vigor week 12, and POMS Vigor week 36.

Relationships between acute effects and treatment response

Because the acute effects of psilocybin were quite variable, it was possible to explore the relationships between the intensity of acute effects and changes in drinking behavior. Table 3 shows correlations between three summary measures of the intensity of acute effects in the first psilocybin session and short-term clinical outcomes. Large correlations were observed between measures of acute effect intensity and change in drinking behavior, as well as changes in craving and self-efficacy in some cases. Supplemental Figure 1 displays scatterplots of the individual data points underlying these correlations.

Table 3. Correlations between acute effects and change in drinking, craving, and self-efficacy (*n* = 9).

	PDD (wk. 8 - wk. 4)	PHDD (wk. 8 - wk. 4)	PACS (wk. 5 - wk. 4)	AASE (wk. 5 - wk. 4)
HRS Intensity	$r = -.844$	$r = -.763$	$r = -.823$	$r = .753$
(wk. 4)	$p = .004$	$p = .017$	$p = .006$	$p = .019$
MEQ total	$r =-.885$	$r = -.852$	$r = -.810$	$r = .762$
(wk. 4)	$p = .002$	$p = .004$	$p = .008$	$p = .017$
G-ASC	$r =-.838$	$r =-.893$	$r =-.654$	$r =-.555$
(wk. 4)	$p = .005$	$p = .001$	$p = .056$	$p = .121$

PDD: Percent Drinking Days; PHDD: Percent Heavy Drinking Days; PACS: Penn Alcohol Craving Scale; AASE = Alcohol Abstinence Self-Efficacy Confidence score; HRS: Hallucinogen Rating Scale Intensity score; MEQ: Mystical Experience Questionnaire; G-ASC: Altered States of Consciousness Scale summary score.

Treatment-related adverse events

Five participants reported mild headaches which resolved within 24 hours following psilocybin administration, consistent with prior reports (Johnson *et al.*, 2012). One participant had nausea with one episode of emesis during one psilocybin session. One participant with irritable bowel syndrome experienced diarrhea during one psilocybin session. One participant reported insomnia on the night following a psilocybin session. No participant required medication or other intervention for blood pressure, anxiety, or other psychiatric symptoms. There was no report of illicit hallucinogen use by any participant during study participation.

Discussion

Overall, the response of our alcohol-dependent participants to psilocybin was qualitatively similar to that which has been reported in other samples (Hasler *et al.*, 2004; Griffiths *et al.*, 2006, 2011; Grob *et al.*, 2011). Medication-related AEs were transient and mild. However, subjective response was highly variable among participants in this study, and numerically weaker on average for some of the measures than that reported in normal volunteers at comparable doses (Griffiths *et al.*, 2011). This is consistent with observations beginning in the 1950s that alcoholics tended to require larger doses of LSD to have a strong effect (Chwelos *et al.*, 1959). Our findings suggest that some alcohol-dependent patients are relatively insensitive to the effects of psilocybin, although larger samples will be necessary to confirm this. The lack of significant differences between the 0.3 mg/kg and 0.4 mg/kg doses is most likely accounted for by the small sample size ($n = 6$) and/or idiosyncratic responses in a small number of participants.

Participants exhibited significant improvement in drinking, with large pre-post effect sizes, as well as significant changes in psychological measures relevant to drinking. Importantly, much of the improvement occurred following the administration of psilocybin, at which time participants had already received 4 weeks of psychosocial treatment and 4-6 hours of assessment. Also, strong correlations were observed between measures of intensity of the acute drug effects and clinical outcomes. Although change in drinking was correlated with the mystical quality of the experience, it was similarly associated with ratings of other acute effects. More work will necessary to determine whether there are particular characteristics of the acute psilocybin experience that are predictive of therapeutic benefit in alcohol use disorder.

While clearly demonstrating feasibility, this study has major, self-evident limitations including small sample size, lack of a control group or blinding, and lack of biological verification of alcohol use. Due to these limitations, it is not possible to separate unequivocally the effects of attention, psychosocial treatment, and time; expectancy effects related to knowledge of receiving psilocybin; and the specific effects of psilocybin. However, the time course of the observed changes and the striking relationship between intensity of response and clinical improvement provide support for the concept that psilocybin may produce lasting benefits in alcohol use disorder when administered under controlled conditions to carefully screened patients, in the context of appropriate psychosocial interventions. Adequately powered randomized trials will be necessary to test this hypothesis rigorously. Neuroimaging studies in alcohol use disorder trial participants would help characterize the persisting effects of psilocybin on brain activity (e.g. resting state functional connectivity, cue response, stress response, response to emotional stimuli, and inhibitory control). Studying the genetics of response to psilocybin may shed light on the variability of response, ultimately aiding in dose selection or identifying patients particularly likely to benefit.

Acknowledgements

We wish to thank the following persons for their contributions to the study. From the University of New Mexico, Albuquerque, NM: for data collection, Rose C. Bigelow, MS; for fidelity monitoring, Christina E. Ripp, MA; for data entry and cleaning, Robert G. Voloshin, DO, Alex M. Pogzeba, BA, Christina E. Ripp, MA, Lindsay M. Worth, MPA; for quality assurance and regulatory compliance, Linda A. Schenkel; CCRC, CPhT; for service on the Data and Safety Monitoring Committee for the study, Jan A. Fawcett, MD, Theresa B. Moyers, PhD. From the University of North Carolina: for providing the psilocybin used for this study, David E. Nichols, PhD. From Johns Hopkins University: for providing training for study interventionists, William A. Richards, PhD; for guidance on intervention and assessment procedures, Roland R. Griffiths, PhD. From the Heffter Research Institute: for advice and support in the design and conduct of the study, George R. Greer, MD.

Declaration of Conflicting Interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr. Bogenschutz reports grants from National Institute on Drug Abuse, during the conduct of the study; and grants from the Lundbeck Foundation and the Heffter Research Institute, outside the submitted work.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The study was supported by a grant from the Heffter Research Institute and NIH grant 1UL1RR031977.

References

1. Abuzzahab FS, Sr. and Anderson BJ (1971) A review of LSD treatment in alcoholism. *Int Pharmacopsychiatry* 6: 223-235.
2. Akash KG, Anju TR, Peeyush KT, *et al*. (2008) Enhanced dopamine D2 receptor function in hypothalamus and corpus striatum: Their role in liver, plasma and in vitro hepatocyte ALDH regulation in ethanol treated rats. *J Biomed Sci* 15: 623-631.
3. Akash KG, Balarama KS and Paulose CS (2008) Enhanced 5-Ht(2a) receptor status in the hypothalamus and corpus striatum of ethanol-treated rats. *Cell Mol Neurobiol* 28: 1017-1025.
4. Anisman H, Du L, Palkovits M, *et al*. (2008) Serotonin receptor subtype and P11 mRNA expression in stress-relevant brain regions of suicide and control subjects. *J Psychiatry Neurosci* 33: 131-141.
5. Benjamani Y and Hochberg Y (1995) Controlling the false discovery rate: A practical and powerful approach to multiple testing. *J Royal Stat Soc Series B (Method)* 57: 289-300.
6. Bogenschutz MP (2012) Effects of psilocybin in the treatment of addictions: A review and preliminary results from two ongoing trials. *Neuropsychopharmacology* 38: S15-S16.
7. Bogenschutz MP and Pommy JM (2012) Therapeutic mechanisms of classic hallucinogens in the treatment of addictions: From indirect evidence to testable hypotheses. *Drug Test Anal* 4: 543-555.
8. Bowen WT, Soskin RA and Chotlos JW (1970) Lysergic acid diethylamide as a variable in the hospital treatment of alcoholism: A follow-up study. *J Nerv Ment Dis* 150: 111-118.
9. Buckholtz NS, Zhou DF, Freedman DX, *et al*. (1990) Lysergic acid diethylamide (LSD) administration selectively downregulates serotonin2 receptors in rat brain. *Neuropsychopharmacology* 3: 137-148.
10. Burdick BV and Adinoff B (2013) A proposal to evaluate mechanistic efficacy of hallucinogens in addiction treatment. *Am J Drug Alcohol Abuse* 39: 291-297.
11. Carhart-Harris RL, Erritzoe D, Williams T, *et al*. (2012) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci U S A* 109: 2138-2143.
12. Carhart-Harris RL, Leech R, Erritzoe D, *et al*. (2013) Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. *Schizophr Bull* 39: 1343-1351.
13. Chwelos N, Blewett DB, Smith CM, *et al*. (1959) Use of D-lysergic acid diethylamide in the treatment of alcoholism. *Q J Stud Alcohol* 20: 577-590.
14. Cohen J (1988) *Statistical Power Analysis for the Behavioral Sciences* (2nd Edn). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
15. Cunningham KA and Anastasio NC (2014) Serotonin at the nexus of impulsivity and cue reactivity in cocaine addiction. *Neuropharmacology* 76 Pt B: 460-478.
16. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCS) in humans. *Pharmacopsychiatry* 31: 80-84.
17. Dyck E (2006) 'Hitting highs at rock bottom': LSD treatment for alcoholism, 1950-1970. *Soc Hist Med* 19: 313-329.
18. Fetzer Institute (1999) *Multidimensional Measurement of Religiousness/Spirituality for Use in Health Research*. Kalamazoo, MI: Fetzer Institute.
19. Diclemente CC, Carbonari JP, Montgomery RP, *et al*. (1994) The Alcohol Abstinence Self-Efficacy Scale. *J Stud Alcohol* 55: 141-148.
20. First MB, Spitzer RL, Gibbon M, *et al*. (1996) *Structured Clinical Interview for DSM-IV Axis I Disorders-Patient Edition (Scid-I/P, Version 2.0)*. New York, NY: Biometrics Research Department, New York State Psychiatric Institute.
21. First MB, Spitzer RL, Gibbon M, *et al*. (1997) *Structured Clinical Interview for DSM-IV Axis I Disorders-Patient Edition*. New York, NY: Biometrics Research Department, New York State Psychiatric Institute.
22. Flannery BA, Volpicelli JR and Pettinati HM (1999) Psychometric properties of the Penn Alcohol Craving Scale. *Alcohol Clin Exp Res* 23:1289-1295.
23. Forcehimes AA (2004) De profundis: Spiritual transformations in Alcoholics Anonymous. *J Clin Psychol* 60: 503-517.
24. Frokjaer VG, Mortensen EL, Nielsen FA, *et al*. (2008) Frontolimbic serotonin 2a receptor binding in healthy subjects is associated with personality risk factors for affective disorder. *Biol Psychiatry* 63:569-576.
25. Garcia-Romeu AP, Johnson MW and Griffiths RR (2013) Examining the psychological mechanisms of psilocybin-assisted smoking cessation treatment: A pilot study. Abstract book. San Diego, CA: CPDD conference, June 16-20, 2013.
26. George AK, Paul J, Kaimal SB, *et al*. (2010) Decreased cerebral cortex and liver 5-HT$_2$a receptor gene expression and enhanced ALDH activity in ethanol-treated rats and hepatocyte cultures. *Neurol Res* 32: 510-518.
27. Ghitza UE, Zhai H, Wu P, *et al*. (2010) Role of BDNF and GDNF in drug reward and relapse: A review. *Neurosci Biobehav Rev* 35: 157-171.
28. Gresch PJ, Smith RL, Barrett RJ, *et al*. (2005) Behavioral tolerance to lysergic acid diethylamide is associated with reduced serotonin-2a receptor signaling in rat cortex. *Neuropsychopharmacology* 30:1693-1702.
29. Griffiths R, Richards W, Johnson M, *et al*. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632.
30. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology (Berl)* 218: 649-665.
31. Griffiths RR, Richards WA, Mccann U, *et al*. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology (Berl)* 187: 268-283; discussion 284-292.
32. Grinspoon L and Balakar JB (1997) *Psychedelic Drugs Reconsidered*. New York: The Lindesmith Center.
33. Grob CS, Danforth AL, Chopra GS, *et al*. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.
34. Grof S (2008) *LSD Psychotherapy*. 4 edn. Ben Lomond, CA: Multidisciplinary Association for Psychedelic Studies.
35. Grof S, Goodman LE, Richards WA, *et al*. (1973) LSD-assisted psychotherapy in patients with terminal cancer. *Int Pharmacopsychiatry* 8:129-144.

36. Halpern JH (1996) The use of hallucinogens in the treatment of addiction. *Addict Res* 4: 177-189.
37. Hasler F, Grimberg U, Benz MA, *et al.* (2004) Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. *Psychopharmacology (Berl)* 172: 145-156.
38. Hoffer A (1967) A program for treatment of alcoholism: LSD, malvaria, and nicotinic acid. In: Abramson HA (ed) *The Use of LSD in Psychotherapy and Alcoholism*. Indianapolis: Bobbs-Merrill. pp. 343-406.
39. Hollister LE, Shelton J and Krieger G (1969) A controlled comparison of lysergic acid diethylamide (LSD) and dextroamphetmine in alcoholics. *Am J Psychiatry* 125: 1352-1357.
40. Hood RWJ, Ghorbani N, Watson PJ, *et al.* (2001) Dimensions of the mysticism scale: Confirming the three-factor structure in the United States and Iran. *J Sci Study Relig* 40: 691-705.
41. James W (1902) *The Varieties of Religious Experience*. Cambridge, MA: Harvard University Press.
42. Johnson BA (2008) Update on neuropharmacological treatments for alcoholism: Scientific basis and clinical findings. *Biochem Pharmacol* 75: 34-56.
43. Johnson BA, Jasinski DR, Galloway GP, *et al.* (1996) Ritanserin in the treatment of alcohol dependence - a multi-center clinical trial. Ritanserin Study Group. *Psychopharmacology (Berl)* 128: 206-215.
44. Johnson MW, Andrew Sewell R and Griffiths RR (2012) Psilocybin dose-dependently causes delayed, transient headaches in healthy volunteers. *Drug Alcohol Depend* 123: 132-140.
45. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al.* (2014) Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
46. Jones KA, Srivastava DP, Allen JA, *et al.* (2009) Rapid modulation of spine morphology by the 5-HT$_{2A}$ serotonin receptor through kalirin-7 signaling. *Proc Natl Acad Sci U S A* 106: 19575-19580.
47. Kast EC (1966) Pain and LSD-25: A theory of attenuation of anticipation. In: Solomon D (ed) *LSD: The Consciousness-Expanding Drug*. New York, NY: GP Putnam, 239-254.
48. Kast EC and Collins VJ (1964) Study of lysergic acid diethylamide as an analgesic agent. *Anesth Analg* 43: 285-291.
49. Kometer M, Schmidt A, Bachmann R, *et al.* (2012) Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol Psychiatry* 72: 898-906.
50. Krebs TS and Johansen PO (2012) Lysergic acid diethylamide (LSD) for alcoholism: Meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
51. Kurland AA, Unger S, Shaffer JW, *et al.* (1967) Psychedelic therapy utilizing LSD in the treatment of the alcoholic patient: A preliminary report. *Am J Psychiatry* 123: 1202-1209.
52. Leuner H (1967) Present state of psycholytic therapy and its possibilities. In: Abramson HA (ed) *The Use of LSD in Psychotherapy and Alcoholism*. Indianapolis: Bobbs-Merrill, pp. 101-116.
53. Ludwig A, Levine J, Stark L, *et al.* (1969) A clinical study of LSD treatment in alcoholism. *Am J Psychiatry* 126: 59-69.
54. Maclean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
55. Mangini M (1998) Treatment of alcoholism using psychedelic drugs: A review of the program of research. *J Psychoactive Drugs* 30: 381-418.
56. Martin WR, Sloan JW, Sapira JD, *et al.* (1971) Physiologic, subjective, and behavioral effects of amphetamine, methamphetamine, ephedrine, phenmetrazine, and methylphenidate in man. *Clin Pharmacol Ther* 12: 245-258.
57. Masters R and Houston J (2000) *The Varieties of Psychedelic Experience: The Classic Guide to the Effects of LSD on the Human Psyche*. Rochester, Vermont: Park Street Press.
58. Mccrae RR, Costa Jr, PT and Martin TA (2005) The Neo-Pi-3: A more readable revised neo personality inventory. *J Pers Assess* 84: 261-270.
59. Mcnair DM, Lorr M and Droppleman LF (1981) *Profile of Mood States*. San Diego, CA: Educational and Industrial Testing Service.
60. Miller WR and C'de Baca J (2001) *Quantum Change : When Epiphanies and Sudden Insights Transform Ordinary Lives*. New York: Guilford Press.
61. Miller WR and Rolnick S (2013) *Motivational Interviewing: Helping People Change*. 3rd. ed. New York, NY: Guilford Press.
62. Miller WR and Tonigan JS (1996) Assessing drinker's motivation for change: The Stages of Change Readiness and Treatment Eagerness Scale (Socrates). *Psychology of Addictive Behaviors* 10: 81-89.
63. Miller WR, Tonigan JS and Longabaugh R (1995) *The Drinker Inventory of Consequences (Drinc): An Instrument for Assessing Adverse Consequences of Alcohol Abuse. Test Manual (Vol. 4)*. Rockville, MD: US Government Printing Office.
64. Morris SB and Deshon RP (2002) Combining effect size estimates in meta-analysis with repeated measures and independent-groups designs. *Psychological Methods* 7: 105-125.
65. Moyers TB, Martin T, Manuel JK, *et al.* (2005) Assessing competence in the use of motivational interviewing. *J Subst Abuse Treat* 28: 19-26.
66. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101: 131-181.
67. Nichols DE (2014) The Heffter Research Institute: Past and hopeful future. *J Psychoactive Drugs* 46: 20-26.
68. Pahnke W (1963) *Drugs and mysticism: An analysis of the relationship between psychedelic drugs and the mystical consciousness*. Ph.D. Thesis, Harvard University.
69. Pahnke WN (1969) Psychedelic drugs and mystical experience. *Int Psychiatry Clin* 5: 149-162.
70. Pahnke WN, Kurland AA, Goodman LE, *et al.* (1969) LSD-assisted psychotherapy with terminal cancer patients. *Curr Psychiatr Ther* 9: 144-152.
71. Pahnke WN, Kurland AA, Unger S, *et al.* (1970) The experimental use of psychedelic (LSD) psychotherapy. *JAMA* 212: 1856-1863.
72. Piedmont RL (1999) Does spirituality represent the sixth factor of personality? Spiritual transcendence and the Five-Factor Model. *J Person* 67: 985-1013.
73. Ray TS (2010) Psychedelics and the human receptorome. *PLoS ONE* 5: e9019.
74. Richards WA (1975) *Counseling, peak experiences and the human encounter with death: An empirical study of the efficacy of*

DPT-assisted counseling in enhancing the quality of life of persons with terminal cancer and their closest family members. Ph.D. Thesis, Catholic University of America, Washington, DC.

75. Richards WA, Rhead JC, Dileo FB, *et al*. (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. *J Psychedelic Drugs* 9: 1-10.
76. Rosell DR, Thompson JL, Slifstein M, *et al*. (2010) Increased serotonin 2a receptor availability in the orbitofrontal cortex of physically aggressive personality disordered patients. *Biol Psychiatry* 67: 1154-1162.
77. Ross S (2012) Serotonergic hallucinogens and emerging targets for addiction pharmacotherapies. *Psychiatric Clin N Am* 35: 357-374.
78. Schwartz SH (1992) Universals in the content and structure of values: Theory and empirical tests in 20 countries. In: Zanna M (ed) *Advances in Experimental Social Psychology, Vol. 25*. New York: Academic Press, pp. 1-65.
79. Schwartz SH (2006) Les valeurs de base de la personne: Theorie, mesures et applications [Basic human values: Theory, measurement, and applications]. *Revue française de sociologie* 42: 249-288.
80. Shelton RC, Sanders-Bush E, Manier DH, Schwartz SH (2009) Elevated 5-HT$_2$a receptors in postmortem prefrontal cortex in major depression is associated with reduced activity of protein kinase A. *Neuroscience* 158: 1406-1415.
81. Sherwood JN, Stolaroff MJ and Harman WW (1962) The psychedelic experience - a new concept in psychotherapy. *J Neuropsychiatr* 4: 69-80.
82. Smart RG, Storm T, Baker EF, Schwartz SH (1966) A controlled study of lysergide in the treatment of alcoholism. 1. The effects on drinking behavior. *Q J Stud Alcohol* 27: 469-482.
83. Sobell LC and Sobell MB (1992) Timeline follow-back: A technique for assessing self-reported alcohol consumption. In: Litten RA and Allen JP (eds) *Measuring Alcohol Consumption: Psychosocial and Biological Methods*. Totowa, NJ: Humana Press, pp. 41-72.
84. Sobell LC and Sobell MB (1995) *Alcohol Timeline Followback Users' Manual*. Toronto, Canada: Addiction Research Foundation.
85. Soloff PH, Price JC, Meltzer CC, *et al*. (2007) 5-HT$_2$a receptor binding is increased in borderline personality disorder. *Biol Psychiatry* 62: 580-587.
86. Strassman RJ (1984) Adverse reactions to psychedelic drugs. A review of the literature. *J Nerv Ment Dis* 172: 577-595.
87. Strassman RJ, Qualls CR, Uhlenhuth EH, *et al*. (1994) Dose-response study of *N,N*-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. *Arch Gen Psychiatry* 51: 98-108.
88. Sullivan JT, Sykora K, Schneiderman J, *et al*. (1989) Assessment of alcohol withdrawal: The Revised Clinical Institute Withdrawal Assessment for Alcohol Scale (CIWA-AR). *Br J Addict* 84: 1353-1357.
89. Thompson PM, Cruz DA, Olukotun DY, *et al*. (2012) Serotonin receptor, Sert mRNA and correlations with symptoms in males with alcohol dependence and suicide. *Acta Psychiatr Scand* 126: 165-174.
90. Tomsovic M and Edwards RV (1970) Lysergide treatment of schizophrenic and nonschizophrenic alcoholics: A controlled evaluation. *Q J Stud Alcohol* 31: 932-949.
91. Tsuchioka M, Takebayashi M, Hisaoka K, *et al*. (2008) Serotonin (5-HT) induces glial cell line-derived neurotrophic factor (GDNF) mRNA expression via the transactivation of fibroblast growth factor receptor 2 (FGFR2) in rat C6 glioma cells. *J Neurochem* 106: 244-257.
92. Turek IS, Soskin RA and Kurland AA (1974) Methylenedioxyamphetamine (MDA) subjective effects. *J Psychedelic Drugs* 6: 7-14.
93. Underwood MD, Mann JJ, Huang YY, *et al*. (2008) Family history of alcoholism is associated with lower 5-HT$_{2A}$ receptor binding in the prefrontal cortex. *Alcohol Clin Exp Res* 32: 593-599.
94. Vaidya VA, Marek GJ, Aghajanian GK, *et al*. (1997) 5-HT$_{2A}$ receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. *J Neurosci* 17: 2785-2795.
95. Vollenweider FX and Kometer M (2010) The neurobiology of psychedelic drugs: Implications for the treatment of mood disorders. *Nat Rev Neurosci* 11: 642-651.
96. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, *et al*. (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9: 3897-3902.
97. Wiesbeck GA, Weijers HG, Chick J, *et al*. (1999) Ritanserin in relapse prevention in abstinent alcoholics: Results from a placebo-controlled double-blind international multicenter trial. Ritanserin in Alcoholism Work Group. *Alcohol Clin Exp Res* 23: 230-235.

Antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide (LSD): a systematic review of clinical trials published in the last 25 years: antidepressive effects of ayahuasca, psilocybin and LSD

by

Rafael G. dos Santos, Flávia L. Osório, José Alexandre S. Crippa, Jordi Riba, Antônio W. Zuardi and Jaime E. C. Hallak

Therapeutic Advances in Psychopharmacology 1-21

DOI: 10.1177/2045125316638008

© The Author(s), 2016.

original source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4910400/pdf/10.1177_2045125316638008.pdf
backup source: http://www.psilosophy.info/resources/10.1177_2045125316638008.pdf

Correspondence to:
Rafael G. dos Santos, PhD Departamento de Neurociências e Ciências do Comportamento, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Hospital das Clínicas, Terceiro Andar, Av. Bandeirantes, 3900, Ribeirão Preto, São Paulo, Brazil.
banisteria@gmail.com

Flávia L. Osório, PhD José Alexandre S. Crippa, MD, PhD Antônio W. Zuardi, MD, PhD Jaime E. C. Hallak, MD, PhD, Department of Neuroscience and Behavior, Ribeirão Preto Medical School, University of São Paulo, SP, Brazil National Institute for Translational Medicine (INCT-TM), CNPq, Brazil

Jordi Riba, PhD, Centre d'Investigació de Medicaments, Servei de Farmacologia Clínica, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain Human Experimental Neuropsychopharmacology, Institut de Recerca, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain Departament de Farmacologia i Terapèutica, Universitat Autònoma de Barcelona, Spain Centro de Investigación Biomédica en Red de Salud Mental, CIBERSAM, Barcelona, Spain.

Table of Contents:

- Abstract
- Methods
  - Data acquisition
  - Search strategy
  - Eligibility criteria
    - Article type
    - Study design
    - Participants
    - Interventions
    - Comparisons
    - Outcomes
  - Data extraction
- Results
  - Study selection
  - Drugs
    - Psilocybin
      - Obsessive-compulsive disorder
      - Anxiety associated with advanced-stage cancer
      - Tobacco dependence
      - Alcohol dependence
    - Lysergic acid diethylamide (LSD)
      - Anxiety associated with life-threatening diseases
    - Ayahuasca
      - Major depressive disorder
- Discussion
  - Possible mechanisms of therapeutic action
  - Safety
- Limitations
- Conclusion
- References

Abstract

To date, pharmacological treatments for mood and anxiety disorders and for drug dependence show limited efficacy, leaving a large number of patients suffering severe and persistent symptoms. Preliminary studies in animals and humans suggest that ayahuasca, psilocybin and lysergic acid diethylamide (LSD) may have antidepressive, anxiolytic, and antiaddictive properties. Thus, we conducted a systematic review of clinical trials published from 1990 until 2015, assessing these therapeutic properties. Electronic searches were performed using the PubMed, LILACS, and SciELO databases. Only clinical trials published in peer-reviewed journals were included. Of these, 151 studies were identified, of which six met the established criteria. Reviewed studies suggest beneficial effects for treatment-resistant depression, anxiety and depression associated with life-threatening diseases, and tobacco and alcohol dependence. All drugs were well tolerated. In conclusion, ayahuasca, psilocybin and LSD may be useful pharmacological tools for the treatment of drug dependence, and anxiety and mood disorders, especially in treatment-resistant patients. These drugs may also be useful pharmacological tools to understand psychiatric disorders and to develop new therapeutic agents. However, all studies reviewed had small sample sizes, and half of them were open-label, proof-of-concept studies. Randomized, double-blind, placebo-controlled studies with more patients are needed to replicate these preliminary findings.

Keywords: ayahuasca, dimethyltryptamine, hallucinogens, LSD, psilocybin, tryptamines

Naturally occurring classical or serotonergic hallucinogens such as the tryptamines *N,N*-dimethyltryptamine (DMT) and psilocybin (4-phosphoryloxy-*N,N*-DMT) have a long history of ritual use in Latin America [Harner, 1976; Grispoon and Bakalar, 1981; Dobkin de Rios, 1984, 1990; Schultes, 1986, 1998; Wasson *et al*. 1986; Schultes and Hofmann, 1992; Furst, 1994; Ott, 1994, 2004; Guzmán, 2008; McKenna and Riba, 2016]. DMT was first synthesized in 1931 by the Canadian chemist Richard Manske and subsequently isolated by the Brazilian chemist Oswaldo Gonçalves de Lima in 1946 from *Mimosa hostilis*, a hallucinogenic plant used by northeastern Brazilian indigenous groups for the preparation of a sacred beverage called *jurema* [Ott, 1994, 1999, 2004; McKenna and Riba, 2016]. DMT is also the main psychotropic compound of ayahuasca, a psychotropic brew used for magico-ritual and therapeutic purposes by indigenous and urban populations of Amazonian countries such as Brazil, Colombia, Peru and Ecuador [Harner, 1976; Dobkin de Rios, 1984, 1990; Schultes, 1986, 1998; Schultes and Hofmann, 1992; Furst, 1994; Ott, 1994, 2004; McKenna and Riba, 2016].

Ayahuasca is usually obtained by boiling the stems of the liana *Banisteriopsis caapi* with the leaves of the shrub *Psychotria viridis* [Harner, 1976; Dobkin de Rios, 1984, 1990; McKenna *et al*. 1984; Schultes, 1986, 1998; Schultes and Hofmann, 1992; Furst, 1994; Ott, 1994, 1999, 2004; Riba *et al*. 2001, 2003; McKenna and Riba, 2016]. *P. viridis* is rich in DMT, while *B. caapi* contains β-carboline compounds that reversibly inhibit monoamine oxidase A (MAO-A), such as harmine, tetrahydroharmine (THH) and harmaline [Buckholtz and Boggan, 1977; Dobkin de Rios, 1984; McKenna *et al*. 1984; Schultes, 1986; Schultes and Hofmann, 1992; Ott, 1994, 1999, 2004; Riba, *et al*. 2001, 2003; McKenna and Riba, 2016]. Due to peripheral (gastrointestinal and liver) MAO-A degradation, DMT is not orally active [Riba *et al*. 2001, 2003, 2015; McKenna and Riba, 2016]. Thus, MAO-A inhibition by the β-carbolines in ayahuasca allows DMT to reach systemic circulation and the central nervous system [Ott, 1999; Riba *et al*. 2001, 2003, 2015; McKenna and Riba, 2016].

Psilocybin and its active dephosphorylated metabolite psilocin (4-hydroxy-*N,N*-DMT) are the primary psychoactive compounds of several species of hallucinogenic mushrooms found throughout the world [Harner, 1976; Grispoon and Bakalar, 1981; Wasson *et al*. 1986; Dobkin de Rios, 1990; Schultes and Hofmann, 1992; Furst, 1994; Schultes 1998; Passie *et al*. 2002; Ott, 2004; Guzmán, 2008; Tylš *et al*. 2014; McKenna and Riba, 2016]. Some of these species, such as *Psilocybe mexicana*, have a crucial role in the religious and medicinal systems of indigenous groups in Mexico [Harner, 1976; Grispoon and Bakalar, 1981; Wasson *et al*. 1986; Dobkin de Rios, 1990; Schultes and Hofmann, 1992; Furst, 1994; Schultes, 1998; Ott, 2004; Guzmán, 2008; McKenna and Riba, 2016]. The Swiss chemist Albert Hofmann first isolated psilocybin and psilocin from *P. mexicana* in 1958 after several self-experiments, and synthetized these compounds later in the same year [Passie *et al*. 2002; Ott, 2004; Hofmann, 2005; Guzmán, 2008; Tylš *et al*. 2014; McKenna and Riba, 2016]. Although psilocybin is usually referred to as being the main psychoactive compound in hallucinogenic mushrooms, it is in fact a so-called prodrug of psilocin. Thus, after ingestion, it is rapidly dephosphorylated in the gut and liver into the active metabolite psilocin [Passie *et al*. 2002; Tylš *et al*. 2014; McKenna and Riba, 2016].

DMT and psilocybin are pharmacologically related to the ergoline D-lysergic acid diethylamide (LSD or LSD-25), a semisynthetic derivative of the naturally occurring lysergic acid moiety, present in several alkaloids found in the rye ergot fungus (*Claviceps purpurea*) [Hofmann, 2005; Passie *et al*. 2008; Hintzen and Passie, 2010; Smith *et al*. 2014; McKenna and Riba, 2016]. LSD was first synthetized by Albert Hofmann in 1938, and its psychoactive effects were discovered when the Swiss chemist accidentally ingested the drug in 1943 [Hofmann, 2005; Passie *et al*. 2008; Hintzen and Passie, 2010; Smith *et al*. 2014; McKenna and Riba, 2016].

DMT, psilocybin and LSD are agonists of serotonin 5-HT$_{1A/2A/2C}$ receptors [Pierce and Peroutka, 1989; McKenna *et al*. 1990; Glennon *et al*. 2000; Passie *et al*. 2002, 2008; Nichols, 2004; Hintzen and Passie, 2010; Hanks and González-Maeso, 2013; Tylš *et al*. 2014; Halberstadt, 2015]. Although the 5-HT$_{1A/2C}$ receptors modulate the effects of serotonergic hallucinogens, activation of fronto-cortical glutamate receptors secondary to 5-HT$_{2A}$ receptor-related glutamate release appears to be the key mechanism of action of these drugs [Nichols, 2004; González-Maeso *et al*. 2008; Moreno *et al*. 2011, 2013; Hanks and GonzálezMaeso, 2013; Santini *et al*. 2014; Buchborn *et al*. 2015; Carbonaro *et al*. 2015; Halberstadt, 2015]. The 5-HT$_{2A}$ and the metabotropic glutamate 2/3 (mGluR2/3) receptors show an overlapping distribution in the brain cortex, and their interaction has a crucial role in the neuropsychopharmacology of classical hallucinogens [González-Maeso *et al*. 2008; Moreno *et al*. 2011].

In the last 25 years, the ritual and therapeutic use of ayahuasca has spread from small cities in the Amazonian jungle to the urban centers of South America, the United States, Europe, Asia and Africa [Labate *et al*. 2009; Labate and Jungaberle, 2011; Labate and Cavnar, 2014]. Animal research [Glick *et al*. 1994; Aricioglu-Kartal *et* *al*. 2003; Hilber and Chapillon, 2005; Farzin and Mansouri, 2006; Lima *et al*. 2006; Wu *et al*. 2009; Fortunato *et al*. 2009, 2010a, 2010b; Réus *et al*. 2010, 2012; Brierley and Davidson, 2012, 2013; Liester and Prickett, 2012; Owaisat *et al*. 2012; Abelaira *et al*. 2013; Oliveira-Lima *et al*. 2015; Pic-Taylor *et al*. 2015; dos Santos *et al*. 2016] and observational and preliminary experimental studies of ayahuasca consumers [Grob *et al*. 1996; Barbosa *et al*. 2005, 2012; da Silveira *et al*. 2005; Doering-Silveira *et al*. 2005; dos Santos *et al*. 2007, 2016; Halpern *et al*. 2008; Barbosa *et al*. 2009; Labate *et al*. 2009, 2014; Fábregas *et al*. 2010; Labate and Jungaberle, 2011; Bouso *et al*. 2012; dos Santos, 2013; Thomas *et al*. 2013; Bouso and Riba, 2014; Fernández and Fábregas, 2014; Fernández *et al*. 2014; Loizaga-Velder and Loizaga Pazzi, 2014; Loizaga-Velder and Verres, 2014; Palhano-Fontes *et al*. 2014; Winkelman, 2014] suggest that ayahuasca and its isolated alkaloids have antidepressive, anxiolytic, and antiaddictive effects.

Moreover, experimental studies of acute ayahuasca administration to healthy volunteers [Riba *et al*. 2001, 2003, 2006; dos Santos *et al*. 2011, 2012; de Araujo *et al*. 2012; Palhano-Fontes *et al*. 2015; McKenna and Riba, 2016] and mental health assessments of long-term ayahuasca consumers [Grob *et al*. 1996; Barbosa *et al*. 2005, 2009, 2012; da Silveira *et al*. 2005; Doering-Silveira *et al*. 2005; Halpern *et al*. 2008; Fábregas *et al*. 2010; Bouso *et al*. 2012, 2015; dos Santos, 2013] suggest that this preparation is quite safe.

In the case of psilocybin and LSD between the mid-1950s and mid-1970s, several studies investigated the potential therapeutic use of these drugs in the treatment of neurosis, obsessive-compulsive disorder (OCD), substance dependence, and as an adjunctive therapy in the terminally ill [Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Grispoon and Bakalar, 1981; Riedlinger and Riedlinger, 1994; Abraham *et al*. 1996; Delgado and Moreno, 1998; Grob, 1998; Grof, 2001; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Liester, 2014; Oram, 2014; Smith *et al*. 2014; Bogenschutz and Johnson, 2016].

However, clinical research with hallucinogens was interrupted in the late 1960s mid-1970s due to an increase in the recreational use of these substances and their association with the countercultural movements [Grispoon and Bakalar, 1981; Riedlinger and Riedlinger, 1994; Grob, 1998; Grof, 2001; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Liester, 2014; Oram, 2014; Smith *et al*. 2014; Bogenschutz and Johnson, 2016]. Moreover, new rules for investigating novel pharmacological agents were introduced in the 1960-1970s [Liester, 2014; Oram, 2014], creating many difficulties for human hallucinogen research since most of these studies had important methodological limitations, such as absence of adequate control groups and follow-up measurements; substantial variation of dose and dosing duration among studies; lack of control for confounding factors such as pre-existing mental health problems or participant sex and age; non-standardized criteria for therapeutic outcome; and use of diverse theoretical approaches for assessing beneficial effects (ranging from psychoanalysis or transpersonal psychology to hypnosis and sensorial isolation or overload) [Grispoon and Bakalar, 1981; Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Riedlinger and Riedlinger, 1994; Grob, 1998; Grof, 2001; Dyck, 2006; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Liester, 2014; Oram, 2014; Bogenschutz and Johnson, 2016].

Therefore, although the early clinical studies with hallucinogens showed promising results, their methodological limitations suggest caution when interpreting their results. After a halt of almost 20 years, controlled laboratory studies in humans involving the administration of hallucinogens resumed in the 1990s with the investigations in healthy volunteers of Leo Hermle and collaborators in Germany, using orally administered mescaline [Hermle *et al*. 1992], and of Rick Strassman and coworkers in the United States, administering intravenous DMT [Strassman and Qualls, 1994; Strassman *et al*. 1994].

More recent preclinical research [Delgado and Moreno, 1998; Zghoul and Blier, 2003; Matsushima *et al*. 2009; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Buchborn *et al*. 2014; Bogenschutz and Johnson, 2016], case reports [Leonard and Rapoport, 1987; Riedlinger and Riedlinger, 1994; Hanes, 1996; Delgado and Moreno, 1998; Perrine, 1999; Wilcox, 2014] and observational [Krebs and Johansen, 2013; Hendricks *et al*. 2014, 2015; Johansen and Krebs, 2015] and preliminary experimental studies in healthy volunteers [Griffiths *et al*. 2006, 2011; Vollenweider and Kometer, 2010; Studerus *et al*. 2011; Kometer *et al*. 2012; Kraehenmann *et al*. 2016; Schmid *et al*. 2016] suggest that classical hallucinogens such as psilocybin and LSD have anxiolytic, antidepressive, and antiaddictive properties.

Moreover, early clinical research [Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Grispoon and Bakalar, 1981; Strassman, 1984; Riedlinger and Riedlinger, 1994; Grob, 1998; Grof, 2001; Passie *et al*. 2002, 2008; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Liester, 2014; Smith *et al*. 2014; Tylš *et al*. 2014; Bogenschutz and Johnson, 2016], and more recent observational studies [Krebs and Johansen, 2013; Hendricks *et al*. 2014, 2015; Johansen and Krebs, 2015], drug harm or risk assessments [Nutt *et al*. 2010; van Amsterdam *et al*. 2011, 2013, 2015; Morgan *et al*. 2013], and pharmacological studies of acute drug administration to healthy volunteers [Griffiths *et al*. 2006, 2011; Vollenweider and Kometer, 2010; Studerus *et al*. 2011; Kometer *et al*. 2012; Carhart-Harris *et al*. 2012a, 2012b, 2013; Kraehenmann *et al*. 2016; Schmid *et al*. 2016] suggest that these compounds have low toxicity and are reasonably safe when administered in supervised or controlled settings. Indeed, classic hallucinogens such as psilocybin and LSD are considered less toxic and harmful than most licit and illicit drugs [Nutt *et al*. 2010; van Amsterdam *et al*. 2011, 2013, 2015; Morgan *et al*. 2013].

Thus, considering this context, this study aimed to conduct a systematic literature review of clinical trials published in the last 25 years (1990- 2015) that investigated anxiolytic, antidepressive, and antiaddictive effects of ayahuasca, psilocybin and LSD.

Methods

Data for this systematic review were collected in accordance with the Systematic Reviews and Meta-Analyses guidelines (PRISMA) [Moher *et al*. 2009].

Data acquisition

We intended to identify all clinical trials available for review from 1 January 1990 to 1 July 2015, in which the anxiolytic, antidepressive, or antiaddictive effects of ayahuasca, psilocybin or LSD were analyzed.

Search strategy

Electronic searches were performed using the PubMed (1 January 1990 - 1 July 2015), LILACS (1 January 1990 - 1 July 2015) and SciELO (1 January 1990 - 1 July 2015) databases. The following key words were used: ayahuasca OR psilocybin OR lysergic acid diethylamide AND anxiety OR depression OR dependence. References were retrieved through searching electronic databases and manual searches through reference lists of identified literature. All studies published in English, Spanish, and Portuguese up to 1 July 2015 were included.

Eligibility criteria

The following inclusion and exclusion criteria were established prior to the literature search:

Article type

For purposes of this review, only clinical trials (open-label pilot studies, single-blind trials, or double-blind placebo-controlled trials) published in peer-reviewed journals were included. Animal studies, experimental studies in healthy volunteers, observational studies, review papers, qualitative studies, opinion pieces or comments, letters or editorials, conference abstracts or posters, books or book chapters, case reports, and published abstracts were excluded.

Study design

The review included only clinical trials involving patients with a diagnosis of an anxiety, depressive, or dependence disorder based on a structured diagnostic interview [Diagnostic and Statistical Manual of Mental Disorders (DSM)].

Participants

Only studies that included patients with a diagnosis of an anxiety, depressive, or dependence disorder based on a structured diagnostic interview (DSM) were included.

Interventions

All clinical trials evaluating the effects of ayahuasca, psilocybin, or LSD on anxiety, depressive, or dependence symptoms were included.

Comparisons

The main comparators considered were placebo and active placebo.

Outcomes

Reductions in anxiety, depressive, or dependence symptoms measured with validated scales.

Data extraction

All studies were screened by two independent reviewers, with discrepancies resolved by a third reviewer. From the articles included we recorded names of authors, year of publication, study design (open label, single or double blind), characteristics of the participants (anxiety, depressive, or dependence symptoms, and sample size), response criteria (anxiolytic, antidepressive, or antiaddictive effect), type of intervention (drug, dose, and form of administration), and type of outcome measure (anxiety, depression, or dependence symptoms and scales).

Results

Study selection

A flow diagram illustrating the different phases of the systematic review is presented in Figure 1.

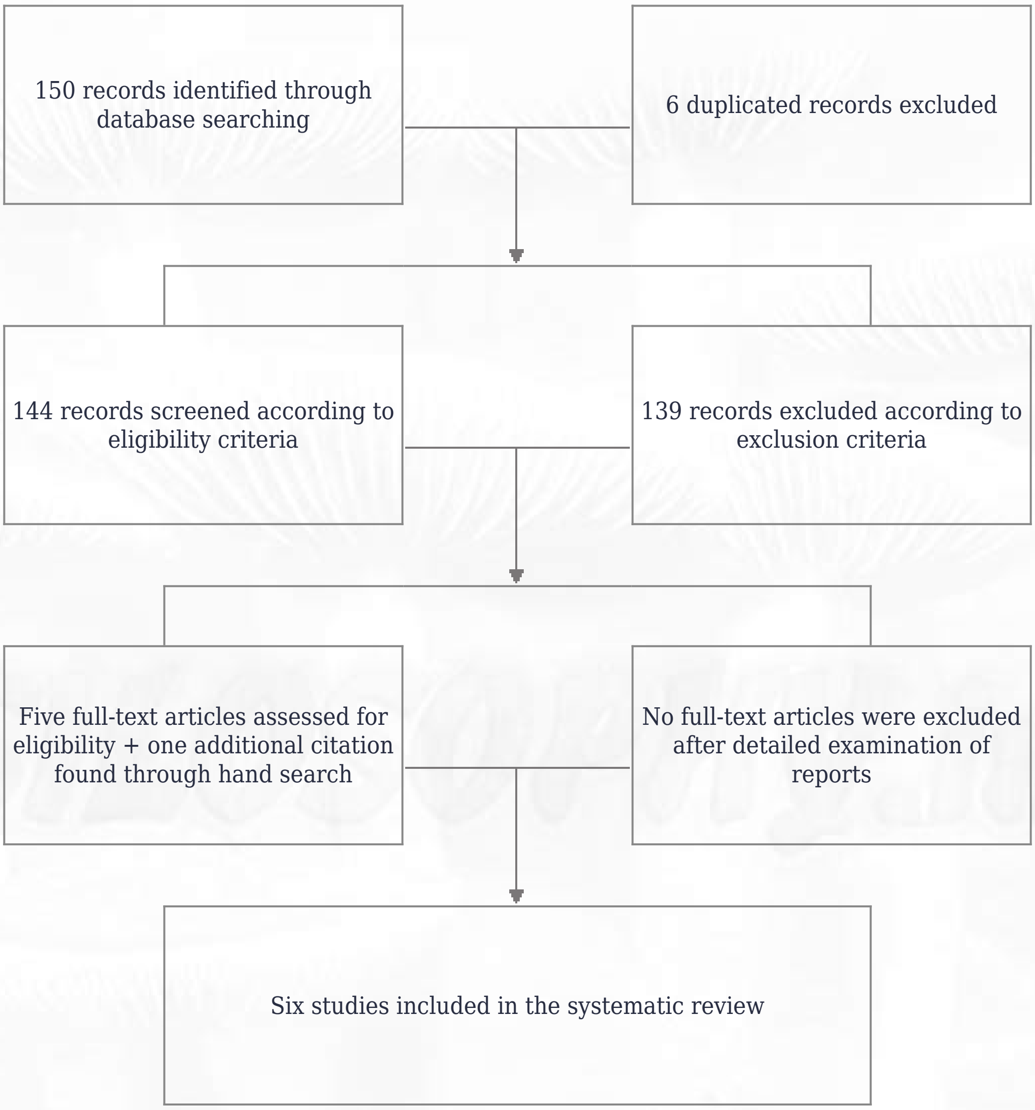

150 records identified through database searching
6 duplicated records excluded
144 records screened according to eligibility criteria
139 records excluded according to exclusion criteria
Five full-text articles assessed for eligibility + one additional citation found through hand search
No full-text articles were excluded after detailed examination of reports
Six studies included in the systematic review

Figure 1. Flow diagram illustrating the different phases of the systematic review.

The search of the literature yielded 150 separate references. Owing to the overlap of coverage between the databases, six of the references were found to be duplicates. Thus, a total of 144 citations were reviewed for abstract screening (first pass). Following the first pass, five potentially relevant references were identified [Moreno *et al*. 2006; Grob *et al*. 2011; Gasser *et al*. 2014; Bogenschutz *et al*. 2015; Osório *et al*. 2015]. The remaining 139 studies were excluded according to the exclusion criteria. Full-text reports of the five selected citations were obtained for more detailed evaluation (second pass). Following detailed examination of the reports, all five citations were included. Another citation was found after hand search of the bibliography of the selected reports [Johnson *et al*. 2014]. Thus, six citations were included in the systematic review.

Studies were classified according to drug (ayahuasca, psilocybin, or LSD) and symptom (anxiety, depression, or dependence symptoms). The included studies comprised four studies with psilocybin (one study of OCD: Moreno *et al*. 2006; one study of anxiety associated with advanced-stage cancer: Grob *et al*. 2011; one study of tobacco dependence: Johnson *et al*. 2014; and one study of alcohol dependence: Bogenschutz *et al*. 2015), one study with LSD (anxiety associated with life-threatening diseases: Gasser *et al*. 2014), and one study with ayahuasca [Osório *et al*. 2015]. The details of the selected studies are summarized in Table 1.

Despite the small number of studies, the small sample sizes (6-15 volunteers), the high degree of heterogeneity among studies, and the lack of placebo and control groups in three of the selected citations (open-label, proof-of-concept studies), the reported results consistently show that ayahuasca, psilocybin, and LSD have anxiolytic, antidepressive, and antiaddictive properties. These findings will be further discussed in detail below.

Table 1. Clinical trials assessing the anxiolytic, antidepressive, and antiaddictive effects of ayahuasca, psilocybin, and lysergic acid diethylamide (LSD).

Reference	No. of Patients/Diagnostic	Study Design	Drug (mg/kg)	Main Findings
Moreno *et al*. [2006]	9 OCD	Double blind, randomized, dose escalation	Psilocybin 0.25-0.3	Reduction in YBOCS scores in all subjects during one or more sessions Reduction in VAS scores for overall OCD symptom severity
Grob *et al*. [2011]	12 Anxiety associated with advanced-stage cancer	Double blind, randomized, active placebo (niacin 250 mg)	Psilocybin 0.2	Reduction in STAI trait anxiety scores at 1 and 3-month follow up, and in BDI scores at 6-month follow up
Gasser *et al*. [2014]	12 Anxiety associated with life-threatening diseases	Double blind, randomized, active placebo (LSD 20 μg)	LSD 2.9×10^{-3}	Reduction in STAI state anxiety scores at 2-month follow up
Johnson *et al*. [2014]	15 Tobacco dependence	Open label	Psilocybin 0.29-0.43	Reduction in breath CO levels, urine cotinine, daily smoking (TLFB), withdrawal (WSWS), craving (QSU), and temptation to smoke (SASE), and increase in confidence to abstain (SASE) through the 6-month follow up
Bogenschutz *et al*. [2015]	10 Alcohol dependence	Open label	Psilocybin 0.3-0.4	Reduction in percent-drinking days (TLFB) at all follow up points (weeks 5-36) Reduction in drinking consequences (SIP) and craving (PACS), and improves in self-efficacy (AASE), motivation (SOCRATES 8A), and mood (POMS) at multiple time points (weeks 5-36)
Osório *et al*. [2015]	6 MDD	Open label	Ayahuasca 2.2 ml/kg[1]	Reduction in HAM-D, MADRS, and BPRS-AD scores between baseline and 1, 7 and 21 days after drug intake

AASE, Alcohol Abstinence Self-Efficacy Confidence score; BPRS-AD, Anxious-Depression subscale of the Brief Psychiatric Rating Scale; BDI, Beck Depression Inventory; CO, carbon monoxide; DSM, Diagnostic and Statistical Manual of Mental Disorders; HAM-D, Hamilton Rating Scale for Depression; LSD, lysergic acid diethylamide; MADRS, Montgomery-Åsberg Depression Rating Scale; MDD, major depressive disorder; OCD, obsessive-compulsive disorder; PACS, Penn Alcohol Craving Scale; POMS, Profile of Mood States; QSU, Questionnaire on Smoking Urges; SASE, Smoking Abstinence Self-Efficacy scale; SIP, Short Inventory of Problems; SOCRATES 8A, Stages of Change Readiness and Treatment Eagerness Scale; STAI, State-Trait Anxiety Inventory; TLFB, Time-Line Follow-Back; VAS, Visual Analog Scales; WSWS, Wisconsin Smoking Withdrawal Scale; YBOCS, Yale-Brown Obsessive-Compulsive Scale.

[1] Orally administered as a decoction; alkaloid content 0.8 mg/ml DMT, 0.21 mg/ml harmine (no harmaline was detected).

Drugs

Psilocybin

Obsessive-compulsive disorder

In a double-blind study, nine subjects (seven men, two women) with obsessive-compulsive disorder (OCD) and at least one treatment failure with a serotonin reuptake inhibitor (mean 3.4 ± 1.9 treatment failures) received up to four different doses of orally administered psilocybin (one dose for test session) in a dose-escalation blinded design [Moreno *et al*. 2006]. Low (100 µg/kg), medium (200 µg/kg), and high (300 µg/kg) doses of psilocybin were administered in that order, and a very low dose (25 µg/kg) was inserted randomly and in double-blind design at any time after the first dose (100 µg/kg). Subjects met DSM-IV criteria for OCD and had a mean baseline Yale-Brown Obsessive-Compulsive Scale (YBOCS) score of 24.1 ± 5.9. YBOCS and Visual Analog Scales (VAS) scores for overall OCD symptom severity were measured immediately before drug ingestion and at 4, 8, and 24 hours after ingestion.

All subjects received the low dose, seven received the very low and medium doses, and six received all doses. Reductions in YBOCS scores ranging from 23% to 100% were observed in all subjects during one or more sessions. Moreover, 88.9% of subjects maintained no less than a 25% decrease and 66.7% maintained no less than a 50% decrease in YBOCS scores at 24 hours with at least one psilocybin dose. Symptom improvement during the following week was reported by two subjects, and one volunteer reported improvement at the 6-month follow up. VAS scores were also reduced throughout the study period, and psilocybin was well tolerated by all volunteers.

Anxiety associated with advanced-stage cancer

A double blind, randomized, placebo-controlled study assessed the safety and potential therapeutic effects of psilocybin in the treatment of psychological distress associated with the existential crisis of terminal disease [Grob *et al*. 2011]. Twelve subjects (11 women) with advanced-stage cancer and a DSM-IV diagnosis of acute stress disorder, generalized anxiety disorder, anxiety disorder due to cancer, or adjustment disorder with anxiety, received oral psilocybin (0.2 mg/kg) or the active placebo niacin (250 mg) in a double-blind fashion. The Beck Depression Inventory (BDI), the Profile of Mood States (POMS), and the State-Trait Anxiety Inventory (STAI) were administered the day before, at the conclusion, the day after, and 2 weeks after each experimental session. The BDI, POMS, and STAI were administered again at monthly intervals for 6 months after the final session.

All 12 participants completed the 3 months of follow up, 11 completed the 4-month follow up, and eight completed the 6-month follow up. During the study, two subjects died of their cancer and two became too ill to continue the study. Significant decreases were observed in STAI scores at the 1- and 3-month follow ups, and in BDI scores at the 6-month follow up. No significant changes were observed in POMS scores, and psilocybin was well tolerated by all patients. By the time of the paper's submission in 2010, 10 of the 12 subjects had died of their cancer.

Tobacco dependence

An open-label study assessed the effects of moderate (20 mg/70 kg) and high (30 mg/70 kg) doses of psilocybin in 15 (ten men, five women; mean age of 51 years) nicotine-dependent smokers [Johnson *et al*. 2014]. Participants had a mean of six previous lifetime quit attempts, and smoked a mean of 19 cigarettes per day for a mean of 31 years. Volunteers participated in a 15-week smoking cessation treatment (cognitive behavioral therapy), with psilocybin administration occurring in weeks 5 (moderate dose), 7 (high dose), and 13 (high dose) (participants were permitted to repeat the moderate dose on sessions two and three). Changes in mean cigarettes per day were compared between the 30 days prior to study intake and the 6 months after the first psilocybin session (at week 5 of treatment). Exhaled carbon monoxide (CO) and urinary cotinine level were assessed at intake, weekly throughout the intervention, and at 6-month follow up to measure recent smoking.

All participants completed the study. According to the Time-Line Follow-Back (TLFB) and biomarker data (breath CO, urine cotinine), 80% (12 of 15) of participants were abstinent at 6-month follow up. Among the entire sample, significant reductions from intake to the 6-month follow up were observed in breath CO levels, urine cotinine, and self-reported daily smoking. Moreover, craving [Questionnaire on Smoking Urges (QSU)] and temptation to smoke [Smoking Abstinence Self-Efficacy scale (SASE)] were significantly reduced across all time points.

Significant increases were reported for confidence to abstain (SASE) from intake to the 6-month follow up, and withdrawal scores [Wisconsin Smoking Withdrawal Scale (WSWS)] peaked at 1-week post-psilocybin and decreased significantly through the 6-month follow up. No significant adverse events were reported during psilocybin sessions.

Alcohol dependence

Ten volunteers (four women, six men) with DSM-IV alcohol dependence (mean duration of dependence 15.1 ± 11.5 years, range 4-32) participated in an open-label trial that included a 12-session psychosocial intervention and two oral doses of psilocybin [Bogenschutz *et al*. 2015]. Eight of the 10 volunteers had evidence of physical dependence (tolerance or withdrawal). The psychosocial intervention included seven sessions of Motivational Enhancement Therapy (MET); three preparation sessions; two debriefing sessions; four sessions before the first psilocybin dose (0.3 mg/kg); four sessions between the first and second psilocybin dose (0.4 mg/kg); and four sessions after the second psilocybin dose. Outcome measures were collected for 36 weeks.

Nine volunteers completed all follow-up assessments; 10 completed the first psilocybin session, and seven the second session. However, only six patients were included in the analysis of the second session since one volunteer did not receive the 0.4 mg/kg psilocybin dose, receiving the 0.3 mg/kg due to meeting criteria for 'complete mystical experience' [Mystical Experience Questionnaire (MEQ)] in the first session. One patient discontinued participation and was excluded from the analysis.

According to the TLFB, percent-drinking days (consumption of any amount of an alcoholic beverage) and heavy-drinking days (consumption of four or more drinks of 14 g of alcohol) decreased significantly relative to weeks 1-4 prior to psilocybin, and also during weeks 5-12 relative to baseline. Following the first psilocybin session, percent-drinking days and heavy-drinking days were significantly lower than baseline at all follow-up points.

Significant correlations were observed between the overall intensity (Hallucinogen Rating Scale Intensity score; Altered States of Consciousness Scale summary score) and mystical quality (MEQ) of the psilocybin session and changes in percent-drinking days (TLFB), craving [Penn Alcohol Craving Scale (PACS)], self-efficacy to abstain from drinking [Alcohol Abstinence Self-Efficacy Confidence score (AASE)], and motivation [Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES 8A)].

Improvements were largely maintained throughout the 36 weeks follow up. At multiple time points relative to baseline and (or) week 4, psilocybin reduced drinking consequences [Short Inventory of Problems, (SIP); weeks 8 to 36] and craving (PACS), and improved self-efficacy (AASE; weeks 5, 9, 24 and 36), motivation (SOCRATES 8A; weeks 5 to 36), and mood [Profile of Mood States, (POMS); weeks 4 and 24]. No significant adverse effects were reported after psilocybin administration.

Lysergic acid diethylamide (LSD)

Anxiety associated with life-threatening diseases

A double blind, randomized, active placebo-controlled study assessed the effects of lysergic acid diethylamide (LSD) in 12 patients (seven men, four women) with anxiety associated with life-threatening diseases (cancer, or chronic motor or inflammatory diseases) [Gasser *et al*. 2014]. Volunteers had a score of no less than 40 on the state or trait scales of the STAI and a DSM-IV diagnosis of major depressive disorder (MDD), reactive depression, dysthymia, posttraumatic stress disorder (PTSD), panic disorder, or social phobia. The study included drug-free psychotherapy sessions and two LSD-assisted psychotherapy sessions. Volunteers received either an experimental dose (200 µg, *n* = 8) or an active placebo (20 µg, *n* = 3) of LSD 2 to 3 weeks apart, with an open-label crossover to 200 µg of LSD after the initial blinded treatment (*n* = 4). Outcome data were collected at baseline, 1 week after LSD sessions, and at 2- and 12-month follow ups.

At the 2-month point, STAI state anxiety was significantly reduced, and a trend was found for reductions in STAI trait anxiety. STAI reductions were sustained for 12 months. Beneficial results were also observed in secondary outcome measures, including the European Cancer Quality of Life Questionnaire 30-item version 1.0 (EORTCQLQ-30), the Symptom Checklist-90-Revised (SCL-90-R), and the Hospital Anxiety and Depression Scale (HADS). However, due to concerns about multiplicity, changes in secondary outcome measures were not analyzed for statistical significance. No adverse effects or treatment-related serious adverse events were reported.

Ayahuasca

Major depressive disorder

An open-label trial assessed the antidepressive potential of ayahuasca in patients with diagnosis of recurrent major depressive disorder (MDD) [Osório *et al*. 2015]. A single dose of orally administered ayahuasca (2.2 ml/kg body weight) was administered to six volunteers (two men, four women) suffering a mild (*n* = 2), moderate (*n* = 3) or severe (*n* = 1) depressive episode. Ayahuasca administration produced statistically significant reductions of up to 82% in depressive scores between baseline and 1, 7 and 21 days after drug intake, according to the Hamilton Rating Scale for Depression (HAMD), the Montgomery-Åsberg Depression Rating Scale (MADRS), and the Anxious-Depression subscale of the Brief Psychiatric Rating Scale (BPRS). Ayahuasca did not produce significant effects in the Young Mania Rating Scale (YMRS) scores or in the other subscales of the BPRS. Ayahuasca was well tolerated by all patients and vomiting was the only adverse effect recorded, being reported by 50% of the volunteers. Patients did not consider this emetic effect as causing severe discomfort.

Discussion

Possible mechanisms of therapeutic action

The mechanisms of action responsible for the beneficial effects produced by ayahuasca, psilocybin and LSD are not completely understood. Preclinical evidence show that ayahuasca [Lima *et al*. 2006; Pic-Taylor *et al*. 2015] and its β-carbolines harmine [Aricioglu-Kartal *et al*. 2003; Farzin and Mansouri, 2006; Fortunato *et al*. 2009, 2010a, 2010b; Réus *et al*. 2010, 2012; Brierley and Davidson, 2012; Owaisat *et al*. 2012] and harmaline [Glick *et al*. 1994; Hilber and Chapillon, 2005; Wu *et al*. 2009], as well as psilocybin [Matsushima *et al*. 2009] and LSD [Zghoul and Blier, 2003; Buchborn *et al*. 2014], have antidepressive, anxiolytic, and antiaddictive properties. Experimental studies with healthy volunteers report that acute administration of DMT [Gillin *et al*. 1976; Strassman *et al*. 1994; Riba *et al*. 2015], psilocybin [Griffiths *et al*. 2006, 2011; Studerus *et al*. 2011; Kometer *et al*. 2012; Kraehenmann *et al*. 2016], and LSD [Schmid *et al*. 2016] increase positive mood. Furthermore, observational and preliminary experimental studies of ayahuasca consumers [Grob *et al*. 1996; Barbosa *et al*. 2005, 2009, 2012; da Silveira *et al*. 2005; Doering-Silveira *et al*. 2005; dos Santos *et al*. 2007, 2016; Halpern *et al*. 2008; Labate *et al*. 2009, 2014; Fábregas *et al*. 2010; Labate and Jungaberle, 2011; Bouso *et al*. 2012; dos Santos, 2013; Thomas *et al*. 2013; Bouso and Riba, 2014; Fernández and Fábregas, 2014; Fernández *et al*. 2014; Loizaga-Velder and Loizaga Pazzi, 2014; Loizaga-Velder and Verres, 2014; Palhano-Fontes *et al*. 2014; Winkelman, 2014], as well as case reports [Leonard and Rapoport, 1987; Riedlinger and Riedlinger, 1994; Hanes, 1996; Delgado and Moreno, 1998; Perrine, 1999; Wilcox, 2014] and observational studies [Krebs and Johansen, 2013; Hendricks *et al*. 2014, 2015; Johansen and Krebs, 2015] involving psilocybin and LSD, also suggest that these drugs have therapeutic potentials.

Since DMT, psilocybin and LSD are agonists of serotonin 5-HT$_{1A/2A/2C}$ receptors [Pierce and Peroutka, 1989; McKenna *et al*. 1990; Glennon *et al*. 2000; Passie *et al*. 2002, 2008; Nichols, 2004; Hintzen and Passie, 2010; Hanks and González-Maeso, 2013; Tylš *et al*. 2014; Halberstadt, 2015], these receptors may be involved in the therapeutic effects of these tryptamines. In fact, cortical expression of 5-HT$_{1A/2A/2C}$ receptor is altered in postmortem samples of depressed patients, suggesting that these receptors are involved in emotional processing [Vollenweider and Kometer, 2010; Baumeister *et al*. 2014]. Furthermore, animal models and clinical studies show that 5-HT$_{1A}$ receptor agonists have anxiolytic and antidepressive properties [Nutt, 2005; Katzman, 2009; Baumeister *et al*. 2014], and 5-HT$_{2A/2C}$ receptor agonists reduce anxiety- and depression-related behavior in animals [Masuda and Sugiyama, 2000; Nic Dhonnchadha *et al*. 2003a, 2003b; Baumeister *et al*. 2014].

Another possible mechanism of therapeutic action is the modulation of glutamatergic neurotransmission induced by 5-HT$_{2A}$-receptor agonism [Nichols, 2004; González-Maeso *et al*. 2008; Vollenweider and Kometer, 2010; Moreno *et al*. 2011, 2013; Hanks and González-Maeso, 2013; Santini *et al*. 2014; Buchborn *et al*. 2015; Carbonaro *et al*. 2015; Halberstadt, 2015]. Activation of frontocortical glutamate networks by 5-HT$_{2A}$ receptor agonists could lead to increases in the expression of neurotrophic factors such as brain-derived neurotrophic factor (BDNF) and glial cell line-derived neurotrophic factor (GDNF) and in the size of dendritic spines on cortical neurons, thus enhancing neuroplasticity and neurogenesis [Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Ross, 2012; Baumeister *et al*. 2014; Bogenschutz and Johnson, 2016]. For instance, depression is associated with deficient neurogenesis and neurotrophic activity, and BDNF levels are decreased in depressed patients and normalized after antidepressant treatment [Baumeister *et al*. 2014]. Furthermore, alcohol self-administration and conditioned place preference are inversely related to BDNF or GDNF expression in animal models [Bogenschutz and Pommy, 2012; Bogenschutz and Johnson, 2016]. Interestingly, a low dose (0.1 mg/kg) of psilocybin produced a trend toward increased neurogenesis in the mouse hippocampus 2 weeks after its administration, while a high dose (1 mg/kg) significantly decreased neurogenesis [Catlow *et al*. 2013]. These results suggest that the effects of psilocybin on neurogenesis are dose- and time-related.

Agonism at the 5-HT$_{2A}$ receptor could also produce beneficial effects due to an anti-inflammatory action [Nau *et al*. 2013; Baumeister *et al*. 2014; dos Santos, 2014; Szabo *et al*. 2014]. Increased levels of pro-inflammatory cytokines such as tumor necrosis factor α (TNFα), interleukin-6 (IL-6), IL-8, and IL-1β are associated with depressive illness, while normalization of these levels are related to antidepressant effects [Baumeister *et al*. 2014; Réus *et al*. 2015]. The 5-HT$_{2A}$ receptor is expressed in central and peripheral immune-related cells [Stefulj *et al*. 2000; Nau *et al*. 2013], and 5-HT$_{2A}$ agonists may modulate the immune system [Forrer and Goldner, 1951; Feld *et al*. 1958; Sackler *et al*. 1963, 1966; Hollister and Sjoberg, 1964; House *et al*. 1994, 1997; Stefulj *et al*. 2000; Passie *et al*. 2002; Davydova *et al*. 2010; Hintzen and Passie, 2010; dos Santos *et al*. 2011, 2012; Frecska *et al*. 2013; Nau *et al*. 2013; Baumeister *et al*. 2014; dos Santos, 2014; Szabo *et al*. 2014]. Indeed, in vitro studies show that LSD inhibits the production of IL-6 [House *et al*. 1994, 1997], and the serotonergic hallucinogen 4-iodo-2,5-dimethoxyphenylisopropylamine (DOI, a 5-HT$_{2A}$ receptor agonist) produces anti-inflammatory effects in mice by blocking TNF-α-induced expression of pro-inflammatory cell adhesion (Icam-1, Vcam-1), cytokine (IL-6, IL-1β), and chemokine (Mcp-1, Cx3cl1) genes, and expression of VCAM-1 protein [Nau *et al*. 2013]. These effects were blocked by a 5-HT$_{2A}$ selective antagonist, implicating this receptor in the anti-inflammatory effects of DOI. Moreover, DMT and the related tryptamine 5-methoxy-DMT (5-MeO-DMT) reduced the mRNA expression and the levels of IL-6, IL-8, IL-1β, and TNF-α, increased the levels of the anti-inflammatory cytokine IL-10, and inhibited the immune responses of inflammatory T helper 1/17 (Th1/Th17) cells [Szabo *et al*. 2014]. Interestingly, gene knock-down experiments showed that the effects of both tryptamines on TNFα, IL-10, and Th1/Th17 responses were mediated by the sigma-1 receptor, and recent studies show that DMT is an endogenous agonist for the sigma-1 receptor [Fontanilla *et al*. 2009; Su *et al*. 2009; Frecska *et al*. 2013; Szabo *et al*. 2014].

The possible modulation of the sigma-1 receptor by DMT shows that other mechanisms of action that are not dependent of the 5-HT$_{1A/2A/2C}$ receptors may also be involved in the therapeutic action of classic hallucinogens. For instance, harmine, THH and harmaline reversibly inhibit MAO-A [Buckholtz and Boggan, 1977; McKenna *et al*. 1984; Ott, 1994, 1999, 2004; Riba *et al*. 2001, 2003; McKenna and Riba, 2016], and reversible inhibitors of MAO-A (RIMAs) are clinically used as anxiolytic and antidepressant drugs [Yamada and Yasuhara, 2004; Nutt, 2005]. Moreover, rodent studies show that the antidepressive effects of harmine are associated with increases in BDNF levels [Fortunato *et al*. 2009; 2010a; 2010b].

Neural oxidative stress and subsequent neuroinflammation are associated with psychiatric disorders such as depression [Réus *et al*. 2015], and several preclinical studies show that harmine and harmaline have antioxidant and neuroprotective effects that seem to be mediated by MAO inhibition [Maher and Davis, 1996; Biradar *et al*. 2013], regulation of the dual specificity tyrosine-phosphorylation-regulated kinase DYRK1A [Frost *et al*. 2011], modulation of dopaminergic [Lee *et al*. 2000; Schwarz *et al*. 2003], cholinergic [Biradar *et al*. 2013], and glutamatergic [Maher and Davis, 1996; Li *et al*. 2011; Sun *et al*. 2014] pathways, interaction with voltage-gated membrane channels [Splettstoesser *et al*. 2005], and regulation of cell-energy homeostasis, mitochondrial functions, and oxygen free radical scavenging [Moura *et al*. 2007; Réus *et al*. 2010, 2012; Abelaira *et al*. 2013]. Furthermore, harmine also has anti-inflammatory properties that seem to be mediated at least in part by DYRK1A [Khor *et al*. 2015].

The antiaddictive effects of ayahuasca, psilocybin and LSD could also be related to the activation of the dopaminergic system. For instance, preclinical studies show that LSD [Nichols, 2004; Passie *et al*. 2008; Hintzen and Passie, 2010], psilocybin [Tylš *et al*. 2014; Sakashita *et al*. 2015], and ayahuasca [de Castro-Neto *et al*. 2013] may indirectly stimulate dopaminergic pathways, probably through 5-HT$_{2A}$-receptor activation (LSD, psilocybin, and DMT) or MAO inhibition (β-carbolines). Moreover, acute psilocybin administration indirectly increased (through 5-HT$_{1A/2A}$ receptors) the release of dopamine in the ventral striatum in humans [Vollenweider *et al*. 1999]. Animal studies suggest that the antiaddictive potentials of harmine and harmaline appear to involve imidazoline, glutamate, and dopamine pathways [Glick *et al*. 1994; Iurlo *et al*. 2001; Aricioglu-Kartal *et al*. 2003; Schwarz *et al*. 2003; Brierley and Davidson, 2012, 2013; Owaisat *et al*. 2012].

Recent neuroimaging studies in humans suggest that the mood-enhancing properties of ayahuasca and psilocybin could be related to modifications in the activity of brain regions such as the amygdala and the anterior cingulate cortex (ACC), involved in emotional processing, and the default mode network (DMN), a group of brain regions associated with introspection and other internally focused functions [Riba *et al*. 2006; Araujo *et al*. 2012; Carhart-Harris *et al*. 2012a, 2014; Tagliazucchi *et al*. 2014; Bouso *et al*. 2015; Palhano-Fontes *et al*. 2015; Alonso *et al*. 2015; Kraehenmann *et al*. 2016; McKenna and Riba, 2016]. Psilocybin reduced amygdala reactivity, which correlated with increases in positive mood [Kraehenmann *et al*. 2016]. Increased activity of the DMN is associated with intensification of the self-reference process of rumination, which is an important depressive symptom, and acute administration of ayahuasca [Palhano-Fontes *et al*. 2015] and psilocybin [Carhart-Harris *et al*. 2012a] reduces brain activity in key regions of the DMN, such as the posterior cingulate cortex (PCC). Moreover, regular ayahuasca use is associated with cortical thinning in the PCC [Bouso *et al*. 2015].

Early human research with classical hallucinogens suggests that the therapeutic properties of these compounds are related at least in part to their effects on perceptions, emotions, and thoughts [Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Grispoon and Bakalar, 1981; Riedlinger and Riedlinger, 1994; Abraham *et al*. 1996; Delgado and Moreno, 1998; Grob, 1998; Grof, 2001; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Liester, 2014; Oram, 2014; Majiæ *et al*. 2015; Bogenschutz and Johnson, 2016]. The subjective experience produced by these drugs would create a 'window of opportunity' in which changes in unhealthy thoughts, emotions, and behaviors could take place in a psychotherapeutic context [Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Grispoon and Bakalar, 1981; Riedlinger and Riedlinger, 1994; Abraham *et al*. 1996; Delgado and Moreno, 1998; Grob, 1998; Grof, 2001; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Liester, 2014; Oram, 2014; Majiæ *et al*. 2015; Bogenschutz and Johnson, 2016]. Recent neuroimaging studies with ayahuasca and psilocybin seem to corroborate these early ideas by suggesting that the altered state of consciousness produced by these drugs would create a disruption or interruption of the repetitive, rigid, and pathological pattern of negative and compulsive thoughts present in anxiety and mood disorders and in drug dependence, contributing to mental flexibility and changes in perspective, values, and behavior [Carhart-Harris *et al*. 2012a, 2014; Tagliazucchi *et al*. 2014; Palhano-Fontes *et al*. 2015; McKenna and Riba, 2016].

Furthermore, the ability of classical hallucinogens to elicit religious, mystical, transcendent, or peak experiences has also been proposed as a possible psychological mechanism associated with the beneficial effects of these drugs [Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Grispoon and Bakalar, 1981; Riedlinger and Riedlinger, 1994; Abraham *et al*. 1996; Delgado and Moreno, 1998; Grob, 1998; Grof, 2001; Hofmann, 2005; Dyck, 2006; Griffiths *et al*. 2006, 2008, 2011; Hintzen and Passie, 2010; Vollenweider and

Kometer, 2010; MacLean *et al*. 2011; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Liester, 2014; Oram, 2014; Majiæ *et al*. 2015; Bogenschutz and Johnson, 2016]. Indeed, recent studies in healthy individuals show that acute psilocybin administration induces highly meaningful and spiritually significant experiences with sustained positive changes in attitudes, mood, personality, and behavior [Griffiths *et al*. 2006, 2008, 2011; MacLean *et al*. 2011]. Moreover, a secondary analysis of the data from the study of psilocybin and tobacco dependence reported that the mystical-type effects of psilocybin and their personal meaning, spiritual significance, and impact on well-being were correlated with improvements in smoking cessation [Garcia-Romeu *et al*. 2014; Johnson *et al*. 2014]. A qualitative follow-up assessment of the patients enrolled in the study of LSD-assisted psychotherapy for anxiety associated with a life-threatening disease also suggested that the intense emotional experiences with mystic-like features produced by LSD could mediate the observed long-term beneficial changes in perspectives, attitudes, values, and quality of life [Gasser *et al*. 2014, 2015].

Interestingly, these findings are consistent with studies that suggest that the dissociative, psychotomimetic, and mystical-type effects produced by the *N*-methyl-D-aspartate (NMDA) antagonist ketamine may mediate the anxiolytic [Kolp *et al*. 2007], antidepressive [Sos *et al*. 2013; Luckenbaugh *et al*. 2014], and antiaddictive [Krupitsky *et al*. 1992, 2002, 2007; Krupitsky and Grinenko, 1997; Jansen, 2001; Kolp *et al*. 2006; Krupitsky and Kolp, 2007; Dakwar *et al*. 2014a, 2014b] properties of this non-classic hallucinogen. Moreover, some authors suggested that the temporary mental state produced by classic hallucinogens might induce profound long-term effects by producing an 'inverse post-traumatic stress disorder (PTSD)-like effect' in which a highly significant and positive experience would cause lasting beneficial changes, as opposed to chronic negative mood and other detrimental symptoms caused by a single traumatic event, which characterizes PTSD [MacLean *et al*. 2011; Young 2013; Garcia-Romeu *et al*. 2014].

Human hallucinogenic research performed in the 1960s and 1970s also suggests that the context and the psychotherapeutic approach used in combination with classic hallucinogens are also important components of the beneficial effects produced by these drugs [Kurland *et al*. 1971; McGlothlin and Arnold, 1971; Grispoon and Bakalar, 1981; Riedlinger and Riedlinger, 1994; Abraham *et al*. 1996; Delgado and Moreno, 1998; Grob, 1998; Grof, 2001; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Burdick and Adinoff, 2013; Baumeister *et al*. 2014; Liester, 2014; Oram, 2014; Majiæ *et al*. 2015; Bogenschutz and Johnson, 2016]. The methodology of the clinical trials included in the present systematic review are very diverse regarding this topic: three studies assessed the effects of single-dose exposures without psychotherapeutic approaches [Moreno *et al*. 2006; Grob *et al*. 2011; Osório *et al*. 2015] and three trials included some form of psychological intervention over a few weeks [Gasser *et al*. 2014; Johnson *et al*. 2014; Bogenschutz *et al*. 2015]. The studies without psychotherapy suggest that biochemical mechanisms may be involved in the beneficial effects observed. On the other hand, the inclusion of psychological interventions in the other studies suggests that at least some part of the therapeutic results is related to nondrug factors. Placebo effects and enhanced suggestibility may also play a role as adjuncts in hallucinogen-assisted psychotherapy [Young, 2013; Carhart-Harris *et al*. 2015].

Future research should investigate the possible influence of different psychotherapeutic approaches or other nondrug factors - such as patient preparation before drug administration and integration of the drug session afterwards - in mediating the therapeutic properties of classic hallucinogens.

Safety

No serious adverse reactions were reported in any of the clinical trials reviewed in the present systematic review, suggesting that classic hallucinogens can be safely administered to patients suffering anxiety, depression, or drug dependence. Previous experimental studies of acute ayahuasca administration to healthy volunteers [Riba *et al*. 2001, 2003, 2006; dos Santos *et al*. 2011, 2012; de Araujo *et al*. 2012; Palhano-Fontes *et al*. 2015; McKenna and Riba, 2016] also suggest that this drug can be safely administered in controlled experimental settings. Observational studies of long-term ayahuasca consumers [Grob *et al*. 1996; Barbosa *et al*. 2005, 2009, 2012; da Silveira *et al*. 2005; Doering-Silveira *et al*. 2005; Halpern *et al*. 2008; Fábregas *et al*. 2010; Bouso *et al*. 2012, 2015; dos Santos, 2013] also suggest that this brew has a low toxicity profile when consumed in ritual contexts. Previous clinical research [Kurland *et al*. 1971; McGlothlin and Arnold, 1971;

Grispoon and Bakalar, 1981; Strassman, 1984; Riedlinger and Riedlinger, 1994; Grob, 1998; Grof, 2001; Passie *et al*. 2002, 2008; Hofmann, 2005; Dyck, 2006; Hintzen and Passie, 2010; Vollenweider and Kometer, 2010; Bogenschutz and Pommy, 2012; Krebs and Johansen, 2012; Bogenschutz, 2013; Liester, 2014; Smith *et al*. 2014; Tylš *et al*. 2014; Bogenschutz and Johnson, 2016] and recent observational studies [Krebs and Johansen, 2013; Hendricks *et al*. 2014, 2015; Johansen and Krebs, 2015], drug harm or risk assessments [Nutt *et al*. 2010; van Amsterdam *et al*. 2011, 2013, 2015; Morgan *et al*. 2013], and experimental studies with healthy volunteers [Vollenweider and Kometer, 2010; Carhart-Harris *et al*. 2012a, 2012b, 2013] also suggest that psilocybin and LSD can be safely administered in controlled settings.

Limitations

A main limitation of the present systematic review is the inclusion of a small number of studies (six) with small sample sizes (6-15 volunteers), which limits the generalization of the reported results. Included studies also show a high degree of heterogeneity, and three of the selected citations did not include placebo or a control group (open-label, proof-of-concept studies). Another important limitation is the difficulty in disentangling placebo effects, drug effects, and the influence of the psychological intervention included in the clinical trial.

However, despite these important limitations, results consistently showed that ayahuasca, psilocybin, and LSD produced anxiolytic, antidepressive, and antiaddictive effects in patients, and these results were also observed in animal studies and with healthy volunteers. Given the low success rates of current pharmacological and nonpharmacological treatments for drug dependence and anxiety and mood disorders, and considering the high morbidity and mortality associated with these disorders, it is necessary to perform more studies with these drugs, even if only a small portion of patients may reduce their suffering with these drugs. Future studies should include more patients, placebo or active placebo, randomized and double-blind designs, and multiple doses during treatment. Moreover, the influence of psychological interventions and the possible increases in therapeutic efficacy proportionated by these psychotherapeutic approaches should be better explored.

Conclusion

Currently available pharmacological treatments for drug dependence and anxiety and mood disorders have limited efficacy and often produce important adverse reactions that may limit treatment continuation. Classic tryptamine hallucinogens such as ayahuasca/DMT, psilocybin, and LSD are safely administered in controlled settings and several basic, experimental, and clinical studies suggest that these drugs have anxiolytic, antidepressive, and antiaddictive effects. Such beneficial properties seem to be mediated by an agonist action of these compounds on 5-HT$_{1A/2A/2C}$ receptors, which are involved in emotional processing, regulation of neurotrophic factors, anti-inflammatory actions, and modulation of frontal and medial brain structures. Other mechanisms of action not related to serotonergic receptors, such as regulation of cell energy homeostasis, mitochondrial functions, and oxidative stress, also appear to mediate these therapeutic effects.

The reviewed studies suggest that the therapeutic use of classic hallucinogens may offer to some patients fast-acting and prolonged beneficial effects after a single dose, producing few adverse effects. Indeed, interest in the medicinal uses of this class of drugs is increasing: new clinical trials investigating the effects of psilocybin in the treatment of alcoholism, cocaine dependence, tobacco dependence, and anxiety and depression associated with cancer are currently underway [ClinicalTrials.gov identifiers: NCT02061293, NCT02037126, NCT01943994, NCT00957359, NCT00465595]. Moreover, our group recently replicated the results of the original open-label, proof-of-concept study [Osório *et al*. 2015] but including an increased sample size (n =17) and single-photon emission computed tomography (SPECT), showing that ayahuasca antidepressive properties may be associated with increased blood perfusion in brain areas related to depressive symptoms (Sanches *et al*. 2016 "This reference was not included in the review because it was not published at the time of the electronic search"). Our group is currently performing randomized, double blind, placebo-controlled studies assessing the antidepressive and anxiolytic potentials of ayahuasca [Frood, 2015].

Further studies are urgently needed to better understand the effects of classical tryptamine hallucinogens in psychiatric disorders.

Acknowledgements

Rafael dos Santos is a fellow of the 'National Post-Doctorate' Program, Brazil (PNPD/CAPES).

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest statement

The authors declare that there is no conflict of interest.

References

1. Abelaira, H., Réus, G., Scaini, G., Streck, E., Crippa, J. and Quevedo, J. (2013) β-Carboline harmine reverses the effects induced by stress on behaviour and citrate synthase activity in the rat prefrontal cortex. *Acta Neuropsychiatr* 25: 328-333.
2. Abraham, H., Aldridge, A. and Gogia, P. (1996) The psychopharmacology of hallucinogens. *Neuropsychopharmacology* 14: 285-298.
3. Alonso, J., Romero, S., Mañanas, M. and Riba, J. (2015) Serotonergic psychedelics temporarily modify information transfer in humans. *Int J Neuropsychopharmacol* 18: 1-9.
4. Aricioglu-Kartal, F., Kayir, H. and Tayfun Uzbay, I. (2003) Effects of harman and harmine on naloxoneprecipitated withdrawal syndrome in morphinedependent rats. *Life Sci* 73: 2363-2371.
5. Barbosa, P., Giglio, J. and Dalgalarrondo, P. (2005) Altered states of consciousness and short-term psychological after-effects induced by the first time ritual use of ayahuasca in an urban context in Brazil. *J Psychoactive Drugs* 37: 193-201.
6. Barbosa, P., Cazorla, I., Giglio, J. and Strassman, R. (2009) A six-month prospective evaluation of personality traits, psychiatric symptoms and quality of life in ayahuasca-naïve subjects. *J Psychoactive Drugs* 41: 205-212.
7. Barbosa, P., Mizumoto, S., Bogenschutz, M. and Strassman, R. (2012) Health status of ayahuasca users. *Drug Test Anal* 4: 601-609.
8. Baumeister, D., Barnes, G., Giaroli, G. and Tracy, D. (2014) Classical hallucinogens as antidepressants? A review of pharmacodynamics and putative clinical roles. *Ther Adv Psychopharmacol* 4: 156-169.
9. Biradar, S., Joshi, H. and Tarak, K. (2013) Cerebroprotective effect of isolated harmine alkaloids extracts of seeds of *Peganum harmala* L. on sodium nitrite-induced hypoxia and ethanol-induced neurodegeneration in young mice. *Pak J Biol Sci* 16: 1687-1697.
10. Bogenschutz, M. (2013) Studying the effects of classic hallucinogens in the treatment of alcoholism: rationale, methodology and current research with psilocybin. *Curr Drug Abuse Rev* 6: 17-29.
11. Bogenschutz, M., Forcehimes, A., Pommy, J., Wilcox, C., Barbosa, P. and Strassman, R. (2015) Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *J Psychopharmacol* 29: 289-299.
12. Bogenschutz, M. and Johnson, M. (2016) Classic hallucinogens in the treatment of addictions. *Prog Neuropsychopharmacol Biol Psychiatry* 64: 250-258.
13. Bogenschutz, M. and Pommy, J. (2012) Therapeutic mechanisms of classic hallucinogens in the treatment of addictions: from indirect evidence to testable hypotheses. *Drug Test Anal* 4: 543-555.
14. Bouso, J., González, D., Fondevila, S., Cutchet, M., Fernández, X., Ribeiro Barbosa, P. *et al*. (2012) Personality, psychopathology, life attitudes and neuropsychological performance among ritual users of ayahuasca: a longitudinal study. *PLoS One* 7: e42421.
15. Bouso, J., Palhano-Fontes, F., Rodríguez-Fornells, A., Ribeiro, S., Sanches, R., Crippa, J. *et al*. (2015) Long-term use of psychedelic drugs is associated with differences in brain structure and personality in humans. *Eur Neuropsychopharmacol* 25: 483-492.
16. Bouso, J. and Riba, J. (2014) Ayahuasca and the treatment of drug addiction. In: Labate, B. and Cavnar, C. (eds), *The therapeutic use of ayahuasca*. Berlin: Springer-Verlag, pp. 95-109.
17. Brierley, D. and Davidson, C. (2012) Developments in harmine pharmacology - implications for ayahuasca use and drug-dependence treatment. *Prog Neuropsychopharmacol Biol Psychiatry* 39: 263-272.
18. Brierley, D. and Davidson, C. (2013) Harmine augments electrically evoked dopamine efflux in the nucleus accumbens shell. *J Psychopharmacol* 27: 98-108. addiction treatment. *Am J Drug Alcohol Abuse* 39: 291-297.
19. Buchborn, T., Schröder, H., Höllt, V. and Grecksch, G. (2014) Repeated lysergic acid diethylamide in an animal model of depression: normalisation of learning behaviour and hippocampal serotonin 5-HT$_2$ signalling. *J Psychopharmacol* 28: 545-552.
20. Buchborn, T., Schröder, H., Dieterich, D., Grecksch, G. and Höllt, V. (2015) Tolerance to LSD and DOB induced shaking behaviour: differential adaptations of frontocortical 5-HT$_{2A}$ and glutamate receptor binding sites. *Behav Brain Res* 281: 62-68.
21. Buckholtz, N. and Boggan, W. (1977) Monoamine oxidase inhibition in brain and liver produced by β-carbolines: structure-activity relationships and substrate specificity. *Biochem Pharmacol* 26: 1991-1996.
22. Burdick, B. and Adinoff, B. (2013) A proposal to evaluate mechanistic efficacy of hallucinogens in addiction treatment. *Am J Drug Alcohol Abuse* 39: 291-297.
23. Carbonaro, T., Eshleman, A., Forster, M., Cheng, K., Rice, K. and Gatch, M. (2015) The role of 5-HT$_{2A}$, 5-HT$_{2C}$ and mGlu2 receptors in the behavioral effects of tryptamine hallucinogens *N,N*-dimethyltryptamine and *N,N*-diisopropyltryptamine in rats and mice. *Psychopharmacology* 232: 275-284.
24. Carhart-Harris, R., Erritzoe, D., Williams, T., Stone, J., Reed, L., Colasanti, A. *et al*. (2012a) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 109: 2138-2143.
25. Carhart-Harris, R., Kaelen, M., Whalley, M., Bolstridge, M., Feilding, A. and Nutt, D. (2015) LSD enhances suggestibility in

healthy volunteers. *Psychopharmacology* 232: 785-794.
26. Carhart-Harris, R., Leech, R., Erritzoe, D., Williams, T., Stone, J., Evans, J. *et al*. (2013) Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. *Schizophr Bull* 39: 1343-1351.
27. Carhart-Harris, R., Leech, R., Hellyer, P., Shanahan, M., Feilding, A., Tagliazucchi, E. *et al*. (2014) The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front Hum Neurosci* 8: 20.
28. Carhart-Harris, R., Leech, R., Williams, T., Erritzoe, D., Abbasi, N., Bargiotas, T. *et al*. (2012b) Implications for psychedelic-assisted psychotherapy: functional magnetic resonance imaging study with psilocybin. *Br J Psychiatry* 200: 238-244.
29. Catlow, B., Song, S., Paredes, D., Kirstein, C. and Sanchez-Ramos, J. (2013) Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning. *Exp Brain Res* 228: 481-491.
30. Dakwar, E., Anerella, C., Hart, C., Levin, F., Mathew, S. and Nunes, E. (2014a) Therapeutic infusions of ketamine: do the psychoactive effects matter? *Drug Alcohol Depend* 136: 153-157.
31. Dakwar, E., Levin, F., Foltin, R., Nunes, E. and Hart, C. (2014b) The effects of subanesthetic ketamine infusions on motivation to quit and cue-induced craving in cocaine-dependent research volunteers. *Biol Psychiatry* 76: 40-46.
32. Da Silveira, D., Grob, C., de Rios, M., Lopez, E., Alonso, L., Tacla, C. *et al*. (2005) Ayahuasca in adolescence: a preliminary psychiatric assessment. *J Psychoactive Drugs* 37: 129-133.
33. Davydova, S., Cheido, M., Gevorgyan, M. and Idova, G. (2010) Effects of 5-HT$_{2A}$ receptor stimulation and blocking on immune response. *Bull Exp Biol Med* 150: 219-221.
34. De Araujo, D., Ribeiro, S., Cecchi, G., Carvalho, F., Sanchez, T., Pinto, J. *et al*. (2012) Seeing with the eyes shut: neural basis of enhanced imagery following ayahuasca ingestion. *Hum Brain Mapp* 33: 2550-2560.
35. De Castro-Neto, E., da Cunha, R., da Silveira, D., Yonamine, M., Gouveia, T., Cavalheiro, E. *et al*. (2013) Changes in aminoacidergic and monoaminergic neurotransmission in the hippocampus and amygdala of rats after ayahuasca ingestion. *World J Biol Chem* 4: 141-147.
36. Delgado, P. and Moreno, F. (1998) Hallucinogens, serotonin and obsessive-compulsive disorder. *J Psychoactive Drugs* 30: 359-366.
37. Dobkin de Rios, M. (1984) *Visionary vine: hallucinogenic healing in the Peruvian Amazon*. Prospect Heights: Waveland Press.
38. Dobkin de Rios, M. (1990) *Hallucinogens: cross-cultural perspectives*. Bridport: Prism Press.
39. Doering-Silveira, E., Grob, C., de Rios, M., Lopez, E., Alonso, L., Tacla, C. *et al*. (2005) Report on psychoactive drug use among adolescents using ayahuasca within a religious context. *J Psychoactive Drugs* 37: 141-144.
40. dos Santos, R. (2013) Safety and side effects of ayahuasca in humans - an overview focusing on developmental toxicology. *J Psychoactive Drugs* 45: 68-78.
41. dos Santos, R. (2014) Immunological effects of ayahuasca in humans. *J Psychoactive Drugs* 46: 383-388.
42. dos Santos, R., Grasa, E., Valle, M., Ballester, M., Bouso, J., Nomdedéu, J. *et al*. (2012) Pharmacology of ayahuasca administered in two repeated doses. *Psychopharmacology* 219: 1039-1053.
43. dos Santos, R., Landeira-Fernandez, J., Strassman, R., Motta, V. and Cruz, A. (2007) Effects of ayahuasca on psychometric measures of anxiety, panic-like and hopelessness in Santo Daime members. *J Ethnopharmacology* 112: 507-513.
44. dos Santos, R., Osório, F., Crippa, J. and Hallak, J. (2016) Antidepressive and anxiolytic effects of ayahuasca: a systematic literature review of animal and human studies. *Rev Bras Psiquiatr*, in press.
45. dos Santos, R., Valle, M., Bouso, J., Nomdedéu, J., Rodríguez-Espinosa, J., McIlhenny, E. *et al*. (2011) Autonomic, neuroendocrine and immunological effects of ayahuasca. A comparative study with *d*-amphetamine. *J Clinical Psychopharmacol* 31: 717-726.
46. Dyck, E. (2006) 'Hitting highs at rock bottom': LSD treatment for alcoholism, 1950-1970. *Soc Hist Med* 19: 313-329.
47. Fábregas, J., González, D., Fondevila, S., Cutchet, M., Fernández, X., Barbosa, P. *et al*. (2010) Assessment of addiction severity among ritual users of ayahuasca. *Drug Alcohol Depend* 111: 257-261.
48. Farzin, D. and Mansouri, N. (2006) Antidepressant-like effect of harmane and other beta-carbolines in the mouse forced swim test. *Eur Neuropsychopharmacol* 16:324-328.
49. Fernández, X., dos Santos, R., Cutchet, M., Fondevila, S., González, D., Alcázar, M. *et al*. (2014) Assessment of the psychotherapeutic effects of ritual ayahuasca use on drug dependency: a pilot study. In: Labate, B.C. and Cavnar, C. (eds), *The therapeutic use of ayahuasca*. Berlin: Springer-Verlag, pp. 183-196.
50. Fernández, X. and Fábregas, J. (2014) Experience of treatment with ayahuasca for drug addiction in the Brazilian Amazon. In: Labate, B.C. and Cavnar, C. (eds), *The therapeutic use of ayahuasca*. Berlin: Springer-Verlag, pp. 161-182.
51. Feld, M., Goodman, J. and Guido, J. (1958) Clinical and laboratory observations on LSD-25. *J Nerv Ment Dis* 126: 176-183.
52. Fontanilla, D., Johannessen, M., Hajipour, A., Cozzi, N., Jackson, M. and Ruoho, A. (2009) The hallucinogen *N,N*-dimethyltryptamine (DMT) is an endogenous sigma-1 receptor regulator. *Science* 323: 934-937.
53. Forrer, G. and Goldner, R. (1951) Experimental physiological studies with lysergic acid diethylamide (LSD-25). *AMA Arch Neurol Psychiatry* 65: 581-588.
54. Fortunato, J., Réus, G., Kirsch, T., Stringari, R., Fries, G., Kapczinski, F. *et al*. (2010a) Effects of betacarboline harmine on behavioral and physiological parameters observed in the chronic mild stress model: further evidence of antidepressant properties. *Brain Res Bull* 81: 491-496.
55. Fortunato, J., Réus, G., Kirsch, T., Stringari, R., Fries, G., Kapczinski, F. *et al*. (2010b) Chronic administration of harmine elicits antidepressantlike effects and increases BDNF levels in the rat hippocampus. *J Neural Transm* 117: 1131-1137.
56. Fortunato, J., Réus, G., Kirsch, T., Stringari, R., Stertz, L., Kapczinski, F. *et al*. (2009) Acute harmine administration induces antidepressive-like effects and increases BDNF levels in the rat hippocampus. *Prog Neuropsychopharmacol Biol Psychiatry* 33: 1425-1430.
57. Frecska, E., Szabo, A., Winkelman, M., Luna, L. and McKenna, D. (2013) A possibly sigma-1 receptor mediated role of dimethyltryptamine in tissue protection, regeneration and immunity. *J Neural Transm* 120: 1295-1303.
58. Frood, A. (2015) Ayahuasca psychedelic tested for depression. *Nature News* Apr 6. Retrieved from http://www.nature.com/news/ayahuasca-psychedelic-tested-for-depression-1.17252 (accessed 15 July 2015).
59. Frost, D., Meechoovet, B., Wang, T., Gately, S., Giorgetti, M., Shcherbakova, I. *et al*. (2011) β-carboline compounds, including

harmine, inhibit DYRK1A and tau phosphorylation at multiple Alzheimer's disease-related sites. *PLoS One* 6: e19264.
60. Furst, P. (1994) *Alucinógenos y cultura* (*Hallucinogens and culture*). México: Fondo de Cultura Económica.
61. Garcia-Romeu, A., Griffiths, R. and Johnson, M. (2014) Psilocybin-occasioned mystical experiences in the treatment of tobacco addiction. *Curr Drug Abuse Rev* 7: 157-164.
62. Gasser, P., Holstein, D., Michel, Y., Doblin, R., Yazar-Klosinski, B., Passie, T. *et al*. (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202: 513-520.
63. Gasser, P., Kirchner, K. and Passie, T. (2015) LSD-assisted psychotherapy for anxiety associated with a life-threatening disease: a qualitative study of acute and sustained subjective effects. *J Psychopharmacol* 29: 57-68.
64. Gillin, J., Kaplan, J., Stillman, R. and Wyatt, R. (1976) The psychedelic model of schizophrenia: the case of *N,N*-dimethyltryptamine. *Am J Psychiatry* 133: 203-208.
65. Glennon, R., Dukat, M., Grella, B., Hong, S., Costantino, L., Teitler, M. *et al*. (2000) Binding of β-carbolines and related agents at serotonin (5-HT_2 and 5-HT_{1A}), dopamine (D2) and benzodiazepine receptors. *Drug Alcohol Depend* 60: 121-132.
66. Glick, S., Kuehne, M., Raucci, J., Wilson, T., Larson, D., Keller, R., Jr. *et al*. (1994) Effects of iboga alkaloids on morphine and cocaine self-administration in rats: relationship to tremorigenic effects and to effects on dopamine release in nucleus accumbens and striatum. *Brain Res* 657: 14-22.
67. González-Maeso, J., Ang, R., Yuen, T., Chan, P., Weisstaub, N., López-Giménez, J. *et al*. (2008) Identification of a serotonin/glutamate receptor complex implicated in psychosis. *Nature* 452: 93-97.
68. Griffiths, R., Johnson, M., Richards, W., Richards, B., McCann, U. and Jesse, R. (2011) Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects. *Psychopharmacology* 218: 649-665.
69. Griffiths, R., Richards, W., Johnson, M., McCann, U. and Jesse, R. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632.
70. Griffiths, R., Richards, W., McCann, U. and Jesse, R. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-283.
71. Grispoon, L. and Bakalar, J. (1981) *Psychedelic drugs reconsidered*. New York: Basic Books.
72. Grob, C. (1998) Psychiatric research with hallucinogens: what have we learned? *Heffter Rev Psychedelic Res* 1: 8-20.
73. Grob, C., Danforth, A., Chopra, G., Hagerty, M., McKay, C., Halberstadt, A. *et al*. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.
74. Grob, C., McKenna, D., Callaway, J., Brito, G., Neves, E., Oberlaender, G. *et al*. (1996) Human psychopharmacology of hoasca, a plant hallucinogen used in ritual context in Brazil. *J Nerv Ment Dis* 184: 86-94.
75. Grof, S. (2001) *LSD psychotherapy* (3rd edn). Sarasota: Multidisciplinary Association for Psychedelic Studies (MAPS).
76. Guzmán, G. (2008) Hallucinogenic mushrooms in Mexico: an overview. *Econ Bot* 62: 404-412.
77. Halberstadt, A. (2015) Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behav Brain Res* 277: 99-120.
78. Halpern, J., Sherwood, A., Passie, T., Blackwell, K. and Ruttenber, A. (2008) Evidence of health and safety in American members of a religion who use a hallucinogenic sacrament. *Med Sci Monit* 14: SR15-22.
79. Hanes, K. (1996) Serotonin, psilocybin and body dysmorphic disorder: a case report. *J Clin Psychopharmacol* 16: 188-189.
80. Hanks, J. and González-Maeso, J. (2013) Animal models of serotonergic psychedelics. *ACS Chem Neurosci* 4: 33-42.
81. Harner, M. (ed.) (1976) *Alucinógenos y chamanismo* (Hallucinogens and shamanism). Madrid: Punto Omega.
82. Hendricks, P., Clark, C., Johnson, M., Fontaine, K. and Cropsey, K. (2014) Hallucinogen use predicts reduced recidivism among substance-involved offenders under community corrections supervision. *J Psychopharmacol* 28: 62-66.
83. Hendricks, P., Thorne, C., Clark, C., Coombs, D. and Johnson, M. (2015) Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *J Psychopharmacol* 29: 280-288.
84. Hermle, L., Fünfgeld, M., Oepen, G., Botsch, H., Borchardt, D., Gouzoulis, E. *et al*. (1992) Mescaline-induced psychopathological, neuropsychological and neurometabolic effects in normal subjects: experimental psychosis as a tool for psychiatric research. *Biol Psychiatry* 32: 976-991.
85. Hilber, P. and Chapillon, P. (2005) Effects of harmaline on anxiety-related behavior in mice. *Physiol Behav* 86: 164-167.
86. Hintzen, A. and Passie, T. (2010) *The pharmacology of lysergic acid diethylamide: a critical review*. New York: Oxford University Press/Beckley Foundation.
87. Hofmann, A. (2005) *LSD: my problem child*. Sarasota, FL: Multidisciplinary Association for Psychedelic Studies (MAPS).
88. Hollister, L. and Sjoberg, B. (1964) Clinical syndromes and biochemical alterations following mescaline, lysergic acid diethylamide, psilocybin and a combination of the three psychotomimetic drugs. *Compr Psychiatry* 5: 170-178.
89. House, R., Thomas, P. and Bhargava, H. (1994) Immunological consequences of *in vitro* exposure to lysergic acid diethylamide (LSD). *Immunopharmacol Immunotoxicol* 16: 23-40.
90. House, R., Thomas, P. and Bhargava, H. (1997) Immunotoxicology of opioids, inhalants and other drugs of abuse. *NIDA Res Monogr* 173: 175-200.
91. Iurlo, M., Leone, M., Schilström, B., Linnér, L., Nomikos, G., Hertel, P. *et al*. (2001) Effects of harmine on dopamine output and metabolism in rat striatum: role of monoamine oxidase-A inhibition. *Psychopharmacology* 159: 98-104.
92. Jansen, K. (2001) *Ketamine: dreams and realities*. Sarasota: Multidisciplinary Association for Psychedelic Studies (MAPS).
93. Johansen, P. and Krebs, T. (2015) Psychedelics not linked to mental health problems or suicidal behavior: a population study. *J Psychopharmacol* 29: 270-279.
94. Johnson, M., Garcia-Romeu, A., Cosimano, M. and Griffiths, R. (2014) Pilot study of the 5-HT_{2A}R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
95. Katzman, M. (2009) Current considerations in the treatment of generalized anxiety disorder. *CNS Drugs* 23: 103-120.
96. Khor, B., Gagnon, J., Goel, G., Roche, M., Conway, K., Tran, K. *et al*. (2015) The kinase DYRK1A reciprocally regulates the differentiation of Th17 and regulatory T cells. *eLife* 4: e05920.
97. Kolp, E., Friedman, H., Young, M. and Krupitsky, E. (2006) Ketamine enhanced psychotherapy: preliminary clinical observations on its effectiveness in treating alcoholism. *Humanistic Psychol* 34: 399-422.
98. Kolp, E., Young, M., Friedman, H., Krupitsky, E., Jansen, K. and O'Connor, L. (2007) Ketamine-enhanced psychotherapy:

preliminary clinical observations on its effects in treating death anxiety. *Int J Transpersonal Stud* 26: 1-17.

99. Kometer, M., Schmidt, A., Bachmann, R., Studerus, E., Seifritz, E. and Vollenweider, F. (2012) Psilocybin biases facial recognition, goal-directed behavior and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol Psychiatry* 72: 898-906.
100. Kraehenmann, R., Preller, K., Scheidegger, M., Pokorny, T., Bosch, O., Seifritz, E. *et al*. (2016) Psilocybin-induced decrease in amygdala reactivity correlates with enhanced positive mood in healthy volunteers. *Biol Psychiatry* 78: 572-581.
101. Krebs, T. and Johansen, P. (2012) Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
102. Krebs, T. and Johansen, P. (2013) Psychedelics and mental health: a population study. *PLoS One* 8: e63972.
103. Krupitsky, E., Burakov, A., Dunaevsky, I., Romanova, T., Slavina, T. and Grinenko, A. (2007) Single *versus* repeated sessions of ketamine-assisted psychotherapy for people with heroin dependence. *J Psychoactive Drugs* 39: 13-19.
104. Krupitsky, E., Burakov, A., Romanova, T., Dunaevsky, I., Strassman, R. and Grinenko, A. (2002) Ketamine psychotherapy for heroin addiction: immediate effects and two-year follow-up. *J Subst Abuse Treat* 23: 273-283.
105. Krupitsky, E. and Grinenko, A. (1997) Ketamine psychedelic therapy (KPT): a review of the results of ten years of research. *J Psychoactive Drugs* 29: 65-183.
106. Krupitsky, E. and Kolp, E. (2007) Ketamine psychedelic psychotherapy. In: Winkelman, M. and Roberts, T. (eds), *Psychedelic medicine: new evidence for hallucinogenic substances as treatments*. Westport: Praeger, pp. 67-85.
107. Krupitsky, E., Grineko, A., Berkaliev, T., Paley, A., Tetrov, U., Mushkov, K. *et al*. (1992) The combination of psychedelic and aversive approaches in alcoholism treatment: the affective contra-attribution method. *Alcoholism Treat Q* 9: 99-105.
108. Kurland, A., Pahnke, W., Unger, S. and Savage, C. (1971) Psychedelic LSD research. In: Evans, W. and Kline, N. (eds), *Psychotropic drugs in the year 2000. Use by normal humans*. Springfield: Charles C. Thomas Publisher, pp. 86-108.
109. Labate, B. and Cavnar, C. (eds), (2014) *The therapeutic use of ayahuasca*. Berlin: Springer-Verlag.
110. Labate, B., dos Santos, R., Strassman, R., Anderson, B. and Mizumoto, S. (2014) Effect of Santo Daime membership on substance dependence. In: Labate, B. and Cavnar, C. (eds), *The therapeutic use of ayahuasca*. Berlin: Springer-Verlag, pp. 153-159.
111. Labate, B. and Jungaberle, H. (eds) (2011) *The internationalization of ayahuasca*. Zurich: Lit Verlag.
112. Labate, B., Rose, I. and dos Santos, R. (2009) *Ayahuasca religions: a comprehensive bibliography and critical essays*. Santa Cruz: Multidisciplinary Association for Psychedelic Studies (MAPS).
113. Lee, C., Han, E., Jang, Y., Han, J., Ha, H. and Kim, D. (2000) Protective effect of harmalol and harmaline on MPTP neurotoxicity in the mouse and dopamine-induced damage of brain mitochondria and PC12 cells. *J Neurochem* 75: 521-531.
114. Leonard, H. and Rapoport, J. (1987) Relief of obsessive-compulsive symptoms by LSD and psilocin. *Am J Psychiatry* 144: 1239-1240.
115. Li, Y., Sattler, R., Yang, E., Nunes, A., Ayukawa, Y., Akhtar, S. *et al*. (2011) Harmine, a natural β-carboline alkaloid, upregulates astroglial glutamate transporter expression. *Neuropharmacology* 60: 1168-1175.
116. Liester, M. (2014) A review of lysergic acid diethylamide (LSD) in the treatment of addictions: historical perspectives and future prospects. *Curr Drug Abuse Rev* 7: 146-156.
117. Liester, M. and Prickett, J. (2012) Hypotheses regarding the mechanisms of ayahuasca in the treatment of addictions. *J Psychoactive Drugs* 44: 200-208.
118. Lima, L., Ferreira, M., Ávila, A., Perazzo, F., Schneedorf, J., Hinsberger, A. *et al*. (2006) Ayahuasca central nervous system effects: behavioral study. *Ärztez Naturheilverfahren* 47: 476-480.
119. Loizaga-Velder, A. and Loizaga Pazzi, A. (2014) Therapist and patient perspectives on ayahuasca-assisted treatment for substance dependence. In: Labate, B. and Cavnar, C. (eds), *The therapeutic use of ayahuasca*. Berlin/Heidelberg: Springer-Verlag, pp. 133-152.
120. Loizaga-Velder, A. and Verres, R. (2014) Therapeutic effects of ritual ayahuasca use in the treatment of substance dependence - qualitative results. *J Psychoactive Drugs* 46: 63-72.
121. Luckenbaugh, D., Niciu, M., Ionescu, D., Nolan, N., Richards, E., Brutsche, N. *et al*. (2014) Do the dissociative side effects of ketamine mediate its antidepressant effects? *J Affect Disord* 159: 56-61.
122. MacLean, K., Johnson, M. and Griffiths, R. (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
123. Maher, P. and Davis, J. (1996) The role of monoamine metabolism in oxidative glutamate toxicity. *J Neurosci* 16: 6394-6401.
124. Majić, T., Schmidt, T. and Gallinat, J. (2015) Peak experiences and the afterglow phenomenon: when and how do therapeutic effects of hallucinogens depend on psychedelic experiences? *J Psychopharmacol* 29: 241-253.
125. Masuda, Y. and Sugiyama, T. (2000) The effect of globopentaosylceramide on a depression model, mouse forced swimming. *Tohoku J Exp Med* 191: 47-54.
126. Matsushima, Y., Shirota, O., Kikura-Hanajiri, R., Goda, Y. and Eguchi, F. (2009) Effects of *Psilocybe argentipes* on marble-burying behavior in mice. *Biosci Biotechnol Biochem* 73: 1866-1868.
127. McGlothlin, W. and Arnold, D. (1971) LSD revisited. A ten-year follow-up of medical LSD use. *Arch Gen Psychiatry* 24: 35-49.
128. McKenna, D., Repke, D., Lo, L. and Peroutka, S. (1990) Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. *Neuropharmacology* 29: 193-198.
129. McKenna, D. and Riba, J. (2016) New World tryptamine hallucinogens and the neuroscience of ayahuasca. *Curr Top Behav Neurosci*, in press.
130. McKenna, D., Towers, G. and Abbott, F. (1984) Monoamine oxidase inhibitors in South American hallucinogenic plants: tryptamine and β-carboline constituents of ayahuasca. *J Ethnopharmacol* 10: 195-223.
131. Moher, D., Liberati, A., Tetzlaff, J. and Altman, D.: The PRISMA Group (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6: e1000097.
132. Moreno, F., Wiegand, C., Taitano, E. and Delgado, P. (2006) Safety, tolerability and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J Clin Psychiatry* 67: 1735-1740.
133. Moreno, J., Holloway, T., Albizu, L., Sealfon, S. and González-Maeso, J. (2011) Metabotropic glutamate mGlu2 receptor is

necessary for the pharmacological and behavioral effects induced by hallucinogenic 5-HT$_{2A}$ receptor agonists. *Neurosci Lett* 493: 76-79.
134. Moreno, J., Holloway, T., Rayannavar, V., Sealfon, S. and González-Maeso, J. (2013) Chronic treatment with LY341495 decreases 5-HT$_{2A}$ receptor binding and hallucinogenic effects of LSD in mice. *Neurosci Lett* 536: 69-73.
135. Morgan, C., Noronha, L., Muetzelfeldt, M., Fielding, A. and Curran, H. (2013) Harms and benefits associated with psychoactive drugs: findings of an international survey of active drug users. *J Psychopharmacology* 27: 497-506.
136. Moura, D., Richter, M., Boeira, J., Pêgas Henriques, J. and Saffi, J. (2007) Antioxidant properties of β-carboline alkaloids are related to their antimutagenic and antigenotoxic activities. *Mutagenesis* 22: 293-302.
137. Nau, F., Jr., Yu, B., Martin, D. and Nichols, C. (2013) Serotonin 5-HT$_{2A}$ receptor activation blocks TNF-α mediated inflammation *in vivo*. *PLoS One* 8: e75426.
138. Nic Dhonnchadha, B., Bourin, M. and Hascoët, M. (2003a) Anxiolytic-like effects of 5-HT$_2$ ligands on three mouse models of anxiety. *Behav Brain Res* 140: 203-214.
139. Nic Dhonnchadha, B., Hascoët, M., Jolliet, P. and Bourin, M. (2003b) Evidence for a 5-HT$_{2A}$ receptor mode of action in the anxiolytic-like properties of DOI in mice. *Behav Brain Res* 147: 175-184.
140. Nichols, D. (2004) Hallucinogens. *Pharmacol Ther* 101: 131-181.
141. Nutt, D. (2005) Overview of diagnosis and drug treatments of anxiety disorders. *CNS Spectr* 10: 49-56.
142. Nutt, D., King, L. and Phillips, L.: Independent Scientific Committee on Drugs (2010) Drug harms in the UK: a multicriteria decision analysis. *Lancet* 376: 1558-1565.
143. Oliveira-Lima, A., Santos, R., Hollais, A., Gerardi-Junior, C., Baldaia, M., Wuo-Silva, R. *et al.* (2015) Effects of ayahuasca on the development of ethanol-induced behavioral sensitization and on a post-sensitization treatment in mice. *Physiol Behav* 142: 28-36.
144. Oram, M. (2014) Efficacy and enlightenment: LSD psychotherapy and the Drug Amendments of 1962. *J Hist Med Allied Sci* 69: 221-250.
145. Osório, F., Sanches, R., Macedo, L., dos Santos, R., Maia-de-Oliveira, J., Wichert-Ana, L. *et al.* (2015) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. *Rev Bras Psiquiatr* 37: 13-20.
146. Ott, J. (1994) *Ayahuasca analogues: pangaean entheogens*. Kennewick, WA: Natural Books Co.
147. Ott, J. (1999) Pharmahuasca: human pharmacology of oral DMT plus harmine. *J Psychoactive Drugs* 31: 171-177.
148. Ott, J. (2004) *Pharmacotheon: drogas enteogénicas, sus fuentes vegetales y su historia* (*Pharmacotheon: entheogenic drugs, their plant sources and history*). Barcelona: La Liebre de Marzo.
149. Owaisat, S., Raffa, R. and Rawls, S. (2012) *In vivo* comparison of harmine efficacy against psychostimulants: preferential inhibition of the cocaine response through a glutamatergic mechanism. *Neurosci Lett* 525: 12-16.
150. Palhano-Fontes, F., Alchieri, J., Oliveira, J., Soares, B., Hallak, J., Galvão-Coelho, N. *et al.* (2014) The therapeutic potentials of ayahuasca in the treatment of depression. In: Labate, B. and Cavnar, C. (eds), *The therapeutic use of ayahuasca*. Berlin: Springer-Verlag, pp. 23-39.
151. Palhano-Fontes, F., Andrade, K., Tofoli, L., Santos, A., Crippa, J., Hallak, J. *et al.* (2015) The psychedelic state induced by ayahuasca modulates the activity and connectivity of the default mode network. *PLoS One* 10: e0118143.
152. Passie, T., Halpern, J., Stichtenoth, D., Emrich, H. and Hintzen, A. (2008) The pharmacology of lysergic acid diethylamide: a review. *CNS Neurosci Ther* 14: 295-314.
153. Passie, T., Seifert, J., Schneider, U. and Emrich, H. (2002) The pharmacology of psilocybin. *Addic Biol* 7: 357-364.
154. Perrine, D. (1999) Hallucinogens and obsessive-compulsive disorder. *Am J Psychiatry* 156: 1123.
155. Pic-Taylor, A., Motta, L., Morais, J., Junior, W., Santos, A., Campos, L. *et al.* (2015) Behavioural and neurotoxic effects of ayahuasca infusion (*Banisteriopsis caapi* and *Psychotria viridis*) in female Wistar rat. *Behav Processes* 118: 102-110.
156. Pierce, P. and Peroutka, S. (1989) Hallucinogenic drug interactions with neurotransmitter receptor binding sites in human cortex. *Psychopharmacology* 97: 118-122.
157. Réus, G., Fries, G., Stertz, L., Badawy, M., Passos, I., Barichello, T. *et al.* (2015) The role of inflammation and microglial activation in the pathophysiology of psychiatric disorders. *Neuroscience* 300: 141-154.
158. Réus, G., Stringari, R., de Souza, B., Petronilho, F., Dal-Pizzol, F., Hallak, J. *et al.* (2010) Harmine and imipramine promote antioxidant activities in prefrontal cortex and hippocampus. *Oxid Med Cell Longev* 3: 325-331.
159. Réus, G., Stringari, R., Gonçalves, C., Scaini, G., Carvalho-Silva, M., Jeremias, G. *et al.* (2012) Administration of harmine and imipramine alters creatine kinase and mitochondrial respiratory chain activities in the rat brain. *Depress Res Treat* 2012: 987397.
160. Riba, J., McIlhenny, E., Bouso, J. and Barker, S. (2015) Metabolism and urinary disposition of *N,N*-dimethyltryptamine after oral and smoked administration: a comparative study. *Drug Test Anal* 7: 401-406.
161. Riba, J., Rodríguez-Fornells, A., Urbano, G., Morte, A., Antonijoan, R., Montero, M. *et al.* (2001) Subjective effects and tolerability of the South American psychoactive beverage ayahuasca in healthy volunteers. *Psychopharmacology* 154: 85-95.
162. Riba, J., Romero, S., Grasa, E., Mena, E., Carrió, I. and Barbanoj, M. (2006) Increased frontal and paralimbic activation following ayahuasca, the pan-Amazonian inebriant. *Psychopharmacology* 186: 93-98.
163. Riba, J., Valle, M., Urbano, G., Yritia, M., Morte, A. and Barbanoj, M. (2003) Human pharmacology of ayahuasca: subjective and cardiovascular effects, monoamine metabolite excretion and pharmacokinetics. *J Pharmacol Exp Ther* 306: 73-83.
164. Riedlinger, T. and Riedlinger, J. (1994) Psychedelic and entactogenic drugs in the treatment of depression. *J Psychoactive Drugs* 26: 41-55.
165. Ross, S. (2012) Serotonergic hallucinogens and emerging targets for addiction pharmacotherapies. *Psychiatr Clin North Am* 35: 357-374.
166. Sackler, A., Weltman, A. and Owens, H. (1966) Endocrine and metabolic effects of lysergic acid diethylamide on female rats. *Toxicol Appl Pharmacol* 9: 324-330.
167. Sackler, A., Weltman, A. and Sparber, S. (1963) Effects of lysergic acid diethylamide on the total leukocytes and eosinophils of the female rat. *Nature* 199: 1194-1195.
168. Sakashita, Y., Abe, K., Katagiri, N., Kambe, T., Saitoh, T., Utsunomiya, I. *et al.* (2015) Effect of psilocin on extracellular

dopamine and serotonin levels in the mesoaccumbens and mesocortical pathway in awake rats. *Biol Pharm Bull* 38: 134-138.

169. Sanches, R., Osório, F., dos Santos, R., Macedo, L., Maia-de-Oliveira, J., Wichert-Ana, L. *et al*. (2016) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a SPECT Study. *J Clin Psychopharmacol* 36: 77-81.
170. Santini, M., Balu, D., Puhl, M., Hill-Smith, T., Berg, A., Lucki, I. *et al*. (2014) D-serine deficiency attenuates the behavioral and cellular effects induced by the hallucinogenic 5-HT$_{2A}$ receptor agonist DOI. *Behav Brain Res* 259: 242-246. Schmid, Y., Enzler, F., Gasser, P., Grouzmann, E.,
171. Preller, K., Vollenweider, F. *et al*. (2016) Acute effects of lysergic acid diethylamide in healthy subjects. *Biol Psychiatry* 78: 544-553.
172. Schultes, R. (1986) El desarrollo histórico de la identificación de las malpigiáceas empleadas como alucinógenos (The historical development of the identification of malpighiaceous used as hallucinogens). *Am Indig* 46: 9-47.
173. Schultes, R. (1998) Antiquity of the use of New World hallucinogens. *Heffter Rev Psychedel Res* 1: 1-7.
174. Schultes, R. and Hofmann, A. (1992) *Plants of the gods: their sacred, healing and hallucinogenic powers*. Rochester, NY: Healing Arts Press.
175. Schwarz, M., Houghton, P., Rose, S., Jenner, P. and Lees, A. (2003) Activities of extract and constituents of *Banisteriopsis caapi* relevant to parkinsonism. *Pharmacol Biochem Behav* 75: 627-633.
176. Smith, D., Raswyck, G. and Davidson, L. (2014) From Hofmann to the Haight Ashbury and into the future: the past and potential of lysergic acid diethylamide. *J Psychoactive Drugs* 46: 3-10.
177. Sos, P., Klirova, M., Novak, T., Kohutova, B., Horacek, J. and Palenicek, T. (2013) Relationship of ketamine's antidepressant and psychotomimetic effects in unipolar depression. *Neuro Endocrinol Lett* 34: 287-293.
178. Splettstoesser, F., Bonnet, U., Wiemann, M., Bingmann, D. and Büsselberg, D. (2005) Modulation of voltage-gated channel currents by harmaline and harmane. *Br J Pharmacol* 144: 52-58.
179. Stefulj, J., Jerne, J., Cicin-Sain, L., Rinner, I. and Schauenstein, K. (2000) mRNA expression of serotonin receptors in cells of the immune tissues of the rat. *Brain Behav Immun* 14: 219-224.
180. Strassman, R. (1984) Adverse reactions to psychedelic drugs. A review of the literature. *J Nerv Ment Dis* 172: 577-595.
181. Strassman, R. and Qualls, C. (1994) Dose-response study of *N,N*-dimethyltryptamine in humans. I. Neuroendocrine, autonomic and cardiovascular effects. *Arch Gen Psychiatry* 51: 85-97.
182. Strassman, R., Qualls, C., Uhlenhuth, E. and Kellner, R. (1994) Dose-response study of *N,N*-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. *Arch Gen Psychiatry* 51: 98-108.
183. Studerus, E., Kometer, M., Hasler, F. and Vollenweider, F. (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *J Psychopharmacol* 25: 1434-1452.
184. Su, T., Hayashi, T. and Vaupel, D. (2009) When the endogenous hallucinogenic trace amine *N,N*-dimethyltryptamine meets the sigma-1 receptor. *Sci Signal* 2: pe12.
185. Sun, P., Zhang, S., Li, Y. and Wang, L. (2014) Harmine mediated neuroprotection via evaluation of glutamate transporter 1 in a rat model of global cerebral ischemia. *Neurosci Lett* 583: 32-36.
186. Szabo, A., Kovacs, A., Frecska, E. and Rajnavolgyi, E. (2014) Psychedelic *N,N*-dimethyltryptamine and 5-methoxy-*N,N*-dimethyltryptamine modulate innate and adaptive inflammatory responses through the sigma-1 receptor of human monocyte-derived dendritic cells. *PLoS One* 9: e106533.
187. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D. and Chialvo, D. (2014) Enhanced repertoire of brain dynamical states during the psychedelic experience. *Hum Brain Mapp* 35: 5442-5456.
188. Thomas, G., Lucas, P., Capler, N., Tupper, K. and Martin, G. (2013) Ayahuasca-assisted therapy for addiction: results from a preliminary observational study in Canada. *Curr Drug Abuse Rev* 6: 30-42.
189. Tylš, F., Páleníček, T. and Horáček, J. (2014) Psilocybin - summary of knowledge and new perspectives. *Eur Neuropsychopharmacol* 24: 342-356.
190. Van Amsterdam, J., Nutt, D., Phillips, L. and van den Brink, W. (2015) European rating of drug harms. *J Psychopharmacol* 29: 655-660.
191. Van Amsterdam, J., Opperhuizen, A. and van den Brink, W. (2011) Harm potential of magic mushroom use: a review. *Regul Toxicol Pharmacol* 59: 423-429.
192. Van Amsterdam, J., Pennings, E., Brunt, T. and van den Brink, W. (2013) Physical harm due to chronic substance use. *Regul Toxicol Pharmacol* 66: 83-87.
193. Vollenweider, F. and Kometer, M. (2010) The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. *Nat Rev Neurosci* 11: 642-651.
194. Vollenweider, F., Vontobel, P., Hell, D. and Leenders, K. (1999) 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man - a PET study with (^{11}C)raclopride. *Neuropsychopharmacology* 20: 24-433.
195. Wasson, R., Kramrisch, S., Ruck, C. and Ott, J. (1986) *Persephone's quest: entheogens and the origins of religion*. New Haven, CT: Yale University Press.
196. Wilcox, J. (2014) Psilocybin and obsessive compulsive disorder. *J Psychoactive Drugs* 46: 393-395.
197. Winkelman, M. (2014) Psychedelics as medicines for substance abuse rehabilitation: evaluating treatments with LSD, peyote, ibogaine and ayahuasca. *Curr Drug Abuse Rev* 7: 101-116.
198. Wu, C., Jiang, X., Shen, H. and Yu, A. (2009) Effects of CYP2D6 status on harmaline metabolism, pharmacokinetics and pharmacodynamics and a pharmacogenetics-based pharmacokinetic model. *Biochem Pharmacol* 78: 617-624.
199. Yamada, M. and Yasuhara, H. (2004) Clinical pharmacology of MAO inhibitors: safety and future. *Neurotoxicology* 25: 215-221.
200. Young, S. (2013) Single treatments that have lasting effects: some thoughts on the antidepressant effects of ketamine and botulinum toxin and the anxiolytic effect of psilocybin. *J Psychiatry Neurosci* 38: 78-83.
201. Zghoul, T. and Blier, P. (2003) Enhancing action of LSD on neuronal responsiveness to serotonin in a brain structure involved in obsessive-compulsive disorder. *Int J Neuropsychopharmacol* 6: 13-21.

Repression of death consciousness and the psychedelic trip

by

Varsha Dutta

Journal of Cancer Research and Therapeutics - July-September 2012 - Volume 8 - Issue 3

original report: http://www.psilosophy.info/resources/Repression of death consciousness and the psychedelic trip.pdf

Table of Contents:

Abstract
Introduction
Constructing an intelligible world
Death and medicine
Psychedelics and the historical glance
The psychedelic trip
Current wave
The way out
References

Varsha Dutta: Department of Clinical Neuroscience and ACRO, Dr. Balabhai Nanavati Hospital, S. V. Road, Vile Parle, Mumbai, India.
For correspondence: Dr. Varsha Dutta, Department of Clinical Neuroscience and ACRO,
Dr. Balabhai Nanavati Hospital, S. V. Road, Vile Parle, Mumbai, India. E-mail: varsha.dutta@vinnana-cns.com

Abstract

Death is our most repressed consciousness, it inheres our condition as the primordial fear. Perhaps it was necessary that this angst be repressed in man or he would be hurled against the dark forces of nature. Modern ethos was built on this edifice, where the 'denial of death' while 'embracing one's symbolic immortality' would be worshipped, so this ideology simply overturned and repressed looking into the morass of the inevitable when it finally announced itself. Once this slowly pieced its way into all of life, 'death' would soon become a terminology in medicine too and assert its position, by giving a push to those directly dealing with the dying to shy away from its emotional and spiritual affliction. The need to put off death and prolong one's life would become ever more urgent. Research using psychedelics on the terminally ill which had begun in the 1950s and 1960s would coerce into another realm and alter the face of medicine; but the aggression with which it forced itself in the 1960s would soon be politically maimed, and what remained would be sporadic outpours that trickled its way from European labs and underground boot camps. Now, with the curtain rising, the question has etched itself again, about the use of psychedelic drugs in medicine, particularly psychedelic psychotherapy with the terminally ill. This study is an attempt to philosophically explore death anxiety from its existential context and how something that is innate in our condition cannot be therapeutically cured. Psychedelic use was immutably linked with ancient cultures and only recently has it seen its scientific revival, from which a scientific culture grew around psychedelic therapy. How much of what was threaded in the ritual and spiritual mores can be extricated and be interpreted in our own mechanized language of medicine is the question that nudges many.

Key words: Death consciousness, LSD, psychedelic drugs, psychedelic therapy, terminally ill.

Introduction

Denial of the death consciousness
Our most primordial angst stems from the repression of our consciousness of death. Buddhism sends us this augury to a lost, perhaps reluctant vision. The dramatic illusion of self-consciousness rests in the way in which Buddhism deconstructs this pervious 'sense of self' as an interplay of the mental and the physical.[1] This primeval angst that was inherent in the human condition, had to be repressed in man or he would be lost in the vast openness of nature, of the unknowing.[2] It had to be shaped and grounded in a way so he could reconcile with his existence. By overcoming the fear of this repressed death angst, one in fact emerges as his own preserver and nourisher, interpreted as the "Oedipal project".[3] Buddhism situates this to the effort of the ideational "sense-of-self" at self-autonomy; the relentless pursuit of wanting to tame this conditioned consciousness, as the symbolic immortal.

Not being equipped to face the totality of his dual existence, one that had flowered as the birthing wound, and the other, more brutal repression of the inevitable - his imminent death; a duality birthed out of the same fear, paradoxically.[1] Right from the time when the birthing wound emerged as the 'conditioned consciousness' it had to cocoon its preservation, find meaning in existence, become real. With this his consciousness would come to being grounded, being ingrained in a reality of his own construct, in a world that he had himself envisaged, history's own doing entrenched in man's collective psyche, hurling him into the continuous spin of objectifying himself in the real world.[4]

But had he not secured this real world that he lived in, he would have been thrown into the abyss of non-being, a vacuum that would gnaw the core of his existence had he not reassured his place in the world. This underlies the Buddhist deconstruction of the ego's anxiety about its own 'sunyata'(emptiness) and its ignorance of the subject-object dualism. Rooted deeply in the Mahayana and Advaita Vedanta tradition, this primary sense of illusory split between the self and the world was because of ignorance.[1]

Kant in his 'first Critique', tried to show this fundamental flaw that underlies traditional metaphysics, "*the presupposition that substantive knowledge claims can be made about the world independently of experience*." He stabbed at the very heart of metaphysical ideology by claiming that, "*it is impossible to know anything a priori about the world as it is, independently of our cognitive apparatus*".[4] "*Though we can make certain synthetic a priori claims, these claims are not about reality per se, but only about reality as it is experienced by us. It is only because we posses certain cognitive principles enabling us to experience the world that we can make certain claims about the world as it appears*".[4] This fallacy was mooted right from the way we observe this objective reality as the other, as for this objectivity to remain consistent, each of us kept constructing reality in a way that it concealed from us the knowledge that we have constructed it. This can be seen in the way we experience reality, the way things appear to us, as though it were independent of our nature.[5]

Constructing an intelligible world

It was when Western civilization began to explode as the Renaissance, that it brought along a new wave of success, and with it isolation and despair.[1] This wave spilled over to the later centuries, sprouting along new seeds, of man's urgent craving for self eminence and notoriety, something that grounded a strong hold in his consciousness as an obscure craving for his own symbolic immortality.[1]

To secure this superfluous subjective self he had to keep holding onto the objective world, play his part, an inescapable act of self consciousness itself that had been endowed through his act of birth. This burden was not for him to bear alone, this had to be leveled with the social act of being itself, attempt itself in solidarity with his fellow human beings so it could be recompensed collectively. This ever repetitive act of man became sedimented in his collective consciousness from which there was no looking back.[5,6] This experiential self in the midst of his self constructed realism became the whole in which he began to grasp his truest capacity of being, often lived in bad faith, *mauvaise foi* as decreed by Sartre.[7] Man's view of himself became fixed and repetitive, determined by a collective madness that was beyond his control. It was this "*pretence of unfreedom that gave him more liberty to disown responsibility in good conscience*". [7] This trickles down to man's search for unity and meaning in his existence when there was none, because when there is a 'demand' for meaning instead of 'search' he knew that this demand was futile as it was made in the death of his historical and metaphysical ideologies.[7]

This awareness only gnawed despair, and the sense of its futility was to become ever more severe when one was dying. One was simply not prepared for this; the consciousness of separating from the self, from life had never seemed so real.

Modern ethos was built on the edifice in which the 'denial of death'[8] while 'embracing one's symbolic immortality' began to be worshipped, so this ideology simply overturned, rather repressed looking into the morass of the inevitable when it came calling.[9,10] Despite its uncomfortable Western origin, this gradually started dwelling into all developing cultures.

Death and medicine

Once 'death' became a terminology in medicine, it only asserted this position, giving a leverage to those directly associated with the dying to shy away from its poignant emotional and spiritual side that naturally came with it. The need to put off death and prolong one's remaining days became ever more urgent, even when the flicker of life was fast fading away.[11]

A change did come, when this poignancy revealed itself as a banal fear that was clinging to the very act of dying and not simply its aftermath. Kubler Ross.[12] would soon bring about the Hospice movement in England where changes in the experiences of the dying would take a more benevolent turn. Simultaneously, research using psychedelics on the terminally ill had already begun in the 1950 s and 60 s which would alter the face of medicine as it coerced into another realm.

Noyes,[13] who worked with near death experiences, emphasized on the key phases of dying, where in the final phase of transcendence, (*after initial resistance and a final appraisal of one's life*) the mystical state of consciousness occurred and personal boundaries dissipated. One felt that the sense of separation that existed in reality was fast dissolving as he was coming in harmony with everything around him. Noyes[14] explained that people who had these experiences induced in them either artificially or naturally, expressed a certain lucidity about the transition of death and rebirth. This symbolic significance of death transcendence would peek out to Western culture and lend it a perceptive glance, through psychedelic therapy a few decades prior to Noyes's observation.

Psychedelics and the historical glance

From the accounts of Grof and Halifax (1977),[11] Valentina Pavlovna Wasson, a pediatrician intrigued by the use of psychedelic mushrooms by Mexicans was the first recorded Westerner to be initiated into a sacred ritual led by a *Mazatec curandera* (*medicine woman*); this was inherent in indigenous Columbian cultures, and spread wide across Central America. The effect of the mushrooms left a deep impression upon the Wassons, and made Valentina reveal later that it could be used to study deep psychic experiences and perhaps could even be extended to other medical uses. The mushrooms were botanically identified as *Psilocybe mexicana* (Psylocybin).

Alduous Huxley, was the first to declare that psychedelic drugs could be used to assist the dying. His interest in death and its spiritual transition stemmed from his own experiences. Huxley declared that these drugs "*could make death a more conscious experience*," this was from his close encounter with the dying, when through a psychedelic-induced hypnosis, he helped his first wife in her final hours as she lay dying from cancer. On his own deathbed too in 1963, it was lysergic acid diethylamide (LSD) that relieved him.[11]

But before the West ventured out into exploring the benefits of psychedelic therapy, legend surrounding the mystical healing powers of psychedelic plants was rife across most ancient cultures. It formed an intrinsic part of all their communal rituals including death, which they understood as a form of transcending reality into the next dimension. Its symbolic meaning was to prepare one for the nascent experience and clear one's insight toward the awakening of the transient nature of consciousness.[15] This would be an extended part of a commonly shared experience, where the shaman or the wise leader would often ingest these psychedelic plants or would make the group do so through a ritualistic process.

Psilocybin, marijuana and mescaline were ritually practiced for spiritual experiences. There is evidence of the first medicinal and ritualistic use of cannabis in China in the book *Pên-ts'ao Ching*, of about 2000 B.C.;[16] its application was preponderant in an array of medical disorders, from psychological malaise to its use as an anesthetic in surgical operations.[17] Later of course the hallucinogenic opium would replace cannabis around the 8th century AD. Herodotus, the Greek historian himself witnessed the use of marijuana among the Scythians of North Central Asia around 5th century B.C. He recorded that its use was at the heart of the ceremonial core of honoring the dead.[18] The Sumerians of the Near East were among the first to use cannabis and right from Mesopotamia to Peru, marijuana use was a common ritualistic practice, the use of which also finds mention in the Old Testament.[19] The Yaqui tribe of South America religiously used psilocybin and mescaline during meditation.

A notable allusion to the psychologically penetrating influence of cannabis finds mention in the *Atharva Veda* (fourth book of the Vedas, 2000-1400 B.C.). Cannabis in India, was time honored since its association with the mythological God Siva. It was extolled for its mind altering properties and was intimately woven with the communal, religious, and medicinal context.[20] To attain deep spiritual experiences or sadhana (spiritual), this practice was unparalleled and is still common among the *Aghoras* and the *Shaivites*, of the Tantra sect. Even among the Tantric Buddhists its use is well-known. Sushruta, elucidated its therapeutic benefits for a wide range of ailments, including its use as an anesthetic for minor surgeries and as cure for fevers.[21]

Between 1893-94, the Indian Hemp Drugs Commission was authorized to look into the use of cannabis in India; they recognized its potential benefits in medicine and deemed it an important drug.[22] Despite being entrenched in the religious, cultural and medical ethos the British Indian Government in 1896 enforced an act that deterred the use of cannabis as an intoxicant. 1930 saw the Dangerous Drugs Act being passed, which even at the state level made the sale and possession of manufactured drugs, including medicinal cannabis difficult. The final nail was hammered in 1964, when the government sanctioned the Single Convention on Narcotic Drugs Act, and by mid 1980 s, the cultivation, possession and consumption of cannabis was severely penalized and came under strict vigilance of the Narcotic Drugs and Psychotropic Substances Act, 1985. Also a hallucinogen, cannabis was often referred to as "Phantastica",[23] that which causes euphoria, and is known to accentuate sensual perceptions, by distorting body boundaries and warping the sense of space and time.[23]

The active psychedelic properties of most of these hallucinogenic plants came under the scrutiny of Western scientists only recently. The psychedelic properties that were pharmacologically synthesized are: rye fungus (LSD), the psilocybin mushroom or 'magic mushrooms' (psilocybin), and the peyote cactus (mescaline).[24] Since LSD first appeared, psychiatrists and psychologists would often lend themselves the experience of the psychedelic states of temporary psychosis, which would let them trudge on the otherwise frozen territories.[25]

The word "hallucinogen" is alternately used as psychedelic, and has its roots in Greek, which literally means "to wander in the mind." Since these drugs do not actually produce true hallucinations but provokes an illusion, it is implicit that it is an effect of the drug.[26] Most of the chemical structures of these psychedelics were also found to closely resemble the chemical properties of the neurotransmitters in the human brain, so this chemical gateway would inevitably provide a sympathetic understanding of psychotic states.[27]

The psychedelic trip

Since its early days LSD began to be seen as a convenient way "*of gaining access to the chronically withdrawn patient*" and would soon gain repute as an adjunct to psychotherapy.[28] Others would soon follow, and it was Sandison in 1953 who opened the first LSD clinic in England. Sandison and his group were to opine that LSD therapy worked best with the obsessionally neurotic and other anxiety groups.[29] But, it was Osmond who would revolutionize its use with chronic alcoholics in 1957.[30] He would use high doses of LSD (300 mcg. or more), sometimes in combination with the other hallucinogens, and soon the wave "psychedelic therapy" caught on after Osmond first coined it. Later, psychedelic psychotherapy, as an adjunct would invigorate the barriers of consciousness to unravel its mystical qualities across a range of therapeutic settings.[31,32] Before Kast and Collins in 1964.[33] embarked on their research on the use of psychedelics with the dying, reports from the

Sherwood *et al.*, and the Savage *et al.*, studies had already shed light on how most patients overcame their fear of death.

Kast's early work in the 1960 s on analgesics led him to LSD, which he learnt could "*markedly distort body image and alter body boundaries*", besides LSD could obstruct the body's own need to selectively concentrate on the physiological sensation of pain. In 1964, he and his colleague, Collins published their work on LSD where they compared its pain relieving effects with the opiate analgesics, Dilaudid (dihydromorphinone) and Demerol (meperidine) on a group of patients with severe physical pain, among whom were several with different types and stages of cancer. LSD turned out to be a superior drug. What struck them was that patients after their LSD experience could easily cast off their fear of an impending death. What followed later was his study on 128 patients with metastatic cancer, in a nonpsychotherapeutic setting, but where he extended it to their psychological aspects of attitudes, emotions and sleep patterns associated with their illness and death. An administered dose of 100 µg of LSD not only remarkably reduced their pain, that lasted for about 12 hours, but also reduced its intensity for 3 weeks. Ten days following the session, sleep too improved in the group and they seemed less occupied with death.[11,25]

1966 saw Kast being intensely occupied with the personal and philosophical experiences of patients with terminally malignant diseases who had but just a few weeks or months ahead of them, an imminent reality they were aware of. Like before, not only did 100 µg of LSD have a relieving effect on physiological pain, emotions and sleep pattern but Kast went on to describe, "*happy, oceanic feelings*", "that would overpower the fear of death and would bring in a sense of community with which they would perceive themselves and those around them with a certain philosophical and religious precept that was beyond the rationalization of any numerical data or graphs".[11,34]

Kast had set the mould from which future research would take shape. Gary Fisher,[35] another researcher in 1970 in his work highlighted the more personal experiences of the dying, and he discussed this in light of transcendental experience gained from practice, either spiritually or induced artificially through psychedelics. Fisher emphasized on the experiences of the dying patient whose concern about death had mitigated as he began to see it less as a physical departure and more as a continuity of life force.

Around the 1960 s simultaneous work on LSD exploring its psychotherapeutic benefits was being headed by Stainslav Grof in Prague, Czechoslovakia.[11] Grof's work with LSD was based on the theory and practice of psychoanalysis on psychiatric patients which would soon grow out of it to become an independent school of its own and take into its ambit the transpersonal and transcendental experience. This would over the years be integrated into the psychedelic therapy associated with the dying. Influenced by his work with psychiatric patients who reported a mitigated feeling toward their own fear of death with LSD therapy, Grof went on to inculcate these same ideas with those patients for whom death was an imminent reality, and this led him to his work with cancer patients. He would soon work with other researchers at Spring Grove, which later became the Maryland Psychiatric Research Center (MPRC) using a specific form of psychedelic therapy with the terminally ill.[36]

What began in MPRC in 1963, as an exploration of the therapeutic potential of LSD on alcoholics and neurotics would soon find its way, although unexpectedly attending to the terminally ill. This would unfold in an event when one of its own research team member developed metastic cancer, and in the face of it underwent severe depression and anxiety; LSD therapy proved to be a peak personal experience for her wherein she could confront and resolve her fears of the unknown.[11]

What was initiated as psychedelic therapy was soon dubbed as psychedelic peak therapy,[36] as one often attained a peak transcendental experience with a high dose of psychedelics (350-400 mcg.), but for this to be conducive, patients would initially undergo intensive psychotherapy that would last at least 20 hours.

The work at Spring Grove would grow to become the most well-documented psychedelic research of that time;[37] and research would remain unrelenting until 1976, when the Comprehensive Drug Abuse Prevention and Control Act of 1970 was enforced under political pressure because of the escalating problems of drug abuse.[37]

Dipropyltryptamine (DPT), another psychedelic was also examined in two cancer studies in lieu of the LSD, since its properties were similar to LSD but was less time consuming.[38] It took about 1 ½ to 6 hours to act, and its effects too wore off easily unlike the LSD that demanded a considerable amount of time. Post-therapeutically DPT's benefits would mimic LSD. It was suggested to be a better alternative than LSD, but because of its quick onset, patients often found the sudden psychological upheaval overwhelming.[39]

Psychedelic research would soon see its decline in the U.S., and whatever sporadic research continued would be published anecdotally. Even though it was interred deep in medical research in the 1950 s and 1960 s,[40] drug use in the recreational scene attained a cult status in the 1960 s, following which it became a medical and sociopolitical taboo.[41]

Another class known as the entactogens comprising of the agent MDMA (3,4-methylenedioxymethamphetamine), has been popular as the street drug ecstasy since the last two decades. In the early 80 s, it begun to be used in the psychotherapeutic setting, as it enhanced one's state of contemplative insight,[42] and helped delve into the repressed parts of the psyche. This it did by mitigating fear in an otherwise emotionally surcharged moment;[43] which is why its potent use was grasped for the terminally ill.[44]

The classical psychedelics (LSD and psilocybin) are nonaddictive, known not to cause any physiological dependency and are nontoxic[45-47] which is why current researchers are making a stab at bringing back these drugs for their exceptional use in relieving the existential encumbrance that comes with the terminally ill.

Psychedelic research is once again starting up, but cautiously. Research continued in Europe throughout the 80 s, but was mostly restricted to private practice. It was in Switzerland, however, where it met the least resistance, and research continued despite the world-wide ban in 1971. Licenses were granted by the government for exclusive research in MDMA, psilocybin, and LSD psychotherapy in 1988.[25,48]

Current wave

Contemporaneous research into psychedelics is delicately being burrowed out of its political tentacles that has not just rendered it deleterious to contemporary health but also kept tightening its fist around any attempted research that could have otherwise proved its authenticity. What also discouraged its use was that pharmaceutical companies would not stand to gain by it as there were no patents to be had and also these drugs do not require regular use. A few sessions of therapy were mostly enough, and sometimes even a single LSD trip could alter one's life.

Most of the current research is being targeted on patients who have developed secondary anxiety-related disorder associated with end-stage cancer, and were refractory to anxiolytic therapy and psychotherapy.[45] Their line of work is inspired by the earlier works of Kast, in which the drug therapy is used as an adjunct with psychotherapy.

LSD and psilocybin are both structurally similar to the neurotransmitter serotonin and can directly affect its pathways in the brain. A study using psilocybin, is being conducted in the University of California in Los Angeles UCLA, USA, by Charles Grob, who waited more than 10 years before he got the approval for a pilot study in 12 patients with advanced-stage cancer, who had developed severe anxiety disorder. The reason why psilocybin was opted instead of LSD is because its action is shorter, and also the effects can be easily controlled.[45,49] Patients were placebo-controlled and assisted with psilocybin in the double-blind study. Implicit to the study is that the psilocybin group will fare better than the controls while they experience reduced pain, anxiety and depression, the effects of which, it is presumed will continue beyond the study period; and will also curb their need for anxiolytic and analgesic therapy. Influenced by Grob's work a similar study was undertaken by Sameet Kumar, TBD, USA in stage IV melanoma patients.[49]

Similar research has been initiated by John Halpern at the McLean Hospital, Harvard Medical School, using MDMA as adjunct to psychotherapy for patients with anxiety secondary to end-stage cancer. In May 2012, the annual report on the Swiss study by Peter Gasser was submitted by the Multidisciplinary Association for Psychedelic Studies (MAPS). Gasser and his team are conducting research on LSD-assisted psychotherapy in twelve subjects with anxiety related to advanced-stage illness (cancer, metabolic and autoimmune diseases).

Psilocybin-assisted psychotherapy is also underway at the Johns Hopkins University, Baltimore, USA; where the principal investigator is Roland Griffiths. This study will accommodate patients with early, nonterminal cancer.

The way out

Ethical concerns for the most part will linger with the use of these psychedelic drugs in human subjects, but to grasp the full extent of these ethical concerns behind such research one also needs to empathize with the views of patients changing perspective toward their lives, particularly when they see the inevitability of a perishable self. But a psychedelic trip enhanced realization of continuity, which dissipates the ego into a boundary-less whole is what seems comforting to the dying.[50] Soon after LSD caught on a new wave in medical research, Albert Hoffman, who engineered its invention opined that psychedelics could see its way into the future through transpersonal psychology.[51] He went on to add that "*it was only through this route of transpersonal psychology that we could gain access to the spiritual world*."[51]

Stanislav Grof was a proponent of this school of transpersonal therapy, along with Abraham Maslow, who posited that altered states of consciousness (ASCs) were the key to realizing one's psychological well being. Psychedelic-induced ASCs "could catalyze a therapeutic response" by adding meaning to therapy.[50] This practice was well known among most spiritual disciplines, particularly Buddhism where most of the monks had had experiences with psychedelics, in keeping with their traditional vow.

When we go back to the history of psychedelic research it is not hard for anyone to see that field held much promise in its incipient stages, before it was cracked down in the 1960 s and 70 s. First the complacency in which researchers and therapists controlled their supply of LSD and later the booming of the counter-culture movement led by the Harvard psychologist Tim Leary led to its indiscriminate use in the most profane way. So the grip tightened more out of societal concerns than any medically linked problems with LSD and the other psychedelics.[52]

A favorable shift in the trend toward bringing psychedelics back into the research was because of researchers like Strassman and the concerted efforts by organisations like the Multidisciplinary Association for Psychedelic Studies (MAPS) and the Heffter Organization, which have pioneered the medical research of these drugs.

For research to continue, and remain unscathed from political breaches, it becomes the responsibility of the individual or researchers directly associated with it to make a conscious effort to steer clear from the lackadaisical attitude of the past that had created much of the unnecessary moral and medical hysteria about psychedelic use.[53] Some of the scandals involved the early known psychotomimetic research sponsored by the CIA under (MK-ULTRA),[54] where LSD was being explored as the truth serum had done enough to tarnish its repute; but, even after a prohibition in conventional research, psychedelic use proliferated as an underground culture, and legal restrictions had little to do with it. So the problem is not whether medical research would give recreational use more leverage and escalate its abuse, the question is how much of this medical ease will actually unrestrain itself from its own excesses. One could see that the removal of criminal penalization for use of non-addictive drugs did little to escalate its recreational use in Holland and Portugal.

Lastly, we are bound by this inescapable concern of anxiety being inherent to our condition; it is the core of who we are, something that we cannot put an end to, because such an end would require the annihilation of the ego-self first (existential school). But because it cannot be overcome therapeutically,[55,56] since one cannot face the terrible possibility of one's condition (our mortality) without anxiety; we had to repress this truth. We have fractionized reality to an extent where we can partially deal with this anxiety, by confining our world within its narrow realm, where we have accessibility and control. But when one is faced with the imminence of death, this anxiety cracks open in all its floridness, the paradoxical stance of the death wound undoing the birth wound conditions itself once again. Death transcending into another alternate realm is the central theme of most religious traditions, but the problem ascends when we try to demythologize these myths,[1] when we try and wheedle out their deeper meaning. The problem is we cannot extricate it out from the myth of our own mechanized language that we are used to (language of modern science), since we can only project ourselves from what we have learnt to learn, with our own cognitive apparatus that does not safeguard us from this duality of life and death.

So psychedelic therapy is not a cure to this eternal morass, it eases our burden alright, giving us a peek into what might be, but we never know, but as long as it helps one wade through one's existential fear, or just numb the reality of pain, then why not? Anxiety dissipates here, the unknown becomes more acquainted, and the knowing becomes obsolete and we feel cured like "the artist who carries death in him like a good monk his breviary" (Boll).

References

1. Loy D. The nonduality of life and death: A Buddhist view of repression. Philos East West 1990;40:151-74.
2. *Ibid*., p. 49. As cited in Loy David. The nonduality of life and death: A Buddhist view of repression. Philos East West 1990;40:151-74.
3. Brown NO. Life against death: The psychoanalytic meaning of history. New York: Vintage; 1961. (as cited in avoiding the void, David Loy)
4. Kant I. The critique of pure reason (first critique). 1787.
5. Yalom. Existential psychotherapy. A similar realization - that the ego not only represses, but represses the fact that it represses - was a turning point in Freud's career, deflecting his investigations from the nature of the repressed to the nature of repressing. p. 222.
6. Loy D. Nonduality: A study in comparative philosophy. New Haven: Yale University Press; 1988.
7. Sartre JP. Being and Nothingness. *L'Etre et le neant*. Washington Square Press. 1943.
8. Yalom ID. Existential psychotherapy. 1980, 524 pages. Basic Books, New York. p. 41.
9. Becker E. Escape from evil. p. 132, 166. New York: Free Press, 1975.
10. Aries, P.1981 *The Hour of Our Death*, New York: Knopf. P.333.
11. Grof S, Halifax J. The history of psychedelic therapy with the dying. Chapter 2 of the human encounter with death. New York: E.P. Dutton; 1977.
12. Kubler-Ross E. Death the final stage of growth. New Jersey: Prentice-Hall; 1975.
13. Noyes R. Dying and mystical consciousness. J Thanatol 1971;1:25-41.
14. Noyes R. The experience of dying. Psychiatry 1972;35:174-84.
15. Grof S, Grof C. Beyond death, the gates of consciousness. London: Thames and Hudson Ltd; 1980.
16. Spicer L. Historical and cultural uses of cannabis and the Canadian "Marijuana Clash." prepared for the senate special committee on illegal drugs Law and Government Division. 2002, library of parliament.
17. Abel. As cited in- Spicer L. Historical and cultural uses of cannabis and the Canadian "Marijuana Clash." Prepared for the senate special committee on illegal drugs (Library of Parliament). 2002. p. 12.
18. Abel. As cited in Spicer L. Historical and cultural uses of cannabis and the Canadian "Marijuana Clash." Prepared for the senate special committee on illegal drugs (Library of Parliament). 2002. p. 23.
19. Creighton C. On indications of the Hachish-Vice in the Old Testament. Amsterdam: Janus; 1903. p. 1.
20. Aldrich M. History of therapeutic cannabis. In: Mathre ML, editor. Cannabis in Medical Practice. North Carolina: McFarland and Company, Inc., Publishers; 1997. p. 36.
21. Aldrich. As cited in- Spicer L. Historical and cultural uses of cannabis and the Canadian "Marijuana Clash." Prepared for the senate special committee on illegal drugs (Library of Parliament). 2002. p. 37.
22. Ibid. As cited in- Spicer L. Historical and cultural uses of cannabis and the Canadian "Marijuana Clash." prepared for the senate special committee on illegal drugs (Library of Parliament). 2002. p. 38.
23. Li H-L. As cited in- Spicer L. Historical and cultural uses of cannabis and the Canadian "Marijuana Clash." Prepared for the senate special committee on illegal drugs (Library of Parliament). 2002. p. 59 and footnote 8 on p. 61.
24. Weil A, Rosen W. Chocolate to morphine understanding mind-active drugs. Boston: Houghton Mifflin; 1983.
25. Sewick B. Psychedelic-assisted psychotherapy for the terminally ill. A Thesis Submitted to the Faculty of the College of Arts and Sciences Roosevelt University,Chicago Illinois,1997.
26. Peoples L. Lecture 1 on hallucinogens. Philadelphia: University of Pennsylvania; 2005.
27. Restak R. Receptors. New York: Bantam Books; 1994.
28. Busch AK, Johnson WC. LSD-25 as an aid in psychotherapy. Dis Nerv Syst 1950;11:241-3.
29. Sandison RA, Spencer AM, Whitelaw JD. The therapeutic value of Lysergic Acid Diethylamide in mental illness. J Ment Sci 1954;100:491- 507.
30. Osmond H. A review of the clinical effects of psychotomimetic agents. Ann N Y Acad Sci 1957;66:418-34.
31. Sherwood J, Stolaroff M, Harman W. The psychedelic experience - a new concept in psychotherapy. J Neuropsychiatr 1962;4:69-80.
32. Savage C, Savage E, Fadiman J, Harman W. LSD: Therapeutic effects of the psychedelic experience. Psychol Rep 1964;14:111-20.
33. Kast E, Collins V. A study of Lysergic Acid Diethylamide as an analgesic agent. Anesth Analg 1964;43:285-91.
34. Kast E. LSD and the dying patient. Chic Med Sch Q 1966;26:80-2.
35. Fisher G. Psychotherapy for the dying. Omega 1970;1:3-15.
36. Pahnke W, Kurland A, Unger S, Savage C, Grof S. The experimental use of psychedelic (LSD) psychotherapy. JAMA 1970;212:1856-63.
37. Yensen R, Dryer D. Thirty years of psychedelic research: The Spring Grove experiment and its sequels. In: Schlichting M, Leuner H, editors. World of Consciousness. Berlin: GAM-Media GmbH; 1992. p. 141-76.
38. Richards W, Rhead J, DiLeo F, Yensen, Kurland A. The peak experience variable in DPT- assisted psychotherapy with cancer patients. J Psychedelic Drugs 1977;9:1-10.
39. Richards W, Rhead J, Grof S, Goodman L, DiLeo F, Rush L. DPT as an adjunct in brief psychotherapy with cancer patients.

Omega Journal of Death and Dying 1979;10:9-26.

40. Grinspoon L, Bakalar JB. Can drugs be used to enhance the psychotherapeutic process? Am J Psychother 1986;40:393-404.
41. Sessa B. Can psychedelics have a role in psychiatry once again? Br J Psychiatry 2005;186:457-8.
42. Vollenweider FX, Gamma A, Liechti M, Huber T. Psychological and cardiovascular effects and short-term sequelae of MDMA ('ecstasy') in MDMA-naïve healthy volunteers. Neuropsychopharmacology 1998;19:241-51.
43. Greer GR, Tolbert R. Subjective reports of the effects of MDMA in a clinical setting. J Psychoactive Drugs 1986;18:319-27.
44. Greer GR, Tolbert R. The therapeutic use of MDMA. In: Peroutka SJ, editors. Ecstasy: The clinical, pharmacological and neurotoxicological effects of the drug MDMA. Holland: Kluwer Academic; 1990.
45. Sessa B. Can psychedelic drugs play a role in palliative care? European Journal of Palliative Care 2008;15:234-7.
46. Hasler F, Grimberg U, Benz MA, Huber T, Vollenweider FX. Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. Psychopharmacology (Berl) 2004;172:145-56.
47. Fantegrossi WE, Woods JH, Winger G. Transient reinforcing effects of phenylisopropylamine and indolealkylamine hallucinogens in rhesus monkeys. Behav Pharmacol 2004;15:149-57.
48. Lukoff D, Zanger R, Lu F. Transpersonal psychology research review: Psychoactive substances and transpersonal states. The Journal of Transpersonal Psychology 1990;22:107-48.
49. Multidisciplinary Association for Psychedelic Studies (MAPS). Available from: http://www.maps.org/.
50. Anderson B. Psychedelic Psychotherapy: The ethics of medicine for the soul. Penn Bioeth J 2006;2:1.
51. Grob C. A conversation with Albert Hofmann. In: Grob CS, editors. Hallucinogens: A Reader. New York: Jeremy P. Tarcher/Putnam; 2002. p. 15-22.
52. Williams L. Human psychedelic research: A historical and sociological analysis. Undergraduate thesis 1999.
53. Novak. As cited in Williams L. (1999). Human psychedelic research: A historical and sociological analysis. Undergraduate thesis. 1997; p. 99.
54. Pellerin (1998) p.49-55, Stevens (1987) p.79-84. Wilner (1995) p.23- 25. As cited in Williams L.(1999). Human psychedelic research: A historical and sociological analysis. Undergraduate thesis.
55. Becker E. The denial of death (New York: Free Press, 1973). As cited in Loy David. The nonduality of life and death: A Buddhist view of repression. Philos East West 1990;40:151-74.
56. Becker E. Escape from Evil (New York: Free Press, 1975). As cited in Loy David. The nonduality of life and death: A Buddhist view of repression. Philos East West 1990;40:151-74.

Psilocybin with psychological support for treatment-resistant depression

An open-label feasibility study

by

Robin L Carhart-Harris, Mark Bolstridge, James Rucker*, Camilla M J Day*, David Erritzoe, Mendel Kaelen, Michael Bloomfield, James A Rickard, Ben Forbes, Amanda Feilding, David Taylor, Steve Pilling, Valerie H Curran, David J Nutt

Lancet Psychiatry 2016; 3: 619-27

© Carhart-Harris *et al*.

original report: http://www.thelancet.com/pb/assets/raw/Lancet/pdfs/S2215036616300657.pdf
backup source: http://www.psilosophy.info/resources/S2215036616300657.pdf

Published Online: May 17, 2016 http://dx.doi.org/10.1016/S2215-0366(16)30065-7
See Comment page 592

*Contributed equally

Centre for Neuropsychopharmacology, Division of Brain Sciences, Faculty of Medicine, Imperial College London, London, UK: (R L Carhart-Harris PhD, M Bolstridge MD, J Rucker MD, C M J Day MD, D Erritzoe MD, M Kaelen BSc, Prof D J Nutt DM);
Department of Pharmacy and Pathology, South London and Maudsley NHS Foundation Trust, London, UK: (Prof D Taylor PhD); **The Institute of Psychiatry, Psychology and Neuroscience**: (J Rucker) **and Institute of Pharmaceutical Science**: (Prof B Forbes PhD), **King's College London, London, UK; Department of Psychiatry**: (M Bloomfield MD), **Clinical Psychology and Clinical Effectiveness**: (Prof S Pilling PhD), **and Clinical Psychopharmacology Unit**: (Prof V H Curran PhD), **University College London, London, UK; Barts Health Pharmaceuticals, Barts Health NHS Trust, The Royal London Hospital, London, UK**: (J A Rickard PhD); **and The Beckley Foundation, Beckley Park, Oxford, UK**: (A Feilding).

Correspondence to: Dr Robin L Carhart-Harris, Centre for Neuropsychopharmacology, Division of Brain Sciences, Faculty of Medicine, Imperial College London, London W12 0NN, UK
r.carhart-harris@imperial.ac.uk

Table of Contents:

- **Summary**
  - Background
  - Methods
  - Findings
  - Interpretation
  - Funding
- **Research in context**
  - Evidence before this study
  - Added value of this research
  - Implications of all the available evidence
- **Introduction**
- **Methods**
  - Study design and participants
  - Procedures
  - Outcomes
  - Statistical analysis
  - Role of the funding source
- **Results**
- **Discussion**
- **Acknowledgments**
- **References**
- **Supplementary appendix**
  - Supplementary information
  - Acute subjective and physiological effects of psilocybin
  - 1.1. Aim of study
  - 1.2 Background of the study
- **2. Project outline**
  - 2.1 Main study design
- **3. Basic safety and scientific background**
- **4. Study design**
  - 4.1. Primary outcome measure
  - 4.2. Volunteers
    - *4.2.1. Screening procedure*
    - *4.2.2. Inclusion criteria*
    - *4.2.3. Exclusion criteria*
    - *4.2.4. Withdrawal Criteria*
- **5. Regulatory Issues and informed consent**
  - 5.1 Ethics Approval
  - 5.2 Consent
  - 5.3 Confidentiality
  - 5.4 Audits and Inspections
  - 5.5. Monitoring
- **6. Patient recruitment strategy**
- **7. Drug specific ethical and safety considerations**
  - 7.1. Suicide and persistent adverse events
  - 7.2 Definitions and reporting of Adverse Events & Reactions
  - 7.2.1 Reporting Procedures
- **8. Study time line**
- **9. Day 1, screening time line**
- **10. Functional MRI**
- **11. Day 5, Functional MRI and prep session with therapist**
- **12. Follow-up**
- **13. Dosing and patient management**
  - 13.1. Dosing procedure
  - 13.2 Dosing parameters and algorithm

13.3 Patient management
14. Standard Operating Procedure for managing adverse events
15. Time commitments
16. Purchasing and storing drug
17. Analysis
18. Dosing day timeline
19. Monitoring
20. IMP details
21. Dosing algorithm
22. References

Summary

Background

Psilocybin is a serotonin receptor agonist that occurs naturally in some mushroom species. Recent studies have assessed the therapeutic potential of psilocybin for various conditions, including end-of-life anxiety, obsessive-compulsive disorder, and smoking and alcohol dependence, with promising preliminary results. Here, we aimed to investigate the feasibility, safety, and efficacy of psilocybin in patients with unipolar treatment-resistant depression.

Methods

In this open-label feasibility trial, 12 patients (six men, six women) with moderate-to-severe, unipolar, treatment-resistant major depression received two oral doses of psilocybin (10 mg and 25 mg, 7 days apart) in a supportive setting. There was no control group. Psychological support was provided before, during, and after each session. The primary outcome measure for feasibility was patient-reported intensity of psilocybin's effects. Patients were monitored for adverse reactions during the dosing sessions and subsequent clinic and remote follow-up. Depressive symptoms were assessed with standard assessments from 1 week to 3 months after treatment, with the 16-item Quick Inventory of Depressive Symptoms (QIDS) serving as the primary efficacy outcome. This trial is registered with ISRCTN, number ISRCTN14426797.

Findings

Psilocybin's acute psychedelic effects typically became detectable 30-60 min after dosing, peaked 2-3 h after dosing, and subsided to negligible levels at least 6 h after dosing. Mean self-rated intensity (on a 0-1 scale) was 0.51 (SD 0.36) for the low-dose session and 0.75 (SD 0.27) for the high-dose session. Psilocybin was well tolerated by all of the patients, and no serious or unexpected adverse events occurred. The adverse reactions we noted were transient anxiety during drug onset (all patients), transient confusion or thought disorder (nine patients), mild and transient nausea (four patients), and transient headache (four patients). Relative to baseline, depressive symptoms were markedly reduced 1 week (mean QIDS difference -11.8, 95% CI -9.15 to -14.35, *p*=0.002, Hedges' g=3.1) and 3 months (-9.2, 95% CI -5.69 to -12.71, *p*=0.003, Hedges' g=2) after high-dose treatment. Marked and sustained improvements in anxiety and anhedonia were also noted.

Interpretation

This study provides preliminary support for the safety and efficacy of psilocybin for treatment-resistant depression and motivates further trials, with more rigorous designs, to better examine the therapeutic potential of this approach.

Funding

Medical Research Council.

Research in context

Evidence before this study

We searched PubMed up to Jan 30, 2016, using the terms "psilocybin", "hallucinogens", "psychedelics", and "depression". We did not find any clinical trials assessing psilocybin as a treatment for depression, but we did find population analyses, review articles, and imaging studies lending support to this approach. We also found one report documenting enduring decreases in depressive symptoms after a single dose of psilocybin in a randomised controlled trial of psilocybin-assisted psychotherapy for end-of-life anxiety, one report on an open-label trial showing rapid decreases in depressive symptoms that endured for up to 21 days after a single dose of ayahuasca, and two early reports or case studies on the effects of lysergic acid diethylamide on "neurotic" and depressive symptoms describing "improvements", albeit without validated measures of symptom severity.

Added value of this research

To our knowledge, this is the first investigation of the safety and efficacy of psilocybin as a treatment for major depression. Our findings imply that psilocybin might have value as a treatment option in the management of treatment-resistant depression. Single oral administrations of 10 mg (safety dose) and 25 mg (treatment dose) psilocybin were well tolerated and led to enduring reductions in symptom severity after the two sessions.

Implications of all the available evidence

The results of this small-scale feasibility study should help to motivate further research into the efficacy of psilocybin with psychological support for major depression. Larger-scale randomised controlled trials are warranted to better examine the potential of psilocybin as a treatment option for this highly prevalent, disabling, costly, and difficult-to-treat disorder. More broadly, the present study should help to catalyse the re-emergence of a promising research area in psychiatry.

Introduction

Psilocybin is a naturally occurring plant alkaloid found in the *Psilocybe* genus of mushrooms. *Psilocybe* mushrooms have been used for millennia for healing purposes, but were only discovered by modern science in the late 1950s.[1,2] Psilocybin is a prodrug of psilocin (4-hydroxy-dimethyltryptamine), a serotonin receptor agonist and classic psychedelic drug whose principal psychoactive effects are mediated by serotonin 2A (5-HT_{2A}) receptor agonism.[3] Psilocybin therefore has a novel pharmacology in the context of currently available antidepressant medications, because selective serotonin-reuptake inhibitors are not direct 5-HT_{2A} receptor agonists.

Enhanced cognitive flexibility,[4] associative learning,[5] cortical neural plasticity,[6] and antidepressant responses have been reported with 5-HT_{2A} receptor agonism in animals,[7] and increased and sustained improvements in wellbeing[8] and optimism[9] have been observed after psychedelic experiences in human beings. Findings from human imaging studies with psilocybin have supplemented these discoveries, showing changes in brain activity suggestive of antidepressant potential; for example, a range of effective antidepressant treatments have been found to normalise hyperactivity in the medial prefrontal cortex and we found reduced blood flow in this region with intravenous psilocybin.[10] Moreover, data obtained from large-scale population studies have recently challenged the view that psychedelics negatively affect mental health,[11-13] with one study's findings showing lower rates of psychological distress and suicidality among people who had used psychedelics within their lifetime than among those who used no psychedelics but an equivalent amount of other drugs.[11] In modern trials, psychedelics have been found to reduce anxious,[14,15] depressive,[15,16] and obsessive-compulsive symptoms,[17] as well as addictive behaviours,[18,19] often for several months after just one or two exposures. Extensive historical and modern evidence now supports the view that, administered in a controlled environment with appropriate support, psychedelics have a favourable safety profile.[20]

Depression is a major public health problem; it is a leading contributor to the global burden of disease, affecting hundreds of millions of people worldwide, and costing the USA alone more than US$200 billion each year.[21] Antidepressant medications and cognitive behavioural therapy can be effective for some patients, but around 20% do not respond to any intervention, and many of those who do respond, eventually relapse.[22] We aimed to investigate the safety and feasibility of psilocybin in patients with treatment-resistant depression, and to establish an initial impression of its efficacy. We postulated that the treatment would be well tolerated and depressive symptoms would be substantially reduced from baseline at all assessment points, for up to 3 months after treatment.

Methods

Study design and participants

This was an open-label feasibility study in patients with treatment-resistant depression; there was no control group. Patients, investigators, raters, and statisticians were not masked to treatment assignment, and all participants received the study intervention (psilocybin administered in two dosing sessions; an initial safety [low] dose and a subsequent treatment [high] dose). The inclusion criteria were major depression of a moderate to severe degree (17+ on the 21-item Hamilton Depression Rating scale [HAM-D]), and no improvement despite two adequate courses of antidepressant treatment of different pharmacological classes lasting at least 6 weeks within the current depressive episode.[23] Exclusion criteria were: current or previously diagnosed psychotic disorder; immediate family member with a diagnosed psychotic disorder; medically significant condition rendering unsuitability for the study; history of serious suicide attempts (requiring hospitalisation); history of mania; blood or needle phobia; positive pregnancy test at screening or during the study; and current drug or alcohol dependence.

Information about the study's recruitment was sent to general practitioners via the North West London Clinical Research Network. However, patients were also allowed to self-refer to the study if they were UK residents. In every case, patients initiated contact with the research team (via email, letter, or telephone), were sent a study information sheet, and a subsequent telephone screening was arranged, during which the lead psychiatrist on the trial (MBo) obtained information about the patient's demographics, medical and psychiatric history, and other key inclusion or exclusion criteria. The patient's general practitioner or psychiatrist provided written documentation of the patient's diagnosis and mental health background in every case.

This trial received a favourable opinion from the National Research Ethics Service London - West London, was sponsored and approved by Imperial College London's Joint Research and Compliance Office (JRCO), and was adopted by the National Institute for Health Research Clinical Research Network. The National Institute for Health Research/Wellcome Trust Imperial Clinical Research Facility gave site-specific approval for the study. The study was reviewed and approved by the Medicines and Healthcare products Regulatory Agency (MHRA). All participants provided written informed consent. Study and data monitoring was carried out independently by the Imperial Clinical Research Facility and JRCO.

Procedures

Psilocybin was obtained from THC-pharm (Frankfurt, Germany) and formulated into the investigational medicinal product (5 mg psilocybin in size 0 capsules) by Guy's and St Thomas' Hospitals' Pharmacy Manufacturing Unit (London, UK). A Home Office Licence for storage and dispensing of Schedule One drugs was obtained.

Screening consisted of written informed consent, a thorough evaluation of the patient's physical and mental health background, a psychiatric interview (Mini-International Neuropsychiatric Interview), clinician assessments of depression severity (the 21-item HAM-D and the Montgomery-Åsberg Depression Rating Scale [MADRS], and Global Assessment of Functioning [GAF]; all assessed by MBo), and additional patient-rated scales (16-item Quick Inventory of Depressive Symptoms [QIDS], Beck Depression Inventory [BDI - original version], Spielberger's State-Trait Anxiety Inventory [form 2, trait version only; STAI-T], and the Snaith-

Hamilton Pleasure Scale [SHAPS]). Patients also received a thorough physical health check, consisting of an electrocardiogram, routine blood tests, blood pressure, heart rate, and physical examination. At the end of screening, eligible patients were given an opportunity to meet with the two clinical psychiatrists who would support them through the remainder of the trial.

Eligible patients attended a subsequent visit involving a baseline functional MRI (fMRI) scanning session lasting 60 min, followed by an extensive preparatory session with their allocated psychiatrists; fMRI data will be reported elsewhere. This preparatory session involved inviting the patient to talk openly about their personal history (including thoughts on the origins of their depression), a discussion of psilocybin's psychological effects, and simulation of aspects of the dosing session itself, such as listening to a sample of the session music while wearing eyeshades. The preparatory session typically lasted for 4 h, with lunch and breaks provided.

Patients enrolled in the study attended two subsequent dosing sessions that were separated by 7 days. No more than one patient was dosed on any given day. Patients arrived at the research facility (Imperial Clinical Research Facility) at 0900 h, gave a urine sample for drugs of abuse (including amphetamines, benzodiazapines, opiates, and cannabinoids), performed a breathalyser test for alcohol use, and completed interim QIDS, BDI, and STAI-T assessments to ensure no substantial deviation from baseline measures. They were then taken to a dosing room that was pre-decorated (eg., with low lighting). Patients were invited to relax on a ward bed in a supine or reclined position and music was played through high-quality stereo speakers and earphones. The two psychiatrists sat on either side of the bed. Patients were supervised at all times by at least two staff members.

Dosing commenced at 1030 h in every case. Patients received a low oral dose of psilocybin 10 mg (two 5 mg capsules) on a first dosing day and a high oral dose of psilocybin 25 mg (five 5 mg capsules) on a second dosing day, separated by 1 week. Blood pressure, heart rate, and observer ratings of the intensity of psilocybin's acute psychoactive effects (0-4, with 0 signifying no effects and 4 signifying extreme effects[8]) were measured at baseline (typically 5 min before dosing) and 30, 60, 120, 180, 240, 300, and 360 min after dosing. Subjective ratings of the acute altered state of consciousness using the revised 11 dimension altered states of consciousness questionnaire (11D ASC)[24] were completed 6-7 h after dosing.

Psychiatrists adopted a non-directive, supportive approach, allowing the patient to experience a mostly uninterrupted inner "journey". Check-ins (ie., asking the patient how they are feeling) occurred at the same timepoints as the physiological recordings. Tranquilising medications (oral lorazepam and risperidone) were available if necessary. The phenomenology of the acute experience, including accounts of the nature of the therapeutic support provided before, during, and after the experience, and considerations related to the music selection and other aspects of the clinical setting, will be discussed in separate publications.

Return transport from the research facility was organised ahead of dosing sessions. Patients were taken to and from the sessions accompanied by a close friend or relative, and had the option of staying overnight in accommodation adjacent to the hospital. Emergency contact details were provided, and patients confirmed their safe return from the research facility.

Patients were contacted via telephone 1 day after their low-dose session to check on their well-being and monitor for any adverse events. Patients returned to the research facility 1 day after their high-dose session for a post-treatment fMRI scan lasting 60 min. After the fMRI scan, patients completed interim questionnaires (QIDS, STAI-T, and HAM-D), and were invited back to the research facility where they were met by their psychiatrists to discuss their experience the previous day.

Patients attended one further study visit to the research facility 1 week after their high-dose session, during which all baseline questionnaires and assessments were repeated and an opportunity was provided for further psychological debriefing (the 1 week follow-up visit). Assessments of HAM-D, MADRS, and GAF were again done by MBo. Subsequent assessments of clinical progress were done via email 2, 3, and 5 weeks after the high-dose session; we assessed only QIDS during subsequent follow-up, so as not to overload the patient. Final follow-up was done remotely at 3 months after the high-dose session, and included QIDS, BDI, STAI-T, and SHAPS. Patients were made aware that they could contact the study psychiatrists at any time if their depression deteriorated. Figure 1 summarises the screening, intervention, and follow-up procedures in this study.

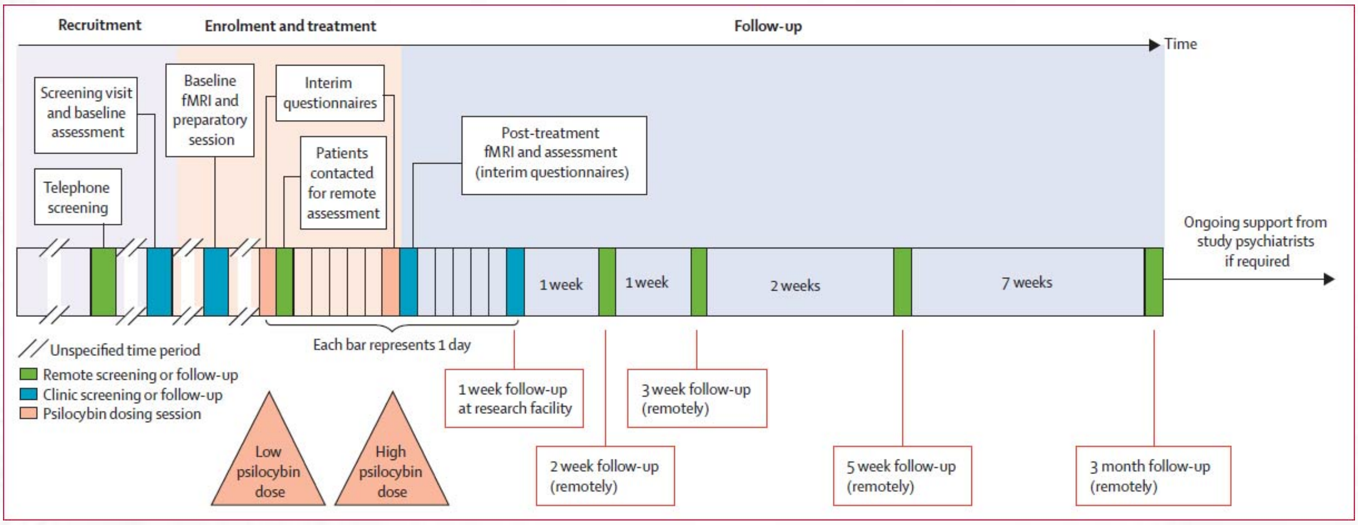

Recruitment
Enrolment and treatment
Follow-up
Time
Screening visit and baseline assessment
Telephone screening
Baseline fMRI and preparatory session
Interim questionnaires
Patients contacted for remote assessment
Post-treatment fMRI and assessment (interim questionnaires)
Ongoing support from study psychiatrists if required
1 week
1 week
2 weeks
7 weeks
Unspecified time period
Remote screening or follow-up
Clinic screening or follow-up
Psilocybin dosing session
Each bar represents 1 day
1 week follow-up at research facility
3 week follow-up (remotely)
2 week follow-up (remotely)
5 week follow-up (remotely)
3 month follow-up (remotely)
Low psilocybin dose
High psilocybin dose

Figure 1 - Schedule of study interventions.

Outcomes

The main objective of this study is to optimise the protocol for the administration of oral psilocybin in this patient group, while gaining an initial impression of treatment efficacy. The primary outcome measure to assess feasibility was patient-rated subjective intensity of psilocybin's effects, which we report on a 0-1 scale. We assessed the safety of the intervention through clinical monitoring during and after dosing sessions, and during 3 months of face-to-face and remote follow-up. We also aimed to assess the preliminary efficacy of psilocybin in patients with treatment-resistant depression; the primary outcome measure for this endpoint was mean change in the severity of self-reported depressive symptoms (with the 16 item QIDS) from baseline to 1 week after the high-dose psilocybin session. The QIDS was chosen as the primary outcome measure due to its brevity, increasingly widespread use, and validity at 1 week intervals.[25] We chose to assess the primary efficacy endpoint at 1 week after the high-dose session to allow comparison with previous studies of ketamine infusion for treatment-resistant depression;[26] the low-dose session was conceived a priori as a safety session rather than a treatment session. We also assessed change in BDI, STAI-T, and SHAPS between baseline and 1 week and 3 months of follow-up, and change in HAM-D, MADRS, and GAF between baseline and 1 week of follow-up.

Statistical analysis

In this feasibility study, we did not perform a formal power calculation. We planned to recruit 12 patients to provide an initial impression of the tolerability and efficacy of this novel treatment approach. A subsequent protocol amendment (Oct 6, 2015) increased the recruitment to 20 patients to provide statistical power for fMRI imaging. Here, we report findings for the 12 patients initially enrolled; outcome and fMRI data for all 20 patients will be reported separately.

Due to the small population, two-tailed Wilcoxon signed ranks tests were performed for non-parametric data. Two-tailed *t* tests were also performed and the relevant *t* values are provided in the appendix. We provide 95% CIs around the mean differences. We calculated effect sizes using the Hedges' g formula, which is more appropriate for small sample sizes. Hedges' g values are very similar to Cohen's d values for dependent data.

This trial is registered with the ISRCTN registry, number ISRCTN14426797. The registration was initiated on March 30, 2015, and finalised on July 7, 2015 (delay caused by administrative issues); recruitment started on April 21, 2015, after initiation of public registration.

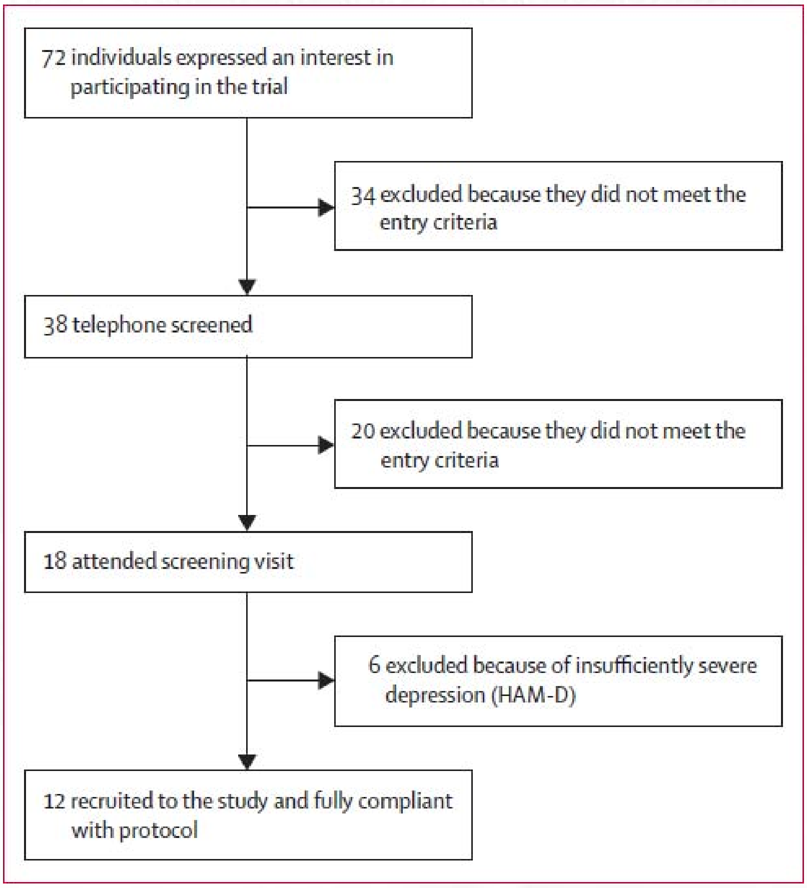

72 individuals expressed an interest in participating in the trial
34 excluded because they did not meet the entry criteria
38 telephone screened
20 excluded because they did not meet the entry criteria
18 attended screening visit
6 excluded because of insufficiently severe depression (HAM-D)
12 recruited to the study and fully compliant with protocol

Figure 2 - Trial profile.

Role of the funding source

The study funder had no role in the design, data collection, analysis, interpretation, or writing of the report. The corresponding author had full access to all of the data in the study and had final responsibility for the decision to submit for publication.

Results

Enrolment started on May 1, 2015, and finished on Aug 25, 2015. 72 people were initially considered for the study, most of whom self-referred after hearing about this trial through public outreach work (eg., public presentations by the investigators and media reports). 38 were considered appropriate for a telephone screen, from which 18 were invited for a formal screening visit, and 12 were ultimately recruited for the trial (figure 2), of whom ten were self-referrals. Patients' demographic and clinical characteristics are shown in table 1. Nine of the 12 patients met criteria for severe or very severe depression at baseline (BDI score ≥30), with the remaining three patients meeting criteria for moderate depression (BDI score 19 to <30). 11 patients had received some form of psychotherapy before participation in the study.

	Sex	Age, years	Ethnic origin	Employment status	Estimated illness duration, years	Baseline scores			Past unsuccessful medications*	Past psychotherapy	Education	Weekly alcohol intake, units	Previous psilocybin use (time since last use)
						BDI	HAM-D	STAI-T					
1	Female	43	Black Caribbean	Employed	30	36	19	72	SSRI (two), SNRI (two), NDRI, NSSRI, MAOI	None	Postgraduate	1	None

2	Male	40	Hispanic	Unemployed	25	33	28	76	SSRI (two), SNRI, NDRI, NSSRI, Na+ channel blocker (two), ketamine infusion, TCA	Cognitive narrative therapy	Postgraduate	0	None
3	Male	37	White	Employed	17	22	18	63	SSRI (two), SNRI	Cognitive behavioural therapy, group therapy	Postgraduate	0	None
4	Female	30	White	Studying	10	26	18	67	NDRI, NSSRI	Cognitive behavioural therapy	Postgraduate	0	One use (6 months)
5	Male	34	White	Unemployed	12	38	25	71	SSRI (three), TCA	Cognitive and mindfulness behavioural therapy	Undergraduate	0	None
6	Female	57	White	Unemployed	29	39	23	78	SSRI (four), SNRI, SARI	Counselling	Secondary education	2	Two uses (45 years)
7	Male	52	White	Unemployed	27	33	22	57	TCA, SARI	Counselling, mindfulness	Secondary education	0	Three uses (30 years)
8	Female	37	White	Employed	17	39	17	71	SSRI (two), TCA	Counselling	Undergraduate	2	None
9	Male	37	White	Unemployed	15	32	26	71	SSRI (three), SNRI	Counselling, cognitive behavioural therapy	Postgraduate	6	None
10	Female	36	Black Caribbean	Unemployed	8	47	28	75	SSRI (two), NSSRI	Counselling	Undergraduate	18	Three uses (14 years)
11	Female	64	White	Employed	15	24	17	72	SSRI (four), SNRI (two), NDRI, MAOI, Na^+ channel blocker, SARI, DRI	Cognitive behavioural therapy	Postgraduate	1	Three uses (48 years)
12	Male	45	White	Employed	8	35	17	68	SSRI, TCA	Cognitive behavioural	Undergraduate	0	None

BDI=Beck Depression Inventory. HAMD-D=Hamilton Depression Rating scale. STAI-T=State-Trait Anxiety Inventory. SSRI=selective serotonin-reuptake inhibitor. SNRI=serotonin-noradrenaline reuptake inhibitor. NDRI=noradrenaline-dopamine-reuptake inhibitor. NSSRI=noradrenaline and specific serotonin-reuptake inhibitor. MAOI=monoamine oxidase inhibitor. TCA=tricyclic antidepressant. SARI=serotonin antagonist and reuptake inhibitor. DRI=dopamine-reuptake inhibitor. *One medication from each class, unless otherwise stated.

Table 1: Baseline and demographic characteristics, by patient.

The acute effects of psilocybin were well tolerated by all of the patients and no serious or unexpected adverse events occurred. Mean self-rated intensity of psilocybin experience was 0.51 (SD 0.36) for the low-dose session and 0.75 (0.27) for the high-dose session (difference 0.24 [95% CI 0.06-0.41], Z -2.4, *p*=0.019). No patients required tranquilising medications (oral lorazepam and risperidone) during the dosing sessions. Psilocybin's acute psychedelic effects typically became detectable between 30 min and 60 min after dosing, peaked between 2 h and 3 h after dosing, and subsided to negligible levels at which the patient could be assessed for discharge at least 6 h after dosing (appendix). Self-rated experiences on the 11D-ASC questionnaire from the two sessions are shown in the appendix. Results from interim patient questionnaires (QIDS, BDI, and STAI-T), done immediately before the low-dose session to monitor for substantial changes since enrolment, did not differ from baseline (data not shown). Interim questionnaires done the day after the high-dose session showed some reduction in depressive symptoms (data for HAM-D in appendix; data for QIDS and STAI-T not shown).

	Severity	Timing or onset	Duration
Patient 1			
Transient anxiety	Mild	Onset of both sessions	60 min

Transient headache	Mild	Day after high-dose session	One day only
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-120 min
Patient 2			
Transient anxiety	Mild	Anticipatory anxiety only (both sessions)	30 min
Patient 3			
Transient anxiety	Mild	Anticipatory anxiety only (both sessions)	30 min
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min
Patient 4			
Transient anxiety	Mild (low dose), moderate (high dose)	Onset of both sessions and peak of high dose	60 min (low dose), 120 min (high dose)
Transient nausea	Moderate	Onset phase of high-dose session	Arose and subsided within 60 min
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min
Transient paranoia	Mild	Peak of high-dose session	Arose and subsided within 30 min
Patient 5			
Transient anxiety	Moderate (low dose), severe (high dose)	Onset of both sessions and peak of high dose	60 min (low dose), 150 min (high dose)
Transient headache	Mild	Day after high-dose session	One day only
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-120 min
Patient 6			
Transient anxiety	Mild	Anticipatory anxiety only (both sessions)	30 min
Patient 7			
Transient anxiety	Mild	Anticipatory anxiety only (both sessions)	30 min
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min
Patient 8			
Transient anxiety	Mild or negligible	Anticipatory anxiety only (both sessions)	30 min
Patient 9			
Transient anxiety	Mild (low dose), moderate (high dose)	Onset of low-dose and high-dose session	60 min (low dose), 150 min (high dose)
Transient headache	Mild	Day after high-dose session	One day only
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min
Patient 10			
Transient anxiety	Mild	Onset of both sessions	60 min
Transient nausea	Mild	Onset and peak of low-dose session	Subsided after 90 min
Transient headache	Mild or moderate	Day after high-dose session	2 days
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min
Patient 11			
Transient anxiety	Moderate (both sessions)	Onset phase and peak of both sessions	150 min (both sessions)
Transient nausea	Mild (high dose)	Onset phase of high-dose session	Arose and subsided within 60 min
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min
Transient paranoia	Mild	Peak of low-dose session	Arose and subsided within 60 min
Patient 12			
Transient anxiety	Mild	Anticipatory anxiety only (both sessions)	30 min
Transient confusion	Mild (core drug effect)	Peak of both sessions	60-180 min

Table 2: Adverse events by patient.

The most common adverse events were transient anxiety (mostly mild) during drug onset (n=12), transient confusion or thought disorder (n=9), mild and transient nausea (n=4), and transient headache (n=4; table 2). These adverse events were expected psychological effects of psilocybin. Subacute headache typically presented 1 day after the psilocybin session, and subsided after 1-2 days. Paranoia presented in only one patient, but this was mild and transient. No prolonged psychotic symptoms were observed in any of the patients. One patient contacted the study psychiatrists during the 3 months of follow-up due to deterioration of their depression, and was referred to their general practitioner.

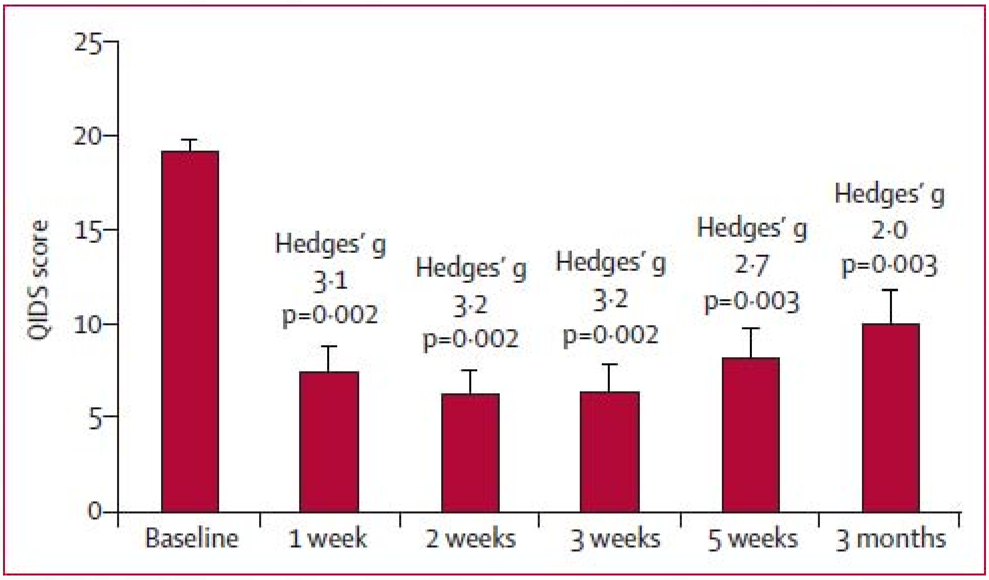


Figure 3 - Mean depression severity (QIDS) over time.
Depression severity determined by self-rated 16-item QIDS. QIDS scores of 16-20 are considered to reflect severe depression, scores of 11-15 are considered moderate depression, scores of 6-10 are considered mild depression, and scores of 5 and less are considered absent depression. All post-treatment assessments were obtained after the high-dose session (ie., 1 week post-treatment refers to 1 week after the high-dose session). Hedges' g values versus baseline are shown. QIDS=Quick Inventory of Depressive Symptoms.

QIDS depression scores were significantly reduced from baseline to 1 week and 3 months post-treatment, with the maximum effect at 2 weeks (figure 3, table 3). BDI and clinician-administered ratings confirmed these results (figure 4, table 3). All patients showed some reduction in depression severity at 1 week that was sustained in the majority for 3 months (appendix). According to standard criteria for determining remission (eg., a score of ≤9 on the BDI), eight (67%) of the 12 patients achieved complete remission at 1 week and seven patients (58%) continued to meet criteria for response (50% reduction in BDI score relative to baseline) at 3 months, with five of these (42%) still in complete remission (figure 4, table 3). STAI-T anxiety scores were also significantly reduced at 1 week and 3 months post-treatment, as were SHAPS anhedonia scores for 1 week and 3 months post-treatment (table 3).

	QIDS						BDI			STAI-T			SHAPS			HAM-D		MADRS		GAF	
	Baseline	1 week	2 weeks	3 weeks	5 weeks	3 months	Baseline	1 week	3 months	Baseline	1 week	3 months	Baseline	1 week	3 months	Baseline	1 week	Baseline	1 week	Baseline	1 week
Mean (SD)	19.2 (2.0)	7.4 (4.9)	6.3 (4.6)	6.4 (5.1)	8.2 (5.4)	10.0 (6.0)	33.7 (7.1)	8.7 (8.4)	15.2 (11.0)	70.1 (5.8	40.6 (14.2)	54.8 (14.5)	7.5 (3.7)	1.4 (2.7)	2.8 (3.7)	21.4 (4.5)	7.4 (6.9)	31.0 (5.0)	9.7 (9.8)	50.3 (9.2)	77.7 (13.0)
Difference versus baseline (95% CI)	..	-11.8 (-9.15 do -14.35)	-12.9 (-10.64 do -15.16)	-12.8 (-9.9 do -15.6)	-11.0 (-7.7 do -14.2)	-9.2 (-5.69 do -12.71)	..	-25.0 (-20.1 do -29.9)	-18.5 (-11.8 do -25.2)	..	-29.5 (-22.03 do -36.97)	-15.3 (-7.77 do -22.83)	..	-6.1 (-4.46 do -7.74)	-4.7 (-3.29 do -6.11)	..	-14.0 (-9.6 do -18.4)	..	-23.3 (-17.1 do -29.5)	..	27.3 (18.0 do 36.6)
Z	..	-3.1	-3.1	-3.06	-2.9	-3.0	..	-3.1	-3.1	..	-3.1	-2.9	..	-3.1	-3.1	..	-3.0	..	-3.1	..	-3.0
Hedges' g*	..	3.1	3.2	3.2	2.7	2.0	..	3.2	2.0	..	2.7	1.4	..	1.9	1.3	..	2.4	..	2.7	..	2.4
p value*	..	0.002	0.002	0.002	0.003	0.003	..	0.002	0.002	..	0.002	0.004	..	0.002	0.002	..	0.003	..	0.002	..	0.003

Follow-up refers to the period starting after the second (high-dose) administration of psilocybin. Clinician-administered ratings (HAM-D, MADRS, and GAF) were completed only at baseline and 1 week after the high-dose session. QIDS=Quick Inventory of Depressive Symptoms. BDI=Beck Depression Inventory. STAI-T=State-Trait Anxiety Inventory. SHAPS=Snaith-Hamilton Pleasure Scale. HAM-D=Hamilton Depression Rating scale. MADRS=Montgomery-Åsberg Depression Rating Scale. GAF=Global Assessment of Functioning. *Compared with baseline.

Table 3: Clinical ratings at baseline and follow-up.

Discussion

In this open-label, single-arm pilot study, we sought to examine the feasibility of administering psilocybin to patients with treatment-resistant depression as a prelude to a larger randomised controlled trial. Our results support the view that, done with appropriate safeguards (eg., careful screening and adequate therapeutic support), psilocybin can be safely administered to this patient group.

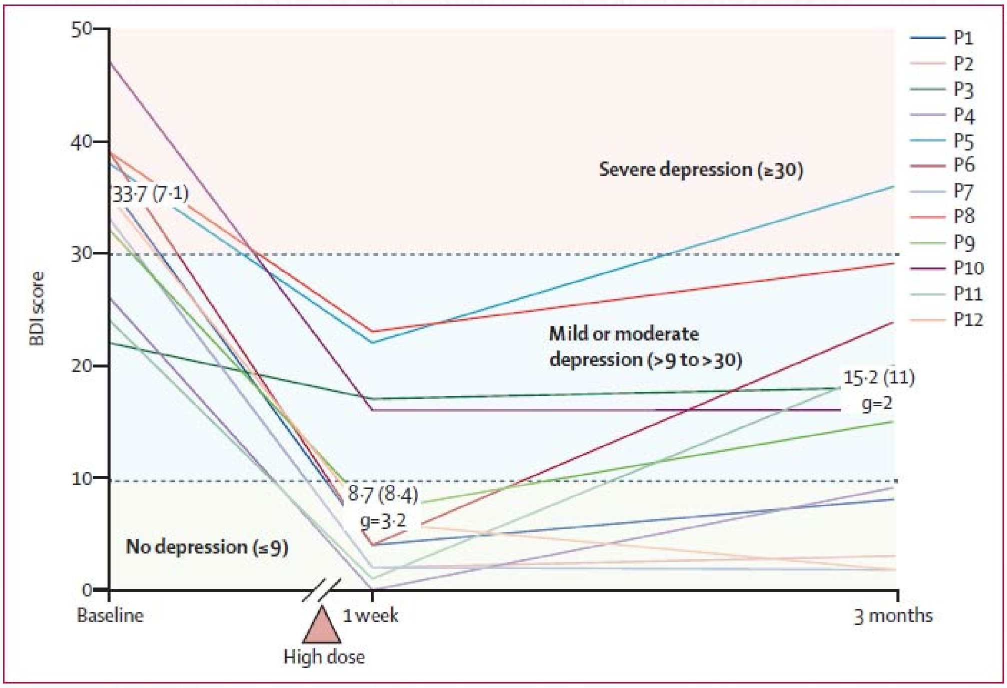


Figure 4 - Depression severity (BDI) over time, by patient.
Figure shows depression severity (BDI) over time plotted for each of the 12 patients. Mean values (SD) are shown as well as the relevant effect sizes (Hedges' g) versus baseline. BDI=Beck Depression Inventory.

Because this was a small-scale feasibility study with an open-label design, strong inferences cannot be made about the treatment's therapeutic efficacy. However, the data do suggest that further research is warranted. The response rate to psilocybin was 67% (n=8) at 1 week after treatment (HAM-D and BDI), and seven of these eight patients also met criteria for remission. Moreover, 58% (n=7) of the patients maintained their response for 3 months, and 42% (n=5) remained in remission. It is also worth noting that psilocybin has a favourable toxicity profile and is not associated with compulsive drug-seeking behaviours in animals or human beings. The side-effects that we noted were minor, and expected in light of previous studies of psilocybin.[27]

Spontaneous recovery in refractory depression is rare, and many of the patients in the present study reported having depression for much of their adult lives (mean estimated illness duration 17.8 years [SD 8]). Key questions for future research therefore should address why the therapeutic effect observed in the present study is so large, and if it can be replicated when tighter experimental controls are introduced. Because the treatment in our study consisted of not just two psilocybin administrations but also psychological support before, during, and after these sessions, as well as a positive therapeutic environment for the sessions, the relative effects of these factors need to be determined, which can only be done by conducting further trials with appropriate control conditions.

A logical next step would be to carry out a placebo-controlled randomised trial in which the level of therapist contact is consistent between conditions. This would enable any between-group differences in clinical outcomes to be attributed to psilocybin rather than the psychological support provided. However, a positive interaction between these variables seems likely, and inert placebo-based blinds are known to be ineffective in studies involving conspicuous experimental interventions, because patients can easily discern whether they are in the active condition or not. Use of an active placebo for the control condition might therefore be worth considering. Additionally, randomised comparative efficacy trials (eg., with an optional crossover component) incorporating another treatment for refractory depression (eg., ketamine infusion) could also be explored.

The magnitude and persistence of the antidepressant effects observed here are not incongruent with what has been observed previously with psilocybin in chronic psychiatric conditions. For example, 80% of long-term heavy tobacco smokers demonstrated abstinence from smoking 6 months after two treatment sessions with psilocybin.[18] Alcohol-dependent patients demonstrated significantly reduced drinking behaviours over 8 months after one or two psilocybin sessions.[19] Significantly decreased anxiety and depression scores were observed 3 and 6 months after a single dose of psilocybin in patients with anxiety related to end-stage cancer,[15] and improvements in well-being lasting for more than 1 year were observed in healthy individuals given a single dose of psilocybin.[8] Rapid and enduring decreases in depressive symptoms were also recently found in a small-scale feasibility trial involving the psychedelic brew, ayahuasca.[16]

It is important to consider the limitations of this pilot study; for example, although all patients showed some clinical improvements for at least 3 weeks after treatment, and no serious or unexpected adverse reactions were observed, enduring improvements beyond 3 weeks were not observed universally, and five of the 12 patients showed a degree of relapse at 3 months.

One should be cautious of the potential for inflated effect sizes in early trials, particularly when the sample size is small. That all patients showed some improvement in their depressive symptoms for up to 3 weeks after treatment could be suggestive of an expectancy bias. It may also be relevant that most patients in this trial were self-referring and, thus, actively sought this treatment. Psychedelics are known to promote suggestibility,[28] which might have further enhanced positive outcomes. Future double-blind randomised controlled trials could address the role of expectancy and suggestibility by measuring and controlling these variables. For example, patients could be asked about their pre-treatment expectations, suggestions could be controlled between conditions, and outcomes from self-referred patients could be compared with those from patients referred via clinicians. From a more pragmatic perspective, if expectancy or suggestibility are found to be influential in the context of psychedelic therapy, they could be treated as exploitable components of the treatment model rather than confounding variables.

Serotonergic antidepressants have been found to downregulate the primary receptor target of psilocybin (the 5-HT_{2A} receptor) and attenuated subjective responses to psychedelics have previously been reported in individuals chronically medicated with serotonergic antidepressants.[29] Thus, patients may be required to withdraw from concurrent antidepressant medication before receiving psilocybin and this should only ever be done with care. In conclusion, we sought to assess the safety and tolerability of psilocybin plus psychological support in patients with unipolar treatment-resistant depression. Our findings support the feasibility of this approach and the magnitude and duration of the post-treatment reductions in symptom severity motivate further controlled research. Psilocybin has a novel pharmacological action in comparison with currently available treatments for depression (ie., 5-HT_{2A} receptor agonism) and thus could constitute a useful addition to available therapies for the treatment of depression.

Contributors

RLC-H and DJN designed the study and RLC-H wrote the report. RLC-H coordinated the study, and collected and analysed the data. MBo was the lead psychiatrist on the trial. MBo, JR, CMJD, DE, and MBl provided psychological support for the patients. All authors critically revised the report or contributed important intellectual content.

Declaration of interests

DT has received research funding and lecture honoraria from Servier, and lecture honoraria from Lundbeck. The other authors declare no competing interests.

Acknowledgments

This study was funded by an MRC clinical development scheme grant (MR/J00460X/1). MK was supported by the Beckley Foundation and this work was carried out as part of the Beckley/Imperial Research Collaboration. The research was carried out at the NIHR/Wellcome Trust Imperial Clinical Research Facility. We would like to thank Robert Sullivan (Meridian West London, London, UK) for provision of high-quality audio equipment for the dosing sessions.

References

1. Hofmann A, Frey A, Ott H, Petr Zilka T, Troxler F. Elucidation of the structure and the synthesis of psilocybin. *Experientia* 1958; 14: 397-99.
2. Hofmann A, Heim R, Brack A, Kobel H. Psilocybin, a psychotropic substance from the Mexican mushroom *Psilicybe mexicana Heim*. *Experientia* 1958; **14:** 107-09.
3. Halberstadt AL, Geyer MA. Multiple receptors contribute to the behavioral effects of indoleamine hallucinogens.

Neuropharmacology 2011; **61:** 364-81.

4. Boulougouris V, Glennon JC, Robbins TW. Dissociable effects of selective 5-HT$_{2A}$ and 5-HT$_{2C}$ receptor antagonists on serial spatial reversal learning in rats. *Neuropsychopharmacology* 2008; **33:** 2007-19.
5. Harvey JA. Role of the serotonin 5-HT(2A) receptor in learning. *Learn Mem* 2003; **10:** 355-62.
6. Vaidya VA, Marek GJ, Aghajanian GK, Duman RS. 5-HT$_{2A}$ receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. *J Neurosci* 1997; **17** (8)**:** 2785-95.
7. Buchborn T, Schroder H, Hollt V, Grecksch G. Repeated lysergic acid diethylamide in an animal model of depression: normalisation of learning behaviour and hippocampal serotonin 5-HT$_2$ signalling. *J Psychopharmacol* 2014; **28:** 545-52.
8. Griffiths R, Richards W, Johnson M, McCann U, Jesse R. Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 2008; **22:** 621-32.
9. Carhart-Harris RL, Kaelen M, Bolstridge M, *et al*. The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol Med* 2016; **46:** 1379-90.
10. Carhart-Harris RL, Erritzoe D, Williams T, *et al*. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 2012; **109:** 2138-43.
11. Hendricks PS, Thorne CB, Clark CB, Coombs DW, Johnson MW. Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *J Psychopharmacol* 2015; **29:** 280-88.
12. Krebs TS, Johansen PO. Psychedelics and mental health: a population study. *PLoS One* 2013; **8:** e63972.
13. Bouso JC, Gonzalez D, Fondevila S, *et al*. Personality, psychopathology, life attitudes and neuropsychological performance among ritual users of Ayahuasca: a longitudinal study. *PLoS One* 2012; **7:** e42421.
14. Gasser P, Holstein D, Michel Y, *et al*. Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 2014; **202:** 513-20.
15. Grob CS, Danforth AL, Chopra GS, *et al*. Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 2011; **68:** 71-78.
16. Osorio Fde L, Sanches RF, Macedo LR, *et al*. Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. *Rev Bras Psiquiatr* 2015; **37:** 13-20.
17. Moreno FA, Wiegand CB, Taitano EK, Delgado PL. Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J Clin Psychiatry* 2006; **67:** 1735-40.
18. Johnson MW, Garcia-Romeu A, Cosimano MP, Griffiths RR. Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 2014; **28:** 983-92.
19. Bogenschutz MP, Forcehimes AA, Pommy JA, Wilcox CE, Barbosa P, Strassman RJ. Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *J Psychopharmacol* 2015; **29:** 289-99.
20. Johnson M, Richards W, Griffiths R. Human hallucinogen research: guidelines for safety. *J Psychopharmacol* 2008; **22:** 603-20.
21. Greenberg PE, Fournier AA, Sisitsky T, Pike CT, Kessler RC. The economic burden of adults with major depressive disorder in the United States (2005 and 2010). *J Clin Psychiatry* 2015; **76:** 155-62.
22. Gaynes BN. Identifying difficult-to-treat depression: differential diagnosis, subtypes, and comorbidities. *J Clin Psychiatry* 2009; **70** (suppl 6)**:** 10-15.
23. Sackeim HA. The definition and meaning of treatment-resistant depression. *J Clin Psychiatry* 2001; **62** (suppl 16): 10-17.
24. Studerus E, Gamma A, Vollenweider FX. Psychometric evaluation of the altered states of consciousness rating scale (OAV). *PLoS One* 2010; **5:** e12412.
25. Rush AJ, Trivedi MH, Ibrahim HM, *et al*. The 16-Item Quick Inventory of Depressive Symptomatology (QIDS), clinician rating (QIDS-C), and self-report (QIDS-SR): a psychometric evaluation in patients with chronic major depression. *Biol Psychiatry* 2003; **54:** 573-83.
26. Ibrahim L, DiazGranados N, Franco-Chaves J, *et al*. Course of improvement in depressive symptoms to a single intravenous infusion of ketamine *vs* add-on riluzole: results from a 4-week, double-blind, placebo-controlled study. *Neuropsychopharmacol* 2012; **37:** 1526-33.
27. Johnson MW, Sewell RA, Griffiths RR. Psilocybin dose-dependently causes delayed, transient headaches in healthy volunteers. *Drug Alcohol Depend* 2012; **123:** 132-40.
28. Carhart-Harris RL, Kaelen M, Whalley MG, Bolstridge M, Feilding A, Nutt DJ. LSD enhances suggestibility in healthy volunteers. *Psychopharmacology* 2015; **232:** 785-94.
29. Bonson KR, Buckholtz JW, Murphy DL. Chronic administration of serotonergic antidepressants attenuates the subjective effects of LSD in humans. *Neuropsychopharmacology* 1996; **14:** 425-36.

Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplementary information

T-values for main tests
QIDS
Baseline vs 1-week post-treatment: t =8.9
Baseline vs 2-weeks post-treatment: t =11.3
Baseline vs 3-weeks post-treatment: t =8.9
Baseline vs 5-weeks post-treatment: t =6.7
Baselines vs 3-months post-treatment: t =5.1

BDI
Baseline vs 1-week post-treatment: t =9.9
Baseline vs 3-months post-treatment: t =5.4

STAI
Baseline vs 1-week post-treatment: t =7.8
Baseline vs 3-months post-treatment: t =4.0

SHAPS
Baseline vs 1-week post-treatment: t =7.3
Baseline vs 3-months post-treatment: t =6.4

HAM-D
Baseline vs 1-week post-treatment: t =6.2

MADRS
Baseline vs 1-week post-treatment: t =7.5

GAF
Baseline vs 1-week post-treatment: t =5.7

HAM-D data for weeks following each dose
Baseline = 21.4 ± 4.5
One week post low dose = 10.7 ± 7.8
One week post high dose = 7.4 ± 6.9

Acute subjective and physiological effects of psilocybin

	Dose 1 (10 mg)			Dose 2 (25 mg)		
Time since dose (hrs)	BPM	BP	Intensity (0-4)	BPM	BP	Intensity (0-4)
Baseline	80.1 (11.9)	126.6 (11.7)	0 (0)	78.4 (8.3)	128.8 (13)	0 (0)
0.5	82.6 (13.8)	130.2 (12.8)	0.5 (0.5)	81.3 (13.1)	135.1 (17.1)	0.8 (0.7)
1	78.8 (13.6)	131.2 (18.5)	0.8 (0.7)	80.1 (14.4)	138.6 (14.6)	1.6 (1)
2	77.3 (15.8)	134.4 (16.4)	1.5 (1)	81.8 (12.6)	135.9 (23.2)	2.8 (0.8)**
3	75,6 (9.3)	131.7 (15.9)	1.5 (0.8)	81.2 (11.5)	130.2 (17)	2.8 (0.9)**
4	74.9 (5.8)	128 (20.2)	1.3 (0.9)	77.1 (11.1)	124.4 (20.2)	2.1 (1)
5	76.6 (8.4)	128.8 (14.9)	0.5 (0.5)	75.5 (8.4)	119.3 (30.9)	1.2 (0.8)
ASC dimension	Dose 1 (10 mg)			Dose 2 (25 mg)		
Experience of unity	0.35 (0.36)			0.39 (0.27)		
Spiritual experience	0.31 (0.30)			0.32 (0.34)		
Blissful state	0.34 (0.34)			0.49 (0.35)		
Insightfulness	0.36 (0.31)			0.49 (0.35)		
Disembodiment	0.4 (0.35)			0.46 (0.31)		
Impaired cognition	0.22 (0.22)			0.55 (0.27)**		
Anxiety	0.25 (0.28)			0.42 (0.26)**		
Complex imagery	0.42 (0.31)			0.36 (0.3)		
Elementary hallucinations	0.47 (0.46)			0.38 (0.27)		
Audio/visual synaesthesia	0.32 (0.28)			0.47 (0.33)		
Special meaning	0.32 (0.33)			0.45 (0.32)		
Global score	0.34 (0.28)			0.43 (0.25)*		

Table S1. Acute measures: Mean values (SD). For upper section of table, ** = $p < 0.01$ high-dose value vs low-dose value, Bonferonni corrected by a factor of 2. Responses for the 11 dimension altered states of consciousness questionnaire (11D-ASC) are presented in the lower section of the table. The range of possible scores = 0-1, with 0 = "not at all" and 1 = "much more than usually". ** = $p < 0.01$ high-dose vs low-dose value, Bonferonni corrected by a factor of 11, * = $p < 0.05$, no correction required.

Patient #	**QIDS** BL, 1wk, 2wks, 3wks, 5wks, 3m	**BDI** BL, 1wk, 3m	**STAI T** BL, 1wk, 3m	**SHAPS** BL, 1wk, 3m	**HAM-D** BL, 1wk	**MADRS** BL, 1wk	**GAF** BL, 1wk
1	19, 2, 3, 4, 4, 8	36, 4, 8	72, 29, 42	8, 0, 5	19, 3	35, 4	52, 82
2	20, 4, 5, 4, 9, 4	33, 2, 3	76, 31, 35	3, 0, 0	28, 8	34, 6	38, 75
3	22, 17, 14, 13, 15, 15	22, 17, 18	63, 33, 58	11, 5, 10	18, 15	27, 20	59, 62
4	14, 7, 2, 4, 11, 7	26, 0, 9	67, 26, 50	1, 0, 0	18, 0	26, 0	58, 95
5	19, 12, 13, 15, 19, 22	38, 22, 36	71, 66, 73	14, 4, 8	25, 16	34, 13	43, 65
6	19, 6, 7, 7, 8, 15	29, 4, 24	78, 58, 65	9, 0, 1	23, 16	31, 17	53, 67
7	18, 1, 1, 0, 2, 1	33, 2, 2	57, 28, 29	8, 0, 0	22, 0	32, 1	38, 95
8	19, 14, 11, 14, 11, 14	39, 23, 29	71, 64, 67	11, 8, 7	17, 18	24, 23	57, 56
9	20, 7, 8, 8, 8, 12	32, 7, 15	71, 41, 66	8, 0, 3	26, 5	32, 4	38, 82
10	21, 9, 7, 5, 8, 5	47, 16, 16	75, 39, 56	7, 0, 0	28, 5	42, 27	46, 78
11	18, 3, 1, 1, 1, 12	24, 1, 20	72, 32, 71	3, 0, 0	17, 2	28, 1	58, 82
12	21, 7, 3, 2, 2, 4	35, 6, 2	68, 40, 46	7, 0, 0	17, 1	27, 0	63, 92
Means (SD): BL, 1wk (2-5wks, QIDS only), 3m	19.2 (2), 7.4 (4.9), 6.3 (4.6), 6.4 (5.1), 8.2 (5.4), 10 (6)	33. 7 (7.1), 8.7 (8.4), 15.2 (11)	70.1 (5.8), 40.6 (14.2), 54.8 (14.5)	7.5 (3.7), 1.4 (2.7), 2.8 (3.7)	21.4 (4.5), 7.4 (6.9)	31 (5), 9.7 (9.8)	50.3 (9.2), 77.7 (13)
Hedges' g*: 1wk (2-5wks, QIDS only), 3m	3.1*, 3.2*, 3.2*, 2.7*, 2*	3.2*, 2*	2.7*, 1.4*	1.9*, 1.3*	2.4*	2.7*	2.4*

Table S2. Individual patient clinical ratings: Displayed are various rating scale values at various different time points. The clinician administered ratings were only completed at baseline and 1 week post-dosing. BL = baseline. * = $p < 0.01$.

1.1. Aim of study

Our long term objective is to test the efficacy of psilocybin as an intervention for treatment-resistant major depressive disorder[31] but the primary objective of this pilot study is to optimise the protocol for the administration of oral psilocybin in this patient group. The knowledge and experience gained from this pilot study will be used to inform a subsequent randomised control trial (RCT) that will evaluate the anti-depressant properties of psilocybin. A secondary aim of the pilot is to use functional magnetic resonance imaging (fMRI) to try and identify how psilocybin affects brain activity before and after the psilocybin intervention.

1.2 Background of the study

This MRC-funded study is designed to optimise the procedures for a subsequent RCT of psilocybin as an intervention for treatment-resistant depression. The burden of depression is severe and increasing. Preventing relapse is a major challenge in depression; first line medications can decrease symptom severity but large numbers of patients fail to respond. Psilocybin is a naturally occurring compound that is structurally similar to the endogenous neurotransmitter serotonin. It had a brief history of use in psychotherapy in the 1960s but this was cut short for political reasons before its efficacy could be properly assessed. In recent years, a growing number of studies, including our own, have shown that psilocybin can be safely administered to human subjects[7] and there are now consistent reports of persistent improvements in well-being after just single exposures to psilocybin[12 10, 14].

2. Project outline

2.1 Main study design

This pilot study will involve 20 patients meeting DSM-IV criteria for major depression of a moderate to severe degree (17+ on the 21-item Hamilton Depression Rating Scale, HAM-D) that have failed to clinically respond to at least two different classes of antidepressant drug treatment (adequate dose, compliance and minimal duration of 6 weeks[31]) within the current episode. The main objective of the pilot study will be to establish feasibility and optimise procedures for a subsequent randomised clinical trial. The primary outcome of this pilot study will be the intensity of the subjective effects of orally administered psilocybin in this patient group. All 20 patients will receive the active drug psilocybin in two oral doses: a low (tester) dose and the other a high (active) dose 7 days apart. The doses that will be used in this study have been chosen based on previous research on the subjective effects of orally administered psilocybin[10-12, 14, 19, 35] and through discussions with leaders in the field that are currently working with oral psilocybin in clinical trials, including those involving patients with symptoms of depression.

Optimum doses for this study will be those that produce subjective effects of an appropriate intensity. To determine this, we will use a standard rating method; namely, patients provide a verbal rating of the intensity of subjective effects on a rating scale from 0 to 10, with 0 equalling 'no effects' and 10 equalling 'extremely intense effects'. Based on the previous literature and discussions with relevant experts, we have determined that 10mg (low dose) and 25mg (high dose) will provide effects of an appropriate intensity for this study. More specifically, it can be predicted that 10mg will produce effects rated 4-6/10 for intensity and 25mg will produce effects rated 7-9/10 and the pilot study will test this. Doses of 30mg psilocybin have been administered to healthy volunteers and patients suffering from anxiety and depression in previous trials (mostly individuals with no previous experience with psychedelic drugs) without major complications. Therefore, the proposed maximum dose (25mg) falls within this safe range. Please see the dosing algorithm below for how the low and high dose may be changed depending on the responses of the first 6 patients. The intention of the low/high dosing protocol is to give patients an initial low dose to enable them to have an impression of the drug effects at an attenuated intensity. We believe this to be a cautious and sensible approach. Thus, on the second dosing day patients will have an improved understanding of the procedure, some idea of the drug's effects and will be habituated to their surroundings and research team, all of which will augur well for receiving a higher active dose of the drug.

There will be around 11 days from screening to the first dosing session to allow the analysis of screening data (e.g. blood tests) to determine eligibility and enable contact to be made with their GP and/or mental health practitioners. Eligibility will be ascertained by the study psychiatrist who will thoroughly screen all patients to identify and confirm the presence of treatment-resistant major depression. Supporting information from relevant mental health professionals and general practitioners will be obtained prior to entry into the trial to confirm diagnosis and ensure that all patients meet the inclusion criteria.

The procedure for recruitment will be as follows: the patient's immediate care team will be made aware of the study (see below are the improved access to psychotherapy, IAPT, scheme) and will identify a patient and ask them if they are willing to be contacted by us. The primary caregiver will then inform us of their patient's interest and will provide a contact telephone number and/or email. The patient will be issued with an A4 summary sheet containing a brief summary of the study and our contact details. After the patient has initiated contact with us, we will inform them about the nature of the study and organise an appropriate time for an initial telephone screen. We will ask the patient if we can contact their GP/psychiatrist (this will be done via an email using a standard letter) and we will ask the patient to provide us with a letter of consent for us to do this. If the patient appears to be eligible (post-telephone screen and post-contact with their GP/psychiatrist), a date for the first screening visit will be arranged.

Typically, a patient would be screened on a Monday, scanned on a Friday and dosed the following Thursday. There will be 1 week from the final dosing session to the final formal follow-up assessment. Patients will be in the study for 26 days in total, see section 8, study time line, after which they will be allowed treatment as usual.

All patients will be contacted at regular intervals in the period following dosing to prompt them to complete the rating scale Quick Inventory of Depressive Symptoms. This will provide an indication of whether their depression has responded to psilocybin. The criteria for determining response will be a reduction of 25% in the (QIDS)[30] scores from baseline (screening), and remission will be scores of ≤5 on the QIDS[29]. Patients will be assessed remotely (i.e. electronically completed QIDS) for six months at which point the study will end.

In total, patients will be required to make at least 6 visits:

Visit 1/day 1: Screening and initial meet with the research team that will supervise the dosing
Visit 2/day 5: Scan 1 in IMANOVA followed by preparation/practice session with therapy team in CRF
Visit 3/day 11: Dosing session 1: low-dose psilocybin (10mg or 15mg) + post-session debrief
Day 12: Telephone follow-up
Days 12-17: remote QIDS
Visit 4/day 18: Dosing session 2: high-dose psilocybin (25mg ±5mg) + post-session debrief
Visit 5/day 19: Follow-up 2 and scan 2 in IMANOVA
Days 20-25: remote QIDS
Visit 6/day 26: Follow-up 3 (primary end point)
Day 32/week 5 (2 weeks post-dose): remote QIDS
Day 39/week 6 (3 weeks post-dose): remote QIDS
Day 53/~ month 2 (5 weeks post-dose): remote QIDS
Day 81/~month 3 (9 weeks post-dose): remote QIDS
Day 165/~month 6 (21 weeks post-dose): remote QIDS

Post-day 26, when we contact patients to request the completion of the QIDS, we will also ask them the open-ended question of whether they have anything to report in terms of persistent effects, whether positive or negative.

We will contact patients daily via telephone, email or text from day 12 to day 26 and thereafter on week 5, 6 and 8, and months 2, 3 and 6, to prompt the electronic completion of the QIDS[30]. Each patient will be issued with a study diary at screening and this will include all the important dates when they are expected to visit the study centre and to complete QIDS.

We may ask to see a patient before the follow-up visit on day 26, or after completion of the study, if adverse events are reported. On dosing days, we will also insist that patients be accompanied home by a friend or family member who can supervise and ensure that they are safe when returning home. We will ask for this person's contact details so that we can contact them if we have any difficulties contacting the patient him or herself. Both the patient and their 'chaperone' will be encouraged to contact us should any problems arise, particularly those that are felt to be attributed to the study intervention. In this way, any concerns in the immediate period or thereafter can be easily brought to our attention. We will be monitoring the patient's response in the ensuing weeks remotely via the QIDS. However, if we have any concerns about their mental state, we will liaise with their GP and/or mental health practitioners who may implement appropriate interventions if they deem fit. If the patient cannot nominate a significant other to accompany them home safely after a dosing session, a member of our study team will do this.

It will **not** be necessary for patients to withdraw from their antidepressant medication or psychological therapy when entering the study, since withdrawal may exacerbate depressive symptoms, and it will be informative to know whether psilocybin can be effective as an add-on to primary interventions. If a patient does decide he/she would like to withdraw from their medication, it will be necessary for them to be medication-free for at least 4 weeks prior to receiving their first dose of psilocybin. There will be 26 days from entry into trial (screening, **visit 1**) to the final follow-up visit (**visit 6**), after which patients may return to their normal treatments if they so wish.

The 4 week washout period should prevent any sudden exacerbation of symptoms during the study itself. However, if after withdrawal, symptoms show a marked increase at any point, we will discuss with the patient and their GP or consultant whether the patient should withdraw from the trial so that previous medications can be resumed or new ones given.

Secondary outcome measures in this study will be the mean change in QIDS scores from pre-dosing baseline at day 1 (**visit 1**) to follow-up at day 26 (**visit 6**, 1 week after the final dosing session). The QIDS is preferable to observer-rated scales such as the HAM-D because it measures internal states, is more sensitive to treatment effects, and covers more of the diagnostic criteria for depression[30]. The Montgomery and Asberg Depression Rating Scale (MADRS[18]) and HAM-D[32] will also be carried out at screening (**visit 1**, day 1), follow-up 2 (**visit 5**, day 19) and follow-up 3 (**visit 6**, day 26).

The HAM-D and MADRS ratings will be performed by clinicians with experience in its use. Assessors will not be directly involved in the dosing sessions. We have identified 1 primary assessor plus a substitute. A single patient will have the same assessor throughout the trial.

Additional outcome measures completed will include the MADRS, HAM-D, Beck depression inventory (BDI), global assessment of functioning (GAF[33]), Beck Anxiety Inventory (BAI[34]), Dysfunctional Attitudes Rating Scale (DARS[2]), the NEO personality inventory (NEO-PI[17]), Peters 21-item delusional inventory (PDI[25]), the Ruminative Responses Scale (RRS[28]), the dynamic emotional expression recognition task (DEER-T)[26], cued autobiographical memory task (AM-T)[37], Spielberger's Trait Anxiety Inventory (STAI), the Positive and Negative Symptoms Scale (PANSS), Snaith Hamilton Anhedonia Pleasure Scale (SHAPS), the Life Orientation Task (LOT-R), the Tellegen Absorption Questionnaire (Tellegen), the 5-Dimension Altered States of Conscious Scale (5D-ASC), the Psychotic Symptoms Inventory (PSI) and the Strunk Prediction of Future Life Events (POFLE) and Prediction of Personality Characteristics (PC) task. With the exception of the 5D-ASC, these assessments will all be carried out at screening and during the final follow-up visit on day 26. The SHAPS, LOT-R will be carried out at screening and repeated on day 19 and 26. Visual Analogue Scales (VAS) and the 5D-ASC will be used to measure subjective states during the dosing sessions and electronic versions of the QIDS will be completed daily in the 2 weeks following the first dosing session, plus also at week 5, 6, 8 and month 3 and 6. With prior consent, we will also send a patient's significant other a small number of self-constructed questions at day 26 (or 8 days after the second dosing session) to enquire whether they have noticed any changes in the patient's behaviour since the intervention. The significant other will also complete a brief questionnaire on the patient prior the first dosing session.

3. Basic safety and scientific background

The LD50 of psilocybin in rats is 280mg/kg[24]; thus, in terms of toxicity, its margin of safety is very large. We intend to give no more than 25mg. Psilocybin has been given to several hundred patients and volunteers in modern studies. In a thorough review of dosing sessions in 110 healthy subjects, dysphoric experiences/bad trips were rare and dose-dependent and there was no evidence of subsequent drug abuse, flashback phenomena or prolonged psychoses[27, 35]. Consistent with magic mushrooms user reports, the majority of subjects described their experiences as enriching, insightful and beneficial - but not something they would regularly repeat. Psilocybin is not habit forming in animals[27] or humans. We recently asked a large sample of experienced drug users to rank the relative harms and benefits of 11 of the most widely used recreational drugs in the UK[4]; users ranked magic mushrooms as the least harmful and one of the most beneficial drugs. The most commonly cited benefits were facilitated psychological insight and improved well-being. In a separate survey, without being explicitly cued, 5% of 503 magic mushroom users reported that magic mushrooms had alleviated their depressive symptoms, and 3.6% of 247 ketamine users reported this for ketamine[6]. Ketamine is currently being trialled for treatment resistant depression, with evidence of an impressive short-term efficacy ([39, 1]) but our survey results imply that psilocybin is safer than ketamine - and at least as effective.

Reports from the 1960s on the use of psilocybin in psychotherapy indicate clear benefits over harms[13]; however, these studies suffer from a lack of experimental control and standardised assessments. More recently, pilot studies have tested the efficacy of psilocybin in OCD[19] and anxiety related to terminal cancer[14]: In the former study, short-term reductions in compulsive symptoms were reported by all of the patients. In the latter study, trait anxiety was significantly decreased 1 and 3 months post session and depression scores were significantly decreased at 6 months. No clinically significant adverse events were observed in either study. In a large sample of healthy volunteers, orally administered high dose psilocybin induced mystical or spiritual-type experiences in over 60% of subjects[11]. Sixty seven percent rated their experience as either the single most meaningful experience of their lives - or among the top five. In a follow-up after 14 months, 64% of the sample maintained that the acute experience had led to a significant improvement in their sense of well-being or life satisfaction[12].

In the last two years, we have completed one pilot study[7], two fMRI studies[3] and one MEG study involving psilocybin infusion. We have carried out 54 dosing sessions in total and have seen no adverse events. Infused during scanning so to capture the transition from normal waking consciousness to the drug state, we found significant decreases in CBF and brain activity after psilocybin infusion and no increases in any region. It is important that the most consistent regional deactivation after psilocybin was in the medial prefrontal cortex (mPFC), a region that is consistently hyperactive in depression[8]. Medial prefrontal activity correlates with rumination[9] and symptom severity in depression[38], and is highly predictive of relapse[9]. Successful treatment with a variety of interventions, including ECT, SSRIs, cognitive behavioural therapy, sleep-deprivation, mindfulness meditation, and placebo, all normalise mPFC activity[8].

4. Study design

4.1. Primary outcome measure

Patient's ratings of the subjective intensity of psilocybin's effects, rated on a 0-10 scale, with 0 equally 'no effects' and 10 'extremely intense effects'.

4.2. Volunteers

Sample size: 20 patients
Males & females
18+ years old.

We will aim to recruit a similar number of male and female patients. Patients will be at least 18 years of age with must have an acceptable level of physical health as determined by a medical screening that will include: routine blood tests, ECG, blood pressure and heart rate, neurological exam and psychiatric assessment (MINI). We will take and store a blood plasma sample at screening for genotyping and baseline Brain Derived Neurotropic Factor (BDNF) levels, a marker of neurogenesis. Patients with cardiovascular abnormalities, epilepsy, personal or family histories of psychosis or psychotic symptoms (including mania), or histories of suicide attempts, will not be allowed to participate. As in previous trials, we will include patients who have previous experience with psychedelic drugs, although it is anticipated that most will be 'psychedelic-naïve'. All patients will have a good command of the English language. Patients will have HAM-D scores of at least 17, and will have failed at least two classes of antidepressant in the current episode. Women must not be pregnant or breast-feeding and appropriate use of contraception is mandatory.

4.2.1. Screening procedure

1. Informed consent
2. Full history-taking and physical examination
3. Psychiatric assessment (MINI)
4. Routine Blood Screen and sample
5. ECG
6. Urine drug screen
7. Height & weight measurements
8. Breathalyser
9. Completion of Clinician administered rating scales (HAM-D & MADRS)
10. Completion of secondary outcome measures as detailed in 2.1

4.2.2. Inclusion criteria

1. Major depression of a moderate to severe degree (17+ on the 21-item HAM-D).
2. No improvement despite two courses of antidepressant treatment for adequate duration (6 weeks minimum) within current episode[31].
3. No MR contraindications.

4.2.3. Exclusion criteria

1. Current or previously diagnosed psychotic disorder.
2. Immediate family member with a diagnosed psychotic disorder.
3. Medically significant condition rendering unsuitability for the study (e.g., diabetes, epilepsy, severe cardiovascular disease, hepatic or renal failure etc).
4. History of suicide attempts.
5. History of mania.
6. Blood or needle phobia.
7. Positive pregnancy test at screening or during the study.
8. Current drug or alcohol dependence.
9. Allergy to gelatine or lactose.
10. Lack of appropriate use of contraception.
11. Breast-feeding.

4.2.4. Withdrawal Criteria

1. Withdrawal of Consent.
2. Development of concurrent physical illness that necessitates their removal from the trial.
3. Deterioration of mental health warranting additional interventions and support.
4. Dependent or problematic alcohol and illicit substance use.

GPs and all pertinent health professionals will be informed of their patient's involvement in the study and will be encouraged to voice any misgivings or reservations they have about their patient entering the study or continuing with it once it has begun. On entering the study, should there be any deterioration in the patient's physical or mental health that may compromise their ability to continue in the trial, then we will reach an informed decision, once we have contacted the relevant health professionals, about whether the patient should continue in the study. This will all be done in discussion with the patient and the extended research team. Since we will be following the patient's progress in the period after dosing, we will be in a position to determine whether any added support or treatment is required should the patient's mental health deteriorate. Any information that comes to light during the study will be communicated to their main health professional in the community who will be in the best position to provide treatment if they consider it necessary.

5. Regulatory Issues and informed consent

5.1 Ethics Approval

The study will be conducted according to the revised declaration of Helsinki (2000), the International Committee on Harmonisation Good Clinical Practice guidelines and NHS Research Governance Framework. Ethics and R&D approval will be obtained.

5.2 Consent

Consent to enter the study will be sought from each participant only after a full explanation has been given, information sheet given and time allowed for consideration. Signed participant consent will be obtained for each patient. It is the right of the patient to refuse to participate without giving reasons and this will be respected. All patients are free to withdraw at any time from the protocol interventions without giving reasons and without prejudicing their further treatment.

5.3 Confidentiality

Patient's identification data will be required for the registration process. The research team will preserve the confidentiality of patients taking part in the study.

5.4 Audits and Inspections

The study may be subject to inspection and audit by Imperial College London and/or Imperial College Healthcare NHS Trust under their remit as sponsor and other regulatory bodies to ensure adherence to GCP. Prof Alan Young of Imperial College will Head a data monitoring committee for this study which will utilise the Inform System of Imperial College.

5.5. Monitoring

Any trial-related monitoring including audits and regulatory inspections will be permitted and direct access to source data and documents will be provided.

6. Patient recruitment strategy

Primary recruitment will be via referrals from mental health practitioners working in the field who have knowledge of the trial and feel that their patients fulfill the inclusion criteria (see below re the IAPT scheme, which will serve as our primary source of recruitment). This study will be adopted by the Mental Health Research Network (MHRN). Professor David Nutt sees patients through the Central & North West London Trust and Prof Steve Pilling via the Camden and Islington Trust (http://www.candi.nhs.uk/): both will act to encourage referrals to the study and the latter will be our primary source of referrals. We have strong links (through Steve Pilling) with the Improvement of Access to Psychotherapy Treatments (IAPT) scheme which runs out of the Camden and Islington Trust and who see many treatment-resistant depressed patients fitting this study's entry criteria. This will be our primary source of recruitment.

We will also liaise with fellow mental health practitioners working in other London Mental Health Trusts and mental health practitioners working in Oxford (Oxford Health Foundation NHS Trust) and Bristol mental health Trusts (Avon & Wiltshire Mental Health Partnership) to assist recruitment if necessary. We may also recruit via word of mouth should any patients want to participate having heard or read about the trial in the media or otherwise. In each case patients will be thoroughly screened by the study psychiatrist to ensure that they comply with our inclusion criteria before entry into the trial. General practitioners will be contacted in every case to inform them of the details of the trial and to enquire whether they have any concerns about their patient entering the trial. Until we have confirmed the patient's background medical and psychiatric history, patients will not be allowed to enter the trial.

7. Drug specific ethical and safety considerations

Recent independent assessments of the harms of popular drugs of abuse, conducted by international experts[22, 23, 36] and experienced drug users[4, 20] have consistently rated magic mushroom as one of the least harmful recreational drugs. Commonly cited risks include: prolonged psychotic reactions, flashback phenomena/hallucinogen persisting perceptual disorder (HPPD), and bad trips. Prolonged psychotic responses are extremely rare in clinical studies with psilocybin (<1%[35]), even with very high doses[11], and none have been reported in modern studies or studies with patients[14, 19]. The risk of flashback phenomena is also minimal. Typically, flashbacks or HPPD refers to drug-like visual perceptual effects (e.g. 'trails' or geometric patterns) occurring when no drug has been taken. The two largest surveys on this phenomenon found that very few psychedelic drug users (3-4%) report perceptual changes that are distressing to them[6]. There have been no cases of flashback-like symptoms occurring in modern clinical studies with psilocybin[35] - even with very high doses[11].

Negative acute psychological experiences or 'bad trips' do occur more frequently however, but they are strongly dose-dependent[10, 35]. In a sample of 36 healthy subjects given a high oral dose of psilocybin (30mg), 11 subjects reported strong anxiety at some point during their session[11]. However, the anxiety was short-lived in every case and no persistent negative mood effects were reported. Most of the subjects reported that their experience had been insightful and beneficial and this positive appraisal of their experience was sustained[12]. This is consistent with the claim that psychologically 'challenging' psychedelic drug experiences can be especially beneficial - if properly mediated. In our own work, dosing 40+ subjects with 2mg psilocybin IV, 30 of which took place in a spatially restrictive and noisy MRI scanner, anxiety scores were not significantly higher after psilocybin than placebo. No subjects showed panic or asked for their scans to be aborted. Patients with psychiatric vulnerabilities are thought to be more likely to experience bad trips, but we will strive to minimize this risk thorough psychological preparation, good patient-staff rapport and a positive environment. Bad trips are best managed psychologically[12 15] and administration of a benzodiazepine would only be used in cases of severe panic. Detailed protocols are available on the safe management of clinical research with psychedelics[15].

Note also that by administering a low dose of psilocybin in the first dosing session (10mg as the default low dose) we will be able assess tolerability prior to the administration of the higher dose (25mg). If a patient has a negative response to the 10mg dose, then he/she will be withdrawn from the trial. Moreover, the initial low dose may be useful therapeutically, allowing patients to accommodate to the effects of psilocybin prior to administration of a higher dose.

The summary of side effects associated with oral psilocybin on page 24 of the investigator's brochure will serve as the reference safety information for this trial.

7.1. Suicide and persistent adverse events

There have been no cases of increased suicidality in modern trails with psilocybin. The risk of suicide with placebo treatment is low (0.4% suicides and 2.7% attempts) and no higher than that with active treatments (0.7% and 3.4%[16]). The risk of suicide will be further minimized by excluding patients with histories of suicide attempts or planning. We will also give patients a study psychiatrist's and psychotherapist's contact number in cases of emergency. We have written a standard operating procedure for dealing with any adverse events and this is detailed below in section 14.

7.2 Definitions and reporting of Adverse Events & Reactions

1. **Adverse Event (AE)**: Any untoward medical occurrence in a patient or clinical trial subject administered a medicinal product and which does not necessarily have a causal relationship with this treatment.
2. **Adverse Reaction (AR)**: All untoward and unintended responses to a medicinal product related to any dose administered.
3. **Unexpected Adverse Reaction (UAR)**: An AR, the nature or severity of which is not consistent with the applicable product information.
4. **Serious Adverse Event (SAE) or Serious Adverse Reaction**: Any untoward medical occurrence or effect that at any dose i) results in death ii) is life-threatening iii) requires hospitalization iv) results in persistent or significant disability or incapacity.
5. **Suspected Unexpected Serious Adverse Reactions (SUSAR)**: any suspected adverse reaction related to a medicinal product that is both unexpected and serious.

Most AEs and ARs that occur in this study, whether they are serious or not, will be expected treatment-related toxicities due to the drugs in this study. The assignment of the causality will be made by the team including the principle investigator responsible for the care of the participant using the following definitions:

1. Unrelated: There is no evidence of any causal relationship.
2. Unlikely: There is little evidence to suggest there is a causal relationship and there is another reasonable explanation for the event.

3. Possible: There is some evidence to suggest a causal relationship however the influence of other factors may have contributed to the event.
4. Probable: There is evidence to suggest a causal relationship and the influence of other factors is unlikely.
5. Definitely: There is clear evidence to suggest a causal relationship and other possible contributing factors can be ruled out.
6. Not Assessable: There is insufficient or incomplete evidence to make a clinical judgment of the causal relationship.

Should any uncertainty exist regarding causality we will discuss within the team and farther afield with local clinicians and representatives. In the event that no agreement is made the MHRA will be informed of both points of view.

7.2.1 Reporting Procedures

All adverse events will be reported and depending on the nature of the event, the following reporting procedures will be followed:

1. Non serious AR/AEs: all such toxicities, whether expected or not, should be recorded as part of a case report and sent to the research team within one month.
2. Serious AR/AEs: Fatal or life threatening SAEs and SUSARs should be reported on the day that the research team is aware of the event. The SAE form requires nature of event, onset, severity, corrective treatment given, outcome and causality. Additional information will be sent within 5 days if the reaction has not resolved at the time of reporting. An SAE form will be completed within 24 hours.
3. SUSARs: a SAE report form will be completed by the staff at the site of where the adverse reaction occurred and sent immediately signed and dated to the research team with relevant treatment forms and anonymised copies of all relevant investigations. We will ensure that the MHRA, REC and the Sponsor are notified of all SUSARs occurring during the study according to the following timeline: fatal and life threatening within 7 days of notification and non-life threatening within 15 days. All investigators will be informed of all SUSARs occurring throughout the study. Any serious adverse events or reactions that are expected or otherwise will be reported to the sponsor immediately.

8. Study time line

Date	Event	Primary assessments	Duration
	Recruitment	QIDS (via web/email or telephone)	25 minutes
Visit 1 Day 1	**Screening at CRF**	BDI, BAI, QIDS, MADRS + HAM-D	4 ¼ hours
Visit 2 Day 5	Scan 1 at IMANOVA plus session with therapist	Brain function	5 hours
Visit 3 Day 11	**Dosing session 1 at CRF**	BDI, BAI + QIDS	8 hours
Days 12-17	Follow-up 1 & remote monitoring	QIDS (via email or telephone)	5 mins each day
Visit 4 Day 18	**Dosing session 2 at CRF**	BDI, BAI + QIDS	8 hours
Visit 5 Day 19	**Follow-up 2 at CRF +** scan 2 at IMANOVA	BDI, BAI, QIDS, MADRS + HAM-D	2 hours + 2 hours for scan
Days 20-25	Remote monitoring	QIDS (via email or telephone)	5 mins each day
Visit 6 Day 26	**Follow-up 3 at CRF**	BDI, BAI, QIDS, MADRS + HAM-D	2 ½ hours

9. Day 1, screening time line

Time	Event	Setting
9am	Subject arrives	CRF
9-9:30am	Informed consent	CRF
9:30-10:15am	Health assessment (inc. blood sample, ECG, blood pressure)	CRF
10:15-11:30am	MADRS, HAM-D and questionnaires	CRF
11:30am-1pm	MINI, open discussion and preparation for drug session	CRF
1:00pm	Patient returns home	CRF

10. Functional MRI

Patients will undergo 2 fMRI scans as part of this study, on the day after screening (day 5) and one on the day after the second dosing session (day 19). Patients will also be allowed an "acclimatisation" scan of ~ 5 minutes. This is an initial exposure to the MRI scan, to assess whether they can tolerate the scanning environment. The acclimatisation session will take place as part of the screening visit.

After entering the scanner, all volunteers will undergo a preliminary structural scan. They will be asked to relax. They may also be asked to carry out some simple psychological tasks (e.g. see[5]). Subjective ratings will be given. Pulse and blood oxygen levels will be measured throughout. Functional scanning will last approximately 50 minutes.

Set-up & structural scan	Functional scanning
~10 mins	~50 mins

Figure 1. Basic scanning protocol.

11. Day 5, Functional MRI and prep session with therapist

Time	Event	Setting
9:00am	Subject arrives	IMANOVA
9:00-9:30am	MR screen	IMANOVA
9:30am-10:30am	Scan	IMANOVA
10:30-11:30am	Questionnaires	IMANOVA
11:30am	Patient returns to CRF	CRF
12:00-3:00pm	Prep session with therapist Lunch break at 1pm	CRF

12. Follow-up

Time	Event	Setting
9am	Subject arrives	CRF
9-9:45am	Blood sample + behavioural tests	CRF
9:45-10:05am	HAM-D and MADRS	CRF
10:05-11:30am	Questionnaires	CRF

Follow-up visits will involve assessment via the HAM-D and MADRS and the completion of some questionnaires. The DEER-T and the AM-T will also be completed. A blood sample will be taken on follow-up 2.

13. Dosing and patient management

13.1. Dosing procedure

It is strongly advised that psychedelic drugs only be taken in a positive environment where the patient feels comfortable and relaxed and is supported by a psychotherapist or psychiatrist[15]. Efforts will be made to arrange the intervention room to promote relaxation without compromising medical safety. Mobile phones will be switched off during every session and efforts will be made to minimize unexpected interruptions.

Following patients' arrival, the study psychiatrist will determine whether the patient is in a medically fit state to proceed with dosing later and will carry out any physical examinations if this is indicated. This will be supplemented by measuring of vital signs and urine drug screen/breathalyser. Patients will have been strongly advised to refrain from alcohol approximately 24 hours prior to their arrival as alcohol may compound the effects of the drug and potentially interfere with its effects. Patients will be psychologically prepared for the experience at screening and we will simulate a dosing session in a pre-dosing preparatory session on the morning of each dosing day. We will advise the patient to surrender to the experience and relaxing music will be used to facilitate calm and a relaxed, accepting mind-set. We will caution patients to expect some anxiety, and they will be encouraged to let us know if they feel this. Consistent with published guidelines on managing psychedelic-drug sessions, patients will be advised to accept feelings of anxiety and to allow the experience to unfold naturally, without psychological resistance[15].

For each session, patients will sit in a reclined position with their head supported. They will be advised to close their eyes and relax.

13.2 Dosing parameters and algorithm

The patient will be provided with psilocybin capsules (x times 5mg capsules) which they will be requested to take with a glass of water to ensure the capsule is swallowed completely. The low dose will be 10mg or 15mg and this will always be administered in the first dosing session. The high dose will be 25mg (±5mg) and this will be given in the second session. This approach is motivated by safety and therapeutic considerations.

The desired effect for the initial low dose is mild/moderate subjective effects rated at 4-6/10 for intensity (0-10 scale with 0 equalling no effects and 10 extremely intense effects). Thus, although there is prior data to support the assumption that 10mg psilocybin will achieve this effect, if, after the first 6 patients have been dosed, it does not, then we will increase it to 15mg.

The desired effect for the 'high' dose is one that produces moderate-strong subjective effects rated 7-9/10 for intensity. Given the extensive literature on the effects of 25mg and higher doses of oral psilocybin, we do not anticipate it will need to be increased or decreased. However, if the desired intensity (rating of 7-9/10) is not observed in the first 6 patients, we will consider increasing it to 30mg or decreasing it to 20mg

for the subsequent 6 patients.
It is important to be clear that a decision to increase or decrease doses will be discussed by the study psychiatrist and the principal investigator (PI), with the PI making the final decision.

13.3 Patient management

The research team of Professor Roland Griffiths at John Hopkins University is experienced in supervising psilocybin sessions in healthy and patient populations. On their advice, we will 'check-in' with the patients at regular intervals (e.g. every 15-30 minutes). Otherwise, we will respond to the patient if they initiate contact with us. It is advised that active-intervention is kept to a minimum during the acute experience. The patient is encouraged to explore their own mental space. Simple guided imagery may be used to assist relaxation. The following is an example of a guided imagery script: "Imagine it is a beautiful sunny day ... you are walking on a beach ... the sky is blue ... the water is crystal clear ... you hear the sound of gentle waves lapping, as the light breeze caresses your skin ... the white sand feels warm on your bare feet and between your toes ... you are wearing flowing light clothes and breathing deeply, inhaling the smell of fresh ocean air ... a sense of freedom washes over your body ... you lie down and let your body sink into the warm soft sand ... you're completely relaxed ... you sink deeper and deeper into relaxation."

All sessions will be supervised by at least 2 individuals who will be introduced to the patient at screening. A medical doctor and study psychiatrist will be present at every dosing session and he/she will administer the drug or placebo. Typically, there will be an experienced psychotherapist and psychiatrist present at each session. Sessions will take place in a purpose built clinical research facility with extensive nursing and emergency support (the NIHR/Wellcome Trust Imperial Clinical Research Facility, **CRF**).

The effects of orally administered psilocybin last for approximately 5-6 hours peaking at 2-3 hours postadministration[10]. With the patient's prior consent, dosing sessions will be video and/or audio recorded and we may also video and/or audio record post-session interviews during follow-up visits. Patients will remain under supervision for at least 7 hours post-administration of psilocybin or until the effects have sufficiently subsided (as determined by the study psychiatrist). Taxis can be ordered to take patients home but they must be accompanied either by a member of the study team or by a significant other. Patients will be asked to text or call us when they return home. Twenty-four hour emergency contact numbers will be provided. Overnight care facilities are available in the clinical research unit in case of unexpected adverse events that require an overnight stay.

14. Standard Operating Procedure for managing adverse events

- Prior to administration of the drug we aim to fully prepare each participant to ensure that they are aware of what to expect. We will also ensure that they are met by all members of the research team and have the opportunity to visit the room in which the drug will be administered. Professor Griffith's team have used this approach and believe it to significantly reduce the possibility of any psychological adverse events following administration and serve to put patients at ease in the process. If patients know what to expect beforehand and are comfortable within their surroundings prior to receiving the drug, then this will reduce the risk of any untoward events.
- Patients will be escorted and chaperoned by a member of the research team at all times throughout their participation in the study and for the 3 to 4 hours during which they will be under the acute effects of psilocybin they will always be supported by a team member.
- The acute effects of the drug should be over within six hours following administration; however we will carefully monitor the patient for the duration of their stay at the study centre.
- Staff will be vigilant of any overly unusual behaviour, anxiety and paranoia. This will be brought to the attention of the research team in a discreet manner so as to not exacerbate the situation.
- Interpersonal exchanges that would be readily overlooked in a normal state of awareness may assume extreme and confusing meaning for persons under the influence of a psychedelic substance. Staff will be aware of this and adopt an open and non-judgemental manner, allowing the patient to speak freely without challenge.

- On occasion nursing staff may be called upon to monitor a patient but this will be rare as there will normally be sufficient personnel from the research team to perform this function.
- We do not envisage any serious side-effects from administration of the drug; however, patients may experience anxiety reactions or paranoid thoughts. These are likely to be short-lived and will be managed by psychological approaches such as reassurance and adopting a calm and supportive demeanour and by using behavioural techniques such as guided imagery.
- If the situation was to deteriorate even further, the research team may have to be more proactive in their attempts to reduce distress and this may require an assertive tone of voice and/or the laying of hands on the individual if their behaviour becomes erratic for example. This would only be done in an attempt to alleviate the patient's distress and maintain their and the research team's safety.
- In the unlikely event that a patient becomes behaviourally disturbed, medical personnel will be on hand to administer tranquillisation if necessary.
- Typical doses administered would be PO 5 - 10mg diazepam initially then titrated to effect.
- If such an adverse event was to occur, the study psychiatrist will closely monitor the patient at all times and in no circumstances will they be permitted to leave the unit until the psychiatrist is satisfied that they are in a fit state to do so.
- On discharge from the unit the patient will be reviewed which will encompass an assessment of their current level of risk and whether they have returned to their normal level of functioning. Once this is performed the psychiatrist in collaboration with the rest of the team will decide whether it is indeed safe for them to leave the unit and return home.
- Ideally, patients will be met by a family member or friend (the responsible other) after completing a dosing day so that this individual can accompany the patient home, supervise them and ensure their safety. If not possible a member of the research team will accompany them home to ensure their safe arrival.
- Overnight care facilities at the clinical research facility are available should these be required, especially if the drug effects have not completely abated and the patient needs ongoing supervision and/or monitoring.
- On discharge phone numbers for each member of the research team will be provided to the patient and their responsible other to ensure immediate contact if required. We will also have contact details for the patient and the responsible other so that we may contact them later that evening to check whether there are any issues that may have arisen.
- Appropriate follow-ups after dosing days are in place for monitoring the patient's status and mental health condition throughout the study and afterwards. We will therefore be able to detect and assess any delayed or persisting adverse events.
- Patients and family members will be encouraged to contact us should their mental or physical health deteriorate. Although our options of managing their current difficulties will be limited after the study is complete, we will be able to offer referral to the relevant services. If indicated, we will offer a further follow-up at the clinical research facility so that we can review the patient in person.

Should we have any concerns about the patient's mental health and safety during the study or follow-up and consider that a community intervention is necessary, we will contact the patient's primary caregiver i.e. their GP or primary mental health practitioner, to discuss to potentially implement this. It may well be that the study psychiatrist is required to make an urgent referral to the local crisis/home intervention service who may be called upon to assess the patient in the community to determine subsequent management. In an emergency situation, where the patient needs to have their mental health assessed and managed immediately, the local emergency duty team can be contacted requesting that an urgent mental health act assessment be convened to decide whether involuntary hospital admission is required.

15. Time commitments

Screening will take ~4 hours for consent, health and psychiatric assessment.
Scanning will take ~2 hours, including ~1hr minutes in the scanner. This is followed by the prep session with therapist on which will take 2 hours. Thus, visit 2 will take ~4 hours.
Each dosing day will take ~8 hours.
Follow-up visit 2 will take ~2 hours with the addition of 2 hours for scanning and follow-up visit 3 will take 2 ½ hours.

16. Purchasing and storing drug

Psilocybin free-base will be purchased and made to Good Manufacturing Practice standards in accordance with Medicines and Healthcare Products Regulatory Agency (MHRA) regulations. The drug will be stored in a secure laboratory in a locked fridge. Home Office permission for possession and storage will be obtained.

17. Analysis

The primary outcome for the pilot study is the intensity ratings given during dosing and since there is no control condition, data can be analysed as we progress. T-tests will be run to compare the intensity of the low and high doses. Functional MRI analyses will include: resting state functional connectivity, changes in CBF from baseline and activation to a simple psychological task. We expect that approximately two-thirds of the patients will agree to fMRI scans. With a sample of approximately 8 we may only be able to present preliminary findings at this point but of course, the fMRI scanned sample will increase with the occurrence of the RCT.

18. Dosing day timeline

Time	Event	Setting
9:00am	Subject arrives	CRF
9:00-9:30am	Brief assessment including vital signs/UDS/alcohol test	CRF
9:30-10:30am	Patient prepared and relaxed (music)	CRF
10:30am	Administration of drug	CRF
10:30am-4:30pm	Acute drug experience	CRF
4:30-5:30pm	Thorough debriefing + questionnaires	CRF
5:30pm+	Patients assessed for suitability to return home	CRF

The dosing day timeline will be subject to adaptation as we proceed but we will not keep patients at the study centre for longer than is necessary to carry out procedures although on occasion we may be obliged to request them to stay longer or overnight to ensure their safety.

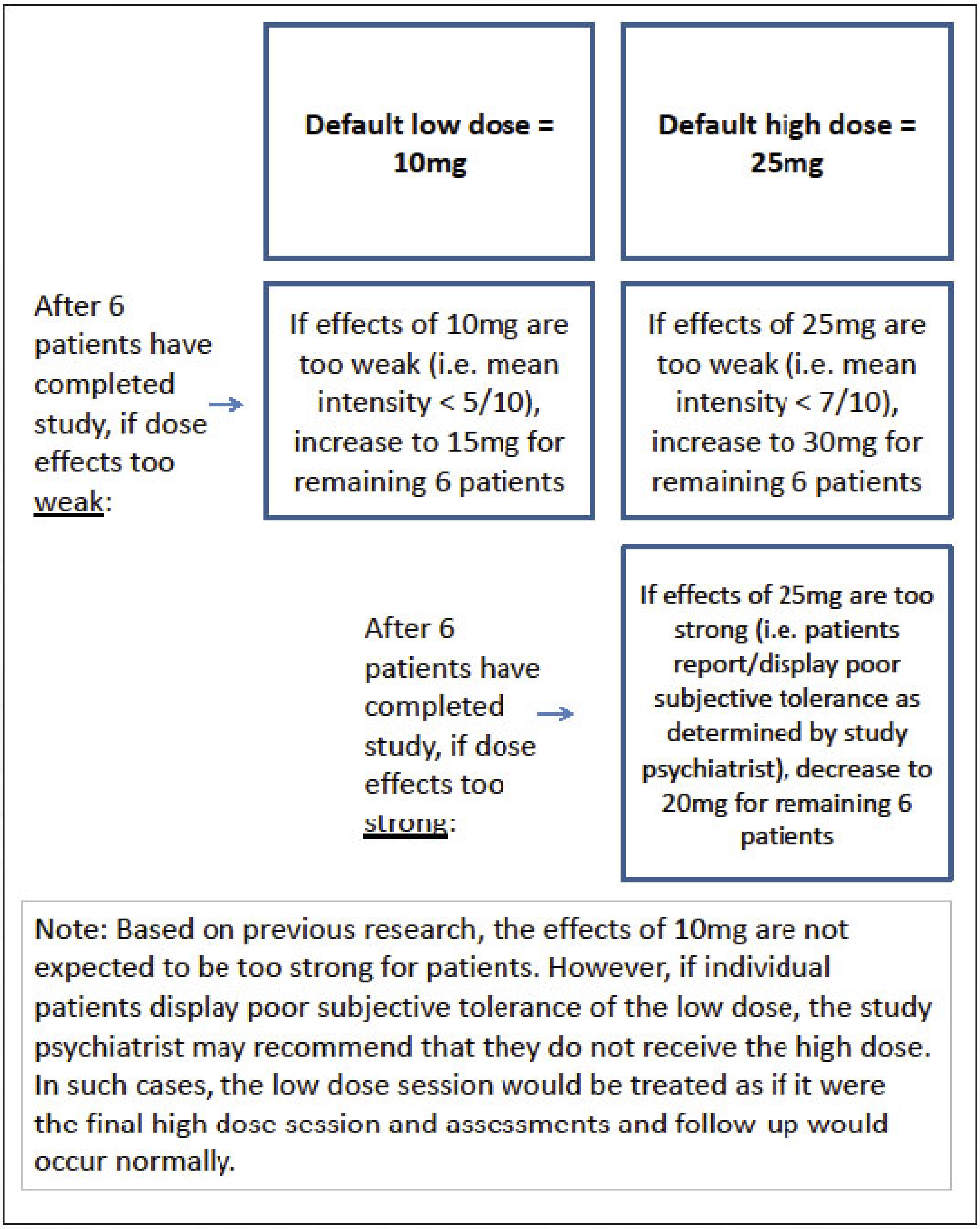
19. Monitoring

The study will be monitored internally by the Centre for Neuropsychopharmacology, through the Trust via InForm and it may also be audited by the MHRA and imperial JRCO.

20. IMP details

Psilocybin freebase (GMP) will be supplied by THC-pharm© (Frankfurt, Germany) with a certificate of analysis detailing purity and GMP quality. The psilocybin will be exported to Prof Val Curran of UCL who holds the necessary Home Office (HO) License for Schedule 1 drugs. Following HO guidelines, Prof Curran will transport the psilocybin to the Guy's and St Thomas' (GSTT) manufacturing pharmacy who also hold a HO License for Schedule 1 drugs. GSTT will weigh and encapsulate the product in accordance with GMP guidelines. Following HO guidelines for transport of Scheduled drugs, the psilocybin will then be transported to Prof Ilan Rabiner of Imanova, who also holds the required HO license. When a patient is to be dosed with psilocybin, Imanova will dispense the IMP to the study psychiatrist. The IMP will be given a shelf-life of 12 months. Storage conditions are light-protected and room temperature. Previous data has shown that psilocybin is stable for at least 6 years when stored under these conditions[21].

21. Dosing algorithm



Default low dose = 10mg

Default high dose = 25mg

After 6 patients have completed study, if dose effects too weak: →

If effects of 10mg are too weak (i.e. mean intensity < 5/10), increase to 15mg for remaining 6 patients

If effects of 25mg are too weak (i.e. mean intensity < 7/10), increase to 30mg for remaining 6 patients

After 6 patients have completed study, if dose effects too strong: →

If effects of 25mg are too strong (i.e. patients report/display poor subjective tolerance as determined by study psychiatrist), decrease to 20mg for remaining 6 patients

Note: Based on previous research, the effects of 10mg are not expected to be too strong for patients. However, if individual patients display poor subjective tolerance of the low dose, the study psychiatrist may recommend that they do not receive the high dose. In such cases, the low dose session would be treated as if it were the final high dose session and assessments and follow up would occur normally.

22. References

1. M. Aan Het Rot, C. A. Zarate, Jr., D. S. Charney, and S. J. Mathew, 'Ketamine for Depression: Where Do We Go from Here?', *Biol Psychiatry,* 72 (2012), 537- 47.
2. I. M. Blackburn, S. Jones, and R. J. Lewin, 'Cognitive Style in Depression', *Br J Clin Psychol,* 25 (Pt 4) (1986), 241-51.
3. R. L. Carhart-Harris, D. Erritzoe, T. Williams, J. M. Stone, L. J. Reed, A. Colasanti, R. J. Tyacke, R. Leech, A. L. Malizia, K. Murphy, P. Hobden, J. Evans, A. Feilding, R. G. Wise, and D. J. Nutt, 'Neural Correlates of the Psychedelic State as Determined by Fmri Studies with Psilocybin', *Proc Natl Acad Sci U S A,* 109 (2012), 2138-43.
4. R. L. Carhart-Harris, L. A. King, and D. J. Nutt, 'A Web-Based Survey on Mephedrone', *Drug Alcohol Depend,* 118 (2011), 19-22.
5. R. L. Carhart-Harris, R. Leech, T. M. Williams, D. Erritzoe, N. Abbasi, T. Bargiotas, P. Hobden, D. J. Sharp, J. Evans, A. Feilding, R. G. Wise, and D. J. Nutt, 'Implications for Psychedelic-Assisted Psychotherapy: Functional Magnetic Resonance Imaging Study with Psilocybin', *Br J Psychiatry,* 200 (2012), 238-44.
6. R. L. Carhart-Harris, and D. J. Nutt, 'User Perceptions of the Benefits and Harms of Hallucinogenic Drug Use: A Web-Based Questionnaire Study', *Journal of Substance Use,* 15 (2010), 283-300.
7. R. L. Carhart-Harris, T. M. Williams, B. Sessa, R. J. Tyacke, A. S. Rich, A. Feilding, and D. J. Nutt, 'The Administration of Psilocybin to Healthy, Hallucinogen-Experienced Volunteers in a Mock-Functional Magnetic Resonance Imaging Environment: A Preliminary Investigation of Tolerability', *J Psychopharmacol,* 25 (2011), 1562-7.
8. W. C. Drevets, J. L. Price, and M. L. Furey, 'Brain Structural and Functional Abnormalities in Mood Disorders: Implications for Neurocircuitry Models of Depression', *Brain Struct Funct,* 213 (2008), 93-118.
9. N. A. Farb, A. K. Anderson, R. T. Bloch, and Z. V. Segal, 'Mood-Linked Responses in Medial Prefrontal Cortex Predict Relapse in Patients with Recurrent Unipolar Depression', *Biol Psychiatry,* 70 (2011), 366-72.
10. R. R. Griffiths, M. W. Johnson, W. A. Richards, B. D. Richards, U. McCann, and R. Jesse, 'Psilocybin Occasioned Mystical-Type Experiences: Immediate and Persisting Dose-Related Effects', *Psychopharmacology (Berl),* 218 (2011), 649-65.
11. R. R. Griffiths, W. A. Richards, U. McCann, and R. Jesse, 'Psilocybin Can Occasion Mystical-Type Experiences Having Substantial and Sustained Personal Meaning and Spiritual Significance', *Psychopharmacology (Berl),* 187 (2006), 268-83; discussion 84-92.
12. R. Griffiths, W. Richards, M. Johnson, U. McCann, and R. Jesse, 'Mystical- Type Experiences Occasioned by Psilocybin Mediate the Attribution of Personal Meaning and Spiritual Significance 14 Months Later', *J Psychopharmacol,* 22 (2008), 621-32.
13. Lester Grinspoon, and James B. Bakalar, *Psychedelic Drugs Reconsidered* (New York: Basic Books, 1979), pp. xiv, 343 p.
14. C. S. Grob, A. L. Danforth, G. S. Chopra, M. Hagerty, C. R. McKay, A. L. Halberstadt, and G. R. Greer, 'Pilot Study of Psilocybin Treatment for Anxiety in Patients with Advanced-Stage Cancer', *Arch Gen Psychiatry,* 68 (2011), 71-8.
15. M. Johnson, W. Richards, and R. Griffiths, 'Human Hallucinogen Research: Guidelines for Safety', *J Psychopharmacol,* 22 (2008), 603-20.
16. A. Khan, R. L. Kolts, A. E. Brodhead, K. R. Krishnan, and W. A. Brown, 'Suicide Risk Analysis among Patients Assigned to Psychotropics and Placebo', *Psychopharmacol Bull,* 39 (2006), 6-14.
17. R. R. McCrae, and P. T. Costa, Jr., 'Reinterpreting the Myers-Briggs Type Indicator from the Perspective of the Five-Factor Model of Personality', *J Pers,* 57 (1989), 17-40.
18. S. A. Montgomery, N. Smeyatsky, M. de Ruiter, and D. B. Montgomery, 'Profiles of Antidepressant Activity with the Montgomery-Asberg Depression Rating Scale', *Acta Psychiatr Scand Suppl,* 320 (1985), 38-42.
19. F. A. Moreno, C. B. Wiegand, E. K. Taitano, and P. L. Delgado, 'Safety, Tolerability, and Efficacy of Psilocybin in 9 Patients with Obsessive-Compulsive Disorder', *J Clin Psychiatry,* 67 (2006), 1735-40.
20. C. J. Morgan, L. Muetzelfeldt, M. Muetzelfeldt, D. J. Nutt, and H. V. Curran, 'Harms Associated with Psychoactive Substances: Findings of the Uk National Drug Survey', *J Psychopharmacol,* 24 (2010), 147-53.
21. D. Nichols, 'Personal Communication', (2014).
22. D. J. Nutt, L. A. King, L. D. Phillips, and Drugs Independent Scientific Committee on, 'Drug Harms in the Uk: A Multicriteria Decision Analysis', *Lancet,* 376 (2010), 1558-65.
23. D. Nutt, L. A. King, W. Saulsbury, and C. Blakemore, 'Development of a Rational Scale to Assess the Harm of Drugs of Potential Misuse', *Lancet,* 369 (2007), 1047-53.
24. T. Passie, J. Seifert, U. Schneider, and H. M. Emrich, 'The Pharmacology of Psilocybin', *Addict Biol,* 7 (2002), 357-64.
25. E. R. Peters, S. A. Joseph, and P. A. Garety, 'Measurement of Delusional Ideation in the Normal Population: Introducing the Pdi (Peters Et Al. Delusions Inventory)', *Schizophr Bull,* 25 (1999), 553-76.
26. B. Platt, S. Kamboj, C. J. Morgan, and H. V. Curran, 'Processing Dynamic Facial Affect in Frequent Cannabis-Users: Evidence of Deficits in the Speed of Identifying Emotional Expressions', *Drug Alcohol Depend,* 112 (2010), 27-32.
27. A. Poling, and J. Bryceland, 'Voluntary Drug Self-Administration by Nonhumans: A Review', *J Psychedelic Drugs,* 11 (1979), 185-90.
28. J. Roelofs, P. Muris, M. Huibers, F. Peeters, and A. Arntz, 'On the Measurement of Rumination: A Psychometric Evaluation of the Ruminative Response Scale and the Rumination on Sadness Scale in Undergraduates', *J Behav Ther Exp Psychiatry,* 37 (2006), 299-313.
29. A. J. Rush, H. C. Kraemer, H. A. Sackeim, M. Fava, M. H. Trivedi, E. Frank, P. T. Ninan, M. E. Thase, A. J. Gelenberg, D. J. Kupfer, D. A. Regier, J. F. Rosenbaum, O. Ray, A. F. Schatzberg, and Acnp Task Force, 'Report by the Acnp Task Force on Response and Remission in Major Depressive Disorder', *Neuropsychopharmacology,* 31 (2006), 1841-53.
30. A. J. Rush, M. H. Trivedi, H. M. Ibrahim, T. J. Carmody, B. Arnow, D. N. Klein, J. C. Markowitz, P. T. Ninan, S. Kornstein, R. Manber, M. E. Thase, J. H. Kocsis, and M. B. Keller, 'The 16-Item Quick Inventory of Depressive Symptomatology (Qids), Clinician Rating (Qids-C), and Self-Report (Qids-Sr): A Psychometric Evaluation in Patients with Chronic Major Depression', *Biol Psychiatry,* 54 (2003), 573-83.
31. H. A. Sackeim, 'The Definition and Meaning of Treatment-Resistant Depression', *J Clin Psychiatry,* 62 Suppl 16 (2001), 10-7.

32. J. J. Schwab, M. R. Bialow, R. S. Clemmons, and C. E. Holzer, 'Hamilton Rating Scale for Depression with Medical in-Patients', *Br J Psychiatry,* 113 (1967), 83-8.
33. J. L. Sorensen, W. A. Hargreaves, and S. Friedlander, 'Choosing a Global Assessment Scale to Describe the Functioning of Children', *Arch Gen Psychiatry,* 41 (1984), 1186.
34. R. A. Steer, D. J. Rissmiller, W. F. Ranieri, and A. T. Beck, 'Structure of the Computer-Assisted Beck Anxiety Inventory with Psychiatric Inpatients', *J Pers Assess,* 60 (1993), 532-42.
35. E. Studerus, M. Kometer, F. Hasler, and F. X. Vollenweider, 'Acute, Subacute and Long-Term Subjective Effects of Psilocybin in Healthy Humans: A Pooled Analysis of Experimental Studies', *J Psychopharmacol,* 25 (2011), 1434-52.
36. J. van Amsterdam, and W. van den Brink, 'Ranking of Drugs: A More Balanced Risk-Assessment', *Lancet,* 376 (2010), 1524-5.
37. J. M. Williams, and K. Broadbent, 'Autobiographical Memory in Suicide Attempters', *J Abnorm Psychol,* 95 (1986), 144-9.
38. S. Yoshimura, Y. Okamoto, K. Onoda, M. Matsunaga, K. Ueda, S. Suzuki, and Shigetoyamawaki, 'Rostral Anterior Cingulate Cortex Activity Mediates the Relationship between the Depressive Symptoms and the Medial Prefrontal Cortex Activity', *J Affect Disord,* 122 (2010), 76-85.
39. C. A. Zarate, N. E. Brutsche, L. Ibrahim, J. Franco-Chaves, N. Diazgranados, A. Cravchik, J. Selter, C. A. Marquardt, V. Liberty, and D. A. Luckenbaugh, 'Replication of Ketamine's Antidepressant Efficacy in Bipolar Depression: A Randomized Controlled Add-on Trial', *Biol Psychiatry,* 71 (2012), 939-46.

The link between use of psychedelic drugs and mental health problems

by

Ragnar Nesvåg[1], Jørgen G Bramness[2] and Eivind Ystrom[1,3]

Journal of Psychopharmacology 2015, Vol. 29(9) 1035-1040

© The Author(s) 2015

original report: http://www.ouramazingworld.org/uploads/4/3/8/6/43860587/j_psychopharmacol-2015-nesva%CC%8Ag-1035-40.pdf
backup source: http://www.psilosophy.info/resources/j_psychopharmacol-2015-nesva%CC%8Ag-1035-40.pdf

[1]Department of Genetics, Environment and Mental Health, Norwegian Institute of Public Health, Oslo, Norway
[2]Norwegian Center for Addiction Research, University of Oslo, Oslo, Norway
[3]Department of Psychology, University of Oslo, Oslo, Norway

Corresponding author:
Ragnar Nesvåg, Department of Genetics, Environment and Mental
Health, Norwegian Institute of Public Health, P.O. Box 4404, Nydalen,
Oslo, N-0403, Norway.
Email: ragnar.nesvag@fhi.no

Table of Contents:

The link between use of psychedelic drugs and mental health problems
References
Reply letter: Mental health of people who have used classical psychedelics and no other illicit drugs
Survey years 2001-2004
Survey years 2008-2011
Age onset of major depressive episode
Limitations
Comments
Acknowledgements
Declaration of Conflicting Interests
Funding
References

The link between use of psychedelic drugs and mental health problems

The March issue of *Journal of Psychopharmacology* included a study of the relationship between use of psychedelics (defined as lysergic acid diethylamide (LSD), psilocybin, and mescaline) and mental health problems (Johansen and Krebs, 2015). The data on 135,095 adult US citizens participating in the National Survey on Drug Use and Health (NSDUH) between 2008 and 2011 were obtained from a freely available database (http://oas.samhsa.gov/nsduh.htm, accessed 8 April 2015). The paper is a follow-up of a similar paper by the same authors on NSDUH data between 2001 and 2004 (Krebs and Johansen, 2013). For their analyses in the most recent paper, the authors distinguished between 19,299 individuals (13.4% of the study population) who reported lifetime use of psychedelic drugs, and the remaining group of individuals who did not report use of psychedelic drugs. Individuals were also asked about a range of mental health problems, and if they had been in contact with mental health service during the previous year.

The authors ran a series of logistic regression models to estimate the risk of having each of the mental health outcomes given lifetime use of psychedelic drugs. From these analyses, the authors concluded that use of psychedelics was not linked to mental health problems or suicidal behavior. In a recent issue of *Nature News*, the results from the Johansen and Krebs (2015) study were presented under the heading "No link between psychedelics and psychosis" (Cormier, 2015). In the following we will argue that the authors' conclusions in their latest paper are not substantiated by their results and will propose supplemental analyses to validate or potentially revise their conclusions.

According to Table 2 in the paper, 97.8% of the individuals reporting use of psychedelic drugs did also report lifetime use of cannabis, 71.3% reported use of cocaine, and 49.7% reported use of opiates. In the comparison group of individuals who did not report lifetime use of psychedelic drugs, the lifetime prevalence of use of other drugs was 36.0% for cannabis, 7.5% for cocaine, and 9.5% for opiates. From these figures, it is clear that the vast majority of users of psychedelic drugs have also used one or more substances other than psychedelic drugs. According to Table 2 in the paper, only 400 of the users of psychedelic drugs had never used cannabis, but a number of these had presumably used other drugs than cannabis. Notwithstanding this high degree of concomitant use of different types of drugs, the authors chose to include lifetime use of all other drugs than LSD, psilocybin, and mescaline as covariates in the logistic regression models of the relationship between psychedelic drugs and mental health outcomes.

From the numbers in Table 3 in the paper it is clear that the group of individuals who reported lifetime use of psychedelic drugs had two to three times higher prevalence of all mental health outcomes when not adjusting for lifetime use of other drugs. However, in the logistic regression analyses, correcting for all other types of drugs, the risk for having a mental health problem was not higher among psychedelic drugs users and the rest of the study population. In our view this is a typical example of over adjustment, a common, but relatively basic fallacy in epidemiological research (Rothman and Greenland, 1998). Since the authors did not report unadjusted risk estimates in their results section, not even as supplemental material, we have calculated odds ratios based on the prevalence figures presented in the paper. As shown in our new Table 1, use of psychedelic drugs was indeed associated with increased risk of mental health problems, e.g. a three times higher odds of being admitted to mental health hospital the previous year.

Given the high prevalence of concomitant drug use among the users of psychedelic drugs, it is difficult to use the NSDUH data to estimate the specific risk of psychedelic drugs for mental health problems in general. This argument is not related to the variance inflation factors, as mentioned by the authors in the statistical methods section of their paper, but to the effect sizes of their estimates. The results of the Johansen and Krebs (2015) paper cannot be generalized to the entire group of psychedelic drug users, and one might question the public health relevance of their findings. This comes in addition to other problematic factors in the paper, like selection bias. To validate their conclusion, we encourage the authors to report the exact number of individuals who had only used psychedelic drugs, and to present results of logistic regression models without adjustment or with different models for adjustment for lifetime use of other drugs.

Table 1. Association of psychedelic use with mental health.

	Ever used psychedelics	Never used psychedelics	OR (95% CI)	*p*
	N = 19,299	N = 115,796		
Serious psychological distress in worst month of past year				
K6 scale	4165	15,525	1.8 (1.7-1.8)	<0.001
Mental health treatment in past year				
Inpatient	694	1349	3.2 (2.9-3.5)	<0.001
Outpatient	3108	8343	2.5 (2.4-2.6)	<0.001
Medication	3472	11,282	2.0 (1.9-2.1)	<0.001
Needed but did not receive	2534	6990	2.4 (2.2-2.5)	<0.001
Suicidal thought and behavior in past year				
Thought about killing self	1748	5533	2.0 (1.9-2.1)	<0.001
Planned to kill self	527	1654	1.9 (1.8-2.1)	<0.001
Attempted to kill self	266	904	1.8 (1.5-2.0)	<0.001
Depression and anxiety in past year				
Symptoms of major depressive episode	2446	8178	1.9 (1.8-2.0)	<0.001
Diagnosis of depression	2,352	7,648	2.0 (1.9-2.1)	<0.001
Diagnosis of an anxiety disorder	2,095	5,747	2.3 (2.2-2.5)	<0.001
Note. OR: unadjusted odds ratio; CI: confidence interval.				

References

1. Cormier Z (2015) No link found between psychedelics and psychosis. *Nat News*. Epub ahead of print 4 March 2015. DOI: 10.1038/ nature.2015.16968.
2. Johansen P-Ø and Krebs TS (2015) Psychedelics not linked to mental health problems or suicidal behavior: a population study. *J Psychopharmacol* 29: 270-279
3. Krebs TS and Johansen P-Ø (2013) Psychedelics and mental health: a population study. *PLoS One* 8: e63972.
4. Rothman K and Greenland S (1998) *Modern Epidemiology*. 2nd ed. Philadelphia, PA: Lippincott-Raven.

Reply letter: Mental health of people who have used classical psychedelics and no other illicit drugs

by

Teri Suzanne Krebs and Pål-Ørjan Johansen
(*EmmaSofia, Oslo, Norway*)

Corresponding author:
Teri Suzanne Krebs, EmmaSofia, Kongsberggata 14, N-0468 Oslo,
Norway.
Email: krebs@emmasofia.org

We have reported that in two large population surveys of randomly selected US adults psychedelic use was not associated increased risk of range of past year mental health outcomes, after adjusting for sociodemographic, psychological, and illicit drug use confounders (Johansen and Krebs, 2015; Krebs and Johansen, 2013). Nesvåg *et al*. (2015) present a table with crude odds ratios unadjusted for any confounders. These crude odds ratios do not take into account that people who have used psychedelics also have higher than typical rates of childhood depression, extremely traumatic experiences, illicit drug use, and other predictors for mental health problems (Johansen and Krebs, 2015; Krebs and Johansen, 2013). There are shared factors that predispose people to both illicit drug use and to mental health problems (e.g. Proal *et al.*, 2014). By considering use of other illicit drugs we are able, to some extent, to adjust for these other factors. In our original analyses, we also examined a stratified sub-sample of people without any past-year illicit drug use, to exclude mental health problems caused by direct drug effects (Johansen and Krebs, 2015; Krebs and Johansen, 2013).

Nesvåg *et al.* (2015) suggest that we look at mental health of people who had used psychedelics but no other illicit drugs. People who have used psychedelics and no other illicit drugs are not representative of the total population of people who have used psychedelics.

However, we have now repeated our analyses in both the 2008-2011 sample and the earlier 2001-2004 sample, excluding people who had ever used other illicit drugs, following the methods described previously (Johansen and Krebs, 2015; Krebs and Johansen, 2013). Results are shown in Table 2.

Table 2. Association between psychedelic (LSD, psilocybin, mescaline, peyote) use and mental health, excluding people with use of other illicit substances.

	Survey years 2001-2004	*p*	Survey years 2008-2011	*p*
	aOR^a (95% CI)		aOR$_b$ (95% CI)	
Serious psychological distress in worst month of past year				
K-6 scale	1.4 (0.8 - 2.5)	0.25	1.6 (0.7 - 3.5)	
Mental health treatment in past year				
Inpatient	0.4 (0.1 - 1.8)	0.23	4.1 (0.9 - 18.7)	0.07
Outpatient	1.5 (0.7 - 3.2)	0.29	3.2 (1.2 - 6.7)	0.02
Medication	1.3 (0.6 - 2.7)	0.44	2.8 (1.3 - 6.2)	0.01
Needed but did not receive	1.9 (1.1 - 3.2)	0.29	0.4 (0.1 - 1.9)	0.25
Suicidal thought and behavior in past year				
Thought about killing self	Not available		2.8 (0.8 - 9.8)	0.10
Planned to kill self	Not available		3.0 (0.4 - 22.9)	0.29
Attempted to kill self	Not available		0.8 (0.1 - 6.1)	0.80
Diagnosis by a physician in the past year				
Diagnosis of depression	Not available		3.4 (1.3 - 8.8)	0.01
Diagnosis of an anxiety disorder	Not available		1.3 (0.3 - 4.8)	0.71
Symptoms of mental disorders in past year				
Major depressive episode	2.4 (0.8 - 7.0)	0.12	1.2 (0.3 - 4.4)	0.76
Panic disorder	1.7 (0.9 - 3.2)	0.09	Not available	
Social phobia	1.2 (0.3 - 4.1)	0.79	Not available	
Generalized anxiety disorder	3.9 (1.2 - 12.9)	0.03	Not available	
Agoraphobia	4.8 (0.6 - 42.1)	0.15	Not available	
Posttraumatic stress disorder	1.9 (0.5 - 6.6)	0.33	Not available	
Mania	2.0 (0.5 - 8.2)	0.34	Not available	
Non-affective psychosis	0.3 (0.1 - 1.7)	0.17	Not available	
Specific psychotic symptoms in past year				
Heard voices others could not	0.6 (0.1 - 3.4)	0.58	Not available	
Felt force taking over mind	0.5 (0.1 - 3.3)	0.45	Not available	
Felt force inserting thoughts	0.7 (0.1 - 7.8)	0.77	Not available	
Felt force steal thoughts	0.4 (0.0 - 4.0)	0.42	Not available	
Force used special signals	0.4 (0.1 - 2.5)	0.35	Not available	
Believed plot to harm you	1.3 (0.4 - 4.1)	0.69	Not available	
Saw vision others could not	1.6 (0.4 - 7.0)	0.51	Not available	

aOR: adjusted odds ratio

[a] Adjusted for age (11 categories, treated as a continuous variable), gender (male, female), race/ethnicity (white, Hispanic, black, Asian, Native American, Native Hawaiian or Pacific Islander, more than one), household income (less than $20,000, $20,000-$49,999, $50,000-$74,999, $75,000 or more), education (not high school graduate, high school graduate, some college, college graduate), married (unmarried, married), likes to test self by doing risky things (never, seldom, sometimes, always), and extremely stressful event (no, yes).

[b] Adjusted for depressive episode before age 18 years (no, yes) and above covariates, except for extremely stressful event.

Survey years 2001-2004

In the 2001-2004 sample, there were 192 adult respondents who reported using classical psychedelics (psilocybin, LSD, mescaline, or peyote) and no other illicit drugs (cannabis (marijuana), heroin, opiate pain relievers, cocaine, tranquilizers (benzodiazepines), sedatives (barbiturates), stimulants (amphetamine, methamphetamine, methylphenidate), MDMA (ecstasy), inhaled anesthetics (nitrous oxide, ether), alkyl nitrites (poppers), other inhalants (solvents, volatile chemicals), and PCP (phencyclidine)). In a logistic regression analysis adjusting for sociodemographic and psychological confounders, rate of symptoms of generalized anxiety disorder was increased with weak statistical significance in psychedelic users (adjusted odds ratio (aOR) = 3.9; p = 0.03). We failed to demonstrate an association between psychedelic use and increased rate of mental health treatment or symptoms of other psychiatric disorders, including major depressive disorder, panic disorder, posttraumatic stress disorder, mania, non-affective psychosis, and individual symptoms of non-affective psychosis including visual hallucinations. Notably, symptoms of non-affective psychosis were reduced in psychedelic users, but this was not statistically significant (aOR = 0.3; p = 0.17).

Survey years 2008-2011

In the 2008-2011 sample, there were 156 adult respondents who reported using classical psychedelics and no other illicit drugs. In logistic regression analysis adjusting for sociodemographic and psychological confounders, we found that people who had used psychedelics had increased rate of self-reported past-year outpatient mental health treatment (aOR = 3.2; p = 0.02), prescribed psychiatric medication (aOR = 2.8; p = 0.01), and physician diagnosis of depression (aOR = 3.4; p = 0.01), with weak statistical significance. Note, these are not independent outcomes, as people who seek psychiatric treatment would be expected to also have increased rates of psychiatric medication prescription and psychiatric diagnosis. In contrast, rate of self-reported needed but not receive psychiatric treatment was decreased but this was not statistically significant (aOR = 0.4; p = 0.25). We failed to detect statistically significant increases in rates of self-reported inpatient mental health treatment, physician diagnosis of anxiety disorder, or any symptoms of psychiatric problems: serious psychiatric distress, major depressive episode, suicidal thoughts, suicidal plans, or suicidal attempts.

Age onset of major depressive episode

Because the adjusted odds ratio of physician diagnosis of depression (but not symptoms of major depressive episode or suicide attempt) was increased amongst people who had used psychedelics but no other illicit drugs in the 2008-2011 sample, we examined reported symptoms of depression in more detail in this group by comparing age at first major depressive episode against age of first use and last use of "hallucinogens" (a broad, vaguely defined category which includes psychedelics). This data was not available in the 2001-2004 sample. Out of 22 respondents with available data on age at first major depressive episode, only two people experienced their first major depressive episode during the years they were using hallucinogens (plus one person reported first major depressive episode 8 years after first using hallucinogens but was missing data on age at last use of hallucinogens), of the remainder, nine people reported that their first major depressive episode occurred years before first using hallucinogens, and 10 people reported that their first major depressive episode occurred 3 years or more after last use of hallucinogens. Thus, data from this sample of people who have used psychedelic hallucinogens and no other illicit drugs does not suggest a temporal connection between psychedelic use and onset of major depressive episode.

Limitations

The confidence intervals on the adjusted odds ratios were large, so in most cases it is not possible to say with confidence if the associations are positive, negative, or neutral. It is possible that rates of both psychiatric symptoms and psychiatric treatment were increased in the psychedelic using group. It is also plausible, based on the 2008-2011 sample, that the select group of people who choose to try psychedelics but decline to try other illicit drugs might have an increased interest in psychology and mental health and be more predisposed than the general population to seek mental health treatment, even if they do not have increased rate of mental health problems. People who have used psychedelics and no other illicit drugs are unlikely to be representative of the total population of people who have used psychedelics.

The major difference between the 2001-2004 and 2008-2011 datasets is that exposure to an extremely traumatic event was available as a confounder only in the 2001-2004 dataset and childhood depression (major depressive episode before age 18) was available as a confounder only in the 2008-2010 dataset. Traumatic events and childhood depression were both correlated with psychedelic use and were both strong predictors of all indicators of mental health problems. It would be preferable to have a data set with data on both exposure to traumatic events and childhood depression, as well as other risk factors, such as history of childhood abuse, and family history of mental illness (McCann *et al.*, 2014; Proal *et al.*, 2014). Note, a study of 52 people hospitalized for first psychotic episode shortly after LSD use found that they had elevated rates of parental psychiatric hospitalization, similar to people with schizophrenia (Vardy and Kay 1983).

The statistical significance of all the "statistically significant" results presented here were weak ($p > 0.01$), and so should be considered with caution. When conducting multiple statistical tests, it is likely to have false-discovery findings simply by chance. None of these "findings" would be considered statistically significant if we adjusted for multiple tests (13 tests for the 2001-2004 sample, not counting the specific symptoms of nonaffective psychosis, and 11 tests for the 2008-2011 sample) using either the Bonferroni method (with alpha of 0.05) or the less stringent Benjamini-Hochberg method (with a false-discovery rate of 0.05) (Benjamini and Hochberg, 1995).

A cross-sectional population study cannot demonstrate causation. We looked only at the population level; it is possible that psychedelics could hurt some individuals and help others. For example, there are some reports of first-episode psychosis after taking psychedelics (Catts and Catts, 2010), but on the other hand there are also reports of sustained recovery from chronic paranoid psychosis in hospitalized patients following a single dose of psychedelics (Denber and Merlis, 1954; Denber, 1956). See the original articles for more limitations and discussion (Johansen and Krebs, 2015; Krebs and Johansen, 2013).

Comments

Overall, there is a lack of evidence that psychedelics increase the rate of mental health problems on a population level (Bonson, 2012; Catts and Catts, 2010). As Jorgen Bramness said in response to our population study of psychedelics and mental health: "The study shows, in agreement with previous studies, that we probably have exaggerated the danger of the use of psychedelics in general, and LSD in particular, at least if we are to judge on the basis of drug laws" (Tveito, 2013).

Data on mental health of psychedelic users is also available from communities where psychedelic use is legal and less stigmatized. A longitudinal case-control study found that people who had used ayahuasca (a South American psychedelic beverage containing dimethyltryptamine which is chemically similar to psilocybin) over 360 times each in legally-protected religious ceremonies scored significantly lower on all psychopathology measures compared to people who regularly participated in nonpsychedelic religious groups, both at baseline and at one year follow-up (Bouso *et al.*, 2012). A case-control study of Native Americans failed to find any evidence of cognitive or mental health deficits among people who regularly used peyote in legally-protected religious services compared to those who did not use peyote, and reported that total lifetime peyote use (mean 300 occasions, range 150-500) was associated with overall better mental health (Halpern *et al.*, 2005). A four-year observational study by a psychiatrist on a Native American reservation estimated the rate of serious adverse psychiatric reactions to peyote as 1 per 70,000 occasions of peyote use in legally-protected religious ceremonies, participants included people with schizophrenia and other mental illness (Bergman, 1971). In the Netherlands, where psychedelic psilocybin mushrooms are legally sold in shops, the rate of ambulance calls leading to hospitalization for acute psilocybin-related psychiatric problems or injury has been estimated at one hospitalization per 50,000 servings of psilocybin mushrooms sold (most cases involved alcohol and other drugs) (CAM, 2007). And out of 4 million attendees at large electronic dance music festivals in the Netherlands, there were only 35 visits to first-aid stations that involved psilocybin mushrooms (none required further medical attention) (Krul, 2011), demonstrating that legal sale of psilocybin mushrooms creates very few problems at "rave" festivals.

The most definitive way to determine adverse effects of psychedelics would be randomized controlled trials.

Recent randomized controlled trials of psilocybin of approximately 1000 doses in approximately 400 volunteers (screened for pre-existing mental health problems) have not reported any adverse emotional reactions lasting beyond a few weeks or any prolonged psychotic reactions (e.g. Studerus *et al.*, 2011). Likewise, clinical trials of LSD and mescaline from the 1950s-1970s are typically interpreted as showing low rates of prolonged problems (McWilliams and Tuttle, 1973). Studies from the 1950s-1960s of LSD and mescaline in people with schizophrenia and other serious mental illness generally reported that psychedelics can temporarily exacerbate pre-existing psychiatric symptoms during the drug effects, but with few or no prolonged adverse effects, and as noted above occasionally lasting remission from psychosis or other psychiatric problems. In the most commonly cited study of prolonged effects of LSD in people with schizophrenic, after 158 total administrations of LSD (dose up to 840 mcg) to 65 patients with chronic psychosis (hospitalized on average for 5 years) there were three instances of prolonged exaggeration of prior symptoms (no details) with onset soon after LSD (Fink *et al.*, 1966), but there was no control group and some of these patients would have been expected to worsen regardless of LSD.

The idea that psychedelics often cause lasting mental health problems or are otherwise "extremely dangerous" appears to have been based on case reports, rumors, "worst-case scenarios," politics, cultural biases, and outdated theories about the inherent dangers of "self-exploration," rather than epidemiological data (Johansen and Krebs, 2015; Krebs, 2015; Rucker 2015). In many ways the mid-20th century "moral panic" against psychedelics paralleled claims from previous generations that mental illness and suicide were caused by activities involving introspection, creativity, and fantasy, such as Christian mystical contemplation (from the influential psychiatrist Philippe Pinel, 1790: "the mind remains in a kind of imbecility during which they speak only of marvels and miracles") (Murat, 2014), reading fictional novels (from 1869: "Common novel-reading is a fearful evil... the safest rule is total abstinence"; from 1820: "his soul kindled into ardor at scenes of imagined bliss, which probably he will never realize, but which will only prepare his mind for bitter disappointment") (Crane, 1869; Dodge, 1820), masturbation (from 1834: "self-abuse" leads to over-stimulation, brain inflammation, insanity, and "mental decay") (Whorton, 2001), and jazz music (from 1921: "the effect of jazz on the normal brain produces an atrophied condition on the brain cells.... it is harmful and dangerous, and its influence is wholly bad") (Knowles, 2009). Restrictions on all these activities were enacted or proposed on pseudo-medical grounds. It was possible to point to case examples of, for instance, a young woman who read many books and then killed herself, and there is evidence that poets, jazz musicians, mathematicians, and other creative professionals do have higher rates of mental illness, but of course this does not demonstrate that these activities directly cause mental health problems (Kaufman and Paul, 2014).

Acknowledgements

The Substance Abuse and Mental Health Data Archive provided the data files from the National Survey on Drug Use and Health, which was sponsored by the Office of Applied Studies of the Substance Abuse and Mental Health Services Administration.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Benjamini Y and Hochberg Y (1995) Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Statist Soc B* 57: 289-300.
2. Bergman RL (1971) Navajo peyote use: its apparent safety. *Am J Psychiatry* 128: 695-699.
3. Bonson KR (2012) Hallucinogenic drugs. In: *Encyclopedia of Life Sciences (eLS)*. Chichester, UK: John Wiley & Sons Ltd. DOI: 10.1002/ 9780470015902.a0000166.pub2.
4. Bouso JC, González D, Fondevila S, *et al*. (2012) Personality, psychopathology, life attitudes and neuropsychological performance among ritual users of ayahuasca: a longitudinal study. *PLoS One* 7: e42421.
5. CAM (Coördinatiepunt Assessment en Monitoring nieuwe drugs) (2007) *Aanvullende informatie paddoincidenten in Amsterdam [Additional information on mushroom incidents in Amsterdam]*. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu. Available at: www.rivm. nl/bibliotheek/digitaaldepot/cam_paddo_aanvulling.pdf (accessed 1 November 2014).
6. Catts VS and Catts S V (2010) Psychotomimetic effects of PCP, LSD, and ecstasy: pharmacological models of schizophrenia? In: Sachdev PS and Keshavan MS (eds) *Secondary Schizophrenia*. Cambridge: Cambridge University Press, pp.141-168.
7. Crane JT (1869) Novels and novel-reading. In: *Popular Amusements*. Cincinnati: Walden & Stowe, pp.121-152.
8. Denber HC (1956) Studies on mescaline. VII. The role of anxiety in the mescaline-induced state and its influence on the therapeutic result. *J Nerv Ment Dis* 124: 74-77.
9. Denber HC and Merlis S (1954) A note on some therapeutic implications of the mescaline-induced state. *Psychiatr Q* 28: 634-640.
10. Dodge S (1820) On novel reading. In: *The Guardian, Or Youth's Religious Instructor, Volume 2*. New Haven, CT: Office of the Religious Intelligence, pp.46-49.
11. Fink M, Simeon J, Haque W, *et al*. (1966) Prolonged adverse reactions to LSD in psychotic subjects. *Arch Gen Psychiatry* 15:450-454.
12. Halpern JH, Sherwood AR, Hudson JI, *et al*. (2005) Psychological and cognitive effects of long-term peyote use among Native Americans. *Biol Psychiatry* 58: 624-631.
13. Johansen PØ and Krebs TS (2015) Psychedelics not linked to mental health problems or suicidal behavior: a population study. *J Psychopharmacol* 29: 270-279.
14. Kaufman SB and Paul ES (2014) Creativity and schizophrenia spectrum disorders across the arts and sciences. *Front Psychol* 5: 1145.
15. Knowles M (2009) *The Wicked Waltz and Other Scandalous Dances: Outrage at Couple Dancing in the 19th and Early 20th Centuries*. Jefferson, NC: McFarland, p.164.
16. Krebs TS (2015) Protecting the human rights of people who use psychedelics. *Lancet Psychiatry* 2: 294-295.
17. Krebs TS and Johansen PØ (2013) Psychedelics and mental health: a population study. *PLoS One* 8: e63972.
18. Krul J, Blankers M and Girbes AR (2011) Substance-related health problems during rave parties in The Netherlands (1997-2008). *PLoS One* 6: e29620.
19. McCann M, Higgins K, Perra O, *et al*. (2014) Adolescent ecstasy use and depression: cause and effect, or two outcomes of home environment? *Eur J Public Health* 24: 845-850.
20. McWilliams SA and Tuttle RJ (1973) Long-term psychological effects of LSD. *Psychol Bull* 79: 341-351.
21. Murat L (2014) *The Man Who Thought He Was Napoleon: Toward a Political History of Madness*. Chicago: University of Chicago Press, p.38.
22. Nesvåg R, Bramnes J and Ystrom E (2015) The link between use of psychedelic drugs and mental health problems. *J Psychopharmacol*.
23. Proal AC, Fleming J, Galvez-Buccollini JA, *et al*. (2014) A controlled family study of cannabis users with and without psychosis. *Schizophr Res* 152: 283-288.
24. Rucker JJ (2015) Psychedelic drugs should be legally reclassified so that researchers can investigate their therapeutic potential. *BMJ* 350: h2902.
25. Studerus E, Kometer M, Hasler F, *et al*. (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *J Psychopharmacol* 25: 1434-1452.
26. Vardy MM and Kay SR (1983) LSD psychosis or LSD-induced schizophrenia? A multimethod inquiry. *Arch Gen Psychiatry* 40: 877-883.
27. Tveito K (2013) LSD gir ikke psykiske problemer. *Tidsskr Nor Legeforen* 133: 2041.
28. Whorton J (2001) The solitary vice: the superstition that masturbation could cause mental illness. *West J Med* 175: 66-68.

Illicit Use of LSD or Psilocybin, but not MDMA or Nonpsychedelic Drugs, is Associated with Mystical Experiences in a Dose-Dependent Manner

by

Michael Lyvers, Ph.D.[a] **& Molly Meester, Honours (Psychology)**[b]

Journal of Psychoactive Drugs, 44 (5), 410-417, 2012

ISSN: 0279-1072 print / 2159-9777 online
DOI: 10.1080/02791072.2012.736842

© Taylor & Francis Group, LLC

original report: https://teonanacatl.org/attachments/6-pdf.48494/

The authors would like to thank Rick Doblin and MAPS for their assistance with this project.
[a] Associate Professor of Psychology, Department of Psychology, Bond University, Gold Coast Queensland, Australia.
[b] Student Researcher, Department of Psychology, Bond University, Gold Coast Queensland, Australia.
Please address correspondence to Michael Lyvers, Department of Psychology, Bond University, Gold Coast Queensland 4229, Australia; email: mlyvers@bond.edu.au

Table of Contents:

- **Method**
  - Participants
  - Materials
    - *Demographics and Drug Use Questionnaire*
    - *Mysticism Scale*
    - *States of Consciousness Questionnaire*
    - *Balanced Emotional Empathy Scale*
    - *Life Values Inventory*
    - *Langer Mindfulness Scale*
    - *Depression Anxiety and Stress Scales*
  - Procedure
- **Results**
- **Discussion**
- **References**

Abstract - Psychedelic drugs have long been known to be capable of inducing mystical or transcendental experiences. However, given the common "recreational" nature of much present-day psychedelic use, with typical doses tending to be lower than those commonly taken in the 1960s, the extent to which illicit use of psychedelics today is associated with mystical experiences is not known. Furthermore the mild psychedelic MDMA ("Ecstasy") is more popular today than "full" psychedelics such as LSD or psilocybin, and the contribution of illicit MDMA use to mystical experiences is not known. The present study recruited 337 adults from the website and newsletter of the Multidisciplinary Association for Psychedelic Studies (MAPS), most of whom reported use of a variety of drugs both licit and illicit including psychedelics. Although only a quarter of the sample reported "spiritual" motives for using psychedelics, use of LSD and psilocybin was significantly positively related to scores on two well-known indices of mystical experiences in a dose-related manner, whereas use of MDMA, cannabis, cocaine, opiates and alcohol was not. Results suggest that even in today's context of "recreational" drug use, psychedelics such as LSD and psilocybin, when taken at higher doses, continue to induce mystical experiences in many users.

Keywords - LSD, MDMA, mystical experiences, psilocybin, psychedelic drugs, religious experiences

When taken in sufficient doses the psychedelic drugs LSD and psilocybin have been widely reported to elicit mystical or transcendental religious/spiritual experiences (e.g., Harris 2011; Griffiths *et al*. 2006; Hasler *et al*. 2004; Horgan 2003; Smith 2000; Bakalar 1985; Hofmann 1983; Pahnke 1969, 1963; Pahnke & Richards 1966; Watts 1965; Leary 1965; Maslow 1964). Insights into God or Ultimate Reality, transcendence of the personal ego, merging with the cosmos and undergoing transformative death and rebirth are common elements of the mystical experiences reported by many of those who have taken high doses of LSD or psilocybin. Such reports resemble in some respects the classical descriptions of self-realization or enlightenment arising from the mystical traditions of major religions such as Buddhism and Hinduism (Horgan 2003; Grinspoon & Bakalar 1979; Watts 1965; Suzuki 1957; James 1905).

Psychedelic drugs are potent direct serotonin agonists (Jacobs 1987) that can induce powerful activation of the cerebral cortex, especially the prefrontal region (Vollenweider *et al*. 1997). Although the peak in popularity of psychedelics, particularly LSD, was in the 1960s, psychedelic drugs are still taken illicitly today but the purposes of present-day use can be quite different from the motives of typical LSD users in the 1960s. Today psychedelics are often used to enhance sensory experiences at concerts and dance parties - in contrast to the ego-transcending or "mind-expanding" goals of most psychedelics users in the 1960s. This change is reflected in the typical unit doses of LSD available on the black market today, which are considerably lower than the typical unit doses available in the 1960s (Laing & Siegel 2003). Black market unit samples of LSD in both the U.S. and Europe in the 1960s often contained several hundred micrograms (see erowid.org/chemicals/lsd/lsd_history1.shtml), a dose range characterized as "strong" or "heavy" by the popular drug use information website erowid.org; by contrast in the past decade typical black market LSD unit doses averaged only about 50 micrograms (Hidalgo 2009; Laing & Siegel 2003), a dose range characterized by erowid.org as "light" and said to be well below the threshold for a revelatory mystical psychedelic experience (Stafford 1983). Moreover the most commonly used drug with psychedelic properties today is not LSD or psilocybin but MDMA ("Ecstasy"), which induces a mix of stimulant and mild psychedelic effects that are reported to be less intense and more controllable than those induced by "full" psychedelics such as LSD and psilocybin (Rushkoff 2001). LSD and psilocybin are often referred to as "entheogens," meaning "to awaken God within," whereas MDMA is often described as an "entactogen," meaning "to touch within" (Bravo 2001; Smith 2000), reflecting the differences between MDMA and "full" psychedelics.

Pahnke (1963) and Griffiths and colleagues (2006) demonstrated that a strong dose of psilocybin administered in a controlled, supportive experimental setting can induce profound mystical experiences in drug-naïve subjects, with self-reported transformative effects that for some have lasted decades (Doblin 1991). The present study examined mystical experiences in relation to illicit drug use among a sample of "recreational" psychedelic and other drug users. Given that psychedelic drug dose is said to be a crucial factor influencing whether an occasion of use is capable of catalyzing a transformational mystical experience, we expected to find that the usual dosage taken as reported by users for the full psychedelics LSD and psilocybin, but not MDMA or nonpsychedelic drugs such as cannabis, cocaine, opiates or alcohol, would be positively related to self-reported mystical experiences as well as to experiences of an "overwhelming" nature. Scores on the Depression Anxiety and Stress Scales (DASS-21) served as a control for the potential influence of mild psychopathology on such self-reports. In addition, self-report measures of specific life values and empathy were examined, as a previous cross-cultural study found that psychedelic drug users rated the life values of spirituality, creativity, concern for the environment and concern for others more highly than did nonusers (Lerner & Lyvers 2006), a difference which the authors speculated might be a result of mystical experiences in the former group. Mindfulness was also examined given the foundation of that concept in the mystical Zen Buddhist tradition (e.g., Maezumi & Glassman 2007).

Method

Participants

Participants were recruited online from members of the Multidisciplinary Association for Psychedelic Studies (MAPS) and those who visited its website (www.maps.org). MAPS is a nonprofit organization promoting research on potential medical and psychiatric applications of marijuana and psychedelic drugs. A monthly newsletter emailed to MAPS members in April 2011 contained a brief description of the online survey and a link to it. This information was also placed on the MAPS website. The total number of participants who completed the survey was 350, with 337 providing usable data. Among these 337 participants, ages ranged from 16 to 79 years (*M* = 29.12 years, SD = 12.14), and 68.5% were male. The majority (68%) reported having a university degree; 32% of participants were students, and 58% of participants were employed full-time.

Approval was obtained from the Bond University Human Research Ethics Committee prior to the commencement of the study. No incentive was offered for participation.

Materials

To commence the online survey administered via Survey Monkey, each participant had to read an explanatory statement which assured them of the anonymity of their data, and informed them of their right to withdraw from the study at any time without consequence. The following questionnaires comprised the survey.

Demographics and Drug Use Questionnaire

This measure was created for this study and asked for the participants' age, gender, education, occupation, and personal history of use of alcohol and illegal drugs including cannabis (marijuana), MDMA (Ecstasy), cocaine, opiates, LSD and psilocybin. Participants were asked to estimate their frequency of use on a six-point scale where 0 = "never," 1 = "rarely," 2 = "monthly," 3 = "fortnightly," 4 = "weekly," and 5 = "daily." They were also asked to estimate their usual dosage taken on a four-point scale where 0 = "none," 1 = "low dose," 2 = "common dose," and 3 = "strong dose." Participants were also asked if they had ever had an overwhelmingly intense experience of any kind - not necessarily drug induced but could include drug experiences - by ticking either "yes" or "no." For those who indicated they had used psychedelics, a question asked for the participant's motives for such use.

Mysticism Scale

This 32-item questionnaire (Hood 1975) contains items that ask participants about past mystical experiences (if any). The Mysticism Scale has been used in research on the psychology of religion (Spilka *et al*. 2003) but has only previously been applied to drug experiences by Griffiths and colleagues (2006), who used it to assess psychedelic drug (psilocybin) experiences. The Mysticism Scale yields a total score based on three dimensions of mystical experience: noetic quality (e.g., "I have never experienced anything to be divine," reverse-scored); introvertive mysticism (e.g., "I have never had an experience which I was unable to express adequately through language," reverse-scored); and extrovertive mysticism (e.g, "I have had an experience in which I felt everything in the world to be part of the same whole"). The items are rated on a nine-point scale ranging from -4 = "this description is extremely not true of my own experience or experiences" through 0 = "I cannot decide" to +4 = "this description is extremely true of my own experience or experiences." The psychometric properties of this scale have been reported to be sound (Reinert & Steifler 1993).

States of Consciousness Questionnaire

The SCQ (Griffiths *et al*. 2006) contains 100 items pertaining to states of consciousness and mood, but only the 43 items of the Pahnke-Richards Mystical Experience Questionnaire (*MEQ*; Pahnke 1969; Richards 1975) are scored, with the remainder being distractor items. The MEQ was used in Pahnke's 1966 Good Friday experiment as well as in the subsequent psilocybin study by Griffiths and colleagues (2006), the latter in the form of the SCQ as in the present study. The MEQ assesses experiences of internal unity, external unity, transcendence of time and space, ineffability, paradoxicality, sacredness, noetic quality, and positive mood. Participants rated each statement on a six-point Likert scale for degree of having experienced the phenomenon listed, from 0 = "not at all" to 5 = "extreme." A sample item is "sense of profound humility before the majesty of what was felt to be sacred or holy." Total scores can range from 0 to 215.

Balanced Emotional Empathy Scale

This scale (BEES; Mehrabian 1996) assesses one's perceived ability to identify and feel the emotions of others. Participants rate 30 items on a nine-point Likert scale where -4 = "very strong disagreement," 0 = "neither agreement or disagreement," and +4 = "very strong agreement" with each item. A sample item is "I am moved deeply when I observe strangers who are struggling to survive." Research has indicated that the BEES has good to excellent internal consistency, convergent validity and predictive validity (Mehrabian, Young & Sato 1988; Mehrabian & Epstein 1972).

Life Values Inventory

The LVI (Crace & Brown 1996) uses 42 items to measure 14 different life values that are rated for personal importance on a five-point Likert scale, where 1 = "almost never guides my behavior," 3 = "sometimes guides my behavior" and 5 = "almost always guides my behavior." The 14 life values are achievement, belonging, concern for the environment, concern for others, creativity, financial prosperity, health and activity, humility, independence, loyalty to family or group, privacy, responsibility, scientific understanding, and spirituality. Brown and Crace reported high test-retest reliability for the 14 life values ranging from .78 to .97. For the purpose of this study only creativity, spirituality, concern for the environment, and concern for others were examined, based on previous findings described earlier above (Lerner & Lyvers 2006).

Langer Mindfulness Scale

The LMS (Langer 2004) assesses the construct of mindfulness as practiced in everyday life. Participants rate 21 items in reference to their personal outlook on a five-point Likert scale where 1 = "strongly disagree," 3 = "neutral," and 5 = "strongly agree." There are four subscales, novelty-seeking, engagement, novelty-producing, and flexibility; as these have been found to load onto a single scale score, only the total score was used in the present study.

Depression Anxiety and Stress Scales

The DASS-21 (Lovibond & Lovibond 1995) is comprised of 21 items concerning negative mood states experienced in the past week, rated using a four-point Likert rating scale where 0 = "these statements did not apply to me at all," 1 = "applied to me some of the time," 2 = "applied to me a good part of the time," and 3 = "applied to me most of the time." There are three subscales, depression, anxiety and stress. Items include "I just couldn't seem to get going" (depression), "I found it difficult to relax" (anxiety) and "I found it hard to wind down" (stress). Normal scores for depression are 0-9, anxiety 0-7, and stress 0-14 (Lovibond & Lovibond 1995), with higher scores indicating psychopathology. The psychometric properties of this widely used measure are regarded as excellent (Crawford & Henry 2003).

Procedure

Participants completed the questionnaires anonymously online via Survey Monkey. Once they opened the link to the present survey on their computer, they first read the explanatory statement. Then, participants clicked "Next," which directed them to the demographics questionnaire. After the completion of this section, participants proceeded to the other questionnaires. Upon completing the last questionnaire, participants clicked "Finished," which brought them to a thank you and appreciation page.

Results

After removal of multivariate outliers and cases with substantial missing data from the dataset, 337 cases remained to provide usable data. Of these 337 participants, 99% reported having used alcohol, 58% reported having used cocaine, 40% reported having used opiates, 96% reported having used cannabis, 74% reported having used MDMA, 83% reported having used LSD, and 89% reported having used psilocybin. The very high proportions of the sample who reported having used cannabis and psychedelics was expected given the nature of MAPS as an advocacy group promoting potential beneficial applications of these substances. However, estimated self-reported frequency of drug use was low in this sample except for use of alcohol and cannabis. The most commonly reported frequency of use for alcohol was "weekly" (35%), whereas for cannabis the most commonly reported frequency of use was "daily" (44%). By contrast, "rarely" (less than monthly) was the most commonly reported frequency of use for cocaine, opiates, MDMA, LSD and psilocybin in this sample. Self-reported doses taken showed a broader distribution than frequency of use, although "common" was the most frequently cited dose level with frequencies ranging from 13% to 45% for this dose category; the exceptions were cocaine and opiates, for which the most commonly cited quantity was "none" (these drugs having the lowest proportion of users in the sample; see above). DASS depression, anxiety and stress scores were quite low in this sample, averaging only three or four out of a possible 21. Among those who reported having used psychedelics and provided motives for use, the most common self-reported motive for use was "mind expansion" (41%), followed by "spiritual" (25%), "curiosity" (13%) and "recreation" (7%), with the remainder citing "other."

Intercorrelations among the measures of interest were calculated and are presented in Table 1. Illicit drug doses were all intercorrelated as expected, such that self-reported use of higher doses of any one drug were associated with self-reported use of higher doses of other drugs as well. LSD dose was significantly positively correlated with scores on the Mysticism Scale, MEQ, and LVI Creativity. Psilocybin dose was significantly positively correlated with Mysticism and MEQ scores. The other illicit drugs (cocaine, cannabis, opiates, MDMA) showed only small to no correlation with any of the scales, and none with Mysticism or MEQ scores. Alcohol dose was significantly negatively correlated with BEES empathy scores and three of the five LVI values: environmental concern, concern for others, and spirituality. Participant age was significantly negatively related to all self-reported drug doses except cocaine, and significantly positively related to BEES empathy, LVI environmental concern and LVI spirituality.

Several of the scales were significantly intercorrelated in expected ways. For example, BEES empathy scores were positively correlated with LVI concern for others; LVI spirituality scores and LMS mindfulness were positively correlated with each other and with Mysticism, MEQ, BEES, and LVI concern for others, creativity and environmental concern; and the DASS scales were all intercorrelated as usual (e.g., Lyvers *et al*. 2010) although interestingly they did not significantly correlate with any other measure including drug use indices (see Table 1).

Hierarchical regression was used to assess predictors of the primary criterion measures of interest, i.e., Mysticism Scale scores and MEQ scores, examining the possible roles of LSD and psilocybin dose after controlling for demographic variables, mood variables, and self-reported doses of drugs other than LSD or psilocybin. In these regressions age, gender and education level were entered at step 1, followed by DASS depression, anxiety and stress scores at step 2, self-reported doses of alcohol, cannabis, cocaine, opiates and MDMA at step 3, and self-reported doses of LSD and psilocybin at step 4. For prediction of Mysticism Scale scores the regression model was only significant at step 4, $F(13, 291) = 2.79$, $p < .001$; the addition of psychedelic drugs at step 4 accounted for 11% of the variance in Mysticism Scale scores, $Fchange\ (2, 291) = 10.60$, $p < .0001$. The only significant drug predictors of Mysticism scale scores were LSD dose, $\beta = .23$, $p < .0001$, and psilocybin dose, $\beta = .13$, $p = .04$. No other predictors approached significance except for age at step 4 only, $\beta = .14$, $p = .02$. For MEQ scores as the criterion the results were very similar; again the regression model was only significant at step 4, $F(13, 291) = 3.12$, $p < .0001$, and the addition of psychedelic drugs at step 4 explained 12% of the variance in MEQ scores, $Fchange(2, 291) = 12.60$, $p < .0001$. The only significant drug predictor in the final model was LSD dose, $\beta = .26$, $p < .0001$, with psilocybin dose approaching significance, $\beta = .11$, $p = .07$, and age again significant at step 4 only, $\beta = .13$, $p = .03$.

Finally, among drug use variables, only use of drugs with psychedelic properties was significantly related to the report of having ever had an overwhelming experience. Among those who reported ever using LSD (n = 280), 89% responded "yes" to the question asking whether they had ever had an overwhelmingly intense experience of any kind, compared to only 68% of those who said they never tried LSD (n = 57), a significant association, $\chi2(1) = 15.81$, $p < .0001$. Similarly, among those who reported ever using psilocybin (n = 299), 88% reported having had an overwhelming experience versus only 59% of those who said they had never tried psilocybin (n = 37), again a significant association, $\chi2(1) = 21.61$, $p < .0001$. By contrast there was no relationship between use of the nonpsychedelic drugs alcohol, cocaine, opiates, and cannabis with having ever had an overwhelming experience, all $p > .20$; however use of MDMA, a drug with mixed stimulant and mild psychedelic properties, was significantly related to the report of an overwhelming experience, $\chi2(1) = 14.96$, $p < .0001$. Of those who said they had tried MDMA (n = 249), 85% reported having ever had an overwhelming experience compared to 72% of those who said they had never taken MDMA (n = 87). However, use of MDMA was strongly related to use of LSD, with 90% of those who reported ever using MDMA also reporting use of LSD versus only 61% of those who reported never using MDMA, $\chi2(1) = 41.00$, $p < .0001$; nearly identical results were obtained for self-reported use of psilocybin by those who reported use of MDMA versus those who did not, $\chi2(1) = 28.67$, $p < .0001$. Therefore the reports of overwhelming experiences by MDMA users may reflect their use of LSD or psilocybin rather than MDMA. In an attempt to assess this, MDMA use was examined in relation to reports of an overwhelming experience among the 15 participants who said they had never tried LSD or psilocybin, ten of whom reported never using MDMA versus five who reported MDMA use. In this subgroup there was no significant association between MDMA use and reports of an overwhelming experience, $\chi2(1) = 1.25$, $p =.26$, however given the very small size of this subgroup the lack of significance is not surprising. Of those who said they had used MDMA, three out of five reported having ever had an overwhelming experience versus only three out of ten of those who reported never using MDMA. By contrast among those 57 participants who reported never using LSD, psilocybin use was significantly related to reports of ever having had an overwhelming experience, $p < .01$; likewise among the 37 who reported never using psilocybin, LSD use was significantly related to reports of ever having had an overwhelming experience, $p < .05$.

Table 1.
Pearson Correlations Among Self-Reported Dosage of Drugs Used and Scores on Questionnaires (See Text for Details)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 Age	-	-.31**	-.05	-.12*	-.22**	-.20**	-.18**	-.21**	.15**	.08	.10	.08	.24**	.09	.04	.25**	-.04	-.06	-.02
2 Alcohol		-	.15**	.03	.17**	.20**	.12*	.13*	-.16**	-.09	-.05	-.02	-.16**	-.13*	-.09	-.18**	.01	.05	.06
3 Cocaine			-	.28**	.18**	.40**	.20**	.23**	.08	.06	.05	.04	.03	.05	.05	.01	.03	-.10	.01
4 Opiates				-	.18**	.19**	.17**	.18**	.03	.09	.10	.12*	-.02	.05	.05	-.06	-.03	-.03	.05
5 Cannabis					-	.13*	.21**	.19**	-.07	.01	.04	.08	-.05	-.12*	.03	.03	.03	.07	.04
6 MDMA						-	.38**	.34**	.00	.02	.08	.07	-.04	.06	-.01	-.10	.04	-.01	-.03
7 LSD							-	.35**	.01	.10	.23**	.26**	.07	.02	.16**	.00	.03	.08	.02
8 Psilocybin								-	-.01	.00	.19**	.19**	.05	.00	.00	-.07	.09	.06	.05
9 BEES									-	.35**	.30**	.27**	.25**	.50**	.18**	.27**	-.02	-.05	-.06
10 LMS										-	.34**	.33**	.23*	.31**	.55**	.19**	.03	-.01	.05
11 Mysticism Scale											-	.86**	.22**	19**	.25**	.40**	-.03	-.04	-.07
12 MEQ												-	.22**	.16**	.28**	.38**	-.05	-.05	-.08
13 Environmental concern													-	49**	.33**	.42**	-.05	-.04	-.04
14 Concern for others														-	.30**	.35**	.02	-.08	-.08
15 Creativity															-	.23**	.05	.05	.03
16 Spirituality																-	.02	.03	-.02
17 Depression																	-	.42**	.64**
18 Anxiety																		-	.52**
19 Stress																			-

Note: * $p < .05$. ** $p < .01$.

Discussion

Results were in line with predictions for the two indices of mystical experiences, the Mysticism Scale and the MEQ, the variances of which were significantly explained by self-reported dose of LSD or psilocybin but not of other drugs. Furthermore the self-report of having ever had an overwhelming experience was significantly associated only with self-reported use of drugs with psychedelic properties, i.e., LSD, psilocybin and MDMA, although the latter association may reflect the extremely high overlap between MDMA users and users of the "full" psychedelics LSD or psilocybin in this sample. Mysticism Scale and MEQ scores were significantly highly positively correlated with each other and with all four LVI values (environmental concern, concern for others, creativity and spirituality) as well as with BEES empathy and LMS mindfulness, consistent with expectations based on the mystical traditions of Buddhism and other religions according to which such values, as well as mindfulness, can be lasting sequelae of mystical enlightenment. However, aside from a small positive correlation between self-reported LSD dose and LVI creativity, there were no significant relationships between self-reported dose of any illicit drug - including psychedelics - and the other LVI values tested, nor with BEES empathy or LMS mindfulness. Alcohol dose was negatively related to BEES empathy and LVI environmental concern, concern for others and spirituality.

The vast majority of the current sample of MAPS members and those who visited the MAPS website reported use of psychedelic drugs. This was expected based on the mission of MAPS, a nonprofit organization dedicated to supporting medical and psychiatric applications of psychedelic drugs as well as MDMA and cannabis. However the vast majority reported only "rare" (i.e., less than once per month) use of such drugs; 74% of LSD users said they "rarely" used LSD, 77% of psilocybin users said they "rarely" used psilocybin, and 69% of MDMA users said they "rarely" used MDMA. This was in contrast to cannabis users, 44% of whom reported "daily" use. Despite the low frequency of use of psychedelic drugs in the sample, self-reported psychedelic dose predicted scores on the two mystical experiences questionnaires as per expectations. The most commonly cited reason given for psychedelic drug use was "mind expansion," although a quarter of psychedelic drug users cited "spiritual" reasons for use. Present findings indicate that, although the 1960s have long passed and black market LSD unit doses have dramatically declined, illicit use of psychedelic drugs LSD and psilocybin is still significantly associated with experiences that can be characterized as mystical, transcendental or spiritual in nature, a relationship which appears to be dose-dependent. Self-reported doses of the quasi-psychedelic drug MDMA, on the other hand, did not predict such experiences in this sample, nor did any other drug examined.

Although LSD and psilocybin have long been recognized as capable of inducing mystical experiences, Horgan (2003) suggested that, as yet, no "psychedelic saints" have emerged from the psychedelic user subculture. Horgan's comment begs the question of how to determine "saint-hood" outside of an established religious tradition such as Catholicism. Lerner and Lyvers (2006) found that users of psychedelics such as LSD or psilocybin differed from users of nonpsychedelic drugs such as cannabis in terms of higher empathy scores and higher scores on LVI creativity, spirituality, concern for others and concern for the environment in the former group. The authors speculated that such differences may in part have resulted from psychedelic mystical experiences in the former group. However, in the present study the strong positive relationships between self-reported dose of LSD or psilocybin and scores on the two mystical experience questionnaires, coupled with the lack of relationships between psychedelic drug dose and scores on empathy, spirituality, concern for others and concern for the environment, suggest a different interpretation. For various reasons those who choose to use psychedelic drugs may on average place greater value on empathy, concern for the environment, creativity, and spirituality than those who do not choose to use psychedelics, as previously found by Lerner and Lyvers in both Israel and Australia, but the present results do not suggest that those differences specifically arise out of psychedelic-induced mystical experiences. Rather the group differences found by Lerner and Lyvers likely reflect the self-selected nature of psychedelic users and their associated subculture, which even today may share many of the values of the "hippie" movement of the 1960s. In mystical religious traditions perhaps the posited relationship between nondrug-induced spiritual enlightenment and "saintly" values - exemplified by the Mahayana Buddhist ideal of the enlightened Bodhisattva as one dedicated to reducing the suffering of all sentient beings - may to a significant extent reflect the nature of the person who undertakes such a rigorous mystical quest through traditional means, typically requiring many years of highly demanding sacrifices and self-discipline in search of ultimate truth, rather than the transient mystical experience of enlightenment per se (Harris 2011).

The present findings that higher self-reported doses of the psychedelic drugs LSD and psilocybin were associated with higher scores on two indices of mystical experiences should not be interpreted as encouraging psychedelic drug use, much less use of high doses. Although both LSD and psilocybin are physically very safe, the psychological hazards of uncontrolled use can be quite high, as was demonstrated in the 1960s when uncontrolled LSD use was widespread (e.g., Cohen 1970). Panic reactions and "bad trips" followed by post-traumatic stress symptoms such as "flashbacks" were widely reported among casual users of psychedelic drugs in the 1960s, although such reactions tend to be much rarer when the drugs are taken by psychologically stable, mature participants in a supportive, controlled environment (as in the recent study by Griffiths *et al*. 2006). Nevertheless even in the latter experiment about one third of participants reported "significant fear" (p. 15) during their psilocybin experience. Griffiths and colleagues noted that under uncontrolled conditions such reactions might easily lead to irrational behavior that could be dangerous to the user or to others. Given the unpredictability and intensity of psychedelic drug effects, such drugs should never be taken casually. Any future licit applications of such drugs are likely to be restricted to highly controlled circumstances involving careful screening, preparation and support of those who take these substances for a specific purpose, whether medical or spiritual.

References

1. Bakalar, J.B. 1985. Social and intellectual attitudes toward drug-induced religious experience. *Journal of Humanistic Psychology* 24: 45-66.
2. Bravo, G.L. 2001. What does MDMA feel like? In: J. Holland (Ed.) *Ecstasy: The Complete Guide*. Rochester, VT: Park Street Press.
3. Crace, R.K. & Brown, D. 1996. *Life Values Inventory*. Ann Arbor, MI: Aviat.
4. Cohen, S. 1970. *The Beyond Within: The LSD Story*. St. Albans, UK: Paladin.
5. Crawford, J.R. & Henry, J.D. 2003. The Depression Anxiety Stress Scales (DASS): Normative data and latent structure in a large non-clinical sample. *British Journal of Psychology* 4: 111-31.
6. Doblin, R. 1991. The Good Friday experiment - a twenty five year follow-up and methodological critique. *Journal of Transpersonal Psychology* 23 (1): 1-28.
7. Griffiths, R.; Richards, W.; McCann, U. & Jesse R. 2006. Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-83.
8. Grinspoon, L. & Balakar, J.B. 1979. *Psychedelic Drugs Reconsidered*. New York: Basic Books.
9. Harris, S. 2011. *Drugs and the Meaning of Life*. Available at: http://www.samharris.org/blog/item/drugs-and-the-meaning-of-life/
10. Hasler, F.; Grimberg, U.; Benz, M.A.; Huber, T. & Vollenweider, F.X. 2004. Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. *Psychopharmacology (Berlin)* 172: 145-56.
11. Hidalgo, E. 2009. *LSD Samples Analysis*. Available at: http://www.erowid.org/chemicals/lsd/lsd_article3.shtml
12. Hofmann, A. 1981. *LSD, my Problem Child*. New York: McGraw-Hill.
13. Hood, R.W. 1975. The construction and preliminary validation of a measure of reported mystical experience. *Journal for the Scientific Study of Religion* 14: 29-41.
14. Horgan, J. 2003. *Rational Mysticism: Dispatches from the Border Between Science and Spirituality*. Boston: Houghton Mifflin.
15. Jacobs, B.L. 1987. How hallucinogenic drugs work. *American Scientist* 75: 386-92.
16. James, W. 1905/2007. *The Varieties of Religious Experience*. New York: Cosimo.
17. Laing, R. & Siegel, J.A. 2003. *Hallucinogens: A Forensic Drug Handbook*. San Diego: Academic Press.
18. Langer, E.J. 2004. *Langer Mindfulness Scale User Guide and Technical Manual*. Worthington, OH: IDS Publishing Corporation.
19. Leary, T. 1965. The religious experience: Its production and interpretation. In: G.M. Weil; R. Metzner & T. Leary (Eds.) *The Psychedelic Reader*. Secaucus, NJ: Citadel Press.
20. Lerner, M. & Lyvers, M. 2006. Values and beliefs of psychedelic drug users: A cross-cultural study. *Journal of Psychoactive Drugs* 38: 143-47.
21. Lovibond, S.H. & Lovibond, P.F. 1995. *Manual for the Depression Anxiety Stress Scales*. Sydney, Australia: The Psychology Foundation of Australia.
22. Lyvers, M.; Thorberg, F.A.; Ellul, A.; Turner, J. & Bahr, M. 2010. Negative mood regulation expectancies, frontal lobe related behaviors and alcohol use. *Personality and Individual Differences* 48: 332-37.
23. Maezumi, T. & Glassman, B. 2007. *The Hazy Moon of Enlightenment*. Somerville, MA: Wisdom Publications.
24. Maslow, A. 1964. *Religions, Values and Peak Experiences*. New York: Viking Press.
25. Mehrabian, A. 1996. *Manual for the Balanced Emotional Empathy Scale (BEES)*. Monterey, CA: Albert Mehrabian.
26. Mehrabian, A. & Epstein, N. 1972. A measure of emotional empathy. *Journal of Personality* 40: 525-43.
27. Mehrabian, A.; Young, A.L. & Sato, S. 1988. Emotional empathy and associated individual differences. *Current Psychology: Research & Reviews* 7: 221-40.
28. Pahnke, W. 1969. Psychedelic drugs and mystical experience. *International Journal of Psychiatry in Clinical Practice* 5: 149-62.
29. Pahnke, W. 1963. Drugs and mysticism: An analysis of the relationship between psychedelic drugs and the mystical consciousness. Doctoral dissertation, Harvard University. Available at: http://www.maps.org/books/pahnke/walter_pahnke_drugs_and_mysticism.pdf
30. Pahnke, W.N. & Richards, W.A. 1966. Implications of LSD and experimental mysticism. *Journal of Religion & Health* 5:

175-208.

31. Reinert, D. & Steifler, K. 1993. Hood's Mysticism Scale revisited: A factor-analytic replication. *Journal for the Scientific Study of Religion* 32: 383-88.
32. Richards, W. 1975. Counseling, peak experiences and the human encounter with death: An empirical study of the efficacy of DPTassisted counseling in enhancing the quality of life of persons with terminal cancer and their closest family members. Doctoral dissertation, The Catholic University of America. Ann Arbor, MI: University Microfilms, 75-18, 531.
33. Rushkoff, D. 2001. Ecstasy: Prescription for cultural renaissance. In: J. Holland (Ed.) *Ecstasy: The Complete Guide*. Rochester, VT: Park Street Press.
34. Smith, H. 2000. *Cleansing the Doors of Perception: The Religious Significance of Entheogenic Plants and Chemicals*. Boulder, CO: Sentient Publications.
35. Spilka, B.; Hood, R.W.; Hunsberger, B. & Gorsuch, R.L. 2003. *The Psychology of Religion*. New York: Guilford.
36. Stafford, P. 1983. *Psychedelics Encyclopedia*. Los Angeles: Tarcher.
37. Suzuki, D.T. 1957/2002. *Mysticism: Christian and Buddhist*. London: Routledge.
38. Vollenweider, F.X.; Leenders, K.L.; Scharfetter, C.; Maguire, P.; Stadelmann, O. & Angst, J. 1997. Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16: 357.
39. Watts, A. 1965. *The Joyous Cosmology*. New York: Random House.

Psilocybin-occasioned mystical-type experience in combination with meditation and other spiritual practices produces enduring positive changes in psychological functioning and in trait measures of prosocial attitudes and behaviors

by

Roland R Griffiths[1,2], Matthew W Johnson[1], William A Richards[3], Brian D Richards[3], Robert Jesse[4], Katherine A MacLean[5], Frederick S Barrett[1], Mary P Cosimano[1] and Maggie A Klinedinst[1]

Journal of Psychopharmacology 2018, Vol. 32(1) 49-69

© The Author(s) 2017

original report: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5772431/pdf/10.1177_0269881117731279.pdf
backup source: http://www.psilosophy.info/resources/10.1177_0269881117731279.pdf

[1] Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, USA
[2] Department of Neuroscience, Johns Hopkins University School of Medicine, Baltimore, USA
[3] Department of Psychiatry, Johns Hopkins Bayview Medical Center, Baltimore, USA
[4] Council on Spiritual Practices, Occidental, USA
[5] Center for Optimal Living, New York, USA

Corresponding author:
Roland Griffiths, Johns Hopkins Bayview Medical Center, 5510 Nathan
Shock Drive, Baltimore, MD 21224-6823, USA.
Email: rgriff@jhmi.edu

Table of Contents:

Abstract
Introduction
Materials and methods
- Participants
- Study design and overview
  - *Assignment to the three experimental groups*
  - *Instructions to participants and guides, and the purpose of a third session*
- Guide-participant meetings and support for spiritual practice
  - *Standard-Support groups*
  - *High-Support group*
  - *Spiritual practice support*
- Psilocybin sessions
- Measures assessed throughout the session
- Measures assessed 7 hours after drug administration
- Spiritual practices assessed at the 6-month follow-up
  - *Spiritual practices questionnaire*
- Persisting effects assessed at the 6-month follow-up
  - *Persisting effects questionnaire*
- Longitudinal measures assessed at baseline and at the 6-month follow-up
  - *Community observer ratings of changes in participants' behavior and attitudes*
- Data analyses

Results
- Integrity of blinding procedures
- Cardiovascular measures and guide ratings assessed throughout the session
  - *Time-course*
  - *Peak effects*
- Drug effect and mystical-type effect measures assessed 7 hours after psilocybin administration
  - *Subjective effects questionnaires*
  - *Measures of mystical experience*
- Spiritual practices assessed at the 6-month follow-up
  - *Spiritual practices questionnaire*
- Persisting effects assessed at the 6-month follow-up
- Longitudinal measures and community observer ratings assessed at 6 months
  - *Analysis of longitudinal measures*
  - *Community observer ratings*
- Relationship of spiritual practice and psilocybin-occasioned mystical experience to various outcome measures
- Open-ended clinical interview at the 6-month follow-up
- Adverse effects

Discussion
- Effects of psilocybin dose
  - *Effects of psilocybin dose on session days*
  - *Spiritual practices at 6 months*
  - *Persisting effects attributed to psilocybin assessed at 6 months*
  - *Longitudinal measures assessed at 6 months*
- Evidence that high support for spiritual practices increased both the acute and enduring effects of psilocybin
  - *Session day effects*
  - *Persisting effects attributed to psilocybin assessed at 6 months*
  - *Longitudinal measures assessed at 6 months*
  - *Relationship of spiritual practices and psilocybin-occasioned mystical experience to outcome measures*
- Experimental design strengths and limitations

Conclusion

Acknowledgements

Declaration of conflicting interests

Funding

Supplemental Material

References

Abstract

Psilocybin can occasion mystical-type experiences with participant-attributed increases in well-being. However, little research has examined enduring changes in traits. This study administered psilocybin to participants who undertook a program of meditation/spiritual practices. Healthy participants were randomized to three groups (25 each): (1) very low-dose (1 mg/70 kg on sessions 1 and 2) with moderate-level ("standard") support for spiritual-practice (LD-SS); (2) high-dose (20 and 30 mg/70 kg on sessions 1 and 2, respectively) with standard support (HD-SS); and (3) high-dose (20 and 30 mg/70kg on sessions 1 and 2, respectively) with high support for spiritual practice (HD-HS). Psilocybin was administered double-blind and instructions to participants/ staff minimized expectancy confounds. Psilocybin was administered 1 and 2 months after spiritual-practice initiation. Outcomes at 6 months included rates of spiritual practice and persisting effects of psilocybin. Compared with low-dose, high-dose psilocybin produced greater acute and persisting effects. At 6 months, compared with LD-SS, both high-dose groups showed large significant positive changes on longitudinal measures of interpersonal closeness, gratitude, life meaning/purpose, forgiveness, death transcendence, daily spiritual experiences, religious faith and coping, and community observer ratings. Determinants of enduring effects were psilocybin-occasioned mystical-type experience and rates of meditation/spiritual practices. Psilocybin can occasion enduring trait-level increases in prosocial attitudes/behaviors and in healthy psychological functioning.

Trial Registration
ClinicalTrials.gov Identifier NCT00802282

Keywords
Psilocybin, psychedelic, entheogen, meditation, mystical experience, traits

Introduction

Quantum change experiences refer to sudden, distinctive, benevolent, and often profoundly meaningful experiences that are said to result in personal transformations that affect a broad range of personal emotions, cognitions and behaviors (Miller, 2004; Miller and C'de Baca, 2001). The phenomenon of quantum change is differentiated from the usual process of behavioral change, which occurs in small incremental steps (James, 1902). Such experiences, which have been described in anecdotal reports dating back centuries, have been variously labeled as mystical experiences, conversion experiences, religious experiences, peak experiences, transcendental experiences, transforming moments, or epiphanies (e.g. James, 1902; Maslow, 1968; Miller and C'de Baca, 2001; Stace, 1960). Although numerous cases of such quantum change experiences have been described, they have generally not been examined in prospective experimental studies because such experiences occur at low rates and usually unpredictably (Paloutzian and Park, 2013).

Administration of psilocybin, a classic psychedelic, provides a model for experimental investigation of quantum change experiences. Controlled, double-blind clinical trials in healthy volunteers show that under supportive conditions psilocybin can reliably occasion deeply personally meaningful and often spiritually significant experiences (e.g. mystical-type experiences) (Griffiths *et al*., 2006, 2011; Pahnke, 1963) having many characteristics similar to those described for quantum change experiences (Miller and C'de Baca, 2001). Such psilocybin effects are dose dependent (Griffiths *et al*., 2011) and have been demonstrated under conditions that provide substantial controls for expectancy bias (Griffiths *et al*., 2006, 2016). Although participants often attribute enduring positive changes in well-being and worldview to such experiences, there is little evidence from studies in healthy volunteers that psilocybin produces enduring changes on well-validated trait measures of disposition or personality (Darling *et al*., 2004; Doblin, 1991; Griffiths *et al*., 2008; 2011; Leary *et al*., 1963; Pahnke, 1963; Studerus *et al*., 2011). For example, a previous study in 36 participants who received a high dose of psilocybin showed enduring positive changes in moods, attitudes, and behavior attributed to the psilocybin experience, but no significant changes from screening to 14-month follow-up on various measures of personality, quality of life, faith maturity, and spiritual well-being (Griffiths *et al*., 2008). A later post-hoc analysis which combined data from that study with data from a similar subsequent study with 18 participants (Griffiths *et al*., 2011) showed that psilocybin-occasioned mystical-type experiences were associated with increases in the personality trait of openness (MacLean *et al*., 2011).

Although an older literature on psilocybin-assisted psychotherapy in psychiatric patient populations suggests that administration of psilocybin in a psychotherapeutic context may produce enduring decreases in psychopathology and increases in positive worldview and dispositional characteristics, methodological limitations render those reports inconclusive (Passie, 2004, 2007). However, recent placebo-controlled trials in psychologically distressed cancer patients showed that psilocybin produced decreases in anxiety and depression and increases in quality of life that persisted for at least a month and possibly 6 months or more (Griffiths *et al*., 2016; Grob *et al*., 2011; Ross *et al*., 2016).

The present study in healthy participants sought to extend understanding of possible enduring effects of quantum change experiences generally and psilocybin-occasioned experiences specifically by manipulating psilocybin dose and the intensity with which participants were encouraged to engage in meditation and other spiritual practices. Acute psilocybin effects, retrospective attributions to the experience, and enduring changes in prosocial attitudes and behaviors, and psychological functioning were assessed. More specifically, the present study used an across-group design to compare these outcomes in three groups of 25 healthy participants: (1) low-dose (active placebo) psilocybin with moderate-level ("standard") support for spiritual practice; (2) high-dose psilocybin with standard support; and (3) high-dose psilocybin with high support.

Materials and methods

Participants

Participants were recruited from the local community through flyers seeking volunteers interested in developing their spiritual lives by participating in a study of the combined effects of meditation and psilocybin, a psychoactive substance found in mushrooms used as sacraments in some cultures. In total, 1305 individuals were screened by telephone and 184 were further screened in person. Primary reasons for exclusion between phone screen and inperson screening were prior use of psychedelics (312); medical/ psychiatric exclusion (288); pre-existing regular meditation or other spiritual practice (261); logistics or lack of interest (220). Eighty-five volunteers were enrolled in the study and 10 did not complete the study. Reasons for non-completion included illness or a disqualifying medical or psychological issue (five volunteers), noncompliance with study procedures for personal or job-related reasons (three volunteers), and missing data on key measures (two volunteers). The 75 study completers (40% male) were medically healthy (as determined by medical history, physical examination, an electrocardiogram, routine medical blood laboratory tests, and urine testing for common drugs of abuse), and psychiatrically healthy. They were without personal or family histories of psychotic disorders or bipolar I or II disorder as determined by structured clinical interviews. Individuals with current alcohol or other drug dependence (including nicotine) were excluded, as were individuals with a past history within the past 5 years of alcohol or drug dependence (excluding nicotine). Twenty-five percent of participants reported past use of a psychedelic, with a mean of 25.1 years since last use. Participants were excluded if they reported any history of either spontaneous or psychedelic-occasioned salient mystical-type experiences. Participants had a mean age of 42 years (range 22 to 69) and a mean weight of 71.5 kg (range 49.2 to 97.5); 89% had college or post-graduate degrees and 87% were full-time employees or students. Although 31% reported practicing seated meditation, the mean frequency of practice was very low (1.1 times per month for the group). Volunteers did not receive monetary compensation for participation. Based on interviews, their motivation for participation was their interest in learning meditation, exploring their spiritual lives, and their curiosity about the effects of psilocybin. The Johns Hopkins IRB approved the study. Written informed consent was obtained from participants.

Study design and overview

The study procedures followed recommendations provided for safe conduct of research administering high doses of a classic psychedelic (Johnson *et al*., 2008). This study investigated the effects of psilocybin dose and the frequency and intensity of support provided for spiritual practice (i.e. meditation, spiritual awareness practice, journaling) on a battery of attitudinal and behavioral outcome measures in 75 healthy participants. The psilocybin dose manipulation was double-blind.

The duration of each volunteer's participation was approximately 6 to 8 months. After enrollment and before the first of two psilocybin sessions (described below), each participant had several preparation meetings with two study staff trained to serve as session "guides." The two psilocybin sessions were separated by about 1 month. Some measures were assessed during and immediately after sessions, and various longitudinal measures were evaluated immediately after study enrollment (i.e. baseline assessment) and 4 months after the second psilocybin session (i.e. 6-month assessment).

Assignment to the three experimental groups

After screening and study enrollment, each participant was randomized to one of three groups of 25 each: (1) very low-dose psilocybin (1 mg/70 kg on sessions 1 and 2 - functionally a placebo) with standard support for spiritual practice (LD-SS); (2) high-dose psilocybin (20 and 30 mg/70 kg on sessions 1 and 2, respectively) with standard support for spiritual practice (HD-SS); and (3) high-dose psilocybin (20 and 30 mg/70 kg on sessions 1 and 2, respectively) with high support for spiritual practice (HD-HS). An urn randomization procedure (Stout *et al*., 1994) was used to balance the three groups as closely as possible on six dichotomous variables (gender, age at study intake, lifetime psychedelic use, baseline lifetime Hood Mysticism Scale score, baseline frequency of meditation, and staff judgment about whether the participant was especially likely to engage in spiritual practices). Table 1 shows that these and other demographic characteristics did not differ across the three experimental groups.

Table 1. Participant demographics.

Measure	Low-Dose Standard-Support (N=25)	High-Dose Standard-Support (N=25)	High-Dose High-Support (N=25)	Group Comparisons
Gender (Male/Female)	9/16	13/12	8/17	N.S.
Age in years (mean, SEM)	40.2 (2.5)	41.0 (2.7)	45.6 (2.3)	N.S.
Weight in kilograms (mean, SEM)	69.0 (2.2)	72.6 (2.4)	72.9 (2.6)	N.S.
Race/Ethnicity				
White	76%	88%	92%	N.S.
Black/African American	8%	4%	4%	
Asian	16%	8%	4%	
Hispanic	4%	8%	4%	
Education (college or post-graduate degree)	96%	84%	88%	N.S.
Employment				
Full-time job or student	84%	84%	92%	N.S.
Part-time, retired or unemployed	16%	16%	8%	
Life-time Use of Psychedelics				
Percent reporting any past use[1]	32%	28%	20%	N.S.
Current Meditation				
Percent reporting some meditation	24%	36%	32%	N.S.
Times per month for the group (mean, SEM)	1.08 (0.44)	1.36 (0.46)	1.00 (0.37)	N.S.
Mysticism Scale Score (mean, SEM)	175.0 (8.1)	166.3 (13.8)	190.3 (10.0)	N.S.
Judged very likely to do spiritual practices[2]	8%	8%	8%	N.S.

N.S. = No significant differences between groups; ANOVA was used for continuous variables; Chi-square was used for categorical variables, with White compared to other racial categories combined and Full-time job or student compared to other employment categories combined.

[1] Mean number of years since last use among those who reported using was 25.1 years.

[2] Judgment made by based on an interview by one of the investigators.

Instructions to participants and guides, and the purpose of a third session

Study instructions and procedures were designed to minimize some of the effects of expectancy. Participants and guides were told that participants would receive psilocybin during each session, that dose levels could range between very low to high, that each participant would receive two or more different dose levels across two or three sessions, and that all participants would have at least one session with a moderately high or high dose of psilocybin. Although the most important comparative data on attitudinal and behavioral change were obtained in the first two sessions and subsequent follow-up, 39 participants were assigned to receive a third session after the 6-month data assessment in which they received 30 mg/70 kg psilocybin. This design feature was used in part to control expectancies through the 6-month follow-up evaluation. Although participants and guides were informed that over two or three sessions all participants would receive one or more high doses of psilocybin, they were not informed which participants or how many participants would be scheduled for a third session, nor were they told that the third session would be a high dose. In fact, all 25 participants in the low-dose psilocybin group (LD-SS) were assigned to receive a third session. An additional 14 participants (eight and six from HD-SS and HD-HS, respectively) were also assigned to receive a third session. Nine of these 14 participants were distributed within the first one-third (25) participants enrolled in the study. The purpose of scheduling a third session in these 14 participants was to obscure the study design from the guides early in the trial and reduce the possibility that guides would have strong expectancies whether or not a participant would have a third session. Data from the third session and data from several exploratory measures are beyond the scope of this report and are not presented.

Guide-participant meetings and support for spiritual practice

The guide-participant meetings served the functions of establishing rapport, providing specific preparation for the psilocybin sessions (see Johnson *et al*., 2008), and providing instructions and support for spiritual practices. The primary guides had established personal meditation practices as well as extensive experience supporting psilocybin sessions. An assistant guide was usually present at these meetings. Except for the dialogue-group meetings described below, the same primary and assistant guides were paired with a given participant throughout the study. Guide-participant meetings began and ended with a brief period of meditation.

Standard-Support groups

The frequency of guide-participant meetings differed across the standard vs. high-support conditions. Before the first psilocybin session (in the 1-month period following enrollment) guides and participants in the two standard-support groups (Low-Dose Standard-Support group; High-Dose Standard-Support group) had three 1-hour meetings and one 2-hour meeting (5 total contact hours). After each of the first two psilocybin sessions, participants in the standard-support group met for 1 hour within one or two days (usually one day) and had a 10 minute teleconference with guides about 2 weeks later. Thus, the total guide-participant contact hours for those in the Standard-Support groups from study acceptance to the 6-month follow-up was about 7 hours and 20 minutes.

High-Support group

Before the first session (in the 1 month period following enrollment) participants and guides in the High-Dose High-Support group had five 2-hour meetings (10 total contact hours). Between the first and second psilocybin sessions (1 month apart) there were three 1-hour participant-guide meetings (3 total contact hours). As with the Standard-Support groups, the first of these meetings was scheduled within a day or two following the session. During the 4-month period after the second psilocybin session, 1-hour participant-guide meetings occurred within a day or two of the session, at weekly intervals for the first 2 weeks, and at twice-monthly intervals for the remainder of the 4 months (10 contact hours). Also during the 4-month period after the second psilocybin session, participants in the High-Support group participated in twice-monthly 90-minute dialogue-group sessions. Approximately eight study participants plus one or two facilitators (study staff) participated in each session. The group membership changed over sessions as individual participants entered and left the group as they progressed through the study. The facilitators provided an opportunity to discuss psilocybin experiences but mainly encouraged dialogue about successes and challenges in implementing and sustaining the regular spiritual practices of meditation, spiritual awareness, and journaling. The total guide-participant contact hours for the High-Support group from study acceptance to the 6-month follow-up was 35 hours.

Spiritual practice support

At the first guide-participant meeting, each participant was given: (1) a copy of the book, *Meditation: A Simple 8-Point Program for Translating Spiritual Ideals into Daily Life* (Easwaran, 1991/1978); (2) a blank journal; and (3) a one-page outline of spiritual practice suggestions. All participants were required to read the book on meditation and integration of spiritual values into daily life. This book was used as a primary teaching resource because its approach provides an easily understood, nonsectarian program for spiritual living that has shown increases in measures of spirituality, well-being, self-efficacy, and health outcomes (Flinders *et al.*, 2007; Oman *et al.*, 2006, 2008a,b). The spiritual practice suggestions had three primary elements: meditation (10 to 30 minutes of sitting meditation daily); daily awareness practice (use of mantra and one-pointed attention in daily activities); and daily self-reflective journaling of insights, benefits, and challenges of spiritual practice in daily life. Participants were also encouraged to engage in activities they personally judged to facilitate spiritual growth (e.g. being in nature, contemplative movement, artwork, or service activities). At each of the guide-participant meetings, the guide asked about, encouraged, and offered instructions in the participant's implementation of the spiritual practice suggestions.

Psilocybin sessions

Psilocybin doses were prepared in opaque, size 0 gelatin capsules of identical appearance, with lactose as the inactive capsule filler. On each session, a single capsule was administered with 180 mL water. As described in more detail previously (Griffiths *et al.*, 2006), psilocybin sessions were conducted in an aesthetic livingroom-like environment with two guides present. Participants were instructed to consume a low-fat breakfast before arriving at the research unit at about 08:15 in the morning. A urine sample was taken to verify abstinence from common drugs of abuse and that female participants were not pregnant. For most of the time during the session, participants were encouraged to lie down on the couch, use an eye mask to block external visual distractions, and use headphones through which a program of classical and world music was played. The same music program was played for all participants in all sessions. Throughout the session, guides were nondirective and supportive and they encouraged participants to focus their attention on their inner experiences.

Measures assessed throughout the session

Ten minutes before and 30, 60, 90, 120, 180, 240, 300, and 360 minutes after capsule administration, blood pressure, heart rate, and monitor ratings were obtained by session guides as described previously (Griffiths *et al.*, 2006). Blood pressure (systolic and diastolic pressure using oscillometric method with the blood-pressure cuff placed on the arm) and heart rate were monitored using a Non-Invasive Patient Monitor Model 507E (Criticare Systems, Inc., Waukesha, WI). At the same time-points the two session guides completed the Monitor Rating Questionnaire, which involved rating or scoring several dimensions of the participant's behavior or mood (Table 2). The dimensions that are expressed as peak scores in Table 2 were rated on a 5-point scale from 0 to 4. Data were the mean of the two monitor ratings at each time-point.

Measures assessed 7 hours after drug administration

When psilocybin effects had subsided, participants completed four questionnaires: *Hallucinogen Rating Scale (HRS)* (Strassman *et al.*, 1994); *5-Dimension Altered States of Consciousness (5DASC)* (Dittrich, 1998); *Mysticism Scale* (Experience-specific version rated on a 9-point scale) (Hood *et al.*, 2001, 2009); and the *States of Consciousness Questionnaire (SOCQ)* (Griffiths *et al.*, 2006). Thirty items on the SOCQ comprise the *Mystical Experience Questionnaire* (MEQ30), which has been shown to be sensitive to mystical-type subjective effects of psilocybin in laboratory studies as well as in survey studies of psilocybin mushroom use (Barrett *et al.*, 2015; MacLean *et al.*, 2012). A total score (mean of all 30 items) and four factor scores were assessed: (1) Mystical, comprising items assessing internal and external unity, sacredness, and noetic feelings; (2) Positive mood (e.g. joy, peace awe); (3) Transcendence of time and space; (4) Ineffability. A participant was designated as having had a "complete" mystical experience if scores on each of the four factors was ≥60% of the maximum possible factor score (Barrett *et al.*, 2015). The MEQ30 is a psychometrically more rigorous derivation of the Pahnke-Richards scale, which has been described previously (Griffiths *et al.*, 2006).

Table 2. Cardiovascular measures and guide ratings of volunteer behavior and mood assessed throughout the session.

Measure	Low-Dose Standard-Support	High-Dose Standard-Support	High-Dose High-Support
Cardiovascular Measures (peak effects)			
Systolic blood pressure (mm Hg)	129.38 (2.37)	145.50 (2.62)***	148.54 (3.33)***
Diastolic blood pressure (mm Hg)	77.44 (1.71)	83.46 (1.68)**	85.22 (1.50)***
Heart rate (beats per minute)	75.74 (1.81)	91.04 (2.70)***	89.96 (2.77)***
Guide Ratings (peak effects, max score=4)			
Overall drug effect	1.17 (0.09)	2.68 (0.14)***	2.82 (0.10)***
Anxiety or Fearfulness	0.31 (0.09)	1.01 (0.17)*	1.43 (0.33)***
Distance from ordinary reality	0.75 (0.11)	2.46 (0.18)***	2.43 (0.11)***
Systematized ideas of reference	0.04 (0.02)	0.14 (0.05)	0.17 (0.06)*
Yawning	0.46 (0.15)	0.76 (0.23)	1.16 (0.24)*
Tearing/Crying	0.19 (0.11)	1.02 (0.17)	2.56 (0.72)***+
Nausea/vomiting	0.06 (0.04)	0.44 (0.15)*	0.5 (0.11)**
Joy/intense happiness	0.46 (0.09)	1.98 (0.20)***	1.8 (0.16)***
Peace/harmony	0.87 (0.13)	2.00 (0.20)***	1.72 (0.13)***
Psychological Discomfort	0.14 (0.06)	0.75 (0.17)**	0.87 (0.17)***
Physical Distress	0.07 (0.03)	0.56 (0.18)**	0.57 (0.13)**

Data are means of the peak response in each of the two psilocybin sessions in each participant. Group means with 1 SEM in parentheses (*n*=25) are shown.
Within a row, asterisks indicate a significant difference from the Low-Dose Standard-Support group (*p<.05, **p<.01, ***p<.001, Planned comparisons), and + indicates a significant difference between the High-Dose High-Support and High-Dose Standard-Support groups (p<.05, Planned comparisons).

Spiritual practices assessed at the 6-month follow-up

Spiritual practices questionnaire

This questionnaire assessed engagement with the three primary spiritual practices that were the focus of the spiritual practice teachings, the guide-participant meetings, and the dialogue-group meetings. Participants were instructed to complete the questionnaire based on their spiritual practices over the past 4 months (since the second psilocybin session). Participants rated the frequency and duration of their usual meditation practice, the frequency of their daily awareness practice (e.g. mantra repetition during daily activities), and the frequency of their self-reflective journaling.

Persisting effects assessed at the 6-month follow-up

Persisting effects questionnaire

This questionnaire assessed changes in attitudes, moods, behavior, and spiritual experience and has been shown sensitive to the effects of psilocybin 14 months after a psilocybin session (Griffiths *et al.*, 2011). Participants were asked to rate any current persisting effects that they attributed to the experiences during either or both of the two psilocybin sessions. One hundred forty items were rated on a 6-point scale (0=none, not at all; 1=so slight cannot decide; 2=slight; 3=moderate; 4=strong; 5=extreme, more than ever before in your life and stronger than 4). Within the questionnaire, the items were labeled in six categories: Attitudes about life (13 positive and 13 negative items); Attitudes about self (11 positive and 11 negative items); Mood changes (9 positive and 9 negative items); Relationships (9 positive and 9 negative items); Behavioral changes

(1 positive and 1 negative item); Spirituality (22 positive and 21 negative items). The positive and negative items were intermixed within each category. For purposes of scoring the resulting 12 scales (positive and negative scales for each of six categories) scores were expressed as the percentage of the maximum possible score.

The questionnaire included three additional questions (see Griffiths *et al.*, 2006 for more specific wording): (1) How personally meaningful was the experience? (rated from 1 to 8, with 1=no more than routine, everyday experiences; 7=among the five most meaningful experiences of my life; and 8=the single most meaningful experience of my life); (2) Indicate the degree to which the experience was spiritually significant to you? (rated from 1 to 6, with 1=not at all; 5=among the five most spiritually significant experiences of my life; 6=the single most spiritually significant experience of my life); (3) Do you believe that the experience and your contemplation of that experience have led to change in your current sense of personal well-being or life satisfaction? (rated from +3=Increased very much; 0=No change; -3=Decreased very much).

Longitudinal measures assessed at baseline and at the 6-month follow-up

At baseline (immediately after study enrollment) and at the 6-month follow-up, a battery of measures focused on attitudes, dispositions, and behaviors thought to be relevant to changes that could occur with engagement in psilocybin-facilitated spiritual practice was assessed. These measures included the previously described *Hood Mysticism Scale (Lifetime)* completed with reference to lifetime experience (Hood *et al.*, 2001); *Faith Maturity Scale*, a questionnaire assessing the degree to which a person embodies the priorities, commitments, and perspectives of faith as these have been understood in mainline Protestant traditions (Benson *et al.*, 1993); *Brief RCOPE*, a measure of religious/spiritual coping with stressful life events (Pargament, 1999; Pargament *et al.*, 1998); *Daily Spiritual Experience Scale*, a measure of an individual's perception of and interaction with the transcendent in daily life (Underwood, 2006; Underwood and Teresi, 2002), scored from 5 (Many times a day) to 0 (Never/almost never); *Death Transcendence Scale*, a 26 item questionnaire rated on a 7-point scale that assesses five subscales reflecting attitudes about death (Hood and Morris, 1983; VandeCreek, 1999); *Gratitude Questionnaire (GQ-6)*, a measure of gratefulness and appreciation in daily life (McCullough *et al.*, 2002); *Coherence and Death Acceptance subscales of the Life Attitude Profile - Revised* (LAPR), these 15 questions assess a dimension (Coherence subscale) of life meaning reflecting a logically integrated analytical and intuitive understanding of self, others, and life in general and a dimension (Death Acceptance subscale) reflecting death acceptance (Reker, 2007); *Trait Forgiveness Scale*, a measure of trait forgiveness (Berry *et al.*, 2005); *TRIM-18*, a scale assessing forgiveness of interpersonal transgression (McCullough *et al.*, 2006); the 3-item *Forgiveness* subscale of the *BMMRS* (The Fetzer Institute, 1999); *Santification of Strivings* rated life strivings on the dimensions of sacred, spiritual, holy, heavenly, and blessed (Mahoney *et al.*, 2005); *Schwartz Value Scale*, a measure of relative importance of various life values (Schwartz, 1992, 1994); *Inclusion of Others in the Self* scale (IOS), a measure of interpersonal closeness (Aron *et al.*, 1992), mean score of ratings of closest person, closest family member, least close family member, a stranger, and a difficult personal relationship; *ASPIRES (Assessment of Spirituality and Religious Sentiments)*, a community observerrated and self-rated questionnaire assessing a construct that reflects an individual's effort to create a broad sense of personal meaning in his or her life, reflected in three factors: Prayer Fulfillment, Universality, and Connectedness (Piedmont, 2010); the *Dispositional Positive Emotions Scale*, a measure assessing seven scales of positive emotion (joy, contentment, pride, love, compassion, amusement, and awe) (Shiota *et al.*, 2006); *Life-Orientation Test-Revised (LOT-R)*, a measure of optimism associated with health outcomes (Scheier *et al.*, 1994); *Satisfaction with Life Scale* (Pavot and Diener, 1993); *Purpose in Life Test (PIL)*, a assessment of meaningfulness in life (Crumbaugh and Maholick, 1964); the *Nonattachment Scale* (NAS), a questionnaire designed to assess the Buddhist concept of nonattachment (Sahdra *et al.*, 2010); and the revised NEO Personality Inventory (NEO) (Costa and McCrae, 1992).

Community observer ratings of changes in participants' behavior and attitudes

This previously described measure was shown to be sensitive to enduring effects of psilocybin (Griffiths *et al.*, 2006, 2011, 2016). After acceptance into the study, each participant designated as raters three adults who were expected to have continuing contact with the participant (e.g. family members, friends, or colleagues at work). Ratings were conducted via a structured telephone interview approximately 1 week after the participant had been accepted into the study, 3 to 4 weeks after the last session, and as part of the 6-month follow-up. The interviewer provided no information to the rater about the participant. The structured interview consisted of asking the rater to rate the participant's behavior and attitudes using a 10 point scale (from 1=not at all, to 10=extremely) on 13 items: inner peace; patience; good-natured humor/playfulness; mental flexibility; optimism; anxiety; interpersonal perceptiveness and caring; negative expression of anger; compassion/social concern; expression of positive emotions (e.g. joy, love, appreciation); self-confidence; forgiveness of others; and forgiveness of self. For the first rating assessment, which occurred soon after acceptance into the study, raters were instructed to base their ratings on observations of and conversations with the participant over the past 3 months. On subsequent assessments, raters were told their previous ratings and were instructed to rate the participant based on interactions over the last several weeks. Data from each interview with each rater were calculated as a total score, with anxiety and anger scored negatively. Changes in each participant's behavior and attitudes after drug sessions were expressed as a mean change score (i.e. difference score) from the baseline rating across the raters. At the same assessment times, the community observer who knew the participant best (as judged by the participant at baseline) also completed via telephone interview the 35 item Observer Rated ASPIRES questionnaire, which assesses spirituality and religious sentiments (Piedmont, 2010). Seven of 225 (<6%) scheduled ratings by community observers at 6 months were missed due to failure to return calls or to the rater not having contact with the participant over the rating period.

Data analyses

Pearson Chi-square (SPSS version 22.0.0.0) was used to compare experimental groups on dichotomous variables (demographics and proportion of group endorsing specific responses). Planned comparisons among groups were conducted with z-tests of proportions.

For time-course data during psilocybin sessions, for each participant, peak score during the time-course was defined as the maximum value from pre-capsule to 6 hours post-capsule and time to peak effect was defined as the time to peak score. ANOVA (SAS version 9.2, PROC GLM) with planned comparisons between groups were used to analyze data at each time-point, peak effects, and time to peak effects for Sessions 1 and 2 separately. A similar analysis was conducted using mean peak data from Sessions 1 and 2 combined. Similar analyses were conducted comparing peak effects and time to peak effect between sessions 1 (20 mg/70 kg) and 2 (30 mg/70 kg) collapsing across the two high-dose groups (n=50).

A similar approach (ANOVA with planned comparisons between groups) was used to examine demographic data for continuous variables, data obtained 7 hours after psilocybin administration (end of session), and single time-point data from the 6-month follow-up (e.g. spiritual practices and persisting effects attributed to psilocybin).

Longitudinal measures (i.e. those measures assessed immediately after study enrollment and at the 6-month follow-up), were analyzed with a repeated measures regression model with AR(1) covariance structure (SAS version 9.2, PROC MIXED) with planned comparisons between groups. Measures that showed significant differences between groups at baseline were reanalyzed as difference from baseline scores using ANOVA (SAS version 9.2, PROC GLM) with planned comparisons between groups. If difference scores at 6 months were not significantly different between groups, those measures were dropped from further analysis. For the remaining longitudinal measures, planned comparisons between groups at 6 months were conducted. Finally, to determine if there were changes over time within each group, planned comparisons between baseline and 6-month data were examined.

Hierarchical regression analysis was used to explore the relationship of spiritual practices and psilocybin-occasioned mystical experience to various outcome measures. For this analysis, the three spiritual practice measures (minutes per day of mediation; times per day of spiritual awareness practice; times per week of spiritual journaling) were entered together in the first step of the regression model. In the second step, the mean of the Mystical Experience Questionnaire (MEQ30) total scores (completed after both psilocybin sessions) was entered into the regression model. In another analysis, MEQ30 mean total score was entered into the regression model first.

Results

Integrity of blinding procedures

After the psilocybin sessions had been completed, the five study staff members who had served as primary guides for the study completed a questionnaire that asked about their understanding of the study drug and dose conditions. Although all correctly believed that psilocybin had been administered, most made incorrect inferences about the drug or dose conditions, with three of five believing that doses higher than 30 mg/70 kg had been administered, two believing that four or more psilocybin dose levels had been administered; two believing that a drug other than psilocybin was administered (guesses included MDMA, ketamine, and dextromethorphan), and two believing that a true placebo had been administered. Surprisingly, some of these incorrect inferences were contrary to study design parameters that had been described verbally and in the consent form to participants and these primary study guides (e.g. administration of something other than psilocybin). None correctly understood the study design, although two correctly inferred that two lower dose sessions were followed by a high-dose third session.

Cardiovascular measures and guide ratings assessed throughout the session

Time-course

As expected, inspection of mean group data over time in the low-dose group (LD-LS) for sessions 1 and 2 showed evidence of only modest effects of 1 mg/70 kg psilocybin. In this group, cardiovascular effects generally reached peak at 30 minutes after capsule administration, while guide ratings reached peak at 120 minutes (Figure 1). Also as expected and as illustrated for guide ratings in Figure 1, the two high-dose groups showed similar time-courses and, compared with the low-dose group, effects in the two high-dose groups were larger, with peak cardiovascular effects occurring at 30 to 180 minutes and peak guide ratings occurring at 180 minutes. Analysis of differences in time to peak effects between the first and second sessions (20 vs. 30 mg/70 kg) for the two high-dose groups separately and combined did not show significant differences in time to peak effects for guide ratings. For the cardiovascular measures, only time to peak heart rate showed a significant difference, with peak effects occurring significantly earlier at the high dose (112 ± 13 vs. 163 ± 14 minutes for sessions 1 (20 mg/70 kg) and 2 (30 mg/70 kg) respectively, mean ± SEM for the two high-dose groups combined).

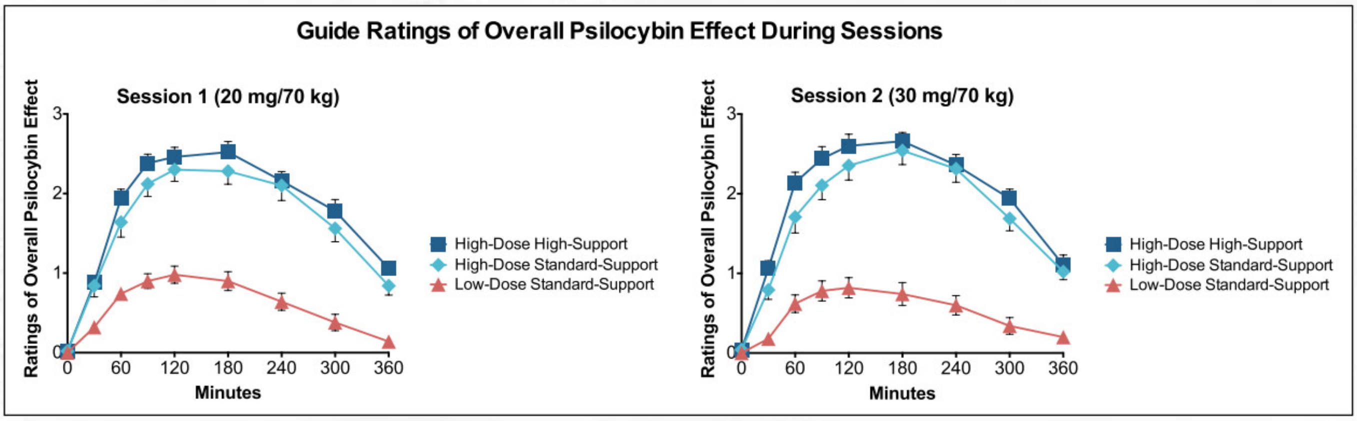


Figure 1. Within-session time-course of guide ratings of overall psilocybin effect during the sessions. Data points are means; brackets show ± 1 SEM (n=25); time 0=before capsule administration). The High-Dose High-Support and the High-Dose Standard-Support groups were significantly different from the Low-Dose Standard-Support group at all post-capsule time-points. The two high-dose groups were not significantly different at any time-points except for 60 and 90 minutes in Session 2.

Peak effects

Analysis of differences in peak effects for guide ratings between the first and second sessions (20 vs. 30 mg/70 kg) for the two high-dose groups separately and combined did not show significant differences. For the cardiovascular measures, peak systolic and diastolic pressures were modestly but significantly higher after the high dose (mean ± SEM for the two high-dose groups combined: 144 ± 2 vs. 150 ± 2 mm Hg systolic pressure for low and high doses, respectively, and 83 ± 1 vs. 86 ± 1 mm Hg diastolic pressure for low and high doses, respectively).

Given that differences between sessions 1 and 2 were minimal, and to simplify comparison across the three experimental groups, mean peak cardiovascular effects and guide ratings across the two sessions were used in subsequent analyses. For all three cardiovascular measures and for almost all of the guide ratings, the HD-SS and HD-HS groups were significantly higher than the LD-SS group (Table 2 and Figure 2). The HD-HS group differed from the HD-SS group only on guide ratings of tearing/ crying, which were higher in the HD-HS group.

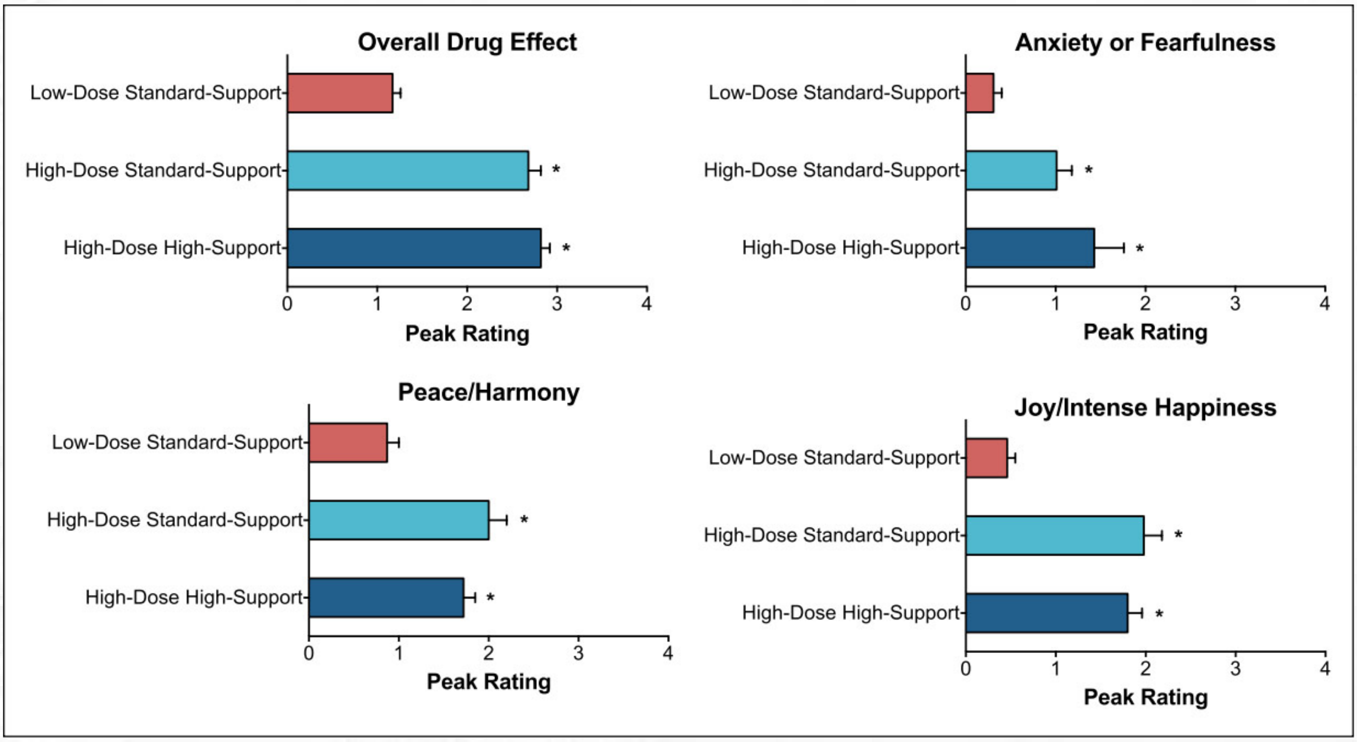


Figure 2. Guide ratings of volunteer behavior and mood assessed throughout the psilocybin sessions (Illustrative results from Table 2). Data are means of the peak response in each of the two psilocybin sessions in each participant. Bars show group means; brackets show 1 SEM; * indicates a significant difference from Low-Dose Standard-Support (Planned comparisons, p<.05); there were no significant differences between the High-Dose High-Support and High-Dose Standard-Support groups.

Drug effect and mystical-type effect measures assessed 7 hours after psilocybin administration

In an analysis similar to that described above for the peak scores during the session, participant-rated drug effect and mystical-type effect measures after psilocybin sessions did not show significant differences between sessions 1 and 2. Therefore, mean data across the two sessions were used in the analyses below.

Subjective effects questionnaires

Two participant-rated subjective effect questionnaires (HRS and 5D-ASC) completed at the end of the sessions showed a pattern of results across the experimental groups similar to peak effects from the cardiovascular and guide rated measures assessed throughout the session (Table 3). Specifically, the HD-HS and HD-SS groups were consistently higher than the LD-SS group, with no differences between the two high-dose groups. Results from these subjective measures, which were developed for sensitivity to hallucinogens, showed that psilocybin produced the expected range of subjective changes including changes in somatic effects, positive and negative affect, perception, cognition, and volition.

Table 3. Participant ratings on subjective effects and mystical experience questionnaires completed 7 hours after psilocybin administration.

Measure	Low-Dose Standard-Support	High-Dose Standard-Support	High-Dose High-Support
Hallucinogen Rating Scale (HRS)			
Intensity (max score=4.25)	1.33 (0.16)	2.92 (0.16)***	2.89 (0.11)***
Somesthesia (max score=4)	0.47 (0.07)	1.48 (0.14)***	1.53 (0.11)***
Affect (max score=4)	0.70 (0.08)	1.82 (0.14)***	1.98 (0.09)***
Perception (max score=4)	0.41 (0.08)	1.78 (0.17)***	1.74 (0.12)***
Cognition (max score=4)	0.52 (0.09)	1.90 (0.19)***	2.02 (0.13)***
Volition (max score=4)	1.16 (0.08)	1.65 (0.09)**	1.59 (0.10)***
5 Dimension Altered States of Consciousness (5D-ASC)			
Oceanic Boundlessness (OBN)(max score=100)	16.54 (3.54)	61.47 (5.56)***	69.50 (3.80)***
Dread of Ego Dissolution (DED)(max score=100)	4.73 (0.91)	20.92 (3.03)**	22.25 (4.42)**
Visionary Restructuralization (VRS)(max score=100)	16.90 (3.46)	57.68 (5.24)***	61.69 (3.44)***
Auditory Alterations (AUA)(max score=100)	4.45 (1.25)	17.04 (2.73)**	19.17 (4.02)**
Vigilance Reduction (VIR)(max score=100)	20.86 (2.53)	32.76 (2.94)**	32.05 (3.52)**
Mystical Experience Questionnaire (MEQ30) [a]			
Mystical (max score=100)	13.9 (3.5)	60.5 (7.3)***	71.8 (3.6)***
Positive mood (max score=100)	30.0 (3.6)	74.5 (4.3)***	79.8 (3.8)***
Transcendence of time and space (max score=100)	22.3 (4.1)	66.6 (5.6)***	70.6 (3.7)***
Ineffability (max score=100)	20.1 (4.1)	74.4 (6.3)***	76.3 (3.9)***
Total (max score=100)	19.4 (3.3)	65.9 (6.0)***	73.6 (3.1)***
Mysticism Scale			
Interpretation (max score=108)	48.82 (4.40)	82.42 (5.63)***	96.08 (2.39)***+
Introvertive (max score=108)	48.00 (3.74)	84.00 (5.13)***	93.20 (2.28)***
Extrovertive (max score=72)	27.44 (3.01)	48.62 (4.28)***	58.86 (2.37)***+
Total (max score=288)	124.26 (10.55)	215.04 (14.52)***	248.14 (6.14)***+

For each participant, ratings were collapsed across the two psilocybin sessions. Data are means with 1 SEM shown in parentheses (*n*=25); data for the 5D-ASC and MEQ30 are expressed as a percentage of the maximum possible score. Within a row, asterisks indicate a significant difference from the Low-Dose Standard-Support group (**p*<.05, ***p*<.01, ****p*<.001, Planned comparisons), and + indicates a significant difference between the High-Dose High-Support and High-Dose Standard-Support groups (*p*<.05, Planned comparisons).

Measures of mystical experience

Also at 7 hours after capsule administration, participants completed two questionnaires (MEQ30 and Mysticism Scale) designed to assess mystical experience (Table 3 and Figure 3). As with the other end-of-day ratings, the HD-HS and HD-SS groups were consistently higher than the LD-SS group. Furthermore, all the subscales from these questionnaires (which are believed to assess various aspects of mystical experience) are numerically higher in the HD-HS group than the HD-SS group and, for three of the four measures on the Mysticism Scale, these differences were significant (Table 3). The proportion of participants who met *a priori* criteria for having had a "complete" mystical experience on the MEQ30 on session 1 and 2, respectively, were 0% and 4% (LD-SS), 48% and 50% (HD-SS), and 44% and 52% (HD-HS). Overall, 4%, 61%, and 64% of participants in the LD-SS, HD-SS, and HD-HS groups had "complete" mystical experiences at either or both sessions 1 and 2.

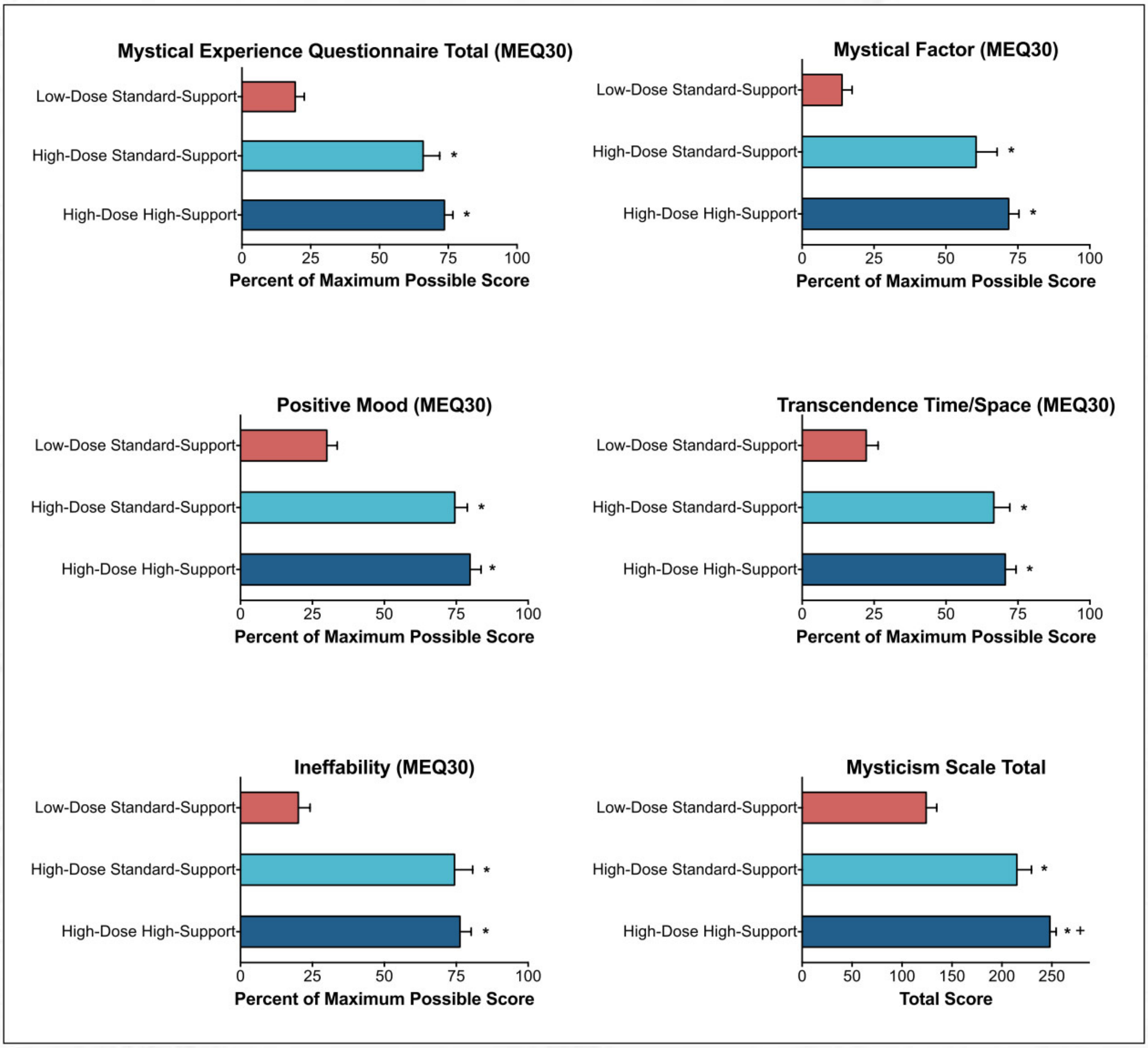


Figure 3. Participant ratings on mystical experience questionnaires completed 7 hours after psilocybin administration (Illustrative results from Table 3).
Data for the Mystical Experience Questionnaire (MEQ30) are percentages of the maximum possible score; data for the Mysticism Scale are total scores. Bars show group means; brackets show 1 SEM; * indicates a significant difference from the Low-Dose Standard-Support group; + indicates a significant difference between the High-Dose High-Support and the High-Dose Standard-Support groups (Planned comparisons, $p<0.05$).

Spiritual practices assessed at the 6-month follow-up

Spiritual practices questionnaire

Consistent with the more frequent and intensive support provided in the high spiritual support condition, rates of meditation, spiritual awareness practice, and journal writing in the HD-HS group were about twice the rates in the two standard-support groups, which were quite similar. Likewise, the percentage of participants meditating daily, engaging in spiritual practices daily, or journaling weekly was higher in the HD-HS group. As shown in Table 4 and Figure 4, the HD-HS group was significantly higher than the LD-SS and HD-SS groups on five and four, respectively, of these measures of engagement with spiritual practice. Moreover, the HD-HS group showed numerically larger effects for all six measures.

Table 4. Spiritual practices at 6 months.

Measure	Low-Dose Standard-Support	High-Dose Standard-Support	High-Dose High-Support
Meditation			
Minutes per day for all days	10.23 (2.24)	9.93 (1.69)	19.33 (0.20)**+++
Percentage of group meditating daily	32%	20%	64%*++
Spiritual awareness practice			
Times per day for all days	2.16 (0.74)	3.05 (0.87)	5.19 (0.97)*
Percentage of group practicing daily	56%	68%	96%**+
Journal writing			
Times per week	1.76 (0.49)	1.78 (0.50)	4.44 (0.52)***+++
Percentage of group journaling daily	12%	16%	40%

Data, which were obtained at the 6-month follow-up, show retrospective ratings for the past 4 months; rate data are means with 1 SEM shown in parentheses (*n*=25); proportion data are the percentage of group (*n*=25) reporting the spiritual practice.
Within a row, asterisks indicate a significant difference from the Low-Dose Standard-Support group (*p<.05, **p<.01, ***p<.001), and plus symbols indicate a significant difference between the High-Dose High-Support group and the High-Dose Standard-Support group (+p<.05, ++p<.01, +++p<.001). Significance levels were determined with z-tests for proportions for percentile data and with Planned comparisons for other numerical ratings.

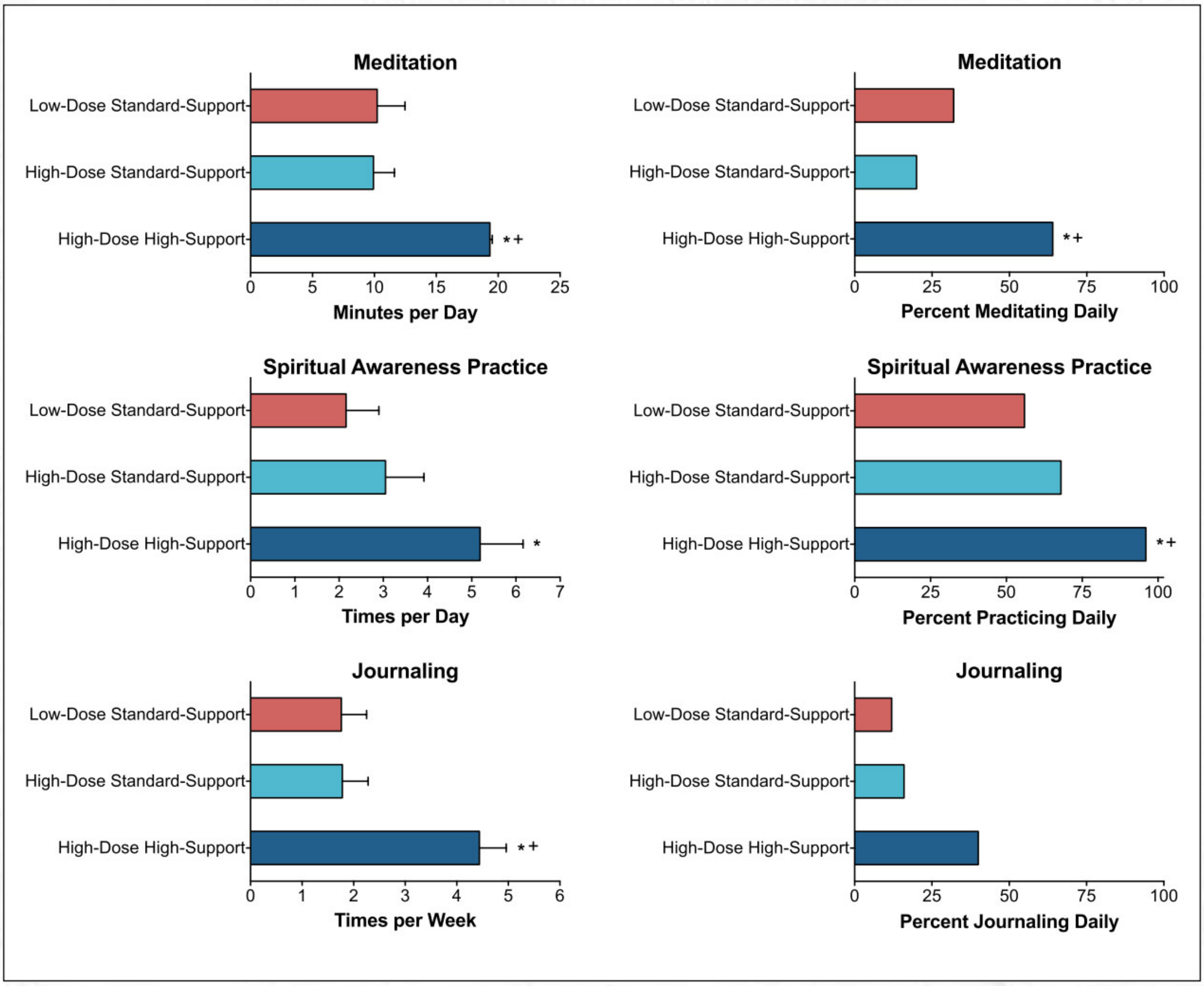


Figure 4. Spiritual practices at 6 months (from Table 4).
Data, which were obtained at the 6-month follow-up, show retrospective ratings for the past 4 months. Bars displaying rate data show means; brackets show 1 SEM (n=25). Meditation rate data are minutes per day for all days. Bars displaying proportion data show the percentage of the group (n=25) reporting the practice during the indicated time interval. * indicates a significant difference from the Low-Dose Standard-Support group; + indicates a significant difference between the High-Dose HighSupport group and the High-Dose Standard-Support group (Planned comparisons, p<0.05).

Persisting effects assessed at the 6-month follow-up

Table 5 and Figure 5 show participant ratings at the 6-month follow-up of effects that the participants attributed to either or both of the two psilocybin sessions. With regard to positive changes in attitudes, mood, altruism, and behavior as well as increased spirituality, the two high-dose groups were significantly higher than the LD-SS group on all these measures. Table S1 shows that the effect sizes for these comparisons were very large (mean Cohen's d=1.65). In addition, the HD-HS group was significantly higher than the HD-SS group on altruistic/positive social effects, positive behavior changes, and increased spirituality. Negative ratings of these same dimensions were very low and did not differ between groups except for negative attitudes about self that showed very small but significant increases in the HD-HS group. Of the eight participants in the HD-HS group that endorsed any increase in negative attitudes about self, all also rated the experience as having increased their sense of personal well-being or life satisfaction at the 6-month follow-up.

Table 5. Participant ratings of effects attributed to psilocybin session experiences at 6 month assessment.

Measure	Low-Dose Standard-Support	High-Dose Standard-Support	High-Dose High-Support
Attitudes, Moods, Behavior, & Spirituality			
Positive attitudes about life	22.71 (5.11)	61.66 (6.18)***	73.11 (4.14)***
Negative attitudes about life	0.98 (0.37)	1.66 (0.63)	3.02 (1.17)
Positive attitudes about self	23.85 (4.92)	55.35 (6.01)***	68.73 (4.22)***
Negative attitudes about self	0.44 (0.27)	2.04 (0.65)	4.00 (1.54)*
Positive mood changes	21.42 (4.42)	51.47 (5.96)***	65.42 (4.73)***
Negative mood changes	1.07 (0.60)	0.71 (0.28)	1.69 (1.30)
Altruistic/positive social effects	21.24 (4.44)	53.24 (5.85)***	67.02 (4.22)***+
Antisocial/negative social effects	0.8 (0.49)	0.36 (0.36)	1.16 (0.60)
Positive behavior changes	27.20 (4.98)	61.60 (6.76)***	78.40 (5.26)***+
Negative behavior changes	0.8 (0.82)	0.00 (0)	0.00 (0)
Increased spirituality	20.76 (4.95)	58.69 (6.36)***	73.62 (4.00)***+
Decreased spirituality	1.14 (0.44)	0.84 (0.36)	1.26 (0.94)
How personally meaningful was experience?			
Mean (max score=8)	3.80 (0.35)	6.76 (0.31)***	7.20 (0.14)***
% rating top 5 most personally meaningful	12%	84%***	84%***
% rating the single most personally meaningful	0%	28%*	36%**
How spiritually significant was the experience?			
Mean (max score=8)	2.60 (0.26)	4.68 (0.34)***	5.52 (0.12)***+
% rating top 5 most spiritually significant	12%	76%***	96%***+
% rating the single most spiritually significant	0%	40%**	56%***
Did the experience change your sense of of well-being or life satisfaction?			
Mean (max/min score= -3 to +3)	1.08 (0.23)	2.20 (0.23)***	2.60 (0.13)***
% rating moderately or very much (+2 or +3)	20%	72%***	92%***

Data on attitudes, mood, altruistic/social effects, behavior, and spirituality are means expressed as percentage of maximum possible score, with 1 SEM shown in parentheses (n=25); data for the final three questions are either mean raw scores with 1 SEM shown in parentheses or percentages of group (n=25).
Within a row, asterisks indicate a significant difference from the Low-Dose Standard-Support group (*p<.05, **p<.01, ***p<.001), and + indicates a significant difference between the High-Dose High-Support group and the High-Dose Standard-Support group (+p<.05). Significance levels were determined with z-tests for proportions for percentile data and with Planned comparisons for other numerical ratings.

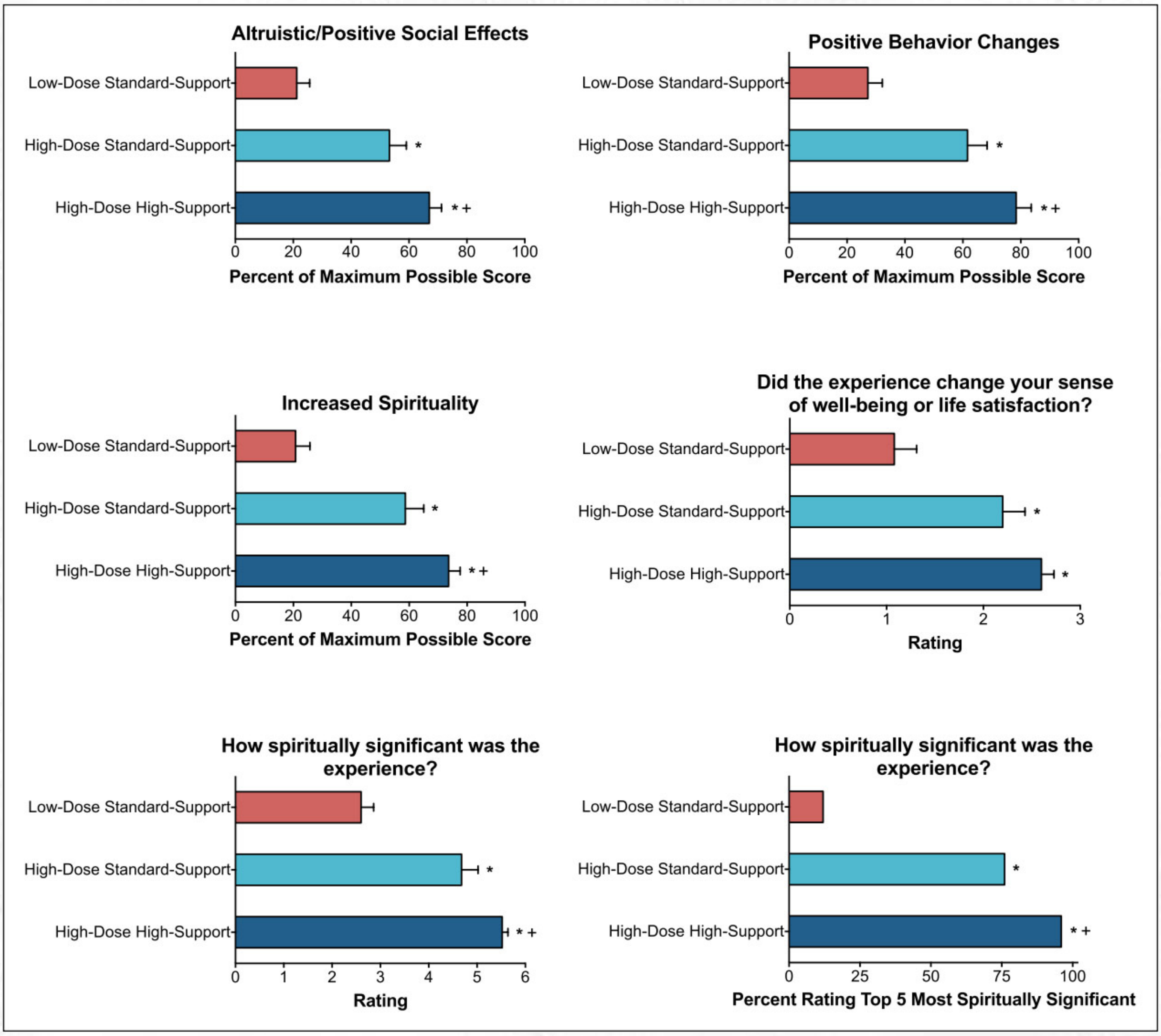


Figure 5. Participant ratings of effects attributed to psilocybin session experiences at the 6-month follow-up (Illustrative results from Table 5). Data on altruistic/social effects, behavior changes, and spirituality are expressed as percentage of maximum possible score (bars show means, brackets show 1 SEM, *n*=25). Data for the questions about spiritual significance and change in well-being or life satisfaction are either raw scores (bars show means, brackets show 1 SEM, *n*=25) or percentages of the group (*n*=25). * indicates a significant difference from the Low-Dose Standard-Support group; + indicates a significant difference between the High-Dose High-Support group and the High-Dose Standard-Support group (Planned comparisons, *p*<0.05).

Both the high-dose groups also rated the personal meaning, spiritual significance, and change in well-being or life satisfaction attributed to the sessions significantly higher than the LD-SS group (Table 5 and Figure 5). Similar findings were shown for the percentage of each group providing strong endorsements of these same three dimensions. For example, 12%, 76%, and 96% of the LD-SS, HD-SS, and HD-HS groups, respectively, rated the experience(s) among the top five most spiritual experiences of their lives, with 0%, 40%, and 56%, respectively, indicating it to be the single most spiritually significant experience of their life.

Longitudinal measures and community observer ratings assessed at 6 months

Analysis of longitudinal measures

Per the plan in the Data Analysis section, three longitudinal measures were dropped from analysis (Forgiveness subscale of the BMMRS; self-rated ASPIRES; and the Satisfaction with Life Scale) because of significant between-group differences at baseline and no significant difference in change from baseline. The

Purpose in Life Test, Nonattachment Scale, and the LOT-R [a measure of optimism] both showed significant increases from baseline to 6 months in the two High-Dose groups. The Openness scale of the NEO showed a significant increase from baseline to 6 months in the HD-HS group, but did not show a significant between-group difference at 6 months on Openness or the other four NEO scales. The DPES showed neither a significant increase from baseline to 6 months nor significant between-group differences at 6 months.

Table 6. Longitudinal measures assessed at 6 months that showed significant between group differences.

Measure	Low-Dose Standard-Support	High-Dose Standard-Support	High-Dose High-Support
Mysticism Scale: (Lifetime)			
Interpretation (max score=108)	75.64 (3.25)	**87.58 (5.10)***	**99.96 (2.05)***+**
Introvertive (max score=108)	60.72 (3.83)	**86.96 (5.75)*****	**95.08 (2.31)*****
Extrovertive (max score=172)	40.12 (3.26)	**49.22 (4.53)**	**59.80 (2.90)***+**
Total Score (max score=288)	176.48 (9.65)	**223.76 (14.78)****	**254.84 (5.82)***+**
Faith Maturity Scale (FMS)			
Total Score (max score=84)	43.96 (2.36)	**52.60 (3.24)***	**58.52 (2.15)*****
Religious Coping (Brief RCope)			
Positive Religious Coping (max score=21)	2.89 (0.89)	7.28 (1.19)**	**7.88 (1.44)****
Daily Spiritual Experience Scale (DSES)			
Total (questions 1-14; max score=70)	28.04 (3.32)	**37.88 (3.66)***	**41.56 (2.80)****
How close do you feel to God (max score=4)	1.63 (0.16)	**2.12 (0.15)***	**2.36 (0.15)****
Death Transcendence Scale (26 items)			
Mysticism scale (max score=35)	20.76 (1.83)	**26.16 (2.12)***	**30.96 (1.25)***
Religious scale (max score=35)	20.72 (1.67)	**26.36 (1.86)***	**27.67 (1.17)***
Total Score (max score=182)	113.92 (3.33)	**125.68 (4.61)***	**131.25 (3.53)***
Gratitude Questionnaire (GQ-6)			
Total Score (max score=43)	37.4 (0.82)	**39.16 (0.66)**	**39.52 (0.58)***
Life Attitude Profile (LAP-R)			
Coherence (Life meaning)(max=56)	36.08 (1.74)	**38.60 (1.85)**	**43.40 (1.60)*+**
Trait Forgiveness Scale			
Total Score (max score=50)	37.88 (1.32)	37.36 (1.43)	**41.08 (0.83)+**
Forgiveness of Transgression (TRIM-18)			
Benevolence Motivation (max score=30)	18.63 (1.11)	**22.88 (1.36)***	**23.80 (0.89)***
Avoidance Motivation (max score=35)[1]	**22.38 (1.41)**	**16.50 (1.67)***	**17.20 (1.50)***
Sanctification of Strivings			
Life strivings as sacred/spiritual (max score=5)	2.43 (0.25)	2.76 (0.26)	**3.47 (0.20)*+**
Schwartz Value Scale			
Tradition (mean centered score)	-1.58 (0.22)	-1.17 (0.24)	**-0.79 (0.19)***
Interpersonal Closeness (IOS)			
Mean rating (max score=7)	2.82 (0.20)	**3.37 (0.29)**	**3.70 (0.29)***
Observer-rated spiritual/religious sentiments (ASPIRES)			
Prayer Fulfillment (max score=50)	32.35 (1.51)	**39.58 (1.24)*****	**40.72 (0.94)****
Universality (max score=35)	24.17 (0.96)	27.04 (1.19)	28.08 (0.68)**
Total (max score=115)	76.30 (2.65)	**88.42 (2.51)****	89.60 (1.69)**
Observer-rated positive changes in behavior & attitudes			
Total change score	3.24 (0.75)	5.39 (0.93)	9.20 (1.40)***+

Outcome measures are shown in the table if there was one or more significant difference between groups at 6 months; measures showing a between-group difference at baseline were excluded unless the between-group difference was also shown in the planned comparison of change from baseline score (6-month minus baseline score).
Data are means with 1 SEM shown in parentheses (_n_=25).
Within a row, asterisks indicate a significant difference from the Low-Dose Standard-Support group (*_p_<.05, **_p_<.01, ***_p_<.001, Planned comparison), and + indicates a significant difference between the High-Dose High-Support group and the High-Dose Standard-Support group (Planned comparisons, _p_<.05).
Within a row, boldface font indicates a significant difference within the group between baseline and 6 months (Planned comparisons, _p_>.05); for all such significant differences, 6-month scores were higher than baseline scores except for Avoidance Motivation in the TRIM-18 which were lower.
[1] Lower scores on this scale indicate more forgiveness.

Table 6 shows the 23 longitudinal measures that demonstrated significant between-group differences at 6 months (Table S2 shows corresponding effect sizes). In the LD-SS group, only one measure (a measure of forgiveness) was significantly different between baseline and 6 months (Table 6, boldface font). In contrast, in the two high dose groups, most of the 23 measures were significantly different between the baseline and 6-month assessment (boldface font). For all 23 measures, the HD-HS group showed numerically larger effects (in the expected direction) than the HD-SS group (Table 6 and Figure 6), with significant differences on seven measures. Furthermore, the HD-HS group differed significantly on all 23 measures from the LD-SS group and, in contrast, on 14 of 23 measures from the HD-SS group.

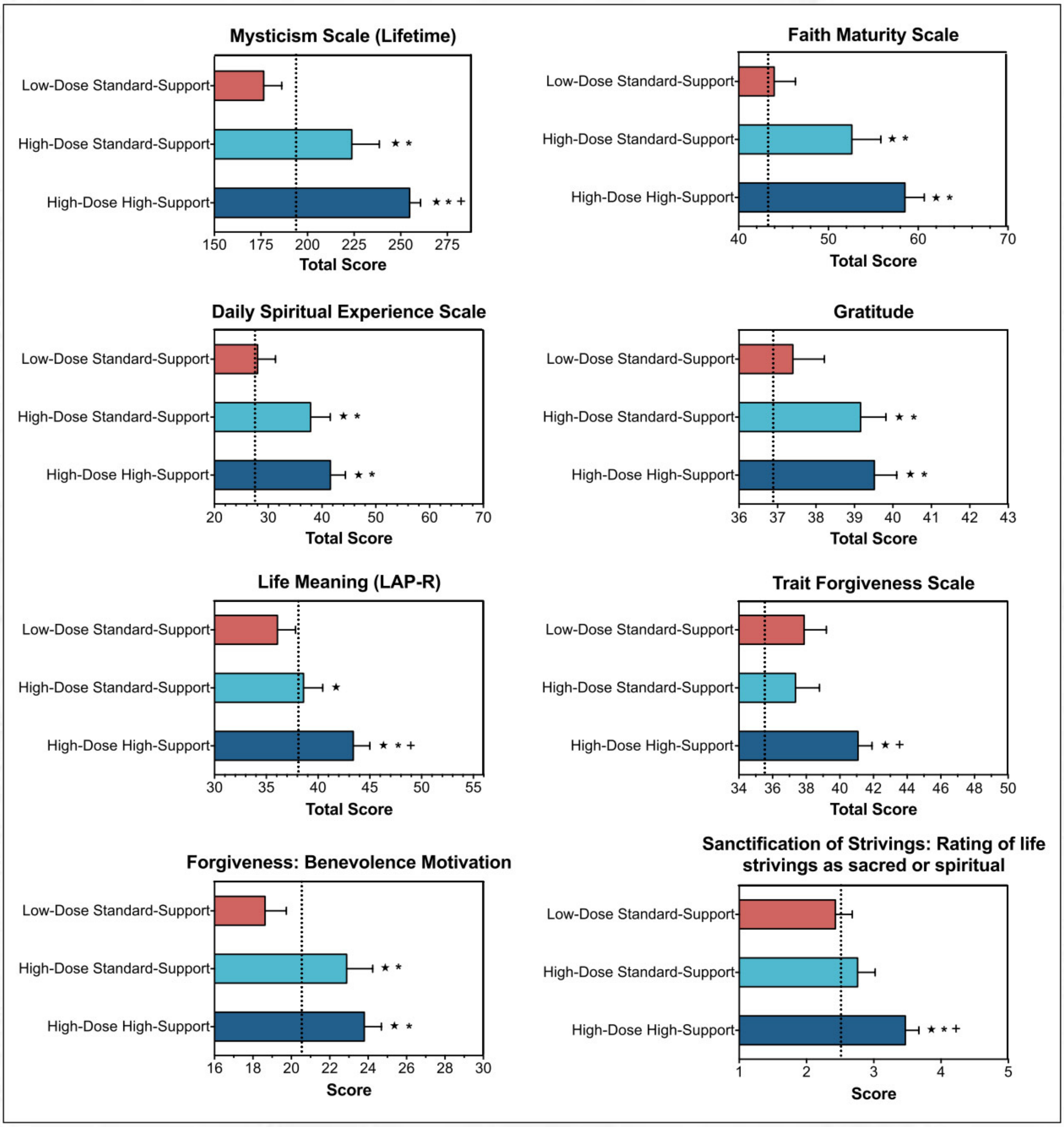


Figure 6. Longitudinal measures assessed at the 6-month follow-up (Illustrative results from Table 6). Bars show means; brackets show 1 SEM (*n*=25); &starf; indicates a significant difference between baseline and 6 months; * indicates a significant difference from the Low-Dose Standard-Support group; + indicates a significant difference between the High-Dose High-Support group and the High-Dose Standard-Support group (Planned comparisons, *p*<0.05). For comparison, dotted lines show mean scores from previous studies for each measure: Mysticism Scale (college students, Hood *et al*., 2001; Ralph W. Hood Jr, personal communication); Faith Maturity Scale (university students, Loma Linda University, 2007), Daily Spiritual Experience Scale (general population survey data, Underwood, 2006); Gratitude Questionnaire-6 (adults, McCullough *et al*., 2002); Life Meaning (college and community sample, Reker, 2007); Trait Forgiveness Scale (college students, Berry *et al*., 2005); Forgiveness Benevolence Motivation (college students, Tsang *et al*., 2006); Sanctification of Strivings (adults, Mahoney *et al*., 2005).

Community observer ratings

In addition to the various participant-rated longitudinal measures, it is noteworthy that several observer-rated measures (total score, prayer fulfillment, and universality on the ASPIRES and total change score on the community observer ratings of positive change in behavior and attitudes) generally showed the same pattern of differences across groups with the HD-HS group showing the largest effects (Table 6 and Figure 7).

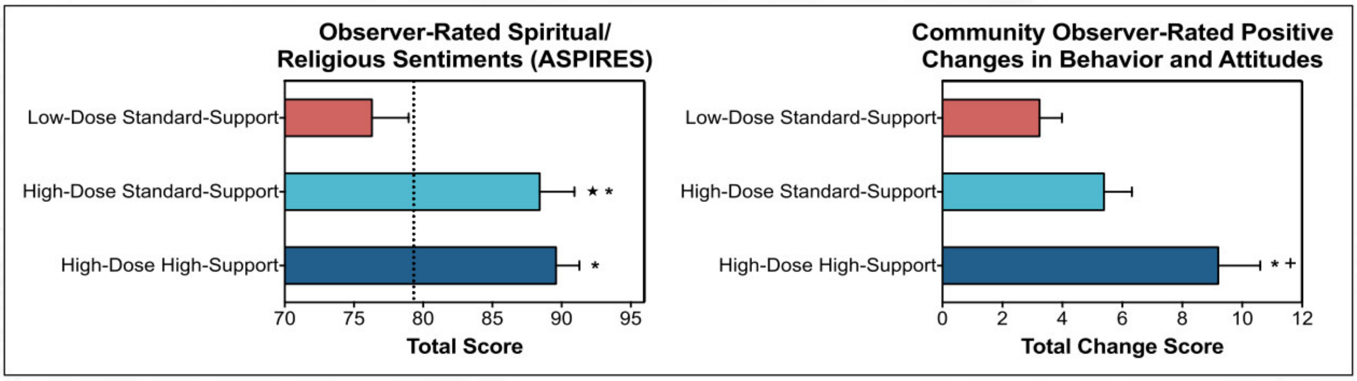


Figure 7. Two observer-rated measures of participant attitudes and behavior assessed at the 6-month follow-up (from Table 6). Bars show means; brackets show 1 SEM (*n*=25); for both measures, * indicates a significant difference from the Low-Dose Standard-Support group; + indicates a significant difference between the High-Dose High-Support group and the High-Dose Standard-Support group (Planned comparisons, *p*<0.05). For the ASPIRES, which was assessed both at baseline and the 6-month follow-up, &starf; indicates a significant difference between baseline and 6 months (Planned comparisons, *p*<0.05). Also for the ASPIRES, dotted line shows mean norm score (Piedmont, 2010).

Relationship of spiritual practice and psilocybin-occasioned mystical experience to various outcome measures

Hierarchical regression analysis was used to determine the relationship of spiritual practice and psilocybin-occasioned mystical experience to various outcome measures from Tables 5 and 6 that showed between-group differences at 6 months. For this analysis, the three spiritual practice measures (minutes per day of mediation; times per day of spiritual awareness practice; times per week of spiritual journaling) were entered together in the first step of the regression model. Mean total score from the Mystical Experience Questionnaire (MEQ30) was entered into the regression model in the second step. As shown in Table 7, spiritual practices accounted for a significant proportion of variance (R^2) in 13 of 19 outcome measures, with R^2 ranging from .050 to .293 (mean=.139). As also shown in the table, mystical experience score (MEQ30) accounted for a significant proportion of variance in 18 of 19 measures after accounting for the impact of spiritual practices, with the change in R^2 ranging from .031 to .619, (mean=.266). In contrast to MEQ30 score which was significant for 18 measures even after accounting for the contribution of spiritual practices, the rightmost columns of the table show that, for the overall regression model, meditation, awareness practice, and journaling were significant for six, two and one of the outcome measures, respectively. Not shown in the table, when MEQ30 score was entered as the first step of a regression model, it accounted for a significant proportion of variance in all 19 outcome measures, with R^2 ranging from .123 to .747 (mean=.351).

Table 7. Hierarchical regression analysis of the relationship of spiritual practices and mystical experience to the outcome measures.

Outcome Measure	Spiritual Practices* entered first					Change in model adding post-session mystical experience score (MEQ30)					Beta (standardized coefficient)				t				*p*		
	R^2	F	d	f	*p*	R^2 *change*	F	d	f	*p*	Meditation	Awareness	Journaling	MEQ**	Meditation	Awareness	Journaling	MEQ	Meditation	Awareness	Journaling
Mysticism Scale: (Lifetime) - total score	0.113	2.97	3	70	**0.038**	0.560	118.34	1	69	**0.000**	0.268	1.052	1.790	14.342	-1.09	0.06	0.34	10.88	0.282	0.949	0.736
Faith Maturity Scale	0.231	7.01	3	70	**0.000**	0.264	36.00	1	69	**0.000**	0.077	0.301	0.512	4.100	2.54	1.10	0.53	6.00	**0.013**	0.276	0.600
Positive Religious Coping	0.201	5.87	3	70	**0.001**	0.066	6.19	1	69	**0.015**	0.041	0.160	0.272	2.183	1.22	0.95	1.84	2.49	0.227	0.344	0.070
Daily Spiritual Experience Scale - total score	0.293	9.52	3	69	**0.000**	0.254	38.12	1	68	**0.000**	0.087	0.340	0.578	4.679	3.43	2.08	-0.04	6.17	**0.001**	**0.042**	0.966
Death Transcendence Scale - total score	0.058	1.44	3	70	0.239	0.285	29.93	1	69	**0.000**	0.124	0.486	0.826	6.616	-0.37	-0.52	0.70	5.47	0.712	0.606	0.489
Gratitude Questionnaire	0.050	1.24	3	70	0.302	0.166	14.62	1	69	**0.000**	0.023	0.089	0.151	1.208	1.98	-0.31	-1.75	3.82	0.052	0.761	0.085
Coherence (Life meaning and purpose)	0.084	2.11	3	69	0.107	0.329	38.06	1	68	**0.000**	0.052	0.204	0.347	2.811	1.64	-1.08	0.38	6.17	0.105	0.282	0.708
Trait Forgiveness Scale	0.083	2.10	3	70	0.108	0.100	8.43	1	69	**0.005**	0.043	0.167	0.284	2.277	1.79	0.12	-0.09	2.90	0.078	0.901	0.927
Forgiveness - benevolence motivations	0.116	2.96	3	68	**0.038**	0.196	19.04	1	67	**0.000**	0.038	0.148	0.250	2.041	2.24	0.43	-0.63	4.36	**0.029**	0.673	0.533
Forgiveness - avoidance motivations	0.120	3.10	3	68	**0.032**	0.081	6.77	1	67	**0.011**	0.054	0.211	0.357	2.914	-2.77	-0.31	0.91	-2.60	**0.007**	0.761	0.367
Sanctification of Strivings	0.173	4.86	3	70	**0.004**	0.131	12.99	1	69	**0.001**	0.008	0.031	0.053	0.422	1.32	0.94	1.10	3.60	0.191	0.351	0.275
Schwartz Value Scale - Tradition	0.060	1.49	3	70	0.224	0.091	7.37	1	69	**0.008**	0.008	0.030	0.051	0.411	0.06	0.66	0.46	2.72	0.954	0.515	0.644
Interpersonal closeness	0.079	2.01	3	70	0.121	0.065	5.26	1	69	**0.025**	0.010	0.037	0.064	0.509	0.98	0.95	0.10	2.29	0.332	0.348	0.923
Observer-rated spiritual/religious sentiments	0.141	3.73	3	68	**0.015**	0.291	34.36	1	67	**0.000**	0.076	0.281	0.485	3.868	2.68	0.50	-1.38	5.86	**0.009**	0.617	0.173
Observer-rated positive behavior and attitude change score	0.248	7.71	3	70	**0.000**	0.031	2.97	1	69	0.089	0.037	0.146	0.249	1.995	0.85	2.00	2.11	1.72	0.400	**0.049**	**0.039**
Positive attitudes about life, self, mood, altruism, behavior, and spirituality***	0.170	4.44	3	65	**0.007**	0.542	120.35	1	64	**0.000**	0.001	0.005	0.008	0.069	0.85	0.77	0.75	10.97	0.397	0.445	0.458
Personal meaning of session experiences	0.132	3.50	3	69	**0.020**	0.551	118.26	1	68	**0.000**	0.009	0.036	0.059	0.472	-2.17	0.56	0.71	10.88	**0.033**	0.578	0.482
Spiritual significance of session experiences	0.132	3.49	3	69	**0.020**	0.619	169.17	1	68	**0.000**	0.007	0.027	0.045	0.359	-0.90	0.69	0.36	13.01	0.372	0.490	0.719
Change in well-being/life satisfaction	0.166	4.57	3	69	**0.006**	0.436	74.53	1	68	**0.000**	0.006	0.023	0.038	0.303	-0.73	1.26	1.08	8.63	0.471	0.214	0.284

The first 15 measures are total scores from measures shown in Table 6 and the last four measures are from Table 5; bold font indicates probability <.05.
*Spiritual Practices were: Meditation (minutes per day), Spiritual Awareness Practice (times per day), and Journaling (times per week).
**MEQ: Mean total score of the Mystical Experience Questionnaire (MEQ30).
***This participant-rated measure is a composite total score of the 6 subscales in Table 5 that assessed positive effects attributed to psilocybin session experiences.

Open-ended clinical interview at the 6-month follow-up

An open-ended clinical interview at the final follow-up visit was used to obtain spontaneous reports of possible persisting adverse events. There were no reports of bothersome or clinically significant persisting perception phenomena sometimes attributed to psychedelic use. Likewise, there were no reports of any non-study use of psychedelics since study enrollment. All 75 volunteers appeared to continue to be psychiatrically healthy, high-functioning, productive members of society.

Adverse effects

No serious adverse events attributed to psilocybin administration or the study procedures occurred. A number of adverse events occurred during psilocybin sessions, none of which was deemed to be serious. Consistent with previous research (Griffiths *et al.*, 2006, 2011, 2016), there were transient moderate increases in systolic and/or diastolic blood pressure after psilocybin. In one participant, diastolic blood pressure was elevated (126 mmHg) about an hour after psilocybin administration in the first session. The increase met protocol criteria for administration of sublingual nitroglycerin. The session was completed uneventfully. Although this participant reported that the session experience was positively meaningful and expressed a desire to continue with the study, the participant was discontinued from further participation.

Discussion

The present study with psilocybin extends a large descriptive literature on non-drug and psilocybin-occasioned transformative mystical- and insightful-type experiences (i.e. quantum change experiences, Miller, 2004) by using a prospective experimental design to test for enduring positive changes on well-validated trait measures of prosocial attitudes and behaviors, psychological functioning, and ratings of the participant by community observers. The rigorous double-blind design, which minimized expectancy effects, showed that psilocybin-occasioned mystical experience contributed significantly to the enduring positive changes. The present study results contrast those from previous studies of psilocybin (Darling *et al.*, 2004; Doblin, 1991; Griffiths *et al.*, 2008; 2011; Leary *et al.*, 1963; Pahnke, 1963; Studerus *et al.*, 2011) and the classic psychedelic LSD (McGlothlin *et al.*, 1967; Weil *et al.*, 1965) in healthy volunteers, which have provided little evidence of enduring positive changes on well-validated trait measures of disposition. This difference seems likely due to the experimental context of the present study, which provided encouragement for engagement in a nonsectarian program of meditation and other practices that emphasized the integration of spiritual values in daily life (e.g. prosocial values, self-knowledge through examining the nature of mind, and cultivating a sense of wonder).

Effects of psilocybin dose

Effects of psilocybin dose on session days

The time-course and profile of acute psilocybin effects were consistent with previous studies that have administered these doses of psilocybin to healthy volunteers under similar conditions (Griffiths *et al.*, 2006, 2011). Comparing the low-dose group with each of the two high-dose groups, psilocybin modestly increased blood pressure and heart rate and significantly affected a range of measures assessed by guides during sessions and by participants immediately after sessions (Tables 2 and 3). The profile of these acute psilocybin effects included perceptual changes (e.g. visual pseudo-hallucinations, illusions, and/or synesthesia), labile moods (e.g. feelings of transcendence, grief, joy, and/or anxiety), and cognitive changes (e.g. sense of meaning, insight, and/or ideas of reference).

In the high-dose conditions, 20 mg/70 kg was administered in session 1 followed by 30 mg/70 kg in session 2. The rationale for administering the doses in the ascending sequence was based on previous research suggesting that ascending doses are more likely to than descending doses to produce long-lasting positive changes in attitudes, behavior, and remembered mystical-type experiences (Griffiths *et al.*, 2011). Peak blood pressure was very modestly higher after the 30 vs. 20 mg/70 kg psilocybin dose but there were no significant differences between these doses on rating by guides during sessions or in participant ratings at the end of the session. It is possible that the fixed sequence of doses contributed to a failure to detect significant differences in acute subjective effects between the two doses.

Spiritual practices at 6 months

The study did not provide evidence that psilocybin dose affected engagement with spiritual practices. As expected, compared with the two standard spiritual support conditions, participants in the high spiritual support condition showed greater engagement with the three primary spiritual practices that were taught and encouraged during the guide-participant and dialogue-group meetings (Table 4 and Figure 4). For the last 4 months of the study, participants in the high-support condition reported average rates of meditation (19.3 minutes per day), spiritual awareness practice (5.2 times per day), and journaling (4.4 times per week) that were about double those reported in the standard-support groups. Likewise, the proportion of volunteers meditating daily, doing spiritual practices daily, or journaling daily was generally significantly higher than that in the two standard-support groups. However, the LD-SS and HD-SS groups were not significantly different on any of these six measures, indicating that, under the conditions of the study, psilocybin did not facilitate engagement with these spiritual practices.

Persisting effects attributed to psilocybin assessed at 6 months

Consistent with a previous study (Griffiths *et al.*, 2011), compared with the low-dose group, the high psilocybin dose groups showed greater increases in persisting positive effects that participants attributed to their psilocybin session experiences (Table 5 and Figure 5). The domains of positive changes were: attitudes about life, attitudes about self, mood, altruism/positive social effects, behavior, and increased spirituality. Also relative to the low-dose group, the two high-dose groups attributed significantly greater personal meaning, spiritual significance, and change in well-being or life satisfaction to the psilocybin experience. Similar significant differences between the low-dose group and two high-dose groups were also shown on the percentage of each group providing strong endorsements of personal meaning, spiritual significance, and change in well-being or life satisfaction (Table 5 and Figure 5).

Longitudinal measures assessed at 6 months

The most intriguing assessments in this study were a series of longitudinal measures, some of which are well-validated trait measures of psychological well-being, prosocial disposition, and spiritual worldview (Table 6). In contrast to prior psilocybin research with healthy volunteers which has generally not demonstrated enduring changes such measures (Griffiths *et al.*, 2008), the present study showed generally large significant effects of psilocybin dose across a range of longitudinal measures (Table 6; Table S2 shows corresponding effect sizes). Specifically, the effect of psilocybin dose is shown by comparing the LD-SS group with the HD-SS group. Of the 23 longitudinal measures in Table 6, the HD-SS group was significantly different from the LD-SS group on 14 measures, all in the expected direction. Furthermore, within-group analysis showed that change from baseline (6-month minus baseline score) were significant on only one of 23 measures in the LD-SS group in contrast to 17 of 23 measures in the HD-SS group.

Contrary to popular beliefs that psychedelic experiences lead to rejection of traditional worldviews (Stevens, 1987), in the current study, the life value of Tradition on the Schwartz Value Scale increased significantly from baseline to 6 months in the HD-HS group and was significantly higher in this group than the LD-SS group at 6 months. This subscale comprises items assessing respect for tradition, moderation of feelings and action, humility, accepting life's circumstances, and holding religious belief and faith. It is plausible that administering psilocybin in the context of encouraging spiritual practices accounts for this effect, which is consistent with the observation that indigenous sacramental use of psilocybin-containing mushrooms, peyote, ayahuasca and other classic psychedelic-containing substances is often strongly grounded in cultural traditions (Schultes *et al.*, 1998).

In the present study, the personality domain of Openness increased from screening to 6 months in the HD-HS group but not in the HD-SS or LD-SS groups. Further, there were no between-group differences in Openness at 6 months. Further analyses of these data (not presented) did not show significant relationships between several measures of mystical-type experience and changes in Openness. These findings contrast with the results from a previous analysis that showed that psilocybin-occasioned mystical experience was associated with increases in Openness from screening to 1-2 months and to 14 months after psilocybin (MacLean *et al.*, 2011). Increases in Openness have been shown 2 weeks after administration of LSD in healthy individuals (Lebedev *et al.*, 2016). Another study showed that increases in Openness predicted greater reduction in post-traumatic stress disorder symptoms among individuals receiving MDMA-assisted psychotherapy (Wagner *et al.*, 2017). The failure to observe significant increases in Openness in the current study may be attributable to engagement in the program of spiritual practices or to some other aspect of the study design.

Evidence that high support for spiritual practices increased both the acute and enduring effects of psilocybin

Session day effects

On several measures that were assessed on session days, the effects of the high dose of psilocybin were greater in the high spiritual practices support group than in the standard-support groups. Guide ratings of tearing/crying during the session and participants scores on the Mysticism Scale (total score and two subscales) were significantly higher in the HD-HS vs. HD-SS groups (Tables 2 and 3). Furthermore, on other participant-rated measures thought to reflect aspects of mystical-type experience (total scores and subscale scores of the MEQ30, and the Oceanic Boundlessness subscale of the 5D-ASC) the HD-HS group was numerically higher than the HD-SS group. These results contrast with the subjective ratings unrelated to mystical experience (Table 3), for which there were no significant differences or consistent trends between the two high-dose groups. The higher ratings on measures of mystical-type experiences in the HD-HS vs. the HD-SS group likely reflects that, before the first session, the high-support group received about twice as much meeting time with guides, with the majority of this extra time focused on discussion of and support for spiritual practices.

Persisting effects attributed to psilocybin assessed at 6 months

As with measures of mystical experience assessed on psilocybin session days, there was evidence for the HD-HS group showing greater effects than the HD-SS group. Significant differences were shown on altruism/positive social effects, positive behavior change, and increased spirituality, as well as ratings and percentage of strong endorsements of spiritual significance (Table 5, Figure 5). Strikingly, more than half (56%) of participants in the high spiritual support condition rated their experience in one or both psilocybin sessions as the single most spiritually significant experience of their life, with 96% rating it as among the top five most spiritually significant experiences. These results indicate that administering psilocybin in a context of high support for spiritual practices increases both the reported spiritual significance of the experience per se and the attribution to it of increased spirituality.

Longitudinal measures assessed at 6 months

As with measures of mystical experience assessed on session days and persisting positive effects attributed to psilocybin at 6 months, the longitudinal measures provide evidence for greater effects in the HD-HS group than the HD-SS group (Table 6 and Figure 6). Across groups, the HD-HS group showed numerically greater effects than the HD-SS group on 22 of the 23 measures, and showed statistically significant differences on seven of 23 measures. Furthermore, the HD-HS group differed significantly from the LD-SS group on all 23 measures, in contrast to the HD-SS group, which differed from the LD-SS group on 14 of 23 measures. These measures included positive changes in interpersonal closeness, gratitude, life meaning/ purpose, forgiveness, death transcendence, daily spiritual experiences, religious faith and coping, sanctification of life strivings, as well as ratings of participants by community observers. The effect sizes for these comparisons were quite large (mean Cohen's d=1.0 across all 23 measures, Table S2). Finally, within the HD-HS group, 6-month scores were significantly different from baseline on 20 of 23 measures (compared with 17 significant differences from baseline in the HD-SS group).

Relationship of spiritual practices and psilocybin-occasioned mystical experience to outcome measures

Prior research suggests an important role of psilocybin-occasioned mystical experience in the observed enduring positive changes in psychological well-being, prosocial disposition, and spiritual worldview (Garcia-Romeu *et al.*, 2014; Griffiths *et al.*, 2008, 2016; Ross *et al.*, 2016). In the present study, hierarchical regression analysis was used to examine the relationship of mystical experience and specific spiritual practices to the various outcome measures that showed between-group differences at 6 months (Table 7). The measure of mystical experience used for this analysis was the mean total score on the Mystical Experience Questionnaires (MEQ30) that were completed immediately following the two psilocybin sessions (4 and 5 months before the 6-month follow-up). Spiritual practices were assessed at the 6-month assessment with a questionnaire in which participants retrospectively rated over the past 4 months the three spiritual practices that were taught and encouraged during the study (minutes per day of mediation; times per day of spiritual awareness practice; times per week of spiritual journaling). When mystical experience alone was entered into a regression model, it accounted for a significant proportion of variance in all 19 outcome measures studied. In a separate hierarchical regression analysis, when the three spiritual practices were entered first into the regression model, they accounted for a significant proportion of the variance in 13 of 19 outcome measures studied. However, when mystical experience was subsequently entered into the model, it accounted for a significant proportion of variance in 18 of 19 measures after accounting for the impact of spiritual practices. For the overall regression model, meditation was significant on six measures (Faith Maturity Scale, Daily Spiritual Experience Scale, Forgiveness-benevolence motivations, Forgiveness-avoidance motivations, Observer-rated spiritual and religious sentiments, and Participant retrospective rating of the personal meaning of the session experiences); spiritual awareness practices were significant on two measures (Daily Spiritual Experience Scale, and Observerrated changes in behavior and attitudes); and journaling was significant on one measure (Observer-rated changes in behavior and attitudes).

Overall, these results suggest that both mystical experience and spiritual practices contribute to positive outcomes, with mystical experience making a substantially greater contribution. The fact that the measure of mystical experience preceded the assessment of outcome measures by 4-5 months strengthens the interpretation that mystical experience and/or its neurophysiological or other correlates are likely determinants of the enduring positive attitudinal, dispositional, and behavioral effects of psilocybin when administered under spiritually supported conditions.

It is interesting that a previous study with a relatively high dose (200 µg) of LSD, a different classic psychedelic, produced only moderate increases in total mystical experience scores (MEQ30), with only 12.5% of participants meeting criteria for a complete mystical experience (Liechti *et al*., 2017). Whether this lower rate of mystical experience reflects pharmacodynamic differences between psilocybin and LSD, the use of a relatively lower dose of LSD than psilocybin, and/or differences between the studies in set, setting, or participant characteristics is unknown (Barrett and Griffiths, 2017). Future research should directly compare LSD and psilocybin within subjects, ideally using procedures to minimize expectancy effects.

There was little evidence that the standard-support intervention alone affected longitudinal measures at 6 months. Of the 23 longitudinal measures (Table 6), only one measure in the LD-SS group showed a significant difference from baseline (immediately after study enrollment) to 6 months. Furthermore, across the longitudinal measures shown in Figures 6 and 7, the LD-SS group tended to be similar or lower than comparison data (e.g. norms) from previous studies. The absence of robust effects of the standard-support intervention contrasts with previous studies that showed a more intensive 8- or 9-session program using a similar intervention resulted in a variety of positive changes in spirituality, well-being, self-efficacy, and mental health outcomes (Flinders *et al*., 2007; Hedberg *et al*., 2006; Oman *et al*., 2006, 2008a,b). The lack of greater efficacy for the standard-support intervention in the present study was likely due to the minimal level of teaching and support provided to the LD-SS group.

Experimental design strengths and limitations

Strengths of the present study include the double-blind design, the use of a very low (possibly inactive) psilocybin dose as a control, and instructions to participants and guides, all serving to obscure the actual dose conditions and thereby minimizing participant and guide expectancy effects. This strategy has been used in previous psilocybin research (Griffiths *et al*., 2016). In the present study, the effects of very low dose of psilocybin (1 mg/70 kg) were compared with the high-dose conditions. The low dose was below a dose (3.15 mg/70 kg) that did not produce statistically significant effects in a previous study (Hasler *et al*., 2004). Participants and guides did report some psilocybin-like effects after the very low dose (e.g. Tables 2, 3, and 5), as might be expected under conditions in which participants (most of whom were psychedelic-naive) had been told they would receive psilocybin. For instance, three of 25 (12%) of participants in the low-dose condition rated their psilocybin session experiences to be among the five most spiritually significant of their lives.

Although the low-dose condition served as an important comparison to the high-dose conditions, in absence of a true placebo-dose condition, it is not possible to determine if the very low dose was pharmacologically active.

The integrity of blinding the guides to the study conditions was assessed with a post-study questionnaire that asked guides about their understanding of study drug and dose conditions. The finding that most guides made incorrect inferences about drug or dose conditions suggests substantial success of the blinding conditions. Guides were not required to make guesses about drug conditions after each session because we did not want to make this a focus of interest for guides. However, the absence of such guide ratings on each session precludes drawing a stronger conclusion about the success of blinding guides to study conditions.

The experimental design of the present study can be viewed as representing 3 of 4 cells of a balanced 2×2 design with dose (low dose vs. high dose) and spiritual support (standard support vs. high support) as factors. The fourth cell of a completely balanced design would be the low-dose high-support condition. Addition of that group would have permitted evaluation of the effects of high support independent of psilocybin. Although we considered the benefits of the balanced 2×2 design, we decided against it because of substantially increased study costs and because of concern that participants in this group, who receive only a low dose of psilocybin, might be less likely to comply with the more intensive schedule of participant-guide and dialogue-group meetings required in the high-support condition.

Additional limitations of the present study were the homogeneity of the participant population (predominately White, college educated, and employed) and the absence of brain-based or physiological measures of change or task-based measures such as assessment of implicit bias, emotion regulation, or social behavior. Finally, because the high-support condition involved group discussion of both spiritual practices and psilocybin experiences, the effect of group discussion of spiritual practice alone cannot be determined.

Conclusion

Although previous research shows that psilocybin, under appropriate conditions, can reliably occasion mystical-type experiences to which participants frequently attribute enduring positive changes in well-being and worldview, there has been little evidence from studies in healthy volunteers that psilocybin produces enduring changes on well-validated trait measures of disposition or personality. In the present study, psilocybin was administered in the context of undertaking a nonsectarian program of meditation and other spiritual practices that emphasized integration of spiritual values in daily life. The study showed robust interactive positive effects of psilocybin dose and added support for spiritual practices on a wide range of longitudinal measures at 6 months including interpersonal closeness, gratitude, life meaning/purpose, forgiveness, death transcendence, daily spiritual experiences, religious faith and coping, and rating of participants by community observers. Analyses suggest that the determinants of these effects were the intensity of the psilocybinoccasioned mystical experience and the rates of engagement with meditation and other spiritual practices. Most broadly, as a model system for studying so-called quantum change experiences, which have been described for centuries but which have eluded rigorous prospective experimental analysis, further investigation of psilocybin-occasioned experiences may have broad implications for the development of drug and non-drug interventions in both therapeutic and nontherapeutic applications in order to engender enduring positive trait-level changes in attitudes and behavior and in healthy psychological functioning.

Acknowledgements

The authors thank Frederick Reinholdt, M.S., Albert Garcia-Romeu, Ph.D., Daniel Evatt, Ph.D., Haley Sweet, Rosemary Flickinger and 13 other staff members for their roles as session guides. We also thank David Nichols, Ph.D. for synthesizing the psilocybin, Linda Felch M.A. for statistical analyses, Dr. Annie Umbricht for medical management, and Dr. David Addiss and Wayne Ramsey of the Fetzer Institute for help in scientific development and administrative support of this study. We are also grateful to Drs. Kenneth Pargament, Doug Oman, and Ralph Hood for helpful comments on the design of the study.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Roland Griffiths is on the Board of Directors of the Heffter Research Institute. Robert Jesse, convener of the Council on Spiritual Practices, participated in designing the study and writing the manuscript, but was not involved in data collection, analysis, or interpretation.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Conduct of this research was primarily supported by grants from the Fetzer Institute and the Council on Spiritual Practices. Some support was also provided by the Heffter Research Institute. Effort for Roland Griffiths, Ph.D. in writing this paper was partially provided by NIH grant RO1DA03889.

Supplemental Material

Supplementary material is available for this article online.

References

1. Aron A, Aron EN and Smollan D (1992) Inclusion of other in the self scale and the structure of interpersonal closeness. *J Pers Soc Psychol* 63: 596-612.
2. Barrett FS and Griffiths RR (2017) Classic hallucinogens and mystical experience: Phenomenology and neural correlates. *Curr Top Behav Neurosci*. Epub ahead of print 26 March 2017. doi: 10.1007/7854_2017_474.
3. Barrett FS, Johnson MW and Griffiths RR (2015) Validation of the revised Mystical Experience Questionnaire in experimental sessions with psilocybin. *J Psychopharmacol* 29: 1182-1190.
4. Benson PL, Donahue MJ and Erickson JA (1993) The Faith Maturity Scale: Conceptualization, measurement, and empirical validation. In: *Research in the Social Scientific Study of Religion*. Vol. 5. Greenwich, Connecticut: JAI Press Inc, pp. 1-26.
5. Berry JW, Worthington EL Jr, O'Connor LE, *et al*. (2005) Forgivingness, vengeful rumination, and affective traits. *J Pers* 73: 183-225.
6. Costa PT and McCrae RR (1992) *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) (Professional manual)*. Odessa, FL: Psychological Assessment Resources.
7. Crumbaugh JC and Maholick LT (1964) An experimental study in existentialism: The psychometric approach to Frankl's concept of noogenic neurosis. *J Clin Psychol* 20: 200-207.
8. Darling DC, Doblin R and Metzner R (2004) Prisoner behavior change and experimental mysticism: Two classic studies from the Harvard psilocybin project. In: Metzner R (ed.) *Teonanacatl: Sacred Mushroom of Visions*. El Verano, CA: Four Trees Press, pp. 135-151.
9. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. *Pharmacopsychiatry* 31(Suppl 2): 80-84.
10. Doblin R (1991) Pahnke's Good Friday experiment: A long-term follow-up and methodological critique. *J Transpersonal Psy* 23: 1-28.
11. Easwaran E (1991/1978) *Meditation: A Simple Eight-Point Program for Translating Spiritual Ideals into Daily Life*. 2nd ed. Tomales, CA: Nilgiri Press.
12. The Fetzer Institute (1999, Reprinted 2003) Brief multidimensional measure of religiousness/spirituality: 1999. In: *Multidimensional Measurement of Religiousness/Spirituality for use in Health Research: A Report of the Fetzer Institute/National Institute on Aging Working Group*. Kalamazoo, MI: Fetzer Institute, pp. 85-95.
13. Flinders T, Oman D and Flinders CL (2007) The eight-point program of passage meditation: Health effects of a comprehensive program. In: Plante TG and Thoresen CE (eds) *Spirit, Science and Health: How the Spiritual Mind Fuels Physical Wellness*. Westport, CT: Praeger, pp. 72-93.
14. Garcia-Romeu A, Griffiths RR and Johnson MW (2014) Psilocybin-occasioned mystical experiences in the treatment of tobacco addiction. *Curr Drug Abuse Rev* 7: 157-164.
15. Griffiths RR, Johnson MW, Carducci MA, *et al*. (2016) Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *J Psychopharmacol* 30: 1181-1197.
16. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology* 218: 649-665.
17. Griffiths RR, Richards W, Johnson M, *et al*. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632.
18. Griffiths RR, Richards WA, McCann U, *et al*. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-283; discussion 284-292.
19. Grob CS, Danforth AL, Chopra GS, *et al*. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.

20. Hasler F, Grimberg U, Benz MA, *et al*. (2004) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. *Psychopharmacology* 172: 145-156.
21. Hedberg J, Oman D, Thoresen CE, *et al*. (2006) [Passage mediation caregivers' project: An eight-point program of spiritually based self-management tools] Unpublished document.
22. Hood RW Jr, Ghorbani N, Watson PJ, *et al*. (2001) Dimensions of the mysticism scale: confirming the three-factor structure in the United States and Iran. *J Sci Stud Relig* 40: 691-705.
23. Hood RW Jr, Hill PC and Spilka B (2009) *The Psychology of Religion: An Empirical Approach*. 4th ed. New York: The Guilford Press.
24. Hood RW Jr and Morris RJ (1983) Toward a theory of death transcendence. *J Sci Stud Relig* 22: 353-365.
25. James W (1902, Republished 1958) *The Varieties of Religious Experience*. New York: Penguin Books.
26. Johnson M, Richards W and Griffiths R (2008) Human hallucinogen research: Guidelines for safety. *J Psychopharmacol* 22: 603-620.
27. Leary T, Litwin GH and Metzner R (1963) Reactions to psilocybin administered in a supportive environment. *J Nerv Ment Dis* 137: 561-573.
28. Lebedev AV, Kaelen M, Lövdén M, *et al*. (2016) LSD-induced entropic brain activity predicts subsequent personality change. *Hum Brain Mapp* 37: 3203-3213.
29. Liechti ME, Dolder PC and Schmid Y (2017) Alterations of consciousness and mystical-type experiences after acute LSD in humans. *Psychopharmacology* 234: 1499-1510.
30. Loma Linda University (2007) *Preliminary Findings from the 2007 Loma Linda University Wholeness Inventory*. Available at: https:// home.llu.edu/sites/home.llu.edu/files/docs/assessment/6-WI_2007-PrelimFindings.pdf (accessed 27 February 2017).
31. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
32. MacLean KA, Leoutsakos JM, Johnson MW, *et al*. (2012) Factor analysis of the mystical experience questionnaire: A study of experiences occasioned by the hallucinogen psilocybin. *J Sci Stud Relig* 51: 721-737.
33. Mahoney AM, Pargament KI, Cole B, *et al*. (2005) A higher purpose: The sanctification of strivings in a community sample. *Int J Psychol Relig* 15: 239-262.
34. Maslow AH (1968) *Toward of Psychology of Being*. New York: John Wiley & Sons.
35. McCullough ME, Emmons RA and Tsang J (2002) The grateful disposition: A conceptual and empirical topography. *J Pers Soc Psychol* 82: 112-126.
36. McCullough ME, Root LM and Cohen AD (2006) Writing about the benefits of an interpersonal transgression facilitates forgiveness. *J Consult Clin Psychol* 74: 887-897.
37. McGlothlin W, Cohen S and McGlothlin MS (1967) Long lasting effects of LSD on normals. *Arch Gen Psychiatry* 17: 521-532.
38. Miller WR (2004) The phenomenon of quantum change. *J Clin Psychol* 60: 453-460.
39. Miller WR and C'de Baca J (2001) *Quantum Change: When Epiphanies and Sudden Insights Transform Ordinary Lives*. New York: Guilford Press.
40. Oman D, Hedberg J and Thoresen CE (2006) Passage meditation reduces perceived stress in health professionals: A randomized, controlled trial. *J Consult Clin Psychol* 74: 714-719.
41. Oman D, Richards TA, Hedberg J, *et al*. (2008a) Passage meditation improves caregiving self-efficacy among health professionals: A randomized trial and qualitative assessment. *J Health Psychol* 13: 1119-1135.
42. Oman D, Shapiro SL, Thoresen CE, *et al*. (2008b) Meditation lowers stress and supports forgiveness among college students: A randomized controlled trial. *J Am Coll Health* 56: 569-578.
43. Pahnke W (1963) *Drugs and Mysticism: An Analysis of the Relationship Between Psychedelic Drugs and the Mystical Consciousness*. PhD thesis. Cambridge, MA: Harvard University, Department of Religion and Society.
44. Paloutzian RF and Park CL (2013) *Handbook of the Psychology of Religion and Spirituality*. 2nd edn. New York: Guilford Press.
45. Pargament KI (1999, Reprinted 2003) Religious/spiritual coping. In: *Multidimensional Measurement of Religiousness/Spirituality for Use in Health Research: A Report of the Fetzer Institute/National Institute on Aging Working Group*. Kalamazoo, MI: Fetzer Institute, pp. 43-56.
46. Pargament KI, Smith BW, Koenig HG, *et al*. (1998) Patterns of positive and negative religious coping with major life stressors. *J Sci Stud Relig* 37: 710-724.
47. Passie T (2004) A history of the use of psilocybin in psychotherapy. In: Metzner R (ed.) *Teonanacatl: Sacred Mushroom of Visions*. El Verano, CA: Four Trees Press, pp. 109-134.
48. Passie T (2007) Contemporary psychedelic therapy: An overview. In: Winkelman MJ and Roberts TB (eds) *Psychedelic Medicine*. Vol. 1. Westport CN: Praeger, pp. 45-68.
49. Pavot W and Diener E (1993) Review of the satisfaction with life scale. *Psychol Assessment* 5: 164-172.
50. Piedmont RL (2010) *ASPIRES: Assessment of Spirituality and Religious Sentiments (Technical Manual)*. 2nd ed. Columbia, MD: Loyola University Maryland, Department of Pastoral Counseling.
51. Reker GT (2007) *The Life Attitude Profile-Revised (LAP-R) (Procedures Manual)*. Research edn. Peterborough, ON: Student Psychologists Press.
52. Ross S, Bossis T, Guss J, *et al*. (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *J. Psychopharmacol* 30: 1165-1180.
53. Sahdra BK, Shaver PR and Brown KW (2010) A scale to measure nonattachment: A Buddhist complement to Western research on attachment and adaptive functioning. *J Pers Assess* 92: 116-127.
54. Scheier MF, Carver CS and Bridges MW (1994) Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *J Pers Soc Psychol* 67: 1063-1078.
55. Schultes RE, Hofmann A and Rätsch C (1998) *Plants of the Gods: Their Sacred, Healing, and Hallucinogenic Powers*. Rochester VT: Healing Arts Press.
56. Schwartz SH (1992) Universals in the content and structure of values: Theoretical advances and empirical tests in 20

countries. In: Zanna MP (ed.) *Advances in Experimental Social Psychology*. Vol. 25. New York: Academic Press, pp. 1-65.

57. Schwartz SH (1994) Are there universals in the content and structure of values? *J Soc Issues* 50: 19-45.
58. Shiota MN, Keltner D and John OP (2006) Positive emotion dispositions differentially associated with Big Five personality and attachment style. *J Posit Psychol* 1: 61-71.
59. Stace WT (1960) *Mysticism and Philosophy*. Philadelphia: Lippincott.
60. Stevens J (1987) *Storming Heaven*. New York: Harper & Row Publishers.
61. Stout RL, Wirtz PW, Carbonari JP, *et al*. (1994) Ensuring balanced distribution of prognostic factors in treatment outcome research. *J Stud Alcohol Suppl* 12: 70-75.
62. Strassman RJ, Qualls CR, Uhlenhuth EH, *et al*. (1994) Dose-response study of *N,N*-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. *Arch Gen Psychiatry* 51: 98-108.
63. Studerus E, Kometer M, Hasler F, *et al*. (2011) Acute, subacute and longterm subjective effects of psilocybin in healthy humans: A pooled analysis of experimental studies. *J Psychopharmacol* 25: 1434-1452.
64. Tsang JA, McCullough ME and Fincham FD (2006) The longitudinal association between forgiveness and relationship closeness and commitment. *J Soc Clin Psychol* 25: 448-472.
65. Underwood LG (2006) Qualitative research, interpretative guidelines, and population distribution for the Daily Spiritual Experience Scale. *Arch Psychol Relig* 28: 181-218.
66. Underwood LG and Teresi JA (2002) The daily spiritual experience scale: Development, theoretical description, reliability, exploratory factor analysis, and preliminary construct validity using healthrelated data. *Ann Behav Med* 24: 22-33.
67. VandeCreek L (1999) The death transcendence scale (Hood and Morris, 1983). In: Hill PC and Hood RW (eds) *Measures of Religiousity*. Birmingham AL: Religious Education Press, pp. 442-445.
68. Wagner MT, Mithoefer MC, Mithoefer AT, *et al*. (2017) Therapeutic effect of increased openness: Investigating mechanism of action in MDMA-assisted psychotherapy. *J Psychopharmacol* 31: 967-974.
69. Weil GM, Metzner R and Leary T (1965, Reprinted 1997) The subjective after-effects of psychedelic experiences: A summary of four recent questionnaire studies. In: Weil GM, Metzner R and Leary T (eds) *The Psychedelic Reader*. Secaucus, NJ: Citadel Press, pp. 13-21.

The Therapeutic Potential of Psychedelic Drugs: Past, Present, and Future

by

Robin L Carhart-Harris[*,1] **and Guy M Goodwin**[2]

Neuropsychopharmacology (2017) 42, 2105-2113; doi:10.1038/npp.2017.84; published online 17 May 2017

Received 21 March 2017; revised 10 April 2017; accepted 20 April 2017; accepted article preview online 26 April 2017

© 2017 American College of Neuropsychopharmacology

original report: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5603818/pdf/npp201784a.pdf
backup source: http://www.psilosophy.info/resources/npp201784a.pdf

[1] Psychedelic Research Group, Centre for Psychiatry, Division of Brain Sciences, Faculty of Medicine, Imperial College London, London, UK;
[2] University of Oxford Department of Psychiatry and Oxford Health NHS Foundation Trust, Warneford Hospital, Oxford, UK

*Correspondence:
Dr RL Carhart-Harris,
Psychedelic Research Group, Centre for Psychiatry,
Division of Brain Sciences, Faculty of Medicine,
Imperial College London, London W12 0NN, UK,
Tel: +44 0 20 7594 7992, Fax: +44 0 20 7594 8921,
E-mail: r.carhart-harris@imperial.ac.uk

Table of Contents:

- Abstract
- The therapeutic potential of psychedelic drugs: tempered optimism (RLC-H)
- A brief history of psychedelic research
- The present revival
- Psychedelics for mental illness
- The therapeutic potential of psychedelic drugs; Upbeat pessimism (GMG)
- Finding signal amidst the psychedelic noise
- The patient population
- The trial design
- The outcome measures
- Does the psilocybin experience really belong in medicine?
- How to move the field forward (GMG and RLC-H)
- Funding and disclosure
- Acknowledgments
- References

Abstract

Plant-based psychedelics, such as psilocybin, have an ancient history of medicinal use. After the first English language report on LSD in 1950, psychedelics enjoyed a short-lived relationship with psychology and psychiatry. Used most notably as aids to psychotherapy for the treatment of mood disorders and alcohol dependence, drugs such as LSD showed initial therapeutic promise before prohibitive legislature in the mid-1960s effectively ended all major psychedelic research programs. Since the early 1990s, there has been a steady revival of human psychedelic research: last year saw reports on the first modern brain imaging study with LSD and three separate clinical trials of psilocybin for depressive symptoms. In this circumspective piece, RLC-H and GMG share their opinions on the promises and pitfalls of renewed psychedelic research, with a

focus on the development of psilocybin as a treatment for depression.

The therapeutic potential of psychedelic drugs: tempered optimism (RLC-H)

"*Your assumptions are your windows on the world. Scrub them off every once in a while, or the light won't come in.*"
(Isaac Asimov, 1919-1992)

A brief history of psychedelic research

Psychedelic drugs (*Psychedelic* is a neologism that combines the words psychē (ψ υ χ ή, 'soul') and dēloun (δ η λ ο ῦ ν, 'to make visible, to reveal'), to denote 'mind-revealing' in reference to the category of drugs in question. I use the term in preference to 'hallucinogens' due to the latter's arguably misleading emphasis on these compounds' hallucinogenic properties. When using the term 'psychedelics' I refer to those compounds with appreciable serotonin 2A receptor agonist properties that can alter consciousness in a marked and novel way. LSD can be considered the prototypical or 'reference-standard' psychedelic.) awakened a significant cultural zeitgeist in mid-twentieth century (Stevens, 1987, see Table 1). Catalyzed by early reports on the unique potency and remarkable subjective effects of lysergic acid diethylamide (LSD) in the early 1950s, psychedelics, and particularly LSD, became widely used by psychologists and psychiatrists in research and clinical practice, with tens of thousands of patients estimated to have been treated with 'psychedelic psychotherapy' over a period of about 15 years (Grinspoon and Bakalar, 1979). From the mid-60s, psychedelic research was increasingly prevented from having the capacity to inform and potentially advance thinking and practice in psychology and psychiatry, but as popular and countercultural movements increasingly embraced the drugs, their societal impact skyrocketed (Grinspoon and Bakalar, 1979; Lee and Shlain, 1992; Stevens, 1987).

Table 1 Notable Landmarks of Mid-Twentieth Century Psychedelic Research Plus Events of Cultural Significance

Year	Landmark	References
1943	LSD's psychoactive effects discovered by Albert Hofmann (16th and 19th April)	Hofmann, 1980
1947	Werner Stoll publishes first paper on psychological effects of LSD in humans	Stoll, 1947
1950	First English language publication on LSD	Busch and Johnson, 1950
c. 1953	ACNP Founding president Joel Elkes (President in 1961) publishes on LSD after openly self-experimenting with it	Bradley *et al*, 1953; Roberts, 2008
1954	Aldous Huxley's 'The Doors of Perception' published: documents mescaline self-experiment	Huxley, 1954
1956	Term 'psychedelic' coined by Humphrey Osmond in communication with Aldous Huxley	Huxley, 1980
1957	Term 'magic mushrooms' coined by LIFE magazine	Wasson, 1957
1958	Identification of psilocybin in magic mushrooms by Albert Hofmann	Hofmann *et al*, 1958
1959	Closed conference held in Princeton on 'the use of LSD in psychotherapy', Jonathan Cole attends, an early ACNP president	Abramson, 1959
1960	First major European conference on psychedelics; Sidney Cohen publishes positive meta-analysis on LSD safety	Passie, 1996; Cohen, 1960
1961	Jonathan Cole (ACNP president 1965-66) expresses 'very mixed feelings on psychedelic research' as critical commentaries emerge	Mangini, 1998
1962	The Marsh Chapel or 'Good Friday' experiment conducted at Harvard under Timothy Leary's supervision but without institutional approval	Pahnke, 1966; Mangini, 1998

1963	Leary dismissed from Harvard; Aldous Huxley and JFK die (both on 22nd November)	Stevens, 1987
1964	Cole takes 'sober look' at psychedelics in JAMA; discussions on LSD take center stage at 1964 APA meeting; Ken Kesey travels across US taking LSD with 'Merry Pranksters'	Mangini, 1998; Cole and Katz, 1964; Stevens, 1987; Wolfe, 1968
1965	Sandoz stop manufacture of LSD and psilocybin	Stevens, 1987
1966	Prohibition of psychedelics and curtailment of research begins in US; Senator Robert Kennedy formally questions this move	Stevens, 1987; Lee and Shlain, 1992
1967	Timothy Leary declares 'turn on, tune in and drop out' at festival in Golden Gate Park	Stevens, 1987
1970	President Nixon signs Controlled Substances Act, LSD and psilocybin made Schedule 1	Stevens, 1987; Lee and Shlain, 1992

Abbreviations: ACNP, American College of Neuropsychopharmacology; JAMA, *Journal of the American Medical Association*; NIMH, National Institute of Mental Health.

The present revival

Human psychedelic research fell into a 25-year hiatus before scientists in Germany (Hermle *et al*, 1992), the United States (Strassman and Qualls, 1994), and Switzerland (Vollenweider *et al*, 1997) began its revival. There now exists a foundation of human neuroimaging (Carhart-Harris *et al*, 2012a, 2016d; Daumann *et al*, 2010; Muthukumaraswamy *et al*, 2013; Palhano-Fontes *et al*, 2015; Preller *et al*, 2017; Riba *et al*, 2004, 2006; Vollenweider *et al*, 1997), psychology (Carhart-Harris *et al*, 2015, 2016c; Carter *et al*, 2007; Gouzoulis-Mayfrank *et al*, 2005; Griffiths *et al*, 2006; MacLean *et al*, 2011; Schmid *et al*, 2015), and psychopharmacology studies with psychedelics (Kometer *et al*, 2012; Preller *et al*, 2017; Valle *et al*, 2016; Vollenweider *et al*, 1998).

These foundational studies complement a small number of early phase clinical trials (Table 2). There are now positive preliminary reports on the safety and tolerability of psilocybin for obsessive compulsive disorder (Moreno *et al*, 2006), psilocybin, and LSD for end-of-life psychological distress (Gasser *et al*, 2014; Griffiths *et al*, 2016; Grob *et al*, 2011; Ross *et al*, 2016), psilocybin for alcohol (Bogenschutz *et al*, 2015), and tobacco addiction (Johnson *et al*, 2014) and ayahuasca (Osorio Fde *et al*, 2015) and psilocybin for major depressive disorder (Carhart-Harris *et al*, 2016a,b). An important caveat here, is that many of these trials report on small sample sizes and would best be described as 'safety and tolerability' studies by conventional standards (Schunemann *et al*, 2006), and while all of them do report outcomes consistent with potential efficacy, most have not been appropriately designed to demonstrate it conclusively. GMG critically discusses two of the largest and better designed trials in the next section (Griffiths *et al*, 2016; Ross *et al*, 2016).

Psychedelics for mental illness

Plant-based psychedelics have been used for hundreds if not thousands of years for holistic healing (Hofmann, 1980) and there remains an active culture of self-medication with psychedelics for mental health (Carhart-Harris and Nutt, 2010; Waldman, 2017). Contrary to the alarmist campaigning that so negatively affected perceptions of psychedelics after the 1960s, subjective (Carhart-Harris and Nutt, 2010, 2013; van Amsterdam *et al*, 2015), naturalistic/ observational (Bouso *et al*, 2012), and population-based data (Hendricks *et al*, 2015) indicate a positive association between psychedelic drug use and mental health, albeit with some important caveats, which will be discussed below.

Progressing to more controlled medical use, psychedelics piqued the interest of psychologists and psychiatrists in the 1950s, who noted early on that they may 'serve as new tools for shortening psychotherapy' (Busch and Johnson, 1950). A recent meta-analysis of 19 studies of psychedelics for mood disorders published between 1949 and 1973 found that 79% of patients showed 'clinically judged improvement' post treatment (Rucker *et al*, 2016). Moreover, a meta-analysis of studies of LSD for alcoholism performed in the 50-60s was similarly supportive of its potential (Krebs and Johansen, 2012). The absence of standardized diagnostic techniques, measures of symptom severity, and lack of randomization and control conditions in these studies needs to be properly heeded, but equally, it would be self-defeating to dismiss their findings outright.

Table 2 Clinical Trials Involving Psychedelics Published During the Present 'Second Wave' of Psychedelic Research

Study	Population/indication and sample size	Drug and design	Main efficacy outcome
Moreno *et al* (2006)	Obsessive compulsive disorder, *n*=9	Psilocybin: single-arm, within subjects, variable doses. Up to four doses of psilocybin	All patients showed improvements within 24 h of a treatment but no effect of dose
Grob *et al* (2011)	Anxiety and depression in endstage cancer, *n*=12	Psilocybin: DB-RCT, crossover, inert placebo. Single dose of psilocybin	Significant reductions in trait anxiety at 3 months and depression at 6 months
Johnson *et al* (2014)	Long-term chronic tobacco smoking, *n*=15	Psilocybin: open-label. Up to three doses of psilocybin after four CBT sessions	80% of sample abstinent at 6 month follow-up
Gasser *et al* (2014)	Anxiety related to life-threatening disease, *n*=12	LSD: DB-RCT, crossover, very low dose (VLD) LSD = control. Single dose of LSD	Significant decreases in state and trait anxiety *vs* VLD at 2 months and sustained for 12 months
Bogenschutz *et al* (2015)	Alcohol dependence, *n*=10	Psilocybin: open-label. Up to two doses after seven motivational therapy sessions	Significant decrease in drinking behaviors for up to 9 months
Osorio Fde *et al* (2015) and Sanches *et al* (2016)	Major depressive disorder (MDD), *n*=6+study extension to *n*=17	Ayahuasca: open-label. Single dose of ayahuasca	Significant decreases in depressive symptoms for up to 21 days
Carhart-Harris *et al* (2016a,b)	Treatment-resistant MDD, *n*=12+study extension to *n*=20	Psilocybin: open-label. Two doses of psilocybin	Significant decreases in depressive symptoms for up to 6 months
Ross *et al* (2016)	Anxiety and depression related to life-threatening cancer, *n*=29	Psilocybin: DB-RCT, crossover, niacin=active placebo. Single dose of psilocybin	Significant decreases in anxiety and depression *vs* niacin at 7 weeks (pre crossover) and sustained for 6.5 months
Griffiths *et al* (2016)	Anxiety and depression related to life-threatening cancer, *n*=51	Psilocybin: DB-RCT, crossover, VLD psilocybin=control. Single dose of psilocybin	Significant decreases in anxiety and depression *vs* VLD at 5 weeks (pre crossover). Effects sustained for 6 months

Abbreviations: DB-RCT, double-blind randomised controlled trial; VLD, very low dose; MDD, major depressive disorder; TRD, treatment-resistant depression.

The modern era of controlled research with psychedelics has seen the adoption of more careful experimental designs, together with a more critical approach to outcomes. In 2006, a double-blind randomized controlled (DB-RC) study compared the acute and longer-term psychological effects of single high doses of psilocybin (30 mg) and methylphenidate (40 mg) in healthy volunteers. Significantly, greater improvements in psychological well-being were observed after psilocybin than methylphenidate at the 2-month end point and more than half considered their psilocybin experience to be among the most personally meaningful experiences of their lives (Griffiths *et al*, 2006). Since then, the focus has shifted to include patients with symptoms of depression and anxiety. Three DB-RC trials have assessed the impact of a single dose of psilocybin on depressive symptoms in patients with life-threatening cancer (Griffiths *et al*, 2016; Grob *et al*, 2011; Ross *et al*, 2016) and an open-label trial of psilocybin for treatment-resistant depression (TRD) has been completed (Carhart-Harris *et al*, 2016a,b). All four studies, and particularly the three most recent, found rapid, marked, and enduring anti-anxiety and depression effects post psilocybin. Significant improvements in obsessive compulsive disorder symptoms (Moreno *et al*, 2006) and alcohol dependence with psilocybin (Bogenschutz *et al*, 2015), anxiety with LSD (Gasser *et al*, 2014), and depression with ayahuasca (Osorio Fde *et al*, 2015; Sanches *et al*, 2016) help supplement the case for psilocybin and inspire questions regarding the potential generalized therapeutic action of psychedelics.

Focusing on antidepressant action, psilocybin, and psychedelics more generally, share some similarities with conventional antidepressants (ie, serotonergic modulation); however, they also possess some important differences. Regarding similarities, an altered relationship with the environment may be critical to recovery with selective serotonin reuptake inhibitors (Belsky, 2016; Harmer and Cowen, 2013) and heightened sensitivity to the environment is a cardinal feature of the psychedelic state (Carhart-Harris *et al*, 2015; Hartogsohn, 2016; Kaelen *et al*, 2015), perhaps due to psychedelics' direct agonist action at the 5-HT$_{2A}$R (Dressler *et al*, 2016; Fiocco *et al*, 2007; Jokela *et al*, 2007). Regarding differences, the chronic antidepressant action of SSRIs includes reduced limbic responsiveness and emotional moderation or blunting, likely via post-synaptic 5-HT$_{1A}$ receptor signaling (Cowen and Browning, 2015; Deakin and Graeff, 1991; McCabe *et al*, 2010); this contrasts with the greater role for 5-HT$_{2A}$R signaling with psychedelics, and emphasis on emotional release

(Carhart-Harris *et al*, 2012b; Roseman *et al*, 2016; Watts *et al*, 2017). Contrasting approaches to emotion may be a fundamental difference between the SSRI and psychedelic treatment models (Figure 1).

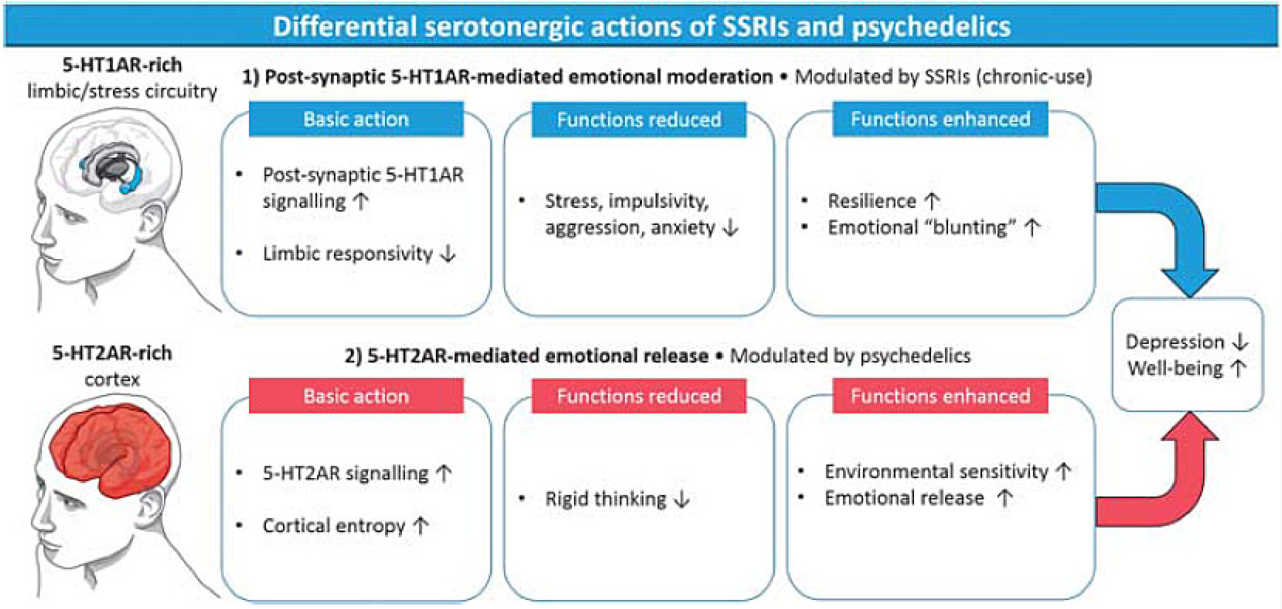

Differential serotonergic actions of SSRIs and psychedelics
5-HT1AR-rich
limbic/stress circuitry
1) Post-synaptic 5-HT1AR-mediated emotional moderation • Modulated by SSRIs (chronic-use)
Basic action
• Post-synaptic 5-HT1AR signalling ↑
• Limbic responsivity ↓
Functions reduced
• Stress, impulsivity, aggression, anxiety ↓
Functions enhanced
• Resilience ↑
• Emotional "blunting" ↑
Depression ↓
Well-being ↑
5-HT2AR-rich
cortex
2) 5-HT2AR-mediated emotional release • Modulated by psychedelics
Basic action
• 5-HT2AR signalling ↑
• Cortical entropy ↑
Functions reduced
• Rigid thinking ↓
Functions enhanced
• Environmental sensitivity ↑
• Emotional release ↑

Figure 1 A bipartite model of serotonergic functioning focused on the effects of post-synaptic 5-HT$_{1A}$R and 5-HT$_{2A}$R signaling. The more pronounced effects of chronically used SSRIs on post-synaptic 5-HT$_{1A}$R signaling is hypothesized to relate to their anti-stress, pro-coping properties but also their tendency to moderate or 'blunt' emotional responsiveness. The direct 5-HT$_{2A}$R agonist properties of psychedelics are hypothesized to relate to their proclivity to enhance sensitivity to the environment as well as facilitate emotional release, which, when combined with psychological support, is hypothesized to be therapeutically potent.

In my opinion, if the science is allowed to progress without the kind of political interference that has hindered it in the past, psilocybin with psychological support (PwPS) will become an early option in the treatment of depression. I predict that PwPS will be found to have important areas of superiority over current early interventions such as SSRIs and CBT. Specifically, PwPS's rapid and enduring action with minimal exposure, positive side-effect profile, and specific therapeutic action - working to address rather than suppress or side-step aversive memories and emotions, may set it apart from the alternative, largely 'palliative' treatment options for major depression.

> "*That is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer.*"
> (Jacob Bronowski, 1908-1974)

Another consideration is that chronic antidepressant medication strategies appear to have a muting effect on psilocybin's acute and putative antidepressant effects (Bonson *et al*, 1996; Bonson and Murphy, 1996), implying that treating medication-heavy, treatment-resistant depressed patients with psilocybin will be especially challenging (Carhart-Harris *et al*, 2016a,b). Medication discontinuation would likely be required prior to receipt of the psychedelic and this often requires careful management (Baldwin *et al*, 2007).

The therapeutic potential of psychedelic drugs; Upbeat pessimism (GMG)

> "*What Leary took down with him was the central illusion of a whole life-style that he helped to create... a generation of permanent cripples, failed seekers, who never understood the essential old mystic fallacy of the Acid Culture: the desperate assumption that somebody, or at least some force, is tending the Light at the end of the tunnel.*"
> (Hunter S Thompson. Fear and Loathing in Las Vegas, 1971)

Finding signal amidst the psychedelic noise

As a clinician long committed to the view that neuroscience should inform psychiatry, psychedelics have always looked like a serious opportunity. Their structure and pharmacology inspired a generation of neurochemists to understand neurotransmitters and their receptors. And, the very idea that drugs could usefully change the experience of distressed patients with psychiatric disorders underpinned the revolution in psychopharmacology in the three decades from 1950. However, the 'illegal' status of psychedelics stopped serious research in humans until quite recently, as RLC-H has explained.

So, can psychedelics take us back to the future? I understand the appeal that RLC-H feels for their potential. However, the difficulty in finding a medical role for psilocybin must not be underestimated. It is worth reflecting on what we have learned from the very recently published clinical trials. Their strengths and their weaknesses define the challenge. As for the strengths, when two very similarly designed but independent studies of the effects of any pharmacological agent give the same result, it is encouraging. Accordingly, the two studies in patients with cancer experiencing enduring psychiatric symptoms and given psilocybin or a comparator (Griffiths *et al*, 2016; Ross *et al*, 2016) deserve to be taken seriously. However, there have to be caveats. Are we confident that we understand the patient population? Did the trial design allow a clear question to be asked and were the outcomes meaningful?

The patient population

In the choice of patient group, why cancer patients? Ross *et al*. (2016) suggested that a domain of distress they call existential/spiritual well being is particularly relevant to depression in cancer while Griffith *et al*. (2016) emphasize that evidence for efficacy of conventional medication or psychotherapy is poor or even negative.

Symptoms of both depression and anxiety are relatively common in cancer patients. But, they are often not very severe and in fact patients may choose not to seek help in their treatment (Baker-Glenn *et al*, 2011). In a case series of 128 patients attending for their first session of chemotherapy for cancer, only about 20% indicated they would appreciate psychological help for distress, depression, or anxiety. Of these, most indicated they would appreciate the opportunity to speak to someone - but only one suggested a psychiatrist.

Significant depressive symptoms can occur in cancer patients of course and active screening of a large consecutive cohort suggested about 8% met criteria for a major depressive episode (Sharpe *et al*, 2004) and many are not offered treatment. A subsequent trial in 200 such patients was conducted to compare a nurse intervention (which included antidepressant medication as an option and problem solving) with treatment as usual (Strong *et al*, 2008). There was a clinically significant and sustained impact of intervention on depressive symptoms (and on anxiety and fatigue): 68% of the treated group achieved remission compared with 45% of the comparator group (odds ratio 3 (confidence interval: 1.6-5.5).

Thus, the case for a particular unmet need in cancer patients is actually quite difficult to sustain. The idea that cancer diagnosis poses a particular threat to existential/ spiritual well-being in some patients may be correct but there is a risk that one recruits into trials people with a particular interest in psychedelic experience, who are hence predisposed to endorse its benefits. They may not be representative of cancer patients in general. In the published study where it is reported, the rate of previous use of hallucinogens was indeed high (55% in the Ross *et al*, 2016).

The trial design

In each of the two cancer studies, the design was a crossover, which compared, respectively, low-dose/high-dose psilocybin and niacin (placebo)/high-dose psilocybin. The subjective effects of the high dose consisted in heightened states of consciousness with marked emotional accompaniments (anxiety, tearfulness, and in a few cases, paranoid ideation). These effects were as expected, given the previous literature. It is difficult to see how blinding can be maintained because the subjective effects of drug were so florid. There was some uncertainty in the ratings by support staff, who supervised the sessions blind to dosing. However, overall one must assume the patients were usually unblinded by their experience on active drug. If so, it provided the kind of cue called a demand characteristic. That is anything that makes participants in an experimental study aware of what the experimenter expects to find or how participants are expected to behave. Such issues would also be difficult to avoid in judging outcomes, without great care in preserving raters to be blind.

The outcome measures

The outcome measures of both trials are self, community, and clinician reports. Thus, they are entirely subjective, as most studies of antidepressants and anxiolytics have been. The demand problem has been noted already for patients, but it will also be problematic for third-party reports if patients communicate their own unblinding at interview. But, just as for other studies, symptoms alone are a problematic way of assessing outcome. In other words, they are not highly proximal to the disease process as for example research domain criteria dimensions have been suggested to be. But, they are also not distal enough for assessing the functional value of treatment either. More objective measures are possible. One could objectively measure simple motor activity or geolocation. Geolocation is particularly simple to obtain entirely passively from mobile phones. The resulting measure of time at home for example correlates well with depression severity in depressed bipolar patients (Palmius *et al*, 2016). In cancer patients, there is the further domain of medical care, which is known to be complicated by co-morbid depression. An increase in adherence to treatment or even efficacy could result from really effective treatment. Greater objectivity should contribute more to the picture in future research of psilocybin's potential role. Nevertheless, for the moment, subjective response remains the regulatory standard against which psychotropic drugs will be measured.

Does the psilocybin experience really belong in medicine?

The unspoken assumption, which I think we both share, is that the use of psilocybin at this stage requires a medical justification. Certainly, it started in western society as a putative aid to psychotherapy, but of course, it has an older cultural history as a constituent of magic mushrooms. Many believed and believe that the justification for the use of such drugs lies in their capacity to open the doors of perception, as Aldous Huxley put it. On this view, access to such drugs should be a recreational right, like access to alcohol, cigarettes, and increasingly cannabis. As with cannabis, medical use may be expected to promote wider discretionary use for any reason. Some may still regard this as a red light for the development of medical indications.

However, there is an important corollary to the continuing illegal status of psychedelics. It seems to me paradoxical, even incredible, that such drugs should not be available for medical use in conditions for which euthanasia is already available. In Belgium, neuropsychiatric disorders were first reported under euthanasia legislation in 2004/5. Of the first such 100 patients considered for euthanasia between 2007 and 2011, 58 had depression. Forty-eight of the total were accepted for euthanasia (35 completed) and six others had died by suicide within 12 months from the end of the study. Most patients were female, aged 40-60 years. Euthanasia for psychological suffering is similarly available in the Netherlands and Luxemburg (Thienpont *et al*, 2015).

So, I think we need psilocybin in medicine but we should not forget the failures of human logic, which mean we need high-quality clinical trials:

> "*All who drink of this remedy recover in a short time, except those whom it does not help, who all die. Therefore, it is obvious that it fails only in incurable cases.*"
> (Galen in 180 AD)

How to move the field forward (GMG and RLC-H)

Our shared interest in the development of psychedelics, and particularly psilocybin, for medical use is a major point of convergence. There may be a subtle difference in our views of the so-called 'mystical' elements of the psychedelic experience, ie, both of us see the term 'mystical' as problematic - but whereas GMG views the acute 'psychedelic experience' as irrelevant to the clinical development of psychedelics, RLC-H sees it as a potentially exploitable component - especially as it has been shown to be predictive of long-term clinical outcomes (eg, in Johnson *et al*, 2014; Bogenschutz *et al*, 2015; Griffiths *et al*, 2016; Ross *et al*, 2016; Carhart-Harris *et al*, 2016a,b). Perhaps the most notable point of divergence, however, relates to the choice of patient population for the clinical development of psilocybin for depression. For GMG, the most obvious and relevant unmet need is treatment-resistant depression (see below), and while RLC-H accepts that treatment resistance is often the first port-of-call for the development of a novel intervention, he feels that unipolar depression more generally, will prove a better indication for this treatment. In his view, psilocybin will be safest, most effective, and easiest to implement, prior to the treatment-resistant stage of illness.

Focusing on treatment-resistant depression for the moment, however, we both recognize that a significant number of patients treated first line with either a SSRI or CBT fail to respond adequately (Gaynes, 2009). Persisting symptoms lead to enduring chronicity of depression, and there is no consensus in existing guidelines on what to do next. Moreover, the efficacy of secondary intervention is often modest and new medications can introduce new side effects. The duration of distress with TRD and its economic impact are considerable. We agree that TRD represents a valid point in the treatment pathway, where a single psychedelic intervention might find a place; however, RLC-H questions whether patients must wait until their depression is significantly stamped-in before psilocybin can be considered, and based on the speed and duration of treatment responses seen in the trials listed above, it seems reasonable to ask whether early intervention with psilocybin could be prophylactic - and there is also the issue of SSRIs obstructing the potential therapeutic action of psilocybin.

If it is to be TRD, however, then patient recruitment can be based on pre-existing criteria (Sackeim, 2001) and patients meeting them will not be rare and should not be excessively treatment resistant. As noted earlier, there is a significant challenge to the issue of continuing medication, most commonly with SSRIs. There is anecdotal evidence that psychedelic effects are largely attenuated by ongoing treatment with SSRIs (Bonson *et al*, 1996) and perhaps with other antidepressants (Bonson and Murphy, 1996). Downregulation of 5-HT$_{2A}$ receptors is a feature of many different first-line antidepressant drugs (Muguruza *et al*, 2014), as well as second-line antidepressant medications (eg, atypical antipsychotics) with significant 5-HT$_{2A}$R antagonist properties (Gray and Roth, 2001). Any trial would ideally be conducted in patients withdrawn from such drugs for at least 2 weeks or so, but we accept that this is not always straightforward (Baldwin *et al*, 2007).

Moving on from questions of the optimal patient population, both of us can see merit in a multiple dose trial comparing, for example, 1, 10 and 25 mg of psilocybin. Such a design seems to overcome some of the problems any trial of a psychedelic will face. The ethical problem of equipoise seems satisfactory because we really do not know which dose, if any, will be effective, and patients can enter the study knowing that whatever group they are allocated to, they will receive active drug. The omission of a strict placebo control would be pragmatic in this sense, as expectation and preparation would be standardized. We know the highest dose of psilocybin will likely unblind participants and the expectation of a possible placebo would complicate recruitment. An approximation to an inert placebo condition may be met with the 1 mg psilocybin arm, as such a dose is likely too low to produce appreciable subjective or physiological effects (Griffiths *et al*, 2016). The differences between a dose mainly producing perceptual distortion (10 mg) and one more capable of producing the more profound, putatively 'transformative' aspects of the psychedelic experience (25 mg) is also of scientific and clinical interest.

Comparing mechanisms and/or efficacy with an established treatment would be a next step to advance the evidence base for psilocybin for TRD. For example, psilocybin could be compared with ketamine since it has some similarities: rapid, single-dose efficacy, and obvious subjective effects during its infusion. Psilocybin's distinctive subjective effects and the implications of this for blinding would still remain a major challenge; moreover, as with ketamine, there will also remain the question of how much an acute response is sustained and whether a maintenance dose may be required.

The traditional view of the mechanism, whereby psilocybin works, emphasizes the importance of accompanying psychotherapy (Johnson *et al*, 2008; Richards, 2015). Accordingly, psychedelics administered without psychological support and/or a supportive environment may have limited antidepressant efficacy, and in very rare cases, could even worsen a patient's condition (Oram, 2014). We share the view that the presence of psychological support is an essential component of the psychedelic treatment model (Johnson *et al*, 2008) but we also recognize that the magnitude and nature of its contribution needs to be better defined and tested.

Pragmatically, we accept that minimizing the active psychological work of the therapy would be desirable (eg, therapy time is expensive) and scientifically, doing so would allow drug effects and dose to be better identified.

Critically however, any such therapy minimization should not be allowed to jeopardize patient safety (Johnson *et al*, 2008). A future challenge will be to learn how psychological interventions can maximize the advantages of the psychedelic state. For example, we can imagine how cognitive therapy, attentional-bias training and/or de-sensitization could be investigated with or without psilocybin assistance.

In other respects, a psilocybin trial is easier to conduct than studies requiring continuing adherence to a daily oral dose of an antidepressant. Exposure to the treatment can be completely controlled and follow-up can be relatively pragmatic. It seems logical to determine an early proximal end point to prove initial impact of treatment and then to follow subsequent illness course as comprehensively as possible. In this way, we will be able to determine time to supplementary treatment, document recovery of symptoms and function, and perhaps objectify improvement using a simple frictionless measure of activity-like geolocation (Palmius *et al*, 2016).

In the short term, there will also be a need to demonstrate cost effectiveness. The requirement for psychological support and/or a supportive environment could be a major limitation of the psychedelic treatment model. However, direct medical costs need to be netted off against the social and economic costs of illness.

In summary, a door has been opened for the medical repurposing of psychedelics. The possibility exists that drugs like psilocybin can meet a major unmet need in the treatment of psychiatric disorders. For GMG, treatment-resistant depression is the most logical place to start because of the uncertainty around the choice of next-step treatment after an SSRI fails, and while RLC-H accepts this (Carhart-Harris *et al*, 2016a,b), he looks forward to a time when an individual may receive psilocybin before the ruts of depression are allowed to deepen (Holtzheimer and Mayberg, 2011). Regardless of who the 'right' patient population might be eventually, a key challenge now is to design the optimal trial to demonstrate efficacy, agree its validity with regulatory authorities and fund it.

Funding and disclosure

GMG is a NIHR senior investigator; the views expressed are those of the author and not necessarily those of the NHS, the NIHR or the Department of Health. GMG holds a grant from Wellcome Trust, holds shares in P1vital and has in the past 3 years served as consultant, advisor or CME speaker for Angelini, MSD, Lundbeck (/Otsuka or /Takeda), Medscape, P1Vital, Pfizer, Servier and Shire. RLC-H is supported by the Alex Mosley Charitable Trust and his research has received support from the Beckley Foundation, as part of the Beckley-Imperial Research Programme. RLC-H and GMG are currently advising Compass Pathways, a commercial initiative to develop psilocybin as a medicine.

Acknowledgments

RLC-H would like to thank Samantha Strong for the illustrations contained in Figure 1.

References

1. Abramson A (1959). *The Use of LSD in Psychotherapy*. Josiah Macy, Jr. Foundation: New York.
2. Baker-Glenn EA, Park B, Granger L, Symonds P, Mitchell AJ (2011). Desire for psychological support in cancer patients with depression or distress: validation of a simple help question. *Psychooncology* 20: 525-531.
3. Baldwin DS, Montgomery SA, Nil R, Lader M (2007). Discontinuation symptoms in depression and anxiety disorders. *Int J Neuropsychopharmacol* 10: 73-84.
4. Belsky J (2016). The differential susceptibility hypothesis: sensitivity to the environment for better and for worse. *JAMA Pediatr* 170: 321-322.
5. Bogenschutz MP, Forcehimes AA, Pommy JA, Wilcox CE, Barbosa PC, Strassman RJ (2015). Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *J Psychopharmacol* 29: 289-299.
6. Bonson KR, Buckholtz JW, Murphy DL (1996). Chronic administration of serotonergic antidepressants attenuates the subjective effects of LSD in humans. *Neuropsychopharmacology* 14: 425-436.
7. Bonson KR, Murphy DL (1996). Alterations in responses to LSD in humans associated with chronic administration of tricyclic antidepressants, monoamine oxidase inhibitors or lithium. *Behav Brain Res* 73: 229-233.
8. Bouso JC, Gonzalez D, Fondevila S, Cutchet M, Fernandez X, Ribeiro Barbosa PC *et al*. (2012). Personality, psychopathology, life attitudes and neuropsychological performance among ritual users of Ayahuasca: a longitudinal study. *PLoS ONE* 7: e42421.
9. Bradley PB, Elkes C, Elkes J (1953). On some effects of lysergic acid diethylamide (L.S.D. 25) in normal volunteers. *J Physiol* 121.
10. Busch AK, Johnson WC (1950). L.S.D. 25 as an aid in psychotherapy; preliminary report of a new drug. *Dis Nerv Syst* 11: 241-243.
11. Carhart-Harris RL, Bolstridge M, Day CMJ, Rucker J, Watts R, Erritzoe DE *et al*. (2016a). Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. *The British Association for Psychopharmacology Summer Meeting*. 17-20 July, Brighton, UK; Abstract.
12. Carhart-Harris RL, Bolstridge M, Rucker J, Day CM, Erritzoe D, Kaelen M *et al*. (2016b). Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. *Lancet Psychiatry* 3: 619-627.
13. Carhart-Harris RL, Erritzoe D, Williams T, Stone JM, Reed LJ, Colasanti A *et al*. (2012a). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 109: 2138-2143.
14. Carhart-Harris RL, Kaelen M, Bolstridge M, Williams TM, Williams LT, Underwood R *et al*. (2016c). The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol Med* 1-12.
15. Carhart-Harris RL, Kaelen M, Whalley MG, Bolstridge M, Feilding A, Nutt DJ (2015). LSD enhances suggestibility in healthy volunteers. *Psychopharmacology* 232: 785-794.
16. Carhart-Harris RL, Leech R, Williams TM, Erritzoe D, Abbasi N, Bargiotas T *et al*. (2012b). Implications for psychedelic-assisted psychotherapy: functional magnetic resonance imaging study with psilocybin. *Br J Psychiatry* 200: 238-244.
17. Carhart-Harris RL, Muthukumaraswamy S, Roseman L, Kaelen M, Droog W, Murphy K *et al*. (2016d). Neural correlates of the LSD experience revealed by multimodal neuroimaging. *Proc Natl Acad Sci USA* 113: 4853-4858.
18. Carhart-Harris RL, Nutt DJ (2010). User perceptions of the benefits and harms of hallucinogenic drug use: a web-based questionnaire study. *J Subst Use* 15: 283-300.
19. Carhart-Harris RL, Nutt DJ (2013). Experienced drug users assess the relative harms and benefits of drugs: a web-based survey. *J Psychoactive Drugs* 45: 322-328.
20. Carter OL, Hasler F, Pettigrew JD, Wallis GM, Liu GB, Vollenweider FX (2007). Psilocybin links binocular rivalry switch rate to attention and subjective arousal levels in humans. *Psychopharmacology* 195: 415-424.
21. Cohen S (1960). Lysergic acid diethylamide: side effects and complications. *J Nerv Ment Dis* 130.1: 30-40.
22. Cole JO, Katz MM (1964). The psychotomimetic drugs: an overview. *JAMA* 187: 758-761.
23. Cowen PJ, Browning M (2015). What has serotonin to do with depression? *World Psychiatry* 14: 158-160.
24. Daumann J, Wagner D, Heekeren K, Neukirch A, Thiel CM, Gouzoulis-Mayfrank E (2010). Neuronal correlates of visual and auditory alertness in the DMT and ketamine model of psychosis. *J Psychopharmacol* 24: 1515-1524.
25. Deakin JF, Graeff FG (1991). 5-HT and mechanisms of defence. *J Psychopharmacol* 5: 305-315.
26. Dressler WW, Balieiro MC, Ferreira de Araujo L, Silva WA Jr, Ernesto Dos Santos J (2016). Culture as a mediator of gene-environment interaction: cultural consonance, childhood adversity, a 2A serotonin receptor polymorphism, and depression in urban Brazil. *Soc Sci Med* 161: 109-117.
27. Fiocco AJ, Joober R, Poirier J, Lupien S (2007). Polymorphism of the 5-HT(2A) receptor gene: association with stress-related indices in healthy middle-aged adults. *Front Behav Neurosci* 1: 3.
28. Gasser P, Holstein D, Michel Y, Doblin R, Yazar-Klosinski B, Passie T *et al*. (2014). Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202: 513-520.
29. Gaynes BN (2009). Identifying difficult-to-treat depression: differential diagnosis, subtypes, and comorbidities. *J Clin Psychiatry* 70 (Suppl 6): 10-15.
30. Gouzoulis-Mayfrank E, Heekeren K, Neukirch A, Stoll M, Stock C, Obradovic M *et al*. (2005). Psychological effects of (S)-ketamine and *N,N*-dimethyltryptamine (DMT): a double-blind, cross-over study in healthy volunteers. *Pharmacopsychiatry* 38: 301-311.
31. Gray JA, Roth BL (2001). Paradoxical trafficking and regulation of 5-HT(2A) receptors by agonists and antagonists. *Brain Res Bull* 56: 441-451.
32. Griffiths RR, Johnson MW, Carducci MA, Umbricht A, Richards WA, Richards BD *et al*. (2016). Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *J Psychopharmacol* 30: 1181-1197.
33. Griffiths RR, Richards WA, McCann U, Jesse R (2006). Psilocybin can occasion mystical-type experiences having substantial

and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-283.

34. Grinspoon L, Bakalar JB (1979). *Psychedelic Drugs Reconsidered*. Basic Books: New York.
35. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstadt AL *et al*. (2011). Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.
36. Grof S (1979). *Realms of the Human Unconscious: Observations from LSD Research*. Souvenir Press: London.
37. Harmer CJ, Cowen PJ (2013). 'It's the way that you look at it'-a cognitive neuropsychological account of SSRI action in depression. *Philos Trans R Soc Lond B Biol Sci* 368: 20120407.
38. Hartogsohn I (2016). Set and setting, psychedelics and the placebo response: an extra-pharmacological perspective on psychopharmacology. *J Psychopharmacol* 30: 1259-1267.
39. Hendricks PS, Thorne CB, Clark CB, Coombs DW, Johnson MW (2015). Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *J Psychopharmacol* 29: 280-288.
40. Hermle L, Funfgeld M, Oepen G, Botsch H, Borchardt D, Gouzoulis E *et al*. (1992). Mescaline-induced psychopathological, neuropsychological, and neurometabolic effects in normal subjects: experimental psychosis as a tool for psychiatric research. *Biol Psychiatry* 32: 976-991.
41. Hofmann A (1980). *LSD: My Problem Child*. McGraw-Hill: New York.
42. Hofmann A, Heim R, Brack A, Kobel H (1958). Psilocybin, a psychotropic substance from the Mexican mushroom Psilicybe mexicana Heim. *Experientia* 14: 107-109.
43. Holtzheimer PE, Mayberg HS (2011). Stuck in a rut: rethinking depression and its treatment. Trends Neurosci 34: 1-9.
44. Huxley A (1954). *The Doors of Perception. On the author's sensations under the influence of the drug mescalin.* Chatto & Windus: London.
45. Huxley A (1980). *Moksha: Writings on Psychedelics and the Visionary Experience*. Chatto and Windus: London. pp 1931-1963.
46. Johnson M, Richards W, Griffiths R (2008). Human hallucinogen research: guidelines for safety. *J Psychopharmacol* 22: 603-620.
47. Johnson MW, Garcia-Romeu A, Cosimano MP, Griffiths RR (2014). Pilot study of the 5-HT_{2A}R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
48. Jokela M, Keltikangas-Jarvinen L, Kivimaki M, Puttonen S, Elovainio M, Rontu R *et al*. (2007). Serotonin receptor 2A gene and the influence of childhood maternal nurturance on adulthood depressive symptoms. *Arch Gen Psychiatry* 64: 356-360.
49. Kaelen M, Barrett FS, Roseman L, Lorenz R, Family N, Bolstridge M *et al*. (2015). LSD enhances the emotional response to music. *Psychopharmacology* 232: 3607-3614.
50. Kometer M, Schmidt A, Bachmann R, Studerus E, Seifritz E, Vollenweider FX (2012). Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol Psychiatry* 72: 898-906.
51. Krebs TS, Johansen PO (2012). Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
52. Lee MA, Shlain B (1992). *Acid Dreams: The Complete Social History of LSD: The CIA, The Sixties, and Beyond*. In: Rev. Evergreen (ed). Grove Weidenfeld: New York.
53. MacLean KA, Johnson MW, Griffiths RR (2011). Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
54. Mangini M (1998). Treatment of alcoholism using psychedelic drugs: a review of the program of research. *J Psychoactive Drugs* 30: 381-418.
55. McCabe C, Mishor Z, Cowen PJ, Harmer CJ (2010). Diminished neural processing of aversive and rewarding stimuli during selective serotonin reuptake inhibitor treatment. *Biol Psychiatry* 67: 439-445.
56. Moreno FA, Wiegand CB, Taitano EK, Delgado PL (2006). Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessivecompulsive disorder. *J Clin Psychiatry* 67: 1735-1740.
57. Muguruza C, Miranda-Azpiazu P, Diez-Alarcia R, Morentin B, Gonzalez-Maeso J, Callado LF *et al*. (2014). Evaluation of 5-HT_{2A} and mGlu(2/3) receptors in postmortem prefrontal cortex of subjects with major depressive disorder: effect of antidepressant treatment. *Neuropharmacology* 86: 311-318.
58. Muthukumaraswamy SD, Carhart-Harris RL, Moran RJ, Brookes MJ, Williams TM, Errtizoe D *et al*. (2013). Broadband cortical desynchronization underlies the human psychedelic state. *J Neurosci* 33: 15171-15183.
59. Oram M (2014). Efficacy and enlightenment: LSD psychotherapy and the drug amendments of 1962. *J Hist Med Allied Sci* 69: 221-250.
60. Osorio Fde L, Sanches RF, Macedo LR, Santos RG, Maia-de-Oliveira JP, Wichert-Ana L *et al*. (2015). Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. *Rev Bras Psiquiatr* 37: 13-20.
61. Pahnke WN (1966). Drugs and mysticism. *Int J Parapsychol* 8: 295-315.
62. Palhano-Fontes F, Andrade KC, Tofoli LF, Santos AC, Crippa JAS, Hallak JEC *et al*. (2015). The psychedelic state induced by ayahuasca modulates the activity and connectivity of the default mode network. *PLoS ONE* 10: e0118143.
63. Palmius N, Tsanas A, Saunders KE, Bilderbeck AC, Geddes JR, Goodwin GM *et al*. (2016). Detecting bipolar depression from geographic location data. *IEEE Trans Biomed Eng* (e-pub ahead of print).
64. Passie T (1996). Hanscarl leuner - pioneer of hallucinogen research and psycholytic therapy. *Maps Newslett* 7: 46-49
65. Preller KH, Herdener M, Pokorny T, Planzer A, Kraehenmann R, Stampfli P *et al*. (2017). The Fabric of meaning and subjective effects in LSD-induced states depend on serotonin 2A receptor activation. *Curr Biol* 27: 451-457.
66. Riba J, Anderer P, Jane F, Saletu B, Barbanoj MJ (2004). Effects of the South American psychoactive beverage ayahuasca on regional brain electrical activity in humans: a functional neuroimaging study using low-resolution electromagnetic tomography. *Neuropsychobiology* 50: 89-101.
67. Riba J, Romero S, Grasa E, Mena E, Carrio I, Barbanoj MJ (2006). Increased frontal and paralimbic activation following ayahuasca, the pan-Amazonian inebriant. *Psychopharmacology* 186: 93-98.
68. Richards WA (2015). *Sacred Knowledge: Psychedelics and Religious Experiences*. Columbia University Press: New York.
69. Roberts A (2008). *Albion Dreaming: A Popular History of LSD in Britain*. Marshall Cavendish: London.

70. Roseman L, Demetriou L, Wall MB, Nutt DJ, Carhart- Harris RL (2016). Psilocybin-assisted therapy increases amygdala responsivity to fearful faces, while reducing depressive symptoms after therapy in treatment-resistant depression. *The British Association for Psychopharmacology Summer Meeting*. 17-20 July, Brighton, UK; Abstract number C32.
71. Ross S, Bossis A, Guss J, Agin-Liebes G, Malone T, Cohen B *et al*. (2016). Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *J Psychopharmacol* 30: 1165-1180.
72. Rucker JJ, Jelen LA, Flynn S, Frowde KD, Young AH (2016). Psychedelics in the treatment of unipolar mood disorders: a systematic review. *J Psychopharmacol* 30: 1220-1229.
73. Sackeim HA (2001). The definition and meaning of treatment-resistant depression. *J Clin Psychiatry* 62(Suppl 16): 10-17.
74. Sanches RF, de Lima Osório F, Dos Santos RG, Macedo LR, Maia-de-Oliveira JP, Wichert-Ana L *et al*. (2016). Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a SPECT study. *J Clin Psychopharmacol* 36: 77-81.
75. Schmid Y, Enzler F, Gasser P, Grouzmann E, Preller KH, Vollenweider FX *et al*. (2015). Acute effects of lysergic acid diethylamide in healthy subjects. *Biol Psychiatry* 78: 544-553.
76. Sessa B (2012). *The Psychedelic Renaissance: Reassessing the Role of Psychedelic Drugs in 21st Century Psychiatry and Society*. Muswell Hill Press: London.
77. Sharpe M, Strong V, Allen K, Rush R, Postma K, Tulloh A *et al*. (2004). Major depression in outpatients attending a regional cancer centre: screening and unmet treatment needs. *Br J Cancer* 90: 314-320.
78. Schunemann HJ, Fretheim A, Oxman AD (2006). Improving the use of research evidence in guideline development: 9. Grading evidence and recommendations. *Health Res Policy Syst* 4: 21.
79. Stevens J (1987). *Storming Heaven: LSD and the American Dream*. Paladin: London.
80. Strassman RJ, Qualls CR (1994). Dose-response study of *N,N*-dimethyltryptamine in humans. I. Neuroendocrine, autonomic, and cardiovascular effects. *Arch Gen Psychiatry* 51: 85-97.
81. Stoll W (1947). Lysergsäure-diäthyl-amid, ein Phantastikum aus der Mutterkorngruppe. *Schweiz Arch Neur* 60: 1-2.
82. Strong V, Waters R, Hibberd C, Murray G, Wall L, Walker J *et al*. (2008). Management of depression for people with cancer (SMaRT oncology 1): a randomised trial. *Lancet* 372: 40-48.
83. Thienpont L, Verhofstadt M, Van Loon T, Distelmans W, Audenaert K, De Deyn PP (2015). Euthanasia requests, procedures and outcomes for 100 Belgian patients suffering from psychiatric disorders: a retrospective, descriptive study. *BMJ Open* 5: e007454.
84. Valle M, Maqueda AE, Rabella M, Rodriguez-Pujadas A, Antonijoan RM, Romero S *et al*. (2016). Inhibition of alpha oscillations through serotonin-2A receptor activation underlies the visual effects of ayahuasca in humans. *Eur Neuropsychopharmacol* 26: 1161-1175.
85. van Amsterdam J, Nutt D, Phillips L, van den Brink W (2015). European rating of drug harms. *J Psychopharmacol* 29: 655-660.
86. Vollenweider FX, Leenders KL, Scharfetter C, Maguire P, Stadelmann O, Angst J (1997). Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16: 357-372.
87. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, Vogel H, Hell D (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9: 3897-3902.
88. Waldman AA (2017). A really good day: how microdosing made a mega difference in my mood, my marriage, and my life. Knopf Publishing Group: New York.
89. Wasson RG (1957). Seeking the magic mushroom. *LIFE Magazine* 49: 100-102.
90. Watts R, Day C, Krzanowski J, Nutt D, Carhart-Harris R (2017). Patients' accounts of increased 'connection' and 'acceptance' after psilocybin for treatment-resistant depression. *J Hum Psychol* (in press).
91. Wolfe T (1968). *The Electric Kool-Aid Acid Test*. Farrar, Straus and Giroux: New York.

Entheogenic rituals, shamanism and green psychology

by

Ralph Metzner

Green Earth Foundation

European Journal of Ecopsychology 4: 64-77 (2013)

© Ralph Metzner

original text: http://eje.wyrdwise.com/v4/EJE%20v4_Metzner.pdf
backup source: http://www.psilosophy.info/resources/EJE%20v4_Metzner.pdf

Table of Contents:

- Abstract
- Introduction
- Psychedelics as sacrament or recreation
- Consciousness research with entheogens
- Entheogenic substances in shamanistic cultures
- The potentials of entheogens in healing ritual practices
- Concluding reflections
- References

Abstract

Psychedelic or consciousness-expanding drugs have been studied by Western scientific researchers as adjuncts to psychotherapy while their plant-based equivalents are used in traditional ceremonial context for healing and spiritual practice. Plant extracts from tobacco, coca, coffee and cannabis, used as sacraments in indigenous cultures have become recreational drugs in contemporary society. Research with consciousness-expanding or entheogenic substances such as MDMA, LSD and psilocybin has focused on their value as adjuncts to psychotherapy. The worldwide underground culture has adopted the use of hallucinogenic plants and fungi, such as psilocybe mushrooms, ayahuasca, iboga and peyote, in small group hybrid therapeutic-shamanic ceremonies as well as large scale events such as raves. Core elements of such hybrid rituals are: the structure of a circle, a ritual space and altar of some kind, the presence of an experienced elder or guide, the use of eye-shades or semi-darkness and the cultivation of a respectful, spiritual attitude.

Keywords: Entheogens, psychedelics, hallucinogens, consciousness expansion, MDMA, psilocybe mushrooms, ayahuasca, LSD, hybrid rituals, shamanism.

Introduction

My research interest in the potentials of psychedelic drugs for the transformation of consciousness began when I was a graduate student at Harvard University in the early 1960s, studying with Timothy Leary and Richard Alpert (who later became Ram Dass). Subsequently, I became interested in the role of altered states of consciousness (induced by plants and other methods) in three great traditional systems of transformation - shamanism, alchemy and yoga. I have now come to regard shamanic or neo-shamanic ritual use of such plants, along with herbal medicine and organic farming, as part of a worldwide movement toward a more balanced and conscious relationship with the plant realm. In this essay, I review the role of psychoactive plant medicines and speculate on how they might be integrated into society in a healthy way.

There is a question that has troubled me, and no doubt others, since the earlier heyday of psychedelic research in the 1960s, when many groups and individuals were preoccupied with the problem of assimilating new and powerful mind-altering substances into Western society. The question, simply stated, was this: how did the American Indians succeed in integrating the use of peyote into their culture, including its legal use as a sacrament to this day, when those interested in pursuing consciousness research with drugs in the dominant white culture succeeded only in having the entire field made taboo to research, and any use of the substances a criminal offense punishable by imprisonment? The use of peyote spread from Mexico to the Northern Native American tribes in the latter half of the nineteenth century, and has found acceptance as a sacrament in the ceremonies of the Native American Church. It is recognized as one kind of religious ritual that some of the tribes practice; and it is acknowledged by sociologists for its role as an antidote for alcohol abuse.

This intriguing puzzle in ethnopsychology and social history was relevant to me personally, since I was one of the psychedelic researchers, who saw the enormous transformative potentials of "consciousness expanding" drugs, as we called them, and were eager to continue the research into their psychological significance. It would be fair to state that none of the early explorers in this field, in the fifties and early sixties, had any inkling of the social turmoil that was to come, nor the vehemence of the legal-political reaction. Certainly Albert Hofmann, the Swiss chemist who discovered LSD, an epitome of the cautious, conservative scientist, has testified to his dismay and concern over the proliferation of patterns of abuse of what he so poignantly called his "problem child" (*Sorgenkind*).

Thus resulted the strange paradox that the substances regarded as a social evil and a law-enforcement problem in the mainstream dominant culture are the sacrament of one particular sub-culture within that larger society. Since the surviving Native American cultures are older and in many ways ecologically more sophisticated than the cultures of the European invaders and settlers, the examination of the paradox posed above could lead to some highly interesting considerations.

The answer to the ethnopsychological puzzle became clear to me only after I started observing and participating in a number of other Native American ceremonies that did not involve the use of peyote - such as singing-healing circles, 'sweat lodge' and 'spirit dance' ceremonies. I noted what many ethnologists have reported: that these ceremonies were simultaneously religious, medicinal, and psychotherapeutic. The sweat lodge, like the peyote ritual, is regarded as a sacred ceremony, as a form of worship of the Creator; they are also practiced as a form of physical healing; *and* they are used for solving personal and collective psychological problems. Thus it was natural, for those tribes that took up peyote, to add this medium to the others they were already familiar with, as a ceremony that expressed and reinforced the integration of body, mind and spirit.

In the dominant white society by contrast, medicine, psychology and religious spirituality are separated by seemingly insurmountable paradigm differences. The medical, psychological and religious professions and established groups, each separately, were much too frightened by the unpredictable transformations of perception and worldview that psychedelic drugs seemed to trigger. Thus, the dominant society's reaction was fear, followed by prohibition, even of further research. None of the three established professions wanted these consciousness-expanding instruments, and neither did they want anyone else to be able to use them of their own free choice. The implicit assumption was (and is) that people are too ignorant and gullible to be able to make reasoned, informed choices as to how to treat their illnesses, solve their psychological problems, or practice their religion. The fragmented condition of our society is mirrored back to us through these reactions.

For most Native Americans and in indigenous societies in all parts of the world, healing, worship and problem-solving are all subsumed in the one way, which is the way of the Great Spirit, the way of Mother Earth, the traditional way. The integrative understanding given in the peyote visions, or in experiences with plant extracts like *ayahuasca* in South America or *iboga* in Central Africa, is not feared, but accepted and respected. Here the implicit assumption is that everyone has the capability, indeed the responsibility, to attune themselves to higher spiritual sources of knowledge and take responsibility for their own health-maintaining and spiritual practices. The purpose of ceremony, with or without medicinal substances, is regarded as a facilitating of such attunement. Indeed, the word "medicine" is used in Native American circles to refer to any substance, practice, even words, or persons - with a kind of integrative spiritual power.

The revival of interest in shamanic practices of healing and divination can be seen as expressions of a worldwide seeking for the renewal of a spiritual relationship with the natural world. Over the past two millennia Western civilization has increasingly developed patterns of domination and exploitation based on arrogant assumptions of human superiority. This dominator pattern has involved the gradual dis-enchantment and enormous destruction of non-human nature. By contrast, many indigenous people with shamanic practices have maintained beliefs and values that honor and respect the integrity, indeed the sacredness, of all of nature, in its infinite variety of manifestations. Their life-style includes rituals of remembrance of the living intelligences, called "spirits", inherent in the natural world.

In the modern worldview, such a recognition of "spirits" in nature, is considered beyond the pale of reason. 'Spiritual' and 'natural' are virtually considered opposites. However, those seekers who are again practicing the shamanic methods of earlier times and cultures are rediscovering that these methods are not at all incompatible with the curiosity and respectful knowledge-seeking of a scientific explorer or researcher. The revival of shamanic ritual practices and an animistic worldview can be seen as part of a worldwide human response to the degradation of ecosystems and the biosphere. These groups and individuals are expressing a new awareness, as well as a revival of ancient awareness of the organic and spiritual interconnectedness of all life on this planet.

Psychedelics as sacrament or recreation

Several observers, including Andrew Weil among others, have pointed out the historical pattern that as Western colonial society adopted psychoactive plant or food substances from native cultures, the pattern of use of such psychoactive materials *devolved* from sacramental to recreational. *Tobacco* was historically regarded as a sacred or power plant by Indians of North, Central and South America and is still so regarded by Native Americans. However, in the white Western culture, and in countries influenced by this dominant culture, cigarette smoking is obviously recreational, and tobacco addiction become a major public health problem. The *coca* plant, as grown and used by the Andean Indian tribes, was treated as a divinity, *Mama Coca*, and valued for its health- and energy-maintaining properties. The concentrated extract *cocaine* on the other hand is purely a recreational drug and its indiscriminate use as such has led to serious public health problems. In this, and other instances, desacralization of the plant-drug has been accompanied by criminalization. Even our most popular stimulant *coffee* is an example of this trend: Apparently first discovered and used by Islamic Sufis, who valued its stimulant properties for long nights of prayer and meditation, it became a fashionable recreational drink in European society in the 17th century, and was even banned for a while as being too dangerous. And *cannabis*, used by some sects of Hindu Tantrism as an amplifier of visualization and meditation and by manual laborers as a relaxant, has become the epitome of the recreational "high", associated with jail terms for simple possession.

Since sacramental healing plants were so rapidly and completely desacralized upon being adopted by the West's increasingly materialistic culture, it is not surprising that newly discovered synthetic psychactive drugs have generally been very quickly categorized as either recreational or narcotic - even those, like the psychedelics, whose effects are the opposite of "sleep-inducing". Concomitantly, as the indiscriminate and non-sacramental use of psychoactive plants and newly synthesized analogs spread, so did patterns of abuse and dependence. Predictably, established society reacted with prohibitions, which in turn furthered organized crime activities. This is so in spite of the fact that many of the original discoverers of the new synthetic psychedelics, people such as Albert Hofmann and Alexander Shulgin, are individuals of deep spiritual integrity. Neither they, nor the efforts of philosophers such as Aldous Huxley, Alan Watts and Huston Smith, or psychologists such as Leary, Alpert and many others, to advocate a sacred and respectful attitude towards these substances, were able to prevent the same profanation from taking place.

The later discovered phenethylamine psychedelic (also called *empathogenic*) MDMA provides an instructive example of this phenomenon. Two patterns of use seem to have become established during the 1970s: some psychotherapists and spiritually inclined individuals began to explore its possible applications as a therapeutic adjuvant and as an amplifier of spiritual practice. Another, much larger group of individuals began using it for recreational purposes, as a social "high" comparable in some respects to cocaine. The irresponsible and widespread use in this second category by increasing numbers of people understandably made the medical and law-enforcement authorities nervous. The predictable reaction occurred: MDMA was classified as a Schedule I drug in the United States, which puts it in the same group as heroin, cannabis and LSD, making it a criminal offense to make, use or sell, and sending a clearly understood taboo signal to pharmaceutical and medical researchers.

After Albert Hofmann had identified psilocybin as the psychoactive ingredient in the Mexican 'magic mushroom' (*Psilocybe mexicana*), he brought some of the synthesized psilocybin to the Mazatec shamaness María Sabina, in order to obtain her assessment of how close the synthesized ingredient was to the natural product. In doing so, he was following the appropriate path of acknowledging the primacy of the botanical over the synthetic. It has been suggested that for everyone of the important synthetic psychedelics, there is some natural plant that has the same ingredients, and that perhaps it should be our research strategy - to find the botanical "host" for the psychedelics emerging from the laboratory. Research on the shamanic use of the hallucinogenic morning glory seeds called ololiuhqui in ancient Mexico, which contain LSD analogs, has enabled a deeper understanding of the possibilities of this substance.

If Wasson, Hofmann and Ruck are correct in their proposal that an LSD-like ergot-derived beverage was used as the initiatory sacrament in Eleusis, the implications are profound. According to Rupert Sheldrake's theory of morphogenetic fields, rituals, like any patterned activity, gain their power through precise repetition of all the elements. One could suppose that by re-growing or re-hybridizing this particular plant, as it was used in ancient times, we could "tune in" to and re-activate the morphogenetic field of the Eleusinian Mysteries, the ancient world's most awe-inspiring mystical ritual.

There is no inherent reason why sacramental use and recreational use of a substance in moderation cannot co-exist. In fact, among Native Americans, tobacco often does play this dual role: after a sacred pipe ritual with tobacco and other herbs, participants may smoke cigarettes to relax. We know the sacramental use of wine, in the Catholic communion rite, and we certainly know the recreational use of wine. We are able to keep the two contexts separate, and we are also able to recognize when recreational use becomes dependence and abuse. One could envision similar sophistication developing with regard to psychoactive plant products. There could be recognized sacramental and therapeutic applications; and certain patterns of use might develop that were more playful, exploratory and hedonistic - and yet could be contained within a reasonable and acceptable social framework that minimizes harm.

The abuse of a drug in such a rational and sensible system would not be a function of who uses it, or where it originated, or its chemical classification - but rather the behavioral consequences in the drug user. Someone becomes recognized as an alcoholic, that is an abuser of alcohol, when their interpersonal and social relationships are noticeably impaired. There should be no difficulty in establishing similar abuse criteria for other psychoactive drugs.

Consciousness research with entheogens

In the field of consciousness research, the "set-and-setting hypothesis", which was first formulated by Timothy Leary in the early sixties, helps us to understand psychoactive drugs and plants as one class of triggers within a whole range of possible catalysts of altered states. The theory states that *the content of a psychedelic experience is a function of the set (intention, attitude, personality, mood) and the setting (interpersonal, social and environmental)*; and that the drug functions as a kind of trigger, or catalyst, or non-specific amplifier (To a lesser extent, the determining role of set-and-setting also applies to other psychoactive drugs such as the stimulants and tranquilizers). The hypothesis can also be applied to the understanding of any altered state of consciousness, when we recognize that other kinds of stimuli can be triggers - for example hypnotic induction, meditation technique, *mantra*, sound or music, breathing, sensory isolation, movement, sex, natural landscapes, a near-death experience, and the like.

An important clarification results from keeping in mind the distinction between a state (of consciousness) and a psychological trait; between state changes and trait changes. For example, psychologists distinguish between state-anxiety and trait-anxiety. William James, in his classic *Varieties of Religious Experience*, discussed this question in terms of whether a religious or conversion experience would necessarily lead to more "saintliness", more enlightened traits. This distinction is crucial to the assessment of the value or significance of drug-induced altered states. Only by attending to both the state-changes (visions, insights, feelings), *and* the longer-term behavioral or trait changes, can a comprehensive understanding of these phenomena be attained.

Having an insight is not the same as being able to apply that insight. There is no inherent connection between a mystical experience of oneness and the expression or manifestation of that oneness in the affairs of everyday life. This point is perhaps obvious, yet it is frequently overlooked by those who argue that, on principle, a drug could not induce a genuine mystical experience, or play any role in spiritual life. The internal factors, including preparation, expectation and intention, are the determinants of whether a given experience is authentically religious. Equally, intention is crucial to the question of whether an altered state results in any lasting personality changes. Intention is like a kind of bridge from the ordinary or consensus reality state to the state of heightened consciousness; and it also can provide a bridge from that heightened state back to ordinary reality.

This model allows us to understand why the same drug(s) could be claimed by some to lead to *nirvana* or religious vision, and in others could lead to perversion, violence and criminality. The drug is only a tool, or a catalyst, to attain certain altered states - which altered states being dependent on the intention. Further, even where the drug-induced state is benign and expansive, whether or not it leads to long-lasting positive changes is also a matter of intention or mind-set, as well as on-going practice.

The potential of psychedelic drugs to act as catalysts to a transformation into *gnosis*, or direct, ongoing awareness of divine reality, even if only in a small number of people, would seem to be of the utmost significance. Traditionally, the number of individuals who had mystical experiences has been very small; the number of those who have been able to make practical applications of such experiences has probably been even smaller. Thus the discovery of psychedelics, in facilitating such experiences and processes, could be regarded as one very important factor in a general spiritual awakening of collective human consciousness. Other factors that could be mentioned in this connection are the revolutionary paradigm shifts in the physical and biological sciences, the burgeoning of interest in Eastern philosophies and spiritual disciplines, and the growing awareness of the multi-cultural oneness of the human family brought about by the global communications networks.

Entheogenic substances in shamanistic cultures

In earlier writings, I emphasized the newness of psychedelic drugs and the unimaginable potentials to be realized by their constructive application. I viewed them as first products of a technology oriented toward the human spirit. I still appreciate the potential role of the new synthetic psychedelics in consciousness research, and perhaps consciousness evolution. However, my views have changed somewhat under the influence of the discoveries and writings of cultural anthropologists and ethnobotanists, who have pointed to the role of mind-altering and visionary botanicals in traditional cultures across the world. In such a worldview, closer to that of aboriginal cultures, humanity is seen as being in a relationship of co-consciousness, communication and cooperation with the animal kingdom, the plant kingdom and the mineral world. In such cultures, the ingestion of hallucinogenic plant preparations in order to obtain knowledge - for healing, for prophecy, for communication with spirits, for anticipation of danger, and for understanding the universe, appears as one of the oldest and most highly treasured traditions.

One cannot read the works of R. Gordon Wasson on the Mesoamerican mushroom cults, or the work of Richard E. Schultes on the profusion of hallucinogens in the Amazon region, or the cross-cultural studies of such authors as Michael Harner, Joan Halifax, Peter Furst, Wade Davis and Luis Eduardo Luna, or the cross-culturally oriented medical and psychiatric researchers such as Andrew Weil, Claudio Naranjo and Stanislav Grof, or more personal accounts such as the writings of Carlos Castaneda, or the McKenna brothers, or Bruce Lamb's biography of Manuel Cordova, without getting a strong sense of the pervasiveness of the quest for visions, insights and non-ordinary states of consciousness in the worldwide shamanic traditions. These studies demonstrate that psychoactive plants and fungi are used in many, though by no means all of the shamanic cultures that pursue such states. In the shamanistic cultures of the Northern hemispere, in America, Europe and Asia, the use of the drumming-journey method appears more widespread - possibly because there is a relative paucity of visionary hallucinogens in the temperate zones, as compared to the tropics.

Shamanic cultures all over the world know a wide variety of means for entering non-ordinary realities. Michael

Harner has pointed out that "auditory driving" with prolonged drumming is perhaps as equally a widespread technology for entering shamanic states as the use of hallucinogens. In some cultures, the rhythmic hyperventilation produced through certain kinds of chanting may be another form of altered state trigger. Animal spirits become guides and allies in shamanic initiation. Plant spirits can become "helpers" also, even when the plant is not taken internally by either doctor or patient. Tobacco smoke used as a purifier, as well as a support to prayer, is actually the most widely used psychoactive plant substance in indigenous and mestizo South American societies. In some traditions crystals are also used in ceremonies, in addition to plants, to focus energy for seeing and healing. There is attunement, through prayer and meditation, with deities and spirits of the land, the four directions, the elements, the Creator Spirit. The knowledge obtained from other states and other worlds is used to improve the way we live in this world. The use of hallucinogenic plants, when it occurs, is usually part of an integrated complex of interrelationships between nature, spirit and human consciousness.

Thus it seems to me that the lessons we are to learn from these consciousness-expanding plants in shamanism have to do not only with the recognition of other dimensions of the human psyche, but with a radically different worldview - a world view that has been maintained in the beliefs, practices and rituals of many indigenous shamanic cultures, and almost totally forgotten or suppressed by the materialist culture of the modern age. There is of course a certain delightful irony in the fact that it has taken a material substance to awaken the sleeping consciousness of so many of our contemporaries to the reality of non-material energies, forms and beings.

The potentials of entheogens in healing ritual practices

If we compare how Western medicine and psychotherapy have, so far, incorporated psychedelics into healing practice (really only on a very limited research basis), with shamanic healing ceremonies involving entheogenic plant substances, a perception of the importance of ritual is inescapable. The traditional shamanic ceremonial form involving hallucinogenic plants is a carefully structured experience, in which a small group of people come together with respectful, spiritual attitude to share a profound inner journey of healing and transformation, facilitated by these powerful catalysts. A "journey" is the preferred metaphor in shamanistic societies for what we call an "altered state of consciousness".

There are three significant differences between shamanic entheogenic ceremonies and the typical psychedelic psychotherapy. *One* is that the traditional shamanic rituals involve very little or no talking among the participants, except perhaps during a preparatory phase, or after the experience to clarify the teachings and visions received. The *second* is that singing, or the shaman's singing, is invariably considered essential to the success of the healing or divinatory process. Furthermore the singing typical in etheogenic rituals usually has a fairly rapid beat, similar to the rhythmic pulse in shamanic drumming journeys. Psychically, the rhythmic chanting, like the drum pulse, seems to give support for moving through the flow of visions, and minimize the likelihood of getting stuck in frightening or seductive experiences. The *third* distinctive feature of traditional ceremonies is that they are almost always done in darkness or low light, - which facilitates the emergence of visions. The exception is the peyote ceremony, done around a fire (though also at night); here participants may see visions as they stare into the fire.

I will briefly mention some of the variations on the traditional rituals involving hallucinogens. In the *peyote* ceremonies of the Native American Church, in North America, participants sit in a circle, in a tipi, on the ground, around a blazing central fire. The ceremony goes all night, and is conducted by a "roadman", with the assistance of a drummer, a firekeeper and a cedar-man (for purification). A staff and rattle are passed around and participants sing the peyote songs, which involve a rapid, rhythmic beat. The peyote ceremonies of the Huichol Indians of Northern Mexico also take place around a fire, with much singing and story-telling, after the long group pilgrimage to find the rare cactus.

The ceremonies of the *San Pedro* cactus, in the Andean regions, are sometimes also done around a fire, with singing; but sometimes the *curandero* sets up an altar, on which are placed different symbolic figurines and objects, representing the light and dark spirits which one is likely to encounter.

The mushroom ceremonies (*velada*) of the Mazatec Indians of Mexico, involve the participants sitting or lying in a very dark room, with only a small candle. The healer, who may be a woman or a man, sings almost uninterruptedly, throughout the night, weaving into her chants the names of Christian saints, her spirit allies and the spirits of the Earth, the elements, animals and plants, the sky, the waters and the fire.

Traditional Amazonian Indian or mestizo ceremonies with ayahuasca also involve a small group sitting in a circle, in semi-darkness, while the initiated healers sing the songs (*icaros*), through which the healing and/or diagnosis takes place. These songs also have a fairly rapid rhythmic pulse, which keeps the flow of the experience moving along. Shamanic "sucking" methods of extracting toxic psychic residues or sorcerous implants are sometimes used.

The ceremonies involving the root of the African *iboga* plant, used by the Bwiti cult in Gabon and Zaïre, involve an altar with ancestral and deity images, and people sitting on the floor with much chanting and some dancing. Often, there is a mirror in the assembly room, in which the initiates may "see" their ancestral spirits.

In comparing Western psychoactive-assisted psychotherapy with shamanic entheogenic healing rituals, we can see that the role of an experienced guide or therapist is equally central in both, and the importance of set (intention) and setting is implicitly recognized and articulated into the forms of the ritual. The underlying intention in both practices is healing and problem resolution. Therapeutic results can occur with both approaches, though the underlying paradigms of illness and treatment are completely different. The two elements in the shamanic traditions that pose the most direct and radical challenge to the accepted Western worldview are the existence of multiple worlds and of spirit beings - such conceptions are considered completely beyond the pale of both reason and science, though they are taken for granted in the worldview of traditional shamanistic societies.

It is worth mentioning that in the case of *ayahuasca*, there have grown in Brazil three distinct syncretic religious movements or churches, that incorporate the taking of ayahuasca into their religious ceremonies as the central sacrament. Here the intention of the ritual is not so much healing or therapeutic insight, as it is strengthening moral values and community bonds. The ceremonial forms here resemble much more the rituals of worship in a church, than they resemble either a psychotherapist's office, or a shamanic healing session.

There are also several different kinds of set-and-setting rituals using hallucinogens in the modern West, ranging from the casual, recreational "tripping" of a few friends to "rave" events of hundreds or even thousands, combining Ecstasy (MDMA) with the continuous rhythmic pulse of techno music. My own research has focussed on what might be called neo-shamanic medicine circles, which represent a kind of hybrid of the psychotherapeutic and traditional shamanic approaches. In the past forty years or so I have been a participant and observer in hundreds of such circle rituals, in both Europe and North America. Plant entheogens used in these circle rituals have included psilocybe mushrooms, ayahuasca, san pedro cactus, iboga and others. My interest has focussed on the nature of the psychospiritual transformation undergone by participants in such circle rituals.

In these hybrid therapeutic-shamanic circle rituals certain basic elements from traditional shamanic healing ceremonies are usually, though not always, kept intact:

- the structure of a circle, with participants either sitting or lying;
- an altar in the center of the circle, or a fire in the center if outside;
- presence of an experienced elder or guide, sometimes with assistants;
- preference for low light, or semi-darkness; sometimes eye-shades are used;
- use of music: drumming, rattling, singing or evocative recorded music;
- dedication of ritual space through invocation of spirits of four directions;
- cultivation of a respectful, spiritual attitude.

Experienced entheogenic explorers understand the importance of set and therefore devote considerable attention to clarifying their intentions with respect to healing and divination. They also understand the importance of setting and therefore devote considerable care to arranging a peaceful place and time, filled with natural beauty and free from outside distractions or interruptions.

Most of the participants in circles of this kind that I have observed were experienced in one or more psychospiritual practices, including shamanic drum journeying, Buddhist *vipassana* meditation, tantra yoga and holotropic breath-work and most have experienced and/or practiced various forms of psychotherapy and body-oriented therapy. The insights and learnings from these practices are woven by the participants into their work with the entheogenic medicines. Participants tend to confirm that the entheogenic plant medicines, when combined with meditative or therapeutic insight processes, function to amplify awareness and sensitize perception, particularly amplifying somatic, emotional and instinctual awareness.

Some variation of the *talking staff* or *singing staff* is often used in such ceremonies: with this practice, which seems to have originated among the Indians of the Pacific Northwest, and is also more generally now referred to as "council", only the person who has the circulating staff sings or speaks, and there is no discussion, questioning or interpretation (as there might be in the usual group psychotherapy formats). Some group sessions however involve minimal or no interaction between the participants during the time of the expanded state of consciousness.

In preparation for the circle ritual there is usually a sharing of intentions and purposes among the participants, as well as the practice of meditation, or sometimes solo time in nature, or expressive arts modalities, such as drawing, painting or journal work. After the circle ritual, sometimes the morning after, there is usually an integration practice of some kind, which may involve participants sharing something of the lessons learned and to be applied in their lives.

Concluding reflections

It appears incontrovertible that plant (and fungal) hallucinogens played some role, of unknown extent, in the healing and transformative traditions of shamanism. If we regard psychotherapy as the modern descendant of these traditions, then a similar, if limited, application of hallucinogens could be made in various aspects of psychotherapy. And this has in fact already occurred, as the various studies of psychedelics in alcoholism, terminal cancer, obsessional neurosis, depression and other conditions testify. It seems likely that these kinds of applications of psychedelics, as adjuncts to psychotherapy, will continue, - if not with LSD and other Schedule I drugs, then with other, newer, perhaps safer psychedelics.

What appears unlikely to me is that this kind of controlled psychiatric application will ever be enough to satisfy the inclinations and needs of those individuals who wish to explore psychedelics in their most ancient role, as tools for seeking visionary states and hidden forms of knowledge. The fact that the serious use of hallucinogens, outside of a psychiatric framework, continues despite severe social and legal sanctions, suggests that this is a kind of individual freedom that is not easy to abolish. It also suggests that there is a strong need, in certain people, to re-establish their connections with ancient traditions of knowledge, in which visionary states of consciousness and exploration of other realities, with or without hallucinogens, were the central concern.

It may be that such a path will always be pursued by only a limited number of individuals - much as the shamanic, alchemical and yogic initiations and practices were pursued by only a few individuals in each society. I find it a hopeful sign that some, however few, are willing to explore how to re-connect with these lost sources of knowledge, because, like many others, I feel that our materialist-technological society, with its fragmented world-view, has largely lost its way, and can ill afford to ignore any potential aids to greater knowledge of the human mind. The ecologically balanced and integrative framework of understanding that the ancient traditions preserved surely has much to offer us.

Furthermore, it is clear that the visions and insights of the individuals who pursue these paths are visions and insights for the present and the future, and not just of historical or anthropological interest. This has always been the pattern: the individual seeks a vision to understand his or her place, or destiny, as a member of the community. The knowledge derived from expanded states of consciousness has been, can be, and needs to be applied to the solution of the staggering problems that confront our species. This is why the discoveries of the mystical chemists and ethnobotanists have immense importance - for the understanding of our past, the awareness of our presence, and the safeguarding of our future.

Correspondence
Ralph Metzner
Email: ralph@greenearthfound.org
Web: http://www.greenearthfound.org/

References

1. Adamson, S. (ed.)(2012). *Through the gateway of the heart. Accounts of experiences with MDMA and other empathogenic substances*. San Francisco: Four Trees Publications (originally published 1985).
2. Davis, W. (1996). *One river: Explorations and discoveries in the Amazon rainforest*. New York: Simon & Schuster.
3. Furst, P. (1976). *Hallucinogens and culture*. San Francisco: Chandler & Sharp.
4. Grof, S. (1985). *Beyond the brain: Birth, death and transcendence in psychotherapy*. Albany, NY: State University Press of New York.
5. Halifax, J. (1982). *Shaman: The wounded healer*. New York: Crossroads
6. Harner, M. (ed.)(1973). *Hallucinogens and shamanism*. New York: Oxford University Press.
7. Harner, M. (1980). *The way of the shaman*. San Francisco: Harper & Row.
8. Hofmann, A. (1979). *LSD: My problem child*. Los Angeles: J. P. Tarcher.
9. Lamb, B. (1971). *Wizard of the upper Amazon*. Boston: Houghton-Mifflin.
10. Leary, T., Metzner, R. & Alpert, R. (1964). *The psychedelic experience*. New York: University Press.
11. Luna, L.E. (1986). *Vegetalismo: Shamanism among the mestizo population of the Peruvian Amazon*. Stockholm: Almqvist & Wiksell International.
12. McKenna, T. & McKenna, D. (1975). *The invisible landscape*. New York: Seabury Press.
13. Metzner, R. (1994). *The well of remembrance: Rediscovering the earth wisdom mythology of northern Europe*. Boston: Shambhala.
14. Metzner, R. (1997). *The unfolding self: Varieties of transformative experience*. Novato, CA: Origin Press.
15. Metzner, R. (1999). *Green psychology: Transforming our relationship to the Earth*. Rochester, VT: Park Street Press.
16. Metzner, R. (ed.)(2005). *Sacred mushroom of visions: Teonanácatl*. Rochester, VT: Park Street Press.
17. Metzner, R. (ed.)(2006). *Sacred vine of spirits: Ayahuasca*. Rochester, VT: Park Street Press.
18. Naranjo, C. (1973). *The healing journey*. New York: Ballantine Books.
19. Schultes, R.E. & Hofmann, A. (1979). *Plants of the gods: Origins of hallucinogenic use*. New York: McGraw-Gill.
20. Sheldrake, R. (1991). *The rebirth of nature: The greening of science and God*. New York: Bantam Books.
21. Wasson, R.G. (1980). *The wondrous mushroom: Mycolatry in Mesoamerica*. New York: McGraw-Hill.
22. Weil, A. (1983). *From chocolate to morphine*. New York: Houghton Mifflin.

Increased nature relatedness and decreased authoritarian political views after psilocybin for treatment-resistant depression

by

Taylor Lyons and Robin L Carhart-Harris

Journal of Psychopharmacology 1-9

Psychedelic Research Group, Department of Medicine, Imperial College London, UK

© The Author(s) 2018

original report: https://spiral.imperial.ac.uk/bitstream/10044/1/57965/2/0269881117748902.pdf
backup source: http://www.psilosophy.info/resources/0269881117748902.pdf

Corresponding author:
Taylor Lyons, Psychedelic Research Group, Centre for Psychiatry, Department of Medicine, Imperial College London, W12 0NN, London, UK.
Email: t.lyons15@imperial.ac.uk

Table of Contents:

- **Abstract**
- **Introduction**
- **Methods**
  - Ethical approvals
  - Study design and participants
  - Drug
  - Procedures and dosing sessions
  - Outcome measures
  - Statistical analysis
- **Results**
  - Demographics
  - Nature relatedness
  - Political perspective
  - Depressive symptoms
- **Discussion**
- **References**

Abstract

Rationale: Previous research suggests that classical psychedelic compounds can induce lasting changes in personality traits, attitudes and beliefs in both healthy subjects and patient populations.
Aim: Here we sought to investigate the effects of psilocybin on nature relatedness and libertarian-authoritarian political perspective in patients with treatment-resistant depression (TRD).
Methods: This open-label pilot study with a mixed-model design studied the effects of psilocybin on measures of nature relatedness and libertarian-authoritarian political perspective in patients with moderate to severe TRD (n=7) versus age-matched non-treated healthy control subjects (n=7). Psilocybin was administered in two oral dosing sessions (10 mg and 25 mg) 1 week apart. Main outcome measures were collected 1 week and 7-12 months after the second dosing session. Nature relatedness and libertarian-authoritarian political perspective were assessed using the

Nature Relatedness Scale (NR-6) and Political Perspective Questionnaire (PPQ-5), respectively.
Results: Nature relatedness significantly increased (*t*(6)=-4.242, *p*=0.003) and authoritarianism significantly decreased (*t*(6)=2.120, *p*=0.039) for the patients 1 week after the dosing sessions. At 7-12 months post-dosing, nature relatedness remained significantly increased (*t*(5)=-2.707, *p*=0.021) and authoritarianism remained decreased at trend level (*t*(5)=-1.811, *p*=0.065). No differences were found on either measure for the non-treated healthy control subjects.
Conclusions: This pilot study suggests that psilocybin with psychological support might produce lasting changes in attitudes and beliefs. Although it would be premature to infer causality from this small study, the possibility of drug-induced changes in belief systems seems sufficiently intriguing and timely to deserve further investigation.

Keywords
Psilocybin, nature relatedness, authoritarianism, depression, political perspective

Introduction

A growing body of evidence suggests that classical psychedelic compounds such as lysergic acid diethylamide (LSD) (Carhart-Harris *et al*., 2016b; Schmid and Liechti, 2017), psilocybin (Carhart-Harris *et al*., 2016a; Griffiths *et al*., 2016; Ross *et al*., 2016) and *N,N*-dimethyltryptamine (DMT) in ayahuasca (Osorio Fde *et al*., 2015) can promote enduring changes in personality traits, attitudes and beliefs - and similar effects have recently been reported for 3,4-methylenedioxy-methamphetamine (MDMA), which shares some properties with classical psychedelic compounds (Wagner *et al*., 2017) albeit with some important differences (Carhart-Harris and Nutt, 2017). Focusing more specifically on psilocybin, a single high dose of this naturally occurring compound was associated with enduring increases in trait openness, psychological wellbeing and life satisfaction in healthy volunteers 14 months later (Griffiths *et al*., 2008; MacLean *et al*., 2011). Psilocybin has also been shown to improve symptoms of addiction (Bogenschutz *et al*., 2015; Johnson *et al*., 2014), anxiety (Griffiths *et al*., 2016; Grob *et al*., 2011; Moreno *et al*., 2006; Ross *et al*., 2016) and depression (Carhart-Harris *et al*., 2016a; Griffiths *et al*., 2016; Ross *et al*., 2016) when administered in a psychologically supportive setting.

In the general population, psychedelic drug use is not associated with increased incidence of mental health problems (Johansen and Krebs, 2015; Krebs and Johansen, 2013), but is instead associated with lower rates of suicidality and psychological distress (Hendricks *et al*., 2015a, 2015b; Johansen and Krebs, 2015; Krebs and Johansen, 2013). Psychedelic drug users have also been shown to exhibit greater optimism (or reduced pessimism) than non-users (Grob *et al*., 1996) as well as increased concern for others, nature and the environment when compared with users of cannabis, amphetamine or heroin (Lerner and Lyvers, 2006). Experience with psychedelics has been found to positively affect one's sense of feeling part of nature rather than separate from it, leading to pro-environmental behavioural changes (Forstmann and Sagioglou, 2017). Nature relatedness, defined as the subjective sense of connection with the natural environment, is associated with lower levels of anxiety (Capaldi *et al*., 2014; Martyn and Brymer, 2014), and has been shown to promote psychological wellbeing at both the trait (Cervinka *et al*., 2012; Howell *et al*., 2011; Mayer and Frantz, 2004; Nisbet *et al*., 2011) and state (Mayer *et al*., 2008; Nisbet and Zelenski, 2011) level. Furthermore, interacting with the natural environment has been shown to improve mood and cognitive functioning in patients with major depressive disorder (MDD) (Berman *et al*., 2012), and visits to outdoor green spaces of 30 min or more per week has been predicted to reduce the population prevalence of depression by up to 7% (Shanahan *et al*., 2016). Taken together, these findings indicate that psychedelics can promote enduring changes in personality traits, attitudes and beliefs.

A recent correlational study of ours found that lifetime psychedelic drug use in the general population positively predicted nature relatedness and negatively predicted authoritarian political views, in a manner that appeared to be mediated by acute and temporary 'ego-dissolution' (Nour *et al*., 2017). Moreover, a recent pilot study of ours found rapid and enduring reductions in depressive symptoms in a treatment-resistant depression (TRD) sample after psychologically supported psilocybin therapy (Carhart-Harris *et al*., 2018a). As part of this project, the present research sought to address potential changes in nature relatedness and political perspective in this sample of TRD patients before versus after psilocybin treatment. Measures were collected at screening, 1 week and 7-12 months post-dosing. To demonstrate robustness to order confounds, we also collected data from an age-matched but non-treated healthy control group, tested over an equivalent period.

Methods

Ethical approvals

This study received a favourable opinion from NRES London-West London, was sponsored by Imperial College London, and was carried out in accordance with Good Clinical Practice Guidelines. The National Institute for Health Research/Wellcome Trust Imperial Clinical Research Facility (ICRF) provided site-specific approval and the Medicines and Healthcare products Regulatory Agency (MHRA) reviewed and approved this research. All patients provided written informed consent.

Study design and participants

This open-label pilot study with a mixed-model design compared the effects of psilocybin on nature relatedness and libertarian-authoritarian political perspective in patients with TRD versus healthy control subjects. The findings presented here are part of a larger open-label pilot study of psilocybin in TRD, the results of which have been reported elsewhere (Carhart-Harris *et al.*, 2016a, 2017). The study participants (*n*=14) and research team were not masked to treatment assignment. All TRD patients (*n*=7) were administered psilocybin in two dosing sessions: an initial safety dose (10 mg) and a subsequent treatment dose (25 mg) 1 week later. The control subjects (*n*=7) were not administered psilocybin and were primarily included to examine test-retest data on the relevant primary measures.

General practitioners were provided with recruitment information via the North West London Clinical Research Network and were asked to identify potential patients with TRD. TRD patients residing in the UK were also able to self-refer to the study. In most cases, it was the TRD patients that initiated contact with the research team. After initiating contact, patients were given a study information sheet and were initially screened via a telephone call with the research team's lead psychiatrist to determine eligibility for the study. Each patient's general practitioner or psychiatrist provided written confirmation and documentation of the patient's diagnosis and mental health background.

The inclusion criteria were (a) MDD of a moderate to severe degree (16+ on the 21-item Hamilton Depression Rating scale [HAM-D]), and (b) no improvement despite two adequate courses of antidepressant treatment of different pharmacological classes lasting at least six weeks within the current depressive episode. The exclusion criteria were (a) current or previously diagnosed psychotic disorder, (b) first-degree relative with a diagnosed psychotic disorder, (c) medically significant condition rendering unsuitability for the study, (d) history of serious suicide attempts (requiring hospitalisation), (e) previous manic episode, (f) blood or needle phobia, (g) positive pregnancy test at screening or during the study, and (h) current drug or alcohol dependence.

Physically and mentally healthy age-matched control subjects were recruited via word of mouth and were subject to the same exclusion criteria outlined above. Informed consent was obtained from all of the study participants, including the controls.

Drug

Psilocybin was obtained from THC Pharm GmbH (Frankfurt, Germany) and formulated by Guy's and St Thomas' Hospitals' Pharmacy Manufacturing Unit (London, UK). Home Office approvals for storing and dispensing Schedule One drugs were obtained.

Procedures and dosing sessions

Screening procedures typically lasted 4 h and consisted of psychiatric and physical health assessments. All patients provided written informed consent. Clinicians carried out a Mini-International Neuropsychiatric Interview (Sheehan *et al.*, 1998) and assessed depression severity using the HAM-D (Hamilton, 1960) and Montgomery-Åsberg Depression Rating Scale (MADRS) (Montgomery and Asberg, 1979) in patient participants. Physical assessments included an electrocardiogram, routine blood tests, blood pressure and heart rate tests, and a physical examination. Eligible TRD patients were allocated two psychiatrists for support throughout the study.

All patients enrolled in the study attended a pre-dosing preparatory session with the allocated psychiatrists on the next visit. Psychological preparation consisted of discussing the effects of psilocybin and simulating aspects of the dosing session to make patients aware of what to expect. Patients also shared their personal history and thoughts on the origins of their depression. This session helped to build rapport and trust between the patient and their allocated psychiatrists, thus minimising the risk of adverse reactions to psilocybin (Metzner *et al.*, 1965).

All patients attended two dosing sessions separated by 1 week at the ICRF. A close friend or relative accompanied each patient to and from the ICRF and return transport was arranged before the dosing sessions took place. A urine sample for drugs of abuse (and pregnancy where applicable), breathalyser test for alcohol use and vital signs measurements were collected before each dosing session. Patients were then taken to a decorated dosing room with dim lighting and music where they were invited to lie down and relax. The allocated psychiatrists remained at either side of the bed and adopted a non-directive, supportive approach. Patients were supervised at all times and the psychiatrists checked how they were feeling at approximately 1 h intervals, and assessed them for discharge approximately 6 h after drug administration.

Outcome measures

To assess political views on the dimension of libertarianism to authoritarianism, a recently validated (Nour *et al.*, 2017) subset of questions (five items) from the Libertarian-Authoritarian Questionnaire (Evans *et al.*, 1996) were used as a short version and termed the Political Perspective Questionnaire (PPQ-5) (Nour *et al.*, 2017). The validated 6-item Nature Relatedness Scale (NR-6) (Nisbet and Zelenski, 2013) was used to measure the subjective sense of connectedness to nature. Self-rated depressive symptoms were measured at baseline and two followup time points (1 week and 7-12 months) in all study participants using the Quick Inventory of Depressive Symptoms (QIDS) (Rush *et al.*, 2003). The above measures were assessed at baseline and then again at the 1 week and 7-12-months follow-ups for all study participants.

Statistical analysis

All statistical analyses were performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Within-group comparisons were performed using one-tailed paired *t*-tests for parametric data and Wilcoxon signed ranks tests for non-parametric data. Between-group comparisons were performed using two-tailed independent *t*-tests for parametric data and Mann-Whitney *U* tests for non-parametric data. We provide 95% CIs around the mean differences. Effect sizes were calculated using the Hedges' *g* formula due to the small sample size in this study

Results

No serious adverse events occurred as a result of the psilocybin administration, and the acute drug effects were well tolerated by all patients (see Carhart-Harris *et al*. (2016a, 2017a) for more information).

Demographics

Of the total 14 participants who took part in this study, the majority were Caucasian (78.6%) and men (64.3%) with a post-secondary level of education (85.7%). In the patient sample (*n*=7), baseline HAM-D scores ranged from 24 to 36 (*M*=28.6, *SD*=3.7) and the MADRS scores from 28 to 40 (*M*=35.9, *SD*=5); thus, all patients recruited were diagnosed with TRD of at least moderate severity, with most meeting criteria for severe depression. Control subjects were not clinically assessed because they were deemed physically and mentally healthy. Self-reported depressive symptoms (QIDS) were collected for all study participants. Table 1 outlines participant demographic details and depressive scores at baseline.

Table 1. Study participant demographics and baseline depression scores.

Characteristic	Control subjects (*n*=7)	TRD patients (*n*=7)	All participants (*n*=14)	*p*-value
Gender (% male)	29%	100%	64.3%	0.005[a]
Age in years (mean, SEM)	43.3 (6.8)	48.3 (4.5)	45.8 (3.9)	0.550[b]
Ethnicity (%)				0.213[a]
White	71.4%	85.7%	78.6%	
Black	0%	14.3%	7.1%	
Asian	28.6%	0%	14.3%	
Education (%)				1.000[a]
Secondary school	14.3%	14.3%	14.3%	
Undergraduate	57.1%	57.1%	57.1%	
Postgraduate	28.6%	28.6%	28.6%	
Baseline scores (mean, SEM)				
QIDS	3.86 (0.91)	19.43 (1.52)	NA	0.002[c]

[a] Chi-square test.
[b] *t* test.
[c] *U* test.

Nature relatedness

Patients showed a significant increase in nature relatedness scores 1 week after psilocybin treatment (*M*=4.14, *SD*=0.75) compared with baseline (*M*=3.67, *SD*=1.00); *t*(6)=-4.242, *p*=0.003, 95% CI [-0.75, 0.2]. The Hedges' g value (*g*=2.5) for this contrast was very large, and the significant change was sustained at the 7-12-month follow-up time-point (*M*=4.12, *SD*=0.60; *t*(5)=-2.707, *p*=0.021, 95% CI [-1.15, -0.03]; *g*=1.2). Non-treated control subjects showed no difference between screening (*M*=4.02, *SD*=0.79) and the first (*M*=4.02, *SD*=0.94; *t*(6)=0.008, *p*=0.994, 95% CI [-0.46, 0.46]) or second (*M*=4.05, *SD*=0.62; *t*(5)=-1.228, *p*=0.274, 95% CI [-0.60, 0.21]) follow-ups. No significant between-groups differences were found at baseline (*p*=0.471) or the first (*p*=0.799) and second (*p*=0.861) follow-ups. These results suggest that psilocybin therapy increases the subjective sense of connectedness to nature 1 week after treatment, and that these effects are sustained for at least 7-12 months (Figure 1(a)).

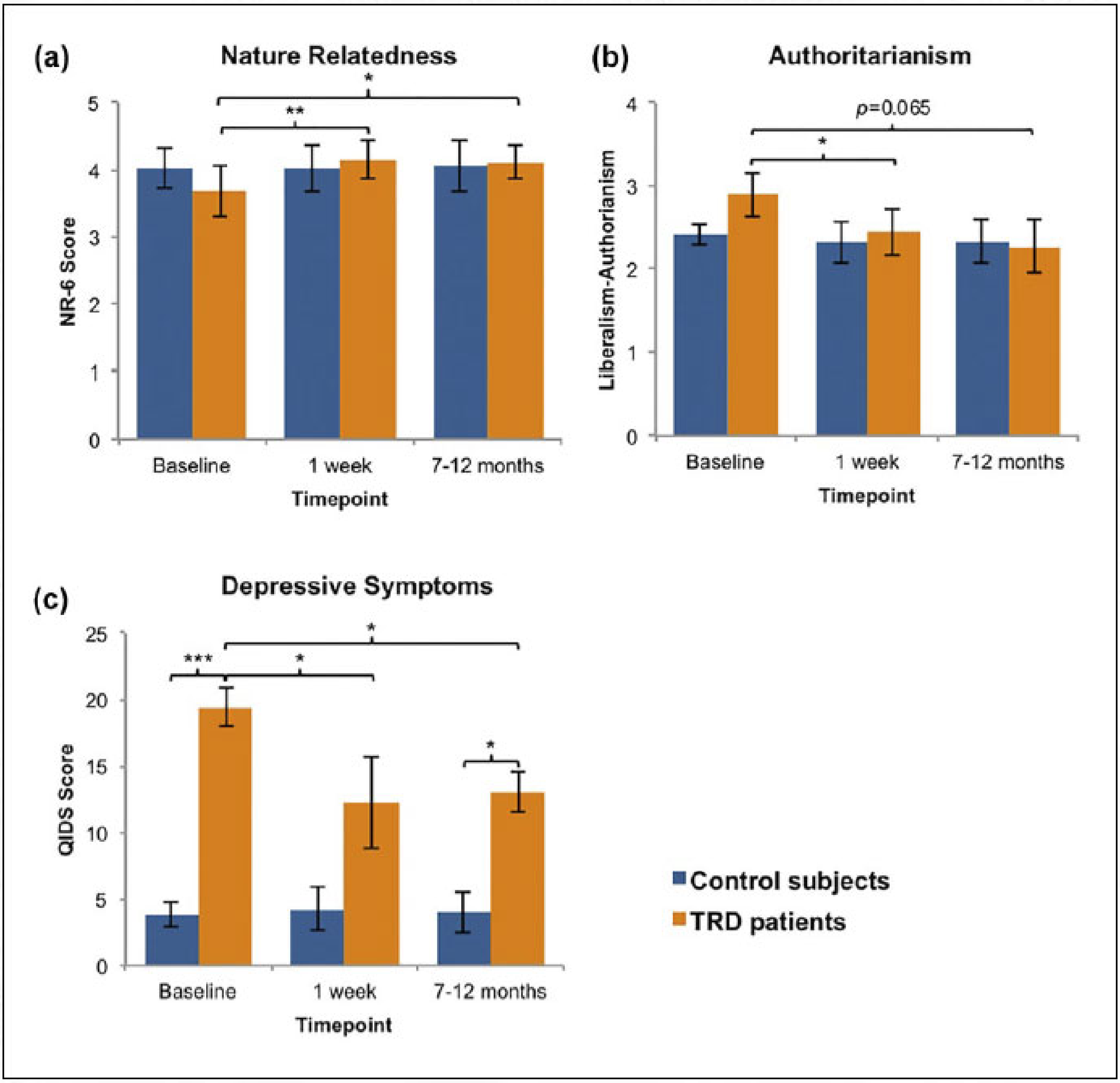


Figure 1. (a) Nature relatedness. Patients reported being significantly more connected to nature 1 week ($t(6)=-4.242$, $p=0.003$) and 7-12 months ($t(5)=-2.707$, $p=0.021$) after psilocybin treatment compared with baseline. No significant difference was found for the controls at the first ($t(6)=0.008$, $p=0.994$) or second follow-ups ($t(5)=-1.228$, $p=0.274$). (b) Political perspective. Patients were significantly less authoritarian 1 week after psilocybin treatment ($t(6)=2.120$, $p=0.039$) and a trend-level decrease was found at 7-12 months ($t(5)=-1.811$, $p=0.065$) compared with baseline. No significant differences were found for the controls at the first ($t(6)=0.642$, $p=0.544$) or second follow-up ($t(5)=0.515$, $p=0.629$). (c) Depressive symptoms. Patients had significantly more depressive symptoms than controls at baseline ($U=0.0E0$, $p=0.001$). One week after psilocybin treatment, depressive symptoms were significantly reduced to levels more comparable with controls ($Z=-2.040$, $p=0.025$) as no significant between-groups differences were found ($U=10.000$, $p=0.062$). The patients' depressive symptoms remained significantly reduced at the 7-12-months follow-up ($Z=-1.782$, $p=0.038$); however, a between-groups difference was found ($U=3.500$, $p=0.020$). No significant differences were found for the control subjects at the first ($Z=-0.422$, $p=0.673$) or second ($Z=-0.137$, $p=0.891$) follow-ups compared with baseline. Data expressed as mean ± SEM [$p<0.05$*; $p\leq0.01$**; $p\leq0.001$***].

Political perspective

Patients showed a significant decrease in authoritarian political perspective 1 week after psilocybin treatment ($M=2.43$, $SD=0.73$) relative to baseline ($M=2.89$, $SD=0.72$); $t(6)=2.120$, $p=0.039$; 95% CI [-0.07, 0.99]. The Hedges' g value ($g=0.8$) was found to meet the conventional criterion for a large effect size. Decreases in authoritarianism were still evident 7-12 months post-dosing ($M=2.27$, $SD=0.68$), and although this trend-level effect no longer reached conventions for statistical significance ($t(5)=-1.811$, $p=0.065$, 95% CI [-0.25, 1.46]), the relevant Hedges' g value ($g=0.7$) met convention for a medium-to-large effect size, suggesting that this study was underpowered to detect a statistically significant result on this particular measure. Nontreated control subjects showed no change in authoritarianism between screening ($M=2.40$, $SD=0.35$) and the first

(*M*=2.31, *SD*=0.66; *t*(6)=0.642, *p*=0.544) or second (*M*=2.33, *SD*=0.78; *t*(5)=0.515, *p*=0.629) follow-ups. No significant between-groups differences were found at baseline (*p*=0.132) or the first (*p*=0.755) or second (*p*=0.877) follow-ups. These results suggest that psilocybin therapy may persistently decrease authoritarian attitudes post-treatment with psilocybin, but that further research is required to test the robustness of this relationship (Figure 1(b)).

Depressive symptoms

Baseline depressive symptoms (QIDS ratings) were significantly higher in patients (*M*=19.43, *SD*=4.04) than controls (*M*=3.86, *SD*=2.41); *U*=0.0E0, *p*=0.001 (Figure 1(c)). Further, the Hedges' g effect size value for this contrast (*g*=4.7) was, by convention, exceptionally high, confirming our assumption that the patients had far higher (baseline) self-reported depressive symptoms than the controls.

Therapeutic outcomes for the full sample are given in previous publications (Carhart-Harris *et al*., 2016a, 2018a, 2017). In the sample reported in this paper, patients showed a significant decrease in QIDS scores 1 week after the psilocybin sessions (*M*=12.29, *SD*=9.18) compared with baseline (*M*=19.43, *SD*=4.04); *Z*=-2.04, *p*=0.025 (Figure 1(c)). Further, the Hedges' g value for this contrast (g=1.3) was, again, large by convention. There was no significant difference found in the controls' baseline (*M*=3.86, *SD*=2.41) versus 1-week follow-up QIDS scores (*M*=4.29, *SD*=4.35; *Z*=-0.422, *p*=0.673). These results confirm that depressive symptoms were significantly reduced for the patients 1 week after psilocybin treatment, but did not change over an equivalent period for the non-treated control subjects.

The patients' 1 week post-treatment QIDS scores (*M*=12.29, *SD*=9.18) did not differ significantly from the controls' follow-up values (*M*=4.29, *SD*=4.35; *U*=10.000, *p*=0.062), implying that the patients' depressive symptoms were reduced to levels comparable with a healthy population at the 1-week post-treatment time-point (Figure 1(c)).

The patients' QIDS scores remained significantly decreased 7-12 months after psilocybin treatment (*M*=13.00, *SD*=6.39) compared with baseline (*M*=19.43, *SD*=4.04); *Z*=-1.782, *p*=0.038. Moreover, the Hedges' g value (*g*=0.7) for this contrast was 'medium-to-large'. There was no significant difference found in the controls' baseline (*M*=3.86, *SD*=2.41) versus 7-12-month follow-up QIDS scores (*M*=4.00, *SD*=3.58); *Z*=-0.137, *p*=0.891 (Figure 1(c)). These results confirm that the patients' significant reductions in depressive symptoms were sustained for 7-12 months after psilocybin treatment, and did not change over an equivalent period for the non-treated control subjects.

Discussion

The present study sought to investigate the effects of psilocybin with psychological support on nature relatedness and authoritarianism in patients with TRD. Patients reported a greater connection with nature 1 week after treatment. This increase in nature relatedness was sustained at the 7-12-months follow-up. One week post-treatment a significant decrease in authoritarianism was also observed, and at the 7-12-month follow-up the decrease was at trend level. No significant differences in nature relatedness, authoritarianism or depressive symptoms were found in an age and education-matched group of control subjects measured over an equivalent time period, thus supporting the inference that the changes were *not* due to order effects. Taken together, these findings indicate that the psychologically supportive administration of psilocybin might induce sustained changes in attitudes and beliefs, including feeling closer to nature and less allied to authoritarian views.

The reduction of depressive symptoms following psilocybin treatment found here is consistent with previous studies demonstrating the therapeutic potential of psychedelic compounds (Carhart-Harris and Goodwin, 2017). Long-term improvements in psychological wellbeing (Griffiths *et al*., 2008) and trait openness and optimism (Carhart-Harris *et al*., 2016b; MacLean *et al*., 2011; Schmid and Liechti, 2017) have been observed in healthy volunteers following a single exposure to a psychedelic drug. A single dose of psilocybin has also been shown to induce enduring reductions in anxiety and depression as well as increases in quality of life, life meaning, and optimism in patients with anxiety reactive to advanced-stage cancer (Griffiths *et al*., 2016; Grob *et al*., 2011; Ross *et al*., 2016). Furthermore, rapid and sustained antidepressant effects were found in patients with recurrent MDD that were treated with a single dose of the plant-based psychedelic brew, ayahuasca (Osorio Fde *et al.*, 2015).

Evidence suggests that greater nature relatedness is associated with lower anxiety (Martyn and Brymer, 2014) and greater personal wellbeing (Capaldi *et al.*, 2014; Cervinka *et al.*, 2012; Howell *et al.*, 2011; Mayer and Frantz, 2004; Mayer *et al.*, 2008; Nisbet and Zelenski, 2011; Nisbet *et al.*, 2011; Zelenski and Nisbet, 2014), and that exposure to awe-inspiring nature may increase pro-social behaviour (Piff *et al.*, 2015) - perhaps through a related mechanism of seeing oneself as small in relation to the vastness of nature. Here, we show that the TRD patients felt more connected to nature up to 7-12 months after psilocybin treatment. This is consistent with a previous study in healthy participants in which 38% of the sample reported enduring positive changes in their relationship to nature and the environment 8-16 months post-psilocybin (Studerus *et al.*, 2011). Psychedelic use in a large sample of web-survey respondents was found to positively predict nature relatedness (Nour *et al.*, 2017); moreover, as with nature-inspiring experiences of awe (Piff *et al.*, 2015), this relationship was strongest in people who experienced the greatest ego-dissolution during their most intense psychedelic experience (Nour *et al.*, 2017).

Psychedelic users have been found to rate themselves as more concerned with the environment than users of other illicit substances (Lerner and Lyvers, 2006; Nour *et al.*, 2017). Interacting with nature has been shown to have cognitive and affective benefits in healthy individuals (Berman *et al.*, 2008) and patients with MDD (Berman *et al.*, 2012). Although we found no correlation between the changes in nature relatedness or authoritarianism and changes in depression in the patients, this may simply have been due to the small sample size (*n*=7), or it is possible that a measure of mental wellbeing may have been more sensitive to such a relationship than the presently used measure of depression. There is, however, evidence to suggest that nature exposure decreases rumination as well as activity in brain regions implicated in depression (Hamilton *et al.*, 2015), namely the subgenual prefrontal cortex (sgPFC) and regions of the default mode network (DMN) (Bratman *et al.*, 2015). Interestingly, the administration of psilocybin has also been shown to acutely decrease sgPFC and DMN blood flow and within-network functional integrity (Carhart-Harris *et al.*, 2012; Hamilton *et al.*, 2015) and to increase global connectivity in the brain (Petri *et al.*, 2014; Roseman *et al.*, 2016). Further work is required to test the hypotheses that a renewed sense of 'connectedness', including feeling connected to nature, is a key factor determining therapeutic outcomes in psychedelic therapy (Carhart-Harris *et al.*, 2018b; Watts *et al.*, 2017b) and to better elucidate its basis in the brain. A working hypothesis is that increased global connectivity in the brain and its relationship to ego-dissolution (Tagliazucchi *et al.*, 2016) and associated 'connectedness' (Watts *et al.*, 2017b) is a key mediating factor (Carhart-Harris *et al.*, 2018b).

Psychedelic drug use in the 1960s and 1970s was strongly associated with anti-establishment and egalitarian counter-culture movements (Nichols, 2016), yet very little controlled research has investigated the link between psychedelic use and political perspectives. Here we show for the first time, in a controlled study, lasting changes in political values after exposure to a psychedelic drug. This is in line with early research showing that recreational LSD users score higher on attitudes of 'personal liberty' and 'foreign policy liberalism' than control subjects (McGlothlin and Arnold, 1971). Psychedelic users have also been shown to score higher on 'concern for others' and place lower value on 'financial prosperity' than non-users of illicit substances as well as users of amphetamine, cannabis or heroin (Lerner and Lyvers, 2006). Given that psychedelics act through the serotonin system, it is interesting that serotonin has been implicated in the assessment of harm in moral decision-making, altruistic punishment and fairness (Crockett *et al.*, 2008, 2010, 2013; Story *et al.*, 2015). Moreover, psychedelics have been shown to increase trait openness (Carhart-Harris *et al.*, 2016b; Griffiths *et al.*, 2008; MacLean *et al.*, 2011), and a substantial body of evidence demonstrates a positive association between openness and liberalism within individuals (Carney *et al.*, 2008; Nour *et al.*, 2017; Sibley *et al.*, 2012; Xu *et al.*, 2013). Relatedly, the role of the serotonin 2A receptor, the key site of action of psychedelics, in mediating 'conversion-type' or 'quantum change' (Miller, 2004) experiences has recently been discussed (Carhart-Harris and Nutt, 2017).

There are a number of important limitations to this study that must be considered when interpreting the results. The study formed part of an open-label clinical trial with a small sample size. The sample was smaller still for the NR-6 and PPQ-5, as these measures were introduced late in the trial due to inspiration from a separate project of ours (Nour *et al.*, 2017). Also, although we recruited a control group to examine test-retest reliability on these measures, the controls were healthy subjects and were not exposed to the same treatment procedures. Critically, since treatment with psilocybin involved more than just drug administration (e.g.

psychological support before and after the psilocybin dosing sessions), it is quite possible that drug-unrelated factors contributed to the changes in NR-6 and PPQ-5 scores observed here. The caring therapeutic model may have been one such factor. A large double-blind randomised control trial, ideally with an active control condition (to try and maintain the study blind), is required to more rigorously test the possible causal association between psilocybin and changes in nature relatedness and political perspective reported here. It would be hasty, therefore, to attempt any strong claims about a causal influence due specifically to psilocybin at this stage, and we should also be aware of anomalies in the relationship between psychedelic use and left-wing politics (Henrik, 2017); however, intriguing questions relating to psychedelics and political/philosophical perspectives remain.

A further limitation concerns the gender matching of control subjects and TRD patients; all TRD patients were male, whereas there were more females (71%) than males (29%) in the control condition. Thus, our findings in the TRD group cannot necessarily be extrapolated to females and the possibility of a gender effect cannot be discounted, and neither can we directly extrapolate the present findings to non-depressed populations.

The specificity of our main results also requires careful consideration. The question remains to be addressed whether the reported changes in nature relatedness and authoritarianism observed here post-treatment with psilocybin were selective for these outcomes, or rather an epiphenomenon of the treatment's core effects on depressive symptoms. The question of causality is of central relevance here, and only further research can elucidate this. In this context, we would like to propose that there is a common mediating factor at play, driving both the improvements in mental health and changes in belief systems seen here - as well as elsewhere with psilocybin and other psychedelics (Carhart-Harris *et al.*, 2016b; Hendricks *et al.*, 2015b; Krebs and Johansen, 2013; MacLean *et al.*, 2011). Such a common factor could be seen as a mental health equivalent of the general intelligence factor (e.g. Spearman's *g*) in cognitive science (Spearman, 1987; Spiegelman, 2010). More specifically, in line with a recent commentary from our team (Carhart-Harris *et al.*, 2018b) we propose that *connectedness* is this factor (see Carhart-Harris *et al.* (2018b); Watts *et al.* (2017b)), and that psychedelics positively and potently modulate this.

Connectedness is a construct in need of development, but related concepts can be found in the literature (Alexander, 2010). In brief, connectedness can be defined as a sense of feeling connected to one's self (i.e. a sense of feeling emotionally and somatically integrated and at peace) as well as others (e.g. one's partner, family, friends, colleagues and community) and the world more generally (e.g. feeling connected to nature and a guiding ethical and/or philosophical principle), as described in our recent work (Carhart-Harris *et al.*, 2018b; Watts *et al.*, 2017b). Thus, a remediating effect on feelings of disconnectedness, characteristic of a broad swathe of mental illness (Alexander, 2010), may underlie both the improvements in depressive symptoms and the relevant changes in political perspective reported here.

What of the association between mental health and political perspective? There is some support for a link between lower authoritarianism and better mental health (Amodio *et al.*, 2007; Hirsh *et al.*, 2010; Jost *et al.*, 2003), although there are also some contradictory findings (Verhulst *et al.*, 2016; Vigil, 2010). The idea that drugs, including legal ones such as alcohol (Nour *et al.*, 2016) and caffeine (Carpenter, 2015), and medications such as stimulants (Ohler and Whiteside, 2017) and selective serotonin reuptake inhibitors (Kramer, 1997) can modulate belief systems, including political perspective, is relatively new - but one that may be fundamentally important, with potentially profound implications. If, for example, it was found that excessive alcohol use promotes a detachment from nature (Nour *et al.*, 2016), chronic stimulant use promotes an aggressive industriousness and hubris - and potential for paranoia (Ohler and Whiteside, 2017) - and psychedelic experiences promote a generalised sense of connectedness (Carhart-Harris *et al.*, 2018b; Watts *et al.*, 2017b), including greater altruism (Forstmann and Sagioglou, 2017; Schmid and Liechti, 2017), what implications would this have for societies and their policies on such drugs? This and related topics may be seen as part of a new branch of political science, focused on the psychology and neurobiology of political perspective (Amodio *et al.*, 2007; Everett *et al.*, 2015; Haidt, 2013; Kanai *et al.*, 2011; Kaplan *et al.*, 2016; Nash *et al.*, 2017).

Finally, we are keen to avoid a value judgement about the political changes that may (or may not) be attributable to psychedelic use. For some, ecological considerations (e.g. captured by nature relatedness) may be assigned the greatest importance (Lovelock and Hudson, 2016), particularly when considering the scale and seriousness of the problem posed by climate change, for example (Prüss-Ustün *et al.*, 2016), whereas others may recognise 'order' (e.g. captured in part by our authoritarianism scale) as an essential and functional counterweight to lawlessness (Bejan, 2017; Haidt, 2013). Testing whether psychedelic use is 'beneficial for society' would be a complex project, not least because opinions will differ on how to define 'beneficial' (although see Harris (2010) for a thought-provoking discussion on this matter). Even so, exploring the potential of psychedelics to moderate extremist views, and/or facilitate reconciliation, might be worth exploring, given the present results and wider supporting literature (Amodio *et al*., 2007; Carhart-Harris *et al*., 2018b; Hirsh *et al*., 2010; Jost *et al*., 2003; Watts *et al*., 2017a).

In conclusion, this study sought to investigate the effects of psilocybin with psychological support on nature relatedness and authoritarian attitudes in patients with TRD. With significant caveats clearly highlighted, our findings tentatively raise the possibility that given in this way, psilocybin may produce sustained changes in outlook and political perspective, here in the direction of increased nature relatedness and decreased authoritarianism. These findings motivate further controlled studies to better determine the causality, reliability, specificity and durability of this relationship, as well as potential applications.

> Before I enjoyed nature, now I feel part of it. Before I was looking at it as a thing, like TV or a painting... [But now I see] there's no separation or distinction, you *are* it. (*Patient from this trial*)

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was funded by Medical Research Council.

ORCID iD

Taylor Lyons http://orcid.org/0000-0002-3118-7344
Robin L Carhart-Harris http://orcid.org/0000-0002-6062-7150

References

1. Alexander BK (2010) *The Globalisation of Addiction a Study in Poverty of the Spirit*. Oxford: Oxford University Press.
2. Amodio DM, Jost JT, Master SL, *et al*. (2007) Neurocognitive correlates of liberalism and conservatism. *Nat Neurosci* 10: 1246-1247.
3. Bejan TM (2017) *Mere Civility*. Cambridge: Harvard University Press.
4. Berman MG, Jonides J and Kaplan S (2008) The cognitive benefits of interacting with nature. *Psychol Sci* 19: 1207-1212.
5. Berman MG, Kross E, Krpan KM, *et al*. (2012) Interacting with nature improves cognition and affect for individuals with depression. *J Affect Disord* 140: 300-305.
6. Bogenschutz MP, Forcehimes AA, Pommy JA, *et al*. (2015) Psilocybin-assisted treatment for alcohol dependence: A proof-of-concept study. *J Psychopharmacol* 29: 289-299.
7. Bratman GN, Hamilton JP, Hahn KS, *et al*. (2015) Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proc Natl Acad Sci U S A* 112: 8567-8572.
8. Capaldi CA, Dopko RL and Zelenski JM (2014) The relationship between nature connectedness and happiness: A meta-analysis. *Front Psychol* 5: 976.
9. Carhart-Harris RL, Bolstridge M, Day CMJ, *et al*. (2018a) Psilocybin with psychological support for treatment-resistant depression: Six-month follow-up. *Psychopharmacology (Berl)* 235: 399-408.
10. Carhart-Harris RL, Bolstridge M, Rucker J, *et al*. (2016a) Psilocybin with psychological support for treatment-resistant depression: An open-label feasibility study. *Lancet Psychiatry* 3: 619-627.
11. Carhart-Harris RL, Erritzoe D, Haijen E, *et al*. (2018b) Psychedelics and connectedness. *Psychopharmacology (Berl)* 235: 547-550.
12. Carhart-Harris RL, Erritzoe D, Williams T, *et al*. (2012) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci U S A* 109: 2138-2143.
13. Carhart-Harris RL and Goodwin GM (2017) The therapeutic potential of psychedelic drugs: Past, present and future. *Neuropsychopharmacology* 42: 2105-2113.
14. Carhart-Harris RL, Kaelen M, Bolstridge M, *et al*. (2016b) The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol Med* 46: 1379-1390.
15. Carhart-Harris RL and Nutt DJ (2017) Serotonin and brain function: A tale of two receptors. *J Psychopharmacol* 31: 1091-1120.
16. Carhart-Harris RL, Roseman L, Bolstridge M, *et al*. (2017) Psilocybin for treatment-resistant depression: FMRI-measured brain mechanisms. *Sci Rep* 7: 13187.
17. Carney DR, Jost JT, Gosling SD, *et al*. (2008) The secret lives of liberals and conservatives: Personality profiles, interaction styles, and the things they leave behind. *Polit Psychol* 29: 807-840.

18. Carpenter M (2015) *Caffeinated: How Our Daily Habit Helps, Hurts, and Hooks Us*. New York: Plume.
19. Cervinka R, Roderer K and Hefler E (2012) Are nature lovers happy? On various indicators of well-being and connectedness with nature. *J Health Psychol* 17: 379-388.
20. Crockett MJ, Apergis-Schoute A, Herrmann B, *et al*. (2013) Serotonin modulates striatal responses to fairness and retaliation in humans. *J Neurosci* 33: 3505-3513.
21. Crockett MJ, Clark L, Lieberman MD, *et al*. (2010) Impulsive choice and altruistic punishment are correlated and increase in tandem with serotonin depletion. *Emotion* 10: 855-862.
22. Crockett MJ, Clark L, Tabibnia G, *et al*. (2008) Serotonin modulates behavioral reactions to unfairness. *Science* 320: 1739.
23. Evans G, Heath A and Lalljee M (1996) Measuring left-right and libertarian-authoritarian values in the British electorate. *Br J Sociol* 47: 93-112.
24. Everett JA, Faber NS, Crockett MJ, *et al*. (2015) Economic games and social neuroscience methods can help elucidate the psychology of parochial altruism. *Front Psychol* 6: 861.
25. Forstmann M and Sagioglou C (2017) Lifetime experiences with classical psychedelics predicts pro-environmental behaviour through an increase in nature relatedness. *J Psychopharmacol* 31: 975-988.
26. Griffiths R, Richards W, Johnson M, *et al*. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritualsignificance 14 months later. *J Psychopharmacol* 22: 621-632.
27. Griffiths RR, Johnson MW, Carducci MA, *et al*. (2016) Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threateningcancer: A randomized double-blind trial. *J Psychopharmacol* 30: 1181-1197.
28. Grob CS, Danforth AL, Chopra GS, *et al*. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.
29. Grob CS, McKenna DJ, Callaway JC, *et al*. (1996) Human psychopharmacology of hoasca, a plant hallucinogen used in ritual context in Brazil. *J Nerv Ment Dis* 184: 86-94.
30. Haidt J (2013) *The Righteous Mind Why Good People are Divided by Politics and Religion*. London: Penguin Books.
31. Hamilton JP, Farmer M, Fogelman P, *et al*. (2015) Depressive rumination, the default-mode network, and the dark matter of clinical neuroscience. *Biol Psychiatry* 78: 224-230.
32. Hamilton M (1960) A rating scale for depression. *J Neurol Neurosurg Psychiatry* 23: 56-62.
33. Harris S (2010) *Science Can Answer Moral Questions*. Available at: https://www.ted.com/talks/sam_harris_science_can_show_what_s_ right/transcript.
34. Hendricks PS, Johnson MW and Griffiths RR (2015a) Psilocybin, psychological distress, and suicidality. *J Psychopharmacol* 29: 1041-1043.
35. Hendricks PS, Thorne CB, Clark CB, *et al*. (2015b) Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adultpopulation. *J Psychopharmacol* 29: 280-288.
36. Henrik D (2017) *Apolitical Pharmacography: From Altruism to Terrorism in Psychedelic Culture*. Available at: http://www.oaktreereview. com/apolitical-pharmacology-from-altruism-to-terrorism-in-psyche- delic-culture/.
37. Hirsh JB, DeYoung CG, Xiaowen X, *et al*. (2010) Compassionate liberals and polite conservatives: Associations of agreeableness with political ideology and moralvalues. *Pers Soc Psychol Bull* 36: 655-664.
38. Howell AJ, Dopko RL, Passmore H-A, *et al*. (2011) Nature connectedness: Associations with well-being and mindfulness. *Pers Indiv Differ* 51: 166-171.
39. Johansen PO and Krebs TS (2015) Psychedelics not linked to mental health problems or suicidal behavior: A population study. *J Psychopharmacol* 29: 270-279.
40. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al*. (2014) Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol*28: 983-992.
41. Jost JT, Glaser J, Kruglanski AW, *et al*. (2003) Political conservatism as motivated social cognition. *Psychol Bull* 129: 339-375.
42. Kanai R, Feilden T, Firth C, *et al*. (2011) Political orientations are correlated with brain structure in young adults. *Curr Biol* 21: 677-680.
43. Kaplan JT, Gimbel SI and Harris S(2016) Neural correlates of maintaining one's political beliefs in the face of counterevidence. *Sci Rep* 6: 39589.
44. Kramer PD (1997) *Listening to Prozac*. New York: Penugin Book.
45. Krebs TS and Johansen PO (2013) Psychedelics and mental health: A population study. *PLoS One* 8: e63972.
46. Lerner M and Lyvers M (2006) Values and beliefs of psychedelic drug users: A cross-cultural study. *J Psychoactive Drugs* 38: 143-147.
47. Lovelock J and Hudson J (2016) *James Lovelock et al: The Earth and I*. Cologne: Taschen.
48. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
49. Martyn P and Brymer E (2014) The relationship between nature relatedness and anxiety. *J Health Psychol* 21: 1436-1445.
50. Mayer FS and Frantz CM (2004) The connectedness to nature scale: A measure of individuals' feeling in community with nature. *J Environ Psychol* 24: 503-515.
51. Mayer FS, Frantz CM, Bruehlman-Senecal E, *et al*. (2008) Why is nature beneficial? *Environ Behav* 41: 607-643.
52. McGlothlin WH and Arnold DO (1971) Lsd revisited: A ten-year follow-up of medical LSD use. *Arch Gen Psychiatry* 24: 35-49.
53. Metzner R, Litwin G and Weil G (1965) The relation of expectation and mood to psilocybin reactions: A questionnaire study. *Psychedelic Rev* 5: 3-39.
54. Miller WR (2004) The phenomenon of quantum change. *J Clin Psychol* 60: 453-460.
55. Montgomery SA and Asberg M (1979) A new depression scale designed to be sensitive to change. *Br J Psychiatry* 134: 382-389.
56. Moreno FA, Wiegand CB, Taitano EK, *et al*. (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J Clin Psychiatry* 67: 1735-1740.

57. Nash K, Baumgartner T and Knoch D (2017) Group-focused morality is associated with limited conflict detection and resolution capacity: Neuroanatomical evidence. *Biol Psychol* 123: 235-240.
58. Nichols DE (2016) Psychedelics. *Pharmacol Rev* 68: 264-355.
59. Nisbet EK and Zelenski JM (2011) Underestimating nearby nature: Affective forecasting errors obscure the happy path to sustainability. *Psychol Sci* 22: 1101-1106.
60. Nisbet EK and Zelenski JM (2013) The NR-6: A new brief measure of nature relatedness. *Front Psychol* 4: 813.
61. Nisbet EK, Zelenski JM and Murphy SA (2011) Happiness is in our nature: Exploring nature relatedness as a contributor to subjective well-being. *J Happiness Stud* 12: 303-322.
62. Nour M, Evans L and Carhart-Harris RL (2017) Psychedelics, personality and political perspectives. *J Psychoactive Drugs* 49: 182-191.
63. Nour MM, Evans L, Nutt D, *et al*. (2016) Ego-dissolution and psychedelics: Validation of the ego-dissolution inventory (EDI). *Front Hum Neurosci* 10: 269.
64. Ohler N and Whiteside S (2017) *Blitzed: Drugs in the Third Reich*. London: Penguin.
65. Osorio Fde L, Sanches RF, Macedo LR, *et al*. (2015) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: A preliminary report. *Rev Bras Psiquiatr* 37: 13-20.
66. Petri G, Expert P, Turkheimer F, *et al*. (2014) Homological scaffolds of brain functional networks. *J R Soc Interface* 11: 20140873.
67. Piff PK, Dietze P, Feinberg M, *et al*. (2015) Awe, the small self, and prosocial behavior. *J Pers Soc Psychol* 108: 883-899.
68. Prüss-Ustün A, Wolf J, Corvalan C, *et al*. (2016) *Preventing Disease through Healthy Environments: A Global Assessment of the Burden of Disease from Environmental Risks*. Geneva, Switzerland: World Health Organization.
69. Roseman L, Sereno MI, Leech R, *et al*. (2016) LSD alters eyes-closed functional connectivity within the early visual cortex in a retinotopic fashion. *Hum Brain Mapp* 37: 3031-3040.
70. Ross S, Bossis A, Guss J, *et al*. (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *J Psychopharmacol* 30: 1165-1180.
71. Rush AJ, Trivedi MH, Ibrahim HM, *et al*. (2003) The 16-Item Quick Inventory of Depressive Symptomatology (QIDS), clinician rating (QIDS-C), and self-report (QIDS-SR): a psychometric evaluation in patients with chronic major depression. *Biol Psychiatry* 54: 573-583.
72. Schmid Y and Liechti ME (2017) Long-lasting subjective effects of LSD in normal subjects. *Psychopharmacology (Berl)*. Epub ahead of print. doi: 10.1007/s00213-017-4733-3.
73. Shanahan DF, Bush R, Gaston KJ, *et al*. (2016) Health benefits from nature experiences depend on dose. *Sci Rep* 6: 28551.
74. Sheehan DV, Lecrubier Y, Sheehan KH, *et al*. (1998) The Mini-International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry* 59(Suppl. 20): 22-33; quiz 34-57.
75. Sibley CG, Osborne D and Duckitt J (2012) Personality and political orientation: Meta-analysis and test of a threat-constraint model. *J Res Pers* 46: 664-677.
76. Spearman C (1987) The proof and measurement of association between two things. By C. Spearman, 1904. *Am J Psychol* 100: 441-471.
77. Spiegelman D (2010) Commentary: Some remarks on the seminal 1904 paper of Charles Spearman 'The proof and measurement of association between two things'. *Int J Epidemiol* 39: 1156-1159.
78. Story GW, Vlaev I, Metcalfe RD, *et al*. (2015) Social redistribution of pain and money. *Sci Rep* 5: 15389.
79. Studerus E, Kometer M, Hasler F, *et al*. (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: A pooled analysis ofexperimental studies. *J Psychopharmacol* 25: 1434-1452.
80. Tagliazucchi E, Roseman L, Kaelen M, *et al*. (2016) Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr Biol* 26: 1043-1050.
81. Verhulst B, Eaves L and Hatemi PK (2016) Erratum to "Correlation not causation: The relationship between personality traits and political ideologies" *American Journal of Political Science* 56(1), 34-51. *American Journal of Political Science* 60: E3-E4.
82. Vigil JM (2010) Political leanings vary with facial expression processing and psychosocial functioning. *Group Process Intergroup Relat* 13: 547-558.
83. Wagner MT, Mithoefer MC, Mithoefer AT, *et al*. (2017) Therapeutic effect of increased openness: Investigating mechanism of action in MDMA-assistedpsychotherapy. *J Psychopharmacol* 31: 967-974.
84. Watts R, Day C, Krzanowski J, *et al*. (2017a) Patients' accounts of increased 'connection' and 'acceptance' after psilocybin for treatment-resistant depression. *J Humanist Psychol* 57: 520-564.
85. Watts R, Day C, Krzanowski J, *et al*. (2017b) Patients' accounts of increased "connectedness" and "acceptance" after psilocybin for treatment-resistant depression. *J Humanist Psychol* 57: 520-564.
86. Xu X, Mar RA and Peterson JB (2013) Does cultural exposure partially explain the association between personality and political orientation? *Person Soc Psychol Bull* 39: 1497-1517.
87. Zelenski JM and Nisbet EK (2014) Happiness and feeling connected: The distinct role of nature relatedness. *Environ Behav* 46: 3-23.

Can Psychedelic Drugs Attenuate Age-Related Changes in Cognition and Affect

by

Jacob S. Aday[1] & Emily K. Bloesch[1] & Christopher C. Davoli[1]

Received: 30 May 2019 / Accepted: 20 August 2019

Journal of Cognitive Enhancement
DOI: 10.1007/s41465-019-00151-6

© Authors 2019

original report:
https://www.researchgate.net/profile/Jacob_Aday/publication/335241754_Can_Psychedelic_Drugs_Attenuate_Age-Related_Changes_in_Cognition_and_Affect/links/5d77d2554585151ee4adb41e/Can-Psychedelic-Drugs-Attenuate-Age-Related-Changes-in-Cognition-and-Affect.pdf
backup source: http://www.psilosophy.info/resources/Can-Psychedelic-Drugs-Attenuate-Age-Related-Changes-in-Cognition-and-Affect.pdf

[1] Department of Psychology, Central Michigan University, Mount Pleasant, MI 48858, USA

Corresponding author:
Jacob S. Aday
aday1js@cmich.edu

Table of Contents:

Abstract
Introduction
Cognitive Parallels
Affective Parallels
Potential Mechanisms
Safety
Future Directions
Conclusion
Compliance with Ethical Standards
References

Abstract

Older adulthood can be characterized by various cognitive and affective changes. In general, older adults show declines in creativity and executive functioning. They also score lower in openness to experience, empathy, and many suffer from a paucity of meaningful experiences. Further, depression, pessimism, and suicide can be major concerns for this population. Although currently there are few interventions that can effectively address these changes, recent findings from psychedelic science suggest myriad parallels between the effects of these drugs and the cognitive/affective shifts seen in older adulthood. Studies have shown that psychedelics are associated with enhanced creativity and executive functioning. They can also lead to increases in openness and empathy, and induce personally meaningful experiences. Lastly, psychedelics' efficacy for treating mood disorders and their role in palliative care are rapidly growing areas of scientific research. In this article, we analyze findings from contemporary psychedelic studies and integrate them with research on cognitive/affective changes in older adulthood to assess whether these drugs have potential to be incorporated into older adult research. We also assess the intuitive follow-up questions of potential mechanisms of action and safety concerns. Findings indicate that psychedelics have effects on a number of cognitive/affective processes that are altered in older adulthood, and are relatively safe when used with professional preparation and supervision. Increased neuroplasticity, neurogenesis, connectedness, and mystical experiences have been argued to underlie cognitive/affective changes. However, further research is needed to overcome current experimental limitations such as generalizability, unstandardized dosages, inadequate controls, and self-selection/experimenter biases.

Keywords Psychedelics, Cognition, Affect, Aging, Well-being

Introduction

A number of cognitive and affective changes have been documented in older adulthood, which is typically conceptualized as beginning in one's 60s (Salthouse 2009). These changes can include declines in creativity and generating novel ideas (Price and Tinker 2014), impaired executive functioning (Baudouin *et al*. 2019), decreased openness to experience (Donnellan and Lucas 2008), and decreased empathy (Grühn *et al*. 2008). Further, although depression scores generally drop after early adulthood, late-life depression is one of the most common causes of emotional suffering in older adults (Blazer 2003; Wang and Blazer 2015), and the elderly have higher rates of suicide than younger adults (De Leo and Meneghel 2001; Kumar *et al*. 2015). These changes in negative affect may be due in part to a lack of meaningful experiences: Baum (1988) found that when elderly persons were asked to recount their most meaningful life experiences, none of the 50 participants reported an event after the age of 40. Lastly, the number of neurons in the brain decreases in older age as neurons that die off are not replaced as efficiently (Galvan and Jin 2007). Because neurogenesis is thought to play a major role in age-related cognitive and affective deficits, interventions which stimulate neurogenesis may build-up a cognitive reserve which could help reduce the intellectual and emotional burdens in late-life (Xu *et al*. 2015).

This is not to say that aging is inherently negative as many older adults experience high life satisfaction and emotional stability (Charles and Carstensen 2010; Scheibe and Carstensen 2010). Yet, risk factors for cognitive and affective decline can have a cumulative effect across individuals' lifespans ultimately leading to impairment (Camacho *et al*. 1993; Zeki Al Hazzouri *et al*. 2014). Addressing these risk factors can stave off cognitive decline (Mossello *et al*. 2008) and identifying holistic treatments which target multiple risk factors could facilitate healthy aging (Cesari *et al*. 2013). Thus, while older adults show changes in cognition and affect at the group level, many variables can exert compensatory effects on individual trajectories (Smith 2016).

Psychedelic drugs such as lysergic acid diethylamide-25 (LSD), psilocybin, and ayahuasca have been shown to induce alterations in cognition and affect that run counter to the changes seen in older adulthood. Research into psychedelic drugs blossomed in the mid-twentieth century but was put to a halt in the late 1960s as the War on Drugs emerged (Aday *et al*. 2019). However, the last 10-15 years has seen a renaissance of psychedelic research, and their public stigma seems to be waning as evidenced by recent positive pieces in mainstream media outlets (e.g., the *New York Times* Carroll 2017; *Wall Street Journal* Pollan 2018; *Business Insider* Brodwin 2018) and successful decriminalization efforts in parts of the USA (Aday *et al*. 2018, A watershed year for psychedelic science, unpublished). There are many parallels between the findings from these new studies and psychological changes in older adulthood. First, psychedelics have been shown to increase divergent (Kuypers *et al*. 2016) and convergent creativity (Uthaug *et al*. 2018). They can also lead to long-lasting increases in the personality trait of openness (MacLean *et al*. 2011) as well as increasing empathy (Pokorny *et al*. 2017). Psychedelic-assisted psychotherapy has been shown to have promising effects on depression (Griffiths *et al*. 2016; Ross *et al*. 2016). Relatedly, psychedelic use is associated with decreased psychological distress and suicidality (Hendricks *et al*. 2015). Psychedelics may also address the lack of meaningful experiences in older adulthood: in one study, two thirds of participants reported their psychedelic session as being one of the top five most meaningful experiences of their life (Griffiths *et al*. 2006). Their role in palliative care is also a rapidly growing area of study (Shelton and Hendricks 2016). Lastly, there is emerging evidence in animal models that psychedelics can stimulate neurogenesis (Catlow *et al*. 2016; Lima da Cruz *et al*. 2018; Morales-García *et al*. 2017) and neuroplasticity (Ly *et al*. 2018), which may be key mechanisms facilitating improvements. Altogether, the reviewed literature suggests many parallels between cognitive/affective changes in older adulthood and the effects of psychedelic drugs. In this paper, we analyze recent findings in psychedelic research and synthesize them with studies on cognitive and affective changes in late-life to determine whether these substances have potential to be incorporated into older adult research.

Cognitive Parallels

Relative to younger individuals, older adults suffer deficits in cognition in areas such as memory and attention (Mok *et al*. 2016). Older age can also be associated with declines in creativity and executive functioning, and these changes in cognition may impair one's quality of life (Baudouin *et al*. 2019). There is growing evidence that psychedelic drug use is associated with improved creativity and executive functioning, suggesting that these drugs may have potential cognitive benefits for older adults.

Anecdotal reports about psychedelics' potential for improving creativity date back to the first era of psychedelic research during the mid-twentieth century and were espoused by diverse figures - from Aldous Huxley to Francis Crick to the Beatles (Goodden 2017; Sessa 2008). Researchers soon picked up on the connection between psychedelics and creativity as demonstrated by myriad articles published during this period (e.g., Harman *et al*. 1966; McGlothlin, Cohen, & McGlothlin *et al*. 1967; Zegans *et al*. 1967; see Sessa 2008, for a review). Today, researchers are revisiting psychedelic drugs' potential for improving creativity. Kuypers *et al*. (2016) found that while under the influence of ayahuasca, participants had increased divergent, but decreased convergent, creativity compared to their pre-ayahuasca session. These results contrast with another study which found improved convergent creativity after ayahuasca ingestion that lasted at least 4 weeks (Uthaug *et al*. 2018). In another study looking at non-acute effects, participants who partook in an ayahuasca retreat demonstrated enhanced creative expression relative to a control group similar in sex and age (Frecska *et al*. 2012). Finally, Prochazkova *et al*. (2018) found that when on "microdoses" of psychedelics (i.e., ~ 1/10th of a standard dose), participants had improved divergent and convergent creativity; however, the results must be interpreted with caution as participants were self-selected and not blind to conditions. It is also important to keep in mind that many of the aforementioned studies lacked adequate control groups given that it is difficult to blind participants between a consciousness-altering drug and placebo (Hendy 2018). Additionally, it is unclear if these effects generalize to older adulthood because no studies to date have directly assessed psychedelics' effects on creativity in this population. The inconclusive results in the literature thus far can most likely be attributed to differences in timing (i.e., acute vs. non-acute effects) and dosage. However, the wealth of anecdotal reports and promising findings from preliminary empirical research suggest a relationship between psychedelic use and creativity. Thus, although more research is needed, psychedelic drugs may have the potential to compensate for declines in creativity in older age and stimulate new ideas or styles of thinking (Uthaug *et al*. 2018).

Psychedelics may also have effects on age-related cognitive changes in areas such as executive functioning. In a study examining regular ayahuasca users with controls who were similar in sex, age, education, and income, Buoso and colleagues (Bouso *et al*. 2012) found that the users performed better on the Stroop task, the Wisconsin Card Sorting Test (WCST), the Letter-Number Sequencing task, and the Frontal Systems Behavior Scale. These findings suggest that psychedelic use is associated with increased working memory and set-shifting, which are two key components of executive functioning. Consistent with these results, another study found greater working memory performance in psychedelic drug users and a trend towards improved scores on the WCST relative to a control group that was matched for sex, age, income, and verbal and fluid intelligence quotient (IQ) scores (Bouso *et al*. 2015). Given the correlational nature of these studies, future experimental research is needed to delineate causation as well as test whether these improvements are maintained as individuals age. However, given that psychedelics stimulate plasticity (Ly *et al*. 2018) and enhanced plasticity has been shown to improve executive functioning (Selemon 2013), there is reason to expect that psychedelics have a causal effect on executive function. These results, in tandem with studies on psychedelics and creativity, suggest that psychedelics may be able to attenuate some of the cognitive changes related to older adulthood.

Affective Parallels

A striking parallel between psychedelic drugs and older adulthood regards their connections with affective processing. As previously mentioned, late-life can be associated with a number of affective shifts, including changes in openness to experience (Donnellan and Lucas 2008), empathy (Grühn *et al*. 2008), pessimism (Chang *et al*. 2013), rates of depression/suicide (De Leo and Meneghel 2001; Kumar *et al*. 2015; Wang and Blazer 2015), and meaningful experiences (Baum 1988). These affective changes can have considerable implications for overall well-being and quality of life in the elderly (Chang *et al*. 2013). For instance, treating depression decreases the severity of cognitive decline in the elderly (Mossello *et al*. 2008) and increased openness to experience is related to successful aging (Gregory *et al*. 2010). For those wanting to counter affective changes documented in older adulthood, evidence is mounting that psychedelics induce several opposing effects.

One affective change that has been consistently related to psychedelics is increased openness to experience. MacLean *et al*. (2011) found that participants reported increased openness after a high-dose psilocybin session relative to a control methlyphenidate session, and these changes were maintained for at least 1 year. Although this study was limited by a selection bias (i.e., recruitment materials advertised that participants would be taking psilocybin), subsequent studies have replicated increased openness after psychedelic use (Bouso *et al*. 2018; Erritzoe *et al*. 2018; Lebedev *et al*. 2016). Studies in this area could also be tainted by experimenter bias: given the stigma historically associated with these drugs, potentially only researchers with deep intrinsic interest in psychedelics would be willing to risk their professional credibility and resources by entering the field. This could bias the type of questions researchers study with the drugs (i.e., there could be a lack of studies on negative outcomes related to psychedelics). Lastly, it is possible that participants showed increased openness because they were on an illicit drug rather than because of psilocybin per se. That is, perhaps after having an enjoyable experience with something highly stigmatized, individuals may wonder what other stigmatized/disconcerting activities they should also be open to. Changes in openness may nevertheless have exponential downstream effects on other cognitive and affective outcomes, such as creativity (Silvia *et al*. 2009). Further, psychedelic use has been shown to increase emotional empathy (Pokorny *et al*. 2017), which may also be related to changes in openness. Speculatively, it seems that increased openness to experience could also increase the number of meaningful experiences in older adulthood. In any case, the changes in openness induced by psychedelics seem to run counter to the changes seen in late-life.

Perhaps the most rapidly growing area of psychedelic research is in their treatment for affective disorders like depression (Griffiths *et al*. 2016; Carhart-Harris *et al*. 2016; Ross *et al*. 2016; Uthaug *et al*. 2018). Indeed, in the USA, the FDA recently designated psilocybin to "breakthrough therapy" status for treatment-resistant depression (Bauer 2019), which should expedite future research in this area. Given the wide variety of negative outcomes associated with depression, this research could have important implications for older adults. In one stark example, Griffiths *et al*. (2016) found that following psilocybin-assisted psychotherapy, 80% of their depressed patients showed a reduction in symptoms that were maintained for at least 6 months after their sessions. Ross *et al*. (2016) concurrently found similar findings (i.e., 60-80% of patients had a reduction in symptoms 6.5 months after their sessions) in a rigorous double-blind, placebo-controlled, and crossover trial of cancer patients experiencing end-of-life distress. The findings from the Griffiths and Ross experiments are particularly pertinent to older adults given the average age in each of their studies was 56 years old. Further, while older adults are generally more pessimistic (Chang *et al*. 2013), psychedelic therapy has been shown to reduce pessimism and these changes are related to therapeutic outcomes with depression (Lyons and Carhart-Harris 2018). Heightened emotion regulation has also been linked with healthy aging (Suri and Gross 2012) and is increased in male psychedelic users compared to male non-users (Thiessen *et al*. 2018). Lastly, correlational research shows a negative relationship between psychedelic use and psychological distress and suicidal behaviors (Hendricks *et al*. 2015). Altogether, there is growing evidence that these drugs induce changes in emotional processing that oppose many changes seen in late-life.

Another affective connection between psychedelics and older adults regards meaningful experiences. As previously mentioned, the elderly report a paucity of meaningful events in later life (Baum 1988). Intuitively, a lack of meaningful experiences may be a contributing factor in pessimism, late-life depression, and increased rates of suicide in the elderly (Heisel and Flett 2008). Indeed, low meaning in life has been linked with increased suicide ideation (Heisel and Flett 2008), and interventions aimed at increasing meaning improve wellbeing in the elderly (Breitbart *et al*. 2015). Recent findings from psychedelic science suggest that psychedelic drugs may be able to treat this lack of meaningful experiences. In what is perhaps the seminal psychedelic study of the twenty-first century so far, Griffiths *et al*. (2006) found in their double-blind experiment that two thirds of their participants rated their psilocybin session as being one of the top five most meaningful experiences in their life - comparable to events like the birth of a child or death of a parent. Further, 38% said it was one of their top five most spiritually significant experiences, and 79% of participants in this study rated that the experience improved their sense of well-being or life satisfaction "moderately" or "very much." The results illustrate that psychedelic drugs can induce experiences that are incredibly meaningful, even spiritual; this could have monumental implications for older adults suffering from a lack of meaningful experiences.

Relatedly, psychedelics' effects on end-of-life distress and palliative care is another area of current study (Kelmendi *et al*. 2016; Shelton and Hendricks 2016). Although this line of research was predated by similar studies in the first era of psychedelic research (e.g., Cohen 1965; Fisher 1970; Grof *et al*. 1973), improved experimental methodology has greatly advanced our understanding of the role psychedelics can play at the end-of-life. The first study in this area during the current era of psychedelic research was a double-blind, placebo-controlled pilot study which showed modest improvements in measures of well-being (Grob *et al*. 2011). Though limited by a small sample and relatively low dosage of psilocybin, the study was important in reestablishing proof-of-concept and safety protocols. More rigorous studies followed in 2016 as both Griffiths *et al*. and Ross *et al*. found robust decreases in measures of end-of-life distress. Finally, another study found that, in a dose-dependent manner, psilocybin treatment led to increases in life satisfaction, positive attitudes about life, and spirituality (Griffiths *et al*. 2011) - which can be critical factors in healthy aging that buffer against emotional distress (Grob *et al*. 2013).

Potential Mechanisms

Given the sheer number of cognitive and affective changes that have been related to psychedelics, they are each likely supported by distinct and overlapping mechanisms. In this section, we touch on the potential mechanisms underlying the previously mentioned alterations in cognition and affect associated with these substances.

Psychedelic drugs exert their acute effects predominantly through serotonin 5-HT$_{2A}$ receptors (Preller *et al*. 2017; Vollenweider *et al*. 1998). These receptors are widely distributed in the cortex, explaining the diverse effects of psychedelics and play a key role in memory and cognition (Zhang and Stackman Jr 2015). In animal studies, 5-HT$_{2A}$ activation has led to increased cognitive flexibility as well as associative learning (Carhart-Harris *et al*. 2014). Therefore, psychedelics may also affect cognitive flexibility, which could explain their effects on creativity, executive functioning (i.e., set-shifting), openness, and depression. Indeed, Jungaberle *et al*. (2018) noted that cognitive flexibility is generally heightened in psychedelic states. Carhart-Harris *et al*. (2014) proposed an exhaustive model of the effects of psychedelic drugs that begins at the 5-HT$_{2A}$ receptor level and builds into the desynchronization of higher-level networks in the brain (see Carhart-Harris 2018, 2019, for further discussion of the entropic brain hypothesis).

Another - more speculative - explanation for the cognitive changes related to psychedelics is increased neurogenesis and neuroplasticity (Lima da Cruz *et al*. 2018). Decreased neurogenesis is thought to be a key factor underlying declines in cognition in older adults as neurons that die off are not replaced as efficiently (Galvan and Jin 2007; Xu *et al*. 2015). Additionally, Goh and Park (2009) argued that enhanced neuroplasticity could act as a compensatory response in the aging brain, and they suggested that interventions should be identified that can stimulate plasticity. Psychedelic drugs are intriguing candidates for inducing these critical changes in the brain. Several studies in recent years have shown that administering psychedelic drugs in vitro (Catlow *et al*. 2013) and in vivo (Catlow *et al*. 2016; Lima da Cruz *et al*. 2018; Morales-García *et al*. 2017) stimulates neurogenesis. Further, a recent paper in *Cell Reports* demonstrated that psychedelics increased neuroplasticity and synaptogenesis (Ly *et al*. 2018). However, this mechanism remains uncertain until the results are replicated in human samples. Increased neurogenesis and neuroplasticity could explain some of the affective changes that have been related to psychedelics. Atrophy of prefrontal cortex neurons is thought to be a contributing factor to depression (Christoffel *et al*. 2011; Ly *et al*. 2018), and Jacobs *et al*. (2000) speculated that enhancing neurogenesis could aid in the recovery from depression. Given that relatively few interventions have been identified that can increase neurogenesis and plasticity, psychedelic drugs' potential in this domain is an important area of future research and this mechanism could contribute to the cognitive and affective changes (Vollenweider and Kometer 2010).

Some have argued that the increased sense of connectedness resulting from psychedelics underlies much of their therapeutic potential (Carhart-Harris *et al*. 2018). Individuals often report a profound sense of "oneness," ego dissolution, and a loss of a sense of self while on the drugs (Lebedev *et al*. 2015). Validating these anecdotal accounts, several recent studies have shown that the default mode network (DMN), which is fundamental in maintaining a sense of self, is deactivated while on psychedelics (Carhart-Harris *et al*. 2012; Palhano-Fontes *et al*. 2015; Smigielski *et al*. 2019). Millière *et al*. (2018) argue that the functional disintegration of the DMN during psychedelic states can drastically alter aspects of consciousness through transient decreases in self-referential thought and access to autobiographical information, leading to alterations in one's sense of self-identity. This shift in perspective may underlie changes in openness and empathy as individuals become less self-centered and more open to new ways of thinking. Indeed, changes in ego dissolution predicted subsequent increases in openness (Lebedev *et al*. 2016) as well as positive therapeutic outcomes (Griffiths *et al*. 2008; Ross *et al*. 2016). Given that depressed individuals are characterized by more self-referential cognitions and increased DMN activity (Sheline *et al*. 2009), these changes in one's sense of self seem to be an important mechanism underlying clinical changes associated with psychedelic drugs.

Finally, the degree to which one has a "mystical" experience while on the drugs predicts therapeutic outcomes (Garcia-Romeu *et al*. 2019, 2014; Griffiths *et al*. 2016; Roseman *et al*. 2018; Ross *et al*. 2016; Russ *et al*. 2019; Schmid and Liechti 2018) as well as changes in openness (MacLean *et al*. 2011). Mystical experiences are marked by a profound sense of meaning/sacredness, interconnectedness with others and the world, transcendence of time and space, ineffability, and a deep positive mood (Grob *et al*. 2013; Kelmendi *et al*. 2016). Deactivation of the DMN seems to be one component in having a mystical experience (Swanson 2018), which may explain their shared therapeutic outcomes. Declines in DMN activity are consistent with the decreases in self-referential processing as well as feelings of spacelessness and timelessness associated with mystical experiences (Barrett and Griffiths 2017). Griffiths *et al*. (2011) found that the dosage of psilocybin which yielded the highest probability of a mystical experience was also the dosage participants reported as the most personally meaningful, spiritually significant, and the session which they would most want to repeat given the opportunity. Similarly, Grob *et al*. (2013) argued that the mystical experience is critical in mediating psychedelic-related benefits, particularly in palliative care. They hypothesized that the patient's self-image can be "recalibrated" during this time of transcendence, such that they adopt a broader existential perspective and the concept of death is less anxiety-provoking. Psilocybin's tendency to increase a sense of continuity after death (Griffiths *et al*. 2011) may also be contributing to declines in end-of-life distress.

Safety

A natural concern when considering administering illicit drugs is safety. It is not recommended for seniors (or anyone) to take these substances unsupervised or without professional medical consultation. The tendency for psychedelics to induce acute increases in blood pressure, body temperature, heart rate, plasma cortisol, and epinephrine should be considered by consulting physicians (Nichols 2016). Current researchers put a strong emphasis on mentally preparing individuals for the experience, and they stress that the benefits derived from psychedelic-assisted psychotherapy sessions may not generalize to recreational psychedelic use (Honig 2019). That being said, correlational studies have shown that psychedelic use is not linked to mental health problems or suicidal behavior (Johansen and Krebs 2015), and their use is linked to reduced psychological distress and suicidality (Hendricks *et al*. 2015). Further, Bouso *et al*. (2012) found that regular ayahuasca users scored lower on every psychopathology measure they administered compared to non-users who were similar in sex, age, education, and income. When evaluating the abuse potential of psilocybin according to the 8 factors of the U.S. Controlled Substances Act, Johnson *et al*. (2018) concluded that there is limited harm associated with the drug. Lastly, rather than being a gateway drug, psychedelic users are at a 40% reduced risk of abusing opiates in the last year (Pisano *et al*. 2017), and they have not been shown to induce dependence (Rucker *et al*. 2016). Given the rapidly rising rates of opiate abuse in older adults (SAMHSA 2017), this could be another potential benefit for this population. This is not to say that psychedelics are risk-free; they can induce experiences that are incredibly psychologically challenging, particularly when used in the absence of proper "set" and "setting" (Barret *et al*. 2016). However, limited harm has been reported in the new era of psychedelic research, which utilizes rigorous preparation, support, and integration procedures. Indeed, Ross *et al*. (2016) noted that in the new era of psychedelic research, over 2000 participants have been run through carefully monitored sessions with zero long-term aversive side effects reported (see Johnson *et al*. 2008 for safety guidelines).

Future Directions

There are several logistical and practical concerns that must be addressed to implement psychedelic treatment for age-related changes in cognition and affect. First, researchers need to identify when the best time is for individuals to take these substances to maximize their therapeutic properties. Perhaps taking them in early adulthood can buffer against downstream effects from chronic traits that psychedelics have been shown to change (i.e., creativity, executive functioning, openness to experience, depression, pessimism). On the other hand, it is still unclear how long psychedelic-related changes in cognitive/affective processing are maintained. While several contemporary studies have demonstrated changes lasting for at least a year (Gasser *et al*. 2014, 2015; Griffiths *et al*. 2008, 2011) and there is evidence that some changes endure as long as 25 years after a single session (Doblin 1991), other studies suggest that "booster" sessions may be valuable (Barbosa *et al*. 2009; Noorani *et al*. 2018). It seems likely that more robust longitudinal studies will emerge as the number of experimental studies has skyrocketed in recent years, and these can inform researchers about optimal timing, dosage, and number of sessions required.

The extent to which all of these changes generalize to older adults is another remaining question. Given the unique changes and life challenges associated with older adulthood, the treatments designed for younger individuals would not be expected to always be appropriate for older adults (and vice versa). For example, treatments like cognitive behavioral therapy (CBT) for mental illness are equally effective in younger and older adults but administered differently (Laidlaw 2014). Older adult CBT focuses on additional concerns such as mobility, bereavement, loneliness, and medical issues that are not common concerns for younger adults. In the same way, psychedelic treatment for young adults may differ in its implementation compared to older adults, and this warrants future study. In any case, some contemporary psychedelic studies have incorporated older adults and demonstrated a variety of positive outcomes (Griffiths *et al*. 2016; Ross *et al*. 2016); thus, there is emerging evidence that administering psychedelics during late-life can lead to cognitive and affective changes.

Conclusion

In short, the reviewed literature demonstrates robust theoretical links between psychedelics and changes in cognition and affect associated with older age. Though many older adults suffer declines in creativity and executive functions, psychedelics have been shown to boost creativity and have been related to improved executive functioning. Older adulthood has also been associated with reduced openness to experience, empathy, and meaningful experiences, all of which can be increased by psychedelic drugs. Their compelling therapeutic potential for depression, pessimism, suicide, and palliative care may also be of benefit to the elderly. Enhanced neurogenesis, neuroplasticity, connectedness, and mystical experiences have been argued to underlie many of the cognitive and affective changes. Finally, recent studies endorse that these drugs are relatively safe when used with professional preparation and supervision. Given that several of these studies have utilized older adults, it seems that they can be implemented into this population. Altogether, the prior research supports that using psychedelics to treat age-related changes in cognition and affect can be a viable, and likely impactful, area of study. This review proposes a novel area of research, and the findings from our critical analysis of the background literature reveal that researchers should consider self-selection biases, experimenter biases, standardized dosages, control groups, and generalizability to improve future experimental methodology in psychedelic science.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

References

1. Aday, J. S., Bloesch, E. K., & Davoli, C. C. (2019). Beyond LSD: A broader psychedelic zeitgeist during the early to mid-20th century. *Journal of Psychoactive Drugs*, 51, 210-217. https://doi.org/10.1080/02791072.2019.158196.
2. Barbosa, P. C. R., Cazorla, I. M., Giglio, J. S., & Strassman, R. (2009). A six-month prospective evaluation of personality traits, psychiatric symptoms and quality of life in ayahuasca-naïve subjects. *Journal of Psychoactive Drugs*, 41, 205-212.
3. Barret, F. S., Bradstreet, M. P., Leoutsakos, J. M. S., Johnson, M. W., & Griffiths, R. R. (2016). The challenging experience questionnaire: Characterization of challenging experiences with psilocybin mushrooms. *Journal of Psychopharmacology*, 30, 1279-1295. https://doi.org/10.1177/0269881116678781.
4. Barrett, F. S., & Griffiths, R. R. (2017). Classic hallucinogens and mystical experiences: Phenomenology and neural correlates. In A. L. Halberstadt, F. X. Vollenweider, & D. E. Nutt (Eds.), *Behavioral neurobiology of psychedelic drugs* (pp. 393-430). Springer: Berlin.
5. Baudouin, A., Isingrini, M., & Vanneste, S. (2019). Executive functioning and processing speed in age-related differences in time estimation: A comparison of young, old, and very old adults. *Aging, Neuropsychology, and Cognition*, 26, 264-281. https://doi.org/10. 1080/13825585.2018.1426715.
6. Bauer, B. (2019). Psilocybin receives FDA breakthrough treatment designation. Psychedelic Science Review. Retrieved from https://psychedelicreview.com/psilocybin-receives-fda-breakthroughtreatment-designation/.
7. Baum, S. K. (1988). Meaningful life experiences for elderly persons. *Psychological Reports*, 63, 427-433. https://doi.org/10.2466/pr0.1988.63.2.427.
8. Blazer, D. G. (2003). Depression in late life: Review and commentary. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 58, M249-M265. https://doi.org/10.1093/gerona/58.3.M249.
9. Bouso, J. C., González, D., Fondevila, S., Cutchet, M., Fernández, X., Barbosa, P. C. R., *et al*. (2012). Personality, psychopathology, life attitudes and neuropsychological performance among ritual users of ayahuasca: A longitudinal study. *PLoS One*, 7, 1-13. https://doi.org/10.1371/journal.pone.0042421.
10. Bouso, J. C., Palhano-Fontes, F., Rodríguez-Fornells, A., Ribeiro, S., Sanches, R., Crippa, J. A. S. ... & Riba, J. (2015). Long-term use of psychedelic drugs is associated with differences in brain structure and personality in humans. *European Neuropsychopharmacology*, 25, 483-492. https://doi.org/10.1016/j.euroneuro.2015.01.008.
11. Bouso, J. C., dos Santos, R. G., Alcázar-Córcoles, M. Á., & Hallak, J. E. (2018). Serotonergic psychedelics and personality: A systematic review of contemporary research. *Neuroscience & Biobehavioral Reviews*, 87, 118-132. https://doi.org/10.1016/j.neubiorev.2018.02. 004.
12. Breitbart, W., Rosenfeld, B., Pessin, H., Applebaum, A., Kulikowski, J., & Lichtenthal, W. G. (2015). Meaning-centered group psychotherapy: An effective intervention for improving psychological well-being in patients with advanced cancer. *Journal of Clinical Oncology*, 33, 749-754.
13. Brodwin, E. (2018). Evidence is mounting that psychedelic drugs can help treat diseases. Here are the most promising uses. Business Insider. Retrieved from https://www.businessinsider.com/most-promising-uses-psychedelic-drugs-medicine-science-2018-10.
14. Camacho, T. C., Strawbridge, W. J., Cohen, R. D., & Kaplan, G. A. (1993). Functional ability in the oldest old: Cumulative impact of risk factors from the preceding two decades. *Journal of Aging and Health*, 5, 439-454.
15. Carhart-Harris, R. L. (2018). The entropic brain - Revisited. *Neuropharmacology*, 142, 167-178. https://doi.org/10.1016/j.neuropharm.2018.03.010.
16. Carhart-Harris, R. L. (2019). How do psychedelics work? *Current Opinion in Psychiatry*, 32, 16-21. https://doi.org/10.1097/YCO. 0000000000000467.
17. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J.M., Reed, L. J., Colasanti, A. ... & Hobden, P. (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proceedings of the National Academy of Sciences*, 109, 2138-2143. https://doi.org/10.1073/pnas.1119598109
18. Carhart-Harris, R. L., Kaelen, M., & Nutt, D. (2014). How do hallucinogens work on the brain? *The Psychologist*, 27, 662-665.
19. Carhart-Harris, R. L., Bolstridge, M., Rucker, J., Day, C. M., Erritzoe, D., Kaelen, M. & ... Taylor, D. (2016). Psilocybin with psychological support for treatment-resistant depression: An open-label feasibility study. *The Lancet Psychiatry*, 3, 619-627. https://doi.org/10.1016/S2215-0366(16)30065-7.
20. Carhart-Harris, R. L., Erritzoe, D., Haijen, E., Kaelen, M., & Watts, R. (2018). Psychedelics and connectedness. *Psychopharmacology*, 235, 547-550. https://doi.org/10.1007/s00213-017-4701-y.
21. Carroll, A. E. (2017). Can psychedelics be therapy? Allow research to find out. New York Times. Retrieved from https://www.nytimes.com/2017/07/17/upshot/can-psychedelics-be-therapy-allow-research-to-find-out.html.
22. Catlow, B. J., Song, S., Paredes, D. A., Kirstein, C. L., & Sanchez-Ramos, J. (2013). Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning. *Experimental Brain Research*, 228, 481-491. https://doi.org/10.1007/s00221-013-3579-0.
23. Catlow, B. J., Jalloh, A., & Sanchez-Ramos, J. (2016). Hippocampal neurogenesis: Effects of psychedelic drugs. In V. Preedy (Ed.), *Neuropathology of drug addictions and substance misuse* (pp. 821-831). London: Academic.
24. Cesari, M., Vellas, B., & Gambassi, G. (2013). The stress of aging. *Experimental Gerontology*, 48, 451-456.
25. Chang, E. C., Elizabeth, A. Y., Lee, J. Y., Hirsch, J. K., Kupfermann, Y., & Kahle, E. R. (2013). An examination of optimism/pessimism and suicide risk in primary care patients: Does belief in a changeable future make a difference? *Cognitive Therapy and Research*, 37, 796-804. https://doi.org/10.1007/s10608-012-9505-0.
26. Charles, S. T., & Carstensen, L. L. (2010). Social and emotional aging. *Annual Review of Psychology*, 61, 383-409.
27. Christoffel, D. J., Golden, S. A., & Russo, S. J. (2011). Structural and synaptic plasticity in stress-related disorders. *Reviews in the Neurosciences*, 22, 535-549. https://doi.org/10.1515/RNS.2011.044.
28. Cohen, S. (1965). LSD and the anguish of dying. *Harper's Magazine*, 231, 69-72.
29. De Leo, D., & Meneghel, G. (2001). The elderly and suicide. In D. Wassermann (Ed.), *Suicide: An unnecessary death* (pp.

195-207). London: Martin Dunitz.

30. Doblin, R. (1991). Pahnke's "Good Friday experiment": A long-term follow-up and methodological critique. *Journal of Transpersonal Psychology*, 23, 1-28
31. Donnellan, M. B., & Lucas, R. E. (2008). Age differences in the Big Five across the life span: Evidence from two national samples. *Psychology and Aging*, 23, 558-566. https://doi.org/10.1037/a0012897
32. Erritzoe, D., Roseman, L., Nour, M. M., MacLean, K., Kaelen, M., Nutt, D. J., & Carhart-Harris, R. L. (2018). Effects of psilocybin therapy on personality structure. *Acta Psychiatrica Scandinavica*, 138, 368-378. https://doi.org/10.1111/acps.12904.
33. Fisher, G. (1970). Psychotherapy for the dying: Principles and illustrative cases with special reference to the use of LSD. *OMEGA-Journal of Death and Dying*, 1, 3-15.
34. Frecska, E., Móré, C. E., Vargha, A., & Luna, L. E. (2012). Enhancement of creative expression and entoptic phenomena as after-effects of repeated ayahuasca ceremonies. *Journal of Psychoactive Drugs*, 44, 191-199. https://doi.org/10.1080/02791072.2012.703099.
35. Galvan, V., & Jin, K. (2007). Neurogenesis in the aging brain. *Clinical Interventions in Aging*, 2, 605-610.
36. Garcia-Romeu, A., Griffiths, R. R., & Johnson, M. W. (2014). Psilocybin-occasioned mystical experiences in the treatment of tobacco addiction. *Current Drug Abuse Reviews*, 7, 157-164. https://doi.org/10.2174/1874473708666150107121331.
37. Garcia-Romeu, A., Davis, A. K., Erowid, F., Erowid, E., Griffiths, R. R., & Johnson, M. W. (2019). Cessation and reduction in alcohol consumption and misuse after psychedelic use. *Journal of Psychopharmacology*. https://doi.org/10.1177/0269881119845793.
38. Gasser, P., Holstein, D., Michel, Y., Doblin, R., Yazar-Klosinski, B., Passie, T., & Brenneisen, R. (2014). Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *The Journal of Nervous and Mental Disease*, 202, 513-520.
39. Gasser, P., Kirchner, K., & Passie, T. (2015). LSD-assisted psychotherapy for anxiety associated with a life-threatening disease: A qualitative study of acute and sustained subjective effects. *Journal of Psychopharmacology*, 29, 57-68.
40. Goh, J. O., & Park, D. C. (2009). Neuroplasticity and cognitive aging: The scaffolding theory of aging and cognition. *Restorative Neurology and Neuroscience*, 27, 391-403
41. Goodden, J. (2017). *Riding so high: The Beatles and drugs*. Fairfield: Pepper & Pearl.
42. Gregory, T., Nettelbeck, T., & Wilson, C. (2010). Openness to experience, intelligence, and successful ageing. *Personality and Individual Differences*, 48, 895-899.
43. Griffiths, R. R., Richards, W. A., McCann, U., & Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology*, 187, 268-283. https://doi.org/10.1007/s00213-006-0457-5.
44. Griffiths, R., Richards, W., Johnson, M., McCann, U., & Jesse, R. (2008). Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *Journal of Psychopharmacology*, 22, 621-632. https://doi.org/10.1177/0269881108094300.
45. Griffiths, R. R., Johnson, M. W., Richards, W. A., Richards, B. D., McCann, U., & Jesse, R. (2011). Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology*, 218, 649-665. https://doi.org/10.1007/s00213-011-2358-5.
46. Griffiths, R. R., Johnson, M. W., Carducci, M. A., Umbricht, A., Richards, W. A., Richards, B. D. ... & Klinedinst, M. A. (2016). Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *Journal of Psychopharmacology*, 30, 1181-1197. https://doi.org/10.1177/0269881116675513.
47. Grob, C. S., Danforth, A. L., Chopra, G. S., Hagerty, M., McKay, C. R., Halberstadt, A. L., & Greer, G. R. (2011). Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Archives of General Psychiatry*, 68, 71-78. https://doi.org/10. 1001/archgenpsychiatry.2010.116.
48. Grob, C. S., Bossis, A. P., & Griffiths, R. R. (2013). Use of the classic hallucinogen psilocybin for treatment of existential distress associated with cancer. In B. I. Carr & J. Steele (Eds.), *Psychological aspects of Cancer* (pp. 291-308). Boston: Springer.
49. Grof, S., Goodman, L. E., Richards, W. A., & Kurland, A. A. (1973). LSD-assisted psychotherapy in patients with terminal cancer. *International Pharmacopsychiatry*, 8, 129-144.
50. Grühn, D., Rebucal, K., Diehl, M., Lumley, M., & Labouvie-Vief, G. (2008). Empathy across the adult lifespan: Longitudinal and experience-sampling findings. *Emotion*, 8, 753-765. https://doi.org/10.1037/a0014123.
51. Harman, W. W., McKim, R. H., Mogar, R. E., Fadiman, J., & Stolaroff, M. J. (1966). Psychedelic agents in creative problem-solving: A pilot study. *Psychological Reports*, 19, 211-227.
52. Heisel, M. J., & Flett, G. L. (2008). Psychological resilience to suicide ideation among older adults. *Clinical Gerontologist*, 31, 51-70.
53. Hendricks, P. S., Thorne, C. B., Clark, C. B., Coombs, D. W., & Johnson, M. W. (2015). Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *Journal of Psychopharmacology*, 29, 280-288. https://doi.org/10.1177/0269881114565653.
54. Hendy, K. (2018). Placebo problems: Boundary work in the psychedelic science renaissance. In B. C. Labate & C. Cavnar (Eds.), *Plant medicines, healing and psychedelic science: Cultural perspectives* (pp. 151-166). Cham: Springer. https://doi.org/10.1007/978-3-319-76720-8_9.
55. Honig, E. (2019). A growing push to loosen laws around psilocybin, treat mushrooms as medicine. In *NPR* Retrieved from https://www.npr.org/sections/health-shots/2019/05/07/720828367/a-growing-push-to-loosen-laws-around-psilocybin-treat-mushrooms-as-medicine.
56. Jacobs, B. L., Van Praag, H., & Gage, F. H. (2000). Adult brain neurogenesis and psychiatry: A novel theory of depression. *Molecular Psychiatry*, 5, 262-269.
57. Johansen, P. O., & Krebs, T. S. (2015). Psychedelics not linked to mental health problems or suicidal behavior: A population study. *Journal of Psychopharmacology*, 29, 270-279. https://doi.org/10.1177/0269881114568039.
58. Johnson, M. W., Richards, W. A., & Griffiths, R. R. (2008). Human hallucinogen research: Guidelines for safety. *Journal of*

Psychopharmacology, 22, 603-620. https://doi.org/10.1177/0269881108093587.
59. Johnson, M. W., Griffiths, R. R., Hendricks, P. S., & Henningfield, J. E. (2018). The abuse potential of medical psilocybin according to the 8 factors of the Controlled Substances Act. *Neuropharmacology*, 142, 143-166. https://doi.org/10.1016/j.neuropharm.2018.05.012.
60. Jungaberle, H., Thal, S., Zeuch, A., Rougemont-Bücking, A., von Heyden, M., Aicher, H., & Scheidegger, M. (2018). Positive psychology in the investigation of psychedelics and entactogens: A critical review. *Neuropharmacology*, 142, 179-199. https://doi.org/10.1016/j.neuropharm.2018.06.034.
61. Kelmendi, B., Corlett, P., Ranganathan, M., D'Souza, C., & Krystal, J. H. (2016). The role of psychedelics in palliative care reconsidered: A case for psilocybin. *Journal of Psychopharmacology*, 30, 1212-1214. https://doi.org/10.1177/0269881116675781.
62. Kumar, P. S., Anish, P. K., & George, B. (2015). Risk factors for suicide in elderly in comparison to younger age groups. *Indian Journal of Psychiatry*, 57, 249. https://doi.org/10.4103/0019-5545.166614.
63. Kuypers, K. P. C., Riba, J., de la Fuente Revenga, M., Barker, S., Theunissen, E. L., & Ramaekers, J. G. (2016). Ayahuasca enhances creative divergent thinking while decreasing conventional convergent thinking. *Psychopharmacology*, 233, 3395-3403. https://doi.org/10.1007/s00213-016-4377-8.
64. Laidlaw, K. (2014). *CBT for older people: An introduction*. Dorchester: Sage.
65. Lebedev, A. V., Lövdén, M., Rosenthal, G., Feilding, A., Nutt, D. J., & Carhart-Harris, R. L. (2015). Finding the self by losing the self: Neural correlates of ego-dissolution under psilocybin. *Human Brain Mapping*, 36, 3137-3153. https://doi.org/10.1002/hbm.22833.
66. Lebedev, A. V., Kaelen, M., Lövdén, M., Nilsson, J., Feilding, A., Nutt, D. J., & Carhart-Harris, R. L. (2016). LSD-induced entropic brain activity predicts subsequent personality change. *Human Brain Mapping*, 37, 3203-3213. https://doi.org/10.1002/hbm.23234.
67. Lima da Cruz, R. V., Moulin, T. C., Petiz, L. L., & Leao, R. N. (2018). A single dose of 5-MeO-DMT stimulates cell proliferation, neuronal survivability, morphological and functional changes in adult mice ventral dentate gyrus. *Frontiers in Molecular Neuroscience*, 11, 1-11.
68. Ly, C., Greb, A. C., Cameron, L. P., Wong, J. M., Barragan, E. V., Wilson, P. C., & ... Duim, W. C. (2018). Psychedelics promote structural and functional neural plasticity. *Cell Reports*, 23, 3170-3182. https://doi.org/10.1016/j.celrep.2018.05.022.
69. Lyons, T., & Carhart-Harris, R. L. (2018). More realistic forecasting of future life events after psilocybin for treatment-resistant depression. *Frontiers in Psychology*, 9, 1-11. https://doi.org/10.3389/fpsyg.2018.01721.
70. MacLean, K. A., Johnson, M. W., & Griffiths, R. R. (2011). Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *Journal of Psychopharmacology*, 25, 1453-1461. https://doi.org/10.1177/0269881111420188.
71. McGlothlin, W., Cohen, S., & McGlothlin, M. S. (1967). Long lasting effects of LSD on normals. *Archives of General Psychiatry*, 17, 521-532.
72. Millière, R., Carhart-Harris, R. L., Roseman, L., Trautwein, F. M., & Berkovich-Ohana, A. (2018). Psychedelics, meditation, and self-consciousness. *Frontiers in Psychology*, 9, 1-29. https://doi.org/10.3389/fpsyg.2018.01475.
73. Mok, R. M., Myers, N. E., Wallis, G., & Nobre, A. C. (2016). Behavioral and neural markers of flexible attention over working memory in aging. *Cerebral Cortex*, 26, 1831-1842. https://doi.org/10.1093/cercor/bhw011.
74. Morales-García, J. A., de la Fuente Revenga, M., Alonso-Gil, S., Rodríguez-Franco, M. I., Feilding, A., Perez-Castillo, A., & Riba, J. (2017). The alkaloids of Banisteriopsis caapi, the plant source of the Amazonian hallucinogen Ayahuasca, stimulate adult neurogenesis in vitro. *Scientific Reports*, 7, 1-13. https://doi.org/10.1038/s41598-017-05407-9.
75. Mossello, E., Boncinelli, M., Caleri, V., Cavallini, M. C., Palermo, E., Di Bari, M., ... & Masotti, G. (2008). Is antidepressant treatment associated with reduced cognitive decline in Alzheimer's disease? *Dementia and Geriatric Cognitive Disorders*, 25, 372-379.
76. Nichols, D. E. (2016). Psychedelics. *Pharmacological Reviews*, 68, 264-355. https://doi.org/10.1124/pr.115.011478.
77. Noorani, T., Garcia-Romeu, A., Swift, T. C., Griffiths, R. R., & Johnson, M. W. (2018). Psychedelic therapy for smoking cessation: Qualitative analysis of participant accounts. *Journal of Psychopharmacology*, 32, 756-769.
78. Palhano-Fontes, F., Andrade, K. C., Tofoli, L. F., Santos, A. C., Crippa, J. A. S., Hallak, J. E. ... & de Araujo, D. B. (2015). The psychedelic state induced by ayahuasca modulates the activity and connectivity of the default mode network. *PLoS One*, 10, 1-13. https://doi.org/10.1371/journal.pone.0118143.
79. Pisano, V. D., Putnam, N. P., Kramer, H. M., Franciotti, K. J., Halpern, J. H., & Holden, S. C. (2017). The association of psychedelic use and opioid use disorders among illicit users in the United States. *Journal of Psychopharmacology*, 31, 606-613. https://doi.org/10.1177/0269881117691453.
80. Pokorny, T., Preller, K. H., Kometer, M., Dziobek, I., & Vollenweider, F. X. (2017). Effect of psilocybin on empathy and moral decision-making. *International Journal of Neuropsychopharmacology*, 20, 747-757. https://doi.org/10.1093/ijnp/pyx047.
81. Pollan, M. (2018). The new science of psychedelics. Wall Street Journal. Retrieved from https://www.wsj.com/articles/the-new-science-of-psychedelics-1525360091.
82. Preller, K. H., Herdener, M., Pokorny, T., Planzer, A., Kraehenmann, R., Stämpfli, P. ... & Vollenweider, F. X. (2017). The fabric of meaning and subjective effects in LSD-induced states depend on serotonin 2A receptor activation. *Current Biology*, 27, 451-457. https://doi.org/10.1016/j.cub.2016.12.030.
83. Price, K. A., & Tinker, A. M. (2014). Creativity in later life. *Maturitas*, 78, 281-286. https://doi.org/10.1016/j.maturitas.2014.05.025.
84. Prochazkova, L., Lippelt, D. P., Colzato, L. S., Kuchar, M., Sjoerds, Z., & Hommel, B. (2018). Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. *Psychopharmacology*, 235, 3401-3413. https://doi.org/10.1007/s00213-018-5049-7.
85. Roseman, L., Nutt, D. J., & Carhart-Harris, R. L. (2018). Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. *Frontiers in Pharmacology*, 8, 1-10. https://doi.org/10.3389/fphar.2017.00974.
86. Ross, S., Bossis, A., Guss, J., Agin-Liebes, G., Malone, T., Cohen, B. ... & Su, Z. (2016). Rapid and sustained symptom reduction

following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *Journal of Psychopharmacology*, 30, 1165-1180. https://doi.org/10.1177/0269881116675512.

87. Rucker, J. J. H., Jelen, L. A., Flynn, S., Frowde, K. D., & Young, A. H. (2016). Psychedelics in the treatment of unipolar mood disorders: A systematic review. *Journal of Psychopharmacology*, 30, 1220-1229. https://doi.org/10.1177/0269881116679368
88. Russ, S. L., Carhart-Harris, R. L., Maruyama, G., & Elliott, M. S. (2019). Replication and extension of a model predicting response to psilocybin. *Psychopharmacology*. https://doi.org/10.1007/s00213-019-05279-z.
89. Salthouse, T. A. (2009). When does age-related cognitive decline begin? *Neurobiology of Aging*, 30, 507-514.
90. SAMHSA (2017) Opioid misuse increases among older adults. Retrieved from https://www.samhsa.gov/data/sites/default/files/report_3186/Spotlight-3186.html.
91. Scheibe, S., & Carstensen, L. L. (2010). Emotional aging: Recent findings and future trends. *The Journals of Gerontology: Series B*, 65, 135-144.
92. Schmid, Y., & Liechti, M. E. (2018). Long-lasting subjective effects of LSD in normal subjects. *Psychopharmacology*, 235, 535-545. https://doi.org/10.1007/s00213-017-4733-3.
93. Selemon, L. D. (2013). A role for synaptic plasticity in the adolescent development of executive function. *Translational Psychiatry*, 3, 1- 9. https://doi.org/10.1038/tp.2013.7.
94. Sessa, B. (2008). Is it time to revisit the role of psychedelic drugs in enhancing human creativity? *Journal of Psychopharmacology*, 22, 821-827. https://doi.org/10.1177/0269881108091597.
95. Sheline, Y. I., Barch, D. M., Price, J. L., Rundle, M. M., Vaishnavi, S. N., Snyder, A. Z., ... & Raichle, M. E. (2009). The default mode network and self-referential processes in depression. *Proceedings of the National Academy of Sciences*, 106, 1942-1947. https://doi.org/10.1073/pnas.0812686106.
96. Shelton, R. C., & Hendricks, P. S. (2016). Psilocybin and palliative end-of-life care. *Journal of Psychopharmacology*, 30, 1207-1208. https://doi.org/10.1177/0269881116675764.
97. Silvia, P. J., Nusbaum, E. C., Berg, C., Martin, C., & O'Connor, A. (2009). Openness to experience, plasticity, and creativity: Exploring lower-order, high-order, and interactive effects. *Journal of Research in Personality*, 43, 1087-1090. https://doi.org/10.1016/j.jrp.2009.04.015.
98. Smigielski, L., Scheidegger, M., Kometer, M., & Vollenweider, F. X. (2019). Psilocybin-assisted mindfulness training modulates self-consciousness and brain default mode network connectivity with lasting effects. *NeuroImage*, 196, 207-215. https://doi.org/10.1016/j.neuroimage.2019.04.009.
99. Smith, G. E. (2016). Healthy cognitive aging and dementia prevention. *American Psychologist*, 71, 268-275.
100. Suri, G., & Gross, J. J. (2012). Emotion regulation and successful aging. *Trends in Cognitive Sciences*, 16, 409-410.
101. Swanson, L. R. (2018). Unifying theories of psychedelic drug effects. *Frontiers in Pharmacology*, 9, 1-23. https://doi.org/10.3389/fphar.2018.00172.
102. Thiessen, M. S., Walsh, Z., Bird, B. M., & Lafrance, A. (2018). Psychedelic use and intimate partner violence: The role of emotion regulation. *Journal of Psychopharmacology*, 32, 749-755.
103. Uthaug, M. V., van Oorsouw, K., Kuypers, K. P. C., van Boxtel, M., Broers, N. J., Mason, N. L. ... & Ramaekers, J. G. (2018). Subacute and long-term effects of ayahuasca on affect and cognitive thinking style and their association with ego dissolution. *Psychopharmacology*, 235, 2979-2989. https://doi.org/10.1007/s00213-018-4988-3.
104. Vollenweider, F. X., & Kometer, M. (2010). The neurobiology of psychedelic drugs: Implications for the treatment of mood disorders. *Nature Reviews Neuroscience*, 11, 642-651. https://doi.org/10.1038/nrn2884
105. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F., Bäbler, A., Vogel, H., & Hell, D. (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport*, 9, 3897-3902.
106. Wang, S., & Blazer, D. G. (2015). Depression and cognition in the elderly. *Annual Review of Clinical Psychology*, 11, 331-360. https://doi.org/10.1146/annurev-clinpsy-032814-112828.
107. Xu, W., Yu, J. T., Tan, M. S., & Tan, L. (2015). Cognitive reserve and Alzheimer's disease. *Molecular Neurobiology*, 51, 187-208. https://doi.org/10.1007/s12035-014-8720-y.
108. Zegans, L. S., Pollard, J. C., & Brown, D. (1967). The effects of LSD-25 on creativity and tolerance to regression. *Archives of General Psychiatry*, 16, 740-749.
109. Zeki Al Hazzouri, A., Vittinghoff, E., Byers, A., Covinsky, K., Blazer, D., Diem, S., ... Yaffe, K. (2014). Long-term cumulative depressive symptom burden and risk of cognitive decline and dementia among very old women. The *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 69, 595-601. https://doi.org/10.1093/gerona/glt139.
110. Zhang, G., & Stackman, R. W., Jr. (2015). The role of serotonin 5-HT$_{2A}$ receptors in memory and cognition. *Frontiers in Pharmacology*, 6, 1-17. https://doi.org/10.3389/fphar.2015.00225.

Emotional breakthrough and psychedelics: Validation of the Emotional Breakthrough Inventory

by

Leor Roseman[1], Eline Haijen[1], Kelvin Idialu-Ikato[1], Mendel Kaelen[1,2], Rosalind Watts[1] and Robin Carhart-Harris[1]

Journal of Psychopharmacology 1-12

DOI: 10.1177/0269881119855974

© The Author(s) 2019

original report:
https://www.researchgate.net/publication/334398937_Emotional_breakthrough_and_psychedelics_Validation_of_the_Emotional_Breakthrough_Inventory

[1] Department of Medicine, Imperial College London, London, UK
[2] Wavepaths Ltd, London, UK

Corresponding author:
Leor Roseman, Department of Medicine, Imperial College London,
Hammersmith Campus, Du Cane Road, London, W2 5PB, UK.
Email: leor.roseman13@imperial.ac.uk

Table of Contents:

- **Abstract**
- **Introduction**
- **Method**
  - Software
  - Design
  - Item selection and face validity
  - Other measures
    - *MEQ (Pahnke et al., 1970; Pahnke and Richards, 1966)*
    - *CEQ*
    - *WEMWBS*
    - *Drug type*
    - *Drug dose*
    - *Therapeutic intention*
    - *Therapeutic setting*
  - Factor analysis and definition of EBI
  - Discriminant validity
  - Predictive validity - changes in well-being
- **Results**
  - Demographics
  - Factor structure
  - Internal consistency
  - Predictive validity - dose, therapeutic intention and setting
  - Discriminant validity
  - Predictive validity - changes in well-being
- **Discussion**
- **References**

Abstract

Background: Psychedelic therapy is gaining recognition and the nature of the psychedelic experience itself has been found to mediate subsequent long-term psychological changes. Much emphasis has been placed on the occurrence of mystical-type experiences in determining long-term responses to psychedelics yet here we demonstrate the importance of another component, namely: emotional breakthrough.

Methods: Three hundred and seventy-nine participants completed online surveys before and after a planned psychedelic experience. Items pertaining to emotional breakthrough were completed one day after the psychedelic experience, as were items comprising the already validated Mystical Experience Questionnaire and the Challenging Experience Questionnaire. Emotional breakthrough, Mystical Experience Questionnaire and Challenging Experience Questionnaire scores were used to predict changes in well-being (Warwick-Edinburgh Mental Well-being Scale) in a subsample of 75 participants with low well-being baseline scores (≤45).

Results: Factor analyses revealed six emotional breakthrough items with high internal consistency (Cronbach's alpha=0.932) and supported our prior hypothesis that emotional breakthrough is a distinct component of the psychedelic experience. Emotional breakthrough scores behaved dose-dependently, and were higher if the psychedelic was taken with therapeutic planning and intent. Emotional breakthrough, Mystical Experience Questionnaire and Challenging Experience Questionnaire scores combined, significantly predicted subsequent changes in well-being (r=0.45, p=0.0005, n=75), with each scale contributing significant predictive value. Emotional breakthrough and Mystical Experience Questionnaire scores predicted increases in well-being and Challenging Experience Questionnaire scores predicted less increases.

Conclusions: Here we validate a six-item 'Emotional Breakthrough Inventory'. Emotional breakthrough is an important and distinct component of the acute psychedelic experience that appears to be a key mediator of subsequent longer-term psychological changes. Implications for psychedelic therapy are discussed.

Keywords: Psychedelics, catharsis, emotion, therapy.

Introduction

Psychedelic therapy is a re-emerging paradigm within mental health research (Schenberg, 2018). It is hypothesised that both biological and psychological processes play a role in this treatment, potentially working synergistically to determine therapeutic outcomes (Carhart-Harris, 2018; Carhart-Harris *et al.*, 2017b). From a purely psychological perspective, most studies to-date have focused on the involvement of the mystical-type experience in determining long-term responses to psychedelics (Bogenschutz *et al.*, 2015; Dakwar *et al.*, 2014; Erritzoe *et al.*, 2018; Garcia-Romeu *et al.*, 2014; Griffiths *et al.*, 2016; Johnson *et al.*, 2016; Klavetter and Mogar, 1967; Kurland *et al.*, 1972; MacLean *et al.*, 2011; O'Reilly and Funk, 1964; Pahnke *et al.*, 1970; Richards *et al.*, 1977; Roseman *et al.*, 2017; Ross *et al.*, 2016) and see Stace (1960) for some classical texts relevant to the mystical experience. Influential measures used to operationally define the mystical experience include factors within the altered states of consciousness questionnaire (Dittrich, 1998; Studerus *et al.*, 2010) and the more recently validated Mystical Experience Questionnaire (MEQ) (MacLean *et al.*, 2012; Pahnke and Richards, 1966). It is now a well-replicated finding that the quality of the acute psychedelic experience is a key determinant of longer-term responses to psychedelics - and the mystical type experience seems to be relevant and important in this regard. However, this does not imply that the construct is well-defined, or that it is the sole, or indeed, primary determinant of long-term psychological outcomes.

Another key component of the acute psychedelic experience that has been found to be influential in determining long-term responses is the challenging experience (CE) (Barrett *et al.*, 2016). Perhaps the best available tool for measuring CEs is the recently validated Challenging Experience Questionnaire (CEQ). This scale was developed with the intention of quantifying challenging emotions such as grief, fear, paranoia, etc.

(Barrett *et al*., 2016). Recent studies have suggested that higher scores of the CEQ and other measures of CE can predict worse longer-term mental health outcomes, thus suggesting that CE might be counter-therapeutic and perhaps even iatrogenic (Barrett *et al*., 2016; Carbonaro *et al*., 2016; Haijen *et al*., 2018; Roseman *et al*., 2017), although there are some contradictory findings in this regard, suggesting a more complex relationship (Barrett *et al*., 2016; Carbonaro *et al*., 2016). A major limitation of the CEQ however, is that it measures different challenging emotions and/or memories without addressing their potential resolution, and consequently is not able to quantify the potential clinical value of accepting and/or overcoming the relevant challenges (Watts *et al*., 2017).

Here, we endeavoured to examine a third potential mediator of longer-term responses to psychedelics, based on the assumption that the MEQ and CEQ do not fully or clearly capture the phenomenon of overcoming challenging emotions/memories and thereby experiencing emotional release or breakthrough. The phenomenon of emotional breakthrough (EB) overlaps to some extent with the psychoanalytic notion of catharsis (Breuer and Freud, 1895; Jackson, 1994). We call the questionnaire we have constructed and validated here, the Emotional Breakthrough Inventory (EBI). Unlike the CEQ, which appears to be a 'negative' predictor of clinical outcomes (i.e. higher CEQ scores predict worse mental health outcomes), we theorised that EBI would serve as a positive predictor of mental health, i.e. higher scores would predict better mental health outcomes such as increases in well-being. The development and use of the EBI in intended to supplement the use of the CEQ and MEQ and motivate further critique of all of three measures and the real-world phenomena they are intended to capture.

The most often-used approach in modern psychedelic therapy trials has its basis in work advanced by the collaboratory effort of Al Hubbard, Humphry Osmond and Abram Hoffer in the 1950s (Dyck, 2006; MacLean *et al*., 1961; Osmond, 1957). The focus of the so-called 'psychedelic' model is to use relatively high doses of a given psychedelic to promote the attainment of a powerful self-transcendent state that may be positively transformative in effect. The other major alternative therapeutic model, is the socalled 'psycholytic' (mind-loosening) model. This approach used lower doses of a psychedelic in concert with psychoanalytically oriented psychotherapy. Despite differences, mainly related to dose and number of sessions (i.e. higher doses but fewer sessions in psychedelic therapy), both of the psychedelic and psycholytic models emphasised the importance of emotional release.

One early account of Lysergic Acid Diethylamide's (LSD) therapeutic action stated that drug works to break emotional or memory blocks and 'in almost every case... terminates in psycho-catharsis, [causing] the patient to experience an exhilarating feeling of liberation' (Frederking, 1955: 263). Other psychedelic therapists, with allegiances to varying psychoanalytic schools, shared this appreciation of the importance of EB (Bonny and Pahnke, 1972; Cohen, 1959; Crocket *et al*., 1963; Eisner and Cohen, 1958; Fisher, 2015; Grof *et al*., 1980; Jensen, 1963; Katzenelbogen and Fang, 1953; Leuner, 1961; Martin, 1957; Richards, 2015; Sandison, 1955), and patients often make special reference to it in post-treatment reports (Belser *et al*., 2017; Gasser *et al*., 2014; Watts *et al*., 2017). EBs are often accompanied by and related to personal and interpersonal insights, and are therefore not necessarily transpersonal in the same way - or to the same extent - that mystical-type or peak experiences appear to be (Belser *et al*., 2017; Gasser *et al*., 2014; Grof, 1975; Loizaga-Velder, 2013; Richards, 2015; Watts *et al*., 2017).

The present study sought to develop and validate a brief EBI that is focused and concise in nature. Specifically, we assessed its internal, convergent, divergent and predictive validity. This was done using an online prospective survey in which participants answered questionnaires before and after drug intake in their own environment rather than e.g. in a laboratory. The sample was self-selecting and comprised mostly of healthy individuals, thus, to combat the issue of floor effects, a well-validated measure of psychological well-being was used as the primary dependent variable and index of post-psychedelic change in psychological/emotional health. We hypothesised that:

- H1: Scores on the EBI will increase in a dose-dependent manner.
- H2: A therapeutic context (therapeutic intention before drug intake and a therapeutic setting) will be associated with higher EBI scores.
- H3: EBI scores will significantly discriminate from MEQ and CEQ scores.
- H4: EBI will predict changes in well-being.
- H5: A model incorporating EBI, MEQ and CEQ will predict changes in well-being, with EBI performing

at least as well as the MEQ and CEQ.

Method

The study was approved by Imperial College Research Ethics Committee and the Joint Research Compliance Office at Imperial College London and carried out in accordance with principles of good clinical practice. Written informed consent was obtained from all subjects. The original survey has now closed but revised and still active versions of related surveys can be found here at www.psychedelicsurvey.com.

Software

Statistical analyses were conducted on SPSS 25 and Matlab 2017.

Design

The data presented in this article was collected as part of a larger prospective study (Haijen *et al.*, 2018). Only elements of the design and data that are relevant to this article are presented here. Data was collected from psychedelic 'users' in a non-controlled, naturalistic and observational manner. Data was collected on-line, through the website and software platform psychedelicsurvey.com. The study was advertised via social media platforms. The baseline time-point was one week before a planned psychedelic experience and the key end-point was two weeks post the relevant experience. The following data were collected at baseline: demographics, intentions for the experience (see below), and the Warwick-Edinburgh Mental Well-being Scale (WEMWBS) which served as the primary and sole dependent variable. Retrospective reports of the acute experience were answered one day after the relevant psychedelic experience. These included: EBI, MEQ, CEQ, dose and whether the experience took place in a therapeutic setting (see below). Longterm outcomes were collected two weeks after the experience. The WEMWBS serving as the sole dependent variable for the present analysis. Data of 379 participants have been used for most of the analysis in this article, however, a subset of 75 participants with low well-being baseline scores (WEMWBS≤45) have been used for prediction of changes in well-being (more information below).

Item selection and face validity

The items of EBI were devised based on interview content from our previous psilocybin for treatment-resistant depression trial (Watts *et al.*, 2017) and knowledge of the extensive literature and personal observations on the phenomenology of the psychedelic experience and its therapeutic application (Belser *et al.*, 2017; Bonny and Pahnke, 1972; Cohen, 1959; Crocket *et al.*, 1963; Eisner and Cohen, 1958; Fisher, 2015; Frederking, 1955; Gasser *et al.*, 2014; Grof *et al.*, 1980; Jensen, 1963; Katzenelbogen and Fang, 1953; Leuner, 1961; Martin, 1957; Richards, 2015; Sandison, 1955). Eight initial items were devised (Table 1), out of which two were 'negative' items that required reverse scoring. Items were rated using a visual analogue scale (VAS) (0-100, with incremental units of one) with zero defined as 'No, not more than usually', and 100 defined as 'Yes, entirely or completely'. Five experts (W Richards, R Watts, R Carhart-Harris, J Rucker and L Roseman) assessed the items and revised them if needed. Below are selected quotes that helped inform the construction of EBI items. These derive from interviews with patients (Watts *et al.*, 2017) in our recent psilocybin for treatment-resistant depression trial (Carhart-Harris *et al.*, 2017a). The quotes are from the qualitative analysis of Watts *et al.* (2017), although most were not included in that study.

> 'It felt like a relief, I was getting so emotional, I could feel it all coming out'
>
> 'One emotional song, and I lost control, the song was so sad I started crying uncontrollable, and was terrified by the depth of emotions'
>
> 'It was an emotional purging. The weight and anxiety and overwhelming depression have been lifted'

> 'It was an uncomfortable experience and it got to the point where I got really really angry with it, like something snapped inside my head, and rather than be afraid of it I challenged it and at that point it kind of vanished, it went away'
>
> 'I was weeping, tears were flowing out of me. It wasn't a painful crying, it was like turning on the taps, like a washing, a washing out.'
>
> 'There was a lot of sadness, really really deep sadness: the loss the grief, it was love and sadness together, and letting go, I could feel the grief and then let it go because holding onto it was hurting me, holding me back. It was a process of unblocking'
>
> 'Excursions into grief, loneliness and rage, abandonment. Once I went into the anger it went 'pouf' and evaporated. I got the lesson that you need to go into the scary basement, once you get into it, there is no scary basement to go into [anymore]'
>
> 'I had lost my ability to grieve and cry. [During the dosing session] I cried and that was a cathartic experience for me, a very welcoming sweet experience'.

Table 1. Factor loadings from factor analysis of eight Emotional Breakthrough Inventory (EBI) items.

Item	Factor 1	Factor 2
I faced emotionally difficult feelings that I usually push aside.	**0.788**	0.192
I experienced a resolution of a personal conflict/trauma.	**0.896**	-0.044
I felt able to explore challenging emotions and memories.	**0.866**	-0.076
I was resisting and avoiding challenging feelings throughout, without breakthrough.	0.260	**0.786**
I had an emotional breakthrough.	**0.872**	-0.151
I was able to get a sense of closure on an emotional problem.	**0.889**	-0.185
I felt emotionally stuck throughout, without breakthrough.	0.249	**0.845**
I achieved an emotional release followed by a sense of relief.	**0.848**	-0.194

The extraction method was principal component analysis (PCA). The six bold Items in Factor 1 reflect the final version of the EBI. The remaining bold items in Factor 2 where not used in the final version of EBI. Factor loadings &gt;0.5 are in bold (*n*=379).

Other measures

MEQ (Pahnke *et al.*, 1970; Pahnke and Richards, 1966)

The MEQ was originally developed by Walter Pahnke and Bill Richards based on the anthropological research and theoretical writings of philosopher Walter Stace (1960). Stace studied reports of mystical-type experiences occurring in a variety of religions and identified common experiential components which he argued are universal, i.e. culturally independent and unspecific to any particular religion or philosophical framework (as in Maslow's peak experience (Maslow, 1959; Maslow, 1964), and Huxley's *Perennial Philosophy* (Huxley, 1945)). The MEQ has been revised since its original conception and now includes 30 questions (MacLean *et al.*, 2012) rated according to a five-point Likert scale. It is divided into four subscales: (a) Mystical - which includes arguably the core features of mystical-type experience: named 'unity', 'noetic' and 'sacredness'; (b) Positive-mood; (c) Transcendence of time and space; and (d) Ineffability. The total MEQ score is calculated as the average of all 30 items and then multiplied by 20 to provide a 0-100 value.

CEQ

The CEQ was recently developed to measure the challenging experience (Barrett *et al.*, 2016). The CEQ is derived from 'challenging' items from other psychedelic questionnaires: Hallucinogen Rating Scale (HRS) (Strassman *et al.*, 1994), Altered State of Consciousness questionnaire (ASC) (Dittrich, 1975, 1998), and States of Consciousness Questionnaire (SOCQ) (Griffiths *et al.*, 2006; Pahnke *et al.*, 1969). The CEQ has 26 questions, five-point Likert scale, and is divided into seven dimensions: (a) Isolation, (b) Grief, (c) Physical distress, (d) Fear, (e) Insanity, (f) Paranoia, and (g) Death. Total CEQ score was calculated as the average of all items and then multiplied by 20 to provide a 0-100 value.

WEMWBS

The WEMWBS (Tennant *et al.*, 2007) was designed to measure the psychological well-being of a population. WEMWBS has 14 questions scored using a five-point Likert scale. Scores reflect feelings and thoughts in the two weeks prior to answering the questionnaire. In the present study, the WEMWBS was used to observe potential changes in well-being two weeks after drug intake compared to baseline. Many of the participants had high baseline WEMWBS scores - which created a potential ceiling effect limiting scope for the predicted increases in well-being. We therefore restricted the present analysis to just those subjects who had relatively low baseline well-being scores (≤45, *n*=75) (Taggart *et al.*, 2015) and therefore greater potential for change (normative data based on the general population in England and Scotland showed a mean WEMWBS score of 50.7 (95% confidence interval (CI): 50.3-51.1)).

Drug type

Participants were asked what specific psychedelic they took. Options included: (a) psilocybin/magic mushrooms/ truffles, (b) LSD/1P-LSD, (c) ayahuasca, (d) DMT/5-5-MeODMT, (e) *Salvia divinorum*, (f) mescaline, (g) iboga/ibogaine or (h) the option to give a free answer.

Drug dose

Drug dose was assessed using a previously implemented approach of estimating dosage in relation to LSD equivalents. The rationale for this is to provide a reference-standard dose that can be compared across different psychedelics (Nour *et al.*, 2016). Options were: a low dose (equivalent to no more than 50 µg of LSD), a moderate dose (equivalent to no more than 100 µg of LSD), a high dose (equivalent to no more than 200 µg of LSD), a very high dose (equivalent to no more than 300 µg of LSD), or an extremely high dose (equivalent to more than 300 µg of LSD).

Therapeutic intention

At pre-drug baseline, participants answered the question 'Can you indicate what your motives are to undergo a psychedelic session/ceremony/experience?' A number of intentions were presented, and participants scored each of them on a four-point Likert scale with the options: 'not at all,' 'somewhat,' 'moderately,' or 'very much.' For this analysis we chose two intentions of interest as potential predictors of EBI scores: the intention to have the experience for (a) 'Therapeutic/ personal growth', and (b) 'To confront difficult emotions'.

Therapeutic setting

Participants answered 'yes' or 'no' to the question 'Was the setting designed and/or prepared with a therapeutic objective in mind?' We hypothesised that those who answered 'yes' here would have higher EBI scores.

Factor analysis and definition of EBI

Scores for the original eight EBI items were subjected to an exploratory factor analysis using principal component analysis (PCA). The appropriate number of factors to be extracted was determined by the scree plot criterion (Cattell, 1966). The PCA yielded two factors (Table 1), out of which only factor 1 with six items was used in further analysis. The internal consistency of the six items was assessed with Cronbach's alpha (Cronbach, 1951).

Discriminant validity

In order to test whether the EBI, and the construct it is intended to sample, is significantly different from the constructs indexed by the MEQ and CEQ, the items of all of the questionnaires were entered into one factor analysis (PCA, 62 items). If EB, and the EBI that samples EB, is insufficiently different from the other questionnaires and the constructs they sample, then the PCA would have been expected to yield just two factors - one containing items of the MEQ and the other containing items from the CEQ, with EBI items loading onto one or both of these two factors. If, however, as predicted, the EBI can be discriminated from the MEQ and CEQ, then the PCA would be expected to discover three independent factors, one of which would contain items of the EBI. A correlation matrix including the EBI and subdimensions of MEQ and CEQ was also calculated to further explore similarities and differences between the three questionnaires and their components.

Predictive validity - changes in well-being

Pearson correlation of the EBI versus ΔWEMWBS was calculated to test whether the EBI could serve as a predictor of clinical changes (*n*=75). Furthermore, a multiple regression was calculated with ΔWEMWBS as the dependent variable and the EBI, MEQ and CEQ as independent variables (*n*=75). Beta coefficients were calculated for each of the questionnaires to assess the contribution of each of the questionnaires to explaining changes in the dependent variable (ΔWEMWBS). If significant beta coefficients were found for scores on all of the questionnaires, this would demonstrate the significant added value of each of the three questionnaires and the variance they can explain when combined. We hypothesised that the beta coefficients of EBI and MEQ would be positive predictors of changes (increases) in WEMWBS scores whereas CEQ scores would be negative predictors of changes in well-being.

Results

Demographics

See Table 2 for the demographics of 379 participants who completed EBI and of a subsample of 75 participants with $\text{WEMWBS}_{\text{baseline}} \leq 45$.

Factor structure

The eight original EBI items were entered into a PCA. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was found to be 0.877, and Bartlett's test of sphericity was significant (χ^2 (28) =2005.9, $p<0.0001$) confirming that the data was suitable for factor analysis (Budaev, 2010). Inspection of the scree plot using Cattell's criterion (Cattell, 1966) supported a two-factor model (Table 1). The first component explained 57.1% of the variance and the second explained 18.3%. Other components explained <8% of the variance. Commonality values (the variance of a variable which is explained by the factors) ranged from 65.7-82.5%. Factor 1 comprised of six items, and factor 2 comprised of the two negative, reverse scored items. Originally, we theorised that all items would load into one single factor with the negative items negatively loading on to this. Results revealed that this is not the case, however, and instead the two negative items load onto a sufficiently distinct factor. We therefore decided not to use these two negative items in the final version of EBI.

Table 2. Demographics.

Total		*n*=379	*n*=75
Gender	Male	252 (66.5%)	57 (76%)
	Female	97 (25.6%)	18 (24%)
	Other	2 (0.5%)	0
	Blank	28 (7.4%)	0
Age		30.6±11.0	29±9.4
Educational level	Left school before age 16 years without qualifications	7 (1.8%)	3 (4%)
	Some high school/GCSE level (in UK)	23 (6.1%)	4 (5.3%)
	High school diploma/A-level education (in UK)	47 (12.4%)	10 (13.3%)
	University (or equivalent)	74 (19.5%)	18 (24%)
	Bachelor's degree (or equivalent)	121 (31.2%)	29 (38.7%)
	Post-graduate degree (e.g. masters or doctorate)	79 (20.1%)	11 (14.7%)
	Blank	28 (7.4%)	0
Employment status	Student	124 (32.7%)	17 (22.7%)
	Unemployed	33 (8.7%)	14 (18.7%)
	Part-time job	55 (14.5%)	16 (21.3%)
	Full-time job	133 (35.1%)	27 (36%)
	Retired	6 (1.5%)	1 (1.3%)
	Blank	28 (7.4%)	0
Nationality	United Kingdom	74 (19.5%)	19 (25.3%)
	United States of America	97 (25.6%)	21 (28%)
	Denmark	42 (11.1%)	4 (5.3%)
	Germany	21 (5.5%)	0
	Canada	13 (3.4%)	5 (6.6%)
	Other (38 other nationalities)	104 (27.4%)	26 (34.8%)
	Blank	28 (7.4%)	
Psychiatric history	Has been diagnosed with at least one psychiatric illness in the past[a]	116 (30.6%)	38 (50.7%)
	Never been diagnosed with a psychiatric illness	235 (62%)	37 (49.3%)
Previous psychedelic drug use	Never (psychedelic naïve)	42 (11.1%)	11 (14.6%)
	Once	20 (5.3%)	7 (9.3%)
	2-5 times	71 (18.7%)	22 (29.3%)
	6-10 times	54 (14.2%)	15 (20%)
	11-20 times	57 (15%)	7 (9.3%)
	21-50 times	63 (16.6%)	8 (10.6%)
	51-100 times	19 (5%)	4 (5.3%)
	More than 100 times	25 (7%)	1 (1.3%)
	Blank	28 (7.4%)	

Absolute frequencies and means±standard deviations are presented in the table. Numbers in the brackets show the percentages of the absolute frequencies. The column with *n*=379 is the whole population in this paper, while the column with *n*=75 is of the subpopulation with Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS)≤45.[a] Psychiatric illnesses include major depressive disorder, bipolar disorder, schizophrenia, anxiety disorder, substance abuse disorder, alcohol dependence, hallucinogen persisting perception disorder, psychotic disorder, personality disorder, attention deficit hyperactivity disorder, obsessive compulsive disorder and eating disorder.

Internal consistency

After discarding the two negative items, the resulting six-item EBI displayed a very high internal consistency (Cronbach's alpha=0.932) (Cronbach, 1951). The average of the six items showed a high correlation with factor 1 score (*r*=0.996, *p*<0.0001) and therefore the average of the six items was used as the total EBI score in further analysis. The mean of EBI scores was significantly higher than 0 (EBI=43±31.5, skewness=0.165, kurtosis=-1.3, *p*<0.0001, one sample *t*-test, *n*=379). The mean MEQ score was 57±22.63. The mean CEQ score was 19.7±16.4. See violin plots (Hintze and Nelson, 1998) of EBI, MEQ and CEQ in Figure 1.

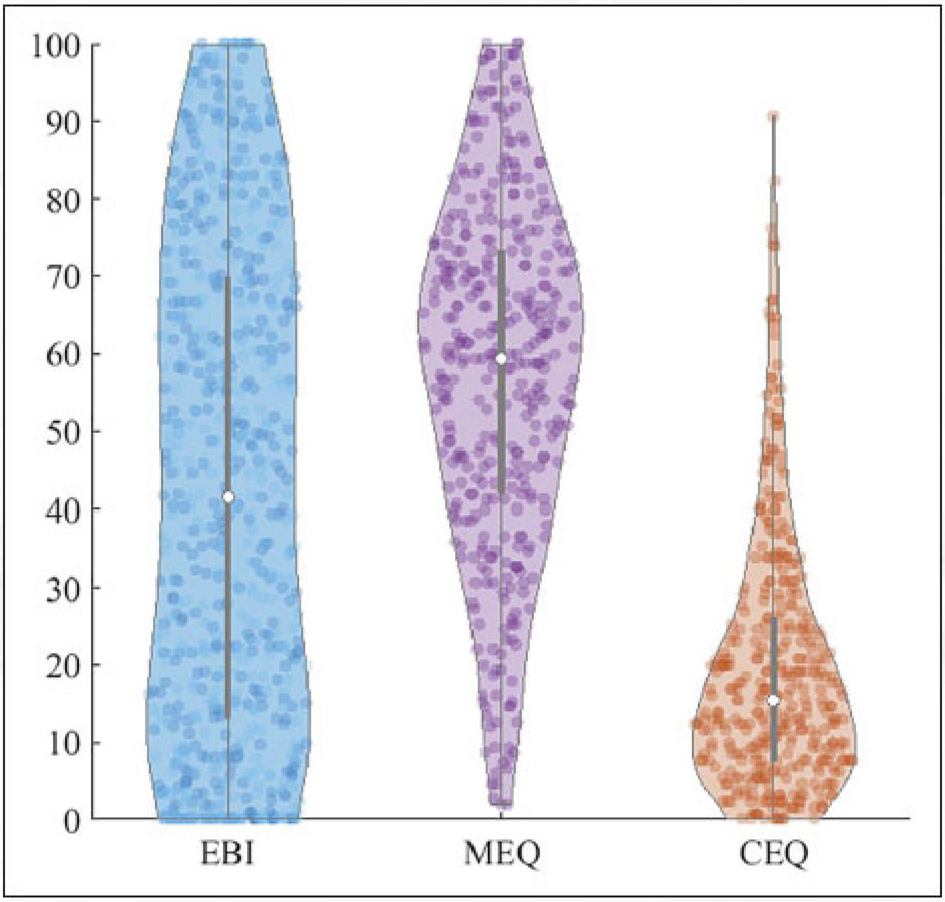


Figure 1. Violin plots of Emotional Breakthrough Inventory (EBI), Mystical Experience Questionnaire (MEQ) and Challenging Experience Questionnaire (CEQ). Total scores of each questionnaire are spread along the y axis. Violin plots are similar to box plots but show also probability density in different values (the width of the plot). The white circle and the thick line are a boxplot in which the white circle is the median and the thick line is the interquartile range (*n*=379).

Predictive validity - dose, therapeutic intention and setting

As predicted, EBI scores significantly (positively) correlated with (estimated) drug dose (r_s=0.192, *p*=0.0001, one-tail, *n*=379). Baseline ratings of therapeutic intention and ratings of willingness to confront difficult emotions significantly correlated (positively) with EBI scores (r_s=0.256 and r_s=0.279, respectively, *p*<0.0001, one-tail, *n*=351). Participants who endorsed the view that the setting for their experience was designed with a therapeutic objective in-mind had higher EBI scores (EBI=47.9±30.1, *n*=144) than those who felt the setting for their experience was not therapeutic in nature or design (EBI=31.6±29.1, *n*=168) (*p*<0.0001, Cohen's *d*=0.55, independent samples *t*-test, one-tail).

Discriminant validity

To demonstrate that the EBI is a novel measure that can be discriminated from the MEQ and CEQ, all of the 62 items from MEQ, CEQ and EBI were entered into a single factor analysis (PCA) (Table 3). The KMO measure of sampling adequacy was 0.941, and Bartlett's test of Sphericity was significant ($\chi^2_{(1891)}$=19829, *p*<0.0001) confirming that the data was suitable for factor analysis (Budaev, 2010). Inspection of the scree plot using Cattell's criterion (Cattell, 1966) supported a model of three factors. The first component explained 31.3% of the variance, the second explained 15.4% of the variance, and the third explained 6.1% of the variance. Other components explained <4% of the variance in the sample. Commonality values ranged from 43.7-81.5%. The first factor contained high loadings from MEQ items, and relatively high loading from EBI items as well. The second factor contained high loadings from CEQ items alone, and the third factor contained high loading from EBI items alone (without any MEQ or CEQ items). These results suggest that for some subjects, EB was accompanied by mystical-type phenomena (and vice versa), whilst for others, EB was distinct from either classical challenging and/or mystical-type phenomena. Note that the relatively low percentage of variance explained by component 3 is probably due to the relatively few EBI items when compared with the MEQ and CEQ (i.e. six in the EBI versus 26 and 30 the CEQ and MEQ, respectively).

A correlation matrix containing all of the EBI items plus subscales of the MEQ and CEQ is presented in Figure 2. It is apparent that the EBI correlates strongly with all MEQ dimensions and also with the grief dimension of CEQ (a relationship between EBI and grief is also suggested in the factor analysis (Table 3)). Correlations between a given subscale of the MEQ and its other subscales are higher than those with the EBI, suggesting that despite some commonalities, the EBI and MEQ are still measuring sufficiently distinct phenomena.

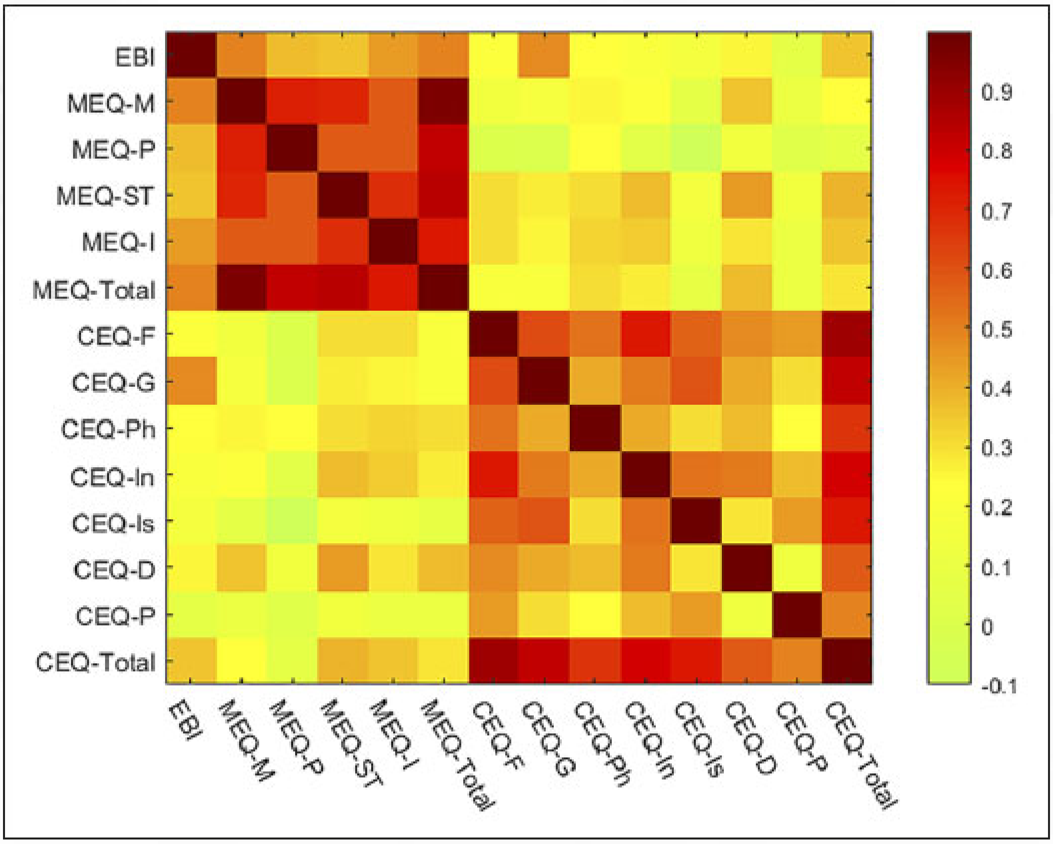


Figure 2. Correlation matrix of Emotional Breakthrough Inventory (EBI), Mystical Experience Questionnaire (MEQ) subscales and Challenging Experience Questionnaire (CEQ) subscales, and CEQ subscales. High Pearson's correlations are observed for EBI with MEQ subscales, and with CEQ_{Grief}. Yet, correlations between any given MEQ subscale and the other MEQ subscales are higher than with the EBI. This analysis, together with the factor analysis in Table 3, suggest that EBI is distinct from MEQ and CEQ (*n*=379).
CEQ-D: Death; CEQ-F: Fear; CEQ-G: Grief; CEQ-In: Insanity; CEQ-Is: Isolation;
CEQ-P: Paranoia; CEQ-Ph: Physical distress; MEQ-I: Ineffability; MEQ-M: Mystical;
MEQ-P: Positive mood; MEQ-ST: Transcendence of space and time.

Predictive validity - changes in well-being

The difference in WEMWBS from baseline (38.8±5.3) to two weeks after the experience (47.9±7.2) was significant (Cohen's d=1.44, p<0.0001, n=75, paired sample t-test). Emotional breakthrough scores significantly correlated with changes in wellbeing (ΔWEMWBS) two weeks after the psychedelic experience (compared with well-being scores at baseline), r=0.294, p=0.005, one-tail, n=75. A multiple regression analysis with ΔWEMWBS as dependent variable and EBI, MEQ and CEQ values as independent variables yielded a strong predictive model (r=0.45, p=0.0005, one-tail, n=75). The standardised beta coefficients for the EBI, MEQ and CEQ were all significant, with the EBI performing as well as the other measures (β_{EBI}=0.29, p=0.017; β_{MEQ}=0.24, p=0.038; β_{CEQ}=-0.35, p=0.002; one-tail). Independent Pearson's correlations between the MEQ and CEQ and ΔWEMWBS were r=0.274, and r=-0.147, respectively. The tolerance measures (collinearity) of EBI, MEQ and CEQ were 0.631, 0.634, 0.814, respectively (tolerance >0.2 means that the independent variables are relatively independent from each other). As a further exploratory analysis, the same regression model was applied to the wider sample regardless of WEMWBS baseline scores. Out of the total sample, 253 participants had completed the WEMWBS at two weeks after the experience. The difference in WEMWBS from baseline (49.5±8.6) to two weeks after the experience (52.7±7.3) for this population was significant as well though with smaller effect size (Cohen's d=0.4, p<0.0001, n=253, paired sample t-test). A multiple regression analysis with ΔWEMWBS as dependent variable and EBI, MEQ and CEQ values as independent variables for these 253 participants yielded a marginally significant result in the same direction as the smaller subsample (r=0.153, p=0.059, one-tail, n=253). The standardised beta coefficients for the EBI, MEQ and CEQ were all marginally significant (β_{EBI}=0.115, p=0.063; β_{MEQ}=0.075, p=0.15; β_{CEQ}=-0.086, p=0.01; one-tail). Independent Pearson's correlations between the EBI, MEQ and CEQ and ΔWEMWBS were r=0.119, r=0.106 and r=-0.019, respectively. Overall, the results of the larger subsample of 253 participants were in a similar direction yet less significant compared to the subsample of 75 participants, and this is probably due to a ceiling effect at the baseline of WEMWBS in the larger subsample. These results confirm that each of the questionnaires contribute added value to the model, whilst being significantly distinct from each other. A natural conclusion from this is that a prediction model containing measures of all three constructs will perform better than a model that neglects any one of them.

Table 3. Factor analysis of Emotional Breakthrough Inventory (EBI), Mystical Experience Questionnaire (MEQ) and Challenging Experience Questionnaire (CEQ). All of the 62 items of the EBI, MEQ and CEQ have been included in a principal component analysis (PCA) which resulted in three factors. The first factor has high loadings of items from MEQ and EBI. The second factor has high loadings of items from CEQ. The third factor has high loading of items from EBI. This analysis, together with the correlation matrix in Figure 2, reveals that EBI is discriminate from MEQ and CEQ. Factor loadings &gt;0.5 are in bold (n=379).

Questionnaire	Subscale	Question	Factor 1	Factor 2	Factor 3
EBI		I faced emotionally difficult feelings that I usually push aside.	**0.524**	0.306	**0.528**
		I experienced a resolution of a personal conflict/trauma.	**0.543**	0.036	**0.656**
		I felt able to explore challenging emotions and memories.	**0.552**	-0.055	**0.613**
		I had an emotional breakthrough.	**0.585**	0.041	**0.631**
		I was able to get a sense of closure on an emotional problem.	**0.515**	-0.057	**0.678**
		I achieved an emotional release followed by a sense of relief.	**0.606**	-0.104	**0.576**
MEQ	Mystical	Freedom from the limitations of your personal self and feeling a unity or bond with what was felt to be greater than your personal self.	**0.755**	-0.309	-0.009
		Experience of pure being and pure awareness (beyond the world of sense impressions).	**0.776**	-0.3	-0.057
		Experience of oneness in relation to an 'inner world' within.	**0.789**	-0.257	-0.056
		Experience of the fusion of your personal self into a larger whole.	**0.778**	-0.271	-0.055
		Experience of unity with ultimate reality.	**0.801**	-0.284	-0.061
		Feeling that you experienced eternity or infinity.	**0.761**	-0.191	-0.127
		Experience of oneness or unity with objects and/or persons perceived in your surroundings.	**0.65**	-0.3	-0.078
		Experience of the insight that 'all is one'.	**0.756**	-0.321	-0.084
		Awareness of the life or living presence in all things.	**0.681**	-0.337	-0.082
		Gain of insightful knowledge experienced at an intuitive level.	**0.705**	-0.28	0.216
		Certainty of encounter with ultimately reality.	**0.682**	-0.283	-0.02

		You are convinced now, as you look back on your experience, that in it you encountered ultimate reality.	**0.653**	-0.294	0.07
		Sense of being at a spiritual height.	**0.715**	-0.299	0.007
		Sense of reverence.	**0.624**	-0.255	-0.015
		Feeling that you experienced something profoundly sacred and holy.	**0.65**	-0.243	-0.008
	Positive mood	Experience of amazement.	**0.675**	-0.291	-0.203
		Feelings of tenderness and gentleness.	**0.596**	-0.374	0.091
		Feelings of peace and tranquillity.	**0.554**	**-0.521**	-0.004
		Experience of ecstasy.	**0.522**	-0.396	-0.097
		Sense of awe or awesomeness.	**0.654**	-0.344	-0.144
		Feelings of joy.	**0.522**	-0.451	-0.098
	Time and space	Loss of your usual sense of time.	**0.632**	-0.059	-0.234
		Loss of your usual sense of space.	**0.648**	-0.049	-0.288
		Loss of usual awareness of where you were.	**0.547**	0.058	-0.319
		Sense of being 'outside of' time, beyond past and future.	**0.742**	-0.05	-0.204
		Being in a realm with no space boundaries.	**0.711**	-0.181	-0.14
		Experience of timelessness.	**0.736**	-0.114	-0.239
	Ineffability	Sense that the experience cannot be described adequately in words.	**0.71**	-0.045	-0.123
		Feeling that you could not do justice to your experience by describing it in words.	**0.711**	-0.074	-0.086
		Feeling that it would be difficult to communicate your own experience to others who have not had similar experiences.	**0.649**	-0.031	-0.086
CEQ	Isolation	Isolation and loneliness.	0.298	**0.647**	-0.001
		Feeling of isolation from people and things.	0.255	**0.623**	-0.025
		I felt isolated from everything and everyone.	0.252	**0.628**	-0.002
	Grief	Sadness.	0.356	**0.542**	0.365
		Feelings of grief.	0.416	**0.502**	0.378
		I felt like crying.	0.423	0.339	0.388
		Feelings of despair.	0.396	**0.662**	0.118
		Despair.	0.366	**0.691**	0.09
		Emotional and/or physical suffering.	0.362	**0.652**	0.241
	Physical distress	Feeling my heart beating.	0.379	0.22	-0.093
		Feeling my body shake/tremble.	0.324	0.301	-0.14
		I felt shaky inside.	0.374	0.425	-0.115
		I felt my heart beating irregularly or skipping beats.	0.348	0.184	-0.073
		Pressure or weight in my chest or abdomen.	0.255	0.283	-0.012
	Fear	I had the feeling something horrible would happen.	0.414	**0.686**	-0.155
		Experience of fear.	0.419	**0.684**	-0.188
		Anxiousness.	0.298	**0.61**	-0.136
		Panic.	0.414	**0.655**	-0.201
		I felt frightened.	0.429	**0.702**	-0.158
	Insanity	Fear that I might lose my mind or go insane.	0.407	**0.61**	-0.203
		I was afraid that the state I was in would last forever.	0.419	**0.54**	-0.235
		I experienced a decreased sense of sanity.	0.414	0.48	-0.206
	Paranoia	I had the feeling that people were plotting against me.	0.233	0.31	-0.204
		Experience of antagonism toward people around me.	0.167	0.368	-0.069
	Death	I had the profound experience of my own death.	**0.501**	0.229	-0.126
		I felt as if I was dead or dying.	0.463	0.408	-0.161

Discussion

Here we sought to devise and carry out validation work on a new scale intended to describe an important and hitherto under-quantified component of the psychedelic experience, the EB. We anticipate that this scale will serve as a useful 'state' predictor of the longer-term psychological outcomes after a psychedelic experience - supplementing already existing state predictor measures such as the MEQ and CEQ. We call this new scale the 'EBI'. Results revealed that (as measured by the EBI) emotional breakthrough is dose dependent and sufficiently different from the mystical-type and challenging experience as indexed by the MEQ and CEQ respectively. Consistent with a major prior hypothesis, we found that (like the MEQ) the EBI significantly predicts post-psychedelic changes in well-being (greater EB, greater increases in well-being) and we also discovered that the EBI does not render either the CEQ or MEQ redundant but rather a multi-factorial predictor model that combines all three measures performs better than any alternative that neglects any one of them. The combined EBI, MEQ and CEQ model is able to predict close to 20% of the variance in well-being changes after a psychedelic experience, a not inconsiderable amount given the relatively 'well' nature of this sample and uncontrolled study design. We also found that both therapeutic intention and therapeutic setting can predict the intensity of EB, suggesting that, as with other components of the acute psychedelic experience, EB is highly influenced by the context in which the psychedelic is taken (Carhart-Harris *et al.*, 2017b; Hartogsohn, 2016, 2017). Taken together, these results support the addition of the EBI to the arsenal of tools used to quantitatively describe the psychedelic experience and predict its longer-term psychological effects.

Modern phenomenological analyses (Belser *et al.*, 2017; Gasser *et al.*, 2014; Watts *et al.*, 2017) and therapists' accounts (Bonny and Pahnke, 1972; Cohen, 1959; Crocket *et al.*, 1963; Eisner and Cohen, 1958; Fisher, 2015; Grof *et al.*, 1980; Jensen, 1963; Katzenelbogen and Fang, 1953; Leuner, 1961; Martin, 1957; Richards, 2015; Sandison, 1955) have tended to recognise the importance of EB within the context of psychedelic experiences and psychedelic therapy; however, a validated quantitative measure of this phenomenon is arguably overdue and there is a significant contemporary need for it. Perhaps due to the relative dearth of psychedelic research since the 1960s and a particular bias common among those few research teams working within the current resurgent era, contemporary researchers have tended to place significant emphasis on the mystical-type experience, in part due to well-replicated findings that its occurrence is predictive of relevant psychological outcomes, such as improvements in well-being (Haijen *et al.*, 2018) changes in personality (MacLean *et al.*, 2011), and improvements in clinical outcomes in patient populations (Roseman *et al.*, 2017).

The present work has demonstrated the added value of measuring EB for predicting subsequent psychological outcomes after a psychedelic experience. However, are there other 'state' and perhaps 'contextual' factors that are also important determinants of longer-term responses to psychedelics - and might there be alternative dependent variables that are differentially influenced by state and contextual predictors? Indeed, these variables may also interact in non-linear ways. We have previously emphasised (Carhart-Harris *et al.*, 2017b), and sought to measure and demonstrate, the influence of contextual factors such as the presence of others, associated therapeutic alliance, a therapeutic intention and setting and a willingness to surrender or 'let-go' to the psychedelic experience on longer-term psychological outcomes, and found them to be important (Haijen *et al.*, 2018). Like 'state' predictors of long-term responses, it is logical to see these factors as mediators of the relevant changes, as they are temporal antecedents of them. Other factors we predict may be important for influencing long-term changes include psychological insight and psychological integration. Insight is a phenomenon that may occur acutely in a state-like fashion (like EB) but could only be more protracted, crystallising in the days to weeks following a psychedelic experience. Integration is another protracted phenomenon that may have no clear end-point as such.

Much more work is needed to understand the neurobiology of the entire psychedelic psychotherapy process and this will naturally require brain imaging at various time points: before, during and after a specific psychedelic experience. Further discussion of this topic is beyond the remit of the present article, only to say that there is some evidence that the magnitude of increased brain entropy, a known biomarker of the psychedelic state, has been found to be predictive of subsequent psychological changes (increased trait 'openness') over a consistent time-scale as was measured here in relation to well-being (Lebedev *et al.*, 2016).

Finally, we advocate looking at other dependent variables than just well-being. Well-being is a useful index of mental health in general populations (Tennant *et al.*, 2007) but it may be that certain psychiatric disorders and/or symptom clusters behave differently in their relation to predictor variables. This is something we intend to investigate more fully in future analyses plus new and on-going studies.

Our novel analysis is part of an effort to elucidate the importance of the psychological mechanism of psychedelics alongside their pharmacological uses, and by doing so to emphasise the importance of the context in which these drugs are taken. That is to say that affirming that the experience mediates the clinical outcomes, means that the regular clinical context will have to be modified to accommodate psychedelics as an effective psychopharmacological intervention within psychiatry. On that note, there is a lesson from history we would like to bring to readers' attention before closing: psychedelic therapy was once a relatively widely practised intervention in Western psychiatry before opinion shifted against it (Baum, 2016; Grinspoon and Bakalar, 1979). As the pharmacological revolution in psychiatry gathered momentum in the 1960s and the thalidomide scandal occurred at a related time, regulations on experimental medicines tightened, as did the methods for assessing their safety and efficacy (Oram, 2012). Within this climate, some efforts were made to extricate the basic pharmacological action of LSD from the psychotherapeutic manner in which it was typically administered, e.g. by giving the drug in a psychologically 'sterile' environment (Ludwig, 1985). In at least one published study, patients treated with LSD were placed in a belt that restrained them to their bed (Johnson *et al*. 1969). Unsurprisingly, such efforts to 'neutralise' context (which is, of course, a misnomer) tended to reveal that LSD without contextual support does not nearly have the same therapeutic value and safety profile as LSD given with therapeutic support (Oram, 2012, 2014). These results, combined with the spread of unfounded but nonetheless affecting misinformation about LSD (Dishotsky *et al*., 1971) plus a tightening of legislation on drugs of potential misuse, best exemplified by the 1970 Controlled Substances Act (1970), signalled the demise of psychedelic psychotherapy. The present study's analyses confirm the findings of other analyses (Dimascio and Klerman, 1960; Haijen *et al*., 2018; Hyde, 1960; Lasagna, 1963; Leary *et al*., 1963; Studerus *et al*., 2012) that context is an essential component of the psychedelic model (Carhart-Harris *et al*., 2017b; Hartogsohn, 2017; Leary *et al*., 1963) and that if one wishes to promote a positive therapeutic response to a psychedelic, then heeding and optimising the role of certain contextual components is entirely necessary, whereas neglecting them is bad practice if not unethical. Our hope is that psychedelic therapy of the future can be done in a way and a context that encourages and allows the free release of emotion, e.g. using tools such as music (Barrett *et al*., 2018; Bonny and Pahnke, 1972; Kaelen *et al*., 2017), empathic listening and purposefully designed supportive environments, even if this presents a significant challenge to the conventions of mainstream medicine:

> [Practicing psychedelic therapy here] has transformed the entire hospital, because the whole atmosphere engendered by LSD has spread throughout the hospital and, in fact, forms an essential part of the hospital culture. If LSD is given in a large institutional setting, treatment will be ineffective unless this transformation has occurred.
>
> British psychiatrist Ronald Sandinson (1916-2010) cited in Abramson (1960: 15)

Three limitations of the present study should be noted. First, the present study's population contained mostly healthy experienced psychedelic users, and therefore the results do not necessarily apply to clinical population (Haijen *et al*., 2018). In these users the outcomes in well-being might be related to the expectation build around psychedelic use in the psychedelic culture and literature. Furthermore the pharmacological mechanism of psychedelics might be different in these users due to greater exposure to this class of drugs. To improve translational relevance, future studies should use the EBI in clinical populations to assess its ability to predict changes in clinically recognised phenomena, such as depressive symptoms and anxiety. The prediction model of changes in well-being predicted only 20% of the variance. However, we do expect this model to perform better in a clinical trial and in a controlled environment. Second, the study has relied on self-reports of drugs, doses and timing, which are not as accurate as in laboratory studies. Psychedelics that are sold in the market are unreliable in many cases and one cannot be sure which drug and what dose was used. Third, there was limited analysis of convergent validity. Although there is clearly some overlap with the MEQ, we are not aware of any other questionnaires that measure a construct closely related to EBI. One way to address this in the future might be to compare EBI scores with quantitative outcomes from qualitative interviews, to assess whether there is some correspondence. A better demonstration of the convergent validity of the EBI will serve to further strengthen its construct validity (Campbell and Fiske, 1959).

In conclusion, EB is an essential component of psychedelic-assisted therapy, and therefore should be measured in future experimental medicine studies and clinical trials with psychedelics, alongside measures of peak and challenging experiences. Quantifying the psychological mechanism of psychedelic-assisted therapy is essential as psychedelic-assisted therapy is rightly both a pharmacological and psychological intervention. The predictive value of peak experiences is well-established within this context, and now the importance of EBs can be better researched and potentially supported as well. Furthermore, based on qualitative studies (Belser *et al.*, 2017; Gasser *et al.*, 2014; Watts *et al.*, 2017) and a broader awareness of the phenomenology of the psychedelic experience, we believe there is scope for additional quantitative measures (e.g. of psychological insight) to be developed, so that a fuller understanding of the psychological and neurobiological mechanism of psychedelic (mind-revealing) therapy can be appreciated and utilised for positive ends.

Acknowledgements

The authors would like to acknowledge Alex Belser, his Interdisciplinary Conference on Psychedelics Research (ICPR) talk in 2016 served as a catalyst for the creation of EBI (Belser, 2016).

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship and/or publication of this article: LR is funded by Imperial College President's Scholarship Scheme and by a donation from Albert Hohohm. MK is funded by Wavepaths. RW is funded by the Alex Mosley Charitable Trust, RCH is funded by the Alex Mosley Charitable Trust and Ad Astra Chandaria Foundation.

References

1. Abramson HA (1960) *The Use of LSD in Psychotherapy: Transactions*. New York: Josiah Macy, Jr. Foundation.
2. Barrett FS, Bradstreet MP, Leoutsakos J-MS, *et al*. (2016) The Challenging Experience Questionnaire: Characterization of challenging experiences with psilocybin mushrooms. *J Psychopharmacol* 30: 1279-1295.
3. Barrett FS, Preller KH and Kaelen M (2018) Psychedelics and music: Neuroscience and therapeutic implications. *Int Rev Psychiatry* 1-13.
4. Baum D (2016) Legalize It All: How to win the war on drugs. *Harper's Magazine*. Available at: https://harpers.org/archive/2016/04/legalize-it-all/ (accessed 28 November 2018).
5. Belser A (2016) Real, Relational, and Embodied: The First Qualitative Study of Patient Experiences of Psilocybin-Assisted Psychotherapy. In: *Interdisciplinary Conference on Psychedelics Research (ICPR)*, 6 June 2016. Amsterdam. Youtube-Available at: https://www.youtube. com/watch?v=DUYDjV8lQxo
6. Belser AB, Agin-Liebes G, Swift TC, *et al*. (2017) Patient experiences of psilocybin-assisted psychotherapy: An interpretative phenomenological analysis. *J Humanist Psychol* 57: 354-388.
7. Bogenschutz MP, Forcehimes AA, Pommy JA, *et al*. (2015) Psilocybinassisted treatment for alcohol dependence: A proof-of-concept study. *J Psychopharmacol* 29: 289-299.
8. Bonny HL and Pahnke WN (1972) The use of music in psychedelic (LSD) psychotherapy. *J Music Ther* 9: 64-87.
9. Breuer J and Freud S (1895) *Studies on Hysteria*. London: Hachette UK.
10. Budaev SV (2010) Using principal components and factor analysis in animal behaviour research: Caveats and guidelines. *Ethology* 116: 472-480.
11. Campbell DT and Fiske DW (1959) Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychol Bull* 56: 81.
12. Carbonaro TM, Bradstreet MP, Barrett FS, *et al*. (2016) Survey study of challenging experiences after ingesting psilocybin mushrooms: Acute and enduring positive and negative consequences. *J Psychopharmacol* 30: 1268-1278.
13. Carhart-Harris R, Bolstridge M, Day C, *et al*. (2017a) Psilocybin with psychological support for treatment-resistant depression: Six-month follow-up. *Psychopharmacology* 235(2): 399-408.
14. Carhart-Harris R, Roseman L, Haijen E, *et al*. (2017b) Psychedelics and the essential importance of context. *J Psychopharmacol* 32(7): 725-731.
15. Carhart-Harris RL (2018) Serotonin, psychedelics and psychiatry. *World Psychiatry* 17: 358-359.
16. Cattell RB (1966) The scree test for the number of factors. *Multivariate Behav Res* 1: 245-276.
17. Cohen S (1959) The therapeutic potential of LSD-25. In: Featherstone RM and Simon A (eds) *A Pharmacologic Approach to the Study of the Mind*. Springfield, Ill.: Thomas, pp. 251-257.
18. Controlled Substances Act (1970) Pub. L. No. 91-513, 84 Stat. 1236 (codified as amended at 21 U.S.C. § 812 (2012). HeinOnline.
19. Crocket RW, Sandison RA and Walk A (1963) *Hallucinogenic Drugs and Their Psychotherapeutic Use*. London: HK Lewis.
20. Cronbach LJ (1951) Coefficient alpha and the internal structure of tests. *Psychometrika* 16: 297-334.

21. Dakwar E, Anerella C, Hart C, *et al*. (2014) Therapeutic infusions of ketamine: Do the psychoactive effects matter? *Drug Alcohol Depend* 136: 153-157.
22. Dimascio A and Klerman GL (1960) Experimental human psychopharmacology: The role of non-drug factors. In: Sarwer-Foner GJ (ed.) *The Dynamics of Psychiatric Drug Therapy*. Springfield, Ill.: Thomas, pp. 56-84.
23. Dishotsky NI, Loughman WD, Mogar RE, *et al*. (1971) LSD and genetic damage. *Science* 172: 431-440.
24. Dittrich A (1975) Zusammenstellung eines Fragebogens (APZ) zur Erfassung abnormer psychischer Zustande [Construction of a questionnaire (APZ) for assessing abnormal mental states]. *Z Klin Psychol Psychiatr Psychother* 23: 12-20.
25. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. *Pharmacopsychiatry* 31: 80-84.
26. Dyck E (2006) 'Hitting highs at rock bottom': LSD treatment for alcoholism, 1950-1970. *Soc Hist Med* 19: 313-329.
27. Eisner BG and Cohen S (1958) Psychotherapy with lysergic acid diethylamide. *J Nerv Ment Dis* 127: 528-539.
28. Erritzoe D, Roseman L, Nour M, *et al*. (2018) Effects of psilocybin therapy on personality structure. *Acta Psychiatr Scand* 138: 368- 378.
29. Fisher FM (2015) *Therapy with Substance: Psycholytic Psychotherapy in the Twenty First Century*. London: Muswell Hill Press.
30. Frederking W (1955) Intoxicant drugs (mescaline and lysergic acid diethylamide) in psychotherapy. *J Nerv Ment Dis* 121: 262-266.
31. Garcia-Romeu AP, Johnson MW and Griffiths RR (2014) Examining the psychological mechanisms of psilocybin-assisted smoking cessation treatment: A pilot study. *Drug Alcohol Depend* 140: e66.
32. Gasser P, Kirchner K and Passie T (2014) LSD-assisted psychotherapy for anxiety associated with a life-threatening disease: A qualitative study of acute and sustained subjective effects. *J Psychopharmacol* 29: 57-68.
33. Griffiths RR, Johnson MW, Carducci MA, *et al*. (2016) Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *J Psychopharmacol* 30: 1181-1197.
34. Griffiths RR, Richards WA, McCann U, *et al*. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-283.
35. Grinspoon L and Bakalar JB (1979) *Psychedelic Drugs Reconsidered*. New York: Basic Books.
36. Grof S (1975) *Realms of the Human Unconscious: Observations from LSD Research*. London: Souvenir Press Ltd; 2016 Edition.
37. Grof S, Hofmann A and Weil A (1980) *LSD Psychotherapy (The healing potential of psychedelic medicine)*. Ben Lomond, CA: Multidisciplinary Association for Psychedelic Studies; 2008 Edition.
38. Haijen ECHM, Kaelen M, Roseman L, *et al*. (2018) Predicting responses to psychedelics: A prospective study. *Front Pharmacol* 9: 897.
39. Hartogsohn I (2016) Set and setting, psychedelics and the placebo response: An extra-pharmacological perspective on psychopharmacology. *J Psychopharmacol* 30: 1259-1267.
40. Hartogsohn I (2017) Constructing drug effects: A history of set and setting. *Drug Sci Policy Law* 3: 2050324516683325.
41. Hintze JL and Nelson RD (1998) Violin plots: A box plot-density trace synergism. *Am Stat* 52: 181-184.
42. Huxley A (1945) *The Perennial Philosophy*. Toronto: New Canadian Library.
43. Hyde RW (1960) Psychological and social determinants of drug action. In: GJ Sarwer-Foner (ed.) *Dynamics of Psychiatric Drug Therapy*. Springfield: Thomas, pp. 297-315.
44. Jackson SW (1994) Catharsis and abreaction in the history of psychological healing. *Psychiatr Clin North Am* 17: 471-491.
45. Jensen S (1963) Treatment of chronic alcoholism with lysergic acid diethylamide. *Can Psychiatr Assoc J* 8: 182-188.
46. Johnson FG (1969) LSD in the treatment of alcoholism. *American Journal of Psychiatry* 126: 481-487.
47. Johnson MW, Garcia-Romeu A and Griffiths RR (2016) Long-term follow-up of psilocybin-facilitated smoking cessation. *Am J Drug Alcohol Abuse* 1-6.
48. Kaelen M, Giribaldi B, Raine J, *et al*. (2017) The hidden therapist: Evidence for a central role of music in psychedelic therapy. *Psychopharmacology* 235: 505-519.
49. Katzenelbogen S and Fang AD (1953) Narcosynthesis effects of sodium amytal, methedrine and LSD-25. *Dis Nerv Syst* 14: 85-88.
50. Klavetter RE and Mogar RE (1967) Peak experiences: Investigation of their relationship to psychedelic therapy and self-actualization. *J Humanist Psychol* 7: 171-177.
51. Kurland AA, Grof S, Pahnke WN, *et al*. (1972) Psychedelic drug assisted psychotherapy in patients with terminal cancer. *J Thanatol* 2(1-2): 644-691
52. Lasagna L (1963) The relation of drug induced changes to personality. In: M. Rinkel (ed.) *Specific and Non-specific Factors in Psychopharmacology*. New York: Philosophical Library, pp. 114-129.
53. Leary T, Litwin GH and Metzner R (1963) Reactions to psilocybin administered in a supportive environment. *J Nerv Ment Dis* 137: 561-573.
54. Lebedev AV, Kaelen M, Lovden M, *et al*. (2016) LSD-induced entropic brain activity predicts subsequent personality change. *Hum Brain Mapp* 37: 3203-3213.
55. Leuner H (1961) Psychotherapy with hallucinogens. *Hallucinogenic Drugs* 67: 67-73.
56. Loizaga-Velder A (2013) A psychotherapeutic view on therapeutic effects of ritual ayahuasca use in the treatment of addiction. *MAPS Bull* 23: 36-40.
57. Ludwig AM (1985) Cognitive processes associated with 'spontaneous' recovery from alcoholism. *J Stud Alcohol* 46: 53-58.
58. MacLean JR, MacDonald DC, Byrne UP, *et al*. (1961) *The use of LSD-25 in the treatment of alcoholism and other psychiatric problems*. New Haven: Laboratory of applied Biodynamics, Yale University.
59. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
60. MacLean KA, Leoutsakos JMS, Johnson MW, *et al*. (2012) Factor analysis of the mystical experience questionnaire: A study of experiences occasioned by the hallucinogen psilocybin. *J Sci Study Relig* 51: 721-737.

61. Martin AJ (1957) LSD (lysergic acid diethylamide) treatment of chronic psychoneurotic patients under day-hospital conditions. *Int J Soc Psychiatry* 3: 188-195.
62. Maslow AH (1959) Cognition of being in the peak experiences. *J Genet Psychol* 94: 43-66.
63. Maslow AH (1964) *Religions, Values, and Peak-Experiences*. Columbus: Ohio State University Press.
64. Nour MM, Evans L, Nutt D, *et al*. (2016) Ego-dissolution and psychedelics: Validation of the ego-dissolution inventory (EDI). *Front Hum Neurosci* 10: 269.
65. O'Reilly P and Funk A (1964) LSD in chronic alcoholism. *Can Psychiatr Assoc J* 9: 258-261.
66. Oram M (2012) Efficacy and enlightenment: LSD psychotherapy and the drug amendments of 1962. *J Hist Med Allied Sci*. Epub ahead of print 16 August 2012. DOI: 10.1093/jhmas/jrs050.
67. Oram M (2014) *The trials of psychedelic medicine: LSD psychotherapy, clinical science, and pharmaceutical regulation in the United States, 1949-1976*. PhD Doctorate. University of Sydney, School of Philosophical and Historical Inquiry, Department of History.
68. Osmond H (1957) A review of the clinical effects of psychotomimetic agents. *Ann N Y Acad Sci* 66: 418-434.
69. Pahnke WN and Richards WA (1966) Implications of LSD and experimental mysticism. *J Religion Health* 5: 175-208.
70. Pahnke WN, Kurland AA, Goodman LE, *et al*. (1969) LSD-assisted psychotherapy with terminal cancer patients. *Curr Psychiatr Ther* 9: 144-152.
71. Pahnke WN, Kurland AA, Unger S, *et al*. (1970) The experimental use of psychedelic (LSD) psychotherapy. *JAMA* 212: 1856-1863.
72. Richards WA (2015) *Sacred Knowledge: Psychedelics and Religious Experiences*. New York: Columbia University Press.
73. Richards WA, Rhead JC, DiLeo FB, *et al*. (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. *J Psychedelic Drugs* 9: 1-10.
74. Roseman L, Nutt DJ and Carhart-Harris RL (2017) Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. *Front Pharmacol* 8: 974.
75. Ross S, Bossis A, Guss J, *et al*. (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *J Psychopharmacol* 30: 1165-1180.
76. Sandison R (1955) LSD treatment for psychoneurosis: Lysergic acid diethylamide for release of depression. *Nurs Mirror* 100: 1529-1530.
77. Schenberg EES (2018) Psychedelic-assisted psychotherapy: A paradigm shift in psychiatric research and development. *Front Pharmacol* 9: 733.
78. Stace WT (1960) Mysticism and philosophy. London: Macmillan Publishers.
79. Strassman RJ, Qualls CR, Uhlenhuth EH, *et al*. (1994) Dose-response study of N, N-dimethyltryptamine in humans: II. Subjective effects and preliminary results of a new rating scale. *Arch Gen Psychiatry* 51: 98-108.
80. Studerus E, Gamma A and Vollenweider FX (2010) Psychometric evaluation of the altered states of consciousness rating scale (OAV). *PloS One* 5: e12412.
81. Studerus E, Gamma A, Kometer M, *et al*. (2012) Prediction of psilocybin response in healthy volunteers. *PloS One* 7: e30800.
82. Taggart F, Stewart-Brown S and Parkinson J (2015) Warwick-Edinburgh Mental Well-being Scale (WEMWBS) User Guide, Version 2. NHS Health Scotland.
83. Tennant R, Hiller L, Fishwick R, *et al*. (2007) The Warwick-Edinburgh mental well-being scale (WEMWBS): Development and UK validation. *Health Qual Life Outcomes* 5: 63.
84. Watts R, Day C, Krzanowski J, *et al*. (2017) Patients' accounts of increased 'Connectedness' and 'Acceptance' after psilocybin for treatment-resistant depression. *J Humanist Psychol* 57: 520-564.

The Fibrinolytic System: a New Target for Treatment of Depression with Psychedelics

by

Idell RD, M.D[1] , Florova G PhD[2], Komissarov AA PhD[2], Shetty S PhD[2], Girard R B.S[3] and Idell S M.D., PhD[2]

original report:
https://psilosybiini.info/paperit/The%20fibrinolytic%20system;%20A%20new%20target%20for%20treatment%20of%20depression%20with%20psychedelics%20(Idell%20et%20al.,%202017).pdf
backup source:
https://www.psilosophy.info/resources/The%20fibrinolytic%20system;%20A%20new%20target%20for%20treatment%20of%20depression%20with%20psychedelics%20(Idell%20et%20al.,%202017).pdf

[1] Department of Behavioral Health, Child and Adolescent Psychiatry
[2] Department of Cellular and Molecular Biology,
[3] Biotechnology Graduate Program, The University of Texas Health Science Center at Tyler, 11937 US HWY 271, Tyler TX, 75708

Please address all correspondence to:
Richard Idell, M.D., Assistant Professor
Department of Behavioral Health, Child and Adolescent Psychiatry
The University of Texas Health Science Center at Tyler
11937 US Highway 271, Tyler, TX 75708
Phone (903) 877 7168
Fax (903) 877 8355
Email: richard.idell@uthct.edu

Funding:
[1] Department of Behavioral Health Institutional Funding and
[2] Texas Workforce Commission.
[3] Institutional Funding from The University of Texas Health Science Center at Tyler derived from offset, NHLBI Grants RO-1HL118401-01A3 and UO-1 HL 121841-01A1 (SI, PI).

Table of Contents:

Introduction
The Linkage Between Peripheral or Cerebral Inflammation and Suppression of the Fibrinolysis in the Brain
Synaptic Plasticity, Depression, And The Fibrinolytic System In The Brain
Antidepressants, Ketamine and Psilocybin: Established and Hypothetical Effects on the Brain Fibrinolytic System and Depression
References

Introduction

Major depression is among the most common mental health disorders in the United States and carries the heaviest burden of disability among mental and behavioral disorders [1]. Over one third of patients will not achieve remission after initiation of an antidepressant treatment and the likelihood of achieving remission diminishes with subsequent medication trials [2]. These considerations demand exploration of alternative treatment strategies and identification of novel mechanisms that can be exploited to improve outcomes. The finding that glutamate modulators such as ketamine have rapid acting antidepressant effects has expanded the current model of depression beyond the traditional monoamine theory involving serotonin, dopamine and norepinephrine. Recent research has focused on the role of cytokine-mediated inflammation, neurogenesis, and the role of the glutamate in the pathogenesis of depression [3].

The involvement of inflammation in the development of depression has been extensively studied, while that of the fibrinolytic system, which is down-regulated by inflammation in a range of disorders including lung and pleural injury, cardiovascular disease, glomerulonephritis, and cirrhosis [4-6] has been comparatively ignored, even though depression is considered to be an independent risk factor for coronary artery disease that predicts increased morbidity and mortality [7]. Brain derived neurotrophic factor (BDNF), a neurotrophic factor regulated by tissue type plasminogen activator (tPA), has been posited as a key link between stress, cardiovascular disease, and depression as well as its treatment, mainly via tPA-mediated cleavage of BDNF by plasmin [8-10]. Animal models with BDNF Val66Met polymorphisms are associated with decreased BDNF activity and demonstrate increased activation of platelets, alterations in coagulation pathways, changes in vessel wall protein composition and increased depressive phenotype [11]. Here, we review these prior hypotheses and extend them in light of more recent understanding of the role of impaired fibrinolysis, aberrant extravascular fibrin deposition and tissue remodeling that has been the longstanding focus of our group. We also provide new supporting evidence, some from our own laboratory, that newly recognized mechanisms underlying impaired fibrinolysis in the lung and pleural space could occur within the brain parenchyma to promote architectural alterations that lead to the development of depressive symptoms. While psychological explanations for depression are certainly important, our focus in this manuscript is on biologic mechanisms that specifically involve the fibrinolytic system, that could likewise contribute to the pathogenesis of depression and that may be amenable to novel pharmacologic approaches including administration of psychedelic agents.

tPA, urokinase (uPA), plasminogen activator inhibitor 1 (PAI-1), neuroserpin, and urokinase receptor (uPAR) are expressed in the brain in neurons, microglia and astrocytes [12,13] while soluble uPAR (suPAR) is a proteolytic cleavage product that can be detected within the systemic circulation. Interestingly, increased suPAR is a biomarker of depression [12] and potentially suicidality [13]. This supports the concept that abnormalities of the fibrinolytic system occur in depression and could potentially contribute to its pathogenesis (Figure 1). We posit that plasminogen activators, uPAR, and the inhibitors, PAI-1 and neuroserpin, are integral to the pathogenesis of depression, in part by regulating the production of mature BDNF (mBDNF) as well as remodeling of brain architecture, neurotransmission and synaptic plasticity. We also propose that psilocybin, a 5-HT_{2A} serotonin receptor agonist and classic psychedelic can exert anti-depressant effects that are mediated by salutary changes in the fibrinolytic system. The classic psychedelic 5-HT_{2A} receptor agonists, which include d-lysergic acid diethylamide (LSD), mescaline, and *N,N*-dimethyltryptamine (DMT) are capable of inducing robust changes in affect, perception, and cognition. Psilocybin in particular may induce positive psychological experiences of high personal significance leading to enduring beneficial changes in mood, thinking, and behavior [14].

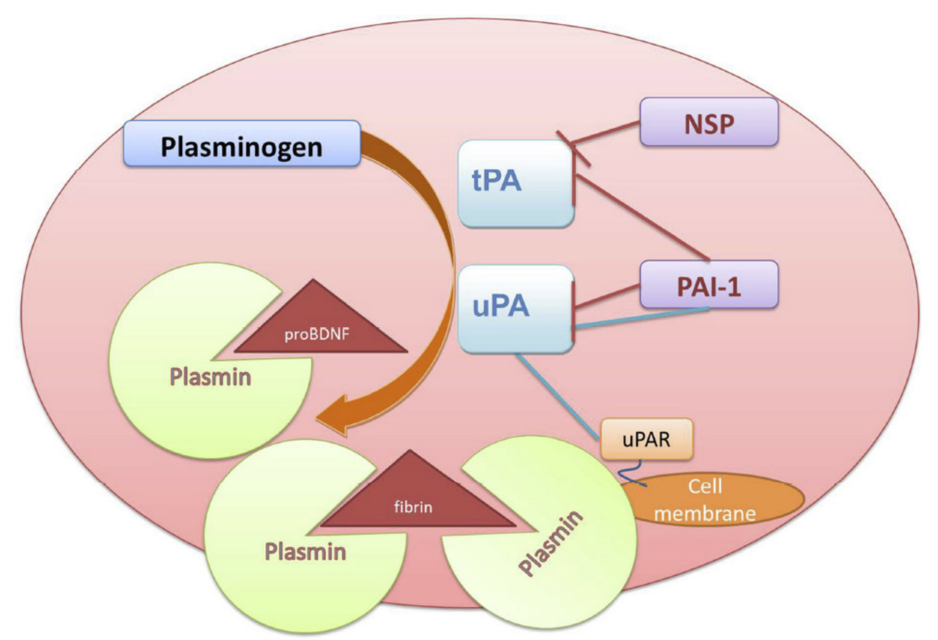


Figure 1. Hypothesis: The contribution of the fibrinolytic system to processing of BDNF as a link to depression. Serpins (PAI-1 and NSP) are elevated in depression and inhibit both tissue (tPA) and urokinase (uPA) plasminogen activators (including uPA bound to its receptor uPAR), suppress activation of plasminogen, and block activation of proBDNF. Inhibition of the fibrinolytic activity promotes transient extravascular fibrin deposition in the brain. An increase in PA activity also results in cleavage of plasminogen producing plasmin, which then activates proBDNF to the activated cleavage product; mature (m)BDNF. However, transient fibrin, due to its high affinity to plasmin and tPA competes with proBDNF for plasmin, and thus affects proBDNF processing.

Our overarching hypothesis is that exploration of fibrinolytic system in the brain will provide an avenue for the development of new treatments for depression including administration of psychedelic agents to patients with refractory depression [15]. We specifically propose that serotonergic classic psychedelics such as psilocybin will demonstrate therapeutic effects on the brain including normalization of changes that occur as a result of chronic stress and disruption of the fibrinolytic system through interactions between neuroserpin, tPA and PAI-1 (Figure 2). We infer that psilocybin may decrease PAI1 activity via reduction of TNF-α levels, leading to disinhibition of tPA, increased mBDNF production, normalized synaptic plasticity, and resolution of depression (Figure 3). This hypothesis relies in part on the established link between peripheral and central inflammation in the pathogenesis of depression, which is described in the next section.

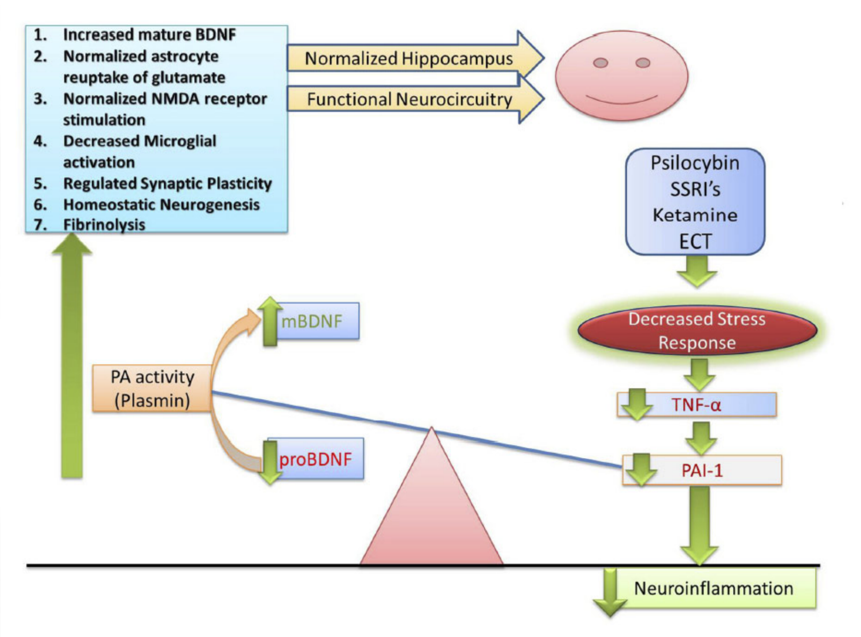

1. Increased mature BDNF
2. Normalized astrocyte reuptake of glutamate
3. Normalized NMDA receptor stimulation
4. Decreased Microglial activation
5. Regulated Synaptic Plasticity
6. Homeostatic Neurogenesis
7. Fibrinolysis
Normalized Hippocampus
Functional Neurocircuitry
Psilocybin
SSRI's
Ketamine
ECT
mBDNF
Decreased Stress Response
PA activity (Plasmin)
TNF-α
proBDNF
PAI-1
Neuroinflammation

Figure 2. Proposed effects of dysregulated fibrinolysis on the pathogenesis of depression. Derangements of the fibrinolytic system are integral to the pathogenesis of depression: Stress initiates a cascade in the brain wherein proinflammatory cytokines such as TNF-α increase PAI-1 levels. This inhibits PA activity and blocks plasmin-mediated cleavage of proBDNF to mBDNF. Inhibition of PA activity also promotes transient fibrin deposition. A decrease in mBDNF (and increase in the proBDNF/mBDNF ratio) leads to disruption of hippocampal neurogenesis, synaptic plasticity, and increased hippocampal atrophy resulting in depression.

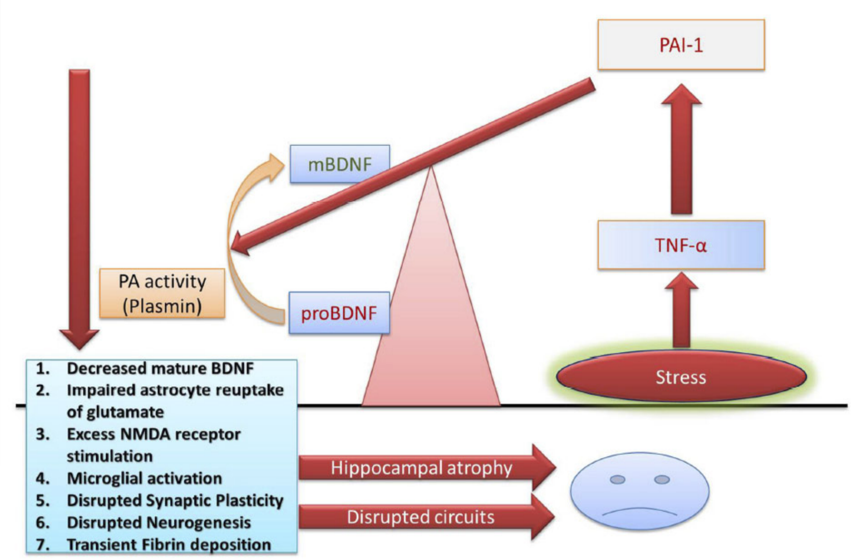

PAI-1
mBDNF
TNF-α
PA activity (Plasmin)
proBDNF
Stress
1. Decreased mature BDNF
2. Impaired astrocyte reuptake of glutamate
3. Excess NMDA receptor stimulation
4. Microglial activation
5. Disrupted Synaptic Plasticity
6. Disrupted Neurogenesis
7. Transient Fibrin deposition
Hippocampal atrophy
Disrupted circuits

Figure 3. Proposed contribution of the fibrinolytic system to the mitigation of depression by psilocybin and other treatments. Psilocybin, Ketamine, Electroconvulsive therapy and SSRI's may act through antinflammatory, profibrinolytic mechanisms simultaneously decreasing TNF-α and PAI-1 levels thereby increasing PA activity to generate plasmin which cleaves proBDNF to mature; mBDNF. This may lead to restoration of homeostatic functional neurocircuitry, increased hippocampal neurogenesis, and euthymia. Possible delay in activation of proBDNF could occur due to competition for plasmin and tPA with transient extravascular fibrin deposition within the brain parenchyma (Figure 1).

The Linkage Between Peripheral or Cerebral Inflammation and Suppression of the Fibrinolysis in the Brain

Evidence from human studies suggests that increased peripheral cytokine levels are associated with depression and suicidality [16]. A recent meta-analysis indicates that levels of interleukin-6 (IL-6) and TNF-α are significantly higher in depressed patients [17]. Aberrant cytokine elevation profiles have been shown to be potential biomarkers of treatment responses, as a recent study showed that subjects with non-remitted Major Depressive Disorder (MDD) have high baseline levels of TNF-α, which falls with exercise as opposed to antidepressant medications [18]. This study underscores the potential utility of alternative depression strategies or treatments, such as treatment with psilocybin for resistant depression.

Peripheral proinflammatory cytokines may access or directly affect the central nervous system (CNS) through several mechanisms such as activating the vagus nerve, disrupting the blood brain barrier (BBB), or accessing the brain directly via the circumventricular organs or saturable transport systems [19]. The BBB is regulated by several mechanisms involving tPA, which opens the BBB and PAI-1, which tightens the BBB [20]. Overexpression of proinflammatory cytokines in the CNS or in the circulation with induction of a relatively more open BBB, may contribute to neuroinflammation. These and other proinflammatory mediators activate microglia and astrocytes, leading to an enhanced local inflammation and the potential for glial scarification. These processes may suppress normal hippocampal neurogenesis which is associated with depression [21].

Disruption of hippocampal neurogenesis may occur throughout the life cycle as a result of chronic peripheral inflammation due to medical illness [22] or chronic stress [23]. In humans, numerous medical comorbidities including inflammatory bowel disease, diabetes mellitus, and obesity have all been linked to depression and cognitive impairment [24], likely mediated by disruption of hippocampal neurogenesis. These reports suggest a link between chronic inflammation due to co-morbidities with suppression of the fibrinolytic system in the brain.

Synaptic Plasticity, Depression, And The Fibrinolytic System In The Brain

Inflammation, coagulation, and fibrinolysis are intricately interwoven systems that are interactive [4,25]. While inflammation has been intensely studied as a risk factor for depression, the role of the fibrinolytic system in the pathogenesis of this disorder remains poorly understood. Several key elements of the fibrinolytic system linked to synaptic plasticity appear to be altered during stress. For example, uPA and uPAR have been shown to increase cellular viability in the stressed lung epithelium [26] and in lung fibroblasts [27] and we infer that they may similarly do so in the brain. uPA may also promote synaptic plasticity in the brain when upregulated by proinflammatory cytokines involved in depression. tPA and uPA convert plasminogen to its active form plasmin. In the vasculature, plasmin is known to degrade fibrin clots. In the brain, fibrin has been demonstrated to activate microglia, increasing neuroinflammation and potentially depression [28]. While it is currently unclear whether or not transitional fibrin occurs with low grade inflammation in the brain in depression, fibrin possesses high affinity for both tPA [29] and plasmin [30,31]. Its presence in the brain parenchyma could adversely affect neuroplasticity via inhibition of proBDNF activation, thus promoting depression. Moreover, PAI-1, which is upregulated in alveolar epithelial cells during lung inflammation, has been shown to inhibit neutrophil apoptosis and subsequent phagocytosis thereby leading to prolonged inflammation within the injured lung [32]. PAI-1 is primarily located in astrocytes and has been suggested to be antiapoptotic for neurons in the brain [33]. This suggests that both tPA and PAI-1 may be neurotoxic or neurotrophic depending on their relative concentrations. PAI-1 is a biomarker and mediator of poor outcomes in lung and pleural diseases [4,34] and we infer that elevated PAI-1 could likewise be a biomarker of depression (Figures 1 and 2).

While the fibrinolytic system plays a key role in the pathogenesis of renal [35,36], hepatic [37] and acute and chronic lung [4] injuries, this system may be of particular importance in the pathogenesis of depression in patients with lung disease. A recent study has shown that about one in four patients with chronic obstructive pulmonary disease (COPD) have persistent depressive symptoms which are associated with risk of COPD exacerbation and decreased exercise tolerance [38]. Additionally, patients with cystic fibrosis (CF) have been shown to have increased incidence of depression and anxiety [39]. The link between lung illness and depression is becoming better characterized by new research showing the influence of mood on other organ systems and vice versa. Inflammation induced epithelial-mesenchymal transition (EMT) in the lungs is associated with increased expression of epithelial PAI-1 and suppressed uPA and loss of lung function [40].

A process analogous to that which occurs in pulmonary remodeling may occur in the brain as a result of stress-induced inflammation. While fibrinogen, the precursor to fibrin, is not present at extravascular sites within the healthy brain it is elevated in the brains of individuals with schizophrenia [41], multiple sclerosis [42], Alzheimer's disease [43] and normal aging [44], all of which are disorders characterized by neuroinflammation and transient or long lasting BBB disruption [20]. These finding suggest that increased inflammation, decreased fibrinolysis and fibrosis may be involved in the pathogenesis of depression. Transitional fibrin deposition may perpetuate microglial activation, in addition to stress-induced, cytokine mediated microglial activation associated with decreased fibrinolysis, increased neuroinflammation, and depression. uPAR is involved in the recruitment of immune cells and cellular adhesion [45] and is a very sensitive marker of low grade inflammation typically seen in depression [12,13]. Further studies are necessary to characterize the roles of fibrin, tPA, uPA, uPAR, PAI-1 and neuroserpin in regulating stress, neural inflammation and mood (Figure 1 and 2).

In the CNS, tPA has been shown to exert effects that extend beyond traditional fibrinolysis and bridge to the regulation of neural cell functionality and behavior. For example, tPA has been demonstrated to influence synaptic plasticity though several mechanisms including degradation of the extracellular matrix through activation of matrix metalloproteases and interaction with the N-methyl-Daspartate (NMDA) receptor in addition to activation of proBDNF [46,47]. In the brain, tPA has been shown to have a role in memory, learning, and stress dependent behavioral responses [48]. In addition to its role in learning, tPA through NMDA receptor mediated activity, has been shown to be involved in the development of the fear response to acute stress through regulation of plasticity in the hippocampus [49]. While the administration of tPA itself for treatment of depression carries the risk of intracerebral bleeding and potentially neurotoxicity in the ischemic brain [50], the up-regulation of endogenous tPA activity is in principal an approach that could be pursued for the treatment of depression.

The literature also provides a link between the fibrinolytic system in the brain, BDNF and depression. BDNF is synthesized in cell bodies of neurons and glia and is transported to terminals where it is released [51]. It has been demonstrated to play a pivotal role in neurogenesis and depression. proBDNF and mBDNF have been shown to have opposite effects on neurogenesis and accordingly patients with major depression demonstrate elevated levels of proBDNF and decreased levels of mBDNF [52]. proBDNF induces dendritic retraction and apoptosis and long-term depression, while mBDNF promotes dendritic growth, cell survival, and long term potentiation indicating the importance of appropriate levels of functional tPA or perhaps uPA. A recent study demonstrated that an enriched environment increases tPA-dependent plasmin cleavage of proBDNF in mice [46]. Exercise has also been shown to increase mBDNF and tPA levels in humans which correlates with euthymia [53]. In rats, electro convulsive therapy, a rapid acting neuromodulatory treatment that is the gold standard treatment for resistant depression, has been shown to increase mBDNF and tPA levels [54], unlike imipramine, suggesting a novel tPA-mediated regulatory mechanism of action.

In the normal brain with no infiltrating microglia, PAI-1 is minimally expressed, and biochemical evidence showing strong inhibition of tPA suggests that the primary inhibitor of tPA is likely neuroserpin [55], particularly as overexpression of neuroserpin decreases activity levels of tPA [56]. Neuroserpin and tPA are expressed in neurons throughout the developing and adult nervous system [47]. Both overexpression and knockout of neuroserpin lead to increased anxiety like responses in mice, further supporting the role of the fibrinolytic system in regulating mood [57].

The literature suggests that tPA is a gliotransmitter mediating cross talk between neurons and astrocytes [58]. Astrocytes regulate the effective concentration of extracellular tPA and glutamate, influencing NMDA receptor signaling involved in regulation of mood. During chronic stress, excess hypothalamic-pituitary-adrenal (HPA) activation leads to activation ot microglia and impaired astrocyte reuptake of glutamate leading to excess extracellular NMDA receptor stimulation, neuro-inflammation and subsequent depression [59]. The disruption of the homeostatic balance of available extrasynaptic tPA, which is regulated by neuroserpin and astrocyte reuptake of glutamate, appears to be critical to cell survival and limitation of neuroinflammation.

uPA may be involved in the regulation of mood as well. Both tPA and uPA activate plasminogen to plasmin leading to degradation of extracellular matrix, which is critical to axonal and synaptic plasticity. Mice deficient in uPAR exhibit increased anxiety and reduced social behavior [60] and cognitive impairment [61], a finding that lends strength to our postulate that this receptor, through localization of uPA within brain cells, also contributes to regulation of cleavage of BDNF and alleviation of depressive symptoms. Notably, uPA-/ - mice have been demonstrated to exhibit a clear reduction in exploratory activity, an enhanced fear response to tone [62] and increased neuroinflammation [63].

Antidepressants, Ketamine and Psilocybin: Established and Hypothetical Effects on the Brain Fibrinolytic System and Depression

Selective serotonin reuptake inhibitors (SSRIs) such as fluoxetine, sertraline, and citalopram inhibit the serotonin transporter (SERT, SCC6A4), a plasma membrane integral glycoprotein found in neurons and platelets that regulates reuptake of serotonin across the plasma membrane. Inhibition of SERT leaves more serotonin available in the synaptic cleft to increase serotonergic neurotransmission, one of the putative mechanisms of SSRIs. SSRIs have been shown to have significant efficacy in severe depression [64]. However, these drugs exert various side effects such as akathisia, sexual dysfunction and weight gain that may lead to discontinuation [65]. Furthermore, SSRIs may take up to 3-4 weeks to take effect, during which time the medication may be discontinued prior to titration to the optimal dose.

Neural circuits involved in emotional processing and reward seeking have been demonstrated to be dysfunctional in major depressive disorder. Individuals with major depressive disorder have demonstrated decreased resting state functional connectivity (RSFC) among specific circuits in the affective network involved in emotional processing and increased RSFC among default mode network neural circuits involved in self referential processing [66]. These imaging studies suggest electrophysiologic circuits that could be interrogated to see if these areas are functionally altered by disruptions of fibrinolysis or transient fibrin deposition in the depressed brain (Figure 1 and 2). Interestingly, psilocybin and mindfulness meditation has been shown to decrease activity in the default mode network [15,67] which could be therapeutic in depression by decreasing rumination or negative self-referencing contributing to the stress response, neuroinflammation and decreased fibrinolysis associated with depression.

Depressive derangements of the hippocampus have also been associated with altered functionality of the fibrinolytic system in the brain (Figure 2). In rats, sertraline (Zoloft), a selective SSRI, has been shown to increase the expression of tPA in the hippocampus and reverse depressive behavioral change in rats exposed to five weeks of chronic unpredictable mild stress [68]. In the same study, sertraline increased BDNF levels in the prefrontal cortex and hippocampus.

There is a growing body of additional clinical evidence supporting the hypothesis that the activity of the fibrinolytic system is decreased in depression. A study of women with MDD on anti-depressant therapy showed elevated plasma PAI-1 associated with increased abdominal fat compared with controls [69]. Variants of the SERPINE1 gene that encodes PAI-1 have been demonstrated to predict response to SSRI's in adults with MDD [70] and in individuals with Alzheimer's disease (AD) and depression [71]. These findings indicate that AD and MDD may show overlapping pathophysiology regulated by derangements in fibrinolysis, potentially alleviated by psilocybin.

Blockade of serotonin uptake in platelets by SSRIs could decrease associated PAI-1 release and its subsequent activity in the blood and brain, in effect elevating Plasminogen Activator (PA) activity leading to higher plasmin levels with cleavage of proBDNF to mBDNF (Figures 2 and 3). Increased mBDNF promotes hippocampal neurogenesis and resolution of depressive symptoms associated with chronic stress induced hypersecretion of cortisol and adrenaline. Whether SSRIs regulate PAI-1 in the systemic circulation in patients receiving these drugs and how cardiovascular risk is affected with chronic use of these drugs is currently unclear.

Ketamine, an NMDA receptor antagonist and fast acting antidepressant has been shown to modulate the inflammation mediated kynurenine pathway with treatment response predicted by baseline levels of IL-6 [72]. To our knowledge, the effect of ketamine on PAI-1 expression within the brain has not been evaluated. Because PAI-1 can revert to an irreversibly latent form or can be cleaved with loss of inhibitory activity, the processing of PAI-1 in response to exposure to ketamine and other drugs and how it is processed in depression itself are issues that are germane to the better understanding of the pathogenesis of this condition. It is possible that by decreasing TNF-α and other pro-inflammatory cytokine activity, ketamine may indirectly affect PAI-1 levels, fibrin deposition, and increases of PA activity involved in hippocampal neurogenesis and the pathogenesis of depression.

Psilocybin binds with high affinity to the 5-HT_{1A}, 5-$HT_{2A/C}$, 5-HT_6 and 5-HT_7 subtypes of the serotonin receptors [73]. Psilocybin and other serotonergic classic psychedelics have been shown to exert their effects through agonism at the 5-HT_{2A} subtype of the serotonin receptor [74], which is associated not only with psilocybin's psychedelic effects, but also with vascular smooth muscle contraction, platelet aggregation, thrombus formation, and coronary artery spasm [75]. The psychedelic effects of psilocybin include perceptual changes, labile moods vacillating from joy to anxiety, and cognitive changes including sense of meaning, insight or ideas of reference. The mystical experience, as defined by Roland Griffiths at Johns Hopkins, induced by psilocybin, is defined by abstract traits such as transcendence of time/space, unitary being, sense of sacredness, and ineffability. Researchers at Johns Hopkins have demonstrated that these traits of psilocybin experiences can be quantified by questionnaires that assess the occurrence of the mystical experience after psilocybin administration, the presence of which can be correlated with enduring positive attitudes, mood and behavior after psilocybin administration [14].

Recent studies suggest that 5-HT_{2A} receptor modulation may have therapeutic potential in treating depression. Downregulation of 5-HT_{2A} receptors, which may occur in response to 5-HT_{2A} receptor stimulation, mediates antidepressant and antianxiety effects of antidepressants and atypical antipsychotic drugs [76]. Studies have shown that cortical 5-HT_{2A} receptor expression is increased in postmortem samples of depressed and suicidal patients [77, 78]. It is possible that the region-specific up regulation of 5-HT_{2A} receptors associated with mood disorders and borderline personality disorder [79] may occur in response to stress related decreases in serotonin transmission, and that these receptors may subsequently be regulated to salutary levels in response to increased 5-HT_{2A} stimulation associated with psychedelic use.

It appears that the 5-HT_{2A} receptor upregulation is linked to the response to inflammation and fibrinolysis as well. C57BL/6J mice have varying degrees of psychological resiliency when exposed to chronic stress, with some mice manifesting behavioral symptoms of depression such as floating in the forced swim test and hyperactivity under stressful lighting conditions. Mice that manifest depressive symptoms demonstrate elevated TNF-α and SERT in the pre-frontal area, while all chronically stressed animals, resilient or susceptible, showed enhanced expression of 5-HT_{2A} and Cox-1 in the pre-frontal area. The study suggests a unique, direct correlation between TNF-α levels, neuroinflammation and expression of 5-HT_{2A} receptors. Previous studies in rabbits demonstrated that 5-HT_{2A} agonists such as LSD can significantly reduce cortical 5-HT_{2A} expression by 33-66% within days [80]. Of note, it has already been established that TNF-α and PAI-1 levels are directly correlated, suggesting that psilocybin could restore the 5-HT_{2A} receptor to pre-stress levels with concomitant and potentially critical salutary downregulation of PAI-1 or perhaps neuroserpin.

R-DOI, a potent psychedelic and 5-HT_{2A} agonist has been demonstrated to have potent anti-inflammatory effects. R-DOI is noteworthy for its specificity to the 5-HT_{2A} receptor which differentiates it from psilocybin. Studies show that R-DOI can block progression of a mouse model of asthma [81], possibly via blockade of TNF-α signaling, which could lead to reduction in PAI-1 levels and alleviation of depressive symptoms. There is also evidence that demonstrates that the microglial 5-HT_{2A} receptor may regulate the release of microglial vesicles called exosomes that may contain cytokines involved in neuroinflammation and growth factors involved in neurogenesis [82]. It is plausible that 5-HT_{2A} agonism may regulate the stress response at the level of the microglia via regulation of exosomal cytokines and growth factors necessary for neuronal growth and survival.

Emerging evidence supports the idea that psilocybin may exert effects through the limbic system including the hippocampus and amygdala that are involved in emotional processing. Psilocybin has been shown to normalize limbic hyperactivity in individuals with depressed mood by attenuating amygdala hyperactivity and increasing positive affect [83]. In mice, low dose psilocybin has been demonstrated to rapidly extinguish cued fear conditioning and induce a slight non-significant trend toward increased hippocampal neurogenesis, suggesting a potential role in the treatment of Post-Traumatic Stress Disorder (PTSD) [84] and possibly depression. Psilocybin has also been shown to be well-tolerated in humans in a controlled setting with proper supervision, screening and preparation [14] and may lead to increases in the personality domain of openness in healthy adults [85]. Small pilot studies in humans have shown efficacy of psilocybin in the treatment of anxiety in advanced stage cancer [86], as well as tobacco [87] and alcohol addiction [88]. Analysis of data from the National Survey of Drug Use and Health pooled across 2008-2012 by Hendricks *et al*. [89] demonstrated that psilocybin may be protective in patients with psychological distress and suicidality. Recently, a clinical study has demonstrated that psilocybin may reduce high sensitivity to social rejection that is characteristic of depression, suggesting that this drug is useful in reducing predisposing factors to depression [90]. Another small recent pilot study suggests that psilocybin administration with psychological support is a safe, efficacious treatment for refractory depression [91].

The role of ketamine and psilocybin in the regulation of the fibrinolytic system in the brain has not yet to our knowledge been studied. However, previous studies of the 5-HT$_{2A}$ receptor suggest a possible therapeutic role for psilocybin in depression involving the fibrinolytic system. Hypertrophic adipocytes have been shown to upregulate expression of the 5-HT$_{2A}$ receptor and PAI-1, while suppression of 5-HT$_{2A}$ gene expression enhances adiponectin expression, which is involved in regulation of glucose levels as well as fatty acid breakdown and is normally downregulated in obesity [92]. This finding demonstrates that downregulation of the 5-HT$_{2A}$ receptor by psilocybin could be associated with reduced PAI-1 expression and potentially help with weight loss and depression simultaneously. PAI-1 is deleteriously up-regulated in both conditions. Whether 5-HT$_{2A}$ receptor modulation and PAI-1 upregulation predispose to depression through interactions with components of the fibrinolytic system remains to be determined.

The role of psilocybin in the treatment of depression remains to be delineated. However, we posit that its administration is beneficial in reducing neuroinflammation, and restoring the fibrinolytic system to baseline, a postulate that can be tested in wild type mice with depressive behavior. If we are correct that effective therapy for depression is unified around a restoration of tPA leading to plasmin mediated activation of BDNF, preservation of neurogenesis and synaptic plasticity and that psilocybin reverses downregulation of tPA activity, the postulate can be confirmed. Additionally, the importance of changes in key components of the fibrinolytic system; tPA, uPA, uPAR or PAI-1 to depressive phenotype can be tested in knockout mice or in animals deficient in plasminogen and exposed to depressive stimuli. Transgenic mice that have upregulation of PAI-1 are also available to determine how its overexpression affects depressive symptoms.

Through *in vitro* studies with astrocytes involving the assessment of the effect of inflammatory cytokines such as TGF-β and TNF-α on the fibrinolytic system, we can assess the potential of psilocybin to alleviate pro-inflammatory, anti-fibrinolytic changes induced in glial cells. Clinically, we are assessing the role of mindfulness meditation on inflammatory and fibrinolytic biomarkers in depression. These studies may add support to pursuing further clinical trials using psilocybin for treatment resistant depression.

In conclusion, the preponderance of literature suggests that the pathogenesis of depression involves dysregulation of the fibrinolytic system and that antidepressants in common use and treatment candidates could be involved in their regulation. We specifically hypothesize that the fibrinolytic system exerts potentially critical effects in the pathogenesis of depression and that psychedelics such as psilocybin may regulate the fibrinolytic system in a salutary manner. We further posit that the therapeutic effects of psilocybin and perhaps commonly used antidepressants act as anti-inflammatory, profibrinolytic treatments that reduces neuroinflammation engendered by chronic stress. Increased inflammation through TNF-α and likely other proinflammatory mediators expressed in the brain is associated with elevated PAI-1 levels, increased 5-HT$_{2A}$ cortical expression, and decreased tPA activity in the CNS. These alterations disrupt synaptic plasticity in structures that mediate functional brain circuits involved in mood. We hypothesize that psilocybin exerts an antidepressant effect by reducing PAI-1 levels, decreases neuro-inflammation and fibrin deposition in the brain and restores the 5-HT$_{2A}$ receptor to pre-stress levels leading to normalized serotonergic tone associated with euthymic mood. Psychedelics have been historically stigmatized, and are currently schedule 1 substances in the U.S. making initiation of new research into the treatment of resistant depression with psilocybin a challenging endeavor. Despite these challenges, we believe that it is imperative to leave no stone unturned when alleviation of chronic suffering from depression is a potential outcome.

References

1. Major Depression Among Adults n.d. http://www.nimh.nih.gov/health/statistics/prevalence/majordepression-among-adults.shtml (accessed October 21, 2015).
2. Rush AJ, Trivedi MH, Wisniewski SR, Nierenberg AA, Stewart JW, Warden D, *et al*. Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report. Am J Psychiatry 2006;163:1905-17. doi:10.1176/appi.ajp.163.11.1905.
3. Wang N, Yu H-Y, Shen X-F, Gao Z-Q, Yang C, Yang J-J, *et al*. The rapid antidepressant effect of ketamine in rats is associated with down-regulation of pro-inflammatory cytokines in the hippocampus. Ups J Med Sci 2015;120:241-8. doi:10.3109/03009734.2015.1060281.
4. Tucker T, Idell S. Plasminogen-Plasmin System in the Pathogenesis and Treatment of Lung and Pleural Injury. Semin Thromb Hemost 2013;39:373-81. doi:10.1055/s-0033-1334486.
5. ªalaru DL, Mertens PR, Bartsch P. Loss of heparin-binding protein prevents necrotizing glomerulonephritis: first clues hint at plasminogen activator inhibitor-1. Int Urol Nephrol 2013;45:1483-7. doi:10.1007/s11255-013-0415-1.
6. Tofler GH, Massaro J, O'Donnell CJ, Wilson PWF, Vasan RS, Sutherland PA, *et al*. Plasminogen activator inhibitor and the risk of cardiovascular disease: The Framingham Heart Study. Thromb Res 2016;140:30-5. doi:10.1016/j.thromres.2016.02.002.
7. Garfield LD, Scherrer JF, Hauptman PJ, Freedland KE, Chrusciel T, Balasubramanian S, *et al*. Association of anxiety disorders and depression with incident heart failure. Psychosom Med 2014;76:128-36. doi:10.1097/PSY.0000000000000027.
8. Tsai S-J. The possible role of tissue-type plasminogen activator and the plasminogen system in the pathogenesis of major depression. Med Hypotheses 2006;66:319-22. doi:10.1016/j.mehy.2005.10.009.
9. Tsai S-J. The P11, tPA/plasminogen system and brain-derived neurotrophic factor: Implications for the pathogenesis of major depression and the therapeutic mechanism of antidepressants. Med Hypotheses 2007;68:180-3. doi:10.1016/j.mehy.2006.06.005.
10. Tsai S-J. Statins may enhance the proteolytic cleavage of proBDNF: implications for the treatment of depression. Med Hypotheses 2007;68:1296-9. doi:10.1016/j.mehy.2006.09.043.
11. Amadio P, Colombo GI, Tarantino E, Gianellini S, Ieraci A, Brioschi M, *et al*. BDNFVal66met polymorphism: a potential bridge between depression and thrombosis. Eur Heart J 2015. doi:10.1093/eurheartj/ehv655.
12. Haastrup E, Grau K, Eugen-Olsen J, Thorball C, Kessing LV, Ullum H. Soluble urokinase plasminogen activator receptor as a marker for use of antidepressants. PloS One 2014;9:e110555. doi:10.1371/journal.pone.0110555.
13. Ventorp F, Gustafsson A, Träskman-Bendz L, Westrin Å, Ljunggren L. Increased Soluble Urokinase-Type Plasminogen Activator Receptor (suPAR) Levels in Plasma of Suicide Attempters. PLoS ONE 2015;10:e0140052. doi:10.1371/journal.pone.0140052.
14. Griffiths RR, Johnson MW, Richards WA, Richards BD, McCann U, Jesse R. Psilocybin occasioned mysticaltype experiences: immediate and persisting dose-related effects. Psychopharmacology (Berl) 2011;218:649-65. doi:10.1007/s00213-011-2358-5.
15. Carhart-Harris RL, Erritzoe D, Williams T, Stone JM, Reed LJ, Colasanti A, *et al*. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. Proc Natl Acad Sci U S A 2012;109:2138-43. doi:10.1073/pnas.1119598109.
16. Oquendo MA, Sullivan GM, Sudol K, Baca-Garcia E, Stanley BH, Sublette ME, *et al*. Toward a Biosignature for Suicide. Am J Psychiatry 2014;171:1259-77. doi:10.1176/appi.ajp.2014.14020194.
17. Dowlati Y, Herrmann N, Swardfager W, Liu H, Sham L, Reim EK, *et al*. A meta-analysis of cytokines in major depression. Biol Psychiatry 2010;67:446-57. doi:10.1016/j.biopsych.2009.09.033.
18. Rethorst CD, Toups MS, Greer TL, Nakonezny PA, Carmody TJ, Grannemann BD, *et al*. Pro-Inflammatory Cytokines as Predictors of Antidepressant Effects of Exercise in Major Depressive Disorder. Mol Psychiatry 2013;18:1119-24. doi:10.1038/mp.2012.125.
19. Chesnokova V, Pechnick RN, Wawrowsky K. Chronic peripheral inflammation, hippocampal neurogenesis, and behavior. Brain Behav Immun n.d. doi:10.1016/j.bbi.2016.01.017.
20. Bardehle S, Rafalski VA, Akassoglou K. Breaking boundaries - coagulation and fibrinolysis at the neurovascular interface. Front Cell Neurosci 2015:354. doi:10.3389/fncel.2015.00354.
21. Beatriz Currier M, B. Nemeroff C. Inflammation and Mood Disorders: Proinflammatory Cytokines and the Pathogenesis of Depression. Anti-Inflamm Anti-Allergy Agents Med Chem Former Cu 2010;9:212-20.
22. Zonis S, Pechnick RN, Ljubimov VA, Mahgerefteh M, Wawrowsky K, Michelsen KS, *et al*. Chronic intestinal inflammation alters hippocampal neurogenesis. J Neuroinflammation 2015;12:65. doi:10.1186/s12974-015-0281-0.
23. Cameron HA, Glover LR. Adult Neurogenesis: Beyond Learning and Memory. Annu Rev Psychol 2015;66:53-81. doi:10.1146/annurev-psych-010814-015006.
24. Kiecolt-Glaser JK, Derry HM, Fagundes CP. Inflammation: Depression Fans the Flames and Feasts on the Heat. Am J Psychiatry 2015:appiajp201515020152. doi:10.1176/appi.ajp.2015.15020152.
25. Idell S. The pathogenesis of pleural space loculation and fibrosis. Curr Opin Pulm Med 2008;14:310-5. doi:10.1097/MCP.0b013e3282fd0d9b.
26. Bhandary YP, Shetty SK, Marudamuthu AS, Gyetko MR, Idell S, Gharaee-Kermani M, *et al*. Regulation of alveolar epithelial cell apoptosis and pulmonary fibrosis by coordinate expression of components of the fibrinolytic system. Am J Physiol - Lung Cell Mol Physiol 2012;302:L463-73. doi:10.1152/ajplung.00099.2011.
27. Bhandary YP, Shetty SK, Marudamuthu AS, Ji H-L, Neuenschwander PF, Boggaram V, *et al*. Regulation of lung injury and fibrosis by p53-mediated changes in urokinase and plasminogen activator inhibitor-1. Am J Pathol 2013;183:131-43. doi:10.1016/j.ajpath.2013.03.022.
28. Davalos D, Akassoglou K. Fibrinogen as a key regulator of inflammation in disease. Semin Immunopathol 2012;34:43-62.

doi:10.1007/s00281-011-0290-8.
29. Nieuwenhuizen W, Voskuilen M, Vermond A, Hoegee-de Nobel B, Traas DW. The influence of fibrin(ogen) fragments on the kinetic parameters of the tissue-type plasminogen-activator-mediated activation of different forms of plasminogen. Eur J Biochem FEBS 1988;174:163-9.
30. Hoylaerts M, Rijken DC, Lijnen HR, Collen D. Kinetics of the activation of plasminogen by human tissue plasminogen activator. Role of fibrin. J Biol Chem 1982;257:2912-9.
31. Collen D. The plasminogen (fibrinolytic) system. Thromb Haemost 1999;82:259-70.
32. Park Y-J, Liu G, Lorne EF, Zhao X, Wang J, Tsuruta Y, *et al*. PAI-1 inhibits neutrophil efferocytosis. Proc Natl Acad Sci U S A 2008;105:11784-9. doi:10.1073/pnas.0801394105.
33. Soeda S, Koyanagi S, Kuramoto Y, Kimura M, Oda M, Kozako T, *et al*. Anti-apoptotic roles of plasminogen activator inhibitor-1 as a neurotrophic factor in the central nervous system. Thromb Haemost 2008;100:1014-20.
34. Prabhakaran P, Ware LB, White KE, Cross MT, Matthay MA, Olman MA. Elevated levels of plasminogen activator inhibitor-1 in pulmonary edema fluid are associated with mortality in acute lung injury. Am J Physiol Lung Cell Mol Physiol 2003;285:L20-28. doi:10.1152/ajplung.00312.2002.
35. Huang Y, Noble NA. PAI-1 as a target in kidney disease. Curr Drug Targets 2007;8:1007-15.
36. Pinheiro MB, Gomes KB, Dusse LMS. Fibrinolytic system in preeclampsia. Clin Chim Acta Int J Clin Chem 2013;416:67-71. doi:10.1016/j.cca.2012.10.060.
37. Leebeek FWG, Rijken DC. The Fibrinolytic Status in Liver Diseases. Semin Thromb Hemost 2015;41:474-80. doi:10.1055/s-0035-1550437.
38. Yohannes AM, Müllerová H, Hanania NA, Lavoie K, Tal-Singer R, Vestbo J, *et al*. Long-term Course of Depression Trajectories in Patients With COPD: A 3-Year Follow-up Analysis of the Evaluation of COPD Longitudinally to Identify Predictive Surrogate Endpoints Cohort. Chest 2016;149:916-26. doi:10.1016/j.chest.2015.10.081.
39. Quittner AL, Goldbeck L, Abbott J, Duff A, Lambrecht P, Solé A, *et al*. Prevalence of depression and anxiety in patients with cystic fibrosis and parent caregivers: results of The International Depression Epidemiological Study across nine countries. Thorax 2014;69:1090-7. doi:10.1136/thoraxjnl-2014-205983.
40. [40] Kim KK, Kugler MC, Wolters PJ, Robillard L, Galvez MG, Brumwell AN, *et al*. Alveolar epithelial cell mesenchymal transition develops in vivo during pulmonary fibrosis and is regulated by the extracellular matrix. Proc Natl Acad Sci 2006;103:13180-5. doi:10.1073/pnas.0605669103.
41. Körschenhausen DA, Hampel HJ, Ackenheil M, Penning R, Müller N. Fibrin degradation products in post mortem brain tissue of schizophrenics: a possible marker for underlying inflammatory processes. Schizophr Res 1996;19:103-9.
42. Marik C, Felts PA, Bauer J, Lassmann H, Smith KJ. Lesion genesis in a subset of patients with multiple sclerosis: a role for innate immunity? Brain J Neurol 2007;130:2800-15. doi:10.1093/brain/awm236.
43. Cortes-Canteli M, Mattei L, Richards AT, Norris EH, Strickland S. Fibrin deposited in the Alzheimer's disease brain promotes neuronal degeneration. Neurobiol Aging 2015;36:608-17. doi:10.1016/j.neurobiolaging.2014.10.030.
44. Viggars AP, Wharton SB, Simpson JE, Matthews FE, Brayne C, Savva GM, *et al*. Alterations in the blood brain barrier in ageing cerebral cortex in relationship to Alzheimer-type pathology: a study in the MRC-CFAS population neuropathology cohort. Neurosci Lett 2011;505:25-30. doi:10.1016/j.neulet.2011.09.049.
45. Rijneveld AW, Levi M, Florquin S, Speelman P, Carmeliet P, Poll T van der. Urokinase Receptor Is Necessary for Adequate Host Defense Against Pneumococcal Pneumonia. J Immunol 2002;168:3507-11. doi:10.4049/jimmunol.168.7.3507.
46. Obiang P, Maubert E, Bardou I, Nicole O, Launay S, Bezin L, *et al*. Enriched housing reverses age-associated impairment of cognitive functions and tPA-dependent maturation of BDNF. Neurobiol Learn Mem 2011;96:121-9. doi:10.1016/j.nlm.2011.03.004.
47. Lee TW, Tsang VWK, Birch NP. Physiological and pathological roles of tissue plasminogen activator and its inhibitor neuroserpin in the nervous system. Front Cell Neurosci 2015:396. doi:10.3389/fncel.2015.00396.
48. Revest J-M, Le Roux A, Roullot-Lacarrière V, Kaouane N, Vallée M, Kasanetz F, *et al*. BDNF-TrkB signaling through Erk1/2 MAPK phosphorylation mediates the enhancement of fear memory induced by glucocorticoids. Mol Psychiatry 2014;19:1001-9. doi:10.1038/mp.2013.134.
49. Norris EH, Strickland S. Modulation of NR2B-regulated contextual fear in the hippocampus by the tissue plasminogen activator system. Proc Natl Acad Sci U S A 2007;104:13473-8. doi:10.1073/pnas.0705848104.
50. Fan M, Xu H, Wang L, Luo H, Zhu X, Cai P, *et al*. Tissue Plasminogen Activator Neurotoxicity is Neutralized by Recombinant ADAMTS 13. Sci Rep 2016;6:25971. doi:10.1038/srep25971.
51. Leßmann V, Brigadski T. Mechanisms, locations, and kinetics of synaptic BDNF secretion: An update. Neurosci Res 2009;65:11-22. doi:10.1016/j.neures.2009.06.004.
52. Zhou L, Xiong J, Lim Y, Ruan Y, Huang C, Zhu Y, *et al*. Upregulation of blood proBDNF and its receptors in major depression. J Affect Disord 2013;150:776-84. doi:10.1016/j.jad.2013.03.002.
53. Sartori CR, Vieira AS, Ferrari EM, Langone F, Tongiorgi E, Parada CA. The antidepressive effect of the physical exercise correlates with increased levels of mature BDNF, and proBDNF proteolytic cleavagerelated genes, p11 and tPA. Neuroscience 2011;180:9-18. doi:10.1016/j.neuroscience.2011.02.055.
54. Segawa M, Morinobu S, Matsumoto T, Fuchikami M, Yamawaki S. Electroconvulsive seizure, but not imipramine, rapidly up-regulates pro-BDNF and t-PA, leading to mature BDNF production, in the rat hippocampus. Int J Neuropsychopharmacol 2013;16:339-50. doi:10.1017/S1461145712000053.
55. Osterwalder T, Cinelli P, Baici A, Pennella A, Krueger SR, Schrimpf SP, *et al*. The axonally secreted serine proteinase inhibitor, neuroserpin, inhibits plasminogen activators and plasmin but not thrombin. J Biol Chem 1998;273:2312-21.
56. Cinelli P, Madani R, Tsuzuki N, Vallet P, Arras M, Zhao CN, *et al*. Neuroserpin, a neuroprotective factor in focal ischemic stroke. Mol Cell Neurosci 2001;18:443-57. doi:10.1006/mcne.2001.1028.
57. Madani R, Kozlov S, Akhmedov A, Cinelli P, Kinter J, Lipp H-P, *et al*. Impaired explorative behavior and neophobia in genetically modified mice lacking or overexpressing the extracellular serine protease inhibitor neuroserpin. Mol Cell Neurosci 2003;23:473-94.

58. Cassé F, Bardou I, Danglot L, Briens A, Montagne A, Parcq J, *et al*. Glutamate Controls tPA Recycling by Astrocytes, Which in Turn Influences Glutamatergic Signals. J Neurosci 2012;32:5186-99. doi:10.1523/JNEUROSCI.5296-11.2012.
59. Kim Y-K, Na K-S. Role of glutamate receptors and glial cells in the pathophysiology of treatment-resistant depression. Prog Neuropsychopharmacol Biol Psychiatry 2016. doi:10.1016/j.pnpbp.2016.03.009.
60. Powell EM, Campbell DB, Stanwood GD, Davis C, Noebels JL, Levitt P. Genetic disruption of cortical interneuron development causes region- and GABA cell type-specific deficits, epilepsy, and behavioral dysfunction. J Neurosci Off J Soc Neurosci 2003;23:622-31.
61. Bissonette GB, Bae MH, Suresh T, Jaffe DE, Powell EM. Prefrontal cognitive deficits in mice with altered cerebral cortical GABAergic interneurons. Behav Brain Res 2014;259:143-51. doi:10.1016/j.bbr.2013.10.051.
62. Rantala J, Kemppainen S, Ndode-Ekane XE, Lahtinen L, Bolkvadze T, Gurevicius K, *et al*. Urokinase-type plasminogen activator deficiency has little effect on seizure susceptibility and acquired epilepsy phenotype but reduces spontaneous exploration in mice. Epilepsy Behav EB 2015;42:117-28. doi:10.1016/j.yebeh.2014.11.001.
63. Gur-Wahnon D, Mizrachi T, Maaravi-Pinto F-Y, Lourbopoulos A, Grigoriadis N, Higazi A-AR, *et al*. The plasminogen activator system: involvement in central nervous system inflammation and a potential site for therapeutic intervention. J Neuroinflammation 2013;10:124. doi:10.1186/1742-2094-10-124.
64. Fournier JC, DeRubeis RJ, Hollon SD, Dimidjian S, Amsterdam JD, Shelton RC, *et al*. Antidepressant drug effects and depression severity: a patient-level meta-analysis. JAMA 2010;303:47-53. doi:10.1001/jama.2009.1943.
65. Murphy TK, Segarra A, Storch EA, Goodman WK. SSRI adverse events: how to monitor and manage. Int Rev Psychiatry Abingdon Engl 2008;20:203-8. doi:10.1080/09540260801889211.
66. Kim SM, Park SY, Kim YI, Son YD, Chung U-S, Min KJ, *et al*. Affective network and default mode network in depressive adolescents with disruptive behaviors. Neuropsychiatr Dis Treat 2015;12:49-56. doi:10.2147/NDT.S95541.
67. Berkovich-Ohana A, Glicksohn J, Goldstein A. Studying the default mode and its mindfulness-induced changes using EEG functional connectivity. Soc Cogn Affect Neurosci 2014;9:1616-24. doi:10.1093/scan/nst153.
68. Tang M, Jiang P, Li H, Cai H, Liu Y, Gong H, *et al*. Antidepressant-like effect of n-3 PUFAs in CUMS rats: role of tPA/PAI-1 system. Physiol Behav 2015;139:210-5. doi:10.1016/j.physbeh.2014.11.054.
69. Eskandari F, Mistry S, Martinez PE, Torvik S, Kotila C, Sebring N, *et al*. Younger, premenopausal women with major depressive disorder have more abdominal fat and increased serum levels of prothrombotic factors: implications for greater cardiovascular risk: The POWER Study. Metabolism 2005;54:918-24. doi:10.1016/j.metabol.2005.02.006.
70. Tsai S-J, Hong C-J, Liou Y-J, Yu YW-Y, Chen T-J. Plasminogen activator inhibitor-1 gene is associated with major depression and antidepressant treatment response. Pharmacogenet Genomics 2008;18:869-75. doi:10.1097/FPC.0b013e328308bbc0.
71. Fang Y, Zhang L, Zeng Z, Lian Y, Jia Y, Zhu H, *et al*. Promoter polymorphisms of SERPINE1 are associated with the antidepressant response to depression in Alzheimer's disease. Neurosci Lett 2012;516:217-20. doi:10.1016/j.neulet.2012.03.090.
72. Yang J-J, Wang N, Yang C, Shi J-Y, Yu H-Y, Hashimoto K. Serum interleukin-6 is a predictive biomarker for ketamine's antidepressant effect in treatment-resistant patients with major depression. Biol Psychiatry 2015;77:e19-20. doi:10.1016/j.biopsych.2014.06.021.
73. Nichols DE. Psychedelics. Pharmacol Rev 2016;68:264-355. doi:10.1124/pr.115.011478.
74. Vollenweider FX, Kometer M. The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. Nat Rev Neurosci 2010;11:642-51. doi:10.1038/nrn2884.
75. Nagatomo T, Rashid M, Abul Muntasir H, Komiyama T. Functions of 5-HT$_{2A}$ receptor and its antagonists in the cardiovascular system. Pharmacol Ther 2004;104:59-81. doi:10.1016/j.pharmthera.2004.08.005.
76. Van Oekelen D, Luyten WHML, Leysen JE. 5-HT$_{2A}$ and 5-HT$_{2C}$ receptors and their atypical regulation properties. Life Sci 2003;72:2429-49.
77. Shelton RC, Sanders-Bush E, Manier DH, Lewis DA. Elevated 5-HT 2A receptors in postmortem prefrontal cortex in major depression is associated with reduced activity of protein kinase A. Neuroscience 2009;158:1406-15. doi:10.1016/j.neuroscience.2008.11.036.
78. Pandey GN, Dwivedi Y, Rizavi HS, Ren X, Pandey SC, Pesold C, *et al*. Higher Expression of Serotonin 5-HT$_{2A}$ Receptors in the Postmortem Brains of Teenage Suicide Victims. Am J Psychiatry 2002;159:419-29. doi:10.1176/appi.ajp.159.3.419.
79. Soloff PH, Price JC, Meltzer CC, Fabio A, Frank GK, Kaye WH. 5-HT$_{2A}$ Receptor Binding is Increased in Borderline Personality Disorder. Biol Psychiatry 2007;62:580-7. doi:10.1016/j.biopsych.2006.10.022.
80. Harvey JA, Quinn JL, Liu R, Aloyo VJ, Romano AG. Selective remodeling of rabbit frontal cortex: relationship between 5-HT$_{2A}$ receptor density and associative learning. Psychopharmacology (Berl) 2004;172:435-42. doi:10.1007/s00213-003-1687-4.
81. Nau F, Miller J, Saravia J, Ahlert T, Yu B, Happel KI, *et al*. Serotonin 5-HT$_2$ receptor activation prevents allergic asthma in a mouse model. Am J Physiol - Lung Cell Mol Physiol 2015;308:L191-8. doi:10.1152/ajplung.00138.2013.
82. Glebov K, Löchner M, Jabs R, Lau T, Merkel O, Schloss P, *et al*. Serotonin stimulates secretion of exosomes from microglia cells. Glia 2015;63:626-34. doi:10.1002/glia.22772.
83. Kraehenmann R, Preller KH, Scheidegger M, Pokorny T, Bosch OG, Seifritz E, *et al*. Psilocybin-Induced Decrease in Amygdala Reactivity Correlates with Enhanced Positive Mood in Healthy Volunteers. Biol Psychiatry n.d. doi:10.1016/j.biopsych.2014.04.010.
84. Catlow BJ, Song S, Paredes DA, Kirstein CL, Sanchez-Ramos J. Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning. Exp Brain Res 2013;228:481-91. doi:10.1007/s00221-013-3579-0.
85. MacLean KA, Johnson MW, Griffiths RR. Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. J Psychopharmacol Oxf Engl 2011;25:1453-61. doi:10.1177/0269881111420188.
86. Grob CS, Danforth AL, Chopra GS, *et al*. Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch Gen Psychiatry 2011;68:71-8. doi:10.1001/archgenpsychiatry.2010.116.
87. Johnson MW, Garcia-Romeu A, Cosimano MP, Griffiths RR. Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. J Psychopharmacol (Oxf) 2014:269881114548296. doi:10.1177/0269881114548296.
88. Bogenschutz MP. Studying the effects of classic hallucinogens in the treatment of alcoholism: rationale, methodology, and

current research with psilocybin. Curr Drug Abuse Rev 2013;6:17-29.

89. Hendricks PS, Johnson MW, Griffiths RR. Psilocybin, psychological distress, and suicidality. J Psychopharmacol (Oxf) 2015;29:1041-3. doi:10.1177/0269881115598338.
90. Preller KH, Pokorny T, Hock A, Kraehenmann R, Stämpfli P, Seifritz E, *et al*. Effects of serotonin 2A/1A receptor stimulation on social exclusion processing. Proc Natl Acad Sci U S A 2016. doi:10.1073/pnas.1524187113.
91. Carhart-Harris RL, Bolstridge M, Rucker J, Day CMJ, Erritzoe D, Kaelen M, *et al*. Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. Lancet Psychiatry 2016. doi:10.1016/S2215-0366(16)30065-7.
92. Uchida-Kitajima S, Yamauchi T, Takashina Y, Okada-Iwabu M, Iwabu M, Ueki K, *et al*. 5-Hydroxytryptamine 2A receptor signaling cascade modulates adiponectin and plasminogen activator inhibitor 1 expression in adipose tissue. FEBS Lett 2008;582:3037-44. doi:10.1016/j.febslet.2008.07.044.

From many to one: Meditation and the plasticity of the predictive mind

by

Ruben E. Laukkonen & Heleen A. Slagter

Vrije Universiteit Amsterdam
University of Amsterdam

original report: https://psyarxiv.com/5sw6m/download

Corresponding author: Ruben E. Laukkonen
Email: r.e.laukkonen@vu.nl

Table of Contents:

- **Abstract**
- **1. Introduction**
- **2. Predictive Processing**
  - 2.1 A hierarchy of expectations
  - 2.2 Perceptual and active inference
  - 2.3 Attention
  - 2.4 The inferred hierarchical self
  - 2.5 Fact free learning and insight
- **3. Meditation**
  - 3.1 Focused attention
  - 3.2 Open monitoring
  - 3.3 Non-dual
- **4. A Unifying Framework: The Many-to-One Model**
  - 4.1 Predictive processing & meditation: A nascent field
- **5. Previous research under a new light**
  - 5.1 Experimental Research
  - 5.2 (Neuro)Phenomenological Research
  - 5.3 Dissolving or disappearing: Psychedelics and meditation
- **6. Discussion**
  - 6.1 From Many to One: Novel insights from a unifying framework
    - *6.1.1 The scientific value of meditation: Plasticity*
    - *6.1.2 The scientific value of meditation: Psychopathology*
    - *6.1.3 The scientific value of meditation: Rumination*
    - *6.1.4 The scientific value of meditation: Self*
    - *6.1.5 The scientific value of meditation: Summary*
    - *6.1.6 Insights for contemplative science: From state to trait*
    - *6.1.7 Insights for contemplative science: Establishing expertise*
    - *6.1.8 Insights for contemplative science: Challenging experiences*
  - 6.2 Methodological considerations
  - 6.3 Conclusion
  - Acknowledgements
  - Footnotes
- **7. References**

Abstract

How profoundly can humans change their own minds? In this paper we offer a unifying account of meditation under the predictive processing view of living organisms. We start from relatively simple axioms. First, the brain is an organ that serves to predict based on past experience, both phylogenetic and ontogenetic. Second, meditation serves to bring one closer to the here and now by disengaging from anticipatory processes. We propose that practicing meditation therefore gradually reduces predictive processing, in particular counterfactual cognition - the tendency to construct abstract and temporally deep representations - until all conceptual processing falls away. Our *Many-to-One* account also places three main styles of meditation (focused attention, open monitoring, and non-dual meditation) on a single continuum, where each technique progressively relinquishes increasingly engrained habits of prediction, including the self. This deconstruction can also make the above processes available to introspection, permitting certain insights into one's mind. Our review suggests that our framework is consistent with the current state of empirical and (neuro)phenomenological evidence in contemplative science, and is ultimately illuminating about the plasticity of the predictive mind. It also serves to highlight that contemplative science can fruitfully go beyond cognitive enhancement, attention, and emotion regulation, to its more traditional goal of removing past conditioning and creating conditions for potentially profound insights. Experimental rigor, neurophenomenology, and no-report paradigms combined with neuroimaging are needed to further our understanding of how different styles of meditation affect predictive processing and the self, and the plasticity of the predictive mind more generally.

1. Introduction

We typically experience ourselves as if in an objective world in which time, space, and self are fixed properties. However, severe psychopathology, brain trauma, psychoactive compounds, and virtual reality environments demonstrate that the way the brain constructs experiences is not set in stone. In certain circumstances, it is possible to lose control of one's body, to forget one's own name, to perceive something that is not there, and to believe one's mind is being controlled by an external force. Our sense of self is also subject to change. It is possible to dissociate, to experience depersonalization, and even to believe that one is already dead. Transformations of experience can be externally induced, but they can also be generated from within.

One way that experience can change from within is through intensive mental training, as cultivated by meditation. Thousands of meditation practitioners going back at least three millennia have reported accessing states far outside the ordinary mind. Meditators, even in laboratory settings corroborated by neural activity (Dor-Ziderman *et al*., 2016), report that aspects of experience that we often take to be stable and unchanging, such as time, space, and self, can in fact be modulated. Moreover, according to many of these meditation traditions attaining such changes in experience are desirable and permit one to lead a happier and more compassionate life. Mindfulness meditation-based interventions are now a conventional treatment for mental health in some countries (Rycroft-Malone *et al*., 2017) and downloads of mindfulness apps are well into the tens of millions. The scientific study of meditation is also growing exponentially (Van Dam *et al*., 2018). But as yet, there does not exist a unifying account of how meditation generates its manifold empirical and phenomenological effects. The lack of a general theory of meditation may be partly owing to a lack of a unifying scientific account of the mind, brain, and behavior, which has been missing until relatively recently.

Beginning with the simple axiom that an organism must resist entropy and the dissolution of its boundaries, Karl Friston's Free Energy Principle (2010) and predictive processing more broadly, is gaining scientific traction as an all-encompassing account of living organisms. It recharacterizes organisms as fundamentally anticipatory - as continuously inferring or predicting the outside world based on prior experience. This framework supposes to explain everything from the behavior and computations of unicellular organisms to the complex cognitive and emotional inner landscapes of homo sapiens through one and the same mechanism: free energy minimization. Due to the fact that the brain lacks direct access to the external world, it must 'guess' the causes of sensory experience based on past experience in order to adaptively interact with it. To improve its guesses, the brain is proposed to *minimize the difference* between these 'guesses' and external input (i.e., free energy or prediction error). Prediction error minimization is proposed to operate at all levels of the neural hierarchy, including those detached from the present environment in service of future adaptive behavior. Thus, in this framework, perception, action and everything in between, are constructed through predictive models that have previously come to reliably reduce *errors* in prediction. Therefore, past experience is a pervasive factor underlying all mental activity.

Obviously, having a mind that is constructed through past experiences is advantageous in many situations. Yet, a mind that is too restricted - that too often occupies habitual modes of thinking and feeling - and is not flexibly adapted to changing situations, can be maladaptive. Crucially, within the free energy framework, the brain does not simply undergo influences from the *outside*, but continuously generates its own model of the environment from *within* based on past experience, a reality that is continuously tested against the outside world. This also turns the typical notion of brain plasticity - the capacity to undergo change (Buonomano & Merzenich, 1998; Feldman, 2009) - on its head (Boonstra & Slagter, 2019). That is, plasticity is not simply the result of outside influences (or the capacity to *receive* form), but very much about the capacity to *produce* form from *within* (Boonstra & Slagter, 2019). This raises important questions about the plasticity of the predictive mind. If our inner mental landscape is determined by models that through past experience have come to reliably minimize uncertainty, to what extent are these models still plastic or capable of revision based on new experiences? And what may be fruitful ways to promote such plasticity given their internal construction?

In this paper, we argue that this new understanding of the brain as a predictive organ coincides well with meditation, which in some cases explicitly aims at deconstructing the mind from within, in order to allow one to experience things anew, no longer wholly determined by acquired mental habits (Friston *et al.*, 2017). Therefore, here we aim to, 1) provide a unifying account of empirical and phenomenological effects of intensive meditation practice that is grounded in predictive processing, and 2) to demonstrate how scientific research on meditation can reveal novel insights into the plasticity of the predictive mind.

The essence of our theory is quite simple. Our main contention is that meditation gradually brings the practitioner more and more into the present moment, thereby progressively abating hierarchically (i.e., temporally) deep predictive processing in the brain. We contend that this not only reduces temporally extended processes, such as episodic future thinking and decision making, but can also explain more unusual kinds of experiences reported by meditators, including loss of self-other distinction and the cessation of time as in non-dual awareness (Josipovic, 2010; Lindahl & Britton, 2019). That is, if awareness rests in the here and now, all mental processes that involve abstract and temporally deep processing should logically fall away, including sense of agency, time, space, and body representation. Even seemingly direct experiences, like that of a flower or a teacup, demand a complex process of construction from past experience and include anticipation of possible changes in sensory input (e.g., proprioceptive and sensory changes related to drinking from the cup). Thus, if awareness rests in the here and now, all conceptualization should also dissipate.

This paper is organized in the following way: we will begin with an outline of predictive processing and its key components, including views on the nature of self, insight, and fact free learning (Friston, 2018; Friston *et al.*, 2017). We then introduce three well-delineated meditation practices, known as focused attention (FA), open monitoring (OM), and non-dual (ND) meditation (Josipovic, 2010; Lutz *et al.*, 2008b, 2015a). We focus on these meditation techniques for the sake of scope, but also because our account makes the novel neurobiologically informed proposal that there is a single mechanism which puts each of these practices clearly on a continuum. That is, *each practice gradually reduces temporally deep processing in the brain*. We will then reformulate the different meditation techniques, and associated changes in phenomenology, and key neural and cognitive effects of meditation in terms of our model. This will cast some seminal findings in a new light, as we also discuss. Finally, we will make several testable predictions that derive from our novel account and outline important avenues for future research. For example, we make state-specific and technique-specific predictions about how meditation may affect habitual responding, learning, and self-specific processing. This capacity to restructure deeply engrained mental habits is what makes meditation a valuable tool for investigating the plasticity and nature of the predictive mind.

For our theory, we have chosen the name *many-to-one* to depict the reduction in *counterfactual or temporal depth*[1] (Corcoran *et al.*, 2019) - the tendency to abstract away from the present moment (Gilead *et al.*, 2019) - that occurs during meditation. There is widespread agreement that information is represented hierarchically in the brain, with early layers of the hierarchy being more temporally precise and concrete, and higher layers being more temporally thick and abstract (Friston, 2008; Huntenburg *et al.*, 2018). The quintessence of meditation is also being in the present moment. Thus, as a heuristic version of our model, we suggest that meditation reins in the mind's habitual tendency to abstract (*the many*) away from the here and now until all phenomenological distinctions stop (*the one*[2]). Metaphorically, we suggest that meditation *prunes*[3] *the counterfactual tree* (see Figure 1).

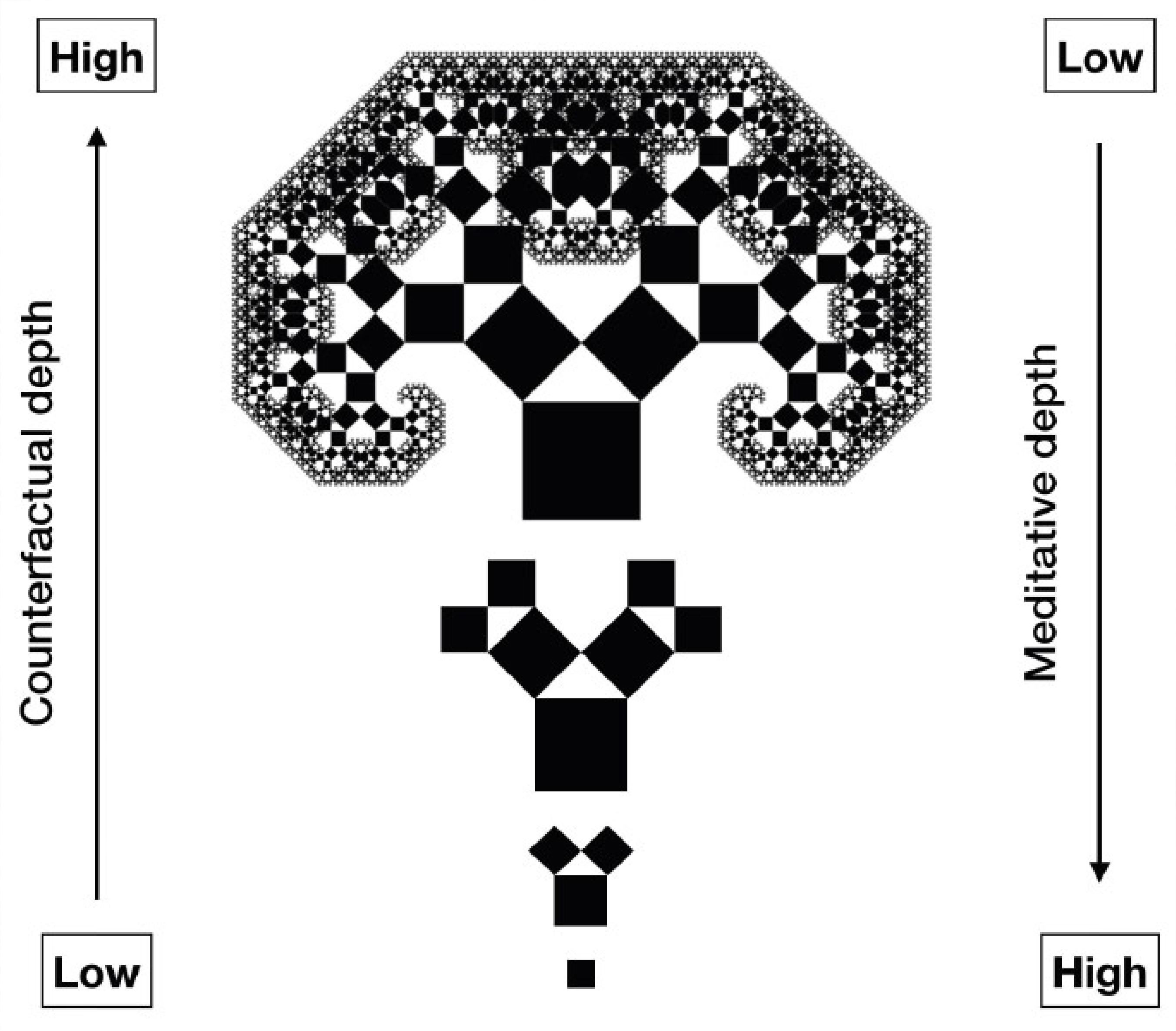


Figure 1. Here we use the Pythagoras Tree to provide an intuitive illustration of how organisms represent the world with increasing counterfactual depth or abstraction[4]. The tree is constructed using squares that are scaled down by √2/2 and placed such that the corners of the squares meet and form a triangle between them, recursively. Analogously, the brain constructs experience from temporally precise and unimodal models of present-moment sensory input (e.g., pixels on a screen), into ever more abstract, transmodal, and temporally deep models (e.g., a theory paper). Meditation brings one increasingly into the present moment, thus reducing the tendency to conceptualize away from the here and now, akin to observing the pixels rather than the words.

According to the predictive processing framework, the self is also a model constructed in the brain's predictive hierarchy. Thus, pruning the counterfactual tree would also logically engender changes in one's sense of self. Indeed, the traditional roots of many meditation techniques (such as Buddhism) explicitly aim to provoke changes in the self (Dahl *et al.*, 2015). Consistent with this praxis, we will also propose that the three meditation techniques gradually deconstruct increasingly foundational forms of self-representation, beginning with the narrative self (Gallagher, 2000), and then the embodied self (Blanke & Metzinger, 2009; Seth, 2013), and finally dissolving the very foundation of a subject-object distinction (Josipovic, 2014). Moreover, we argue that reducing temporally deep processing allows certain insights to arise as the constructed nature of cognition becomes perceptible. Finally, as an interesting counter-model, we compare our account of meditation to a popular predictive processing account of psychedelics (Carhart-Harris & Friston, 2019).

2. Predictive Processing

What does the brain do? What is the basic imperative of a living organism? Evolution and gene selection theory were able to provide answers to core questions at the level of biology, explaining how life can emerge and adapt over time through natural selection (Ashburner *et al*., 2000). However, a unifying account of life *within the living* has yet to take hold. Organisms in their relatively short life spans also change, adapt, behave, think, and feel and seem to possess some inner imperative to survive beyond procreation. What is at the heart of this compulsion? According to the free energy principle (Friston, 2010), the basic imperative is not pleasure seeking, or any kind of simple reinforcement scheme. The imperative is to maintain a boundary between oneself and the world, or in other words, to resist the second law of thermodynamics (i.e., the tendency for isolated systems, including the human organism, to become more entropic over time). If an organism loses its boundaries, it becomes more entropic as its constitution and the world become increasingly inseparable. In order to avoid the dissolution of its boundaries, what the organism *does* is make predictions across many timescales to produce autopoietic[5] actions that minimize the tendency towards entropy (Friston & Buzsáki, 2016). It is perhaps these relatively uncontroversial axioms on which the free energy principle is founded that has made it so appealing to philosophers and scientists alike (Allen & Friston, 2018; Clark, 2013; Milliere & Metzinger, 2020; Wacongne *et al*., 2011).

The organism's survival depends on high fidelity predictions. But how can the organism and its brain, which has no direct access to the outside world - only to the often ambiguous and noisy sensory signals it receives via the senses - improve its predictions? In vision, for example, the size of the image on the retina is influenced by the size of the object and how far it is from the observer. The computationally efficient solution to this problem is for the brain to prune its models using *prediction errors*. By processing the difference between model predictions and sensory input the organism can indirectly quantify the accuracy of its predictions to improve the models that generated them (Friston, 2010). Focusing on minimizing prediction errors (*entropy in the long-term*) is computationally much less expensive than processing a complex temporally layered gamut of interoceptive and exteroceptive input in every instance.

To illustrate how predictive processing works, consider the following example of drinking water. Picking up a glass of water, while avoiding tipping over the dishwashing detergent, and drinking the water, entails successful modelling of one's body, movements, immediate visuo-spatial environment, as well as the internal mechanisms that prevent the water from entering the trachea. Moreover, if one is subsequently "surprised" by the sensory input (e.g., what is meant to be water), then it is likely that one is drinking something dangerous. Indeed, the very desire to drink fluids is itself a prediction error arising from appropriate expectations of one's bodily volume of water via osmolality. It is not difficult to see then that an organism that does not aim to minimize prediction errors over time would not survive for long.

In order to keep our discussion focused, below we review five core features of predictive processing that are relevant in the context of meditation. The first is the *hierarchical* nature of predictive processing, which is important because our model proposes that meditation gradually reduces the temporal depth of hierarchical processing. The second is *active inference* which accounts for action (mental and physical), and is relevant because meditation often involves either complete non-action such as sitting still, or a highly constrained action like walking slowly. Mental actions are also often constrained (e.g., thoughts) by focusing attention on a sensation such as the breath (Lutz *et al*., 2019). The third is *precision-weighting*, which is equated with attention in the predictive processing framework (Friston & Stephan, 2007; Hohwy, 2013). Precision-weighting is also highly relevant because changes in the deployment of attention are important in many meditation techniques (Slagter *et al*., 2011) and ordinary attention is to be released altogether in some meditation practices. And the fourth is the implication that self consciousness implies minimizing *expected* free-energy in next moments in time (Friston, 2018). As stated above, the nature of self is important because many meditation techniques explicitly aim to engender changes to one's sense of self (Dahl *et al*., 2015; Dor-Ziderman *et al*., 2016). Finally, we describe how the brain can learn without sampling new input - e.g., as in meditation - by refining, selecting, and compressing existing representations, through *fact-free learning* (Friston *et al*., 2017). Learning and attaining 'insights' about the nature of one's mind are also at the heart of many meditation practices (Bodhi, 2011), and we suggest that these may naturally arise through fact-free learning[6].

2.1 A hierarchy of expectations

It is a key tenet of the free energy principle that the brain models the world hierarchically (Friston & Stephan, 2007). Early basal layers of processing are temporally precise and concrete (e.g., sensory and interoceptive input) and deeper layers are temporally thick and abstract (e.g., thoughts and concepts, Limanowski & Friston, 2020). Each layer of the hierarchy aims to predict the input of the layer below, and inconsistencies between predictions and the input (i.e., prediction errors) are propagated further up the hierarchy. The hierarchical nature of the brain is not controversial (Badcock *et al.*, 2019; Friston, 2008; Huntenburg *et al.*, 2018; Kumar *et al.*, 2007; Lee & Mumford, 2003; Taylor *et al.*, 2015; Vidaurre *et al.*, 2017). We will unpack the nature of this hierarchy and how it relates to self-processing and meditation in later sections.

Predictive processing accounts such as Friston's free-energy principle have roots in Bayesian Brain theories. That is, in order to answer the difficult question of, "how should I update my beliefs given new evidence" the brain is proposed to follow hierarchical *Bayesian* inference. This means that the brain computes the 'new hypothesis' (*posterior* probability) by considering the 'old hypothesis' (*prior* probability) and the *likelihood* of the new evidence given the 'old hypothesis' or prior. Clearly, in this scheme priors - intuitively analogous to beliefs - play a key role in what the organism ends up experiencing and believing, at every layer of the hierarchy. These priors are conditioned by past experience, and not just developmentally but also phylogenetically (Badcock *et al.*, 2019). Thus, some priors may be deeply resistant to change (i.e., *stubborn*). Examples of stubborn predictions are expectations that critical physiological variables are within some range (e.g., a bodily temperature of ~37 degrees Celsius), the expectation that one has a body, and the expectation that light comes from above (Yon *et al.*, 2019). Predictions established ontogenetically are conceivably less stubborn than predictions that are necessary for survival and developed phylogenetically, but an important outstanding question is to what extent these predictions once established, e.g., after sensitive periods in development, can still be modified based on new experiences and learning (Yon *et al.*, 2019).

2.2 Perceptual and active inference

Prediction errors can be minimized in two ways: an organism can change its models, or it can *act in ways that are consistent with expectations*. Put differently, one can revise (perceptual inference) or confirm (active inference): like a scientist who either changes their theory in light of new evidence, or turns a blind eye, and instead conducts experiments (makes actions) that produce expected results (Friston & Frith, 2015). Under this account, actions are reflex arcs that unfold to create an experience that is consistent with an expected state of sensory affairs (Allen & Friston, 2018). Returning to our earlier example, organisms have certain stubborn expectations regarding fluid levels. If those expectations are not met, a strong prediction error is incurred in the form of thirst. Once a certain threshold is reached, the organism generates a prediction regarding a series of sensory and proprioceptive states that eventuate in an appropriate fluid to weight ratio. By reducing the difference (prediction error) between this prediction and the current sensory input, the organism will find water and regain its balance. Like the imperative to stay hydrated, modeling of the world is primarily in the service of *utility* rather than fidelity: "The brain is in the game of predicting the world, but only as a means to the end of embodied self-preservation" (Allen & Friston, 2018, p. 12).

It should be noted that active inference, although directed at confirming predictions, is also critical for model revision because by manipulating the sensory input through action, the brain can also test hypotheses in order to check them against the subsequent input. In other words, by generating information through action, the brain can test its models about the outside world. Crucially, the hierarchical and temporally deep nature of generative models in the human brain permits that we can also *think about actions and their potential consequences without performing them* (Friston, 2018). Thinking, decision-making, and guided attention are thus kinds of mental actions (Metzinger, 2017; Spratling, 2016). They allow us to disembody from the present moment flow of sensory data in order to covertly entertain possible, but nonexistent states, i.e., *counterfactual hypotheses* (Metzinger, 2017). This counterfactual cognition is thought to be in the service of allostasis - of predicting future states that minimize expected free-energy under different scenarios (Corcoran *et al.*, 2019). And since all predictive processes are driven by past experiences, then higher cognition is similarly conditioned by past mental experiences. That is, learning is also a pervasive feature of thought.

2.3 Attention

Simply revising beliefs whenever prediction errors occur is ultimately not beneficial, as incoming signals are often unreliable or noisy or not representative of the larger world. Hence, the reliability or *precision of prediction errors* ought to also play a role. That is, not only the upcoming sensory input needs to be estimated, but also its precision (second order prediction), which requires integrating information over time (Friston, 2009). In predictive processing, attention is equated with *precision-weighting* and plays a key role in contextualising prediction errors (Feldman & Friston, 2010). Intuitively, attention partly determines whether one changes their beliefs (priors) in light of new information. The quintessential example is that of perception in either dark or well-lit contexts. In the dark, visual input tends to be awash with inconsistency and low definition, and thus prediction errors have *low precision* and are more likely to be ignored. On the other hand, in daylight the sensory input is clear and reliable, and thus even a surprising visual event will be registered because it has *high precision*. And paying attention to a blurry object in our periphery (is it a teacup or a mug?) can incur more *precision* to any incoming surprises (a teacup!). Mechanistically, paying attention to a particular sensory event is proposed to increase the synaptic gain of the cells that are encoding the prediction error (Feldman & Friston, 2010; Smout *et al.*, 2019). Thus, attention is said to turn up the "volume" (Clarke, 2013, p. 22) of the input.

To risk over-stretching the function of attention slightly: the more attention that an event receives, the more real it is. If a change in belief occurs, it is because new information is believed to be true and can be trusted (i.e., has high precision). And since attention is expected precision, then attention modulates reality-correspondence, 'realness', or "felt confidence" in input (Carhart-Harris & Friston, 2019). This reality-shaping effect of attention may be one reason that it plays such a key role in most meditation traditions. Preempting later sections, it is interesting to note that in certain meditations, attention must eventually be released in favor of a form of bare or non-preferential attention, and in yet other meditation practices of the non-dual category, attention is released altogether (Dunne, 2011).

2.4 The inferred hierarchical self

Predictive processing accounts of the self are in the early stages (Milliere & Metzinger, 2020), and there is still not widespread agreement among scientists on a definition of the self. Nevertheless, assuming a predictive brain, we can draw some tentative conclusions. First, like all other aspects of cognition and experience the self must also be a construction built out of hierarchical models driven by past experience. Indeed, according to Friston (2018) and others (e.g., Deane, 2020) possessing a self-model is a natural consequence of active inference and prospection: One cannot predict future actions without representing oneself in those actions. For example, picking up a glass of water requires that we have a model of our body as an intentional agent who *can* pick up a glass of water given certain behaviors. And indeed, we must have a model for that fact that we are an agent that needs such a thing as water. This self-modeling further endows the organism with the ability to consider itself in different future scenarios (i.e., entertaining counterfactuals: I'm thirsty, but I could drink water, or tea). The second implication, which is perhaps more controversial, is that the self is itself hierarchical in nature. We will briefly provide evidence for these ideas below.

It is clear that one's usual sense of self can change, and in seemingly myriad ways. These changes may be usefully put on a continuum, from relatively minor changes (e.g., the retrospective sense that I was acting "not like myself"), to more verifiable concrete changes (e.g., the rubber hand illusion, Botvinick & Cohen, 1998), to changes that are more holistic (e.g., perceiving someone else's body as your own, Petkova & Ehrsson, 2008). Or, on the extreme end, it is also possible to completely disrupt normal self-related processing, such as during a psychotic episode (Sterzer *et al.*, 2018) or high doses of psychedelic drugs (Millière *et al.*, 2018; Timmermann *et al.*, 2018). Such changes to self-representation are usefully accounted for in predictive processing by aberrant priors and precision-weighting (Adams *et al.*, 2013; Corlett *et al.*, 2016; Sterzer *et al.*, 2018), although the mechanisms may vary depending on the specific case. Nevertheless, since subjective experience - including therefore any self-models (Blanke & Metzinger, 2009) - is inferred through Bayes-optimal inference under the predictive processing scheme, the existence of aberrant self-perceptions are *not* surprising (e.g., in the context of the rubber-hand or full-body illusions, highly precise sensory input contradicts proprioceptive input leading to a misperception of ownership). Taken together, the fact that the self is constructed is not controversial because it is prone to change and can even disappear under predictable conditions (e.g., virtual reality, psychopathology, or psychoactive substances).

Is the self also hierarchical? Gallagher (2000) made the now well-known distinction between a *narrative* and an *experiencing* self. The narrative self is embedded in our thoughts and includes our stories about the past, the future, and all our self-referential knowledge and beliefs. On the other hand, the experiencing self refers to our awareness of bodily sensations and events occurring in the present moment. The narrative self is perhaps neurally instantiated by the default-mode-network (DMN; Raichle, 2015), which is associated with key features of high-level cognition, especially mental time-travel (Østby *et al.*, 2012) or more basic forms of counterfactual thinking (Van Hoeck *et al.*, 2013). Indeed, Carhart-Harris & Friston (2019) propose that "...the human DMN can be considered to sit at the top end - or center - of a uniquely deep hierarchical system...". The experiencing self is likely instantiated by task-positive and interoceptive networks (that are anti-correlated with the DMN), including executive and control areas in the prefrontal cortex and anterior cingulate cortex (Fox *et al.*, 2016) as well as the anterior insula (Seth, 2013) and other subcortical regions associated with homeostatic functions (Damasio, 2012).

Within the predictive processing account, abstract thought and therefore the narrative self is placed *higher* in the predictive hierarchy (*temporally thick*, Carhart-Harris & Friston, 2010). On the other hand, sensory and interoceptive input and therefore the experiencing self would be lower in the hierarchy (*temporally thin*, Friston, 2008). There may also be a minimal form of self even lower in the hierarchy, such as the first-person perspective itself, but this is still debated (Blanke & Metzinger, 2009; Sebastian, 2020). Moreover, in recent years experiments and a growing database of personal accounts are leading many researchers to accept the existence of *self-less* states (see Milliere & Metzinger, 2020 for a special issue). It is also worth mentioning how a minimal or basal form of self might arise (though this is an area of considerable debate). As alluded to earlier, self-modeling may be intimately tied to action, because one cannot model one's own action pathways without modeling oneself as a hidden cause. Simply put, the brain needs to model a 'self' in order to predict future states that the 'self' might inhabit. Along this line of thought, Friston (2018) suggested that self-awareness arises whenever a system generates action predictions, and thus aims to minimize the *expected* free energy resulting from those actions.

2.5 Fact free learning and insight

In the above we discussed the different roles that attention (i.e., precision weighting) and active inference (i.e., mental/physical actions) play in the revision of beliefs (priors). However, there is another way to refine generative models that doesn't involve active inference or novel sensory input, known as *fact free learning* (Friston *et al.*, 2017). Aha! moments or insights instantiate fact free learning because they involve the discovery of a solution, idea, or perspective without new information. For example, we might unexpectedly discover a solution while taking a shower or while engaged in another task (Metcalfe & Wiebe, 1987; Ovington *et al.*, 2018). Moreover, experiments show that such insights are usually correct (indicative of refinement, Salvi *et al.*, 2016) and can change subsequent beliefs (indicative of model revision, Laukkonen *et al.*, 2020).

Take the simple example of an anagram. An anagram is a scrambled word, such as "nirtostcpeion". If it is not immediately clear what the hidden word is, then at a certain point it may suddenly become clear, without any new input or facts. We can also speed up the process with a clue: "*Looking inward*"[7]. Similar to anagrams, there are many instances wherein a novel perspective or idea is gained without necessarily being exposed to anything new. Central to fact free learning is that insights arise because the brain continues to refine and compress models through *Bayesian model reduction* (Friston *et al.*, 2016). Bayesian model reduction entails finding simpler and more parsimonious models using only posterior beliefs (i.e., not using sensory outcomes, Friston & Penny, 2011). This process of refinement is comparable to the "...physiological processes in sleep, where redundant (synaptic) model parameters are eliminated to minimize model complexity" (Friston *et al.*, 2017, p.2638). As models undergo refinement and selection - thus making them more parsimonious explanations of sensory input - they can also engender new discoveries, such as the discovery of a new perspective (generative model) that permits a novel insight (or inference, Friston *et al.*, 2017).

Friston *et al.* (2017) suggest that fact free learning may not only occur during sleep but also result from reflection (or *introspection*), both explicit and implicit: "...Having acquired data, the "good scientist" reflects on what she knows (and perhaps sleeps on it), implicitly testing plausible hypotheses of a progressively simpler (less complex and less ambiguous) nature that could provide an accurate account of the data at hand" (p. 2666). The connection between fact free learning, insight, and meditation is therefore quite obvious. Meditation is in many ways the embodiment of fact free learning, by virtue of its emphasis on stillness (both in body and mind) or *in-active* inference. Moreover, meditation can induce extraordinary, novel mental experiences ("input"), that cannot easily be accounted for by existing models, increasing their uncertainty and necessitating revision. Thus, although we argue that meditation practice in essence reduces counterfactual abstract processing, it is simultaneously an opportune moment for model revision and selection as the brain - despite the reduced activity of body and mind - continues its prerogative of hierarchical prediction-error minimization via internal hypothesis testing: "...much like a sculpture is revealed by the artful removal of stone" (Friston *et al.*, 2017, p. 2669). The prospect that meditation engenders insight is also at the very foundation of (for example) classical Theravada Buddhism and vipassanā (insight) meditation practice, which aim to permit specific insights into the workings of one's mind, discussed further below.

3. Meditation

It is now worthwhile to return briefly to our central thesis in light of the previous sections. Our core proposal is that meditation gradually reduces the temporal depth of processing[8] in the predictive hierarchy by bringing the practitioner more and more into the here and now. This process gradually prunes the counterfactual tree, reducing the brain's tendency to abstract temporally thick predictive models. Ultimately, since self-related processes imply temporal depth of processing (Friston, 2018), being fully immersed in the here and now may also occasion a radical shift in one's ordinary sense of self-consciousness. Moreover, meditation may also foster fact free learning (insights), where one's models are refined without active inference.

To prepare for a more nuanced overview of our model, in this section we briefly describe three categories of meditation most studied in contemplative science, that also represent three main classes of meditation in Buddhism (for much more detailed reviews of these practices see, Dahl *et al.*, 2015; Dunne, 2011; Lutz *et al.*, 2007, 2008, 2015). These three categories (FA, OM, and ND) are umbrella terms that do not capture the full diversity found in Buddhist theories and practices. Moreover, similar practices are found outside of Buddhism, for example in Advaita Vedanta and Sufism (Dahl *et al.*, 2015). The practices are also not always clearly distinct and multiple techniques may be used throughout one's training (Lutz *et al.*, 2008). In the Buddhist tradition, ND meditation (Lutz *et al.*, 2006) is particularly emphasized within Mahayana and Vajrayana Buddhism (so-called non-dual traditions). So far, most research on ND meditation has focused on Mahamudra and Dzogchen from the Vajrayana tradition (Antonova *et al.*, 2015; Josipovic, 2010).

As we describe each meditation technique, we also highlight key ways in which they may affect predictive processing, though these notes will be made more formally in the next section. Our central hypothesis here is that each meditation style gradually draws predictive processing closer and closer to the here and now (i.e., less abstract hierarchically deep processing).

3.1 Focused attention

Focused attention (FA) is often practiced when one begins meditation. It involves the explicit focus on a particular aspect of one's present moment sensorium to the exclusion of everything else. The target of one's attention is often the breath, but ultimately any object in present moment experience, like a candle or one's feet while walking, can serve the same purpose. The primary aim of this practice is to stabilize one's attention in the present moment. When thoughts or mind-wandering episodes arise, attention is guided back to the sense object. Thus, FA also involves monitoring or meta-awareness of the quality of attention on the object. With practice and the development of meta-awareness it is said to become easier and eventually effortless to sustain attention on one point of focus in the present moment. Crucially, FA may help to develop the first steps of dereification that are foundational for more "advanced" practices: the ability to discover that all of one's experience is a process rather than a true reflection of reality (Lutz *et al.*, 2015). The development of meta-awareness and dereification permit an easier transition to more advanced practices in which these aspects are further developed (Lutz *et al.*, 2015), as discussed further below. Yet, experienced practitioners may continue to practice FA at the beginning of a meditation period to initially stabilize attention, and indeed may continue to practice FA for other reasons, such as the achievement of deep states of tranquility (Wallace, 1999).

From a predictive processing perspective, we propose that FA meditation *increases the precision-weighting of one source of present moment sensory experience*, and thereby reduces the frequency of abstract thought and the narrative self, i.e., mental processes that rely on deep temporal models. By confining experience as much as possible to one prediction (e.g., breath sensations), FA automatically encourages less habitual 'grasping' of other predictions (such as thoughts), and reduces their appearance (as their relative precision-weighting is diminished). Novice practitioners may have trouble sustaining their attention at one point of focus, reducing the precision assigned to the corresponding sensory signals, providing space for mental distractions (e.g., mind wandering). Advanced practitioners may reach a kind of 'focused homeostasis' once distracting counterfactual hypotheses become sufficiently infrequent. Another natural consequence of restricting awareness to one "object" of experience is that with more advanced practice, one is no longer engaged primarily in the narrative self, and instead is in a less abstracted, present moment mode of experiencing.

As noted earlier, expected precision prescribes reality-correspondence, 'realness', or "felt confidence", so the up-weighting of precision for the input of the FA object (e.g., the breath) should also lead to a relative down-weighting of predictions higher in the hierarchy (e.g., thoughts), and this in turn may reduce the subjective realness of distracting thoughts and feelings and provide a first step towards dereification (Lutz *et al.*, 2015).

3.2 Open monitoring

Open monitoring (OM) may follow after one's mind is sufficiently anchored in the present moment through FA. The practitioner may then begin to gradually open the scope of attention to the broader field of experience: A kind of 'open monitoring'. Particularly in Theravada Buddhist schools of meditation, FA practice is often used to prepare the meditator to practice OM, which is believed to permit deeper insights into the nature of the mind (Lutz *et al.*, 2007), namely: impermanence (aniccā), non-self (anattā), and suffering (dukkha). During OM, one does not sustain attention to an explicit object of experience. Instead, in an open and receptive way one allows whatever arises in experience to come and go: sensations, thoughts, or feelings, or other states of mind, without judgement or evaluation. The focus of this practice is in the cultivation of meta-awareness and in dereification from the contents of experience. In other words, everything that appears in experience is treated equally from the perspective of a nonjudgmental observer. OM may initially require some effort to maintain awareness in the here and now, and explicit attention may be briefly given to the different events that appear in experience (e.g., through a practice of labeling the contents of experience). Advanced practitioners are said to be able to effortlessly observe experience as a whole, without being 'caught' by thoughts, emotions, or anything else that arises in one's sensorium. This way, mental events "lose their representational integrity and are experienced simply as mental events, situated and embodied within a field of sensory, proprioceptive, affective, and somatic feeling tones" (Lutz *et al.*, 2015). Thus, in OM, awareness of the background of experience further comes to the foreground, as one develops the ability to rest in a stable sense of pure experiencing.

Although oscillation between FA and OM may often occur during practice, unlike the directed focus of FA, OM treats all arising signals non-preferentially (e.g., a thought, an emotion, or a sensation). Thus, from a predictive processing perspective, any content of experience is assigned equal precision, and consequently *low precision* in relative terms. Crucially, the goal of OM is *not* to stop experiences from arising. Instead, one reduces 'grasping' by quickly letting arising experiences (predictions) go without confirmation, by maintaining a restful but alert state of non-judgmental observing. Thus, OM continues to reduce the precision and temporal span of predictions arising in experience. As restful non-judgmental observing increases, the system may begin to experience a kind of 'pure' sensing without evaluation. This 'pure experiencing' is conceivably temporally *prior to* evaluations of the sensory experience. For example, sensations in the knees or back during sitting meditation may occur prior to the evaluation of the experience as "painful". This is what is believed to allow practitioners to sit for extended (sometimes many hours) at a time without moving. Thus, *non-judgmental experiencing could be said to be the natural state of the system at a lower level of the hierarchy*. We therefore propose that as the frequency and temporal span of predictions such as thoughts, emotions, and sensations, decreases, then a hierarchically lower layer of the predictive hierarchy (non-judgmental experiencing, or experiencing prior to evaluation of experiencing) dominates. This state is different from FA since no experience is given preferential precision-weighting, and thus 'attention' becomes 'bare' rather than 'object-oriented'.

Under this scheme, the novice OM practitioner experiences more frequent and temporally extended predictions with higher average precision than the experienced OM meditator. The more precision the prediction errors are assigned, the more likely the corresponding content is to 'eclipse' one's mindful (non-judgmental) observation. As expertise increases, the temporal span, precision, and frequency of predictions decreases, making more 'room' for background awareness. With even further practice, experiencing may lose its evaluative quality entirely. The expert OM practitioner therefore should eventually come to rest in a non-judgmental experiencing that we propose is earlier in the predictive hierarchy.

It is also plausible that the practice of non-judgmentally observing and releasing arising predictions could also foreseeably permit *epistemic* changes to the system, in line with classical Buddhism (Bodhi, 2011) and fact free learning (Friston *et al.*, 2017). If all generated predictions (thoughts, feelings, sensations) are continually seen as appearing and disappearing, it would be logical to conclude - have the insight - that they are *impermanent* (aniccā)[9]. Moreover, if one sees that all predictions are quickly interpreted by the system as pleasant or unpleasant leading to craving or aversion respectively (i.e., later in the hierarchy), then one would see the *suffering* (duhkha) inherent in much of experience. Finally, if arising predictions are not under control (i.e., appearing spontaneously), then it is also perhaps recognizable that they - including all embodied sensations and narrative self-centred thinking that are usually ascribed self-hood - are not self-induced, i.e., *do not* have any consistent unchanging self-like character (anattā). In other words, OM by making earlier layers of the predictive hierarchy perceptible may reveal that the embodied and narrative self are just *processes* rather than concrete entities. Buddhist insights may therefore be seen as new priors engendered by OM practice possibly as a result of Bayesian Model Reduction or fact free learning.

3.3 Non-dual

Non-dual (ND) meditation is of growing interest to scientists (see for example, Dunne, 2011; Josipovic, 2010; & Metzinger, 2020)[10]. The key component of this practice is that one aims to discover an awareness that is unchanging regardless of what happens in experience. Metaphorically the "ground of all experience". Some historians propose that this style of meditation was developed later in time than FA and OM meditation, based on emphasizing the idea that there is an awareness that is "beyond" the subject observing experience that is implicated in FA and OM (J. Dunne, 2011; Gyatso, 2010). From the perspective of the 'nondual' discovery, the duality between subject and object is itself a conceptual model constructed from past experience. Clearly FA and OM still have embedded within the practice the duality between an (unconditional) observer and objects that are observed. Thus, as a final 'release' of any abstraction away from the here and now, in ND meditation the idea that there is a distinction between self and objects of experience also falls away. This results in a state of awareness in which there is no background or foreground of experiencing, that is hence devoid of concepts (self, objects), intentionality or the experience of time and space, i.e., a state in which even the most basic constructs of cognition allegedly no longer persist.

It is against this awareness that all cognition is said to arise. It is somewhat paradoxical then to talk about a 'non-dual practice', since the term 'practice' itself implies a duality (someone who is practicing something). Thus, one way to understand the nature of non-dual practice is as follows: *creating the conditions that reduce ordinary cognition that normally 'hides' non-dual awareness*. Such a practice is exemplified in "open presence" and Dzogchen styles of practice within Tibetan Buddhism (Dahl *et al.*, 2015a) and Shikantaza or "just sitting" within the Zen Buddhist tradition (Leighton, 2004). There are also other even older practices with Hindu origins such as self-enquiry in Advaita Vedanta (Dahl *et al.*, 2015) that utilizes questions such as "who am I?" that point attention towards the 'subject' of experience so that its absence may be discovered (Nisargadatta Maharaj, translated talks by Frydman, 1973[11]). For a collection of case-studies describing non-dual experiences see Metzinger (2020), and for a detailed review see Josipovic (2019).

Non-dual meditation, and particularly the qualities of the non-dual experience, is perhaps the most challenging to characterize within the predictive processing framework. However, since all mental experience is constructed through a process of abstraction away from the here and now, then if one were truly to be in the present moment - i.e., not constructing models with temporal thickness - then something akin to a non-dual experience would logically arise. That is, any mental activity that relies on active inference should disappear, including activity related to self-awareness (Friston, 2018; Limanowski & Friston, 2020; Metzinger, 2020). To draw this conclusion, we must assume that some minimal form of experience is still possible without contents or sense of self, though it *may*[12] raise certain philosophical conundrums. As noted by Limanowski & Friston (2020, p. 2), "How could one have a conscious experience - and able to report on it afterwards - in the absence of any awareness of oneself (as having the experience)?".

In search for a naturalistic explanation of ND experiences, Metzinger (2020) developed the concept of minimal phenomenal experience and proposed that non-dual experiences are a Bayesian representation of intrinsic arousal. Indeed, maintaining an optimal level of arousal or alertness is central to many meditation practices. This proposal fits with a large body of work showing that arousal levels causally determine one's level of consciousness and critically enable cortical activity and therefore cognition (Laureys *et al.*, 2009). According to Metzinger (2020), an inner representation of arousal would be expected to possess the characteristics of non-dual awareness described by practitioners, including: "...a complete absence of time-representation and any form of sensorimotor or high-level cognitive content. Further, there would be an absence of low-level embodiment in the sense of spatiotemporal self-location, interoception, and affective background, as well as of higher levels of selfhood like attentional control and cognitive agency." (p. 36). Although there is an absence of representations of self, space, and time, there would nevertheless remain an experience of wakefulness and the *potential* for cognition. A different proposal from Josipovic (2014; Josipovic *et al.*, 2011), although not grounded in the notion of predictive processing, is that non-dual awareness in particular affects the fragmentation of the field of experience into habitual dualities, such as self vs. other, inside vs. outside, good vs. bad, and that this may be brought about by reducing the normally antagonistic relationship between brain networks involved in self-referential processing and external task-related processing (Josipovic, 2014; Josipovic *et al.*, 2011). Future studies are necessary to dissociate between these and other theories.

It is also possible to see how the ND state can potentially go beyond insight or fact free learning, as was the implied goals of OM practice. Having a *conscious* insight moment implies temporal depth, whereby higher levels make predictions about the input of lower levels, and thus refine themselves until a new point of view is uncovered (Friston *et al.*, 2017). Hence theoretically, the ND state ought to be "empty" even of the very possibility to attain conscious insights that characterize OM meditation, assuming that the system is no longer constructing temporally deep models. This appears consistent with perhaps the most popular Mahāyāna (ND) Buddhist scripture, known as the Heart Sutra, which for example states - seemingly transcending the insights of OM practice - that there is "...no truth of suffering, of the cause of suffering, of the cessation of suffering, or of the path. There is no wisdom and there is no attainment whatsoever... And, thus, he passes far beyond confused imagination. And reaches Ultimate Nirvana." (Lok To *et al.*, 2000). The 14th Dalai Lama also noted that the Mahāyāna tradition emphasizes emptiness (¶ūnyatā) of all phenomena (including Buddhist teachings and laws, or *Dharmas*, Gyatso, 2010) whereas classical Theravada Buddhism emphasizes the cessation of suffering, or insight. While we maintain that during non-dual awareness conscious insights seem logically impossible, discovering (perhaps in retrospect) that *everything* is empty can also be considered an insight, as it allegedly qualitatively alters one's subsequent experience of reality. This may suggest that model reduction can also occur during states of minimal temporal depth (cf. in sleep) or happens relatively quickly after coming out of the non-dual state. Moreover, despite 'experiential emptiness' some forms of fact free learning may continue (e.g., selecting between model x and equally probable model y because model *x* is likely to lead to the least surprising outcomes, Friston *et al.*, 2017).

It is important here to note that, although we have placed FA, OM, and ND practice on a continuum of reducing counterfactual or deep temporal processing, we are not claiming that any particular practice or tradition is superior. The interconnectedness and progression of practice highlights that they are in many ways inseparable, and may have different effects that might be perceived as valuable or not depending on the tradition.

4. A Unifying Framework: The Many-to-One Model

Having now laid most of the groundwork for our model, in this section we provide two illustrations and with them aim to capture the key components of the theory. It is perhaps worthwhile restating our aims: The goal of the many-to-one model is to provide a mechanistic predictive processing account of meditation, and in turn reveal how meditation affects the plasticity of predictive processing. In Figure 2 below, we illustrate the effects of FA, OM, and ND meditation specifically as they relate to the depth of processing in the predictive hierarchy. Then, in Figure 3, we illustrate with more nuance how the different meditations effect the time-course of prediction and precision at different levels of the hierarchy.

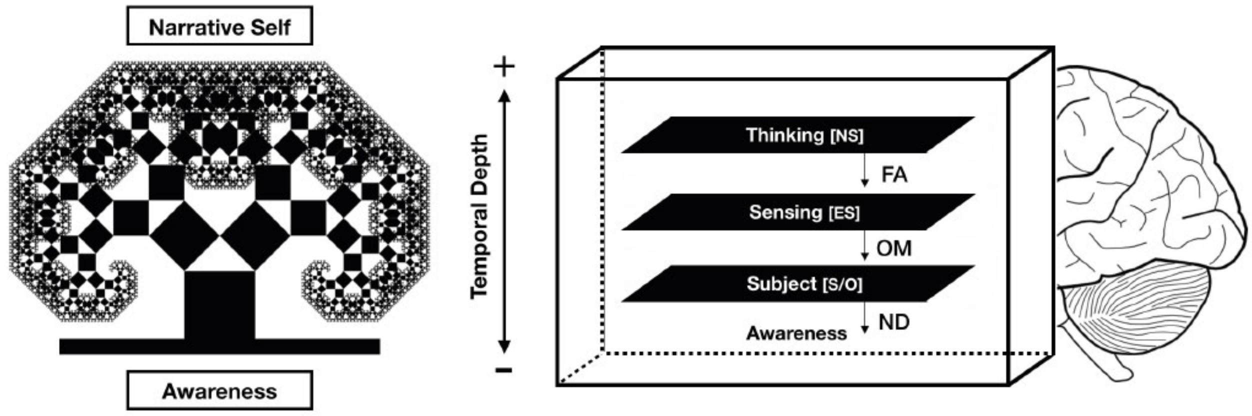


Figure 2. In this schematic we illustrate two aspects of the many-to-one model. The first and most foundational proposal is that meditation gradually *flattens the predictive hierarchy* or 'prunes the counterfactual tree', by bringing the meditator into the here and now, illustrated in the left figure. Thus, meditative depth is defined by the extent that the organism is *not* constructing temporally thick predictions. In the right figure, we dissect the predictive hierarchy into three broad layers. We propose that thinking (and therefore the narrative self [NS]) sits at the top of the predictive hierarchy (Carhart-Harris & Friston, 2010; 2019). Sensing and perceiving and therefore the embodied experiencing self [ES] sits below it (Gallagher, 2000; Seth, 2013). Finally, a basal form of self-hood characterized by the subject-object [S/O] duality sits at the earliest level. FA brings the practitioner out of the narrative self and into a more experiencing and embodied mode of being. Then, through dereification from present moment experience (including bodily sensations) OM brings the practitioner more into a state where contents of experience are treated equally, and one is able to experience non-judgmentally (sensing without appraisal), but even in very advanced states, a subject-object duality remains. During OM, certain epistemic discoveries or insights about the nature and behavior of generative models may occur. Finally, through ND practices the subject-object distinction may fall away and the background or "groundless ground" of all experience - awareness itself - can be uncovered. Another way to characterize this process is as follows: FA employs *regular* (conditional) attention to an object of sensing, OM employs *bare* (unconditional) attention, and ND practice employs *reflexive* awareness that permits the non-dual witnessing of the subject-object dichotomy and finally pure or non-dual awareness.

The above figure provides a broad illustration of how each meditation technique gradually decreases abstraction in the predictive hierarchy. Although we have delineated three layers of the hierarchy to correspond to the three meditation techniques, the hierarchy is of course far more multilayered. For instance, within sensations there is also a hierarchical constructive process, whereby two-dimensional impressions are built into more complex shapes through learned statistical regularities grounded in past experience (Friston, 2005; Serre, 2014). Thus, intensive and prolonged FA practice may also be able to break down sensations into its earlier stages of construction in the hierarchy. Thinking is also likely hierarchical, ranging from simple conceptualization of an object (e.g., noting the observation of a cup), to task-unrelated and disembodied mind-wandering.

We also intentionally did not specify the nature of the subject-object distinction because what precisely constitutes the 'subject' of experience, whether it be a unified proprioceptive model (Friston, 2005; Serre, 2014), or something more basal like witness consciousness (Albahari, 2009)[13], is still debated. Nevertheless, drawing on Friston (2018), we suggest that the experience of being a subject as separate from objects (that is *self*-consciousness but not consciousness per se, see Deane, 2020; Metzinger, 2020) occurs due to predictive models aiming to reduce expected uncertainty. Thus, by being truly present, it may be possible that there occurs a release of any expectations of future states, and thus a 'non-activation' of the most basal self-model and duality itself.

Strikingly consistent with the continuum of decreasing abstraction in our framework, in a recent meta-bioinformatics study of 17,000 experiments and approximately 1/4 of the fMRI literature, Taylor *et al*. (2015) used connectivity models and a data-driven approach to reveal "...an objective hierarchical landscape of cognition in the brain, *with awareness at its structural core*, and all results defined solely by a computational analysis, largely devoid of human bias" (p. 11, emphasis ours). Moreover, ~500 subjects intuitively ranked the behavioral tasks used in the analysis on a spectrum from concrete to abstract, and this ranking - somewhat astonishingly - mirrored the objective physiologically-based ranking. Thus, indicating that the brains functional hierarchy can be considered a process of abstraction further away from the core (awareness) followed by direct sensory input, and then further abstraction in the hierarchy from there (e.g., conceptual thought). An outstanding question following Figure 2 is *how* precisely each meditation technique reduces abstract processing. To this end, in Figure 3 below illustrates how each meditation type changes the frequency and precision of predictions over time.

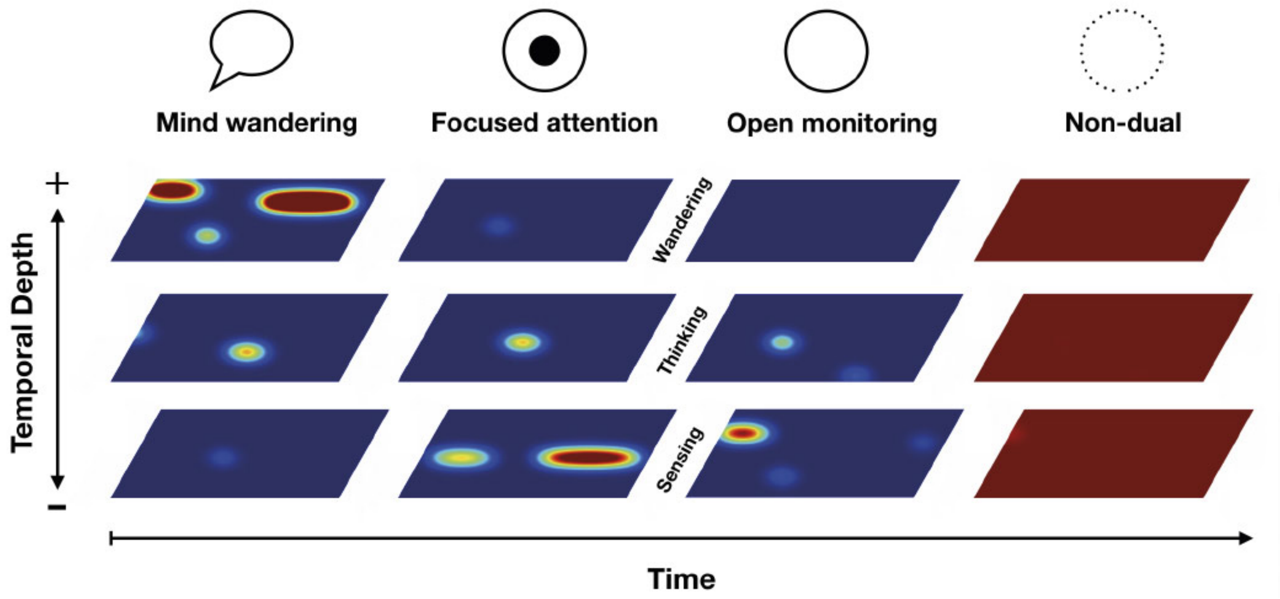


Figure 3. Here we illustrate the precision and frequency of predictions at different levels of the predictive hierarchy during mind wandering, FA, OM, and ND. Blue rectangles represent layers of the predictive hierarchy, with deeper and later layers represented at the top (e.g., mind wandering and the narrative self), task-relevant thinking in the middle, and the bottom rectangles represent earlier layers (e.g., present moment sensory experience). Ovals represent the predictions active in one's experience. The redder the oval the higher the precision-weighting of the prediction. The location of the oval in a specific rectangle represents a different prediction of the same layer of the hierarchy. For example, during FA meditation, one engages attention (increases precision) of a *specific* prediction at earlier layers of the predictive hierarchy (e.g., the breath). With practice, one can sustain attention on the same prediction for a longer period of time while decreasing the frequency and relative precision of predictions higher in the hierarchy. When one practices OM, different predictions will still arise in experience but are assigned lower precision, as illustrated by smaller and lighter ovals. With ongoing practice of OM, predictions arise less frequently and become less 'sticky', thus also disappearing faster. Increasingly experiencing without appraisal (an earlier layer of the predictive hierarchy) dominates as predictions, or contents of experience, become less relevant and capture attention less. Finally, during ND meditation, the awareness inherent in experience becomes the foreground. In FA and OM, predictions within experience are still the prominent event in experience. However, in the ND state, all contents of experience, as well as the subject of experience, fall away, and only awareness (without background or foreground) remains. This is represented by the background of the rectangle becoming red instead of blue. Note that for the FA, OM, and ND categories we have exemplified a relatively advanced practitioner. For a more novice meditator one can generally expect longer, more frequent, and more variable predictions at higher layers of the hierarchy[14].

To our knowledge, what we have described is the first integrated predictive processing account of FA, OM, and ND meditation styles. Although each meditation is proposed to uniquely modulate predictive processes, they nevertheless exist on a continuum where each strategy gradually breaks down increasingly ingrained expectations. Yet, one may wonder if true present-momentness is ever possible, given that also in the ND state, vital bodily parameters must remain within bounds. Thus, we propose that the ND state is characterized by a collapse of predictive processes that possess temporal depth and involve minimization of *expected* surprise. If one is no longer making any predictions about the next moment in time, then there is also no reference for time (i.e., past or future within which to define the present) or a continuous sense of self (i.e., no construct of self that was, is, and will be). Under this view, vital homeostatic predictive processes that operate at low levels of the hierarchy and do not elicit subjective experiences of time and self may continue, such as the maintenance of body temperature and blood circulation within necessary bounds. Yet, obviously, if one would stay in the ND state too long (as in the dark room), one would naturally end up dead. Ultimately, humans, like any living creature, have evolved to occupy a specific econiche that allows them to maintain their boundary, and not dissolve into entropy, which requires for example expectations to eat. Expert meditators report that it is possible not to experience hunger or thirst (indeed any bodily experience whatsoever) during meditation, which makes sense from our perspective given that "...hunger does not simply reflect an inference about hypoglycaemia but the belief that if I act in this way, I will avoid (surprising) interoceptive (low blood sugar) cues. This reflects the quintessentially counterfactual nature of allostatic processing in hierarchical models." (Pezzulo *et al.*, 2015, p. 26). Yet, we experience the world not just with our bodies, but because of our bodies, so ultimately, expectations inherited through evolution about physiological allostasis ought to 'kick in' and drive behavior towards survival, except perhaps in extreme cases[15].

4.1 Predictive processing & meditation: A nascent field

> "...it is easy to see that the FEP [Free Energy Principle] framework appears optimally suited for the scientific investigation of contemplative practices. In fact, it ties together in a coherent theoretical scaffold the core meditative notions of attention (top-down deployment of precision weighting), the conditioning power of habitual self-related patterns of thought and behavior (priors), and the embodied nature of cognition and emotion (interoceptive inference)." (Lutz *et al.*, 2019, p. 167)

Several theoretical proposals have been put forward in recent years about how meditation may affect predictive processing, although none of these distinguished between effects of different styles of meditation (although the existence of possible differences were acknowledged by both Lutz *et al.*, 2019 & Pagnoni, 2019). In a published conversation on predictive processing and meditation between Pagnoni (a neuroscientist) and Guareschi (an Abbot of a Zen monastery, Pagnoni & Guareschi, 2017), the role of attention and bodily posture was emphasized as important ingredients to make generative models more susceptible for revision in light of new inputs (Pagnoni & Hasenkamp, 2017). More recently, Lutz *et al*. (2019) framed FA meditation in predictive processing terms as corresponding to "the selection of a policy that includes the mental action of setting a high precision for the sensory prediction errors associated to the chosen attentional target and the prescribed bodily posture". They furthermore describe the shift from a state of focus to mind wandering as involving two processes: a change in prediction from sensory input (e.g., breath) to mental events (e.g., thought), and a corresponding shift in expected precision higher in the hierarchy (e.g., from sensing to thinking). This characterization is largely consistent with our account of FA meditation, where the goal is to bring attention away from thoughts (predictions high in the hierarchy) via increasing expected-precision of a sensory object (lower in the hierarchy).

Lutz *et al*. (2019) further proposed that FA meditation is characterized by inaction at multiple levels: the level of behaviour (sitting still), vision (e.g., keeping one's eyes centrally directed), and thought (by maintaining attention on a specific object). This non-action radically restricts active inference, and thus reduces the influence of prior beliefs and upweights the influence of sensory evidence. Indeed, past theorizing emphasizes that the strict bodily posture adopted in meditation is not arbitrary (Pagnoni & Guareschi, 2017; Pagnoni, 2019; Lutz *et al*. 2019). Lutz *et al*. (2019) suggested that the posture aids focus by alerting the meditator to mind-wandering whenever one "slouches", thus eliciting a prediction error that brings the meditator back to the sensory object, functioning as a kind of bio-feedback device (Pagnoni, 2019). Pagnoni (2019) also recently connected another specific meditation technique to predictive processing known as Shinkantaza, a form of Japanese (ND) Zen meditation. Interestingly, and at first glance in contrast to our model, Pagnoni suggests that this meditation practice *increases* the counterfactual richness of processing. Noting that this is "paradoxical" given the meditators focus on the here and now, the idea is that meditation weakens ingrained prediction loops and this in turn permits one to entertain a broader set of counterfactuals (particularly outside of formal meditation). Thus, while we propose that meditation itself "prunes the counterfactual tree", this pruning may be precisely what allows the system to *then* embody a more flexible and variable - or more rich - set of counterfactuals post-meditation by down-weighting the precision of ingrained habits of mentation. Put simply, the *state* of meditation decreases counterfactual processing (as we propose), but the enduring result or *trait* of meditation may permit a more flexible and rich counterfactual processing in daily life.

To date, no distinctions were made regarding the way that different styles of meditation may change predictive processing. Moreover, our model takes an important step by proposing a single mechanism that can account for the effects of FA, OM, and ND: They progressively reduce abstract processing in the brain. We also suggest that when viewed as a continuum of 'hereness and nowness', the purpose of these practices go beyond the regulation of cognition, attention, and emotion (as typically emphasized in the literature, e.g., Slagter *et al*., 2011) and instead emphasize the reduction of habitually generating predictions based on past experience. Like previous work, we also acknowledge the crucial role played by the embodied, holistic *inactive inference* of meditation that we think serves to prevent habitual predictions from arising in experience. Our model also goes further to propose how the three main meditation techniques may gradually deconstruct self-related predictions, unraveling increasingly basal forms of self-hood, until that which is even prior to self-modeling can be experienced. And finally, we also provide a framework for understanding how certain key insights may arise through fact free learning, which may cascade a radical revision of one's generative model and key priors.

5. Previous research under a new light

As yet there are only a handful of studies that have specifically tested how meditation affects self-specific processing, engrained habits (i.e., stubborn predictive processes), or that explicitly manipulated prediction formation, which we review in the following section. Nevertheless, existing work seems to align well with our predictive processing account of meditation, and the continuum of effects expected due to FA, OM, and ND practice. The review is divided into experimental and (neuro)phenomenological research. Given the nascent field, our model is also forward looking and we hope that it will inspire many new directions for empirical work at the intersection of meditation and prediction.

5.1 Experimental Research

Much of human waking consciousness is spent engaged in a thinking and narrative mode of being (Killingsworth & Gilbert, 2010), and we have suggested that FA meditation primarily aims to bring about an initial shift from thinking to sensing, laying the groundwork for subsequent practices. FA achieves this 'presentness' by reducing engagement with abstract temporally deep predictions (e.g., thinking) by increasing the expected precision of one source of present sensory experience, increasing the weight of actual sensory input over sensory predictions induced by spontaneous thoughts. This is evidenced by the fact that even very brief mindfulness of breathing (8 minutes) can occasion reduced mind-wandering episodes (Mrazek *et al.*, 2012), and four days (20 min/day) can improve mindfulness scores and sustained attention (compared to an active control group, Zeidan *et al.*, 2010). In a neuroimaging study, Farb *et al.* (2007) also proposed that humans possess a narrative-self bias:

> "The theory of narrative generation as a default state of self-reference is increasingly supported by neural evidence: the cortical midline activity, which underlies narrative-generating mind wandering (Mason *et al.*, 2007) is very similar to activity associated with the 'default mode' of resting attention (Gusnard *et al.*, 2001; Raichle *et al.*, 2001). This default mode suggests an endemic reliance upon the networks supporting temporally extended narrative processing..." (p. 314).

Suggestive that meditation may make it easier to voluntarily shift out of this narrative mode of being, the authors found that participants who underwent an 8-week mindfulness course (which involves characteristics of both FA and OM, Kabat-Zinn, 2003) showed a more pronounced shift in neural activity when volitionally engaging an experiencing versus narrative self-focus. For example, those who underwent the meditation training showed a more "marked and pervasive" reduction in medial prefrontal cortex activity - a key hub of the DMN associated with self-processing - during 'experience focus' compared to controls. In terms of our model, the meditators may have been able to more completely disengage temporally thick predictions in favor of a less abstracted present moment experiencing. Like many meditation studies, there are methodological limitations to be kept in mind: the design was not pre-post and there was no *active* control group, and thus it's hard to determine whether the mindfulness program was the causal factor. Nevertheless, these neural findings are broadly consistent with several other behavioral studies showing that meditation reduces mind-wandering (Levinson *et al.*, 2014; MacLean *et al.*, 2010; Mrazek *et al.*, 2012) and other neuroimaging results indicating that mindfulness reduces activity in key nodes of the DMN (Fox *et al.*, 2016). The prospect that FA can enhance present-moment experience of a sensory object, and reduce mental distraction, is also suggested by findings from an EEG study by Lutz *et al.* (2008), which found that practitioners of a three-month meditation retreat exhibited an increase in the temporal consistency with which the brain responded to auditory tones presented in the attended ear, that was accompanied by a reduction in reaction time variability.

While FA aims primarily to increase one's sustained attention of a sensory object in order to derive a more present and tranquil state of mind, OM meditation withdraws selective attention in favor of a broad scale dereification from the contents of experience. Such non-judgmental experiencing we have suggested equates to a reduction in the relative expected precision of all contents of experience, further increasing present-moment awareness. This should also reduce the development of new expectations. Consistent with this idea, Valentine & Sweet (1999) hypothesized that FA enhances attentional capacity for *expected* stimuli, whereas OM may (relatively speaking) enhance detection of *unexpected* stimuli, because one should not be 'caught up' by expectations. The study included novice (24 months or less) and experienced meditators (25 months or more) who predominately practiced either FA or OM, and a non-meditator control group. The participants were tasked with counting a stream of sounds that were first presented at a slow rate (0.25hz, expected condition), and in a final block, at a much faster rate (7hz, unexpected condition). In the expected condition, overall counting performance was lowest for control subjects, followed by novice meditators, and highest for experienced meditators. Moreover, and in line with their hypotheses, only the *unexpected* condition differentiated between FA and OM meditators, wherein the OM group performed better. These results may suggest that the OM meditators were less biased by the previous temporal regularities in the expected condition, in line with the notion that OM induces a state of present-moment awareness in which experience is less influenced by what just happened or may happen in the future. Another possible explanation is that, because the unexpected condition was also *faster*, then OM meditators were better able to 'release' each appearing stimulus in order to count the subsequent sound.

Slagter *et al*. (2007) showed a similar effect using the well-established attentional blink task. After 3 months of OM practice under intensive retreat conditions, participants showed a smaller attentional blink (i.e., the ability to notice a target stimulus (T2) that is rapidly presented after another target stimulus) compared to a control group. This finding was also backed up by EEG measurements that showed a smaller P3b to the first target (T1) stimulus, which is a brain potential that is associated with higher-order stimulus processing. These results make sense within our framework: if each passing stimulus is assigned lower precision, then the first target is less likely to capture attention, permitting better detection of T2. More specifically, these data support our hypothesis that OM meditation brings the practitioner more into a state of non-judgmental direct experiencing (i.e., lower in the temporal hierarchy of processing). More shallow processing means faster 'letting go' (better behavioral performance), which is further reinforced by a smaller P3b in meditators (an index of temporally deep processing).

We have also suggested that meditative depth can essentially be defined by the modulation of increasingly engrained habits or expectations. Thus, we would expect that more advanced meditation practices and greater expertise would permit the modulation of more stubborn predictions (or reactions to prediction-violations). Next, we briefly discuss four paradigms where this has been studied in the context of meditation - neural markers of prediction errors, startle responses, analgesic effects, and binocular rivalry. Each of these paradigms invoke an experience or reaction in the organism that is ordinarily believed to be automatic. However, below we outline some preliminary evidence suggesting that meditation may be able to modulate these responses by - we suggest - preventing the construction of temporally deep predictions grounded in past experience. These findings therefore are also revealing about the plasticity of predictive processing more broadly. In many cases, the evidence is also consistent with the idea that expertise and practices that go beyond FA are required to induce effects on more stubborn predictions.

A promising method for investigating the effect of meditation on prediction is the odd-ball paradigm, where a surprising (usually auditory) stimulus is presented after several repetitions of predictable stimuli. EEG studies show that the deviant stimulus ordinarily evokes an auditory event-related potential known as the mismatch negativity (MMN) thought to be a kind of neural correlate of prediction errors (Garrido *et al*., 2009). Initial investigations of FA meditation found increased MMN in response to surprising auditory stimuli (Srinivasan & Baijal, 2007), indicative of the development of more precise sensory expectations through FA. There is also evidence of trait effects, whereby experienced meditators showed a larger MMN than novices also while not meditating (Biedermann *et al*., 2016). These results are consistent with the idea that FA meditation leads to increased attentional capacities for low-level sensory stimuli. However, other meditation practices, according to our model, also involve a *retraction* of attention and precision-weighting to any particular components of experience, in favor of a more holistic and *bare* attention towards one's experience as a whole as in OM, or releasing of attention all together, as in ND. Interestingly, Fucci *et al*. (2018) recently found that FA meditation lead to a higher MMN than a control condition (as in Biedermann *et al*., 2016), but ND meditation did not. Non-dual meditation showed approximately the same degree of MMN as a control 'reading' or "distracted" condition, and the difference between practitioners in the FA versus ND was only different at the trend level. Thus, ND meditation in this study did *not* abate the MMN as would be expected if the meditator were genuinely not forming expectations across time. Expertise in ND meditation is hard to establish (i.e., it is very difficult to say if participants were genuinely in such a state). It is also possible that low-level neural signatures of oddballs are sufficiently automatic that they cannot be eliminated by changes in mental state (see below for a study where a higher-level prediction error is attenuated by meditation). Yet, it has been shown that the prediction error-related MMN vanishes during deep sleep (Strauss *et al*., 2015). Future research is necessary to replicate this finding by Fucci *et al*. (2018) and will be critical for establishing which predictions are capable of change through meditation and which are truly stubborn.

In a related paradigm, Kirk & Montague (2015) found that Zen meditators (compared to controls) showed *no* reward-related prediction error responses as measured by fMRI. In this experiment, participants were not meditating; thus, the results likely represent trait effects. One explanation is that, by resting in the here and now, the meditators were no longer constructing inferences about the positive or negative valence of an event. The other possibility is that Zen meditation, because it is primarily a ND tradition, makes it possible that the effect is due to a modulation of prediction error signaling more broadly.

Clearly, further research is needed to properly disentangle the relationship between FA, OM, and ND meditation on prediction error signaling. Nevertheless, we see these results as providing preliminary evidence that FA increases expected precision-weighting of sensory experience leading to higher prediction-error signaling (Srinivasan & Baijal, 2007), whereas the more advanced practices such as ND retract precision-weighting of any specific content of experience - emphasizing awareness itself - making stimuli less surprising in general (Fucci *et al*., 2018; Kirk & Montague, 2015). Yet, as noted above, some predictions, like the oddball effect, may be evolutionary engrained and difficult to abolish even by experienced meditators.

Representing another highly automatic process, the startle response is believed to be a phylogenetically primitive defense reflex (Koch, 1999). Testing whether meditation may lead to modulations in the startle response, Levenson *et al*. (2012) found that a highly experienced meditator (40 years of practice) showed a smaller startle response when meditating compared to 12 control subjects. Notably, ND meditation resulted in the smallest startle response (relative to FA), consistent with our framework. In another study investigating *habituation* to the startle response, Antonova *et al*., (2015) reported no evidence of habituation in 12 expert meditators who were instructed to rest in a non-dual state while being presented with startling sounds. Interestingly, participants with moderate meditation experience showed more habituation than control subjects, highlighting that expertise or depth of meditation may not be a linear process, but something more akin to an inverted U-curve. In contrast to Levenson *et al*. (2012), Antonova *et al*. (2015) found no effect of meditation on the initial startle reflex, which they propose might be due to the meditators being less experienced or due to the use of a weaker startle stimulus in their study. These studies provide preliminary evidence that expertise and advanced practices lead to the largest modulations of the startle response, both in terms of the initial reflexes elicited by a "surprising" stimulus (Levenson *et al*., 2012) and in terms of startle habituation, a form of learned inhibition (Antonova *et al*., 2015; see also Hanley & Garland, 2019 for evidence that mindfulness training can reduce Pavlovian conditioning).

The experience of pain is also a highly automatic inference. But, like other subjective experiences, under the predictive processing framework, pain is the outcome of an inferential process. Thus, being fully immersed in the here and now - i.e., not constructing temporally deep models - it would *theoretically* be possible for meditation to modulate the construction of painful experiences. Indeed, there is growing evidence that some forms of meditation can have such analgesic effects. Grant (2014) reviewed experimental work on the effects of meditation on pain reduction and found that OM meditation but *not* FA showed consistent and relatively strong reductions (up to 23%, Grant & Rainville, 2009) in pain intensity ratings (see also Zeidan & Vago, 2016). Such findings are also supported by differences between meditators and non-meditators in neural activity both before and during the painful stimulus (Lutz *et al*., 2013). Reductions in experiences of pain may be driven by different mechanisms, for example the most complete cessation would occur if one were able to halt pain prediction entirely. Such a finding would theoretically be possible in a ND state. However, it is more likely that existing findings represent a more modest deconstruction of predictive processes, where OM meditation leads to less anticipation and/or judgment of the pain as aversive (Lutz *et al*., 2013). Consistent with this idea, Perlman *et al*. (2010) found that OM (but not FA) lead to significantly lower ratings of unpleasantness for painful stimuli, but *not* intensity. This finding also makes sense under our framework where OM works to reduce the temporal depth of processing to a more direct experiencing prior to appraisal/judgment.

Finally, the phenomenon of binocular rivalry highlights how past experience affects the most basic levels of perceptual experience. In this task, two images are presented separately to each eye (e.g., a face and a house), which leads to a fascinating phenomenon wherein the observer perceives an alternating face *or* house image (and sometimes a mix). Under the predictive processing framework (Hohwy *et al*., 2008), the rivalrous perception occurs because the input violates the brains expectations that two different images can occur in the same spatio-temporal location. Thus, past experience prevents the perception of the 'true' input, i.e., a coalesced face-house image. Moreover, perception continues to switch between percepts because the unperceived stimulus continues to trigger prediction errors until it leads to a revision in the posterior hypothesis (and the cycle continues). Intriguingly, Carter *et al*. (2005) presented binocular rivalry stimuli to Tibetan monks with extensive meditation experience. The authors found that one-point meditation (an advanced form of FA) reduced perceptual switch rates (including three monks who experienced a stable stimulus for the whole five-minute period!). From the predictive processing perspective, this makes sense if the meditators, through FA, increase the precision of the prediction errors of the attended stimulus (thus, overpowering prediction errors from the unperceived stimulus). The authors also found something highly unusual: One of the monks reported experiencing a prolonged so-called 'mixed percept'. Under the predictive processing framework this suggests that the stubborn prediction 'two images cannot appear in the same spatio-temporal location' was broken down[16]. Carter *et al*. (2005) concluded that "These results contrast sharply with the reported observations of over 1000 meditation-naive individuals tested previously". Since it is difficult to maintain deep states of meditation while providing responses, several subjects were not comfortable in responding during the experiments, and thus the results were dependent on post-hoc self-reports. An important direction for meditation research is to develop paradigms that do not interrupt the meditation, but can track neural representations and perceptual experience, which we address in the Discussion.

In the above, we discussed several key findings from meditation studies to showcase how these findings may be re-understood based on our many-to-one model, and how meditation may shed novel light on the extent to which predictive models are plastic versus stubborn. In the below, we discuss meditation-related changes in self-reported phenomenal experience in relation to our model.

5.2 (Neuro)Phenomenological Research

Perhaps the most radical evidence for the deconstruction of the predictive processing hierarchy is found in the self-reported phenomenology of expert meditators. Indeed, many generations of practitioners from Buddhist meditation traditions have theorized about subjective experiences that are expected to occur at specific stages of practice (Bodhi, 2011; Wallace, 1999). Many expert meditators also report being able to access such states on demand, and there is now a growing effort to map these subjective experiences under controlled settings and to identify corresponding neural changes (Dor-Ziderman *et al*., 2013, 2016, 2016; Petitmengin *et al*., 2017, 2019). These reports support the notion that more advanced states correspond to the breaking down of increasingly engrained habits of mentation, including perceptions of selfhood, space, and time: Experiences that are supported by unique and consistent neural signatures (Berkovich-Ohana *et al*., 2013). In the following we describe some of the studies conducted on meditative phenomenology as they relate to our model. We are primarily interested in the possibility that meditative (neuro)phenomenology can provide evidence of the deconstruction of highly engrained models, thus offering initial evidence that predictive processes may be more malleable than previously thought.

Below we particularly focus on changes in the sense of self, since it is the explicit aim of some meditation techniques (Dahl *et al*., 2015) and has received the most (neuro)phenomenological research. Changes in the self-sense is also central to our model, which proposes that meditation gradually permits the discovery of increasingly basal forms of selfhood, culminating in the ND state, where the practitioner is "resting" in/as the here and now to the extent that there is no self-awareness or temporal experience whatsoever.

In a seminal neuro-phenomenology study by Dor-Ziderman *et al*. (2013), 12 experienced vipassana meditators were instructed to enter 3 states of "self-awareness" while MEG recordings were made. The three states - similar to our characterization - were: the narrative self, the minimal self (or experiencing self), and the "self-less". Self-less experiences were defined by a lack of agency or ownership. One subject described such an experience as follows, "It was emptiness, as if the self fell out of the picture. There was an experience but it had no address, it was not attached to a center or subject..." (Dor-Ziderman *et al*., 2013, p. 6). Nearly all participants reported success in accessing all three states of self-awareness and in maintaining them for the duration of the instructed period. Consistent with the idea that deeper and more self-less states involve less conceptual processing (placing them lower in the predictive hierarchy), the minimal self and self-less conditions also showed a dramatic reduction in self-reported emotions (negative, positive, and mixed) compared to the narrative self. Furthermore, consistent with extensive fMRI research on self-related processing (Gusnard *et al.*, 2001), attenuation of the narrative self was supported by decreases in gamma oscillations source localized to frontal and particularly medial prefrontal cortices. And finally, some of the highly experienced meditators who reported the most vividly self-less experiences showed additional attenuation of the inferior parietal lobule and left dorsomedial thalamus in the beta band (Dor-Ziderman *et al.*, 2013). As noted by Dor-Ziderman (2013), the inferior parietal lobule has been implicated as a key region associated with the sense of agency and subjective control (Nahab *et al.*, 2011).

In another study with a similar design, Dor-Ziderman *et al.* (2016) focused on the phenomenology of an advanced meditation practitioner who was entering into a state of ND awareness. Consistent with the previous study, the transition from a minimal form of self-experience to a self-less state was associated with changes in beta oscillations localized to the temporo-parietal junction (TPJ, including the inferior parietal lobule, as in the previous study) as well as the medial parietal cortex including the precuneus (a key node for self-representation). The TPJ has been extensively shown to play a key role in self-related processing, including self-awareness, self-location, agency and ownership, egocentrism, and the experiential unity of body and self (Dor-Ziderman *et al.*, 2016). Another study using functional magnetic resonance imaging (fMRI) in 24 Tibetan Buddhist meditation practitioners suggests that ND meditation may lead to alterations in interactions between intrinsic networks involved in self-referential processing, of which the precuneus is a central node, and extrinsic networks involved in external, task-related processing (Josipovic *et al.*, 2011). This finding is consistent with the idea that ND practice particularly influences the habitual organization of cognition along a subject-object dichotomy.

Most recently, Winter *et al.* (2020) reported data from joint EEG-fMRI while an extremely experienced meditator with over 40 years and approximately 50,000 hours of practice entered a ND state. The participant reported afterwards that towards the end of the meditation, he experienced no mental or sensory content whatsoever, including no self, time, or space, but *did* report maintaining a steady 'wakefulness' throughout the whole period. Compared to a resting state baseline, the subject showed sharp decreases in alpha-band power (EEG) and functional connectivity of the DMN (fMRI). This latter finding is in line with the research reviewed above, as Winter *et al.* (2020) also noted: "The interplay between the medial and lateral parietal nodes of the DMN has been found to be associated with meditative experiences of non-dual awareness (Josipovic, 2014), selflessness (Dor-Ziderman *et al.*, 2013), spacelessness and timelessness (Berkovich-Ohana *et al.*, 2013)".

The above studies together suggest that some meditators can volitionally enter states that gradually deconstruct self-representations, including the narrative self and the minimal self (Dor-Ziderman *et al.*, 2013, 2016), and through more advanced practices may be able to collapse the subject-object distinction (Josipovic, 2014; Winter *et al.*, 2020), which are corroborated by relatively consistent neural signatures. According to our model, this gradual deconstruction of the self-hierarchy is a natural consequence of resting in the here and now, because as meditation 'prunes the counterfactual tree' (flattening the predictive hierarchy) it necessarily also prunes one's sense of self, from a narrative form of selfhood all the way to selfless awareness.

Achieving advanced states of meditation is not a process that is always experienced positively, and that challenging and even impairing experiences can arise (Lindahl *et al.*, 2017; Lindahl & Britton, 2019). In some cases alterations to the sense of self are also experienced as distressing or resembling psychopathology (Lindahl & Britton, 2019). Thus, the outcomes of (especially) more intensive meditation may not coincide with the goals of mindfulness practice for many lay practitioners (e.g., reducing stress, being more productive), a possibility we return to in the Discussion. The above review is not intended to be exhaustive, but a focused review of key papers that are revealing about the flexibility of predictive processing during different meditation practices. In the Discussion, we return to issues of methodological rigor and propose promising novel paradigms that may strengthen the above findings and improve our capacity to experimentally investigate deep states of meditation.

5.3 Dissolving or disappearing: Psychedelics and meditation

There seems to be some merit in briefly comparing our predictive processing account of meditation to recently formulated predictive processing theories of psychedelics. The reason for this is four-fold, 1) psychedelics and meditation both show deconstructive effects on predictive processes, 2) they can both radically alter one's sense of self (Millière *et al.*, 2018), 3) they show some neuro-biological similarities (Millière *et al.*, 2018; Timmermann, Spriggs, *et al.*, 2018), and 4) they are both thought to lead to novel insights about the workings of one's mind and can exhibit positive effects on mental health (Carhart-Harris & Friston, 2019). Although there are clear conceptual similarities, there are also important differences between our account and predictive processing models of psychedelics. Highlighting some of these may help guide future research on the intersection of meditation and psychedelics (for recent examples see, Millière *et al.*, 2018; Milliere & Metzinger, 2020; Smigielski *et al.*, 2019). Below we focus on the recent predictive processing model of psychedelics termed relaxed beliefs under psychedelics, or REBUS for short (Carhart-Harris & Friston, 2019). Although competing models exist (Swanson, 2018), the REBUS model shows growing empirical support (e.g., Alamia *et al.*, 2020; Girn *et al.*, 2020; Herzog *et al.*, 2020).

According to Carhart-Harris & Friston (2019), psychedelics induce their characteristic effects on phenomenology by inducing increased entropy via agonism of the serotonin 5-HT$_{2A}$ receptors found predominately at high levels of the cortical hierarchy. This entropy purportedly leads to a breakdown of the DMN and temporally deep priors that ordinarily constrain input from lower layers of the hierarchy. These loosened beliefs in turn permit a kind of unconstrained "anarchic" phenomenology, where predictions that would ordinarily be explained away by deeper models, now arise in conscious experience. Moreover, since the classic psychedelics - e.g., psilocybin and lysergic acid diethylamide (LSD) - are thought to effect the highest levels of abstract processing, then self-related processing (especially that which is instantiated by the DMN, Carhart-Harris *et al.*, 2014) is expected to breakdown. One similarity with our account is that meditation should also engender relaxed high level beliefs by decreasing their expected precision. But perhaps unlike psychedelics, meditation may radically reduce the frequency of high-level predictions (such as mind-wandering) and the very formation of some predictions. That is, we contend that the three meditation styles gradually reduce deep predictions from arising (e.g. thoughts, emotions, senses), ultimately resulting in the non-dual state. This contrasts with states induced by most psychedelics, including drug-induced ego dissolution, which often have a rich sensory and emotional phenomenology (Millière *et al.*, 2018).

Both psychedelics and meditation also result in consistent reports of experiences where one's usual sense of self changes (see Millière *et al.*, 2018 for a review). We have suggested that the reason these changes in self experience occur in meditation is through a gradual reduction in temporally deep processing by resting in the here and now. On the other hand, following the REBUS model, changes in self-processing purportedly occur due to the entropic effects of psychedelics on existing priors (which may also 'flatten' or 'collapse' the hierarchy, Girn *et al.*, 2020; Deane, 2020), and thus ordinary self-modelling breaks down. Thus, we propose that meditation gradually *abates* the emergence of predictions by restricting awareness to the here and now, whereas psychedelics loosens priors and, in this way, leads to the dissolution or "mergence" of self-world boundaries in experience. Or put simply, meditation *reduces* counterfactual inference, whereas psychedelics disrupt it. This difference is evident in the fact that self-less experiences during psychedelic ingestion tend to be described with high phenomenal richness whereas meditative experiences often have very little (or no) phenomenal content. Claims of "unity", or "oneness" with the environment, and statements such as "...merging with my surroundings" are common among psychedelic reports (Millière *et al.*, 2018). On the other hand, meditators more commonly report "emptiness", "space", and "nothing" (Metzinger, 2020; Millière *et al.*, 2018). Indeed, if the experience is truly non-dual, then there should be no experience of self, environment, or their 'mergence'. These reports are not surprising under our account, where meditation abates counterfactual processing, whereas psychedelics relax them. Put simply, we suggest that meditation prunes the counterfactual tree, whereas psychedelics dissolve it, both leading to possibly unique changes and absences in one's sense of self (see Figure 4).

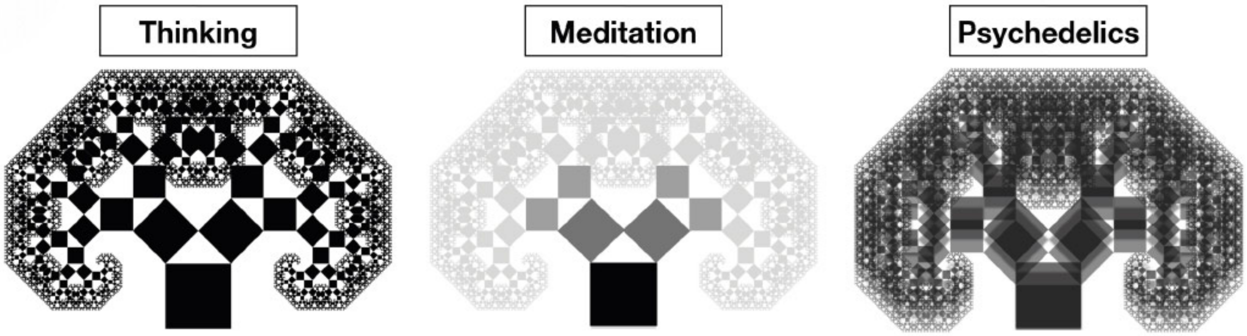


Figure 4. Here we provide an intuitive illustration of how meditation and psychedelics may differentially affect counterfactual processing. On the one hand, the psychedelic state may lead to greater counterfactual richness through its reduction of sensory gating, where relaxed high-level beliefs release low-level predictions (or counterfactuals) that would normally be explained away. Existing priors about one's self and bodily representation may then begin to dissolve because the usual models that maintain such boundaries are less precise (or *relaxed*). On the other hand, in the meditative state, counterfactual processing is gradually reduced, permitting a more progressive reduction in self-related processing, first at the higher levels (e.g., narrative self) and later at the lower levels (e.g., embodied self). During psychedelics, narrative and experiencing aspects of self-hood may begin to dissolve simultaneously and affect each other in innumerable ways, which is perhaps consistent with the more variable changes in self-processing that seem to occur during psychedelics (Millière *et al*., 2018). Although this figure is meant to serve as an intuitive illustration, it is consistent with the fact that psychedelics are known to induce greater entropy in neural activity, which is further believed to correspond to increased phenomenological richness (Carhart-Harris *et al*., 2014).

These differences also raise an intriguing, albeit speculative possibility that deep meditation may prevent some of the classic psychedelic effects. Hallucinations as well as changes in cognition and emotion experienced in the psychedelic state imply altered deep temporal processing, and if meditation halts the construction of models based on past experience, then it may also reduce some forms of hallucination and distorted perception - particularly since psychedelics are thought to target the highest levels of the cortical hierarchy (5-HT$_{2A}$ seratonin receptors). A simple hypothesis is that classic psychedelic effects at higher levels of the hierarchy (e.g., that pertain to changes in *narrative* self-processing) would be reported to a lesser degree by experienced practitioners during meditation. There is some preliminary evidence for this idea. In a double-blind placebo controlled study, Smigielski *et al*. (2019) administered Psilocybin to experienced meditators on the fourth day of a meditation retreat. Using the well-known Five Dimensional Altered States of Consciousness scale (5D-ASC), the meditators exhibited some of the usual effects of the psychedelics. Notably however, no signficant effects were found on the Dread of Ego Dissolution dimension (items include, loss of thought control, negative derealization, and thought disorder), which is in contrast to the results of eight other experiments administering psilocybin to non-meditators (Studerus *et al*., 2011). If the meditator has halted much of high-level narrative processing, then indeed any effects related to thinking ought to be diminished[17].

Providing an interesting anecdote, the late Richard Alpert (known as Ram Dass) and former Harvard Professor who assisted in the famous Good Friday LSD experiments - the first controlled double-blind study of its kind - reported giving an extremely high dose of LSD to his meditation teacher in India (Dass, 2010). On two occasions, he watched as the "Guru" (Neem Karoli Baba) ingested approximately 900 and then 1200 micrograms of LSD - up to ten times a normal dose - and appeared to show no effects, eventually asking if Alpert "...had anything stronger" (Dass, 2014). The recent renaissance and rapid growth of research on both meditation (Van Dam *et al*., 2018) and psychedelics (Swanson, 2018), and their purported positive effects on mental health, make their interplay an exciting domain of future study, particularly as they relate to the ability of the mature mind to change.

6. Discussion

> "*The senses perceive the object, which then the mental consciousness instantly conceptualizes in a manner conditioned by all of our past experience, and superimposes this conceptualized version back onto the originally neutral data of our senses - all of this occurring so fast that we don't even notice the process, and are only left in the end with the mind's conceptual version of things that we take to be reality.*" (Thrangu, 2011)

Cognitive neuroscience is undergoing a kind of Gestalt switch, from an understanding of the brain as a vessel that 'drinks in' the world, to an organ that repeatedly regurgitates the world through predictions derived from the past. This view of experience - as deeply contrived through past conditioning - is remarkably similar to Buddhist ideas at the root of mindfulness-based interventions now popular in Western science, as the above quote illustrates. Moreover, the gradual breaking down of concepts in Buddhist meditation maps on strikingly well to the gradual building up of a concept in the brain.

Previous research has often focused on how meditation can improve functioning in one way or another, including stress reduction, cognitive performance, or emotion regulation (Kabat-Zinn, 2003; Lutz *et al*., 2008a; Slagter *et al*., 2011b; Tang *et al*., 2015). However, many contemplative traditions from which these practices emerge suggest that meditation can go much deeper, focusing instead on understanding one's "true nature", "the nature of the self", or attaining certain insights about the nature of reality (Bodhi, 2011a; Suzuki, 1961; Wallace, 1999b)[18]. These seemingly esoteric aspects of meditation have been largely washed out of modern science perhaps for easier integration within a secular vision of mind, body, and brain. However, from the perspective of predictive processing, these facets of meditation suddenly become less mysterious and instead - we propose - the logical consequence of being truly "at one" with the present moment. That is, simply being present enough would naturally reduce abstract predictive modeling within the brain, and this in turn would naturally give rise to the phenomenology reported at various stages of practice.

More specifically, we have put forward the novel hypothesis that the habitual *modus operandi* of hierarchical predictive processing is progressively broken down by three main styles of meditation (FA, OM, and ND). We postulated that: (1) FA meditation reduces the precision and frequency of deep temporal models by up-weighting the precision of one input lower in the predictive hierarchy (e.g., the breath). (2) OM meditation further reduces counterfactual processing by reducing the frequency of predictions and balancing expected precision, thus permitting non-judgmental experiencing. Finally, (3) ND meditation creates the conditions for the final subject-object abstraction to fall away. In the ND state, all *expected*[19] error-minimization and thereby conceptualization (including self and time) ceases.

We also proposed in Section 4 (see also Figure 2) that FA, OM, and ND gradually abate the construction of self-processing at different levels of the predictive hierarchy, from the narrative self (i.e., thinking), to the embodied experiencing self (i.e., sensing), to non-self (i.e., awareness). We also showed how key insights - as targeted in classical Buddhism - can occur through meditation (Section 3.2). We proposed that reducing abstract processing in the predictive hierarchy may reveal certain insights about one's mind by increasing the transparency of predictive processes(e.g., discovering the impermanent or 'conditioned' nature of one's predictions as they are constructed and deconstructed). Further insights may arise through fact free learning (Friston *et al*., 2017) - the internal revision and refinement of models supported by the holistic non-action of meditation (i.e., *in-active* inference, Section 2.5). Below, we discuss the scientific value of meditation and outline important avenues for future research.

6.1 From Many to One: Novel insights from a unifying framework

There is a growing body of work investigating how meditation can change cognitive, emotional, and neural functioning (Dahl *et al*., 2015; Hölzel *et al*., 2011; Josipovic, 2014; Lutz *et al*., 2015b; Raffone *et al*., 2019; Vago & David, 2012; Vago & Zeidan, 2016). This work has also related specific styles of meditation to changes in predictive processing (Lutz *et al*., 2019; Pagnoni, 2019). Here, we extend this work by delineating how predictive processing may change from FA to OM to ND meditation, providing a unified account of meditation. Below we outline the scientific value of this new framework, with implications to our understanding of plasticity, psychopathology, rumination, and self. There are also several remaining outstanding questions in contemplative science (Van Dam *et al*., 2018) that our Many-to-One framework may specifically help address, including how meditation practice may induce enduring or trait changes in brain and mental functioning, how to determine meditation expertise, and how to approach negative meditation-related experiences.

6.1.1 The scientific value of meditation: Plasticity

It is not only interesting to know how meditation 'works' but also what meditation can teach us about the brain and mind. Clearly, such an intensive mental practice that can fundamentally shift perception and cognition may also be revealing about how the mind and the organ that gives rise to all mental activity, the brain, work. We have particularly suggested that meditation can be used as a tool to investigate the plasticity of brain and cognition by revealing what is amenable to change from within, and what is not. For instance, given at least preliminary evidence that meditation can modulate strong mental habits (see Section 5), then meditation could in turn be used to investigate which features of phenomenology are more or less engrained, thereby also informing theory in cognitive neuroscience. For instance, Yon *et al*. (2019) recently proposed that the sense of agency is a stubborn prediction, but as now suggested by multiple studies, the sense of agency can fall away during meditation (Dor-Ziderman *et al*., 2013, 2016; Lindahl & Britton, 2019; Metzinger, 2020). Meditation research may also be revealing regarding the processes that are most phylogenetically constrained in human beings: Some predictive processes may simply be too stubborn for any voluntary regulation. Nevertheless, it is important to keep an open mind since it is often very difficult to find and test multiple subjects who can reliably induce profoundly altered states during meditation, and very hard to determine who can do so a-priori. As contemplative science progresses valuable strides will perhaps occur when scientists are able to better establish expertise (see also 6.1.7) and gain access to highly advanced practitioners from a variety of different meditation traditions.

6.1.2 The scientific value of meditation: Psychopathology

Beyond brain plasticity, our framework can also shift the way we look at clinical outcomes. Meditation and mindfulness-based interventions show promise in treating depression, anxiety, stress, and more (Chiesa & Serretti, 2009; Hofmann *et al*., 2010). All such findings represent transformations in the way individuals construct their experience and behave in the world, and thus can be conceptualized as changes in predictive processing. Given our framework, clinical outcomes may conceivably follow from an initial deconstruction of problematic habits of prediction, and then a 'healthier' reemergence. This healthier reconstruction may be achieved particularly through model selection, optimization, and compression mechanisms (described in Section 2.5). Moreover, the inherently explorative nature of meditation - where the curious observation of all inner-experiences is strongly encouraged - may also serve the refinement of predictive modeling, and make perceptible hitherto ignored interoceptive, emotional, and cognitive processes (Schwartenbeck *et al*., 2019). Taken together, meditation may induce positive clinical outcomes by reducing habitual patterns of mental activity, revising stubborn habits and by increasing self-awareness.

6.1.3 The scientific value of meditation: Rumination

There may also be some further truths in the metaphor of '*pruning* the counterfactual tree'. It's obvious that excessive rumination is not conducive to a happy life (Killingsworth & Gilbert, 2010). Moreover, ruminative counterfactualizing seems to play a key role in the maintenance of psychopathologies such as anxiety and depression (Nolen-Hoeksema *et al*., 2008). We also earlier mentioned the tendency for humans to think about things that they are trying to avoid (Bulley *et al*., 2017) - what we called *anti-predictions* (e.g., "I don't want to get Alzheimer's disease"). Such ruminations may underlie substantial unnecessary mental turmoil and energy expenditure, as evidenced by the high metabolic demands of the DMN and links between rumination and negative mood states (Smallwood *et al*., 2009). Although rumination can have adaptive value when it is not excessive (Baird *et al*., 2012; Vago & Zeidan, 2016), *pruning* these high-level counterfactual cognitions through meditation may be one way to revise the immense multiplicity of thoughts to those that are adaptive to one's goals. Although meditation creates the potential for profound change, the nature of those changes also needs to be carefully and gently guided in constructive directions to mitigate harmful experiences (Britton, 2019). There are many meditation styles that are suited for this, for example compassion meditation, or loving kindness. These more 'constructive' practices (Dahl *et al*., 2015) may be important ingredients for guiding 'change' in a positive direction.

6.1.4 The scientific value of meditation: Self

Conducting experiments often require the manipulation of some variable. Therefore, in order to carry out rigorous experiments that are revealing about the nature of self-processing in the mind and brain scientists require ways to modulate it. Meditation is therefore obviously well placed as a tool for investigating the nature of the self, and relatively rare states of consciousness where self-processing either changes or entirely disappears. Both modern science and Eastern traditions of contemplative practice concur that the self is a kind of 'construct' that can breakdown or disappear under various conditions. Yet, science has gained most of its insights about the constructed nature of self-processing through clinical populations where such events can be highly debilitating and accompanied by several comorbidities and other symptoms. Meditation may uniquely permit the scientists to study the targeted modulation of specific self-processes constructed at various layers of the brain hierarchical system, and the changes to behavior, emotion, and phenomenology therein. The scientific study of ND meditation in particular may be crucial for better understanding the nature and neural basis of the so-called minimal phenomenal experience, consciousness without self-location in space, time representation or self-consciousness (or 'sciousness as William James termed it) (Metzinger, 2020). This state of awareness is currently not included in any major cognitive neuroscience theory of consciousness, yet, proposed by some to lie at the core of all conscious experiencing, as discussed above. Some expert ND meditators can allegedly reliably induce the non-dual state in laboratory settings, rendering this basic self-less awareness accessible to scientific investigation. Yet, as elaborated on below, this will require the development of novel methodological approaches.

6.1.5 The scientific value of meditation: Summary

Informed by our framework, we conclude that meditation has promise in expanding scientific frontiers by increasing our understanding of brain plasticity, the concomitants of psychopathology, as well as thinking and counterfactual cognition. Meditation is also well placed to help scientists address basic and fundamental questions for how the experience of an 'I' as an agent separate from a world 'out there' emerges from prediction-error minimization. There is also promise that meditation may unveil properties of consciousness itself, such as the possibility that there exists a state in which *only* consciousness remains, a kind of 'minimal phenomenal experience' (Metzinger, 2020), which raises the possibility of more targeted investigations of consciousness as such, rather than the experiences appearing through it. In the below, we outline how our framework can also push contemplative science to the next level by addressing outstanding questions in the scientific study of meditation.

6.1.6 Insights for contemplative science: From state to trait

As state-level meditation changes are known to lead to longer-term trait-level changes (Rael & Polich, 2006), one may also expect that meditators should display differential functioning of the predictive processing machinery 'off the cushion'. Drawing on our framework, more advanced meditators would be expected to naturally reside in a state where, over time, there is less abstract counterfactual cognition. This does not mean that a meditator is *incapable* of abstract processing, but that the habitual tendency to engage with deep temporal models ought to decrease, and be more easily attenuated. Indeed, there is fMRI evidence that meditators (regardless of tradition) may "...transform the resting state into one that resembles a meditative state" (Brewer *et al.*, 2011, p. 20255). Moreover, some well-known adepts of non-dual meditation have claimed that perceptions, sensations, and hence 'the world' does not exist for them, because the appearance of sensing and high-level thinking may be highly infrequent or barely noticeable (Maharshi, 2004; Nisargadatta, 1973). Long-term practice may hence also reduce the frequency of arising predictions in experience and their expected precision over time.

The transition of meditation from state to trait may also be driven by fact free learning and insight (Friston *et al.*, 2017). Meditation is a unique practice in the sense that it reduces typical active inference processes (including mental actions) and may thereby accelerate the revision or refinement of *existing* models. These revisions may then result in the development of new and potentially stable priors. Meditation experience could also render mental activity more counterfactually rich in the long term, as proposed by Pagnoni (2019). If meditation weakens ingrained prediction loops during practice, this would permit one to entertain a broader set of counterfactuals outside of formal meditation contexts. In other words, the broadscale loosening of beliefs may permit more flexibile and multidimensional processing (a prospect there is already some evidence for, Moore & Malinowski, 2009). In general, meditators should also experience less habitual grasping onto passing experience i.e., they should display a decrease of salience and stickiness of arising predictions (see for example, van Leeuwen *et al*., 2009). Thoughts and feelings may also become less self-related, which may foster an enduring sense of psychological well-being (Dambrun & Ricard, 2011).

6.1.7 Insights for contemplative science: Establishing expertise

Our model also has implications for what might constitute markers of meditation expertise. Currently, expertise in meditation is notoriously difficult to pin down and there has been much inconsistency on what counts as an experienced meditator in the literature (Van Dam *et al*., 2018). According to our account, meditative expertise could be partly captured by the extent to which the meditator is able to voluntarily modulate objective markers of stubborn predictions. For example, Antonova *et al*. (2015) found that startle habituation discriminated intensity of meditation practice better than self-report, dispositional, and practice-related measures. Thus, they proposed that habituation to the startle response could be used as an objective marker of expertise. We suggest that the startle response represents one of many possible objective markers of meditation expertise because it is a highly automatic response (i.e., a stubborn prediction). Many other measures could foreseeably be used, ideally in combination, to test whether a practitioner is able to enter states that are free from such habitual responses. Crucially, the more automatic the prediction, the more expertise would be required to prevent the habitual response.

To provide a few new directions for research on meditative depth, we suggest the following automatic responses are worthwhile investigating further, (1) implicit learning, statistical learning, and conditioning, (2) conceptual processing, such as the automatic formation of words from sounds, (3) visual illusions, such as perception of illusory shapes, and (4) the volitional modulation of wakefulness and arousal (Britton *et al*., 2014). Intriguingly, since many decisions and tasks require abstract, self, time, and space related processing, it is also possible that performance on some tasks would be *impaired* due to meditation. For example, while some mindfulness-based interventions might improve learning by enhancing the ability to focus attention (Laukkonen *et al*., 2020), other meditation practices may reduce the ability to learn and retain new information or extract statistical regularities. Indeed, a study in nonmeditators showed that individuals scoring high on self-reported mindfulness displayed impaired artificial grammar learning (Whitmarsh *et al*., 2013). Thus, meditation could also impede performance in some everyday life settings. Just as meditation may not always improve performance, it may not always lead to positive experiences.

6.1.8 Insights for contemplative science: Challenging experiences

Profoundly deconstructing the mind is not a simple and straightforward endeavor, and recent evidence suggests that negative and challenging experiences do occur and can be severe (Britton, 2019; Lindahl *et al*., 2017; Lindahl & Britton, 2019). Of particular relevance is a study conducted by Lindahl and Britton (2019) on changes to sense of self. They found that 72% of meditators - many of which were meditation teachers - reported experiencing changes to their sense of self as a consequence of practice, and 55% of these were accompanied by distress, and 45% with impairments in functioning. Changes to sense of self included changes to the narrative self, loss of ownership, loss of agency, changes to embodiment, changes to self-other or self-world boundaries, and the most debilitating experiences tended to accompany a loss of one's 'basic' self or sense of 'being'. Changes to the narrative self often occurred even during daily practice (33%), whereas the vast majority of more profound changes to one's basic embodied self happened while on a meditation retreat (93%). Under an 'emotion and attention regulation' view of meditation, such experiences seem surprising. However, within our framework, a deconstruction of self-related processing naturally arises from being immersed in the here and now, and changes to more basal forms of self-hood are expected with more prolonged and advanced practices, like those employed on meditation retreats. Thus, our framework is able to also account for the negative side effects of meditation, especially as they pertain to changes in self-related processing.

The prospect of severe negative side effects that outlast the actual meditation, including depersonalization and dissociation (Lindahl & Britton, 2019) certainly demands further research. One possibility drawn from our framework is that if during meditation one's sense of self does not fully abate, but instead is *partially* altered, this may then be experienced as distressing. Many aberrant experiences of self that may occur during for instance psychosis and schizophrenia, may indeed represent *changes* to self-modeling processes rather than the explicit *absence* that may arise through carefully guided meditation training. Similarly, as counterfactual processing is deconstructed and early layers of the predictive hierarchy become perceptible, what is discovered may not coincide (indeed strongly contradict) one's models at higher more abstract layers of the hierarchy, which may cause uncertainty and distress. Meditation thus may engender enormous prediction errors that can demand significant support and integration. As the popularity of meditation grows, more attention is needed within the secular meditation movement about the side-effects that practitioners may unwillingly encounter, and what 'priors' may be necessary to integrate surprising experiences in a healthy way. We stress that being present is not just an easy way to feel better but can in fact profoundly change how we view ourselves. Looking to the future, below we make specific recommendations for how to improve methodology in contemplative science to ensure balanced and accurate findings.

6.2 Methodological considerations

For the field of meditation research to grow into a mature field of science it has to address several methodological challenges (Davidson & Kaszniak, 2015; Slagter *et al.*, 2011; Van Dam *et al.*, 2018). First, meditation practice is inherently a subjective endeavor, and the number of hours of meditation experience does not necessarily indicate how advanced someone is in their practice. Thus, developing better methods to determine the quality of meditative states and track meditation experience is of utmost importance for understanding the physiological and psychological effects of meditation. Neurophenomenology, the combination of brain imaging with micro-phenomenology - detailed reports about one's mental experiences - provides one fruitful approach (Petitmengin *et al.*, 2019; Varela, 1996), as discussed above. But much further progress is still possible and necessary. It is particularly important that a systematic and validated set of first-person methods is developed, that is also specifically tailored towards different styles of meditation, but also treats them as lying on a continuum with partially overlapping effects. While the three styles of meditation are here proposed to lie on a continuum, gradually reducing the temporal depth of processing, their effects also greatly overlap. Present-moment awareness and dereification are for example likely higher during advanced states of FA than during novice OM states (Lutz *et al.*, 2015). In developing methods to track stages of meditation advancement, it is also very important to acknowledge that different meditation traditions may have different aims. For instance, classical Buddhism emphasizes insight into the three characteristics of experience: impermanence (aniccā), nonself (anattā), and suffering (dukkha). Thus, while we may be able to scientifically determine a meditators capability to enter 'deep states of meditation' based on our framework, what exactly constitutes "progress" is also determined uniquely by different meditation traditions and involves factors well beyond the meditation practice, such as ethical action. In general, researchers should be well aware of the many different meditation practices and Buddhist traditions that exist, and the historical context in which they developed (Dunne, 2015).

Another methodological challenge is that some very advanced meditative states may make it difficult to provide *any* useful self-reports whatsoever (during meditation or post-hoc) given the inherently non-conceptual nature of the meditation states. Moreover, one cannot ask meditators to engage in typical experimental tasks that require them to respond to stimuli during more advanced meditative states either, as this would automatically force them to engage in active inference. One promising approach that may reveal the neural basis of phenomenal experience during advanced meditative states without relying on reports is to combine so-called no-report paradigms with brain imaging (Tsuchiya *et al.*, 2015). Specifically, machine learning methods that utilize neural activity as *representational information*, for example multivariate pattern analysis or "decoding" techniques - in concert with the delivery of subtle or even pre-conscious stimuli through so-called no-report paradigms - could be used to learn more about advanced states of meditation that would otherwise be out of scientific reach, and their effects on predictive processing. Future studies should also include measurements of physiological activity, such as bodily arousal, that may critically change during meditation (Britton *et al.*, 2014; Metzinger, 2020).

Another major methodological challenge in the scientific study of meditation concerns the fact that participants cannot be blinded to the nature of the study (i.e., meditation) and hence may have certain expectations on how meditation should affect e.g., their cognitive performance that can (implicitly) bias results (i.e., the well-known placebo effect; Baskin *et al*., 2003). A recent study, for example, found that participants that were recruited using a suggestive flyer, advertising a "brain training and become smarter" study, scored 5 to 10 IQ points higher on an intelligence test after performing a 30-min cognitive "training" than participants that were recruited using a non-suggestive flyer that simply advertised a psychological study for monitory reimbursement (Foroughi *et al*., 2016). This example illustrates the profound effects that expectations can have on study outcomes. Participants in a meditation study may also be more motivated to do well because they believe meditation has positive effects or because they think the experimenter expects them to do well. It is therefore critical that meditation researchers try to control for these non-specific effects that can confound results by including active control groups. Active control groups could consist of experts in some other domain (e.g., athletes; Andreu *et al*., 2017) that are also invited to participate because of their specific expertise, or of participants that undergo a different intervention that is matched to the meditation intervention in the extent to which both the participants and teachers believe in the effectiveness of the intervention and on other important variables, such as number of contact hours (MacCoon *et al*., 2014). Another possibility is to use meditators as their own controls, for example, by comparing their brain activity or task performance during different states of meditation that are expected to induce differential effects (e.g., Josipovic *et al*., 2011; van Vugt & Slagter, 2014). This may also better control for potential pre-existing differences between expert meditators and controls, e.g., in sleep habits or personality characteristics.

Besides proper controls for non-specific effects, it will be important that the field of meditation research moves in the direction of a-priori specification of study predictions and analysis plans through preregistration, to counter experimenter biases during data collection and analysis. This is particularly important given that many meditation researchers are themselves meditators, and believe in the value of meditation. To summarize, despite much promise of meditation as a powerful intervention for neuro-cognitive change, and its potential contributions to science, progress critically depends on methodological rigor and the development of novel approaches that allow for more objective and/or non-intrusive assessment of the effects of meditation. Neurophenomenology and no-report paradigms in particular provide fruitful avenues for future research. Embracing Open Science is another important step towards scientific progress.

6.3 Conclusion

We have taken on the daunting task of providing a theory for understanding the effects of meditation within the predictive processing framework. Contemplative science is a young field and predictive processing is a new theory, although both have roots going much farther back. All theories are subject to change, but perhaps particularly so for such new domains of enquiry. Nevertheless, we think the conditions are suitable for a more overarching theory that may also thwart further siloing and fragmentation of scientific research, as has been commonplace among the mind-sciences. A strength of our framework is its simplicity: Being in the here and now reduces predictive processing. And yet, this basic idea can explain how each meditation technique uniquely deconstructs the minds tendency to project the past onto the present, how certain insights may arise, the nature of hierarchical self-processing, and the plasticity of the human mind. There is scope here, we think, to eventually reveal what makes a meditator an expert, why meditation has such broad clinical effects, and how we might begin mitigating some of the negative consequences of meditation. Last but not least, our framework seems to bring Eastern and Western ideas closer together, showing how first-person tools of contemplative enquiry can lead to similar viewpoints as the third-person tools of science.

Acknowledgements

This work was supported by an ERC starting grant (679399) to H.A.S. We would like to thank several colleagues and meditation teachers who provided insightful comments on our paper, including Henk Barendregt, Gregg Howard, Adam Bulley, Michiel van Elk, Aidan Lyon, and Yair Pinto. We also thank a colleague who wishes to remain anonymous for contributing to the ideas presented in this paper, but who is of the opinion that their ideas are misrepresented in the paper. Finally, we would like to thank Thomas Metzinger for valuable discussions on the topics addressed here.

Footnotes

1. Throughout this paper we use temporal depth, counterfactual depth, and abstraction, rather interchangeably. They are each different characteristics of hierarchically deep processing, and are often used interchangeably in the literature.
2. Here 'one' should be understood as 'not-two', or non-dual (i.e., one without the concept of one).
3. As the horticulturist shears away overgrown branches, meditation trims away the habitual conceptualization of experiences.
4. As soon as one is 'away' from the present moment, one has made an 'abstraction'. For example, there are the wavelengths of light that represent the shape of a 'teacup'. However, once it has been conceptualized *as a teacup* there is a new layer of abstraction that demands further inference from past experience than simply representing the wavelengths of light (i.e., more temporally deep processing). And yet, experiencing a 'tea cup' first necessitates the representation of the wavelengths of light contacting the retina (thus, hierarchical processing). Representing the teacup *then* permits further hierarchically deep processing: Such as recalling the time you drank green tea with brown rice kernels in a Japanese garden.
5. Autopoietic actions are those that allow an organism to reproduce, regenerate, and therefore maintain itself (Maturana & Varela, 1991).
6. Here we have already introduced many novel terms for readers new to predictive processing. By the time our theory is more concretely described these words should make much more sense.
7. The hidden word is 'introspection'
8. See Section 2.1: A hierarchy of expectations.
9. Evan Thompson (2020) has also argued that meditation involves the development of new concepts, such as 'moment-to-moment arising', 'not-self', and 'impermanence', concepts that then shape one's experience. From the perspective of fact-free learning, novel priors such as 'impermanence' may cast a simpler and more parsimonious account of the behavior of thoughts, feelings, and sensations, thereby reducing model complexity.
10. The non-dual state was also described early on in Western Psychology. In 1890 William James coined the term 'sciousness', which he described as an awareness preceding con-sciousness that is without subject or object (Bricklin, 2003). Other descriptions of non-duality are present in Hinduism as well as western neo-Platonic and Christian traditions. James also described an experience that has non-dual qualities as follows: "During the syncope, there is absolute psychic annihilation, the absence of all consciousness; then at the beginning of coming to, one has at a certain moment a vague, limitless, infinite feeling - a sense of existence in general without the least trace of a distinction between the me and the not-me." (James, 1890/1950, p. 273)
11. See also Ashtavakra Gita (Byrom, 1990 translation), perhaps the oldest non-dual text with Hindu origins.
12. Whether this is a genuine philosophical conundrum is questionable (certainly it's not inherently paradoxical that memories should form without selfhood, e.g., semantic memories). Moreover, it's possible that transition periods away-from and into non-dual states afford memory encoding.
13. Albahari (2009) proposes that the Eastern construct of witness-consciousness "captures the essence of subjectivity". The concept is originally derived from the contemplative tradition of Advaita Vedãnta, and was described as follows by Gupta (1998) in his book *The Disinterested Witness: A fragment of Advaita Vedānta Phenomenology*: "[it is] the basis for all knowing [but] different from the object known. It is implied in every act of knowing. It is the ultimate subject; it can never become an object of knowledge."
14. In Figure 3 we have used different layers of the hierarchy than Figure 2 in order to emphasize the behaviour of generative models. In lower layers in the hierarchy (i.e., "pure witnessing" or the subject/object divide shown in Figure 2) there is no longer phenomenology of sensory objects, and if there are, they are arising in later layers.
15. In the famous case of Ramana Maharshi, it is said that he was so absorbed in ND awareness that "...he was completely oblivious of his body and the world; insects chewed away portions of his legs, his body wasted away because he was rarely conscious enough to eat and his hair and fingernails grew to unmanageable lengths... [a return to a normal physical condition] was not completed for several years." (Godman, 2017). When he was discovered, food had to be placed in his mouth to prevent him from starving.
16. The Carter *et al*. (2005) findings also highlight the fact that very advanced FA practices may also be able to break down stubborn predictions. Indeed, it is believed that some practitioners are able to discover non-dual awareness through advanced FA, thus bypassing OM (Wallace, 1999b).
17. On the other hand, if a meditation practitioner is naturally embodying a more *experiencing* mode of self - but not yet in a non-dual state - then psychedelics may help to further deconstruct hierarchical processing in tandem with meditation. Consistent with this idea, the authors *did* find significant increases in Oceanic Boundlessness - a construct reminiscent of ND awareness - among meditators administered the psilocybin.
18. As noted by (Britton *et al*., 2014): "In his *Science and Buddhism: A Guide for the Perplexed*, Buddhist studies scholar Donald Lopez [(Lopez Jr, 2009)] laments "Where is the insistence that meditation is not intended to induce relaxation but rather a vital transformation of one's vision of reality?" Others warn how "a practice that only relaxes the mind might eventually prove harmful." [(Lutz *et al*., 2006)]"
19. As discussed in section 2.4 & 4, *expected* free-energy minimization involves predictions about states in the next moment (thus, counter-facts to the present moment, Friston, 2018).

7. References

1. Adams, R. A., Stephan, K. E., Brown, H. R., Frith, C. D., & Friston, K. J. (2013). The computational anatomy of psychosis. *Frontiers in Psychiatry*, 4, 47.
2. Alamia, A., Timmermann, C., VanRullen, R., & Carhart-Harris, R. L. (2020). *DMT alters cortical travelling waves* [Preprint]. Neuroscience. https://doi.org/10.1101/2020.05.06.080937
3. Albahari, M. (2009). Witness-consciousness: Its definition, Appearance and reality. *Journal of Consciousness Studies*, *16*(1), 62-84.
4. Allen, M., & Friston, K. J. (2018). From cognitivism to autopoiesis: Towards a computational framework for the embodied mind. *Synthese*, *195*(6), 2459-2482. https://doi.org/10.1007/s11229-016-1288-5
5. Antonova, E., Chadwick, P., & Kumari, V. (2015a). More Meditation, Less Habituation? The Effect of Mindfulness Practice on the Acoustic Startle Reflex. *PLOS ONE*, *10*(5), e0123512. https://doi.org/10.1371/journal.pone.0123512
6. Antonova, E., Chadwick, P., & Kumari, V. (2015b). More Meditation, Less Habituation? The Effect of Mindfulness Practice on the Acoustic Startle Reflex. *PLOS ONE*, *10*(5), e0123512. https://doi.org/10.1371/journal.pone.0123512
7. Ashburner, M., Ball, C. A., Blake, J. A., Botstein, D., Butler, H., Cherry, J. M., Davis, A. P., Dolinski, K., Dwight, S. S., Eppig, J. T., Harris, M. A., Hill, D. P., Issel-Tarver, L., Kasarskis, A., Lewis, S., Matese, J. C., Richardson, J. E., Ringwald, M.,Rubin, G. M., & Sherlock, G. (2000). Gene Ontology: Tool for the unification of biology. *Nature Genetics*, *25*(1), 25-29. https://doi.org/10.1038/75556
8. Badcock, P. B., Friston, K. J., & Ramstead, M. J. D. (2019). The hierarchically mechanistic mind: A free-energy formulation of the human psyche. *Physics of Life Reviews*, *31*, 104-121. https://doi.org/10.1016/j.plrev.2018.10.002
9. Baird, B., Smallwood, J., Mrazek, M. D., Kam, J. W. Y., Franklin, M. S., & Schooler, J. W. (2012). Inspired by Distraction: Mind Wandering Facilitates Creative Incubation. *Psychological Science*, *23*(10), 1117-1122. https://doi.org/10.1177/0956797612446024
10. Berkovich-Ohana, A., Dor-Ziderman, Y., Glicksohn, J., & Goldstein, A. (2013). Alterations in the sense of time, space, and body in the mindfulness-trained brain: A neurophenomenologically-guided MEG study. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00912
11. Biedermann, B., de Lissa, P., Mahajan, Y., Polito, V., Badcock, N., Connors, M. H., Quinto, L., Larsen, L., & McArthur, G. (2016). Meditation and auditory attention: An ERP study of meditators and non-meditators. *International Journal ofPsychophysiology*, *109*, 63-70. https://doi.org/10.1016/j.ijpsycho.2016.09.016
12. Blanke, O., & Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends in Cognitive Sciences*, *13*(1), 7-13.
13. Bodhi, B. (2011a). *Noble Eightfold Path: Way to the End of Suffering*. Pariyatti Publishing.
14. Bodhi, B. (2011b). What does mindfulness really mean? A canonical perspective. *Contemporary Buddhism*, *12*(1), 19-39. https://doi.org/10.1080/14639947.2011.564813
15. Botvinick, M., & Cohen, J. (1998). Rubber hands 'feel'touch that eyes see. *Nature*, *391*(6669), 756-756.
16. Brewer, J. A., Worhunsky, P. D., Gray, J. R., Tang, Y.-Y., Weber, J., & Kober, H. (2011). Meditation experience is associated with differences in default mode network activity and connectivity. *Proceedings of the National Academy of Sciences*, *108*(50), 20254-20259.
17. Bricklin, J. (2003). Sciousness and Con-sciousness: William James and the prime reality of non-dual experience. *Journal of Transpersonal Psychology*, *35*(2), 85-110.
18. Britton, W. B. (2019). Can mindfulness be too much of a good thing? The value of a middle way. *Current Opinion in Psychology*, *28*, 159-165. https://doi.org/10.1016/j.copsyc.2018.12.011
19. Britton, W. B., Lindahl, J. R., Cahn, B. R., Davis, J. H., & Goldman, R. E. (2014). Awakening is not a metaphor: The effects of Buddhist meditation practices on basic wakefulness: Meditation and wakefulness. *Annals of the New York Academy of Sciences*, *1307*(1), 64-81. https://doi.org/10.1111/nyas.12279
20. Bulley, A., Henry, J. D., & Suddendorf, T. (2017). Thinking about threats: Memory and prospection in human threat management. *Consciousness and Cognition*, *49*, 53-69. https://doi.org/10.1016/j.concog.2017.01.005
21. Bulley, A., Henry, J., & Suddendorf, T. (2016). Prospection and the present moment: The role of episodic foresight in intertemporal choices between immediate and delayed rewards. *Review of General Psychology*, *20*(1), 29-47.
22. Buonomano, D. V., & Merzenich, M. M. (1998). Cortical plasticity: From synapses to maps. *Annual Review of Neuroscience*, *21*(1), 149-186.
23. Byrom, T. (1990). *The heart of awareness: A translation of the Ashtavakra Gita*.
24. Carhart-Harris, R. L., & Friston, K. J. (2010). The default-mode, ego-functions and free-energy: A neurobiological account of Freudian ideas. *Brain*, *133*(4), 1265-1283. https://doi.org/10.1093/brain/awq010
25. Carhart-Harris, R. L., & Friston, K. J. (2019). REBUS and the Anarchic Brain: Toward a Unified Model of the Brain Action of Psychedelics. *Pharmacological Reviews*, *71*(3), 316-344. https://doi.org/10.1124/pr.118.017160
26. Carhart-Harris, Robin Lester, Leech, R., Hellyer, P. J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D. R., & Nutt, D. (2014). The entropic brain: A theory of conscious states informed by neuroimaging research with psychedelic drugs. *Frontiers in Human Neuroscience*, *8*, 20.
27. Chiesa, A., & Serretti, A. (2009). Mindfulness-based stress reduction for stress management in healthy people: A review and meta-analysis. *The Journal of Alternative and Complementary Medicine*, *15*(5), 593-600.
28. Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, *36*(3), 181-204. https://doi.org/10.1017/S0140525X12000477
29. Corcoran, A. W., Pezzulo, G., & Hohwy, J. (2019). *From Allostatic Agents to Counterfactual Cognisers: Active Inference, Biological Regulation, and The Origins of Cognition* [Preprint]. ARTS & HUMANITIES. https://doi.org/10.20944/preprints201911.0083.v1
30. Dahl, C. J., Lutz, A., & Davidson, R. J. (2015a). Reconstructing and deconstructing the self: Cognitive mechanisms in

meditation practice. *Trends in Cognitive Sciences*, *19*(9), 515-523. https://doi.org/10.1016/j.tics.2015.07.001

31. Dahl, C. J., Lutz, A., & Davidson, R. J. (2015b). Reconstructing and deconstructing the self: Cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences*, *19*(9), 515-523. https://doi.org/10.1016/j.tics.2015.07.001
32. Damasio, A. (2012). The origins of homeostasis; the body in mind. In *Self comes to mind* (pp. 43-107). London, Vintage.
33. Dambrun, M., & Ricard, M. (2011). Self-Centeredness and Selflessness: A Theory of Self-Based Psychological Functioning and Its Consequences for Happiness. *Review of General Psychology*, *15*(2), 138-157. https://doi.org/10.1037/a0023059
34. Dass, R. (2010). *Be here now*. Harmony.
35. Davidson, R. J., & Kaszniak, A. W. (2015). Conceptual and methodological issues in research on mindfulness and meditation. *The American Psychologist*, *70*(7), 581-592. https://doi.org/10.1037/a0039512
36. Deane, G. (2020). Dissolving the self. *Philosophy and the Mind Sciences*, *1*(I), 2. https://doi.org/10.33735/phimisci.2020.I.39
37. Dor-Ziderman, Y., Ataria, Y., Fulder, S., Goldstein, A., & Berkovich-Ohana, A. (2016). Self-specific processing in the meditating brain: A MEG neurophenomenology study. *Neuroscience of Consciousness*, *2016*(1).https://doi.org/10.1093/nc/niw019
38. Dor-Ziderman, Y., Berkovich-Ohana, A., Glicksohn, J., & Goldstein, A. (2013). Mindfulness-induced selflessness: A MEG neurophenomenological study. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00582
39. Dunne, J. (2011). Toward an understanding of non-dual mindfulness. *Contemporary Buddhism*, *12*(1), 71-88. https://doi.org/10.1080/14639947.2011.564820
40. Dunne, J. D. (2015). Buddhist Styles of Mindfulness: A Heuristic Approach. In B. D. Ostafin, M. D. Robinson, & B. P. Meier (Eds.), *Handbook of Mindfulness and Self-Regulation* (pp. 251-270). Springer New York. https://doi.org/10.1007/978-1-4939-2263-5_18
41. Feldman, D. E. (2009). Synaptic mechanisms for plasticity in neocortex. *Annual Review of Neuroscience*, *32*, 33-55.
42. Feldman, H., & Friston, K. (2010). Attention, uncertainty, and free-energy. *Frontiers in Human Neuroscience*, *4*, 215.
43. Fox, K. C. R., Dixon, M. L., Nijeboer, S., Girn, M., Floman, J. L., Lifshitz, M., Ellamil, M., Sedlmeier, P., & Christoff, K. (2016). Functional neuroanatomy of meditation: A review and meta-analysis of 78 functional neuroimaging investigations. *Neuroscience & Biobehavioral Reviews*, *65*, 208-228. https://doi.org/10.1016/j.neubiorev.2016.03.021
44. Friston, K. (2005). A theory of cortical responses. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *360*(1456), 815-836. https://doi.org/10.1098/rstb.2005.1622
45. Friston, K. (2008). Hierarchical Models in the Brain. *PLoS Computational Biology*, *4*(11), e1000211. https://doi.org/10.1371/journal.pcbi.1000211
46. Friston, K. (2010). The free-energy principle: A unified brain theory? *Nature Reviews Neuroscience*, *11*(2), 127-138. https://doi.org/10.1038/nrn2787
47. Friston, K. (2018). Am I Self-Conscious? (Or Does Self-Organization Entail Self-Consciousness?). *Frontiers in Psychology*, *9*, 579. https://doi.org/10.3389/fpsyg.2018.00579
48. Friston, K., & Buzsáki, G. (2016). The Functional Anatomy of Time: What and When in the Brain. *Trends in Cognitive Sciences*, *20*(7), 500-511. https://doi.org/10.1016/j.tics.2016.05.001
49. Friston, K. J., & Frith, C. D. (2015). Active inference, communication and hermeneutics. *Cortex*, *68*, 129-143. https://doi.org/10.1016/j.cortex.2015.03.025
50. Friston, K. J., Lin, M., Frith, C. D., Pezzulo, G., Hobson, J. A., & Ondobaka, S. (2017). Active Inference, Curiosity and Insight. *Neural Computation*, *29*(10), 2633-2683. https://doi.org/10.1162/neco_a_00999
51. Friston, K. J., Litvak, V., Oswal, A., Razi, A., Stephan, K. E., Van Wijk, B. C., Ziegler, G., & Zeidman, P. (2016). Bayesian model reduction and empirical Bayes for group (DCM) studies. *Neuroimage*, *128*, 413-431.
52. Friston, K. J., & Stephan, K. E. (2007). Free-energy and the brain. *Synthese*, *159*(3), 417-458. https://doi.org/10.1007/s11229-007-9237-y
53. Fucci, E., Abdoun, O., Caclin, A., Francis, A., Dunne, J. D., Ricard, M., Davidson, R. J., &
54. Lutz, A. (2018). Differential effects of non-dual and focused attention meditations on the formation of automatic perceptual habits in expert practitioners. *Neuropsychologia*, *119*, 92-100. https://doi.org/10.1016/j.neuropsychologia.2018.07.025
55. Gallagher, S. (2000). Philosophical conceptions of the self: Implications for cognitive science. *Trends in Cognitive Sciences*, *4*(1), 14-21. https://doi.org/10.1016/S1364-6613(99)01417-5
56. Garrido, M. I., Kilner, J. M., Stephan, K. E., & Friston, K. J. (2009). The mismatch negativity: A review of underlying mechanisms. *Clinical Neurophysiology*, *120*(3), 453-463.
57. Gilead, M., Trope, Y., & Liberman, N. (2019). Above and Beyond the Concrete: The Diverse Representational Substrates of the Predictive Brain. *Behavioral and Brain Sciences*, 1-63. https://doi.org/10.1017/S0140525X19002000
58. Girn, M., Roseman, L., Bernhardt, B., Smallwood, J., Carhart-Harris, R. L., & Spreng, N. (2020). *LSD flattens the functional hierarchy of the human brain* [Preprint]. Neuroscience. https://doi.org/10.1101/2020.05.01.072314
59. Godman, D. (2017). *Be as you are: The teachings of Sri Ramana Maharshi*. Penguin Books. Grant, J. A. (2014). Meditative analgesia: The current state of the field: Meditative analgesia. *Annals of the New York Academy of Sciences*, *1307*(1), 55-63. https://doi.org/10.1111/nyas.12282
60. Grant, J. A., & Rainville, P. (2009). Pain sensitivity and analgesic effects of mindful states in Zen meditators: A cross-sectional study. *Psychosomatic Medicine*, *71*(1), 106-114.
61. Gupta, B. (1998). *The Disinterested Witness: A Fragment of Advaita Vedānta Phenomenology*. Northwestern University Press.
62. Gusnard, D. A., Akbudak, E., Shulman, G. L., & Raichle, M. E. (2001). Medial prefrontal cortex and self-referential mental activity: Relation to a default mode of brain function. *Proceedings of the National Academy of Sciences*, *98*(7), 4259-4264.
63. Gyatso, T. (2010). *Essence of the Heart Sutra: The Dalai Lama's heart of wisdom teachings*. Hanley, A. W., & Garland, E. L. (2019). Mindfulness training disrupts Pavlovian conditioning. *Physiology & Behavior*, *204*, 151-154.
64. Herzog, R., Mediano, P. A. M., Rosas, F. E., Carhart-Harris, R., Perl, Y. S., Tagliazucchi, E., & Cofre, R. (2020). A mechanistic model of the neural entropy increase elicited by psychedelic drugs. *BioRxiv*, 2020.05.13.093732. https://doi.org/10.1101/2020.05.13.093732
65. Hofmann, S. G., Sawyer, A. T., Witt, A. A., & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, *78*(2), 169.

66. Hohwy, J. (2013). *The predictive mind*. Oxford University Press.
67. Hohwy, J., Roepstorff, A., & Friston, K. (2008). Predictive coding explains binocular rivalry: An epistemological review. *Cognition*, *108*(3), 687-701. https://doi.org/10.1016/j.cognition.2008.05.010
68. Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011).
69. How Does Mindfulness Meditation Work? Proposing Mechanisms of Action From a Conceptual and Neural Perspective. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *6*(6), 537-559. https://doi.org/10.1177/1745691611419671
70. Huntenburg, J. M., Bazin, P.-L., & Margulies, D. S. (2018). Large-Scale Gradients in Human Cortical Organization. *Trends in Cognitive Sciences*, *22*(1), 21-31. https://doi.org/10.1016/j.tics.2017.11.002
71. Josipovic, Z. (2010a). Duality and nonduality in meditation research. *Consciousness and Cognition*, *19*(4), 1119-1121.
72. Josipovic, Z. (2010b). Duality and nonduality in meditation research. *Consciousness and Cognition*, *19*(4), 1119-1121. https://doi.org/10.1016/j.concog.2010.03.016
73. Josipovic, Z. (2014). Neural correlates of nondual awareness in meditation. *Annals of the New York Academy of Sciences*, *1307*, 9-18. https://doi.org/10.1111/nyas.12261
74. Josipovic, Z. (2019). Nondual awareness: Consciousness-as-such as non-representational reflexivity. In *Progress in brain research* (Vol. 244, pp. 273-298). Elsevier.
75. Josipovic, Z., Dinstein, I., Weber, J., & Heeger, D. J. (2011). Influence of meditation on anti-correlated networks in the brain. *Frontiers in Human Neuroscience*, *5*, 183. https://doi.org/10.3389/fnhum.2011.00183
76. Kabat-Zinn, J. (2003). Mindfulness-based stress reduction (MBSR). *Constructivism in the Human Sciences*, *8*(2), 73.
77. Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science*, *330*(6006), 932-932.
78. Kirk, U., & Montague, P. R. (2015). Mindfulness meditation modulates reward prediction errors in a passive conditioning task. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00090
79. Koch, M. (1999). The neurobiology of startle. *Progress in Neurobiology*, *59*(2), 107-128.
80. Kumar, S., Stephan, K. E., Warren, J. D., Friston, K. J., & Griffiths, T. D. (2007). Hierarchical Processing of Auditory Objects in Humans. *PLoS Computational Biology*, *3*(6), 9.
81. Laukkonen, R. E., Kaveladze, B. T., Tangen, J. M., & Schooler, J. W. (2020). The dark side of Eureka: Artificially induced Aha moments make facts feel true. *Cognition*, *196*, 104122.
82. Laukkonen, R., Leggett, J. M. I., Gallagher, R., Biddell, H., Mrazek, A., Slagter, H., & Mrazek, M. (2020). *The Science of Mindfulness-Based Interventions and Learning: A Review for Educators*.
83. Laukkonen, R., Webb, M. E., Salvi, C., Tangen, J. M., & Schooler, J. (2018). *Eureka Heuristics: How feelings of insight signal the quality of a new idea* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/ez3tn
84. Laureys, S., Boly, M., Moonen, G., & Maquet, P. (2009). Two dimensions of consciousness: Arousal and awareness. *Encycl Neurosci*, *2*, 1133-1142.
85. Lee, T. S., & Mumford, D. (2003). Hierarchical Bayesian inference in the visual cortex. *Journal of the Optical Society of America A*, *20*(7), 1434. https://doi.org/10.1364/JOSAA.20.001434
86. Leighton, T. D. (2004). *The art of just sitting: Essential writings on the Zen practice of Shikantaza*. Simon and Schuster.
87. Levenson, R. W., Ekman, P., & Ricard, M. (2012). Meditation and the startle response: A case study. *Emotion*, *12*(3), 650-658. https://doi.org/10.1037/a0027472
88. Levinson, D. B., Stoll, E. L., Kindy, S. D., Merry, H. L., & Davidson, R. J. (2014). A mind you can count on: Validating breath counting as a behavioral measure of mindfulness. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01202
89. Limanowski, J., & Friston, K. (2020). Attenuating oneself. *Philosophy and the Mind Sciences*, *1*(I), 6. https://doi.org/10.33735/phimisci.2020.I.35
90. Lindahl, J. (2017). Somatic Energies and Emotional Traumas: A Qualitative Study of
91. Practice-Related Challenges Reported by Vajrayāna Buddhists. *Religions*, *8*(8), 153. https://doi.org/10.3390/rel8080153
92. Lindahl, J. R., & Britton, W. B. (2019). "I Have This Feeling of Not Really Being Here": Buddhist Meditation and Changes in Sense of Self. *Journal of Consciousness Studies*, *26*(7-8), 157-183.
93. Lindahl, J. R., Fisher, N. E., Cooper, D. J., Rosen, R. K., & Britton, W. B. (2017a). The varieties of contemplative experience: A mixed-methods study of meditation-related challenges in Western Buddhists. *PloS One*, *12*(5), e0176239. https://doi.org/10.1371/journal.pone.0176239
94. Lindahl, J. R., Fisher, N. E., Cooper, D. J., Rosen, R. K., & Britton, W. B. (2017b). The varieties of contemplative experience: A mixed-methods study of meditation-related challenges in Western Buddhists. *PLOS ONE*, *12*(5), e0176239. https://doi.org/10.1371/journal.pone.0176239
95. Lok To, Tripitaka Hsuan Tsang, T'an Hsu, K'un Li Shih, & Frank French. (2000). *Prajna Paramita Heart Sutra* (Second edition). Buddha Dharma Education Association. Lopez Jr, D. S. (2009). *Buddhism and science: A guide for the perplexed*. University of Chicago Press.
96. Lutz, A., Dunne, J. D., & Davidson, R. J. (2006). Meditation and the neuroscience of consciousness: An introduction. *The Cambridge Handbook of Consciousness*, *19*. http://www.sheermind.com/uploads/9/3/7/0/9370422/meditation_and_the_neuroscience_of_consciousness.pdf
97. Lutz, A., Dunne, J. D., & Davidson, R. J. (2007). Meditation and the neuroscience of consciousness. *Cambridge Handbook of Consciousness*, 499-555.
98. Lutz, A., Jha, A. P., Dunne, J. D., & Saron, C. D. (2015a). Investigating the phenomenological matrix of mindfulness-related practices from a neurocognitive perspective. *American Psychologist*, *70*(7), 632-658. https://doi.org/10.1037/a0039585
99. Lutz, A., Jha, A. P., Dunne, J. D., & Saron, C. D. (2015b). Investigating the phenomenological matrix of mindfulness-related practices from a neurocognitive perspective. *The American Psychologist*, *70*(7), 632-658. https://doi.org/10.1037/a0039585
100. Lutz, A., Mattout, J., & Pagnoni, G. (2019). The epistemic and pragmatic value of non-action: A predictive coding perspective on meditation. *Current Opinion in Psychology*, *28*, 166-171. https://doi.org/10.1016/j.copsyc.2018.12.019
101. Lutz, A., McFarlin, D. R., Perlman, D. M., Salomons, T. V., & Davidson, R. J. (2013). Altered anterior insula activation during anticipation and experience of painful stimuli in expert meditators. *Neuroimage*, *64*, 538-546.

102. Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008a). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*(4), 163-169.
103. Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008b). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*(4), 163-169. https://doi.org/10.1016/j.tics.2008.01.005
104. MacLean, K. A., Ferrer, E., Aichele, S. R., Bridwell, D. A., Zanesco, A. P., Jacobs, T. L., King, B. G., Rosenberg, E. L., Sahdra, B. K., Shaver, P. R., Wallace, B. A., Mangun, G. R., & Saron, C. D. (2010). Intensive Meditation Training Improves Perceptual Discrimination and Sustained Attention. *Psychological Science*, *21*(6), 829-839. https://doi.org/10.1177/0956797610371339
105. Maharshi, R. (2004). *The spiritual teaching of Ramana Maharshi*. Shambhala Publications.
106. Maturana, H. R., & Varela, F. J. (1991). *Autopoiesis and cognition: The realization of the living* (Vol. 42). Springer Science & Business Media.
107. Metcalfe, J., & Wiebe, D. (1987). Intuition in insight and noninsight problem solving. *Memory & Cognition*, *15*(3), 238-246. https://doi.org/10.3758/BF03197722
108. Metzinger, T. (2017). The Problem of Mental Action. In T. Metzinger & W. Wiese (Eds.), *Philosophy and Predicitive Processing*.
109. Metzinger, T. (2020). Minimal phenomenal experience. *Philosophy and the Mind Sciences*, *1*(I), 7. https://doi.org/10.33735/phimisci.2020.I.46
110. Millière, R., Carhart-Harris, R. L., Roseman, L., Trautwein, F.-M., & Berkovich-Ohana, A. (2018). Psychedelics, Meditation, and Self-Consciousness. *Frontiers in Psychology*, *9*, 1475. https://doi.org/10.3389/fpsyg.2018.01475
111. Millière, R., & Metzinger, T. (2020). Radical disruptions of self-consciousness. *Philosophy and the Mind Sciences*, *1*(I), 1. https://doi.org/10.33735/phimisci.2020.I.50
112. Moore, A., & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition*, *18*(1), 176-186. https://doi.org/10.1016/j.concog.2008.12.008
113. Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2012). Mindfulness and mind-wandering: Finding convergence through opposing constructs. *Emotion*, *12*(3), 442-448. https://doi.org/10.1037/a0026678
114. Nahab, F. B., Kundu, P., Gallea, C., Kakareka, J., Pursley, R., Pohida, T., Miletta, N., Friedman, J., & Hallett, M. (2011). The Neural Processes Underlying Self-Agency. *Cerebral Cortex*, *21*(1), 48-55. https://doi.org/10.1093/cercor/bhq059
115. Nisargadatta, S. (1973). *I am that: Talks with Sri Nisargadatta Maharaj. SS Dikshit (Ed.), M. Frydman (Trans.).*
116. Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*(5), 400-424.
117. Østby, Y., Walhovd, K. B., Tamnes, C. K., Grydeland, H., Westlye, L. T., & Fjell, A. M. (2012). Mental time travel and default-mode network functional connectivity in the developing brain. *Proceedings of the National Academy of Sciences*, *109*(42), 16800-16804.
118. Ovington, L. A., Saliba, A. J., Moran, C. C., Goldring, J., & MacDonald, J. B. (2018). Do People Really Have Insights in the Shower? The When, Where and Who of the Aha! Moment. *The Journal of Creative Behavior*, *52*(1), 21-34. https://doi.org/10.1002/jocb.126
119. Pagnoni, G. (2019). The contemplative exercise through the lenses of predictive processing: A promising approach. In *Progress in Brain Research* (Vol. 244, pp. 299-322). Elsevier. https://doi.org/10.1016/bs.pbr.2018.10.022
120. Perlman, D. M., Salomons, T. V., Davidson, R. J., & Lutz, A. (2010). Differential effects on pain intensity and unpleasantness of two meditation practices. *Emotion*, *10*(1), 65-71. https://doi.org/10.1037/a0018440
121. Petitmengin, C., van Beek, M., Bitbol, M., Nissou, J.-M., & Roepstorff, A. (2019). Studying the experience of meditation through Micro-phenomenology. *Current Opinion in Psychology*, *28*, 54-59. https://doi.org/10.1016/j.copsyc.2018.10.009
122. Petitmengin, C., van Beek, M., Bitbol, M., & Roepstorff, A. (2017). *What is it Like to Meditate?* 29.
123. Petkova, V. I., & Ehrsson, H. H. (2008). If I were you: Perceptual illusion of body swapping. *PloS One*, *3*(12).
124. Pezzulo, G., Rigoli, F., & Friston, K. (2015). Active Inference, homeostatic regulation and adaptive behavioural control. *Progress in Neurobiology*, *134*, 17-35. https://doi.org/10.1016/j.pneurobio.2015.09.001
125. Raffone, A., Marzetti, L., Del Gratta, C., Perrucci, M. G., Romani, G. L., & Pizzella, V. (2019). Chapter 9 - Toward a brain theory of meditation. In N. Srinivasan (Ed.), *Progress in Brain Research* (Vol. 244, pp. 207-232). Elsevier. https://doi.org/10.1016/bs.pbr.2018.10.028
126. Raichle, M. E. (2015). The brain's default mode network. *Annual Review of Neuroscience*, *38*, 433-447.
127. Ram Dass. (2014, February 19). *Ram Dass Gives Maharaji the "Yogi Medicine."* Ram Dass.
128. Rycroft-Malone, J., Gradinger, F., Griffiths, H. O., Crane, R., Gibson, A., Mercer, S., Anderson, R., & Kuyken, W. (2017). Accessibility and implementation in the UK NHS services of an effective depression relapse prevention programme: Learning from mindfulness-based cognitive therapy through a mixed-methods study.*Health Services and Delivery Research*, *5*(14), 1-190.
129. Salvi, C., Bricolo, E., Kounios, J., Bowden, E., & Beeman, M. (2016). Insight solutions are correct more often than analytic solutions. *Thinking & Reasoning*, *22*(4), 443-460. https://doi.org/10.1080/13546783.2016.1141798
130. Schwartenbeck, P., Passecker, J., Hauser, T. U., FitzGerald, T. H., Kronbichler, M., & Friston, K. J. (2019). Computational mechanisms of curiosity and goal-directed exploration. *ELife*, *8*, e41703. https://doi.org/10.7554/eLife.41703
131. Sebastian, M. A. (2020). Perspectival self-consciousness and ego-dissolution. *Philosophy and the Mind Sciences*, *1*(I), 9. https://doi.org/10.33735/phimisci.2020.I.44
132. Serre, T. (2014). *Hierarchical Models of the Visual System.*
133. Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. *Trends in Cognitive Sciences*, *17*(11), 565-573. https://doi.org/10.1016/j.tics.2013.09.007
134. Slagter, H. A., Davidson, R. J., & Lutz, A. (2011a). Mental Training as a Tool in the Neuroscientific Study of Brain and Cognitive Plasticity. *Frontiers in Human Neuroscience*, *5*. https://doi.org/10.3389/fnhum.2011.00017
135. Slagter, H. A., Davidson, R. J., & Lutz, A. (2011b). Mental Training as a Tool in the Neuroscientific Study of Brain and Cognitive Plasticity. *Frontiers in Human Neuroscience*, *5*. https://doi.org/10.3389/fnhum.2011.00017
136. Slagter, H. A., Davidson, R. J., & Lutz, A. (2011c). Mental training as a tool in the neuroscientific study of brain and cognitive plasticity. *Frontiers in Human Neuroscience*, *5*, 17. https://doi.org/10.3389/fnhum.2011.00017

137. Smallwood, J., Fitzgerald, A., Miles, L. K., & Phillips, L. H. (2009). Shifting moods, wandering minds: Negative moods lead the mind to wander. *Emotion*, *9*(2), 271.
138. Smigielski, L., Scheidegger, M., Kometer, M., & Vollenweider, F. X. (2019). Psilocybin-assisted mindfulness training modulates self-consciousness and brain default mode network connectivity with lasting effects. *NeuroImage*, *196*, 207-215.
139. Smout, C. A., Tang, M. F., Garrido, M. I., & Mattingley, J. B. (n.d.). *Attention promotes the neural encoding of prediction errors*. 22.
140. Spratling, M. W. (2016). Predictive coding as a model of cognition. *Cognitive Processing*, *17*(3), 279-305.
141. Srinivasan, N., & Baijal, S. (2007). Concentrative meditation enhances preattentive processing: A mismatch negativity study: *NeuroReport*, *18*(16), 1709-1712. https://doi.org/10.1097/WNR.0b013e3282f0d2d8
142. Sterzer, P., Adams, R. A., Fletcher, P., Frith, C., Lawrie, S. M., Muckli, L., Petrovic, P., Uhlhaas, P., Voss, M., & Corlett, P. R. (2018). The predictive coding account of psychosis. *Biological Psychiatry*, *84*(9), 634-643.
143. Strauss, M., Sitt, J. D., King, J.-R., Elbaz, M., Azizi, L., Buiatti, M., Naccache, L., van Wassenhove, V., & Dehaene, S. (2015). Disruption of hierarchical predictive coding during sleep. *Proceedings of the National Academy of Sciences*, *112*(11), E1353-E1362. https://doi.org/10.1073/pnas.1501026112
144. Studerus, E., Kometer, M., Hasler, F., & Vollenweider, F. X. (2011). Acute, subacute and long-term subjective effects of psilocybin in healthy humans: A pooled analysis of experimental studies. *Journal of Psychopharmacology*, *25*(11), 1434-1452. https://doi.org/10.1177/0269881110382466
145. Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans? *Behavioral and Brain Sciences*, *30*(3), 299-313.
146. Suzuki, D. T. (1961). *Essays in Zen Buddhism, first series* (Vol. 309). Grove Press.
147. Swanson, L. R. (2018). Unifying Theories of Psychedelic Drug Effects. *Frontiers in Pharmacology*, *9*, 172. https://doi.org/10.3389/fphar.2018.00172
148. Tang, Y.-Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience*, *16*(4), 213-225. https://doi.org/10.1038/nrn3916
149. Taylor, P., Hobbs, J. N., Burroni, J., & Siegelmann, H. T. (2015). The global landscape of cognition: Hierarchical aggregation as an organizational principle of human cortical networks and functions. *Scientific Reports*, *5*(1), 18112. https://doi.org/10.1038/srep18112
150. Timmermann, C., Roseman, L., Williams, L., Erritzoe, D., Martial, C., Cassol, H., Laureys, S., Nutt, D., & Carhart-Harris, R. (2018). DMT models the near-death experience. *Frontiers in Psychology*, *9*, 1424.
151. Timmermann, C., Spriggs, M. J., Kaelen, M., Leech, R., Nutt, D. J., Moran, R. J., Carhart-Harris, R. L., & Muthukumaraswamy, S. D. (2018). LSD modulates effective connectivity and neural adaptation mechanisms in an auditory oddballparadigm. *Neuropharmacology*, *142*, 251-262. https://doi.org/10.1016/j.neuropharm.2017.10.039
152. Tsuchiya, N., Wilke, M., Frässle, S., & Lamme, V. A. F. (2015). No-Report Paradigms: Extracting the True Neural Correlates of Consciousness. *Trends in Cognitive Sciences*, *19*(12), 757-770. https://doi.org/10.1016/j.tics.2015.10.002
153. Vago, D. R. P. D., & David, S. A. M. D. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience*, *6*. https://doi.org/10.3389/fnhum.2012.00296
154. Vago, D. R., & Zeidan, F. (2016a). The brain on silent: Mind wandering, mindful awareness, and states of mental tranquility. *Annals of the New York Academy of Sciences*, *1373*(1), 96-113. https://doi.org/10.1111/nyas.13171
155. Vago, D. R., & Zeidan, F. (2016b). The brain on silent: Mind wandering, mindful awareness, and states of mental tranquility: The brain on silent. *Annals of the New York Academy of Sciences*, *1373*(1), 96-113. https://doi.org/10.1111/nyas.13171
156. Valentine, E. R., & Sweet, P. L. G. (1999). Meditation and attention: A comparison of the effects of concentrative and mindfulness meditation on sustained attention. *Mental Health, Religion & Culture*, *2*(1), 59-70. https://doi.org/10.1080/13674679908406332
157. Van Dam, N. T., van Vugt, M. K., Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., Meissner, T., Lazar, S. W., Kerr, C. E., Gorchov, J., Fox, K. C. R., Field, B. A., Britton, W. B., Brefczynski-Lewis, J. A., & Meyer, D. E. (2018a). Mind theHype: A Critical Evaluation and Prescriptive Agenda for Research on Mindfulness and Meditation. *Perspectives on Psychological Science*, *13*(1), 36-61. https://doi.org/10.1177/1745691617709589
158. Van Dam, N. T., van Vugt, M. K., Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., Meissner, T., Lazar, S. W., Kerr, C. E., Gorchov, J., Fox, K. C. R., Field, B. A., Britton, W. B., Brefczynski-Lewis, J. A., & Meyer, D. E. (2018b). Mind the Hype: A Critical Evaluation and Prescriptive Agenda for Research on Mindfulness and Meditation. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *13*(1), 36-61. https://doi.org/10.1177/1745691617709589
159. Van Hoeck, N., Ma, N., Ampe, L., Baetens, K., Vandekerckhove, M., & Van Overwalle, F. (2013). Counterfactual thinking: An fMRI study on changing the past for a better future. *Social Cognitive and Affective Neuroscience*, *8*(5), 556-564.
160. van Leeuwen, S., Müller, N. G., & Melloni, L. (2009). Age effects on attentional blink performance in meditation. *Consciousness and Cognition*, *18*(3), 593-599. https://doi.org/10.1016/j.concog.2009.05.001
161. van Vugt, M. K., & Slagter, H. A. (2014). Control over experience? Magnitude of the attentional blink depends on meditative state. *Consciousness and Cognition*, *23*, 32-39. https://doi.org/10.1016/j.concog.2013.11.001
162. Varela, F. J. (1996). Neurophenomenology: A methodological remedy for the hard problem. *Journal of Consciousness Studies*, *3*(4), 330-349.
163. Vidaurre, D., Smith, S. M., & Woolrich, M. W. (2017). Brain network dynamics are hierarchically organized in time. *Proceedings of the National Academy of Sciences*, *114*(48), 12827-12832. https://doi.org/10.1073/pnas.1705120114
164. Wacongne, C., Labyt, E., van Wassenhove, V., Bekinschtein, T., Naccache, L., & Dehaene, S. (2011). Evidence for a hierarchy of predictions and prediction errors in human cortex. *Proceedings of the National Academy of Sciences*, *108*(51), 20754-20759. https://doi.org/10.1073/pnas.1117807108
165. Wallace, B. A. (1999a). The Buddhist tradition of Samatha: Methods for refining and examining consciousness. *Journal of Consciousness Studies*, *6*(2-3), 175-187.
166. Wallace, B. A. (1999b). The Buddhist Tradition of Samatha: Methods for Refining and Examining Consciousness. *Journal of*

Consciousness Studies, *6*(2-3), 175-187.

167. Whitmarsh, S., Uddén, J., Barendregt, H., & Petersson, K. M. (2013). Mindfulness reduces habitual responding based on implicit knowledge: Evidence from artificial grammar learning. *Consciousness and Cognition*, *22*(3), 833-845. https://doi.org/10.1016/j.concog.2013.05.007
168. Winter, U., LeVan, P., Borghardt, T. L., Akin, B., Wittmann, M., Leyens, Y., & Schmidt, S. (2020). Content-Free Awareness: EEG-fcMRI Correlates of Consciousness as Such in an Expert Meditator. *Frontiers in Psychology*, *10*, 3064. https://doi.org/10.3389/fpsyg.2019.03064
169. Yon, D., de Lange, F. P., & Press, C. (2019). The Predictive Brain as a Stubborn Scientist. *Trends in Cognitive Sciences*, *23*(1), 6-8. https://doi.org/10.1016/j.tics.2018.10.003
170. Zeidan, F., Johnson, S. K., Diamond, B. J., David, Z., & Goolkasian, P. (2010). Mindfulness meditation improves cognition: Evidence of brief mental training. *Consciousness and Cognition*, *19*(2), 597-605. https://doi.org/10.1016/j.concog.2010.03.014
171. Zeidan, F., & Vago, D. (2016). Mindfulness meditation-based pain relief: A mechanistic account. *Annals of the New York Academy of Sciences*, *1373*(1), 114-127. https://doi.org/10.1111/nyas.13153

The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas

by

R. L. Carhart-Harris[1] and K. J. Friston[2]

doi:10.1093/brain/awq010 Brain 2010: 133; 1265-1283 / 1265

Received August 16, 2009. Revised and Accepted December 23, 2009. Advance Access publication February 28, 2010

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

© The Author(s) 2010. Published by Oxford University Press on behalf of Brain.

original report: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2850580/pdf/awq010.pdf
backup source: http://www.psilosophy.info/resources/awq010.pdf

[1] Neuropsychopharmacology Unit, Imperial College London, Hammersmith Campus, Du Cane Road, London, UK
[2] The Wellcome Trust Centre for Neuroimaging, 12 Queen Square, London, UK

Correspondence to: R. L. Carhart-Harris,
Neuropsychopharmacology Unit,
Imperial College London,
Hammersmith Campus,
Du Cane Road,
London,
W12 ONN, UK
E-mail: r.carhart-harris@imperial.ac.uk

Table of Contents:

- Abstract
- Introduction
- The primary and secondary process
- Free-energy and the Bayesian brain
- Intrinsic brain networks and the default mode
- Large-scale intrinsic networks, the secondary process and ego
- Functional anatomy of the default-mode
- Theoretical formulations of the default mode
- Hierarchical brain systems
- Spontaneous BOLD oscillations and neuronal activity
- Summary and synthesis
  - The phenomenology of primary process thinking
- Neurophysiology of the primary process
  - Summary and synthesis
- Discussion
- Conclusion
- Acknowledgements
- Funding
- Supplementary material
- References

Abstract

This article explores the notion that Freudian constructs may have neurobiological substrates. Specifically, we propose that Freud's descriptions of the primary and secondary processes are consistent with self-organized activity in hierarchical cortical systems and that his descriptions of the ego are consistent with the functions of the default-mode and its reciprocal exchanges with subordinate brain systems. This neurobiological account rests on a view of the brain as a hierarchical inference or Helmholtz machine. In this view, large-scale intrinsic networks occupy supraordinate levels of hierarchical brain systems that try to optimize their representation of the sensorium. This optimization has been formulated as minimizing a free-energy; a process that is formally similar to the treatment of energy in Freudian formulations. We substantiate this synthesis by showing that Freud's descriptions of the primary process are consistent with the phenomenology and neurophysiology of rapid eye movement sleep, the early and acute psychotic state, the aura of temporal lobe epilepsy and hallucinogenic drug states.

Keywords: freud; the ego; default-mode; prediction; free-energy

Abbreviations: BOLD = blood oxygen level dependent; DMN = default-mode network; fMRI = functional magnetic resonance imaging; REM = rapid eye movement

Introduction

In this synthesis we explore the notion that Freudian constructs may have real neurobiological substrates and could be usefully revisited in the context of modern neuroscience. It is worth noting that Freud had a formal training in neuroanatomy and was influenced by people like Helmholtz, who laid many of the foundations for theoretical neurobiology. Advances in empirical and theoretical neuroscience now allow us to recast some central Freudian ideas in a mechanistic and biologically informed fashion. Specifically, we note that the psychoanalytic distinction between the primary and secondary processes (as functions of the id and ego respectively) fit comfortably with modern notions of functional brain architecture, at both a computational and neurophysiological level. Although this may seem a rather abstract and ambitious synthesis, there is in fact an enormous amount of empirical evidence from neuropsychology, neuroimaging and psychopharmacology to support it.

In what follows we attempt to demonstrate consistencies between key Freudian ideas and recent perspectives on global brain function that have emerged in imaging and theoretical neuroscience. The intention is to demonstrate and develop the *construct validity* of the Freudian concepts. This should allow Freudian concepts to be operationalized and measured empirically and could enable a dialogue between psychoanalysts and neurobiologists. This may have implications for psychiatry to the extent that mechanistic theories of psychopathology appeal to either neurobiological or psychoanalytical constructs. We start by summarizing the key elements of the three areas that we want to relate to each other; namely the central Freudian constructs, the Helmholtzian or Bayesian brain framework and empirical findings from neuroimaging on the global organization of brain activity.

The primary and secondary process

Freud came to a realization that there are two fundamentally different modes of cognition (the primary and secondary process) through a study of 'altered' or 'non-ordinary' states of consciousness (e.g. Q115, Q333 and Q462 in Supplementary material). He recognized in certain non-ordinary states (e.g. dreaming and psychosis) a *mode of cognition* that is characterized by a primitive, animistic style of thinking. Freud conjectured that the exchange of neuronal energy is relatively 'free' in this mode and he named this the 'primary process'. Simultaneously, Freud recognized in non-ordinary states the loss of certain functions, which are normally present in waking cognition. He ascribed these functions to a central organization (the ego) which works to minimize the mind's free-energy. Freud named this function the 'secondary process' and defined its aim as one of converting 'free energy' into 'bound energy' (for a more thorough discussion of these central concepts of Freudian theory see the supporting quotes in the online Supplementary material, cited in Table 1):

> We seem to recognize that nervous or psychical energy occurs in two forms, one freely mobile and another, by comparison, bound; we speak of [activations] and [hyperactivations] of psychical material, and even venture to suppose a [hyperactivation] brings about a kind of synthesis of different processes - a synthesis in the course of which free energy is transformed into bound energy ...We hold firmly to the view that the distinction between the [primary] and the [secondary] state lies in dynamic relations of this kind, which would explain how it is that, whether spontaneously or with our assistance, the one can be changed into the other ... We have found that processes in the unconscious or in the id obey different laws from those in the ego. We name these laws in their totality the primary process, in contrast to the secondary process which governs the course of events in the ego. (Q461, Freud, 1940)

Table 1. **List of quotations pertaining to the characteristics of the secondary process (and the ego) and primary process thinking (and the id)**

The ego and the secondary process	**Relevant quotations from Freud**
1. Default energy store or reservoir, which possesses the property of being spontaneously or tonically active.	Q5, Q15, Q109, Q154, Q162, Q209, Q273, Q298, Q300, Q301, Q314, Q320, Q321, Q416, Q438, Q454
2. Receives and 'contains' or 'represses' endogenous excitation.	Q1, Q15, Q46, Q80, Q132, Q152, Q154, Q183, Q205, Q209, Q212, Q219, Q283, Q283, Q287, Q328, Q358, Q363, Q391, Q392, Q427, Q427, Q429, Q437, Q448, Q475
3. Minimizes free-energy.	Q2, Q8, Q18, Q70, Q199, Q200, Q283, Q285, Q307, Q314, Q321, Q366, Q373, Q410, Q461, Q483
4. Integrates or binds the primary process and its representational system (the id) into a broader, more cohesive, composite organization (the ego).	Q15, Q29, Q45, Q46, Q154, Q209, Q218, Q231, Q233, Q234, Q237, Q300, Q302, Q308, Q314, Q315, Q334, Q339, Q351, Q358, Q360, Q383, Q384, Q385, Q391, Q397, Q402, Q413, Q429, Q447, Q461, Q483
5. Specific ontogenetic development.	Q47, Q113, Q174, Q273, Q300, Q301, Q358, Q414, Q440, Q459, Q486
6. Supports reality-testing and perceptual processing.	Q15, Q19, Q23, Q39, Q51, Q153, Q234, Q258, Q259, Q310, Q350, Q356, Q363, Q373, Q375, Q380, Q392, Q427, Q428, Q429, Q448, Q482, Q485
7. Supports conscious awareness, cognition and directed attention.	Q10, Q21, Q27, Q39, Q40, Q153, Q154, Q204, Q234, Q238, Q249, Q254, Q334, Q372, Q380, Q427
8. Possesses internally and externally-focused components, which are inversely related (anti-correlated).	Q6, Q39, Q162, Q173, Q204, Q243, Q273, Q289, Q300, Q301, Q320, Q329, Q363, Q438, Q448, Q454, Q484
9. Excessive-engagement of internally-focused component and impoverished engagement of externally-focused network during pathological withdrawal; e.g. in depression and schizophrenia.	Q144, Q147, Q158, Q161, Q168, Q169, Q170, Q172, Q244, Q252, Q253, Q263, Q265, Q266, Q267, Q277, Q288, Q292, Q293, Q297, Q301, Q329, Q330, Q368,
10. Failure of systems to minimize free-energy (suppress endogenous excitation) results in disturbed affect, cognition and perception; as seen in non-ordinary states such as dreaming and psychosis.	Q23, Q35, Q58, Q115, Q134, Q135, Q147, Q231, Q261, Q262, Q333, Q365, Q383, Q455, Q462, Q466, Q469, Q475, Q476, Q482, Q485
The id and primary process thinking	**Relevant quotations from Freud**
11. Characteristics of the system unconscious/the id and primary process thinking: i.e. a primitive, 'magical' or animisitic style of thinking, characterized neurophysiologically by 'free' movement of energy. One can think of primary process thinking in evolutionary terms as a 'protoconsciousness'.	Q58, Q63, Q90, Q92, Q97, Q115, Q135, Q151, Q160, Q171, Q198, Q201, Q203, Q209, Q211, Q216, Q217, Q218, Q228, Q229, Q230, Q231, Q233, Q237, Q241, Q242, Q247, Q249, Q254, Q257, Q261, Q270, Q279, Q280, Q282, Q299, Q305, Q311, Q315, Q335, Q359, Q388, Q389, Q396, Q397, Q423, Q424, Q425, Q426, Q437, Q440, Q442, Q443, Q446, Q453, Q461, Q465, Q467, Q468, Q470, Q471, Q472, Q474, Q477, Q479, Q480, Q482, Q490, Q491

The quotations can be found in Supplementary material.

Free-energy and the Bayesian brain

In terms of theoretical and computational neuroscience, we will focus on Helmholtz's suggestion that the brain is an inference machine (Helmholtz, 1866; Dayan *et al*., 1995); this idea is now a fundamental premise in neurobiology (Gregory, 1968). Key examples of this include the Bayesian brain (Knill and Pouget, 2004), predictive-coding (Rao and Ballard, 1998) and the free-energy principle (Friston, 2009). This framework assumes that the brain uses internal hierarchical models to predict its sensory input and suggests that neuronal activity (and synaptic connections) try to minimize the ensuing prediction-error or (Helmholtz) free-energy. This free-energy is a measure of surprise and is essentially the amount of prediction-error. It is an information theory quantity that, mathematically, plays the same role as free-energy in statistical thermodynamics. Free-energy is not an abstract concept; it can be quantified easily and is used routinely in modelling empirical data (Friston *et al*., 2007) and in neuronal simulations of perception and action (Friston *et al*., 2009).

The notion of a hierarchy is central here because it allows the brain to construct its own top-down prior expectations about sensory samples from the world. This resolves one of the key challenges facing the brain and also allows it to resolve ambiguities when inferring and representing the causes of exteroceptive and interoceptive sensations. Crucially, the hierarchical form of internal models (and associated neuroanatomy) (Felleman and Van Essen, 1991) entails a progression in the complexity of representations, as one proceeds up the hierarchy from thalamic nuclei and primary sensory cortex to association and paralimbic cortex (e.g. from sensations, through perceptions to concepts). This progression is reflected in the temporal extent of what is represented; with higher levels representing extended sequences of events that best account for the stream of sensory information represented in lower levels (see Kiebel *et al*., 2008 for a full discussion and simulations).

The hierarchical architecture may also accommodate the distinction between the Freudian primary and secondary processes, where the secondary process provides top-down predictions to reduce free-energy associated with the primary process (*cf*. converting free energy into bound energy). Under this mapping between Freudian and Helmholtzian models, one can link the energy associated with the primary process and the free-energy of Bayesian formulations. In both accounts, higher cortical areas are trying to organize activity in lower-levels through suppression of their free-energy.

Intrinsic brain networks and the default mode

Analyses of spontaneous fluctuations in the blood oxygen level dependent (BOLD) signal of functional magnetic resonance imaging (fMRI) during unconstrained 'resting' states (typically lying quietly with eyes closed or fixating on a cross) have identified a number of large-scale intrinsic networks (Beckmann *et al*., 2005; Damoiseaux *et al*., 2006). Of particular interest here is the so called 'default-mode network' (DMN), a network of regions that show high metabolic activity and blood flow at rest but which deactivate during goal-directed cognition (Raichle, 2001). Recent work has confirmed that the major nodes of the DMN are functionally and structurally connected (van den Heuvel *et al*., 2008; Greicius *et al*., 2009) and that this connectivity develops through ontogeny (Fair *et al*., 2008; Kelly *et al*., 2009). Another feature of the DMN is the inverse relationship of its neuronal activity with that of another large-scale intrinsic network; the 'attention system' (Fox *et al*., 2005; Fransson, 2005; Corbetta and Shulman, 2002). In this article, we pursue the idea that these intrinsic networks correspond to the high-levels of an inferential hierarchy, which function to suppress the free-energy of lower levels (i.e. suppress prediction errors with top-down predictions). We associate this optimization process with the secondary process. Furthermore, we associate failures of top-down control with non-ordinary states of consciousness, such as early and acute psychosis, the temporal-lobe aura, dreaming and hallucinogenic drug states. In what follows, we organize the evidence that speaks to the integration of neurobiological and psychoanalytic ideas and conclude with a defence of its value and potential utility.

This article comprises three sections: in the first, we review evidence that the development and functioning of the DMN is consistent with ego-functions and the secondary process. We focus specifically on the DMN's containment of endogenous excitation and its suppression of systems engaged by exogenous stimuli. In the second, we review evidence that a loss of top-down control over limbic activity in hierarchically lower systems is equivalent to a loss of the ego's control over the primary process. In the final section, we discuss the clinical relevance of these ideas.

Large-scale intrinsic networks, the secondary process and ego

In this section, we introduce the idea that Freud's descriptions of the development and functioning of the ego resonate with the development and functioning of the DMN and its reciprocal exchanges with subordinate brain systems. Freud's first useful account of the ego was given in his posthumously published *Project for a Scientific Psychology* (Freud, 1895). Inspired by the recent introduction of 'neurone theory' by Cajal and Waldeyer-Harz, Freud hypothesized three functionally-distinct classes of neurone: the 'w neurones', which receive endogenous input and make up the ego; the 'neurones', which are sensitive to exogenous input; and the 'ω neurones', which signal qualitative information. Although this neuronal classification system was abandoned by Freud soon after its conception, the ideas that inspired it remained a source of influence throughout his work. Several of Freud's most important ideas were introduced and/or developed in the *Project*, including the notion that the ego is an organization that receives and contains/represses bottom-up endogenous excitation (Table 1, row 2; Q1, Q15, Q46 and Q429).

The secondary process, or 'secondary process cognition', is the mode of cognition of the ego; put simply, it is the mode of normal waking consciousness of adult humans (e.g. Q317). Freud described the secondary process as 'inhibited' and 'bound'; in contradistinction to the primary process which is 'free' and 'motile' (Freud, 1895, 1900). The concept of 'bound' energy was attributed by Freud to ideas first expressed by Breuer in their *Studies on Hysteria* (Breuer and Freud, 1895). Breuer conjectured the existence of a system of tonically active neurons, forming a 'reservoir of nervous tension' (e.g. Q45, Q154 and Q233). It is significant that the primary and secondary processes owe their inception to observations of non-ordinary states of consciousness (e.g. row 10, Table 1; Q23, Q35, Q115, Q333 and Q462). We shall see later that compelling evidence for the existence of two distinct modes of cognition can be found in studies of non-ordinary states. In what follows, we review the functional anatomy of the default-mode and related networks and then consider these networks from a theoretical perspective.

Functional anatomy of the default-mode

The notion of the DMN originated in a paper by Marcus Raichle reviewing a pattern of blood flow, glucose metabolism and oxygen consumption in the resting-state, which consistently decreases during goal-directed cognition (Raichle, 2001); in other words, a high-level distributed system whose activity is reciprocally related to the activity in cortical areas subserving task or stimulus-bound processing. Raichle proposed that this pattern reflects a default mode of brain function and a functionally relevant physiological baseline (Raichle, 2001). Subsequent work has associated activity in the network identified by Raichle and others (Greicius *et al*., 2003; Beckmann *et al*., 2005; Damoiseaux *et al*., 2006; Fransson and Marrelec, 2008; Wu *et al*., 2009) with phenomena such as self-referential processing, autobiographical recollection, mind-wandering and theory-of-mind (Gusnard *et al*., 2001; Vincent *et al*., 2006; Mason *et al*., 2007; Buckner *et al*., 2008; see also Q332).

Regions specifically implicated in the DMN include the medial prefrontal cortex, the posterior cingulate cortex, the inferior parietal lobule, the lateral and inferior temporal cortex and the medial temporal lobes (Buckner *et al*., 2008; Fransson and Marrelec, 2008). Analyses of resting-state functional connectivity and diffusion tensor imaging have showed that the major nodes of the DMN are strongly interconnected (Greicius *et al*., 2003, 2009; Van den Heuvel *et al*., 2009) and that this connectivity matures through development (Fair *et al*., 2008; Kelly *et al*., 2009). Functional connectivity in the DMN is relatively weak in the elderly (Andrews-Hanna *et al*., 2007; Damoiseaux *et al*., 2008) and in patients with attention deficit disorder (Castellanos *et al*., 2008) and impulse control disorders (Church *et al*., 2009). Interestingly, medial prefrontal cortex-posterior cingulate cortex connectivity is entirely absent in infants (Fransson *et al*., 2007). These findings imply that the DMN develops through ontogeny, in a manner that parallels the emergence of ego-functions (Table 1, row 5).

Model and data-driven analyses of resting-state functional connectivity, diffusion tensor imaging analyses of structural connectivity and anatomical work in primates suggest that the medial temporal lobes are connected to the medial prefrontal cortex and posterior cingulate cortex nodes of the DMN (Catani *et al*., 2003; Vincent *et al.*, 2006; Buckner *et al.*, 2008; Fransson and Marrelec, 2008; Kahn *et al.*, 2008; Saleem *et al.*, 2008; van den Heuvel *et al.*, 2008; Robinson *et al.*, 2009). This is important because the medial temporal lobes contain key structures (e.g. the hippocampal formation, the amygdala, parahippocampal gyrus and entorhinal cortex) that play a role in mnemonic and hedonic or emotional processing. The evidence suggests that medial prefrontal cortex-medial temporal lobe functional and structural connectivity increases through ontogeny (Eluvathingal *et al.*, 2007; Kelly *et al.*, 2009) with a notable increase at puberty (Benes *et al.*, 1989). A recent study found reduced medial prefrontal cortex-amygdala functional connectivity in patients with schizophrenia and an inverse correlation between connectivity and aggression in these patients (Hoptman *et al.*, 2009). Preclinical work indicates that emotional extinction takes place via glutamatergic projections from the medial prefrontal cortex terminating on inhibitory interneurons in the medial temporal lobes (Rosenkranz and Grace, 2002; Rosenkranz *et al.*, 2003) and a recent analysis of effective connectivity implied that activation of the rostral anterior cingulate drives inhibition of the amygdala in response to fearful faces (Stein *et al.*, 2007).

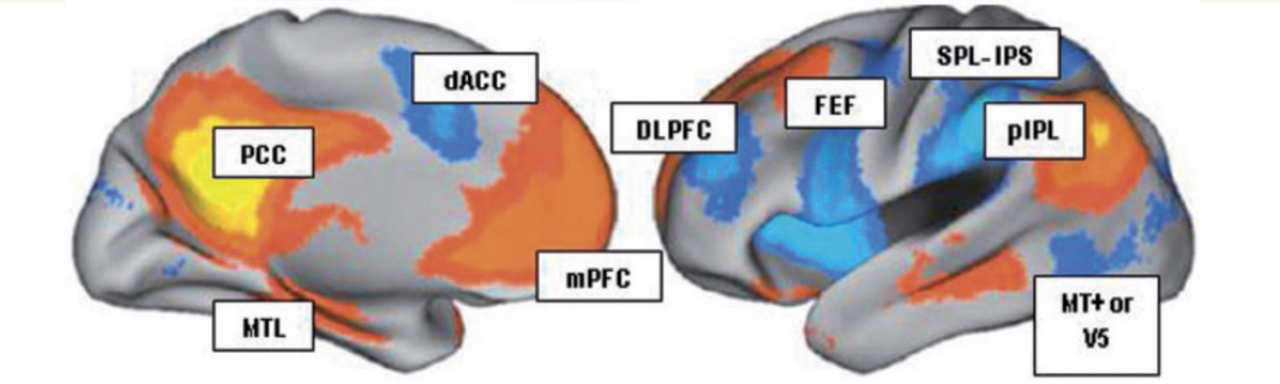


Figure 1 The DMN (yellow/orange) and attention system (blue): resting state functional connectivity of three seed regions: the dorsal medial prefrontal cortex, ventral medial prefrontal cortex and hippocampal formation (medial temporal lobes). Positive correlations (yellow-orange) with all seeds were evident in the posterior cingulate (PCC), posterior inferior parietal lobule (pIPL) and medial prefrontal cortex (mPFC). Regions negatively correlated with these seeds constitute the attention system and include the superior parietal lobule (SPL), intraparietal sulcus (IPS), the motion-sensitive middle temporal area (MT+), the frontal eye fields (FEF) the dorsal anterior cingulate (dACC), the dorsolateral prefrontal cortex (DLPFC), the ventral premotor cortex and the frontal operculum. Image reproduced from Buckner *et al.* (2008), with permission.

There is a huge amount of clinical and preclinical evidence supporting the limbic-suppressive function of the medial prefrontal cortex (Hariri *et al.*, 2000; Milad and Quirk, 2002; Rosenkranz and Grace 2002; Phillips *et al.*, 2003; Phelps *et al.*, 2004; Etkin *et al.*, 2006; Milad *et al.*, 2006). Functional neuroimaging studies have correlated primitive thought and emotion with decreased activity in the medial prefrontal cortex and increased activity in the medial temporal lobes (Pietrini *et al.*, 2000; Dougherty *et al.*, 2004), while suppression of these behaviours correlated with medial prefrontal cortex activations (Pietrini *et al.*, 2000; Beauregard *et al.*, 2001; Dougherty *et al.*, 2004). The recollection of distressing memories and emotions in patients with post-traumatic stress disorder has also been found to correlate with medial prefrontal cortex deactivations and medial temporal lobe activations (Bremner *et al.*, 1999; Shin *et al.*, 2004, 2006; Hopper *et al.*, 2007) and the blockade of these memories also correlated with medial prefrontal cortex activations (Lanius *et al.*, 2002; Reinders *et al.*, 2003, 2006). Damage to the ventromedial prefrontal cortex has long been associated with impaired impulse control (Grafmen *et al.*, 1996; Anderson *et al.*, 1999; Davidson *et al.*, 2000; Kaplan-Solms and Solms, 2001; Solms and Turnbull, 2002). The medial prefrontal cortex sends dense projections to the ventral striatum (Ferry *et al.*, 2000) and midbrain (Carr and Sesack, 2000). The ventral striatum displays functional connectivity with the midbrain, medial temporal lobes and higher-level nodes of the DMN (Postuma and Dagher, 2006; Di Martino *et al.*, 2008; Gutman *et al.*, 2009) and the midbrain and ventral striatum signal prediction-error and motivational-salience (Robbins and Everitt, 1996; Berridge and Robinson, 1998; Schultz, 2002; Kapur, 2005). In summary, the DMN comprises high-level cortical nodes such as the medial prefrontal cortex that exchange neuronal signals with subcortical systems and other association and polymodal cortex, especially the systems responsible for emotional learning and memory. Much of the evidence suggests that activation of the DMN suppresses activity in lower systems. We now consider these aspects of functional anatomy in the light of hierarchical inference and the secondary process.

Theoretical formulations of the default mode

Freud argued that the ego modulates both endogenous and exogenous excitation. Empirically, this can be seen in early and acute psychosis, the aura of temporal lobe epilepsy and hallucinogenic states, where affective (e.g. fear), mnemonic (e.g. moments of déjà vu or vivid recollection), perceptual (e.g. hallucinations) and cognitive (e.g. confused or muddled thinking) processing is perturbed (Bleuler, 1911; Epstein and Ervin, 1956; Cohen, 1964; Vollenweider *et al.*, 1997) (Table 1, row 10; e.g. Q462). He further hypothesized that the ontogenetic/phylogenetic evolution of healthy, adult waking cognition depends on the formation of an equilibrium between the pressing forces of the primary process (entailed by the id) and the counter forces of the secondary process (entailed by the ego) (e.g. Q116). This description is remarkably consistent with contemporary models of cognition based on hierarchical Bayesian inference and Helmholtzian free-energy; where backward connections from higher cortical areas work to minimize the free-energy of lower areas (Mumford, 1992; Rao and Ballard, 1999; Friston, 2003; Kiebel *et al.*, 2009).

Anatomically speaking, forward connections originate in supragranular layers and terminate in layer four spiny stellate cells. They project from lower to higher-levels; e.g. from thalamic nuclei to primary sensory cortex or from secondary sensory cortex to tertiary sensory areas. Backward connections are more abundant and diffuse than forward connections and their effects are primarily modulatory. Backward connections originate in deep pyramidal cells (infragranular layers) of the cortex and target infra and supragranular layers of lower cortical areas. Based on Bayesian and Helmholtzian principles it has been proposed that forward connections convey prediction-errors that optimize representations in higher levels. These representations are then used to form predictions that are conveyed by backward connections to lower levels. These predictions suppress or cancel prediction-errors (free-energy) until they can be minimized no further (Friston, 2003, 2005). In this way, the brain optimizes its representation of the world by suppressing prediction-errors with reciprocal message passing between hierarchical levels to minimize free-energy. This suppression simply involves countering excitatory presynaptic inputs (from representational units to neurons encoding prediction-error) with top-down presynaptic inputs, mediated by inhibitory interneurons. When the representations at any level can be explained by top-down predictions from the level above, prediction-error is minimized and the representations are internally consistent over levels. The aim of this process is to optimize parsimonious explanations for what caused sensory input (Friston, 2003) and establish sensory predictions to guide action and behaviour (Friston *et al.*, 2009). Crucially, this empirically-informed scheme (Sandell and Schiller, 1982; Girard and Bullier, 1989; Hupé *et al.*, 1998; Kleinschmidt *et al.*, 1998; Murray *et al.*, 2002; Lachaux *et al.*, 2005; Chen *et al.*, 2008) recapitulates Freud's 19th century conception and in particular his *principle of constancy*:

> [We] have taken the view that the principle which governs all mental processes is a special case of Fechner's "tendency towards stability", and have accordingly attributed to the mental apparatus the purpose of reducing to nothing, or at least of keeping as low as possible, the sums of excitation which flow in upon it. (Freud, 1924; Q366)

It is significant that Freud cited as his inspiration for these ideas, Gustav Fechner, the founder of psychophysics and a contemporary of Helmholtz (e.g. Q307, Q353, Q366, Q379): the process of minimizing 'the sums of excitation' is exactly the same as minimizing the sum of squared prediction-error or free-energy in Helmholtzian schemes. This rests on the assumption that the brain explicitly encodes prediction-error with neuronal activity (excitation) that is suppressed or explained by backward (top-down) afferents.

As mentioned above, Freud argued that the ego modulates and suppresses both exogenous and endogenous signals (Table 1, rows 2 and 6). In neurobiological terms, exogenous signals correspond to interoceptive and exteroceptive signals from thalamic and unimodal sensory areas that convey sensory signals (predictionerrors) to polymodal and medial temporal lobe structures. Endogenous signals could be equated with subsequent bottom-up prediction errors (excitation) arising in limbic and paralimbic systems, which are passed up to high-level polymodal cortical areas that comprise the nodes of the default-mode.

Clearly, the principles that attend hierarchical inference under Helmholtzian schemes are generic and may apply to all hierarchically deployed brain systems. However, we will focus on the DMN; specifically, on medial prefrontal suppression of limbic and paralimbic activity, and associate this with the suppression of endogenous activity by the ego. We now consider how the ego modulates excitation evoked by stimuli from the external world.

Hierarchical brain systems

As discussed in the introduction, BOLD signal oscillations in the DMN are characterized by their inverse relation to those of another major intrinsic network, referred to as the attention system (Corbetta and Shulman, 2002; Fox *et al*., 2005; Fransson, 2005). As well as showing a spontaneous inverse relationship with the DMN, the attention system is activated during externally-directed cognition and deactivated during internally-directed cognition, whereas the opposite is true of the DMN (Buckner *et al*., 2008); implying a 'give-and-take' relationship (Raichle, 2009). Regions implicated in the attention system include the dorsolateral prefrontal cortex, the dorsal anterior cingulate cortex, the frontal eye fields, the extrastriate cortex (e.g. V5) the superior parietal lobule, the intraparietal sulcus and the ventral premotor cortex (Buckner *et al*., 2008). These regions are active during target detection, attention to spatial detail and hand-eye coordination (Corbetta and Shulman, 2002; Shulman, 2003). Moreover, many of these nodes have been associated with top-down control of primary sensory input (Friston and Büchel, 2000; Lachaux *et al*., 2005). High-level association cortices not only receive feedforward signals from sensory regions but also anticipate and reciprocate these inputs with backward connections conferring context-specificity and higher-level constraints (i.e. predictions) (Rao and Ballard, 1999; Friston, 2003, 2005; Angelucci and Bressloff, 2006).

Recent work has suggested that what we have referred to as the 'attention system' is in fact not a unified system. Based on independent component analyses of resting state BOLD activity, Seeley *et al*. (2007) have shown that the system described by Fox *et al*. (2005) and Fransson (2005) can be differentiated into a 'salience system' which includes the dorsal anterior cingulate cortex, frontoinsular cortices, amygdala and ventral midbrain; and a more dorsal and lateral cortical system (the 'dorsal attention system') which includes the dorsolateral prefrontal cortex, frontal eye fields, dorsal medial prefrontal cortex, intraparietal sulcus and superior parietal lobule. BOLD signal oscillations in both systems exhibit an inverse relationship with those in the posterior cingulate cortex of the DMN (Greicius *et al*., 2003) but the systems do not appear to be well integrated with each other. This differentiation has also been suggested by others (He *et al*., 2007; Dosenbach *et al*., 2008; Sridharan *et al*., 2008; Vincent *et al*., 2008).

The picture that emerges is of a hierarchy of brain systems with the DMN at the top and the salience and dorsal attention systems at intermediate levels, above thalamic and unimodal sensory cortex. Under a Helmholtzian model, each system is trying to suppress the free-energy of its subordinates, through a process of optimizing predictions to reduce prediction-errors. This rests on recurrent message-passing between these systems that leads to self-organized activation patterns with a characteristic reciprocity or 'give-and-take' among levels. In this view, activation of the attention system may facilitate the suppression of exogenous excitation (Q258). Similarly, the DMN furnishes top-down control of the attentional and salience systems by explaining and thereby suppressing their activity. We next address the physiological basis of message-passing or interactions among brain regions that mediate this self-organized suppression.

Spontaneous BOLD oscillations and neuronal activity

Until recently, there had been some uncertainty about whether spontaneous BOLD-signal oscillations are generated by neuronal activity or non-neuronal physiological processes (Wise *et al*., 2004; Birn *et al*., 2006). Recent work has shown that spontaneous BOLD oscillations most probably have a neuronal origin (He *et al*., 2008; Nir *et al*., 2008; Shmuel and Leopold, 2008). Simultaneous fMRI and intracranial recordings in monkeys (Shmuel and Leopold, 2008) and humans (Nir *et al*., 2007) have identified spontaneous neuronal fluctuations that correlate with spontaneous BOLD fluctuations (Shmuel and Leopold, 2008). The neuronal fluctuations, which are coherent across the hemispheres, were evident in multiunit firing rates and local field potential gamma power. Stimulus evoked BOLD activations have also been shown to correlate positively with gamma power (Niessing *et al*., 2005). Gamma has been associated with attention, feature-binding and expectancy (Singer and Gray, 1995; Herrmann, 2000; Engel *et al*., 2001). This suggests that BOLD fluctuations reflect cortical coherence associated with gamma and secondary process cognition, particularly since the gamma frequency, recorded in higher-level cortical areas, has recently been shown to suppress lower frequencies in lower-level cortical areas (Chen *et al.*, 2009). This leads us to predict that the fluctuations in gamma power evident in the large-scale intrinsic networks index the ongoing minimization of free-energy in subordinate levels of the hierarchy (Engel *et al.*, 2001; Raichle, 2007) and could provide an empirical measure of the secondary process.

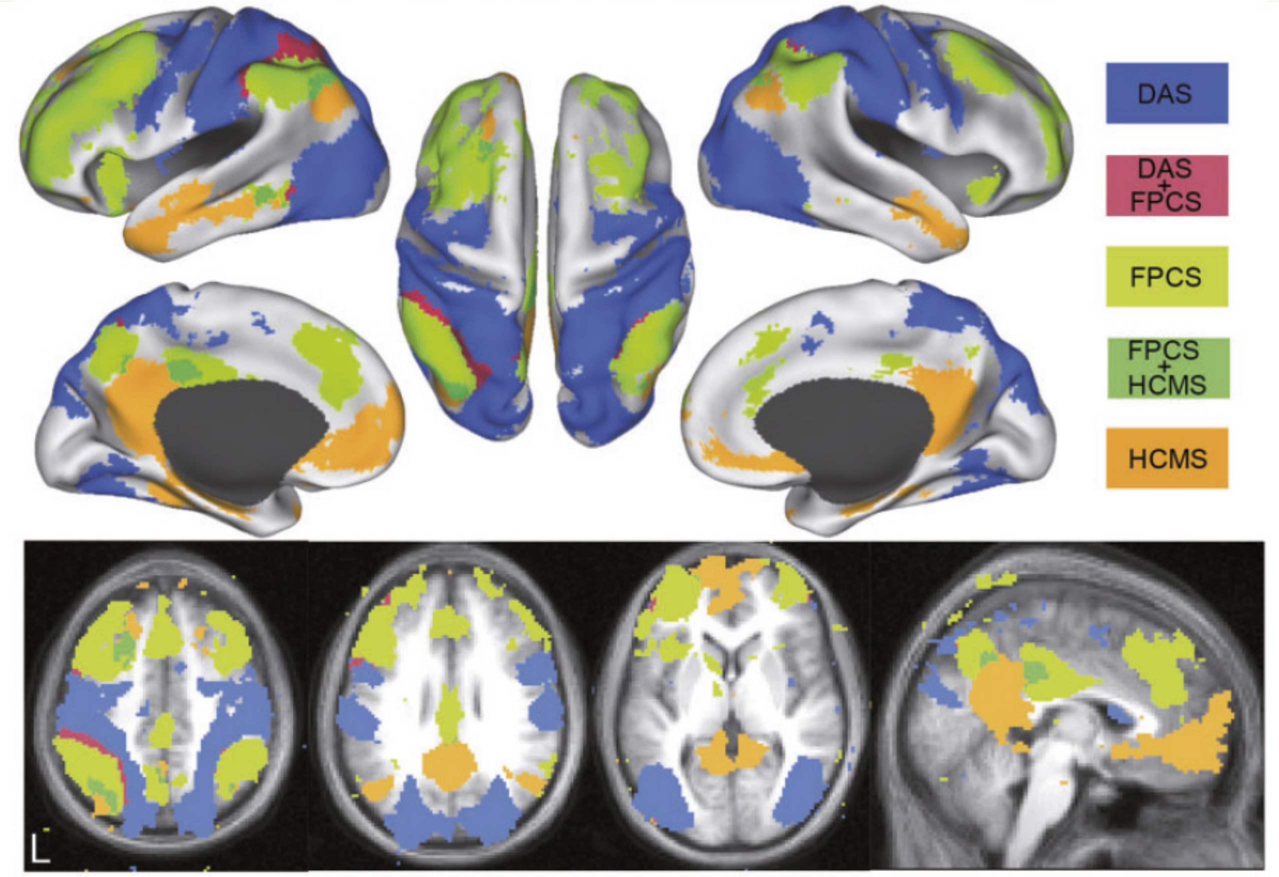


Figure 2 Resting state functional connectivity in three cortical networks: (i) dorsal attention system (DAS, blue) using voxels in the middle temporal area and superior parietal lobule as regions of interest; (ii) the salience system (light green) using voxels in the anterior PFC and anterior inferior parietal lobule as regions of interest; and (iii) the default mode network (orange) using the hippocampal formation and posterior inferior parietal lobule as regions of interest. Overlap between the networks is shown in dark green (salience system and DMN) and red (dorsal attention systems and salience system). Image used with permission from Justin Vincent and Randy Buckner.

Generally speaking, oscillatory processes are ubiquitous in the brain and serve to couple remote neuronal populations. High frequency gamma has often been implicated in perceptual synthesis and binding (e.g. Singer, 2009); while theta rhythms have been most studied in the hippocampal system, where they are associated with (spatial) memory and exploration (e.g. Lisman and Redish, 2009). Crucially, theta and gamma are themselves coupled (e.g. Sirota *et al.*, 2008), where slower theta oscillations may provide a temporal frame of reference for faster computations mediated at gamma frequencies. We will return to the oscillations and frequency-specific coupling in the brain in the next section.

So far we have discussed the importance of reciprocal or anti-correlated activity in the DMN and networks for goal-directed cognition. However, it should be noted that spontaneous fluctuations in the DMN continue during active cognition, just as spontaneous fluctuations in the dorsal attention system continue during rest (Hampson *et al.*, 2002; Beckmann *et al.*, 2005; Damoiseaux *et al.*, 2006; Fox *et al.*, 2007). This tonicity presumably primes structures to infer exogenous inputs (Fox *et al.*, 2007; Raichle, 2007) and supports a background level of predictive coding (Hampson *et al.*, 2002). Furthermore, spontaneous fluctuations in the BOLD signal, which can be as large in amplitude as evoked BOLD responses (Fox *et al.*, 2007), have been shown to reflect variations in behaviour (Boly *et al.*, 2007; Fox *et al.*, 2007). Much of the brain's vast energy budget is reserved for spontaneous neuronal activity (Fox and Raichle, 2007; Raichle, 2007). We speculate that spontaneous activity in the DMN reflects the constant containment of spontaneous endogenous activity - commensurate with Freud's concept of repression (Q209), while spontaneous activity in the dorsal attention system indexes the continual monitoring and suppression of exogenous stimuli. This conjecture appeals to the

Helmholtzian view of the brain as an inference engine that continually generates predictions and hypotheses that, when freed from the present (Kiebel *et al.*, 2009), necessarily entails the past and future.

In addition to the functional importance of spontaneous neuronal activity in intrinsic networks, the give-and-take between the default system and task-positive systems appears to be vital for active cognition and conscious awareness (Pomarol-Clotet *et al.*, 2008; He and Raichle, 2009; Whitfield-Gabrieli *et al.*, 2009). Functional connectivity within the DMN has been shown to increase through ontogeny (Fair *et al.*, 2008; Kelly *et al.*, 2009), decrease in ageing (Andrews-Hanna *et al.*, 2007; Damoiseaux *et al.*, 2008) and to be underdeveloped in patients with impaired impulse control (Church *et al.*, 2009). These findings imply that functional connectivity in the DMN (Hampson *et al.*, 2006) and the dorsal attention system (Seeley *et al.*, 2007) provides an index of cognitive aptitude but not necessarily *active cognition* (Larson-Prior *et al.*, 2009). Ineffective deactivation of the DMN has been associated with cognitive error in healthy subjects (Li *et al.*, 2007; Eichele *et al*. 2008) and negative symptoms in schizophrenia (Pomarol-Clotet *et al.*, 2008; Whitfield-Gabrieli *et al.*, 2009) and depression (Grimm *et al.*, 2009; Sheline *et al.*, 2009). Functional connectivity in the DMN is not significantly altered in sleep, sedation or coma (Boly *et al.*, 2008; Larson-Prior *et al.*, 2009) but the give-and-take between the DMN and its anti-correlated networks is (He and Raichle, 2009) (see Q238).

Summary and synthesis

In this section, the secondary process was considered in relation to large-scale intrinsic networks working to predict and suppress excitation (Helmholtz free-energy) in subordinate systems. The concept of the secondary process entailed by ego-functions was associated with the suppressive effect of the DMN on its subcortical nodes and anti-correlated networks. Functional connectivity between limbic (e.g. the hippocampus and amygdala) structures and major nodes of the DMN during rest (Buckner *et al.*, 2008; Di Martino *et al.*, 2008) supports the notion that the systems enacting ego-functions have evolved to receive and control endogenous excitation that underlies mnemonic and hedonic processing. In the next section, we focus on the primary process and specifically how it is manifest in non-ordinary states of consciousness.

The phenomenology of primary process thinking

In this section we describe the phenomenology of non-ordinary states of consciousness that have been associated with primary process thinking. The primary process is not generally regarded as a serious topic of science but the phenomenology of certain non-ordinary states compel us to consider its importance. Psychoanalysis owes its origins to observations of non-ordinary states (Table 1, row 10; e.g. Q23, Q35, Q115, Q333; Q462). An early observation that has remained at the core of the Freudian model is that there exists in the mind an archaic *mode of cognition*, which under normal waking conditions is effectively suppressed (Q315). Freud saw this 'primary' mode as belonging to an ontogenetically and phylogenetically primitive system, which he referred to initially as 'the unconscious' (Breuer and Freud, 1895), later as 'the system unconscious', 'system Ucs' or just 'Ucs' (Freud, 1900, 1915 b) and eventually as 'the it' (Freud, 1923) (note: Freud's original term for 'the id' was 'das es' and should really have been translated 'the it', just as his original term for 'the ego', 'das Ich', should have been translated 'the I'; for simplicity however, we will use the familiar terms 'id' and 'ego').

Thus, the term 'the id' was introduced relatively late by Freud (Freud, 1923) as a new name for 'the unconscious' in its systematic sense (i.e. 'the system unconscious' or 'system Ucs') (Freud, 1900, 1915 b). Freud wrote relatively less about the id than the system unconscious but the two are essentially synonymous (see Q422, Q423, Q458 and Q461). Freud's decision to rename the system unconscious 'the id' was motivated by his acknowledgement that aspects of the ego are also unconscious (in the descriptive sense) and processes in the id can become conscious. The introduction of the id was useful in this respect as it resolved ambiguities relating to the descriptive meaning of 'unconscious'. Referred to as 'the id', the unconscious could be understood more explicitly as a *system* subserving a specific *mode* of cognition (e.g. Q461).

The characteristics of primary process thinking are clearest when contrasted against those of the secondary process: just as the characteristics of the primary process only become manifest in certain non-ordinary states, the characteristics of the secondary process only really become evident when they are lost. For example, Freud considered timelessness to be a major characteristic of the id and time perception to be a function of the ego (e.g. Q424). The notion of timelessness is difficult to comprehend from the vantage of normal waking consciousness but becomes clearer if we consider the phenomenology of states such as the temporal lobe aura: 'Time seems endless' (Epstein and Ervin, 1956); acute psychosis: 'Time slowed down, much more experience could be crowded into a brief time span' (Bowers, 1965) and the hallucinogenic drug state: '[Under the influence of drugs such as LSD, one has] the feeling that *so much* was "seen" that "hours" or "days" or "aeons" must have passed' (Masters and Houston, 2000). Recent work involving the serotoninergic hallucinogen, psilocybin, has shown that hallucinogen-induced impairments in temporal perception are dose-dependent (Wackermann *et al.*, 2008). Furthermore, recent formulations of the free-energy principle suggest that there is a systematic increase in temporal coherence in higher-level structures (Kiebel *et al.*, 2009). Thus, impaired temporal perception is a property of primary process thinking that has the potential to be measured psychophysically; thus bringing previously intangible phenomena into the scientific realm. Four other qualities of primary process thinking that can be assessed empirically include the following.

i. Sensations of fear or dread, e.g. in the aura of temporal lobe epilepsy: 'I feel afraid, as if something awful might happen' (Williams, 1956); early psychosis: 'Suddenly Fear, agonizing, boundless, Fear, overcame me, not the usual uneasiness of unreality, but real fear, such as one knows at the approach of danger, of calamity' (Sechehaye, 1951); the hallucinogenic drug state: 'I found myself all at once on the brink of panic' (Huxley, 1954); and dreaming: 'Fear is the most frequently occurring dream emotion' (Bulkeley, 2009).
ii. Perceptual distortions/visual hallucinations, e.g. in the aura of temporal lobe epilepsy: 'The surroundings feel strange and unfamiliar' (Hansen and Brodtkorb, 2003); early psychosis: 'It wasn't really unreal; it was just strange, funny, different' (Cutting and Dunne, 1989); and the hallucinogenic drug state: 'The room and furniture were distorted, strange and terrifying' (LSD, Cohen, 1964).
iii. Déjàvu, recollective or reliving phenomena, e.g. in the aura of the temporal lobe epilepsy: 'I went back to all that occurred in my childhood' (Hughlings-Jackson, 1879); early psychosis: 'My whole world seemed to cave in - I kept thinking about my birthplace and my past' (Cutting and Dunne, 1989); and the hallucinogenic drug state: 'I started to cry uncontrollably and nothing could have stopped it - it was like a dam giving way. At first I didn't know what I was weeping about, but soon became aware that I was reliving childhood experiences of which I had scarcely any conscious knowledge. Until today I had remembered only fragments, but now the entire sequence reeled off as from a microfilm that was securely stored within my head' (LSD, Cohen, 1964).
iv. Disturbance to the sense-of-self, e.g. in the aura of temporal lobe epilepsy: 'I felt that I disappeared' (Johanson *et al.*, 2008); early psychosis: 'When I look at somebody my own personality is in danger. I am undergoing a transformation and myself is beginning to disappear' (Chapman, 1966); and the hallucinogenic drug state: 'I felt the relaxing of the self boundaries' (LSD, Cohen, 1964).

Other characteristics of primary process thinking include a fear of losing control of ones mind, a general sense of the peculiarity of things, euphoria, grandiosity, paranoia and suspiciousness, thought-disturbances, bizarre thought-content and an increased interest in mystical, magical or animistic notions. All these phenomena could easily be assessed using subjective rating scales as a global measure of ego-disturbance or primary process thinking. However, an association between the primary process and dreaming, acute psychosis, temporal lobe aura and hallucinogenic states can be motivated at a purely phenomenological level. Crucially, all these states have been compared with each other previously; e.g. psychosis and dreaming (Freud, 1900; Jung, 1907; Bleuler, 1911); psychosis and the temporal lobe aura (Slater and Beard, 1963; Bear, 1979; Ferguson and Rayport, 2006); psychosis and the hallucinogenic drug state (Behringer, 1927; Bowers and Freedman, 1966; Gouzoulis *et al.*, 1994); dreaming and the temporal lobe aura (Rodin *et al.*, 1955; Penfield and Perot, 1963; Mahl *et al.*, 1964); dreaming and the hallucinogenic drug state (Grof, 1975; Fischman, 1983; Callaway, 1988); and the temporal lobe aura and the hallucinogenic drug state (Bercel *et al.*, 1956; Schwarz *et al.*, 1965; Balestrieri, 1967). It is also worth noting that dreaming (Freud, 1900), psychosis (Freud, 1900; Bleuler, 1911), the temporal lobe aura (Kubie, 1952; Robin *et al.*, 1955; Delgado *et al.*, 1956; Epstein and Ervin, 1956; Ostow, 1957; Mahl *et al.*, 1964; Horowtiz *et al.*, 1968) and the hallucinogenic drug state (Busch and Johnson, 1950; Sandison *et al.*, 1954; Cattell, 1957; Martin, 1957; Eisner, 1959; Cohen, 1964; Abramson, 1967; Horowitz *et al.*, 1968; Grof, 1975) have all been described as states conducive to the emergence of primary process thinking. In the remainder of this section we will review evidence that these states, which clearly display a related phenomenology, also possess a related neurophysiology.

Neurophysiology of the primary process

In this section, we show that brain states associated with primary process thinking have common neurophysiological substrates. Intracranial electroencephalography (EEG) recordings in medial temporal structures, the superior temporal gyrus and the visual association cortex, after high-frequency stimulation of the perirhinal cortex, reveals bursts of synchronous high-amplitude theta activity spreading from the medial temporal lobes to the visual association cortices during the hallucinatory revival of past experiences (Barbeau *et al.*, 2005). This activity is consistent with Freud's speculations about the processes underlying dreaming and related states (e.g. Q97 and Q98). Similar activity has been recorded in the medial temporal lobes of other epileptic patients during states of hallucinosis and recollection (Rodin *et al.*, 1955; Heath, 1961; Stevens *et al.*, 1969) and increased theta power has been recorded over the medial temporal lobes during recollection using magnetoencephalography (Guderian and Düzel, 2005).

In the 1950s and early 1960s, activity was recorded in cortical and subcortical structures in a large number of patients experiencing acute psychotic episodes (Heath, 1954; Lesse *et al.*, 1955; Sem-Jacobsen *et al.*, 1956; Heath and Mickle, 1960; Sherwood, 1962; Heath and Walker, 1985). Subcortical contacts revealed conspicuous activities, which were generally not seen in the cortex or at the scalp (Sem-Jacobsen *et al.*, 1956; Heath and Mickle, 1960). In actively psychotic patients, spiking and bursts of high-amplitude synchronous activity (of variable frequency but often theta) were recorded in the septum (which until the mid-1970s included the nucleus accumbens) (Heath, 1954; Stevens, 1999) amygdala and hippocampus (Sem-Jacobsen *et al.*, 1956; Heath and Mickle, 1960; Sherwood, 1962). This activity was specific to these regions, was most pronounced when the psychosis was most florid and was absent when the symptoms remitted (Heath and Mickle, 1960).

Intracranial recordings in subjects administered the hallucinogenic drugs LSD and mescaline revealed spiking and bursts of high-amplitude activity in the medial temporal lobes similar to that recorded in the acutely psychotic patients (Schwarz *et al.*, 1956; Sem-Jacobsen *et al.*, 1956; Monroe *et al.*, 1957; Heath and Mickle, 1960; Chapman *et al.*, 1962). LSD and related drugs were used extensively in the 1950s and 60s as adjuncts to psychoanalytic psychotherapy (Abramson, 1967; Grinspoon and Bakalar, 1979). Spontaneous recollections of a similar nature to those associated with the temporal lobe aura (e.g. Penfield and Perot, 1963; Barbeau *et al.*, 2005) have been reported after ingestion of LSD and psilocybin (e.g. Sandison *et al.*, 1954; Grof, 1975; Vollenweider *et al.*, 1997). High-amplitude bursts of lowfrequency/theta activity have also been recorded in the human hippocampus in rapid eye movement (REM) sleep (Brazier, 1968; Freemon and Walter, 1970; Giaquinto, 1973; Moiseeva and Aleksanyan, 1976; Mann *et al.*, 1997; Yu *et al.*, 1997; Bódizs *et al.*, 2001; Cantero *et al.*, 2003) and LSD given to humans immediately prior to (Toyoda, 1964; Muzio *et al.*, 1966) or during sleep (Torda, 1968) has been shown to promote REM sleep and dreaming. These studies provide converging evidence that a specific mode of cognition (primary process thinking), rests on brain states, which possess a characteristic neurophysiology.

There are also some interesting examples of medial temporal activities being influenced by psychiatric interview (Heath, 1954, 1964; Lesse *et al.*, 1955). Sporadic bursts of high-amplitude synchronous activity recorded intracranially in the medial temporal lobes (Heath, 1954, 1964; Lesse *et al.*, 1955) were detected as personal memories, with strong emotional content, were touched on. The activity desynchronized if the patient attended to his environment (Lesse *et al.*, 1955) or carried out a mathematical problem (Heath, 1954, 1964).

The abnormal limbic activity recorded in the temporal lobe aura, acute psychosis, the hallucinogenic drug state and REM sleep is often seen in the theta range (Sem-Jacobsen *et al.*, 1955; Heath *et al.*, 1955-56; Schwarz *et al.*, 1956; Sem-Jacobsen *et al.*, 1956; Monroe *et al.*, 1957; Heath and Mickle, 1960; Chapman *et al.*, 1962; Sherwood, 1962; Cantero *et al.*, 2003; Barbeau *et al.*, 2005), although bursts of high-amplitude fast activity were also seen (e.g. Lesse *et al.*, 1955; Heath *et al.*, 1955-56). Hippocampal theta in animals is reliably associated with locomotion, orienting and REM sleep (Kahana *et al.*, 2001) and also long-term potentiation (Hölscher *et al.*, 1997). Hippocampal theta depends on inputs from the septal nuclei, a major theta generator (Petsche *et al.*, 1962; Winson 1978) and another site from which the abnormal activity was recorded in non-ordinary states in humans (e.g. Heath, 1954; Sherwood, 1962). As well as providing conditions for encoding new experiences, hippocampal theta facilitates the retrieval of past experiences (Hasselmo *et al.*, 2002 Barbeau *et al.*, 2005). Scalp recordings of increased theta power associated with goal-directed cognition

(Burgess and Gruzelier, 2000; Krause *et al.*, 2000; Onton *et al.*, 2005) are unlikely to relate to the high-amplitude bursts seen in the septum and medial temporal lobes during the non-ordinary states of consciousness described above (Gevins *et al.*, 1997; Kahana *et al.*, 2001; Buzsaki 2002; Raghavachari *et al.*, 2006). The cortex is capable of generating its own theta (Silva *et al.*, 1991; Raghavachari *et al.*, 2006) and intracranial work in humans has provided more evidence for low-amplitude, *high-frequency* oscillations in the hippocampus during *attentiveness* than for theta (Heath, 1954, 1964; Lesse *et al.*, 1955; Halgren *et al.*, 1978; Arnolds *et al.*, 1980; Huh *et al.*, 1990; Meador *et al.*, 1991; Caplan *et al.*, 2001; Axmacher *et al.*, 2007). Moreover, in the non-ordinary states, activity recorded from the scalp and in the cortex is generally low-amplitude, high-frequency and desynchronous (Heath and Mickle, 1960; Chapman *et al.*, 1962; Rodin *et al.*, 1966; Cantero *et al.*, 2003); such activity is highly characteristic of REM sleep (Jouvet, 1965; Maquet *et al.*, 1996; Braun *et al.*, 1998; Cantero *et al.*, 2003; Wehrle *et al.*, 2007) and other cortical 'up' states (Steriade *et al.*, 2001) such as those induced by serotoninergic hallucinogens (Lambe and Aghajanian, 2006).

Based on empirical findings (e.g. Cañive *et al.*, 1996; Jeanmonod *et al.*, 1996, 2003; Llinás *et al.*, 1998, 1999) it has been proposed that bursts of limbic theta, recorded in the cortex as increased gamma, can index the positive symptoms of various neurological and psychiatric disorders (Llinás *et al.*, 1999; Jeanmonod *et al.*, 2003; Llinás and Steriade, 2006). Under normal conditions, cortical gamma readily suppresses low-frequency oscillations (Chen *et al.*, 2009). This function is analogous to the secondary process, but in pathological states and dreaming, limbic activity is more anarchic (e.g. Oertel *et al.*, 2007; Wehrle *et al.*, 2007) and the cortex must work harder to contain it (Llinás *et al.*, 1999; Jeanmonod *et al.*, 2003; Llinás and Steriade, 2006).

Recent intracranial EEG work in humans, using subdural electrodes recorded theta phase-modulation of high-frequency (80-150 Hz) gamma power (Canolty *et al.*, 2006). Theta modulation of gamma power was evident at rest but also during behavioural tasks. Theta-gamma coupling was highest at the trough of the theta phase. Moreover, electrodes showing the highest mean theta power also showed the strongest theta-gamma coupling. These findings imply that theta modulates coupling between theta and gamma and a number of researchers have suggested that theta may promote long-range coupling in cortical networks (e.g. von Stein and Sarnthein, 2000; Buzsaki, 2006).

Summary and synthesis

Integrating these findings, we propose that high-amplitude low-frequency (e.g. theta) discharges in limbic and paralimbic regions index the *free-energy* of the Helmholtzian scheme and mediate the *primary process* of the Freudian scheme. In waking cognition, low-frequency limbic oscillations couple to (i.e. entrain) gamma in the cortex (Canolty *et al.*, 2006; Llinás and Steriade, 2006) enabling the activity of the cortex to explain and thereby contain the activity of the limbic regions (Engel *et al.*, 2001; Friston, 2003; Chen *et al.*, 2009). In non-ordinary states, this function may be perturbed (e.g. in the case of hallucinogenic drugs, through actions at modulatory post-synaptic receptors) (Aghajanian and Marek, 1997), compromising the hierarchical organization and suppressive capacity of the intrinsic networks.

To investigate these phenomena further, neuroimaging measures of functional and effective connectivity could be employed to assess whether e.g. phasic events in REM sleep or the hallucinogenic drug state correlate with an increased limbic input to higher-level association cortices. It might transpire that in these states, limbic discharges become capable of traversing systems, which they are unable to do under normal conditions. For example, it might be possible to observe limbic discharges influencing activity in visual association areas (see Barbeau *et al.*, 2005). One might expect limbic activity to be suppressed by higher-level regions of the DMN in normal waking cognition but not in non-ordinary states. This might explain the difference between the experience of day-dreaming in the resting-state (Mason *et al.*, 2007, Q284 and Q332) and hallucinosis in non-ordinary states (Q97), where limbic activity is released from top-down control. The mechanisms of this release have been discussed previously in terms of perceptual inference and synaptic gain (Friston, 2005*b*; Stephan *et al.*, 2009), where the major determinant of synaptic gain is neuronal synchronization.

Table 2. **Some points of contact between Freud's account of the mind and empirical findings in neurobiology**

- The overlapping phenomenology of REM sleep, early and acute psychosis, the temporal lobe aura and the hallucinogenic drug state.
- All these states have been independently compared with each other previously and described independently as conducive to primary process thinking.
- The neurophysiology of these non-ordinary states is remarkably consistent both empirically and with Freud's descriptions of the 'free-flowing' energy of the primary process.
- LSD given immediately prior to or during sleep promotes REM sleep.
- The overlap between Freud's descriptions of the give-and-take relationship between ego-libido and object-libido and the give-and-take relationship between the DMN and its anti-correlated networks.
- The concordance between Freud's descriptions of the secondary process working to minimize free-energy and the free-energy account of the hierarchical organization of intrinsic networks working to minimize prediction errors.
- The integrated, compound nature of the DMN and Freud's descriptions of the integrated, compound nature of the ego.
- The development of functional connectivity between the nodes of the DMN during ontogeny, a process that parallels the emergence of ego-functions.
- Freud's account of the ego as a recipient and product of regular endogenous activity concerned with drive, memory and affect and the functional and structural connectivity of the DMN's cortical nodes with limbic structures concerned with drive, memory and affect.
- Freud's description of the ego as a tonic reservoir of activity and the high resting-state metabolism of the DMN.
- Freud's account of the ego as the seat of the sense-of-self and studies showing increased activity in the DMN during self-referential processing and a failure to deactivate the DMN in pathology characterized by withdrawal.

Discussion

In this article we have explored the notion that Freud's descriptions of the secondary process are consistent with the functional anatomy of large-scale intrinsic networks. We have proposed that intrinsic networks self-organize into hierarchical frameworks, in order to suppress the free-energy of their subordinate levels. This was associated with the function of the secondary process. We hypothesized that spontaneous fluctuations in neuronal activity in cortical nodes of the DMN function to suppress or contain otherwise anarchic and unconstrained endogenous activity in limbic and paralimbic systems, while fluctuations in subordinate networks anti-correlated with the DMN predict and counter prediction errors induced by exogenous sensory input in sensory and visceral systems.

Given the nature of this synthesis, different readers will find merit in different aspects of it. For example, some readers may see value in relating inferential coding to intrinsic networks and regard this as a potentially useful perspective on functional anatomy. Others may take the formal similarity between Freudian formulations and functionalist interpretations of neuronal processes as evidence for their construct validity. For example, the remarkable overlap between Freud's theories and modern neurobiology may engage clinicians and academics who are more familiar with (and receptive to) Freud's work (Table 2). Developing these points of contact may help anchor Freudian concepts to measurable biological phenomena and inform psychoanalytic thinking. As has been argued previously (Kandel, 1999; Solms, 2009), this process may be important for psychoanalysis. Furthermore, given the enduring, albeit marginal, influence of psychoanalysis in psychiatry, it may benefit psychiatry if psychoanalysis is properly grounded in neuroscience. This is the agenda of the Neuro-Psychoanalysis movement (www.neuro-psa.org.uk) and should assist the process of separating premises that have construct validity from those which do not.

Freud's writings contain many useful heuristics for exploring global brain function, especially in non-ordinary states of consciousness. Indeed, the Freudian model owes its origins to inferences based on unconstrained states, whereas the cognitive-behavioural approach is uncertain in this domain (Morcom and Fletcher, 2007). Science usually analyses phenomena extrospectively but in the mind-sciences especially, certain phenomena demand that we look both inwards and outwards - even if introspection entails some compromise and a confrontation with our 'it'. Freud's theories were conceived through a study of non-ordinary states, his schooling in neurology and a readiness to introspect. If they were built on false inference and loose philosophy, it is unlikely they would have endured in the way that they have. For those opposed to Freud, who would rather see his constructs dissolved into pure phenomenology and neurobiology, we put up little resistance (e.g. Q176). Phenomenology and neurobiology can stand alone. The Freudian model adds a framework for an integrated understanding of psychopathological phenomena. Once the full-character of non-ordinary states and cognition are understood, this framework may dissolve naturally.

The synthesis attempted in this article is intended to facilitate a more comprehensive understanding of psychological and neurobiological phenomena; addressing topics which have hitherto been considered incompatible with the cognitive paradigm (e.g. Morcom and Fletcher, 2007). The Freudian model should not impede hypothesis testing but rather facilitate it by emphasizing the importance of studying the phenomenology, neurophysiology and neurodynamics of different *modes* or *states* of cognition; and by indicating where we might look for anomalies. For example, altered functional connectivity between limbic and cortical nodes of the DMN may predict symptoms of ego-disturbance or primary process thinking. Identifying the neurobiological signature of ego-disturbance or primary process thinking may provide new insights into the pathogenesis of schizophrenia, given that related symptoms are prevalent in the prodromal phase (Møller and Husby, 2000; Parnas and Handset, 2003; Häfner and Maurer, 2006). Another symptom cluster, which might benefit from a Freudian treatment, is the withdrawal seen in depression and schizophrenia. The association between ego-libido and object-libido and the give-and-take between the DMN and its anti-correlated networks may be especially relevant here:

> All that we know about [libido] relates to the ego, in which at first the whole available quota of libido is stored up. We call this state absolute, primary narcissism. It lasts till the ego begins to invest the ideas of objects with libido, to transform narcissistic libido [ego-libido] into object-libido. Throughout the whole of life the ego remains the great reservoir from which libidinal investments are sent out to objects and into which they are also once more withdrawn. (Freud, 1940; Q454)

The notion of displacing energy from a default store to networks concerned with scrutinizing the external world is consistent with the functional relationship of the DMN to its anti-correlated networks, where e.g. activity is displaced from the DMN to the dorsal attention system during goal-directed cognition (Raichle *et al.*, 2001):

> We see also, broadly speaking, an antithesis between ego-libido and object-libido. The more of one is employed, the more the other becomes depleted. (Freud, 1914; Q173)

It is interesting that Freud's notion of a finite 'reservoir' of energy and the reciprocal patterns of activation between the DMN and subordinate networks both fit comfortably with hierarchical minimization of free-energy. This minimization entails recurrent message-passing between hierarchical brain systems that try to suppress the free-energy at all levels (this scheme is also called predictive coding; e.g. Jehee and Ballard, 2009). The ensuing dynamics mean that increased neuronal activity at one level suppresses neural activity encoding prediction-error in another, leading to reciprocal patterns of activation and deactivation; see Murray *et al.* (2002) for a nice empirical example of this in the visual system and Friston and Stephan (2005) for a simulation in the auditory system. In brief, the 'reservoir' of free-energy is constantly primed by surprising or unaccountable exchanges with the sensorium and is distributed throughout the hierarchy in an attempt to minimize its expression at any one level.

Recent work has shown reduced task-evoked suppressions of DMN activity in schizophrenia (Pomarol-Clotet *et al.*, 2008; Whitfield-Gabrieli *et al.*, 2009) the severity of which correlated positively with connectivity in the DMN (Whitfield-Gabrieli *et al.*, 2009). These findings support the observation that there is a reduced engagement with the external world in schizophrenia (see Table 1, row 9 and especially Q168 and Q170). In this article we have proposed that the brain's functional anatomy is organized *hierarchically* to ensure that free-energy is minimized in the most efficient way. Organized in this manner, the brain explains internal and external events and effectively discriminates between them. However, assuming that the development and maintenance of this organization is *use-dependent*, it will be jeopardized if the individual withdrawals from the external world. If the brain's hierarchical organization begins to breakdown, there may be an ensuing confusion over, among other things, what are internal and external sensations. This may be especially relevant during puberty, when the ego is forced to negotiate new demands from internal and external sources and through this, develop an adult ego. According to our model, the development of an adult ego (a properly functional DMN) is necessary to contain internal excitations and coordinate engagements with the external world. If this is not achieved, systems normally inhibited by the DMN (e.g. the salience system) may slip from its control. In the ensuing chaos, the patient may develop delusions as a compromise strategy for containing the increase in free-energy. Thus, from the free-energy perspective, withdrawal, psychomotor poverty and delusional thinking may be last resorts for someone who finds everything surprizing and unpredictable. See

Fletcher and Frith (2009) and Corlett *et al*. (2009) for a free-energy (predictive coding) treatment of false inference in schizophrenia.

As in schizophrenia, Freud recognized that a retreat from the external world is also characteristic of depression. In depression however, emphasis was laid on a loss of an intense object-love. Freud argued that the patient reacts to this loss by targeting the aggression felt towards the lost object back upon his/her own ego:

> There is no difficulty in reconstructing [the] process of [melancholia]. An object-choice, an attachment of the libido to a particular person, had at one time existed; then, owing to a real slight or disappointment coming from this loved person, the object-relationship was shattered ... But the free libido was not displaced on to another object; it was withdrawn into the ego ... Thus the shadow of the object fell upon the ego and the latter could henceforth be judged by a special agency, as though it were the forsaken object ... One or two things may be directly inferred with regards to the preconditions and effects of a process such as this. On the one hand, a strong fixation to the loved object must have been present; on the other hand, in contradiction to this, the object-[investment] must have had little power of resistance ... This contradiction seems to imply that the object-choice had been effected on a narcissistic basis, so that the object-[investment], when obstacles [came] in its way, [could] regress to narcissism. (Freud, 1917*b*, Q267)

As in schizophrenia, recent work has shown a reduced task-induced suppression of DMN activity in depression (Grimm *et al*., 2009; Sheline *et al*., 2009) and these reductions correlated positively with depression severity and ratings of hopelessness (Grimm *et al*., 2009). Reduced blood flow and activation in the dorsolateral prefrontal cortex and hyper-perfusion, metabolism and activity in limbic and medial prefrontal regions are also reliably associated with depression (e.g. Mayberg *et al*., 2005, 2007; Drevets *et al*., 2008). These findings support the notion of a withdrawal from the external world and a pathological self-focus in depression, consistent with the Freudian account (Table 1, row 9).

Conclusion

The first section of this article reviewed evidence that the development and functioning of the DMN and its functional relationship with its anti-correlated networks is consistent with that of the ego. In the second we described the phenomenology of primary process thinking, reviewed evidence that it can be observed in certain non-ordinary states and cited studies indicating that these states share a common neurophysiology. In the final section we sought to justify the synthesis and show how reference to the Freudian model might be used to understand clinically relevant phenomena in neurobiological terms.

This article does not address the efficacy of psychoanalysis as a treatment (see Fonagy, 2003 for a relevant review and Q478). Our focus is on the validity of Freudian constructs in relation to global phenomena and related theories that have recently emerged in systems neuroscience.

Finally, this synthesis was compelled by the links between psychopathology and the neurophysiology of certain non-ordinary states of consciousness, and between the functional organization of intrinsic brain networks and the secondary process as described by Freud. The synthesis is empirically-led, as are the methods we recommend for testing and applying it. The neurobiological phenomena addressed in this synthesis are central topics in contemporary neuroscience and the Freudian concepts are principal components of his model, where these components can be traced to his schooling in neurology and the influence of people like Meynert, Helmholtz, Fechner, Hering, Herbart, Charcot and Hughlings-Jackson.

Acknowledgements

We would like to thank our reviewers for very helpful guidance in presenting and extending these ideas.

Funding

KJF was funded by the Wellcome Trust. RCH is supported by the Beckley Foundation and has recently received a research grant from the Neuropsychoanalysis Association.

Supplementary material

Supplementary material containing relevant quotations of Freud is available at Brain online.

References

1. Abramson HA. The Second International Conference on the Use of LSD in Psychotherapy. New York: The Bobbs-Merrill Company; 1967.
2. Aghajanian GK, Marek GJ. Serotonin induces excitatory postsynaptic potentials in apical dendrites of neocortical pyramidal cells. Neuropharmacol 1997; 36: 589-99.
3. Anderson SW, Bechara A, Damasio H, Tranel D, Damasio AR. Impairment of social and moral behavior related to early damage in human prefrontal cortex. Nat Neurosci 1999; 2: 1032-7.
4. Andrews-Hanna JR, Snyder AZ, Vincent JL, Lustig C, Head D, Raichle ME, *et al*. Disruption of large-scale brain systems in advanced aging. Neuron 2007; 56: 924-35.
5. Angelucci A, Bressloff PC. Contribution of feed-forward, lateral and feedback connections to the classical receptive field center and extra-classical receptive field surround of primate V1 neurons. [Review] Prog Brain Res 2006; 154: 93-120.
6. Arnolds DE, Lopes da Silva FH, Aitink JW, Kamp A, Boeijinga P. The spectral properties of hippocampal EEG related to behaviour in man. Electroencephalogr Clin Neurophysiol 1980; 50: 324-8.
7. Axmacher N, Mormann F, Fernández G, Cohen MX, Elger CE, Fell J. Sustained neural activity patterns during working memory in the human medial temporal lobe. J Neurosci 2007; 27: 7807-16.
8. Balestrieri A. On the Action Mechanisms of LSD. In: Abramson HA, editor. The Use of LSD in Psychotherapy. New York: Bob-Merrill Company; 1967.
9. Barbeau E, Wendling F, Régis J, Duncan R, Poncet M, Chauvel P, *et al*. Recollection of vivid memories after perirhinal region stimulations: synchronization in the theta range of spatially distributed brain areas. Neuropsychologia 2005; 43: 1329-37.
10. Bear DM. Temporal lobe epilepsy - a syndrome of sensory-limbic hyperconnection. Cortex 1979; 15: 357-84.
11. Beauregard M, Lévesque J, Bourgouin P. Neural correlates of conscious self-regulation of emotion. J Neurosci 2001; 21: RC165.
12. Beckmann CF, DeLuca M, Devlin JT, Smith SM. Investigations into resting-state connectivity using independent component analysis. Philos Trans R Soc Lond B Biol Sci 2005; 360: 1001-13.
13. Behringer K. Der Meskalinrausch. Berlin: Springer; 1927.
14. Benes FM. Myelination of cortical-hippocampal relays during late adolescence. Schizophr Bull 1989; 15: 585-93.
15. Bercel NA, Travis LE, Olinger LB, Dreikurs E. Model psychoses induced by LSD-25 in normals. I. Psychophysiological investigations, with special reference to the mechanism of the paranoid reaction. AMA Arch Neurol Psychiatry 1956; 75: 588-611.
16. Berridge KC, Robinson TE. What is the role of dopamine in reward: hedonic impact, reward learning, or incentive salience? Brain Res Brain Res Rev 1998; 28: 309-69.
17. Bettelheim B. Freud and Man's Soul. New York: Vintage Books; 1982.
18. Birn RM, Diamond JB, Smith MA, Bandettini PA. Separating respiratory-variation-related fluctuations from neuronal-activity-related fluctuations in fMRI. Neuroimage 2006; 31: 1536-48.
19. Bleuler E. Dementia Praecox or the Group of Schizophrenias. New York: International Universities Press; 1911.
20. Bódizs R, Kántor S, Szabó G, Szûcs A, Erõss L, Halász P. Rhythmic hippocampal slow oscillation characterizes REM sleep in humans. Hippocampus 2001; 11: 747-53.
21. Boly M, Balteau E, Schnakers C, Degueldre C, Moonen G, Luxen A, *et al*. Baseline brain activity fluctuations predict somatosensory perception in humans. Proc Natl Acad Sci USA 2007; 104: 12187-92.
22. Boly M, Phillips C, Tshibanda L, Vanhaudenhuyse A, Schabus M, Dang-Vu TT, *et al*. Intrinsic brain activity in altered states of consciousness: how conscious is the default mode of brain function? Ann NY Acad Sci 2008; 1129: 119-29.
23. Bowers M. The onset of psychosis-a diary account. Psychiatry 1965; 28: 346-58.
24. Bowers MB Jr, Freedman DX. "Psychedelic" experiences in acute psychoses. Arch Gen Psychiatry 1966; 15: 240-8.
25. Braun AR, Balkin TJ, Wesensten NJ, Gwadry F, Carson RE, Varga M, *et al*. Dissociated pattern of activity in visual cortices and their projections during human rapid eye movement sleep. Science 1998; 279: 91-5.
26. Brazier MA. Studies of the EEG activity of limbic structures in man. Electroencephalogr Clin Neurophysiol 1968; 25: 309-18.
27. Bremner JD, Staib LH, Kaloupek D, Southwick SM, Soufer R, Charney DS. Neural correlates of exposure to traumatic pictures and sound in Vietnam combat veterans with and without posttraumatic stress disorder: a positron emission tomography study. Biol Psychiatry 1999; 45: 806-16.
28. Breuer J, Freud S. Studies of hysteria. Vol. 2, Standard edn. London: Vintage; 1895.
29. Buckner RL, Andrews-Hanna JR, Schacter DL. The brain's default network: anatomy, function, and relevance to disease. Ann NY Acad Sci 2008; 1124: 1-38.
30. Bulkeley K. Seeking patterns in dream content: A systematic approach to word searches. Conscious Cogn 2009; 18: 905-16.

31. Burgess AP, Gruzelier JH. Short duration power changes in the EEG during recognition memory for words and faces. Psychophysiology 2000; 37: 596-606.
32. Busch AK, Johnson WC. L.S.D. 25 as an aid in psychotherapy; preliminary report of a new drug. Dis Nerv Syst 1950; 11: 241-3.
33. Buzsáki G. Theta oscillations in the hippocampus. [Review]. Neuron 2002; 33: 325-40.
34. Buzsáki G. Rhythms of the brain. New York: Oxford University Press; 2006.
35. Callaway JC. A proposed mechanism for the visions of dream sleep. Med Hypotheses 1988; 26: 119-24.
36. Cañive JM, Lewine JD, Edgar JC, Davis JT, Torres F, Roberts B, *et al*. Magnetoencephalographic assessment of spontaneous brain activity in schizophrenia. Psychopharmacol Bull 1996; 32: 741-50.
37. Canolty RT, Edwards E, Dalal SS, Soltani M, Nagarajan SS, Kirsch HE, *et al*. High gamma power is phase-locked to theta oscillations in human neocortex. Science 2006; 313: 1626-8.
38. Cantero JL, Atienza M, Stickgold R, Kahana MJ, Madsen JR, Kocsis B. Sleep-dependent theta oscillations in the human hippocampus and neocortex. J Neurosci 2003; 23: 10897-903.
39. Caplan JB, Madsen JR, Raghavachari S, Kahana MJ. Distinct patterns of brain oscillations underlie two basic parameters of human maze learning. J Neurophysiol 2001; 86: 368-80.
40. Carr DB, Sesack SR. Projections from the rat prefrontal cortex to the ventral tegmental area: target specificity in the synaptic associations with mesoaccumbens and mesocortical neurons. J Neurosci 2000; 20: 3864-73.
41. Castellanos FX, Margulies DS, Kelly C, Uddin LQ, Ghaffari M, Kirsch A, *et al*. Cingulate-precuneus interactions: a new locus of dysfunction in adult attention-deficit/hyperactivity disorder. Biol Psychiatry 2008; 63: 332-7.
42. Catani M, Jones DK, Donato R, Ffytche DH. Occipitotemporal connections in the human brain. Brain 2003; 126(Pt 9): 2093-107.
43. Cattell JP. Use of drugs in psychodynamic investigations. In: Hoch PH, Zubin J, editors. Experimental psychopathology. New York: Grune and Stratton; 1957. p. 218-35.
44. Chapman LF, Walter RD, Adey WR, Crandall PH, Rand RW, Brazier MAB, *et al*. Altered electrical activity of human hippocampus and amygdala induced by LSD. Physiologist 1962; 5: 118.
45. Chapman J. The early symptoms of schizophrenia. Br J Psychiatry 1966; 112: 225-51.
46. Chen CC, Henson RN, Stephan KE, Kilner JM, Friston KJ. Forward and backward connections in the brain: a DCM study of functional asymmetries. Neuroimage 2009; 45: 453-62.
47. Church JA, Fair DA, Dosenbach NU, Cohen AL, Miezin FM, Petersen SE, *et al*. Control networks in paediatric Tourette syndrome show immature and anomalous patterns of functional connectivity. Brain 2009; 132(Pt 1): 225-38.
48. Cohen S. The beyond within - the LSD story. New York: Atheneum; 1964.
49. Corbetta M, Shulman GL. Control of goal-directed and stimulus-driven attention in the brain. Nat Rev Neurosci 2002; 3: 201-15.
50. Corlett PR, Frith CD, Fletcher PC. From drugs to deprivation: a Bayesian framework for understanding models of psychosis. Psychopharmacology (Berl) 2009; 206: 515-30.
51. Cutting J, Dunne F. Subjective experience of schizophrenia. Schizophr Bull 1989; 15: 217-31.
52. Damoiseaux JS, Rombouts SA, Barkhof F, Scheltens P, Stam CJ, Smith SM, *et al*. Consistent resting-state networks across healthy subjects. Proc Natl Acad Sci USA 2006; 103: 13848-53.
53. Damoiseaux JS, Beckmann CF, Arigita EJ, Barkhof F, Scheltens P, Stam CJ, *et al*. Reduced resting-state brain activity in the "default network" in normal aging. Cereb Cortex 2008; 18: 1856-64.
54. Davidson RJ, Putnam KM, Larson CL. Dysfunction in the neural circuitry of emotion regulation-a possible prelude to violence. Science 2000; 289: 591-4.
55. Dayan P, Hinton GE, Neal RM. The Helmholtz machine. Neural Computation 1995; 7: 889-904.
56. Delgado JR, Hamlin H, Higgins JW, Mahl GF. Behavioral changes during intracerebral electrical stimulation. AMA Arch Neurol Psychiatry 1956; 76: 399-419.
57. Di Martino A, Scheres A, Margulies DS, Kelly AM, Uddin LQ, Shehzad Z, *et al*. Functional connectivity of human striatum: a resting state FMRI study. Cereb Cortex 2008; 18: 2735-47.
58. Dosenbach NU, Fair DA, Cohen AL, Schlaggar BL, Petersen SE. A dual-networks architecture of top-down control. Trends Cogn Sci 2008; 12: 99-105.
59. Dougherty DD, Rauch SL, Deckersbach T, Marci C, Loh R, Shin LM, *et al*. Ventromedial prefrontal cortex and amygdala dysfunction during an anger induction positron emission tomography study in patients with major depressive disorder with anger attacks. Arch Gen Psychiatry 2004; 61: 795-804.
60. Drevets WC, Price JL, Furey ML. Brain structural and functional abnormalities in mood disorders: implications for neurocircuitry models of depression. Brain Struct Funct 2008; 213: 93-118.
61. Eichele T, Debener S, Calhoun VD, Specht K, Engel AK, Hugdahl K, *et al*. Prediction of human errors by maladaptive changes in event-related brain networks. Proc Natl Acad Sci USA 2008; 105: 6173-8.
62. Eisner B. Observations on possible order within the unconscious. In: Bradley PB, Deniker P, Radouco-Thomas C, editors. Neuro-Psychopharmacology. Proc. 1st International Congress for Neuro-Psychopharmacology. London: Elsevier; 1959. p. 439-41.
63. Eluvathingal TJ, Hasan KM, Kramer L, Fletcher JM, Ewing-Cobbs L. Quantitative diffusion tensor tractography of association and projection fibers in normally developing children and adolescents. Cereb Cortex 2007; 17: 2760-8.
64. Engel AK, Fries P, Singer W. Dynamic predictions: oscillations and synchrony in top-down processing. Nat Rev Neurosci 2001; 2: 704-16.
65. Epstein AW, Ervin F. Psychodynamic significance of seizure content in psychomotor epilepsy. Psychosom Med 1956; 18: 43-55.
66. Etkin A, Egner T, Peraza DM, Kandel ER, Hirsch J. Resolving emotional conflict: a role for the rostral anterior cingulate cortex in modulating activity in the amygdala. Neuron 2006; 51: 871-82.
67. Fair DA, Cohen AL, Dosenbach NU, Church JA, Miezin FM, Barch DM, *et al*. The maturing architecture of the brain's default network. Proc Natl Acad Sci USA 2008; 105: 4028-32.

68. Farb NA, Segal ZV, Mayberg H, Bean J, McKeon D, Fatima Z, *et al*. Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference. Soc Cogn Affect Neurosci 2007; 2: 313-22.
69. Felleman DJ, Van Essen DC. Distributed hierarchical processing in the primate cerebral cortex. Cerebral Cortex 1991; 1: 1-47.
70. Ferguson SM, Rayport M. Id, ego, and temporal lobe revisited. Int Rev Neurobiol 2006; 76: 21-31.
71. Ferry AT, Ongür D, An X, Price JL. Prefrontal cortical projections to the striatum in macaque monkeys: evidence for an organization related to prefrontal networks. J Comp Neurol 2000; 425: 447-70.
72. Fischman LG. Dreams, hallucinogenic drug states, and schizophrenia: a psychological and biological comparison. Schizophr Bull 1983; 9: 73-94.
73. Fletcher PC, Frith CD. Perceiving is believing: a Bayesian approach to explaining the positive symptoms of schizophrenia. Nat Rev Neurosci 2009; 10: 48-58.
74. Fonagy P. Psychoanalysis today. World Psychiatry 2003; 2: 73-80.
75. Fox MD, Snyder AZ, Vincent JL, Corbetta M, Van Essen DC, Raichle ME. The human brain is intrinsically organized into dynamic, anti-correlated functional networks. Proc Natl Acad Sci USA 2005; 102: 9673-8.
76. Fox MD, Raichle ME. Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. Nat Rev Neurosci 2007; 8: 700-11.
77. Fox MD, Snyder AZ, Vincent JL, Raichle ME. Intrinsic fluctuations within cortical systems account for intertrial variability in human behavior. Neuron 2007; 56: 171-84.
78. Fransson P. Spontaneous low-frequency BOLD signal fluctuations: an fMRI investigation of the resting-state default mode of brain function hypothesis. Hum Brain Mapp 2005; 26: 15-29.
79. Fransson P, Skiöld B, Horsch S, Nordell A, Blennow M, Lagercrantz H, *et al*. Resting-state networks in the infant brain. Proc Natl Acad Sci USA 2007; 104: 15531-6.
80. Fransson P, Marrelec G. The precuneus/posterior cingulate cortex plays a pivotal role in the default mode network: Evidence from a partial correlation network analysis. Neuroimage 2008; 42: 1178-84.
81. Freemon FR, Walter RD. Electrical activity of human limbic system during sleep. Compr Psychiatry 1970; 11: 544-51.
82. Freud S. Papers on hypnotism and suggestion. Standard edn., Vol. 1. London: Vintage. p. 1888-92.
83. Freud S. Project for a scientific psychology. Standard edn., Vol. 1. London: Vintage; 1895.
84. Freud S. The interpretation of dreams. London: Penguin; 1900.
85. Freud S. Three essays on the theory of sexuality. Standard edn., Vol. 7. London: Vintage; 1905.
86. Freud S. A case of obsessional neurosis. Standard edn., Vol. 10. London: Vintage; 1909.
87. Freud S. On narcissism. Standard edn., Vol. 14. London: Vintage; 1914.
88. Freud S. Instincts and their vicissitudes. Standard edn., Vol. 14. London: Vintage; 1915a.
89. Freud S. The unconscious. Standard edn., Vol. 14. London: Vintage; 1915b.
90. Freud S. The metapsychology of dreams. Standard edn., Vol. 14. London: Vintage; 1917a.
91. Freud S. Mourning and melancholia. Standard edn., Vol. 14. London: Vintage; 1917b.
92. Freud S. A child is being beaten: a contribution to the study of the origin of sexual perversions. Standard edn., Vol. 17. London: Vintage; 1919.
93. Freud S. Beyond the pleasure principle. Standard edn., Vol. 18. London: Vintage; 1920.
94. Freud S. Group psychology. Standard edn., Vol. 18. London: Vintage; 1921.
95. Freud S. The ego and the id. Standard edn., Vol. 19. London: Vintage; 1923.
96. Freud S. The economic problem of masochism. Standard edn., Vol. 19. London: Vintage; 1924.
97. Freud S. Negation. Standard edn., Vol. 19. London: Vintage; 1925a.
98. Freud S. Inhibitions symptoms and anxiety. Standard edn., Vol. 20. London: Vintage; 1926.
99. Freud S. New introductory lectures on psychoanalysis. Standard edn., Vol. 22. London: Vintage; 1933.
100. Freud S. Moses and monotheism. Standard edn., Vol. 23. London: Vintage; 1939.
101. Freud S. An outline of psychoanalysis. Standard edn., Vol. 23. London: Vintage; 1940.
102. Friston KJ, Büchel C. Attentional modulation of effective connectivity from V2 to V5/MT in humans. Proc Natl Acad Sci USA 2000; 97: 7591-6.
103. Friston KJ, Harrison L, Penny W. Dynamic causal modelling. Neuroimage 2003; 19: 1273-302.
104. Friston KJ. Learning and inference in the brain. Neural Netw 2003; 16: 1325-52.
105. Friston KJ. A theory of cortical responses. Philos Trans R Soc Lond B Biol Sci 2005a; 360: 815-36.
106. Friston KJ. Hallucinations and perceptual inference. Behavioral and Brain Sciences [0140-525X] 2005b; 28: 764-6.
107. Friston K, Mattout J, Trujillo-Barreto N, Ashburner J, Penny W. Variational free energy and the Laplace approximation. Neuroimage 2007; 34: 220-34.
108. Friston K, Stephan KE. Free energy and the brain. Synthese 2007; 159: 417-458.
109. Friston K. The free-energy principle: a rough guide to the brain? Trends Cogn Sci 2009; 13: 293-301.
110. Friston KJ, Daunizeau J, Kiebel SJ. Reinforcement learning or active inference? PLoS ONE 2009; 4: e6421.
111. Gevins A, Smith ME, McEvoy L, Yu D. High-resolution EEG mapping of cortical activation related to working memory: effects of task difficulty, type of processing, and practice. Cereb Cortex 1997; 7: 374-85.
112. Giaquinto S. Sleep recordings from limbic structures in man. Confin Neurol 1973; 35: 285-303.
113. Girard P, Bullier J. Visual activity in area V2 during reversible inactivation of area 17 in the macaque monkey. J Neurophysiol 1989; 62: 1287-302.
114. Gouzoulis E, Hermle L, Sass H. Psychedelic experiences at the onset of productive episodes of endogenous psychoses. Nervenarzt 1994; 65: 198-201.
115. Grafman J, Schwab K, Warden D, Pridgen A, Brown HR, Salazar AM. Frontal lobe injuries, violence, and aggression: a report of the Vietnam Head Injury Study. Neurology 1996; 46: 1231-8.
116. Gregory RL. Perceptual illusions and brain models. Proc R Soc Lond B 1968; 171: 179-96.
117. Greicius MD, Krasnow B, Reiss AL, Menon V. Functional connectivity in the resting brain: a network analysis of the default mode hypothesis. Proc Natl Acad Sci USA 2003; 100: 253-8.

118. Greicius MD, Supekar K, Menon V, Dougherty RF. Resting-state functional connectivity reflects structural connectivity in the default mode network. Cereb Cortex 2009; 19: 72-8.
119. Grimm S, Boesiger P, Beck J, Schuepbach D, Bermpohl F, Walter M, *et al*. Altered negative BOLD responses in the default-mode network during emotion processing in depressed subjects. Neuropsychopharmacology 2009; 34: 932-43.
120. Grinspoon L, Bakalar JB. Psychedelic drugs reconsidered. New York: Basic Books; 1979.
121. Grof S. Realms of the human unconscious. London: Souvenir Press; 1975.
122. Guderian S, Düzel E. Induced theta oscillations mediate large-scale synchrony with mediotemporal areas during recollection in humans. Hippocampus 2005; 15: 901-12.
123. Gusnard DA, Akbudak E, Shulman GL, Raichle ME. Medial prefrontal cortex and self-referential mental activity: relation to a default mode of brain function. Proc Natl Acad Sci USA 2001; 98: 4259-64.
124. Gutman DA, Holtzheimer PE, Behrens TE, Johansen-Berg H, Mayberg HS. A tractography analysis of two deep brain stimulation white matter targets for depression. Biol Psychiatry 2009; 65: 276-82.
125. Häfner H, Maurer K. Early detection of schizophrenia: current evidence and future perspectives. World Psychiatry 2006; 5: 130-8.
126. Halgren E, Babb TL, Crandall PH. Human hippocampal formation EEG desynchronizes during attentiveness and movement. Electroencephalogr Clin Neurophysiol 1978; 44: 778-81.
127. Hampson M, Peterson BS, Skudlarski P, Gatenby JC, Gore JC. Detection of functional connectivity using temporal correlations in MR images. Hum Brain Mapp 2002; 15: 247-62.
128. Hampson M, Driesen NR, Skudlarski P, Gore JC, Constable RT. Brain connectivity related to working memory performance. J Neurosci 2006; 26: 13338-43.
129. Hansen BA, Brodtkorb E. Partial epilepsy with "ecstatic" seizures. Epilepsy Behav 2003; 4: 667-3.
130. Hariri AR, Bookheimer SY, Mazziotta JC. Modulating emotional responses: effects of a neocortical network on the limbic system. Neuroreport 2000; 11: 43-8.
131. Hasselmo ME, Bodelón C, Wyble BP. A proposed function for hippocampal theta rhythm: separate phases of encoding and retrieval enhance reversal of prior learning. Neural Comput 2002; 14: 793-817.
132. Hassin RR, Uleman JS, Bargh JA. The new unconscious. New York: Oxford University Press; 2005.
133. He BJ, Raichle ME. The fMRI signal, slow cortical potential and consciousness. Trends Cogn Sci 2009; 13: 302-9.
134. He BJ, Snyder AZ, Vincent JL, Epstein A, Shulman GL, Corbetta M. Breakdown of functional connectivity in frontoparietal networks underlies behavioral deficits in spatial neglect. Neuron 2007; 53: 905-18.
135. He BJ, Snyder AZ, Zempel JM, Smyth MD, Raichle ME. Electrophysiological correlates of the brain's intrinsic large-scale functional architecture. Proc Natl Acad Sci USA 2008; 105: 16039-44.
136. Heath RG. Studies in schizophrenia. Cambridge, Massachusetts: Harvard University Press; 1954.
137. Heath RG, Mickle WA, Monroe RR. Characteristics of recordings from various specific subcortical nuclear masses in the brain of psychotic and non-psychotic patients. Trans Am Neurol Assoc 1955-56; 80th Meeting: 17-2.
138. Heath RG, Mickle WA. Evaluation of seven years experience with depth electrode studies in human patients. In: Ramey ER, O'Doherty DS, editors. Electrical studies of the unanethetized brain. New York: Harper and Brothers; 1960. p. 214-47.
139. Heath RG. Common characteristics of epilepsy and schizophrenia: clinical observation and depth electrode studies. Epilepsy Behav 1961; 6: 633-45.
140. Heath RG. Role of pleasure in behaviour. New York: Hoeber; 1964.
141. Heath RG, Walker CF. Correlation of deep and surface electroencephalograms with psychosis and hallucinations in schizophrenics: a report of two cases. Biol Psychiatry 1985; 20: 669-74.
142. Helmholtz H. von. Concerning the perceptions in general. In: Treatise on physiological optics. vol. III, 3rd edn. (translated by J. P. C. Southall 1925 Opt. Soc. Am. Section 26, reprinted New York: Dover, 1962).
143. Herrmann CS. Gamma activity as a functional correlate of cognition. special issue. Int J Psychophysiol 2000; 38: vii-viii.
144. Hobson JA. The dream drugstore: chemically altered states of consciousness. Cambridge, Massachusetts: MIT Press; 2001.
145. Hobson JA. 13 Dreams freud never had. New York: Pi Press, 2005.
146. Hölscher C, Anwyl R, Rowan MJ. Stimulation on the positive phase of hippocampal theta rhythm induces long-term potentiation that can Be depotentiated by stimulation on the negative phase in area CA1 in vivo. J Neurosci 1997; 17: 6470-7.
147. Hopper JW, Frewen PA, van der Kolk BA, Lanius RA. Neural correlates of reexperiencing, avoidance, and dissociation in PTSD: symptom dimensions and emotion dysregulation in responses to script-driven trauma imagery. J Trauma Stress 2007; 20: 713-25.
148. Hoptman MJ, D'Angelo D, Catalano D, Mauro CJ, Shehzad ZE, Kelly AM, *et al*. Amygdalofrontal Functional Disconnectivity and Aggression in Schizophrenia. Schizophr Bull 2009; in Press.
149. Horowitz MJ, Adams JE, Rutkin BB. Visual imagery on brain stimulation. Arch Gen Psychiatry 1968; 19: 469-86.
150. Hughlings-Jackson J. Lectures on Epilespy. Br Med J 1879; 1: 141-3.
151. Huh K, Meador KJ, Lee GP, Loring DW, Murro AM, King DW, *et al*. Human hippocampal EEG: effects of behavioral activation. Neurology 1990; 40: 1177-81.
152. Hupé JM, James AC, Payne BR, Lomber SG, Girard P, Bullier J. Cortical feedback improves discrimination between figure and background by V1, V2 and V3 neurons. Nature 1998; 394: 784-7.
153. Huxley A. The doors of perception. New York: Harper and Row; 1954.
154. Jeanmonod D, Magnin M, Morel A. Low-threshold calcium spike bursts in the human thalamus. Common physiopathology for sensory, motor and limbic positive symptoms. Brain 1996; 119(Pt 2):
155. 363-75. Jeanmonod D, Schulman J, Ramirez R, Cancro R, Lanz M, Morel A, *et al*. Neuropsychiatric thalamocortical dysrhythmia: surgical implications. Neurosurg Clin N Am 2003; 14: 251-65.
156. Jehee JF, Ballard DH. Predictive feedback can account for biphasic responses in the lateral geniculate nucleus. PLoS Comput Biol 2009; 5: e1000373.
157. Johanson M, Valli K, Revonsuo A, Wedlund JE. Content analysis of subjective experiences in partial epileptic seizures. Epilepsy Behav 2008; 12: 170-82.

158. Johnson M, Richards W, Griffiths R. Human hallucinogen research: guidelines for safety. J Psychopharmacol 2008; 22: 603-20.
159. Jouvet M. Paradoxical sleep - a study of its nature and mechanisms. Prog Brain Res 1965; 18: 20-6.
160. Jung CG. Über die Psychologie der Dementia Praecox. Halle: Marhold; 1907.
161. Kahana MJ, Seelig D, Madsen JR. Theta returns. Curr Opin Neurobiol. 11. 739-44.
162. Kahn I, Andrews-Hanna JR, Vincent JL, Snyder AZ, Buckner RL. Distinct cortical anatomy linked to subregions of the medial temporal lobe revealed by intrinsic functional connectivity. J Neurophysiol 2008; 100: 129-39.
163. Kandel ER. Biology and the future of psychoanalysis: a new intellectual framework for psychiatry revisited. Am J Psychiatry 1999; 156: 505-24.
164. Kaplan-Solms K, Solms M. Clinical studies in neuro-psychoanalysis. New York: Other Press; 2001.
165. Kapur S, Mizrahi R, Li M. From dopamine to salience to psychosis-linking biology, pharmacology and phenomenology of psychosis. Schizophr Res 2005; 79: 59-68.
166. Kelly AM, Di Martino A, Uddin LQ, Shehzad Z, Gee DG, Reiss PT, *et al*. Development of anterior cingulate functional connectivity from late childhood to early adulthood. Cereb Cortex 2009; 19: 640-57.
167. Kiebel SJ, Daunizeau J, Friston KJ. A hierarchy of time-scales and the brain. PLoS Comput Biol 2008; 4: e1000209.
168. Kleinschmidt A, Büchel C, Zeki S, Frackowiak RS. Human brain activity during spontaneously reversing perception of ambiguous figures. Proc Biol Sci 1998; 265: 2427-33.
169. Knill DC, Pouget A. The Bayesian brain: the role of uncertainty in neural coding and computation. Trends Neurosci 2004; 27: 712-9.
170. Krause CM, Sillanmäki L, Koivisto M, Saarela C, Häggqvist A, Laine M, *et al*. The effects of memory load on event-related EEG desynchronization and synchronization. Clin Neurophysiol 2000; 111: 2071-8.
171. Kubie LS. Some implications for psychoanalysis of modern concepts of the organization of the brain. Psychoanal Q 1952; 22: 21-68.
172. Lachaux JP, George N, Tallon-Baudry C, Martinerie J, Hugueville L, Minotti L, *et al*. The many faces of the gamma band response to complex visual stimuli. Neuroimage 2005; 25: 491-501.
173. Lambe EK, Aghajanian GK. Hallucinogen-induced UP states in the brain slice of rat prefrontal cortex: role of glutamate spillover and NR2B-NMDA receptors. Neuropsychopharmacology 2006; 31: 1682-9.
174. Lanius RA, Williamson PC, Boksman K, Densmore M, Gupta M, Neufeld RW, *et al*. Brain activation during script-driven imagery induced dissociative responses in PTSD: a functional magnetic resonance imaging investigation. Biol Psychiatry 2002; 52: 305-11.
175. Larson-Prior LJ, Zempel JM, Nolan TS, Prior FW, Snyder AZ, Raichle ME. Cortical network functional connectivity in the descent to sleep. Proc Natl Acad Sci USA 2009; 106: 4489-9.
176. Lesse H, Heath RG, Mickle WA, Monroe RR, Miller WH. Rhinencephalic activity during thought. J Nerv Ment Dis 1955; 122: 433-40.
177. Li CS, Yan P, Bergquist KL, Sinha R. Greater activation of the "default" brain regions predicts stop signal errors. Neuroimage 2007; 38: 640-8.
178. Lisman J, Redish AD. Prediction, sequences and the hippocampus. Philos Trans R Soc Lond B Biol Sci 2009; 364: 1193-201.
179. Llinás R, Ribary U, Contreras D, Pedroarena C. The neuronal basis for consciousness. [Review]. Philos Trans R Soc Lond B Biol Sci 1998; 353: 1841-9.
180. Llinás RR, Ribary U, Jeanmonod D, Kronberg E, Mitra PP. Thalamocortical dysrhythmia: A neurological and neuropsychiatric syndrome characterized by magnetoencephalography. Proc Natl Acad Sci USA 1999; 96: 15222-7.
181. Llinás RR, Steriade M. Bursting of thalamic neurons and states of vigilance. [Review]. J Neurophysiol 2006; 95: 3297-308.
182. Macdonald N. Living with schizophrenia. Can Med Assoc J 1960; 82: 218-21.
183. Mahl GF, Rothenberg A, Delgado JM, Hamlin H. Psychological responses in the human to Intracerebral electrical stimulation. Psychosom Med 1964; 26: 337-68.
184. Mann C, Simmons J, Wilson C, Engel J, Bragin A. EEG in human hippocampus, amygdala and entorhinal cortex during REM and NREM sleep. Sleep Res 1997; 26: 27.
185. Maquet P, Péters J, Aerts J, Delfiore G, Degueldre C, Luxen A, *et al*. Functional neuroanatomy of human rapid-eye-movement sleep and dreaming. Nature 1996; 383: 163-6.
186. Martin JA. L.S.D. (lysergic acid diethylamine) treatment of chronic psychoneurotic patients under day-hospital conditions. International Journal of Social Psychiatry 1957; 3: 188-95.
187. Mason MF, Norton MI, Van Horn JD, Wegner DM, Grafton ST, Macrae CN. Wandering minds: the default network and stimulus-independent thought. Science 2007; 315: 393-5.
188. Masters R, Houston J. The varieties of psychedelic experience. New York: Park Street Press; 2000.
189. Mayberg HS, Lozano AM, Voon V, McNeely HE, Seminowicz D, Hamani C, *et al*. Deep brain stimulation for treatment-resistant depression. Neuron 2005; 45: 651-60.
190. Mayberg HS. Defining the neural circuitry of depression: toward a new nosology with therapeutic implications. Biol Psychiatry 2007; 61: 729-30.
191. Meador KJ, Thompson JL, Loring DW, Murro AM, King DW, Gallagher BB, *et al*. Behavioral state-specific changes in human hippocampal theta activity. Neurology 1991; 41: 869-72.
192. Milad MR, Quirk GJ. Neurons in medial prefrontal cortex signal memory for fear extinction. Nature 2002; 420: 70-4.
193. Milad MR, Rauch SL, Pitman RK, Quirk GJ. Fear extinction in rats: implications for human brain imaging and anxiety disorders. Biol Psychol 2006; 73: 61-71.
194. Moiseeva NI, Aleksanyan ZA. Activity of neuronal populations of human subcortical structures during sleep. Electroencephalogr Clin Neurophysiol 1976; 41: 467-75.
195. Møller P, Husby R. The initial prodrome in schizophrenia: searching for naturalistic core dimensions of experience and behavior. Schizophr Bull 2000; 26: 217-32.
196. Monroe RR, Heath RG, Mickle WA, Llewellyn RC. Correlation of rhinencephalic electrograms with behavior; a study on humans under the influence of LSD and mescaline. Electroencephalogr Clin Neurophysiol 1957; 9: 623-42.

197. Morcom AM, Fletcher PC. Does the brain have a baseline? Why we should be resisting a rest. Neuroimage 2007; 37: 1073-82.
198. Mumford D. On the computational architecture of the neocortex. II. The role of cortico-cortical loops. Biol Cybern 1992; 66: 241-51.
199. Murray SO, Kersten D, Olshausen BA, Schrater P, Woods DL. Shape perception reduces activity in human primary visual cortex. Proc Natl Acad Sci USA 2002; 99: 15164-9.
200. Muzio JN, Roffwarg HP, Kaufman E. Alterations in the nocturnal sleep cycle resulting from LSD. Electroencephalogr Clin Neurophysiol 1966; 21: 313-24.
201. Niessing J, Ebisch B, Schmidt KE, Niessing M, Singer W, Galuske RA. Hemodynamic signals correlate tightly with synchronised gamma oscillations. Science 2005; 309: 948-51.
202. Nimchinsky EA, Gilissen E, Allman JM, Perl DP, Erwin JM, Hof PR. A neuronal morphologic type unique to humans and great apes. Proc Natl Acad Sci USA 1999; 96: 5268-73.
203. Nir Y, Fisch L, Mukamel R, Gelbard-Sagiv H, Arieli A, Fried I, *et al*. Coupling between neuronal firing rate, gamma LFP, and BOLD fMRI is related to interneuronal correlations. Curr Biol 2007; 17: 1275-85.
204. Nir Y, Mukamel R, Dinstein I, Privman E, Harel M, Fisch L, *et al*. Interhemispheric correlations of slow spontaneous neuronal fluctuations revealed in human sensory cortex. Nat Neurosci 2008; 11: 1100-8.
205. Oertel V, Rotarska-Jagiela A, van de Ven VG, Haenschel C, Maurer K, Linden DE. Visual hallucinations in schizophrenia investigated with functional magnetic resonance imaging. Psychiatry Res 2007; 156: 269-73.
206. Onton J, Delorme A, Makeig S. Frontal midline EEG dynamics during working memory. Neuroimage 2005; 27: 341-56.
207. Ostow M. Psychic function of temporal lobe as inferred from seizure phenomena. AMA Arch Neurol Psychiatry 1957; 77: 79-85.
208. Parnas J, Handest P. Phenomenology of anomalous self-experience in early schizophrenia. Compr Psychiatry 2003; 44: 121-34.
209. Penfield W, Jasper S. Epilepsy and the functional anatomy of the human brain. New York: Little, Brown and Co; 1954.
210. Penfield W, Perot P. The brain's record of auditory and visual experience. A final summary and discussion. Brain 1963; 86: 595-696.
211. Petsche H, Stumpf C, Gogolak G. The significance of the rabbit's septum as a relay station between the midbrain and the hippocampus. I. The control of hippocampus arousal activity by the septum cells. Electroencephalogr Clin Neurophysiol 1962; 42: 202-1.
212. Phelps EA, Delgado MR, Nearing KI, LeDoux JE. Extinction learning in humans: role of the amygdala and vmPFC. Neuron 2004; 43: 897-905.
213. Phillips ML, Drevets WC, Rauch SL, Lane R. Neurobiology of emotion perception I: the neural basis of normal emotion perception. Biol Psychiatry 2003; 54: 504-14.
214. Pietrini P, Guazzelli M, Basso G, Jaffe K, Graffman J. Neural correlates of imaginal aggressive behaviour assessed by positron emission tomography in healthy subjects. Am J Psychiatry 2000; 157: 1772-1781.
215. Pomarol-Clotet E, Salvador R, Sarró S, Gomar J, Vila F, Martínez A, *et al*. Failure to deactivate in the prefrontal cortex in schizophrenia: dysfunction of the default mode network? Psychol Med 2008; 38: 1185-93.
216. Postuma RB, Dagher A. Basal ganglia functional connectivity based on a meta-analysis of 126 positron emission tomography and functional magnetic resonance imaging publications. Cereb Cortex 2006; 16: 1508-21.
217. Raichle ME, MacLeod AM, Snyder AZ, Powers WJ, Gusnard DA, Shulman GL. A default mode of brain function. Proc Natl Acad Sci USA 2001; 98: 676-82.
218. Raichle ME, Snyder AZ. A default mode of brain function: a brief history of an evolving idea. Neuroimage 2007; 37: 1083-90; discussion 1097-9.
219. Raichle ME. A paradigm shift in functional brain imaging. J Neurosci 2009; 29: 12729-34.
220. Raghavachari S, Lisman JE, Tully M, Madsen JR, Bromfield EB, Kahana MJ. Theta oscillations in human cortex during a working-memory task: evidence for local generators. J Neurophysiol 2006; 95: 1630-8.
221. Rao RP, Ballard DH. Predictive coding in the visual cortex: a functional interpretation of some extra-classical receptive-field effects. Nat Neurosci 1999; 2: 79-87.
222. Reinders AA, Nijenhuis ER, Paans AM, Korf J, Willemsen AT, den Boer JA. One brain, two selves. Neuroimage 2003; 20: 2119-25.
223. Reinders AA, Nijenhuis ER, Quak J, Korf J, Haaksma J, Paans AM, *et al*. Psychobiological characteristics of dissociative identity disorder: a symptom provocation study. Biol Psychiatry 2006; 60: 730-40.
224. Revonsuo A. The reinterpretation of dreams: an evolutionary hypothesis of the function of dreaming. Cambridge: Cambridge University Press; 2003.
225. Robbins TW, Everitt BJ. Neurobehavioural mechanisms of reward and motivation. Curr Opin Neurobiol 1996; 6: 228-36.
226. Robinson JL, Laird AR, Glahn DC, Lovallo WR, Fox PT. Metaanalytic connectivity modeling: Delineating the functional connectivity of the human amygdala. Hum Brain Mapp 2009; 31: 173-84.
227. Rodin EA, Mukder DW, Faucett RL, Bickford RG. Psychologic factors in convulsive disorders of focal origin. AMA Arch Neurol Psychiatry 1955; 74: 365-74.
228. Rodin E, Luby E. Effects of LSD-25 on the EEG and photic evoked responses. Arch Gen Psychiatry 1966; 14: 435-41.
229. Rosenkranz JA, Grace AA. Cellular mechanisms of infralimbic and prelimbic prefrontal cortical inhibition and dopaminergic modulation of basolateral amygdala neurons in vivo. J Neurosci 2002; 22: 324-37.
230. Rosenkranz JA, Moore H, Grace AA. The prefrontal cortex regulates lateral amygdala neuronal plasticity and responses to previously conditioned stimuli. J Neurosci 2003; 23: 11054-64.
231. Saleem KS, Kondo H, Price JL. Complementary circuits connecting the orbital and medial prefrontal networks with the temporal, insular, and opercular cortex in the macaque monkey. J Comp Neurol 2008; 506: 659-9.
232. Sandell JH, Schiller PH. Effect of cooling area 18 on striate cortex cells in the squirrel monkey. J Neurophysiol 1982; 48: 38-48.
233. Sandison RA, Spencer AM, Whitelaw JD. The therapeutic value of lysergic acid diethylamide in mental illness. J Ment Sci 1954; 100: 491-507.

234. Scarone S, Manzone ML, Gambini O, Kantzas I, Limosani I, D'Agostino A, *et al*. The dream as a model for psychosis: an experimental approach using bizarreness as a cognitive marker. Schizophr Bull 2008; 34: 515-22.
235. Schultz W. Getting formal with dopamine and reward. Neuron 2002; 36: 241-63.
236. Schwarz BE, Sem-Jacobsen CW, Petersen MC. Effects of mescaline, LSD- 25, and adrenochrome on depth electrograms in man. AMA Arch Neurol Psychiatry 1956; 75: 579-87.
237. Sechehaye M. Autobiography of a schizophrenic girl. New York: Grune and Stratton; 1951.
238. Seeley WW, Menon V, Schatzberg AF, Keller J, Glover GH, Kenna H, *et al*. Dissociable intrinsic connectivity networks for salience processing and executive control. J Neurosci 2007; 27: 2349-56.
239. Sem-Jacobsen CW, Petersen MC, Lazarte JA, Dodge HW Jr, Holman CB. Intracerebral electrographic recordings from psychotic patients during hallucinations and agitation. Am J Psychiatry 1955; 112: 278-88.
240. Sem-Jacobsen CW, Petersen MC, Dodhe HW Jr, Lynge HN, Lazarte JA, Holman CB. Intracerebral electrographic study of 93 psychotic patients. Acta Psychiatr Neurol Scand Suppl 1956; 106: 222-6.
241. Sheline YI, Barch DM, Price JL, Rundle MM, Vaishnavi SN, Snyder AZ, *et al*. The default mode network and self-referential processes in depression. Proc Natl Acad Sci USA 2009; 106: 1942-7.
242. Sherwood SL. Electrographic depth recordings from the brains of psychotics. Ann NY Acad Sci 1962; 96: 375-85.
243. Shin LM, Dougherty DD, Orr SP, Pitman RK, Lasko M, Macklin ML, *et al*. Activation of anterior paralimbic structures during guilt-related script-driven imagery. Biol Psychiatry 2000; 48: 43-50.
244. Shin LM, Orr SP, Carson MA, Rauch SL, Macklin ML, Lasko NB, *et al*. Regional cerebral blood flow in the amygdala and medial prefrontal cortex during traumatic imagery in male and female Vietnam veterans with PTSD. Arch Gen Psychiatry 2004; 61: 168-76.
245. Shin LM, Rauch SL, Pitman RK. Amygdala, medial prefrontal cortex, and hippocampal function in PTSD. Ann N Y Acad Sci 2006; 1071: 67-79.
246. Shmuel A, Leopold DA. Neuronal correlates of spontaneous fluctuations in fMRI signals in monkey visual cortex: implications for functional connectivity at rest. Hum Brain Mapp 2008; 29: 751-6.
247. Shulman GL, McAvoy MP, Cowan MC, Astafiev SV, Tansy AP, d'Avossa G, *et al*. Quantitative analysis of attention and detection signals during visual search. J Neurophysiol 2003; 90: 3384-97.
248. Silva LR, Amitai Y, Connors BW. Intrinsic oscillations of neocortex generated by layer 5 pyramidal neurons. Science 1991; 251: 432-5.
249. Singer W, Gray CM. Visual feature integration and the temporal correlation hypothesis. Annu Rev Neurosci 1995; 18: 555-86.
250. Singer W. Distributed processing and temporal codes in neuronal networks. Cogn Neurodyn 2009; 3: 189-96.
251. Sirota A, Montgomery S, Fujisawa S, Isomura Y, Zugaro M, Buzsáki G. Entrainment of neocortical neurons and gamma oscillations by the hippocampal theta rhythm. Neuron 2008; 60: 683-97.
252. Slater E, Beard AW. The schizophrenia-like psychoses of epilepsy, V: discussion and conclusions. J Neuropsychiatry Clin Neurosci 1963; 7: 372-8.
253. Solms M. Oral presentation at the 10th Annual International Congress for Neuropsychoanalysis. Paris, 2009.
254. Solms M. Dreaming and REM sleep are controlled by different brain mechanisms. In Pace-Schott EF, Solms M, Blagrove M, Harnad S, editors. Sleep and dreaming. Cambridge: Cambridge University Press; 2003.
255. Solms M, Turnbull O. The brain and the inner world. London: Karnac; 2002.
256. Steriade M, Timofeev I, Grenier F. Natural waking and sleep states: a view from inside neocortical neurons. J Neurophysiol 2001; 85: 1969-85.
257. Sridharan D, Levitin DJ, Menon V. A critical role for the right fronto-insular cortex in switching between central-executive and default-mode networks. Proc Natl Acad Sci USA 2008; 105: 12569-74.
258. Stein JL, Wiedholz LM, Bassett DS, Weinberger DR, Zink CF, Mattay VS, *et al*. A validated network of effective amygdala connectivity. Neuroimage 2007; 36: 736-45.
259. Stephan KE, Friston KJ, Frith CD. Dysconnection in schizophrenia: from abnormal synaptic plasticity to failures of self-monitoring. Schizophr Bull 2009; 35: 509-27.
260. Stevens JR, Mark VH, Erwin F, Pacheco P, Suematsu K. Deep temporal stimulation in man. Long latency, long lasting psychological changes. Arch Neurol 1969; 21: 157-69.
261. Taylor DC, Lochery M. Temporal lobe epilepsy: origin and significance of simple and complex auras. J Neurol Neurosurg Psychiatry 1987; 50: 673-81.
262. Torda C. Contribution to serotonin theory of dreaming (LSD infusion). N Y State J Med 1968; 68: 1135-8.
263. Toyoda J. The effects of chlorpromazine and imipramine on the human nocturnal sleep cycle. Folia Psychiatrica et Neurologica Japonica 1964; 18: 198-221.
264. van den Heuvel M, Mandl R, Luigjes J, Hulshoff Pol H. Microstructural organization of the cingulum tract and the level of default mode functional connectivity. J Neurosci 2008; 28: 10844-51.
265. van den Heuvel MP, Mandl RC, Kahn RS, Hulshoff Pol HE. Functionally linked resting-state networks reflect the underlying structural connectivity architecture of the human brain. Hum Brain Mapp 2009; 30: 3127-41.
266. Vincent JL, Snyder AZ, Fox MD, Shannon BJ, Andrews JR, Raichle ME, *et al*. Coherent spontaneous activity identifies a hippocampal-parietal memory network. J Neurophysiol 2006; 96: 3517-31.
267. Vincent JL, Kahn I, Snyder AZ, Raichle ME, Buckner RL. Evidence for a frontoparietal control system revealed by intrinsic functional connectivity. J Neurophysiol 2008; 100: 3328-42.
268. Vollenweider FX, Leenders KL, Scharfetter C, Maguire P, Stadelmann O, Angst J. Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. Neuropsychopharmacology 1997; 16: 357-72.
269. von Stein A, Sarnthein J. Different frequencies for different scales of cortical integration: from local gamma to long range alpha/theta synchronization. [Review]. Int J Psychophysiol 2000; 38: 301-13.
270. von Stein A, Rappelsberger P, Sarnthein J, Petsche H. Synchronization between temporal and parietal cortex during multimodal object processing in man. Cereb Cortex 1999; 9: 137-50.

271. Wackermann J, Wittmann M, Hasler F, Vollenweider FX. Effects of varied doses of psilocybin on time interval reproduction in human subjects. Neurosci Lett 2008; 435: 51-5.
272. Webster R. Why freud was wrong. London: Harper Collins; 1995.
273. Wehrle R, Kaufmann C, Wetter TC, Holsboer F, Auer DP, Pollmächer T, *et al*. Functional microstates within human REM sleep: first evidence from fMRI of a thalamocortical network specific for phasic REM periods. Eur J Neurosci 2007; 25: 863-71.
274. Whitfield-Gabrieli S, Thermenos HW, Milanovic S, Tsuang MT, Faraone SV, McCarley RW, *et al*. Hyperactivity and hyperconnectivity of the default network in schizophrenia and in first-degree relatives of persons with schizophrenia. Proc Natl Acad Sci USA 2009; 106: 1279-84.
275. Winson J. Loss of hippocampal theta rhythm results in spatial memory deficit in the rat. Science 1978; 201: 160-3.
276. Wise RG, Ide K, Poulin MJ, Tracey I. Resting fluctuations in arterial carbon dioxide induce significant low frequency variations in BOLD signal. Neuroimage 2004; 21: 1652-64.
277. Wu CW, Gu H, Lu H, Stein EA, Chen JH, Yang Y. Mapping functional connectivity based on synchronized CMRO fluctuations during the resting state. Neuroimage 2009; 45: 694-701.
278. Yu Q, Rayport M, Farison JB, Dennis MJ, Choi YS. Computer analysis of human depth EEG in different sleep stages. Biomed Sci Instrum 1997; 33: 184-90.

Yale Manual for Psilocybin-Assisted Therapy of Depression

by

Jeffrey Guss, Robert Krause, Jordan Sloshower,

First edition: August 2020

DOI: 10.31234/osf.io/u6v9y

© 2020 Jeffrey Guss, Robert Krause, and Jordan Sloshower

original report: https://psyarxiv.com/u6v9y/download

Authors: Jeffrey Guss, MD Robert Krause, DNP APRN-BC Jordan Sloshower, MD, MSc
Contributors: Ryan Wallace, MD, MPH Monnica Williams, PhD Sara Reed, MA Anne Dutton, MA, LCSW
For information, write to Dr. Jordan Sloshower: Jordan.Sloshower@yale.edu

Table of Contents:

Acknowledgements
Part 1 - Theoretical Foundation for Psilocybin-Assisted Act Therapy in Treatment of Depression
1. Introduction
  1.1 Goals of This Manual
  1.2 General Elements of Psychedelic-Assisted Therapy
  1.3 Theoretical Considerations of Psilocybin-Assisted Therapy for Depression
  1.4 Development of This Psychedelic-Assisted Therapy for Depression
  1.5 Acceptance and Commitment Therapy in Psilocybin-Assisted Therapy for Major Depressive Disorder
  1.6 Why Utilize ACT in Psilocybin-Assisted Therapy for Major Depressive Disorder?
2. Therapist Foundation
  2.1 Essential Therapist Background
  2.2 Therapist Training
3. Set and Setting
  3.1 Set: The Inner World of The Participant
  3.2 Setting: The Outer World of The Participant

3.3 Preparing the Physical Setting
3.4 Preparing Social Support Following Medication Sessions
3.5 Planning for the Therapeutic Use of Music
3.6 Relationship with Therapists as Setting: The Therapists' Commitments
4. Prior to the First Session with Therapists
4.1 Screening and Consent
4.2 Prerequisites and Contraindications
4.3 Commitments from The Participant (Part of the Consenting Process)
Part 2 - Psilocybin-assisted Therapy Manual and Description of Sessions
5. Introduction
5.1 ACT-Based Clinical Formulation
5.2 ACT-Based Clinician Intervention
Didactic Explanations
Experiential Exercises
6. Psychoeducation Session #1
6.1 Internal Agenda for Therapists During Psychoeducation Session #1
Cognitive Fusion
Experiential Avoidance
6.2 Building Rapport and Therapeutic Alliance
6.3 Review the Overall Structure of Today's Session:
6.4 Reviewing The Participant's Lived Experience of Depression
6.5 Reviewing The Participant's Lived Experience of Psychopharmacology Treatment
6.6 Understand The Participant's Preconceptions About Psychedelic Experiences
6.7 Listen for ACT "Misdemeanors" and Begin Constructing an ACT-Based Clinical Formulation
6.8 Intention-Setting
6.9 Educating The Participant About Psilocybin Dosing Sessions
a. Common Experiences with Psilocybin Script
b. Difficult Experiences Script
c. Ski Slope Script
d. Therapist Interventions & Grounding Techniques Script
e. Grounding Technique Script 1: Abdominal Breathing
f. Grounding Technique Script 2: Therapeutic Touch
g. Grounding Technique Script 3: Awareness of Body Sensation Exercise
h. Rescue Medications
i. Practical Guidance and Safety Instructions Script
j. Departure Requirements
6.10 Eyeshade, Music Trial and Introduction to the Physical Space
6.11 Ending: Questions, Recap of Details for Arrival for Session
7. Medication Sessions #1 & #2
7.1 General Guidelines and Overview for Medication Sessions
7.1.1 Check-In
7.1.2 Dosing
Guidelines for therapist actions/attitudes during session
Principles of non-intrusive presence
Responding to invitations to talk
Responding to intense, painful affect states
Responding to agitation or restlessness
Responding to requests for contact
Responding to marked agitation
Responding to marked, persistent paranoid reactions
Responding to urge to undress or move about the room
Therapist's role/attitude/frame-of-mind during psychedelic-assisted sessions
7.1.3 First Narrative Telling (15-60 minutes)
7.1.4 Departure
7.2 Medication Session #2
8. Debriefing Sessions #1 and #2

8.1 General Guidelines for Debriefing Sessions
8.2 Debriefing Session #1
8.2.1 Open Narrative
8.2.2 Session #1 Ending
8.3 Debriefing Session #2
8.3.1 Session #2 Ending
9. Psychoeducation Session #2
9.1 Checking In
9.2 Differentiating the Traditional Psychopharmacology Model of Depression Treatment from This Psychedelic-Assisted Therapy Model
9.3 Psychoeducation Regarding Psychological Processes in Depression
Cognitive Fusion
Experiential Avoidance
9.4 Mindfulness Metaphors and Mindfulness Practice
Examples of mindfulness practices
9.5 Intention-Setting
9.6 Ending: Questions, Recap of Details for Arrival for Session
10. Debriefing Session #3
10.1 Open Narrative
10.2 Metaphor
10.3 Ending
11. Debriefing Session #4
11.1 Open Narrative
11.2 Values-Into-Action
11.3 Ending
12. Follow-up Sessions #1, #2
12.1 Follow-Up Session #1
12.1.1 Check-In
12.1.2 Termination Discussion
12.1.3 Acceptance and Commitment
12.1.4 Begin Reviewing After-Care Plan
12.2 Follow-Up Session #2
13. Limitations
13.1 Cultural Considerations of ACT-Facilitated Psychedelic Therapy
Appendix A: Therapist Self-Care
What is Compassion Fatigue?
Appendix B: Psilocybin
Safety of Psilocybin
Appendix C: References

Acknowledgements

We express deep gratitude to both the early and contemporary pioneers of this work - the scientists, authors, practitioners, guides, research volunteers, and organizations whose work with psychedelics kept their possibilities alive - and who campaigned to revive and extend the study of psychedelics for the benefit of others. Without these pioneers, this study and the majority of research related to the transformative and therapeutic benefits of these compounds would not exist.

Thanks to funders and supporters:

Yale University Department of Psychiatry
Carey and Claudia Turnbull
Heffter Research Institute

Additional thanks:

Dr. Cyril D'Souza, MD for his role as Principal Investigator of the Yale PsilocybinDepression study.
Staff of the Schizophrenia Neuropharmacology Research Group at Yale for their dedication implementing the study.
All of the participants in our study who have entrusted us with their wellbeing.

Part 1 - Theoretical Foundation for Psilocybin-Assisted Act Therapy in Treatment of Depression

1. Introduction

1.1 Goals of This Manual

The Yale Manual for Psilocybin-Assisted Therapy of Depression provides researchers and therapists with methods, structure, and areas to consider regarding the use of psychedelic-assisted therapy in the treatment of Major Depressive Disorder (MDD). In particular, this manual illustrates a mode of utilizing Acceptance and Commitment Therapy (ACT) as a therapeutic framework for psilocybin-assisted therapy of depression.

This manual is intended for use with participants in an approved clinical trial who have provided their informed consent. In this manual, the people who participate in the experimental psychotherapy sessions are referred to as "participants" rather than as "patients" or "subjects." The manual is intended for use in conjunction with an approved study protocol, contained in a separate document, describing the study design. The design of the study for which this manual was developed involves several experimental ("dosing" or "medicine") sessions with associated preparatory and integrative therapy sessions. The number and order of sessions presented here is particular to this trial.

We consider the process of integrating the principles of ACT into psychedelic therapy to be an iterative project requiring ongoing case supervision and refinement or adaptation of the protocol. As such, the number and order of sessions may be adapted, based on the needs of other research studies. Additionally, certain aspects of the manual may be adjusted to meet the needs of different studies. However, elements of the manual designed to ensure the safety of the participant(s) or therapists should be followed. Because of the adaptable nature of the information presented in this document, the authors have adopted a mostly suggestive tone, using words like "should" or "may" in describing activities. In instances where certain practices or standards must be observed to ensure safety, the authors have chosen a directive tone, using words like, "will" or "shall."

The specific goals of this manual are to:

a. Delineate the essential elements of research-based, psychedelic-assisted therapy for individuals suffering from Major Depressive Disorder, including establishing and maintaining proper set and setting.
b. Delineate theoretical and clinical approaches drawn from Acceptance and Commitment Therapy (ACT) as a platform that offers a model for understanding and depression and treating the psychological rigidity/inflexibility that is common in MDD.
c. Provide guidelines to therapists for use of this model regarding: preparation sessions (psychoeducation), dosing (experimental) sessions, and integration (debriefing and followup) sessions.
d. Educate therapists regarding self-care practices that support this work.
e. Educate therapists regarding inclusion and exclusion criteria, screening procedures and consenting procedures.
f. Define basic criteria required to function as a study therapist.

1.2 General Elements of Psychedelic-Assisted Therapy

The term "psychedelic-assisted psychotherapy" refers to a particular mode of using psychedelic substances in which the effects of the drug, both biological and psychological, play a significant role in facilitating a psychotherapeutic intervention. This intervention begins before the first psychedelic dosing session occurs, and continues after the final dosing session. While most clinical trials using psychedelic therapy have followed the basic preparation, support, and integration model, the content of the preparation and integration sessions has varied considerably among protocols, based on the condition being treated as well as the therapeutic orientation of the researchers writing the protocol. Nonetheless, psychedelic-assisted therapies have certain common recognizable features. This therapeutic modality places significant emphasis on set, setting, preparation, integration, the creation of a supportive therapeutic container to focus and frame the effects of the psychedelic drug, and the creation and maintenance of a strong therapeutic alliance.

Traditionally, psychedelic-assisted therapy is comprised of three parts: preparation for the dosing session, support during the dosing session, and integration following it. Preparatory sessions, occurring prior to the medication session, aim to accomplish several important tasks. Therapists must develop therapeutic rapport with the participant, gather information about the participant and their history, and provide psychoeducation regarding the psychedelic experience, the therapeutic approach to be used, and expectations of the participant's active collaboration in the process. Additionally, the sessions seek to clarify the participant's expectations of the medication session. We explain the logistics of the session (how long it will last, the type of music to be utilized) and delineate acceptable boundaries of interaction between the participant and the therapist, as well as safety measures. Support in this context refers to the affirming, largely nondirective stance taken by the therapists during the experimental drug sessions. In psilocybin trials, therapists generally encourage participants to focus their mind inward during dosing sessions. Therapists provide emotional support and encourage the participant to engage with difficult thoughts, sensations, or memories that arise. They also assist the participant by meeting any immediate needs for comfort or safety. The integration phase usually begins the day after the dosing session; it involves reviewing the participant's experience during the dosing session thoroughly and, in some cases, applying therapeutic techniques to reinforce particular aspects of the experience so they foster sustained desirable patterns of thought and behavior. In other words, integration continues the therapeutic process that began during preparation sessions, and intensified during a psychedelic experience. The role of the therapist is to facilitate the integration process and help consolidate the newly developed mindset, including the actualization of insights and initiation of behavioral changes that foster recovery from depression.

It is a well-established principle that subjective effects from psilocybin administration are highly variable and are strongly influenced by psychological and environmental factors, commonly referred to as "set and setting" (Leary, Metzner, & Alpert, 1995). "Set" refers to the mindset and intention of the individual prior to the experience. This includes their beliefs, hopes, fears, traumas, personality and temperament, as well as their expectations and fantasies about psychedelic experiences and the therapists, themselves. In the context of clinical research, the participant's attitude toward the research setting, the medication, and the therapists, as well as expectations for relief also constitute important parts of the participant's set. "Setting" refers to the physical space, environment and context in which one experiences the drug effects. This includes its inhabitants (therapists or guides), as well as factors such as music, artwork, and safety equipment. The relationship with the therapists is a primary determinant of the setting. Given the influence of all these factors on the participant's experience, most research with psychedelics emphasizes the importance of set and setting to maximize safety, reduce the risk of harmful experiences, and guide therapeutic response. Guidelines for maximizing safety and minimizing risk in research studies with psychedelic substances have been published (M. Johnson, Richards, & Griffiths, 2008). Recent clinical trials with psilocybin have demonstrated that its use is remarkably safe when conducted in a safe, therapeutic environment in which individuals are adequately prepared for the experience.

1.3 Theoretical Considerations of Psilocybin-Assisted Therapy for Depression

While most clinical trials of psychedelic therapy have followed this basic model, the content of the preparation and integration sessions has varied considerably among protocols, based on the condition being treated as well as the therapeutic orientation of the researchers and therapists. Importantly, some studies have employed non-specific supportive psychotherapeutic models while others have incorporated elements of evidence-based, condition-specific therapies. An example of the latter is a study of psilocybin-assisted therapy for Alcohol Use Disorder underway at New York University School of Medicine, which integrates elements of Motivational Enhancement Therapy and Cognitive Behavioral Therapy into the familiar structure of preparation and integration sessions (Bogenschutz & Forcehimes, 2017). Numerous forms of psychosocial interventions could potentially be compatible or adaptable for use in psychedelic-assisted therapies, provided there is some theoretical synergism with the pharmacologic treatment to produce desired therapeutic outcomes.

In contrast, supportive models of psychedelic therapy are not linked to particular therapeutic orientations, nor do they target the specific disorder being treated. Instead, they provide containment, safety, and clear guidelines to help participants navigate the psychedelic experience. Some large-scale clinical trials of psilocybin treatment for major depressive disorder currently being implemented are employing nonspecific models of "psychological support" (Carhart-Harris *et al.*, 2016). While this decision is consistent with, and determined by, research priorities trials aiming to isolate drug effects from therapy effects, it also relates to the reality that it is not clear "how best to integrate the psychedelic experience into treatment models designed to have specific therapeutic effects, for example, to ameliorate the symptoms of a specific disorder" (Bogenschutz & Forcehimes, 2017).

In "psychological support only" models, the clinician is not referred to as a "therapist" but instead is named a "sitter," "guide," or "monitor." Such nonspecific models sometimes evoke the notion of an "inner healer" that abides within the psyche of the individual person and is unleashed or brought forward by the psychedelic medicine. The job of the guide, then, is to "hold space" for this natural healing process of the individual to unfold. We do not question the possibility that a self-regulating process with some potential for internally generated self-repair may be a part of psychedelic efficacy. Likewise, we also employ a nondirective approach during psilocybin dosing sessions themselves, trusting that whatever content and processes that arise will be of therapeutic value, in an analogous manner to free association in the psychoanalytic situation. However, we see numerous compelling reasons to employ a therapeutic modality with an explicit theoretical orientation in the treatment of research participants with Major Depressive Disorder.

First, we feel that an important therapeutic opportunity is lost when a condition-specific treatment modality is not employed in the overall course of psychedelic therapy for moderate to severe diagnosed mental disorders. Major Depressive Disorder is a complex, vexing, chronic condition that is best understood in neuroscientific *and* cognitive *and* behavioral *and* social dimensions. Thus, the notion that a non-specific, supportive psychosocial container is the *best* method to address such a complex clinical situation seems highly specious, and reinforces a "magic bullet" approach to psychedelic therapy, that is, one which idealizes and fetishizes the molecule itself as the active agent that is internally powerful, isolated from its social and cultural contexts. Whatever changes emerge from an intense psilocybin dosing experience will inevitably be countered by deeply ingrained patterns of thinking, feeling and behaving and are unlikely to be permanently reconfigured by even the most intense psychedelic experience. Setting the groundwork for the psychedelic experience to occur with a specific change intention, during preparatory sessions, and then reinforcing that approach during integration can help direct the psychedelic experience in ways that are known to be therapeutic for depression. As we will discuss later, this is our explicit intention in utilizing ACT as a therapeutic frame in our study. While efficacy trials of psychedelics may minimize the role of formal psychotherapy in order to separate drug effects from psychotherapy effects, we argue that the "support only" approach puts participants at risk for receiving suboptimal treatment.

Second, failure to specifically outline a coherent therapeutic approach with standardized and theorized therapy methods presents a problem for controlled research. Without a therapeutic approach being defined, much of what the sitters or guides do or say goes unaccounted for and leaves hidden the role of their therapeutic attitudes, fantasies, desires and fears. We do not believe that "psychological support" can be provided in a truly neutral manner; this ignores the existence of unconscious processes, unspoken consciously held attitudes, beliefs and emotions that live under the obfuscating blanket concept of bland and non-intrusive "support." The supportive interactions of monitors are likely to contain more than neutral space holding, especially while working with and bearing witness to the suffering of significantly depressed participants, with the therapists operating in a highly complex setting with their own deeply held relationship dynamics regarding psychedelics. In any scenario, each study therapist is likely to employ their own intuitive therapeutic modalities at different times and in different ways with different participants, even without an intention to. Thus, we believe it is more scientifically rigorous to proactively outline a therapeutic approach and structure, acknowledging there will be some reasonable variability in session content, rather than to refrain from delineating these variables at all and imagine that "non-specific support" is a specific, controlled intervention.

Third, we concur with the NIH-endorsed approach that research "interventions to change health behaviors ought to be guided by a hypothesis about why the behavior exists and how best to change it" (Nielsen *et al.*, 2018). Most psychotherapies provide answers to both of these questions. In the case of major depressive disorder, we have a panoply of theories regarding etiology and treatment, reflecting the evident truth that depression can be understood meaningfully within many different discourses (Parker, 2005). For these reasons, at the very beginning of our study, we deliberated on several empirically studied depression treatments for our therapists to employ during the course of the study.

1.4 Development of This Psychedelic-Assisted Therapy for Depression

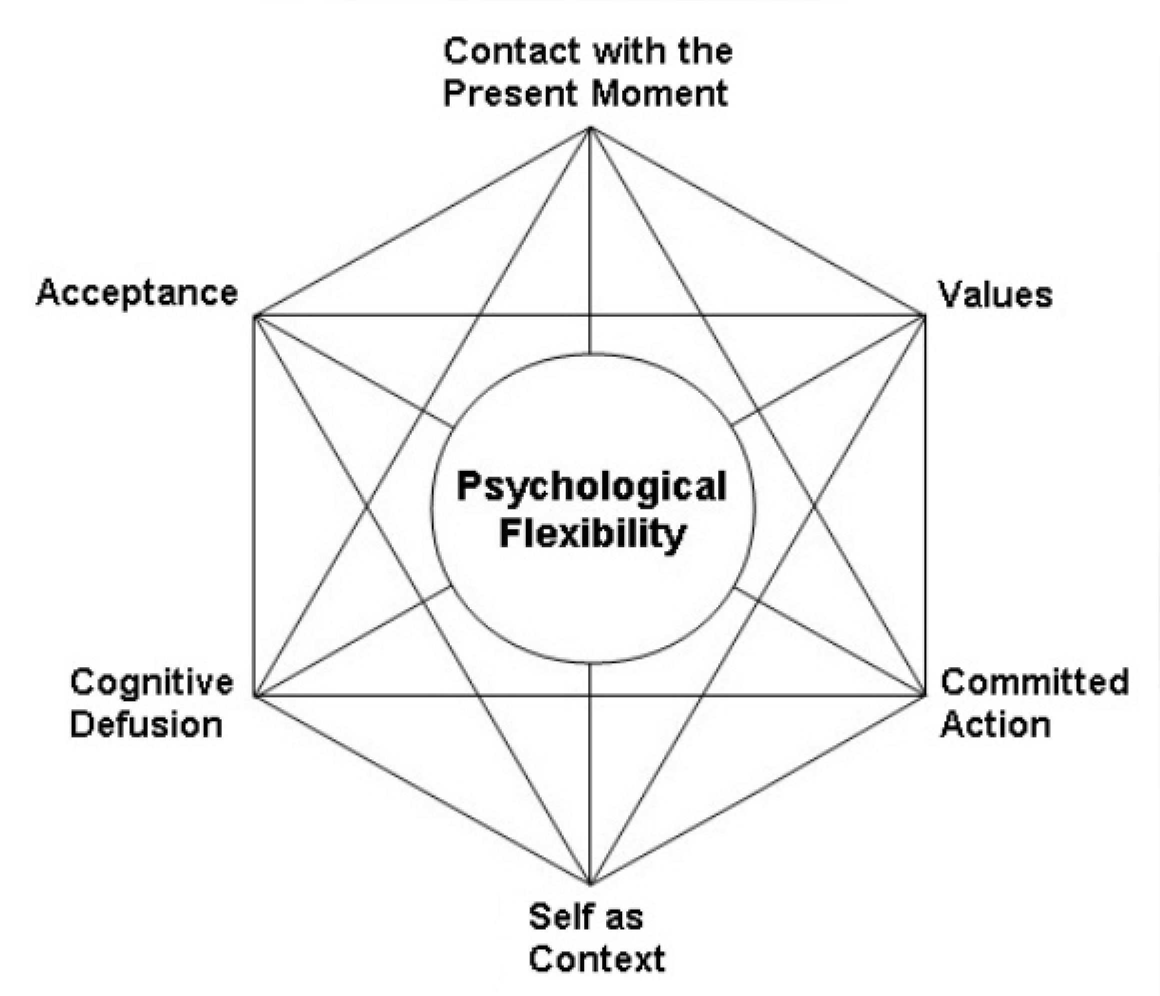
We began the process of constructing a therapy manual for psilocybin-assisted therapy of depression by studying several manualized therapies for depression that both had an evidence base and at least some conceptual overlap with psychedelic therapy. We specifically sought a therapeutic approach that would be facilitated by the effects of the psychedelic dosing sessions and also offer a structure for the preparation and integration sessions. The therapeutic modalities considered were: a) Weissman and Klerman's Interpersonal Psychotherapy (IPT) for Depression (Klerman, Weissman, Rounsaville, & Chevron, 1994); b) Frankl's Logotherapy (Schulenberg, Hutzell, Nassif, & Rogina, 2008); c) Mindfulness-Based Cognitive Therapy for Depression (Segal, Williams, & Teasdale, 2018); and d) Acceptance and Commitment Therapy (Zettle, 2007).

Our process involved outlining these key factors for each modality: the etiology of depression (how the causes of depression are understood), the therapeutic mechanism(s) (how the therapy intends to relieve depression), targeted outcomes (in addition to improvement of depressive symptoms), and the therapeutic approach (how the therapist engages with the patient). Finally, we reflected upon how the therapeutic modality may or may not relate to psychedelic experience and possible psychological mechanisms of psychedelic therapy.

Of the four modalities that were studied, two emerged as best suited for integration with psychedelic therapy in the treatment of Major Depressive Disorder: Acceptance and Commitment Therapy (ACT) and Mindfulness Based Cognitive Therapy (MBCT). Mindfulness-Based Cognitive Therapy had many positives, with a focus on non-judgmental acceptance of self, acceptance of all that arises in the mind, a focus on the present moment, and self-transcendence. All of these elements are represented in ACT, which offers, in addition, exploration of personal values (often lost in depression) and the need for values-based action (also, often missing in depression). Thus, ACT provided the most conceptual overlap with existing traditional approaches to psychedelic therapy as well as matching our intuitive notions of how psychedelic therapy may be beneficial in the treatment of depression.

1.5 Acceptance and Commitment Therapy in Psilocybin-Assisted Therapy for Major Depressive Disorder

ACT was developed through the integration of radical behaviorism and experiential/existential approaches intended to target transdiagnostic drivers of psychological distress. The FEAR acronym describes the common targets that ACT is oriented toward: "fusion, evaluation, avoidance, and reason giving" (Hayes, Strosahl, & Wilson, 2003). The common human experience of over-reliance on thoughts and beliefs over direct experiences (i.e., fusion), the evaluation of our experiences as wanted or unwanted, and attempts to avoid both external and internal (e.g. thoughts, feelings, memories) antecedents of unwanted experiences can all amplify and create the experience of suffering. Within the context of a culture that values the pursuit of positive emotions over a life lived in accordance with one's values or a sense of deeper meaning (Ryan, Huta, & Deci, 2008), attempts to control or avoid unpleasant internal states become a major source of unhappiness and psychological distress (Hayes, Strosahl, & Wilson, 2011). Though derived within the behavioral tradition, there are a number of parallels that have been noted between ACT, mindfulness interventions, and Buddhist philosophy (Hayes, 2002), including the concept of an *observer mind* or *transcendent self*, separate from the content of the mind or conceptualizations of the self, that can be experienced. In ACT, such transcendent experiences are considered to arise from amplified contact with the learned experience of the verbal relations I-you, here-there, and now-then



(McHugh, Stewart, & Almada, 2019).

The central treatment target of ACT is the development of psychological flexibility, cultivated through a careful focus on six core processes: present-moment awareness, acceptance of one's experiences, defusion from the literal belief in one's thoughts, values clarification, the identification of specific behaviors in the service of those values (committed action), and contact with a flexible experience of the self (self-as-context) (Hayes *et al.*, 2011). This "hexaflex" model is outlined in the figure below.

In contrast, psychological inflexibility can be seen as functionally related to a range of psychological problems, including depressive, anxiety, substance disorders, and eating disorders (Levin *et al.*, 2014). Within the framework of treating depression, it can be helpful to consider that experiential avoidance behaviors are better described as *experiential escape*; rather than experiencing these unwanted experiences (the internal aspects of depression, such as guilt, shame, or painful memories of loss) we see an attempt to escape painful internal experiences that are present, leading to their persistence, rather than their elimination (Zettle, 2007). A detailed description of how the processes of psychological inflexibility manifest in depression is beyond the scope of this manual. However, as a whole, this lens offers a highly valuable description of problems encountered in depressed patients in a discourse that is humanistic and of higher heuristic value than DSM-5 descriptive diagnostic criteria; it offers a construct that describes the effects of depression on thinking and behavior in ways that are amenable to specific psychological interventions. Moreover, the evidence base for ACT in the treatment of depression is growing and several studies demonstrate that it is equally effective to traditional cognitive behavioral therapies (Forman, Herbert, Moitra, Yeomans, & Geller, 2007; Zettle, 2015)

1.6 Why Utilize ACT in Psilocybin-Assisted Therapy for Major Depressive Disorder?

In this section, we will describe how we conceived of ACT principles as complementary and synergistic with those of psilocybin therapy.

First, we will discuss how ACT and our conception of psilocybin therapy share several key differences from traditional pharmacological approaches to depression (Sloshower, 2018). In the current era of biological psychiatry, mental illnesses like depression, schizophrenia, as well as addictions, are often conceptualized as brain diseases resulting from aberrant neural circuitry and chemical imbalances. To address brain-based pathology, psychiatrists primarily prescribe medications and deliver other interventions, such as electroconvulsive therapy (ECT) or transcranial magnetic stimulation (TMS), that target brain circuits, levels of neurotransmitters, and neuroreceptors. In this model, the patient is positioned as a passive recipient or consumer of such treatments, tasked only with adhering to the treatment regimen and reporting their response. Additionally, conventional pharmacological approaches to depression primarily target signs and symptoms of depression, but do not address underlying psychological, emotional, social, and spiritual causes of depressive suffering.

ACT, like most psychotherapies, differs from pharmacologic approaches in several important ways. First, it actively engages the participant in the process of recovery. For instance, in ACT, patients are required to engage in mindfulness practices, values clarification exercises, as well as behavioral activation.

Second, ACT does not explicitly set as its goal the amelioration of symptoms of depression or any other specific condition. Rather, it targets the more complex construct of psychological flexibility as discussed above. Part of increasing psychological flexibility involves acceptance of internal and external discomfort, which perhaps paradoxically for some patients, involves decreased avoidance of unpleasant thoughts and emotions, and instead, fully experiencing them with openness and acceptance. The desired outcome is to live a full, meaningful life. Doing so may indirectly lead to a reduction of depressive symptoms.

Similarly, we postulate that psilocybin-assisted therapy requires the active engagement of participants in their own healing. We question the view of psychedelic therapy as a "magic bullet" intervention, requiring only the safely contained dosing of the medicine by the suffering participant, with the magical appearance of an "inner healer" to do the necessary repair work. Certainly, psychedelic substances may have beneficial pharmacological effects that are independent of set and setting or therapeutic approach. Recent studies suggest that psychedelics can alter functional connectivity in a manner that disrupts stable spatiotemporal patterns of brain activity and increases communication between brain regions that are usually isolated (Carhart-Harris *et al.*, 2014; 2012; 2017). Our research study, which includes the ACT protocol described here[1], actively investigated the hypothesis that psilocybin induces a transient neuroplastic brain state (Ly *et al.*, 2018). While these pharmacological effects may inherently confer some degree of symptom relief or benefit, we suggest that the full potential of psychedelic therapy is more likely to be unlocked when the participant is actively engaged in a multifaceted therapeutic process of interrupting deep-seated pathological patterns of thought and behavior via integrated neurobiological and psychosocial intervention. This biopsychosocial approach (Engel, 1980) is especially important when working with chronic depressive pathology characterized by deeply ingrained rigid self-criticism, hopelessness, experiential avoidance of pain, and abandonment of valued actions. Thus, it is our hypothesis that psilocybin-assisted therapy of depressive disorders can confer more meaningful and longer lasting benefits by thoughtfully infusing ACT principles into the course of psilocybin therapy.

[1] Please see (National Institutes of Health, 2018) for more information on clinical trial NCT03554174.

In order to achieve this, we constructed our therapy protocol according to the theory that the experience of moderate to high doses of psilocybin, with preparatory priming and psychoeducation, can provide direct experiential contact with the ACT processes known to increase psychological flexibility (McCracken & Gutiérrez-Martínez, 2011) and that these deeply felt experiences may in turn be reinforced during ACT-informed therapy sessions. The ACT model involves helping patients learn skills to: a) be in the present moment, b) develop a more flexible experience of the self (self-as-context) rather than be fused to a particular personal narrative (self-as-content), c) disengage from attempts to control thoughts and emotions and instead, observe and accept them as they are (acceptance and defusion), d) to clarify values that have been lost through depression and then, e) engage in values-based action.

The intensity of the psychedelic experience may bring the participant directly and forcefully into contact with the present moment via the highly intense thoughts, sensations, emotions, and memories that may arise. These experiences are generally perceived as occurring beyond conscious control, often as a stream or flood of consciousness.[2] Participants are encouraged to surrender to their experience during drug sessions, or to "trust, let go, and be open" (W. A. Richards, 2015). The release of tension that may be experienced when this is done can serve as a deeply felt experience of the ACT principle of acceptance. Another aspect of psychedelic experience is the alteration of self-perception towards an experience of unity, or at its extreme, ego dissolution (MacLean, Leoutsakos, Johnson, & Griffiths, 2012). This may allow the experience of self-transcendence: an experience of the self that is larger than a familiar depressive identity, and thus, not as strongly identified with depressive cognition and self-critical, pessimistic, ruminative narratives. From this spacious vantage point, the participant may have an intensely felt experience of self-as-context in which the self is perceived as distinct from the thoughts that arise in the mind. Finally, it is possible for psychedelic therapy to assist people in gaining clarity of their values and priorities in life (Swift *et al*., 2017). The experience may reveal areas of life that have been neglected, aspects of self-care that need to be addressed, or how interpersonal relationships might be improved. Thus, there are many potential areas of synergism between ACT and psychedelic experience.

[2] The organization of this emergent experience occurs at a level of consciousness that is outside awareness and is a source of many speculative discourses.

Of course, not all of these processes and experiences will occur in every psychedelic experience for every individual, and study participants with long standing depressive disorders may have particularly entrenched problems of psychological inflexibility. This suggests that ultimately, multiple psilocybin sessions may be required for the successful treatment of Major Depressive Disorder. It also speaks to the important role of preparatory and integration or follow-up psychotherapy sessions to support the effects of the psilocybin dosing sessions. Integration sessions are almost universally recommended in psychedelic therapy protocols as a means of both making sense and meaning out of the experience, and helping positive changes and insights carry forth into day-to-day life. While psychedelic integration has become a buzzword in psychedelic communities, it remains somewhat vaguely conceived, undertheorized, and, in general, longs for an operational relationship to the problem being treated. It often centers a non-specific mixture of supportive listening and encouragement to engage in introspective practices, such as journaling, meditation, and spending time in nature. In the context of our study, ACT offers a template for use in integration sessions, as well as preparatory sessions with individuals who suffer from depression, which we will outline in the following section. We believe that having such a template will allow therapists to more successfully engage with a participant's familiar depressive negativism, pessimism, self-criticism, inactivity and despair as they may arise during integration sessions that follow the psilocybin dosing day.

In summary, we propose that ACT and psilocybin therapy create a synergism as both foster the core principles of psychological flexibility. It is our hypothesis that embedding psilocybin therapy within an ACT framework may amplify the response and lengthen duration of improvement from depression by actively engaging the participant, in a specific way, in making changes to their patterns of thinking and behavior. We believe these changes are a cocreation of neurobiological effects, psychological experiences, and effects of the container (ACT, the therapists and our culture) during psilocybin sessions, followed by active reinforcement by the therapists.

Note: Much of this section was adapted from Sloshower et al. (2019).

2. Therapist Foundation

2.1 Essential Therapist Background

Therapists involved in our study were required to have:

a. An up-to-date license to practice as a psychiatrist, psychologist, master's prepared social worker, or psychiatric nurse, and
b. At least 5 years' experience treating psychiatric patients in a clinical setting.

Experience in conducting psychodynamic as well as cognitive-behavioral therapies was viewed favorably, as was experience with altered states of consciousness, including yoga, mindfulness practices, holotropic breathwork, hypnosis, flotation tank work, etc.

2.2 Therapist Training

Therapists in our research study received specialized training in treating depression with psilocybin-assisted ACT therapy. The objective of the training program was to introduce them to core principles of both psychedelic therapy and ACT, and to train them to implement our therapy protocol. The training program consisted of pre-assigned didactic videos and readings, including the study therapy manual, followed by four day-long sessions. These inperson sessions consisted of close reading and discussion of the therapy manual, didactic teaching, and role plays. Day 1 of the training focused on essential elements of psychedelic therapy. Day 2 was spent reviewing core principles and techniques of ACT and how these are used in the therapy manual. Days 3 and 4 focused on role plays and experiential exercises, including a day long intensive retreat led by a peer-reviewed ACT trainer. Role-play scenarios provided therapists an opportunity to practice using ACT interventions and supporting participants through challenging psychedelic experiences.

Training methods may be adapted to suit other research studies and may include:

- Attending supplemental trainings given by MAPS, California Institute of Integral Studies' psychedelic psychotherapy program
- Attending ACT trainings
- Consultation and supervision with ACT practitioners

3. Set and Setting

> *"...the unconscious mind is often terribly frightening; we have made much of its contents unconscious because we want nothing to do with it. It takes a strong heart, honesty, and a desire to learn and face one's problems in order to enter the dark areas of our suppressed inner self. Nothing is more helpful than the presence of a kind, loving, understanding person thoroughly familiar with the dark regions of the mind - a companion who is confident of his ability to help one navigate and resolve those regions that have been an enormous burden in the past, a person who knows the wonder of being free. The willingness to surrender to the experience and allow such resolution to proceed often results in the most valuable kind of learning about one's repressed feelings, hidden values, compulsions and aspirations, and inappropriate behavior."*
> ~ Myron Stolaroff, The Secret Chief Revealed (2004)

3.1 Set: The Inner World of The Participant

"Set" and "setting" are concepts used to describe what the participant brings to the psychedelic situation and what they find there. "Set" refers to the conscious and unconscious parts of the individual leading up to the experience. This includes their beliefs, hopes, fears, traumas, personality and temperament, as well as their expectations and fantasies about psychedelic experiences and the therapists, themselves. In the context of clinical research, the participant's attitude toward the research setting, the medication, cultural attributions to psychedelics, the relationships with the therapists, as well as expectations for relief also constitute important parts of the participant's set.

We do not know what traits will lead people to have specific kinds of experiences, but through this study, we asked: what do people who experience major depression bring to the psychedelic experience? How can an ACT-based formulation guide the therapeutic process? Does the experience of psilocybin therapy help promote psychological flexibility?

3.2 Setting: The Outer World of The Participant

"Setting" refers to the physical space, environment, and context in which one experiences the drug's effects. Setting includes elements such as music, artwork, safety equipment, hospital, city, and state, etcetera and inhabitants of the space (therapists and participant). The participant's relationship with the therapists is a primary aspect of the setting.

The current standard in clinical psychedelic research is to create a warm, inviting, and private environment where participants can feel comfortable and safe to experience the medicine's intense effect and express themselves freely. To make study rooms more comfortable, researchers often decorate with plants, fresh flowers, artwork, warm colors, and homey furnishings (see Johnson *et al*. 2008 for general guidelines).

Each therapist will bring their unique combination of training and perspectives to their encounters with the participant. This includes their identity as a therapist, personal history with depression (or not), personal experience with psychedelics (or not), and experience treating patients experiencing major depression. Therapists also carry their own experiences, transferences toward the study, feelings about their home institution, transferences between therapists, and transferences between disciplines and the psychedelic community. We encourage therapists to be mindful of how their life experiences affect their emotional presence in the clinical sessions.

While one particular psychotherapeutic school of thought does not exist for psychedelic therapists, all of the practitioners in our study had significant experience working in traditional psychiatric and psychotherapeutic contexts, and training in a blend of psychodynamic and cognitive-behavioral approaches. Most had experience with mindfulness practices, including the use of mindfulness in psychotherapy. Our approach combines each therapist's background with applied ACT/MBCT principles. In this approach, it is important that all therapists receive training in treating depression from a modified ACT and MBCT point of view. This is the primary psychological framework the therapists consciously, mindfully offer.

3.3 Preparing the Physical Setting

Establishing a safe and therapeutic physical setting and mindset for the participant requires that the therapists take an active role in creating the environment. Ensure the space is conducive to the therapeutic psilocybin experience and supports the participant's ability to engage fully in their internal experience.

If possible, choose a physical setting that is private, free from interruption, and has minimal external stimuli. Make the room comfortable and, to hide or remove anything that would impart a hospital room feeling. Our study, located at the West Haven VA hospital, utilized an office space with a couch made up like a bed, pleasing artwork, and plants (see photos). We avoided religious iconography in favor of nature imagery.

The ability to play prerecorded music through speakers as well as headphones is integral to creating the setting. The deliberate and thoughtful selection of music will affect the participant's perceptions of the setting (see the section on music below).

Although a homey feeling matters, do make the participant aware of all safety equipment in place for medical monitoring. This generally includes a blood pressure and pulse monitor and locked areas for protocol materials and records. Maintaining physical safety includes providing access to treatment for possible reactions to the medicine during or immediately after each treatment session. Most reactions can be dealt with through supportive care. However, to ensure the participant's emotional comfort and physical safety, review the use of **rescue medications** with the participant as described in Part II, Section 6.9.

Only conduct psychedelic-assisted therapy in a setting where Basic Cardiac Life Support (BCLS) is immediately available and Advanced Cardiac Life Support (ACLS) can be summoned reasonably quickly in the unlikely event of an acute medical problem.

During psychedelic-assisted sessions, therapists should ensure participant's physical safety by providing adequate cautions when patients move about the room or ambulate. This includes assisting participants getting to and from the bathroom, and helping participants to remain hydrated during the test day. The setting thus includes the presence of drinking water, electrolyte-containing beverages or juices, and small snacks.

3.4 Preparing Social Support Following Medication Sessions

Following a dosing session, discharge the participant from the treatment setting only in the company of a designated support person, such as a family member or friend who understands the research project and the participant's involvement with it. The therapists need to meet or at least speak with this individual during the preparatory period prior to dosing. The therapists should assess the suitability of the support person for these tasks, which include safely accompanying the participant home, providing a safe, non-intrusive, supportive environment, responding to participant needs, and notifying the therapists of any problematic developments that need evaluation or discussion. The support person should receive education regarding the nature of the study, common and rare side effects or after effects that might emerge and advice on how to be most helpful. The support person should also be provided with contact information for both therapists and investigators as well as any other emergency contact numbers. See **departure requirements** in Part II, Section 6.9 for more information.

3.5 Planning for the Therapeutic Use of Music

Research into the specific types and forms of music most conducive to psychedelic-assisted therapies is still in its infancy and varying styles of music have historically been used in studies employing psychedelic-assisted therapies; from western classical music to Indian ragas to rock to ambient soundscapes. The role of the music, regardless of style, is to provide guidance and emotional support for a wide range of emotions throughout the session. Other general points relating to music used in psychedelic studies include:

- The playlist is crafted in such a way as to reflect and complement the psychedelic experience.
- Participants are encouraged to utilize the music to facilitate their journey, but should have the ability to decrease the volume or turn the music off, if they desire.
- Headphones are an ideal way for the participants to listen to the music as they create an internal experience with the music. Speakers may simultaneously play the music in the study room, thereby providing a valuable point of connection between therapist and participant during the session.
- Eye masks are generally available to participants, again to facilitate inward exploration and contemplation.

The music playlist we used in our study was created specifically for a phase 1 clinical trial at Imperial College London of psilocybin treatment for depression by Mendel Kaelen, PhD. Doctor Kaelen has conducted seminal research on the use of music in psychedelic-assisted therapies (see Kaelen *et al.*, 2018). In developing this playlist, he considered more than the music, thinking also about the entire soundscape the organization of the playlist would create and the ways songs transition into each other.

In order to control variables across dosing sessions and between participants, we used the same playlist for all experimental sessions in the study. However, one could argue that listening to a novel selection of music during each session would more accurately control between dosing sessions for a given participant, as the experience of re-listening is different than hearing for the first time. Another viable and more culturally considerate approach would be to develop a standardized method for customizing the music to each participant based on their cultural background and preferences.

3.6 Relationship with Therapists as Setting: The Therapists' Commitments

The therapist's responsibility is primarily to establish a well working therapeutic alliance, to support the participant's honest expressiveness, and utilize ACT treatment principles. The therapists work to support the participant's openness, self-acceptance, willingness to take action, and increased psychological flexibility. They attempt to engage with a participant's depressive way of thinking and living and access/teach strategies for change. In helping to accomplish these goals the therapist acts as empathic listeners, trustworthy guides, facilitators of self-transcendence, and also, unavoidably, each brings their own unique way of working with patients.

Psychedelic medications can have profound emotional and physical effects. To foster a therapeutic mindset and contribute to a collaborative therapeutic rapport, the therapist and participant prepare for each experimental session through numerous specific agreements discussed prior to the session:

1. The therapists commit to providing adequate preparation time and focused attention to the treatment during preparatory, dosing, debriefing and follow-up sessions.
2. Therapists and participant agree on boundaries regarding touch. Any sexual or erotic touch is explicitly forbidden. The participant is asked to agree to refrain from self-harm, harm to others, and harm to property. Participants also must remain appropriately clothed throughout the session. The participant is asked to agree to follow the therapist's recommendations regarding safety.
3. At least one of the therapist or sitters will be present in the room at all times throughout the entire psychedelic-assisted session. Both therapist and sitter commit to remain in the room with the participant throughout the psychedelic-assisted sessions except for brief periods for restroom breaks or other such needs.
4. Along with the supervising physician, the therapists will assess the participant to determine mental status and stability to leave at the end of the dosing session.
5. The therapists commit to being available by phone or text throughout the course of the study for emergency.
6. The therapists accept the extensive time commitment that may be required (exceeding the expected length of dosing sessions) should the participant need additional support.

4. Prior to the First Session with Therapists

4.1 Screening and Consent

The study investigators and study research staff conduct the screening and consenting process. For our study, the therapists did not participate in these sessions. It is worth noting that establishing a trusting rapport with the participant begins with the first contact made; this includes all screening and consenting conversations as well as sessions with therapists. Thus, the investigators, study physicians, and research staff are part of the rapport building process.

The screening and preparatory period is the time to gather participant history and to begin establishing an effective therapeutic alliance. It provides an important opportunity for the therapists and study staff to address the participant's questions and concerns, and to prepare the participant for psychedelic-assisted sessions by familiarizing them with the logistics of the sessions and the therapeutic approach that will be used, as well as establishing a tone of gentle concern, professionalism and organization. This should be done with the intention of helping the participant feel a sense of safety and comfort in the therapeutic setting. It is also an opportunity to model attitudes that will be important during psychedelic-assisted sessions, such as unhurried pacing, open ended curiosity about the participant's present moment experience (including their somatic experiences), respect for the participant's boundaries and innate wisdom about their own healing process. In clinical research, there are quite a number of questionnaires and forms to be completed, especially during the preparation period. Study staff should strive to have the necessary forms completed while still allowing time to foster a therapeutic setting and deepen the therapeutic alliance.

4.2 Prerequisites and Contraindications

Prior to enrolling in the study, participants will be given written information about the clinical trial. Participants will be given ample time to ask questions and discuss the meaning and ramifications of informed consent with staff prior to signing the Consent Form.

4.3 Commitments from The Participant (Part of the Consenting Process)

1. The participant agrees to:
    a. Attend all preparatory therapy and follow-up sessions,
    b. Complete the evaluation instruments, and
    c. Comply with dietary and drug restrictions.
2. Participants are not required to complete the study; they may withdraw consent and leave the study at any time, except during a medicine dosing session. Follow-up assessments may be performed if a participant drops out, but has not withdrawn consent.
3. The participant will be required to agree that they will remain within the treatment area until completion of each session. This means they cannot leave until the study physician and the therapists have affirmed the participant's readiness and stability to leave. (The therapists will assess the participant for signs that the psychedelic effects of the medication have ceased. The therapists and study physician will clinically assess the participant's ability to leave safely and function without medical supervision.)
4. Participants must commit to refrain from self-harm during the study, to communicate suicidal ideation to their therapists or seek emergency room care if self-harm is imminent. If they cannot make this commitment, they will be excluded from the study and referred to active clinical assessment and treatment.
5. Participants should be aware that clinical trials of psychedelic-assisted therapy often generate attention from the media. While such communication always remains the participant's choice, we encourage the participant to complete the study before engaging in public/media discussions of their experience. We encourage each participant to discuss this decision with the therapists, in order to emotionally prepare for the experience of being interviewed by the media and its aftermath.

Part 2 - Psilocybin-assisted Therapy Manual and Description of Sessions

5. Introduction

Part II outlines the content and goals of each participant encounter as designed for this particular clinical trial. In constructing our therapy protocol, we maintained the familiar structure of preparation, support, and integration sessions used in other psychedelic therapy protocols. However, we infused the sessions with ACT perspectives, principles, and interventions in various ways. Practitioners who use this manual to guide other research or clinical practice may find adding sessions or renaming sessions makes sense.

The overall goal of combining psilocybin-assisted therapy for depression with ACT is to provide a therapeutic framework that will enable participants to alter patterns of cognition and behavior that characterize depression, while increasing values-based active engagement in the world. Fostering these two types of change (which characterize psychological flexibility) through the interactive effects of the therapy and the medication sessions is the central hypothesized mechanism for change and improvement from depressive symptoms. In this manual, this approach is implemented through ACT-based Clinical Formulation and ACT-based Clinician Intervention during the psychoeducation, experimental, and debriefing/follow up sessions.

5.1 ACT-Based Clinical Formulation

While depressive and psychedelic narratives can be understood through a variety of different discourses, in our protocol, ACT provides a primary mode of understanding the nature of depressive thoughts, feelings, and behaviors, as well as participants' responses to psychedelic experiences. During preparatory sessions, therapists are instructed to listen to participants' histories of depression through an ACT lens, noticing examples of cognitive fusion, experiential avoidance, loss of values or other examples of psychological inflexibility. In this way, they begin to understand the participant's narrative along these ACT dimensions and identify which ACT processes on the hexaflex model are sites of potential exploration and change for the individual. The participant also completes the Valued Living Questionnaire (Wilson, Sandoz, Kitchens, & Roberts, 2017) at baseline, which is reviewed by the therapist for later discussion. During dosing and debriefing sessions, therapists pay attention to instances when the participant's experience either moved them toward or away from psychological flexibility. Cases of the former can serve as deeply felt reference points for more flexible and "workable" ways of thinking and behaving, which can guide the therapeutic approach during the integration period. Conversely, instances in which the participant avoided experiences of the present moment, or specific emotional states or self-concepts, can point to these particular areas that might benefit from increased attention during follow-up sessions. Thus, ACT-based clinical formulation occurs throughout all therapeutic encounters with the participant, guiding therapeutic approach and assessment of progress in an iterative manner.

5.2 ACT-Based Clinician Intervention

Holding an ACT formulation of the participant's difficulties and values in mind, therapists can provide feedback and use other interventions to target particular areas of the ACT hexaflex that need more attention, such as values-based goal setting, defusion from unworkable negative thought constructs, and overcoming experiential avoidance. For example, several of our participants expressed deeply held negative beliefs regarding their self-worth. In this case, the therapist may examine the ways that the participant is conflating a depressive thought with an absolute truth (fusion) and the resulting impacts on their behavior. During debriefing and follow-up sessions, therapists may evoke moments from the psilocybin sessions to reinforce lived experiences of increased psychological flexibility. For example, the therapist might say, "Remember how you told me you were calmly watching a stream of shapes, colors, and images move through your mind for several minutes during your dosing session? That is the kind of mindful attention we hope to cultivate through everyday mindfulness practices."

One participant in our study presented with an obsessive tendency to try to articulate perfectly during social interactions; this often resulted in anxious avoidance and social isolation. During their dosing session, however, they became very playful with their language and body movements. The therapist reminded them of this openness and freedom from fear with the hope of decreasing their experiential avoidance of future social interactions. The important part was not "making the participant wrong" for having a fixed belief about themself, but rather reinforcing their direct experience of playfulness and ease of expression.

Didactic Explanations

At several points in the protocol, the therapist directly teaches the participant about ACT principles, including during:

- Preparatory sessions, to prime the subject to register elements of the psilocybin sessions as reflecting ACT-defined shifts in thinking, behavior, and awareness of values; and
- Follow-up sessions, to help the participant solidify their understanding and implementation of ACT principles in their ongoing work toward psychological flexibility (after conclusion of their time in the research study.)

Experiential Exercises

While didactic explanations of ACT principles provide a cognitive understanding of problematic patterns and potential remedies, it is also critical that participants experience psychological flexibility on a deeper level to connect their experience with the concepts. We hypothesize that the psilocybin experience can provide this to a significant degree, especially with priming. However, we also implement ACT consistent metaphors, mindfulness practices, and worksheets to deepen this experience. We use metaphors to help convey the concepts of fusion and self-as-context. We use worksheets to help participants clarify their values, as well as the "ACT Matrix" (Polk & Schoendorff, 2014) to help participants discover how their internal experiences impact their ability to engage in values driven actions. For the purposes of standardization in research, we selected a handful of metaphors, worksheets, and exercises to include in our protocol; however, these could be flexibly employed by ACT trained clinicians in other contexts. (Table 1 outlines the sequence of therapy sessions in our treatment protocol and some of the specific ways to employ ACT in each session.)

Table 1: Overview of Therapy Session Sequence + Ways to Employ ACT in Each Session

Session Name	**Session Overview and Ways ACT is Employed**
Preparatory Psychoeducation Session #1 (2 hours)	Therapist aims to establish therapeutic alliance through: • Listening to participant's narrative of depression and treatment history to understand patterns of psychological inflexibility that are most prominent; • Psychoeducation regarding the psilocybin experience, therapeutic boundaries (e.g., touch) and safety measures; • Teaching grounding techniques including diaphragmatic breathing; • Assisting the participant in setting an intention for medication session #1.
Medication Session #1 (at 1 week)	• In line with supportive stance during medication sessions, the therapist does not provide significant ACT interventions or feedback. • ACT-based clinical formulation continues as therapist listens to emergent narratives and notes instances of psychological flexibility and inflexibility, especially present moment awareness, self-as-context, and experiential avoidance.
Debriefing Session #1 (1-2 hours, day after medication session)	• Therapist elicits complete narrative of participant's experience during medication session. • Identify and explore aspects of the participant's narrative that engage with ACT principles, as well as instances when they moved toward or away from psychological flexibility.

Debriefing Session #2 (1-2 hours, 1 week after medication session)	Therapist and participant continue to review and reflect on the participant's: • Psilocybin experience, including any emotional, mental, or lifestyle changes that followed the dosing session. • Values, by discussing the participant's completed Valued Living Questionnaire, and relative importance of valued domains of living. • Experiences living in accordance with or not living in alignment with their values.
Preparatory Psychoeducation Session #2 (2 hours, at 4 weeks)	• Conduct psychoeducation regarding: - The cognitive processes and behaviors that contribute to depression from an ACT perspective (i.e. cognitive fusion, experiential avoidance, reason-giving etc.); - How depressive patterns can be changed through an interactive process between the principles of ACT and the experience with psilocybin; and - Mindfulness practice • Through this process, the therapist aims to induce "creative hopelessness." • Assisting the participant in setting an intention for medication session #2.
Medication Session #2 (at 5 weeks)	Same as medication session #1
Debriefing Session #3 (1-2 hours, day after medication session)	Therapist elicits complete narrative of participant's experience during medication session, exploring: • Aspects of the experience in relation to ACT principles discussed previously. • Metaphors derived from psilocybin experience or from ACT (i.e. house and furniture metaphor) to aid in understanding of the principles, such as self-as-context.
Debriefing Session #4 (1-2 hours, 1 week after medication session)	Using the ACT Matrix if helpful, therapist and participant continue to review and reflect on the participant's medication experience and changes that have taken place, to explore: • What the participant values most; • How to put their values into action. Therapist may shift towards a more directive behavioral approach to help the participant to define precise actions they can take to start living in accordance with their values.
Follow-up Sessions #1 and #2 (2 and 4 weeks after medication session #2)	Therapist continues to explore and reinforce; • Insights gained from the psilocybin experience while assessing for changes in psychological flexibility; • How the dosing and therapy sessions brought each ACT process to light, using the ACT hexaflex; • Relevant ACT concepts • Successful behavioral changes and committed actions taken; • Mindfulness practices and other concrete ways the study experience can be translated into lasting changes. Therapist leads termination discussions and plans for post-study follow up care for the participant.

6. Psychoeducation Session #1

When people see some things as beautiful,
other things become ugly.
When people see some things as good,
other things become bad.

Being and non-being create each other.
Difficult and easy support each other.
Long and short define each other.
High and low depend on each other.
Before and after follow each other.
~ Lao Tzu, Tao Te Ching

By this point, the participant has completed the screening and consenting stages and is meeting their primary psychedelic therapist(s) for the first time. The tasks described in this section need to be accomplished during the first Psychoeducation Session, which lasts about two hours, or during the preparatory period leading up to the first dosing session. Due to practical and logistical study design reasons, during our study, we covered all of the tasks in one lengthy session. However, this content may be covered more effectively over the course of several preparatory sessions.

6.1 Internal Agenda for Therapists During Psychoeducation Session #1

Explicit education of the participant regarding the common cognitive and behavioral problems seen in depression will not occur until the Psychoeducation Session #2. However, during Psychoeducation Session #1, therapists will observe carefully which of these are most prominent for this participant, where strengths lie, and which particular psychological patterns seem most amenable to intervention. The therapists will also note where resilience and creativity may lie.

Cognitive Fusion

Does the participant experience thoughts, words, and language as if they were factually, absolutely true? The thought "I am a worthless person" may be experienced and believed as if it were true in some absolute sense. "I am so depressed that I cannot move" is experienced as truth when it is actually a metaphor for the experience of depression. "My life is worthless" or "I cannot do anything right" are taken at face value, rather than as thoughts that come and go and are not accurate representations of a permanent reality. "I am a depressive" or other thoughts indicating that depression comprises their core identity are examples of cognitive fusion. This intense vulnerability to internally generated pain (my thoughts are hurtful to me, I am my thoughts, I am what I think and feel), once experienced as painfully true, may then result in experiential avoidance.

Experiential Avoidance

This refers to attempts to avoid or change thoughts, feelings, memories, physical sensations and other internal experiences through:

> **Thought suppression**: trying not to think painful thoughts, suppression, distraction
>
> **Rumination**: obsessing over events, memories, narratives in a stereotyped, repetitive way that solves nothing but serves to preoccupy the mind, or
>
> **Behavioral avoidance**: social withdrawal, not taking action that might trigger depressed feelings or thoughts.

Experiential avoidance is maintained through negative reinforcement: it relieves pain in the short run but is associated with persistence or even worsening depression in the long run. For instance, "If I don't get off the couch and go to that party, I won't feel like a loser when no one wants to dance with me" leads to temporarily reduced discomfort from staying in a safe place, but more long-term depressogenic isolation and impaired social functioning.

Reason-Giving/Rumination: Searching for reasons that one experiences depression does not change the condition. In fact, searching for reasons can lead to persistence or exacerbation of the condition. This is especially true with historical events that "caused" the depression. Since no one can change the past, identifying an event that caused the depression can lead to the conclusion that recovery from depression is hopeless. For example: "My childhood trauma caused this depression, and nothing can change what happened then. Therefore, my situation is hopeless." Exploring such reasons, as if that exploration might ameliorate symptoms, is contraindicated in this approach.

Our protocol involves focusing on the relationship between the symptom and its current contextual implication.

Self-Discrepancy: Failing to live up to one's own (high) expectations and feeling like a failure generates depression. When applied to the outside world, this is useful (the house is messy, I'd prefer it neat; I will clean and vacuum and achieve that goal). This is not useful with internal assessments such as, "I am depressed because I am a terrible person, therefore I must become a good person." Internal assessments that reflect unrealistic, grandiose, or even modest self-expectations typically generate depressive cognition when not met.

Willingness vs. Desire: A common promise in psychopharmacologic treatment is that the medication treatment will *make* the individual *want* to do things, have desire, and be happier through correcting a chemical imbalance. This implies that passivity, patience and surrender to the treatment are the primary role expectations for the participant/patient. The willingness to take action to change one's life is explicitly evoked in ACT (commitment), and the passive wish to feel better solely through the medication's action is confronted as a untenable proposition. While this step (confrontation) is not addressed in Psychoeducation Session 1, the therapists take care to observe the balance of activity and passivity in the participant's narrative and behavior in session.

6.2 Building Rapport and Therapeutic Alliance

The therapist's manner of welcoming a new patient into treatment, introducing themself, and cordially beginning the process of building rapport will inform this part of the therapeutic process. The therapist may ask the participant about their experiences during the screening and consenting process, or invite the participant to ask about the experience of coming to the sessions. Including only experienced clinicians in the study will enable the principal investigator and study physician to trust the therapists to find the most effective way to make each participant comfortable and welcome.

Specific approaches include:

- Asking about the participant's experience in the research so far,
- Active listening: asking for elaboration and details to evoke specificity,
- Nodding and non-verbal sounds of understanding and empathy,
- Accepting whatever is said as the participant's lived truth,
- Empathizing with expressed affect, anxiety about being in the study, fears of failure in the study, and
- Admiring the courage and strength that allows the participant to carry on living in the face of such suffering and despair.

6.3 Review the Overall Structure of Today's Session:

Describe the things that will be covered in today's session. For example:

"First, we'd like to get to know you, your life and what things are like for you right now. We'd like to learn about your experience with depression, and what your depression treatments have been like for you. Then, we'll talk about how this psilocybin-assisted therapy treatment works and how it is different from the usual psychopharmacological treatment of depression. After that we will give you a detailed description of the psilocybin sessions. At the end, we'll give you a chance to try out the eyeshades and earphones that you'll use during the session and we'll review our schedules for all the remaining sessions that are part of the study. Sound good?"

6.4 Reviewing The Participant's Lived Experience of Depression

During the preparatory session or period, the participant is invited to describe how depression expresses itself in their life. The goal here is for the participant to speak freely, without structure from the therapist, and to feel truly heard and supported in telling their own story, however it emerges. The therapist's role is to offer empathy for the pain and suffering that the participant shares, while carrying out the *Internal Agenda* described above. The emphasis is not on accurately acquiring a psychiatric history (which has already been done) but in learning the psychological and behavioral patterns that define depression for this individual. If concerning new information emerges, for example if the participant reveals a history of self-injurious behaviors, bulimia, dissociative episodes, or similar experiences, move to a structured approach. Finding out when such experiences began, how frequently they occur(red), and the severity of the behaviors or episodes will be an appropriate intervention. Following this session, consult immediately with the principal investigator and study physician. The team may need to reconsider the person's eligibility to participate in the study.

6.5 Reviewing The Participant's Lived Experience of Psychopharmacology Treatment

Participants in this study are likely to have had several courses of treatment, experiencing numerous medications, medication combinations, possibly ECT or TMS or ketamine, and to have worked with a variety of mental health practitioners. These experiences may have left an overall transference towards treatment that is likely to be intense and unique for each person in the study. The participant may feel strongly that a psilocybin experience is their only and last hope; thus, the participant may idealize the study and feel desperate to participate. This may make it challenging for the participant to be genuine with the therapist, therefore it is valuable for therapists to explore the participant's history with psychiatric treatments in an accepting but neutral way. *Colluding with the idealization of psilocybin would be very problematic here*. However, awareness of the participant's emotional valence toward psychopharmacology as a disappointing part of their treatment history may be helpful in understanding the relationship with psilocybin and the psilocybin study.

6.6 Understand The Participant's Preconceptions About Psychedelic Experiences

Ask participants about their preconceptions, expectations, and learning history about psychedelic experiences and psilocybin. Elicit their concerns and hopes. Ask about their experiences in youth, including with marijuana, and about their conversations with friends who have had psychedelic experiences. Explore the participant's responses to Michael Pollan's book, *How To Change Your Mind* (2019) or other media representations of psilocybin therapy they have seen.

6.7 Listen for ACT "Misdemeanors" and Begin Constructing an ACT-Based Clinical Formulation

During preparatory sessions, therapists will listen to the participant through an ACT lens, noticing examples of cognitive fusion, experiential avoidance, loos of values or other examples of psychological inflexibility. In this way, they begin to understand the participant's narrative along these ACT dimensions and identify which ACT processes on the hexaflex model are sites of potential exploration and change for the individual.

6.8 Intention-Setting

> "*Having an intention is akin to having a compass aboard a sailboat. When we enter the vast ocean of expanded consciousness, there can be waves and storms, placid waters, gentle breezes, or intense winds. Having our sail raised high and compass in hand gives is a point of reference to return to, and a direction to pursue*"
> ~ Bourzat & Hunter, 2018

Intention is an important aspect of the participant's 'set' going into the experimental session. In this portion of the psychoeducation session, the therapists introduce the concept of intention setting, elicit any initial intentions, and encourage the participant to think about and solidify their intention between now and the dosing session.

Sample dialogue: "An intention is a statement of one's motivation or direction. Why are you here? What do you want for your life out of this experience? We believe that your intentions play a large part in creating your experience. We hope that the medicine and talk-therapy sessions will help you adjust the habitual thoughts and behaviors that foster your experience with depression, so you can make positive changes in your life. We do not know how the medicine session will unfold for you or just what needs to happen in the medicine session to bring about such changes. Setting your intention will help keep you on track during the dosing session, so you can get the answers and insights you need."

6.9 Educating The Participant About Psilocybin Dosing Sessions

Although some of the following will have been discussed with study staff during the consent process, it is crucial to ensure the participant understands this material. It is also valuable for this information to come from the lead study therapist. We suggest using the following scripts, or similar, when imparting this information to the participant:

a. Common Experiences with Psilocybin Script

We recommend covering the following points of psychoeducation with the participant regarding the range of experiences that may occur during a psilocybin session:

- Psilocybin is a "classical" hallucinogen that can cause profound changes in sensation, perception, thought processes, emotions, your experience of time, the nature of reality and of the self. The effects may range from very mild to very strong.
- Psilocybin alters perception. You may experience visual distortions or illusions, strong visual imagery and rarely true hallucinations. Towards the beginning of a session, you may experience cascading geometric forms and colors.
- You may see things from a radically different perspective. For instance, you may find yourself in a different reality, as if you were or are living in another time or place. You may even feel you are ceasing to exist, going crazy, or are becoming an animal, plant or other organism. Such changes may feel confusing or disturbing at times, but may also contribute to strong spiritual or mystical/transcendent experiences.
- The experience with psilocybin therapy may help you make significant positive changes in your life, but it is not a magic cure for anything. For instance, you may have psychological insights about yourself or others. These insights alone will probably not help your experience with depression unless you translate their impact and teaching into your dayto-day life and make conscious changes in the way you think and behave.
- We encourage you to take an attitude of curiosity and acceptance toward everything that happens during your session. Whatever comes up has some kind of meaning or wisdom that you can learn from, even if this meaning is not immediately obvious. It is not uncommon to feel as though your thoughts and perceptions are coming more swiftly than you can process them. We encourage you to fully allow all your emotions and perceptions, good and bad. Let memories, images, and body sensations arise. Accepting and feeling these deep and sometimes difficult emotions is the path toward being able to

change your deep-seated patterns of fear, powerlessness, guilt, and shame.

b. Difficult Experiences Script

- This medicine may cause periods of physical or emotional discomfort.
- Physically, you may experience periods of nausea, chills, anxiety, or panic. Your blood pressure may become somewhat elevated, and we will be monitoring this. Remember: although the psychological effects may feel extreme, the physiological risks of this medicine are extremely low.
- You may have bizarre sensations and experiences, and you may experience frightening images or thoughts. These may alternate rapidly. This is normal and does not mean anything is wrong. The effects will end and present no major risks to the body. It is best to embrace these experiences as they occur and seek to learn from them.
- We encourage you to "go with" or surrender to difficult experiences rather than fight them. Approach rather than flee; accept rather than reason away, lean into whatever comes up, including any impulse to run away. Strive to stay with the experience and explore it, allow yourself to be curious about what is emerging in your experience. Trust. Let go. Be open.
- What we are asking you to do is difficult, counter-intuitive and not anyone's typical pattern. It is natural to avoid negative or uncomfortable emotions and experiences. Don't be surprised if, during the session, we remind you to allow or even move toward the uncomfortable sensation or thought.
- There are methods for grounding and calming yourself, if you would like to use them. We will teach you several strategies before the end of today's session.
- If you are having difficulty of any kind, please let us know. We may be able to help you by providing reassurance, support, redirection or therapeutic touch (if you give permission for that).

c. Ski Slope Script

We have just covered a lot of information about psilocybin experiences and you may be wondering why having such an experience could be useful in treating depression. One way to think about this is that, in some ways, the mind is like a ski slope with many paths. Thoughts may start on one path, then veer in another direction. You may return to the top of the mountain and try a new thought pathway. But rumination is similar to skiing down the same path repeatedly - once you go down that one path a few times, you are more likely to go down that way again and again. Each time you do, you deepen the grooves, making it harder to turn onto a new path. In depression, people often ski down well-established ruts of thinking, feeling, and behaving. Their cognition is repetitive and inflexible.

We can think of psilocybin treatment as providing a fresh coating of snow on the mountain. With fresh powder, you have much more freedom to ski anywhere (a greater ability to think freely and tolerate a broader range of emotions). The psilocybin therapy experience can help you find new, different paths down the mountain, finding new terrain and new sights (and a sense of yourself as freer).

d. Therapist Interventions & Grounding Techniques Script

During the preparatory and integration sessions, we will have a free exchange of ideas, and ample time for conversation and discussion. During the medicine session, we invite you to take an inward journey. You can work *with* this medicine to co-create your experience. We encourage you to collect experiences and save discussion about them for later review and reflection. We will be in the room, and will check in with you if you seem to be in distress. However, for the most part, we will not seek contact with you unless you reach out to us for assistance. Please feel free to let us know if you become concerned with anything you are experiencing. You may also ask for contact at any time, either verbally or by gesturing to us, and we will always be present to help you.

e. Grounding Technique Script 1: Abdominal Breathing

- If you are feeling tense, anxious or overwhelmed during the session, abdominal breathing may be helpful.
- Direct your attention to your breathing, the sound, the feeling, the bodily experience.
- Focus on moving air with your diagram rather than your chest muscles. Imagine a balloon in your stomach connected to tube passing through your chest to your mouth. Send air through the tube to inflate the balloon, then deflate the balloon.
- With each exhalation, let go and allow tension to leave your body.
- Detailed instructions:
    1. Sit or lie flat in a comfortable position.
    2. Put one hand on your belly just below your ribs and the other hand on your chest.
    3. Take a deep breath in through your nose, and let your belly push your hand out. Your chest should not move.
    4. Breathe out through pursed lips as if you were whistling. Feel the hand on your belly go in, and use it to push all the air out.
    5. Do this breath cycle 3 to 10 times. Take your time with each breath.
    6. Notice how you feel at the end of the exercise.

f. Grounding Technique Script 2: Therapeutic Touch

- It can be helpful to establish physical contact with one or both of your therapists.
- If you agree, we may offer to hold your hand, foot, or shoulder in order to make contact with you.
- Consenting process: We would like to check with you now to see what kinds of touch you are comfortable with and under which circumstances you would like us to make physical contact. We can make physical contact with you only when you request it or use a certain gesture, or we may offer this to you if it seems like you're having a difficult time. In either case, you may always change your mind and let us know you do not want to be touched at any time. You also should feel free to signal your wish to end the touch if you desire. You may also request contact with one or the other therapist, if you prefer. Do not worry about hurting anyone's feelings; please be direct in asking for what you would like.
- We will only touch you with your advance permission. Do you give us permission to make physical contact with you during the session? Are you okay with us initiating the touch or would you prefer to be touched only when you request it? You are, of course, invited to change your answer to this question at any time.
- (If participant agrees) You may request this at any time during your medication session if you think it would be helpful. Pay attention to your inner signals regarding what is right or desirable or comfortable for you. If you cannot speak and would like physical contact, raise your hand or gesture towards us to communicate this.

Note to Therapists: If participants are experiencing ongoing physical discomfort during the dosing sessions or have significant somatic symptoms during any therapy session, it may be useful to practice the following, Awareness of Body Sensation exercise. If time permits, this may be practiced with the participant during the preparatory period.

g. Grounding Technique Script 3: Awareness of Body Sensation Exercise

- When you are experiencing strong emotion that is causing you to feel you like you are falling, this mindfulness practice can help you regain a sense of balance.
- As you are lying on the couch, arrange your body in a comfortable position, turning your attention to your body at that moment. We feel emotions in our body: perhaps a heaviness in the heart when we are sad, or maybe a tightness across the jaw when we are angry. Where in your body do you feel that emotion?
- *Pause to allow experience.*
- People sometimes report feeling emotion in the gut or stomach or chest and other places as well - in the throat or behind the eyes, for example. Notice the location where sensation is most vivid for you at this

moment. Purposefully rest your attention here.
- *Pause.*
- As you attend to sensations in this part of your body, bring awareness to their specific qualities, with sincerity but without a drive for perfection. For example, you may be noticing heaviness, pressure, tension, heat or coldness, fluttering, vibration or some other sensation. Some sensations are hard to describe. That's OK - no need to put them into words. Stay with the sensation from moment to moment, as best you can.
- *Pause.*
- *This next part should be done for a minimum of 10 minutes, up to 20 minutes, repeating the instructions periodically. Cue participant to attend to or refocus on their sensation(s) every 1 - 2 minutes, more frequently in the beginning and gradually reducing frequency and using fewer and fewer words, interrupting their process as little as possible.*
- When you notice your attention has wandered, gently return it to the sensations in your body. This is especially important if you notice yourself lost in thinking about the events or circumstances connected to the emotion.
- *Pause.*
- *Wait at least five minutes before giving the following instruction:*
- Notice if the sensations shift. They may grow weaker or stronger, or shift in location. Sensations may spread out, or shrink, or change in some other way. Whatever happens, continue resting your attention on the sensations, moment after moment after moment.
- Now, we have come to the end of the practice. As you feel ready, let your attention expand to include a sense of your body as a whole, the sounds in the room, and anything else that is here right now.

This can be followed by a brief inquiry into the experience of the participant, focused breath work, or some other grounding practice. You may also choose to ask participants about their experience of this practice during the debriefing session.

h. Rescue Medications

Review with the participant the rescue medications that will be available during the session and the indications for their use. These medications and their indications will have been discussed once during the consent process.

1. Emphasize that use of rescue medication will generally be a last resort, and that other strategies, such as relaxation exercises, will be tried first to manage anxiety or elevated blood pressure.
2. Reiterate that these medications are available to ensure the participant's safety if needed.
3. Explain that for the most part, using any rescue medications will be a joint decision, not a unilateral decision. However, in the case of an unresolvable difference of opinion, the participant must accept the clinical judgment of the study physician and therapists.

i. Practical Guidance and Safety Instructions Script

- Think of the experimental session as a multi-day experience. Minimize stress for a few days before the session and especially the day before. Spending some time in nature can help reduce stress. We also recommend reducing time on the phone or Internet. Abstaining from heavy and spicy foods is a time-honored way to prepare for spiritual experiences. You will be in the best position to benefit from the session if you are refrain from consuming alcohol and other intoxicants for one week before the session.
- We also suggest not working the day after the session, or at least having a light schedule. It is helpful to have time to reflect on what happened during the session and you may want to take some time to recover from the intensity of the session.
- On the day of the session, please arrive well rested, although you may have some difficulty sleeping the night before and this is normal. The most important thing is to be ready to devote yourself fully to the experience of the session for the full 8 hours.
- We encourage eating a light, low fat breakfast either before your arrival or at the lab. We will have light snacks, such as granola bars and crackers, as well as water and ginger ale available to you throughout

the day if you become hungry. You will also have the opportunity to order a sandwich for lunch.
- Wear loose fitting comfortable clothes, such as sweat pants, t-shirt, yoga pants, etc. Dress in layers, as it is common to have fluctuations in feeling warm or cold during the course of the medication session. Please also bring a change of clothes just in case. We invite you to bring photos, small artwork, or any objects that you feel will be supportive of your process during your session.
- On the day of the session, arrive at 8:00 a.m. to complete final questionnaires, urine toxicology, and urine pregnancy test (if indicated).
- After you take the study medication, you are required to stay in the clinic for at least six hours and until you are deemed safe to leave by study staff. Leaving before being cleared by study staff could be dangerous. **We need a clear commitment from you that you will stay in the study facility for the full duration of the session (minimum 6 hours) until you are cleared to leave by study staff.**
- We can change the light, temperature, volume of music, and provide additional blankets. Just ask, and we will do whatever we can to make you comfortable.
- Vital signs will be checked every 30 minutes for the first 2 hours, then hourly. We may ask how you're doing during these blood pressure checks; otherwise, we will generally not intrude unless you initiate contact or appear to be in distress.
- If you feel emotional, need to laugh or cry, express yourself, or move your body, please go ahead. Emotional release is normal, expected, and welcome in the session, unless your behavior threatens your safety, or the safety of other people or the study environment. We will let you know if your behavior is causing any concern and work with you to find a safe way to express yourself.
- Nausea and stomach ache may occur. Vomiting is rare, but we will have a basin available just in case.
- After about 6-7 hours, we anticipate that the effects of the medication will have almost worn off completely. At that point, we will ask you to complete some questionnaires.
- **After the session**: After you arrive home, please take some time to write down everything significant that you can remember from the session. Some of these memories and sense impressions can fade very rapidly. Don't worry if some parts of your session are difficult to recall. We will go over your experience the next day at your debriefing session. Don't feel any obligation to be sociable the night after your session. You may prefer to keep your experience of the dosing session private, even from people who care deeply and want to hear about what happened. If you wish to talk about your experience, limit discussions to people who know what you've been doing and are close to you.

j. Departure Requirements

- The participant will arrange a companion or support person to come at the end of the dosing day and accompany them home. That person will be contacted ahead of time by study staff and invited to join the end of the preparatory session in order to assess competence and appropriateness for their role, provide psychoeducation and invite questions. If they cannot attend the session in person, they must be contacted by phone (this will be the responsibility of study staff/physician rather than the therapist). The support person will be educated regarding:
    1. Basic structure of the study
    2. Range of possible after effects:
    3. Headache, common, treated with ibuprofen. 200 mg po
    4. Infrequent: changes in mood, confusion, anxiety, insomnia.
    5. Rare effects: paranoia, panic, suicidality.
    6. Methods for reaching the therapists and/or Study Physician
- The support person will be asked to come to the study area to meet the participant and therapist team upon conclusion of the session. They will be provided an information sheet containing contact information for study staff in case any concerns arise.

The authors gratefully acknowledge the use of work by Bogenschutz & Forcehimes, (2015) in this section.

6.10 Eyeshade, Music Trial and Introduction to the Physical Space

If possible, the therapists will give the participant an opportunity to adjust and try on the eyeshades that will be used in the dosing session, as well as listening to a few minutes of the music playlist. At the same time, they will offer the participant an opportunity to recline on the sofa or armchair they will use during the medication session. (Note: if this is not done during preparation, it can be done prior to dosing during the experimental session).

6.11 Ending: Questions, Recap of Details for Arrival for Session

Offer an opportunity to ask questions, confirm details for arrival at dosing session and companion pick up.

7. Medication Sessions #1 & #2

7.1 General Guidelines and Overview for Medication Sessions

Each session will last up to eight hours. Prior to the participant's arrival, ensure the room will be fully devoted to that day's dosing session exclusively. Except in case of emergency, no other persons should enter the room. Prepare the room to create a safe, warm, private atmosphere, using the checklist below.

Two study staff will be present for the entire experimental dosing session, except for bathroom breaks. The participant's therapist will be the primary person making interventions, and a study physician will be the second sitter. There will always be a study physician available and the support of nursing and research staff is also available as needed, for instance to assist with vital signs collection and completion of scales and assessments.

The sessions begin when the participant arrives and completes the assessments scheduled for that morning. Researchers and nursing staff check blood pressure and pulse to make certain that they are in an acceptable range for proceeding with the dosing. Perform urine toxicology, and if the participant is a woman of childbearing age, conduct a pregnancy test.

Session preparation checklist (gather and prepare items the morning of the session)

- Room decor: art, plants, flowers, food etc.
- Sheets, blankets, pillow
- Water-resistant sheet below cotton sheets in case of incontinence
- Emesis basin
- Standardized music system ready with ambient speakers
- Eyeshades
- Lamps and comfortable lighting
- Art materials
- Air purifier
- Blood pressure machine or manual sphygmomanometer, as decided
- Psilocybin or placebo medication
- Rescue medications, PO and IM
- Monitor rating forms and vital sign forms as required

7.1.1 Check-In

Researchers and nursing staff greet the participant and give standard medical/psychiatric assessments:

1. Check blood pressure and pulse for appropriateness for dosing,
2. Evaluate the participant for suicidality (a therapist will conduct an emergency assessment and make a referral, if needed),

3. Conduct urine toxicology and, if appropriate, a pregnancy test, and
4. Ask the participant about any changes in their medications.

Given that a lot of information was covered during preparation, we have found it useful to briefly review the following items with participants before they ingest the medication:

1. Expectations for test day (minimum 6 hours, cannot leave the floor, will have at least one person in room with them at all times)
2. Orient to bathroom location and procedure (participant to let us know if they need to use the restroom and, will be escorted)
3. Trial of eyeshades and headphones (adjust eyeshade straps, headphone volume)
4. Food: mention snacks available, take lunch order in advance
5. Review trip instructions, such as attitude of curiosity and acceptance to whatever arises, lean into experience rather than run away, 'trust, let go, be open'
6. Review techniques for dealing with distress (focus on the breath, asking therapists for support)
    a. Reconfirm consent for supportive physical contact, as well as assuring participant they can say no to these interventions at any time without offending therapists
7. Review participant's intention(s) for the session
8. Personal items brought by the participant will be available to them through the session.
9. Vital signs will be monitored at 30-minute intervals for the first two hours, then hourly.
10. Rescue medication will be available in the nearby research lab as detailed in the study protocol. After approximately five hours, art supplies may be offered to the participant.
11. Final reminder that participant can ask therapists to help them with any needs as they arise

7.1.2 Dosing

After the supervising physician clears the participant for the dosing session, the therapists have reviewed all preparatory information, and the participant is feeling ready, the therapists will offer the participant the study medication. In line with actively engaging participants in their own recover and promoting the sense that the patient is taking this medication and embarking on the experience as a matter of their own choice, we offer the medication in a dish or vessel so that the participant can pick up the capsule and take it on their own accord (i.e. we are not directly administering the medication). The therapists will invite the participant to drink an entire cup of water to help the capsule dissolve fully in the stomach. After ingestion, the participant usually will want to speak for a few minutes prior to lying down and putting on eye shades and headphones. If the participant has not already done so by 30 minutes post-dosing, they should be encouraged to lie on the couch and begin turning their focus inward. Remind them that, if they feel comfortable to do so, putting on the eyeshades will facilitate their inward focus.

Guidelines for therapist actions/attitudes during session

Principles of non-intrusive presence

The in-session therapist will maintain an attentive but non-intrusive presence. Interactions with the participants should be supportive and non-intrusive, and therapists should not attempt any significant type of psychotherapeutic work, except in addressing extremes of emotion or behavioral disruption. There will be an opportunity for brief check-ins during vital sign monitoring. As a rule, the therapist will not engage with the subject during the session except in a supportive manner when sought by the subject or if the participant appears in significant distress.

Responding to invitations to talk

If the subject requests engagement with the therapist, the therapists shall listen and respond in a supportive manner. After a few minutes, the therapist should gently suggest the participant resume an inward-directed focus, including the optional use of headphones and eyeshades. If the participant resists the suggestion, continue to work with them in a supportive and compassionate manner until they are ready to resume an inward focus. Note such instances as they may represent experiential avoidance or other important processes to be discussed during debriefing. Note that dialogue may naturally be more substantial towards the end of the session, as the medication is wearing off. As some sessions are placebo sessions, it will be more challenging to not engage in significant conversation, but therapists should attempt to conduct all experimental sessions in a similar manner if the context is a clinical trial.

Responding to intense, painful affect states

The therapists will gently encourage the subject to "lean in" or "go towards" intense or difficult affective states, rather than try to avoid or diminish them.

Responding to agitation or restlessness

The therapist will encourage breathing exercises and grounding techniques, as described above. If these are not helpful, the participant will be invited to sit up, take off the eyeshades and make visual contact with the therapists and the room. The therapists may offer reassurance that such states are to be expected and are likely to be short lived.

Responding to requests for contact

The therapist will keep in mind the subject's stated boundaries regarding touch and as appropriate will respond to requests for physical contact.

Responding to marked agitation

If the subject displays significant or marked agitation and previously mentioned interventions fail, the therapist will consult with the physician regarding the possible administration of benzodiazepine or antipsychotic medication. Medical intervention will be utilized only when agitation is persistent, and no other means to help relieve the agitation are effective.

Responding to marked, persistent paranoid reactions

If the subject presents with significant persistent paranoia the therapists must strive to remain calm and present. The therapist should reassure the subject that they are safe and offer a reminder that they have taken a powerful medicine that is affecting their thinking. It is useful to remind the participant that their experience will end within [x] hours and symptoms they are having will likely resolve quickly.

Responding to urge to undress or move about the room

If the subject begins to undress or expresses a desire to undress, the therapist will remind them of their commitment to remain fully dressed. If necessary, this will become a firm instruction. If the subject desires to move about the room, the therapist will encourage the participant to enjoy this activity briefly, and return to sitting or lying on the couch before too long.

Therapist's role/attitude/frame-of-mind during psychedelic-assisted sessions

The therapist's calm attentive self-awareness benefit both them and the participant during the dosing sessions. An empathic presence during the session will offer the best support to the participant. In so doing, the therapist encourages the participant to stay present with their inner experience, and they create a safe environment that fosters willingness to remain open to new, challenging perceptions that may arise.

The intensity of the therapeutic experience for the participant is affected by the therapist's capacity to remain calm in the face of highly intense emotion and expressiveness. The processes of "reperceiving" and radical self-acceptance need to be modeled by the therapists in order for the participant to have the best chance of learning these skills. When needed, the therapists may offer assistance to the participant in managing difficulty or confusion, while fostering the awareness that the participant's relationship with the medicine is the primary source of healing.

The therapists hold in mind any intentions for the session that the participant has identified during preparatory sessions, while also allowing for additional, perhaps unexpected, psychic material to emerge. They also consider individual psychological factors that may impact the therapeutic relationship (transference and countertransference) and seek to offer specific interventions that will be best suited to that particular individual, at that point in time.

7.1.3 First Narrative Telling (15-60 minutes)

Toward the end of the session, the participant will be invited to talk about the experience they just had, the emotions it evoked and their in-the-moment reflection on their journey. The therapist will focus on eliciting phenomenology, rather than interpreting or guiding this report. Notes will be taken by one of the therapists, which are normally given to the participant to take home as a memory aid. It is valuable to use the principles of "active listening," namely: asking open ended questions, inquiring for details and associations, avoidance of "why" questions and supporting a free-flowing report that isn't concerned with logic, rationality or productivity. This may last between 15 minutes and an hour depending on the participant. Following this (or during it) the participant will be offered water, juice, fruit and snacks to satisfy hunger and facilitate the return to ordinary consciousness.

7.1.4 Departure

About 6-7 hours after ingestion of the study medication, the majority of psilocybin effects are likely to have abated and the participant should be capable of sitting up, ambulating, conversing, and eating. They will be asked to complete any questionnaires that are part of the study. After all assessments, narratives and eating are complete, the supervising physician, in collaboration with the therapist, will assess the participant's safety for discharge from the clinic. The time from ingestion to discharge from the treatment room will be a minimum of 6 hours. So, if ingestion occurs at 9 am, the discharge will be 3 pm or later. Assessment of readiness to leave the treatment setting entails performing a mental status exam, assessment of physical safety (vital sign stability, coordination, steadiness of gait) and inquiry into any lingering effects of the medication (visual illusions, unusual beliefs, paranoia, thought processes and content, mood and insight). If cleared for discharge, the participant will be released to their companion. The next days' debriefing session, which has already been scheduled, is confirmed. The therapist ensures both the participant and the support companion have both therapist and study staff telephone numbers.

7.2 Medication Session #2

The second experimental session occurs five weeks after this one and can be conducted according to the same guidelines as described in this section.

The authors wish to acknowledge the excellent standard of care offered by Michael Bogenschutz and Alyssa Forcehimes, and to thank them for permission to use many elements of their therapy manual for psilocybin assisted therapy of alcohol dependence (Bogenschutz and Forcehimes (2015).

8. Debriefing Sessions #1 and #2

8.1 General Guidelines for Debriefing Sessions

Each debriefing session lasts one hour. The primary goal of debriefing sessions is to offer support for the participant's reflections on the medicine session. Therapists accomplish this by asking open-ended questions about the session, intended to elicit the introspective, interpersonal, spiritual or noetic insights that occurred during the session that the participant may otherwise forget or have difficulty verbalizing. Eliciting such insights may provide important clues to changes in behavior, thought, or relationships that may be intimately related to the participant's depression. Therapists will support the participant's narrative expression of their experience, and emphasize this over making interpretive interventions.

A critical related goal for therapists during debriefing is to listen for (during debriefing #1) and explore (during debriefing #2) aspects of the participant's narrative that are consistent with core ACT principles: cognitive defusion, acceptance, transcendent self, values, and action.

Thus, the therapists' agenda during debriefing is to hold an open, affirming manner while listening to the psilocybin experience, and simultaneously contextualizing the participant's narrative through core ACT principles.

8.2 Debriefing Session #1

This session takes approximately one hour and occurs the day after the first medication session.

8.2.1 Open Narrative

The therapists should use the following script or cover the following content using their own style:

1. "Today the main goal is to talk about your medication session. We are interested in learning how the session affected you, what you experienced, and most importantly, how it has affected your thinking and ideas about your experience with depression."
2. "Can you tell us everything you remember about your session, from beginning to end? What happened? What did you see? What did you hear or feel? What happened in your body?"
3. "Did anything happen that was difficult or challenging for you? Did you experience periods of negative emotion, fear, sadness, depression, or terror? Did images emerge that were hard to bear? Have any of these persisted; have any of these gotten worse since the session?"
4. "What have you been thinking and feeling since the session? Do you notice anything different about your usual depressive thoughts, beliefs, attitudes, or emotions?"
5. "How have you been sleeping and eating since yesterday's session? What was it like coming here and seeing us (the therapist and support person) today? How did family contacts feel since yesterday's session?"
6. "How are you feeling emotionally today?"

8.2.2 Session #1 Ending

As the debriefing session comes to a close, the therapist performs a mental status exam and safety assessment to evaluate for worsening mood, passive or active suicidal ideation, paranoia or confusion, persistent hallucinations, illusions, or delusions. If acute safety concerns are identified, the therapist should notify one of the study physicians to determine a plan and assess the need for further evaluation. If no acute safety concerns are identified, the therapists close the session by confirming the next appointment, and restate their availability by phone.

8.3 Debriefing Session #2

This session takes one-to-two hours and occurs one week after medication session #1. The overall goals of the second debriefing session are similar to the first but include an exploration of the role of **personal values** in recovering from depression. This debriefing session will be divided into two sections.

In the first part of the session therapists will help the participant integrate the content and process of the medication session, and their experiences during the following week.

In the second section of Debriefing Session #2, the therapists review the participant's Valued Living Questionnaire (VLQ) and values clarification list, in order to help the participant further clarify their personal values. The therapists will use the results of the participant's previously completed VLQ (done the day before first experimental session) to conduct a sincere exploration of values lost, values forgotten, values retained, and how values have changed. This may require more active exploration on the therapist's part than has been the case, as loss of values and loss of awareness of values is a common experience in depression. Not only will values be clarified, but also past activities that have demonstrated those values will be identified and explored (preferably with humor, warmth and kindness). Please note that while we utilized the VLQ as a standardized way of exploring values in our study, numerous other ACT tools and worksheets may be utilized for this purpose. The session may conclude with a metaphor to highlight important topics if appropriate.

The therapists may use the following questions to facilitate the discussion with the participant:

Debriefing of Medicine Session Script:

- "How have you been since our last session? How is your mood, your sleep and appetite? What have you been doing?"
- "Have you noticed any changes in important relationships in your life? Work? Family life?
- Where has the medicine session of (one-two-three) weeks ago been in your thoughts and emotions? Do you think of it often? When you do, what comes to mind? Do you feel its impact still being with you or does it feel like it's faded? Do you notice any changes in how you think or how your emotions express themselves?"

Values Clarification Script

- "The day before your dosing session, you completed something called a Valued Living Questionnaire. Do you remember doing that? We'd like to take some time to discuss that with you."

The therapists bring out the Valued Living Questionnaire results and give a copy to the participant. After allowing the participant to review the results, they ask the participant to respond to their feedback, which will fall along these lines as the therapist tries to help the participant clarify:

- Which values matter most to you?
- Which values do you feel most attached to?
- Which values used to be expressed in your daily life but got lost to depression?
- Which values were imposed by others, not chosen, and need to be retired?
- Values from your childhood or early adulthood have you lost touch with?
- Which values used to be important, but now are unimportant?
- Which values have been impeded by depression?
- How has living with depression led to important values being neglected or discarded?

Having gathered the participant's feedback to the VLQ, the therapists review the experience of assessing their values with the participant.

- "As we go through this exercise, what do you feel? What memories are triggered? Are you surprised at what came up for you in the questionnaire?"
- "How did these values (family, creativity, loyalty, recognition) show up during your medicine experience? Does today's conversation make you think about how you might reconnect with these values

as you move forward? How do you see your experience with depression affecting your life in terms of these values?"

8.3.1 Session #2 Ending

a. Confirm the safety and stability of the participant.
b. The participant may leave the session on their own, provided no worsening depression symptoms have emerged. If the participant has experienced worsening symptoms of depression during the debriefing session, conduct a full mental status examination and safety assessment in conjunction with the study physician, and develop an appropriate follow-up plan.
c. Confirm scheduling for the next sessions: Psychoeducation #2, Dosing #2, Debriefing #3 and Debriefing #4

9. Psychoeducation Session #2

The second psychoeducation session takes approximately two hours and occurs four weeks after the first medication session. The purpose of this session is to introduce the participant to ACT principles: the thoughts and behaviors (cognitive processes, actions) that are problematic in depression can be changed through an interactive process that links the principles of ACT and the effects psilocybin.

9.1 Checking In

Check in with the participant about their progress since the last session as in previous sessions.

9.2 Differentiating the Traditional Psychopharmacology Model of Depression Treatment from This Psychedelic-Assisted Therapy Model

Briefly introduce the participant to the basic distinction between a traditional passive pharmacologic approach to depression treatment versus the more *active* integrated medication and psychotherapeutic approach being offered in this study. This is important as patients may not only be accustomed to the pharmacologic paradigm from prior medication trials, but also may have unrealistic beliefs that psilocybin will cure them, like a 'magic bullet.' The basic principles are as follows:

a. In traditional psychopharmacology model for depression, depression is seen as a medical illness, which exists in the brain.
b. The doctor (or other MH practitioner) diagnoses the condition, explains it as such to the patient, and prescribes medication.
c. The patient's role is to report symptoms honestly, accept the doctor's diagnosis and treatment recommendation.
d. The medicine, then, is the active agent, which works to change the brain chemistry. Hopefully, improved mood, altered thought patterns, and behavioral activation follow over the coming weeks.
e. In psilocybin-assisted therapy for depression, the participant is invited to be a more active agent in changing their patterns of thinking and behaving.
f. The experience of the medicine and the relationship with the therapists are used to facilitate these changes in thinking and behaving
g. The medicine may have a profound effect in facilitating these changes, but it will likely not accomplish them on its own, and if it does, such changes are unlikely to persist without active engagement on the participant's part.
h. The therapists seek to facilitate the active utilization of the medicine experience and the therapy in bringing about meaningful changes in the participant's way of life (not simply in reducing feelings of depression).

Another key distinction is that traditional pharmacologic approaches attempt to directly ameliorate depressive symptoms - i.e. take the pill and the symptoms will hopefully get better. However, in ACT, we are actually trying to improve **psychological flexibility**, which is the ability to be present in the moment with full awareness and openness to our experience, and to take action guided by our values. In other words, "ACT assumes that a) quality of life is primarily dependent upon mindful, values-guided action, and b) this is possible regardless of how many symptoms you have - provided you respond to your symptoms with mindfulness" (Harris, 2009).

9.3 Psychoeducation Regarding Psychological Processes in Depression

The purpose of this segment of the psychoeducation session is to induce "Creative Hopelessness," or the acceptance that the participant's normal, instinctive ways of fighting depression are, in fact, sustaining it. Here, the therapist uses didactic explanation to help the participant understand how, we believe, the ACT plus psilocybin combination therapy approach works. *In our study, therapists used the following framework to structure the discussion*:

"We are going to teach you what the field of psychology has learned about depression, namely, how the minds of people with depression commonly work. It's not about understanding WHY you're depressed, but about understanding HOW the depressed mind works and changing that. In fact, focusing on WHY leads to a continuation of depression, not an amelioration of it. This is counterintuitive, but true. As I discuss some of these points, I want you to think about the ways in which they may or may not apply to you. Some may feel more relevant to your particular experience than others. Some of what we discuss may in fact feel off-base or may challenge some of the ways you have been coping with depression for a long time."

"We hope what we're going to describe here will give you some new ways to think about depression. We anticipate that the medicine sessions will help you to feel these new ideas on a deep emotional level."

The following types of depressive thinking and behaving often accompany or exacerbate depression. Using the suggested language below, the therapist should explain the types of depressive thinking and behaving and provide some examples of each.

Cognitive Fusion

"In plain language, cognitive fusion 'means getting caught up in our thoughts and allowing them to dominate our behavior' (Harris 2009). 'In a state of cognitive fusion, we're inseparable from our thoughts: we're welded to them, bonded to them, so caught up in them that we aren't even aware that we are thinking… Defusion means separating or distancing from our thoughts, letting them come and go instead of being caught up in them.'"

The therapist gives some examples of cognitive fusion in the abstract or recounts a clinical moment from their previous sessions with the participant, sharing an example of cognitive fusion that they observed in the participant. For example, the participant may say: "I know I'm not really a worthless piece of garbage, but I FEEL like I am." This is an opportunity to a) differentiate thoughts from feelings/emotions and b) bring in the ACT concept of cognitive defusion. The therapist might inquire what it actually feels like when they think they are a piece of garbage. Is there an associated bodily sensation? What is the impact on them when they have that thought? How does this thought affect the participant's relationship with the outside world? Do not try to convince the participant that they are not a worthless piece of garbage, rather that the thought is simply one thought among many others, and that it has a particular impact on them. (This ties into the next concept of workability.) Our goal is to reduce the power of the thought to guide behavior, not remove the thought. The bottom line in this section is to introduce the idea: I am not my thoughts; thoughts arise and pass away, arise and pass away, and I can observe that happening.

Introduce the concept of **workability**: The issue is not whether thoughts are true or false, but how they get in the way living life in a full, meaningful way in accordance with abiding values.

Experiential Avoidance

Explain the concept of experiential avoidance to the participant. We suggest simply using the term "avoidance", rather than the more technical term "experiential avoidance."

"Painful thoughts and feelings are extremely uncomfortable. To escape the pain, the mind may avoid experiences in one of two ways: **internal avoidance** and **external avoidance**. Internal avoidance is characterized by avoiding painful emotions or thoughts and trying to make them go away, either by suppressing them or trying to fix them through understanding (reason giving)."

Here, the therapist offers examples of internal experiential avoidance that they've seen in the weeks of working with this participant. This invokes **creative hopelessness**, showing that the participant's attempts to alleviate their depression, although understandable, have been not only ineffective, but may actually be perpetuating it. This may not be easy for them to take in, and you may see resistance or distress as familiar strategies for blunting pain are challenged. This is where **acceptance** of emotion can be put forward as part of their healing process. Acceptance refers to opening up and making room for painful feelings, sensations, urges, and emotions, rather than struggling, resisting, or getting overwhelmed by them.

External Avoidance: The therapist explains the term 'external avoidance,' and if possible, gives examples of places where this particular participant has demonstrated external experiential avoidance. It might be valuable to explain why giving up experiential avoidance is so difficult: it works, but only in the short run. Not doing something anxiety provoking leads to a reduction in painful emotion, and then, a deeply felt reinforcement for not taking action in the world. Yet studies show that prolonged experiential avoidance is associated with persisting or even worsening depression because it reinforces isolation, passivity, withdrawal and hopelessness about the ability to change.

Reason-giving/explaining why: The therapist explains that exploring narratives about the past and what "caused" the depression are not part of this therapy. This does not mean that those narratives are false or trivial, but they are not as relevant to solving the problem of depression, even though they may have caused it. Reviewing these narratives over and over is not helpful as they can limit us from having a rich, full, meaningful life.

Willingness to act in valued directions: The therapist explains the difference between willing and wanting, and introduces the idea that how the participant feels about doing something doesn't have to determine whether they actually do it. They may not want to do something, but can still be *willing* to do it. Saying "I'm going to do it *only if I feel like it*," is very problematic, perpetuates depression, and is the opposite of willingness.

The therapist tries to help the participant recognize that while there is one voice in their head that says, "I cannot go to the gym because I am immobilized by my depression," or, "I would go to the gym BUT I feel depressed, tired etcetera," they can find another voice that says, "I can go to the gym even though I feel tired and depressed." The therapist suggests a new narrative, which might be: "I can feel depressed AND go to the gym." This is the principle of 'And not But.'

9.4 Mindfulness Metaphors and Mindfulness Practice

In order to provide participants with the experience of contacting the present moment, we encourage and teach a concentration type of mindfulness practice that seems suited to the particular participant we are working with.

To introduce the concept of mindfulness, the therapist may consider offering a metaphor if that seems helpful, such as the "Sky and the Weather Metaphor" (Harris, 2009, p. 175). Introducing the concept of The Transcendent Self/Self-As-Context may also be appropriate here.

The therapist asks about the participant's prior experience with mindfulness and meditation, learning about any existing practices they maintain or have tried in the past. We want to encourage regular practice of a mindfulness or meditation at this point, which will form one means of integration after the dosing session and after their study participation ends. If the participant already practices a form of mindfulness and wishes to continue practicing that, then the therapist should gain a better understanding of that practice and set goals for regular practice. If the participant does not yet have a mindfulness practice or wishes to learn a new one, the therapist should help them learn a new one, based on their knowledge and assessment of the participant.

Examples of mindfulness practices

a. Breath awareness practices (counting breaths, following breaths, ratio breathing)
b. Touch points: awareness of the points of your body that contact the environment or themselves
c. Sound Awareness
d. Mantra meditation

It may be helpful to guide the participant through the mindfulness practice while in the session. A sample set of breath awareness instructions are as follows:

1. Find a comfortable seated position. If on the floor, use a pillow under your buttocks. Sit in cross legged position, or, if it's comfortable, in lotus position or half lotus position. If on a chair, sit on the forward 6 inches or so of the chair with your feet flat on the floor.
2. Maintain good posture. Do not slump or make the back rigidly upright.
3. Pick a point about 4 feet ahead of you on the floor. Softly rest your gaze on this point. Keep your eyes half open and half closed. If your eyes are open fully, you will be too easily distracted; if they are closed, you will too easily go to sleep or daydream.
4. Rest your hands in your lap, one on top of the other, thumbs touching. They should just touch. If they separate you may be drifting or falling asleep. If they press together you may be thinking too hard.
5. Become aware of your breathing. Breathe through your nose if you can. For every inhalation, count silently "one," then breathe out. On your next inhalation, count, "two," and so on until "ten." Once you reach "ten," start over.
6. Now here's the challenging part. If you think of any thought at all besides the number you intend to count, start over. Do not be surprised if you cannot make it to 10 or even to 3 for quite some time.
7. When thoughts come into your mind besides the number you intend to count, observe the thought, put it aside, and return to counting.
8. It is common for the thoughts to be random: things you need to do, things you have done, lists, things from a long time ago, song lyrics, and perhaps, thoughts of things you regret. Whatever they are, observe them for a moment, put them aside and return to counting.
9. You may become aware that you are frustrated by the difficulty of the task. That is ok. Observe the frustration then put it down and return to the counting.
10. Before you start, decide how long you will sit. Do not stop before that time is up. Even if you feel that you are making no headway at all. Sit with that.
11. Set a time daily to meditate, you may light a candle or do another symbolic gesture to initiate and end the sitting. However, music should not be used as it is too easily distracting.
12. This is a practice. You should not expect that it will be easy to do this. It will take time to become better at it. It is something that you will grow into.

If it hasn't already been introduced, the therapist may also guide the participant in the Awareness of Body Sensation exercise described in Psychoeducation Session #1.

9.5 Intention-Setting

Intention is an important aspect of the participant's 'set' going into the experimental session. In this section, we review the concept of intention setting, elicit the participant's intentions for the next dosing session, reflect on how their intentions may or may not have changed from the first session, and encourage the participant to think about their intention between now and the dosing session.

9.6 Ending: Questions, Recap of Details for Arrival for Session

Offer an opportunity to ask questions, confirm details for arrival at dosing session and companion pick up.

NOTE: In this study, Medication Session #2 occurs four weeks after the 1st medication session and can be conducted according to the guidelines described in Section 7.

10. Debriefing Session #3

This being human is a guest house.
Every morning a new arrival.
A joy, a depression, a meanness,
some momentary awareness comes
as an unexpected visitor.

Welcome and entertain them all!
Even if they are a crowd of sorrows,
who violently sweep your house
empty of its furniture,
still treat each guest honorably.

He may be clearing you out
for some new delight.
The dark thought, the shame, the malice,
meet them at the door laughing and
invite them in.

Be grateful for whatever comes,
because each has been sent
as a guide from beyond.
~ Rumi

The third debriefing session is one-to-two hours long and occurs the day after the second medication session. As in other debriefing sessions, the primary goal is to support the participant in reflecting on the medicine session. In this session, the therapists also strive to help the participant begin to adopt a more flexible attitude, so they can be less defined by their depressive symptoms, whether they persist or not.

10.1 Open Narrative

The therapist may use the following script verbatim, or simply as a helpful conversation guide:

- "Today our main goal is to talk about your medication session yesterday. We are interested in talking about how the session affected you, what you learned, and most importantly, how it has affected your thinking, feeling, and experience of depression."
- "What happened? What do you remember that surprised you? What did you see? What did you hear or feel? What happened in your body?"
- "What have you been thinking and feeling since the session? What do you notice about your familiar depressive thoughts, beliefs, attitudes, emotions?"
- "What happened that was difficult or challenging for you? Did you have periods of negative emotions, fear, sadness, depression, terror? Did images emerge that were beautiful or confusing or hard to bear? Have any of these persisted; have any of these gotten worse since the session?
- "In the last Psychoeducation session, we talked about many thought patterns that happen when people are in a depressed state, and how the medicine session might change some of those. Did you learn anything about how you experience depression and what perpetuates it? And, what you can do to change it?"

- "How have you been sleeping and eating since yesterday's session? What was it like coming here and seeing us today? How did family and friends feel to you after yesterday's session?"

10.2 Metaphor

If helpful and relevant to the discussion, the therapist may share the poem by Rumi (above) to illustrate the concept of *acceptance*. The following metaphor may also be offered and discussed to help the participant understand the concept of *self-as-context*:

In the **house and furniture metaphor**, the subject is invited to explore the idea of "self-as-context," vs. "self-as-content". In other words, we encourage the participant to imagine themselves as larger, or more, than their everyday sense of who they are. The house, like their true nature, is permanent and stable; the furniture is more like their thoughts and feelings, which can come and go, and may be in a constant condition of change and flux. We encourage the participant to identify with the house, their larger Self, which we suggest is distinct from their depressive symptoms. With this concept in mind, they might be able to accept or even welcome a change in the array of furniture or guests (thoughts and feelings).

10.3 Ending

As the debriefing session comes to a close, the therapist performs a mental status exam and safety assessment to evaluate for worsening mood, passive or active suicidal ideation, paranoia or confusion, persistent hallucinations, illusions, or delusions. If acute safety concerns are identified, the therapist should notify one of the study physicians to determine a plan. This may be a phone check in, an additional visit, or an assessment in the hospital ED. If no acute safety concerns are identified, the therapists close the session by confirming the next appointment, and reconfirm their availability by phone.

11. Debriefing Session #4

The fourth debriefing session occurs one week after the second medication session and lasts between one and two hours. In it, the therapist continues to help the subject move toward integrating the medication session experience with ACT and taking the values exercise into the action phase.

11.1 Open Narrative

During the first part of this session, the therapist listens to the participant's experiences since the last session in the standard open, empathic way. However, they pay close attention to the places where the participant incorporates the new patterns of thought and behavior that have been taught and, conversely, when the participant engages in thought fusion, internal or external avoidance, reason giving, unrealistic goals, confusion of wanting and willing. The therapist will take a gently didactic approach, pointing out successful changes with praise and encouragement while tactfully correcting ways of thinking/behaving that are part of the depressive condition. The therapist may remind the participant that mindfulness is an ongoing practice.

One important therapist-orientation point to make here: the participant will likely be sharing their material in a way that would evoke an exploratory response from a therapists in a traditional psychotherapy session. In an ACT-based facilitation of psychedelic therapy, the therapists are listening for the change processes defined by ACT and mindfulness-based practice; they privilege this above the content of what is reported, which may reinforce fusion.

For example, a participant may speak in an emotional way about the death of a child, and how this is preventing them from getting out of bed, taking care of other children, and leads them to feel like a bad mother. A typical therapeutic response might be to show empathy for their suffering, to talk about the death, and in doing so, likely deepen the intensity of affect around it. An ACT response might be to listen compassionately, of course, and then use defusion to draw attention to the participant's relationship with this narrative and how it impacts their ability to engage in values-driven behaviors. The therapist might point out that the participant's mind is a relentless machine generating stories and thoughts that can limit freedom to act in the world (not workable). The therapists might clarify values that have become obscured or lost in the relentless story generation and fusion with thoughts.

11.2 Values-Into-Action

This part of the conversation takes up where Debriefing Session #2 ended. By this time, the personal values of the participant have been part of the conversation for at least 3-4 weeks, and through one medication session. That experience itself can have a helpful effect on the discovery or rediscovery of abiding personal values. The therapist and participant devote 20-30 minutes to discuss the topic of values, and any value-driven actions that are underway. The therapist may refer back to the participant's Valued Living Questionnaire or use any other ACT values clarification work sheet. They may offer to assist the participant in planning values-based actions. Some participants may find a small booklet or journal to be helpful in planning. It may also be useful to employ SMART goals (Specific, Measurable, Attainable, Relevant, and Time-Bound). For instance, rather than, "I will start doing some yoga," the therapist should encourage the participant to arrive at a concrete plan, such as, "I will take the vinyasa yoga class this coming up this Wednesday at 10:30 am at the Integral Yoga Institute on Spring Street".

It is very possible, of course, that habitual patterns and processes of psychological inflexibility, as well as strong emotional states, such as fear, doubt, anger, and/or sadness may emerge in the session, especially in response to the encouragement to take action. Thus, this session will be a good opportunity to implement and practice ACT techniques for working with these intense emotional states. The therapist in this session functions somewhat like a coach. Rather than being non-directive, the therapist gently directs the participant to be present with the emotion and to practice: bringing their attention to the present moment, defusing from thoughts, and accepting what is.

It may be helpful to take 3-minute mindfulness breaks during the session to work with activated emotion or experiential avoidance.

11.3 Ending

Confirm safety and stability of the participant. After the session, the participant may go home on their own, provided no worsening depression symptoms have emerged. (If depression symptoms have worsened, a full mental status examination and clinical interview should be done, followed by stabilization of the situation.) Confirm scheduling for the next sessions.

12. Follow-up Sessions #1, #2

Follow-up sessions #1 and #2 are designed to keep moving the patient towards psychological flexibility, with an eye towards empowering them to continue making progress after their participation in the study ends. These two sessions reinforce important concepts, encourage successful changes, and facilitate further ownership of lessons and gains drawn from the psilocybin/therapy experience. The sessions provide encouragement of continued practice of mindfulness and ACT skills. The sessions also address study termination issues.

12.1 Follow-Up Session #1

This one-hour session occurs two weeks after the 2nd medication session. If case/therapy supervision is available, the therapists should use this opportunity to discuss the case and consult with the supervisor prior to this session with the explicit goal of establishing an individualized plan for the remaining sessions.

12.1.1 Check-In

This session begins with a brief, cordial check-in and catching up.

12.1.2 Termination Discussion

The therapist speaks to the fact that the participant's time in the study is coming to an end and that there will be one more session after this. The therapist invites the participant to share their feelings, thoughts, and questions about the termination sessions, including disappointment and fears that might be emerging as termination comes closer.

12.1.3 Acceptance and Commitment

This will be the focus of the session. The therapists continue the work of integrating ACT insights and behavioral changes into everyday life. Based on clinical formulation the therapist may focus on specific ACT principles. To facilitate the discussion and review progress made thus far, the therapist may introduce the ACT hexagram and explore how the medicine session and therapy have worked on the points of the ACT hexagram. The discussion focuses on the experiences of acceptance (including mindfulness and self-transcendence) and commitment (values, willingness to act) that are emerging in the participant's life. A brief meditation or period of contemplation may be incorporated into the session.

12.1.4 Begin Reviewing After-Care Plan

Begin discussing the participant's plans for ongoing treatment and self-development endeavors beyond the study. If available, give the participant a prepared list of referrals that are suitable for after-care, taking into account their financial, geographical, and clinical needs. Some examples include psychotherapy, psychopharmacologic treatment, group or individual psychedelic integration, ketamine therapy, mindfulness-based stress reduction, meditation groups, yoga studios, and exercise programs.

The discussion regarding ongoing psychotherapy may be complicated as participants may have certain feelings about returning to their prior therapist after having undergone psilocybin treatment. Participants may inquire about continuing therapy with the study therapist and so the therapist and study investigators should develop a plan and position on this ahead of time. In most clinical studies, there is either an indefinite or time-limited prohibition against clinical work together after the study. Therapists or investigators should offer to contact the participant's prior therapist to discuss progress made in the study and how this progress can be continued.

12.2 Follow-Up Session #2

This one-hour session occurs four weeks after the 2nd medication session. After briefly checking in about any significant experiences the participant had in the weeks since last session, the therapist will devote the bulk of this session to reviewing the participant's experience in the study and termination from it. The therapists and participant will reminisce, narrate, and share observations of themselves and each other during the study period. By this time in the study, there may be much improvement to celebrate.

This unique triad will have shared a distinctive experience, nothing ever to be repeated in quite the same fashion. The three will have formed a group, a container, a type of family. The therapist may reinforce practices of mindfulness and acceptance to help the participant navigate the rather abrupt termination of their short-term therapy. They will also review and confirm plans to transition back to the treating psychiatrist and therapist. They may need to restate parameters for contact after the end of the study and discuss norms around phone calls, email, texting, etcetera. The therapists may also need to review the participants ongoing responsibility to the study for assessments.

As the therapists wrap up the last session, they may express gratitude to and receive appreciation from the participant. The therapists may wish to acknowledge the participant's hard work. If it seems appropriate, the therapists may exchange hugs with the participant. If further follow up data collection is necessary, this can be reconfirmed. Finally, therapists and study staff offer goodbyes and well wishes.

13. Limitations

While our limited experience using this treatment protocol with research participants suggests it holds promise, there are a number of important limitations to the approach outlined in this manual. First, there have not been any trials comparing our approach to psilocybin treatment with non-specific psychological support only. Thus, we cannot make any definitive claims that the integration of ACT is actually more effective. We are however in the process of collecting qualitative data and self-report measures of mindfulness, changes in values, cognitive flexibility, personality, and quality of life, which we hope will shed light on which aspects of this therapy protocol are effective or helpful to participants. Additionally, our protocol does not include the full range of possible ACT interventions. This limitation is inherent to this therapy protocol being designed for a small, placebo-controlled, within subject crossover clinical trial. For scientific reasons, we attempted to standardize the therapy protocol and provide a relatively consistent approach throughout the protocol and for each participant. For reasons related to feasibility, the number of therapy sessions was constrained; we suspect that more preparatory and follow-up sessions would be optimal. As a result of these limitations, we accept that we are providing a limited form of ACT and that there are alternative, possibly superior ways that ACT could be integrated with psychedelic therapy.

13.1 Cultural Considerations of ACT-Facilitated Psychedelic Therapy

Another important potential limitation of the approach outlined here is its untested cultural relevance and acceptability among people of color and other marginalized and oppressed groups. This issue pertains to psychedelic therapy and research in general (Michaels, Purdon, Collins, & Williams, 2018) and to aspects of ACT in particular. The behavior analytic roots of ACT do not preclude a deep understanding of cultural contexts and histories of clients belonging to oppressed or stigmatized groups (Hayes & Toarmino, 1995) and preliminary evidence suggests that ACT may be effective with different ethnic groups (Woidneck, Pratt, Gundy, Nelson, & Twohig, 2012). Nonetheless, a number of core concepts and practices in ACT need to be utilized with caution and thoughtfulness when working with oppressed and stigmatized groups.

Due to a variety of cultural factors, people of color may not seek treatment until problems are severe, and most communities of color have taboos against sharing problems outside their community (Chapman, DeLapp, & Williams, 2018). Mental health literacy and self-stigma of help-seeking may also vary among cultural groups, and some people may not consider their difficulties as signs of a mental disorder as defined by Western psychiatry and psychology (Cheng, Wang, McDermott, Kridel, & Rislin, 2018). To use ACT effectively with people of color, therapists must be aware of these factors and account for them in order to build rapport with clients. At the onset of treatment, clients of color may expect therapists to provide expert advice to help them resolve urgent problems. Therefore, a non-directive approach could be experienced as frustrating, unhelpful, and invalidating. For this reason, a clear explanation of the mechanism of treatment is essential, especially when using a modality like ACT whose therapeutic concepts may seem foreign, mysterious, or counterintuitive. For instance, the idea of "acceptance" may be misinterpreted as a need to continually accept inequitable and hurtful treatment from others, rather than noting and allowing whatever responses are experienced as a result of such treatment. Marginalized individuals must be validated in their intersectional realities before acceptance can take place. Further, among people of color, the idea of "commitment" may be experienced as an extension of racist cultural assumptions about an unwillingness to be accountable. The more neutral term, "Committed action" could be used to identify small steps the participant can take to live a fuller or more meaningful life in line with their stated values. This eliminates any implied link with a lack of commitment and retains the meaning of this mechanism within ACT. In sum, therapists should take care to use the language of ACT flexibly; the concepts can be described in a number of ways, and ACT protocols for topics such as chronic pain routinely excise the use of the word "acceptance" while retaining the principles in practice (McCracken, 2005).

Caution must also be used when introducing mindfulness exercises, such as meditation, as this may be misconstrued as engaging in a competing religious practice, resulting in ambivalence or refusal to engage in such activities. Fortunately, formal meditation is only one of many ways to establish contact with the present moment and is not a necessary component of ACT. All faiths have some type of contemplative practice, and it may be best to first gain an understanding of a participant's religious beliefs so that mindfulness exercises can be made congruent with their existing religious practices and worldview.

Finally, the ACT therapeutic frame permits participants to make contact with difficult internalized experiences, like racism. However, if this occurs prematurely or is encouraged in an inappropriate manner, they may feel alienated, invalidated, or drained, thereby decreasing therapeutic rapport and opportunities to deepen psychological flexibility. This exemplifies the importance of diversity training when doing this kind of therapeutic work. Therapists should be well-practiced and comfortable discussing issues of racism and oppression with clients, and they should have a ready response for how ACT can be useful in navigating, resisting, and healing from the effects of discrimination. For example, a therapist can highlight that a client could accept distressing emotional responses to racism and still view their life circumstances as unacceptable (Sobczak & West, 2013).

Appendix A: Therapist Self-Care

Compassion and love are necessities; they are not luxuries.
Without them we cannot survive.
- Dalai Lama

Therapists are wise to engage in regular self-care in order to avoid vicarious traumatization and compassion fatigue resulting from interacting with participants' suffering. It is important that therapists continue doing their own inner work and take time for regular debriefing conversations with their co-therapist or study team. This may include an opportunity to process their own emotional responses to participants as well as peer supervision and discussion about the optimal application of the therapeutic method in specific situations. It is also an opportunity for developing and maintaining their skills as a therapeutic team by reviewing their interactions during study sessions.

What is Compassion Fatigue?

Sabo (2006) described compassion fatigue as a severe malaise resulting from the process of giving care to patients who are experiencing any type of pain (i.e., physical, emotional, social). "Compassion fatigue refers to the strain and weariness that evolves over time from offering care to suffering people."

Therapists will spend close, attuned time with participants, being fully present as they describe their life story, concerns, anxieties, and dreams during preparatory, dosing and integration sessions. This close work, especially as a new activity added to existing clinical responsibilities, may lead to compassion fatigue. The following are some simple suggestions for self-care:

a. Listen to your body and pay attention to what it is telling you. It is the best guide to staying healthy.
b. Use your body to inform your own process; are you holding your breath, is your body tense or numb, are you cold or hot?
c. Use either diaphragmatic breathing or simple breathing that expands your ribs front to back and side to side. Do a "body scan" meditation and send breath to the areas of your body that feel tight or numb.
d. Give yourself enough time before you start a session to gather your thoughts, ground yourself, and shift roles. Take enough time to feel "inner stillness."
e. Listen to your expectations and be realistic about your goals.
f. Know who you can ask for support.
g. Take time after the session to release emotions that have come up for you in the session.
h. Have a good nutritious meal after a session and do something grounding and enjoyable.
i. Taking a bath, shower, or hot tub following a session may be relaxing and calming.
j. Consider having your own ongoing psychotherapy and/or supervision with another therapist.

Appendix B: Psilocybin

> "*When we look within ourselves with psilocybin, we discover that we do not have to look outward toward the futile promise of life that circles distant stars in order to still our cosmic loneliness. We should look within; the paths of the heart lead to nearby universes full of life and affection for humanity.*"
> ~ Terence McKenna

Psilocybin (4-phosphoryloxy-*N,N*-dimethyltryptamine) is a tryptamine compound that naturally occurs in species of mushrooms (*Psilocybe* sp.), such as *P. cubensis* and *P. mexicanus*. Psilocybin was first isolated and identified from *Psilocybe mexicana* by Albert Hoffman in 1957 (Passie, Seifert, Schneider, & Emrich, 2002).Once ingested, psilocybin is converted by the liver into four metabolites, of which psilocin (4-hydroxy-*N,N*-dimethyltryptamine) is the main psychoactive compound (Passie *et al.*, 2002). For the sake of simplicity and consistency with prior studies, the term psilocybin will be used in this protocol to indicate both the ingested and active substances.

Acutely, psilocybin causes profound dose-related alterations in perceptions, emotion and thought in humans, leading to its classification as a hallucinogen or psychedelic drug (Passie *et al.*, 2002). The psychedelic effects of oral psilocybin begin about 30 minutes after ingestion, peak after another 1-2 hours, and last another 1-2 hours more (Nichols, 2004; Passie *et al.*, 2002). The oral bioavailability in humans is 50%, with about 20% variability (Hasler, Bourquin, Brenneisen, Bär, & Vollenweider, 1997; Hopf & Eckert, 1974). It can be administered intravenously with a much shorter half-life and duration of subjective effects, 20 and 15-30 minutes, respectively. Once in the bloodstream, psilocybin and its metabolites are renally cleared (Passie *et al.*, 2002).

Psilocybin acts primarily as an agonist of serotonergic receptors, particularly presynaptic 5-HT_{2A} and 5-HT_{1A} receptors (Nichols, 2004; Passie *et al.*, 2002; Vollenweider & Kometer, 2010). Activation of 5-HT_{2A} receptors is believed to be the source of hallucinogenesis, as ketanserin, a selective 5-HT_{2A} receptor antagonist, blocks the psychotomimetic effects of psilocybin (Nichols, 2004; Vollenweider, Vollenweider-Scherpenhuyzen, Bäbler, Vogel, & Hell, 1998). Other serotonergic hallucinogens, such as LSD, mescaline, and dimethyltryptamine (DMT), also directly bind 5-HT_{2A} receptors (Nichols, 2004). However, unlike LSD, psilocybin has no affinity for dopamine D2 receptors though a D2 blocker, such as haloperidol, has been shown to reduce the acute effects of psilocybin, indicating known overlap between the serotonergic and dopaminergic circuits in the brain. (Passie *et al.*, 2002; Vollenweider, Vontobel, Hell, & Leenders, 1999).

Safety of Psilocybin

Psilocybin mushrooms have been used ritually by native peoples in Mexico in religious ceremonies and for healing from as early as 3000 years ago up until the 16th century, after which the Spanish prohibited their use (Schultes, Hofmann, & Rätsch, 2001). Historical accounts of psilocybin-associated fatalities involve situations that are clearly compounded by other factors: accidental over-ingestion by a child, concomitant heroin overdose, and psychological disturbance (e.g. jumping from a window with the belief one could fly) (Nichols, 2004; van Amsterdam, Opperhuizen, & van den Brink, 2011). The effective oral hallucinogenic dose of psilocybin ranges from 4 to 20 mg (0.06 to 0.3 mg/kg), whereas the LD50 for oral psilocybin ranges from 12.5 mg/kg in rabbits to 285 mg/kg in rats and mice (Nichols, 2004; Passie *et al.*, 2002; Usdin & Efron, 1972; van Amsterdam *et al.*, 2011). Therefore, the LD50 in humans is likely on the order of grams (Passie *et al.*, 2002). There are no human cases describing birth defects or complications of pregnancy associated with the use of psilocybin. In a report of one woman who took psilocybin every two weeks during pregnancy, there were no detrimental effects to herself or her baby (Leary, Litwin, & Metzner, 1963). Furthermore, as with other hallucinogens (e.g. LSD), psilocybin is non-addicting (Nichols, 2004; van Amsterdam *et al.*, 2011).

A recent summary of 227 experimental psilocybin sessions in 110 healthy subjects demonstrated safety and tolerability of psilocybin with no evidence of increasing risk of subsequent drug abuse, persisting disorders of perception, prolonged psychosis or other longterm impairments of functioning (Studerus, Kometer, Hasler, & Vollenweider, 2011). The study reported that fatigue, headaches or head pain, lack of energy, difficulty concentrating, a "gone" feeling, lack of appetite, and heavy or tired legs were the most frequent adverse events experienced in the 24 hours following a session with oral psilocybin (Studerus *et al*., 2011). Other unpleasant somatic effects include dizziness, nausea, flushing, increased heart rate, and elevated blood pressure (M. Johnson *et al*., 2008).

Appendix C: References

1. Bogenschutz, M. P., & Forcehimes, A. A. (2015). Therapy Manual: Preparation, Support and Integration (PSI) for use in Psilocybin Assisted Treatment of Alcohol Dependence.
2. Bogenschutz, M. P., & Forcehimes, A. A. (2017). Development of a Psychotherapeutic Model for Psilocybin-Assisted Treatment of Alcoholism. *Journal of Humanistic Psychology*, 57(4), 389-414. http://doi.org/10.1177/0022167816673493
3. Bourzat, F., & Hunter, K. (2018). Consciousness Medicine.
4. Carhart-Harris, R. L., Bolstridge, M., Rucker, J., Day, C. M. J., Erritzoe, D., Kaelen, M., *et al*. (2016). Psilocybin with psychological support for treatment-resistant depression: an openlabel feasibility study. *The Lancet Psychiatry*, 1-9. http://doi.org/10.1016/S2215-0366(16)30065-7
5. Carhart-Harris, R. L., Leech, R., Hellyer, P. J., Shanahan, M., Feilding, A., Tagliazucchi, E., *et al*. (2014). The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Frontiers in Human Neuroscience*, 8, 20. http://doi.org/10.3389/fnhum.2014.00020
6. Carhart-Harris, R. L., Leech, R., Williams, T. M., Erritzoe, D., Abbasi, N., Bargiotas, T., *et al*. (2012). Implications for psychedelic-assisted psychotherapy: functional magnetic resonance imaging study with psilocybin. *The British Journal of Psychiatry*, *200*(3), 238-244. http://doi.org/10.1192/bjp.bp.111.103309
7. Carhart-Harris, R. L., Roseman, L., Bolstridge, M., Demetriou, L., Pannekoek, J. N., Wall, M. B., *et al*. (2017). Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Scientific Reports*, *7*(1), 1-11. http://doi.org/10.1038/s41598-017-13282-7
8. Chapman, L. K., DeLapp, R., & Williams, M. T. (2018). Impact of race, ethnicity, and culture on the expression and assessment of psychopathology. In D. Beidel, B. Frueh, & M. Hersen (Eds.), *Adult Psychopathology and Diagnosis* (8 ed.).
9. Cheng, H. L., Wang, C., McDermott, R. C., Kridel, M., & Rislin, J. L. (2018). Self-Stigma, Mental Health Literacy, and Attitudes Toward Seeking Psychological Help. *Journal of Counseling & Development*, *96*(1), 64-74. http://doi.org/10.1002/jcad.12178
10. Forman, E. M., Herbert, J. D., Moitra, E., Yeomans, P. D., & Geller, P. A. (2007). A randomized controlled effectiveness trial of acceptance and commitment therapy and cognitive therapy for anxiety and depression. *Behavior Modification*, *31*(6), 772-799. http://doi.org/10.1177/0145445507302202
11. Harris, R. (2009). ACT Made Simple. New Harbinger Publications.
12. Hasler, F., Bourquin, D., Brenneisen, R., Bär, T., & Vollenweider, F. X. (1997). Determination of psilocin and 4-hydroxyindole-3-acetic acid in plasma by HPLC-ECD and pharmacokinetic profiles of oral and intravenous psilocybin in man. *Pharmaceutica Acta Helvetiae*, *72*(3), 175-184. http://doi.org/10.1016/S0031-6865(97)00014-9
13. Hayes, S. C. (2002). Buddhism and acceptance and commitment therapy. *Cognitive and Behavioral Practice*, *9*(1), 58-66. http://doi.org/10.1016/S1077-7229(02)80041-4
14. Hayes, S. C., & Toarmino, D. (1995). If Behavioral Principles Are Generally Applicable, Why Is It Necessary to Understand Cultural Diversity? *Journal of Counseling Psychology*, *28*(25), 257.
15. Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2003). Acceptance and Commitment Therapy. Guilford Press.
16. Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2011). Acceptance and Commitment Therapy. Guilford Publications.
17. Hopf, A., & Eckert, H. (1974). Distribution patterns of 14-C-psilocin in the brains of various animals. *Activitas Nervosa Superior*, *16*(1), 64-66.
18. Johnson, M., Richards, W., & Griffiths, R. (2008). Human hallucinogen research: guidelines for safety. *Journal of Psychopharmacology*, *22*(6), 603-620. http://doi.org/10.1177/0269881108093587
19. Kaelen, M., Giribaldi, B., Raine, J., Evans, L., Timmerman, C., Rodriguez, N., *et al*. (2018). The hidden therapist: evidence for a central role of music in psychedelic therapy. *Psychopharmacology*, *235*(2), 1-15. http://doi.org/10.1007/s00213-017-4820-5
20. Klerman, G. L., Weissman, M. M., Rounsaville, B. J., & Chevron, E. S. (1994). Interpersonal Psychotherapy of Depression. Jason Aronson, Incorporated.
21. Leary, T., Litwin, G. H., & Metzner, R. (1963). Reactions to Psilocybin Administered in a Supportive Environment. *The Journal of Nervous and Mental Disease*, *137*(6), 561-573. http://doi.org/10.1097/00005053-196312000-00007
22. Leary, T., Metzner, R., & Alpert, R. (1995). The Psychedelic Experience. Citadel Press.
23. Levin, M. E., MacLane, C., Daflos, S., Seeley, J., Hayes, S. C., Biglan, A., & Pistorello, J. (2014). Examining psychological inflexibility as a transdiagnostic process across psychological disorders. *Journal of Contextual Behavioral Science*, *3*(3), 155-163. http://doi.org/10.1016/j.jcbs.2014.06.003
24. Ly, C., Greb, A. C., Cameron, L. P., Wong, J. M., Barragan, E. V., Wilson, P. C., *et al*. (2018). Psychedelics Promote Structural and Functional Neural Plasticity. *CellReports*, *23*(11), 3170-3182. http://doi.org/10.1016/j.celrep.2018.05.022
25. MacLean, K. A., Leoutsakos, J.-M. S., Johnson, M. W., & Griffiths, R. R. (2012). Factor Analysis of the Mystical Experience Questionnaire: A Study of Experiences Occasioned by the Hallucinogen Psilocybin. *Journal for the Scientific Study of Religion*, *51*(4), 721-737. http://doi.org/10.1111/j.1468-5906.2012.01685.x
26. McCracken, L. M. (2005). Contextual cognitive-behavioral therapy for chronic pain. Intl Assn for the Study of Pain.
27. McCracken, L. M., & Gutiérrez-Martínez, O. (2011). Processes of change in psychological flexibility in an interdisciplinary group-based treatment for chronic pain based on Acceptance and Commitment Therapy. *Behaviour Research and Therapy*, *49*(4), 267-274. http://doi.org/10.1016/j.brat.2011.02.004
28. McHugh, L., Stewart, I., & Almada, P. (2019). A Contextual Behavioral Guide to the Self. New Harbinger Publications.
29. Michaels, T. I., Purdon, J., Collins, A., & Williams, M. T. (2018). Inclusion of people of color in psychedelic-assisted

psychotherapy: a review of the literature. *BMC Psychiatry*, *18*(1), 1-14. http://doi.org/10.1186/s12888-018-1824-6

30. National Institute of Health. (2018). Psilocybin-Induced Neuroplasticity in the Treatment of Major Depressive Disorder. Retrieved from https://clinicaltrials.gov/ct2/show/NCT03554174
31. Nichols, D. E. (2004). Hallucinogens. *Pharmacology & Therapeutics*, *101*(2), 131-181. http://doi.org/10.1016/j.pharmthera.2003.11.002
32. Nielsen, L., Riddle, M., King, J. W., Aklin, W. M., Chen, W., Clark, D., *et al*. (2018). The NIH Science of Behavior Change Program: Transforming the science through a focus on mechanisms of change. *Behaviour Research and Therapy*, *101*, 3-11. http://doi.org/10.1016/j.brat.2017.07.002
33. Parker, G. (2005). Beyond major depression. *Psychol Med*, *35*(4), 467-474. http://doi.org/10.1017/S0033291704004210
34. Passie, T., Seifert, J., Schneider, U., & Emrich, H. M. (2002). The pharmacology of psilocybin. *Addiction Biology*, *7*(4), 357-364. http://doi.org/10.1080/1355621021000005937
35. Polk, K. L., & Schoendorff, B. (2014). The ACT Matrix. New Harbinger Publications.
36. Pollan, M. (2019). How to Change Your Mind. Penguin Books.
37. Richards, W. A. (2015). Sacred Knowledge. New York: Columbia University Press. http://doi.org/10.7312/rich17406
38. Ryan, R. M., Huta, V., & Deci, E. L. (2008). Living well: A self-determination theory perspective on eudaimonia. *Journal of Happiness Studies*, *9*(1), 139-170. http://doi.org/10.1007/s10902-006-9023-4
39. Sabo, B. M. (2006). Compassion fatigue and nursing work: Can we accurately capture the consequences of caring work? *International Journal of Nursing Practice*, *12*(3), 136-142. http://doi.org/10.1111/j.1440-172X.2006.00562.x
40. Schulenberg, S. E., Hutzell, R. R., Nassif, C., & Rogina, J. M. (2008). Logotherapy for clinical practice. *Psychotherapy: Theory, Research, Practice, Training*, *45*(4), 447-463. http://doi.org/10.1037/a0014331
41. Schultes, R. E., Hofmann, A., & Rätsch, C. (2001). Plants of the Gods. Healing Arts Press.
42. Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2018). Mindfulness-Based Cognitive Therapy for Depression. New York: The Guilford Press.
43. Sloshower, J. A. (2018). Integrating Psychedelic Medicines and Psychiatry: Theory and Methods of a Model Clinic. In B. C. Labate & C. Cavnar (Eds.), *Plant Medicines, Healing and Psychedelic Science Cultural Perspectives* (pp. 113-132). Cham: Springer. http://doi.org/10.1007/978-3-319-76720-8
44. Sloshower, J., Guss, J., Krause, R., Wallace, R. M., Williams, M. T., Reed, S., & Skinta, M. D. (2019). Psilocybin-assisted therapy of major depressive disorder using Acceptance and Commitment Therapy as a therapeutic frame. *Journal of Contextual Behavioral Science*, *15*, 12-19. http://doi.org/10.1016/j.jcbs.2019.11.002
45. Sobczak, L. R., & West, L. M. (2013). Clinical Considerations in Using Mindfulness- and Acceptance-Based Approaches With Diverse Populations: Addressing Challenges in Service Delivery in Diverse Community Settings. *Cognitive and Behavioral Practice*, *20*(1), 13-22. http://doi.org/10.1016/j.cbpra.2011.08.005
46. Stolaroff, M. (2004). The Secret Chief Revealed (pp. 1-96).
47. Studerus, E., Kometer, M., Hasler, F., & Vollenweider, F. X. (2011). Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *Journal of Psychopharmacology (Oxford, England)*, *25*(11), 1434-1452. http://doi.org/10.1177/0269881110382466
48. Swift, T. C., Belser, A. B., Agin-Liebes, G., Devenot, N., Terrana, S., Friedman, H. L., *et al*. (2017). Cancer at the Dinner Table: Experiences of Psilocybin-Assisted Psychotherapy for the Treatment of Cancer-Related Distress. *Journal of Humanistic Psychology*, *57*(5), 488-519. http://doi.org/10.1177/0022167817715966
49. Tzu, L., Laozi. (2008). Tao Te Ching. Penguin.
50. Usdin, E., & Efron, D. H. (1972). Psychotropic Drugs and Related Compounds. National Institute of Mental Health.
51. van Amsterdam, J., Opperhuizen, A., & van den Brink, W. (2011). Harm potential of magic mushroom use: A review. *Regulatory Toxicology and Pharmacology*, *59*(3), 423-429. http://doi.org/10.1016/j.yrtph.2011.01.006
52. Vollenweider, F. X., & Kometer, M. (2010). The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. *Nature Publishing Group*, *11*(9), 642-651. http://doi.org/10.1038/nrn2884
53. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F., Bäbler, A., Vogel, H., & Hell, D. (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport*, *9*(17), 3897-3902.
54. Vollenweider, F. X., Vontobel, P., Hell, D., & Leenders, K. L. (1999). 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man - A PET study with [C-11]raclopride. *Neuropsychopharmacology*, *20*(5), 424-433. http://doi.org/10.1016/S0893-133X(98)00108-0
55. Wilson, K. G., Sandoz, E. K., Kitchens, J., & Roberts, M. (2017). The Valued Living Questionnaire: Defining and Measuring Valued Action within a Behavioral Framework. *The Psychological Record*, *60*(2), 249-272. http://doi.org/10.1007/BF03395706
56. Woidneck, M. R., Pratt, K. M., Gundy, J. M., Nelson, C. R., & Twohig, M. P. (2012). Exploring cultural competence in acceptance and commitment therapy outcomes. *Professional Psychology: Research and Practice*, *43*(3), 227-233. http://doi.org/10.1037/a0026235
57. Zettle, R. D. (2007). ACT for Depression. New Harbinger Publications.
58. Zettle, R. D. (2015). Acceptance and commitment therapy for depression. *Current Opinionin Psychology*, *2*, 65-69. http://doi.org/10.1016/j.copsyc.2014.11.011

Psychedelics Promote Structural and Functional Neural Plasticity

by

Calvin Ly[1], Alexandra C. Greb[1], Lindsay P. Cameron[2], Jonathan M. Wong[2], Eden V. Barragan[2], Paige C. Wilson[3], Kyle F. Burbach[4], Sina Soltanzadeh Zarandi[1], Alexander Sood[5], Michael R. Paddy[3], Whitney C. Duim[1], Megan Y. Dennis[4,6,7], A. Kimberley McAllister[5,8,9], Kassandra M. Ori-McKenney[3], John A. Gray[5,8], and David E. Olson[1,5,6,10,*]

Ly *et al.*, 2018, Cell Reports 23, 3170-3182

June 12, 2018
https://doi.org/10.1016/j.celrep.2018.05.022

© 2018 The Author(s)

original report: https://www.cell.com/cell-reports/pdfExtended/S2211-1247(18)30755-1

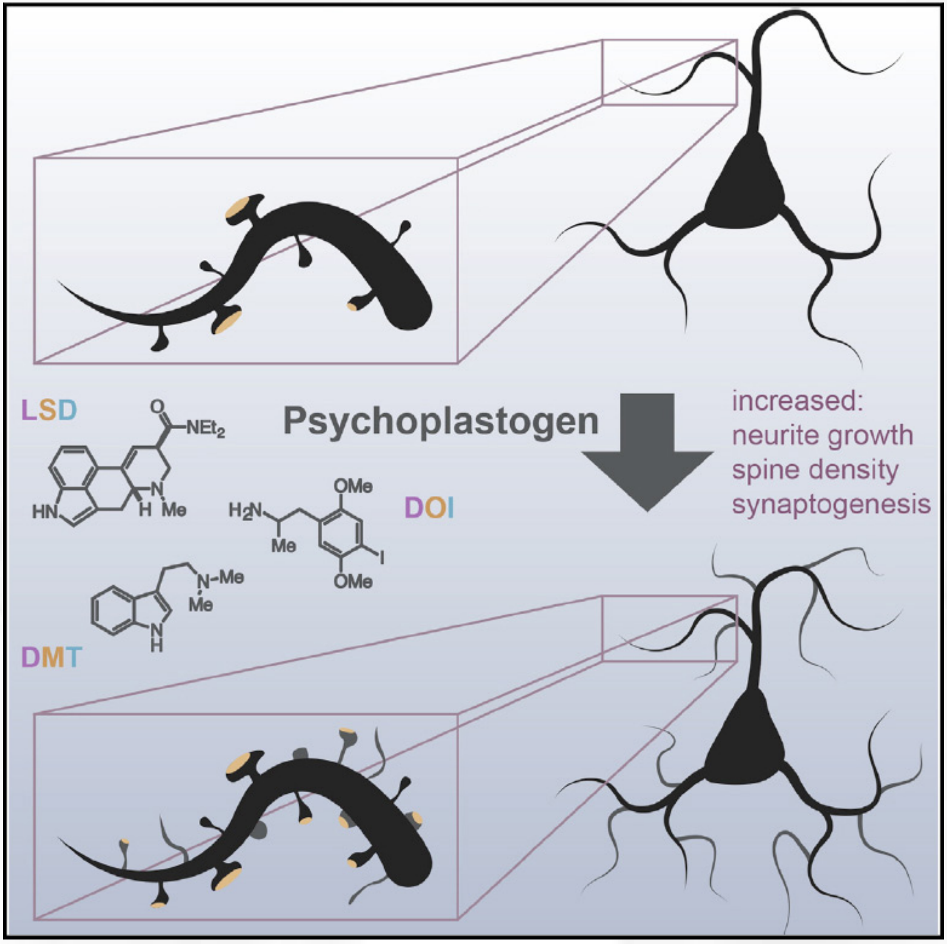
[1]Department of Chemistry, University of California, Davis, Davis, CA 95616, USA
[2]Neuroscience Graduate Program, University of California, Davis, Davis, CA 95618, USA
[3]Department of Molecular and Cellular Biology, University of California, Davis, Davis, CA 95616, USA
[4]Genome Center, University of California, Davis, Davis, CA 95616, USA
[5]Center for Neuroscience, University of California, Davis, Davis, CA 95618, USA
[6]Department of Biochemistry and Molecular Medicine, School of Medicine, University of California, Davis, Sacramento, CA 95817, USA
[7]MIND Institute, University of California, Davis, Sacramento, CA 95817, USA
[8]Department of Neurology, School of Medicine, University of California, Davis, Sacramento, CA 95817, USA
[9]Department of Neurobiology, Physiology, and Behavior, University of California, Davis, Davis, CA 95616, USA
[10]Lead Contact
[*]Correspondence: deolson@ucdavis.edu

Table of Contents:

- **Summary**
- **Introduction**
- **Results**
  - Psychedelics Promote Neuritogenesis
  - Psychedelics Promote Spinogenesis and Synaptogenesis
  - Psychedelics Promote Plasticity through a TrkBand mTOR-Dependent Mechanism
  - The 5-HT2A Receptor Mediates the Effects of Psychedelics on Structural Plasticity
- **Discussion**
- **Experimental Procedures**
  - Drugs
  - Animals
  - Cell Culture
  - Statistical Analysis
- **Acknowledgments**
- **Author Contributions**
- **Declaration of Interests**
- **References**
- **Supplemental Information**
  - Supplemental Methods
    - *Drugs*
    - *Neuritogenesis Experiments*
    - *Spinogenesis Experiments*

  - Synaptogenesis Experiments
  - ELISA
  - ddPCR
  - 5-HT2A Staining Experiments
  - Drosophila Experiments
  - Zebrafish Experiments
  - Golgi-Cox Staining
  - Electrophysiology
- Code Availability
- Data Availability
- Supplemental References

Graphical Abstract



Summary

Atrophy of neurons in the prefrontal cortex (PFC) plays a key role in the pathophysiology of depression and related disorders. The ability to promote both structural and functional plasticity in the PFC has been hypothesized to underlie the fast-acting antidepressant properties of the dissociative anesthetic ketamine. Here, we report that, like ketamine, serotonergic psychedelics are capable of robustly increasing neuritogenesis and/or spinogenesis both *in vitro* and *in vivo*. These changes in neuronal structure are accompanied by increased synapse number and function, as measured by fluorescence microscopy and electrophysiology. The structural changes induced by psychedelics appear to result from stimulation of the TrkB, mTOR, and 5-HT$_{2A}$ signaling pathways and could possibly explain the clinical effectiveness of these compounds. Our results underscore the therapeutic potential of psychedelics and, importantly, identify several lead scaffolds for medicinal chemistry efforts focused on developing plasticity-promoting compounds as safe, effective, and fast-acting treatments for depression and related disorders.

Introduction

Neuropsychiatric diseases, including mood and anxiety disorders, are some of the leading causes of disability worldwide and place an enormous economic burden on society (Gustavsson *et al.*, 2011; Whiteford *et al.*, 2013). Approximately one-third of patients will not respond to current antidepressant drugs, and those who do will usually require at least 2-4 weeks of treatment before they experience any beneficial effects (Rush *et al.*, 2006). Depression, post-traumatic stress disorder (PTSD), and addiction share common neural circuitry (Arnsten, 2009; Russo *et al.*, 2009; Peters *et al.*, 2010; Russo and Nestler, 2013) and have high comorbidity (Kelly and Daley, 2013). A preponderance of evidence from a combination of human imaging, postmortem studies, and animal models suggests that atrophy of neurons in the prefrontal cortex (PFC) plays a key role in the pathophysiology of depression and related disorders and is precipitated and/or exacerbated by stress (Arnsten, 2009; Autry and Monteggia, 2012; Christoffel *et al.*, 2011; Duman and Aghajanian, 2012; Duman *et al.*, 2016; Izquierdo *et al.*, 2006; Pittenger and Duman, 2008; Qiao *et al.*, 2016; Russo and Nestler, 2013). These structural changes, such as the retraction of neurites, loss of dendritic spines, and elimination of synapses, can potentially be counteracted by compounds capable of promoting structural and functional neural plasticity in the PFC (Castrén and Antila, 2017; Cramer *et al.*, 2011; Duman, 2002; Hayley and Litteljohn, 2013; Kolb and Muhammad, 2014; Krystal *et al.*, 2009; Mathew *et al.*, 2008), providing a general solution to treating all of these related diseases. However, only a relatively small number of compounds capable of promoting plasticity in the PFC have been identified so far, each with significant drawbacks (Castrén and Antila, 2017). Of these, the dissociative anesthetic ketamine has shown the most promise, revitalizing the field of molecular psychiatry in recent years.

Ketamine has demonstrated remarkable clinical potential as a fast-acting antidepressant (Berman *et al.*, 2000; Ionescu *et al.*, 2016; Zarate *et al.*, 2012), even exhibiting efficacy in treatment-resistant populations (Diaz-Granados *et al.*, 2010; Murrough *et al.*, 2013; Zarate *et al.*, 2006). Additionally, it has shown promise for treating PTSD (Feder *et al.*, 2014) and heroin addiction (Krupitsky *et al.*, 2002). Animal models suggest that its therapeutic effects stem from its ability to promote the growth of dendritic spines, increase the synthesis of synaptic proteins, and strengthen synaptic responses (Autry *et al.*, 2011; Browne and Lucki, 2013; Li *et al.*, 2010).

Like ketamine, serotonergic psychedelics and entactogens have demonstrated rapid and long-lasting antidepressant and anxiolytic effects in the clinic after a single dose (Bouso *et al.*, 2008; Carhart-Harris and Goodwin, 2017; Grob *et al.*, 2011; Mithoefer *et al.*, 2013, 2016; Nichols *et al.*, 2017; Sanches *et al.*, 2016; Osório *et al.*, 2015), including in treatment-resistant populations (Carhart-Harris *et al.*, 2016, 2017; Mithoefer *et al.*, 2011; Oehen *et al.*, 2013; Rucker *et al.*, 2016). In fact, there have been numerous clinical trials in the past 30 years examining the therapeutic effects of these drugs (Dos Santos *et al.*, 2016), with 3,4-methylenedioxymethamphetamine (MDMA) recently receiving the "breakthrough therapy" designation by the Food and Drug Administration for treating PTSD. Furthermore, classical psychedelics and entactogens produce antidepressant and anxiolytic responses in rodent behavioral tests, such as the forced swim test (Cameron *et al.*, 2018) and fear extinction learning (Cameron *et al.*, 2018; Catlow *et al.*, 2013; Young *et al.*, 2015), paradigms for which ketamine has also been shown to be effective (Autry *et al.*, 2011; Girgenti *et al.*, 2017; Li *et al.*, 2010). Despite the promising antidepressant, anxiolytic, and anti-addictive properties of serotonergic psychedelics, their therapeutic mechanism of action remains poorly understood, and concerns about safety have severely limited their clinical usefulness.

Because of the similarities between classical serotonergic psychedelics and ketamine in both preclinical models and clinical studies, we reasoned that their therapeutic effects might result from a shared ability to promote structural and functional neural plasticity in cortical neurons. Here, we report that serotonergic psychedelics and entactogens from a variety of chemical classes (e.g., amphetamine, tryptamine, and ergoline) display plasticity-promoting properties comparable to or greater than ketamine. Like ketamine, these compounds stimulate structural plasticity by activating the mammalian target of rapamycin (mTOR). To classify the growing number of compounds capable of rapidly promoting induced plasticity (Castrén and Antila, 2017), we introduce the term "psychoplastogen," from the Greek roots psych- (mind), -plast (molded), and -gen (producing). Our work strengthens the growing body of literature indicating that psychoplastogens capable of promoting plasticity in the PFC might have value as fast-acting antidepressants and anxiolytics with efficacy in treatment-resistant populations and suggests that it may be possible to use classical psychedelics as lead structures for identifying safer alternatives.

Results

Psychedelics Promote Neuritogenesis

Because atrophy of cortical neurons is believed to be a contributing factor to the development of mood and anxiety disorders (Christoffel *et al.*, 2011; Duman and Aghajanian, 2012), we first treated cultured cortical neurons with psychedelics from a variety of structural classes (Figures 1A and S1A) and measured the resulting changes in various morphological features. Using Sholl analysis (Ristanovi&cacute; *et al.*, 2006), we observed that several psychedelics increased dendritic arbor complexity comparably to ketamine, as measured by the area under the curve of the Sholl plots as well as the maximum number of crossings (Figures 1B-1E and S1B-S1E). This increase in arbor complexity appeared to result from large changes in both the number of dendritic branches and the total length of the arbors (Figures 1F, 1H, S1F, and S1H). Psychedelics had a limited effect on the number of primary dendrites and did not alter the length of the longest dendrite (Figures 1G, 1I, S1G, and S1I).

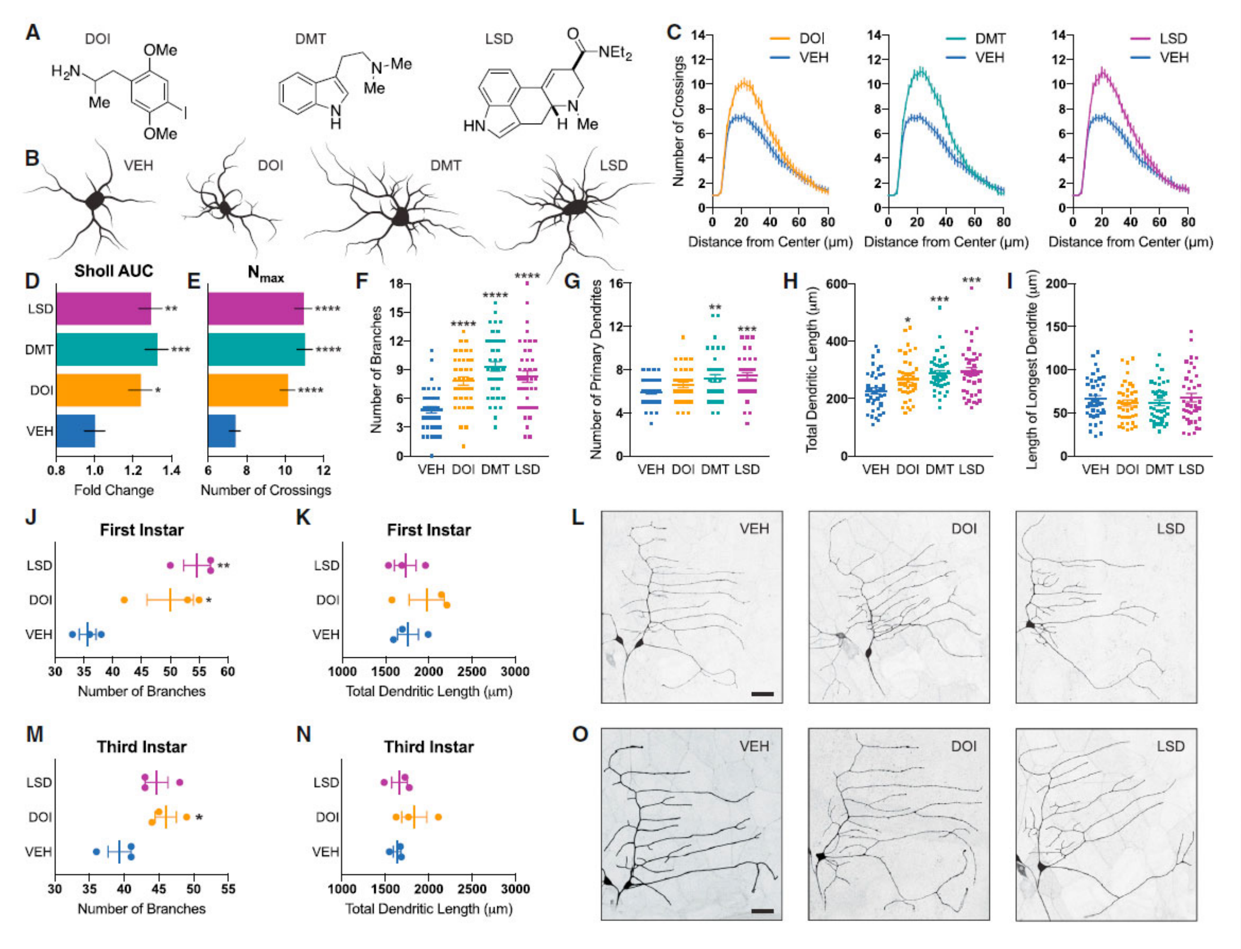


Figure 1. Psychedelics Promote Neuritogenesis both *In Vitro* and *In Vivo*
(A) Chemical structures of psychedelics.
(B) Representative tracings of cortical neurons (DIV6) treated with compounds.
(C) Sholl analysis demonstrates that psychedelics increase dendritic arbor complexity (*n* = 39-41 neurons).
(D) Area under the curve (AUC) of the Sholl plots in (C).
(E) Maximum number of crossings (N_{max}) of the Sholl plots in (C).
(F-I) Cortical neurons treated with psychedelics display an increase in the number of branches (F), the number of primary dendrites (G), and the total length of the dendritic arbor (H) but not the length of the longest dendrite (I).
(J and K) Class I neurons from *Drosophila* larvae treated with psychedelics during the first instar display increased branching (J) but not total length of the dendritic arbor (K) (*n* = 3 neurons).
(L) Representative images of neurons from (J) and (K).
(M and N) Class I neurons from *Drosophila* larvae treated with psychedelics during the third instar display increased branching (M) but not total length of the dendritic arbor (N) (*n* = 3 neurons).
(O) Representative images from (M) and (N).
$*p < 0.05$, $**p < 0.01$, $***p < 0.001$, $****p < 0.0001$, as compared to vehicle control (VEH). Scale bars, 30 µm. Data are represented as mean ± SEM. See also Figures S1-S5.

Nearly all psychedelic compounds tested were capable of robustly promoting neuritogenesis, with comparable effects being produced by tryptamines (*N,N*-dimethyltryptamine [DMT] and psilocin), amphetamines (2,5-dimethoxy-4-iodoamphetamine [DOI] and MDMA), and ergolines (lysergic acid diethylamide [LSD]). As a positive control, we treated cells with 7,8-dihydroxyflavone (DHF), a psychoplastogen structurally dissimilar to classical psychedelics (Jang *et al.*, 2010), and found that it also increased dendritic arbor complexity (Figure S2). This neurite outgrowth structural phenotype seems to only be induced by select compounds because serotonin and D-amphetamine, molecules that are chemically related to classical psychedelics and entactogens, exerted minimal to no effects on neuritogenesis (Figure S2).

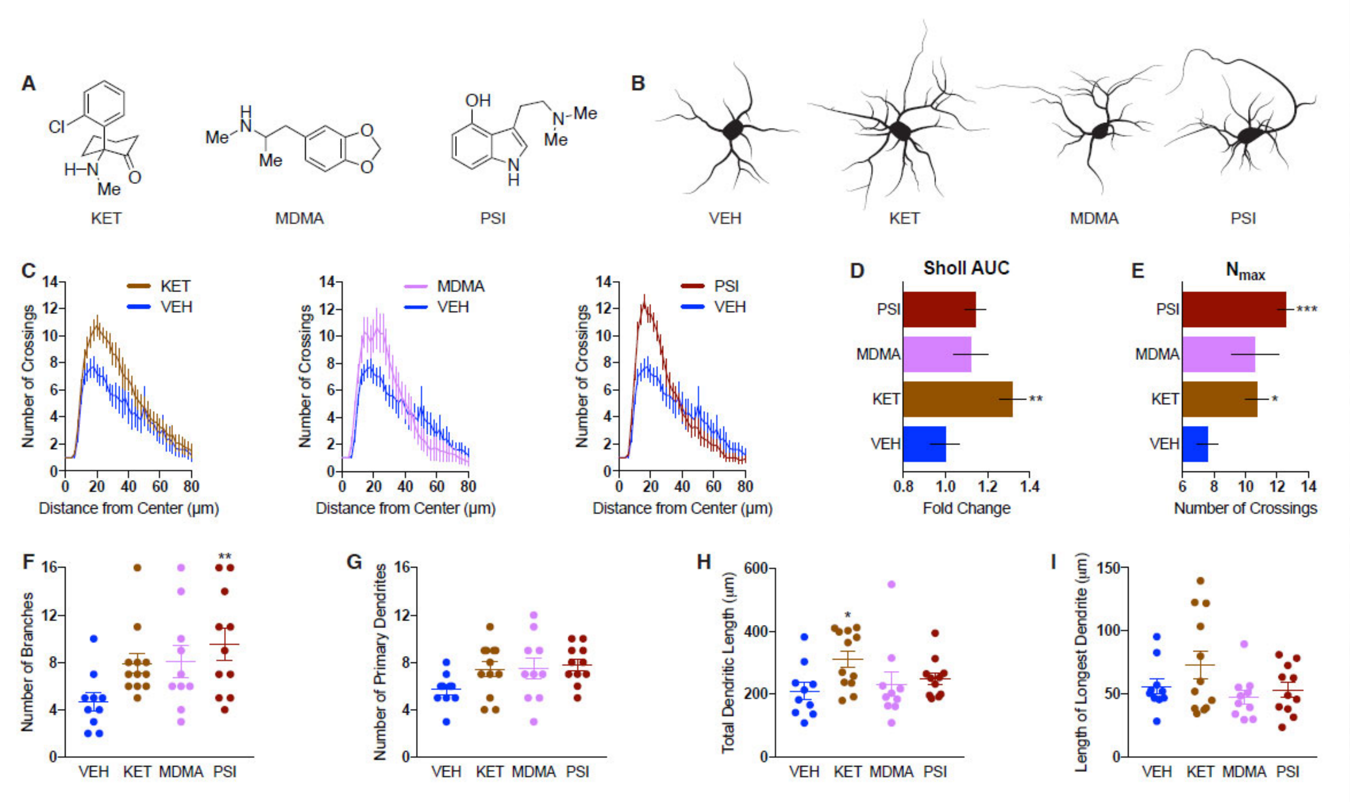


Figure S1. Psychedelics Promote Neuritogenesis (Additional Compounds), Related to Figure 1. (A) Chemical structures of additional psychedelics used in these studies. (B) Representative tracings of cultured embryonic rat cortical neurons (DIV6) treated with compounds. (C) Sholl analysis (circle radii = 2 μm increments) demonstrates that cultured cortical neurons treated with several psychedelics have more complex dendritic arbors as compared to vehicle control (n = 10-12 neurons per treatment). (D) Area under the curve (AUC) of the Sholl plots in C. (E) Maximum number of crossings (N_{max}) of the Sholl plots in C. (F-I) Cultured cortical neurons treated with several psychedelics display a trend towards an increase in the number of branch points (F), the number of primary dendrites (G), and the total length of the dendritic arbor (H), but not the length of the longest dendrite (I). Error bars represent s.e.m. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$, as compared to vehicle control (One-way ANOVA with Dunnett's post-hoc test). VEH = vehicle, KET= ketamine, MDMA = (±)-3,4-methylenedioxymethamphetamine, PSI = psilocin.

To establish the relative potencies and efficacies of hallucinogens and entactogens for promoting neurite outgrowth, we conducted 8-point dose-response studies (Figure S3). We defined 100% and 0% efficacy as the maximum number of crossings induced by ketamine (10 μM) and vehicle (0.1% DMSO), respectively. We chose the 10 μM concentration of ketamine as the upper limit because this concentration of ketamine is reached in the brain following intraperitoneal administration of an antidepressant dose in rats (Yang *et al.*, 2018). For consistency, we used this same concentration when testing the effects of psychedelics and entactogens, with DMT being the only exception. We used a maximum 90 μM concentration of DMT in our studies to more closely mimic the brain concentration of DMT in rats treated with an antidepressant dose (Cohen and Vogel, 1972; Cameron *et al.*, 2018). In this neuritogenesis assay, ketamine's half maximal effective concentration (EC_{50}) value was 132 nM. Surprisingly, the majority of the psychedelics and entactogens we tested exhibited significantly greater potency than ketamine, with LSD being particularly potent (EC_{50} = 0.409 nM). In fact, LSD exhibited activity across 8 orders of magnitude into the low picomolar range (Figure S3).

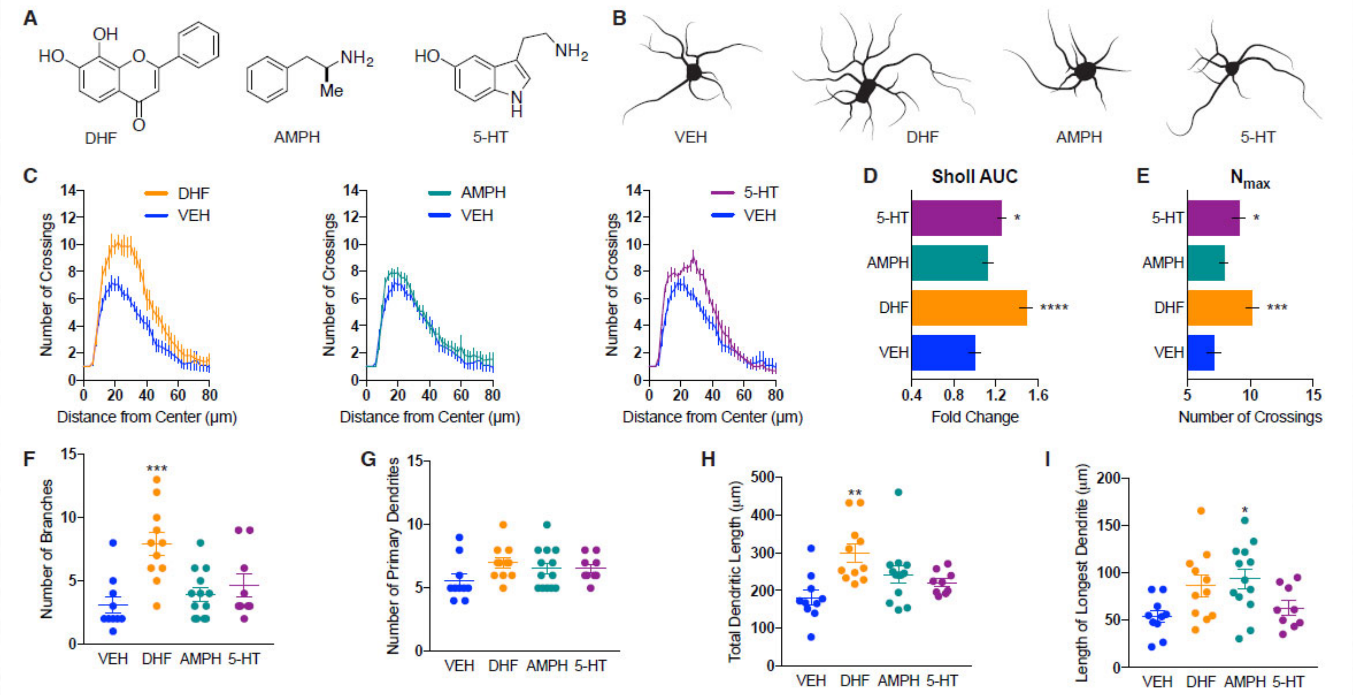


Figure S2. Structural Plasticity is Promoted by a TrkB Agonist, but Not a Psychostimulant or Monoamine Neurotransmitter Structurally Related to Classical Psychedelics, Related to Figure 1. (A) Chemical structures of control compounds used in these studies (DHF = positive control, AMPH and 5HT = negative controls). (B) Representative tracings of cultured embryonic rat cortical neurons (DIV6) treated with compounds. (C) Sholl analysis (circle radii = 2 µm increments) demonstrates that cultured cortical neurons treated with DHF, a TrkB agonist, have more complex dendritic arbors as compared to vehicle control. However, AMPH and 5-HT were not able to elicit a similar response (n = 9-13 neurons per treatment). (D) Area under the curve (AUC) of the Sholl plots in C. (E) Maximum number of crossings (N_{max}) of the Sholl plots in C. (F-I) Cultured cortical neurons treated with DHF, but not AMPH or 5-HT, exhibited an increased number of branch points (F) and total length of the dendritic arbor (H), but minimal changes in the number of primary dendrites (G) or the length of the longest dendrite (I). Error bars represent s.e.m. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$, $****p < 0.0001$ as compared to vehicle control (One-way ANOVA with Dunnett's post-hoc test). VEH = vehicle, AMPH = D-Amphetamine, 5-HT = 5-hydroxytryptamine (serotonin), DHF = 7,8-dihydroxyflavone.

Notably, the anti-addictive alkaloid ibogaine (Alper, 2001; Belgers *et al.*, 2016) was the only psychedelic tested that had absolutely no effect (Figure S4). This was a surprising result because we hypothesized that ibogaine's long-lasting antiaddictive properties might result from its psychoplastogenic properties. Previous work by He *et al.* (2005) clearly demonstrated that ibogaine increases the expression of glial cell linederived neurotrophic factor (GDNF) and that this plasticity-promoting protein is critical to ibogaine's anti-addictive mechanism of action. Because several reports have suggested that noribogaine, a metabolite of ibogaine, might actually be the active compound *in vivo* (Zubaran *et al.*, 1999; Baumann *et al.*, 2000, 2001), we decided to test its ability to promote neuritogenesis in cultured cortical neurons. Gratifyingly, noribogaine robustly increased dendritic arbor complexity with an EC_{50} value comparable to ketamine (Figure S3), providing additional evidence suggesting that it may be the active compound *in vivo*.

To assess the *in vivo* effects of classical psychedelics on neuritogenesis, we started treating *Drosophila* larvae during the first instar with LSD and DOI. As observed in rodent cortical cultures, both LSD and DOI significantly increased dendritic branching of class I sensory neurons; however, they did not increase the total length of the dendritic arbors (Figures 1J-1L). Because of the striking effects of psychedelics on the structures of immature neurons, we hypothesized that they might influence neurodevelopment. To test this, we chronically treated zebrafish embryos with compounds for 6 days immediately following dechorionation and assessed gross morphological changes and behavior. We did not observe any differences in head sizes between the treatment groups, nor did we detect any statistically significant differences in activity levels (Figure S5). Next we assessed the ability of psychedelics to promote neuritogenesis in more mature neurons by starting to treat *Drosophila* larvae during the late second instar. Again, psychedelics increased the branching of class I neurons, although the effect was less dramatic than that observed when treatment was started during the first instar (Figure 1M-1O). Although different developmental stages might be more or less susceptible to the effects of psychedelics, it is also possible that the smaller effect size observed after administering compounds starting at the later time point was simply the result of treating the larvae for a shorter period of time. Regardless, it was quite surprising to observe compound-induced changes in neuronal structure after initiating treatment during the late second instar because class I neurons are stereotyped and typically possess relatively few higher-order branches (Grueber *et al.*, 2002). Moreover, our results demonstrate that psychedelics can promote changes in neuronal structure across vertebrate (rats) and invertebrate (*Drosophila*) species, suggesting that they act through an evolutionarily conserved mechanism.

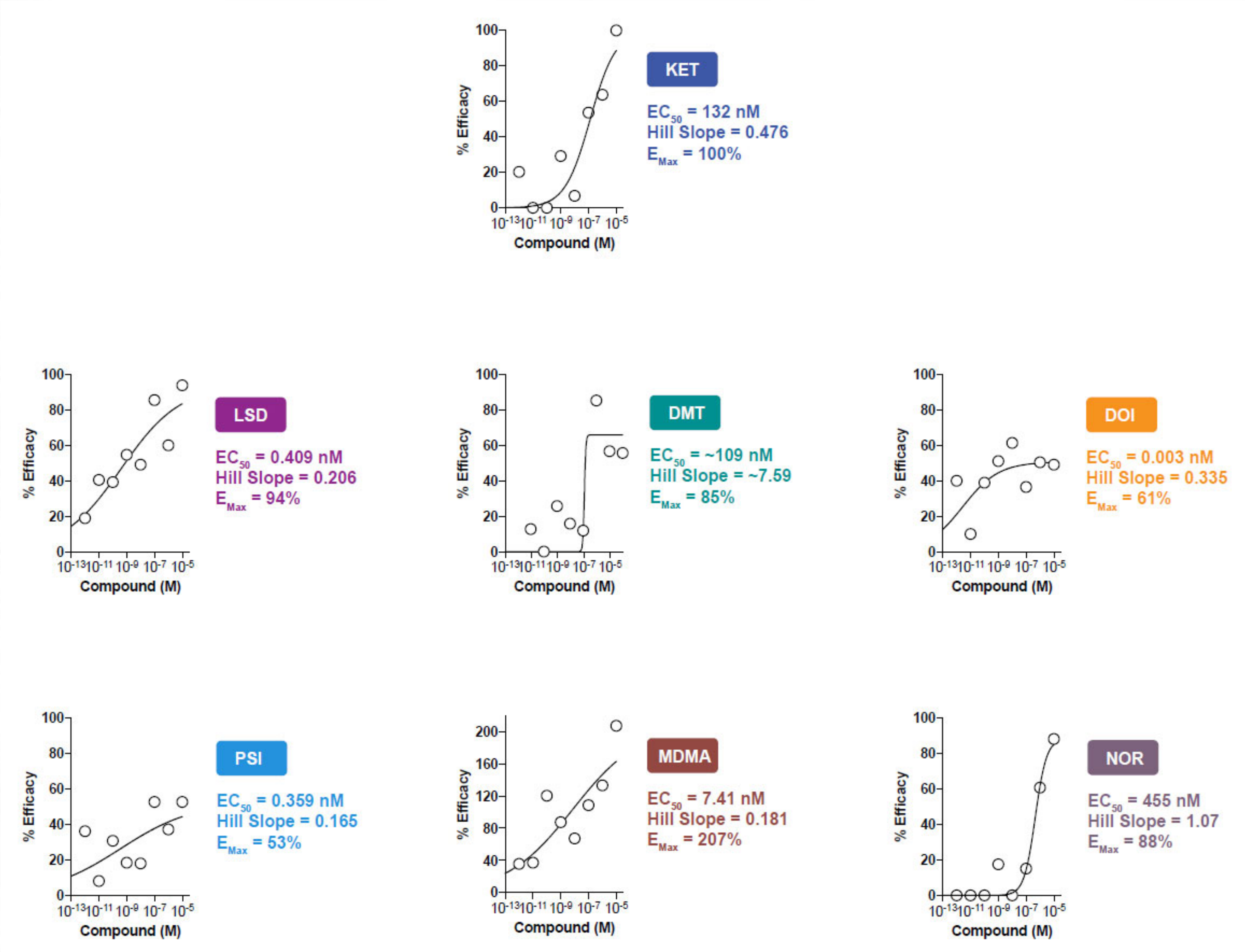


Figure S3. Psychedelics Promote Neuritogenesis in a Dose-Dependent Manner, Related to Figure 1. Cultured embryonic rat cortical neurons (DIV6) were treated with 8 decreasing concentrations of each compound (1Array-fold dilutions) and subjected to Sholl analysis. The N$_{max}$ values obtained following treatment with 1Array µM ketamine and vehicle (Array.1% DMSO) were defined as 1ArrayArray% and Array% respectively. The maximum number of crossings (N$_{max}$) of the Sholl plots are reported relative to these values. Using nonlinear regression analysis, EC$_{5Array}$ values and Hill slopes were calculated. Maximum efficacy relative to 1Array µM ketamine is also shown. Most of the compounds display Hill slopes substantially different from 1, which suggests that this cellular phenotype is not mediated by binding to a single site and implies polypharmacology. KET = ketamine, LSD = lysergic acid diethylamide, DMT = N,N-dimethyltryptamine, DOI = (±)-2,5-dimethoxy-4-iodoamphetamine, PSI = psilocin, MDMA = (±)-3,4-methylenedioxymethamphetamine, NOR = noribogaine.

Psychedelics Promote Spinogenesis and Synaptogenesis

In addition to dendritic atrophy, loss of dendritic spines is a hallmark of depression and other neuropsychiatric disorders (Christoffel *et al.*, 2011; Duman and Aghajanian, 2012), so we next assessed the effects of psychedelics on spinogenesis. We treated mature rat cortical cultures for 24 hr with DOI, DMT, and LSD as representative compounds from the amphetamine, tryptamine, and ergoline classes of psychedelics, respectively. All three compounds increased the number of dendritic spines per unit length, as measured by super-resolution structured illumination microscopy (SIM) (Figures 2A, 2B, and S6), with LSD nearly doubling the number of spines per 10 µm. Additionally, treatment caused a shift in spine morphology, favoring immature (thin and filopodium) over more mature (mushroom) spine types (Figure 2C). Colocalization of pre- and postsynaptic markers following treatment demonstrated that psychedelics promoted synaptogenesis by increasing the density, but not the size of synapses (Figure 2D-2F). This increase in synapse density was accompanied by an increase in the density of VGLUT1 puncta, but not PSD-95 puncta, following compound administration (Figures 2G and 2H).

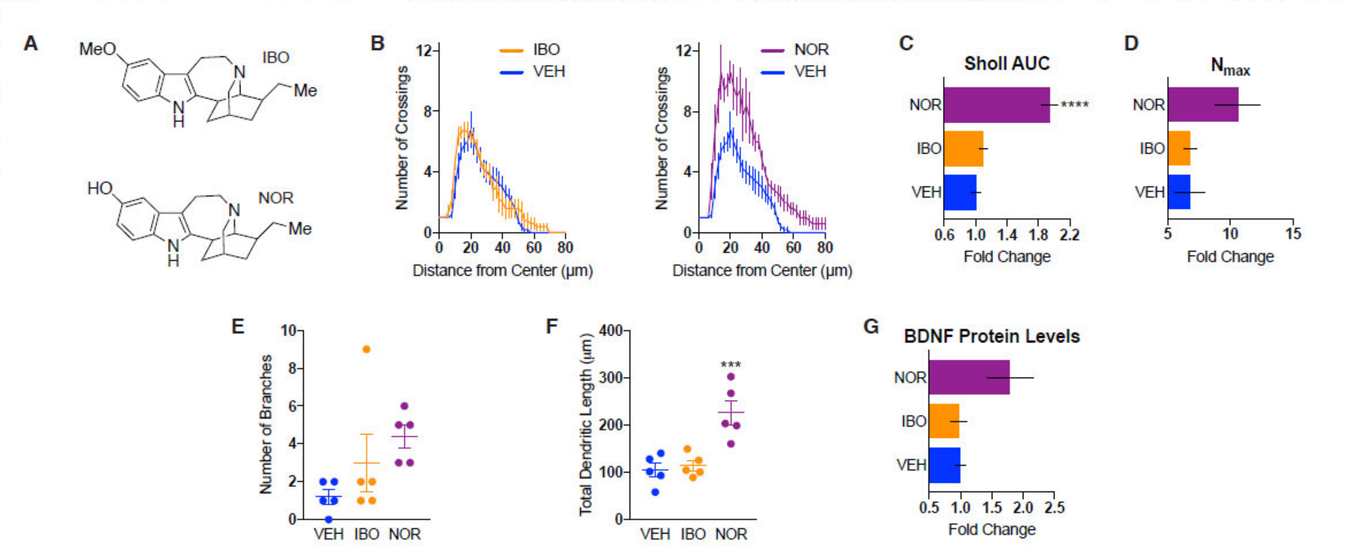


Figure S4. Noribogaine, but Not ibogaine, Promotes Structural Neural Plasticity, Related to Figure 1. (A) Chemical structures of the anti-addictive compound ibogaine and its metabolite noribogaine. (B) Sholl analysis (circle radii = 2 µm increments) demonstrates that cultured embryonic rat cortical neurons (DIV6) treated with noribogaine, but not ibogaine, have more complex dendritic arbors as compared to vehicle control (n = 5 neurons per treatment). (C) Area under the curve (AUC) of the Sholl plots in B. (D) Maximum number of crossings (N_{max}) of the Sholl plots in B. (E-F) Cultured cortical neurons treated with noribogaine, but not ibogaine, exhibited an increased number of branch points (E) and total length of the dendritic arbor (F). (G) Treatment with noribogaine, but not ibogaine, increases BDNF protein levels in DIV18 cultured cortical neurons after 24 h. Error bars represent s.e.m. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$, $****p < 0.0001$ as compared to vehicle control (One-way ANOVA with Dunnett's post-hoc test). VEH = vehicle, IBO = Ibogaine, NOR = Noribogaine.

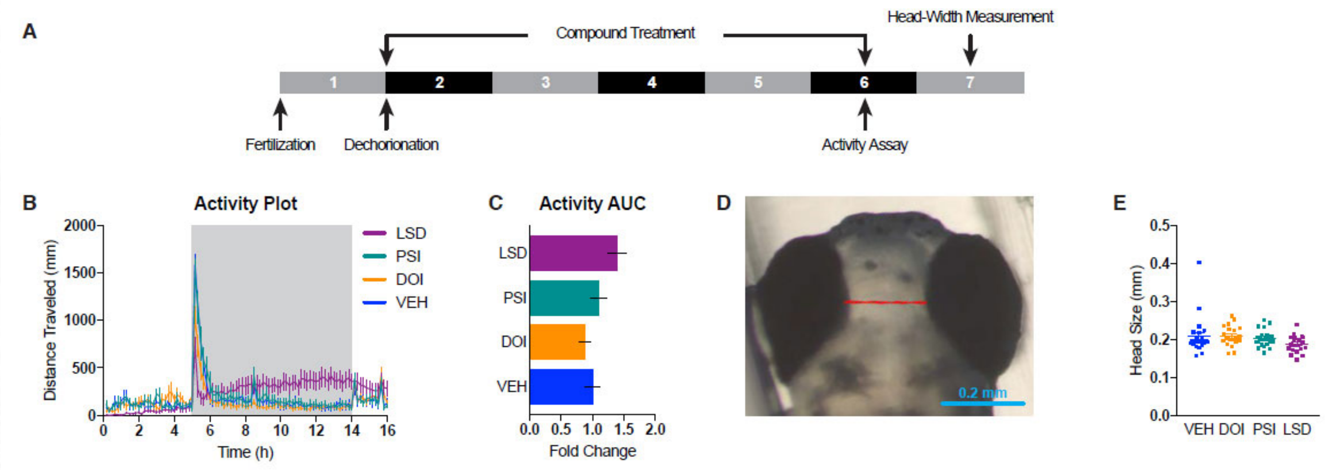


Figure S5. Psychedelics Do Not Induce Behavioral or Gross Morphological Changes in Developing Zebrafish, Related to Figure 1. (A) Experimental design used to assess the effects of psychedelics on zebrafish development. Alternating gray and black blocks represent individual days. Days are numbered in white. (B) Average activity of 5.5 dpf zebrafish (n = 23-24 zebrafish per treatment). The shaded area represents the dark period. A surge in activity immediately followed the transition from light to dark. (C) Area under the curve of the activity plot in B. (D) Representative example of a head-width measurement. (E) Treatment with psychedelics does not affect head size at 6.5 dpf. Error bars represent s.e.m. Treatments did not result in any significant differences as compared to vehicle control (One-way ANOVA with Dunnett's post-hoc test). VEH = vehicle, DOI = (±)-2,5-dimethoxy-4-iodoamphetamine, PSI = Psilocin, LSD = lysergic acid diethylamide, dpf = days post-fertilization.

Encouraged by our *in vitro* results, we next assessed the effects of a single intraperitoneal dose of DMT on spinogenesis in the PFC of adult rats using Golgi-Cox staining. We chose to administer a 10 mg/kg dose of DMT for three reasons. First, all available data suggested that this dose would produce hallucinogenic effects in rats with minimal safety risks (Glennon *et al.*, 1980, 1983; Glennon, 1999; Gatch *et al.*, 2009; Smith *et al.*, 1998; Appel *et al.*, 1999; Winter *et al.*, 2007; Carbonaro *et al.*, 2015; Helsley *et al.*, 1998; Strassman *et al.*, 1994; Nair and Jacob, 2016). Second, we have previously shown that a 10 mg/kg dose of DMT produces positive effects in rat behavioral tests relevant to depression and PTSD (Cameron *et al.*, 2018). Finally, we wanted to directly compare the effects of DMT with ketamine, and seminal studies conducted by Li *et al.* (2010) had previously demonstrated that a 10 mg/kg dose of ketamine produced a robust increase in dendritic spine density in the PFC of rats. We observed a significant increase in the density of dendritic spines on cortical pyramidal neurons 24 hr after dosing with DMT (Figures 2I and 2J). This effect was comparable with that produced by ketamine at the same dose (Figure 2J). Importantly, this DMT-induced increase in dendritic spine density was accompanied by functional effects. *Ex vivo* slice recordings revealed that both the frequency and amplitude of spontaneous excitatory postsynaptic currents (EPSCs) were increased following DMT treatment (Figures 2K-2M). Interestingly, 10 mg/kg and 1 mg/kg doses produced similar responses despite the fact that they are predicted to be hallucinogenic and subhallucinogenic, respectively (Strassman *et al.*, 1994; Nair and Jacob, 2016).

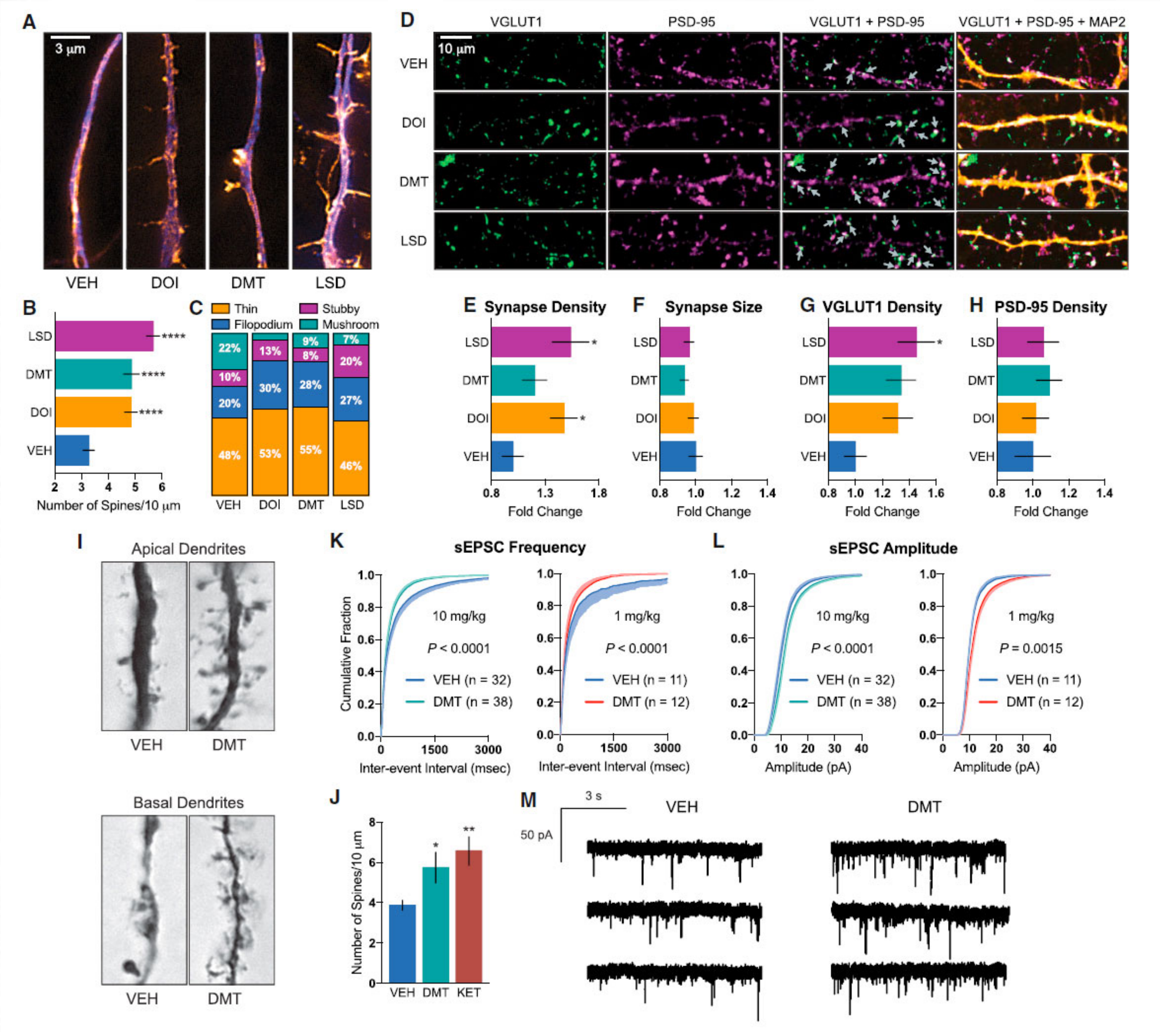


Figure 2. Psychedelics Promote Spinogenesis, Synaptogenesis, and Functional Plasticity
(A) Representative images of cortical neurons (DIV19) treated with compounds for 24 hr, demonstrating that psychedelics increase the number of dendritic spines (blue, MAP2; orange, F-actin).
(B) Quantification of spine density (n = 56-65 neurons).
(C) Relative proportions of spine types following treatment of cortical cultures with psychedelics (n = 16-21 neurons).
(D) Representative images of cortical neurons (DIV19) treated for 24 hr, demonstrating that psychedelics increase synaptogenesis (green, VGLUT1; magenta, PSD-95; yellow, MAP2). White areas in the VGLUT1 + PSD-95 images indicate colocalization of pre- and postsynaptic makers and are indicated by gray arrows.
(E-H) Quantification of synapse density (E), synapse size (F), presynaptic density (VGLUT1) (G), and postsynaptic density (PSD-95) (H) following 24-hr treatment of cortical neurons (DIV19) (n = 39-42 neurons).
(I) Representative images of Golgi-Cox-stained pyramidal neurons from the PFC of rats 24 hr after receiving a 10 mg/kg dose of DMT.
(J) Quantification of spines from (I), demonstrating that DMT (10 mg/kg) increases spinogenesis *in vivo* to a comparable extent as ketamine (10 mg/kg) (n = 11-17 neurons).
(K and L) Whole-cell voltage-clamp recordings of layer V pyramidal neurons from slices obtained 24 hr after DMT treatment (10 mg/kg and 1 mg/kg) demonstrate that DMT increases both spontaneous excitatory postsynaptic current (sEPSC) frequency (K) and amplitude (L) (n = 11-38 neurons from 3 animals).
(M) Representative traces for the 10 mg/kg experiments quantified in (K) and (L). $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{****}p < 0.0001$, as compared to vehicle control (VEH). Data are represented as mean ± SEM. See also Figure S6.

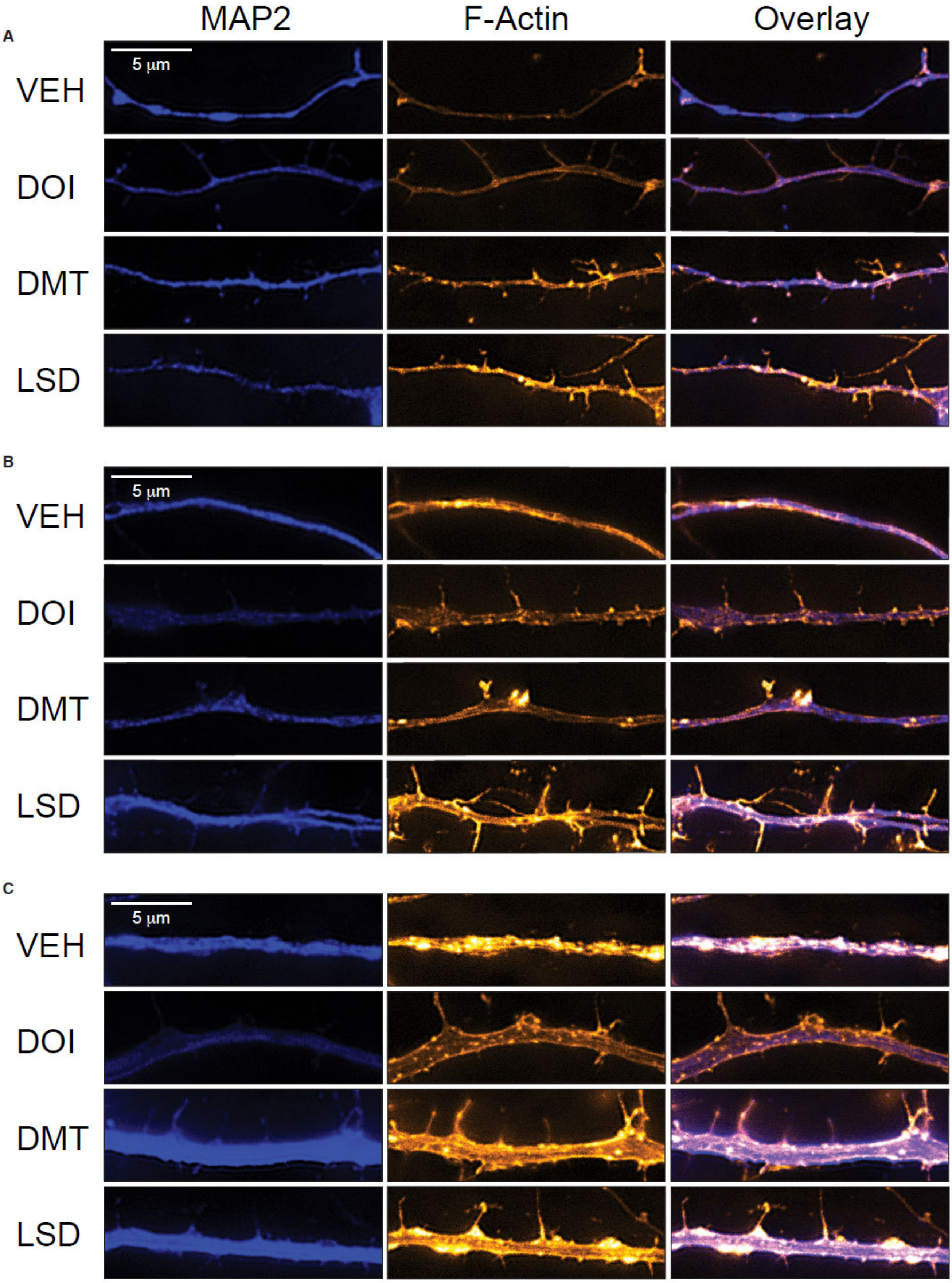


Figure S6. Psychedelics Promote Spinogenesis in Cultured Cortical Neurons, Related to Figure 2. (A-C) Representative super-resolution structured illumination microscopy (SIM) images of cultured embryonic rat cortical neurons (DIV19) treated with compounds for 24 h demonstrate that psychedelics promote spinogenesis (Blue = MAP2, Orange = F-actin). As MAP2 primarily labels the dendritic shaft while F-actin is found in all processes, orange protrusions from the shaft with minimal co-staining indicate dendritic spines. Examples of thin (A), medium (B), and thick (C) dendrites are presented.

Because the half-life of DMT is exceedingly short (~15 min), these results confirm that structural and functional changes induced by DMT persist for hours after the compound has been cleared from the body. Moreover, they demonstrate that DMT produces functional effects on pyramidal neurons of the PFC that mirror those produced by ketamine (Li *et al.*, 2010). Because the PFC is a key brain region involved in extinction learning (Quirk *et al.*, 2006), and both ketamine and DMT have been shown to facilitate fear extinction (Cameron *et al.*, 2018; Girgenti *et al.*, 2017), our results suggest a link between the plasticity-promoting and behavioral effects of these drugs. Because fear extinction can be enhanced by increasing levels of brain-derived neurotrophic factor (BDNF) in the PFC (Peters *et al.*, 2010), and ketamine's behavioral effects have been shown to be BDNF-dependent (Lepack *et al.*, 2014), we next sought to determine the role of BDNF signaling in the plasticity-promoting effects of classical psychedelics.

Psychedelics Promote Plasticity through a TrkBand mTOR-Dependent Mechanism

The role of BDNF in both neuritogenesis and spinogenesis is well known (Cohen-Cory *et al.*, 2010), and several reports suggest that psychedelics are capable of increasing levels of neurotrophic factors (He *et al.*, 2005; Martin *et al.*, 2014; Nichols and Sanders-Bush, 2002; Vaidya *et al.*, 1997). Therefore, we treated cortical neurons with BDNF, DOI, and a combination of the two to see whether they had any additive or synergistic effects. Dose-response studies using recombinant BDNF (Figures 3A-3C) revealed that a 50 ng/mL treatment increased neuritogenesis to a comparable extent as DOI (10 µM). Moreover, a combination of the two did not confer any added benefit, suggesting that they operate through a related mechanism (Figures 3D-3F). Next, we treated cortical neurons with DOI, DMT, and LSD for 24 hr before measuring BDNF gene and protein expression using droplet digital PCR (ddPCR) and ELISA, respectively. Although psychedelics did not increase the expression of *BDNF* transcript (Figure 3G), they did result in a 2-fold increase in BDNF protein levels, although this effect was not statistically significant (Figure 3H). When cortical cultures were co-treated with ANA-12 (Cazorla *et al.*, 2011), a selective antagonist of BDNF's high-affinity receptor TrkB, the ability of psychedelics or BDNF to stimulate neuritogenesis and spinogenesis was completely blocked (Figure 4).

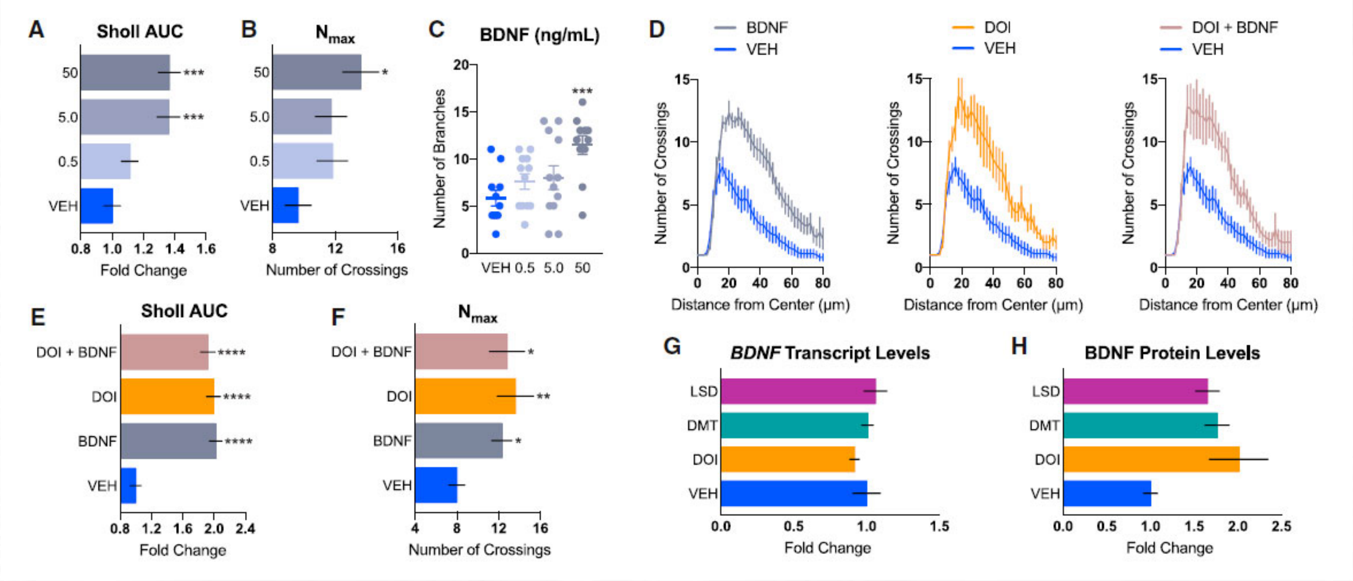


Figure 3. Psychedelics and BDNF Promote Neuritogenesis via a Related Mechanism
(A-C) Dose response of recombinant BDNF on neuritogenesis. AUC of the Sholl plots (A), N_{max} of the Sholl plots (B), and total number of branches (C) of treated cortical neurons (n = 11-12 neurons per treatment, DIV6) indicate that the highest concentration of BDNF (50 ng/mL) is more effective at promoting neuritogenesis than lower concentrations (5.0 and 0.5 ng/mL).
(D) Sholl analysis (n = 5-10 neurons) demonstrating that DOI (10 µM) increases neuritogenesis to a comparable extent as recombinant BDNF (50 ng/mL). A combination of DOI (10 µM) and BDNF (50 ng/mL) did not have any additive or synergistic effects.
(E) AUC of the Sholl plots in (D).
(F) N_{max} of the Sholl plots in (D).
(G and H) Cultured cortical neurons (DIV18) were treated with compounds for 24 hr, and then BDNF gene (G) and protein (H) expression was assessed via ddPCR (n = 4) and ELISA (n = 3-4), respectively. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$, as compared to vehicle control (VEH). Data are represented as mean ± SEM.

Activation of TrkB is known to promote signaling through mTOR (Takei *et al.*, 2004), which plays a key role in structural plasticity (Jaworski *et al.*, 2005; Kumar *et al.*, 2005), the production of proteins necessary for synaptogenesis (Hoeffer and Klann, 2010), and the effects of ketamine (Dwyer and Duman, 2013; Li *et al.*, 2010). Treatment with rapamycin, an mTOR inhibitor, completely blocked psychedelic-induced neuritogenesis (Figure 5), thus confirming that mTOR activation plays a role in the plasticity-promoting effects of classical serotonergic psychedelics.

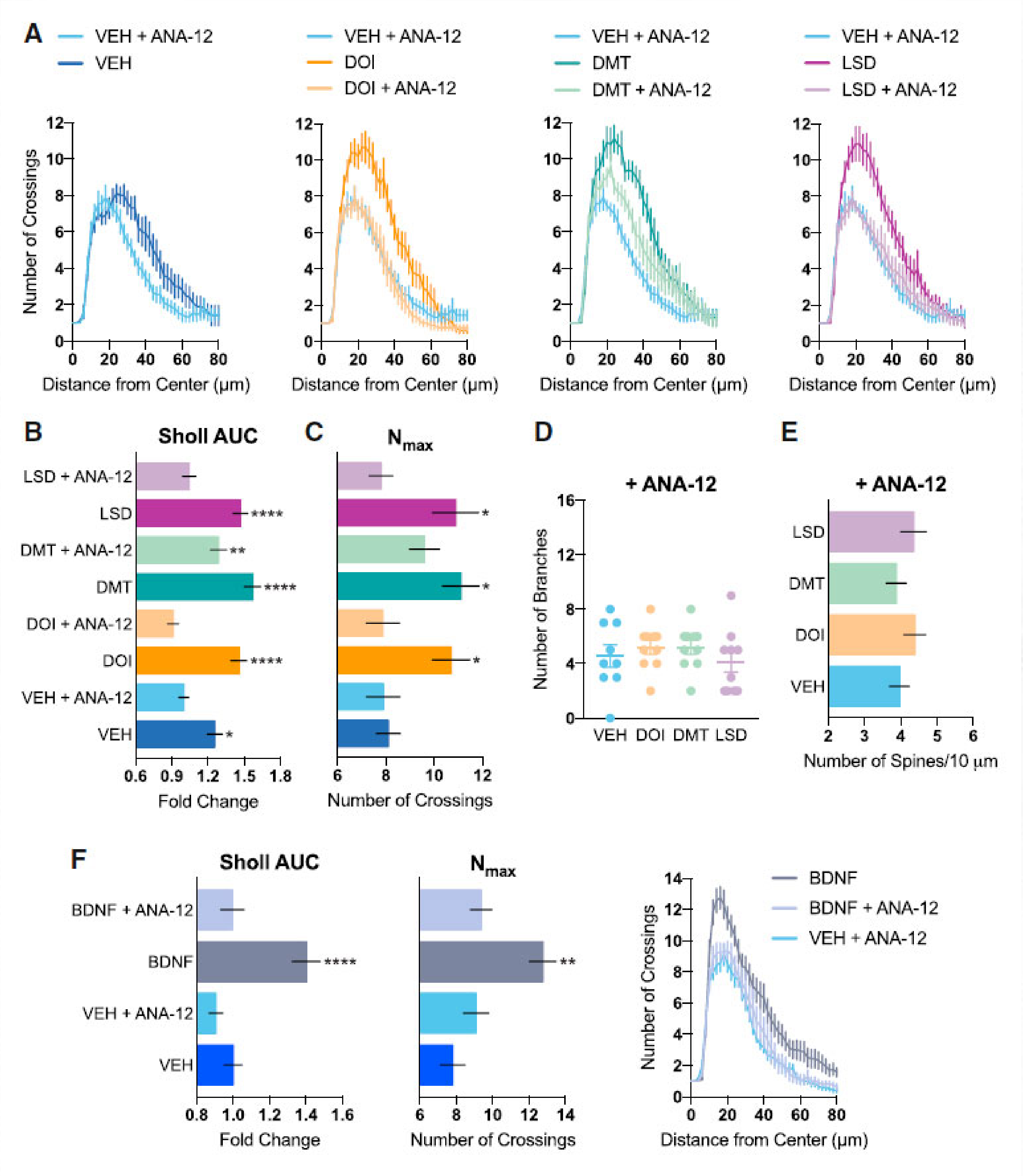


Figure 4. Psychedelic-Induced Changes in Neuronal Structure Are Mediated by TrkB
(A-D) The effects of psychedelics on dendritic arbor complexity are blocked by ANA-12, a selective inhibitor of TrkB, as measured by Sholl analysis of cultured cortical neurons (A) (DIV6). Compound-induced increases in the AUC of the Sholl plots (B), the N_{max} of the Sholl plots (C), and the number of dendritic branches (D) are completely blocked by ANA-12 (n = 8-10 neurons).
(E) The spinogenesis-promoting properties of psychedelics are blocked by ANA-12 (n = 19-21 neurons, DIV19).
(F) Control experiment demonstrating that ANA-12 blocks the effects of BDNF on neuritogenesis (n = 11-15 neurons). $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{****}p < 0.0001$, as compared to vehicle control (VEH) or vehicle + antagonist. Data are represented as mean ± SEM.

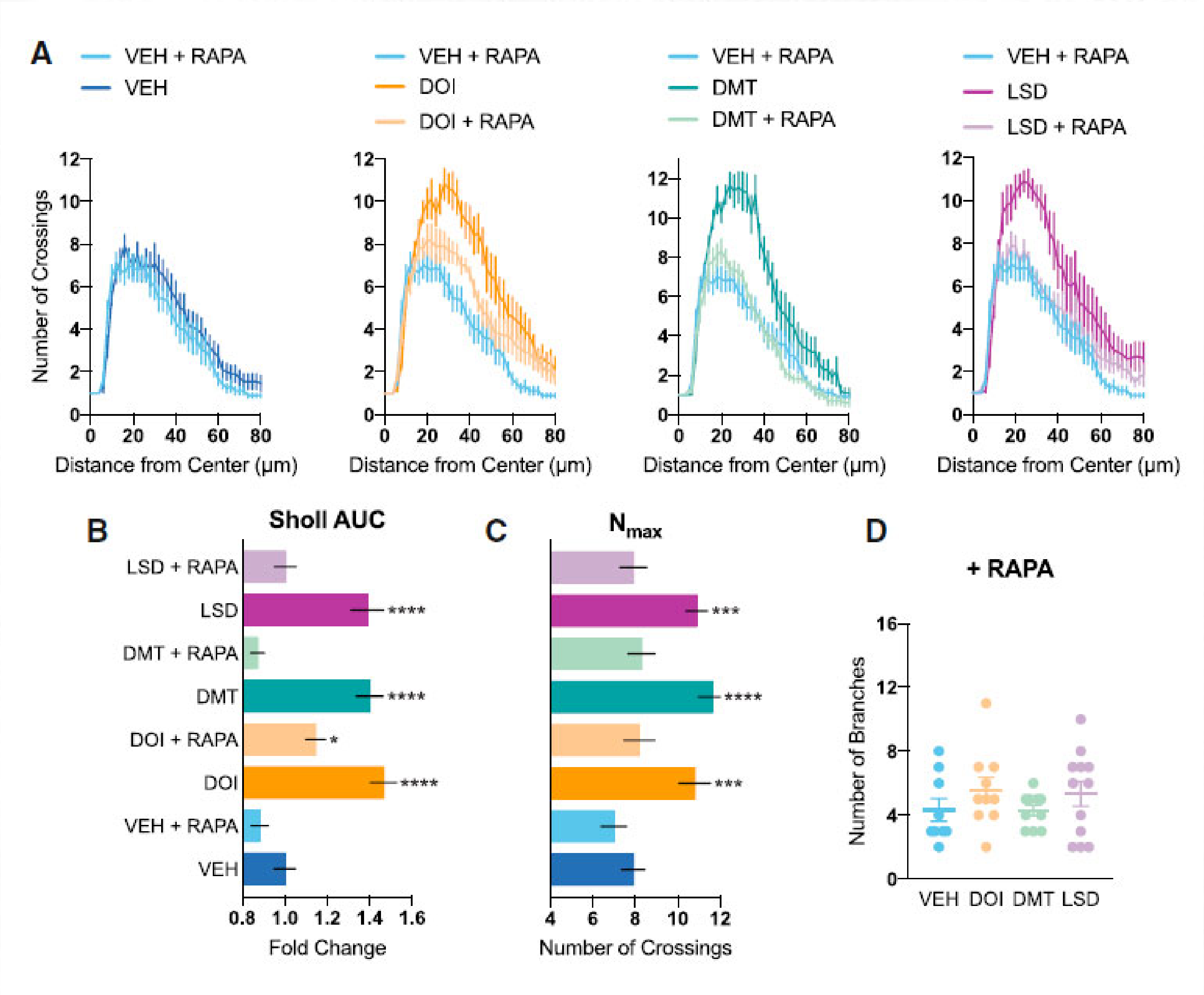


Figure 5. Psychedelic-Induced Changes in Neuronal Structure Are Mediated by mTOR
(A-D) The effects of psychedelics on dendritic arbor complexity are blocked by rapamycin, an inhibitor of mTOR, as measured by Sholl analysis of cultured cortical neurons (A) (DIV6). Compoundinduced increases in the AUC of the Sholl plots (B), the N_{max} of the Sholl plots (C), and the number of dendritic branches (D) are completely blocked by rapamycin (n = 9-12 neurons). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$, as compared to vehicle control (VEH) or vehicle + antagonist. Data are represented as mean ± SEM.

The 5-HT2A Receptor Mediates the Effects of Psychedelics on Structural Plasticity

Finally, we sought to determine whether the 5-HT_{2A} receptor played any role in the plasticity-promoting effects of DOI, DMT, and LSD because this receptor is known to be primarily responsible for the hallucinogenic effects of classical psychedelics (Nichols, 2004, 2016). Furthermore, the psychoplastogenic potencies of these and related compounds correlate well with their 5-HT_{2A} receptor affinities (Figure S3) (i.e., a higher 5-HT_{2A} binding affinity generally predicts more potent psychoplastogenic effects). Control experiments demonstrated that 5-HT_{2A} receptors were expressed on cultured rat cortical neurons at both 6 days *in vitro* (DIV6) and DIV19 (Figure 6A). Next we found that co-treatment with ketanserin, a selective 5-HT_{2A} antagonist, completely abrogated the ability of DMT, LSD, and DOI to promote both neuritogenesis and spinogenesis (Figures 6B-6F). Ketanserin was also able to block the effects of psilocin as well as the non-classical psychedelic noribogaine and entactogen MDMA (Figure 6G).

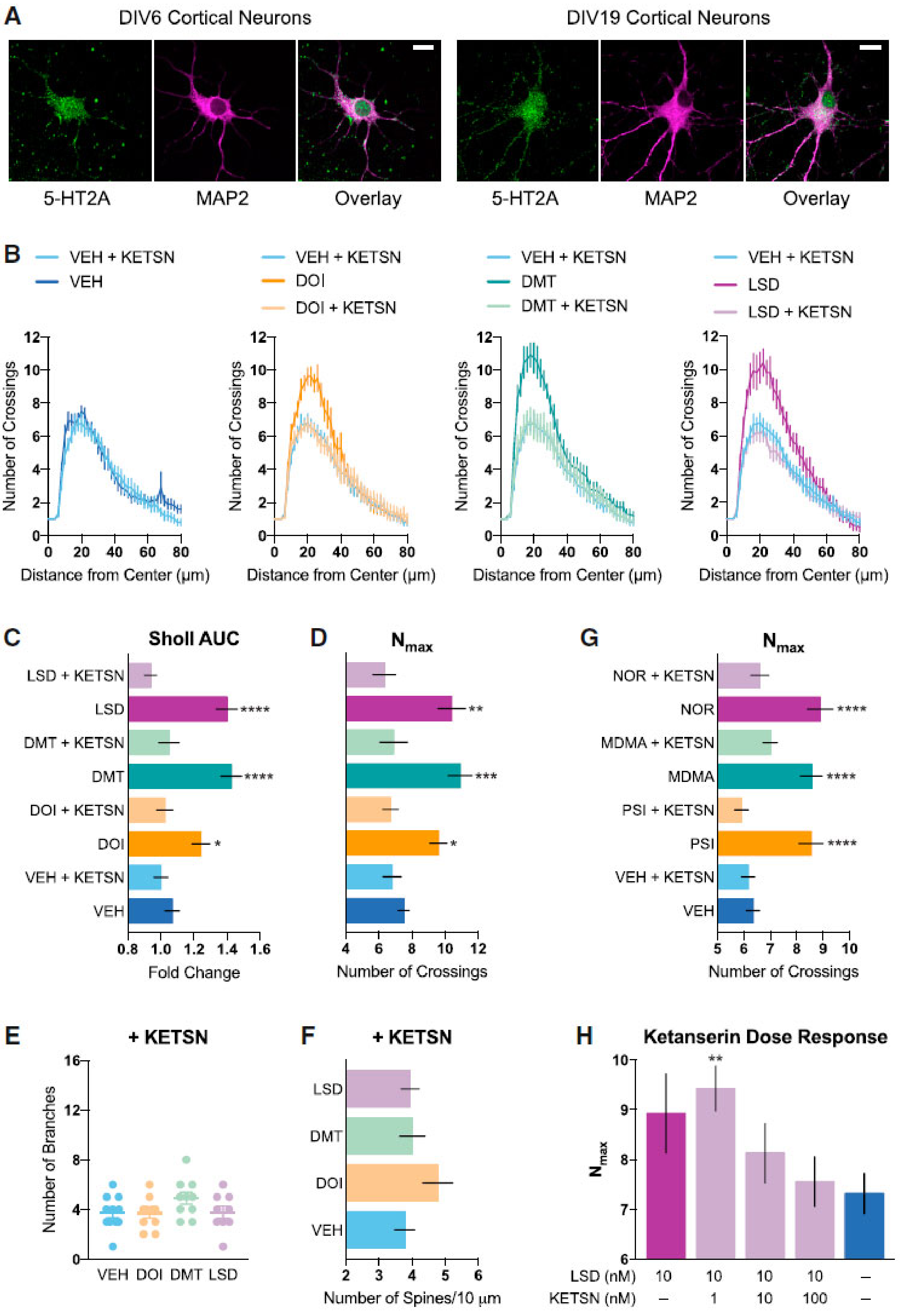


Figure 6. The 5-HT$_{2A}$ Receptor Mediates the Effects of Psychedelics on Structural Plasticity

(A) Rat embryonic cortical neurons express 5-HT$_{2A}$ receptors at both DIV6 and DIV19 (scale bar, 10 μm).

(B) The effects of psychedelics on increasing dendritic arbor complexity are blocked by cotreating with ketanserin, a selective antagonist of 5-HT$_{2A}$ receptors, as measured by Sholl analysis of cultured cortical neurons (DIV6).

(C-E) Compound-induced increases in the AUC of the Sholl plots (C), the N$_{max}$ of the Sholl plots (D), and the number of dendritic branches (E) are completely blocked by ketanserin (n = 10-11 neurons, DIV6).

(F) The spinogenesis-promoting properties of psychedelics are blocked by ketanserin (n = 19-20 neurons, DIV19).

(G) Ketanserin also blocks the increased N$_{max}$ induced by psilocin, noribogaine, and MDMA.

(H) Ketanserin dose-dependently blocks the psychoplastogenic effects of 10 nM LSD (n = 9-38 neurons, DIV6). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$, as compared to vehicle control (VEH) or vehicle + antagonist. Data are represented as mean ± SEM.

These initial experiments were performed using doses of psychoplastogens that produced maximal effects on structural plasticity (circa 10 µM) in combination with a 10-fold excess of ketanserin (100 µM). At these concentrations, we could not rule out the possibility of other receptors contributing to the antagonistic effects of ketanserin. Therefore, we treated cultured cortical neurons with a significantly lower dose of LSD (10 nM) and attempted to block its ability to promote neurite outgrowth using increasing doses of ketanserin (Figure 6H). We found that ketanserin blocks the psychoplastogenic effects of LSD by ~50% when treated at 10 nM. This is consistent with the fact that the binding affinities of ketanserin and LSD for the 5-HT$_{2A}$ receptor are roughly equivalent (low nanomolar). Increasing the concentration of ketanserin to 100 nM, 10-fold higher than the concentration of LSD used in this experiment, completely prevented LSD-induced neuritogenesis. At 100 nM, ketanserin is relatively selective for the 5-HT$_{2A}$ receptor, although, at this concentration, we cannot rule out the possible involvement of 5-HT$_{2C}$, adrenergic, or histamine receptors.

As a final note, the concentration responses of most psychoplastogens had Hill slopes that deviated from 1.0 (Figure S3), implying polypharmacology. Because psychedelics have relatively high affinities for 5-HT$_{2A}$ receptors, it is likely that the effects of psychedelics are mediated primarily through 5-HT$_{2A}$ receptors at low concentrations and modulated by other targets at high concentrations. Interestingly, the concentration response of DMT was the only one to exhibit a Hill slope greater than 1.0, indicating some form of cooperativity.

Discussion

Classical serotonergic psychedelics are known to cause changes in mood (Griffiths *et al.*, 2006, 2008, 2011) and brain function (Carhart-Harris *et al.*, 2017) that persist long after the acute effects of the drugs have subsided. Moreover, several psychedelics elevate glutamate levels in the cortex (Nichols, 2004, 2016) and increase gene expression *in vivo* of the neurotrophin *BDNF* as well as immediate-early genes associated with plasticity (Martin *et al.*, 2014; Nichols and Sanders-Bush, 2002; Vaidya *et al.*, 1997). This indirect evidence has led to the reasonable hypothesis that psychedelics promote structural and functional neural plasticity, although this assumption had never been rigorously tested (Bogenschutz and Pommy, 2012; Vollenweider and Kometer, 2010). The data presented here provide direct evidence for this hypothesis, demonstrating that psychedelics cause both structural and functional changes in cortical neurons.

Prior to this study, two reports suggested that psychedelics might be able to produce changes in neuronal structure. Jones *et al.* (2009) demonstrated that DOI was capable of transiently increasing the size of dendritic spines on cortical neurons, but no change in spine density was observed. The second study showed that DOI promoted neurite extension in a cell line of neuronal lineage (Marinova *et al.*, 2017). Both of these reports utilized DOI, a psychedelic of the amphetamine class. Here we demonstrate that the ability to change neuronal structure is not a unique property of amphetamines like DOI because psychedelics from the ergoline, tryptamine, and iboga classes of compounds also promote structural plasticity. Additionally, D-amphetamine does not increase the complexity of cortical dendritic arbors in culture, and therefore, these morphological changes cannot be simply attributed to an increase in monoamine neurotransmission.

The identification of psychoplastogens belonging to distinct chemical families is an important aspect of this work because it suggests that ketamine is not unique in its ability to promote structural and functional plasticity. In addition to ketamine, the prototypical psychoplastogen, only a relatively small number of plasticity-promoting small molecules have been identified previously. Such compounds include the *N*-methyl-D-aspartate (NMDA) receptor ligand GLYX-13 (i.e., rapastinel), the mGlu2/3 antagonist LY341495, the TrkB agonist 7,8-DHF, and the muscarinic receptor antagonist scopolamine (Lepack *et al.*, 2016; Castello *et al.*, 2014; Zeng *et al.*, 2012; Voleti *et al.*, 2013). We observe that hallucinogens from four distinct structural classes (i.e., tryptamine, amphetamine, ergoline, and iboga) are also potent psychoplastogens, providing additional lead scaffolds for medicinal chemistry efforts aimed at identifying neurotherapeutics. Furthermore, our cellular assays revealed that several of these compounds were more efficacious (e.g., MDMA) or more potent (e.g., LSD) than ketamine. In fact, the plasticity-promoting properties of psychedelics and entactogens rivaled that of BDNF (Figures 3A-3C and S3). The extreme potency of LSD in particular might be due to slow off kinetics, as recently proposed following the disclosure of the LSD-bound 5-HT$_{2B}$ crystal structure (Wacker *et al.*, 2017).

Importantly, the psychoplastogenic effects of psychedelics in cortical cultures were also observed *in vivo* using both vertebrate and invertebrate models, demonstrating that they act through an evolutionarily conserved mechanism. Furthermore, the concentrations of psychedelics utilized in our *in vitro* cell culture assays were consistent with those reached in the brain following systemic administration of therapeutic doses in rodents (Yang *et al.*, 2018; Cohen and Vogel, 1972). This suggests that neuritogenesis, spinogenesis, and/or synaptogenesis assays performed using cortical cultures might have value for identifying psychoplastogens and fast-acting antidepressants. It should be noted that our structural plasticity studies performed *in vitro* utilized neurons exposed to psychedelics for extended periods of time. Because brain exposure to these compounds is often of short duration due to rapid metabolism, it will be interesting to assess the kinetics of psychedelic-induced plasticity.

A key question in the field of psychedelic medicine has been whether or not psychedelics promote changes in the density of dendritic spines (Kyzar *et al.*, 2017). Using super-resolution SIM, we clearly demonstrate that psychedelics do, in fact, increase the density of dendritic spines on cortical neurons, an effect that is not restricted to a particular structural class of compounds. Using DMT, we verified that cortical neuron spine density increases *in vivo* and that these changes in structural plasticity are accompanied by functional effects such as increased amplitude and frequency of spontaneous EPSCs. We specifically designed these experiments to mimic previous studies of ketamine (Li *et al.*, 2010) so that we might directly compare these two compounds, and, to a first approximation, they appear to be remarkably similar. Not only do they both increase spine density and neuronal excitability in the cortex, they seem to have similar behavioral effects. We have shown previously that, like ketamine, DMT promotes fear extinction learning and has antidepressant effects in the forced swim test (Cameron *et al.*, 2018). These results, coupled with the fact that ayahuasca, a DMT-containing concoction, has potent antidepressant effects in humans (Osório *et al.*, 2015; Sanches *et al.*, 2016; Santos *et al.*, 2007), suggests that classical psychedelics and ketamine might share a related therapeutic mechanism.

Although the molecular targets of ketamine and psychedelics are different (NMDA and 5-HT$_{2A}$ receptors, respectively), they appear to cause similar downstream effects on structural plasticity by activating mTOR. This finding is significant because ketamine is known to be addictive whereas many classical psychedelics are not (Nutt *et al.*, 2007, 2010). The exact mechanisms by which these compounds stimulate mTOR is still not entirely understood, but our data suggest that, at least for classical psychedelics, TrkB and 5-HT$_{2A}$ receptors are involved. Although most classical psychedelics are not considered to be addictive, there are still significant safety concerns with their use in medicine because they cause profound perceptual disturbances and still have the potential to be abused. Therefore, the identification of non-hallucinogenic analogs capable of promoting plasticity in the PFC could facilitate a paradigm shift in our approach to treating neuropsychiatric diseases. Moreover, such compounds could be critical to resolving the long-standing debate in the field concerning whether the subjective effects of psychedelics are necessary for their therapeutic effects (Maji&cacute; *et al.*, 2015). Although our group is actively investigating the psychoplastogenic properties of non-hallucinogenic analogs of psychedelics, others have reported the therapeutic potential of safer structural and functional analogs of ketamine (Moskal *et al.*, 2017; Yang *et al.*, 2015; Zanos *et al.*, 2016).

Our data demonstrate that classical psychedelics from several distinct chemical classes are capable of robustly promoting the growth of both neurites and dendritic spines *in vitro*, *in vivo*, and across species. Importantly, our studies highlight the similarities between the effects of ketamine and those of classical serotonergic psychedelics, supporting the hypothesis that the clinical antidepressant and anxiolytic effects of these molecules might result from their ability to promote structural and functional plasticity in prefrontal cortical neurons. We have demonstrated that the plasticity-promoting properties of psychedelics require TrkB, mTOR, and 5-HT$_{2A}$ signaling, suggesting that these key signaling hubs may serve as potential targets for the development of psychoplastogens, fast-acting antidepressants, and anxiolytics. Taken together, our results suggest that psychedelics may be used as lead structures to identify next-generation neurotherapeutics with improved efficacy and safety profiles.

Experimental Procedures

Drugs

For *in vitro* studies, all compounds were dissolved in DMSO and diluted 1:1,000, with the exception that BDNF was dissolved in water. Cells were treated with DMT at a final concentration of 90 µM (0.1% DMSO), whereas all other compounds were used at 10 µM (0.1% DMSO) unless noted otherwise. For *in vivo* studies, DMT or ketamine was dissolved in sterile 0.9% saline and administered intraperitoneally at a dose of 10 mg/kg and an injection volume of 1 mL/kg.

Animals

Sprague-Dawley rats were obtained from Charles River Laboratories (Wilmington, MA, USA). The age and sex of the animals used are noted under each individual experimental subheading. All experimental procedures involving animals were approved by the University of California, Davis Institutional Animal Care and Use Committee (IACUC) and adhered to the principles described in the NIH Guide for the Care and Use of Laboratory Animals. The University of California, Davis is accredited by the Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC) and has an Animal Welfare Assurance number (A3433-01) on file with the Office of Laboratory Animal Welfare (OLAW).

Cell Culture

Primary cortical cultures were prepared using tissue from embryonic day 18 (E18) Sprague-Dawley rats. Cells were plated at various densities on poly-Dlysine-coated plates depending on the specific experiment (Supplemental Experimental Procedures). Plating medium consisted of 10% heat-inactivated fetal bovine serum (FBS) (Life Technologies), 1% penicillin-streptomycin (Life Technologies), and 0.5 mM glutamine (Life Technologies) in Neurobasal (Life Technologies). After 15-24 hr, the medium was removed and exchanged for replacement medium containing 13 B27 supplement (Life Technologies), 1% penicillin-streptomycin, 0.5 mM glutamine, 12.5 µM glutamate, and Neurobasal. After 96 hr, 50% of the medium was removed and replaced with feed medium containing 13 B27 supplement, 1% penicillin-streptomycin, and 0.5 mM glutamine. Once per week, until the cultures had reached sufficient maturity for experiments, 50% of the culture medium was removed and replaced with feed medium, with an additional 20% by volume being added to account for evaporation. For experiments using antagonists or inhibitors, cells were pretreated with ANA-12 (10 µM), rapamycin (100 nM), and ketanserin (100 µM) for 10 min prior to addition of test compounds unless otherwise noted. The final DMSO concentration of these experiments was 0.2%. The neurons used in each cellular experiment were taken from at least two different treatment wells, and the wells were randomized to account for plate effects. All of the cellular experiments were replicated on at least two occasions by two or more experimenters.

Statistical Analysis

Appropriate samples sizes were estimated based on our previous experiences performing similar experiments. Data are represented as mean ± SEM. Statistical analyses were performed using GraphPad Prism (version 7.0a). For analyses involving comparison of three or more groups, a one-way analysis of variance (Dunnett's *post hoc* test) was utilized. No statistics were calculated for the individual points of the Sholl plots. Instead, statistical analyses were performed on the aggregate data (i.e., the area under the curve of the Sholl plot). Probability distributions from electrophysiology experiments were compared using a Kolmogorov-Smirnov test. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, and $^{****}p < 0.0001$ compared with vehicle control or vehicle + antagonist.

Acknowledgments

We thank Lee E. Dunlap for synthesizing DMT, Aurora Martinez-Horta for assistance with Golgi-Cox staining experiments, the Light Microscopy Imaging Facility in the Department of Molecular and Cellular Biology for the use of their Nikon N-SIM, Javier González-Maeso for providing 198A2 cells, and members of the Olson laboratory for discussions regarding the manuscript. We also thank Valentina Popescu in the Department of Classics at UC Davis for assistance with coining the term ''psychoplastogen.'' Several antibodies were generously provided by the Stanley Center for Psychiatric Research at the Broad Institute. This work was supported by funds from the UC Davis Department of Chemistry and Department of Biochemistry and Molecular Medicine, a UC Davis Provost's Undergraduate Fellowship (to A.C.G.), a UC Davis MIND Institute IDDRC grant U54 HD079125 (to M.Y.D. and K.B.), an Alfred P. Sloan Fellowship (FG-2016-6814 to M.Y.D.), and NIH grants T32GM113770 (to C.L.) and 5T32MH082174-09 (to L.P.C. and E.B.).

Author Contributions

D.E.O., C.L., and A.K.M. were responsible for the overall experimental design. C.L. performed the majority of the neuritogenesis, spinogenesis, synaptogenesis, and biochemical experiments described, with A.C.G. and S.S.Z. providing assistance. C.L., L.P.C., and D.E.O. performed the Golgi-Cox staining experiments. L.P.C., J.M.W., and E.V.B. performed the electrophysiology experiments, with J.A.G. supervising these studies. K.M.O.-M. and P.C.W. performed the experiments in *Drosophila*. M.Y.D. and K.F.B. performed the zebrafish experiments. A.S. developed the program for analyzing synapse number and size. M.R.P. supervised the SIM experiments. W.C.D. performed 5-HT$_{2A}$ expression studies and assisted with fluorescence microscopy data analysis. D.E.O. conceived the project, supervised the experiments, and wrote the manuscript with input from all authors.

Declaration of Interests

D.E.O. has submitted a patent application related to this work (PCT/US2017/ 054277).

Received: November 16, 2017
Revised: April 3, 2018
Accepted: May 7, 2018
Published: June 12, 2018

References

1. Alper, K.R. (2001). Ibogaine: a review. Alkaloids Chem. Biol. 56, 1-38.
2. Appel, J.B., West, W.B., Rolandi, W.G., Alici, T., and Pechersky, K. (1999). Increasing the selectivity of drug discrimination procedures. Pharmacol. Biochem. Behav. 64, 353-358.
3. Arnsten, A.F.T. (2009). Stress signalling pathways that impair prefrontal cortex structure and function. Nat. Rev. Neurosci. 10, 410-422.
4. Autry, A.E., and Monteggia, L.M. (2012). Brain-derived neurotrophic factor and neuropsychiatric disorders. Pharmacol. Rev. 64, 238-258.
5. Autry, A.E., Adachi, M., Nosyreva, E., Na, E.S., Los, M.F., Cheng, P.F., Kavalali, E.T., and Monteggia, L.M. (2011). NMDA receptor blockade at rest triggers rapid behavioural antidepressant responses. Nature 475, 91-95.
6. Baumann, M.H., Pablo, J.P., Ali, S.F., Rothman, R.B., and Mash, D.C. (2000). Noribogaine (12-hydroxyibogamine): a biologically active metabolite of the antiaddictive drug ibogaine. Ann. N Y Acad. Sci. 914, 354-368.
7. Baumann, M.H., Pablo, J., Ali, S.F., Rothman, R.B., and Mash, D.C. (2001). Comparative neuropharmacology of ibogaine and its O-desmethyl metabolite, noribogaine. Alkaloids Chem. Biol. 56, 79-113.
8. Belgers, M., Leenaars, M., Homberg, J.R., Ritskes-Hoitinga, M., Schellekens, A.F., and Hooijmans, C.R. (2016). Ibogaine and addiction in the animal model, a systematic review and meta-analysis. Transl. Psychiatry 6, e826.
9. Berman, R.M., Cappiello, A., Anand, A., Oren, D.A., Heninger, G.R., Charney, D.S., and Krystal, J.H. (2000). Antidepressant effects of ketamine in depressed patients. Biol. Psychiatry 47, 351-354.
10. Bogenschutz, M.P., and Pommy, J.M. (2012). Therapeutic mechanisms of classic hallucinogens in the treatment of addictions: from indirect evidence to testable hypotheses. Drug Test. Anal. 4, 543-555.
11. Bouso, J.C., Doblin, R., Farré, M., Alcázar, M.A., and Gómez-Jarabo, G. (2008). MDMA-assisted psychotherapy using low doses in a small sample of women with chronic posttraumatic stress disorder. J. Psychoactive Drugs 40, 225-236.

12. Browne, C.A., and Lucki, I. (2013). Antidepressant effects of ketamine: mechanisms underlying fast-acting novel antidepressants. Front. Pharmacol. 4, 161.
13. Cameron, L.P., Benson, C.J., Dunlap, L.E., and Olson, D.E. (2018). Effects of *N,N*-dimethyltryptamine on rat behaviors relevant to anxiety and depression. ACS Chem. Neurosci. Published online April 24, 2018. https://doi.org/10.1021/acschemneuro.8b00134.
14. Carbonaro, T.M., Eshleman, A.J., Forster, M.J., Cheng, K., Rice, K.C., and Gatch, M.B. (2015). The role of 5-HT2A, 5-HT2C and mGlu2 receptors in the behavioral effects of tryptamine hallucinogens *N,N*-dimethyltryptamine and *N,N*-diisopropyltryptamine in rats and mice. Psychopharmacology (Berl.) 232, 275-284.
15. Carhart-Harris, R.L., and Goodwin, G.M. (2017). The therapeutic potential of psychedelic drugs: past, present, and future. Neuropsychopharmacology 42, 2105-2113.
16. Carhart-Harris, R.L., Bolstridge, M., Rucker, J., Day, C.M., Erritzoe, D., Kaelen, M., Bloomfield, M., Rickard, J.A., Forbes, B., Feilding, A., *et al*. (2016). Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. Lancet Psychiatry 3, 619-627.
17. Carhart-Harris, R.L., Roseman, L., Bolstridge, M., Demetriou, L., Pannekoek, J.N., Wall, M.B., Tanner, M., Kaelen, M., McGonigle, J., Murphy, K., *et al*. (2017). Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. Sci. Rep. 7, 13187.
18. Castello, N.A., Nguyen, M.H., Tran, J.D., Cheng, D., Green, K.N., and LaFerla, F.M. (2014). 7,8-Dihydroxyflavone, a small molecule TrkB agonist, improves spatial memory and increases thin spine density in a mouse model of Alzheimer disease-like neuronal loss. PLoS ONE 9, e91453.
19. Castrén, E., and Antila, H. (2017). Neuronal plasticity and neurotrophic factors in drug responses. Mol. Psychiatry 22, 1085-1095.
20. Catlow, B.J., Song, S., Paredes, D.A., Kirstein, C.L., and Sanchez-Ramos, J. (2013). Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning. Exp. Brain Res. 228, 481-491.
21. Cazorla, M., Preémont, J., Mann, A., Girard, N., Kellendonk, C., and Rognan, D. (2011). Identification of a low-molecular weight TrkB antagonist with anxiolytic and antidepressant activity in mice. J. Clin. Invest. 121, 1846-1857.
22. Christoffel, D.J., Golden, S.A., and Russo, S.J. (2011). Structural and synaptic plasticity in stress-related disorders. Rev. Neurosci. 22, 535-549.
23. Cohen, I., and Vogel, W.H. (1972). Determination and physiological disposition of dimethyltryptamine and diethyltryptamine in rat brain, liver and plasma. Biochem. Pharmacol. 21, 1214-1216.
24. Cohen-Cory, S., Kidane, A.H., Shirkey, N.J., and Marshak, S. (2010). Brainderived neurotrophic factor and the development of structural neuronal connectivity. Dev. Neurobiol. 70, 271-288.
25. Cramer, S.C., Sur, M., Dobkin, B.H., O'Brien, C., Sanger, T.D., Trojanowski, J.Q., Rumsey, J.M., Hicks, R., Cameron, J., Chen, D., *et al*. (2011). Harnessing neuroplasticity for clinical applications. Brain 134, 1591-1609.
26. Diaz-Granados, N., Ibrahim, L.A., Brutsche, N.E., Ameli, R., Henter, I.D., Luckenbaugh, D.A., Machado-Vieira, R., and Zarate, C.A., Jr. (2010). Rapid resolution of suicidal ideation after a single infusion of an *N*-methyl-D-aspartate antagonist in patients with treatment-resistant major depressive disorder. J. Clin. Psychiatry 71, 1605-1611.
27. Dos Santos, R.G., Osoório, F.L., Crippa, J.A., Riba, J., Zuardi, A.W., and Hallak, J.E. (2016). Antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide (LSD): a systematic review of clinical trials published in the last 25 years. Ther. Adv. Psychopharmacol. 6, 193-213.
28. Duman, R.S. (2002). Synaptic plasticity and mood disorders. Mol. Psychiatry 7 (Suppl 1), S29-S34.
29. Duman, R.S., and Aghajanian, G.K. (2012). Synaptic dysfunction in depression: potential therapeutic targets. Science 338, 68-72.
30. Duman, R.S., Aghajanian, G.K., Sanacora, G., and Krystal, J.H. (2016). Synaptic plasticity and depression: new insights from stress and rapid-acting antidepressants. Nat. Med. 22, 238-249.
31. Dwyer, J.M., and Duman, R.S. (2013). Activation of mammalian target of rapamycin and synaptogenesis: role in the actions of rapid-acting antidepressants. Biol. Psychiatry 73, 1189-1198.
32. Feder, A., Parides, M.K., Murrough, J.W., Perez, A.M., Morgan, J.E., Saxena, S., Kirkwood, K., Aan Het Rot, M., Lapidus, K.A., Wan, L.B., *et al*. (2014). Efficacy of intravenous ketamine for treatment of chronic posttraumatic stress disorder: a randomized clinical trial. JAMA Psychiatry 71, 681-688.
33. Gatch, M.B., Rutledge, M.A., Carbonaro, T., and Forster, M.J. (2009). Comparison of the discriminative stimulus effects of dimethyltryptamine with different classes of psychoactive compounds in rats. Psychopharmacology (Berl.) 204, 715-724.
34. Girgenti, M.J., Ghosal, S., LoPresto, D., Taylor, J.R., and Duman, R.S. (2017). Ketamine accelerates fear extinction via mTORC1 signaling. Neurobiol. Dis. 100, 1-8.
35. Glennon, R.A. (1999). Arylalkylamine drugs of abuse: an overview of drug discrimination studies. Pharmacol. Biochem. Behav. 64, 251-256.
36. Glennon, R.A., Young, R., Rosecrans, J.A., and Kallman, M.J. (1980). Hallucinogenic agents as discriminative stimuli: a correlation with serotonin receptor affinities. Psychopharmacology (Berl.) 68, 155-158.
37. Glennon, R.A., Young, R., Jacyno, J.M., Slusher, M., and Rosecrans, J.A. (1983). DOM-stimulus generalization to LSD and other hallucinogenic indolealkylamines. Eur. J. Pharmacol. 86, 453-459.
38. Griffiths, R.R., Richards, W.A., McCann, U., and Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology (Berl.) 187, 268-283, discussion 284-292.
39. Griffiths, R.R., Richards, W.A., Johnson, M., McCann, U., and Jesse, R. (2008). Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. J. Psychopharmacol. (Oxford) 22, 621-632.
40. Griffiths, R.R., Johnson, M.W., Richards, W.A., Richards, B.D., McCann, U., and Jesse, R. (2011). Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects. Psychopharmacology (Berl.) 218, 649-665.
41. Grob, C.S., Danforth, A.L., Chopra, G.S., Hagerty, M., McKay, C.R., Halberstadt, A.L., and Greer, G.R. (2011). Pilot study of

psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch. Gen. Psychiatry 68, 71-78.

42. Grueber, W.B., Jan, L.Y., and Jan, Y.N. (2002). Tiling of the Drosophila epidermis by multidendritic sensory neurons. Development 129, 2867-2878.
43. Gustavsson, A., Svensson, M., Jacobi, F., Allgulander, C., Alonso, J., Beghi, E., Dodel, R., Ekman, M., Faravelli, C., Fratiglioni, L., *et al.*; CDBE2010Study Group (2011). Cost of disorders of the brain in Europe 2010. Eur. Neuropsychopharmacol. 21, 718-779.
44. Hayley, S., and Litteljohn, D. (2013). Neuroplasticity and the next wave of antidepressant strategies. Front. Cell. Neurosci. 7, 218.
45. He, D.Y., McGough, N.N., Ravindranathan, A., Jeanblanc, J., Logrip, M.L., Phamluong, K., Janak, P.H., and Ron, D. (2005). Glial cell line-derived neurotrophic factor mediates the desirable actions of the anti-addiction drug ibogaine against alcohol consumption. J. Neurosci. 25, 619-628.
46. Helsley, S., Fiorella, D., Rabin, R.A., and Winter, J.C. (1998). A comparison of *N,N*-dimethyltryptamine, harmaline, and selected congeners in rats trained with LSD as a discriminative stimulus. Prog. Neuropsychopharmacol. Biol. Psychiatry 22, 649-663.
47. Hoeffer, C.A., and Klann, E. (2010). mTOR signaling: at the crossroads of plasticity, memory and disease. Trends Neurosci. 33, 67-75.
48. Ionescu, D.F., Swee, M.B., Pavone, K.J., Taylor, N., Akeju, O., Baer, L., Nyer, M., Cassano, P., Mischoulon, D., Alpert, J.E., *et al*. (2016). Rapid and Sustained Reductions in Current Suicidal Ideation Following Repeated Doses of Intravenous Ketamine: Secondary Analysis of an Open-Label Study. J. Clin. Psychiatry 77, e719-e725.
49. Izquierdo, A., Wellman, C.L., and Holmes, A. (2006). Brief uncontrollable stress causes dendritic retraction in infralimbic cortex and resistance to fear extinction in mice. J. Neurosci. 26, 5733-5738.
50. Jang, S.W., Liu, X., Yepes, M., Shepherd, K.R., Miller, G.W., Liu, Y., Wilson, W.D., Xiao, G., Blanchi, B., Sun, Y.E., and Ye, K. (2010). A selective TrkB agonist with potent neurotrophic activities by 7,8-dihydroxyflavone. Proc. Natl. Acad. Sci. USA 107, 2687-2692.
51. Jaworski, J., Spangler, S., Seeburg, D.P., Hoogenraad, C.C., and Sheng, M. (2005). Control of dendritic arborization by the phosphoinositide-3'-kinase-Akt-mammalian target of rapamycin pathway. J. Neurosci. 25, 11300-11312.
52. Jones, K.A., Srivastava, D.P., Allen, J.A., Strachan, R.T., Roth, B.L., and Penzes, P. (2009). Rapid modulation of spine morphology by the 5-HT2A serotonin receptor through kalirin-7 signaling. Proc. Natl. Acad. Sci. USA 106, 19575-19580.
53. Kelly, T.M., and Daley, D.C. (2013). Integrated treatment of substance use and psychiatric disorders. Soc. Work Public Health 28, 388-406.
54. Kolb, B., and Muhammad, A. (2014). Harnessing the power of neuroplasticity for intervention. Front. Hum. Neurosci. 8, 377.
55. Krupitsky, E., Burakov, A., Romanova, T., Dunaevsky, I., Strassman, R., and Grinenko, A. (2002). Ketamine psychotherapy for heroin addiction: immediate effects and two-year follow-up. J. Subst. Abuse Treat. 23, 273-283.
56. Krystal, J.H., Tolin, D.F., Sanacora, G., Castner, S.A., Williams, G.V., Aikins, D.E., Hoffman, R.E., and D'Souza, D.C. (2009). Neuroplasticity as a target for the pharmacotherapy of anxiety disorders, mood disorders, and schizophrenia. Drug Discov. Today 14, 690-697.
57. Kumar, V., Zhang, M.X., Swank, M.W., Kunz, J., and Wu, G.Y. (2005). Regulation of dendritic morphogenesis by Ras-PI3K-Akt-mTOR and Ras-MAPK signaling pathways. J. Neurosci. 25, 11288-11299.
58. Kyzar, E.J., Nichols, C.D., Gainetdinov, R.R., Nichols, D.E., and Kalueff, A.V. (2017). Psychedelic Drugs in Biomedicine. Trends Pharmacol. Sci. 38, 992-1005.
59. Lepack, A.E., Fuchikami, M., Dwyer, J.M., Banasr, M., and Duman, R.S. (2014). BDNF release is required for the behavioral actions of ketamine. Int. J. Neuropsychopharmacol. 18, pyu033.
60. Lepack, A.E., Bang, E., Lee, B., Dwyer, J.M., and Duman, R.S. (2016). Fastacting antidepressants rapidly stimulate ERK signaling and BDNF release in primary neuronal cultures. Neuropharmacology 111, 242-252.
61. Li, N., Lee, B., Liu, R.J., Banasr, M., Dwyer, J.M., Iwata, M., Li, X.Y., Aghajanian, G., and Duman, R.S. (2010). mTOR-dependent synapse formation underlies the rapid antidepressant effects of NMDA antagonists. Science 329, 959-964.
62. Majic, T., Schmidt, T.T., and Gallinat, J. (2015). Peak experiences and the afterglow phenomenon: when and how do therapeutic effects of hallucinogens depend on psychedelic experiences? J. Psychopharmacol. (Oxford) 29, 241-253.
63. Marinova, Z., Walitza, S., and Grunblatt, E. (2017). The hallucinogen 2,5-dimethoxy-4-iodoamphetamine hydrochloride activates neurotrophin receptors in a neuronal cell line and promotes neurites extension. J. Neural Transm. (Vienna) 124, 749-759.
64. Martin, D.A., Marona-Lewicka, D., Nichols, D.E., and Nichols, C.D. (2014). Chronic LSD alters gene expression profiles in the mPFC relevant to schizophrenia. Neuropharmacology 83, 1-8.
65. Mathew, S.J., Manji, H.K., and Charney, D.S. (2008). Novel drugs and therapeutic targets for severe mood disorders. Neuropsychopharmacology 33, 2080-2092.
66. Mithoefer, M.C., Wagner, M.T., Mithoefer, A.T., Jerome, L., and Doblin, R. (2011). The safety and efficacy of +/-3,4-methylenedioxymethamphetamineassisted psychotherapy in subjects with chronic, treatment-resistant posttraumatic stress disorder: the first randomized controlled pilot study. J. Psychopharmacol. (Oxford) 25, 439-452.
67. Mithoefer, M.C., Wagner, M.T., Mithoefer, A.T., Jerome, L., Martin, S.F., Yazar-Klosinski, B., Michel, Y., Brewerton, T.D., and Doblin, R. (2013). Durability of improvement in post-traumatic stress disorder symptoms and absence of harmful effects or drug dependency after 3,4-methylenedioxymethamphetamine-assisted psychotherapy: a prospective long-term follow-up study. J. Psychopharmacol. (Oxford) 27, 28-39.
68. Mithoefer, M.C., Grob, C.S., and Brewerton, T.D. (2016). Novel psychopharmacological therapies for psychiatric disorders: psilocybin and MDMA. Lancet Psychiatry 3, 481-488.
69. Moskal, J.R., Burgdorf, J.S., Stanton, P.K., Kroes, R.A., Disterhoft, J.F., Burch, R.M., and Khan, M.A. (2017). The development of rapastinel (formerly GLYX-13); a rapid acting and long lasting antidepressant. Curr. Neuropharmacol. 15, 47-56.
70. Murrough, J.W., Perez, A.M., Pillemer, S., Stern, J., Parides, M.K., aan het Rot, M., Collins, K.A., Mathew, S.J., Charney, D.S., and Iosifescu, D.V. (2013). Rapid and longer-term antidepressant effects of repeated ketamine infusions in treatment-resistant

major depression. Biol. Psychiatry 74, 250-256.
71. Nair, A.B., and Jacob, S. (2016). A simple practice guide for dose conversion between animals and human. J. Basic Clin. Pharm. 7, 27-31.
72. Nichols, D.E. (2004). Hallucinogens. Pharmacol. Ther. 101, 131-181.
73. Nichols, D.E. (2016). Psychedelics. Pharmacol. Rev. 68, 264-355.
74. Nichols, C.D., and Sanders-Bush, E. (2002). A single dose of lysergic acid diethylamide influences gene expression patterns within the mammalian brain. Neuropsychopharmacology 26, 634-642.
75. Nichols, D.E., Johnson, M.W., and Nichols, C.D. (2017). Psychedelics as medicines: an emerging new paradigm. Clin. Pharmacol. Ther. 101, 209-219.
76. Nutt, D., King, L.A., Saulsbury, W., and Blakemore, C. (2007). Development of a rational scale to assess the harm of drugs of potential misuse. Lancet 369, 1047-1053.
77. Nutt, D.J., King, L.A., and Phillips, L.D.; Independent Scientific Committee on Drugs (2010). Drug harms in the UK: a multicriteria decision analysis. Lancet 376, 1558-1565.
78. Oehen, P., Traber, R., Widmer, V., and Schnyder, U. (2013). A randomized, controlled pilot study of MDMA (± 3,4-Methylenedioxymethamphetamine)-assisted psychotherapy for treatment of resistant, chronic Post-Traumatic Stress Disorder (PTSD). J. Psychopharmacol. (Oxford) 27, 40-52.
79. Osório, Fde.L., Sanches, R.F., Macedo, L.R., Santos, R.G., Maia-de-Oliveira, J.P., Wichert-Ana, L., Araujo, D.B., Riba, J., Crippa, J.A., and Hallak, J.E. (2015). Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. Rev. Bras. Psiquiatr. 37, 13-20.
80. Peters, J., Dieppa-Perea, L.M., Melendez, L.M., and Quirk, G.J. (2010). Induction of fear extinction with hippocampal-infralimbic BDNF. Science 328, 1288-1290.
81. Pittenger, C., and Duman, R.S. (2008). Stress, depression, and neuroplasticity: a convergence of mechanisms. Neuropsychopharmacology 33, 88-109.
82. Qiao, H., Li, M.X., Xu, C., Chen, H.B., An, S.C., and Ma, X.M. (2016). Dendritic Spines in Depression: What We Learned from Animal Models. Neural Plast. 2016, 8056370.
83. Quirk, G.J., Garcia, R., and González-Lima, F. (2006). Prefrontal mechanisms in extinction of conditioned fear. Biol. Psychiatry 60, 337-343.
84. Ristanovi&cacute;, D., Milosevi&cacute;, N.T., and Stuli&cacute;, V. (2006). Application of modified Sholl analysis to neuronal dendritic arborization of the cat spinal cord. J. Neurosci. Methods 158, 212-218.
85. Rucker, J.J., Jelen, L.A., Flynn, S., Frowde, K.D., and Young, A.H. (2016). Psychedelics in the treatment of unipolar mood disorders: a systematic review. J. Psychopharmacol. (Oxford) 30, 1220-1229.
86. Rush, A.J., Trivedi, M.H., Wi&sacute;niewski, S.R., Nierenberg, A.A., Stewart, J.W., Warden, D., Niederehe, G., Thase, M.E., Lavori, P.W., Lebowitz, B.D., *et al*. (2006). Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report. Am. J. Psychiatry 163, 1905-1917.
87. Russo, S.J., and Nestler, E.J. (2013). The brain reward circuitry in mood disorders. Nat. Rev. Neurosci. 14, 609-625.
88. Russo, S.J., Mazei-Robison, M.S., Ables, J.L., and Nestler, E.J. (2009). Neurotrophic factors and structural plasticity in addiction. Neuropharmacology 56 (Suppl 1), 73-82.
89. Sanches, R.F., de Lima Osório, F., Dos Santos, R.G., Macedo, L.R., Maia-deOliveira, J.P., Wichert-Ana, L., de Araujo, D.B., Riba, J., Crippa, J.A., and Hallak, J.E. (2016). Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a SPECT study. J. Clin. Psychopharmacol. 36, 77-81.
90. Santos, R.G., Landeira-Fernandez, J., Strassman, R.J., Motta, V., and Cruz, A.P. (2007). Effects of ayahuasca on psychometric measures of anxiety, panic-like and hopelessness in Santo Daime members. J. Ethnopharmacol. 112, 507-513.
91. Smith, R.L., Canton, H., Barrett, R.J., and Sanders-Bush, E. (1998). Agonist properties of *N,N*-dimethyltryptamine at serotonin 5-HT2A and 5-HT2C receptors. Pharmacol. Biochem. Behav. 61, 323-330.
92. Strassman, R.J., Qualls, C.R., Uhlenhuth, E.H., and Kellner, R. (1994). Doseresponse study of *N,N*-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch. Gen. Psychiatry 51, 98-108.
93. Takei, N., Inamura, N., Kawamura, M., Namba, H., Hara, K., Yonezawa, K., and Nawa, H. (2004). Brain-derived neurotrophic factor induces mammalian target of rapamycin-dependent local activation of translation machinery and protein synthesis in neuronal dendrites. J. Neurosci. 24, 9760-9769.
94. Vaidya, V.A., Marek, G.J., Aghajanian, G.K., and Duman, R.S. (1997). 5-HT$_{2A}$ receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. J. Neurosci. 17, 2785-2795.
95. Voleti, B., Navarria, A., Liu, R.J., Banasr, M., Li, N., Terwilliger, R., Sanacora, G., Eid, T., Aghajanian, G., and Duman, R.S. (2013). Scopolamine rapidly increases mammalian target of rapamycin complex 1 signaling, synaptogenesis, and antidepressant behavioral responses. Biol. Psychiatry 74, 742-749.
96. Vollenweider, F.X., and Kometer, M. (2010). The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. Nat. Rev. Neurosci. 11, 642-651.
97. Wacker, D., Wang, S., McCorvy, J.D., Betz, R.M., Venkatakrishnan, A.J., Levit, A., Lansu, K., Schools, Z.L., Che, T., Nichols, D.E., *et al*. (2017). Crystal Structure of an LSD-Bound Human Serotonin Receptor. Cell 168, 377-389.e12.
98. Whiteford, H.A., Degenhardt, L., Rehm, J., Baxter, A.J., Ferrari, A.J., Erskine, H.E., Charlson, F.J., Norman, R.E., Flaxman, A.D., Johns, N., *et al*. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 382, 1575-1586.
99. Winter, J.C., Rice, K.C., Amorosi, D.J., and Rabin, R.A. (2007). Psilocybin-induced stimulus control in the rat. Pharmacol. Biochem. Behav. 87, 472-480.
100. Yang, C., Shirayama, Y., Zhang, J.C., Ren, Q., Yao, W., Ma, M., Dong, C., and Hashimoto, K. (2015). R-ketamine: a rapid-onset and sustained antidepressant without psychotomimetic side effects. Transl. Psychiatry 5, e632.
101. Yang, Y., Cui, Y., Sang, K., Dong, Y., Ni, Z., Ma, S., and Hu, H. (2018). Ketamine blocks bursting in the lateral habenula to rapidly relieve depression. Nature 554, 317-322.
102. Young, M.B., Andero, R., Ressler, K.J., and Howell, L.L. (2015). 3,4-Methylenedioxymethamphetamine facilitates fear

extinction learning. Transl. Psychiatry 5, e634.

103. Zanos, P., Moaddel, R., Morris, P.J., Georgiou, P., Fischell, J., Elmer, G.I., Alkondon, M., Yuan, P., Pribut, H.J., Singh, N.S., *et al*. (2016). NMDAR inhibition-independent antidepressant actions of ketamine metabolites. Nature 533, 481-486.
104. Zarate, C.A., Jr., Singh, J.B., Carlson, P.J., Brutsche, N.E., Ameli, R., Luckenbaugh, D.A., Charney, D.S., and Manji, H.K. (2006). A randomized trial of an N-methyl-D-aspartate antagonist in treatment-resistant major depression. Arch. Gen. Psychiatry 63, 856-864.
105. Zarate, C.A., Jr., Brutsche, N.E., Ibrahim, L., Franco-Chaves, J., Diaz-Granados, N., Cravchik, A., Selter, J., Marquardt, C.A., Liberty, V., and Luckenbaugh, D.A. (2012). Replication of ketamine's antidepressant efficacy in bipolar depression: a randomized controlled add-on trial. Biol. Psychiatry 71, 939-946.
106. Zeng, Y., Lv, F., Li, L., Yu, H., Dong, M., and Fu, Q. (2012). 7,8-dihydroxyflavone rescues spatial memory and synaptic plasticity in cognitively impaired aged rats. J. Neurochem. 122, 800-811.
107. Zubaran, C., Shoaib, M., Stolerman, I.P., Pablo, J., and Mash, D.C. (1999). Noribogaine generalization to the ibogaine stimulus: correlation with noribogaine concentration in rat brain. Neuropsychopharmacology 21, 119-126.

Supplemental Information

Supplemental Methods

Drugs

The NIH Drug Supply Program provided (±)-2,5-dimethoxy-4-iodoamphetamine (DOI), lysergic acid diethylamide (LSD), ibogaine (IBO), noribogaine (NOR), (±)-3,4-metheylendioxymethamphetamine (MDMA), psilocin (PSI), and D-amphetamine (AMPH). Other chemicals were purchased from commercial sources such as ketamine hydrochloride (KET, Fagron), serotonin hydrochloride (5-HT, Alfa Aesar), 7,8-dihydroxyflavone (DHF, TCI), ANA-12 (MedChem Express), rapamycin (RAPA, Alfa Aesar), ketanserin (KETSN, ApexBio), and brain-derived neurotrophic factor (BDNF, Sigma-Aldrich). The fumarate salt of *N,N*-dimethyltryptamine (DMT), was synthesized in house as described previously (Cameron *et al.*, 2018) and judged to be analytically pure based on NMR and LC-MS data.

Neuritogenesis Experiments

After 3 days *in vitro* (DIV3), approximately 50,000 cells/well in poly-D-lysine coated 24 well plates were treated. Treatment was accomplished by first diluting DMSO stock solutions of compounds 1:10 in Neurobasal followed by a 1:100 dilution into each well (total dilutio*n* = 1:1000). After 72 h, cells were fixed by removing 80% of the media and replacing it with a volume of 4% aqueous paraformaldehyde (Alfa Aesar) equal to 50% of the working volume of the well. Then, the cells were allowed to sit for 20 min at room temperature before the fixative was aspirated and each well washed twice with DPBS. Cells were permeabilized using 0.2% Triton X-100 (ThermoFisher) in DPBS for 20 minutes at room temperature without shaking. Plates were blocked with antibody diluting buffer (ADB) containing 2% bovine serum albumin (BSA) in DPBS for 1 h at room temperature. Then, plates were incubated overnight at 4°C with gentle shaking in ADB and a chicken anti-MAP2 antibody (1:10,000; EnCor, CPCA-MAP2). The next day, plates were washed three times with DPBS and once with 2% ADB in DPBS. Plates were incubated for 1 h at room temperature in ADB containing an anti-chicken IgG secondary antibody conjugated to Alexa Fluor 488 (Life Technologies, 1:500) and washed five times with DPBS. After the final wash, 500 µL of DPBS was added per well and imaged on a Leica inverted epifluorescence microscope at 40x magnification. Images were analyzed using the Simple Neurite Tracer and Sholl analysis plug-ins for ImageJ Fiji (version 1.51N). Sholl analysis circle radii = 2 µm increments. All images were taken and analyzed by an experimenter blinded to treatment conditions.

For the dose response experiments (Figure S3) and two of the ketanserin blocking experiments (Figure 6G and H), a slightly modified method was employed. Neurons were cultured at approximately 15,000 cells/well in poly-D-lysine coated 96-well plates. For the dose response studies, neurons were treated at DIV3 by removing 10% of the media and replacing that with a 10x solution of compound in Neurobasal to reach the desired concentrations (final concentration of DMSO = 0.1%). For the ketanserin blocking experiments, the media was replaced on DIV3 with "replacement media" containing ketanserin. After 10 mins, compounds dissolved in Neurobasal were added to yield final concentrations of experimental compound and ketanserin (final concentration of DMSO = 0.2%). On DIV6, cells were fixed and imaged as described above. Plates were imaged on a Molecular Devices ImageXpress Micro XLS Widefield High-Content Analysis System at 9 sites per well using 20x magnification. Images were analyzed using ImageJ Fiji (version 1.51N). All analysis was done by an experimenter blinded to treatment conditions.

Spinogenesis Experiments

Cells were plated at a density of 35,000 cells/well on glass coverslips in 24 well plates. At DIV18, cells were treated for 24 h and fixed as described for the neuritogenesis experiments (vide supra). Fixative was aspirated and each well washed twice with DPBS. Cells were permeabilized using 0.2% Triton X-100 (ThermoFisher) in DPBS for 20 minutes at room temperature without shaking. Plates were blocked with antibody diluting buffer (ADB) containing 2% bovine serum albumin (BSA) in DPBS for 1 h at room temperature. Then, plates were incubated overnight at 4°C with gentle shaking in ADB and anti-chicken MAP2 (1:10,000; EnCor, CPCA-

MAP2). The next day, plates were washed three times with DPBS and once with 2% ADB in DPBS. Plates were incubated for 1 h at room temperature in ADB containing an anti-chicken IgG secondary antibody conjugated to Alexa Fluor 568 (Life Technologies, 1:500) and phalloidin conjugated to Alexa Fluor 488 (Life Technologies, 1:40). Then, the cells were washed five times with DPBS. Finally, the coverslips were mounted onto microscope slides using ProLong Gold (Life Technologies) and allowed to cure for 24 hours at room temperature. Images of secondary dendrites were taken using a Nikon N-SIM Structured Illumination Super-resolution Microscope with a 100x/NA 1.49 objective, 100 EX V-R diffraction grating, and an Andor iXon3 DU-897E EMCCD. Images were recollected and reconstructed in the "2D-SIM" mode (no out of focus light removal; reconstruction used three diffraction grating angles each with three translations). Dendritic spines were counted manually by a trained experimenter who was blinded to the treatment conditions.

Synaptogenesis Experiments

Cells were plated at a density of 35,000 cells/well on glass coverslips in 24 well plates. At DIV18, cells were treated for 24 h and fixed as described for the neuritogenesis experiments (vide supra). Fixative was aspirated and each well washed twice with DPBS. Cells were permeabilized using 0.2% Triton X-100 (ThermoFisher) in DPBS for 20 minutes at room temperature without shaking. Plates were blocked with antibody diluting buffer (ADB) containing 2% bovine serum albumin (BSA) in DPBS for 1 h at room temperature. Then, plates were incubated overnight at 4°C with gentle shaking in ADB and anti-MAP2 (1:10,000; EnCor, CPCA-MAP2), anti-VGLUT1 (Millipore, AB5905, 1:1000), and anti-PSD-95 (Millipore, MABN68, 1:500) antibodies. The next day, plates were washed three times with DPBS and once with 2% ADB in DPBS. Plates were incubated for 1 h at room temperature in ADB containing secondary antibodies conjugated to Alexa Fluor 488 (Life Technologies, 1:500), Cy3 (Jackson ImmunoResearch Inc, 1:500), or Alexa Fluor 647 (Jackson ImmunoResearch Inc, 1:500). Images of secondary dendrites were collected using a confocal microscope (Olympus FV1000) with a 60x oil objective and a 1.42 numerical aperture.

Synaptic density and size as well as PSD-95 and VGLUT1 densities were determined using custom software that works in three stages. The first stage is a foreground/background separation that outputs a mask of pixels within the image that correspond to the neuron. Next, puncta of synaptic proteins are identified using only pixels belonging to the foreground mask from the first stage. Finally, synapses are identified as colocalizations of puncta of pre- and post-synaptic proteins. The foreground mask is determined using a fluorescence intensity threshold chosen to maximize the connectedness of both the foreground and the background. Specifically, for a given threshold, connected pixels that pass the threshold are clustered together, and connected pixels that fall below threshold are clustered together. The average cluster size is computed for each type of cluster, and the threshold that maximizes the product of these averages is chosen. The resulting foreground mask is cleaned by removing clusters smaller than 0.06 μm^2 and smoothed by eliminating pixels connected to fewer than three other pixels that passed the threshold and adding pixels connected to more than four pixels that passed the threshold. Within the foreground mask, every pixel that has greater intensity than its neighbors is treated as a seed point for a potential punctum. The median and standard deviation of pixel intensities is computed for foreground pixels in the neighborhood of each seed point. The size of the local neighborhood is made dynamic in order to maintain sufficient statistics, with a minimum size of 5 μm^2. Seed points with intensities less than 3 standard deviations above the local median are rejected. For seed points that pass this threshold, adjacent pixels that pass a less stringent threshold (the minimum of 2 standard deviations above the median and the average of the median and seed point intensities) are clustered. In order to prevent neighboring puncta from being clustered together, intensities for newly added pixels are required to decrease if adjacent established pixels are already close to the lower threshold. Once the clustering is complete, puncta are smoothed in the same manner as the foreground and rejected if they are smaller than 0.03 μm^2. Pixels that are part of a punctum passing all of the above criteria are removed from the foreground mask so as not to be included in the threshold calculation for future puncta. After every seed point has been tested, those that failed are iterated over again until no new puncta are added. At the beginning of each iteration, puncta smaller the 3 times the minimum size threshold are removed to be reclustered. Synapses are defined as a colocalization of PSD-95 and VGLUT1 puncta. Two puncta are considered colocalized if they have at least 1 pixel of overlap. Synapse densities as well as the densities of presynaptic and postsynaptic markers are calculated using dendrite areas computed by counting pixels within a region of interest belonging to the foreground mask in the MAP2 channel. A similar approach for calculating synapse density has been described previously (Nielend *et al.*, 2014). Synapse size was calculated using the number of pixels representing each colocalization event. Outliers were removed using the ROUT method in GraphPad Prism (version 7.0a) with a Q value equal to 5%.

ELISA

Cortical cultures were grown in 6-well plates (600,000 cells per well). At DIV17-18, all media was removed and replaced with fresh Neurobasal. After 4 h, each well was treated with compound dissolved in DMSO (1:1000) for 24 h. After the treatment period, the media was removed and the cells washed once with ice-cold DPBS. To each well was added 200 µL of Cell Extraction Buffer (Life Technologies) supplemented with cOmplete and PhoSTOP inhibitors, and incubated on ice for 5-10 min. Plates were scrapped and the contents collected. The samples were centrifuged at 10,000 x g for 10 min at 4°C and subjected to a BDNF ELISA assay (ThermoFisher) as per the manufacturer's protocol with the exception that the colorimetric signal was only allowed to develop for 8 minutes.

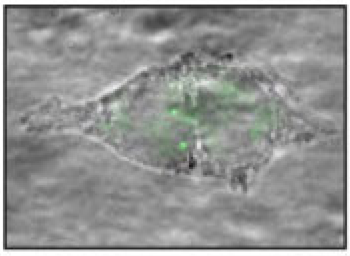
ddPCR

Cortical cultures were grown in 6-well plates (600,000 cells per well) until DIV17-18. At that time, cells were treated with compounds (1:1000 dilution from DMSO stock solutions) for 24h. Cells were then lysed using QIAzol Lysis Reagent (QIAGEN) and RNA extracted using the RNeasy isolation kit (QIAGEN) following instructions of the manufacturer. The resulting RNA was converted to cDNA using the iScript cDNA Synthesis Kit (BioRad). Droplets containing PCR master mix and taqman probes for BDNF (ThermoFisher, RN02531967_s1) and ESD (ThermoFisher, RN01468295_g1) were generated using the QX200 Droplet Digital PCR System (BioRad). Following PCR amplification, BDNF signal was quantified and normalized to the housekeeping gene ESD.

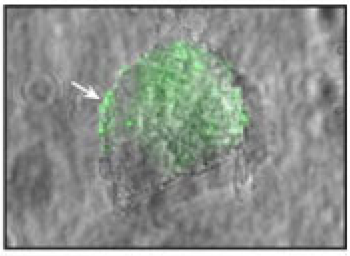
5-HT2A Staining Experiments

Cells were plated at a density of 35,000 cells/well on glass coverslips in 24 well plates. At DIV6 and DIV19, cells were fixed as described for the neuritogenesis experiments (vide supra). Fixative was aspirated and each well washed three times with DPBS. Cells were permeabilized and blocked using 0.1% Triton X-100 (ThermoFisher) and 5% goat serum (Vector Labs S-1000) in DPBS (TPG) for 1 hour at room temperature with gentle shaking. Plates were incubated overnight at 4°C with gentle shaking with anti-MAP2 (1:1000) and rabbit anti-5-HT_{2A} (Millipore Sigma PC176, 1:100) antibodies diluted in TPG. The next day, plates were washed three times for 5 min each with wash buffer (0.1% Triton X-100 in DPBS). Plates were incubated for 1 hour at room temperature in TPG containing secondary antibodies conjugated to Oregon Green 488 (Life Technologies, 1:500) and Alexa Fluor 568 (Life Technologies, 1:500). Plates were again washed three times for 5 min each with wash buffer (0.1% Triton X-100 in DPBS) and post-fixed for 10 min with 4% PFA in DPBS. Cells were washed three times with DPBS and mounted onto microscope slides using Prolong Gold (Life Technologies). After curing for 24 hours at room temperature, images of neurons were collected using a confocal microscope (Olympus FV1000) with a 60x oil objective (1.42 NA).

The anti-5-HT_{2A} antibody used in these studies (i.e., Millipore Sigma PC176) was produced using a peptide antigen corresponding to residues 22-41 of the rat 5-HT_{2A} receptor. The specificity of an antibody produced using the same antigen has been validated previously (Garlow *et al.*, 1993). As it was unclear from the manufacturer's information whether or not the antibody utilized in our studies was produced using the same carrier protein (McDonald and Mascagni, 2007), we performed our own validation experiments. Briefly, HEK293T cells (ATCC, CRL-3216) and 198A2 cells (i.e., a HEK293 cell line stably expressing 5-HT_{2A} receptors, donated by Javier González-Maeso; see González-Maeso *et al.*, 2003; Ebersole *et al.*, 2003) were fixed, stained, and imaged with a 100x oil objective (1.3 NA) on an inverted widefield microscope (Leica DMIL). Representative bright-field images (grayscale) overlaid with fluorescence images (green) indicating 5- HT2A expression are shown below. The cells expressing 5-HT_{2A} receptors exhibit significantly more fluorescence and the expected staining at the cell membrane (white arrow), validating this antibody for immunofluorescence studies.



HEK293T
(Does Not Express 5-HT$_{2A}$)



1988A
(Stably Expresses 5-HT$_{2A}$)

Drosophila Experiments

For morphological analysis, we crossed *221-Gal4* with *UAS-cd4-tdGFP*, collected the progeny at either the first larval instar (early treatment) or late second larval instar (late treatment), then transferred the larvae to grape agar plates smeared with yeast paste. This yeast paste was dissolved in 1 mL of autoclaved water containing 0.1% DMSO with or without compounds dissolved at concentration of 10 µM. Whole, live wandering third instar larvae were mounted in 90% glycerol under coverslips sealed with grease and imaged using an Olympus FV1000 laser scanning confocal microscope. For fly stocks, we used the Gal4 driver line, *221-Gal4* (Grueber *et al*., 2003), to drive the expression of the membrane marker, *UAS-cd4-tdGFP* (Han *et al*., 2011), to visualize dendrite morphology for all conditions. Collected Z-stacks containing the dendritic arbors of the class I da sensory neurons were used for analysis. One neuron from segment A3 or A4 was imaged per larvae and three larvae were imaged per drug condition per treatment window (early vs. late treatment). All larval drug treatments were performed at least three separate times. Total dendrite length and the number of branch points were determined from maximum Z projections of the Z-stack image files using the Simple Neurite Tracer plugin for ImageJ Fiji (Longair *et al*., 2011). Data acquisition and analysis was performed by an experimenter blinded to treatment conditions.

Zebrafish Experiments

Wildtype fish (NHGRI-1) were dechorionated 24 h post fertilization (hpf) and placed individually into a 96-well plate containing chemicals of interest (10 µM compound, 0.1% DMSO). Larvae were raised in a light-cycled incubator (28°C) and subsequently subjected to an activity assay for 16 hours, from 5pm to 9am, at 5.5-6.5 days post fertilization (dpf). Specifically, they were imaged using DanioVision with a light cycle mimicking their natural day/night cycle. Subsequently, fish larvae (6.5 dpf) were immediately fixed following the movement assay using 4% aqueous paraformaldehyde overnight. Head-width measurements were performed by imaging larvae dorsally using a stereomicroscope (12x magnification) and a digital ruler (ImageJ) to measure the distance between the inner edges of each eye. Data acquisition and analysis was performed by an experimenter blinded to treatment conditions.

Golgi-Cox Staining

Female Sprague Dawley rats (~8 weeks old) were given an intraperitoneal injection of DMT, ketamine, or vehicle and sacrificed via decapitation 24 h later. Tissue was prepared following the protocol outlined in the FD Neurotechnologies Rapid GolgiStain Kit (FD Neurotechnologies) with slight modifications. Brains were stored in solution C for 2 months prior to slicing into 120 µm sections using a vibratome. These slices were placed onto microscope slides that were pre-coated with (3-aminopropyl)triethoxysilane. Slices were air dried for a week before staining. Slides were immersed in water twice for 2 minutes, DE solution for 10 minutes, and then water for 2 minutes. After this, slides were immersed sequentially in 25% ethanol for 1 minute, 50% ethanol for 4 minutes, 75% ethanol for 4 minutes, 95% ethanol for 4 minutes, and 100% ethanol for 4 minutes. Slides were then briefly dipped into xylenes before being mounted using DPX Mountant For Histology (Sigma), air-dried, and imaged on a Zeiss AxioScope. Spines were traced in three dimensions using Neurolucida software (version 10) at 100x magnification. Data acquisition and analysis was performed by an experimenter blinded to treatment conditions. Data represents individual neurons taken from 3 different animals per treatment,

Electrophysiology

Female Sprague Dawley rats (~8 weeks old) were given an intraperitoneal injection of DMT or vehicle. After 24 h, rats were anesthetized with isofluorane and transcardially perfused with ice-cold artificial cerebrospinal fluid (ACSF), containing 119 mM NaCl, 26.2 mM $NaHCO_3$, 11 mM glucose, 2.5 mM KCl, 1 mM NaH_2PO_4, 2.5 mM $CaCl_2$ and 1.3 mM $MgSO_4$. Brains were rapidly removed and 300 μm coronal slices from the mPFC were cut on a Leica VT1200 vibratome (Buffalo Grove, IL) with ice-cold ACSF solution. Slices were incubated in 32°C NMDG solution for 10 minutes, transferred to room temperature ACSF, and held for at least 50 minutes before recording. All solutions were vigorously perfused with 95% O_2 and 5% CO_2. Spontaneous excitatory postsynaptic currents (sEPSCs) were recorded at -70 mV in 32°C ACSF. Cells were patched with 3-5 MΩ borosilicate pipettes filled with intracellular solution containing 135 mM cesium methanesulfonate, 8 mM NaCl, 10 mM HEPES, 0.3 mM Na-GTP, 4 mM Mg-ATP, 0.3 mM EGTA, and 5 mM QX-314 (Sigma, St Louis, MO). Series resistance was monitored throughout experiments; cells were discarded if series resistance varied more than 25%. All recordings were obtained with a Multiclamp 700B amplifier (Molecular Devices, Sunnyvale, CA). Analysis was performed with the Mini Analysis program (Synaptosoft, Decatur, GA) with a 4 pA detection threshold. Data represents individual neurons taken from 3 different animals per treatment. Data acquisition and analysis was performed by experimenters blinded to treatment conditions.

Code Availability

The code used to generate synaptogenesis data is available from the corresponding author upon reasonable request.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Supplemental References

1. Ebersole, B.J., Visiers, I., Weinstein, H., and Sealfon, S. C. (2003). Molecular basis of partial agonism: orientation of indoleamine ligands in the binding pocket of the human serotonin 5-HT_{2A} receptor determines relative efficacy. Mol. Pharmacol. 63, 36-43.
2. Garlow, S.J., Morilak, D.A., Dean, R.R., Roth, B.L., and Ciaranello, R.D. (1993). Production and characterization of a specific 5-HT2 receptor antibody. Brain Res. 615, 113-120.
3. Grueber, W.B., Ye, B., Moore, A.W., Jan, L.Y., and Jan, Y.N. (2003). Dendrites of distinct classes of *Drosophila* sensory neurons show different capacities for homotypic repulsion. Curr. Biol. 13, 618-626.
4. Han, C., Jan, L.Y., and Jan, Y.N. (2011). Enhancer-driven membrane markers for analysis of nonautonomous mechanisms reveal neuron-glia interactions in *Drosophila*. Proc. Natl. Acad. Sci. USA 108, 9673-9768.
5. Longair, M.H., Baker, D.A., and Armstrong, J.D. (2011). Simple Neurite Tracer: open source software for reconstruction, visualization and analysis of neuronal processes. Bioinformatics 27, 2453-2454.
6. McDonald, A.J., and Mascagni, F. (2007). Neuronal localization of 5-HT type 2A receptor immunoreactivity in the rat basolateral amygdala. Neuroscience 146, 306-320.
7. Nieland, T.J., Logan, D.J., Saulnier, J., Lam, D., Johnson, C., Root, D.E., Carpenter, A.E., and Sabatini, B.L. (2014). High content image analysis identifies novel regulators of synaptogenesis in a high-throughput RNAi screen of primary neurons. PLoS One 9, e91744
8. González-Maeso, J., Yuen, T., Ebersole, B.J., Wurmbach, E., Lira, A., Zhou, M., Weisstaub, N., Hen, R., Gingrich, J.A., and Sealfon, S.C. (2003). Transcriptome fingerprints distinguish hallucinogenic and nonhallucinogenic 5-hydroxytryptamine 2A receptor agonist effects in mouse somatosensory cortex. J. Neurosci. 23, 8836-8843.

Increased global integration in the brain after psilocybin therapy for depression

by

Richard E. Daws[1,2], Christopher Timmermann[1,3], Bruna Giribaldi[3], James D. Sexton[3],Matthew B. Wall[4,5,6], David Erritzoe[3], Leor Roseman[3], David Nutt[3] and Robin Carhart-Harris[3,7]

Nature Medicine volume 28, pages 844-851 (2022)

© Authors

original report: https://www.nature.com/articles/s41591-022-01744-z.pdf
backup source: http://www.psilosophy.info/resources/s41591-022-01744-z.pdf

Table of Contents:

Abstract
Main
Results
Open-label trial
Rapid antidepressant effect of psilocybin therapy
Decreased brain modularity one day after psilocybin therapy
Decreased modularity predicts improved clinical outcomes
DMN changes in within-network and between-network functional connectivity one day after treatment
Double-blind randomized controlled trial
Psilocybin therapy versus escitalopram for depression
Decreased brain modularity for psilocybin but not escitalopram
Response to psilocybin correlates with network flexibility
Discussion
Methods
Trial overviews
Participants
Interventions
Measuring depression severity
MRI acquisition
fMRI data preprocessing
Functional connectivity
Brain network modularity
Functional cartography
Dynamic flexibility
Reporting Summary
Data availability
Code availability
Acknowledgements
Author contributions
Competing interests
Additional information
References

[1] The Computational, Cognitive and Clinical Neuroimaging Laboratory (C3NL), Imperial College London, London, UK.
[2] Centre for Neuroimaging Sciences,Kings College London, London, UK.
[3] Centre for Psychedelic Research, Division of Academic Psychiatry, Imperial College London, London, UK.
[4] InvicroLondon, Hammersmith Hospital, London, UK.

[5] Department of Metabolism, Digestion and Reproduction, Faculty of Medicine, Imperial College London, London, UK.
[6] Clinical Psychopharmacology Unit, University College London, London, UK.
[7] Psychedelics Division, Neuroscape, Department of Neurology, University of California, San Francisco, CA, USA
 e-mail: richard.daws@kcl.ac.uk

Abstract

Psilocybin therapy shows antidepressant potential, but its therapeutic actions are not well understood. We assessed the subacute impact of psilocybin on brain function in two clinical trials of depression. The first was an open-label trial of orally administered psilocybin (10 mg and 25 mg, 7 d apart) in patients with treatment-resistant depression. Functional magnetic resonance imaging (fMRI) was recorded at baseline and 1 d after the 25-mg dose. Beck's depression inventory was the primary outcome measure (MR/J00460X/1). The second trial was a double-blind phase II randomized controlled trial comparing psilocybin therapy with escitalopram. Patients with major depressive disorder received either 2 × 25 mg oral psilocybin, 3 weeks apart, plus 6 weeks of daily placebo ('psilocybin arm') or 2 × 1 mg oral psilocybin, 3 weeks apart, plus 6 weeks of daily escitalopram (10-20 mg) ('escitalopram arm'). fMRI was recorded at baseline and 3 weeks after the second psilocybin dose (NCT03429075). In both trials, the antidepressant response to psilocybin was rapid, sustained and correlated with decreases in fMRI brain network modularity, implying that psilocybin's antidepressant action may depend on a global increase in brain network integration. Network cartography analyses indicated that 5-HT$_{2A}$ receptor-rich higher-order functional networks became more functionally interconnected and flexible after psilocybin treatment. The antidepressant response to escitalopram was milder and no changes in brain network organization were observed. Consistent efficacy-related brain changes, correlating with robust antidepressant effects across two studies, suggest an antidepressant mechanism for psilocybin therapy: global increases in brain network integration.

Main

Depression is a highly prevalent mental health condition[1], the incidence of which has increased during the COVID-19 pandemic[2], for example, as reflected in increased prescriptions of antidepressant medications[3]. However, even the best-performing antidepressant drugs show modest efficacy, non-negligible side effects, discontinuation problems and high relapse rates[4-7], highlighting the need for new, improved treatments[8].

Patients with a diagnosis of depression often exhibit a negative cognitive bias, characterized by pessimism, poor cognitive flexibility, rigid thought patterns and negative fixations regarding 'self' and the future[9,10]. A number of authors have directly or indirectly taken inspiration from dynamical systems theory to describe depressive episodes as 'attractor states' (stereotyped cognitive states with 'gravitational pull'[11]).

Neuroimaging research has consistently found examples of abnormal brain functioning in depression, resonant with its phenomenology[12-14]. A hierarchically supraordinate intrinsic brain network[15], the default mode network (DMN), is associated with introspection and self-referential thinking[16]. These cognitive functions are often overactive in depression[9], and several studies have linked excessive engagement of DMN functioning with depressive symptomatology[12].

In addition to the DMN, other higher-order brain networks such as the executive network (EN) and salience network (SN) have been implicated in depression[14,17]. These networks are associated with 'cognitive control' and internal versus external attention switching[18-20]. Such attentional switching is often impaired in depression[21]. Tellingly, the serotonin 2A (5-HT$_{2A}$) receptor subtype, which is the key proteomic binding site of 'classic' serotonergic psychedelic drugs, such as psilocybin[22], is most densely expressed in a broad pattern of cortex that closely resembles a conjunction map of the DMN, EN and SN[23], corresponding to the transmodal portion of the brain's principal hierarchical gradient[15].

In the last 15 years, at least six separate clinical trials have reported impressive improvements in depressive symptoms with psilocybin therapy[24]. Included among these studies are (1) an open-label trial in treatment-resistant depression[25] and (2) a double-blind, randomized controlled trial (DB-RCT) with an active comparator, the selective serotonin reuptake inhibitor (SSRI) and conventional antidepressant, escitalopram[26]. These two trials, which included pre-treatment and post-treatment fMRI, are the focus of this paper's analyses.

The therapeutic action of psilocybin and related psychedelics is incompletely understood; however, one model proposes that psychedelics cause a 5-HT$_{2A}$ receptor-induced dysregulation of spontaneous population-level neuronal activity, linked to a temporary 'disintegration' of intrinsic functional brain networks[27] and a hypothesized decrease in the precision-weighting of predictive models encoded (at least in part) by the integrity of functional modules[28]. One important corollary of modular 'disintegration' seems to be the broadening of the brain's functional repertoire of states, commensurate with a broader or flatter global energy landscape[29].

Here we hypothesize that the well-replicated finding of brain network disintegration and desegregation under psychedelics[30,31] will be apparent subacutely, in post-treatment resting-state fMRI data. We also hypothesize that this effect, consistent with a flatter energy landscape, will relate to improved depression outcomes and will not be observed after a course of the SSRI, escitalopram.

Results

Open-label trial

Rapid antidepressant effect of psilocybin therapy

Patients with treatment-resistant depression (TRD) participated in a single-arm, open-label psilocybin therapy clinical trial (Fig. 1a). Baseline clinical assessment and resting-state fMRI were followed by fixed-order 'low' (10mg) and 'high' (25mg) psilocybin therapy dosing days (DDs) that were separated by 1 week. A second clinical assessment and fMRI scan were conducted 1d after DD2. Remote assessments of clinical status were conducted 1 week, 3 months and 6 months after DD2. Further details are available in Methods and elsewhere[25].

Of the 19 patients recruited, 3 were excluded due to excessive fMRI head motion (Fig. 2a). We first confirmed an antidepressant effect of psilocybin in this imaging sample of 16 patients (mean age, 42.75 years, s.d.=10.15, 4 females) using the Beck Depression Inventory (BDI-1A). This patient-rated measure was preregistered for the original investigation (gtr.ukri.org MR/J00460X/1). The BDI captures a broad range of symptoms and places particular emphasis on the cognitive features of depression[32], which may be an important target of psilocybin therapy.

Baseline BDI scores indicated severe depression (mean BDI=34.81, s.d.=7.38). In line with our previous report[25], rapid, substantial and sustained reductions in depression severity were observed after treatment (Fig. 3a,b). Relative to baseline, significant BDI reductions were observed at 1 week (mean difference, -21.0 points t_{15}=7.11, 95% confidence interval (CI) -27.30 to -14.71, $P<0.001$, Cohen's d=1.78) and still evident at 6 months (mean difference, -14.19 points t_{15}=4.26, 95% CI -21.29 to -7.09, $P<0.001$, d=1.07).

Decreased brain modularity one day after psilocybin therapy

To test our primary hypothesis, preprocessed fMRI data were used to estimate normalized network modularity from Pearson correlation functional connectivity matrices of the cortex (Methods). Confirming our primary hypothesis, brain network modularity was significantly reduced (Fig. 4a) 1d after psilocybin therapy (mean difference, -0.29; t_{15}=2.87, 95% CI 0.07 to 0.50, P=0.012, d=0.72). This result implies a global increase in functional connectivity between the brain's main intrinsic networks.

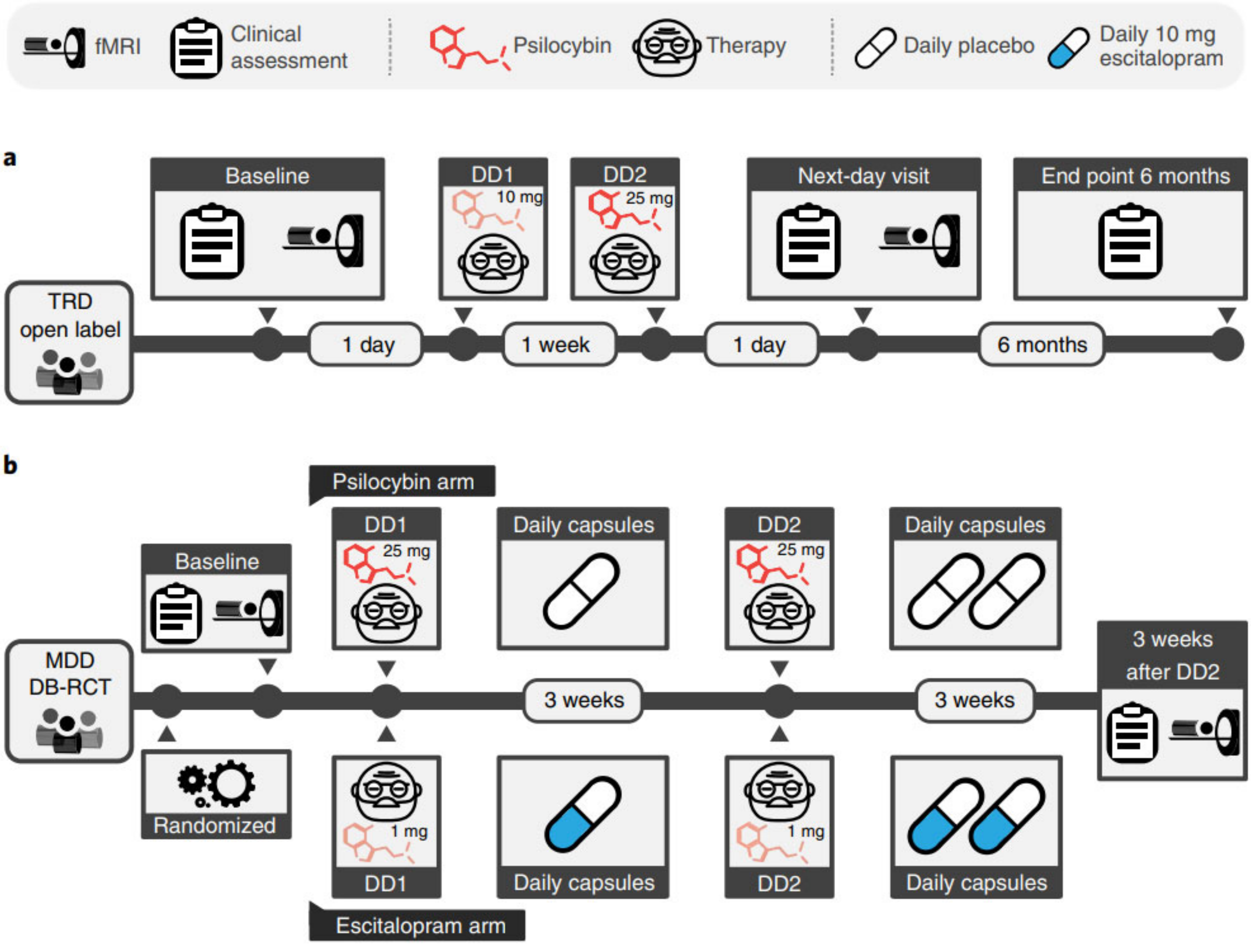

fMRI
Clinical assessment
Psilocybin
Therapy
Daily placebo
Daily 10 mg escitalopram
a
TRD open label
Baseline
DD1
10 mg
DD2
25 mg
Next-day visit
End point 6 months
1 day
1 week
1 day
6 months
b
MDD DB-RCT
Baseline
Randomized
Psilocybin arm
DD1
25 mg
Daily capsules
DD2
25 mg
Daily capsules
3 weeks
3 weeks
3 weeks after DD2
1 mg
DD1
Daily capsules
1 mg
DD2
Daily capsules
Escitalopram arm

Fig. 1 - **Trial design schematics. a**, Open-label trial. Eligible patients attended a baseline clinical assessment and resting-state fMRI visit. This was followed by two orally administered psilocybin therapy DDs separated by 1 week, which differed in dose strength (10 mg on DD1, 25 mg on DD2). The post-treatment fMRI scan occurred 1 d after DD2. Remote clinical assessment continued for 6 months. **b**, DB-RCT. Patients attended a baseline clinical assessment and resting-state fMRI visit and were randomly assigned to the psilocybin arm (top) or escitalopram arm (bottom). The psilocybin arm involved 2 × 25 mg psilocybin therapy DDs with 3 weeks of daily placebo capsules following each DD. The escitalopram arm involved 2 × 1 mg psilocybin therapy DDs with 3 weeks of 10 mg daily escitalopram following DD1 and 20 mg of escitalopram following DD2. Both groups attended a post-treatment clinical assessment and fMRI visit 3 weeks and 1 d after DD2.

Decreased modularity predicts improved clinical outcomes

We hypothesized that decreased brain network modularity would relate to the sustained improvements in depression severity that follow psilocybin therapy. To test this, we calculated Pearson correlations between the post-treatment brain modularity and BDI scores from the three post-treatment time points (1 week, 3 months, 6 months). After false discovery rate (FDR) correction for multiple comparisons, a strong significant Pearson correlation was observed at the 6 months primary end point (r_{14}=0.64, 95% CI 0.29 to 0.84, P=0.023; Fig. 4b). Directionally consistent relationships were seen at 3 months (r_{14}=0.46, 95% CI 0.03 to 0.74, P=0.114) and 1 week (r_{14}=0.29, 95% CI -0.16 to 0.64, P=0.284), but these did not survive correction. Pre-treatment versus post-treatment changes in modularity significantly correlated with change in BDI score at 6 months, relative to baseline (r_{14}=0.54, 95% CI 0.14 to 0.78, P=0.033; Fig. 4c). These results imply that decreased brain modularity 1d after psilocybin therapy relates to long-term improvements in depression symptom severity.

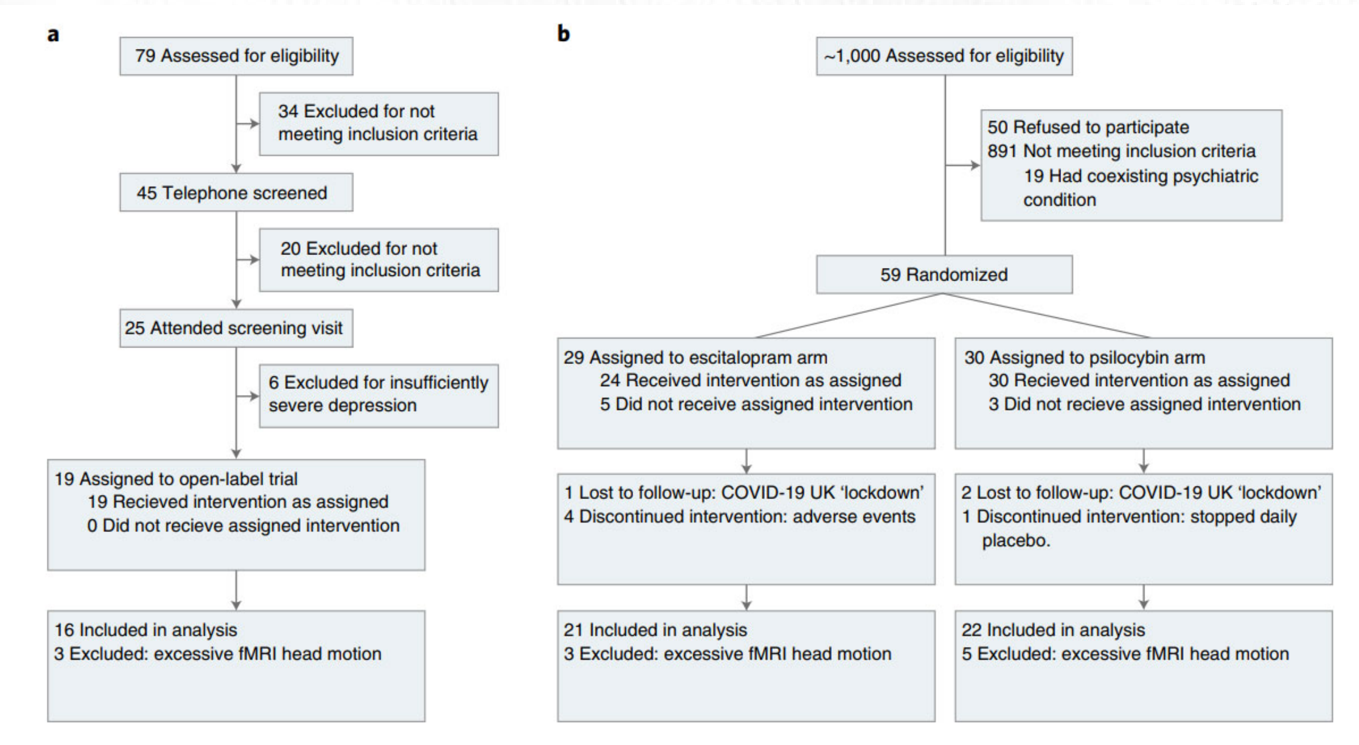

a
79 Assessed for eligibility
34 Excluded for not meeting inclusion criteria
45 Telephone screened
20 Excluded for not meeting inclusion criteria
25 Attended screening visit
6 Excluded for insufficiently severe depression
19 Assigned to open-label trial
19 Recieved intervention as assigned
0 Did not recieve assigned intervention
16 Included in analysis
3 Excluded: excessive fMRI head motion
b
~1,000 Assessed for eligibility
50 Refused to participate
891 Not meeting inclusion criteria
19 Had coexisting psychiatric condition
59 Randomized
29 Assigned to escitalopram arm
24 Received intervention as assigned
5 Did not receive assigned intervention
30 Assigned to psilocybin arm
30 Recieved intervention as assigned
3 Did not recieve assigned intervention
1 Lost to follow-up: COVID-19 UK 'lockdown'
4 Discontinued intervention: adverse events
2 Lost to follow-up: COVID-19 UK 'lockdown'
1 Discontinued intervention: stopped daily placebo.
21 Included in analysis
3 Excluded: excessive fMRI head motion
22 Included in analysis
5 Excluded: excessive fMRI head motion

Fig. 2 - Recruitment flow diagrams. a, The open-label trial was conducted during 2015-2016. **b**, The DB-RCT was conducted during 2019-2020.

DMN changes in within-network and between-network functional connectivity one day after treatment

Previous research has implicated depressive symptomology with hyperconnectivity of the DMN[12] and hypoconnectivity of the DMN with other higher-order 'cognitive' networks, including the EN and SN[14,17]. We therefore tested for evidence of these abnormalities being attenuated after treatment using functional cartography (Methods). Consistent with our previous hypothesis, significant reductions in DMN network recruitment (mean difference, -0.54; t_{15}=-2.99, 95% CI -0.92 to -0.15, P=0.009, d=0.75; Fig. 4d) and increased between-network integration between the DMN and EN (mean difference, 0.53 t_{15}=3.01, 95% CI 0.15 to 0.90, P=0.01, d=0.75) and between the DMN and SN (mean difference, 0.55 t_{15}=2.89, 95% CI 0.14 to 0.95, P=0.01, d=0.72; FDR-corrected) were observed 1d after psilocybin therapy. An exploratory analysis of the changes in network recruitment and between-network integration of other brain networks is available in Supplementary Fig. 2.

Double-blind randomized controlled trial

Psilocybin therapy versus escitalopram for depression

The design of this DB-RCT (Fig. 1b) gave a new opportunity to compare not just the safety and efficacy, but also the mechanisms of action of psilocybin therapy to those of a conventional antidepressant drug, escitalopram. Patients with major depressive disorder (MDD) were randomly allocated to a 'psilocybin arm' or 'escitalopram arm' (Fig. 1b). Baseline clinical assessment and resting-state fMRI was followed by DD1, when patients received either 25mg psilocybin (psilocybin arm) or a presumed inactive 1mg psilocybin dose (escitalopram arm). All patients were informed that they would receive psilocybin but were blind to the dosage. DD2 occurred 3 weeks after DD1 and was a duplicate dosage. Beginning 1d after DD1, patients took daily capsules for 6 weeks and 1d in total. For both conditions, one capsule per day was ingested for the first 3 weeks and two capsules per day were ingested thereafter. Capsule content was either inert placebo (microcrystalline cellulose in the psilocybin arm) or 10mg escitalopram in the escitalopram arm (10mg daily for the first 3 weeks and 2×10mg (20mg) daily for the final 22d). Further details are available in Methods and elsewhere[26].

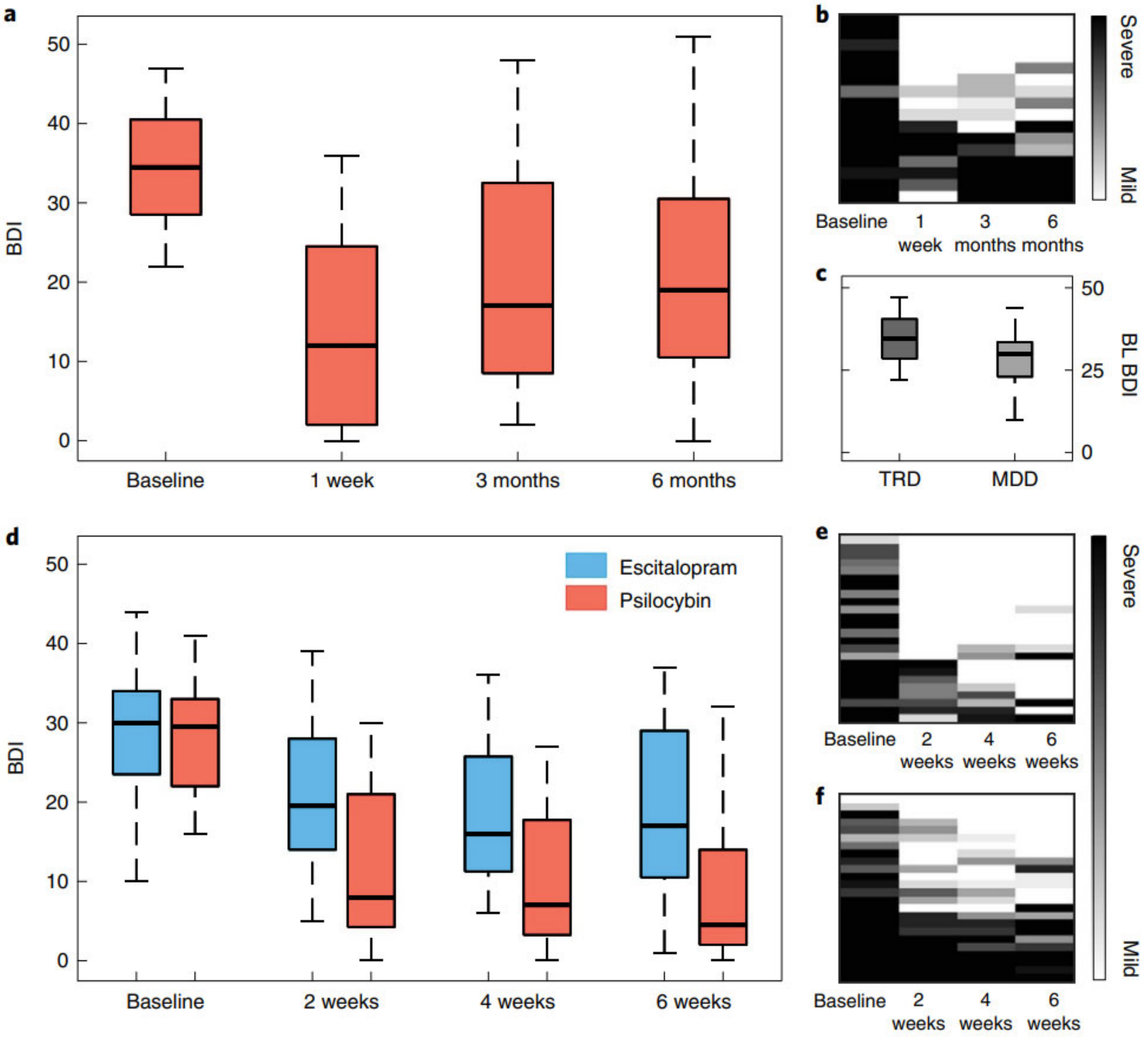


Fig. 3 - **Beck depression inventory scores.** **a**, Open-label trial box plots of BDI scores of patients with TRD across time points. **b**, Qualitative raster plots of individual patient's BDI score for each time point (columns). **c**, Baseline BDI of patients with TRD in the open-label trial was significantly greater than that in patients with MDD in the DB-RCT (t_{57}= 3.01, 95% CI 2.18 to 10.88, P= 0.013, d= 0.83). **d**, DB-RCT BDI scores from each study arm and time point. **e**,**f**, Qualitative raster plots of individual patient's BDI for each time point for the psilocybin arm (**e**) and escitalopram arm (**f**). The box plot central marks represent the group median, the box edges represent the 25th to 75th percentiles and the whiskers extend to the data range. Independent samples of n= 16 TRD were used in **a** and alongside n= 43 MDD in **c**, of which n= 21 in the escitalopram arm and n= 22 in the psilocybin arm are displayed in **d**. The rows from each qualitative raster plot were ordered by the sum BDI score across time points.

Of the 59 patients with MDD recruited, 29 were randomly allocated to the escitalopram arm. Of those, four discontinued due to adverse reactions to escitalopram, one was lost due to the COVID19 UK lockdown and three were excluded due to excessive fMRI head motion (Fig. 2b). The remaining 21 patients (mean age, 40.9 years, s.d.=10.1, 6 female) were included in the escitalopram imaging sample. Thirty patients were randomly allocated to the psilocybin arm. Of those, one was excluded for choosing not to take the daily (placebo) capsules, two did not attend the post-treatment session due to the COVID-19 UK lockdown and five were excluded due to excessive fMRI head motion. The remaining 22 patients (mean age, 44.5 years, s.d.=11.0, 8 female) were included in the psilocybin imaging sample (Fig. 2b).

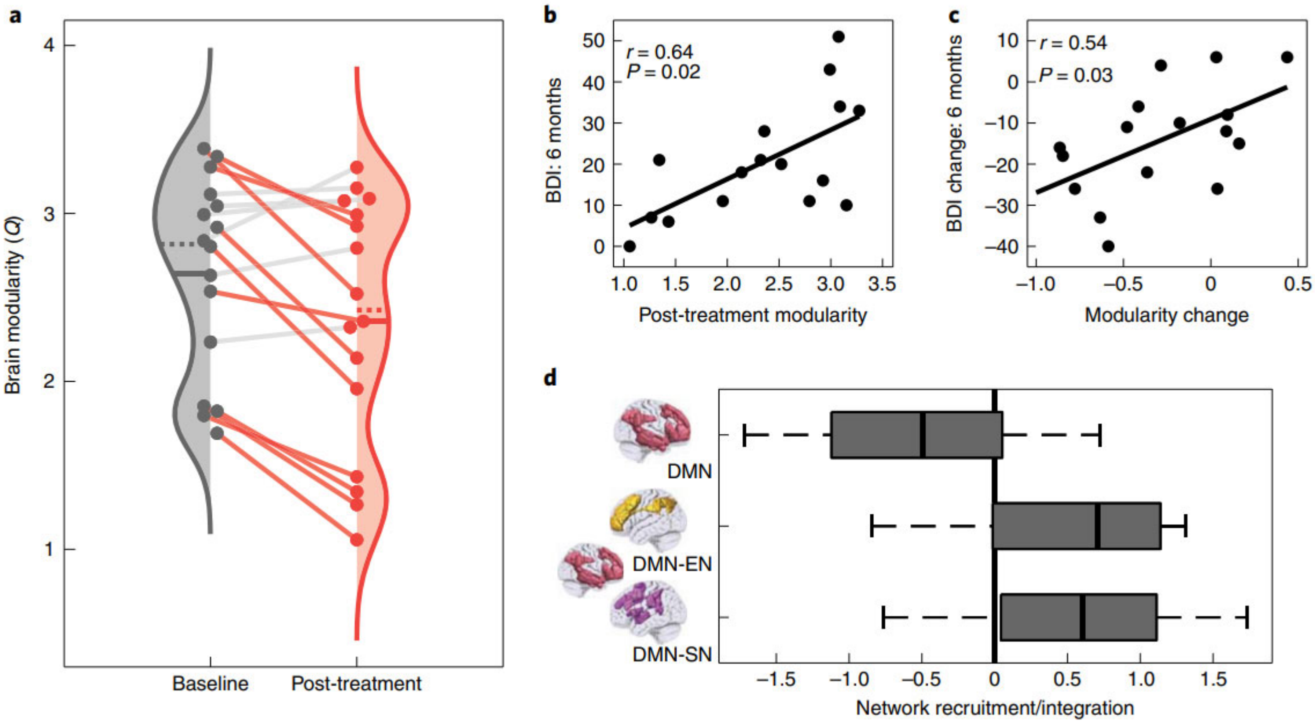


Fig. 4 - Responses of patients with TRD to psilocybin therapy relate to increases in brain network integration. a, Brain modularity (normalized Q) significantly reduced, indicating a global increase in brain network integration following psilocybin therapy in patients with TRD (t_{15}= 2.87, 95% CI 0.07 to 0.50, P= 0.012, d= 0.72). The solid and dotted lines represent the mean and median, respectively. Patient's data are connected by solid lines and rendered in color if modularity decreased. **b**, Absolute post-treatment scan modularity correlated with absolute BDI scores at the 6 months primary end point (r_{14}= 0.64, 95% CI 0.29 to 0.84, P= 0.023, FDR-corrected). **c**, Post-treatment change in brain modularity significantly correlated with treatment response (BDI, baseline - 6 months) (r_{14}= 0.54, 95% CI 0.14 to 0.78, P= 0.033). **d**, DMN (red) recruitment decreased (t_{15}=-2.99, 95% CI -0.92 to -0.15, P= 0.009, d= 0.75) and its between-network integration with the EN (gold) (t_{15}= 3.01, 95% CI 0.15 to 0.90, P= 0.01, d= 0.75) and SN (purple) (t_{15}= 2.89, 95% CI 0.14 to 0.95, P= 0.01, d= 0.72) increased following psilocybin therapy (all FDR-corrected). The box plot central marks represent the group median, the box edges represent the 25th to 75th percentiles and the whiskers extend to the data range. Independent samples of n= 16 TRD were used in **a-d**.

The BDI was a primary outcome measure for the open-label trial (MR/J00440/1) and a secondary outcome measure for this DB-RCT (ClinicalTrials.gov identifier NCT03429075); however, this measure proved to be an especially sensitive index of post-psilocybin reductions in symptom severity across the trials[26]. Between trials, baseline BDI (Fig. 3c) was significantly greater in the open-label TRD trial compared with the DB-RCT MDD trial (mean difference, 6.53 points t_{57} = 3.01, 95% CI 2.18 to 10.88, P = .013, d = 0.83). This difference is likely due to TRD being an inclusion criteria in the open-label trial, but not in this DB-RCT.

As described in our previous report[26], BDI-measured reductions in depressive symptom severity were significantly greater after psilocybin than escitalopram, indicating superior efficacy of psilocybin therapy versus escitalopram (Fig. 3d). Moreover, we confirmed the statistical significance of this contrast within the smaller neuroimaging sample included in the present analyses after testing for an arm × time point analysis of variance interaction on BDI scores ($F_{3,123}$, 4.47; P=0.005). FDR-corrected pairwise comparisons relative to baseline were significantly different at 2 weeks (mean difference, -8.73; t_{41}=-3.66, 95% CI -13.55 to -3.91, P=0.002, d=0.98), 4 weeks (mean difference, -7.79 t_{41}=-2.69, 95% CI -13.62 to -1.95, P=0.013, d=0.77) and at 6 weeks (mean difference, -8.78 t_{41}=-2.61, 95% CI=-15.58 to -1.97, P=0.013, d=0.75), all favoring the psilocybin arm.

Decreased brain modularity for psilocybin but not escitalopram

Reconfirming our primary hypothesis (Fig. 5a,b) and replicating analyses on the open-label trial data, brain network modularity was significantly reduced at the trial's primary end point, 3 weeks after psilocybin therapy (mean difference, -0.39; t_{21}=-2.20, 95% CI -0.75 to -0.02, P=0.039, d=0.47). Moreover, for the psilocybin condition, post-treatment decreases in brain network modularity significantly correlated with improvements in depression symptom severity at this primary end point (r_{20}=0.42, P=0.025, one-tailed).

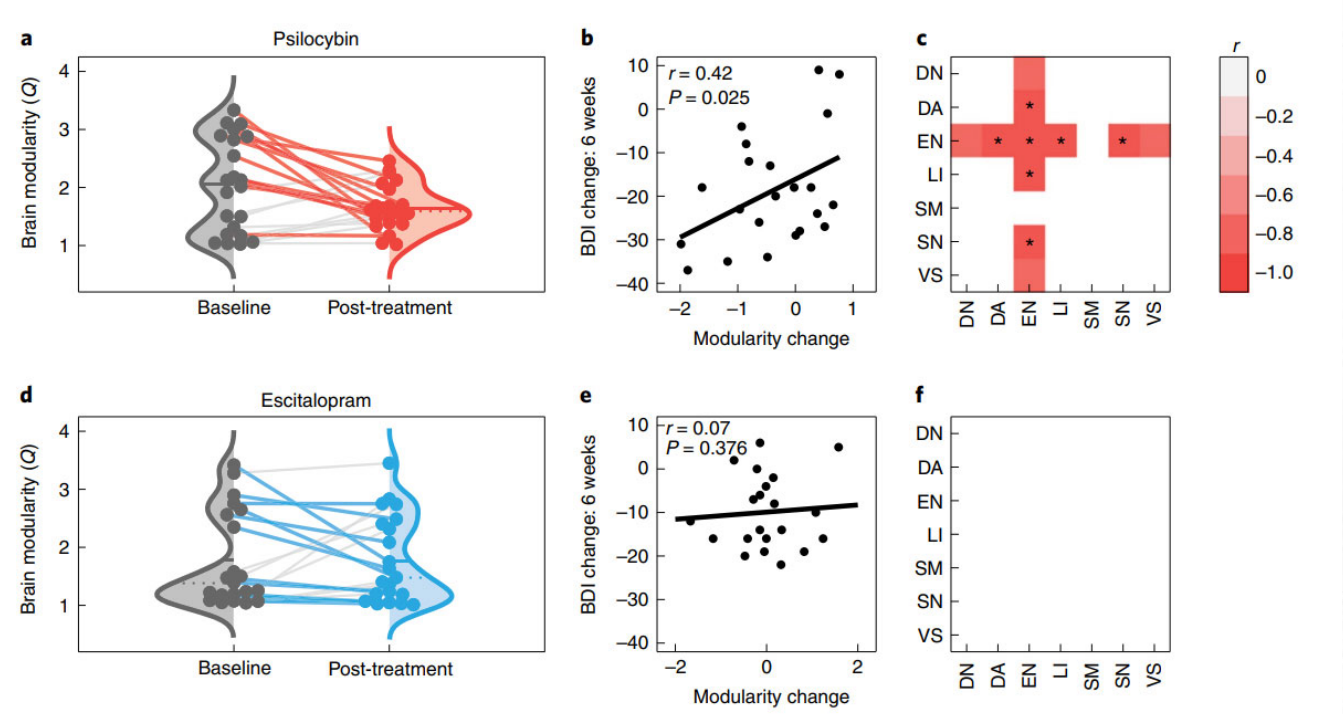


Fig. 5 - Increased global brain network integration correlates with treatment response following psilocybin, but not following escitalopram. a, Significant decreases in brain network modularity (normalized Q), indicating greater brain network integration following psilocybin therapy (t_{21}=-2.20, 95% CI -0.75 to -0.02, P= 0.039, d= 0.47). The solid and dotted lines on the distributions represent the mean and median, respectively. Individual patient data are represented and connected with solid lines between sessions that are rendered with color if modularity decreased between sessions. **b**, Post-treatment change in brain modularity significantly correlated with the treatment response primary end point (BDI, baseline - 6 weeks) (r_{20}= 0.42, P= 0.025, one-tailed). **c**, Significant correlations between increased dynamic network flexibility and the psilocybin primary end point treatment response (BDI, baseline - 6 weeks) are colored (white, P> 0.05; *survives FDR correction). The EN exhibited the largest correlation (r_{20}=-0.76, 95% CI -0.90 to -0.50, P= 0.001). **d-f**, The equivalent analyses of brain network modularity in the escitalopram arm did not show significant session differences (**d**), relationship to individual treatment response (**e**) or network flexibility (**f**). n= 22 independent psilocybin arm samples are displayed in **a-c** and n= 21 independent escitalopram arm samples are displayed in **d-f**. DN, default mode network; DA, dorsal attention; EN, executive network; LI, limbic; SM, somatomotor; SN, salience network; VS, visual.

Notably, there was no significant interaction between treatment arm and scanning session on network modularity ($F_{1,41}$=2.719, P=0.107); however, there was evidence that the reduction in network modularity and its relationship to depression severity may be specific to the psilocybin arm. Namely, in the escitalopram group (Fig. 5d,e), network modularity did not change from baseline (mean difference, 0.01; t_{20}=0.07, 95% CI -0.35 to 0.33, P=0.95, d=0.02) and there was no significant correlation between changes in modularity and changes in BDI scores (r_{19}=0.08; P=0.361, one-tailed).

Response to psilocybin correlates with network flexibility

The specific changes in network recruitment observed 1 d after psilocybin therapy in the open-label trial were not replicated at 3 weeks in this DB-RCT (Supplementary Information). However, the faster fMRI scanning protocol adopted in the DB-RCT generated twice as much temporal data per scanning session (Methods). This provided the rare opportunity to examine changes in the dynamic flexibility of brain networks following psilocybin therapy.

The metric known as 'dynamic flexibility' indexes how often brain regions change their community allegiance over time, during the course of an fMRI scan[33,34] (Methods). Reduced functional dynamics have been previously associated with depression symptomology[14]. In an exploratory analysis, post-psilocybin therapy changes in network flexibility were correlated with changes in BDI score (Fig. 5c). After FDR correction, increased EN dynamic flexibility strongly correlated with greater symptom improvement at the 6-week primary end point for the psilocybin arm (r_{20}=-0.76, 95% CI -0.90 to -0.50, P=0.001). Strong correlations that survived FDR correction were also observed when combining regions from the EN with other lateral frontoparietal networks, such as the SN and dorsal attention network (Fig. 5c). Critically, there were no significant correlations between changes in BDI scores and changes in dynamic flexibility in the escitalopram arm (Fig. 5f).

Discussion

In light of growing evidence for the antidepressant efficacy of psilocybin therapy[26], the present findings advance our understanding of its possible underlying brain mechanisms. Across two trials, decreased brain modularity was observed and correlated with improvements in depressive symptomatology. Moreover, this antidepressant action may be specific to psilocybin therapy, as no changes in modularity were observed with the conventional SSRI antidepressant, escitalopram.

Research into the acute brain action of psychedelics has revealed well-replicated changes in global brain function that are somewhat consistent with those observed here (an increased repertoire of inter-regional and between-network functional connectivity (FC)[29-31]). A previous analysis of ours had suggested some contrasting changes in the architecture of spontaneous brain function 1d following psilocybin treatment for depression relative to what has been observed during the acute psychedelic state itself: spatially expanded DMN FC (1d after treatment for TRD) versus acute DMN 'disintegration'[25]. However, others have reported evidence of increased inter-network FC 1 week and 1 month after psilocybin treatment[35], as well as 1d after ayahuasca, including increases in DMN-SN FC in healthy volunteers[36]. These findings are consistent with the present study, but here we show robust and reliable evidence that increases to global brain network integration accompanies the antidepressant efficacy of psilocybin therapy

The present modularity metrics may be more sensitive indices of the antidepressant action of psilocybin than previously applied time-averaged within-network and between-network FC analyses[25]. Indeed, they may bear relevance to other FC metrics applied to acute-state psychedelic fMRI data[29,30] where a general picture of increased global FC and a broadened dynamic state space has emerged[28]. In this context, the results could be understood as a 'carryover' effect resembling brain dynamics associated with the acute action of psychedelics, albeit at an attenuated level and in a specific population (depressed patients). To show robustness to analytical method, we also carried out more traditional mass-univariate analyses and these yielded consistent findings (Supplementary Figs. 3 and 4). However, an advantage of network modularity is its capacity to elegantly summarize global changes in the brain's functional network organization[37].

Previous research on resting-state activity in depression has found heightened network modularity correlating with symptom severity[17,38]. Additional work implies heightened within-DMN FC and elevated FC between limbic regions such as the amygdala, and high-level cortical regions correlates with ruminative symptoms in depression[12,39]. Taken together, a model emerges of abnormally modular spontaneous brain function in depression that is effectively remediated by psilocybin therapy. According to various findings, the FC energy landscape or state space in depression can be described as abnormally constricted, paralleling the narrow, internally focused, ruminative quality of mood and cognition in the disorder[11]. In contrast, psilocybin seems to increase the brain's ability to visit a broader state space, both acutely and after psilocybin therapy in patients who are depressed, as shown here. Moreover, this 'liberating' action of psilocybin is paralleled by subjective reports of 'emotional release'[40,41] as well as subacute increases in behavioral optimism[9], cognitive flexibility[42] and psychological flexibility after taking a psychedelic drug[43]. Indeed, heightened emotional responsiveness may be specific to psilocybin therapy versus SSRIs[26].

It is plausible that this putative liberating effect of psilocybin on cortical activity occurs via its direct agonist action on cortical 5-HT$_{2A}$ receptors, dysregulating activity in regions rich in their expression. We surmise that chronic escitalopram does not have the same effect on brain modularity due to its more generalized action on the serotonin system and predominant action on inhibitory postsynaptic 5-HT^{1}A receptors, which are richly expressed in limbic circuitry[27,44].

Beyond the global decrease in network modularity after psilocybin, we observed functional changes in DMN, EN and SN dynamics that are consistent with neurobiological models of depression[45]. These high-order transmodal networks house the highest density of 5-HT$_{2A}$ receptors, the principal action site for serotonergic psychedelics[22,23]. Higher-order networks are implicated in the acute action of psychedelics, where they show reduced modularity and increased communication with regions ordinarily outside of their community limits[29-31].

The EN and SN have been associated with tasks requiring cognitive flexibility such as learning and task switching[18,19,46,47]; impaired functioning of these networks have been reported in depression[14,17] and other disorders exhibiting cognitive inflexibility such as autism spectrum disorder[48] and obsessive-compulsive disorder[49]. Our results suggest that decreased modularity or increased flexibility of these networks following psilocybin therapy is a key component of its therapeutic mechanism of action. We did not formally assess cognitive flexibility in the clinical trials reported here but we did observe improvements in general cognitive functioning after psilocybin treatment in the DB-RCT, as well as treatment-specific improvements in 'emotional avoidance' (an inversion of the related construct 'psychological flexibility'[26]).

It should be noted that psychological processes that do not reliably relate to brain modularity changes may have played a role in the main clinical outcomes of this study, and an inability to discount such factors precludes the making of confident inferences that drug alone was the main causal determinant of the imaging outcomes or, indeed, that decreased modularity is sufficient for response to psilocybin therapy. Nevertheless, the changes observed in the neuroimaging data were consistent with previous brain imaging research regarding the acute action of psychedelics and are plausible in light of evidence of elevated modularity and abnormal functioning of higher-order networks in depression[12,17,38,39,50].

Successful phase III DB-RCTs will be required to achieve licensing for psilocybin therapy, but pragmatic trials may better address questions regarding treatment practicability, specificity and optimization[51]. Given the emerging research into psychedelic therapy, it is important for large-scale trials to establish the generalizability, reliability and specificity of psilocybin's antidepressant response. For example, it is likely that efficacy will depend on symptom severity, depression subtypes and comorbidities, as well as other key pharmacological and extrapharmacological factors[52]. For brain imaging studies, we would recommend network modularity analyses such as those employed here. fMRI datasets are complex, burdensome and susceptible to noise, contributing to the challenge of detecting reliable biomarkers. Simplifying composite measures, such as network modularity, combined with a research domain, symptoms-based approach to psychological phenomena, may be a particularly productive way forward[37,51].

It should be noted that the present study's findings do not support baseline modularity as a predictor of response to psilocybin therapy. Patients with a range of baseline modularity values showed modularity reductions after treatment with psilocybin; however, the present results do suggest that the early-phase modularity change is predictive of the long-term treatment response to psilocybin therapy.

It is noteworthy to consider the potentially confounding effects of head motion when interpreting fMRI data. Here, a robust fMRI preprocessing pipeline was employed alongside strict head motion criteria for patient inclusion. To examine robustness to motion, an analysis of head motion was conducted and is available in the Supplementary Information. These analyses bolster the present findings, as there was no evidence that head motion differed between sessions or treatment arms or that it correlated with network modularity. The fMRI data were collected with an eyes-closed protocol, which has some advantages; however, it would be compelling if these findings were replicated in data acquired with an eyes-open protocol. In-scanner sleep can be more likely during eyes-closed fMRI, which is a particular disadvantage[53]. In-scanner sleep cannot be ruled out here. However, the head motion analyses make it unlikely that sleep was a confounding factor. Furthermore, a self-reported visual analog scale of time spent asleep and 'sleepiness' were acquired immediately after all scan runs in study 2. An analysis of these data is available in the Supplementary Information. Critically, ratings of in-scanner sleep or sleepiness were low and did not differ between treatment arms or scanning session.

This study's primary hypothesis was confirmed and replicated despite substantial differences between the design of the two trials. Baseline depression severity was significantly greater in the open-label trial. Furthermore, the open-label trial post-treatment fMRI scan was only 1d after DD2 and was recorded with a 12-channel head coil and a 2-s repetition time (TR). In contrast, the DB-RCT post-treatment scan was conducted 3 weeks after DD2 and was recorded with a 32-channel head coil and a 1.25-s TR.

Acknowledging these differences between the trial designs serves to strengthen the validity of the main findings, as they were robustly replicated; however, the lack of replication in the finer-grained cartography analyses limits the network-specific inferences. A supplementary analysis (Supplementary Information) did confirm that baseline depression severity correlated with within-DMN connectivity and between-network DMN-EN and DMN-SN connectivity, as has been previously reported[12,17,38,39,50]; however, in the DB-RCT, we did not replicate the entirety of the changes in network cartography that were observed in the open-label trial. Given that the observed network effects directly follow predictions from the depression literature, it may be that they are more pronounced in more severe cases, such as those included in the open-label TRD trial. Alternatively, it may be that these effects are only detectable in a short-term, subacute phase after psilocybin therapy and not, for example, 3 weeks later. Parsing the relative contribution of baseline severity and time since treatment will be an important feature of future clinical trials with neuroimaging, ideally with larger samples and repeated scanning sessions.

Dynamic analyses can be challenging to conduct. To be sufficiently powered, time series need to be of sufficient length to be split into multiple time windows that are themselves sufficiently long to compute reliable FC measures, and previous research guided our selection of parameters[54,55]. Collecting sufficient fMRI data in patient cohorts can be challenging, but given the appeal of dynamic analyses, efforts are underway to facilitate and improve them[54]. It should be noted that a sufficiently broad window of time was used to estimate Pearson correlation FC; however, ongoing work is required to better understand how to capture the most functionally meaningful dynamic data.

With these caveats entered, it should be emphasized that the inferences from both cartography analyses converged on the brain's higher-order networks. In particular, the DB-RCT analyses showed robust correlations (r~0.8) between increased higher-order network flexibility and psilocybin's treatment response, and this converges with the open-label trial as well as previous research[14].

In summary, depression is a major public health problem associated with huge burden and cost. Here, we identify a robust, reliable and potentially specific biomarker of response to psilocybin therapy for depression. Our results may help to explain why psilocybin therapy holds promise as a new treatment option in psychiatry.

Methods

Trial overviews

The trial designs (Fig. 1) and main clinical outcomes of the open-label[31] (gtr.ukri.org: MR/J00460X/1) and DB-RCT[32] (clinicaltrials.gov: NCT03429075) trials have been previously published. Both trials were conducted at the National Institute for Health Research Imperial Clinical Research Facility and received Imperial College London Sponsorship, NHS research and Imperial college Joint Research and Compliance Office ethical approval, Health Research Authority and Medicines and Healthcare products Regulatory Agency approval. This work was conducted under a UK Home Office Schedule 1 Drug Licence. All participants provided written informed consent. Participants were not financially compensated.

Participants

For both trials, eligibility required a general practitioner-confirmed diagnosis of unipolar MDD (16+on the 21-item Hamilton Depression Rating scale). The open-label trial had the additional criteria of TRD, as defined by no improvement despite multiple courses of antidepressant medication (mean n=4.6±2.6 past medications; range, 2-11)[39]. Patients were asked whether they had previous experience of using psychedelics. In the open-label trial, 25% had previous experience. Similarly, in the DB-RCT, 31% of patients in the psilocybin arm and 24% in the escitalopram arm had previous experience.

Exclusion criteria were immediate family or personal history of psychosis, risky physical health condition (physician-assessed), history of serious suicide attempts, positive pregnancy test and MRI contraindications. The DB-RCT had the additional exclusion criteria of SSRI contraindications or previous escitalopram use. Of note, treatment resistance was neither an inclusion or exclusion criterion in the DB-RCT. All eligible patients undertook telephone screening interviews, provided written informed consent and their mental and physical medical histories were thoroughly evaluated.

Interventions

Nineteen patients with TRD were recruited to the open-label trial and attended a 1-d pre-treatment baseline session that included eyes-closed resting-state fMRI and clinical assessment (Fig. 1a). This was followed by two psilocybin therapy DDs, separated by 1 week. A low dose of psilocybin (10mg) was orally ingested on DD1 and followed by a high dose (25mg) on DD2. The follow-up fMRI and clinical assessment occurred 1d after DD2. Patients attended an on-site clinical assessment at 1 week after DD2 and completed further clinical assessment electronically at 3 and 6 months. Of the 19 patients with TRD, 16 were retained (mean age, 42.75 years; s.d.=10.15, 4 female) for the present analysis after 3 were excluded due to excessive fMRI head motion (Fig. 2a).

Of the 59 MDD patients recruited to the DB-RCT, a random number generator allocated 30 to the psilocybin arm and 29 to the escitalopram arm (Fig. 1b). The final imaging samples for this investigation were n=22 for the psilocybin arm (mean age, 44.5 years, s.d.=11.0, 8 female) and n=21 for the escitalopram arm (mean age, 40.9 years, s.d.=10.1, 6 female) (Fig. 2b). Patients attended a pretreatment baseline eyes-closed resting-state fMRI. DD1 consisted of either 25mg psilocybin (psilocybin arm) or a presumed negligible 1mg psilocybin (escitalopram arm) dose. All patients were informed that they would receive psilocybin but were blind to the dosage. DD2 occurred 3 weeks after DD1 and was a duplicate dosage. There was no dosage crossover. Beginning 1d after DD1, patients took daily capsules for 6 weeks and 1d in total. For both conditions, one capsule per day was ingested for the first 3 weeks and two thereafter. Capsule content was either inert placebo (microcrystalline cellulose in the psilocybin arm) or escitalopram in the escitalopram arm, 10mg for the first 3 weeks and 2×10mg (20mg) total thereafter.

Measuring depression severity

BDI-1A scores were used to assess depression severity in both studies. This patient-rated measure captures a broader range of symptoms, with an additional focus on the cognitive features of depression, compared with other measures such as the QIDS-SR-16 (ref. [40]). BDI was preregistered as a primary outcome measure in the open-label trial (gtr.ukri.org MR/J00460X/1) and was measured at baseline and 1 week, 3 months and 6 months after DD2. For the DB-RCT, BDI was measured at baseline and 2, 4 and 6 weeks after DD1. BDI was a secondary outcome measure for this DB-RCT (ClinicalTrials.gov NCT03429075) and was used here to test for a replication of the effects observed in the open-label trial.

MRI acquisition

Brain imaging was performed on a 3T Siemens Tim Trio at Invicro. Anatomical images were acquired using the Alzheimer's Disease Neuroimaging Initiative, Grand Opportunity (ADNI-GO[56]) recommended MPRAGE parameters (1-mm isotropic voxels; TR, 2,300ms; TE, 2.98ms; 160 sagittal slices; 256×256 in-plane field of view; flip angle, 9 degrees; bandwidth, 240Hz per pixel; GRAPPA acceleration, 2).

In both studies, eyes-closed resting-state fMRI data were collected with T2*-weighted echo-planar images with 3-mm isotropic voxels. In study 1, a 12-channel head coil was used to acquire 240 volumes in ~8min: TR, 2,000ms; TE, 31ms; 36 axial slices; flip angle, 80 degrees; bandwidth, 2,298Hz per pixel; and GRAPPA acceleration, 2). In study 2, a 32-channel head coil was used to acquire 480 volumes in ~10min: TR, 1,250ms; TE, 30ms; 44 axial slices; flip angle, 70 degrees; bandwidth, 2,232Hz per pixel; and GRAPPA acceleration, 2).

fMRI data preprocessing

Imaging data were preprocessed via a custom in-house pipeline composed of tools from the FMRIB Software Library[57], Analysis of Functional NeuroImages (AFNI)[58], Freesurfer[59] and Advanced Normalization Tools[60] packages. Patients were excluded if either fMRI scan contained >20% of volumes with a framewise displacement >0.5mm.

Specifically, the following preprocessing stages were performed: (1) removal of the first three volumes; (2) despiking (3dDespike, AFNI); (3) slice time correction (3dTshift, AFNI); (4) motion correction (3dvolreg, AFNI) by registering each volume to the volume most similar, in the least-squares sense, to all others; (5) brain extraction (BET, FSL); (6) rigid body registration to anatomical scans (BBR, FSL); (7) nonlinear registration to the 2 mm Montreal Neurological Institute (MNI) brain (Symmetric Normalization, Advanced Normalization Tools); (8) scrubbing, using a framewise displacement threshold of 0.5 mm, scrubbed volumes were replaced with the mean of the neighboring volumes; (9) 6 mm full width at half maximum Gaussian spatial smoothing (3dBlurInMask, AFNI); (10) 0.01 to 0.08Hz band-pass filtering (3dFourier, AFNI); (11) linear and quadratic detrending (3dDetrend, AFNI) and (12) voxelwise nuisance regression with the six realignment motion regressors and three tissue signal regressors (Ventricles, Freesurfer, eroded in 2 mm space), draining veins (FSL's CSF minus Freesurfer's Ventricles, eroded in 1 mm space) and local white matter (WM) (FSL's WM minus Freesurfer's subcortical gray matter structures, eroded in 2 mm space). Regarding local WM regression, AFNI's 3dLocalstat was used to calculate the mean local WM time series for each voxel, using a 25-mm radius sphere centered on each voxel.

Functional connectivity

Following the preprocessing, a functional atlas was used to separate the cerebral cortex into 100 regions of interest (ROIs)[61]. FC between each pair of ROIs was calculated with a Pearson correlation coefficient between each pair of mean signal 'time courses' (representing fluctuations in neural activity over time). This resulted in an $N \times N$ FC matrix, with each element representing the connectivity strength between a pair of ROIs. Positive values were retained and Fisher-transformed to &zscr; scores. This procedure was repeated independently for each patient and scan (baseline and post-treatment).

Brain network modularity

The community structure or segregation between the brain's functional networks, was measured by summarizing each FC matrix with a common Louvain-like community detection algorithm[62] where the objective is to maximize the extent to which brain areas can be separated into nonoverlapping communities or modules. The modularity quality function score, Q[63], tends to be high when the brain exhibits a high segregation between its functional networks (such as strong clusters of FC within brain networks/communities with weak FC to the rest of the brain).

This approach has been commonly applied to fMRI data to characterize how brain function adapts in a number of contexts[55]. Here, modularity, Q[63], was defined in the standard way by:

$$Q=12m\sum ij(Aij-\gamma kikj2m)\delta(ci,cj),$$

where A_{ij} represents the weight of FC (correlation) between ROI i and j, γ is the structural resolution free parameter (set to 1) and is the expected null FC defined with

as the total FC across all connections with ROI i c_i is the community to which ROI i is assigned,

is the Kronecker δ function and equals 1 if ROI i and j belong to the same community and 0 otherwise[64] and is the total FC of the network.

To allow valid comparisons between patients and scans, the modularity scores were generated 100 times and the partition with the largest modularity score was normalized by the mean modularity generated from 100 randomly rewired (shuffled) FC matrices[65]. This common procedure was applied to account for the nondeterministic and near-degenerate partitions (solutions with differing but similar optimality) generated by Louvain algorithms and to account for modularity scores relating to the total sum of FC within the network[66]. This process was repeated independently for each patient and scan.

Functional cartography

The community detection procedure generates a community assignment to each ROI. We used these labels to determine the extent to which ROIs were recruited to the functional network that they typically 'belong to', as defined by healthy adults (such as DMN regions should reliably form communities with each other).

First, we created an allegiance matrix, P[33], which represented the probability that two regions i and j were assigned to the same community across the 100 iterations of the modularity algorithm, defined here as:

where $O = 100$ as the number of partitions. For each partition, equals 1 if regions i and j belong to the same community.

Using the allegiance matrix, we then summarized how often ROIs either formed communities with ROIs from the same functional network (network recruitment) or formed communities with ROIs between different networks (between-network integration) across the partitions[33]. These functional cartography measures were then normalized against the mean values from 1,000 randomly shuffled ROI network assignments to account for differences in the number of regions in each network[55]. Finally, network recruitment and between-network integration scores were averaged at the network level using seven predefined cortical networks[61].

Dynamic flexibility

The short TR used in the fMRI protocol of study 2 generated approximately twice the number of time points, and this afforded an additional analysis of dynamic flexibility. Multilayer modularity estimation[34] was conducted using a $N \times N \times T$ matrix of 30 volume-sliding windows (37.5 s of real time) with 50% overlap. This window size is typical for estimating dynamic FC with fMRI[54]. For each patient and scan, multilayer modularity, Q_{ML}, was estimated 100 times from each $N \times N \times T$ FC matrix by:

where

is the total FC of the multilayer network, and

is the total FC of layer l, A_{ijl} is the FC between ROI i and j at layer l,

is the expected null FC at layer l. The two free γ and ω structural and temporal resolution parameters are used to scale the number of communities and strength of inter-layer edges, respectively. As is typical for fMRI modularity analyses, both were set to 1 (refs. [33,55]).

The multilayer modularity estimation generates an $N \times T$ matrix where each element represents the community assignment of each ROI at each layer (time window). From this, the flexibility metric, f, can be simply calculated as the number of times an ROI changes its community allegiance, given the number of observations[33]:

Flexibility scores close to 0 represent rigid ROIs whose community allegiance is stable across time, scores close to 1 represent flexible ROIs whose community allegiance regularly changes (highly flexible). Network level flexibility scores were defined by the average flexibility of ROIs assigned to the given network.

Reporting Summary

Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

All requests for raw and analyzed data and materials are promptly reviewed by R.C.H. and D.J.N., chief investigator and principal investigator, respectively, on the original work. Patient-related data not included in the paper were generated as part of clinical trials and may be subject to patient confidentiality. Source data are provided with this paper.

Code availability

All analyses and data visualizations were conducted in MATLAB R2020a. Codes for generating each data figure are available at https://github.com/rdaws/psilodep.

Acknowledgements

R.E.D. was supported by an Engineering and Physical Sciences Research Council PhD scholarship at the Imperial College London Centre for Neurotechnology (EP/L016737/1). The research was carried out at the National Institute for Health Research/Wellcome Trust Imperial Clinical Research Facility. The open-label trial was funded by a Medical Research Council clinical development scheme grant (MR/J00460X/1). The DB-RCT was funded by a private donation from the Alexander Mosley Charitable Trust, supplemented by Founders of Imperial College London's Centre for Psychedelic Research.

Author contributions

This study was designed and planned by R.C.-H. and D.N. and conducted by B.G., M.B.W., D.E. and L.R. The specific analysis was designed by R.E.D. and C.T. The analysis was conducted and visualized by R.E.D. The manuscript was drafted by R.E.D., C.T. and R.C.-H. All authors contributed to the interpretation of the study results and revised and approved the manuscript for intellectual content. The corresponding author (R.E.D.) attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Competing interests

R.C.H. reports receiving consulting fees from Entheon Biomedical and Beckley Psytech; B.G. received consulting fees from SmallPharma; D.E. received consulting fees from Field Trip and Mydecine; D.N. received consulting fees from Algernon and H. Lundbeck and Beckley Psytech, advisory board fees from COMPASS Pathways and lecture fees from Takeda and Otsuka and Janssen plus owns stock in Alcarelle, Awakn and Psyched Wellness. The other authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41591-022-01744-z.

Correspondence and requests for materials should be addressed to Richard E. Daws.

Peer review information *Nature Medicine* thanks David Hellerstein, Jared Van Snellenberg and the other, anonymous, reviewer(s) for their contribution to the peer review of this work. Primary Handling Editor: Jerome Staal, in collaboration with the *Nature Medicine* team.

References

1. *Depression and Other Common Mental Disorders: Global Health Estimates* (World Health Organization, 2017).
2. Tang, F. et al. COVID-19 related depression and anxiety among quarantined respondents. *Psychol. Health* **36**, 164-178 (2021).
3. Rabeea, S. A., Merchant, H. A., Khan, M. U., Kow, C. S. & Hasan, S. S. Surging trends in prescriptions and costs of antidepressants in England amid COVID-19. *DARU J. Pharm. Sci.* https://doi.org/10.1007/s40199-021-00390-z (2021).
4. Hofmann, S. G., Curtiss, J., Carpenter, J. K. & Kind, S. Effect of treatments for depression on quality of life: a meta-analysis. *Cogn. Behav. Ther.* **46**, 265-286 (2017).
5. Locher, C. et al. Efficacy and safety of selective serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, and placebo for common psychiatric disorders among children and adolescents: a systematic review and meta-analysis. *JAMA Psychiatry* **74**, 1011 (2017).
6. Haddad, P. The SSRI discontinuation syndrome. *J. Psychopharmacol.* **12**, 305-313 (1998).
7. Steinert, C., Hofmann, M., Kruse, J. & Leichsenring, F. Relapse rates after psychotherapy for depression - stable long-term effects? A meta-analysis. *J. Affect. Disord.* **168**, 107-118 (2014).
8. Nutt, D. & Carhart-Harris, R. The current status of psychedelics in psychiatry. *JAMA Psychiatry* https://doi.org/10.1001/jamapsychiatry.2020.2171 (2020).
9. Lyons, T. & Carhart-Harris, R. L. More realistic forecasting of future life events after psilocybin for treatment-resistant depression. *Front. Psychol.* **9**, 1721 (2018).
10. Beck, A. T. & Clark, D. A. Anxiety and depression: an information processing perspective. *Anxiety Res.* **1**, 23-36 (1988).
11. Rolls, E. T. A non-reward attractor theory of depression. *Neurosci. Biobehav. Rev.* **68**, 47-58 (2016).
12. Hamilton, J. P. et al. Default-mode and task-positive network activity in major depressive disorder: implications for adaptive and maladaptive rumination. *Biol. Psychiatry* **70**, 327-333 (2011).
13. Kendler, K. S. The phenomenology of major depression and the representativeness and nature of DSM criteria. *Am. J. Psychiatry* **173**, 771-780 (2016).
14. Goodman, Z. et al. Whole-brain functional dynamics track depressive symptom severity. *Cereb. Cortex* https://doi.org/10.1093/cercor/bhab047 (2021).
15. Margulies, D. S. et al. Situating the default-mode network along a principal gradient of macroscale cortical organization. *Proc. Natl Acad. Sci. USA* **113**, 12574-12579 (2016).
16. Andrews-Hanna, J. R., Smallwood, J. & Spreng, R. N. The default network and self-generated thought: component processes, dynamic control, and clinical relevance: the brain's default network. *Ann. NY Acad. Sci.* **1316**, 29-52 (2014).
17. Lydon-Staley, D. M. et al. Repetitive negative thinking in daily life and functional connectivity among default mode, fronto-parietal, and salience networks. *Transl. Psychiatry* **9**, 234 (2019).
18. Daws, R. E. et al. Optimisation of brain states and behavioural strategies when learning complex tasks. Preprint at *bioRxiv* https://doi.org/10.1101/2020.06.17.156570 (2021).
19. Kim, C., Cilles, S. E., Johnson, N. F. & Gold, B. T. Domain general and domain preferential brain regions associated with different types of task switching: a meta-analysis. *Hum. Brain Mapp.* **33**, 130-142 (2012).
20. Turnbull, A. et al. Reductions in task-positive neural systems occur with the passage of time and are associated with changes in ongoing thought. *Sci. Rep.* **10**, 9912 (2020).
21. Wilkinson, P. O. & Goodyer, I. M. Attention difficulties and mood-related ruminative response style in adolescents with unipolar depression. *J. Child Psychol. Psychiatry* https://doi.org/10.1111/j.1469-7610.2006.01660.x (2006).
22. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F. I., Bäbler, A., Vogel, H. & Hell, D. Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *NeuroReport* **9**, 3897-3902 (1998).

23. Beliveau, V. et al. The structure of the serotonin system: a PET imaging study. *NeuroImage* **205**, 116240 (2020).
24. Andersen, K. A. A., Carhart-Harris, R., Nutt, D. J. & Erritzoe, D. Therapeutic effects of classic serotonergic psychedelics: a systematic review of modern-era clinical studies. *Acta Psychiatr. Scand.* **143**, 101-118 (2021).
25. Carhart-Harris, R. L. et al. Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Sci. Rep.* **7**, 13187 (2017).
26. Carhart-Harris, R. L. et al. Trial of psilocybin versus escitalopram for depression. *N. Engl. J. Med.* **384**, 1402-1411 (2021).
27. Nutt, D., Erritzoe, D. & Carhart-Harris, R. Psychedelic psychiatry's brave new world. *Cell* **181**, 24-28 (2020).
28. Carhart-Harris, R. L. & Friston, K. J. REBUS and the anarchic brain: toward a unified model of the brain action of psychedelics. *Pharmacol. Rev.* **71**, 316-344 (2019).
29. Lord, L.-D. et al. Dynamical exploration of the repertoire of brain networks at rest is modulated by psilocybin. *NeuroImage* **199**, 127-142 (2019).
30. Luppi, A. I. et al. LSD alters dynamic integration and segregation in the human brain. *NeuroImage* **227**, 117653 (2021).
31. Carhart-Harris, R. L. et al. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl Acad. Sci. USA* **109**, 2138-2143 (2012).
32. Fried, E. I. The 52 symptoms of major depression: lack of content overlap among seven common depression scales. *J. Affect. Disord.* **208**, 191-197 (2017).
33. Mattar, M. G., Cole, M. W., Thompson-Schill, S. L. & Bassett, D. S. A functional cartography of cognitive systems. *PLoS Comput. Biol.* **11**, e1004533 (2015).
34. Mucha, P. J., Richardson, T., Macon, K., Porter, M. A. & Onnela, J.-P. Community structure in time-dependent, multiscale, and multiplex networks. *Science* **328**, 876-878 (2010).
35. Barrett, F. S., Doss, M. K., Sepeda, N. D., Pekar, J. J. & Griffiths, R. R. Emotions and brain function are altered up to one month after a single high dose of psilocybin. *Sci. Rep.* **10**, 2214 (2020).
36. Pasquini, L., Palhano-Fontes, F. & Araujo, D. B. Subacute effects of the psychedelic ayahuasca on the salience and default mode networks. *J. Psychopharmacol.* **34**, 623-635 (2020).
37. Parkes, L., Satterthwaite, T. D. & Bassett, D. S. Towards precise resting-state fMRI biomarkers in psychiatry: synthesizing developments in transdiagnostic research, dimensional models of psychopathology, and normative neurodevelopment. *Curr. Opin. Neurobiol.* **65**, 120-128 (2020).
38. Ye, M. et al. Changes of functional brain networks in major depressive a graph theoretical analysis of resting-state fMRI. *PLoS ONE* **10**, 133775 (2015).
39. Feurer, C. et al. Resting state functional connectivity correlates of rumination and worry in internalizing psychopathologies. *Depress. Anxiety* https://doi.org/10.1002/da.23142 (2021).
40. Roseman, L. et al. Emotional breakthrough and psychedelics: validation of the emotional breakthrough inventory. *J. Psychopharmacol.* **33**, 1076-1087 (2019).
41. Watts, R., Day, C., Krzanowski, J., Nutt, D. & Carhart-Harris, R. Patients' accounts of increased 'connectedness' and 'acceptance' after psilocybin for treatment-resistant depression. *J. Humanist. Psychol.* **57**, 520-564 (2017).
42. Murphy-Beiner, A. & Soar, K. Ayahuasca's 'afterglow': improved mindfulness and cognitive flexibility in ayahuasca drinkers. *Psychopharmacol.* **237**, 1161-1169 (2020).
43. Zeifman, R. J. et al. Post-psychedelic reductions in experiential avoidance are associated with decreases in depression severity and suicidal ideation. *Front. Psychiatry* **11**, 782 (2020).
44. Carhart-Harris, R. L. & Nutt, D. J. Serotonin and brain function: a tale of two receptors. *J. Psychopharmacol.* **31**, 1091-1120 (2017).
45. Wang, X., Öngör, D., Auerbach, R. P. & Yao, S. Cognitive vulnerability to major depression: view from the intrinsic network and cross-network interactions. *Harv. Rev. Psychiatry* **24**, 188-201 (2016).
46. Hampshire, A. et al. Probing cortical and sub-cortical contributions to instruction-based learning: regional specialisation and global network dynamics. *NeuroImage* **192**, 88-100 (2019).
47. Soreq, E., Violante, I. R., Daws, R. E. & Hampshire, A. Neuroimaging evidence for a network sampling theory of individual differences in human intelligence test performance. *Nat. Commun.* **12**, 2072 (2021).
48. Watanabe, T. & Rees, G. Brain network dynamics in high-functioning individuals with autism. *Nat. Commun.* **8**, 16048 (2017).
49. Gu, B.-M. et al. Neural correlates of cognitive inflexibility during task-switching in obsessive-compulsive disorder. *Brain* **131**, 155-164 (2007).
50. Wei, M. et al. Abnormal dynamic community structure of the salience network in depression: abnormal salience network in depression. *J. Magn. Reson. Imaging* **45**, 1135-1143 (2017).
51. Carhart-Harris, R. L. et al. Can pragmatic research, real-world data and digital technologies aid the development of psychedelic medicine? *J. Psychopharmacol.* https://doi.org/10.1177/02698811211008567 (2021).
52. Carhart-Harris, R. L. et al. Psychedelics and the essential importance of context. *J. Psychopharmacol.* **32**, 725-731 (2018).
53. Tagliazucchi, E. & Laufs, H. Decoding wakefulness levels from typical fMRI resting-state data reveals reliable drifts between wakefulness and sleep. *Neuron* **82**, 695-708 (2014).
54. Leonardi, N. & Van De Ville, D. On spurious and real fluctuations of dynamic functional connectivity during rest. *NeuroImage* **104**, 430-436 (2015).
55. Finc, K. et al. Dynamic reconfiguration of functional brain networks during working memory training. *Nat. Commun.* **11**, 2435 (2020).
56. Jack, C. R. et al. The Alzheimer's disease neuroimaging initiative (ADNI): MRI methods. *J. Magn. Reson. Imaging* **27**, 685-691 (2008).
57. Smith, S. M. et al. Advances in functional and structural MR image analysis and implementation as FSL. *NeuroImage* **23**, S208-S219 (2004).
58. Cox, R. W. AFNI: software for analysis and visualization of functional magnetic resonance neuroimages. *Comput. Biomed. Res.* **29**, 162-173 (1996).
59. Dale, A. M., Fischl, B. & Sereno, M. I. Cortical surface-based analysis. *NeuroImage* **9**, 179-194 (1999).

60. Avants, B. B., Tustison, N. & Song, G. Advanced normalization tools (ANTs). *Insight J.* **2**, 1-35 (2009).
61. Schaefer, A. et al. Local-global parcellation of the human cerebral cortex from intrinsic functional connectivity MRI. *Cereb. Cortex* **28**, 3095-3114 (2018).
62. Blondel, V. D., Guillaume, J.-L., Lambiotte, R. & Lefebvre, E. Fast unfolding of communities in large networks. *J. Stat. Mech. Theory Exp.* **2008**, P10008 (2008).
63. Newman, M. E. J. & Girvan, M. Finding and evaluating community structure in networks. *Phys. Rev. E* **69**, 026113 (2004).
64. Bassett, D. S. et al. Task-based core-periphery organization of human brain dynamics. *PLoS Comput. Biol.* **9**, e1003171 (2013).
65. Maslov, S. & Sneppen, K. Specificity and stability in topology of protein networks. *Science* **296**, 910-913 (2002).
66. Rubinov, M. & Sporns, O. Weight-conserving characterization of complex functional brain networks. *NeuroImage* **56**, 2068-2079 (2011).

The Experimental Use of Psychedelic (LSD) Psychotherapy

by

Walter N. Pahnke, MD, PhD; Albert A. Kurland, MD; Sanford Unger, PhD; Charles Savage, MD; and Stanislav Grof, MD

JAMA, June 15, 1970 - Vol 212, No 11

© 1970 Author(s)

Table of Contents:

Effects in Man Facilitated by Psychedelic Drugs
The Varieties of Psychedelic Drug Therapies
Research Projects With Psychedelic-Peak Psychotherapy
Report of a Case
The Question of Safety
Comment
References

From the Maryland State Psychiatric Research Center, the Johns Hopkins University School of Medicine (Drs, Pahnke, Unger, Savage, and Grof), and the Department of Mental Hygiene, State of Maryland (Dr. Kurland), Baltimore.

Read before the Symposium on Psychedelic Drugs at the 118th annual convention of the American Medical Association, New York, July 17, 1969. Based partially on a presentation by Albert Kurland, MD, at the American College of Neuropsychopharmacology, San Juan, Puerto Rico, Dec 20, 1968.

The history of research with psychedelic drugs has produced a variety of methods for their use and conflicting claims about results. First came the wave of excitement among experimentalists in the 1950s when it was claimed that lysergic acid diethylamide (LSD) could produce a model psychosis which might be useful in understanding schizophrenia. While this promise was fading, enthusiastic reports about the possibility of LSD as an aid to psychotherapy in the treatment of alcoholism and other psychiatric disorders appeared. All these approaches were represented in 1959 at the first international conference devoted entirely to LSD.[1] Since then, there have been at least five more published proceedings of such conferences on various aspects of psychedelic drugs.[2-6] The most recent conference on various means of producing states of consciousness was sponsored by the Menninger Foundation and the American Association of Humanistic Psychology on April 7 to 11, 1969, in Council Grove, Kan, and was called "Voluntary Control Of Internal States."

In the 1960s we have seen research attempts to test scientifically the efficacy and safety of psychedelic drugs for the treatment of various forms of mental illness, chiefly alcoholism. At the same time, there has been a rapidly growing interest concerning these drugs by laymen for pleasure, excitement, mental exploration, and religious experience. The use of psychedelic drugs for all these purposes has produced conflicting claims both in the scientific and popular literature, intense public attention stimulated by the mass media, and legislative attempts at control of both research and the black market.

Effects in Man Facilitated by Psychedelic Drugs

Before we turn to the use of psychedelic drugs as a therapeutic tool, let us review briefly some basic facts. At the outset, it is important to remember that psychedelic drugs are a special class of psychopharmacological agents, not to be confused with sedatives like barbiturates or alcohol, stimulants like amphetamines or methylphenidate hydrochloride (Ritalin), tranquilizers like chlordiazepoxide hydrochloride (Librium) or meprobamate (Miltown), antipsychotic agents like the phenothiazines, or narcotic drugs like the opiates (whether synthetic or natural). Psychedelic drugs in contrast to true narcotics are not physically addicting and produce-quite different psychological experiences from all these other groups of drugs.

What makes psychedelic drugs unique as a class are the psychological phenomena which they facilitate. Five major kinds of potential psychedelic drug experiences have been described in detail with examples elsewhere[7-8] and will only briefly be summarized here.

First is the *psychotic psychedelic experience* characterized by the intense, negative experience of fear to the point of panic, paranoid delusions of suspicion or grandeur, toxic confusion, impairment of abstract reasoning, remorse, depression, and isolation or somatic discomfort or both; all of these can be of very powerful magnitude.

Second is the *cognitive psychedelic experience*, characterized by astonishingly lucid thought. Problems can be seen from a novel perspective, and the inner relationships of many levels or dimensions can be seen all at once. The creative experience may have something in common with this kind of psychedelic experience, but such a possibility must await the results of future investigation.

Third is the *aesthetic psychedelic experience*, characterized by a change and intensification of all sensory modalities. Fascinating changes in sensations and perception can occur: synesthesia in which sounds can be "seen," apparent pulsations or lifelike movements in objects such as flowers or stones, the appearance of great beauty in ordinary things, release of powerful emotions· through music, and eyes-closed visions of beautiful scenes, intricate geometric patterns, architectural forms, historical events, and almost anything imaginable.

Fourth is the *psychodynamic psychedelic experience*, characterized by a dramatic emergence into consciousness of material that was previously unconscious or preconscious. Abreaction and catharis are elements of what may subjectively be experienced as an actual reliving of incidents from the past or a symbolic portrayal of important conflicts.

The fifth and last type of psychedelic experience has been called by various names: *psychedelic peak*, *cosmic*, *transcendental*, or *mystical*, and can be summarized under the following six major psychological characteristics (described in more detail elsewhere7): (1) sense of unity or oneness (positive ego transcendence, loss of usual sense of self without loss of consciousness), (2) transcendence of time and space, (3) deeply felt positive mood (joy, peace, and love), (4) sense of awesomeness, reverence, and wonder, (5) meaningfulness of psychological or philosophical insight or both; and (6) ineffability (sense of difficulty in communicating the experience by verbal description).

The Varieties of Psychedelic Drug Therapies

In the course of experimental therapeutic work with psychedelic drugs (especially LSD), three major approaches have evolved: (1) psycholytic therapy, (2) psychedelic-chemotherapy, and (3) psychedelic-peak therapy. Each of these methods has been described and discussed in detail at the international conference on LSD therapy held in 1965.[3] In any evaluation of therapeutic effects, it is essential to keep in mind the differences in procedure among the various methods, not only because different kinds of experiences are facilitated, but because conflicting results can be correlated with the method used. Reactions to LSD invariably involve a complex interaction between drug dosage, set, and setting.

In psycholytic therapy, which is practiced mainly in Europe, the aim is usually the uncovering of unconscious material which can be psychodynamically analyzed both at the time and in subsequent psychotherapy sessions. There is considerable time spent on psychotherapy before, during, and after the actual drug sessions. This type of therapy is relatively long-term with multiple sessions over time and usually with small doses of the drug (25µg to 150µg).

In psychedelic-chemotherapy, the major emphasis is on administration of the drug itself, during which limited psychotherapy mayor may not be carried out. There is minimal preparation and follow-up therapy. A single session with a relatively high dose of the drug (200µg or more) has been the usual practice, although there have been experiments which consisted of weekly sessions with little or no attempt at help with interpretation or integration. This method is called hypnodelic when hypnotic induction is employed during the preparation for the session or before the onset of drug effects or both with the aim of providing better control. The major differences between psychedelic-chemotherapy and psycholytic therapy are the number of drug sessions, amount of therapy outside the drug sessions, and drug dosage.

In psychedelic-peak therapy, one of the distinctive characteristics and immediate goals in the drug session itself is the achievement of a peak or transcendental experience, but just as important is the intensive psychotherapy which occurs in the weeks prior to the psychedelic drug session and the follow-up therapy in the weeks after to help with the work of integration. The LSD session can add meaningful emotional insight and dramatic validation of an individual's basic self-worth, but usually only after the achievement of psychodynamic resolution and self-understanding during the preparatory psychotherapy. This preparation, which averages about 20 hours per patient, enables the therapist to establish close rapport with the patient and to gain intimate knowledge of the patient's developmental history, dynamics, defenses, and difficulties. In specific preparation for the session itself the patient is encouraged to trust the therapist, himself, and the situation, to let go voluntarily of his usual ego controls and be carried by the experience, and to be completely open to whatever experiences he encounters.

The experimental drug sessions themselves are carried out in a special treatment suite furnished like a comfortable living room, with sofa, easy chairs, rugs, drapes, pictures, flowers, and high-fidelity music equipment. The patient's therapist and a psychiatric nurse are in constant attendance throughout the period of drug action (10 to 12 hours). For most of the session, the patient reclines on the sofa with eyeshades and stereophonic earphones, alternately listening to carefully selected classical music or interacting with his therapist. The function of the music is to help the patient let go more easily, to enter more fully into his unfolding inner world of experience, and to facilitate the release of intense emotionality.

Although the LSD session itself is only one part of psychedelic-peak therapy, it plays a unique and necessary role without which the total therapeutic impact would not be the same. In a dosage of 2000µg or more, LSD produces a 10- to 12- hour period of striking, varied, and anomalous mental functioning; the range of possible effects or episodes of reaction or both is multiform. Certain dimensions of possible reactivity are therapeutically irrelevant (eg. sensory changes) others have distinctly anti therapeutic consequences (eg. panic, terror, or psychotic reactions). The major dimension of drug-altered reactivity with therapeutic relevance is the affective or emotional sphere; intense, labile, personally meaningful emotionality is uniformly produced, with periodic episodes of overwhelming feeling. In terms of sequence of events, the first several hours of a psychedelic session are nonspecific and pervasive; persistent preoccupations and emotional distress patterns are "broken" or fragmented, and subsequent recall for this period is nearly always poor. During the third to fifth hours, psychedelic reactivity usually appears at peak intensity. With skillful handling, the remainder of the session may be stabilized in an elevated mood state in which psychotic and other turbulent phenomena are no longer problems. Follow-up therapy begins during the reentry period of the session day and continues the next day as the patient and therapist review the events of the session and attempt to integrate them. The patient is encouraged to write a detailed description of his experience.

If a psychedelic-peak experience has been achieved and stabilized during the session, a clinical picture which we have termed the psychedelic afterglow can be observed in the days after the session. Mood is elevated and energetic; there is a relative freedom from concerns of the past and from guilt and anxiety, and the disposition and capacity to enter into close interpersonal relationships is enhanced. These psychedelic feelings generally persist for from two weeks to a month and then gradually fade into vivid memories that hopefully will still influence attitude and behavior. During this immediate post-drug period, there is a unique opportunity for effective psychotherapeutic work on strained family or other interpersonal relationships.

It should be emphasized, however, that even with optimal programming, such peak experiences are neither universally achieved nor stabilized, and certainly they do not automatically occur merely by administration of a psychedelic drug. In our research setting,profound or marked psychedelic-peak reactions were judged to have occurred in 68% (56) of 82 consecutive alcoholic patients who received a total of 450µg of LSD given in two equal doses 45 to 60 minutes apart.

Research Projects With Psychedelic-Peak Psychotherapy

Since 1963, at the Spring Grove State Hospital, Baltimore, and now continuing at the Maryland Psychiatric Research Center, research has been in progress to investigate the usefulness of psychedelic-peak psychotherapy with alcoholic, neurotic, and narcotic addict patients and patients who are dying of cancer.9-18 The project which involved alcoholic and neurotic patients, both originally funded by research grants from the National Institute of Mental Health (NIMH) were designed as double-blind, controlled studies. In each project the experimental group received a relatively high dose of LSD (350µg to 450µg) in contrast to only 50µg for the control group; both groups received exactly the same therapeutic preparation. In the study of neurotic patients there was an additional control group of randomly assigned patients who received an equivalent number of hours of group psychotherapy without any LSD. Evaluation of each patient's status was performed by an independent rating team before treatment and at 6, 12, and 18 months following the treatment phase. Full and final analysis and evaluation of these data are still in progress.

Results are now completed at the six-month checkpoint for the study of a total of 135 alcoholic patients who were treated with psychedelic psychotherapy. While the study design made it possible for the patients to have up to three sessions, the vast majority in both experimental and control group (total of 117 patients) received only one treatment with LSD. The 18 patients who had more than one LSD session were not found to be different from the other 117 in psychological and social measures based on pre-treatment testing, but as a group they received more average hours of treatment. Therefore, in the interests of uniformity concerning amount of treatment, results were analyzed separately for the 117 patients who had only one LSD session (either a high or low dose). Out of these 117 patients, 104 were personally located for follow-up interview after six months. It should be noted that the 13 patients not reached for follow-up were properly proportioned according to the original random assignment in which two thirds of the patients were allotted to the high-dose procedure.

Comparison of means before treatment and six months after treatment for global adjustment and drinking behavior are shown in Table 1. Global adjustment included occupational, interpersonal, and residential factors as well as the patient's reaction to alcohol. Ratings were made on each patient on a predetermined 0 to 10 behavior rating scale. The end points of the scale measuring drinking behavior were 0, indicating daily alcohol consumption, and 10 indicating total abstinence. Patients were also categorized according to whether a profound, marked, or minimal psychedelic-peak experience was achieved during the LSD session as rated by the patient's therapist immediately after the session. In Table 1, comparison of means before and after treatment between groups receiving high and low doses and among the psychedelic reactivity groups may be seen to show statistically significant differences using an analysis of covariance statistical procedure (one-tailed test).

The percentage of patients functioning in an "essentially rehabilitated" fashion is shown for the various groups in Table 2. A score of 8 or more on the 0 to 10 scale was considered a rigorous criterion, indicating for global adjustment that a patient was making "good attainment or adjustment" with regard to drinking, occupation, interpersonal relations, etc. A score of 8 on the drinking scale indicated some, but only minimal, departure from total abstinence. Statistical analysis revealed that there were significant differences between the high and low-dose groups in percentage of patients reaching this criterion, both in global adjustment and on the scale measuring drinking. The group of patients with the most profound psychedelic-peak experiences had the highest percentage of patients who showed evidence of rehabilitation. This trend was statistically significant among the three psychedelic reactivity groups for global adjustment, but not for drinking, and thus must be interpreted with caution.

In evaluating these findings in practical terms, we can say that a given alcoholic patient receiving a single high dose of LSD in the context of psychedelic-peak psychotherapy and experiencing a profound psychedelic-peak reaction has the best likelihood for improvement six months later. Within the context of our method, dosage appears to be a more certain outcome predictor than type of experience, although peak experiences do occur more frequently with high doses of LSD. Also the estimation of psychedelic reactivity (from the individual judgments of different therapists) is probably not as reliable as the measurement of therapeutic outcome made by evaluators independent from the treatment team.

Table 1 - Comparison of Means of Alcoholic Patients Receiving One LSD-Session

Patient Group	**Global Adjustment**		**Drinking Behavior**	
	Before Treatment	6 mo After Treatment	Before Treatment	6 mo After Treatment
Dosage High (N = 64)	4.16	6.52	2.83	7.02
Low (N = 40)	3.28	5.13	2.93	5.75
Psychedelic reactivity Profound (N =31)	4.43	7.13	2.65	7.52
Marked (N = 31)	3.87	6.16	2.94	6.94
Minimal (N = 50)	3.50	5.34	2.92	5.82
Results of Covariance Analyses For Above Data	*F*	*P**	*F*	*P**
High dose vs low dose	3.76	0.05	4.43	0.025
Psychedelic reactivity groups	2.42	0.05	3.09	0.025

* P values are for one-tatted tests of significance.

An NIMH-sponsored project to investigate the effect of psychedelic-peak psychotherapy with narcotic addicts is well underway, but it is too early for any indication of therapeutic outcome. These patients in general seem to have a greater degree of psychopathology than the alcoholics with whom we have worked, but the skilled implementation of psychedelic psychotherapy seems to be proceeding smoothly. An observation of interest is that the character of the drug experience with LSD has been reported by the addicts to be distinctly and qualitatively different from what they experienced under heroin (ie, a confrontation with their problems rather than an escape from them).

During the past several years, we have also been exploring the potential of psychedelic-peak psychotherapy with patients with cancer.[16-18] The purpose has been to treat the depression, anxiety, psychological isolation, and intractable pain which so many of these patients face. The families, too, must cope with psychological problems which relate to their own fears and impending sense of loss. How to relate to the patient and what to tell him about his diagnosis further complicates what is already a grim situation. This use of LSD is similar to that already outlined, except that not quite as much time is spent in preparation, and the treatment takes place in a private room of a general medical facility (Sinai Hospital, Baltimore). Also, family therapy plays a larger role.

Thus far, we have treated 35 patients in a pilot project. Our findings must remain only suggestive at this point, but they do give some promising indications of the potential of this form of treatment. Measurements before and after LSD on depression, anxiety, emotional tension, psychological isolation, fear of death, and amount of medication required for pain have shown change in a positive direction in about two-thirds of the patients. In half of these the improvement was dramatic, and those patients who had the most profound peak experiences tended to show the most benefit. Also, patients treated earlier in the course of their disease were able to use the experience more rewardingly.

While not all patients were helped dramatically, none, even the most ill, appeared to have been harmed. This finding in regard to the safety of the procedure has been consistent with our results in alcoholic and neurotic patients.

The following case summary will serve to illustrate both the method and possible outcome.

Table 2 - Acoholic Patients Improved Six Months After One LSD Session

Patient Group	**No. of Patients With Global Adjustment Scores of 8, 9, or 10 (%)**	**No. of Patients With Drinking Behavior Scores of 8, 9, or 10 (%)**
Dosage High (N = 64)	44 (28/64)	53 (34/64)
Low (N = 40)	25 (10/40)	33 (13/40)
Psychedelic reactivity Profound (N = 23)	61 (14/23)	61 (15/23)
Marked (N = 31)	39 (12/31)	48 (48/31)
Minimal (N = 50)	24 (12/50)	36(18/5)

X^2 Results For Above Data

	Global Adjustment		**Drinking Behavior**	
	X^2	*P**	X^2	*P**
High vs low dose	2.97	0.05	3.44	0.05
Psychedelic reactivity groups	7.74	0.025	3.07	Not significant

* *P* values are for one-tailed tests of significance.

Report of a Case

The patient, a 58-year-old Jewish married woman, had suffered from cancer of the breast for 12 years. In spite of numerous surgical and medical procedures which included hysterectomy, oophorectomy, and adrenalectomy, the disease had spread widely in her spine. At the time she was referred for LSD treatment, pressure on nerves in her spine had caused numbness and a paralysis of the lower half of her body. When first interviewed, the patient was anxious and depressed.

After six hours of preparatory psychotherapy with the patient and her family. over the period of a week, during which the nature and purpose of the treatment was explained, the patient was given 300 µg of LSD. The first few hours of her psychedelic session went well and were pleasant, but a complete psychedelic-peak experience was not obtained. There were a few moments of intense positive psychedelic reactivity; for example, at one point the patient exclaimed, "This is one of the happiest days of my life. I will always remember it." There were also transient episodes of apprehension, confusion, and paranoia which were easily handled by reassurance and support.

During the latter part of the session, the patient raised the question of whether or not she would walk again. This issue was handled by a realistic review of the patient's condition, and the therapist finally stated in a direct answer to her question that it was very· unlikely that she would be able to walk again. The patient then expressed her reluctant acceptance of the idea that her life could still go on even if she were confined to bed, a condition which she had previously greatly feared. However, the patient spontaneously expressed her determination to try her best in physiotherapy, in spite of the odds against her. She was supported in her resolve to try, but also discussed was acceptance of her condition, if it could not be improved. During the evening after the patient had emerged from the effects of the drug, the patient's family visited. This was a time of intense closeness and interpersonal sharing. The family remarked on the change in her mental condition from that of anxiety and depression to one of peace and joy.

In the days after the session the patient's mood was cheerful and hopeful. Upon discharge from the hospital six days after her LSD treatment, the patient returned home and began intensive work with a physiotherapist. She made remarkable, quite unexpected progress and within four months was able to use a walker. Six months after treatment the patient was doing some limited walking with a cane.

In spite of her impressive accomplishments, the patient again became depressed and difficult to manage at home because of her feelings that she would always be an invalid. She was especially distressed because the back-brace which she had to wear out of bed (four to six hours a day) was cumbersome and she needed assistance by another person in order to put it on. Because of her increasing depression, both the patient and her family requested another LSD treatment. She was seen regularly for preparation. Interpersonal relations, her self-concept, and some realistic expectations for the future were the major issues explored.

Ten months after her first session the patient was readmitted to the hospital for her second LSD treatment. Her initial reaction to the session was one of anxiety, and then the issue of her disease was encountered. She faced the fact that throughout her illness she had tended to deny that she was really sick. She remembered patients she had known with cancer, and her fear of decaying flesh was symbolized by visions of vultures feeding on rotten meat. After confronting rather than retreating from these unpleasant feelings and experiences, the patient had the experience of passing through a series of blue curtains or veils. On the other side she felt as if she were a bird in the sky soaring through the air. Then she was on a high mountain top in a small cabin alone with the snow falling. She experienced wonderful feelings of peace and harmony and visions of beautiful colors like the rainbow. After this, she stabilized the experiences and had enjoyable reliving of happy memories from her past, the best of which was her wedding day, which she relived in great detail including a reexperience of the way her mother sighed as she came down the aisle. These happy memories were in contrast to the early part of her experience when she had relived some unpleasant events such as the prejudice she felt against her as a child because she was Jewish and her failure to take advantage of the cultural opportunities her father had provided. In the latter part of the experience the patient thought deeply about her family while looking at their pictures. She was able to resolve some of the ambivalence she had about her younger daughter who was to be married in three months. She felt sorry for some of the strife they had had and came out of the experience with a resolve to make a more constructive attempt to relate to this girl in the future. When the patient's family arrived after supper, she had a serene smile on her face, but was reluctant to talk about her experience too much. She said, "You wouldn't believe me if I did tell you."

Subsequently, the patient left the hospital in good spirits and was able to participate actively in her daughter's wedding. She fulfilled her desire to walk down the aisle without the aid of even a cane, and during the wedding reception she amazed all the guests by dancing with her husband. Her sister said she had been the life of the party.

Table 3 - Means of Chromosomal Aberration Rates* Before and After LSD Among Various Experimental Groups

Group	**Before LSD**	**After LSD**	**Difference**	***P***
32 patients	4.28	5.91	+1.63	Not significant†
5 users	2.81	3.57	+0.76	Not significant‡
8 experimental subiects	...	2.79	...	...
2 normal subjects	2.65	...	...	...

*Aberration rate = percentage of aberrant cells/total metaphases analyzed (at least 200 per culture).
† Wilcoxon matched-pairs, signed-ranks, two-tailed test.
‡ Fisher exact probability test.

Within six months the patient requested a third LSD treatment. At this time she had increasing pain and was discouraged because she had not worked in over two years although she had kept the hope alive that she would eventually return to her old job. The session began smoothly but the patient became frightened when she saw a huge wall of flames. After support and encouragement by the therapist, the patient was able to go through the middle of the flames, and at this point experienced positive ego transcendence. She felt that she had left her body, was in another world, and was in the presence of God which seemed symbolized by a huge diamond-shaped iridescent Presence. She did not see Him as a Person but knew He was there. The feeling was one of awe and reverence, and she was filled with a sense of peace and freedom. Because she was free from her body, she felt no pain at all. She was quiet during most of the day and emerged from the session with a deep feeling of peace and joy. When her family had arrived, she radiated a psychedelic afterglow of peace and beauty which all remarked upon. During the course of the evening the patient had a serious talk with her daughters about her condition and what might lie ahead. Shortly thereafter the patient was discharged from the hospital in good spirits. One effect of the treatment was that when the patient was troubled with pain, she could push the pain out of her mind by remembering her out-of-the-body LSD experience.

The patient did very well for about one month, until she slipped on the stairs one day and injured her back, which began causing her considerable pain again. She also became sick with influenza and was confined to bed. Prior to this she had been considering going back to work at her old job, part-time, but with the worsening of her physical condition these plans had to be postponed. With these physical setbacks and especially the recurrence of her pain, the patient again became somewhat depressed. Both the patient and her family requested another LSD treatment. The patient was seen weekly for about a month as an outpatient, and then readmitted for a treatment with LSD, almost six months after her third treatment.

The evening before her session, during the final preparation, the patient suddenly asked a direct question about her diagnosis for the first time in the almost two years she had been in the LSD-treatment program. Although she knew that her breast had been removed for a tumor, she had believed there was no further growth, but the increasing pain in her back had made her wonder. Her questions were answered gently, but without evasion, and the meaning and emotional impact were discussed with her. The family members were informed of this conversation immediately thereafter, and they reacted by becoming quite upset and angry. That very evening, in a general family discussion with the patient and therapist, however, most of them were able to resolve their feelings. Some felt embarrassed because of their previous pretense; most felt relieved when they saw how well the patient had dealt with the situation. The patient stated that she was glad to know the truth and was obviously not psychologically shattered or further depressed as some of the family members had feared.

The fourth session the next day went smoothly, except for some nausea which was experienced shortly before admission when she had eaten some spoiled food. Much psychodynamic material emerged concerning her feelings about various members of her family, especially her two daughters. In the evening the patient felt very close to her family and spent some time in talking to each of them alone in a very personal way. She was reluctant to have them leave at the end of the evening, even though she was very tired. In the days after the session the patient felt relaxed and in good spirits. She was not pessimistic about the future, in spite of the new knowledge about the diagnosis of metastatic cancer of the spine. She was able to tolerate the pain in the back with the aid of narcotic drugs, but did not have complete relief from pain.

While still in the hospital, an hypophysectomy was attempted as a possible means to stop further spread of her metastatic process. Because of hemorrhage the operation could not be completed, and the patient died a few days later.

This patient experienced considerable relief from pain, depression, and anxiety over the period of almost two years during which she received four LSD treatments. Her first session was not judged to have had much psychedelic content, but the second, third, and fourth sessions did. The third session was the most complete psychedelic-peak experience and seemed to provide the most benefit. This patient's gratifying physical improvement can be attributed only indirectly to the LSD treatment in that her own underlying resolution to pursue physiotherapy emerged when her depression and anxiety were relieved. By a fortunate coincidence, her condition responded well to these efforts on her part, contrary to the most informed medical prognosis. All our patients are told that LSD is for treatment of psychological distress and not a cure for their physical disease. In this case, as happens not infrequently, sometime during the course of LSD treatment the issue of diagnosis was brought up by the patient and had to be worked out with the patient and the family.

The Question of Safety

When psychedelic drugs are administered under controlled medical conditions (as has been the case in several large-scale research projects in recent years), permanent adverse effects have been rare. Since 1963, at the Spring Grove State Hospital and now at the Maryland Psychiatric Research Center, Baltimore, over 300 patients have been treated with LSD without a single case of long-term psychological or physical harm directly attributable to the treatment, although there have been two cases in which disturbances persisted in the days following the actual LSD session. Both patients subsequently responded to conventional psychiatric treatment.

Throughout the years of research with LSD many possible harmful physical effects have been suggested, but careful subsequent investigation has failed to furnish much conclusive scientific evidence. Most recently, the question of chromosomal damage has been raised following the positive *in vitro* findings in white blood cells by Cohen.[19] Retrospective studies on persons having taken LSD (most from the black market and only a few under medical supervision) have produced conflicting reports. Some researchers[20-22] found increased chromosomal breakage over normal rates, and others no Increase.[23-25]

Because we were in a position to study the effect of pure LSD of known amount on patients who were to be treated with psychedelic psychotherapy, we entered into collaboration with the cytogenetics laboratory of Joe-Hin Tjio, PhD, at the National Institute of Arthritis and Metabolic Diseases to carry out a rigorously controlled study. Blood samples from 32 patients being treated at the Spring Grove State Hospital were drawn and cultured both before and after LSD administration. The white blood cell (WBC) chromosomes were then studied without prior identification of the slides, and at least 200 metaphases were analyzed per culture. In addition, the WBC chromosomes of five chronic LSD users were studied before, during, and after the administration of known doses of LSD in research on sensory, cognitive, and perceptual functions at the National Institutes of Health.

No difference was found in the rate of chromosomal aberrations before and after administration of LSD when the data from these 37 separate individuals were statistically analyzed. Also, chromosomal analysis after LSD administration was done on eight normal subjects who had received LSD in research experiments in the past, and no increase over normal chromosomal breakage rate was found. A summary of these results is presented in Table 3. The mean rates before LSD in the 32 patients (4.28%) and the five LSD users (2.81%) are comparable to each other and to the values obtained from samples from two normal control subjects for eight to ten consecutive days (2.65%). The differences between the rates before and after receiving LSD for both the 32 patients (+1.63%) and the five LSD users (+0.76%) are not statistically significant. The mean chromosomal aberration rates for the 32 patients and five LSD users (including those both before and after administration of LSD), eight experimental LSD subjects (after LSD administration), and two normal controls (no LSD) only vary from 2.65% to 5.91%. Detailed reports of this research have been presented and published.[26,27]

Comment

Part of the conflicting evidence about the efficacy of psychedelic drugs as a therapeutic tool for the treatment of mental illness comes from the differences in the methods employed by various groups of researchers. Unfortunately, rather than replicating each other's methods, each research team seems to have developed its own procedure.

In spite of such diversity of approach, several points seem to be clear by now. Use of LSD is not a substitute for skilled psychotherapy. Experiments where LSD was used primarily as a chemotherapeutic agent or with a minimum of psychotherapy have not shown any greater efficacy regarding therapeutic outcome, especially with alcoholics, than control groups."e- 3! The evidence from the psycholytic use of LSD by European researchers and psychedelic-peak therapy as practiced at the Maryland Psychiatric Research Center indicates that LSD can be an enhancer of skilled psychotherapy when integrated with an intensive psychotherapeutic program of sufficient duration (30 to 50 hours).

The scientific evidence concerning possible genetic hazards of LSD is conflicting and inconclusive. The difference in results between our carefully controlled study before and after administration of LSD in patients and the research on LSD abusers may be explained by the many uncontrolled variables such as viral infections and the effects of other drugs. Certainly much more research needs to be done in this complex area before valid conclusions can be drawn.

Research with psychedelic drugs needs to be continued to learn more about their effective use. Questions need to be answered, such as what kinds of patients will benefit most and under what circumstances. As our research progresses and we gain more experience we expect to modify our implementation of psychedelic-peak psychotherapy. Newer psychedelic drugs may have certain advantages over more well-known ones. For example, we have been testing dipropyltryptamine (DPT) developed by Szara[32] at the NIH, which has a duration of action of from two to four hours depending on dosage. If this drug proves to be as effective and safely manageable as the much longer-acting LSD, it could result in a psychedelic procedure that could be more flexibly and easily implemented than that with LSD.

In spite of the potential uses for psychedelic drugs suggested by our work, the future of such research, unfortunately, seems uncertain. Contributing factors for this dim prognosis are sensationalism of the effects of LSD along with a continuing spread of illicit use, public fear stimulated especially by reports of irreversible genetic and psychological damage, the decreasing amount of research being initiated, the dearth of investigators who have had first-hand clinical or research experience with LSD, and the difficulty of obtaining such training.

Our hope is that the current public concern over abuse can give way to a resurgence of careful and informed research including specialized training and experience for those interested in this area. Our past and present research continues to intrigue us with the promise of psychedelic drugs, but they are obviously powerful tools that need to be used and handled wisely. Hopefully, it is not too late for them to be harnessed for medical and research use in a variety of ways in the future.

These investigations were supported in part by Public Health Service research support grants MH-13747 (Psychedelic Therapy Research Program), MH-15555 (Program for Treatment of the Narcotic Addict), MH-08474 (Controlled Study of LSD Therapy with Alcoholics), MH-1100l (A Controlled Study of LSD Therapy with Neurotics), and FR-05546 (General Research Support Program). These grants were administered by Friends of Psychiatric Research, Inc, Baltimore.

The lysergic acid diethylamide used in this research was manufactured by the Sandoz Pharmaceutical Co., Basel, Switzerland, and distributed by the FDA-NIMH Committee for psychomimetic drug research.

Lee McCabe, PhD, Sidney Wolf, MA, William Richards, STM, and Thomas Cimonetti, MD, collaborated in these studies. James Olsson, PhD, performed the statistical analyses. Harry Shock, LLB, headed the independent evaluation follow-up team. Louis Goodman, MD, Sinai Hospital, Baltimore, Md, arranged the clinical facilities for the study of patients with cancer.

References

1. Abramson HA (ed): *The Use of LSD in Psychotherapy*. New York, Josiah Macy, Jr, Foundation Publications, 1960.
2. Crockett R, Sandison RA, Welk A (eds): *Hallucinogenic Drugs and Their Psychotherapeutic Use*. London, HK Lewis & Co Ltd, 1963.
3. Abramson HA (ed): *The Use of LSD in Psychotherapy and Alcoholism.* New York, Bobbs-Merrill & Co, 1967.
4. Leaf R, Debold R (eds): *LSD, Man and Society.* Middletown, Conn, Wesleyan University Press, 1967.
5. Cavanna R, Ulmann M (eds): *Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi, 1967.* New York, Garrett Press, 1968.
6. Hicks RE, Fink PJ (eds): *Psychedelic Drugs.* New York, Grune & Stratton, 1969.
7. Pahnke W, Richards W: Implications of LSD and experimental mysticism. *J Religion Health* 5:175-208, 1966.
8. Pahnke WN: LSD and religious experience, in Leaf R, Debold R (eds): *LSD, Man and Society*. Middletown, Conn, Wesleyan University Press, 1967.
9. Kurland AA, Unger S, Shaffer JW, et al: Psychedelic therapy utilizing LSD in the treatment of the alcoholic patient: A preliminary report. *Amer J Psychiat* 123: 1202-1209, 1967.
10. Kurland AA, Unger S, Shaffer JW, et al: Psychedelic psychotherapy (LSD) in the treatment of alcoholism: An approach to a controlled study, in Abramson HA (ed): *The Use of LSD in Psychotherapy and Alcoholism*. New York, BobbsMerrill & Co, 1967, pp 496-503.
11. Kurland AA, Savage C, Shaffer JW, et al: Therapeutic potential of LSD in medicine, in Leaf R, Debold R (eds): *LSD, Man and Society*. Middletown, Conn, Wesleyan University Press, 1967, pp 20-35.
12. Unger S, Kurland AA, Shaffer JW, et al: LSD-type drugs and psychedelic therapy, in Shlien J, Hunt H, Mataruzzo J, et al (eds): *Research in Psychotherapy.* Washington, DC, American Psychological Assoc Inc, 1968, vol 3, pp 521-535.
13. Unger S: The psychedelic use of LSD: Reflections and observations, in Hicks RE, Fink PJ (eds): *Psychedelic Drugs.* New York, Grune & Stratton Inc, 1969, pp 199-209.
14. Savage C: Psychedelic therapy, in Shlien J, Hunt H, Mataruzzo J, et al (eds): *Research in Psychotherapy*. Washington,.DC, American Psychological Assoc Inc, 1968 vol 3, pp 512-520.
15. Savage C, McCabe OL, Olsson JE, et al: Research with psychedelic drugs, in Hicks RE, Fink PJ (eds): *Psychedelic drugs.* New York, Grune & Stratton Inc, 1969, pp 15-22.
16. Kurland AA, Pahnke WN, Unger S, et al: Psychedelic psychotherapy (LSD) in the treatment of a patient with a malignancy, in Cerletti A, Dove FL (eds): *The Present Status of Psychotropie Drugs: Proceedings of the Sixth International Congress of the Collegium International Neuropsychopharmacologicum*, publication 180. International Congress series, Amsterdam, Excerpta Medica Foundation, 1969, pp 432-434.
17. Pahnke WN, The psychedelic mystical experience in the human encounter with death. *Harvard Theological Review* 62:1-32, 1969.
18. Pahnke W, Kurland AA, Goodman LE, et al: LSD-assisted psychotherapy with terminal cancer patients, in Hicks RE, Fink PF (eds): *Psychedelic Drugs.* New York, Grune & Stratton Inc, 1969 pp 33-42.
19. Cohen M, Marinello M, Bach N: Chromosomal damage in human leucocytes induced by Lysergic acid diethylamide. *Science* 155:1417-1419, 1967.
20. Cohen, M, Hirschhorn K, Frosch W: In vivo and in vitro chromosomal damage induced by LSD-25. *New Eng J Med* 227: 1043-1049, 1967.
21. Egozcue J, Irwin S, Maruffo CA: Chromosomal damage in LSD users. *JAMA* 204:214-218, 1968.
22. Nielsen J, Friedrich U, Tsuboi T: Chromosome abnormalities and psychotropic drugs. *Nature* 218:488-489, 1968.
23. Loughman WD, Sargent TW, Israelstam DM: Leukocytes of humans exposed to lysergic acid diethylamide: Lack of chromosomal damage. *Science* 158:508- 510, 1967.
24. Bender L, Sankar DVS: Chromosomal damage not found in leucocytes of children treated with LSD-25. *Science* 159: 749, 1968.
25. Sparkes RS, Melnyk J, Bozzetti LP: Chromosomal effect in vivo of exposure to lysergic acid diethylamide. *Science* 160: 1343-1344, 1968.
26. Tjio JH, Pahnke WN, Kurland AA: Pre- and post-chromosomal aberrations: A comparative study, in Costa E, Greengard P (eds): *Advances in Biochemical* Psychopharmacology*.* New York, Raven Press, 1969, vol 1, pp 191-204.
27. Tjio JH, Pahnke WN, Kurland AA: LSD and chromosomes: A controlled study. *JAMA* 210:849-856, 1969.
28. Smart RG, Storn T, Baker EF, et al: *Lysergic Acid Diethylamide (LSD) in the Treatment of Alcoholism*, publication 6. Bookside monograph of the Addiction Research Foundation, Toronto, University of Toronto Press, 1967.
29. Johnson FG: LSD in the treatment of alcoholism. *Amer J Psychiat* 126:481- 487, 1969.
30. Ludwig A, Levine J, Spark L, et al: The clinical study of LSD treatment in alcoholism. *Amer J Psychiat* 126:59-69, 1969.
31. Hollister LE, Shelton J, Krieger G: A controlled comparison of lysergic acid diethylamide (LSD) and dextroamphetamine in alcoholics. *Amer J Psychiat* 125 58-63, 1969.
32. Szara S, Faillace LA, Speck LB: Metabolic and physiological correlates of the psychological reaction to three shortacting tryptamine derivatives, in Brill H Cole J, Deniker P, et al (eds): *Proceedings of the Fifth International Congress of the Collegium lnternationale Neuropsychopharmacologicum*, publication 129. International Congress series, Amsterdam, Excerpta Medica Foundation, 1967, p 115.

Drugs and Mysticism

An Analysis of the Relationship between Psychedelic Drugs and the Mystical Consciousness

by

Walter Norman Pahnke

A thesis presented

by

Walter Norman Pahnke

to

The Committee on Higher Degrees in

History and Philosophy of Religion

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

in the subject of

Religion and Society

Harvard University

Cambridge, Massachusetts

June, 1963

© 1963 Walter Norman Pahnke

original source: http://www.maps.org/images/pdf/books/pahnke/walter_pahnke_drugs_and_mysticism.pdf
backup source: http://www.psilosophy.info/resources/walter_pahnke_drugs_and_mysticism.pdf

SUMMARY

of

THE THESIS:

DRUGS AND MYSTICISM

An Analysis of the Relationship between Psychedelic Drug Experience and the Mystical State of Consciousness

by

Walter Norman Pahnke

Table of Contents:

Acknowledgments
List of tables

Preface
Chapter I - INTRODUCTION
Chapter II - RELIGION AND PSYCHEDELIC SUBSTANCES: A SURVEY
 Data from History, Archaeology, Anthropology, Botany, and Psychopharmacology
 Data from Clinical Research
Chapter III - THE DEFINITION OF MYSTICISM
 Mystical Experience in General
  The Relationship between Mystical Experience and Religious Experience
  The Universality of the Characteristics of Mystical Experience
  Primary Experience versus Interpretation
 Phenomenological Typology of Mystical States of Consciousness
  Category I: Unity
   Internal Unity
   External Unity
  Category II: Transcendence of Time and Space
  Category III: Deeply Felt Positive Mood
  Category IV: Sense of Sacredness
  Category V: Objectivity and Reality
  Category VI: Paradoxicality
  Category VII: Alleged Ineffability
  Category VIII: Transiency
  Category IX: Persisting Positive Changes in Attitude and/or Behavior
 The Continuum of Mystical Experiences
Chapter IV - EXPERIMENTAL DESIGN
 Non-drug Factors
 Choice of Drug
 Recruitment and Pre-testing of Subjects
 Preparation and Grouping of Subjects
 Experimental Procedure
  Drug Preparation
  Protocol During the Experimental Day
 Collection of Data after the Experiment
Chapter V - DATA USED IN MATCHING OF SUBJECTS
 Pre-drug Questionnaire and Interview Data
  Rating Scale
  Categories
  Description of Average Subject
 California Psychological Inventory Data
Chapter VI - DATA FROM QUESTIONNAIRES, INTERVIEWS, AND CONTENT ANALYSES
 Data Relevant to the Categories of the Typology of Mysticism
  Method of Presentation
  Category I: Unity
   Internal Unity
   External Unity
   Supplementary Phenomena
  Category II: Transcendence of Time and Space
  Category III: Deeply Felt Positive Mood
   The most universal phenomena (Joy, Blessedness, and Peace)
   Closely Related Phenomena (Love)
  Category IV: Sense of Sacredness
  Category V: Objectivity and Reality
  Category VI: Paradoxicality

Category VII: Alleged Ineffability
Category VIII: Transiency
Category IX: Persisting Positive Changes in Attitude and Behavior
Changes toward self
Changes toward others
Changes toward life
Changes toward the experience
Other Data
Chapter VII - GENERAL DISCUSSION AND CONCLUSIONS
Discussion of Design
Observations of the Experimenter during the Experiment
Summary and Discussion of Data
Conclusions
Chapter VIII - SUGGESTIONS FOR FURTHER RESEARCH AND IMPLICATIONS FOR THE FUTURE
Appendix A - MEDICAL HISTORY FORM FOR VOLUNTEER SUBJECTS FOR PSILOCYBIN RESEARCH
Appendix B - PRE-DRUG EXPERIENCE QUESTIONNAIRE
Appendix C - POST-DRUG QUESTIONNAIRE WITH SIGNIFICANCE LEVELS OF THE DIFFERENCE BETWEEN SCORES OF EXPERIMENTALS AND CONTROLS
Appendix D - FOLLOW-UP QUESTIONNAIRE WITH SIGNIFICANCE LEVELS OF THE DIFFERENCE BETWEEN SCORES OF EXPERIMENTALS AND CONTROLS
Section I
Section II
Section III
Appendix E - CONTENT ANALYSIS
Content Analysis Instruction Manual for Judges
Content Analysis Score Sheet Used by Judges with the Probability for each Item that the Difference between Experimentals and Controls was due to Chance
Reliability of Judges as Determined from Kendall Rank Correlation Coefficient
Appendix F - EXPLANATION OF THE COLUMNS AND SYMBOLS USED IN THE CATEGORY TABLES
Appendix G - DATA NOT DIRECTLY RELEVANT TO CATEGORIES OF THE TYPOLOGY OF MYSTICISM
Group I: Integrative and Constructive Phenomena
Group II: Disturbing Changes in Attitude and Behavior
Group III: Physical Sensations
Group IV: Miscellaneous
Bibliography

LIST OF TABLES

1. Data Used in Matching Pairs of Subjects from Pre-Drug Questionnaires and Interviews
2. From the California Psychological Inventory: Relevant Scores Used in Matching Pairs of Subjects
3. Category I: Unity (Combination of All Subcategories)
4. Category I: Unity (Internal Unity)
5. List of Items Used to Measure Internal Unity
6. Category I: Unity (External Unity)
7. List of Items Used to Measure External Unity
8. Category I: Unity (Supplementary Phenomena)
9. List of Supplementary Phenomena of Unity
10. Category II: Transcendence of Time and Space (Combination of all Subcategories)
11. Category II: Transcendence of Time and Space
12. List of Items Used to Measure Transcendence of Time and Space
13. Category III: Deeply Felt Positive Mood (Combination of all Subcategories)
14. Category III: Deeply Felt Positive Mood (Most Universal phenomena: joy, blessedness, & peace. Less universal: Love)
15. List of Items Used to Measure the Most Universal Phenomena of Deeply Felt Positive Mood (Joy, Blessedness, and Peace)
16. List of Items Used to Measure Love

17. Category IV: Sense of Sacredness (Combination of all Subcategories)
18. List of Items Used to Measure Sense of Sacredness
19. Category IV: Sense of Sacredness (Phenomena with Implicit Indication of Sense of Sacredness. Phenomena which Explicitly Mention the Holy, Sacred, and Divine)
20. Category V: Objectivity and Reality
21. List of Items Used to Measure Objectivity and Reality
22. Category VI: Paradoxicality (Combination of all Items)
23. List of Items Used to Measure Paradoxicality
24. Category VII: Alleged Ineffability (Combination of all Items)
25. List of Items Used to Measure Alleged Ineffability
26. Category VIII: Transiency (Combination of all Phenomena. Essential Phenomena)
27. List of Items Used to Measure Transiency
28. Category IX: Persisting Positive Changes after Six Months
29. List of Items Used to Measure Persisting Positive Changes in Attitude and Behavior
30. Category IX: Persisting Changes *Toward Self* after Six Months (Persisting POSITIVE changes. Persisting NEGATIVE Changes)
31. Category IX: Persisting Changes *Toward Others* after Six Months (Persisting POSITIVE changes. Persisting NEGATIVE Changes)
32. Category IX: Persisting Changes *Toward Life* after Six Months (Persisting POSITIVE changes. Persisting NEGATIVE Changes)
33. Category IX: Persisting Changes *Toward Experience* after Six Months (Persisting POSITIVE changes. Persisting NEGATIVE Changes)
34. Summary of Significance levels Reached by Experimental Group for Categories Measuring the Typology of Mysticism
35. Summary of Data Measuring Degree of Completeness or Intensity of Categories of the Typology of Mysticism

Acknowledgments

The author wishes to express his deep gratitude for the support and encouragement of many members of the academic community who made this study possible in a troubled but promising area of research. Particular appreciation is extended to Dr. Hans Hofmann, who was a continuing source of counsel and inspiration, and to Dr. Timothy Leary, who assisted with the execution of the experiment. Through the guidance of the thesis committee, the author's perspectives have been clarified and deepened. Mr. Peter H. John contributed much time and tireless effort toward the mechanics of the manuscript. Finally, the author desires sincerely to thank all the persons who volunteered to participate in this investigation as experimental subjects or group leaders.

Preface

**This section was untitled in original work. "Preface" was added to non-sheet html version.*

This dissertation was an empirical study designed to investigate the similarities and differences between experiences described by mystics and those induced by psychedelic (or mind-manifesting) drugs such as d-lysergic acid diethylamide (LSD), psilocybin, and mescaline. First, a phenomenological typology of the mystical state of consciousness was carefully defined after a study of the writings of the mystics themselves and of scholars who have tried to characterize mystical experience. Then, some drug experiences were empirically studied, not by collecting such experiences wherever an interesting or striking one might have been found and analyzed after the fact, but by conducting double-blind, controlled experiments with subjects whose religious background and experience as well as personality had been measured *before* their drug experiences. The preparation of the subjects, the setting under which the drug was administered, and the collection of data about the experience were made as uniform as possible. The experimenter himself devised the experiment, collected data, and evaluated the results without ever having had an experience with any of these drugs.

The long and continuing history of the religious use of plants which contain psychedelic substances was surveyed. In some instances, such natural products were ingested by a priest, shaman, or witch doctor to induce a trance for revelatory purposes; sometimes they were taken by groups of people who participated in sacred ceremonies. For example, the dried heads of the peyote cactus, whose chef active ingredient is mescaline, were used by the Aztecs at least as early as 300 B.C. and are currently being employed by over 200,000 Indians of the North American Native Church as a vital part of their religious ceremonies. Both *ololiuqui*, a variety of morning glory seed, and certain kinds of Mexican mushrooms (called *teonanacatl*, "flesh of the gods") were also used for divinatory and religious purposes by the Aztecs. These practices have continued to the present among remote Indian tribes in the mountains of southern Mexico. Modern psychopharmacological research has shown the active chemicals to be psilocybin in the case of the mushrooms, and several compounds closely related to LSD in the case of *ololiuqui*. *Amanita muscaria*, the mushroom which has been used for unknown centuries by Siberian shamans to induce religious trances, does not contain psilocybin. The most important psychologically active compound from this mushroom has not yet been isolated. Other naturally-occurring plants, which are used by various South American Indian tribes in in a religious manner for prophecy, divination, clairvoyance, the tribal initiation of male adolescents, or sacred feasts, are cohobe snuff made from the pulverized seeds of *Piptadenia* (a tree); the drink, *vinho de Jurumena*, made from the seeds of *Mimosa hostilis* (a tree); and the drink, *caapi*, made from *Banisteriopsis* (a jungle creeper). These last three products contain various indolic compounds which are all closely related to psilocybin, both structurally and in their psychic effects (e.g., dimethyltryptamine, bufotenine, and harmine).

Some of the researchers who have experimented with synthesized mescaline, LSD, or psilocybin have remarked upon the similarity between drug-induced and mystical experiences because of the frequency with which some of their subjects have used mystical and religious language to describe their experiences. Our study was an attempt to explore this claim in a systematic and scientific way.

The nine-category typology of the mystical state of consciousness was defined as a basis for measurement of the phenomena of the psychedelic drug experiences. Among the numerous scholars of mysticism, the work of W. T. Stace[1] was found to be the most helpful guide for the construction of this typology. His conclusion that in the mystics experience there are certain fundamental characteristics which are universal and are not restricted to any particular religion or culture (although particular cultural, historical, or religious conditions may influence both the interpretation and description of these basic phenomena) was taken as a presupposition. Whether or not the mystical experiences is "religious" depends upon one's definition of religion and was not the problem investigated. Our typology defined the universal phenomena of the mystical experience, whether considered "religious" or not.

The nine categories of our phenomenological typology may be summarized as follows:

Category I: **Unity**
Unity, the most important characteristic of the mystical experience, is divided into internal and external types, which are different ways of experiencing an undifferentiated unity. The major difference is that the internal type finds unity through an "inner world" *within* the experiencer, and the external type finds unity through the external world *outside* the experiencer.

The essential elements of *internal unity* are loss of usual sense impressions and loss of self without becoming unconscious. The multiplicity of usual external and internal sense impressions (including time and space) and the empirical ego or usual sense of individuality fade or melt away while consciousness remains. In the most complete experience this consciousness is a pure awareness beyond empirical content, with no external or internal distinctions. In spite of the loss of sense impressions and dissolution of the usual personal identity or self, the awareness of oneness or unity is still experienced and remembered. One is not unconscious, but rather very much aware of an undifferentiated unity.

External unity is perceived outwardly with the physical senses through the external world. A sense of underlying oneness is felt behind the empirical multiplicity. The subject or observer feels that the usual separation between himself and an external object (inanimate or animate) is no longer present in a basic sense, yet the subject still knows that on another level, at the same time, he and the objects are separate. Another way of expressing this same phenomenon is that the essences of objects are experienced intuitively and felt to be the same at the deepest level. The subject feels a sense of oneness with these objects because he "sees" that at the most basic level all are a part of the same undifferentiated unity. In the most complete experience a cosmic dimension is felt so that the experiencer feels in a deep sense a part of everything that is.

Category II: **Transcendence of Time and Space**
This category refers to loss of the usual sense of time and space. Time means clock time but may also be one's personal sense of his past, present, and future. Transcendence of space means that a person loses his usual orientation as to where he is during the experience in terms of the usual three-dimensional perception of his environment. Experiences of timelessness and spacelessness may also be described as an experience of "eternity" or "infinity".

Category III: **Deeply Felt Positive Mood**
The most universal elements (and therefore, the ones which are most essential in the definition of this category) are joy, blessedness, and peace. Their unique character in relation to the mystical experience is that their intensity marks them as being at the highest levels of the human experience of these feelings, and they are valued highly by the experiencers. Tears may be associated with any of these elements because of the overpowering nature of the experience. These feelings may occur at the peak of the experience or during the "ecstatic afterglow" when the peak has passed, but its effects and memory are still quite vivid and intense. Love may also be an element of deeply felt positive mood, but does not have the same universality as joy, blessedness, and peace.

---

[1] W. T. Stace. Mysticism and Philosophy (Philadelphia and New York: J. B. Lippincott, 1960).

Category IV: **Sense of Sacredness**
This category comprises the sense of sacredness which is evoked by the mystical experience. The sacred is here defined broadly as that which a person feels to be of special value and capable of being profaned. The basic characteristics of sacredness is a non-rational, intuitive, hushed, palpitant response of awe and wonder in the presence of inspiring realities. No religious "beliefs" or traditional theological terminology need necessarily be involved even though a sense of reverence or a feeling that what is experienced is holy or divine may be included.

Category V: **Objectivity and Reality**
This category has two interrelated elements: (1) insightful knowledge or illumination felt at an intuitive, non-rational level and gained by direct experience and (2) the authoritativeness of the experience or the certainty that such knowledge is truly real, in contrast to the feeling that the experience is a subjective delusion. These two elements are connected because the knowledge through experience of ultimate reality (in the sense of being able to "know" and "see" what is really *real*) carries its own sense of certainty. The experience of "ultimate" reality is an awareness of another dimension not the same as "ordinary" reality (The reality of usual, everyday consciousness), yet the knowledge of "ultimate" reality is quite real to the experiencer. Such insightful knowledge does not necessarily mean an increase in facts, but rather intuitive illumination. What becomes "known" (rather than only intellectually assented to) is intuitively felt to be authoritative, requires no proof at a rational level, and has an inward feeling of objective truth. The content of this knowledge can be divided into two main types: (a) insights into being and existence in general, and (b) insights into one's personal, finite self.

Category VI: **Paradoxicality**
Accurate descriptions and even rational interpretations of the mystical experience tend to be logically contradictory when strictly analysed. For example, in the experience of internal unity there is a loss of all empirical content in an *empty* unity which is at the same time *full* and complete. This loss includes the loss of the sense of self and dissolution of individuality, yet something individual remains to experience the unity. The "I" both exists and does not exists. Another example is the separateness from, yet at the same time unity with, objects in the experience of external unity (essentially a paradoxical transcendence of space).

Category VII: **Alleged Ineffability**
In spite of attempts to tell or write about the mystical experience, mystics insist that words fail to describe it adequately or that the experience is beyond words. Perhaps the reason is an embarrassment with language because of the paradoxical nature of the essential phenomena.

Category VIII: **Transiency**
Transiency refers to duration and means the temporariness of the mystical experience in contrast to the relative permanence of the level of usual experience. There is a transient appearance of the special and unusual levels or dimensions of consciousness which are defined by our typology, but eventual disappearance and return to the more usual. The characteristic of transiency indicates that the mystical state of consciousness is not sustained indefinitely.

Category IX: **Persisting Positive Changes in Attitude and/or Behavior**
Because our typology is of a healthful, life-enhancing mysticism, this category describes positive, lasting effects which are the result of the experience. These changes are divided into four groups: (1) toward self, (2) toward others, (3) toward life, and (4) toward the mystical experience itself.

(1) Increased integration of personality is the basic inward change in the personal self. Undesirable traits may be faced in a way that enables them to be dealt with and finally reduced or eliminated. Issuing from personal integration, the sense of one's inner authority may be strengthened, and the vigor and dynamic quality of a person's life may be increased. Creativity and greater achievement efficiency may be released. There may be an inner optimistic tone with consequent increase in feelings of happiness, joy, and peace. (2) Changes in attitude and behavior toward others include more sensitivity, more tolerance, more real love, and more authenticity as a person by being more open and more one's true self with others. (3) Changes toward life in a positive direction include philosophy of life, sense of values, sense of meaning and purpose, vocational commitment, need of service to others, and new appreciation for life or the whole of creation. Life may seem richer. The sense of reverence may be increased, and more time may be spent in devotional life and

meditation. (4) Positive change toward the experience means that it is regarded as valuable and that what has been learned is thought to be useful. The experience is remembered as a high point, and an attempt is made to recapture the experience, or if possible, to gain new experiences as a source of growth and strength. Mystical experiences of others are more appreciated and understood.

The purpose of the experiment in which psilocybin was administered in a religious context was to gather empirical data about the state of consciousness experienced. In a private chapel on Good Friday twenty Christian theological students, ten of whom had been given psilocybin one-and-one-half hours before, listened over loud speakers to a two-and-one-half-hour religious service which consisted of organ music, four solos, readings, prayers, and personal meditation. The assumption was made that for experiences most likely to be mystical, the atmosphere should be broadly comparable to that achieved by tribes who actually use natural psychedelic substances in religious ceremonies. The particular content and procedure of the ceremony had to be applicable (i.e. familiar and meaningful) to the participants. Attitude toward the experience, both before and during, was taken into serious consideration in the experimental design. Preparation was meant to maximize positive expectation, trust, confidence, and reduction of fear. Setting was planned to utilize this preparation through group support and rapport friendship, an open and trusting atmosphere, and prior knowledge of the procedure of the experiment in order to eliminate, if possible, feelings of manipulation which might arise.

In the weeks before the experiment each subject participated in five hours of various preparation and screening procedures which included psychological tests, medical history, physical exam, questionnaire evaluation of previous religious experience, intensive interview, and group interaction. The twenty subjects were graduate-student volunteers, all of whom were from middle-class Protestant backgrounds and from one denominational seminary in the free-church tradition. None of them had ever taken psilocybin or related substances before this experiment. The volunteers were divided into five groups of four student each on the basis of compatibility and friendship. Two leaders who knew from past experience the positive and negative possibilities of the psilocybin reaction meat with their groups to encourage trust, confidence, group support, and fear reduction. The method of reaction to the experience was emphasized (i.e. to relax and cooperate with, rather than to fight against, the effects of the drug). Throughout the preparation an effort was made not to suggest the characteristics of the typology of mysticism.

Double-blind technique was employed in the experiment so that neither the experimenter nor any of the participants (leaders or subjects) knew the specific contents of the capsules which were identical in appearance. Half of the subjects and one of the leaders in each group received psilocybin. Without prior knowledge of the effects, the remaining subjects and the other leader received nicotinic acid, a vitamin which causes transient feelings of warmth and tingling of the skin, in order to maximize suggestion for the control group.

Data were collected during the experiment and at various times up to six months afterwards. On the experimental day tape recordings were made both of individual reactions immediately after the religious service and of the group discussions which followed. Each subject wrote an account of his experience as soon after the experiment as was convenient. Within a week all subjects had completed a 147-item questionnaire which had been designed to measure phenomena of the typology of mysticism on a qualitative, numerical scale. The results of this questionnaire were used as the basis for a one-and-one-half-hour, tape-recorded interview which immediately followed. Six months later each subject was interviewed again after completion of follow-up questionnaire in three parts with a similar scale. Part I was open-ended; the participant was asked to list any changes which he felt were a result of his Good Friday experience and to rate the degree of benefit or harm of each change. Part II (52 items) was a condensed and somewhat more explicit repetition of items from the post-drug questionnaire, Part III (93 items) was designed to measure both positive and negative attitudinal and behavioral changes which had lasted for six months and were due to the experience. The individual, descriptive accounts and Part I of the follow-up questionnaire were content analyzed with a qualitative, numerical scale by judges who were independent from the experiment.

Prior to the experiment the twenty subjects had been matched into ten pairs on the basis of data from the pre-drug questionnaires, interviews, and psychological tests. Past religious experience, religious background, and general psychological make-up were used for the pairings in that order of importance. The experiment was designed so that one subject from each pair received psilocybin and one received the control substance, nicotinic acid. This division into an experimental and control group was for the purpose of statistical evaluation of the scores from each of the three methods of measurements which used a numerical scale: the post-drug questionnaire, the follow-up questionnaire, and the content analysis of the written accounts.

The data from these three methods of measurement were presented by categories. The individual items which were used to measure each category were listed in groups for each method. The difference in score between each of the ten pairs of experimental and control subjects were analyzed statistically by the Sign Test for each item and also for the total scores of items in groups. In addition, examples of each of the nine categories were given in the form of excerpts from the descriptions which were written by the subjects.

From these data the conclusion was drawn that under the conditions of our experiment, those subjects who received psilocybin experienced phenomena which were apparently indistinguishable from, if not identical with, certain categories defined by our typology of mysticism. When analyzed statistically, the scores of the experimental subjects were significantly higher than those of the control subjects form all three methods of measurement in all categories except sense of sacredness. In all the other eight categories there were less that two chances in one hundred that the difference was due only to chance rather than to psilocybin, and in more than half the categories less than two chances in one thousand. Even sacredness showed a statistically significant difference in score (chance expectation of no more than five chances in one hundred) from both questionnaires, but not from the content analysis. The degree of completeness or intensity of the various categories was presented and discussed by comparing the consistency of score levels on individual items and groups of items among the three methods of measurement. Not all categories were experienced in the most complete way possible, although there was evidence that each category had been experienced to some degree.

In terms of our typology of mysticism, ideally the most "complete" mystical experience should have demonstrated the phenomena of all the categories in a maximal way. The evidence (particularly from the content analysis and also supported by impressions from the interviews) showed that such perfect completeness in all categories was not experienced by the experimental subjects. The phenomena of internal unity, however, were experienced to a rather complete degree; and because unity is the heart of the mystical experience, phenomena of the other categories might also have been expected to have been experienced to just as complete a degree as "by-products". In our data such a prediction was correct for transcendence of time and space, transiency, paradoxicality, and persisting positive changes in attitude and behavior toward self and life. The evidence indicated a less, although almost, complete experience of external unity, objectivity and reality, joy, and alleged ineffability. There was a relatively greater lack of completeness for sense of sacredness, love, and persisting positive changes in attitude and behavior toward others and toward the experience. Each of these last eight categories or subcategories was termed incomplete to a more or less degree for the experimentals, but was definitely present to some extent when compared with the controls. When analyzed most rigorously and measured against all possible categories of the typology of mysticism, the experience of the experimental subjects was considered incomplete in this strictest sense. Usually such incompleteness was caused by results of the content analyses.

The control subjects did not experience much phenomena of the mystical typology and even then only to a low degree of completeness. The phenomena for which the scores of the controls were closest to (although still always less than) the experimentals were: blessedness and peace, sense of sacredness, love, and persisting positive changes in attitude and behavior toward others and toward the experience.

The design of the experiment suggested an explanation for the experience of these phenomena at all by the controls. The meaningful religious setting of the experiment would have been expected to have encouraged a response of blessedness, peace, and sacredness. In the case of sacredness, implicit phenomena such as awe, wonder, mysterious fascination in spite of terror or fear, and sense of the wholly otherness of what was met in the experience showed a statistically significant score difference in favor of the experimentals compared to the controls, whereas phenomena with a more explicit indication of sacredness by the use of conventional religious or theological terminology did not show a significant difference between the two groups. In the case of love and persisting changes toward others and toward the experience, observation by the controls of the profound experience of the experimentals and interaction between the two groups on an interpersonal level appeared from both post-experimental interviews to have been the main basis for the controls' experience of these phenomena.

The experience of the experimental subjects was certainly more like mystical experience than that of the controls who had the same expectation and suggestion from the preparation and setting. The most striking difference between the experimentals and controls was the ingestion of thirty milligrams of psilocybin, which it was concluded was the facilitating agent responsible for the difference in phenomena experienced. This conclusion gave support to the claims made by others who have used psilocybin or similar drugs such as LSD or mescaline to aid in the induction of experiences which are concluded to be not unlike those described by mystics. Such evidence also pointed to the possible importance of biochemical changes which might occur in so-called "non-artificial" mystical experience (especially the effects of ascetic practices).

After and admittedly short follow-up period of only six months, life-enhancing and -enriching effects similar to some of those claimed by mystics were shown by the higher scores of the experimental subjects when compared to the controls. In addition, after four hours of follow-up interviews with each subject, the experimenter was left with the overwhelming impression that the experience had made a profound impact (especially in terms of religious feeling and thinking) on the lives of eight out of ten of the subjects who had been given psilocybin. Although the psilocybin experience was quite unique and different from the "ordinary" reality of their everyday lives, these subjects felt that this experience had motivated them to appreciate more deeply the meaning of their lives, to gain more depth and authenticity in ordinary living, and to rethink their philosophies of life and values. The data did not suggest that any "ultimate" reality was no longer important or meaningful. The fact that the experience took place in the context of a worship service with the use of symbols which were familiar and meaningful to the participants appeared to provide a useful framework within which to derive meaning and integration from the experience, both at the time and later.

The relationship and relative importance of psychological preparation, setting, and drug were important questions raised by our results. A meaningful religious preparation, expectation, and environment appeared to be conducive to positive drug experiences although the precise qualitative and quantitative role of each factor was not determined. For example, everything possible was done to maximize suggestion, but suggestion alone cannot account for the results because of the different experience of the control group. The hypothesis that suggestibility was heightened by psilocybin could not be ruled out on the basis of our experiment. An effort was made to avoid suggesting the phenomena of the typology of mysticism, and the service itself made no such direct suggestion. Psychologists of religion by their interest in psychology and presumed religious sensitivity should be well qualified to study the variables at work here.

Mention was made of the elucidating suggestiveness of our experimental findings for a better psychological understanding of the theological significance of worship and of such doctrines as the efficacy of the sacraments, the Incarnation, the Holy Spirit, the presence of Christ, and *gratia activa*. Questions were raised as to the place of the emotional factor compared to the cognitive in religious worship and as to the validity of mystical experience in terms of religious truth.

The demonstration of at least psilocybin, if not LSD and mescaline by analogy, as a tool for the study of the mystical state of consciousness suggested both further research and implications for the future. Possibilities for research in the psychology of religion with these chemicals were divided into two different kinds in relation to the aim: (1) theoretical understanding of the phenomena and psychology of mysticism and (2) experimental investigation of possible social application in a religious context.

The method suggested for the first or theoretical kind was to approach the mystical state of consciousness as closely as possible under experimental conditions and to measure the effect of variables. Suggestions were given for confirmatory studies of the work already done, additional new experiments, and better techniques of measurement. This dissertation was only a start toward this approach for a better understanding of mysticism form a physiological, biochemical, and psychological perspective.

Several experimental approaches were envisioned for the second kind of research to determine the best method for useful application in a religious context. One suggestion was the establishment of a pilot research center on the model of a religious retreat where carefully controlled drug experiments could be done by a trained research staff which would consist of psychiatrists, clinical psychologists, and ministers. Another suggestion was a study of the effect on small natural groups of four to six people who would meet periodically, both prior to and after a drug experience, for serious personal and religious discussions, Bible study, and worship in the form of prayer and meditation.

It was emphasized, however, that more research is needed at the theoretical level before such pilot research projects should be started because confirmation is first required that personally and socially useful changes in attitude and behavior are facilitated through the administration of these drugs with a meaningful religious preparation and setting. Care and caution were stressed because of the social resistance to be overcome and, most importantly, because of potential dangers involved.

Although relatively rare and not evident in our experimental results, possible harmful effects of the drug experience were discussed, such as, psychological dependence, apathy toward productive work and accomplishment, and suicide or prolonged psychosis in depressed or unstable individuals who would not be able to manage the intense emotional discharge. Research to minimize such dangers was suggested.

With full recognition of the caution and sensitivity which would be required, great promise was seen for future research in this complex and challenging area of the psychology of religion. A plea was made, however, for a serious and thoughtful examination of the sociological, ethical, and theological implications while research on the primary or theoretical level is progressing and before projects for testing useful social application in a religious context become widespread.

Chapter I
INTRODUCTION

Psychology of religion has always been interested in religious experience, and especially such intense forms as conversion and mysticism. Research has had to depend mostly on autobiographical accounts long after the fact. There have been few truly empirical studies which have analyzed these phenomena during or shortly after they have occurred.

With increasing frequency, books and articles have been appearing which make the claim that certain chemical substances (most notably mescaline, lysergic acid diethylamide, and psilocybin) are capable of inducing under appropriate conditions "mystical" or "religious" experience. Such claims have been met with skepticism from many religious people, and rightly so. The evidence presented has been, in most cases, a series of very subjective personal accounts which, while interesting, does not systematically attack the problem or prove the point.

In the first place, "mystical" or "religious" experience is to broad and general a term; it lacks precise definition as to what exactly is meant. One cannot be sure that any two persons are talking about the same thing unless the phenomena are first carefully defined. In the second place, personal accounts and subjective claims do not prove anything without controlled studies to rule out the possibility that these experiences were due to factors other than drugs. Also, such experiences usually occur under a variety of conditions and circumstances in which the number of unknown factors is so complex as to defy differentiation and elucidation. In the third place, an enthusiastic claim made by a person who has had the experience is open to the suspicion of misguided personal bias in the interpretation of what actually occurred.

This investigation was undertaken, therefore, to study in an empirical way the similarities and differences between experiences described by mystics and those induced by these drugs. The research was designed to overcome the three shortcomings which were mentioned above.

(1) A phenomenological typology of the mystical state of consciousness was carefully defined after a study of the writings of the mystics themselves and of scholars who have tried to characterize mystical experience.

(2) Some drug experiences were empirically studied not by collecting such experiences wherever an interesting or striking one might have been found and analyzed after he fact, but by conducting a double-blind, controlled experiment with subjects whose religious background and experience as well as personality were evaluated *before* their drug experiences. The preparation of the subjects the setting under which the drug was administered, and the collection of data about the experiences, were made as uniform as possible.

(3) The experimenter himself conducted the experiment, collected the data, and wrote up the results without ever having had an experience with any of these drugs. Furthermore, the typology by which the drug experiences were measured was constructed before the drug experiment was run.

Before proceeding with a presentation of our typology of mysticism and our experimental evidence, we shall briefly review the historical use of naturally occurring psychedelic[1] substances used in connection with religious practice as well as the literature on so-called "mystical" or "religious" experiences produced by synthetic psychedelic chemicals.

---

1. "Psychedelic" was coined by Dr. Humprey Osmond from the Greek and, literally translated, means "mind-manifesting" or "mind-opening" ("A review of the clinical effects of psychotomimetic agents," *Annals of the New York Academy of Sciences*, Vol. LXVI, [1957], pp. 418-434.) These substances produce changes in the mental state with the retention of mental clarity and awareness. Mescaline, psilocybin, and lysergic diethylamide (or, more simply, LSD) are the best known. Other terms which have been used are: "psychotomimetic," "hallucinogenic," "illusionogenic," "mind-distorting," etc. Although such effects may also occur, these words imply a negative evaluation, whereas the phenomena herein studied were generally regarded positively by those who experienced them.

Chapter II
RELIGION AND PSYCHEDELIC SUBSTANCES: A SURVEY

Data from History, Archaeology, Anthropology, Botany, and Psychopharmacology

Evidence from archaeology and anthropology has indicated that certain plants have been used in connection with rituals and religious ceremonies in the past; and there are groups of people who still employ them for such purposes in order to induce unusual states of consciousness. In some instances, such naturally-occurring substances are taken by a priest, shaman, or witch doctor to induce a trance for divinatory or revelatory purposes; sometimes they are taken by groups of people who are participating in sacred ceremonies.[1] Many of these plants have been found to contain compounds identical with, or closely related to, mescaline, LSD, or psilocybin.[2] From this evidence, some of which he has helped to discover, and from personal experience as a participant observer in certain of these ceremonies, R. Gordon Wasson has proposed the hypothesis that the use of such plants was an important factor in the origin of religious ideas among primitive peoples.[3]

No one knows when "mescal buttons," the spineless heads of the small, gray-green cactus, *Lophophora williamsii*, first began to be used by the Indians of Mexico. But when the Conquistadores arrived, they found that the Aztecs regarded peyote as a sacred plant and used it for ritual dances and curing ceremonies.[4] Some sources indicate that peyote was known and used as a religious sacrament as far back as 300 B.C.[5] The ritual and medicinal use of peyote spread northward to the United States sometime between 1700 and 1880, but there is no agreement as to whether this was by slow diffusion or because of knowledge gained while northern tribes were on warring expeditions into Mexico.[6]

Peyotism in Mexico, with its shamanistic emphasis on curing and divination, tribal dancing, and close association with agriculture and hunting, is compared and contrasted in detail by La Barre with the Mescalero or transitional peyotism of the Southwest and with Plains peyotism.[7] According to Slotkin, by 1885 "the tribal dancing rite had been changed into the form of a religion-like rite of singing, prayer, and quiet contemplation. ... both as a symbol of the spirits being worshiped and as a sacrament."[8] This peyotism of the Plains Indian spread farther northward from tribe to tribe by active proselytization all the way to Canada. The "Peyote Religion" of the Native American Church, which was officially founded in Oklahoma in 1918, has followed the form of Plains peyotism, which combines traditional Indian ritual and symbology with some Christian elements.[9]

The ceremony itself has some important features in common among different groups. The rite is an all-night affair from about 8:00 p.m. on Saturday until about 8:00 a.m. on Sunday. Four or five Indian officials lead the rite which usually takes place in a tipi with a fire in the center. The time is spent in prayer; songs by each participant in turn, accompanied by the water drum; ingestion of the sacramental peyote; and contemplation.

---

1. Richard Evans Schultes, "Pharmacognosy," *The Pharmaceutical Sciences* (Third Lectures Series; Austin, Texas: University of Texas College of Pharmacy, 1960), pp. 142-185.
2. A. Hofmann, "Chemical, Pharmacological, and Medical Aspects of Psychotomimetic," *J. Exper. Med. Sci.*, Vol. V, No. 2 (September, 1961), pp. 32-34.
3. R. Gordon Wasson, "The Hallucinogenic Fungi of Mexico: An Inquiry into the Origins of the Religious Idea among Primitive Peoples," *Botanical Museum Leaflets, Harvard University*, Vol. XIX, No. 7 (1961), pp. 137-162.
4. Weston La Barre, *The Peyote Cult* ("Yale Univ. Publications in Anthropology," No. 19; New Haven: Yale Univ. Press, 1938), pp. 109-110.
5. Bernardino Sahagún, *Historia General de las Cosas de Nueva Espańa*, ed. Carlos Maria de Bustamante, (Mexico, 1829-30), cited by R. E. Schultes, "Peyote - An American Indian Heritage from Mexico," *El Mexico Antiquo*, Vol. IV, No. 5/6 (April, 1938), p. 200.
6. Schultes, *ibid.*, pp. 201-203.
7. Weston La Barre, *op. cit.*, pp. 29-56.
8. J. S. Slotkin, *The Peyote Religion* (Glencos, Ill.: The Free Press, 1956), pp. 34, 28.
9. *Ibid.*, pp. 58, 68-77.

The ritual follows a definite general pattern, but the contents of the individual prayers and songs are spontaneous. At midnight there is a water-drinking ceremony and at dawn, after a ritual "baptism" with water from the drum, a ceremonial breakfast of water, parched corn in sweetened water, fruit, and dried sweetened meat, is eaten.[10]

The ceremony is regarded as very sacred by the participants who feel that peyote aids contemplation by increasing the powers of introspection, sensitizing the conscience, and producing visions of great meaning. Preparation for the rite is taken seriously by the Indians who conduct themselves with due solemnity throughout the ceremony.

Proper ritual behavior includes being physically clean; spiritually pure; and psychologically humble, sincere, and in a mood for concentrated meditation.[11]

White men who have attended these worship services and eaten peyote with the Indians in a receptive way as participant-observers, have confirmed the serious and sacred nature of the ceremony. "I had respect for the ceremony. It was reverent and well conducted."[12] "On a number of occasions, I have taken peyote in Indian ceremonies in Oklahoma, and I must say that I am impressed with the reverence and seriousness of the Indian in the practice of the peyote ceremony, the moral teachings of which are of the highest."[13] "I have never been in any white man's house of worship where there is either as much religious feeling or decorum."[14]

Peyote has been found to contain mescaline and seven other anhalonium alkaloids of the isoquinoline series. One of mescaline's notable effects is the production of richly colored visual imagery.[15]

Another plant used for religious purposes by the Aztecs was called *ololiuqui* and has been identified as the climbing morning glory, *Rivea corymbosa*. The brown seeds were crushed and eaten, usually by an individual rather than by a group, as an aid in divination for lost objects or diagnose and treat disease. The effect was the production of revelatory visions. *Ololiuqui* was held in great veneration and was considered a powerful force in native religious philosophy. The seeds were thought to possess a deity and therefore were called "divine food." These seeds are still used in a sacred way by the Chinantec, Mazatec, Mixtec, and Zapotec Indians of Oaxaca Province.[16]

Badoh negro, the black seeds of another morning glory, *Ipomoea violacea*, have recently been discovered to have a similar ceremonial use in some parts of the Zapotec country.[17]

Both *ololiuqui* and *badoh negro* seeds have been found to contain the same three derivatives of LSD-25 (*d*-lysergic acid diethylamide): (1) *d*-lysergic acid amide, (2) *d*-isolysergic acid amide, and (3) chanoclavine. Of these derivatives, *d*-lysergic acid amide has the most similarity in psychic effects to LSD, but is much weaker on an equivalent-weight basis.[18]

The practice of a sacred-mushroom cult has survived in three parts of the world: Northeastern New Guinea, the mountains of Oaxaca Province in Mexico, and Western Siberia.[19] Not much is known about the New Guinea cultic use, but research is in progress.

---

[10] For a detailed description of the ritual plus diagrams of the arrangement, see Omer C. Stewart, *Washo-Northern Paiute Peyotism*, ("University of California Publications in American Archaeology and Ethnology," Vol. XL, No. 3; Los Angeles; Univ. of California Press, 1944), pp. 99-113; and Weston La Barre, *op. cit.*, pp. 57-92.

[11] J. S. Slotkin, "The Peyote Way," *Tomorrow Magazine*, Vol. IV, No. 3 (1956), pp. 67-68.

[12] H. Osmond, "Peyote Night," *Tomorrow Magazine*, Vol. IX, No. 2 (1961), p. 112.

[13] Schultes, *The Pharmaceutical Sciences*, p. 156.

[14] J. S. Slotkin, "Menomini Peyotism," *The Drug Experience*, ed. David Ebin (New York: Orion Press, 1961), pp. 237-269.

[15] Schultes, *The Pharmaceutical Sciences*, p. 154. For a complete list, with a summary of physiological effects, see La Barre, *op. cit.*, pp. 138-150.

[16] R. E. Schultes, *A Contribution to our Knowledge of Rivea Corymbosa. The Narcotic Ololiuqui of the Aztecs*. (Cambridge: Botanical Museum of Harvard Universtity, 1941.)

[17] R. Gordon Wasson, *op. cit.*, pp. 151-153, citing Thomas MacDougall, "*Ipomoea tricolor*: A Hallucinogenic Plant of the Zapotecs," *Boletin of the Centro de Investigaciones Anthropologicas de Mexico*, No. 6 (March 1, 1960).

[18] Hofmann, *op. cit.*, pp. 38, 46-48.

[19] V. P. Wasson and R. G. Wasson, *Mushrooms, Russia and History* (New York: Pantheon Books, 1957), Vol. II, pp. 215-216.

The sacred mushrooms of Mexico were called *teonanacatl*, "flesh of the gods," by the Aztecs. In 1939 Schultes presented evidence from historical, anthropological, and botanical sources for the existence of such cultic rites.[20] Johnson and his party were the first modern white people to observe, but not participate in, the sacred ceremony, which has survived in Mexico from before the Spanish conquest until the present.[21] In 1957 the Wassons presented a review of all the previous evidence along with their own discoveries. They argued that the pre-Columbian "mushroom stones" which had been found in the highlands of Guatemala really were meant to represent mushrooms as a symbol of the center of a sacred cult. The earliest of these artifacts have been dated about 1500 B.C.[22]

The ceremony itself has been described in detail (with pictures) by the Wassons, who were the first outsiders to partake of the sacred mushrooms in the secret rite, which took place at night and combined ancient Indian religious tradition with some Roman Catholic symbols. The mushrooms are used in different ways in different places in the remote mountains of Oaxaca, but they are always considered sacred and used with solemnity and seriousness. The Wassons have testified in their account to the profound impression which the various ceremonies in which they have participated have made upon them.[23]

Roger Heim, Director of the National Museum of Natural History in Paris, collaborated with the Wassons on later expeditions and classified most of the different sacred mushrooms as species of *Psilocybe*.[24] Hofmann identified and named the active ingredients as psilocybin and psilocin and was later able to synthesize both.[25]

The mushroom ceremonies of the tribes of Western Siberia, in the area of Kamchatka, have not been studied in so great detail as those of the Mexican Indians. It is clear, however, that the *Amanita muscaria* has been used for centuries by shamans prior to ceremonial rituals, to induce oracular and ecstatic trances. These mushrooms are also eaten in group ceremonies, the religious character of which is not so evident.[26] *Amanita muscaria* has been found to contain muscarine and slight traces of bufotenine, but no psilocybin. Although bufotenine in sufficient quantity can affect psychic functioning in a way somewhat resembling psilocybin, there is considerable doubt that there is enough in these mushrooms to account for the effects produced.[27]

Bufotenine has also been identified as an active ingredient of *cohoba* snuff of ancient Hispaniola, and is still used by Indian tribes. The seeds of several species of *Piptadenia*, a tree of South America and the Caribbean Islands, are pulverized and used as snuff to induce a trance-like state for prophesying, clairvoyance, and divination.[28] Also chemically present may be N,N-dimethyltryptamine, which is definitely responsible for the psychic activity of *vinho de Jurumena*, a drink made from the seeds of the closely related leguminose *Mimosa hostilis* and used in the magico-religious ceremonies of the Pancaru Indians in Pernambuco, Brazil.[29]

The Indians of the Western Amazon prepare a magic drink called *ayahuasca*, *caapi*, or *yaje* (equivalent designations), from several species of *Banisteriopsis*, a jungle creeper, or in some areas, *Tetrapterys methystica*.[30] This drink is used in religious manner, for prophecy, divination, the tribal initiation of male adolescents, and sacred feasts.[31]

---

20. Schultes, "Plantae Mexicanas II: The Identification of Teonanacatl, a Narcotic Basidiomycete of the Aztecs," *Botanical Museum Leaflets, Harvard University*, Vol. VII, No. 3 (1939), pp. 37-54.
21. Jean Bassett Johnson, *Elements of Mazatec Witchcraft* ("Ethnological Studies," No. 9; Gothenburg, Sweden: Gothenburg Ethnographical Museum, 1939) cited by Wasson and Wasson, *op. cit.*, p. 237.
22. Wasson and Wasson, *op. cit.*, Vol II, pp. 274-279.
23. *Ibid.*, pp. 287-316.
24. Wasson has listed the technical names and earliest reported sacred or divinatory use of the twenty-four Mexican hallucinogenic mushrooms which had been discovered through 1960. Nineteen out of these twenty-four were classified as species of *Psilocybe*. Wasson and Heim claimed responsibility for the discovery and classification of eighteen out of the twenty-four (R. G. Wasson, *Botanical Museum Leaflets*, Vol. XIX, pp. 159-162).
25. Hofmann, *op. cit.*, pp. 41-45.
26. W. Jochelson, "Religion and Myths of the Koryak," in *Jssup North Pacific Expedition VI* (New York: American Museum of Natural History, 1906), Vol. X, pp. 1-382, cited by Howard D. Fabing, "On Going Berserk: A Neurochemical Inquiry," *Scientific Monthly* Vol. LXXXIII, No. 5 (November, 1956), pp. 232-233. See also a fuller discussion on Wasson and Wasson, *op. cit.*, Vol. I, pp. 190-192, 194.
27. Hofmann, *op. cit.*, p. 34.
28. Schultes, *Pharmaceutical Sciences*, pp. 158-159.
29. *Ibid.*, p. 165.
30. *Ibid.*, pp. 170-179.
31. Robert S. DeRopp, *Drugs and the Mind*, (New York: St. Martin's Press, 1957), pp. 264-69.

There is still debate as to the exact nature of all the chemical compounds which are responsible for the pronounced psychic effects, but it seems very certain that harmine and its analogs, harmaline and *d*-tetrahydroharmine, are actively present.[32]

Bufotenine (5-hydroxydimethyltryptamine) and N,N-dimethyltryptamine are both closely related to psilocybin (4-phosphoryloxy-w-N,N-dimethyltryptamine). Harmine and LSD also contain the same basic indole ring structure. All these compounds have a structural relationship to serotonin (5-hydroxytryptamine) which is found in the brains of warm-blooded animals and which plays an as yet unknown role in psychic functioning.[33]

Data from Clinical Research

Once the active ingredients of these plants were isolated, their chemical structure determined, and a method of synthesis discovered, clinical research on their effects was facilitated. Mescaline was synthesized in 1920;[34] LSD in 1938 (although the mental effects were only discovered accidentally by Hofmann in 1943);[35] and psilocybin in 1958.[36] There was a surge of psychiatric interest on these drugs in the 1950's because many of their effects resembled psychotic symptoms. The drugs became known as "psychotomimetics."

Unger, in a comprehensive review article,[37] has shown how the possibility of rapid and positive personality change in contrast to the production of "model psychosis" began to be explored by some researchers who emphasized the importance of *extra*-drug variables in determining the type of reaction experienced by experimental subjects. These extra-drug factors included preparation and personality of the subject, a trust-filled setting in which the subject felt secure, and the expectation of both the subject and the experimenter. Unger has compared examples from William James' *Varieties of Religious Experience* with some of these experimentally-produced drug experiences.

Some of the researchers have reported that their subjects have tended to describe their drug experiences in mystico-religious language. A group of Canadian investigators, in their research on the treatment of alcoholics with LSD and mescaline, were struck by the resemblance of some of the drug experiences to religious conversions.[38] They also noted that the experiences which seemed to be the most therapeutic as measured by decrease in drinking were the ones which were the most intensely religious or transcendental in nature.[39] Sherwood *et al.*, using a similar method of preparation and administration, in their preliminary report, have described the results of these Canadian workers. Experiences which both the researchers and their subjects regarded as religious were encountered and also tended to be the most beneficial in terms of lasting therapeutic results. These experimenters classified such experiences in the "stage of immediate perception." The nature of the religious and philosophical insights reported by their patients were discussed in the appendix to their paper.[40]

Chandler and Hartman have mentioned the mythological, symbolic, religious, mystical and philosophical content of the experience of some of their subjects.[41]

---

[32] Schultes, *Pharmaceutical Sciences*, p. 179.

[33] Hofman, *op. cit.*, pp. 47-49.

[34] La Barre, *op. cit.*, p. 138.

[35] Hofmann, *op. cit.*, p. 35.

[36] *Ibid*., p. 44.

[37] Sanford M. Unger, "Mescaline, LSD, Psilocybin, and Personality Change: A Review," to be published in *Psychiatry*, Vol. XXVI, No. 2 (1963).

[38] C. M. Smith, "Some Reflections on the Possible Therapeutic Effects of the Hallucinogens." *Quart. J. Stud. Alcohol*, Vol. XIX (1959), p. 293.

[39] N. Chwelos, D. B. Blewett, C. Smith, and A. Hoffer, "Use of LSD-25 in the Treatment of Chronic Alcoholism." *Quart. J. Stud. Alcohol*, Vol. XX, 1959, pp. 580-584. See also Hoffer's comments on their work, at the Josiah Macy Foundation Conference. *The Use of LSD in Psychotherapy* (New York: Josiah Macy, Jr. Foundation Publications, 1960), pp. 114-115. Similar results were reported by J. R. MacLean, *et al.*, "The Use of LSD-25 in the Treatment of Alcoholism and Other Psychiatric Problems." *Quart. J. Stud. Alcohol*, Vol. XXII, 1961, pp. 34-45.

[40] J. N. Sherwood, M. J. Stolaroff, and W. W. Harman, "The Psychedelic Experience - A New Concept in Psychotherapy." *J. Neuropsychiatry*, Vol. IV, No. 2 (Nov.-Dec., 1962), pp. 69-80.

[41] A. L. Chandler and M. A. Hartman, "Lysergic Acid Diethylamide (LSD-25) as a Facilitating Agent in Psychotherapy," A. M. A. *Arch. Gen. Psych.*, Vol. II (1960), pp. 286-299.

Ditman and Whittlesey have recorded the rather numerous religious elements in questionnaire studies of their subjects after the experience. "Those who had a religious orientation, particularly those with a mystical orientation, claimed the most benefit from the experience and found it the most pleasant."[42]

Leary found that even subjects who had no formal interest in religion found religious language most adequate in describing their psilocybin experiences:

> We were dealing rather with the potentialities of expanded consciousness, the state of ego-suspension or self-transcendence. Such ancient concepts as faith, belief, trust, served as the best predictors.
> Another surprising result was the frequent use of religious terminology to explain the reactions. Less than ten percent of our original sample were orthodox believers or churchgoers, yet such terms as "God," "divine," "deep religious experience," "meeting the infinite," occurred in over half of the reports.[43]

Another clinical psychologist, Wilson Van Dusen, likened his LSD experience to the Zen Buddhist experience of *satori*, although his realizations were unexpected in the sense that he had not embarked upon the experience with such an expectation in mind.[44]

Persons already interested in religion or philosophy who have personally had a meaningful drug experience have been struck by the similarity of their experiences with those described by mystics and visionaries from a variety of cultures. Aldous Huxley opened the eyes of many to such a possibility when he described his first mescaline experience in *The Doors of Perception*.[45] Some of the others who have compared their experiences favorably to religious or mystical experience are Watts,[46] Heard,[47] Jordan,[48] Graves,[49] and Dunlap.[50]

Persons who have written in the field of the psychology of religion have been mixed in their reactions to drug-induced experiences as a method of approach to the study of religious or mystical experience. William James felt that in his own experiences with nitrous oxide, he approached closer than at any other time to a mystical state of consciousness. He was also extremely interested in the "anesthetic revelations" of others.[51] In general he judged all religious experiences more by the pragmatic "fruits for life," rather than by their origin, and therefore was open to the study of any phenomenon, regardless of its cause.[52] Stace has termed this "the principle of causal indifference"[53] and has himself included in his major work on mysticism a mescaline experience as a duly-qualifying example.[54]

---

[42] K. S. Ditman, M. Hayman, and J. R. B. Whittlesey, "Nature and Frequency of Claims Following LSD," *J. Nervous Mental Disease*, Vol. CXXXIV (1962), pp. 347-348.

[43] Timothy Leary and Walter H. Clark, "Religious Implications of Consciousness-Expanding Drugs." *Relig. Educ.*, Vol. LVIII, No. 3 (1963), p. 252.

[44] Wilson Van Dusen, "LSD and the Enlightenment of Zen," *Psychologia* (Kyoto), Vol. IV, No. 1 (March, 1961), pp. 11-16.

[45] Aldous Huxley, *The Doors of Perception* (New York: Harpers, 1954). Huxley also stimulated a storm of protest from those who did not agree with him. One of the most immediate and critical attacks was by a Roman Catholic, R. C. Zaehner, in "Menace of Mescaline," *Blackfriars*, Vol. CXXXV (July-August, 1954), pp. 310-321. Zaehner followed this by a scholarly book, *Mysticism, Sacred and Profane: An Inquiry into some Varieties of Praeternatural Experience* (New York: Oxford Univ. Press, 1957). Since 1954, Huxley has continued to expound his position. A good summary of his views are found in his essay "Visionary Experience," in *Clinical Psychology*, ed. G. S. Nielsen (Proceedings of the XIV Int. Cong. of Appl. Psychol., Vol. IV; Copenhagen: Munksgaard, 1962), pp. 11-35.

[46] Alan W. Watts, "The New Alchemy," in *This is It, and Other Essays on Zen and Spiritual Experience* (New York: Pantheon Books, 1960), pp. 127-153. See also his *The Joyous Cosmology: Adventures in the Chemistry of Consciousness* (New York: Pantheon Books, 1962).

[47] Gerald Heard, "Can This Drug Enlarge Man's Mind?" *Horizon Magazine*, Vol. V, No. 5 (May, 1963), pp. 28-31, 114-115.

[48] G. Ray Jordan, Jr., "LSD and mystical experiences," *J. Bible and Religion*, Vol. XXXI, No. 2 (April, 1963), pp. 114-123. This statement is more explicit than his earlier "Reflections on LSD, Zen Meditation, and Satori," *Psychologia* (Kyoto), Vol. V, No 3 (September, 1962), pp. 124-30.

[49] Robert Graves, "A Journey to Paradise," *Holiday*, Vol. XXXII, No. 2, (1962), pp. 36-37, 110-111.

[50] Jane Dunlap, *Exploring Inner Space* (New York: Harcourt, Brace & World, 1961).

[51] *Varieties of Religious Experience* (Modern Library Edition; New York: Random House, 1902), pp. 378-384.

[52] *Ibid.*, p. 21.

[53] W. T. Stace *Mysticism and Philosophy* (Philadelphia and New York: J. B. Lippincott, 1960), pp. 29-31.

[54] *Ibid.*, pp. 71-77.

Leuba had a chapter entitled "Mystical Ecstasy as Produced by Physical Means" in which he discussed the effects produced by alcohol, opium, hasheesh, and peyote, but he considered such experiences as lower forms of mysticism, and did not do any experimental work with these substances.[55] Laski[56] and Walker[57] discuss the issue, but tend to be more interested in, and favorable toward, "natural" experiences than "artificial." Zaehner, referred to in footnote 45, regarded such induced states as much nearer to psychotic than religious experience, and argued for the difference rather than similarity to Christian mysticism. Havens has presented a thoughtful and conservatively favorable review of the problem in relation to the religious experience of Quakers.[58] Clark has suggested the opportunities and challenges which such a research tool provides for future work in a relatively unexplored area in the psychology of religion.[59]

---

[55] J. Leuba, *The Psychology of Religious Mysticism* (New York: Harcourt, Brace, 1925), pp. 8-36.

[56] Margharita Laski, *Ecstasy: A Study of Some Secular and Religious Experiences* (London: The Cresset Press, 1961), pp. 263-273.

[57] Kenneth Walker, *The Conscious Mind: A Commentary on the Mystics* (London: Rider & Co., 1962), pp. 124-140.

[58] Joseph Havens, "Memo to Quakers on the Consciousness-Changing Drugs." (Unpublished.)

[59] Leary and Clark, *op. cit.*, pp. 254-56.

Chapter III
THE DEFINITION OF MYSTICISM

The purpose of this chapter is to define what we meant by the term, mystical state of consciousness. A typology of basic characteristics of mystical experience in the broad sense is developed. The broad sense means a basic typology which is universal and holds true for mystical experience in different cultures and religions. Before defining the typology in detail, we shall discuss mystical experience with regard both to its relationship to religious experience and to the universality of its occurrence.

Mystical Experience in General

The Relationship between Mystical Experience and Religious Experience

A simple identification of religious experience and mystical experience fails to take into account the many definitions of religion. Religions vary in their emphasis upon mysticism, although there is a tendency, especially among psychologists of religion who have been interested in the dramatic and intense phenomena of the mystical experience, to make the mystical element the most important characteristic of religion.[1]

All religious experience is not necessarily mystical in the sense of our definition of mystical experience as given below. Pratt, for example, divides religion into four kinds or aspects, of which the mystical is only one, the other three being the traditional, the rational, and the practical or moral.[2] Even when quite emotionally meaningful, participation in a particular religion by such practices as observance of religious laws, intellectual belief in a certain creed or theology, institutional membership, and attendance at rites and rituals, may not result in or be the product of mystical experience.

On the other hand, all mystical experience is not necessarily religious. Again, of course, much depends on how one chooses to define religion. If one makes the concept of a "personal God" central in the definition of religion, many forms of mystical experience could not be considered religious. The phenomena of mystical experience, for example, may occur outside the framework of any formal religion, with no reference to any articulated theology.

The problem is by-passed or merely indicated, rather than solved, by broadening the definition of religion to include any experience which would qualify as mystical by our criteria. Tillich, for example, considers as religious an experience which gives ultimate meaning, structure, and aim to human experience or in which one is concerned ultimately.[3] Wach gives a similar definition of religious experience as a total and intense existential response to what is experienced as Ultimate Reality (i.e., nothing finite) and adds the practical criterion that the experience must compel to action.[4]

Rather than attempting to define religion and religious experience in order to differentiate precisely the relationship between religious and mystical experience, we have indicated the nature of the problem and the error of loosely speaking of religious and mystical experience as if the two were always synonymous.

---

1. William James reflects this attitude by his preference for religion which is an "acute fever" rather than a "dull habit" (*op. cit.*, p. 8).
2. J.B. Pratt, *The Religious Consciousness: A Psychological Study* (New York: Macmillan, 1921), p. 14. Compare a similar discussion of the elements of religion by R. M. Thouless, *An Introduction to the Psychology of Religion* (Cambridge: Cambridge University Press, 1956), pp. 12-15. Pratt includes all four divisions in his definition of religion, which is as follows: "the serious and social attitude of individuals or communities toward the power or powers which they conceive as having ultimate control over their interests or destinies" (*op. cit.*, p. 2). Note Thouless's similar definition of religion: "a felt practical relationship with what is believed in as a superhuman being or beings" which are "felt to be greater than man or may be looked up to by him" (*op. cit.*, p. 4).
3. Paul Tillich, *Systematic Theology* (Chicago: University of Chicago Press, 1951), Vol. I, pp. 11-14. It is Tillich's opinion that what is truly ultimate can be best symbolized by Jesus who is called the Christ, in Christian theology (pp. 15-18).
4. Joachim Wach, *The Comparative Study of Religions*, (Columbia Paperback Edition; New York: Columbia University Press, 1961), pp. 30-36. See also his important work, *Types of Religious Experience: Christian and Non-Christian* (Chicago: The University of Chicago Press, 1951), pp. 32-33.

Our attention will be focused upon the nature of the mystical experience, whether the experience be religious or not.

The Universality of the Characteristics of Mystical Experience

Many of the well-known commentators on and analysts of mystical experience have made the presupposition that there are certain fundamental characteristics of the experience itself which are universal and are not restricted to any particular religion or culture, although particular cultural, historical and religious conditions may influence both the understanding and the description of the essential mystical experience.

James lists four common or universal characteristics of mystical experience: (1) ineffability, or the feeling that the experience cannot adequately be expressed with words; (2) noetic quality, or the certainty that the knowledge gained as insight is true; (3) transiency, or the impermanence of the mystical state; (4) passivity, or the feeling that one is not acting but, rather, being acted upon.[5] His examples range from persons with no particular religious allegiance to minks and nuns, but the cases in his series possess these common characteristics. Pratt provides a broad and universal definition of mysticism as a consciousness of Beyond, or the sense or feeling of the presence of a being or reality, via other means than sense perception or reason.[6] He distinguishes between mild and extreme types. The mild is characterized by (1) ineffability, (2) noetic certainty, especially of the presence of the Beyond, and (3) joy and calm.[7] The extreme type is exemplified by the unitive state of ecstasy which includes the phenomena of (1) suddenness, (2) passivity, (3) loss of sense impressions of the outside world, (4) noetic insight or knowledge or acquaintance which combines feeling and cognitive intuition, (5) ineffability, (6) immediate intuition of the Beyond, or God's presence, and (7) intense, ecstatic joy and love.[8] He takes his examples from both Eastern and Western sources.

Bucke has collected cases from various times and cultures with the following universal criteria of cosmic consciousness": (1) suddenness or instantaneousness, (2) photism or subjective light, (3) moral elevation, with an emotion of joy, assurance, and triumph, (4) ineffable intellectual illumination, (5) sense of immortality, (6) loss of the fear of death, (7) loss of the sense of sin, (8) usual occurrence between the ages of 30-40, and (9) added charm to the personality after the experience.[9]

Underhill gives four universal tests which must be satisfied by any example of true mysticism and which penetrate behind the particular descriptive symbolism employed.[10] For her mysticism must: (1) be an organic life-process in which the whole self is involved in an active, practical, and intense experience (this in contrast to an intellectual opinion which can be merely passive and theoretical), (2) have a wholly transcendental and spiritual aim (i.e., the mystic is interested in a realm of ultimate reality, the changeless One, beyond ordinary, everyday reality); (3) know this One not merely as the Reality of all that is, but also as a living personal object of Love which draws one's whole being under the guidance of the heart - love is defined as the driving power and deep-seated desire of the soul toward its Source and is "the ultimate expression of the self's most vital tendencies";[11] (4) have a Living Union with this One involving the liberation of a new, or rather latent, form of consciousness which is called "ecstasy" or better, the Unitive State.

Clark also makes the assumption that there are universal characteristics of the mystical state of consciousness. He lists and comments upon those mentioned by James and Underhill and adds (1) that "the language of mysticism makes extensive use of figures of speech and paradox,"[12] (2) that the mystics "regard what the ordinary man considers the Real as the Unreal, and what the ordinary person considers the Unreal as the Real"[13] and (3) that the mystic has a "tendency toward extravagance in behavior" which expresses his "desire for integration of the psychic life."[14]

---

[5] James, *op. cit.*, pp. 371-372.
[6] Pratt, *op. cit.*, pp. 337-341.
[7] *Ibid.*, pp. 346-362.
[8] *Ibid.*, pp. 394-429.
[9] R. M. Bucke, *Cosmic Consciousness: A Study in the Evolution of the Human Mind* (Philadelphia: Innes & Sons, 1901), pp. 60-62.
[10] E. Underhill, *Mysticism: A Study in the Nature and Development of Man's Spiritual Consciousness* (New York: Meridian, 1955), pp. 81-94.
[11] *Ibid.*, p. 85.
[12] W. H. Clark, *The Psychology of Religion: An Introduction to Religious Experience and Behavior* (New York: Macmillan, 1955), pp. 81-94.

Johnson universally defines mystical experience as the state of illumination in which the sense of separateness, of individuality, is to a great degree lost and which has positive significance, value, and certainty for the experiencer.[15] Such experiences are divided into the slighter and the more profound types. He finds the following four common features of the slighter type:

> (a) The illumination or radiance which is seen to infuse everything 'without' is felt to come from 'within.' (b) The sense of belonging to a new and greater unity is always felt. That which is seen forms a part of a larger whole (c) The emotional tones are always supremely attractive: pulsing light, livingness, joy, peace, happy wonder. Through them, and interwoven, is an enormously enhanced sense of the supreme values, and the most adequate description usually seems to the experiencer to be a 'revelation of God.' (d) Words fail to express the experience, and the terms used are known to be only symbols and analogies.[16]

He lists the universal features of the more profound type in two groups:

> 1. Those who have had the more profound type of mystical experiences, no matter in what age or to what race or creed they have belonged, tell us the *same* fundamental things: the sense of separateness vanishes into an all-embracing unity, there is certain knowledge of immortality, there is an enormously enhanced appreciation of values, and there is knowledge that at the heart of the universe is Joy and Beauty. This unanimity of testimony is quite remarkable.
> 2. Those who have known such an experience are always profoundly impressed by its significance as a revelation of truth. There is from then onwards, not the satisfaction of an intellectual answer to life's ultimate questions, but a serenity born of the knowledge that all is well, and that the secret purpose of the universe is good beyond all telling.[17]

Johnson quotes experiences which are described in traditional religious language as well as those which do not mention orthodox religious symbols yet still have the universal phenomenology covered by his description.
Walker considers the mystical consciousness a state of Universal Consciousness which is a higher level than the usual self-consciousness of everyday existence. Characteristics include an intuitive, experiential realization that "the small individual self has *always* been a part of the great Universal Self," a "melting away of the individual 'self' into 'boundless being'"[18] and "a world completely *outside* of time."[19] His chief examples are Edward Carpenter, Wordsworth, Sri Aurobindo, R. M. Bucke, Jacob Boehme, H. G. Wells, Plotinus, Meister Eckhart, and his own personal experience. His quote from Ouspensky demonstrates his own presupposition and that of the other writers mentioned above:

> If we follow neither the religious nor the scientific views, but try to compare descriptions of the mystical experiences of people of entirely different races, of different periods and of different religions, we shall find a striking resemblance amongst these descriptions, which can in no case be explained by similarity of preparation, or by any resemblances in ways of thinking and feeling. In mystical states, utterly different people, in utterly different conditions, *learn* one and the same thing, and what is still more striking, in mystical states there is no difference of religion. All the experiences are absolutely identical: the differences can be only in the language and in the form of discipline.[20]

---

[13] *Ibid.*, p. 273.
[14] *Ibid.*, pp. 274-275.
[15] R. C. Johnson, *The Imprisoned Splendor: An Approach to Reality, based upon the significance of data drawn from the fields of Natural Science Psychical Research and Mystical Experience* (New York: Harper, 1953), pp. 300-302.
[16] *Ibid.*, pp. 324-325.
[17] *Ibid.*, pp. 320-321.
[18] Walker, *op. cit.*, p. 40.
[19] *Ibid.*, p. 41.
[20] *Ibid.*, pp. 92-93, quoting from P. D. Ouspensky, *A New Model of the Universe* (London: Routledge & Kegan Paul, 1937), p. 51.

Although Suzuki doesn not make the claim that the *satori* experience is the same as other mystical states of consciousness, his description has many of the same universal characteristics given by other writers on mysticism: (1) irrationality which defies intellectualization, conceptualization, or logical explanation, (2) intuitive insight, (3) authoritativeness or finality, (4) affirmation or positive acceptance of all things that exist, (5) sense of the beyond or a melting away into something indescribable and of quite a different order than that to which one is accustomed, (6) impersonal tone, (7) feeling of exaltation, (8) momentariness - abruptness and transitoriness.[21]

W. T. Stace in *Mysticism and Philosophy* has surveyed the mystical literature to make his case for the universality of the basic phenomena of mystical experience. He has given examples from the writings of those who have personally experienced mystical states of consciousness to support what he calls the universal core of mystical experience. He has distinguished between introvertive and extrovertive types which both "culminate in perception of, and union with, a Unity or One though this end is reached through different means in the two cases."[22] He has listed seven characteristics of each type but five of the seven are the same. These five common elements are:

1. Sense of objectivity or reality, (comparable to James' noetic quality which leads to certainty of the objective reality of what is learned in the experience).
2. Feelings of blessedness, joy, peace, happiness, satisfaction, etc.
3. Feeling that what is apprehended is holy, divine, and sacred.
4. Paradoxicality.
5. Alleged by mystics to be ineffable.[23]

The introvertive type as the name suggests is inner-directed and its essence is the experience of undifferentiated unity which is "... the Unitary Consciousness, from which all the multiplicity of sensuous or conceptual or other empirical content has been excluded, so that there remains only a void and empty unity."[24] The Unitary Consciousness is by definition nonspatial and nontemporal. The extrovertive type is outer-directed and is experienced through the physical senses in or through the multiplicity of objects. The essential characteristic for this type is "... the unifying vision expressed abstractly by the formula 'All is One.'" The One is apprehended "... as being an inner subjectivity in all things, described variously as life, or consciousness, or a living Presence."[25] Spatiality is paradoxically preserved, but the normal sense of time may be lost.

The extrovertive and introvertive are not mutually exclusive and may occur in the same mystic.[26] Stace shows how Meister Eckhart is an example of this.[27] Brinton's study of Jacob Boehme supports Stace's point. Boehme harmonized the in-going and out-going wills by going from one goal to the other and back in a kind of dynamic equilibrium.[28] Stace maintains that although the extrovertive and the introvertive One are experienced in different ways, they are identical.[29]

Primary Experience versus Interpretation

After a general discussion of the problem of the universal core Stace quotes the writings of representative mystics from a wide variety of cultures to substantiate the extrovertive and introvertive types and each of them common characteristics. He always tries to reach behind individual interpretations which he feels are conditioned by various theological and intellectual frames of reference, to the raw experience itself. Again and again he emphasizes his distinction between primary phenomenology and interpretations conditioned by culture. He feels that his characteristics of the universal core are the basic phenomenology of mystical experience stripped bare of interpretation.[30]

---

[21] D. T. Suzuki, *Zen Buddhism: Selected Writings of D. T Suzuki*, ed. William Barrett (Doubleday Anchor Edition; Garden City, New York: Dobleday, 1956), pp. 103-108.
[22] Stace, *op. cit.*, p. 62.
[23] *Ibid.*, pp. 13-132.
[24] *Ibid.*, p. 110.
[25] *Ibid.*, p. 79.
[26] *Ibid.*, pp. 63-65.
[27] *Ibid.*, pp. 98-99.
[28] H. H. Brinton, *The Mystic Will: Based on a Study of the Philosophy of Jacob Boehme* (New York: Macmillan, 1930), p. 21.
[29] *Ibid.*, p. 152, 273-274.

Stace's distinction between the primary experience and the interpretation is either stated or implied by other writers who attempt to abstract general characteristics of the mystical experience from the phenomenological accounts thereof. Some examples are as follows:

> Such symbolism as this - a living symbolism of experience and action, as well as of statement - seems almost essential to mystical expression. The mind must employ some device of the kind if its transcendental perceptions - wholly unrelated as they are to the phenomena with which intellect is able to deal - are ever to be grasped by the surface consciousness. Sometimes the symbol and the perception which it represents become fused in that consciousness, and the mystic's experience then presents itself to him as 'visions' or 'voices' which we must look upon as the garment he has himself provided to veil that Reality upon which no man may look and live. The nature of this garment will be largely conditioned by his temperament - as in Rolle's evident bias toward music, St. Catherine of Genoa's leaning toward the abstract conceptions of fire and light - and also by his theological education and environment. Cases in point are the highly dogmatic visions and auditions of St. Gertrude, Suso, St. Catherine of Siena, the Blessed Angel of Foligno; above all of St. Teresa, whose marvellous self-analyses provide the classic account of these attempts of the mind to translate transcendental intuitions into concepts with which it can deal. (underlinings mine)[31]
>
> We must however, be careful to distinguish between the content of the intuition which takes place during the ecstasy, and the truths which the mystic comes to believe as a result of reflecting upon his experience.[32]
>
> I recognize the fact that those who have enjoyed mystical experiences are likely to describe them afterwards in terms of their own religion, and that this entails their making use of the terminology and the beliefs of the religion in which they happen to have been brought up.[33]
>
> This mystical experience, in its essential aspects as *experience*, is pretty much the same through the centuries and in all lands. What accounts for the historical *types* is, there fore, not the nature of the experience as such is, therefore, not the nature of the experience as such, but the prevailing theological or metaphysical conceptions of the time and place, which color the *expectation* of the given mystic, and form the background setting through which he interprets his illumination.[34]
>
> The fact is that the mystical feeling of enlargement, union, and emancipation has no specific intellectual content whatever of its own. It is capable of forming matrimonial alliances with material furnished by the most diverse philosophies and theologies, provided only they can find a place in their framework for its peculiar emotional mood.[35]
> As far as the psychology of satori is considered, a sense of the Beyond is all we can say about it; to call this the Beyond, the Absolute, or God, or a Person is to go further than the experience itself and to plunge into a theology or metaphysics.[36]

It is recognized that not all writers on mysticism accept the presupposition that mystical experience has a universal core which is basically the same but which is interpreted differently according to time, place, personality, and culture. We are not speaking of Rudolph Otto who in *Mysticism, East and West* might seem to

---

30. See especially pp. 62-133, 153-182.
31. Underhill, *op. cit.*, pp. 78-79. See also her *Essentials of Mysticism* (Dutton Everyman Paperback Edition; New York: E. P. Dutton, 1960), pp. 4, 18-19.
32. Pratt, *op. cit.*, p. 407.
33. Walker, *op. cit.*, pp. 156-157.
34. Rufus Jones, *The Radiant Life* (New York: Macmillan, 1944), p. 100.
35. James, *op. cit.*, pp. 416-417.
36. Suzuki *op. cit.*, p. 106.

take the position that mysticism is *not* fundamentally one and the same, and therefore, that the essence of the experience is not independent of circumstances and conditions. For example, he says:

> It is still very generally held that mysticism, however diverse the sources from which it springs is fundamentally one and the same, and as such is beyond time and space, independent of circumstances and conditions. But this seems to me to contradict the facts. Rather, I hold that, in spite of the similarity of terms, which can be surprising enough, there is a diversity in mystical experience which is not less than that of religious feeling in general.[37]

Diversity which he emphasizes here is the variety of expression or interpretation. For example: he distinguishes between the soul-mysticism of Yoga and Buddhism and the God-mysticism (mysticism of union) of Theism.[38] He points to subtle differences between Eckhart and Sankara in use of metaphors and ethical content reflected in doctrines of salvation, justification, sanctification, and grace as well as in valuating of the world.[39] He devotes the longest part of his discussion, however, to a comparison of their similarities, both in regard to their experiences and to their metaphysical speculations.

In terms of Stace's position, these differences are mainly differences of interpretation or intellectual expression rather than of the primary experience itself. In fact, Otto also makes this distinction when he gives the conclusions of his study:

> We maintain that in mysticism there are indeed strong primal impulses working in the human soul which as such are completely unaffected by differences of climate, of geographical position or of race. These show in their similarity an inner relationship of types of human experience and spiritual life which is truly astonishing. Secondly, we contend that it is false to maintain that mysticism is always and everywhere one and the same quantity. Rather, there are within mysticism many varieties of expression which are just as great as the variations in any other sphere of spiritual life, be it in religion generally, or in ethics or in art. (underlining mine)[40]

Many of Stace's categories are illustrated as basic to the experience of both Eckhart and Sankara even when Otto is trying to show their metaphysical differences. For example, the introvertive and extrovertive types are discussed by Otto as "the two ways: the mysticism of introspection and the mysticism of unifying vision" which interpenetrate and become one in both Sankara and Eckhart.[41] Both describe an experience of unity with a losing of self and a submergence into the absolute, unqualified, one divinity.[42] The category of objectivity and reality is illustrated by the discussion of their common intuitive mystical knowledge.[43] Both hold to a metaphysical theism which resulted from a personal experience of the holy, sacred, and divine.[44] Both give evidence of the experience of the exalted feeling of mystical, numinous rapture, although Otto feels that Eckhart also paradoxically emphasizes humility as result of the experience of numinous majesty.[45]

The Otto of *The Idea of the Holy* is closer to Stace's approach because here Otto describes the phenomenology of what he calls the "characteristic notes of mysticism in all its forms, however otherwise various in contents."[46] The universal features he lists are (1) annihilation of the self or rejection of the delusion of selfhood by means of a consciousness of the transcendent as the sole and entire reality[47] and (2) "Identification in different degrees of completeness, of the personal self with the transcendent Reality ... the Something that is at once supreme in power and reality and wholly non-rational."[48]

---

[37] R. Otto, *Mysticism East and West: A Comparative Analysis of the Nature of Mysticism* (Living Age Edition; New York: Meridian, 1957), p. 139. See also pp. 162, 165, 168, 206.
[38] *Ibid*., pp. 142-146.
[39] *Ibid*., pp. 181-211.
[40] *Ibid*., p. XVI.
[41] *Ibid*., pp. 38-69.
[42] *Ibid*., p. 166.
[43] *Ibid*., pp. 35-67.
[44] *Ibid*., pp. 103-136.
[45] *Ibid*., pp. 181-182.
[46] R. Otto, *The Idea of the Holy: An Inquiry into the non-rational factor in the idea of the divine and its relation to the rational* (Galaxy Edition; New York: Oxford University Press, 1958), pp. 21-22.
[47] *Ibid*., p. 21.

R. C. Zaehner clearly does not agree with Stace's argument for the universal core and in *Mysticism, Sacred and Profane* argues against such a view throughout.[49] Zaehner goes one step beyond Otto's analysis by stating: "But there is not only a difference in tone between Eckhart and Sankara, which Otto himself fully brough out; there is obviously a fundamental difference in the experiences which must have formed the basis of the two men's writings" (underlining mine).[50] In his analysis of mystical experience Zaehner distinguishes three types which he insists are quite distinct: (1) the pan-en-henic (all-in-one) experience found especially in nature mystics, (2) the Atman-Brahman union of the individual self with the Absolute (in this experience the phenomenal world is superceded), and (3) Christian theistic mystical union with God by love (in this experience the self remains a distinct entity.).[51]

Zaehner admits his own Roman Catholic bias.[52] He implies that Christian theistic mysticism at its best is true supernatural union with God, whereas the Atman-Brahman experience, although theistic, reaches only self-isolation in rest and emptiness within the self. For him the pan-en-henic experience is definitely inferior to either of the other two, because to admit that nature mysticism is a form o union with God would be pantheism and would identify God with the evil in nature.[53]

The pan-en-henic and Atman-Brahman types correspond to Stace's extrovertive and introvertive experiences of unity with the One, although he would maintain that the same One or Absolute was being experienced in both types.[54] Stace argues that the Atman-Brahman and Christian theistic types represent the same basic experience and that culture and individual conditioning account for the apparent differences.[55] Here again Stace insists that interpretation not be confused with the primary experience.

No one would deny that there are many varieties of expression and interpretations of mystical experience. This study is not an attempt to settle the debate as to whether there is a universal core of primary experience interpreted differently because of differences in cultural situation and individual conditioning or whether there are many varieties of expression and interpretation because different cultural situations and individual conditioning actually produce different experiences which have no universal, basic core of identity. The former position is taken as our presupposition on the basis of the work of Stace and the others mentioned above.

As a tool of evaluation for the empirical data from drug experiences, a typology of the phenomenology of mystical experience is developed below. Stace's position has been used as a presupposition in two ways. First, his list of the basic characteristics of the universal core of mystical experience has been used as a framework which has been enriched and expanded from other thinkers who have dealt with the same problem. Second, his distinction between primary experience and the interpretation of this experience points toward an ideal of phenomenological analysis. The reservation must be added that perhaps it is impossible ever to reach pure uninterpreted experience.

---

[48] *Ibid*., p. 22.
[49] The first part of the final chapter gives a clear statement of his position (*op. cit*., pp. 198-199).
[50] *Ibid*., p. 182.
[51] *Ibid*., pp. 28-29.
[52] *Ibid*., p. XII.
[53] *Ibid*., p. 200.
[54] Stace, *op. cit*., p. 152.
[55] *Ibid*., p. 97 (footnote 44).

Phenomenological Typology of Mystical States of Consciousness

Category I: Unity

Category of unity is divided into internal and external types, which are different ways of experiencing and undifferentiated unity. The major difference is that internal unity is experienced through an "inner world" *within* the experiencer, and external unity is perceived with the senses through the external world *outside* the experiencer.[56] The experiences themselves are phenomenologically different. Both are experiences of unity and therefore are listed as subcategories.

Internal Unity

The essence of internal unity is the direct experience of an undifferentiated unity. This unity comes with the loss of the multiplicity of all particular sense impressions. There is a fading or melting away into pure awareness with no empirical distinctions or particular content except the awareness of the unity itself.[57] One is beyond the self-consciousness of sense impressions or empirical ego, yet one is not unconscious, but very much aware of the undifferentiated unity. There is a loss of the sense of finite selfhood and personal separate identity, but experience is not extinguished: it has its content the pure awareness of the empty, yet full and complete unity. During the experience there is a dissolution of individuality with no internal or external distinctions, yet the person is aware of the experience.[58] After the experience such a phenomenon can be remembered. Such a non-empirical, inner experience is by definition non-temporal and non-spatial.[59]

These phenomenological descriptions contain several paradoxes which Stace maintains are necessary in order to give as adequate a representation in words as is possible of an experience which the mystics allege to be ineffable. He calls the loss of the empirical ego with the retention of awareness of the unity one example.[60] The undifferentiated unity itself is called empty, yet full and complete; is considered both impersonal and personal; is experienced both as totally inactive, static, and motionless and as dynamic, creative, and active. Stace calls this the vacuum-plenum paradox referring to the negative and positive aspects respectively. These aspects are not mutually exclusive, but one side may be emphasized more than the other due to culture, personality, and intellectual frame of reference. Stace gives examples from representative mystics of the world.[61]

Such a discussion of paradox involves the question of interpretation. Interpretations are handles with which to get a hold on and deal with the experience conceptually. We are interested chiefly in the universal core of primary experience. Some mention, however, of the various interpretations which different mystics have used to integrate their experiences into their philosophies of life or theological frameworks is necessary in order to recognize the basic experience more easily.

According to Stace, the closest to the pure experience of internal unity with no interpretation added is the Hinayana Buddhist experience of Nirvana which is revealed and participated in when the stream of ordinary conscious states is gradually stopped. Nirvana "transcends both the individual consciousness and the space-time world."[62] Hinayana Buddhism stops with this experience of pure undifferentiated unity and makes no interpretation of what this experience is other than to call it Nirvana. The mystical traditions of all the other higher cultures go at least one step further and interpret this unity as the pure ego or the unity of the self. The Samkhya, Yoga, and Jaina philosophies stop here, but other cultures then push the interpretation and identify the pure undifferentiated unity which is reached after transcendence of the usual sense of self or empirical ego with something greater-than-self or all-encompassing.[63]

---

56. Internal and external unity correspond to Stace's introvertive unitary consciousness and extrovertive unifying vision, respectively (*op. cit.*, pp. 63-133.
57. Stace, *op. cit.*, pp. 86-87.
58. *Ibid.*, pp. 111-123, 245.
59. *Ibid.*, p. 110.
60. *Ibid.*, pp. 224-245.
61. *Ibid.*, pp. 163-178.
62. *Ibid.*, p. 127.
63. *Ibid.*, pp. 123-127.

Suzuki describes the *satori* or enlightenment experience of Zen Buddhism as a dissolution of the usual sense of individuality by melting "away into something indescribable, something which is of a quite different order from what I am accustomed to."[64] It is this something of a quite different order which has received many names. For example, for Tennyson, "individuality itself seemed to dissolve and fade away into boundless being." (underlying mine)[65] For Koestler, "the I ceases to exists because it has, by a kind of mental osmosis, established communication with, and been dissolved in the universal pool."[66] J. A. Symonds, the nineteenth century man of letters, called this underlying or essential consciousness "a pure absolute, abstract Self."[67] Plotinus described the state of simple unity as a merging with the Supreme or the One.[68] It is Stace's opinion that the Hinduism of the Upanishads and the advaita Vedanta identify the pure ego with the Universal or Cosmic Self (Brahman or the Absolute)[69] and that Mahayana Buddhism uses the concept of Sunyata or the pure Void for the same basic experience.[70]

According to Stace, orthodox Islam, Christianity and Judaism have emphasized the transcendence of God and condemned pantheism or identity with God as heresy. Their mystical traditions reflect this emphasis and regard the experience of unity as something less than identity with God.[71] In the Sufi mysticism of Islam, *fana* (passing away or melting away into the Infinite is correlative to baga, "which means the survival in God of the soul which has experience fana."[72] Orthodox Christian mysticism uses such terms as union with God, the Divine Unity, or spiritual marriage, but is careful to qualify such statements with the explanation that "the individual soul does not wholly pass away into God, but remains a distinct entity."[73] Stace regards Judaism as the least mystical of all the great world religions. Judaism insists on the greatest gulf between creature and Creator, yet does not rule out relationship between the individual and God. The Haisidic mystics are closest in phenomenological description to an experience of internal unity, but Stace does not consider them the major trend in Judaism.[74]

With the example of Martin Buber, the Jewish philosopher, we come back to the basic experience, free from interpretation.

> "Now from my own unforgettable experience I know well that there is a state in which the bonds of the personal nature of life seem to have fallen away and we experience an undivided unity." (underlining mine)[75]

Stace points out how Buber at first interpreted this experience as "union with the primal being or the God-head," but that later he repudiated this interpretation and chose to understand his experience as "the basic unity of my own soul ... certainly beyond the reach of all the multiplicity it has hitherto received from life ... though not in the least beyond individuation ... and not 'the soul of the All.'" Such a position shows similarities with Hinayana Buddhism in the basic phenomenology of the experience and the refusal to interpret the experience beyond the self. Buber's Jewish background may well be the reason for his repudiation of his initial interpretation, as Stace suggests, but his basic experience of undivided unity still remains.[76]

Various metaphorical expressions occur in descriptions of this state of internal unity and can be classified according to which side of the vacuum-plenum paradox they belong.

---

64. Suzuki, *op. cit.*, p. 105.
65. Stace (*op. cit.*, p. 119) cites this example which James (*op. cit.*, p. 374) quoted from Tennysons' letter to Mr. B. P. Blood (no reference given).
66. A. Koestler, *The Invisible Writing* (New York: MacMillan, 1954), p. 352, quoted in Stace, *op. cit.*, pp. 120-121.
67. Stace, *op. cit.*, p. 91, uses this example from James, *op. cit.*, p 376, who quotes it from H. F. Brown, *J. A. Symonds, A Biography* (London, 1895), pp. 29-31.
68. Stace, *op. cit.*, pp. 104-105, citing from Plotinus, *Works* (trans. by Stephen MacKenna; New York Medical Society, n.d.), Enneads VI, IX, XI.
69. Stace, *op. cit.*, p. 120.
70. *Ibid.*, pp. 107-109.
71. *Ibid.*, p. 113.
72. *Ibid.*, p. 115. Stace uses as his authority, R. A. Nicholson, *Studies in Islamic Mysticism* (London, n.d.), p. 66.
73. Stace, *op. cit.*, p. 114.
74. *Ibid.*, p. 157-158.
75. Martin Buber, *Between Man and Man* (London: Routledge & Kegan Paul, 1947), pp. 24-25, cited by Stace, *op. cit.*, p. 155.
76. Stace, *op. cit.*, pp. 156-157, quoting from Buber, *op. cit.*, pp. 24-25.

The vacuum or negative side includes nouns as emptiness, darkness, nothingness, void, abyss, silence, stillness, nakedness, nudity, or desert; and such adjectives as contentless, imageless, numberless, formless, wayless, fathomless, soundless, spaceless, or timeless. The plenum or positive side includes such nouns as fullness, completeness, brightness, light, oneness, perfection, or pureness; and such adjectives as harmonious, infinite, limitless, or boundless. Both sides are needed to give a complete picture of the basic experience and sometimes they are paradoxically joined in the same metaphor.[77]

Other writers on mystical experience besides Stace have described the phenomena of internal unity as an important characteristic of the mystical state.

> The central aspect of it (genuine mystical experience) is the fusion of the self into a larger undifferentiated whole.[78]

Underhill says the following in her account of the state of mystical ecstasy:

> In this experience the departmental activities of thought and feeling, the consciousness of I-hood, of space and time - all that belongs to the World of Becoming and our own place therein - are suspended. The vitality which we are accustomed to split amongst these various things, is gathered up to form a state of 'pure apprehension': a vivid intuition of - or if you like conjunction with - the Transcendent.[79]
> Self-mergence, then - that state of transcendence in which ... the barriers of selfhood (are) abolished ... is the secret of ecstasy.[80]

Others do not give as precise a phenomenological description as Stace, but the similarity is apparent. Pratt describes the unity as a state of consciousness in which the outside world is shut out and the senses are closed.[81]

Johnson states that "the highest mystical experiences show that the Spirit of man, his true Self, lies beyond this (usual sense of selfhood) and is normally veiled from the Ego ... The essence of mysticism is the glimpsing of the true Self by the Ego." In the highest state when all the "veils" are stripped away, "there is complete blissful unity in the One, the Impersonal, the Absolute."[82] Walker's mention of "the melting away of the individual 'self' into 'boundless being'" (underlining mine) is similar to the passages quoted from Suzuki and Tennyson above.[83]

Stace classifies the experiences of Tennyson and Koestler (see quotes above) as incomplete examples of internal unity because they din not *completely* experience undifferentiated unity. There was not a total loss of extraneous sense impressions or complete certainty of the loss of individuality, and there fore, not truly *pure* awareness.[84] Such a distinction is an attempt to be very precise, but if some of the mystics which Stace uses as examples of the complete experience could have been questioned as Koestler was, perhaps their experiences, too, would have to be categorized as incomplete. However, this distinction between complete and incomplete can be used as a general guide when other statements which might be included under the subcategory of internal unity are examined. For example, the consciousness of "Beyond" as described by Pratt[85] and Clark[86] or the awareness of a "More" with which one's higher self is coterminous and continuous as discussed by James[87] is not alone sufficient for internal unity without also the loss of sense impressions and pure awareness.

---

77. Stace, *op. cit.*, pp. 299-301.
78. Rufus Jones, *The Inner Life* (New York: Macmillan, 1916), p. 185.
79. Underhill, *Mysticism*, p. 367.
80. *Ibid.*, p. 373.
81. Pratt, *op. cit.*, pp. 396-397.
82. Johnson, *op. cit.*, pp. 331-332.
83. Walker *op. cit.*, p. 40.
84. Stace *op. cit.*, pp. 119-123.
85. Pratt, *op. cit.*, pp. 337-341, 412-413.
86. Clark, *op. cit.*, p. 263.
87. James, *op. cit.*, pp. 498-499.

Although such phenomena are certainly very close to internal unity and can form a valid part of the complete experience, alone they are not enough. Similarly the boundaries of the personal self of usual experience may be partially broken down or dissolved within the self without complete loss of all distinctions and the emergence of pure awareness.

Also the kind of loss of sense of self which results in unconsciousness as in sleep or coma is not the same as the paradoxical dissolution of the self in internal unity. Without the phenomena which includes the essential experience of undifferentiated unity, these experiences are characteristic only of an incomplete form of internal unity.

In summary, there are both complete and incomplete forms of the basic introvertive experience of internal unity, and there are various metaphors and ways of interpretation. The essence of the experience stripped bare of all interpretation is a direct, conscious experience of undifferentiated unity in pure awareness when all sense impressions fade or melt away and the empirical ego is transcended.

The state then attained is called by various names in the major mystical traditions: Nirvana, the Void, the Pure Self, the Universal or Cosmic Self, the Absolute, the One, or union, bond, or contact with God. But here interpretation begins and basic phenomenological analysis ends.

External Unity

Unity may also be experienced through the physical senses as an underlying oneness behind the empirical multiplicity of the external world. The sense of oneness with external objects (inanimate or animate) is the essence of this subcategory. The observer or subject feels that the usual separation between himself and an object is no longer present, yet the subject still knows that his individuality is retained. In spite of the empirical multiplicity of objects, which are still perceived as separate, the subject-object dichotomy is nevertheless in a paradoxical sense dissolved. On one level the objects are separate, yet at the same time at another and more basic level they are one with the subject.[88] Another way of expressing this phenomenon is to say that the essences of objects are experienced intuitively while their outward forms are experienced through the senses. At the deepest level the essence or inner reality of all things is felt to be one.[89] The subject feels a sense of oneness with these objects, because he "sees" that at the most basic level all are a part of a single unity.[90] External unity may also present itself as a deeply felt awareness of the life or living presence in all things or as the realization that nothing is "really dead."[91] The unifying vision is experienced at an insightful rather than purely rational level through animate and/or inanimate "objects" external to the self. This profound feeling of oneness as an expression of the underlying undifferentiated unity despite empirical multiplicity is the criterion.

The most complete form of external unity has both depth and breadth. The deep oneness experienced through individual objects or people is felt to be part of the underlying unity in all things. Any experience without this cosmic dimension lacks maximum completeness.

The fully developed experience of external unity certainly includes an expansion of consciousness beyond the usual sense of self as well as a consciousness of a "Beyond" or "More" which in such a case may represent the unity. As in the instance of internal unity, however, these phenomena alone, without any relation to undifferentiated unity experienced through the external world of objects, are not enough to constitute external unity. At best they may be considered incomplete or undeveloped forms. They are necessary but not sufficient elements.

---

88. Stace, *op. cit.*, pp. 64-65.
89. *Ibid.*, pp. 69-70.
90. Walker, in describing the level of Universal Consciousness experienced by Edward Carpenter, states: "...we lose the customary feeling of existing as separate individuals and find ourselves, instead, a part of everything else ... the subject and object coalesce and become one." (*op. cit.*, p. 39.) Johnson phrases the same thought as "The sense that all the visible, tangible world is a part of a larger whole and is apprehended as having an underlying unity ..." (*op. cit.*, p. 326).
91. Stace *op. cit.*, p. 78. Bucke also describes such a living presence in his own experience of cosmic consciousness. (*Op. cit.*, p. 8.)

Stace expresses external unity abstractly by the formula, "all is One." He makes this kind of unity by the chief characteristic of the extrovertive type of mystical experience.[92] Underhill discusses the same kind of experience as the illuminated vision of the world or the pantheistic and external type of mysticism.[93] The claim is made in both the experiences of internal and external unity that a level of reality other than the ordinary is touched. Stace identifies this reality or unity as basically the same in both kinds although the unity is perceived in a different way. He feels that the "all is One" of external unity has the same "One" which is experienced during the state called internal unity.[94] Although Stace's argument is impressive, it is not crucial to our thesis.

Category II: Transcendence of Time and Space

This category refers to loss of the usual sense of time and space. Time means clock time, but may also be one's personal sense of his past, present, and future.[95] Transcendence of space means that a person loses his usual orientation as to where he is during the experience in terms of the usual three-dimensional perception of his environment. Experiences of timelessness and spacelessness may also be described as an experience of "eternity" or "infinity."

The experience of internal unity by definition includes transcendence of both time and space because of the loss of all empirical sense impressions. The experience of external unity may or may not include the transcendence of time, but space is paradoxically and only partially transcended because external objects seem both separate and yet not separate because of the feeling of underlying unity.

Category III: Deeply Felt Positive Mood

The most universal elements (and therefore, the ones which are most essential in the definition of this category) are joy, blessedness, and peace. Their unique character in relation to the mystical experience is that their intensity marks them as being at the highest levels of the human experience of these feelings and they are valued highly by the experiencers.[96] Joy may be of an exuberant or quiet nature and may include such feelings as exultation, rapture, ecstasy, bliss, delight, and/or happiness.[97] Peace is of the profound nature that "passeth understanding." Closely related to peace is blessedness which includes beatitude, satisfaction, and/or a sense of well-being. Tears may be associated with any of these feelings of positive mood because of the overpowering nature of the experience.[98] These feelings may be directly associated with the peak of the experience or occur during the "ecstatic afterglow" when the peak has passed, but its effects and memory are still quite vivid and intense.[99]

Love is also an element of deeply felt positive mood which has been mentioned by many students of mysticism, but love does not have the same universality as joy, blessedness, and peace.[100] One example of mystical love is the love which may rise to an indescribable intensity and tenderness.[101]

---

92. Stace, *op. cit.*, p. 79.
93. Underhill, *Mysticism*, pp. 254-265.
94. Stace, *op. cit.*, pp. 152, 273-274.
95. Walker in describing the experience of Universal Consciousness says: "...the words 'before' and 'after' seem to have lost all their former meaning for us, so that we appear to have been transported to a world completely *outside* of time." (*Op. cit.*, p. 41.)
96. Stace, *op. cit.*, p. 68. Pratt, *op. cit.*, pp. 351-352.
97. Underhill, *Mysticism*, p. 366.
98. Laski, *op. cit.*, pp. 85-86.
99. "This is the condition that I call the 'ecstatic afterglow' when, with returning consciousness, the realization, appreciation, and interpretation of the experience begins." Laski feels that especially calm, stillness, peace, and sense of well-being are likely to carry over into an "ecstatic afterglow." (*Ibid.*, pp. 85-86)
100. Stace does not include love as one of the "universal core" characteristics (*op. cit.*, pp. 68). Pratt suggests that the more personal that God is to the mystic, the more the sentiment of personal love is aroused (*op. cit.*, p. 349). The very mention of "God" is for Stace already an interpretation rather than a description of the basic psychological experience.
101. Underhill, *Mysticism*, pp. 425-428.

Love has an interrelation with several other categories. The love of God which is especially common in Christian mysticism is an obvious example of the experience of sacredness (see next category). Love in terms of Union with God is one way of interpreting the experience of internal unity.[102] External unity also may have a mood of love especially if the oneness is attained through people, who become a symbol of the oneness in all things. The deeply felt mood or feeling in this case is not necessarily interpreted as love of "God."

In summary, deeply felt positive mood is most universally expressed by joy, blessedness, and peace. Love is closely related and may also be present.

Category IV: Sense of Sacredness

This category comprises the sense of sacredness which is evoked by the mystical experience. The sacred is here defined broadly as that which a person feels to be of special value and capable of being profaned. The basic characteristic of sacredness is a non-rational, intuitive, hushed, palpitant response in the presence of inspiring realities. No religious "beliefs" need necessarily be involved even though a sense of reverence or a feeling that what is experienced is holy or divine may be included.[103]

As Rufus Jones points out, Rudolph Otto calls such a non-rational (yet deeply felt) response the consciousness of the "numinous" which uniquely transcends the finite or ordinary and moves one with awe and wonder.[104] Otto's phenomenological description includes feelings of awe (with the emphasis on uncanniness or numinous dread), profound humility before the overpowering majesty of what is felt to be holy, numinous energy or urgency, a sense of the wholly otherness of what is experienced, and mysterious fascination in spite of terror or fear in the sense of shaking or trembling in the innermost depths of one's being.[105] These characteristics which Otto mentions are sufficient, but not exclusively necessary conditions. If they are present they can lead to a feeling of sacredness; but such a feeling may be experienced in other ways as well.

Otto emphasizes the feelings of fear, creaturehood, finitude, and humility in his description of the response to the holy. However, the previously listed elements of joy, blessedness, peace, and love may be closely related to, but not identical with, the sense of sacredness.[106] Positive mood and unity may be the emphasis rather than fear and separation. Awe has two elements, wonder and fear, and contributes to both types of experience; wonder is an important part of one type, and fear predominates in the other. Both types give rise to the feeling that what is apprehended is sacred, and both may be present at different points in the same experience.

It might be argued that an exclusive experience of separation could not also include the experience of unity. Fear and creatureliness emphasize the negative side of the vacuum-plenum paradox. The full range of the mystical experience must take into consideration both negative and positive possibilities or a combination of the two sides.[107] An experience with no element of unity or no joy, blessedness, or peace would not be considered the most complete kind of mystical experience. (See the last section in this chapter for a further discussion of completeness.)

The expressions, "joy of the Lord" or "Love of God," which are used by Christian mystics show the close relationship between deeply felt mood and sacredness.[108] The phenomenology from the category of sacredness may be interpreted by the experiencer as an experience of "God," the presence of some other specific deity, or simply as a "sense of Presence."[109] Spontaneous acts of worship such as prayer or kneeling may be evoked. Otto argues that a profound existential experience of "creature-feeling" makes the experiencer strongly feel that the numinous is objective and outside the self.[110] Such a feeling is one possible example of the category of objectivity and reality which is to be defined and discussed next. However, an interpretation is involved if this something objective outside the self is identified as "God."

---

[102] Stace, *op. cit.*, pp. 101-105.
[103] Stace, *op. cit.*, p. 341.
[104] *New Studies in Mystical Religion* (New York: Macmillan, 1927), pp. 31-32.
[105] Otto, *Idea of the Holy*, pp. 13-46.
[106] Stace, *op. cit.*, p. 79.
[107] *Ibid.*, p. 250.
[108] Pratt, *op. cit.*, pp. 356-357, 416-418.
[109] Stace, *op. cit.*, p. 79.
[110] Otto, *op. cit.*, pp. 10-11.

Category V: Objectivity and Reality

These category has two inter-related elements:

(1) insightful knowledge or illumination felt at an intuitive, non-rational level and gained by direct experience and
(2) the authoritativeness of the experience or the certainty that such knowledge is truly real, in contrast to the feeling that the experience is a subjective delusion. These two elements are connected because the knowledge through experience of ultimate reality (in the sense of being able to "know" and "see" what is really *real*) carries its own sense of certainty. The experience of "ultimate" reality is an awareness of another dimension not the same as "ordinary" reality which is the reality of usual, everyday consciousness, yet the knowledge of "ultimate" reality is quite real to the experiencer.

Such knowledge does not mean necessarily an increase in facts, but rather in insightful knowledge or intellectual illumination, e.g. seeing new relationships of old facts or ideas, new understandings of meanings, new appreciation of the universe as a whole, or an experience of "everything falling into place."[111] This immediate feeling of objective truth is called by James the noetic quality.[112] Things seen in a new light can become vital and living as never before.[113] Although the mystics do not dwell on personal psychological insights, Underhill has described an increase in self-understanding which comes from the mystical experience.[114] Such insight is also an example of intuitive knowledge which seems very real.

The lasting authoritativeness or conviction of the true reality of the experience and the sense of the profound significance of the content are at least closely related to, and perhaps enhanced by, the totality and intensity of the response. This knowledge at the level of intuition and insight is felt to require no proof at a rational level by the experiencer.[115] There is a feeling of being totally grasped and dealt with by ultimate reality. James calls this passivity.[116] The intensity and totalness is such as to leave no doubt to the experiencer of his participation at a very deep and basic level which although non-rational and even non-verbal is most convincing.[117] The unshakable certainty of the objective reality of the experience persists even after the experience is over. Stace discusses in detail the validity of the claim to objective reference, but we are concerned here only with the fact that the mystic is convinced of the objective reality of the experience of what to him is ultimate reality.[118]

Category VI: Paradoxicality

Rational statements about, descriptions of, and even interpretations of the mystical experience tend to be logically contradictory when strictly analyzed. Such paradoxical language is universally found in the writings of those who have had mystical states of consciousness when they try to describe their experiences.[119]

---

[111] Bucke describes such intellectual illumination in his definition of cosmic consciousness: "Like a flash there is presented to his consciousness a clear conception (a vision) in outline of the meaning and drift of the universe ... The person who passes through this experience will learn in the few minutes, or even moments, of its continuance more than in months or years of study, and he will learn much that no study ever taught or can teach. Especially does he obtain such a conception of THE WHOLE, or at least of an immense WHOLE, as dwarfs all conception, imagination or speculation, springing from and belonging to ordinary self consciousness, such a conception as makes the old attempts to mentally grasp the universe and its meaning petty and even ridiculous." (*Op. cit.*, p. 61).
Similar is his description of his own experience: "...it was impossible for him ever to forget what he at that time saw and knew, neither did he, or could he, ever doubt the truth of what was then presented to his mind." (*Ibid.*, p. 3.)

[112] James, *op. cit.*, pp. 331-332.

[113] Pratt, *op. cit.*, p. 411.

[114] *Mysticism*, pp. 375, 378.

[115] "There is no certitude to equal the mystic's certitude." (Underhill, *Mysticism*, p. 331.)

[116] "...the mystic feels as if his own will were in abeyance, and indeed sometimes as if he were grasped and held by a superior power." (James, *op. cit.*, p. 372.

[117] Pratt, *op. cit.*, pp. 347-48, 400-403.

[118] Stace, *op. cit.*, pp. 67-68, 134-206.

Examples of paradox have been mentioned in the typology above as a basic part of the mystical consciousness. In the experience of internal unity there is a loss of all empirical content in an *empty* unity which is at the same time *full* and complete. This loss includes the loss of the sense of self and dissolution of individuality, yet something individual remains to experience the unity. The "I" both exists and does not exist. External unity is experienced through the empirical multiplicity of the external world with the insight that all is One. There may also be a paradoxical transcendence of space.[120] The vacuum-plenum or negative-positive paradox has three aspects: the One or Universal Self is both unqualitied and qualitied, both impersonal and personal, and both inactive and active.

Category VII: Alleged Ineffability

The impossibility of adequate expression in words or unintelligibility of the mystical state of consciousness has been stressed as a main characteristic by writers on mysticism.[121] A distinction must be made between the time during the actual experience and afterwards. During the experience of either internal or external unity, there are no concepts or multiplicity to describe within the "unity" or the "One."[122] The profound intensity of positive mood accompanying the experience adds to the inadequacy of words to accurately communicate and tends to make one fall silent.[123] It would appear that there are grounds for the claim that during the experience, ineffability is a characteristic. But afterwards when they have had time to integrate and interpret, mystics have written descriptions of their remembered experiences while at the same time they have insisted that the actual experiences were indescribable.[124]

Stace gives an interesting psychological explanation for this alleged ineffability. Any experience, sensory or nonsensory, cannot be adequately communicated with words to a person who has not had the experience himself.[125] The unique and actual characteristic that mystics allege their experiences to be ineffable is based on an embarrassment with language. Statements made afterwards about the actual experience stripped of interpretation are literally true descriptions, but because mystical experience is paradoxical in nature, an attempt to be strictly logical involves contradiction. To avoid the frustration of contradiction, the mystic calls his experience ineffable.[126] The categories of ineffability and paradoxicality are thus closely related.[127] The category of objectivity and reality also has a close relationship to ineffability because the intuitive and insightful knowledge gained cannot be adequately communicated to others, although it remains of profound significance and reality to the experiencer.[128] Whether or not Stace's explanation is accepted, the alleged ineffability of mystical experience is a more accurate description of this category than simply "ineffability." If the actual experiences were truly beyond words, not much could be accomplished in a study of the mystical state of consciousness by a phenomenological analysis of even the remembered descriptions.

---

[119] James, *op. cit.*, pp. 408-412. Suzuki feels that persons who experience satori "are always at a loss to explain it coherently or logically." (*Op. cit.*, p. 103) Stace argues that mystical paradoxes are meant to be true paradoxes (i.e., both sides although contradictory are actually experienced and are not due to confusion or unclearness (*op. cit.*, pp. 257-276). The extensive use of figures of speech and paradox is one of Clark's characteristics of the mystical experience (*op. cit.*, pp. 273-74). Stace wold agree but would insist that much of what might at first be thought to be figure of speech or metaphor is in fact true description which is by nature paradoxical (*op. cit.*, pp. 299-303). This point is discussed further in the next section.

[120] Stace maintains that this paradox of identity in difference gives rise to pantheistic philosophical interpretations of mysticism. For example, the contradictory propositions that the world is identical with God and that the world is distinct from God are both asserted to be true (*op. cit.*, pp. 212-218ff).

[121] James, *op. cit.*, p. 371; Pratt, *op. cit.*, pp. 346-347, 476; Johnson, *op. cit.*, p. 325; Suzuki, *op. cit.*, p. 103.

[122] Stace, *op. cit.*, p. 297.

[123] *Ibid.*, pp. 281-283; Pratt, *op. cit.*, p. 410.

[124] Stace, *op. cit.*, p 298.

[125] *Ibid.*, p. 283.

[126] *Ibid.*, pp. 304-306.

[127] Underhill, *Mysticism*, pp. 331-32. Suzuki uses the term "irrational" to cover both categories (*op. cit.*, p. 103).

[128] Pratt, *op. cit.*, p. 476.

Category VIII: Transiency

Transiency refers to duration and means the temporariness of the mystical state of consciousness in contrast to the relative permanence of the level of usual consciousness. Transient appearance of the special and unusual levels or dimensions of consciousness which are defined by this typology with subsequent disappearance and return to the more usual is the characteristic of this category. The peak level or climactic moment of the experience may last for only a relatively short period (variously described from seconds to hours) although the feelings of an "ecstatic afterglow" effect may be experienced for many hours or even days.[129] The characteristic of transiency, however, means that the mystical state of consciousness cannot be sustained indefinitely.

An objection might be raised at this point on the grounds that the greatest mystics achieved a permanent state of mystical consciousness which continued while they led active lives in the world.[130] Although continuing effects of the ecstatic afterglow can remain (but with decreasing intensity unless there are repeated mystical experiences) a prolongation of the peak experience of unitary consciousness or unifying vision could not have been sustained at the same level or lives of fruitful activity in the world would have been impossible.[131] With proper discipline for successful repetition of mystical experiences, a general change in level of consciousness may be induced, but this is not the same as a continual peak experience.[132] Such changes and other permanent effects of the experience in the experiencers' lives are considered in the last category below. The mystics' own descriptions of internal unity usually include references to transiency.[133] Similarly, the actual experience of external unity is not described as permanent.[134] Transiency is a characteristic of the immediate mystical state of consciousness which is felt by the experiencer to be on a different level or dimension from his usual state. The transient nature is realized by contrast when the experience is over.

Closely related to transiency is the suddenness of appearance and disappearance of these levels or dimensions of consciousness which are different from usual. The unexpected character of coming with an element of surprise no matter how well prepared one is or how hard one has tried to gain the experience enhances the sense of striking change from ordinary consciousness. Although Suzuki[135] combines both suddenness and transiency in the same category (listed as momentariness), we consider transiency the universal and most important of the two elements.

Category IX: Persisting Positive Changes in Attitude and/or Behavior

If a person goes through the kind of experience characterized by the eight categories above, his attitude and/or behavior are changed.[136] He cannot remain indifferent to the experience. The profound personal impact is a strong motivation for action, even if the result is only a rearrangement of the life in order to cultivate more mystical experience.[137] Positive effects of the mystical experience in the life and personality of the experiencer is the criterion of whether or not to call the experience truly mystical by many commentators and also by mystics themselves.[138] Such a value judgment, as well as the fact that the phenomena observed extend over a longer time that just the few minutes or hours when the primary experience occurred, makes this category stand apart from the preceding eight. However, the "fruits for life" or "value for life" is included in the typology with this acknowledgment in order to distinguish the experience as defined above from an experience which might resemble the typology but result in negative effects in the individual's life. Quietism and unhealthy self-indulgence are examples of this possible potentiality for effects in a negative direction.[139] We seek a typology of a healthful, life-enhancing mysticism, and thus, the present category describes positive effects.

---

[129] Laski, *op. cit.*, pp. 60-66. James, p. 372.

[130] See Underhill's discussion of the "unitive life" (*Mysticism*, pp. 413-44) or Pratt's chapter on "The Mystic Life" (*op. cit.*, pp. 430-441.

[131] Pratt speaks of the rhythm between contemplation and activity (*ibid.*, p. 433).

[132] Underhill states that "the greatest of the contemplatives have been unable to sustain the brilliance of this awful vision for more than a little while." (*Mysticism*, p. 331.).

[133] C. Butler in his *Western Mysticism* (Grey Arrow Edition; London: Arrow Books, 1960) includes transiency as a characteristic in his description of mysticism and gives specific examples from the writings of St. Augustine (pp. 165-167), St. Gregory the Great (pp. 140-141), and St. Bernard of Clairvoux (pp. 165-167).

[134] For example, Jacob Boehme's experiences as related in Brinton's biographical chapter were temporary although the impact and insight gained were so great as to have a lasting influence on his life. (Howard H. Brinton, *The Mystic Will* [New York: Macmillan, 1930], pp. 47-52)
Bucke's own experience of cosmic consciousness happened only once. "The illumination itself continued not more than a few moments, but its effects proved ineffaceable; ...There was no return that night or at any other time of the experience." (*Op. cit.*, pp. 7-8.

[135] *Op. cit.*, p. 108.

[136] Johnson, *op. cit.*, p.332. Clark, *op. cit.*, pp. 274-275.

[137] Compare this necessity for action to Wach's fourth universal characteristic of genuine religious experience - that it results in action. He distinguishes, however, the "right" action from any action. (Wach, *Comparative Study of Religions*, pp. 36-37).

These effects can be divided into four main groups of persisting changes in behavior and/or attitude: (1) toward self, (2) toward others, (3) toward life, and (4) toward the mystical experience itself. The duration of the change must also be considered. Diminishing afterglow effects may persist for days or even weeks, but usually fade away in time unless the experience is repeated. Changes which remain even after the experience is only a memory are the most significant.

(1) Increased integration of personality is the basic inward change in the personal self. This may come about as a fruit of a radical experience of death and rebirth or conversion; or from the profound depth of the experience, insight may be gained which can subsequently be utilized in a gradual reorganization of the personality and growth in maturity. Undesirable traits may be faced in a way that enables them to be dealt with and finally reduced or eliminated. Issuing from personal integration, the sense of one's inner authority may be strengthened, and the vigor and dynamic quality of a person's life may be increased. Creativity and greater achievement efficiency may be released. There may be an inner optimistic tone with consequent increase in feelings of happiness, joy and peace.[140]

(2) Attitudes and behavior toward others may change in such ways as more sensitivity, more tolerance, more real love.[141] The effectiveness of such change is measured by the response in others who may remark on the development of a more positive relationship, or have the tone of their lives changed. Another result of increased personal integration may be to be more authentic as a person by being more open and more one's true self with others.

(3) The third area of change is in attitude toward life and what one works for in life. One's philosophy in life, sense of values, sense of meaning, and purpose in life may be changed.[142] Vocational commitment may be strengthened or changed completely. The need to serve others may be felt. As a result of the experience of a new dimension in life, more appreciation for life and the whole of creation, a stronger sense of the preciousness of life, or an increased sense of reverence may emerge in a new way.[143] More time may be spent in devotional life and meditation.

(4) The experience itself is regarded as valuable and what has been learned is thought to be useful.[144] A positive experience is remembered as a high point, and an attempt may be made to recapture the experience or, if possible, to gain new experiences as a source of growth and inspiration. However, the experience is seen neither as a means to and end nor as an end it itself, but as a balance of both.[145] Mystical experiences of others

---

[138] James uses such a pragmatic approach as a guide in evaluating all kinds of religious experience (*op. cit.*, pp. 21-22, 321). Pratt also judges the value for life by the practical fruits (*op. cit.*, pp. 466-477). Zaehner points to Ruysbroeck's condemnation of quietism on the basis of what it produced (*Mysticism, Sacred and Profane*, pp. 173-174).

[139] H. N. Wieman and R. Westcott-Wieman, *Normative Psychology of Religion* (New York: Crowell, 1935), pp. 186-188.

[140] Such positive changes toward self are emphasized in discussions by Jones, the Wiemans, and Underhill. R. Jones especially notes the optimistic tone and heightened dynamic quality in the life of a person who has been opened to the utilization of resources of vital energy through transcendent experience (*The Inner Life*, pp. 171, 180). The Wiemans give a balanced presentation of both the potential evils and values of mystical experience. (*op. cit.*, pp. 186-91). Underhill is one of the most enthusiastic describers of the life-enhancing power of mysticism. (*Mysticism*, pp. 413-46; *Essentials of Mysticism*, pp. 12-14.)

[141] Underhill, *Mysticism*, p. 437.

[142] Clark stresses extravagance in behavior, (i.e., acting in an imprudent way for self-benefit) as a characteristic effect of mystical experience, (*op. cit.*, pp. 274-275).

[143] Wieman and Westcott-Wieman, *op. cit.*, pp. 190-191.

[144] Walker, *op. cit.*, p. 156.

[145] Stace, *op. cit.*, pp. 339-340.

are more appreciated and understood although even among mystics theological, philosophical, or cultural bias can lead to value judgments of preference for their own particular interpretations.

The Continuum of Mystical Experiences

Many writers on mysticism have noted a difference in degree in the experience. For example, Pratt distinguishes mild and extreme types of mystical experience.[146] Johnson divides his fifteen examples into three groups ranging from the slighter to the more profound.[147] Stace regards the extrovertive type of experience as on a lower level than the introvertive.[148] Thouless and Underhill differentiate various stages in the growth of the mystic life on a continuum from the prayer of quiet in which the self is awakened and illuminated to the ecstasy and spiritual marriage or unitive life.[149]

The categories in the above typology allow for e difference in intensity or level within the mystical experience. The question arises as to when an experience ceases to be defined as mystical. Stace has classified experiences which do not have all the core characteristics of either the introvertive or extrovertive types as atypical or borderline.[150] Laski in her study of what she calls transcendent ecstasy includes aesthetic experiences in art, poetry, music, drama, and nature; creative experiences in writing or scientific work; and certain sexual and childbirth experiences as well as the commonly termed religious or mystical experiences. Some of her criteria are the same as our categories, but the breadth of her characteristics leads her to include experiences in which all our categories would not be represented.[151] Such experiences would be called more or less atypical or borderline by our definition unless some essential characteristics from all of our categories were present. Some categories have a variety of phenomena which are an expression of the same universal characteristics. Not all the phenomena of each category need be experienced for the category to be counted positively in the evaluation of a particular experience (e.g., all the various elements of deeply positive mood or changes in attitude and behavior). What is experienced however, should occur to a strong or adequate degree to qualify that particular category when the completeness of the mystical typology as a whole is judged.

The category of unity is the most important, and if either external or internal unity is experienced, characteristics from the other categories are likely to be experienced also.[152] If neither internal nor external unity is complete, unity has not been truly experienced. Even if all the other categories are represented, such an experience must be considered as close to, but not strictly the same as the most complete mystical experience by our definition. In such a case, the total experience would be classified as incomplete, although more complete than atypical or borderline.

All the phenomena which resemble and include mystical experience[153] can be placed on a continuum from dim aesthetic feelings in nature and the arts through experiences considered as atypical or borderline to the complete extrovertive type and finally to the most profound introvertive experience with the strongest presence of characteristics in each of our categories.[154] The ideal example of the most complete mystical state would be an experience in which all categories were experienced to the strongest or most complete degree. With the suggested continuum in mind, this categorization of mystical states of consciousness can now be used to evaluate drug experiences and determine where on the continuum, if at all, they fit.

---

[146] Pratt, *op. cit.*, pp. 338-339.
[147] Johnson, *op. cit.*, pp. 301-318.
[148] Stace *op. cit.*, p. 132.
[149] R. H. Thouless, *An Introduction to the Psychology of Religion* (Cambridge: Cambridge University Press, 1956), pp. 228-233. Underhill, *Mysticism*, pp. 167-443.
[150] Stace, *op. cit.*, pp. 81-84.
[151] See especially her Appendix D for a summary of her characteristics (*op. cit.*, pp. 482-495).
[152] Stace, *op. cit.*, p. 67, 83, 110, 132-133.
[153] The phenomena of visual and auditory hallucinations, trances involuntary vocal utterances, and/or automatic writing have not been included in the universal characteristics of the mystical state of consciousness. None of these phenomena are universal or necessary although they may be present along with mystical experience, but their varying content and presence are determined by the culture and temperament of the individual. (*Ibid*., pp. 47-55.)
[154] *Ibid*., pp. 80-81.

Chapter IV
EXPERIMENTAL DESIGN

The purpose of the experiment in which psychedelic drugs were administered in a religious context was to gather empirical data about the state of consciousness experienced. These data form the basis for a comparison with the typology of the mystical state of consciousness which has been presented above. Tape recordings, written accounts, questionnaires, and personal interviews were used to collect the data.

Non-drug Factors

Although descriptions in the psychopharmacological literature of the effects of these substances (LSD, mescaline and psilocybin) vary from "model psychosis" to "transcendental experience", investigators seem to agree that an alteration in the usual state of consciousness is produced. Researchers who report "transcendental" experiences in their subjects claim that set and setting are important factors.[1] Set is defined as the personal expectation, mood, mental attitude and past experience of the subject; setting is the external environment and atmosphere and includes the expectations of the investigator. Trust and confidence in both the administrator and the situation are emphasized as crucial. In this view, the drug is seen as the necessary means by which this kind of potential experience may be actualized in a person who is properly handled and prepared.

The kinds of experiences reported by those who have studied the use of these substances in religious ceremonies seem to support this theory.[2] Both the setting and psychological expectation are conducive to an experience of great positive significance for the participant. The participant knows what the procedure of the ceremony will be, and feels at ease as part of a group which undergoes the experience together.

The effects of set and setting were planned to maximize the possibility that mystical phenomena would occur. The assumption was made that for experiences most useful for comparison with the typology of mysticism, the atmosphere should be broadly comparable to that achieved by tribes who actually use natural psychedelic substances in religious ceremonies. The particular content and procedure of the ceremony had to be made applicable (i.e. familiar and meaningful) for the participants. Attitude toward the experience, both before and during, was taken into serious consideration in the experimental design. Preparation was meant to maximize positive expectation, trust, confidence, and reduction of fear. Setting was planned to utilize this preparation through group support and rapport, friendship, an open and trusting atmosphere, and previous acquaintance with the procedure of the experiment in order to eliminate, if possible, feelings of manipulation which might arise. The physical environment was a private chapel. There, on Good Friday, a two-and-one-half-hour religious service which consisted of organ music, four solos, readings, prayers, and personal meditation was attended by twenty Christian theological students, some of whom had taken psilocybin prior to the service.

Choice of Drug

Psilocybin was chosen because its duration of action is only four to five hours, compared to eight to ten for LSD and ten to twelve for mescaline, in doses equivalent in potency. The practical problem of the time needed

---

1. For a general statement of this position see T. Leary's article, "How to Change Behavior," in *Clinical Psychology*, ed. G.S. Nielsen (Proceedings of the XIV International Congress of Applied Psychology, Vol. IV; Copenhagen: Munksgaard, 1962), pp. 62-64. A more detailed account of the application and implications of this approach from the work of Leary's group is given by R. Metzner, G. Litwin, and G. Weil in *The Relation of Expectation and Setting to Experience with Psilocybin: A Questionnaire Study* (Dittoed by Harvard University Department of Social Relations) pp. 1-30. The method pioneered by A.M. Hubbard and used by the Canadian investigators, N. Chwelos, D.B. Blewett, C.M. Smith, A. Hoffer, H. Osmond, J.R. MacLean, D.C. MacDonald and U.P. Byrne, is explained in detail in Chwelos and Blewett's *Handbook for the Therapeutic Use of Lysergic Acid Diethylamide 25* (to be published), pp. 15-48. Sherwood, Stolaroff, and Harman have come to similar conclusions (*op. cit.*, p. 69).
2. As was mentioned in Chapter II, the following have been participant-observers in Indian ceremonies in which sacred mushrooms or peyote were eaten: Wasson and Wasson (*op. cit.*, pp. 287-316, Slotkin (*Tomorrow Magazine* Vol. IV, No. 3, pp. 64-70), and Osmond (*Tomorrow Magazine*, Vol. IX, No. 2, pp. 105-125).

to supervise experimental subjects dictated that the use of psilocybin was more feasible. Claims of various differences in the effects of these three drugs have not been conclusively demonstrated, e.g., greater color and visual imagery with mescaline, or more unpleasant reactions with LSD.[3] Any apparent advantage of psilocybin in terms of less preoccupation with imagery or generally more pleasant reaction is perhaps because psilocybin is newer and has not yet been researched as thoroughly. Also, because of the greater potency per unit weight of LSD, comparisons are not always between dosage effects of equivalent potencies. Higher doses of the same drug usually produce more intense effects, whether positive or negative. The oral dosage of psilocybin used was 30 mg. This dosage corresponds roughly to 150-200 micrograms of LSD or 500-750 mg of mescaline. The controls received 200 mg of nicotinic acid in identical capsules. This control substance produces transient vasodilation of blood vessels in the skin, especially of the face, and general relaxation.[4] This was used to potentiate suggestion in the control subjects, all of whom knew that psilocybin produced various somatic effects, but none of whom had ever had psilocybin or any related substance before the experiment.

Recruitment and Pre-testing of Subjects

Subjects were student volunteers from a local theological seminary. They were recruited through a lecture on rehabilitation-experiments in which psilocybin was given to convicts at the Concord State Prison. Those students who wanted a personal experience with psilocybin met with the experimenter. At this meeting it was explained that psilocybin would be administered during a private Good Friday worship service, and questions were answered about possible harmful effects and risks involved in taking an experimental drug. An effort was made not to overemphasize negative effects such as fear and psychotic-like symptoms which might produce a negative set. The California Psychological Inventory (CPI) as well as a medical-history form[5] and a pre-drug questionnaire[6] was completed by all volunteers. The medical history form was similar to that used by the Harvard University Health Services for screening volunteers for the Harvard Psilocybin Project (sponsored by the Center for Research in Personality).

The pre-drug questionnaire was designed by the experimenter to assess personal religious background, training, and experience in a predominantly open-ended way. Questions included church affiliation, theological position, conversion experience, mystical or other religious experience, and devotional life. During the following week, each volunteer participated in a two-hour interview with the experimenter. During this time the medical history was reviewed with further questioning on any positive item which had been mentioned. Particular note was taken of metabolic diseases; previous consumption of drugs, alcohol, and tobacco; seizures; family and personal history of mental illness and psychotherapy; and symptoms of hysteria. Each person was asked to interpret the meaning of the proverb, "A rolling stone gathers no moss," in order to check on fundamental abstract reasoning power. A physical exam was given to evaluate general physical condition and to provide a baseline in case any physical complaints developed after the experiment. Suggestibility was tested by having the person stand with his eyes closed and imagine that a strong wind was pushing him backwards. This test was also a measure of the degree of resistance or cooperation with the experimenter.

Conditions which would have been grounds for rejection of a volunteer were cardiac impairment sufficient to limit exercise or contraindicate emotional strain, liver enlargement or history of liver disease (e.g. hepatitis or jaundice), history of psychosis, present psychological imbalance (especially depression), or current intensive psychotherapy or analysis for severe psychological problems. No volunteer needed to be rejected on these grounds.

---

3. Unger summarizes the evidence (*op. cit.*, pp. 2-3 of his manuscript copy). The similarity between LSD and mescaline is stated by P. Hoch, H. Pennes, J. Cattell, *Chemical Concepts of Psychosis*, ed. M. Rinkel (New York: McDowell, 1958), p. 143. H. Isbell found similar effects produced by LSD and psilocybin ("Comparison of the reactions induced by psilocybin and LSD-25 in man," *Psychopharmacologia*, Vol. I 1959, p. 37). He also reported cross-tolerance which indicates the probability of a common pathway for LSD and psilocybin (H. Isbell et al., "Cross-tolerance between LSD and psilocybin," *Psychopharmacologia*, Vol. II 1961, pp. 147-159.
4. L.S. Goodman and A. Gilman, *The pharmacological Basis of Therapeutics* (New York: Macmillan, 1955), p. 1701.
5. See appendix A for a sample of the medical-history form.
6. See appendix B for a sample of the pre-drug questionnaire.

After the physical exam and review of the medical history, the pre-drug questionnaire was used as a guide in discussing the person's religious background and, especially, experience. Most of this time was spent in eliciting a description of the most meaningful religious experiences in the person's life. Care was taken not to suggest the basic phenomenology of the mystical experience to the subject, but rather to let him talk about his own experiences which he had mentioned in his questionnaire.

Preparation and Grouping of Subjects

Each person was given a written summary of the planned procedure of events on Good Friday and of the cooperation which was expected from him in collecting data during the days following. These points were discussed and questions answered. Suggestions were made for preparation by self-examination in depth, meditation, private devotional life, or reading of literature deeply meaningful to the person. These were suggestions only, and each person was told to prepare in the way which suited him best, but every effort was made to have him prepare, in as serious a manner as possible, for a meaningful experience.

When all the interviews had been completed, the data on each person were reviewed. Notes had been taken during each interview, and afterwards a general impression of the person had been written by the experimenter.

Related data from the questionnaire supplemented by the interview were combined into categories which were scored with a 0-5 rating scale made relevant to each category. The categories fell into three main divisions: 1) Past religious experience, 2) Religious background and training, 3) General psychological makeup. Ratings on the categories in these groups, the CPI scores, and the interviewer's general impression of each person were used to match the twenty volunteers into ten pairs. (For a more detailed description of the data used in matching, and how the 0-5 scale was adapted to each category, see the next chapter).

The twenty subjects were also divided into five groups of four persons each, on the basis of friendship and compatibility. Most of the subjects were in the same classes, ate together, and lived in the two dormitories which were next to each other on the campus. Groups were constituted without reference to matched pairs. There were only two different groups in which a pair of subjects were together. Each group was assigned two leaders who met with the group before the experiment.

These leaders were familiar with the effects and potentialities of psilocybin through personal experience and observation of others in group sessions of the Harvard Psilocybin Project. Each of the five leaders with the most experience worked in a group with another leader who had not had quite as much experience in helping people through the experience. The two leaders who worked together knew each other and felt compatible working as a team. They knew from past experience the positive and negative possibilities of the drug experience, and their very presence was a reassuring factor to the subjects. The chief purpose of these leaders was to aid in creating a friendly and trust-filled set and setting which, it was hoped, would maximize the potential for positive experience, and to manage with confidence any disturbing reactions which might occur. There was one leader far each subject who received psilocybin.

The experimenter held a briefing meeting with the leaders. Each leader received a printed summary of hist purpose and functions, and a protocol of the experimental procedure. Stress was placed on a supportive but non-directive role so that each subject's experience could have its own development. The leaders were purposely not told the characteristics of the typology of mysticism and were not shown the post-drug questionnaire or any of the data already collected on the subjects. Neither the leader nor the experimenter knew which subject would receive psilocybin. The experimental procedure was discussed in detail so that the leaders could be of maximal help in making the experiment run smoothly. Emphasis was placed on creation of an atmosphere which would not create feelings of manipulation, suspicion, or psychotic terror in the subjects. Strategies for handling such disturbing reactions were reviewed (e.g., taking the subject out of the chapel and reassuring him). Leaders were instructed not to interfere unless a subject was having obvious difficulty. Group assignments were made, and the procedure and purpose of the group meetings to be held by the leaders with their groups before the experiment were discussed.

Each group of subjects met with its two leaders for two hours on one occasion two to five days before Good Friday. The meeting was held in the dormitory room of one of the group members. The purpose of this meeting was to develop group spirit and to prepare subjects for as positive and meaningful an experience as possible. Group members had an opportunity to become acquainted and feel at ease with their leaders. Subjects were encouraged to let themselves go into unexplored realms of experience during the actual experiment and not to try to fight the effects of the drug, even if the experience became very unusual or frightening. The method of reaction to the experience was suggested, rather than specific content either positive or negative. The point was made that each person's drug experience was to be uniquely his own and could not be predicated with accuracy at the present state of knowledge. Possible physical symptoms such as nausea and vomiting were discussed as unwanted side effects which could be minimized or not experienced at all if the subjects were reassured that they were in good hands and that the experience, no matter how unusual, would be temporary. Personal preparation and the plan of the day on Good Friday were reviewed and discussed so that everyone was clear on the expected procedure. Subjects were instructed to eat an early, very light, non-fat breakfast. Each group selected its own meeting place on campus for the morning of the experiment.

Experimental Procedure

Drug Preparation

Double-blind technique was employed. The subjects had been told that some of them would receive psilocybin and some would be controls, but they did not know, that two of the subjects in each group would receive psilocybin, nor that the other two members, as controls, would receive a control substance, nicotinic acid. They had been told that one of their two leaders would receive a small dose of psilocybin. This was meant to add to the reassurance of the subjects and to aid group spirit and rapport with the leaders. Each pair of leaders knew that one of them and two of their group would receive psilocybin, but they were not told the nature of the control substance. Thirty capsules which were identical in outward appearance were prepared, eight hours before the experiment. Ten contained 30 mg of psilocybin; five contained 15 mg of psilocybin; and fifteen contained 200 mg of nicotinic acid. Powdered sugar was used to fill any unused space in the capsules. Each capsule was sealed in an unmarked envelope, and the envelopes were kept in three groups, according to contents.

The list of paired subjects was given to a helper who did not participate in the experiment and did not know any of the subjects or leaders. He flipped a coin for each pair to designate which would be experimental and which would be control. He then checked the group lists to make sure that the experimental and control subjects were divided evenly in each group. In one instance, the coin-flip determination was arbitrarily changed to maintain this balance. A similar procedure was followed for the five pairs of leaders. The helper then wrote the names on the appropriate envelopes, and the coding key was sealed in an envelope and locked in a drawer.

Protocol During the Experimental Day

The actual experiment in which psilocybin was administered to half of the participants occupied most of the day on Good Friday. A church in Boston provided exclusive use of a small prayer chapel which was connected by a hallway to three adjoining rooms in the basement. This chapel was large enough for fifty people. Two of the rooms were large, and the other was considerably smaller, but large enough to accommodate easily a group of six persons. The rooms were comfortably furnished with sofas and chairs. The "live" Good Friday service in the main sanctuary of the church upstairs was transmitted through a high-fidelity amplifier to speakers in the private chapel and two large rooms. Lighting in the chapel was controlled by a rheostat which was set for dim light. Candles were lit on the altar on either side of a golden cross. There were three stained-glass windows behind the altar. No incense was used. Exits from the experimental area were locked, except for one which could not be. A helper who was a clergyman was stationed there throughout the experiment to keep all participants in the experimental area and to prevent any persons not connected with the experiment from entering. Signs were placed on the outside of all other exits to indicate that a private worship service was in progress.

On the morning of the experiment, the two leaders met the four members of their group at their own predetermined meeting place at about 9:30 AM and went as a group by automobile to the church. By 10:05

AM, all groups had assembled in the church basement. Separate areas were assigned to each of the five groups so that one group met in each end of the two large rooms, and the fifth group in the smaller room. Participants helped to arrange the sofas and chairs into small circles with a tape recorder in the middle of each area. An opportunity was given for each person to become familiar with the physical surroundings of the experimental area, it.e., the chapel, the three rooms opening off the hallway, and the toilet facilities which also were entered from the hall. A brief meeting was held for everyone in one of the large rooms and to enable all student participants to meet the other group leaders whom they had not seen before. The minister who was to "stand guard" at the unlocked entrance was introduced and his function explained. The participants were encouraged to stay together in the chapel for the entire service, but were given the freedom to leave if they had to go to the toilet or if they felt restless. The understanding was made clear that everyone was to stay in the experimental area during the course of the day. An effort was made to allay any fearful tension and to encourage serious expectancy.

After this meeting, each group of four student volunteers and two leaders sat together in their assigned area. Shortly thereafter, at 10:30 AM, the envelopes were distributed to the group by the experimenter who watched as the capsules were swallowed with a small amount of water. For the next eighty minutes until it was time to move into the chapel, silence was observed in each group. Each individual was free to read, meditate or pray. The leaders were ready to help anyone who became frightened or experienced disturbing physical symptoms.

At 11:45 AM, a bell was sounded as the pre-arranged signal for all the group to move into the chapel. Each group sat together with their leaders. The minister welcomed everyone in the chapel before he went upstairs to start the service. An organ prelude was heard before the actual service started.

The experimenter remained outside the chapel in the hall to be of assistance in case of emergencies. Oral and injectible thorazine were available as well as other standard emergency drugs. A written record was taken of the subjects and leader who left the service from time to time to go to the toilet or to one of the other rooms. One of the large rooms was reserved for subjects who wanted to talk and the other for those who wanted to sit in silence. Each person who came out of the service was encouraged but not coerced to return. Most of the subjects remained in the chapel for the entire service.

At 2:30 PM when the service was over, the groups remained in the chapel. One leader went with one subject at a time back to the original group area where each subject described his experience into a tape recorder. After recording, each subject was escorted back to his group in the chapel. The other leader stayed with the group in the chapel during the recording.

At about 3 PM, after all the recordings were made, each group assembled in its area for a discussion and sharing of the experience. Fruit and juice were provided. All this conversation was recorded on tape.

By 4:30 PM, all subjects were judged recovered enough to leave. Each group was dismissed as a unit, and went out to eat together. After the meal, the leaders took each person home.

Collection of Data after the Experiment

The next morning, each subject called the experimenter to report his physical and psychological condition and how he had slept. Mental alertness and clarity, and presence or absence of headache, nausea, or dizziness were specifically elicited. The schedule of post-session interviews was arranged at this time.

In the days following the experiment, each subject wrote a description of his experience and mailed it to the experimenter. During the two-hour post-session interview, a 147-item questionnaire[7] was completed by each participant in about 30 minutes before any discussion. Certain items were based on the categories of the typology of mystical experience. Other items measured physical symptoms or unpleasant reactions such as fear, terror, anxiety, loneliness, depression, or hatred. The person was asked to evaluate the degree to which he experienced each item on a scale from 0-4:

---

[7] See appendix C for a sample of this post-drug questionnaire.

0 - None, or not experienced at all.
1 - Experienced so slightly as to be doubtful.
2 - Experienced slightly.
3 - Experienced moderately.
4 - Experienced strongly.

It was explained that the highest rating ("4" or "strong") was for extreme experiences. For an item to be scored as "4", the experience had to equal or excel an experience which the participant considered *strong*, either in comparison to his personal past experiences or to what he would regard as strong in terms of each particular item. The written description and post-drug questionnaire were used as the basis for the ensuing interview. Unclear points were discussed. A tape-recording was made of each interview. A summary of each person's experience and reactions to Good Friday was written by the experimenter.

Six months after the experiment another two-hour period was devoted to each subject. A follow-up questionnaire which consisted of three parts was first completed.[8] Part I was open-ended. The participant was asked to list any changes which he felt were a result of his Good Friday experience, and to rate the degree of benefit or harm of each change. Part II (52 items) was a condensed and somewhat more explicit repetition of items from the post-session questionnaire. Part III (93 items) was designed to measure specific changes in attitude and behavior, both positive and negative. The same rating scale as in the post-session questionnaire was employed in all three parts except that the scale used was from 0-5. A distinction could be made in the highest rating as to whether this experience merely equalled what had previously been thought to be a strong experience ("4"), or excelled it ("5"). Thus "4" and "5" are more precise ratings of what would have been scored as "4" on the 0-4 scale of the post-session questionnaire. In the one-and-one-half-hour interview which followed, most emphasis was placed on a discussion of the nature of any changes which had been indicated. With the aid of Part II, the phenomena of the main categories of the typology were quickly reviewed. The interviewer took a more active role in this part than in the post-session interview. Categories were described in phenomenological terms, and the subject was asked to compare this Good Friday experience to these categories. The response to Part III was used as a basis for fuller description during the interview of any changes in attitude or behavior which had persisted for the six months since Good Friday.
Subjects were also invited to express their feelings about the whole experiment and asked how they would have preferred the set and setting to have been structured. The whole interview was taped. After each interview the experimenter wrote a summary of each subject's experience compared to the mystical typology. Subjects were not told whether they were experimentals or controls. The interviewer himself did not know until after completion of the content analysis of the individual writeups.

The accounts written within a few days after the Good Friday experience and those written six months later (Part I of the follow-up questionnaires) were content analyzed for phenomenological evidence of the categories from the typology of mysticism. The content analysis proceeded in three steps. First, the categories of this typology were described by the experimenter in the form of a training manual for judges who were unsophisticated in both mysticism and psychological experimentation. The description attempted neither to use theological concepts nor to identify the experience as "religious"; it sought instead to describe the phenomenology of the categories of mysticism without naming them as such. These phenomena were described in levels of completeness or intensity, corresponding to the following 0-3 scale for each category:

0 - None, or not experienced at all.
3 - Experienced to a strong degree.
2 - Experienced to a moderate degree.
1 - Experienced to a slight degree.
0 - None or not experienced at all.

The judges were instructed to read the accounts and make a qualitative rating for the highest level attained in each experience for each category or sub-category.[9]

---

[8] See appendix D for a sample of this questionnaire.
[9] See appendix E for the training manual and judges' score sheet.

Second, the category description and rating system were pre-tested on five judges. Originally the plan was to score the content both for qualitative intensity or completeness, and for quantitative number of mentions of each level for each category. The results of this pre-test showed that the category descriptions were in general satisfactory but that there were to many confusing sub-categories. Also, the overlapping nature of the categories made quantitative scoring quite confusing, because the categories were imposed *a priori* on the accounts, rather than derived from the accounts. New, non-overlapping categories were not devised because a major purpose of the content analysis was to determine whether or not phenomena which would correspond to the *a priori* categories were present before the administration of the questionnaire, which could have suggested such phenomena.

Third, the scoring of the categories was revised to a more simple method, and an additional three final judges were trained. These judges were former school teachers who were now housewives and mothers. They did not know the nature or design of the experiment, or that drugs had been given. They were not told that there were experimental and control groups. They were asked to score twenty experiences reported by persons who had attended a Good Friday worship service. The categories were explained by the written description in the training manual, and sample accounts were scored and discussed. All three judges attended the same training session and so were exposed to the same supplemental oral explanation. They received mimeographed copies of the accounts (60 single-spaced typewritten pages) which had been edited to remove all mention of receiving a drug and which were coded to remove all names. A different code was used for the authors of each account and for mention of these same persons in other accounts so that one writer's impression of someone else's experience would not bias the judges.

The accounts were arranged in the same order for each judge. Matched pairs of subjects were placed consecutively with the order of experimental followed by control, or vice versa, determined by a coin-flip. The judges were instructed to read all the accounts through at one sitting and then to proceed with the individual scoring of each account one by one. With enough time allowed to finish all the categories in any account which was started, each judge gave qualitative score to each subcategory or category on a 0-3 scale, as described in the training manual. (Twenty-two items for each account, or 440 in all, were used.) The attempt to score each qualitative level of each item quantitatively was dropped. The scoring procedure was designed so that each account was read five times and different categories scored each time. The easiest categories (e.g., loss of time and space, and positive mood) were scored first. The more difficult categories were then scored after the account became more familiar through repeated readings. This technique was meant to reduce the chance that data would be missed. Each judge estimated that between 15 and 20 hours were required for the scoring of all 20 accounts. The Kendall Rank Correlation Coefficient (γ)[10] was found by comparing ranks of the total scores given be each judge for the same subjects. The ranking procedure using the 0-3 scale was found to be quite reliable. The rankings of the judges' scores were found to have a high correlation with each other ($\gamma = .80$; p less than .001) (See appendix E).

There was *total* initial agreement among all three judges in 68.7% of the 440 items. After each judge's score on each item had been recorded, the three judges held a meeting in which consensus was reached on the remaining 31.3% or 138 items on which there had not been initial total agreement. The experimenter organized the meeting and explained the procedure, but did not participate in the discussion. He only listened to the deliberations from another room to gain an impression of how well the judges had understood the category definitions. For most of the items discussed two of the three judges were already in agreement. Most of the disagreement had been due to one judge having missed a piece of datum rather than a basic misunderstanding of the categories. The ease with which they came to final consensus reflected the good level of initial agreement as well as an adequate understanding of the categories. These final scores were used in statistical calculations which compared the scores of experimental and control subjects.

---

[10] S. Siegel, *Nonparametric Statistics for the Behavioral Sciences* (New York: Mc-Graw-Hill, 1956), pp. 213-223.

Chapter V
DATA USED IN MATCHING OF SUBJECTS

Pre-drug Questionnaire and Interview Data

Rating Scale

For use in matching pairs of subjects groups of items from the pre-drug questionnaire were combined into categories which were scored by the experimenter with the following rating scale:

0 - None, or not experienced at all
5 - Very Strong
4 - Strong
3 - Moderate
2 - Slight
1 - So slight as to be Doubtful
0 - None or Not at All

This scale was adapted to the phenomena of each category. These categories and the score distribution for the twenty subjects are listed in table 1.

TABLE 1
DATA USED IN MATCHING PAIRS OF SUBJECTS FROM PRE-DRUG QUESTIONNAIRES AND INTERVIEWS

	Frequency Distribution of Scores					
I. Religious Background	5's	4's	3's	2's	1's	0's
A. Formal religious commitment & practice of parents	1	9	7	1	1	1
B. Religious atmosphere, influence, & training in the home	4	4	7	2	2	1
C. Participation in the life of the church up to high school graduation	4	8	5	1	1	1
D. Theological conservatism	0	2	7	7	4	0
II. Past Religious Experience						
A. Meaningfulness of public worship	0	11	7	1	1	0
B. Conversion or vocational decision experience	7	3	4	6	0	0
C. Certainty of vocational commitment	6	6	7	1	0	0
D. Intensity and regularity of prayer	5	5	5	3	2	0
E. Sense of sin	3	7	4	4	2	0
F. Experiences in nature	0	2	8	6	3	1
G. Transcendence of time and space	0	2	2	2	2	12
H. Sense of presence, mystical union, or experience of the Numinous	0	5	2	5	6	2
I. Joy, blessedness, peace	0	2	4	6	8	0
III. General Psychological Makeup						
A. Moralism	0	0	3	4	4	9
B. Apprehension about participation in the experiment	1	2	6	9	2	0
C. Suggestibility	6	4	4	5	1	0
D. Proverb interpretation	6 Negatives			14 Positives		

Categories

The firs main division of categories was *religious background*. The formal religious commitment and activities of the parents were scored "5" if they were in full-time Christian service such as ministers of missionaries, "4" if they were very active in the life of the church as well as in attendance, "3" if they were faithful in attendance at services but did not participate in many other activities, "2" if they were interested enough to be irregular attenders, and "1" if they were only interested enough to send their children to Sunday school or church. Religious atmosphere, influence, and training in the home were scored "5" if there were regular and meaningful family worship, prayers, grace, and religious discussions; "4" if only some of these activities were regularly practiced but in a meaningful way; "3" if they were irregular and partial, but meaningful; "2" if they were irregular, partial, and generally unmeaningful; and "1" if they were only occasional. Participation in the life of the church through high school graduation was scored "5" if the person regularly, actively, and meaningfully participated in all the activities of the church which were available to him such as Sunday school, church, young people's meetings, and summer church camp, "4" if he participated regularly and meaningfully as an attender but took no active part in planning or helping, "3" if he participated only in some of the activities he could have, "2" if he was an irregular participator because he found such activities not particularly interesting or meaningful, "1" if only an occasional participator; and "0" if he did not participate at all. The preparation for, and meaningfulness of, joining the church were also given consideration in this score. Theological conservativism was scored according to degree of orthodoxy, with "5" representing fundamentalism; "3" neo-orthodoxy, and "1" the most liberal liberalism. "4" and "2" indicated gradations between these positions. Theological discussions, however, were avoided during the interview.

The second major division of categories and the one on which the most time was spent during the pre-drug interview was *past religious experience*. Meaningfulness of public worship (including communion services) was scored "5" if it was usually very meaningful; "4" if it was sometimes very meaningful; "3" if it was usually moderately meaningful; "2" if it was usually slightly meaningful; and "1" if it was usually unmeaningful. Conversion or vocation decision experience was scored according to the intensity of original emotional expression in relation to the present significance of the experience. A "5" experience was one that was sudden, climactic, dramatic, and intense and provided considerable emotional release. The person at the time of the interview still regarded the experience as a peak experience, a turning point, and still significant in his on-going life. A "4" experience was similar but not as intense, although still meaningful. A "3" experience was similar to "5" or "4" in intensity of original emotional expression but one which was not still considered particularly important, valuable, or meaningful. A "2" experience did not have the sudden or "twice-born" character, but was a slowly-dawning gradual decision which was made after considerable thought, yet remained very significant for the on-going life of the subject. A "1" experience was purely a gradual intellectual decision without much emotional involvement.

Certainty of vocational commitment combined such elements as sense of call, dedication, and definiteness of future plans, but was scored on strength of certainty. Intensity and regularity of prayer life (exclusive of public worship) were scored "5" if the person had an active and regular personal devotional life which had great meaning for him. Sin combined both general and specific senses of sin.

The more characteristic mystical elements were divided into four categories: 1) experiences in nature; 2) transcendence of time and space; 3) sense of presence, mystical union, or experience of the Numinous; and 4) joy, blessedness, and peace. These categories were scored "5" only if they corresponded to the most complete or intense degree of the typology of mysticism. A score of "4" meant a definite though less complete resemblance. Lesser degrees were scored from 1-3 with a score of "1" having only the faintest general similarity.

The third main division was *general psychological make-up*. Moralism was evaluated by asking the person about his attitude toward smoking and drinking in himself and others. A score of "5" indicated a very puritanical and legalistic attitude. The degree of apprehension that the person felt about participation was scored after review of several points in the interview. There had been a discussion of direct fears about immediate or long-term effects, the appropriateness of using drugs in a religious service (to discover any prejudice against such an experiment), and the motivation for volunteering. The person had also been asked how apprehensive he felt. A score of "5" for suggestibility meant that the person fell backwards almost immediately without trying to fight the suggestion of the wind. Scores of 4-2 represented persons who eventually fell with varying degrees of resistance. A score of "1" meant that the person did not fall backwards, but was suggestible enough so that he had to fight to maintain balance. Each person's interpretation of the proverb about the rolling stone was listed as either P (for positive), meaning that a person who keeps active and moving does not get stagnant, or N (for negative), meaning that a person who doesn't settle down to one thing is shiftless and will never accomplish anything. This was assumed to be one measure of the person's background and general outlook on life.

The data in table 1 show the homogeneity of the volunteers in terms of religious background, interest, and experience. Other pre-drug questionnaire data also supported this conclusion. The very fact that they were all undergoing professional training for the Christian ministry at a denominational seminary tended to serve as a screening factor. All volunteers were healthy young males between the ages of 22 and 35. The average age was 24. 17 out of the 20 were first year students and had recently graduated from college. They were all from the free church tradition. Denominations represented were Baptist (9), United Church of Christ (7), Congregationalist (1), and Swedenborgian (3).

Description of Average Subject

The average subject came from a home where there was interest in religion but not in an extreme way, and the parents were active in the church. He attended Sunday school as a child and joined the church in his early teens. During high school he attended the church youth group and perhaps went to summer church camp. The decision to take ministerial training was a gradual one which was made during college after much consideration of vocational possibilities. It was done with serious commitment although at present the exact type of ministry was not certain. At some point there had been a sudden conversion which was prompted by the kind of religious service which stressed a "personal decision for Christ" in order to be "saved". The theology behind the experience had been rethought and modified, but the experience was regarded as important in the religious development of the person. His theological position was neo-orthodox. He was generally unfamiliar with the characteristics of mystical experience either through experience or reading. The elements which were present were only of low intensity and completeness. Prayer was regarded as important and some kind of private devotional life was practiced in addition to public worship, which was usually moderately meaningful. Sense of sin was moderately well developed. Moralism was low. There was openness to the possibility of a meaningful religious experience through the use of psilocybin. Apprehension about participation was moderate. Suggestibility was high.

California Psychological Inventory Data

Certain categories of the California Psychological Inventory were chosen as most relevant for matching subjects whom it was hoped would have similar natural inclination for the mystical state of consciousness. The assumption was made that psychological make-up would have something to do with the potentiality for such experiences. The categories which were used in matching are listed in table 2 which gives a summary of the range of scores, median score, and average score for each category. As a whole the medians and averages were all between 55 and 63 except for socialization and self control which were just below 50. There were more scores above 50 than below and not too many extremely high or low scores. The majority of scores were between 40 and 60. Self acceptance had the most scores above 60. Flexibility had the widest range (37-79).

TABLE 2
FROM THE CALIFORNIA PSYCHOLOGICAL INVENTORY: RELEVANT SCORES USED IN MATCHING PAIRS OF SUBJECTS

Categories	Range of Scores	Median Scores	Average Scores
Sa (self-acceptance)	41-82	63.0	63.7
Wb (sense of well-being)	26-66	56.0	53.15
So (socialization)	29-61	48.5	49.85
Sc (self-control)	34-62	47.0	48.2
To (tolerance)	32-69	59.0	58.5
Py (psychological-mindedness)	47-69	59.5	59.9
Fx (flexibility)	37-79	62.5	62.5
Fe (femininity)	34-70	55.0	53.0
Sy (sociability)	39-65	59.0	57.8

The data in tables 1 and 2 plus the general impression from the two-hour interview were used in matching the twenty subjects into ten pairs. The categories listed under past religious experience were given the most weight, especially the more mystical elements, conversion or vocation decision experience, vocational commitment and devotional life. Next in importance were the categories under religious background. Categories under general psychological make-up and scores on the California Psychological Inventory were not given as much weight in the matching decisions. The general impression of the person by the interviewer also played a significant part, especially where the other data did not indicate a clear cut match. The pairings were done mostly on the basis of subjective impressions by the interviewer, because he scored the pre-drug questionnaires, but were done before the administration of the drug. The initial impressions which the volunteers gave were confirmed, rather than changed, by subsequent interviews.

Chapter VI
DATA FROM QUESTIONNAIRES, INTERVIEWS, AND CONTENT ANALYSES

Data Relevant to the Categories of the Typology of Mysticism

Method of Presentation

The available data for each category will be discussed separately, and the relevant information from the methods used to measure each category will be compared. The post-drug questionnaire (within one week), followup questionnaire (six months later), and judges' content-analysis of individual accounts (written a day or two after the experience as well as after six months) complement each other and measure the same category from different perspectives. For example, the followup questionnaire was not an attempt to repeat the same individual items exactly as in the post-drug questionnaire, but to measure the same category in a clearer or more precise way. The judges' score was on most cases a single category score which was based on the definition of each category as explained in the training manual. Each category will also be illustrated by quotations from individual accounts and tape recordings.

The single-tailed, non-parametric Sign Test was used throughout in statistical calculations of significance levels both for individual items and items combined into categories.[1] For each pair the score or sums of scores (for more than one item) of the control subject was subtracted from the comparable score of the matched experimental subject, and the number of differences was counted. In the tables "N" is the number of pairs with a difference (differences of 0 were not counted); the statistical calculation took into account the relative number of differences with a positive or negative sign. The prediction was made for most of the phenomena measured that the experimental subjects who took psilocybin would score significantly higher than the controls. The items for which a higher control score was predicted will be indicated.

The items used for each method of measurement were listed for each category with the level of probability (*p*) that the difference between the experimentals and controls was due to chance. A *p*-value less than .05 means that the experimentals (as predicted unless otherwise indicated) scored significantly higher than the controls on the phenomena described by that item or category. In other words there would be less than five chances in one hundred that the observed difference was due to chance rather that to psilocybin. The *p*-values were listed for individual items which measured the category for groups of items within the category, and for each category as a whole (i.e., the combination of all the items in the category).

The scores of the combined items in each category or sub-category were summarized in table form.[2] The frequency distribution of scores at comparable levels on the rating scale of each method of measurement were listed (i.e., the number of *times* that the ten experimentals or controls responded at each level). The total numerical sum of all scores at all levels for the ten experimentals and ten controls was listed next to the maximum possible score (i.e., the numerical sum obtained if all subjects had scored all items at the highest possible level). The *p*-value for the combination of items was also indicated.

The data were arranged to answer four questions for each category. Each question expressed a progressively more rigorous examination of the data to elicit the similarities and differences between the phenomenology of the drug experience and that of the mystical typology. 1) Did the experimentals score significantly higher that the controls on a combination of the scores of all items in the category? This question was answered by the *p*-value for the category. 2) If there was a significant difference in the category as a whole, was it because of high or low scores? The difference between "4" and "0" and "1" and "0" counts the same under the Sign Test. This question was answered by a comparison of the total score and frequency distribution for experimentals

---

1. For a detailed explanation of the Sign Test and the tables used see Siegel, *op. cit.*, pp. 65-78.
2. See appendix F for a more detailed explanation of the columns and symbols used in the tables.

and controls. 3) Which individual items in the category showed a significant difference between experimental and control scores? This question was answered by each item's *p*-value, which was calculated using all scores on the scale for that item. 4) Did the difference in these items remain significant if only the scores at the top of each scale were used in calculation of the difference? This question was answered by another application of the Sign Test to the items selected in question 3, but all differences which were obtained from scores of "moderate" or lower were counted as 0. This loss of data would be expected to increase the probability (p) that the difference between experimentals and controls was due to chance unless, in fact, the difference was originally due a strong scores, which would indicate that this phenomenon of the mystical typology had been experienced to a complete degree. The cluster of items which emerged as most significant were then compared to the original definition of the category.

Another technique of analysis was also employed. In some categories the number of items which contributed to the category covered a broad range. Some of these items corresponded more closely to the *a priori* definition of the category than others which were more supplementary but which helped to gather all evidence for the category. Therefore, not only will the results of the combined scores of all items related to the category be given, but also the combination of only those items most crucial to the category as defined in the mystical typology above. The use of this technique added precision to the analysis. The significance level of these essential items when only "strong" scores were used was a valuable measure of the completeness of the category.

Category I: Unity

As shown in Table 3, the experimental subjects scored significantly higher than the control subjects on the category of unity as w whole when the scores of individual items in all subcategories were combined (*p* less than .002 for all three methods of measurement). In other words there were only two chances in 1000 that this difference was due to chance rather than to psilocybin. The score distribution revealed that the experimentals had higher total scores and many more "strong" scores (maximum possible on various rating scales) than the controls, who had relatively few scores as high as "moderate" and a predominance of scores of "0".

Each subcategory was analyzed both as a combination of items and item by item in order to discover the contributing factors to the significance of the data as a whole.

TABLE 3
Category I: UNITY
Combination of All Subcategories

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
13 Post-drug:	Exper:	68	12	22	28	337	520	10	.001
	Contr:	1	11	18	98	65	520		
14 Follow-up:	Exper:	72	4	20	45	387	700	10	.001
	Contr:	0	9	12	120	45	700		
2 Content Analysis:	Exper:	9	5	2	14	39	60	9	.002
	Contr:	0	1	0	29	2	60		

Internal Unity

As shown in Table 4 the subcategory of internal unity as a whole was significant at the .002 level for all three methods of measurement. The score distribution revealed that with all three methods the experimentals had had more total score and a predominance of scores at the top of the scales, while the controls had only a few scores as high as moderate and a predominance of scores of "0".

TABLE 4
Category I: UNITY
Internal Unity

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
4 Post-drug:: P72a, P73, P74, P9	Exper:	24	3	7	6	113	160	10	.001
	Contr:	0	5	1	34	17	160		
6 Follow-up: F18, F19, F33, F42, F43, F47	Exper:	33	2	8	18	178	300	9	.002
	Contr:	0	4	3	53	16	300		
1 Content Analysis: C7	Exper:	6	3	0	1	24	30	9	.002
	Contr:	0	1	0	9	2	30		

The eleven individual items which measured this subcategory are listed in Table 5 with the probability of each that the higher scores of the experimentals were due to chance rather than psilocybin. All the individual items had a *p* less than .008 except F43 which is the same as F42 only with a negative rather than positive value judgment by the subject about the phenomenon of loss of self. The fact that F43 did not show a significant difference between experimentals and controls would imply that the experimentals regarded their experience of loss of self as more positive than negative. When highest possible or "strong" scores were used in computing differences between pairs of experimentals and controls, only P74 (unity with ultimate reality) lost its significance (*p* less than .063). Perhaps this loss was due to the addition of the interpretive phrase, "ultimate reality," as was suggested by several subjects during the interviews. The items which were most essential to the definition of internal unity (loss of sense of self, loss of all sense impressions, and pure awareness) remained significant at the .04 level and most of the items were significant at the .01 level. All three methods of measurement were consistent.

The content analysis data illustrated these essential elements:

TABLE 5
LIST OF ITEMS USED TO MEASURE *INTERNAL UNITY*

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug questionnaire data (4 items):		
P9 Loss of self:	.001	.008
P72a Sense of the loss of the multiplicity of all particular sense impressions:	.004	.016
P73 Pure awareness with no empirical distinctions (i.e., one is beyond the self-consciousness of sense impressions, yet one is not unconscious):	.002	.008
P74 Sense of unity with ultimate reality at the level described by 72a & 73:	.008	(.063)
(2) Follow-up data (6 items):		
F18 Loss of your own identity:	.004	.008
F19 Pure awareness beyond any empirical content:	.002	.004
F33 Fusion of the self into a larger undifferentiated whole:	.008	.032
F42 Loss of sense of self as a predominantly positive experience:	.004	.008
F43 Loss of sense of self as a predominantly negative experience:	(.13)	(.25)
F47 Freedom for the limitations of the self in connection with a unity or bond with what was felt to be all-encompassing and greater-than-self:	.004	.032
(3) Content-analysis data (1 item):		
C7 Internal unity:	.002	.016

Experimental Subject RM:

> I saw the cosmos. It was all molten plastic. Then I knew that I must be somewhere there. Where was my self? What am I? Where am I in the real (plastic) world? Then I was afraid no more. My self is no one place, but in many places. It floats, I float. Body is not real. Only the adventurous *self* is real. The adventurous self floats into all Being, the orange plastic cosmos. It leaves the old ego behind. The old ego is behind but it glows like a far away harbor light. I can always return.

(Comment: This is a good example of lostness of self and unity with all Being, symbolized by "the orange plastic cosmos").

Experimental Subject KR:

> I found myself grunting in agreement or mumbling "Of course, it has always been this way" over and over again as the panorama of my life seemed to be swept up by this unifying and eternal principle. ... I seemed to relinquish my life in "layers"; the more I let go, the greater sense of oneness I received. As I approached what I firmly believed to be the point of death, I experienced an ever greater sense of an eternal dimension to life. There seemed to be infinite possibilities of time and space.

Experimental Subject QX:

> I lapsed into a period of complete lostness of self that must have lasted for an hour but seemed very brief. This was a blank sensation, better still, a void. ... My experience seemed to be dominated by a sense of *oneness*, *unity*, and *harmony*.

(Comment: This resembles the classical phenomenological description of undifferentiated unity with pure awareness yet no specific content and loss of usual sense of self.)

The evidence from total scores of all items, frequency distribution, and individual item analysis has indicated that psilocybin induced the phenomena of internal unity in the experimental subjects to a rather complete degree.

External Unity

As shown in Table 6, this subcategory was significant at the .016 level for all methods of measurement. The distribution of scores revealed that the controls hardly experienced the phenomena of external unity at all and none to more than a slight degree. The predominance of high scores for the experimentals was not so marked as in the case of internal unity. All individual items were significant at the .032 level except oneness through objects other than people (C8), which had a *p* greater than .25. C8 is more crucial to the definition of external unity than oneness through people (C9), unless the underlying unity of the whole external world were experienced through people as the means for the expression of this deep and broad unity of all things. For his to be the case, however, the highest scores on the judges' rating scale should have been used (i.e., "3's"), but for both C8 and C9, *p* is greater than .25 when only these top scores were used.

TABLE 6
Category I: UNITY
External Unity

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
4 Post-drug: P68, P69, P70, P71	Exper:	14	4	8	14	80	160	8	.008
	Contr:	0	0	4	36	5	160		
3 Follow-up: F25, F37, F44	Exper:	11	0	5	14	58	150	6	.016
	Contr:	0	0	1	30	2	150		
2 Content Analysis: C8, C9	Exper:	3	2	2	13	15	60	6	.016
	Contr:	0	0	0	20	0	60		

The dissolving of the subject-object dichotomy (P68) and loss of feelings of difference from objects (F25) are essentially the same phenomenon and were the only items which remained significant at the .032 level under such a rigorous treatment of the data. This phenomenon is an important element in the experience of external unity and is alone enough to make the data from this category qualify as an example of this subcategory of the mystical typology. Against this evidence must be placed the lack of confirmation from the judges. The content analysis data showed a greater depth of underlying cosmic unity or oneness through people than through objects.

Experimental Subject HQ:

> Couple of times I kicked against YS's leg accidentally, and I opened my eyes, for my foot seemed to combine with his left leg.

Experimental Subject QX:

> I remained in a bent a prayerful position, but I was not praying. What seemed to be happening was my becoming complete, i.e., my body was whole or one. My arms seemed to merge into my body, yet I knew I still had arms. I could rub my hands into my legs, yet I still had hands. Everything was a part of the other yet distinct in itself. From this, I moved to a oneness with the pews, both the one I was sitting on and the one in front of me. The pew seemed to be giving itself to me when I would turn in my seat or assume different positions. It seemed to "give" to my movements all the while aiding and giving to my comfort. Even my legs which touched against the pew in front of me seemed to find an extremely giving and helping friend in the wooden pew.

(Comment: These two examples of the dissolution of the subject-object dichotomy do not have the cosmic dimension at this point in the experience.)

Experimental Subject KR:

> Early in the sequence, the "I"-"You" structure broke down both in relation to my inner experience and to the others in the room. A sense of "we-ness" took its place eventually.

Experimental Subject QX:

> My attention was directed toward L6 when I felt a sensational oneness with him. I felt he and I had seen and interpreted life as it truly was meant to be understood, i.e., as man in harmony and love and oneness through all eternity.

For more examples of oneness through people see the section on love in Category III below.

TABLE 7
LIST OF ITEMS USED TO MEASURE *EXTERNAL UNITY*

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug questionnaire data (4 items):		
P68 Paradoxical dissolving of the subject-object dichotomy in spite of the empirical multiplicity of objects (they are still perceived as separate):	.008	.016
P69 Intuitive experience of the essences of objects:	.016	(.13)
P70 Sense of unity with these objects:	.008	(.13)
P71 Felt awareness of the life or living presence in all things:	.032	(.25)
(2) Follow-up Questionnaire data (3 items):		
F25 Loss of feelings of difference from objects:	.016	.032
F37 Intuitive experience of the essences of objects:	.032	(.63)
F44 Sense of unity with objects:	.032	(.5)
(3) Content-analysis data (2 items):		
C8 Oneness through external objects other than people:	(.25)	(1)
C9 Oneness through people:	.032	(.25)

The strongest evidence for external unity is from the questionnaire data because of the dissolution of the subject-object dichotomy. The content analysis failed to show the depth and breadth necessary for the most complete level. We conclude, therefore, that the phenomenon of external unity did occur in the experimental subjects but in an incomplete way.

Supplementary Phenomena

The items in this subcategory as explained in the typology are corroborative, but not definitive, phenomena which occur in connection with either internal or external unity or both. Table 9 lists these items and their significance levels which indicate that the experimentals showed significantly higher scores than the controls (*p* less than .016) for most individual items. Only P77 (consciousness of a "Beyond" or "More") and P67 (sense of being a part of a larger whole) showed no significant difference between experimentals and controls. During the interviews several subjects commented that the "Beyond" or "More" seemed to imply a theological interpretation which they were not ready to make. Only items F36 (feeling of completeness) and F49 (unity with ultimate reality) lost significance when only "strong" scores were used. In F49 the interpretive phrase "ultimate reality" (cf. P74) may have been responsible.

As seen in Table 8 the scores of the experimentals compared to those of the controls followed the same pattern in score distribution and significance level of difference, as for the category of unity as a whole (*p* less than .001). We conclude that these closely related items strengthen, and certainly do not weaken, the conclusions made about the subcategories "internal" and "external unity."

TABLE 8
Category I: UNITY
Supplementary Phenomena

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
5 Post-drug: P67, P77, P78, P79, P96a	Exper:	30	5	7	8	144	200	10	.001
	Contr:	0	6	13	30	43	200		
5 Follow-up: F31, F32, F36, F41, F49	Exper:	28	2	7	13	151	250	10	.001
	Contr:	0	5	8	37	27	250		

TABLE 9
LIST OF SUPPLEMENTARY PHENOMENA OF UNITY

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug questionnaire data:		
P67 Sense that what is experienced forms part of a larger whole:	(.26)	(.26)
P77 Consciousness of a "Beyond" or "More":	(.15)	(.15)
P78 Expansion of usual personal consciousness to other dimensions *within* the self:	.001	.008
P79 Expansion of usual personal consciousness to other dimensions *beyond* the self:	.004	.004
P96a Sense of belonging to a new and greater unity during the experience:	.008	.063
(2) Follow-up questionnaire data:		
F31 Expansion of usual personal consciousness to other dimensions *within* the self:	.001	.001
F32 Expansion of usual personal consciousness *beyond* the self:	.004	.016
F36 Feeling of completeness:	.004	(.13)
F41 Sense of belonging to a new and greater unity:	.008	.016
F49 Unity with ultimate reality:	.016	(.13)

Category II: Transcendence of Time and Space

As is shown in Table 10, this category as a whole had significantly higher scores for experimentals than for controls (*p* less than .001 for all three methods of measurement). The distribution of scores showed a predominance of high scores for the experimentals and "0's" for the controls. On the basis of total scores, controls experienced these phenomena to a negligible extent. As shown in Table 11, when the subcategories of time and space were analyzed separately, all the differences between experimentals and controls were in the same direction as in the analysis of the category as a whole (*p* less than .001 for time and less than .004 for space). In other words there were less than four chances in 1000 that this transcendence of time and space was due to chance rather than psilocybin.

The individual items which were used to measure the subcategories of time and space are shown in Table 12. All individual items were significant in the same direction (*p* no greater than .004 for any item). When only the "strong" level scores were used, all the items remained significant on at least the .016 level.

Examples of the loss of sense of time were numerous in the content-analysis data:

TABLE 10
Category II: TRANSCENDENCE OF TIME AND SPACE
Combination of all Subcategories

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
5 Post-drug:	Exper:	39	0	4	7	162	200	10	.001
	Contr:	0	2	3	45	12	200		
5 Follow-up:	Exper:	37	3	5	5	195	250	10	.001
	Contr:	0	3	5	42	17	250		
2 Content Analysis:	Exper:	16	4	0	0	56	60	10	.001
	Contr:	0	0	4	16	4	60		

TABLE 11
Category II: TRANSCENDENCE OF TIME AND SPACE

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Transcendence of Time									
2 Post-drug: P75, P80	Exper:	17	0	2	1	71	80	10	.001
	Contr:	0	2	1	17	8	80		
3 Follow-up: F1, F26, F35	Exper:	25	0	3	2	125	150	10	.001
	Contr:	0	3	2	25	12	150		
1 Content Analysis: C1	Exper:	8	2	0	0	28	30	10	.001
	Contr:	0	0	2	8	2	30		
Transcendence of Space									
3 Post-drug: P76, P81, P72	Exper:	22	0	2	6	91	120	8	.004
	Contr:	0	0	2	28	4	120		
2 Follow-up: F2, F34	Exper:	12	3	2	3	70	100	9	.002
	Contr:	0	0	3	17	5	100		
1 Content Analysis: C2	Exper:	8	2	0	0	28	30	10	.001
	Contr:	0	0	2	8	2	30		

TABLE 12
LIST OF ITEMS USED TO MEASURE TRANSCENDENCE OF TIME AND SPACE

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Transcendence of Time		
a. Post-drug questionnaire data:		
P75 Transcendence of time in the sense defined by items 72a to 74 (internal unity):	.002	.004
P80 Transcendence of time in the sense defined by items 77 to 79 (supplementary phenomena of unity):	.001	.002
b. Follow-up questionnaire data:		
F1 Loss of usual time sense:	.001	.001
F26 Eternity:	.002	.008
F35 Timelessness:	.004	.008
c. Content-analysis data:		
C1 Loss of usual sense of time:	.001	.004
(2) Transcendence of Space		
a. Post-drug questionnaire data:		
P72 Paradoxical transcendence of space as defined in items 68 to 71 (external unity):	.004	.008
P76 Transcendence of space in the sense defined by items 72a to 74 (internal unity):	.004	.008
P81 Transcendence of space in the sense defined by items 77 to 79 (phenomenon of unity):	.004	.004
b. Follow-up questionnaire data:		
F2 Loss of usual awareness of where you were:	.002	.016
F34 Spacelessness:	.004	.016
c. Content-analysis data:		
C2 Loss of usual sense of space:	.001	.004

Experimental Subject HQ:

> It seemed that I was there for the longest time. I recall looking at the clock again and again, but it didn't change.

Experimental Subject SE:

> I kept looking at my watch and thinking, looking and thinking, looking and thinking - time seemed to stand still, to be endless.

Experimental Subject QX:

> Matter and time seemed to be of no consequence. I was living in the most beautiful reality I had ever known, and it was eternal.

Experimental Subject CZ:

> Space and position were meaninglessness - I could as well have been wandering lost on the moon.

Experimental Subject GP:

> The place was nowhere I had ever been, nor any place that I belonged in. I was afraid sometimes that there was nothing outside, or before, or after ... I did not know where I was, nor when it was, nor where I had come from nor how long I had been there.

Experimental Subject EB:

> Somewhere about this time I lost contact with myself ... There was no center; there was no sense of time; there was no sense of space in the physical sense. I just felt a sense of unity with an endless world of abstract, colorful beauty which didn't seem to be going anywhere, but just was...

(Comment: Some of these examples show that transcendence of time and space is an integral part of the experience of internal unity.)

We conclude from the data presented in this section that the transcendence of time and space, corresponding to the most complete degree defined by our typology of mysticism, was experienced by the experimental subjects who took psilocybin.

Category III: Deeply Felt Positive Mood

As shown in Table 13, the experimental subjects scored significantly higher than the controls when the scores of individual items in both subcategories of deeply felt positive mood were combined (*p* less than .020 for all three methods of measurement). The frequency distribution of scores revealed that all of the highest scores were recorded by the experimental subjects, and the controls recorded the great majority of the "0's". In the middle range of the rating scales, however, the balance was more even between experimentals and controls.

For more precise analysis, the two subcategories were treated separately.

TABLE 13
Category III: DEEPLY FELT POSITIVE MOOD
Combination of all Subcategories

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
12 Post-drug:	Exper:	40	33	23	28	284	400	9	.020
	Contr:	3	36	27	54	167	400		
10 Follow-up:	Exper:	50	5	15	21	269	500	9	.020
	Contr:	6	15	24	45	115	500		
3 Content Analysis:	Exper:	9	4	7	10	42	90	9	.002
	Contr:	0	0	3	27	3	90		

The most universal phenomena (Joy, Blessedness, and Peace)

As seen in Table 14, the combined scores of the sixteen items describing joy, blessedness, and peace were significantly higher for experimentals than controls from all three methods of measurement (*p* less than .020). Although the controls scored these phenomena on the lower ranges of the scoring scales, the highest scores were exclusively from the experimentals as seen from the total scores and frequency distribution. These items are listed in Table 15. All items which were aspects of joy were significant at the .020 level except F13, happiness. *No* individual items under blessedness and peace were significant (*p* greater than .063 in all cases). When only the "strong" scores were used, exultation (P39), ecstasy (F13), delight (F29), and joy (F39) remained significant (*p* less than .032), but important items which lost their significant difference were ecstatic joy (P52) and joy (C3) (*p* less than .063).

TABLE 14
Category III: DEEPLY FELT POSITIVE MOOD

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Joy, Blessedness, Peace									
7 Post-drug: P39, P52, P44, P50, P14, P7, P49	Exper:	23	13	17	17	158	280	9	.020
	Contr:	0	11	16	43	60	280		
7 Follow-up: F13, F11, F29, F39, F40, F12, F45	Exper:	32	4	9	16	173	350	9	.020
	Contr:	4	8	11	37	59	350		
2 Content Analysis: C3, C5	Exper:	7	2	4	7	29	60	9	.020
	Contr:	0	0	1	19	1	60		
Love									
5 Post-drug: P41, P43, P90a, P122, P124	Exper:	17	16	6	11	126	200	8	(.15)
	Contr:	3	25	11	11	107	200		
3 Follow-up: F24, F28, F51	Exper:	18	1	6	5	96	150	10	.055
	Contr:	2	7	13	8	56	150		
1 Content Analysis: C4	Exper:	2	2	3	3	13	30	8	.035
	Contr:	0	0	2	3	2	30		

TABLE 15
LIST OF ITEMS USED TO MEASURE THE MOST UNIVERSAL PHENOMENA OF DEEPLY FELT POSITIVE MOOD (JOY, BLESSEDNESS, AND PEACE)

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug data (7 items):		
P39 Exultation:	.020	.032
P44 Exuberance:	.002	(.13)
P50 Overflowing energy:	.008	(1)
P52 Ecstatic joy:	.004	(.063)
P14 Sense of well-being:	(.38)	(.38)
P47 Blessedness:	(.15)	(.15)
P49 Peace:	(.09)	(.09)
(2) Follow-up questionnaire data (7 items):		
F11 Ecstasy:	.004	.016
F13 Happiness:	(.23)	(.23)
F29 Delight:	.016	.016
F39 Joy:	.016	.032
F46 Exultation:	(.37)	(.37)
F12 Peace:	(.50)	(.50)
F45 Blessedness:	(.11)	(.13)
(3) Content-analysis data (2 items):		
C3 Joy:	.020	(.063)
C5 Peace or blessedness:	(.063)	(.13)

Experimental Subject KR:

> Having died only to have life given back gave me a tremendous sense of exultation and manliness. I grasped the back of the pew or wooden upright in front of me as I exclaimed and I delighted in the heightened sensations of all five senses.

Experimental Subject GP:

> I heard PK (or whoever it was) return to the chapel and play "Jesus Christ is Risen today, Hallelujah!" I had a brief but violently intense feeling of joy.

Experimental Subject FK:

> Then I read the Scripture, put out the candles (which I believe to be symbolic of the crucifixion of Christ), and after more *blackness*, found myself in the pulpit, preaching about love and peace. ... I attempted to play the organ, wanting to play "Christ the Lord is Risen Today," being motivated by a strange sense of joy in the reality of this event.

(Comment: This example shows the close relationship between various elements of positive mood as well as their possible close interrelation with sense of sacredness.)

Other evidence of blessedness and peace combined with a sense of sacredness is as follows:

Experimental Subject KR:

> Opening my eyes I noticed that tears were streaming down L1's face, that we were all caught up in a glow of holy light from off the altar, that we were all participating in one great cosmic drama of all races, creatures and eras, in short, that we were experiencing beatitude.

Experimental Subject QX:

> There seemed to be complete support from all the surrounding elements; no hostility at all was present in anything. I would on occasion lower my head and close my eyes as if to pray and would seem to be in the realm of eternity. It was sheer bliss and something I didn't want to leave.

Control Subject BL:

> Such communion with God as I experienced on Good Friday is not quite the same as another experience with the Divine which I describe through such terminology as "being grasped," or melting." I did not approach this experience of "exalted or divine tenderness" which in the past has caused me to feel one with everything that is. The peace which comes through this experience was missing from the worship Service on Good Friday.

This control subject did not experience the most profound peace he has ever known but he did score peace and blessedness at a level of "moderate" degree. Other controls also scored these items. The experimentals in general did not score peace to the most complete degree as shown by the lack of significant difference between experimentals and controls on each individual item which measured these phenomena.

We conclude that although the subcategory as a whole showed a significant difference between experimentals and controls, the difference was due to the usually intense joy which was a part of the psilocybin experience. Because all the data were not consistent in measuring this joy at the highest intensity, we conclude that the experience of the experimentals was not the most complete example of the joy described by your typology for this category.

Closely Related Phenomena (Love)

Although love is not one of the *universal* characteristics of the typology of mysticism, the experience of love may occur in connection with joy, blessedness, and peace. As seen in Table 14, the experimentals experienced the phenomena of love more than the controls at a significance level of .055 in the follow-up data and .035 in the content analysis data. The experimentals had higher total score and had more strong scores with each method of measurement. The reason for no significant difference in the post-drug data was that the controls also scored this phenomenon (total score of 126 for experimentals and 107 for controls).

The nine items which were used to measure the phenomenon of love are listed in Table 16. Individual items were mostly not significant at the .05 level except for P41, F24, and C4 (*p* less than .035). The only item which remained significant when only "strong" scores were counted was F24, deep interpersonal relations (*p* less than .035).

Cosmic love such as love of God was not significant. Psilocybin seemed to increase depth of interpersonal relationships on a very human level both for experimentals and the controls with whom they interacted.

TABLE 16
LIST OF ITEMS USED TO MEASURE LOVE

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug questionnaire data (5 items):		
P41 Love:	.035	(.063)
P43 Tenderness:	(.66)	(.66)
P90a Feeling of love toward others:	(.38)	(.38)
P122 Did you particularly like or feel close to either of leaders?:	(.11)	(.25)
P124 Did you particularly like or feel close to any participant in the experiment?:	(.35)	(.35)
(2) Follow-up questionnaire data (3 items):		
F24 Deep interpersonal relations with other people present:	.035	.035
F28 Love:	(.26)	(.26)
F51 Love of God or Christ:	(.26)	(.26)
(3) Content-analysis data (1 item):		
C4 Love:	.035	(.25)

Some examples of such love from the content-analysis data are as follows:

Experimental Subject EB:

> There was a certain feeling that all people were good, and that I wanted to *love* them for it.

Experimental Subject FK:

> However, my strongest feelings were toward L3, who in a sense wanted to help me. Never before have I sensed such a feeling of *filia* (Greek for love, i.e., friendship); he represented the forces of good, forcing me to face my frailty and human fallibility; ... I felt that the only one who really understood me when I was "under", was L3, for he understood what I was going through, for he had undergone the same experience himself. This alone, not counting the other far more significant aspects of my experience, would make the situation of real value.

Experimental Subject QX:

> I looked up at the front of the Chapel but the light seemed to be too bright for my eyes and I had to lower my head. I was overcome by a feeling of oneness with L6 and FK. I seemed to be caught up in a realm of complete understanding of them and with them.
> All this time, I felt a strong pull to FX - which said to me he needed my support if nothing else. I saw him as himself but also as representing all men, and I knew deep within that I could not turn my back of him. At that time, I went over and sat by him. I did not speak a word. I just sat in a chair between him and L6. Another fellow was sitting on the sofa with FK, and during one of the songs he and FK clasped hands and this was very beautiful and significant to me, for I saw two men at one with each other in genuine love existing in eternity.

(Comment: The depth of oneness expressed by QX is an example of the oneness through people which can be part of the subcategory "external unity." This example shows the relationship between the two subcategories of "love" and "external unity.")

Control Subject NJ:

> FK went to the altar, turned around, and showed us his face - a face I had never seen before on a human being. This caused the service to be more meaningful than ever before - why? Although FK moved up to the altar with a vigorous drive, clutched the cross firmly, exhibiting such strength, and a first seemed as if he was going to tear everything from one end to the other, he turned and showed himself differently. His face showed as much love, gentleness, sincerity and strength to bear real suffering as any face has ever shown.

(Comment: NJ's experience of love was caused by the experimental subject FK's experience.)

We conclude, therefore, that although the category of "deeply felt positive mood" was significant as a whole for all three methods of measurement, psilocybin produced the most significant difference between experimentals and controls in this category in the experience of joy. There was also a difference in the experience of love on a human level for the most part, but not so significantly, and the experience of blessedness and peace was not significantly different between experimentals and controls.

Category IV: Sense of Sacredness

As seen in Table 17, the combined scores of all items related to this category were significantly higher for the experimentals than for the controls from the post-drug data (*p* less than .020). From the follow-up data, the significance level was .055, and the content-analysis data showed no significant difference (*p* equal to .37). In other words, the evidence is very suggestive but not conclusive that psilocybin induced a sense of sacredness in the experimental subjects. In all methods of measurement, a basic pattern in the data was reflected by the frequency distribution of scores. The top-of-the-scale scores were made almost exclusively by the experimentals. The controls, however, had more total middle-range scores than the experimentals did.

TABLE 17
CATEGORY IV: SENSE OF SACREDNESS
Combination of all Subcategories

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
13 Post-drug:	Exper:	52	23	22	33	304	520	9	.02
	Contr:	1	25	55	49	173	520		
8 Follow-up:	Exper:	43	5	12	20	231	400	10	.055
	Contr:	3	10	30	37	99	400		
1 Content Analysis:	Exper:	4	1	0	5	14	30	8	(.37)
	Contr:	0	2	4	4	8	30		

The twenty-two items which were used to measure sacredness are listed in Table 18 with the probability that the difference found in each case was due to chance rather than psilocybin.

Only eight out of these twenty-two individual items showed a significant difference between experimentals and controls at the .035 level, and one more item (humility - P61) was close to being significant (*p* equal to .062).

TABLE 18
LIST OF ITEMS USED TO MEASURE SENSE OF SACREDNESS

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Phenomena with implicit indication of sense of sacredness:		
a. Post-drug data (6 items):		
P7 Sense of wonder:	.004	(.13)
P56 Sense of awe or awesomeness:	.011	.016
P58 Mysterious fascination in spite of terror or fear (in the sense of a shaking or trembling in the utmost depths of your inner being):	.008	(.13)
P59 Sense of the wholly-otherness of what was met in the experience:	.035	(.063)
P6 Sense of finitude:	(.23)	(.23)
P13 Sense of humility:	(.35)	(.35)
b. Follow-up data (2 items):		
F22 Awe:	.011	.011
F14 Sense of presence of what can only be described as nameless:	.032	(.063)
(2) Phenomena with explicit mention of holy, sacred, or divine:		
a. Post-drug data (7 items):		
P61 Sense of profound humility before the majesty of what was felt to be sacred or holy:	(.063)	(.063)
P60 Sense of your own finitude in contrast to the infinite:	(.090)	(.090)
P77 Consciousness of a "Beyond" or "More":	(.15)	(.15)
P62 Sense of presence of what was felt to be sacred or holy:	(.64)	(.64)
P57 Sense of reverence:	(.78)	(.78)
P83 Contact or bond with God:	(.64)	(.64)
P82 Sense of the presence of God:	(.83)	(.83)
b. Follow-up data (6 items):		
F48 Sense of being at a spiritual height:	.016	.032
F30 Sense of your own finitude in contrast with the infinite:	.020	.032
F51 Love of God or Christ:	(.26)	(.26)
F15 Sense of sacredness with which you regarded your experience:	(.37)	(.37)
F40 Sense of reverence:	(.50)	(.50)
F50 Sense of the presence of God:	(.50)	(.50)
c. Content-analysis data (1 item):		
C6 Sense of sacredness:	(.37)	(.37)

When only "strong" scores were used, the items which remained significant were: awe (F56 and F22), sense of finitude in contrast with the infinite (F30), and spiritual height (F48) - *p* less than .032 for all four items. Sense of wholly otherness (P59) and sense of nameless presence (F14) were almost significant (*p* less than .063) under this rigorous analysis. The other two items which complete the list of eight significant ones were: wonder (P7) and mysterious fascination in spite of terror or fear (P58).

Six of these eight significant items were phenomena with an implicit indication rather than explicit mention of the holy, sacred, or divine. The items which were most explicit, such as reverence (P57 and F40), sacredness (F15), sense of Presence (P62), consciousness of "Beyond" (P77), or those which mention God (P82, P83, F50, and F51), were *not* significant at the .05 level.

For the purpose of a more precise analysis, the explicit and implicit items in the post-drug and follow-up data were combined separately. As shown in Table 19, the experimentals scored significantly higher than the controls on the implicit group (*p* less than .02 for both methods) but not on the explicit (*p* less than .09 for both questionnaires). In other words there were only two chances in one hundred that this implicit phenomena experienced by the experimentals was not due to psilocybin.

TABLE 19
Category IV: SENSE OF SACREDNESS

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Phenomena with implicit indication of sense of sacredness									
6 Post-drug: P6, P7, P13, P56, P58, P59	Exper:	24	15	13	8	159	240	9	.020
	Contr:	1	8	22	29	62	240		
7 Follow-up: F14, F52	Exper:	12	2	2	4	66	100	10	.011
	Contr:	0	1	6	13	14	100		
Phenomena which explicitly mention the Holy, Sacred, and Divine									
7 Post-drug: P57, P60, P61, P62, P77, P82, P83	Exper:	28	8	9	25	145	280	9	(.09)
	Contr:	0	17	33	20	111	280		
6 Follow-up: F15, F30, F40, F48, F50, F51	Exper:	31	3	10	16	170	300	9	(.09)
	Contr:	3	9	24	24	85	300		

The explicit items are more conventionally "religious," while the implicit items are more representative of the basic phenomenology of the "holy" described by Rudolf Otto.[3] Both explicit and implicit are examples of the category of sacredness as defined by our typology. The experimental subjects in our experiment experienced more implicit phenomena than did the control subjects. The phenomena of this category that the controls did experience were mainly explicit (see distribution of scores in the tables). Such an occurrence could have been expected, because the experiment was conducted with a worship service for setting and on a day particularly meaningful for Christian theological students who were the subjects. This could explain the lack of significant difference in the content-analysis data.

There were examples of the sense of sacredness in the content-analysis data, in both experimentals and control subjects, as the following excerpts show:

> *Experimental* Subject RM:
>
> > My eyes began to water and there was a wholesome beauty as I massaged the soft fleshy eyebags in my tears. I strained to fall on my knees with the meaningfulness of my younger days in lower school. My cowardliness was finally overcome and true humility ensued. The organ music blended beautifully and the scripture reading was the chorus of angels in bass clef.
>
> *Experimental* Subject GP:
>
> > I began the service with a feeling of intense devotion, and another strange, detached feeling… I directed my thoughts to the Passion Story, and saw Christ carrying his cross in a procession. Someone stepped in to help him, then I stepped in, too.
>
> *Experimental* Subject KR:
>
> > Rev. X's voice and manner set a definite mood in me. He was at one with the total experience of the divine and holy in that chapel.

---

[3] *Idea of the Holy*, pp. 24-35.

Control Subject IA:

> My first reaction to the chapel was its appropriateness for inducing a religious experience. The altar display, the darkness, and the solemness of the congregation, were immediately for "getting in tune with God." Later Rev. X's penetrating voice, combined with his very meaningful prayers and devotions, brought me to a spiritual height for the week.

Control Subject BL:

> I immediately began to meditate and pray and read my New Testament - I Cor. 13 ... I thought about the possibility of exploring new dimensions of one's self, and I prayed for God through Christ to be Lord of this dimension of being, for certainly no dimension of reality escapes His jurisdiction. Although I was curious about the experience of others around me, yet I was more concerned with my own private worship.
> When we entered the chapel, I began to pray for forgiveness and to praise God for the blessings of life. Although I did look around me on occasion, yet I found myself very much able to concentrate on my own private worship-service. As the organized service began, I found myself calmly participating in the richness of its structure. Often I would drift off into my own private prayer and devotional response, yet I was very able to find meaning in the long passages of prayer and poetry which I did hear. It seems that I was able to escape the distractions which usually hamper corporate worship, and to "lose myself" in the dimension of the religious. When interruptions did occur in my concentration, I did regain a certain intellectual curiosity, yet it lasted for only short durations of time. I easily re-entered the world of prayer and communion. ... In speaking of the worship service itself, I must stress that God seemed very close to me at this time. I found myself freed from the intellectual and conceptual dimensions of myself, to a large extent, and able to plunge into the emotive-intuitive dimension where my response was often that of "listening" to God. Very seldom were my conscious prayers "forced" in any way; rather, they followed naturally from "listening."

Control Subject MC:

> The chapel service was a meaningful one for me. ... Though the religious service was meaningful ... I cannot remember what Rev. "X" said, only what he did. He did move me, I remember, especially in his Scriptural readings. I was able to feel being with Christ. Christ stood out to me as he has only a few times before.

Control Subject NJ:

> As to the meaningfulness of the service - well, here goes. At first, the service became as any prior service. Then Rev. "X" caught me up into the real power and life of it (was he tremendous!).

Item P63, "sense of absence of anything that was felt to be holy, sacred, or divine," was *not* significant (*p* equal to .35). This is also indirect support for the conclusion that some degree of sacredness was experienced by both experimentals and controls.

The evidence has indicated, however, that sacredness was experienced more by the experimentals than by the controls, particularly the implicit type of phenomena, of which *awe* was an outstanding example. But from the lack of significance in the content-analysis data (*p* equal to .37), and the borderline significance of the combined follow-up data (*p* less than .055), we hesitate to conclude that sacredness was experienced by the experimental subjects in the most intense and complete way as defined by the mystical typology. That there was significant implicit phenomena in the experience of experimental subjects who had psilocybin has been demonstrated.

Category V: Objectivity and Reality

When all items which contributed to this category were combined, as shown in Table 20, *p* was not over .020 for any method of measurement. The distribution of scores showed a predominance of high scores for the experimentals, and "0's" for the controls.

All the items which contributed to this category are listed in Table 21 with the probability that the difference between scores of experimentals and controls was due to chance rather than to psilocybin. When individual items were examined, certainty of encounter with ultimate reality (P33, F17, and F70), intellectual illumination (P54 and F10), gain of some type of intuitive knowledge (P18, P23, F7, F27 and C11), increased capacity of mind (F4) and intensity and totality of the experience (P37, P38, P55, F5, F6, F38) all had significantly higher scores for the experimentals than for controls (*p* was less than .035 for each of these items). One item involving the retention of the certainty about the encounter with ultimate reality (P34) and one item involving intellectual illumination (P53) had *p* value of .062. This slight lack of significance was counterbalanced by the five other items measuring the same specific phenomena with *p* values all less than .035. Item F3 (certainty of the reality of the experience was also significant at the .02 level, but was not listed as essential because a reality other than ordinary reality is not specifically mentioned. Most controls, in fact, rated this item as "4" ("strong" - similar to other strong experiences of reality), and most experimentals rated is as "5" ("very strong" - stronger than ever before in my life). Other individual items which were not significant were: seeing symbolic meanings (P1), knowing everything (P4), knowledge of personal immortality (P24), communion with ultimate reality (F23), and psychological insight (C12). All these items received some scores from the experimentals but not enough to show a significant difference from the controls. P1, P4, and P24 are clearly supplementary when compared to the *a priori* definition of the category, and not essential. C12 compared to C11 showed that the intuitive insight gained through the experience was regarded by the experimentals as more philosophical-religious than personal-psychological.

When these 18 individual items which were significant were analyzed most rigorously by only counting the "strong" level scores, the *p* values of P54, P18, P23, P55, F7, and C11 rose to .063. For the other 12 items, *p* remained less than .035.

A more precise analysis of this category, however, was obtained when those items which corresponded most closely to the *a priori* definition of the category from the typology were combined separately. These items have been listed under the subcategory "most essential phenomena." As shown in Table 20 these basic items as a group were significant at the .02 level for all methods of measurement. The total scores and frequency distribution of scores followed the same pattern as did the combined scores in the same table.

Seven out of ten of these essential items were significant (*p* less than .035) and five of these seven remained significant when only "strong" scores were used (*p* less than .032). Of these five most important items, four were from the follow-up data after six months; one (P33) was from the post-drug data. Even under this most rigorous analysis, all of the rest of these ten items were almost significant (*p* less than .063). Item C11 from the content-analysis data (insights from being and existence in general) was in this last group. This loss of significance for the content-analysis data raises some doubt as to the completeness of the category as experienced by the experimentals. Individual item F70, however, was very strong evidence for this category because it measured after six month the *retention* of the certainty that ultimate reality had indeed been encountered (significant at the .032 level when only "strong" scores were used).

TABLE 20
Category V: OBJECTIVITY AND REALITY

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Combination of all phenomena:									
12 Post-drug:	Exper:	55	11	17	37	278	480	10	.011
	Contr:	1	15	32	72	92	480		
11 Follow-up:	Exper:	77	7	5	21	393	550	10	.001
	Contr:	6	16	18	70	101	550		
2 Content Analysis:	Exper:	5	8	0	7	31	60	9	.020
	Contr:	0	0	1	19	1	60		
Most essential phenomena:									
5 Post-drug: P33, P34, P53, P54	Exper:	21	3	4	12	99	160	8	.004
	Contr:	1	5	11	23	36	160		
5 Follow-up: F10, F17, F23, F27, F70	Exper:	28	6	3	13	155	250	9	.020
	Contr:	0	3	7	40	19	250		
2 Content Analysis: C11, C12	Exper:	5	8	0	7	31	60	9	.020
	Contr:	0	0	1	19	1	60		

The content-analysis material itself illustrated this category, as the following examples show:

Experimental Subject HQ:

> I felt I was at the real level of being.

Experimental Subject QX:

> I finally determined the truth was in man and that all his seeking was in vain and absurd, for it was not ultimately important what man knew intellectually but rather that he was at one with himself and his fellow man, i.e., in harmony and unity and love with mankind. ... Everything seemed to be more real and purposeful than I had ever known before.

(Comment: These two examples indicate the basic distinctions between "ultimate" reality and "ordinary" reality.)

Experimental Subject FK:

> Of first significance was the feeling of a profound religious "call" - the first I think I have ever really had. Before, I just felt as if I should enter the ministry, but now I "know" that I must. ... up to this time, I have never known the real meaning of the Christian truth - I have overintellectualized it, and have not involved myself in its eternal meaning and significance.

(Comment: This example also has strong overtones of the category "sense of sacredness.")

Experimental Subject FK:

> I would most emphatically emphasize this: I was helped in the liberation of previously repressed or inhibited areas of my life. That which was just a conception, was now made real. I had realized that one of my problems was now made real. I had realized that one of my problems was my far-reaching egocentricity - for the first time, I truly felt it, in the whole of my being.

Experimental Subject KR:

> The experiences are not unpleasant which confirms my belief that the Self (Jung's term for the integrating principle in the collective unconscious) has been further released in me toward greater wholeness.

(Comment: The certainty of intuitive-psychological knowledge of self in the last two examples represented a very meaningful kind of ultimate reality for these subjects.

TABLE 21
LIST OF ITEMS USED TO MEASURE OBJECTIVITY AND REALITY

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Most essential phenomena:		
a. Post-drug data:		
P33 Sense of certainty or conviction of encounter with ultimate reality (in the sense of being able to "know" and "see" what is really *real*) at the time of the experience:	.020	.020
P34 Sense of certainty or conviction of encounter with ultimate reality (in the sense of being able to "know" and "see" what is really *real*) now (in looking back):	(.062)	(.062)
P53 Intellectual illumination:	(.062)	(.063)
P54 Retention of such illumination after the experience:	.008	(.063)
b. Follow-up data:		
F27 Gain of insightful knowledge experienced at an intuitive level:	.004	.004
F17 Certainty of encounter with ultimate reality (in the sense of being able to "know" and "see" what is really *real*):	.008	.016
F70 You are convinced now, in retrospect, that you encountered ultimate reality in your experience (i.e., that you "knew" and "saw" what was really *real*):	.016	.032
F10 Intellectual illumination:	.035	.032
F23 Communion with ultimate reality:	(.227)	(.227)
c. Content-analysis data (2 items):		
C11 Insights into being and existence in general:	.004	(.063)
C12 Insights into personal finite self:	(.11)	(.25)
(2) Supplementary phenomena:		
a. Post-drug data (8 items):		
P37 Intensity of the response to ultimate reality:	.004	.008
P38 Totality of the response to ultimate reality:	.016	.016
P55 Sense of being grasped and dealt with:	.004	(.063)
P18 Sense of having known the universe in its wholeness:	.016	(.063)
P23 Sense of ultimate goodness as the basis of reality:	.035	(.063)
P24 Intuitive knowledge of your immortality:	(.11)	(.11)
P1 Seeing symbolic meanings of things:	(.18)	(.18)
P4 Feeling of being very wise, knowing everything:	(.23)	(1)
b. Follow-up data (6 items):		
F5 Intensity of your response to the experience:	.001	.001
F6 Totality of the response to the experience:	.001	.001
F38 Sense of being grasped and dealt with by the experience:	.001	.002
F4 Enhanced capacity of mind:	.008	.008
F7 Sense of having known the universe in its wholeness:	.016	(.063)
F3 Certainty of the reality of what was experienced:	.020	.020

The evidence taken together certainly indicates that phenomena corresponding to that described in our typology did occur and to a marked degree in the form of most essential elements as well as some supplementary ones. The lack of consistency, however, in all three methods of measurement when only "strong" scores were analyzed makes not fully certain the conclusion that the experimentals experienced the most complete form of this category.

We thus conclude that the phenomena described by the category "objectivity and reality" did occur significantly more in the experimentals who received psilocybin than in the controls who did not, as judged from analysis of the essential items alone as well as in combination with the supplementary ones. Evidence showed that the experience of this category was very close to, but not quite identical with, the most complete form of the mystical typology.

Category VI: Paradoxicality

As seen in Table 22, the experimentals scored significantly higher than the controls in the phenomena of paradoxicality for all three methods of measurement (*p* less than .004). The experimentals had more "strong" ratings than the controls, as demonstrated by the frequency distribution of scores. In other words, there are only four chances in 1000 that this difference between experimentals and controls was not enhanced by psilocybin.

TABLE 22
Category VI: PARADOXICALITY
Combination of All Items

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
4 Post-drug: P65, P68, P72, P73c	Exper:	24	4	5	7	116	160	9	.002
	Contr:	1	2	4	33	17	160		
3 Follow-up: F73, F25, F33	Exper:	10	0	4	16	51	150	8	.004
	Contr:	0	1	1	28	4	150		
1 Content Analysis: C13	Exper:	6	2	2	0	24	30	10	.001
	Contr:	0	0	0	10	0	30		

All phenomena which were used to measure paradoxicality are listed in Table 23. All individual items were significant at the .016 level except F73. The interviews revealed the reason for this apparent discrepancy. The wording of this item made the statement untrue for most subjects because of the words, "You have been accused." Subjects who later were found to be experimentals stated that they had not been *accused* of logical contradiction because they had not even tried to describe their experience to someone who would be unsympathetic enough to accuse them of such contradiction. These subjects readily admitted the difficulty of being strictly logical in descriptions of their experience. The content-analysis data and other items which are paradoxical even in their description did show significant differences from the controls even when only the "strong" scores were used (*p* less than .032). Paradoxicality was also supported implicitly by item P64, the converse of item P65. Item P64 stated that "the experience is describable by logical statements which are not contradictory" and did not show a significant difference between experimentals and controls (*p* equal to .35).

TABLE 23
LIST OF ITEMS USED TO MEASURE PARADOXICALITY

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug data (4 items):		
P65 Sense that an attempt to describe the experience in logical statements becomes involved in contradictory language:	.016	.063
P68 Paradoxical dissolving of the subject-object dichotomy in spite of the empirical multiplicity of objects (they are still perceived as separate):	.008	.016
P72 Paradoxical transcendence of space as defined in 68-71:	.004	.008
P73 Pure awareness with no empirical distinctions (i.e., one is beyond the self-consciousness of sense impressions, yet one is not unconscious):	.002	.008
(2) Follow-up data (3 items):		
F73 You have been accused of logical contradiction in trying to describe the meaningfulness of your own experience to others who were not present:	(1)	(1)
F25 Loss of feelings of difference from objects:	.016	.032
F33 Fusion of the self into a larger undifferentiated whole:	.008	.032
(3) Content-analysis data (1 item):		
C13 Paradoxicality:	.001	.016

Experimental Subject QX:

> Everything was part of the other, yet distinct in itself.

(Comment: This is an example of external unity as well as paradoxicality.)

Experimental Subject GP:

> In fact, I'm not sure I have one over-riding impression, unless it is one of a confused kind of clarity.

Experimental Subject TD:

> I had a vision in which the flowing colors seemed to be me. It was infinity, with many timelines running through it. ... I decided then that words were adequate to describe the experience, but only if you could describe each tributary, and say the words all at once.

(Comment: The description is not only paradoxical but is also an example of the next category, alleged ineffability.)

From the consistency of statistical evidence from all methods of measurement we conclude that the experimentals who got psilocybin experienced the phenomena of paradoxicality to the most complete degree defined by this category in our typology of the mystical consciousness.

Category VII: Alleged Ineffability

As seen in Table 24, the experimentals scored significantly higher than the controls in this category for all three methods of measurement (*p* less than .008). The experimentals had more strong ratings than the controls, as demonstrated by the distribution of scores.

TABLE 24
Category VII: ALLEGED INEFFABILITY
Combination of All Items

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
1 Post-drug: P66	Exper:	5	3	2	0	33	40	8	.004
	Contr:	0	4	3	3	16	40		
3 Follow-up: F16, F57a, F92	Exper:	22	5	1	2	115	150	10	.001
	Contr:	1	3	6	20	22	150		
1 Content Analysis: C14	Exper:	2	1	4	3	12	30	7	.008
	Contr:	0	0	0	10	0	30		

All phenomena which were used to measure alleged ineffability are listed in Table 25. All individual items were significant at the .008 level and most were even more significant than this. Alleged ineffability was also supported indirectly by the nonsignificance of item F57b, "the *ease* of communication of your experience," which was the converse of F57a. When only the "strong" scores were used, all individual items remained significant (*p* less than .032) except for the content-analysis data. These were, in fact, a sparsity of statements in the accounts which explicitly stated the difficulty of describing the experience. Perhaps this was due to the fact that the subjects were at the time actually describing their experiences as best they could. Implicit allusions to this phenomenon were more frequent.

Some of the best examples from the content-analysis data of those who had psilocybin are as follows:

Experimental Subject TD:

> I imagined I heard someone describing or explaining our experience, and I wanted to object because they were lying. And yet I felt that it was all that could be said. Somehow it was theological ideas they were messing up, yet I could understand that these lies were the best we could do. But they *were* lies, and that was important, too.

Experimental Subject KR:

> During this time the sense of "we-ness" became a sense of oneness with what I can only describe as "Logos" or a personal Word... (Theological terms were given great meaning in this experience but are totally inadequate in describing the depth and impact of it.)

(Comment: This was also the beginning of the phenomenon of internal unity for this subject.)

Experimental Subject FK:

> I cannot describe the sense of the Divine - He was the eternal mystery that *was*: He was everywhere, but completely transcendent; the Divine, truly not of this world, but whose message had the greatest significance for this world. I felt compelled to go to the front of the chapel, to minister in the name of Christ - for no one else was doing it, and it *had* to be done... For really the first time, I realized that man cannot challenge and try to limit God to a conceptual system: it is God who challenges men to do His will. God is, and that is all one can say. I am human; I will still try to build an elaborate theological system, for my egocentric gratification, and also to be able to communicate with others. (I am not saying that intellectual theology is bad, but that it is so completely inadequate to interpret the Divine.)

(Comment: This is an example not only of alleged ineffability but expresses the sense of sacredness as well. The reality which he felt is an example of the category: Objectivity and reality.)

TABLE 25
LIST OF ITEMS USED TO MEASURE ALLEGED INEFFABILITY

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug data (1 item):		
P66 Sense that the experience cannot be adequately described in words:	.008	.032
(2) Follow-up data (3 items):		
F16 Feeling that you could not do justice to your experience by a verbal description:	.001	.016
F57a You have had difficulty in trying to communicate your own experience to others who were not present:	.002	.032
F92 You now feel that the meaningfulness of your own experience is beyond words:	.004	.016
(3) Content-analysis data (1 item):		
C14 Ineffability:	.008	(.25)

We therefore conclude that the experimentals did experience the phenomenon of alleged ineffability to a considerable degree - certainly sufficient for inclusion as an example of this category as defined by the mystical typology but not in the most intense way possible. In other words, the psilocybin experience under the conditions of this experiment can be concluded to closely resemble this aspect of mystical experience.

Category VIII: Transiency

As seen in Table 26, when the scores of all items were combined, the experimentals scored significantly higher than the controls for all methods of measurement (*p* less than .004). The frequency distribution of scores demonstrated the predominance of high scores for the experimentals and scores of "0" for the controls. In other words, there are only four chances in a thousand that the phenomenon of transiency was not due to psilocybin.

TABLE 26
Category VIII: TRANSIENCY

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Combination of all phenomena:									
6 Post-drug: P12, P26, P27, P28, P30, P31	Exper:	34	11	7	8	180	240	10	.001
	Contr:	0	1	7	52	12	240		
4 Follow-up: F8, F9, F52, F86a	Exper:	27	8	3	2	151	200	10	.001
	Contr:	1	4	1	34	17	200		
1 Content Analysis: C10	Exper:	8	1	0	1	26	30	8	.001
	Contr:	1	0	0	9	3	30		
Essential phenomena:									
2 Post-drug: P30, P31	Exper:	8	6	3	3	56	80	9	.002
	Contr:	0	0	2	18	2	80		
2 Follow-up: F52, F86a	Exper:	11	8	0	1	70	100	9	.002
	Contr:	1	2	0	17	10	100		
1 Content Analysis: C10	Exper:	8	1	0	1	26	30	8	.004
	Contr:	1	0	0	9	3	30		

All the items which were used to measure transiency are listed in Table 27 in two groups: essential and supplementary phenomena. When scores were used in the analysis, all individual items showed a significantly higher score for experimentals than for controls at the .004 level except for suddenness of appearance which was still significant at the .02 level. Under the most rigorous analysis using only "strong" scores, most of the essential items which directly defined transiency as such, remained significant (*p* less than .032) except for F31 and F52. It was interesting that these last two items are consistent because they would indicate that the lighter levels of unusual consciousness (F31) were the ones which did not disappear completely by the next day. Such an "afterglow effect" was confirmed during the interviews. All items which directly measured suddenness remained significant under the most rigorous analysis (P27, F28, and F9), as did those which indicated a change in usual consciousness, P26 and F8 (*p* less than .020 for all these items). The only other item which did not remain significant (*p* less than .13) when only the "strong" scores were used was the experience of several levels (of consciousness) at once (P12) which was not so closely related to transiency as the other items.

Other substantiating evidence that the experimentals experienced change from usual consciousness was item P29 (stability of level of consciousness *during* the experience) which was significant for the controls (*p* less than .035).

Examples of transiency from personal accounts of two experimentals are presented below as further evidence:

Experimental Subject GP:

> ... after I was quite completely "out" of the experience, talking with my group and eating an apple...

Experimental Subject QX:

> At this point, the service had come to a close, and I was beginning to lose the full strength of my experience.

TABLE 27
LIST OF ITEMS USED TO MEASURE TRANSIENCY

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Essential phenomena:		
a. Post-drug data (2 items):		
P30 Transiency of duration of deepest levels:	.002	.032
P31 Transiency of duration of levels other than the deepest:	.004	(.13)
b. Follow-up data (2 items):		
F52 Return to you usual state of consciousness day after the experience:	.002	(.063)
F86a You have lost by now the state of consciousness you experienced on Good Friday:	.004	.016
c. Content-analysis data (1 item):		
C10 Transiency of unity:	.004	.008
(2) Supplementary phenomena:		
a. Post-drug data (4 items):		
P26 Appearance of various levels of consciousness:	.001	.002
P27 Suddenness of appearance of various levels of consciousness:	.002	.004
P28 Suddenness of disappearance of various levels of consciousness:	.004	.016
P12 Being able to operate on several levels at once:	.004	(.13)
b. Follow-up data (2 items):		
F8 Definite change in your usual state of consciousness:	.002	.002
F9 Suddenness of appearance of various dimensions of consciousness:	.020	.020

For more precise analysis, the items most essential to the definition of the category were analyzed as a group separately from those items which were only closely related. As seen in Table 26, the results in terms of total scores, score distribution, and significance level, followed a pattern similar to that of the combined scores of all the items (*p* less than .004 for all subcategories).

The most important individual item was F86a because here the return to usual consciousness was measured after six months rather than after a few days. The experimentals had significantly more "strong" scores than the controls (*p* less than .016).

The closely related items were really a prerequisite for the essential ones, because a return to usual consciousness would not be relevant if there had been no change during the experience. The most specific item in this regard is from the content-analysis data. C10 represents the whole category because this distinction between "during" and "after" the experience was explained. Judges were told to score evidence of transiency of unity - a basic phenomenon of the mystical typology.[4] The fact that this item remained significant under the most rigorous analysis confirms the conclusion from the rest of the data that the phenomena of transiency indeed were experienced more by the experimentals than controls, and to the most complete degree in the typology. In other words this phenomenon was induced by the ingestion of psilocybin under the conditions of this experiment.

Category IX: Persisting Positive Changes in Attitude and Behavior

As seen in Table 28, the experimentals scored significantly higher than the controls for both methods of measurement, when all items were combined which rated persisting positive changes, compared to the subjects' condition before the experiment (*p* less than .001 for followup data, and less than .002 for content-analysis data). The frequency distribution of scores indicated that there was a predominance of "strong" scores for the experimentals, and "0's" for the controls. The individual items which measured this category were listed in Table 29 in four subcategories: (1) changes toward self, (2) changes toward others, (3) changes toward life, and (4) changes toward the experience.

---

4. See instruction manual in appendix E under "transiency of unity."

TABLE 28
Category IX: PERSISTING POSITIVE CHANGES AFTER SIX MONTHS
Combination of All Subcategories

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
39 Follow-up:	Exper:	152	42	86	110	944	1950	10	.001
	Contr:	14	47	52	227	290	1950		
4 Content Analysis:	Exper:	20	2	1	17	65	120	9	.002
	Contr:	4	1	0	35	14	120		

TABLE 29
LIST OF ITEMS USED TO MEASURE PERSISTING POSITIVE CHANGES IN ATTITUDE AND BEHAVIOR

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Toward Self:		
a. Follow-up data (11 items):		
F55b You have more personal integration:	.002	(.063)
F58b Your behavior has changed in ways you would consider positive since the experience:	.002	(.063)
F63a You have a greater sense of inner authority in your life:	.002	.032
F64b Your life has a heightened dynamic quality:	.008	(.063)
F74b Feelings of anxiety have decreased:	.016	(.25)
F87a You have more joy in your life:	.016	(.25)
F77b You are more creative person:	(.062)	(.25)
F61b Feelings of depression have decreased:	(.063)	(.25)
F66b You have increased feelings of happiness:	(.11)	(.25)
F69b You have more peace in your life:	(.11)	(.25)
F71b You have an increased achievement efficiency:	(.50)	(1)
b. Content-analysis data (1 item):		
C15 Changes toward self after six months:	.004	.008
(2) Changes toward others:		
a. Follow-up data (7 items):		
F54a You have become more sensitive to the needs of others:	.002	.032
F60b You are more your true self with others:	.008	.032
F91a You are a more authentic person:	.016	.032
F85b You now feel more love toward others:	.016	(.063)
F68a You are more tolerant toward others:	.032	(.063)
F76a You have a more positive relationship with others:	(.063)	(.063)
F65b Others have remarked about a positive change in you since Good Friday:	(.19)	(.19)
b. Content-analysis data (1 item):		
C17 Changes toward others after 6 months:	(.812)	(.812)
(3) Changes toward life:		
a. Follow-up data (15 items):		
F53a The experience has changed your philosophy of life positively:	.001	.032
F89a Time spent in quiet meditation has increased:	.008	(.25)
F83b You spend more time for devotional life:	.008	.032
F62a Your appreciation for life has increased:	.002	(.13)
F82 You feel you now know a new dimension of life:	.004	.032
F81b Your life has more richness:	.020	(.13)
F67a Your life has more meaning:	.035	(.063)
F79a Your sense of values (i.e., what is important to you in life) has changed positively:	.035	(.13)
F59a You now feel a greater need for service for others:	.035	(.13)
F84a Your appreciation for the whole of creation has increased:	.035	(.063)
F95 You now feel your life has taken a definite change of course because of this experience:	.032	(.13)
F72a You have an increased sense of reverence:	(.062)	(.063)
F78a You have more enthusiasm for life:	(.062)	(.13)
F75b You now have a more certain vocational commitment:	(.063)	(.063)
F93b You have more of a sense of the adventurous outreach of life:	(.09)	(.09)
b. Content-analysis data (1 item):		
C19 Changes toward life after six months:	.016	.016
(4) Changes toward the experience:		
a. Follow-up data (5 items):		
F56a You learned something useful from the experience:	.004	.032
F94a Your experience has been valuable for your life:	.020	.020
F96 You have tried to recapture any parts of the Good Friday experience since then:	(.15)	(.15)
F98a You would be interested in repeating the same experience you had on Good Friday:	(.26)	(.26)
F99a You would be interested in having more of these kinds of experiences (not necessarily with the hope of an exact repetition of your Good Friday experience):	(.23)	(.23)
b. Content-analysis data (1 item):		
C21 Changes toward the experience after six months:	(.5)	(.5)

Changes toward self

Seven out of the twelve items which represented persisting changes toward self, were significant below the .016 level. These items indicated a definite positive change in both behavior (F58b) and attitude in terms of better inner functioning - e.g., increased personal integration (F55b), inner authority (F63a), dynamic quality (F64b), and joy (F87a); and decreased anxiety (F74b). Increased creativity (F77b) and decreased depression (F61b) were almost significant (*p* less than .063). When only "strong" scores were used, inner authority (F63a) remained significant (*p* less than .032), and F55b, F58, and F64b had higher scores for experimentals than for controls but just above the .05 level of significance (*p* less than .063).

Changes toward others

Five out of the seven items which represented changes toward others were significant (*p* less than .032). These items indicated a definite positive change in interpersonal relations in terms of more sensitivity (F54a), authenticity (F60b and F91a), tolerance (F68a), and love (F85b). More positive relationships with others (F76a) was almost significant (*p* less than .063). Of these five most significant items, three remained significant at the .032 level when only "strong" scores were used. These most important items were the phenomena of more sensitivity and more authenticity in being one's true self with others (F54a, F60b, F91a).

Changes toward life

Thirteen out of the 17 items which represented changes toward life were significant at the .035 level. Increased sense of reverence (F72a), vocational commitment (F75b), and enthusiasm for life (F78a), were only significant at the .063 level. Of the 13 most significant items, the four most important, as indicated from "strong"-score analysis were: positive change in philosophy of life (F53a), knowledge of a new dimension of life (F82), and increased sense of the preciousness of life (F90b) - *p* less than .032: increased meaning (F67a), sense of reverence (F72a), vocational commitment (F75b), and appreciation for creation (F84a) were significant under such analysis only at the .063 level.

Changes toward the experience

Two of the six items which represented persisting changes toward the experience were significant at the .020 level: learned something useful (F56a) and considered the experience valuable (F94a). These differences between experimentals and controls also remained significant when only the "strong" scores were used (*p* less than .032 for both items).

TABLE 30
Category IX: PERSISTING CHANGES *TOWARD SELF* AFTER SIX MONTHS

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Persisting POSITIVE Changes:									
11 Follow-up: F55b, F58b, F61b, F63a, F64b, F66b, F69b, F71b, F74b, F77b, F87a	Exper:	30	12	27	41	205	550	10	.001
	Contr:	0	7	11	92	36	550		
1 Content Analysis: C15	Exper:	7	1	0	2	23	30	8	.004
	Contr:	0	0	0	10	0	30		
Persisting NEGATIVE Changes:									
11 Follow-up: F55a, F58a, F61a, F63b, F64a, F66a, F69a, F71a, F74a, F77a, F87b	Exper:	2	1	28	79	52	550	7	(.062)
	Contr:	0	1	5	104	9	550		
1 Content Analysis: C16	Exper:	1	0	2	1	5	30	3	(.13)
	Contr:	0	0	0	10	0	30		

As shown in Tables 30-33, the combined scores for the subcategories, changes toward self and toward life, were significant for the experimentals from both methods of measurement (*p* less than .016). The total scores and score distribution from these two subcategories were consistent with those of the combined scores of all items in the category (predominance of "strong" scores for experimentals and "0's" for controls). While the other two subcategories, changes toward others and toward the experience were significant from the follow-up data (*p* less than .001 for others and less than .055 for the experience), there was no significant difference between experimentals and controls in the content-analysis data (*p* greater than .19).

TABLE 31
Category IX: PERSISTING CHANGES *TOWARD OTHERS* AFTER SIX MONTHS

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Persisting POSITIVE Changes:									
7 Follow-up: F54a, 60b, 65b, 68a, 76a, 85b, 91a	Exper:	30	8	14	18	178	350	10	.001
	Contr:	0	10	10	50	45	350		
1 Content Analysis: C17	Exper:	3	0	1	6	10	30	5	(.50)
	Contr:	2	1	0	7	8	30		
Persisting NEGATIVE Changes:									
7 Follow-up: F54b, F60a, F65a, F68b, F76b, F85a, F91b	Exper:	0	0	7	63	11	350	3	(.50)
	Contr:	0	0	1	69	1	350		
1 Content Analysis: C18	Exper:	0	1	0	9	2	30	1	(1)
	Contr:	0	0	0	10	0	30		

TABLE 32
Category IX: PERSISTING CHANGES *TOWARD LIFE* AFTER SIX MONTHS

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Persisting POSITIVE Changes:									
16 Follow-up: F53a, F59a, F62a, F67a, F72a, F75b, F78a, F79a, F81b, F82, F83b, F84a, F89a, F90b, F93b, F95	Exper:	60	19	39	42	393	800	10	.011
	Contr:	3	19	20	118	105	800		
1 Content Analysis: C19	Exper:	6	0	0	4	18	30	6	.016
	Contr:	0	0	0	10	0	30		
Persisting NEGATIVE Changes:									
14 Follow-up: F53b, F59b, F62b, F67b, F72b, F75a, F78b, F81a, F83a, F84b, F89b, F90a, F93a, F79b	Exper:	0	1	16	123	21	700	5	(.50)
	Contr:	0	2	4	134	11	700		
1 Content Analysis: C20	Exper:	1	0	0	9	3	30	1	(1)
	Contr:	0	0	0	10	3	30		

TABLE 33
Category IX: PERSISTING CHANGES *TOWARD EXPERIENCE* AFTER SIX MONTHS

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items	**(*n*=10)**	**Strong**	**Moder.**	**Slight**	**None**	**Actual**	**Maximum**	***N***	***p***
Persisting POSITIVE Changes:									
5 Follow-up: F56a, F94a, F96, F98a, F99a	Exper:	32	3	6	9	168	250	10	.055
	Contr:	11	11	11	17	104	250		
1 Content Analysis: C21	Exper:	4	1	0	5	14	30	5	(.19)
	Contr:	2	0	0	8	6	30		
Persisting NEGATIVE Changes:									
4 Follow-up: F56b, F94b, F98b, F99b	Exper:	2	5	2	31	27	200	8	(.64)
	Contr:	3	1	0	36	16	200		
1 Content Analysis: C22	Exper:	0	0	2	8	2	30	2	(.25)
	Contr:	0	0	0	10	0	30		

Both the follow-up accounts were designed to measure negative as well as positive changes. The positive items discussed above had their negative counterparts, but the only individual items significant below the .01 level were F74a, increased feelings of anxiety (*p* less than .032), and F61a, increased feelings of depression (*p* less than .63). When only "strong" scores were used, neither of these items remained significant (*p* greater than .5). Some ambiguity existed, however, because the positive expressions of both these items (F74b and F61b) were at least, if not more, significant than the negative. These two negative items belong to the subcategory "changes toward self," which tended toward significance (*p* = .062) in the follow-up data for this subcategory as a whole, but was clearly not significant in the content-analysis data. None of the negative subcategories showed a significant difference between experimentals and controls, at the .05 level, from either method of measurement. (See Tables 30-33.) The total negative scores of these categories were relatively low in relation to the number of items represented, and the score distribution was predominantly at the low end of the scale - almost entirely "0's" for both experimentals and controls. The positive changes far outbalanced in number and intensity the few and relatively moderate negative changes reported.

Some examples of persisting positive changes from the content-analysis data are as follows:

Changes toward self:

Experimental Subject HQ:

> Very strongly beneficial: I have had a much greater degree of self-realization since Good Friday. By this I mean a greater certainty of being and becoming. Closely connected with this is the feeling of being a creature of purpose.
> I feel that I have a greater realization of my motives that lie behind my various actions. I do believe I have an awareness of the selfishness that underlies many of my actions. This realization has been met with attempts to cast this selfishness aside to go beyond it.
> I have made reference to the joy I experienced when I came back to life since the Good Friday afternoon experience. At times I have felt a joy of being alive and having real existence. I do not believe I have ever experienced it previous to Good Friday to the degree I did then or to the degree I have since, even though I intellectually knew of it.

Experimental Subject GP:

> Very strongly beneficial: Expanded awareness of myself. Regularly, in introspection, occasionally spontaneously, I recognize dimensions of my life that I had not known before: longings, goals, abilities, kinds of strength.

Changes toward others:

Experimental Subject TD:

> Strongly beneficial: Increased willingness, though not necessarily ability, to see interpersonal relations from the side of the other person. An increased insight into interpersonal relations.

Experimental Subject FK:

> Strong benefit: A startling sensitivity to others - especially to those with "problems".

Changes toward life:

Experimental Subject FK:

> Very strong benefit: A sense of "call" - insofar as this means that the Word must be proclaimed to the "world" - not so much verbally as "existentially", and that somehow I must respond to this challenge, as it has appeared to me.

Changes toward the experience:

Experimental Subject EB:

> Moderately beneficial: An appreciation of and ability to enter in a limited way into experiences dealing with that beyond one's usual consciousness (two aspects of which are "mystical" elements and "unconscious" elements).

Experimental Subject FK:

> Very strong benefit: A profound recognition of the role of the "mystical" in the full religious life - but this attitude seemed not as an escape from the world, rather giving me a greater sense of concern for the here and now.

Experimental Subject RM:

> Very strongly beneficial: Strong desire for prayer, communion with God, and time in the "wilderness".

Experimental Subject KR:

> Strongly beneficial: Aid in spiritual growth.

A significant difference between experimentals and controls in persistent positive changes after six months in all four subcategories has been demonstrated by these data. The most significant subcategories were changes toward self and changes toward life. The most important changes were those due to strong scores, as has been suggested. Changes toward others and toward the experience, occurred in both the experimentals and the controls, as seen from the total scores of these subcategories. Perhaps the interaction with the experimentals was a factor in these results, as is suggested by the following quotes from three controls:

Control Subject NJ:

> The entire day was meaningful - helped to draw friendships tighter and added much meaning to my religious life. ... Reverend "X", FK, and his entire activity (including playing "Jesus Christ is Risen Today"), and the talks afterward, were contributors to an extremely meaningful experience.

Control Subject IA:

> It was one of the most exciting days of my life. The fellowship with the students, and particularly with all of the wonderful group leaders, was very meaningful.

Control Subject JN:

> I was very glad to have been able to be part of the experience; for the first time I was really able to talk in depth with RM and TD.

(Comment: RM and TD were the experimentals in JN's group.)

The conclusion can be drawn that in terms of certain changes toward self and changes toward life, the drug experience is similar if not identical with changes resulting from mystical experiences as defined by our typology. This conclusion is not as certain for changes toward others and toward the experience because of lack of confirmation from content-analysis data, although specific items, as well as these subcategories as a whole, were strongly significant in the followup data.

Other Data

Items which were not directly applicable to categories of our typology of mysticism are listed in Appendix G, in four main groups:

I. Integrative and constructive phenomena.
II. Disturbing changes in attitude and behavior.
III. Physical sensations.
IV. Miscellaneous.

The significance level of the difference in scores between experimentals and controls was given both when all scores were counted and also when only "strong" scores were used. This information, while interesting, does not contribute directly to the argument presented above.

I. Integrative and constructive phenomena:
The most striking phenomena under this grouping were the death-rebirth experiences during the experiment (significant at .032 level), which may have helped foster the lasting sense of new significance and meaning to life.

II. Disturbing changes in attitude and behavior:
Almost all of these phenomena which showed a significant difference between experimentals and controls, took place *during* the experience. In the six-month follow-up questionnaire, as has been shown above, only increased anxiety was significant below the .05 level, and this was not due to "strong" scores. Nine out of ten of the experimentals gave a positive evaluation to their experiences as a whole, in spite of the occurrence of some negative elements, of which transient fear was the most striking, as shown in the following examples from the content-analysis:

> *Experimental* Subject FK:
>
> > Afterwards (by that, meaning Saturday and somewhat Sunday), I did have a distinct negative feeling beside the much, much stronger feeling of having been through a most meaningful, deep and significant experience. I would like to sincerely thank you for making this opportunity available for me... and I am sure it will have positive and creative effects on my "quest for realization" as I integrate the insights which were gained.
>
> *Experimental* Subject DT:
>
> > Despite the fear and negative attitude when I was in that one violent and painful dream, my reaction to the whole experience was a positive one, and I think I should like to do it again.

The relation between mysticism and phenomena generally considered as psychopathology is an interesting one which needs further elucidation and research, but is beyond the scope of this dissertation.

III. Physical phenomena:
The variety of physical sensations, especially visual, which accompanied the drug experiences, were interesting and could be compared to the equally diverse physical manifestations reported by the mystics, but again, such a comparison was not the chief area of interest of this research. It is noteworthy that no experimental subject became preoccupied with negative physical phenomena such as dizziness or vomiting, although transient nausea was experienced (p less than .008). This result may have been due to the lack of emphasis on physical phenomena in the preparation of the subjects. The controls had significantly higher scores than the experimentals on the sensations of warmth and itching (P115 and P116) at the .035 level. These scores reflected the effectiveness of action of nicotinic acid on the controls.

IV. Miscellaneous:

There was 100% agreement among experimentals and controls as to who got psilocybin, as shown by the score difference between experimentals and controls on P128, F100a, and F100b, when only "strong" scores were used (*p* less than .001).

Chapter VII
GENERAL DISCUSSION AND CONCLUSIONS

Discussion of Design

Alternate ways of designing the experiment were considered. Subjects could have been told nothing other than that they were going to participate in a psychological experiment with drugs in a non-religious setting. The presupposition, however, that set and setting are very important led to the use of techniques which would encourage a serious and expectant attitude, group support, a trustful atmosphere, and security for the subjects who, it was hoped, would have meaningful experiences. Everything possible was done to discourage the development of fear, suspicion and mistrust. The chapel as setting; theological students as subjects; and the religious focus in preparation, expectation, and implementation were deliberate for maximum encouragement of "religious or mystical" phenomena, because these were what we wanted to study. To control for so much positive suggestion double-blind procedure was employed for an experimental and control group.

The psychedelic drug experience is so unique and powerful that the double-blind control design would have been completely meaningless if the subjects had known what to expect from previous experience for they would have certainly known whether or not they received the drug.[1] In our study double-blind technique was initially effective because none of the twenty subjects had ever had an experience before with LSD, psilocybin, or mescaline. In spite of this fact by the time the chapel service was over all of the experimentals were certain that they had received psilocybin because of the profound changes from their usual state of consciousness. One purpose of the control group was to measure the effect of suggestion. Data from the tape recordings, written accounts, and interviews indicated that in the early part of the experiment positive suggestibility was greatly enhanced by the somatic effects of the nicotinic acid which the controls had all assumed was psilocybin. They had waited with eager anticipation for more effects. By the end of the chapel service, however, most of the control subjects were doubtful that they had received psilocybin, but were still uncertain because of the impact of the service combined with the initial somatic effects. The following excerpt from a tape recording which was made immediately after the service illustrates this fact:

> *Control* Subject MC:
>
> > Soon after swallowing the pill I noticed sensations of heat. Then I found myself in a very relaxed state... very free. After going into the chapel, time went very quickly. The service was very meaningful. ... Rev. "X's" voice seemed to have an effect on me. A times I felt like cheering and at other times like crying. His Bible readings moved me. I felt as if I were there for the first time and really experiencing these things, but at this time I honestly can't say whether I had the drug or not.

During the group discussions the qualitative difference in experiences became strikingly obvious to the participants. This created a bias in the controls, but their written accounts were remarkably similar to their tape recordings which were made after the service before the group discussions. Also the fact that the subjects had been told that some would not receive psilocybin made them curious as to their status and eager for any distinguishing sign. The nicotinic acid acted within ten to twenty minutes, but within an hour and one-half most of the physical affects had worn off. The psilocybin took from thirty minutes to one-and-one half hours to become noticeable. Two of the ten experimentals did not feel any effects until after the chapel service started. The possibility of giving the experimentals a combination of psilocybin and nicotinic acid to produce a similarity of initial somatic effects (e.g., flushing and itching of the skin) in both the experimental and control groups was considered but rejected because the possible antagonism between nicotinic acid and psilocybin was not known. Also, such initial physical effects might have focused the psilocybin experience on physical symptoms.

---

[1] Sherwood, Stolaroff, and Harman, *op. cit.*, p. 72.

Deception might have been used by telling the subjects that they all would receive psilocybin, but it was felt that such a design might have disturbed the atmosphere of trust and friendliness by arousing confusion and suspicion. Actually some deception was used because although the subjects had been told that some would not receive psilocybin, they had not been told that a control substance would be given. The controls had assumed that they would get a true placebo. Afterwards three control subjects expressed some resentment because of this assumption, but were still willing to cooperate in collection of data. Disappointment was a much stronger sentiment. During the interviews (including the one after six months) discussion of who might have been an experimental or control was discouraged. The experimenter emphasized the fact that he did not know who had received psilocybin and that there was a possibility of non-reaction to the drug. Most of the subjects, however, did not become less certain that they either received or did not receive psilocybin.

Obviously, a disadvantage of having the experimentals and controls mixed in the same session was that the behavior and experience of the experimentals had an effect upon the way that the controls evaluated their own experiences by giving them a clue as to their status. The mixed discussion period after the service would be subject to the same criticism only more so because the controls listened to others describe their experiences. The discussion period was designed to give group support and security to those recovering from the effects of the drug. The controls could not help comparing their experiences to those of their friends. Such a comparison would have been inevitable, however, because of the close-knit relationship of all the participants who attended classes together at the same school.

As an alternative procedure, the control group of matched subjects could have attended the same service (which could have been reproduced because it was taped) at a different time from the experimentals. Such a design, however, would have destroyed the double-blind feature, and the set and setting would not have been the same for both groups. The separate, although matched, experimental and control groups would have had to have been kept from communicating or even knowing about each other (perhaps by using students from different seminaries). The preparation and expectation would not have been quite the same. The natural effect of a Good Friday service would have been lost by having the reproduced service on two separate occasions other than Good Friday. With such a design the experimenter and leaders would have known which group was experimental and which was control after the first group had participated. The way the experiment was actually run, uniformity of set, setting, and suggestion was maximized. The experiment demonstrates the difficulties of double-blind technique in group sessions with such dramatic and powerful drug-induced effects in the experimental group.

Subjects might have been screened to find only those who had a particular mystical inclination or who had previously had experiences which closely resembled the mystical typology. Such persons might have felt more at ease in the drug situation, and perhaps their drug experiences might have been even closer to the mystical state of consciousness. Only four of the twenty subjects would have definitely qualified under such a criterion. These four were matched into pairs, and these two experimentals had some of the more strongly "mystical" experiences. As might be expected, their controls were the two who found the religious service most meaningful. To ding twenty such subjects might not have been possible at the same seminary and would heave required hundreds of hours of interviews. It was thought more instructive to see what would happen with a more representative sample within an already specialized group, all of whom were especially interested in religion.

Observations of the Experimenter during the Experiment

Although the main purpose of this research was to study the internal experience of the subjects, their external behavior during the experiment was also observed and recorded. In general the experiment ran smoothly, according to plan. Before the capsules were distributed there was a general tone of excitement, and eager yet serious expectation. During the first one-and-on-half hours, quiet was observed relatively unbroken in the groups. A few subjects felt the need to visit the men's room for natural purposes or for a smoke. Several subjects asked the experimenter for reassurance because of various somatic symptoms (such as heat or "feeling very strange"). Some were noticeably flushed. The majority sat quietly with their groups. When the time came to move into the chapel, only one subject who felt a little nauseated remained behind with his leader for a time.

The experimentals as a group stayed in the chapel for about 85% of the service compared to the controls who stayed for about 95%. During the first half of the service there was not much activity in or outside the chapel. For the last half more overt behavior occurred in the experimentals. A few went up to the altar. One entered the pulpit and sat at the organ in a symbolic way to express what he felt was a need for someone to lead the service. There were some spontaneous vocal exclamations and some weeping. A few lay down on the pews or the floor; most sat quietly throughout.

Most of the movement outside the chapel was to the men's room. One experimental subject wanted to sit quietly in one of the large rooms for about an hour. Only one subject was taken out of the service by his leader because he became too restless. The leader stayed with him for reassurance.

The leaders were especially helpful in making the experiment run smoothly. The ones who received psilocybin seemed to be entering into the experience much more fully. As leaders, there was no observable difference in effectiveness between the psilocybin and non-psilocybin group. Most of the experimental subjects did not need individual attention, but several later expressed appreciation for the reassurance afforded by the presence of experienced leaders. During the relaxed group discussions, there was more rapport between leaders and subjects who had received psilocybin than between those who had not. Not until after the service had begun did the leaders definitely determine which of their group members received psilocybin. In fact, there were a few initial wrong guesses.

In some cases, there was, after the service, a difference in appearance and behavior between experimentals and controls. Pupil dilation was an obvious physical sign. Experimentals were also more informally attired; ties had been loosened or removed, and hair was not combed. Their dominant mood was quiet detachment or joyful exuberance. They wanted to share the impact of their experience with their friends. Two had a little difficulty in readjusting to the "ordinary" world and needed special reassurance by their leaders until the drug effects subsided.

Summary and Discussion of Data

The data in general have indicated that the experimental subjects, who received psilocybin in the same setting and with the same preparation as the controls, had a statistically significant, *different* experience, as indicated by the higher scores on particular items and groups of items from the three methods of measurement.

These differences in terms of the phenomena of the categories defined in our typology of mysticism were presented in detail in Chapter VI. With the exception of sense of sacredness the combined scores of all items in every category were significantly higher for the experimentals than for the controls, by all three methods. As summarized in Table 34, the significance levels of these score differences were less than .02. The difference in sacredness was not significant only in the content-analysis data (*p* greater than .37). The conclusion from these data is that the persons who received psilocybin experienced to a greater extent than did the controls the phenomena described by our typology of mysticism. But a more rigorous analysis was needed to determine the degree to which these persons experienced such phenomena. As presented in Chapter VI and summarized in Table 35, when only the scores of the items most essential to the definition of each category were combined into more precise subcategories, the differences between experimentals and controls persisted, for the most part, in their significance (*p* less than .02). This finding adds weight to our initial impression from Table 34, but still does not answer the question of completeness.

The essential items which remained significant at less than below the .05 level when only "strong" scores were used, were the best indication of the *degree* of completeness or intensity to which the phenomena of the mystical typology had been experienced. In each subcategory the number and occurrence of such essential items from each method of measurement have been discussed above in Chapter VI. The results from the most important subcategories are presented in summary form in Table 35. The subcategories fell into three groups representing three levels of completeness or intensity on the basis of the empirical data.

TABLE 34

SUMMARY OF SIGNIFICANCE LEVELS REACHED BY EXPERIMENTAL GROUP FOR CATEGORIES MEASURING THE TYPOLOGY OF MYSTICISM

	Method of Measurement		
	Post-drug Questionnaire	Follow-up Questionnaire	Content Analysis
Category			
I: Unity	.001	.001	.002
II: Transcendence of Time & Space	.001	.001	.001
III: Deeply Felt Positive Mood	.020	.020	.002
IV: Sacredness	.020	.055	(.37)
V: Objectivity & Reality	.011	.001	.020
VI: Paradoxicality	.002	.004	.001
VII: Alleged Ineffability	.004	.001	.008
VIII: Transiency	.001	.001	.004
IX: Persisting Positive Changes in Attitude & Behavior	this method of measurement did not measure this category	.001	.002

TABLE 35

SUMMARY OF DATA MEASURING DEGREE OF COMPLETENESS OR INTENSITY OF CATEGORIES OF THE TYPOLOGY OF MYSTICISM

	Significance levels reached by experimental group when only the most essential items were combined:			Essential items which remained significant at .05 level when only "strong" scores were used:		
Category	**Post-drug Quest'n're**	**Follow-up Quest'n're**	**Content Analysis**	**Post-drug Quest'n're**	**Follow-up Quest'n're**	**Content Analysis**
I: Unity						
A. Internal	.001	.002	.002	P9, P72a, P73, P74	F18, F19, F33, F42, F47	C7
B. External	.008	.016	.016	P68	F25	NONE
II: Transcendence of Time and Space						
A. Time	.001	.001	.001	P75, P80	F1, F26, F35	C1
B. Space	.004	.002	.001	P72, P76, P81	F2, F34	C2
III: Deeply Felt Positive Mood						
A. Most Universal	.020	.020	.020	P39	F11, F29, F39	NONE
B. Love	(.15)	.055	.035	NONE	F24	NONE
IV: Sacredness						
A. Implicit	.020	.011	(.37)	P56	F22	NONE
B. Explicit	.09	.09	(.37)	NONE	F30, F48	NONE
V: Objectivity & Reality	.004	.020	.020	P33	F10, F17, F27, F70	NONE
VI: Paradoxicality	.002	.004	.001	P68, P72, P73	F25, F33	C13
VII: Alleged Ineffability	.004	.001	.008	P66	F16, F57a, F92	NONE
VIII: Transiency	.002	.002	.004	P30, P31	F86a	C10
IX: Persisting Positive Changes						
A. Toward Self	a	.001	.004	a	F63a	C15
B. Toward Others	a	.001	(.50)	a	F54a, F60b, F91a	NONE
C. Toward Life	a	.011	.016	a	F53a, F82, F90b	C19
D. Toward Experience	a	.055	(.19)	a	F56a, F94a	NONE

[a] Not used for measuring this category.

The *first* group very closely approximated the most complete phenomenological expression of the mystical typology. From all methods of measurement, they had both statistically significant higher scores for the experimentals than for the controls (*p* less than .016), and essential items which remained significant after "strong" score analysis. These subcategories were: *internal unity*, *transcendence of both time and space*, *transiency*, *paradoxicality*, and *persisting positive changes in attitude and behavior* toward *self and life*. We conclude that these phenomena of the mystical typology were experienced in a rather complete way by the subjects who took psilocybin.

The *second* group of subcategories was considered almost but not quite equivalent to the maximum degree of intensity or completeness defined by our typology. They had statistically significant, higher scores for the experimentals than for the controls, from all three methods of measurement (*p* less than .020), and had some items which survived by the most rigorous application of the Sign Test from both questionnaire studies, but *not* from the content-analysis data. These essential subcategories were: *external unity*, *objectivity and reality*, *alleged ineffability*, and the most universal phenomena of *deeply felt positive mood* (*joy*, *blessedness*, and *peace*). It will be remembered from our analysis in Chapter VI that joy was the significant element in this last-mentioned subcategory and that peace and blessedness were experienced but not to a significantly higher degree by experimentals. Objectivity and reality had strong supporting evidence from supplementary phenomena such as intensity and totality of the experience. We conclude that the evidence for completeness in this group (from experimentals who took psilocybin) was strong, but not maximal.

The *third* group showed evidence that the phenomena of the mystical typology had been experienced, but not to the most complete degree possible. They did not have confirmation on the significance of the subcategory as a whole, nor on items which remained significant after "strong" score analysis from all methods of measurement. The content-analysis data usually were not significant. These subcategories were the less universal phenomenon of *deeply felt positive mood* (*love*), *persisting positive changes toward others* and *the experience, and sense of sacredness*.

Persisting positive changes in attitude and behavior toward others and toward the experience after six months, while not confirmed by the content-analysis, nevertheless have strong evidence from the follow-up questionnaire. Judged from the content analysis, these changes were apparently not so important to the subjects as changes toward self and life, but the subjects still indicated, when specifically asked on the follow-up questionnaire, that in ways such as more sensitivity and more authenticity toward others, and evaluation of the experience in terms of learning something considered personally very valuable, the experimentals scored significantly higher than the controls with "strong" scores. In addition, when all scores were used, other individual items from all the subcategories under persisting positive changes were significant, as has been discussed above. The weakest evidence for difference between experimentals and and controls was for the category, sense of sacredness. Even here the weight of evidence indicated that sacredness definitely was experienced more by the experimentals, as indicated from the post-drug and follow-up data in both the category as a whole and when only "strong" scores were used. The implicit kind of phenomena predominated, and awe (P56 and F22) was especially strong (see Table 35).

We should here distinguish between experimentals and controls in these categories which did not show evidence that the phenomena of the mystical typology had been experienced to the highest degree. In every category, subcategory, or individual item which contributed to a category or subcategory, the experimentals always had a higher total score than the controls, and no individual item was significant for the controls when only "strong" scores were used.

The controls did not experience the phenomena of the mystical typology to any degree of completeness. The subcategories in which the total scores of the controls were closest to the experimentals, were: blessedness and peace; sense of sacredness; love; and persisting changes toward others and toward the experience. These categories were the ones which were least significant (although *p* was still less than .055 in the majority of instances), and showed the most disagreement from the three methods of measurement. The design of the experiment suggests an explanation for the relatively high scores of the controls in these subcategories. In the case of sacredness, the meaningful religious setting of the experiment would naturally have encouraged such a response. The data from the questionnaires illustrated the difference in significance between explicit and implicit kinds of sacredness. Table 19 shows that the controls were closer to, although still below, the experimentals in total score for explicit phenomena than for implicit, in which the experimentals had significantly higher scores (*p* less than .02). In the case of love and changes toward others and toward the experience, observations by the controls of the profound experiences of the experimentals and interaction between the two groups on an interpersonal level were important parts of the experience for the controls. This fact was confirmed by the interviews after the experience.

The phenomena which the controls experienced most were among those which were experienced to the least degree of completeness by the experimentals. It can reasonably be assumed that the lack of significance for the experimentals in these categories was due to the experience of the phenomena by the controls, although at a lesser level of intensity and completeness, as was seen from frequency distributions of scores in Chapter VI.

External unity, on the other hand, was not experienced to any marked degree by the controls (mostly scores of "0"). The lack of significance, in this case in the content-analysis data, is assumed to be due to inadequate evidence from the accounts. The design of the experiment did not bring out this type of phenomenon. Individual meditation in a darkened chapel for the peak of the drug effect emphasized and nurtured internal rather than external experience.

From inspection of Table 35, it can be seen that for the subcategories which failed to be confirmed from all methods of measurement, the content analysis was usually the reason. This means that the judges felt that the personal accounts did not indicate "strong" or "most complete" experiences in these categories. Were they correct in their judgment? On the one hand, as judges who understood how each category was defined, they could give a more accurate score than subjects who were rating themselves on individual phenomenological items, but did not know what category was being measured. On the other hand, the judges were scoring only on the basis of second-hand reports. We must not make the assumption that each subject wrote down his complete experience. He might not have mentioned some particular phenomena because he did not think of it when he was writing his report, although we can assume that he reported what he thought was most important or what impressed him the most. Stace has pointed out that even the mystics did not write as much as we would have liked about the actual phenomenology of their experiences.[2] The questionnaires and interviews provided a check on this type of omission, and such evidence should not be ignored. It might be argued that the experimentals may have used "strong" scores indiscriminately on the questionnaires merely because their experiences were so unusual or intense. There was, however, a selective preference for certain items as can be seen from appendices C and D where the significance levels for all items in both questionnaires are listed. The score distributions listed in the tables in Chapter VI also showed that not all phenomena scored by the experimentals were rated "strong".

Individual reactions to the experience as a whole came out strongly in the interviews. Nine out of ten of the experimentals considered that their experience was significant and worthwhile and would be very willing, in fact eager, to try the experience again. Judged from the interviewer's perspective, eight out of ten of these experiences were predominantly positive, and had a pronounced significant and worthwhile effect in the lives of the persons involved, according to their own testimonies. One experimental had what he considered a worthwhile and significant experience from which he learned a great deal, but in regard to mystical phenomena his experience was not on the same level with the other eight. In his account and interview it was obvious that he had spent much of his time trying to remain in control and to interpret and intellectualize his experience. At one point he attempted to memorize Greek vocabulary-cards. After one such experience he was eager to have another chance to let himself go into the experience more completely without trying to resist the effects of the drug.

The tenth experimental subject had what he termed an interesting "psychological" and "aesthetic" experience for the first three-fourth of his experience, but then became frightened by loss of control and spent the remaining time in a terrifying fight to overcome the drug effects. He would not be interested in repeating the experience because his most predominant memory of the experience was that of fear. Six months later, in Part I of the followup questionnaire, he considered this fear-experience *slightly* harmful because "in a mob panic-situation, I feel I would be less likely to maintain a calm objective position than I might have formerly." During the interview he admitted that he had gone into the experience "as a psychological experiment" and had done

---

2. Stace, *op. cit.*, pp. 55-56.

no serious devotional preparation. His "inspirational" reading while the drug was taking effect consisted of studying some Psalms for a course in the Old Testament. His interpretation of his experience was a "psychotic episode."

The best indication of the reaction of the controls was the fact that they all were very eager for the opportunity to try psilocybin for themselves in the future. As far as their own experiences during the experiment were concerned, nine out of ten remarked in their accounts, in varying degrees of enthusiasm, about the meaningfulness of the setting in regard to the religious service. Because of the length of the service and the distractions from the experiences of others, only two out of the ten were able to keep from getting a little tired and/or bored. In the interviewer's opinion, only one of the controls had an experience which came anywhere near the level of mystical phenomena experienced by those who got psilocybin.

These subjective observations about the experimentals and controls are substantiated to some degree by certain items on the questionnaires. Within a few days after the experience (post-drug questionnaire data) the scores of experimentals were higher than those of controls for the degree to which the experience was considered both meaningful (P126) and religious or mystical (P127), but this difference only tended toward significance ($p = .062$). After six months, the usefulness of the experience (F56a) was significant at the .004 level and the value for life at the .02 level for the experimentals.
There was no significant difference between the two groups in their desire for more psilocybin experiences as indicated by F98a and F99a (p greater than .23 for both). This evidence was consistent with the fact that nineteen out of the twenty subjects wanted to volunteer for more experiments when questioned after six months.

Conclusions

Under the conditions of this experiment, those subjects who received psilocybin experienced phenomena which were indistinguishable from, if not identical with, certain categories defined by our typology of mysticism. The differences in completeness or intensity among the various categories have been discussed. Not all categories were experienced in the most complete way possible, although there was evidence that each category had been experienced to some degree.

In terms of our typology of mysticism, a "complete" mystical experience as a whole should have demonstrated the phenomena of all the categories in a complete way. The evidence from the content analysis (also supported by impressions from the interviews) showed that such perfect completeness of all categories was not experienced by the experimental subjects in contrast to the controls. The phenomena of internal unity, however, were experienced to a rather complete degree. Because unity is the heart of the mystical experience we might expect that phenomena of the other categories also should have been experienced to a complete degree as "by-products." In our data such a prediction was unquestionably correct for transcendence of time and space, transiency, paradoxicality, and persisting positive changes toward self and life. The evidence indicated a lesser degree of completeness in objectivity and reality, joy, and alleged ineffability; and a relatively greater lack in sense of sacredness, love, and persisting positive changes toward others and toward the experience. The experience of each of these last six subcategories could be termed incomplete to a more or less degree, but definitely present to some extent when compared to the controls. The experience as a whole, therefore, must be termed incomplete, in the strictest sense. It was remarkable, however, that so many phenomena of the mystical typology were experienced by our group of ten experimental subjects, none of whom were especially chosen other than by their own volunteering or had previous experience with psilocybin. While it is true that they were already committed to an interest in religion by the fact that they were all in a graduate school of theology, their middle-class, protestant backgrounds were rather non-mystical. Pre-drug testing indicated that there was no special tendency toward mysticism in personal experience or inclination except in the case of one or two.

The experience of the experimentals was certainly more like mystical experience than that of the controls who had the same expectation and suggestion from the preparation and setting. The most striking difference between the experimentals and controls was the ingestion of 30 mg of psilocybin, which it can be concluded was the facilitating agent responsible for the difference in phenomena experienced.

Although lacking in maximal completeness in some categories, the experimental evidence has strongly suggested that under the conditions described psilocybin can induce states of consciousness which are apparently indistinguishable from, if not identical with, those experienced by the mystics, according to their own descriptions. This conclusion gives support to the claims made by others who have used the same or similar drugs such as LSD or mescaline to aid in the induction of such experiences.

Such evidence can throw new light upon the psychological and biochemical mechanism which are at work in so-called "non-artificial" mystical experience. The biochemical equilibrium of the body and consequently of the mind should not be ignored in any serious study of mysticism. Ascetic practices such as fasting, sustained meditation, diet, restriction, sleep deprivation, flagellation and subsequent infection, sensory deprivation in caves or monastic cells, and breathing and postural exercises have an effect on biochemistry which in turn can produce psychological effects. Psychological conditioning also may influence body biochemistry. Psychology of religion needs to consider biochemical factors as well as psychological, social, cultural, economic, and political forces in the history, practice, and influence of mysticism.

Mystics have generally reported life-enhancing and -enriching effects from their experiences. It is now possible to test these claims by producing the phenomena of the experience and by observing behavior over a period of years in the lives of individuals. The evidence presented above indicated that over a short follow-up of six months, such claims seemed to be true. In addition, after four hours of follow-up interview with each subject, the experimenter was left with the overwhelming impression that the experience had made a profound impact (especially in terms of religious feeling and thinking) on the lives of eight out of ten of the experimental subjects. The control subjects were also impressed with the depth of the experiences of their friend who received psilocybin. These subjective impressions of those who intimately witnessed the experiment by participation and observation without the drug confirm the conclusion that profound and meaningful experiences occurred.

Let us consider more closely the pragmatic question of the lasting benefit or harm of the psilocybin experience and the kind of changes which were produced in individual lives. After six months the changes with the highest scores were all positive, and the experimental subjects attributed these changes to the drug experience. These data have indicated that although the psilocybin experience was quite unique and different from the "ordinary" reality of their everyday lives, the subjects felt that this experience enabled them to appreciate more deeply the meaning of their lives, to gain more depth and authenticity on ordinary living, and to rethink their philosophies of life and values. The data did not suggest that any "ultimate" reality was no longer important or meaningful. Each person who received psilocybin was motivated to integrate constructively what he had learned from his experience into his life-situation in his own way. The fact that the experience took place in the context of a worship service with the use of symbols which were familiar and meaningful to the participants was a help in this regard. Some persons found the music most significant, others the readings and spoken meditations, and still others the theological implications which they discerned themselves.

The continuing significance of the whole experience is perhaps best illustrated by what took place one year later during the next Easter season. Several of the subjects who had received psilocybin requested permission to listen to the tape of the Good Friday service. It was decided that this would be done in a chapel setting for any of the twenty subjects who were interested. Six of the seven students from the experimental group who were in the area attended while none out of nine control subjects did so. Several of the controls commented that they could not afford the time for such a lengthy service which had seemed too long the first time, although they indicated that they would have been quite eager to come if the chance to take psilocybin in such a setting had been offered. This reaction would seem to indicate that the lasting impact of the service was more meaningful to the psilocybin group than to the controls, although unconscious resentment against the experimenter from disappointment at not receiving the drug the first time could also have played a part. During the replay, reverent silence was maintained for the entire two-and-one-half-hour service. After the service, by their quiet demeanor, seriousness, and unenthusiasm for conversation at first, all six persons indicated the meaningfulness of the service for them. This was confirmed in the written accounts and discussion which followed. They all reported that the experience was helpful for integration and appreciation of what had taken place the previous year with psilocybin. The drug experience was not relieved in its original intensity or character, but many things which had been experienced previously on an unconscious level were now made conscious. The familiar and meaningful context was a great help in gaining benefit from both experiences. This follow-up study after one year has not been reported as a part of the data of the experiment because only part of the psilocybin group was involved, and there was no control group. What happened, however, gives some basis for the conclusion that the psilocybin experience in a religious context can provide the initial stimulus for an ongoing and lasting influence for the benefit of personal life, and that parts of the experience can be reactivated in the integration process without the further use of drugs.

Mysticism and *inner* experience have been stressed much more by Eastern religions than by Western. Perhaps Western culture is as far off balance in the opposite direction with its manipulation of the *external* world as exemplified by the emphasis on material wealth, control of nature, and admiration of science. Mysticism has been accused of fostering escapism from the problems of society, indifference to social conditions, and disinterest in social change. While the possibility of such excesses must always be remembered, our study has suggested the beneficial potential of mystical experience in stimulating the ability to feel and experience deeply and genuinely with the full harmony of both emotion and intellect. Such wholeness may have been neglected in modern Western society.

The relationship and relative importance of set, setting, and drug is a crucial question raised by our results. The fact that the controls had the same set and setting as the experimentals, but not the same experience, shows the utility of the drug as an important facilitating agent for the experimentals induction of mystical phenomena. Other investigators, however, report the predominance of unpleasant and "psychotomimetic" experiences rather than the majority of predominantly positive and mystical experiences which we witnessed.[3] The drugs in this case were comparable; the set and setting were not. Thus it would seem that the "drug effect" is a delicate combination of drug plus set and setting. The drug alone is not sufficient, and positive experiences are by no means automatic. A meaningful religious atmosphere has been shown to be one setting in which positive drug experiences can occur. The religious The religious context in our experiment appeared to give the psilocybin subjects a useful framework within which to derive meaning and integration from their experience both at the time and later. Our experience in this experiment has suggested that much forethought and preparation are needed to insure adequate set and setting although the precise qualitative and quantitative role of each factor has not been shown. For example, it must be pointed out that everything possible was done to maximize suggestion, but suggestion alone cannot account for the results because of the different experience of the control group. The hypothesis that suggestibility was heightened by psilocybin cannot be ruled out on the basis of our experiment. Although persuasive and similar to the explanation of mysticism by auto-suggestion,[4] this hypothesis still needs proof. An effort was made in our experiment to avoid suggesting the phenomena of the typology of mysticism, and the service itself made no such direct suggestion. Psychologists of religion by their interest in psychology and presumed religious sensitivity should be well-qualified to study the variables at work here.

Such research on the effect of the religious context on the psilocybin experience might illuminate the dynamics and significance of worship. Increased understanding of the psychological mechanisms involved might lead to more meaningful worship experiences for those who have not had the drug experience. Of course, there are various approaches to the theological significance of worship. This study was an empirical investigation, but we are aware that there are theological implications. The analogy to the efficacy of the sacraments would have to be considered. Furthermore, theologians must evaluate the light that such research could shed on the doctrine of Incarnation, the Holy Spirit, the presence of Christ, and of *gratia activa*. It must be kept in mind that we are only talking about the analogy or the elucidating suggestiveness of such drug research for a better psychological understanding of these theological concepts. Such considerations raise the question of the place of the emotional factor compared to the cognitive in religious worship. An even more basic question is the validity of religious experience of the mystical type on terms of religious truth. Reactions to these religious implications will vary with theological position and presuppositions, but one value of our study is to stimulate thoughtful examination of the problems.

Many unknown conscious and unconscious factors operate in mystical experience. Much investigation is needed in this area, and drugs like psilocybin can be a powerful tool. Experimental facilitation of mystical experience under controlled conditions can be an important method of approach to a better understanding of

---

3. P.M. Hoch, "Remarks on LSD and mescaline," *Amer. J. Psychiatry*, Vol. 111 (1955), pp. 787-790. See also remarks in Abramson (ed.), *op. cit.*, pp. 56-60, and review of the history of this view in Unger, *op. cit.*, pp. 115-119.
4. Geroge A. Coe, *The Psychology of Religion* (Chicago: The University of Chicago Press) 1916.

mysticism. Better understanding can lead to appreciation of the role and place of such experiences in the history and practice of religion.

Chapter VIII
SUGGESTIONS FOR FURTHER RESEARCH AND IMPLICATIONS FOR THE FUTURE

This dissertation has demonstrated the potential of at least psilocybin, if not LSD and mescaline by analogy, as a tool for the study of the mystical state of consciousness. A program of future research with these chemicals in the psychology of religion can be divided into two different kinds, depending on the aim: (1) theoretical understanding and (2) social application in a religious context.

The first kind would be primarily theoretical and would have as its aim a more basic understanding of the psychology and phenomenology of mysticism. The method would be to approach the mystical state of consciousness as closely as possible under experimental conditions and to measure the effect of variables. This thesis has been a start toward this approach, but much work needs to be done in this area for a better understanding of mysticism from a physiological, biochemical, and psychological perspective.

Obviously, the first step in such a program would be to reproduce the same experiment with a different group of individuals who would be similar to the subjects already tested to check the repeatability and reliability of the results with the same design. This work should be done both by the same experimenter and by other independent experimenters with as much the same set and setting for the subjects as possible. The service itself has been taped and could be repeated exactly. The same experimental protocol, techniques for matching pairs, questionnaires, and tests could be used. Repetition of our experiment by different workers with other subjects would add to what has already been learned about the most effective way to design and run such experiments. A comparison of these data would further enlarge our understanding of the mystical state of consciousness.

From the work reported above certain interesting modifications can be suggested. If the effect of nicotinic acid plus psilocybin were first determined to be synergistic, antagonistic, or neutral, such a combination in the proper strength could be given to the experimentals while the controls received only nicotinic acid. A better double-blind control would be obtained from such a procedure because everyone would have the same initial reaction. To insure that bias from communication and observation of others would be reduced, the protocol could also be changed so that neither during nor after the experiment each participant would discuss his experience with the others. Subjects in such a case should not know each other outside the experiment, but his would detract considerably from the security and friendliness of the setting. Another perhaps more practical modification in design would be to administer the psilocybin and control substance at the beginning of the chapel service after an initial quiet period of personal meditation (perhaps for 15 to 30 minutes). The set and setting during the important time while the drug was taking effect would be that of serious worship in an actual service and would preserve unbroken a continuity which was disturbed when the groups moved into the chapel. With this change in the timing of the drug administration, either a longer service would have to be used, or when the service was over some type of supervised group interaction and exploration of interpersonal relations would have to be planned for the remaining time during which the psilocybin reaction would still be present (i.e., for two to three hours).

Preparation could be changed so that greater uniformity of expectancy would be achieved. A selected and uniform bibliography of mystical literature could be read and discussed by the groups to gain some familiarity with the kind of experience to be anticipated and to decrease the fear which sometimes occurs from a new and unexpected situation. This would provide a more uniform individual preparation. Also more meetings of the members of the groups with their leaders would increase rapport, mutual support, and sense of security. The practice of group meditation and worship would also aid this sense of togetherness and might make the experimental situation more natural. Experiments could be run with total fasting in advance for varying periods as part of the preparation. This would certainly insure more uniformity of the time of onset of the drug effects. Other ascetic practices such as sensory deprivation or sexual abstinence could be investigated for their influences. Another preparation factor to be tested would be the effect of being in a "state of grace" (i.e., prior absolution and restitution for any "sins" and guilt therefrom). The meaningfulness of the religious service for the leaders is another important variable. Their attitude and feeling might well add or detract from the sense of sacredness and seriousness which the subjects would feel in the experimental situation.

With adequate and appropriate pre-tests and enough subjects a correlation could be attempted between prior personality structure or religious experience and the types of drug reactions, both positive and negative. There was some very tentative suggestion in a few of our subjects that persons with a "mystical" temperament (i.e., those who already have experienced some mystical phenomena) are more likely to experience a degree of the mystical state of consciousness with the aid of psilocybin. Such an hypothesis could be tested by rigorous screening for subjects with such a temperament by interviews, psychological tests, and questionnaires. A double-blind study with the same experimental procedure as was used above could be run using only such screened subjects. Another method of screening would be to measure a prior, non-drug response to the taped chapel service as measured by questionnaire and interview. Only those subjects to whom such a service was meaningful and moving would be used in the drug experiment when the same service would be repeated at another time.

The success in producing states of consciousness which resemble, although incompletely, the mystical typology in prepared subjects with a single, initial dose of psilocybin encourages the trial of multiple sessions. The sheer uniqueness of the drug experience is overwhelming even to a well-prepared subject and may detract from his ability to let himself go completely and surrender to the experience. The hypothesis that familiarity with the experience positively reinforces set and setting and increases the likelihood of positive experience and mystical phenomena could be tested by repeating the psilocybin experience at regular intervals over a period of time (e.g., two, three, or four sessions in a year).[1] After the first session, single-blind controlled studies would be more practical than double-blind because of the very uniqueness of the experience. A matched control group could be run through repeated sessions at different times from the experimentals with as identical a set and setting as possible. Testing by interview and questionnaire could be done after each session to determine whether any new phenomenology had occurred which more closely resembled the mystical typology.

The questionnaires which were designed for gathering the data for this dissertation could be refined. As has been suggested above certain items did not contribute much to their categories or were not worded well enough to measure what was intended. What has been learned about the effectiveness of the questionnaires as a measuring tool for the study of mysticism could be incorporated into a revised version. For multiple sessions a questionnaire would be needed which could show an increase each time in a particular item if it occurred. During the first session, for example, the participant might rate certainty of the encounter with ultimate reality as "5" on a 0-5 scale if this were the strongest experience he had ever had or had imagined possible up to that time. In his next session, however, he might experience an even more "ultimate" reality. Therefore, although the same questionnaire might be used, a 0-7 scale would provide the opportunity to indicate the same strength as previously ("5"), a little stronger ("6"), or very much stronger ("7"). For the third session a 0-9 scale could be used, etc. New types of questionnaires could also be tried. Instead of directly asking about categories by means of individual scattered items, each category could be explained in an instruction manual similar to that written for the judges. Then each category could be scored as a whole or by a cluster of the most representative items for that category. Another approach might be to quote short descriptions which are good examples of each category from the writings of the mystics and ask the participant to compare his drug experience with these examples on a rating scale of degree of similarity.

Another modification in any on-going research in this field would be longer and more thorough follow-up studies. The subjects could be checked periodically for one to three years to assess possible psychological benefit or harm. For accurate assessment of persisting changes in attitude and behavior, not only the person's own subjective judgment but also those of other persons close to him, such as spouse or intimate friend, could be measured. Actual changes in behavior could be listed and tabulated.

---

[1] Chwelos and Blewett found this to be the case with LSD (*Handbook*, pp. 66-67).

If the conclusions of this dissertation are first confirmed and clarified by the additional experiments suggested above, other experiments could be designed to test more precisely the effect of set and setting on the relative frequency of occurrence of specific mystical elements in the drug experience. For example, if a relatively homogeneous sample of subjects were divided into four equal groups (two groups of experimentals and two of controls), four sessions could be run for each group in two different settings by two different groups of investigators in a Latin-square design. The "religious" setting could be in a chapel as described above by investigators convinced that the drug experience was positive and even potentially "mystical". The other setting would be in a psychiatric hospital by investigators convinced that the experience was negative and merely a "model psychosis." The same pre-drug tests, questionnaires, and interviews would be given to each group, but the initial set and setting in two groups would be "religious" and in two, "psychiatric."

Each group would have two drug sessions and two control sessions - one of each in each of the two settings. The same questionnaire which would have both "positive" and "negative" responses would be given to each group after each session after an account had been written by each person. It would be interesting to determine whether or not the initial set and setting had a controlling effect on both the initial and subsequent experiences in different and the same settings. Such a series of experiments might also shed light on the whole problem of the relationship between psychosis and intense mystical states of consciousness. All the accounts could be content analyzed for both "mystical" and "psychotic" elements.

The study of the basic phenomenology of mysticism in the drug experiences of persons already interested in religion would be only the first step. The claim of some investigators[2] that mystical phenomena occur even in persons with no interest in religion could be checked by administering psilocybin in a setting free from any religious suggestion. Of course, the basic setting factor of trust, confidence, and friendliness should be maintained.

Let us turn now to the second kind of research which would involve experimental investigation of possible social application in a religious context. Such experiments would be undertaken only after adequate evidence had been accumulated by means of the first or theoretical approach to substantiate the findings and suggestions of our research. If it were confirmed, for example, that personally and socially useful changes in behavior are produced with a meaningful religious setting and preparation, experiments could be designed to develop the best methods and conditions of administration to provide the maximal chance for beneficial effects to occur without danger.

One such experiment could be to establish a retreat center with a trained, permanent staff consisting of psychiatrists, clinical psychologists, and ministers. A uniform technique of procedure and testing would have to be devised so that the results over a period of time could be compared. Small groups, preferably already in rapport, of laymen or ministers to whom such a setting would be meaningful would spend from five to seven days at the center. Screening by means of physical examination and history, psychological testing, preparation of an autobiography, and preliminary interviews, would be done before the group came to the retreat center. Several leaders (staff personnel) would join each group as integral members for the duration of the retreat. At least the first three days would be spent in preparation for the drug session and would include readings of selected materials which had been found helpful to others, group discussions with the staff, worship and meditation alone and with the group, meals and recreation as a group, and individual interviews with the staff. The emphasis would be on building group rapport, a spirit of trust and friendship, and serious expectation of a meaningful experience. The techniques which have proved successful in group dynamics work could be used to facilitate sharing of past experiences between group members and to build the interpersonal honesty and solidarity of the group. After this period of preparation, one whole day would be set aside for the drug session in an appropriate religious setting. The staff members with whom the groups had been working would be in charge with assistance if needed from other staff members who would be standing by. Group discussion of the experience would be an important part of the retreat and would continue for at least two days after the session while data was gathered by the staff by means of written accounts, questionnaires, and interviews. Follow-up meetings of the group could be arranged, and perhaps a repeat of the retreat could be made after a year.

---

[2] Leary and Clard, *op. cit.*, pp. 252-253. See also Sherwood, Stolaroff, and Harman, *J. Neuropsychiatry*, Vol. IV, No. 2, pp. 76-79. The loose use of the terms "religious experience" or "classic, mystic, conversion reaction." adds confusion and misunderstanding unless these terms are carefully defined. See our discussion above on this point, pp. 24-27.

Another experiment along a similar line would be the formation of small natural groups of 4-6 people who would meet periodically for serious religious and personal discussions in depth, Bible study, and worship in the form of prayer and meditation. After a period of several months in which rapport, mutual trust, and bond of fellowship were being established, a drug session could be planned in collaboration with a psychiatrist and minister who both had been trained in the use of psychedelic substances. Pretesting could be done at one of the meetings. A whole day would have to be set aside for the session with the psychiatrist and minister in attendance to administer the drugs, run the session, and collect data in such a way as to add to positive set and setting. Post-session discussion, meetings, and collection of follow-up data would also be important here. The effects of multiple drug sessions could also be studied.

In both of these proposals the most practical kind of controls could be matched groups who underwent the same retreat or cell-group experience without the drug over the same time interval with the same staff at the same place, but at a different time from the experimentals. Once the effectiveness of the method was proved in terms of personal and social usefulness, the most valuable data would consist of comparisons between groups in which different techniques were tried to determine the best method to use for an experience of of maximal benefit.

It must, however, be emphasized that much more research needs to be done at the theoretical level before such pilot research projects for social application should be attempted. Such work must be done carefully and cautiously both because of the social resistance to be overcome and because of potential dangers involved.

In our society the use of drugs for any reason other than for a medical indication in the treatment of some specific illness is suspect. Fear of addiction or physical harm is the intuitive association, but beyond this legitimate fear perhaps the American Puritan heritage with its disapproval of pleasure or enjoyment for its own sake, especially if unearned by hard work, may be a factor. Also the relative ease with which the phenomena of the mystical state of consciousness were induced in our experimental subjects with the aid of psilocybin might seem undeserved when compared to the rigorous discipline which many mystics describe as necessary. Although a drug experience might seem "unearned", our evidence has suggested that preparation and expectation play an important part, not only in the type of experience attained, but in later fruits for life. Perhaps the hardest "work" comes after the experience which itself may only provide the motivation for future efforts to integrate and appreciate what has been learned. The best way to overcome social resistance is to demonstrate the value and safety by careful and responsible investigation.

Although our experimental results indicated predominantly positive and beneficial subjective effects, possible dangers must not be underestimated and should be thoroughly evaluated by specific research designed to discover the causes and methods of prevention of physical or psychological harm, both short term and long term. While physiological addiction has not been reported with psychedelic substances, psychological dependence might be expected if the experience were continually repeated. The intense subjective pleasure and enjoyment of the experience for its own sake could lead to escapism and withdrawal from the world. An experience which is capable of changing motivation and values might cut the nerve of achievement. Widespread apathy toward productive work and accomplishment could cripple a society. Another possible danger might be prolonged psychosis or suicide in very unstable or depressed individuals who were not ready for the intense emotional discharge. If it can be determined that any of these forms of harm occur in certain types of individuals, research could be directed toward the development of pre-test methods to screen out such persons. Our evidence would suggest that research on conditions and methods of administration of the drugs might minimize the chance of harmful reactions. Spectacular immediate advance must be sacrificed for ultimate progress by careful, yet daring and imaginative research under adequate supervision.

The ethical implications also cannot be ignored. Any research which uses human volunteers must examine its motives and methods to make certain that human beings are not being manipulated like objects for purposes which they do not understand or share. But in research with powerful mental chemicals which may influence the most cherished human functions and values, the ethical problem is even more acute. The mystical experience historically has filled man with wondrous awe and has been able to change his style of life and values, but it must not be assumed that greater control of such powerful phenomena will automatically result in wise and constructive use. Potential abuse is just as likely. Those who undertake such research carry a heavy responsibility. A detailed examination and discussion of all the ethical implications would require another thesis; such considerations must be constantly kept in mind as a reminder of the more than normal caution required.

This is not to say that research should be stopped because of the fear of these various risks in an extremely complex and challenging area with great promise for the psychology of religion. But while research is progressing on the theoretical or primary level and before projects for testing useful social application in a religious context become widespread, serious and thoughtful examination of the sociological, ethical, and theological implications is needed without delay.

Appendix A

MEDICAL HISTORY FORM FOR VOLUNTEER SUBJECTS FOR PSILOCYBIN RESEARCH[1]

Name: ....

Address: ....
....

Date: ....

Age: ....

Sex: ....

I. Have you ever had any of the following:

Heart disease (rheumatic heart disease, congenital heart defects, or high blood pressure) Yes No

Epilepsy Yes No

Liver disease Yes No

Previous jaundice Yes No

If you have answered "yes" to any of the above, please explain below:

....
....
....

II. a) How much alcohol do you consume per week on the average? ....

b) How often do you use aspirins and in how large a dose? ....

c) What other headache or sleeping pills do you use, how often? ....

d) How much tobacco do you use per week on the average? ....

III. a) Have you ever received psychotherapy? Yes No

When? ....

For how long? ....

Are you presently in therapy? ....

b) Have you ever been hospitalized for mental illness? Yes No

If yes, please explain in detail (symptoms, length and number of hospitalizations, treatment).

....
....
....

c) Has anyone in your immediate family ever been hospitalized for mental illness? Yes No

If yes, who and for what?

....
....
....

IV. Have you any allergic reactions (thorazine, etc.)? Yes No

If yes, please explain:

....
....
....

Examined by: .... M.D. Date: ....

---

1. This was given about three weeks before the experiment and reviewed during physical exam at first interview.

Appendix B

PRE-DRUG EXPERIENCE QUESTIONNAIRE[2]

1. Name:	1. ....
2. Address:	2. ....
3. Phone:	3. ....
4. Age:	4. ....
5. Sex:	5. ....
6. Religious denomination:	6. ....
7. Present occupation:	7. ....
8. Future plans:	8. ....
9. Have you ever had a drug experience with psilocybin, mescaline, or LSD?	9. ....
10. Family history: indicate ages of brothers: Sisters: Which parents are alive?	10. ....
11. Are you single? married? divorced?	11. ....
12. Where you raised in the church?	12. ....
13. At what age did you join the church?	13. ....
14. Did you ever attend a young peoples' church camp? At what age?	14. ....
15. Which of your parents were actively interested in religious?	15. ....
16. Which of your parents actively participated in the church?	16. ....
17. Do you hesitate to call yourself a Christian?	17. ....
18. Indicate your theological position on the following continuum:	18. Orthodox Neo-orthodox Liberal
19. How meaningful is the usual worship of your public religious life to you?	19. unmeaningful, slightly meaningful, very meaningful sometimes, very meaningful usually
20. How meaningful is your participation in Holy Communion?	20. unmeaningful, slightly meaningful, very meaningful sometimes, very meaningful usually
21. Are you undertaking your life work in the religious sense of a vocation or calling?	21. ....
22. Was your decision to follow your life work tied to any particular experience you have had? If so, describe briefly:	22. ....
23. Did you ever have a sudden conversion experience? At what age? A more gradual one? Over how long? Climax at what age?	23. ....
24. Have you ever had any mystical or religious experience in the presence of nature? If so, describe briefly:	24. ....

25. Have you ever had an experience in which you felt that you transcended time and/or space? (If yes, circle which) Describe briefly:	25. ....
26. Have you ever had an intuitive experience of a sense of Presence of the Divine? If so, describe briefly:	26. ....
27. Have you ever experienced a feeling of mystical union to any degree? If so, describe briefly:	27. ....
28. Have you ever had an experience in which you felt that the Numinous was made near to you? If so, describe briefly:	28. ....
29. Have any of your religious experiences given you a feeling of joy, blessedness, or peace in the Biblical sense of the peace that passes all understanding? Have you had this experience in ways or circumstances that you would not consider religious?	29. ....
30. Do you practice any spiritual exercises such as prayer? regular meditation? yogic exercises? special postures? breath control? fasting? others? (describe):	30. ....
31. Do you have a regular prayer life besides formal public worship?	31. ....
32. Do you practice intercessory prayer? prayers of thanksgiving? prayers of petition? requests for forgiveness?	32. ....
33. Do you believe that the effects of prayer are completely auto- or group suggestion?	33. ....
34. Have you ever experienced a sense of sin in a general sense? In a specific sense in which you felt overpoweringly guilty about a particular wrong deed or attitude?	34. ....

---

2. This was administered about three weeks before the experiment and reviewed during first interview.

Appendix C

POST-DRUG QUESTIONNAIRE WITH SIGNIFICANCE LEVELS OF THE DIFFERENCE BETWEEN SCORES OF EXPERIMENTALS AND CONTROLS[3]

(*Interactive version of this questionnaire is here:* http://en.psilosophy.info/TripograM.)

Name: ....   Date: ....

Approximately what percentage of the 2-1/2 hour service did you remain in the chapel?

Please evaluate the following items in regard to your own experience in the psilocybin experiment. Rate each descriptive unit according to the following scale:
0 - did not experience at all
1 - cannot decide whether I experienced this or not
2 - experienced slightly
3 - experienced moderately
4 - experienced strongly

Note: Please reserve the highest rating (4) for a qualitative level which would equal or excel any previous personal experience or expectation which you would consider **strong** of these states. Feel free to make any further comments on any item in order to clarify your response.

1. Seeing symbolic meanings of things.	....	(.18)
2. Feeling of unity with your group.	....	(.64)
3. Sense of the preciousness of life.	....	.02
4. Feeling of being very wise, knowing everything.	....	(.23)
5. Terror or fear.	....	.004
6. Sense of finitude.	....	(.23)
7. Sense of wonder.	....	.004
8. Panic.	....	.016
9. Lose of self.	....	.001
10. Easy understanding of the feelings of others.	....	(.5)
11. Concern and preoccupation with other people coming and leaving the room.	....	(.64)
12. Being able to operate on several levels at once.	....	.004
13. Sense of humility.	....	(.35)
14. Sense of well being.	....	(.38)
15. Fear of losing control.	....	.004
16. Seeing a light which appeared to have no naturally explainable source.	....	.016
17. Feeling that you were going to die during the experience.	....	(.63)
18. Sense of having known the universe in its wholeness.	....	(.016)
19. General sense of sin.	....	(.5)
20. Conviction of certain specific sins in your life.	....	(.50)
21. Sense of forgiveness or cleansing.	....	(.35)
22. Sense of loneliness or aloneness.	....	.02
23. Sense of ultimate goodness as the basis of reality.	....	.035
24. Intuitive knowledge of your immortality.	....	(.11)
25. Sense of judgment on your life.	....	(.78)
26. Appearance of various levels of consciousness.	....	.001
27. Suddenness of appearance of various levels of consciousness.	....	.002
28. Suddenness of disappearance of various levels of consciousness.	....	.004
29. Stability of level of consciousness during the experience.	....	.035

30. Transciency of duration of deepest levels.	....	.002
31. Transciency of duration of levels other that the deepest.	....	.004
32. Permanence of new levels of consciousness **after** the experience.	....	(.062)
33. Sense of certainty or conviction of encounter with ultimate reality (in the sense of being able to "know" and "see" what is really **real**) at the time of the experience.	....	.020
34. Sense of certainty or conviction of encounter with ultimate reality now (in looking back).	....	(.062)
35. Sense that what was encountered was **not** real at the time of the experience.	....	(.5)
36. Sense that what was encountered was **not** real **now** (in looking back).	....	(.5)
37. Intensity of the response to ultimate reality.	....	.004
38. Totality of the response to ultimate reality.	....	.016
39. Exaltation.	....	.020
40. Depression.	....	(.09)
41. Love.	....	.035
42. Hate.	....	(.35)
43. Tenderness.	....	(.66)
44. Exuberance.	....	.002
45. Meanness.	....	(.19)
46. Insecurity.	....	(.11)
47. Blessedness.	....	(.15)
48. Despair.	....	.02
49. Peace.	....	(.09)
50. Overflowing energy.	....	.008
51. Anxiety.	....	(.26)
52. Ecstatic Joy.	....	.004
53. Intellectual illumination.	....	(.062)
54. Retention of such illumination after the experience.	....	.008
55. Sense of being grasped and dealt with.	....	.004
56. Sense of awe or awesomeness.	....	.011
57. Sense of reverence.	....	(.78)
58. Sense of mysterious fascination in spite of terror or fear (in the sense of a shaking or trembling in the utmost depths of your inner being).	....	.008
59. Sense of the wholly otherness of what was met in the experience.	....	.035
60. Sense of your own finitude in contrast to the infinite.	....	(.09)
61. Sense of profound humility before the majesty of what was felt to be sacred or holy.	....	(.062)
62. Sense of presence of what was felt to be holy, sacred, or divine.	....	(.64)
63. Sense of absence of anything that was felt to be holy, sacred, or divine.	....	(.35)
64. Sense that the experience is describable by logical statements which are not contradictory.	....	(.35)
65. Sense that an attempt to describe the experience in logical statements becomes involved in contradictory language.	....	.016
66. Sense that the experience cannot adequately be described in words.	....	.008
67. Sense that what is experienced forms part of a larger whole.	....	(.26)
68. Paradoxical dissolving of the subject-object dichotomy in spite of the empirical multiplicity of objects (they are still perceived as separate).	....	.008
69. Intuitive experience of the essences of objects.	....	.016
70. Sense of unity with these objects.	....	.008
71. Felt awareness of the life or living presence in all things.	....	.032
72. Paradoxical transcendence of space as defined in 68-71.	....	.004
72a. Sense of the loss of the multiplicity of all particular sense impressions.	....	.004
73. Pure awareness with no empirical distinctions (i.e., one is beyond the self consciousness of sense impressions, yet one is not unconscious).	....	.002
74. Sense of unity with ultimate reality at the level described by 72a and 73.	....	.008
75. Transcendence of time in the sense defined by 72a-74.	....	.002
76. Transcendence of space in the sense defined by 72a-74.	....	.004
77. Consciousness of a "Beyond" or "More".	....	(.15)
78. Expansion of usual personal consciousness to other dimensions **within** the self.	....	.001

79. Expansion of usual personal consciousness to other dimensions **beyond** the self.	....	.004
80. Transcendence of time in the sense defined by 77-79.	....	.001
81. Transcendence of space in the sense defined by 77-79.	....	.004
82. Sense of the presence of God.	....	(.83)
83. Contact or bond with God.	....	(.64)

Please rate yourself on the following items both a) **during** and b) **since** the experience:

		During		**Since**
84. Increased integration of personality.	....	(.37)	....	(.09)
85. Disintegration or destructive effects on personality.	....	(.062)	....	(.13)
86. New significance to life.	....	(.62)	....	.002
87. Lessening of significance to life.	....	(.13)	....	(1)
88. Death experience.	....	.032	....	(.063)
89. Rebirth experience.	....	.032	....	(.19)
90. Feeling of love toward others.	....	(.38)	....	(.38)
91. Feelings of antagonism and hate toward others.	....	(.09)	....	(.25)
92. Felt need for some type of service for others.	....	(.50)	....	(.25)
93. Actual changes in behavior in ways you would consider constructive and positive.	....	(.66)	....	(.18)
94. Sense of increased self-centeredness.	....	(.11)	....	(.25)
95. Conversion experience.	....	(.35)	....	(.19)
96. Sense of belonging to a new and greater unity.	....	.008	....	(.062)
97. Sense of subjective delusion.	....	(.063)	....	(.063)
98. Confusion of thinking.	....	.004	....	.032
99. Feelings of unreality.	....	.016	....	(.063)
100. Physical discomfort.	....	(.23)	....	(1)
101. Loss of memory for part of the experience.	....	.35	....	.020

Please rate the following phenomena in regard to your experience **during** the experiment:

102. Loss of consciousness.	....	.16
103. Distortion of visual perception.	....	(.055)
104. Colors more intense.	....	.001
105. Visions of colors, geometric patterns, objects, animals, people, scenes (circle any experienced).	....	.001
106. Seeing colors around heads or bodies of others.	....	.032
107. Hearing voices which were not from anyone present or from the loudspeaker.	....	(.13)
108. Unusual odors or scents.	....	(.063)
109. Hunger.	....	(.15 - for controls)
110. Tears.	....	(.35)
111. Sense of body melting.	....	(.19)
112. Nausea.	....	.008
113. Dizziness.	....	(.15)
114. Sensation of floating.	....	(.09)
115. Sense of bodily warmth.	....	.035 (for controls)
116. Itching or burning of skin.	....	.011 (for controls)
117. Headache.	....	.5 (for controls)
118. Coldness.	....	(.37)
119. Sense of being out of the body.	....	(.062)
120. Explosive anger of fury.	....	(.13)

121. Anxious about having to come "out of it."	…………	.008
122. Did you particularly like or feel close to either of your leaders? Which one? Please rate your feeling (0-4).	…………	(.11)
123. Did you particularly dislike either leader? Which one? Please rate your feeling (0-4).	…………	.032
124. Did you particularly like or feel close to any participant in the experiment? Who? Please rate your feeling (0-4).	…………	(.35)
125. Did you particularly dislike any participant in the experiment? Who? Please rate your feeling (0-4).	…………	(.37)

Please rate (0-4) the degree to which you now feel that:

126. Your experience was valuable to you personally.	…………	(.062)
127. Your experience was mystical or religious.	…………	(.062)
128. Do you think you had psilocybin?	…………	.001
129. Please rate (0-4) the meaningfulness of the service as a whole.	…………	(.64)

---

3. Probabilities that the difference was due to chance are listed for each item. The Sign Test was used and the prediction was made that the scores of experimentals would be higher than of controls unless otherwise indicated.

Appendix D
FOLLOW-UP QUESTIONNAIRE WITH SIGNIFICANCE LEVELS OF THE DIFFERENCE BETWEEN SCORES OF EXPERIMENTALS AND CONTROLS[4]

Name: .... Date: ....

SECTION I:
Please list the most important persisting changes in you since Good Friday. These changes should be only those which you feel are due to your Good Friday experience and which are still present in you now.

Then please make a numerical evaluation of the benefit or harm of each change with the following rating scale. Use for comparison your status before Good Friday.

5 - **Very** strongly beneficial (to a degree more than ever before in my life and stronger than 4 for this type of change)
4 - Strongly beneficial (to a degree equivalent to any previous change or expectations of this type)
3 - Moderately beneficial
2 - Slightly beneficial
1 - Cannot decide whether this was beneficial or not
0 - None: neither beneficial nor harmful
-1 - Cannot decide whether this was harmful or not
-2 - Slightly harmful
-3 - Moderately harmful
-4 - Strongly harmful (to a degree equivalent to any previous change of expectation of this type)
-5 - **Very** strongly harmful (to a degree more than ever before in my life and stronger than 4 for this type of change)

Please list your changes below:[5] (Use the back of the sheet if needed.)
....
....
....
....
....
....
....
....
....
....
....
....
....
....
....
....

---

[4] Probabilities that the difference was due to chance are listed for each item. The Sign Test was used and the prediction was made that the scores of experimentals would be higher that of controls unless otherwise indicated.
[5] These changes were content analyzed by the judges with the accounts written soon after the Good Friday experience.

Name: .... Date: ....

SECTION II:

(*Interactive version of this questionnaire is here:* http://en.psilosophy.info/TripograM.)

Looking back on your Good Friday experience, please rate the **degree to which** at **any** time during that day (after the experience began) you experienced the following:

NOTE: In your evaluations of degree please use this rating scale:

5 - **Very** strongly (more than ever before in my life and stronger than 4)
4 - Strongly (would be equivalent in degree to any previous strong experience or expectation of this description)
3 - Moderately
2 - Slightly
1 - Cannot decide
0 - None, not at all

1. Loss of usual time sense.	....	.001
2. Loss of usual awareness of where you were.	....	.002
3. Certainty of the reality of what was experienced.	....	.020
4. Enhanced capacity of mind.	....	.008
5. Intensity of your response to the experience.	....	.001
6. Totality of your response to the experience.	....	.001
7. Sense of having known the universe in its wholeness.	....	.016
8. Definite change in your usual state of consciousness.	....	.002
9. Suddenness of appearance of various dimensions of consciousness.	....	.020
10. Intellectual illumination.	....	.035
11. Ecstasy.	....	.004
12. Peace.	....	(.5)
13. Happiness.	....	(.23)
14. Sense of presence of what can only be described as nameless.	....	.032
15. Sense of sacredness with which you regarded your experience.	....	(.37)
16. Feeling that you could not do justice to your experience by a verbal description.	....	.001
17. Certainty of encounter with ultimate reality (in the sense of being able to "know" and "see" what is really real).	....	.008
18. Loss of your own identity.	....	.004
19. Pure awareness beyond any empirical content.	....	.002
20. Meaningfulness of your own life.	....	(.055)
21. Rebirth experience.	....	.016
22. Awe.	....	.011
23. Communion with ultimate reality.	....	(.23)
24. Deep interpersonal relations with other people present.	....	.035
25. Loss of feelings of difference from objects.	....	.016
26. Eternity.	....	.002
27. Gain of insightful knowledge experienced at an intuitive level.	....	.004
28. Love (toward one's fellow man as a human being, not of an erotic or sexual nature).	....	(.26)
29. Delight.	....	.016
30. Sense of your own finitude in contrast with the infinite.	....	.020
31. Expansion of usual personal consciousness to other dimensions **within** the self.	....	.001
32. Expansion of usual personal consciousness to other dimensions **beyond** the self.	....	.004
33. Fusion of the self into a larger undifferentiated whole.	....	.008
34. Spacelessness.	....	.004
35. Timelessness.	....	.004
36. Feeling of completeness.	....	.004
37. Intuitive experience of the essences of objects.	....	.032
38. Sense of being grasped and dealt with by the experience.	....	.001
39. Joy.	....	.016
40. Sense of reverence.	....	(.5)

41. Sense of belonging to a new and greater unity.	....	.008
42. Loss of sense of self as a predominantly positive experience.	....	.004
43. Loss of sense of self as a predominantly negative experience.	....	.004
44. Sense of unity with objects.	....	.032
45. Blessedness.	....	(.11)
46. Exaltation.	....	(.37)
47. Freedom from the limitations of the self in connection with a unity or bond with what was felt to be all-encompassing and greater-than-self.	....	.004
48. Sense of being at a spiritual height.	....	.016
49. Unity with ultimate reality.	....	.016
50. Sense of the presence of God.	....	(.5)
51. Love of God or Christ.	....	(.26)
52. Return to your usual state of consciousness the day after the experience.	....	.002

SECTION III:

(*Interactive version of this questionnaire is here:* http://en.psilosophy.info/TripograM.)

The purpose of this section is to measure certain persisting effects which you consider due to your Good Friday experience. Use for comparison your status before Good Friday. Using the same rating scale as in Section II preceding (singe 0 to 5 scale), please evaluate in regard to your **present** condition **the degree to which**:

53. The experience has changed your philosophy of life.	......	a) positively .001	......	b) negatively (1)
54. You have become more sensitive.	......	a) more sensitive .002	......	b) less sensitive (1)
55. You have less personal integration.	......	a) (.5)	......	b) more .002
56. You have learned something useful from the experience.	......	a) .004	......	b) detrimental (1)
57. You have had difficulty in trying to communicate your own experience to others who were not present.	......	a) .002	......	b) Have had ease (.11 - for controls)
58. Your behavior has changed in ways you would consider negative since the experience.	......	a) (.13)	......	b) positive (.002)
59. You now feel a greater need for service for others.	......	a) .035	......	b) lesser need (1)
60. You are less your true self with others.	......	a) (1)	......	b) more .008
61. Feelings of depression have increased.	......	a) (.063)	......	b) decreased (.063)
62. Your appreciation for life has.	......	a) increased .002	......	b) decreased (.25)
63. You have a greater sense of inner authority in your life.	......	a) .002	......	b) lesser (1)
64. Your life has a diminished dynamic quality.	......	a) (.25)	......	b) heightened .008
65. Others have remarked about a negative change in you since Good Friday.	......	a) (1)	......	b) positive change (.19)
66. You have decreased feelings of happiness.	......	a) (.13)	......	b) increased (.11)
67. Your life has more meaning.	......	a) .035	......	b) less meaning (.5)
68. You are more tolerant toward others.	......	a) .032	......	b) less tolerant (1)
69. You have less peace in your life.	......	a) (.7)	......	b) more peace (.11)
70. You are convinced now in retrospect that you encountered ultimate reality in your experience (i.e., that you "knew" and "saw" what was really **real**).	......	.016	-	-
71. You have a decreased achievement efficiency.	......	a) (.7)	......	b) increased (.5)
72. You have an increased sense of reverence.	......	a) (.062)	......	b) decreased (1)
73. You have been accused of logical contradiction in trying to describe the meaningfulness of your own experience to others who were not present.	......	(1)	-	-

74. Feelings of anxiety have increased.	......	a) .032	......	b) decreased .016
75. You now have a less certain vocational commitment.	......	a) (1)	......	b) more certain (.063)
76. You have a more positive relationship with others.	......	a) (.063)	......	b) more negative (.9)
77. You are a less creative person.	......	a) (.25)	......	b) more creative (.06)
78. You have more enthusiasm for life in general.	......	a) (.062)	......	b) less enthusiasm (.25)
79. Your sense of values (i.e., what is important to you in life has changed.	......	a) positively .035	......	b) negatively (1)
80. You place more importance on traditional theological formulations to express spiritual insights.	......	a) (.5)	......	b) less importance (.035)
81. Your life has less richness.	......	a) (1)	......	b) more richness .020
82. You feel that you now know a new dimension of life.	......	a) .004	-	-
83. You spend less time for devotional life.	......	a) (.6)	......	b) more time .008
84. Your appreciation for the whole of creation has increased.	......	a) (.035)	......	b) decreased (.25)
85. You now feel more hatred toward others.	......	a) (.9)	......	b) more love .016
86. You have lost by now the state of consciousness which you experienced on Good Friday.	......	a) .004	......	b) retained (.5)
87. You have more joy in your life.	......	a) .016	......	b) less joy (.25)
88. You now feel that what you experienced was a subjective delusion.	......	(.25)	-	-
89. Time spent in quiet meditation has increased.	......	a) .008	......	b) decreased (.5)
90. You have less of a sense of the preciousness of life.	......	a) (1)	......	b) more .008
91. You are a more authentic person.	......	a) .016	......	b) less authentic (1)
92. You now feel that the meaningfulness of your own experience is beyond words.	......	.004	-	-
93. You have less of a sense of the adventurous outreach of life.	......	a) (1)	......	b) more (.09)
94. Your experience has been valuable for your life.	......	a) .020	......	b) has been a hindrance (.13)
95. You now feel that life has taken a definite change of course because of this experience.	......	.032	-	-
96. You have tried to recapture any parts of the Good Friday experience since then.	......	(.15)	-	-
97. You have been successful in this attempt.	......	(.19)	-	-
98. You would be interested in repeating the same experience you had on Good Friday.	......	a) (.26)	......	b) would not be interested (.5)
99. You would be interested in having more of these kind of experience (not necessarily with the hope of an exact repetition of your Good Friday experience).	......	a) (.23)	......	b) would not be interested (.25)
100. You are convinced that you had psilocybin.	......	a) .001	......	b) did not .001 (for controls)

Appendix E
CONTENT ANALYSIS

Content Analysis Instruction Manual for Judges

1. On the basis of categories described below, you are asked to score twenty accounts of personal experiences.
The scoring is based on the degree to which each category is experienced.
The degree is defined in terms of either intensity or completeness, depending on the nature of the category. In general, the following rating-scale is used:
3 Experienced to a **strong** degree. (Such a level corresponds to the highest degree of intensity or completeness as defined for each category.)
2 Experienced to a **moderate** degree. (More than slight, but not enough to be scored as strong.)
1 Experienced to a **slight** degree. (But enough for inclusion in this category.)
0 None, or not applicable. (The account gives no impression that this category was experienced at all.)

2. Definition and Explanation of Categories to be Scored

I. **Transcendence of Time and Space**
This category refers to loss of the usual sense of time and space, without loss of consciousness (in contrast to sleep or coma). Time means clock time, but may also be one's personal sense of his past, present, and future. Subjectively-felt time may be shortened or lengthened. Space means the usual three-dimensional perception of one's environment.

Loss of time and space is scored separately, and is based on completeness. A high score (3) for time indicates that for some period, however be belief, the experiencer is aware that his normal sense of time is completely gone. There may be a feeling of being completely "outside" of time, or that time has "stopped" or ceased to exist. Lesser degrees than "complete" are the shortening or lengthening of subjective periods of time. The apparent lengthening or dragging of time which may be described in connection with boredom is the lowest level (1). A strong degree of loss of the sense of space indicates that the experiencer is no longer aware of where he is during the experience. There may be a complete or partial feeling of loss of the limitations of usual three-dimensional space. If orientation remains but spatial perceptions are altered, score as "slight" (1) or "moderate" (2), depending on the degree of approximation to complete loss of space. Experience of "eternity" or "infinity" indicates timelessness, spacelessness, or both, depending on the context.

II. **Positive mood**
The elements of this positive mood are joy, love, and peace. They are called positive because of the value attached to them by the experiencer. They may occur together or individually, and at any time during the whole experience - e.g., at a climactic point or as part of an afterglow effect.

Joy may be of the exuberant or quiet type and may include such feelings as exaltation, rapture, ecstasy, bliss, delight, and/or happiness. Love is of one's fellow man as a human being, but not of an erotically stimulation nature; or may be of a cosmic scope such as love of nature, of the universe, of God. A feeling of harmoniousness may be included.

Scoring level is based on intensity:
3 This level indicates an experience that is profound and deeply felt, i.e., close to the strongest human experience of such elements. For example, the strongest degree of peace is that which "passeth understanding." Tears associated with any of these elements of positive mood may be a sign of the overpowering nature of the experience.
2 This level lacks the extreme profundity and depth of feeling, but the mood is still moderately intense.
1 There is definite evidence here of the mood being present, but with low intensity.

III. **Sense of Sacredness**

This category comprises the sense of sacredness which is evoked by the experience, in whole or in part. The sacred is here defined broadly as that which a person feels to be of special value and capable of being profaned. The basic characteristic of sacredness is a non-rational, intuitive response in the presence of inspiring realities. No religious "beliefs" need necessarily be involved in such a sense of sacredness or be included in a sense of reverence or a feeling that what is experienced is holy or divine.

This basic characteristic may be described directly, or the response may take various forms. The experiencer may be moved with awe, wonder, humility, or a hushed reverent feeling. Spontaneous acts such as prayer or kneeling may be evoked. Other examples of this non-rational, intuitive response may include a sense of: finitude in contrast to the infinite; humility before the overpowering majesty of that which uniquely transcends the finite; the "wholly other"-ness of what is felt to be holy or divine; a mysterious fascination in spite of a feeling of awe, fear, or terror in the sense of shaking or trembling in the innermost depths of one's being; the urgency or energy of the holy or divine. As indicated, fear or terror may be part of the experience of sacredness, but certainly also can be experienced in a quite unrelated way. Do not score fear under this category, if not related.

The use of religious terminology to describe the experience is another indication of sacredness. For example, the response may be interpreted by the experiencer as a sense of Divine Presence, the consciousness of a Beyond or More, the awareness of some cosmic Principle or Universal Self, or more specifically as the presence of Christ, God, or some other deity. Sacredness may be strongly felt, however, without any of these interpretations being give.

Feelings of joy, love, or peace (of the previous category) may be evoked with a response of sacredness. Such an interconnection of these two categories should be watched for, but both categories should only be scored when there is clear indication that elements of both are present. However, they do not necessarily occur together.

Scoring level is based on intensity of the basic response in any of the possible forms. Intensity may be judged from the tone, manner of description, and context.

3 The profound sacredness of this level may include the high value and significance which the person places on his experience. The impact is shaking and very inspiring. Breathless awe may also accompany this level.
2 The profundity and extreme character of 3 is lacking, but the sacredness is still impressive.
1 Sacredness is definitely present, but weakly felt, i.e., not outstanding.

IV. **Unity**

The category of unity is divided into internal and external types which are different ways of experiencing an undifferentiated unity. The major difference is that the internal type finds unity through an "inner world" **within** the experiencer, and the external type finds unity through the external world **outside** the experiencer. Both types may be experienced by the same person.

A. Internal Unity

The essential elements of unity experienced by turning inward are: loss of usual sense impressions, and loss of self without becoming unconscious. The multiplicity of usual external and internal sense impressions (including time and space), and the empirical ego or usual sense of individuality, fade or melt away, while consciousness remains. In the most complete experience, this consciousness is a pure internal awareness beyond empirical content, with no external or internal distinctions. One is not unconscious, however, but rather very much aware of an "inner world" of undifferentiated unity.

These essential elements are described in terms of paradox. In spite of loss of sense impressions and dissolution of usual personal identity or self, the "I" still experiences the awareness of oneness or unity. The unity itself may be described as empty, yet full and complete. Either or both sides of this paradox may be emphasized by the various expressions used. On the one side, for example, the feeling of oneness with an empty unity expresses an awareness of the loss of sense impressions and may be indicated by such words as emptiness, void, abyss, wayless, unorganized, darkness, dissolution, or pure self. On the other side, the feeling of oneness with what is all-encompassing or greater than the usual self may be expressed by such words as fullness, completeness, pure being, or unity with the whole. These various expressions of the essential elements are evidence of the internal type of unity. Of course, the context must be considered.

Watch for associated experiences which may alert you to these essential elements. Some examples are: expansion of consciousness to another "world" of reality different from the ordinary; or consciousness of an underlying cosmic Principle, Beyond or More, Universal Self, Logos, Christ, or God. However, for internal unity to be scored, such experiences must have additional clear indication of the loss of sense impressions or self with retention of awareness (e.g., unity, bond, or absorption with the particular example or additional description with some of the expressions used above).

Scoring level is based on completeness:
3 A strong degree of completeness means that there is loss of the multiplicity of all sense impressions and complete loss of self. A pure awareness of an undifferentiated unity is present beyond empirical content with no internal or external distinctions. In fact, internal and external lose their meaning. Time and space are completely transcended.
2 A moderate degree of completeness means that internal distinctions remain. Although all external sense impressions and the usual sense of self are lost, internal imagery continues. Oneness is not complete.
1 There is definite evidence of the essential elements, but not in a complete a way as in level 2. Sense impressions are lost, but only partially. There is only incomplete loss of the sense of self. Some awareness of the external environment remains.

B. External Unity
In this sub-category, unity is perceived outwardly with the physical senses through the external world. A sense of underlying oneness is felt behind the empirical multiplicity. The observer or subject feels that the usual separation between himself and an external object (inanimate or animate) is no longer present in a basic sense, yet the subject still knows that his individuality is retained. In spite of the empirical multiplicity of objects, which are still perceived as separate, the subject-object dichotomy is nevertheless in a paradoxical sense dissolved. On one level, the objects are separate, yet on another they are, at the same time, one with the subject. Another way of expressing this same phenomenon is that the essences of objects are experienced intuitively and felt to be the same at the deepest level. The subject feels a sense of oneness with these objects, because he "sees" that at the most basic level all are a part of the same undifferentiated unity. This oneness may be felt through things or people. Such external unity may also come as a deeply felt awareness of the life or living presence in things. There may be the realization that nothing is "really dead".

Watch for associated elements such as expansion of consciousness beyond the usual sense of self or consciousness of a Beyond or More, some cosmic Principle, etc. Such associated elements may point to more specific evidence of oneness or unity through external things. Completeness of associated loss of time varies, but transcendence of space is only partial or paradoxical, because external objects seem both separate and yet not separate.

Scoring level is based on completeness:
3 At this most complete level, the oneness has both depth and breadth. The capsule statement, "All is One," emphasizes the broad dimension of this underlying unity in all things. A cosmic dimension i felt.
2 The depth of oneness through things or people is present, but not the same wide scope of underlying unity in everything as in the most complete experience. The loss of usual separation between subject and object is limited to the immediate rather than cosmic dimension.
1 Oneness, kinship, friendship is felt with unusual closeness, but the depth of oneness is not so complete as level 2.

V. **Transiency of Unity**
Transiency means non-permanence of duration, i.e., loss of the phenomena of internal or external unity after, or perhaps even before, the whole experience is over. The duration of unity during the experience may last from second to hours, and the completeness may vary. Disappearance may seem gradual because of the afterglow effect, but transiency means that unity is not continuously sustained when the experience

is over. Watch for indications that the essential elements are no longer present, e.g., mentions of "coming out" or "back to normal."

Scoring level is based on the intensity of the contrast between the degree of unity experienced during and afterwards:
3 A strong intensity of contrast means that although there may be a re-living in memory and persisting changes in other ways, the actual experience of unity does not continue in the ongoing life of the experiencer. Even a moderate or slight degree of unity can produce a strong contrast in comparison to usual consciousness.
2 A moderate intensity of contrast means that some of the actual phenomena of unity persist after the experience as a part of regular consciousness (even after 5 months), although perhaps in a lower degree of completeness.
1 A low intensity of contrast means that much of the actual phenomena of unity persists at the same level of completeness as during the experience as a part of regular consciousness.
0 No contrast means that the level of unity experienced continues unchanged afterwards. Of course, if none of the phenomena of unity was experienced at all, transiency also would be scored as 0.

VI. **Objectivity or Reality**
This category has two interrelated elements: (1) insightful knowledge or illumination which is felt at an intuitive, non-rational level and gained by direct experience, and (2) the authoritativeness or the certainty for the experiencer that such knowledge is truly or ultimately real, in contrast to the feeling that the experience was a subjective delusion. These two elements are connected because the knowledge through participation in ultimate reality (in the sense of being able to "know" and "see" what is really **real**), carries its own sense of certainty. Two kinds of reality must be distinguished in reading the accounts: (a) "ordinary" reality (the reality of usual, everyday consciousness), and (b) "ultimate" reality (awareness of another dimension not the same as "ordinary" reality but still quite "real" to the experiencer. In fact, "ultimate" reality may be judged to be more profoundly real that "ordinary" reality. In each individual case, the context must determine which type of reality is being mentioned or described.

Such insightful knowledge does not necessarily mean an increase in facts, but rather intuitive illumination. What becomes "known" (rather than intellectually assented to) is intuitively felt to be authoritative and requires no proof at a rational level, and has an inward feeling of objective truth. The content of this knowledge can be divided into two main types: insights into being and existence in general, and insights into one's personal, finite self. The certainty of the reality and significance of the content applies to both. Examples of insights about being and existence in general are the direct realization through the present experience of hitherto undreamed-of realities and possibilities of experience, new perspectives on old facts or ideas, new understanding of relationships and meanings, new appreciation of the universe as a whole, or an experience of "everything falling into place." Examples of insights about one's personal self are: a new certainty about vocational choice; realization of faults or problems to be met; understanding of the causes of conflict; or a clear vision of one's true self without self-deception. Such personal insights are at a level different from "ordinary" everyday reality.

Scoring level is based on the intensity of the certainty for the experiencer that the insightful knowledge gained is of "ultimate" reality (i.e., really **real** and not a delusion):
3 The characteristic of this level is the profundity of the conviction that "ultimate" reality has been encountered. The insightful knowledge is felt to be profoundly significant and true. The response of ultimate reality is total, and there is a feeling of being totally grasped and dealt with. There is no doubt that what is experienced and known is truly or ultimately real, and this conviction persists after the actual experience is over (even after 5 months).
2 The totalness and profundity of the certainty is lacking. There is some doubt as to the "ultimate" or true reality of the insights gained. Degree of certainty may decrease after the experience.
1 Insights are present, but at a less intense level of certainty of their "ultimate" reality than in 2. There is serious doubt as to their reality, but some conviction of reality remains, although it may be on the wane.

VII. **Paradoxicality**
Any use of paradoxical language in describing or interpreting the experience or its meaning should be scored in this category. Paradoxical language is defined as language which is logically contradictory in

statements about, descriptions of, or interpretations of the experience. Examples may include the experience of an empty, yet full and complete unity, the paradoxical loss of the sense of self and dissolution of individuality with retention of consciousness of what is experienced, or the separateness, yet unity with objects in the experience of external unity (paradoxical transcendence of space). Watch for descriptions of such paradoxical experiences.

Degree of paradoxicality is to be scored on how paradoxical any examples found appear to the judge, i.e., based on degree of intensity:
3 This level means that although obviously contrary to common sense, contradictory statements are still strongly stated as true descriptions of the experience. The examples are striking, and the account gives a strong impression of paradoxicality.
2 Contradictory statements appear only moderately paradoxical. The striking element is lacking.
1 Paradoxicality is present, but only to a low degree. The examples are not particularly impressive.

VIII. **Alleged Ineffability**
This category is for any mention or indication of difficulty in adequately describing one's own experience in words. Watch for comparisons with the person's previous ease or difficulty in describing his personal experiences. The tone of the whole account is important in judging this category.

Scoring level is based on the intensity of the indication of difficulty of description.
3 This level designates direct statements made with conviction that the experience is beyond words and verbal description.
2 This level reflects direct statements of ineffability which are made without the emphasis of level 3, or strong indirect indications from the account in general.
1 Statements give an impression of ineffability, but only weakly.

IX. **Persisting Changes in Attitude and/or Behavior after Six Months**
This category is for any **persisting** changes, positive or negative, in attitude and/or behavior which are a result of the experience. These changes are divided into sub-categories according to type of change, whether positive or negative. Phenomena occurring during the actual experience are not included, only their continuing effects in the life of the experiencer. Watch for changes occurring during the experience, or by the time of the initial write-up, and see if they are still present six months later.

The positive changes are divided into 4 main groups: A) toward self, B) toward others, c) toward life, d) toward the experience itself.

A) Increased integration of personality is the basic inward change in the personal **self**. Such integration in the form of a reorganization of the personality and growth in maturity may have developed relatively rapidly or slowly as a result of what occurred during the experience. (For example, from a radical experience of death and rebirth, or conversion, or as an effect of insight which was gained in the depth of the experience and gradually utilized later. Undesirable traits may be faced in a way that they can be dealt with and finally reduced or eliminated. Issuing from personal integration, the sense of one's inner authority may be strengthened, and the vigor and dynamic quality of life may be increased. Creativity and greater achievement-efficiency may be released. There may be an inner optimistic tone with consequent increase in feelings of happiness, joy, and peace.

B) Change in attitude and behavior toward **others** (includes more sensitivity, more tolerance, more real love, and more authenticity as a person by being more open and more one's true self with others. The response of others is a good indication of such changes, if mentioned.

C) Positive change in **life-attitude** or goal may include philosophy of life, sense of values, sense of meaning, purpose in life, vocational commitment, need for service to others, and new appreciation for life or the whole of creation. Life may seem richer. The sense of reverence may be increased, and more time may be spent in devotional life and meditation.

D) Positive attitude toward the **experience** means that it is regarded as valuable and that what has been learned is thought to be useful. The experience is remembered as a high point, and an attempt is made to recapture the experience or, if possible, to gain new experiences as a source of growth and strength. Mystical experiences of others are more appreciated and understood.

Negative changes are divided into the same four groups and include the negative counterparts of the positive elements mentioned above.

A) Personal disintegration is the basic change toward self and includes fear, anxiety, insecurity, loneliness, depression, despair, mental confusion, delusion, feeling of "unreality," regression in maturity, less dynamic quality and vigor, unhappiness, turmoil, inner pessimism.

B) Negative changes toward others include less effective interpersonal relations, withdrawal into self, friction, antagonism, hatred, less sensitivity, less tolerance, and less authenticity as a person.

C) Negative changes toward life may include a cynical and bitter attitude and less intensity in or loss of the positive items listed above under this sub-category.

D) Negative changes toward the experience include regret for participation and attempts to forget and suppress the experience. which may be regarded as harmful.

Scoring level is based on intensity of benefit or harmfulness. Decide to which sub-category each item of the six-month followup data belongs. Then score each sub-category according to the intensity communicated by the account.
3 This level means that the person feels strong or very strong benefit or harm.
2 This level indicated moderate benefit or harm.
1 This level indicates slight or questionable benefit or harm.

3. With the above categories in mind, read all the accounts through in succession, at one sitting.

4. Working on the accounts one at a time, in order:
a) Read the firs account straight through to get the general feel and tone. Feel free to mark in the margin in pencil, with the major category numbers (I to IX) any sentence which impresses you at the time as an obvious example of a particular category. Don't worry at this point about scoring intensity or completeness. Read to get an impression of the account as a whole.
b) Using the score sheet, read the account through and look for examples of category I (transcendence of time and/or space). Mark them with the category number. Then give a qualitative rating (0 to 3) fora each scoring division of this category, as indicated on the score sheet. Base your score on the highest level reached at any point in the experience. Thus an element mentioned only once may have been described in such a way as to indicate a 3-level experience. Rate on the basis of the highest level for **any** essential element of a particular scoring division, in accordance with the description of the category. Be sure to rate the experience of the person writing the account, not his description of what other people were experiencing.
c) Then read the same account through again and mark examples of categories II and III (positive mood and sense of sacredness). Score these items on the score sheet in the appropriate place. Follow this same procedure for the rest of the categories. Look for evidence of categories IV and V at one reading. Categories VII and VIII may also be combined in this way.
d) When you have finished the first account, do the same for each of the remaining ones, in order. Try to finish two accounts at least at one sitting.

Content Analysis Score Sheet Used by Judges with the Probability for each Item that the Difference between Experimentals and Controls was due to Chance[6]

Category	*p* values (for Experimentals)	
I. Transcendence of time or space		
A. Loss of usual sense of time	.001 (1)	
B. Loss of usual sense of space	.001(2)	
II. Positive mood		
A. Joy	.002 (3)	
B. Love	.035 (4)	
C. Peace or blessedness	(.063) (5)	
III. Sense of sacredness	(.37) (6)	
IV.Unity		
A. Internal unity	.002 (7)	
B. External unity		
1. Oneness through external objects other than people	(.25) (8)	
2. Oneness through people	.032 (9)	
V. Transciency of unity	.004 (10)	
VI. Objectivity and reality		
A. Insights into being and existence in general	.004 (11)	
B. Insights into personal finite self	(.11) (12)	
VII. Paradoxicality	.001 (13)	
VIII. Ineffability	.008 (14)	
IX. Persisting changes in attitude or behavior six months later	Positive	Negative
A. Toward self	.004 (15)	(.13) (16)
B. Toward others	(.50) (17)	(1) (18)
C. Toward life	.016 (19)	(1) (20)
D. Toward the experience	(.19) (21)	(.25) (22)

Reliability of Judges as Determined from Kendall Rank Correlation Coefficient[7]

Judge Compared	τ	*p* less than
A and B	.74	.00006
B and C	.88	.00006
C and A	.78	.00006
All three	.80	.00006

---

6. The Sign Test was used to calculate *p* values from judges' scores.
7. Siegel, *op. cit.*, pp. 213-223.

Appendix F

EXPLANATION OF THE COLUMNS AND SYMBOLS USED IN THE CATEGORY TABLES

TABLE 3
Category I: UNITY
Combination of All Subcategories

	Subject group	Frequency Distribution (Number of *times* scored)				Total score (10 subjects)		Sign Test Statistics	
Items[a]	**(*n*=10)**[b]	**Strong**	**Moder.**	**Slight**	**None**[c]	**Actual**	**Maximum**[d]	***N***	***p***[e]

[a] The items which were combined from either the post-drug, follow-up, or content-analysis data.

[b] The group of subjects, either 10 experimentals or 10 controls.

[c] Frequency distribution shows the total **number** of responses made by all experimentals and controls at the particular scoring level indicated. The scoring scales on the three methods of measurement were correlated for easy comparison (i.e., the "strong" level for each rating scale was not the same numerical value. This level represented a score of "three" on the content-analysis scale, "four" on the post-drug questionnaire scale, and both "four" and "five" on the follow-up questionnaire scale. The "slight" level represented a score of "one" on content-analysis scale, and both "one" and "two" on the questionnaire scales).

[d] The sum of the **weighted** scores at each level. Maximum is the sum which would have been obtained if all the subjects scored all the items at the highest possible level.

[e] *N* = number of matched pairs with a difference in score when the score of the control subject was subtracted from the score of the experimental subject. The prediction had been made that the experimental score would be higher. The maximum value of *N* = 10.

p = the probability that the predicted higher scores of the experimentals were due to chance.

Appendix G

DATA NOT DIRECTLY RELEVANT TO CATEGORIES OF THE TYPOLOGY OF MYSTICISM

Group I: Integrative and Constructive Phenomena

Phenomena which occurred during experience	**values *p* (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug data:		
P3 Sense of the preciousness of life:	.020	.032
P88a Death experience:	.032	(.13)
P89a Rebirth experience:	.032	(.13)
P86a New significance to life:	(.062)	(.063)
P95a Conversion experience:	(.35)	(.35)
P21 Sense of forgiveness or cleansing:	(.35)	(.35)
P84a Increased integration of personality:	(.37)	(.37)
P10 Easy understanding of feelings of others:	(.5)	(.5)

P2 Feeling of unity with your group:	(.64)	(.64)
P93a Felt need for some type of service to others:	(.5)	(.5)
(2) Follow-up data:		
F21 Rebirth experience:	.016	(.063)
F20 Meaningfulness of your own life:	.055	(.062)
Phenomena which occurred within a few days after the experience (all from post-drug data):		
P86b New significance to life:	.002	.032
P96b Sense of belonging to a new and greater unity:	(.063)	(.063)
P126 Your experience was valuable to you personally:	(.062)	(.062)
P127 Your experience was mystical or religious:	(.062)	(.062)
P88b Death experience:	(.063)	(.25)
P84b Increased integration of personality:	(.090)	(.063)
P92b Felt need for some type of service to others:	(.18)	(.18)
P89b Rebirth experience:	(.19)	(.19)
P93b Actual changes in behavior in ways you would consider constructive and positive:	(.18)	(.18)
P95b Conversion experience:	(.19)	(.19)

Group II: Disturbing Changes in Attitude and Behavior

Phenomena which occurred during experience	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Fear and Anxiety:		
P5 Terror or fear:	.004	.008
P15 Fear of losing control:	.004	(.13)
P121 Anxious about having to "come out of it":	.008	.008
P8 Panic:	.016	(.25)
P46 Insecurity:	(.11)	(.063)
P51 Anxiety:	(.26)	(.26)
(2) Melancholia:		
P22 Sense of loneliness or aloneness:	.02	.032
P48 Despair:	.02	.032
P40 Depression:	(.09)	(.25)
P87a Lessening of significance to life:	(.13)	(.25)
(3) Disorientation:		
P98a Confusion of thinking:	.004	(.063)
P99a Feelings of unreality:	.016	(.13)
P101a Loss of memory:	.035	(.13)
P85a Disintegration or destructive effects on personality:	(.062)	(.25)
P97a Sense of subjective delusion:	(.063)	(1)
P17 Feeling that you were going to die during the experience:	(.063)	(1)

P19 General sense of sin:	(.50)	(.50)
P20 Conviction of certain specific sins in your life:	(.50)	(1)
P25 Sense of judgment on your life:	(.78)	(.78)
(4) Antisocial Feelings or Behavior:		
P123 Dislike for either leader:	.032	(1)
P91a Feelings of antagonism and hate toward others:	(.090)	(1)
P45 Meanness:	(.19)	(1)
P120 Explosive anger or fury:	(.13)	(1)
P94a Sense of increased self-centredness:	(.11)	(1)
P125 Dislike for any participant in the experiment:	(.37)	(1)
P42 Hate:	(.35)	(1)
Phenomena which occurred within a few days after the experience (all from post-drug data):		
P101b Loss of memory for part of the experience:	.020	(1)
P98b Confusion of thinking:	.032	(1)
P99b Feelings of unreality:	(.063)	(.13)
P97b Sense of subjective delusion:	(.063)	(1)
P85b Disintegration or destructive effects on personality:	(.13)	(1)
P87b Lessening of significance to life:	(1)	(1)
P91b Feelings of antagonism and hate toward others:	(.25)	(1)
P94b Sense of increased self-centeredness:	(.25)	(1)
Phenomena which occurred within six months after the experience:		
F74a Increased feelings of anxiety:	.032	(1)
F61a Increased feelings of depression:	(.063)	(1)
(See part III of Follow-up Questionnaire in Appendix D for the remaining negative items, none of which proved significant - *p* greater than .1)		

Group III: Physical Sensations

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
P16 Seeing a light which appeared to have no naturally explainable source:	.016	(.13)
P102 Loss of consciousness:	.016	(.25)
P103 Distortion of visual perception:	.055	(.063)
P104 Colors more intense:	.001	.008
P105 Visions of colors, geometric patterns, objects, animals, people, scenes:	.001	.008
P106 Seeing colors around heads or bodies of others:	.032	(1)
P108 Unusual odors or scents:	(.063)	(1)
P114 Sensation of floating:	(.09)	(.13)
P119 Sense of being out of the body:	(.062)	(.13)
P112 Nausea:	.008	(1)
P115 Sense of bodily warmth:	.035 (for controls)	(1)

P116 Itching or burning of skin:	.011 (for controls)	(.25)
(See items P100-P118 on post-drug questionnaire in Appendix C - for items above .1 level.)		

Group IV: Miscellaneous

	***p* values (for experimentals)**	
	Using all scores:	Using only "strong" scores:
(1) Post-drug data:		
P128 Got psilocybin:	.001	.007
(2) Follow-up data:		
F80b You place less importance on traditional theological formulations to express spiritual insights:	.035	(.25)
F100a You are convinced you had psilocybin:	.001	.001
F100b ...did not have psilocybin:	.001 (for controls)	.001

Bibliography

1. Abramson, Harold A. (ed.). The Use of LSD in Psychotherapy: Transactions of a Conference on d-Lysergic Acid Diethylamide (LSD-25). New York: Josiah Macy, Jr. Foundation, 1960.
2. Alken, J.W. "Can Drugs Lead You to God?" Fate, XVI, No. 5 (May, 1963), 66-70.
3. Ames, Edward S. The Psychology of Religious Experience. Boston & New York: Houghton Mifflin Co., 1910.
4. Barrow, George A. The Validity of the Religious Experience. Sherman, French, and Co., 1917.
5. Beecher, H.K., "Science, drugs, and students." Harvard Alum. Bull., LXV, No. 8 (Feb. 2, 1963), 338; repr. in Medical Tribune, IV, No. 29 (April 12, 1963), 11.
6. Begbie, Harold. Twice-Born Men: A Clinic in Regeneration. New York: Fleming H. Revell, 1909.
7. Blewett, Duncan B., and Chwelos, Nicolas. Handbook for the Therapeutic Use of Lysergic Acid Diethylamide-25, Individual and Group Procedures. Saskatchewan, 1959 (unpublished; mimeographed).
8. Blewett, Duncan B., "Psychedelic Drugs in Parapsychological Research," Intern. J. Parapsychol., V, No. 1 (Winter, 1963), 43-74.
9. Boison, Anton T. The Exploration of the Inner World: A Study of Mental Disorder and Religious Experience. New York: Harper, 1936. (Harper "Torchbooks," 1962.)
10. Boison, Anton T. Lift Up Your Hearts: A Service Book for Use in Hospitals. Boston: Pilgrim Press, 1926.
11. Boison, Anton T. Out of the Depths: An Autobiographical Study of Mental Disorder and Religious Experience. New York: Harper, 1960.
12. Boison, Anton T. Religion in Crisis and Custom: A Sociological and Psychological Study. New York: Harper, 1955.
13. Brinton, H. H. The Mystic Will: Based on a Study of the Philosophy of Jacob Boehme. New York: Macmillan, 1930.
14. Brown, H. F. J. A. Symonds. A Biography. London, 1895.
15. Buber, Martin. Between Man and Man. London: Routledge & Kegan Paul, 1947.
16. Bucke, R. M. Cosmic Consciousness: A Study in the Evolution of the Human Mind. Philadelphia: Innes & Sons, 1901.
17. Butler, C. Western Mysticism. London: Arrow Books (Grey Arrow Edition), 1960.
18. Chandler, A. L., and Hartman, M. A., "Lysergic Acid Diethyl-amide (LSD-25) as a Facilitating Agent in Psychotherapy," A.M.A. Arch. Gen. Psychiat., II (1960), 286-299.
19. Chwelos, N., Blewett, D. B., Smith, C., and Hoffer, A., "Use of LSD-25 in the Treatment of Chronic Alcoholism," Quart. J. Stud. Alcohol. XX (1959), 577-590.
20. Cholden, Louis (ed.). Lysergic Acid Diethylamide and Mescaline in Experimental Psychiatry. New York & London: Grune and Stratton, 1956.
21. Clark, E. T. The Psychology of Religious Awakening. New York: Macmillan, 1929.
22. Clark, Walter Huston. The Psychology of Religion: An Introduction to Religious Experience and Behavior. New York: Macmillan, 1958.
23. Coe, Georga Albert. The Psychology of Religion. Chicago: University of Chicago Press, 1916.
24. Cohen, Sidney, "Lysergic acid diethylamide: side effects and complications." J. Nery. Ment. Diseases. Vol. CXXX, No. 1 (January, 1960), 30-40.
25. Cohen, Sidney, "Notes on the Hallucinogenic State," Intern. Record of Medicine, 173, No. 6 (June, 1960), 380-387.
26. Cohen, Sidney, "The Therapeutic Potential of LSD-25," in: A Pharmacologic Approach to the Study of the Mind, eds. R. M. Featherstone and A. Simon. Springfield, Ill.: Thomas, 1959.
27. Cohen, Sidney, and Ditman, Keith S., "Complications associated with Lysergic Acid Diethylamide (LSD-25), J. Amer. Med. Assoc. CLXXXI, No. 2 (July 14, 1962), 161-162.
28. Cohen, Sidney, and Ditman, Keith S., "Prolonged Adverse Reactions to Lysergic Acid Diethylamide," A.M.A. Arch. Gen. Psychiat., VIII, (May, 1963), 475-480.
29. Cohen, Sidney, and Eisner, B. G., "Use of Lysergic Acid Diethylamide in a Psychotherapeutic Setting," A.M.A. Arch. Neurol. Psychiat., LXXXI (May, 1959), 615-619.
30. D'Arcy, Martin C, "Drugs, Brainwashing, and this Self," The Current, III, No. 2 (May, 1962), 92-100.
31. Deikman, R.J., "Experimental Meditation," J. Nerv. Mental Disease, 130, No. 4 (April, 1963), 329-343.
32. Delay, Jean, "Psychotropic Drugs in Experimental Psychiatry," in: Recent Advances in Biological Psychiatry. New York: Plenum Press, 1962.
33. DeRopp, Robert S. Drugs and the Mind. New York: St. Martin's Press, 1957. (Also in paperback: Evergreen Books and Black Cat Editions.)
34. DiMascio, A., and Klerman, G. L., "Experimental, Human Psychopharmacology: the Role of Nondrug Factors," in: The Dynamics of Psychiatric Drug Therapy, ed. G. J. Sarwer-Foner. Springfield, Ill.: Thomas, 1960, 56-84.
35. Ditman, Keith S., Hayman, M., and Whittlesey, J. R, B., "Nature and Frequency of Claims Following LSD," J. Nery. Mental Disease, CXXXIV (1962). 346-352.
36. Dunlap, Jane. Exploring Inner Space; Personal Experiences Under Lsd-25. New York: Harcourt, Brace & World, 1961.
37. Dunlap, Jane. "Exploring the Soul with LSD," Fate. XV, No. 6 (June, 1962), 25-36.
38. Ebin, David (ed.). The Drug Experience; First-Person Accounts of Addicts, Writers, Scientists and Others. New York: The Orion Press, 1961.
39. Fabing, Howard D., "On Going Berserk: A Neurochemical Inquiry." Scientific Monthly, LXXXIII, No. 5 (November, 1956), 232-237; repr. in Amer. J. Psychiat., CXIII, No. 5, (November, 1956), 409-415.
40. Farber, Seymour M., and Wilson, Roger H. L. (eds.). Man and Civilization: Control of the Mind. New York: McGraw-Hill, 1961.
41. Featherstone, R. M., and Simon, R. (eds.). A Pharmacologic Approach to the Study of the Mind. Springfield, 111.: Thomas, 1959.
42. Garrett, Eileen, (ed.). Proceedings of the Conference on Parapsychology and Psychopharmacology. New York: Parapsychology Foundation, Inc., 29 W. 57th St., 1961. (Abstracts of papers.)

43. Goldman, R. H. "Amanita Muscaria: Bridge to Fantasy." Unpublished Honors term paper, Harvard College, Library of Economic Botany, Harvard University, 1957.
44. Goodman, L. S., and Gilman, A. The Pharmacological,Basis of Therapeutics. New York: Macmillan, 1955.
45. Graves, Robert, "Centaurs Food," in: Food for Centaurs; Stories, Talks, Critical Studies, Poems. New York: Doubleday, 1960, 257-282.
46. Graves, Robert, "A Journey to Paradise," Holiday, XXXII, No. 2, (1962), 36-37, 110-111.
47. Havens, Joseph, "Memo to Quakers on the Consciousness-Changing Drugs." (Unpublished; mimeographed.)
48. Heard, Gerald, "Can This Drug Enlarge Man's Mind?" Horizon, V, No. 5 (May, 1963), 28-31, 114-115; repr. in The Psychedelic Review (P. O. Box 223, Cambridge 38, Mass.), I, No. 1 (June, 1963), 7-17, omitting accompanying commentaries.
49. Heim, Roger, Les Champignons, d'Europe. Parie: Editions N. Boubee & Cie, 1957.
50. Heim, Roger, and Wasson, R. Gordon. Les Champignons Hallucinogenes du Mexique. Paris: Museum National d'Histoire Naturelle, 1958.
51. Hoch, P., Pennes, H., Cattell, J. P., "Psychoses produced by Administration of Drugs," in: M. Rinkel (ed.), Chemical Concepts of Psychosis. New York: McDowell/Obolensky, 1958, 141-151.
52. Hoffer, A., Osmond, H., & Smythies, J., "Schizophrenia: a New Approach," J. Mental Sci., C, No. 418 (January, 1954), 29-45.
53. Hofmann, A., "Chemical, Pharmacological, and Medical Aspects of Psychotomimetic," J. Exper. Med. Sci., V, No. 2, (September, 1961), 31-51.
54. Hofmann, A., "Psychotomimetic Drugs: Chemical and Pharmacologic Aspects," Acta Physiol. Pharmacol. Neerlandica. VIII (1959), 240-258.
55. Hügel, Baron Friedrich von. The Mystical Element in Religion, 2 vols. New York: Dutton, 1909.
56. Huxley, Aldous, The Doors of Perception (and) Heaven and Hell. Penguin Books, 1960.
57. Huxley, Aldous, "Education on the Nonverbal Level," Paedalus, 91, NO. 2 (Spring, 1962), 279-293.
58. Huxley, Aldous, "Human Potentialities," in Man and Civilization: Control of the Mind. eds, 8. M. Farber & R. K. L. Wilson. New York: McGraw-Hill, 1961.
59. Huxley, Aldous, "Visionary Experience," in: Clinical Psychology ed. G. S. Nielsen (Proc. XIV Intern. Congr. Appl. Psychol., Vol. IV). Copenhagen: Munksgaard, 1962, 11-35.
60. Huxley, Julian, "Psychometabolism," J. Neuropsychiat., III, Suppl. No. 1 (August, 1962), S1-S14.
61. Isbell, H., "Comparison of the Reactions induced by Psilocybin and LSD-25 in Man," Psychopharmacologia. I, 1959, 29-38.
62. Isbell, H., *et al*., "Cross-Tolerance between LSD and Psilocybin," ibid., II, 1961, 147-159.
63. James, William, Varieties of Religious Experience (Mod. Lib. Edition.) New York: Random House, 1902.
64. Janiger, Oscar, "The Use of Hallucinogenic Agents in Psychiatry," California Clinician. LX, Nos. 7, 8 (July-August, 1959), 222-224, 251-259.
65. Jensen, S. E., "A Treatment Program for Alcoholics in a Mental Hospital," Quart. J. Stud. Alcohol. XXIII, No. 2 (June. 1962), 315-320.
66. Jochelson, W., "Religion and Myths of the Koryak," in: Jessup North Pacific Expedition VI. New York: Amer. Mus. Nat'l Hist., V, 1960, 1-382.
67. Johnson, Jean Bassett. Elements of Mazatec Witchcraft. ("Ethnological Studies" No. 9.) Gothenburg, Sweden: Gothenburg Ethnographical Museum, 1939.
68. Johnson, Paul E. Personality and Religion. New York/Nashville: Abingdon Press, 1957.
69. Johnson, Paul E. Psychology of Religion. New York/Nashville: Abingdon Press, 1959.
70. Johnson, Raynor C. The Imprisoned Splendour: An Approach to Reality based upon the Significance of Data drawn from the Fields of Natural Science, Psychical Research and Mystical Experience. New York: Harper, 1953.
71. Jones, Rufus, The Inner Life. New York: Macmillan, 1916.
72. Jones, Rufus, New Studies in Mystical Religion. New York: Macmillan, 1927.
73. Jones, Rufus, The Radiant Life. New York: Macmillan, 1944.
74. Jones, Rufus, Some Exponents of Mystical Religion. New York/Cincinnati/Chicago: Abingdon Press, 1930.
75. Jordan, G. Ray, Jr., "LSD and Mystical Experiences," J. Bible and Religion. XXXI, No. 2 (April, 1963), 114-123.
76. Jordan, G. Ray, Jr., "Reflections on LSD, Zen Meditation and Satori," Psychologia (Kyoto, Japan), V, No. 3 (September, 1962), 124-130.
77. Klee, Gerald D., "Lysergic Acid Diethylamide (LSD-25) and Ego Functions," A.M.A. Arch. Gen. Psychiat., X, (May, 1963), 461-473.
78. Knudson, Albert C. The Validity of Religious Experience. New York: Abingdon Press, 1937.
79. Koestler, Arthur, The Invisible Writing. New York: Macmillan, 1954 (quoted in Stace, below).
80. La Barre, Weston, The Peyote Cult. ("Yale University Publications in Anthropology" No. 19.) New Haven: Yale University Press, 1938. Repr. 1962, New Haven: Shoe String Press.
81. La Barre, Weston, "Twenty Years of Peyote Studies," Curr. Anthropol. Vol. I (1960), 45-60.
82. Laski, Marghanita. Ecstasy: A Study of Some Secular and Religious Experiences. London: Cresset Press, 1961.
83. Leary, Timothy, "The Effects of Testscore Feedback on Creative Performance and of Drugs on Creative Experience." Department of Social Relations: Harvard University, 1962. (Dittoed.)
84. Leary, Timothy, "How to Change Behavior," in: Clinical Psychology. ed. G. S. Nielsen. (Proc. XIV Intern. Congr. Appl. Psychol., Vol. IV.) Copenhagen: Munksgaard, 1962, 50-68.
85. Leary, Timothy, and Clark, Walter H., "Religious Implications of Consciousness Expanding Drugs," Relig. Educ, LVIII, No. 3 (1963), 252-256.
86. Leary, Timothy, Metzner, R., and Litwin, G., "Americans and Mushrooms in a Naturalistic Environment: A Preliminary Report." Department of Social Relations: Harvard University, 1962. (Dittoed.)
87. Leary, Timothy, Metzner, R., and Litwin, G., "Reactions to Psilocybin in a Supportive Environment." J. Nerv. & Mental Disease, 1963. (In press.)
88. Leary, Timothy, Metzner, R., Presnell, W. M., Schwitzgebel, R., Kinne, S., and Weil, G., "A New Behavior-Change Program

using Psilocybin." Department of Social Relations: Harvard University, 1962. (Dittoed.)

89. Leuba, James H. God or Man: A Study of the Value of God to Man. New York: Henry Holt & Co., 1933.
90. Leuba, James H. A Psychological Study of Religion: Its Origin, Function, and Future. New York: Macmillan, 1912.
91. Leuba, James H. The Psychology of Religious Mysticism. New York: Harcourt, Brace, 1925.
92. Lewin, Louis. Phantastica: Narcotic and Stimulating Drugs, their Use and Abuse. London: Kegan Paul, Trench, Trubner; N.Y.: E. P. Dutton, 1931. (Trans, from the German edition of 1924.)
93. Linton, H. B., and Langs, R. J., "Subjective Reactions to Lysergic Acid Diethylamide (LSD-25) - measured by a Questionnaire." Arch. Gen. Psychiat., VI, (May, 1962), 36-52.
94. MacLean, F. R., *et al.*, "The Use of LSD-25 in the Treatment of Alcoholism and Other Psychiatric Problems." Quart. J. Stud. Alcohol, XXII (1961), 34-45.
95. Marquette, Jacques de, Introduction to Comparative Mysticism. New York: Philosophical Library, 1949.
96. Maslow, Abraham H. Toward a Psychology of Being. Princeton. N.J.: D. Van Nostrand Co., Inc., 1962.
97. McGlothlin, W. H. Long-lasting Effects of LSD on Certain Attitudes in Normals: An Experimental Proposal. Santa Monica, California: Rand Corporation, 1962. (Privately published.)
98. Metzner, R., Litwin, G., and Weil, G., "The Relation of Expectation and Setting to Experience with Psilocybin: A Questionnaire Study." Department of Social Relations: Harvard University, 1962. (Dittoed; in press.)
99. Miller, James G., and Uhr, Leonard. Drugs and Behavior. New York/London: John Wiley, 1960.
100. Mystery and Mysticism (A Symposium). London: Blackfriars. Publications, 1956.
101. Newland, Constance. My Self and I. Foreword by H. Greenwald. New York: Coward-McCann, 1962.
102. Nicholson, R. A. Studies in Islamic Mysticism. London (n.d.).
103. Osmond, Humphry, "Peyote Night." Tomorrow Magazine, IX, No. 2 (1961), 105-125.
104. Osmond, Humphry, "A Review of the Clinical Effects of Psychotomimetic Agents." Ann. N. Y. Acad. Sci., LXVI (1957), 418-434.
105. Otto, Rudolf, The Idea of the Holy: An Inquiry into the Non-Rational_Factor in the Idea of the Divine and Its Relation to the Rational. (Galaxy Book). New York: Oxford University Press, 1958.
106. Otto, Rudolf, Mysticism East and West: A Comparative Analysis of the Nature of Mysticism. New York: Meridian Books, 1957.
107. Ouspensky, P. D. A New Model of the Universe. London: Routledge, Kegan Paul, 1937.
108. Plotinus, Works. Transl. Stephen Mackenna. (Enneads VI, IX, XI.) New York Medici Society, n.d.
109. Pratt, James B. Eternal Values in Religion. New York: Macmillan, 1950.
110. Pratt, James B. The Religious Consciousness: a Psychological Study. New York: Macmillan, 1921.
111. Puharich, Andrija, The Sacred Mushroom, Key to the Door of Eternity. Garden City, N. Y.: Doubleday & Co., 1959.
112. Puharich, Andrija, Beyond Telepathy. New York: Doubleday & Co., 1962.
113. Ramsbottom, John, Mushrooms and Toadstools. London: Collins, 1953.
114. Rinkel, Max (ed.). Chemical Concepts of Psychosis. New York: McDowell/Oblensky, 1958.
115. Rinkel, Max., Atwell, C. R., DiMascio, A., and Brown, Jonathan, "Psilocybine, a new Psychotropic Drug," New Engl. J. Med., CCLXII (Feb. 11, 1960), 295-297.
116. Rinkel, Max (ed .). Specific and Non-Specific Factors in Psychopharmacology. New York: Philosophical Library, 1963.
117. Sahagún, Bernardino. Historia General de las Cosas de Nueva España, ed. Carlos Maria de Bustamante (Mexico, 1829-30), cited in R. E. Schultes, "Peyote - An American Indian Heritage from Mexico," El Mexico Antiguo, IV, No. 5/6 (April, 1938), 200-209.
118. Sanctus, Sante De. Religious Conversion. Transl. H. Augur. New York: Harcourt, Brace, 1927.
119. Sandoz Pharmaceuticals. Annotated Bibliography on LSD 25 (d-lysergic acid diethylamide). Five Parts. Hanover, N.J.: Medical Department, Sandoz Pharmaceuticals: 1957-1961. (Mimeographed.)
120. Sandoz Pharmaceuticals. Annotated Bibliography on Psilocybin. Hanover, N.J.: Medical Department, Sandoz Pharmaceuticals; 1960. (Mimeographed.)
121. Sandoz Pharmaceuticals. Catalogue of the Literature on Delysid (D-lysergic acid diethylamide or LSD-25). Hanover, N. J.: Medical Department, Sandoz Pharmaceuticals; September, 1962. (Miroeographed.)
122. Saudreau, Auguste, The Mystical State: Its Nature and Phases. New York/Cincinnati/Chicago: Benziger Bros., 1924.
123. Schultes, Richard Evans, A Contribution to our Knowledge of Rivea Corymbosa, the Narcotic Ololiuqui of the Aztecs. Cambridge: Botanical Museum of Harvard University, 1941.
124. Schultes, Richard Evans, "Peyote - An American Indian Heritage from Mexico," El Mexico Antiguo. IV, No. 5/6 (April, 1938), 200-209.
125. Schultes, Richard Evans, "Pharmacognosy." The Pharmaceutical Sciences (3rd Lecture Series.) Austin, Texas: University of Texas College of Pharmacy, 1960, 142-185.
126. Schultes, Richard Evans, "Plantae Mexicanae II: The Identification of Teonanacatl, a Narcotic Basidiomycete of the Aztecs." Botanical Museum Leaflets, Harvard University, VII, No. 3 (1939), 37-54.
127. Sherwood, J. N., Stolaroff, M. J., and Harman, W. W., "The Psychedelic Experience - A New Concept in Psychotherapy." J. Neuropsychiatry. XV, No. 2 (Nov.-Dec, 1962), 69-80.
128. Siegel, S., Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill, 1956.
129. Slotkin, J. S., "Menomini Peyotism," in: The Drug Experience, ed. David Ebin. New York: Orion Press, 1961, pp. 237-269.
130. Slotkin, J. S., The Peyote Religion. Glencoe, Ill.: The Free Press, 1956.
131. Slotkin, J. S., "The Peyote Way." Tomorrow Magazine. IV, No. 3 (1956), pp. 65-70.
132. Smith, C. M., "Some Reflections on the Possible Therapeutic Effects of the Hallucinogens." Quart. J. Stud. Alcohol. XIX (1959), 292-301.
133. Stace, Walter T. Mysticism and Philosophy. Philadelphia and New York: J. B. Lippincott, 1960.
134. Starbuck, Edwin Diller. The Psychology of Religion:, An Empirical Study of the Growth of Religious Consciousness. London: Walter Scott, 1899.
135. Stewart, Omer C. Washo-Northern Paiute Peyotism. ("University of California Publications in American Archaeology and Ethnology," XL, No. 3.) Los Angeles: University of California Press, 1944, 63-142.

136. Suzuki, D. T. Mysticism: Christian and Buddhist. New York: Harper, 1957.
137. Suzuki, D. T. Zen Buddhism: Selected Writings of D. T. Suzuki, ed. William Barrett. Garden City, N.Y.: Doubleday, 1956.
138. Swain, Frederick, "The Mystical Mushroom." Tomorrow Magazine, X, No. 4 (Autumn, 1962), 27-34.
139. Terrill, J., Savage, C, and Jackson, D. D., "LSD, Transcendence, and the New Beginning." (Panel on the nature of the LSD experience.) J. Nerv. and Mental Disease, CXXXV, No. 5 (November, 1962), 425-439.
140. Thouless, Robert H. An Introduction to the Psychology of Religion. Cambridge: Cambridge University Press, 1956.
141. Tillich, Paul, Systematic Theology. I. Chicago: University of Chicago Press, 1951.
142. Underhill, E. Essentials of Mysticism. (Everyman Paperback Edition.) New York: E. P. Dutton, 1960.
143. Underhill, E. Mysticism: A Study in the Nature and Development of Han's Spiritual Consciousness. New York: Meridian, 1955.
144. Unger, Sanford M., "Mescaline, LSD, Psilocybin, and Personality Change: A Review," Psychiatry. XXVI, No. 2 (May, 1963), 111-126.
145. Van Dusen, Wilson, "LSD and the Enlightenment of Zen,"Psychologia (Kyoto, Japan), IV, No. 1 (March, 1961), 11-16.
146. Vetter, George B. Magic and Religion: Their Psychological Nature, Origin, and Function. New York: Philosophical Library, 1958.
147. Wach, Joachim, Comparative Study of Religions. New York: Columbia University Press, 1961.
148. Wach, Joachim, Types of Religious Experience: Christian and Non-Christian. Chicago: University of Chicago Press, 1951.
149. Walker, Kenneth. The Conscious Mind: A Commentary on the Mystics. London: Rider & Co., 1962.
150. Walter, W. Grey, The Neurophysiological Aspects of Hallucinations and Illusory Experience. XIVth F. W. H. Meyers Memorial Lecture. London: Society for Psychical Research, 1960.
151. Wasson, R. Gordon, "The Hallucinogenic Fungi of Mexico: An Inquiry into the Origins of the Religious Idea among Primitive Peoples," Botanical Museum Leaflets, Harvard University, XIX, No. 7 (1961), 137-162. (Repr., omitting botanical appendix, in The Psychedelic Review, I, No. 1 (June, 1963), 27-42.
152. Wasson, R. Gordon, "Notes on the Present Status of Ololiuqui and the Other Hallucinogenics of Mexico," Botanical Museum Leaflets, Harvard University. (In press.)
153. Wasson, R. Gordon, and Wasson, V. P. Mushrooms, Russia and History. New York: Pantheon Books, 2 Vols., 1957.
154. Watts, Alan W. The Joyous Cosmology: Adventures in the Chemistry of Consciousness. New York: Pantheon Books, 1962.
155. Watts, Alan W. "The New Alchemy," in: This is It, and Other Essays on Zen and Spiritual Experience. New York: Pantheon Books, 1960, 127-153.
156. Wieman, H. N., and Wieman, R. W. Normative Psychology of Religion. New York: T. Y. Crowell, 1935.
157. Zaehner, R. C, "Menace of Mescaline," Blackfriars. CXXXV (July-August, 1954), 310-321.
158. Zaehner, R. C, Mysticism, Sacred and Profane. An Inquiry into some Varieties of Praeternatural Experience. New York: Oxford University Press, 1957.

Pahnke's Good Friday Experiment - Long-Term Follow-Up and Methodological Critique

by

Rick Doblin

Cambridge, Massachusetts

original source: https://www.erowid.org/plants/mushrooms/mushrooms_journal2.pdf
backup source: http://www.psilosophy.info/resources/mushrooms_journal2.pdf

Table of Contents:

- Methodology of the original experiment
  - *Difficulties with the Double-Blind*
  - *Critique of the Questionnaire*
- Findings of the original study and long-term follow-up
- The long-term follow-up interviews: General overview
  - *A Significant Omission*
- Discussion
- References
- Bibliography of related literature

On Good Friday, 1962, before services commenced in Boston University's Marsh Chapel, Walter Pahnke administered small capsules to twenty Protestant divinity students. Thus began the most scientific experiment in the literature designed to investigate the potential of psychedelic drugs to facilitate mystical experience (Pahnke, 1963, 1966, 1967, 1970; Pahnke & Richards, 1969a, 1969b, 1969c). Half the capsules contained psilocybin (30mg), an extract of psychoactive mushrooms, and the other half contained a placebo. According to Pahnke, the experiment determined that "the persons who received psilocybin experienced to a greater extent than did the controls the phenomena described by our typology of mysticism" (Pahnke, 1963, p. 220).

This paper is a brief methodological critique and long-term follow- up study to the "Good Friday Experiment." Pahnke, who was both a physician and a minister, conducted the experiment in 1962 for his Ph.D. in Religion and Society at Harvard University, with Timothy Leary as his principal academic advisor (Leary, 1962, 1967, 1968). Describing the experiment, Walter Houston Clark, 1961 recipient of the American Psychological Association's William James Memorial Award for contributions to the psychology of religion, writes, "There are no experiments known to me in the history of the scientific study of religion better designed or clearer in their conclusions than this one" (Clark, 1969, p. 77).

Since a classic means of evaluating mystical experiences is by their fruits, follow-up data is of fundamental importance in evaluating the original experiment. A six-month follow-up was part of the original experiment and a longer term follow-up would probably have been conducted by Pahnke himself had it not been for his death in 1971. For over twenty-five years it has not been legally possible to replicate or revise this experiment. Hence, this long-term follow-up study, conducted by the author, is offered as a way to advance scientific knowledge in the area of psychedelics and experimental mysticism. Lukoff, Zanger and Lu's review (1990) of psychoactive substances and transpersonal states offers a recent overview of this topic.

Though all raw data from the original experiment is lost, including the uncoded list of participants, extensive research over a period of four years and the enthusiastic cooperation of most of the original subjects have resulted in the identification and location of nineteen out of the original twenty subjects. From November, 1986 to October, 1989, this author tape recorded personal interviews with sixteen of the original subjects, meeting fifteen in their home cities throughout the United States and interviewing one subject (from the control group) over the telephone. In addition to the interviews, all sixteen subjects participating in the long-term follow-up, nine from the control and seven from the experimental group, were re-administered the six-month 100- item follow-up questionnaire used in the original experiment.

Of the remaining three subjects from the experimental group, one is deceased. The identity of another is unknown. One declined to participate citing concerns about privacy. One subject, from the control group, declined to be interviewed or to fill out the questionnaire because he interpreted Pahnke's pledge of confidentiality to mean that the subjects should not talk about the experiment to anyone. This author's discussion of the meaning of confidentiality and mention of the explicit support for the long-term follow-up by Pahnke's wife failed to enlist his participation.

Informal discussions were also conducted with seven out of the ten of Pahnke's original research assistants for purposes of gathering background information about the experiment. At the time of the experiment, these people were professors or students of religion, psychology and philosophy at universities, colleges and seminaries in the Boston area.

Methodology of the original experiment

Pahnke hypothesized that psychedelic drugs, in this case psilocybin, could facilitate a "mystical" experience in religiously inclined volunteers who took the drug in a religious setting. He further hypothesized that such experiences would result in persisting positive changes in attitudes and behavior.

Pahnke believed the most conducive environment for his experiment would be a community of believers participating in a familiar religious ceremony designed to elicit religious feelings, in effect creating an atmosphere similar to that of the tribes which used psilocybin-containing mushrooms for religious purposes (Harner, 1973; Hofmann, Ruck & Wasson, 1978; Hofmann & Schultes, 1979; Wasson, 1968). Accordingly, the experiment was designed to administer psilocybin to a previously acquainted group of Christian divinity students in church during a Good Friday service.

Methodologically, the study was designed as a randomized controlled, matched group, double-blind experiment using an active placebo. Prior to Good Friday, twenty white male Protestant volunteers, all of whom were students at the same theological school in the Boston area, were given a series of psychological and physical tests. Ten sets of closely matched pairs were created using variables such as past religious experience, religious background and training, and general psychological makeup. On the morning of the experiment, a helper who did not participate further in the experiment and who did not know any of the subjects, flipped a coin to determine to which group, psilocybin or placebo, each member of the pair would be assigned.

Three different methods were used to create numerical scales quantifying the experiences of the subjects in terms of an eight-category typology of mystical experiences designed by Pahnke especially for the experiment. Blind independent raters trained in content-analysis procedures scored descriptions of the experiences written by the subjects shortly after Good Friday as well as transcripts of three separate tape-recorded interviews conducted immediately, several days and six months after the experiment. A 147-item questionnaire was administered to the subjects one or two days after Good Friday and a 100-item questionnaire was administered six months after the experiment. The subject's responses to the interview and the two questionnaires were transformed into three distinct scores averaging the percentage of the maximum possible score in each category. Each of the three complementary scores was then compared to each other.

Pahnke secured support and permission to use Marsh Chapel from Rev. Howard Thurman, Boston University's dynamic black chaplain. Several small meeting rooms and a self-contained basement chapel were set aside on Good Friday for the participants in the experiment while the main service led by Rev. Thurman was taking place upstairs in the larger chapel. The two-and-a-half hour service was broadcast into the basement chapel, where altar, pews, stained glass windows and various religious symbols were permanently located.

Pahnke gave an active placebo of nicotinic acid to the controls who were expecting to receive either the psilocybin or an inactive placebo. This was done in order to "potentiate suggestion in the control subjects, all of whom knew that psilocybin produced various somatic effects, but none of whom had ever had psilocybin or any related substance before the experiment" (Pahnke, 1963, p. 89).

The ten research assistants worked as part of the experimental team in order to provide emotional support to the subjects prior to and during the service. Subjects were divided into five groups of four with two research assistants, known as group leaders, assigned to each group. These small groups met for two hours prior to the service to build trust and facilitate group support. Subjects were encouraged to "go into the unexplored realms of experience during the actual experiment and not try to fight the effects of the drug even if the experience became very unusual or frightening" (Pahnke, 1963, p. 96).

As a precaution against biasing the subjects toward the typology of mystical experience, leaders were told not to discuss specific aspects of the psychedelic or mystical experience. The lack of overt bias was confirmed by all of the subjects in their long-term follow-up interviews. In a typical long-term follow-up report, psilocybin subject S.J. (all initials used to identify subjects are coded to preserve anonymity) made the following remarks both about the preparation phase of the experiment and the conduct of the group leaders:

> None of the fine points of the mystical experience were given to us. We were not told to read any books such as Stace's book on mysticism or Jacob Boheme's books, nothing like that. They did not bias us in any way towards that, not at all.

At the insistence of one of the group leaders as well as Pahnke's faculty sponsor, Timothy Leary, but over the objections of Pahnke, all of the group leaders were also given a pill prior to the service (Leary, 1984, p. 107). This was done in a double-blind manner with one of each group's leaders receiving a half dose of psilocybin (15 mg) and the other the placebo. Pahnke was concerned this would lead to charges of experimenter bias being leveled against the study, but Leary and the group leader felt that the full involvement of the group leaders would create more of a community feeling and lend necessary confidence to the subjects. Though administered a capsule at the Good Friday service, the group leaders' reactions were not tape recorded, nor did they fill out questionnaires. Pahnke himself refrained from having any personal experiences with any psychedelic drug until after die experiment and follow-up had been completed.

Difficulties with the Double-Blind

The double-blind was successfully sustained through all of the preparation phases of the experiment up to and including ingestion of the capsule. The double-blind was even sustained for a portion of the Good Friday service itself because of the use of nicotinic acid as an active placebo. Nicotinic acid acts more quickly than does psilocybin and produces a warm flush through vasodilation of blood vessels in the skin and general relaxation. Subjects in the placebo group mistakenly concluded, in the early stages of the experiment, that they were the ones who had received the psilocybin (Pahnke, 1963, p. 212). The group leaders, unaware that an active placebo was going to be used, were also initially unable to distinguish whether subjects had received the psilocybin or the placebo.

Psilocybin's powerful subjective effects were eventually obvious to all subjects who received it, even though they had not previously ingested the drug or anything similar to it (Pahnke, 1963, p. 212). Inevitably, the double-blind was broken during the service as the psychoactive effects of the psilocybin deepened and the physiological effects of the nicotinic acid faded. At the end of the day of the experiment, all subjects correctly determined whether they had received the psilocybin or the placebo even though they were never told which group they were in (Pahnke, 1963, p. 210). Pahnke himself remained technically blind until after the six month follow-up. The comments of subject O.W., gathered in the course of this author's long-term follow-up, are typical of members of the control group.

> After about a half hour I got this burning sensation. It was more like indigestion than a burning sensation. And I said to T.B., "Do you feel anything?" And he said, "No, not yet." We kept asking, "Do you feel anything?" I said, "You know, I've got this burning sensation, and it's kind of uncomfortable." And T.B. said, "My God, I don't have it, you got the psilocybin, I don't have it." I thought, "Jeez, at least I was lucky in this trial. I'm sorry T.B. didn't get it, but I'm gonna' find out." I figured, with my luck, I'd probably get the sugar pill, or whatever it is. And I said to Y.M., "Do you feel anything?" No, he didn't feel anything. So I sat there, and I remember sitting there, and I thought, "Well, Leary told me to chart my course so I'm gonna concentrate on that." And I kept concentrating and sitting there and all I did was get more indigestion and uncomfortable.
>
> Nothing much more happened and within another 40 minutes, 45 minutes, everybody was really

> quiet and sitting there. Y.M. was sitting there and looking ahead, and all of the sudden T.B. says to me, "Those lights are unbelievable." And I said, "What lights?" He says, "Look at the candles." He says, "Can you believe that?" And I looked at the candles, and I thought, 'They look like candles." He says, "Can't you see something strange about them?" So I remember squinting and looking. I couldn't see anything strange. And he says, "You know it's just spectacular." And I looked at Y.M. and he was sitting there saying, "Yeah." And I thought, "They got it, I didn't."

The follow-up interviews yielded no evidence that the experimental team consciously used their knowledge of which pill the subjects had received to bias the results. However, unconscious bias resulting in an "expectancy effect" cannot be ruled out (Barber, 1976). Still, valuable information can be generated without the successful use of the double-blind methodology. Louis Lasagna, Director of the Center for the Study of Drug Development at Tufts University, writes:

> We have witnessed the ascendancy of the randomized, double-blind, controlled clinical trial (RCCT), to the point where many in positions of authority now believe that data obtained via this technique should constitute the only basis for registering a drug or indeed for coming to any conclusions about its efficacy at any time in the drug's career. My thesis is that this viewpoint is untenable, needlessly rigid, unrealistic, and at times unethical. ... Modern trial techniques [were not] necessary to recognize the therapeutic potential of chloral hydrate, the barbiturates, ether, nitrous oxide, chloroform, curare, aspirin, quinine, insulin, thyroid, epinephrine, local anesthetics, belladona, antacids, sulfonamides, and penicillin, to give a partial list. ... (Lasagna, 1985, p. 48).

Commenting about the attempt to remove the experimenter from the experiment completely, Tooley and Pratt remark:

> In certain participant-observer situations (e.g. psychotherapy, education, change induction, action research) the purpose might be to influence the system under investigation as much as possible, but still accounting for (though now exploiting) the variance within the system attributable to the several significant and relevant aspects of the investigator's participant observation. ... From this perspective, the quixotic attempt to eliminate the effects of participant-observation in the name of a misplaced pseudo-objectivity is fruitless, not so much because it is impossible but because it is unproductive. ... From our point of view... the question becomes not how to eliminate bias (unaccounted-for influence) of participant observation, but how optimally to account for and exploit the effects of the participant observation transaction in terms of the purposes of the research (Tooley & Pratt, 1964, p. 254-56).

The loss of the double-blind makes it impossible to determine the relative contributions of psilocybin and suggestion in producing the subjects' reported experiences. If the experiment were designed specifically to measure the pure drug effects of psilocybin, the failure of the double-blind would be quite damaging. In this instance the loss of the double-blind is of lesser significance because the entire experiment was explicitly designed to maximize the combined effect of psilocybin and suggestion. The setting was religious, the participants were religiously inclined and the mood was positive and expectant. Pahnke did not set out to investigate whether psilocybin was able to produce mystical experiences irrespective of preparation and context. He designed the experiment to determine whether volunteers who received psilocybin within a highly supportive, suggestive environment similar to that found in the ritual use of psychoactive substances by various native cultures would report more elements of a classical mystical experience (as defined by the questionnaires) than volunteers who did not receive psilocybin. The loss of the double-blind may have enhanced the power of suggestion to some extent and suggests that restraint should be used in attributing the experiences of the experimental group exclusively to the psilocybin (Zinberg, 1984).

Critique of the Questionnaire

Pahnke designed the questionnaire he used to measure the occurrence of a mystical experience specifically for the experiment. No similar questionnaires existed at the time (Larson, 1986; Rue, 1985; Silverman, 1983). Pahnke decided to measure the mystical experience in reference to eight distinct experiential categories. The categories include 1) sense of unity, 2) transcendence of time and space, 3) sense of sacredness, 4) sense of objective reality, 5) deeply felt positive mood, 6) ineffability, 7) paradoxicality and 8) transiency. These categories are very similar to those elaborated by such well-respected scholars of mystical experience as William James (1902), Evelyn Underhill (1910), and W.T. Stace (1960) and are accepted as valid even by academic critics of the Good Friday experiment such as R.C. Zaehner (1972). At present, the scientific questionnaire most widely used by researchers to assess mystical experiences is a 32-item questionnaire created by Ralph Hood, also based on categories developed by W.T. Stace (Spilka, Hood & Gorsuch, 1985).

Zaehner's critique of Pahnke's questionnaire is that it does not contain a category for experiences which are specifically Christian, such as identification with the death and rebirth of Jesus Christ. From Zaehner's perspective, this omission made it impossible to determine if the experiences reported by the subjects during the Good Friday experiment were religious, since he thought a religious experience for Christians necessarily involves a theistic encounter with Christ. Zaehner objected to the claim that an experience of a generalized, non-specific, apprehension of a transcendent reality beyond any specific cultural forms and figures could properly be called religious. Anticipating this critique, Pahnke asserted in the thesis that he was not attempting to resolve the question of what can properly be called religious but was simply investigating mystical experiences, regardless of whether or not they were considered religious. This author will also leave this delicate discussion to others.

The questionnaire used in the Good Friday experiment has been modified and expanded oyer the years by Pahnke, William Richards, Stanislav Grof, Franco Di Leo, and Richard Yensen for use in subsequent psychedelic research (Richards, 1975, 1978). From the initial creation of the questionnaire by Pahnke in 1962 to Di Leo and Yensen's computerized version, called the Peak Experience Profile, the basic items relating to the mystical experience have remained essentially unchanged (Di Leo, 1982). While the original follow-up questionnaire was composed of eight different categories, the Peak Experience Profile uses only six. The category of transiency was eliminated since it measures any altered state of consciousness whether mystical or not. The paradoxicality and alleged ineffability categories were combined into the ineffability category. Over the years, new categories measuring transpersonal but not necessarily mystical experiences were added. For example, new questions relate to the reexperiencing of the stages of birth and the perinatal matrixes as defined by Grof (Grof, 1975, 1980) and also to past-life experiences (Ring, 1982, 1984, 1988). A series of questions relating to difficult and painful nadir experiences, in some sense the opposites of peak experiences, has also been added.

In Pahnke's original questionnaire and in the subsequent revisions, the completeness with which each subject experienced each category is measured through numerical responses to category- specific questions. Pahnke's subjects rated each question on the post-drug questionnaire from zero to four, with zero indicating that the item was not experienced at all and four indicating that it was experienced as strong or stronger than ever before. The six-month follow-up questionnaire used a zero to five scale, with four indicating that it was experienced as strong as before and five indicating that it was experienced stronger than ever before.

The questions themselves are of two types. The predominant type asks the subject about experiences of a new perspective. For example, some of the questions used to determine the sense of unity ask subjects to rate the degree to which they experienced a pure awareness beyond any empirical content, a fusion of the self into a larger undifferentiated whole, or a freedom from the limitations of the self in connection with a unity or bond with what was felt to be all-encompassing and greater-than-self. These type of questions are sufficiently detailed and specific to be an effective test for the specific category.

The second type of question, used much less frequently, asks about the loss of a normal state. For example, two questions used to determine the presence of a sense of unity simply required subjects to rate the degree to which they lost their sense of self or experienced a loss of their own identity. This type of question is a minor weak point of the questionnaire because it can be rated highly without having anything to do with mystical experiences. For example, one subject reported in the follow-up interview that under the influence of psilocybin he temporarily had difficulty recalling his career choice, home, names of his wife and children, and even his own name. This experience of a powerful loss of the usual sense of self and identity would be highly correlated with mystical experience in the questionnaire but may not actually be related because it can occur for a variety of reasons. Though the questionnaire has relatively few of this type of question, some overestimation of the completeness of the mystical experience could have been introduced into the data as a result.

In addition to asking questions about the experience itself, the follow-up questionnaire also sought to assess the effects of that experience on the attitudes and behaviors of the subjects. For example, the subjects' attitude changes were assessed by asking them to use a 0 to 5 scale to rate whether they had experienced an increase or a decrease in their feelings of happiness, joy, peace, reverence, creativity, vocational commitment, need for service, anxiety, and hatred. Changes in subjects' behavior were assessed by means of questions asking whether or not they experienced changes in their relationships with others, in time spent in quiet meditation or devotional life, or whether they thought their behavior had changed in positive or negative ways.

Pahnke's questionnaire gathered information only from the selfreports of the subjects, resulting in a general sense of the subjects' own assessment of the direction of the effects of their Good Friday experience. The data do not yield specific information about the internal psychodynamic mechanisms at work within each subject, nor do they include the views of significant others regarding the effects of the experiment on the subjects. In contemporary psychotherapy research, more sophisticated methods than Pahnke's are used to assess personality change (Beutler & Crago, 1983). Reports from significant others such as family members and close friends of the subject are almost always used to add an important "objective" element in assessing personality change. Data from the follow-up questionnaires, administered by Pahnke at six-months and by the author after twenty-four to twenty-seven years, should be considered valuable as far as they go, but this is not very far. Since no detailed personality tests were given prior to the experiment, results of such tests at the time of the long-term follow-up would have been of little value and were not conducted. The long-term follow-up interviews, because of their open-ended format and extensive questioning, yielded more detailed information than the questionnaire about the content of the experiences and the persisting effects.

Findings of the original study and long-term follow-up

Pahnke arbitrarily determined that for a mystical experience to be considered complete for the purposes of the experiment, out of the maximum total possible score, "the total score and the score in each separate category must be at least 60 to 70 percent" (Pahnke, 1967, p. 66). According to this cut-off point, "Four of the ten psilocybin subjects reached the 60 to 70 percent level of completeness, whereas none of the controls did" (Pahnke, 1967, p. 64). Looked at by subjects and categories, Pahnke reported that "eight out of ten of the experimental subjects experienced at least seven out of the nine categories. None of the control group, when each individual was compared to his matched partner, had a score which was higher" (Pahnke, 1966, p. 647). In every general category and in every specific question, the average score of the experimental subjects exceeded that of the control subjects. The differences between the groups in the scores on the questionnaires were significant at $p<.05$ level for all categories.

When asked at a conference if any of the controls had a mystical experience, Pahnke replied:

> To take an individual case, there was one control subject who scored fairly high on sacredness and sense of peace and that he himself, in his written account, said "It was a very meaningful experience, but in the past I've certainly had one that was much more so" (Pahnke, 1966, p. 648).

Pahnke's six-month follow-up data and the author's long-term follow-up questionnaire data, both of which used the same instrument, are displayed in Table 1. The six-month scores are listed first and the long-term follow-up scores follow in parentheses. For each category, the percentages in the chart represent the total scores of the subjects divided by the highest possible scores that could have been reported. The numbers measure the completeness with which each category was experienced.

Comparisons can reliably be made between the control group's six-month and long-term scores because nine out of the original ten control group subjects participated in the long-term follow-up and the variance in scores between control subjects was small. The absence of completed long-term questionnaires from three of the ten original subjects from the psilocybin group makes comparing their six-month and long-term scores more difficult. The long-term follow-up interviews produced specific information suggesting that one of the three missing psilocybin subjects had scores significantly lower than average. No information was generated suggesting that the other two missing subjects had scores significantly different than average. The average scores for the long-term follow-up may thus overstate somewhat the scores from the entire psilocybin group.

The average scores for the eight categories of the mystical experience and the scores for persisting positive and negative changes in attitude and behavior have changed remarkably little for either the controls or the experimentals despite the passage of between twenty-four and twenty-seven years between the two tests. The questionnaire seems to be reliable and indicates that time has not substantially altered the opinions of the subjects about their experiences. In the long-term follow-up even more than in the six-month follow-up, the experimental group has higher scores than the control group in every category. For the long-term follow-up, these differences are significant at p<.05 in every category.

TABLE 1.
"GOOD FRIDAY EXPERIMENT" EXPERIMENTAL AND CONTROL GROUPS
AT SIX-MONTH AND LONG-TERM FOLLOW-UP,
SHOWN AS PERCENTAGES OF MAXIMUM POSSIBLE SCORES

CATEGORY	EXPERIMENTALS		CONTROLS	
	Six-month	Long-Term	Six-month	Long-Term
1. Unity A. Internal B. External	60 39	(77) (51)	5 1	(5) (6)
2. Transcendence of Time and Space	78	(73)	7	(9)
3. Deeply Felt Positive Mood	54	(56)	23	(21)
4. Sacredness	58	(68)	25	(29)
5. Objectivity and Reality	71	(82)	18	(24)
6. Paradoxicality	34	(48)	3	(4)
7. Alleged Ineffability	77	(71)	15	(3)
8. Transiency Average for the Categories	76 60.8	(75) (66.8)	9 11.8	(9) (12.2)
9. Persisting Positive Changes in Attitude and Behavior	48	(50)	15	(15)
10. Persisting Negative Changes in Attitude and Behavior	6	(6)	2	(4)

At Six-Month Follow-up, Exper. N=10, Control = 10
Long-Term Follow-Up (In Parenthesis) Exper. N=7, Control N=9
p<.05 for all category comparisons at both six-months and long-term

For the experimental group, the average score for the mystical categories at the six-month follow-up was 60.8 percent. They scored 66.8 percent at the long-term follow-up. In the six-month follow-up, the experimental group scored above 34 percent in all categories while in the long-term follow-up they scored above 48 percent in all categories. The experimental group scored the highest in those categories that typify a different state of consciousness such as transcendence of time and space, alleged ineffability and transiency.

For the control group, the average score for the eight categories of mystical experience at the six-month follow-up was 11.8 percent. They scored 12.2 percent at the long-term follow-up. The highest score of the control group at either time was 29 percent, in the sacredness category. The control group scored the highest in the categories of experience that religious services are most likely to induce, namely sense of sacredness, deeply felt positive mood and sense of objectivity and reality.

For the psilocybin group, the long-term follow-up yielded moderately increased scores in the categories of internal and external unity, sacredness, objectivity and reality, and paradoxicality, while all other categories remained virtually the same as the six-month data. Several decades seem to have strengthened the experimental groups' characterization of their original Good Friday experience as having had genuinely mystical elements. For the controls, the only score that changed substantially was that of alleged ineffability, which decreased.

A relatively high degree of persisting positive changes were reported by the experimental group while virtually no persisting positive changes were reported by the control group. In the open-ended portion of the long-term follow-up questionnaire, experimental subjects wrote that the experience helped them to resolve career decisions, recognize the arbitrariness of ego boundaries, increase their depth of faith, increase their appreciation of eternal life, deepen their sense of the meaning of Christ, and heighten their sense of joy and beauty. No positive persisting changes were reported by the control group in the open-ended section of the follow-up questionnaire.

There was a very low incidence of persisting negative changes in attitudes or behavior in either group at either the six-month follow-up or the long-term follow-up. However, the one psilocybin subject reported to have had the most difficult time during the experiment was the one who declined this author's request to be interviewed in person or fill out a questionnaire, placing in question the generalizability of this finding for the long-term.

Both the six-month and long-term follow-up questionnaire results support Pahnke's hypothesis that psilocybin, when taken in a religious setting by people who are religiously inclined, can facilitate experiences of varying degrees of depth that either are identical with, or indistinguishable from, those reported in the cross-cultural mystical literature. In addition, both the six-month and the long-term follow-up questionnaire results support Pahnke's hypothesis mat the subjects who received psilocybin, more so than the controls, experienced substantial positive persisting effects in attitude and behavior.

The long-term follow-up interviews: General overview

This long-term follow-up was conducted roughly a quarter century after the subjects participated in the original experiment. All subjects contacted live in the United States, with five out of the eight psilocybin subjects and five out of the ten placebo subjects currently working as ministers. Other professions represented are stockbroker, lawyer, community developer, social worker, administrative- assistant and educator. Except for one of the psilocybin subjects, all are currently married. All are working and self-supporting. All but two welcomed the opportunity to discuss their participation in the Good Friday experiment.

Each of the psilocybin subjects had vivid memories of portions of their Good Friday experience. For most this was their life's only psychedelic experience, in part because there have been no legal opportunities for such experiences for the last twenty-five years in the United States (or in any of the roughly 90 countries who are party to the international drug control treaties coordinated by the United Nation's World Health Organization). The experimental subjects unanimously described their Good Friday psilocybin experience as having had elements of a genuinely mystical nature and characterized it as one of the highpoints of their spiritual life. Some subjects reported that the content of their experience was specifically involved with the life of Christ and related directly to the Christian message while others had experiences of a more universal, non-specific nature. Most of the control subjects could barely remember even a few details of the service.

Most of the psilocybin subjects had subsequent experiences of a mystical nature with which they were able to compare and to contrast to their psilocybin experience. These subsequent experiences occurred either in dreams, in prayer life, in nature or with other psychedelics and seemed to the psilocybin subjects to be of the same essential nature as their Good Friday experience. Significant differences between their non-drug and drug mystical experiences were noted, with the drug experiences reportedly both more intense and composed of a wider emotional range than the non-drug experiences. The non-drug experiences were composed primarily of peaceful, beautiful moments experienced with ease while the drug experiences tended to include moments of great fear, agony and self-doubt.

The discussion of Subject T.B. about the relationship between his psilocybin and his other mystical experiences illustrates how the subjects saw the validity of their psilocybin experiences.

> I can think of no experiences [like the Good Friday experience] quite of that magnitude. That was the last of the great four in my life. The dream state ... I had no control over when it was coming. It was when I [was about nine and] had scarlet fever and rheumatic fever, apparently at either similar or at the same times. And they thought that I was going to die. And I saw a light coming out of the sky, this is in the dream, and it came toward me and it was like the figure of Christ and I said, "No, let me live and I'll serve you." And I'm alive and I've served. The prayer state when I was in seventh grade was very similar in the way it happened to me. I intentionally went for an experience with God. In seventh grade. And I also went for an experience with God at the Good Friday experience. And those were similar. The West Point experience was different. In that yes,

> it was prayers, it was on my knees, it was there, but the face of Christ was ... it happened more to me than me participating in it. It was more like a saving experience kind of thing. So I've had that and can talk about "a salvation experience," a born again experience, it was that kind of dedication.

Each of the psilocybin subjects felt that the experience had significantly affected his life in a positive way and expressed appreciation for having participated in the experiment. Most of the effects discussed in the long-term follow-up interviews centered around enhanced appreciation of life and of nature, deepened sense of joy, deepened commitment to the Christian ministry or to whatever other vocations the subjects chose, enhanced appreciation of unusual experiences and emotions, increased tolerance of other religious systems, deepened equanimity in the face of difficult life crises, and greater solidarity and identification with foreign peoples, minorities, women and nature. Subject K.B.'s description of the long-term effects is representative. He remarks:

> It left me with a completely unquestioned certainty that there is an environment bigger than the one I'm conscious of. I have my own interpretation of what that is, but it went from a theoretical proposition to an experiential one. In one sense it didn't change anything, I didn't discover something I hadn't dreamed of, but what I had thought on the basis of reading and teaching was there. I knew it. Somehow it was much more real to me. ... I expect things from meditation and prayer and so forth that I might have been a bit more skeptical about before. ... I have gotten help with problems, and at times I think direction and guidance in problem solving. Somehow my life has been different knowing that there is something out there. ... What I saw wasn't anything entirely surprising and yet there was a powerful impact from having seen it.

In addition to self-reports, several subjects who had stayed in contact with each other over the years spoke about the effects they noticed in each other. In the instances where such information was obtained, the observations of fellow subjects were similar to the self-reports and confirmed claims of beneficial effects.

Several of the psilocybin subjects discussed their deepened involvement in the politics of the day as one result of their Good Friday experience. Feelings of unity led many of the subjects to identify with and feel compassion for minorities, women and the environment. The feelings of timelessness and eternity reduced their fear of death and empowered the subjects to take more risks in their lives and to participate more fully in political struggles.

Subject T.B. discussed how his perception of death during the Good Friday experience affected his work in the political field. He remarked:

> When you get a clear vision of what [death] is and have sort of been there, and have left the self, left the body, you know, self leaving the body, or soul leaving the body, or whatever you want to call it, you would also know that marching in the Civil Rights Movement or against the Vietnam War in Washington [is less fearful]. ... In a sense [it takes away the fear of dying] ... because you've already been there. You know what it's about. When people approaching death have an out-of-body experience ... [you] say, "I know what you're talking about. I've been there. Been there and come back. And it's not terrifying, it doesn't hurt. ..."

Subject S.J. found that his Good Friday experience of unity supported his efforts in the political field.

> I got very involved with civil rights after that [his psychedelic experience] and spent some time in the South. I remember this unity business, I thought there was some link there. ... There could have been. People certainly don't write about it. They write about it the opposite way, that drugs are an escape from social obligations. That is the popular view. ...

Only one of the control subjects felt that his experience of the Good Friday service resulted in beneficial personal growth. That particular control subject thought he was probably the one in the original experiment reported to have had a partial mystical experience. Ironically, he felt that the most important benefit he received from the service was the decision to try psychedelics at the earliest opportunity. The Good Friday service had that same effect on one other placebo subject, who also had a subsequent psychedelic experience.

The actual experiences of the original psilocybin subjects are best communicated by quoting from, the transcripts of the long-term follow-up interviews. Reverend S.J. had an experience almost uniformly positive. He describes his experience as follows:

> Something extraordinary had taken place which had never taken place before. All of a sudden I felt sort of drawn out into infinity, and all of a sudden I had lost touch with my mind. I felt that I was caught up in the vastness of Creation ... huge, as the mystics say. ... I did experience that kind of classic kind of blending. ... Sometimes you would look up and see the light on the altar and it would just be a blinding sort of light and radiation. ... The main thing about it was a sense of timelessness.
>
> The meditation was going on all during this time, and he [Rev. Howard Thurman] would say things about Jesus and you would have this overwhelming feeling of Jesus. ... It was like you totally penetrated what was being said and it penetrated you. ... Death looked different. It became in focus. ... I got the impression, the sensation ... that what people are essentially in their essence that somehow they would continue to live. They may die in one sense, the physical sense, but their being in heaven would survive. ...
>
> We took such an infinitesimal amount of psilocybin, and yet it connected me to infinity.

Subject L.J. confronted the issue of personal mortality, which he described as follows:

> I was on the floor underneath the chapel pew and he [a group leader] was looking after me and sort of aware of, you know, "L.J. is down there, is everything all right?" I was hearing my uncle who had died [several months before], the one who was a minister, saying, "I want you to die, I want you to die, I want you to die" I could hear his voice saying. The more that I let go and sort of died, the more I felt this eternal life, saying to myself under my breath perhaps, "it has always been this way, it has always been this way. ... O, isn't it wonderful, there's nothing to fear, this is what it means to die, or to taste of eternal life. ..." And the more I died the more I appropriated this sense of eternal life. ... While the service went on I was caught up in this experience of eternal life and appreciating what the peyote Indians or the sacred mushroom Indians experienced with their imbibing of the drug. Just in that one session I think I gained experience I didn't have before and probably could never have gotten from a hundred hours of reading or a thousand hours of reading.
> I would have to say as far as I'm concerned it was a positive, mystical experience ... confirmed by experiences both before and after.

Reverend L.R. had one of the most difficult experiences of all the psilocybin subjects. He described the early portion of his experience as follows:

> Shortly after receiving the capsule, all of a sudden I just wanted to laugh. I began to go into a very strong paranoid experience. And I found it to be scary. The chapel was dark and I hated it in there, just absolutely hated it in there. And I got up and left. I walked down the corridor and there was a guard, a person stationed at the door so individuals wouldn't go out, and he says, "Don't go outside," and I said, "Oh no, I won't. I'll just look outdoors." And I went to the door and out I went. They sent [a group leader] out after me. We [L.R. and the group leader] went back into the building and again, I hated to be in that building and being confined because there were bars on the window and I felt literally like I was in prison. One of the things that was probably happening to me was a reluctance to just flow. I tried to resist that and as soon as resistance sets in there's likely to be conflict and there's likely, I think, for there to be anxiety.

In addition to his emotional struggles, Reverend L.R. discusses the mystical aspect of his experience as follows:

> The inner awareness and feelings I had during the drug experience were the dropping away of the external world and those relationships and then the sudden sense of singleness, oneness. And the rest of normal waking consciousness is really ... illusion. It's not real and somehow that inner

> core experience of oneness is more real and more authentic than normal consciousness. ... I was also experiencing some of those same kind of states that produced anxiety, and I wanted to try to get at the bottom of it.
>
> I personally feel that the experience itself was, and I know his [Pahnke's] research came to the conclusion, that the effect of the chemicals like that is very similar, parallel to, perhaps the same as a classical mystical experience. ...

Reverend Y.M. describes his experience, which also had some difficult moments, as follows:

> I closed my eyes and the visuals were back, the color patterns were back, and it was as if I was in an ocean of bands, streams of color, streaming past me. The colors were brilliant and I could swim down any one of those colors. Then that swirl dissolved itself into a radial pattern, a center margin radial pattern with the colors going out from the center. I was at the center and I could swim out any one of those colors and it would be a whole different life's experience. I could swim out any one of them that I wanted. I mean I could swim metaphorically. There wasn't the sense that I could actually paddle. I could choose any one I wanted, but I had to choose one.
>
> I couldn't decide which one to go out, and eventually it connects to the decision I was in the midst of making about career choices ... when I couldn't decide, I died. Very existential ... for a brief moment there, I was physically dying. My insides were literally being scooped out, and it was very painful. ... I said to myself ... that nobody should have to go through this ... it was excruciating to die like that. Very painful. And I died. ...
>
> After the psilocybin experience, I never consciously made the choice as to what I was going to do career-wise, but the choice was made. It was made while I was on the psilocybin. But it never had to be consciously, intentionally, "Ah, let's see, what I am going to do is. ..." It was made, and I was confident of it, it was going to be. And I did it afterwards. ...

Reverend K.B. describes his mystical experience in the following manner:

> I reel almost whatever I say about it ... is a little bit artificial in terms of describing. What it is is something deeper and probably also more obvious and I think I endeavor to put it into some kind of category which may obscure the point in some way. I remember feeling at the time that I was very unusually incapable of describing it. Words are a familiar environment for me and I usually can think of them, but I didn't find any for this. And I haven't yet.
>
> I closed my eyes, either thinking of meditating or maybe I was drowsy or something. I closed my eyes and it seemed to be darker than usual. And then there was a sudden bolt of light which I think was entirely internal and a feeling almost like a shock or something and that was only for an instant. It wasn't violent but it was a definite tingling like taking hold of a wire or something.
>
> I closed my eyes and ... thought that this would be a fine time for [meditating on the Passion]. ... So I did think about the procession to the cross. And with my eyes closed I had an unusually vivid scene of the procession going by. A scene quite apart from any imagining or anything on my part. A self-actualizing thing-kind of like watching a movie or something, it was apart from me but very vivid.
>
> I had a definite sense of being an infant or being born, or something like that. I had a sense of death, too, but I think actually the sense of death came after the sense of birth. ... I had my hands on my legs and there wasn't any flesh, there were bare bones, resting on my bones. That part wasn't frightening, I was just kind of amazed. ... I think I must have gone along through the life of Christ identifying in a very total sort of way-reliving the life in some way until finally dying and going into the tomb.
>
> I really am glad I took it. And glad that I was a subject. I don't think it would be a particularly memorable experience if I just had listened to the service. I've heard some good services and I

> imagine this was as moving as most. But I think it would be in that category instead of a once-in-a-lifetime sort of thing. ...
>
> I've remained convinced that my ability to perceive things was artificially changed, but the perceptions I had were real as anything else.

Subject T.B. was very comfortable with the effects of the psilocybin, perhaps because he had had mystical experiences prior to the experiment. He describes his experience in the following way:

> I was kneeling there praying and beginning to feel like I was experiencing the kind of prayer life that I experienced back when I was in the seventh grade, eleven or twelve years old. It was the kind of experiences that you knew that something great was happening. I started to go to the root of all being. And discovered that ... you never quite get there. That was my discovery during that time ... it's a philosophy and a theology that I hold yet today. You can approach the fullness of all being in either prayer, or in the psilocybin experience. You can reach out, but you can't dive down ... and hit that root.
>
> The discovery within that experience is that you could approach God by two different ways. You either get to the root, the ground of all being, or the fullness of all being. And in getting to the root, you'll strive, you'll come closer and closer, but it's always half, and you'll think another half step, another half step, and you'll never quite get there. The fullness, to approach the fullness of God is the only way to approach God.

Subject H.R. tells of his largely positive experience in the following way:

> It was a feeling of being ... lifted out of your present state. I just stopped worrying about time and all that kind of stuff ... there was one universal man, personhood, whatever you want to call i t ... a lot of connectedness with everybody and every thing. I don't think Christ or other religious images that I can remember came into it. That's the only reason I didn't think it was religious. I don't remember any religious images. ...
>
> I was convinced after the experiment that I had had quite an experience but that it was really into my psychological depths, and it was not a religious experience. ... It was really the sense that I was discovering the depths of my own self. It did not have a sacredness kind of element to it. ... I didn't think I had experienced a God that was particularly outside of me. What I experienced was a God that was inside of me. And I think that ... made me say, I don't think this is religious, I think this is psychological. But that was because of the way I was defining being ... the way I thought God was being defined by other people at that point.

After the Good Friday experiment, two out of the ten placebo subjects experienced psychedelics. Placebo subject P.J. describes his first psychedelic experience, which took place in a chapel with psilocybin subject L.R. as his guide, as follows:

> I laid on the front pew and watched myself-it seemed like eternity- pour through my navel and totally become nothing. And I felt that this would never stop. It seemed like an eternity of being in heaven and everything. One of the most beautiful experiences in my entire life.
>
> It sure kicks the hell out of one being rigid with what could go on and what kind of experiences you could have. To take one of these drugs says a lot more can happen than what's been happening in your total experience. And I think that's good, and that's why I would want my kids to take it.

Placebo subject L.G. received psilocybin in a hospital as a part of a subsequent experiment conducted by Pahnke (1966) in a fruitless search for a placebo substance which would permit a successful double-blind experiment. L.G. describes his experience as follows:

> It was rather removed from the religious context. Certainly the environment we were in had no

> particular religious symbols. I recall they really stressed [the need to] be absolutely open and just relax and flow with the experience whatever comes. So, there was no context really to suggest a particular experience like there might have been with the Good Friday experiment. We didn't talk about mysticism, as I recall, or religious symbols. ...
>
> At one point I kind of felt like, "Well, maybe this is what it is like to be crazy." I never really panicked but I was acutely aware of anxiety. ... As time evolved I just had this incredible sense of joy and humor, too. I was laughing, real ecstasy. ... The thing that struck me was how anybody could worry or not trust, that just struck me as an absurdity. It was very exciting.
>
> There was an energy, it was almost a sexual thing, an intensity and a joy. The visual things that I experienced and the music, I think were aligned with the sense of unity, everything was unified. We were all part of the same thing. You didn't sense a difference between the music or the physical objects. ...
>
> I think that you can certainly have a religious experience without the religious symbols. Certainly the religious symbols can lead you to a mystical experience. Unfortunately, they can also be divisive. The sectarianism can flow from the different symbols and justify the differences rather than the commonality. I think the mystic experience as I understand it comes down more on the commons.

Contrasting with the desire of two of the control subjects to have their own psychedelic experience, several of the remaining control subjects decided during the course of the experiment that they had no desire to try psychedelics. The behavior of some of their fellow subjects who received psilocybin had frightened them. Placebo subject B.A. remarks:

> I tend to look back on it as an historical curiosity, with intellectual interest to me, but you know, frankly not much else at this point. ... The only change that I can think of that it brought about in my life was a conviction that I never wanted to go on a drug trip of any type ever. And I never have, except for booze. The sights I saw [during the experiment] were very disturbing to me, and I didn't see myself wanting to be in that kind of position. It appeared to he hopelessly out of control and life threatening in several instances.

The remaining control subjects viewed psilocybin with some equanimity but were not motivated enough to seek out their own experience. If the circumstances were right and the substances were legal, several indicated that they might be willing to participate in another experiment.

A Significant Omission

Out of the seven psilocybin subjects formally interviewed, only two had had Good Friday experiences that they reported to be completely positive without significant psychic struggles. The others all felt moments in which they feared they were either going crazy, dying, or were too weak for the ordeal they were experiencing. These struggles were resolved during the course of the Good Friday service and according to the subjects contributed to their learning and growth.

It appears that these difficult moments were significantly underemphasized in Pahnke's thesis and in the subsequent reporting on the experiment. Psilocybin subject H.R. states:

> The other thing I found unique that wasn't talked at all about in what I read, at least in the thesis, was that it was all on the positive up side. I don't know whether other people have said this but I had a down side. ... It was a roller coaster. ... I mean I had a very strong positive sense of the whole ... one with humanity kind of positive glowing, unity kind of feeling and then I went down to the bottom where I was really just ... guilt ... that's all I can say. It was a very, very profound sense of guilt.

Pahnke does mention that two of the subjects who received the psilocybin "had a little difficulty in readjusting to the 'ordinary world' and needed special reassurance by their group leaders until the drug effects subsided"

(Pahnke, 1963, p. 219). Almost certainly, one of those subjects was L.R., who found the chapel to be like a prison and went outside for much of the service. The other subject is, almost certainly, the one who refused to participate in the follow-up study.

In one technical section of the thesis, and in none of his subsequent papers, Pahnke mentions that one of those two subjects later referred to his experience as "a psychotic episode" (Pahnke, 1963, p. 232). In another part of the thesis, Pahnke mentions that injectable thorazine was on hand for emergencies. What he does not report anywhere is that one subject was actually given a shot of thorazine as a tranquilizer during the course of the experiment. Several of the subjects and group leaders remembered this incident and reported in the long-term follow-up interviews that it involved the one psilocybin subject who refused to be interviewed by the author. Needless to say, this occurrence should surely have been mentioned in Pahnke's thesis and, by those few who knew that such an event had actually transpired, in any subsequent reporting on the experiment.

Pahnke probably did not report his use of the tranquilizer because he was fearful of adding to the ammunition of the opponents of the research. Fears that negative aspects of the experiment would be taken out of context and exaggerated may have been justified. In an example of just such a critique, Zaehner asserts in his book, Zen, Drugs and Mysticism, that Pahnke, in an article Pahnke published several years after the Good Friday experiment, repudiated the results of his own study (Zaehner, 1972, p. 105). In that article, Pahnke does indeed say that mystical experiences were absent (Pahnke, 1967, p.71). Pahnke was, however, referring to the control subjects. This misreading of Pahnke by Zaehner is an indication of how, even in an educated scholar, bias can overwhelm facts. This observation, of course, is also true of Pahnke. His silence about his administration of a tranquilizer may perhaps have been good politics; certainly it was bad science.

Although an interview with the subject who was tranquilized would be necessary to understand the subtleties of his experience and its consequences, several long-term follow-up interviews generated second-hand information which may be summarized as follows: This subject was reported to be deeply moved by a sermon delivered by the very dynamic preacher who emphasized that it was the obligation of all Christians to tell people that there was a man on the cross. This subject was reported to have gone outside of the chapel possibly intending to follow the exhortation.

A struggle ensued when the group leaders, worried for his safety, tried to bring him back inside. After a time during which he seemed fearful and was not settling down, Pahnke tranquilized him with a shot of thorazine. He was then brought back into the chapel and remained calm for the duration of the experiment. He participated in all further aspects of the experiment and in the six-month follow-up reported that he considered his fear-experience "slightly harmful" because "in a mob panic-situation I feel I would be less likely to maintain a calm objective position than I might have formerly" (Pahnke, 1963, p. 232).

Subsequent to the Good Friday experiment, the use of tranquilizers in controlled psychedelic psychotherapy research was largely abandoned in favor of simply providing a supportive environment and letting the drug run its course (Richard Yensen, personal communication, 1991).

Discussion

The original Good Friday experiment is one of the preeminent psychedelic experiments in the scientific literature. Despite the methodological shortcomings of the unavoidable failure of the double-blind and the use of several imprecise questions in the questionnaire used to quantify mystical experiences, the experiment's fascinating and provocative conclusions strongly support the hypothesis that psychedelic drugs can help facilitate mystical experiences when used by religiously inclined people in a religious setting. The original experiment also supports the hypothesis that those psilocybin subjects who experienced a full or a partial mystical experience would, after six months, report a substantial amount of positive, and virtually no negative, persisting changes in attitude and behavior.

This long-term follow-up, conducted twenty-four to twenty-seven years after the original experiment, provides further support to the findings of the original experiment. All psilocybin subjects participating in the long-term follow-up, but none of the controls, still considered their original experience to have had genuinely mystical elements and to have made a uniquely valuable contribution to their spiritual lives. The positive changes described by the psilocybin subjects at six months, which in some cases involved basic vocational and value choices and spiritual understandings, had persisted over time and in some cases had deepened. The overwhelmingly positive nature of the reports of the psilocybin subjects are even more remarkable because this long-term follow-up took place during a period of time in the United States when drug abuse was becoming the public's number one social concern, with all the attendant social pressure to deny the value of drug-induced experiences. The long-term follow- up interviews cast considerable doubt on the assertion that mystical experiences catalyzed by drugs are in any way inferior to non-drug mystical experiences in both their immediate content and long-term positive effects, a critique of the Good Friday experiment advanced primarily by Zaehner (Bakalar, 1985).

Unexpectedly, the long-term follow-up also uncovered data that should have been reported in the original thesis. Pahnke failed to report the administration of the tranquilizer thorazine to one of the subjects who received psilocybin. There is no justification for this omission no matter how unfairly the critics of this research may have used the information and no matter how minimal were the negative persisting effects reported by the subject. In addition, Pahnke underemphasized the difficult psychological struggles experienced by most of the psilocybin subjects. These very serious omissions point to an important incompleteness in Pahnke's interpretation of the effects of psilocybin.

Some of the backlash that swept the psychedelics out of the research labs and out of the hands of physicians and therapists can be traced in part to the thousands of cases of people who took psychedelics in non-research settings, were unprepared for the frightening aspects of their psychedelic experiences and ended up in hospital emergency rooms. These unfortunate instances of panic reaction have many causes, yet some of them stem from the way in which the cautionary elements of the Good Friday experiment were inadequately discussed in Pahnke's thesis, in subsequent scholarly reports and in the popular media. For example, Time magazine reported on the experiment in glowing, exaggerated terms stating, "All students who had taken the drug [psilocybin] experienced a mystical consciousness that resembled those described by saints and ascetics" (9/23, 1966, p. 62).

The widespread use of psychedelics, both in medical and nonmedical settings, which began in the 1960s and is still currently taking place, apparently largely underground. Such use was partially founded upon an optimism regarding the inherent safety of the psychedelic experience which did not fully acknowledge the complexity and profundity of the psychological issues associated with psychedelic experiences. With some proponents of psychedelics exaggerating the benefits and minimizing the risks, a backlash against these substances was predictable. With the intriguing connection reported by several psilocybin subjects between mystical experiences and political action, the backlash in retrospect may have been inevitable (Baumeister & Placidi, 1985).

Despite the difficult moments several of the psilocybin subjects passed through, the subjects who participated in the long-term follow-up reported a substantial amount of persisting positive effects and no significant long-term negative effects. Even the subject who was tranquilized in the original experiment reported only "slightly harmful" negative persisting effects at the sixmonth follow-up. Second-hand information gathered during the course of the long-term follow-up suggests that his experience caused no persisting dysfunction and may even have had some beneficial as well as detrimental effects.

The lack of long-term negative effects or dysfunction is not surprising. Strassman's literature review of all controlled scientific experiments using psychedelics in human volunteers found that panic reactions and adverse reactions were extremely rare. He concluded that the potential risks of future research were outweighed by the potential benefits (Strassman, 1984).

This long-term follow-up study, even in light of the new data about the difficulties of the psychedelic experiences of many of the subjects, adds further support to the conclusion that additional studies are justified. Future experiments should be approached cautiously and carefully, with a multidisciplinary team of scientists involved in planning and implementation. Such a team should include psychiatrists, psychologists, religious professionals from a variety of traditions, as well as drug abuse prevention, education and treatment officials. Questions as fundamental as those raised by the Good Friday experiment deserve to be addressed by the scientific community, and pose special challenges to the regulatory agencies. Renewed research can be expected to require patience, courage and wisdom from all concerned.

References

1. BAKALAR, J. (1985). Social and intellectual attitudes toward drug-induced religious experience. *J. Humanistic Psychology*, 25(4), 45-66.
2. BARBER, T.X. (1976). *Pitfalls in human research*. New York: Pergamon Press.
3. BAUMEISTER, R. & PLACIDI, K. (1985). A social history and analysis of the LSD controversy. *J. Humanistic Psychology*, 23(4), 25-60.
4. BEUTLER, L.E. & CRAGO, M. (1983). Self-report measures in psychotherapy outcome. In M. Lambert, E. Christensen, & S. DeJulio (Eds.), *The assessment of psychotherapy outcome*. New York: Wiley.
5. CLARK, W. H. (1969). *Chemical ecstasy: Psychedelic drugs and religion*. New York: Sheed & Ward.
6. Di LEO. F. (1982). Protocol: LSD-assisted psychotherapy correlation of peak experience profiles with behavior change. Appendix C: Peak experience profile. Unpublished.
7. GROF, S. (1975). *Realms of the human unconscious: Observations from LSD research*. New York: Viking Press.
8. GROF, S. (1980). *LSD psychotherapy*. Pomona, CA: Hunter House.
9. HARNER, M. (Ed.) (1973). *Hallucinogens and shamanism*. New York: Oxford University Press.
10. HOFMANN, A., RUCK, C. & WASSON, R. G. (1978). *The road to Eleusis: Unveiling the secret of the mysteries*. New York: Harvest Books.
11. HOFMANN, A. & SCHULTES, R. E. (1979). *Plants of the gods: Origins of hallucinogenic use*. New York: McGraw-Hill.
12. JAMES, W. (1961, orig. 1902). *Varieties of religious experience*. New York: Collier Books.
13. LARSON, D. et al. (1986). Systematic analysis of research on religious variables in four major psychiatric journals, 1978-1982. *American J. Psychiatry, 143* (3), 329-34.
14. LASAGNA, L. (1985). *Clinical trials in the natural environment*. Boston, Tufts University: Center for the Study of Drug Development, Reprint Series RS 8695. 45-49.
15. LEARY, T. et al. (1962). Investigations into the religious implications of consciousness expanding experience. Newsletter #1: Research program on consciousness-altering substances. Cambridge, MA: Harvard University.
16. LEARY, T. (1967). The religious experience: Its production and interpretation. *J. Psychedelic Drugs, 1*(2), 3-23.
17. LEARY, T. (1968). *High priest*. New York: College Notes and Texts, Inc.
18. LEARY, T. (1984). *Flashbacks*. Los Angeles: J.P. Tarcher.
19. LUKOFF, D., ZANGER, R. & Lu, F. (1990). Transpersonal psychology research review: Psychoactive substances and transpersonal states. *J. Transpersonal Psychology*, 22(2), 107-18.
20. PAHNKE, W. (1963). Drugs and mysticism: An analysis of the relationship between psychedelic drugs and the mystical consciousness. Ph.D. dissertation. Harvard University.
21. PAHNKE, W. (1966). The contribution of the psychology of religion to the therapeutic use of psychedelic substances. In Abramson, H. (Ed.), *The use of LSD in psychotherapy and alcoholism*. New York: Bobbs-Merrill, 629-49.
22. PAHNKE, W. (1967). LSD and religious experience. In DeBold, R. & Leaf, R. (Eds.), *LSD, man and society*. Middletown, CT: Wesleyan University Press, 60-85.
23. PAHNKE, W. (1970). Drugs and mysticism. In B. Aaronson. & H. Osmond. (Eds.), *Psychedelics: The uses and implications of hallucinogenic drugs*. Garden City, NY: Anchor Books. 145-64.
24. PAHNKE, W. & RICHARDS, W. (1969a). Implications of LSD and experimental mysticism. *J. Religion and Health*, 5(3), 175-208.
25. PAHNKE, W. & RICHARDS, W. (1969b). The psychedelic mystical experience and the human encounter with death. *Harvard Theological Review*, 62(1), 1-32.
26. PAHNKE, W. & RICHARDS, W. (1969c). Implications of LSD and experimental mysticism. *J. Transpersonal Psychology, 1*(2), 69-102.
27. RICHARDS, W. (1975). Counseling, peak experiences, and the human encounter with death. Ph.D. dissertation, Washington, D.C.: Catholic University.
28. RICHARDS, W. (1978). Mystical and archetypal experiences of terminal patients in DPT-assisted psychotherapy. *J. Religion and Health, 17*(2), 117-26.
29. RING, K. (1982). *Life at death: A scientific investigation of the near-death experience*. New York: Quill.
30. RING, K. (1984). *Heading toward omega: In search of the meaning of the near-death experience*. New York: Quill.
31. RING, K. (1988). Paradise is paradise: Reflections on psychedelic drugs, mystical experiences and the near-death experience. *J. of Near-Death Experiences*, 6(3), 138-48.
32. RUE, L.D. (1985). Our most outrageous blind spot: The academic study of religion. *Chronicle of Higher Education*, (29), 40.
33. SILVERMAN, W. (1983). Bibliography of measurement techniques used in the social scientific study of religion. *Psychological Documents 13*(7). Washington, D.C.: American Psychological Association.
34. SPILKA, B., HOOD, JR., R. W. & GORSUCH, R. (1985). *The psychology of religion: An empirical approach*. Englewood Cliffs, NJ: Prentice Hall.
35. STACE, W.T. (1960). *Mysticism and philosophy*. London: MacMillan.
36. STRASSMAN, R. (1984). Adverse reactions to psychedelic drugs: A review of the literature. *J. Nervous and Mental Disease*, 172, 577-95.
37. TIME. (1966) Mysticism in the Lab. September 23, 62.
38. TOOLEY & PRATT (1964). Letter to the editor, *Behavioral Science, 9*(3), 254-56.
39. UNDERHILL, E. (1974, orig. 1910). *Mysticism*. New York: Meridian.
40. WASSON, R. G. (1968). *Soma: Divine mushroom of immortality*. Rome: Harcourt, Brace & Jovanovich, Inc.
41. ZAEHNER, R.C. (1972). *Zen, drugs and mysticism*. New York: Vintage Books.
42. ZINBERG, N. (1984). *Drug, set and setting*. New Haven: Yale University Press.

Bibliography of related literature

1. AARONSON, B. & OSMOND, H. (Eds.) (1970). *Psychedelics: The uses and implications of hallucinogenic drugs*. Garden City, NY: Anchor Books.
2. ABRAMSON, H. (Ed.) (1967). *The use of LSD in psychotherapy and alcoholism*. New York: Bobbs-Merrill.
3. BAKALAR, J. (1979-80). Psychedelic drug therapy: Cultural conditions and obstacles. *J. Altered States of Consciousness*, 5(4), 297-307.
4. BAKALAR, J. & GRINSPOON, L. (1986). Can drugs be used to enhance the psychotherapeutic process? *American J. of Psychotherapy, XL*(3), July.
5. CLARK, W. H. (1973). *Religious experience: Its nature and function in the human psyche*. Springfield, IL: Charles C. Thomas.
6. D'AQUILI, E. (1982). Senses of reality in science and religion: A neuroepistemological perspective. *Zygon, 17*(4), 361-84.
7. DEAN, S. (Ed.). (1975). *Psychiatry and mysticism*. Chicago: Nelson Hall.
8. DEIKMAN, A. (1982). *The observing self: Mysticism and psychotherapy*. Boston: Beacon Press.
9. DOBKIN DE Rios, M. (1972). *Visionary vine: Hallucinogenic healing in the Peruvian Amazon*. Prospect Heights, IL: Waveland Press.
10. EFRON, D. (Ed.) (1967). *Ethnopharmacologic search for psychoactive drugs*. Washington, D.C.: Public Health Service Publication No 1645.
11. GRINSPOON, L. & BAKALAR, J. (1979). *Psychedelic drugs reconsidered*. New York: Basic Books.
12. GRINSPOON, L. & BAKALAR, J. (Eds.) (1983). *Psychedelic reflections*. New York: Human Sciences Press.
13. HUXLEY, A. (1954). *Doors of perception*. New York: Harper.
14. LEE, M. & SCHLAIN, B. (1986). *Acid Dreams: LSD, the CIA and the sixties rebellion*. New York: Grove Press.
15. MASTERS, R.E.L. & HOUSTON, J. (1966). *The varieties of psychedelic experience*. New York: Dell.
16. MASLOW, A. (1964). *Religions, values, and peak experiences*. New York: Viking Press.
17. MULLER, R. (1982). *New genesis: Shaping a global spirituality*. Garden City, NY: Doubleday.
18. MYERHOFF, B. (1974). *Peyote hunt: The sacred journey of the Huichol Indians*. Ithaca, NY: Cornell University Press.
19. O'CONNELL, S. (1983). The placebo effect and psychotherapy. *Psychotherapy: Theory, research and practice, 20*(3), 335-57.
20. PAHNKE, W. (1966). Report on a pilot project investigating the pharmacological effects of psilocybin in normal volunteers. Massachusetts Mental Health Center. Unpublished manuscript.
21. PERSLNGER, M. (1987). *The neurophysiological basis for "God" experiences*. New York: Praeger Press.
22. PRINCE, R. H. & SALMAN, D. H. (Eds.). (1967). *Do psychedelics have religious implications?* Proceedings of the third annual conference, R. M. Bucke Memorial Society for the Study of Religious Experience, Quebec.
23. RAM DASS. (1974). *The only dance there is*. New York: Doubleday.
24. SCHMTTZ-MOORMAN, K. (1986). Philosophical and theological reflections on recent neurobiological discoveries. *Zygon, 21*(2), 249-57.
25. SHULGIN, A., SHULGIN, L. A. & JACOB III, P. (1986). A protocol for the evaluation of new psychoactive drugs in man. *Methods and Findings in Experimental Clinical Pharmacology*, 8(5), 313-20.
26. SMITH, D. (Ed.) (1967-68). Psychedelic drugs and religion. *J. Psychedelic Drugs, 1*(2).
27. SMITH, H. (1964). Do drugs have religious import? *J. Philosophy, LXI*(18), 517-30.
28. STAFFORD, P. (1983). *Psychedelics encyclopedia*. Los Angeles: J.P. Tarcher.
29. WEIL, A. (1972). *The natural mind*. Boston: Houghton Mifflin.
30. WILBER, K. (Ed.) (1984). *Quantum questions: Mystical writings of the world's great physicists*. Boulder, CO: Shambhala.
31. WOLMAN, B. & ULLMAN, M. (Eds.) (1986). *Handbook of states of consciousness*. New York: Van Nostrand Reinhold.

Recollections of the Good Friday Experiment - Interview with Huston Smith

by

Huston Smith

Interviewed by Thomas B. Roberts Dekalb, Illinois

and

Robert N. Jesse San Francisco, California

original source: http://www.atpweb.org/jtparchive/trps-29-97-02-099.pdf
backup source: http://www.psilosophy.info/resources/trps-29-97-02-099.pdf

T.B.R.: This is October 1, 1996. Huston Smith will be telling us about an event that happened in the Good Friday Experiment in 1962. Huston, do you want to tell us about the student who ran out of the experiment?

Huston Smith: The basic facts of the experiment have been recorded elsewhere and are fairly well known, but I will summarize them briefly. In the early sixties, Walter Pahnke, an M.D. with strong interests in mysticism, wanted to augment his medical knowledge with a doctorate from the Harvard Divinity School (Pahnke, 1963). He had heard that the psychedelics often occasion mystical experiences, so he decided to make that issue the subject of his doctoral research. He obtained the support of Howard Thurman, Dean of Marsh Chapel at Boston University, for his project and also that of Walter Houston Clark who taught psychology of religion at Andover Newton Theological Seminary and shared Wally's [Pahnke] interest in the psychedelics.

Clark procured volunteers from his seminary to engage in an experiment. Howard Thurman's three-hour 1962 Good Friday service at Boston University would be piped down to a small chapel in the basement of the building where the volunteers, augmented by Walter Clark and myself, would participate in it. Half of us would receive, double blind, a dose of psilocybin, and the other half a placebo. The day after the experiment we would all write our accounts of what we had experienced, and Pahnke would have them scored on a scale of from one to ten for the degree to which each subject's experience included the seven traits of mystical experience that W.T. Stace targets in his *Mysticism and Philosophy*. There was one borderline case, but apart from that, the experiences of those who received psilocybin were dramatically more mystical than those in the control group. I was one of those who received the chemical, and I will say a word about my experience before I proceed to the student that you asked about.

The Experiment was powerful for me, and it left a permanent mark on my experiential world view. (I insert the qualifier *experiential* world view to distinguish between the way I *think* and *believe* that the world is, on the one hand, and the way I usually experience it to be.) For as long as I can remember, I have believed in God, and I have frequently experienced his presence in beauty, in nature, and (less frequently) in the clear light of the void that mystics speak of. But until the Good Friday Experiment, 1 had had no direct personal encounter with Him/Her/It of the sort that *bhakti* yogis, Pentecostals, and born-again Christians describe. The Good Friday Experiment changed that, presumably because the service focused on God as incarnated in Christ.

For me the climax of the three-hour service came during a solo that was sung by a soprano whose voice, through the prism of psilocybin, I can only describe as angelic. What she sang was no more than a simple hymn, but it entered my soul so deeply that its opening and closing verses have stayed with me ever since.

> My times are in Thy hand, my God, I wish them there;
> My life, my friends, my soul, I leave, entirely to Thy care.
>
> My times are in Thy hands, I'll always trust in Thee;
> And after death at Thy right hand I shall forever be.

In broad daylight those lines are not at all remarkable, but in the context of the Experiment, as there sung, they said everything. The last three measures of each stanza ascended to a dominant seventh which the concluding tonic then resolved. This is as trite a way to end a melody as exists, but the context changed that totally. My mother was a music teacher and instilled in me an acute sensitivity to harmonic progressions. When that talent and my Christian nurturance converged on the Good Friday story under psilocybin, the gestalt transformed the routine musical progression of that hymn into the most powerful cosmic homecoming I have ever experienced.

There is a second reason for gratitude to the Good Friday Experiment: it rounded out my experience of God's nature. *Jnanic* by nature, I had had (as I have noted) a number of powerful transpersonal experiences of God, but I had not strongly experienced his personal side. The Good Friday Experiment changed that. Since that momentous afternoon, I know firsthand what *bhaktis* are talking about when they speak:of their personal, loving relationship with God. All of this is a long prelude to the student who ran out of the experiment, which is what you asked about, but a knowledge of the context helps us understand the episode, I think.

As the chemical came over me, I began to be aware of a mounting disorder in the chapel. After all, half of our number were in a condition where social decorum meant nothing, and the other half were more interested in the spectacle that was unfolding than in the service proper. They were not above commenting on the spectacle and even joking about it among themselves. Afterwards a number of them confessed that feelings of being cheated of the experience helped fuel their quips.

In any case, from out of this bizarre mix, one of our number emerged. He arose from his pew, walked up the aisle, and with uncertain steps mounted the chapel's modest pulpit. Thumbing through its Bible for a few moments, he then mumbled a brief incoherent homily, blessed the congregation with the sign of the cross, and started back down the aisle. But instead of returning to his pew, he marched to the rear entrance of the chapel and exited.

Now, before the experiment began, each of us had been paired with a partner in the buddy system. We knew that one member in each pair would receive psilocybin and were instructed that the other member should look after his partner if the need arose. I was not "John's" partner - but no one else followed him out of the chapel, so I did.

This introduces an interesting parenthetical point. More than once I have been struck by the fact, widely corroborated, that however far one may be into the psychedelic experience (short of the dissociation that John was experiencing), if the need arises to snap back to normal, one has no problem doing so. So it was in this case. When John's buddy didn't respond to his leaving the chapel, I sprang to my feet and followed him out.

He had made a right turn and was striding down the hall, but we had been told that the entire basement had been sealed off for the experiment, so I was not overly concerned. But when he reached the door at the end of the corridor and jammed down its latch bar, it swung open. Something had misfired in the instructions to the janitor, and my charge, zonked out of his skull, was at large on Commonwealth Avenue. I ran after him, but my urgings to return to the chapel fell on deaf ears, and he shook off my grip on his elbow as if it were cobwebs.

What to do? I was afraid to leave him lest I lose track of him, but alone I was powerless to dissuade him from what appears to be a determined mission.

Providentially, help arrived from an unexpected quarter. The wife of someone: involved in the study was having a picnic on the grass with their child, and I shouted to her to keep track of John while I rushed back to the chapel for help. The strategy worked. When I returned on the double with Wally and another accomplice, John was still visible a block and a half ahead. Before we reached him, we saw him enter what turned out to be 745 Commonwealth Avenue, the building that houses Boston University's School of Theology and parts of its College of Liberal Arts. We caught up with him on the stairs to the third floor, but Wally's remonstrances cut no more ice than mine had. Together, however, the three of us were able to block his further ascent.

Things were at a standstill when a postman rounded the corner of the steps from below. He was carrying a brown envelope copiously plastered with special delivery stickers, and as he was passing us, John's arm shot out and snatched it from him. I was too occupied to notice the expression on the postman's face, for two of us had all we could do pinning John's arms while, finger by finger, Wally pried the crumpled envelope from John's vice-like grip and returned it to its stunned carrier. I have often wondered how that postman explained the mangled condition of his packet to its recipient, and how he described the incident to his wife at dinner that evening.

The rest is simply told. Realizing that he was overpowered - barely, for under the influence his strength was like Samson's - John, tightly flanked, submitted to being walked back to the chapel where Wally injected an antidote. Immediately he was back in his right mind but with total amnesia as to what had occurred.

It took twenty-four hours for all the pieces of the episode to come back to him and be fitted into place. God, it turned out, had chosen him to announce to the world the dawning millennium of peace and good will. (As often happens in such cases, the actual wording of the message made little sense to normal ears.) In his homily in the chapel, John broke the news to our congregation, but he needed to get it to the world at large, which was what caused him to leave the chapel. When, walking down Commonwealth Avenue, he saw the plaque announcing "Dean of the College of Liberal Arts" by the entrance to 745 Commonwealth Avenue, it occurred to him that deans have influence, so if he could get to that dean, that dean would call a press conference that would complete John's mission. The postman's packet was for the dean, he felt sure, so if he attached himself to it, it would take him to his targeted dean.

John's long-term feelings about the experiment were heavily negative. He was the only one of its subjects who refused to participate in Rick Doblin's twenty-fifth-year retrospective study of the long-term effects of the Experiment on its subjects and threatened to sue if his name was included (Doblin, 1991).

T.B.R.: Was there something in Howard Thurman's sermon that made him feel he should spread the message or be messianic or prophetic?

H.S.: Not that I noticed. It was a typical Good Friday service with meditations on the seven last words of Christ. Howard Thurman was very good, a spiritual genius, and even without psychedelics, he could move people. People were moved spiritually, uplifted by him, but I don't remember the content of Howard Thurman's words, only their moving impact. Did you ever meet him?

T.B.R.: No. I'd like to have heard him.

HS.: Just recounting this and getting my mind back into that afternoon makes my spine tingle.

T.B.R.: Are there other memories of the afternoon that come to mind?

H.S.: I remember that at times a hubbub seemed to erupt in our small chapel. I was too deep into my own experience for it to distract me, but I was peripherally aware of it and realize now, in retrospect, that a spectator would probably have found us a pretty unruly bunch. After all, half of us were stoned to the point where decorum meant nothing, and the other half - as I learned from several of them the next day - were resentful at having been left out and were not above acting out their resentment in derisive laughter and incredulous hoots at the way the rest of us were behaving.

I also remember a short exchange with one of the subjects in the foyer to the chapel just before the service began. Our doses had been administered an hour before noon, and, already under the influence of my psilocybin and sensing (wrongly, as it turned out) that he was as well, I said to him from the depths of my being, "It's true, isn't it?" He didn't respond and told me a day or two later that he had gotten only a placebo and hadn't a clue as to what the "it" that I had reverentially alluded to was all about. I think of that when I hear people claim that acid enables you to read minds. I couldn't have been more wrong in my surmise as to where things stood with him.

T.B.R.: Anything else?

H.S. Only the renewed gratitude to Wally Pahnke and his Experiment that our conversation has awakened in me. As I noted toward the beginning of our conversation, what his Experiment did for me was to round out my experience of the holy by enabling me to experience it in a personal mode, not just abstractly - a questionable word here - in music and nature and (more rarely) in the clear light of the void. Because Good Friday centers on God incarnated in a person, Christ, in that setting I experienced (for the first time powerfully) the divine in that mode. Spirit responding to Spirit, deep to deep, in the classic, dualist mode of *bhakti* yogis. This permanently enlarged my experiential toolbox. My first psychedelic experience was neoplatonically monistic; this one was personal and relational. So ever since then I have been able to understand experientially that classic mode of mysticism.

T.B.R.: When was your first, monistic experience?

H.S. New Year's Day, 1961, with Timothy Leary in his home in Newtonville.

T.B.R.: What about carryover from your Good Friday experience? Did it change you?

H.S.: Who knows? As a psychologist, you know better than I do that behavior change is one of the hardest things to measure. Staying off the bottle, or out of jail, for example, seem to be the only objective criteria we have. Subjectively, all of my three or four important experiences left me feeling that I was a better person. And I think that actually, in each case, I was more slowed down, sensitive, attuned to the moment, considerate toward others, and aware of life's wonder and mystery. For a few days, I must immediately add, however, for sooner or later the everyday world always reclaimed me. All I can say is that following the Good Friday Experiment, its spell lasted longer. It was more like three months than three weeks or three days.

T.B.R.: Walter Houston Clark reported the same thing - that he too felt that he was a better person. More considerate of family and friends.

Thank you, Huston, for filling us in on an important part of the Good Friday Experiment not previously recorded.

References

1. Doblin, R. (1991) - Pahnke's "Good Friday Experiment": A Long-term follow-up and methodological critique. *The Journal of Transpersonal Psychology*, 23(1), 1-28.
2. Pahnke, W.N. (1963) - *Drugs and mysticism: An analysis of the relationship between psychedelic drugs and the mystical consciousness*. Unpublished doctoral dissertation. Harvard University, Cambridge, MA.

Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later

by

Roland R. Griffiths et al.

© Roland R. Griffiths et al.

original source: http://www.maps.org/research-archive/w3pb/2008/2008_Griffiths_23042_2.pdf
backup source: http://www.psilosophy.info/resources/2008_Griffiths_23042_2.pdf

RR Griffiths *Department of Psychiatry and Behavioral Sciences and Department of Neuroscience, Johns Hopkins University, School of Medicine, Baltimore, MD, USA.*
WA Richards *Johns Hopkins Bayview Medical Center, Baltimore, MD, USA.*
MW Johnson *Department of Psychiatry and Behavioral Sciences, Johns Hopkins University, School of Medicine, Baltimore, MD, USA.*
UD McCann *Department of Psychiatry and Behavioral Sciences, Johns Hopkins University, School of Medicine, Baltimore, MD, USA.*
R Jesse *Council on Spiritual Practices, San Francisco, CA, USA.*

Corresponding author: Roland Griffiths, Department of Psychiatry and Behavioral Sciences, Johns Hopkins University, School of Medicine, 5510 Nathan Shock Drive, Baltimore, MD, USA. Email: rgriff@jhmi.edu

Table of Contents:

Abstract
Introduction
Methods
Participants
Study design
Preparation and drug session procedures
Measures of personality, affect, quality of life and spirituality assessed at screening, 2 months after each session, and at the 14-month follow-up
Measures assessed throughout the session
Measures assessed 7 h after drug administration
Measures assessed two months post-session
14-month follow-up
Statistical analysis
Results
Measures of personality, affect, quality of life and spirituality assessed at screening, 2 months after the psilocybin session, and at the 14-month follow-up
Pahnke-Richards Mystical Experience Questionnaire assessed immediately after sessions and at the 14-month follow-up
Measures of persisting effects assessed 2 months after drug sessions and at the 14-month follow-up
Relationships between screening data and the 14-month follow-up data on volunteer ratings of personal meaning and spiritual significance
Relationships between psilocybin session data and the 14-month follow-up data on volunteer ratings of personal meaning and spiritual significance
Verbatim comments at the 14-month follow-up about the nature of the psilocybin-occasioned spiritual experience
Open-ended clinical interview at the 14-month follow-up
Comment

Acknowledgements
References

Abstract

Psilocybin has been used for centuries for religious purposes; however, little is known scientifically about its long-term effects. We previously reported the effects of a double-blind study evaluating the psychological effects of a high psilocybin dose. This report presents the 14-month follow-up and examines the relationship of the follow-up results to data obtained at screening and on drug session days. Participants were 36 hallucinogen-naïve adults reporting regular participation in religious/ spiritual activities. Oral psilocybin (30 mg/70 kg) was administered on one of two or three sessions, with methylphenidate (40 mg/70 kg) administered on the other session(s). During sessions, volunteers were encouraged to close their eyes and direct their attention inward. At the 14-month follow-up, 58% and 67%, respectively, of volunteers rated the psilocybin-occasioned experience as being among the five most personally meaningful and among the five most spiritually significant experiences of their lives; 64% indicated that the experience increased well-being or life satisfaction; 58% met criteria for having had a 'complete' mystical experience. Correlation and regression analyses indicated a central role of the mystical experience assessed on the session day in the high ratings of personal meaning and spiritual significance at follow-up. Of the measures of personality, affect, quality of life and spirituality assessed across the study, only a scale measuring mystical experience showed a difference from screening. When administered under supportive conditions, psilocybin occasioned experiences similar to spontaneously occurring mystical experiences that, at 14-month follow-up, were considered by volunteers to be among the most personally meaningful and spiritually significant of their lives.

Key words: entheogen; hallucinogen; humans; mystical experience; psilocybin; psychedelic; religion; spiritual

Introduction

Although many have anecdotally claimed that psilocybin, the principal psychoactive component of various hallucinogenic mushroom species, can facilitate experiences providing sustained, positively valued impact, little is known scientifically about such effects. Psilocybin has been used as a sacrament for centuries, possibly millennia, in structured religious ceremonies (Wasson, 1980; Stamets, 1996; Metzner, 2004). Like other classical hallucinogens [*d*-lysergic acid diethylamide (LSD), mescaline, *N*,*N*-dimethyltyrptamine (DMT)], the effects of psilocybin are primarily mediated at 5-HT$_{2A}$ receptor sites (Nichols, 2004), and the acute subjective effects include robust changes in perception, cognition, affect, volition and somaesthesia (Isbell, 1959; Wolbach, *et al*., 1962; Rosenberg, *et al*., 1964).

The degree to which responses to psilocybin are influenced by nonpharmacological variables was not understood by early researchers (e.g. Isbell, 1959; Malitz, *et al*., 1960; Rinkel, *et al*., 1960; Hollister, 1961). By providing more preparation and interpersonal support during drug action, subsequent research described more positively valued experiences and fewer adverse effects (e.g. panic and paranoia) (Chwelos, *et al*., 1959; Leary, *et al*., 1963; Metzner, *et al*., 1965; Pahnke, 1969). In response to the hallucinogen abuse of the 1960s, human hallucinogen research largely ceased and has only recently resumed. Notably, Vollenweider and colleagues in Switzerland and Gouzoulis-Mayfrank and colleagues in Germany have studied the neurocognitive, perceptual and psychosis-mimicking effects of psilocybin (e.g. Vollenweider, *et al*., 1998; Gouzoulis- Mayfrank, *et al*., 1999; Hasler, *et al*., 2004; Carter, *et al*., 2005, 2007).

Recently, we used rigorous double-blind methods to evaluate the acute (7 h) and longer term (2 months) psychological effects of a high dose of psilocybin (30 mg/70 kg) relative to an active comparison compound (40 mg/70 kg methylphenidate) in 36 hallucinogen-naïve volunteers (Griffiths, *et al*., 2006). In contrast to the aforementioned recent psilocybin studies, the study optimized the potential for positively valued experiences by providing 8 h of preparation and by instructing volunteers to focus explicitly on the phenomenology of the drug experience rather than perform tasks. The results showed psilocybin to occasion experiences with substantial personal meaning and spiritual significance when evaluated 2 months after psilocybin. We have subsequently conducted a follow-up study evaluating effects at 14 months after their last drug session. Volunteers completed questionnaires that assessed personality, affect, quality of life, spiritual experience, and persisting changes in attitude and behaviour attributed to the blinded psilocybin session. This report analyses these 14-month follow-up results and the contribution of baseline characteristics and immediate drug effects to long-term persisting effects.

Methods

Participants

Participants were recruited through flyers announcing a study of states of consciousness brought about by a naturally occurring psychoactive substance used sacramentally in some cultures. The 36 study participants were medically and psychiatrically healthy and without histories of hallucinogen use. Sixteen participants were males [incorrectly reported as 14 in the previous publication (Griffiths, *et al.*, 2006)]. Participants had an average age of 46 years (range 24-64); 97% were college graduates and 56% had post-graduate degrees. All were employed full- or part-time. Fifty-three per cent indicated affiliation with a religious or spiritual community, such as a church, synagogue or meditation group. All volunteers indicated at least intermittent participation in religious or spiritual activities, such as religious services, prayer, meditation or study groups. Volunteers did not receive monetary compensation for participation. Additional information about participant recruitment and demographics has been described previously (Griffiths, *et al.*, 2006).

Study design

The study compared the effects of orally administered psilocybin (30 mg/70 kg) and methylphenidate hydrochloride (40 mg/70 kg) using a double-blind design that involved two or three 8-h drug sessions conducted at 2-month intervals. Thirty-six volunteers were randomly assigned to receive either two sessions ($n = 30$) or three sessions ($n = 6$). The volunteers who received two sessions were then randomly assigned to receive psilocybin or methylphenidate on the first session (15 per group), with the alternative drug administered on the second session. The third group ($n = 6$) received methylphenidate on the first two sessions and unblinded psilocybin on the third session. The purpose of having the possibility of a third session was to help control for expectancy effects (Griffiths, *et al.*, 2006).

Preparation and drug session procedures

Participants and monitors were informed that participants would have either two or three sessions, that in at least one session they would receive a moderate or high dose of psilocybin, and that an inactive placebo, a low dose of psilocybin, or various other drugs could be administered in the other session(s). Participants and monitors were unblinded to drug conditions after all participants had completed the 14-month follow-up. The primary monitor met with each volunteer on four occasions before the first session to develop rapport and trust.

The 8-h drug sessions were conducted in a living room-like environment. During the session, two monitors were present with a single participant. Participants were encouraged to focus their attention inward by lying down on the couch and wearing an eye mask and headphones through which a programme of classical music was played. Additional details of instructions to volunteers, volunteer-monitor meetings before and after sessions, and outcome measures have been described previously (Griffiths, *et al.*, 2006).

Measures of personality, affect, quality of life and spirituality assessed at screening, 2 months after each session, and at the 14-month follow-up

The following instruments were assessed: NEO Personality Inventory (NEO PI-R) (Costa and McCrae, 1992); Positive and Negative Affect Scale - Expanded Form (PANAS-X) for how one feels generally (Watson and Clark, 1994); Quality of Life Inventory raw score (Frisch, 1994); Measure of Actualization Potential (Leclerc, *et al.*, 1999); Mysticism Scale (described below); Spiritual Transcendence Scale (Piedmont, 1999, 2007); Faith

Maturity Scale - 12 item version (Benson, *et al.*, 1993); Functional Assessment of Chronic Illness Therapy - Non-Illness - Spiritual Well-Being Scale (FACITSp-NI-12) (Peterman, *et al.*, 2002).

Measures assessed throughout the session

At 0.5-6 h after capsule administration, monitors rated several dimensions of participant behaviour and mood, including a rating of the overall drug effect on a 5-point scale from 0 = none to 4 = extreme. Data were the mean of the two monitors peak scores (i.e. the maximum value from 0.5 to 6 h after capsule administration for each monitor).

Measures assessed 7 h after drug administration

When the major drug effects had subsided, the participant completed two questionnaires assessing subjective drug effects: Hallucinogen Rating Scale (HRS) (Strassman, *et al.*, 1994) and APZ (assessing altered states of consciousness) (Dittrich, 1998).

Participants also completed two questionnaires assessing mystical experience. The Mysticism Scale (9-point version) has been extensively studied, demonstrates cross-cultural generalizability, and is well-regarded in the psychology of religion (Hood, *et al.*, 2001; Spilka, *et al.*, 2003). When administered 7 h after drug administration, participants were instructed to complete the questionnaire with reference to their experiences since they received the capsules that morning. For the lifetime version of the questionnaire, participants were instructed to answer with reference to their total life experiences.

As part of the States of Consciousness Questionnaire, volunteers completed the Pahnke-Richards Mystical Experience Questionnaire (Griffiths, *et al.*, 2006), which assesses seven domains of mystical experiences: internal unity (pure awareness; a merging with ultimate reality); external unity (unity of all things; all things are alive; all is one); transcendence of time and space, ineffability and paradoxicality (claim of difficulty in describing the experience in words); sense of sacredness (awe); noetic quality (claim of intuitive knowledge of ultimate reality) and deeply felt positive mood (joy, peace, love). Ratings were made on a 6-point scale relative to the participant's overall life experience. Data on each scale were expressed as a proportion of the maximum possible score. A mean total score was calculated as the mean of the following six domains: unity (either internal or external, whichever was greater), transcendence of time and space, ineffability, sense of sacredness, noetic quality and positive mood. Based on prior research (Pahnke, 1969; Griffiths, *et al.*, 2006), criteria for designating a volunteer as having had a 'complete' mystical experience were that scores on each of the six domains were ≥0.6.

Measures assessed two months post-session

For this assessment, participants completed the previously described standardized measures and the Persisting Effects Questionnaire, a measure of changes in attitudes, mood, and social and other behaviours (Griffiths, *et al.*, 2006). The questionnaire also included three questions: (I) How personally meaningful was the experience? (1, no more than routine, everyday experiences; 2, similar to meaningful experiences that occur on average once or more a week; 3, similar to meaningful experiences that occur on average once a month; 4, similar to meaningful experiences that occur on average once a year; 5, similar to meaningful experiences that occur on average once every 5 years; 6, among the 10 most meaningful experiences of my life; 7, among the five most meaningful experiences of my life; 8, the single most meaningful experience of my life); (II) Indicate the degree to which the experience was spiritually significant to you? (1, not at all; 2, slightly; 3, moderately; 4, very much; 5, among the five most spiritually significant experiences of my life; 6, the single most spiritually significant experience of my life) and (III) Do you believe that the experience and your contemplation of that experience have led to change in your current sense of personal well-being or life satisfaction? (rated from +3 = increased very much to -3 = decreased very much). This questionnaire was developed after the initiation of the study and was completed by 29 of the 36 participants (approximately the same per cent within all three groups).

14-month follow-up

This assessment was conducted 14 months after the last session, which was 16 months after the psilocybin session in volunteers who received psilocybin in session 1, and 14 months after psilocybin in volunteers who received psilocybin in sessions 2 or 3. For this assessment, all 36 participants completed the Retrospective Questionnaire as well as the previously described standardized measures. At this same time, volunteers participated in an open-ended clinical interview reflecting on study experiences and current life situation.

For purposes of completing the Retrospective Questionnaire, volunteers were first asked to identify on which session they experienced the 'most pronounced changes in your ordinary mental processes'. All but one volunteer identified the psilocybin session. That volunteer, who reported having unusual experiences during both sessions, was asked to complete the questionnaire with regard to the psilocybin session. The remaining volunteers completed the questionnaire in reference to the identified session.

Forty-three items in this questionnaire comprised the previously described Pahnke-Richards Mystical Experience Questionnaire, which was completed looking back on the session and rating the degree to which various phenomena were experienced during the session. The rationale for reassessing these ratings at the 14-month follow-up was that the ratings were made relative to the participant's overall life experience, which could have changed over the intervening follow-up period. Eighty-nine items comprised the previously described Persisting Effects Questionnaire. For these items, volunteers were asked to rate any current persisting effects that they attribute to the experience. Within the Retrospective Questionnaire, volunteers were also asked to provide written descriptions of what was most memorable and what was most spiritually significant about the experience.

Statistical analysis

Inspection of the data indicated that the results from the 30 subjects, who received each drug once, were similar to results from the six subjects, who received methylphenidate twice followed by psilocybin once. Therefore, data from all 36 subjects are analysed below. Data from the first methylphenidate session were used for the six, who received it twice.

To characterize the study sample on measures of personality, affect, quality of life and spirituality relative to the general population, individual subject data at screening were converted to T-scores using norms for: the five factors of the NEO PI-R (Costa and McCrae, 1992); the Positive and Negative Affect factors of the PANAS-X (Watson and Clark, 1994); raw score on the Quality of Life Inventory (Frisch, 1994); the overall mean on the Measure of Actualization Potential (Leclerc, *et al.*, 1999); total score on the Mysticism Scale-Lifetime (Hood and Williamson 2000; Ralph W. Hood Jr, 2007, personal communication) and total score of the Spiritual Transcendence Scale (Ralph L. Piedmont, 2007, personal communication). *T*-scores below 45 or above 55 were considered low or high, respectively, on that dimension.

Repeated measures analysis of variance (ANOVA) was conducted to examine changes in the measures of personality, affect, quality of life and spirituality that were assessed at screening, 2 months after the psilocybin session, and 14 months after the last session ($N = 36$). Bonferroni-corrected *t*-tests were used to assess differences among the three time-points. ANOVA with Bonferroni-corrected *t*-tests were also conducted with the Persisting Effects Questionnaire data ($n = 29$) assessed at 2 months post-methylphenidate and post-psilocybin, and again retrospectively for psilocybin at the 14-month followup, and with the Pahnke-Richards Mystical Experience Questionnaire data ($N = 36$) assessed 7 h post-methylphenidate and post-psilocybin, and again retrospectively for psilocybin at the 14-month follow-up.

To examine differences in the proportion of subjects endorsing specific answers on the Persisting Effects Questionnaire, *z*-tests of proportions compared data at 2 months post-methylphenidate, 2 months post-psilocybin and again retrospectively for psilocybin at the 14-month follow-up. For ratings of personally meaningful and spiritually significant, endorsement was defined as rating either 'among the top 5' or 'the single most'. For ratings of increased well-being or life satisfaction, endorsement was defined as rating 'increased moderately' or 'increased very much'. For ratings of positive behavioural change, endorsement was defined as rating 'moderate', 'strong' or 'extreme'.

Pearson's correlations were calculated to examine the relationships between: (1) volunteer's ratings of personal meaning and spiritual significance at the 14-month follow-up and (2) the following screening measures: scores on the five factor subscales of the NEO PI-R, total scores on the Mysticism Scale, Spiritual Transcendence Scale, Faith Maturity Scale, and FACIT-Sp-NI, and mean overall score on the Measure of Actualization Potential Questionnaire.

Pearson's correlations were calculated between: (1) volunteer's ratings of personal meaning and spiritual significance at the 14-month follow-up and (2) data obtained on the psilocybin session day. The psilocybin session data used for these calculations were: peak monitor ratings of six dimensions of participant's behaviour during sessions (overall drug effect, anxiety or fearfulness, distance from ordinary reality, tearing/crying, joy/intense happiness, and peace/harmony); the six subscales of the HRS; the three subscales of the APZ questionnaire; total scores on the post-session Mysticism Scale and mean score on the post-session Pahnke-Richards Mystical Experience Questionnaire. The follow-up data used for these calculations were the volunteer ratings of personal meaning and spiritual significance attributed to the psilocybin session experience.

Significant correlations between the total scores on the Mysticism Scale and follow-up measures of personal meaning or spiritual significance were further examined using a multiple regression model to control for any confounding by intensity of drug effect. Three separate measures of drug effect intensity were examined: peak monitor ratings of overall drug effect; subject-rated intensity as measured by the Intensity subscale of the HRS and subject-rated intensity from the single item rating 'Intensity' in the HRS. In separate analyses for each intensity measure, the intensity measure was entered into the regression first and the post-session Mysticism Scale score was entered second to assess its effect on the follow-up measures independently of intensity.

For statistical tests, $p < 0.05$ was considered significant except for correlations (for which a more conservative $p < 0.01$ was used) and for the Bonferroni-corrected *t*-tests.

Results

Measures of personality, affect, quality of life and spirituality assessed at screening, 2 months after the psilocybin session, and at the 14-month follow-up

The measures of personality, affect, quality of life, and spirituality assessed at screening indicated that the volunteers were generally well-adjusted, outgoing, open and high in spirituality. More specifically, relative to adult norms, the mean *T*-score for the group of volunteers on the NEO PI-R were low on Neuroticism (*T*-score, 41.8) and high on Extroversion, Openness, and Agreeableness (55.3, 65.7, and 55.7 respectively); low on Negative Affect on the PANAS-X (44.4); and high on the Measure of Actualization Potential (59.2), Mysticism Scale-Lifetime (55.6), and Spiritual Transcendence Scale (63.1).

Of the eight questionnaires assessed, only the Mysticism Scale-Lifetime showed significant changes across the study. For the Mysticism Scale-Lifetime, the total score (Figure 1) and the scores on each of the three factors (Interpretation, Introvertive Mysticism, and Extrovertive Mysticism) were significantly greater than screening at both the 2-month and 14-month assessments.

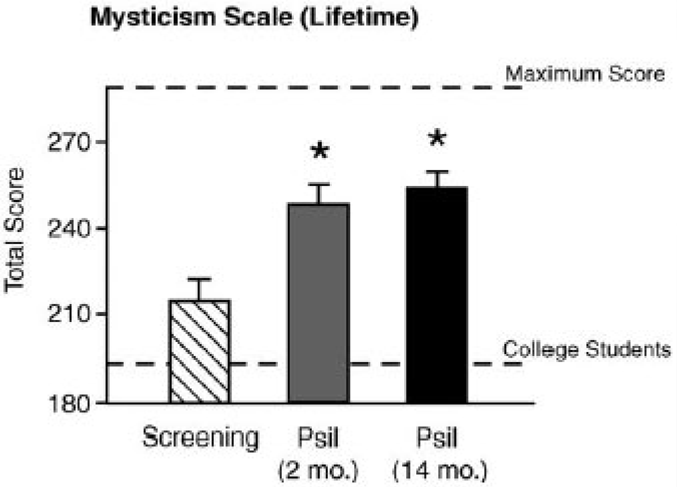


Figure 1. Total score on lifetime version of the Mysticism Scale at screening, 2 months following psilocybin, and at the 14-month follow-up. Bars are mean scores with brackets showing 1 SEM (N = 36). Asterisks show significant differences from the screening assessment. For comparison, lower dashed line shows mean score for college students (Hood, *et al*., 2001; Ralph W. Hood Jr, 2007, personal communication); upper dashed line show maximum possible score.

Pahnke-Richards Mystical Experience Questionnaire assessed immediately after sessions and at the 14-month follow-up

The psilocybin session experience, when rated immediately post-session and when rated retrospectively at the 14-month follow-up, produced significant elevations compared with the methylphenidate experience in each of seven domains of mystical experience and the mean total score on the Pahnke-Richards Mystical Experience Questionnaire (Table 1). The 14-month retrospective rating for psilocybin did not differ significantly from the immediate post-session rating. Based on *a priori* criteria, 22 of the 36 volunteers had a 'complete' mystical experience based on immediate post-session ratings; at follow-up, 21 volunteers continued to fulfil these criteria.

Table 1. Volunteer Ratings on the Pahnke-Richards Mystical Experience Questionnaire section of the State of Consciousness Questionnaire completed at the end of methylphenidate and psilocybin sessions, and again retrospectively for psilocybin at the 14-month follow-up[a]

Scale description	Methylphenidate (post-session)[b] (*N* = 36)	Psilocybin (post-session) (*N* = 36)	Psilocybin (14 months) (*N* = 36)
Internal unity	0.26 (0.04)	0.73 (0.05)*	0.71 (0.05)*
External unity	0.22 (0.04)	0.64 (0.05)*	0.67 (0.05)*
Sacredness	0.38 (0.04)	0.80 (0.04)*	0.78 (0.04)*
Intuitive knowledge	0.32 (0.05)	0.74 (0.05)*	0.73 (0.04)*
Transcendence of time and space	0.27 (0.04)	0.75 (0.04)*	0.75 (0.04)*
Deeply felt positive mood	0.39 (0.04)	0.75 (0.04)*	0.70 (0.05)*
Ineffability and paradoxicality	0.33 (0.04)	0.80 (0.04)*	0.78 (0.05)*
Mean total score	0.33 (0.04)	0.76 (0.04)*	0.75 (0.04)*

[a] Data were mean scores with 1 SEM shown in parentheses; data were expressed as a proportion of the maximum possible score.
[b] For the six subjects, who received methylphenidate on two sessions, the data were from the first session.
*Significant difference from the post-methylphenidate condition ($P < 0.05$); there were no significant differences between the psilocybin post-session condition and the psilocybin 14-month follow-up.

Measures of persisting effects assessed 2 months after drug sessions and at the 14-month follow-up

Compared with methylphenidate, the psilocybin session experience produced significant increases in ratings of positive attitudes, mood, social effects and behaviour when rated retrospectively at both 2 months and at the 14-month follow-up (Table 2). The ratings at the 14-month follow-up did not differ significantly from those at 2 months. The ratings of negative changes on these same dimensions were very low and not significantly different across conditions.

Table 2. Volunteer ratings on the Persisting Effects Questionnaire completed 2 months following the methylphenidate and psilocybin sessions, and again retrospectively for psilocybin at the 14-month follow-up[a,b]

Scale or question description	Methylphenidate (2 months) (*n* = 29)[c]	Psilocybin (2 months) (*n* = 29)	Psilocybin (14 months) (*n* = 29)	Psilocybin (14 months) (*n* = 36)[d]
Positive attitudes about life and/or self	23.4 (4.0)	53.1 (4.6)*	53.5 (5.4)*	53.6 (4.7)
Negative attitudes about life and/or self	0.3 (0.1)	0.6 (0.3)	0.5 (0.3)	0.7 (0.3)
Positive mood changes	16.6 (3.1)	37.4 (4.7)*	36.0 (5.5)*	37.9 (4.8)
Negative mood changes	0.5 (0.4)	1.4 (0.6)	1.6 (0.9)	1.7 (0.8)
Altruistic/positive social effects	19.0 (4.1)	44.5 (5.3)*	45.5 (6.3)*	46.3 (5.4)
Antisocial/negative social effects	0.3 (0.2)	0.7 (0.4)	0.7 (0.4)	0.6 (0.4)
Positive behaviour changes	29.7 (6.1)	56.6 (5.0)*	58.3 (5.4)*	58.1 (4.9)
Negative behaviour changes	1.4 (1.0)	0.0 (0)	0.7 (0.7)	0.6 (0.6)
How personally meaningful was the experience?	3.6 (0.3)	6.4 (0.2)*	6.3 (0.3)*	6.1 (0.2)
How spiritually significant was the experience?	2.7 (0.2)	4.8 (0.2)*	4.5 (0.3)*	4.5 (0.2)
Did the experience change your sense of well-being or life satisfaction?	+0.9 (0.2)	+1.9 (0.2)*	+1.9 (0.2)*	+1.8 (0.2)

[a] Data were mean ratings with 1 SEM shown in parentheses.

[b] Data on attitudes, mood, social, and behaviour changes were expressed as percentage of maximum possible score; data for the three questions were raw scores.

[c] For the five subjects who received methylphenidate on two sessions and who completed this questionnaire, the data are from the first session.

[d] Data for the full group of 36 were not available for the 2-month assessments, but is presented here for comparison.

*Significant difference from methylphenidate 2-month assessment ($p < 0.0001$); there were no significant differences between the psilocybin 2-month condition and the psilocybin 14-month follow-up (*n* = 29).

Table 2 also shows that the psilocybin session was associated with significant increases in ratings of the personal meaning of the experience, the spiritual significance of the experience, and well-being or life satisfaction due to the experience. No volunteer rated the experience as having decreased his or her sense of well-being or life satisfaction at either 2 months or the 14-month follow-up. Figure 2 shows ratings from these three questions plus a question on positive behaviour change expressed as the percentage of the participants endorsing specific answers. Even at the 14-month follow-up, 58% of 36 volunteers rated the experience on the psilocybin session as among the five most personally meaningful experiences of their lives and 67% rated it among the five most spiritually significant experiences of their lives, with 11% and 17%, respectively, indicating that it was the single most meaningful experience, and the single most spiritually significant experience. Furthermore, 64% of the 36 volunteers indicated that the psilocybin session experience increased their sense of well-being or life satisfaction either moderately or very much, and 61% rated that the experience was associated with moderate to extreme positive behaviour change.

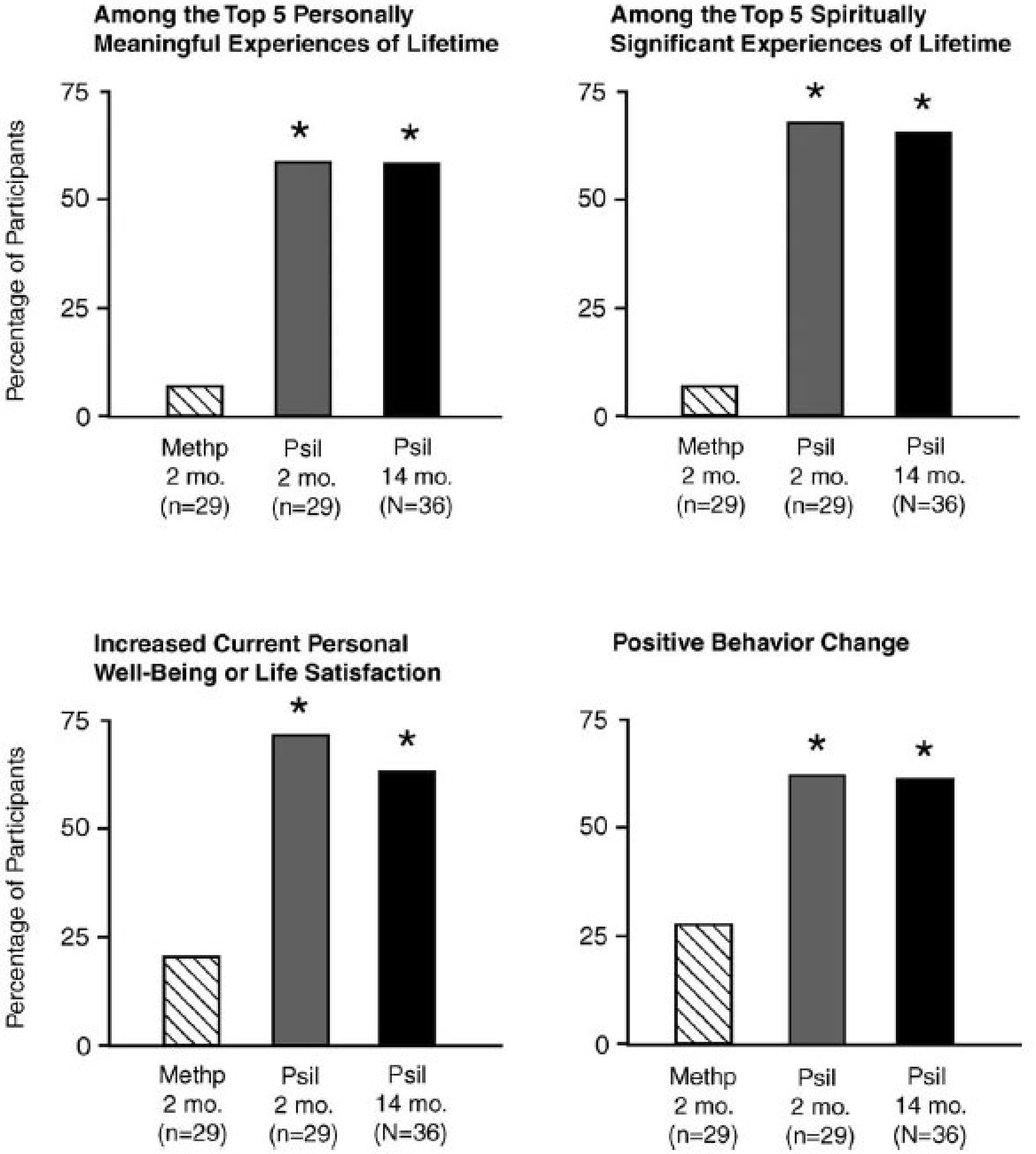


Figure 2. Percentage of volunteers endorsing specific answers on the Persisting Effects Questionnaire completed 2 months following the methylphenidate (Methp) and psilocybin (Psil) sessions (*n* = 29), and again retrospectively for psilocybin at the 14-month follow-up (*N* = 36). For ratings of personally meaningful and spiritually significant (top two panels), the data are the percentage rating 'among the top 5' or 'the single most'. For ratings of increased well-being or life satisfaction, the data were the percentage rating 'increased moderately' or 'increased very much'. For ratings of positive behavioural change, the data were the percentage rating 'moderate', 'strong' or 'extreme'. Asterisks show significant differences ($p < 0.05$, *z*-test of proportions, *n* = 29 at each assessment) from the methylphenidate 2-month assessment; there were no significant differences between the psilocybin 2-month condition and the psilocybin 14-month follow-up assessment. For the methylphenidate results, the data presented are from the first methylphenidate session for the five subjects who received methylphenidate on two sessions and who completed this questionnaire.

Relationships between screening data and the 14-month follow-up data on volunteer ratings of personal meaning and spiritual significance

Because attribution at follow-up of sustained high personal meaning and spiritual significance to the psilocybin session experience was so striking, correlations were used to examine the relationships between data obtained at screening and the 14-month follow-up data on volunteer's ratings of personal meaning and spiritual significance. Ratings of personal meaning at follow-up were significantly correlated (Pearson's r, df = 34, two-tailed $p < 0.01$) with negative affect on the PANAS-X ($r = -0.51$), raw score on the Quality of Life Inventory ($r = +0.47$), total score on the FaithMaturity Scale ($r = +0.41$) and mean score of the Measure of Actualization Potential questionnaire ($r = +0.44$). There were no significant correlations between any of the outcome measures and the subscales of the NEO PI-R (Neuroticism, Extroversion, Openness, Agreeableness and Conscientiousness) or the total scores on the Mysticism Scale, Spiritual Transcendence Scale or FACIT-Sp-NI.

Relationships between psilocybin session data and the 14-month follow-up data on volunteer ratings of personal meaning and spiritual significance

To further understand the sustained ratings of high personal meaning and spiritual significance, correlations were used to examine the relationships between data obtained on the psilocybin session day and the 14-month follow-up data of volunteer's ratings of personal meaning and spiritual significance. Rating of the experience as personally meaningful correlated significantly (Pearson's r, df = 34, two-tailed $p < 0.01$) with the HRS subscales somaesthesia, affect, perception and cognition ($r = 0.35$, 0.49, 0.42, and 0.46, respectively), the APZ questionnaire subscales OSE-oceanic boundlessness ($r = 0.55$) and VUS-visual restructuralization ($r = 0.54$), total score on Mysticism Scale ($r = 0.65$), and total score on Pahnke-Richards Mystical Experience Questionnaire ($r = 0.65$). Rating of spiritual significance showed a significant correlation with the APZ questionnaire subscales OSE ($r = 0.56$) and VUS ($r = 0.48$), total score on Mysticism Scale ($r = 0.77$), and total score on Pahnke-Richards Mystical Experience Questionnaire ($r = 0.66$). Ratings of personally meaningful and spiritual significance did not significantly correlate with peak monitor ratings during the session of overall drug effect, anxiety or fearfulness, distance from ordinary reality, tearing/crying, joy/intense happiness, or peace/harmony. Figure 3 illustrates the robust correlation between the score on the Mysticism Scale (completed 7 h after psilocybin administration and with reference to the experience during the session) and ratings of the spiritual significance of the experience at the 14-month follow-up. For contrast, the figure also shows the relative lack of relationship between the subject-rated Intensity (of drug effect) HRS scale completed 7 h after psilocybin administration and ratings of the spiritual significance of the experience at the 14-month follow-up.

To further examine the contribution of mystical experience (as measured immediately post-session by the Mysticism Scale) to these follow-up measures, regression analysis controlling for intensity of drug effects was undertaken. Three separate measures of intensity of drug effect were used: peak monitor ratings of overall drug effect; subject-rated intensity as reflected in the Intensity subscale of the HRS questionnaire and subject-rated intensity as assessed by the single item rating 'Intensity' in the HRS questionnaire. For both the rating of personally meaningful and the rating of spiritual significance, the measures of intensity contributed only small non-significant effects. The resulting r-values for scores on Mysticism Scale remained highly significant ($p < 0.0001$): personally meaningful (0.65, 0.61, and 0.61 controlling for the three measures of intensity, respectively); spiritually significant (0.77, 0.78 and 0.74 controlling for the three measures of intensity, respectively).

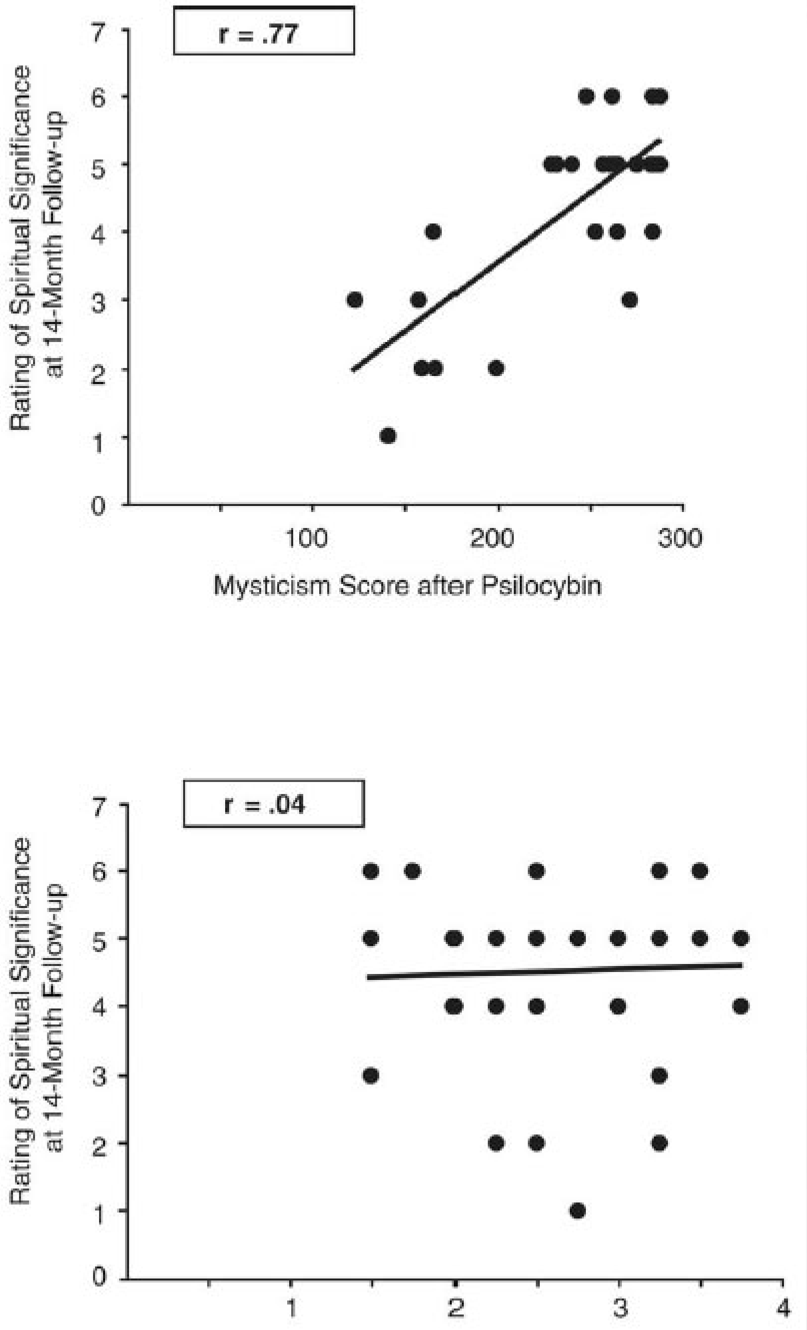


Figure 3. Ratings of the spiritual significance of the psilocybin session experience at the 14-month follow-up as a function of subject ratings complete 7 h after psilocybin administration on the Mysticism Scale (upper panel) and the Intensity subscale of the Hallucinogen Rating Scale (HRS). Data points represent individual subject data (*N* = 36); slope and correlation coefficients are shown.

Verbatim comments at the 14-month follow-up about the nature of the psilocybin-occasioned spiritual experience

Although the patterns of responses on the various subscales of questionnaires provide an empirical representation of the nature of the psilocybin session experiences, unstructured comments from volunteers are helpful to further understand the sustained high ratings of spiritual significance at the 14-month follow-up. Table 3 presents verbatim written comments about the nature of the spiritual experience for all 24 volunteers, who rated the experience at the 14-month follow-up as being among the top five spiritual experiences of their lives. Although not easily summarized, several themes from these unstructured comments include a sense of the unity of all things, a separate 'self' ceasing to exist, and merging and/or an encounter with ultimate reality (or God).

Table 3. Verbatim written comments about the nature of the spiritual experience for all 24 volunteers who rated the experience at the 14-month follow-up as being among the top five (including the single most) spiritual experiences of their lives. These comments were excerpted from the Retrospective Questionnaire that asked open-ended questions about what was most memorable and what was most spiritually significant about the experience.

Volunteer	Verbatim comments
02	The understanding that in the eyes of God - all people...were all equally important and equally loved by God. I have had other transcendent experiences, however, this one was important because it reminded and comforted me that God is truly and unconditionally loving and present.
03	Freedom from every conceivable thing including time, space, relationships, self, etc... It was as if the embodied 'me' experienced ultimate transcendence - even of myself.
04	A non-self self held/suspended in an almost tactile field of light.
05	That in every horrible experience or frightening experience, if you stay with it, enter into it, you will find God. That the horror is in reality only an illusion and God lies beneath it all. It has become a guiding principal in my life.
07	The utter joy and freedom of letting go - without anxiety - without direction - beyond ego self
08	Collapse of ordinary space and time sense. Realization of unity of existence and relativity of ordinary consciousness... I have had glimpses of this before - but this was profound and sustained.
09	The 'knowing' was so powerful and yet personal. Experiencing the Beloved and falling in love.
13	The sense that all is One, that I experienced the essence of the Universe and the knowing that God asks nothing of us except to receive love.
17	I became like a point of awareness able to travel inside myself, others and the outside world. No reference to time or space... The feeling of joy and sadness at the same time - paradoxical.
21	The experience of death, which initially was very uncomfortable, followed by absolute peace and being in the presence of God. It was so awesome to be with God that words can't describe the experience.
23	To cease to 'BE', as I understand it, was not frightening. It was safe and much greater than I have words for or understanding of. Whatever is larger than the state of being is what was holding me.
27	'Surrender' is intensely powerful. To 'let go' and become enveloped in the beauty of - in this case - music - was enormously spiritual.
28	The feeling of no boundaries - where I didn't know where I ended and my surroundings began. Somehow I was able to comprehend what oneness is.
29	The profound grief I experienced as if all of the pain and sadness of the world were passing through me cell by cell tearing apart my being.
32	The breath of God/wind/and my breath are all the same... I really enjoy the deep knowings or truths and laughing about them with 'God'.
36	It opened my third eye - I could see many spiritual beliefs that I hold/held and linked them - a more cohesive and comprehensive spiritual landscape became apparent to me.
37	The experience expanded my conscious awareness permanently. It allows me to let go of negative ideas faster. I accept 'what is' easier.
39	[I experienced] a reality that was clear, beautiful, bright and joyful...In short, this experience opened me up (gave me a tangible vision) of what I think is attainable every day.
40	I felt as if tons of information about 'what is' was being downloaded quickly into my knowing/understanding.
43	The part that continues to stick out for me was 'knowing' and 'seeing' and 'experiencing' with every sense and fiber of my being that all things are connected.
45	When I confronted my shadow and yelled 'What do you want?' and it disappeared in a puff of smoke.
46	The complete and utter loss of self... The sense of unity was awesome... I now truly do believe in God as an ultimate reality.
47	My conversation with God (golden streams of light) assuring me that everything on this plane is perfect; but I do not have the physical body/mind to fully understand.
50	I remember feeling a profound sense of loss of [my family]... I remember after I resolved my fears, the shift then went to joy.

Open-ended clinical interview at the 14-month follow-up

An open-ended clinical interview at the 14-month follow-up provided a clinical context conducive to the spontaneous reporting of study-associated adverse events. There were no reports of persisting perceptual phenomena sometimes attributed to hallucinogen use or of recreational abuse of hallucinogens. Overall, all participants appeared to continue to be well-adjusted, high-functioning and productive members of society.

Comment

The most striking finding from this 14-month follow-up evaluation of the effects of psilocybin and methylphenidate administered to hallucinogen-naïve volunteers is that a large proportion of volunteers rate their 'psilocybin experience'[1] as among the most personally meaningful and spiritually significant of their lives. [[1] Use of the phrase 'psilocybin experience' is not intended to imply that a single type of psilocybin experience exists. Qualitative features of the 'psilocybin experience' may vary widely. The experience is best understood as formed of many factors, including psychological state (i.e. set) and environment (i.e. setting), in addition to the drug.] Fifty-eight per cent and 67% of volunteers, respectively, rated the experience as being among the five most personally meaningful experiences of their lives, and the five most spiritually significant experiences of their lives; 11% and 17%, respectively, indicated that it was the single most meaningful experience, and the single most spiritually significant experience. Furthermore, 64% of the volunteers also indicated that the psilocybin experience increased their sense of well-being or life satisfaction moderately or very much, and no volunteer rated the experience as having decreased well-being or life satisfaction. The magnitude of these effects was undiminished from similar ratings completed 2 months after the psilocybin session and were substantially and significantly greater than ratings completed 2 months after the methylphenidate session. Compared with methylphenidate, attributions to the psilocybin experience also included positive changes in attitudes, mood, altruism, and other behaviour. Although the generalizability of the findings is limited by the study population (hallucinogen-naïve, well-educated, spiritually active, middle-aged adults), it is remarkable that a 8-h laboratory-based intervention could have such large and sustained personally and spiritually significant effects in such a large proportion of volunteers. The findings of sustained reports of positive effects after psilocybin are consistent with a 25-year follow-up study (Doblin, 1991) of seven theological seminary students, who received psilocybin in the context of a religious service (the Good Friday Experiment: Pahnke, 1963, 1967).

One mechanism underlying these effects appears to be that psilocybin occasioned an experience having features similar to spontaneously occurring classical mystical or religious experiences. Of the eight questionnaires measuring personality, affect, quality of life, and spirituality assessed before the study and at follow-up, only the Mysticism Scale-Lifetime showed significant differences (Figure 1). This extensively studied, empirically derived scale is based on the dimensions of mystical experience originally described by William James in 1902 in his classic book 'The Varieties of Religious Experience' (James, 1902) and further elaborated by Stace (1960). Because the version of the scale shown in Figure 1 assesses mystical experience over the entire life-time, it is not possible to attribute the increases observed at both the 2-month and 14-month assessments to the psilocybin experience *per se*. However, the original study (Griffiths, *et al*., 2006) showed that the version of this questionnaire that assessed experience at the end of the session was significantly increased after psilocybin compared with methylphenidate, suggesting that the increases at 2 and 14 months were probably due to the psilocybin experience. Eight dimensions of the mystical experience were also assessed by the Pahnke-Richards Mystical Experience Questionnaire, which documented robust increases on all dimensions after psilocybin (Table 1). Based on *a priori* criteria, almost 60% of the volunteers at the 14-month follow-up continued to fulfil the criteria for having had a 'complete' mystical experience during the psilocybin session. Correlation and regression analyses provided further evidence suggesting a central role of this mystical-type experience in the sustained high ratings of personal meaning and spiritual significance at follow-up, with r-values from regression analyses ranging from 0.74 to 0.78 for the analyses between Mysticism Scale scores immediately after psilocybin sessions and the follow-up ratings of the spiritual significance of the experience. Finally, unstructured written comments in a retrospective questionnaire completed at follow-up asked what was most memorable and spiritually significant about the experience. Responses were suggestive of a sense of the unity (e.g. the unity of all things and merging and/or an encounter with ultimate reality), which is a core aspect of mystical experiences as described by James and Stace, and as assessed by the Mysticism Scale. Thus, the domain(s) of experience assessed by the Mysticism Scale appear to be closely related to later attributions of spiritual significance and personal meaning.

Notably, none of the assessments of personality, affect, quality of life, or spirituality conducted at screening were predictive of (i.e. correlated with) ratings of spiritual significance at follow-up, and only a few of these measures significantly correlated with ratings of personal meaning. Given the large number of correlations conducted and the seeming inconsistency across different types of measures that presumably assess similar domains (e.g. openness as a personality trait was assessed by both the NEO and by the Measurement of Actualization Potential; spirituality as assessed by four separate measures), there do not appear to be any strong predictors of these sustained effects of psilocybin. Future research should explore the replicability of the observed negative correlation of ratings of personal meaning with negative affect and positive correlation with quality of life. Finally, it should be noted that, by design, the volunteer group of this study was relatively homogeneous, with screening measures showing low neuroticism and negative affect and high extroversion, openness, agreeableness and spirituality. It is possible that predictive relationships with such screening measures might emerge in a group showing more variability on such measures.

Although the 14-month follow-up provided no evidence of adverse effects of the psilocybin exposure, it is important not to underestimate the potential risks of hallucinogen exposure. These risks include: (1) panic or fear reactions resulting in dangerous behaviour during the time of drug action; (2) precipitation or exacerbation of enduring psychiatric conditions; (3) long-lasting perceptual disturbances and (4) development of a pattern of abuse of hallucinogens (Abraham, *et al.*, 1996; Halpern and Pope, 1999; Johnson, *et al.*, in press). In the original report of this study (Griffiths, *et al.*, 2006), we reported that 11 of the 36 volunteers experienced a period of significant fear during the psilocybin session, with six having transient ideas of reference/paranoia. These effects did not persist beyond the session. Given the extensive screening, preparation and supportive monitoring in the study protocol, this rate of difficult experience is notable and underscores the possible risk of under-supervised use escalating to panic or dangerous behaviour. Elsewhere, we provide a detailed discussion of the risks of human hallucinogen administration and safety guidelines for minimizing these risks in the context of human research (Johnson, *et al.*, in press).

The high personal meaning and spiritual significance ascribed to the psilocybin-occasioned mystical-type experience prompts consideration of whether such effects could be used to facilitate treatment of some psychiatric and behavioural disorders. Descriptive research suggests that naturally occurring instances of dramatic positive behavioural change are sometimes associated with spontaneously occurring, transformative psychological experiences, frequently of a mystical-type variety (Miller and C'de Baca, 2001; C'de Baca and Wilbourne, 2004; Forcehimes, 2004). Consistent with this, observations in early studies with classical hallucinogens that examined treatment of drug and alcohol dependence (Chwelos, *et al.*, 1959; Kurland, *et al.*, 1971; Savage and McCabe, 1973) and psychological distress associated with advanced cancer (Pahnke, *et al.*, 1969; Richards, *et al.*, 1977) suggested that the occurrence of a mystical-type (i.e. transcendent or peak) experience played a key role in positive therapeutic outcome. Unfortunately, many of the early studies of therapeutic use of hallucinogens used sub-optimal procedures for supporting the experience and/or lacked modern methodological controls now expected of rigorous clinical trials (Mangini, 1998). The present demonstration that mystical experiences having sustained meaning can be occasioned in a high proportion of volunteers suggests that there may be value to re-initiating therapeutic trials with classical hallucinogens.

When administered under supportive conditions, psilocybin occasioned experiences similar to spontaneously occurring mystical experiences that, over a year later, were considered by volunteers to be among the most personally meaningful and spiritually significant experiences of their lives and to have produced positive changes in attitudes, mood, altruism, behaviour and life satisfaction. In addition to possible therapeutic applications, the ability to prospectively produce mystical-type experiences should permit rigorous scientific investigations about their causes and consequences, and may provide novel information about the biological bases of moral and religious behaviour.

Acknowledgements

Conduct of the study was supported by grants from NIDA (R01 DA03889) and the Council on Spiritual Practices. Analysis and write up of the follow-up study was supported by grants from the Council on Spiritual Practices and the Heffter Research Institute. The sponsors were provided the manuscript for comment, but had no role in manuscript approval. Roland Griffiths has been a consultant to or received grants from various pharmaceutical companies on issues about drug abuse liability. The authors thank David Nichols, PhD for synthesizing the psilocybin, Mary Cosimano, MSW for her role as assistant monitor, Brian Richards, PsyD for psychiatric screening, Linda Felch, MA and Paul Nuzzo, MA for statistical analysis, and Dr David Nichols, Dr George Greer andDr Ryan Vandrey for comments on the manuscript.

References

1. Abraham, HD, Aldridge, AM, Gogia, P (1996) The psychopharmacology of hallucinogens. Neuropsychopharmacology 14: 285-298.
2. Benson, PL, Donahue, MJ, Erickson, JA (1993) The Faith Maturity Scale: conceptualization, measurement, and empirical validation. Research in the Social Scientific Study of Religion, Vol 5. Greenwich, Connecticut: JAI Press Inc, pp. 1 -26.
3. C'de Baca, J, Wilbourne, P (2004) Quantum change: ten years later. J Clin Psychol 60: 531-541.
4. Carter, OL, Hasler, F, Pettigrew, JD, Wallis, GM, Liu, GB, Vollenweider, FX (2007) Psilocybin links binocular rivalry switch rate to attention and subjective arousal levels in humans. Psychopharmacology (Berl) 195: 415-424.
5. Carter, OL, Pettigrew, JD, Hasler, F, Wallis, GM, Liu, GB, Hell, D, et al. (2005) Modulating the rate and rhythmicity of perceptual rivalry alternations with the mixed 5-HT2A and 5-HT1A agonist psilocybin. Neuropsychopharmacology 30: 1154-1162.
6. Chwelos, N, Blewett, DB, Smith, CM, Hoffer, A (1959) Use of d-lysergic acid diethylamide in the treatment of alcoholism. Q J Stud Alcohol 20: 577-590.
7. Costa, PT, McCrae, RR (1992) Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) Professional Manual. Odessa, FL: Psychological Assessment Resources.
8. Dittrich, A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. Pharmacopsychiatry 31(Suppl. 2): 80-84.
9. Doblin, R (1991) Pahnke's Good Friday experiment: a long-term follow-up and methodological critique. J Transpersonal Psychol 23:1-28.
10. Forcehimes, AA (2004) De profundis: spiritual transformations in Alcoholics Anonymous. J Clin Psychol 60: 503-517.
11. Frisch, MB (1994) QOLI, Quality of Life Inventory: Manual and Treatment Guide for the Quality of Life Inventory. Minneapolis, MN: National Computer Systems Inc.
12. Gouzoulis-Mayfrank, E, Thelen, B, Habermeyer, E, Kunert, HJ, Kovar, KA, Lindenblatt, H, et al. (1999) Psychopathological, neuroendocrine and autonomic effects of 3,4-methylenedioxyethylamphetamine (MDE), psilocybin and d-methamphetamine in healthy volunteers. Results of an experimental double-blind placebo-controlled study. Psychopharmacology (Berl) 142:41-50.
13. Griffiths, RR, Richards, WA, McCann, U, Jesse, R (2006) Psilocybin can occasion mystical experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology (Bert) 187: 268-283.
14. Halpern, JH, Pope, HG (1999) Do hallucinogens cause residual neuropsychological toxicity? Drug Alcohol Depend 53: 247-256.
15. Hasler, F, Grimberg, U, Benz, MA, Huber, T, Vollenweider, FX (2004) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology (Berl) 172: 145-156.
16. Hollister, LE (1961) Clinical, biochemical and psychologic effects of psilocybin. Arch Int Pharmacodyn Ther 130:42-52.
17. Hood Jr, RW, Ghorbani, N, Watson, PJ, Ghramaleki, AF, Bing, MN, Davison, HK, Morris, RJ, Williamson, WP (2001) Dimensions of the mysticism scale: confirming the three-factor structure in the United States and Iran. J Sci Study Relig 40: 691-705.
18. Hood Jr, RW, Williamson, WP (2000) An empirical test of the unity thesis; the structure of mystical descriptors in various faith samples. J Psychology Christ 19: 232-244.
19. Isbell, H (1959) Comparison of the reactions induced by psilocybin and LSD-25 in man. Psychopharmacologia 1:29-38.
20. James, W (1902, republished 1958) The Varieties of Religious Experience. New York, NY: Penguin Books.
21. Johnson, MW, Richards, WA, Griffiths, RR (in press) Human hallucinogen research: guidelines for safety. Journal of Psychopharmacology 22.
22. Kurland, A, Savage, C, Pahnke, WN, Grof, S, Olsson, JE (1971) LSD in the treatment of alcoholics. Pharmacopsychiatry 4:83-94.
23. Leclerc, G, Lefrançois, R, Dubé, M, Hébert, R, Gaulin, P (1999) Criterion validity of a new measure of self-actualization. Psychol Rep 85: 1167-1176.
24. Leary, T, Litwin, GH, Metzner, R (1963) Reactions to psilocybin administered in a supportive environment. J Nerv Ment Dis 137: 561-573.
25. Mangini, M (1998) Treatment of alcoholism using psychedelic drugs: a review of the program of research. J Psychoactive Drugs 30: 381-418.
26. Malitz, S, Esecover, H, Wilkens, B, Hoch, PH (1960) Some observations on psilocybin, a new hallucinogen, in volunteer subjects. Compr Psychiatry 1:8-17.
27. Metzner, R (2004) Teonanacatl: Sacred Mushroom of Visions. El Verano, CA: Four Tree Press.
28. Metzner, R, Litwin, G, Weil, G (1965) The relation of expectation and mood to psilocybin reactions: a questionnaire study. Psychedelic Rev 5:3-39.

29. Miller, WR, C'de Baca, J (2001) Quantum Change: When Epiphanies and Sudden Insights Transform Ordinary Lives. New York, NY: The Guilford Press.
30. Nichols, DE (2004) Hallucinogens. Pharmacol Ther 101: 131-181.
31. Pahnke, WN (1963) Drugs and mysticism: an analysis of the relationship between psychedelic drugs and the mystical consciousness. PhD Thesis presented to the President and Fellows of Harvard University in Religion and Society.
32. Pahnke, WN (1967) LSD and religious experience. In: DeBold, RC, Leaf, RC (eds), LSD Man & Society. Middletown, CT: Wesleyan University Press, pp. 60-85.
33. Pahnke, WN (1969) Psychedelic drugs and mystical experience. Int Psychiatry Clin 5: 149-162.
34. Pahnke, WN, Kurland, AA, Goodman, LE, Richards, WA (1969) LSD-assisted psychotherapy with terminal cancer patients. In: Hicks, RE, Fink, PJ, (eds), Psychedelic Drugs: Proceedings of a Hahnemann Medical College and Hospital Symposium. New York, NY: Grune and Stratton, pp. 33-42.
35. Peterman, AH, Fitchett, G, Brady, MJ, Hernandez, L, Cella, D (2002) Measuring spiritual well-being in people with cancer: the functional assessment of chronic illness therapy-Spiritual Well-being Scale (FACIT-Sp). Ann Behav Med 24:49-58.
36. Piedmont, RL (1999) Does spirituality represent the sixth factor of personality? Spiritual transcendence and the five-factor model. J Pers 67: 985-1013.
37. Piedmont, RL (2007) Cross-cultural generalizability of the spiritual transcendence scale to the Philippines: spirituality as a human universal. Ment Health Relig Culture 10:89-107.
38. Richards, WA, Rhead, JC, DiLeo, FB, Yensen, R, Kurland, AA (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. J Psychedelic Drugs 9:1-10.
39. Rinkel, M, Atwell, CR, Dimascio, A, Brown, J (1960) Experimental psychiatry. V. Psilocybine, a new psychotogenic drug. N Engl J Med 262: 295-297.
40. Rosenberg, DE, Isbell, H, Miner, EJ, Logan, CR (1964) The effect of N, N-Dimethyltryptamine in human subjects tolerant to lysergic acid diethylamide. Psychopharmacologia 5: 217-227.
41. Savage, C, McCabe, OL (1973) Residential psychedelic (LSD) therapy for the narcotic addict: a controlled study. Arch Gen Psychiatry 28:808-814.
42. Spilka, B, Hood Jr, RW, Hunsberger, B, Gorsuch, R (2003) The Psychology of Religion: An Empirical Approach, third ed. New York: The Guilford Press.
43. Stace, WT (1960) Mysticism and Philosophy. Philadelphia, PA: Lippincott.
44. Stamets, P (1996) Psilocybin Mushrooms of the World: An Identification Guide. Berkeley, CA: Ten Speed Press.
45. Strassman, RJ, Qualls, CR, Uhlenhuth, EH, Kellner, R (1994) Dose-response study of N, N-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry 51:98-108.
46. Vollenweider, FX, Vollenweider-Scherpenhuyzen, MFI, Babler, A, Vogel, H, Hell, D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 9: 3897-3902.
47. Wasson, RG (1980) The Wondrous Mushroom: Mycolatry in Meso-america. New York, NY: McGraw-Hill Book Co.
48. Watson, D, Clark, LA (1994) (updated 1999) The PANAS-X manual for the positive and negative affect schedule-expanded form. Iowa City, Iowa: The University of Iowa.
49. Wolbach Jr, AB, Miner, EJ, Isbell, H (1962) Comparison of psilocin with psilocybin, mescaline and LSD-25. Psychopharmacologia 3: 219-223.

Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects

by

Roland R. Griffiths et al.

original source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3308357/pdf/nihms-347884.pdf
backup source: http://www.psilosophy.info/resources/nihms-347884.pdf

Table of Contents:

- Abstract
- Introduction
- Materials and methods
  - *Participants*
  - *Study design and overview*
  - *Instructions to participants and monitors*
  - *Drug conditions*
  - *Meetings with monitor before and after sessions*
  - *Drug Sessions*
  - *Measures assessed throughout the session*
  - *Measures assessed 7 hours after drug administration*
  - *Persisting effects assessed one month after sessions*
  - *Retrospective persisting effects assessed at 14-month follow-up*
  - *Longitudinal measures assessed at baseline, after session 5, and at 14-month follow-up*
  - *Post-study monitor ratings of enduring effects in participants*
  - *Data Analyses*
- Results
  - *Integrity of blinding procedures*
  - *Cardiovascular measures and monitor ratings assessed throughout the session*
  - *Drug effect and mysticism measures assessed 7 hours after drug administration*
  - *Psilocybin-Induced Fear/Anxiety or Delusions*
  - *Persisting effects assessed one month after sessions*
  - *Retrospective persisting effects assessed at 14-month follow-up*
  - *Longitudinal measures assessed at baseline, after session 5, and at 14-month follow-up*
  - *Post-study monitor ratings of enduring effects in participants*
  - *Open-ended clinical interview at the 14-month follow-up*
- Discussion
- Acknowledgments
- References

R. R. Griffiths, Department of Psychiatry and Behavioral Sciences Johns Hopkins University School of Medicine 5510 Nathan Shock Drive Baltimore, MD 21224-6823, USA; Department of Neuroscience Johns Hopkins University School of Medicine 5510 Nathan Shock Drive Baltimore, MD 21224-6823, USA
M.W. Johnson, Department of Psychiatry and Behavioral Sciences Johns Hopkins University School of Medicine 5510 Nathan Shock Drive Baltimore, MD 21224-6823, USA
W. A. Richards, Department of Psychiatry Johns Hopkins Bayview Medical Center 2516 Talbot Road Baltimore, MD 21216-2032
B.D. Richards, Department of Psychiatry Johns Hopkins Bayview Medical Center 2516 Talbot Road Baltimore, MD 21216-2032
U. McCann, and Department of Psychiatry and Behavioral Sciences Johns Hopkins University School of Medicine 5510 Nathan Shock Drive Baltimore, MD 21224-6823, USA
R. Jesse Council on Spiritual Practices Box 460220 San Francisco, CA 94146-0220

Abstract

Rationale-This dose-effect study extends previous observations showing that psilocybin can occasion mystical-type experiences having persisting positive effects on attitudes, mood, and behavior.

Objectives-This double-blind study evaluated psilocybin (0, 5, 10, 20, 30 mg/70 kg, p.o.) administered under supportive conditions.

Methods-Participants were 18 adults (17 hallucinogen-naïve). Five 8-hour sessions were conducted individually for each participant at 1-month intervals. Participants were randomized to receive the four active doses in either ascending or descending order (9 participants each). Placebo was scheduled quasi-randomly. During sessions volunteers used eyeshades and were instructed to direct their attention inward. Volunteers completed questionnaires assessing effects immediately after and 1 month after each session, and at 14 months follow-up.

Results-Psilocybin produced acute perceptual and subjective effects including, at 20 and/or 30 mg/70 kg, extreme anxiety/fear (39% of volunteers) and/or mystical-type experience (72% of volunteers). One month after sessions at the two highest doses, volunteers rated the psilocybin experience as having substantial personal and spiritual significance, and attributed to the experience sustained positive changes in attitudes, mood, and behavior, with the ascending dose sequence showing greater positive effects. At 14 months, ratings were undiminished and were consistent with changes rated by community observers. Both the acute and persisting effects of psilocybin were generally a monotonically increasing function of dose, with the lowest dose showing significant effects.

Conclusions-Under supportive conditions, 20 and 30 mg/70 kg psilocybin occasioned mystical-type experiences having persisting positive effects on attitudes, mood and behavior. Implications for therapeutic trials are discussed.

Keywords psilocybin; dose-effects; hallucinogen; entheogen; psychedelic; mystical experience; fear; spiritual; religion; positive psychology; humans

Introduction

Psilocybin, which is the principal psychoactive component of *Psilocybe* and other genera of mushrooms, has likely been used for millennia within some cultures in structured manners for divinatory or religious purposes (Wasson, 1980; Stamets 1996; Metzner 2004; Guzmán 2008). Like other classic hallucinogens (*d*-lysergic acid diethylamide [LSD], mescaline, *N,N*-dimethyltryptamine [DMT]), the effects of psilocybin are primarily mediated at 5-HT_{2A} receptor sites (Glennon et al. 1984; Nichols 2004), and the acute subjective effects include robust changes in perception, cognition, affect, volition, and somesthesia (Isbell 1959; Wolbach et al. 1962; Rosenberg et al. 1964). In early clinical research with psilocybin, the affective character of subjective experiences often varied from positive to negative, and highly valued personal or mystical-type experiences were rare (e.g., Isbell 1959; Malitz et al. 1960; Rinkel et al. 1960; Hollister 1961). Subsequent research that generally used higher psilocybin doses and provided more preparation and interpersonal support reported a higher rate of affectively positive experiences, sometimes of a mystical nature, that were rated as being of personal significance (Leary et al. 1963; Metzner et al. 1965; Pahnke 1969).

Recently, we used rigorous double-blind methods to evaluate the acute (7 hour) and longer-term (2 months and 14 months) psychological effects of a high dose of psilocybin (30 mg/70 kg) relative to an active comparison compound (40 mg/70 kg methylphenidate) in 36 hallucinogen-naïve volunteers (Griffiths et al. 2006, 2008). The study was designed to optimize the potential for positively-valued experiences by providing eight hours of preparation, administering psilocybin in a pleasant, supportive setting, and instructing volunteers to focus explicitly on their subjective or inner experience rather than, for example, perform tasks. The results showed that psilocybin occasioned mystical-type experiences and, sometimes, significant fear. The mystical-type experiences were rated as having substantial and persisting personal meaning and spiritual significance to which volunteers attributed sustained positive changes in attitudes, moods and behavior. The present study was undertaken using similar procedures to characterize the acute and persisting effects of a range of lower doses of psilocybin (0, 5, 10, 20, 30 mg/70 kg). The study was also designed to compare the ascending and descending sequences of drug dose exposure.

Materials and methods

Participants

Participants were recruited from the local community through flyers announcing a study of states of consciousness brought about by psilocybin, a naturally occurring psychoactive substance used sacramentally in some cultures. Two hundred seventy-nine individuals were screened over the telephone and 31 were further screened in person. The 18 study participants (8 males) were medically healthy (as determined by medical history, physical examination, an electrocardiogram, routine medical blood laboratory tests, and urine testing for common drugs of abuse), psychiatrically healthy, and without family histories of psychotic disorders or bipolar I or II disorder (as determined by structured clinical interviews). Individuals with current alcohol or drug dependence (including nicotine) were excluded, as were individuals with a past history within the past 20 years of alcohol or drug dependence (excluding nicotine). Participants were hallucinogen naïve, except for one who reported using psilocybin mushrooms on two occasions more than 20 years previously. Participants had an average age of 46 years (range 29 to 62) and were well-educated; all had at least some college, 94% were college graduates, and 56% had post-graduate degrees. Fifty-six percent were employed full-time, 33% part-time, and 11% were retired. Fifty percent indicated affiliation with a religious or spiritual community, such as a church, synagogue, or meditation group. While not an inclusion criterion, all 18 volunteers indicated at least intermittent participation in religious or spiritual activities such as religious services, prayer, or meditation, with 39% reporting daily activities and an additional 39% reporting at least weekly activities. Volunteers did not receive monetary compensation for participation. Based on interviews, their motivation for participation was curiosity about the effects of psilocybin and the opportunity for extensive self-reflection in the context of the day-long drug sessions and the meetings with the monitors that occurred before and after sessions. The Institutional Review Board of the Johns Hopkins University School of Medicine approved the study, and all volunteers gave their informed consent before participation.

Study design and overview

The study procedures followed recommendations provided for safe conduct of research administering high doses of a classic hallucinogen (Johnson et al. 2008). The study examined psilocybin (0, 5, 10, 20, and 30 mg/70 kg) using a double-blind, between-group, crossover design that involved five 8-hour drug sessions conducted at approximately 1- month intervals, and a 14-month follow-up. Eighteen volunteers were randomly assigned to receive the active psilocybin doses in either an ascending dose sequence or a descending sequence. Although each volunteer received the 0 mg/70 kg condition once, across the 9 volunteers in each of the ascending and descending sequences, the 0 mg/70kg condition occurred twice on sessions 1, 2, 4, and 5, and once on session 3. The purpose of this quasi-random scheduling of placebo was to obscure the dose sequence to the participants and monitors (see Instructions section below). Outcome measures obtained throughout the drug sessions included blood pressure and monitor ratings of participant mood and behavior. At about 7 hours after drug ingestion (when the primary drug effects had subsided), participants completed several questionnaires designed to assess various aspects of hallucinogen experience (described below). Various longitudinal and persisting effects measures were assessed at screening, 1 month after each drug session, and at 14 months after the last session.

Instructions to participants and monitors

Participants and monitors were informed that participants would receive placebo and four different doses (ranging from low to high) of psilocybin in mixed order across sessions. Neither participants nor monitors were informed that the active psilocybin doses would be tested in an ascending or descending sequence. The only exception to this was that two of the seven assistant monitors were not blind to the ascending/descending nature of the experimental design, however they were blind to the outcome of randomization.

Drug conditions

Psilocybin doses and placebo (0 mg/70 kg) were prepared in identically-appearing opaque, size 0 gelatin capsules, with lactose as the inactive capsule filler. On each session, a single capsule was administered with 180 ml water.

Meetings with monitor before and after sessions

The primary monitor (usually along with the assistant monitor) met with each participant on four occasions before his or her first session (for 8 hours total), once for about an hour on the day following each of the five sessions, and one more time about 3 weeks after each session. The purpose and content of these meetings are described elsewhere (Griffiths et al. 2006; Johnson et al. 2008). Monitors and assistant monitors were trained by personnel with extensive prior experience monitoring hallucinogen sessions.

Drug Sessions

As described in more detail previously (Griffiths et al. 2006), drug sessions were conducted in an aesthetic living-room-like environment with two monitors present. Participants were instructed to consume a low-fat breakfast before coming to the research unit. A urine sample was taken to verify abstinence from common drugs of abuse (cocaine, benzodiazepines, and opioids including methadone). Although the presence of THC was not tested, none of the volunteers reported recent use of cannabis. For most of the time during the session, participants were encouraged to lie down on the couch, use an eye mask to block external visual distraction, and use headphones through which a music program was played. The same music program was played for all participants in all sessions. Participants were encouraged to focus their attention on their inner experiences throughout the session.

Measures assessed throughout the session

Ten minutes before and 30, 60, 90, 120, 180, 240, 300, and 360 minutes after capsule administration, blood pressure, heart rate, and monitor ratings were obtained.

Blood pressure and heart rate - Blood pressure (systolic and diastolic pressure using oscillometric method with the blood-pressure cuff placed on the arm) and heart rate were monitored using a Non-Invasive Patient Monitor Model 507E (Criticare Systems, Inc., Waukesha, WI).

Monitor Rating Questionnaire - At the same time-points at which the physiological measures were taken, the two session monitors completed the Monitor Rating Questionnaire, which involved rating or scoring several dimensions of the participant's behavior or mood (Table 1). The dimensions that are expressed as peak scores in Table 1 were rated on a 5- point scale from 0 to 4. Dimensions expressed as total duration in Table 1 were rated as the estimated number of minutes since the last rating. Data were the mean of the two monitor ratings at each time-point.

Measures assessed 7 hours after drug administration

At about 7 hours after capsule administration when the major drug effects had subsided, the participant completed three questionnaires developed for assessing the subjective effects of hallucinogen drugs and two questionnaires developed for assessing mystical experience. Participants typically completed these questionnaires in about 40 minutes.

Hallucinogen Rating Scale - This 99 item questionnaire, which was designed to show sensitivity to the hallucinogen *N,N*-dimethyltryptamine (DMT) (Strassman et al. 1994), consists of six subscales assessing various aspects of hallucinogen effects (Intensity, Somaesthesia, Affect, Perception, Cognition, and Volition).

Table 1. Cardiovascular measures and monitor ratings of volunteer behavior and mood assessed throughout the session.*

Measure	Psilocybin Dose (mg/70 kg)				
	0	5	10	20	30
Cardiovascular Measures (peak effects)					
Systolic blood pressure (mm Hg)	132.6 (3.6)	**143.3 (4.3)**^{a}	**145.7 (4.6)**^{a}	**145.7 (4.2)**^{a}	**153.1 (4.2)**^{b}
Diastolic blood pressure (mm Hg)	77.5 (1.9)	**83.4 (2.1)**^{a}	**83.9 (2.0)**^{a}	**84.3 (2.5)**^{a}	**88.8 (2.4)**^{b}
Heart rate (beats per minute)	74.8 (2.5)	78.7 (2.7)^{a}	77.9 (2.0)^{a}	**81.2 (3.0)**$^{a.b}$	**83.0 (2.4)**^{b}
Monitor Ratings (peak effects, max score=4)					
Overall drug effect	0.69 (0.15)	**2.03 (0.13)**^{a}	**2.44 (0.19)**^{b}	**3.06 (0.15)**^{c}	**3.42 (0.15)**^{c}
Sleepiness/sedation	1.11 (0.22)	0.69 (0.18)	0.78 (0.20)	0.58 (0.16)	0.58 (0.14)
Unresponsive to questions	0.17 (0.09)	**0.19 (0.12)**^{a}	**0.44 (0.14)**^{b}	**0.97 (0.30)**^{c}	**1.14 (0.24)**^{d}
Anxiety or Fearfulness	0.28 (0.10)	**0.61 (0.19)**^{a}	**0.75 (0.15)**^{b}	**1.06 (0.22)**^{c}	**1.19 (0.22)**^{d}
Stimulation/arousal	0.53 (0.19)	**1.19 (0.13)**^{a}	**1.64 (0.19)**^{b}	**1.97 (0.20)**$^{b.d}$	**2.17 (0.22)**$^{c.d}$
Distance from ordinary reality	0.75 (0.17)	**1.92 (0.19)**^{a}	**2.36 (0.21)**^{b}	**2.97 (0.17)**^{c}	**3.22 (0.15)**^{c}
Ideas of reference/paranoid thinking	0.03 (0.03)	0.00 (0.00)^{a}	0.08 (0.05)^{a}	0.14 (0.06)^{a}	**0.44 (0.14)**^{b}
Yawning	0.22 (0.10)	0.53 (0.15)^{a}	**0.97 (0.27)**$^{a.b}$	**1.36 (0.37)**$^{b.c}$	**1.81 (0.39)**^{c}
Tearing/crying	0.61 (0.24)	**1.00 (0.29)**^{a}	**1.25 (0.26)**^{b}	**1.50 (0.33)**^{c}	**1.81 (0.24)**^{d}
Nausea	0.00 (0.00)	**0.33 (0.10)**^{a}	**0.42 (0.15)**^{b}	**0.31 (0.13)**^{c}	**0.47 (0.13)**^{d}
Spontaneous motor activity	0.22 (0.09)	0.64 (0.15)^{a}	**0.78 (0.20)**^{a}	**1.14 (0.32)**$^{a.c}$	**1.47 (0.35)**$^{b.c}$
Restless/fidgety	0.17 (0.07)	**0.44 (0.18)**^{a}	**0.58 (0.12)**^{b}	**0.89 (0.19)**^{c}	**0.81 (0.17)**^{d}
Joy/Intense happiness	0.64 (0.19)	1.19 (0.22)^{a}	**1.42 (0.27)**$^{a.b}$	**1.81 (0.33)**$^{b.c}$	**2.14 (0.31)**^{c}
Peace/harmony	0.78 (0.19)	**1.39 (0.22)**^{a}	**1.64 (0.22)**$^{a.b}$	**2.11 (0.30)**^{b}	**2.03 (0.27)**^{b}
Monitor Ratings (total duration in minutes, max score=360)					
Talking with monitor	85.94 (7.32)	85.42 (6.90)	83.06 (8.08)	83.75 (10.29)	85.03 (11.32)
Physical contact with monitor †	21.64 (7.26)	**35.61 (9.33)**^{a}	**45.00 (12.05)**^{b}	**69.94 (21.31)**^{c}	**86.00 (21.15)**^{d}
Sleep	13.72 (6.80)	3.83 (3.31)	2.67 (1.99)	3.42 (2.13)	0.61 (0.44)
Strong anxiety	0.33 (0.34)	0.61 (0.63)	1.14 (0.69)	1.81 (0.80)	11.11 (6.75)

*Data are means with 1 SEM shown in parentheses (*N*=18); within a row, bold font indicates significant difference from 0 mg/70 kg; for active doses, values not sharing a common letter are significantly different (Fisher's LSD $p<0.05$)

APZ - The APZ is a 72 item yes/no questionnaire designed to assess altered states of consciousness, including those produced by hallucinogens (Dittrich 1998). The three major scales on the APZ are the OSE (oceanic boundlessness; a state common to classic mystical experiences including feelings of unity and transcendence of time and space), the AIA (dread of ego dissolution; dysphoric feelings), and the VUS (visionary restructuralization; includes items on visual pseudo-hallucinations, illusions, and synesthesias). Data on each scale were expressed as a proportion of the maximum possible score.

Addiction Research Center Inventory (ARCI) - The ARCI was developed to differentiate subjective effects among several classes of psychoactive drugs including the hallucinogens (Haertzen 1966). The short form of the ARCI consists of 49 true/false questions and contains five major scales: lysergic acid diethylamide (LSD), a hallucinogen-sensitive scale that is often interpreted as providing a measure of dysphoric changes; pentobarbital, chlorpromazine, alcohol group (PCAG), a sedative sensitive scale; benzedrine group (BG) and amphetamine (A) scales, amphetamine-sensitive scales; and morphine-benzedrine group (MBG), often interpreted as a measure of euphoria (Martin et al. 1971; Jasinski 1977). Participants were instructed to answer the questions on the ARCI with reference to the effects they experienced since they received the capsule that morning.

States of Consciousness Questionnaire - This 100 item questionnaire is rated on a 6-point scale [0=none; not at all; 1=so slight cannot decide; 2=slight; 3=moderate; 4=strong (equivalent in degree to any previous strong experience or expectation of this description); 5=extreme (more than ever before in my life and stronger than 4)]. Forty-three items on this questionnaire comprised the current version of the Pahnke-Richards mystical experience items, which was shown sensitive to psilocybin (Electronic Supplementary Table 1 in Griffiths et al. 2006). An earlier version of this scale was also previously shown sensitive to psilocybin and other hallucinogens (Pahnke 1963; Turek et al. 1974; Richards et al. 1977). The 43 items provide scale scores for each of seven domains of mystical experiences: internal unity (pure awareness; a merging with ultimate reality); external unity (unity of all things; all things are alive; all is one); sense of sacredness (reverence; sacred); noetic quality (claim of an encounter with ultimate reality; more real than everyday reality); transcendence of time and space, deeply-felt positive mood (joy, peace, love); paradoxicality and ineffability (claim of difficulty in describing the experience in words). Data on each domain scale were expressed as a percentage of the maximum possible score. As in previous studies (Pahnke 1969; Griffiths et al. 2006), criteria for designating a volunteer as having had a "complete" mystical experience were that scores on each of the following six scales had to be at least 60%: unity (either internal or external, whichever was greater), sense of sacredness, noetic quality, transcendence of time and space; positive mood; and ineffability. A mean total score was calculated as a mean of all items from the preceding six scales. The remaining 57 items in the States of Consciousness Questionnaire served as distracter items.

Mysticism Scale (Experience-specific) - This 32-item questionnaire, which assesses primary mystical experiences, has been extensively studied and shows cross-cultural reliability (Hood et al. 2001, 2009) and has previously been shown sensitive to psilocybin (Griffiths et al. 2006). A total score and three empirically-derived factors are measured: Interpretation (corresponding to three mystical dimensions: noetic quality, sacredness, and deeply felt positive mood); Introvertive Mysticism (corresponding to the mystical dimensions of internal unity, transcendence of time and space, and ineffability); Extrovertive Mysticism (corresponding to the dimension of the unity of all things/all things are alive). Items were rated on a 9-point scale (Griffiths et al. 2006). For this experience-specific version of the questionnaire used 7 hours after drug administration, participants were instructed to complete the questionnaire with reference to their experiences since they received the capsule that morning.

Persisting effects assessed one month after sessions

At 3 to 4 weeks after each session, and before any additional session, participants returned to the research facility and completed a series of questionnaires to assess possible changes in various standardized measures of personality, mood, and spirituality (not included in this report) as well as possible persisting changes in attitudes, mood, behavior, and spirituality. Participants typically completed these questionnaires in about 75 minutes.

Persisting Effects Questionnaire - This 143-item questionnaire sought information about changes in attitudes, moods, behavior, and spiritual experience that, on the basis of prior research (Pahnke 1969; Doblin 1991, Griffiths et al. 2006), would be sensitive to the effects of psilocybin a month after the session. One hundred forty of the items were rated on a 6-point scale (0=none, not at all; 1=so slight cannot decide; 2=slight; 3=moderate; 4=strong; 5=extreme, more than ever before in your life and stronger than 4). Within the questionnaire, the items were labeled in six categories: Attitudes about life (13 positive and 13 negative items); Attitudes about self (11 positive and 11 negative items); Mood Changes (9 positive and 9 negative items); Relationships (9 positive and 9 negative items); Behavioral changes (1 positive and 1 negative item); Spirituality (22 positive and 21 negative items). The positive and negative items were intermixed within each category. For purposes of scoring the resulting 12 scales (positive and negative scales for each of 6 categories) scores were expressed as the percentage of the maximum possible score. The version of the questionnaire used (available from the authors upon request) was an expanded version of that described by Griffiths et al. 2006. Scale scores on the original and the expanded version were highly correlated (.958-.997) on scales showing reasonable variability. Scales measuring negative effects did not have enough responses and therefore did not have enough variability for these calculations to be meaningful.

The questionnaire included three additional questions (see Griffiths et al. 2006 for more specific wording):
1) How personally meaningful was the experience? (rated from 1-8, with 1=no more than routine, everyday experiences; 7=among the 5 most meaningful experiences of my life; and 8=the single most meaningful experience of my life).
2) Indicate the degree to which the experience was spiritually significant to you? (rated from 1 to 6, with

1=not at all; 5=among the 5 most spiritually significant experiences of my life; 6=the single most spiritually significant experience of my life).
3) Do you believe that the experience and your contemplation of that experience have led to change in your current sense of personal well-being or life satisfaction? (rated from +3=Increased very much; 0=No change; -3=Decreased very much).

Retrospective persisting effects assessed at 14-month follow-up

At 14 months after the last session, participants completed a Retrospective Questionnaire and an open-ended clinical interview reflecting on study experiences and current life situation. For purposes of completing the Retrospective Questionnaire, volunteers were reminded that over the 5 sessions they had received 4 different doses of psilocybin. They were then informed on which two sessions they had received the two highest doses of psilocybin, although they were not informed which of the two was the highest dose. One hundred forty-three items comprised the previously described Persisting Effects Questionnaire. For these items, volunteers were asked to rate any current persisting effects that they attribute to the experiences during either or both the two highest dose sessions.

Volunteers were also asked to provide written descriptions about the session experiences, including how their behavior changed in response to the experiences. Forty-three items on this questionnaire were the previously described mystical experience items from the States of Consciousness Questionnaire, which were completed twice - looking back separately on each of the two sessions associated with the two highest doses. In four final questions, participants were asked, of all five sessions, which session was associated with the strongest effect, which was most personally meaningful, which was most spiritually significant, and which would they chose to repeat if they had the opportunity to do so.

Longitudinal measures assessed at baseline, after session 5, and at 14-month follow-up

More than a dozen longitudinal measures were assessed at screening or shortly after enrollment, after sessions, and at the 14-month follow-up. The results from most of these measures will be combined with results from a previous study (Griffiths et al. 2006) and reported separately. Three measures are reported here.

Mysticism Scale (Lifetime) - Participants were instructed to complete this previously described questionnaire with reference to their lifetime experience.

Death Transcendence Scale - The 26-item Death Transcendence Scale (Hood and Morris, 1983; VandeCreek, 1999) was administered because a potentially important clinical application of psilocybin is in treatment of individuals who are anxious or depressed in response to terminal illness (Grob et al. 2011). Items were rated on a 9-point scale and five subscales were scored: Mysticism, Religious, Nature, Creative, and Biosocial.

Community Observer Ratings of Changes in Participants' Behavior and Attitudes - This previously described measure was shown sensitive to psilocybin 2 months after a high dose session (Griffiths et. al., 2006). After acceptance into the study, each participant designated as raters three adults who were expected to have continuing contact with the participant (e.g. family members, friends, or colleagues at work). Ratings were conducted via a structured telephone interview approximately 1 week after the participant had been accepted into the study, 3 to 4 weeks after the last session, and as part of the 14-month follow-up. The interviewer provided no information to the rater about the participant. The structured interview consisted of asking the rater to rate the volunteer's behavior and attitudes using a 10 point scale (from 1=not at all, to 10=extremely) on eleven items: inner peace; patience; good-natured humor/playfulness; mental flexibility; optimism; anxiety; interpersonal perceptiveness and caring; negative expression of anger; compassion/social concern; expression of positive emotions (e.g. joy, love, appreciation); and self-confidence. On the first rating occasion, which occurred soon after acceptance into the study, raters were instructed to base their ratings on observations of and conversations with the participant over the past 3 months. On subsequent assessments, raters were told their previous ratings and were instructed to rate the participant based on interactions over the last several weeks. Data from each interview with each rater were calculated as a total score, with anxiety and anger scored negatively. Changes in each participant's behavior and attitudes after drug sessions were expressed as a mean change score (i.e. difference score) from the baseline rating across the raters. Rating completion rate was 96%; seven ratings were missed due to a failure to return calls or to the rater not having contact with the volunteer over the rating period.

Post-study monitor ratings of enduring effects in participants

At the conclusion of the study, the primary and assistant monitor for each volunteer were asked to assess any enduring changes in the volunteer's attitudes and behaviors that the monitor believed resulted directly or indirectly from the psilocybin session experiences in the study. Three ratings were done on a 7-point scale (-3=decreased very much; 0=No change; +3=increased very much): 1. Change in volunteer's sense of personal well-being or life satisfaction; 2. Change in quality of volunteer's social relationships (e.g. spouse, family, friends and acquaintances); and 3. Change in the volunteer's sense of spirituality, broadly construed. Score for each volunteer was the mean of the primary and assistant guide ratings for each question.

Data Analyses

Cardiovascular and Monitor Ratings assessed throughout the session - Two sets of analyses were conducted. For the time-course data, Planned Comparisons were conducted comparing the effect of each of the active psilocybin doses with 0 mg/70 kg at each time-point. For the second set of analyses, for each participant, peak scores during the time-course were defined as the maximum value from pre-capsule to 6 hr post-capsule, and temporal measures (e.g. minutes talking or sleeping) were summed across the 8 post-capsule time-points. A repeated measures regression model with AR(1) covariance structure was used with Dose (0, 5, 10, 20, 30 mg/70 kg), Time (10 min before and 0.5, 1, 1.5, 2, 3, 4, 5, and 6 hr after capsule administration), Dose Sequence (ascending vs. descending), and interactions among these as the effects in the model. Fisher's LSD post-hoc tests were used to compare the drug conditions. Two of the seven assistant guides were not blind to the ascending/descending nature of the experimental design, so the analysis described above was repeated excluding ratings from these two monitors. Because there were no differences in the statistical significance of Sequence or Sequence interactions and only minor other differences occurred, the data presented are from all monitor ratings.

Measures assessed 7 hours after drug administration and measures assessed one month after sessions - For the hallucinogen-sensitive questionnaires and the mystical experience questionnaires assessed 7 hours after sessions and for the Persisting Effects Questionnaire assessed one month after sessions, a repeated measures regression was used with Dose (0, 5, 10, 20, 30 mg/70 kg) and Dose Sequence (ascending vs. descending) and their interaction as effects in the model. Fisher's LSD post-hoc tests were used to compare the drug conditions. For analysis of dichotomous responses across the five drug conditions for measures shown in Table 5 (Persisting Effects Questionnaire), Cochran's Q, a non-parametric, binary repeated measures test, was conducted with a factor of Dose (0, 5, 10, 20, 30 mg/70 kg). Planned comparisons for these data were conducted using Wald chi square tests to compare active doses to 0 mg/70 kg.

Retrospective persisting effects assessed at 14 month follow-up - For analysis of the eight scales from the mystical experience items of the States of Consciousness Questionnaire, a repeated measures regression was used with Condition (7 hours after 0 mg/ 70 kg; 7 hours after 30 mg/70 kg; and 14 month retrospective for 30 mg/70 kg), Dose Sequence, and their interaction as effects in the model. Fisher's LSD post-hoc tests were used to compare the conditions. For analysis of dichotomous responses across three sets of conditions (1 month after 0 mg/70 kg; combined data for 1 month follow-ups after both the 20 and 30 mg/70 kg dose sessions; 14 month follow-up data for retrospective rating for either or both the 20 and/or 30 mg/70 kg dose sessions), Cochran's Q was conducted with a factor of Condition (the three conditions described above). Planned comparisons were conducted using Wald chi square tests to compare the three conditions.

Longitudinal measures assessed at screening, after session 5, and at 14-month follow-up - For analysis of the measures of mystical experience, of death transcendence, and of community observer ratings of changes in participants' behavior and attitudes assessed at screening, 1 month after session 5, and at 14-

month follow-up, a repeated measures regression was used with Time (screening, after session 5, and 14-month follow-up) and Dose Sequence and their interaction as effects in the model. Planned comparisons were used to compare screening values with the two post-drug time points. For all statistical analysis, results were considered significant at $p < .05$.

Results

Integrity of blinding procedures

At the conclusion of the study, the primary and assistant guides completed a questionnaire that asked about their understanding of the experimental design. None of the three primary guides or the five assistant guides who were blind the ascending or descending nature of the doses sequences guessed or reported awareness of this aspect of the study procedures.

Cardiovascular measures and monitor ratings assessed throughout the session

Psilocybin produced significant and orderly dose- and time-related effects on cardiovascular measures and monitor ratings assessed throughout the session. At the two highest doses (20 and 30 mg/70kg), onset of significant effects generally occurred at the 30- or 60-minute assessment, with effects usually peaking from 90 to 180 minutes and decreasing toward predrug levels over the remainder of the session (see Figure 1 for illustrative measures). Table 1 shows the mean effects at each dose for these measures. For measures sensitive to psilocybin, effects were generally a monotonically increasing function of dose. For most measures, the 5 mg/70 kg dose was significantly greater than placebo and the 20 and/or 30 mg/70 kg dose(s) were significantly greater than the lower active doses. There were no significant Sequence or Dose x Sequence interactions. The blood pressures of the four volunteers who had the highest pressures 60 minutes or longer after the 30 mg/70 kg psilocybin were: 187/84, 166/64, 182/88, and 178/95 mmHg. These pressures were considered high enough to warrant further repeated blood pressure assessment, however they were not judged to be of sufficient magnitude to necessitate pharmacological treatment.

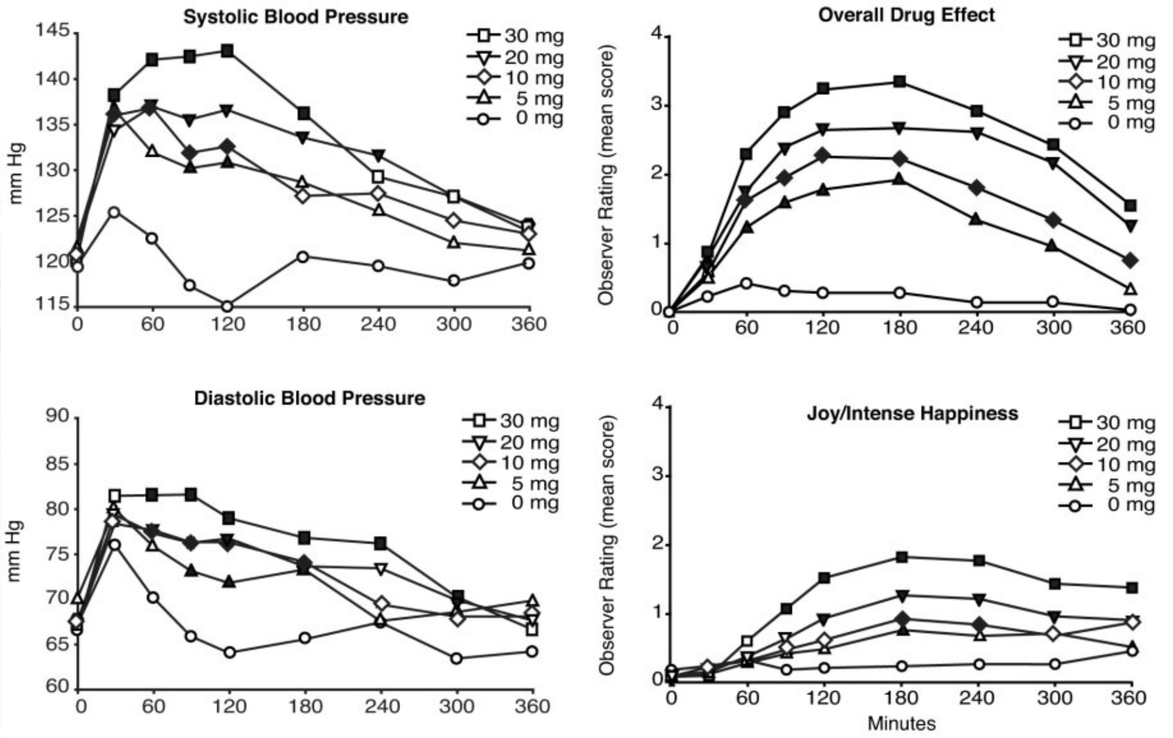


Fig. 1. Within session time-course of psilocybin. Systolic and diastolic blood pressure and monitor ratings of overall drug effect, and joy/intense happiness as a function of time since capsule ingestion (time 0 = before drug administration). Data points are means; filled data points indicate a significant difference from 0 mg/70 kg at the indicated time point (Planned Comparisons).

Drug effect and mysticism measures assessed 7 hours after drug administration

Subjective effects questionnaires - The three questionnaires developed for sensitivity to the subjective effects of hallucinogens showed orderly dose-related increases (Table 2). All six scales of the Hallucinogen Rating Scale, all three scales on the APZ Questionnaire, and the A and LSD scales of the ARCI showed significant and monotonically increasing effects as a function of dose, with significant effects on most measures at even the lowest dose of 5 mg/70 kg. These effects, which are typical of hallucinogens, include perceptual changes (e.g. visual pseudo-hallucinations, illusions, and/or synesthesias), labile moods (e.g. feelings of transcendence, grief, joy, and/or anxiety), and cognitive changes (e.g. sense of meaning, insight, and/or ideas of reference). There were no significant Sequence or Sequence x Dose interactions.

Table 2. Volunteer ratings on three subjective effects questionnaires completed 7 hours after drug administration.*

Questionnaire and Subscale Description	Psilocybin Dose (mg/70kg)				
	0	5	10	20	30
Hallucinogen Rating Scale					
Intensity	0.94 (0.17)	**1.85 (0.15)**^{a}	**2.50 (0.14)**^{b}	**2.64 (0.15)**^{b}	**2.69 (0.13)**^{b}
Somaesthesia	0.35 (0.07)	**1.32 (0.14)**^{a}	**1.56 (0.16)**^{a}	**1.91 (0.17)**^{b}	**2.12 (0.15)**^{b}
Affect	0.93 (0.11)	**1.48 (0.16)**^{a}	**1.76 (0.16)**$^{a.b}$	**1.95 (0.14)**^{b,c}	**2.16 (0.16)**^{c}
Perception	0.23 (0.07)	**1.14 (0.16)**^{a}	**1.38 (0.18)**^{a}	**1.72 (0.17)**^{b}	**2.09 (0.20)**^{c}
Cognition	0.70 (0.14)	**1.33 (0.20)**^{a}	**1.63 (0.18)**^{a}	**2.08 (0.19)**^{b}	**2.26 (0.22)**^{b}
Volition	1.04 (0.08)	**1.52 (0.12)**^{a}	**1.69 (0.11)**^{a,b}	**1.79 (0.12)**^{b}	**1.81 (0.16)**^{b}
APZ Questionnaire					
OSE (oceanic boundlessness)	2.67 (0.56)	**5.72 (0.76)**^{a}	**5.89 (0.76)**^{a,c}	**7.22 (0.70)**^{b,c}	**8.33 (0.73)**^{b}
AIA (dread of ego dissolution)	0.50 (0.24)	**2.50 (0.79)**^{a}	**3.11 (0.65)**^{a,c}	**4.17 (0.61)**^{b,c}	**4.89 (0.84)**^{b}
VUS (visionary restructuralization)	1.78 (0.48)	**6.06 (0.82)**^{a}	**7.28 (0.64)**^{a,b}	**7.67 (0.68)**^{b}	**8.44 (0.82)**^{b}
Addiction Research Center Inventory (ARCI)					
PCAG (sedative)	5.28 (0.50)	6.28 (0.87)	7.22 (0.81)	6.78 (0.80)	7.22 (0.96)
BG (amphetamine/self-control)	4.94 (0.36)	4.83 (0.38)	5.56 (0.60)	5.06 (0.55)	4.72 (0.53)
A (amphetamine)	2.78 (0.35)	**4.94 (0.39)**	**5.17 (0.52)**	**4.83 (0.48)**	**5.06 (0.62)**
MBG (euphoria)	5.61 (0.86)	8.11 (1.05)	8.06 (0.84)	7.89 (0.90)	8.28 (1.13)
LSD (hallucinogen/dysphoria)	2.56 (0.29)	**6.06 (0.64)**^{a}	**6.39 (0.64)**^{a,c}	**7.39 (0.65)**^{b,c}	**7.83 (0.57)**^{b}

* Data are mean scores with 1 SEM shown in parentheses (*N*=18); within a row, bold font indicates significant difference from 0 mg/70 kg; for active doses, values not sharing a common letter are significantly different (Fisher's LSD $p<0.05$)

Measures of mystical experience - Also at 7 hours after capsule administration, volunteers completed two questionnaires designed to assess mystical experience (Table 3). The total score and all three empirically-derived factors of the Mysticism Scale and all seven scales on States of Consciousness Questionnaire showed significant and monotonically increasing effects as a function of dose, with significant effects at the 5 mg/70 kg dose. The proportion of volunteers who met *a priori* criteria for having had a "complete" mystical-type experience on the States of Consciousness Questionnaire was also an increasing function of dose: 0, 5.6, 11.1, 44.4, and 55.6% at 0, 5, 10, 20, and 30 mg/70kg, respectively. Overall, 72.2% of volunteers had "complete" mystical experiences at either or both the 20 and 30 mg/70 kg session. Only the Mysticism Scale showed an effect of Sequence or a Dose x Sequence interaction. This effect was largely due to differences in response to placebo. Examination of the position of the placebo condition within the sequence suggested this result was spurious.

Table 3. Volunteer ratings on two mystical experience questionnaires completed 7 hours after drug administration and at 14 month follow-up.*

Questionnaire and Subscale Description	7 Hours after Drug Administration					14 Month Follow-up (30 mg/70 kg)[‡]
	Psilocybin Dose (mg/70 kg)					
	0[†]	5[†]	10[†]	20[†]	30[†]	
States of Consciousness Questionnaire						
Internal unity	15.2 (4.6)	**38.0 (6.7)**^{a}	**44.6 (5.1)**^{a}	**64.4 (6.0)**^{b}	**70.2 (6.2)**^{b}	**76.5 (6.4)**
External unity	12.4 (3.7)	**32.6 (6.0)**^{a}	**35.0 (6.0)**^{a}	**53.3 (5.6)**^{b}	**60.7 (6.7)**^{b}	**63.5 (7.4)**
Sacredness	23.7 (5.5)	**48.7 (6.9)**^{a}	**54.0 (6.4)**^{a}	**71.1 (5.8)**^{b}	**77.1 (6.4)**^{b}	**83.3 (4.7)**
Noetic Quality	19.4 (5.3)	**47.5 (6.7)**^{a}	**54.4 (5.8)**^{a,b}	**65.3 (6.0)**^{b,c}	**70.6 (6.5)**^{c}	**76.9 (6.4)**
Transcendence of time and space	18.3 (4.8)	**40.4 (6.8)**^{a}	**44.4 (5.6)**^{a}	**65.4 (6.2)**^{b}	**78.2 (5.2)**^{c}	**82.6 (5.2)**
Deeply felt positive mood	26.8 (4.7)	**47.6 (5.4)**^{a}	**57.5 (6.3)**^{a,b}	**68.3 (5.5)**^{b,c}	**73.2 (6.5)**^{c}	**77.3 (5.7)**
Ineffability	19.3 (6.0)	**48.4 (6.3)**^{a}	**59.1 (5.8)**^{a}	**73.1 (6.6)**^{b}	**81.3 (6.0)**^{b}	**81.1 (4.6)**
Total	21.0 (4.7)	**45.1 (5.9)**^{a}	**52.0 (5.2)**^{a}	**68.3 (5.0)**^{b}	**75.6 (5.4)**^{b}	**80.1 (4.9)**
Mysticism Scale						
Interpretation	57.1 (6.5)	**83.5 (5.3)**^{a}	**84.1 (5.2)**^{a}	**95.7 (3.7)**^{b}	**99.1 (2.6)**^{b}	**N/A**
Introvertive	54.4 (7.1)	**77.6 (6.2)**^{a}	**79.7 (5.1)**^{a}	**93.0 (3.7)**^{b}	**97.4 (3.4)**^{b}	**N/A**
Extrovertive	30.7 (4.7)	**48.2 (4.7)**^{a}	**49.4 (5.0)**^{a}	**57.1 (3.9)**^{b}	**61.3 (3.8)**^{b}	**N/A**
Total (max score=288)	142.2 (17.7)	**209.2 (15.4)**^{a}	**213.2 (14.4)**^{a}	**245.8 (9.0)**^{b}	**257.9 (8.9)**^{b}	**N/A**

* Data are mean scores with 1 SEM shown in parentheses (N=18); data for the States of Consciousness Questionnaire are expressed as a percentage of the maximum possible score.

[†] Data in these columns show rating data 7 hours after the indicated dose of psilocybin; within the same row for these columns, bold font indicates significant difference from 0 mg/70 kg; for active doses, values not sharing a common letter are significantly different (Fisher's LSD p<0.05).

[‡] For the States of Consciousness Questionnaire, data in this column show ratings of the 30 mg/70 kg session experience at the 14 month follow-up; each value in this column was significantly greater than the value at 0 mg/70 kg after 7 hours (as indicated by bold font) but was not different from the value at 30 mg/kg 1 month (Fisher's LSD p<0.05); 14 month follow-up data were not obtained for the experience-specific version of the Mysticism Scale (indicated by N/A), although data were obtained for the Lifetime version (see text).

Psilocybin-Induced Fear/Anxiety or Delusions

Although volunteers were carefully screened and psychologically prepared, and close interpersonal support was provided during sessions, on questionnaires completed at the end of the session, 39% of participants (7 of 18) had extreme ratings of fear, fear of insanity or feeling trapped at some time during the session. Such episodes occurred in 6 of 7 of these participants after the 30 mg/70 kg dose and in 1 of 7 after the 20 mg/70 kg dose. Monitor ratings of peak anxiety/fear during the session showed dose-rated increases, with each dose producing a significantly higher rating than the lower doses (Table 1). After 30 mg/70 kg, monitor ratings of anxiety/fear across the session showed varying time-courses of onset and duration, with peak effects of anxiety/fear being rated as early as 60 minutes in some participants, but as late as 180 or 240 minutes in others (see Figure 2 for illustrative data). Forty-four percent of participants (8 of 18) reported delusions or paranoid thinking sometime during the session; such episodes occurred in 7 of 8 of these participants after the 30 mg/70 kg dose and in 1 of 7 after 20 mg/70 kg dose. Examples of delusions included the belief that a child or loved one had died during the time of the session, or that the session monitors were malevolently manipulating the participant. Three of 8 volunteers who had such episodes were those who also rated extreme fear or fear of insanity. Inspection of the data indicated that delusions and extreme ratings of fear/anxiety were not differentially affected by dose sequence.

These psychological struggles did not affect the overall rate of having "complete" mystical experiences as rated by volunteers at the end of the session day. Five of seven (71%) of participants reporting extreme fear, insanity or feeling trapped provided data consistent with "complete" mystical experiences, and 4 of 8 (50%) of participants who had delusions or paranoid thinking provided data consistent with "complete" mystical experiences. These rates of "complete" mystical experience are generally similar to the rate for the group as a whole (56%). Although psychological struggles did not affect the overall rate of "complete" mystical experience, it should be noted that neither of the two volunteers who had the most sustained anxiety during the 30 mg/70 kg session (Figure 2, square and circle symbols) had a "complete" mystical experience. In addition to not affecting rate of mystical experience, inspection of the data indicated no consistent relationship between psychological struggle and subsequent ratings of the session as having personal meaning and spiritual significance. No volunteer rated the overall experience as having decreased her or his sense of well-being or life satisfaction.

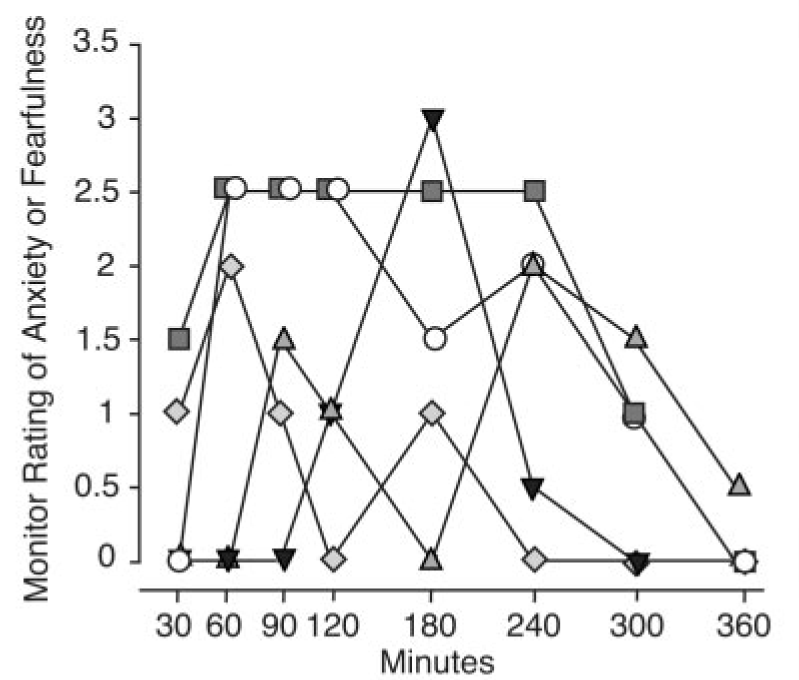


Fig. 2. Time-course of monitor ratings of anxiety or fearfulness after 30 mg/70 kg in the five volunteers whose mean ratings were 2.0 or higher at one or more time point. Data points are mean ratings of the two session monitors. Different symbols represent different volunteers. The figure illustrates the unpredictable time-course of anxiety or fear across the session.

The volunteer who had the most sustained anxiety during the 30 mg/70 kg dose session (Fig. 2, square symbols) provides an interesting case example. Likely as a consequence of the sustained psychological struggle during the session, this volunteer also had the lowest mystical experience rating immediately after the session of all 18 volunteers studied. Immediately after the session, this volunteer, who for decades had held reincarnation as part of her worldview, reported that it was the worst experience of her life and that she would rather spend three lifetimes on a mountaintop meditating than repeat what she had just experienced during the session. Although she considered dropping out of the study after this first session and she remained hesitant to receive psilocybin again, over the next several weeks she increasingly felt that she had learned something useful from the experience. At 1 month, she rated the experience as having slight spiritual significance and as having slightly increased her sense of well-being or life satisfaction. Because she remained curious about the effects of psilocybin, she decided to continue to participate in the study. She received 20 mg/70 kg psilocybin on the second session. In contrast to her first session, her post-session ratings fulfilled criteria for a "complete" mystical experience and, at 1 month, she retrospectively rated this experience as the single most personally meaningful and spiritually significant of her life.

Persisting effects assessed one month after sessions

Persisting Effects Questionnaire - As shown in Table 4, psilocybin produced significant and generally monotonically increasing effects as a function of dose in positive ratings of attitudes about life, attitudes about self, mood, social effects, and behavior. Negative ratings of these same dimensions were very low and did not differ across the doses except for negative attitudes about self that showed small but significant increases at the two lowest doses. Table 4 also shows that ratings of the personal meaningfulness and spiritual significance of the experience, and ratings of well-being or life satisfaction were significant and a monotonic increasing function of dose. Of the persisting effects measures shown in Table 4, all six of the positive subscales (attitudes about life, attitudes about self, mood, altruism, behavior, and spirituality) and one of the three questions (sense of well-being/life satisfaction) showed significant Dose x Dose Sequence interactions. Inspection of these data showed that this effect was primarily due to the ascending dose sequence producing relatively larger effects at the 20 and 30 mg/70 kg doses and relatively smaller effects at lower doses compared to the descending dose sequence. Figure 3 shows this effect for two representative measures: persisting effects on well-being/life satisfaction and on positive mood.

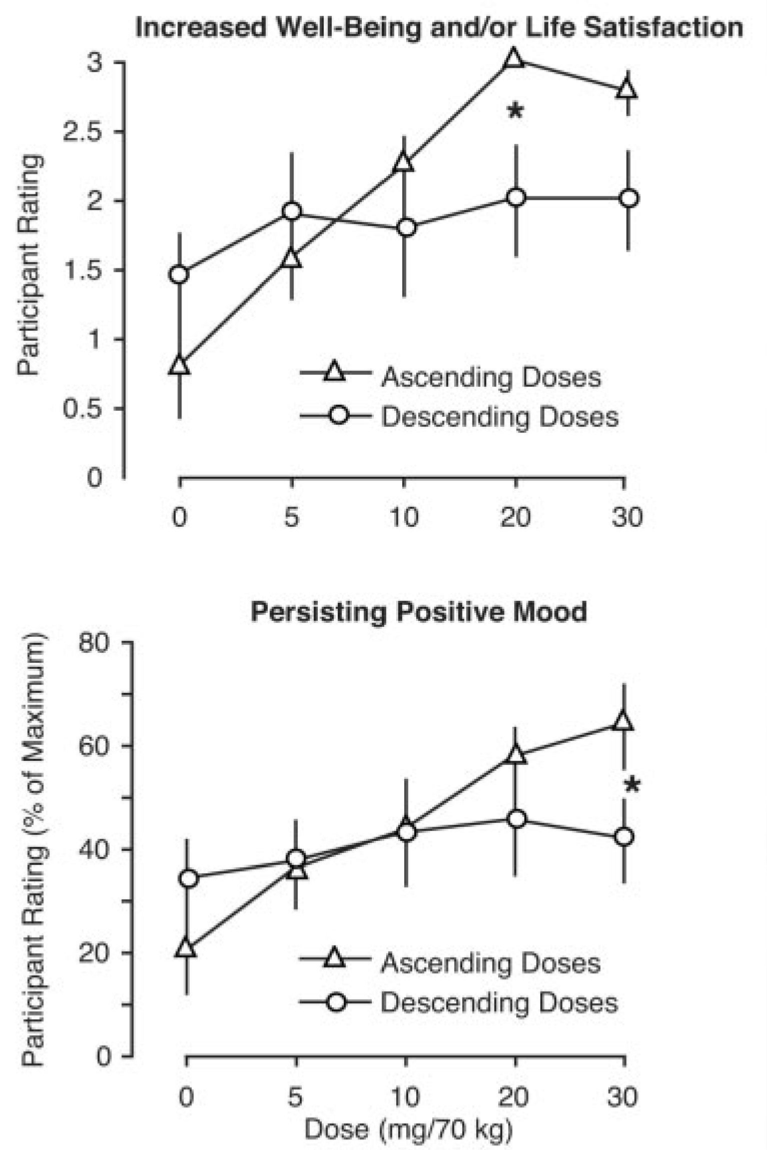


Fig. 3. Effects of dose sequence on ratings of persisting effects of well-being/life satisfaction and positive mood completed one month after sessions. Data points are means and brackets show 1 SEM for participants in the ascending dose sequence (triangles) and the descending dose sequence (circles). Dose x Dose Sequence interactions were significant. Asterisks indicate a significant difference between the ascending and descending dose sequence at the indicated dose (Fisher's LSD post hoc).

Table 5 shows the percentages of volunteers who endorsed specific outcomes on four items on the Persisting Effects Questionnaire. Endorsement increased as a function of dose. Notably, 61% of volunteers considered the psilocybin experience during either or both the 20 and 30 mg/70 kg sessions to have been the single most spiritually significant of their lives, with 83% rating it in their top 5. Consistent with this, 94%, and 89% of volunteers, respectively, indicated that the experiences on those same sessions increased their well-being or life satisfaction and positively changed their behavior at least moderately. Of the 90 total sessions, none were rated as having decreased well-being or life satisfaction.

Retrospective persisting effects assessed at 14-month follow-up

The right-most columns of Tables 3, 4 and 5 show that the retrospective ratings at the 14-month follow-up on the States of Consciousness Questionnaire mystical experience items and on the Persisting Effects Questionnaire were undiminished from ratings obtained 1 month after sessions. No participant rated that their behavior was affected negatively or that their well-being/life satisfaction was decreased as a result of the psilocybin experiences on the two highest dose sessions. The analysis of the States of Consciousness Questionnaire mystical experience items showed significant Condition x Dose Sequence Interactions on Internal Unity, Mood, and Total score. Inspection of these data showed that the ascending dose sequence was associated with relatively larger effects at 30 mg/70 kg both post-session and at 14-month follow-up.

When asked at 14 months which of the five sessions seemed strongest, 83% and 17% of volunteers indicated the session associated with 30 and 20 mg/70 kg, respectively; most personally meaningful (44%, 44%, and 11% at 30, 20, and 10 mg/70 kg, respectively); most spiritually significant (56%, 33%, and 11% at 30, 20, and 10 mg/70 kg, respectively); and which session they would want to repeat if they had an opportunity to do so (67%, 28% and 6% at 30, 20 and 10 mg/70 kg, respectively).

Table 4. Volunteer ratings of persisting effects 1 month and 14 months after sessions.[*]

Questionnaire and Subscale Description	1 Month after Sessions					14 Month Follow-up (20 or 30 mg/70 kg)[‡]
	Psilocybin Dose (mg/70 kg)					
	0[†]	5[†]	10[†]	20[†]	30[†]	
Persisting Effects Questionnaire						
Positive attitudes about life	33.3 (6.6)	**45.9 (5.6)**^{a}	**50.3 (6.6)**^{a}	**62.2 (5.6)**^{b}	**65.9 (5.9)**^{b}	68.8 (4.8)
Negative attitudes about life	0.6 (0.4)	0.8 (0.5)	1.4 (0.6)	0.8 (0.4)	0.6 (0.4)	3.2 (1.3)
Positive attitudes about self	31.9 (6.1)	**44.4 (5.4)**^{a}	**46.5 (6.2)**^{a,c}	**54.2 (5.5)**^{b,c}	**58.9 (6.0)**^{b}	61.1 (5.4)
Negative attitudes about self	0.1 (0.1)	**2.1 (0.6)**^{a}	**1.5 (0.6)**^{a,b}	0.7 (0.5)^{b,c}	1.1 (0.4)^{a,c}	2.3 (0.9)
Positive mood changes	26.8 (5.4)	36.4 (5.1)^{a}	**42.9 (6.2)**^{a,b}	**51.3 (5.8)**^{b}	**52.7 (6.0)**^{b}	55.3 (5.9)
Negative mood changes	0.3 (0.2)	0.4 (0.3)	1.1 (0.7)	0.8 (0.4)	0.2 (0.2)	1.7 (0.8)
Altruistic/positive social effects	28.3 (6.0)	**37.1 (5.3)**^{a}	**42.4 (6.5)**^{a}	**52.0 (5.9)**^{b}	**54.6 (5.7)**^{b}	54.1 (6.5)
Antisocial/negative social effects	0.2 (0.2)	1.3 (0.9)	0.9 (0.7)	1.2 (0.9)	0.8 (0.9)	2.5 (0.9)
Positive behavior changes	35.6 (8.1)	**45.6 (6.4)**^{a}	**58.9 (8.7)**^{a,b}	**57.8 (7.6)**^{a,b}	**71.1 (6.7)**^{b}	68.9 (5.9)
Negative behavior changes	0.0 (0.0)	2.2 (2.3)	2.2 (2.3)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Increased spirituality	31.1 (6.2)	**42.3 (6.7)**^{a}	**48.2 (7.0)**^{a,b}	**57.9 (6.2)**^{b}	**58.3 (5.8)**^{b}	71.6 (6.3)
Decreased spirituality	0.4 (0.3)	0.2 (0.2)	0.6 (0.3)	0.6 (0.4)	0.8 (0.4)	1.1 (0.6)
How personally meaningful was the experience? (max score=8)	3.33 (0.40)	**5.06 (0.36)**^{a}	**5.56 (0.43)**^{a}	**6.67 (0.31)**^{b}	**6.67 (0.34)**^{b}	7.22 (0.22)
How spiritually significant was the experience? (max score=6)	2.72 (0.35)	3.28 (0.27)^{a}	**3.94 (0.32)**^{a,c}	**4.67 (0.31)**^{b,c}	**4.94 (0.33)**^{b}	5.28 (0.23)
Did the experience change your sense of well-being or life satisfaction? (max score=3)	1.11 (0.23)	**1.72 (0.25)**^{a}	**2.0 (0.25)**^{a,c}	**2.5 (0.22)**^{b}	**2.39 (0.21)**^{b,c}	2.39 (0.22)

[*] Data are mean scores with 1 SEM shown in parentheses (*N*=18); data on attitudes, mood, altruistic/social effects, and behavior changes are expressed as percentage of maximum possible score; data for the final three questions are raw scores.

[†] Data in these columns show rating data 1 month after the indicated dose of psilocybin; within the same row for these columns, bold font indicates significant difference from 0 mg/70 kg; for active doses (Fisher's LSD $p<0.05$), values not sharing a common letter are significantly different (Fisher's LSD $p<0.05$)

[‡] Data in this column show ratings at the 14 month follow-up; ratings were completed with respect to experiences during either or both the 20 and 30 mg/70 kg dose sessions (see Methods); no statistical comparison was conducted

Consistent with the flattened dose-effect curve for persisting effects shown in Fig. 3, most volunteers in the ascending dose sequence rated the highest dose session (30 mg/70 kg) as the most personally meaningful (67%) and spiritually significant (78%) of the five sessions; in contrast, a smaller proportion of volunteers in the descending sequence rated the highest dose session as most personally meaningful (22%) and spiritually significant (22%). The mean ± 1 SEM dose of the sessions that were rated as being the most personally meaningful were 25.6 ± 2.6 and 21.1 ± 1.8 in the ascending and descending dose sequence, respectively

(N.S.); similar ratings of spiritual significance were 27.8 ± 2.6 and 21.1 ± 1.5 respectively (*p*<.05, *t*-test).

Table 5. Percentage of volunteers endorsing specific outcomes on four persisting effects items 1 month and 14 months after sessions.*

Questionnaire Items	1 Month after Sessions						14 Month Follow-up (20 or 30 mg/70 kg)**
	Psilocybin Dose (mg/70 kg)						
	0†	5†	10†	20†	30†	20 lub 30‡	
How personally meaningful was the experience?							
Single most meaningful experience of life	0.0	0.0	5.6	16.7	**33.3**	**44.4**	**38.9**
Top 5 most meaningful, including single most	0.0	11.1	**33.3**	**77.8**	**61.1**	**77.8**	**94.4**
How spiritually significant was the experience?							
Single most spiritually significant experience of life	0.0	0.0	5.6	**27.8**	**44.4**	**61.1**	**44.4**
Top 5 most spiritually significant, including single most	11.1	11.1	**44.4**	**66.7**	**77.8**	**83.3**	**94.4**
Did the experience change your sense of well-being or life satisfaction?							
Increased well-being/life satisfaction (very much)	5.6	**27.8**	**38.9**	**72.2**	**55.6**	**77.8**	**61.1**
Increased well-being/life satisfaction (moderately or very much)	38.9	55.6	**72.2**	**83.3**	**88.9**	**94.4**	**83.3**
Your behavior changed in ways you would consider positive since the experience.							
Positive behavioral change (strong or extreme)	22.2	16.7	**50.0**	38.9	**55.6**	**55.6**	**44.4**
Positive behavioral change (moderate, strong or extreme)	33.3	50.0	61.1	61.1	**88.9**	**88.9**	**88.9**

* Data in table show the percentage of volunteers endorsing the specific outcome.

† Data in these columns are the percentage of volunteers endorsing the specific outcome 1 month after the indicated dose of psilocybin; within the same row for these columns, bold font indicates significant difference in pair-wise comparisons to 0 mg/70 kg (Cochran's Q showed *p*<.001 for all variables; planned comparisons performed with Wald test; see Methods for details).

‡ Data in this column are the percentage of volunteers endorsing the specific outcome 1 month after either or both the 20 and 30 mg/70 dose sessions; bold font indicates significant difference in pair-wise comparisons to 0 mg/70 kg (Cochran's Q showed *p*<.05 for all variables; planned comparisons performed with Wald test; see Methods for details).

** Data in this column are the percentage of volunteers at 14 month follow-up endorsing the specific outcome with respect to experiences during either or both the 20 and 30 mg/70 kg dose sessions (see Methods); each value in this column was significantly greater than the value at 0 mg/70 kg (as indicated by bold font) but was not significantly different from the value at 20 or 30 mg/kg at 1 month (Cochran's Q showed *p*<.05 for all variables; planned comparisons performed with Wald test; see Methods for details).

Also at the 14-month follow-up, participants provided written descriptions, based on their memories of their two highest dose sessions, of how they thought their behavior changed in response to those experiences. As summarized in Table 6, only 2 volunteers indicated no positive change in their behavior. The domains of change most frequently cited were better social relationships with family and others, increased physical and psychological self-care, and increased spiritual practice.

Longitudinal measures assessed at baseline, after session 5, and at 14-month follow-up

Longitudinal measures of mystical experience, of death transcendence, and of community observer ratings of changes in participants' behavior and attitudes showed effects generally consistent with the previously described persisting effects. After session 5 and at 14-month follow-up, the total score (as well as each of the three subscales) of the Mysticism Scale (Lifetime) was significantly higher than at screening (217.9 ± 10.8, 264.1 ± 6.8, and 260.4 ± 7.6, means and SEMs for total scores at screening, post-session 5, and 14-month follow-up, respectively)(Planned comparisons, *p*<.0001). The Religious subscale of the Death Transcendence Scale, which assesses a sense of continuity after death, showed similar increases (28.72 ± 1.57, 31.00 ±, 0.99, and 31.28 ± 1.07, means and SEMs for screening, post-session 5, and 14-month follow-up, respectively)(Planned comparisons, *p*<.05). The other subscales were not significant. For the community observer ratings of participants' behavior and attitudes, change scores from those taken about 1 week after study enrollment (means ± SEMs) were significant both after session 5 (8.85 ± 1.64) and at the 14-month follow-up (5.36 ± 1.68)(Planned comparisons, *p*<.001).

Table 6. Self-reported behavior change. Verbatim written comments about the nature of behavioral changes volunteers attributed to either or both the two highest dose psilocybin session experiences in the Retrospective Questionnaire completed at the 14-month follow-up.

Volunteer	Verbatim Comments
201	Virtually eliminated all religious practices; much more spiritual now. Accepting of my parents and have a more open and honest dialogue with them. Less judgmental and more open hearted. Taken a more active role in pursuing what I want for myself.
202	I have an increased commitment to spiritual practices; I think my heart is more open to all interactions with other people; more aware of choices, take time to pause and choose, more breaks; better boundaries at work and personal relationships.
205	I have a stronger desire for devotion, have increased yoga practice and prayer. I have better interaction with close friends and family and with acquaintances and strangers... I feel more certain of my career as an author. I need less food to make me full. My alcohol use has diminished dramatically... I consider myself to be better [at self-care] now than before the study...
206	Feel closer to family and friends. Incorporating Ayurvedic theory into diet and self care. [Also changed her meditation and yoga practice]
207	More regular meditation; more mindful with family; more generous with strangers; started new yoga practice; more relaxation of pace of change.
210	I feel that I relate better in my marriage. There is more empathy - a greater understanding of people and understanding their difficulties and less judgment. Less judging of myself too.
211	I take more time in nature, with art. I feel closer to children and parents. I am more comfortable with friends and acquaintances. I am more committed to my career. I eat better and have taken up dance...
213	Increased time for meditation. I think I'm even warmer towards people and more accepting. I now believe I have something important to tell people about how the universe works. I am slowing learning to give myself a break.
214	[This participant endorsed no specific behavior change, although did report an increased sense of spirituality]
215	I try to judge less and forgive more. I no longer worry about money.
217	More frequent and enjoyable meditation; more desire to connect with loving energy and have loving energy flow through me to others; less willingness to allow manipulative or abusive treatment to happen without my confronting it.
218	A greater integration of the pieces of my life; more spirit less religion; less fear of being wrong.
219	More fulfilling meditation; more appreciation of and openness to others [and] my own emotional reactions.
222	Less concerned with the appearance of "spirituality", while realizing more that everything is sacred. I feel more accommodating and forgiving toward both friends and strangers, and less anxious to label them or convert them to my viewpoint. I am learning to recognize and release old definitions of myself.
223	During my sessions, much was shown to me about letting go of attachment around my son. More and more, sensuality and passion and gratitude continue to unfold and deepen within me.
226	The energy experience stoked my curiosity about the spiritual awakening stimulus of kundalini [spiritual energy] and has opened a new path for me!
228	[This participant endorsed no specific behavior change, although did report a deeper appreciation of positive emotional experience and empathy]
230	I am more aware and accepting [of everyone]. I have a thousand ideas to write about and am making time and space in my life to accommodate them.

Post-study monitor ratings of enduring effects in participants

The post-study monitor ratings of enduring effects in participants were consistent with the participant self-ratings and the community observer ratings of changes in participants' behavior and attitudes. Mean ± SEM of monitor ratings of the volunteers' personal wellbeing/ life satisfaction, quality of social relationships, and sense of spirituality were all in the positive direction (2.33 ± 0.14, 1.64 ± 0.14, and 2.41 ± 0.15, respectively).

Open-ended clinical interview at the 14-month follow-up

An open-ended clinical interview at the 14-month follow-up was conducive to the spontaneous reporting of possible persisting adverse events. There were no reports of bothersome or clinically significant persisting perception phenomena sometimes attributed to hallucinogen use. Likewise, there were no reports of any non-study use of hallucinogens since study enrollment. All 18 volunteers appeared to continue to be psychiatrically healthy, high-functioning, productive members of society.

Discussion

The present study demonstrated orderly dose-related increases in the effects of psilocybin on volunteer and observer ratings of drug effect and on the cardiovascular measures of blood pressure and heart rate. Notably, even the 5 mg/70 kg (71 μg/kg) dose of psilocybin produced significant subjective, physiological, and observer-rated effects. This is the lowest dose of psilocybin demonstrated to produce significant effects. A previous study showed dose-related effects of psilocybin at doses of 45, 115, 215, and 315 μg/kg, however did not show statistically significant effects at the lowest dose (Hasler et al. 2004). Consistent with previous findings, the present study showed orderly time-related observer-rated and cardiovascular effects during the session, with significant effects at the highest doses generally occurring at 30-60 minutes, peaking at 90-180 minutes, and decreasing toward pre-drug levels over the remainder of the session (Griffiths et al. 2006).

The present study extends previous observations showing that psilocybin can occasion mystical-type experiences having sustained personal and spiritual significance (Pahnke 1963; Doblin 1991; Griffiths et al. 2006, 2008). Two volunteer-rated measures of mystical-type experience completed at the end of the session days showed dose-related increases, with 72% of volunteers fulfilling criteria for having had a "complete" mystical experience at either or both of the two highest dose sessions. Retrospective ratings of mystical experience and spiritual significance did not diminish in time. One month after either or both the two highest dose sessions, 83% of participants rated the experience as the single most or among the 5 most spiritually significant experiences of their life. At the 14-month follow-up, this number was even higher (94%). Likewise, at 14 months, retrospective ratings of mystical experience at the highest dose were generally slightly higher than at the 1-month rating time. Finally, longitudinal measures of lifetime mystical experience and of death transcendence (Religious subscale) were significantly increased over screening levels at both one month and 14 months after the final session. The significant increase in the Religious subscale of the Death Transcendence Scale is notable in this group of healthy volunteers because questions in this subscale assess a sense of continuity after death (e.g. Death is a transition to something even greater than this life; Death is never just an ending, but a part of a process). This effect may be relevant to the proposed palliative effects of psilocybin and similar hallucinogens in treating existential anxiety in terminal illness (Kast 1967; Richards et al. 1972; Grob et al. 2011).

The present study also extends previous observations indicating that psilocybin can occasion persisting positive changes in attitudes, mood, life satisfaction, behavior, and altruism/social effects (Griffiths et al. 2006, 2008). All of these domains showed dose-related increases one month after sessions, with effects at the highest doses sustained at the 14-month follow-up. One month after sessions at either or both the two highest dose sessions, 94% of volunteers endorsed that the experience increased their sense of well-being or life satisfaction moderately or very much, and 89% rated moderate or higher changes in positive behavior. At the 14-month follow-up, these ratings remained high. The types of behavior change most frequently cited by volunteers were better social relationships with family and others, increased physical and psychological self-care, and increased spiritual practice (Table 6). Ratings by community observers before and after the study as well as ratings by study monitors after the study were consistent with the persisting positive changes in behavior and attitudes claimed by the volunteers. The persisting positive changes, particularly in attitudes, mood, and life satisfaction, occasioned by psilocybin appear similar in kind and breadth to the enduring changes reported in case studies of individuals who have had spontaneously-occurring mystical- or insightful-types of experiences (Miller and C' de Baca, 2001).

A novel aspect of the present study was that it compared effects in volunteers who received the four active psilocybin doses in either an ascending or a descending dose sequence. Although the acute measures of psilocybin effects were not affected by the dose sequence, volunteer-rated positive changes in attitudes and behavior assessed 1 month after each session showed Dose x Dose Sequence interactions reflecting relatively larger effects at the highest psilocybin doses than the lower doses in the ascending dose sequence compared to the descending sequence (Figure 2). Analogous differences occurred at the 14-month follow-up assessment on the mystical experience items of the States of Consciousness Questionnaire and on retrospective ratings of the personal meaning and spiritual significance associated with various session doses. Overall, these findings suggest that the ascending dose sequence is somewhat more likely than the descending sequence to produce long-lasting positive changes in attitudes, behavior, and remembered mystical-type experiences. Thus it appears that having experience with lower doses facilitates the likelihood of having sustained positive effects after a high dose of psilocybin. The biological or psychological mechanisms underlying this effect are unknown. This finding suggesting an advantage of an ascending dose sequence may have clinical application in the design of therapeutic studies of psilocybin (Griffiths and Grob, 2010; Grob et al. 2011). It is noteworthy, however, that this finding is contrary to some older recommendations of psychotherapists who administered classic hallucinogens. Specifically, in one report (Blewett and Chwelos, 1959) psychotherapists inferred from their clinical experience that a single high-dose overwhelming experience was more therapeutic than an approach that began with a small doses and gradually increased the dose over successive experiences.

Also of relevance to the design of future research trials with psilocybin, the present study provides information about the relative likelihood of different doses of psilocybin to occasion acute adverse subjective effects as well as mystical-type effects having persisting positive effects. The acute anxiety/fear-producing effects of psilocybin, as assessed by monitor and volunteer ratings, increased with increasing doses. Thirty-nine percent of volunteers reported extreme fear, fear of insanity, or feeling trapped sometime during the session (0 at placebo or the two lower doses, 1 at 20 mg/70 kg, and 6 at 30 mg/70 kg). Furthermore, 44% of volunteers reported delusions or paranoid thinking sometime during the session (0 at placebo and the two lower doses, 1 at 20 mg/70 kg, and 7 at 30 mg/70 kg). In the present study, such negative effects were well managed with reassurance in the highly supportive setting. Interestingly, these psychological struggles did not generally affect rates of having "complete" mystical experiences, possibly because the negative feelings were most often of short duration. However, under conditions in which volunteers are less well screened and psychologically prepared, or sessions are not as well supervised, there could be a possibility that extreme anxiety and/or delusion could be prolonged and result in dangerous behavior. Under such conditions, administration of doses higher than about 20 mg/70 would be inadvisable. The unpredictable time-course across the session of anxiety or fear (Fig.2) underscores the importance that session monitors remain vigilant throughout the session.

Furthermore, the unpredictable time-course of anxiety, in combination with the finding that even experienced session monitors cannot rate with high reliability whether or not psilocybin has been administered (Griffiths *et al.*, 2006), suggests the potential risk of the recommendation by some psychotherapists that a "booster" dose of a classic hallucinogen should be administered relatively shortly after the initial dose if the effects are less than expected (Blewett and Chwelos, 1959; Stolaroff 1997).

In a therapeutic or other research trial, the possibility of such potentially adverse effects should be considered in relationship to the potential persisting positive effects. The proportion of volunteers having "complete" mystical-type experiences, which likely mediate persisting positive effects (Richards et al. 1977; Griffiths et al. 2008), as well as the persisting positive effects (Table 4 and 5) were generally an increasing function of dose, with the percentage change from 20 to 30 mg/70 kg varying widely (-23% to a +99%), with a mean of +17%. However, endorsement of having had a "complete" mystical experience, or of having had the single most spiritually significant experience of his/her life increased 25% and 60%, respectively from 20 to 30 mg/70 kg. Likewise, endorsement of moderate to extreme positive behavioral change, which may be the most relevant outcome measure in some therapeutic trials, increased 45% from 20 to 30 mg/70 kg. Thus, in addition to considering the extent of screening and support provided to volunteers, the decision to administer psilocybin doses higher than about 20 mg/70 kg should be made on the basis of the type of outcome desired.

The present study provided no evidence of adverse effects of high dose psilocybin exposure other than the episodes of psychological struggle during some portion of the time of psilocybin action. This should not be interpreted to suggest that casual use of high dose psilocybin is safe. It is important to recognize that the present study was conducted in carefully screened volunteers who received ample preparation before sessions, were closely monitored during sessions, and had some continuing contact with study staff after sessions (see Johnson *et al.*, 2008 for detailed safety guidelines for minimizing risks of high dose hallucinogen exposure in human research). The reported potential risks of hallucinogen exposure include: (1) panic or fear reactions resulting in dangerous behavior during the time of drug action; (2) precipitation or exacerbation of enduring psychiatric conditions; (3) long-lasting perceptual disturbances and (4) development of an abusive pattern of hallucinogen use (Abraham, *et al.*, 1996; Halpern and Pope, 1999; Johnson, *et al.*, 2008).

The generalizability of the results of the present study is limited by the study population, a group of hallucinogen-naïve, well-educated, psychologically stable, mostly middle-aged adults, most of whom reported at least weekly participation in religious or spiritual activity. It would be particularly interesting to determine whether volunteers who identified as atheist or agnostic would be as likely to have mystical-type experiences and whether they would ascribe spiritual significance to such experiences. It would also be interesting to compare hallucinogen-naïve volunteers with past users to provide information about whether the novelty of effects in naïve volunteers contributes to the high persisting ratings of personal meaning and spiritual significances.

Overall, the present study shows that psilocybin can dose-dependently occasion mystical-type experiences having persisting positive effects on attitudes, mood, and behavior. The observations that episodes of extreme fear, feeling trapped, or delusions occur at the highest dose in almost 40% of volunteers, that anxiety and fear have an unpredictable time-course across the session, and that an ascending sequence of dose exposure may be associated with long-lasting positive changes have implications for the design of therapeutic trials with psilocybin. Considering the rarity of spontaneous mystical experiences in the general population, the finding that more than 70% of volunteers in the current study had "complete" mystical experiences suggests that most people have the capacity for such experiences under appropriate conditions and, therefore, such experiences are biologically normal.

Acknowledgments

Conduct of this research was supported by grants from the Council on Spiritual Practices, the Heffter Research Institute, and the Betsy Gordon Foundation. Effort for Roland Griffiths, Ph.D. in writing this paper was partially provided by NIH grant RO1DA03889. We thank David Nichols, Ph.D. for synthesizing the psilocybin, Mary Cosimano, M.S.W. for her role as a primary session monitor, Maggie Klinedinst for data management, and Linda Felch M.A. and Paul Nuzzo, M.A. for statistical analyses. We also thank Larry Carter, Ph.D., Ryan Lanier, Ph.D., Benjamin McKay, Chad Ressig, Ph.D., and Ryan Vandrey, Ph.D. for serving as assistant session monitors. The study was conducted in compliance with United States laws.

References

1. Abraham HD, Aldridge AM, Gogia P (1996) The psychopharmacology of hallucinogens. Neuropsychopharmacology 14:285-298.
2. Blewett DB., Chwelos N (1959) Handbook for the therapeutic use of lysergic acid diethylamide-25: individual and group procedures. Available at http://www.erowid.org/psychoactives/ guides/handbook_lsd25.shtml#11. Accessed January 4, 2011
3. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. Pharmacopsychiatry 31(Suppl 2):80-84
4. Doblin R (1991) Pahnke's Good Friday experiment: a long-term follow-up and methodological critique. J Transpers Psychol 23:1-28
5. Glennon RA, Titeler M, McKenney D (1984) Evidence for 5-HT2 involvement in the mechanism of action of hallucinogenic agents. Life Sci 35:2505-2511
6. Griffiths RR, Grob CS (2010) Hallucinogens as medicine. Scientific American 303:77-79
7. Griffiths RR, Richards WA, McCann U, Jesse R (2006) Psilocybin can occasion mystical experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology (Berl) 187:268-283
8. Griffiths RR, Richards WA, Johnson MW, McCann U, Jesse R (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. J Psychopharmacol 22(6):621-632
9. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstadt AL, Greer GR (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch Gen Psychiatry 68(1):71-78
10. Guzman G (2008) Hallucinogenic mushrooms in Mexico: an overview. Econ Bot 62:404-412
11. Haertzen CA (1966) Development of scales based on patterns of drug effects, using the Addiction Research Center Inventory (ARCI). Psychol Rep 18:163-194
12. Halpern JH, Pope HG (1999) Do hallucinogens cause residual neuropsychological toxicity? Drug Alcohol Depend 53:247-256
13. Hasler F, Grimberg U, Benz MA, Huber T, Vollenweider FX (2004) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology (Berl) 172:145-156
14. Hollister LE (1961) Clinical, biochemical and psychologic effects of psilocybin. Arch Int Pharmacodyn Ther 130:42-52
15. Hood RW Jr, Morris RJ (1983) Toward a theory of death transcendence. J Sci Stud Rel 22(4):353-365
16. Hood RW Jr, Ghorbani N, Watson PJ, Ghramaleki AF, Bing MN, Davison HK, Morris RJ, Williamson WP (2001) Dimensions of the mysticism scale: confirming the three-factor structure in the United States and Iran. J Sci Stud Rel 40:691-705
17. Hood RW Jr, Hill PC, Spilka B (2009) The psychology of religion: an empirical approach, 4th edn. Guilford, New York
18. Isbell H (1959) Comparison of the reactions induced by psilocybin and LSD-25 in man. Psychopharmacologia 1:29-38
19. Jasinski DR (1977) Assessment of the abuse potential of morphine-like drugs (methods used in man). In: Martin WR (ed) Drug addiction. Springer, New York, pp 197-258
20. Johnson MW, Richards WA, Griffiths RR (2008) Human hallucinogen research: guidelines for safety. J Psychopharmacol 22(6):603-620
21. Kast E (1967) Attenuation of anticipation: a therapeutic use of lysergic acid diethylamide. Psychiatr Q 41:646-657
22. Leary T, Litwin GH, Metzner R (1963) Reactions to psilocybin administered in a supportive environment. J Nerv Ment Dis

137:561-573

23. Malitz S, Esecover H, Wilkens B, Hoch PH (1960) Some observations on psilocybin, a new hallucinogen, in volunteer subjects. Compr Psychiatry 1:8-17
24. Martin WR, Sloan JW, Sapira JD, Jasinski DR (1971) Physiologic, subjective, and behavioral effects of amphetamine, methamphet-amine, ephedrine, phenmetrazine, and methylphenidate in man. Clin Pharmacol Ther 12:245-258
25. Metzner R (2004) Teonanacatl: sacred mushroom of visions. Four Tree, El Verano
26. Metzner R, Litwin G, Weil G (1965) The relation of expectation and mood to psilocybin reactions: a questionnaire study. Psychedelic Rev 5:3-39
27. Miller WR, C'de Baca J (2001) Quantum change: when epiphanies and sudden insights transform ordinary lives. Guilford, New York
28. Nichols DE (2004) Hallucinogens. Pharmacol Ther 101:131-181
29. Pahnke W (1963) Drugs and mysticism: an analysis ofthe relationship between psychedelic drugs and the mystical consciousness. Thesis presented to the President and Fellows of Harvard University for the Ph.D. in Religion and Society
30. Pahnke WN (1969) Psychedelic drugs and mystical experience. Int Psychiatry Clin 5:149-162
31. Richards WA, Grof S, Goodman LE, Kurland AA (1972) LSD-assisted psychotherapy and the human encounter with death. J Transpers Psychol 4(2):121-150
32. Richards WA, Rhead JC, DiLeo FB, Yensen R, Kurland AA (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. J Psychedelic Drugs 9:1-10
33. Rinkel M, Atwell CR, Dimascio A, Brown J (1960) Experimental psychiatry. V. Psilocybine, a new psychotogenic drug. N Engl J Med 262:295-297
34. Rosenberg DE, Isbell H, Miner EJ, Logan CR (1964) The effect of N, N-dimethyltryptamine in human subjects tolerant to lysergic acid diethylamide. Psychopharmacologia 5:217-227
35. Stamets P (1996) Psilocybin mushrooms of the world: an identification guide. Ten Speed, Berkeley
36. Stolaroff MJ (1997) The secret chief revealed. Multidisciplinary Association for Psychedelic Studies, Sarasota
37. Strassman RJ, Qualls CR, Uhlenhuth EH, Kellner R (1994) Dose-response study of N,N-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry 51:98-108
38. Turek IS, Soskin RA, Kurland AA (1974) Methylenedioxyam-phetamine (MDA) subjective effects. J Psychedelic Drugs 6:7-14
39. VandeCreek L (1999) The death transcendence scale. In: Hill PC, Hood RW Jr (eds) Measures of religiosity. Religious Education Press, Birmingham, pp 442-445
40. Wasson RG (1980) The wondrous mushroom: mycolatry in Mesoamerica. McGraw-Hill, New York
41. Wolbach AB Jr, Miner EJ, Isbell H (1962) Comparison of psilocin with psilocybin, mescaline and LSD-25. Psychopharmacologia 3:219-223

Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance

by

R. R. Griffiths, W. A. Richards, U. McCann, R. Jesse

Received: 20 January 2006 / Accepted: 27 May 2006

original source: http://www.maps.org/images/pdf/books/pahnke/2006_griffiths_22780_1.pdf
backup source: http://www.psilosophy.info/resources/2006_griffiths_22780_1.pdf

R. R. Griffiths:U. McCann
Department of Psychiatry and Behavioral Sciences,
Johns Hopkins University School of Medicine,
5510 Nathan Shock Drive,
Baltimore, MD 21224-6823, USA
e-mail: rgriff@jhmi.edu

R. R. Griffiths
Department of Neuroscience,
Johns Hopkins University School of Medicine,
5510 Nathan Shock Drive,
Baltimore, MD 21224-6823, USA

W. A. Richards
Johns Hopkins Bayview Medical Center,
2516 Talbot Road,
Baltimore, MD 21216-2032, USA

W. A. Richards:R. Jesse
Council on Spiritual Practices,
Box 460220, San Francisco, CA 94146-0220, USA

Electronic Supplementary Material Supplementary material is available for this article at http://dx.doi.org/10.1007/s00213-006-0457-5 and is accessible for authorized users.

Table of Contents:

Abstract
Introduction
Materials and methods
Participants
Study design
Drug conditions
Meetings with monitor before and after sessions
Drug sessions
Expectancy
Instructions to participants and monitors
Measures assessed throughout the session
Blood pressure and heart rate
Monitor rating questionnaire
Measures assessed 7 h after drug administration
Hallucinogen rating scale
APZ
Addiction research center inventory (ARCI)
States of consciousness questionnaire
Mysticism scale
Measures assessed 2 months post-session
Persisting Effects Questionnaire
Mysticism Scale-Lifetime
Spiritual Transcendence Scale
NEO Personality Inventory (NEO PI-R)
PANAS-X (Positive and Negative Affect Schedule Expanded Form)
Community observer ratings of changes in participants' behavior and attitudes
Data analyses
Physiological and monitor rating questionnaire assessed throughout the session
Measures assessed 7 h after drug administration (data analysis)
Measures assessed 2 months post-session (data analysis)
Results
Integrity of blinding procedures
Blood pressure, heart rate, and monitor ratings throughout the session
Drug effect and mysticism measures assessed 7 h after drug administration
Hallucinogen-sensitive questionnaires
Measures of mystical experience
Measures assessed 2 months post-sessions
Persisting Effects Questionnaire (2 months post-sessions)
Personality and affect
Lifetime assessment of mystical experience and spirituality
Community observer ratings of changes in participants' and behavior and attitudes
Fear, anxiety/dysphoria, and ideas of reference/paranoia
Discussion
Acknowledgements
References

Abstract

Rationale Although psilocybin has been used for centuries for religious purposes, little is known scientifically about its acute and persisting effects.

Objectives This double-blind study evaluated the acute and longer-term psychological effects of a high dose of psilocybin relative to a comparison compound administered under comfortable, supportive conditions.

Materials and methods The participants were hallucinogen-naïve adults reporting regular participation in religious or spiritual activities. Two or three sessions were conducted at 2-month intervals. Thirty volunteers received orally administered psilocybin (30 mg/70 kg) and methylphenidate hydrochloride (40 mg/70 kg) in counterbalanced order. To obscure the study design, six additional volunteers received methylphenidate in the first two sessions and unblinded psilocybin in a third session. The 8-h sessions were conducted individually. Volunteers were encouraged to close their eyes and direct their attention inward. Study monitors rated volunteers' behavior during sessions. Volunteers completed questionnaires assessing drug effects and mystical experience immediately after and 2 months after sessions. Community observers rated changes in the volunteer's attitudes and behavior.

Results Psilocybin produced a range of acute perceptual changes, subjective experiences, and labile moods including anxiety. Psilocybin also increased measures of mystical experience. At 2 months, the volunteers rated the psilocybin experience as having substantial personal meaning and spiritual significance and attributed to the experience sustained positive changes in attitudes and behavior consistent with changes rated by community observers.

Conclusions When administered under supportive conditions, psilocybin occasioned experiences similar to spontaneously occurring mystical experiences. The ability to occasion such experiences prospectively will allow rigorous scientific investigations of their causes and consequences.

Keywords Psilocybin, Methylphenidate, Hallucinogen, Entheogen, Mystical, experience, Spiritual, Religion, Anxiety, Humans

Introduction

Psilocybin, a naturally occurring tryptamine alkaloid with actions mediated primarily at serotonin 5-HT$_{2A/C}$ receptor sites, is the principal psychoactive component of a genus of mushrooms (*Psilocybe*) (Presti and Nichols 2004). Psilocybin, in the form of these mushrooms, has been used for centuries, possibly millennia, within some cultures in structured manners for divinatory or religious purposes (Wasson 1980; Stamets 1996; Metzner 2004). The psychological effects of psilocybin, which are similar to other classical serotonergically mediated hallucinogens [lysergic acid diethylamide (LSD), mescaline, and *N*,*N*-dimethyltryptamine (DMT)], include significant alterations in perceptual, cognitive, affective, volitional, and somatesthetic functions, including visual and auditory sensory changes, difficulty in thinking, mood fluctuations, and dissociative phenomena (Isbell 1959; Wolbach *et al*. 1962; Rosenberg *et al*. 1964).

Early clinical research with psilocybin in the 1950s and early 1960s attempted to study the effects of psilocybin without recognition of the powerful influences of set and setting (e.g., Isbell 1959; Hollister 1961; Malitz *et al*. 1960; Rinkel *et al*. 1960). Subsequent research, which included more preparation and interpersonal support during the period of drug action, found fewer adverse psychological effects, such as panic reactions and paranoid episodes, and increased reports of positively valued experiences (Leary *et al*. 1963; Metzner *et al*. 1965; Pahnke 1969). In response to the epidemic of hallucinogen abuse that occurred in the 1960s, clinical research with psilocybin and other hallucinogens largely ceased and has resumed only recently. Notably, Vollenweider and colleagues from Switzerland and Gouzoulis- Mayfrank from Germany have reported a series of studies that have characterized the acute subjective, physiological, and perceptual effects of psilocybin (e.g., Vollenweider *et al*. 1998; Gouzoulis-Mayfrank *et al*. 1999; Hasler *et al*. 2004; Carter *et al*. 2005).

In the present study, we sought to use rigorous double-blind clinical pharmacology methods to evaluate both the acute (7 h) and longer-term (2 months) mood-altering and psychological effects of psilocybin (30 mg/70 kg) relative to an active comparison compound (40 mg/70 kg methylphenidate). The study was conducted with 36 well-educated, hallucinogen-naïve volunteers.

Materials and methods

Participants

The participants were recruited from the local community through flyers announcing a "study of states of consciousness brought about by a naturally occurring psychoactive substance used sacramentally in some cultures." There were 135 individuals screened over the telephone and 54 were further screened in person. The 36 study participants (14 males) were medically and psychiatrically healthy, without histories of hallucinogen use, and without family histories of schizophrenia or other psychotic disorders or bipolar I or II disorder. The participants had an average age of 46 years (range 24 to 64) and were well educated; 97% (35 volunteers) were college graduates and 56% (20 volunteers) had post-graduate degrees. Eighty-three percent (30 volunteers) were employed full time, with the remainder employed part time. Fifty-three percent (19 volunteers) indicated affiliation with a religious or spiritual community, such as a church, synagogue, or meditation group. All 36 volunteers indicated at least intermittent participation in religious or spiritual activities such as religious services, prayer, meditation, church choir, or educational or discussion groups, with 56% (20 volunteers) reporting daily activities and an additional 39% (14 volunteers) reporting at least monthly activities. The volunteers did not receive monetary compensation for participation. Although most volunteers had very busy personal and professional schedules, they were interested in the study and made participation a priority. Based on interviews, their motivation for participation was curiosity about the effects of psilocybin and the opportunity for extensive self-reflection in the context of both the day-long drug sessions and the meetings with the monitors that occurred between sessions. The Institutional Review Board of the Johns Hopkins University School of Medicine approved the study, and all volunteers gave their informed consent before participation.

Study design

The study compared psilocybin (30 mg/70 kg) and methylphenidate hydrochloride (40 mg/70 kg) using a double-blind between-group, crossover design that involved two or three 8-h drug sessions conducted at 2-month intervals. Thirty-six volunteers were randomly assigned to receive either two sessions (N=30) or three sessions (N=6). The group of 30 volunteers were then randomly assigned to receive psilocybin or methylphenidate on the first session (15 per group), with the alternative drug administered on the second session. The other six volunteers received methylphenidate on the first two sessions and unblinded psilocybin on the third session. The purpose of this condition was primarily to obscure the study design to the participants and monitors (see "Expectancy" section), and data from the six participants were not used in the statistical analyses; however, those data were generally consistent with the results described in this report. Outcome measures obtained throughout the drug sessions included blood pressure and monitor ratings of participant mood and behavior. At about 7 h after drug ingestion (when the primary drug effects had subsided), the participants completed several questionnaires designed to assess various aspects of hallucinogen experience (described below). The longitudinal measures assessed before and 2 months after each drug session included measures of psychiatric symptoms, personality measures, quality of life, and lifetime mystical experiences. A 1-year follow-up assessment is still underway.

Drug conditions

Psilocybin and methylphenidate were administered in identically appearing opaque, size 0 gelatin capsules with approximately 180 ml water. The dose of psilocybin (30 mg/70 kg) was selected as a high safe dose based on non-blind (Malitz *et al*. 1960; Metzner *et al*. 1965; Leuner 1981) and blind (Pahnke 1963, 1969) studies conducted with hallucinogen-naïve individuals in the 1950s-1960s. The methylphenidate dose (40 mg/70 kg) was selected for the comparison condition because it is a high, discriminable but safe dose, it has an onset and duration of subjective effects similar to psilocybin, and it produces some subjective effects (e.g., excitability, nervousness, and/or increased positive mood) overlapping with those of psilocybin (Chait 1994; Rush *et al*. 1998; Kollins *et al*. 1998).

Meetings with monitor before and after sessions

The primary monitor met with each participant on four occasions before his or her first session (for 8 h total) and on four occasions (for 4 h total) after each session. A major purpose of the participant-monitor meetings was to develop and maintain rapport and trust, which is believed to minimize the risk of adverse reactions to psilocybin (Metzner *et al*. 1965). During these meetings, the participant's life history and current life circumstances were reviewed. The preparation of participants by the monitors explicitly included the monitor's expectation that the drug session experiences could increase personal awareness and insight, however, avoided even mention of the criteria used to assess mystical experiences. A male clinical psychologist (W.R.) with extensive prior experience monitoring hallucinogen sessions and a female clinically trained social worker (M.C.) served as primary and assistant monitors, respectively, for all study participants.

Drug sessions

The participants were instructed to consume a low-fat breakfast before reporting to the research unit at 0800 hours, about 1 h before drug administration. A urine sample was taken to verify drug-free status, and the participants were encouraged to relax and reflect before drug administration. The 8-h drug sessions were conducted in an aesthetic living-room- like environment designed specifically for the study. Two monitors were present with a single participant throughout the session. For most of the time during the session, the participant was encouraged to lie down on the couch, use an eye mask to block external visual distraction, and use headphones through which a classical music program was played. The same music program was played for all participants in all sessions. The participants were encouraged to focus their attention on their inner experiences throughout the session. If a participant reported significant fear or anxiety, the monitors provided reassurance verbally or physically (e.g., with a supportive touch to the hand or shoulder). The sessions were videotaped and about 25% were reviewed by the first author to verify session procedures.

Expectancy

It is widely believed that expectancy plays a large role in the qualitative effects of hallucinogens (Metzner *et al*. 1965). Some expectancy effects are unavoidable because it would be unethical not to inform both the participants and the session monitors about the range of possible effects with hallucinogens. In addition, it is believed by many that ethical hallucinogen administration requires that sessions be monitored by individuals who are familiar with such altered states of consciousness (Masters and Houston 1966; Roberts 2001; Stolaroff 2001). Thus, the beliefs of the session monitors introduce another source of expectancy. While it was not possible to completely eliminate such expectancy effects, it was possible to significantly reduce such effects by studying participants without personal histories of hallucinogen use, by studying only a single participant at a time, and by using an experimental design and instructional sets that provided the expectation that sessions could involve not only the administration of a wide range of psilocybin doses but also a range of novel drugs, some of which could produce effects that overlap with those produced by psilocybin. Expectancy effects were also reduced because the experimental design was further obscured from both participants and monitors, who were not aware of which or how many participants would have a final unblinded psilocybin session (see "Instructions to participants and monitors").

Instructions to participants and monitors

The participants and monitors were informed that the participants would have either two or three sessions and that, in at least one session, they would receive a moderate or high dose of psilocybin. They were informed that an inactive placebo, a low dose of psilocybin or various doses of 11 other drugs that could produce various effects (dextromethorphan, nicotine, diphenhydramine, caffeine, methylphenidate, amphetamine, codeine, alprazolam, diazepam, triazolam, or secobarbital), could be administered in sessions in which a moderate or high dose of psilocybin was not administered. After data collection 2 months after the second session, the six participants who received methylphenidate on the first and second session were informed that they would have a third session that would involve administration of a moderate or high dose of psilocybin. These six sessions were the only unblinded sessions. To help focus the participants on their experiences during the sessions, they were not asked to guess whether or not they received psilocybin. However, the monitors completed a rating form which recorded their guesses about the contents of capsules approximately 7 h after capsule administration but before the participant completed detailed questionnaires describing his or her experiences. The participants were given no information about these or any other monitor ratings.

Measures assessed throughout the session

Ten minutes before and 30, 60, 90, 120, 180, 240, 300, and 360 min after capsule administration, monitor ratings, blood pressure, and heart rate were obtained.

Blood pressure and heart rate

Blood pressure (systolic, diastolic, and mean arterial pressure using oscillometric method with the blood pressure cuff placed on the arm) and heart rate were monitored using a Non-Invasive Patient Monitor Model 507E (Criticare Systems, Waukesha, WI, USA).

Monitor rating questionnaire

At the same time-points at which the physiological measures were taken, the two session monitors completed the Monitor Rating Questionnaire, which involved rating or scoring 20 dimensions of the participant's behavior or mood (Table 1). The dimensions expressed as peak scores in Table 1 were rated on a five-point scale from 0 to 4. The dimensions expressed as total duration in Table 1 were rated as the estimated number of minutes since the last rating. The data were the mean of the two monitor ratings at each time-point.

Measures assessed 7 h after drug administration

At about 7 h after capsule administration, when the major drug effects had subsided, the participants completed three empirically derived (i.e., via factor analysis) questionnaires assessing subjective drug effects and two questionnaires assessing mystical experience, as described below. The participants typically completed these questionnaires in about 40 min.

Hallucinogen rating scale

This 99-item questionnaire, which was designed to show sensitivity to the hallucinogen *N,N*-dimethyltryptamine (Strassman *et al*. 1994; Riba *et al*. 2001), consists of six subscales assessing various aspects of hallucinogen effects (intensity, somaesthesia, affect, perception, cognition, and volition).

APZ

The APZ is a 72-item yes/no questionnaire designed to assess altered states of consciousness induced by drug (e.g., DMT or psilocybin) or non-drug (e.g., perceptual deprivation, hypnosis, and sensory overload) manipulations (Dittrich 1998). The three major scales on the APZ are the OSE (oceanic boundlessness, a state common to classic mystical experiences including feelings of unity and transcendence of time and space), the AIA (dread of ego dissolution, dysphoric feelings similar to those of some "bad trips" described by hallucinogen users), and the VUS (visionary restructuralization, which includes items on visual pseudo-hallucinations, illusions, and synesthesias). The data on each scale were expressed as a proportion of the maximum possible score.

Addiction research center inventory (ARCI)

The ARCI was developed to differentiate subjective effects among several classes of psychoactive drugs including hallucinogens (Haertzen 1966). The short form of the ARCI consists of 49 true/false questions and contains five major scales: lysergic acid diethylamide (LSD, a hallucinogen-sensitive scale that is often interpreted as providing a measure of dysphoric changes); pentobarbital, chlorpromazine, and alcohol group (PCAG, a sedative sensitive scale); benzedrine group (BG); amphetamine (A) scales (amphetamine-sensitive scales); and morphine-benzedrine group (MBG, often interpreted as a measure of euphoria) (Martin *et al*. 1971; Jasinski 1977). The participants were instructed to answer the questions on the ARCI with reference to the effects they experienced after they received the capsules that morning.

States of consciousness questionnaire

This 100-item questionnaire is rated on a six-point scale [0=none, not at all; 1=so slight, cannot decide; 2=slight; 3=moderate; 4=strong (equivalent in degree to any previous strong experience or expectation of this description); and 5=extreme (more than ever before in my life and stronger than 4)]. Forty-three items on this questionnaire comprised the current version of the Pahnke-Richards Mystical Experience Questionnaire (Pahnke 1969; Richards 1975), which was designed to assess mystical experiences, used as a primary outcome measure in the Good Friday Experiment (Pahnke 1963; Doblin 1991), and has been shown to be sensitive to other hallucinogens (Turek *et al*. 1974; Richards *et al*. 1977). This questionnaire is based on the classic descriptive work on mystical experiences and the psychology of religion by Stace (1960), and it provides scale scores for each of seven domains of mystical experiences: internal unity (pure awareness; a merging with ultimate reality); external unity (unity of all things; all things are alive; all is one); transcendence of time and space; ineffability and paradoxicality (claim of difficulty in describing the experience in words); sense of sacredness (awe); noetic quality (claim of intuitive knowledge of ultimate reality); and deeply felt positive mood (joy, peace, and love). The specific items in each of the scales of the Pahnke-Richards Mystical Experience Questionnaire are available online as Electronic Supplementary Material, Table 1. The data on each scale were expressed as a proportion of the maximum possible score. Based on prior research (Pahnke 1969), the criteria for designating a volunteer as having had a "complete" mystical experience were that the scores on each of the following scales had to be at least 0.6: unity (either internal or external, whichever was greater), transcendence of time and space, ineffability, sense of sacredness, noetic quality, and positive mood. The remaining 57 items in the questionnaire served as distracter items.

Mysticism scale

This 32-item questionnaire was developed to assess primary mystical experiences (Hood *et al*. 2001; Spilka *et al*. 2005). The Mysticism Scale has been extensively studied, demonstrates cross-cultural generalizability, and is well regarded in the field of the psychology of religion (Hood *et al*. 2001; Spilka *et al*. 2005) but has not previously been used to assess changes after a drug experience. A total score and three empirically derived factors are measured: interpretation (corresponding to three mystical dimensions described by Stace (1960): noetic quality, deeply felt positive mood, and sacredness); introvertive mysticism (corresponding to the Stace dimensions of internal unity, transcendence of time and space, and ineffability); and extrovertive mysticism (corresponding to the dimension of the unity of all things/all things are alive). The items were rated on a nine-point scale (−4=this description is extremely not true of my own experience or experiences; 0=I cannot decide; and +4=this description is extremely true of my own experience or experiences). For the version of the questionnaire used 7 h after drug administration, the participants were instructed to complete the questionnaire with reference to their experiences after they received the capsules that morning.

Measures assessed 2 months post-session

At 7 to 8 weeks after each session and before any additional session, the participants returned to the research facility and completed a series of questionnaires to assess possible persisting changes in attitudes, mood, or behavior as well as possible changes in standardized measures of personality, mood, and spirituality. The participants typically completed these questionnaires in about 75 min.

At about this same time, community observer ratings of participants' attitudes and behavior were obtained by telephone. The outcome measures at this time-point are described below.

Persisting Effects Questionnaire

This 89-item questionnaire sought information about changes in attitudes, moods, behavior, and spiritual experience that, on the basis of prior research (Pahnke 1963, 1969; Doblin 1991; Richards *et al*. 1977), would possibly be sensitive to the effects of psilocybin 2 months after the session. Eighty-six of the items were rated on a six-point scale (0=none, not at all; 1=so slight, cannot decide; 2=slight; 3=moderate; 4=strong; and 5=extreme, more than ever before in your life and stronger than 4). Sixty-six of the items were from Pahnke (1963, 1969) and 20 items were new. For purposes of summarizing the results before data analysis, 61 of the 86 items were judged as likely to be unambiguously divided into six categories: positive attitudes about life and/or self, negative attitudes about life and/or self, positive mood changes, negative mood changes, altruistic/positive social effects, and antisocial/negative social effects. Six raters independently sorted the 61 items into the six categories. Three items were excluded because fewer than five of the six raters agreed on the categories. For the remaining 58 items, at least five of the six raters agreed with the assignment of each item to each category, suggesting the appropriateness of the category descriptors. The category descriptors and the number of items associated with each category were: positive attitudes about life and/or self (17 items), negative attitudes about life and/or self (17 items), positive mood changes (four items), negative mood changes (four items), altruistic/positive social effects (eight items), and antisocial/negative social effects (eight items). Two additional categories were comprised of one item each: positive behavior change and negative behavior change. For scoring purposes, the eight category scores based on a total of 60 items were expressed as the percentage of the maximum possible score. The items in each of the categories of the Persisting Effects Questionnaire are available online as electronic supplementary material, Table 2. The remaining 23 items in the questionnaire that did not readily fit into the categories predominately reflected aspects of spirituality and mystical experience; these domains were characterized by other outcome measures.

The questionnaire also included these three questions: (1) How personally meaningful was the experience (rated 1= no more than routine, everyday experiences; 2= similar to meaningful experiences that occur on average once or more a week; 3=similar to meaningful experiences that occur on average once a month; 4=similar to meaningful experiences that occur on average once a year; 5=similar to meaningful experiences that occur on average once every 5 years; 6=among the 10 most meaningful experiences of my life; 7=among the 5 most meaningful experiences of my life; and 8=the single most meaningful experience of my life)? (2) Indicate the degree to which the experience was spiritually significant to you (rated 1=not at all, 2=slightly, 3=moderately, 4=very much, 5=among the 5 most spiritually significant experiences of my life, and 6=the single most spiritually significant experience of my life). (3) Do you believe that the experience and your contemplation of that experience have led to change in your current sense of personal well-being or life satisfaction (rated +3=increased very much, +2=increased moderately, +1=increased slightly, 0=no change, −1=decreased slightly, −2=decreased moderately, and −3=decreased very much)? This questionnaire was developed after the initiation of the study and was completed by all 24 of the 30 participants who thereafter received psilocybin and methylphenidate in counterbalanced order in the first two sessions (12 participants in each of the two drug orders).

Mysticism Scale-Lifetime

The Lifetime version of this previously described questionnaire instructed the participants to answer questions with reference to their total life experiences. This questionnaire was completed at screening and at 2 months after each session.

Spiritual Transcendence Scale

This 24-item questionnaire assesses a construct that reflects an individual's effort to create a broad sense of personal meaning in his or her life and has been shown to demonstrate cross-cultural generality (Piedmont 1999, 2005, 2006; Piedmont and Leach 2002). A total score and three empirically derived factors are scored: prayer fulfillment, universality, and connectedness. This questionnaire was completed at screening and at 2 months after each session.

NEO Personality Inventory (NEO PI-R)

This 241-item questionnaire, which was completed on a computer, permits the assessment of five major personality factors: neuroticism, extraversion, openness, agreeableness, and conscientiousness (Costa and McCrae 1992). This questionnaire was completed at screening and at 2 months after each session.

PANAS-X (Positive and Negative Affect Schedule Expanded Form)

This 60-item questionnaire permits the assessment of two broad general factors (positive affect and negative affect) accounting for most of the variance in self-rated affect (Watson and Clark 1994, 1997). The version of the questionnaire used instructed the participants to answer questions based on how they feel on the average. This questionnaire was completed at screening and at 2 months after each session.

Community observer ratings of changes in participants' behavior and attitudes

After acceptance into the study, each participant designated three adults who were expected to have continuing contact with the participant (e.g., family members, friends, or coworkers/colleagues at work) such that they would be likely to observe changes in the participants' behavior and attitudes that might occur during the study. Ratings by the designated individuals were conducted via a structured telephone interview approximately 1 week after the participant had been accepted into the study and 7 to 8 weeks after each of the drug sessions. The interviewer provided no information to the community volunteer about the participant. Furthermore, most of the interviews (60%) were conducted by a research assistant who had never met the participant and had no knowledge about the participant's experiences during drug sessions. The structured interview consisted of asking the rater to rate the volunteer's behavior and attitudes using a ten-point scale (from 1=not at all to 10=extremely) on 11 dimensions that were identified from prior research (Pahnke 1963; Richards *et al*. 1977; Doblin 1991) as possibly sensitive to the effects of psilocybin. The rated dimensions were: inner peace, patience, good-natured humor/playfulness, mental flexibility, optimism, anxiety, interpersonal perceptiveness and caring, negative expression of anger, compassion/social concern, expression of positive emotions (e.g., joy, love, appreciation), and self-confidence. On the first rating occasion, which occurred soon after acceptance into the study, the raters were instructed to base their ratings on observations of and conversations with the participant over the past 3 months. On subsequent ratings, which occurred 7 to 8 weeks after each session, the raters were told their previous ratings and were instructed to rate the participant based on interactions over the last several weeks. The data from each interview with each rater were calculated as a total score, with anxiety and anger scored negatively. The changes in participants' behavior and attitudes after drug sessions were expressed as a mean change score from the preceding rating across the raters.

A failure to interview all three of the raters after one of the drug sessions resulted in elimination of 4 of the 30 participants who received psilocybin and methylphenidate in counterbalanced order on the first two sessions. Of the 52 rating occasions in the 26 participants, the majority (83%) involved interviews with all three raters on each rating occasion, with all of the remaining interviews conducted with two raters.

Data analyses

The data were statistically analyzed for the 30 participants who received psilocybin and methylphenidate in counterbalanced order on the first two sessions.

Physiological and monitor rating questionnaire assessed throughout the session

Two sets of analyses were conducted. For the first, a two-factor analysis of variance was used with drug (psilocybin and methylphenidate) and time (10 min before and 0.5, 1, 1.5, 2, 3, 4, 5, and 6 h after capsule administration) as within-subject factors. The mean square error term for the drug × time interaction was then used to conduct Tukey's honestly significant differences (HSD) post hoc tests comparing psilocybin and methylphenidate at each post-drug-administration time point. For the second set of analyses, the peak scores during the time-course were defined as the maximum value from 0.5 to 6 h after capsule administration, and temporally based measures (i.e., minutes sleeping and minutes speaking) were summed across the eight post-capsule time-points. Paired *t* tests were used to compare psilocybin and methylphenidate conditions.

Measures assessed 7 h after drug administration (data analysis)

Paired *t* tests were used to compare psilocybin and methylphenidate conditions on the three measures of subjective drug effect (Hallucinogen Rating Scale, APZ, and Addiction Research Center Inventory) and the two questionnaires assessing mystical experience (States of Consciousness Questionnaire and Mysticism Scale).

Measures assessed 2 months post-session (data analysis)

Paired *t* tests were used to compare psilocybin and methylphenidate conditions for the 24 participants who completed the Persisting Effects Questionnaire and the 26 participants for whom complete data were obtained for the community observer ratings of changes in participants' attitudes and behavior.

The remaining four questionnaires completed 2 months post-session (NEO, PANAS-X, Mysticism Scale-Lifetime, and Spiritual Transcendence Scale) provide general measures of personality, affect, and spirituality that could result in carry-over effects from post-session 1 to post-session 2. Accordingly, these data were analyzed using the following planned comparisons: (1) comparison (*t* test) of data obtained at screening for the group of participants that received psilocybin in session 1 (N=15) with that for the group that received methylphenidate in session 1 (N=15), (2) comparison (*t* test) of post-session 1 data for the group of participants that received psilocybin in session 1 (N=15) with the group that received methylphenidate in session 1 (N=15), and (3) comparison (paired *t* test) of data post-session 1 with data post-session 2 for the group of participants that received methylphenidate on session 1 and psilocybin on session 2 (N=15).

Results

Integrity of blinding procedures

The integrity of the blinding procedures was assessed by having the monitors complete a questionnaire after each session on which they guessed the capsule content and a questionnaire at the end of the study on which they provided their guesses about the study design. Overall, 23% of sessions were misclassified (methylphenidate identified as psilocybin or psilocybin identified as something other than psilocybin) by one or both of the monitors. The primary and most experienced monitor had an overall misclassification rate of 17%. Most misclassification errors involved rating a methylphenidate session as psilocybin. It is interesting to note that even the primary monitor, however, sometimes rated the psilocybin condition, which was a high dose, as being something other than psilocybin. On two of the three occasions on which this occurred, the participants subsequently rated their experiences as among the five most meaningful and spiritually significant experiences of their lives. These observations suggest that the experiences reported during psilocybin sessions were not merely artifacts of monitor expectation or suggestion.

At the conclusion of the study, the primary monitor and the assistant monitor completed a debriefing questionnaire in which they provided their guesses about the study design. Both monitors believed that a range of psilocybin doses had been administered as well as other active drugs and placebo. Caffeine, dextromethorphan, and diphenhydramine were thought likely to be the other drugs administered, and the primary monitor specifically guessed, based on his previous clinical experience, that methylphenidate had not been administered. Thus, we conclude that the blinding procedures overall were adequately maintained despite the differences in the pharmacological profiles of psilocybin and methylphenidate.

Blood pressure, heart rate, and monitor ratings throughout the session

Both psilocybin and methylphenidate produced significant and orderly time-related effects. For both drugs, the onset of significant blood pressure and monitor-rated effects occurred either at the 30- or 60-min assessment, with the effects generally peaking from 90 to 180 min and decreasing toward pre-drug-administration levels over the remainder of the session (Fig. 1). Heart rate increased by about 10 bpm for both drugs and remained significantly elevated over the pre-drug value throughout the session. The volunteers were rated as showing very low sleepiness/ sedation and restlessness during sessions, with no differences between the psilocybin and methylphenidate conditions (Table 1). The volunteers had a significantly greater number of minutes talking with the monitors after methylphenidate than psilocybin (72 vs 51 min, during the 6 h after capsule ingestion), although after psilocybin they had more physical contact (e.g., handholding) with the monitor (24 vs 58 min) and higher peak ratings of stimulation/ arousal and spontaneous motor activity (Fig. 2; Table 1). It is noteworthy that, during psilocybin sessions, the participants were rated as being less responsive to questions, further from ordinary reality, and showing greater emotionality as reflected in peak ratings of tearing/crying, anxiety/ fearfulness, joy/intense happiness, and peace/harmony (Fig. 2; Table 1).

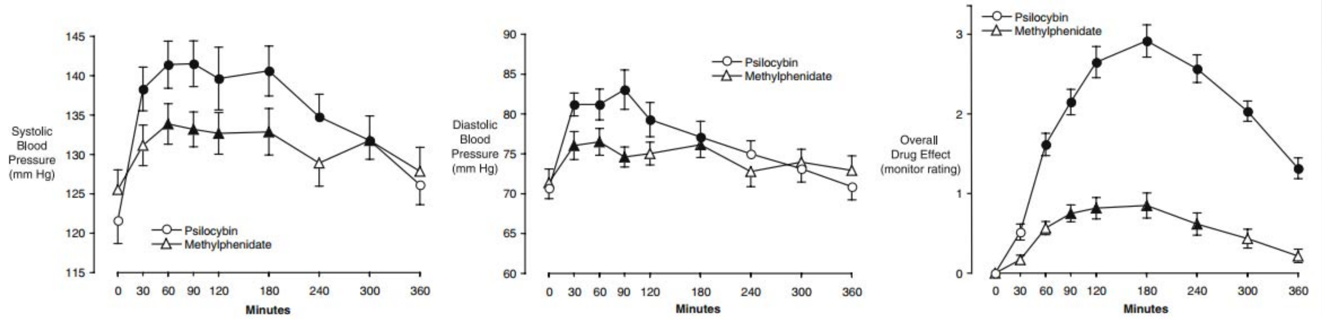


Fig. 1 Within-session time-course of psilocybin and methylphenidate effects. Blood pressure (systolic and diastolic) and monitor ratings (mean of overall drug effect) as a function of time since capsule ingestion (time 0=before drug administration). *Data points* are means with *brackets* showing ±1 SEM (*N*=30) *Filled data* points indicate a significant difference (Tukey HSD) from pre-administration of the drug (time 0). The figure shows that, compared to methylphenidate, psilocybin produced modestly higher elevations in blood pressure but substantially higher monitor rating of overall drug effect.

Table 1. Monitor ratings of volunteer behavior and mood throughout the session.

Rated description	Methylphenidate	Psilocybin	*P* value
Peak effects (maximum score=4)			
Overall drug effect	1.10 (0.15)	3.13 (0.16)	<0.001
Sleepiness/sedation	0.17 (0.07)	0.10 (0.05)	N.S.
Unresponsive to questions	0.07 (0.05)	0.58 (0.20)	<0.05
Anxiety or fearfulness	0.42 (0.09)	1.05 (0.17)	<0.01
Stimulation/arousal	0.68 (0.12)	1.42 (0.26)	<0.001
Distance from ordinary reality	1.12 (0.16)	3.12 (0.14)	<0.001
Ideas of reference/paranoid thinking	0 (0)	0.17 (0.09)	N.S.
Yawning	0.05 (0.03)	1.18 (0.23)	<0.001
Tearing/crying	0.77 (0.13)	1.38 (0.21)	<0.001
Nausea	0.12 (0.06)	0.42 (0.11)	<0.01
Spontaneous motor activity	0.53 (0.17)	1.02 (0.23)	<0.05
Restless/fidgety	0.18 (0.07)	0.27 (0.08)	N.S.
Joy/intense happiness	0.63 (0.15)	2.03 (0.22)	<0.001
Peace/harmony	0.92 (0.15)	1.90 (0.20)	<0.001
Total duration in minutes (maximum score=360)			
Talking with monitor	72.0 (4.8)	50.9 (2.2)	<0.001
Total speech	122.2 (10.7)	106.0 (10.7)	N.S.
Non-speech vocalization[a]	2.2 (1.3)	16.1 (4.5)	<0.01
Physical contact with monitor[b]	23.7 (4.7)	57.6 (8.0)	<0.001
Sleep	0.5 (0.3)	0.2 (0.2)	N.S.
Strong anxiety	0.7 (0.3)	5.6 (2.7)	N.S.

Data are mean scores with one SEM shown in parentheses (*N*=30)
N.S. not significant
[a] For example, humming, sighs, laughter
[b] For example, reassuring touch

Drug effect and mysticism measures assessed 7 h after drug administration

Hallucinogen-sensitive questionnaires

The three questionnaires developed for sensitivity to hallucinogenic drugs showed differences between psilocybin and methylphenidate (Table 2). All six scales of the Hallucinogen Rating Scale, all three scales on the APZ Questionnaire, and the LSD scale of the ARCI were significantly higher after psilocybin than after methylphenidate. These differences reflect the fact that, after psilocybin, the participants experienced alterations in mood, affect, and cognition typical of hallucinogenic drugs. These included perceptual changes (e.g., visual pseudo-hallucinations, illusions, and synesthesias), labile moods (e.g., feelings of transcendence, grief, joy, and/or anxiety), and cognitive changes (e.g., sense of meaning and/or ideas of reference).

A mixed pattern of results occurred on the other scales of the ARCI. The PCAG subscale, which is sensitive to sedative drugs, was higher after psilocybin. It is interesting to note that the two stimulant scales showed opposite effects. The amphetamine scale (A), which was designed to show dose-related sensitivity to amphetamine, was significantly higher after psilocybin than after methylphenidate. However, the benzedrine group scale (BG), which measures amphetamine-induced increases in self-control, efficiency, and concentration, was significantly higher after methylphenidate than after psilocybin. Finally, the morphine-benzedrine group (MBG) scale, which is considered a measure of drug-induced euphoria, did not differ significantly between the drug conditions.

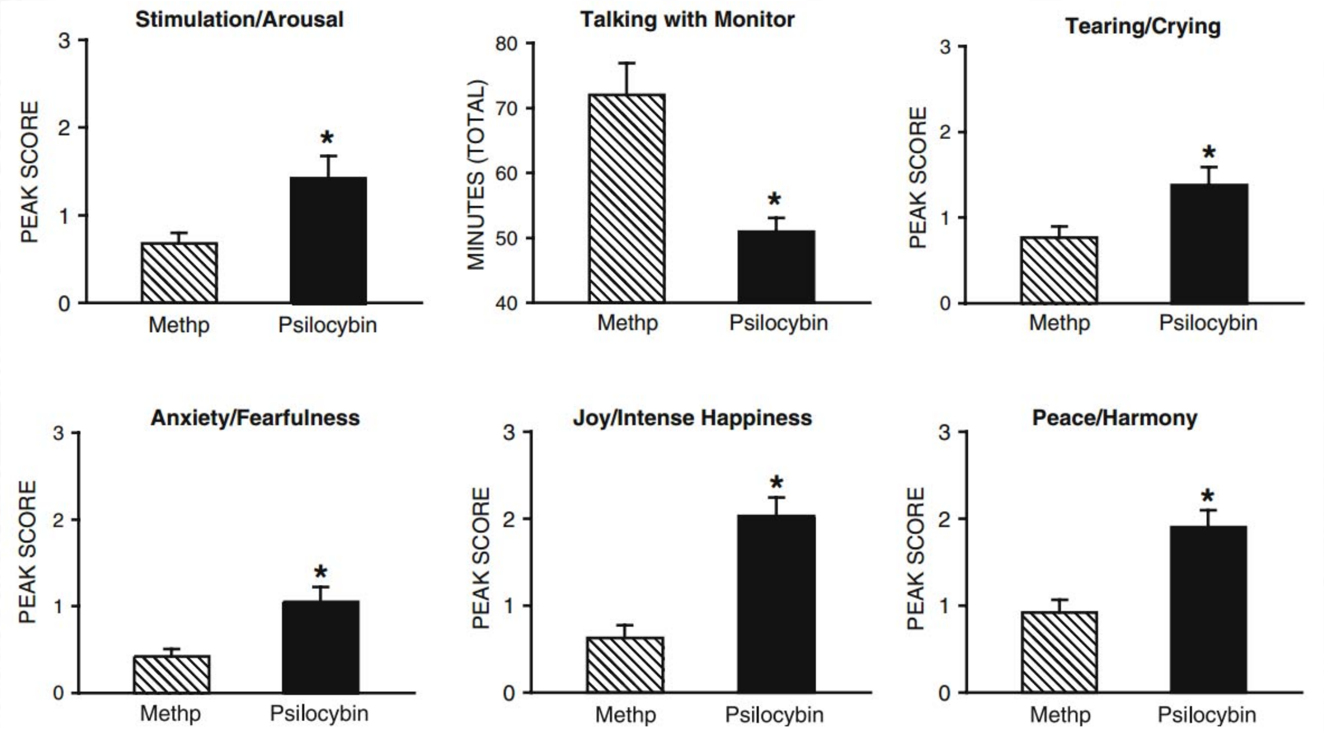


Fig. 2 Monitor ratings during sessions. *Bars* are mean ratings with 1 SEM shown in *brackets* (*N*=30). *Asterisks* indicate a significant difference between the methylphenidate (*Methp*) and psilocybin conditions. Maximum possible rating=4.

Table 2. Volunteer ratings on three drug-sensitive questionnaires completed 7 h after drug administration.

Questionnaire	Subscale description	Methylphenidate	Psilocybin	*P* value
Hallucinogen Rating Scale (4=maximum)	Intensity	1.38 (0.14)	2.79 (0.12)	<0.001
	Somaesthesia	0.91 (0.10)	1.92 (0.11)	<0.001
	Affect	1.16 (0.10)	2.16 (0.10)	<0.001
	Perception	0.54 (0.11)	2.07 (0.14)	<0.001
	Cognition	1.03 (0.14)	2.54 (0.15)	<0.001
	Volition	1.39 (0.06)	1.77 (0.07)	<0.001
APZ Questionnaire	OSE (oceanic boundlessness)	3.30 (0.50)	8.00 (0.45)	<0.001
	AIA (dread of ego dissolution)	1.03 (0.21)	5.03 (0.74)	<0.001
	VUS (visionary restructuralization)	3.70 (0.59)	8.87 (0.47)	<0.001
Addiction Research Center Inventory (ARCI)	PCAG (sedative)	4.83 (0.41)	7.27 (0.58)	<0.001
	BG (amphetamine/self-control)	5.83 (0.38)	4.57 (0.32)	<0.05
	A (amphetamine)	3.80 (0.44)	5.13 (0.41)	<0.05
	MBG (euphoria)	6.77 (0.73)	8.60 (0.67)	N.S.
	LSD (hallucinogen/dysphoria)	4.33 (0.37)	7.33 (0.40)	<0.001

Data are mean ratings with one SEM shown in parentheses (*N*=30)
N.S. not significant

Measures of mystical experience

At 7 h after capsule administration, the volunteers also completed two questionnaires designed to assess primary mystical experiences based on classic phenomenological descriptions from the psychology of religion (Table 3). The total score and all three empirically derived factors of the Mysticism Scale and all seven scales on States of Consciousness Questionnaire were significantly higher after psilocybin than after methylphenidate. Based on *a priori* criteria, 22 of the total group of 36 volunteers had a "complete" mystical experience after psilocybin (ten, nine, and three participants in the first, second, and third session, respectively) while only 4 of 36 did so after methylphenidate (two participants each in the first and second sessions).

Table 3. Volunteer ratings on two mystical experience questionnaires completed 7 h after drug administration.

Questionnaire	Subscale description	Methylphenidate	Psilocybin	*P* value
Mysticism Scale	Interpretation	70.6 (4.5)	96.1 (3.3)	<0.001
	Introvertive	66.9 (4.4)	96.3 (2.8)	<0.001
	Extrovertive	37.2 (3.2)	59.7 (2.9)	<0.001
	Total	174.7 (11.3)	252.1 (8.5)	<0.001
States of Consciousness Questionnaire[a]	Internal unity	0.25 (0.05)	0.73 (0.05)	<0.001
	External unity	0.21 (0.05)	0.66 (0.06)	<0.001
	Sacredness	0.36 (0.05)	0.80 (0.04)	<0.001
	Intuitive knowledge	0.30 (0.05)	0.72 (0.05)	<0.001
	Transcendence of time and space	0.27 (0.05)	0.76 (0.04)	<0.001
	Deeply felt positive mood	0.38 (0.04)	0.77 (0.05)	<0.001
	Ineffability	0.29 (0.05)	0.81 (0.05)	<0.001

Data are mean scores with one SEM shown in parentheses (*N*=30)
N.S. not significant
[a] For States of Consciousness Questionnaire, data are expressed as a proportion of the maximum possible score

Measures assessed 2 months post-sessions

Persisting Effects Questionnaire (2 months post-sessions)

As shown in Table 4, compared to methylphenidate, psilocybin produced significantly greater elevations in ratings of positive attitudes, mood, social effects, and behavior; the negative ratings of these same dimensions were very low and did not differ across the drug conditions. This questionnaire also included ratings of the personal meaningfulness and spiritual significance of the experience and whether the experience changed their sense of well being or life satisfaction. Table 4 shows that these ratings were significantly higher after psilocybin than after methylphenidate. It is remarkable that 67% of the volunteers rated the experience with psilocybin to be either the single most meaningful experience of his or her life or among the top five most meaningful experiences of his or her life (Fig. 3). In written comments, the volunteers judged the meaningfulness of the experience to be similar, for example, to the birth of a first child or death of a parent. Thirty-three percent of the volunteers rated the psilocybin experience as being the single most spiritually significant experience of his or her life, with an additional 38% rating it to be among the top five most spiritually significant experiences. In written comments about their answers, the volunteers often described aspects of the experience related to a sense of unity without content (pure consciousness) and/or unity of all things. After methylphenidate, in contrast, 8% of volunteers rated the experience to be among the top five (but not the single most) spiritually significant experiences. Seventy-nine percent of the volunteers rated that the psilocybin experience increased their current sense of personal well being or life satisfaction "moderately" (50%) or "very much" (29%), in contrast to 17 and 4%, respectively, after methylphenidate. No volunteer rated either the psilocybin or methylphenidate experience as having decreased their sense of well being or life satisfaction.

Table 4. Volunteer ratings and community observer ratings completed 2 months after sessions.

Outcome measures	Description	Methylphenidate	Psilocybin	*P* value
Persisting Effects Questionnaire (volunteer ratings)[a]	Positive attitudes about life and/or self	22.8 (4.5)	55.0 (5.0)	<0.001
	Negative attitudes about life and/or self	0.3 (0.1)	0.5 (0.3)	N.S.
	Positive mood changes	16.0 (3.5)	39.2 (5.3)	<0.001
	Negative mood changes	0.6 (0.5)	1.5 (0.7)	N.S.
	Altruistic/positive social effects	17.3 (4.4)	46.6 (5.5)	<0.001
	Antisocial/negative social effects	0.3 (0.2)	0.7 (0.5)	N.S.
	Positive behavior changes	29.2 (6.5)	60.0 (4.8)	<0.001
	Negative behavior changes	1.7 (1.2)	0 (0)	N.S.
	How personally meaningful was the experience?	3.42 (0.35)	6.54 (0.22)	<0.001
	How spiritually significant was the experience?	2.63 (0.22)	4.79 (0.26)	<0.001
	Did the experience change your sense of well being or life satisfaction?	+0.79 (0.18)	+2.04 (0.17)	<0.001
Community observer ratings of changes in participants’ behavior and attitudes[b]	Positive change score	-0.03 (0.68)	2.42 (0.7)	<0.01

Data are mean ratings with one SEM shown in parentheses
N.S. Not significant
[a] For Persisting Effects Questionnaire, data on attitude, mood, social, and behavior changes are expressed as percentage of maximum possible score, and data for the last three questions are raw scores; for volunteer ratings, *N*=24 (cf., "Materials and methods")
[b] For ratings by community observers, data are mean positive change scores; for observer ratings, *N*=26 (cf., "Materials and methods")

Personality and affect

None of the factors on the two widely used questionnaires assessing five factors of personality (NEO and PI-R) and measures of general positive and negative affect (PANAS-X) was differentially affected by psilocybin. At screening and at 2 months after session 1, there were no significant differences between the group that received psilocybin on the first session (*N*=15) and the group that received methylphenidate on the first session (*N*=15). Furthermore, within the latter group, there were no significant changes from post-session 1 to post-session 2.

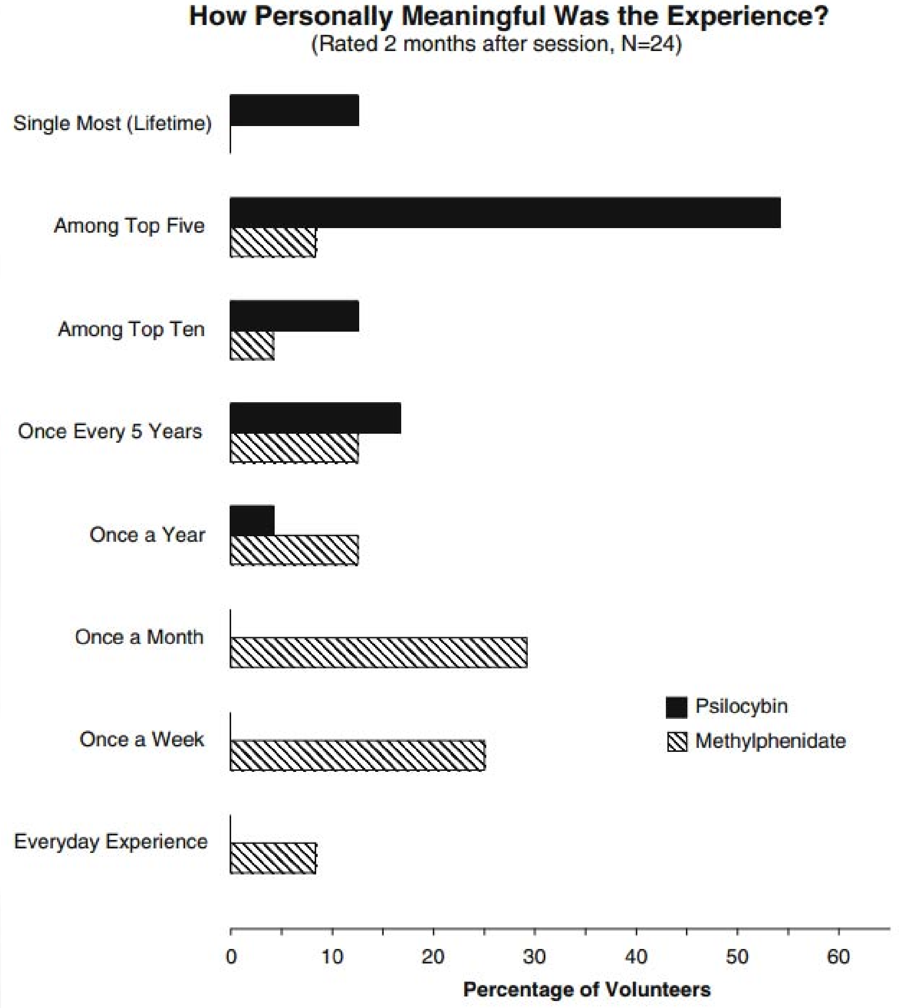


Fig. 3 Percentage of volunteers who endorsed each of eight possible answers to the question "how personally meaningful was the experience?" on a questionnaire completed 2 months after the session (*N*=24)

Lifetime assessment of mystical experience and spirituality

Two additional questionnaires completed 2 months after each session provided lifetime measures of mystical experiences (Mysticism Scale) and spirituality (Spiritual Transcendence Scale). As with the measures of personality and affect, there were no significant differences at screening between the group that received psilocybin on the first session (*N*=15) and the group that received methylphenidate on the first session (*N*=15). As shown in Fig. 4, at 2 months after the first session, lifetime mystical experience and spiritual transcendence scores were significantly higher in the group that received psilocybin on the first session than the group that received methylphenidate on the first session. At 2 months after the second session, the scores in the group that received psilocybin on the second session increased significantly on both measures. As expected, because these scores reflect *lifetime* measures, these scores did not decrease after the second session in the group that received psilocybin on the first session.

Community observer ratings of changes in participants' and behavior and attitudes

Table 4 shows that, compared to methylphenidate, psilocybin sessions were associated with small but significant positive changes in the participants' behavior and attitudes.

Fear, anxiety/dysphoria, and ideas of reference/paranoia

According to monitor ratings, post-session ratings and written comments by the monitors and the participants, and post-session interviews with the participants, many participants reported mild or moderate anticipatory anxiety at the beginning of sessions. In post-session ratings, 11 of the 36 total volunteers after psilocybin and none after methylphenidate rated on the States of Consciousness Questionnaire their "experience of fear" sometime during the session to be "strong" or "extreme." Four volunteers (all of whom had high post-session fear ratings) reported that their entire session was dominated by anxiety or unpleasant psychological struggle (i.e., dysphoria). Four others (again, all of whom had high post-session fear ratings) reported that a significant portion of their session was characterized by anxiety/dysphoria. Although the onset of episodes of notable anxiety/dysphoria was most likely to occur shortly after onset of drug effect, there were occasions on which onset occurred later in the session when drug effects were subsiding. Anxiety/dysphoria occurred when psilocybin was administered on the first (two participants), second (four participants), and third (two participants) sessions, suggesting that longer preparation time and being unblinded to psilocybin administration were not protective. Six of the eight volunteers with a notable anxiety/dysphoria response had mild, transient ideas of reference/paranoid thinking sometime during the 6 h after psilocybin administration. These effects were readily managed with reassurance and did not persist beyond the session. Two of the eight volunteers compared the experience to being in a war and three indicated that they would never wish to repeat an experience like that again. Despite these psychological struggles, most of these participants rated the overall experience as having personal meaning and spiritual significance and no volunteer rated the experience as having decreased their sense of well being or life satisfaction.

Discussion

The present double-blind study shows that psilocybin, when administered under comfortable, structured, interpersonally supported conditions to volunteers who reported regular participation in religious or spiritual activities, occasioned experiences which had marked similarities to classic mystical experiences and which were rated by volunteers as having substantial personal meaning and spiritual significance. Furthermore, the volunteers attributed to the experience sustained positive changes in attitudes and behavior that were consistent with changes rated by friends and family.

The present study advances the empirical analysis of mystical experience. From a scientific perspective, most of what is known about mystical or religious experience is based on descriptive characterization of spontaneously occurring experience (Stace 1960; Spilka *et al*. 2005). Rigorous attempts to prospectively experimentally manipulate such experiences have generally been associated with only modest effects (e.g., Hood *et al*. 1990; Spilka *et al*. 2005). Although there are anecdotal reports from the clinical research in the 1960s of hallucinogens occasioning religious experiences, even when administered in a secular setting (Smith 1964; Masters and Houston 1966; Dobkin de Rios and Janiger 2003), a systematic study of such effects has been almost nonexistent. The most relevant study was one in which theological seminary students received either 30 mg psilocybin (ten participants) or 200 mg nicotinic acid (ten participants) in a group setting during a religious service (the Good Friday Experiment, Pahnke 1963; 1967; Doblin 1991). The participants who received psilocybin showed significant elevations on the Pahnke Mystical Experience Questionnaire and reported positive changes in attitudes and behavior at 6 months and at 25-year followup. Those results are consistent with the present study, which also demonstrated sustained increases on two closely related outcome measures (Pahnke-Richards Mystical Experience Questionnaire and Persisting Effects Questionnaire). Significant limitations of the Pahnke study were that the participants were explicitly told that some would receive psilocybin and some would be controls, and that it was conducted in a group setting. These features resulted in the double-blind being quickly broken during the session, which presumably contributed to the assessed differences between the groups (Doblin 1991; Wulff 1991; Smith 2000). The present study represents an important extension of the Pahnke study using better blinding and comparison control procedures, assessment of effects in individual participants unconfounded by group interactions, empirically validated measures of mystical experience (the Mysticism Scale and the Spiritual Transcendence Scale), and assessment of effects by community observers. The credibility of the blinding procedure is reflected in the facts that the debriefing interviews with the monitors at the end of the study indicated that they remained unaware of the study design and that some volunteers rated their experience during the methylphenidate session as being among the most personally meaningful experiences of their lives (Fig. 3).

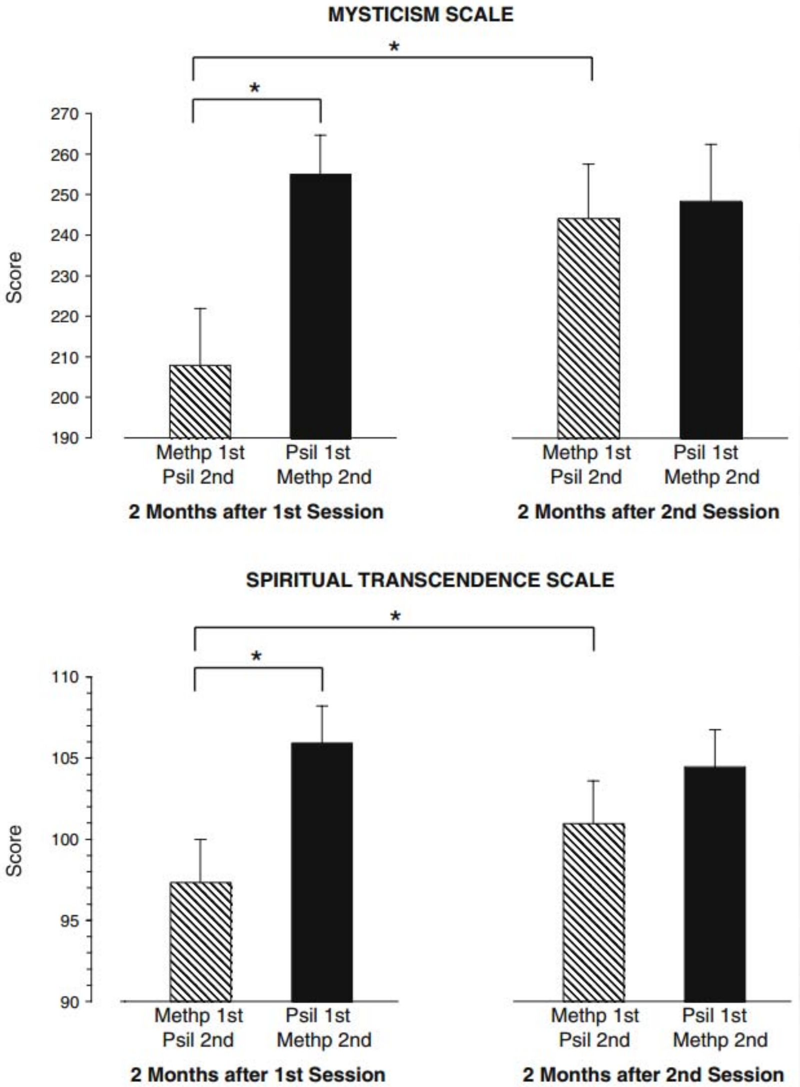


Fig. 4 Lifetime mystical experience (Mysticism Scale) and spirituality (Spiritual Transcendence Scale) scores 2 months after the first session (*left two columns*) and 2 months after the second session (*right two columns*) in two groups of participants. One group (*N*=15) received methylphenidate on the first session and psilocybin on the second session (*Methp 1st, Psil 2nd*) and the other group (*N*=15) received the reverse order (*Psil 1st, Methp 2nd*). Bars are means with *brackets* showing one SEM. *Asterisks* indicate a significant difference between the conditions.

The proportion of volunteers who fulfilled Pahnke's criteria for having a "complete" mystical experience (61%, 22 of 36) is somewhat higher than the 30-40% reported by Pahnke in the Good Friday Experiment (cf. Pahnke 1967, p 67). It seems likely that the greater preparation time (at least 8 versus 3 h in the Pahnke study) and the differences in context (individual sessions with an eye mask and music in an aesthetic room verses the Pahnke study conducted in a group setting with 30 individuals, some of whom were acting bizarrely) likely contributed to this difference. The present study provides no evidence that preparation beyond that given before the first session produced an increase in the incidence of a mystical experience (i.e., on the first, second, and third session, respectively, 67, 60, and 50% of participants who received psilocybin met the criteria for a complete mystical experience) or a decrease in the incidence of anxiety/dysphoria.

The extent to which the study population limits the generalizability of the results is unknown. The participants in this study were hallucinogen-naïve, well educated, psychologically stable, and middle-aged adults, who reported regular participation in religious or spiritual activities. In particular, it seems plausible that the religious or spiritual interest of the participants may have increased the likelihood that the psilocybin experience would be interpreted as having substantial spiritual significance and personal meaning. It is also unknown how the hallucinogen-naïve status of the participants affected either the intensity or qualitative interpretation of the experience. Recruiting volunteers without histories of use avoided the problem of participant selection bias in which individuals who had previously had positive experiences with hallucinogens would have been most likely to participate. However, it is also possible that the novelty of the experience in hallucinogen-naïve individuals enhanced both the intensity and the personal and spiritual significance of the experience.

An important finding of the present study is that, with careful volunteer screening and preparation and when sessions are conducted in a comfortable, well-supervised setting, a high dose of 30 mg/70 kg psilocybin can be administered safely. It is also noteworthy that, despite meetings and prior sessions with monitors ranging from 8 h (when psilocybin was administered on the first session) up to 24 h (when psilocybin was administered on the third session) of contact time, 22% (8 of 36) of the volunteers experienced a period of notable anxiety/dysphoria during the session, sometimes including transient ideas of reference/ paranoia. No volunteer required pharmacological intervention and the psychological effects were readily managed with reassurance. The primary monitor remained accessible via beeper/phone to each volunteer for 24 h after each session, but no volunteer called before the scheduled follow-up meeting on the next day. The 1-year follow-up is ongoing but has been completed by most volunteers (30 of 36). In that follow-up, an open-ended clinical interview reflecting on the study experiences and current life situation provides a clinical context conducive to the spontaneous reporting of study-associated adverse events. To date, there have been no reports of persisting perceptional phenomena sometimes attributed to hallucinogen use or of recreational abuse of hallucinogens, and all participants appear to continue to be high-functioning, productive members of society.

The results of the present study have implications for understanding the abuse of hallucinogens. Although psilocybin is regulated by the federal government under the most restrictive category (Schedule I) of the Controlled Substances Act, the National Institute on Drug Abuse (2001, 2005) does not consider psilocybin and the other classical hallucinogens to be drugs of "addiction" because they do not produce compulsive drug-seeking behavior as do classic addicting drugs such as cocaine, amphetamine, heroin, and alcohol. This conclusion is consistent with observations that psilocybin and other classic hallucinogens do not maintain reliable drug self-administration in animal laboratory models of drug abuse (Griffiths *et al*. 1980; Fantegrossi *et al*. 2004) and that most recreational users of classical hallucinogens decrease or stop their use over time (National Institute on Drug Abuse 2001). In the present study, psilocybin did not produce a classic euphorigenic profile of effects: measures of anxiety and dysphoria (monitor ratings of anxiety: AIA scale on the APZ Questionnaire, LSD scale on the ARCI) were significantly greater after psilocybin than after methylphenidate. However, the present study also shows that, in some people under some conditions, psilocybin can occasion experiences that are rated as highly valued. This seems a likely mechanism underlying the long-term historical use of psilocybin and other hallucinogens such as DMT within some cultures for divinatory or religious purposes.

While there is no indication that carefully monitored clinical exposure of psilocybin to hallucinogen-naïve volunteers results in subsequent abuse (present study; Gouzoulis-Mayfrank, personal communication; Yensen and Dryer, (1992)[1]; Leuner 1981), the epidemic of hallucinogen abuse in the 1960s raises an important cautionary note. Abuse of hallucinogens can be exacerbated under conditions in which hallucinogens are readily available illicitly and the potential harms to both the individual and society are misrepresented or understated. It is important that the risks of hallucinogen use not be underestimated. Even in the present study in which the conditions of volunteer preparation and psilocybin administration were carefully designed to minimize adverse effects, with a high dose of psilocybin 31% of the group of carefully screened volunteers experienced significant fear and 17% had transient ideas of reference/paranoia. Under unmonitored conditions, it is not difficult to imagine such effects escalating to panic and dangerous behavior. Also, the role of hallucinogens in precipitating or exacerbating enduring psychiatric conditions and long-lasting visual perceptual disturbances should remain a topic of research (Abraham *et al*. 1996; Halpern and Pope 1999).

In conclusion, the present study showed that, when administered to volunteers under supportive conditions, psilocybin occasioned experiences similar to spontaneously occurring mystical experiences and which were evaluated by volunteers as having substantial and sustained personal meaning and spiritual significance. The ability to prospectively occasion mystical experiences should permit rigorous scientific investigations about their causes and consequences, providing insights into underlying pharmacological and brain mechanisms, nonmedical use and abuse of psilocybin and similar compounds, as well as the short-term and persisting effects of such experiences.

[1] Yensen R, Dryer D (1992) Thirty years of psychedelic research: the spring grove experiment and its sequels. Unpublished Manuscript. Based on an address to the European College of Consciousness (ECBS) International Congress, Worlds of Consciousness in Gottingen, Germany

Acknowledgements

This research was supported by grants from NIDA (R01 DA03889) and the Council on Spiritual Practices. We thank Dave Nichols, Ph.D., for synthesizing the psilocybin, Mary Cosimano, M.A., for her role as assistant monitor, Brian Richards, Psy.D. and Kori Kindbom, M.A., for psychiatric screening, Heather Cronin for data management, Paul Nuzzo, M.A., for statistical analysis, Matthew W. Johnson, Ph.D., for discussions about the data, and Dr. George Bigelow, Dr. Eric Strain, Dr. Maxine Stitizer, and Dr. Larry Carter for comments on the manuscript. The study was conducted in compliance with US laws.

References

1. Abraham HD, Aldridge AM, Gogia P (1996) The psychopharmacology of hallucinogens. Neuropsychopharmacology 14:285-298
2. Carter OL, Pettigrew JD, Hasler F, Wallis GM, Liu GB, Hell D, Vollenweider FX (2005) Modulating the rate and rhythmicity of perceptual rivalry alternations with the mixed 5-HT2A and 5-HT1A agonist psilocybin. Neuropsychopharmacology 30:1154-1162
3. Chait LD (1994) Reinforcing and subjective effects of methylpheni-date in humans. Behav Pharmacol 5:281-288
4. Costa PT, McCrae RR (1992) Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) professional manual. Psychological Assessment Resources, Odessa, FL
5. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. Pharmacopsychiatry 31 (Suppl 2):80-84
6. Dobkin de Rios M, Janiger O (2003) LSD spirituality and the creative process. Park Street, Rochester, VT
7. Doblin R (1991) Pahnke's Good Friday experiment: a long-term follow-up and methodological critique. J Transpers Psychol 23:1-28
8. Fantegrossi WE, Woods JH, Winger G (2004) Transient reinforcing effects of phenylisopropylamine and indolealkylamine hallucino-gens in rhesus monkeys. Behav Pharmacol 15:149-157
9. Gouzoulis-Mayfrank E, Thelen B, Habermeyer E, Kunert HJ, Kovar KA, Lindenblatt H, Hermle L, Spitzer M, Sass H (1999) Psychopathological, neuroendocrine and autonomic effects of 3,4-methylenedioxyethylamphetamine (MDE), psilocybin and D-methamphetamine in healthy volunteers. Results of an experi-mental double-blind placebo-controlled study. Psychopharmacology (Berl) 142:41-50
10. Griffiths RR, Bigelow GE, Henningfield JE (1980) Similarities in animal and human drug-taking behavior. In: Mello NK (ed) Advances in substance abuse, vol 1. JAI, Greenwich, pp 1 -90
11. Haertzen CA (1966) Development of scales based on patterns of drug effects, using the addiction Research Center Inventory (ARCI). Psychol Rep 18:163-194
12. Halpern JH, Pope HG (1999) Do hallucinogens cause residual neuropsychological toxicity? Drug Alcohol Depend 53:247-256
13. Hasler F, Grimberg U, Benz MA, Huber T, Vollenweider FX (2004) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology (Berl) 172:145-156
14. Hollister LE (1961) Clinical, biochemical and psychologic effects of psilocybin. Arch Int Pharmacodyn Ther 130:42-52
15. Hood RW Jr, Morris RJ, Watson PJ (1990) Quasi-experimental elicitation of the differential report of mystical experience among intrinsic indiscriminatively pro-religious types. J Sci Study Relig 29:164-172
16. Hood RW Jr, Ghorbani N, Watson PJ, Ghramaleki AF, Bing MN, Davison HK, Morris RJ, Williamson WP (2001) Dimensions of the mysticism scale: confirming the three-factor structure in the United States and Iran. J Sci Study Relig 40:691-705
17. Isbell H (1959) Comparison of the reactions induced by psilocybin and LSD-25 in man. Psychopharmacologia 1:29-38
18. Jasinski DR (1977) Assessment of the abuse potential of morphine-like drugs (methods used in man). In: Martin WR (ed) Drug addiction. Springer, Berlin Heidelberg New York, pp 197-258
19. Kollins SH, Rush CR, Pazzaglia PJ, Ali JA (1998) Comparison of acute behavioral effects of sustained-release and immediate-release methylphenidate. Exp Clin Psychopharmacol 6:367-374
20. Leary T, Litwin GH, Metzner R (1963) Reactions to psilocybin administered in a supportive environment. J Nerv Ment Dis 137:561-573
21. Leuner H (1981) Halluzinogene psychische grenzzustande in for-schung und psychotherapie. Hans Huber, Bern
22. Malitz S, Esecover H, Wilkens B, Hoch PH (1960) Some observationson psilocybin, a new hallucinogen, in volunteer subjects. Compr Psychiatry 1:8-17
23. Martin WR, Sloan JW, Sapira JD, Jasinski DR (1971) Physiologic, subjective, and behavioral effects of amphetamine, methamphet-amine, ephedrine, phenmetrazine, and methylphenidate in man. Clin Pharmacol Ther 12:245-258
24. Masters REL, Houston J (1966) The varieties of psychedelic experience. Holt Rinehart & Winston, New York
25. Metzner R (2004) Teonanacatl: sacred mushroom of visions. Four Tree, El Verano, CA
26. Metzner R, Litwin G, Weil G (1965) The relation of expectation and mood to psilocybin reactions: a questionnaire study. Psychedelic Rev 5:3-39
27. National Institute on Drug Abuse (2001) Hallucinogens and dissociative drugs. National Institute on Drug Abuse research report series, NIH publication, volume 01-4209
28. National Institute on Drug Abuse (2005) LSD NIDA infofacts. National Institute on Drug Abuse, Rockville, MD, February 2005

29. Pahnke W (1963) Drugs and mysticism: an analysis ofthe relationship between psychedelic drugs and the mystical consciousness. Ph.D. thesis, Harvard University
30. Pahnke WN (1967) LSD and religious experience. In: DeBold RC, Leaf RC (eds) LSD man & society. Wesleyan University Press, Middletown, CT, pp 60-85
31. Pahnke WN (1969) Psychedelic drugs and mystical experience. Int Psychiatry Clin 5:149-162
32. Piedmont RL (1999) Does spirituality represent the sixth factor of personality? Spiritual transcendence and the five-factor model. J Person 67:985-1013
33. Piedmont RL (2005) Aspires assessment of spirituality and religious sentiments. Technical Manual, Loyola College in Maryland, Columbia, MD
34. Piedmont RL (2006) Cross-cultural generalizability of the Spiritual Transcendence Scale to the Philippines: spirituality as a universal. Ment Health Relig Cult (In press)
35. Piedmont RL, Leach MM (2002) Cross-cultural generalizability of the spiritual transcendence scale in India. Am Behav Sci 45:1886-1899
36. Presti DE, Nichols DE (2004) Biochemistry and neuropharmacology of psilocybin mushrooms. In: Metzner R, Darling DC (eds) Teonanacatl. Four Trees, El Verano, CA, pp 89-108
37. Riba J, Rodriguez-Fornells A, Strassman RJ, Barbanoj MJ (2001) Psychometric assessment of the Hallucinogen Rating Scale. Drug Alcohol Depend 62:215-223
38. Richards WA (1975) Counseling, peak experiences and the human encounter with death: an empirical study of the efficacy of DPT-assisted counseling in enhancing the quality of life of persons with terminal cancer and their closest family members. Ph.D. thesis, Catholic University of America, Washington, DC
39. Richards WA, Rhead JC, DiLeo FB, Yensen R, Kurland AA (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. J Psychedelic Drugs 9:1-10
40. Rinkel M, Atwell CR, Dimascio A, Brown J (1960) Experimental psychiatry. V. Psilocybine, a new psychotogenic drug. N Engl J Med 262:295-297
41. Roberts TB (2001) Psychoactive sacramentals: essays on entheogens and religion. Council on Spiritual Practices, San Francisco, CA
42. Rosenberg DE, Isbell H, Miner EJ, Logan CR (1964) The effect of N, N-dimethyltryptamine in human subjects tolerant to lysergic acid diethylamide. Psychopharmacologia 5:217-227
43. Rush CR, Kollins SH, Pazzaglia PJ (1998) Discriminative-stimulus and participant-rated effects of methylphenidate, bupropion, and triazolam in D-amphetamine-trained humans. Exp Clin Psychopharmacol 6:32-44
44. Smith H (1964) Do drugs have religious import? J Philos 61:517-530
45. Smith H (2000) Cleansing the doors of perception: the religious significance of entheogenic plants and chemicals. Tarcher/ Putnam, New York
46. Spilka B, Hood RW, Hunsberger B, Gorsuch R (2005) The psychology of religion: an empirical approach, 3rd edn. Guilford, New York
47. Stace WT (1960) Mysticism and philosophy. Lippincott, Philadelphia
48. Stamets P (1996) Psilocybin mushrooms of the world: an identification guide. Ten Speed, Berkeley, CA
49. Stolaroff MJ (2001) A protocol for a sacramental service. In: Roberts TB (ed) Psychoactive sacramentals: essays on entheogens and religion. Council on Spiritual Practices, San Francisco, CA
50. Strassman RJ, Qualls CR, Uhlenhuth EH, Kellner R (1994) Dose-response study of N, N-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry 51:98-108
51. Turek IS, Soskin RA, Kurland AA (1974) Methylenedioxyamphet-amine (MDA) subjective effects. J Psychedelic Drugs 6:7-14
52. Vollenweider FX, Vollenweider-Scherpenhuyzen MFI, Babler A, Vogel H, Hell D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 9:3897-3902
53. Wasson RG (1980) The wondrous mushroom: mycolatry in Meso-america. McGraw-Hill, New York
54. Watson D, Clark LA (1994) The PANAS-X manual for the positive and negative affect schedule-expanded form. The University of Iowa, Iowa City, Iowa
55. Watson D, Clark LA (1997) Measurement and mismeasurement of mood: recurrent and emergent issues. J Pers Assess 68:267-296
56. Wolbach AB Jr, Miner EJ, Isbell H (1962) Comparison of psilocin with psilocybin, mescaline and LSD-25. Psychopharmacologia 3:219-223
57. Wulff DM (1991) Psychology of religion; classic and contemporary views. Wiley, New York

Commentary on: Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance by Griffiths et al.

by

Charles R. Schuster, Herbert D. Kleber, Solomon H. Snyder, David E. Nichols, Harriet de Wit

original source: http://www.maps.org/research-archive/cluster/psilo-lsd/commentaries_griffiths.pdf
backup source: http://www.psilosophy.info/resources/commentaries_griffiths.pdf
original source: http://www.hopkinsmedicine.org/Press_releases/2006/GriffithsCommentaries.pdf
backup source: http://www.psilosophy.info/resources/GriffithsCommentaries.pdf

Table of Contents:

- Charles R. Schuster
  - *Reference*
- Herbert D. Kleber
  - *References (Kleber)*
- Solomon H. Snyder
- David E. Nichols
  - *References (Nichols)*
- Towards a science of spiritual experience (Harriet de Wit)

Charles R. Schuster

Received: 11 May 2006 / Accepted: 27 May 2006

C. R. Schuster
Department of Psychiatry and Behavioral Neuroscience,
Wayne State University School of Medicine,
Detroit, MI 48207, USA
e-mail: cschust@med.wayne.edu

The study by Griffiths *et al*. is noteworthy both for the rigorousness of its design and execution, as well as the clarity of its results. It demonstrates that psilocybin can be safely studied in normal human beings who do not have a history of hallucinogenic drug use. As would be expected, during the psilocybin session participants showed perceptual changes and labile mood. It is striking that majority of the participants reported 2 months later that the psilocybin-induced experience was personally very meaningful and spiritually significant. Indeed, most of them rated the psilocybin-induced experience as one of the top five most important experiences in their life. It is especially notable that participants reported that the drug produced positive changes in attitudes and behaviors well after the sessions, and these self-observations were consistent with ratings by friends and relatives. These participants were well-prepared for the psilocybin experience by an experienced monitor, who expressly stated that psilocybin might produce increased personal awareness and insight. However, it is clear that the effects of psilocybin were more than expectancy effects because the active drug control condition (40 mg of methylphenidate) did not produce similar effects on ratings of significance or on measures of spirituality, positive attitude, or behavior.

The term psychedelic, when applied to drugs, implies that the drug experience is "mind-expanding." The paper by Griffiths *et al*. illustrates the accuracy of this description for psilocybin, and I hope that this landmark paper will also be "field-expanding." The report clearly demonstrates that we can objectively study the experiences reported by many to be profoundly spiritual and meaningful, and that we can investigate the long-term positive consequences for the individual's attitudes and behavior. It will open the way to study the neural mechanisms responsible for these drug-altered states of consciousness. It is entirely conceivable that psychotropic agents that produce these experiences may have a role in the treatment of addictive states. Spirituality has long been a major component of the 12- step approach to the treatment of alcoholism and other forms of drug addiction. Although the investigations of LSD for the treatment of alcoholism failed to show any clear-cut significant beneficial effects, the possibility that a spiritual experience, such as that reported in the present study, might be useful cannot be discounted. The set and setting in which the drug is administered may dramatically alter the drug experience. In the present study by Griffiths *et al.*, the set was well-established for a positive experience by the preparatory sessions with the monitor, and the setting was one that was designed to produce an introspective state. This may be an important determinant of the experience and could well alter any possible therapeutic efficacy. The possibility of easing the ennui and anguish of impending death with agents such as psilocybin is also suggested in the study by Kast (1966) and those that are reviewed in the commentary of Professor Nichols. It is likely that psilocybin might have the same salutary effects. This is not an insignificant issue especially considering the large numbers of aging individuals in our society who may be in need of hospice care.

In summary, I hope that this paper by Griffiths *et al*. renews interest in a fascinating and potentially useful class of psychotropic agents. The misuse of these substances that led to their control in Schedule I of the Controlled Substances Act cannot be allowed to continue to curtail their use as tools for understanding the neurobiology of human consciousness, self-awareness, and their potential as therapeutic agents. Personally, I also believe that these drugs have a role in discovering the brain mechanisms underlying feelings of spirituality and that such understanding may lead to our investigation of nonpharmacological means of engendering such states. Ultimately, human consciousness in its ever-changing state is a function of the ebb and flow of neural impulses interacting in the various regions of the brain-the very substrate that drugs such as psilocybin act upon. Understanding the brain mechanisms mediating these effects is clearly within the realm of neuroscience and deserves further intensive investigation. Griffiths *et al*. are to be highly commended for reinvigorating this important area of research.

Reference

1. Kast E (1966) LSD and the dying patient. Chic Med Sch Q 26:80–87

Table of Contents

Herbert D. Kleber

Received: 24 May 2006 / Accepted: 27 May 2006

H. D. Kleber
College of Physicians and Surgeons, Columbia University,
New York, USA
e-mail: hdk3@columbia.edu

H. D. Kleber
Division on Substance Abuse,
New York State Psychiatric Institute,
1051 Riverside Drive, Unit 66, Room 3713,
New York, NY 10032, USA

The decade of the 1960s began the current era of heavy drug use in America, beginning perhaps with Timothy Leary's Pied Piper invitation to, "Turn On, Tune In, Drop Out" (with psychedelic drugs). While fortunately most youths who experimented did not suffer lasting damage, those of us on the mental health front lines at the time saw a number of casualties (Kleber 1967). Eventually, the hippies and the LSD-fueled "Summer of Love" in San Francisco were replaced by motorcycle gangs, amphetamines, and gratuitous violence. Psychedelic drugs receded into a permanent background of US drug use, never going away altogether, but not reaching the same penetration.

Unfortunately, one of the lasting casualties of the street use of these agents was research. Sandoz, the manufacturer of LSD, discontinued supplying it to researchers around 1965, concerned that the company's reputation was being tainted by the illicit use. Even though street chemists supplied the vast majority of the illicit use, the licit supply for research more or less disappeared and so did research funding. Prior to the cessation, research with LSD and other psychedelics was active in a variety of areas: as a potential producer of a model psychosis (it has significant limitations); the nature of hallucinations (it produces more illusions); as a therapeutic agent for trauma and the dying (inadequate data); and as a way to study altered reality states, e.g., Huxley's *The Doors of Perception*, Pahnke's Good Friday Experiment, and *Blum's Utopiates: The Use and Users of LSD-25*. Some of the research was carefully done; in most, the researchers seem to be carried away by the effects of the agents.

This category of agents has many names, each reflecting a different point of view as noted above: psychotomimetics (mimicking psychosis), hallucinogens (producing hallucinations), entheogens (revealing the God within), and psychedelics (mind-manifesting). It is in these last two domains that the findings of the study of Griffiths *et al*. belong to even though they did not use either term.

The authors should be commended for the way they designed and carried out the double-blind project. The design involved using 30 mg/70 kg of psilocybin as the active experimental agent and 40 mg/70 kg of methylphenidate as an active control. All subjects received at least one session with each agent in a counterbalanced method. Great care was taken both to minimize risk to subjects, who were all naïve to this category of drugs, and to be able to separate drug effects from expectancy and possible suggestion bias by the monitors. The blinding was done so carefully that even the experienced monitors misidentified the administered agent approximately one quarter of the time. The extensive time with the monitors both before and after the sessions kept adverse effects such as fear and panic to a minimum although 8 of the 36 subjects described all or most of the psilocybin sessions to be dominated by anxiety or dysphoria. These effects did not persist beyond the session, were handled by reassurance, and apparently were of no lasting negative consequence. None of the methylphenidate subjects reported this response. As far as positive effects were concerned, psilocybin increased measures relating to mystical experiences: 22 of the 36 volunteers had a "complete" mystical experience after psilocybin compared to only 4 of the 36 after methylphenidate. At the 2-month follow-up, 67% rated the psilocybin experience to be either "The single most meaningful experience" of their lives or among the top five most meaningful "experiences." After methylphenidate, 8% of the volunteers rated the experience to be "among the top five most meaningful experiences," with none rating it as the single most meaningful experience. Thus, psilocybin significantly increased subjective reports of such experiences while methylphenidate was associated with them only occasionally and to a much lesser effect.

As far as future research is concerned, this study suggests a number of possibilities, both basic and translational, that should merit NIH support. More information is needed on dose effects, subject differences, and the actions of various selective antagonists. Neuroimaging may shed light on sites and mechanisms of action. It would be interesting to see whether the positive responders to methylphenidate activated similar brain sites as the positive psilocybin responders or different ones, as well as what was happening in the brains of the psilocybin nonresponders. From a translational perspective, experienced clinicians are well aware of the profound role that spiritual reawakening experiences, whether achieved through Alcoholics Anonymous, traditional religious venues, or some life experience, can have on successful outcomes from addictive disorders. Increased knowledge about the neuroscience underpinnings of such transformational events could improve drug abuse treatment. It is necessary to keep in mind, however, that drug-induced states are unlikely to have lasting effects in inadequately prepared individuals, as LSD studies on alcoholism in the 1960s suggested.

The positive findings of the study cannot help but raise concern in some that it will lead to increased experimenting with these substances by youth in the kind of uncontrolled and unmonitored fashion that produced casualties over the past three decades. Such a concern, in view of history, is not unwarranted. Even a proponent of such research, Humphry Osmond, who coined the term "psychedelic," noted, "Psychedelics are instruments and like most of our artifacts are capable of being used well or ill. Unluckily, misuse is at least as likely as good use..."

Any study reporting a positive or useful effect of a drug of abuse raises these same concerns. In this Internet age, however, where youth are deluged with glowing personal reports in chat rooms and web sites as well as detailed information about the various agents and how to use them, it is less likely that a scientific study would move the needle much. Psychedelic drug use has remained in a relatively constant range over the past three decades as various fads have come and gone and enthusiastic personal accounts are balanced by negative reports about casualties. Discovering how these mystical and altered consciousness type states arise in the brain could have major therapeutic possibilities, e.g., treatment of intolerable pain, treatment of refractory depression, amelioration of pain and suffering of the terminally ill, to name but a few, as well as the already noted and needed improvement in treatment of substance abuse and dependence states so that it would be scientifically shortsighted not to pursue them.

References (Kleber)

1. Kleber HD (1967) Prolonged adverse reactions from unsupervised use of hallucinogenic drugs. J Nerv Ment Dis 144(4):308-319
2. Blum R et al (1964) Utopiates: the use and users of LSD-25. Atherton, NY
3. Huxley A (1954) The doors of perception. Harper & Row
4. Osmond H (1993) In a letter quoted in "Entheogens and the future of religion" In: Forte R (ed) Council on spiritual practices (1997). CSP, San Francisco, p 152
5. Pahnke WN (1969) Psychedelic drugs & mystical experience. Int Psychiatry Clin 5:149-162

Solomon H. Snyder

Received: 6 May 2006 / Accepted: 27 May 2006

S. H. Snyder
The Solomon H. Snyder Department of Neuroscience,
Johns Hopkins University School of Medicine,
725 N. Wolfe Street, WBSB 813,
Baltimore, MD 21205-2185, USA
e-mail: ssnyder@jhmi.edu

S. H. Snyder
The Department of Pharmacology and Molecular Sciences,
Johns Hopkins University School of Medicine,
Baltimore, MD 21205-2185, USA

S. H. Snyder
The Department of Psychiatry and Behavioral Sciences,
Johns Hopkins University School of Medicine,
Baltimore, MD 21205-2185, USA

Psychedelic drugs such as psilocybin, lysergic acid diethylamide (LSD), mescaline, dimethyltryptamine (DMT), and many others include synthetic chemicals and the active ingredients in psychoactive extracts of plants that have been used since time immemorial for their mind-altering properties. These agents were first employed for religious purposes, evidently to facilitate contact with the supernatural. After the discovery of LSD by Albert Hofmann in the early 1940's, much attention was devoted to the perceptual distortions elicited by LSD and related substances, as well as to the similarity of the drug-induced state to transcendental states reported by mystics of varied religious persuasions.

The different effects elicited by these drugs have led to different names. They are designated "psychotomimetics" because one can reasonably argue that individuals taking the drugs have lost contact with reality and are, hence, psychotic. They are called "hallucinogens" because of the perceptual distortions. However, frank hallucinations - seeing or hearing something that doesn't exist at all in the environment - are rare. Rather, visual and auditory perceptions are notably intensified and altered. Subjects report synesthesia, a seeming transmutation of the senses, e.g., visualizing sound waves upon hearing a loud noise. Humphrey Osmond coined the term "psychedelic" meaning "mind-manifesting" to emphasize the extraordinary change in the sense of self, a feeling of communion with the infinite, a dissolution of ego boundaries with the self, seeming to merge with environment. These are arguably the most remarkable of all the drug effects and may teach us much about neurochemical systems that mediate our sense of consciousness. Hence, I prefer the term psychedelic despite this term's possibly connoting the irresponsible use of these drugs by some in the late 1960s. In the interests of full disclosure, I myself had single sessions each with LSD and DMT well over 40 years ago and experienced the effects described here. Numerous clinical studies with psychedelic drugs were conducted in the 1950s and 1960s. One of the few controlled investigations of the relationship of psychedelic drugs and mystical consciousness was carried out by Walter Pahnke as his doctoral dissertation at Harvard University. He utilized psilocybin, the psychoactive ingredient in the mushroom psilocybe, which for logistic reasons, has been the most widely employed psychedelic drug in clinical research. Psychedelic drugs vary in chemical structure with mescaline, (DOM), and 3,4-methylenedioxymethamphetamine (MDMA or Ecstasy), being phenethylamines that resemble neurotransmitters such as norepinephrine and dopamine. Others, such as psilocybin, LSD, and DMT, contain indole moieties and more closely resemble serotonin. Extensive pharmacologic studies have established that all the drugs, phenethylamines and indoles, exert their actions primarily by mimicking serotonin at one of its receptor subtypes, 5-$HT_{2A,C}$. In the Pahnke "Good Friday" study, groups of ten theological seminary students were administered either 30 mg psilocybin or 200 mg nicotinic acid in a group setting as part of a religious service. Psilocybin consistently elicited a mystical experience not evident with nicotinic acid.

The rampant abuse of psychedelic drugs in the late 1960s led to strict controls with such severe restrictions that clinical and even laboratory research virtually vanished. Griffiths *et al*. now report a rigorous, blinded study of mystical experiences associated with psilocybin. Exquisite care was devoted to the design of the trial to minimize risk to subjects and to discriminate drug effects from the influences of suggestion. Participants were emotionally stable, generally middle-aged college graduates. They received either 30 mg of psilocybin or 40 mg of methylphenidate (Ritalin) per 70 kg, with each subject receiving the two drugs in separate sessions. Most important was the careful preparation with study monitors meeting with subjects on multiple occasions before and after each drug session. Such a setup was designed to diminish the likelihood of panic and to facilitate each subject's acceptance of major changes in consciousness. Subjects were administered an extensive array of questionnaires evaluating potential mystical experiences and they were followed up in depth 2 months later. One striking result was the effectiveness of the blinding procedure, which is often virtually impossible for psychoactive agents. Surprisingly, even the sophisticated monitors mistook one of the drugs for the other in about 25% of the sessions. Thus, the study results are not likely to be contaminated by expectant attitudes and biases of experimenters and/or subjects.

Psilocybin elicited what one would expect, perceptual distortions including visual distortions, feelings of transcendence, and a high incidence of mystical experiences, substantially greater than in the Pahnke study. Particularly impressive was the persistence of influences of psilocybin upon subjects' sense of their selves. When interviewed 2 months after the drug session, subjects reported that psilocybin enhanced their attitudes about life in general, their mood and relationships with others. Most remarkable was the sentiment of two-thirds of the subjects that the psilocybin experience was either the "single most meaningful experience of his/her life or among the top five most meaningful experiences of his/her life."

What are the major take-home messages of the Griffiths *et al*. investigation? The ability of these researchers to conduct a double-blind, well-controlled study tells us that clinical research with psychedelic drugs need not be so risky as to be off-limits to most investigators. Indeed, there were very few adverse events acutely and none at the 2-month and 1-year follow-ups.

The observation that psilocybin reliably elicits a transcendent, mystical state tells us that investigations of these drugs may help us understand molecular alterations in the brain that underlie mystical religious experiences. Religious sensibilities are increasingly prominent throughout the world and often involve "born again" ineffable experiences analogous to psychedelic drug effects. Thus, seeking the "locus of religion" in the brain is by no means fanciful. We already have a hint in evidence that psychedelic drugs act by mimicking serotonin at $5HT_{2A,C}$ receptors. The major serotonin neuronal projections in the brain have their cell bodies in midline brainstem structures called the raphe nuclei, which receive input from neuronal input for the major senses. Accordingly, it is not far-fetched to ascribe to altered serotonin neurotransmission the subjective interconversion of senses that occurs with synesthesia. As the boundaries of our sense of self, our ego, are determined by the integration of sensory perception, it is conceivable that changes in serotonin systems mediate the diffusion of ego boundaries that underlies the transcendent merger of "self with universe" that is reported consistently by mystics of all religious persuasions and occurs often under the influence of psychedelic drugs.

By showing that one can responsibly conduct clinical research with psychedelic drugs and by confirming the mystical influences of these agents, Griffiths *et al*. may help resurrect psychedelic drugs as major tools in probing the molecular bases of consciousness.

David E. Nichols

Received: 3 May 2006 / Accepted: 27 May 2006

D. E. Nichols
Department of Medicinal Chemistry and Molecular
Pharmacology, Purdue University School of Pharmacy
and Pharmaceutical Sciences,
West Lafayette, IN 47907, USA
e-mail: drdave@pharmacy.purdue.edu

The article by Griffiths *et al*. in this issue of Psychopharmacology should make all scientists interested in human psychopharmacology sit up and take notice. It is the first well-designed, placebo-controlled, clinical study in more than four decades to examine the psychological consequences of the effects of the hallucinogenic (psychedelic) agent known as psilocybin. In fact, one would be hard-pressed to find a single study of psychedelics from any earlier era that was as well-done or as meaningful. Perhaps more importantly, despite the notion by many people that psychedelics are nothing more than troublesome drugs of abuse, the present study convincingly demonstrates that, when used appropriately, these compounds can produce remarkable, possibly beneficial, effects that certainly deserve further study.

Although many people seem to believe that "psychedelics" simply appeared during the turbulent 1960s, in fact the use of these materials spans back through many millennia of human history. Ancient substances with names such as *Soma* (India), Kykeon (Greece), and *Teonanacatl* (South America) served for thousands of years as psychopharmacological catalysts in a variety of sacred religious and magical rituals (Nichols 2004; Schultes and Hofmann 1979). Peyote, the ceremonial use of which is now thought by anthropologists to date back at least 5,000 years, is revered as a sacrament by the Native American Church. Ayahuasca, a decoction made from plants that grow in the Amazon basin, is a sacrament used by a syncretic church in Brazil. This church has a small following in the US that has just received a favorable decision by the US Supreme Court allowing them continued use of this material.

The parallel between mystical states and the effects of psychedelic drugs is well-known among those familiar with the literature. Aldous Huxley, in his classic but controversial 1954 book, *The Doors of Perception*, (Huxley 1970) noted the similarity of his own mescaline-induced state to experiences described by mystics and visionaries from a variety of cultures. Perhaps it is not surprising then that the name "entheogen," with the connotation that these materials reveal god within, is becoming increasingly popular among those who continue to use these substances for purposes that are neither medical nor "recreational."

We must, therefore, take note of what has come to be known as the "Good Friday Experiment," carried out by Walter Pahnke for his Ph.D. studies at a small private chapel in Boston. His 1963 Ph.D. dissertation was titled *Drugs and Mysticism. An analysis of the relationship between psychedelic drugs and the mystical consciousness*. He described in an experiment with 20 student volunteers from a local Christian theological seminary. Subjects were given either 30 mg of psilocybin or 200 mg of nicotinic acid as a "placebo." The experiment was carried out in a religious setting during a Good Friday service. Pahnke concluded, "Under the conditions of this experiment, those subjects who received psilocybin experienced phenomena which were indistinguishable from, if not identical with, certain categories defined by our typology of mysticism."

Clearly, these substances have profound effects on human consciousness, and in the 1950s and 1960s, the drug known as LSD was hailed as a revolutionary new technology for psychiatry. LSD was intensively investigated for its medical potential and for possible use as an adjunct to psychotherapy until clinical research was abruptly halted by laws passed in response to concerns over widespread recreational use. Despite studies that involved tens of thousands of patients, using "therapeutic" approaches that employed LSD in a variety of ways, little of clear significance resulted, at least partly due to faulty experimental design and data analysis. As a consequence, a conventional wisdom seems to have developed that psychedelic drugs are generally pretty worthless. But medical technology has advanced in the past four decades; we know quite a bit more about the brain now than we did then, and human experimental methods are certainly much better.

All that being said, there was one indication for the use of psychedelics, particularly LSD, that was reasonably well-documented. Chicago internist Eric Kast first reported in 1964 that some "gravely ill" patients treated with LSD obtained mood elevation and reductions in the need for pain medication that lasted for nearly 2 weeks after the drug, and that some patients "displayed a peculiar disregard for the gravity of their situations" (Kast and Collins 1964). In a subsequent study, he further noted that, "Patients who had been listless and depressed were touched to tears by the discovery of a depth of feeling they had not thought themselves capable" (Kast 1966).

Kast's findings served as the foundation for a series of groundbreaking studies into the value of LSD in the treatment of terminal cancer patients. That work was carried out at the Maryland Psychiatric Research Center in Baltimore, Maryland by Drs. Stanislav Grof, Al Kurland, Walter Pahnke, Sanford Unger, and their colleagues (Grof *et al*. 1973; Pahnke *et al*. 1969, 1970a,b). Significantly reduced need for analgesics and improved mood and quality of life were observed in 60-70% of patients treated with LSD. The treatment response appeared to be correlated with the extent to which the patients experienced a mystical or transcendental state. That is, those who experienced the most profound LSD-induced states seemed to gain the most improvement. The basis for this benefit appeared to be related to a reduced or abolished fear of death, with an attendant reduction in anxiety, which we know affects subjective pain.

What Griffiths *et al*. have done in their present work represents an important extension of Pahnke's "Good Friday" experiment. They have used proper controls, better experimental design, and have provided a better analysis of the experience using more modern instruments. The experiments were not conducted in a church, or in a venue that would lead to a strong expectation of some sort of religious experience. The subjects in the Griffiths *et al*. study were not theology students, but were simply ordinary people with an interest in spiritual things. The work by Griffiths *et al*. demonstrates that, under appropriate experimental conditions, psilocybin occasioned experiences similar to spontaneously occurring mystical states. Most importantly, some of the persisting positive changes in attitudes and behavior reported by subjects were confirmed by independent ratings from community observers such as family members or friends.

The prospects for far-ranging scientific advancement are exciting. We know that psychedelics have powerful effects in many areas of the brain that are critically important for cognition and awareness. Our present understanding is that they act principally by activating serotonin 5-HT$_{2A}$ receptors, especially those densely expressed on the apical dendrites of cortical pyramidal cells, the quintessential computational units within the cortex of the brain. In that respect, psychedelics depolarize these cortical cells, leading one to speculate that they may become more sensitive to low-level signals. That is, perhaps they can do more with less, potentially amplifying processes that are normally running, but which are not generally apparent in everyday awareness.

The science of pharmacology involves perturbing biological systems with chemical modulators (i.e., drugs), the results of which have had profound effects on our understanding of both normal and disease state physiology. Rigorous research with psychedelics may hold the key to understanding the very nature of consciousness, self-awareness, the ability to introspect, and the properties of mind that set us apart from other species.

With such a huge potential impact, is there any good reason why a well-done study like the one reported here by Griffiths *et al*. should appear only once in half a century? Until a related compound, DMT, was studied by Rick Strassman at the University of New Mexico in the mid- 1990s (Strassman and Qualls 1994; Strassman *et al*. 1994; Strassman 1996), no significant work on the clinical effects of psychedelics had appeared in the scientific literature for more than a generation. Perhaps the time has now come to reinvestigate the psychopharmacological properties of psychedelics. Thus, the study by Griffiths *et al*. in this issue could be a watershed event.

Finally, Griffiths *et al*. conclude, "The ability to occasion such experiences prospectively will allow rigorous scientific investigations of their causes and consequences." Indeed.

References (Nichols)

1. Grof S, Goodman LE, Richards WA, Kurland AA (1973) LSD-assisted psychotherapy in patients with terminal cancer. Int Pharmacopsychiatry 8:129-144
2. Huxley A (1970) The Doors of Perception. Perenial Library, New York
3. Kast E (1966) LSD and the dying patient. Chic Med Sch Q 26:80-87
4. Kast EC, Collins VJ (1964) Lysergic acid diethylamide as an analgesic agent. Anesth Analg 43:285-291 Psychopharmacology
5. Nichols DE (2004) Hallucinogens. Pharmacol Ther 101:131-181
6. Pahnke WN, Kurland AA, Goodman LE, Richards WA (1969) LSD-assisted psychotherapy with terminal cancer patients. Curr Psychiatr Ther 9:144-152
7. Pahnke WN, Kurland AA, Unger S, Savage C, Grof S (1970a) The experimental use of psychedelic (LSD) psychotherapy. JAMA 212:1856-1863
8. Pahnke WN, Kurland AA, Unger S, Savage C, Wolff MC, Goodman LE (1970b) Psychedelic therapy (utilizing LSD) with cancer patients. J Psychedelic Drugs 3:63-75
9. Schultes RE, Hofmann A (1979) Plants of the gods. Origins of hallucinogenic use. Alfred van der Marck Editions, New York
10. Strassman RJ (1996) Human psychopharmacology of N,N-dimethyltryptamine. Behav Brain Res 73:121-124
11. Strassman RJ, Qualls CR (1994) Dose-response study of N,Ndimethyltryptamine in humans. I. Neuroendocrine, autonomic, and cardiovascular effects. Arch Gen Psychiatry 51:85-97
12. Strassman RJ, Qualls CR, Uhlenhuth EH, Kellner R (1994) Dose-response study of N,N-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry 51:98-108

Table of Contents

Towards a science of spiritual experience (Harriet de Wit)

Received: 24 May 2006 / Accepted: 27 May 2006

Harriet de Wit
Department of Psychiatry, The University of Chicago,
MC3077, 5841 S. Maryland Avenue,
Chicago, IL 60637, USA
e-mail: hdew@midway.uchicago.edu

People have long sought meaning and significance in their lives through a variety of spiritual practices including prayer, fasting, chanting, solitude, and meditation. Historically, some of these practices have included the use of certain psychoactive plants. A common theme of these experiences, with or without the aid of psychoactive agents, has been to free oneself of the bounds of everyday perception and thought in a search for universal truths and enlightenment. To a large extent, this type of subjective and uniquely human experience has enjoyed little credibility in the mainstream scientific world and, thus, has been given little scientific attention. However, it may be time now to recognize these extraordinary subjective experiences, even if they are, at present, not directly verifiable by objective measures and even if they sometimes involve claims about ultimate realities that lie outside the purview of science.

The article by Griffiths *et al*. describes one of the first attempts to study these experiences in a systematic scientific investigation of the reportedly profound and sometimes life-altering experiences induced by the powerful hallucinogen psilocybin. Their study is unique in several ways. First, it applies rigorous, modern methods of psychopharmacological research, including use of controlled, double-blind drug administration with a positive control drug and counterbalanced orders, standardized and replicable testing conditions, and sensitive outcome measures. Second, the study was conducted in specially designed environment, where the drug effects could be experienced safely yet unconstrained by an unnecessarily impersonal laboratory or clinical setting. Third, this is the first modern psychopharmacology study to focus, with healthy volunteers, upon experiences of deeply meaningful insights and understanding. Finally, the study is unique in that the investigators have also begun to study the lasting, life-changing effects that have been attributed to such experiences, using systematic follow-up assessments of mood and overt behavioral changes in the participants' lives.

The Editors invited commentaries from four experts to put this study in a larger context. These commentaries by Drs. Solomon Snyder, Charles R. Schuster, Herbert Kleber, and David Nichols provide a context for the study in terms of the history, policy, psychiatry, and future research. They relate this study historically to previous studies with hallucinogens and discuss the implications for drug and drug research policy. They discuss this class of drugs in terms of potentially adverse psychiatric consequences and also in terms of potential therapeutic applications. The commentaries identify important future directions for research on the neurochemistry and neurobiology of these drugs and these experiences. Taken together, these commentaries indicate that the Griffiths *et al*. study will likely take an important place in the history of human psychopharmacology research.

It is time for psychopharmacologists to open their minds and their laboratories to the full domain of human drug experience. We would do well to be wary of our own preconceptions and prejudgments, and to be prepared to consider the entire scope of human experience and behavior as legitimate targets for systematic and ethical scientific investigation. Griffiths *et al*. set an excellent example for such a venture.

Mystical Experiences Occasioned by the Hallucinogen Psilocybin Lead to Increases in the Personality Domain of Openness

by

Katherine A. MacLean[1], Matthew W. Johnson[1] oraz Roland R. Griffiths[1,2]

Published in final edited form as: J Psychopharmacol. 2011 November ; 25(11): 1453-1461.
doi:10.1177/0269881111420188.

original source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3537171/pdf/nihms-430337.pdf
backup source: http://www.psilosophy.info/resources/nihms-430337.pdf

[1] Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, MD, USA.
[2] Department of Neuroscience, Johns Hopkins University School of Medicine, Baltimore, MD, USA.
Autor korespondencyjny: Katherine MacLean, 5510 Nathan Shock Drive, Baltimore, MD 21224-6823, USA, e-mail; katherine.a.maclean (@t) gmail.com

Please address correspondence to: Katherine MacLean, 5510 Nathan Shock Drive, Baltimore MD 21224-6823, USA, katherine.a.maclean@gmail.com, Tel. +1 410 550-3075, Fax +1 410 550-0030.

Table of Contents:

- **Abstract**
- **Methods**
  - Participants
  - Psilocybin sessions
  - Measures
  - Analysis
- **Results**
  - Changes in personality following the psilocybin session
  - Relationship between session-day effects and changes in Openness
  - Effect of mystical experience on changes in openness
  - Follow-up
- **Discussion**
- **Acknowledgments**
- **References**

Abstract

A large body of evidence, including longitudinal analyses of personality change, suggests that core personality traits are predominantly stable after age 30. To our knowledge, no study has demonstrated changes in personality in healthy adults after an experimentally manipulated discrete event. Intriguingly, double-blind controlled studies have shown that the classic hallucinogen psilocybin occasions personally and spiritually significant mystical experiences that predict long-term changes in behaviors, attitudes and values. In the present report we assessed the effect of psilocybin on changes in the five broad domains of personality - Neuroticism, Extroversion, Openness, Agreeableness, and Conscientiousness. Consistent with participant claims of hallucinogen-occasioned increases in aesthetic appreciation, imagination, and creativity, we found significant increases in Openness following a high-dose psilocybin session. In participants who had mystical experiences during their psilocybin session, Openness remained significantly higher than baseline more than one year after the session. The findings suggest a specific role for psilocybin and mystical-type experiences in adult personality change.

Keywords: hallucinogen; mystical experience; openness; personality; psilocybin; psychedelic.

Psilocybin and other classic hallucinogens with actions mediated at the 5-HT_{2A} receptor site (Glennon *et al.*, 1984; Nichols, 2004) produce a unique profile of subjective effects including robust changes in perception, cognition, affect, volition, and somaesthesia (Isbell, 1959; Wolbach *et al.*, 1962; Rosenberg *et al.*, 1964). In early trials of hallucinogens administered under supportive conditions, 50 - 80% of participants claimed lasting beneficial changes in personality, values, attitudes and behavior (Metzner and Editors, 1963; McGlothlin and Arnold, 1971). Some of the most frequent subjective reports included greater appreciation of music, art and nature, greater tolerance of others, and increased creativity and imagination (McGlothlin *et al.*, 1967). Consistent with these findings, Studerus *et al*. (2010) recently reported that nearly 40% of participants in several laboratory studies of psilocybin claimed positive long-term changes in aesthetic experience and in their relationship with the environment (i.e., nature) following their psilocybin sessions.

The long-term positive impact of hallucinogens may depend on their ability to occasion profound insights and mystical-type experiences (Pahnke, 1963; Doblin, 1991). The core features of *mystical experience*, as defined by Stace (1960) and Hood (2003), are feelings of unity and interconnectedness with all people and things, a sense of sacredness, feelings of peace and joy, a sense of transcending normal time and space, ineffability, and an intuitive belief that the experience is a source of objective truth about the nature of reality. Because such experiences appear to enable individuals to transcend their usual patterns of thinking, feeling, and acting, it is plausible that they could occasion changes in core dimensions of personality. In support of this, a double-blind controlled study by Griffiths *et al*. (Griffiths *et al.*, 2006; Griffiths *et al.*, 2008) demonstrated that a single psilocybin session occasioned mystical experiences associated with positive changes in behaviors, attitudes and values more than a year later. Moreover, independent ratings from participants' romantic partners, coworkers, and friends corroborated the first-person reports. These findings suggest fundamental changes in personal concerns, goals, and identity, which are considered to be important dimensions of personality (e.g., in the framework described in McAdams, 1995). However, the impact of psilocybin-occasioned mystical experience on core personality traits is unknown.

There is general agreement that personality traits are relatively enduring styles of thinking, feeling, and acting (McCrae and Costa, 1997). The most widely accepted model of personality structure is the five-factor model, which describes five broad domains of personality each encompassing many related traits: Neuroticism, Extroversion, Openness, Agreeableness and Conscientiousness (Digman, 1990; McCrae, 2009). Many studies have confirmed that these personality factors are heritable (Bouchard *et al.*, 1990) and reliable across cultures, suggesting a universal human personality structure that is rooted in biology (McCrae and Costa, 1997). Longitudinal studies have shown that individual personality is predominantly stable across the lifespan. Although there are mean-level personality changes after age 30, these shifts are typically gradual and subtle (1 - 2 *T*-score points per decade; Terracciano *et al.*, 2005).

Despite the relatively stable nature of personality, researchers have hypothesized that significant life events could change adult personality quite dramatically. Studies investigating individual differences in personality-trait change have found that certain life experiences are associated with changes in adult personality (see review in Roberts and Mroczek, 2008). For example, personality changes have been associated with divorce (e.g., increases in Extroversion and Openness in women, Costa *et al.*, 2000), remarriage (e.g., decreases in Neuroticism in men, Mroczek and Spiro, 2003), and career success (e.g., decreases in Conscientiousness in individuals who were fired vs. promoted, Costa *et al.*, 2000). However, such correlational studies cannot address the causal link between particular events and subsequent personality change.

Relatively little research has investigated personality change in the laboratory, likely because events that might be expected to change personality are difficult to create under experimental (i.e., randomized or assigned) conditions. Some studies have shown changes in personality after experimental treatment interventions in patients, such as several weeks of antidepressant medication (e.g., Costa *et al.*, 2005) and intensive outpatient counseling for substance abuse rehabilitation (Piedmont, 2001). Personality changes have also been shown in healthy adults after three months of intensive contemplative training in attention- and emotion-regulation (Sahdra *et al.*, 2011). These personality changes, as well as socioemotional and behavioral improvements, were maintained several months after completion of training, suggesting possible long-term benefits.

To our knowledge, no study has prospectively demonstrated personality change in healthy adults after an experimentally manipulated discrete event. Although it has been speculated that treatment with classic hallucinogens could be a method for occasioning dramatic and rapid personality change (Unger, 1964), a controlled study of LSD in healthy volunteers failed to find significant changes in a large battery of empirical measures of personality, aesthetic sensitivity, and creativity six months after LSD sessions (McGlothlin *et al.*, 1967). Nevertheless, these investigators confirmed the subjective claims of long-term change frequently reported in uncontrolled trials.

The subjective claims of hallucinogen-occasioned long-term changes (Metzner and Editors, 1963; McGlothlin *et al.*, 1967; McGlothlin and Arnold, 1971; Studerus *et al.*, 2010) appear to align with the personality construct of Openness, which encompasses aesthetic appreciation and sensitivity, imagination and fantasy, and broad-minded tolerance of others' viewpoints and values. The present report combines data from two double-blind controlled studies of psilocybin (Griffiths *et al.*, 2006; Griffiths *et al.*, 2011) to analyze changes in Openness and the other four broad personality domains using the NEO Personality Inventory (Costa and McCrae, 1992). Personality change was assessed 1 - 2 months after a high-dose psilocybin session and again more than one year later to determine the persistence of personality change. Consistent with previous results indicating a correlation between mystical experiences during the session and long-term spiritual significance and personal meaning attribution (Griffiths *et al.*, 2008), we hypothesized that mystical experiences during the psilocybin session would lead to enduring increases in Openness.

Methods

Participants

Recruitment methods and screening procedures were similar across the two studies. Participants were recruited from the local community by flyers announcing "a study of states of consciousness brought about by psilocybin, a naturally occurring psychoactive substance used sacramentally in some cultures". The first phase of screening involved a scripted telephone interview, which was used to pre-screen for the major inclusion/exclusion criteria. Common reasons for not passing the telephone screen included distance from study site, extensive prior hallucinogen use, and inability to make the time commitment required for participation. Individuals who passed the telephone screen (approximately 20% of those screened) were evaluated in-person for inclusion/exclusion criteria and medical and psychiatric health, as described previously for human research with classic hallucinogens (Johnson *et al.*, 2008). The inclusion/exclusion criteria were similar across the two studies, although participants in Study 2 were permitted to have limited prior experience with hallucinogens (Griffiths *et al.*, 2011). The single participant in Study 2 who had prior lifetime experience with psilocybin was excluded from the present analyses. In addition, 1 participant in Study 1 (Griffiths *et al.*, 2006) had incomplete personality data and was excluded. Thus, the present analyses included 52 hallucinogen-naïve participants (Table 1). Participants were generally well educated (54% had post-graduate degrees) and spiritually active (90% regularly participated in religious services, discussion groups, prayer, or meditation).

Participants did not receive monetary compensation but generally reported being motivated by curiosity about the effects of psilocybin and the opportunity for extensive self-reflection. The Institutional Review Board of the Johns Hopkins University School of Medicine approved the studies, and all participants gave their informed consent before participation.

Psilocybin sessions

Dose conditions - Participants completed two to five 8-hour drug sessions, with consecutive sessions separated by at least 3 weeks. Participants were informed that they would receive a "moderate or high dose" of psilocybin during one of their drug sessions, but neither the participant nor the session monitors knew when this session would occur. In Study 1 (Griffiths *et al.*, 2006), each participant received psilocybin (30 mg/70 kg body weight) on one session and an active control drug, methylphenidate (40 mg/70 kg), on the other one or two sessions. In Study 2 (Griffiths *et al.*, 2011), each participant received four doses of psilocybin (5, 10, 20 and 30 mg/70 kg) in ascending or descending order (50% random assignment) across four sessions, with a fifth placebo session quasi-randomly inserted in the sequence. In the present report, we analyzed mystical experiences and changes in personality associated with the high-dose (30 mg/70 kg) psilocybin session.

Table 1 - Demographic and Personality Variables at Screening.

	Study 1	Study 2
Age at study entry (years)	46 (24-64)	46 (29-62)
Sex	14 M, 21 F	8 M, 9 F
Education	4.2 (2-5)	4.0 (2-5)
Mysticism Scale - Lifetime	215 (184-283)	216 (124-282)
NEO Personality Inventory		
Neuroticism	41.8 (26.4-64.6)	46.1 (19.3-61.3)
Extroversion	55.3 (31.3-76.4)	52.1 (34.0-78.0)
Openness	65.4 (42.1-80.3)	62.7 (45.6-83.8)
Agreeableness	55.7 (41.0-75.1)	55.1 (37.2-72.6)
Conscientiousness	51.0 (22.7-80.6)	51.7 (32.9-72.1)

Note: The table presents mean values (with ranges in parentheses) for hallucinogen-naïve participants with complete personality data (*n* = 35 in Study 1; *n* = 17 in Study 2). Educational achievement was scored on the following scale: 1 = high school diploma; 2 = some college; 3 = college degree; 4 = some graduate study; 5 = graduate degree. Mystical experiences across the lifetime were quantified as total score on the Hood Mysticism Scale at screening (Hood *et al.*, 2001). Personality was assessed using a computer-based version of the revised NEO Personality Inventory (Costa and McCrae, 1992). No significant study-group differences in demographic or personality variables were evident at screening (*p*s > 0.10).

Session protocol - Participants received extensive preparation and met with session monitors for at least eight hours on several different occasions prior to their first drug session, in line with recommendations for hallucinogen research (Johnson *et al.*, 2008). The drug was orally administered in capsule form with 100 mL water at the beginning of each session. During the session, participants were encouraged to lie down on a couch, use an eye mask to block external visual distraction, wear headphones through which a music program was played, and focus their attention on their inner experiences.

Measures

NEO Personality Inventory (NEO-PI) - Personality was assessed at screening, 1 - 2 months after each drug session, and approximately 14 months after the last drug session using a computer-based version of the revised NEO-PI (Costa and McCrae, 1992). This 240- item instrument measures the five factors of personality and the six facets that define each factor. The facets of Openness are Fantasy (e.g., "I have a very active imagination"), Aesthetics (e.g., "I am intrigued by patterns I find in art and nature"), Feelings (e.g., "I experience a wide range of emotions and feelings"), Ideas (e.g., "I often enjoy playing with theories or abstract ideas"), Values (e.g., "I consider myself broad-minded and tolerant of other people's lifestyles"), and Actions (e.g., "I think it's interesting to learn and develop new hobbies"). Items were answered on a 5-point scale ranging from *strongly disagree* to *strongly agree*, and raw scores were standardized as *T* scores (*M* = 50, *SD* = 10) using the combined-sex norms reported in the NEO PI-R manual.

States of Consciousness Questionnaire (SOCQ) - Mystical-type phenomena during the drug sessions were assessed using 43 mystical-experience items embedded within a 100- item instrument, the States of Consciousness Questionnaire (SOCQ), which assesses phenomenological content during altered states of consciousness (Griffiths *et al.*, 2006). The mystical-experience items have been shown to be sensitive to the effects of psilocybin (Pahnke, 1963; Doblin, 1991; Griffiths *et al.*, 2006; Griffiths *et al.*, 2011) and other hallucinogens (Turek *et al.*, 1974; Richards *et al.*, 1977). The SOCQ was administered after each session (approximately 7 hours after capsule administration). Items were answered on a 6-point scale ranging from 0 (*none, not at all*) to 5 (extreme, more than ever before in my life and stronger than 4). Data on each of the following six subscales were expressed as percentage of maximum possible score: unity; transcendence of time and space; ineffability and paradoxicality; sacredness; noetic quality; and positive mood. Consistent with previous research (Griffiths *et al.*, 2006), a "complete mystical experience" was defined as having a score of 60% or higher on each subscale. A total score was also calculated as the mean across all items in the six subscales.

Mysticism Scale - The Mysticism Scale was originally developed to assess mystical experiences across the lifetime and has been validated in several studies, including cross-culturally (Hood, 1975; Hood *et al.*, 2001; Hood, 2003). Items were answered on a 9-point scale ranging from -4 (this description is extremely not true of my own experience) to +4 (this description is extremely true of my own experience). Total score (sum across 32 items) was used to quantify lifetime mystical experiences at screening (see Table 1). Additionally, a modified version of the Mysticism Scale was used to assess mystical effects during the drug sessions. Participants completed the experience-specific version approximately 7 hours after capsule administration and answered the items in reference to their experiences since receiving the capsule that morning.

APZ - The APZ is a 72-item yes/no questionnaire designed to assess altered states of consciousness, including those produced by hallucinogens (Dittrich, 1998). The three scales on the APZ are OSE ("oceanic boundlessness"; this scale assesses phenomena such as unity, bliss, and transcendence of time and space); VUS ("visionary restructuralization"; this scale assesses visual pseudo-hallucinations, illusions, and synaesthesias); and AIA ("dread of ego dissolution"; this scale assesses dysphoric feelings such as anxiety, fear, and feeling trapped). Data on each scale were expressed as percentage of maximum possible score.

Analysis

We combined data from two double-blind psilocybin studies to achieve greater statistical power to detect personality change at the group level and to examine personality change in sub-groups of individuals who differed in mystical-type psilocybin effects. Because Study 2 involved multiple doses of psilocybin in addition to the single high dose used in Study 1, it was not possible to completely isolate the high-dose session in Study 2. However, the session protocol implemented in Study 2 was identical to that used in Study 1. Furthermore, changes in personality following the high-dose session were always assessed within 1 - 2 months of the high-dose session and before any subsequent session.

We hypothesized that mystical experiences during the psilocybin session, as measured by the SOCQ, would lead to increases in Openness. We investigated this prediction using three analysis approaches (all analyses were conducted in SPSS version 18.0). First, we used multivariate repeated measures analysis of variance (ANOVA) to analyze changes in Openness and the other four NEO-PI factors (Neuroticism, Extroversion, Agreeableness, and Conscientiousness) from screening to post-test (1 - 2 months after the high-dose psilocybin session). After confirming that Openness changed significantly following the high-dose session, we calculated Pearson's linear correlations between changes in Openness and session-day measures (the SOCQ, the Mysticism Scale, the OSE, the VUS, and the AIA). We then confirmed via regression analysis that mystical experience, as measured by the SOCQ, was a significant predictor of changes in Openness. Specifically, we conducted a series of linear regression analyses that tested the predictive power of the SOCQ above and beyond the predictive power of the four questionnaire measures that also correlated with Openness change (the Mysticism Scale, the OSE, the VUS, and the AIA). In each of four models (one model for each questionnaire), we tested the following predictors of Openness at post-test in a step-wise manner: 1) Openness at screening, 2) an alternate questionnaire measure (e.g., total score on the Mysticism Scale), and 3) mystical score on the SOCQ. We hypothesized that mystical score on the SOCQ (Step 3) would explain significantly more variability in Openness than each of the alternate questionnaire measures (Step 2), as indicated by significant estimates of R-squared change from Step 2 to Step 3.

Finally, we compared Openness change in participants who met the criteria for having had a complete mystical experience during their high-dose session (n = 30) to participants who did not meet the criteria (n = 22). We used the "complete mystical experience" classification (60% on each subscale of the SOCQ) rather than data-driven classification (e.g., median split) for several reasons. First, median split analyses have been associated with reductions of power and effect size (MacCallum *et al.*, 2002). Second, classification based on subscale scores takes into account the breadth of mystical-type effects, which total score does not. For example, a participant could have a high total score while not endorsing many sacredness items. Finally, designating participants who met the criteria for a complete mystical experience allowed a comparison with previous studies (Griffiths *et al.*, 2008; Griffiths *et al.*, 2006; Pahnke, 1963; Richards *et al.*, 1977; Griffiths *et al.*, 2011).

Results

Changes in personality following the psilocybin session

Consistent with our hypothesis, the repeated measures ANOVA showed that Openness increased significantly from screening to post-test ($M = +2.8$, $F(1, 51) = 5.47$, $p = .023$, $\eta_p^2 = .10$). Moreover, because participants received the high dose on different sessions, it was possible to conduct a comparison analysis of changes in Openness following the first session in the subgroup of participants who did not receive a high dose of psilocybin on that session ($n = 30$ participants received inactive placebo, methylphenidate, or 5 mg/70 kg of psilocybin on their first session). There were no significant changes in Openness after the first session in this subgroup ($F(1, 29) = 0.52$, $p = .48$). Finally, with regard to changes in the other four personality factors after the high-dose session, there were no significant changes from screening to post-test in Neuroticism ($M = -0.5$; $F(1, 51) = 0.24$, $p = .62$), Extroversion ($M = +0.8$; $F(1, 51) = 0.79$, $p = .38$), Agreeableness ($M = +1.7$; $F(1, 51) = 2.31$, $p = .16$), or Conscientiousness ($M = -0.9$; $F(1, 51) = 1.22$, $p = .28$), and test-retest correlations were high across assessments (*r*s = .61 - .84). Taken together, these results indicate predominantly stable personality traits with specific increases in Openness following the high-dose session.

Relationship between session-day effects and changes in Openness

We hypothesized that individual differences in mystical experience during the psilocybin session, as measured by the SOCQ, would be related to individual differences in Openness change. There was considerable variability in mystical-type effects during the high-dose session, with nearly the full range of possible scores (range: 0.03 - 1.00) represented across the six subscales of mystical experience. Consistent with our hypothesis, mystical experience (mean score across all of the items in the six subscales) correlated significantly with increases in Openness ($r = .42$, $p = .002$; Figure 1). Importantly, mystical experience did not correlate significantly with screening levels of Openness ($r = .12$, $p = .41$) or its facets; the highest correlation was with Feelings ($r = .24$, $p = .09$).

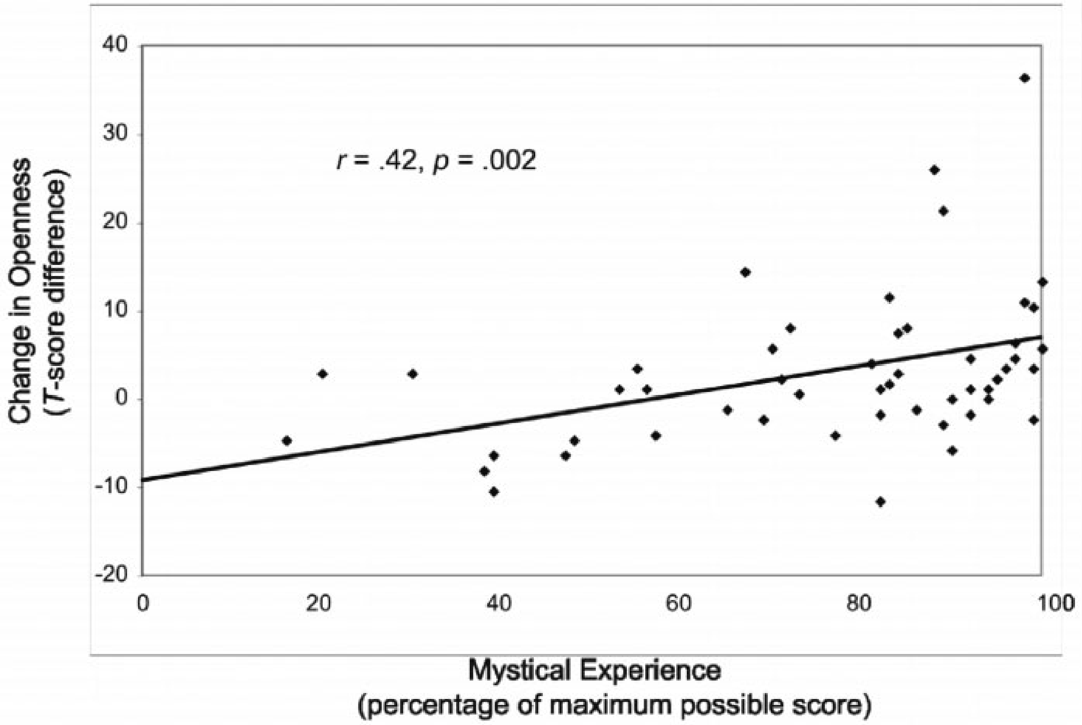


Figure 1. Change in Openness from screening to post-test as a function of mystical experience during the high-dose psilocybin session ($N = 52$). Data points show individual experimental data; a linear regression line has been fit to those data.

Changes in Openness were also correlated with scores on the Mysticism Scale ($r = .33$, $p = .017$), the OSE ($r = .44$, $p = .001$), the VUS ($r = .41$, $p = .003$), and the AIA ($r = .31$, $p = .024$). The significant relationships shown by Pearson's linear correlations were also shown by Spearman's rank order correlations between change in Openness and the SOCQ (r_s = .47, p < .001), the Mysticism Scale (r_s = .40, p = .003), the OSE (r_s = .45, p = .001), the VUS (r_s = .47, p < .001), and the AIA (r_s = .33, p = .018). However, a series of stepwise regression analyses showed that the SOCQ explained significantly more variability in Openness change than the Mysticism Scale (R-squared change = .046, p = .033), the OSE (R-squared change = .047, p = .031), the VUS (R-squared change = .042, p = .036), and the AIA (R-squared change = .12, p = .001).

Effect of mystical experience on changes in openness

We further examined the relationship between mystical experience and increases in Openness by comparing participants who met the criteria for having had a complete mystical experience during their high-dose session (n = 30) to participants who did not meet the criteria (n = 22). ANOVA revealed a significant interaction between time (screening vs. post-test) and group (complete mystical experience vs. no complete mystical experience) (F(1, 50) = 9.32, p = .004, η_p^2 = .16). Follow-up t tests confirmed that the complete mystical experience group showed significant increases in Openness from screening to post-test (M = +5.7; t(29) = 3.44, p = .002) while the other group did not (M = -1.2; t(21) = .87, p = .39) (Figure 2). Five of the six facets of Openness showed this same pattern when examined individually: The interaction between time and group was significant for Fantasy (p = .029, η_p^2 = .09), Aesthetics (p = .010, η_p^2 = .13), Feelings (p = .038, η_p^2 = .08), Ideas (p = .014, η_p^2 = .11), and Values (p = .036, η_p^2 = .09), but not Actions (p = .19). Follow-up t tests for the five facets showing significance confirmed that the complete mystical experience group increased in these facets while the other group did not (Figure 3).

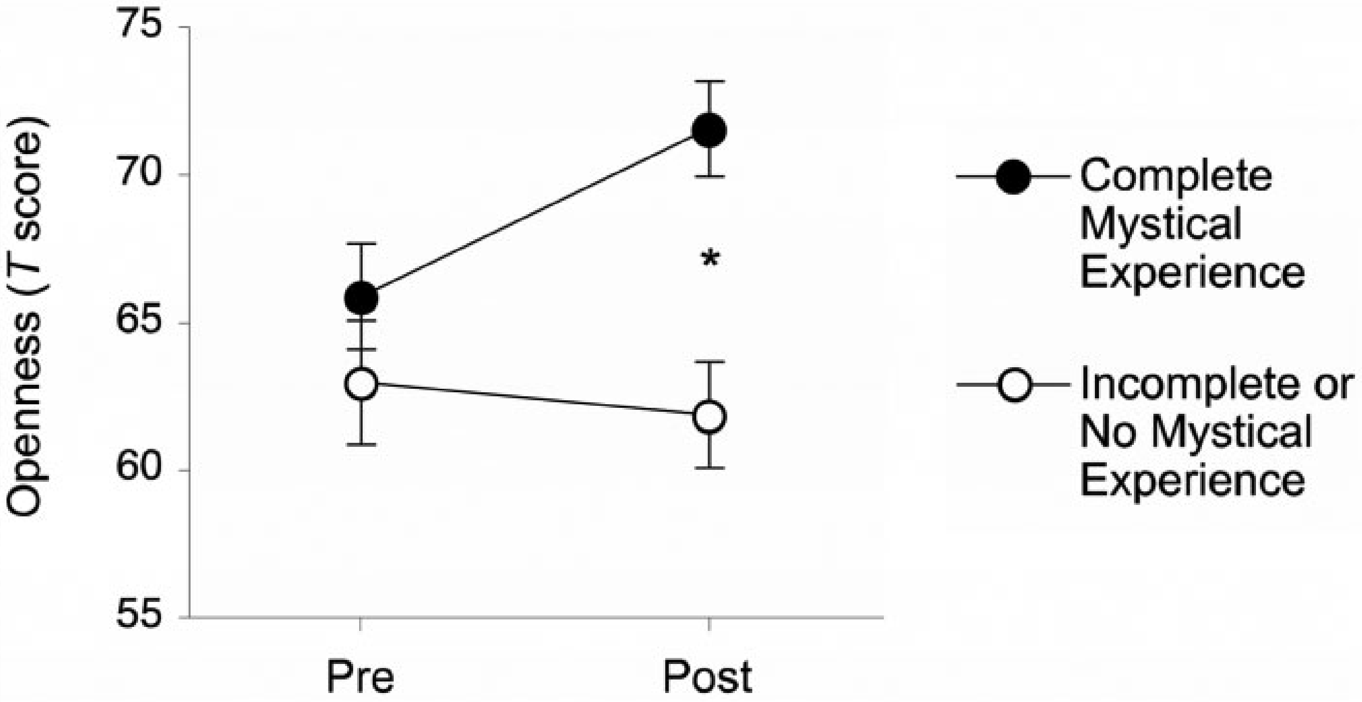


Figure 2. Changes in Openness after psilocybin in participants who did and did not have mystical experiences. Figure shows Openness T scores at screening (Pre) and post-test (Post) in participants who had a complete mystical experience (n = 30; filled symbols) and those who had an incomplete or no mystical experience (n = 22; open symbols). Data points are means; bars show ± 1 SEM; asterisk indicates a significant difference (p < .001) at the post-psilocybin assessment. Screening levels of Openness and its facets did not differ between participants who met the criteria for having had a complete mystical experience and those who did not (ps > .10).

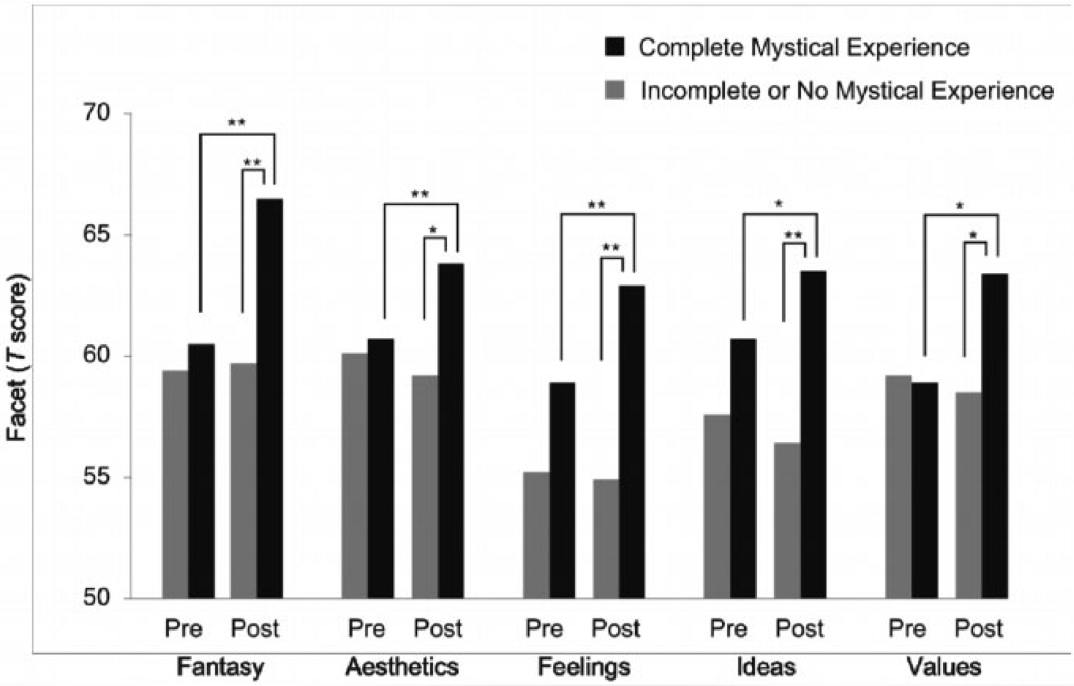


Figure 3. Changes in five facets of Openness after psilocybin in participants who did and did not have mystical experiences. Figure shows facet *T* scores (Fantasy, Aesthetics, Feelings, Ideas and Values) at screening (Pre) and post-test (Post) in participants who had complete mystical experiences (black bars) and those who did not (grey bars). Bars show means; brackets indicate statistical differences ($*p < .05$, $**p < .01$).

Follow-up

The persistence of increases in Openness was assessed at a follow-up assessment conducted more than one year after the high-dose session ($M = 16$ months). In participants who had a complete mystical experience ($n = 30$), Openness levels at follow-up decreased slightly from post-test but did not differ significantly from Openness levels at post-test ($p = .12$) and remained significantly higher than at screening ($M = +4.2$; $F(1, 29) = 4.17$, $p = .050$, $\eta_p{}^2 = .13$). In contrast, participants who did not have a complete mystical experience ($n = 21$) had nearly identical Openness levels at follow-up and screening ($M = -0.3$; $p = .86$).[1, 2]

---

[1] The overall pattern of results was similar between Study 1 and Study 2. In participants who had a complete mystical experience, there were no differences between the studies in Openness change ($p = .11$) or in Openness at screening ($p = .28$), post-test ($p = .69$) or follow-up ($p = .36$).

[2] Three participants in Study 2 met the criteria for a complete mystical experience during their 20 mg/70 kg (i.e., moderately high dose) psilocybin session but not during their 30 mg/70 kg (i.e., high dose) session. Including these participants in the "complete mystical experience" group ($n = 33$) did not change the reported results.

Discussion

We observed significant increases in Openness after a high-dose psilocybin session that were larger in magnitude than changes in personality typically observed in healthy adults over decades of life experience (Terracciano *et al.*, 2005). Moreover, in participants who met criteria for having had a complete mystical experience during their psilocybin session, Openness remained significantly higher than baseline more than one year after the session. This is the first study to demonstrate changes in personality in healthy adults after an experimentally manipulated discrete event. To our knowledge, the only other experimental (i.e., randomized) intervention reported to change healthy adults' personality involved hundreds of hours of solitary meditation over the course of three months (Sahdra *et al.*, 2011). The present findings are suggestive of lasting change in core personality traits. However, it will be important to replicate these results in larger groups of individuals with diverse baseline personality profiles.

It is informative to compare the magnitude of Openness change observed in the present study with previous findings of longitudinal personality change. During normal aging, Openness typically *decreases* linearly at a rate of approximately 1 *T*-score point per decade (see Figure 4 in Terracciano *et al*., 2005). In comparison, participants in the present study who had a complete mystical experience during their psilocybin session increased more than 4 *T*-score points from screening to follow-up. Notably, this increase is larger than increases in Openness seen in individuals treated successfully with antidepressant medication (see Figure 1 in Costa *et al*., 2005) and intensive outpatient counseling for substance abuse (see Table 1 in Piedmont, 2001).

Openness includes a relatively broad range of intercorrelated traits covering aesthetic appreciation and sensitivity, fantasy and imagination, awareness of feelings in self and others, and intellectual engagement. People with high levels of Openness are "permeable to new ideas and experiences" and "motivated to enlarge their experience into novel territory" (DeYoung *et al*., 2005). Openness is strongly associated with creativity (Silvia *et al*., 2009), and some of its facets (Ideas, Values) are correlated with general fluid intelligence and cognitive ability (DeYoung *et al*., 2005; DeYoung *et al*., 2009). Although the present study did not directly investigate the corollary benefits of increased Openness, significant increases in nearly all of the facet scores indicate the potential for improvements in aesthetic and cognitive domains.

Very few controlled studies have attempted to characterize the effects of classic hallucinogens on aesthetic and creative outcomes. One previous well-controlled study of LSD (McGlothlin *et al*., 1967) found evidence for short-term improvements on measures of artistic ability (e.g., figure drawings), aesthetic sensitivity (e.g., compatibility between participant and expert ratings of paintings), and creativity (e.g., generating alternate uses for a common object). However, McGlothin and colleagues failed to find significant improvements in creativity or aesthetic measures at a 6-month follow-up. Notably, the McGlothlin study included graduate students who were paid for participation, generally showed little interest in LSD, and received minimal preparation and support for the LSD sessions. In contrast, the present study included unpaid community volunteers who were motivated by curiosity about the effects of psilocybin and received extensive interpersonal preparation and support for the psilocybin sessions. It is likely that differences in participant motivation and preparation contributed to different long-term outcomes following hallucinogen sessions. In addition, nearly all of the participants in the present study regularly engaged in spiritual activities such as religious services, prayer, and meditation. It is possible that such individuals are particularly sensitive to the mystical-type effects of psilocybin, which were predictive of increases in Openness.

Cross-sectional methods have been used to examine differences in personality, attitudes and values between regular hallucinogen users and controls. A study in Brazil by Grob *et al*. (1996) found that individuals who used the hallucinogenic plant ayahuasca as a spiritual sacrament had lower trait levels of excitability, disorderliness and impulsivity, and higher trait levels of confidence, gregariousness and optimism compared to community members who did not use ayahuasca. Lerner & Lyvers (2006) found that individuals who used hallucinogens valued spirituality, concern for others, concern for the environment (i.e., nature), and creativity more highly than individuals who used other illicit drugs (e.g., marijuana, amphetamine, heroin). Although the findings are suggestive of personality changes that might be associated with hallucinogen exposure, it is not possible to isolate the effects of hallucinogens *per se* because of the self-selection bias that may confound results of cross-sectional studies. Longitudinal studies will be required to replicate hallucinogen-related changes in personality, attitudes, and values.

The NEO-PI is one of the most widely used measures of personality in modern psychology. However, it is useful to consider alternate methods of classifying personality. For example, the Temperament and Character Inventory (TCI) measures personality as a combination of *temperament* or automatic responses to emotional stimuli and *character* or self-aware concepts that are associated with voluntary intentions and attitudes (see review in Cloninger, 1994). The TCI scales are considered distinct from the factors in the NEO-PI. However, a factor analysis showed that TCI scales loaded on the five NEO-PI factors (McCrae *et al*., 2001). In particular, the Self-Transcendence scale of the TCI loaded on Openness, effectively representing "openness to spiritual experience" (McCrae, 2009: 154). Given the connection between mystical experience and increases in Openness observed in the present study, it is likely that Self-Transcendence might also increase following a high-dose psilocybin session.

In contrast to the numerous questionnaires available for assessing personality, very few questionnaire measures have been developed to assess mystical experiences. Despite the generally infrequent use of the SOCQ, it has been used effectively along with the more widely used and validated Mysticism Scale (Hood, 2003) to characterize hallucinogen effects (Griffiths *et al*., 2008; Griffiths *et al*., 2006; Griffiths *et al*., 2011).

Although a psychometric validation of the SOCQ has not been published, data from a study in our laboratory involving several hundred respondents indicate that the mystical items in the SOCQ have a reliable factor structure and that the factor scores differentiate self-reported mystical experiences from otherwise profound positive experiences. In the present study, the SOCQ was a better predictor of changes in Openness than other questionnaire measures of mystical effects (e.g., the Mysticism Scale) and positively experienced hallucinogen effects (e.g., the OSE). Overall, these results suggest a specific role for the SOCQ in quantifying mystical experiences and predicting personality change, although it will be necessary to continue to examine the sensitivity and validity of the SOCQ in characterizing the mystical-type effects of psilocybin and other classic hallucinogens.

The findings have important implications for the application of psilocybin and classic hallucinogens in clinical psychiatry. Recent reviews have suggested that hallucinogens could have positive effects on the outcomes of clinical disorders, particularly anxiety and mood disorders (Griffiths and Grob, 2010; Vollenweider and Kometer, 2010). Clinical work along these lines was initiated in the 1950s and suggested possible improvements after hallucinogen treatment in individuals with terminal cancer (Kast, 1967; Richards *et al.*, 1977; Grob *et al.*, 2011) and substance dependence (Mangini, 1998; Halpern, 1996; Terrill *et al.*, 1964). Although there is still much to learn about the mechanisms by which hallucinogens might produce positive changes, the increases in Openness observed in the present study indicate novel avenues of future research into the biological and psychological mechanisms of psilocybin treatment.

It will also be important in future treatment studies to examine the effects of psilocybin and mystical experience on changes in maladaptive personality traits. For example, although we did not observe decreases in mean Neuroticism (feeling tense, anxious, moody, or insecure), which was nearly 1 *SD* below normal at baseline, reductions in Neuroticism have been observed in patients undergoing treatment for depression (Costa *et al.*, 2005) and substance abuse (Piedmont, 2001). Similarly, reductions in Neuroticism might accompany reductions in anxiety and depressed mood following psilocybin treatment in patient populations (e.g., individuals with advanced-stage cancer; Grob *et al.*, 2011). In addition, although the present study focused on personality change following a single high-dose session, it is possible that multiple sessions would be associated with changes in additional domains besides Openness.

In conclusion, the present results indicate that a high dose of psilocybin administered under supportive conditions produced increases in Openness, consistent with participants' subjective claims of the long-term effects of hallucinogens. Importantly, participants who had a complete mystical experience during their high-dose session, but not others, showed enduring increases in Openness, suggesting that other mystical experiences could occasion similar change. Qualitative research has documented sudden and dramatic positive changes in attitudes, values and behaviors following spontaneous mystical or spiritual experiences (Miller, 2004; Paloutzian *et al.*, 1999). Further, correlational research has highlighted a role for spirituality in addiction recovery (Kelly *et al.*, 2011) and in coping with life-threatening illnesses such as cancer (McCoubrie and Davies, 2006), which may account for the potential efficacy of psilocybin in the aforementioned treatment of addictions and cancer distress. Future research should continue to investigate the conditions - both pharmacological and non-pharmacological - that might occasion mystical experiences, as well as describe their potential long-term consequences.

Acknowledgments

This research was supported by grants from NIDA (R01DA03889; T32DA007209), the Council on Spiritual Practices, Heffter Research Institute, and the Betsy Gordon Foundation. We thank Margaret Klinedinst, Samantha Gebhart and Ashley Bathgate for data management; as well as the authors and contributors to the two original studies upon which this analysis was based.

Funding: This research was supported by grants from NIDA (R01DA03889; T32DA007209), the Council on Spiritual Practices, the Heffter Research Institute, and the Betsy Gordon Foundation.

References

1. Bouchard Jr TJ, Lykken DT, McGue M, Segal NL and Tellegen A (1990) Sources of human psychological differences: the Minnesota Study of Twins Reared Apart. Science 250: 223-228.
2. Cloninger CR (1994) Temperament and personality. *Curr Opin Neurobiol* 4: 266-273.
3. Costa Jr PT, Bagby RM, Herbst JH and McCrae RR (2005) Personality self-reports are concurrently reliable and valid during acute depressive episodes. *J Affect Disord* 89: 45-55.
4. Costa Jr PT, Herbst JH, McCrae RR and Siegel IC (2000) Personality at midlife: stability, intrinsic maturation, and response to life events. *Assessment* 7: 365-378.
5. Costa Jr PT and McCrae RR (1992) *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five Factor Inventory (NEO-FFI) Professional Manual*. Odessa, FL: Psychological Assessment Resources.
6. DeYoung CG, Peterson JB and Higgins DM (2005) Sources of openness/intellect: cognitive and neuropsychological correlates of the fifth factor of personality. *J Pers* 73: 825-858.
7. DeYoung CG, Shamosh NA, Green AE, Braver TS and Gray JR (2009) Intellect as distinct from Openness: differences revealed by fMRI of working memory. *J Pers Soc Psychol* 97: 883-892.
8. Digman JM (1990) Personality structure: emergence of the five-factor model. *Annu Rev Psychol* 41: 417-440.
9. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. *Pharmacopsychiatry* 31(Suppl 2): 80-84.
10. Doblin R (1991) Pahnke's good friday experiment: a long-term follow-up and methodological critique. *J Transpers Psychol* 23: 1-28.
11. Glennon RA, Titeler M and McKenney D (1984) Evidence for the 5-HT2 involvement in the mechanism of action of hallucinogenicagents. Life Sci 35: 2505-2511.
12. Griffiths RR and Grob CS (2010) Hallucinogens as medicine. *Scientific American* December: 77-79.
13. Griffiths RR, Johnson MW, Richards WA, Richards BR, McCann UD and Jesse R (2011) Psilocybin-occasioned mystical-type experiences: immediate and persisting dose-related effects. *Psychopharmacology (Berl)* 00:00-00.
14. Griffiths RR, Richards WA, Johnson MW, McCann UD and Jesse R (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632.
15. Griffiths RR, Richards WA, McCann U and Jesse R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology (Berl)* 187: 268-283; discussion 284-292.
16. Grob CS, Danforth AL, Chopra GS, et al. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.
17. Grob CS, McKenna DJ, Callaway JC, et al. (1996) Human psycho-pharmacology of hoasca, a plant hallucinogen used in ritual context in Brazil. *J Nerv Ment Dis* 184: 86-94.
18. Halpern JH (1996) The use of hallucinogens in the treatment of addiction. *Addict Res* 4: 177-189.
19. Hood RW (1975) The construction and preliminary validation of a measure of reported mystical experience. *J Sci Study Relig* 14: 29-41.
20. Hood RW (2003) Conceptual and empirical consequences of the unity thesis. In: Belzen JA and Geels A (eds) *Mysticism: A Variety ofPsychological Perspectives*. New York: Rodopi, 17-54.
21. Hood RW, Ghorbani N, Watson PJ, et al. (2001) Dimensions of the mysticism scale: confirming the three-factor structure in the United States and Iran. *J Sci Study Relig* 40: 691-705.
22. Isbell H (1959) Comparison of the reactions induced by psilocybin and LSD-25 in man. *Psychopharmacologia* 1: 29-38.
23. Johnson M, Richards W and Griffiths R (2008) Human hallucinogen research: guidelines for safety. *J Psychopharmacol* 22: 603-620.
24. Kast EC (1967) Attenuation of anticipation: a therapeutic use of lysergic acid diethylamide. *Psychiatry Q* 41: 646-657.
25. Kelly JF, Stout RL, Magill M, Tonigan JS and Pagano M (2011) Spirituality in recovery: a lagged mediational analysis of Alcoholics Anonymous' principle theoretical mechanism of behavior change. *Alcohol Clin Exp Res* 35: 454-463.
26. Lerner M and Lyvers M (2006) Values and beliefs of psychedelic drug users: a cross-cultural study. *J Psychoactive Drugs* 38: 143-147.
27. McAdams DP (1995) What do we know when we know a person? *J Personal* 63: 365-396.
28. MacCallum RC, Zhang S, Preacher KJ and Rucker DD (2002) On the practice of dichotimization of quantitative variables. *Psychol Methods* 7: 19-40.
29. Mangini M (1998) Treatment of alcoholism using psychedelic drugs: a review of the program of research. *J Psychoactive Drugs* 30: 381-418.
30. McCoubrie RC and Davies AN (2006) Is there a correlation between spirituality and anxiety and depression in patients with advanced cancer? *Support Care Cancer* 14: 379-385.
31. McCrae RR (2009) The five-factor model of personality traits: Consensus and controversy. In: Corr PJ and Matthews G (eds) *The Cambridge Handbook of Personality Psychology*. Cambridge: Cambridge University Press.
32. McCrae RR and Costa Jr PT (1997) Personality trait structure as a human universal. *Am Psychol* 52: 509-516.
33. McCrae RR,Herbst JH and Costa JrPT(2001)Effectsofacquiescence on personality factor structures. In: Riemann R, Ostendorf F and Spinath F (eds) *Personality and Temperament: Genetics, Evolution, and Structure*. Berlin: Pabst Science Publishers, 217-231.
34. McGlothlin WH and Arnold DO (1971) LSD revisited: a ten-year follow-up of medical LSD use. *Arch Gen Psychiatry* 24: 35-49.
35. McGlothlin WH, Cohen S and McGlothlin MS (1967) Long lasting effects of LSD on normals. *Arch Gen Psychiatry* 17:521-532.
36. Metzner R and Editors (1963) The subjective after-effects of psychedelic experiences: a summary of four recent questionnaire studies. *Psychedel Rev* 1: 18-26.
37. Miller WR (2004) The phenomenon of quantum change. *J Clin Psychol* 60: 453-460.
38. Mroczek DK and Spiro AI (2003) Modeling intraindividual change in personality traits: Findings from the Normative Aging

Study. *J Gerontol B Psychol Sci Soc Sci* 58: 153-165.
39. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101: 131-181.
40. Pahnke WN (1963) Drugs and mysticism: an analysis of the relationship between psychedelic drugs and the mystical consciousness. Thesis. Harvard University, Boston.
41. Paloutzian RF, Richardson JT and Rambo LR (1999) Religious conversion and personality change. *J Personal* 67: 1047-1079.
42. Piedmont RL (2001) Cracking the plaster cast: Big Five personality change during intensive outpatient counseling. *J Res Personal* 35:500-520.
43. Richards WA, Rhead JC, DiLeo FB, Yensen R and Kurland AA (1977) The peak experience variable in DPT-assisted psychotherapy with cancer patients. *J Psychedel Drugs* 9: 1-10.
44. Roberts BW and Mroczek DK (2008) Personality trait change in adulthood. *Curr Dir Psychol Sci* 17: 31-35.
45. Rosenberg DE, Isbell H, Miner EJ and Logan CR (1964) The effect of N, N-Dimethyltryptamine in human subjects tolerant to lyseric acid diethylamide. *Psychopharmacologia* 5: 217-227.
46. Sahdra BK, MacLean KA, Shaver PR, et al. (2011) Enhanced response inhibition during intensive meditation training predicts improvements in self-reported adaptive socioemotional functioning. *Emotion* 11: 299-312.
47. Silvia PJ, Nusbaum EC, Berg C, Martin C and O'Connor A (2009) Openness to experience, plasticity, and creativity: exploring lower-order, higher-order, and interactive effects. *J Res Personal* 43: 1087-1090.
48. Stace WT (1960) Mysticism and Philosophy. Philadelphia: Lipincott.
49. Studerus E, Kometer M, Hasler F and Vollenweider FX (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *J Psychopharmacol* 25: 1434-1452.
50. Terracciano A, McCrae RR, Brant LJ and Costa Jr PT (2005) Hierarchical linear modeling analyses of the NEO-PI-R scales in the Baltimore Longitudinal Study of Aging. *Psychol Aging* 20: 493-506.
51. Terrill J, Savage C and Jackson DD (1964) LSD, transcendence, and the new beginning. In: Solomon D (ed.) *LSD: The Consciousness-expanding Drug*. New York: G.P. Putnam's Sons, 174-199.
52. Turek IS, Soskin RA and Kurland AA (1974) Methylenedioxyam-phetamine (MDA) subjective effects. *J Psychedel Drugs* 6: 7-14.
53. Unger SM (1964) Mescaline, LSD, psilocybin and personality change. In: Solomon D (ed.) *LSD: The Consciousness-expanding Drug*. New York: G.P. Putnams Sons, 200-228.
54. Vollenweider FX and Kometer M (2010) The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. *Nat Rev Neurosci* 11: 642-651.
55. Wolbach AB, Miner EJ and Isbell H (1962) Comparison of psilocin with psilocybin, mescaline and LSD-25. *Psychopharmacologia* 3: 219-223.

The entheogenic origins of Mormonism

*A working hypothesis**

by

Robert Beckstead[1], Bryce Blankenagel[2], Cody Noconi[3], Michael Winkelman[4]**

© 2019 The Author(s)

Journal of Psychedelic Studies 3(2), pp. 212-260 (2019)

(Received: March 19, 2019; accepted: June 8, 2019)

original report: https://akjournals.com/downloadpdf/journals/2054/3/2/article-p212.xml

[1] Retired, Department of Emergency Medicine, Pocatello, ID, USA
[2] Naked Mormonism Podcast, Seattle, WA, USA
[3] Independent Researcher, Portland, OR, USA
[4] Retired, School of Human Evolution and Social Change, Arizona State University, Tempe, AZ, USA

* The authors have made minor spelling and grammatical corrections to some quotations to clarify writing errors.

** Corresponding author: Michael Winkelman, PhD; Caixa Postal 62, Pirenopolis, Go. 72980-000, Brazil; Phone: +1 623 239 1662; E-mail: michaeljwinkelman@gmail.com

This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium for non-commercial purposes, provided the original author and source are credited, a link to the CC License is provided, and changes - if any - are indicated.

Table of Contents:

- **Introduction**
  - Visionary experience as veridical
  - Entheogens as authentic mystical experience
  - Context of Mormon entheogens
  - Entheogens as the "means"
  - Wholesome herbs God hath ordained
- **Historical setting: Ancestors, mentors, and colleagues**
  - Salem witch trials
  - Joseph Smith Sr.
    - *Ginseng extraction*
    - *Family magical practices*
  - The visions of Joseph Smith's parents
    - *Lucy's first vision*
    - *Joseph Smith Sr.'s first vision*
  - Emma Smith
  - Native Americans
  - Esoteric Christianity
    - *Spiritual alchemy*
    - *Speculative Masonry*
  - Policy of secrecy
  - Luman Walters, Occultist and eclectic physician
    - *Esoteric practice*
    - *Medical practice*
  - Frederick G. Williams, Apothecary
    - *Indian Mission*
- **Entheogenic materials**
  - *D. stramonium* and *H. niger*
  - *P. ovoideocystidiata*

- *Amanita muscaria*
- *C. purpurea* (ergot and mushroom)
- *L. williamsii* (peyote)
- *Incilius alvarius* (Sonoran Desert toad)

Shamanic transformation
- Unimaginable childhood trauma

Joseph Smith Jr.'s visions
- 1820: The first vision
- Anticholinergic toxidrome
- Entheogenic replication of Smith's first vision
- Joseph Smith's actual first vision
- 1823 Indian visions

Psychedelics in *The Book of Mormon*
- Death and rebirth symbology (ego death)
- Synesthesia
- Mood elevation
- Entheogenic ordinances

Early convert visions
- Three witness' visions
- 1830: New York visions
- 1830-1831: Kirtland, Ohio, charges of intemperance
  - *Unusual manifestations*
  - *Negative publicity*
  - *Peter Kerr*
  - *Prejudice and secrecy*
- 1833: Kirtland, Ohio School of the Prophets and the Mormon Pentecost

1842: Nauvoo temple
- The Edenic tree
- Nauvoo Entheogen

Peyote entheogen
- Quest for a new entheogen
- The Potawatomi
- Lyman Wight
- Joseph Smith's Peyote Stone
- Lyman Wight, Mission to Texas

The end of visionary mormonism
- Death of Joseph Smith
- Schismatic Mormonism
- Return of the Egyptian Papyri
- Successors' negative views of visionary symptomology

Entheogenic successors
- Frederick M. Smith
- Oto Church of the First-Born and the Native American Church (NAC)
- The Peyote Way Church of God
- James Warren "Flaming Eagle" Mooney

Conclusions

References

Historical documents relating to early Mormonism suggest that Joseph Smith (1805-1844) employed entheogen-infused sacraments to fulfill his promise that every Mormon convert would experience visions of God and spiritual ecstasies. Early Mormon scriptures and Smith's teachings contain descriptions consistent with using entheogenic material. Compiled descriptions of Joseph Smith's earliest visions and early Mormon convert visions reveal the internal symptomology and outward bodily manifestations consistent with using an anticholinergic entheogen. Due to embarrassing symptomology associated with these manifestations, Smith sought for psychoactives with fewer associated outward manifestations. The visionary period of early Mormonism fueled by entheogens played a significant role in the spectacular rise of this American-born religion. The death of Joseph Smith marked the end of visionary Mormonism and the failure or refusal of his successor to utilize entheogens as a part of religious worship. The implications of an entheogenic origin of Mormonism may contribute to the broader discussion of the major world religions with evidence of entheogen use at their foundation and illustrate the value of entheogens in religious experience.

Keywords: Joseph Smith, Mormonism, entheogen, psychedelic, spirituality.

Introduction

The number and quality of spiritual experiences reported by participants in early Mormonism (Welch & Carlson, 2005) far exceeded the daily background frequency reported in today's general population (Underwood, 2006, 2011). Multiple supernatural and naturalistic explanations have been suggested to account for the sheer number of early Mormon visions and ecstasies, including rational supernaturalism (Erying, 1989; Park, 2008; Widtsoe, 1915), out-of-body experiences (Bushman, 2006; Fillerup, 1996), animal magnetism or Mesmerism (Bunker & Bitton, 1975), prophetic charisma (Foster, 2005), dissociation secondary to childhood trauma (Morain, 1998), enthusiasm associated with the Second Great Awakening (Staker, 2009, pp. 19-26; Taves, 1999), apparent materialization of the sacred during trance (Taves, 2014), pious fraud (Vogel, 2004, p. vii), and automatic writing (Dunn, 2002). However, no single explanation has to date successfully accounted for the number and quality of visions in early Mormonism. Nor can these modalities explain the "on-demand" visions that were neither spontaneous nor the result of prolonged austerities. To date, Joseph Smith's and early Mormon converts' visionary experience are neither easily defined nor understood (Waterman, 1999).

Against this background, we present compelling evidence suggesting that many early Mormon visionary experiences were facilitated by entheogenic substances that resulted in mood elevation and heightened spiritual awareness among early Mormon converts. In this entheogenic working hypothesis of early Mormonism, we consider the supernatural as natural (Taves, 2014; Winkelman & Baker, 2015) and entheogens as medical therapy (Rucker, Jelen, Flynn, Frowde, & Young, 2016; Winkelman, 2001; Winkelman & Sessa, 2019). Because the two largest factions of Mormonism have opened their libraries to everyone (Spencer, 2009) and "*primary source materials are so abundant and available, far more so than for more ancient religions*" (Mason, 2015, p. 22), Mormonism may provide insight into the role entheogens played in the early success of traditional religions (see Richards, 2016; Winkelman, 2010, 2013).

Visionary experience as veridical

Converts who reported angelic visitations, ecstasies, and visions of God in 19th-century Mormonism regarded their experiences as veridical and not as imaginary constructs of the mind. The 19th-century publication, *The Essential Guide to Datura* ("Essential," n.d.), describes the subjective visionary experience of datura intoxication as "widely perceived to be real." In reviewing firsthand reports of early Mormon visionary experience, we find overlaps of these with contemporary accounts of visions facilitated by entheogenic substances, and with known symptomology associated with entheogenic use.

Defenders and critics of Mormonism may misunderstand this paper's thesis as questioning the validity of Mormonism's founding visionary experiences. Nothing could be further from the truth. All human experience and insight emerge in the chemistry of the brain, including the achievements of mathematics, science, epistemology, and even morality. To explore how brain chemistry was involved in Joseph Smith's religious experiences and those of other early Mormon believers and whether entheogens facilitated those experiences is not to question the spiritual validity and power of those experiences but to illuminate *how* such compelling experiences were accessed then and draw implications for how they may be accessed now. If the preponderance of evidence leads to the conclusion that entheogens facilitated many of Smith's visionary experiences and those of many early Mormon converts, then another oddity of the rise of Mormonism is explainable, the dramatic decline in reported visionary experience after Joseph Smith's death.

Entheogens as authentic mystical experience

Clinical research with entheogens (psychedelics) indicates that while they produce varying experiences, they also produce mystical experiences indistinguishable from those produced by non-drug means (i.e., prolonged meditation; see Griffiths, Hurwitz, Davis, Johnson, & Jesse, 2019; Griffiths, Richards, McCann, & Jesse, 2006; Richards, 2016). A double-blind study in the 1960s with students at the Harvard Divinity School (Pahnke 1963, 1966) found those sessions facilitated by psilocybin-reported experiences ranked, immediately and decades later, as among the most profound and life-shaping spiritual experiences in their lives (also see Doblin's, 1991 follow-up study). Richards (2016) reviewed this and other clinical research and examined their implications for issues in religious studies. The profound and undeniable implications of entheogens are their ability to produce genuine mystical experiences that are phenomenologically indistinguishable from the mystical experiences that result from devoted spiritual practices or which occur spontaneously. The clinical research establishes that it is pharmacology rather than personal expectation alone that enables entheogens to produce the standard core mystical features such as union with and intuitive knowledge of God, a sense of transcendence of time and space, a connection with sacredness, a sense of ineffability, and positive mood. This direct encounter with primal religious and mystical experiences provoked by entheogens has profound implications for religious studies in general (Smith, 2000, 2001), and as we will show here, for our understanding of the sacred visionary experience of early Mormonism.

Context of Mormon entheogens

Two salient characteristics of the early Mormon religion, founded by Joseph Smith (Figure 1) in 1830, were: (a) converts who were "seekers" whose "*greatest hunger was for spiritual gifts like dreams, visions, tongues, miracles, and spiritual raptures*" (Bushman, 2005, p. 147); and (b) converts who would sacrifice everything they possessed, even their own lives, and those of their family, to gather together, establish cities, and build temples to create a New Jerusalem, or Zion in America. While new religions were prevalent in the 19th-century America, the zeal with which Mormons defended their religion speaks to the charismatic power of the founding prophet, a charisma which may have leveraged entheogens for chemically induced spiritual awakening. We propose that the entheogenic context of early Mormon involved sacraments, ordinances, and endowments feeding these seekers' hunger for primary religious experience.

Discovering their yearning could be satisfied in Mormonism, seekers flocked to Joseph Smith (Figure 1), swelling Church membership from a mere 6 in 1830 to 8,000 living in Nauvoo by 1844 rivaling Chicago in population size (Hoyt, 1933, p. 50). Critical to the rise of convert numbers that the Church experienced was that between 1830 and 1836, seeker converts participating in Mormon rituals in which sacraments were ingested or anointing oils applied, had the dreams, speaking in tongues, miracles, and spiritual raptures they sought, with many enjoying visions of God and Jesus Christ (Anderson, K. R., 1996, 2012; Petersen, 1975, pp. 80-81). The experiences surrounding the dedication of the Kirtland temple in 1836 have been called the Mormon Pentecost (Olmstead, 2000), and had a similar impact on the rise of early Mormonism as the early Christian Pentecost had on the rise of Christianity; both sects faced the same charges of drug-related visions (see Acts 2:1-31, "KJV").

Sectarian observers were appalled by the strange behaviors associated with visionary sacrament meetings that Mormons had opened to the public. Of this period, the *Cleveland Harold & Gazette* reported:

> *Large [Mormon] meetings, continued for successive days, were held - earnest preachings and alarming exhortations were given ... swoons, trances, jerkings, and visions were frequent* ("The Mormons," 1839)

Figure 1. Painting of Joseph Smith, ca. 1842. Community of Christ. Public domain.

A non-Mormon medically trained observer, James J. Moss who witnessed several meetings concluded that the strange behaviors and visions were produced by drinking "medicated" sacramental wine and contemplated stealing a bottle "*to see if it were drugged or not*" (Moss, 1878). Importantly, Moss, who was a believing Campbellite and had witnessed Methodist enthusiasm during the same period, distinguished between characteristic religious enthusiasm and sensational early Mormon visionary experience. Although Joseph Smith was not present at these meetings, he attended subsequent meetings where the sacrament produced similar bodily manifestations (Bushman, 2005, pp. 156-157). In response to the multiple complaints generated by the strange behaviors of Mormon enthusiasts, Smith closed sacrament meetings to outside observers, restricted attendance to male members only, added anointings with oil, and began construction of a temple in Kirtland, Ohio. During the dedication period of the Kirtland temple in early 1836, en mass visions were once again reported by many of those who participated, with the same accusations of drugged sacramental wine (see below).

The evidence for Joseph Smith's use of entheogens explained in detail in this paper is primarily based on six straightforward phenomena reported or observed during the life of Joseph Smith.

1. Entheogens were found in every area the Smith family resided, and produce visions, and spiritual ecstasies.
2. Joseph Smith was mentored by individuals with experience in esoteric fields of knowledge.
3. Visionary experience in early Mormonism was frequently "on-demand" rather than spontaneous.
4. Joseph Smith devised a method to facilitate dramatic religious experience among his followers (Welch & Carlson, 2005).
5. There was an association between early Mormon visionary experience and participation in Mormon ordinances where bread and wine were served, and oil anointings were received.
6. Visionary experiences of the magnitude experienced during Joseph Smith's life ceased at his death.

We find the best explanation for these phenomena is Joseph Smith's personal use of entheogens and his administration of entheogens to early Mormon converts.

Entheogens as the "means"

In contrast to traditional Christianity, Smith consistently understood matter and the body to be sacred, not profane. For Joseph Smith, the physical did not impede the spiritual but was instead the *route* to the spiritual. This unique aspect of Joseph Smith's theology and prophetic practice finds expression in his doctrine of "means." In Smith's theology, divine action operates through the instrumentality of material causes, including human action and natural law. *The Book of Mormon* raises this idea to the status of a general law of divine action, asserting: "*The Lord God worketh through means*" (Smith, 1830, p. 236, emphasis added).

Joseph Smith's doctrine that God operates by "means" and that the physical is a gateway to the spiritual provides a theological rationale for using entheogenic herbs and fungi. In the view of some prominent Mormons, entheogens are not prohibited by Joseph Smith's dietary "word of wisdom" (see below). Such entheogens would be physical means God has provided for humankind to achieve spiritual ends. Smith's approach anticipated recent developments in the study of religion, particularly the role physical process plays in religious experience. In this, Smith seemed to anticipate Edward O. Wilson, professor of biology at Harvard and one of the world's leading experts on biological diversity, who concluded that "*we have come to the crucial stage in the history of biology when religion itself is subject to the explanations of the natural science*" (Fuller, 2008, p. 4).

Joseph Smith likely understood that entheogens were a trigger for religious experience, a fact vindicated when considering entheogens as simple molecules cannot create the richness of early Mormon visions and ecstasies without the human capacity for religious experience. Instead, the religious experience is a product of the body through the actions of endogenous and exogenous neurotransmitters on human cognition. Mormons regularly modify their physical chemistry to promote spiritual experience through the Mormon practice of monthly prayer and fasting, but this is an unreliable method of inducing a transcendent spiritual experience of the nature experienced at the foundation of Mormonism.

In Smith's (1835) "the Word of Wisdom," he overtly endorses the use of one mind-altering substance for spiritual ends, wine in the sacrament of communion (D&C 89:5). The revelation further teaches that "*all wholesome herbs God hath ordained for the constitution, nature, and use of man - every herb in the season thereof, and every fruit in the season thereof; all these to be used with prudence and thanksgiving*" (D&C 89:10-11). Adherence to the prohibition of addictive substances and the use herbs carries the promise of "*wisdom and great treasures of knowledge, even hidden treasures*" and protection from the "destroying angel" (D&C, 89:19-21). Herbs were a physical means to profound religious experience, experiences that rarely occur without using entheogens. As we discuss, evidence suggests that Smith gained knowledge and skill in working with herbs (D&C, 42:43; 59:17-18; 89:10-11; Haller, 2000; Heinerman, 1975), including entheogens. Joseph Smith's grandson, Frederick M. Smith, came to the same conclusion as discussed below.

Joseph Smith was also a restorationist and advocated a unique form of Native American "restoration" or "revival. From its title page onward, The *Book of Mormon* advocated a "restoration" of Native temporal and spiritual power and Smith sought alliances with Native Americans and traded objects of spiritual significance with them. If Smith learned of entheogens that bore the imprimatur of Native American shamanism, he would have been likely to seek mentors in their use, not only for himself but also for converts of his Church. Besides facilitating religious visions and spiritual ecstasies, entheogens have remarkable antidepressant properties, suggesting a motivation, possibly unconscious, for their use by the Smith family and in early Mormonism.

Wholesome herbs God hath ordained

That Joseph Smith did not consider entheogens a problem is evident from his attitudes toward herbs. Joseph Smith knew of herbs and their uses and claimed the requisite knowledge and skill to devise and prescribe herbal remedies for others (Heinerman, 1975). Joseph Smith's development into a village scryer or "seer" involved following the path set forward in several esoteric traditions of the area he grew up, and possibly from his interpretation of biblical passages indicating the ingestion of some material preceding the visions of Ezekiel and John as discussed below.

In line with other health edicts of the 19th century, in 1835, Joseph Smith delivered a revelation called "The Word of Wisdom" suggesting dietary practices and the proper and improper use of alcohol, tobacco, and other substances. However, Smith carved out an exception for plant and herb medicine in the Word of Wisdom.

> *And again, verily I say unto you, all wholesome herbs God hath ordained for the constitution, nature, and use of man. Every herb in the season thereof, and every fruit in the season thereof. All these to be used with prudence and thanksgiving* (Smith, 1835)

The first "anti-Mormon" book, *Mormonism Unvailed* [sic] by Eber D. Howe (1834), attributed the exemption carved out for "*herb[s] in the season thereof* " to Frederick G. Williams' influence on Joseph Smith (discussed below). Howe referenced Williams' herbarium on either side of his Kirtland home while disparaging his "communion with spirits from other worlds." Howe continues,

> *We are next told that every wholesome herb, God ordained for the use of man!! and we should infer that the writer or the recording angel had been inducted into the modern use of herbs, by the celebrated Doctor. F. G. Williams in Kirtland. F. G. Williams is a revised quack, well known in this vicinity, by his herbarium on either side of his house; but whether he claims protection by right of letters, patent from the General Government, or by communion with spirits from other worlds, we are not authorized to determine.* (pp. 229-230)

The Smith family exemption of entheogenic herbs as prohibited substances in the Word of Wisdom seems generational considering that Joseph Jr.'s grandson Frederick M. Smith, also a prophet to the Reorganized Church of Jesus Christ of Latter Day Saints, carved out a similar exemption for peyote as discussed below. We begin by examining the historical setting of entheogenic practices of Joseph Smith Jr. and his ancestors, mentors, and colleagues. We then summarize the evidence for the entheogens available to Joseph Smith and his mentors, followed by descriptions of early Mormon visions and ecstasies we correlate with a clinical syndrome suggestive of intoxication with visionary anticholinergic substances.

Historical setting: Ancestors, mentors, and colleagues

For Joseph Smith to fulfill his promise that every Mormon convert would have visions of God and spiritual ecstasies, he needed assistance from trusted associates who would covertly procure, process, store, and administer entheogens. Several early church leaders (including the Smiths, Cowdery, and Whitmer families in particular) were deeply invested in the study of occult practices, and herbal, plant, pharmaceutical, folk medicine /craft, and the utilization of "spirituous liquors" (Brooke, 1996; Quinn, 1998).

Salem witch trials

The Smith family involvement with the magic world view and possibly entheogenic material went back several generations. For instance, the Smiths were involved with the witch trials in 17th century Salem, Massachusetts, that may have been instigated by the psychedelic ergot fungi (*Claviceps purpurea*). Samuel Smith, Joseph Smith's great grandfather, gave testimony in April 1692 that Mary Easty threatened him after which he reported, "*I received a little blow on my shoulder, and the stone wall rattled very much*" (Smith, 1692). After the Salem trials, other generations of his ancestors resided in areas noted for beliefs and practices of folk magic and alchemy (Quinn, 1998, p. 31). European occultism also shaped the cultural milieu in which the witch trials occurred. Mormon historian B. H. Roberts noted, "*Indeed it is scarcely conceivable how one could live in New England [in the 18th-19th centuries] and not have shared such beliefs*" (Quinn, 1998, p. 29).

The hypothesis of ergotism as the culprit in the Salem witch trials of 1692 (Caporael, 1976) is based on the signs of convulsive ergotism including seeing apparitions, feeling pinpricks, pinches, burning sensations, and by symptoms of urinary obstruction. However, those afflicted had none of the constitutional symptoms or residual effects known to occur with ergot poisoning (Woolf, 2000), making poisoning by ergot-infected rye bread less likely. The manifest symptoms were attributed to potions made by Tituba, a South American Arawak Indian or Caribbean enslaved person (Albanese, 2005; Breslaw, 1996) owned by the Reverend Samuel Parris (Dannaway, Piper, & Webster, 2006). Tituba was familiar with Hoodoo religion (Martin, 2006) and plant medicines from her African heritage and could have prepared an anticholinergic such as datura (Caporael, 1976). This could have produced the symptoms ascribed to Parris' daughter, and her cousin, the first "bewitched" inhabitant of Salem, whose behaviors, resembled the anticholinergic toxidromal (Holstege & Borek, 2012) and dissociative features of Hallucinogen Persisting Perception Disorder (Martin, 2006).

Joseph Smith Sr.

The founding prophet of Mormonism, Joseph Smith Jr., was born on the December 23, 1805 into a Christian family enmeshed in folk-magic and the occult (Quinn, 1998). Joseph Smith's father, along with his other sons Alvin and Joseph Jr., engaged in the "*more esoteric components of the western New York religious-cultural situation*" (Shipps, 1987). Joseph Smith's earliest mentor was his father, who we believe would have communicated his entheogenic and magico-religious knowledge to his sons.

Ginseng extraction

Joseph Sr.'s knowledge of preparing plant extracts was recorded in 1811 when he collected and crystallized the 2018 equivalent of $57,000 worth of ginseng root (Figure 2) intended for sale in China (Smith, L. M., 1853, p. 49). Administration of ginseng root extract compares well with Modafinil, a widely prescribed pharmaceutical drug used to treat "*excessive daytime sleepiness associated with narcolepsy or shift-work*" (Neale, Camfield, Reay, Stough, & Scholey, 2013). Having crystallized and likely made use of this psychoactive themselves, the Smith's would have had no difficulty collecting, processing, and storing more potent psychoactive plants and fungi for their medicinal and magico-religious practices.

Figure 2. Ginseng found near the old Smith family farm, Sharon, Vermont (photo by Robert Beckstead).

Family magical practices

Quinn (1998) has argued that the Smiths, who lived in Vermont, New Hampshire, Upstate New York, and Northern Ohio, engaged several magico-religious practitioners of which Luman Walters (discussed below) played a significant role as mentor to both Joseph and his father (pp. 98-135). The Smith family, including Joseph Jr., possessed and employed several magic-related artifacts including astrological charts, magical parchments, a ceremonial dagger, an alchemical amulet, a silver Jupiter talisman, and a cane that all "manifest direct indebtedness" to occultists including Sibly, Scot, Agrippa, and Barrett (Quinn, 1998, p. 118). Quinn characterizes these occult books of "enormous significance" to the Smith family, especially Joseph Jr. whose cane was inscribed with symbols from The Magus conveying the message: "Jupiter-reigns over-Joseph Smith" (Ibid). Shown in Figure 3 is the silver Jupiter talisman also bearing the markings of Jupiter.

Figure 3. Joseph Smith's silver Jupiter talisman, after Barrett's *The Magus* (courtesy of Signature Books).

Joseph Smith Jr. possessed a Jupiter talisman, and a cane with a carved "serpent," a character in the Edenic allegory, and one animal believed to be "governed by both Saturn and Jupiter;" this, Quinn argues, shows that Smith relied on the works of occultists Francis Barrett and Heinrich Cornelius Agrippa (Quinn, 1998, pp. 90-91). Agrippa (1486-1535) names henbane, mandrake, and black poppy as three herbs "under the power of Jupiter" (Agrippa, 1801). According to Barrett (1801, pp. 89-92), henbane and black poppy are among the herbs used to invoke the "images of spirits" through proper suffumigations involving hemlock, henbane, black poppies, mandrake root, and other plants. Also, Joseph Smith possessed an esoteric Amulet (Quinn, 1998, p. 93) that seems to bear symbols belonging to both alchemy and masonry and representing *Psilocybe species* mushroom, which we discuss below.

The visions of Joseph Smith's parents

In 1853, Joseph Smith's mother, Lucy Mack Smith, related several family dreams in her book, *Biographical Sketches of Joseph Smith, the Prophet, and his progenitors for many Generations* and from which we learn about Joseph Smith's life growing up in the magically and religiously charged environments of sparsely populated New England and Upstate New York.

Lucy's first vision

The golden *Amanita muscaria* could be the mushroom that best fits Lucy Smith's remarkable first vision. Lucy's dream occurred c. 1802-1808, at least 3 years before her husband's two dreams in 1811 (described below) and 12 years before her son's first vision. Joseph Sr. had just informed Lucy it was best for her to "desist" attending the Methodist church because his father and older brother were very displeased. Lucy related that "*after praying for some time ... [she] fell asleep and had the following dream" in which she saw trees that "were very beautiful, they were well proportioned, and towered with majestic beauty to a great height ... I saw one of them was surrounded with a bright belt, that shone like burnished gold, but far more brilliantly*" (Smith, J., 1853, pp. 54-55).

A. muscaria occasionally forms "fairy rings" around the host tree (Figure 4), and the color of a mature *A. muscaria*, as shown in Figure 5, "*takes on a metallic sheen ranging in color from red-orange to golden or bronze*" (Heinrich, 2002, p. 14), a feature enhanced by early morning or evening light. Further, aging and drying converts ibotenic acid to the more hallucinogenic and less toxic muscimol and "*once completely dry, the golden mushroom's power is complete*" (Heinrich, 2002, p. 170). A golden *A. muscaria* surrounding its host tree may have been one of Lucy's waking memories and incorporated into this dream.

Figure 4. Ring surrounds a host tree (not shown) Shutterstock.

Figure 5. Mature, Burnished Golden *A. muscaria* (photo by Heinrich, 2002).

Lucy's dream ended with her mood lightened as she concluded that her husband would share her feelings, when "*more advanced in life, would ... rejoice therein; and unto him would be added intelligence, happiness, glory, and everlasting life*" (Smith, L. M., 1853, p. 56). Lucy's dream included a conscious memory of having seen a "burnished gold" ring probably of *A. muscaria*. If Lucy deliberately tried this entheogenic fungus, she may have done so as treatment for her lifelong depression (Groesbeck, 1988).

Joseph Smith Sr.'s first vision

Two dreams reported by Joseph Smith Sr. strongly suggest experience with entheogens whose content contains not only allisions to entheogens but also some familiarity with esoteric allegory and symbolism.

Datura dream. In what his wife described as his "first vision," Joseph Sr. found himself entirely alone, although accompanied by an "attendant spirit." In the "desolate field," before him, Joseph Sr. saw only dead, fallen timber, and heard only "deathlike silence." Querying his attendant spirit on the meaning of such desolation and dreariness, Joseph Sr. was told that ahead he would find, "*a certain log a box, the contents of which, if you eat thereof, will make you wise*." Shortly after "tasting" the contents, Joseph Sr. reports being threatened by "*all manner of beasts ... bellowing ... most terrifically.*" In the panic, Joseph Sr. escaped on the "fly," and when he returned to his natural senses, Joseph Sr. found himself "trembling." Despite the frightful experience, Joseph Sr. reported being "perfectly happy" (Smith, L. M., 1853, p. 57).

The following datura experience posted online is impressive for its robust emotional impact, the overlay of visionary material on everyday reality, and the generation of a different reality.

> *You effectively keep your rational, sober mind along with your ego while on Datura; it's rather that your sober mind is experiencing a completely different reality. Imagine normal sobriety but as you start to dream while awake. Rather than enlightenment through ego death, the nightshades offer dimensional travel to other planes of reality* (deCypher, 2008)

The frightening aspect of Smith's dream suggests a waking experience with datura fruit and his memory of the biblical warnings of death ("thou shalt surely die") associated with the "tree of knowledge of good and evil" (Genesis 2:17), coupled with his awareness of reports of fatalities associated with datura poisoning (e.g., Bigelow, 1817). Smith's guide echoes the serpent in Genesis 3:3, who advises that eating of the fruit "will make you wise." An element of Joseph Sr.'s first dream reappears in his second dream, thorns. Significantly, thorns are introduced into the world, according to Genesis 3:3, because of the ingestion of the "forbidden fruit" of the tree, perhaps symbolically referencing the thorny mature datura seedpod. What then, was the knowledge that Joseph Sr. received from his spirit guide and his dreams? According to his wife, following his two dreams, Joseph Sr. "*seemed more confirmed than ever, in the opinion that there was no order or class of religionists that knew any more concerning the Kingdom of God, than those of the world, or such as made no profession of religion whatever*" (Smith, L. M., 1853, p. 60).

A. muscaria dream. The same year as the first dream, Joseph Sr. had a second entheogen-related dream, which involved basking in ecstasy, the joy, and love associated with the Edenic tree of life. In this dream, which he related to his wife Lucy, a psychopomp leads Joseph Sr. to a tree with, "*beautiful branches spread themselves somewhat like an umbrella, and it bore a kind of fruit, in shape much like a chestnut bur, and as white as snow, or, if possible, whiter.*" As he watched, the chestnut "*shells commenced opening and shedding their particles, or the fruit which they contained, which was of dazzling whiteness*." When he partook of the fruit, he experienced something "*delicious beyond description*" and, inviting his family to eat, they "*got down upon [their] knees, and scooped [the fruit] up, eating it by double handfuls*" (Smith, L. M., 1853, p. 85).

In this dream, Joseph Sr. incorporates the spiny, thorny fruit of the chestnut, a feature of the first dream, which is similar in appearance to the fruit of datura. Instead of datura, however, the umbrella-shaped fruit scooped from the ground in the second dream evokes images of dazzling white spores dropping from the gills of an *A. muscaria* against a bright background or on a black surface.

Joseph Sr.'s esoteric Christian *A. muscaria* dream concludes with Joseph Sr. explaining to his wife, Lucy, "*I drew near and began to eat [the fruit] of it, and I found it delicious beyond description. As I was eating, I said in my heart, 'I cannot eat this alone, I must bring my wife and children, that they may partake with me.' I went and brought my family, which consisted of a wife and seven children, and we all commenced eating, and praising God for this blessing. We were exceedingly happy, insomuch that our joy could not easily be expressed*" (Smith, L. M., 1853, p. 85).

Emma Smith

Emma Hale, Joseph's wife, was gifted in using herbs. One of Emma's medicines was a healing salve that contained "jimson weed" or *Datura stramonium* (Bailey, 1952) and when the Sauk Indians visited Nauvoo in 1841, she exchanged recipes for herbal medicines with the wife of Chief Keokuk (Newell & Avery, 1994). In 1867, Emma wrote to her son, Joseph Smith III: "*I will tell you now how I make the salve. Of sweet elder bark a good large handful after it is scraped, and as much gymson [jimson] leaves and buds if they are green and tender enough to be pounded up fine*" (Bidamon, 1867; Youngreen, 2001, pp. 97, 119). Emma's grandchildren also reported her use of psychoactive medicinal beer, ginseng, and lobelia, or "Indian tobacco" (Youngreen, 2001, pp. 73, 99). Ginseng has stimulant, antidepressant, and aphrodisiac properties, while lobelia (a hallucinogen and sedative) had entheogenic uses among Native Americans (Alrashedy & Molina, 2016).

Native Americans

Smith always lived close to Native Americans and likely was influenced by shamanic activities. For instance, the Algonquin (Delaware, Fox, Ojibwa, Potawatomi, Sauk) in the Northeast and Great Plains, the Iroquois (Cayuga, Oneida, Onondaga, Seneca) in the northeast (Tooker & Sturtevant, 1979, p. xviii) and the Cherokee in the southeast (Hamel & Chiltoskey, 1975, p. 41) and their shamans resided close enough to Joseph Smith that he would have been captivated by their religious and medical practices.

In 1822 Seneca Indian Chief, Red Jacket, nephew of Chief Handsome Lake, spoke only miles from where Joseph Smith lived. Red Jacket might have sparked 17-year-old Joseph Smith's interest in Native American culture and seeking a Native American shamanic mentoring (Taylor, 2010).

Joseph Smith demonstrated his interest in Native American life at age 18 when he regaled his family with stories of ancient Indian life (Smith, L. M., 1853, p. 79), and later partially built his prophetic career on a Native platform with *The Book of Mormon*. Comparative religionist Åke V. Ström (1969) has demonstrated many parallels of Joseph Smith's teachings and practices with those of Native religions of Northeastern North America, especially that of the Algonquins. The parallels are extensive enough that Ström posits that the boy Joseph may have been heavily influenced by an Algonquin neighbor. Smith's Native American influences may have included North American entheogens, such as *D. stramonium*, *A. muscaria*, and *Psilocybe species*. The Native Americans used entheogens in medical and spiritual practices such as the Ojibway Midewiwin or Grand Medical Society. The Ojibway (Anishinaabe people) in their legend of Miskwedo described the use and effects of *A. muscaria* (Navet, 1988).

We summarize here the version told by medicine woman Keewaydinoquay Peschel (1979) where Miskwedo, the red-topped mushrooms, the spiritual children of Grandmother Cedar and Grandfather Birch. Two brothers came upon Miskwedo "*turning and revolving, buzzing and murmuring, singing a strange song of happiness under a brilliantly sunny sky*." The older brother tried to dissuade his younger brother from eating the mushroom, but defies his brother and merged with the mushroom, becoming a Miskwedo himself. Distraught, the older brother ran home to ask the medicine men what to do; and he was told to return, locate the chief and the wisest Miskwedo, and stick the quill of an eagle feather through each of their stipes to stop them turning and singing songs of happiness, then to do the same to his younger brother and carry him home. He followed the elder's instruction, and his younger brother turned back into his previous form. However, after returning home, the older brother arose in the morning "with his heart heavy with sadness and foreboding," while his younger brother "arose smiling each day, his heart filled with happiness, his lips singing merriment." The older brother became suspicious when, the younger brother urinated more frequently and took longer than before. When the older brother investigated, he found his younger brother with "arms are open wide, spread like the umbrella of a mushroom" with beautiful robes "glowing red, and tufts of white" singing with a "voice of happiness" to the "people following him." Now and forever, older brothers are unhappy in contrast to the younger brothers who "drink the Elixir of the Great Miskwedo" learning much of "the supernatural and other knowledge" by drinking "the liquid Power of the Sun."

Together, these stories transmit knowledge about *A. muscaria*, where to look for it, how to recognize it, the joys it can bestow, and the displeasure of authorities if consumed. For instance, these mushrooms are always associated with trees such as cedar and birch and have red tops with white tufts. The experience of ingesting these mushrooms includes transient ego disillusion, unity with the Divine, and mood elevations. The stories also warn of authoritarian displeasure, whom themselves refuse filling their hearts with happiness, try to suppress its use. In *The Book of Mormon*, Joseph Smith relates a similar story about Lehi's use of entheogens. Lehi comes upon a tree ladened with fruit that filled his soul "with exceeding great joy." However, others, whose dress was "exceeding fine," mocked, and pointed their fingers at those "partaking of the fruit." The scoffing caused some who ate from the tree to feel ashamed and fall "away into forbidden paths" (Smith, J., 1830, p. 20).

Midewiwin shaman are believed to possess the power of a long life, even "victory over death" through healing plants and the rituals. Such power strongly suggests that among other herbal remedies, the Midewiwin shaman utilized entheogenic material.

Delaware (Tantaquidgeon, 1972, p. 37) and Mohegan (Ibid, pp. 72, 128) peoples were familiar with datura. Native Americans living in Virginia gave a psychoactive brew called "wysoccan" to their young men during a rite of passage, causing a "derangement for 20 days," strongly suggesting it contained *D. stramonium* (Schultes, 1975, 9, 142) or *A. muscaria* (Geraty, 2015). Most North American Eastern Woodland Indian groups reported: "*datura as the base of a narcotic drink used in manhood initiation rites*" (Goodman, 1993). In 1705, Virginian Indians were reported to have been using datura in their religious ceremonies (Safford, 1922) and there was widespread use of datura in initiation ceremonies in Native North America (Jacobs, 1996). Further, sometimes, Eastern Native Americans would add "*datura and other powerful substances ... to tobacco to prepare a particularly potent smoke*" (Fuller, 2008, p. 81).

Growing up and into adulthood, Smith lived relatively near to the Algonquin areas of the Potawatomi, Ojibwa, and Delaware peoples whom all belonged to the Algonquin family. We will explore Smith's relationships with this group of peoples when we discuss his transactions with the Potawatomi in the early 1840s Nauvoo. However, it is enough to note that Smith likely noted the secretive Midewiwin medical society with its selective membership, graded training of new shamans, and their use psychoactive materials including datura and *A. muscaria.*

Esoteric Christianity

Joseph Smith was influenced at a young age by several categories of esotericism, including esoteric Christianity, spiritual alchemy, and speculative freemasonry (Owens, 1999). Significantly, some members of these esoteric schools of thought had an interest in entheogen use and encoded their knowledge in esoteric works of art.

During the 13th century, esoteric Christian artists painted Biblical themes associated with entheogenic mushrooms (Brown & Brown, 2016; also see Brown & Brown in this issue). For instance, in Figure 6 is an "Eden Panel" found in Saint Michael's Church, Germany (1240 CE) showing Adam and Eve standing, and a serpent coiled on a tree in front of a spotted *A. muscaria* mushroom cap. Also, in Figure 7, the Edenic tree also takes on the form of an *A. muscaria* in a ca. 1291 fresco found in Plaincourault Abbey, Indre, France. Figure 8 shows a painting by the Flemish artist, Petrus Christus (c. 1410-1475) portraying the child Christ laying supine on an *A. muscaria* bed looked over by Joseph, Mary, and winged angels. The relative abundance of Christian *A. muscaria* syncretic art led Antonio Escohotado (2012) to conclude, "*it seems indisputable that there is a connection between visionary mushrooms and Christianity*" (p. 73). There are reasons to think that given his esoteric background, Joseph Smith or one of his mentors had access to this art, decrypted it, and then encoded in Smith's teachings, revelations, and ordinances.

Figure 6. Eden Panel, St. Michael's Church Germany, 1240. Public domain.

Figure 7. Temptation in the Garden of Eden, Plaincourault Chapel, France, ca. 1299. Color enhanced. Public domain.

Figure 8. The Nativity, Petrus Christus, 1452 (only close up of infant Jesus is shown). Public domain.

Where then did Joseph Smith first learn of alchemy and esoteric Christianity? In his book, *Magic Mushrooms in Religion and Alchemy*, Heinrich (2002, pp. 105-153) discusses the relationship between esoteric Christianity and using *A. muscaria* as a sacramental meal. According to Heinrich, Jesus unmistakably identifies himself with an entheogenic substance, an elixir of life and bread of heaven, the *A. muscaria* mushroom shown in Figure 9. Heinrich quotes Jesus telling a woman,

> *... whosoever drinketh of the water that I shall give him shall never thirst; but the water that I shall give him shall be in him a well of water springing up into everlasting life*. (p. 120)

Figure 9. *A. muscaria* as elixir (blood of Christ) and bread (flesh of Christ) (photo by Heinrich, 2002).

The "living water," according to Heinrich, is water-soluble muscimol, the principle psychoactive in *A. muscaria*. Muscimol is excreted unchanged in the urine, which the shaman or others can consume. Supporting Heinrich's argument of entheogenic urine, we note Jesus's saying in John 7:8,

> *He that believeth on me, as the scripture hath said, out of his belly shall flow rivers of living water.*

The phrase "out of [Jesus'] belly" may describe entheogeniclaced urine. Due to physiological processes, urine after ingesting *A. muscaria* is more potent than the tea initially consumed. The entheogenic component of *A. muscaria* is water-soluble, and when extracted with water, turns the water the color of red wine. Further, the mushrooms upturned cap (Figure 9) and becomes the cup holding the elixir of life, and the mushroom itself becomes the life-giving bread. Heinrich (2002, p. 122) quotes Jesus telling he disciples:

> *I am the living bread that has come down from heaven. Anyone who eats this bread will live forever; and the bread that I shall give is my flesh ... if you do not eat [my] flesh and drink [my] blood, you will not have life in you. Anyone who does eat my flesh and drink my blood has eternal life ... for my flesh is real food and my blood is real drink ... As I, who am sent by the living Father, myself draw life from the Father, so whoever eats me will draw life from me. This is the bread come down from heaven ... anyone who eats this bread will live forever.* (p. 121)

Implied in Heinrich's discussion of these passages is his confidence that anyone using entheogens in a Christian context will experience "*many of the states described ... in mystical Christianity*" (p. 5).

Although most of Smith's revelations and teachings suggest the traditional Christian understandings of Jesus, occasionally he betrayed a different view. For instance, in 1844, Smith is reported to have said,

> *I am the only man that has ever been able to keep a whole church together since the days of Adam ... Neither Paul, John, Peter, nor Jesus ever did it ... The followers of Jesus ran away from Him; but the Latter-day Saints never ran away from me yet.* (Roberts, 1915, pp. 408-409)

In this statement, Smith seems to suggest that Jesus did not differ from him - meaning that Smith understood Jesus as shaman-like, as a human and not a God. Likewise, Jesus-like Smith healed the "lame arm" of Mrs. John Johnson (Dahl & Cannon, 1997) and raised William Hungtington from the dead (Curtis, 1892).

Spiritual alchemy

Owens (1999) argues that Joseph Smith "*certainly [learned]... about the Philosopher's Stone and alchemy's transmutational mystery*" (p. 158). Alchemy became a subject of several artists in Europe. Owens argues that Smith likely learned about alchemy from "*a physician named Luman Walter(s), who was a distant cousin of Smith's future wife and a member of the circle associated with the early treasure quests*" (p. 16) of which young Joseph was a member. Agreeing with Owens, D. Michael Quinn reasons that Walters was Smith's teenage mentor and occult advisor (1998, pp. 116-122).

In his book, *Science, Alchemy and the Great Plague of London* William S. Shelley (2017) stated "*that alchemical writings concerned chemical processes from their late antique beginning until the Renaissance. Spiritual alchemy originated, it would appear, in the early sixteenth century when Paracelsus [1493-1541] blended his medical practice of alchemy with his interest in the Hermetic-Platonic tradition of Renaissance esotericism*" (p. 4). Sometime late in the reign of Queen Elizabethan (1533-1603), alchemical texts "*seem to be exclusively spiritual, that is, that have no apparent interest in practical laboratory procedures*" (Ibid)

English alchemists such as Elisa Ashmole (1617-1692) and Robert Boyle (1627-1691), according to Shelley, "*were concerned with one or more substances, termed the red stone, the angelic stone, and otherwise, whose effects were described as spiritual*." Shelley then argues, "*these are substances that produced mystical experiences and was implicitly psychoactive*" and associates it with "*the motif of [Israelite] manna, ... the hidden manna of Revelation 2:17, ... [the] hermetic tradition, ... English alchemical literature from the Tudor period onward,*" *and in* "*the twelfth century theology of the school of Laon [northern France], afterward spreading to Cistercian, Franciscan, and other writers*" (Ibid).

Heinrich (2002) explores the connection between alchemy and entheogens, including the allegorical use of the Rebis such as the one in Figure 10 to transmit privileged knowledge of entheogenic *A. muscaria* (pp. 172-177, 184). The Rebis is a double-headed hermaphrodite linked to the prima materia, philosophers stone, an elixir of life within the allegory, *A. muscaria*. According to Lewis Spence (1920, p. 10), one of the "grand objects of alchemy" was the discovery of an elixir to ensure health and prevent death, "elixirs of life" containing herbs and medicinals that Heinrich argues are entheogens.

We now examine an amulet in Figure 11 belonging to Joseph Smith and gifted to Eliza R. Snow, his most esoteric plural wife. Figure 12 shows an inverted mushroom species (presumably *Psilocybin*) comparing favorably to the mushroom-appearing tassels dangling from both the belt worn by the Rebis in Figure 13 and the belt engraved on Joseph Smith's amulet in Figure 14. It is reasonable to propose that Figures 11 and 13 represent the same thing, *Psilocybe species* mushrooms.

Figure 10. Rebis by Solomon Trismosis, 1852. Public domain.

Figure 11. Joseph Smith's alchemical amulet (courtesy of Signature Books).

Figure 12. Inverted relatively young *Psilocybe* species mushroom (Shutterstock photo).

Figure 13. Enlarged belt on the Salomon Trismosin Rebis (adapted from Figure 10).

Figure 14. Enlarged belt on the Joseph Smith amulet (adapted from Figure 11).

Speculative Masonry

Mormon historian and former director of the Institute of Religion in Salt Lake City, Reid C. Durham documented Joseph Smith's Masonic heritage and his adoption of Masonic ritual and iconography found in the Mormon Nauvoo temple endowment (Durham, 1974). The Nauvoo Masonic Lodge, founded at the end of 1839, anticipated the spring of 1842 groundbreaking of the Nauvoo temple.

Joseph Smith's father and older brother, Joseph Sr. and Hyrum, respectively, were both Masons, and Joseph Jr. was likely familiar with Captain William Morgan, famously murdered for publishing the secrets of Masonry in 1826. After Morgan's death, his widow, Lucinda Morgan, secretly became one of Smith's 33 known plural wives in 1838 (Compton, 1997). Early Mormon leaders and successors to Joseph Smith, including Brigham Young, the leader of Mormonism's most successful schism, were deeply involved in Masonry before their conversion to Mormonism (Durham, 1974; Tanner, n.d.). There were masonic motifs, architecture, ritual, and iconography in the Nauvoo, Illinois temple. For example, on the outside architecture of the temple were the masonic sunstones, upside-down five-pointed star stones, moonstones, and a masonic compass and a square weathervane. Inside the temple, the masonic "all-searching eye" was shown on the original architect's drawing (Stack, 2002).

Joseph's mother, Lucy Smith (Anderson, 2001, p. 23; also see Joseph Smith Papers, 1844-1845) revealed how "*for a season that we stopped our labor and went trying to win the faculty of Abrac*," a secret masonic process with roots in much older traditions. Mormon scholar and historian Michael Quinn (1998) reports that the

> *Faculty of Abrac was a well-known phrase linking magic and divinity. Medieval and early modern magic manuscripts in England used "Abrac" and "Abraca" as one of the names of God in conjurations. [And that] "Abraxas [was a] Gnostic name for God that had become associated with magic*." (pp. 68-67)

In America, as in Europe, speculative masonry subsumed many mysteries in the ancient world (Casey & Gutierrez 2005, p. 222). There is evidence to suggest that these mysteries utilized entheogens including the Greek Eleusinian mysteries (Wasson, Ruck, & Hofmann, 2008, pp. 2-7), the Demeter-Persephone cult (Ibid, pp. 12-15), and the Dionysiac mystery cults (Ibid, pp. 15-18). The Roman Phrygian rites for Magna Mater (Drummond, 2013, p. 46), the Mithraic cults of Persia (Ezdejini, 2016), and the mysteries surrounding the Egyptian gods Osiris and Isis (Berlant, 2005) are all suspected of entheogen use in their rites.

According to Chris Bennett (2018), the "*imagery of the [Masonic] Lodge, was built with a set and setting that in many ways could be enhanced by the use of entheogens*" (p. 681) and the idea that some "*masonic drinks may be a remnant of early sacramental potions that contained psychoactive ingredients ... [has] been pondered for well over a century*" (p. 693). For instance, Bennett quotes from an 1835 Masonic history by John Fellows who in rehearsing the entheogens of Ancient Egyptians, Pythagoreans, and Druids, "*refers to a soporific cake of honey and medicated grain medicatis frugibus [i.e. drugged]) along with preparations of poppy and other psychoactive substances [with fellow Mason as] its target audience*" (Ibid). Bennett then notes Fellow's informing the candidate that in drinking the potion offered to him during initiation, it is a eucharist by which "*the real presence of the Saviour is manifest*" (Ibid).

In his book, *Alchemically Stoned*, the 33rd degree Mason P. D. Newman (2017) argues that features of Masonic ceremonies, architecture, and accouterments strongly suggest some Masonic lodges used entheogenic material from *Acacia* species known to contain the psychedelic dimethyltryptamine (DMT). Shannon (2008) and Nemu (2019; Editor's Note: see Nemu's article here) similarly argue for the Hebraic use of the entheogenic *Acacia* tree.

According to Mormon writer Jeffrey Bradshaw (2015), "*In the ceremonies of the Royal Arch Degree of the York rite, candidates pass through a series of veils and eventually enter into the divine presence*" (p. 162), but in the Nauvoo temple endowment, it "*is not a mere representation but is the reality of coming into a heavenly presence*" (p. 218). Mormon historian Andrew Ehat (1994) explains, "In temples, we have a staged representation of the step-by-step ascent into the presence of the Eternal while we are yet alive ... [and] "*there should have been a change in us as there certainly was with Moses when he was caught up to celestial realms and saw and heard things unlawful to utter*" (pp. 53-54, emphasis added). We argue that the "change" required to be "caught up to celestial realms" required the administration of an entheogen, a change that, like in Kirtland, would produce observable symptomatology. If this hypothesis is correct, an entheogenic endowment may have been the source of Smith's confidence that converts would in "reality" be "caught up to celestial realms." The secret that Smith needed converts to keep was the visible symptomology they would observe during the Nauvoo temple endowment.

Policy of secrecy

In an 1841 meeting, Joseph Smith explained a purpose of the lodge is to learn to keep secrets. Smith explained, "*the reason we do not have the secrets of the Lord revealed unto us is because we do not keep them*" (Roberts, 1908, p. 478) and later observed, "*The secret of Masonry is to keep a secret*" (Roberts, 1915, p. 59). What did Smith want to keep secret? Besides Smith's unusual marriage practice (Hales, 2015; Van Wagoner, 1985, 1989) and his kingdom building ambitions (Grow, Esplin, McGee, & Mahas, 2016), we argue it was to keep secret administration of an entheogen in the endowment.

Luman Walters, Occultist and eclectic physician

Mormon scholar and historian Michael Quinn (1998) reviewed the historical record about Luman Walters (1789-1860), who was an accomplished physician, preacher, and magician. Through his travels and scientific training in France, Germany, and Italy, Walters became an "eclectic" physician whose practices involved occult techniques that included the administration of medicinal herbs he processed in his well-stocked laboratory. Walters was an exceptionally qualified mentor. During Joseph Smith's teen years and early twenties, Walters utilized his occult training as an astrologer and seer for treasure companies, one of which was a "fraternity" of rodsmen, with Joseph Sr. as one of the leading members. During this period, Walters was young Joseph's "constant companion and bosom friend" and given Smith's extraordinary level of intelligence, he readily received Walters' teachings and eventually exceeded his skills as a conjurer and scryer (Cole, 1831).

Esoteric practice

Walters used a seer stone, conjuration, animal sacrifice, and likely a hallucinogen to occasion "*interview with the spirit, supposed to have the custody of [a particular] hidden treasure*" (Quinn, 1998). It was Walters who "first suggested to Joseph the idea of finding a book." Occasionally, Walters could be found reading to a receptive audience from an "old book" in a language that only he could understand and prophesied that Joseph Jr. "*was about to find ... a history of hidden treasures*" *and a* "*record of the former inhabitants of America*" (Cole, 1831; Morgan, 2014).

Joseph Jr. was chosen as a treasure seer by the same company that had hired Walters, leaving him angry and resentful (Kane, 1995). Residents believed Walters' mantle fell on the young Joseph. While acting as a seer for this company, Smith announced that he found golden plates containing a history of Amerindian ancestors, from which he subsequently "translated" *The Book of Mormon*. Smith used a seer stone to translate, and we hypothesize an entheogen; the use of the latter is suggested by reports of his frequent "intoxication" or "altered" appearance while translating. Luman Walters and Joseph reconciled because Walters was later reported to be a "disciple" of Joseph Smith in Kirtland, Ohio, suggesting Walters' direct impact on Mormon visionary experience could extend into the early Kirtland period at least (Quinn, 1998, p. 131). Walters likely received his esoteric training, including alchemical-drug expertise while studying in Europe (see below). The esoteric physician's involvement in Mormonism was confirmed by Brigham Young, one of Joseph Smith's successors (Young, 1858). Joseph Smith's alchemical-masonic amulet suggests Walter's drug-alchemical influence in Smith's early career (see below).

Medical practice

Walters' medical practice fared much better than his seership duties. He secured his medical reputation by curing a child of severe "croup" after traditional physicians had, in despair, given up. Croup was "the common term for every affection of the windpipe," stridor that produced a high-pitched crowing sound on exhalation. Porter (1826) notes that antiphlogistics (anti-inflammatories) were used by all physicians of the period, as were opium (*Papaver somniferum*) and *Atropa belladonna* and *D. stramonium*, both of which contain hallucinogenic anticholinergic alkaloids (Hartshorne, 1855).

Operating his laboratory, Walters could isolate the active anticholinergic component of the *Datura* plant as an extract or a tincture. He would know the appropriate doses to treat: respiratory diseases such as asthma, cough-variant asthma, and to relieve pain from sciatica, menstruation, and cancer (Benich & Carek, 2011). Datura was well known, and "*Indeed, so closely does it resemble belladonna, that even, in the intoxication which it produces, the same follies are committed.*" The effects of this plant are well-known in some parts of Europe, and the plant was vulgarly called "Herbe aux Sorciers" (Thomson, 1832) and was "*commonly connected with witchcraft, death, and horror*" (Folkard, 1884). Walters undoubtedly used anticholinergics such as *A. belladonna*, *D. stramonium*, and *Hyoscyamus niger* as treatments and knew of their use as visionary substances. He may have also known the antidepressant properties of anticholinergic-facilitated experience and used these medicines to treat melancholy (Drevets, Zarate, & Furey, 2013). Further suggesting that Walters prescribed psychoactives is a statement in the following report in the Geneva (NY) Times, "*In the olden days, roots, herbs and vegetables were considered highly essential as medicine for nervous disorders by* *a number of physicians. Among the early physicians to use these ingredients in his prescriptions for nervous disorders was Dr. Luman Walters, a noted physician and surgeon who practiced in the village of Gorham over a half-century ago*" (Anon., 1929).

Walters would have brought from Europe the medical and occult books from which he taught and perhaps loaned to the Smiths. Anyone with access to *The Magus*, such as Walters and the Smiths did, would read recipes describing hallucinogenic anticholinergics, or "herbs of the spirits" that could be smoked, used orally, dermally, or intravaginally. Ceremonial magicians in both Europe and America used visionary substances. Dale Pendell notes that included in John Porta's book *Natural Magick*, published in 1558, "*a number of recipes both for sleeping potions and madness potions, using stramonium (Datura), belladonna, and henbane*. Natural Magick was an immediate best-seller" (Pendell, 2005, p. 244). Weirus includes "nightshade" in his visionary formula. Although nightshade can be a generic term for members of the *Solanaceae* family, including the *Solanum* genus of food plants such as tomato, potato, and eggplant, it could also be a term for highly toxic Bittersweet (*Solanum dulcamara*), or woody nightshade, with purple and yellow flowers and red ovoid berries (Evens & Stellpflug, 2012).

Frederick G. Williams, Apothecary

One early convert to Mormonism living in Kirtland was a second-generation German immigrant named Frederick G. Williams. Born in October 1787, Williams took up the practice of medicine around 1816 after the death of his sister-in-law during childbirth. Williams gravitated towards Thomsonianism medicine and was frequently called an "herbal" or "vegetable" doctor. However, Williams (2012) did not limit his practice to herbal medicine; his skill set included setting fractured bones, suturing wounds, and treating burns, cholera, venereal disease, and delivering newborns (Williams, 2012, pp. 10, 15, 159, 162, 167). If Williams followed Samuel Thomson's (1841) *Materia Medica*, which was in its 13th edition, he would have given enemas to assist with childbirth (p. 698), and if needed, given a tea consisting of raspberry leaves and "No. 2," the later signifying the class of medicinal stimulants found in London and Edinburgh Dispensatories (p. 115). Since 1822, ergot of rye was thought "*to be the most efficacious remedy in cases of protracted labor and excessive hemorrhage*" and by 1838, was "*was available in every dispensary in London*" (Bauer, 1838, p.479).

Favoring herbs himself, Smith had great sympathy for this branch of medical practice. Soon after his induction into the religion, Smith appointed Williams to the office of Second Counselor to the Prophet, Smith's scribe, and printer for church publications. As a physician, Williams was "*universally known through this country as an eminent and skillful man*" saving Samuel Smith's wife in childbearing and reviving the newborn child (Williams, 1972). Fellow physicians living in Nauvoo used ergot in the obstetrical practices and we have no reason to believe that Williams' skills were any different.

Indian Mission

One aspect of Williams' involvement in early Mormonism was his mission journey to proselytize to the Native Americans from late 1830-1831. Joseph Smith revealed to Oliver Cowdery and three other Elders they were to commence their missionary efforts to the Lamanite, as Smith called Native Americans Indians (Smith, 1833, p. 68) and scout the location for a satellite "stake" (or congregation) to be organized in Missouri. During this journey, the missionaries met Williams, and he joined the group to meet with, and proselytize to, the Natives near modern Kansas City, Missouri, in a Native settlement known as Kaw Township. For a botanically centric physician, an opportunity to meet with the so-called "Lamanites" and intermingle knowledge of herb craft and mysticism with the people who had been using American plants for millennia would have been an exciting prospect. Dr. Williams' medical practice later reflects this newfound knowledge of "Indian medicine," as evidenced by multiple advertisements Williams published in the Quincy Whig from 1839 to 1842 (Williams, 2012, p. 169).

The overwhelming logistical constraints of supplying scores or hundreds of Mormons on multiple occasions with various plant medicines could have been satisfied by an experienced Thomsonian Botanical physician like Frederick G. Williams, with his herbarium. As evidence of their close fraternity, Joseph Smith named one of his children after Frederick G. Williams. Smith had a strong and previously unremarked tendency to draw physicians close to him and place them in positions of close confidence. Smith began his career as a seer with botanical physician Luman Walters as his mentor, and later made Frederick Williams one of his top two or three confidants. In the early 1830s, Smith ordained him his counselor in the newly organized First Presidency. In the early 1840s, he made physician Willard Richards an apostle and his private secretary. Also, around the same time, he made physician John Cook Bennett a counselor in the First Presidency and arguably his right-hand man and closest companion in the early 1840s.

Entheogenic materials

The availability of entheogenic material to the Smith family and their ability to process and utilize it are foundational to our thesis of an entheogenic early Mormonism. Sources of entheogens available to the Smith family and other herbalists interested in divination, visions, and spiritual ecstasies included *D. stramonium*, *A. muscaria variation guessowii*, *Psilocybe ovoideocystidiata*, and *C. purpurea*. Moreover, with established trade networks extending into southwestern Texas, Smith Joseph Smith potentially had access to two additional entheogens, *Lophophora williamsii* and *Incilius alvarius*.

D. stramonium and *H. niger*

Two prominent members of the *Solanaceae* plant family were available in the areas the Smith family domiciled, *D. stramonium* (Jimson weed or Jamestown weed) and *H. niger* (Black henbane). The Drug Enforcement Administration (2013) reports datura plants growing wild, as ornamentals, and in herbal gardens throughout much of the United States from the northeastern states to Texas; and the USDA plant database shows both *D. stramonium* and *H. niger* growing in extensive areas across the entire Northeastern states and other areas in the country.

Both plants contain the tropane alkaloid deliriants atropine, hyoscyamine, and scopolamine and are among the oldest medicines known to humankind (Sweta & Lakshmi, 2015); physicians used them since antiquity as effective medicinals in Eurasia (Alizadeh, Moshiri, Alizadeh, & Balali-Mood, 2014), and early post-colonial America (Ashe, 1808; Coxe, 1827, pp. 209-210). *Datura*, for example, was used for its analgesic, antispasmodic, anti-inflammatory, and antihelmintic properties (Soni, Siddiqui, Dwivedi, & Soni, 2012). Antithetically, 19th-century clinicians reported successfully treating a case of a chronic delusional state with a 10-day course of carefully prescribed *D. stramonium* (Sigmond, 1849).

Magico-religious practitioners also used hyoscyamine and scopolamine since antiquity (Muller, 1998), primarily to facilitate visions and ecstasies during divinatory and shamanic healing ceremonies, religious rituals, and witchcraft (Busia & Heckels, 2006; Keller & Kane, 1967). Anticholinergics were also used as an anesthetic by the Greek physician, Pediacus Dioscorides (c. 40 - 90 AD), and noted by the Roman encyclopedist, Aulus Celcus (c. 25 BC - c. 50 AD). In the earliest attempts at general anesthesia, wine extractions of the bark of the root of mandrake, and the seeds of opium and henbane were used to cause "dead sleep" so the patient "not apprehend the pain" of surgery (Carter, 1996).

The properties of datura were also well-known among colonials living in 18th-century Boston (Meyers, 2011, p. 40). During the 1676 rebellion by Virginia settlers, "*hungry [British] soldiers consumed the plant and then hallucinated for eleven days*" (p. 58). This same symptomology will return in 1830-1831 Kirtland.

P. ovoideocystidiata

P. ovoideocystidiata (Figure 15) mushroom ranges from Rhode Island to Kentucky and is especially common in the Ohio River valley (Guzmán, Gaines, & Ramírez-Guillén, 2007). These mushrooms are usually harvested from April to mid-June but sometimes persist into late September or early November and have a farinaceous or flour-like taste, possibly making ground-up mushroom concealable in bread.

Psilocybin-containing mushrooms have different pharmacology than *A. muscaria* and historically are a major entheogen in cultures worldwide. When ingested, psilocybin content of these mushrooms is dephosphorylated into the psychoactive compound psilocin, explaining why these fungi "*have been exploited for their psychotropic effects since prehistoric times*" (Guzmán, 2009). *Psilocybe species* mushrooms are best known for their entheogenic use in pre-Columbian Mexico, where they were used at least the last 2,000 years. *Psilocybe* mushroom use extends back to 6000 BP in Europe and to 7000 BP in Africa (Ruiz, Piper, & Ruck, 2011).

Figure 15. *P. ovoideocystidiata* (Shutterstock photo).

Amanita muscaria

A. muscaria var. *guessowii* mushrooms, such as the one shown growing near Kirtland, Ohio in Figure 16, are widely distributed in the woodlands and forests of Northeastern America, where it is recognizable by its yellow to yellow-orange cap with remnants of the universal veil forming white scales and a skirt about its stem (Ostry, Anderson, & O'Brien, 2010). It fruits in enormous quantities, often attaining dinner-plate size, and can be found growing in a circle or "fairy ring" around its host tree. The fairy ring can be striking in appearance, especially as the mushroom matures and takes on a golden color, enhanced by the early morning or evening light (Heinrich, 2002, plate 36). The cap contains ibotenic acid and muscimol, with the more hallucinogenic and less toxic muscimol content increasing as the mushroom dries.

Figure 16. *A. muscaria* var. *guessowii* found just outside Kirtland, Ohio (photo by Robert Beckstead, 2007).

A. muscaria may be the oldest entheogen known with some believing its use began after the "*last Ice Age in the northern Eurasian forest belt [and] spread north following the retreating polar ice cap, approximately 11,000 B.P.*" (Hajicek-Dobberstein, 1995. p. 100) and used as an entheogen by Siberian shaman for millennia (Lee, Dukan, & Milne, 2018). Further, Indo-European speaking groups developed "*a vocabulary pertaining to its shamanic use*" followed centuries later by the "*priests of the Vedic culture [who] sang hymns in praise of Soma the god, the sacred plant and the sacred drink pressed from the plant*" (Ibid). It appears from the 2nd to the 9th-century CE among "*Buddhist adepts ... [who] may have been ingesting this mushroom*" as an entheogen (Ibid). *A. muscaria* use appears in alchemy, Christianity, and among free and adept masons; we argue that it appears in the dreams and visions of the Joseph Smith family.

C. purpurea (ergot and mushroom)

The physicians Luman Walters, Frederic G. Williams, and John C. Bennett (see below) may have provided Joseph Smith with visionary ergot. In Figure 17, soft white sphacelia (tissue) is producing sugary or honey-tasting honeydew (Shelley, 1995). The darkly colored sclerotium in Figure 18, when mature, drops to the ground. When there is moisture, ergot on the ground germinates, forming mushroom-like fruiting bodies (stromas) with stipes and heads of various colors in Figure 19. The non-water-soluble ergopeptine alkaloids "*were the agents responsible for the recurring plagues of ergotism known throughout European history*" (Webster, Perrine, & Ruck, 2000, p. 8). The same alkaloids were used by physicians since the 16th century to stimulate uterine contraction to hasten childbirth, to stop post-partum hemorrhage, or to induce abortion (Scarborough, 1971). Use of ergot for these purposes included 1840s Nauvoo, Illinois where it was available to Mormon physicians.

Figure 17. Sweet Honeydew stage of ergot on wheat development (photo by Crop Production Magazine, 2018).

Figure 18. Ergot (*C. purpurea*) sclerotium on rye (photo by Dominique Jacquin. Shutterstock).

Figure 19. Stromata germinating on a sclerotium of *C. purpurea* (photo by KnarkKorven, 2011).

William Shelley (1995) argues that ergot use as an entheogen can be "*traced through the Greco-Roman World, through the worship of Mithra and the Hebrew Scriptures into the activities of the early Christians and from there to the 'hidden tradition' of alchemy*'" (Marshall, 1999). Water-soluble psychoactive alkaloids from *C. purpurea* (ergot) include ergonovine and methylergonovine (Webster *et al.*, 2000, p. 2). These alkaloids are believed to constitute the *kykeon* elixir of the greater Greek Eleusinian mysteries (Wasson *et al.*, 2008). Peter Webster argues that "*Greek priests could easily have harvested enough ergot [0.5 kg] from the nearby barley fields [to serve] 1000 Eleusis participants*" (Webster *et al.*, 2000, p. 8).

"*Hierophantic priests might well have discovered how to achieve partial hydrolysis of the most toxic alkaloids of C. purpurea, resulting in an extract of ergot containing a blend of psychedelic[s] ... eliminat[ing] the toxic ergopeptine alkaloids, converting them to psychoactive ergine and isoergine ... closely similar to the Aztec's ololiuqui*" (Ibid, p. 7), LSD, or psilocybin (Wasson, Kramrish, Ott, & Ruck, 1986).

The life cycle of ergot lends itself to allegory in esoteric Judeo-Christian as it does in spiritual alchemy and masonry. For instance, the manna which Moses said came from heaven tastes "like waters [made] with honey" (Exodus 16:14, "KJV"), a description consistent with ergot's honeydew stage. While undetected ergot infects bread and causes disease, water-soluble alkaloids can be added to bread, making it an entheogenic Hebrew sacrament. Consistent with entheogenic use of ergot, Moses tells the tribes of Israel that manna is "*the bread which the Lord hath given you to eat*" (Exodus 16:15), a theme echoed in the Christian era when Jesus says here is the "bread of life" (John 6:30, "KJV").

Figure 20 shows frame from the *ca*. 1200 Great Canterbury Salter, in Canterbury, England, titled "God Creates Plants" showing God with four mushroom-appearing figures below him; all five figures have uplifted hands seeming to mirror each other. This medieval salter reveals esoteric Christianity's fascination with entheogenic mushrooms. In this figure, God appears to wear an *A. muscaria* cap showing its gill side down, while the left-most figure appears to be a stylized *Psilocybe* mushroom and the far-right figure appears to represent the stromata of an ergot fungus sclerotium. The dark, purplish sclerotium in Figure 18 that has replaced a grain of rye will remain dormant for an extended time if harvested, or fall to the ground. The grounded sclerotium will eventually be moistened by rain or irrigation and produce stroma resembling tiny mushrooms in Figure 19, while Figure 21 is an enlargement of a stroma showing its yellowish-red stippled head comparable to the head of the rightmost mushroom figure in the salter frame.

Figure 20. God Creates Plants, ca. 1200. Public domain.

Figure 21. Enlarged ergot stroma (adapted from Figure 19).

A Mason and early Mormon convert, John C. Bennett, was a practicing physician and obstetrician. There is circumstantial evidence that Bennett, accused of administering "medicine" to induce abortion, was familiar with the medical uses of ergot (Hedges & Smith, 2010). Luman Walters or Frederick G. Williams likely had the education and practical training to cultivate, harvest, and prepare the psychoactive materials associated with ergot for the Kirtland temple. Bennett would have been qualified to safely prepare visionary ergot as a ceremonial entheogen in the Nauvoo temple.

L. williamsii (peyote)

During the period of Indian Removal beginning in 1830, Native Americans living east of the Mississippi River passed through Nauvoo on their way to their seasonal hunting grounds. Potawatomi delegations, also often including members of the Fox and Sauk nations, visited Joseph Smith between April 18 and August 28 of 1843 (discussed below). The purpose of these negotiations is not altogether clear to historians. However, as we will see, the negotiations probably involved Joseph Smith giving valuable and sacred property to the Potawatomi without apparent gain to Smith in return. We suggest that Joseph Smith may have negotiated with Native Americans for the delivery of peyote to Nauvoo for the Nauvoo temple endowment.

Peyote (*L. williamsii*) in Figure 22 grows along the Mexican-Texas border and has been used in Native American magico-religious ceremonies for millennia (Bruhn, De Smet, El-Seedi, & Beck, 2002). "*Indians regard the [peyote] as a panacea in medicine, a source of inspiration. Moreover, [it is] the key which opens to him all the glories of another world*" (Stewart, 1974, 1987). In aboriginal time, the peyote cult was among the Uto-Aztecan tribes (Slotkin, 1955, p. 203), and perhaps even earlier "*in the Mesoamerican and Greater Southwest cultural superareas*" (Ibid, p. 204), and among "*tribes adjacent to those of the United States: Pima, Opata, Jumano, Lagunero, and Coahuilteco*" (Ibid, pp. 206-207). The diffusion of peyotism northeastward occurred in stages beginning to the "Old Peyote Complex" of Mexico before the Spaniards arrived in the 16th century, eventually culminating in the Plains Indian Peyote Religion in the late 19th century (Slotkin, 1955, p. 28; Troike, 1962). The map in Figure 23 shows the location of the peyote beds (dark gray) and the Indian tribes (light gray) who were practicing peyotism before 1800 (Slotkin, 1955, p. 207). When Joseph Smith sent Lyman Wight to Texas to establish Mormon colonies, he would have been in contact with both the source of peyote and Native Americans expert in its use.

Figure 22. Peyote cactus (*L. williamsii*) (Shutterstock photo).

Figure 23. Tribal distribution of peyotism before 1800. Map by Allen K. Philbrick (Slotkin, 1955, p. 107)

After the Spaniards took control of what is now Mexico in 1571, peyote cults were suppressed by priests of the Catholic Inquisition, who nearly eradicated peyote rituals. An Inquisition document of 1620 outlines Catholic opposition to the ancient Amerindian religion and its peyote sacrament: " ... *peyote has been introduced into these provinces for the purposes of detecting thefts, of divining other happenings and of foretelling future events, it is an act of superstition, condemned - as opposed to the purity and integrity of our Holy Catholic faith. The fantasies suggest the intervention of the Devil, the real authority of this vice*" (Rudgley, 1993, p. 75).

Peyote cult recovery first took place among the Huichol (discussed below) and Tarahumara tribes. Peyote use among Mescaleros and Lipan Apache likely had its origin in the late 18th century with "*the Apache making one ritual complex from features selected from the totality of the Mexican and Spanish religious and ceremonial life they knew*" (Stewart, 1948, pp. 35-36). Also, Åke Hultkrantz (1997, p. 31) argued there are "*reasons to assume that Mexican tribal Peyote ritualism constituted the transition to the Plains Peyote rite, and thereby to the modern Peyote religion*" with intermediates being the Comanche, Kiowa, and Kiowa Apache. Further, there is evidence of peyote use by Lipan Apache in the 1770s. It would be naive to believe that Plains Indians shaman, medicine men, or doctors would not have been interested in peyote long before the establishment of Peyote religion.

Why would Joseph Smith be interested in peyote that requires an overland journey of 1,300 miles through Missouri, Kansas, Oklahoma, and Indian Territory before arriving in the peyote fields? We suggest that Smith heard of "aspects of peyotism" and its visionary properties as information made its way east, until in 1835, there were "*European [peyote] cactus fanciers*" (Slotkin, 1955, p. 208).

Typifying Native American's feelings about peyote, Comanchero war chief Quanah Parker once spoke of the advantage peyote offered Native American religion over those in the United States:

> "*The white man goes into his church house and talks about Jesus, but the Indian goes into his tipi and talks to Jesus*" ... *[and the Indians received]* "*their inspiration from the Great Father, while the white man [received] his through the book they have.*" (Hagan, 1995, p. 56)

Joseph Smith, who had promised converts visions of God, would have been naturally interested in the ceremonial use of peyote for Mormon rituals. Below we discuss evidence he sought to obtain peyote.

Incilius alvarius (Sonoran Desert toad)

One of the most dramatic religious experiences found in the "Tree of Life" dream accounts reported by Joseph Sr. and recorded in The Book of Mormon by Joseph Jr. may be facilitated by smoking parotid gland secretions of the Sonoran Desert toad (*I. alvarius*) shown in Figure 24 and found in the same general area as peyote (see Figures 23 and 25 below).

Figure 24. Sonoran Desert toad (*I. alvarius*) (photo by Todd Pierson, 2011). Creative Commons.

Figure 25. Distribution of *I. alvarius* in brown (Terry, 2017), *L. williamsii* in red (Hammerson & Santos-Barrera, 2004), and the proposed Mormon territory in purple (see text). The area where *L. williamsii* overlaped with the proposed Mormon territory is in blue. Distribution of *I. alvarius* and *L. williamsii* adapted from the University of Texas Libraries at Austin.

According to Lyttle, Goldstein, and Gartz (1996), "*Bufo toad (and related genera) has held a place in humanity's archaic consciousness since time immemorial. The earliest representations of Bufo toads (and toads generally) go back thousands of years. The appearance of toad-based artifacts is prehistoric were portrayed in ancient pictographs, paintings, and sculpture*" (p. 268). Secretions harvested from the parotid glands of *I. alvarius* are rich in highly entheogenic 5-MeODMT (Barsuglia *et al*. 2018; Griffiths, 2018). Evidence suggests that 5-MeO-DMT, harvested from *I. alvarius*, was an entheogen used by the Olmec, Mayan and especially the Aztec civilizations where "*Aztec icons focus in great detail on the Bufo toad's parotid glands, which contain substances that may be trance inducing*" (Lyttle *et al*., 1996, p. 269). The *I. alvarius* in Figure 24 bears a striking resemblance to pre-Columbian stone toad effigies such as the toad effigy with the Mayan Sun-God carved on its back from Northern Guatemala or Southeastern Mexico, in Figure 26, and the stone pipe toad effigy from the Ohio Hopewell Culture in Figure 27.

Figure 26. Toad-shaped Effigy container carrying Sun-God mask from Guatemala or Mexico (photo from Art of the Ancient Americas, Los Angeles County Museum of Art. Public Domain).

Figure 27. Stone toad of Hopewell culture origin (100 BC-400 AD). Ohio History Connection Archaeology Photograph Collection.

Early critics of Mormonism linked magical toads with Joseph Smith. For instance, a neighbor of the Smiths, Willard Chase, reported that in 1827, Joseph Smith's father related the following story:

> *Some years ago a spirit had appeared to Joseph, his son, in a vision, and informed him that in a certain place there was a record on plates of gold ... [and that] he must repair to the place where was deposited this manuscript ... [Joseph Smith repaired to the place] opened the box, and in it saw the book, and ... something like a toad* (Howe, 1834, p. 242)

The subsequent transformation of the toad described by Chase strongly suggests an entheogenic source for this vision.

Further, in 1830, the year Joseph Smith finished his "translation" of the "plates of gold," his occult mentor, Luman Walters reportedly possessed a stuffed toad (Quinn, 1998, p. 117), a common familiar of a conjurer (Ermacora, 2017). Walters, who traveled in Europe, would have known the toad's magical and possibly hallucinogenic properties. According to Lyttle *et al*. (1996), the more "*purely psychedelic applications of the Bufo toad had to do with the so-called toad stone, supposedly found in the head [parotid gland?] of the Bufo toad ... In 1644 [France], Boetious de Boot, in his Parfait Joallier [Perfect Jeweler], described 'the toad stone' alleged 'to exist in the toads head ... another sure talisman for obtaining perfect Earthly happiness*.'"

The twice mentioned "toad" during the production of *The Book of Mormon* suggests the remote possibility that Smith employed a toad entheogen in its writing. Further, the happiness mentioned by Boetious de Boot is a significant sequela of many early Mormon visions discussed below. For Joseph Smith to have used toad 5-MeO-DMT, it would have had to been smoked or snuffed. Further, *I. alvarius* entheogen would have had to be transported from Southwest Texas (Figure 25) along existing Indian trade routes into the American Northeast (Tanner, 1996, see map by Sanderson Associates). Peyote, found in Texas (Figure 25), retains its potency (2% mescaline) over thousands of years (Terry, Steelman, Guilderson, Dering, & Rowe, 2006), while5-MeO-DMT retains its potency over a much shorter period. Although no literature indicated how long and at what temperatures, 5-MeO-DMT remains active, if it is like is cousin, N, N-dimethyltryptamine, its salts retain their potency significantly longer than when kept in solution. Presuming this entheogen remained active between harvesting, arrival in the Midwest, and use, a stuffed toad with 5-MeO-DMT could easily supply the needs of a magician or seer for a prolonged period or a small congregation of believers for a year. Further 5-MeO-DMT would be an attractive entheogen for Joseph Smith due to its immediate and profound antidepressant properties (Davis, So, Lancelotta, Barsuglia, & Griffiths, 2018).

Had Joseph Smith known the features of entheogenic toad venom, he would have undoubtedly arranged for its procurement and transport to Nauvoo in the 1840s. Further, in 1844, Joseph Smith instructed fellow Mormons to settle the region surrounding the Rio Grande River. One follower, Lyman Wight (referenced below) went to Midwestern Texas to form the Mormon colony of Zodiac (Langford & Bandera, 2003), a site within easy traveling distance to both the peyote beds and the Sonoran Deseret Toad catchment area. Figure 25 also shows the area where the distribution of *L. williamsii* and Native American expertise in peyote sacraments and medicine overlapped with the proposed Mormon territory.

Shamanic transformation

We have discussed mentors for Joseph Smith, which we believe knew entheogens and employed them in his mentoring. Overwhelming childhood trauma suffered by Joseph Smith facilitated his formation as a shaman prophet of a successful new religion, enabling the use of entheogens to their maximum religious potential.

Unimaginable childhood trauma

Groesbeck (1990, 2004, 2005), a Jungian trained psychiatrist, has argued that the shamanic-healer archetype aptly describes Joseph Smith's personality structure. Groesbeck, who studied with a Huichol shaman, agreed with Mircea Eliade (1964) that the shaman's role and function depended on their techniques of facilitating ecstasy. According to Eliade, a shamanic healer's abilities in ecstasy or trance, to enter "*into contact with divine or semidivine beings*" (p. 84) and to "*consort with the dead with impunity*" (p. 214), generally resulted from severe trauma during early life. This shamanic complex and its archetypal pattern result from a severe illness early in life and strenuous ordeals (Groesbeck, 1975, 1989). Joseph endured such an ordeal at age 7 when stricken with life- and limb-threatening osteomyelitis secondary to typhoid fever (Adams, 2013; Morain, 1998, 2013; Wirthlin, 1981). In a horrific and prolonged ordeal, the young Joseph Smith (1833) suffered multiple exquisitely painful surgical procedures without the benefit of anesthesia or sedation. One might get a sense of what this 7-year-old boy must have endured in a revealing revelation:

> *I [God] command you [to] repent, lest I smite you … and your sufferings be sore. How sore you know not! How exquisite you know not! Yea, how hard to bear you know not!* (Smith, 1833, p. 23)

The appalling nature of young Joseph's surgeries, documented by physician LeRoy Wirthlin, is incomprehensible except to those who have experienced them (Wirthlin, 1981). William Morain, a surgeon with a Mormon background, describes how the terror of such painful surgical assaults creates dissociative injuries within a child's developing brain that become "*an integral part of the psyche that can permeate all corners of [his] mind forever*" (Morain, 2013). However, severe childhood trauma does not explain his ability to facilitate en masse visionary experience; and does not explain the anticholinergic symptoms associated with his own early visions and many early convert visions reported to have occurred between 1830 and 1831 as discussed below.

Joseph Smith Jr.'s visions

Joseph Smith Jr. had visionary experiences in his spiritual quests that display several specific features. Analysis of these accounts and the features of his experiences provide data to support the hypothesis he deliberately employed entheogenic substances.

1820: The first vision

At 14 (Smith, 1838) or 15 years of age (Smith, 1832), Joseph Smith Jr. embarked on a spiritual quest. Like the alchemical "philosophers" before him, one object of his quest was "wisdom" (Smith, 1838, 1843). Joseph Smith's later revelation "the Word of Wisdom" reflects the view that taking the proper things into one's body - avoiding addictants and using "*every herb in the season thereof*" would enable the seeker to "*find wisdom and great treasures of knowledge, even hidden treasures*" (D&C 89). Before he went into the grove in 1820 or 1821 to obtain wisdom, already three powerful precedents directed Joseph to seek wisdom through what he ate. First, he had a prototype for his quest in the story of Adam and Eve, who acquired wisdom by what they ate (Genesis 3:6, 22, "KJV"). Next, the search for wisdom had also been modeled for him by the Christian alchemists and Freemasons, who sought wisdom through the philosopher's stone, the Bible's "white stone," and by partaking of the elixir, the "hidden manna" of the Book of Revelation, which also promised that "*to him that overcometh*" the gift to "*eat of the tree of life*" (Revelation 2:7, 17, "KJV"). Also, finally, the quest for wisdom was more immediately modeled for the young Joseph by the elder Joseph, his father, who had been instructed through prophetic dreams how he could gain wisdom. Here again, the model was that one could acquire wisdom by what one *ate*.

Joseph Smith's spiritual quest is a continuation of his father's - a quest for Christ's "primitive church" for temporal and spiritual salvation, and *wisdom*. Joseph Jr. reported that a quest for "wisdom" was his motivation for going to a grove of trees where, at the age of 15, he experienced his first vision (Smith, 1839-1841, pp. 2-3). In what Lucy Mack Smith similarly called Joseph Smith Sr.'s "first vision," Joseph Sr. began a quest for wisdom and forgiveness of sins by journeying into a fallen wood. He was told, "eat," of certain edible materials found on a fallen tree, and informed, "*[this] will make you wise, and give unto you wisdom and understanding*" (Smith, L. M., 1853, p. 57). It would be remarkable if the younger Joseph's quest for "wisdom" were not informed by the visions of his father. Joseph Jr. should, therefore, have expected that to obtain wisdom, he also would need to "*eat*" something provided by God. However, where would he acquire the necessary entheogenic foods? Here again, his father's vision showed the way.

Joseph Jr. sought his visionary experience in the clearing in "early spring" (Smith, 1839-1841, p. 3), the precise time when plants would be sprouting and entheogenic mushrooms could begin to be harvested amid the dead timber. Joseph, a firm believer in providence, saw divine purposes in nature's provision of various herbs and perceived God's "hand in all things," the minute details of life (D&C 59:21; 8,9:10-11; Bradley, 2019, pp. 186-188). After seeking a physical landscape for his own "first vision" quest for wisdom that actualized the dreamscape of his father's "first vision" wisdom quest, what did Joseph intend to do when he arrived if not to *follow the commandment* given to his father in his vision, to obtain wisdom?

Against the backdrop of the biblical Adam and Eve story, the Masonic-biblical promises of "hidden manna," and the visionary commandment to his father to acquire wisdom by eating what God placed on the dead timber, Joseph Jr. was primed to perceive entheogenic plants and mushrooms at the culminating moment of his search for wisdom as a providence auguring that he needed to eat to obtain wisdom and of *what* he needed to eat to become wise.

Another potential clue to what Joseph Jr. needed to eat to gain wisdom was the biblical description of it as the "hidden manna." The original biblical manna, appearing in the story of Moses's Exodus, was described in Joseph's King James Bible ("KJV") as round edible objects found on the ground in the morning (Exodus 16:13-15). If Smith expected the "hidden manna" to take a similar form, he would have found obvious candidates all around him in the spot where he sought wisdom, growing on and hidden under the fallen trees of his father's clearing.

- Saw all kinds of improper pictures;

- [Was] seized upon by some power which entirely overcame [him];
- [Was blinded as] thick darkness gathered around [him];
- His tongue ... cleaved to [the] roof [of his mouth] so that [he] could not speak;
- He heard a noise behind [him] like someone walking towards [him];
- He sprang upon [his] feet and looked round but saw no person.
- [Was] ready to sink into despair and abandon [himself] to destruction, not to an imaginary ruin but to the power of some actual being from the unseen world [with such] marvelous power as I had never ... felt in any being (see also Harper, 2012).

Anticholinergic toxidrome

Had Joseph been taken to a local physician of the period during the initial phase of intoxication, the diagnosis of poisoning with a member of the Solanaceae family, such as Black Henbane (*H. niger*) or *D. stramonium* would have easily been made ("Communications", 1811; Copland, Darwall, & Conolly, 1826, pp. 422-423; Jonasson & Afshari, 2016; Thornton, 1811, pp. 55-61; W, 1833). Similar clinical features can also present with poisoning by the *A. muscaria* mushroom (Burkhart, 2004, p. 691; Cahill, 2003; RolstonCregler, 2017). Ibotenic acid (pantherine and agarine) and muscimol are among the active components of *A. muscaria*, substances that with powerful effects on the central nervous system. Although tropanic alkaloids are not present, the signs and symptoms of poisoning with the fly agaric are called "mycoatropinic," and they resemble those produced by *D. stramonium*, *A. belladonna*, and *H. niger* (Satora, Pach, Butryn, Hydzik, & Balicka-&Sacute;lusarczyk, 2005).

The symptoms Smith experienced related to those of the anticholinergic or mycoatropinic toxidrome were: hypertension and hyperthermia, agitated hallucinations, delirium and strange mental states, slurred speech, tremors, coma, and occasionally seizures, tachycardia and dysrhythmias, dry and flushed skin - especially the face-dilated pupils, mydriasis, and blurred vision, and dry mouth. These symptoms constitute one of five basic toxidromes (Omar, & Foxworth, 2014). Features of the anticholinergic toxidrome in Joseph's accounts of his first vision include being rendered "blind as a bat" (mydriasis, blurred vision), "mad as a hatter" (altered mental status, delusional paranoia, and hallucinations), and "dry as a bone" (dry mucous membranes), and a duration of intoxication lasting several hours or more. Paralysis associated with *D. stramonium* is also reported (Anon., 1811).

Young Joseph either understood the sublethal, visionary dose or was lucky, since coma and death may ensue in severe poisonings of *D. stramonium* (Le Garff, Delannoy, Mesli, Hédouin, & Tournel, 2016) and *A. muscaria* (Mikaszewska-Sokolewicz, *et al.*, 2016). From Eldon Watson's (1983) textural harmony of Joseph Smith's first vision, we learn that just as Joseph was anticipating ego dissolution and imminent death, a "*light appeared to ... gradually descending towards him*" until he was "surrounded by a brilliant light" creating "a peculiar sensation throughout his whole system" and causing "his mind" to be "*caught away from the natural objects with which he was surrounded; and he was enwrapped in a heavenly vision*." In the vision, Joseph's profound sense of guilt was assuaged as an angel appeared (the Lord) and assured him that his sins were forgiven. Then, "*when I came to myself again*," Joseph explained, "*I found myself lying on [my] back looking up into Heaven ... without any strength ... [but with a] mind in a state of calmness and peace, indescribable*." Joseph added, "*my Soul was filled with love and for many days. I could rejoice with great Joy, and the Lord was with me*."

Table 1 compares the relationship between Smith's symptomatology and those of the anticholinergic syndrome. Joseph Jr.'s description of his first vision is profoundly personal and unlikely to have been manufactured due to embarrassing symptoms diagnostic of anticholinergic intoxication he later attempted to hide or contextualize. Further confirming that Joseph was in a visibly physically altered condition after his initial recovery from the visionary state, he reports that upon his reentry into his family home, his mother asked him, "*What is the matter?*" (Smith, L. M., 1853, p. 133). Similar symptoms also appeared during Mormon convert visionary experience when Joseph Smith founded his Church in 1830 (referenced below).

Table 1. Joseph Smith's first vision and related anticholinergic symptoms.

Joseph Smith's symptoms	Anticholinergic syndrome
Category 1: Onset of peripheral anticholinergic syndrome	

Blind as a bat ... thick darkness gathered around [him]	Pupils to dilate widely, inhabitation of accommodation of the eyes
Dry as a bone. His tongue ... cleaved to [the] roof [of his mouth] so that [he] could not speak	Inhibition of salivary and bronchial secretion and sweating
Face and skin color changes - initially flushed, then pale	Bradycardia and decreasing blood pressure due to blocking of muscarinic M2 receptors on the postganglionic parasympathetic neurons
Category 2: Onset of central anticholinergic syndrome	
Mad as a hatter. All kinds of improper pictures	Hallucinations
Heard a noise behind [him] like someone walking towards [him]; ... sprang upon [his] feet and looked round but saw no person	Paranoia and delusion
[Was] seized upon by some power which entirely overcame [him]	Facial and body contortions, feeling bound
Was ready to sink into despair and abandon [himself] to destruction, not to an imaginary ruin	Fear associated with ego dissolution and/or actual death
Category 3: Anticholinergic visionary ecstasies and sequelae	
Surrounded by a brilliant light	Visions and ecstasies
His mind [was] caught away from the natural objects with which he was surrounded. Was enwrapped in a heavenly vision	
... an angel who had appeared (the Lord) informed him that his sins were forgiven	Hallucinations
Category 4: After effects and anticholinergic-related mood elevation	
I [lay] on [my] back looking up into Heaven ... with no strength	Post intoxication weakness and fatigue
A mind in a state of calmness and peace, indescribable	Peak experiences or afterglow phenomenon
Soul was filled with love and for many days. I could rejoice with great Joy and the Lord was with me	Sustained mood elevation
Desire to heal others	Shamanic personality (see text)

The positive symptoms associated with Joseph's vision also suggest the known antidepressant effects of scopolamine (from *D. stramonium* or Black Henbane) or possibly muscimol from *Amanita muscaria*. Scopolamine "*produces rapid and significant symptom improvement in patients with depression*" (Witkin *et al.*, 2014), similar to the afterglow phenomenon of classic entheogens (Maji&cacute;, Schmidt, & Gallinat, 2015).

A feature of Smith's "first vision" experience that cries out for explanation is its stark tangibility and experienced veridicality. He emerged from his experience of the demonic and the divine convinced of the *actuality* of the beings he had encountered: "*But exerting all my powers to call upon God to deliver me out of the power of this enemy which had seized upon me, and at the very moment when I was ready to sink into despair and abandon myself to destruction, not to an imaginary ruin but to the power of some actual being from the unseen world who had such a marvelous power as I had never before felt in any being ... I had actually seen a light and in the midst of that light I saw two personages, and they did, in reality, speak unto me*" (Smith, 1839-1841, p. 4). Smith either found himself bound by an "actual being" and then "actually saw" a light, or there were neurophysiological changes in his brain and body that facilitated their perception. Even if Smith is understood to have encountered external spiritual forces, one would have to explain what physiological changes facilitated his ability to physically engage with entities that cannot usually be seen or felt. Entheogenic *D. stramonium* explains how Joseph Smith perceived his engagement with spiritual forces as an actual physical encounter.

A high dose of psilocybin would have provided the mind-opening, cosmological, transformative, and disintegrating/ reintegrating aspects of the experience, while *D. stramonium* would have given the experience of another reality, initially in the grips of a terrifyingly, physically *real* evil being. Unbeknownst to Joseph Smith, as for the mythical Adam and Eve, eating the "forbidden fruit" entailed an experience of evil in tangible form (Satan/the serpent) to obtain wisdom - that is to experience the "deepest abyss" besides "commune with God" (Smith, 1977, p. 137). Smith also acted the part of an alchemist transmuting or "transfiguring" his physical state to enable himself to find wisdom through the visionary experience of both good and evil, Satan and God.

It is also possible that Joseph Smith used *P. ovoideocystidiata* or another species of psilocybin-containing mushroom, although this is less likely than an anticholinergic entheogen based solely on the symptomology. We mention the possibility of *P. ovoideocystidiata* use here because this mushroom can be found from Rhode Island to Kentucky and is especially prevalent in the Ohio River Valley (Allen, Gartz, Molter, & Sihanonth, 2009; Guzmán *et al.*, 2007), where it grows on wood debris, especially along rivers, streams, and wet valley areas such as the Sacred Grove. The Sacred Grove hosts a great variety of fungi, besides *A. muscaria* due to it residing in a small valley of seasonally wet and cooler terrain. On two visits to the Sacred Grove before the conception of an entheogenic origin of Mormonism, one author (RB) found abundant mushrooms of several varieties, including one in Figure 28. The photographed mushroom in the sacred grove appears suspiciously like a *Psilocybe species* mushroom in Figure 29; unfortunately, no field-testing for the typical blue reaction to pressure was conducted.

Figure 28. Mushroom found in Sacred Grove (photo by Robert Beckstead).

Figure 29. *Psilocybe* species (Shutterstock photo).

Entheogenic replication of Smith's first vision

Many examples of entheogenic experiences are reported in peer-reviewed literature and on the internet that bear a striking similarity to those of Joseph Smith. For example, religious historian Huston Smith initiation into "ultimate reality" was occasioned by a psilocybin-containing mushroom. Huston reports:

> *What the day accomplished, ... was to enable me for the first time to experience the respective levels of the Chain [of Being], all the way to its top. The dominant effects of the experience were two: awe (which I had known conceptually as the distinctive religious emotion but had never before experienced so intensely) and certainty. There was no doubting that the Reality I experienced was ultimate. That conviction has remained. (2001, p. 126)*

In the same year (1961), Huston ingested peyote cactus and reported: "*I noted mounting tension in my body that turned into tremors in my legs ... I [began] experiencing ... the clear, unbroken Light. I was now seeing ... with the force of the sun, in comparison with which everyday experience reveals only flickering shadows in a dim cavern ... [I saw] worlds within worlds*" (2000, p. 11). Smith concluded that using entheogenic substances can occasion an experience with a form indistinguishable from those of the experiences of religious mystics.

Heinrich (2002, pp. 201-203) ingested *A. muscaria* as the entheogenic facilitator and reported:

> - I felt like I weighed thousands of pounds and could no longer sit up.
> - [In] a great darkness and a great silence, the heavens opened above my head.
> - The bliss I had experienced prior to this new revelation now paled to insignificance in an immensity of light that was also the purest love.
> - The absolute profundity of the experience cannot be denied, neither can be adequately expressed, though one is moved to try.

Huston's and Heinrich's entheogenic reports reveal the core features of Smith's earlier vision: an experience of physical heaviness, visual darkness, an awe-inspiring light from above, a voice out of heaven, experience with the unfathomable Godhead and feelings of unspeakable joy.

Joseph Smith's actual first vision

His "actual first vision" and a vision of a divining instrument, a "seer stone," initiated Joseph Smith's career as a visionary scryer. Mormon historians connected this seer stone vision, in which Smith saw "*a small stone ... which] became luminous, and dazzled his eyes, and after a short time it became as intense as the mid-day sun*," with his theophanic "first vision," linking the visions conceptually and placing them in roughly the same time frame (Bradley, 2010; Purple, 1877).

Smith's understanding of his white seer stone as the white stone of Revelation 2:17 also connects it with the white stone of Hiram Abiff and, therefore, the "hidden manna" mentioned in the Masonic degrees and thought to have been administered in the more esoteric versions of those degrees.

It was from underneath of the acacia sprig, believed to be an entheogenic symbol in masonic lore, that Hiram Abiff's remains and "jewel" were reportedly excavated (Bernard, 1829). Conflating "jewel" and "white stone," Smith may have conceived of Hiram Abiff's body and "white stone" being recovered together from under the tree. The acacia marking the burial site of Hiram Abiff's body and "jewel" is understood in freemasonry as a "tree of life" (referenced below).

Joseph Smith reported excavating under a tree to find his white stone, recalling the excavation of Hiram's white stone under the acacia tree. After recovering this stone, Joseph Smith placed it in the darkness of his hat, looked into it, and discovered that he had acquired "*one of the attributes of Deity, an All-Seeing Eye*" (Bradley, 2010; Purple, 1877) reflecting another probable occasion on which he ate from an entheogenic plant. Joseph Smith, eating from such "tree of life" anticipated *The Book of Mormon*'s descriptions of an entheogenic "tree of life," discussed below.

1823 Indian visions

Joseph Smith's next vision in 1823 is notable for the post-vision weakness and its ancestral Amerindian content. The many ancestral Amerindian tumuli found and excavated in New York and Ohio undoubtedly fascinated the young Joseph, as did the widely held belief that Amerindians were the remnants of Lost Tribes of Israel. However, as he had 3 years previously, Joseph's vision was preceded by fervently asking forgiveness of his sins. When the vision opened, a brilliant light appeared; and in the light, Joseph claimed that he saw an angel, identified as an ancestral Amerindian, with whom he spent the entire night. "*I discovered a light appearing ... until the room was lighter than at noonday, when immediately a personage appeared at my bedside, standing in the air ... his whole person was glorious beyond description, and his countenance truly like lightning. The room was exceedingly light ... When I first looked upon him, I was afraid. [And he] said there was a book deposited, written upon gold plates, giving an account of the former inhabitants of this continent*" (Smith, 1830, front piece). Following these visions, Joseph arose to work on the family farm but on meeting his father in the field, "found [his] strength so exhausted as to render [him] entirely unable" to labor.

Psychedelics in *The Book of Mormon*

Several lines of evidence in *The Book of Mormon* suggest Joseph Smith's awareness of psychedelics and their effects. *The Book of Mormon* functioned as sacred scripture and acted as a psychopomp for early Mormon converts seeking direct and personal experience with God under the influence of entheogenic material. Consistent with this view, Mormon Jungian psychiatrist Groesbeck (2004) argues for *The Book of Mormon* as "symbolic history." We suggest that passages in *The Book of Mormon* and other early Mormon sacred writings guide spiritual experiences as outlined by Leary, Metzner, and Alpert (1964) in discussing the Tibetan Book of the Dead - to establish a setting for predisposing early Mormon converts to direct and personal experience with God through spiritual ecstasies. Another aspect of the set and setting of early Mormon visionary experience is Joseph Smith himself - as the archetypal shaman. Leary *et al*. (1964) emphasize the need for "*a trusted person ... to remind and refresh the memory of the voyager during the experience*." Smith was that trusted person.

Herbs, although not frequently mentioned in *The Book of Mormon*, are highly endorsed as medicines explicitly and entheogenic substances implicitly. For instance, *The Book of Mormon* speaks of the "*excellent qualities of the many plants and roots which God had prepared to remove the cause of diseases*" (Smith, 1830, p. 353). We argue here that Smith, in *The Book of Mormon*, intended to reference not only the treatment of bodily diseases but also maladies of the soul. While traditional herbs may be useful for treating ailments relating to the body, it is the entheogenic herbs that lift the mood and relieve despair, as demonstrated after partaking of unusual fruit described in Joseph Sr.'s entheogenic dream discussed above and in *The Book of Mormon* tree of life allegory discussed below. Also, in *The Book of Mormon*, Smith associates the use of herbs with symptomatology such as

- death-like experience lasting days rather than hours,
- symptoms resulting in sensations of tongue swelling,
- sensations of motions,
- taste of light,
- enlightenment, and
- mood elevation

These symptoms, in our view, demonstrate that Smith encoded his entheogenic knowledge encoded in *The Book of Mormon*.

Death and rebirth symbology (ego death)

Mormon historian Don Bradley (2019) interprets that Joseph Smith's first vision is an initiation or endowment transforming an unaccomplished young man from an improvised family into religious royalty as a seer and prophet. We argued here that Smith's first vision, facilitated by an entheogen, corresponds to similar royal entheogen-infused death and rebirth initiation rituals. Knight and Lomas (1996) explain:

> *The new king would have undergone 'death' by means of a potion administered by him to the high priest in the gathering of the inner group of the holders of the royal secrets. This drug would have been a hallucinogenic that slowly induced a catatonic state, leaving the new king, as inert as a corpse.* (p. 145)

An entheogenic initiation of this nature would change the thoughts and feelings previously held by the new king. Two *Book of Mormon* narratives reflect entheogen-infused royal initiation rites discussed by Knight and Lomas. In the first narrative, after being chastised for unrighteousness,

> *[The King] fell unto the earth, as if he were dead ... for the space of two days ... under the power of God ... and the light which did light up his mind ... had infused such joy into his soul (276-7) [and similarly, the Queen then arose and] ... cried ... O blessed Jesus ... [clasping] her hands, being filled with joy.* (pp. 278-279)

In the second narrative, the son of a Prophet King unprepared to succeed him on the throne is reprimanded by his father. In this account, the son reported:

> *I fell to the earth; and it was for the space of three days and three nights, that I could not open my mouth; neither had I the use of my limbs ... I [thought] that I could ... become extinct both soul and body ... [after three days and three nights] I cried within my heart, O Jesus, thou Son of God, have mercy on me, ... and when I thought this, ... I was harrowed up by the memory of my sins no more. And O, what joy, and what marvelous light I did behold; yea, my soul was filled with joy as exceeding as was my pain.* (pp. 324-325)

These remarkable narratives in *The Book of Mormon* parallel the first-vision accounts given by Joseph Smith supporting the thesis that his first vision was an entheogen-infused initiation. In his first vision,

1. Smith felt profound guilt and shame associated with his sin (Smith, J., 1832, p. 6),
2. He was in mortal fear of "sudden destruction" (Smith, J., 1839-1841, p. 3),
3. When Smith came to himself, he "*was sprawling on [his] back and it was some time before [his] strength returned*" (Smith, J., 1842, p. 748).
4. Afterward, he had feelings of "*calmness and peace, indescribable*" (Pratt, 1840, p. 7).

We suggest that more than coincidence, Joseph Smith's first vision, *The Book of Mormon* death and rebirth accounts parallel Knight and Lomas' entheogen-infused royal initiation rite. It seems reasonable to conclude that Smith's experience and *The Book of Mormon* accounts were related to esotericism and entheogens.

Synesthesia

One feature of visionary experiences reported in *The Book of Mormon*, synesthesia (the stimulation of one sense modality provoking sensation in another) strongly suggests the effect of an ingested entheogen. In *The Book of Mormon*, Joseph informs the convert that after ingesting the seed of the fruit of the tree, they should expect it to feel "swelling" within the chest closely followed by "swelling motions." After the onset of the swelling motions, Smith informed converts to expect the appearance of light that "enlightens the understanding" so the "mind doth begin to expand," i.e., experiences the desired psychedelic properties of the seed. This mind expansion is accompanied, according to Smith, by the taste of light suggesting the phenomena of psychedelic associated synesthesia: "*when you feel these swelling motions ... it beginneth to be delicious ... ye have tasted this light*" (Smith, 1830, pp. 315-316).

Two examples will be most relevant here: Lehi's dream of the tree of life and Alma's parable of a seed that grows into a tree of life. Joseph Jr. inserts into *The Book of Mormon* a vision of an Edenic tree its fruit, and upon ingesting it, the profound experience of the love of God - nearly identical to his father's Edenic vision in 1811 (Smith, 1830, pp. 18-21). Another probable reference to synesthetic bodily symptoms in the text of *The Book of Mormon* appears in a parable by the prophet Alma comparing God's word to a seed. The parable describes the cultivation of a plant from seed, ultimately to a full-grown tree revealed to be, like Lehi's, "a tree of life" bearing fruit.

> *Now, we will compare the word unto a seed. Now, if ye give place, that a seed may be planted in your heart, behold, if it be a true seed, or a good seed, if ye do not cast it out by your unbelief, that ye will resist the Spirit of the Lord, behold, it will begin to swell within your breasts; and when you feel these swelling motions, ye will begin to say within yourselves - It must needs be that this is a good seed, or that the word is good, for it beginneth to enlarge my soul; yea, it beginneth to enlighten my understanding, yea, it beginneth to be delicious to me.* (Smith, 1830, p. 315)

The effects of cultivating this seed expand the mind, enlarge the soul, stimulate the taste of light, and produce inexpressible joy and happiness. In these passages, Joseph Smith encapsulated the very meaning of the current meanings of "psychedelic" and "entheogen." More importantly, at least as far as Joseph Smith is concerned, the reader of *The Book of Mormon* is invited in this passage to experience the same psychedelic or entheogenic enlightenment, synesthesia, and transformation as he had.

Mood elevation

Descriptions of the visionary dreams of Joseph Smith's father, and his first vision, his Indian visions, and early Mormon visions in Kirtland Ohio (discussed below) manifest mood-elevating properties. The mood-elevating effects of entheogens are well established: eventually, they will be one modality of managing treatment-resistant depression (see articles in Winkelman & Sessa, 2019). The antidepressant effects of psychedelic experience suggest motivational salience for entheogen use throughout history and specifically in the Smith family to facilitate visionary experience and as antidepressants. La Barre (1947) observed that Native American peyote use in religious confessionals provided a primitive form of psychotherapy. Similarly, the mood-elevating sequelae of Joseph Smith's use of entheogens in early Mormon rituals and confessionals was practical psychotherapy for early Mormons; and likely unconscious salience for conversion to Mormonism and convert resilience during the hardships of Mormon diasporas.

Entheogenic ordinances

In early Mormonism, converts anticipated visions and direct face-to-face communication with God, but only in the context of Church ordinances administered by Joseph Smith. In 1832, Joseph Smith explained:

> *And this greater priesthood administereth the gospel and holdeth the key of the mysteries of the kingdom, even the key of the knowledge of God. - Therefore, in the ordinances thereof, the power of godliness is manifest; and without the ordinance thereof, and the authority of the priesthood, the power of godliness is not manifest unto men in the flesh; for without this no man can see the face of God, even the Father, and live.* (Smith, 1833, Section 4)

Importantly, visions and ecstasies in early Mormonism are associated with ordinances involving the serving of bread and wine sacraments, and anointings of bodies with anointings; while the expected visionary Nauvoo temple endowment also features oil anointings but adds plucking fruit from tree branches. In June, Joseph Smith (1839, pp. 17-18) told trusted leaders:

> *God hath not revealed anything to Joseph, but what He will make known unto ... the least Saint ... for the day must come when no man need say to his neighbor, 'Know ye the Lord; for all shall know ... [he] will have the personage of Jesus Christ to attend him ... and the visions of the heavens will be opened unto him, and the Lord will teach him face to face.*

It is likely that models of Biblical visions, and esoteric-minded mentors guided Joseph Smith to ingest something crucial to his own visionary experience.

> - Genesis 2:17 pointed to the need to eat the fruit of any tree in the garden to retain peace, happiness, and tranquility (possibly *A. muscaria*), but not the fruit of the tree of knowledge (possibly datura).
> - Moses instructed Israel to eat manna that tasted like a water made with honey (Exodus 16:31).
> - Ezekiel (3:1-3) eats a scroll that was as sweet as honey in Ezekiel 3:1, the consumption of a

> scroll or book tasted "*as honey for sweetness*." - John, in association with his vision in Revelations 10:10, eats an entheogen that tastes sweet but in "*belly [it] was bitter*."
> - Jesus said, "*To him who conquers I will give some of the hidden manna, and I will give him a white stone*" (Revelation 2:17, see also 10:9).

In each of these cases, the ingestion of some substance tasting bitter, sweet, or forbidden was transformative. Gastrointestinal upset is a feature of ergot alkaloids (Schiff, 2006), *Psilocybe species*, and *A. muscaria* mushroom ingestion (Beug, Shaw, & Cochran, 2006). Also, Smith expounded on the Revelation of St. John, explaining that "*the little book which was eaten by John, as mentioned in the 10th chapter of Revelation*" is understood to be "*an ordinance*." In this statement, Joseph Smith informs converts that visions are associated with consuming a substance or the application of anointing oil during Mormon ordinance work.

Early convert visions

As a budding prophet, Joseph Smith's altered appearance was readily apparent to observers (see Sally Heller above), but with experience, his demeanor during visions did not so readily betray an altered state.

Early Mormon converts, as novice prophets themselves, would experience altered states similar to those reported by Joseph Smith in his early visions.

For instance, in an 1832 shared experience Joseph Smith and his first counselor, Sidney Rigdon alternately related what they saw in vision while others wrote the revelation down. As was the customary order of the priesthood at that time, Smith and Rigdon likely partook of the sacrament at the beginning of this meeting. After this vision, Sidney appeared pale and exhausted.

As a budding prophet, Joseph Smith's altered appearance was readily apparent to observers (see Sally Heller above), but with experience, his demeanor during visions did not so readily betray an altered state. Early Mormon converts, as novice prophets themselves, would experience altered states similar to those reported by Joseph Smith. For instance, in an 1832 joint vision reported orally by both Joseph Smith and Sidney Rigdon each taking turns and witnessed by several others, likely after partaking of the sacrament that was the custom, Sidney appeared exhausted. An observer reported: "*Joseph sat firmly and calmly all the time in the midst of a magnificent glory, but Sidney sat limp and pale, apparently as limber as a rag, observing which, Joseph remarked, smilingly, 'Sidney is not used to it as I am'*" (Dibble, 1892; for a description of this vision, see Smith, 1835, pp. 225-231; Woodward, 2012).

Joseph Smith's and Sidney Rigdon's account of this vision was added to the Latter-day Saint canon as Doctrine and Covenants, currently Section 76. This vision entailed a physical change, elsewhere called "transfiguration," a change that converts would experience in their own bodies in connection with priesthood ordinances, if they desired to see God and Heaven. According to Smith, such a transformation of the body was needed so that "*while in the flesh, they may be able to bear his presence in the world of glory*" (D&C 76:117-118; Moses 1:11, 31). Smith taught that Mormon ordinances and "transfiguration" were prerequisite to visionary experience. Partaking of an entheogen would account for the physical symptoms experienced by Sidney Rigdon and other early Mormon converts and also account for the "transfiguration" phenomenon. Early Mormons were led to understand that distressing bodily symptoms following sacraments and anointing were nothing to fear but instead to eagerly anticipate.

Early Mormon converts prepared for entheogenic Church ordinances in several ways. Many of the most ardent early Mormon converts joined Mormonism after hearing of convert visions and after reading *The Book of Mormon*, which itself has multiple allusions to entheogenic experience. These allusions, we argue, prepared converts to experience similar entheogenic interactions with Heaven and divine beings. Among the significant exhortations Joseph Smith gave on this topic did not have so much to do with personal worthiness as it did by a willingness to participate in the ordinances and loyalty to the Church and himself. If a member remained loyal, Smith in effect guaranteed their personal and immediate success in accessing Heaven and angels and receiving revelation themselves.

Smith's promise that converts would see God and experience visions, dreams, and ecstasies would occur in receiving sacraments and endowments. The settings where sacraments were received were initially nature-based, followed by private homes; and later shifted to specially constructed temples incorporating mystical symbols, including symbols utilizing esoteric and masonic imagery. For instance, labyrinths, gonfalons, spirals, and squares within squares adorned the Kirtland temple. Even more mysterious, unquestionably alchemical-masonic symbols decorated the Nauvoo temple. Further, Joseph Smith himself was the trusted guide for ceremonies, prayers, and singing; and when necessary, Smith managed problematic entheogenic experiences. By following this entheogenic protocol, Joseph Smith facilitated an unprecedented number of "on demand" religious visions and ecstasies.

Three witness' visions

The type and quality of visionary experience among Mormon converts was similar to that experienced by Joseph Smith, including the replication of the troublesome symptomology reported by Smith. Converts receiving visions containing doctrine and commandments that contradicted that of Joseph Smith, however, were tightly controlled by him and non-binding on the Church (Smith, 1835, p. 181).

In July 1829, shortly after Joseph Smith completed his work on the text of *The Book of Mormon*, Oliver Cowdery, David Whitmer, and Martin Harris accompanied Joseph Smith in prayer and Cowdery, Whitmer, and Smith, and then separately Harris and Smith, experienced visions of an angel descending from Heaven and showing the golden plates and other artifacts associated with *The Book of Mormon*, a testimony they never recanted even when ridiculed.

However, considerable controversy raged in the 19th century and today about whether the witnesses saw the plates in a physical, sensory way (with "natural eyes") or in an altered, visionary state (with "spiritual eyes"). One witness, Martin Harris, equivocated on whether the experience was "natural" or "spiritual." Further light was shed on the experience by another witness, David Whitmer: "*I have been asked if we saw those things with our natural eyes. Of course, they were our natural eyes. There is no doubt that our eyes were prepared for the sight, but they were our natural eyes nevertheless*" (Vogel, 2003). Of particular interest to this discussion is David Whitmer's statement that: "*our eyes were prepared for the sight*." In 3 Nephi 28 found in *The Book of Mormon*, Joseph Smith's reveals that the physical body must change, or "transfigure" to see spiritual things or else they would die (Moses 1; 3 Nephi 28). From Whitmer's testimony, it appears that *The Book of Mormon* witnesses were informed by Joseph Smith either directly or in the form of *The Book of Mormon* passages that symptomology precedes visionary experience.

The Three Witnesses and Mormon converts alike were aware of the biblical precedent involving Adam and Eve eating the "forbidden fruit." Another precedent involved the practice of receiving communion, in which ordinary food and drink received an Apostolic blessing leading to those present at the visionary Christian Pentecost to appear intoxicated. The telling of Joseph Smith Sr's. entheogenic dreams and the entheogenic accounts in *The Book of Mormon* would also have provided yet another precedent. All of these precedents, and others discussed in this paper, placed in the immediate backdrop of their vision, provided "emotional immunization" from fear and embarrassment secondary to the troublesome entheogen-related physical and emotional symptomology preceding their visionary and ecstatic experience.

1830: New York visions

Joseph Smith promised converts visions, but only in Mormon "ordinances" and in the presence of Church leaders. In the first conference of the Church held on June 9th of 1830 in Fayette, New York, organizing his Church, Smith formalized the instructions to "oft" partake of the sacrament. Of this meeting, Joseph Smith wrote:

> *… we partook together of the emblems of the body and blood of our Lord Jesus Christ … Much exhortation and instruction were given; and the Holy Ghost was poured out upon us in a miraculous manner many of our number prophesied, whilst others had the Heavens opened to their view, and were so overcome that we had to lay them on beds, or other convenient places: Among the rest was Brother Newel Knight who had to be placed on a bed, being unable to help himself. By his own account of the transaction, He could not understand why we should lay him on the bed, as he felt no sensibility of weakness. He felt his heart filled with love, with glory and*

> *pleasure unspeakable, and could discern all that was going on in the room, when all of a sudden, a vision of futurity burst upon him. He saw there represented, the great work which through my instrumentality was yet to be accomplished. He saw Heaven opened and beheld the Lord Jesus Christ, seated at the right hand of the majesty on high, and had it made plain to his understanding that the time would come when he would be admitted into his presence to enjoy his society for ever and ever. When their bodily strength was restored to these brethren, they shouted, "hosannas to God and the lamb" and rehearsed the glorious things which they had seen and felt, whilst they were yet in the Spirit.* (Smith, 1843, pp. 41-42)

The relationship of the symptomology associated with this visionary experience highly suggests Joseph Smith surreptitious use of entheogenic material in the Mormon sacrament ordinance. Further, symptomology associated with Mormon visionary experience likely results in charges of medicating or doctoring the wine. Seeming to deflect this criticism onto those making the charges, Smith warned members in August 1830 they should not "partake" of wine "except it is made new among you" (Smith, 1835, p. 27). As he will do again in 1833, and in 1836 (see below), Joseph seems to suggest that any wine he administers during Mormon ordinances will be new wine, consecrated, and non-intoxicating.

1830-1831: Kirtland, Ohio, charges of intemperance

When Joseph Smith arrived in Kirtland, Ohio in 1831, converts had experienced visionary sacraments similar to that witnessed in New York. How did these Mormons, having not met Joseph Smith, institute an entheogenic sacrament? Mark Staker (2009, pp. 19-26) in his "Hearken, O Ye People" contextualizes the episode in 19th-century African American worship practices and the enthusiasms of the Second Great Awakening. However, there are reasons to believe that "wild enthusiasms" associated with early Mormon visionary meetings were more than just such reflections. For instance, a medically trained school teacher, Jesse Moss, who knew the nature of religious enthusiasms, reported that Mormon enthusiasms far exceeded those of the Methodists. A more likely possibility for early Mormon wild enthusiasms is one of the four Mormon missionaries who visited Kirtland and departed before the onset of the Mormon excesses described below. Mormon missionaries, including Frederick G. Williams (see above), stopped in Kirtland on their way to Independence, Missouri. In Kirtland, they converted most of Sidney Rigdon's Campbellite congregation, including Isaac Morley and Peter Kerr.

Unusual manifestations

In his book, *Hearts Made Glad: The Charges of Intemperance. Against Joseph Smith, the Mormon Prophet*, author Lamar Petersen noted during the early days of the Church there were "unusual spiritual manifestations" associated with the drinking of sacramental wine, behaviors of such a shocking nature it "*impaired the image of the young Church among sober people*" (Petersen, 1975, p. 79). According to Moss (1913), a medically trained school teacher in Kirtland, Ohio, offered testimony that Mormons,

> *took what was called the sacrament up at the [Isaac] Morley house. They were in the habit of turning everybody out of the door when they partook of the bread and wine, putting blankets up at the windows, shutting off the sight from without ... then [later] they opened the door and let us all come in again. [The] poor-house in Portage County, Ohio, where there were half a dozen insane and idiotic persons, was the best comparison of anything to the scene that night. And if I had had my cloak on, I would have stolen the wine and carried it home to see whether it was drugged or not.* (p. 384)

William S. Smith, testifying after Moss, supported the recollections of Mr. Moss:

> *I have attended the meetings at Mr. Morley's. ... in the house I have seen young men and women seemingly unconscious, and the folks said they had lain so for two days and they were there on their beds, and nobody tried to prevent us looking at them, but we were not allowed to go into the room.* (Ibid, p. 888)

On another occasion, Moss concluded that Mormon sacrament meetings "exceeded the wildest scene ever exhibited among the Methodists" and instead "became fully satisfied the wine was medicated," even attempting to secure a bottle for testing but was unsuccessful (Moss, 1878). Petersen also noted that "*the catalepsy could, of course, have been induced without the aid of wine [but the scene was] reminiscent of the first conference of the Church a year earlier at Fayette, New York*." That Moss indicated that Mormon enthusiasms exceeded that of the Methodists and lasting 24-48 hr, strongly supporting this conjecture of Smith including psychoactive substances in the sacraments.

Joseph Smith arrived in Kirtland, Ohio after the incidences discussed above but in time to preside over the June 6th, 1831 Elders conference. According to Levi Hancock (1858, p. 90) who was present as this meeting:

> *Joseph put his hands upon Harvey Whitlock and ordained him to the high Priesthood he [Whitlock] turned as black as [Lyman Wight] was white his fingers was set like Claws he went around the room and showed his hands and tried to speak his eyes were in the shape of Oval O's. Hyrum Smith said Joseph that is not God. Joseph said do not speak against this.* (Ibid)
>
> *It is likely that Joseph Smith, had considerable experience with entheogens, is not concerned with the chaos they create, and is reluctant to attempt to intervene. However, Joseph's brother was not convinced:*
>
> *I will not believe ... unless you inquire of God and owns it. [At this] Joseph bowed his head, and in a short time got up and commanded Satan to leave Harvey, laying his hands upon his head at the same time." ... [Then] Copley, who weighed over two hundred pounds, somersaulted in the air and fell on his back over a bench. Wight cast Satan out of Copley, and Copley was calmed. The evil spirit, according to Hancock, was in and out of people all day and the greater part of the night.* (Ibid)

Taken together, the events of the 1830 and 1831 conferences strongly suggest entheogenic influence and compares well with Joseph Smith's earlier entheogenic-facilitated early visions (Smith, 1830, pp. 276-267, 324-325).

Negative publicity

A letter to the editor of *Palmyra Reflector*, published in January 1831, accused Joseph Smith of *legerdemain*. Since this term referred then, as now, to "*Sleight of hand; a deceptive performance which depends on dexterity of hand; a trick performed with such art and adroitness, that the manner or art eludes observation*" (Webster, 1828), its use in this context may reflect ongoing accusations that Joseph Smith was manipulating the sacramental wine.

Sacramental wine was not the only possible carrier for an entheogen enhancing early Mormon sacramental experience. We have noted the entheogenic potential of ergot-infected rye, possibly mixed with the sacramental bread, like that which may have induced preternatural experiences in the life of Joseph Smith's great grandfather Samuel Smith. As we will see in discussing Mormonism's 1840s Nauvoo, Illinois period, ergot-infected rye was widely used as a medicinal remedy in Joseph Smith's day and may also have lent itself to more spiritual uses.

Complaints about Mormon enthusiasms drew the attention of the nation's newspapers. For instance, in the September 1831 edition of the *Vermont Gazette* (Bennington, Vermont), published a letter to the editor reporting: "*Some [Church members] lie in trances a day or two and visit the unknown regions in the meantime; some are taken with a fit of terrible shaking which they say is the power of the Holy Ghost*" (Kirkham, 1959). A trance lasting 24-48 hr is highly suggestive of *D. stramonium* intoxication (Bryson, 1996, p. 673; Wiebe, Sigurdson, & Katz, 2008). The *Independent Gazetteer* (Taunton, Massachusetts) reported on January 11, 1833 that during Mormon meetings there would be "*shoutings, wailing, fallings, contortions, trances, visions, speaking in unknown tongues and prophesying*" (Morgan, n.d.). Also, Henry Caswell (1843, p. 63) wrote of "a pretended sacrament" associated with manifestations of power in early LDS meetings. A pretended sacrament, although not stated explicitly, suggests drugged wine. So vociferous were Mormon critics that local Church leaders became alarmed and complained to Joseph Smith of similar undisciplined scenes. Table 2 summarizes what was reported by church leaders.

Table 2. Comparison of converts undisciplined scenes and Joseph Smith's first vision

Church leader reports	Undisciplined scenes
George A. Smith (1867)	Unnatural distortions
David Whitmer ("John Whitmer, History," 1831-*ca*. 847)	Extravagant and wild ideas Wielded the sword of Laban as expertly as a light dragoon Acted like an Indian ... scalping Slid on the floor with the rapidity of a serpent, sailing in boats to preach to the Lamanites
Parley P. Pratt (Bushman, 2005, p. 151)	Swoons
Joseph Smith's First Vision (from Table 1)	Unseemly gestures Cramps Falling into ecstasies Insanity Bound hand and foot in chains as immovable as a stick of timber Getting on the stumps of trees and shouting Pursuing balls flying in the air Running off a cliff, nearly being killed in pursuit of a floating croll

Although Joseph Smith chastised Isaac Morley in whose house many of the sacrament meetings occurred, Smith failed to acknowledge their similarity to his own first 1820 vision of God, his 1823 visions of an angel and golden plates, and the 1829 scrying visions while translating *The Book of Mormon*. Similar problematic scenes beset meetings Smith conducted. At Kirtland sacrament meeting in 1831, Joseph Smith suggested imminent mass visions and promised Lyman Wight he would have a vision of Christ. Mormon historian, Richard Bushman, explains what happened next: "*Wight turned stiff and white, exclaiming he had indeed viewed the Savior ... Joseph himself said, 'I now see God and Jesus Christ' ... Then Harvey Whitlock ... turn as black as Lyman was white ... his fingers were set like claws. He went around the room and showed his hands and tried to speak, his eyes were the shape of ovals "O's" ... [Then] Leman Copley, who weighed over two hundred pounds, somersaulted in the air and fell on his back over a bench ... [Similar behavior was manifested by] people all day and the greater part of the night*" (Bushman, 2005, pp. 156-157). These experiences, likely following the administration of the sacrament with Joseph present, are difficult to explain absent some toxidrome, yet easy to explain in the presence of one, and are strikingly similar to those described in Smith's own first vision and those that took place in early Kirtland, possibly under the direction of Peter Kerr, a former slave known as "Black Pete" in early Mormon literature.

Peter Kerr

According to Mark Staker (2009), after the missionaries left Kirtland later in 1830, 55-year-old Peter Kerr ("Black Pete") acted as "a revelator" and "a chief man" to a small Mormon community in Kirtland, Ohio, until Joseph Smith arrived in early 1831 (pp. 77, 79). Kerr was raised by a mother whose religious tradition was the syncretic African-Muslim religious tradition of what is now the Ivory Coast. When enslaved, she lived along the Monongahela River in western Virginia where Peter was likely raised in an ecstatic religious fusion of African, Baptist, and Methodist ideas that included "*interacting with the spirit world, dancing in fire, and speaking in tongues*" (p. 11). It is therefore likely that Kerr had exposure to African folk magic, conjure, and root medicine and knowledge of *D. stramonium*.

According to Catherine Yronwode, "root doctoring" mixed African magical practices with American Indian herbal medicine. Further, "most medical herbs also have magical uses, so urban conjures were able to take advantage of the medical industry's commitment to herb purity and specificity" (2002). Among the visionary materials used by Native Americans was jimson weed or *D. stramonium* (see Schultes, 1975), a substance also used in African medicine (Hamby, 2004, pp. 39, 54).

According to Staker (2009, p. 34), Kerr was "*among those brought into the Reformed Baptist movement in early 1828*" and not until late 1830, a period of nearly 3 years, that he converted to Mormonism and "*was recognized as a 'revelator' among them*" (Ibid, p. 119). If Kerr was solely responsible for the entheogenic-infused enthusiasms in early Mormonism, why didn't the same enthusiasms appear after he joined the Reformed Baptists in 1828? It seems more likely that one of the missionaries noted that like Joseph Smith, Kerr was a "*charismatic with a distinctive religious perspective*" (Ibid, p. 3) and concluded he was the logical choice to minister to converts' spiritual needs. As Staker states, "*Kirtland's religious enthusiasm was similar in so many ways to the religious world Black Pete knew that it is unlikely it developed as an independent experience*" (Ibid, p. 171). It would have been surprising, given Kerr's background and the likely promptings of at least one Mormon missionary, had he not utilized *D. stramonium* in his visionary syncretism.

For several months, Kerr (like Joseph Smith would do later when he arrived in Kirtland) introduced converts to entheogenic facilitated visions and spiritual ecstasies bringing many into the nascent Church. Further, like Smith's use of datura, Kerr's administration of this anticholinergic entheogen was problematic, leading to an embarrassed Church and accusations of medicated wine.

In 1833, Joseph Smith blamed the enemies of the Church for the medicated wine. In an 1833 revelation, it was advised, "*in consequence of evils and designs which do and will exist in the hearts of conspiring men in the last days ... your sacraments ... should be wine, yea pure wine of the grape of the vine of your own make*" (Smith, 1835, pp. 207-208).

Prejudice and secrecy

Joseph Smith's surreptitious use of entheogenic material was a closely guarded secret for obvious reasons. Although the ingestion of such substances was not illegal in the 19th century, their use was discouraged by withering ridicule. In a telling passage of *The Book of Mormon*, Joseph psychologically prepared early converts for the ridicule they might face and primed them to embrace it. This persecution incorporated, into *The Book of Mormon* that associates an entheogenic tree and the hostility of his neighbors, "*And after they had a tasted of the fruit, they were ashamed, because of those that were scoffing at them*" (Smith, 1830, p. 20).

Smith even faced strong opposition from his family. In a family gathering: Joseph Sr. began to speak of the discovery and translation of *The Book of Mormon*. At this, [his cousin] Jesse grew very angry, and exclaimed, "*If you say another word about that Book of Mormon, you shall not stay a minute longer in my house, and if I can't get you out any other way, I will hew you down with my broad ax*" (Smith, L. M., 1853, pp. 154-156). Although Jesse's heart eventually softened and he reconciled with his cousin, such prejudice against the visionary, magico-religious practices of Joseph Smith Jr. required that he make considerable efforts to conceal his selective use of entheogens.

1833: Kirtland, Ohio School of the Prophets and the Mormon Pentecost

In 1833, visionary endowments associated with washings, anointings, and sacramental wine during sessions of the "School of the Prophets." For example, in a March 1833 meeting of high priests, "*Bro Joseph ... [gave] a promise that the pure in heart that were present should see a heavenly vision ... after which the bread and wine was distributed by Bro Joseph after which many of the brethren saw a heavenly vision of the savior and concourses of angels and many other things*" (Roberts, 1902). During this period, on-demand visions again suggest the administration of an entheogen. Mormon elder Zebedee Coltrin reported Joseph Smith confidently promising Coltrin and Oliver Cowdery, "*Now brethren we will see some visions,*" after which Smith verbally guided them through a trip to heaven, where they saw Adam and Eve seated on a golden throne that looked like a celestial lighthouse (Anderson, D. S., 2018).

Between 1833 and 1836, we have no reported visions such as seen in New York or early Kirtland period. The embarrassment to the Church and various accusations surrounding Mormon visionary experience necessitated a change in venue. Smith would build a temple to house convert visions before the next series of reports of drugged wine would emerge.

The spiritual outpouring associated with the dedication of the Kirtland Temple in March and April of 1836 was called the Mormon Pentecost, the equivalent to the early Christian Pentecost that was also accused of alcohol intoxication. Visionary experiences during this period are linked, we argue, to the administration of bread and wine sacraments and oil anointings. Although not exhaustive, these remembrances are pertinent to the question of entheogen-infused Mormon ordinances and visionary experience.

The Kirtland temple endowments created a sacred space decorated with labyrinths, gonfalons, spirals, and squares within squares (Howlett, 2014) and a prolonged ceremony that included a day of fasting and the "*reenactment of the Passion narrative and Pentecost*" (Olaiz, 2014) that included the washing of feet and anointing the head with holy oil. In the evening, the fast was broken with a communion of bread and wine as a "reenactment of the Last Supper" followed by a ceremony that "*mimicked the high point of Christian redemption ... they stayed up all night ... a re-enactment of Gethsemane*" (Ibid). In serving the wine, Joseph Smith explained, "*the wine was consecrated, and would not make them drunk ... they began to prophesy, pronouncing blessings upon their friends*" (Harris, 1841, p. 32).

With increasing confidence in his entheogenic sacraments, Joseph Smith enabled hundreds to received visions during the dedication ceremonies of the Kirtland temple, but only if willing to participate in the Mormon ordinances. Smith's exuberance, however, was tempered as the manifestations of anticholinergic toxidromal symptoms led, once again, to accusations of drugged wine. For instance, a Church member with the last name of McWhitney complained that the wine consumed in the temple ordinances was actually "mixed liquor" and that "*the Mormon leaders intended to get the audience under [its] influence*" so visions experienced were believed to be of "the Lord's doing" (1888, p. 135). John W. Gunnison interviewed the Church elders present at the 1836 Kirtland Pentecost and reported: "*Wine was administered ... that had been consecrated and declared by the Prophet to be harmless and not intoxicating. This ... produced unheard of effects, if we may credit the witnesses of these proceedings. Visions, tongues, trances, wallowings on the ground, shoutings, weeping, and laughing, the outpouring of prophecies ... these and other fantastic things were among 'the signs following' at Kirtland*" (Gunnison, 1852, p. 107)

Even though descriptions of visions and ecstasies associated with entheogenic sacraments and anointings at the Kirtland temple were inspirational and stirring, problems developed almost immediately. Soon afterward accusations of adultery beset Joseph Smith as did challenges to his leadership, a Mormon war in Missouri, and the failure of the Kirtland Anti-Bank society. These catastrophes would occupy Smith's attention and prevent him from creating an environment suitable for entheogen administration. It would not be until the Smith had established the City of Nauvoo, formed the Nauvoo Legion to protect him and the Saints, and completed a new temple would he again promise mass visionary experience.

1842: Nauvoo temple

In 1841, Joseph Smith laid the cornerstone of a new temple in Nauvoo, Illinois, and in May of 1842, Smith taught a lengthy Masonic-like initiation rite to trusted leaders. The purpose of the training was to prepare for the dedication of the temple (Smith, 1977, p. 237). Since the temple was not completed and likely not wishing to repeat the embarrassment associated with the open access to the Kirtland visionary period, there were no visions during this initial endowment, and there were none promised. However, the expected endowment planned for the completed Nauvoo would eclipse those of the Kirtland Pentecost. Smith explained,

> *I spent the day ... instructing them in the principles and order of the Priesthood, attending to washings, anointings, endowments ... by which anyone is enabled to ... come up and abide in the presence of the Eloheim ... [as] soon as they are prepared to receive, and a proper place is prepared to communicate them, even to the weakest of the Saints [see D&C 89:3]; therefore let the Saints be diligent in building the Temple.* (Smith, 1977, p. 237)

The Edenic tree

The organization and context of the anticipated Nauvoo endowment provide for the covert administration of entheogenic anointings and sacraments, although for this endowment, the sacrament included partaking of the fruit from the tree in the Garden of Eden. Following purifying ceremonies of washing and oil anointing, a "new name" was given to initiates, who were informed was connected with Christ's promise in Revelation 2:17 of a "white stone" (Van Dusen, 1847). Then, fruit representing the forbidden fruit of "the tree of knowledge of good and evil" was plucked from the tree and eaten by the initiate. The Nauvoo endowment would avoid the problems of mass entheogenic visionary experience by conducting initiates in small groups within the seclusion of the temple. Receiving this sacred food also fulfilled the *other* promise of Revelation 2:17 - that they would be given "to eat of the hidden manna." Their initiation followed both the pattern of alchemical freemasonry with its entheogenic elixir and philosopher's stone and the pattern set by Joseph Smith when he ate of "hidden manna" and acquired his "white stone." Following this, the initiates engaged in an interactive entheogenic journey through the fall of Adam and the redemption of man by Jesus Christ after which they would pass through a curtain into a beautifully decorated celestial room and the presence of God (Buerger, 2001; Hyde, 1857).

We argue that to fulfill his promise of coming into the presence of God in the Nauvoo temple, Joseph Smith would have offered:

1. An overall sense of the holy and a mindset of sacredness.
2. An impressive and uplifting multistoried edifice with esoteric symbols inside and out and multiple special purpose rooms.
3. Trusted attendants to guide initiates through each aspect of the ceremony, to prompt attendees should they experience confusion and provide assurance if distress occurs, and
4. An entheogen that would not produce the indecorous symptoms and outside criticisms such as the Church experienced during the visionary Kirtland period.

After receiving the new name, an entheogenic anointing, and ingesting Edenic fruit, converts basked in emotional and physical safety designed to provide spiritual experiences of such consequence it would enhance the joy of living and provide comfort during periods of struggle.

Nauvoo Entheogen

The procurement of an entheogen for the Nauvoo temple would not be as easy as harvesting datura seeds found growing in the surrounding countryside and used as ornamentals in some gardens. Because of the Kirtland experience, datura as an entheogen would draw unwanted attention. And gathering enough entheogenic mushrooms for the rapidly increasing Church population, at time around 10,000, was not practical. However, several physicians in positions of Church leadership would have known about the medical use of ergot in obstetrics and could easily extract ergot's water-soluble entheogenic component. In Nauvoo, ergot was readily availability, easy to hide, and of high potency making it an ideal entheogen for burgeoning Church population. However, by 1842, two important physicians in the Mormonism, Luman Walters and John C. Bennett, became disaffected with Joseph Smith and a third, Frederick G. Williams died. Another physician, Williard Richards, may have been able fill these vacancies, but in 1843, the malpractice trial of doctor William Brinks may have persuaded Joseph that an ergot-derived entheogen could become very problematic.

A year before the 1843 trial, Dr. Brinks treated a female in labor suffering from severe pain and fever. When he treated her with ergot to hasten delivery, her womb "lacerated or ruptured" (Dinger, 2016, p. 85). In his defense, Dr. Brink explained, "*I gave her ergot ... nothing but what any physician would do*" (The Joseph Smith Papers, 1842-1844). However, Dr. Samuel Bennett, a traditional doctor, testified against Dr. Brink, stating that he "*should not have administered ergot ... its effect on the uterus [is] to expel the contents of the uterus [or] to produce delivery*," but ergot caused increased intrauterine pressure, rupture, and permanent disability (Dinger, 2016, p. 85.) The case was high drama and 3 months later, Joseph Smith meet with Native American leaders in what appear to be negotiations for a safer, more effective entheogen - peyote.

Peyote entheogen

During the period of Indian Removal beginning in 1830, Native Americans living east of the Mississippi River passed through Nauvoo on their way to their seasonal hunting grounds. Potawatomi delegations, including members of the Fox and Sauk nations, visited Joseph Smith between April 18 and August 28 of 1843 (discussed below). The purpose of these negotiations is not altogether clear to historians. However, as we will see, the negotiations probably involved Joseph Smith giving valuable and sacred property to the Potawatomi without apparent gain to Smith in return. We suggest that Joseph Smith negotiated with nearby Native Americans for the delivery of peyote to Nauvoo for the Nauvoo temple endowment.

Quest for a new entheogen

There were several groups of Native Americans living on the American Prairie in the early 19th century, any of which could have provided for the transport of peyote from South Texas. Joseph Smith has had dealings with the Prairie groups of the Potawatomi, Fox, Sauk, and Delaware (Lenape), with Smith sending missionaries to the Mahican, Sioux, and other Indian peoples residing in Wisconsin and Canada (Jensen, 2012; Mahas, 2017; Walker, 1993). Further, although few Indians joined Mormonism, there were "many among the Shawnees" who believed in Smith's mission (Byron, 1993).

The Potawatomi

The Potawatomi were an Algonquian-speaking Eastern Woodlands group related to the Ojibway, discussed in relation to *D. stramonium* and *A. muscaria*. However, with the Indian Removal Act of 1830, "*the Potawatomi were removed in two groups: The Prairie and Forest Bands from northern Illinois and southern Wisconsin went to Council Bluffs in southwest Iowa, and the Potawatomi of the Woods (Michigan and Indian bands) relocated to eastern Kansas near Osawatomie*" (Bassett, 2016).

Peyote "*was used in ancient times in Mexico, spreading from the Rio Grande Valley and taking hold on the Plains [the American Prairie] as early as the 1840s*" (White, 2011, p. 178). Peyotism existed among Native American shaman and medicine people for centuries and was likely used by Potawatomi and other Plains Indian shamans before they formally adopted the Peyote Religion in the 1890s (Stewart, 1987, p. 93). The Potawatomi passed through Nauvoo on their way to and from their hunting grounds in Iowa territory (Smith & Edwards, 1972) and could have served as an early bridge between the Indians of the Southwest (e.g., Comanche-Osage) and Joseph Smith for the delivery of peyote to Illinois for the Nauvoo temple. Prairie Potawatomi began actively trading peyote imported from South Texas at least by 1870 (Schaefer, 2015) and perhaps even earlier (Howard, 1962).

In August 1841, a large group of Fox and Sauk Indians, including 100 chiefs, visited Nauvoo in 1841 (Appanoose-Biography, n.d.) with their leader, Chief Keokuk, forming a personal relationship with Joseph Smith and his wife, Emma. Emma exchanged recipes for herbal medicines with the wife of Chief Keokuk (Newell & Avery, 1994, p. 278). During the spring and summer of 1843, three delegations of Potawatomi traveled to Nauvoo primarily to ask Joseph Smith "*for assistance and advice in their struggles with white Americans*" and in April 1844, eleven Potawatomi Indians visited Smith again "seeking help to avoid losing their land" (Council of Fifty, 1844-1846). Joseph Smith had a significant number of Native American contacts during the Nauvoo period, any of which could have provided for the delivery of peyote to Nauvoo; we feel it was most likely with the Potawatomi.

Besides this encounter, there were additional meetings between Joseph Smith and the Potawatomi. According to LDS Church Historian Jay Todd (1968), in June 1843,

> *Several of the Potawatomi Chiefs called to see the Nauvoo House and Temple ... Nauvoo was a prominent spot for Indians and was called by them Quashquema ... [and] Indian burial grounds abounded in the area." However, not finding Joseph Smith present, the Potawatomi explained, "They were not free to talk, and did not wish to communicate their feelings until they could see the great Prophet."* (Ibid)
>
> *They returned in July and told Smith, "We have talked with the Great Spirit, and ... the Great Spirit has told us that he had raised up a great Prophet ... We will now wait and hear your word."* (Ibid) *After Smith spoke, Smith had an ox killed for them and they were given fresh horses for their journey home.* (Ibid)

During one of the several visits of Potawatomi to Nauvoo, Joseph possibly gave the Potawatomi captain a significant portion of the Egyptian papyri from which he "translated" a work of scripture said to have been written by the hand of the Biblical Abraham (Todd, 1969). These papyri were from a larger collection purchased by Joseph Smith in 1835 for $2,400 (Gee, 2007; Remini, 2002, p. 105). The value of these papyri was significant since $2,400 in 1835 represents nearly $70,000 adjusted to 2019 value. It is a mystery why

Smith would give away such valuable papyri when he anticipated showing them on display for a fee, and also anticipated translating the "Book of Joseph" from the same collection of papyri (Larsen, 1992). The gesture is striking.

Was Smith negotiating for access to Native entheogens? Such negotiation is suggested by the timing of these interactions with the Potawatomi, Fox, and Sauk, beginning within weeks of the discrediting of ergot in the Brink trial, by Smith's inordinate "gift" to these representatives, and by earlier exchanges of herbal information between the Smith family and the family of the local Sauk chief Keokuk. Acquiring Native American entheogens could have fueled a new and more profound spiritual Pentecost in the endowment to be given in the Nauvoo temple, scheduled for completion in 1845-1846.

Lyman Wight

Joseph Smith's vision was for Mormon colonies to span the globe, with Independence, Missouri being the center of a worldwide kingdom of God. After the Mormon War of 1838, Smith moved the center of the kingdom to Nauvoo, Illinois but still sought to establish colonies adjacent to Indian Territory in areas such as California, Oregon, Minnesota, the Great Basin, and Texas (The Joseph Smith Papers, 1842-1844, pp. 55, 170, fns 46-47). Smith's emissaries also negotiated for the Neueces strip (Figure 30) in deep south Texas, an area extending from Corpus Christi down the coast to Brownsville, then westward between the Rio Neueces and the Rio Grande River.

Figure 30. The Neueces strip shown in pink and white stripes. Adapted from the U. S. Army Campaigns of the Mexican War (Carney, n.d.). In Figure 25, the same area is shown in the purple-blue area.

Lyman Wight, having experienced an entheogenic vision of Christ as documented above, became a reliable friend of Joseph Smith and resolutely carried out his orders, including being part of a Mormon pinery colony in Wisconsin. Joseph Smith used such colonies, flung out from the Church's central hub at Nauvoo, to acquire resources for the main body of the Church. The Mormon colony in Wisconsin, between 1841 and spring 1845, floated timber to Nauvoo amounting to "*1.5 million board feet of milled time, more than two hundred thousand shingles, and a large number of miscellaneous logs, barn board, and timbers*" (Clark, 1997-1998, p. 67). In February 1844, Lyman Wight, in conversation with local Wisconsin Native Americans, concocted a plan to form a joint Mormon-Indian colony in Texas. Wight wrote to Smith requesting permission for himself and the Native Americans to travel to Texas to initiate such a colony (Figure 31). Smith agreed, and Wight was ordered "*to take a small colony to Texas and make smooth and ready the path for a major migration of the L.D.S. church to Texas*" (Banks, 1945; Johnson, 2006, p. 5). However, given the Mormon emphasis, since 1829, on building settlements near Native American lands, and given that the initial colony idea proposed by Wight was to be a Mormon-Indian colony, it seems highly probable, if not nearly inevitable, that Woodworth would have entered into contact with Native Americans there.

Joseph Smith aimed to establish colonies to procure resources for the body of the central hub of the Mormon community at Nauvoo. What resource was the planned Texas Mormon-Indian colony intended to provide? Texas was a keystone to peyotism; peyote grew in abundance in Southwest Texas, especially along the Texas-Mexico border and the Rio Grande River, with an active peyote trade that only abated in 1959 (Morgan & Stewart, 1984). In this expedition, Joseph Smith may have attempted to plant a Mormon-Indian colony in the heart of peyote country, where his colony could harvest thousands of peyote buttons, just what the thousands of Nauvoo saints would need if peyote was the entheogen used in the completed Nauvoo temple.

Did Joseph Smith know he was planting his prospective colony where Mormon colonists could acquire peyote? Smith's evident use of entheogens, his need for them to replicate the Kirtland Pentecost, the timing of the Texas negotiations shortly after other potential entheogens and sources of entheogens faltered, his intention to involve Native Americans in his scheme, his pattern of planting colonies to supply resources from the local environment, and his choice of *the* peyote environs suggest to us his intention to use his Texas colony to supply peyote. In addition, tangible, artifactual evidence exists indicating that Joseph Smith knew and was interested in the peyote trade and had contacted a peyote trade network of Native Americans through intermediaries, or directly from the anticipated Texas Mormon colony, or both. A sacred stone found among

Smith's belongings, which we will call "the peyote stone," is that artifactual evidence.

Joseph Smith's Peyote Stone

Among Joseph Smith's possessions during his death was a finely tooled sandy-colored seer stone (Figure 32), unlike any other he used for scrying (Quinn, 1998, pp. 246-247, Figure 10). The stone is smooth in texture with a hole through the center surrounded by eight smaller indentations of alternating sizes where the central flower and tuffs of the peyote button have been cored out. It is comparable to the eight-lobed peyote button in Figure 33. The coin-like ridged circular edge of Smith's stone not seen on the peyote button signifies the visionary nature of peyote. The alternating sizes of the indentations on this stone are somewhat similar to the peyote button and are comparable to the alternating size of the tufts in Figure 33, an eight-lobed Plains Indian peyote pouch (Figure 34) currently displayed in the Plains Indian Museum in Cody, Wyoming (see Hultkrantz, 1997, p. 6).

Figure 31. Route and locations of the Wight Colony in Texas, 1845-1858 by Davis Bitton (1969).

Figure 32. Joseph Smith's peyote stone (image from Quinn, 1998, Figure 10, colored version. Copyright: Signature Books).

Figure 33. Eight-lobed peyote cactus reduced sized photo. Shutterstock.

Figure 34. Eight-lobed peyote pouch (image from the Plains Indian Museum in Cody, Wyoming).

The nomadic aboriginal peoples of the American Plains included the Lipan Apache, Tonkawa, Comanche, Kiowa, Otto, Osage, Arapaho, Sioux, and Pawnee, bordered on the northeast by the Ojibway, Potawatomi, Sauk, and Fox. Most of these groups were relocated, westward into Plains Indian territory following the Indian Removal Act of 1830 and interacted with Joseph Smith (Walker, 1993, pp. 6-7). For instance, by the 1840s, the Potawatomi had been resettled west of Nauvoo, Illinois, within the cultural boundaries of the Plains Indian groups, providing an opportunity for the transmission of information about peyote to Joseph Smith.

According to Omer Steward (1974), "*The Lipan Apache Indians in the vicinity of Laredo, 1760 to 1850s, learned of the properties of Peyote and the ritual for its use from Coahuiltecan-speaking Carrizo and Tonkawa and in turn taught Peyotism to the Comanche and Kiowa*" (p. 211), their northern allies by 1830 (p. 215). A possible route for the spread of peyotism toward the northeast from Texas proposed by Steward (pp. 215-216) and included in the report by R. A. Smith (1961) states, "*The demand for Mexican livestock, captives, and plunder increased after American commissioners made treaties of amity and trade with the Indians of the South Plains in the 1830s. The Comanche and Kiowa consequently stepped up their predatory raids below the Rio Grande ... Their deepest penetrations of Mexico put the Indians at points a thousand miles straight south of their home range in Kansas and Oklahoma ... One can suspect the warriors might also have learned about and experimented with the little spineless cactus, peyote, which grew in the area.*"

The intricate patterning on Joseph Smith's peyote stone in Figure 32 above may be a Native American stone gorget such as the stone in Figure 35 belonging to David Whitmer one of the three witnesses to the angel and golden plate and used as a seer stone. Native American gorgets, worn around the neck as signs of goodwill or an indication of status, and Smith's peyote stone, although of Native American origin, is not typical of a Native American gorget. Instead, it is similar to the pre-Columbian stone whorl from Mixtec, Mexico, shown in Figure 36. Joseph Smith's stone appears to be a Native American visionary peyote stone effigy. Similarly made pre-Columbian visionary stone effigies appear to represent the *I. alvarus* toad in Figures 35 and 36. Further, the Native Americans of the Lower Pecos region of southwest Texas have a history of ritual peyote use and the manufacture peyote effigies extending back 5,000 years (Powell, 2017; Terry *et al.*, 2006).

Figure 35. Gorget seers stone belonging to David Whitmer (courtesy: Signature Books).

Figure 36. Pre-Columbian Aztec stone spindle whorl (photo by Christophe Helmke).

Peyote has tufts of "hair" on each of its lobes and a central flower that if removed, leave a corresponding number of depressions. Native art, such as the peyote pouch in Figure 31 depicts peyote by the several circular depressions or tufts, often five or eight, surrounding a central circle or hole. The representation can further be stylized in native art by showing the tufts or depressions as alternating in size around the button as in Figure 32. An examination of Joseph Smith's stone shows precisely this same stylization. The stone consists of a central circle surrounded by eight circular depressions arranged in an alternating pattern of large-small-large.

Joseph Smith's peyote stone in Figure 32 above bears a striking resemblance to Figures 37-39 (frames from a video produced by DiezyMedia in 2007). In Figure 37, the transfixed, partially transformed shaman is holding a smooth-edged cactus, but in Figure 38, the shaman's eye is wide open, and reflecting a partial transformed eight-lobed peyote button that had five lobes in Figure 37. In Figure 39, the consumed peyote button has further undergone entheogenic transformation amidst "spiritual light" pouring from its scalloped edges. In comparison, a reduced image of Joseph Smith's peyote in Figure 40 favorably compares to the visionary portrayal of the Huichol peyote button reflected in the shamans eye in Figure 41. Figure 41 shows the shaman in spirit and endowed with new powers.

While ownership of the peyote stone transferred to his heirs after his death, how this curious stone came to Joseph Smith is unknown. Quinn (1998, pp. 246-247) speculated this stone, which was one of the seer stones Brigham Young had mentioned Joseph finding at Nauvoo on the banks of the Mississippi. However, considering the information above, it is likely a tooled stone that was hand-tooled by a Native American familiar with peyote. Joseph Smith owned other hand-tooled Native American stones used for divination, as other early Mormons did, each one tooled by a Native American (Quinn, 1998, p. 247). For instance, the Whitmer family, followers of Joseph Smith from the 1820s, used two hand-tooled Native American gorgets with holes bored into them as seer stones (Quinn, 1998, Figures 11-13). Further, research conducted on these stones by Mormon scholars aside from Quinn has uniformly identified them as tooled by Native Americans (Ashurst-McGee, 2000, p. 165; Murphy & Baca, 2016, p. 707). The peyote stone broadly resembles Native American gorgets but has a more intricate representation carved into it, and compares well to Native American representation of peyote.

Figure 37. Huichol shaman transfixed as he looks on a five-lobe peyote cactus. DiezyMedia (2007).

Figure 38. Partially transformed five to eight-lobed button is reflected in shaman's eye. DiezyMedia (2007).

Figure 39. Fully transformed eight-lobed peyote button appears illuminating a new world. DiezyMedia (2007).

Figure 40. Joseph Smith's visionary peyote stone reduced in size for comparison (adapted from Figure 35).

Figure 41. Huichol shaman in vision with new powers. DiezyMedia (2007).

Lyman Wight, Mission to Texas

Joseph Smith's vision was for Mormon colonies to span the globe, with Independence, Missouri being the western hub a worldwide kingdom of God, Jerusalem being the eastern hub. After the Mormon War of 1838, Smith moved the center of the kingdom to Nauvoo, Illinois along with his converts; simultaneously, he attempted to establish colonies adjacent to Indian territory in areas such as California, Oregon, Minnesota, the Great Basin, and Texas (The Joseph Smith Papers, 1842-1844, pp. 55, 170, fns 46-47). The purposes of these colonies were twofold: (a) expand the Kingdom of God until it filled the earth and (b) provide a place where, if another Moron War were to break out, the Mormons could find protection.

How did Joseph Smith acquire a peyote stone? Given that peyote was grown at the Texas-Mexican border, and Joseph Smith sent a scouting-and-negotiating team to south Texas to establish a Mormon-Indian colony on the Rio Grande, it represents one of two possible modes by which the peyote stone traveled from the hands of a peyotist in Texas to those of Joseph Smith in Nauvoo, Illinois. In 1844, Smith sent a Mormon expedition to persuade Sam Huston to allot lands then disputed by the Texans and the Mexicans. These lands included the entire Neueces strip (Figure 30) extending from Corpus Christi down the gulf coast to Brownsville, then westward between the Rio Neueces and the Rio Grande Rivers encompassing the northern reaches of peyote inhabitation.

Just weeks after the Texas expedition party's return, Smith tasked Lyman Wight to establish a Texas colony, gave him a seer stone, and told him he would need this stone to receive revelation pertaining to his colonization work (Johnson, 2006, pp. 30-31). The stone Smith gave Wight was a seer stone, but not the peyote stone he retained until his death.

With the single exception of giving Oliver Cowdery his brown seer stone in 1829, Smith is not reported to have given anyone else such a stone until he gave this one to Wight in April 1844. This unique action on Smith's part and its timing are both readily explainable if the negotiating party delivered the peyote stone to Smith in Nauvoo.

Also noteworthy is that Joseph Smith gave Lyman Wight not just any seer stone but specifically a white stone. We have noted above that the "white stone" has a place in Joseph Smith's biography, biblical interpretation, and theology. Drawing on Jesus' promise in Revelation 2:17 ("KJV"), the young Joseph Smith had searched for a "white stone" to use in scrying. This biblical promise of receiving a "white stone" also included the promise of receiving "the hidden manna to eat," a promised gift that appears to have materialized for Smith as *A. muscaria* mushrooms or datura in the family's "sacred grove."

Since Smith's own experience of becoming a seer included obtaining a "white stone" used to find entheogenic "hidden manna," Smith's bestowal to Wight would have been only a halfway-boon had he stopped there. Joseph Smith's instructions to Lyman Wight on how to be a seer on the same pattern as Smith would have included instructions on using "hidden manna" as an entheogen to facilitate Wight's experience of second sight.

Some researchers have concluded that the "manna" in Judeo-Christian scripture was a psychoactive variously identified as a water-soluble extract of ergot (Merkur, 2000) and the *A. muscaria* mushroom, also known to some as the white stone. (Allegro, 1970; Irvin, 2009). Such a reading was known in early Christianity judging by the number of works of art featuring the *A. muscaria* and psilocybin-containing mushroom (Brown & Brown, 2016; Merkur, 2014; Rush, 2011). Joseph Smith, if he had not learned it from a mentor, had his own experience with entheogens, which would have led him conclude that entheogens were used in Judeo-Christian religion. It would be reasonable to believe that Joseph Smith would want to transmit his entheogenic knowledge to a trusted friend who had successfully ingested entheogens. Lyman Wight had responded well to the administration of an entheogen in 1831 when he "turned white" and "saw the Savior" (Hancock, 1858, p. 90) and remained a loyal friend to Joseph Smith even after Smith's death. It seems apparent that Wight's experience and loyalty resulted in Smith's gift of a white stone to locate entheogens in Texas. Apparently successful, Wight would have visions of Smith himself, years after the latter's death (Blythe, 2014; see also Johnson, 2006). Wight could easily carry 20,000 peyote buttons weighing 60 pounds to Joseph Smith in Nauvoo.

The end of visionary mormonism

The end of visionary and ecstatic Mormon can be causally associated with the death of Joseph Smith. Only a few of the many Mormon schisms that successors organized proved to be visionary. Those are visionary Mormon-Native American syncretisms that use peyote as an entheogen. Only one of Smith's descendants is reported to have used entheogens to facilitate spiritual growth and wished to introduce it as a general form of religious worship.

Death of Joseph Smith

Friction between Mormonism and their Missouri neighbors increased to the breaking point, and war broke out with Joseph Smith barely escaping with his life and the body of Mormons moving north in Illinois (Baugh, 2000). After fleeing Missouri, Smith established a new city that he called Nauvoo, the Beautiful along the eastern banks of the Mississippi River. Anticipating continued contention with non-Mormons, Smith formed a theocracy with political and military branches (Hansen, 1960, 1967). After Mormons deserters published an inflammatory first issue of the Nauvoo Expositor, Joseph Smith as the mayor of Nauvoo and general of the Nauvoo Legion ordered the destruction of the press.

Schismatic Mormonism

Within a century following the death of Joseph Smith, Mormonism splintered into over 200 schisms that collectively boast worldwide membership of over 16 million. The largest Mormon denominations are The Church of Jesus Christ of Latter-day Saints, The Community of Christ (formerly the Reorganized Church of Jesus Christ of Latter Day Saints), and groups collectively called Fundamentalist Mormons who still practice polygamy (Shields, 1982).

The leaders of these schisms each claim to be the legitimate heir to Joseph Smith, and prophet leader of their only true Church. Each schism attempts to maintain Mormonism as it was under Joseph Smith's leadership, including teaching his doctrine, believing his revelations, build temples, and performing his ordinances. For instance, in 1846, Brigham Young conducted temple endowments in the Nauvoo temple, as he understood Joseph Smith intended, including oil anointing, and raisins plucked from an Edenic tree (Buerger, 2001). However, to the disappointment of many, no religious visions or spiritual ecstasies were reported.

Return of the Egyptian Papyri

In winter 1846 as Brigham Young led the first contingent of Mormon's westward out of Illinois and across the Mississippi River and into Iowa where they camped. While there, a Potawatomi Captain inexplicably presented Brigham Young with "*two sheets of the Book of Abraham [papyri]; also, a letter from their 'Father' Joseph Smith, dated 1843, and a map of their land by W. W. Phelps*" (Todd, 1968, p. 40). Had Joseph Smith arranged for the Potawatomi captain to deliver peyote to Nauvoo and exchanged a peyote stone for Egyptian papyri as a token of their bargain, then the return of the papyri following Smith death solves the mystery.

Successors' negative views of visionary symptomology

Joseph Smith told early converts to expect somatology-associated religious visions and spiritual ecstasies. To prepare converts for the entheogen-facilitated spiritual manifestations and associated symptomology, Joseph Smith (1839, pp. 18-19) explained:

> *It is more powerful in expanding the mind, enlightening the understanding, and storing the intellect with present knowledge, of a man who is of the literal seed of Abraham, than one that is a Gentile though it may not have half as much visual effect upon his body; for as the Holy Ghost falls upon one of the literal seed of Abraham, it is calm and serene; and his whole soul and body are only exercised by the pure spirit of intelligence; while the effect of the Holy Ghost upon a Gentile, is to purge out the old blood, and make him actually of the seed of Abraham. That man*

> *that has none of the blood of Abraham (naturally) must have a new creation by the Holy Ghost.*

Therefore, stark was the difference between the many visions reported in early Mormonism and lack of similar reported after Joseph Smith's death, which distressed members inquired of their leaders. Mormon Apostle George A. Smith responded to these concerns in an 1867 discourse in Salt Lake City:

> *The question has often arisen among us, why it is that we do not see more angels, have more visions, [and] do not see greater and more manifestations of power?* (Smith, 1867, p. 10)

What followed is revealing. Apostle Smith recalled that in 1836, a filled Kirtland temple with over four hundred men of the priesthood, most of whom witnessed,

> *great manifestations of power, such as speaking in tongues, seeing visions, administration of angels. Many individuals bore testimony that they saw angels, and David Whitmer bore testimony that, he saw three angels passing up the south aisle, and there came a shock on the house like the sound of a mighty rushing wind, and almost every man in the house arose, and hundreds of them were speaking in tongues, prophesying or declaring visions, almost with one voice.* (Ibid)

Then, Apostle Smith diminished the value of these experiences when he noted that,

> *A number of them who manifested the greatest gifts, and had the greatest manifestations have fallen out by the way side, you look around among us and they are not here ... . But where you find men who have turned away, and have got terribly afflicted with self-conceit, you will find those, who, on that occasion and similar occasions, received great and powerful manifestations, and when the spirit came on them it seemed to distort the countenance, and caused them to make tremendous efforts in some instances.* (Ibid)

Reflected in George A.'s next remarks is the post-Joseph Smith Mormon attitude regarding public religious manifestations and spiritual ecstasies. Speaking favorably of nonvisionary post-Smith "revelation" by inspiration, George A. spoke of faithful converts,

> *who received the knowledge of the things of God by the power of his spirit, and sought not after signs and wonders, and when the spirit rested upon them seemed to produce no visible demonstration.* (Ibid)

George A. Smith knew there was a significant change in convert's visionary and ecstatic experience following the death of Joseph Smith. Direct and personal experience with angels and God gave way to revelation described as inspirational manifestations. As discussed above, in every case involving entheogen use in early Mormonism, a change in mental and emotional state was apparent to non-intoxicated observers both inside and outside the Church. That cessation of observable symptomology associated with post-Joseph Smith spiritual experience and the lack of visions and ecstasies reported by his successors provide persuasive evidence that Joseph Smith made use of entheogens. Even more noticeable are the many contemporary reports of entheogen-facilitated visions and ecstasies echoing those of Joseph Smith and early of Mormon converts.

The cessation of convert and leadership visionary and ecstatic experience following the death of Joseph Smith may partly inform the observation of Sterling Professor of Humanities at Yale University, Harold Bloom (2007) when he observed, "*I am puzzled by the current Salt Lake City hierarchy. If there is any spiritual continuity between [Joseph] Smith and Gordon B. Hinckley [a Prophet and Utah successor to Joseph Smith], I am unable to see it. No disrespect is intended by that observation.*" If "placebo sacraments" replaced those infused with entheogens in early Mormonism, the spiritual discontinuity between Joseph Smith and his successors noted by Hard Bloom is readily accounted for and easily explainable.

Entheogenic successors

More than any other American religion, Mormonism has spawned several forays into entheogenic sacraments. We start with Joseph Smith's grandson, Frederick G. Smith.

Frederick M. Smith

The evidence reviewed above that Joseph Smith kept a Native American peyote stone as a sacred possession, attempted to locate a colony in peyote country, and intended to offer his followers peyote in the temple to facilitate their experience of God puts us in a better position to now to address a question we raised early in the paper. Like his grandfather Joseph Smith, Frederick M. Smith (1875-1946) manifested a precocious openness to entheogens, particularly peyote. As shown by Emma's letters and oral transmission of information to her children and grandchildren about the entheogenic-potent herbs jimson (datura) and lobelia, information about entheogens was passed on from Joseph Smith Jr's generation not through his Church but within his family. Joseph's family was also heirs to his hand-tooled seer stone in a peyote button. After his death, the stone remained in possession of his widow Emma, who passed it on to her second husband, Lewis Bidamon. The stone eventually came into the possession of Lewis's illegitimate son Charles Bidamon.

Frederick G. Smith, born in 1874, is likely to have seen the stone as a child and would have known it by reputation at the least. As the stone passed beyond the Smith family and eventually to collector Wilford C. Wood, any oral lore passed along with the stone within the Smith family failed to be transmitted with it further, and the stone was known only as one of Joseph Smith's seer stones, with no other information about its provenance or significance. However, just because the stone's representational significance was unknown to those who later sold and bought, it does not mean this significance was unknown to the Smith family.

Joseph Smith family's cross-generational legacy of a peyote stone and oral traditions about entheogenic herbs, and possibly about the stone itself, makes it unsurprising that Frederick M. Smith would have been exceptionally open to using entheogens, including peyote. Joseph Smith's revelations were the "bed-rock" of Mormonism and Frederick "*wanted to understand the [revelatory] process*," a subject he explored in *The Higher Powers of Man* (1918), with an entire chapter devoted "*to the wonders of peyote*" (Tommasini, 1997, p. 83). In this work, Frederick discussed the usefulness of peyote as an aid to spiritual development, reverberating his previous entheogenic experiences, experiences "*he did not dare to chronicle*" (Tommasini, 1997, p. 83). Frederick wrote, "*Ecstasy has played an important role in human affairs, particularly the religious, and it is scarcely stating the matter fairly to hold that it is always associated with the pathological. Ecstasy is the central experience of religious experience usually associated with mysticism*" (Smith, 1918).

Frederick learned "*the rituals and powers of peyote*" while pursuing his PhD in psychology. When Frederick visited Texas on vacation, "*he observed Native American Indians who ate [peyote] ... [and] Catholic converts, who [drank it as a tea] for communion*" (Tommasini, 1997, p. 83). Frederick believed the use of peyote in a spiritual setting was not a violation either of the spirit or the letter of his grandfather, Joseph Smith's 1833 dietary revelation known as the "word of wisdom" (Smith, 1833, pp. 207-208). "*Frederick did not believe that peyote was technically, a drug. To him it was a natural substance, an ancient means to tap one's inner power derived from hallucinogenic cactus [as Frederick put it, is] 'neither injurious nor habit-forming'*" (Tommasini, 1997, p. 83).

Frederick introduced peyote to Virgil Tomson (1896-1989), an American composer who played a significant role in creating an "American Sound" in classical music. Smith gave Virgil "*five bumpy little buttons less than an inch across and hard as wood and suggested that he chew them up before he went to bed*" (Ibid). Virgil described his experience: "*The effect, full visions complete in color and texture as a stage set, began slowly to appear before my closed or open eyes. Then came more rapidly ... Each one, moreover, had a meaning [and] could have been published with a title; and their symbolisms or subjects ... constituted a view of life not only picturesque and vast, but just as clearly all mine and all true*" (Tommasini, 1997, p. 84).

Virgil introduced S. Foster Damon, an academic and poet specializing in the mystic William Black, and "*who reported on the similarity of Blake's art to Peyote visions*" (Piper, 2016). Frederick, Virgil, Damon, and others belonged to a "Harvard psychedelic circle" who were engaged in the exploration of peyote spirituality (Piper, 2016). Damon was profoundly affected by his peyote experiences and subsequently penned articles titled, *The Evidence for Literal Transmutation* and *Symbols of Alchemy* (Ibid). In *Symbols of Alchemy*, Damon (1922) argues that "*To the alchemists, 'Gold,' the most perfect in the metalline world, stood for Man, the perfect product of creation*" and "*'to make gold,' actually meant to make (or materialize) a human being*" (p. 79). Damon also discussed "*The Elixir of Life*" stating it was called such "*because of the way it [by a chemical* *process] manifested itself ... since by its means, the afterworld could be reached*." Further, "*each alchemist used a new term [for the Elixir] every time he could think of one*" (p. 81). Damon argued that Alchemists kept their secret by means of symbols and "*frankly confessed that they deliberately confused their symbols*" because it "*was a matter of life and death for these men to keep their secret: one hint, and they with all their colleagues would have been massacred*" (Ibid, 79, emphasis added). We have argued that Joseph Smith's intentionally obscured entheogen for the same reason.

Frederick Smith represents a rare confluence of many factors discussed in this paper. He was the patrilineal grandson of Joseph Smith, the prophet of the Reorganized Mormon church (1915-1946), a classically trained psychologist, and his doctoral thesis extensively discussed and advocated for using the entheogen peyote in religious settings. And if Frederick Smith's engagement with psychedelics and the "Harvard psychedelic circle" (Piper, 2016) reverberated in family traditions of his grandfather Joseph Smith's engagement with psychedelics, then Joseph Smith may himself have exerted an indirect but positive influence on the unfolding of psychedelic culture in the United States. One might think such was the case since the next "Harvard psychedelic circle" included Timothy Leary, Ram Dass, Huston Smith, and Andrew Weil who played a significant role ushering in a "New Age" for America (Lattin, 2011).

Contemporary scripture in the Community of Christ establishes Joseph Smith's original, historic goal of universal prophethood as one of the faith's immediate priorities. Revelations issued by Community of Christ prophet presidents Grant McMurray and Stephen Veazey and accepted by the Church into its *Doctrine and Covenants* (Community of Christ, 2007) who proclaim that participants in the Community of Christ are called "to be a prophetic people" and to "live prophetically" (Section 162:2c, 8c; 164:1). With its heritage of two early prophets who used and promoted entheogens as a potent means for living out this age-old vision, the Community of Christ is perhaps uniquely positioned among restorationist and liberal Christian denominations to leverage entheogens to become "a prophetic people" as Joseph Smith envisioned.

Oto Church of the First-Born and the Native American Church (NAC)

The Mormon-Indian-peyote syncretisms began in 1914 with the incorporation the Oto Church of the First-Born, the predecessor to the Native American Church (Rigal-Cellard, 1995). According to Weston La Barre (1938), early Plains Indian peyote "*rites diffuse[ed] from the Kiowa-Comanche ... [to] the Oto Church of the First-born ... and its successor, the Native American Church*." In their Churches, the Oto met to see the "*faces of their dead relatives*" and the Osage met "*to see the face of Jesus*" (Ibid).

The Oto Church of the First-born was found by Jonathan Koshiway (La Barre, 1938), the first Native American syncretism to seek legal incorporation. Koshiway was a missionary for the Reorganized Church of Jesus Christ of Latter Day Saint, now the Community of Christ and later "met with Kiowa and Arapaho to found the Native American Church" (Rigal-Cellard, 2004).

The Oto Church of the Firstborn likely represents Koshiway familiarity with the Mormon concept of the "Church of the Firstborn," and its visionary nature as described in Mormon scripture. Joseph Smith (1844) explained that Mormon's who were faithful and obtained the ordinances,

> "*have the privilege of receiving the mysteries of the kingdom of heaven, to have the heavens opened unto them, to commune with the general assembly and Church of the Firstborn, and to enjoy the communion and presence of God the Father, and Jesus the mediator of the new covenant*" (pp. 101-102; also see Collier, 1977).

Probably, Koshiway viewed peyote as the key to commune with the heavenly Church described by Joseph Smith.

The Peyote Way Church of God

The next Mormon-Native American-peyote syncretism, The Peyote Way Church of God (PWCG), was founded by Reverend Immanuel Pardeahtan Trujillo in 1979 and is based in Willcox, Arizona (Rigal-Cellard, 2004). In 1948, before founding the PWCG, Rev. Trujillo (50% San Carlos Apache) joined the NAC. However, Trujillo became dissatisfied with the NAC because it limits membership and peyote sacrament to "genuine Natives" who can prove at least 25% American Indian ancestry, and their spouses regardless of race. Trujillo's objection arose when, "*William Russell, Apache Roadman for the NAC. Rev. Russell and Rev. Eugene Yoakum. .. [taught] Trujillo about the Spirit Walk and instilled in him the non-racist nature of the Holy Sacrament Peyote*" (Peyote Way Church of God, n.d.).

Preferring not to limit peyote sacraments to Native Americans, Trujillo left the NAC in 1966. The PWCG "*strictly adheres to the creeds of the L.D.S. Church*" (Rigal-Cellard, 2004). According to Rigal-Cellard, "*Anne Zapf, the President of the Church from 1985 to 1993, became a Mormon while in college and helped Trujillo settle the Church and … a fairly high number of Natives of the region belong to the L.D.S. Church*" (Ibid). Shields (1982, p. 221) goes further stating the PWCG descends from Joseph Smith's Mormonism. The PWCG believes that Joseph Smith's "Word of Wisdom" (D&C 89) provides for their peyote sacrament (Murphy, 1994a, 1994b). Furthermore, the bylaws of the PWCG published in 1981 permit it to: "*To grow, obtain, steward, protect and defend the Holy Psychedelic Sacrament of Peyote and its religious use; and to regulate the distribution of this Holy Psychedelic Sacrament to other members of this and other churches that use a psychedelic as their Holy Sacrament.*"

In its mission to offer peyote sacraments to non-Native Americans, the PWCG ran into legal difficulties. In 1991, one leader, Brother Bill Stites, was arrested by federal officers for felony possession of peyote found in his car (Rigal-Cellard, 2004). The legal challenges to the NAC offering peyote sacraments to non-Native Americans faced by the PWCG would bleed into the legal woes of the next Mormon-Native American-peyote syncretism, the Oklevueha NAC (ONAC).

James Warren "Flaming Eagle" Mooney

James Warren Mooney, a former Mormon, is the founder of the controversial ONAC that openly provides peyote ceremonies for people without Native American descent. Mooney reports being told in 1988 by Oklevueha Chief and Medicine Woman Little Dove he was a descendant of both Osceola, the Seminole Indian chief, and the famed ethnologist James Mooney (1861-1921); these genealogical attributions would become a center of controversy.

James Warren Mooney, then a Mormon and successful businessman, was given to understand that he was called to carry Native American plant medicine to non-Indians, the particulars of which he was instructed to decide for himself (L. B. Buford, personal communication, May 6, 2019). In 1994, after a lengthy period of training with various Native American medicine people including Guadalupe Rio de la Cruz, a Huichol Medicine woman, Mooney, conducted NAC peyote sacrament ceremonies without regard to race. In 1997, Mooney founded the ONAC and in 2000 was excommunicated from the Church of Jesus Christ of Latterday Saints.

In 2001, Mooney's home and new Church was raided by local law enforcement officials. In these places of worship, according to Mooney, they seized peyote amounting to over thirty pounds, representing about 10,000 dried peyote buttons. Mooney and his wife, arraigned on charges of "*a dozen counts of drug trafficking and one count of racketeering,*" faced life in prison (Gehrke, 2001). The State of Utah contended that Mooney was not covered by the Federal Religious Peyote Exemption (21 C.F.R. § 1307.3) because he was not of Native American descent, nor a member of a federally recognized tribe. The trial resulted in James' and his wife Linda's conviction on multiple felony counts related to what was alleged to be a criminal enterprise based on distributing peyote within the context of their religious services. In 2003, the Mooney's appealed the trial court's decision to the Utah Supreme Court who: "*Reverse[d] the trial court's decision … the federal regulation does not restrict the exemption to members of federally recognized tribes. We therefore rule that the exemption is available to all members of the Native American Church*" (State of Utah, 2004).

Following this decision, the Utah District Attorney attempted to convince the federal government to prosecute James and Linda on similar charges related to peyote sacrament. The question in the government's case against James Mooney was his claimed Native American descent. Unexpectedly, government-certified genetic testing revealed Mooney's ethnicity: 58% European, 35% Native American, and 9% Sub-Saharan African. (Certificate of Ancestry, 2005). After 6 months of investigation by United States Federal Attorneys and Federal Investigators, the case against James Mooney resolved when the Mooneys entered into a plea agreement. In conversation with one of the authors, Mooney believes that ONAC worldwide membership top well over 10,000.

Conclusions

In this paper, we have reviewed the historical and psychopharmacological data that Joseph Smith employed entheogens in religious ordinances, facilitating many early Mormon visions and ecstasies. Gaining proficiency over time, Smith dealt with troublesome entheogen-related symptomology and "difficult trips" by encoding them, along with entheogenic visions and ecstasies, in his published teachings and revelations. The reproduction of biblical prophetic and apostolic experience and the antidepressant effects of entheogens in early Mormonism contributes to an understanding of Joseph Smith's charisma and the spectacular rise of his Church - it continues to do so if only in story. If organized religion is to relevant in our post-modern, Internet-informed, and ecopsychologically sensitive world, it must come to grips with what cognitive and neuroscience have to say about religious experience as natural phenomena and entheogens as near-universal facilitators of that experience.

Acknowledgements: The authors would like to thank Cindy Winkelman for her work in completing and formatting references, and Michael Winkelman for his tireless assistance and mentoring. They would also like to thank historian Don Bradley who provided extensive research on Joseph Smith's first vision, possible origins of the peyote stone, activities as an herbalist, and entheogenic Freemasonry; and his son Don Bradley Jr. who offered insight into Joseph Smith Sr.'s possible identification of entheogens with the Bible's "forbidden fruit" and "tree of life." They would also like to acknowledge the vast amount of historical data covering the Joseph Smith period that has been published as electronic transcriptions and photocopies of original documents by the Church of Jesus Christ of Latter-day Saints and the historical documents published by the Community of Christ. To their credit, these two Churches have placed on the Internet, both appealing and troublesome aspects of their foundation, making the combined collection an invaluable resource to researchers in religious studies. Collectively, these publications are well situated to provide valuable insights into religions with visionary and ecstatic origins, and whose historical data is relatively sparse.

Conflict of interest: The authors have no conflicting interest in writing and publishing this paper.

References

1. Adams, V. M. (2013). Joseph Smith's boyhood surgery: Mercy during a "desperate siege." *The Ensign of the Church of Jesus Christ of Latter-Day Saints*, 43(6), 66-69. Retrieved from https://www.churchofjesuschrist.org/study/ensign/2013/06/joseph-smithsboyhood-surgery-mercy-during-a-desperate-siege?lang=eng
2. Agrippa, H. C. (1801). *The magus, or celestial intelligencer; being a complete system of occult philosophy, in three books*. London, UK: Lackington, Allen, and Co.
3. Albanese, C. L. (2005). Nature religion in the United States. In B. Taylor (Ed.), *Encyclopedia of religion and nature* (Vol. 2, pp. 1175-1185). London, UK: Continuum.
4. Alizadeh, A., Moshiri, M., Alizadeh, J., & Balali-Mood, M. (2014). Black henbane and its toxicity: A descriptive review. *Avicenna Journal of Phytomedicine*, 4(5), 297-311. doi:10.22038/ajp.2014.3187
5. Allegro, J. M. (1970). *The sacred mushroom and the cross: A study of the nature and origins of Christianity within the fertility cults of the ancient Near East*. New York, NY: Doubleday & Co.
6. Allen, J. W., Gartz, J., Molter, D., & Sihanonth, P. (2009). *Psilocybe ovoideocystidiata*: A new bluing species (*Agricales*) from Ohio, Pennsylvania and West Virginia. *Ethnomycological Journals: Sacred Mushrooms Studies*, 12, 75-86. Retrieved from https://www.researchgate.net/publication/235436020_The_Occurrence_ Cultivation_and_Chemistry_of_*Psilocybe*_ovoideocystidiata_a_ new_Bluing_Species_*Agaricales*_from_Ohio_Pennsylvania_and_West_VirginiaByAllen_John_W_Gartz_Jochen_Molter_Dan_ and_Prakitsin_Sih
7. Alrashedy, N. A., & Molina, J. (2016). The ethnobotany of psychoactive plant use: A phylogenetic perspective. *PeerJ*, 4, e2546. doi:10.7717/peerj.2546
8. Anderson, D. S. (2018). *Salt Lake School of the prophets*, 1867-1883. Salt Lake City, UT: Signature Books.

9. Anderson, K. R. (1996). *Joseph Smith's Kirtland: Eyewitness accounts*. Salt Lake City, UT: Deseret Book Company.
10. Anderson, K. R. (2012). *The Savior in Kirtland: Personal accounts of divine manifestations*. Salt Lake City, UT: Deseret Book.
11. Anderson, L. F. (Ed.). (2001). *Lucy's book: A critical edition of Lucy Mack Smith's family memoir*. Salt Lake City, UT: Signature Books.
12. Anon. (1811). Communications *relative to the Datura Stramonium, or Thorn-Apple as a cure or relief of asthma* (p. 86). London, UK: Richard Phillips.
13. Anon. (1929, July 26). Doctor of olden days used herb remedies. *Geneva Daily Times*, New York, p. 6. Retrieved from http://www. fullerconsideration.com/images/Geneva_NY_Daily-Luman.png
14. Appanoose-Biography. (n.d.). *Joseph Smith papers*. Retrieved from https://www.josephsmithpapers.org/person/appanoose?highlight=Appanoose
15. Ashe, T. (1808). *Travels in America performed in 1806*. London, UK: William Sawyer & Co.
16. Ashurst-McGee, M. R. (2000). *A pathway to prophethood: Joseph Smith Junior as rodsman, village seer, and Judeo-Christian prophet* (MA thesis). Utah State University, Logan, UT. Retrieved from https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=7976&context=etd
17. Bailey, R. T. (1952). *Emma Hale: Wife of the Prophet Joseph Smith* (MS thesis). Brigham Young University, Provo, UT. Retrieved from https://scholarsarchive.byu.edu/cgi/viewcontent. cgi?article=5493&context=etd
18. Banks, C. S. (1945). The Mormon Migration into Texas. *The Southwestern Historical Quarterly*, 49(2), 233-244. Retrieved from https://www.jstor.org/stable/30237238
19. Barrett, F. (1801). *The magus, or celestial intelligencer: Being a complete system of occult philosophy*. London, UK: Lackington, Allen, & Co. Retrieved from https://archive.org/details/b22006795/page/n16
20. Barsuglia, J., Davis, A. K., Palmer, R., Lancelotta, R., Windham-Herman, A. M., Peterson, K., & Griffiths, R. R. (2018). Intensity of mystical experiences occasioned by 5-MeO-DMT and comparison with a prior Psilocybin study. *Frontiers in Psychology*, 9(2459), 1-6. doi:10.3389/fpsyg.2018.02459
21. Bassett, B. (2016). Newton County: Another time, another place. *The Newcomer*, 22(1), 9-15. Retrieved from http://ingenweb.org/innewton/newcomer/Winter%202016%20digital.pdf
22. Bauer, F. (1838). On ergot of rye. *Transactions of the Linnean Society of London*, 8, 475-482. doi:10.1111/j.1095-8339.1838.tb00195.x
23. Baugh, A. (2000). *A call to arms: The 1838 Mormon defense of Northern Missouri, dissertations in Latter-day Saint history*. Provo, UT: Joseph Fielding Smith Institute for Latter-day Saint History and BYU Studies
24. Benich, J. J., & Carek, J. (2011). Evaluation of the patient with chronic cough. *American Family Physician*, 84(8), 887-892. Retrieved from aafp.org/afp/2011/1015/p887.html
25. Bennett, C. (2018). Liber 420: *Cannabis, magickal herbs and the occult*. Walterville, OR: Trine Day.
26. Berlant, S. R. (2005). The entheomycological origin of Egyptian crowns and the esoteric underpinnings of Egyptian religion. *Journal of Ethnopharmacology*, 102(2), 275-288. doi:10.1016/j.jep.2005.07.028
27. Bernard, D. (1829). *Light on Masonry: A collection of all the most important documents on the subject of speculative Free Masonry*. Utica, NY: William Williams. Retrieved from http://hdl.handle.net/2027/hvd.32044024149429
28. Beug, M. W., Shaw, M., & Cochran, K. W. (2006). Thirty-plus years of mushroom poisoning: Summary of the approximately 2,000 reports in the NAMA case registry. *McIlvainea*, 16(2), 47-68. Retrieved from https://namyco.org/docs/Poisonings30year.pdf
29. Bidamon (Smith), E. (1867). *Emma Smith Bidamon letter to Joseph Smith III*. Community of Christ Archives.
30. Bigelow, J. (1817). *American medical botany of the native medicinal plants of the United States. U.S. Commission of fish and fisheries* (Vol. 1). Boston, MA: Cummings and Hilliard.
31. Bitton, D. (1969). Mormons in Texas: The Ill-Fated Lyman Wight Colony. 1844-1858. *Arizona and the West*, 11(1), 5-26. Retrieved from https://www.jstor.org/stable/40167489
32. Bloom, H. (2007). Perspectivism and Joseph Smith. *Sunstone Magazine*, 145, 18-19. Retrieved from https://www.sunstonemagazine.com/pdf/145-18-19.pdf
33. Blythe, C. J. (2014). "Would to God, brethren, I could tell you who I am!": Nineteenth-Century Mormonisms and the Apotheosis of Joseph Smith. *Nova Religio: The Journal of Alternative and Emergent Religions*, 18(2), 5-27. doi:10.1525/nr.2014.18.2.5
34. Bradley, D. (2010). *Acquiring an all-Seeing eye: Joseph Smith's first vision as seer initiation and ritual apotheosis*. Unpublished Manuscript copy in possession of author RB.
35. Bradley, D. (2019, August, 7). Joseph *Smith's First Vision as Endowment and Epitome of the Gospel of Jesus Christ*. Paper presented at Fair Conference Proceedings, Salt Lake City, UT.
36. Bradshaw, J. M. (2015). Freemasonry and the origins of modern temple ordinances. *Interpreter: A Journal of Mormon Scripture*, 15, 159-237. Retrieved from https://journal.interpreterfoundation. org/freemasonry-and-the-origins-of-modern-temple-ordinances/
37. Breslaw, E. G. (1996). *Tituba: Reluctant witch of Salem, devilish Indians and Puritan fantasies*. New York, NY: New York University Press.
38. Brooke, J. L. (1996). *The refiner's fire: The making of Mormon cosmology*, 1644-1844. Cambridge, UK: Cambridge University Press.
39. Brown, J. B., & Brown, J. M. (2016). *The psychedelic gospels: The secret history of hallucinogens in Christianity*. Rochester, VT: Park Street Press.
40. Bruhn, J. G., De Smet, A., El-Seedi, H. R., & Beck, O. (2002). Mescaline use for 5700 years. *The Lancet*, 359(9320), 1866. doi:10.1016/S0140-6736(02)08701-9
41. Bryson, D. (1996). *Comprehensive review in toxicology for emergency clinicians*. Washington, DC: Taylor & Francis.
42. Buerger, D. J. (2001). The development of the Mormon temple endowment ceremony. *Dialogue: A Journal of Mormon Thought*, 34(1-2), 75-122. Retrieved from https://www. dialoguejournal.com/wp-content/uploads/sbi/articles/Dialogue_ V34N0102_87.pdf
43. Bunker, G. L., & Bitton, D. (1975). Mesmerism and Mormonism. *Brigham Young University Studies*, 15(2), 146-170. Retrieved from https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article= 1677&context=byusq

44. Burkhart, K. K. (2004). The anticholinergic patient. In R. C. Dart (Ed.), *Medical toxicology* (3rd ed., pp. 51-54). Philadelphia, PA: Lippincott.
45. Bushman, R. L. (2005). *Joseph Smith: Rough stone rolling*. New York, NY: Alfred A. Knopf.
46. Bushman, R. W. (2006). *The first vision as out-of-body experience and what that means about the first vision* (rev.). Washington, DC: Sunstone Symposium.
47. Busia, K., & Heckels, F. (2006). Jimsonweed: History, perceptions, traditional uses, and potential therapeutic benefits of the genus *Datura. HerbalGram the Quarterly Journal of the American Botanical Council*, 69, 40-50. Retrieved from http://cms.herbalgram.org/herbalgram/issue69/article2930.html?ts=156548 788&signature=88ddb192b08c91fb3e874470ed6340be
48. Byron, R. M. (1993). Joseph Smith and the Lamanites. In S. E. Black & C. D. Tate, Jr. (Eds.), *Joseph Smith: The prophet, the man* (pp. 187-202). Provo, UT: Religious Studies Center, Brigham Young University.
49. Cahill, J. (2003). *Updates in emergency medicine*. New York, NY: Springer.
50. Caporael, L. R. (1976). Ergotism: The Satan loosed in Salem? *Science*, 192(4234), 21-26. doi:10.1126/science.769159
51. Carney, S. A. (n.d.). *Guns along the Rio Grande: Palo Alto and Resaca de la Palma: In the U. S. Army Campaigns of the Mexican War*. Retrieved from https://history.army.mil/brochures/Resaca de la Palma/Palo Alto.htm
52. Carter, A. J. (1996). Narcosis and nightshade. British Medical Journal, 313(7072), 1630-1632. doi:10.1136/bmj.313.7072.1630
53. Casey, E., & Gutierrez, C. (2005). From Eleusis to America: Masonry and the modern mysteries. In C. Gutierrez (Ed.), *The "occult" in nineteenth-century America* (pp. 215-244). Aurora, CO: The Davies Group.
54. Caswell, H. (1843). *The prophet of the nineteenth century*. London, UK: J.G.F. & J. Rivington.
55. Certificate of Ancestry. (2005). *Test sample no*. S070309. Salt Lake City, UT: DNA Print Genomics. Blood drawn under the supervision of federal law enforcement. Copy in possession of the author signed by James Sorenson, Laboratory Supervisor.
56. Clark, D. L. (1997-1998). The Mormons of the Wisconsin Territory: 1835-1848. *Brigham Young University Studies Quarterly*, 37(2), 57-85. Retrieved from https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=3213&context;=byusq
57. Cole, A. (1831, February 28). *Gold Bible*, No. 5. Palmyra, NY: The Reflector. Retrieved from http://www.sidneyrigdon.com/dbroadhu/NY/wayn1830.htm
58. Collier, F. C. (1977). The *Church of the firstborn and the holy order of God*. Doctrine of the Priesthood (Vol. 1, p. 4). Salt Lake City, UT: Collier's Publishing Co.
59. Communications. (1811). Communications *relative to the Datura Stramonium, or Thorn-Apple as a cure or relief of asthma*. London, UK: Richard Phillips.
60. Community of Christ. (2007) *Book of doctrine and covenants. Community of Christ*. Independence, MO: Herald Publishing House.
61. Compton, T. (1997). *In sacred loneliness: The plural wives of Joseph Smith*. Salt Lake City, UT: Signature Books.
62. Converse, R. N. (1996). The Tremper Mound Pipes. *Ohio rchaeologist*, 46(1), 27-28. Retrieved from https://kb.osu.edu/bitstream/handle/1811/55920/OHIO_ARCHAEOLOGIST_46_1_WINTER_1996.pdf?sequence=1&isAllowed;=y
63. Copland, J., Darwall, J., & Conolly, J. (1826). *The London medical repository and review* (Vol. 3). London, UK: Thomas and George Underwood.
64. Council of Fifty. (1844-1846). *Record of the council of fifty or Kingdom of God, minutes and other records, 3 vols.; handwriting of William Clayton. Church History Library: Church of Jesus Christ of Latter-day Saints*. Retrieved from https://www.josephsmithpapers.org/paper-summary/council-of-fifty-minutes-march-1844-january-1846-volume-1-10-march-1844-1-march-1845/9#source-note
65. Coxe, J. R. (1827). *The American dispensatory* (7th ed.). Philadelphia, PA: H. C. Carey & I. Lea.
66. Crop Production Magazine. (2018, June). *Ergot alkaloids under the spotlight*. Retrieved from http://www.cpm-magazine.co.uk/wp-content/uploads/2018/06/ErgotJun18.pdf
67. Curtis, L. (1892). Recollections of the prophet Joseph Smith. *Juvenile Instructor*, 27(12), 385-386. Retrieved from https://scottwoodward.org/josephsmith_miracles_raisingwilliam huntingtonfromdead.html
68. Dahl, L. E., & Cannon, D. Q. (Eds.). (1997). *Encyclopedia of Joseph Smith's teachings*. Salt Lake City, UT: Bookcraft.
69. Damon, S. F. (1922). Symbols of alchemy. *Occult Review*, 36(2), 77-85. Retrieved from http://www.iapsop.com/archive/materials/occult_review/occult_review_v36_n2_aug_1922.pdf
70. Dannaway, F. R., Piper, A., & Webster, P. (2006). Bread of heaven or wines of light: Entheogenic legacies and esoteric cosmologies. *Journal of Psychoactive Drugs*, 38(4), 493-503. doi:10.1080/02791072.2006.10400588
71. Davis, A. K., So, S., Lancelotta, R., Barsuglia, J., & Griffiths, R. R. (2018). The epidemiology of 5-methoxy-N, N-dimethyltryptamine (5-MeO-DMT) use: Benefits, consequences, patterns of use, subjective effects, and reasons for consumption. *Journal of Psychopharmacology*, 32(7), 779-792. doi:10.1177/0269881 118769063
72. deCypher. (2008, November 15). *Re: Datura Stramonium and Cannabis Indica ... An unholy matrimony of blood, fire, and death*. Retrieved from https://www.shroomery.org/forums/showflat.php/Number/9482564
73. Dibble. (1892). Recollections of the prophet Joseph Smith. *The Juvenile Instructor*, 27(10), 303-304. Retrieved from https://ia800503.us.archive.org/25/items/juvenileinstruct2710geor/juvenileinstruct2710geor.pdf
74. DiezyMedia. (2007). Huichol, the Mystical Journey: An animation of a painting by Mariano Valadez Navarro. Found in Lozoya, X. (2003). The plants of the soul: Pre-hispanic hallucinogens. *Mexican Archeology*, 10(59), 58-63. Images from animation. Retrieved from https://www.youtube.com/watch? v=Tf4H8sS6F9c
75. Dinger, S. C. (2016). The doctors in this region don't know much: Medicine and obstetrics in Mormon Nauvoo. *Journal of Mormon History*, 42(4), 51-68. doi:10.5406/jmormhist.42.4.0051
76. Doblin, R. (1991). Pahnke's "Good Friday experiment": A long-term follow-up and methodological critique. *The Journal of Transpersonal Psychology*, 23(1), 1-28. Retrieved from http://www.atpweb.org/jtparchive/trps-23-91-01-001.pdf
77. Drevets, W. C., Zarate, C. A., & Furey, M. L. (2013). Antidepressant effects of the muscarinic cholinergic receptor antagonist scopolamine: A review. *Biological Psychiatry*, 73(12), 1156-1163. doi:10.1016/j.biopsych.2012.09.031
78. Drug Enforcement Administration. (2013). *Jimson weed (Datura stramonium)*. Retrieved from https://www.deadiversion.usdoj.gov/drug_chem_info/jimson_w.pdf

79. Drummond, J. G. (2013). *Mystery cults in Roman Britain* (MA thesis). Southampton, UK: University of Southampton.
80. Dunn, S. C. (2002). Automaticity and the dictation of The Book of Mormon. In D. Vogel & B. Metcalf (Eds.), *American apocrypha: Essays on The Book of Mormon* (pp. 17-46). Salt Lake City, UT: Signature Books.
81. Durham, R. C. (1974). *Is there no help for the widow's son?* Presented as the presidential address of the Mormon history association, Nauvoo, IL. Retrieved from https://archive.org/stream/IsThereNoHelpForTheWidow/Is+There+No+Help+For+The+Widow_djvu.txt
82. Ehat, A. F. (1994). 'Who shall ascend into the hill of the Lord?' Sesquicentennial reflections of a sacred day: 4 May 1842. In D. W. Parry (Ed.), *Temples of the ancient world* (Chapter 3). Salt Lake City, UT: Deseret.
83. Eliade, M. (1964). *Shamanism: Archaic techniques of ecstasy*. London, UK: Routledge & Kegan Paul.
84. Ermacora, D. (2017). The comparative milk-suckling reptile. *Anthropozoologica*, 52(1), 59-81. doi:10.5252/az2017n1a6
85. Erying, H. (1989). The faith of a scientist. Salt Lake City, UT: Deseret Book.
86. Escohotado, A. (2012). *The general history of drugs* (p. 73). Valparaiso, Chile: Graffiti Militante Press.
87. Essential. (n.d.). *The essential guide to Datura: (Jimsonweed, Devil's weed, Devil's trumpet, Moonflower, Toloache*. Retrieved from https://thethirdwave.co/psychedelics/datura
88. Evens, Z. N., & Stellpflug, S. J. (2012). Holiday plants with toxic misconceptions. *Western Journal of Emergency Medicine*, 13(6), 538-542. doi:10.5811/westjem.2012.8.12572
89. Ezdejini, A. (2016). Controversial A Vestan compounds relating to the fire cult. *Theory and Practice in Language Studies*, 6(10), 1996-2001. doi:10.17507/tpls.0610.15
90. Fillerup, R. (1996). *Early Mormon vision & near-death experiences* (Revised from August 22, 1990 presentation). Salt Lake City, UT: Sunstone Symposium.
91. Folkard, R. (1884). *Plant lore, legends, and lyrics: Embracing the myths, traditions, superstitions, and folk-lore of the plant kingdom* (p. 566). London, UK: S. Low, Marston, Searle, and Rivington.
92. Foster, L. (2005). The psychology of prophetic charisma: New approaches to understanding Joseph Smith and the development of charismatic leadership. *Dialogue: A Journal of Mormon Thought*, 36(4), 1-14. Retrieved from https://www.dialoguejournal.com/wp-content/uploads/sbi/articles/Dialogue_ V36N04_21.pdf
93. Fuller, R. C. (2008). *Spirituality in the flesh: Bodily sources of religious experience*. Oxford, UK: Oxford University Press.
94. Gee, J. (2007). New light on the Joseph Smith papyri. *FARMS Review*, 19(2), 245-259. Retrieved from https://scholarsarchive.byu.edu/msr/vol19/iss2/20
95. Gehrke, R. (2001, January 9). Peyote pariah' faces legal, religion woes. *Deseret News*. Retrieved from https://www.deseretnews. com/article/818235/Peyote-pariah-faces-legal-religion-woes.html
96. Geraty, L. F. L. (2015). *Berserk for Berserkir: Introducing combat trauma to the compendium of theories on the Norse Berserker*. Reykjavík, Iceland: University of Iceland.
97. Goodman, J. (1993). *Tobacco in history: The cultures of dependence*. New York, NY: Routledge.
98. Griffiths, R. R. (2018). Intensity of mystical experiences occasioned by 5-MeO-DMT and comparison with a prior psilocybin study. *Frontiers in Psychology*, 9(2459), 1-6. doi:10.3389/fpsyg.2018.02459
99. Griffiths, R. R., Hurwitz, E. S., Davis, A. K., Johnson, M. S., & Jesse, R. (2019). Survey of subjective "God encounter experiences": Comparisons among naturally occurring and those occasioned by the classic psychedelics psilocybin, LSD, ayahuasca, or DMT. *PLoS One*, 23(4), e0214377. doi:10.1371/journal.pone.0214377
100. Griffiths, R. R., Richards, W. A., McCann, U., & Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial, sustained personal meaning and spiritual significance. *Psychopharmacology*, 187(3), 268-283. doi:10.1007/s00213-006-0457-5
101. Groesbeck, C. J. (1975). The archetypal image of the wounded healer. *Journal of Analytical Psychology*, 20(2), 122-145. doi:10.1111/j.1465-5922.1975.00122.x
102. Groesbeck, C. J. (1988). The Smiths and their dreams and visions: A psycho-historical study of the first Mormon family. *Sunstone Magazine*, 3, 22-29. Retrieved from https://www.sunstonemagazine.com/wp-content/uploads/sbi/articles/064-21-29.pdf
103. Groesbeck, C. J. (1989). C. G. Jung and the shaman's vision. *Journal of Analytical Psychology*, 34(3), 255-275. doi:10.1111/j.1465-5922.1989.00255.x
104. Groesbeck, C. J. (1990). Audio recording retrieved from https://www.sunstonemagazine.com/joseph-smith-and-the-translation-of-the-book-of-mormon-a-huchol-indian-parallel/
105. Groesbeck, C. J. (2004). The Book of Mormon as symbolic history: A new perspective on its place in history and religion. *Sunstone Magazine*, 3, 35-45. Retrieved from https://www.sunstonemagazine.com/wp-content/uploads/sbi/articles/131%2035-45.pdf
106. Groesbeck, C. J. (2005). *Joseph Smith and the shaman's vision: A forgotten paradigm for the life of the Mormon prophet*. Salt Lake City, UT: Sunstone Symposium. Retrieved from https://www.sunstonemagazine.com/joseph-smith-the-shamans-vision-a-forgotten-paradigm-for-the-life-of-the-mormon-prophet/
107. Grow, M. J., Esplin, R. K., McGee, M. A., & Mahas, J. D. (Ed.) (2016). *Administrative records, Council of Fifty, Minutes, March 1844-January 1846, Matthew J. Grow edition*. Salt Lake City, UT: Church Historian's Press.
108. Gunnison, J. W. (1852). *The Mormons, or, Latter-Day Saints, in the Valley of The Great Salt Lake: A history of their rise and progress, peculiar doctrines, present conditions, and prospects*. Philadelphia, PA: Lippincott, Grambo & Co.
109. Guzmán, G. (2009). The hallucinogenic mushrooms: diversity, traditions, use and abuse with special reference to the genus *Psilocybe*. In J. K. Misra & S. K. Deshmukh (Eds.), *Fungi from different environments* (pp. 256-277). Enfield, NH: Science Publishers.
110. Guzmán, G., Gaines, R. V., & Ramírez-Guillén, F. (2007). New species of hallucinogenic psilocybin in eastern U.S.A. *International Journal of Medicinal Mushrooms*, 9, 75-77. doi:10.1615/IntJMedMushr.v9.i1.90
111. Hagan, W. (1995). *Quanah Parker, Comanche Chief*. Norman, OK: University of Oklahoma Press.
112. Hajicek-Dobberstein, S. (1995). Soma siddhas and alchemical enlightenment: Psychedelic mushrooms in Buddhist tradition. *Journal of Ethnopharmacology*, 48(2), 99-118. doi:10.1016/0378-8741(95)01292-L

113. Hales, B. C., & Hales, L. H. (2015). *Joseph Smith's Polygamy: Toward a better understanding*. Sandy, UT: Greg Kofford Books.
114. Haller, J. S., Jr. (2000). *The people's doctors: Samuel Thomson and the American botanical movement*, 1790-1860. Carbondale, IL: Southern Illinois University Press.
115. Hamby, E. B. (2004). *The roots of healing: Archaeological and historical investigations of African-American herbal medicine* (Unpublished doctoral dissertation). Tennessee Research and Creative Exchange, University of Tennessee, Knoxville, Tennessee. Retrieved from https://trace.tennessee.edu/utk_ graddiss/4543/
116. Hamel, B., & Chiltoskey, M. U. (1975). *Cherokee plants and their uses: A 400-year history*. Sylva, NC: Herald Publishing Co.
117. Hammerson, G., & Santos-Barrera, G. (2004). *Incilius alvarius. The IUCN red list of threatened species*. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T54567A111 52901.en
118. Hancock, L. (1858). *Autobiography (1803-1836) copied from his own journal by Clara E. H. Lloyd, great-grand daughter*. Retrieved from http://www.ourlittlecircle.com/journals/lhancock.pdf
119. Hansen, K. (1960). The political kingdom of God as a cause for Mormon-Gentile conflict. *Brigham Young University Studies*, 2, 241-260. Retrieved from https://www.jstor.org/stable/43044910
120. Hansen, K. (1967). *Quest for empire: The political kingdom of god and the council of fifty in Mormon history*. East Lansing, MI: Michigan State University Press.
121. Harper, S. C. (2012). *Joseph Smith's first vision: A guide to the historical accounts*. Salt Lake City, UT: Deseret Book. Retrieved from https://history.churchofjesuschrist.org/article/first-vision-accounts-synthesis?lang=eng
122. Harper, S. C. (2016). *The first vision, a narrative from Joseph Smith's own accounts*. Retrieved from https://history.churchofjesuschrist.org/article/first-vision-accounts-synthesis? lang=eng.
123. Harris, W. (1841). *Mormonism portrayed*. Warsaw, Poland: Sharp & Gamble.
124. Hartshorne, H. (1855). On the nature and treatment of cholera. In G. A. Wilson & R. A. Lewis (Eds.), *The stethoscope: Monthly journal of medicine and the collateral sciences* (Vol. 5, pp. 438-440). Richmond, VA: Ritchie and Dunnavant.
125. Hedges, A. H., & Smith, A. D. (2010). Joseph Smith, John C. Bennett, and the extradition attempt. In R. N. Holzapfel & K. Jackson (Eds.), *Joseph Smith, the Prophet and Seer* (pp. 437-466). Provo, UT: Religious Studies Center, Brigham Young University.
126. Heinerman, J. (1975). *Joseph Smith and herbal medicine: A brief study of the botanical arts in Mormonism*. Manti, UT: Mountain Valley Publishers.
127. Heinrich, C. (2002). *Magic mushrooms in religion and alchemy*. Rochester, VT: Park Street Press.
128. Holstege, P., & Borek, H. A. (2012). Toxidromes. *Critical Care Clinics, 28(4), 479-498. doi:10.1016/j.ccc.2012.07.008*
129. Howard, J. (1962). Potawatomi mescalism and its relationship to the diffusion of the peyote cult. *Plains Anthropologist*, 7(16), 125-135. doi:10.1080/2052546.1962.11908289
130. Howe, E. D. (1834). Mormonism *unvailed or, a faithful account of that singular imposition and delusion, the Golden Bible*. Painesville, NY: E. D. Howe.
131. Howlett, D. J. (2014). *Kirtland temple: The biography of a shared Mormon sacred space*. Urbana, IL: University of Illinois Press.
132. Hoyt, H. (1933). *One hundred years of land values in Chicago* (p. 50). Chicago, IL: University of Chicago Press.
133. Hultkrantz, Å. (1997). *The attraction of Peyote: An inquiry into the basic conditions for the diffusion of the Peyote religion in North America*. Stockholm, Sweden: Stockholm University Press.
134. Hyde, J. (1857). *Mormonism: Its leaders and designs* (2nd ed.). New York, NY: W. Petridge & Company.
135. Irvin, J. R. (2009). *The holy mushroom: Evidence of mushrooms in Judeo-Christianity*. Crestline, CA: Gnostic Media Research & Publishing.
136. Jacobs, D. (1996). The use of datura in rites of transition. In M. Winkelman & W. Andritzky (Eds.), *Sacred plants, consciousness and healing: A cross-cultural and interdisciplinary perspectives yearbook of cross-cultural medicine and psychotherapy* (pp. 341-351). Berlin, Germany: Verlag.
137. Jensen, M. K. (2012). Rest of the story: Latter-day Saint relations with Utah's Native Americans. *Mormon Historical Studies*, 12(2), 17-25. Retrieved from http://mormonhistoricsites.org/wp-content/uploads/2013/03/The-Rest-of-the-Story-Latter-day-Saint-Relations-with-Utah%E2%80%99s-Native-Americans.pdf
138. Johnson, M. C. (2006). *Polygamy on the Pedernales. Lyman Wight's Mormon Villages in Antebellum Texas, 1845 to 1858. Logan, UT: Utah State University Press.*
139. Jonasson, M., & Afshari, R. (2016). Chronicle of datura toxicity in 18th and 19th century. *Asia Pacific Journal of Medical Toxicology*, 5(4), 101-106. doi:10.22038/apjmt.2016.8134
140. Joseph Smith Papers. (1844-1845). *Lucy Mack Smith, History*, 1844-1845 (p. 10, bk. 3). Retrieved from https://www.josephsmithpapers.org/paper-summary/lucy-mack-smith-history-1844-1845/40
141. Kane, E. (1995). Artemisia Snow's account of Luman Walters. In E. W. Kane & N. R. Bowen (Eds.), *Gentile account of life in Utah's Dixie, 1872-73: Elizabeth Kane's St. George journal* (pp. 1-16). Salt Lake City, UT: Tanner Trust Fund, University of Utah Library.
142. Keller, M. H., & Kane, F. (1967). The use of hyoscyamine as a hallucinogen and intoxicant. American Journal of Psychiatry, 124(6), 852-854. doi:10.1176/ajp.124.6.852
143. Kirkham, F. W. (1959). *A new witness for Christ in America* (p. 401). Salt Lake City, UT: Utah Printing.
144. KnarkKorven. (2011, July 13). *Stromata germinating on a sclerotium of C. purpurea*. Retrieved from https://www.shroomery.org/forums/showflat.php/Number/-
145. Knight, C., & Lomas, R. (1996). The Hiram Key: Pharaohs, Freemasons *and the discovery of the secret scrolls*. United Kingdom: Century Books.
146. La Barre, W. (1947). Primitive psychotherapy in Native American cultures: Peyotism and confession. *The Journal of Abnormal and Social Psychology*, 42(3), 294-309. doi:10.1037/h0060765
147. La Barre, W. (1938). *They Peyote Cult*. New Haven, CT: Yale University Publications.
148. Langford, L. A., & Bandera, J. W. (2003). Lyman Wight and his colony: A brief history. *The Bandera County Historian*, 24(3).

Retrieved from https://www.banderacounty.org/historical/HistorianFall2003.pdf
149. Larsen, C. M. (1992). *By his own hand upon papyrus: A new look at the Joseph Smith papyri*. Grand Rapids, MI: Institute for Religious Research.
150. Lattin, D. (2011). *The Harvard Psychedelic Club: How Timothy Leary, Ram Dass, Huston Smith, and Andrew Weil killed the Fifties and ushered in a new age for America* (Repr. Ed.). San Francisco, CA: HarperOne.
151. Le Garff, E., Delannoy, Y., Mesli, V., Hédouin, V., & Tournel, G. (2016). Forensic features of a fatal datura poisoning case during a robbery. *Forensic Science International*, 261, e17-e21. doi:10.1016/j.forsciint.2016.02.028
152. Leary, T., Metzner, R., & Alpert, R. (1964). *The psychedelic experience: A manual based on the Tibetan Book of the Dead*. New York: University Books.
153. Lee, M. R., Dukan, L., & Milne, I. (2018*). Amanita muscaria* (fly agaric): From a shamanistic hallucinogen to the search for acetylcholine. *Journal of the Royal College of Physicians of Edinburgh*, 48(1), 85-91. doi:10.4997/JRCPE.2018.119
154. Lyttle, T., Goldstein, D., & Gartz, J. (1996). Bufo toads and bufotenine: Fact and fiction surrounding an alleged psychedelic. *Journal of Psychoactive Drugs*, 28(3), 267-290. doi:10.1080/02791072.1996.10472488
155. Mahas, J. D. (2017). American Indians and the Nauvoo-era Council of Fifty. In M. J. Grow & R. E. Smith (Eds.), *The Council of Fifty: What the records reveal about Mormon history* (p. 120). Provo, UT: Religious Studies Center, Brigham Young University.
156. Maji&cacute;, T., Schmidt, T. T., & Gallinat, J. (2015). Peak experiences and the afterglow phenomenon: When and how do therapeutic effects of hallucinogens depend on psychedelic experiences? *Journal of Psychopharmacology*, 29(3), 241-253. doi:10.1177/0269881114568040
157. Marquardt, H. M. (2002). Martin Harris: The Kirtland years, 1831-1870. *Dialogue: A Journal of Mormon Thought*, 35(3, Fall), 1-40. Retrieved from https://dialoguejournal. com/wp-content/uploads/sbi/articles/Dialogue_V35N03_9.pdf
158. Marshall, J. (1999). The elixir: An alchemical study of the ergot mushroom. *The Australian Journal of Anthropology*, 10(1), 118ff. Retrieved from https://link.gale.com/apps/doc/A55007541/ITOF?u=marriottlibrary&sid;=ITOF&xid;=d006da05
159. Martin, K. L. (2006). *Conjuring moments and other such hoodoo: African American women & spirit work* (Unpublished doctoral dissertation). Florida State University, Tallahassee, FL. Retrieved from https://fsu.digital.flvc.org/islandora/object/fsu:180961/datastream/PDF/view
160. Mason, P. Q. (2015). Mormonism. Oxford research encyclopedia of religion. Oxford, UK: Oxford University Press. Retrieved from https://oxfordre.com/religion/view/10.1093/acrefore/9780199340378.001.0001/acrefore-9780199340378-e-75
161. McWhitney, B. (1888). Brother McWhitney. [Interview by Arthur B. Deming of McWhitney's friend Stephen H. Hart: Naked truths about Mormonism, (April), 2-3]. In L. Petersen (Ed.), *Hearts made glad: The charges of intemperance against Joseph Smith the Mormon Prophet*. Salt Lake City, UT: LaMar Petersen.
162. Merkur, D. (2000). *The mystery of mana: The psychedelic sacrament of the Bible*. Rochester, VT: Park Street Press.
163. Merkur, D. (2014). The hidden manna: The psychedelic sacrament in medieval Roman Catholicism. In J. H. Ellens (Ed.), *Seeking the sacred with psychoactive substances: Chemical paths to spirituality and to God* (pp. 157-180). Santa Barbara, CA: Praeger.
164. Meyers, C. F. (2011). *The marketplace of Boston: Macrobotanical remains from Faneuil Hall* (MA thesis). University of Massachusetts, Boston, MA. Retrieved from https://www. sunstonemagazine.com/wp-content/uploads/sbi/articles/064-21-29.pdf
165. Mikaszewska-Sokolewicz, M. A., Pankowska, S., Janiak, M., Pruszczyk, P., £azowski, T., & Jankowski, K. (2016). Coma in the course of severe poisoning after consumption of red fly agaric (*Amanita muscaria*). *Acta Biochimica Polonica*, 63(1), 181-182. doi:10.18388/abp.2015_1170
166. Morain, W. D. (1998). *The sword of Laban: Joseph Smith, Jr. and the dissociated mind*. Washington, DC: American Psychiatric Press.
167. Morain, W. D. (2013). Joseph Smith - Fantasies and their origins. *The John Whitmer Historical Association Journal*, 33(1), 170-183. Retrieved from https://www.jstor.org/stable/43200319
168. Morgan, D. (2014). *Dale Morgan on the Mormons: Collected works, part 2*, 1949-1970. Norman, OK: University of Oklahoma Press.
169. Morgan, D. (n.d.). *The Independent Gazetteer (Taunton, Massachusetts) reported on 11 January 1833*. Retrieved from http://www.sidneyrigdon.com/dbroadhu/NE/miscne01.htm
170. Morgan, G. R., & Stewart, O. C. (1984). Peyote trade in South Texas. *The Southwestern Historical Quarterly*, 87(3), 269-296. Retrieved from https://www.jstor.org/stable/30239815
171. Mormons, the Mormon Bible. (1839). *Cleveland Harold & Gazette, Cleveland, Ohio*. Retrieved from http://www.sidneyrigdon.com/dbroadhu/oh/miscoh08.htm
172. Moss, J. J. (1878). *Letter J. J. Moss to James T. Cobb dated Dec. 17, 1878. Original in A. T. Schroeder Collection, Wisconsin State Historical Society*. Retrieved from http://www. solomonspalding.com/docs/Wil1878a.htm
173. Moss, J. J. (1913). Testimony of Moss, J. James in Open Court. In E. B. Bond, W. H. Kelley, & A. B. Deming (Eds.), *Public discussion of the issues between The Reorganized Church of Jesus Christ of Latter Day Saints and The Church of Christ [Disciples]* (pp. 383-387). Marrickville, NSW: Wentworth Press.
174. Muller, L. J. (1998). Love potions and the ointment of witches: Historical aspects of the nightshade alkaloids. *Clinical Toxicology*, 36, 617-627. doi:10.3109/15563659809028060
175. Murphy, T. (1994a). Word of wisdom and peyote: The diversity of interpretations, part one. *Sacred Record*, 15(1), 3-6. Retrieved from https://ssrn.com/abstract=2246451
176. Murphy, T. (1994b). Word of wisdom and peyote: The diversity of interpretations, part two. *Sacred Record*, 15(2), 4-6. Retrieved from https://ssrn.com/abstract=2246463
177. Murphy, T., & Baca, A. (2016). Rejecting racism in any form: Latter-day Saint rhetoric, religion, and repatriation. *Open Theology*, 2(1), 700-725. doi:10.1515/opth-2016-0054
178. Navet, E. (1988). The Ojibway and the fly *Amanita* (*Amanita muscaria*). For ethnomycology of North American Indians. *Journal of the Society of Americanists*, 74(1), 163-180. doi:10.3406/jsa.1988.1334
179. Neale, C., Camfield, D., Reay, J., Stough, C., & Scholey, A. (2013). Cognitive effects of two nutraceuticals ginseng and bacopa

benchmarked against modafinil: A review and comparison of effect sizes. *British Journal of Clinical Pharmacology*, 75(3), 728-737. doi:10.1111/bcp.12002

180. Nemu, D. (2019). Getting high with the host high: Entheogens in the Old Testament. *Journal of Psychedelic Studies*. Advance online publication. 1-16. doi:10.1556/2054.2019.004
181. Newell, L. K., & Avery, V. T. (1994). *Mormon enigma: Emma Hale Smith* (2nd ed.). Urbana, IL: University of Illinois Press.
182. Newman, D. (2017). *Alchemically stoned: The psychedelic secret of Freemasonry*. Oklahoma City: The Laudable Pursuit.
183. Olaiz, H. (2014). The Kirtland temple as a shared space: A conversation with David J. Howlett. *Dialogue: A Journal of Mormon Thought*, 47(1), 104-123. Retrieved from https://www.dialoguejournal.com/wp-content/uploads/sbi/articles/Dialogue_V47N01_310.pdf
184. Olmstead, J. W. (2000). From Pentecost to administration: A reappraisal of the history of the Hosanna Shout. *Mormon Historical Studies*, 2(2), 7-37. Retrieved from http://mormonhistoricsites.org/wp-content/uploads/2013/05/Mhs2.2OlmsteadFall2001.pdf
185. Omar, M. N. I. A., & Foxworth, J. (2014). Using toxidromes to assess poisoned patients. *Hospital Medicine Clinics*, 3(1), e128-e138. doi:10.1016/j.ehmc.2013.09.001
186. Ostry, M. E., Anderson, N. A., & O'Brien, J. G. (2010). *Field guide to common macrofungi in eastern forests and their ecosystem functions* (USDA Forest Service Northern Research Station General Technical Report, NRS-79). Delaware, OH: United States Forest Service. Retrieved from https://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs79.pdf
187. Owens, L. S. (1999). Joseph Smith: America's hermetic prophet. In B. Waterman (Ed.), The *prophet puzzle: Interpretive essays on Joseph Smith* (pp. 155-171). Salt Lake City, UT: Signature Book.
188. Pahnke, W. N. (1963). *Drugs and mysticism: An analysis of the relationship between psychedelic drugs and mystical consciousness* (PhD dissertation). Harvard University, Cambridge, MA.
189. Pahnke, W. N. (1966). Drugs and mysticism. *International Journal of Parapsychology*, 8, 295-313. Retrieved from https://pdfs.semanticscholar.org/5b11/fee8012402efb16d534d7ec45c0533 6902c0.pdf
190. Park, B. (2008). Rational supernaturalism: Early Mormonism and enlightened-romantic rhetoric. *Library Research Grants*, 25, 1-16. Retrieved from https://scholarsarchive.byu.edu/libraryrg_ studentpub/25
191. Pendell, D. (2005). *PharmakoGnosis*. San Francisco, CA: Mercury House.
192. Peschel, K. (1979). The legend of Miskwedo. *Journal of Psychedelic Drugs*, 11, 1-2. doi:10.1080/02791072.1979.10472089
193. Petersen, L. (1975). *Hearts made glad: The charges of intemperance against Joseph Smith the Mormon Prophet*. Salt Lake City, UT: LaMar Petersen.
194. Peyote Way Church of God. (n.d.). *Detailed chronology of events in the history of the Peyote way Church of God*. Retrieved from https://peyoteway.org/history/chronology.php
195. Pierson, T. (2011). *Image of Colorado River toad*. Retrieved from https://eol.org/media/8799933
196. Piper, A. (2016). A 1920's Harvard psychedelic circle with a Mormon connection; Peyote use amongst the Harvard aesthetics. In G. J. Llwydd (Ed.), *The invisible college magazine* [Electronic] (8th ed.). Amazon.com: CreateSpace Independent Publishing Platform. Retrieved from https://www. academia.edu/23387519/A_1920_s_Harvard_Psychedelic_Circle_with_a_Mormon_Connection_Peyote_Use_amongst_ the_Harvard_Aesthetes
197. Porta, J. B. (1558). *Natural magick*. London, uk: John Wright.
198. Porter, M. (1826). On the surgical pathology of the larynx and trachea. In J. Copland, J. Darwall, & J. Conolly (Eds.), *The London medical repository and review* (pp. 328-339). London, UK: Thomas and George Underwood.
199. Powell, E. A. (2017). *Reading the White Shaman Mural*. Archeology: A publication of the Archaeological Institute of America. Retrieved from https://www.archaeology.org/issues/274-1711/features/5996-reading-the-white-shaman-mural
200. Pratt, O. (1840). *A[n] Interesting Account of Several Remarkable Visions, 1840*. The Joseph Smith Papers. Retrieved from https://www.josephsmithpapers.org/paper-summary/appendix-orson-pratt-an-interesting-account-of-several-remarkable-visions-1840/7
201. Purple, W. D. (1877, May 3). Joseph Smith, The originator of Mormonism. Historical reminiscences of the town of Afton. *Chenango Union*, 30(33), 3. Retrieved from https://www. josephsmithpapers.org/paper-summary/appendix-reminiscence-of-william-d-purple-28-april-1877-people-v-js/1#full-transcript
202. Quinn, D. M. (1998). *Early Mormonism and the magic world view* (Revised and Enlarged). Salt Lake City, UT: Signature Books.
203. Remini, R. V. (2002). *Joseph Smith*. London, NY: Penguin Group.
204. Richards, W. (2016). *Sacred knowledge: Psychedelics and religious experience*. New York, NY: Columbia University Press.
205. Rigal-Cellard, B. (1995). The Peyote Way Church of God: Native Americans v. new religions v. the law. *European Review of Native American Studies*, 9(1), 35-43. Retrieved from http://classiques.uqac.ca/contemporains/rigal_cellard_bernadette/Peyote_way_church_of_god/Peyote_way_church.html
206. Rigal-Cellard, B. (2004). *An analysis of the Peyote Way Church of God in the legal field*. Paper presented at CESNUR 2004 Conference, Waco, Texas. Retrieved from http://classiques. uqac.ca/contemporains/rigal_cellard_bernadette/Peyote_way_church_of_god/Peyote_way_church.html
207. Roberts, B. H. (Ed.). (1902). *History of the Church* (Vol. 1, pp. 334-335). Salt Lake City, UT: Deseret News.
208. Roberts, B. H. (Ed.). (1908). *History of the Church* (Vol. 4, p. 580). Salt Lake City, UT: Deseret News.
209. Roberts, B. H. (Ed.). (1915). *History of the Church* (Vol. 6). Salt Lake City, UT: Deseret News.
210. Rolston-Cregler, L. (2017). Hallucinogenic mushroom toxicity. *Medscape*. Retrieved from https://emedicine.medscape.com/article/817848-treatment#d10
211. Rucker, J. J., Jelen, L. A., Flynn, S., Frowde, K. D., & Young, A. H., (2016). Psychedelics in the treatment of unipolar mood disorders: A systematic review. *Journal of Psychopharmacology*, 30(12), 1220-1229. doi:10.1177/02698811166 79368
212. Rudgley, R. (1993). *The alchemy of culture: Intoxicants in society*. London, UK: British Museum Press.
213. Ruiz, J. F., Piper, A., & Ruck, C. (2011). A prehistoric mural in Spain depicting neurotropic psilocybe mushrooms? *Economic Botany*, 65(2), 1-8. doi:10.1007/s12231-011-9152-5
214. Rush, J. A. (2011). *The mushroom in Christian art: The identity of Jesus in the development of Christianity* (p. 144). Berkeley,

CA: North Atlantic Books.
215. Safford, W. E. (1922). *Daturas of the Old World and New: An account of their narcotic properties and their use in oracular and initiatory ceremonies*. Smithsonian report for 1920, 2622: 537-567. Washington, DC: Government Printing Office.
216. Satora, L., Pach, D., Butryn, B., Hydzik, P., & Balicka-&Sacute;lusarczyk, B. (2005). Fly agaric (*Amanita muscaria*) poisoning, case report and review. Toxicon, 45(7), 941-943. doi:10.1016/j. toxicon.2005.01.005
217. Scarborough, J. (1971). Gnostîcism, drugs, and alchemy in Late Roman Egypt. *Pharmacy in History*, 13(4), 151-157. Retrieved from http://www.jstor.org/stable/41108719
218. Schaefer, S. B. (2015). *Amada's blessings from the peyote gardens of south Texas*. Albuquerque, NM: University of New Mexico Press.
219. Schiff, L. (2006). Ergot and its alkaloids. American Journal of Pharmaceutical Education, 70(5), 98. doi:10.5688/aj700598
220. Schultes, R. E. (1975). *Hallucinogenic plants*. New York, NY: Golden Press.
221. Shannon, B. (2008). Biblical entheogens: A speculative hypothesis. *Time and Mind: The Journal of Consciousness and Culture*, 1(1), 51-74. doi:10.2752/175169608783489116
222. Shelley, W. S. (1995). The *Elixir: An alchemical study of the ergot mushrooms*. Notre Dame, IN: Cross Cultural Pubs/Crossroads.
223. Shelley, W. S. (2017). S*cience, alchemy and the Great Plague of London*. New York, NY: Algora Publishing.
224. Shields, S. (1982). Divergent paths of the restoration: A history of the Latter Day Saint movement (3rd ed.). Salt Lake City, UT: Restoration Research.
225. Shipps, J. (1987). *Mormonism, the story of a new religious tradition*. Chicago, IL: University of Illinois Press.
226. Sigmond, D. (1849). Correspondence from Paris. *The Journal of Psychological Medicine and Mental Pathology*, 2, 342.
227. Slotkin, J. S. (1955). Peyotism, 1527-1891. *American Anthropologist*, 57(2), 202-230. doi:10.1525/aa.1955.57.2.02a00030
228. Smith, F. M. (1918). *The higher powers of man*. Lamoni, IA: The Herald Publishing House.
229. Smith, G. A. (1867). *Historical discourse* (Vol. 11, pp. 1-12). Journal of Discourses. Liverpool, UK: Brigham Young.
230. Smith, H. (2000). *Cleansing the doors of perception: The religious significance of entheogenic plans and chemicals* (p. 11). Boulder, CO: Sentient Publications.
231. Smith, H. (2001). Do drugs have religious import? A thirty-five year retrospect. In T. B. Roberts (Ed.), *Psychoactive sacramentals: Essays on entheogens and religion* (pp. 11-18). San Francisco, CA: Council on Spiritual Practices.
232. Smith, H. C., & Edwards, F. H. (Eds.). (1972). *History of the reorganized Church of Jesus Christ of Latter Day Saints* (Vol. 5, 646 n7). Independence, MO: Herald House.
233. Smith, J. (1830). *The Book of Mormon: An account written by the hand of Mormon, upon plates taken from the plates of Nephi*. Palmyra, Syria: E.B. Grandin.
234. Smith, J. (1832). *Joseph Smith history, circa summer 1832. The Joseph Smith papers*. Retrieved from https://www.josephsmithpapers.org/paper-summary/history-circa-summer-1832/2
235. Smith, J. (1833). *A Book of commandments for the government of the Church of Christ*. Independence, MO: W. W. Phelps & Co.
236. Smith, J. (1835). *The doctrine and covenants of the Church of the Latter Day Saints: Carefully selected from the revelations of God*. Kirtland, OH: F. G. Williams & Co.
237. Smith, J. (1838). *History, 1838-1856, volume A-1*. Retrieved from https://www.josephsmithpapers.org/paper-summary/history-1838-1856-volume-a-1-23-december-1805-30-august-1834
238. Smith, J. (1839). *Discourse, between circa 26 June and circa 2 July 1839, as Reported by Willard Richards*. Retrieved from https://www.josephsmithpapers.org/transcript/discourse-between-circa-26-june-and-circa-2-july-1839-as-reported-by-willard-richards?print=true#ft-source-note
239. Smith, J. (1839-1841). *History, circa June 1839-circa 1841* [Draft 2]. Retrieved from https://www.josephsmithpapers.org/paper-summary/history-circa-june-1839-circa-1841-draft-2
240. Smith, J. (1842). *Times and seasons, 1 April 1842* (p. 748). The Joseph Smith Papers. Retrieved from https://www.josephsmithpapers.org/paper-summary/times-and-seasons-1-april-1842/14
241. Smith, J. (1843). Revelation. *The Latter Day Saints' Morning and Evening Star*, 4(1), 116-118.
242. Smith, J. (1844). Conference minutes. In J. Taylor (Ed.), *Times and seasons, containing a compendium of intelligence pertaining to the upbuilding of the Kingdom of God* (Vol. 5, p. 615). Nauvoo, IL.
243. Smith, J. (1853). History of Joseph Smith. *The Latter-Day Saints' Millennial Star*, 15, 621.
244. Smith, J. (1977). *Teachings of the Prophet Joseph Smith (Originally published 1938)*, J. F. Smith (Ed.), Salt Lake City, UT: Deseret Book Company.
245. Smith, L. M. (1853). *Biographical sketches of Joseph Smith, the Prophet, and His progenitors for many generations*. Liverpool, UK: S. W. Richards.
246. Smith, R. A. (1961). The Comanche Bridge between Oklahoma and Mexico, 1843-1844. *Chronicles of Oklahoma*, 39, 54-69.
247. Smith, S. (1692). Deposition of Samuel Smith v. Mary Esty. *Essex County Court Archives, Salem-Witchcraft*, 1, 292. Retrieved from http://salem.lib.virginia.edu/n45.html#n45.20
248. Soni, P., Siddiqui, A., Dwivedi, J., & Soni, V. (2012). Pharmacological properties of *Datura stramonium* L. as a potential medicinal tree: An overview. *Asian Pacific Journal of Tropical Biomedicine*, 2(12), 1002-1008. doi:10.1016/S2221-1691(13)60014-3
249. Spence, L. (1920). *An encyclopedia of occultism* (p. 10). New York, NY: Dodd, Mead & Company.
250. Spencer, J. M. (2009). *The rise of Mormon cultural history and the changing status of the archive*. ProQuest Dissertations and Theses, 182. Retrieved from https://search.proquest.com/docview/305183687?accountid=11664
251. Stack, P. F. (2002). The Historic Nauvoo Temple. *The Salt Lake Tribune*, 4 May, C3. Retrieved from http://users.marshall.edu/~brown/nauvoo/SLT-05042002.html
252. Staker, M. L. (2009). Hearken, *O ye people: The historical setting for Joseph Smith's Ohio revelations*. Sandy, UT: Greg Kofford Books.
253. State of Utah. (2004, June 22). *State of Utah, Plaintiff and Appellee, v. James W. Mooney, aka James W.B.E. Mooney, Linda T.*

Mooney, and Oklevueha Earthwalks Native American Church of Utah, Inc. Defendants and Appellants, No. 20010787. Retrieved from https://law.justia.com/cases/utah/supreme-court/2004/mooney062204.html
254. Stewart, O. C. (1948). *Ute Peyotism: A study of a cultural complex*. Boulder, CO: University of Colorado Press.
255. Stewart, O. C. (1974). Origin of peyote religion in the United States. *Plains Anthropologist*, 19(65), 211-223. doi:10.1080/2052546.1974.11908677
256. Stewart, O. C. (1987). *Peyote religion: A history*. Norman, OK: University of Oklahoma Press.
257. Ström, Å. V. (1969). Red Indian Elements in Early Mormonism. *Temenos - Nordic Journal of Comparative Religion*, 5. Retrieved from https://journal.fi/temenos/article/view/6398
258. Sweta, V. R., & Lakshmi, T. (2015). Pharmacological profile of tropane alkaloids. *Journal of Chemical and Pharmaceutical Research*, 7(5), 117-119. Retrieved from http://www.jocpr.com/articles/pharmacological-profile-of-tropane-alkaloids.pdf
259. Tanner, H. H. (1996). Travel and transportation routes. In F. E. Hoxie (Ed.), *Encyclopedia of North American Indians* (pp. 640-643). Boston, MA: Houghton Mifflin. Retrieved from https://login.ezproxy.lib.utah.edu/login?url=https://search.credoreference.com/content/entry/hmenai/travel_and_ transportation_routes/0? institutionId=6487
260. Tanner, S. (n.d.). *Masonic symbols and the LDS temple*. Retrieved from http://www.utlm.org/onlineresources/masonicsymbolsandtheldstemple.htm
261. Tantaquidgeon, G. (1972). *Folk medicine of the Delaware and related Algonkian Indians, anthropological paper #3* (p. 3). Harrisburg, PA: Pennsylvania Historical Commission.
262. Taves, A. (1999). *Fits, trances, and visions: Experiencing religion and explaining experience from Wesley to James*. Princeton, NJ: Princeton University Press.
263. Taves, A. (2014). History and the claims of revelation: Joseph Smith and the materialization of the golden plates. *Numen, Special Issue: Methodological Debates in the Study of Religion*, 61(2-3), 182-207. doi:10.1163/15685276-12341315
264. Taylor, L. (2010). *Joseph Smith in Iroquois Country: The Handsome Lake Story*. *Juvenile Instructor* (Unpublished PhD dissertation). Retrieved from https://juvenileinstructor.org/joseph-smith-in-iroquois-country-the-handsome-lake-story/
265. Terry, M. (2017). *Lophophora williamsii* (amended version of 2013 assessment). *The IUCN Red List of Threatened Species*. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2017-3. RLTS.T151962A121515326.en
266. Terry, M., Steelman, K. L., Guilderson, T., Dering, P., & Rowe, M. W. (2006). Lower Pecos and Coahuila peyote: New radiocarbon dates. *Journal of Archaeological Science*, 33(7), 1017-1021. doi:10.1016/j.jas.2005.11.008
267. The Joseph Smith Papers. (1842-1844). *Journal, December 1842-June 1844; Book 1, 21 December 1842-10 March 1843* (p. 242). Retrieved from https://www.josephsmithpapers. org/paper-summary/journal-december-1842-june-1844-book-1-21-december-1842-10-march-1843/250-full-transcript
268. Thomson, A. T. (1832). *Elements of materia medica and therapeutics* (Vol. 1, p. 578). London, UK: Longman, Rees, Orme, Brown, Green, and Longman.
269. Thomson, S. (1841). *The Thomsonian Materia Medica, or Botanic Family Physician. Albany, NY: J. Munsell.*
270. Thornton, Dr. (1811). *Communications relative to the Datura Stramonium, or Thorn-Apple: As a cure or relief of asthma*. London: Richard Phillips.
271. Todd, J. M. (1968). New light on Joseph Smith's Egyptian papyri: Additional fragment disclosed. *The Improvement Era*, 71(2). Retrieved from https://ia800304.us.archive. org/3/items/improvementera7102unse/improvementera7102unse. pdf
272. Todd, J. M. (1969). *The Saga of the Book of Abraham* (pp. 278-281). Provo, UT: Deseret News Presses.
273. Tommasini, A. (1997). Virgil Thomson: Composer on the Isle. New York, NY: W. W. Norton & Company.
274. Tooker, E., & Sturtevant, W. C. (Eds.). (1979). *Native North American Spirituality of the Eastern Woodlands* (pp. 94-95). Mahwah, NJ: Paulist Press.
275. Troike, R. C. (1962). The origins of Plains Mescalism. *American Anthropologist, 64(5), 946-963.*
276. Underwood, L. G. (2006). Ordinary spiritual experience: Qualitative research, interpretive guidelines, and population distribution for the daily spiritual experience scale. *Archive for the Psychology of Religion*, 28(1), 181-218. doi:10.1163/008467206777832562
277. Underwood, L. G. (2011). Daily Spiritual Experience Scale. *Religions, 2(1), 29-50. doi:10.3390/rel2010029*
278. Van Dusen, I. M. (1847). *Positively true: A dialogue between Adam and Eve, the Lord and the Devil, called the endowment*. Albany, NY: C. Killmer.
279. Van Wagoner, R. S.. (1985). Mormon Polyandry in Nauvoo. *Dialogue: A Journal of Mormon Thought, 18, 67-83.*
280. Van Wagoner, R. S. (1989). *Mormon Polygamy: A history*. Salt Lake City, UT: Signature Books.
281. Vogel, D. (2003). *Early Mormon documents* (Vol. 5). Salt Lake City, UT: Signature Books.
282. Vogel, D. (2004). *Joseph Smith: The making of a prophet*. Salt Lake City, UT: Signature Books.
283. W. (1833). Cases of poisoning by *Datura stramonium*. *Boston Medical Surgery Journal*, 9(1), 10-13. doi:10.1056/NEJM183308140090104
284. Walker, R. W. (1993). Seeking the 'Remnant': Native Americans during the Joseph Smith Period. *Journal of Mormon History*, 19(1), 1-33. Retrieved from https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1020&context;=mormonhistory
285. Wasson, G. R., Ruck, C. A. P., & Hofmann, A. (2008). *The road to Eleusis: Unveiling the secret of the mysteries (1978 Anniversary edition). Berkeley, CA: North Atlantic Books.*
286. Wasson, R. G., Kramrish, S., Ott, J., & Ruck, C.A. (1986). *Persephone's quest: Entheogens and the origins of religion*. New Haven, CT: Yale University Press.
287. Waterman, B. (1999). The prophet puzzle: *Interpretive essays on Joseph Smith*. Salt Lake City, UT: Signature Books.
288. Watson, E. J. (1983). *Joseph Smith's first vision: A harmony*. Retrieved from http://www.eldenwatson.net/harmony.htm
289. Webster, N. (1828). *An American dictionary of the English language* (Vol. 2). New York, NY: S. Converse.
290. Webster, P., Perrine, D. M., & Ruck, C. A. (2000). Mixing the Kykeon. *Eleusis: Journal of Psychoactive Plants and Compounds*, 4, 55-86. Retrieved from https://www.researchgate. net/publication/317412224_Mixing_the_Kykeon
291. Welch, J. W., & Carlson, E. B. (Eds.). (2005). *Opening the heavens: Accounts of divine manifestations, 1820-1844*. Provo, UT: Brigham Young University Press.
292. Widtsoe, J. (1915). *A rational theology as taught by the Church of Jesus Christ of Latter-day Saints*. Salt Lake City, UT: General

Priesthood Committee.
293. Wiebe, T. H., Sigurdson, E. S., & Katz, L. Y. (2008). Angel's Trumpet (*Datura stramonium*) poisoning and delirium. *Paediatrics & Child Health*, 13(3), 193-196. doi:10.1093/pch/13.3.193
294. Williams, F. G. (1972). Frederick Granger Williams of the First Presidency of the Church. *Brigham Young University Studies*, 12(3), 243-261. Retrieved from https://byustudies.byu.edu/content/frederick-granger-williams-first-presidency-church
295. Williams, F. G. (2012). The medical practice of Dr. Frederick G. Williams. *BYU Studies Quarterly*, 51(1), 153-159. Retrieved from https://scholarsarchive.byu.edu/byusq/vol51/iss1/9
296. Winkelman, M. J. (2001). Psychointegrators: Multidisciplinary perspectives on the therapeutic effects of hallucinogens. *Complementary Health Practice Review*, 6(3), 219-237. doi:10.1177/153321010100600304
297. Winkelman, M. J. (2010). *Shamanism: A biopsychosocial paradigm of consciousness and healing*. Santa Barbara, CA: ABC-CLIO.
298. Winkelman, M. J. (2013). Shamanism and psychedelics: A biogenetic structuralist paradigm of ecopsychology. *European Journal of Ecopsychology*, 4, 90-115. Retrieved from https://pdfs.semanticscholar.org/8f69/0213afbbcf3a0ef3d1c62ce2cbd75aa102ad.pdf
299. Winkelman, M. J., & Baker, J. (2015). *Supernatural as natural: A biocultural approach to religion*. London, UK: Routledge.
300. Winkelman, M. J., & Sessa, B. (Eds.). (2019). *Advances in psychedelic medicine*. Santa Barbara, CA: ABC-CLIO.
301. Wirthlin, L. S. (1981). Joseph Smith's boyhood operation: An 1813 surgical success. *BYU Studies*, 21(2), 131-154. Retrieved from https://scholarsarchive.byu.edu/byusq/vol21/iss2/2/
302. Witkin, J. M., Overshiner, C., Li, X., Catlow, J. T., Wishart, G. N., Schober, D. A., & Felder, C. C. (2014). M1 and M2 muscarinic receptor subtypes regulate antidepressant-like effects of the rapidly acting antidepressant scopolamine. *Journal of Pharmacology and Experimental Therapeutics*, 351(2), 448-456.doi:10.1124/jpet.114.216804
303. White, J. E. M. (2011). *Everyday life of the North American Indian* (2nd ed.). Mineola, NY: Dover Publications.
304. Woodward, R. J. (2012). Joseph Smith and 'The Vision,' 1832. In R. N. Holzapfel & K. P. Jackson (Eds.), *Joseph Smith, the Prophet and Seer* (pp. 101-126). Provo, UT: Religious Studies Center, Brigham Young University.
305. Woolf, A. (2000). Witchcraft or mycotoxin? The Salem witch trials. *Journal of Toxicology - Clinical Toxicology*, 38(4), 457-460. doi:10.1081/CLT-100100958
306. Young, B. (1858). *Journal of discourses* (Vol. 5). Liverpool, UK: Asa Calkin.
307. Youngreen, B. (2001). *Reflections of Emma, Joseph Smith's wife*. Orem, UT: Grandin Book Company.
308. Yronwode, C. (2002). *Hoodoo herb and root magic: A materia magica of African-American conjure, traditional formulary, given the spiritual uses of natural herbs, roots, mineral, and zoological curios*. Forestville, CA: Lucky Mojo Curio Company.

Restoration and the Sacred Mushroom: Did Joseph Smith use Psychedelic Substances to Facilitate Visionary Experiences

by

Robert T. Beckstead

Presented at the Sunstone Symposium, August 2007

Revised

original text: http://www.mormonthink.com/files/restoration-sacred-mushroom.pdf
backup source: http://www.psilosophy.info/resources/restoration-sacred-mushroom.pdf

Table of Contents:

Abstract
Introduction
Motive to Administer Entheogens
Access and Training to Administer Entheogens
Use of Entheogens to Discover and Translate the Gold Plates
Opportunity to Administer Entheogens
Pentecost for Richard Bushman, Joseph Smith, Rough Stone Rolling
Evidence of Datura Use
A Harmony: Excerpted
Amanita Muscaria Mushroom
Peyote
Weaknesses of the Entheogenic Theory of Mormon Origins
Implications
Links
Appendices
Delusions of Grandeur
Footnotes

Abstract

Did hallucinogens facilitate Joseph Smith's visions & those of early Mormon converts? In his 1975 book, *Hearts Made Glad*, Lamar Petersen carefully documented the use of intoxicants by Joseph Smith and early converts to the LDS Church. While mostly interested in the consumption of various fermented and distilled alcohols, Petersen also noted strange behaviors associated with the sacramental use of what seemed to outside observers to be medicated wine. It appears that soon after the Church was organized in New York and later in Ohio, members partook of wine in sacrament meetings which occasioned visionary states and strange behaviors not typically associated with alcohol consumption or intoxication. It is my thesis that beginning at a young age, Joseph Smith experimented with psychedelic plants and that many of Joseph Smith revelations and much of his behavior can be attributed to the use of psychedelics. Following Joseph Smith's death, the pragmatic Brigham Young had no interest in psychedelic material, or was unaware of its use, and hence it did not become a part of Utah Mormonism. However, James Strang and Fredrick M. Smith (Joseph Smith's grandson and president of the RLDS Church) perpetuated the use of psychedelics in their branches of Joseph Smith's original movement. The use of psychedelics by the Strangites and the RLDS Church could not be sustained.

Introduction

According to the official web site of the LDS Church, in the spring of 1820, Joseph Smith offered a simple prayer that set into motion a series of events leading to the restoration of the true Church and the truth about life's greatest questions.[1] But for many early LDS coverts, learning about truth was a second rank endeavor. Instead, seeking for a personal visionary experience was primary. According to LDS scholar, Richard Bushman, early Mormon converts were "seekers" whose

> ... greatest hunger was for spiritual gifts like dreams, visions, tongues, miracles, and spiritual raptures.[2]

These early Church members sought direct experience with God and believed that Joseph Smith had the power to grant their desires. Confidence in their Prophet was not misplaced. Between 1829 and 1836, under the supervision of Joseph Smith, many early Mormon converts enjoyed heavenly visions and spiritual raptures. While the nature of these visions are a matter of debate, there is no doubt as to the amazing number of visions experienced by Joseph Smith and early converts during these seven years.

However, after Joseph's death in 1844, the great visionary period of Church history came to an end.[3] The only vision recorded in Church of Jesus Christ of LDS scripture (D&C 138) is that of Joseph F. Smith dated October 3, 1918. Since 1918, there has be no visionary experience recorded by any of the subsequent presidents of the LDS Church. Interestingly, the vast majority of Mormons living today believe that Joseph Smith-like visionary and revelatory experience continues amongst the living "General Authorities" of the Church, but in secret. However, an Apostle of the LDS Church admitted in 1985 that he had never had such an experience and he was unaware of anyone living who had. (In person interview of an LDS Church Apostle by the author)

So stark was the dearth of visionary experience that in 1864, twenty years after Joseph Smith's death, members would ask Mormon Apostle George A. Smith,

> ...why it is that we do not see more angels, have more visions, that we do not see greater and more manifestations of power?[4]

The mystery seems to center around Joseph Smith himself. According to Richard Bushman, it was Joseph Smith himself that connected converts to heaven by some power that he possessed, a power that remains a mystery to this day.[5]

Indeed, after the death of Joseph Smith in 1844, the only vision recorded in LDS history is that of Joseph F. Smith dated October 3, 1918. (D&C 138)

But is Joseph Smith's spiritual power to connect converts with heaven really beyond our ability to investigate and understand? Over the last 50 years Joseph Smith-like spiritual power has come under examination by an ever-increasing number of anthropologists, religious historians, ethno botanists and ethno mycologists. It now appears that spiritual power comparable to that of Joseph Smith can be acquired in the course of consuming visionary plants, mushrooms and cactus. Otherwise known as psychedelics and hallucinogens, when these visionary materials are taken in a religious setting, they are often referred to as entheogens. An entheogen is any substance, such as a plant or drug, taken to occasion a heavenly vision or spiritual rapture.[6] Entheogens can induce visions during an altered state of waking consciousness and out-of-body and near death experiences.

How important are entheogens to the world's great religions? In 2000, Robert C. Fuller, a leading historian and interpreter of American religious life wrote that the use of entheogens

> ... is one of the most mysterious and important subjects in all religious history. Entheogens have figured prominently in the mystical practice of some of the world's greatest civilizations. They have been widely employed in shamanic society and their use continues today throughout the world. They alter consciousness in such a profound way, that ... their effects can range from states resembling psychosis to what are perhaps the ultimate human experiences, union with god or revelations of other mystical realities.[7]

The psychobiology of non-pharmacologic and pharmacological induced altered states of consciousness is now a matter of scientific research. Michael Winkelman writes,

> Vision-inducing plants ("hallucinogens") are important in many societies, evoking powerful emotional, psychological, cognitive, religious, spiritual, therapeutic and political reactions. These substances' psychophysiological properties shape cross-cultural similarities in patterns of use and experiences, while political factors shape their cultural desirability. Neurological studies illustrate that common effects are based in intervention in serotonergic neurotransmission. Effects upon neural, sensory, emotional, and cognitive processes stimulate integrative information processing, justifying a new term- "psychointegrators." Psychointegrators disinhibit sensory and emotional processes. They stimulate systemic integration of brain information-processing functions, enhancing integration of limbic system self and emotional dynamics with neocortical processes. Their therapeutic applications are reviewed from perspectives of cross-cultural and clinical studies. (Abstract from: Psychointegrators: Multidisciplinary Perspectives on the Therapeutic Effects of Hallucinogens, Michael Winkelman. Arizona State University Tempe, AZ)

Just how legitimate are visions and raptures occasioned by entheogens? Religious historian Huston Smith wrote that the use of entheogenic material is able to occasion an "experience that is indistinguishable from, if not identical with" those of religious mystics.[8] For instance, in an article published in Life Magazine May 13th 1957, R. Gordon Wasson, the "father of ethnomycology", reported the discovery of a divine mushroom that could easily occasion visions and ecstasies. Wasson wrote,

> On the night of June 29, 1955... I shared with a family of Indians a celebration of "holy communion" where "divine" mushrooms where first adored and then consumed.[9]

Wasson then reports,

> Now I am seeing for the first time, seeing direct, without the intervention of mortal eyes ... vistas beyond the horizons of this life, to travel backwards and forwards in time, to enter other planes of existence, even to know God.[10]

But Wasson's experience isn't an isolated example of psychedelics ability to reproduce a transpersonal, religious experience. In 1961, Huston Smith ingested peyote cactus and made a similar report.

> I noted mounting tension in my body that turned into tremors in my legs ... I [began] experiencing ... the clear, unbroken Light ... I was now seeing ... with the force of the sun, in comparison with which everyday experience reveals only flickering shadows in a dim cavern ... [I saw] worlds within worlds.[11]

In a 2000 essay, Huston explains that through an entheogen, he experience the ultimate reality.

> The personal word is this: I was initiated to the entheogens through Timothy Leary and psilocybin in his home in Newton on New Year's Day, 1961. The day didn't change my worldview, for the Great Chain of Being had already moved to the center of my convictions through thirty years of jnanic work with the great religions. What the day accomplished, you will not be surprised to hear, was to enable me for the first time to experience the respective levels of the Chain, all the way to its top. The dominant effects of the experience were two: awe (which I had known conceptually as the distinctive religious emotion but had never before experienced so intensely) and certainty. There was no doubting that the Reality I experienced was ultimate. That conviction has remained.[11b]

From the 1950's to present, an increasingly large volume of data has been assembled in the quest to understand the use of entheogens in important religious and mystery traditions. Hebrew, Mexico, Central and South America, India, China, Siberia, Europe, and ancient Greece, Christian and Alchemical mythic-religious systems often refer to visionary plants or fungi.[15] The result has been a maturing theory of entheogens and the origins of religion. In September 2006, Michael S. Hoffman summarized what is now believed by many to be the relationship between religion and entheogens.[12]

> The entheogen theory of religion holds that the main origin and ongoing wellspring of religion is visionary plants ... [such as] Peyote ... *Datura* ... and *Amanita muscaria* mushrooms. Visionary plants have been commonly used around the world throughout the history of religion and culture,[13] including the various forms of Western Esotericism.[14]

More recently, in the premier issue of Time and Mind, Benny Shannon, Professor of psychology at the Hebrew University of Jerusalem (Israel).

> In his book *Poisons Sacrés, Ivresses Divines* [sacred poisons, divine intoxication] (which, to my knowledge, has not been translated into English), Philippe de Félice (1970 [1936]) reviews various cultures throughout the world and notes the use of psychotropic substances in them. The use of such substances, most of which fall in our contemporary Western culture under the label "drug," has in many traditions been considered sacred. Indeed, de Félice points out that in many religions, both in the old world and in the new, the use of such substances was (and often still is) central. The substances, or the plants from which they were produced, were deemed holy and at times even divine. De Félice puts forward the hypothesis that the use of psychotropic substances is deeply embedded in human culture and intrinsically intertwined with what he characterizes as the most basic human instinct - the search for transcendence. Thus, he proposes, the use of psychotropic substances is at the root of perhaps all religions. (Time and Mind Volume 1, Issue 1, March 2008, pp. 51-74 - http://www.psychointegrator.com/down/biblical_entheogens.pdf)

In the patients to successfully treat mental disorders and the anxiety associated with the diagnosis of cancer. The Fox News Networks broadcast a segment about the psychedelic substance "Psilocybin" and asked the question "Can this dangerous party drug help extend the life of terminally ill patients?" The cases of two patients were reviewed followed by a short statement of the principle investigator, Dr. Charles Grob professor of Psychiatry at Harbor UCLA Medical Center. Dr. Grob makes this additional comments

> It might even facilitate a powerful psychispiritual or even mystical experience which does appear to have a therapeutic impact.

If entheogens can shed light on some of the world's most important religions, including possibly early Christianity, is it possible that they may also shed light on the rise of Mormonism, America's most successful religion? In order to address this question, it seems reasonable to consider the motive, opportunity and evidence to suggest that Joseph Smith employed entheogens to occasion heavenly visions and spiritual raptures.

Motive to Administer Entheogens

What would motivate Joseph Smith to use entheogens? One possible answer is that without entheogens, most visions and raptures come only after years of disciplined meditation or severe physical austerity. Ake Hultkranz, retired professor of comparative religion[16] explains that the popularity of entheogens ... is partly due to the fact that visions are rendered easily accessible, and fasting, isolation, and self-torture[17] are unnecessary.

Terence McKenna, speaker and philosopher, is widely known to be experienced in the use of psychedelics and the meditative arts. McKenna believes that meditative and other spiritual practices were developed as tools to enhance and guide the psychedelic experience. His views in a small discussion group are summarized (with minor editing) as follows:

> Q. Are you against meditation in favor of the psychedelics experience? A: If by meditation you mean lying down or sitting up and close your eyes, I do that a lot and I like it but would never confuse it with the psychedelic enterprise. I think they are completely different realms of human activity. With meditation, you don't hallucinate. [Some may] say you do, but they aren't very convincing. [And when you fail to hallucinate with meditation] the monks rush over and explain that you are doing it wrong.

> Q. Do you think you have the same revelatory experience with meditation? A: I really don't. All these spiritual techniques are not substitutions for the psychedelic experience but trade-offs. I think that all of these techniques ... work incredibly well in the presence of psychedelics leading me to suppose that what these are tools that were developed in the Paleolithic world of psychedelic magic and all we have now is all these tools but we don't have the original engine that drove them. I am very bored by spiritual practice unless I've taken a psychedelic; then mantric chanting is beyond the power of mind to encompass or describe. [Psychedelics] seems to be a general functional enhancement [of spiritual techniques]. Acoustical driving (drumming) is also a tried and true tradition. It's not about the exclusivity of methods but the combinations of method. What you want to do is beat your drum while sitting in yum, yum [position] while stoned on "x", while at the holy mount, while the astrological configuration is correct and then line it all up and push it through, that's the way to do it.

While most will not achieve a "revelatory experience" with meditation alone, there are techniques which may facilitate such experiences in a limited number of devotes. For instance, William Buhlman has developed several out-of-body meditation techniques that has been successful in some cases. Techniques developed by Stephen LaBarge are able to produce lucid dreams. In lucid dreaming, the dreamer becomes conscious during the dream and in some cases may be enveloped in a religious epiphany. Joseph Smith is known to have used a seer stone to see buried treasure and to "translate" the Book of Mormon. The technique is called scrying and as discussed by Clay L. Chandler, is another technique to enter revelatory realms.

However, these techniques are relatively unreliable for most seekers and often takes years of practice to produce meaningful revelatory results. It is becoming apparent that meditation, fasting and religious ceremony may not be primary causes of visionary states and spiritual raptures but instead in many cases play a supportive role for the use of entheogens. Michael Hoffman notes

> Meditation, shamanic drumming, and liturgical ritual were developed as activities to do in the plant-induced [visionary] state, not as methods of inducing the [visionary] state in the first place.[18]

In other words, if Joseph Smith employed entheogens, he met the requirement to place himself and early Mormon converts in the express lane to spiritual powers without the need for years of meditation, repetitive religious ritual or severe physical austerities.

Access and Training to Administer Entheogens

How available were entheogens to Joseph Smith. In 1998, Richard Evans Schultes, former director of the Botanical Museum of Harvard University and the "father of ethnobotany" identified three culturally important entheogens available in the area Joseph lived and traveled: *Datura* plant, *Amanita muscaria* mushroom and peyote cactus.

Culturally Significant Major Entheogens Accessable from Where Joseph Smith Lived According to Richard Evans Schultes

Peyote Cactus

Amanita muscaria
(Fly Amanita)

Datura
(Angel's Trumpet)

C. Jess Groesbeck, who studied with a Huichol Indian Shaman, has shown that the model of Joseph Smith as a shamanic personality is a comprehensible way to understand and embrace Joseph's life and work.

Groesbeck defines shaman:

> Mircea Eliade, a great historian of religion said, "This is the particular type of medicine man, holy man or healer who through the controlled use of trance or ecstasy communicates directly with the spirits and realities of the other world for the benefit of his community." Ake Hulkrantz stated that a shaman is a social functionary who with the help of guardian spirits obtained ecstasy in order to create rapport with the supernatural world on behalf of the individual or group members and his power comes from direct experience. Other people such as priests and other official healers and representatives often do this through technology or indirectly through various structures or systems or mythological structures, whereas the shaman, if he is truly in that character has the direct experiences and in fact becomes the creator, as we shall see, and synthesizer of the symbolic experiences, these otherworldly experiences for a new system of religion or belief or understanding or healing...
>
> They ultimately have an experience through ecstasy, through trance, through dissociation. They then go to the other world and have contact usually with animals, an animal of some kind. And that animal then will give them their personal powers. Through this experience, many times, they will go through dismemberment experiences where they themselves will see in vision themselves being dismembered and then put back together. Later, when they have these personal powers, they often have the powers of telepathy, psychokinesis, precognition, the ability to interpret dreams and then also to see. They are often seers and they use sacred objects such as stones by which to visualize. And then they have helping spirits or agents who come to them and who work with them.[19]

It is possible that AmerIndian Shaman were mentors for Joseph Smith in his use of entheogens. There is reason to believe that Joseph Smith was familiar with Indian chief. Charles M. Larson writes that a fragment of the Egyptian papyrus purchased by Joseph Smith in 1835

> was given to an Indian chief as a token of respect. (Charles M. Larson, ... By His Own Hand Upon Papyrus: A new look at the Joseph Smith Papyri, Institute for Religious Research, Grand Rapids Michigan, 1992, p. 78, note 230 states, "This was the basis for the article in the February, 1968 Improvement Ears, p. 40-A through 40- G...")

Mircea Elliade, during his early work, was not convinced that the use of psychedelics was an important aspect of indigenous shamanic work. However, just before he died, he reversed his position recognizing the nearly universal use of psychedelics by indigenous shaman.

Michael Cole, the Charles J. MacCurdy professor emeritus of Anthropology at Yale University and curator emeritus of the Division of Anthropology at the school's Peabody Museum of Natural History also believes that Joseph Smith is best described as a Shaman. Speaking of Joseph Smith, Cole explains

> This extraordinary man, who put together a religion - probably with many falsities in it, falsehoods, so forth, to begin with - eventually came to believe in it so much that he really bought his own story and made it believable to other people. In this respect, he's a lot like a shaman in anthropology: these extraordinary religious practitioners in places like Siberia, North America among the Eskimo, the Inuit, who start out probably in their profession as almost like magicians doing magic. (PBS Interview, May 16th 2006)

Algonquin Indian shamans inhabiting the region from the Atlantic seaboard running north through eastern and central Canada and south to the Ohio River are known to have used both *Datura* plant and *Amanita muscaria* mushroom in their religious ceremonies.[20] Since Jess Groesbeck has shown that many aspects of Joseph Smith's visionary career is consistent with Amerindian shamanism, it is possible that Joseph Smith was mentored by an Algonquin shaman.

John Heinerman has demonstrated Joseph Smith's interest in Thomsonian herbal medicine. Thomsonian medicine was inspired by early American root doctors using magical plants to occasion cures. According to Catherine Yronwode, "root doctoring" is an admixture of the hoodoo magical practices of African-American slaves mingled with the botanical knowledge of the Amerindian medicine man.[21] Root doctors are known to have used the visionary *Datura* plant in their magical practices.[22] A possible mentor for Joseph Smith in the use of *Datura* was Black Pete. Black Pete, an African-American was called a revelator and a chief suggesting that he was also a root doctor. Black Pete was initially from Pennsylvania and in 1825 may have met the young Joseph Smith digging for buried treasure. After leaving Pennsylvania, Black Pete became one of the earliest converts in Kirtland Ohio joining the Church in early 1831. Black Pete was present during the Kirtland visionary period of early 1831 when the strange manifestations likely associated with *Datura* plant ingestion were particular pronounced.

D. Michael Quinn and Lance S. Owens have shown that Joseph Smith incorporated elements of ceremonial magic and alchemy imported from Europe.[23] Alchemists are believed to have employed the visionary *Amanita muscaria* mushroom in their occult practices[24] and Lance Owens identifies a possible alchemical mentor for Joseph Smith by the name of Dr. Luman Walter.[25] Quinn writes,

> As previously discussed, folk magic and the occult involved training, practice, and inner "gifts" to be an adept. Academic magic required occult texts, hundreds of which were available in English by the 1800s (see Ch. 1, and above). Folk magic's universal source of instruction was the occult's oral tradition which summarized centuries-old writings for all classes of people. Many people gained occult knowledge from both directions. Aside from verbal transmission of occult knowledge, some adepts also furnished practical training to interested persons. (Quinn. Early Mormonism. 116)

There is evidence that Joseph's mother, Lucy Mack Smith, used seer stones, and Joseph may have gained most of his knowledge regarding their use from her, but Quinn also points to the probability that Joseph had one or more occult mentors, Luman Walters being primary among them. (Clay L. Chandler, Scrying for the Lord:

Magic, Mysticism, and the Origins of the Book of Mormon. Dialogue: A Journal of Mormon Thought, Vol. 36, No. 4, Winter 2003. p. 43
http://www.dialoguejournal.com/wpcontent/uploads/sbi/articles/Dialogue_V36N04_63.pdf)

Joseph Smith may have also been in contact with Amerindian shaman familiar with the use of the visionary Peyote cactus. The Peyote cactus grows in an extensive area surrounding the middle and lower Rio Grande River. Amerindian Peyote cults spread northeast from these areas to the plains states many years after Joseph Smith died.

However, an ancient Amerindian trade route led from the Peyote fields through a major trade center to the Northeast where Joseph Smith resided.[26] It is very probable that Peyote was transported along this route and found its way into Joseph Smith's hands because at the time of his death, Joseph possessed a seer stone shaped in the form of the visionary Peyote cactus button.

Use of Entheogens to Discover and Translate the Gold Plates

It has been reported that Joseph Smith was typically intoxicated while discovering and translating the Book of Mormon. According to Lu B. Cake, Joseph Smith was intoxicated during his "vision of Moroni" dated September 21, 1823. LeMar Petersen notes,

> At what age and in what capacity Vermont-born Joseph, Jr. arose to prominence is a moot point among his biographers. Mormon historians have dated his fame from the vision of the Gods in the Sacred Grove in 1820.* Others, less credulous, have insisted that Joseph's notoriety sprang from participation in necromantic arts accompanied by frequent tilts of the bottle. Joseph's self-admitted foibles were not charitably viewed by critics who were willing to place the worst possible interpretation on them. I. Woodbridge Riley, in a Yale University thesis for which he was awarded the Doctor of Philosophy degree in 1902, accused:
>
>> "What took place between the first and second visions was described by Joseph as the 'weakness of youth, foolish errors, divers temptations and gratifications of appetites offensive in the sight of God.' Stripped of verbiage this means, for one thing, - drunkenness."[12]
>> (http://archive.org/download/founderofmormoni00rilerich/founderofmormoni00rilerich.pdf)
>
> A lurid monograph certain not to win a degree for its author was Lu B. Cake's *Peepstone Joe Exposed* (http://archive.org/download/peepstonejoepeck00cake/peepstonejoepeck00cake.pdf) which appeared just prior to Riley's psychological study. Adding an introduction to the presentation of a manuscript by Reed Peck (an officer in the Danite band whose testimony helped put Joseph in Liberty jail in 1838), Cake wrote:
>
>> "September 21, 1823 Joe got drunk, swore, lied and swindled, contrary to revelation. Train up a child in the way he should *not* go and when he is eighteen years old like Joe Smith, he will not depart from it. Yet Joe claims that while in bed this drunken September 21st, an angel came to him, told him the history of the ancient inhabitants of America was engraven on gold plates and hidden in a hill between Manchester and Palmyra, in western New York. Whether it was angel, or alcohol, that gave Joe inspiration is the question; for although drunk on September 21st, yet on September 22nd he claims that he found the plates in the place to which he was directed."[14] Inasmuch as Peck had not referred to Joseph's inebriety in the MS, it may be that Cake obtained his information by direct revelation. (LeMar Petersen, Hearts Made Glad: *Charges of Intemperance Against Joseph Smith the Mormon Prophet*. 1975. Self-Published. Salt Lake City. 44-45)

Intoxication can explain Joseph Smith's visionary experiences but not intoxication with alcohol. Having worked in an Emergency Department for over 30 years, I have never seen an intoxicated patient who was actively hallucinating unless there was pre-existing alcohol induced central nervous system damage. If we accept that Joseph Smith was intoxicated and link that intoxication to visions, the only intoxicant class capable of doing that is psychedelics such as *Amanita muscaria* mushroom, *Datura* and Mescaline containing cactus.

It is possible that Joseph was intoxicated with a hallucinogen during the visionary experiences surrounding his September 1923 vision and later enabling him to see sentences in spiritual light while excluding natural light using a seer stone placed in the hat. Joseph Smith was intoxicated while translating the Book of Mormon. LeMar Petersen notes:

> One of Emma Hale Smith's cousins, Levi Lewis, son of Reverend Nathaniel Lewis of the Methodist Church, made affidavit that while Joseph was in Harmony, Pennsylvania he "saw him intoxicated three different times while he was composing the Book of Mormon."[55]
>
> Another who reported that Joseph drank too much liquor while translating was Martin Harris, first scribe for the modern scripture. When the wine goes in, strange things come out.[64] But after censure from the High Council at Kirtland he amended the charge to "this thing occurred previous to the translation of the Book." Shalemanasseh (one of Martin's spiritual names in the Doctrine and Covenants 82:11) then confessed that his mind was darkened, and that he had said many things inadvertently, calculated to wound the feelings of his brethren, and promised to do better.[57] (LeMar Petersen, *Hearts Made Glad: Charges of Intemperance Against Joseph Smith the Mormon Prophet*. 1975. Self-Published. Salt Lake City. 65-66)

This is not to suggest that Joseph Smith wasn't frequently intoxicated on alcohol. The evidence is clear that he was. However, alcohol is an excellent vehicle to administer both *Amanita* and *Datura*. That Joseph Smith was knowledgable about the use of medicated alcohol is found in the *Book of Mormon*. LeMar Petersen notes,

> The scene with the Missouri jailors is reminiscent of a scene concerning the wicked Lamanites in the first edition of the Book of Mormon:
>
> > "And many times did they atempt to administer of their wine to the Nephites, that they might destroy them with poison or with drunkenness. But behold, the Nephites were not slow to remember the Lord their God, in this their times of affliction. They could not be taken in their snares; yea, they would not partake of their wine; yea, they would not take of wine, save they had firstly given to some of the Lamanite prisoners. And they were thus cautious, that no poison should be administered among them; for if their wine would poison a Lamanite, it would also poison a Nephite; and thus they did try all their liquors.[16]
>
> In Mormon belief the Lamanites of the Book of Mormon were the ancestors of the American Indian. It is fortunate the Lamanite wine-tasters of old were spared a sampling of the potent brew prepared for their Missouri descendants. This heady recipe for Indian firewater was given by "Teddy Blue" Abbott (born 1860) in *We Pointed Them North*:
>
> > "You take one barrel of Missouri River water, and two gallons of alcohol. Then you add two ounces of strychnine to make them crazy - because strychnine is the greatest stimulant in the world - and three plugs of tobacco to make them sick - an Indian wouldn't figure it was whisky unless it made him sick - and five bars of soap to give it a bead, and half a pound of red pepper, and then you put in some sagebrush and boil it until it's brown. Strain into a barrel, and you've got your Indian whisky; that one bottle calls for one buffalo robe and when the Indian got drunk it was two robes." (LeMar Petersen, *Hearts Made Glad: Charges of Intemperance Against Joseph Smith the Mormon Prophet*. 1975. Self-Published. Salt Lake City. 150-151)

Intoxication and visionary experience is hinted at in the Book of Mormon. A more through discussion of the "bitterness" or bitter taste of psychedelics and the "opening" of one's eyes was tangentially expressed by LeMar Petersen.

> Though Joseph's philosophy was only partially hedonistic a good case for sin could be made from certain Book of Mormon passages. The patriarch Lehi explained to his son Jacob that sin was necessary and desirable in the Garden of Eden, otherwise Adam and Eve
>
> > "would have had no children; wherefore they would have remained in a state of innocence, having no joy, for they knew no misery, doing no good, for they knew no sin."
>
> Moral: To do good, one must sin; transgression is essential. This precept may well be the key to Joseph Smith's ambivalence in drink habits and in those areas of behavior generally defined as moralistic. He often affirmed that "what many people call sin is not sin," and "there must needs be opposition in all things." The most oft-quoted phrase in Mormonism, next to "The glory of God is Intelligence," is "Adam fell that man might be, and man is that he might have joy." In Mormon belief the fall was upward.[34]
>
> In Joseph's scriptures Adam blessed God
>
> > "for because of my transgression [eating from the tree of knowledge] my eyes are opened, and in this life I shall have joy," and Eve, the abettor, seconded, "were it not for our transgression we never should have had seed, and never should have known good and evil."
>
> The Lord explained to Adam,
>
> > "Inasmuch as thy children are conceived in sin, even so when they begin to grow up, sin conceiveth in their hearts, and they taste the bitter, that they may know to prize the good."
>
> And though conceived in sin
>
> > "every spirit of man was innocent in the beginning; and God having redeemed man from the fall, men became again, in their infant state, innocent before God."
>
> Nevertheless, "since man had fallen he could not merit anything of himself." The difficulty of reconciling such passages with God's first command in Genesis to "be fruitful and multiply, and replenish the earth" seemed not to disturb the modern Revelator.[35]
>
> Did not God countermand his own word in,
>
> > "But of the tree of the knowledge of good and evil, thou shalt not eat of it: for in the day thou eatest thereof thou shalt surely die?"
>
> (LeMar Petersen, Hearts Made Glad: *Charges of Intemperance Against Joseph Smith the Mormon Prophet*. 1975. Self-Published. Salt Lake City. 158-159)

The connection between eating, the initial bitter taste and eventual sweetness of joy while apparently metaphorical is also an excellent description of the effects of ingesting psychedelics many of which are bitter but eventually envelop the inbiber in spiritual raputures of love. How this might relate to Joseph Smith Senior's dreams and Joseph Smith Junior's "tree of life" will be discussed below.

Opportunity to Administer Entheogens

Is there evidence to suggest that Joseph Smith gifted new converts with visionary experience by adding a visionary plant such as *Datura* to sacramental wine? According to LaMar Petersen in his 1975 book, *Hearts Made Glad* the answer is probably yes.[27] Petersen noted a correlation in early Mormonism between the ingestion of sacramental wine and visionary experience. In the very first conference of the Church in June 1830 at Fayette, New York,

Joseph Smith recorded

> ... we partook together of the emblems of the body and blood of our Lord Jesus Christ ... many of our members ... had the heavens opened to their view, [and beheld Jesus Christ].[28]

Heavenly manifestations occurred in a March 18th 1833 sacrament meeting held in Kirtland Ohio under the direction of Joseph Smith.

> Bro Joseph ... promise[d] that the pure in heart that were present should see a heavenly vision ... after which the bread and wine was distributed by Bro Joseph after which many of the brethren saw a heavenly vision of the savior and concourses of angels.[29]

In the afternoon of March 27th 1833, Ebenezer Robinson reported that after the administration of the bread and wine

> Frederick G. Williams bore record that a holy angel of God came and sat between him and Joseph Smith, Senior.[30]

A meeting in which visions were occasioned by the application of anointing oil, which can also be laced with entheogenic material[31] occurred on January 21, 1836. Joseph Smith was anointed first and in turn he anointed several of the Brethren. Joseph reported that after the anointing,

> The heavens were opened upon us and I beheld the celestial kingdom of God, and the glory thereof, whether in the body or out I cannot tell ... Joseph said that many of the brethren "saw glorious visions also.[32]

Pentecost for Richard Bushman, Joseph Smith, Rough Stone Rolling

> Thursday January 21 1836 A new kind of washing; one for the whole body was instituted, following OT practices. Joseph's journal: "We attended to the ordinance of washing our bodies in pure water. We also perfumed our bodies and our heads, in the name of the Lord" Oliver C. gave a fuller description of the W and A. No spiritual, otherworldly things mentioned.
>
> When the brethren met the following Thursday, they added an anointing with oil. Joseph and six other men attended to this. They poured the oil on the heads and then rubbed their hands over his anointed face and head. In Exodus it called for calumus and myrrh and sweet cinnamon. Cinnamon was all these poor saints could afford to mix with the oil. Hmmm?
>
> After Joseph's anointing he wrote, "the heavens opened upon us and I beheld the celestial kingdom of God and the glory thereof, whether in the body or out I cannot tell." "Streets of gold" "Alvin" etc. All through the night Joseph had visions. "Many of the other brethren saw visions also." JS. After the presidency Joseph anointed the bishops of Kirtland and Clay County with their counselors. Edward Partridge wrote "a number of them saw visions and others were blessed with outpouring of the Holy Ghost. The vision of heaven was opened to these also, some of them saw the face of the Saviour and others were ministered unto by holy angels." At 1am they sang a song and went home.

> The next day no one could concentrate on school. They wanted to talk over "the glorious scenes that transpired on the preceding evening." That evening the twelve and the seventy underwent same. Following the ordinances "toungs, fell upon us in mighty pow[e]r, angels mingled their voices with ours, while their presence was in our midst, and unseasing prasis swelled our bosoms for the space of half an hour." Joseph said "the spirit and visions attended me through the night."
>
> Six days later they did anointings for high priests and then quorum. Through January and February, the brethren read Hebrew by day, and washed, anointed, and prayed, and beheld visions by night. He went home weary.
>
> Some quorums did not comply with everything they were asked to do one Sat. early in Feb. They were not standing and speaking when they had a spiritual experience. Hyrum and Oliver went to request them to observe order but they said that "they had a teacher of their own and did not wish to be troubled by others." Joseph said, "This quorem lost the[e]ir blessing in a great measure." A "cloud of darkness" filled the elders' room, their minutes reported, while the more careful quorums "enjoyed a great flow of the holy spirit" that was "like fire in their bones."
>
> At the temple dedication on Mar 27 they did all the tedious sustainings, then the dedicatory prayer. Some said they saw angels etc. But the congregation did NOT see the face of God. The level of spiritual manifestations did not equal the outpourings of January and Feb. Bushman says. Mar 29 washing of feet and sacramental wine. Holy Spirit, prophecying and giving glory all night in temple Mar 30 about 300 people joined them in the temple. More tubs more towels, bread and wine. Prophecying and speaking in tongues. Exhausted after the all night session the presidency retired but the rest of the brethren remained, "exhorting, prophecying, speaking in tongues" until 5am. A few skeptics wondered if the brethren had become drunk on sacramental wine, but according to JS journal the nonstop Tues and Wed meetings were, finally, the endowment. (What they wanted to happen at the dedication) The next Sunday about 1000 people attended (they must have heard about that great wine huh?) the morning service. To their surprise (J and O?) the spiritual experiences in the temple were not over. Behind a veil J and O saw the Savior standing on the breastwork of the pulpit. Bushman says, What could this staggering experience have meant to J and O? (They had too much sacramental wine maybe) Joseph seemed to be stilled by the event. They saw Moses ELIAS and Elijah but after this no mention of the experience in D&C during J lifetime. The Book of Abraham's weirdo stuff started to happen after this two month high. No wonder it is such a messed up thing.

On March 30, 1836 during the dedication week of the Kirtland temple the *Millennial Star* reported that nearly five hundred brethren gathered in expectation of a spiritual Pentecost.

> The bread and wine were then brought in … The Savior made His appearance to some, while angels ministered to others.[33]

Charles L. Walker recorded that when the brethren had

> … partaken of the Lord's supper, namely a piece of bread as big as your double fist and half a pint of wine in the temple … the Holy Ghost descend upon the heads of those present like cloven tongues of fire.[34]

Following consumption of sacramental bread and wine on the afternoon of April 3rd 1836, Joseph Smith and Oliver Cowdery retired to the pulpit where a series of visions were opened to them including the appearance of Jesus Christ, Moses, Elias and Elijah.[35]

Then in a meeting on May 1st 1836, Ebenezer Robinson[36] remembered

> … when we partook of consecrated bread and wine … some testified of having the visions of heaven opened to their view.[37]

Can untainted wine and pure anointing oil have occasioned heavenly visions or spiritual raptures of early Church converts? The answer is probably not. Alcohol related hallucinations only occur after years of abuse and abrupt withdrawal. Therefore visions associated with the ingestion of wine argue strongly for the surreptitious inclusion of an entheogen such as the visionary *Datura* plant.

Evidence of Datura Use

What evidence is there that the plant *Datura* occasioned early Mormon convert visions rather than hypnosis, mass hysteria or spontaneous religious experience? *Datura* has been shown to be over 80 percent effective in creating a visionary experience whereas hypnosis is much less reliable, probably less than 10 percent. An even smaller percentage, likely less than 1 percent, will experience spontaneous heavenly visions. *Datura* would not only account for the high percentage of early Church converts having visionary experience following the ingestion of sacramental wine, but may also explain the accompanying untamed thoughts and behaviors that attended early Mormon sacrament meetings.

Lamar Petersen noted that the drinking of sacramental wine in the early days of the Church occasioned "unusual spiritual manifestations" of such a shocking nature they "impaired the image of the young Church among sober people."[38] In early 1831, sacrament meetings held at the Kirkland Ohio farm of Isaac Morley produced both visions and scandalous behavior. A Kirtland Ohio schoolteacher, Jesse Moss observed

> They partook of the Lords supper at night with darkened windows and excluded from the room all but their own till they got through and then opened the doors and called the outsiders in to witness a scene far exceeding the wildest scene ever exhibited among the Methodists.[39]

What were the wild scenes associated with early Mormon administration of sacramental wine?

Reporter	Undisciplined Scenes
George A. Smith[40]	- Unnatural distortions - Extravagant and wild ideas
David Whitmer[41]	- Wielded the sword of Laban as expertly as a light dragoon - Acted like an Indian in the act of scalping - Slid on the floor with the rapidity of a serpent, sailing in boats to preach to the Lamanites.
Parley P. Pratt[42]	- Swoons - Unseemly gestures - Cramps - Falling into ecstasies
Joseph Smith[43]	- Insanity - Bound hand and foot in chains as immovable as a stick of timber - Getting on the stumps of trees and shouting Pursuing balls flying in the air and jumping of a cliff.

As shown in the table above, George A. Smith reported that members in Kirtland manifested unnatural distortions and extravagant and wild ideas.[44] David Whitmer said that members wielded the sword of Laban as expertly as a light dragoon, behaved like Indians in the act of scalping, slid on the floor with the rapidity of a serpent, sailed in boats to preach to the Lamanites.[45] Parley P. Pratt reported swoons, unseemly gestures, cramps and falling into ecstasies.[46] Joseph Smith himself noted manifestations of insanity, members becoming immovable as though bound hand and foot.[47]

Joseph Smith reportedly was not present at these Kirtland meetings and disavowed the manifestations as being of a lying spirit. However, Joseph Smith's own first vision was attended by similar strange thoughts and behaviors. Eldon Watson who harmonized Joseph's nine accounts of the first vision notes the following aberrations from normal thinking and bodily function.[48]

A Harmony: Excerpted

For Full Accounts Click Here

Arranged by Elden J. Watson with References

All of these signs and symptoms described below can be produced by hallucinogens, especially *Amanita muscaria* Mushroom and *Datura* Species!

Incapacitation (An effect of anticholinergic)

- **1839** I had scarcely done so, when immediately I was [seized] upon by some power which entirely overcame me … But exerting all my powers to call upon God to deliver me out of the power of this enemy which had seized upon me, and at the very moment when I was ready to sink into despair and abandon myself to destruction, not to an imaginary ruin but to the power of some actual being from the unseen world who had such marvelous power as I had never before felt in any being … It [the light] no sooner appeared than I found myself delivered from the enemy which held me bound.

Normal Vision Impared, Darkened (Dilation of pupils, blurry vision, marked decrease in vision)

- **1839** I had scarcely done so, when immediately I was [seized] upon by some power which entirely overcame me. Thick darkness gathered around me and it seemed to me for a time as if I were doomed to sudden destruction.
- **1840** At first, he was severely tempted by the powers of darkness, which endeavored to overcome him;
- **1842B** At first, he was severely tempted by the powers of darkness, which endeavoured to overcome him.

Anxiety and Strange Visuals (Early paranoia and unorganized visual distortions/hallucinations)

- **1842B** The adversary benighted his mind with doubts, and brought to his soul all kinds of improper pictures and tried to hinder him in his efforts and the accomplishment of his goal.

Tongue Felt Swollen & Stuck to Roof of Mouth (Anticholinergic drying effect on mouth)

- **1835** My tongue seemed to be swoolen in my mouth, so that I could not utter
- **1839** and [had] such an astonishing influence over me as to bind my tongue so that I could not speak.
- **1844** his tongue was closet cleaveh to his roof - could utter not a word,

He heard strange sounds (Auditory Hallucinations)

- **1835** I heard a noise behind me like some one walking towards me: I strove again to pray, but could not; the noise of walking seemed to draw nearer; I sprang upon my feet and looked round, but saw no person, or thing that was calculated to produce the noise of walking.

Withdrawl from Physical Sensations (As Physical Incapitation Increases, Thinking Switches from External Sensations to Inner Realities)

- **1842B** However, the overflowing mercy of God came to buoy him up, and gave new impulse and momentum to his dwindling strength. Soon the dark clouds disappeared, and light and peace filled his troubled heart.
- **1840** but he continued to seek for deliverance, until darkness gave way from his mind … When [the light] first came upon him, it produced **a peculiar sensation throughout his whole system; and immediately, his mind was caught away, from the natural objects with which he was surrounded**; and he was enwapped in a heavenly vision,
- **1842A** while fervently engaged in supplication my mind was taken away from the objects with which I was surrounded, and I was enwrapped in a heavenly vision
- **1842B** At this sacred moment his mind was caught away from the natural objects with which he was surrounded, and he was enwrapped in a heavenly vision,

Brilliant light (Extremely Common with Hallucinogens)

- **1832** a pillar of ~~fire~~ light above the brightness of the sun at noon day come down from above and rested upon me.
- **1835** A pillar of fire appeared above my head; which presently rested down upon me, and filled me with unspeakable joy.
- **1839** Just at this moment of great alarm, I saw a pillar [of] light exactly over my head, above the brightness of the sun, which descended ~~gracefully~~ gradually untill it fell upon me.
- **1840** he at length, saw a very bright and glorious light in the heavens above; which, at first, seemed to be a considerable distance. He continued praying, while the light appeared to be gradually descending towards him; and as it drew nearer, it increased in brightness and magnitude, so that, by the time that it reached the tops of the trees, the whole wilderness, for some distance around was illuminated in a most glorious and brilliant manner. He expected to have seen the leaves and boughs of the trees consumed, as soon as the light came in contact with them; but perceiving that it did not produce that effect, he was encouraged with the hope of being able to endure its presence. It continued descending slowly, until it rested upon the earth, and he was enveloped in the midst of it.
- **1842A** surrounded with a brilliant light which eclipsed the sun at noon-day.
- **1843** Directly I saw a light,
- **1844** -saw a fire toward heaven came near and nearer;
- **1850** While he was thus engaged, he was surrounded by a brilliant light.

Psychodramatic Theophany (The sought after psychedelic experience)

- **1832** and I was filled with the spirit of god and the [lord] opened the heavens upon me
- content well known. See Accounts of First Vision

Return of Physical Sensations (Waning of the hallucinatory experience and gradual return of normal physiological functioning).

- **1839** When I came to myself again I found myself lying on [my] back looking up into Heaven... When the light had departed I had no strength, but soon recovering in some degree,
- **1840** after which, the vision withdrew,
- **1842B** after which, the vision withdrew,
- **1843** The vision then vanished, and when I came to myself, I was sprawling on my back ...and it was some time before my strength returned.
- **1844** I endeavored to arise but felt uncommon feeble
- **1850** after which the vision withdrew

Afterglow of Hallucinatory Experience (Antidepressant Effect of Psychedelics)

- **1832** and my Soul was filled with love and for many days I could rejoice with **great Joy** and the Lord was with me
- **1840** leaving his mind in a state of **calmness and peace, indescribable**.
- **1842B** leaving his mind in a state of calmness and peace indescribable.
- **1850** leaving his mind in a state of calmness and peace.

Notes

Joseph's tongue would not function, he heard strange sounds and sprang to his feet but saw nothing, he was seized upon and could not move, his vision was severely impaired, he saw all kinds of "improper pictures", he believed he was going to be destroyed, he felt a peculiar sensation course through his entire body, he lost consciousness and awoke to find himself sprawling on his back and was unable to get up for some time.

Joseph Smith personified these strange manifestations as the actions of a being from the unseen world. This is consistent with Joseph's analysis of the bizarre manifestations in 1831 Kirtland Ohio as being the responsibility of a lying spirit. However, Joseph would contradict this view in 1843 when he explained that evil spirits can neither manipulate the physical world nor occasion strange physical manifestations. Joseph explained to apparently worried Church members that if such a being was encountered and attempted to physically interact, nothing at all would be felt.[49]

Rather than the devil being responsible for the peculiar manifestations attending the first vision and early Church convert visions, it is much more likely that *Datura* plant was involved.

Clinical Effects of Datura	**Correlates with LDS Visions**
Hallucinations (83%)	Visions
Pupil Dilatation	Blindness
Dry mucus membranes	Dry mouth, can't speak
Vasomotor instability	Facial color changes (initially flushed, then white as blood pressure falls)
Delirium, paranoia (central stimulation)	Unfounded fears, feeling of impending death, acting like or preaching to Indians, crawling, wallowing, chasing balls flying through the air.
Muscle abnormalities (jerks, myclonic movements, choreoathetosis)	Facial and body contortions, feeling bound
Unconsciousness (central depression)	Coma
Onset: 1-4 hours Duration: 24-48 hours	Experiences lasted hours to days.

As noted above, *Datura* is over 80% reliable in occasioning hallucinations and visions. It also causes pupil dilatation and near blindness, dry mucus membranes making it difficult to speak; vasomotor instability with the face initially turning red then white as blood pressure falls; delirium including acting out inner visions and paranoid ideation; abnormal muscle movements including jerks and contortions and finally unconsciousness. Symptom onset is usually less than an hour and can continue for as long as two days.

The *Independent Messenger* published in Worcester, Massachusetts reported on May 27th 1831 that

> Some [Church members] lie in trances a day or two and visit the unknown regions in the meantime; some are taken with a fit of terrible shaking which they say is the power of the Holy Ghost.[50]

In an early June 1831 Kirtland sacrament meeting, Joseph Smith alluded to possible mass visions and outright promised Lyman Wight that he would see Christ that day. Bushman explains what happened next:

> Wight turned stiff and white, exclaiming that he had indeed viewed the Savior ... Joseph himself said, "I now see God, and Jesus Christ" ... Then Harvey Whitlock ... turn as black as Lyman was white ... his fingers were set like claws. He went around the room and showed his hands and tried to speak, his eyes were the shape of ovals "O's" ... [Then] Leman Copley, who weighed over two hundred pounds, somersaulted in the air and fell on his back over a bench ... [Similar behavior was manifested by] people all day and the greater part of the night.[51]

In the *Independent Gazetter* published in Taunton, Massachusetts on January 11, 1833 it was reported that "in a few hours at a single meeting" there would be

> ... shoutings, wailing, fallings, contortions, trances, visions, speaking in unknown tongues and prophesying.[52]

John W. Gunnison who interviewed Church elders present during the 1836 Kirtland Pentecost reported that wine was administered ...

> ... that had been consecrated, and declared by the Prophet to be harmless and not intoxicating. This... produced unheard of effects, if we may credit the witnesses of these proceedings. Visions, tongues, trances, wallowings on the ground, shoutings, weeping, and laughing, the outpouring of prophecies... these, and other fantastic things, were among 'the signs following' at Kirtland.'[53]

Joseph Smith's standard response was to attribute foul manifestations to the adversary while the heavenly manifestations were attributed to God. But a more reasonable explanation may be that the visionary effects of *Datura* plant are frequently accompanied by rather unnerving physical and psychological side effects.

Some witnesses of these events came to the conclusion that the sacrament had been laced with a drug. On January 6, 1831, a letter to the editor in the Palmyra Reflector[54] accused Joseph Smith of legerdemain. Legerdemain means the practice of using "psychology, misdirection and natural choreography in accomplishing a magical effect."[55] In other words, Joseph Smith was being accused of using the sacrament as misdirection for the surreptitious administration of a visionary substance. In 1843, Henry Caswell wrote of "a pretended sacrament" associated with manifestations of power in early LDS meetings.[56]

After witnessing several sacrament meetings in Kirtland Ohio, Jesse Moss "became fully satisfied the wine was medicated" and one night attempted to steal a bottle but was caught. Immediately after his attempt was discovered, Moss made a public statement about how with drugged wine "angels could be manufactured & strange wonders made to appear in the night".[57]

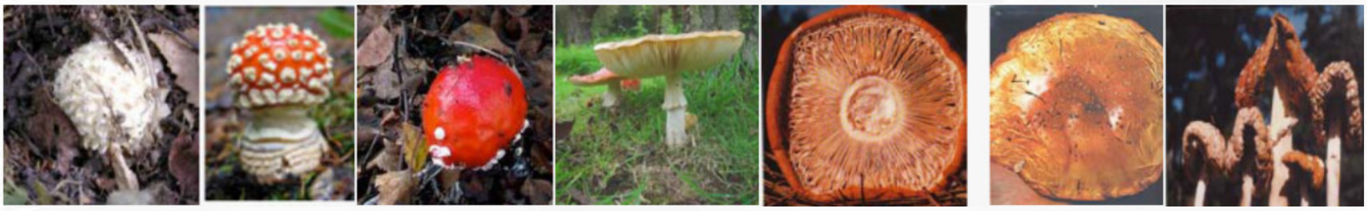
A member of the Church by the last name of McWhithey was reportedly present during the 1836 Kirtland temple dedication week. Obviously disgruntled, McWhitney complained that the wine consumed was actually "mixed liquor" and that "the Mormon leaders intended to get the audience under [its] influence" so that visions experienced were believed to be of "the Lord's doings."[58]

The connection of wine with fits of psychotic thinking and strange physical manifestations attending heavenly visions and spiritual raptures argues strongly in favor of the covert inclusion of the visionary *Datura* plant in the sacramental meal and anointing oil administered by Joseph Smith.

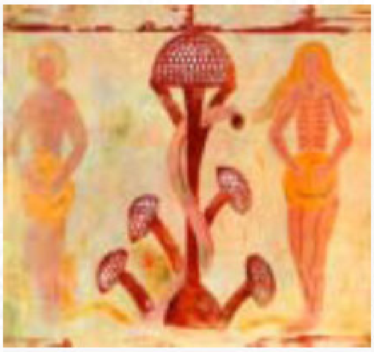
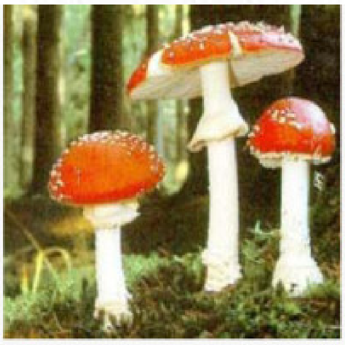
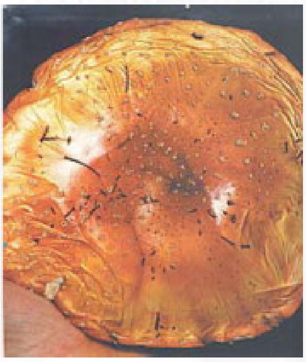
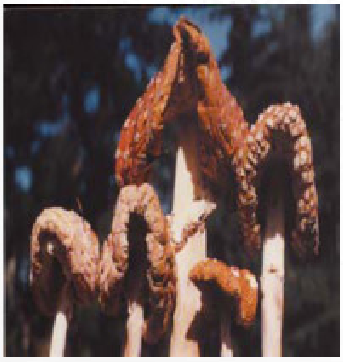
Amanita muscaria Mushroom

What about Joseph Smith's own use of entheogens? As noted, the psychotic thinking and peculiar physical manifestations attending Joseph's first vision are compatible with *Datura* plant ingestion. But another entheogen most likely was the intoxicant involved.

The *Amanita muscaria* mushroom may be one of man's oldest entheogens. According to Dan Merker, an academic with a background in religious history, an entheogenic laced sacrament existed in a Judaeo-Christian context.[59] Clark Heinrich suggests there is evidence to believe the *Amanita muscaria* mushroom may have played a role, along with ergot fungus related to LSD, in occasioning the visions reported by Old Testament prophets as well as being employed in some early Christian Eucharist celebrations.[60] However, these entheogens were not administered openly, but covertly within a more benign substance such as wine and anointing oil. To maintain secrecy, descriptions of *Amanita muscaria* mushroom use were cloaked in allegory and metaphor. (Listen to Clark Heinrich discuss the *Amanita* Mushroom.)



The *Amanita muscaria* mushroom, because of its changing form; its symbiotic relationship with pines, oaks and birch trees; and its profound visionary effect makes itself amenable to mystical personification and simile. A few examples of the *Amanita muscaria* mushroom in various stages of life underneath its host trees are shown above. In its newborn state, it takes on the appearance of a small dazzling white stone or particle; then a woolly lamb, a constellation of sun, moon and stars, a brilliantly colored ground fruit; a winged bird adorned with a string of pearls around its neck; a sun disk radiating light in all directions; a gold plate upon which is found strange writing and a serpent hanging on a pole. According to those who have consumed this fruit, the visionary state it produces occasions an endowment of divine knowledge and celestial love.

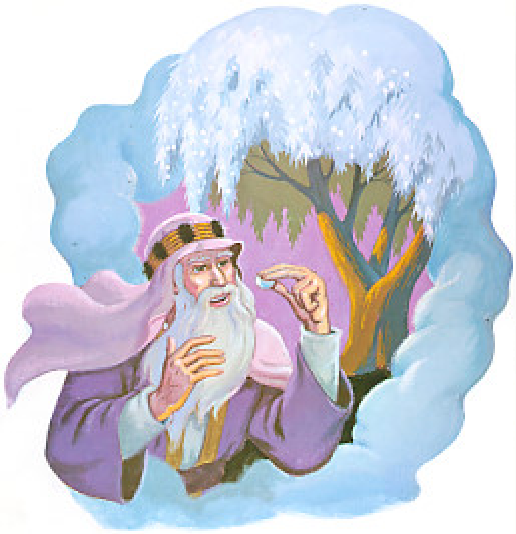
This 13th century Christian fresco from France shows an *Amanita muscaria* mushroom as the tree of knowledge with Adam on the left and Eve on the right. Notice the tree's umbrella shaped branches bearing white particles analogous to the veil remnants on the caps of three *Amanita muscaria* mushrooms shown to its right. Also, in the Christian fresco, the gold plates covering Adam and Eve's nakedness match the golden color of an aged *Amanita muscaria* mushroom. Finally, the snake hanging on a pole in the Christian fresco corresponds to a dying *Amanita muscaria* mushroom that also has an appearance of a snake hanging on a pole.

What is remarkable about this early Christian pictographic simile of the *Amanita muscaria* mushroom is its resemblance to the dreams of Joseph Smith Sr. and the early visionary experiences of Joseph Smith Jr. In 1802, Joseph Sr. gathered and crystallized more than $3000 worth of ginseng to sell in China.[61] Ginseng, although not a major entheogen, was "attributed with secret and magical powers".[62] The ability to crystallize ginseng shows that Joseph Sr. was able to work with psychoactive material, changing it into a stable, storable form that could be administered at a later time.

In 1811, Joseph Sr. reportedly had two dreams that are very suggestive of the *Amanita muscaria* mushroom. In the first dream, a spirit led Joseph Sr. to a box on the ground containing an entheogenic material. Of the box, the spirit said

> the contents of which, if you eat thereof, will make you wise, and give unto you wisdom and understanding.[63]

In the next dream, Joseph Sr. was led to a tree whose "branches spread themselves somewhat like an umbrella" and released "particles ... of dazzling whiteness" which fell to the ground. When he partook of fruit lying on the ground, he experienced something "delicious beyond description". Then Joseph Sr. with his family "got down upon [their] knees, and scooped [the fruit] up, eating it by double handfuls".[64]



In 1830, Joseph Smith Jr. published his own version of his father's entheogen related dreams. In an early chapter in the *Book of Mormon* those who held onto the rod of iron ultimately "fell down and partook of the fruit of the tree" which represented the love of God. It is not a far stretch to think that a single entheogen is being described in these three related dreams.

The points where the Smith dreams appear to represent the *Amanita muscaria* mushroom are ...

1. the umbrella shape of the tree branches,
2. the brilliant white particles on the branches, appearing to fall to the ground arguably appearing as small brilliant white stones
3. the fruit that must be gathered from the ground, not plucked from the branches of the tree as would be expected
4. fruit that can either be eaten fresh or dried and stored for later consumption
5. magical fruit able to occasion visions and raptures bestowing divine wisdom and heavenly love.

The *Amanita muscaria* mushroom not only fits the images depicted in the Smith dreams, it also has the capacity to reproduce the early visionary experiences reported by Joseph Smith. The 1832 account of the first vision, written 12 years from when it reportedly occurred, had undoubtedly already undergone significant revision. The core event was arguably an experience of physical heaviness, visual darkness, an awe-inspiring light from above, a voice out of heaven, an experience with the unfathomable Godhead and feelings of unspeakable joy.[65]

Contemporary visionary experience occasioned by entheogens show remarkable similarity to that of Joseph Smith. For instance, a few years ago, after ingesting the *Amanita muscaria* mushroom in the context of a Christian sacramental meal, Clark Heinrich reports a Joseph Smith-like first vision. Heinrich writes

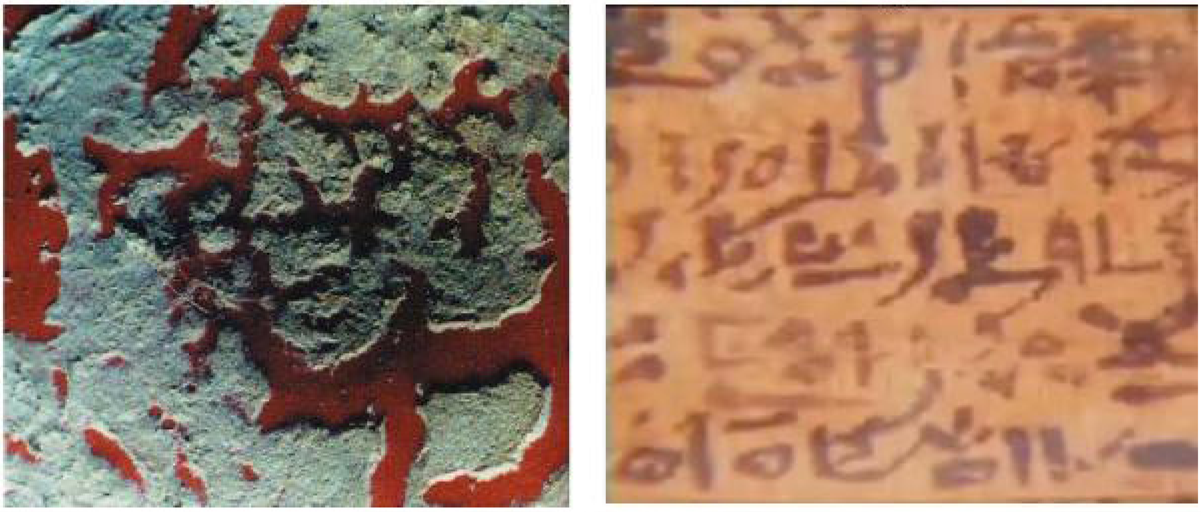
> I felt like I weighed thousands of pounds and could no longer sit up ... in the midst of a great darkness and a great silence, the heavens opened above my head. In an instant I was flooded with light from above, light of the utmost whiteness and splendor that quickly dissolved everything in its glory. The bliss I had experienced prior to this new revelation now paled to insignificance in an immensity of light that was also the purest love. As the truth of the situation dawned on me the word "FATHER" resounded in this heaven of light and I was taken up and absorbed by the unspeakable Godhead.

The similarity of Heinrich's vision to that of Joseph Smith's is remarkable including immobility, darkness, light appearing from above, a voice out of heaven, an experience with the Godhead and the feeling of indescribable joy. James Arthur reports that the *Amanita muscaria* "mushroom is also a symbiotic with the Birch tree, the trees which were in the Sacred Grove".[66]

On another occasion in which *Amanita muscaria* mushroom was ingested in a sacramental setting, Heinrich reported an experience reminiscent of the February 16, 1832 joint vision of Joseph Smith and Sydney Rigdon. This singular vision was manifested as they read from the *Book of John*. Similarly, Heinrich and a friend partook of the sacred *Amanita muscaria* sacrament, opened the *Bible* to the *Book of John* and reported having a singular spiritual experience.

I picked up a *Bible* from the bookshelf, opened to the *Book of John*, and started reading aloud. What I had before considered ridiculously partisan prose and poetry (fiction really) was now revealed in a whole new light. It became for us an [*Amanita muscaria*] initiation document, speaking the living truth directly to us through the mists of the centuries, uncovering layer after layer of meaning artfully hidden in the text. We understood it all; all the references, all the metaphors, all the hidden wisdom ... It was as though God had manifested from the book and was addressing us directly. And we couldn't have been happier.[67]

The *Amanita muscaria* mushroom may also have played a role in Joseph's account of the *Book of Mormon*'s origin. This sacred mushroom appears in the autumn of each year coinciding with Joseph's annual visits to the Hill Cumorah. Importantly, Joseph told his wife and his mother that he hid the gold plates in an oak and birch tree. Interestingly, *Amanita muscaria* mushroom grows in symbiotic relationship with both trees. The sacred mushroom is born underneath a tree as a small "pure brilliant white stone"[68] which is then transformed into a woolly lamb, then a brilliant red fruit; a constellation of sun, moon and stars and finally a gold plate upon which appears to be written strange hieroglyphs. On the left is a freshly picked shiny gold *Amanita muscaria* mushroom in its potent entheogenic form. The photo on the right is a collection of dried gold *Amanita muscaria* mushrooms that retain their entheogenic potency for up to a year.[69]



Amanita muscaria

Book of Abraham Papyrus

A comparison of a photo of an *Amanita muscaria* mushroom on the left with hieroglyphics from an Egyptian manuscript shows remarkable similarity. *Amanita muscaria* may also have occasioned Joseph's interest in translating. In a recent study conducted in Britain, ingestion of *Amanita muscaria* mushroom stirred a member of the test group to spontaneously translate an unknown language.

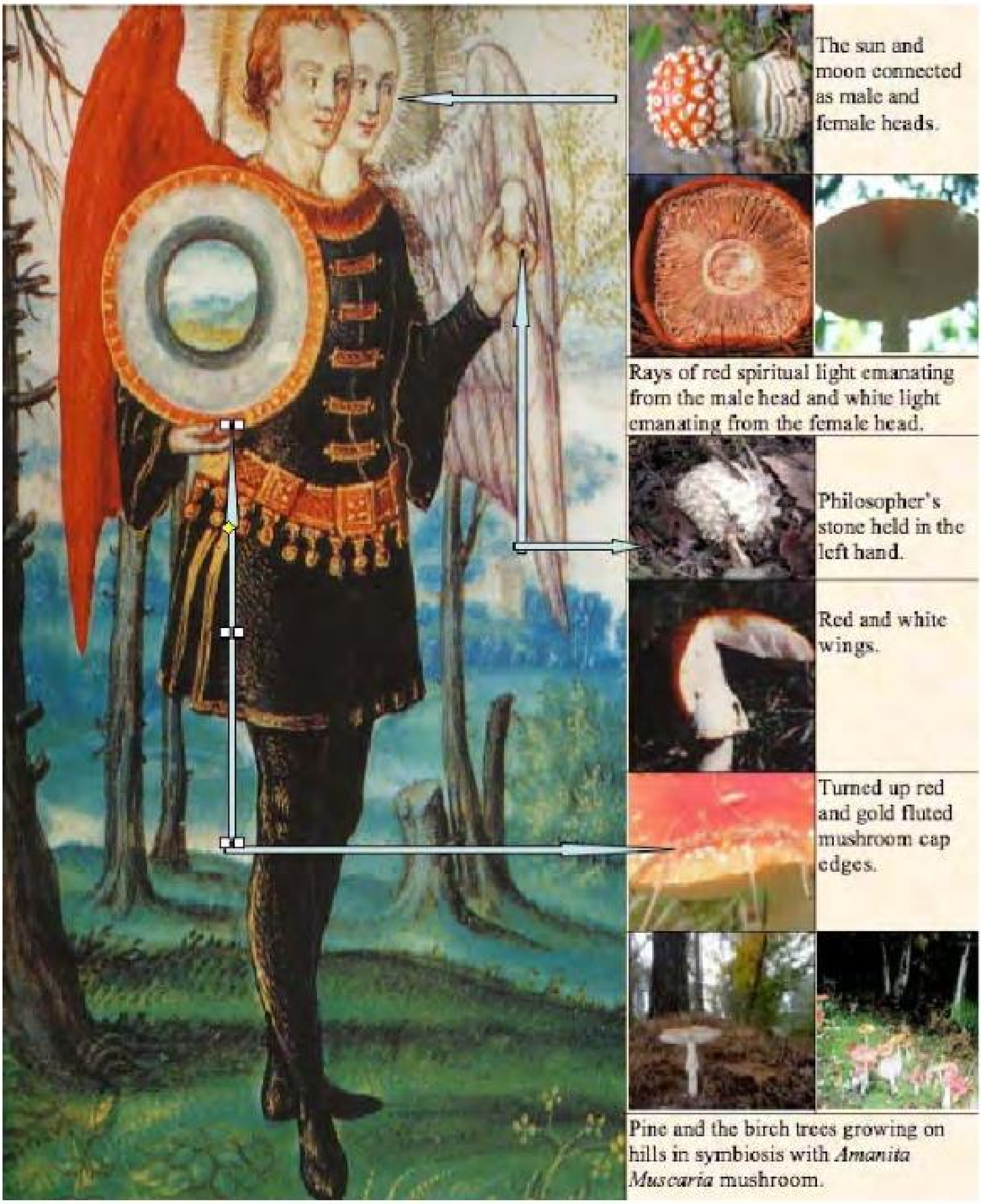
It also appears that Joseph may have been inebriated while composing the Book of Mormon. Martin Harris told A.C. Russell in 1834 that Joseph Smith was frequently intoxicated while translating.[70] It is possible that Joseph was not intoxicated as much with wine as with *Amanita muscaria* mushroom.

In addition to replicating aspects of Joseph Smith's visions and providing an allegorical story of gold plates upon which was written reformed Egyptian, a visionary mushroom is able to provoke Joseph Smith-like millennial zeal. In a 1962 experiment, visionary mushrooms were served to fifteen volunteers. As the entheogen began to take effect, one volunteer declared that he had been chosen by God "to announce to the world the dawning of the Messianic Age, a millennium of universal peace".[71]

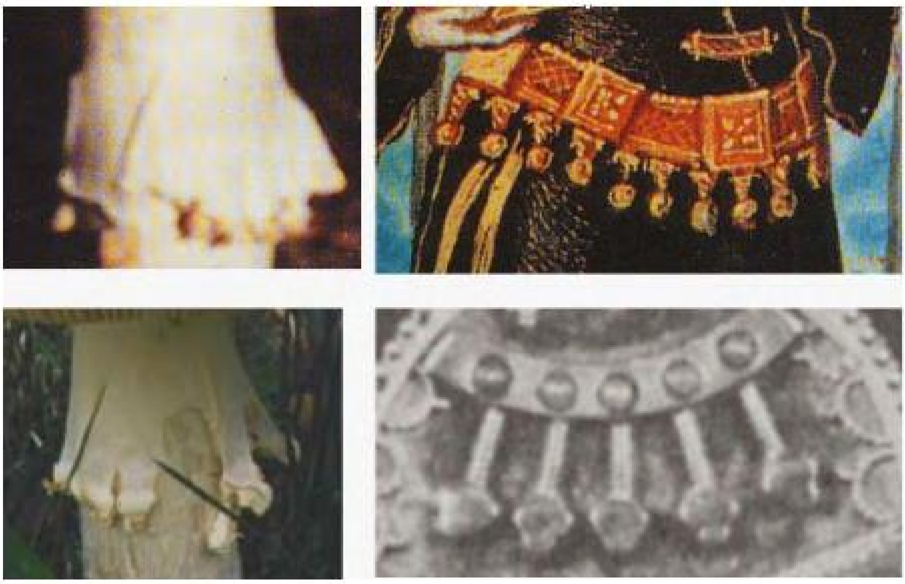
Moreover, *Amanita muscaria* is known to increase physical strength, aggressiveness and confidence to the point of grandiose behavior all defining characteristics of Joseph Smith's personality.

There may also be a connection between the *Amanita muscaria* mushroom, alchemical pictographic riddles and an amulet gifted by Joseph Smith to his most mystical plural wife, Eliza R. Snow.[72] While the rational for suggesting a connection between the *Amanita muscaria* mushroom and Joseph Smith's amulet is rather complex, it may be worth introducing the subject, which can be investigated further on www.mormonelixirs.org if one is interested.

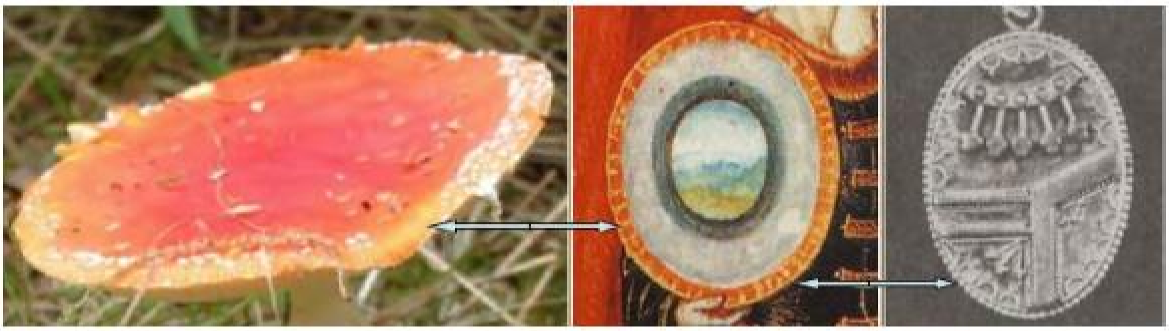
Lance Owens has demonstrated a connection between Joseph Smith and hermetic traditions including alchemy.[73] Alchemists were absorbed in pursuing *prima materia*, a single substance that occasioned a direct and personal experience of illumination.[74] Clark Heinrich has shown that the most likely candidate for the alchemical entheogen is the *Amanita muscaria* mushroom.[75] To avoid persecution, Heinrich explains that alchemists kept the identity of *Amanita muscaria* mushroom secret by creating pictographic riddles.


The sun and moon connected as male and female heads.
Rays of red spiritual light emanating from the male head and white light emanating from the female head.
Philosopher's stone held in the left hand.
Red and white wings.
Turned up red and gold fluted mushroom cap edges.
Pine and the birch trees growing on hills in symbiosis with *Amanita Muscaria* mushroom.

This 16th century alchemical pictographic[76] appears to be a personification of the *Amanita muscaria* mushroom.[77] Shown in the photos on the right are various stages of *Amanita muscaria* mushroom growth represented by the elements of the alchemical pictograph. Notice the figure's male and female heads representing the sun and moon phase of *Amanita muscaria* growth; the rays of red spiritual light emanating from the male head and the white spiritual light emanating from the female head represent the changing colors of the underside of the sacred mushroom cap; the philosopher's stone held in the left hand representing the brilliant white stage of early *Amanita muscaria* growth; the red and white wings representing the halved mushroom cap; the red and gold edged disk held in the figures right hand representing the red and gold fluted edges of a maturing upturned mushroom cap and finally the figure standing on a hill with pines to the left and the birches to the right representing the symbiotic relationship between those trees and the *Amanita muscaria* mushroom.



Another remarkable feature of the *Amanita muscaria* mushroom is the veil remnant found on the stem just underneath the cap. The veil's lower fringe appears to be trimmed with red-gold spheres dangling by ropes. This feature of the *Amanita muscaria* mushroom appears to be represented on the figures belt adorned with red-gold orbs. Further, there is a striking similarity between the personification of the *Amanita muscaria* veil on the figure's belt and the amulet belonging to Joseph Smith.

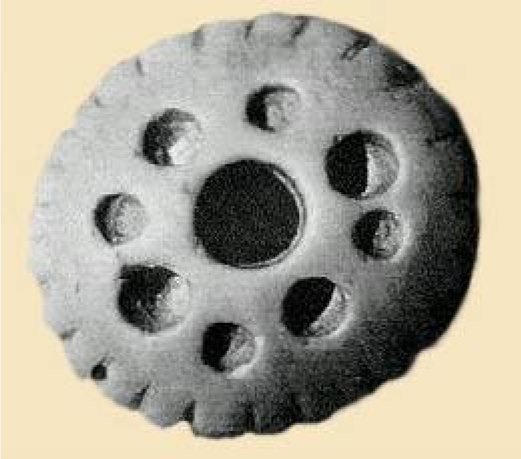


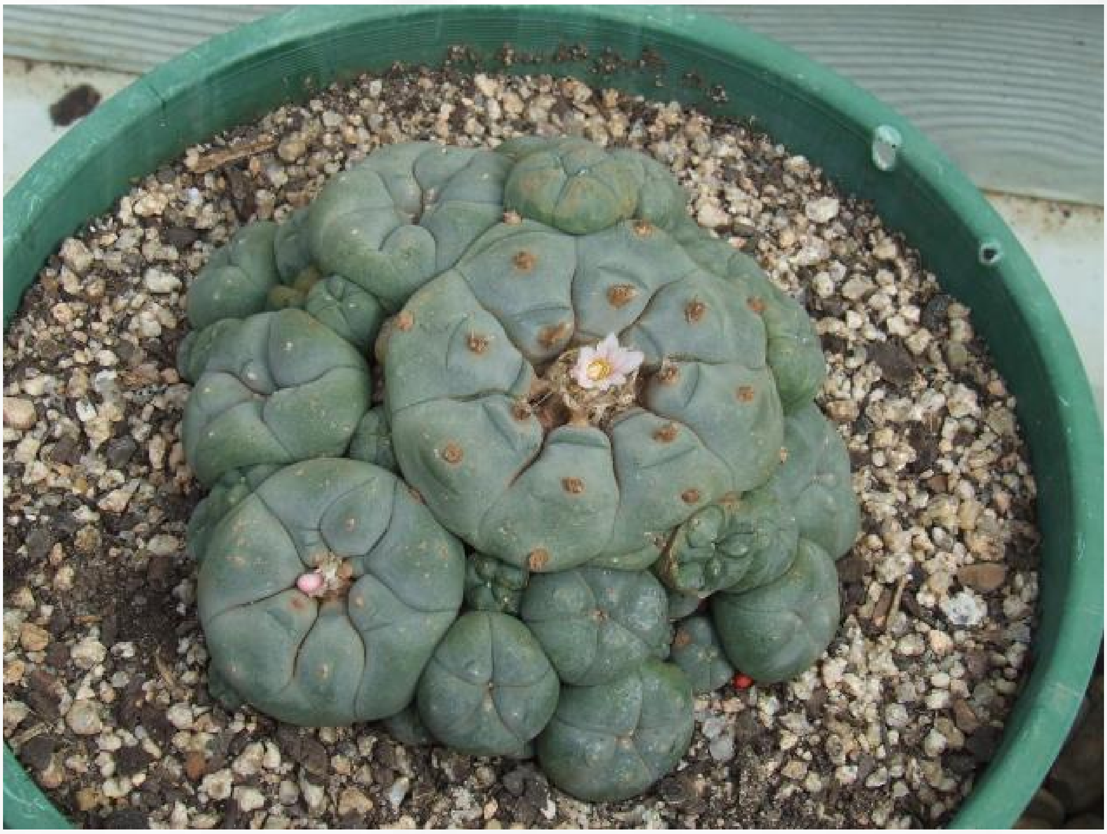
Another feature of the *Amanita muscaria* mushroom is the red and gold fluted edge of the mushrooms upturned cap. This appears to be represented in the red and gold fluted edge of the pictographic disk and on the outer edge of the Joseph Smith amulet. Other symbols on Joseph's amulet such as the compass and square, the down pointing arrows, the five orbs, and the half circles can be found on similar alchemical pictographs representing the *Amanita muscaria* mushroom.

In summary, the visionary *Amanita muscaria* mushroom appears as a meaningful thread in the Smith's dreams, in Joseph Smith Junior's first vision, in the account of Joseph finding the *Book of Mormon*, in the *Book of Mormon*'s translation, in the joint vision with Sidney Ridgon, in Joseph's strong and extravagant personality and in an alchemical amulet gifted to Eliza R. Snow.

Peyote

Another entheogen that can occasion experience which duplicates a portion of the *Book of Mormon* narrative, is the Peyote Cactus. At the time of his death, Joseph Smith possessed a seer stone shaped in the likeness of a visionary peyote button.





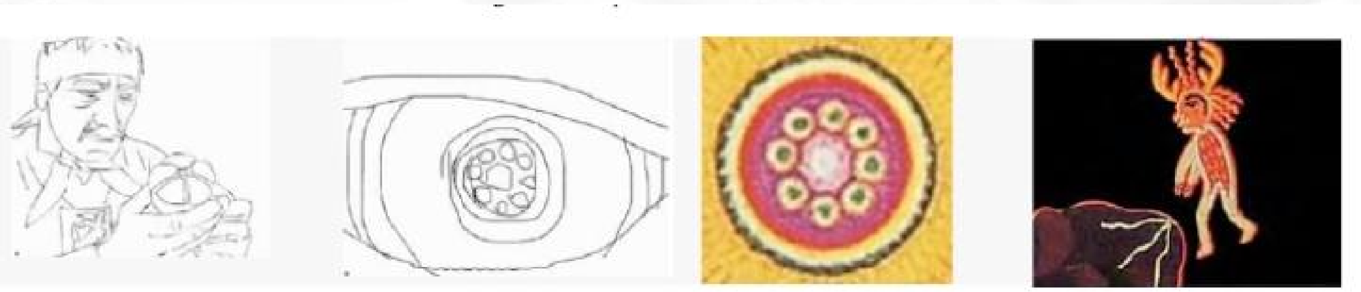
D. Michael Quinn writes that Joseph Smith found this stone, possibly in its rough unshaped form, along the Mississippi River's shore between 1839 and 1844. After Joseph's death, the stone was kept by Emma Smith and inherited by her second husband, Lewis Bidamon. It eventually made its way to the Wilford Wood Museum in Woods Cross, Utah. Quinn describes the stone as the size of a U.S. quarter dollar and "is the most intricate of those attributed to Smith. It has a hole through the center surrounded by eight smaller indentations, with tooled ridges around the edge".[78]

Gary R. Varner writes in *Menhirs, Domen and Circles of Stone: The Folklore and Magic of Sacred Stones* [Published 2004, Algora Publishing] in his introduction and on pages 14 and 15 that

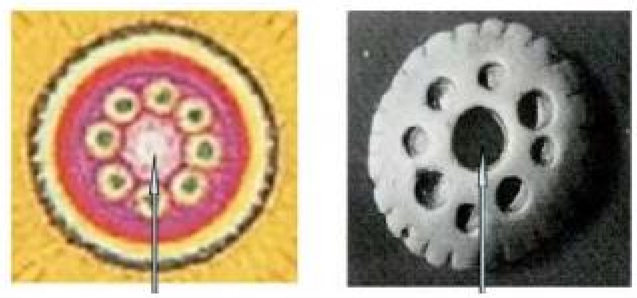
> Humans since the dawn of civilization have used stone to represent the holy, both by fashioning sacred symbols for themselves and by granting recognition to certain sites occurring naturally...

> Ethnographic evidence indicates that Comanche shamans used stones at least into the 1970's, if not later, in healing rituals. Ethologist David E. Jones wrote that a medicine woman he had studies "applied the stone peyote drum 'bosses' to the patient's face so that, through her powers, the positive qualities of these stones - firmness and stability - could be injected into the patient's contorted face to heal him." [Jones, David E. *Sanapia: Comanche Medicine Woman*. New York: Holt, Rinehart and Winston Case Studies in Cultural Anthropology, 1972, 96]
>
> Small stones with naturally occurring holes in them have been especially prized for their purported magical properties and in many cases, they were believed to be linked directly to the Goddess. In North Carolina, at least through the 1920s ... and Northumberland up to the early 20th century ... [and] in the Ozarks.

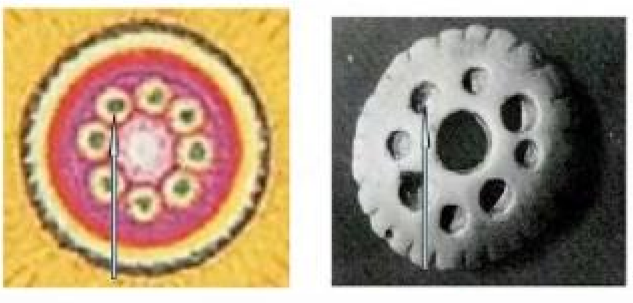
The peyote cactus resembles a pie cut in wedges, tufts of hair growing from each wedge and a central pinkish flower. To turn the Peyote cactus into a visionary sacrament, the hair tuffs of each pie shaped section are removed, the central flower is cored out and the tough bark is peeled off.[79]



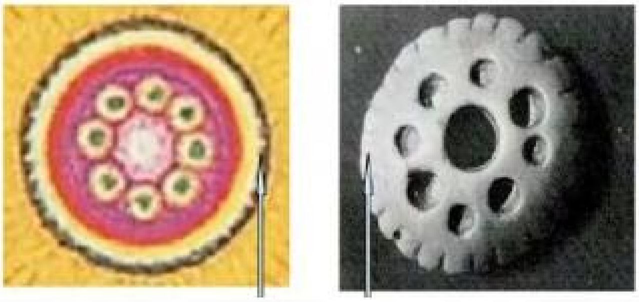
Shown above is a series of stills from a video[80] produced by a modern well educated Huichol Indian. The scenes depict a Shaman ingesting a prepared Peyote button and entering a visionary world. The first two images are of the shaman ritually contemplating the sacramental meal. Note the reflection of the peyote in the shaman's eye. This image has round edges, depressions where the tufts of hair were removed and a hole where the central flower was cored out. The next image is a depiction of the visionary transformation of the ingested peyote cactus demonstrated by its vivid colors and its scalloped edges radiating spiritual light, illuminating the spiritual world. The next photo shows a spirit or God seen in vision or perhaps the shaman in out-of-body flight.



Above is shown a comparison between the Huichol Indian representation of the visionary peyote cactus button and Joseph Smith's most intricate seer stone. There is a central hole allowing light to shine through in both the peyote cactus and the seer stone.



Surrounding the central hole on both the cactus and stone are eight circular depressions with shadows.



And finally, the edges of the visionary cactus and stone are both scalloped suggesting its entheogenic property of illuminating the spiritual world.

Why would Joseph Smith have a visionary peyote stone? What could peyote have to do with Joseph's visionary experience? The answer may be that peyote put Joseph Smith in contact with ancient Amerindian cultures gifting him with the material that was later incorporated into the *Book of Mormon*. The experience occasioned by mescaline, the psychoactive component of peyote, in a modern user replicates an account of Joseph Smith's boyhood visionary knowledge of the ancient Amerindian. Joseph's mother, Lucy Mack noted that even before receiving the gold plates, her son was gifted with an extensive knowledge of the inhabitants of ancient America.

> During our evening conversations, Joseph would … describe the ancient inhabitants of this continent, their dress, mode of traveling, and the animals upon which they rode; their cities, their buildings with every particular; their mode of warfare; and also their religious worship. This he would do with as much ease, seemingly, as if he had spent his whole life with them.[81]

A cactus like Peyote that contains mescaline could have occasioned direct experience with ancient Amerindian cultures.

Earl Crockett, a successful businessman and amateur ethnobotonist, gave an account that replicates Joseph Smith's recitals of ancient Amerindian culture. In a 2005 report, Crockett indicated that sometime earlier he had taken mescaline while sitting near a cave used by a mysterious Baja California Indian tribe that vanished long ago. After ingesting the cactus, Crockett explains

> I'm sitting there for however, who knows long, eyes open and I look up above the canyon wall and there's Venus. And this light came down from Venus and I went back up it and was gone. I learned who they were, how they dressed, how they got there, on and on and on and on and on.[82]

Interestingly, Joseph Smith's grandson, Frederick M. Smith, president of the Reorganized Church of Jesus Christ of Latter-day Saints participated in Amerindian peyote ceremonies. Shelby M. Barnes reports that President Smith experimented with peyote as early as 1913 and notes that President Smith

> … widely used [peyote] … [opening his mind] to the mysteries of human ecstasy as an essential element of religion … He was convinced that every human being had the potential to expand the limits of his or her mind.[83]

Like his great grandfather, Joseph Smith Junior, President Frederick M. Smith felt that even the least Saint should have access to the heavenly realms. In 1919, President Smith encouraged others in the RLDS Church to use peyote in a controlled manner[84] and defended peyote ceremonies from Federal intrusion.

Weaknesses of the Entheogenic Theory of Mormon Origins

It is theorized that psychedelics substances disinhibit unconscious material from reaching conscious awareness. Jung suggested that unconscious material, especially material in the collective unconscious is represented by myth and symbols. It is possible that Joseph Smith's genetic heritage combined with severel psychological and physical trauma when seven years old made material in Joseph Smith's unconscious easily "bleed" into the conscious during periods of meditation or stress. In this case, there is a low threshold for the release of endogenous psychedelics such as DMT (Dimethyltryptamine) that may have facilitated visionary experiences. In this case, exogenous psychedelics would not have been necessary. Additionally, it is possible that Joseph Smith selected men such as himself who had low thresholds for release of DMT. This seeker psyche was expunged from the church because of their destabilizing influence as suggested by Richard Bushman. In this case, the Kirkland excesses highly suggestive of exogenous psychedelics were unauthorized by Joseph Smith and the visions associated with the Kirtland temple were the result of the seeker psyche rather than psychedelics.

Even if the entheogenic theory of Mormon origins is incorrect, there is little doubt that psychedelics can facilitate visionary experiences remarkably similar if not indistinguishable from those experienced by Joseph Smith and early Mormon converts. If the final pathway for this visions is a psychedelic substance, whether externally administered or internally released, should seekers without a genetic disposition, be discouraged from taking psychedelics in a set and setting that is both suitable and safe? The primary transcendent experience, for some, is undoubtedly a boon, relieving depression and existential anxieties.

Implications

As Richard Bushman noted, it was Joseph Smith himself that connected early Mormon converts to heavenly visions and spiritual raptures by a power that he, himself possessed.[85] It is to the mystery of Joseph Smith's spiritual power that this presentation has addressed itself. This presentation has theorized that the main origin and ongoing wellspring of Joseph's spiritual power was his skilled utilization of the visionary *Datura* plant, the sacred *Amanita muscaria* mushroom and the revered peyote cactus. These natural chemical disinhibited the unconscious mind and by excluding light, revelations of mythic quality were generated. In the administration of these entheogens, it is hypothesized that Joseph Smith (using ritual i.e. set, setting, substance, support) was able to gift his followers with access to God and spiritual dimensions without the years of fasting, isolation, and self-torture employed by other mystic and spiritual leaders.

If the entheogen theory of the rise of Mormonism proves to be correct, it is probable that if Joseph Smith had lived to complete the Nauvoo temple, the visionary experiences surrounding its dedication would have eclipsed those of the Kirtland Pentecost in both glory and power. Further, there is reason to conjecture that if Joseph Smith had lived to be 85 as he speculated he might,[86] members would not have been asking in 1864 "why it is that we do not see more angels, have more visions, that we do not see greater and more manifestations of power [as did the first converts and leadership]?"

The fact that members of the LDS Church must look backward to the early years of the "restoration" suggests that Mormon Church had lost its mystical core early in its history. David Steindl-Rast addressed the question of the mystic in organized religion when he writes:

Mysticism has been democratized in our day. Not so long ago, "real" mystics were those who had visions, levitations, and bilocations and, most important, were those who had lived in the past; any contemporary mystic was surely a fake (if not a witch). Today, we realize that extraordinary mystical phenomena have little to do with the essence of mysticism. (Of course, genuine mystics had told us this all along; we just wouldn't listen.) We've come to understand mysticism as the experience of communion with Ultimate Reality (i.e., with "God," if you feel comfortable with this time-honored, but also time-distorted term).

Many of us experience a sense of communion with Ultimate Reality once in a while. In our best, most alive moments, we feel somehow one with that fundamental whatever-it-is that keeps us all going. Even psychological research suggests that the experience of communion with Ultimate Reality is nearly universal among humans. So we find ourselves officially recognized as bona fide mystics. Some of us even sense the challenge to translate the bliss of universal communion into the nitty-gritty of human community in daily living. That's certainly a step forward.

Like every step forward in life, however, the discovery of mysticism as everyone's inalienable right brings with it a puzzling tension. Those who feel this tension most keenly are people who have long been members of an established religion, with its doctrines, ethical precepts, and rites. They may discover the mystical reality inside the religious establishment or outside of it: either in church or on a mountaintop, while listening to

Bach's BMinor Mass, or while watching a sunset. In any case, but especially out in nature, those who taste mystical ecstasy may begin to sense a discrepancy between this undeniably religious experience and the forms that normally pass as religious. If the religious pursuit is essentially the human quest for meaning, then these most meaningful moments of human existence must certainly be called "religious." They are, in fact, quickly recognized as the very heart of religion, especially by people who have the good fortune of feeling at home in a religious tradition. And yet, the body of religion doesn't always accept its heart. This can happen in any religious tradition, Eastern or Western. To the establishment, after all, mysticism is suspect. The established religion asks: Why is there a need for absorption in the Cloud of Unknowing when we have spelled out everything so clearly? And isn't that emphasis on personal experience a bit egocentric? Who can be sure that people standing on their own feet won't go their own way? These suspicions gave rise to the famous saying that "myst-i-cism begins with mist, puts the I in the center, and ends in schism." ...

The question we need to tackle is this: How does one get from mystic experience to an established religion? My one-word answer is: inevitably. What makes the process inevitable is that we do with our mystical experience what we do with every experience, that is, we try to understand it; we opt for or against it; we express our feelings with regard to it. Do this with your mystical experience and you have all the makings of a religion. This can be shown.[87]

If the entheogen theory of the rise of Mormonism proves to be correct, it is probable that if Joseph Smith had lived to complete the Nauvoo temple, the visionary experiences surrounding its dedication would have eclipsed those of the Kirtland Pentecost in both glory and power. Further, there is reason to conjecture that if Joseph Smith had lived to be 85 as he speculated he might,[86] members would not have been asking in 1864 "why it is that we do not see more angels, have more visions, that we do not see greater and more manifestations of power [as did the first converts and leadership]?"

Links

- Psychedelics & the Transcendent Experience
- Psychedelic Safety

Appendices

James Arthur & Alex Andoven. *The Golden Mushroom Plates of Mormonism: Did Joseph Smith, the Founder of the Latter Day Saints (Mormon) Religion, Consume Psychedelic Fungi?* Unpublished. A selection from the unfinished chapter titled "The Host". Found at http://groups.yahoo.com/group/egodeath/message/4011

Many organisms are parasitic but others, which are associated with a host life form, are not. They are Symbiotic life forms, living in harmony with another life form and thriving off of its energy and substance while also feeding the other with its own energy and substance. Mushrooms do this very thing, and the *Amanita* is one of the most famous for it. The mushroom grows in a relationship with coniferous trees (Pine, Spruce, Cedar etc.) because the mushroom is only the fruit of a bigger organism, which actually lives underground. This is the mushroom's main body, mycelium, an organism that is symbiotic with the tree because it is attached to the tree's root system and thrives off of the energy and substance of the tree, from its roots. The mycelium is the host for the tree and the tree is the host for the mycelium, and thus the mushroom, and these hosts live in a Mycorhizzal Symbiotic relationships with each other. So the mushroom is a host in the botanical, ethnobotanical, esoteric, magickal, occultic, alchemical senses of the word. The mushroom can also be seen, by a visionary imbiber, as a host for a state of mind, the host to a party in an extra dimensional realm, the host for a visit to another state of consciousness. The lord of hosts in this regard can also be interpreted to mean; of all the hosts that the planet has to offer, in this sense, Peyote, *Psilocybe* (another species of entheogenic mushrooms), Marijuana, Opium Poppies, Coca leaves etc. The Lord of all hosts is the *Amanita muscaria*. Certainly it has more religious connections than any other specific entheogen. Its appearance, striking color and majesty (Kings crowns, robes, and scepters are designed after its likeness) make it a brilliant and obvious living presence on our planet. The Lord of Hosts is a perfect euphemism for the mushroom and its esoteric interpretation, in this sense, expounds on the understanding of the meaning of the religion, as a good, deeper, secret revelation should. Of course, as would be expected, another meaning for the term host is the sacramental water, or consecrated bread, which is of course the body of jesus, the mushroom, the hidden manna, the host which lives under the Pine tree ('Christmas tree') it's host. It bears mentioning here again that the mushroom is also a symbiotic with the Birch tree, the trees which were in the Sacred Grove.

Delusions of Grandeur

It is no secret that Joseph Smith believed himself to be a messianic figure, the one man capable of ushering in the millinial reign of Jesus Christ. Where could this distortion of reality originated? One possiblility is the use of psychedelics.

One of the major negative side effect of psychedelic experimentation is delusional ideation, and one of the most common pathologies associated with frequent high-dose psychedelic experimentation is persistent recurring delusions of grandeur. Delusional ideation within the psychedelic state is to be expected; but when delusional ideations cross the boundary from dream-state into waking state, this is where the trouble begins...

The first thing to keep in mind is that persistent recurring delusions of grandeur (PRDoG) don't typically take hold after a single isolated psychedelic voyage. Though one might run up against some savory delusional, messianic, or paranoid ideation in a single trip, the content derived from a single psychedelic session is often easily forgotten, dismissed, or toyed with for a while before it simply fades away. The key patterns we are looking for when approaching persistent delusions of grandeur are 1) high dose ranges, 2) high frequency of use, 3) ingestion contexts which isolate the user from external stimulus, and 4) ingestion contexts that revolve around repetitive rituals, themes, or patterns. (James Kent, Psychedelic Information Theory: Chapter 20: Messianic Ideation & Delusions of Grandeur. http://www.tripzine.com/listing.php?id=pit_toc)

Footnotes

1. http://www.lds.org
2. Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. p. 113. See page 147 where it read, "In one affidavit, the Palmyra neighbors observed that all with whom we were acquainted, that have embraced Mormonism from this neighborhood, we are compelled to say, were very visionary, and most of them destitute of moral character."
3. Except in the faction of the Church, including many of the Joseph Smith family that followed James Strang.
4. In 1864, Apostle George A. Smith observed: "The question has often arisen among us, why it is that we do not see more angels, have more visions, that we do not see greater and more manifestations of power." George Albert Smith. 1864. See: http://www.journalofdiscourses.org/Vol_11/refJDvol11-1.html. Other examples of aberrational behavior are discussed later in the presentation. See also Harold Bloom, "If there is any spiritual continuity between [Joseph Smith] and Gordon B. Hinkley, I am unable to see it. No disrespect is intended by that observation." Bloom, H. (2007). Perspectivism and Joseph Smith. *Sunstone Magazine*, Issue 145, p. 18-19.
5. Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. P. 560. See also Jan Shipps who wrote, "The mystery of Mormonism cannot be solved until we solve the mystery of Joseph Smith himself." http://www.signaturebooks.com/reviews/prophet.htm.
6. http://dictionary.reference.com/browse/entheogen
7. Robert C. Fuller. *Stairways to Heaven: Drugs in American Religious History*. Boulder, Colo.: Westview. 2000. as quoted in Stephen Hoeller, Misca-06
8. http://www.psychedelic-library.org/books/ecstatic5.htm
9. http://www.imaginaria.org/wasson/life.htm
10. Smith, H. (2003). *Cleansing the Doors of Perception: The Religious Significance of Entheogenic Plans and Chemicals*. Boulder, Colorado: Sentient Publications. P. 52
11. Smith, H. (2000). *Cleansing the Doors of Perception: The Religious Significance of Entheogenic Plans and Chemicals*. Boulder, Colorado: Sentient Publications. p. 10-11
    11 b. Smith, H. (2000). *Psychoactive Sacramentals: Essays on Entheogens and Religion No, 3 in the Entheogen Project Series*. San Francisco, CA.
12. Michael S. Hoffman. *Entheogenic Theory of Religion and Ego Death*. September 24, 2006 Salvia Divinorum Magazine, Issue 4.)
13. Hofmann, Schultes, & Ratsch 1992
14. Heinrich 1994
15. Ruck, Staples, & Heinrich 2001
16. ÅKE HULTKRANZ is Professor Emeritus of Comparative Religion at the University of Stockholm and recognized as a world authority on Native American religions and shamanism. His is the author of nearly twenty books, including THE RELIGIONS OF THE AMERICAN INDIANS and SHAMANIC HEALING AND RITUAL DRAMA: HEALTH AND MEDICINE IN THE NATIVE NORTH AMERICAN RELIGIOUS TRADITIONS. Åke is quoted by C. Jess Groessbeck.
17. Hultkrantz, A. (1967). *The Religions of the American Indians*. Berkeley, California: University of California Press. P. 153
18. Michael S. Hoffman. *Entheogenic Theory of Religion and Ego Death*. September 24, 2006 Salvia Divinorum Magazine, Issue 4.
19. C. Jess Groesbeck. *The Shaman's Visions*. Sunstone Symposium 1985; *Joseph Smith And The Translation Of The Book Of*

Mormon, A Huichol Indian Parallel Sustone Symposium 1990. *Joseph Smith and the Shaman's Vision: A Forgotten Paradigm for the Life of the Mormon Prophet*. Sunstone Symposium 2005

20. *Datura*: http://www.erowid.org/library/books_online/golden_guide/g141-150.shtml http://leda.lycaeum.org/?ID=16212; *Amanita muscaria*: Heinrich, C. (2002). *Magic Mushrooms in Religion and Alchemy*. Rochester, New York: Park Street Press. P. 209-212.
21. http://www.luckymojo.com/hoodooherbmagic.html; http://www.luckymojo.com/hoodoo.html; http://www.luckymojo.com/hoodoohistory.html#hoodoois; http://www.imperiouspublishing.com/DrBuzzard_Book1_SampleBook_rev3.pdf
22. http://www.ubersite.com/m/82759
23. Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. P. 107, 131
24. Heinrich, C. (2002). *Magic Mushrooms in Religion and Alchemy*. Rochester, New York: Park Street Press.
25. Lance Owens 1994a. Owens explains "Walter was a distant cousin of Smith's future wife and a member of the circle associated with Smith's early treasure quests. By contemporary reports he was not only a physician, but a magician and mesmerist who had traveled extensively in Europe to obtain 'profound learning' - probably including knowledge of alchemy, Paracelcian medicine, and hermetic lore."
26. http://www.cradleboard.org/curriculum/powwow/supplements/images/a_trading.gif
27. Petersen, L. (1975). *Hearts Made Glad: The Charges of Intemperance Against Joseph Smith the Mormon Prophet*. Salt Lake City, Utah: p. 90. It is likely that early converts were totally unaware of the tainted wine, bread and anointing oil. In 1855, Sir Joseph Hooker reported that thieves would haunt way stations where a traveler might rest and place "pounded or whole *Datura* seeds into his food, producing a twenty-hours intoxication, during which he is robbed"
28. http://www.saintswithouthalos.com/m/300609.phtml End of the quote: "beds ... brother Newel Knight, who had to be placed on a bed, being unable to help himself ... all of a sudden ... saw the heaven opened, and beheld the Lord Jesus Christ seated at the right hand of the Majesty on high... When their bodily strength was restored to these brethren, they ... rehearsed the glorious things which they had seen and felt, whilst they were yet in the spirit"
29. Kirtland High Council Minutes (December 1832-November 1837). P. 16-17. Selected Collections, 1:19 // New Mormon Studies CD-ROM. Original, Church Archives, MS 3432. Found at http://www.saintswithouthalos.com/m/330318.phtml#equal LDS History of the Church, Vol I. p. 283. See also at http://www.centerplace.org/history/ch/v1ch11.htm
30. http://www.boap.org/LDS/Early-Saints/ERobinson.html
31. Pendell, D. (2005). *PharmakoGnosis: Plant Teachers and the Poison Path*. San Francisco, California: Mercury House. P. 263
32. JS, Journal, Jan. 21, 1836, in PJS, 2:157-58; CR Cowdery, "Sketch Book," 419 (Jan 21, 1836 Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. P. 312, 313 "... Edward Partridge wrote that "a number saw visions & others were blessed with the outpouring of the Holy Ghost. The vision of heaven was opened to these also, some of them saw the face of the Savior, and others were ministered unto by holy angels".
33. Millennial Star 15:726-728. See also Lamar Petersen, *Hearts Made Glad*, Salt Lake City Utah 1975, p. 124-125. See also http://restorationbookstore.org/prints/kirtlandtempleded.htm
34. "Diary of Charles L. Walker," 1855-1902, excerpts typed, 1969, p. 35. Cited http://www.utlm.org/onlinebooks/changecontents.htm (pages 479 - 481)
35. History of the Church 2:434-435. See also Notes and Comments, *BYU Studies*, vol. 15 (1974-1975), Number 4 - Summer 1975 551.) D&C 110.
36. who helped with the *Times and Seasons*
37. Ebenezer Robinson, "Items of Personal history of the Editor," *The Return*, I (June, 1889), 88-91. As found in Lamar Petersen, *Hearts Made Glad*, Salt Lake City Utah 1975, p. 139. Also found at http://www.boap.org/LDS/Early-Saints/ERobinson.html
38. *Hearts Made Glad*, Salt Lake City Utah 1975, p. 79
39. J. J. Moss letter to J. T. Cobb dated Dec. 17, 1878. Found at http://solomonspalding.com/docs/Wil1878a.htm
40. George Albert Smith. 1864. See: http://www.journalofdiscourses.org/Vol_11/refJDvol11-1.html. Other examples of aberrational behavior are discussed later in the presentation. See also Harold Bloom, "If there is any spiritual continuity between [Joseph Smith] and Gordon B. Hinkley, I am unable to see it. No disrespect is intended by that observation." Bloom, H. (2007). Perspectivism and Joseph Smith. *Sunstone Magazine*, Issue 145, p. 18-19.
41. Found in Lamar Petersen, *Hearts Made Glad*, Salt Lake City Utah 1975, p. 81
42. Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. p. 151.
43. *History of the Church*. IV (April 1, 1842), 580. See George A. Smith's account of Joseph Smith description: George Albert Smith. 1864. See: http://www.journalofdiscourses.org/Vol_11/refJDvol11-1.html.
44. George Albert Smith. 1864. See: http://www.journalofdiscourses.org/Vol_11/refJDvol11-1.html. Other examples of aberrational behavior are discussed later in the presentation. See also Harold Bloom, "If there is any spiritual continuity between [Joseph Smith] and Gordon B. Hinkley, I am unable to see it. No disrespect is intended by that observation." Bloom, H. (2007). Perspectivism and Joseph Smith. *Sunstone Magazine*, Issue 145, p. 18-19.
45. Found in Lamar Petersen, *Hearts Made Glad*, Salt Lake City Utah 1975, p. 81
46. Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. p. 151.
47. *History of the Church*. IV (April 1, 1842), 580. See George A. Smith's account of Joseph Smith description: George Albert Smith. 1864. See: http://www.journalofdiscourses.org/Vol_11/refJDvol11-1.html.
48. http://eldenwatson.net/harmony.htm
49. Instructions given by Joseph Smith, Nauvoo, Illinois, February 9, 1843. History of the Church 5:267.
50. Petersen, L. (1975). Hearts Made Glad: The Charges of Intemperance Against Joseph Smith the Mormon Prophet. Salt Lake City, Utah: p. 81.
51. Bushman, R. L. (2005). Joseph Smith: Rough Stone Rolling. New York: Alfred A. Knopf. P. 156-157.
52. http://www.sidneyrigdon.com/dbroadhu/NE/miscne01.htm
53. Leut. J.W. Gunnison: The Mormons, or, Latter-Day Saints (Philadelphia: J.B. Lippincott & Col.: 1852, 107 as found in Lamar Petersen, *Hearts Made Glad*, Salt Lake City Utah 1975, p. 133.

54. http://www.signaturebookslibrary.org/dalemorgan/daleappendixb.htm
55. http://www.reference.com/browse/wiki/Sleight_of_hand
56. http://olivercowdery.com/smithhome/1840s/1843Cas1.htm
57. J. J. Moss to James T. Cobb, Dec. 17, 1878, original in A. T. Schroeder Collection, Wisconsin State Historical Society). Found at http://www.sidneyrigdon.com/dbroadhu/OH/miscoh08.htm
58. Demming, Naked Truths (April, 1888), pp. 2-3. As found in Lamar Petersen, *Hearts Made Glad*, Salt Lake City Utah 1975, p. 135.
59. Merkur, D. (2000). *The Mystery of Manna: The Psychedelic Sacrament of the Bible*. Rochester, Vermont: Park Street Press.
60. Clark Heinrich. *Magic Mushrooms in Religion and Alchemy*. Park Street Press, Rochester Vermont 2002. See also http://egodeath.com.
61. Richard Bushman, 2005a. p. 18.
62. Richard Evans Schultes, A. H. a. C. R. (2001). *Plants of the Gods: Their Sacred, Healing, and Hallucinogenic Powers*. Rochester, Vermont: Healing Arts Press.
63. *Biographical Sketches of Joseph Smith the Prophet and His Progenitors*. Lamoni, Iowa: The Church of Jesus Christ of Latter Day Saints, 1912, reprinted 1969. P. 57-58. Photo reprint available at Utah Light House Ministries, Salt Lake City. Online version at http://www.centerplace.org/history/misc/jsp.htm See also Vogel, D. (2004). *Joseph Smith: The Making of a Prophet*. Salt Lake City, Utah: Signature Books. p. 15-19. n 1811,
64. *Biographical Sketches of Joseph Smith the Prophet and His Progenitors*. Lamoni, Iowa: The Church of Jesus Christ of Latter Day Saints, 1912, reprinted 1969. P. 57-58. Photo reprint available at Utah Light House Ministries, Salt Lake City. Online version at http://www.centerplace.org/history/misc/jsp.htm See also Vogel, D. (2004). *Joseph Smith: The Making of a Prophet*. Salt Lake City, Utah: Signature Books. p. 15-19. n 1811
65. On this later point, I would recommend reviewing Thomas Alexander's 1980 and my 2003 Sunstone presentation to understand why Joseph Smith would have experienced God as a trinity of Father, Son and Holy Ghost. If this last point is correct, Joseph Smith's first vision was replicated in the 1977 experience of Clark Heinrich. Thomas G. Alexander, Chairman Honors Department BYU. *The Reconstruction of Mormon Doctrine: From Joseph Smith to Progressive Theology*. Sunstone, July-August 1980.
66. Andoven, James Arthur & Alex. The Golden Mushroom Plates of Mormonism: Did Joseph Smith, the Founder of the Latter Day Saints (Mormon) Religion, Consume Psychedelic Fungi? Unpublished. Unfinished chapter "The Host". Copy published Jul 3, 2005 by James Arthur found at http://groups.yahoo.com/group/egodeath/message/4011
67. Clark Heinrich. *Magic Mushrooms in Religion and Alchemy*. Park Street Press, Rochester Vermont 2002.
68. Clark Heinrich. *Magic Mushrooms in Religion and Alchemy*. Park Street Press, Rochester Vermont 2002. p. 14.
69. Additionally the psychedelic component of *Amanita muscaria* can be extract by soaking it in water, which turns a faint wine color from rosy red to faintly golden.
70. Church History Vol II Found at http://www.exmormon.org/mhistpart4.html
71. Smith, H. (2000). *Cleansing the Doors of Perception: The Religious Significance of Entheogenic Plants and Chemicals*. Boulder, Colorado: Sentient Publications. 101 - 103.
72. Quinn, D. M. (1998). *Early Mormonism and the Magic World View*. Salt Lake City, Utah: Signature Books. Figure 40.
73. Lance S. Owens, Joseph Smith and Kabbala: The Occult Connection, Dialogue a Journal of Mormon Thought. P. 117-194.
74. Lance S. Owens, Joseph Smith and Kabbala: The Occult Connection, Dialogue a Journal of Mormon Thought. P. 117-194.
75. Richard Evans Schultes, A. H. a. C. R. (2001). *Plants of the Gods: Their Sacred, Healing, and Hallucinogenic Powers*. Rochester, Vermont: Healing Arts Press.
76. http://www.levity.com/alchemy/splensol.html
77. Heinrich, C. (2002). *Magic Mushrooms in Religion and Alchemy*. Rochester, New York: Park Street Press. p. 172.
78. D. Michael Quinn. 1998a p. 246-247.
79. Dale Pendell, 2005b:338.
80. http://www.youtube.com/watch?v=Tf4H8sS6F9c
81. Smith, L. M. (1853). *Biographical Sketches of Jsoeph Smith the Prophet, and His Progenitors for many Generations*. Liverpool, England: S.W. Richards. P. 85.
82. http://www.podcastblaster.com/directory/podcast-19161.html
83. Shelby M. Barnes, "The Higher Powers: Fred M. Smith and the Peyote Ceremonies," *Dialogue: A Journal of Mormon Thought*, Vol. 28, No. 4, Winter 1995, p. 9l-99.
84. Frederick Madison Smith, "Preparation," *Saints Herald*, 19 Aug. 1914, 783-85. See http://help4rlds.com/ch_2.htm#_ftn16
85. Bushman, R. L. (2005). *Joseph Smith: Rough Stone Rolling*. New York: Alfred A. Knopf. P. 560. See also Jan Shipps who wrote, "The mystery of Mormonism cannot be solved until we solve the mystery of Joseph Smith himself." http://www.signaturebooks.com/reviews/prophet.htm.
86. History of the Church, Vol.5, pp. 336-37
87. David Steindl-Rast. The Mystical Core of Organized Religion. First appeared in *ReVision*, Summer 1989 12(1):11-14. Digital copy found at http://www.csp.org/experience/docs/steindl-mystical.html.

Psychedelics, Meditation, and Self-Consciousness

by

Raphaël Millière[1*], Robin L. Carhart-Harris[2], Leor Roseman[2], Fynn-Mathis Trautwein[3] and Aviva Berkovich-Ohana[4*]

Frontiers in Psychology: September 2018, Volume 9, Article 1475

published: 04 September 2018 doi: 10.3389/fpsyg.2018.01475

© authors 2018

original report: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6137697/pdf/fpsyg-09-01475.pdf
backup source: https://www.psilosophy.info/resources/fpsyg-09-01475.pdf

[1] Faculty of Philosophy, University of Oxford, Oxford, United Kingdom,
[2] Psychedelic Research Group, Psychopharmacology Unit, Department of Medicine, Centre for Psychiatry, Imperial College London, London, United Kingdom,
[3] Department of Social Neuroscience, Max-Planck-Institut für Kognitions- und Neurowissenschaften, Leipzig, Germany,
[4] Faculty of Education, Edmond Safra Brain Research Center, University of Haifa, Haifa, Israel

OPEN ACCESS
Edited by: Jennifer Michelle Windt, Monash University, Australia
Reviewed by: Chris Letheby, University of Adelaide, Australia Monima Chadha, Monash University, Australia
***Correspondence**: Raphaël Millière raphael.milliere@philosophy.ox.ac.uk Aviva Berkovich-Ohana avivabo@edu.haifa.ac.il
Specialty section: This article was submitted to Theoretical and Philosophical Psychology, a section of the journal Frontiers in Psychology
Citation: Millière R, Carhart-Harris RL, Roseman L, Trautwein F-M and Berkovich-Ohana A (2018) Psychedelics, Meditation, and Self-Consciousness. Front. Psychol. 9:1475. doi: 10.3389/fpsyg.2018.01475

Copyright © 2018 Millière, Carhart-Harris, Roseman, Trautwein and BerkovichOhana. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Table of Contents:

Abstract
Introduction
The nuroscience of meditation and psychedelics: an overview
- Neural Correlates of Meditative Practices
- Neural Correlates of Psychedelic States

Alterations of self-consciousness induced by meditation and psychedelics
- Disruption of Narrative Aspects of Self-Consciousness
- Disruption of Multisensory Aspects of Self-Consciousness
  - *The Sense of Body Ownership*
  - *Bodily Awareness*
  - *Spatial Self-Location*

Pure consciousness, non-dual awareness and total selflessness
- Non-dual Awareness
- Pure Consciousness

Toward a multidimensional model of altered self-consciousness
Long-term outcomes of altered self-consciousness
- Selflessness as a Trait
- Relation to Therapeutic Outcomes, Well-Being and Prosociality

General conclusion
Author contributions
Funding
Acknowledgements
References

Abstract

In recent years, the scientific study of meditation and psychedelic drugs has seen remarkable developments. The increased focus on meditation in cognitive neuroscience has led to a cross-cultural classification of standard meditation styles validated by functional and structural neuroanatomical data. Meanwhile, the renaissance of psychedelic research has shed light on the neurophysiology of altered states of consciousness induced by classical psychedelics, such as psilocybin and LSD, whose effects are mainly mediated by agonism of serotonin receptors. Few attempts have been made at bridging these two domains of inquiry, despite intriguing evidence of overlap between the phenomenology and neurophysiology of meditation practice and psychedelic states. In particular, many contemplative traditions explicitly aim at dissolving the sense of self by eliciting altered states of consciousness through meditation, while classical psychedelics are known to produce significant disruptions of self-consciousness, a phenomenon known as drug-induced ego dissolution. In this article, we discuss available evidence regarding convergences and differences between phenomenological and neurophysiological data on meditation practice and psychedelic drug-induced states, with a particular emphasis on alterations of self-experience. While both meditation and psychedelics may disrupt self-consciousness and underlying neural processes, we emphasize that neither meditation nor psychedelic states can be conceived as simple, uniform categories. Moreover, we suggest that there are important phenomenological differences even between conscious states described as experiences of self-loss. As a result, we propose that self-consciousness may be best construed as a multidimensional construct, and that "self-loss," far from being an unequivocal phenomenon, can take several forms. Indeed, various aspects of self-consciousness, including narrative aspects linked to autobiographical memory, self-related thoughts and mental time travel, and embodied aspects rooted in multisensory processes, may be differently affected by psychedelics and meditation practices. Finally, we consider long-term outcomes of experiences of self-loss induced by meditation and psychedelics on individual traits and prosocial behavior. We call for caution regarding the problematic conflation of temporary states of self-loss with "selflessness" as a behavioral or social trait, although there is preliminary evidence that correlations between short-term experiences of self-loss and long-term trait alterations may exist.

Keywords: psychedelics, meditation, self-consciousness, consciousness, bodily self-consciousness, autobiographical memory, mind wandering, mental time travel.

Introduction

The scientific study of meditation and psychedelic drugs has seen remarkable developments in recent years. The increased focus on meditation in cognitive neuroscience has led to a cross-cultural classification of standard meditation styles validated by functional and structural neuroanatomical data (Lutz *et al.*, 2008; Dahl *et al.*, 2015; Fox *et al.*, 2016). Meanwhile, the renaissance of psychedelic research (Carhart-Harris and Goodwin, 2017) has shed light on the neurophysiology of altered states of consciousness induced by classical hallucinogens, such as psilocybin and LSD, whose effects are mainly mediated by agonism of serotonin receptors, and the serotonin 2A receptor subtype specifically (Carhart-Harris *et al.*, 2012, 2016b; Nichols, 2016). However, few attempts have been made at bridging these two domains of inquiry, despite increasing evidence of overlap between the phenomenology and neurophysiology of meditation practices and psychedelic states.

In particular, many contemplative traditions explicitly aim at dissolving the sense of self by eliciting altered states of consciousness through meditation (Austin, 2000; Josipovic, 2010; Vago and Silbersweig, 2012; Dahl *et al.*, 2015), while classical psychedelics are known to produce significant disruptions of self-consciousness[1], a phenomenon known as "drug-induced ego dissolution" (Millière, 2017; Nour and Carhart-Harris, 2017; DIED). In this article, we discuss available evidence regarding convergences and differences between phenomenological and neurophysiological data on meditation practice and psychedelic drug-induced states, with a particular emphasis on alterations of self-experience. While both meditation and psychedelics are suspected to disrupt self-consciousness and its underlying neural processes, this general hypothesis requires careful qualification.

[1] By "self-consciousness," we refer in this article to a subject's consciousness of themselves - also called "sense of self," "self-awareness," "phenomenal selfhood," or "self-experience." Importantly, "self-consciousness" does not refer here to the social awareness of being the object of the observation of others.

First, it is important to emphasize right away that neither meditation nor psychedelic states can be conceived as simple, uniform categories. Many variables modulate the subjective effects of contemplative practice and psychedelics, including the style of meditation or the drug and dosage used, as well as personal factors such as level of experience and personality traits. In particular, dramatic disruptions of self-consciousness seem to occur mostly for highly experienced meditators or with high doses of psychedelics. Thus, we suggest that both meditation and psychedelics can induce a wide variety of global states of consciousness, but these states are sensitive to a multitude of factors in addition to the specific inducers we are highlighting here[2].

[2] From a methodological perspective, disruptions of self-consciousness induced by meditation might be more challenging in terms of laboratory production, while disruptions of self-consciousness following the administration of psychedelic drugs might be more strictly dose-dependent and therefore easier to produce in a controlled setting. In a similar vein, the choice of baseline conditions and control groups is a multi-faceted issue in meditation research, often limiting interpretability, whereas placebo-controlled designs are the default for studies on psychedelics. Nonetheless, true placebo control is difficult to achieve with psychedelics, given their vivid and characteristic subjective effects.

In addition, we suggest that there are important phenomenological differences even between conscious states described as experiences of self-loss. As a result, we propose that self-consciousness may be best construed as a multidimensional construct, and that "self-loss" or "ego dissolution," far from being an unequivocal phenomenon, can take several forms. Indeed, various aspects of self-consciousness, including narrative aspects linked to autobiographical memory, self-related thoughts and mental time travel, and embodied aspects rooted in multisensory processes, may be differently affected by psychedelics and meditation practices. It is also worth acknowledging that "self-loss" or "ego dissolution" may be a non-linear phenomenon that only occurs after a critical inflection point has been reached.

Finally, we consider long-term outcomes of experiences of self-loss induced by meditation and psychedelics on individual traits and prosocial behavior. We call for caution regarding the problematic conflation of temporary states of self-loss with "selflessness" as a personal or social trait, although it remains possible that correlations exist between short-term experiences and long-term dispositions in this regard.

The nuroscience of meditation and psychedelics: an overview

Meditation refers to a set of cognitive training techniques and practices that aim to monitor and regulate attention, perception, emotion and homeostasis (e.g., breathing rate) (Fox and Cahn, forthcoming; Tang *et al.*, 2015). Such techniques and practices have been developed in many different cultures and spiritual traditions, yielding more than a 100 varieties of meditation. Most scientific research on the topic has focused on techniques originating in the Buddhist tradition from China, Tibet, India and Southeast Asia, with a particular focus on practices often subsumed under the loose category of mindfulness meditation (see **Box 1**; on the limitations of the notion of mindfulness, see Dam *et al.*, 2018). Nonetheless, there are a growing number of studies on meditative practices from other contemplative traditions - including yogic, Hindu, Christian, Sufi, shamanic and transcendental practices.

To address this remarkable diversity of traditions, researchers have also sought to categorize the main styles of meditation across cultural, geographical and historical contexts, based on the core goals and principles of the mental techniques involved (Lutz *et al.*, 2008; Travis and Shear, 2010; Nash and Newberg, 2013). Common styles of meditation include focused attention meditation (FA) - which requires sustaining one's attention on a particular object or sensation such as the breath - , open monitoring meditation (OM) - which involves a non-judgmental, non-selective awareness of the present moment - , loving-kindness and compassion meditation (LK) - which involves the cultivation of compassion toward oneself and others - , and mantra recitation (MR) - which involves the repetition of a sound, word or sentence (see Box 1). The subjective effects of meditation are multifaceted, including enhanced attention and sensory processing (Brown, 1977; Jha *et al.*, 2007), largely positive emotions and mood (Ortner *et al.*, 2007; Davidson and Lutz, 2008; Lutz *et al.*, 2008), increased cognitive flexibility and creativity (Horan, 2009; Capurso *et al*., 2014; Ding *et al*., 2014; Berkovich-Ohana *et al*., 2017), and, in some cases (usually with increasing expertise) dramatic disruptions of one's sense of self (Austin, 2006; Dorjee, 2016; Berkovich-Ohana and Wittmann, 2017).

BOX 1 | Glossary.

Drug-induced Ego Dissolution (DIED). A family of acute effects produced by high doses of psychedelic drugs, typically reported as a loss of one's sense of self and self-world boundary.
Focused Attention (FA). A common style of meditation that involves sustaining one's attentional focus on a particular object, either internal (e.g., breathing) or external (e.g., a candle flame). The practitioner is instructed to monitor their attention, notice episodes of distraction (mind-wandering), and bring their attention back to the object. FA is usually the starting point for novice meditators.
Loving-Kindness Meditation (LK). A common style of meditation that focuses on developing compassion and love for oneself and others, gradually extending the focus of empathy to foreign and disliked individuals or even all living-beings. While loving-kindness meditation incorporates technical elements from FA and open monitoring (OM, defined below), it has a distinct phenomenology and neural correlates due to its emotional content.
Mantra Recitation (MR). A style of meditation that involves repeating a sound, word or sentence, either aloud or in one's mind, in order to calm the mind and avoid mind-wandering. Although MR is arguably a form of Focused Attention meditation, it is distinguished by its speech component and may have distinct neural correlates.
Meta-Awareness. The ability to take note of the content of one's current mental state. In the context of meditative practices, meta-awareness often refers specifically to the meditator's awareness of episodes of mind-wandering (spontaneous thoughts arising during meditation).
Mindfulness Meditation. A group of practices aimed at cultivating mindfulness, typically defined as a state of non-judgmental awareness to one's present moment experience. Mindfulness meditation may refer to both focused attention (FA) and open monitoring (OM) practices.
Non-Dual Awareness (NDA). In many contemplative traditions (including Advaita Vedanta and Kashmiri Shaivism within Hinduism, and Dzogchen and Mahāmudrā within Buddhism), the practice of meditation aims at recognizing the illusory nature of the subject-object dichotomy that allegedly structures ordinary conscious experience, thus revealing the "non-dual awareness" that lies at the background of consciousness.
Open Monitoring (OM). A common style of meditation that aims at bringing attention to the present moment and openly observing mental contents without getting caught up in focusing on any of them. Open monitoring meditation traditionally follows focused awareness, as the practitioner learns to switch from a narrow attentional focus on an object to a global awareness of the present moment.
Psychedelic Drugs. A family of psychoactive compounds whose complex effects on the quality of conscious experience are mainly mediated by their action on serotonin receptors in the brain (and specifically their binding to and stimulation of serotonin 2A receptor subtype). Psychedelic substances include mescaline, psilocybin (so-called "magic mushrooms"), Lysergic Acid Diethylamide (LSD), *N,N*-Dimethyltryptamine (DMT), and the DMT-containing brew Ayahuasca.
Pure Consciousness (PC). A state of consciousness described as "objectless" or entirely devoid of phenomenal content. While the possibility of such states is very controversial, certain conscious states induced by some meditative practices and classical psychedelics might lack at least ordinary phenomenal content. In the Hindu and Buddhist traditions, the practice of Samadhi is often described as leading to the experience of PC.

Classic psychedelics, also known as classic hallucinogens, are a family of psychoactive substances that exert their subjective effects primarily by agonism (or partial agonism) of serotonin 2A (5-HT_{2A}) receptors (Halberstadt, 2015; Nichols, 2016). Psychedelics include molecules found in the natural world such as psilocybin (a prodrug of psilocin found in so-called "magic mushrooms"), mescaline (found in various South

American cacti, including Peyote, San Pedro and Peruvian torch), *N,N*-Dimethyltryptamine (DMT, found in many plants such as *Mimosa tenuiflora*, *Diplopterys cabrerana*, and *Psychotria viridis*, and used in combination with monoamine oxidase inhibitors in the shamanic brew Ayahuasca) and 5-MeO-DMT (found in the toxin of the toad *Bufo alvarius*, as well as a wide variety of plants such as *Anadenanthera peregrina* used in yopo snuff). Psychedelics also include many synthetic compounds, such as lysergic acid diethylamide (LSD) and phenethylamines of the 2C-*x* family (e.g., 2C-B). The subjective effects of psychedelics are complex and multifaceted, including visual and auditory distortions and complex closed-eye "visions," profound changes in emotions and mood, heightened sensitivity to internal and external context, and at higher doses, dramatic alterations of self-consciousness known as drug-induced ego dissolution (DIED) (Strassman *et al.*, 1994; Vollenweider *et al.*, 1998; Studerus *et al.*, 2011; Carhart-Harris *et al.*, 2012, 2016b; Schmid *et al.*, 2015; Fox *et al.*, 2016; Millière, 2017).

Neural Correlates of Meditative Practices

Over the past 20 years, a large number of neuroimaging studies have investigated various styles of meditation, using electroencephalography (EEG), functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) to measure changes in blood flow and electrical activity in the brain during meditation. This research program seeking to isolate the neural correlates of various meditation practices has come to be known as contemplative neuroscience. Interestingly, the wealth of data collected from these studies has begun to reveal that meditation practices from distinct traditions relying on similar mental techniques, also share some common neural correlates. A recent meta-analysis of 78 functional neuroimaging studies of meditation found dissociable patterns of activation and deactivation for four common styles of meditation: focused attention (FA), mantra recitation (MR), open monitoring (OM), and loving-kindness meditation (LK) (Fox *et al.*, 2016; see **Table 1**).

Table 1 - Significant clusters of activation/deactivation in four common meditation styles from a meta-analysis of 78 neuroimaging studies (Fox *et al.*, 2016).

	Focused Attention (FA)	Mantra Recitation (MR)	Open Monitoring (OM)	Loving-Kindness (LK)
Significant activation clusters	PMC Dorsal ACC	Broca's Area PMC SMC	Insula IFG SMA/preSMA PMC	IPL Anterior Insula
Significant deactivation clusters	PCC IPL	Anterior Insula	Thalamus	/

FA was correlated with significant activation clusters in executive brain areas such as the premotor cortex and the dorsal anterior cingulate cortex, which may underlie top-down regulation of attention and monitoring of spontaneous thoughts. FA was also correlated with the deactivation of two important hubs of the so-called default-mode network (DMN) namely, the posterior cingulate cortex and inferior parietal lobule, involved in a plethora of introspection-related functions including self-reflection, mind-wandering, autobiographical memory recollection, mental time travel to the future and imagination more broadly. The main clusters of activation for MR were found in the motor control network (Broca's area, premotor cortex and supplementary motor cortex) and the putamen. The involvement of these regions in speech production and attention regulation is consistent with the practice of mantra recitation, which relies on the constant repetition of a phrase either in one's mind or out loud. MR was also associated with a significant deactivation cluster in the anterior insula, suggesting that the focus on a repeated phrase is linked to decreased awareness of bodily sensation.

By contrast, OM was found to be correlated with activation clusters in the insular cortex, involved in awareness of interoceptive signals, as well as in brain regions associated with the voluntary control of thought and action, such as the left inferior frontal gyrus, the pre-supplementary and supplementary motor areas, and the premotor cortex. OM was also associated with the deactivation of the right thalamus, a region involved in filtering out sensory stimuli (sensory gating), suggesting that the increased focus of awareness during OM is mediated by decreased sensory gating. Finally, significant activation clusters for LK were found in the right somatosensory cortices, the inferior parietal lobule and the right anterior insula, while no significant deactivation cluster was found. Although these four meditation styles are clearly dissociated by their neural correlates, Fox and colleagues found a few recurrent patterns of activity modulation, in particular in the insular cortex, an important multisensory area heavily involved in interoceptive awareness (Craig, 2002; Simmons *et al.*, 2013).

It is worth noting that distinct styles of meditation were found to modulate the activity of the insula in different ways, namely activation for FA, OM, and LK, and deactivation for MR. Nonetheless, the involvement of the insula in all four styles of meditation points toward the central role of the attentional control of bodily awareness, and awareness of breathing in particular, during various contemplative practices. Other convergent patterns of activity were found to a lesser extent in regions involved in the regulation of attention such as the premotor cortex, supplementary motor area and dorsal cingulate cortex (Fox *et al.*, 2016).

Importantly, and albeit not emphasized by Fox *et al.* (2016), attenuation of either activity or functional connectivity in the default mode network (DMN), a large-scale intrinsic network which is highly active at rest but less active during goal-directed tasks (Raichle *et al.*, 2001), was shown for MR (Berkovich-Ohana *et al.*, 2015), and in many studies of mindfulness meditation (combining FA and OM in different degrees). These studies reported a decrease of activity in key nodes of the DMN, particularly in the medial prefrontal cortex (Farb *et al.*, 2007, 2013; Brewer *et al.*, 2011; Scheibner *et al.*, 2017) and in the posterior cingulate cortex (Brewer *et al.*, 2011; Ives-Deliperi *et al.*, 2011; Pagnoni, 2012; Brewer and Garrison, 2014; Lutz *et al.*, 2016; Scheibner *et al.*, 2017), compared to meditation-naïve controls or within-group resting state (reviewed by Tang *et al.*, 2015). While DMN deactivation is not specific to mindfulness meditation, it has been found to be more pronounced during meditation than during other cognitive tasks (Garrison *et al.*, 2015). Moreover, several studies reported altered connectivity during different types of meditation most consistently in association with the DMN (Tang *et al.*, 2015). Specifically, within-DMN connectivity was found to be reduced during LK (Garrison *et al.*, 2014).

Neural Correlates of Psychedelic States

Recent years have seen a renaissance of scientific research on psychedelic drugs, using modern neuroimaging techniques to gather insight into the neural correlates of their vivid subjective effects (see dos Santos *et al.*, 2016 for a review). Early neuroimaging studies using PET and single-photon emission computed tomography (SPECT) after administration of psilocybin and mescaline found excitatory effects on frontal cortical areas, medial temporal lobes and the amygdala (Hermle *et al.*, 1992; Vollenweider *et al.*, 1997, 1998; Gouzoulis-Mayfrank *et al.*, 1999). By contrast, recent fMRI of psilocybin and ayahuasca found significant reductions in activity across many brain areas, including frontal and temporal cortical regions, as well as hubs of the DMN (Carhart-Harris *et al.*, 2012; Palhano-Fontes *et al.*, 2015; see Table 2). This apparent discrepancy could be due to the much greater timescales used by PET/SPECT compared to fMRI (Carhart-Harris *et al.*, 2012).

Recent fMRI studies also revealed alterations of resting-state functional connectivity in key nodes of the DMN after administration of psilocybin (Carhart-Harris *et al.*, 2012, 2013; Tagliazucchi *et al.*, 2014; Lebedev *et al.*, 2015), ayahuasca (Palhano-Fontes *et al.*, 2015) and LSD (Carhart-Harris *et al.*, 2016b; Tagliazucchi *et al.*, 2016; see **Table 2**). Researchers found increased integration between cortical regions under ayahuasca (de Araujo *et al.*, 2012), psilocybin (Carhart-Harris *et al.*, 2013; Roseman *et al.*, 2014), and LSD (Carhart-Harris *et al.*, 2016b; Tagliazucchi *et al.*, 2016; Müller *et al.*, 2017). Finally, psilocybin and LSD were found to produce an enhanced repertoire of dynamical brain states (Tagliazucchi *et al.*, 2014; Atasoy *et al.*, 2017) and increased spontaneous MEG signal diversity (Schartner *et al.*, 2017).

Psychedelic drugs are known to produce short-term, dramatic effects on self-consciousness, especially at higher doses. This phenomenon is known as drug-induced ego dissolution (DIED); it is described a loss of one's sense of self and self-world boundaries, together with a concomitant oceanic feeling of "oneness" or "unity" (Letheby and Gerrans, 2017; Millière, 2017; Nour and Carhart-Harris, 2017). Such effects on self-consciousness had already been reported in early studies with mescaline (Mayer-Gross and Stein, 1926; Beringer, 1927; Guttmann and Maclay, 1937), LSD (Anderson and Rawnsley, 1954; Savage, 1955; Von Mering *et al.*, 1955; Bercel *et al.*, 1956; Klee, 1963; Sedman and Kenna, 1964; Pahnke and Richards, 1966) and psilocybin (Rümmele and Gnirss, 1961; Pahnke, 1966). Recent studies have sought to investigate the neural correlates of DIED, using correlations between questionnaire items and neuroimaging data. The main correlates of DIED, summarized in **Table 3**, include increased functional connectivity between the DMN and a task-positive network (Carhart-Harris *et al.*, 2013), decreased integrity of the DMN (i.e., decreased within network correlation of timecourses) (Carhart-Harris *et al.*, 2016b) and salience network (Lebedev *et al.*, 2015), decreased connectivity between the parahippocampal and retrosplenial cortices (Carhart-Harris *et al.*, 2016b), increased entropic brain activity (Lebedev *et al.*, 2016) and spontaneous MEG signal diversity (Schartner *et al.*, 2017), and decreased mean energy and fluctuations of low frequency connectome harmonics (Atasoy *et al.*, 2017).

Table 2 - Main changes in activity and connectivity in the psychedelic state.

References	Psychedelic drug	Changes in activity	Changes in functional connectivity
Carhart-Harris *et al.*, 2012	Psilocybin	↘ in ACC, PCC, mPFC and thalamus	↘ mPFC-PCC connectivity
de Araujo *et al.*, 2012	Ayahuasca	↗ in primary visual cortex during imagery task ↗ cuneus, lingual gyrus, PH, RSC, and frontopolar cortex	↗ DMN-TPN connectivity
Carhart-Harris *et al.*, 2013	Psilocybin		↗ DMN-TPN connectivity
Roseman *et al.*, 2014	Psilocybin		↗ between-network connectivity
Tagliazucchi *et al.*, 2014	Psilocybin		↗ diversity of connectivity motifs in HP-ACC network
Palhano-Fontes *et al.*, 2015	Ayahuasca	↘ in mPFC, PCC, precuneus	↘ PCC-precuneus connectivity
Carhart-Harris *et al.*, 2016b	LSD	↗ in visual cortex (correlating with visual hallucinations)	↘ DMN integrity and PHC-RSC connectivity
Tagliazucchi *et al.*, 2016	LSD		↗ global connectivity, especially thalamus, frontoparietal and inferior temporal cortices
Müller *et al.*, 2017	LSD		↗ thalamocortical connectivity

Table 3 - Neural correlates of drug-induced ego dissolution (DIED).

References	Drug	Correlates of DIED
Carhart-Harris *et al.*, 2013	Psilocybin	↗ Increased DMN-TPN functional connectivity
Muthukumaraswamy *et al.*, 2013	Psilocybin	↘ alpha power in PCC
Lebedev *et al.*, 2015	Psilocybin	↘ functional connectivity in aPHC ↘ MTL-neocortex coupling ↘ integrity of salience network ↘ interhemispheric connectivity
Tagliazucchi *et al.*, 2016	LSD	↗ Connectivity density in bilateral TPJ/angular gyrus and insular cortex
Carhart-Harris *et al.*, 2016b	LSD	↘ integrity of DMN ↘ PHC-RSC connectivity ↘ alpha & delta power in PCC
Lebedev *et al.*, 2016	LSD	↗ entropic brain activity
Schartner *et al.*, 2017	Psilocybin	↗ spontaneous MEG signal diversity (measured with Lempel-Ziv complexity)
Atasoy *et al.*, 2017	LSD	↘ mean energy and energy fluctuations of low frequency connectome harmonics

Alterations of self-consciousness induced by meditation and psychedelics

While it is often claimed that meditation and psychedelic drugs are both able to induce "selfless" states of consciousness, that is conscious states entirely lacking a sense of self, this statement requires qualification. Indeed, "self-loss" and related expressions such as "ego dissolution" are notoriously ambiguous notions. Self-consciousness itself may be best construed as a multidimensional construct including somatosensory, agentive, narrative and social components (Gallagher, 2000, 2013; Zahavi, 2014; Seth and Friston, 2016). A conscious state in which one of these aspects is radically disrupted may be described as "selfless" in one respect, although a subject undergoing such a state could retain other forms of self-consciousness. Therefore, it is important to investigate which aspect(s) of self-consciousness can be disrupted by meditation and psychedelics, and whether both modes of induction may alter self-consciousness in similar ways. In addition, there is a further question regarding the possibility of truly "selfless" states, namely conscious mental states lacking *any* kind of self-consciousness. While some meditative practices and psychedelic drugs have been hypothesized to produce such "selfless" states, this claim needs to be supported by an examination of phenomenological reports in light of the distinction between different aspects of self-consciousness. In this section, we discuss the ways in which meditation and psychedelics may disrupt narrative, agentive and somatosensory aspects of self-consciousness, either in isolation or in combination. Moreover, we critically examine theoretical discussions and self-reports about states of "non-dual awareness" and "pure consciousness" allegedly induced by meditation.

Disruption of Narrative Aspects of Self-Consciousness

The familiar experience of thinking about oneself is perhaps the most salient form of self-consciousness. In philosophy of mind, this is also known as having *de se* thoughts, namely thoughts that involve the first-person concept and are naturally expressed using the first-person pronoun (García-Carpintero, 2015). *De se* thoughts themselves come in different flavors, which are more or less egocentric. Thus, one may explicitly reflect on one's personality traits or one's life trajectory, both of which are important elements of an individual's identity. This category of *de se* thought broadly pertains to the entertainment of core self-related beliefs, and is often linked to the notion of narrative selfhood - the stories we tell ourselves about the kind of person we are or want to be. Admittedly, this kind of *de se* thought only occurs sporadically in the waking state, because we are not constantly reflecting on our personal identity. However, *de se* thoughts also include more mundane and pervasive instances of mind-wandering, such as wondering what one will have for dinner. Such thoughts also link back to the self, insofar as they engage the first-person concept, even if they are not directly related to fundamental beliefs about one's identity. More generally, this family of self-referential cognitive content includes not only *de se* thoughts about the present moment, but also autobiographical memory retrieval and self-centered mental time travel to the future, both of which also crucially involve the self. Together, these self-referential mental episodes constitute what may be called narrative self-consciousness, namely the complex sequences of self-centered thoughts, memories and imaginings that weave the narrative of our daily lives and shape our core self-related beliefs (Damasio, 1999; Gallagher, 2000; Schechtman, 2011).

There are at least two ways in which narrative self-consciousness may be disrupted. First, the rate of occurrence of self-referential thought and mental time travel may be dramatically reduced, or altogether suppressed, during a certain time interval. There is convincing evidence from experience sampling studies that mind-wandering and mental time travel is more ubiquitous in the waking state than we might think, due to the fact that we are often unaware of such episodes (Smallwood and Schooler, 2006; Killingsworth and Gilbert, 2010; Baird *et al*., 2011). Moreover, daily mind-wandering episodes are predominantly future-focused, and frequently involve the planning and anticipation of personal goals, known as autobiographical planning (Baird *et al*., 2011; D'Argembeau, 2016). Thus, it is not exaggerated to say that a large part of our lives is spent entertaining self-involving thoughts, insofar as this includes spontaneous *de se* thoughts about the future. Most contemplative practices, especially in the Buddhist tradition, explicitly aim at increasing meta-awareness of mind-wandering, namely monitoring and taking explicit note of spontaneous thoughts, in order to disengage from them and re-focus attention back onto a particular object (such as the breath or a mantra) or on a wider awareness of the present moment (Hasenkamp, 2018). Once attention has been stabilized and the mind "quieted," meditators can undergo prolonged conscious episodes entirely lacking in self-referential thoughts[3].

This is consistent with the neurophysiological basis of mindfulness meditation reviewed in the previous section. While key nodes of the DMN such as the mPFC and the PCC are especially active during mind-wandering (Christoff *et al*., 2009; Fox *et al*., 2015), a number of studies have found that these regions are deactivated during mindfulness meditation - which is consistent with the practice's focus on attentional control of mind-wandering episodes (Farb *et al*., 2007; Brewer *et al*., 2011; Lutz *et al*., 2016; Scheibner *et al*., 2017). Importantly, the decrease in DMN activity is more significant during meditation than during other cognitive tasks (Garrison *et al*., 2015), which speaks to the crucial issue of specificity and may be characteristic of the suppression of mind-wandering that can be achieved by trained meditators. It is also worth noting that experiences of flow (Csikszentmihalyi, 1975, 1990), namely states of intense focus in which self-referential processing is inhibited (such as intense practice in expert athletes or jazz improvisation in expert musicians), are also associated with decreased activity in the mPFC (Ulrich *et al*., 2014). Interestingly, psychedelic drugs have been shown to decrease activity in the mPFC and PCC as well (Carhart-Harris *et al*., 2012; Palhano-Fontes *et al*., 2015). These nodes of the DMN have been shown to be more active during various types of self-related stimuli (Northoff *et al*., 2006; Sugiura *et al*., 2008; Qin and Northoff, 2011; Tacikowski *et al*., 2017), self-reflection (Jenkins and Mitchell, 2011; D'Argembeau, 2018) and autobiographical memory retrieval (Cabeza and St Jacques, 2007). A recent study using dynamic causal modeling suggested that self-referential processes are driven by PCC activity and modulated by the regulatory influences of the mPFC (Davey *et al*., 2016).

[3] To be specific, meta-awareness of mind-wandering episodes may crucially involve *de se* thought, such as the thoughts "My mind is wandering" or "I need to refocus my attention on the breath." Here, we are referring to what may happen with experienced meditators when this cycle of mind-wandering and meta-awareness comes to a halt, if only for a brief period, giving way to an episode of thought-free awareness.

Aside from changes in cerebral blood flow in these regions, psilocybin, ayahuasca and LSD have also been consistently linked to decreased functional integrity of the DMN (Carhart-Harris *et al*., 2012, 2016b; Palhano-Fontes *et al*., 2015). Moreover, DMN disintegration was correlated with reports of ego dissolution (Carhart-Harris *et al*., 2016b) and decreased mental time travel to the past (Speth *et al*., 2016). These findings are intriguing, because strong DMN connectivity at rest is associated with increased tendency for mental time travel, in particular spontaneous thoughts about the future (Schacter *et al*., 2007; Godwin *et al*., 2017; Karapanagiotidis *et al*., 2017; Wang *et al*., 2017). This suggests that reports of drug-induced ego dissolution may be related to the experience of decreased self-referential thought and mental time travel, which is also fundamental to the practice of meditation.

While the temporary cessation of self-referential thoughts is one way in which narrative self-consciousness may be altered, it may also be disrupted by a total loss of access to autobiographical memories and self-related beliefs. These two cases are not unrelated, given that the unavailability of personal memories and beliefs precludes the possibility of at least some forms of *de se* thought and mental time travel. However, the experience of losing access to these memories and beliefs might differ from the mere cessation of *de se* thought from a phenomenological point of view. Indeed, anecdotal evidence from narrative self-reports suggests that drug-induced ego dissolution may be related in some cases to reversible retrograde amnesia, specifically regarding abstract information about oneself (i.e., semantic autobiographical memory). For example, one subject responding to an online questionnaire on ego dissolution reported "forgetting that I was a male, a human, a being on Earth - all gone, just infinite sensations and visions," while another stated "I no longer felt human. I didn't remember what a human was" (R.M., unpublished data from an online survey on drug-induced ego dissolution completed by experienced users of psychedelic drugs)[4].

[4] While it is possible that such drug-induced episodes are only partially integrated into autobiographical memory (similarly to dreams), these reports specifically suggest that the episodes themselves may involve a loss of access to autobiographical information.

Interestingly, decreased functional connectivity within the DMN is associated with age-related memory deficits (Damoiseaux *et al*., 2008; Ward *et al*., 2015) and Alzheimer's disease (Greicius *et al*., 2004; Dennis and Thompson, 2014; Dillen *et al*., 2017). Given the link between DMN disintegration (decreased within-network connectivity) and ego dissolution, it is intriguing to speculate that the temporary loss of access to semantic autobiographical information that can occur in the psychedelic state may be mediated by pronounced reductions in DMN integrity. Interestingly, *post-hoc* mediation analyses from Dillen and colleagues revealed that the retrosplenial cortex enables communication between the hippocampus and DMN regions in healthy controls, but not in individuals reporting cognitive decline or diagnosed with prodromal Alzheimer's disease (Dillen *et al*., 2017). Ratings of ego dissolution under LSD have been shown to correlate with decreased resting-state functional connectivity between the retrosplenial cortex and the parahippocampus (Carhart-Harris *et al*., 2016b). If the retrosplenial cortex acts as a gateway between the hippocampal formation and specific DMN regions for memory retrieval, the correlation between this change in connectivity and ego dissolution may be related to a loss of access to autobiographical memories. It is also interesting to note that damage to the retrosplenial cortex has been linked with retrograde amnesia (Valenstein *et al*., 1987; Takayama *et al*., 1991; Gainotti *et al*., 1998; Oka *et al*., 2003), and damage to the hippocampal formation has been associated with both retrograde amnesia (Scoville and Milner, 1957; Squire, 1992; Steinvorth *et al*., 2005) and loss of general world knowledge (Rempel-Clower *et al*., 1996; Bayley *et al*., 2006; Gregory *et al*., 2014).

In summary, narrative aspects of self-consciousness can be radically altered during a specific conscious episode in two ways: through a temporary cessation of self-referential thought and mental time travel, or more dramatically through a temporary loss of access to semantic autobiographical information, resulting in a complete breakdown of one's personal identity. While the former can seemingly be induced both by contemplative practices and by psychedelic drugs, the latter appears to be more specific to psychedelics, and may be related to more pronounced reductions in DMN integrity - which does not appear to be such a reliable feature of meditation.

In the first case, the retrieval of self-related information is effectively reduced, via attentional control in the case of meditation, and perhaps via an involuntary attentional shift in the case of psychedelic states. In the second case, even the dispositional ability to retrieve such information is temporarily impaired, which amounts to a form of reversible amnesia. It is important to note that these alterations of narrative aspects of self-consciousness come in degrees. At low doses of psychedelics or in novice meditators, self-referential spontaneous thoughts and mental time travel are unlikely to disappear entirely for an extended period of time. By contrast, states of deep absorption achieved by advanced meditators or with higher doses of psychedelics are more likely to involve a complete cessation of these thoughts. Similarly, the disruption of *access* to self-related information may be partial or total in different cases. For example, there is a difference between the inability to remember what one has done the day before, the inability to remember one's name, and the inability to remember anything at all about oneself, including that one belongs to the human species (which has been reported, *post-hoc*, with certain doses of some psychedelics). Thus, narrative aspects of self-consciousness may be temporarily disrupted in different ways and to varying degrees by meditation and psychedelics and it is not yet clear whether these different degrees or grades lie on a linear or nonlinear scale.

Disruption of Multisensory Aspects of Self-Consciousness

While self-related thoughts are a paradigmatic example of self-consciousness, it is widely agreed that self-consciousness is not strictly limited to the cognitive domain. In particular, a number of authors have stressed the need to distinguish between the "narrative self," congruent with narrative aspects of self-consciousness outlined in the previous section, and the "minimal" or "embodied" self (Damasio, 1999; Gallagher, 2000; Legrand and Ruby, 2009; Christoff *et al*., 2011; Musholt, 2013; Zahavi, 2014). For example, Gallagher defines the minimal self as "a consciousness of oneself as an immediate subject of experience, unextended in time" (Gallagher, 2000, p. 15), by opposition with the temporal thickness of the narrative self-woven by autobiographical memories and self-projection to the future. Moreover, many authors have insisted on the idea that the minimal self is crucially linked to embodiment and agency, equating this basic form of self-consciousness with an awareness of oneself as an embodied agent (Legrand, 2006; Bayne and Pacherie, 2007; Christoff *et al*., 2011; Seth, 2013). While the distinction between high-level/narrative and minimal/embodied selfhood is helpful as a first pass to clarify the umbrella notion of self-consciousness, it remains somewhat ambiguous and potentially simplistic as such. As we have seen, the "narrative self " is better construed as a family of distinct self-referential processes, which may or may not involve mental time travel, be spontaneous, or recruit abstract semantic information. Likewise, the "embodied" or "minimal" self may be construed as a complex set of somatosensory and agentive aspects of self-consciousness which can come apart in special cases (Blanke and Metzinger, 2009).

At least three constructs that have been related to a basic form of self-consciousness rooted in multisensory processing may be distinguished, namely: (a) the sense of body ownership, namely the alleged sense of "mineness" that one experiences with respect to one's own body or individual limbs; (b) bodily awareness in general, namely the awareness of any bodily sensation, either internal (interoception and proprioception) or external (tactile); and (c) spatial self-location, namely the experience of being located somewhere in space with respect to one's perceived environment.

The Sense of Body Ownership

Body ownership is a controversial notion, as it is not obvious that there is a phenomenology of ownership (a sense of "mineness" over one's body) in daily experience, or how to characterize such phenomenology (Alsmith, 2014; Bermúdez, 2015; De Vignemont, forthcoming). Clinical and experimental evidence suggests that individuals may see body parts or feel tactile sensations originating from them without experiencing them as their own. Indeed, subjects diagnosed with the monothematic delusion known as somatoparaphrenia routinely deny ownership of a limb, despite the fact that nociception and touch may be preserved in the rejected body part (Melzack, 1990; Bottini *et al.*, 2002; see De Vignemont, forthcoming). In the rubber hand illusion, one of the subjects' hands is hidden and stroked synchronously with a rubber hand placed in an anatomically congruent position in front of them (Botvinick and Cohen, 1998); not only do healthy participants report experiencing an illusory ownership over the fake hand, but they also report a loss of ownership over their real hand (Valenzuela Moguillansky *et al.*, 2013). Moreover, a number of physiological measurements appear to indicate that the real limb is temporarily 'disowned' by the body during the illusion, such as a drop in temperature and an increase in histamine reactivity in the participant's real hand (Moseley *et al.*, 2008; Barnsley *et al.*, 2011; but see Rohde *et al.*, 2013). Beyond individual body parts, questionnaire data suggest that ownership over one's *whole body* can be manipulated in so-called full-body illusions induced by synchronous visuotactile stimulation, during which the participant's body - seen in front of them through a head-mounted display - may no longer feel like their own (Ehrsson, 2007; Blanke and Metzinger, 2009).

Although still a matter of controversy, many authors interpret these data as evidence that ordinary conscious experience involves a sense of body ownership that can both be experimentally manipulated and disrupted in clinical cases. Experiencing one's body as one's own would constitute a form of self-consciousness that does not require the possession or deployment of a self-concept, unlike thinking of oneself. Assuming that such a sense of body ownership is indeed ubiquitous at least in the ordinary experience of neurotypical individuals, is there any evidence that it can be altered by meditation and psychedelics? Interestingly, recent studies by Aviva Berkovich-Ohana and colleagues suggest that mindfulness meditation can indeed induce a loss of body ownership (Dor-Ziderman *et al.*, 2013, 2016; Ataria *et al.*, 2015). Ataria and colleagues studied a single highly experienced meditator "S" (with around 20,000 h of practice) trained in the Satipathana and Theravada Vipassana traditions, who was reportedly able to voluntarily induce a state in which basic aspects of self-consciousness appeared to fade away. In particular, S described the dissolution of the sense of body ownership in a series of open-ended interviews following the methodological principles of the microphenomenological interview technique, designed to elicit fine-grained reports of subjective experience while minimizing potential for confabulation (Petitmengin, 2006; Petitmengin and Lachaux, 2013). S reported that in the altered state of consciousness he achieved through meditation "there really isn't any [sense of ownership]. It's a feeling of dissolving. [It is] hard to distinguish between senses in the body and senses outside [sic]... There is no sense of mine [and] there is no sense of me" (Ataria *et al.*, 2015, Supplementary Material). While evidence from single-subject studies should be treated as tentative and interpreted with caution, Dor-Ziderman and colleagues also tested 12 long-term mindfulness meditators in a neurophenomenological study combining magnetoencephalogram (MEG) recording and first-person reports (Dor-Ziderman *et al.*, 2013). Participants were instructed to voluntarily induce a "selfless" mode of awareness characterized as "momentary phenomenal experience free of the sense of agency and ownership" (Dor-Ziderman *et al.*, 2013, p. 3). Subjective reports were analyzed and grouped in categories validated by 12 naïve referees. Four reports were grouped in the category of experiences lacking a sense of ownership, including the following descriptions: "I understood that it was just a sensation, it was not the hand itself… there was a deep thought that all this was not mine" (subject 9); "it was emptiness, as if the self-fell out of the picture. There was an experience but it had no address, it was not attached to a center or subject" (subject 12); "it was to be aware of the body, the sensations, pulse, location of limbs, sounds and sights - to be only a witness to all this" (subject 14) (Dor-Ziderman *et al.*, 2013, p. 6).

There are also many reports of depersonalization-like experiences induced by psychedelics, suggesting that the sense of body ownership can be pharmacologically manipulated (Guttmann and Maclay, 1937; Savage, 1955; Von Mering *et al.*, 1955; Sedman and Kenna, 1964; Studerus *et al.*, 2011). Reports of drug-induced ego dissolution frequently include descriptions of a loss of ownership over one's body (e.g., "I felt disconnected from my physical being, my body"; "[I] looked down at my hand and didn't feel anything that would indicate that this was my hand I was looking at"; R.M., unpublished data from online survey). An intriguing hypothesis is that top-down constraints on body representation are loosened in the psychedelic state. In the rubber hand illusion, for example, it has been hypothesized that the high-level prior probability that one's actual hand is truly one's own is decreased (Limanowski and Blankenburg, 2013; Apps and Tsakiris, 2014). There is preliminary evidence for a weakening of top-down perceptual priors in the psychedelic states, as evidenced by reduced binocular rivalry switching rate and occasional phenomenal fusion of rival images under psilocybin and ayahuasca (Frecska *et al.*, 2003; Carter *et al.*, 2007), as well as reduced susceptibility to the "hollow mask" illusion (unpublished result of Torsten Passie's hollow mask study at the Hannover Medical School in Germany). In addition, a recent study showed that LSD attenuates top-down suppression of prediction error in response to surprising auditory stimuli, as measured by mismatch negativity in the auditory oddball paradigm (Timmermann *et al.*, in press). It is possible that a similar disruption of top-down processing of somatosensory stimuli plays a role in the modulation of body ownership by psychedelics (see also Swanson, 2018 for a discussion of the effects of psychedelics on top-down processing).

Thus, assuming that there is a phenomenology of body ownership in ordinary experience, available evidence from open-ended interviews and self-report questionnaires tentatively suggests that it can go missing during certain conscious states induced by meditation and psychedelics - not only for specific body parts but also for the whole body. However, more evidence is needed to confirm this hypothesis, as well as a rigorous definition and measurement of the sense of body ownership.

Bodily Awareness

Bodily awareness can be defined as the conscious awareness of bodily sensations in general, including tactile, proprioceptive and interoceptive stimuli. A number of authors have argued that bodily awareness constitutes a form of self-consciousness, in part because it grounds self-ascriptions that are immune to error through misidentification (Bermúdez, 2011; De Vignemont, 2011). When one feels pain, for example, one cannot be wrong about *who* is in pain; generally, bodily sensations are said to be immune to error through misidentification insofar as the only body that one can have access to through them is one's own. This kind of consideration has led some philosophers to argue that bodily awareness constitutes a basic form of self-consciousness through which an embodied subject is directly conscious of the bodily self (Evans, 1982; Cassam, 1997; Bermúdez, 2011). In recent years, a similar idea has emerged within neuroscience with a particular focus on interoception, the awareness of internal bodily sensations such as cardiac, respiratory and gastric signals. It has been argued that interoceptive awareness grounds a core sense of self in normal experience, anchoring oneself in one's body (Damasio, 1999; Craig, 2002; Seth, 2013; Tsakiris, 2017). It should be noted that this idea does not necessarily rest on the hypothesis that there is a specific phenomenology of body ownership, although it is not always easy to disentangle the claim that one's body is experienced as one's own from the claim that one's bodily sensations underlie a consciousness of oneself as a bodily subject. The distinction of these two claims turns on the clarification of their theoretical commitments. Here, we will leave this issue aside, and assume that bodily awareness constitutes a basic form of self-consciousness, whether or not it is associated with a specific phenomenology of ownership.

Can meditative practices and psychedelics induce a partial or complete loss of bodily awareness? Given the focus of many meditation practices on bodily sensations, either through open awareness of all present moment sensations (in open monitoring) or through focal awareness of the breath (in focused attention), one would not expect bodily awareness to fade away during meditation practice. The meta-analytic cluster of activation of the insular cortex during OM, FA, and LK reported in the previous section (Fox *et al.*, 2016) also suggests that bodily awareness is central to these meditation practices, given that the insula is an important hub for the processing of interoceptive signals (Critchley *et al.*, 2004; Craig, 2009; Simmons *et al.*, 2013). Nonetheless, there is preliminary evidence that bodily awareness can be reduced in certain forms of mindfulness meditation, at least for highly experienced practitioners. For example, subject S from Ataria and colleagues' study reported that in the "selfless" altered state of consciousness voluntarily achieved through meditation, bodily sensations were "almost invisible" and reduced to a subtle and indistinct background presence: "there is a sense of something happening, it is very hard to tell if there is a sense of body, it is more in the background... a sense of body-ness, but it's so spread... I am not dead; there is a kind of very light sense of body in this experience" (Ataria *et al.*, 2015, Supplementary Material). In their analysis of the same data, Dor-Ziderman and colleagues comment that "even when the [sense of boundaries] disappears, a minimal level of dynamic proprioception continues to exist: there remains a sense that there is a body without any experience of [a sense of boundaries]" (Dor-Ziderman *et al.*, 2016, p. 3).

It is debatable whether proprioceptive awareness was retained in this state, given the difficulty that subject S had in locating his bodily sensations on a body-part-centered spatial frame of reference ("I can't tell you at all which [hand] is right and which is left. I don't know", Ataria *et al.*, 2015, Supplementary Material). Nonetheless, it is plausible that some degree of *interoceptive* awareness was preserved, which is consistent with the fact that the body was merely experienced as some kind of vague background presence. Berkovich-Ohana and colleagues also found that experienced mindfulness meditators could significantly inhibit awareness of bodily sensations during their practice (Berkovich-Ohana *et al.*, 2013): "The experience of the body faded. There was a sense of body in the background, not in front of consciousness" (subject 4); "A wide experience with un-defined boundaries. A sense... that I am dissolving, my body dissolving." (subject 5); "There was a vanishing of bodily sensations" (subject 11).

While it remains unclear whether bodily awareness can completely disappear during meditation, there is evidence that subjects can lack any awareness of their body and of specific bodily sensations in altered states induced by psychedelic substances. As previously mentioned, early studies with mescaline and LSD reported depersonalization-like effects which occasionally involved a loss of bodily awareness (Guttmann and Maclay, 1937; Savage, 1955; Von Mering *et al.*, 1955; Sedman and Kenna, 1964). In the psychometrically validated 5D-OAV questionnaire commonly used to assess the subjective experience of altered states of consciousness (Studerus *et al.*, 2010), healthy participants score rather high on the "disembodiment" factor, which includes the item "it seemed to me as if I did not have a body anymore," after administration of psilocybin (Kometer *et al.*, 2012; Bernasconi *et al.*, 2014; Preller *et al.*, 2016; Pokorny *et al.*, 2017) and LSD (Schmid *et al.*, 2015; Carhart-Harris *et al.*, 2016a,b; Kraehenmann *et al.*, 2017; Liechti *et al.*, 2017; Preller *et al.*, 2017b). The strength of the subjective effects of LSD (as measured by the mean score on the 5D-ASC questionnaire) was found to correlate with the magnitude of increase in functional connectivity in a somatomotor network including the primary motor and sensorimotor cortices, the caudal premotor cortex and the superior parietal lobule (Preller *et al.*, 2017a).

In a recent neuroimaging study of DMT, a drug whose short lasting subjective effects are more intense and immersive than those of psilocybin or LSD, almost all participants reported a loss of awareness of their body for several minutes during the peak of the experience in post-hoc microphenomenological interviews: "I lost awareness of gravity and awareness of my body" (Timmermann *et al.*, in preparation). There is also considerable anecdotal evidence from narrative reports that psychedelics can radically disrupt bodily awareness, an effect often associated with the dissolution of the sense of self (Millière, 2017): "It felt as if 'I' did no longer exist. There was purely my sensory perception of my environment, but sensory input was not translated into needs, feelings, or acting by 'me'. Also, I felt disconnected from my physical being, my body" (R.M., unpublished data from online survey). Anecdotal evidence regarding the dramatic effects of 5- MeO-DMT suggests that this drug may be particularly effective at suppressing bodily awareness, although controlled studies of these effects are needed[5].

[5] See section Spatial self-location below for anecdotal reports and questionnaire data regarding states induced by 5-MeO-DMT.

Thus, it seems that certain meditation practices may inhibit awareness of bodily sensations, reduced in some cases to a mere background interoceptive awareness, while psychedelic substances (DMT and 5-MeO-DMT in particular) may completely suppress awareness of the body. Sensory deprivation is likely to be a factor in this reduction of bodily awareness: meditators are usually sitting in silence with eyes closed, while participants of neuroimaging studies of psychedelics are often lying down in supine position with a blindfold. The lack of somatosensory and motor feedback in these states may play an important role in the loss of bodily awareness. Interestingly, two recent findings emphasize the influence of sensory deprivation on the plasticity of body representation: short-term visual deprivation has been shown to lead to significantly larger proprioceptive drift in the rubber hand illusion (Radziun and Ehrsson, 2018), while audio-visual sensory deprivation has been found to degrade the boundary of the whole body peripersonal space (Noel *et al.*, 2018). These results suggest that sensory deprivation enhances the flexiblity of body representation, and could facilitate the disruption of bodily awareness in meditation and psychedelic states.

Finally, it is important to note that psychedelic drugs, just like some styles of meditation, may also *increase* awareness of the body, especially at lower doses associated with salient and unusual bodily sensations (see section Toward a multidimensional model of altered self-consciousness below). Finally, it can also be observed that drug-induced states are not the only known altered states of consciousness in which bodily awareness can fade away altogether; there is good evidence that this can also be the case in so-called "bodiless" dreams (LaBerge and DeGracia, 2000; Cicogna and Bosinelli, 2001; see Windt, 2010, 2015; Occhionero and Cicogna, 2011) and "asomatic" out-of-body experiences (Alvarado, 2000; see Metzinger, 2013).

Spatial Self-Location

A third notion associated with a minimal form of self-consciousness rooted in multisensory integration is spatial self-location (Blanke and Metzinger, 2009; Serino *et al.*, 2013; Maselli, 2015). It has been argued that perceptual experience, and visual experience in particular, is *self-locating* (Cassam, 1997; Noë, 2005; Schwenkler, 2014). This idea typically combines two claims: first, in virtue of being structured by an egocentric frame of reference[6], visual experience represents the location of the point of origin of this reference frame relatively to environmental landmarks; secondly, the location of this point of origin is represented as the location of the subject (i.e., where *I* am located with respect to objects in the visual scene). This analysis may be extended to other sensory modalities whose content presumably has a perspectival structure centered onto a single point of origin, such as auditory perception (Coleman, 1963; Zahorik *et al.*, 2005; Kolarik *et al.*, 2016).

[6] On the notion of egocentric frame of reference, see Klatzky (1998).

Whether perspectival structure always entails *self-locating* content - namely a representation of the location of the origin as the location of the *subject* - is a matter of debate (Alsmith, 2017). Some authors have argued that self-locating content also requires the ability to act upon objects perceived in one's environment (Brewer, 1992; Schellenberg, 2007; Alsmith, 2017). Nonetheless, it is generally agreed that ordinary perceptual experience has self-locating content. In other words, one normally experiences oneself as located at a certain distance with respect to objects perceived in one's environment. Interestingly, both questionnaire data and behavioral measurements suggest that self-location can be manipulated in full-body illusions, such that subjects may feel located outside of their own body (Ehrsson, 2007; Guterstam *et al.*, 2015) or closer to the virtual avatar over which they feel ownership during the illusion (Lenggenhager *et al.*, 2007, 2009; Ionta *et al.*, 2011). Similarly, out-of-body experiences and heautoscopic phenomena of clinical origin, in which subjects hallucinate seeing their own body from the outside, appear to involve a shift of self-location (often to an elevated position) associated with a hallucinatory visuospatial perspective (Blanke and Arzy, 2005; Blanke and Mohr, 2005).

Such experimental and clinical evidence isolating spatial self-location as a dissociable component of ordinary experience has led researchers to claim that it constitutes an important aspect of bodily self-consciousness (Blanke and Metzinger, 2009; Blanke *et al.*, 2015), and even a minimally sufficient condition for self-consciousness (Metzinger, 2013; Windt, 2015). Interestingly, there is evidence that both meditation and psychedelics may radically disrupt the experience of being located somewhere in space; moreover, this disruption appears to be often associated with reports of "selflessness" or "ego dissolution," suggesting that spatial self-location is indeed a basic and important building block of self-consciousness. The highly experienced mindfulness meditator studied by Ataria and colleagues described the selfless state he reportedly achieved for the experiment in the following terms: "it's like falling into empty space... and a sense of dissolving... and there really isn't a center... I don't have any kind of sense of location... I have no idea where I am in stage three, it's all background, I'm not there basically, just world, so there's no real location at all in stage three. It's very minimal, almost nothing... When there's no boundary, there's no personal point of view, it's the world point of view, it's like the world looking, not [me] looking, the world is looking." (Ataria *et al.*, 2015, Supplementary Material). As Dor-Ziderman and colleagues comment, in this meditation-induced altered state of consciousness, it seems that "the sense of orientation in space is lost altogether" (Dor-Ziderman *et al.*, 2016, p. 3). In another neuroimaging study of long-term mindfulness meditation practitioners, Berkovich-

Ohana and colleagues found that some of them were able to induce what they described as a state of "spacelessness," reported in the following terms: "the center of space became endless, without a reference point in the middle" (subject 4); "it was a sense of spaciousness, boundlessness... there was no clarity where the center is and where is the periphery. There was no quality of border" (subject 11) (Berkovich-Ohana *et al.*, 2013).

Likewise, there is converging evidence from subjective reports that psychedelic drugs can induce a loss of spatial self-location, associated to loss of boundary between self and world and a feeling of unity with everything (Millière, 2017): "I felt myself mold into the world around me... ," "My mind started to blend with everything" (R.M., unpublished data from online survey). On the psychometrically-validated 5D-ASC questionnaire, subjects score high on the factor related to "experience of unity" after administration of LSD (Schmid *et al.*, 2015; Carhart-Harris *et al.*, 2016a,b; Kraehenmann *et al.*, 2017; Liechti *et al.*, 2017; Preller *et al.*, 2017b) and to a slightly lesser extent psilocybin (Kometer *et al.*, 2012; Bernasconi *et al.*, 2014; Preller *et al.*, 2016; Pokorny *et al.*, 2017). This factor includes the items "it seemed to me that my environment and I were one" and "everything seemed to unify into oneness". Moreover, studies using custom questionnaire items have also measured high scores for "I experienced a sense of merging with my surroundings" after administration of psilocybin and LSD (Muthukumaraswamy *et al.*, 2013; Carhart-Harris *et al.*, 2016b; Schartner *et al.*, 2017). A recent online survey on the effects of 5-MeO-DMT with 515 participants also found that the overwhelming majority of respondents scored positively on items of the Mystical Experience Questionnaire corresponding to "Loss of your usual sense of space" (95% of respondents), "Loss of usual awareness of where you were" (88% of respondents) and "Being in a realm with no space boundaries" (87% of respondents) (Davis *et al.*, 2018).

In addition to questionnaire data from controlled studies, there is a large amount of anecdotal evidence from online narrative reports that DMT and 5-MeO-DMT can induce a loss of self-location: "at the time I didn't know where it was, or where I was... I didn't know what had happened before this point, in-between, sideways, up, down or anywhere" (DMT, report from www.dmt-nexus.me), "I was the universe, I was everywhere and nowhere, everything and nothing all at the same time" (5-MeO-DMT, report #49690 from Erowid.org), "The feeling was very cosmic, of oneness with everything" (5-MeO-DMT, report #78485 from Erowid.org), "an immediate complete dissolution of any identity and a merging into the Oneness, timeless, pure awareness and light energy of the Universe... Similar in some ways with a previous *Samadhi* meditation experience" (5-MeO-DMT, report #5804 from Erowid.org; see below on *Samadhi* meditation). A similar phenomenological report can be found in a (non-academic) monograph on 5-MeO-DMT: "I was completely disconnected somatically, unable to locate or feel my body... unable to locate myself - or anything else - anywhere in particular. I had no body, not even the slightest semblance of a dream-body or mental-body, and I had absolutely no sense of where I was" (Masters, 2005). Taken at face value, these reports suggest that psychedelic drugs can induce experiences which may have perceptual content without spatial - or at least self-locating - content. Although narrative reports from online databases offer at best anecdotal evidence, their convergence with questionnaire data from multiple controlled studies suggests that they may be taken into consideration to inform hypotheses about the effect of psychedelics on the sense of self-location.

We note that these reports of meditative and psychedelic experiences lacking spatial self-locating content might be reminiscent of reports of conscious episodes during dreamless sleep, which allegedly lack any form of self-consciousness and spatial content (Thompson, 2014a; Windt *et al.*, 2016). Jennifer Windt has argued that such dreamless sleep experiences might be characterized by "pure subjective temporality," conceived as the minimal phenomenology of temporal self-location ("nowness") and duration (Windt, 2014). If such states do exist, we can plausibly hypothesize that they might also be induced by meditation and psychedelic drugs, on the basis of the preliminary evidence discussed in this section. However, we also note that many reports of drug-induced ego dissolution, especially with 5-MeO-DMT, insist on the *timeless* character of the experience, described as a complete loss of the sense of temporal duration. The aforementioned online survey on the effects of 5-MeO-DMT found that the overwhelming majority of respondents scored positively on items of the Mystical Experience Questionnaire corresponding to "Loss of your usual sense of time" (97% of respondents), "Experience of timelessness" (90% of respondents), "Sense of being outside of time, beyond past and future" (89% of respondents) and "Feeling that you experienced eternity or infinity" (88% of respondents) (Davis *et al.*, 2018). Interestingly, some mindfulness meditators have been reported to achieve a similar disruption of the phenomenology of duration through their practice (Berkovich-Ohana *et al.*, 2013). Thus, we tentatively suggest that some drug-induced and meditative states might lack both *spatial* and *temporal* self-locating content.

From a neurophysiological point of view, it is interesting to note that the intensity of drug-induced ego dissolution reported by participants under LSD was found to correlate with the magnitude of increased functional connectivity in the bilateral insular cortex and the temporoparietal junction (Tagliazucchi *et al*., 2016). Meanwhile, Dor-Ziderman and colleagues found that the transition from minimal self-consciousness to a "selfless" state characterized by a loss of body ownership and self-location in experienced meditators was correlated with a decrease in beta power in the temporoparietal junction (Dor-Ziderman *et al*., 2016). These findings are intriguing since there is evidence from neuroimaging studies of out-of-body experiences and full-body illusions that the temporoparietal junction plays a role in processing spatial self-location (Blanke and Arzy, 2005; Ionta *et al*., 2011; Blanke, 2012). Given that a number of intracranial EEG and MEG studies have suggested that beta oscillations encode top-down modulations of predictions (Bauer *et al*., 2014; Michalareas *et al*., 2016; Sedley *et al*., 2016), it is intriguing to speculate that decreased beta power in the TPJ may relate to weakened top-down constraint on multisensory processing underlying self-location. In addition, the insular cortex is associated with the integration of interoceptive information (Craig, 2009; Simmons *et al*., 2013), and may play an important role in body awareness and ownership (Aspell *et al*., 2013; Seth, 2013; Suzuki *et al*., 2013). Thus, while the modulation of beta oscillatory power and functional connectivity in the temporoparietal junction in some psychedelic and meditative states may be linked to the disruption of spatial self-location, the modulation of functional connectivity in the insula during drug-induced ego dissolution might be specifically related to the loss of bodily awareness. However, more data is needed to confirm these hypotheses.

To conclude this section, it should be noted that our overview of narrative and multisensory aspects of self-consciousness has left out the notion of the sense of agency, typically defined as the experience of being in control of one's actions (Haggard, 2017). There are three reasons for this omission aside from spatial constraints. Firstly, the sense of agency is an ambiguous concept, which has been construed both as a feeling of control over one's bodily movements allegedly produced by comparator mechanisms, and as a feeling of control over the production of one's thoughts. Secondly, there is little available evidence regarding how the sense of agency, in either construal, may be modulated by meditation and drug-induced states. Although experiences of self-loss with both psychedelics and meditation typically occur when subjects are immobile (in seated or supine position), increased voluntary control over one's breathing in certain styles of meditation could modulate the sense of bodily agency. Further evidence could be provided by measures of intentional binding during meditation and psychedelic states. Likewise, one could expect attentional control of spontaneous thoughts in meditation to have an effect on the sense of cognitive agency, if this notion is valid. Finally, it is worth mentioning that the claim that voluntary movements and thoughts are ordinarily accompanied by a pervasive sense of agency has recently come under criticism (Grünbaum, 2015; Grünbaum and Christensen, 2017; Parrott, 2017). According to a more deflationary account, there is no special phenomenology of agency in ordinary experience[7].

Pure consciousness, non-dual awareness and total selflessness

In this section, we examine in more detail some meditation practices which explicitly aim at a dissolution of all aspects of self-consciousness, and consider how the resulting global states of consciousness compare to drug-induced states. More specifically, we focus on practices targeting the subject-object dichotomy which allegedly structures ordinary conscious experience, in order to reach a state of "non-dual awareness" (NDA; Josipovic, 2010), or even induce a state of consciousness supposedly empty, i.e., devoid of any content ("pure consciousness"). It is an open question whether NDA differs from pure consciousness, and in what respect; but a critical examination of descriptions of these states suggests that both may involve a dramatic form of self-loss characterized by a dramatic inhibition of the dimensions of self-consciousness outlined in the previous section.

[7] In a predictive coding framework, in particular, it is reasonable to assume that the violation of expectations regarding one's bodily movements, rather than the match between those expectations and sensory feedback, modulates phenomenology. Accordingly, prediction error signals might give rise to a feeling of alienation from one's action, but the absence of prediction error signals should not be associated with a positive feeling of agency (Fletcher and Frith, 2009; although see Hohwy, 2016 for a predictive coding account of the sense of agency). This explanatory model can be extended to thoughts to account for schizophrenic thought insertion without appealing to a loss of the sense of agency (Parrott, 2017). However, it should be acknowledged that the existence of a positive phenomenology of agency might be more in line with the active inference framework, according to which organisms minimize prediction error not only by updating prior expectations, but also through

action (Friston, 2013). Within this framework, the sense of agency may result from the process of modeling the effects of the selective sampling of sensations through action (Limanowski and Blankenburg, 2013).

Non-dual Awareness

Non-dual awareness meditation (NDA) refers to a family of practices which can be found in several Eastern contemplative traditions, including Dzoghen and Mahāmudrā within Tibetan Buddhism, and Advaita Vedanta and Kashimiri Shaivism within Hinduism (Josipovic, 2010; Dunne, 2011). NDA meditation rests on three core assumptions: (a) ordinary experience is "dual" or dichotomous, insofar as it is structured around a subject-pole and an object-pole; (b) this subject-object dichotomy is illusory, because conscious awareness as such is not fundamentally dual; (c) it is possible, through the practice of NDA meditation, to dispel this illusion and directly experience conscious awareness as non-dual. All of these assumptions are worth discussing. The first assumption, in particular, requires clarification. It is rather uncontroversial that all conscious mental states have a subject of experience, insofar as "an experience is impossible without an experience" (Frege, 1956, p. 299, translation modified). This is merely a metaphysical requirement of conscious experience[8]. However, assumption (a) goes further in claiming that the phenomenal character of conscious experience is itself structured by a subject-object dichotomy.

There are at least two ways to understand this claim. As we have seen in the previous section, a number of components of ordinary experience can be related to a form of self-consciousness - including self-related thought, body ownership, bodily awareness and spatial awareness. One can claim that conscious experience normally involves a background awareness of oneself which is reducible to one or several of these components (Damasio, 1999; Blanke and Metzinger, 2009; Bermúdez, 2011; Seth, 2013). According to this reductionist interpretation, ordinary consciousness is structured by a subject/object dichotomy.

There are at least two ways to understand this claim. As we have seen in the previous section, a number of components of ordinary experience can be related to a form of self-consciousness - including self-related thought, body ownership, bodily awareness and spatial awareness. One can claim that conscious experience normally involves a background awareness of oneself which is reducible to one or several of these components (Damasio, 1999; Blanke and Metzinger, 2009; Bermúdez, 2011; Seth, 2013). According to this reductionist interpretation, ordinary consciousness is structured by a subject/object dichotomy insofar as we are normally aware of ourselves via thought, perception and bodily sensations in addition to being aware of external objects. A second interpretation holds that there is a form of *sui generis* self-awareness in experience which is irreducible to the cognitive, bodily and spatial features of experience: "being presented with something necessarily involves being pre-reflectively and pre-conceptually aware of being the subject to whom something is presented" (Nida-Rümelin, 2017, p. 66; see also Strawson, 1999; Kriegel, 2009; Zahavi, 2014; Guillot, 2017). According to this second interpretation, the seemingly dichotomous nature of experience does not rest on a specific kind of self-representing content, but on the very nature of conscious representation in general, which is structured by an implicit distinction between the represented objects and the subject to whom those objects are presented. In similar fashion, Evan Thompson has argued that ordinary experience is infused with a sense of mineness such that every thought, emotion, perception or sensation is experienced *as one's own*, and has also suggested that this feature can disappear during meditation (Thompson, 2014b, p. 362).

On both of these interpretations, conscious experience is structured by a subject-object dichotomy insofar as it involves an awareness of oneself in addition to the awareness of external objects. Accordingly, non-dual awareness states can be construed as conscious states which lack the background self-awareness normally present in experience. However, a core assumption of non-dual awareness meditation practices is that the subject-object dichotomy supposedly found in ordinary experience is illusory, in line with the so-called "no self" doctrine of Buddhism (*anātman* in Sanskrit or *anattā* in Pali). Thus, non-dual awareness practice is supposed to reveal that the putative phenomenological distinction between oneself and one's experience of the external world is ultimately an illusion[9].

---

[8] Importantly, the notion of subject of experience at play in this claim is very thin - it does not carry more substantial commitments about subjects being Cartesian substances enduring in time, or identical to organisms or parts of organisms. Rather, the claim merely stems from conceptual analysis of the notion of experience. Accordingly, a thin subject of experience is simply the bare locus of an experience; an experience cannot occur without there being something it is like for such a thin subject to have it, and conversely a thin subject cannot exist without the occurrence of an experience whose subject it is (see Peacocke, 2014; Strawson, 2017). One might wonder whether this supposedly uncontroversial claim is compatible with the Buddhist "no self " doctrine. This is a difficult question, not least because there are several interpretations of the "no self " doctrine. However, common interpretations of the "no self " view articulate two claims: a metaphysical claim, according to which there is no such thing as *the self* construed as a substance or enduring entity; and a phenomenological claim, according to which the sense of self is not a necessary and invariant feature of experience (see MacKenzie, 2016). Both points are compatible with the minimal claim that all experiences have subjects of experiences, in the thin sense outlined above.

While this general idea appears to be consistent with recent proposals regarding the notion of non-dual awareness, it is not always clear which of the two interpretations outlined above is favored. For example, Wolfgang Fasching has argued that in normal experience, subjects are aware of their body and location in addition to objects of the external world, which suggests that he favors the reductionist interpretation of the subject/object dichotomy. In the same vein, he suggests that self-consciousness is rooted in the identification of oneself with "certain configurations of experienced contents as opposed to others" (Fasching, 2008, p. 476), which is also consistent with the first interpretation. However, he goes on to argue that "in perception I am necessarily co-conscious of myself " (Fasching, 2008, p. 472), because the subject/object polarity is built in all conscious representational states. He further claims that some meditation practices can reveal that "I am not something 'inner' as distinct from external objects" and that "there is no 'I' to which things are given, there is just the event of givenness" (Fasching, 2008, p. 478). In this context, meditation is conceived as a way of becoming aware of consciousness as such, without the illusory distinction between the subject and the objects of experience. Fasching cites a central text of the Vedic tradition, the Māṇḍūya Upaniṣad, which describes the state of non-dual awareness reached through meditation as one in which the subject is "not conscious of the internal world, nor conscious of the external world" (Deutsch, 1969, p. 62). Similarly drawing on the Vedic tradition, Miri Albahari suggests that non-dual awareness meditation involves "a direct realization that consciousness... is ownerless" (Albahari, 2010, p. 104).

[9] Note that this further assumption does not sit well with the proposals of Nida-Rümelin and Zahavi, according to whom "pre-reflective self-awareness" or "self-givenness" is a necessary component of all conscious experiences in general.

These descriptions seem consistent with the second interpretation above: in ordinary conscious states, subjects have a sense that all of their experiences are *theirs*, *given to them*, or *owned by them*; in turn, this introduces an artificial distinction between oneself as the subject of experience and the experiences themselves; finally, trained meditators can dispel this illusion by becoming aware of consciousness itself as a non-dual process. Although we cannot discuss this proposal at length within the scope of this article, it is worth underlining that it rests on a controversial picture of ordinary experience. Indeed, the idea that consciousness is normally infused with a special sense of phenomenal mineness or awareness of oneself as the owner of one's experiences is far from obvious and has been met with a number of objections (see Howell and Thompson, 2017; O'Conaill, 2017; Chadha, 2018; McClelland, forthcoming; Wu, forthcoming).

By contrast, the first interpretation of non-duality outlined above seems consistent with the evidence presented in the previous section: the inhibition of self-related thoughts, body ownership, bodily awareness and self-location should entail a blurring or dissolution of the boundary between self and world, and the associated "unitive experience" - identified by Walter Stace as the core feature of so-called "mystical-type experiences" (Stace, 1960). Although narrative and multisensory aspects of self-consciousness are not illusory as components of ordinary experience, their transient cessation in meditation or drug-induced states may be interpreted as revealing that their association with a more substantial notion of selfhood is fallacious (see also Metzinger, 2003; MacKenzie, 2016; Letheby and Gerrans, 2017). It is worth noting, however, that classic accounts of non-dual awareness in the Buddhist and Hindu traditions emphasize its reliance on the loss of narrative aspects of self-consciousness more than the loss of multisensory aspects. Non-dual Mahāmudrā a practice, for example, instructs students to "drop thoughts of past, present and future and release the mind into its natural state of clear, non-conceptual awareness" (Dunne, 2011, p. 81). Consequently, it is possible that global states of consciousness reached through NDA meditation may preserve some awareness of bodily sensations[10].

[10] One possibility, in line with the distinctions outlined in section Alterations of self-consciousness induced by meditation and psychedelics, is that NDA states may involve a minimal awareness of bodily sensations (e.g., interoceptive signals) without a sense of body ownership (an awareness of these sensations *as one's own*).

In summary, we have suggested that the notion of NDA states can be understood in two different ways. According to the first interpretation, they are conscious states in which both narrative and perhaps multisensory aspects of self-consciousness are radically disrupted, such the distinction between oneself and the external world no longer has an experiential basis. According to the second interpretation, ordinary conscious states involve a minimal form of self-awareness which is not tied to any specific content, but to a special sense of "self-givenness" or "mineness" built in normal experience; in NDA states, this feature supposedly goes missing, such that subjects become aware of consciousness itself as an ownerless process. While the second interpretation rests on a controversial assumption about normal experience, the first is consistent with the evidence presented so far regarding the phenomenology of alleged "selfless" states in meditation and drug-induced states[11].

[11] To be clear, we are not denying that actual descriptions of NDA states from contemplative scholars may seem more consistent with the second interpretation, if they are taken at face value. Rather, we suggest that such an interpretation rests on an account of the phenomenology of ordinary experience which is at best ambiguous and at worst implausible - in so far as it seems to postulate the ubiquity of a *sui generis* "sense of mineness." Accordingly, we put forward an interpretation of NDA states which appears to be more consistent with an evidence-based account of the multiple dimensions of the sense of self, as described in section Alterations of self-consciousness induced by meditation and psychedelics. It is also worth emphasizing that our purpose in this article is *not* to engage in the exegesis of historical sources from the Buddhist and Hindu traditions, but to offer a critical discussion of available evidence regarding global states of consciousness described as involving a dramatic loss of the sense of self.

Although there have been few neuroimaging studies of NDA meditation, the available evidence is intriguing. In the resting state, activity in the default-mode network has been found to be negatively correlated with activity in a set of regions commonly recruited in attention-demanding tasks, in particular the sensory (Golland *et al*., 2007), dorsal attention network and fronto-parietal control network (Greicius *et al*., 2003; Fox *et al*., 2005; Uddin *et al*., 2009; Chai *et al*., 2012; Carbonell *et al*., 2014). A similar pattern of anticorrelation has been reported during mindfulness meditation (Brewer *et al*., 2011; Kilpatrick *et al*., 2011; Hasenkamp *et al*., 2012), and there is some preliminary evidence of increased anti-correlation between the DMN and a task-positive network during focused attention meditation compared to the resting state (Josipovic *et al*., 2012). However, Josipovic and colleagues found that this anticorrelation was significantly *decreased* during NDA meditation compared to both focused awareness meditation and the resting state (Josipovic *et al*., 2012; Josipovic, 2014). It is worth noting that a similar pattern of increased correlation between the DMN and the habitually anti-correlated networks has been observed during various other forms of meditation, such as mantra recitation (Berkovich-Ohana *et al*., 2015) as well as choiceless-awareness, loving-kindness and concentration in experienced meditators compared to novice meditators (Brewer *et al*., 2011). Thus, it is questionable that this change of connectivity is unique to NDA meditation. Interestingly, a similar decrease of the anticorrelation between the DMN and a task-positive network has been observed after administration of psilocybin, and was hypothesized to correlate with decreased separatedness between internally and externally focused states (Carhart-Harris *et al*., 2013). Although this hypothesis is speculative, it is possible that conscious states induced through NDA meditation have a lot in common with certain states of "ego dissolution" induced by psychedelics from a phenomenological point of view. Before discussing this potential convergence, we will assess how NDA may relate to so-called "pure consciousness."

Pure Consciousness

The notion of pure consciousness seems to originate in Stace (1960, p. 86), who applies it to mystical experiences. A purely conscious state is characterized by "an 'emptying out' by a subject of all experiential content and phenomenological qualities, including concepts, thoughts, sense perception, and sensuous images" (Gellman, 2017). States which have been qualified as purely conscious include experiences reached through certain forms of meditation (Nash and Newberg, 2013) and mystical experiences (Stace, 1960; Shear, 1994).

There has been considerable debate about whether purely conscious states are even possible. Some have argued that they are impossible because one cannot be conscious without being conscious of anything at all (Bayne, 2007, p. 16) or because one cannot have episodic memory of a state devoid of experiential content (Bagger, 1999, p. 102; Gennaro, 2008). Others have argued that pure consciousness is not ruled out by logical or phenomenological considerations (Woodhouse, 1990; Shear, 1994), and that we might even find empirical evidence of pure consciousness in contemplative practices (Koch, 2004; Baars, 2013; Metzinger, 2013; Nash and Newberg, 2013) or dreamless sleep (Windt *et al*., 2016). Note that this apparent disagreement could be a mere verbal dispute, because there is an important ambiguity in the notion of a conscious mental state devoid of any content. Indeed, "content" might refer here to *representational* or *phenomenal* content.

Although controversial, the hypothesis that some conscious mental states lack *representational* content has been defended on the ground that states such as moods, pain or orgasm which do not seem to represent anything (Rey, 1998; Kind, 2007; Aydede, 2009). This is in fact the basis of a prominent objection to representationalism, the thesis that all phenomenally conscious states have representational content, or in its stronger version that the phenomenal character of all conscious mental states is wholly constituted by their representational content. But representational contentlessness is presumably not what proponents of pure consciousness have in mind, as they suggest that purely conscious states lack "all determinate phenomenological contents... whatsoever" (Shear, 1994, p. 320). Thus, the strict definition of a purely conscious state would be a conscious mental state lacking phenomenal character. However, this definition cannot be taken literally if we are talking about phenomenal consciousness: by definition, a phenomenally conscious mental state is a mental state such that there is something it like for a creature to be in it (Nagel, 1974), and if there is something it is like to be in a mental state then the mental state has phenomenal character. Therefore, the notion of a (phenomenally) conscious mental state literally lacking phenomenal character is absurd (Gennaro, 2008; Strawson, 2013): the experience of absence is not equivalent to the absence of experience.

There is, however, a more plausible, non-literal definition of pure consciousness as a conscious state lacking *ordinary* phenomenal content (Gennaro, 2008; Strawson, 2013). The question, then, is what counts as an *ordinary* phenomenal content, and how phenomenally "bare" or "sparse" purely conscious states can get. Presumably, if there are phenomenal properties pertaining to self-consciousness in ordinary experience (i.e., the narrative and somatosensory aspects of self-consciousness previously discussed), then such ordinary phenomenal properties should be missing in purely conscious states, among other ordinary phenomenal properties. Defined in this way, pure consciousness appears to be at least conceivable, and constitutes a plausible candidate for a wholly "selfless" state, lacking self-referential thoughts, bodily ownership, body awareness and self-location. The question is now whether purely conscious states can actually occur, specifically during meditation or after psychedelic intake, and whether they differ from states of alleged "non-dual awareness."

In the Hindu and Buddhist traditions, the meditative practice called *Samadhi* aims at inducing a state of deep absorption (Shankman, 2008). The practice of *Samadhi* includes four stages or *jhanas*, culminating in a "formless" or "objectless" state. It relies on successive shifts of attention, first from the breath to somatosensory pleasure, then to mere positive affect, until all intentional objects have been stripped away and only "one-pointed" awareness remains. In the final stage of *Samadhi* practice (i.e., the last *jhana*), "there is no directing of attention, no representation held in focal attention, no pleasure and no aversion, affective contentment has dropped away, and all that remains is an alert, clear, one-pointed, equanimous awareness." (Yamashiro, 2015, p. 7).

The aim of this practice is frequently described as reaching a state of pure consciousness which involves a complete loss of self-consciousness: "attaining *Samadhi* is to reach the silent state of pure consciousness where there is no phenomenological content and a loss of any sense of individual self or duality" (Wahbeh *et al*., 2018, p. 6)[12]. Miri Albahari has suggested that the state of pure consciousness allegedly reached through *Samadhi* meditation could provide evidence for the existence of what she calls "witness-consciousness," which she defines as the neutral common denominator between all conscious experience (Albahari, 2009). She argues that witness-consciousness has its own intrinsic phenomenal character, which explains why purely conscious states in *Samadhi* are not devoid of phenomenal content, and thus not logically inconsistent. However, this hypothesis seems unduly inflationary: rather than postulating that a special "objectless" phenomenology is ubiquitous in consciousness and is the only thing remaining in purely conscious states, one may seek to describe such states as a form of deep absorption associated with extreme sensory gating which does not have much in common with ordinary experience.

Unfortunately, the neurophysiological evidence regarding *Samadhi* practice is still extremely sparse (Yamashiro, 2015). A single-participant study found decreased activity in Brodmann areas 5 and 7, which may be associated with the representation of the body's orientation in three-dimensional space (Hagerty *et al*., 2013). This reflected the participant's experience of losing body boundaries. Nash and Newberg (2013) also suggest that activity of the posterior parietal lobule is modulated by *Samadhi*, and "might be critical for

[12] As previously noted, it is by definition impossible for a phenomenally conscious mental state to lack any phenomenal content. More realistically, states induced by *Samadhi* practice might lack *ordinary* phenomenal content.

distinguishing between the self and the external world" (Nash and Newberg, 2013, p. 8). Another contemplative tradition which aims at inducing pure consciousness is transcendental meditation (TM), whose goal is the "loss of boundaries of time, space, and body sense that defines the framework for typical waking experience," but neurophysiological data on TM is also very limited (Travis and Pearson, 2000; Wahbeh *et al.*, 2018).

It is unclear to what extent the notions of non-dual awareness and pure consciousness should be distinguished, both in terms of their conceptualization in the relevant literature on contemplative traditions, and in terms of the phenomenology and neurophysiology of the associated states induced by meditation. According to Josipovic, NDA meditation is not content-driven like focused attention and open monitoring, because it seeks awareness of the background of experience rather than any specific bodily or perceptual content (Josipovic, 2014). Moreover, he argues that NDA meditation also differs from "objectless" meditation "in which the mind is emptied of content and held in an empty state through the force of concentration" (Josipovic, 2014, p. 12)[13]. Indeed, Josipovic contends that pure consciousness practice like *Samadhi* aims at actively "eliminating" each pole of the subject/object dichotomy, while NDA meditation involves the recognition of a background non-dual awareness that "precedes conceptualization and intentionality" (Josipovic, 2014, p. 12). Likewise, John Dunne argues that non-dual awareness differs from objectless meditation techniques such as *Samadhi* insofar as it should not involve any cognitive effort (Dunne, 2011). However, these conceptual distinctions are not straightforward, and there is not yet enough data on the phenomenology and neurobiology of alleged states of "pure consciousness" and "non-dual awareness" to determine whether these are valid and distinct constructs.

[13] However, recent data suggests that TM practice does not involve focused attention either and relies on distinct mechanisms; given that TM is often described in terms of pure consciousness, this casts doubt on Josipovic's assumption that "objectless" meditation is a form of focused attention (Travis and Parim, 2017).

As we have suggested, one possible construal of non-dual awareness is in terms of the inhibition of both narrative and multisensory aspects of self-consciousness, leading to a temporary loss of experiential boundary between self and world, or between endogenous and exogenous stimuli. In turn, purely conscious states could be defined as states of extreme absorption involving high sensory gating, whose sparse phenomenal content has little overlap with the rich phenomenology of ordinary wakeful experience. If these tentative definitions are sound, states of pure consciousness should also be states of non-dual awareness, because they should lack ordinary phenomenal content *including* the narrative and multisensory components of self-consciousness. By contrast, non-dual awareness might not entail pure consciousness, because states of total self-loss (lacking narrative and multisensory self-consciousness) need not have very sparse phenomenal content.

This raises the question of whether psychedelic drugs can induce virtually "contentless" states similar to the descriptions of pure consciousness from mystical and contemplative traditions. While most reports of drug-induced ego dissolution involve a rich sensory phenomenology, including vivid hallucinations, this is not always the case. In particular, there is anecdotal evidence that certain compounds such as 5-MeO-DMT may induce states of radical absorption reminiscent of *Samadhi* practice[14]. Indeed, users of 5-MeO-DMT frequently describe an experience of "emptiness," "nothingness" or "void" which is associated with a cessation of thoughts, extreme sensory deprivation and a complete loss of self-consciousness: "my brain was not conveying anything meaningful from what my senses were receiving; I was completely unaware of my body, experiencing profound stillness" (report #99920 from Erowid.org); "I felt that there was nothing to me and there was nothing around me" (#11701); "the reality around me disintegrated into nothing. I fell into a void [that] I can't even describe" (#23487); "I wasn't anything anymore. I had been broken down into nothingness, into oblivion" (#87426); "my thoughts ceased to exist, and my senses shut off completely. I could not hear, see, smell, taste or feel anything" (#37301). This suggests that states of drug-induced ego dissolution may vary not only according to the extent to which narrative and multisensory aspects of self-consciousness are inhibited, but also according to the richness or sparsity of their phenomenology. While some forms of self-loss induced by psychedelics may involve a rich sensory phenomenology, others are more similar to descriptions of "pure consciousness," and may be almost devoid of sensory content.

[14] Some narrative reports about 5-MeO-DMT from Erowid.org explicitly refer to *Samadhi* practice: "Everything I've read about enlightenment and the attainment of *Samadhi* makes perfect sense to me now. It has all become so obvious. During this part of the experience I am not me, I am simply awareness" (#88450), "an immediate complete dissolution of any identity and a merging into the oneness, timeless, pure awareness... similar in some ways with a previous *Samadhi* meditation experience" (#5804).

Toward a multidimensional model of altered self-consciousness

In what precedes, we have suggested that some meditation practices and some psychedelic substances can disrupt self-consciousness in different ways, or more precisely can disrupt different aspects or components of self-consciousness. This analysis stems from the assumption that self-consciousness is not a simple or unidimensional construct, as many other authors have emphasized (Blanke and Metzinger, 2009; Gallagher, 2013; Metzinger, 2014; Zahavi, 2014). We have proposed to organize different components of self-consciousness into two main categories, roughly equivalent to the influential dichotomy between "narrative" and "embodied" self-hood. Unlike some models of the narrative/embodied self-distinction, however, we have suggested that each of these dimensions can be modulated by meditation and drugs in different ways, and to different degrees. The resulting picture can be simplified in the form of a two-dimensional model of "self-loss" or "ego dissolution," which is etiology-independent insofar as both meditation-induced and drug-induced altered states of consciousness could be located within this model, and overlap in some cases (Figure 1A).

This two-dimensional model is greatly simplified, because it suggests that the loss of body ownership, bodily awareness and self-location are all degrees of self-loss that can be ordered along the same dimension. Available evidence does suggest that this is often the case: for example, patients with somatoparaphrenia lack body ownership without lacking bodily awareness and self-location; individuals undergoing bodiless dreams, asomatic out-of-body experience and some psychedelic states (e.g., DMT-induced states) lack both body ownership and bodily awareness, but not necessarily self-location; and finally full-blown drug-induced ego dissolution, particularly after administration of 5- MeO-DMT, appears to involve the loss of all three components. Nonetheless, as we have mentioned, it is unclear whether meditation-induced states can involve a complete loss of bodily awareness (including interoceptive awareness), while it does seem that they can involve a loss of self-location. Thus, this two-dimensional model should be considered at most as a helpful idealization which reduces the dimensionality of the notion of self-consciousness. A more complex and accurate model would probably involve more dimensions (Figure 1B; see Bayne *et al*., 2016 on multidimensional accounts of global states of consciousness in general). In our example, we have represented global states of consciousness within a six-dimensional state space which models various cognitive and multisensory features of self-consciousness as independent dimensions (although systematic correlations are possible). Furthermore, this complex model takes into account another important variable to identify phenomenally distinct forms of self-loss, namely the overall richness or sparsity of phenomenology or the "bandwidth" of conscious contents. This parameter is relevant because many drug-induced states, including some of those reported as instances of drug-induced ego dissolution, have a rich sensory and emotional phenomenology, contrary to meditation-induced instances of self-loss. A more sophisticated model could perhaps take into account additional parameters, such as the sense of agency (see the end of section Spatial self-location above). Meditation-induced states involve intense attentional control at least during certain stages of the practice, unlike drug-induced states, although it is not obvious that this always results in a greater sense of agency in meditation than in psychedelic states. States of "objectless" or "pure consciousness" which lack ordinary phenomenal content, such as those induced by *Samadhi* practice and perhaps by certain psychedelics like 5-MeO-DMT, should be represented in the central region of this model, scoring the lowest in most if not all dimensions. Finally, it should be noted that "access to autobiographical information" is not on par with other dimensions of our tentative model, insofar as it is a functional and dispositional feature rather than phenomenological feature of conscious episodes. Nonetheless, as discussed in section Alterations of self-consciousness induced by meditation and psychedelics, the inability to retrieve semantic autobiographical information may occasionally be associated with a specific phenomenology of retrograde amnesia which differs from the mere cessation of self-related thoughts.

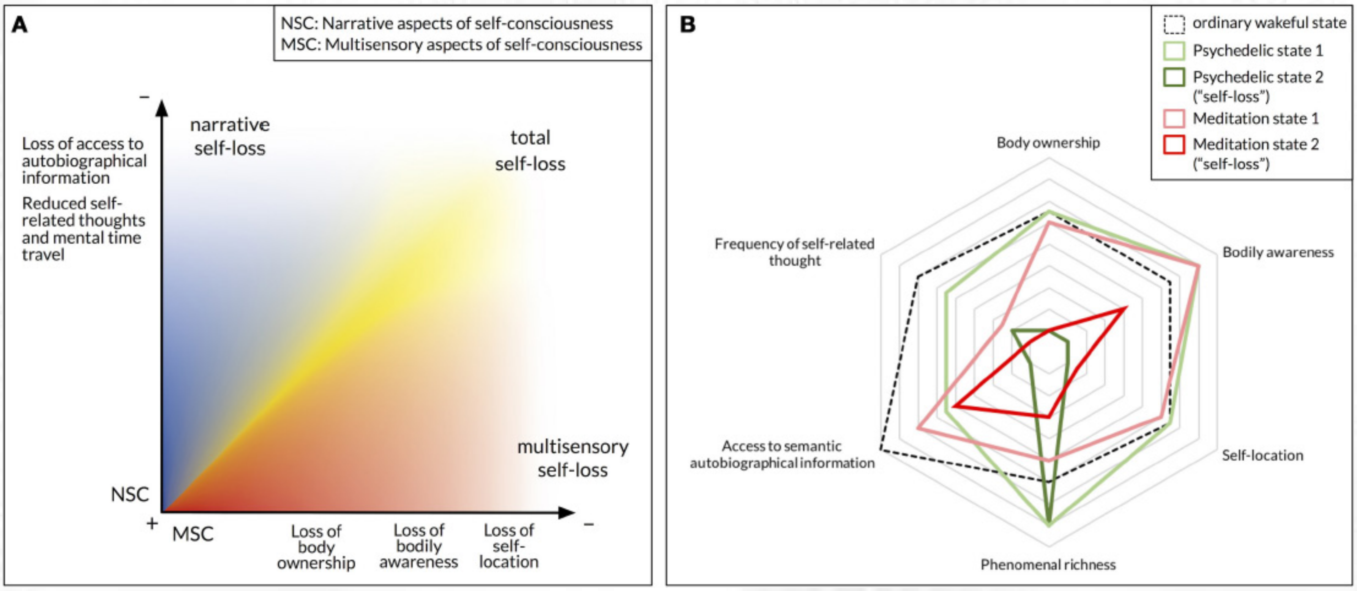

A
NSC: Narrative aspects of self-consciousness
MSC: Multisensory aspects of self-consciousness
–
Loss of access to autobiographical information
Reduced self-related thoughts and mental time travel
narrative self-loss
total self-loss
multisensory self-loss
NSC
+
MSC
Loss of body ownership
Loss of bodily awareness
Loss of self-location
–
B
ordinary wakeful state
Psychedelic state 1
Psychedelic state 2 ("self-loss")
Meditation state 1
Meditation state 2 ("self-loss")
Body ownership
Bodily awareness
Self-location
Phenomenal richness
Access to semantic autobiographical information
Frequency of self-related thought

FIGURE 1 - Multidimensional models of self-loss in global states of consciousness. **(A)** A simplified two-dimensional model of self-loss. The X-axis represents the degree to which multisensory aspects of self-consciousness are disrupted, and the Y-axis represents the degree to which narrative aspects of self-consciousness are disrupted. The color gradients represent the gradual disruption of narrative aspects (blue), multisensory aspects (red), or both (yellow) within the two-dimensional state space of altered states of consciousness induced by meditation and psychedelics could theoretically be plotted. This two-dimensional model can be conceived as a conceptual sketch that reduces the dimensionality of the notion of self-consciousness to two orthogonal principal dimensions, somewhat similarly to Principal Component Analysis. The shortcomings of this simplified model are tentatively addressed in the more complex **(B)**. **(B)** A tentative multidimensional model of self-loss. Global states of consciousness are plotted on the radar chart according to their score on six dimensions (using an arbitrary scale), representing the degree to which they involve (1) a sense of body ownership, (2) awareness of bodily sensations, (3) awareness of spatial self-location, (4) rich phenomenology, (5) access to semantic autobiographical information, and (6) self-related thoughts. Regions in the radar chart represent idealized examples of global states of consciousness, including an ordinary state during wakefulness (dotted black line), two examples of meditation-induced states and two examples of drug-induced states. The region in pink is an example of a typical meditative state with increased bodily awareness (via attentional focus on the breath), slightly decreased overall phenomenal richness (via visual-auditory deprivation) and decreased frequency of self-related thoughts. The region in red is an example of a "selfless" state described by experienced meditators, with a cessation of self-related thought, a loss of body ownership, agency and self-location, and significant reductions in bodily awareness and phenomenal richness. The region in light green is an example of a state induced by a moderate dose of psychedelic drugs such as LSD or psilocybin, with increased bodily awareness (modulated by salient and unusual bodily sensations) and increased phenomenal richness (via decreased sensory gating and vivid perceptual abnormalities). The region in dark green is an example of drug-induced ego dissolution with a loss of narrative and multisensory aspects of self-consciousness, but rich sensory content. **(B)** illustrates how even states of "total self-loss" as represented by a single region on **(A)** can differ from a phenomenological perspective between meditation (red line) and psychedelics (dark green line). In addition, it shows that some states of consciousness induced by both meditation practice and psychedelics can also score higher than baseline on certain dimensions of self-consciousness, in particular bodily awareness. Overall, states of "self-loss" are the exception rather than the norm for both modes of induction. Finally, it should be noted that the phenomenology of altered states induced by meditation and psychedelics may considerably change over time, sometimes very quickly; consequently, the idealized states plotted on this figure should be considered as phenomenological "snapshots" at a given time. For example, "Psychedelic state 1" (light green line) could be part of the same drug-induced experience as "Psychedelic state 2" (dark green line), assuming that the phenomenology dynamically shifts toward the peak of the experience (during the transition to drug-induced ego dissolution).

Although we have specifically focused on disruptions of self-consciousness in this paper, it is important to underline that both meditation and psychedelics can not only inhibit various aspects of self-experience, but may also *increase* their salience in other cases. In particular, meditation techniques focusing on the awareness of the breath, as well as psychedelic drugs such as LSD and psilocybin, may temporarily increase awareness of bodily sensations. This apparent paradox is resolved when one considers the many parameters that may modulate the phenomenology of meditation practice and psychedelic states. As we have insisted, there are many different styles of meditation, and states of "self-loss" are usually reported by highly experienced individuals trained in specific traditions. Moreover, the phenomenology of a single meditation session unfolds in distinct phases, with the occasional experience of self-loss being the culmination of this succession of phase transitions (Yamashiro, 2015; see Ataria *et al*., 2015; Dor-Ziderman *et al*., 2016). Similarly, the phenomenology of psychedelic states may be modulated by a number of variables, including: the particular drug used (e.g., the effects of 5-MeO-DMT appear to differ from those of other psychedelics), dosage (high doses being more likely to lead to ego dissolution), context of use (immobility and sensory deprivation may modulate the loss of body awareness and self-location) and finally pharmacodynamics (the effects of a drug evolve across time, with experiences of self-loss occurring at the peak, if at all). In **Figure 1B**, we have represented four examples of global states of consciousness induced by meditation and psychedelics to emphasize these nuances. Only two of these states (represented in red and dark green respectively) may be described as involving experiences of "total self-loss" as depicted on **Figure 1A**, although they do not completely overlap in the multidimensional state space. We have tentatively summarized in **Table 4** below how such states of self-loss might differ between meditation and psychedelics.

The upshot of this discussion is that there is no such thing as "self-loss" or "ego dissolution" in absolute terms. Future research could develop new tools to assess in a more fine-grained way the features of conscious states described as involving a loss of one's sense of self. As an example, neuroimaging studies of psychedelics have often used a single questionnaire item ("I experienced a disintegration of myself or ego") to measure drug-induced ego dissolution and correlate its intensity with neurophysiological observations (Muthukumaraswamy *et al.*, 2013; Carhart-Harris *et al.*, 2014, 2016b; Lebedev *et al.*, 2016; Tagliazucchi *et al.*, 2016). While this strategy has yielded very interesting results, it does not allow for the discrimination between several kinds of disruption of self-consciousness. The recent Ego Dissolution Inventory, which has been psychometrically validated, does not discriminate between the loss of narrative and embodied or multisensory aspects of self-consciousness either (Nour and Carhart-Harris, 2017). Future questionnaires focusing on alterations of self-consciousness could include both items related to disruptions of self-related thoughts and mental time travel, and items related to body ownership, bodily awareness and self-location. A psychometric analysis of subsequent item ratings could test whether these items can be grouped into two orthogonal factors, namely narrative and embodied self-loss.

Table 4 - Summary of overlap and differences between meditation-induced and drug-induced states of "total self-loss"

	Self-loss in psychedelic states	Self-loss in meditation
Body ownership	- - -	- - -
Bodily awareness	- - -	- -
Self-location	- - -	- - -
Phenomenal richness	+ + + (except 5-MeO-DMT)	- -
Self-related thoughts	- -	- - -
Access to semantic autobiographical information	- -	-

It is also important to underline that evidence from subjective reports should be treated with caution. Although the reports discussed in this paper show a remarkable convergence and can be treated as preliminary evidence for the disruption of body ownership, bodily awareness and self-location in meditation and psychedelic states, alternative interpretations are available. First, one could refuse to take these self-reports at face value on the ground that they could be systematically unreliable and confabulatory. This is rather unlikely, however, given the convergence of reports from different groups of subjects in different conditions, as well as the consistency of reports with questionnaire data. Moreover, there is no reason to suspect that either meditators or volunteers participating in studies of psychedelic drugs are particularly prone to confabulation, and their reports are less problematic than those of patients suffering from delusions such as the Cotard syndrome (Billon, 2016). In addition, the microphenomenological interview used to collect some of these reports is designed to minimize the risk of confabulation and theoretical contamination (Petitmengin, 2006; Petitmengin and Lachaux, 2013). Finally, there is some evidence that meditative experience predicts introspective accuracy (Fox *et al.*, 2012; Baird *et al.*, 2014). Nonetheless, it should be noted that the evidence discussed in this article is still tentative insofar as most studies of the effects of meditation and psychedelics rely on a limited sample size.

A second alternative interpretation of the reports discussed in the previous sections would emphasize that the experience of loss is not equivalent to the loss of experience. In other words, the fact that subjects report having a sense of *losing* ownership over their body or awareness of their spatial location does not necessarily entail that body ownership or self-location were part of their overall phenomenology at baseline (i.e., prior to meditating or drug administration). While this idea is not incoherent, we have provided independent reasons to believe that at least bodily awareness and spatial self-location are part of the content of ordinary conscious experience; in other words, there is evidence that we usually experience bodily sensations, and have some awareness of our relative location with respect to our perceived environment. While we acknowledge that the existence of a specific phenomenology of body ownership is more controversial, we have also mentioned some clinical and experimental evidence from somatoparaphrenia, autoscopic phenomena, the rubber hand illusion and full-body illusions suggesting that some feature(s) of the ordinary experience of neurotypical individuals are associated with the experience of one's body as one's own.

In order to address the limitations of self-reports, future research could use implicit and behavioral measurements to circumvent the risk of introspective biases. For example, researchers could investigate the representation of trunk-centered peripersonal space, which has been shown to encode self-location (Blanke *et al.*, 2015; Noel *et al.*, 2015; Serino *et al.*, 2015), both during meditation and after psychedelic intake. A plausible prediction is that the boundaries of the full-body (trunk-centered) peripersonal space are blurred both during some instances of drug-induced ego dissolution and some forms of meditation described as a loss of self-location and body boundaries (see Millière, 2017).

Long-term outcomes of altered self-consciousness

Selflessness as a Trait

Accumulating evidence shows that meditation's state effects linger into daily life, to become long-term, trait alterations (Cahn and Polich, 2006). These trait effects include alterations in resting state function or connectivity, as well as structural changes, compared to control groups (Fox *et al.*, 2014; reviewed in Tang *et al.*, 2015). A full review of all the accumulated evidence is beyond the scope of this paper. Instead, here we focus on trait-effects of alterations in self-consciousness, either from the neurophysiological (underlying mechanisms, specifically regarding the DMN) or first-person perspective.

Several studies have provided evidence that meditation practitioners, compared to controls, exhibit reduced resting state DMN activity and connectivity, either using electrophysiology (Berkovich-Ohana *et al.*, 2012, 2013) or fMRI (Hasenkamp and Barsalou, 2012; Berkovich-Ohana *et al.*, 2016). Specifically, resting state functional connectivity analyses showed that following 8-weeks of mindfulness-training, participants demonstrated significantly increased functional connectivity of the anterior DMN region with the auditory/salience network (Kilpatrick *et al.*, 2011). Similarly, long-term mindfulness practitioners showed compared to controls increased functional connectivity between DMN and visual regions (Berkovich-Ohana *et al.*, 2016). In other studies, proficient mindfulness meditators showed increased functional connectivity between the DMN and fronto-parietal control network compared to novices (Brewer *et al.*, 2011; Hasenkamp *et al.*, 2012; Taylor *et al.*, 2013), although there is some evidence of increased anti-correlation between the DMN and a task-positive network during focused attention meditation compared to the resting state (Josipovic *et al.*, 2012), or the DMN and visual regions following MBSR (Kilpatrick *et al.*, 2011). While fMRI studies largely show that mindfulness meditation practice is associated with reduced DMN activity, the related structural effects in the DMN are less clear (recently reviewed by Fox *et al.*, 2014). Specifically, several neuroanatomical studies reported changes in PCC gray matter thickness: while a few studies indicate reduction in meditators relative to controls (Kang *et al.*, 2013), another study failed to find group differences (Grant *et al.*, 2013), and yet another reported gray matter increases following a short 8-weeks mindfulness meditation intervention (Hölzel *et al.*, 2011). Initial evidence suggests that such changes in DMN functioning are indeed related to a reduced tendency to engage in self-referential processing. One earlier study (Farb *et al.*, 2007) showed that after an 8-week mindfulness intervention, participants were able to disengage from a "narrative self-focus" in the trait judgment task (typically employed to investigate self-referential processes, cf. Northoff *et al.*, 2006), as evidenced by more pronounced reductions in the DMN compared to the control group. Similarly, another study found reduced bias in neural responses to the self vs. an other's face for long-term meditators compared to controls (Trautwein *et al.*, 2016).

Less is known about whether meditation practice affects multisensory aspects of self-consciousness in a trait-like manner. Studies investigating neural and phenomenological state effects of meditation suggest that long-term meditators are capable of flexibly modulating and reducing bodily self-awareness (Ataria *et al.*, 2015; Dor-Ziderman *et al.*, 2016). However, controlled studies have not yet systematically assessed whether this is an outcome of long-term practice (some effects also seem to occur in novice practitioners, cf. Dambrun, 2016) and to which degree such flexibility affects daily life functioning.

There is no evidence that the experience of drug-induced ego dissolution may have long-term effects on narrative and multisensory aspects of self-consciousness, such as a reduction of self-related thoughts. This question may be answered by future longitudinal studies.

Relation to Therapeutic Outcomes, Well-Being and Prosociality

While the long-term consequences of ego dissolution on self-consciousness are uncertain, there is preliminary evidence that drug-induced alterations of self-consciousness may mediate therapeutic outcomes. The current model of psychedelic-assisted therapy originated in the 50's and 60's (Pahnke *et al.*, 1971; Dyck, 2006). In this model, subjects receive a high dose of a psychedelic drug in a supportive environment, with the aim of experiencing a mystical-type or "peak" experience (Maslow, 1959; Stace, 1960). This experience is conceived as a "unitive" state involving the loss of self-world boundaries, as described in sections Alterations of self-consciousness induced by meditation and psychedelics and Pure consciousness, non-dual awareness and total selflessness. The therapeutic model suggests that this experience mediates long-term outcomes (Pahnke *et al.*, 1971; Grof *et al.*, 2008; Maji&cacute; *et al.*, 2015; Richards, 2015). In recent years, many controlled studies have shown that that the magnitude of the mystical-type experience predicts positive psychological outcomes for depression, addiction, palliative care, and general well-being (O'Reilly and Funk, 1964; Klavetter and Mogar, 1967; Pahnke *et al.*, 1971; Kurland and Grof, 1972; Richards *et al.*, 1977; Griffiths *et al.*, 2006, 2016; MacLean *et al.*, 2011; Garcia-Romeu *et al.*, 2014; Bogenschutz *et al.*, 2015; Ross *et al.*, 2016; Johnson *et al.*, 2017; Roseman *et al.*, 2018). Furthermore, a recent analysis of the psychedelic experience in uncontrolled environments suggests that mystical-type experiences predict changes in well-being (Carhart-Harris *et al.*, 2018). It is also suggested that mystical-type experiences are linked to the positive emotional outcomes of meditation (Russ and Elliott, 2017).

Two variables appear to predict the occurrence of mystical-type experience in both meditation and psychedelics: trait absorption and surrender state. Absorption (Tellegen and Atkinson, 1974) is a trait characterized by the disposition to have episodes of "total" attention to one's representational resources. Subjects with higher absorption tend to have stronger mystical-type experiences both under psychedelics (Studerus *et al.*, 2012) and in meditation (Russ and Elliott, 2017). The second variable is the pre-experience state characterized by the disposition to "let-go" or "surrender" to whatever experience comes, sometimes called "surrender state" (Richards, 2015). This state is not only related to the subject's personality but also to interactions with the environment (e.g., trust toward the therapist). Higher ratings of willingness to surrender are associated with stronger mystical-type experience in both psychedelic experiences (Carhart-Harris *et al.*, 2018) and meditation (Russ and Elliott, 2017).

Do experiences of "self-loss" induced by meditation or psychedelics have a relevance for therapeutic outcomes or general well-being? There is preliminary evidence that the therapeutic effects of psychedelics for treatment-resistant depression is mediated by meaningful "breakthrough" experiences, which may include ego dissolution (Roseman *et al.*, 2018). By contrast, long-term effects of contemplative practices on well-being do not appear to be necessarily mediated by intense experiences, but rather by training of different cognitive mechanisms, such as attentional control mediating meta-awareness of mind-wandering. Interestingly, one suggested mechanism is a (gradual) shift in the perspective on the self-described as "detachment from identification with a static sense of self " (Hölzel *et al.*, 2011). In the Buddhist tradition, this process is thought to be a crucial factor for the attainment of stable well-being (Olendzki, 2006; Shiah, 2016). Some psychometric research supports this link (Dambrun, 2017). Moreover, a related construct called "decentering" has been found to mediate treatment effects of mindfulness based interventions (reviewed in Bernstein *et al.*, 2015). Anecdotal reports and traditional sources do also claim that peak meditative experiences involving a loss of the sense of self can have lasting effects on well-being (Austin, 2009); however, perhaps due to the difficulty to induce such experiences in the lab, they have not been systematically investigated. In a first qualitative survey on experiences associated with long-term meditative practice, changes in the sense of self, including narrative and bodily levels were frequently reported (more than 75%) (Lindahl *et al.*, 2017). Of note, the affective response to these experiences was not always positive, but ranged "from neutral curiosity, to bliss and joy, to fear and terror" (p. 20). Interestingly, ayahuasca administration was also found to produce after 24 h a significant reduction in judgmental processing of experiences measured by the Five Facets Mindfulness Questionnaire (FFMQ), as well as a significant increase in decentering ability measured by the Experiences Questionnaire (EQ) (Soler *et al.*, 2016). Thus, it is possible that the medium- to long-term effects of meditation and psychedelic experiences involve a reduced tendency to be personally and emotionally engaged in one's thoughts and feelings, such that "the contents of consciousness are less filtered through considerations of self-relevance than is usual" (Letheby and Gerrans, 2017, p. 7).

A further question worth investigating in future research regards the specific kind of "self-loss," if any, which may mediate long-term therapeutic outcome and increased well-being. For example, are such effects more likely to be mediated by the loss of narrative or multisensory aspects of self-consciousness? Given the potential link between mind-wandering and unhappiness (Killingsworth and Gilbert, 2010), it is intriguing to speculate that increased control of spontaneous thoughts might mediate increased well-being in experienced meditators, which would indicate that the disruption of narrative aspects of self-consciousness may have a positive effect, to some extent. At this stage, however, this speculative hypothesis remains unsubstantiated by significant evidence.

Besides individual well-being, one potential outcome of meditative practice is an increase in empathy and compassion, which are regarded as antecedents of prosocial behavior. There is indeed evidence that meditation fosters these aspects of prosociality (Condon *et al*., 2013; Ashar *et al*., 2016; see Kreplin *et al*., 2018 for a recent meta-analysis; Leiberg *et al*., 2011; Weng *et al*., 2013). Importantly, it has been hypothesized that these effects rely on a change in the sense of self. For example, Dambrun and Ricard (2011) suggested that meditation can support a shift from self-centered to selfless functioning, characterized by "a weak distinction between self and others, and self and the environment as a whole," which in turn "is closely related to characteristics such as altruism, kindness, respect, empathy, compassion and the search for harmony" (Dambrun and Ricard, 2011, p. 140). Providing evidence for one part of this relationship, recent studies demonstrated that manipulation of bodily levels of self-awareness can affect empathy and social cognition (Maister *et al*., 2013, 2015). However, the link to meditation is still largely hypothetical, although one study found that reduced self-related processing in long-term meditators was correlated with increased trait levels of self-reported compassion (Trautwein *et al*., 2016). Intriguingly, the administration of a high dose of psilocybin 1 or 2 months after a program of meditation practice was found to occasion enduring trait-level increases in prosocial behavior (Griffiths *et al*., 2018). This finding raises the question of whether psychedelic intake may potentiate in certain cases the putative long-term effects of meditation on prosociality. In summary, it is possible that there is a link between "selflessness" as a conscious episode lacking self-consciousness and trait increase in prosocial behavior, but these two constructs should not be conflated. Future research could determine whether such an association exists for meditation training and perhaps psychedelic use, and get clearer on the mechanisms involved.

General conclusion

There is converging evidence that high doses of psychedelic drugs and certain forms of meditation practice for highly experienced practitioners can produce strong, short-term, and reversible disruptions of self-consciousness. However, drug-induced and meditation-induced experiences of "self-loss" are not uniform, and can be decomposed in terms of alterations of various aspects or dimensions of self-consciousness. These include "narrative" aspects, such as the inhibition of self-related thoughts and self-related mental time travel, and the loss of access to autobiographical information, as well as bodily and multisensory aspects, such as the loss of body ownership, bodily awareness and self-location. Questionnaire data, subjective reports and neurophysiological results suggest that some of these aspects might be independently modulated in the global states of consciousness that can be induced by meditation and psychedelic drugs. Thus, the notion of self-consciousness can be construed as a multidimensional construct, and consequently "self-loss" or "ego dissolution" should not be conceived as a simple graded phenomenon ordered along a single dimension.

Moreover, even forms of putative "total" self-loss involving the radical disruption of both narrative and multisensory aspects of self-consciousness are best thought of as a family of states which can differ from a phenomenological perspective with respect to variables that are not directly related to self-consciousness. Indeed, strong forms of drug-induced ego dissolution may involve a very vivid and rich sensory phenomenology, perhaps as a result of decreased sensory gating, while available evidence on some "selfless" states induced by meditation suggests that their phenomenal content is very sparse (e.g., in states of so-called "pure consciousness" achieved in *Samadhi* practice).

One potential limitation of this analysis is that empirical data remains too sparse to reliably determine the phenomenological and neurophysiological specificity of the global states of consciousness under consideration. For example, it remains difficult to assess in what respect conscious states induced by *Samadhi* practice really differ from states induced by other meditation practices or psychedelic drugs. Few controlled studies have investigated the experience of self-loss in meditation or drug-induced states, and those which have done so have limited sample sizes. Another potential issue is the interpretation of self-reports. It is notoriously difficult to gather reliable evidence about subjective experience, and this is all the more problematic with altered states of consciousness often deemed ineffable.

Future research on this topic could focus on developing more fine-grained psychometric tools to validate and measure various dimensions of self-consciousness, and their respective disruptions in altered states of consciousness. Furthermore, researchers could seek to correlate reports gathered from questionnaires not only with neuroimaging data, but also with independent implicit measurements. As an example, the disruption of spatial self-location might be associated with a dissolution of the boundaries of the trunk-centered peripersonal space, which can be measured using an established psychophysical paradigm (Noel *et al.*, 2015). Finally, future research could investigate the possible relationship between temporary disruptions of self-consciousness induced by meditation and psychedelics, and long-term changes in cognitive processing, personality traits and prosocial behavior. While it is important to avoid conflating states of self-loss with "selflessness" as a trait or moral construct, it is possible that correlations might exist between these distinct notions, although perhaps only for a subset of highly experienced meditators or drug-users. More research is needed to provide answers to these outstanding questions.

Author contributions

All authors listed have made a direct contribution to the work. RM has written the first draft of the manuscript, with the exception of the final section Long-term outcomes of altered self-consciousness. RC-H, LR, F-MT and AB-O have written the latter, and have completed the section The neuroscience of meditation and psychedelics: an overview. All authors listed have contributed to subsequent revisions of the manuscript.

Funding

RM was funded by the Ertegun Scholarship Programme. RC-H was funded by the Alex Mosley Charitable Trust. LR was funded by Imperial College London, President's PhD Scholarship and by Albert Hobohm. F-MT was funded by a DFG individual fellowship (GZ: TR 1587/1-1). AB-O was funded by a grant from the Bial Foundation (228/14).

Acknowledgements

The authors would like to thank Martin Davies, Link Swanson and Christopher Timmermann for their helpful comments on previous versions of this article.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Albahari, M. (2009). Witness-consciousness: its definition, appearance and reality. *J. Consciousn. Studi*. 16, 62-84.
2. Albahari, M. (2010). "Nirvana and ownerless consciousness," in *Self, No Self?: Perspectives From Analytical, Phenomenological, and Indian Traditions*, eds M. Siderits, E. Thompson, and D. Zahavi (Oxford: Oxford University Press). doi: 10.1093/acprof:oso/9780199593804.003.0004
3. Alsmith, A. (2014). Mental Activity and the Sense of Ownership. *Rev. Philos. Psychol*. 6, 881-896. doi: 10.1007/s13164-014-0208-1
4. Alsmith, A. (2017). "Perspectival structure and agentive self-location," in *The Subject's Matter: Self-Consciousness and the Body*, eds A. Alsmith and F. De Vignemont (Oxford: Oxford University Press), 263.
5. Alvarado, C. S. (2000). "Out-of-body experiences," in *Varieties of Anomalous Experiences: Examining the Scientific Evidence*, eds E. Cardeña, S. J. Lynn, and S. Krippner (Washington, DC: American Psychological Association), 183-218. doi: 10.1037/10371-006
6. Anderson, E. W., and Rawnsley, K. (1954). Clinical studies of lysergic acid diethylamide. *Eur. Neurol*. 128, 38-55. doi: 10.1159/000139775
7. Apps, M. A. J., and Tsakiris, M. (2014). The free-energy self: a predictive coding account of self-recognition. *Neurosci*.

Biobehav. Rev. 41, 85-97. doi: 10.1016/j.neubiorev.2013.01.029

8. Ashar, Y. K., Andrews-Hanna, J. R., Yarkoni, T., Sills, J., Halifax, J., Dimidjian, S., *et al.* (2016). Effects of compassion meditation on a psychological model of charitable donation. *Emotion* 16, 691-705. doi: 10.1037/emo0000119
9. Aspell, J. E., Heydrich, L., Marillier, G., Lavanchy, T., Herbelin, B., and Blanke, O. (2013). Turning body and self inside out visualized heartbeats alter bodily self-consciousness and tactile perception. *Psychol. Sci.* 24, 2445-2453. doi: 10.1177/0956797613498395
10. Ataria, Y., Dor-Ziderman, Y., and Berkovich-Ohana, A. (2015). How does it feel to lack a sense of boundaries? A case study of a long-term mindfulness meditator. *Consciousn. Cogn.* 37, 133-147. doi: 10.1016/j.concog.2015.09.002
11. Atasoy, S., Roseman, L., Kaelen, M., Kringelbach, M. L., Deco, G., and Carhart-Harris, R. L. (2017). Connectome-harmonic decomposition of human brain activity reveals dynamical repertoire re-organization under LSD. *Sci. Rep.* 7:17661. doi: 10.1038/s41598-017-17546-0
12. Austin, J. H. (2000). Consciousness evolves when the self dissolves. *J. Consciousn. Stud.* 7, 209-230.
13. Austin, J. H. (2006). *Zen-Brain Reflections, 1 edn.* Cambridge, MA: The MIT Press.
14. Austin, J. H. (2009). *Selfless Insight: Zen and the Meditative Transformations of Consciousness, 1 edn.* Cambridge, MA: The MIT Press.
15. Aydede, M. (2009). Is Feeling Pain the Perception of Something? *J. Philos.* 106, 531-567. doi: 10.5840/jphil20091061033
16. Baars, B. J. (2013). A scientific approach to silent consciousness. *Front. Psychol.* 4:678. doi: 10.3389/fpsyg.2013.00678
17. Bagger, M. C. (1999). *Religious Experience, Justification, and History*. Cambridge; New York, NY: Cambridge University Press.
18. Baird, B., Mrazek, M. D., Phillips, D. T., and Schooler, J. W. (2014). Domain-specific enhancement of metacognitive ability following meditation training. *J. Exper. Psychol. Gen.* 143, 1972-1979. doi: 10.1037/a0036882
19. Baird, B., Smallwood, J., and Schooler, J. W. (2011). Back to the future: autobiographical planning and the functionality of mind-wandering. *Conscious. Cogn.* 20, 1604-1611. doi: 10.1016/j.concog.2011.08.007
20. Barnsley, N., McAuley, J. H., Mohan, R., Dey, A., Thomas, P., and Moseley, G. L. (2011). The rubber hand illusion increases histamine reactivity in the real arm. *Curr. Biol.* 21, R945-R946. doi: 10.1016/j.cub.2011.10.039
21. Bauer, M., Stenner, M.-P., Friston, K. J., and Dolan, R. J. (2014). Attentional modulation of Alpha/Beta and Gamma oscillations reflect functionally distinct processes. *J. Neurosci.* 34, 16117-16125. doi: 10.1523/JNEUROSCI.3474-13.2014
22. Bayley, P. J., Hopkins, R. O., and Squire, L. R. (2006). The fate of old memories after medial temporal lobe damage. The fate of old memories after medial temporal lobe damage. *J. Neurosci.* 26, 13311-13317. doi: 10.1523/JNEUROSCI.4262-06.2006
23. Bayne, T. (2007). Conscious states and conscious creatures: explanation in the scientific study of consciousness. *Philos. Perspect.* 21, 1-22. doi: 10.1111/j.1520-8583.2007.00118.x
24. Bayne, T., Hohwy, J., and Owen, A. M. (2016). Are there levels of consciousness? *Trends Cogn. Sci.* 20, 405-413. doi: 10.1016/j.tics.2016.03.009
25. Bayne, T., and Pacherie, E. (2007). Narrators and comparators: the architecture of agentive self-awareness. *Synthese* 159, 475-491. doi: 10.1007/s11229-007-9239-9
26. Bercel, N. A., Travis, L. E., Olinger, L. B., Dreikurs, E., and Polos, M. G. (1956). Model psychoses induced by lsd-25 in normals: I. psychophysiological investigations, with special reference to the mechanism of the paranoid reaction. *A.M.A. Arch. Neurol. Psychiatry* 75, 588-611. doi: 10.1001/archneurpsyc.1956.02330240026003
27. Beringer, K. (1927). *Der Meskalinrausch: Seine Geschichte und Erscheinungsweise (Monographien aus dem Gesamtgebiete der Neurologie und Psychiatrie)*. Berlin: Springer. doi: 10.1007/978-3-662-11451-3
28. Berkovich-Ohana, A., Dor-Ziderman, Y., Glicksohn, J., and Goldstein, A. (2013). Alterations in the sense of time, space, and body in the mindfulness-trained brain: a neurophenomenologically-guided MEG study. *Front. Psychol.* 4:912. doi: 10.3389/fpsyg.2013.00912
29. Berkovich-Ohana, A., Glicksohn, J., Ben-Soussan, T. D., and Goldstein, A. (2017). Creativity is enhanced by long-term mindfulness training and is negatively correlated with trait default-mode-related low-gamma inter-hemispheric connectivity. *Mindfulness* 8, 717-727. doi: 10.1007/s12671-016-0649-y
30. Berkovich-Ohana, A., Glicksohn, J., and Goldstein, A. (2012). Mindfulness-induced changes in gamma band activity - implications for the default mode network, self-reference and attention. *Clin. Neurophysiol.* 123, 700-710. doi: 10.1016/j.clinph.2011.07.048
31. Berkovich-Ohana, A., Harel, M., Hahamy, A., Arieli, A., and Malach, R. (2016). Alterations in task-induced activity and resting-state fluctuations in visual and DMN areas revealed in long-term meditators. *Neuroimage* 135, 125-134. doi: 10.1016/j.neuroimage.2016.04.024
32. Berkovich-Ohana, A., Wilf, M., Kahana, R., Arieli, A., and Malach, R. (2015). Repetitive speech elicits widespread deactivation in the human cortex: the "Mantra" effect? *Brain Behav.* 5:e00346. doi: 10.1002/brb3.346
33. Berkovich-Ohana, A., and Wittmann, M. (2017). A typology of altered states according to the consciousness state space (CSS) model: a special reference to subjective time. *J. Consciousn. Stud.* 24, 37-61.
34. Bermúdez, J. L. (2011). "Bodily awareness and self-consciousness," in *The Oxford Handbook of the Self*, ed S. Gallagher (Oxford: Oxford University Press), 157-179. doi: 10.1093/oxfordhb/9780199548019.003.0007
35. Bermúdez, J. L. (2015). Bodily ownership, bodily awareness and knowledge without observation. *Analysis* 75, 37-45. doi: 10.1093/analys/anu119
36. Bernasconi, F., Schmidt, A., Pokorny, T., Kometer, M., Seifritz, E., and Vollenweider, F. X. (2014). Spatiotemporal brain dynamics of emotional face processing modulations induced by the serotonin 1A/2A receptor agonist psilocybin. *Cereb. Cortex* 24, 3221-3231. doi: 10.1093/cercor/bht178
37. Bernstein, A., Hadash, Y., Lichtash, Y., Tanay, G., Shepherd, K., and Fresco, D. M. (2015). Decentering and related constructs: a critical review and metacognitive processes model. *Perspect. Psychol. Sci.* 10, 599-617. doi: 10.1177/1745691615594577
38. Billon, A. (2016). Making sense of the cotard syndrome: insights from the study of depersonalisation. *Mind Lang.* 31, 356-391. doi: 10.1111/mila.12110
39. Blanke, O. (2012). Multisensory brain mechanisms of bodily self-consciousness. *Nat. Rev. Neurosci.* 13, 556-571. doi: 10.1038/nrn3292

40. Blanke, O., and Arzy, S. (2005). The out-of-body experience: disturbed self-processing at the temporo-parietal junction. *Neuroscientist* 11, 16-24. doi: 10.1177/1073858404270885
41. Blanke, O., and Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends Cogn. Sci.* 13, 7-13. doi: 10.1016/j.tics.2008.10.003
42. Blanke, O., and Mohr, C. (2005). Out-of-body experience, heautoscopy, and autoscopic hallucination of neurological origin: implications for neurocognitive mechanisms of corporeal awareness and self-consciousness. *Brain Res. Rev.* 50, 184-199. doi: 10.1016/j.brainresrev.2005.05.008
43. Blanke, O., Slater, M., and Serino, A. (2015). Behavioral, neural, and computational principles of bodily self-consciousness. *Neuron* 88, 145-166. doi: 10.1016/j.neuron.2015.09.029
44. Bogenschutz, M. P., Forcehimes, A. A., Pommy, J. A., Wilcox, C. E., Barbosa, P. C. R., and Strassman, R. J. (2015). Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *J. Psychopharmacol.* 29, 289-299. doi: 10.1177/0269881114565144
45. Bottini, G., Bisiach, E., Sterzi, R., and Vallarc, G. (2002). Feeling touches in someone else's hand. *Neuroreport* 13:249.
46. Botvinick, M., and Cohen, J. (1998). Rubber hands 'feel' touch that eyes see. *Nature* 391, 756-756.
47. Brewer, B. (1992). Self-location and agency. *Mind* 101, 17-34. doi: 10.1093/mind/101.401.17
48. Brewer, J. A., and Garrison, K. A. (2014). The posterior cingulate cortex as a plausible mechanistic target of meditation: findings from neuroimaging. *Ann. NY. Acad. Sci.* 1307, 19-27. doi: 10.1111/nyas.12246
49. Brewer, J. A., Worhunsky, P. D., Gray, J. R., Tang, Y.-Y., Weber, J., and Kober, H. (2011). Meditation experience is associated with differences in default mode network activity and connectivity. *Proc. Natl. Acad. Sci. U.S.A.* 108, 20254-20259. doi: 10.1073/pnas.1112029108
50. Brown, D. P. (1977). A model for the levels of concentrative meditation. *Int. J. Clin. Exper. Hypnosis* 25, 236-273. doi: 10.1080/00207147708415984
51. Cabeza, R., and St Jacques, P. (2007). Functional neuroimaging of autobiographical memory. *Trends Cogn. Sci.* 11, 219-227. doi: 10.1016/j.tics.2007.02.005
52. Cahn, B. R., and Polich, J. (2006). Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychol. Bull.* 132, 180-211. doi: 10.1037/0033-2909.132.2.180
53. Capurso, V., Fabbro, F., and Crescentini, C. (2014). Mindful creativity: the influence of mindfulness meditation on creative thinking. *Front. Psychol.* 4:1020. doi: 10.3389/fpsyg.2013.01020
54. Carbonell, F., Bellec, P., and Shmuel, A. (2014). Quantification of the impact of a confounding variable on functional connectivity confirms anti-correlated networks in the resting-state. *Neuroimage* 86, 343-353. doi: 10.1016/j.neuroimage.2013.10.013
55. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J. M., Reed, L. J., Colasanti, A., *et al.* (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl. Acad. Sci. U.S.A.* 109, 2138-2143. doi: 10.1073/pnas.1119598109
56. Carhart-Harris, R. L., and Goodwin, G. M. (2017). The therapeutic potential of psychedelic drugs: past, present, and future. *Neuropsychopharmacology* 42, 2105-2113. doi: 10.1038/npp.2017.84
57. Carhart-Harris, R. L., Kaelen, M., Bolstridge, M., Williams, T. M., Williams, L. T., Underwood, R., *et al.* (2016a). The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol. Med.* 46, 1379-1390. doi: 10.1017/S0033291715002901
58. Carhart-Harris, R. L., Leech, R., Erritzoe, D., Williams, T. M., Stone, J. M., Evans, J., *et al.* (2013). Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. *Schizophr. Bull.* 39, 1343-1351. doi: 10.1093/schbul/sbs117
59. Carhart-Harris, R. L., Leech, R., Hellyer, P. J., Shanahan, M., Feilding, A., Tagliazucchi, E., *et al.* (2014). The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front. Hum. Neurosci.* 8:20. doi: 10.3389/fnhum.2014.00020
60. Carhart-Harris, R. L., Muthukumaraswamy, S., Roseman, L., Kaelen, M., Droog, W., Murphy, K., *et al.* (2016b). Neural correlates of the LSD experience revealed by multimodal neuroimaging. *Proc. Natl. Acad. Sci. U.S.A.* 113, 4853-4858. doi: 10.1073/pnas.1518377113
61. Carhart-Harris, R. L., Roseman, L., Haijen, E., Erritzoe, D., Watts, R., Branchi, I., *et al.* (2018). Psychedelics and the essential importance of context. *J. Psychopharmacol.* 32, 1-7. doi: 10.1177/0269881118754710
62. Carter, O. L., Hasler, F., Pettigrew, J. D., Wallis, G. M., Liu, G. B., and Vollenweider, F. X. (2007). Psilocybin links binocular rivalry switch rate to attention and subjective arousal levels in humans. *Psychopharmacology* 195, 415-424. doi: 10.1007/s00213-007-0930-9
63. Cassam, Q. (1997). *Self and World*. Oxford: Oxford University Press.
64. Chadha, M. (2018). No-Self and the Phenomenology of Ownership. *Australas. J. Philos.* 96, 14-27. doi: 10.1080/00048402.2017.1307236
65. Chai, X. J., Castañón, A. N., Öngür, D., and Whitfield-Gabrieli, S. (2012). Anticorrelations in resting state networks without global signal regression. *Neuroimage* 59, 1420-1428. doi: 10.1016/j.neuroimage.2011.08.048
66. Christoff, K., Cosmelli, D., Legrand, D., and Thompson, E. (2011). Specifying the self for cognitive neuroscience. *Trends Cogn. Sci.* 15, 104-112. doi: 10.1016/j.tics.2011.01.001
67. Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., and Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *Proc. Natl. Acad. Sci. U.S.A.* 106, 8719-8724. doi: 10.1073/pnas.0900234106
68. Cicogna, P., and Bosinelli, M. (2001). Consciousness during dreams. *Conscious. Cogn.* 10, 26-41. doi: 10.1006/ccog.2000.0471
69. Coleman, P. D. (1963). An analysis of cues to auditory depth perception in free space. *Psychol. Bull.* 60, 302-315. doi: 10.1037/h0045716
70. Condon, P., Desbordes, G., Miller, W. B., and DeSteno, D. (2013). Meditation increases compassionate responses to suffering. *Psychol. Sci.* 24, 2125-2127. doi: 10.1177/0956797613485603

71. Craig, A. D. (2002). How do you feel? Interoception: the sense of the physiological condition of the body. *Nat. Rev. Neurosci.* 3, 655-666. doi: 10.1038/nrn894
72. Craig, A. D. (2009). How do you feel - now? The anterior insula and human awareness. *Nat. Rev. Neurosci.* 10, 59-70. doi: 10.1038/nrn2555
73. Critchley, H. D., Wiens, S., Rotshtein, P., Öhman, A., and Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nat. Neurosci.* 7, 189-195. doi: 10.1038/nn1176
74. Csikszentmihalyi, M. (1975). *Beyond Boredom and Anxiety: the Experience of Play in Work and Games.* San Francisco, CA: Jossey-Bass.
75. Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience (Underlining Edition)*. New York, NY: HarperCollins.
76. Dahl, C. J., Lutz, A., and Davidson, R. J. (2015). Reconstructing and deconstructing the self: cognitive mechanisms in meditation practice. *Trends Cogn. Sci.* 19, 515-523. doi: 10.1016/j.tics.2015.07.001
77. Dam, N. T. V., Vugt, M. K., van, Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., *et al*. (2018). Mind the hype: a critical evaluation and prescriptive agenda for research on mindfulness and meditation. *Perspect. Psychol. Sci.* 13, 36-61. doi: 10.1177/1745691617709589
78. Damasio, A. (1999). *The Feeling of What Happens: Body and Emotion in the Making of Consciousness.* New York, NY: Houghton Mifflin Harcourt.
79. Dambrun, M. (2016). When the dissolution of perceived body boundaries elicits happiness: the effect of selflessness induced by a body scan meditation. *Conscious. Cogn.* 46, 89-98. doi: 10.1016/j.concog.2016.09.013
80. Dambrun, M. (2017). Self-centeredness and selflessness: happiness correlates and mediating psychological processes. *PeerJ* 5:e3306. doi: 10.7717/peerj.3306
81. Dambrun, M., and Ricard, M. (2011). Self-centeredness and selflessness: a theory of self-based psychological functioning and its consequences for happiness. *Rev. Gen. Psychol.* 15, 138-157. doi: 10.1037/a0023059
82. Damoiseaux, J. S., Beckmann, C. F., Arigita, E. J. S., Barkhof, F., Scheltens, P., Stam, C. J., *et al*. (2008). Reduced resting-state brain activity in the "default network" in normal aging. *Cereb. Cortex* 18, 1856-1864. doi: 10.1093/cercor/bhm207
83. D'Argembeau, A. (2016). "The role of personal goals in future-oriented mental time travel," in *Seeing the Future: Theoretical Perspectives on Future-Oriented Mental Time Travel,* eds K. Michaelian, S. B. Klein, and K. K. Szpunar (Oxford: Oxford University Press), 199-216.
84. D'Argembeau, A. (2018). "Mind-Wandering and Self-Referential Thought," in *The Oxford Handbook of Spontaneous Thought*, eds K. C. R. Fox and K. Christoff (Oxford: Oxford University Press), 181-192.
85. Davey, C. G., Pujol, J., and Harrison, B. J. (2016). Mapping the self in the brain's default mode network. *Neuroimage* 132, 390-397. doi: 10.1016/j.neuroimage.2016.02.022
86. Davidson, R. J., and Lutz, A. (2008). Buddha's brain: neuroplasticity and meditation [in the spotlight]. *IEEE Signal Process. Mag.* 25, 176-174. doi: 10.1109/MSP.2008.4431873
87. Davis, A. K., Barsuglia, J. P., Lancelotta, R., Grant, R. M., and Renn, E. (2018). The epidemiology of 5-methoxy-*N,N*-dimethyltryptamine (5-MeO-DMT) use: benefits, consequences, patterns of use, subjective effects, and reasons for consumption. *J. Psychopharmacol.* 32, 1-14. doi: 10.1177/0269881118 769063
88. de Araujo, D. B., Ribeiro, S., Cecchi, G. A., Carvalho, F. M., Sanchez, T. A., Pinto, J. P., *et al*. (2012). Seeing with the eyes shut: neural basis of enhanced imagery following ayahuasca ingestion. *Hum. Brain Mapp.* 33, 2550-2560. doi: 10.1002/hbm.21381
89. De Vignemont, F. (2011). "Bodily immunity to error," in *Immunity to Error Through Misidentification: New Essays,* eds S. Prosser and F. Recanati (Cambridge: Cambridge University Press), 1-27.
90. De Vignemont, F. (forthcoming). "The phenomenology of bodily ownership," in *The Sense of Mineness*, eds M. Garcia-Carpintero and M. Guillot (Oxford: Oxford University Press).
91. Dennis, E. L., and Thompson, P. M. (2014). Functional brain connectivity using fMRI in aging and Alzheimer's disease. *Neuropsychol. Rev.* 24, 49-62. doi: 10.1007/s11065-014-9249-6
92. Deutsch, E. (1969). Advaita Vedanta. *A Philosophical Reconstruction*. Honolulu, HI: University of Hawaii Press.
93. Dillen, K. N. H., Jacobs, H. I. L., Kukolja, J., Richter, N., von Reutern, B., Onur, Ö. A., *et al*. (2017). Functional disintegration of the default mode network in Prodromal Alzheimer's disease. *J. Alzheimer's Dis.* 59, 169-187. doi: 10.3233/JAD-161120
94. Ding, X., Tang, Y.-Y., Tang, R., and Posner, M. I. (2014). Improving creativity performance by short-term meditation. *Behav. Brain Funct.* 10:9. doi: 10.1186/1744-9081-10-9
95. Dorjee, D. (2016). Defining contemplative science: the metacognitive self-regulatory capacity of the mind, context of meditation practice and modes of existential awareness. *Front. Psychol.* 7:1788. doi: 10.3389/fpsyg.2016.01788
96. Dor-Ziderman, Y., Ataria, Y., Fulder, S., Goldstein, A., and Berkovich-Ohana, A. (2016). Self-specific processing in the meditating brain: a MEG neurophenomenology study. *Neurosci. Consciousn.* 2016:niw019. doi: 10.1093/nc/niw019
97. Dor-Ziderman, Y., Berkovich-Ohana, A., Glicksohn, J., and Goldstein, A. (2013). Mindfulness-induced selflessness: a MEG neurophenomenological study. *Front. Hum. Neurosci.* 7:582. doi: 10.3389/fnhum.2013.00582
98. dos Santos, R. G., Osório, F. L., Crippa, J. A. S., and Hallak, J. E. C. (2016). Classical hallucinogens and neuroimaging: a systematic review of human studies: Hallucinogens and neuroimaging. *Neurosci. Biobehav. Rev.* 71, 715-728. doi: 10.1016/j.neubiorev.2016.10.026
99. Dunne, J. (2011). Toward an understanding of non-dual mindfulness. *Contemp. Buddh.* 12, 71-88. doi: 10.1080/14639947.2011.564820
100. Dyck, E. (2006). 'Hitting Highs at Rock Bottom': LSD Treatment for Alcoholism, 1950-1970. *Soc. Hist. Med.* 19, 313-329. doi: 10.1093/shm/hkl039
101. Ehrsson, H. H. (2007). The experimental induction of out-of-body experiences. *Science* 317, 1048-1048. doi: 10.1126/science.1142175
102. Evans, G. (1982). *The Varieties of Reference*. Oxford: Oxford University Press.
103. Farb, N. A. S., Segal, Z. V., and Anderson, A. K. (2013). Mindfulness meditation training alters cortical representations of interoceptive attention. *Soc. Cogn. Affect. Neurosci.* 8, 15-26. doi: 10.1093/scan/nss066
104. Farb, N. A. S., Segal, Z. V., Mayberg, H., Bean, J., McKeon, D., Fatima, Z., *et al*. (2007). Attending to the present: mindfulness

meditation reveals distinct neural modes of self-reference. *Soc. Cogn. Affect. Neurosci.* 2, 313-322. doi: 10.1093/scan/nsm030

105. Fasching, W. (2008). Consciousness, self-consciousness, and meditation. *Phenomenol. Cogn. Sci.* 7, 463-483. doi: 10.1007/s11097-008-9090-6
106. Fletcher, P. C., and Frith, C. D. (2009). Perceiving is believing: a Bayesian approach to explaining the positive symptoms of schizophrenia. *Nat. Rev. Neurosci.* 10, 48-58. doi: 10.1038/nrn2536
107. Fox, K. C. R., and Cahn, B. R. (forthcoming). "Meditation and the brain in health and disease," in *The Oxford Handbook of Meditation*, eds M. Farias, D. Brazier, and M. Lalljee (Oxford University Press). Available online at: https://mindrxiv.org/m2sez/
108. Fox, K. C. R., Dixon, M. L., Nijeboer, S., Girn, M., Floman, J. L., Lifshitz, M., *et al.* (2016). Functional neuroanatomy of meditation: a review and meta-analysis of 78 functional neuroimaging investigations. *Neurosci. Biobeh. Rev.* 65, 208-228. doi: 10.1016/j.neubiorev.2016.03.021
109. Fox, K. C. R., Nijeboer, S., Dixon, M. L., Floman, J. L., Ellamil, M., Rumak, S. P., *et al.* (2014). Is meditation associated with altered brain structure? A systematic review and meta-analysis of morphometric neuroimaging in meditation practitioners. *Neurosci. Biobeh. Rev.* 43, 48-73. doi: 10.1016/j.neubiorev.2014.03.016
110. Fox, K. C. R., Spreng, R. N., Ellamil, M., Andrews-Hanna, J. R., and Christoff, K. (2015). The wandering brain: meta-analysis of functional neuroimaging studies of mind-wandering and related spontaneous thought processes. *Neuroimage* 111, 611-621. doi: 10.1016/j.neuroimage.2015.02.039
111. Fox, K. C. R., Zakarauskas, P., Dixon, M., Ellamil, M., Thompson, E., and Christoff, K. (2012). Meditation experience predicts introspective accuracy. *PLoS ONE* 7:e45370. doi: 10.1371/journal.pone.0045370
112. Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., Essen, D. C. V., and Raichle, M. E. (2005). The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proc. Natl. Acad. Sci. U.S.A.*102, 9673-9678. doi: 10.1073/pnas.0504136102
113. Frecska, E., White, K. D., and Luna, L. E. (2003). Effects of the amazonian psychoactive beverage ayahuasca on binocular rivalry: interhemispheric switching or interhemispheric fusion? *J. Psychoact. Drugs* 35, 367-374. doi: 10.1080/02791072.2003.10400019
114. Frege, G. (1956). The thought: a logical inquiry. *Mind* 65, 289-311. doi: 10.1093/mind/65.1.289
115. Friston, K. (2013). Active inference and free energy. *Behav. Brain Sci.* 36, 212-213. doi: 10.1017/S0140525X12002142
116. Gainotti, G., Almonti, S., Betta, A. M. D., and Silveri, M. C. (1998). Retrograde amnesia in a patient with retrosplenial tumour. *Neurocase* 4, 519-526. doi: 10.1080/13554799808410644
117. Gallagher, S. (2000). Philosophical conceptions of the self: implications for cognitive science. *Trends Cogn. Sci.* 4, 14-21. doi: 10.1016/S1364-6613(99)01417-5
118. Gallagher, S. (2013). A pattern theory of self. *Front. Hum. Neurosci.* 7:443. doi: 10.3389/fnhum.2013.00443
119. García-Carpintero, M. (2015). *De Se Thought*. Oxford Handbooks Online. doi: 10.1093/oxfordhb/9780199935314.013.61
120. Garcia-Romeu, A. P., Johnson, M. W., and Griffiths, R. R. (2014). Examining the psychological mechanisms of psilocybin-assisted smoking cessation treatment: a pilot study. *Drug Alcohol Depend. Complete* 140:e66. doi: 10.1016/j.drugalcdep.2014.02.200
121. Garrison, K. A., Scheinost, D., Constable, R. T., and Brewer, J. A. (2014). BOLD signal and functional connectivity associated with loving kindness meditation. *Brain Behav.* 4, 337-347. doi: 10.1002/brb3.219
122. Garrison, K. A., Zeffiro, T. A., Scheinost, D., Constable, R. T., and Brewer, J. A. (2015). Meditation leads to reduced default mode network activity beyond an active task. *Cogn. Affect. Behav. Neurosci.* 15, 712-720. doi: 10.3758/s13415-015-0358-3
123. Gellman, J. (2017). "Mysticism," in *The Stanford Encyclopedia of Philosophy,* eds E. N. Zalta (Spring 2017). Metaphysics Research Lab; Stanford University. Available online at: https://plato.stanford.edu/archives/spr2017/ entries/mysticism/
124. Gennaro, R. J. (2008). "Are there pure conscious events?" in *Revisiting Mysticism,* eds C. Chakrabarti and G. Haist (Newcastle: Cambridge Scholars Press), 100-120.
125. Godwin, C. A., Hunter, M. A., Bezdek, M. A., Lieberman, G., Elkin-Frankston, S., Romero, V. L., *et al.* (2017). Functional connectivity within and between intrinsic brain networks correlates with trait mind wandering. *Neuropsychologia* 103, 140-153. doi: 10.1016/j.neuropsychologia.2017.07.006
126. Golland, Y., Bentin, S., Gelbard, H., Benjamini, Y., Heller, R., Nir, Y., *et al.* (2007). Extrinsic and intrinsic systems in the posterior cortex of the human brain revealed during natural sensory stimulation. *Cereb. Cortex* 17, 766-777. doi: 10.1093/cercor/bhk030
127. Gouzoulis-Mayfrank, E., Thelen, B., Habermeyer, E., Kunert, H. J., Kovar, K.- A., Lindenblatt, H., *et al.* (1999). Psychopathological, neuroendocrine and autonomic effects of 3,4-methylenedioxyethylamphetamine (MDE), psilocybin and d-methamphetamine in healthy volunteers Results of an experimental double-blind placebo-controlled study. *Psychopharmacology* 142, 41-50. doi: 10.1007/s002130050860
128. Grant, J. A., Duerden, E. G., Courtemanche, J., Cherkasova, M., Duncan, G. H., and Rainville, P. (2013). Cortical thickness, mental absorption and meditative practice: possible implications for disorders of attention. *Biol. Psychol.* 92, 275-281. doi: 10.1016/j.biopsycho.2012.09.007
129. Gregory, E., McCloskey, M., and Landau, B. (2014). Profound loss of general knowledge in retrograde amnesia: evidence from an amnesic artist. *Front. Hum. Neurosci.* 8:287. doi: 10.3389/fnhum.2014.00287
130. Greicius, M. D., Krasnow, B., Reiss, A. L., and Menon, V. (2003). Functional connectivity in the resting brain: a network analysis of the default mode hypothesis. *Proc. Natl. Acad. Sci. U.S.A.* 100, 253-258. doi: 10.1073/pnas.0135058100
131. Greicius, M. D., Srivastava, G., Reiss, A. L., and Menon, V. (2004). Default-mode network activity distinguishes Alzheimer's disease from healthy aging: evidence from functional MRI. *Proc. Natl. Acad. Sci. U.S.A.* 101, 4637-4642. doi: 10.1073/pnas.0308627101
132. Griffiths, R. R., Johnson, M. W., Carducci, M. A., Umbricht, A., Richards, W. A., Richards, B. D., *et al.* (2016). Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. *J. Psychopharmacol.* 30, 1181-1197. doi: 10.1177/0269881116675513
133. Griffiths, R. R., Johnson, M. W., Richards, W. A., Richards, B. D., Jesse, R., MacLean, K. A., *et al.* (2018). Psilocybin-occasioned

mystical-type experience in combination with meditation and other spiritual practices produces enduring positive changes in psychological functioning and in trait measures of prosocial attitudes and behaviors. *J. Psychopharmacol.* 32, 49-69. doi: 10.1177/0269881117731279

134. Griffiths, R. R., Richards, W. A., McCann, U., and Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187, 268-283; discussion 284-292. doi: 10.1007/s00213-006-0457-5
135. Grof, S., Hoffman, A., and Weil, A. (2008). *LSD Psychotherapy (The Healing Potential of Psychedelic Medicine)*. Ben Lomond, CA: Multidisciplinary Association for Psychedelic Studies.
136. Grünbaum, T. (2015). The feeling of agency hypothesis: a critique. *Synthese* 192, 3313-3337. doi: 10.1007/s11229-015-0704-6
137. Grünbaum, T., and Christensen, M. S. (eds.). (2017). *Sensation of Movement, 1 Edn.* Abingdon; New York, NY: Routledge.
138. Guillot, M. (2017). I me mine: on a confusion concerning the subjective character of experience. *Rev. Philos. Psychol.* 8, 23-53. doi: 10.1007/s13164-016-0313-4
139. Guterstam, A., Björnsdotter, M., Gentile, G., and Ehrsson, H. H. (2015). Posterior cingulate cortex integrates the senses of self-location and body ownership. *Curr. Biol.* 25, 1416-1425. doi: 10.1016/j.cub.2015.03.059
140. Guttmann, E., and Maclay, W. S. (1937). Mescaline and depersonalization. *J. Neurol. Psychopathol.* 16, 193-212.
141. Hagerty, M. R., Isaacs, J., Brasington, L., Shupe, L., Fetz, E. E., and Cramer, S. C. (2013). Case study of ecstatic meditation: fMRI and EEG evidence of self-stimulating a reward system. *Neural Plast.* 2013:653572. doi: 10.1155/2013/653572
142. Haggard, P. (2017). Sense of agency in the human brain. *Nat. Rev. Neurosci.* 18, 196-207. doi: 10.1038/nrn.2017.14
143. Halberstadt, A. L. (2015). Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behav. Brain Res.* 277, 99-120. doi: 10.1016/j.bbr.2014.07.016
144. Hasenkamp, W. (2018). "Catching the wandering mind: meditation as a window into spontaneous thought," in *The Oxford Handbook of Spontaneous Thought*, eds K. C. R. Fox and K. Christoff (Oxford: Oxford University Press), 539-552.
145. Hasenkamp, W., and Barsalou, L. W. (2012). Effects of meditation experience on functional connectivity of distributed brain networks. *Front. Hum. Neurosci.* 6:38. doi: 10.3389/fnhum.2012.00038
146. Hasenkamp, W., Wilson-Mendenhall, C. D., Duncan, E., and Barsalou, L. W. (2012). Mind wandering and attention during focused meditation: a fine-grained temporal analysis of fluctuating cognitive states. *Neuroimage* 59, 750-760. doi: 10.1016/j.neuroimage.2011.07.008
147. Hermle, L., Fünfgeld, M., Oepen, G., Botsch, H., Borchardt, D., Gouzoulis, E., *et al.* (1992). Mescaline-induced psychopathological, neuropsychological, and neurometabolic effects in normal subjects: experimental psychosis as a tool for psychiatric research. *Biol. Psychiatry* 32, 976-991. doi: 10.1016/0006-3223(92)90059-9
148. Hohwy, J. (2016). "Prediction, agency, and body ownership," in *The Pragmatic Turn: Toward Action-Oriented Views in Cognitive Science*, eds A. K. Engel, K. J. Friston, and D. Kragic (Cambridge, MA: MIT Press). Available online at: http://www.universitypressscholarship.com/view/10.7551/mitpress/ 9780262034326.001.0001/upso- 9780262034326- chapter-7
149. Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., and Ott, U. (2011). How does mindfulness meditation work? proposing mechanisms of action from a conceptual and neural perspective. *Perspect. Psychol. Sci.* 6, 537-559. doi: 10.1177/1745691611 419671
150. Horan, R. (2009). The neuropsychological connection between creativity and meditation. *Creat. Res. J.* 21, 199-222. doi: 10.1080/10400410902858691
151. Howell, R. J., and Thompson, B. (2017). Phenomenally mine: in search of the subjective character of consciousness. *Rev. Philos. Psychol.* 8, 103-127. doi: 10.1007/s13164-016-0309-0
152. Ionta, S., Heydrich, L., Lenggenhager, B., Mouthon, M., Fornari, E., Chapuis, D., *et al.* (2011). Multisensory mechanisms in temporo-parietal cortex support self-location and first-person perspective. *Neuron* 70, 363-374. doi: 10.1016/j.neuron.2011.03.009
153. Ives-Deliperi, V. L., Solms, M., and Meintjes, E. M. (2011). The neural substrates of mindfulness: an fMRI investigation. *Soc. Neurosci.* 6, 231-242. doi: 10.1080/17470919.2010.513495
154. Jenkins, A. C., and Mitchell, J. P. (2011). Medial prefrontal cortex subserves diverse forms of self-reflection. *Soc. Neurosci.* 6, 211-218. doi: 10.1080/17470919.2010.507948
155. Jha, A. P., Krompinger, J., and Baime, M. J. (2007). Mindfulness training modifies subsystems of attention. *Cogn. Affect. Behav. Neurosci.* 7, 109-119. doi: 10.3758/CABN.7.2.109
156. Johnson, M. W., Garcia-Romeu, A., and Griffiths, R. R. (2017). Long-term follow-up of psilocybin-facilitated smoking cessation. *Am. J. Drug Alcohol Abuse* 43, 55-60. doi: 10.3109/00952990.2016.1170135
157. Josipovic, Z. (2010). Duality and nonduality in meditation research. *Conscious. Cogn.* 19, 1119-1121. doi: 10.1016/j.concog.2010.03.016
158. Josipovic, Z. (2014). Neural correlates of nondual awareness in meditation. *Ann. N.Y. Acad. Sci.* 1307, 9-18. doi: 10.1111/nyas.12261
159. Josipovic, Z., Dinstein, I., Weber, J., and Heeger, D. J. (2012). Influence of meditation on anti-correlated networks in the brain. *Front. Hum. Neurosci.* 5:183. doi: 10.3389/fnhum.2011.00183
160. Kang, D.-H., Jo, H. J., Jung, W. H., Kim, S. H., Jung, Y.-H., Choi, C.-H., *et al.* (2013). The effect of meditation on brain structure: cortical thickness mapping and diffusion tensor imaging. *Soc. Cogn. Affect. Neurosci.* 8, 27-33. doi: 10.1093/scan/nss056
161. Karapanagiotidis, T., Bernhardt, B. C., Jefferies, E., and Smallwood, J. (2017). Tracking thoughts: exploring the neural architecture of mental time travel during mind-wandering. *Neuroimage* 147, 272-281. doi: 10.1016/j.neuroimage.2016.12.031
162. Killingsworth, M. A., and Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science* 330, 932-932. doi: 10.1126/science.1192439
163. Kilpatrick, L. A., Suyenobu, B. Y., Smith, S. R., Bueller, J. A., Goodman, T., Creswell, J. D., *et al.* (2011). Impact of mindfulness-based stress reduction training on intrinsic brain connectivity. *Neuroimage* 56, 290-298. doi: 10.1016/j.neuroimage.2011.02.034
164. Kind, A. (2007). Restrictions on representationalism. *Philos. Stud.* 134, 405-427. doi: 10.1007/s11098-007-9079-y

165. Klatzky, R. (1998). "Allocentric and egocentric spatial representations: definitions, distinctions, and interconnections," in *Spatial Cognition*, eds C. Freksa, C. Habel and K. F. Wender (Berlin: Springer Verlag), 1-18.
166. Klavetter, R. E., and Mogar, R. E. (1967). Peak experiences: investigation of their relationship to psychedelic therapy and self-actualization. *J. Human. Psychol.* 7, 171-177. doi: 10.1177/002216786700700206
167. Klee, G. D. (1963). Lysergic acid diethylamide (lsd-25) and ego functions. *Arch. Gen. Psychiatry* 8, 461-474. doi: 10.1001/archpsyc.1963.01720110037005
168. Koch, C. (2004). *The Quest for Consciousness: A Neurobiological Approach*. Denver, CO: Roberts & Co.
169. Kolarik, A. J., Moore, B. C. J., Zahorik, P., Cirstea, S., and Pardhan, S. (2016). Auditory distance perception in humans: a review of cues, development, neuronal bases, and effects of sensory loss. *Attent. Percept. Psychophys.* 78, 373-395. doi: 10.3758/s13414-015-1015-1
170. Kometer, M., Schmidt, A., Bachmann, R., Studerus, E., Seifritz, E., and Vollenweider, F. X. (2012). Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol. Psychiatry* 72, 898-906. doi: 10.1016/j.biopsych.2012.04.005
171. Kraehenmann, R., Pokorny, D., Aicher, H., Preller, K. H., Pokorny, T., Bosch, O. G., *et al*. (2017). LSD increases primary process thinking via serotonin 2A receptor activation. *Front. Pharmacol.* 8:814. doi: 10.3389/fphar.2017.00814
172. Kreplin, U., Farias, M., and Brazil, I. A. (2018). The limited prosocial effects of meditation: a systematic review and meta-analysis. *Sci. Rep.* 8:2403. doi: 10.1038/s41598-018-20299-z
173. Kriegel, U. (2009). *Subjective Consciousness: A Self-Representational Theory*. Oxford: Oxford University Press.
174. Kurland, A. A., and Grof, S. (1972). Psychedelic drug assisted psychotherapy in patients with terminal cancer. *J. Thanatol.* 2, 644-691.
175. LaBerge, S., and DeGracia, D. J. (2000). "Varieties of lucid dreaming experience," in *Individual Differences in Conscious Experience*, eds R. G. Kunzendorf and B. Wallace (Amsterdam: John Benjamins Publishing Company), 269-307. doi: 10.1075/aicr.20.14lab
176. Lebedev, A. V., Kaelen, M., Lövdén, M., Nilsson, J., Feilding, A., Nutt, D., *et al*. (2016). LSD-induced entropic brain activity predicts subsequent personality change. *Hum. Brain Mapp.* 37, 3203-3213. doi: 10.1002/hbm.23234
177. Lebedev, A. V., Lövdén, M., Rosenthal, G., Feilding, A., Nutt, D. J., and Carhart-Harris, R. L. (2015). Finding the self by losing the self: neural correlates of ego-dissolution under psilocybin. *Hum. Brain Mapp.* 36, 3137-3153. doi: 10.1002/hbm.22833
178. Legrand, D. (2006). The bodily self: the sensori-motor roots of pre-reflective self-consciousness. *Phenomenol. Cogn. Sci.* 5, 89-118. doi: 10.1007/s11097-005-9015-6
179. Legrand, D., and Ruby, P. (2009). What is self-specific? Theoretical investigation and critical review of neuroimaging results. *Psychol. Rev.* 116, 252-282. doi: 10.1037/a0014172
180. Leiberg, S., Klimecki, O., and Singer, T. (2011). Short-term compassion training increases prosocial behavior in a newly developed prosocial game. *PLoS ONE* 6:e17798. doi: 10.1371/journal.pone.0017798
181. Lenggenhager, B., Mouthon, M., and Blanke, O. (2009). Spatial aspects of bodily self-consciousness. *Conscious. Cogn.* 18, 110-117. doi: 10.1016/j.concog.2008.11.003
182. Lenggenhager, B., Tadi, T., Metzinger, T., and Blanke, O. (2007). Video ergo sum: manipulating bodily self-consciousness. *Science* 317, 1096-1099. doi: 10.1126/science.1143439
183. Letheby, C., and Gerrans, P. (2017). Self unbound: ego dissolution in psychedelic experience. *Neurosci. Consciousn.* 3:nix016. doi: 10.1093/nc/nix016
184. Liechti, M. E., Dolder, P. C., and Schmid, Y. (2017). Alterations of consciousness and mystical-type experiences after acute LSD in humans. *Psychopharmacology* 234, 1499-1510. doi: 10.1007/s00213-016-4453-0
185. Limanowski, J., and Blankenburg, F. (2013). Minimal self-models and the free energy principle. *Front. Hum. Neurosci.* 7:547. doi: 10.3389/fnhum.2013.00547
186. Lindahl, J. R., Fisher, N. E., Cooper, D. J., Rosen, R. K., and Britton, W. B. (2017). The varieties of contemplative experience: a mixed-methods study of meditation-related challenges in Western Buddhists. *PLoS ONE* 12:e0176239. doi: 10.1371/journal.pone.0176239
187. Lutz, A., Slagter, H. A., Dunne, J. D., and Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends Cogn. Sci.* 12, 163-169. doi: 10.1016/j.tics.2008.01.005
188. Lutz, J., Brühl, A. B., Scheerer, H., Jäncke, L., and Herwig, U. (2016). Neural correlates of mindful self-awareness in mindfulness meditators and meditation-naïve subjects revisited. *Biol. Psychol.* 119(Suppl. C), 21-30. doi: 10.1016/j.biopsycho.2016.06.010
189. MacKenzie, M. D. (2016). (Re-)Constructing the Self. *J. Consciousn. Stud.* 23, 105-124.
190. MacLean, K. A., Johnson, M. W., and Griffiths, R. R. (2011). Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J. Psychopharmacol.* 25, 1453-1461. doi: 10.1177/0269881111420188
191. Maister, L., Slater, M., Sanchez-Vives, M. V., and Tsakiris, M. (2015). Changing bodies changes minds: owning another body affects social cognition. *Trends Cogn. Sci.* 19, 6-12. doi: 10.1016/j.tics.2014.11.001
192. Maister, L., Tsiakkas, E., and Tsakiris, M. (2013). I feel your fear: shared touch between faces facilitates recognition of fearful facial expressions. *Emotion* 13, 7-13. doi: 10.1037/a0030884
193. Majic', T., Schmidt, T. T., and Gallinat, J. (2015). Peak experiences and the afterglow phenomenon: when and how do therapeutic effects of hallucinogens depend on psychedelic experiences? *J. Psychopharmacol.* 29, 241-253. doi: 10.1177/0269881114568040
194. Maselli, A. (2015). Allocentric and egocentric manipulations of the sense of self-location in full-body illusions and their relation with the sense of body ownership. *Cogn. Process.* 16, 309-312. doi: 10.1007/s10339-015-0667-z
195. Maslow, A. H. (1959). Cognition of being in the peak experiences. *J. Genet. Psychol.* 94, 43-66. doi: 10.1080/00221325.1959.10532434
196. Masters, R. A. (2005). *Darkness Shining Wild: An Odyssey to the Heart of Hell & Beyond: Meditations on Sanity, Suffering, Spirituality, and Liberation*. Tehmenos Press.
197. Mayer-Gross, W., and Stein, H. (1926). Über einige abänderungen der sinnestätigkeit im Meskalinrausch. *Zeitschrift für die*

gesamte Neurologie und Psychiatrie 101, 354-386. doi: 10.1007/BF02 878343

198. McClelland, T. (forthcoming). "Four impediments to the case for mineness," in *The Sense of Mineness*, eds M. Garcia-Carpintero and M. Guillot (Oxford: Oxford University Press).
199. Melzack, R. (1990). Phantom limbs and the concept of a neuromatrix. *Trends Neurosci.* 13, 88-92. doi: 10.1016/0166-2236(90)90179-E
200. Metzinger, T. (2003). *Being No One: The Self-Model Theory of Subjectivity*. Cambridge, MA: A Bradford Book.
201. Metzinger, T. (2013). Why are dreams interesting for philosophers? The example of minimal phenomenal selfhood, plus an agenda for future research. *Front. Psychol.* 4:746. doi: 10.3389/fpsyg.2013.00746
202. Metzinger, T. (2014). "First-order embodiment, second-order embodiment, third-order embodiment: from spatiotemporal self-location to minimal phenomenal selfhood," in *The Routledge Handbook of Embodied Cognition,* ed L. Shapiro (London: Routledge), 272-286.
203. Michalareas, G., Vezoli, J., van Pelt, S., Schoffelen, J.-M., Kennedy, H., and Fries, P. (2016). Alpha-Beta and Gamma rhythms subserve feedback and feedforward influences among human visual cortical areas. *Neuron* 89, 384-397. doi: 10.1016/j.neuron.2015.12.018
204. Millière, R. (2017). Looking for the self: phenomenology, neurophysiology and philosophical significance of drug-induced ego dissolution. *Front. Hum. Neurosci.* 11:245. doi: 10.3389/fnhum.2017. 00245
205. Moseley, G. L., Olthof, N., Venema, A., Don, S., Wijers, M., Gallace, A., *et al.* (2008). Psychologically induced cooling of a specific body part caused by the illusory ownership of an artificial counterpart. *Proc. Natl. Acad. Sci. U.S.A.* 105, 13169-13173. doi: 10.1073/pnas.0803768105
206. Müller, F., Lenz, C., Dolder, P., Lang, U., Schmidt, A., Liechti, M., *et al.* (2017). Increased thalamic resting-state connectivity as a core driver of LSD-induced hallucinations. *Acta Psychiatr. Scand.* 136, 648-657. doi: 10.1111/acps. 12818
207. Musholt, K. (2013). Self-consciousness and nonconceptual content. *Philos. Stud.* 163, 649-672. doi: 10.1007/s11098-011-9837-8
208. Muthukumaraswamy, S. D., Carhart-Harris, R. L., Moran, R. J., Brookes, M. J., Williams, T. M., Errtizoe, D., *et al.* (2013). Broadband cortical desynchronization underlies the human psychedelic state. *J. Neurosci.* 33, 15171-15183. doi: 10.1523/JNEUROSCI.2063-13.2013
209. Nagel, T. (1974). What is it like to be a bat? *Philos. Rev.* 83, 435-450. doi: 10.2307/2183914
210. Nash, J. D., and Newberg, A. (2013). Toward a unifying taxonomy and definition for meditation. *Front. Psychol.* 4:806. doi: 10.3389/fpsyg.2013.00806
211. Nichols, D. E. (2016). Psychedelics. *Pharmacol. Rev.* 68, 264-355. doi: 10.1124/pr.115.011478
212. Nida-Rümelin, M. (2017). Self-awareness. *Rev. Philos. Psychol.* 8, 55-82. doi: 10.1007/s13164-016-0328-x
213. Noë, A. (2005). *Action in Perception (First Edition, First Printing Edition)*. Cambridge, MA: The MIT Press.
214. Noel, J.-P., Park, H.-D., Pasqualini, I., Lissek, H., Wallace, M., Blanke, O., *et al.* (2018). Audio-visual sensory deprivation degrades visuo-tactile peri-personal space. *Conscious. Cogn.* 61, 61-75. doi: 10.1016/j.concog.2018.04.001
215. Noel, J.-P., Pfeiffer, C., Blanke, O., and Serino, A. (2015). Peripersonal space as the space of the bodily self. *Cognition* 144, 49-57. doi: 10.1016/j.cognition.2015.07.012
216. Northoff, G., Heinzel, A., de Greck, M., Bermpohl, F., Dobrowolny, H., and Panksepp, J. (2006). Self-referential processing in our brain - A meta-analysis of imaging studies on the self. *Neuroimage* 31, 440-457. doi: 10.1016/j.neuroimage.2005.12.002
217. Nour, M. M., and Carhart-Harris, R. L. (2017). Psychedelics and the science of self-experience. *Br. J. Psychiatry* 210, 177-179. doi: 10.1192/bjp.bp.116. 194738
218. Occhionero, M., and Cicogna, P. C. (2011). Autoscopic phenomena and one's own body representation in dreams. *Conscious. Cogn.* 20, 1009-1015. doi: 10.1016/j.concog.2011.01.004
219. O'Conaill, D. (2017). Subjectivity and mineness. *Erkenntnis* 1-17. doi: 10.1007/s10670-017-9960-9
220. Oka, Y., Maeshima, S., Morita, S., Ishida, K., Kunimoto, K., Yoshida, M., *et al.* (2003). A case of amnesia caused by a subcortical hematoma in the left retrosplenial region. *No Shinkei Geka. Neurol. Surg.* 31, 289-295.
221. Olendzki, A. (2006). "The transformative impact of non-self," in *Buddhist Thought and Applied Psychological Research: Transcending the Boundaries*, eds D. K. Nauriyal, M. Drummond, and Y. B. Lal (London: Routledge), 250-261.
222. O'Reilly, P. O., and Funk, A. (1964). LSD in chronic alcoholism. *Can. Psychiatr. Assoc. J.* 9, 258-261.
223. Ortner, C. N. M., Kilner, S. J., and Zelazo, P. D. (2007). Mindfulness meditation and reduced emotional interference on a cognitive task. *Motiv. Emot.* 31, 271-283. doi: 10.1007/s11031-007-9076-7
224. Pagnoni, G. (2012). Dynamical properties of BOLD activity from the ventral posteromedial cortex associated with meditation and attentional skills. *J. Neurosci.* 32, 5242-5249. doi: 10.1523/JNEUROSCI.4135-11.2012
225. Pahnke, W. N. (1966). *Drugs and Mysticism: An Analysis of the Relationship Between Psychedelic Drugs and the Mystical Consciousness.* Cambridge, MA: Harvard University.
226. Pahnke, W. N., Kurland, A., Unger, S., Savage, C., and Grof, S. (1971). The experimental use of psychedelic (LSD) psychotherapy. Internationale Zeitschrift Fur Klinische Pharmakologie, Therapie, Und Toxikologie. *Int. J. Clin. Pharmacol. Ther. Toxicol.* 4, 446-454.
227. Pahnke, W. N., and Richards, W. A. (1966). Implications of LSD and experimental mysticism. *J. Relig. Health* 5, 175-208. doi: 10.1007/BF01532646
228. Palhano-Fontes, F., Andrade, K. C., Tofoli, L. F., Santos, A. C., Crippa, J. A. S., Hallak, J. E. C., *et al.* (2015). The psychedelic state induced by ayahuasca modulates the activity and connectivity of the default mode network. *PLoS ONE* 10:e0118143. doi: 10.1371/journal.pone.0118143
229. Parrott, M. (2017). Subjective misidentification and thought insertion. *Mind Lang.* 32, 39-64. doi: 10.1111/mila.12132
230. Peacocke, C. (2014). *The Mirror of the World: Subjects, Consciousness, and Self-Consciousness.* Oxford: OUP Oxford.
231. Petitmengin, C. (2006). Describing one's subjective experience in the second person: an interview method for the science of consciousness. *Phenomenol. Cogn. Sci.* 5, 229-269.doi: 10.1007/s11097-006-9022-2
232. Petitmengin, C., and Lachaux, J.-P. (2013). Microcognitive science: bridging experiential and neuronal microdynamics. *Front. Hum. Neurosci.* 7:617. doi: 10.3389/fnhum.2013.00617

233. Pokorny, T., Preller, K. H., Kometer, M., Dziobek, I., and Vollenweider, F. X. (2017). Effect of psilocybin on empathy and moral decision-making. *Int. J. Neuropsychopharmacol.* 20, 747-757. doi: 10.1093/ijnp/pyx047
234. Preller, K. H., Burt, J. B., Ji, J. L., Schleifer, C., Adkinson, B., Staempfli, P., *et al.* (2017a). Changes in global brain connectivity in LSD-induced altered states of consciousness are attributable to the 5-HT$_{2A}$ receptor. *BioRxiv*. doi: 10.1016/j.biopsych.2017.02.677
235. Preller, K. H., Herdener, M., Pokorny, T., Planzer, A., Kraehenmann, R., Stämpfli, P., *et al.* (2017b). The fabric of meaning and subjective effects in LSD-induced states depend on serotonin 2A receptor activation. *Curr. Biol.* 27, 451-457. doi: 10.1016/j.cub.2016.12.030
236. Preller, K. H., Pokorny, T., Hock, A., Kraehenmann, R., Stämpfli, P., Seifritz, E., *et al.* (2016). Effects of serotonin 2A/1A receptor stimulation on social exclusion processing. *Proc. Natl. Acad. Sci. U.S.A.* 113, 5119-5124. doi: 10.1073/pnas.1524187113
237. Qin, P., and Northoff, G. (2011). How is our self related to midline regions and the default-mode network? *Neuroimage* 57, 1221-1233. doi: 10.1016/j.neuroimage.2011.05.028
238. Radziun, D., and Ehrsson, H. H. (2018). Short-term visual deprivation boosts the flexibility of body representation. *Sci. Rep*, 8:6284. doi: 10.1038/s41598-018-24496-8
239. Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., and Shulman, G. L. (2001). A default mode of brain function. *Proc. Natl. Acad. Sci. U.S.A.* 98, 676-682. doi: 10.1073/pnas.98.2.676
240. Rempel-Clower, N. L., Zola, S. M., Squire, L. R., and Amaral, D. G. (1996). Three cases of enduring memory impairment after bilateral damage limited to the hippocampal formation. *J. Neurosci.* 16, 5233-5255. doi: 10.1523/JNEUROSCI.16-16-05233.1996
241. Rey, G. (1998). A narrow representationalist account of qualitative experience. *Philos. Perspect.* 12, 435-458. doi: 10.1111/0029-4624.32.s12.19
242. Richards, W. (2015). *Sacred Knowledge: Psychedelics and Religious Experiences.* New York, NY: Columbia University Press.
243. Richards, W. A., Rhead, J. C., Dileo, F. B., Yensen, R., and Kurland, A. A. (1977). The peak experience variable in DPT-assisted psychotherapy with cancer patients. *J. Psychoact. Drugs* 9, 1-10. doi: 10.1080/02791072.1977.10472020
244. Rohde, M., Wold, A., Karnath, H.-O., and Ernst, M. O. (2013). The human touch: skin temperature during the rubber hand illusion in manual and automated stroking procedures. *PLoS ONE* 8:e80688. doi: 10.1371/journal.pone. 0080688
245. Roseman, L., Leech, R., Feilding, A., Nutt, D. J., and Carhart-Harris, R. L. (2014). The effects of psilocybin and MDMA on between-network resting state functional connectivity in healthy volunteers. *Front. Hum. Neurosci.* 8:204. doi: 10.3389/fnhum.2014.00204
246. Roseman, L., Nutt, D. J., and Carhart-Harris, R. L. (2018). Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. *Front. Pharmacol.* 8:974. doi: 10.3389/fphar.2017.00974
247. Ross, S., Bossis, A., Guss, J., Agin-Liebes, G., Malone, T., Cohen, B., *et al.* (2016). Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *J. Psychopharmacol.* 30, 1165-1180. doi: 10.1177/0269881116675512
248. Rümmele, W., and Gnirss, F. (1961). Untersuchungen mit Psilocybin, einer psychotropen Substanz aus *Psilocybe* Mexicana. *Schweiz. Arch. Neurol. Neurochir. Psychiatr.* 87, 365-385.
249. Russ, S. L., and Elliott, M. S. (2017). Antecedents of mystical experience and dread in intensive meditation. *Psychol. Consciousn. Theory Res. Pract.* 4, 38-53. doi: 10.1037/cns0000119
250. Savage, C. (1955). Variations in ego feeling induced by d-lysergic acid diethylamide (LSD-25). *Psychoanal. Rev.* 42, 1-16.
251. Schacter, D. L., Addis, D. R., and Buckner, R. L. (2007). Remembering the past to imagine the future: the prospective brain. *Nat. Rev. Neurosci.* 8:657. doi: 10.1038/nrn2213
252. Schartner, M. M., Carhart-Harris, R. L., Barrett, A. B., Seth, A. K., and Muthukumaraswamy, S. D. (2017). Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. *Sci. Rep.* 7:46421. doi: 10.1038/srep46421
253. Schechtman, M. (2011). "The narrative self," in *The Oxford Handbook of the Self*, ed S. Gallagher (Oxford: Oxford University Press).
254. Scheibner, H. J., Bogler, C., Gleich, T., Haynes, J.-D., and Bermpohl, F. (2017). Internal and external attention and the default mode network. *Neuroimage* 148(Suppl. C), 381-389. doi: 10.1016/j.neuroimage.2017.01.044
255. Schellenberg, S. (2007). Action and self-location in perception. *Mind* 116, 603-632. doi: 10.1093/mind/fzm603
256. Schmid, Y., Enzler, F., Gasser, P., Grouzmann, E., Preller, K. H., Vollenweider, F. X., *et al.* (2015). Acute effects of lysergic acid diethylamide in healthy subjects. *Biol. Psychiatry* 78, 544-553. doi: 10.1016/j.biopsych.2014.11.015
257. Schwenkler, J. (2014). Vision, self-location, and the phenomenology of the 'point of view.' *Noûs* 48, 137-155. doi: 10.1111/j.1468-0068.2012.00871.x
258. Scoville, W. B., and Milner, B. (1957). Loss of recent memory after bilateral hippocampal lesions. *J. Neurol. Neurosurg. Psychiatr.* 20, 11-21. doi: 10.1136/jnnp.20.1.11
259. Sedley, W., Gander, P. E., Kumar, S., Kovach, C. K., Oya, H., Kawasaki, H., *et al.* (2016). Neural signatures of perceptual inference. *ELife* 5:e11476. doi: 10.7554/eLife.11476
260. Sedman, G., and Kenna, J. C. (1964). The occurrence of depersonalization phenomena under LSD. *Eur. Neurol.* 147, 129-137. doi: 10.1159/000128893
261. Serino, A., Alsmith, A., Costantini, M., Mandrigin, A., Tajadura-Jimenez, A., and Lopez, C. (2013). Bodily ownership and self-location: components of bodily self-consciousness. *Conscious. Cogn.* 22, 1239-1252. doi: 10.1016/j.concog.2013.08.013
262. Serino, A., Noel, J.-P., Galli, G., Canzoneri, E., Marmaroli, P., Lissek, H., *et al.* (2015). Body part-centered and full body-centered peripersonal space representations. *Sci. Rep.* 5:18603. doi: 10.1038/srep1860
263. Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. *Trends Cogn. Sci.* 17, 565-573. doi: 10.1016/j.tics.2013.09.007
264. Seth, A. K., and Friston, K. J. (2016). Active interoceptive inference and the emotional brain. *Phil. Trans. R. Soc. B* 371:20160007. doi: 10.1098/rstb.2016.0007

265. Shankman, R. (2008). *The Experience of Samadhi: An In-depth Exploration of Buddhist Meditation, 1st Edn*. Boston, MA: Shambhala.
266. Shear, J. (1994). On mystical experiences as support for the perennial philosophy. *J. Am. Acad. Relig.* 62, 319-342. doi: 10.1093/jaarel/LXII.2.319
267. Shiah, Y.-J. (2016). From self to nonself: the nonself theory. *Front. Psychol.* 7:124. doi: 10.3389/fpsyg.2016.00124
268. Simmons, W. K., Avery, J. A., Barcalow, J. C., Bodurka, J., Drevets, W. C., and Bellgowan, P. (2013). Keeping the body in mind: insula functional organization and functional connectivity integrate interoceptive, exteroceptive, and emotional awareness. *Hum. Brain Mapp.* 34, 2944-2958. doi: 10.1002/hbm.22113
269. Smallwood, J., and Schooler, J. W. (2006). The restless mind. *Psychol. Bull.* 132, 946-958. doi: 10.1037/0033-2909.132.6.946
270. Soler, J., Elices, M., Franquesa, A., Barker, S., Friedlander, P., Feilding, A., *et al.* (2016). Exploring the therapeutic potential of Ayahuasca: acute intake increases mindfulness-related capacities. *Psychopharmacology* 233, 823-829. doi: 10.1007/s00213-015-4162-0
271. Speth, J., Speth, C., Kaelen, M., Schloerscheidt, A. M., Feilding, A., Nutt, D. J., *et al.* (2016). Decreased mental time travel to the past correlates with default-mode network disintegration under lysergic acid diethylamide. *J. Psychopharmacol.* 30, 344-353. doi: 10.1177/0269881116628430
272. Squire, L. R. (1992). Memory and the hippocampus: a synthesis from findings with rats, monkeys, and humans. *Psychol. Rev.* 99, 195-231. doi: 10.1037/0033-295X.99.2.195
273. Stace, W. T. (1960). *Mysticism and Philosophy*. London: Distributed by St. Martin's Press.
274. Steinvorth, S., Levine, B., and Corkin, S. (2005). Medial temporal lobe structures are needed to re-experience remote autobiographical memories: evidence from H.M. and W.R. *Neuropsychologia* 43, 479-496. doi: 10.1016/j.neuropsychologia.2005.01.001
275. Strassman, R. J., Qualls, C. R., Uhlenhuth, E. H., and Kellner, R. (1994). Dose-response study of n,n-dimethyltryptamine in humans: Ii. subjective effects and preliminary results of a new rating scale. *Arch. Gen. Psychiatry* 51, 98-108. doi: 10.1001/archpsyc.1994.03950020022002
276. Strawson, G. (1999). The self and the SESMET. *J. Conscious. Stud.* 6, 99-135.
277. Strawson, G. (2013). 'Self-intimation.' *Phenomenol. Cogn. Sci.* 14, 1-31. doi: 10.1007/s11097-013-9339-6
278. Strawson, G. (2017). *The Subject of Experience*. Oxford, New York: Oxford University Press.
279. Studerus, E., Gamma, A., Kometer, M., and Vollenweider, F. X. (2012). Prediction of psilocybin response in healthy volunteers. *PLoS ONE* 7:e30800. doi: 10.1371/journal.pone.0030800
280. Studerus, E., Gamma, A., and Vollenweider, F. X. (2010). Psychometric evaluation of the altered states of consciousness rating scale (OAV). *PLoS ONE* 5:e12412. doi: 10.1371/journal.pone.0012412
281. Studerus, E., Kometer, M., Hasler, F., and Vollenweider, F. X. (2011). Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *J. Psychopharmacol.* 25, 1434-1452. doi: 10.1177/0269881110382466
282. Sugiura, M., Sassa, Y., Jeong, H., Horie, K., Sato, S., and Kawashima, R. (2008). Face-specific and domain-general characteristics of cortical responses during self-recognition. *Neuroimage* 42, 414-422. doi: 10.1016/j.neuroimage.2008.03.054
283. Suzuki, K., Garfinkel, S. N., Critchley, H. D., and Seth, A. K. (2013). Multisensory integration across exteroceptive and interoceptive domains modulates self-experience in the rubber-hand illusion. *Neuropsychologia* 51, 2909-2917. doi: 10.1016/j.neuropsychologia.2013.08.014
284. Swanson, L. R. (2018). Unifying theories of psychedelic drug effects. *Front. Pharmacol.* 9:172. doi: 10.3389/fphar.2018.00172
285. Tacikowski, P., Berger, C. C., and Ehrsson, H. H. (2017). Dissociating the neural basis of conceptual self-awareness from perceptual awareness and unaware self-processing. *Cereb. Cortex* 27, 3768-3781. doi: 10.1093/cercor/ bhx004
286. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D., and Chialvo, D. R. (2014). Enhanced repertoire of brain dynamical states during the psychedelic experience. *Hum. Brain Mapp.* 35, 5442-5456. doi: 10.1002/hbm.22562
287. Tagliazucchi, E., Roseman, L., Kaelen, M., Orban, C., Muthukumaraswamy, S. D., Murphy, K., *et al.* (2016). Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr. Biol.* 26, 1043-1050. doi: 10.1016/j.cub.2016.02.010
288. Takayama, Y., Kamo, H., Ohkawa, Y., Akiguchi, I., and Kimura, J. (1991). A case of retrosplenial amnesia. *Rinsho Shinkeigaku* 31, 331-333.
289. Tang, Y.-Y., Hölzel, B. K., and Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nat. Rev. Neurosci.* 16, 213-225. doi: 10.1038/nrn3916
290. Taylor, V. A., Daneault, V., Grant, J., Scavone, G., Breton, E., Roffe-Vidal, S., *et al.* (2013). Impact of meditation training on the default mode network during a restful state. *Soc. Cogn. Affect. Neurosci.* 8, 4-14. doi: 10.1093/scan/ nsr087
291. Tellegen, A., and Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *J. Abnorm. Psychol.* 83, 268-277.
292. Thompson, E. (2014a). *Dreamless Sleep, the Embodied Mind, and Consciousness*. Open MIND. Frankfurt am Main: MIND Group. Available online at: http://open-mind.net/papers/dreamless-sleep-the-embodied-mind-and-consciousness-the-relevance-of-a-classical-indian-debate-to-cognitive-science/getAbstract
293. Thompson, E. (2014b). *Waking, Dreaming, Being: Self and Consciousness in Neuroscience, Meditation, and Philosophy*. New York, NY: Columbia University Press.
294. Timmermann, C., Spriggs, M. J., Kaelen, M., Leech, R., Nutt, D. J., Moran, R. J., *et al.* (in press). LSD modulates effective connectivity and neural adaptation mechanisms in an auditory oddball paradigm. *Neuropharmacology*. doi: 10.1016/j.neuropharm.2017.10.039. [Epub ahead of print].
295. Trautwein, F.-M., Naranjo, J. R., and Schmidt, S. (2016). Decentering the self? reduced bias in self- vs. other-related processing in long-term practitioners of loving-kindness meditation. *Front. Psychol.* 7:1785. doi: 10.3389/fpsyg.2016.01785
296. Travis, F., and Parim, N. (2017). Default mode network activation and Transcendental Meditation practice: focused attention or automatic self-transcending? *Brain Cogn.* 111, 86-94. doi: 10.1016/j.bandc.2016.08.009
297. Travis, F., and Pearson, C. (2000). Pure consciousness: distinct phenomenological and physiological correlates of

"consciousness itself." *Int. J. Neurosci.* 100, 77-89. doi: 10.3109/00207450008999678
298. Travis, F., and Shear, J. (2010). Focused attention, open monitoring and automatic self-transcending: categories to organize meditations from Vedic, Buddhist and Chinese traditions. *Conscious. Cogn.* 19, 1110-1118. doi: 10.1016/j.concog.2010.01.007
299. Tsakiris, M. (2017). "The material me: unifying the exteroceptive and interoceptive sides of the bodily self," in *The Subject's Matter: Self-Consciousness and the Body*, eds F. De Vignemont and A. Alsmith (Cambridge, MA: MIT Press).
300. Uddin, L. Q., Clare Kelly, A., m., Biswal, B. B., Xavier Castellanos, F., and Milham, M. P. (2009). Functional connectivity of default mode network components: correlation, anticorrelation, and causality. *Hum. Brain Mapp.* 30, 625-637. doi: 10.1002/hbm.20531
301. Ulrich, M., Keller, J., Hoenig, K., Waller, C., and Grön, G. (2014). Neural correlates of experimentally induced flow experiences. *Neuroimage* 86, 194-202. doi: 10.1016/j.neuroimage.2013.08.019
302. Vago, D. R., and Silbersweig, D. A. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): a framework for understanding the neurobiological mechanisms of mindfulness. *Front. Hum. Neurosci.* 6:296. doi: 10.3389/fnhum.2012.00296
303. Valenstein, E., Bowers, D., Verfaellie, M., Heilman, K. M., Day, A., and Watson, R. T. (1987). Retrosplenial amnesia. *Brain* 110, 1631-1646. doi: 10.1093/brain/110.6.1631
304. Valenzuela Moguillansky, C., O'Regan, J. K., and Petitmengin, C. (2013). Exploring the subjective experience of the "rubber hand" illusion. *Front. Hum. Neurosci.* 7:659. doi: 10.3389/fnhum.2013.00659
305. Vollenweider, F. X., Leenders, K. L., Scharfetter, C., Maguire, P., Stadelmann, O., and Angst, J. (1997). Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16, 357-372. doi: 10.1016/S0893-133X(96)00246-1
306. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F., Bäbler, A., Vogel, H., and Hell, D. (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9, 3897-3902. doi: 10.1097/00001756-199812010-00024
307. Von Mering, O., Morimoto, K., Hyde, R. W., and Rinkel, M. (1955). Experimentally induced depersonalization. *Proc. Annu. Meet. Am. Psychopathol. Assoc.* 66-77.
308. Wahbeh, H., Sagher, A., Back, W., Pundhir, P., and Travis, F. (2018). A systematic review of transcendent states across meditation and contemplative traditions. *Explore* 14, 19-35. doi: 10.1016/j.explore.2017.07.007
309. Wang, H.-T., Poerio, G., Murphy, C., Bzdok, D., Jefferies, E., and Smallwood, J. (2017). Dimensions of experience: exploring the heterogeneity of the wandering mind. *Psychol. Sci.* 29, 56-71. doi: 10.1177/0956797617728727
310. Ward, A. M., Mormino, E. C., Huijbers, W., Schultz, A. P., Hedden, T., and Sperling, R. A. (2015). Relationships between default-mode network connectivity, medial temporal lobe structure, and age-related memory deficits. *Neurobiol. Aging* 36, 265-272. doi: 10.1016/j.neurobiolaging.2014.06.028
311. Weng, H. Y., Fox, A. S., Shackman, A. J., Stodola, D. E., Caldwell, J. Z. K., Olson, M. C., *et al*. (2013). Compassion training alters altruism and neural responses to suffering. *Psychol. Sci.* 24, 1171-1180. doi: 10.1177/0956797612469537
312. Windt, J. M. (2010). The immersive spatiotemporal hallucination model of dreaming. *Phenomenol. Cogn. Sci.* 9, 295-316. doi: 10.1007/s11097-010-9163-1
313. Windt, J. M. (2014). *Just in Time - Dreamless Sleep Experience as Pure Subjective Temporality*. Open MIND. Frankfurt am Main: MIND GroupAvailable online at: http://open-mind.net/papers/just-in-time-dreamless-sleep-experience-as-pure-subjective-temporality-a-commentary-on-evan-thompson/getAbstract
314. Windt, J. M. (2015). *Dreaming: A Conceptual Framework for Philosophy of Mind and Empirical Research, 1 Edn.* Cambridge, MA; London: MIT Press.
315. Windt, J. M., Nielsen, T., and Thompson, E. (2016). Does consciousness disappear in dreamless sleep? *Trends Cogn. Sci.* 20, 871-882. doi: 10.1016/j.tics.2016.09.006
316. Woodhouse, M. (1990). "On the possibility of pure consciousness," in *The Problem of Pure Consciousness*, ed M. Forman (Oxford: Oxford University Press), 254-268.
317. Wu, W. (forthcoming). "Mineness and introspectible data," in *The Sense of Mineness*, M. Garcia-Carpintero and M. Guillot (Oxford: Oxford University Press).
318. Yamashiro, J. (2015). Brain basis of samadhi: the neuroscience of meditative absorption. *New School Psychol. Bull.* 13, 1-10.
319. Zahavi, D. (2014). *Self and Other: Exploring Subjectivity, Empathy, and Shame*. Oxford: Oxford University Press.
320. Zahorik, P., Brungart, D. S., and Bronkhorst, A. W. (2005). Auditory distance perception in humans: a summary of past and present research. *Acta Acust. United Acust.* 91, 409-420.

Response of cluster headache to psilocybin and LSD

by

R. Andrew Sewell, John H. Halpern and Harrison G. Pope, Jr

This information is current as of June 26, 2006

original source: http://www.maps.org/research-archive/w3pb/2006/2006_Sewell_22779_1.pdf
backup source: http://www.psilosophy.info/resources/2006_Sewell_22779_1.pdf

Neurology 2006;66;1920-1922
DOI: 10.1212/01.wnl.0000219761.05466.43

Additional material related to this article can be found on the Neurology Web site. Go to www.neurology.org and scroll down the Table of Contents for the June 27 issue to find the title link for this article.

From the Biological Psychiatry Laboratory (J.H.H., H.G.P.) and Clinical Research Laboratory (R.A.S.), Alcohol and Drug Abuse Research Center, McLean Hospital/Harvard Medical School, Belmont, MA.

Funding sources include MAPS of Sarasota, FL (J.H.H., H.G.P.), and NIDA, NIH T32-DA07252 (R.A.S.). No funding source had any role in study design; collection, analysis, or interpretation of data; writing the report; or submission of the manuscript.

Disclosure: The authors report no conflicts of interest.

Received December 20, 2005. Accepted in final form March 10, 2006.

Address correspondence and reprint requests to Dr. R. Andrew Sewell, Oaks Building, ADARC, McLean Hospital, 115 Mill St., Belmont, MA 02478; e-mail: asewell@mclean.harvard.edu

Abstract - The authors interviewed 53 cluster headache patients who had used psilocybin or lysergic acid diethylamide (LSD) to treat their condition. Twenty-two of 26 psilocybin users reported that psilocybin aborted attacks; 25 of 48 psilocybin users and 7 of 8 LSD users reported cluster period termination; 18 of 19 psilocybin users and 4 of 5 LSD users reported remission period extension. Research on the effects of psilocybin and LSD on cluster headache may be warranted.

Cluster headache, often considered the most painful of all types of headache,[1] affects predominantly men (0.4% vs 0.08% of women) and typically begins after age 20 years. The disorder is categorized as either *episodic*, occurring for 1-week to 1-year periods, interspersed with pain-free remission periods, or *chronic*, in which the headaches occur constantly for more than a year with no remission longer than 1 month.[2] Ten percent of episodic cluster headaches ultimately evolve into the chronic form, and these are termed *secondary chronic*. In standard descriptions of cluster headache, an *attack* refers to the actual paroxysm of pain, a *cluster period* refers to a period of time when attacks occur regularly, and a *remission* period refers to a prolonged attack-free interval. [3] Oxygen and sumatriptan are the mainstays of acute abortive treatment, whereas verapamil, lithium, corticosteroids, and other neuromodulators can suppress attacks during cluster periods. No medications are known to terminate cluster periods or extend remission periods. The effects of the ergot alkaloid derivative lysergic acid diethylamide (LSD) and the related indolalkylamine psilocybin on cluster headache have not previously been described and may include such properties.

Case series. We were contacted by a 34-year-old man, diagnosed with episodic cluster headache at age 16 years, who reported a complete remission of his cluster periods when he repeatedly used LSD on a recreational basis between ages 22 and 24 years. Cluster periods resumed once he stopped. Based on this experience, he attempted to treat his cluster headache by ingesting psilocybin-containing mushrooms every 3 months and again achieved lasting remission. On three occasions when he missed his scheduled dose, a cluster period reoccurred.

Intrigued by this history, we located-through cluster headache support groups and an Internet-based survey-several hundred people with cluster headache who reported use of psilocybin-containing mushrooms or LSD specifically to treat their disorder, and we administered a standardized questionnaire (available from the authors). The consent form and study were approved by the McLean Hospital institutional review board. We restricted our analysis to the 53 individuals who 1) agreed to be contacted for evaluation by telephone or e-mail and 2) met International Classification of Headache Disorders-2 criteria for cluster headache and allowed us to obtain copies of medical records documenting a diagnosis of cluster headache by an MD or DO. If the medical records did not support the diagnosis, the subject was excluded from further analysis. The final sample included subjects from across the United States as well as Great Britain, The Netherlands, and South Africa. We found no significant differences between men and women on demographic indices or headache features (table 1). Notably, 31 (58%) of the 53 individuals reported that they had never used psilocybin or LSD except to treat their cluster headache, and a further 13 (25%) had used these drugs for recreational purposes only in the remote past during adolescence.

Results are summarized in table 2 and listed in complete form in table E-1 (on the Neurology Web site at www.neurology.org). Of the 32 subjects with episodic cluster headache, 19 had used sublingual psilocybin during cluster attacks; 17 found psilocybin to be effective in aborting attacks (defined as ending the attack within 20 minutes). Only one subject had used sublingual LSD for an acute attack, reporting it to be effective. Twenty-nine subjects had used psilocybin prophylactically during a cluster period; 15 (52%) reported that it was effective (defined as causing total cessation of attacks), and a further 12 (41%) reported partial efficacy (defined as attacks decreasing in intensity or frequency but not ceasing). Five of six LSD users reported cluster period termination. Twenty subjects ingested psilocybin during a remission period; 19 reported an extension of their remission period, in that their next expected cluster period was delayed or prevented entirely. Four of five subjects reported similar remission extension with LSD.

Of the 21 subjects with chronic cluster headache, 5 of 7 reported that psilocybin aborted a cluster attack; 10 of 20 reported that psilocybin induced a complete termination of cluster attacks; and a further 8 reported partial efficacy. Of two chronic cluster headache patients who ingested LSD, both at subhallucinogenic doses, one reported no attacks for 10 days, and the other reported none for 2 months. Interestingly, 22 (42%) of the 53 subjects reported partial or complete efficacy (as defined above) from subhallucinogenic doses of psilocybin or LSD.

Discussion

Our results are interesting for three reasons. First, no other medication, to our knowledge, has been reported to terminate a cluster period. Second, unlike other ergot-based medications, which must be taken daily, a single dose of LSD was described as sufficient to induce remission of a cluster period, and psilocybin rarely required more than three doses. Third, given the apparent efficacy of subhallucinogenic doses, these drugs might benefit cluster headache by a mechanism unrelated to their psychoactive effects.

Several limitations of this study should be considered. First, it is subject to recall bias, because it relies primarily on participants' retrospective reports. However, 6 participants (11%) provided detailed headache diaries that corroborated their recall. In addition, 3 (6%) of the 53 participants tried psilocybin for the first time subsequent to consenting to participate in the study but before being questioned; 2 reported complete efficacy and 1 reported partial efficacy - a prospective response rate consistent with our retrospective findings.

A second consideration is the possibility of selection bias, in that individuals with a good outcome may have been more likely to participate. Recruitment over the Internet also selects for younger, more educated, and more motivated subjects,[4] likely leading to increased reported efficacy.

Table 1. Cluster headache characteristics by sex and subtype.

Headache type	n	Age, y	Headache features			
			Attack duration, min	Attacks/day at peak	Cluster period duration, wk	Remission period duration, wk
Episodic						
Men	26	45 (8)	97 (66)	5.5 (3.7)	13 (10)	11 (10)
Women	6	45 (11)	66 (34)	6.2 (3.0)	15 (10)	9 (5)
Total	32	45 (8)	91 (60)	5.6 (3.5)	13 (10)	11 (9)
1° Chronic						
Men	6	48 (8)	79 (57)	9.8 (7.4)	NA	NA
Women	1	38 (NA)	90 (NA)	8.0 (NA)		
Total	7	47 (8)	81 (53)	9.6 (6.8)		
2° Chronic						
Men	10	45 (6)	105 (70)	6.9 (3.0)	NA	NA
Women	4	46 (10)	139 (64)	7.5 (1.0)		
Total	14	45 (7)	115 (68)	7.1 (2.5)		

Data are presented as mean (SD).
1° = primary; 2° = secondary; NA = not applicable.

Table 2. Reported efficacy of principal reported treatments for cluster attacks, cluster periods, and remission extension.

Medication	Total, n	Effective, n (%)	Partially effective, n (%)	Ineffective, n (%)
Acute treatment				
Oxygen	47	24 (52)	19 (40)	4 (9)
Triptans	45	33 (73)	8 (18)	4 (9)
Psilocybin	26	22 (85)	0 (0)	4 (15)
LSD	2	1 (50)	0 (0)	1 (50)
Prophylactic				
Propanolol	22	0 (0)	2 (9)	20 (91)
Lithium	20	1 (5)	8 (40)	11 (55)
Amitriptyline	25	0 (0)	4 (16)	21 (84)
Verapamil	38	2 (5)	22 (58)	14 (37)
Prednisone	36	15 (45)	5 (14)	15 (42)
Psilocybin	48	25 (52)	18 (37)	3 (6)
LSD	8	7 (88)	0 (0)	1 (12)
Remission extension				
Psilocybin	22 (31)	20 (91)	NA	2 (9)
LSD	5 (7)	4 (80)	NA	1 (20)

Nine additional individuals had taken psilocybin and two additional had taken lysergic acid diethylamide (LSD) purposefully for remission extension but were not yet due for another cluster period at the time of our evaluation; hence, for them, efficacy could not be scored.

Third, participants were not blind to their treatment, raising the possibility of a placebo response. However, cluster headache is known to respond poorly to placebo; controlled trials have shown a placebo response of 0% to prophylactic medications such as verapamil, [5] capsaicin,[6] and melatonin,[7] and less than 20% to abortive medications such as sumatriptan.[8] Therefore, it seems unlikely that we would have found more than 50 cases of apparent response to psilocybin or LSD through placebo effects alone.

Our observations must be regarded as preliminary, in that they are unblinded, uncontrolled, and subject to additional limitations as described above. Therefore, our findings almost certainly overestimate the response of cluster headache to psilocybin and LSD and should not be misconstrued as an endorsement of the use of illegal substances for the self-treatment of cluster headache. However, given the high reported efficacy for this notoriously refractory condition, it is difficult to dismiss this series of cases as entirely artifactual. Further research is warranted.

Acknowledgment

The authors thank Nancy K. Mello, PhD, and Kimberley Lindsey, PhD, for their comments on an earlier version of this manuscript, and Robert Wold, Earth and Fire Erowid, for assistance with data collection.

References

1. Dodick DW, Rozen TD, Goadsby PJ, Silberstein SD. Cluster headache. Cephalalgia 2000;20:787-803.
2. Headache Classification Subcommittee of the International Headache Society. The International Classification of Headache Disorders. Cephalalgia 2004;24 (suppl 1):44-48.
3. Ekbom K. Some remarks on the terminology of cluster headache. Cephalalgia 1988;8:59-60.
4. Etter JF, Perneger TV. A comparison of cigarette smokers recruited through the Internet or by mail. Int J Epidemiol 2001;30:521-525.
5. Leone M, D'Amico D, Frediani F, et al. Verapamil in the prophylaxis of episodic cluster headache: a double-blind study versus placebo. Neurology 2000;54:1382-1385.
6. Marks DR, Rapoport A, Padla D, et al. A double-blind placebo-controlled trial of intranasal capsaicin for cluster headache. Cephalalgia 1993;13: 114-116.
7. Leone M, D'Amico D, Moschiano F, Fraschini F, Bussone G. Melatonin versus placebo in the prophylaxis of cluster headache: a double-blind pilot study with parallel groups. Cephalalgia 1996;16:494-496.
8. van Vliet JA, Bahra A, Martin V, et al. Intranasal sumatriptan in cluster headache: randomized placebo-controlled double-blind study. Neurology 2003;60:630-633.

Safety, Tolerability, and Efficacy of Psilocybin in 9 Patients With Obsessive-Compulsive Disorder

by

Francisco A. Moreno, M.D.; Christopher B. Wiegand, M.D.; E. Keolani Taitano, Ph.D.; and Pedro L. Delgado, M.D.

original source: http://www.maps.org/research-archive/w3pb/2006/2006_Moreno_22868_1.pdf
backup source: http://www.psilosophy.info/resources/2006_Moreno_22868_1.pdf

Table of Contents:

- Preface
- Method
  - *Safety and Ethical Considerations*
  - *Subjects*
  - *Procedure*
  - *Measurements*
  - *Data Analysis*
- Results
  - *Safety and Tolerability*
  - *Effect on OCD Symptoms*
- Conclusions
- Acknowledgments
- References

Received Dec. 19, 2005; accepted April 10, 2006. From the Department of Psychiatry, University of Arizona, Tucson (Drs. Moreno, Wiegand, and Taitano); and the Department of Psychiatry, University of Texas Health Sciences Center, San Antonio (Dr. Delgado).

This study was supported by grants from the Multidisciplinary Association for Psychedelic Studies; the Heffter Research Institute, which included funding support from Peggy Hitchcock; and the Nathan Cummings Foundation, with the support and encouragement of Richard A. and Roberta Friedman Cummings.

Presented at the 58th annual meeting of the Society of Biological Psychiatry, May 15-17, 2003, San Francisco, Calif.; the 42nd annual meeting of the American College of Neuropsychopharmacology, Dec. 7-11, 2003, San Juan, Puerto Rico; and the 44th annual meeting of the New Clinical Drug Evaluation Unit, June 1-4, 2004, Phoenix, Ariz.

Dr. Moreno is a consultant for Cyberonics and Forest and has received grants from Cyberonics. Dr. Delgado has been a consultant for and been on the speakers/advisory boards of Eli Lilly and Wyeth; has received grant/research support from AstraZeneca; has received honoraria from Eli Lilly, Wyeth, and Pierre Fabre; and is a stock shareholder in Pfizer. Drs. Wiegand and Taitano report no additional financial or other relationship relevant to the subject of this article.

Acknowledgments are listed at the end of the article.

Corresponding author and reprints: Francisco A. Moreno, M.D., Department of Psychiatry, College of Medicine, University of Arizona Health Sciences Center, 1501 N. Campbell Ave. 7-OPC, Tucson, AZ 85724 (e-mail: fmoreno@email.arizona.edu).

Background: Anecdotal reports suggest that psychedelic agents may relieve symptoms of obsessive-compulsive disorder (OCD). This modified double-blind study investigated the safety, tolerability, and clinical effects of psilocybin, a potent 5-HT_{1A} and $5\text{-HT}_{2A/2C}$ agonist, in patients with OCD.

Method: Nine subjects with DSM-IV-defined OCD and no other current major psychiatric disorder participated in up to 4 single-dose exposures to psilocybin in doses ranging from subhallucinogenic to frankly hallucinogenic. Low (100 µg/kg), medium (200 µg/kg), and high (300 µg/kg) doses were assigned in that order, and a very low dose (25 µg/kg) was inserted randomly and in double-blind fashion at any time after the first dose. Testing days were separated by at least 1 week. Each session was conducted over an 8-hour period in a controlled environment in an outpatient clinic; subjects were then transferred to a psychiatric inpatient unit for overnight observation. The Yale-Brown Obsessive Compulsive Scale (YBOCS) and a visual analog scale measuring overall obsessive-compulsive symptom severity were administered at 0, 4, 8, and 24 hours post-ingestion. The Hallucinogen Rating Scale was administered at 8 hours, and vital signs were recorded at 0, 1, 4, 8, and 24 hours after ingestion. The study was conducted from November 2001 to November 2004.

Results: Nine subjects were administered a total of 29 psilocybin doses. One subject experienced transient hypertension without relation to anxiety or somatic symptoms, but no other significant adverse effects were observed. Marked decreases in OCD symptoms of variable degrees were observed in all subjects during 1 or more of the testing sessions (23%-100% decrease in YBOCS score). Repeated-measures analysis of variance for all YBOCS values revealed a significant main effect of time on Wilks lambda (F = 9.86, df = 3,3; p = .046), but no significant effect of dose (F = 2.25, df = 3,3; p = .261) or interaction of time and dose (F = 0.923, df = 9,45; p = .515). Improvement generally lasted past the 24-hour timepoint.

Conclusions: In a controlled clinical environment, psilocybin was safely used in subjects with OCD and was associated with acute reductions in core OCD symptoms in several subjects.

(J Clin Psychiatry 2006;67:1735-1740)

Preface

Obsessive-compulsive disorder (OCD) is a chronic and debilitating condition with a lifetime prevalence of 2% to 3%, which makes it the fourth most common psychiatric diagnosis[1,2] and one with a very high disease burden.[3] Furthermore, OCD is commonly complicated by the presence of comorbid delusions, suicidality, panic, substance abuse, depression, and interpersonal difficulties. Many patients with OCD delay or altogether avoid pursuing care, and of those who seek help, many remain unrecognized and untreated.

It is now well established that serotonin (5-HT) reuptake inhibitors (SRIs), such as the selective serotonin reuptake inhibitors (SSRIs) and clomipramine, are among the most effective pharmacologic treatments for OCD, although these treatments generally reduce symptoms by only 30% to 50%.[4,5] Some SRI-treated patients who receive the 5-HT_2 antagonist metergoline experience a resurgence of OCD symptoms.[6] Supporting the central role of 5-HT in the efficacy of SRIs, drugs such as desipramine and bupropion, which may act primarily by blocking reuptake of norepinephrine and/or dopamine, are not effective treatments for OCD.[7,8]

In spite of the greater efficacy of potent SRIs compared with other agents in the treatment of OCD, they are still suboptimal. The length of time required for improvement of patients undergoing treatment with SRIs is quite extensive, the rates of remission are minimal, and many patients considered responders have residual symptoms that continue to cause dysfunction and may increase vulnerability to complications and exacerbations.[9] In addition to SRIs, other effective treatments include cognitive behavioral psychotherapy (CBT), combination of SRIs and CBT, and the use of polypharmacy.[5,9] It is estimated that as many as 40% to 60% of those who are adequately treated will fail to respond to standard therapies.[9] For these reasons, identifying new options for treatments has become a high priority.

There are several reported cases concerning the beneficial effects of hallucinogenic drugs (psilocybin and lysergic acid diethylamide [LSD]) in patients with OCD and related disorders.[10-14] For example, a 34-year-old man had suffered from OCD symptoms (checking and counting compulsions, performing actions a specific number of times, and a variety of other rituals) since age 14. However, he began using freeze-dried psilocybe mushrooms recreationally at age 18 and observed consistently that during the psilocybe mushroom intoxication, he was free of obsessions or compulsions. Repeated use induced tolerance to the psychedelic effects, but the subject continued to experience relief of his OCD symptoms despite the lack of a "high." Chronic use of this hallucinogen led to a symptomatic remission, which lasted for several months after discontinuing use.[15]

Psilocybin (4-phosphoryloxy-*N,N*-dimethyltryptamine), an indolealkylamine, is the main active compound of many species of the genus Psilocybe, commonly known as "magic mushrooms." Psilocybin binds potently as an agonist to the 5-HT$_{1A}$, 5-HT$_{2A}$, and 5-HT$_{2C}$ receptors. [16,17] Behavioral pharmacology and electrophysiologic research show that agonist activity at 5-HT$_2$ receptors strongly correlates with a stimulus effect in animals and a hallucinogenic effect in humans.[18,19] Oral doses ranging from 8 to 20 mg p.o. or 100 to 315 µg/kg are considered safe and able to induce a quantifiable psychedelic experience that lasts, depending on the dose, from 3 to 8 hours.[20,21] Given a large first-pass metabolism in which psilocybin is converted primarily to psilocin, the latter may actually be responsible for the psychotropic effects observed after psilocybin administration.

Given the large body of clinical data suggesting that pharmacologic potency in increasing synaptic 5-HT may underlie the therapeutic effects of some drugs in the treatment of OCD and the anecdotal reports of acute reduction in OCD symptoms with hallucinogens, we hypothesized that agonist activity at 5-HT$_{1A}$, 5-HT$_{2A}$, and/or 5-HT$_{2C}$ receptors might underlie the efficacy of drug treatments for OCD. The present study sought to evaluate the safety, tolerability, and potential therapeutic effect of psilocybin administration in OCD patients who had failed to respond to at least 1 adequate treatment trial with SRI agents. Additionally, we sought to explore the relationship between the intensity of psychedelic experience and the severity of obsessions and compulsions during testing.

Method

Safety and Ethical Considerations

This project was approved by the University of Arizona Human Subjects Committee and the U.S. Food and Drug Administration (FDA). All participants signed informed consent statements, which included a detailed discussion of potential somatic and mental effects of psilocybin. The subject selection and study design were the result of extensive discussions with members of the Human Subjects Committee at the University of Arizona and representatives of the FDA, who had a number of comments geared toward improving the safety of research subjects. The study was conducted from November 2001 to November 2004.

Subjects

Nine subjects (7 male, 2 female) who met criteria for current OCD based on the Structured Clinical Interview[22] for the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (DSM-IV)[23] were recruited through word-of-mouth, Internet postings, and local advertisement. Their ages ranged from 26 to 62 years (mean ± SD = 40.9 ± 13.2 years); 3 of the subjects were employed, 1 was a housewife, and 5 were unable to work because of their OCD symptomatology. Six of 9 participants lived alone, 2 were living with a significant other, and 1 was married.

Subjects were required to have at least 1 "treatment failure," defined as lack of significant improvement after an adequate treatment course with an SRI for at least 12 weeks (based on dose range recommendations published in the Expert Consensus Guidelines for OCD[5]). Subjects had a mean ± SD of 3.4 ± 1.9 treatment failures. Subjects were required to be symptomatic at the time of enrollment and had a baseline Yale-Brown Obsessive Compulsive Scale (YBOCS)[24] score ranging from 18 to 36 (mean ± SD = 24.1 ± 5.9) on the first test day. None of the subjects met criteria for current major psychiatric disorders other than OCD, including current substance abuse/ dependence, and none of the subjects had a personal or family history of psychosis. Due to safety concerns over potential adverse reaction to psychedelic drugs, subjects were required to have tolerated well at least 1 prior exposure to indole-based psychedelics. Two of the subjects (1 and 4) reported a history of clinical benefit with use of psychedelics.

Subjects were free of general medical or neurologic conditions based on the clinical history and review of systems; physical examination; electrocardiogram; routine laboratory blood, urine, and pregnancy screenings; and urine testing for drugs of abuse. Subjects were required to abstain from use of antidepressants for at least 2 weeks (6 weeks for fluoxetine) and any pharmaceutical or nutritional supplement for at least 1 week before testing. Additionally, subjects were free of any other prescription or over-the-counter medication or drug of abuse.

Procedure

Testing was performed in the Department of Psychiatry at the University of Arizona Health Sciences Center. Psilocybin sessions were conducted in the outpatient offices of the Psychopharmacology Research Program. As a cautionary measure, subjects were then transferred to the psychiatric inpatient unit of the same hospital for overnight observation and were discharged the next morning. When a bed was not available in the psychiatric unit, subjects were admitted to the medical-surgical units under the care of the psychiatric service and remained under constant supervision by a staff member. Subjects had an opportunity to develop rapport with the study team during screening. All subjects met with the principal investigator (F.A.M.) and whenever possible with the sitters the day before testing. During the initial visit, further rapport was established, the procedure was again discussed, and the testing room and the psychiatric inpatient unit were shown to the subjects.

Subjects reported for testing at 8:00 a.m., after having had a light snack. Testing for drugs of abuse and pregnancy (when applicable) was conducted prior to each session. Subjects were escorted to the testing room, where they remained for the next 8 hours. Subjects were allowed to use a nearby restroom, but no other outings were allowed. A light snack was again made available for subjects at about 1:00 p.m. Study drug was ingested at about 8:30 a.m. Subjects received up to 4 different doses, 1 dose per test session, in a modified dose escalation blinded protocol. Doses were 25 (very low dose [VLD]), 100 (low dose [LD]), 200 (medium dose [MD]), and 300 (high dose [HD]) µg/kg of body weight. LD, MD, and HD were assigned in that order, and VLD was inserted randomly and in double-blind fashion at any time after the first dose (LD). Testing days were separated by at least 1 week. Subjects were asked to wear eyeshades, listen to a standardized set of music, and minimize interactions during the sessions. Trained sitters were present at all times and included at least 1 of the investigators; whenever possible, a male and a female sitter were present simultaneously. Toward the end of the 8-hour test, subjects were allowed to modify the music selection, have more conversation, discontinue use of the eyeshades, and gradually debrief with the principal investigator regarding aspects of their experience.

Measurements

The YBOCS and a visual analog scale (VAS) for overall obsessive-compulsive symptom severity were administered immediately before psilocybin ingestion (baseline) and at 4, 8, and 24 hours postingestion. The Hallucinogen Rating Scale (HRS)[25] was administered at 8 hours post ingestion. The HRS is a non-theoretically constructed scale, and its item selection is based on reported observations from experienced hallucinogen users who could experience a full range of effects. It measures 6 aspects of the hallucinogenic experience, including the following subscales: somaesthesia, affect, volition, cognition, perception, and intensity. Volition and intensity subscales are compounded by a small number of items and lack the established validity of the other mentioned subscales. Vital signs were monitored at baseline and 1, 4, 8, and 24 hours after psilocybin ingestion.

Data Analysis

Change in YBOCS and VAS scores was assessed by multivariate analysis of variance (ANOVA) in a repeated-measures design. This allowed for an assessment of the main effect of time, dose, and time-by-dose interaction. ANOVA within-subjects linear contrast was utilized to test for dose-response relationship in the HRS intensity subscale. Pearson correlation was used to assess the relationship between HRS intensity score and change in YBOCS score.

Results were considered significant when $p \leq .05$. Trends are also reported when $p \leq .1$. All tests were 2-tailed. Data analysis and graphic presentation utilized SPSS[26] and SYSTAT[27] software programs.

Results

Safety and Tolerability

Subjects generally tolerated the procedure well. One subject experienced transient hypertension (132/90, 135/90, 142/105, 142/95, and 116/78 mm Hg at 0, 1, 4, 8, and 24 hours, respectively, after ingestion of a medium dose of psilocybin), which was not associated with psychic anxiety or somatic symptoms. Two subjects declined further participation after the first testing session due to discomfort with hospitalization. No other adverse reactions were observed. All 9 subjects received LD, 7 of them also received VLD and MD, and 6 of them received all 4 doses.

Effect on OCD Symptoms

Repeated-measures ANOVA for all YBOCS values revealed a significant main effect of time on Wilks lambda (F = 9.86, df = 3,3; p = .046), but no significant effect of dose (F = 2.25, df = 3,3; p = .261) or interaction of time and dose (F = 0.923, df = 9,45; p = .515). Marked decreases in OCD symptoms of variable degree were observed in all subjects during 1 or more sessions (23% - 100% reduction in YBOCS score). Contrast comparison of baseline versus postingestion YBOCS scores for all doses combined was also statistically significant (F = 9.37, df = 1,5; p = .028); see Figures 1 and 2.

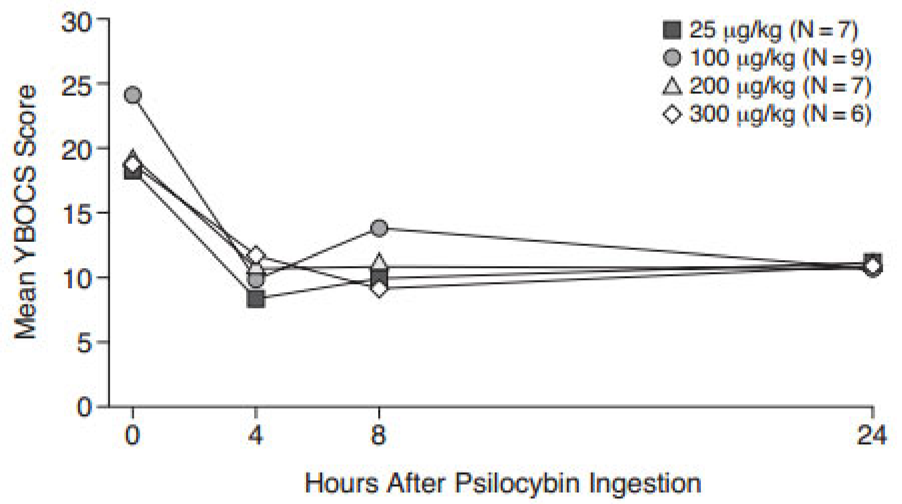


Figure 1. Effects of Psilocybin on Obsessive-Compulsive Symptom Severity[a]

[a] Mean YBOCS scores immediately prior to ingesting psilocybin (T-0) and 24 hours after ingesting psilocybin (T-24) for each dose were as follows: 25 µg/kg, T-0 = 18.29, T-24 = 11.14; 100 µg/kg, T-0 = 24.11, T-24 = 10.67; 200 µg/kg, T-0 = 19.57, T-24 = 11.00; 300 µg/kg, T-0 = 18.83, T-24 = 11.33.

Abbreviation: YBOCS = Yale-Brown Obsessive Compulsive Scale.

Repeated-measures ANOVA for effects of individual doses on YBOCS scores found a significant effect of time for LD (p = .004) and MD (p = .006), but not for VLD (p = .128) or HD (p = .406). Changes in obsessions and compulsions were comparable. ANOVA of baseline to 24 hours YBOCS score also showed a significant effect of time (F = 7.89, df = 1,5; p = .038), but no effect of dose or time-by-dose interaction.

VAS scores for all doses combined showed no significant effect of time (F = 3.05, df = 3,3; p = .192) or dose (F = 2.7, df = 3,3; p = .218). Repeated-measures ANOVA for effect of individual doses on VAS scores found a significant effect of time for LD (p = .010), but not for VLD (p = .307), MD (p = .182), or HD (p = .25). Contrast comparison of baseline versus postingestion VAS scores for all doses combined was also statistically significant (F = 11.41, df = 1,5; p = .020). ANOVA of baseline to 24 hours revealed a significant main effect of time (F = 5.38, df = 1,5; p = .068), a nonsignificant effect of dose (F = 1.83, df = 3,3; p = .316), and a significant interaction of time and dose (F = 183.1, df = 3,3; p = .001).

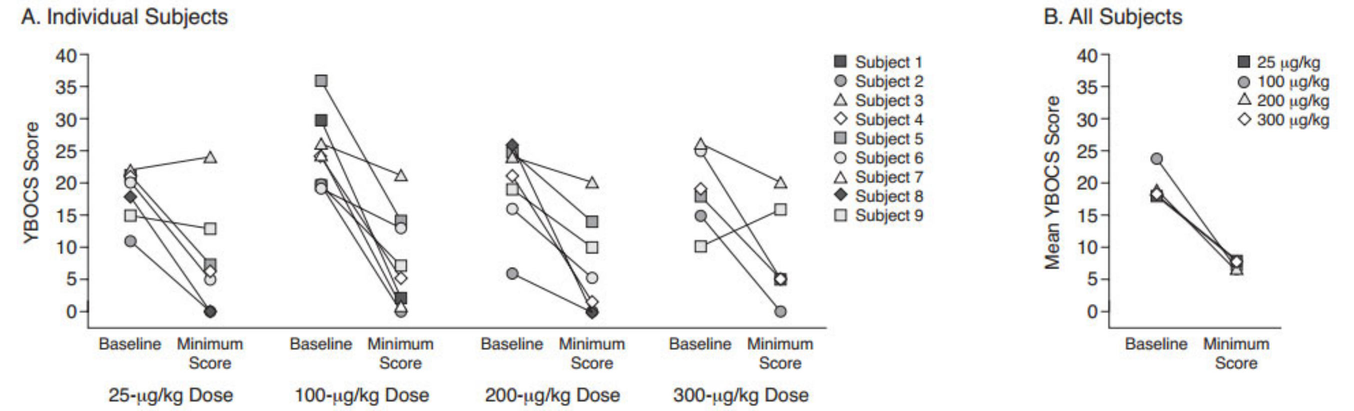


Figure 2. Comparison of Baseline to Minimum YBOCS Score During Testing[a]
[a]Baseline = score obtained immediately prior to ingesting psilocybin, minimum = lowest score observed (4, 8, or 24 hours) after ingestion of psilocybin.
Abbreviation: YBOCS = Yale-Brown Obsessive Compulsive Scale.

The HRS intensity subscale showed a significant linear main effect of dose (F = 12.36, df = 1,5; p = .017) (Figure 3). Total HRS score and every subscale with the exception of volition also showed a statistically significant linear main effect of dose. There were no significant correlations between HRS total or subscale scores and changes in OCD severity based on YBOCS or VAS scores.

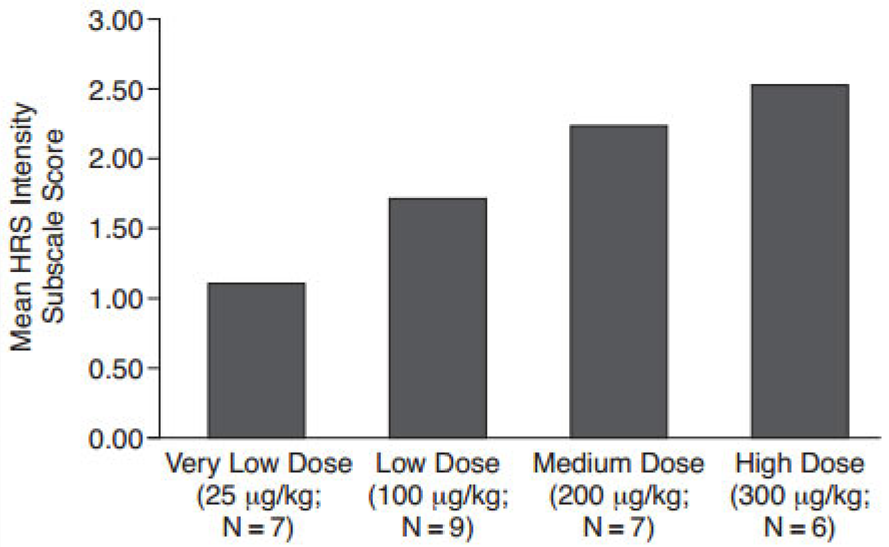


Figure 3. Relationship Between Psilocybin Dose and Intensity of Hallucinogenic Experience
Abbreviation: HRS = Hallucinogen Rating Scale.

OCD measurements were only obtained for up to 24 hours following psilocybin ingestion prior to the next session, and the duration of symptomatic improvement was not prospectively measured; however, 88.9% of subjects maintained a ≥ 25% decrease and 66.7% maintained a ≥ 50% decrease in YBOCS score at 24 hours with at least 1 of the testing doses. Two of the subjects reported that their symptomatic improvement lasted most of the following week after testing. Although there was a numerical difference between baseline scores at test 1 versus other test times, there was no statistically significant order effect when ANOVA with repeated measures was used (p = .133). One subject achieved long-term remission at the end of the 4 test sessions, as measured at 6- month follow-up.

Post hoc pairwise *t* test analysis comparing YBOCS scores during screening (25.2 ± 8.6) and baseline scores (24.1 ± 6.3) on test day 1 showed no statistical difference (p = .673), suggesting stability of YBOCS scores prior to psilocybin testing and the lack of anxiety-induced increase in YBOCS score prior to testing.

Conclusions

When administered in a supportive clinical environment, psilocybin appears to be safe and well tolerated. Psilocybin was associated with transient symptomatic reduction of OCD symptoms in subjects with treatment-resistant OCD.

These data result from a small proof-of-concept, phase I study designed to explore the safety for human consumption of 4 doses of psilocybin in a small sample of symptomatic OCD patients. The escalating dosing scheme was selected to allow exposure to increasingly higher doses only to individuals who had tolerated previous exposures. A smaller dose (VLD) was hypothesized to have negligible psychedelic effects and was introduced randomly at any time after the first dose. Subjects experienced stronger than anticipated response to this dose, as shown in Figure 3, and its clinical effects were also greater than anticipated. This response to VLD impedes the use of VLD as a placebo comparator, which clearly represents a major obstacle in our ability to explore clinical effects. Another methodological concern is the fact that the order of the doses was escalating, with the exception of VLD, which was inserted randomly and in double-blind fashion. This modified blind may have influenced expectations in both subjects and raters. Despite the obvious limitations from design and sample size, the data are suggestive of an acute benefit, worth exploring further.

Although we understand the psychedelic mechanism of action of psilocybin, it is not clear which specific receptors or pathways may mediate antiobsessional responses. It may be possible for subjects to experience a decrease in symptoms by the mere artifact of mindset and setting, which are known to affect the psychedelic experience in itself; by the contextual expectation of improvement; or just by the distracting psychedelic effects or a "pleasurable experience." It should be noted that to some of the patients the exposure to a psychedelic agent was perceived as a stressful event; for others, testing represented a time without access to the usual distractions that help reduce their obsessions; and for most, the overnight stay in the hospital represented a significant stressor. Therefore, the setting was ideal not for reduction of stress and obsessions, but rather for safety and monitoring purposes. This issue may have introduced selection bias by allowing participation by only those subjects who tolerated travel and overnight hospitalization.

There was, however, no clear dose-response relationship to the change in YBOCS score and no correlation of YBOCS score reduction to the perceived psychedelic intensity based on HRS total score or intensity subscale score.

Although the intent of this study was not to conduct psychedelic-facilitated therapy during testing, 5 of the subjects readily described their experiences as very psychologically and spiritually enriching. Four subjects reported during HD profound positive transcendental experiences such as exploration of other planets, visiting past-life reincarnations, and interacting with deities.

Most subjects reporting symptom reduction experienced a period of relief that extended beyond the pharmacologically expected life of the drug and beyond the 24-hour rating (see Figure 1). This lingering effect, which extends clearly beyond the "high" or psychedelic state, raises a number of intriguing mechanistic questions. For example, does the effect result from a residual feeling of well-being due to the experience of temporary symptom distraction or "pleasure," from the psychological insights described above, or from changes in working memory and attention as reported previously, or is the effect directly pharmacologically mediated? Although the explanation is highly speculative, if these are prolonged pharmacologic effects, they may be related to a rapid adaptive cascade of events such as postsynaptic 5-HT receptor down-regulation or early gene expression.

A large body of evidence supports the down-regulation of 5-HT$_{2A}$ receptors in response to hallucinogen administration in animal models and human subjects.[28] LSD has been reported to induce intracellular signal transduction changes that are different from endogenous 5-HT despite binding to the same receptor site.[29] In fact, LSD is reported to decrease gene expression in rat brain after single-dose administration, while no changes in expression of 5-HT$_{1A}$, 5-HT$_{2A}$, or 5-HT$_{2C}$ were observed.[30] These changes in gene expression, although reported with a similar compound rather than with psilocybin, may result in physiologic alterations that explain the delayed effect described above. It is also possible that the early changes in gene expression may be different after repeated administration of LSD or similar compounds, leading to the known downregulation of 5-HT_{2A}.[28]

Ingestion of psilocybin and similar substances will facilitate subjects' experiencing of altered states of consciousness and may lead to the development of powerful insights and profound existential and spiritual questions. Administration of these substances therefore should be approached with caution to minimize exposure to individuals who are vulnerable to psychosis or overvalued ideas. Researchers should carefully consider the subject's mindset prior to exposure, address concerns developed during the psychedelic experience through careful debriefing, and secure a source of supportive continuity afterward. In spite of these concerns, given that OCD is associated with a great deal of human suffering and societal burden, and that treatment-resistant OCD represents a valid indication for irreversible brain surgery, it may be reasonable to consider psilocybin, with its potential benefit, a less burdensome alternative and one worth investigating further.

In summary, this study confirms and extends anecdotal reports of acute reduction in OCD symptoms with exposure to psilocybin. Given the chronicity and disease burden of OCD and the high rate of insufficient response to currently approved treatments, future studies involving traditional blinded, randomized, placebo-controlled methodology should explore the efficacy of and duration of therapeutic benefit from a more prolonged exposure to repeated doses of psilocybin in patients with OCD.

Drug names: bupropion (Wellbutrin and others), clomipramine (Anafranil and others), desipramine (Norpramin and others), fluoxetine (Prozac and others).

Acknowledgments

The authors thank Stanislav Grof, M.D.; Michael Mithoefer, M.D.; John Halpern, M.D.; and Torsten Passie, M.D., as well as George Greer, M.D., of the Heffter Research Institute, and Rick Doblin, Ph.D., of the Multidisciplinary Association for Psychedelic Studies, for their insights into the use and administration of psychedelic drugs; and Marcy Watchman and Jean McCreedy for their support as sitters. They also acknowledge the Arizona Hispanic Center of Excellence for logistics support and Ron Wright, M.D., Ph.D., for statistical consultation.

References

1. Karno M, Golding JM, Sorenson SB, et al. The epidemiology of obsessive compulsive disorder in 5 US communities. Arch Gen Psychiatry 1988;45:1094-1099
2. Kessler RC, McGonagle KA, Zhao S, et al. Lifetime and 12-month prevalence of DSM-III-R psychiatrie disorders in the United States. Arch Gen Psychiatry 1994;51:8-19
3. Murray CJL, Lopez AD, eds. A Comprehensive Assessment of Mortality and Disability From Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020: The Global Burden of Disease. Cambridge, Mass: The Harvard School of Public Health, on Behalf of the World Health Organization and The World Bank; 1996
4. Greist JH, Jefferson JW, Kobak KA. Efficacy and tolerability of serotonin transport inhibitors in obsessive-compulsive disorder: a meta-analysis. Arch Gen Psychiatry 1995;52:53-60
5. Expert Consensus Guideline Series: Treatment of Obsessive Compulsive Disorder. J Clin Psychiatry 1997;58(suppl 4): 1-72
6. Benkelfat C, Murphy DL, Zohar J. Clomipramine in obsessive-compulsive disorder: further evidence for a serotonergic mechanism of action. Arch Gen Psychiatry 1989;46:23-28
7. Goodman WK, Price LH, Delgado PL, et al. Specificity of serotonin reuptake inhibitors in the treatment of obsessive-compulsive disorder. Arch Gen Psychiatry 1990;47:577-585
8. Vulink NCC, Denys D, Westenberg HGM. Bupropion for patients with obsessive-compulsive disorder: an open-label, fixed-dose study. J Clin Psychiatry 2005;66:228-230
9. Goodman WK. Obsessive-compulsive disorder: diagnosis and treatment. J Clin Psychiatry 1999;60(suppl 18):27-32
10. Brandrup E, Vanggaard T. LSD treatment in a severe case of compulsive neurosis. Acta Psychiatr Scand 1977;55:127-141
11. Leonard HL, Rapoport JL. Relief of obsessive-compulsive symptoms by LSD and psilocybin [letter]. Am J Psychiatry 1987;144:1239-1240
12. Hanes KR. Serotonin, psilocybin, and body dysmorphic disorder: a case report [letter]. J Clin Psychopharmacol 1996;16:188-189
13. Delgado PL, Moreno FA. Hallucinogens, serotonin, and obsessive-compulsive disorder. J Psychoactive Drugs 1998;30:359-366
14. Anonymous. Personal account of mushrooms curing obsessive-compulsive disorder. Bull Multidisciplinary Assoc Psychedelic Stud 2002; 12:17
15. Moreno FA, Delgado PL. Hallucinogen-induced relief of obsessions and compulsions [letter]. Am J Psychiatry 1997;154:1037-1038
16. Glennon RA, Titeler M, McKenney JD. Evidence for 5-HT2 involvement in the mechanism of action of hallucinogenic agents.

Life Sci 1984;35: 2505-2511

17. McKenna DJ, Repke DB, Lo L, et al. Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. Neuropharmacology 1990;29:193-198
18. Aghajanian GK, Marek GJ. Serotonin and hallucinogens. Neuropsycho-pharmacology 1999;21(suppl 2):16S-23S
19. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, et al. Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 1998;9:3897-3902
20. Passie T, Seifert J, Schneider U, et al. The pharmacology of psilocybin. Addict Biol 2002;7:357-364
21. Hasler F, Grimberg U, Benz MA. Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology 2004;172:145-156
22. First MB, Gibbon M, Spitzer RL, et al. User's Guide for the Structured Interview for DSM-IV Axis I Disorders-Research Version (SCID-I, version 2.0). New York, NY: Biometric Research, New York State Psychiatrie Institute; 1996
23. American Psychiatrie Association. Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Washington, DC: American Psychiatrie Association; 1994
24. Goodman WK, Price LH, Rasmussen SA, et al. The Yale-Brown Obsessive Compulsive Scale, 1: development, use, and reliability. Arch Gen Psychiatry 1989;46:1006-1011
25. Riba J, Rodriguez-Fornells A, Strassman RJ, et al. Psychometric assessment of the Hallucinogen Rating Scale. Drug Alcohol Depend 2001;62:215-223
26. Norusis MJ. SPSS 13 Base System User's Guide. Chicago, Ill: SPSS Inc; 2005
27. SYSTAT 11. Point Richmond, Calif: Systat Software, Inc; 2005
28. Gresch PJ, Smith RL, Barrett RJ, et al. Behavioral tolerance to lysergic acid diethylamide is associated with reduced serotonin-2A receptor signaling in rat cortex. Neuropsychopharmacology 2005;30:1693-1702
29. Backstrom JR, Chang MS, Chu H, et al. Agonist-directed signaling of serotonin 5-HT2C receptors: differences between serotonin and lysergic acid diethylamide (LSD). Neuropsychopharmacology 1999; 21:77S-81S
30. Nichols CD, Sanders-Bush E. A single dose of lysergic acid diethylamide influences gene expression patterns within the mammalian brain. Neuro-psychopharmacology 2002;26:634-642

Psilocybin impairs high-level but not low-level motion perception

by

Olivia L. Carter,[1,4],CA John D. Pettigrew,[1] David C. Burr,[2] David Alais,[3] Felix Hasler[4] and Franz X. Vollenweider[4,5]

original source: http://www.researchgate.net/publication/8406301_Psilocybin_impairs_high-level_but_not_low-level_motion_perception

[1] VisionTouch and Hearing Research Center, School of Biomedical Sciences,University of Queensland, Australia;
[2] Instituto di Neuroscienze del CNR, Pisa, Italy;
[3] Auditory Neuroscience Laboratory,Department of Physiology and Institute for Biomedical Research, School of Medical Science, University of Sydney, Australia;
[4] Heffter Research Center;
[5] Neuropsychopharmacology and Brain Imaging,University Hospital of Psychiatry, Lenggstr. 31, 8029 Zurich, Switzerland

Address where work was carried out: Heffter Research Center, University Hospital of Psychiatry, Lenggstr. 31, 8029 Zürich, Switzerland
CA Corresponding author: o.carter@uq.edu.au
Received 21 May 2004; accepted 23 June 2004

Table of Contents:

Introduction
Materials and Methods
Substance and dosing
Subjects
Stimulus and procedure
Experimental design and statistical analysis
Results
Discussion
References
Acknowledgements

The hallucinogenic serotonin 1A & 2A agonist psilocybin is known for its ability to induce illusions of motion in otherwise stationary objects or textured surfaces. This study investigated the effect of psilocybin on local and global motion processing in nine human volunteers.Using a forced choice direction of motion discrimination task we show that psilocybin selectively impairs coherence sensitivity for random dot patterns, likely mediated by high-level global motion detectors, but not contrast sensitivity for drifting gratings, believed to be mediated by low-level detectors.These results are in line with those observed within schizophrenic populations and are discussed in respect to the proposition that psilocybin may provide a model to investigate clinical psychosis and the pharmacological underpinnings of visual perception in normal populations.
NeuroReport 15:1947-1951 © 2004 Lippincott Williams&Wilkins.

Key words: Hallucinogen; Human; Motion; Perception; Psilocybin; Schizophrenia; Vision

Introduction

Like LSD and mescaline, the serotonergic (5-HT) hallucinogen psilocybin is renowned for its ability to temporarily alter an individual's conscious state. Known for causing visual disturbances, it is often reported that psilocybin causes surrounding objects and colours to appear brighter or clearer, with successively higher doses leading to illusions of motion and colour that can increase in complexity, resulting in elementary geometric and scenic hallucinations[1]. Although psilocybin binds to both 5-HT$_{2A}$ (k$_i$=6 nmol) and 5-HT$_{1A}$ (k$_i$=190 nmol) subtypes of serotonin receptors[2], recent evidence demonstrates that psilocybin induces visual distortions via 5-HT$_{2A}$ receptor activation[3]. Accordingly, this drug can be used to induce transient and predictable changes in neurotransmitter activity, in a controlled and selective manner, to gain insight into the mechanisms responsible for visual distortions associated with drug induced and schizophrenia related altered states of consciousness[4,5].

Vision is a fundamental component of the human conscious experience[6]. Consequently, an accurate characterization of where and how hallucinogens, such as psilocybin, influence different stages of visual perception could be beneficial on a number of counts. Given that psilocybin is known to induce illusions of motion, this study was designed to investigate two aspects of motion perception: contrast sensitivity for drifting gratings and coherence sensitivity for drifting random dot patterns. Evidence suggests that contrast sensitivity is limited by an early stage of visual processing, likely to be V1 itself[7,8]. However, the integration of local motion signals necessary for coherent thresholds is probably mediated by higher-level processes and is generally considered to involve the middle temporal area (MT or V5)[8-10]. Neural activity in this region shows strong motion opponency[11], increases linearly with motion coherence[12] and correlates closely with motion perception[13]. Because contrast sensitivity is thought to reflect early visual processes and motion coherence requires higher regions such as MT, the relative influence of psilocybin on these two visual processes can be used as an indication of the effect of this drug on different levels of cortical processing.

The primary aim of this study was to determine whether psilocybin impairs motion processing. A secondary aim was to investigate whether it does so with a selectivity similar to that seen in schizophrenic individuals, as this population has been shown to have deficits in local but not global motion processing[14]. Independent of clinical relevance, the final aim of this study was to use psilocybin's primary and preferential mode of action at 5-HT$_{2A}$ receptors to investigate a possible role of the serotonergic system in visual perception. This is of relevance because despite the common belief that the visual disturbances characteristics of hallucinogens are mediated predominantly via 5-HT receptors[3,15], to date, most research into the pharmacology of visual deficits in schizophrenic populations has tended to focus on dopamine[16,17].

Materials and Methods

Substance and dosing

Psilocybin was obtained through the Swiss Federal Office for Public Health. Psilocybin capsules (1mg and 5 mg) were prepared at the pharmacy of the Cantonal Hospital of Aarau, Switzerland and quality was controlled through tests for identity, purity and uniformity of content. The psilocybin dose (215 mg/kg) and lactose placebo were administered in gelatine capsules of identical appearance.

Subjects

Nine healthy volunteers (five male, four female) aged between 21 and 31 (mean 7 s.d.=27.172.6) were recruited through advertisement from the local university and technical college. After being informed by a written and oral description of the aim of the study, the procedures involved, and the effects and possible risks of psilocybin administration all volunteers were asked to give their written consent as a requirement of participation. All subjects had normal or corrected to normal vision and were healthy according to medical history, clinical examination, electrocardiography and blood analysis. They were also deemed by psychiatric interview to have no personal or family (first-degree relatives) history of major psychiatric disorder nor evidence for regular alcohol or substance abuse. Five of the participants reported having previous experience with psilocybin through the ingestion of psilocybe mushrooms; the other four were psilocybin-naïve. Subjects were reimbursed for their time and they were instructed that at any time they were free to withdraw from the study. The study was approved by the ethics committee of the University Hospital of Psychiatry, Zurich, and the use of psilocybin in humans was authorized by the Swiss Federal Office for public health.

Stimulus and procedure

Measures of contrast sensitivity were obtained using drifting gratings (Fig. 1). The stimulus comprised a 5 circular patch of vertical, sinusoidal grating with a spatial frequency of 1 cycle/deg, embedded in dynamic random noise. The grating was caused to drift leftwards or rightwards at 20 deg/s (10 Hz). Subjects were instructed to maintain fixation on a central fixation point and attend only to the direction of motion of the gratings within the patch while reporting the drift direction by pressing either the left or right arrow key of the keyboard.

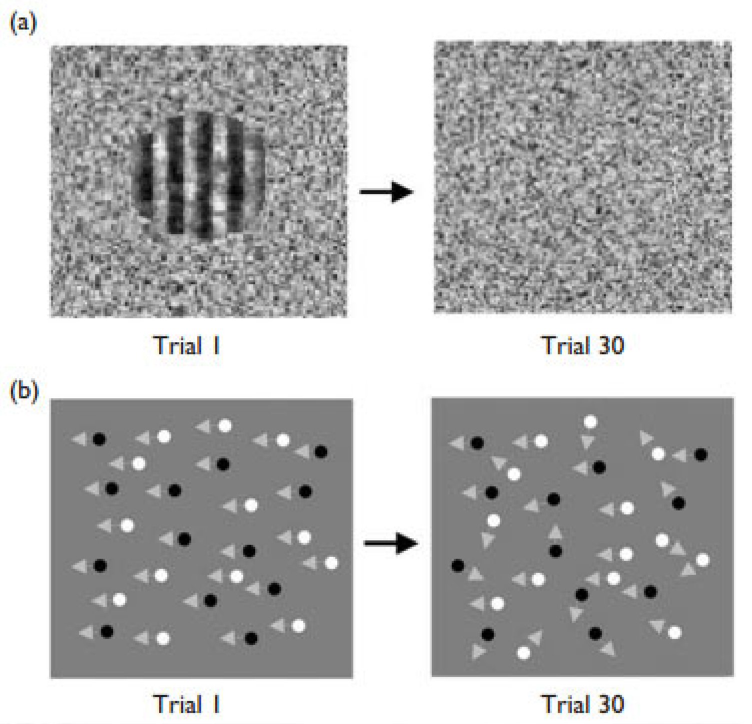


Fig. 1. Experimental stimuli.
(a) Visual contrast sensitivity was measured by asking subjects to report the direction of motion of a sinusoidal grating embedded within a background of noise. During the 30 trials of the session, the contrast of the gratings was reduced or increased adaptively, depending on whether or not the subject's response was correct. In this way a threshold estimate was calculated: the level of contrast at which motion direction identification was just possible.
(b) Coherence thresholds for global visual motion were measured with a random - dot pattern where a proportion of dots moved coherently, leftwards or rightwards, while the others were displayed at random.The ratio of coherent to randomly moving dots was varied from trial to home in on the threshold at which direction of motion was just detectable.

The gratings were generated in Matlab, using the Psychophysics Toolbox extensions[18,19] and presented on the screen for 400 ms (frame rate 100 Hz, mean luminance 30 cd/m^2). The contrast of the gratings was set initially to 30%, and then varied to home in on threshold using the adaptive QUEST algorithm[18,19]. Each session comprised 30 trials, and three sessions were run for each condition.

For the coherence thresholds, the stimuli comprised 100 small dots (each subtending 20' arc), half black and half white, generated by a C program running in DOS. A proportion of the dots were caused to drift leftwards or rightwards (20 deg/s), while the remainder of dots were displayed at random positions. Coherence thresholds (inverse of coherence sensitivity) were defined as the minimum proportion of coherently moving dots to produce 75% correct direction discrimination. Again, the stimulus was presented for 400 ms and coherence was varied from trial to trial by the QUEST algorithm, giving three separate estimates of threshold, each from 30 trials.

All stimuli were presented to subjects on a Sony Trinitron Multiscan E215 monitor and viewed from a distance of 60 cm within a dimly lit room. The final estimates of sensitivity for all conditions were calculated offline by fitting all data of a particular condition (90 trials) with cumulative Gaussian functions, and estimating the level of contrast or coherence to support 75% correct response.

Note that although the speed was matched for both types of stimuli (20 deg/s), the spatiotemporal characteristics were not identical: the stimuli for contrast sensitivity were narrow-band gratings, with a single spatial and temporal frequency (0.5 cycles/deg, 20 Hz), while the coherence stimuli were broadband random-dot patterns, with a range of temporal and spatial frequencies. The motivation for the choice of stimuli was that it was considered that narrow-band stimuli isolate better early motion mechanisms, whereas higher motion mechanisms have a broad range of spatial frequency selectivity[20].

Experimental design and statistical analysis

The study was double-blind, placebo-controlled, the order of dose assignment was counterbalanced and each experimental day was separated by at least 14 days. On each experimental day subjects were tested on all conditions prior to administration of psilocybin or placebo and then re-tested during the peak effect of the drug ~120 min after administration. In all sessions, subjects repeated the local and global motion discrimination tasks 3 times and the presentation order of these two tasks was sequentially alternated and counterbalanced. A repeated measures ANOVA was used to determine significance between the log sensitivity values for the respective drug conditions at pre-test and after 120 min for each of the two measures. In the case where significance was found, Tukey's *post-hoc* pair-wise comparisons were performed with $\alpha=0.05$.

Results

The geometric means for contrast and coherence sensitivity for pre-test and 120 min after drug intake, under both placebo (open bars) and psilocybin (grey bars) conditions are reported in Figure 2. With the contrast sensitivity for moving gratings, no significant time or drug effects were found ($F(1,8)=1.27$; p=NS). There was a slight reduction in average contrast sensitivity for the psilocybin condition at 120 min but the difference between this and the placebo condition was not statistically significant ($p=0.58$). However, the coherence sensitivities did show a significant effect of time and drug ($F(1,8)=7.39$; $p<0.05$). Subsequent post-hoc analysis revealed that the coherence sensitivity 120 min after psilocybin intake was significantly reduced from both the psilocybin pretest measure ($p=0.025$) and the corresponding 120 min placebo measure ($p=0.032$).

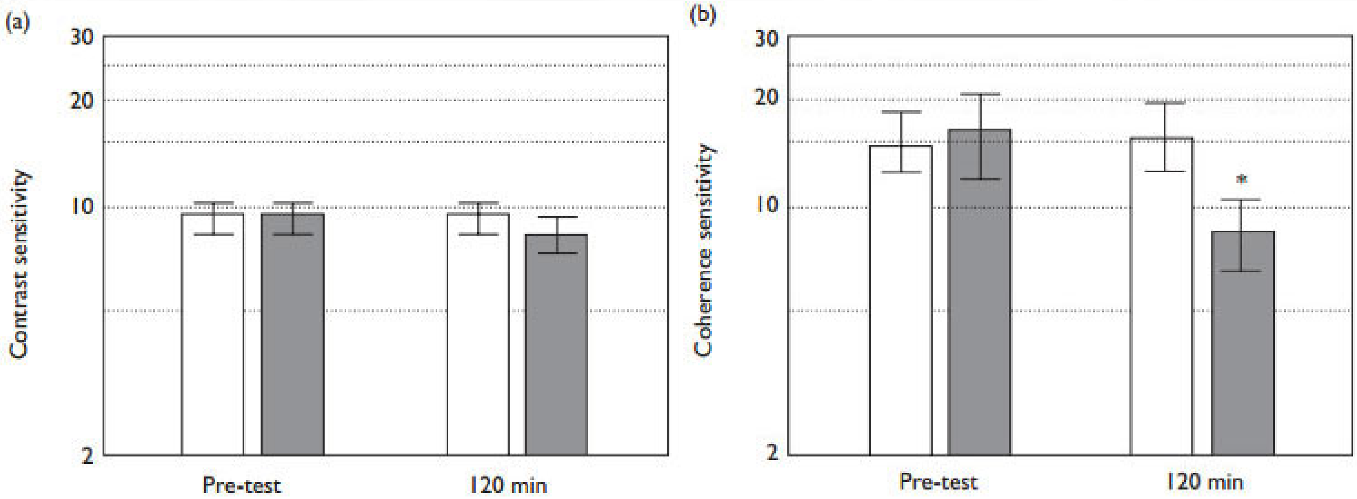


Fig. 2. Psilocybin administration was found to significantly reduce coherence but not contrast sensitivity. The two graphs illustrate the geometric mean for sensitivities at pre-test and peak state, tested 2 h after administration of either placebo (open bars) or psilocybin (grey bars), for (a) contrast and (b) coherence motion detection respectively. In the psilocybin condition, there is a significant reduction in global motion sensitivity in the 120 min peak condition compared with the pre-test level. No significant differences are observed in the placebo conditions. Error bars represent ± I s.e.; *$p<0.05$ level.

Figure 3 shows the individual results as a scatter plot, plotting the reduction in coherence sensitivity (ratio of placebo to psilocybin sensitivities) against the reduction in contrast sensitivities. While there is some scatter in the data, most points sit below the equality line (dashed), showing a greater effect for coherence than for contrast sensitivity. There was virtually no correlation (r^2=0.002) between the two estimates of sensitivity, consistent with the fact that one was affected and the other not.

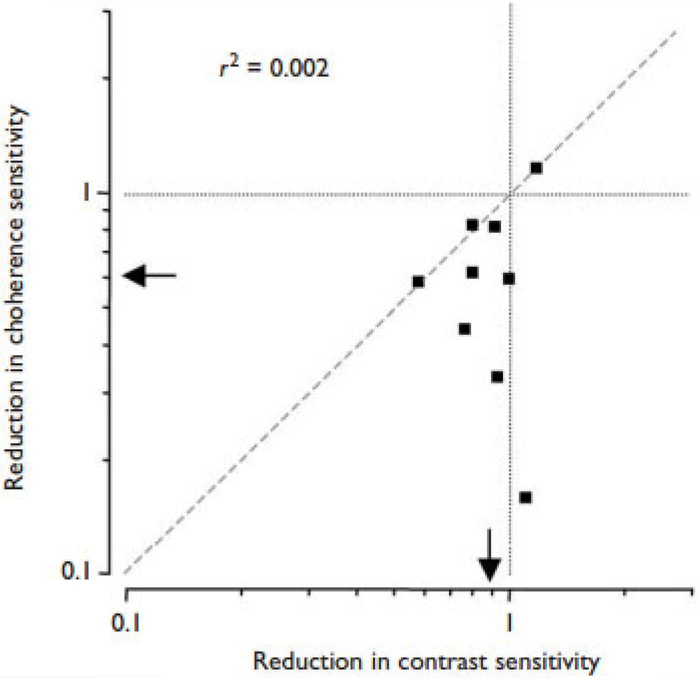


Fig. 3. Individual data showing reduction in relative sensitivity at the peak testing time for coherence sensitivity (ordinate) plotted against contrast sensitivity (abscissa). The estimates of sensitivity reduction were calculated as the ratio of placebo to psilocybin sensitivity in the 120 min peak condition. The arrows show the respective mean reduction in sensitivity. The vertical and horizontal dashed lines passing through unity correspond to no drug effect, while the diagonal line indicates equal effect for the two conditions. Most points pass below this line, indicating greater reduction of coherence than contrast sensitivities.

Discussion

Here we show that a 215 mg/kg dose of the 5-HT$_{1A\&2A}$ agonist psilocybin selectively impairs global motion, but not local motion processing in humans. Current evidence suggests that local motion discrimination is resolved at the level of V1[7,8], while the integration of local motion signals necessary for global motion discrimination is believed to be dependent on higher processing areas such as MT[8,12].

Consumption of psilocybin, in doses similar to those used in the current study, often results in visual and cognitive disturbances (for a detailed psychometric report see[1]). In this study subjects were encouraged to report their subjective impressions, prior to and after the experimentation. Some reported that surfaces appeared to pulsate in depth or acquire a texture comprising intricate dynamic patterns. Many reported that objects themselves were seen to sway or to protrude further into their surrounding space. Beyond a general warping of perspective, however, the gross spatial organisation of objects and their surrounds remained stable relative to the observer. For example, a plant situated in the corner of the room may appear to be dancing or growing towards the viewer and the room itself may shrink or expand but the room will not spin around the observer nor would the plant appear to hover in space or move to the other side of the room. Subjects reported that the computer keyboard and monitor generally remained stable while dynamic textures and patterns would sometimes be seen both within the background grey component of the display and the target stimulus. Some subjects also reported the stimulus to be flickering. All these reports are in general agreement with previous studies using similar doses[1].

Based on converging evidence it has been suggested that psilocybin-induced altered states of consciousness may provide a model through which to investigate clinical symptoms of psychosis such as those common to schizophrenia[5]. In support of this proposition, our results are in line with previous work showing that schizophrenic individuals are impaired in coherent but not local motion processing, compared to normal populations[14]. Given that psilocybin is known to show relative selectivity as an agonist at the 5-HT$_{1A\&2A}$ receptor sites, this result raises questions regarding the assertion that the motion perception deficits observed in schizophrenic patients are due to differential activation of the dopamine D2 receptor within this population[16]. As both neurotransmitter systems are commonly targeted in anti-psychotic medication, it is important that the relative influence of these transmitters is understood if optimal anti-psychotic medications are to be designed in the future.

In addition to the observed drug induced reduction in coherent motion sensitivity, the fact that psilocybin did not significantly affect local motion contrast sensitivity is a valuable result in itself. First, it shows that subjects were still capable of attending to the stimulus and accurately reporting their perception, whist under the influence of psilocybin. Second, because local motion discrimination is believed to be a relatively low-level process resolvable at the level of V1, the lack of effect on local motion thresholds indicates that the visual disturbances and hallucinations associated with this drug are unlikely to reflect changes either at the retinal level or in the transfer of information from the retina through the lateral geniculate nucleus (LGN) to primary visual cortex.

It is currently unclear to what degree psilocybin effects the vestibular system and this is an additional area that may be worth investigating in the future, particularly in light of a recent paper by Jeong *et al*. indicating that vestibular nuclei may be activated by the 5-HT2 receptors[21]. However, given that subjects had no trouble moving around their environment and the experimenter observed no evidence of nystagmus or any other systematic changes in eye movements, it seems unlikely that the illusions of motion described here result from vestibular dysfunction. Furthermore, the reported illusions of motion were confined to specific objects, not gross translations of the whole visual field, or sensations of self motion, as would be expected from disturbance of the vestibular system.

As a number of subjects commented that subjectively the global motion task became harder due to an increased salience of the randomly moving dots, one avenue for future research is the question of whether the coherent motion deficit induced by the psilocybin reflects a reduction in sensitivity to motion signals or reduced inhibition of the non-coherent motion signals. Further investigation of this distinction between reduced sensitivity to the motion signals of interest, as opposed to a reduction of inhibition of the noise (increasing the interference/distraction) caused by the non-coherent motion, is of particular relevance given the hypothesized role of sensorimotor gating deficits in schizophrenia[5].

Because the stimulus presentation time in the current study was 400 ms, an alternative explanation to be considered is that psilocybin causes a reduction in temporal integration. It has been shown that for local motion processing, performance improves linearly as stimulus presentation increases up until about 200 ms, whereas for global motion processing performance continues to improve with increased stimulus exposure durations of up to 3 s[22]. It is possible that psilocybin acts to reduce this limit in a similar way that it is known to vary with attentional load[23]. The issue of temporal integration is worthy of further investigation as it is of relevance to the observed motion processing deficits in clinical populations, as well as the psilocybin induced effects reported here.

To date, investigations into visual consciousness has focused on identifying the aspects of neural activity which correlate with perception, whilst little attention has been paid to understanding the integral role of the neurotransmitters in modulating this neural activity. This work illustrates that drugs that transiently alter an individual's visual perception may offer one means to explore the pharmacological processes underlying vision and redress this imbalance.

Acknowledgements

This investigation was financially supported by the Heffter Research Institute, Santa Fe, New Mexico, USA and a Stanley Foundation grant to J.D. Pettigrew.

References

1. Hasler F, Grimberg U, Benz MA, Huber T and Vollenweider FX. Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology 2004; 172:145-156.
2. McKenna DJ, Repke DB, Lo L and Peroutka SJ. Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. Neuro-pharmacology 1990; 29:193-198.
3. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, Vogel H and Hell D. Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 1998; 9:3897-3902.
4. Klosterkötter J, Hellmich M, Steinmeyer EM and Schultze-Lutter F. Diagnosing schizophrenia in the initial prodromal phase. Arch Gen Psychiatry 2001; 58:158-164.
5. Vollenweider FX and Geyer MA. A systems model of altered consciousness: integrating natural and drug-induced psychoses. Brain Res Bull 2001; 56:495-507.
6. Crick F and Koch C. Consciousness and Neuroscience. Cereb Cortex 1998; 8:97-107.
7. Boynton GM, Demb JB, Glover GH and Heeger DJ. Neuronal basis of contrast discrimination. Vision Res 1999; 39:257-269.
8. Morrone MC, Burr DC and Vaina L. Two stages of visual processing for radial and circular motion. Nature 1995; 376:507-509.
9. Movshon JA and Newsome WT. Visual response properties of striate cortical neurons projecting to area MT in macaque monkeys. J Neurosci 1996; 16:7733-7741.
10. Zeki SM. The response properties of cells in the middle temporal area (area MT) of owl monkey visual cortex. Proc Roy Soc Lond 1980; 207: 239-248.
11. Heeger DJ, Boynton GM, Demb JB, Seidemann E and Newsome WT. Motion opponency in visual cortex. J Neurosci 1999; 19:7162-7174.
12. Rees G, Friston K and Koch C. A direct quantitative relationship between the functional properties of human and macaque V5. Nature Neurosci 2000; 3:716-723.
13. Britten KH, Newsome WT, Shadlen MN, Celebrini S and Movshon JA. A relationship between behavioral choice and the visual responses of neurons in macaque MT. Vis Neurosci 1996; 13:87-100.
14. Chen Y, Nakayama K, Levy D, Matthysse S and Holzman P. Processing of global, but not local, motion direction is deficient in schizophrenia. Schizophr Res 2003; 61:215-227.
15. Nichols D. Hallucinogens. Pharmacol Ther 2004; 101:131-181.
16. Chen Y, Levy DL, Sheremata S, Nakayama K, Matthysse S et al. Effects of typical, atypical, and no antipsychotic drugs on visual contrast detection in schizophrenia. Am J Psychiatry 2003; 160:1795-1801.
17. Sheremata S and Chen Y. Co-administration of atypical antipsychotics and antidepressants disturbs contrast detection in schizophrenia. Schizophr Res 2004; in press.
18. Brainard DH. The Psychophysics Toolbox. Spat Vis 1997; 10:433-436.
19. Pelli DG. The VideoToolbox software for visual psychophysics: transforming numbers into movies. Spat Vis 1997; 10:437-442.
20. Yang Yand Blake R. Broad tuning for spatial frequency of neural mechanisms underlying visual perception of coherent motion. Nature 1994; 371:793-796.
21. Jeong HS, Lim YC, Kim TS, Heo T, Jung SM, Cho YB, Jun JY and Park JS. Excitatory effects of 5-hydroxytryptamine on the medial vestibular nuclear neuron via the 5-HT$_2$ receptor. Neuroreport 2003; 14:2001-2004.
22. Burr DC and Santoro L. Temporal integration of optic flow, measured by contrast and coherence thresholds. Vision Res 2001; 41:1891-1899.
23. Melcher D, Crespi S, Bruno A and Morrone C. The role of attention in central and peripheral motion integration. Vision Res 2004; 44:1367-1374.

Mismatch Negativity Predicts Psychotic Experiences Induced by NMDA Receptor Antagonist in Healthy Volunteers

by

Daniel Umbricht, Rene Koller, Franz X. Vollenweider, and Liselotte Schmid

© 2002 Society of Biological Psychiatry

original source: http://archive.beckleyfoundation.org/bib/doc/ah/2002/2002_umbricht_6013_1.pdf
backup source: http://www.psilosophy.info/resources/2002_umbricht_6013_1.pdf

From the Psychiatric University Hospital Zurich (DU, RK, LS), Department of Psychiatric Research; and the Psychiatric University Hospital Zurich (FXV), Zurich, Switzerland.
Address reprint requests to Dr. D. Umbricht, Psychiatric University Hospital Zurich, Research Department, P.O. Box 68, 8029 Zurich, Switzerland.
Received March 8, 2001; revised July 19, 2001; accepted July 27, 2001.

Table of Contents:

Introduction
Methods and Materials
Results
Discussion
References

Background: Previous studies indicate that mismatch negativity (MMN)-a preattentive auditory event-related potential (ERP)-depends on NMDA receptor (NMDAR) functioning. To explore if the strength of MMN generation reflects the functional condition of the NMDAR system in healthy volunteers, we analyzed correlations between MMN recorded before drug administration and subsequent responses to the NMDAR antagonist ketamine or the 5-HT$_{2A}$ agonist psilocybin.

Methods: In two separate studies, MMN was recorded to both frequency and duration deviants prior to administration of ketamine or psilocybin. Behavioral and subjective effects of ketamine and psilocybin were assessed with the Brief Psychiatric Rating Scale and the OAV Scale-a rating scale developed to measure altered states of consciousness. Correlations between ERP amplitudes (MMN, N1, and P2) and drug-induced effects were calculated in each study group and compared between them.

Results: Smaller MMN to both pitch and duration deviants was significantly correlated to stronger effects during ketamine, but not psilocybin administration. No significant correlations were observed for N1 and P2.

Conclusions: Smaller MMN indicates a NMDAR system that is more vulnerable to disruption by the NMDAR antagonist ketamine. MMN generation appears to index the functional state of NMDAR-mediated neurotransmission even in subjects who do not demonstrate any psychopathology.

Biol Psychiatry 2002;51:400–406 Biol Psychiatry 2002;51:400–406
2002 Society of Biological Psychiatry

Key Words: NMDA receptor, 5-HT$_{2A}$ receptor, mismatch negativity, psychosis, ketamine, psilocybin

Introduction

Mismatch negativity (MMN) is an auditory event-related potential (ERP) indexing preattentive detection of stimulus deviance (Näätänen 1995). It is automatically generated with a latency of 100 to 200 ms after the presentation of a stimulus that deviates in one of its physical dimensions (pitch, intensity, duration, location) from preceding frequently repeated standard stimuli (Näätänen 1995; Novak *et al*. 1990; Ritter *et al*. 1995). Mismatch negativity is thus the manifestation of a preattentive process that compares the deviant stimulus to the sensory memory trace of the standard stimulus (Näätänen 1990; Novak *et al*. 1990; Ritter *et al*. 1995).

Mismatch negativity-like activities can also be recorded in animals and thus are amenable to investigations of its underlying neurobiological substrate (Csépe *et al*. 1987; Javitt *et al*. 1994; Javitt *et al*. 1996). Studies in monkeys and cats show that MMN specifically involves activation of the supragranular layer of the primary and secondary auditory cortices (Karmos *et al*. 1998; Javitt *et al*. 1994; Javitt *et al*. 1996). It has been hypothesized that this activation involves excitation of pyramidal neurons as a net result of two processes: 1) reduction of tonic inhibition (disinhibition) due to stimulation by the standard tone, and 2) excitation of NMDA receptor (NMDAR) in response to the deviant stimulus (Schroeder *et al*. 1997; Karmos *et al*. personal communication; Javitt *et al*. 1996). NMDAR functions are uniquely sensitive to membrane potential (Cotman *et al*. 1995); thus, the magnitude of stimulation-induced current flow through NMDAR depends upon the degree of neuronal disinhibition. This property makes the NMDAR uniquely suited for mediating conditional responses such as MMN. Studies in monkeys have indeed demonstrated that intracortical and systemic application of NMDAR antagonists selectively abolishes MMN-like activities without affecting such sensory ERPs as N1 (Javitt *et al*. 1996; Javitt *et al*. 1994). In addition, we recently demonstrated that ketamine, a noncompetitive NMDAR antagonist, selectively impairs MMN generation in humans without reducing sensory ERPs (Umbricht *et al*. 2000). Furthermore, ketamine significantly reduced the magnetic counterpart of MMN, MMNm, in healthy volunteers (Sauer *et al*. 2000). The NMDAR antagonist nitrous oxide (N2O) (Jevtovic-Todorovic *et al*. 1998) has also been reported to induce a significant reduction of MMN (Pang *et al*. 1999). In contrast, the psychotomimetic psilocybin does not significantly affect MMN in healthy volunteers, although it reduces N1 (Umbricht *et al*. 2001).

Psilocybin (O-phosphoryl-4-hydroxy-*N*,*N*-dimethyltryptamine) - a naturally occurring indoleamine hallucinogen- is readily metabolized to psilocin after ingestion (Hasler *et al*. 1997). In rats, psilocin binds with high affinity to the 5-HT$_{2A}$ (Ki = 6.0 nM) and with moderate affinity to the 5-HT$_{1A}$ receptor (Ki = 190 nM) (McKenna *et al*. 1990). Although indoleamine hallucinogens bind to various subtypes of serotonin receptors, the hallucinogenic and cognitive effects are primarily believed to be mediated through agonist action at the 5-HT$_{2A}$ receptor (Aghajanian *et al*. 1999a, Vollenweider *et al*. 1998). Moreover, the affinity of indoleamine hallucinogens at the 5-HT$_{2A}$ receptor is highly correlated with their hallucinogenic potency in humans (Aghajanian *et al*. 1999a).

In summary, the available evidence strongly indicates a central role of the NMDAR in MMN generation. Thus, deficits in MMN generation as observed in such neuropsychiatric disorders as schizophrenia (Catts *et al*. 1995; Javitt *et al*. 1995; Umbricht *et al*. 1998) may be a manifestation of deficient NMDAR-dependent neurotransmission (Olney *et al*. 1995; Javitt *et al*. 1991).

Furthermore, these data suggest that even in non-patient subjects the strength of MMN generation may reflect the functional condition of NMDAR systems. To explore this hypothesis, we examined the correlations between MMN recorded prior to drug administration and psychosis-like experiences and behavioral effects induced by the subsequent administration of ketamine or the psychotomimetic psilocybin. Ketamine, and to a lesser extent psilocybin, can induce signs and symptoms in healthy volunteers that mimic some psychotic symptoms of schizophrenia (Krystal *et al*. 1994; Vollenweider *et al*. 1998). Thus, we hypothesized that if the strength of MMN indeed reflects the functional condition of the NMDAR system (i.e., its efficiency or redundancy), then the effects of ketamine should be more disruptive. (i.e., stronger in a subject with a smaller MMN at baseline). In other words, an inverse correlation between baseline MMN and ketamine-induced psychosis-like experiences should exist. On the other hand, such a correlation should not be observed between MMN and the effects of psilocybin.

To test this hypothesis, data from two separate studies on the effects of ketamine and psilocybin in healthy volunteers were analyzed. The main goal of both studies was to assess the effects of ketamine or psilocybin, respectively, on MMN generation. The results of these studies have been (Umbricht *et al*. 2000) or will be reported elsewhere (Umbricht unpublished). Here, we only report on the session with active drug administration (ketamine infusion or psilocybin administration, respectively).

Methods and Materials

Data from two separate studies of effects of ketamine and psilocybin in healthy volunteers (ketamine study: N = 20, M/F = 14/6, mean age = 24.6 ± 2.9 y; psilocybin study: N = 18, M/F = 10/8, mean age = 25.1 ± 4.3 y) were analyzed. The details of the methodology-identical in many aspects for both studies-have been published previously (Umbricht *et al*. 2000). Both studies had been approved by the ethics committee of the Psychiatric University Hospital Zurich. Briefly, prior to study entry, all subjects underwent a detailed screening to ensure the absence of any personal or family psychiatric history and signed informed consent after having been informed in detail about the study and the expected drug effects. Subjects underwent two sessions (placebo/active drug) in counterbalanced and randomized order in both studies. Ketamine was administered intravenously (a bolus dose of 0.24 mg/kg was given over 5 min, then a maintenance ketamine infusion at 0.9 mg/kg/hour was started after a pause of 5 min). Psilocybin was given po at a dose of 0.28 mg/kg. Here, were only report on aspects of the active drug session.

In each session, EEG recordings were acquired with a Neuroscan Scan system (Neuroscan Labs; Sterling Virginia) and obtained from 28 scalp locations, consisting of standard 10/20 placements plus right and left mastoid placements, along with right vertical and horizontal EOG electrodes. An electrode placed on the nose served as reference. Electrode impedance was kept below 5 kΩ. The sampling rate was 500 Hz.

Auditory stimuli consisted of 100 ms, 1000 Hz standard intermixed with 100 ms, 1500 Hz pitch deviants and 250 ms, 1000 Hz duration deviants. Stimuli were presented in a fixed order (nine standards, one pitch deviant, nine standards, one duration deviant) with stimulus onset asynchrony of 300 ms presented through foam insert earphones at a nominal intensity of 75 dB SPL. Rise/fall time was 5 ms for all stimuli. Stimuli were presented in four blocks with a total of 1517 stimuli. During presentation of the auditory test paradigm, subjects performed a visual AX-Continuous Performance Task.

For the analyses of the auditory ERPs, epochs with a 100-ms prestimulus baseline and a 500-ms poststimulus interval were constructed. After correction of horizontal eye movements and blinks, epochs with amplitudes that exceeded ± 75 µV at any electrode except the vertical eye leads were excluded from further averaging. Following artifact rejection, epochs were averaged offline for each subject and stimulus type and were digitally filtered with a low-pass filter of 15 Hz (24 dB down). Analyses focused on N1 and P2 to the standard stimuli and MMN generation to pitch and duration deviant stimuli as measured at electrode Fz. The N1 amplitude was measured as peak negativity within the 50 to 150 ms latency; P2 amplitude as peak positivity within the 150 to 250 ms latency. Mismatch negativity to pitch deviants was measured as peak negativity within the 100 to 225 ms latency window and MMN to duration deviants within the 200 to 300 ms range in the difference waveforms (deviant minus standard waveforms; see Figure 1). Waveforms were mathematically referenced to an average-mastoid reference prior to peak detection.

Drug-induced signs and symptoms were assessed both with an observer administered rating scale, the Brief Psychiatric Rating Scale (BPRS) (Overall *et al*. 1962), and with a self-rating scale (the OAV questionnaire [Dittrich 1998]). An anchored version of the BPRS with scale points of 1 to 7 was used (Woerner *et al*. 1988). For this analysis, the BPRS total score and the BPRS psychosis factor score (sum of the items "conceptual disorganization", "suspiciousness," "hallucinatory behavior," "unusual thought content") were used. Although the BPRS has been used previously (Krystal *et al*. 1994; Anand *et al*. 2000) to assess drug-induced psychotic symptoms in healthy volunteers, it was not developed and validated for that purpose and thus may not capture some of the more subtle effects induced by psychotomimetics. For this reason, we chose to use the OAV questionnaire as an additional assessment. The OAV questionnaire is a visual analog scale version of the APZ questionnaire that has been well validated as a tool to measure altered states of consciousness (Dittrich 1998; Bodmer *et al*. 1994). It contains three factor-analytically derived subscales: "Oceanic Boundlessness (OSE)" "Dread of Ego Dissolution (AIA)" and "Visionary Restructuralization (VUS)." "Oceanic Boundlessness" describes a positive state similar to mystic experiences. "Dread of Ego Dissolution" reflects an unpleasant state characterized by anxiety, feelings of being disconnected from the surroundings, and not in control of one's own thoughts. "Visionary Restructuralization" refers to illusionary experiences, ideas of reference, and changes in the meaning of things. Subjects were asked to fill out this questionnaire on the evening after each study session. All subjects in the ketamine study and 16 subjects in the psilocybin study returned completely filled out questionnaires after the active drug session. Statistical analyses were thus performed with the data from these subjects.

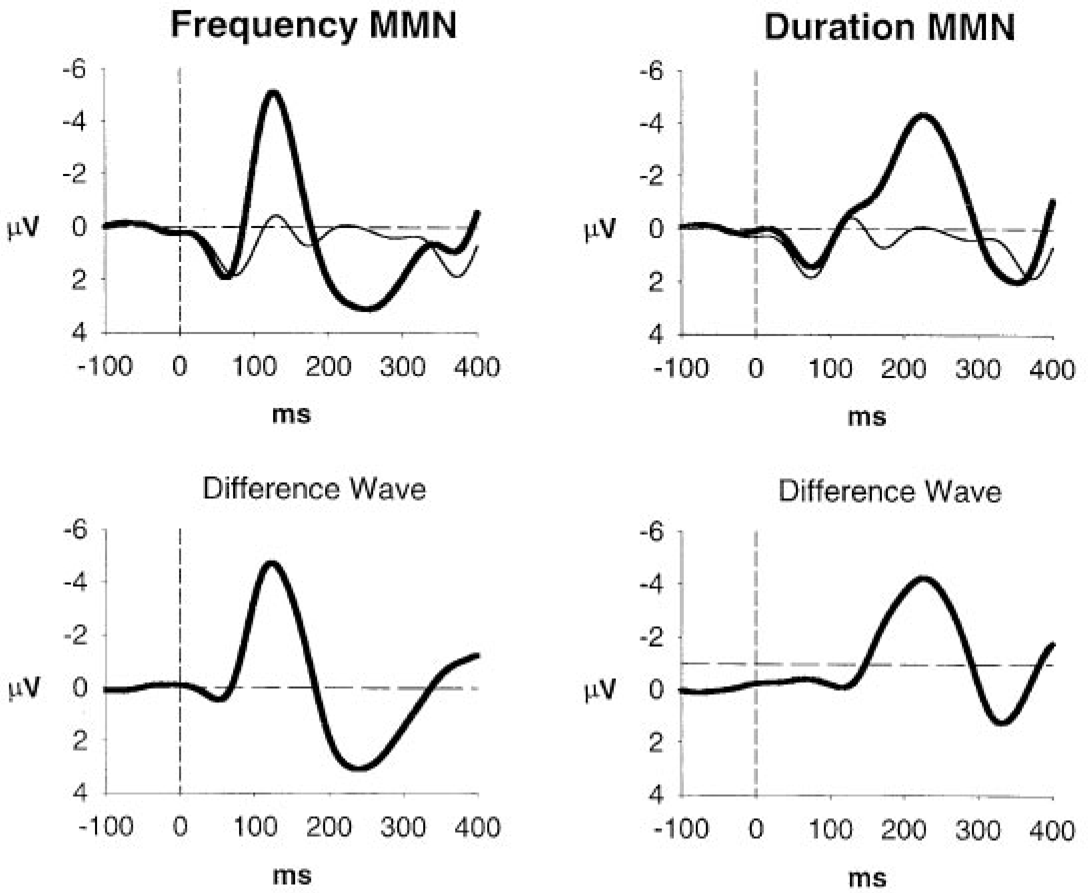


Figure 1. ERPs to standard stimuli (thin line, both panels upper row) and frequency deviants (thick line, left panel, upper row) and duration deviants (thick line, right panel, upper row). Difference waves (ERP to deviant stimuli minus ERP to standard stimuli) are presented in the lower row (left panel: frequency deviant condition; right panel: duration deviant condition). MMN amplitudes were measured in these differences waves.

Pearson product correlations were calculated between ERP measures (amplitudes of N1, P2, mean MMN, and MMN to frequency and duration deviants individually) and the behavioral measures (BPRS total score, BPRS psychosis factor score, OAV total score and its three factors) separately for the ketamine and the psilocybin study. Correlations were compared between groups using ANOVAs with the behavioral measures as dependent variable, group membership (drug) coded as dummy variable, and the ERP measure as covariate. Alpha levels of .05 were considered significant.

Results

Both ketamine and psilocybin administration induced robust behavioral effects as evidenced in significant increases of the BPRS total and the BPRS psychosis factor scores and strong subjective effects as rated on the OAV questionnaire (see Table 1). The increase of the BPRS total and psychosis factor score was greater during ketamine than psilocybin administration. The difference of the BPRS psychosis factor score was significant (t = 3.15, df = 35, $p < .05$). However, the subjectively rated effects of ketamine and psilocybin as assessed by the OAV scale and its three factors were not significantly different (see Table 1).

The peak amplitudes and latencies of N1, P2, and MMN to pitch and duration deviants prior to drug administration did not differ between subjects in the ketamine study and those in the psilocybin study (see Table 2). In the ketamine study, the mean MMN amplitude prior to drug administration correlated significantly with the BPRS total score, the OAV total score, and its three factor scores (see Table 3). Subjects with smaller amplitudes experienced stronger effects during ketamine administration. Examining MMN to frequency and duration deviants separately, we observed significant correlations between MMN to duration deviants and OAV total score and its three factors (see Table 3 and Figure 2). The correlation with the BPRS total score did not reach significance. Similarly, the correlations between MMN to frequency deviants and OAV total scores and the OSE and VUS factors were significant, while the correlation with the BPRS total score dropped below significance level. In contrast, in the psilocybin study, no significant correlations between mean MMN or separate MMNs and any of the behavioral measures were observed; however, only the correlation between mean MMN and total OAV score was significantly greater in the ketamine than the psilocybin group (see Table 3).

Table 1. OAV and BPRS Scores during Ketamine and Psilocybin Administration.

	Ketamine		Psilocybin		
	Mean ± SD	Range	Mean ± SD	Range	Significance
TOTAL OAV SCORE	2257 ± 947	1006 to 4282	2126 ± 1141	60 to 3836	t=0.38, df=34. p=0.7
OSE SCORE	938 ± 511	94 to 2125	880 ± 583	0 to 1812	t=0.32, df=34, p=0.8
AIA SCORE	645 ± 408	71 to 1502	543 ± 523	1 to 1475	t=0.66, df=84, p=0.5
VUS SCORE	673 ± 292	182 to 1177	703 ± 361	58 to 1201	t=0.27, df=34, p=0.8
BPRS TOTAL SCORE	31.5 ± 7.9[a]	20 to 52	27.5 ± 9.0[a]	18 to 53	t=1.80, df=85, p=0.08
BPRS PSYCHOSIS FACTOR SCORE	9.2 ± 2.8[b]	4 to 13	6.5 ± 2.5[b]	4 to 15	t=3.15, df=35, p<0.05

BPRS - Brief Psychiatric Rating Scale
OSE - Oceanic Boundlessness
AIA - Dread of Ego Dissolution
VUS - Visionary Restructuralization
[a] Minimum = 18
[b] Minimum = 4

Table 2. Mean Peak Amplitudes and Latencies of MMN, N1, and P2 at Electrode Fz

		Ketamine Study		Psilocybin Study		Significance	
		Peak Amplitude	Peak Latency	Peak Amplitude	Peak Latency	Amplitude[a]	Latency[a]
MMN	Pitch Deviant	-5.4 ± 2.02	126 ± 15	-5.1 ± 3.3	129 ± 16	t=-0.46, p=0.6	t=0.52, p=0.6
	Duration Deviant	-4.3 ± 1.9	228 ± 20	-4.6 ± 2.4	227 ± 20	t=0.49, p=0.6	t=0.11, p=0.9
N1		-0.6 ± 0.9	129 ± 20	-0.6 ± 0.8	133 ± 9	t=0.14, p=0.9	t=0.73, p=0.5
P2		0.8 ± 0.5	177 ± 21	0.9 ± 0.9	181 ± 21	t=0.51, p=0.6	t=0.64, p=0.5

Amplitudes ± SD w µV
Latencies ± SD w ms
MMN - mismatch negativity
[a] df = 36

Table 3. Correlations of MMN Amplitudes Recorded Prior to Drug Administration and Drug-Induced Effects

	Mean MMN			Pitch MMN			Duration MMN		
	r	*F*[a]	Sig	*r*	*F*[a]	Sig	*r*	*F*[a]	Sig
TOTAL OAV SCORE		4.06	0.5		2.51	0.12		1.26	0.27
Ketamine Infusion	0.74[b]			0.63[c]			0.64[c]		
Psilocybin Administration	0.37			0.33			0.38		
AIA SCORE		0.77	0.39		0.10	0.76		0.77	0.39
Ketamine Infusion	0.45[d]			0.27			0.52[d]		
Psilocybin Administration	0.24			0.22			0.24		
OSE SCORE		3.84	0.06		4.12	0.05		0.75	0.39
Ketamine Infusion	0.65[c]			0.65[c]			0.45[e]		
Psilocybin Administration	0.27			0.26			0.39		
VUS SCORE		2.09	0.16		1.39	0.25		0.38	0.54
Ketamine Infusion	0.63[c]			0.53[d]			0.58[c]		
Psilocybin Administration	0.38			0.30			0.44		
BPRS TOTAL SCORE		0.68	0.42		0.26	0.62		0.15	0.69
Ketamine Infusion	0.48[d]			0.41[e]			0.39[e]		
Psilocybin Administration	0.38			0.38			0.33		
BPRS PSYCHOSIS FACTOR		0.37	0.55		0.18	0.68		0.05	0.83
Ketamine Infusion	0.35			0.34			0.26		
Psilocybin Administration	0.38			0.42[e]			0.29		

The F values and significance levels are given for the interaction of drug ERP measure in an univariate ANOVA with the behavioral measure as dependent variable, group membership (drug) as the independent factor and the ERP measure as covariate. A significant value for the interaction indicates that the correlations are significantly different in the two groups.

MMN - Mismatch negativity
AIA - Dread of Ego Dissolution
OSE - Oceanic Boundlessness
VUS - Visionary Restructuralization
BPRS - Brief Psychiatric Rating Scal

[a] $df = 1.30$
[b] $p < 0.001$ (2-tailed)
[c] $p < 0.005$ (2-tailed)
[d] $p < 0.05$ (2-tailed)
[e] $p < 0.1$ (2-tailed)

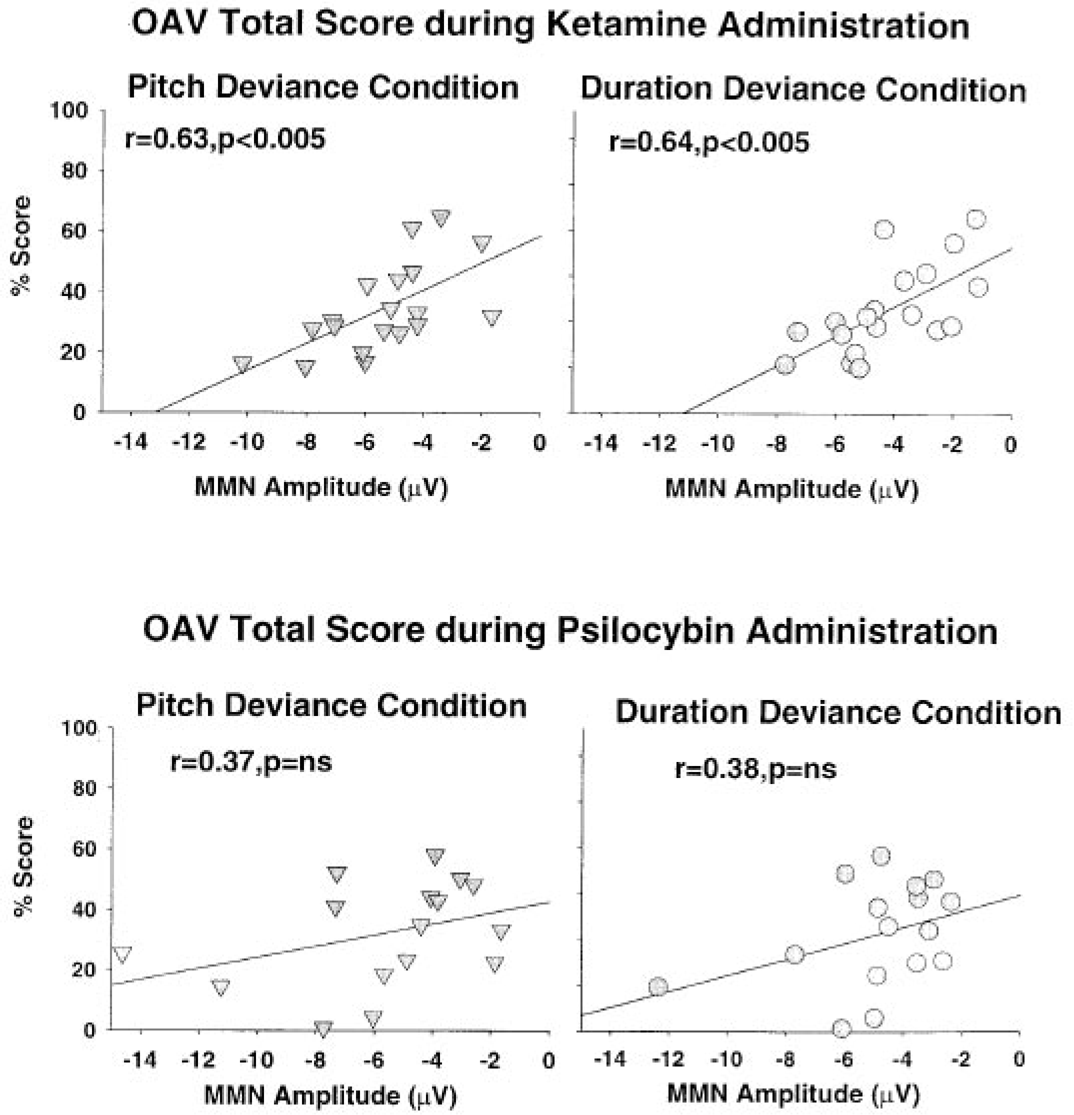


Figure 2. Scatterplot of MMN to pitch or duration deviants prior to drug administration and subjective experiences during ketamine (upper panel) or psilocybin administration (lower panel) as assessed by the OAV self-questionnaire. The OAV rating is expressed as percentage of the maximum points possible.

Peak amplitudes of neither N1 or P2 were significantly correlated with any behavioral measure both in the ketamine and the psilocybin studies.

Discussion

Previous studies have demonstrated that the auditory event-related potential MMN is significantly reduced or abolished by NMDAR antagonists in humans and nonhuman primates, indicating a role of the NMDAR in its generation (Umbricht *et al*. 2000; Javitt *et al*. 1996; Sauer *et al*. 2000; Pang *et al*. 1999). We recently reported that ketamine significantly reduced MMN in healthy volunteers (Umbricht *et al*. 2000). In this additional study, we explored the hypothesis that MMN in these healthy volunteers - recorded prior to drug administration - should therefore correlate with psychosis-like behavioral effects and experiences induced by subsequent administration of the NMDAR antagonist ketamine. Indeed, we found strong correlations between the magnitude of MMN in a baseline condition and subjectively rated ketamine-induced effects, whereas the clinician-rated effects showed weaker correlations albeit in the right direction. In contrast, in the psilocybin study, none of the corresponding correlations reached significance. Furthermore, significant correlations were only observed with MMN amplitudes, but not between the effects of ketamine and the amplitudes of the sensory ERPs N1 and P2 (i.e., with those ERPs that are thought to depend less on NMDAR functioning, and indeed are not diminished by NMDAR blockade in humans) (Umbricht *et al*. 2000). Thus, our findings lend some support to our hypothesis that the strength of MMN generation as expressed in its amplitude reflects the resilience of the NMDA system to perturbation by an acute administration of NMDAR antagonists. It has been previously demonstrated that the relative affinity of (S)- and (R)-ketamine enantiomeres at the NMDAR complex correlates with the degree of psychosis-like experiences (Oye *et al*. 1992; Vollenweider *et al*. 1997). The magnitude of pharmacologically induced deficits in NMDAR-dependent functions is therefore reflected in the magnitude of psychosis-like symptoms. Conversely, stronger psychosis-like effects at the same dose of NMDAR antagonist are likely reflecting a greater disruption in NMDAR-dependent neurotransmission. Given the correlation of MMN with the psychosis-like effects of ketamine, MMN- recorded in a normal state of consciousness-can thus be regarded as an in vivo indicator for the vulnerability to disruption of NMDAR-dependent systems. Thus, MMN provides some information about the functional "condition" of NMDAR-mediated neurotransmission: a smaller MMN indicates a less resilient or less redundant NMDAR system; such a system is also more perturbed by NMDAR antagonist given at comparable doses. The fact, however, that similar, albeit weaker, correlations were observed in the psilocybin study that-with the exception of the correlation between mean MMN and total OAV-were not significantly different from the corresponding correlations in the ketamine study indicates that a smaller MMN may also manifest a general vulnerability to the effects of psychotomimetics. Interestingly, both NMDAR antagonists and 5-HT$_{2A}$ receptor agonists induce excessive glutamate release, thus sharing a final common pathway that has been suggested to account for their overlapping cognitive and psychotomimetic effects (Aghajanian *et al*. 2000; Aghajanian *et al*. 1999b; Moghaddam *et al*. 1997; Moghaddam *et al*. 1998). In addition, both NMDAR antagonists and 5-HT$_{2A}$ agonists lead to excessive dopamine release in humans (Kegeles *et al*. 2000; Breier *et al*. 1998; Vollenweider *et al*. 2000; Vollenweider *et al*. 1999). In other words, both compounds appear to induce abnormalities in the dynamics of these neurotransmitter systems. It is conceivable, but speculative, that the functional state of the NMDARs may modulate the effects of 5-HT$_{2A}$ agonists on glutamate and dopamine release. In such a scenario, the magnitude of MMN as an indirect expression of NMDAR functioning would be expected to show some correlation with 5-HT$_{2A}$ agonist-induced effects. The results of our study are consistent with such a view.

We used the analog scale version of the APZ questionnaire (Dittrich 1998; Bodmer *et al*. 1994) to assess the drug-induced subjective effects. While less known than the BPRS, this scale was specifically developed and validated to measure drug-induced states of altered consciousness in healthy subjects; however, in a recent study, schizophrenic patients rated the OAV questionnaire as a moderate to very good instrument for the assessment of their psychotic experiences (Gouzoulis-Mayfrank *et al*. 1998). Furthermore, a principal component analysis revealed a similar three-factor structure in schizophrenic patients as in altered states of consciousness in healthy volunteers, supporting the observation that symptoms induced by psychotomimetics in healthy subjects resemble psychotic symptoms of schizophrenia. In addition, the total OAV score was found to correlate significantly with the score on the BPRS thought disorder factor. Thus, these findings strongly suggest that subjectively rated drug-induced effects in healthy volunteers are similar to genuine psychotic experience. The use of this self-rating scale permits to capture drug effect in a detailed way that does not always seem possible with the BPRS that focuses on some key psychotic symptoms, but may fail to assess more subtle effects, particularly in subjects who become completely withdrawn and mute. This may explain why the correlations of MMN and BPRS scores were weaker in our study.

This study has several limitations. We did not obtain blood levels of ketamine and psilocin, the main active metabolite of psilocybin. Even though we used the same dose per kilogram body weight for each person, it is conceivable that the actual concentration of ketamine and psilocybin and their psychoactive metabolites at the receptor differed between subjects, thus accounting for the differently strong subjective effects. Yet, since MMN was recorded prior to drug administration, such a possibility can hardly explain our findings unless one postulates rather implausible correlations between strength of MMN generation and factors influencing the metabolism of ketamine and psilocin or their transfer through the blood brain barrier. Secondly, the number of subjects available for analysis of the subjectively rated effects was lower in the psilocybin study, thus reducing the power to find significant correlations in this group. Thirdly, we performed multiple correlational analyses, thus inflating the probability of type-I errors; however, the overall pattern of significant correlations (only between MMN and behavioral effects and only in the ketamine study) would argue against our results being a chance finding.

In conclusion, the results of our study suggest that MMN in a normal state of consciousness is an indicator for the vulnerability to disruption of NMDAR-dependent systems in healthy volunteers. Smaller MMN manifested a state that was more vulnerable to disruption and, thus, functionally closer to a deficient NMDAR system. MMN generation appears to index the functional state of NMDAR-mediated neurotransmission, even in subjects who do not demonstrate any psychopathology. MMN may thus become a useful tool in studies on

NMDAR functioning in humans.

Supported by grants from the Swiss National Science Foundation to Dr. Umbricht (SNF 32-050957.97) and to Dr. Vollenweider (SNF 3200- 040900.94), and the Heffter Research Institute (USA).

References

1. Aghajanian GK, Marek GJ (1999a): Serotonin and hallucinogens. *Neuropsychopharmacol* 21:16S-23S.
2. Aghajanian GK, Marek GJ (1999b): Serotonin, via 5-HT2A receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release. *Brain Res* 825:161-171.
3. Aghajanian GK, Marek GJ (2000): Serotonin model of schizophrenia: emerging role of glutamate mechanisms. *Brain Res Brain Res Rev* 31:302-312.
4. Anand A, Charney DS, Oren DA, et al (2000): Attenuation of the neuropsychiatric effects of ketamine with lamotrigine: support for hyperglutamatergic effects of N-methyl-D-aspartate receptor antagonists. *Arch Gen Psychiatry* 57:270-276.
5. Bodmer I, Lamparter D, Dittrich A (1994): Aussergewöhnliche Bewusstseinszustände -ihre gemeinsame Struktur und Messung. In: Dittrich A, Hofmann H, Leuner H, editors. *Welten des Bewusstsein, Vol 3: Experimentelle Psychologie, Neurobiologie und Chemie*. Berlin: Verlag für Wissenschaft und Bildung, pp 45-58.
6. Breier A, Adler CM, Weisenfeld N, Su TP, Elman I, Picken L et al (1998): Effects of NMDA antagonism on striatal dopamine release in healthy subjects: application of a novel PET approach. *Synapse*29:142-147.
7. Catts SV, Shelley AM, Ward PB, Liebert B, McConaghy N, Andrews S et al (1995): Brain potential evidence for an auditory sensory memory deficit in schizophrenia. *Am J Psychiatry*152:213-219.
8. Cotman CW, Kahle JS, Miller SE, Ulas J, Bridges RJ (1995): Excitatory Amino Acid Neurotransmission. In: Bloom FE, Kupfer DJ, editors. *Psychopharmacology: The Fourth Generation of Progress*.New York: Raven Press, pp 75-85.
9. Csépe V, Karmos G, Molnar M (1987): Effects of signal probability on sensory evoked potentials in cats. *Inter J Neurosci* 33:61-71.
10. Dittrich A (1998): The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. [Review] [17 refs]. *Pharmacopsychiatry*31 (suppl 2):80-84.
11. Gouzoulis-Mayfrank E, Habermeyer E, Hermle L, Steinmeyer AM, Kunert HJ, Sass H (1998): Psychedelic-like phenomena are common features of acute endogenous psychotic states: results of an empirical study. *Eur Psychiatry* 13:399-406.
12. Hasler F, Bourquin D, Brenneisen R, Bar T, Vollenweider FX (1997): Determination of psilocin and 4-hydroxyindole-3 acetic acid in plasma by HPLC-ECD and pharmacokinetic profiles of oral and intravenous psilocybin in man. *Pharmaceutica Acta Helvetiae* 72:175-184.
13. Javitt DC, Doneshka P, Grochowski S, Ritter W (1995): Impaired mismatch negativity generation reflects widespread dysfunction of working memory in schizophrenia. *Arch Gen Psychiatry* 52:550-558.
14. Javitt DC, Steinschneider M, Schroeder CE, Arezzo JC (1996): Role of cortical N-methyl-D-aspartate receptors in auditory sensory memory and mismatch negativity generation: implications for schizophrenia. *Proc Natl Acad Sci USA* 93:11962-11967.
15. Javitt DC, Steinschneider M, Schroeder CE, Vaughan HG, Arezzo JC (1994): Detection of stimulus deviance within primate primary auditory cortex: intracortical mechanisms of mismatch negativity (MMN) generation. *Brain Res*667:192-200.
16. Javitt DC, Zukin SR (1991): Recent advances in the phencyclidine model of schizophrenia. *Am J Psychiatry* 148:1301-1308.
17. Jevtovic-Todorovic V, Todorovic SM, Mennerick S, Powell S, Dikranian K, Benshoff N, et al (1998): Nitrous oxide (laughing gas) is an NMDA antagonist, neuroprotectant and neurotoxin. *Nature Med* 4:460-463.
18. Kegeles LS, Abi-Dargham A, Zea-Ponce Y, Rodenhiser-Hill J, Mann JJ, Van Heertum RL, et al (2000): Modulation of amphetamine-induced striatal dopamine release by ketamine in humans: implications for schizophrenia. *Biol Psychiatry* 48:627-640.
19. Krystal JH, Karper LP, Seibyl JP, Freeman GK, Delaney R, Bremner JD, et al (1994): Subanesthetic effects of the noncompetitive NMDA antagonist, ketamine, in humans. Psychotomimetic, perceptual, cognitive, and neuroendocrine responses. *Arch Gen Psychiatry* 51:199-214.
20. McKenna DJ, Repke DB, Lo L, Peroutka SJ (1990): Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. *Neuropharmacol* 29:193-198.
21. Moghaddam B, Adams B, Verma A, Daly D (1997): Activation of glutamatergic neurotransmission by ketamine: a novel step in the pathway from NMDA receptor blockade to dopaminergic and cognitive disruptions associated with the prefrontal cortex. *J Pharmacol Exp Ther* 17:2921-2927.
22. Moghaddam B, Adams BW (1998): Reversal of phencyclidine effects by a group II metabotropic glutamate receptor agonist in rats. *Science* 281:1349-1352.
23. Näätänen R (1990): The role of attention in auditory information processing as revealed by event-related potentials and other brain measures of cognitive function. *Behavi Brain Sci*13:201-288.
24. Näätänen R (1995): The mismatch negativity: a powerful tool for cognitive neuroscience. *Ear Hear*16:6-18.
25. Novak GP, Ritter W, Vaughan HG, Wiznitzer ML (1990): Differentiation of negative event-related potentials in an auditory discrimination task. *Electroencephalogr Clin Neurophysiol* 75:255-275.
26. Olney JW, Farber NB (1995): Glutamate receptor dysfunction and schizophrenia. *Arch Gen Psychiatry* 52:998-1007.
27. Overall JE, Gorham DR (1962): Brief psychiatric rating scale. *Psychol Rep* 10:799-812.
28. Oye I, Paulsen O, Maurset A (1992): Effects of ketamine on sensory perception: evidence for a role of N-methyl-Daspartate receptors. *J Pharma & Exp Therap* 260:1209-1213.
29. Pang EW, Fowler B (1999): Dissociation of the mismatch negativity and processing negativity attentional waveforms with nitrous oxide. *Psychophysiol* 36:552-558.

30. Ritter W, Deacon D, Gomes H, Javitt DC, Vaughan HG, Jr. (1995): The mismatch negativity of event-related potentials as a probe of transient auditory memory: a review. *Ear Hear* 16:52-67.
31. Sauer H, Kreitschmann-Andermahr I, Gaser E, Nowak H, Demme U, Rosburg T (2000): Ketamine reduces the neuromagnetic mismatch reaction. *Schizophr Res* 41:148.
32. Schroeder CE, Javitt DC, Steinschneider M, Mehta AD, Givre SJ, Vaughan et al (1997): N-methyl-D-aspartate enhancement of phasic responses in primate neocortex. *Exp Brain Res* 114:271-278.
33. Umbricht D, Javitt DC, Novak GP, Bates JA, Pollack S, Lieberman J et al (1998): Effects of clozapine on auditory event-related potentials in schizophrenia. *Biol Psychiatry* 44:716-725.
34. Umbricht D, Schmid L, Koller R, Vollenweider FX, Hell D, Javitt DC (2000): Ketamine-induced deficits in auditory and visual context-dependent processing in healthy volunteers: implications for models of cognitive deficits in schizophrenia. *Arch Gen Psychiatry* 57:1139-1147.
35. Vollenweider FX, Leenders KL, Oye I, Hell D, Angst J (1997): Differential psychopathology and patterns of cerebral glucose utilisation produced by (S)-and (R)-ketamine in healthy volunteers using positron emission tomography (PET). *European Neuropsychopharmacol* 7:25-38.
36. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, Vogel H, Hell (1998): Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9:3897-3902.
37. Vollenweider FX, Vontobel P, Hell D, Leenders KL (1999): 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man -a pet study with $[^{11}C]$raclopride. *Neuropsychopharmacology* 20:424-433.
38. Vollenweider FX, Vontobel P, Oye I, Hell D, Leenders KL (2000): Effects of (S)-ketamine on striatal dopamine: a $[^{11}C]$raclopride PET study of a model psychosis in humans. *J Psychiatr Res* 34:35-43.
39. Woerner MG, Manuzza S, Kane JM (1988): Anchoring the Brief Psychiatric Rating Scale; an aid to improve reliability. *Psychopharmacol Bull* 24:112-117.

Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action

by

Franz X. Vollenweider,[CA] Margreet F. I. Vollenweider-Scherpenhuyzen, Andreas Bäbler, Helen Vogel and Daniel Hell

© 1998 Lippin-cott Williams & Wilkins

original source: http://chemistry.mdma.ch/hiveboard/rhodium/pdf/psilopsychosis.pdf
backup source: http://www.psilosophy.info/resources/psilopsychosis.pdf

[CA]Corresponding Author

Research Department, Psychiatric University
Hospital Zürich, Box 68, CH-8029 Zürich;
Department of Anesthesiology, University
Hospital of Zürich, Zürich, Switzerland

Table of Contents:

- Introduction
- Materials and Methods
  - *Experiment 1*
  - *Experiment 2*
- Results
- Discussion
- Conclusion
- Acknowledgements
- References

PSILOCYBIN, an indoleamine hallucinogen, produces a psychosis-like syndrome in humans that resembles first episodes of schizophrenia. In healthy human volunteers, the psychotomimetic effects of psilocybin were blocked dose-dependently by the serotonin-2A antagonist ketanserin or the atypical antipsychotic risperidone, but were increased by the dopamine antagonist and typical antipsychotic haloperidol. These data are consistent with animal studies and provide the first evidence in humans that psilocybin-induced psychosis is due to serotonin-2A receptor activation, independently of dopamine stimulation. Thus, serotonin-2A overactivity may be involved in the pathophysiology of schizophrenia and serotonin- 2A antagonism may contribute to therapeutic effects of antipsychotics. *NeuroReport* 9: 3897-3902

Keywords: Haloperidol; 5-HT$_{2A}$ receptor; Human; Ketanserin; Model psychosis; Psilocybin; Psychopathology; Risperidone; Schizophrenia; Visual-manual delayed response task

Introduction

The dopamine (DA) hypothesis of schizophrenia has emphasized that a dopaminergic dysbalance is critical in the pathophysiology and treatment of schizophrenia. Increasing evidence, however, suggests that serotonin (5-HT) may also be implicated. Support for an involvement of the serotonin system stems from observations that schizophrenia patients show alterations in cortical serotonin receptor binding; novel atypical antipsychotics have potent antagonistic action at 5-HT$_2$ receptors; and classic indoleamine hallucinogens, which interfere with the serotonin system, can elicit schizophrenia-like symptoms in humans (for a review see Ref. 1).

Psilocybin (O-phosphoryl-4-hydroxy-*N*,*N*-dimethyltryptamine) in particular, a natural indoleamine hallucinogen, has been reported in extensive studies to produce a clinical syndrome that resembles in certain respects the first manifestation of schizophrenic decompensation[1,2] Ego-disorders,[2,3] affective changes,[2] loosened associations4 and perceptual alterations are especially common features of psilocybin-induced and early acute schizophrenic stages.[1,2,5,6] Similar findings have also been reported for the structurally related indoleamine hallucinogen lysergic acid diethylamide (LSD), when the comparison involved early, as opposed to chronic, schizophrenics.[7] Consistent with this suggested clinical similarity, we recently found that psilocybin in normal subjects produced a marked prefrontal activation associated with ego- and thought disorder[3] comparable to that seen in acutely ill unmedicated or first episode schizophrenics.[8]

After ingestion, psilocybin is immediately dephosphorylated to psilocin (4-hydroxy-*N,N*-dimethyltryptamine), [9] which is closely related in chemical structure to serotonin (5-hydroxytryptamine, 5-HT). Psilocybin and LSD also share similarities in psychological effects in humans and in neurochemical actions in animals with phenalkylamine hallucinogens, such as 2,5-dimethoxy-4-iodoamphetamine (DOI.[10] Both indole and phenalkylamine hallucinogens bind primarily to 5-HT$_1$, 5-HT$_2$, 5-HT$_5$, and 5-HT$_7$ receptors.[11] The common effects of these hallucinogens may be mediated by agonist actions at 5-HT$_2$ receptors,[12] since the potency of hallucinogens in humans correlates well with 5-HT$_2$ receptor binding affinity in animals,[13] and the behavioral[14] and electrophysiological[15] effects of hallucinogens in animals can be blocked by 5-HT$_2$ antagonists. Although these animal data suggest a contribution of the 5-HT$_2$ receptor system in hallucinogenic drug action, there are, however, some difficulties with interpreting the mechanism of action of these drugs. First, data from animal studies are difficult to extrapolate to humans, so animal models of hallucinogenic drug action may not reliably predict hallucinogenic properties in humans. Second, LSD has also been reported to stimulate dopamine receptors, suggesting a possible involvement of dopamine in LSD psychosis.[16] Third, psilocybin, although it displays no activity at dopamine receptors,[16] might well modulate the dopamine systems through interactions of central serotonin and dopamine systems.[10] Thus, it remains unclear whether psilocybin and LSD mediate their psychological effects in humans via 5- HT$_2$ receptor stimulation alone or a subsequent activation of the dopamine systems, or both. Given the suggested importance of 5-HT$_2$ receptors in schizophrenia and mechanism of action in antipsychotics, it is important to further investigate the role of 5-HT$_2$ receptors in psychotic symptom formation.

To test the hypotheses that 5-HT$_2$ and/or DA D2 receptors contribute to psychological effects of indoleamine hallucinogens in humans, we studied the influence of pretreatment with the 5-HT$_2$ antagonist ketanserin,[17] the D2 antagonist and typical antipsychotic haloperidol,[18] or the mixed 5-HT$_{2/D2}$ antagonist and atypical antipsychotic risperidone[18] on the psychotomimetic effects of psilocybin in normal subjects, using a placebo-controlled, within-subject design. The Altered State of Consciousness rating scale (APZ-OAV) was used to assess the psilocybin-induced clinical syndrome because it validly measures changes from the normal waking state independently of the etiology of those changes.[19] In addition, based on our previous metabolic findings in psilocybin subjects,[3] we have hypothesized that psilocybin may lead to working memory deficits as seen in schizophrenic patients.[20] A visual-manual delayed response task (DRT) was used to measure possible drug-induced alterations in reaction times indicative of spatial working memory deficits.[20]

Materials and Methods

The study was approved by the Ethics Committee of the Psychiatric University Hospital Zürich and the use of psilocybin by the Swiss Federal Health Office (BAG), Department of Pharmacology and Narcotics (DPN), Bern. Psilocybin was obtained from the BAG (DPN), Bern, and prepared as capsules (1 and 5 mg) at the Pharmaceutical Institute of the University of Bern, Switzerland.

Twenty-five healthy volunteers were recruited from university staff and screened by psychiatric interview to assure that they had neither personal nor family histories of major psychiatric disorders in first-degree relatives. Subjects with a history of illicit drug abuse were excluded from the study. Subjects were healthy according to physical examination, electrocardiogram, and blood analyses. All subjects gave written informed consent. The psilocybin dose used was high enough (0.25 mg/kg, p.o.) to induce robust psychological alterations over a period of 120-180 min.[3] The doses of haloperidol (0.021 mg/kg, i.v.) and risperidone (1 mg, p.o.) chosen were expected to occupy about 55-65% of dopamine D2 receptors.[21,22]

Experiment 1

Fifteen subjects (eight male, seven female; mean age (± s.d.) 29.7 ± 5.3) were divided into three groups of five and tested at monthly intervals. Subjects in the ketanserin pretreatment experiment received pretreatment with either placebo, 20 mg ketanserin, or 40 mg ketanserin (p.o.); subjects in the haloperidol pretreatment experiment received either placebo, or 0.021 mg haloperidol (i.v.). 75 min later. Subjects of both groups received treatment with either placebo or 0.25 mg/kg psilocybin (p.o.). Subjects in the risperidone pretreatment experiment received pretreatment with either placebo, 0.5 mg risperidone, or 1.0 mg risperidone (p.o.). In these subjects, placebo or 0.25 mg/kg psilocybin (p.o.) was administered 90 min after pretreatment, due to kinetic reasons of risperidone. The (APZ-OAV) rating scale and a delayed response task (DRT) were applied just prior to treatment with either placebo or psilocybin and again 80 min after to coincidence with the peak effects of psilocybin.[9]

Experiment 2

A second group (five male, five female; age 28.4 ± 4.0) received pretreatment with either placebo or 40 mg ketanserin (p.o.). After 75 min subjects received treatment with either placebo or 0.25 mg/kg psilocybin (p.o.). APZ-OAV ratings (but no DRT) were performed according to the protocol of experiment 1.

The Altered State of Consciousness (APZ-OAV) rating scale yields three dimensions (factors) comprised of several item clusters.[19] The first subscale, OSE (oceanic boundlessness), measures derealization and depersonalization phenomena associated with a positive basic mood ranging from heightened feelings to sublime happiness, grandiosity, and alterations in the sense of time and space. The second subscale, VUS (visionary restructuralization), assesses illusions, (pseudo-) hallucinations, synaesthetic phenomena, and changes in the meaning of various percepts. The third subscale AIA (dread of ego-dissolution), measures thought disorder, anxious ego-disintegration, loss of control over body and thought, and derealization phenomena associated with arousal and anxiety.

To assess working memory deficits, a visual-manual delayed response task (DRT) was used, as previously reported in detail by Park *et al*.[20] and summarized here. In this DRT, subjects were required to respond to visually presented targets (black circles) by touching a position on a computer screen (a touch screen) with their hand. While subjects sat still on an armchair and stared fixedly at the center of the screen, a target appeared on the screen for 200 ms in one of eight possible locations on the circumference of an imaginary circle. After the presentation of each target, there was a 10 s delay period during which the subject had to perform a category shift task by reading changing numbers appearing in the center of the screen. After that the fixation point and eight reference circles (empty instead of black) appeared on the screen and subjects were required to touch the screen at the remembered position. If the correct target position was hit, the screen cleared and the next trial could begin. If the target position was incorrect, the reference circles remained on the screen until the subjects found the correct position or until 10 s had elapsed, whichever was sooner. There were 32 randomized trials, four at each location. Response times in milliseconds of correct trials were recorded.

The data for each APZ-OAV scale and data for performance on the DRT (response times) were analyzed separately for each antagonist with a two-way ANOVA (analysis of variance) with pretreatment (placebo and dose of antagonist) and drug (placebo and psilocybin) as within-subjects factors. When significant main effects or interactions were revealed in the ANOVA, Tukey post hoc comparisons were done. The significance level of the main factors and/or interactions are cited in the text, and those for Tukey's post hoc tests of individual groups are shown in the figures. Since haloperidol appeared to increase the psilocybin-induced AIA scores and the reaction time on the DRT, but no significant interactions were found in the two-way ANOVAs, the significance of these increases was also tested using non-parametric Friedman ANOVA. The Spearman correlation coefficient was used to evaluate correlations between changes in reaction time of DRT task and psycho(patho)logical alterations. The criterion for significance was set at $p < 0.05$.

Results

Psilocybin (0.25 mg/kg, p.o.) produced a psychotic syndrome including changes in mood, disturbances of sensory perception and thought processes, and impaired ego-functioning. The drug effects began 20-30 min after administration, peaked after another 30-50 min, and lasted 1-2 h. Thus psychological measurements and neuropsychological testing were undertaken during the peak drug effects.

The APZ-OAV scores for placebo, psilocybin, and psilocybin plus the different doses of antagonists for experiment 1 are summarized in Fig. 1. Two-way ANOVA's and Tukey's *post hoc* comparisons revealed that psilocybin significantly increased the OSE, VUS and AIA scores in the ketanserin, risperidone and haloperidol groups (Fig. 1). The increase in the OSE score was due to a prominent increase in derealization associated with euphoria, exaltation or grandiosity, and an altered sense of time and space. The increase in the VUS score was attributable to perceptual alterations including visual disturbances ranging from illusions to complex scenery hallucinations, synaesthesias, and changed meaning of percepts. The increase in AIA scores was mainly due to an anxiously experienced loss of ego-boundaries, thought disorder, and moderate suspiciousness and paranoid ideation.

As shown in Fig. 1, pretreatment with the 5-HT_2 antagonist ketanserin dose-dependently blocked psilocybin-induced psychosis, as revealed by two-way ANOVAs and significant drug x pretreatment interactions (OSE (F(2,8) = 12.2, $p < 0.004$); VUS (F(2,8) = 26.3, $p < 0.0003$); AIA (F(2,8) = 21.7, $p < 0.0006$)). Specifically, 20 mg ketanserin reduced the psilocybin-induced APZ-OAV scores by about 50-70%, while 40 mg ketanserin completely prevented the development of psilocybin effects in four of five subjects (98-100%). In the remaining subject, the mean APZ-OAV scores were also markedly reduced (75-87%), but the subject still reported discrete distortions in the experience of time and space, and impaired body control. Similarly, 0.5 mg of the mixed 5-$HT_{2/D2}$ antagonist risperidone attenuated the effects of psilocybin on all three APZ-OAV scales (69-78%), while 1 mg risperidone effectively blocked the development of psilocybin-induced psychosis (98-99%). Two-way ANOVAs yielded again significant drug x pretreatment interactions (OSE (F(2,8) = 7.4, $p < 0.02$); VUS (F(2,8) = 8.2, $p < 0.01$); AIA (F(2,8) = 8.5, $p < 0.01$)). By themselves, neither ketanserin nor risperidone (0.5 and 1.0 mg) had any effects on any APZ-OAV scores.

In contrast, pretreatment with haloperidol (0.021 mg/kg, i.v.) reduced the effect of psilocybin only on the OSE scale (54% reduction; drug x pretreatment interaction for OSE (F(1,4) = 20.4, $p < 0.01$). Tukey's *post hoc* analysis revealed that this reduction was significant (Fig. 1). Haloperidol had no influence on psilocybin-induced visual illusions and hallucinations as measured by the VUS scale (main effect of drug (F(1,4) = 52.3, $p < 0.002$)) and pretreatment (F(1,4) = 0.51, $p < 0.5$), and drug x pretreatment interaction (F(1,4) = 0.4, $p < 0.5$)). Surprisingly, haloperidol uniformly increased the AIA scores in all of the subjects treated with psilocybin (148% increase). A two-way ANOVA revealed significant main effect of drug (F(1,4) = 14.4, $p < 0.02$) and pretreatment (F(1,4) = 8.7, $p < 0.04$), but no significant drug x pretreatment interaction (F(1,4) = 2.1, $p < 0.22$). Additional non-parametric Friedman ANOVAs showed that this psilocybin-induced increase in AIA scores after haloperidol was significantly greater than psilocybin alone ($p < 0.025$) and that haloperidol by itself slightly (9.6%), but not significantly, increased the AIA scores as compared to placebo. Furthermore, item-based analysis of the AIA scores revealed that psilocybin mainly increased thought disorder and anxiety after pretreatment with haloperidol.

As seen in Figure 2, psilocybin also increased the reaction time on the memory-guided delayed response task during the peak effects of the drug. Again, ketanserin and risperidone, but not haloperidol, dose-dependently blocked the increase in reaction time on the DRT, as revealed by significant drug x pretreatment interactions (ketanserin (F(2.8) = 6.0, $p < 0.03$); risperidone (F(2.8) = 4.8, $p < 0.04$)). Additional Friedman ANOVAs showed that ketanserin, risperidone and haloperidol by themselves did not have any significant effects on reaction times. Performance as measured by the rate of correct responses did not differ significantly between the various conditions. Interestingly, the impairment in reaction time did not correlate significantly with changes in the APZ-OAV scores.

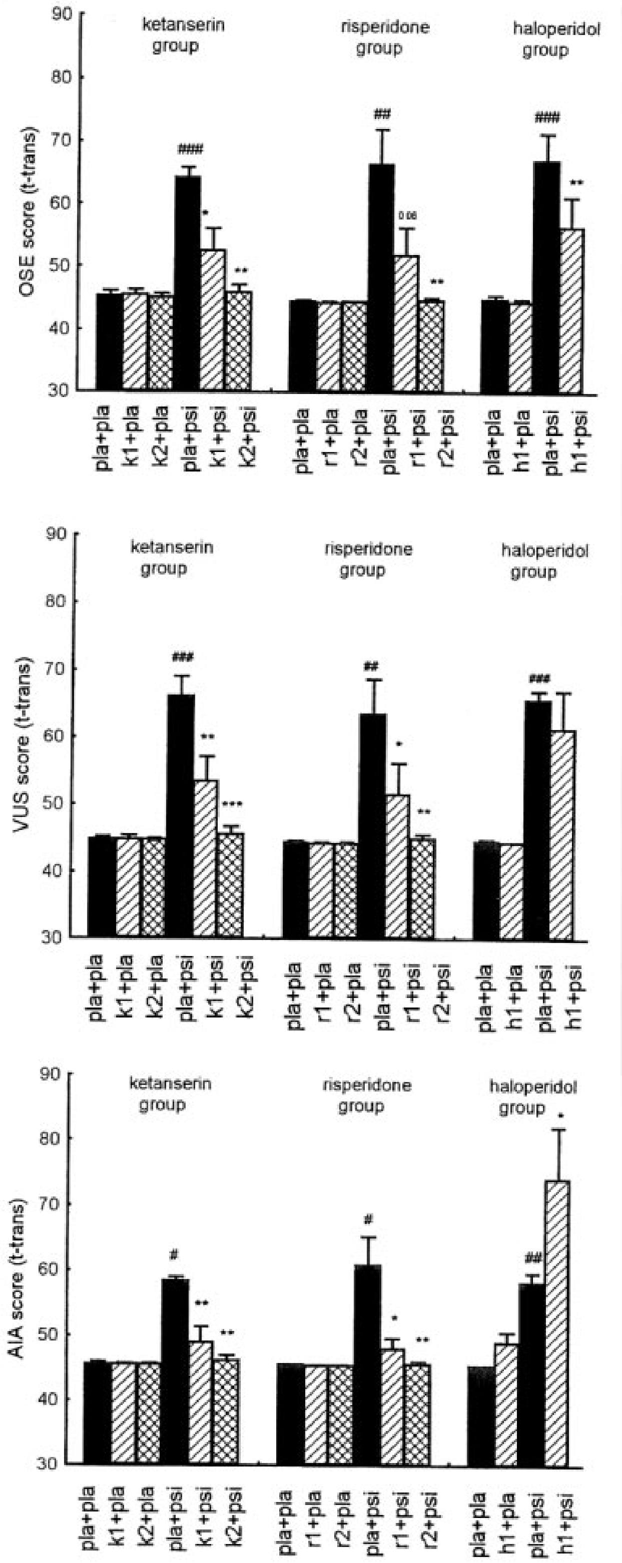


FIG. 1. Bars show the pretreatment alone effects of placebo, ketanserin, risperidone and haloperidol, and the effects of pretreatment on the psilocybin-induced APZ-OAV scores (OSE, VUS and AIA) in normal subjects. The OSE scale includes items for derealization and depersonalization associated with euphoria, the VUS scale rates illusions, hallucinations, and changed meaning, and the AIA scale rates anxious ego-dissolution, thought disorder, and paranoia. Data are means ± s.e. ($n = 5$ for each antagonist): placebo (pla), psilocybin (psi = 0.25 mg/kg), ketanserin (k1 = 20 mg, k2 = 40 mg, p.o.), risperidone (r1 = 0.5 mg, r2 = 1.0 mg, p.o.) and haloperidol (h1 = 0.021 mg/kg, i.v.). Significant increases from placebo to psilocybin: #$p < 0.05$, ##$p < 0.01$, ###$p < 0.001$. Significant decreases from psilocybin to antagonist conditions: *$p < 0.05$, **$p < 0.01$ (Tukey's *post hoc* test). Note: The psilocybin-induced increase in AIA after haloperidol was tested by a Friedman ANOVA.

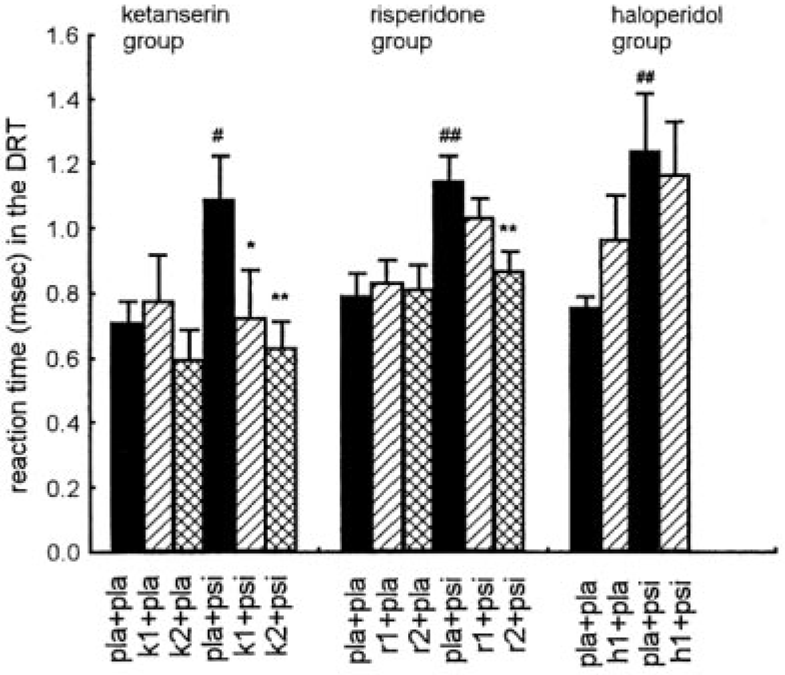


FIG. 2. Bars show the pretreatment alone effects of placebo, ketanserin, risperidone, and haloperidol and the effects of pretreatment on the psilocybin-induced spatial working memory deficits as measured by a memory-guided delayed response task (DRT). Data are means ± s.e. ($n = 5$ for each antagonist). For abbreviations see Fig. 1. Significant increases in reaction time (rt) from placebo to psilocybin: #$p < 0.05$, ##$p < 0.01$. Significant decreases from psilocybin to antagonist conditions: *$p < 0.05$, **$p < 0.01$ (Tukey's *post hoc* test). Note: The psilocybin-induced increase in reaction time after haloperidol was tested by a Friedman ANOVA.

Given the importance of the ketanserin findings obtained in experiment 1, a second group of 10 subjects was tested to corroborate the results obtained with 40 mg ketanserin. Once again, pretreatment with 40 mg ketanserin effectively blocked the effects of psilocybin on all APZ-OAV measures by 87-96%. Two-way ANOVAs yielded significant drug x pretreatment interactions for OSE ($F(1.9) = 51.7$, $p < 0.0001$), VUS ($F(1.9) = 111.7$, $p < 0.00001$), and AIA ($F(1.9) = 16.2$, $p < 0.003$) and Tukey's *post hoc* comparisons confirmed that these effects were significant (Fig. 3).

Discussion

The present results provide compelling evidence that the model psychosis induced by psilocybin in healthy human volunteers is the result of a specific activation of the 5-HT$_2$ subtype of serotonin receptors. These findings validate the many studies in animals indicating that the behavioral effects of hallucinogens are attributable to 5-HT$_2$ agonist actions.

This study corroborates the several previous suggestions of similarities between the early and acute stages of schizophrenia and the psychological effects of indoleamine-derived hallucinogens such as psilocybin and LSD.[3,5,7] In particular, the finding that psilocybin produced derealization and depersonalization associated with heightened mood, euphoria and/or grandiosity (OSE) and visual hallucinations (VUS) is consistent with the observation that the earliest affective changes in incipient schizophrenia are often pleasurable and that visual, as opposed to auditory, hallucinations occur with higher prevalence in first-break than chronic schizophrenics[7]. Anxious ego-dissolution, loss of body and thought control, and ideas of reference (AIA), however, are not only common features of both psilocybin-induced psychosis and early schizophrenic stages, but also occur in chronic schizophrenics in acute episodes. Indeed, a recent study demonstrated that schizophrenics during both first episodes and relapse had similar prominent OSE and AIA scores as seen in this study in psilocybin subjects.[1] The most novel aspect of the present findings is the demonstration that psilocybin-induced psychosis could be completely prevented by either the atypical neuroleptic and mixed 5-HT$_{2/D2}$ antagonist risperidone or by the 5-HT$_2$ antagonist ketanserin, but not by the typical neuroleptic and D2 antagonist haloperidol. This finding adds substantial evidence to the view that 5-HT$_2$ agonism is responsible for the psychological effects of psilocybin and, presumably, other indoleamine hallucinogens. Furthermore, the finding that ketanserin, with about 100-fold greater potency at the 5-HT_{2A} vs 5-HT_{2C} receptor, completely blocked psilocybin-induced psychosis strongly indicates that the effects of psilocybin are mediated by 5-HT_{2A} rather than 5-HT_{2C} receptor activation. This interpretation is corroborated by recent findings demonstrating that the highly selective 5-HT_{2A} receptor antagonist M100,907 (formerly MDL 100,907), but not 5-HT_{2C} antagonists, completely antagonized the disruptive effect of the hallucinogenic 5-$HT_{2A/C}$ agonist DOI on prepulse inhibition (PPI) of startle in rats.[14] Insofar that PPI deficits and 5-HT_{2A} receptor alterations were recently found in schizophrenic patients,[23] the present data are consistent with the hypothesis that serotonergic hyperactivity may also contribute to the pathophysiology of schizophrenia.

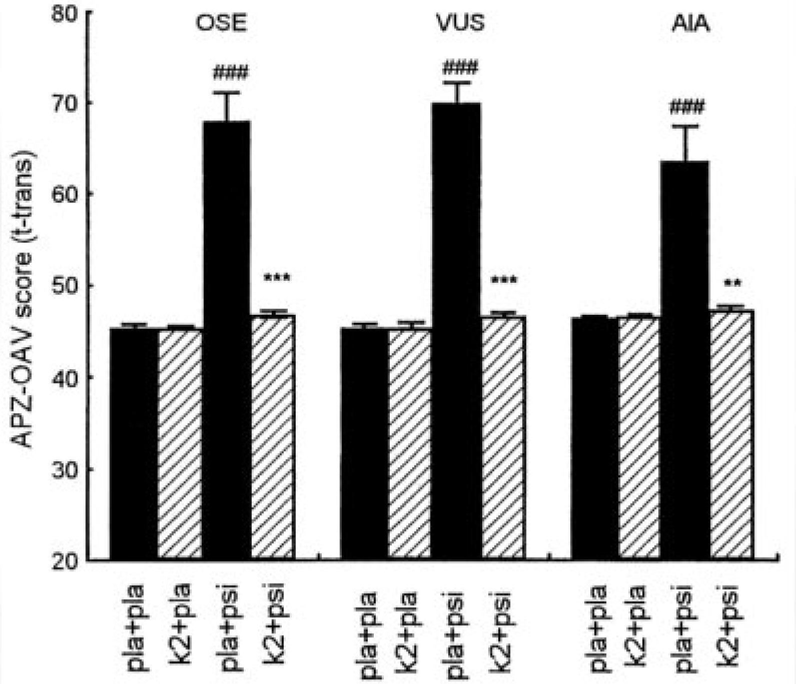


FIG. 3. A second experiment to corroborate the effects of placebo and ketanserin pretreatment on the psilocybin-induced APZ-OAV scores was performed in normal subjects. Data are means ± s.e. (n = 10): placebo (pla), ketanserin (k2 = 40 mg, p.o.) and psilocybin (psi = 0.25 mg/kg). Significant increases from placebo to psilocybin: ###$p < 0.001$. Significant decreases from psilocybin to antagonist conditions: **$p < 0.01$, ***$p < 0.001$ (Tukey's *post hoc* test).

To the extent that the effects of psilocybin studied here are relevant to the symptoms of acute schizophrenia, the blockade of these effects by a 5-HT_2 antagonist supports the notion that 5-HT_2 antagonism may contribute significantly to the antipsychotic actions of atypical neuroleptics.[18] In this regard, it is particularly interesting to note that the typical antipsychotic haloperidol was substantially less effective than risperidone in blocking the psychosis-like symptoms produced by psilocybin, despite the fact that the doses of haloperidol and risperidone were selected to have comparable effects on dopamine D2 receptors.[21,22] In contrast, haloperidol even increased psilocybin-induced AIA scores. This finding might be somewhat surprising, but is consistent with single case reports indicating that classic neuroleptics do enhance, rather than ameliorate, LSD-induced psychosis.[24] Whether psilocybin increases the AIA scores after pretreatment with haloperidol through a serotonergic modulation of dopamine or other neurotransmitter systems, such as GABA,[10] or both, cannot be inferred from the present data. Nevertheless, despite the fact that psilocybin and psilocin do not act directly upon D2 receptors[16] haloperidol partially ameliorated psilocybin- induced OSE scores. This finding could indicate that psilocybin has an indirect influence on dopaminergic systems which is then antagonized by haloperidol. Finally, haloperidol, in contrast to ketanserin and risperidone, had no effects on psilocybin-induced perceptual disturbances and hallucinatory phenomena (VUS) indicating that these symptoms are specifically attributable to direct activation of 5-HT_{2A} receptors and do not depend upon the dopaminergic system.

The second important result was that psilocybin produced spatial working memory deficits comparable to those seen in schizophrenic patients[20] and that these deficits could be completely prevented by 5-HT_2, but not D2 antagonism. This finding strongly suggests that 5-HT, and particularly 5-HT_{2A} receptor stimulation, may also contribute to cognitive impairments in schizophrenia. This interpretation is consistent with the observation that schizophrenic patients with cognitive deficits respond better to atypical than typical neuroleptics.[25] Furthermore, the observation that psilocybin-induced working memory deficits did not correlate with psychopathological measures is in line with the notion that cognitive deficits in schizophrenia appear to occur independent of positive and negative symptoms of schizophrenia.[25]

Conclusion

The present study demonstrated that psilocybin produces schizophrenia-like symptoms primarily through 5-HT_2 receptor stimulation. This finding adds further evidence to the hypothesis that excessive 5-HT_2 receptor activation, particularly 5-HT_{2A}, may be a critical factor in psychotic symptom formation and cognitive deficits in schizophrenia, at least in a subset of schizophrenic patients.[23] Thus, selective 5-HT_{2A} antagonists may be useful in normalizing such imbalances.[18] Furthermore, the classic amphetamine-induced model of psychosis has generally been used to assess the actions of typical antipsychotics, such as haloperidol, whose efficacy appears to be attributable to dopamine antagonism. By contrast, it appears that the psilocybin-induced psychosis may offer a potential model to study specifically those aspects of atypical antipsychotic action that differ from the actions of typical antipsychotics.

Acknowledgements

This study was supported in part by the Swiss National Science Foundation (32-040'900) and Janssen-Cilag, Switzerland. The authors especially thank Dr S. Park and Dr J. Püschel for kindly providing the delayed response task (DRT), and Professor M. Geyer, UCSD, for critical comments on the manuscript.

References

1. Gouzoulis-Mayfrank E, Hermle L, Thelen B et al. Pharmacopsychiatry 31 (Supp), 63-68 (1998).
2. Rümmele W and Gnirss F. Schweiz Arch Neurol Psychiat 87, 365-385 (1961).
3. Vollenweider FX, Leenders KL, Scharfetter C et al. Neuropsycho-pharmacology 16, 357-372 (1997).
4. Spitzer M, Thimm M, Hermle L et al. Biol Psychiatry 39, 1055-1057 (1996).
5. Bowers MB and Freedman DX. Arch Gen Psychiatry 15, 240-248 (1966).
6. Heimann H. Psychiat Neurol 141, 69-100 (1991).
7. Fischman LG. Schizophrenia Bull 9, 73-94 (1983).
8. Ebmeier KP, Lawrie SM, Blackwood DH et al. J Neurol Neurosurg Psychiat 58, 452-456 (1995).
9. Hasler F, Bourquin D, Brenneisen R et al. Pharm Acta Helv 72, 175-184 (1997).
10. Abi-Dargham A, Laruelle M, Aghajanian GK et al. J Neuropsychiatry Clin Neurosci 9, 1-17 (1997).
11. Peroutka SJ. 5-hydroxytryptamine receptor interactions of D-lysergic acid diethylamide.In: Pletscher A and Ladewig D, eds. 50 Years of LSD. Current Status and Perspectives of Hallucinogens. New York: Parthenon Publishing, 1994: 19-26.
12. Sanders-Bush E, Burries KD and Knoth K. J Pharmacol Exp Ther 246, 924-928 (1988).
13. Titeler M, Lyon RA and Glennon RA. Psychopharmacology 94, 213-216 (1988).
14. Sipes TA and Geyer MA. Behav Pharmacol 6, 839-842 (1995).
15. Marek GJ and Aghajanian GK. J Pharmacol Exp Ther 278, 1373-1382 (1996).
16. Creese I, Burt DR and Snyder SH. Life Sci 17, 1715-1720 (1975).
17. Hoyer D and Schoeffter P. J Receptor Res 11, 197-214 (1991).
18. Meltzer HY. Schizophrenia Bull 17, 263-287 (1991).
19. Dittrich A. Psychological aspects of altered states of consciousness of the LSD type: measurements of their basic dimensions and prediction of indi-vidual differences. In: Pletscher A and Ladewig D, eds. 50 Years of LSD. Current Status and Perspectives of Hallucinogens. New York: Parthenon Publishing, 1994: 101-118.
20. Park S and Holzman PS. Arch Gen Psychiatry 49, 975-982 (1992).
21. Farde L, Nordström A-L, Wiesel F-A et al. Arch Gen Psychiatry 49, 538-544 (1992).
22. Nyberg S, Farde L, Eriksson L et al. Psychopharmacology 110, 265-272 (1993).
23. Gurevich EV and Joyce JN. Biol Psychiatry 42, 529-545 (1997).
24. Abramson HA, Rolo A and Stache J. J Neuropsychiatry 307-310 (1960).
25. Green MF, Marshall BDJ, Wirshing WC et al. Am J Psychiatry 154, 799-804 (1997).

Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin

by

Robin L. Carhart-Harris[a,b], David Erritzoe[a,c], Tim Williams[b], James M. Stone[a], Laurence J. reed[a], Alessandro Colasanti[a], Robin J. Tyacke[a], Robert Leech[d], Andrea L. Malizia[b], Kevin Murphy[e], Peter Hobden[e], John Evans[e], Amanda Feilding[f], Richard G. Wise[e], oraz David J. Nutt[a,b,1]

Edited by Leslie Lars Iversen, University of Oxford, Oxford, United Kingdom, and approved December 20, 2011 (received for review December 3, 2011)

original source: http://www.pnas.org/content/109/6/2138.full.pdf
backup source: http://www.psilosophy.info/resources/2138.full.pdf

[a] Neuropsychopharmacology Unit,
[d] Imperial College London, London W12 0NN, United Kingdom;
[b] Academic Unit of Psychiatry, University of Bristol, Bristol BS8 2BN, United Kingdom;
[e] Brain Research Imaging Centre, Cardiff University, Cardiff CF10 3AT, United Kingdom;
[f] The Beckley Foundation, Beckley Park, Oxford OX3 9SY, United Kingdom; and
[c] Neurobiology Research Unit, Rigshospitalet, and Center for Integrated Molecular Brain Imaging, University of Copenhagen, DK-2100 Copenhagen, Denmark

Author contributions: R.L.C.-H., J.E., R.G.W., and D.J.N. designed research; R.L.C.-H., D.E.,T.W., J.M.S., L.J.R., A.C., R.J.T., R.L., A.L.M., K.M., P.H., J.E., A.F., and R.G.W. performed research; R.L.C.-H., K.M., and R.G.W. analyzed data; and R.L.C.-H., K.M., R.G.W., and D.J.N. wrote the paper.
The authors declare no conflict of interest.
This article is a PNAS Direct Submission.
See Commentary on page 1820.
[1] To whom correspondence should be addressed. E-mail: d.nutt@imperial.ac.uk.
This article contains supporting information online at:
www.pnas.org/lookup/suppl/doi:10.1073/pnas.1119598109/-/DCSupplemental.

Table of Contents:

Results
- ASL Perfusion fMRI
- BOLD fMRI
- Pharmaco-Physiological Interaction
- Physiological Correction and Breath-Hold

Discussion

Materials and Methods
- MRI Anatomical Scan
- MRI Methods
  - *ASL relative perfusion measurement*
  - *BOLD measurement*
- Pharmaco-Physiological Interaction/Functional Connectivity Analysis
- Physiological Noise Correction
- Cerebrovascular Reactivity

Acknowledgments

References

Psychedelic drugs have a long history of use in healing ceremonies, but despite renewed interest in their therapeutic potential, we continue to know very little about how they work in the brain. Here we used psilocybin, a classic psychedelic found in magic mushrooms, and a task-free functional MRI (fMRI) protocol designed to capture the transition from normal waking consciousness to the psychedelic state. Arterial spin labeling perfusion and blood-oxygen level dependent (BOLD) fMRI were used to map cerebral blood flow and changes in venous oxygenation before and after intravenous infusions of placebo and psilocybin. Fifteen healthy volunteers were scanned with arterial spin labeling and a separate 15 with BOLD. As predicted, profound changes in consciousness were observed after psilocybin, but surprisingly, only decreases in cerebral blood flow and BOLD signal were seen, and these were maximal in hub regions, such as the thalamus and anterior and posterior cingulate cortex (ACC and PCC). Decreased activity in the ACC/medial prefrontal cortex (mPFC) was a consistent finding and the magnitude of this decrease predicted the intensity of the subjective effects. Based on these results, a seed-based pharmaco-physiological interaction/ functional connectivity analysis was performed using a medial prefrontal seed. Psilocybin caused a significant decrease in the positive coupling between the mPFC and PCC. These results strongly imply that the subjective effects of psychedelic drugs are caused by decreased activity and connectivity in the brain's key connector hubs, enabling a state of unconstrained cognition.

Keywords: default mode network, hallucinogens, serotonin, depression, 5-HT$_{2A}$ receptor.

Psilocybin is the prodrug of psilocin 4-hydroxy-dimethyltryptamine), the primary hallucinogenic component of magic mushrooms, and a classic psychedelic ("mind-manifesting") drug. Psilocybin has been used for centuries in healing ceremonies[1] and more recently in psychotherapy[2]; it is capable of stimulating profound existential experiences[3], which can leave a lasting psychological impression[4]. However, despite a wealth of literature on its phenomenology, we currently know very little about how its effects are produced in the brain. The present study sought to address this question using complementary functional MRI (fMRI) techniques and a protocol designed to image the transition from normal waking consciousness to the psychedelic state. Two groups of healthy subjects were scanned using arterial spin labeling (ASL) perfusion and blood-oxygen level-dependent (BOLD) fMRI during intravenous infusion of psilocybin. Infused over 60 s 2 mg in 10-mL saline), psilocybin's subjective effects begin within seconds[5], allowing the capture of the corresponding change in brain state.

Results

ASL Perfusion fMRI

Fifteen healthy, hallucinogen-experienced subjects (five females), mean age 34.1 (SD 8.2) were scanned with ASL. Subjects underwent an anatomical scan followed by two task-free functional scans, each lasting 18 min. Subjects were instructed to relax and a fixation cross was displayed. Solutions were infused manually over 60 s, beginning 6 min after the start of each functional scan. Subjects received placebo (10-mL saline) in the first scan and psilocybin (2 mg in 10-mL saline) in the second. The intensity of the subjective effects was rated via button press on a 0-10 visual analog scale (10 = extremely intense effects) at the start of each functional scan, just before infusion, 5-min postinfusion, and 12-min postinfusion. The average rating 5-min postinfusion was 6.7 (±1.9), and 5.2 (±2.3) 12-min postinfusion. Earlier work showed that the effects of 2 mg i.v. psilocybin are comparable with ~15 mg of orally administered psilocybin, which is considered a moderate dose [6]. Nineteen additional items were rated immediately after each ASL scan. Fig. 1 displays the top 10 rated items from the two studies. Ratings for all of the items used in the ASL and BOLD studies can be found in Table S1.

The interaction between cerebral blood flow (CBF) and the infusion event was modeled, contrasting CBF before and after infusion. The subjective effects began toward the end of the infusion period and reached a sustained peak after ~4 min [5]. The first level results were entered into a higher level analysis, contrasting CBF after psilocybin with CBF after placebo for all 15 subjects. Fig. 2 displays these results.

Table S1. All items rated after each scan.

Item	ASL plac	ASL psilo	BOLD plac	BOLD psilo	Combine: psilo - plac (SD)
I saw geometric patterns			0.3	73.5	73.2 (16.9)
I saw my surroundings change in unusual ways	7.1	75.3			68.2 (21.3)
I felt unusual bodily sensations			6.5	67.3	60.9 (23.1)
Things looked strange	8.1	69.9	2.2	59.3	59.5 (22)
My sense of size or space was altered	3.9	64.1	0.9	53.0	56.2 (23.2)
Sounds influenced things I saw			2.4	57.5	55.1 (21.7)
My imagination was extremely vivid	3.5	54.7	6.5	64.7	54.7 (23.9)
My perception of time was distorted			5.2	58.2	53 (20.2)
My sense of size or space was distorted			0.9	53.0	52.1 (16.3)
My sense of time was altered	6.3	55.4	5.2	58.2	51 (24.3)
The experience had a dreamlike quality	8.9	53.3	6.2	57.5	47.8 (24.2)
It felt like I was floating			3.7	51.1	47.5 (23.9)
My thoughts wandered freely	11.0	57.7	10.5	56.7	46.4 (23.2)
Everything seemed 'alive'	1.5	47.1			45.5 (21.6)
It felt like I was merging with my environment			2.2	47.3	45.1 (21.9)
I felt a sense of awe	3.1	48.0			44.9 (21.5)
The experience had a supernatural quality			0.7	44.5	43.7 (20.2)
I experienced a loss of separation from my surroundings			2.1	45.3	43.2 (18.7)
I felt a sense of joy	5.1	45.9			40.8 (25.4)
My sense of self was altered	2.6	43.3			40.7 (23.4)
The experience had a spiritual or mystical quality			1.8	40.3	38.5 (23.6)
My thinking was muddled	5.9	40.9	1.4	41.5	37.5 (19)
I felt a profound inner peace			7.0	41.3	34.3 (21.2)
I lost all sense of ego			3.2	34.6	31.4 (20.6)
The experience had a mystical quality	1.9	31.5			29.5 (19.6)
The experience had a magical or supernatural quality	2.4	31.7			29.2 (20.2)
The experience had a spiritual quality	2.7	28.2			25.5 (19)
I thought about myself and my past	4.8	22.9			18.1 (17)
I feared losing control of my mind	3.3	18.0	3.1	14.6	13.1 (16.7)
I felt afraid	5.8	13.7	6.5	20.4	10.9 (17.3)
I felt suspicious or paranoid	4.1	6.0	3.5	14.3	6.3 (12.8)

All of these items were rated at the end of each scan in a visual analog scale format with a bottom anchor of "no more than usually" and a top anchor of "much more than usually." Scores are expressed as a percentage, with 100% being a mark adjacent to the top anchor "much more than usually." All items were rated significantly higher after psilocybin than placebo with the exception of "I felt afraid" and "I felt suspicious or paranoid" (t tests, P=0.05).

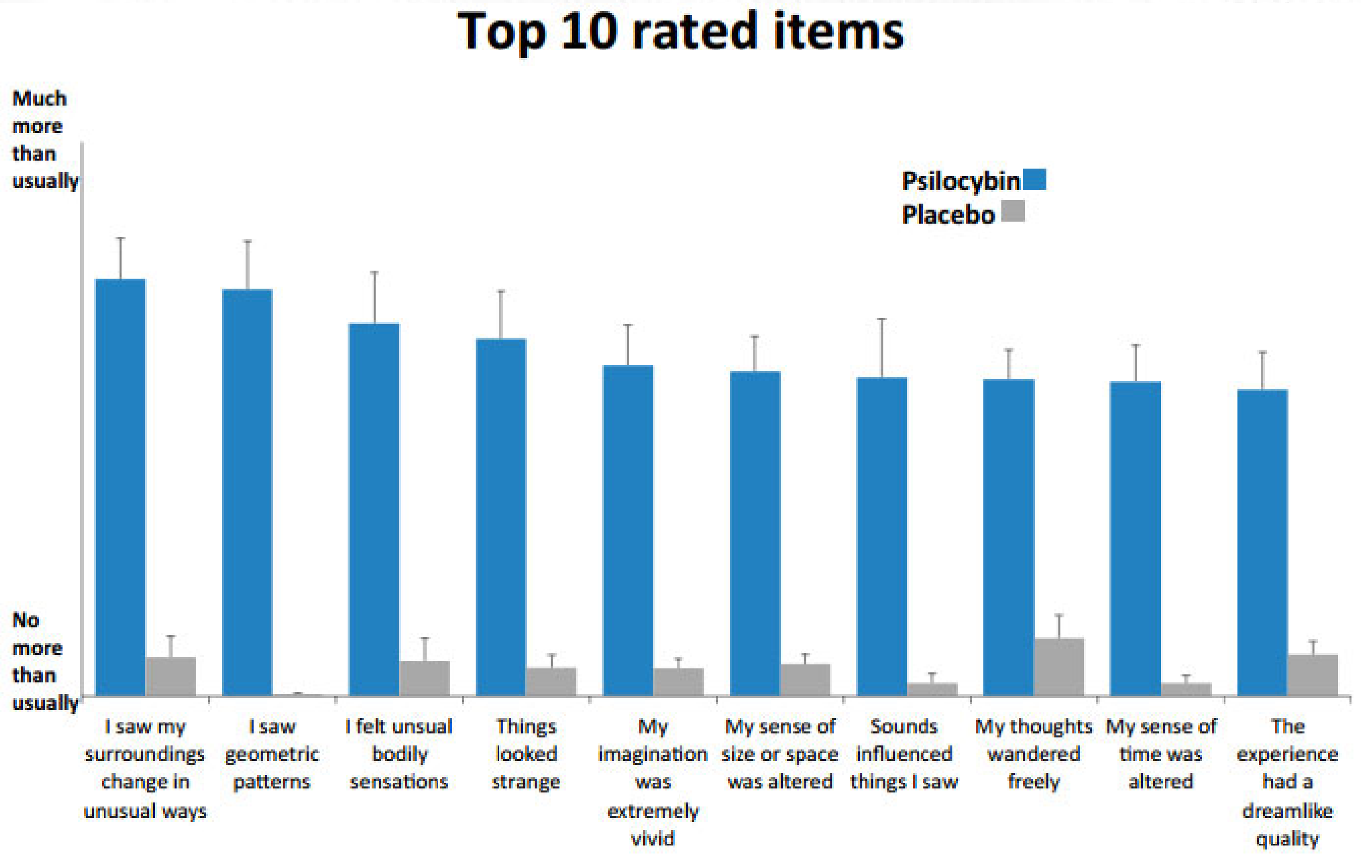


Fig. 1. Subjective ratings ($n = 30$). Displayed are mean values + SEs. Ratings were given shortly after the scans. Subjects were instructed that "no more than usually" refers to normal waking consciousness. All 10 items were scored significantly higher after psilocybin than placebo ($P < 0.01$).

The group level results (Fig. 2) revealed significant CBF decreases in subcortical (bilateral thalamus, putamen, and hypothalamus) and cortical regions [the posterior cingulate cortex (PCC), retrosplenial cortex, precuneus, bilateral angular gyrus, supramarginal gyrus, rostral and dorsal anterior cingulate cortex (ACC), paracingulate gyrus, medial prefrontal cortex (mPFC), frontoinsular cortex, lateral orbitofrontal cortex, frontal operculum, precentral gyrus, and superior, middle and inferior frontal gyrus] (Fig. S1). The decreases were localized to high-level association regions (e.g., the PCC and mPFC) and important connector hubs, such as the thalamus, PCC and ACC/mPFC.

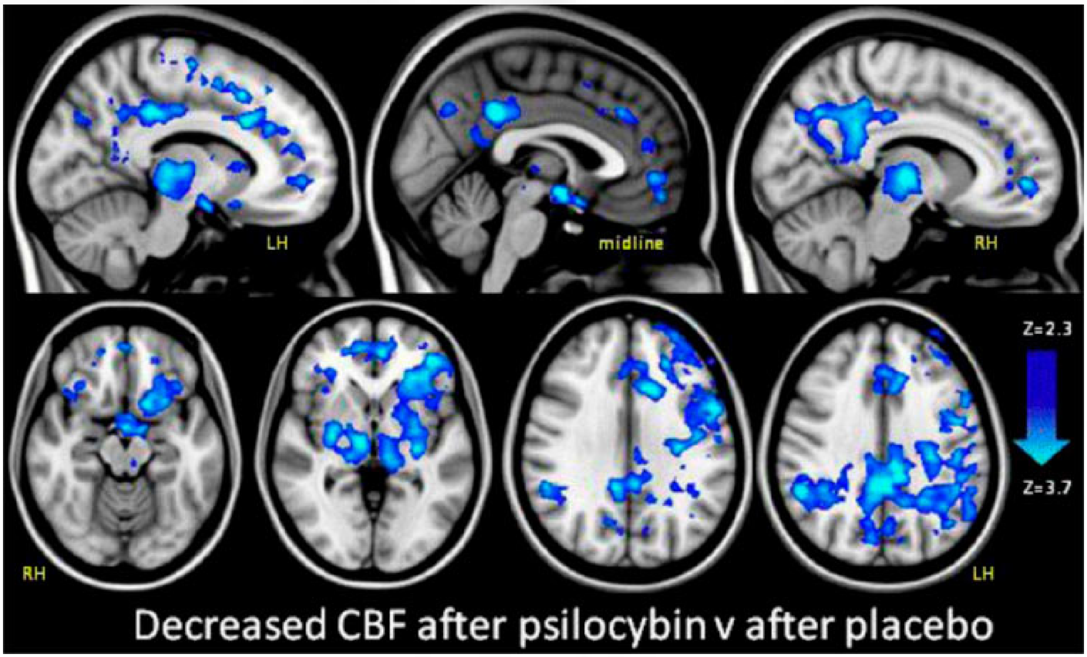


Fig. 2. Decreased CBF after psilocybin (ASL perfusion fMRI). Regions where there was significantly decreased CBF after psilocybin versus after placebo are shown in blue (z: 2.3-3.7). Mixed effects analysis, $z > 2.3$, $P < 0.05$ whole-brain cluster-corrected, $n = 15$. LH, left hemisphere; RH, right hemisphere. Note, we observed no increases in CBF in any region.

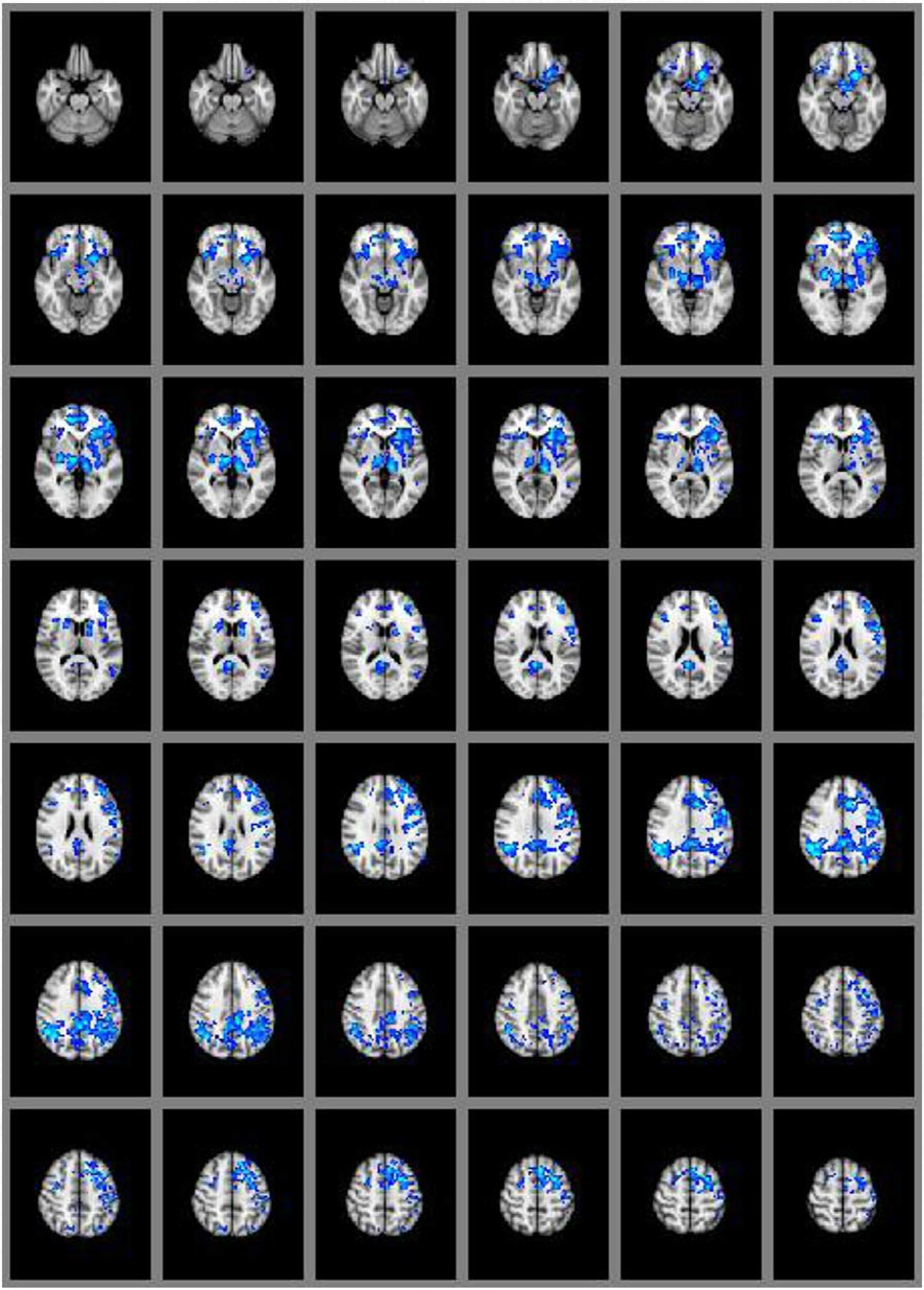


Fig. S1. Slices for arterial spin labeling (ASL) result. Lightbox display of slices showing regions where there were significant decreases in cerebral blood flow (CBF) after psilocybin versus placebo. Mixed-effects analysis, cluster threshold = 2.3, $P = 0.05$ whole-brain corrected, $n = 15$. The right hemisphere is shown on the left.

To assess the temporal dynamics of the CBF changes post-infusion, thalamic, ACC, and PCC masks were made; voxels within these were restricted to those that were significantly decreased after psilocybin. For each region of interest (ROI), the percent CBF change postinfusion was plotted against time (Fig. 3). All ROIs showed steep decreases in CBF after psilocybin that were sustained for the duration of the scan.

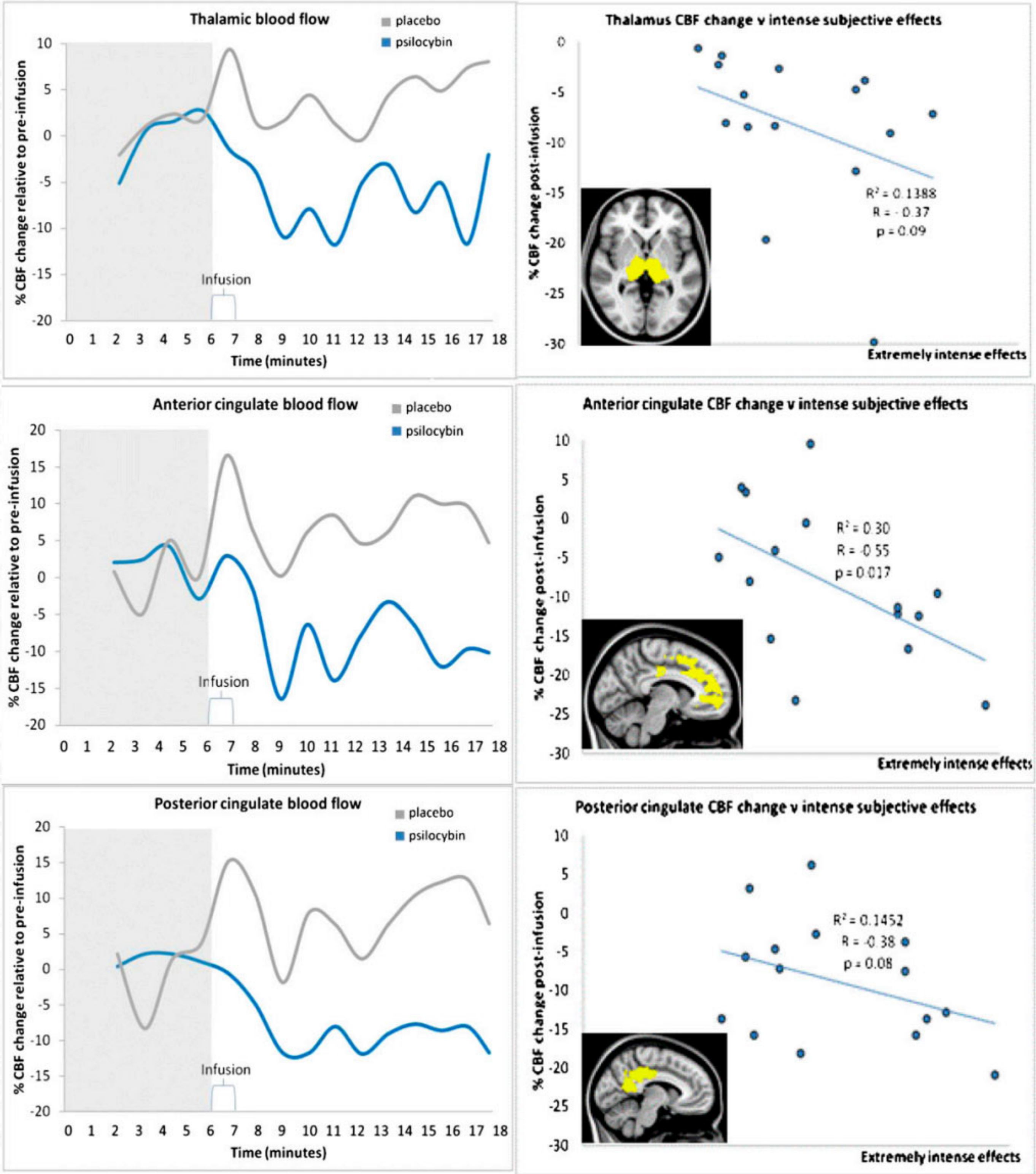


Fig. 3. Group CBF changes over time (*Left*) and CBF vs. subjective effects (*Right*). Plots on the left show blood flow changes over time for the thalamus, ACC, and PCC. These plots were made by calculating the postinfusion change in CBF as a percentage of the preinfusion CBF. This process was done for each ROI for each individual subject and then the group mean was plotted. Note, these plots are shown for display purposes; error bars are not included because the inclusion of error is implicit in the statistical parametric maps shown in Fig. 2. Plots on the right show the relationship between ROI CBF changes after psilocybin-infusion for each subject and their ratings of the intensity of the subjective effects given 5- and 12-min postinfusion (plotted are the average of these two ratings). There was a significant negative correlation between ACC CBF change postpsilocybin and intense subjective effects (Pearson's correlation, r = -0.55, P = 0.017, one-tailed) and CBF vs. intensity met a trend level significance for the thalamus and PCC ($P < 0.01$).

To test for a relationship between regional CBF changes and subjective effects, we plotted each subjects' ROI CBF change post-psilocybin against their ratings of drug effects intensity (Fig. 3D). For each ROI, it was evident that the greater the decreases in CBF, the more intense the subjective effects.

BOLD fMRI

A separate sample of 15 subjects was scanned with BOLD fMRI. The BOLD scans took place ~6 mo after the ASL. The sample included two females and had a mean age of 32 (SD 8.9). Subjects underwent an anatomical scan followed by an eyes-closed task-free BOLD scan, which lasted 12 min. This process occurred on two visits, ~14 d apart. Placebo was given on one occasion and psilocybin on the other in a balanced order. Infusions began 6 min after the start of the scan, following the same procedure as the ASL study. The data were high-pass filtered with a cutoff of 300 s and the pharmacodynamics of intravenous psilocybin was used to model changes in the BOLD signal coinciding with the infusion event [5]. The first level results were entered into a higher level analysis, contrasting BOLD signal changes before and after psilocybin, and before and after psilocybin versus before and after placebo (Fig. 4, Upper).

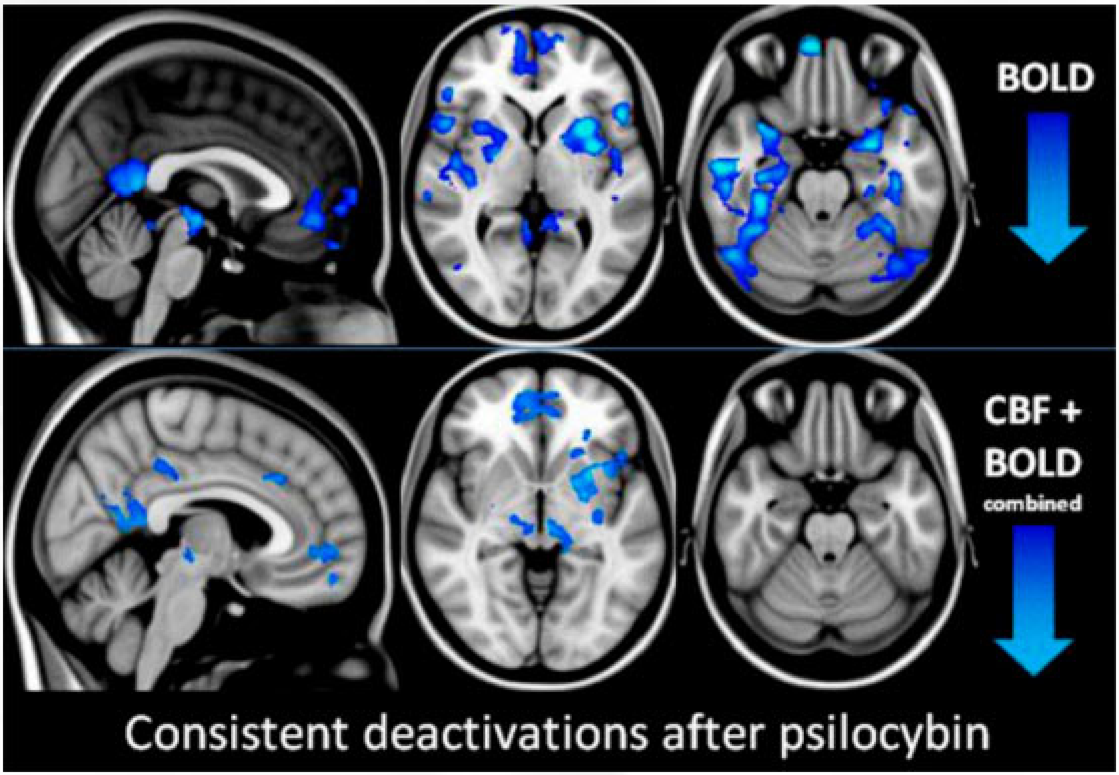


Fig. 4. Brain deactivations after psilocybin. (*Upper*) Regions where there was a significant decrease in the BOLD signal after psilocybin versus after placebo (z: 1.8-3). Mixed-effects analysis, $z > 1.8$, $P < 0.05$ whole brain cluster corrected, $n = 15$. (*Lower*) Regions where there was a consistent decrease in CBF and BOLD after psilocybin. For display purposes, significant BOLD decreases were calculated within a mask based on the ASL result (Fig. 2) at an uncorrected voxel level threshold of $P = 0.05$. Note, we observed no increases in CBF or BOLD signal in any region.

The regional decreases in BOLD signal were similar to the regional decreases in CBF observed with ASL, with consistent decreases in the mPFC, ventral PCC, putamen, and subthalamic nuclei (Fig. 4, Lower). There were, however, additional BOLD signal decreases (e.g., in higher order visual areas) that were not observed with ASL (Fig. 4, Upper, and Fig. S2).

Pharmaco-Physiological Interaction

These results implicate the ACC/mPFC in the mechanism of action of psilocybin. The ACC/mPFC showed decreased CBF (Fig. 2) and BOLD signal (Fig. 4) after psilocybin and the magnitude of CBF decreases correlated positively with the intensity of the drug's subjective effects (Fig. 3). Based on these results, a ventromedial prefrontal (vmPFC) ROI (Fig. 5, red) was chosen for a psycho-physiological interaction (PPI) analysis. PPIs test for changes in linear coupling under a psychological factor. In our case, this factor was the administration of psilocybin. This finding means that, strictly speaking, we are looking at a pharmaco-physiological interaction. Although commonly referred to as analyses of functional connectivity, PPIs can also be regarded as tests for changes in effective connectivity under a simple linear model of the influence of one region upon another.

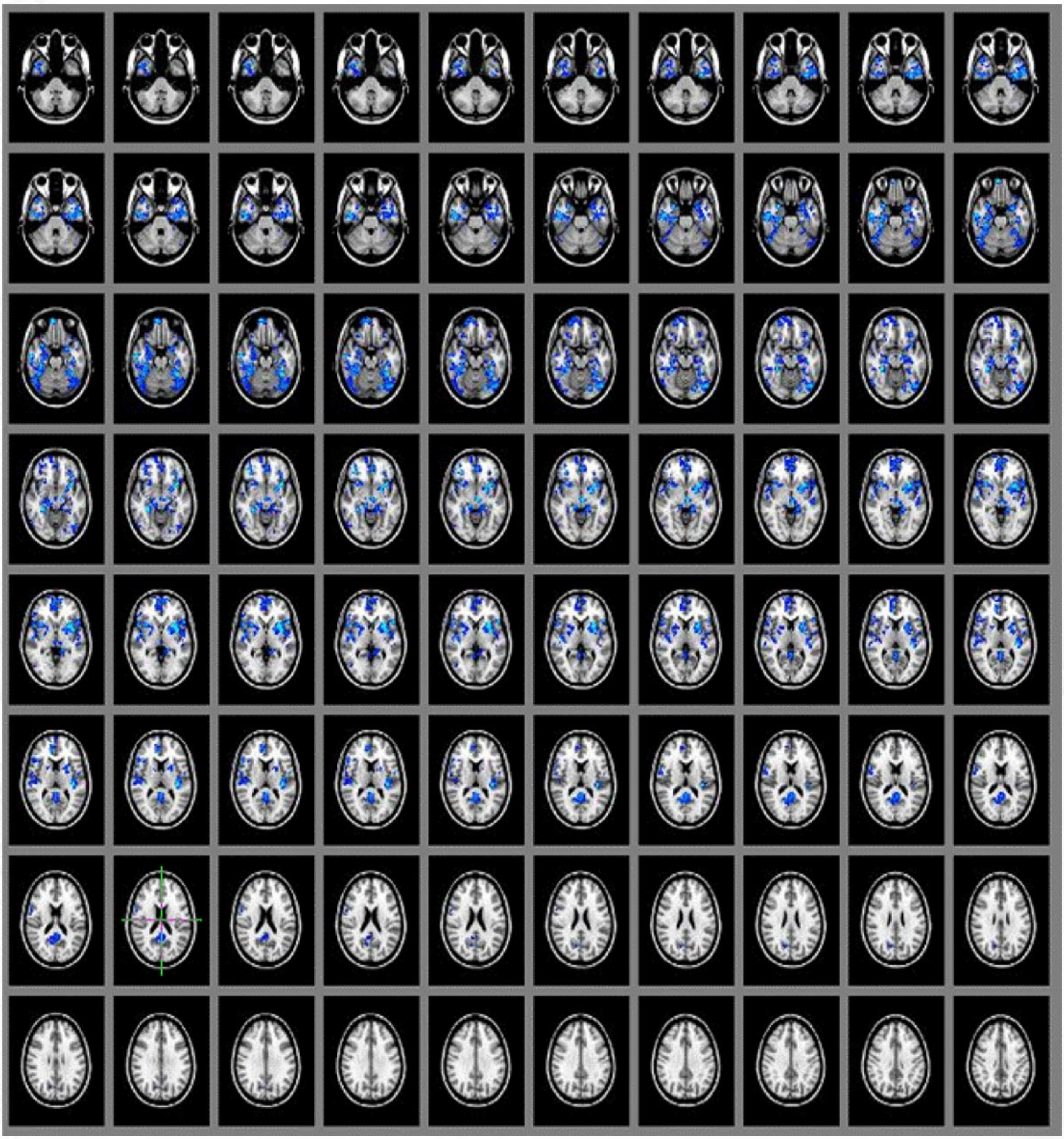


Fig. S2. Slices for blood-oxygen level-dependent (BOLD) result: Lightbox display of slices showing regions where there were significant decreases in BOLD after psilocybin vs. placebo. Mixed-effects analysis, cluster threshold = 1.8, $P < 0.05$ whole-brain corrected, $n = 15$. The right hemisphere is shown on the left.

For each subject, the vmPFC time series was entered into a model that included independent gray matter, white matter, and cerebrospinal fluid time series as regressors of no-interest. Fig. 5 displays regions where activity was positively (yellow/orange) and negatively (blue) coupled to activity in the vmPFC throughout the placebo scan. However, the salient images are those shown as follows in Fig. 5: the middle row displays regions where activity became significantly less (blue) and more (red) coupled to activity in the vmPFC after psilocybin infusion and the bottom row displays these effects relative to those after placebo.

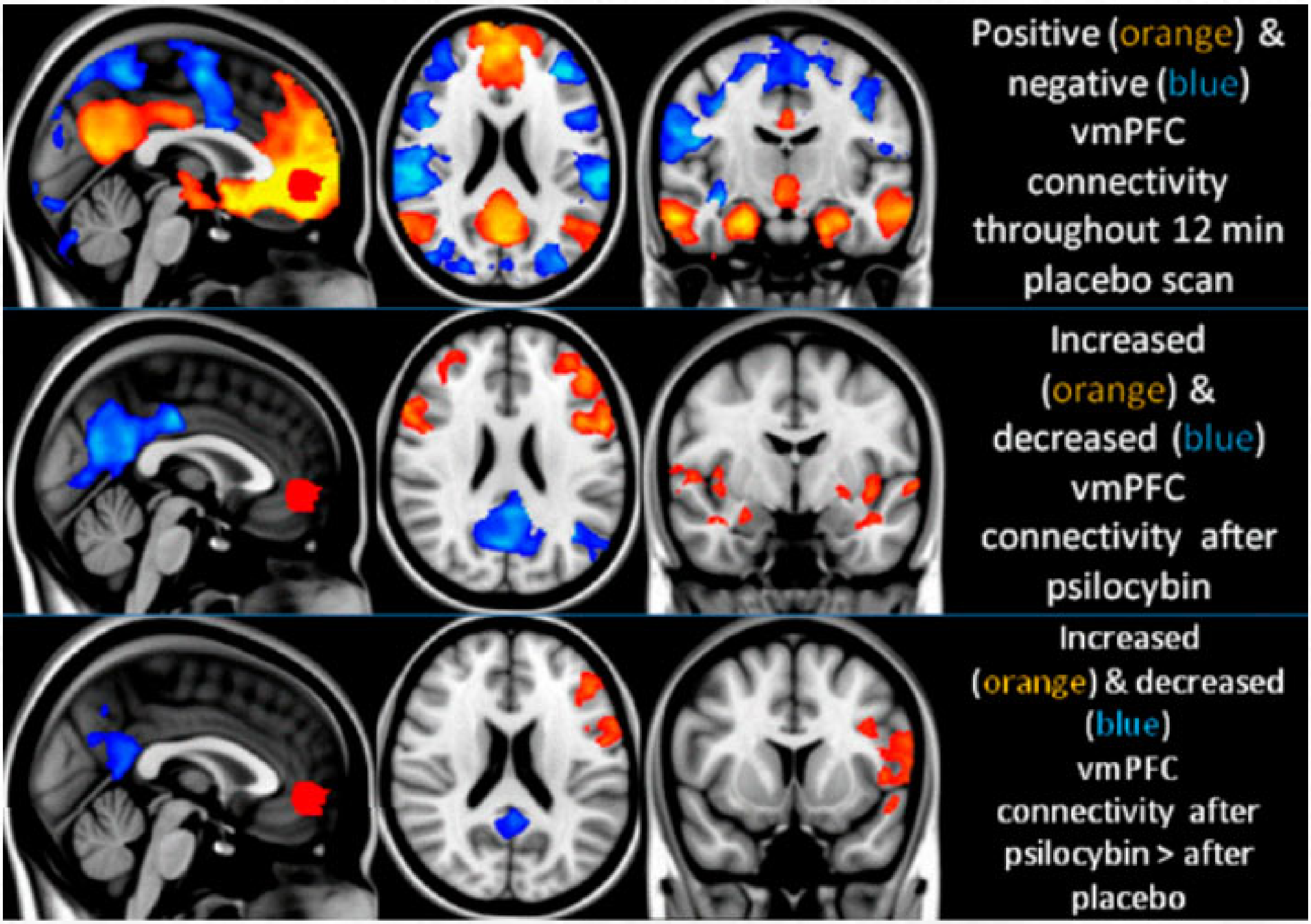

Positive (orange) & negative (blue) vmPFC connectivity throughout 12 min placebo scan
Increased (orange) & decreased (blue) vmPFC connectivity after psilocybin
Increased (orange) & decreased (blue) vmPFC connectivity after psilocybin > after placebo

Fig. 5. Psilocybin-induced changes in vmPFC (red) functional connectivity. (*Top*) Regions where activity was positively coupled to that of the vmPFC are shown in orange and regions where activity was "negatively" coupled to activity in the vmPFC are shown in blue (it should be noted however, that the appearance of negative connectivity is forced by regression of the global signal). (*Middle*) Significant increases (orange) and decreases (blue) in functional connectivity after psilocybin infusion. (*Bottom*) Increases and decreases in functional connectivity after psilocybin that were significantly greater than any connectivity changes after placebo. All analyses were mixed effects, $z > 2.3$, $P < 0.05$ whole-brain cluster corrected, $n = 15$. Note: The significant psycho-physiological interactions in the posterior PCC and left lateral parietal region suggest that the positive coupling (under placebo) has decreased significantly. This finding should not necessarily be interpreted as a negative coupling, simply a significant decrease in a positive coupling.

Physiological Correction and Breath-Hold

BOLD and ASL fMRI measure changes in a vascular signal that is coupled to changes in neural activity. It is therefore important to address factors that may modulate brain vasculature without affecting neural activity. For example, increases in blood carbon dioxide that occur with changes in respiration can drive increases in CBF [7]. Thus, to address the possibility that the effects observed in this study were driven by nonneural physiological changes, physiological variance (i.e., heart rate, respiration rate, and respiration depth) was regressed from the functional data before repeating the BOLD analyses described above. This correction step did not significantly alter the statistical parametric maps (Fig. S3), suggesting that changes in physiological parameters were not responsible for the positive outcomes.

Furthermore, to test the possibility that psilocybin had acted directly on the cerebral vasculature, we included a blocked breath-hold paradigm at the end of each BOLD scan. Hypercapnia is known to significantly increase the BOLD signal via CO_2-induced vasodilation (see ref. 7 and Fig. S4); thus, it was reasoned that a direct effect of psilocybin on brain vasculature would cause an altered BOLD response to breath-hold. However, no difference was found in the BOLD response to breath-hold under psilocybin and placebo, implying that the drug had not acted directly on the vascular system.

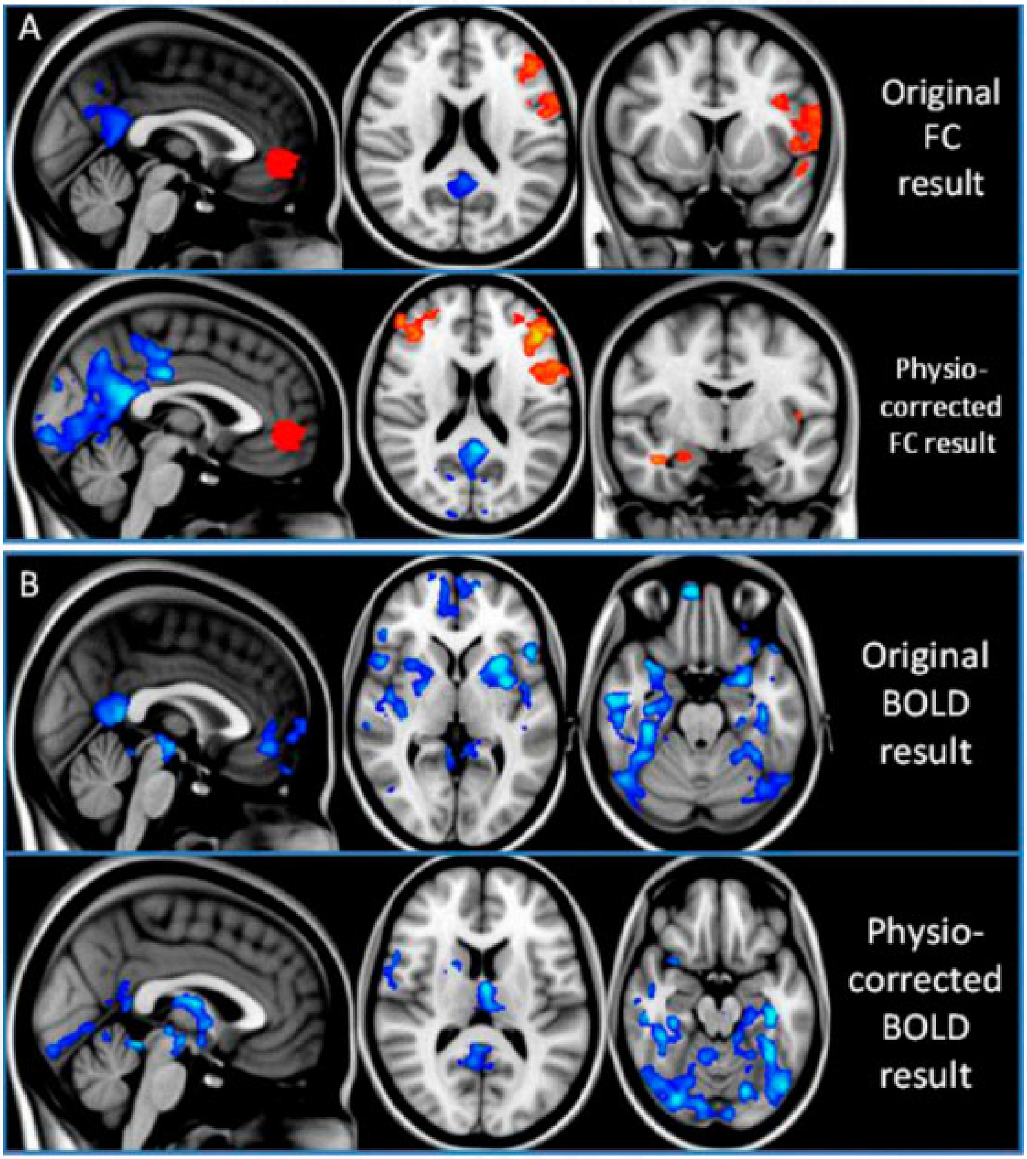


Fig. S3. Physiologically corrected results. (A) Corrected functional connectivity result. The original image used a cluster threshold of 2.3, mixed effects, $P < 0.05$, whole-brain corrected and the corrected image used a cluster threshold of 1.8, mixed effects, $P < 0.05$ whole-brain corrected. Both results show connectivity changes under psilocybin that were greater than connectivity changes under placebo (orange, increases in connectivity with the vmPFC; blue, decreases). (B) Corrected BOLD results. Both BOLD maps were based on mixed effects analyses, cluster-threshold 1.8, $P < 0.05$, whole-brain corrected. Both maps show greater decreases in BOLD after psilocybin vs. after placebo.

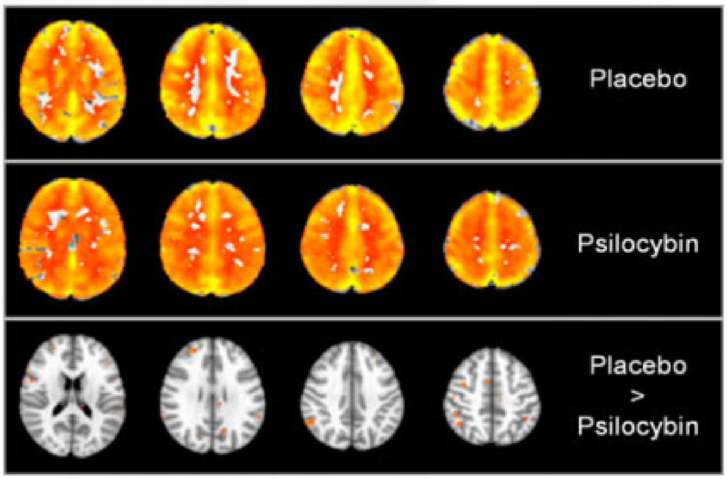


Fig. S4. Cerebrovascular reactivity (CVR) maps. The across-subject mean CVR maps are shown for both the placebo and psilocybin conditions (Top and Middle). Each map is thresholded at a very liberal $P < 0.01$ uncorrected threshold (t tests vs. 0). These maps demonstrate the high CVR values are located in gray matter as is expected. (Bottom) The results from a paired t test between placebo and drug conditions, again thresholded at $P < 0.01$ uncorrected. The paucity of differences at such a liberal threshold demonstrates that CVR remains unchanged by psilocybin.

Discussion

The fMRI studies reported here revealed significant and consistent outcomes. Psilocybin significantly decreased brain blood flow and venous oxygenation in a manner that correlated with its subjective effects, and significantly decreased the positive coupling of two key structural hubs (the mPFC and the PCC). Our use of fMRI to measure resting-state brain activity after a psychedelic is unique, and because the results are unexpected, they require some explanation.

The effect of psilocybin on resting-state brain activity has been measured before with PET and glucose metabolism [8]. This study found a global increase in glucose metabolism after oral psilocybin, which is inconsistent with our fMRI results. One possible explanation for this discrepancy relates to the fact that the radiotracer used to measure glucose metabolism (^{18}F-fluorodeoxyglucose) has a long half-life (110 min). Thus, the effects of psilocybin, as measured by PET, are over much greater timescales than indexed by our fMRI measures. It is therefore possible that phasic or short-term effects of psilocybin show some rebound that is detected by longer-term changes in glucose metabolism. More direct measures of neural activity will help inform this hypothesis, but in support of the inference that psilocybin does decrease neural activity, direct recordings of cortical local field potentials (LFPs) in rats found broadband decreases in resting state LFP power after psilocybin infusion - including γ-power[9] - changes in which are known to correlate with changes in the BOLD signal [10].

It has been commonly assumed that psychedelics work by increasing neural activity; however, our results put this into question. Psilocin is a mixed serotonin receptor agonist, but there is a general consensus that the characteristic subjective and behavioral effects of psychedelics are initiated via stimulation of serotonin 5-Hydroxytryptamine, 5-HT) 2A receptors[11]. It is possible that the deactivations observed in the present studies were caused by stimulation of 5-HT receptors other than 5-HT$_{2A}$; however, this seems unlikely given that the affinity of psychedelics for the 5- HT$_{2A}$ receptor correlates with their potency[12] and 5-HT$_{2A}$ antagonists block the subjective effects of psychedelics[13]. There is a large body of preclinical evidence that stimulation of 5-HT$_{2A}$ receptors increases GABAergic transmission and pyramidal cell inhibition[14-21], which may explain the deactivations observed here (Figs. 2 and 4). fMRI studies with serotonergic compounds that stimulate other 5-HT receptors, such as the 5-HT$_{2C}$[22] or (mainly) the 5-HT$_{1A}$ receptor[23], have not found comparable results to those shown here, and 5-HT$_{2A}$ receptors are present in high concentrations in the cortical regions that were significantly deactivated and decoupled after psilocybin (Table S2).

Stimulation of the 5-HT$_{2A}$ receptor increases excitation in the host cell by reducing outward potassium currents [24]. Thus, if the 5-HT$_{2A}$ receptor did mediate the observed deactivations, then it may have been via 5-HT$_{2A}$-induced excitation of fast-spiking interneurons terminating on pyramidal cells (e.g., ref. [24]) or 5-HT$_{2A}$-induced excitation of pyramidal cells projecting onto interneurons [25].

Regardless of how these effects were initiated at the receptor level, it is necessary for us to offer a functional explanation for them. It is noteworthy that the regions which showed the most consistent deactivations after psilocybin (e.g., the PCC and mPFC) are also those that show disproportionately high activity under normal conditions [26]. For example, metabolism in the PCC is ~20% higher than most other brain regions [27], yet psilocybin decreased its blood flow by up to 20% in some subjects. There is some mystery about the function of the PCC; its large size, buffered location, and rich vasculature means that it is well protected from damage. The high metabolic activity of the PCC and the default-mode network (DMN) with which is it associated [26] has led some to speculate about its functional importance, positing a role in consciousness [28] and high-level constructs, such as the self [29] or "ego" [30, 31]. Indeed, the DMN is known to be activated during self-referencing [28] and other high-level functions linked to the self-construct [27]. Moreover, DMN regions are also known to host the highest number of cortico-cortical connections in the brain, making them important "connector hubs" [32]. These hubs may be critical for efficient information transfer in the brain by allowing communication between different regions via the fewest number of connections [33]. However, such an integrative function would confer a significant responsibility on these regions, which may explain why their deactivation has such a profound effect on consciousness, as shown here.

Table S2. Regional 5-HT_{2A} receptor binding potentials: 5-HT_{2A} binding potential was assessed with ^{18}F-altanserin PET in 136 healthy adult human subjects

Brain region	BP_p(av)	SD
Posterior cingulate cortex	1.64	0.51
Superior temporal cortex	1.59	0.53
Medial inferior temporal cortex	1.57	0.52
Dorsolateral prefrontal cortex (DLPFC)	1.51	0.52
Anterior cingulate cortex	1.49	0.54
Medial inferior frontal gyrus	1.49	0.50
Occipital cortex	1.47	0.47
Orbitofrontal cortex	1.46	0.54
Paracingulate cortex	1.45	0.48
Average frontal cortex	1.45	0.50
Average global neocortex	1.44	0.48
Ventrolateral prefrontal cortex (VLPFC)	1.44	0.50
Insula	1.44	0.49
Superior frontal gyrus	1.38	0.48
Sensorimotor cortex	1.09	0.39
Amygdala	0.64	0.28
Putamen/pallidum	0.51	0.16
Hippocampus	0.51	0.28
Entorhinal cortex	0.43	0.32
Thalamus	0.33	0.18
Caudate nucleus	0.25	0.17

For further details about the data presented in the table, please see Erritzoe, et al.,[1] for study sample and imaging methods, Frokajer, et al.,[2] for delineation of VLPFC and DLPFC, and Svarer, et al.[3] for delineation of other brain regions. Please note that the VLPFC and the DLPFC are defined so that they are both overlapping with the medial and inferior frontal cortex, and in addition the DLPFC overlaps with the superior frontal cortex. Av, average; BPP, binding potential normalized to plasma; 5-HT, 5-Hydroxytryptamine.

References:

1. Erritzoe D, et al. (2009) Brain serotonin 2A receptor binding: Relations to body mass index, tobacco and alcohol use. *Neuroimage* 46:23-30.
2. Frokjaer VG, et al. (2009) High familial risk for mood disorder is associated with low dorsolateral pefrontal cortex serotonin transporter binding. *Neuroimage* 46:360-366.
3. Svarer C, et al. (2005) MR-based automatic delineation of volumes of interest in human brain PET images using probability maps. *Neuroimage* 24:969-979.

These results may have implications beyond explaining how psilocybin works in the brain by implying that the DMN is crucial for the maintenance of cognitive integration and constraint under normal conditions. This finding is consistent with Aldous Huxley's "reducing valve" metaphor [34] and Karl Friston's "free-energy principle" [35], which propose that the mind/brain works to constrain its experience of the world.

The pharmaco-physiological interaction results were particularly intriguing, revealing significant decreases in the positive coupling between the PCC and mPFC after psilocybin. This result can be understood in terms of a regression of PCC activity on mPFC activity, in which the regression slope decreases. This finding can either be interpreted as a decrease in the (backward or top-down) connectivity from prefrontal to parietal regions or, equivalently, an increase in the reciprocal (forward or bottom-up) direction from parietal to prefrontal regions. This asymmetrical change in coupling, induced by psilocybin, is consistent with a reduction in the sensitivity of superficial pyramidal cells in the parietal region targeted by prefrontal afferents, which may or may not be associated with a compensatory increase in the influence of parietal regions on prefrontal activity. Whatever the underlying synaptic mechanisms, these results provide clear evidence for a perturbation in reciprocal coupling between these two association areas and speak to a rebalancing of hierarchical activity in distributed high-level modes.

Finally, consistent with their history of use as adjuncts to psychotherapy, the idea has recently re-emerged that psychedelics may be useful in the treatment of certain psychiatric disorders [36]. It seems relevant therefore that activity in [37] and connectivity with [38] the mPFC is known to be elevated in depression and normalized after effective treatment [39]. The mPFC was consistently deactivated by psilocybin (Fig. 4) and the magnitude of the deactivations correlated with the drug's subjective effects (Fig. 3). Depression has been characterized as an "overstable" state, in which cognition is rigidly pessimistic [39]. Trait pessimism has been linked to deficient 5-HT_{2A} receptor stimulation [40, 41], particularly in the mPFC [40], and mPFC hyperactivity has been linked to pathological brooding [42]. Recent work has shown that psilocybin can increase subjective well-being [4] and trait openness [43] several months after an acute experience, and depression scores in terminal cancer patients were significantly decreased 6 mo after treatment with psilocybin [2]. Our results suggest a biological mechanism for this: decreased mPFC activity via 5-HT_{2A} receptor stimulation. Further work is required to test this hypothesis and the putative utility of psilocybin in depression.

We also observed decreased CBF in the hypothalamus after psilocybin (Fig. 2), which may explain anecdotal reports that psychedelics reduce symptoms of cluster headaches [44]. Increased hypothalamic CBF was observed during acute headache in cluster headache sufferers [45] and inhibition of the hypothalamus via direct electrical stimulation can provide therapeutic relief for this condition [46].

To conclude, here we used an advanced and comprehensive fMRI protocol to image the brain effects of psilocybin. These studies offer the most detailed account to date on how the psychedelic state is produced in the brain. The results suggest decreased activity and connectivity in the brain's connector hubs, permitting an unconstrained style of cognition.

Materials and Methods

All subjects gave informed consent to participate in the study. The study was approved by a National Health Service research ethics committee. A physical examination, including electrocardiogram(ECG), routine blood tests, and urine test for drugs of abuse and pregnancy were carried out. A psychiatric assessment was conducted and participants disclosed their drug taking histories. Exclusion criteria were: less than 21 y of age, pregnancy, personal or immediate family history of psychiatric disorder, substance dependence, cardiovascular disease, claustrophobia, blood or needle phobia, or a significant adverse response to a hallucinogenic drug. All subjects had previous experience with a hallucinogenic drug but not within 6 wk of the study.

MRI Anatomical Scan

All imaging was performed on a 3T GE HDx system. For every functional scan, we obtained an initial 3D FSPGR scan in an axial orientation, with field of view= 256× 256× 192 and matrix = 256 × 256× 192 to yield 1-mm isotropic voxel resolution (TR/TE = 7.9/3.0 ms; inversion time = 450 ms; flip angle = 20°).

MRI Methods

ASL relative perfusion measurement

Whole-brain perfusion was measured using single-shot pulsed ASL PICORE (proximal inversion with a control for off-resonance effects) QUIPSSII (quantitative imaging of perfusion using a single subtraction) sequence with GE-EPI readout. The 240 tag-control image pairs with 16 axial slices (3 × 3 × 6-mm voxel resolution, matrix = 64 × 64, with a 1-mm gap in the axial direction) were acquired (TR/TE = 2200/19.8 ms, single-inversion time with TI1 = 700 and TI2 = 1,350 ms for the most proximal slice).

General linear modeling was used to evaluate the drug-induced modulation of the perfusion signal. In the first-level analysis, the difference between tag and control images was explicitly modeled as one regressor representing the voxel-wise mean perfusion per scan per voxel. A second regressor was established from the interaction of the first regressor and the estimated time-course based on the drug pharmacodynamics [5]. This represents the within-scan modulation of perfusion by the drug.

The results of fitting this model at the first level were combined in a higher level within-subjects analysis to compare modulation of perfusion during psilocybin infusion with that during saline infusion. A mixed-effects analysis was performed. Z statistical parametric maps were thresholded at a cluster size of $z > 2.3$ and a whole-brain significance of $P < 0.05$. To assist with this process, perfusion data underwent unwarping for B0 field distortions and were registered to the T1-weighted high-resolution (1 × 1 × 1 mm) structural scan which was itself registered to a 1-mm resolution Montreal Neurological Institute (MNI) standard brain, using nonlinear registration.

BOLD measurement

BOLD-weighted fMRI data were acquired using a gradient-echo EPI sequence, TR/TE 3000/35 ms, field-of-view = 192 mm, 64 × 64 acquisition matrix, parallel acceleration factor = 2, 90° flip angle. Fifty-three oblique-axial slices were acquired in an interleaved fashion, each 3 mm thick with zero slice gap (3 × 3 × 3-mm voxels). A total of 240 volumes were acquired.

At the first-level, a basic square function informed by the time-course of intravenous psilocybin's subjective effects [5] was used to model changes in the BOLD signal. A mixed-effects analysis was performed at the group level. Z statistical parametric maps were thresholded using clusters determined by $z > 2.3$ and a whole-brain cluster significance threshold of $P < 0.05$. The results were registered to the T1-weighted high-resolution (1 × 1 × 1 mm) structural scan, which was itself nonlinearly registered to a 1-mm MNI standard brain.

Pharmaco-Physiological Interaction/Functional Connectivity Analysis

A medial prefrontal ROI was drawn on a standard brain over maps of the CBF and BOLD decreases. This mask was then transformed into single-subject functional space and time series were derived for each subject. Gray matter, white matter, and CSF were segmented in each subjects' anatomical image and these masks were thresholded and transformed into functional space. Their time series were derived and used as regressors of no interest in the general linear model. The primary contrasts of interest within each subjects' scan was the interaction between vmPFC connectivity and the infusion event (i.e., maps were generated showing regions where activity became significant more and less coupled to activity in the vmPFC ROI after infusion versus before). Maps were generated for the effect of psilocybin infusion alone (Fig. 5, *Middle*) and psilocybin infusion versus placebo infusion (Fig. 5, *Bottom*). All maps were generated via mixed effects analyses, thresholded at a cluster size of 2.3, and whole-brain corrected for multiple comparisons with a P value of 0.05.

Physiological Noise Correction

After infusion of psilocybin, alterations in physiological rhythms, such as the respiration and cardiac cycle, may occur leading to changes in resting state BOLD signal fluctuations, thus biasing connectivity analyses. To adjust for such confounds, physiological correction routines were used. Respiration, cardiac, and end-tidal CO_2 traces were recorded during MR acquisitions using a chest bellows, a pulse oximeter, and a nasal canula attached to a capnograph, respectively. After extracting cycle timings, harmonics of the respiration and cardiac cycle (two respiration, two cardiac, and one interaction term) were removed from the data using RETROICOR (47). Variance because of cardiac and respiration rate changes was removed (48, 49) along with end-tidal CO_2-related fluctuations (50) using general linear model analyses.

Cerebrovascular Reactivity

Psilocybin may alter cerebrovascular reactivity (CVR), a blood vessel's ability to respond to a stimulus, thus introducing a bias between conditions. To determine if changes in reactivity occur, MR measurements of CVR were acquired using the approach of Murphy *et al.* [7]. Briefly, participants were asked to perform a breath-hold task (30-s paced breathing, 10-s breath-hold) while MR data with a similar acquisition to above and end-tidal CO_2 traces were acquired. BOLD responses to breath-hold were normalized to subject-specific CO_2 increases to give percent BOLD/mmHg, a CVR measure. These maps were transformed into MNI space and voxel-wise paired t tests were performed between the placebo and psilocybin conditions.

Acknowledgments

The authors thank Alison Diaper, Ann Rich, Sue Wilson, and Karl Friston. These studies received financial and intellectual support from the Beckley Foundation and financial support from the Neuropsychoanalysis Foundation, Multidisplinary Association for Psychedelic Studies, and the Heffter Research Institute.

References

1. Wasson GR (1957) Seeking the magic mushroom. *Life Magazine*, May 15:109-120.
2. Grob CS, et al. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68:71-78.
3. Griffiths RR, Richards WA, McCann U, Jesse R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology (Berl)* 187:268-283, discussion 284-292.
4. Griffiths R, Richards W, Johnson M, McCann U, Jesse R (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22:621-632.
5. Carhart-Harris RL, et al. (2010) The administration of psilocybin to healthy, hallucinogen-experienced volunteers in a mock-functional magnetic resonance imaging environment: A preliminary investigation of tolerability. *J Psychopharmacol* 25:1562-1567.
6. Hasler F, Grimberg U, Benz MA, Huber T, Vollenweider FX (2004) Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. *Psychopharmacology (Berl)*172:145-156.
7. Murphy K, Harris AD, Wise RG (2011) Robustly measuring vascular reactivity differences with breath-hold: normalising stimulus-evoked and resting state BOLD fMRI data. *Neuroimage* 54:369-379.
8. Vollenweider FX, et al. (1997) Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16:357-372.
9. Pälenicek T, et al. (2011) Comparison of the effects of hallucinogens psilocin and mescaline on quantitative EEG and sensorimotor gating - an animal model of psychosis. *Psychiatrie* 15:44-48.
10. Shmuel A, Leopold DA (2008) Neuronal correlates of spontaneous fluctuations in fMRI signals in monkey visual cortex: Implications for functional connectivity at rest. *Hum Brain Mapp* 29:751-761.
11. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101:131-181.
12. Glennon RA, Titeler M, McKenney JD (1984) Evidence for 5-HT2 involvement in the mechanism of action of hallucinogenic agents. *Life Sci* 35:2505-2511.
13. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Bäbler A, Vogel H, Hell D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9:3897-3902.
14. Shen RY, Andrade R (1998) 5-Hydroxytryptamine2 receptor facilitates GABAergic neurotransmission in rat hippocampus. *J Pharmacol Exp Ther* 285:805-812.
15. Scruggs JL, Schmidt D, Deutch AY (2003) The hallucinogen 1-[2,5-dimethoxy-4-iodo-phenyl]-2-aminopropane (DOI) increases cortical extracellular glutamate levels in rats. *Neurosci Lett* 346:137-140.
16. Abi-Saab WM, Bubser M, Roth RH, Deutch AY (1999) 5-HT2 receptor regulation of extracellular GABA levels in the prefrontal cortex. *Neuropsychopharmacology* 20:92-96.
17. Zhang QJ, et al. (2010) Unilateral lesion of the nigrostriatal pathway decreases the response of interneurons in medial prefrontal cortex to 5-HT 2A/2C receptor stimulation in the rat. *Brain Res* 1312:127-137.
18. Ashby CR, Jr., Jiang LH, Kasser RJ, Wang RY (1990) Electrophysiological characterization of 5-hydroxytryptamine2 receptors in the rat medial prefrontal cortex. *J Pharmacol Exp Ther* 252:171-178.
19. Marek GJ, Aghajanian GK (1996) LSD and the phenethylamine hallucinogen DOI are potent partial agonists at 5-HT2A receptors on interneurons in rat piriform cortex. *J Pharmacol Exp Ther* 278:1373-1382.
20. el Mansari M, Blier P (1997) In vivo electrophysiological characterization of 5-HT receptors in the guinea pig head of caudate nucleus and orbitofrontal cortex. *Neuropharmacology* 36:577-588.
21. Bergqvist PB, Dong J, Blier P (1999) Effect of atypical antipsychotic drugs on 5-HT2 receptors in the rat orbito-frontal cortex: An in vivo electrophysiological study. *Psychopharmacology (Berl)*143:89-96.
22. Anderson IM, et al. (2002) 5-HT(2C) receptor activation by m-chlorophenylpiperazine detected in humans with fMRI. *Neuroreport* 13:1547-1551.
23. McKieS, etal. (2005) Neuronal effects of acute citalopram detected by pharmacoMRI. *Psychopharmacology (Berl)*180:680-686.
24. Andrade R (2011) Serotonergic regulation of neuronal excitability in the prefrontal cortex. *Neuropharmacology* 61:382-386.
25. Alexander GM, et al. (2009) Remote control of neuronal activity in transgenic mice expressing evolved G protein-coupled receptors. *Neuron* 63:27-39.
26. Raichle ME, etal. (2001)A default mode of brain function. *Proc Natl Acad Sci USA* 98: 676-682.
27. Buckner RL, Andrews-Hanna JR, Schacter DL (2008) The brain's default network: Anatomy, function, and relevance to disease. *Ann N Y Acad Sci* 1124:1 -38.
28. Raichle ME (1998) The neural correlates of consciousness: An analysis of cognitive skill learning. *Philos Trans R Soc Lond B Biol Sci* 353:1889-1901.
29. Gusnard DA, Akbudak E, Shulman GL, Raichle ME (2001) Medial prefrontal cortexand self-referential mental activity: Relation to a default mode of brain function. *Proc Natl Acad Sci USA* 98:4259-4264.
30. Carhart-Harris RL, Mayberg HS, Malizia AL, Nutt D (2008) Mourning and melancholia revisited: Correspondences between principles of Freudian metapsychology and empirical findings in neuropsychiatry. *Ann Gen Psychiatry* 7:9.
31. Carhart-Harris RL, Friston KJ (2010) The default-mode, ego-functions and free-energy: A neurobiological account of Freudian

ideas. *Brain* 133:1265-1283.
32. Hagmann P, et al. (2008) Mapping the structural core of human cerebral cortex. *PLoS Biol* 6:e159.
33. Bullmore E, et al. (2009) Generic aspects of complexity in brain imaging data and other biological systems. *Neuroimage* 47:1125-1134.
34. Huxley A (1954) *The Doors of Perception and Heaven and Hell* (Harper & Brothers, London).
35. Friston K (2010) The free-energy principle: A unified brain theory? *Nat Rev Neurosci* 11:127-138.
36. Sessa B (2005) Can psychedelics have a role in psychiatry once again? *Br J Psychiatry* 186:457-458.
37. Drevets WC, Price JL, Furey ML (2008) Brain structural and functional abnormalities in mood disorders: Implications for neurocircuitry models of depression. *Brain Struct Funct* 213:93-118.
38. Sheline YI, Price JL, Yan Z, Mintun MA (2010) Resting-state functional MRI in depression unmasks increased connectivity between networks via the dorsal nexus. *Proc Natl Acad Sci USA* 107:11020-11025.
39. Holtzheimer PE, Mayberg HS (2011) Stuck in a rut: Rethinking depression and its treatment. *Trends Neurosci* 34:1 -9.
40. Bhagwagar Z, et al. (2006) Increased 5-HT(2A) receptor binding in euthymic, medication-free patients recovered from depression: A positron emission study with [(11) C]MDL 100,907. *Am J Psychiatry* 163:1580-1587.
41. Meyer JH, et al. (2003) Dysfunctional attitudes and 5-HT2 receptors during depression and self-harm. *Am JPsychiatry* 160:90-99.
42. Farb NA, Anderson AK, Bloch RT, Segal ZV (2011) Mood-linked responses in medial prefrontal cortex predict relapse in patients with recurrent unipolar depression. *Biol Psychiatry* 70:366-372.
43. Griffiths RR, et al. (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25:1453-1461.
44. Sewell RA, Halpern JH, Pope HG, Jr. (2006) Response of cluster headache to psilocybin and LSD. *Neurology* 66:1920-1922.
45. May A, Bahra A, Büchel C, Frackowiak RS, Goadsby PJ (1998) Hypothalamic activation in cluster headache attacks. *Lancet* 352:275-278.
46. Franzini A, Messina G, Cordella R, Marras C, Broggi G (2010) Deep brain stimulation of the posteromedial hypothalamus: Indications, long-term results, and neurophysiological considerations. *Neurosurg Focus* 29:E13.
47. Glover GH, Li T-Q, Ress D (2000) Image-based method for retrospective correction of physiological motion effects in fMRI: RETROICOR. *Magn Reson Med* 44:162-167.
48. Shmueli K, et al. (2007) Low-frequency fluctuations in the cardiac rate as a source of variance in the resting-state fMRI BOLD signal. *Neuroimage* 38:306-320.
49. Birn RM, Diamond JB, Smith MA, Bandettini PA (2006) Separating respiratory-variation-related fluctuations from neuronal-activity-related fluctuations in fMRI. *Neuroimage* 31:1536-1548.
50. Wise RG, Ide K, Poulin MJ, Tracey I (2004) Resting fluctuations in arterial carbon dioxide induce significant low frequency variations in BOLD signal. *Neuroimage* 21: 1652-1664.

Enhanced Repertoire of Brain Dynamical States During the Psychedelic Experience

by

Enzo Tagliazucchi, Robin Carhart-Harris, Robert Leech, David Nutt, Dante R. Chialvo

27 May 2014

original report: http://www.chialvo.net/chialvo.net/Publications_files/Psilo_2014.pdf
backup source: http://www.psilosophy.info/resources/Psilo_2014.pdf

- **Enzo Tagliazucchi** - Neurology Department and Brain Imaging Center, Goethe University, Frankfurt am Main, Germany
- **David Nutt, Robin Carhart-Harris** - Imperial College London, Centre for Neuropsychopharmacology, Division of Experimental Medicine, London, UK
- **Robert Leech** - Computational, Cognitive and Clinical Neuroimaging Laboratory (C3NL), Division of Brain Sciences, Imperial College London, UK
- **Dante R. Chialvo** - Consejo Nacional de Investigaciones Cientificas y Tecnologicas (CONICET), Buenos Aires, Argentina.

Contract grant sponsors: CONICET (Argentina) and LOEWE Neuronale Koordination Forschungsschwerpunkt Frankfurt - NeFF (Germany).
*Correspondence to: Enzo Tagliazucchi, Neurology Department and Brain Imaging Center, Goethe University, Frankfurt am Main, Germany. E-mail: tagliazucchi.enzo@googlemail.com

Received for publication 11 January 2014; Revised 21 May 2014; Accepted 23 May 2014.
DOI: 10.1002/hbm.22562

Table of Contents:

INTRODUCTION
MATERIALS AND METHODS
Study Overview and Design
Participants
Anatomical Scans
Drug Infusion
fMRI Data Acquisition and Preprocessing
Analysis of Spatiotemporal Dynamics
Analysis of Temporal Variability
Further Spectral Analysis of BOLD Fluctuations
Point-Process Analysis
Computation of Dynamical Functional Connectivity States and its Associated Entropy
Statistical Testing
RESULTS
DISCUSSION
ACKNOWLEDGMENTS
REFERENCES

Abstract: The study of rapid changes in brain dynamics and functional connectivity (FC) is of increasing interest in neuroimaging. Brain states departing from normal waking consciousness are expected to be accompanied by alterations in the aforementioned dynamics. In particular, the psychedelic experience produced by psilocybin (a substance found in "magic mushrooms") is characterized by unconstrained cognition and profound alterations in the perception of time, space and selfhood. Considering the spontaneous and subjective manifestation of these effects, we hypothesize that neural correlates of the psychedelic experience can be found in the dynamics and variability of spontaneous brain activity fluctuations and connectivity, measurable with functional Magnetic Resonance Imaging (fMRI). Fifteen healthy subjects were scanned before, during and after intravenous infusion of psilocybin and an inert placebo. Blood-Oxygen Level Dependent (BOLD) temporal variability was assessed computing the variance and total spectral power, resulting in increased signal variability bilaterally in the hippocampi and anterior cingulate cortex. Changes in BOLD signal spectral behavior (including spectral scaling exponents) affected exclusively higher brain systems such as the default mode, executive control, and dorsal attention networks. A novel framework enabled us to track different connectivity states explored by the brain during rest. This approach revealed a wider repertoire of connectivity states post-psilocybin than during control conditions. Together, the present results provide a comprehensive account of the effects of psilocybin on dynamical behavior in the human brain at a macroscopic level and may have implications for our understanding of the unconstrained, hyper-associative quality of consciousness in the psychedelic state.

Key words: Psilocybin; fMRI; functional connectivity; resting state; psychedelic state

INTRODUCTION

Psilocybin (phophoryl-4-hydroxy-dimethyltryptamine) is the phosphorylated ester of the main psychoactive compound found in magic mushrooms. Pharmacologically related to the prototypical psychedelic LSD, psilocybin has a long history of ceremonial use via mushroom ingestion and, in modern times, psychedelics have been assessed as tools to enhance the psychotherapeutic process [Grob *et al*., 2011; Krebs *et al*., 2012; Moreno *et al*., 2006]. The subjective effects of psychedelics include (but are not limited to) unconstrained, hyperassociative cognition, distorted sensory perception (including synesthesia and visions of dynamic geometric patterns) and alterations in one's sense of self, time and space. There is recent preliminary evidence that psychedelics may be effective in the treatment of anxiety related to dying [Grob *et al*., 2011] and obsessive compulsive disorder [Moreno *et al*., 2006] and there are neurobiological reasons to consider their potential as antidepressants [Carhart-Harris *et al*., 2012, 2013]. Similar to ketamine (another novel candidate antidepressant) psychedelics may also mimic certain psychotic states such as the altered quality of consciousness that is sometimes seen in the onset-phase of a first psychotic episode [Carhart-Harris *et al*., 2014]. There is also evidence to consider similarities between the psychology and neurobiology of the psychedelic state and Rapid Eye Movement (REM) sleep [Carhart-Harris, 2007; Carhart-Harris and Nutt, 2014], the sleep stage associated with vivid dreaming [Aserinsky and Kleitman, 1953].

The potential therapeutic use of psychedelics, as well as their capacity to modulate the quality of conscious experience in a relatively unique and profound manner, emphasizes the importance of studying these drugs and how they act on the brain to produce their novel effects. One potentially powerful way to approach this problem is to exploit human neuroimaging to measure changes in brain activity during the induction of the psychedelic state. The neural correlates of the psychedelic experience induced by psilocybin have been recently assessed using Arterial Spin Labeling (ASL) and BOLD fMRI [Carhart-Harris *et al*., 2012]. This work found that psilocybin results in a reduction of both CBF and BOLD signal in major subcortical and cortical hub structures such as the thalamus, posterior cingulate (PCC) and medial prefrontal cortex (mPFC) and in decreased resting state functional connectivity (RSFC) between the normally highly coupled mPFC and PCC. Furthermore, our most recent study used magnetoencephalography (MEG) to more directly measure altered neural activity post-psilocybin and here we found decreased oscillatory power in the same cortical hub structures [Muthukumaraswamy *et al*., 2013, see also Carhart-Harris *et al*., 2014 for a review on this work).

These results establish that psilocybin markedly affects BOLD, CBF, RSFC, and oscillatory electrophysiological measures in strategically important brain structures, presumably involved in information integration and routing [Carhart-Harris *et al*., 2014; de Pasquale *et al*., 2012; Hagmann *et al*., 2008; Leech *et al*., 2012]. However, the effects of psilocybin on the variance of brain activity parameters across time has been relatively understudied and this line of enquiry may be particularly informative in terms of shedding new light on the mechanisms by which psychedelics elicit their characteristic psychological effects. Thus, the main objective of this article is to examine how psilocybin modulates the dynamics and temporal variability of resting state

BOLD activity. Once regarded as physiological noise, a large body of research has now established that resting state fluctuations in brain activity have enormous neurophysiological and functional relevance [Fox and Raichle, 2007]. Spontaneous fluctuations self-organize into internally coherent spatiotemporal patterns of activity that reflect neural systems engaged during distinct cognitive states (termed "intrinsic" or "resting state networks" - RSNs) [Fox and Raichle, 2005; Raichle, 2011; Smith *et al.*, 2009]. It has been suggested that the variety of spontaneous activity patterns that the brain enters during task-free conditions reflects the naturally itinerant and variegated quality of normal consciousness [Raichle, 2011]. However, spatio-temporal patterns of resting state activity are globally well preserved in states such as sleep [Boly *et al.*, 2009, 2012; Brodbeck *et al.*, 2012; Larson-Prior *et al.*, 2009; Tagliazucchi *et al.*, 2013a,b,c] in which there is a reduced level of awareness - although very specific changes in connectivity occur across NREM sleep, allowing the decoding of the sleep stage from fMRI data [Tagliazucchi *et al.*, 2012c; Tagliazucchi and Laufs, 2014]. Thus, if the subjective quality of consciousness is markedly different in deep sleep relative to the normal wakeful state (for example) yet FC measures remain largely preserved, this would suggest that these measures provide limited information about the biological mechanisms underlying different conscious states. Similarly, intra-RSN FC is decreased under psilocybin [Carhart-Harris *et al.*, 2013] yet subjective reports of unconstrained or even "expanded" consciousness are common among users (see Carhart-Harris *et al.* [2014] for a discussion). Thus, the present analyses are motivated by the view that more sensitive and specific indices are required to develop our understanding of the neurobiology of conscious states, and that measures which factor in variance over time may be particularly informative.

A key feature of spontaneous brain activity is its dynamical nature. In analogy to other self-organized systems in nature, the brain has been described as a system residing in (or at least near to) a critical point or transition zone between states of order and disorder [Chialvo, 2010; Haimovici *et al.*, 2013; Tagliazucchi and Chialvo, 2011; Tagliazucchi *et al.*, 2012a]. In this critical zone, it is hypothesized that the brain can explore a maximal repertoire of its possible dynamical states, a feature which could confer obvious evolutionary advantages in terms of cognitive and behavioral flexibility. It has even been proposed that this cognitive flexibility and range may be a key property of adult human consciousness itself [Tononi, 2012]. An interesting research question therefore is whether changes in spontaneous brain activity produced by psilocybin are consistent with a displacement from this critical point - perhaps towards a more entropic or supercritical state (i.e. one closer to the extreme of disorder than normal waking consciousness) [Carhart-Harris *et al.*, 2014]. Further motivating this hypothesis are subjective reports of hyper-associative cognition under psychedelics, indicative of unconstrained brain dynamics. Thus, in order to test this hypothesis, it makes conceptual sense to focus on variability in activity and FC parameters over time, instead of the default procedure of averaging these over a prolonged period. In what follows, we present empirical data that tests the hypothesis that brain activity becomes less ordered in the psychedelic state and that the repertoire of possible states is enhanced. After the relevant findings have been presented, we engage in a discussion to suggest possible strategies that may further characterize quantitatively where the "psychedelic brain" resides in state space relative to the dynamical position occupied by normal waking consciousness.

MATERIALS AND METHODS

Study Overview and Design

This was a within-subjects placebo-controlled study. The study was approved by a local NHS Research Ethics Committee and University of Bristol Research and Development department, and conducted in accordance with Good Clinical Practice guidelines. A Home Office License was obtained for storage and handling of a Schedule 1 drug and the University of Bristol sponsored the research.

Participants

This is a new analysis on previously published data [Carhart-Harris *et al.*, 2012, 2013]. Fifteen healthy subjects took part: 13 males and 2 females (mean age = 32, SD = 8.9). Recruitment was via word of mouth. All subjects were required to give informed consent and undergo health screens prior to enrollment. Study inclusion criteria were: at least 21 years of age, no personal or immediate family history of a major psychiatric disorder, substance dependence, cardiovascular disease, and no history of a significant adverse response to a hallucinogenic drug. All of the subjects had used psilocybin at least once before (mean number of uses per subject = 16.4, SD = 27.2) but not within 6 weeks of the study.

Anatomical Scans

Image acquisition was performed on a 3T GE HDx system. Anatomical scans were performed before each functional scan and thus during sobriety. These were three-dimensional fast spoiled gradient echo scans in an axial orientation, with field of view = 256 x 256 x 192 and matrix = 256 x 256 x 192 to yield 1 mm isotropic voxel resolution (repetition time/echo time [TR/TE] = 7.9/3.0 ms; inversion time = 450 ms; flip angle = 20°).

Drug Infusion

All subjects underwent two 12 min eyes closed resting state BOLD fMRI scans on two separate occasions at least 7 days apart: placebo (10 ml saline, 60 s intravenous injection) was given on one occasion and psilocybin (2 mg dissolved in 10 ml saline, 60 s infusion) on the other. Seven of the subjects received psilocybin in scan 1, and 8 received it in scan 2. Injections were given manually by a doctor within the scanning suite. The 60 s infusions began exactly 6 min after the start of the 12 min scans. The subjective effects of psilocybin were felt almost immediately after injection and were sustained for the remainder of the RS scan. For more details on the subjective effects of intravenous psilocybin see [Carhart-Harris *et al*., 2012, 2013].

fMRI Data Acquisition and Preprocessing

BOLD-weighted fMRI data were acquired using a gradient echo planar imaging sequence, TR/TE 3,000/35 ms, field-of-view = 192 mm, 64 x 64 acquisition matrix, parallel acceleration factor = 2, 90° flip angle. Fifty-three oblique axial slices were acquired in an interleaved fashion, each 3 mm thick with zero slice gap (3 x 3 x 3 mm voxels). A total of 240 volumes were acquired, with infusion taking place in the middle of the session. Data were motion corrected using FSL MCFLIRT and a high-pass filter of 100 s was applied. Data were smoothed using a Gaussian kernel of 5 mm FWHM. Motion time courses were regressed from the data during the preprocessing step, together with average CSF and white matter time courses. As an additional control to exclude epochs of large movement amplitude, all volumes associated with a mean head displacement larger than 1 SD were erased from the analysis.

Analysis of Spatiotemporal Dynamics

The methods here employed are based on a statistical physics framework useful for characterizing fluctuations in systems composed of large number of coupled degrees of freedom. From this perspective, fluctuating activity in a particular region and correlations between different regions are interdependent or related [Ross, 1966]. Therefore, any change in the cortical dynamics due to a given intervention is expected to be reflected both at the level of the variance of the activity at one region and in the strength of the interactions between different regions. In what follows, the methodology accounting for these two aspects (i.e. the temporal variability and the dynamical changes in correlations) are explained in detail. All the numerical analyses for these calculations were performed using in-house MATLAB scripts.

Analysis of Temporal Variability

The analysis referred to here as "temporal variability" is concerned with the variance in the amplitude of the BOLD signal and it can be expressed both in a temporal (i.e., the standard variance) and frequency domain, as will be explained below. As a time domain measure of variability in the amplitude of the BOLD signal, straightforward voxel-wise computation of BOLD variance was performed, resulting in whole-brain BOLD variance maps for each condition (psilocybin/placebo before and after infusion) and participant. An additional evaluation of variance can be performed in the frequency domain, noting that by Parseval's theorem:

$$\int x^2(t)dt = \int |A(f)|^2 df \tag{1}$$

Then, the following series of equalities holds (for a signal with zero mean):

$$\sigma^2 = \lim_{T\to\infty} \frac{1}{T}\int_{-T/2}^{T/2} x^2(t)dt = \lim_{T\to\infty} \frac{1}{T}\int |A(f)|^2 df = \int \Phi(f)df \tag{2}$$

In Eqs. (1) and (2), $A(f)$ represents the Fourier transform of $x(t)$ and $\Phi(f)$ is the power spectral density. Therefore, the variance can also be obtained by integrating $\Phi(f)$ across the whole range of frequencies.

Further Spectral Analysis of BOLD Fluctuations

Equations (1) and (2) show that the integral of the power spectral density equals the variance of the signal. If this integral is not performed across all frequencies but in a certain range, the result will correspond to the contribution of the frequencies to the variance in the specified ranges. It is generally considered that slow (0.01-0.1 Hz) BOLD frequencies carry neural significance in the resting state fMRI signal [Cordes *et al.*, 2001], therefore, we evaluated separately the low frequency power (LFP) in this range and compared it before and after the psilocybin infusion.

Given the fact that the spectral content of spontaneous BOLD fluctuations, like many other complex systems in nature, follows a power law of the form $1/f^{\alpha}$ [Expert *et al.*, 2011], its power spectrum density can also be characterized by a single parameter (α). This parameter condenses the scaling behavior and is demonstrative of the longrange temporal correlations (or memory) of any given signal. Thus, for uncorrelated noise, $\alpha = 0$ (i.e. a flat spectrum, or so called "white noise") is obtained, whereas for signals presenting some degree of long-term correlations, values of $\alpha > 0$ (i.e., the so called "colored noise") are observed. To obtain the scaling exponent α, the first derivative of BOLD time series was first computed (in order to minimize the influence of nonstationarities) and the fit was performed on the spectrum of the derivative. Note that for a power spectrum of the form $1/f^{\alpha}$, differentiation decreases the value of α by 2, so the exponent of the original time series can be recovered from that of the derivative.

Point-Process Analysis

A recent series of studies demonstrated that the continuous BOLD signal can be transformed into a discrete point-process encoding the timings of the most functionally relevant events [Petridou *et al.*, 2012, Davis *et al.*, 2013; Tagliazucchi *et al.*, 2010a,b, 2012a]. In this approach, relevant events are defined by a threshold crossing (e.g. whenever the signal departs + SD from its mean value). Besides allowing a dramatic compression of the information present in a BOLD timeseries, this approach has the particular benefit of allowing a simple criterion to eliminate motion artifacts: i.e. "points" (threshold crossings) occurring during high movement epochs (i.e. larger than a certain value) are simply ignored in the analysis.

Two interdependent observables are defined once the point-process is obtained: the rate (number of crossings divided by the series length) and inter-event intervals (average temporal separation between two consecutive points). On average, there is a clear inverse relationship between these two variables. Furthermore, the rate is expected to increase (or the interval to decrease) for a signal with a high contribution of fast frequencies.

As an efficient alternative to the spectral analysis described in the previous section, we computed the voxel-wise distribution of rates and intervals and compared it between the different conditions.

Computation of Dynamical Functional Connectivity States and its Associated Entropy

As already discussed above, for spatio-temporal fluctuations arising from the dynamics of large scale systems, the relation between the temporal fluctuations of the average signal and its spatial correlation function is well defined [Ross, 1966]. It is known that under general assumptions, the mean field peak-to-peak amplitude of a signal (or its variance) is directly proportional to its mean correlation value. Intuitively, this is analogous to the principle that synchronized/desynchronized clapping produces stronger/weaker collective effects. Therefore, to complement the investigation of regional changes in the variance of the BOLD signal in various regions of the cortex, it is logical to also look at measures of the mean functional correlations between participating regions. Given the highly transient nature of these correlations, we term these indices "dynamical functional connectivity states". They are computed as follows (see Fig. 4 for an illustration of the general procedure).

MNI coordinates	AAL region	Hemisphere	*t*-value
BOLD variance (after psilocybin > before psilocybin)			
(-34, -22, -16)	Hippocampus	Left	4.51
(26, -22, -16)	Hippocampus	Right	3.54
(-2, 22, 28)	Anterior cingulate	Left	3.72
(4, 34, 18)	Anterior cingulate	Right	3.74
BOLD total spectral power (after psilocybin > before psilocybin)			
(32, -14, -13)	Hippocampus	Right	4.03
(-26, -18, -15)	Hippocampus	Left	4.39
(-26, 1, 38)	Parahippocampal Gyrus	Left	4.77
(37, -2, -38)	Parahippocampal Gyrus	Right	4.55
(7, 27, 17)	Anterior cingulate	Right	4.02
(-7, 43, -2)	Anterior cingulate	Left	4.12

Table I: Regions corresponding to local maxima of statistical significance (provided they are more than 8 mm apart) for increased cortical BOLD variance and total spectral power after psilocybin infusion (compared to before psilocybin infusion).
Montreal Neurological Institute (MNI) coordinates and Automatic Anatomical Labeling (AAL) regions are provided.

The BOLD time series is first divided into M non-overlapping windows of length L. Then, the partial correlation values between a set of N brain regions of interest is computed inside each temporal window as follows,

$$R_C(X, Y) = \min R(X, Y|Z) \tag{3}$$

where $R(X, Y|Z)$ is defined as follows,

$$R(X,Y|Z) = \frac{R(X,Y) - R(Y,Z)}{\sqrt{1 - R(X,Z)^2}} \tag{4}$$

In Eq. (3), the minimum is taken across all signals Z different from X,Y. In Eq. (4), $R(X, Y)$ represents the linear correlation between variables X and Y. Thus, the partial correlation RC(X,Y) measures the correlation of both variables removing the effect of a set of controlling variables. In what follows, the set of variables will include all BOLD signals from the N brain regions under study plus the time series of absolute head displacement (to remove spurious correlations), as estimated during the motion correction step. Finally, for each pair of regions a link is established between them if the correlation P value is significant at the level of $P < 0.05$, Bonferroni corrected (N (N - 1)/2). Performing this computation for all temporal windows gives the temporal evolution of the connectivity graph.

For N brain regions, the total number of dynamical functional connectivity graphs (i.e. all possible connectivity motifs) equals $2^{(N(N-1)/2)}$. For example, for $N = 3, 4, 5$, the number of states is 8, 64, 1,024. Once the dynamical functional connectivity states are obtained by the procedure above described, a symbolization procedure can be used to map the limited amount of states into discrete symbols (a bijection or one-to-one mapping of each temporal sequence of states into "words" - whose letters represent the different connectivity graphs). Then, the entropy of this sequence can be computed using the straightforward definition of Shannon's entropy:

$$H = \sum_{i=1}^{N(N-1)/2} p_i \log(1/p_i) \tag{5}$$

where p_i is the probability of the ith state occurring in the sequence. We evaluate the entropy of dynamical functional connectivity states in the network of regions of peak statistical significance presented in Table I and Figure 1 (i.e., the left and right hippocampus and ACC). This choice is motivated by the well-known observation that, for a system of coupled elements, the temporal variability of the activity time series is driven by variability in the collective interactions [Ross, 1966]. This process resulted in four regions and a total of 64 connectivity states (i.e. the number of possible dynamical interaction motifs between the four nodes).

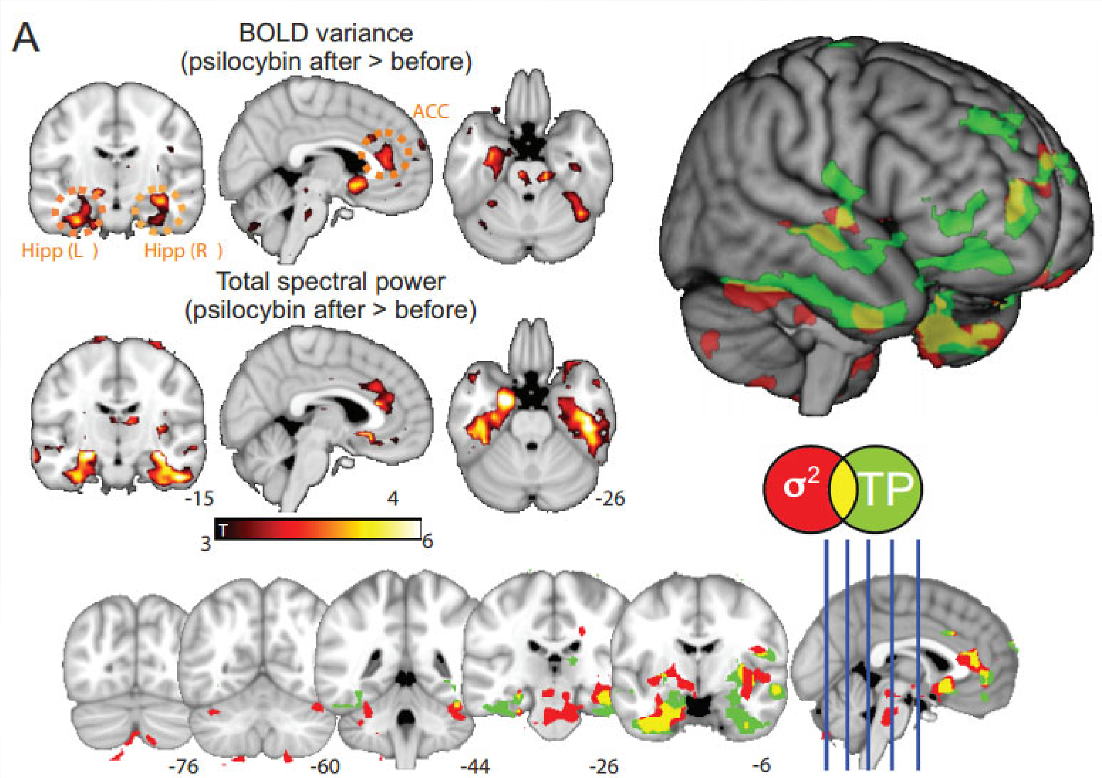


Figure 1. Psilocybin infusion modifies the temporal variability of BOLD signal in a network comprising anterior cingulate cortex (ACC) and bilateral hippocampus. **A**) Maps of statistical significance for variance (σ^2) and total spectral power (TP) increases after psilocybin infusion. Results are shown overlaid separately into an anatomical MNI152 template, overlaid together and also rendered together into a threedimensional anatomical image. In all cases only clusters surviving a threshold of $P < 0.05$, Family Wise Error (FWE) cluster corrected (after passing an uncorrected threshold of $P < 0.005$) are shown.

Statistical Testing

To perform statistical significance testing, a paired *t*-test was used, as implemented in SPM8. Only clusters passing a threshold of $P < 0.05$ Family Wise Error (FWE) corrected for multiple comparisons were considered significant. For display purposes, significance maps were thresholded at $P < 0.005$, showing only clusters passing the above mentioned criterion. Significance testing for the entropy differences reported in Figure 5 was also evaluated using a paired *t*-test.

RESULTS

The statistical significance maps for the BOLD signal variance and total spectral power can be found in Figure 1A and the significance peaks are summarized in Table I (in this and the following sections, unless explicitly stated no differences were found by examining the opposite contrasts). Both measures show increased variability following psilocybin administration - both in the temporal and spectral domain - with peaks in the anterior cingulate cortex and bilateral hippocampus (total spectral power is also increased in the bilateral parahippocampal gyri). As shown in Figure 1 there is a large overlap in the regions affected by both measures, as can be expected from Eq. (2). The differences found for the power spectral estimation in the parahippocampal gyrus are not apparent for the variance. Most likely this discrepancy is due to the numerical evaluation of these two equivalent quantities.

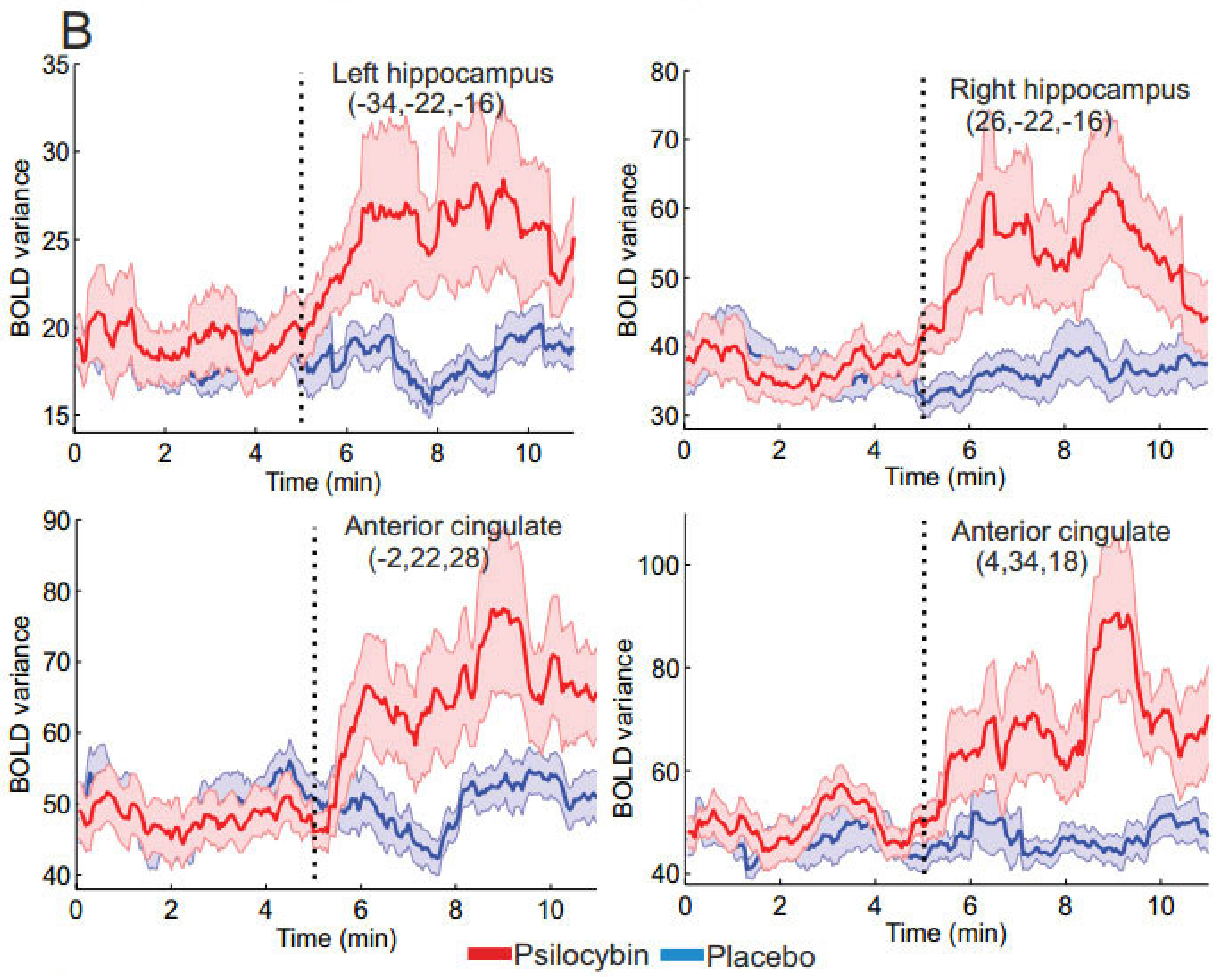


Figure 1B. BOLD Variance time courses (obtained over a 1 min. sliding window) into the four regions of peak statistical significance defined in Table I for the psilocybin and the placebo infusion.

To find the temporal evolution of the variance increases, we selected the four significance peaks for BOLD variance as ROIs (Table I) and used a sliding window analysis (1 min. window length) to compute the evolution of the variance. Since these ROI are selected as regions of high variance, it is already known that fluctuations in their activity will have an increased variance relative to baseline. However, this analysis provides additional information about when those increases occurred (e.g. just after the psilocybin infusion or later). In Figure 1B the results of this analysis are presented. A homogeneous increase in signal variance is observed during the first 3 min post-psilocybin infusion, with a tendency to plateau or slightly decrease afterwards. A longer experiment would be needed to confirm the persistence of this effect, but it does seem to correspond well with the known pharmaco-dynamics of intravenous psilocybin, i.e. subjects reported the most intense subjective effects within the first 3 min of the infusion and the effects were persistent for the duration of the scan [Carhart-Harris *et al*., 2012, 2013].

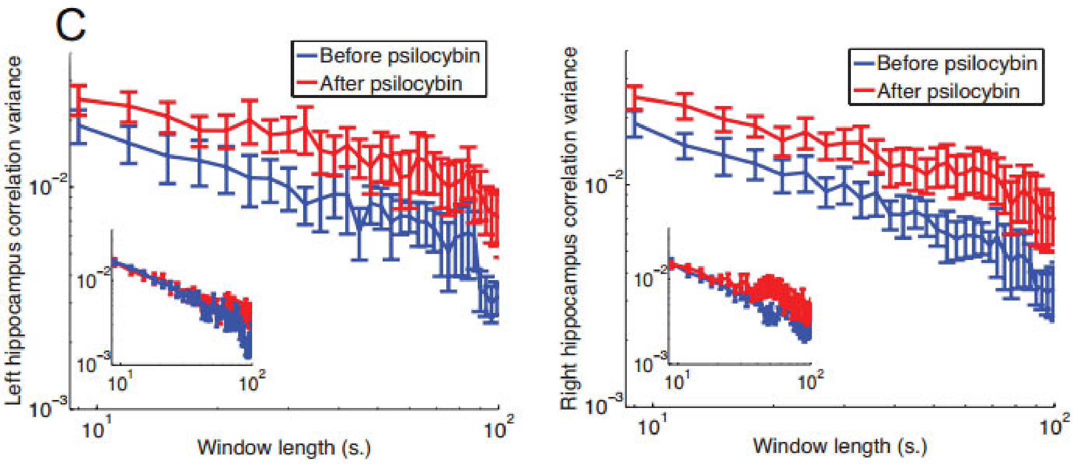


Figure 1C. Variance of the time course of intra-hippocampal correlations (computed over a range of non-overlapping window lengths) before and after psilocybin infusion. Results for placebo infusion are shown as insets (before and after in blue and red, respectively).

We also studied the variance of intra-hippocampal connectivity time courses, computed as the linear correlation of all hippocampal voxels over nonoverlapping windows of different lengths. Results are shown in Figure 1C. It can be seen that the variance is higher in both hippocampi after the psilocybin infusion.

Next, we studied the spectral content of spontaneous BOLD fluctuations. This was done by computing the low frequency (0.01-0.1 Hz) power (LFP) and the power spectrum scaling exponent (α). Statistical significance maps are presented in Figure 2A and statistical significance peaks in Table II.

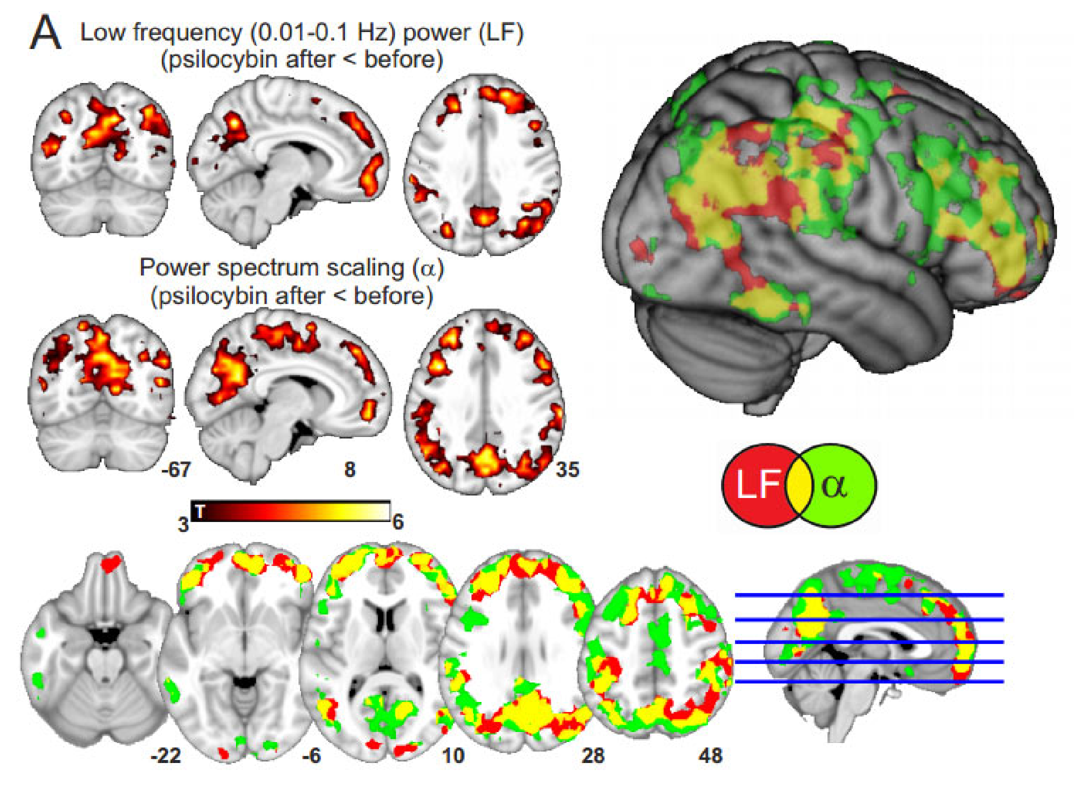

A Low frequency (0.01-0.1 Hz) power (LF)
(psilocybin after < before)
Power spectrum scaling (α)
(psilocybin after < before)
-67
8
35
T
3
6
LF
α
-22
-6
10
28
48

Figure 2. Psilocybin infusion modifies BOLD spectral content in a distributed fronto-parietal network. **A**) Maps of statistical significance for decreased low frequency power (LFP) and power spectrum scaling exponent α after psilocybin infusion. Results are shown overlaid separately into an anatomical MNI152 template, overlaid together and also rendered together into a threedimensional anatomical image. Notice that in all cases only clusters surviving a threshold of $P < 0.05$, FWE cluster corrected (after passing an uncorrected threshold of $P < 0.005$) are shown.

After psilocybin infusion, diffuse widespread decreases in LFP and the scaling exponent α were observed in frontal and parietal regions. Changes in LFP and the scaling exponent (α) were found consistently in the same spatial locations, which is expected since a scaling closer to that of uncorrelated noise (i.e. an α value closer to 0) will result in weaker low frequency spectral power. These effects were confined to the post-psilocybin period. No differences were found when performing the same comparison in the placebo condition.

To further characterize BOLD fluctuations, we transformed whole brain signals into a spatio-temporal pointprocess and extracted two statistics: the rate (average number of events) and the interval (average separation between two events). By the very definition of the pointprocess, a signal with high power in fast frequencies will give a high rate and therefore a low separation between events i.e., the average interval will be small. Results shown in Figure 2B confirm this observation. Statistical significance peaks are presented in Table III. A rate increase and interval decrease after psilocybin was observed in parietal and frontal regions largely overlapping with those of Figure 2A. No differences were found when performing the same comparison in the placebo condition.

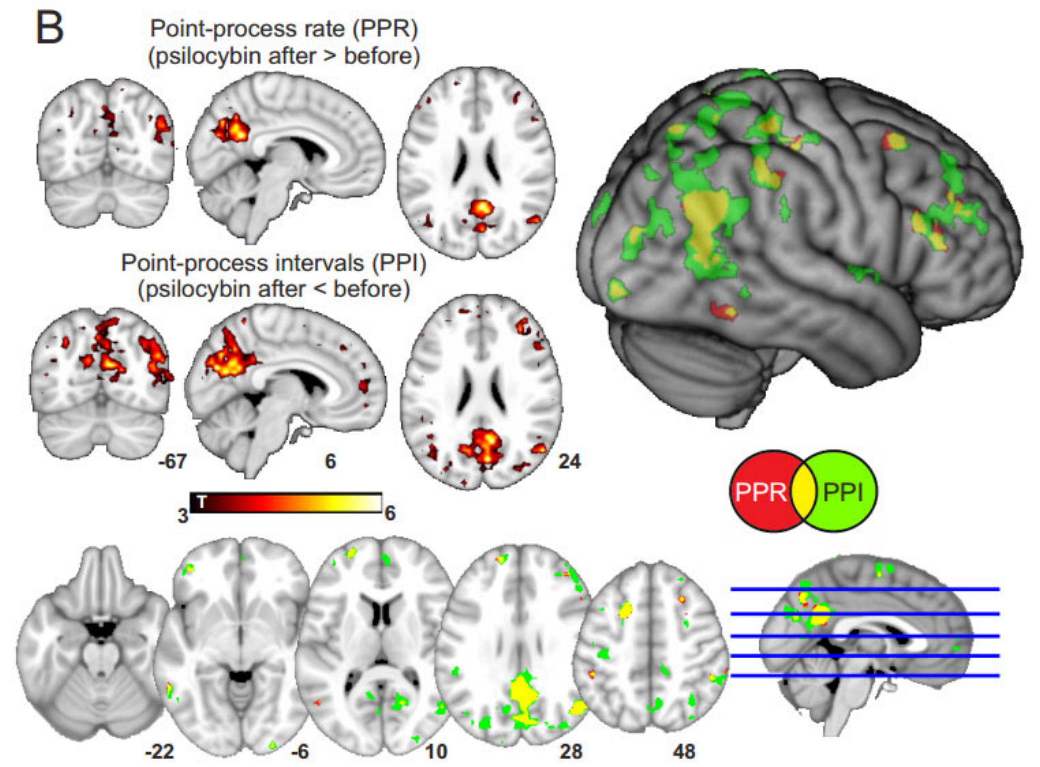

B
Point-process rate (PPR)
(psilocybin after > before)
Point-process intervals (PPI)
(psilocybin after < before)
-67
6
24
T
3
6
PPR
PPI
-22
-6
10
28
48

Figure 2B. Maps of statistical significance of increased power point rate (PPR) and decreased point process interval (PPI) after psilocybin infusion (same renderings and statistical thresholds as in A).

To identify the brain networks associated with the changes shown in Figure 2A,B, we computed the overlap of the statistical significance maps with a set of well-established Resting State Networks (RSNs) [Beckmann and Smith, 2004; Beckmann *et al.*, 2005]. These included: two visual (medial and lateral), an auditory, sensori-motor, default mode, executive control and two lateralized dorsal attention networks.

To compute the overlap for a given map, we counted the number of voxels included in each RSN and normalized by the total number of voxels in the RSN mask. Using this approach, larger maps present a higher chance of having large overlaps, therefore, we constructed a null-hypothesis by randomizing the phases of the maps (after transforming to Fourier space), resulting in images with the same second order statistics [see also Tagliazucchi *et al.*, 2013c]. A total of 100 randomizations were performed for each comparison and an empirical p-value was constructed, counting the ratio of instances in which the real overlap exceeded the overlap computed with the randomized map. The results of these analyses are presented in Figure 3. For LFP and α, significant overlaps were detected in the default mode, control and attention networks, whereas all sensory networks remained unaffected. For the point-process rate (PPR) and point-process interval (PPI) the changes were locally confined to the default mode network.

Next, the dynamic functional connectivity states were obtained from the set of regions showing increased temporal variability (Fig. 1 and Table I) by applying the analysis outlined in Figure 4. Using different window lengths (ranging from 15 to 150 s.) we evaluated the entropy of the distribution of connectivity states in the network comprised by two ACC ROIs and the bilateral hippocampi. An entropy increase was found when comparing the results between the periods before and after the psilocybin infusion and after the psilocybin infusion vs. after the placebo infusion, but no changes were observed when comparing before and after placebo (see Fig. 5A). The entropy increase was not seen for very short window lengths but was manifest for all lengths larger than approximately 1 min.

MNI coordinates	AAL region	Hemisphere	*t*-value
BOLD low frequency power (after psilocybin < before psilocybin)			
(11, -60, 40)	Precuneus	Right	4.92
(38, -67, 44)	Angular gyrus	Right	4.60
(-34, -69, 44)	Angular gyrus	Left	5.05
(-39, -42, 42)	Inferior parietal cortex	Left	4.66
(-39, 45, -3)	Middle frontal gyrus	Left	5.10
(47, 44, -3)	Inferior frontal gyrus	Right	5.08
(5, 56, -9)	Middle frontal gyrus (orbital)	Right	4.28
BOLD power spectrum scaling exponent α (after psilocybin < before psilocybin)			
(4, -59, 33)	Precuneus	Right	4.86
(53, -61, 33)	Angular gyrus	Right	4.31
(-48, -55, 34)	Angular gyrus	Left	4.20
(-40, -34, 60)	Postcentral gyrus	Left	4.80
(6, -22, 60)	Paracentral lobule	Right	4.79
(50, -30, 60)	Superior parietal cortex	Right	5.73
(-41, 14, 33)	Middle frontal gyrus	Left	4.32
(52, 7, 28)	Precentral gyrus	Right	5.12
(38, 41, 28)	Middle frontal gyrus	Right	6.22
(-27, 43, 28)	Middle frontal gyrus	Left	5.10
(10, 55, -6)	Middle frontal gyrus (orbital)	Right	4.48

Table II: Regions corresponding to local maxima of statistical significance (provided they are more than 8 mm apart) for decreased cortical BOLD low frequency power and power spectrum scaling exponent after psilocybin infusion (compared to before psilocybin infusion).

MNI coordinates	AAL region	Hemisphere	*t*-value
Point-process rate (after psilocybin > before psilocybin)			
(5, -52, 25)	Precuneus	Right	4.47
(47, -66, 29)	Angular gyrus	Right	3.99
(-41, -66, 24)	Angular gyrus	Left	2.84
(-41, 47, -5)	Middle frontal gyrus (orbital)	Left	2.82
(-41, 41, 24)	Middle frontal gyrus	Left	2.97
(35, 40, 24)	Middle frontal gyrus	Right	3.14
Point-process interval (after psilocybin < before psilocybin)			
(5, -57, 25)	Precuneus	Right	4.06
(50, -58, 36)	Angular gyrus	Right	3.98
(-34, -66, 36)	Angular gyrus	Left	3.00
(-37, -32, 62)	Postcentral gyrus	Left	3.35
(41, -39, 62)	Paracentral lobule	Right	3.18
(-26, -9, 60)	Postcentral gyrus	Left	3.59
(28, 17, 54)	Middle frontal gyrus	Right	3.72
(-20, 15, 54)	Superior frontal gyrus	Left	2.87
(-22, 59, 12)	Superior frontal gyrus	Left	3.54
(4, 54, 6)	Anterior cingulated	Right	3.29

Tabela III: Regions corresponding to local maxima of statistical significance (provided they are more than 8 mm apart) for increased cortical point-process rate (PPR) and decreased point-process interval (PPI) after psilocybin infusion (compared to before psilocybin infusion).

The most frequent states in each condition are shown in Figure 5B. These have sparse connectivity and represent functional connections between homologous ROIs and between ROIs in the same hemisphere, but cross-hemisphere connections between hippocampal and ACC ROIs also appear in the psilocybin condition. The psilocybin state is also characterized by a larger repertoire of states: i.e. novel motifs that are exclusive to the psychedelic state and which are shown in the last row of Figure 5B. These motifs are among the most interconnected states possible.

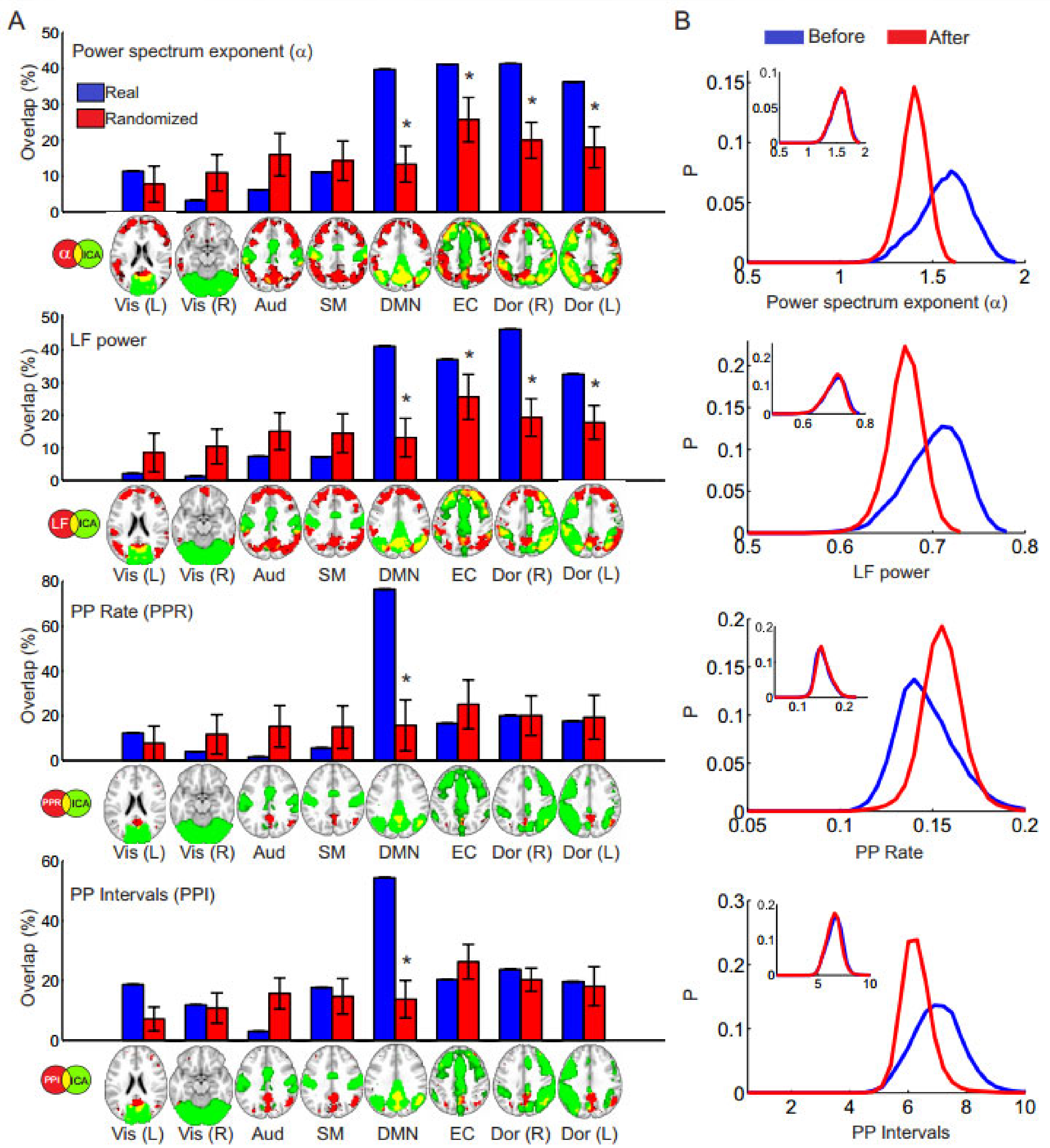


Figure 3. BOLD spectral changes after psilocybin infusion are located in higher order brain networks and leave primary sensory areas unaffected. **A**) Overlap between statistical significance maps presented in Figure 2 and a group of well-established cortical RSN (from Beckmann *et al*. [2005]) together with the average overlap obtained after 100 spatial randomizations preserving first order statistics (image phase shuffling). (*) indicates an empirical *P* value smaller than 0.05, Bonferroni corrected. This *P* value is defined as the ratio of instances in which the real maps yield a higher overlap than the randomized versions. **B**) Whole brain grey matter average probability distributions for α, LFP, PPR, and PPI, before and after psilocybin infusion. In the inset, the same distributions are shown before and after the placebo infusion.

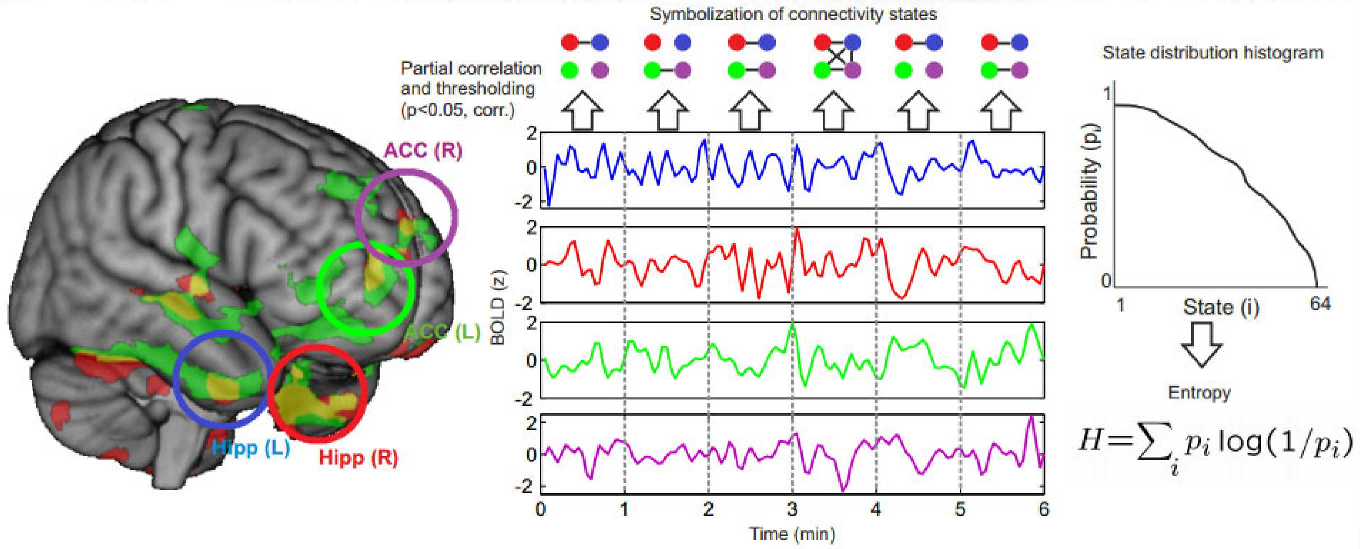


Figure 4. Entropy of the dynamical functional connectivity states. Illustration of the procedure to estimate the temporal evolution of the collective states (i.e. all possible 64 motifs) in the network of regions associated with increased temporal variability (bilateral hippocampi and ACC). After selecting the four regions of interest demonstrating enhanced variability after psilocybin infusion (left and right hippocampus, left and right ACC), the partial correlation between all variables is computed (including also the mean head displacement time series as a partial regressor). After thresholding (with $P < 0.05$, corrected) a series of up to 64 discrete connectivity states are obtained from which the probability distribution can be computed. Finally, from this information, histograms of states (provided here as an illustration) and their corresponding Shannon's entropy (H) can be computed.

DISCUSSION

The novel analyses described in this article provide a considerable amount of new information about how psilocybin affects brain activity. In summary, increased variance in the BOLD signal was observed in the bilateral hippocampi and ACC and the temporal dynamics of these increases corresponded well with the rapid pharmacodynamics of intravenous psilocybin [Carhart-Harris *et al*., 2012, 2013]. Decreased low frequency power and frequency scaling exponent (indicative of a less correlated signal) were observed in higher-level association regions accompanied by an increase in the point process rate at the default mode network. Perhaps the most novel and intriguing aspect of the present analyses was our assessment of dynamical functional connectivity within a simple hippocampal/ACC network. Specifically, a greater diversity of connectivity motifs was observed after psilocybin, reflecting increased entropy in this system's dynamical behavior. Overall these quantities demonstrate an increase in the dynamical repertoire (i.e., new states) in the brain under psilocybin as well as an increase in the rate at which the repertoire is examined.

We first interpret the changes described in the results section from a purely dynamical point of view. The results presented in Figure 1 represent a larger variance in the "mean field activity" of the hippocampus and ACC. This change in variance is the expression of an increased amplitude of the BOLD signal fluctuations in these regions. From a statistical physics point of view, increased signal amplitude implies increased synchronization and so increased correlated activity in the source structures. This is also reflected in the analysis of the repertoire of connectivity states in a hippocampal-ACC network (discussed in Figs. 4 and 5). These two results together reveal an increased variability in the collective repertoire (i.e. a larger number of motifs) of metastable states [Tognoli and Kelso, 2014] within the psychedelic state.

The increased amplitude fluctuations in the hippocampus are particularly intriguing given early depth electroencephalography (EEG) work that recorded similar abnormalities in hippocampal activity after LSD and mescaline [Monroe and Heath, 1961; Schwarz *et al*., 1956]. Similar increases in oscillation amplitude have also been observed in the hippocampus using depth EEG recordings in patients showing nondrug-induced psychotic symptoms [Heath, 1954; Sem-Jacobsen *et al*., 1956] and bursts of high amplitude activity have been seen in human rapid-eye movement (REM) sleep [Cantero *et al*., 2003]. Moreover, other imaging modalities have implicated increased hippocampal activity in psychosis [e.g., Friston *et al*., 1992] and REM sleep [Braun *et al*., 1997; Miyauchi *et al*., 2009]. Given that phenomenological similarities have previously been noted between the psychedelic, psychotic and dream states [Carhart-Harris, 2007; Carhart-Harris and Nutt, 2014], it is intriguing to consider whether altered hippocampal activity may be an important common property of these states.

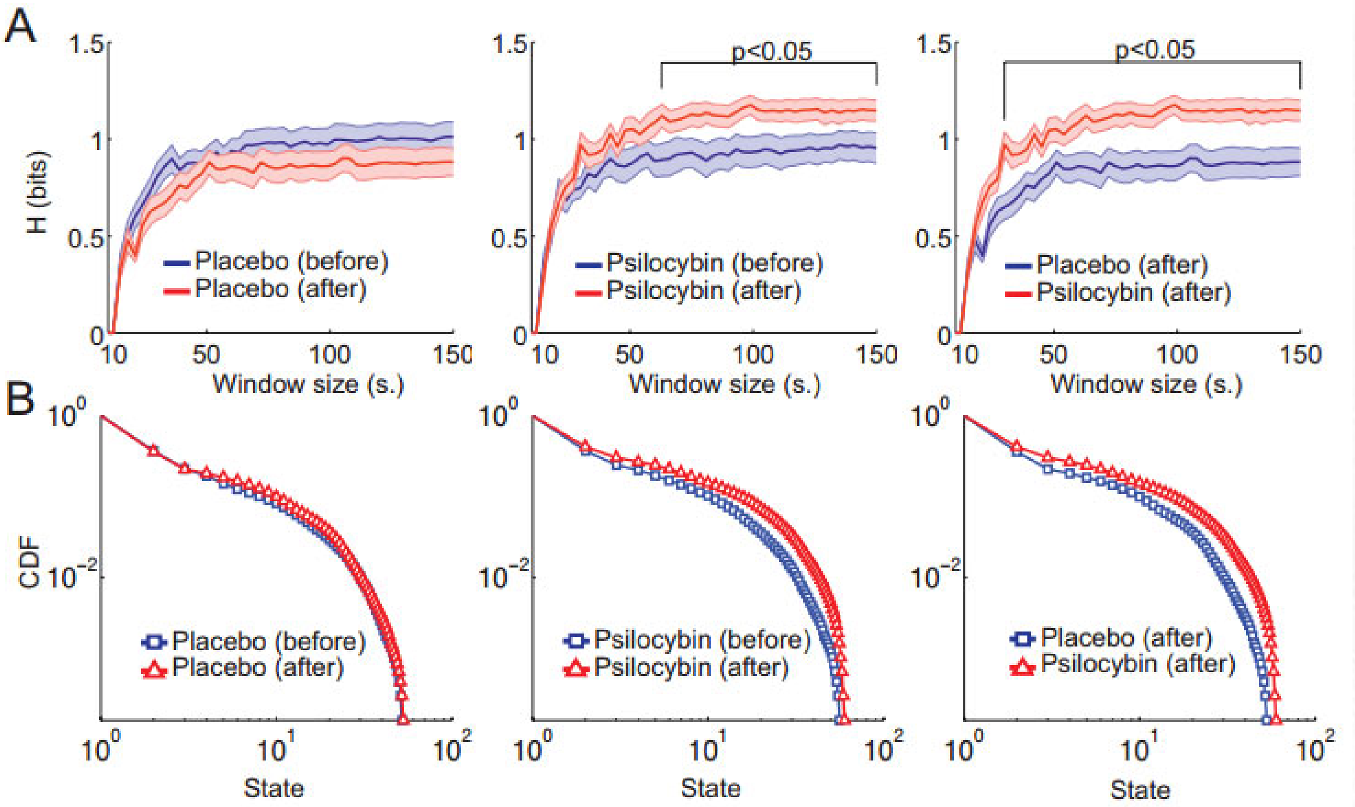


Figure 5. Dynamical functional connectivity entropy increased after psilocybin infusion. **A**) Entropy of connectivity states (H, defined following the procedure outlined in Figure 4 and computed at different time window lengths) are plotted for the comparisons placebo before versus after, psilocybin before versus after and psilocybin after versus placebo after (mean ± SEM). **B**) The probability distributions for the (ranked) dynamical functional connectivity states across all conditions. Histograms were obtained pooling states across subjects and window sizes.

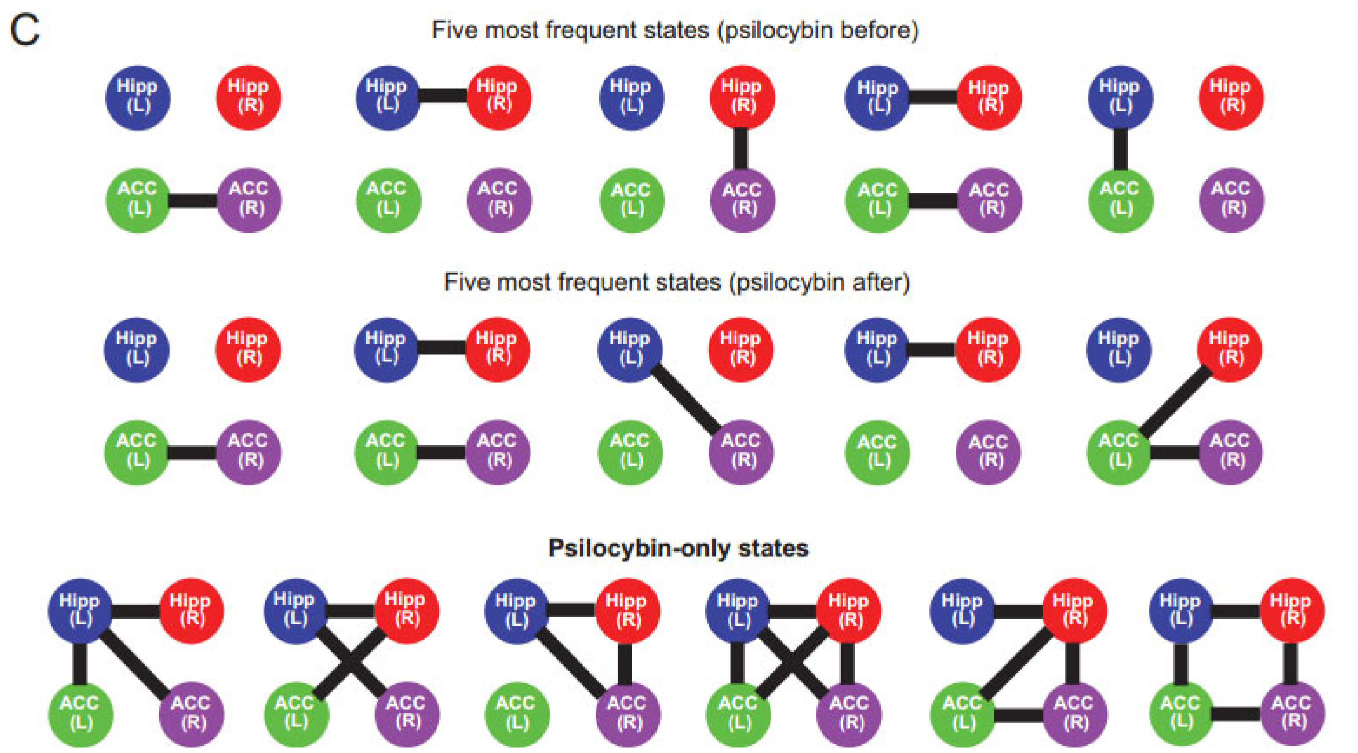

C
Five most frequent states (psilocybin before)
Hipp (L)
Hipp (R)
ACC (L)
ACC (R)
Five most frequent states (psilocybin after)
Psilocybin-only states

Figure 5C. First row: five most frequent connectivity states before the infusion of psilocybin. Second row: five most frequent states after the infusion of psilocybin. Third row: states observed only after the infusion of psilocybin, but absent before the infusion and in the placebo condition. In all cases the lines are used to indicate a significant transient functional connectivity between two nodes.

It has long been claimed that the psychedelic (translated "mind-revealing" [Huxley *et al*., 1977]) state is an expanded state of consciousness in which latent psychological material can emerge into consciousness [Cohen, 1967] and novel associations can form. Indeed, this was the original rationale for the use of LSD in psychotherapy [Busch and Johnson, 1950]. It has also been claimed that psychedelics may be able to assist the creative process, for example, by promoting divergent thinking and remote association [Fadiman, 2011]. Thus, the increased repertoire of metastable states observed here with psilocybin may be a mechanism by which these phenomena occur [see also Carhart-Harris *et al.*, 2014].

It was also interesting that under psilocybin, more interhemispheric dynamical correlations were detected in the hippocampal/ACC network (Fig. 5C). Recent electrophysiological work in mice has shown that layer five pyramidal neurons (the primary cellular units implicated in the action of psychedelic drugs [Muthukumaraswamy *et al.*, 2013]) that are sensitive to serotonin 2A receptor mediated excitation (the primary pharmacological process implicated in the action of psychedelics [Muthukumaraswamy *et al.*, 2013]) are disproportionately those pyramidal neurons that project interhemispherically [Avesar and Gulledge, 2012]. Thus, altered interhemispheric communication may be an important component of the mechanism of action of psychedelics.

Concerning the low frequency fluctuations results, these were consistent with our earlier work with MEG in which we observed decreased oscillatory power in neural fields in high-level cortical regions in the 1 to 100 Hz frequency range [Muthukumaraswamy *et al.*, 2013]. In the present analysis, decreased low frequency power in the 0.01 to 0.1 Hz range was found and again, these effects were localized to consistent high-level cortical regions. Low frequency fluctuations in BOLD are known to correlate with neuronal parameters such as fluctuating gamma power and infraslow fluctuations in local field potentials [Pan *et al.*, 2013]. The slower beta band also shows positive correlations with fMRI fluctuations in key DMN regions [Laufs *et al.*, 2003], whereas both alpha and beta apparently inhibit large-scale cortical BOLD coherence [Tagliazucchi *et al.*, 2012b]. Thus, it seems that a primary action of psilocybin, and likely other psychedelics [Riba *et al.*, 2002], is to cause a generalized desynchrony and loss of oscillatory power in higher level cortical regions - likely via serotonin 2A receptor mediated excitation of deep-layer pyramidal neurons in these regions [Muthukumaraswamy *et al.*, 2013]. However, the high amplitude activity detected in the hippocampi and ACC (Fig. 1) suggests that this desynchronizing effect does not generalize to these deeper structures.

The frequency domain result was further examined by a separate analysis of the point-process rate and interval distributions (see Fig. 3). The RSNs which exhibited the most significant changes correspond to higher brain systems such as the DMN, executive control and attention networks and not primary sensory and motor networks. This outcome is consistent with the regional distribution of serotonin 2A receptors [Erritzoe *et al.*, 2009], the receptors implicated in psilocybin's psychedelic action [Vollenweider *et al.*, 1998]. These receptors are concentrated in higher level cortical regions (e.g. the highest distribution in humans is in the PCC [Carhart-Harris *et al.*, 2013; Erritzoe *et al.*, 2009] and are relatively less prevalent in the sensori-motor cortex. That the default mode network has consistently been implicated in the action of psilocybin is also intriguing given its association with self-reflection [Gusnard *et al.*, 2001] and selfhood more generally [Carhart-Harris and Friston, 2010]. It is likely to be relevant therefore that one of the most commonly reported features of an intense psychedelic experience is a compromised sense of selfhood typically described as "ego dissolution" or "ego disintegration" [Carhart-Harris *et al.*, 2014; Klee, 1963; Savage, 1955].

A potential limitation of our study arises from the possibility that psilocybin modifies the coupling between neuronal sources and hemodynamic activity as measured with fMRI (i.e. the hemodynamic response function). However, we note that there exists no evidence for this so far and, on the other hand, there exists ample direct electrophysiological evidence showing that psilocybin modifies brain activity in a way compatible with our findings [Muthukumaraswamy *et al.*, 2013].

Another limitation stems from the limited number of regions included in the definition of dynamical states. This limited number is required to perform an exhaustive counting of all possible states, however, differences in the motifs between conditions (Fig. 5) could arise by direct influence of regions outside the scope of the analysis, which are directly wired to a pair of nodes. Future work should address this limitation and attempt to track those regions to obtain a more complete picture of how dynamical states differ after and before psilocybin infusion.

Finally, it is important to offer some cautionary notes on the analyses documented in this article. Mapping relatively transient dynamical motifs based on resting state fMRI data is a new and exploratory technique. Thus, further work is required to clarify its functional meaning. More specifically, given the Zipf-like behavior of the state distribution probability (Fig. 5B), states that appear rarely (i.e. at the tail of a power law distribution) cannot be trivially tested using the usual statistical significance, i.e. they do not fit easily into the standard frequentist framework of *t*-test statistics, in contrast to well established functional connectivity analyses that represent an average over prolonged periods of time. Thus, further mathematical testing and empirical work is required before we can begin to make confident predictions about the functional relevance of outcomes derived from their application.

ACKNOWLEDGMENTS

The original experiments were performed as part of a broader Beckley-Imperial psychedelic research programme. Authors thank Christian Beckmann for sharing the RSN masks reported in Beckmann *et al*. [2005].

REFERENCES

1. Aserinsky, E., Kleitman, N., 1953. Regularly occurring periods of eye motility, and concomitant phenomena, during sleep. Science 118(3062), 273-274.
2. Avesar, D., Gulledge, A.T., 2012. Selective serotonergic excitation of callosal projection neurons. Front. Neural Circuits 6,12.
3. Beckmann, C.F., Smith, S.M., 2004. Probabilistic independent component analysis for functional magnetic resonance imaging. IEEE Trans. Med. Imag. 23,137-152.
4. Beckmann, C.F., DeLuca, M., Devlin, J.T., Smith, S.M., 2005. Investigations into resting state connectivity using independent component analysis. Phil. Trans. Roy. Soc. B. 360(1457), 1001-1013.
5. Braun, A.R., Balkin, T.J., Wesenten, N.J., Carson, R.E., Varga, M., Baldwin, P., Selbie, Belenky, G., Herscovitch, P., 1997. Regional cerebral blood flow throughout the sleep-wake cycle. An H2(15)O PET study. Brain 120, 1173-97.
6. Brodbeck, V., Kuhn, A., von Wegner, F., Morzelewski, A., Tagliazucchi, E., Borisov, S., Michel, C., Laufs, H., 2012. EEG microstates of wakefulness and NREM sleep. Neuroimage 62, 2129-2139.
7. Boly, M., Phillips, C., Tshibanda, L., Vanhaudenhuyse, A., Schabus, M., Dang-Vu, T. T., Moonen, G., Hustinx, R., Maquet, P., Laureys, S., 2008. Intrinsic brain activity in altered states of consciousness. Ann. NY Acad. Sci. 1129(1), 119-129.
8. Boly, M., Perlbarg, V., Marrelec, G., Schabus, M., Laureys, S., Doyon, J., Pelegrini-Issac, M., Maquet, P., Benali, H., 2012. Hierarchical clustering of brain activity during human nonrapid eye movement sleep. Proc. Natl. Acad. Sci. USA, 109(15), 5856-5861.
9. Busch, A.K., Johnson, W.C., 1950. L.S.D. 25 as an aid in psychotherapy; preliminary report of a new drug. Diseases of the nervous system 11(8),241243.
10. Cantero, J.L., Atienza, M., Stickgold, R., Kahana, M.J., Madsen, J.R., Kocsis, B., 2003. Sleep-dependent theta oscillations in the human hippocampus and neocortex. J. Neurosci. 23, 10897-903.
11. Carhart-Harris, R., 2007. Waves of the unconscious: The neurophysiology of dreamlike phenomena and its implications for the psychodynamic model of the mind. Neuro-Psychoanalysis. 9(2), 83-211.
12. Carhart-Harris, R.L., Friston, K.J., 2010. The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. Brain. 133, 1265-1283.
13. Carhart-Harris, R.L., Erritzoe, D., Williams, T., Stone, J.M., Reed, L.J., Colasanti, A., Tyacke, R.J., Leech, R., Malizia, A.L., Murphy, K., Hobden, P., Evans, J., Feilding, A., Wise, R.G., Nutt, D.J., 2012. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. Proc. Natl. Acad. Sci. USA. 109(6), 2138-2143.
14. Carhart-Harris, R.L., Leech, R., Erritzoe, D., Williams, T.M., Stone, J.M., Evans, J., Sharp, D.J., Feilding, A., Wise, R.G., Nutt, D.J., 2012b. Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. Schizophrenia Bull. doi: 10.1093/schbul/sbs117.
15. Carhart-Harris, R. L., Leech, R., Hellyer, P.J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D.R., Nutt, D., 2014. The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. Front Hum Neurosci. 8(20). doi:10.3389/fnhum.2014.00020.
16. Carhart-Harris, R.L., Nutt, D.J., 2014.Was it a vision or a waking dream? Front Psychology. 5 doi: 10.3389/fpsyg.2014.00255.
17. Chialvo, D. R., 2010. Emergent complex neural dynamics. Nature Phys., 6(10), 744-750.
18. Cohen, S., 1967. The beyond within: the LSD story. New Ed. Atheneum: New York.
19. Cordes, D., Haughton, V.M., Arfanakis, K., Carew, J.D., Turski, P.A., Moritz, C.H., Quigley, M.A., Meyerand, M.E., 2001. Frequencies contributing to functional connectivity in the cerebral cortex in "resting-sate" data. Am. J. Neuroradiol. 22,1326-33.
20. Davis, B., Jovicich, J., Iacovella, V., Hasson, U., 2013. Functional and developmental significance of amplitude variance asymmetry in the BOLD resting-state signal. Cereb. Cortex. doi: 10.1093/cercor/bhs416
21. de Pasquale, F., Della Penna, S., Snyder, A.Z., Marzetti, L., Pizzella, V., Romani, G.L., Corbetta, M., 2012. A cortical core for dynamic integration of functional networks in the resting human brain. Neuron 74, 753-764.
22. Erritzoe, D., Frokjaer, V.G., Haugbol, S., Marner, L., Svarer, C., Holst, K., Baar, W.F.C., Rasmussen, P.M., Madsen, J., Paulson, O.B., Knudsen, G., 2009. Brain serotonin 2A receptor binding: relations to body mass index, tobacco and alcohol use. NeuroImage 46(1), 23-30.
23. Expert, P., Lambiotte, R., Chialvo, D. R., Christensen, K., Jensen, H. J., Sharp, D. J., Turkheimer, F., 2011. Self-similar correlation function in brain resting-state functional magnetic resonance imaging. J. Roy. Soc. Interface 8, 472-479.
24. Fadiman, J., 2011. The psychedelic explorer's guide: safe, therapeutic, and sacred journeys. Edn. Park Street Press: Rochester, Vt.

25. Fox, M.D., Raichle, M.E., 2005. The human brain is intrinsically organized into dynamic, anticorrelated functional networks. Proc. Natl. Acad. Sci. USA 102, 9673-9678.
26. Fox, M.D., Raichle, M.E., 2007. Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. Nat. Rev. Neurosci. 8, 700-711.
27. Friston, K.J., Liddle, P.F., Frith, C.D., Hirsch, S.R., Frackowiak, R.S., 1992. The left medial temporal region and schizophrenia. A PET study. Brain 115, 367-82.
28. Grob, C.S., Danforth, A.L., Chopra, G.S., Hagerty, M., McKay, C.R., Halberstadt, A.L., Greer, G.R., 2011. Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch. Gen. Psychiat. 68, 71-78.
29. Gusnard, D.A., Akbudak, E., Shulman, G.L., Raichle, M.E., 2001. Medial prefrontal cortex and self-referential mental activity: relation to a default mode of brain function. Proc. Natl. Acad. Sci. USA 98, 4259-4264.
30. Hagmann, P., Cammoun, L., Gigandet, X., Meuli, R., Honey, C. J., Wedeen, V. J., Sporns, O., 2008. Mapping the structural core of human cerebral cortex. PLoS Biol., 6(7), e159.
31. Haimovici, A., Tagliazucchi, E., Balenzuela, P., Chialvo, D. R., 2013. Brain organization into resting state networks emerges at criticality on a model of the human connectome. Phys. Rev. Lett., 110(17), 178101.
32. Heath, R.G. Studies in schizophrenia, Camb. Mass., 1954
33. Huxley, A., Palmer, C., Horowitz, M., 1977. Moksha : writings on psychedelics and the visionary experience (1931-1963). Edn. Stonehill: New York.
34. Klee, G.D., 1963. Lysergic acid diethylamide (LSD-25) and ego functions. Arch. Gen. Psychiat. 8,461-474.
35. Krebs, T.S., Johansen, P.O., 2012. Lysergic acid diethylamide (LSD) for alcoholism: metaanalysis of randomized controlled trials. J. Psychopharmacol. 26, 994-1002.
36. Larson-Prior, L. J., Zempel, J. M., Nolan, T. S., Prior, F. W., Snyder, A. Z., Raichle, M. E., 2009. Cortical network functional connectivity in the descent to sleep. Proc. Natl. Acad. Sci. USA, 106(11), 4489-4494.
37. Laufs, H., Krakow, K., Sterzer, P., Eger, E., Beyerle, A., Salek-Haddadi, A., Kleinschmidt, A. 2003. Electroencephalographic signatures of attentional and cognitive default modes in spontaneous brain activity fluctuations at rest. Proc. Natl. Acad. Sci. USA 100, 11053-11058.
38. Leech, R., Braga, R., Sharp, D.J., 2012. Echoes of the brain within the posterior cingulate cortex. J. Neurosci. 32, 215-222.
39. Miyauchi, S., Misaki, M., Kan, S., Fukunaga, T., Koike, T., 2009. Human brain activity time-locked to rapid eye movements during REM sleep. Exp. Brain Res. 192, 657-67.
40. Monroe, R.R. and Heath, R.G., 1961. Effects of lysergic acid and various derivatives on depth and cortical electrograms. J. Neuropsychiatr. 3,75-82.
41. Moreno FA, Wiegand CB, Taitano EK, Delgado PL (2006). Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. J. Clin. Psychiat. 67, 1735-1740.
42. Pan, W.J., Thompson, G.J., Magnuson, M.E., Jaeger, D., Keilholz, S., 2013. Infraslow LFP correlates to resting-state fMRI BOLD signals. NeuroImage 74, 288-297.
43. Raichle, M.E., 2011. The restless brain. Brain Connect. 1(1), 3-12.
44. Petridou, N., Gaudes, C. C., Dryden, I. L., Francis, S. T., Gowland, P. A., 2012. Periods of rest in fMRI contain individual spontaneous events which are related to slowly fluctuating spontaneous activity. Hum. Brain. Mapp. 34, 1319-1329.
45. Riba, J., Anderer, P., Morte, A., Urbano, G., Jane, F., Saletu, B., Barbanoj, M.J., 2002. Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers. Brit. J. Clin. Pharmaco. 53(6), 613-628.
46. Ross, S.M., 1996. Stochastic Processes. New York, NY: John Wiley and Sons Inc.
47. Savage, C., 1955. Variations in ego feeling induced by D-lysergic acid diethylamide (LSD-25). Psychoanalytic Review 42(1), 1-16.
48. Schwarz, B.E., Sem-Jacobsen, C.W., Petersen, M.C., 1956. Effects of mescaline, LSD-25, and adrenochrome on depth electrograms in man. AMA Arch. Neurol. Psychiatry 75, 579-87.
49. Sem-Jacobsen, C.W., Petersen, M.C., Dodge Jr., H.W., Lazarte, J.A., Holman, C.B., 1956. Electroencephalographic rhythms from the depths of the parietal, occipital and temporal lobes in man. Electroencephalogr. Clin. Neurophysiol. 8, 263-78.
50. Smith, S.M., Fox, P.T., Miller, K.L., Glahn, D.C., Fox, P.M., Mackay, C.E., Filippini, N., Watkins, K., Toro, R., Laird, A.R., Beckmann, C.F., 2009. Correspondence of the brain's functional architecture during activation and rest. Proc. Natl. Acad. Sci. USA 106(31),13040-13045.
51. Tagliazucchi, E., Balenzuela, P., Fraiman, D., Chialvo, D. R., 2010. Brain resting state is disrupted in chronic back pain patients. Neurosci. Lett. 485, 26-31.
52. Tagliazucchi, E., Balenzuela, P., Fraiman, D., Montoya, P., Chialvo, D. R., 2010. Spontaneous BOLD event triggered averages for estimating functional connectivity at resting state. Neurosci. Lett. 488, 158-163.
53. Tagliazucchi, E., Balenzuela, P., Fraiman, D., Chialvo, D. R., 2012. Criticality in large-scale brain fMRI dynamics unveiled by a novel point process analysis. Front. Physiol. 3:15.
54. Tagliazucchi, E., Chialvo D.R. The collective brain. Decision Making: A Psychophysics Application of Network Science 15 (2011): 57.
55. Tagliazucchi, E., Von Wegner, F., Morzelewski, A., Brodbeck, V., Laufs, H., 2012. Dynamic BOLD functional connectivity in humans and its electrophysiological correlates. Front. Hum. Neurosci. 6.
56. Tagliazucchi, E., von Wegner, F., Morzelewski, A., Borisov, S., Jahnke, K., Laufs, H., 2012. Automatic sleep staging using fMRI functional connectivity data. Neuroimage 63, 63-72.
57. Tagliazucchi, E., Von Wegner, F., Morzelewski, A., Brodbeck, V., Borisov, S., Jahnke, K., Laufs, H., 2013. Large-scale brain functional modularity is reflected in slow electroencephalographic rhythms across the human non-rapid eye movement sleep cycle. Neuroimage, 70, 327-339.
58. Tagliazucchi, E., Behrens, M., Laufs, H., 2013. Sleep neuroimaging and models of consciousness. Front. Psychol. 4.
59. Tagliazucchi, E., von Wegner, F., Morzelewski, A., Brodbeck, V., Jahnke, K., Laufs, H., 2013. Breakdown of long-range temporal dependence in default mode and attention networks during deep sleep. Proc. Natl. Acad. Sci. USA, 110 (38),

15419-15424.

60. Tagliazucchi, E., Laufs, H., 2014. Decoding wakefulness levels from typical fMRI resting-state data reveals reliable drifts between wakefulness and sleep. Neuron, http://dx.doi.org/10.1016/j.neuron.2014.03.020
61. Tognoli, E., Kelso J. A., 2014. The metastable brain. Neuron, 81(1), 35-48.
62. Tononi, G., 2012. Integrated information theory of consciousness: an updated account. Arch. Ital. Biol. 150(2-3), 56-90.
63. Vollenweider, F.X., Vollenweider-Scherpenhuyzen, M.F., Babler, A., Vogel, H., Hell, D., 1998. Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 9(17), 3897-3902.

Homological scaffolds of brain functional networks

by

G. Petri, P. Expert, F. Turkheimer, R. Carhart-Harris, D. Nutt, P. J. Hellyer, F. Vaccarino

Received: 5 August 2014
Accepted: 3 October 2014

http://dx.doi.org/10.1098/rsif.2014.0873

© 2014 The Authors. Published by the Royal Society under the terms of the Creative Commons Attribution License http://creativecommons.org/licenses/by/4.0/, which permits unrestricted use, provided the original author and source are credited.

original source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4223908/pdf/rsif20140873.pdf
backup source: http://www.psilosophy.info/resources/rsif20140873.pdf

G. Petri[1], P. Expert[2], F. Turkheimer[2], R. Carhart-Harris[3], D. Nutt[3], P. J. Hellyer[4] oraz F. Vaccarino[1,5]

[1] ISI Foundation, Via Alassio 11/c, 10126 Torino, Italy
[2] Centre for Neuroimaging Sciences, Institute of Psychiatry, Kings College London, De Crespigny Park, London SE5 8AF, UK
[3] Centre for Neuropsychopharmacology, Imperial College London, London W12 0NN, UK
[4] Computational, Cognitive and Clinical Neuroimaging Laboratory, Division of Brain Sciences, Imperial College London, London W12 0NN, UK
[5] Dipartimento di Scienze Matematiche, Politecnico di Torino, C.so Duca degli Abruzzi no 24, Torino 10129, Italy

Table of Contents:

- **1. Motivation**
- **2. From networks to topological spaces and homology**
- **3. A persistent homology of weighted networks**
- **4. Homological scaffolds**
- **5. Results from fMRI networks**
- **6. Discussion**
- **7. Methods**
  - 7.1. Dataset
    - *7.1.1. Scanning parameters*
    - *7.1.2. Image pre-processing*
    - *7.1.3. Functional connectivity*
  - 7.2. Persistent homology computation
- **References**

Subject Areas: computational biology

Keywords: brain functional networks, fMRI, persistent homology, psilocybin

Author for correspondence: P. Expert, e-mail: paul.expert@kcl.ac.uk

Networks, as efficient representations of complex systems, have appealed to scientists for a long time and now permeate many areas of science, including neuroimaging (Bullmore and Sporns 2009 *Nat. Rev. Neurosci*. 10, 186-198. (doi:10.1038/nrn2618)). Traditionally, the structure of complex networks has been studied through their statistical properties and metrics concerned with node and link properties, e.g. degree-distribution, node centrality and modularity. Here, we study the characteristics of functional brain networks at the mesoscopic level from a novel perspective that highlights the role of inhomogeneities in the fabric of functional connections. This can be done by focusing on the features of a set of topological objects - *homological cycles* - associated with the weighted functional network. We leverage the detected topological information to define the *homological scaffolds*, a new set of objects designed to represent compactly the homological features of the correlation network and simultaneously make their homological properties amenable to networks theoretical methods. As a proof of principle, we apply these tools to compare resting-state functional brain activity in 15 healthy volunteers after intravenous infusion of placebo and psilocybin - the main psychoactive component of magic mushrooms. The results show that the homological structure of the brain's functional patterns undergoes a dramatic change post-psilocybin, characterized by the appearance of many transient structures of low stability and of a small number of persistent ones that are not observed in the case of placebo

1. Motivation

The understanding of global brain organization and its large-scale integration remains a challenge for modern neurosciences. Network theory is an elegant framework to approach these questions, thanks to its simplicity and versatility[1]. Indeed, in recent years, networks have become a prominent tool to analyse and understand neuroimaging data coming from very diverse sources, such as functional magnetic resonance imaging (fMRI), electroencephalography and magnetoencephalography[2,3], also showing potential for clinical applications[4,5].

A natural way of approaching these datasets is to devise a measure of dynamical similarity between the microscopic constituents and interpret it as the strength of the link between those elements. In the case of brain functional activity, this often implies the use of similarity measures such as (partial) correlations or coherence[6-8], which generally yield fully connected, weighted and possibly signed adjacency matrices. Despite the fact that most network metrics can be extended to the weighted case[9-13], the combined effect of complete connectedness and edge weights makes the interpretation of functional networks significantly harder and motivates the widespread use of ad hoc thresholding methods[7,14-18]. However, neglecting weak links incurs the dangers of a trade-off between information completeness and clarity. In fact, it risks overlooking the role that weak links might have, as shown for example in the cases of resting-state dynamics[19,20], cognitive control[21] and correlated network states[22].

In order to overcome these limits, Rubinov & Sporn[13,23,24] recently introduced a set of generalized network and community metrics for functional networks that among others were used to uncover the contrasting dynamics underlying recollection[25] and the physiology of functional hubs[26]. In this paper, we present an alternative route to the analysis of brain functional networks. We focus on the combined structure of connections and weights as captured by the homology of the network. A summary of all the keywords and concepts introduced in this paper can be found in table 1.

Table 1. List of notations.

name	*symbol*	*definition*
graph	G	a graph $G=(V, E)$ is a representation of a set V of nodes i interconnected by edges or links $e_{ij} \in E$; this interaction can be weighted, directional and signed
clique	c	a completely connected subgraph $C=(V', E')$ contained in an undirected and unweighted graph $G=(V, E)(V' \subset V, e_{ij} \in E' \forall i,j \in E')$
k-simplex	σ_k	formally, a convex hull of $k+1$ nodes $[p_0, p_1, \dots, p_k]$, it is used here as a generalization to higher dimensions of the concept of link, e.g. a 2-simplex is a triangle, a 3-simplex a tetrahedron. The faces f of σ_k are obtained as subsets of $[p_0, p_1, \dots, p_k]$
simplicial complex	$\mathscr{K}$	a topological space composed by attaching simplices σ, with two conditions: (i) if $\sigma \in \mathscr{K}$ then all its faces $f \in \mathscr{K}$, and (ii) the intersection of any two σ_i, $\sigma_j \in \mathscr{K}$ is empty or a face of both σ_i and σ_j
clique complex	$\ell(G)$	a simplicial complex built from a graph G by promoting every k-clique $c \subset G$ to a $(k - 1)$-simplex defined by the nodes of c, e.g. a 3-clique becomes a 2-simplex (a full triangle)
kth homology group	$H_k(\mathscr{K})$	a group describing the holes of a simplicial complex $\mathscr{K}$ bounded by k-dimensional boundaries, e.g. H_1 describes two-dimensional cycles bounded by 1-simplices, H_2 describes three-dimensional voids bounded by 2-simplices, etc.
H_k generator	g	an element of the generating set of H_k , a subset of H_k such that all elements can be expressed as combination of generators
homological scaffold	$\mathscr{H}(\mathscr{K})$	a weighted graph constructed from the persistent homology generators of H_1 of a simplicial complex $\mathscr{K}$

2. From networks to topological spaces and homology

Homology is a topological invariant that characterizes a topological space X by counting its holes and their dimensions. By hole, we mean a hollow region bounded by the parts of that space. The dimension of a hole is directly related to the dimension of its boundary. The boundary of a two-dimensional hole is a one-dimensional loop; the three-dimensional inner part of a doughnut, where the filling goes, is bounded by two-dimensional surface; for dimensions higher than 2, it becomes difficult to have a mental representation of a hole, but k-dimensional holes are still bounded by $(k - 1)$ dimensional faces. In our work, we start with a network and from it construct a topological space. We now use figure 1 to show how we proceed and make rigorous what we mean by boundaries and holes.

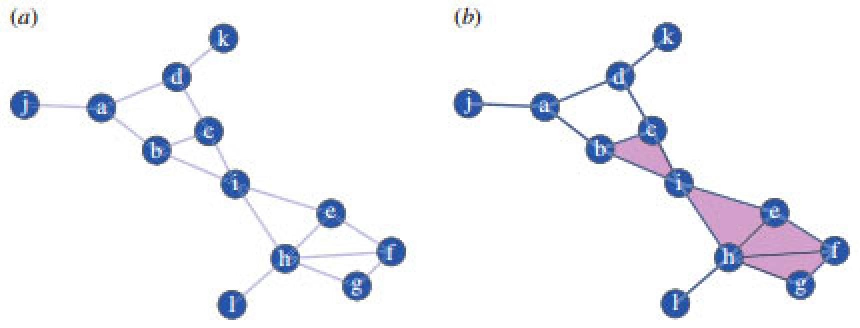


Figure 1. Panels (*a*,*b*) display an unweighted network and its *clique complex*, obtained by promoting cliques to simplices. Simplices can be intuitively thought as higher-dimensional interactions between vertices, e.g. as a simplex the clique (*b*,*c*,*i*) corresponds to a filled triangle and not just its sides. The same principle applies to cliques - thus simplices - of higher order.

In a network like that of figure 1*a*, we want the ring of nodes (*a*,*b*,*c*,*d*) to be a good candidate for a one-dimensional boundary, whereas the other rings of three nodes should not constitute interesting holes. The reason for this choice comes from the formalization of the notion of hole. One way to formalize this is by opposition that is we define what we mean by a dense subnetwork in order to highlight regions of reduced connectivity, i.e. holes. The most natural and conservative definition we can adopt for a dense subnetwork is that of *clique*, a completely connected subgraph[27]. Moreover, cliques have the crucial property, which will be important later, of being nested, i.e. a clique of dimension k (k-clique) contains all the m-cliques defined by its nodes with $m < k$. Using this definition and *filling in* all the maximal cliques, the network in figure 1*a* can be represented as in figure 1*b*: 3-cliques are filled in, becoming tiles, and the only interesting structure left is the square (*a,b,c,d*). It is important at this point to note that a k-clique can be seen as a k - 1 simplex, i.e. as the convex hull of k-points. Our representation of a network can thus be seen as a topological space formed by a finite set of simplices that by construction satisfy the condition that defines the type of topological spaces called abstract simplicial complexes[28]: each element of the space is a simplex, and each of its faces (or subset in the case of cliques) is also a simplex.

This condition is satisfied, because each clique is a simplex, and subsets of cliques are cliques themselves, and the intersection of two cliques is still a clique.

The situation with weighted networks becomes more complicated. In the context of a weighted network, the holes can be thought of as representing regions of reduced connectivity with respect to the surrounding structure.

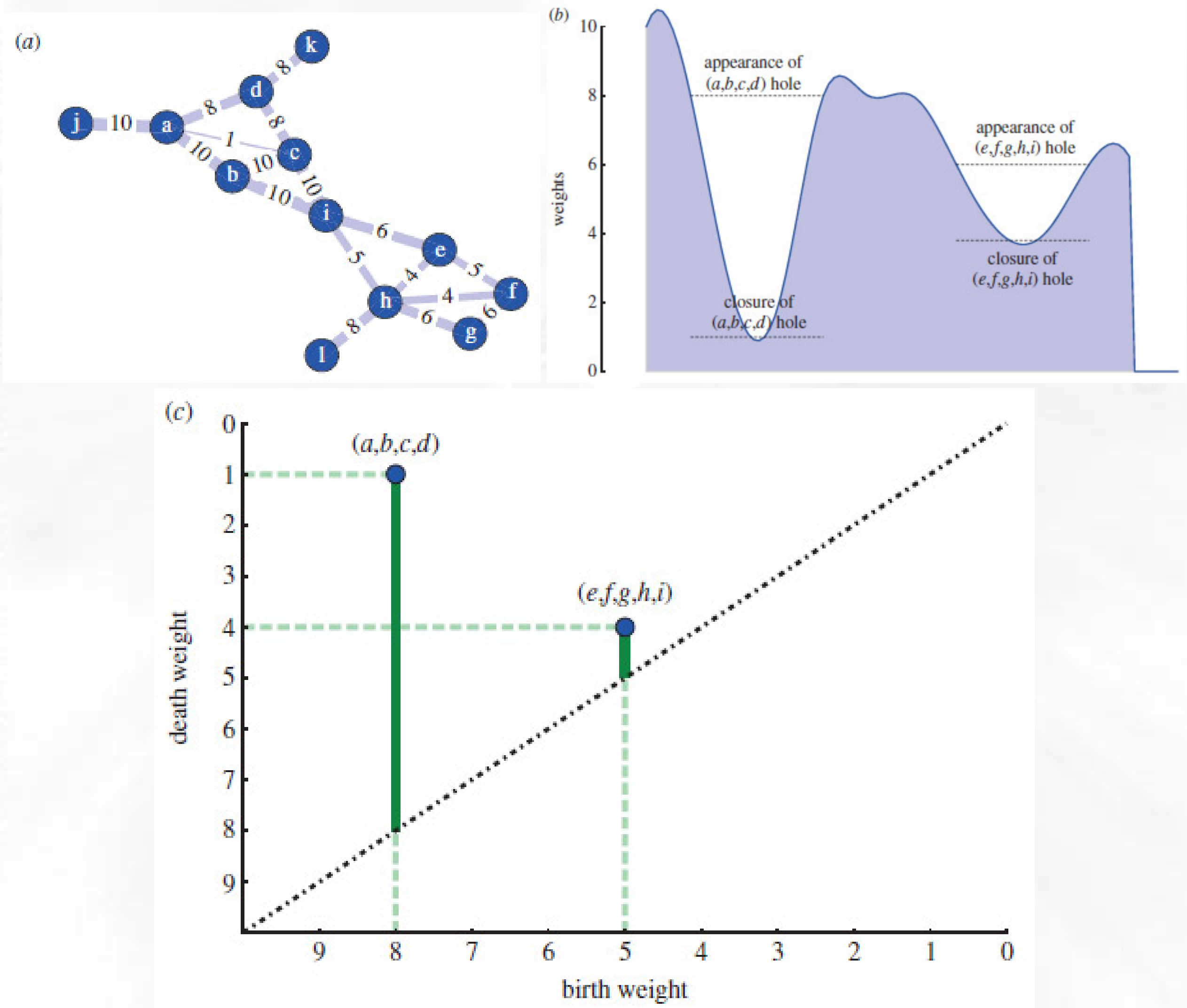


Figure 2. Panels (*a-c*) display a weighted network (*a*), its intuitive representation in terms of a stratigraphy in the weight structure according the weight filtration described in the main text (*b*) and the persistence diagram for H_1 associated with the network shown (*c*). By promoting cliques to simplices, we identify network connectivity with relations between the vertices defining the simplicial complex. By producing a sequence of networks through the filtration, we can study the emergence and relative significance of specific features along the filtration. In this example, the hole defined by (*a,b,c,d*) has a longer persistence (vertical solid green bars) implying that the boundary of the cycle are much heavier than the internal links that eventually close it. The other hole instead has a much shorter persistence, surviving only for one step and is therefore considered less important in the description of the network homological properties. Note that the births and deaths are defined along the sequence of descending edge weights in the network, not in time.

Consider, for example, the case depicted in figure 2*a*: the network is almost the same as figure 1 with the two exceptions that it now has weighted edges and has an additional very weak edge between nodes *a* and *c*. The edges in the cycle [*a*,*b*,*c*,*d*] are all much stronger than the link (*a*,*c*) that closes the hole by making (*a*,*b*,*d*) and (*b*,*c*,*d*) cliques and therefore fills them. The loop (*e*,*f*,*g*,*h*,*i*) has a similar situation, but the difference in edge weights between the links along the cycle and those crossing, is not as large as in the previous case. It would be therefore useful to be able to generalize the approach exposed earlier for binary networks to the case of weighted networks in such a way as to be able to measure the difference between the two cases (*a*,*b*,*c*,*d*) and (*e*,*f*,*g*,*h*,*i*). As shown by figure 2*b*, this problem can be intuitively thought of as a stratigraphy in the link-weight fabric of the network, where the aim is to detect the holes, measure their depth and when they appear as we scan across the weights' range.

From figure 2*b*, it becomes clear that the added value of this method over conventional network techniques lies in its capability to describe mesoscopic patterns that coexist over different intensity scales, and hence to complement the information about the community structure of brain functional networks. A way to quantify the relevance of holes is given by *persistent homology*. We describe it and its application to the case of weighted networks in full detail in §3.

3. A persistent homology of weighted networks

The method that we adopt was introduced in references[29,30] and relies on an extension of the metrical persistent homology theory originally introduced by references[31,32]. Technical details about the theory of persistent homology and how the computation is performed can be found in the works of Carlsson, Zomorodian and Edelsbrunner[28,31-35]. Persistent homology is a recent technique in computational topology developed for shape recognition and the analysis of high dimensional datasets[36,37]. It has been used in very diverse fields, ranging from biology[38,39] and sensor network coverage[40] to cosmology[41]. Similar approaches to brain data[42,43], collaboration data[44] and network structure[45] also exist. The central idea is the construction of a sequence of successive approximations of the original dataset seen as a topological space X. This sequence of topological spaces $X_0, X_1, \ldots, X_N, = X$ is such that $X_i \subseteq X_j$ whenever $i<j$ and is called the *filtration*. Choosing how to construct a filtration from the data is equivalent to choosing the type of goggles one wears to analyse the data.

In our case, we sort the edge weights in descending order and use the ranks as indices for the subspaces. More specifically, denote by $\Omega=(V, E, \omega)$ the functional network with vertices V, edges E and weights $\bar{\omega}: E \rightarrow \mathbb{R}$. We then consider the family of binary graphs $G_\omega=(V, E_\omega)$*, where an edge* $e \in E$ *is also included in* G_ω *if its weight* ω_e *is larger than* ω $(e \in E_\omega \Leftrightarrow \bar{\omega}(e) \geq \omega)$.

To each of the $G_{\omega'}$, we associate its *clique*, or *flag complex* $\mathcal{K}_{\omega'}$, that is the simplicial complex that contains the k-simplex $[n_0, n_1, n_2, \ldots n_{k-1}]$ whenever the nodes $n_0, n_1, n_2, \ldots n_{k-1}$ define a clique in G_ω[27]. As subsets of cliques and intersections of cliques are cliques themselves, as we pointed out in §2, our clique complex is thus a particular case of a simplicial complex.

The family of complexes $\{\mathcal{K}_\omega\}$ defines a filtration, because we have $\mathcal{K}_\omega \subseteq \mathcal{K}'_\omega$ for $\omega > \omega'$. At each step, the simplices in $\mathcal{K}_\omega$ inherit their configuration from the underlying network structure and, because the filtration swipes across all weight scales in descending order, the holes among these units constitute mesoscopic regions of reduced functional connectivity.

Moreover, this approach also highlights how network properties evolve along the filtration, providing insights about where and when lower connectivity regions emerge. This information is available, because it is possible to keep track of each k-dimensional cycle in the homology group H_k. A generator uniquely identifies a hole by its constituting elements at each step of the filtration process. The importance of a hole is encoded in the form of 'time-stamps' recording its birth β_g and death δ_g along the filtration $\{\mathcal{K}_\omega\}$[31]. These two time-stamps can be combined to define the *persistence* $\pi_g = \delta_g - \beta_g$ of a hole, which gives a notion of its importance in terms of it lifespan. Continuing the analogy with stratigraphy, β_g and δ_g correspond, respectively, to the top and the bottom of a hole and π_g would be its depth. As we said above, a generator g_i^k, or hole, of the kth homology group H_k is identified by its birth and death along the filtration. Therefore, g_i^k is described by the point $(\beta_g, \delta_g) \in \mathbb{R}^2$. A standard way to summarize the information about the whole kth persistent homology group is then to consider the diagram obtained plotting the points corresponding to the set of generators. The (multi)set $\{(\beta_g, \delta_g)\}$ is called the persistence diagram of H_k. In figure 2*c*, we show the persistence diagram for the network shown in figure 2*a* for H_1. Axes are labelled by weights in decreasing order. It is easy to check that the coordinates correspond exactly to the appearance and disappearance of generators. The green vertical bars highlight the persistence of a generator along the filtration. The further a point is from the diagonal (vertically), the more persistent the generator is. In §4, we introduce two objects, the persistence and the frequency homological scaffolds, designed to summarize the topological information about the system.

4. Homological scaffolds

Once one has calculated the generators $\{g_i^k\}_i$ of the kth persistent homology group H_k, the corresponding persistence diagram contains a wealth of information that can be used, for example, to highlight differences between two datasets. It would be instructive to obtain a synthetic description of the uncovered topological features in order to interpret the observed differences in terms of the microscopic components at least for low dimensions k. Here, we present a scheme to obtain such a description by using the information associated with the generators during the filtration process. As each generator,g_i^k is associated with a whole equivalence class, rather than to a single chain of simplices, we need to choose a representative for each class, we use the representative that is returned by the *javaplex* implementation[46] of the persistent homology algorithm[47]. For the sake of simplicity in the following, we use the same symbol g_i^k to refer to a generator and its representative cycle.

We exploit this to define two new objects, the persistence and the frequency *homological scaffolds* $\mathscr{H}^p_G$ and $\mathscr{H}^f_G$ of a graph G. The *persistence homological scaffold* is the network composed of all the cycle paths corresponding to generators weighted by their persistence. If an edge e belongs to multiple cycles g_0, g_1, ..., g_s, its weight is defined as the sum of the generators' persistence:

$$\omega_e^\pi = \sum_{g_i | e \in g_i} \pi_{g_i}. \tag{4.1}$$

Similarly, we define the *frequency homological scaffold* $\mathscr{H}^f_G$ as the network composed of all the cycle paths corresponding to generators, where this time, an edge e is weighted by the number of different cycles it belongs to

$$\omega_e^f = \sum_{g_i} 1_{e \in g_i}, \tag{4.2}$$

where $1_{e \in g_i}$ is the indicator function for the set of edges composing g_i. By definition, the two scaffolds have the same edge set, although differently weighted.

The construction of these two scaffolds therefore highlights the role of links which are part of many and/or long persistence cycles, isolating the different roles of edges within the functional connectivity network. The persistence scaffolds encodes the overall persistence of a link through the filtration process: the weight in the persistence scaffold of a link belonging to a certain set of generators is equal to the sum of the persistence of those cycles. The frequency scaffold instead highlights the number of cycles to which a link belongs, thus giving another measure of the importance of that edge during the filtration. The combined information given by the two scaffolds then enables us to decipher the nature of the role different links have regarding the homological properties of the system. A large total persistence for a link in the persistence scaffold implies that the local structure around that link is very weak when compared with the weight of the link, highlighting the link as a locally strong bridge. We remark that the definition of scaffolds we gave depends on the choice of a specific basis of the homology group, and the choice of a consistent basis is an open problem in itself, therefore the scaffolds are not topological invariants. Moreover, it is possible for an edge to be added to a cycle shortly after the cycle's birth in such a way that it creates a triangle with the two edges composing the cycle. In this way, the new edge would be part of the shortest cycle, but the scaffold persistence value would be misattributed to the two other edges. This can be checked, for example, by monitoring the clustering coefficient of the cycle's subgraph as edges are added to it. We checked for this effect and found that in over 80% of the cases the edges do not create triangles that would imply the error, but instead new cycles are created, whose contribution to the scaffold is then accounted for by the new cycle. Finally, we note also that, when a new triangle inside the cycle is created, the two choices of generator differ for a path through a third strongly connected node, owing to the properties of boundary operators. Despite this ambiguity, we show in the following that they can be useful to gain an understanding of what the topological differences detected by the persistent homology actually mean in terms of the system under study.

5. Results from fMRI networks

We start from the processed fMRI time series (see Methods for details). The linear correlations between regional time series were calculated after covarying out the variance owing to all other regions and the residual motion variance represented by the 24 rigid motion parameters obtained from the preprocessing, yielding a partial-correlation matrix χ^α for each subject. The matrices χ^α were then analysed with the algorithm described in the previous sections. We calculated the generators g_i^1 of the first homological group H_1 along the filtration. As mentioned before, each of these generators identifies a lack of mesoscopic connectivity in the form of a one-dimensional cycle and can be represented in a persistence diagram. We aggregate together the persistence diagrams of subjects belonging to each group and compute an associated persistence probability density (figure 3). These probability density functions constitute the statistical signature of the groups' H_1 features.

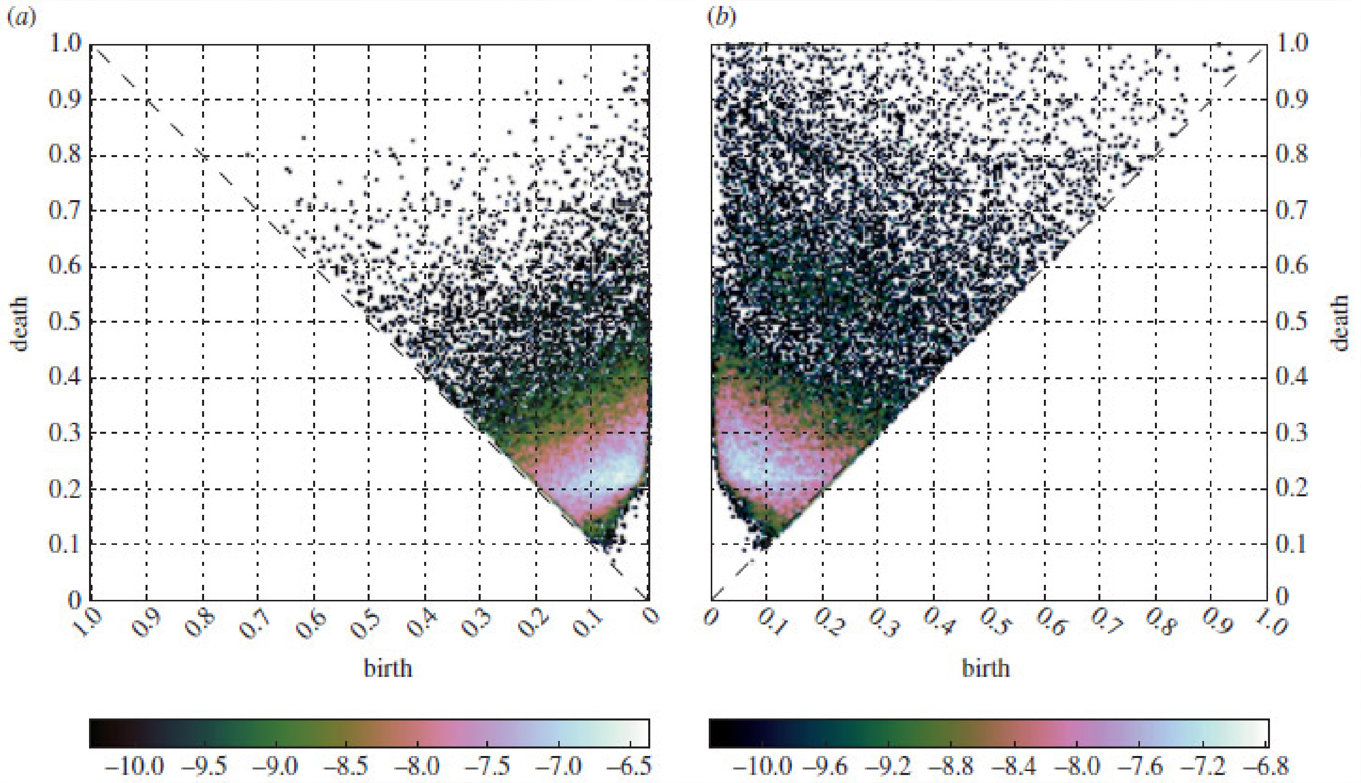


Figure 3. Probability densities for the H_1 generators. Panel (*a*) reports the (log-)probability density for the placebo group, whereas panel (*b*) refers to the psilocybin group. The placebo displays a uniform broad distribution of values for the births - deaths of H_1 generators, whereas the plot for the psilocybin condition is very peaked at small values with a fatter tail. These heterogeneities are evident also in the persistence distribution and find explanation in the different functional integration schemes in placebo and drugged brains.

We find that, although the number of cycles in the groups are comparable, the two probability densities strongly differ (Kolmogorov-Smirnov statistics: 0.22, *p*-value less than 10^{-10}).

The placebo group displays generators appearing and persisting over a limited interval of the filtration. On the contrary, most of the generators for the psilocybin group are situated in a well-defined peak at small birth indices, indicating a shorter average cycle persistence. However, the psilocybin distribution is also endowed with a longer tail implying the existence of a few cycles that are longer-lived compared with the placebo condition and that influences the weight distribution of the psilocybin persistence scaffold. The difference in behaviour of the two groups is made explicit when looking at the probability distribution functions for the persistence and the birth of generators (figure 4), which are both found to be significantly different (Kolmogorov-Smirnov statistics: 0.13, p-value $< 10^{-30}$ for persistence and Kolmogorov-Smirnov statistics: 0.14, p-value $< 10^{-35}$ for births). In order to better interpret and understand the differences between the two groups, we use the two secondary networks described in §4, $\mathscr{H}^{f}_{\text{Pla}}$ and $\mathscr{H}^{p}_{\text{Pla}}$ for the placebo group and $\mathscr{H}^{f}_{\text{Psi}}$ and $\mathscr{H}^{p}_{\text{Psi}}$ for the psilocybin group. The weight of the edges in these secondary networks is proportional to the total number of cycles an edge is part of, and the total persistence of those cycles, respectively. They complement the information given by the persistence density distribution, where the focus is on the entire cycle's behaviour, with information on single links. In fact, individual edges belonging to many and long persistence cycles represent functionally stable 'hub' links. As with the persistence density distribution, the scaffolds are obtained at a group level by aggregating the information about all subjects in each group. These networks are slightly sparser than the original complete χ^{α} networks

$$\rho(\mathscr{H}^{f,p}_{\text{pla}}) = \frac{2m(\mathscr{H}^{p}_{\text{pla}})}{n(n-1)} = 0.92 \tag{5.1}$$

and

$$\rho(\mathscr{H}^{f,p}_{\text{Psi}}) = \frac{2m(\mathscr{H}^{p}_{\text{Psi}})}{n(n-1)} = 0.91 \tag{5.2}$$

and have comparable densities. A first difference between the two groups becomes evident when we look at the distributions for the edge weights (figure 5*a*). In particular, the weights of $\mathscr{H}^{p}_{\text{Pla}}$ display a cut-off for large weights, whereas the weights of $\mathscr{H}^{p}_{\text{Psi}}$ have a broader tail (Kolmogorov-Smirnov statistics: 0.06, p-value $< 10^{-20}$; figure 5*a*). Interestingly, the frequency scaffold weights probability density functions cannot be distinguished from each other figure 5*a* (inset) (Kolmogorov- Smirnov statistics: 0.008, p-value = 0.72). Taken together, these two results imply that while edges statistically belong to the same number of cycles, in the psilocybin scaffold, there exist very strong, persistent links.

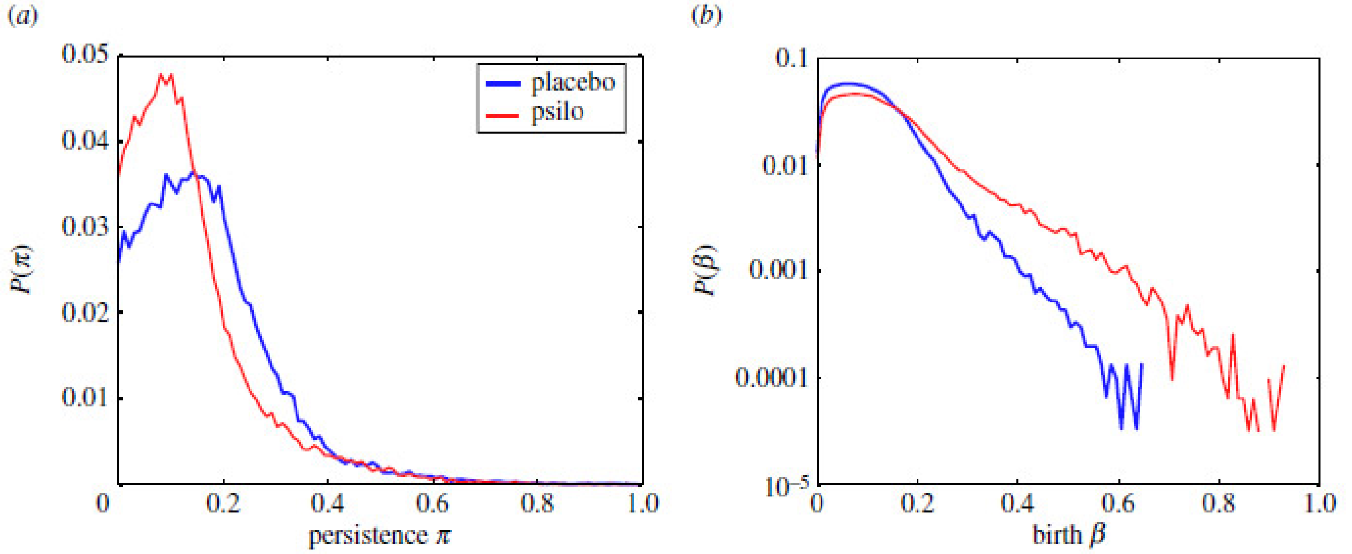


Figure 4. Comparison of persistence π and birth β distributions. Panel (*a*) reports the H_1 generators' persistence distributions for the placebo group (blue line) and psilocybin group (red line). Panel (*b*) reports the distributions of births with the same colour scheme. It is very easy to see that the generators in the psilocybin condition have persistence peaked at shorter values and a wider range of birth times when compared with the placebo condition.

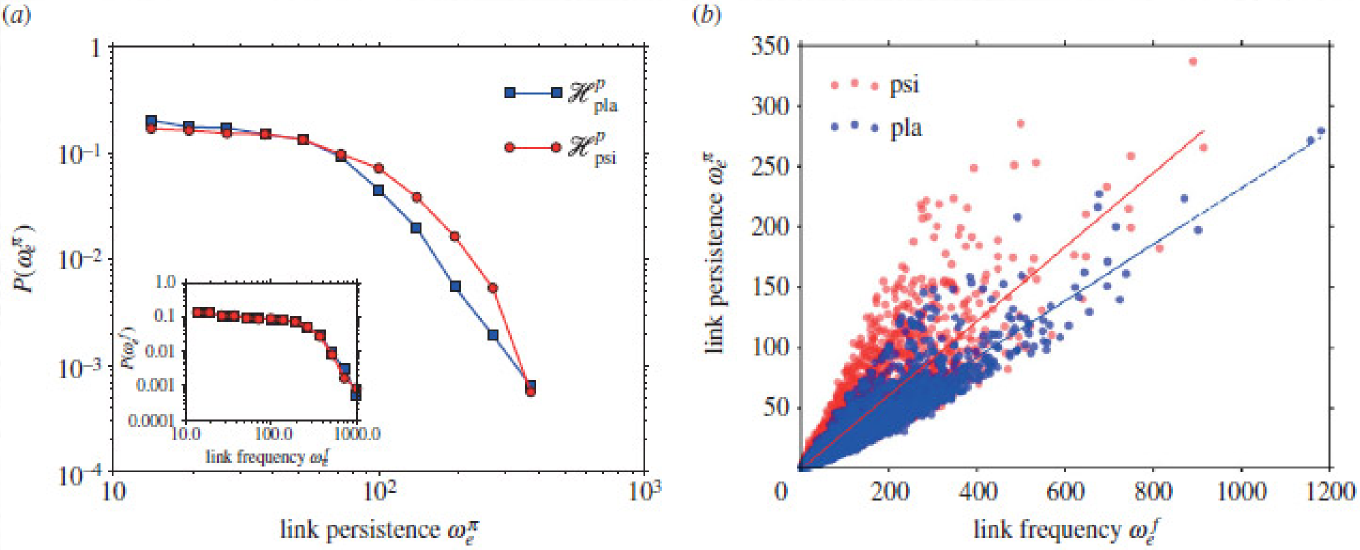


Figure 5. Statistical features of group homological scaffolds. Panel (*a*) reports the (log-binned) probability distributions for the edge weights in the persistence homological scaffolds (main plot) and the frequency homological scaffolds (inset). While the weights in the frequency scaffold are not significantly different, the weight distributions for the persistence scaffold display clearly a broader tail. Panel (*b*) shows instead the scatter plot of the edge frequency versus total persistence. In both cases, there is a clear linear relationship between the two, with a large slope in the psilocybin case. Moreover, the psilocybin scaffold has a larger spread in the frequency and total persistence of individual edges, hinting to a different local functional structure within the functional network of the drugged brains.

The difference between the two sets of homological scaffolds for the two groups becomes even more evident when one compares the weights between the frequency and persistence scaffolds of the same group. Figure 5*b* is a scatter plot of between the weights of edges from both scaffolds for the two groups. The placebo group has a linear relationship between the two quantities meaning that edges that are persistent also belongs to many cycles (R^2 = 0.95, slope = 0.23). Although the linear relationship is still a reasonable fit for the psilocybin group (R^2 = 0.9, slope = 0.3), the data in this case display a larger dispersion. In particular, it shows that edges in $\mathscr{H}^{f,p}{}_{psi}$ can be much more persistent/longer-lived than in $\mathscr{H}^{f,p}{}_{pla}$ but still appear in the same number of cycles, i.e. the frequency of a link is not predictive of its persistence or simply put: some connections are much more persistent in the psychedelic state. Moreover, the slopes of linear fits of the two clouds are statistically different (p-value < 10^{-20}, n_{pla}=13 200 and n_{psi}=13 275[48]) pointing to a starkly different local functional structure in the two conditions.

The results from the persistent homology analysis and the insights provided by the homological scaffolds imply that although the mesoscopic structures, i.e. cycles, in the psilocybin condition are less stable than in the placebo group, their constituent edges are more stable.

6. Discussion

In this paper, we first described a variation of persistent homology that allows us to deal with weighted and signed networks. We then introduced two new objects, the homological scaffolds, to go beyond the picture given by persistent homology to represent and summarize information about individual links. The homological scaffolds represent a new measure of topological importance of edges in the original system in terms of how frequently they are part of the generators of the persistent homology groups and how persistent are the generators to which they belong to. We applied this method to an fMRI dataset comprising a group of subjects injected with a placebo and another injected with psilocybin.

By focusing on the second homology group H_1, we found that the stability of mesoscopic association cycles is reduced by the action of psilocybin, as shown by the difference in the probability density function of the generators of H_1 (figure 3).

It is here that the importance of the insight given by the homological scaffolds in the persistent homology procedure becomes apparent. A simple reading of this result would be that the effect of psilocybin is to relax the constraints on brain function, ascribing cognition a more flexible quality, but when looking at the edge level, the picture becomes more complex. The analysis of the homological scaffolds reveals the existence of a set of edges that are predominant in terms of their persistence although they are statistically part of the same number of cycles in the two conditions (figure 5). In other words, these functional connections support cycles that are especially stable and are only present in the psychedelic state. This further implies that the brain does not simply become a random system after psilocybin injection, but instead retains some organizational features, albeit different from the normal state, as suggested by the first part of the analysis. Further work is required to identify the exact functional significance of these edges. Nonetheless, it is interesting to look at the community structure of the persistence homological scaffolds in figure 6. The two pictures are simplified cartoons of the placebo (figure 6*a*) and psilocybin (figure 6*b*) scaffolds. In figure 6*a,b*, the nodes are organized and coloured according to their community membership in the placebo scaffold (obtained with the Louvain algorithm for maximal modularity and resolution 1[50]). This is done in order to highlight the striking difference in connectivity structure in the two cases.When considering the edges in the tail of the distribution, weight greater than or equal to 80, in figure 5*a*, only 29 of the 374 edges present in the truncated psilocybin scaffold are shared with the truncated placebo scaffold (165 edges). Of these 374 edges, 217 are between placebo communities and are observed to mostly connect cortical regions. This supports our idea that psilocybin disrupts the normal organization of the brain with the emergence of strong, topologically long-range functional connections that are not present in a normal state.

The two key results of the analysis of the homological scaffolds can therefore be summarized as follows (i) there is an increased integration between cortical regions in the psilocybin state and (ii) this integration is supported by a persistent scaffold of a set of edges that support cross modular connectivity probably as a result of the stimulation of the 5-HT_{2A} receptors in the cortex[51].

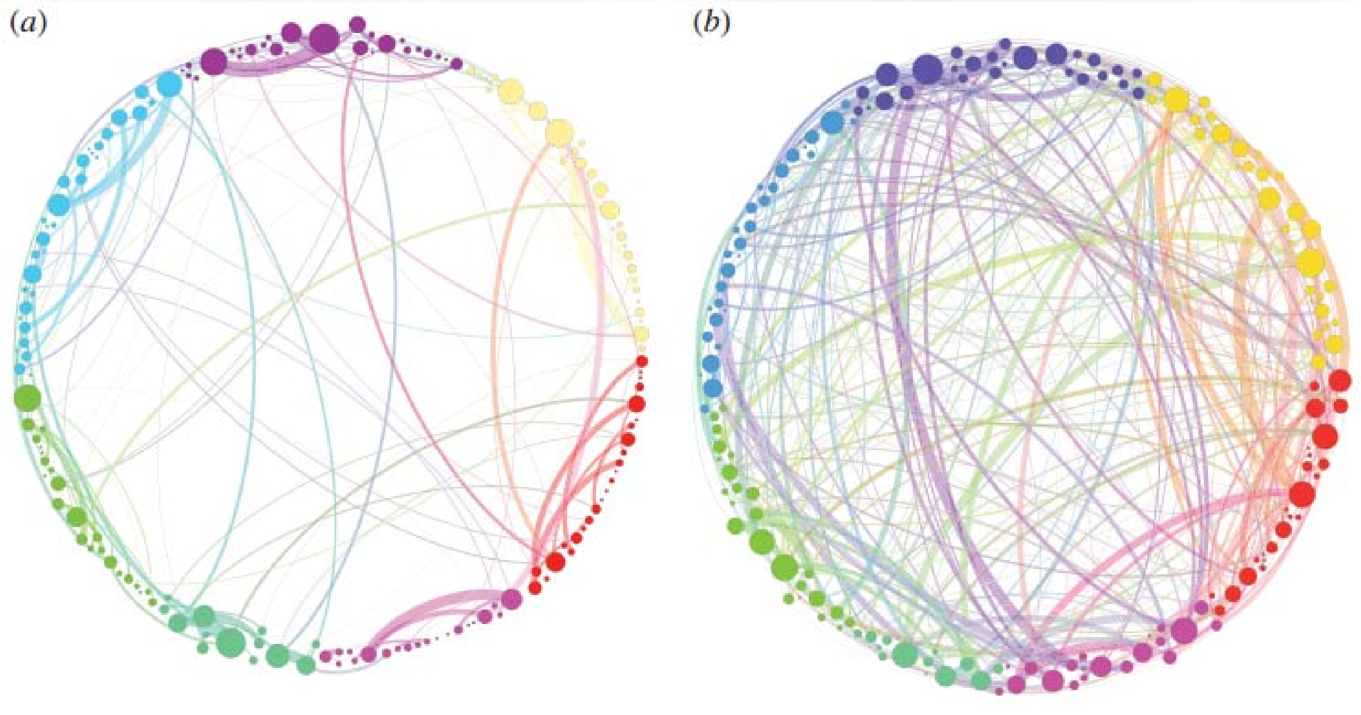


Figure 6. Simplified visualization of the persistence homological scaffolds. The persistence homological scaffolds $\mathscr{H}^{p}_{\mathrm{pla}}$ (*a*) and $\mathscr{H}^{p}_{\mathrm{psi}}$ (*b*) are shown for comparison. For ease of visualization, only the links heavier than 80 (the weight at which the distributions in figure 5*a* bifurcate) are shown. This value is slightly smaller than the bifurcation point of the weights distributions in figure 5*a*. In both networks, colours represent communities obtained by modularity[49] optimization on the placebo persistence scaffold using the Louvain method[50] and are used to show the departure of the psilocybin connectivity structure from the placebo baseline. The width of the links is proportional to their weight and the size of the nodes is proportional to their strength. Note that the proportion of heavy links between communities is much higher (and very different) in the psilocybin group, suggesting greater integration. A labelled version of the two scaffolds is available as GEXF graph files as the electronic supplementary material.

We can speculate on the implications of such an organization. One possible by-product of this greater communication across the whole brain is the phenomenon of synaesthesia which is often reported in conjunction with the psychedelic state. Synaesthesia is described as an inducer-concurrent pairing, where the inducer could be a grapheme or a visual stimulus that generates a secondary sensory output - like a colour for example. Drug-induced synaesthesia often leads to chain of associations, pointing to dynamic causes rather than fixed structural ones as may be the case for acquired synaesthesia[52]. Broadly consistent with this, it has been reported that subjects under the influence of psilocybin have objectively worse colour perception performance despite subjectively intensified colour experience[53].

To summarize, we presented a new method to analyse fully connected, weighted and signed networks and applied it to a unique fMRI dataset of subjects under the influence of mushrooms. We find that the psychedelic state is associated with a less constrained and more intercommunicative mode of brain function, which is consistent with descriptions of the nature of consciousness in the psychedelic state.

7. Methods

7.1. Dataset

A pharmacological MRI dataset of 15 healthy controls was used for a proof-of-principle test of the methodology[54]. Each subject was scanned on two separate occasions, 14 days apart. Each scan consisted of a structural MRI image (T1-weighted), followed by a 12 min eyes-close resting-state blood oxygen-level-dependent (BOLD) fMRI scan which lasted for 12 min. Placebo (10 ml saline, intravenous injection) was given on one occasion and psilocybin (2 mg dissolved in 10 ml saline) on the other. Injections were given manually by a study doctor situated within the scanning suite. Injections began exactly 6 min after the start of the 12-min scans, and continued for 60 s.

7.1.1. Scanning parameters

The BOLD fMRI data were acquired using standard gradient-echo EPI sequences, reported in detail in reference[54]. The volume repetition time was 3000 ms, resulting in a total of 240 volumes acquired during each 12 min resting-state scan (120 pre- and 120 post-injection of placebo/psilocybin).

7.1.2. Image pre-processing

fMRI images were corrected for subject motion within individual resting-state acquisitions, by registering all volumes of the functional data to the middle volume of the acquisition using the FMRIB linear registration motion correction tool, generating a six-dimension parameter time course[55]. Recent work demonstrates that the six parameter motion model is insufficient to correct for motion-induced artefact within functional data, instead a Volterra expansion of these parameters to form a 24 parameter model is favoured as a trade-off between artefact correction and lost degrees of freedom as a result of regressing motion away from functional time courses[56]. fMRI data were pre-processed according to standard protocols using a high-pass filter with a cut-off of 300 s.

Structural MRI images were segmented into n = 194 cortical and subcortical regions, including white matter cerebrospinal fluid (CSF) compartments, using FREESURFER (http://surfer.nmr. mgh.harvard.edu/), according to the Destrieux anatomical atlas[57]. In order to extract mean-functional time courses from the BOLD fMRI, segmented T1 images were registered to the middle volume of the motion-corrected fMRI data, using boundary-based registration[58], once in functional space mean time-courses were extracted for each of the n = 194 regions in native fMRI space.

7.1.3. Functional connectivity

For each of the 194 regions, alongside the 24 parameter motion model time courses, partial correlations were calculated between all couples of time courses (i,j), non-neural time courses (CSF, white matter and motion) were discarded from the resulting functional connectivity matrices, resulting in a 169 region cortical/subcortical functional connectivity corrected for motion and additional non-neural signals (white matter/CSF).

7.2. Persistent homology computation

For each subject in the two groups, we have a set of persistence diagrams relative to the persistent homology groups H_n. In this paper, we use the H_1 persistence diagrams of each group to construct the corresponding persistence probability densities for H_1 cycles.

Filtrations were obtained from the raw partial-correlation matrices through the PYTHON package *Holes* and fed to *javaplex*[46] via a Jython subroutine in order to extract the persistence intervals and the representative cycles. The details of the implementation can be found in reference[30], and the software is available at Holes[59].

Funding statement. G.P. and F.V. are supported by the TOPDRIM project supported by the Future and Emerging Technologies programme of the European Commission under Contract IST-318121. I.D. P.E. and F.T. are supported by a PET methodology programme grant from the Medical Research Council UK (ref no. G1100809/1). The authors acknowledge support of Amanda Feilding and the Beckley Foundation and the anonymous referees for their critical and constructive contribution to this paper.

References

1. Baronchelli A, Ferrer-i-Cancho R, Pastor-Satorras R, Chater N, Christiansen MH. 2013 Networks in cognitive science. *Trends Cogn. Sci*. **17**, 348-360. (doi:10.1016/j.tics.2013.04.010)
2. Bullmore E, Sporns O. 2009 Complex brain networks: graph theoretical analysis of structural and functional systems. *Nat. Rev. Neurosci*. **10**, 186-198. (doi:10.1038/nrn2618)
3. Meunier D, Lambiotte R, Bullmore E. 2010 Modular and hierarchically modular organization of brain networks. *Front. Neurosci*. **4**, 200. (doi:10.3389/ fnins.2010.00200)
4. Pandit AS, Expert P, Lambiotte R, Bonnelle V, Leech R, Turkheimer FE, Sharp DJ. 2013 Traumatic brain injury impairs small-world topology. *Neurology* **80**, 1826-1833. (doi:10.1212/WNL.0b013e3182929f38)
5. Lord LD *et al*. 2012 Functional brain networks before the onset of psychosis: a prospective fMRI study with graph theoretical analysis. *Neuroimage: Clin*. **1**, 91-98. (doi:10.1016/j.nicl.2012.09.008)
6. Lord LD, Allen P, Expert P, Howes O, Lambiotte R, McGuire P, Bose SK, Hyde S, Turkheimer FE. 2011 Characterization of the anterior cingulate's role in the at-risk mental state using graph theory. *Neuroimage* **56**, 1531-1539. (doi:10.1016/j. neuroimage.2011.02.012)
7. Zalesky A, Fornito A, Bullmore E. 2012 On the use of correlation as a measure of network connectivity. *Neuroimage* **60**, 2096-2106. (doi:10.1016/j. neuroimage.2012.02.001)
8. Achard S, Salvador R, Whitcher B, Suckling J, Bullmore E. 2006 A resilient, low-frequency, smallworld human brain functional network with highly connected association cortical hubs. *J. Neurosci*. **21**, 63-72. (doi:10.1523/JNEUROSCI.3874-05.2006)
9. Newman MEJ. 2001 Scientific collaboration networks. II. Shortest paths, weighted networks, and centrality. *Phys. Rev. E* **64**, 016132. (doi:10. 1103/PhysRevE.64.016132)
10. Opsahl T, Agneessens F, Skvoretz J. 2010 Node centrality in weighted networks: generalizing degree and shortest paths. *Soc. Netw*. **32**, 245- 251. (doi:10.1016/j.socnet.2010.03.006)
11. Opsahl T, Colizza V, Panzarasa P, Ramasco JJ. 2008 Prominence and control: the weighted rich-club effect. *Phys. Rev. Lett*. **101**, 168702. (doi:10.1103/ PhysRevLett.101.168702)
12. Colizza V, Flammini A, Serrano MA, Vespignani A. 2006 Detecting rich-club ordering in complex networks. *Nat. Phys*. **2**, 110-115. (doi:10.1038/ nphys209)
13. Rubinov M, Sporns O. 2010 Complex network measures of brain connectivity: uses and interpretations. *Neuroimage* **52**, 1059-1069. (doi:10.1016/j.neuroimage.2009.10.003)
14. Zuo XN, Ehmke R, Mennes M, Imperati D. 2012 Network centrality in the human functional connectome. *Cereb. Cortex* **22**, 1862-1875. (doi:10.1093/cercor/bhr269)
15. Qian S, Sun G, Jiang Q, Liu K, Li B, Li M, Yang X, Yang Z, Zhao L. 2013 Altered topological patterns of large-scale brain functional networks during passive hyperthermia. *Brain Cogn*. **83**, 121-131. (doi:10. 1016/j.bandc.2013.07.013)
16. Sepulcre J, Liu H, Talukdar T, Martincorena I. 2010 The organization of local and distant functional connectivity in the human brain. *PLoS Comput. Biol*. **6**, e1000808. (doi:10.1371/journal.pcbi.1000808)
17. Ginestet CE, Nichols TE, Bullmore ET, Simmons A. 2011 Brain network analysis: separating cost from topology using cost-integration. *PLoS ONE* **6**, e21570. (doi:10.1371/journal.pone.0021570)
18. Power JD, Cohen AL, Nelson SM, Wig GS, Barnes KA. 2011 Functional network organization of the human brain. *Neuron* **72**, 665-678. (doi:10.1016/j.neuron. 2011.09.006)
19. Schwarz AJ, McGonigle J. 2011 Negative edges and soft thresholding in complex network analysis of resting state functional connectivity data. *J. Neuroimage* **55**, 1132-1146. (doi:10.1016/j. neuroimage.2010.12.047)
20. Bassett DS, Nelson BG, Mueller BA, Camchong J, Lim KO. 2012 Altered resting state complexity in schizophrenia. *Neuroimage* **59**, 2196-2207. (doi:10.1016/j.neuroimage.2011.10.002)
21. Cole MW, Yarkoni T, Repovs G, Anticevic A, Braver TS. 2012 Global connectivity of prefrontal cortex predicts cognitive control and intelligence. *J. Neurosci*. **32**, 8988-8999. (doi:10.1523/JNEUROSCI.0536- 12.2012)
22. Schneidman E, Berry MJ, Segev R, Bialek W. 2006 Weak pairwise correlations imply strongly correlated network states in a neural population. *Nature* **440**, 1007-1012. (doi:10.1038/nature04701)

23. Rubinov M, Sporns O. 2011 Weight-conserving characterization of complex functional brain networks. *Neuroimage* **56**, 2068-2079. (doi:10. 1016/j.neuroimage.2011.03.069)
24. Sporns O. 2013 Structure and function of complex brain networks. *Dialogues Clin. Neurosci.* **15**, 247-262.
25. Fornito A, Harrison BJ, Zalesky A, Simons JS. 2012 Competitive and cooperative dynamics of large-scale brain functional networks supporting recollection. *Proc. Natl Acad. Sci. USA* **109**, 12 788-12 793. (doi:10.1073/pnas.1204185109)
26. Liang X, Zou Q, He Y, Yang Y. 2013 Coupling of functional connectivity and regional cerebral blood flow reveals a physiological basis for network hubs of the human brain. *Proc. Natl Acad. Sci. USA* **110**, 1929-1934. (doi:10.1073/pnas.1214900110)
27. Evans TS. 2010 Clique graphs and overlapping communities. *JSTAT* **2010**, P12037. (doi:10.1088/ 1742-5468/2010/12/P12037)
28. Edelsbrunner H, Harer J. 2010 *Computational topology: an introduction*. Providence, RI: American Mathematical Society.
29. Petri G, Scolamiero M, Donato I, Vaccarino F. 2013 Networks and cycles: a persistent homology approach to complex networks. In *Proc. the European Conf. on Complex Systems 2012* (eds T Gilbert, M Kirkilionis, G Nicolis), pp. 93-99. Springer Proceedings in Complexity. Berlin, Germany: Springer. (doi:10.1007/ 978-3-319-00395-5)
30. Petri G, Scolamiero M, Donato I, Vaccarino F. 2013 Topological strata of weighted complex networks. *PLoS ONE* **8**, e66506. (doi:10.1371/journal.pone. 0066506)
31. Edelsbrunner H, Letscher D, Zomorodian A. 2002 Topological persistence and simplification. *Discrete Comput. Geom.* **28**, 511-533. (doi:10.1007/s00454- 002-2885-2)
32. Carlsson G, Zomorodian A. 2005 Computing persistent homology. *Discrete Comput. Geom.* **33**, 249-274. (doi:10.1007/s00454-004-1146-y)
33. Steiner DC, Edelsbrunner H, Harer J. 2007 Stability of persistence diagrams. *Discrete Comput. Geom.* **37**, 103-120. (doi:10.1007/s00454-006-1276-5)
34. Carlsson G. 2009 Topology and data. *Bull. Am. Math. Soc.* **46**, 255-308. (doi:10.1090/S0273-0979-09- 01249-X)
35. Ghrist R. 2008 Barcodes: the persistent topology of data. *Bull. Am. Math. Soc.* **45**, 61-75. (doi:10.1090/ S0273-0979-07-01191-3)
36. Carlsson G, Ishkhanov T, Silva V, Zomorodian A. 2008 On the local behaviour of spaces of natural images. *Int. J. Comput. Vision* **76**, 1-12. (doi:10. 1007/s11263-007-0056-x)
37. Lum PY *et al.* 2012 Extracting insights from the shape of complex data using topology. *Sci. Rep.* **3**, 1236. (doi:10.1038/srep01236)
38. Chan JM, Carlsson G, Rabadan R. 2013 Topology of viral evolution. *Proc. Natl Acad. Sci. USA* **110**, 18 566-18 571. (doi:10.1073/pnas.1313480110)
39. Nicolau M, Levine A, Carlsson G. 2011 Topology based data analysis identifies a subgroup of breast cancers with a unique mutational profile and excellent survival. *Proc. Natl Acad. Sci. USA* **108**, 7265-7270. (doi:10.1073/pnas.1102826108)
40. De Silva V, Ghrist R. 2007 Coverage in sensor networks via persistent homology. *Algebr. Geom. Topol.* **7**, 339-358. (doi:10.2140/agt.2007.7.339)
41. van de Weygaert R *et al.* 2011 Alpha, betti and the megaparsec universe: on the topology of the cosmic web. *Trans. Comput. Sci.* **XIV**, 60-101. Special issue on Voronoi diagrams and Delaunay triangulation. (http://arxiv.org/abs/1306.3640)
42. Lee H, Chung MK, Kang H, Kim B-N, Lee DS. 2011 Discriminative persistent homology of brain networks. In *IEEE Int. Symp. on Biomedical Imaging: From Nano to Macro, 30 March 2011-2 April 2011*, pp. 841-844. Piscataway, NJ: IEEE. (doi:10.1109/ ISBI.2011.5872535)
43. Lee H, Kang H, Chung MK, Kim BN, Lee DS. 2012 Persistent brain network homology from the perspective of dendrogram. *IEEE Trans. Med. Imaging* **31**, 2267-2277. (doi:10.1109/TMI.2012.2219590)
44. Carstens CJ, Horadam KJ. 2013 Persistent homology of collaboration networks. *Math. Probl. Eng.* **2013** 1-7. (doi:10.1155/2013/815035)
45. Danijela H, Maletić S, Rajković M. 2009 Persistent homology of complex networks. *J. Stat. Mech.* **2009**, P03034. (doi:10.1088/1742-5468/2009/03/ P03034)
46. Computational Topology workgroup, Stanford University. 2014 JavaPlex: Java library for computing persistent homology and other topological invariants. See http://git.appliedtopology.org/javaplex/.
47. Skraba P, Vejdemo-Johansson M. 2013 Persistence modules: algebra and algorithms. (http://arxiv.org/ abs/1302.2015)
48. Cohen J, Cohen P. 1983 *Applied multiple regression/ correlation analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.
49. Newman MEJ. 2006 Modularity and community structure in networks. *Proc. Natl Acad. Sci. USA* **103**, 8577-8582. (doi:10.1073/pnas. 0601602103)
50. Blondel VD, Guillaume JL, Lambiotte R, Lefebvre E. 2008 Fast unfolding of communities in large networks. *J. Stat. Mech. Theory Exp.* **2008**, P10008. (doi:10.1088/1742-5468/2008/10/P10008)
51. Eastwood SL, Burnet PW, Gittins R, Baker K, Harrison PJ. 2001 Expression of serotonin 5-HT(2A) receptors in the human cerebellum and alterations in schizophrenia. *Synapse* **42**, 104-114. (doi:10.1002/syn.1106)
52. Sinke C, Halpern JH, Zedler M, Neufeld J, Emrich HM, Passie T. 2012 Genuine and drug-induced synesthesia: a comparison. *Conscious. Cogn.* **21**, 1419-1434. (doi:10.1016/j.concog.2012.03.009)
53. Hartman AM, Holister LE. 1963 Effect of mescaline, lysergic acid diethylamide and psylocibin on colour perception. *Psychomarmacolgia* **4**, 441-451. (doi:10.1007/BF00403349)
54. Carhart-Harris RL *et al.* 2012 Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl Acad. Sci. USA* **109**, 2138-2143. (doi:10.1073/pnas. 1119598109)
55. Smith SM *et al.* 2004 Advances in functional and structural MR image analysis and implementation as FSL. *Neuroimage* **23**, 208-219. (doi:10.1016/j. neuroimage.2004.07.051)
56. Satterthwaite TD *et al.* 2013 An improved framework for confound regression and filtering for control of motion artifact in the preprocessing of resting-state functional connectivity data. *Neuroimage* **64**, 240-256. (doi:10.1016/j. neuroimage.2012.08.052)
57. Destrieux C, Fischl B, Dale A, Halgren E. 2010 Automatic parcellation of human cortical gyri and sulci using standard anatomical nomenclature. Neuroimage 15, 1-15. (doi:10.1016/j.neuroimage. 2010.06.010)

58. Greve DN, Fischl B. 2009 Accurate and robust brain image alignment using boundary-based registration. *Neuroimage* **48**, 63-72. (doi:10.1016/j.neuroimage. 2009.06.060)
59. Computational Topology workgroup, Stanford University. 2013 Holes: Java library for computing persistent homology and other topological invariants. See https://code.google.com/p/javaplex/.

Dynamical exploration of the repertoire of brain networks at rest is modulated by psilocybin

by

Louis-David Lord[a], Paul Expert[b,c], Selen Atasoy[a], Leor Roseman[d], Kristina Rapuano[e], Renaud Lambiotte[f], David J. Nutt[d], Gustavo Deco[g,h], Robin L. Carhart-Harris[d], Morten L. Kringelbach[a,i,j,k], Joana Cabral[a,i,k,*]

NeuroImage 199 (2019) 127-142
Received 17 April 2019; Received in revised form 20 May 2019; Accepted 23 May 2019 Available online 25 May 2019

https://doi.org/10.1016/j.neuroimage.2019.05.060

original report: https://repositorium.sdum.uminho.pt/bitstream/1822/62352/1/1-s2.0-S1053811919304525-main.pdf
backup source: http://www.psilosophy.info/resources/1-s2.0-S1053811919304525-main.pdf

[a] Department of Psychiatry, University of Oxford, UK
[b] Centre for Mathematics of Precision Healthcare, Imperial College London, UK
[c] Department of Mathematics, Imperial College London, UK
[d] Centre for Psychedelic Research, Department of Brain Sciences, Imperial College London, UK
[e] Department of Psychology, Yale University, USA
[f] Mathematical Institute, University of Oxford, UK
[g] Center for Brain and Cognition, Universitat Pompeu Fabra, Spain
[h] Institució Catalana de la Recerca i Estudis Avançats (ICREA), Universitat Pompeu Fabra, Spain
[i] Centre for Music in the Brain, Department of Clinical Medicine, Aarhus University, Denmark
[j] Institut d'Études Avancées de Paris, France
[k] Life and Health Sciences Research Institute (ICVS), School of Medicine, University of Minho, Portugal
[*] Corresponding author: Department of Psychiatry, University of Oxford, UK
E-mail address: joana.cabral@psych.ox.ac.uk (J. Cabral).

Table of Contents:

Abstract
1. Introduction
2. Methods
3. Participants
4. Ethics statement
5. Experimental protocol
6. Neuroimaging data acquisition & processing
- 6.1. Anatomical scan acquisition
- 6.2. fMRI acquisition
- 6.3. fMRI processing

7. Dynamic BOLD phase-locking analysis
- 7.1. Leading eigenvector of the phase-locking matrix

8. BOLD phase-locking states
- 8.1. Detection of recurrent BOLD phase-locking patterns
- 8.2. Probability of occurrence and switching profiles of PL states
- 8.3. Selection of the optimal number of PL states
- 8.4. Comparison with resting-state networks
- 8.5. Global order and metastability

9. Data and code availability statement
10. Results
- 10.1. Repertoire of PL states reveals canonical resting-state networks
- 10.2. Consistency of between-condition differences across partition models
- 10.3. Network-specific neuromodulation
- 10.4. Validation using the placebo dataset

10.5. Dynamical exploration in a low-dimensional manifold
10.6. Trajectories between BOLD phase-locking states
10.7. Subjective intensity of the psychedelic experience correlates with network occupancy
10.8. Psilocybin modulates the global order of BOLD phases
10.9. Effect of motion on PL state probabilities
11. Discussion
Acknowledgments
References

Abstract

Growing evidence from the dynamical analysis of functional neuroimaging data suggests that brain function can be understood as the exploration of a repertoire of metastable connectivity patterns ('functional brain networks'), which potentially underlie different mental processes.
The present study characterizes how the brain's dynamical exploration of resting-state networks is rapidly modulated by intravenous infusion of psilocybin, a tryptamine psychedelic found in "magic mushrooms". We employed a data-driven approach to characterize recurrent functional connectivity patterns by focusing on the leading eigenvector of BOLD phase coherence at single-TR resolution. Recurrent BOLD phase-locking patterns (PL states) were assessed and statistically compared pre- and post-infusion of psilocybin in terms of their probability of occurrence and transition profiles. Results were validated using a placebo session.
Recurrent BOLD PL states revealed high spatial overlap with canonical resting-state networks. Notably, a PL state forming a frontoparietal subsystem was strongly destabilized after psilocybin injection, with a concomitant increase in the probability of occurrence of another PL state characterized by global BOLD phase coherence. These findings provide evidence of network-specific neuromodulation by psilocybin and represent one of the first attempts at bridging molecular pharmacodynamics and whole-brain network dynamics.

1. Introduction

Brain dynamics can be understood as the exploration of activity configurations over both space and time (Tononi and Edelman, 1998; Watanabe *et al*., 2014; Cabral *et al*., 2017b; Gu *et al*., 2018). This exploration may be defined in terms of trajectories within a fixed repertoire of metastable activity patterns, which potentially underlie different brain processes. Indeed, a robust repertoire of large-scale functional networks has been consistently detected across individuals and neuroimaging modalities, not only during task performance but also during rest (Damoiseaux *et al*., 2006; De Luca *et al*., 2006; Mantini *et al*., 2007; Seeley *et al*., 2007; Musso *et al*., 2010; Brookes *et al*., 2011; Yeo *et al*., 2011; Hipp *et al*., 2012), indicating that brain function involves the coordinated integration of information over a repertoire of spatially distributed networks of specialized brain areas (Varela, 1979; Bressler and Menon, 2010; Menon, 2011; Cavanna *et al*., 2017; Lord *et al*., 2017). While the mechanisms driving the spontaneous formation and dissolution of functional networks remain under debate (Cabral *et al*., 2017a), brain function has recently been explored in terms of transitions between recurrent states of functional connectivity (Hansen *et al*., 2015; Cabral *et al*., 2017a; Cavanna *et al*., 2017; Tewarie *et al*., 2019). Although the functional relevance of these explorative dynamics during rest remains unclear (Christoff *et al*., 2016), recent evidence suggests that transitions between brain states are organized in a hierarchical manner (Vidaurre *et al*., 2017) and relate to cognitive function (Cabral *et al*., 2017b).

Novel insights into the neurobiological correlates of functional network states and their relationship to behavior in both health and disease can be gained by understanding how specific psychoactive compounds modulate the relative stability of functional networks over time, as well as the transitions between them. Toward this aim, the present study investigates how psilocybin (4-phosphoryloxy-N,Ndimethyltryptamine) changes the exploration of the brain's dynamical repertoire. Psilocybin is a prodrug of psilocin (4-OH-*N,N*-dimethyltrayptamine) - a psychoactive ingredient found in so-called "magic mushrooms" and classical tryptamine 'psychedelic'. The subjective effects of psilocybin/psilocin include broadly unconstrained perception and cognition, hyper-associative cognition and, at higher doses, a breakdown in the perception of time, space and selfhood (Griffiths *et al*., 2006; Carhart-Harris *et al*., 2014). Psilocybin provides a promising experimental framework for linking molecular pharmacodynamics to changes in the brain's dynamical repertoire because its potent psychoactive effects are selectively due to its agonist activity at the serotonin 2A (5-HT$_{2A}$) receptor (McKenna *et al.*, 1990; Vollenweider *et al.*, 1998; Passie *et al.*, 2002; González-Maeso *et al.*, 2007) - see Beliveau *et al.* (2017) for the highest resolution *in vivo* mapping of 5-HT$_{2A}$ receptor densities in the human brain. Furthermore, investigating how psilocybin modulates the exploration of functional network states over time may help better understand the functional mechanisms underlying the recently demonstrated therapeutic potential of psilocybin (and other indolealkylamines) for disorders including depression, anxiety and addiction (McKenna *et al.*, 1990; Griffiths *et al.*, 2006; Grob *et al.*, 2011; Meltzer *et al.*, 2012; Johnson *et al.*, 2014; Carhart-Harris *et al.*, 2016).

The first fMRI investigation of psilocybin's effects on the human brain consisted of a task-free paradigm in which healthy subjects were intravenously injected with the compound inside the scanner (or a placebo, at least 1 week apart) to characterize changes in brain activity under the influence of the drug (Carhart-Harris *et al.*, 2012). The first dynamical analysis of this dataset found increased variance of intra-network synchrony over time for a number of canonical resting-state networks under psilocybin (Carhart-Harris *et al.*, 2014). Somewhat consistently, a subsequent analysis of this same fMRI dataset using sliding-window correlations within a specific network of four brain regions (comprising the bilateral hippocampus and anterior cingulate cortex) revealed both a larger repertoire of functional motifs under psilocybin as well as greater entropy of the motif sequence (Tagliazucchi *et al.*, 2014). Another experiment using MEG revealed increased Lempel-Ziv complexity -a measure of neural signal diversity calculated at the single-channel level (Lempel and Ziv, 1976)- following psilocybin administration relative to placebo (Schartner *et al.*, 2017). However, it is important to clarify that an increase in local complexity does not necessarily imply higher randomness at the larger scale. This seeming paradox can be explained by the findings in a recent study (Atasoy *et al.*, 2018), where higher coherence - expressed as increased power and energy of connectome harmonic brain states under psilocybin - was accompanied by an enlarged repertoire of brain states, leading to higher spatial and temporal variability. Additionally, other works have shown that the serotonergic psychedelics psilocybin and LSD induce an alternative type of functional integration characterized by greater global integration (Petri *et al.*, 2014; Roseman *et al.*, 2014; Tagliazucchi *et al.*, 2016). However, despite the consistent advancements, how psilocybin modulates the relative occupancy of specific functional networks over time and how it relates to the subjective psychedelic experience has not yet been explored.

Recently, a number of methodological approaches have been proposed to analyze BOLD connectivity dynamics at high temporal resolution (i.e., single volume/TR), focusing either on BOLD co-activation patterns (Tagliazucchi *et al.*, 2012; Liu and Duyn, 2013; Karahanoglu and Van De Ville, 2015), or on BOLD phase coherence patterns (Glerean *et al.*, 2012; Hellyer *et al.*, 2015; Cabral *et al.*, 2017b). While co-activation approaches (in their variant forms) are only sensitive to simultaneity in the data, phase coherence techniques can, by definition, capture temporally delayed relationships, which may be more sensitive to capture the ultra-slow oscillatory processes governing the formation of resting-state networks - as proposed by recent experimental and computational studies (Deco *et al.*, 2009; Cabral *et al.*, 2014a, 2017a; Ponce-Alvarez *et al.*, 2015; Deco and Kringelbach, 2016; Gutierrez-Barragan *et al.*, 2018; Roberts *et al.*, 2019).

To identify recurrent patterns of BOLD phase coherence across subjects and quantify differences in the exploration of the repertoire of functional networks in the current dataset, we employed a recently developed data-driven approach, the Leading Eigenvector Dynamics Analysis (LEiDA), which captures instantaneous phase-locking patterns with reduced dimensionality by considering only the relative phase of BOLD signals (i.e., how all BOLD phases project into their leading eigenvector at each discrete time point) (Cabral *et al.*, 2017b; Figueroa *et al.*, 2019). LEiDA appears as a valuable step in the search for functional network recurrences in dynamical analysis because the reduced dimensionality (from an NxN matrix to a 1xN vector) allows for better convergence of the clustering algorithm, revealing robust BOLD phase-locking patterns that consistently reoccur across fMRI scans for different subjects. However, despite returning meaningful functional subsystems in previous studies (Cabral *et al.*, 2017b; Figueroa *et al.*, 2019), the recurrent patterns identified by LEiDA have not yet been qualitatively compared to canonical resting-state networks (Damoiseaux *et al.*, 2006; Yeo *et al.*, 2011).

In the current work, we therefore employed the LEiDA approach to identify recurrent BOLD phase-locking patterns (PL states) and quantified differences in their probability of occurrence and transition profiles before and after the infusion of psilocybin, while subjects were inside the MRI scanner. The validity of the results was subsequently verified using the placebo dataset, and the repertoire of PL patterns returned by LEiDA was compared to well-established resting-state networks described in the literature.

2. Methods

The full description of the participants, protocol and acquisition is provided in Carhart-Harris *et al*. (2012). Only a brief description is included below.

3. Participants

Employing rigorous standards for data quality, namely minimal motion during the scan, at least 21 years of age, no personal or family history of a major psychiatric disorder, no substance dependence, no cardiovascular disease, and no history of adverse response to a psychedelic drug yielded datasets for nine participants. All subjects had used psilocybin at least once before, but not within 6 weeks of the study.

4. Ethics statement

The study was approved by a National Health Service research ethics committee and all participants gave informed consent to participate in the study.

5. Experimental protocol

All subjects underwent two 12 min eyes-closed resting state fMRI scans over separate sessions, at least 7 days apart. In each session, subjects were injected intravenously with either psilocybin (2 mg dissolved in 10 ml saline, 60 s intravenous injection) or a placebo (10 ml saline, 60 s intravenous injection) in a counterbalanced design (see Fig. 2 for an illustration of the scanning paradigm). Injections were given manually by a Physician within the scanning suite. The infusions began exactly 6 min after the start of the 12 min scans and lasted 60 s. The subjective effects of psilocybin were felt almost immediately after injection and sustained for the remainder of the scanning session. This experimental approach thus provided four distinct fMRI recordings (6 min each) corresponding to each of four experimental conditions: pre/post placebo injection and pre/post psilocybin injection. To account for potential confounds related to the infusion event and to focus analyses on the active drug state, the last 5 min of each scan were used for the relevant analyses. In order to have BOLD timeseries of equal length pre- and post-injection, only the first 5 min of scanning (pre-infusion) were considered in the analysis. At the end of each session, subjects were asked to rate the overall intensity of their subjective experience under the drug (or placebo) and to comment on their wakefulness level throughout the scan. As expected, all participants rated the subjective effects of psilocybin (mean intensity = 6.9/10 ± 2.6) as much stronger than placebo (mean intensity = 0.4/10 ± 0.6) and none of the subjects reported falling asleep during either scanning session.

6. Neuroimaging data acquisition & processing

6.1. Anatomical scan acquisition

Neuroimaging data were acquired using a 3T GE HDx MRI system. Anatomical scans were performed before each functional scan and thus prior to administering either the drug or placebo. Structural scans were collected using a 3D fast spoiled gradient echo scans in an axial orientation, with field of view = 256 × 256 × 192 and matrix = 256 × 256 × 192 to yield 1 mm isotropic voxel resolution (repetition time/echo time TR/TE = 7.9/3.0 ms; inversion time = 450 ms; flip angle = 20).

6.2. fMRI acquisition

BOLD-weighted fMRI data were acquired using a gradient echo planar imaging sequence, TR/TE 3000/35 ms, field-of-view = 192 mm, 64 × 64 acquisition matrix, parallel acceleration factor = 2, 90 flip angle. Fifty-three oblique axial slices were acquired in an interleaved fashion, each 3 mm thick with zero slice gap (3 × 3 × 3 mm voxels).

6.3. fMRI processing

fMRI data were processed using MELODIC (Multivariate Exploratory Linear Decomposition into Independent Components) (Beckmann and Smith, 2004), part of FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl). The default parameters of this imaging pre-processing pipeline were used on all participants: motion correction using MCFLIRT (Jenkinson *et al.*, 2002), non-brain removal using BET (Smith, 2002), spatial smoothing using a Gaussian kernel of FWHM 5 mm, grand-mean intensity normalization of the entire 4D dataset by a single multiplicative factor and linear de-trending over 50 s intervals.

We used the Anatomical Automatic Labeling (AAL) atlas (Tzourio-Mazoyer *et al.*, 2002) to parcellate the MNI brain into $N = 90$ cortical and sub-cortical non-cerebellar brain areas and the BOLD signals were then averaged over all voxels belonging to each brain area using FSL tools. The BOLD signals in each of the 90 brain areas were subsequently band-pass filtered between 0.02 and 0.1 Hz (using a 2nd order Butterworth filter), discarding in this way the high frequency components associated to cardiac and respiratory signals (>0.1 Hz), and focusing on the most meaningful frequency range of resting-state fluctuations (Biswal *et al.*, 1995).

For each subject, this procedure was applied separately to the fMRI data from all four experimental conditions listed above, resulting in four NxT BOLD datasets where $N = 90$ is the number of brain areas and $T = 100$ is the number of TRs.

7. Dynamic BOLD phase-locking analysis

To compute the phase alignment between each pair of AAL regions, first the BOLD phases, $\theta(n,t)$, were estimated using the Hilbert transform for each BOLD regional timecourse (see Fig. 1A) (Glerean *et al.*, 2012; Cabral *et al.*, 2017b). The Hilbert transform expresses a given signal x as $x(t) = A(t)*\cos(\theta(t))$, where A is the time-varying amplitude and θ is the time-varying phase. In Fig. 1A, we represent the BOLD signal phase of one area n over time as $e^{i\theta(t)}$ with $\sin(\theta(t))$ representing the imaginary part of the analytic phase, and $\cos(\theta(t))$ representing its real part (black dotted lines). We show that $\cos(\theta(t))$ captures the oscillatory dynamics of the original BOLD signal (green) - which is mostly preserved after band-pass filtering between 0.02 and 0.1 Hz (blue) - but with constant amplitude (i.e., between -1 and 1). The arrows in red represent the Hilbert phases at each TR, which can be projected into the complex plane (i.e., the plane defined by the real and imaginary axes, represented at $t = 0$).

Fig. 1B shows, at a single time point t, all N = 90 BOLD phases in the cortical space, placed at the center of gravity of each brain area. Here, the arrows are colored according to their direction when projected into the leading eigenvector of phase coherence. On the middle of panel B, the same N = 90 BOLD phases are plotted in the complex plane, i.e., all centered at the same origin.

To obtain a whole-brain pattern of BOLD phase coherence at each single time point t, we compute a dynamic Phase-Locking matrix dPL(n,p,t) which estimates the phase alignment between each pair of brain areas n and p at each time t using Equation (1):

$$\mathrm{dPL}\,(n, p, t) = \cos(\theta(n, t) - \theta(p, t)). \qquad (1)$$

Using the cosine function, two areas n and p with temporarily aligned BOLD signals (i.e., with no phase difference) at a given TR will have a phase-locking value $dPL(n, p, t) = \cos(0°) = 1$. On the other hand, time points when the BOLD signals have180° phase difference (in complex plane) will have $dPL(n, p, t) = \cos(180°) = -1$. The cosine function being even, the $dPL(t)$ matrix is symmetric with values ranging between -1 and 1.

The resulting *dPL* for each subject in each condition is thus a three-dimensional tensor with size *NxNxT*, where $N = 90$ is the number of brain areas and $T = 100$ is the total number of time points.

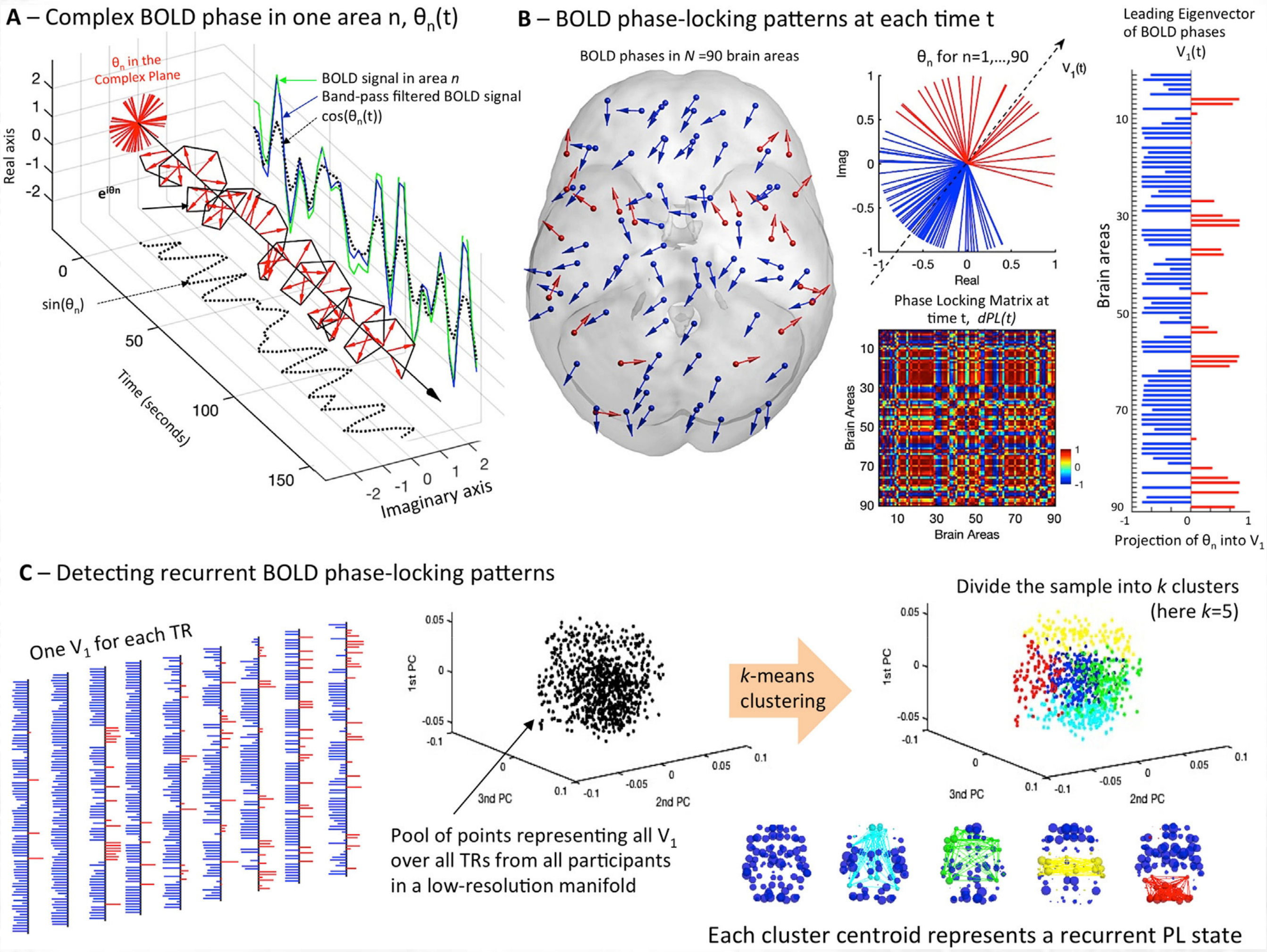

A – Complex BOLD phase in one area n, θn(t)
θn in the Complex Plane
BOLD signal in area n
Band-pass filtered BOLD signal
cos(θn(t))
Real axis
e^iθn
sin(θn)
Time (seconds)
Imaginary axis
B – BOLD phase-locking patterns at each time t
BOLD phases in N =90 brain areas
θn for n=1,...,90
V1(t)
Imag
Real
Phase Locking Matrix at time t, dPL(t)
Brain Areas
Leading Eigenvector of BOLD phases V1(t)
Brain areas
Projection of θn into V1
C – Detecting recurrent BOLD phase-locking patterns
One V1 for each TR
1st PC
2nd PC
3nd PC
Pool of points representing all V1 over all TRs from all participants in a low-resolution manifold
k-means clustering
Divide the sample into k clusters (here k=5)
Each cluster centroid represents a recurrent PL state

Fig. 1. Detection of recurrent BOLD phase-locking (PL) patterns. A) The BOLD signal in a given brain area n (green) is first band-pass filtered between 0.02 and 0.1 Hz (blue) and then transformed into an analytic signal (with real and imaginary components) using the Hilbert transform. The phase dynamics of the analytic signal can be represented over time by $e^{i\theta}$ (black line), where the real part is captured by cos(θ) and the imaginary part by sin(θ) (black dotted lines). The red arrows represent the BOLD phases at each TR. **B)** At a single time point, the BOLD phases in all N = 90 brain areas are represented both in the cortical space (arrows centered at the center of gravity of each brain area) and in the complex plane (i.e., the unit circle with real and imaginary axes, where all phases are centered at the same origin). The phase-locking matrix at time t captures the BOLD phase alignment between each pair of brain areas. (Right) The leading eigenvector of the phase-locking matrix at time t, $V_1(t)$, is the vector that best captures the main orientation of all BOLD phases (represented as a black dashed arrow in the unit circle in the left), where each element in $V_1(t)$ corresponds to the projection of the BOLD phase in each area into $V_1(t)$. The elements of $V_1(t)$ are colored according to their relative direction with respect to V_1 (red: positive; blue: negative). **C)** We take the leading eigenvector $V_1(t)$ as a low-dimensional representation of the BOLD phase-locking patterns over time. To identify recurrent phase-locking patterns, we apply a clustering algorithm (k-means), which divides the pool of data points into a predefined number of clusters k. Each cluster is represented by a central vector, which we take to represent a recurrent BOLD phase-locking pattern, or PL state.

7.1. Leading eigenvector of the phase-locking matrix

To characterize the evolution of the dPL matrix over time with reduced dimensionality, we employed a method termed Leading Eigenvector Dynamics Analysis (LEiDA) (Cabral *et al.*, 2017b; Figueroa *et al.*, 2019). The leading eigenvector of the NxN phase-locking matrix at time t, $V_1(t)$, is a Nx1 vector that captures the main *orientation* of BOLD phases over all areas, where each element in $V_1(t)$ represents the projection of the BOLD phase in each brain area into the leading eigenvector (Fig. 1B, right). When all elements of $V_1(t)$ have the same sign, all BOLD phases are pointing in the same direction (half-plane) with respect to the orientation determined by $V_1(t)$, which is indicative of a global mode governing all BOLD signals. If instead the first eigenvector $V_1(t)$ has elements of different signs (i.e., positive and negative), the BOLD signals follow different directions with respect to the leading eigenvector, which naturally divides the brain areas into 2 clusters according to their BOLD phase relationship (see Fig. 1B). Moreover, the magnitude of each element in $V_1(t)$ indicates the 'strength' with which brain areas belong to the communities in which they are placed (see Newman (2006) and the Supplementary Information for further details). Since V and -V span the same one-dimensional subspace, we use a convention ensuring that most of the elements have negative values, because, as we will show, our results revealed that the smallest group of areas whose BOLD phases do not follow the global mode reveal meaningful functional brain networks (i.e., canonical resting-state networks).

This approach substantially reduces the dimensionality of the data, while still explaining most of the variance of BOLD phase coherence (see the Supplementary Fig. S1 where we show that the leading eigenvector consistently represents >50% of the variance in phase coherence at all time points).

8. BOLD phase-locking states

8.1. Detection of recurrent BOLD phase-locking patterns

To identify recurrent PL patterns, we applied a k-means clustering algorithm to divide the set of 1800 eigenvectors (corresponding to all 100 TRs of all 9 subjects both before and after psilocybin injection) into a predefined number of clusters *k* (see Fig. 1C), with higher k revealing more rare and more fine-grained patterns. Since the optimal number of functional networks to consider remains an open question, we ran the k-means clustering algorithm with *k* ranging from 5 to 10 (i.e., dividing the set of eigenvectors into *k* = 5, 6, ..., 10 clusters) to cover the range of functional networks commonly reported in the resting-state fMRI literature (Beckmann *et al.*, 2005; Damoiseaux *et al.*, 2006; Yeo *et al.*, 2011).

For each partition model considered (i.e., k = 5 to k = 10), the clustering returns *k* cluster centroids in the shape of Nx1 vectors V_C, which represent the average vector of each cluster (in Fig. 2A we show the 7 central vectors obtained with k = 7; the centroids obtained for all solutions ranging from k = 5 to k = 10 are shown in Supplementary Fig. S2). We take these central vectors as representing recurrent BOLD phase-locking states, or PL states. As shown in Fig. 2B, each PL state can be represented as a network in cortical space, where the value of $V_C(n)$ is used to scale the color of each brain area and links are plotted between areas with positive sign to highlight the network detaching from the global mode (in Fig. 2 we used $V_C(n) > 0.3$ for visualization purposes only). Also, to facilitate visualization and interpretation of PL states, the cluster centroid vectors V_C can be rendered onto a cortical surface, e.g. using the HCP Workbench (Fig. 2C). Finally, we note that the PL states can also be represented back into matrix format (NxN) by computing the outer product $V_C. V_C^T$ resulting in a matrix of rank 1 (i.e., a matrix that is obtained from a single vector), with positive values between all elements with the same sign in V_C (be they positive or negative), and negative values between elements of different signs (Fig. 2D).

8.2. Probability of occurrence and switching profiles of PL states

The clustering assigns to each TR a single PL state, by selecting the closest centroid V_C at each TR, as illustrated by the color-coded bars in Fig. 3A for one representative subject (the color-coded cluster time courses are shown for all 9 subjects in Supplementary Figs. S3 and S4). Using the state time courses, we calculated the probability of occurrence of each state, which is simply the number of epochs assigned to a given PL state divided by the total number of epochs (TRs) in each scanning session (see Fig. 3A for an illustration with k = 7). For each partition model (i.e., with k = 5 to k = 10) the probabilities of each PL state were calculated for each subject before and after psilocybin injection separately.

Differences in probabilities of occurrence before and after injection were statistically assessed using a permutation-based paired *t*-test. This non-parametric test uses permutations of group labels to estimate the null distribution, which is computed independently for each experimental condition (before versus after psilocybin injection). For each of 1000 permutations, a *t*-test is applied to compare populations and a *p*-value is returned.

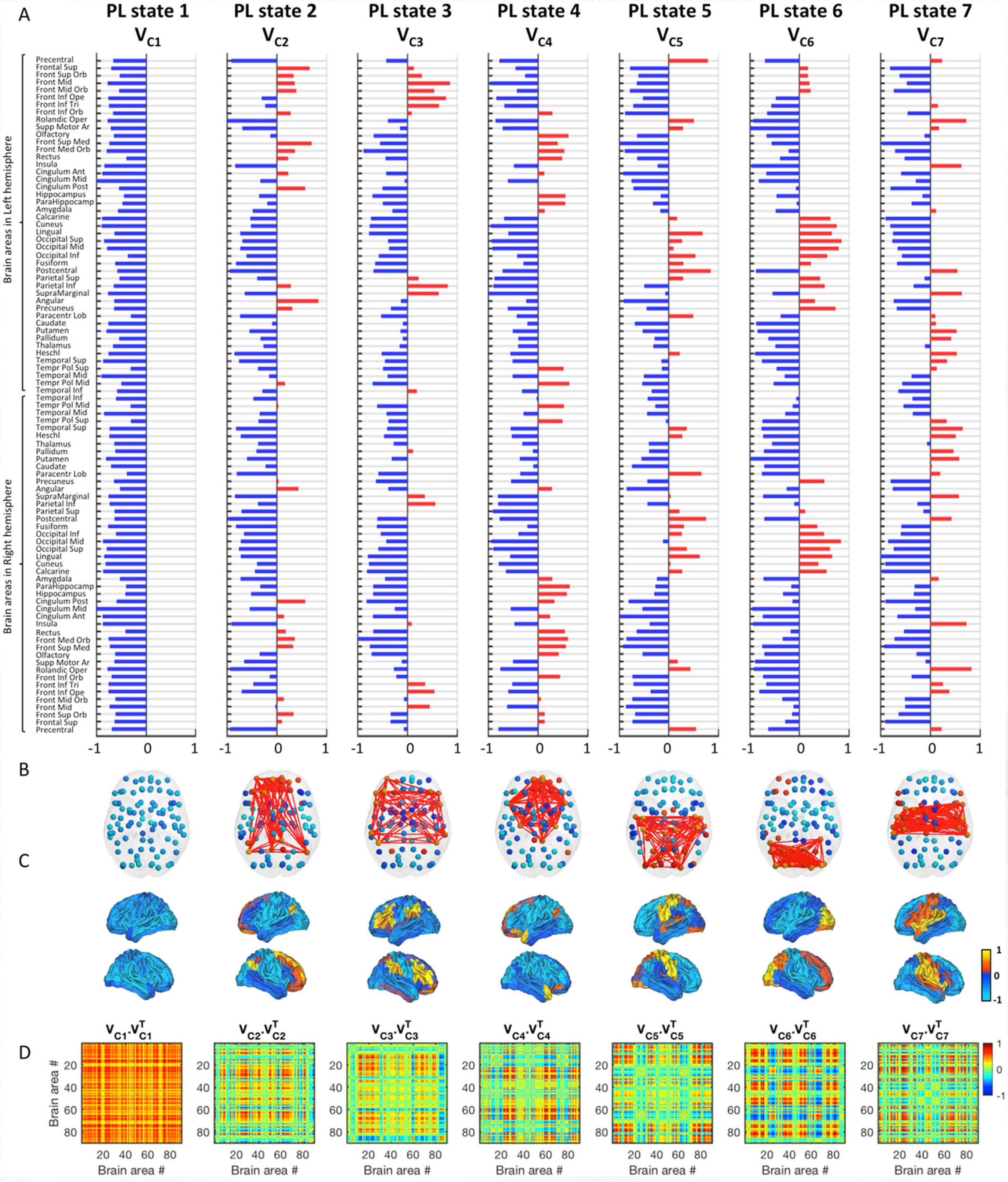


Fig. 2. Repertoire of recurrent BOLD phase-locking patterns (PL states) obtained by clustering the leading eigenvectors of BOLD phase coherence (here with k = 7). Seven recurrent PL states were obtained from unsupervised clustering of the 1800 eigenvectors of BOLD phase coherence over time, sorted (left to right) according to decreasing probability of occurrence before psilocybin injection. Each PL state is represented by the central vector of each cluster V_C as: **A)** a bar plot showing the N elements in V_C, representing the projection of the BOLD phase in each brain area into the leading eigenvector; **B)** a network in cortical space, where the value of $V_C(n)$ is used to scale the color of each brain area and links are plotted between areas with $V_C(n) > 0.3$ to highlight the network detaching from the global mode; **C)** cortical renderings in AAL space of regional contributions to the respective V_C and **D)** a matrix obtained by calculating the outer product of V_C, where positive values are the product of V_C elements with the same sign, be they positive or negative.

8.3. Selection of the optimal number of PL states

In the current study we did not aim to determine the optimal number of PL states governing resting-state activity, but rather to investigate if there are PL state(s) that significantly differ in their probability of occurrence following the administration of psilocybin. As such, we employed a data mining approach to detect meaningful activity patterns (PL states) from the session during which psilocybin was infused, and left the placebo session (recorded more than 7 days apart) as a validation dataset (see section *Validation using the Placebo dataset*).

To search for PL patterns affected by psilocybin, we varied k (number of clusters) between 5 and 10, and for each k examined how the probability of occurrence of each PL state changed after the injection of psilocybin. We subsequently analyzed the robustness of the results over the range of partition models by plotting the p-values with respect to different significance thresholds, i.e., the standard $\alpha_1 = 0.05$ or the Bonferroni corrected significance threshold $\alpha_2 = 0.05/k$ to correct for the number of independent hypotheses compared in each partition model.

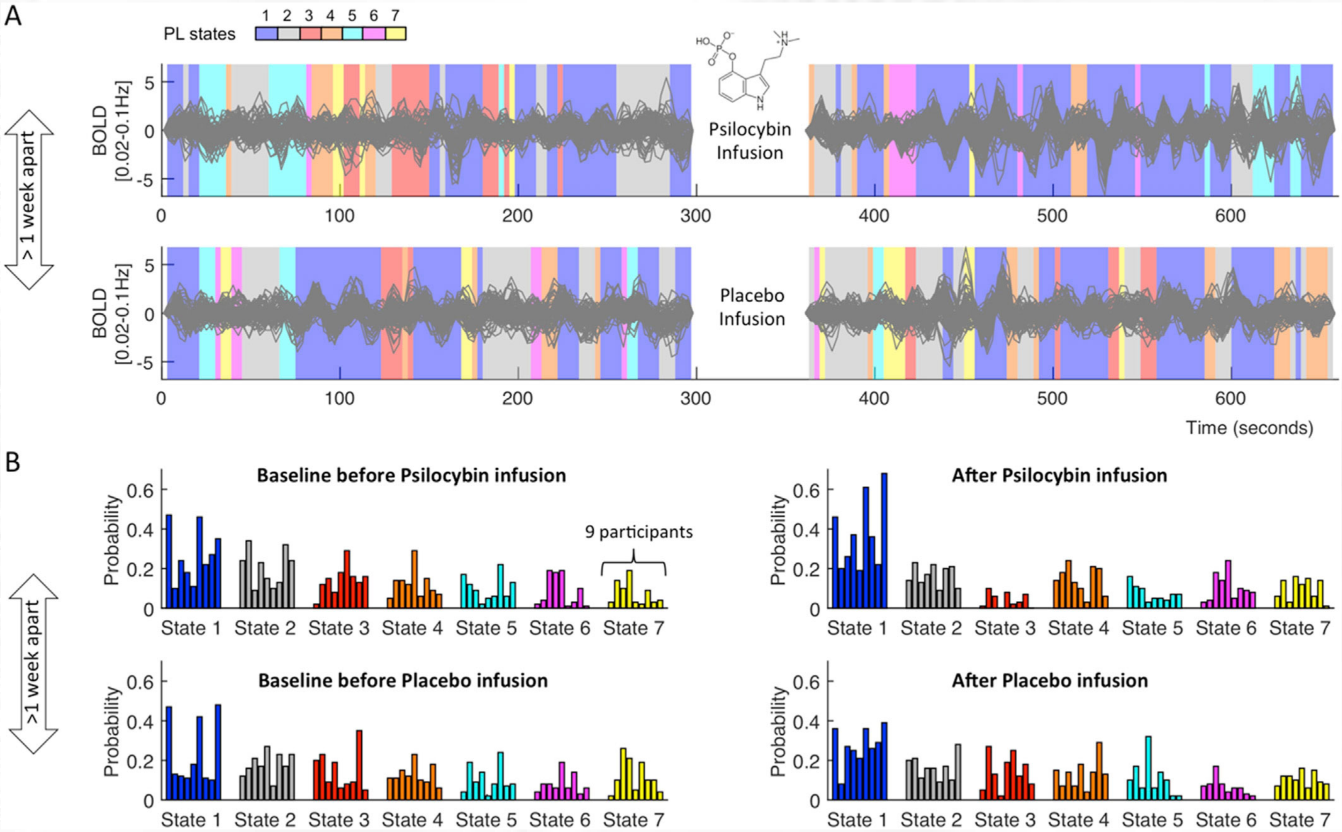


Fig. 3. Assignment of one BOLD Phase-Locking (PL) state to each TR and corresponding probabilities of occurrence for each condition and participant. A) For each of the 9 participants, 2 fMRI sessions were recorded at least one week apart. In the middle of each session, either Psilocybin or a Placebo was intravenously administered inside the scanner. The color-coded bars behind the BOLD signals represent the PL state assigned to each TR (corresponding to the 7 PL states reported in Fig. 2). Results are shown here for subject 9 (the remaining participants are shown in SI Figs. S3 and S4). **B)** The probabilities of occurrence of each PL state were obtained for each of the 4 conditions and for each subject separately, which were used for the subsequent statistical analysis.

For the subsequent validation using the placebo condition, we used exactly the same PL states obtained previously for the psilocybin session for the selected optimal k, and evaluated how these same PL states were explored during the placebo session. As in the previous analysis, we first obtained the 1800 leading eigenvectors V_1 (9 subjects, 2 conditions, 100 TRs each) and ran a *single* iteration of the k-means algorithm with $k = 7$, defining as 'start vectors' the 7 cluster centroids V_C obtained before. This computes the cosine distance between each observation in the placebo dataset and the previously defined 7 cluster centroids, returning a sequence of cluster time courses for the placebo fMRI session. Critically, this approach allows a direct comparison with the psilocybin fMRI sessions recorded several days apart, enabling us to verify whether the probabilities of approaching a given cluster centroid in the placebo sessions were: i) consistent with the pre-psilocybin condition and ii) different from the post-psilocybin condition.

In a follow-up analysis, we compared the number of within-subject occurrences of the most meaningful PL states before and after the psilocybin injection using a paired *t*-test.

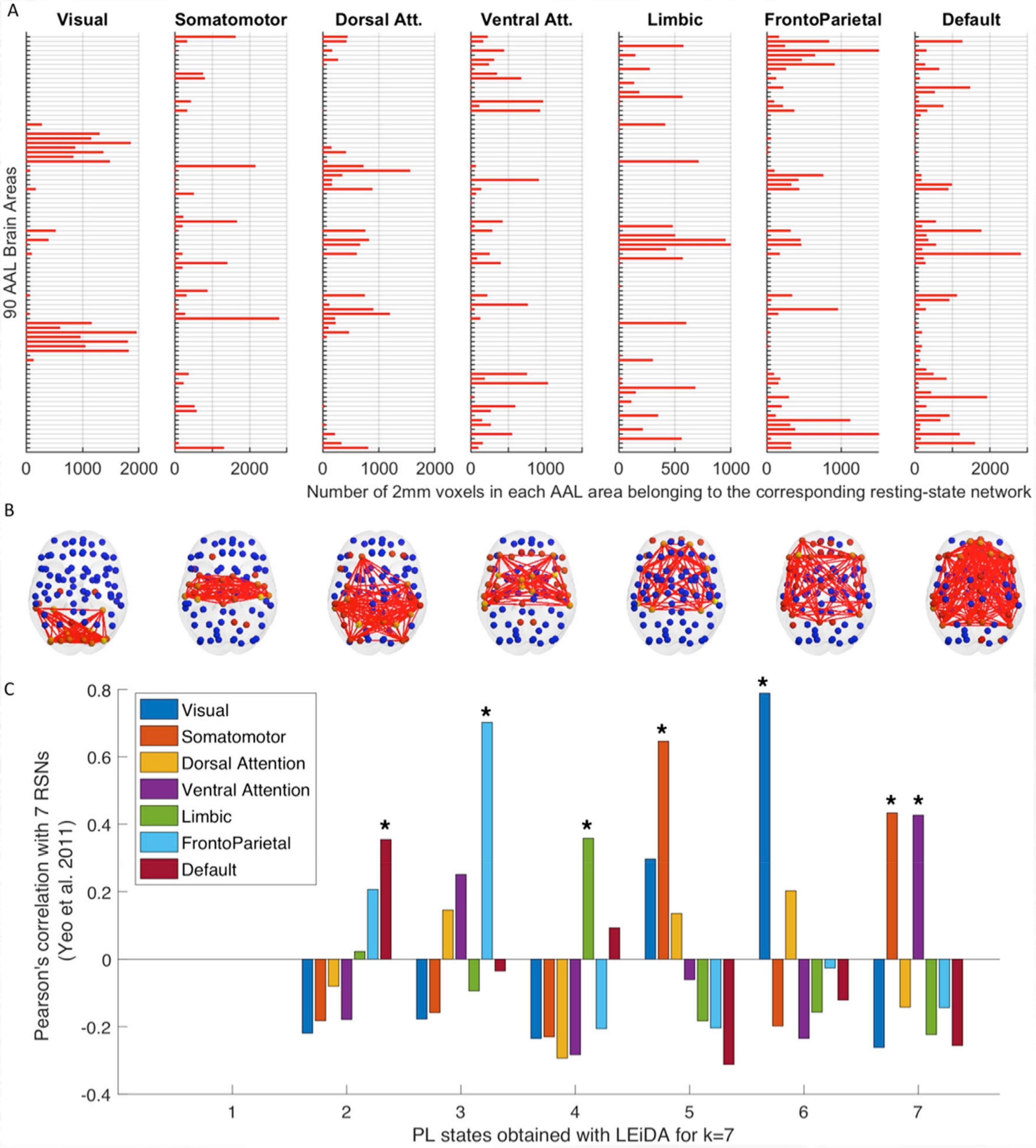


Fig. 4. Overlap of the 6 non-global PL states with seven canonical resting-state networks (RNSs). A) The 7 cortical networks defined in Yeo *et al*. (2011) were transformed into AAL space by counting the number of 2 mm^3 MNI voxels in each AAL brain area that belong to each of the 7 networks, obtaining in this way a vector with N = 90 elements that we can compare with the PL states obtained in this work. **B)** Representation in cortical space of the vectors shown in (A) colouring in red the spheres representing the brain areas contributing to each RSN. Red links were plotted between AAL areas with >400 MNI voxels contributing to each RSN. **C)** We compared the 6 non-global PL states obtained with LEiDA (for k = 7) with the 7 RSNs by computing the Pearson's correlation between the 1 × 90 centroid vectors V_C (shown in Fig. 3) and the vectors shown in (A). Asterisks denote significant correlations with p-value < 0.001.

8.4. Comparison with resting-state networks

We first transformed the 7 RSNs defined in 2 mm^3 MNI space by Yeo *et al*. (2011) into 7 vectors with 90 elements each (shown in Fig. 4), where each element scales the contribution of each AAL brain area to the corresponding RSN. Subsequently, we computed the bivariate correlation with the centroid vectors V_C, setting all negative elements in V_C to zero, keeping only the values of the positive elements (the red links in Fig. 2B).

8.5. Global order and metastability

Using a perspective from dynamical systems theory, we investigated how psilocybin affected the order and stability of BOLD signals. At each instant of time, the degree of order between BOLD phases $\theta(n, t)$, $n = 1,..,90$, can be quantified using the magnitude of the Kuramoto Order Parameter, $OP(t)$, which can range between 0 (when all BOLD signals are out of phase) and 1 (when all BOLD signals are in phase):

$$\mathrm{OP(t)=1N|\sum n=1Nei\theta(n,t)|.}$$

The mean magnitude of the Order Parameter over time informs whether the system is mostly incoherent, partially synchronized or fully synchronized (Acebrón *et al*., 2001; Acebrón *et al*., 2005; Cabral *et al*., 2011; Deco and Kringelbach, 2016). Moreover, the standard deviation of the order parameter, STD(OP), can be used to characterize the degree of *metastability* in the system (Shanahan, 2010; Cabral *et al*., 2014b). In other words if the order parameter is constant over time, it means that the system is in a stable equilibrium, be it synchronized or not. When more than one weakly stable states co-exist and the system systematically switches from one to another, then the variance of the order parameter increases, indicating a dynamical system with metastability. To investigate the effects of psilocybin on the stability of the global order of BOLD phases, we therefore calculated the standard deviation of the order parameter over time within each subject before and after the psilocybin infusion. Between-condition differences on these measures were assessed using a one-sample *t*-test.

9. Data and code availability statement

fMRI data from the 9 participants in the 4 conditions is available on request. Please contact Robin L Carhart-Harris r.carhart-harris@imperial.ac.uk at the Centre for Psychedelic Research, Department of Brain Sciences, Imperial College London.

The Matlab codes developed for the analysis are made available open source at github.com/juanitacabral/LEiDA_Psilocybin, together with the post-processed data.

10. Results

10.1. Repertoire of PL states reveals canonical resting-state networks

The repertoire of PL states obtained when dividing the set of leading eigenvectors into seven clusters is plotted in Fig. 2, where each state is represented by its central vector V_C as: (A) a bar plot showing the projection of the BOLD phase in each brain area into the leading eigenvector, (B) a network in cortical space, where links are plotted between areas with $V_C(n) > 0.3$ to highlight the network detaching from the global mode; (C) a rendering of regional values of V_C onto the cortical surface, and (D) a matrix obtained by calculating the outer product of V_C. While partitions with different *k* were produced, we selected the partition into k = 7 PL states because it returned the PL states that most significantly differed in terms of probability of occurrence after psilocybin injection, as we will explain in section *Results - Consistency of between-condition differences across partition models.*

Results reveal that the most probable BOLD phase-locking state (PL state 1) corresponds to a state where all

BOLD signals are following one main direction (i.e., all projecting toward the same direction into the leading eigenvector), in line with findings from prior studies using LEiDA (Cabral *et al.*, 2017b; Figueroa *et al.*, 2019). While this global modulation occurs for a significant fraction of the time, we detect a number of non-global patterns that transiently and recurrently shape the phase alignment of BOLD signals during the remaining time.

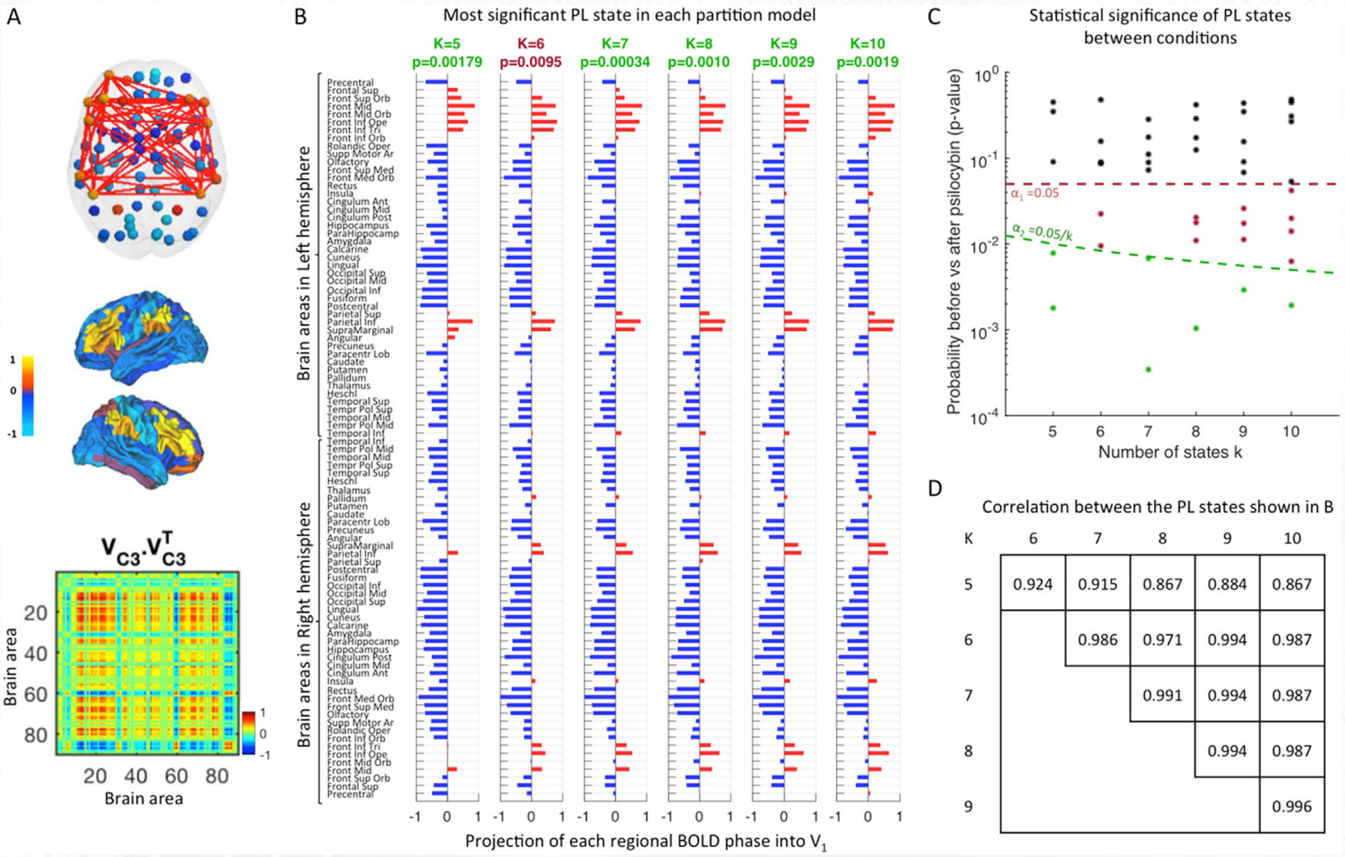
The non-global PL states 2-7 shown in Fig. 3 reveal striking spatial similarities with canonical resting-state networks reported in the literature. We verified this overlap by computing the correlation between the 7 resting-state networks (RSNs) defined in Yeo *et al*. (2011) and each PL state obtained herein (Fig. 4). Corroborating our observations, we found that all non-global PL states show strong and statistically significant spatial overlap with well-documented resting-state networks, namely PL state 6 reveals a strong correlation with the Visual network (Pearson's $r = 0.79$, $p = 2.3*10^{-20}$), PL state 3 correlates with the Frontoparietal network ($r = 0.70$, $p = 1.1*10^{-14}$), PL state 5 correlates with the Somatomotor network ($r = 0.65$, $p = 6.1*10^{-12}$), PL state 4 correlates with the Limbic network ($r = 0.36$, $p = 5.5*10^{-4}$) and PL state 2 correlates with the Default Mode network ($r = 0.35$, $p = 5.5*10^{-4}$). Finally, PL state 7 reveals approximately equal contributions of the Ventral Attention ($r = 0.43$, $p = 2.0*10^{-5}$) and the Somatomotor networks ($r = 0.43$, $p = 2.8*10^{-5}$).

10.2. Consistency of between-condition differences across partition models

The repertoire of PL states obtained depends on the number of clusters k defined in the k-means clustering algorithm, with a higher k generally revealing more fine-grained, less frequent and often less symmetric networks. Here, we chose to cover a range of partition models (i.e., with k varying gradually between $k = 5$ to $k = 10$) and examined the PL configurations that most significantly differentiate brain activity under psilocybin in each partition model relative to the pre-injection baseline.

In Fig. 5, we show, for each partition into k PL states (horizontal axis), the p-values obtained from between-condition comparisons (pre vs post-psilocybin) in terms of probability of occurrence of each of the corresponding k PL states. Since a higher number of comparisons increases the chances of false positives (i.e., of p-values falling below the standard threshold of $\alpha_1 = 0.05$, shown in red in Fig. 5C), we Bonferroni correct the threshold by the number of independent hypotheses tested within each partition model, i.e., $\alpha_2 = 0.05/k$ (green dashed line in Fig. 5C). Note that across partition models, the null hypotheses being tested are not independent from each other (as shown in the correlations reported in Fig. 5D), so correcting for the full number of comparisons would not be adequate here.

We find that, for the entire range of partition models explored (i.e., $5 \leq k \leq 10$), the PL state that most strongly alters its probability of occurrence after the psilocybin infusion is a frontoparietal network (Fig. 5A) passing the corrected threshold α_2 for all k except for $k = 6$ ($p = 0.0095$), which despite falling below α_1, narrowly misses the α_2 cutoff. The most significantly different PL state of each partition model is reported in Fig. 5B in vector format. These PL states were highly correlated across clustering solutions (CC > 0.86 for all pairs of PL states, Fig. 5D), which indicates that they refer to the same underlying functional network, with small differences arising from the number of output states constrained by k. Furthermore, we note that a second network exhibited significant differences between conditions surviving the correction for the number of clusters ($\alpha_2 = 0.05/k$) for the clustering solutions: $k = 5$ ($p = 0.0078$) and $k = 7$ ($p = 0.0068$) (Fig. 5C, second smallest p-value for each k). This network corresponds to the globally coherent PL state 1, which also showed a high level of consistency across the range of clustering solutions, with some brain areas being more strongly aligned to the global mode of BOLD phase coherence than others (see Supplementary Fig. S2).



K	6	7	8	9	10
5	0.924	0.915	0.867	0.884	0.867
6		0.986	0.971	0.994	0.987
7			0.991	0.994	0.987
8				0.994	0.987
9					0.996

Fig. 5. Detection of the PL states that most significantly change their probabilities of occurrence after psilocybin infusion across partition models. A) The PL state differing the most between conditions is a functional network consisting of lateral frontoparietal areas, shown here for k = 7 (PL state 3 from Fig. 2). B) Bar plots showing, for each partition into k = 5 up to k = 10 PL states, the cluster centroid of the PL state that most significantly changed in probability of occurrence between conditions (p-values reported in the title are colored according to significance level). **C)** For each partition model, we plot the p-values associated to the comparison between all PL state probabilities before and after psilocybin injection. We find that, although most PL states do not show significant differences between groups (black dots falling above the α_1 = 0.05 threshold), some PL states show significant differences in probability of occurrence between groups, falling below (or very near for k = 6) the corrected threshold by the number of clusters (α_2 = 0.05/k, green dashed line). **D)** The PL states representing the Frontoparietal network in different partition models (shown in B) are highly correlated with one another.

10.3. Network-specific neuromodulation

The probabilities of occurrence of each PL state in each of the 4 experimental conditions for the optimal solution with k = 7 are shown in the bar plots of Fig. 6B. As predicted from the previous analysis, we find that for k = 7, psilocybin significantly alters the occurrence of two of the seven BOLD phase-locking modes. The probability of occurrence of PL state 3 (red) significantly decreased from 14.3 ± 2.4% pre-injection (third most visited state) to 4.1 ± 1.2% following the psilocybin administration (p = 0.00034 uncorrected, p' = 0.0021 after correction). Conversely, a significant increase in the probability of occurrence of PL state 1 (dark blue) was also observed, shifting from 26.7 ± 4.5% pre-psilocybin injection to 37.2 ± 6.0% post-psilocybin injection (p = 0.0068 uncorrected, p' = 0.047 after correction). In contrast, the probability of occurrence of all other PL states remained statistically similar before and after the psilocybin infusion (all p-values > 0.05).

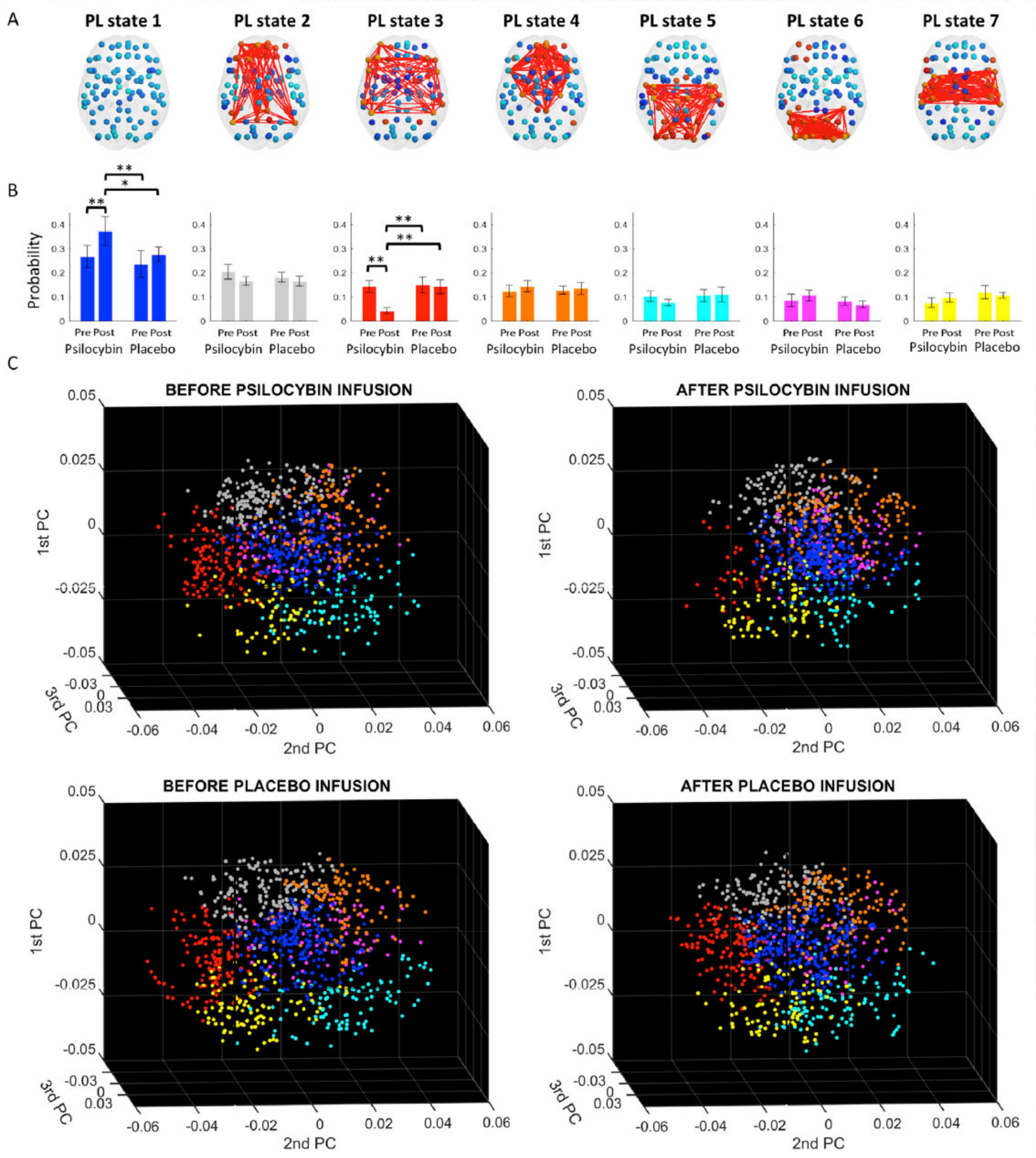


Fig. 6. Psilocybin modulates the exploration of BOLD Phase-Locking configurations. A) Repertoire of PL states detected with LEiDA for k = 7 from the session when psilocybin was infused (same as shown in Fig. 2). **B)** Probability of occurrence (mean ± standard error of the mean across subjects) of each PL state in each of the four experimental conditions (pre/post psilocybin and pre/post placebo injection). We find that after the infusion of psilocybin, PL state 3 (red) significantly decreases in probability of occurrence from an average of 14.3-4.1% ($p = 0.00034$), whereas PL state 1 (blue) significantly increases after psilocybin injection ($p = 0.0068$). All other PL states did not change in fractional occupancy with psilocybin. Importantly, when the BOLD phase leading eigenvectors from the placebo session (900 before and 900 after infusion) were matched to the 7 PL cluster centroids obtained from the psilocybin session, we found that *all* the probabilities of occurrence were consistent with the resting state *before* psilocybin injection (despite being more than a week apart), and exhibited the same significant differences with respect to the psilocybin condition. Asterisks denote the presence of statistically significant differences (* < 0.05; ** < 0.05/k correcting for the number of independent hypotheses tested). **C)** Representation of all PL configurations in each experimental condition on a low-dimensional manifold highlighting the reduced number of occurrences of the Frontoparietal network (red dots) after psilocybin injection. In each scatter plot, each dot represents one PL configuration, captured by $V_1(t)$. Each panel corresponds to a different session (before/after psilocybin/placebo). Dots are colored according to the closest cluster centroid vector, V_C, using the same color code as in B. It can clearly be observed that the number of red dots is substantially reduced after the psilocybin injection. This representation serves to illustrate how the reduced occurrence of the Frontoparietal network under psilocybin can be interpreted in terms of fewer excursions into a specific region of a low-dimensional manifold of network configurations.

10.4. Validation using the placebo dataset

The 7 PL states shown in Fig. 2 were defined solely from half of the fMRI scans in the dataset, i.e., the scans from the 9 participants recorded during the day in which psilocybin was infused (including the pre-injection baseline), consisting of 9 2 100 TRs. Using a data mining approach, we searched for the partition model that returned the most significant differences between pre- and post-injection conditions.

To further validate our findings, we verified whether these same 7 PL states were expressed in the fMRI session during which placebo was infused - recorded more than a week apart -, and if they occurred with similar probabilities as during the baseline condition before psilocybin was injected. To do so, we took exactly the same cluster centroids (shown in Fig. 2A) and evaluated their probabilities of occurrence both before and after the placebo infusion.

Validating our results, we found that the probabilities of occurrence of all 7 PL states both before and after placebo injection did not differ from the baseline condition before psilocybin was infused (all p-values > 0.05). Notably, this indicates that the dynamical exploration of PL states assessed with LEiDA remained stable across subjects under baseline conditions over a period of more than a week (Fig. 6B). Corroborating our previous findings, the fractional occupancy of PL state 3 remained within normal levels both before (15.0 ± 3.3%) and after (14.3 ± 2.9%) placebo injection (p = 0.49 uncorrected), and was in each case significantly higher than the probability of occurrence found during the psychedelic state (4.1 ± 1.2%, p = 0.00057 and p = 0.00014, respectively, both falling below the corrected threshold $\alpha_2 = 0.05/k = 0.007$). Moreover, the probability of occurrence of PL state 1, remained unchanged following the placebo injection (23.6 ± 5.6% versus 27.4 ± 3.1%, p = 0.38), being substantially lower than the probability of occurrence of PL state 1 under psilocybin (37.2 ± 6.0%, p = 0.00051 before, p = 0.012 after placebo injection), with the pre-placebo comparison surviving correction for multiple comparisons with α_2.

10.5. Dynamical exploration in a low-dimensional manifold

The non-stationary dynamics of the PL leading eigenvectors over time can be interpreted as the constant exploration of a cloud of PL configurations in a multi-dimensional space (with N = 90 dimensions in the selected parcellation). In order to visualize this cloud of observations in a low-dimensional manifold (Fig. 6C), we applied a Principal Components Analysis (PCA) to all leading eigenvectors across conditions and subjects (90 × 3600) and used the first 3 Principal Components (3 × 3600) to project each observation in a low-dimensional manifold. In this way, each 90 dimensional leading eigenvector V_1 obtained at each TR can be plotted as a dot in a 3-dimensional (3-D) space defined by the first 3 principal components and colored according to its closest centroid vector, V_C, using the same color scheme from Fig. 6B. By construction, the k-means clustering algorithm produces compact clusters (i.e., non-overlapping and well separated in the 90 dimensional space where the leading eigenvectors are defined). As can be seen in Fig. 6C, retaining the first 3 principal components is sufficient to conserve well-defined clusters (see also Supplementary Fig. S3 to view the 3-D manifolds from a different angle).

This representation serves to illustrate how the occurrence of the different functional networks can be interpreted mechanistically in terms of excursions into distinct regions of a low-dimensional manifold of network configurations. The visual rendition of the data from all subjects in the 4 different experimental conditions shown in Fig. 6C highlights the reduced number of excursions into the region of the manifold associated to the frontoparietal PL state under psilocybin (number of red dots in the upper right-hand plot), compared to the 3 non-psychedelic conditions (before psilocybin and before/after placebo injection). Although less evident, it can also be seen that the blue cluster, corresponding to the globally coherent PL state 1, becomes denser (more dots) after the psilocybin injection. The statistical analysis shown in Fig. 5C serves to define the partition model that optimally delineates the region of the cloud affected after psilocybin injection.

10.6. Trajectories between BOLD phase-locking states

In order to explore the trajectories between the different PL states, we report in Fig. 7 the switching matrices containing the mean probabilities of, being in a given PL state (rows), transitioning to any of the other PL states (columns) both before (left) and after the psilocybin injection (right). Switching probabilities were calculated for each subject and each condition and then statistically compared using a permutation-based paired *t*-test (5000 permutations). To facilitate the interpretation of the differences found in PL state switching profiles, we provide an illustration of the transitions that were most significantly affected by psilocybin (solid red: increased; dashed blue: decreased). We find that the probability of transitioning from any given PL state to the frontoparietal PL state 3 is consistently reduced under psilocybin effects. Conversely, all PL states except one were more likely to transition toward the PL state of global coherence following the psilocybin injection. The p-values for each state-to-state transition in the switching matrix are provided in Supplementary Table ST1.

10.7. Subjective intensity of the psychedelic experience correlates with network occupancy

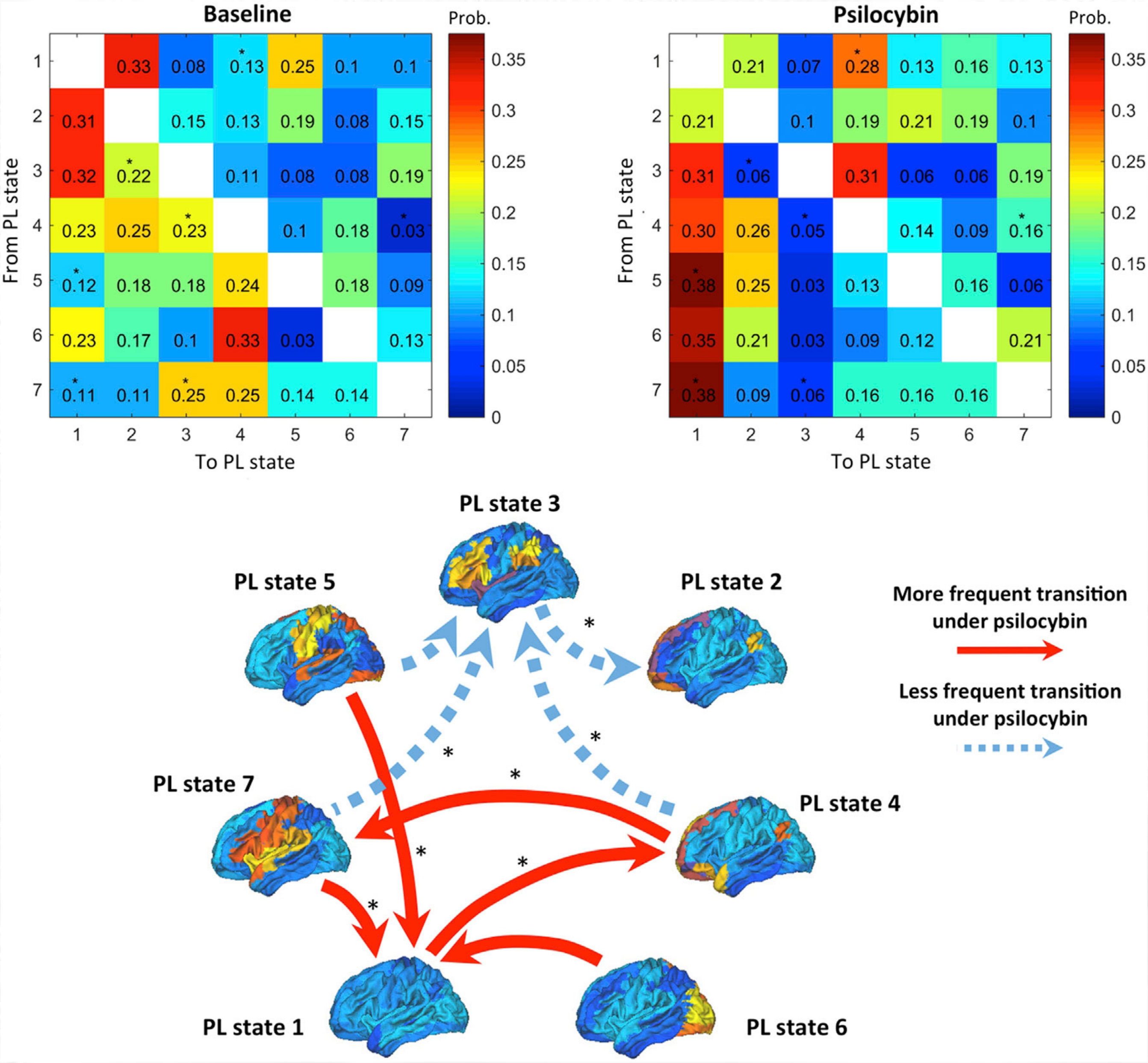
After each scanning session participants were asked to rate the subjective intensity of the psychedelic (or placebo) experience on a scale of 1-10. We correlated those subjective intensity ratings with the probability of occurrence of each of the 7 PL states (Fig. 8). We found that the occurrence of frontoparietal network (PL state 3) was negatively correlated with the subjective rating of the psychedelic experience (Pearson's $r = -0.56$; $p = 0.0083$, one-tailed). Conversely, a near-significant positive correlation was found between the fractional occupancy of the globally coherent PL state 1 and the subjective intensity of the psychedelic experience ($r = 0.36$, $p = 0.07$, one-tailed). Other PL states whose fractional occupancy was not changed by psilocybin did not correlate with this behavioral measure.

10.8. Psilocybin modulates the global order of BOLD phases

We also investigated how psilocybin affected the global order of BOLD phases using the Kuramoto Order Parameter (OP) and, although the mean synchrony degree did not reveal significant differences between conditions ($p > 0.05$), we found that the degree of whole-brain metastability (i.e., how much the synchrony degree fluctuates over time) significantly increased following the psilocybin injection compared to baseline (standard deviation, $STD(OP) = 0.18 \pm 0.01$ vs $STD(OP) = 0.16 \pm 0.015$, $t(8) = 2.41$, $p = 0.04$ using a paired sample *t*-test). In Supplementary Fig. S4, we report the OP over time before and after the psilocybin injection in all subjects.

In addition, we investigated how the OP relates with the different PL states. As expected, we found that the probability of occurrence of the PL state of global coherence (state 1) at the single subject level during a given scan is strongly correlated with the mean of the global OP ($cc = 0.825$, $p = 2.9*10^{-5}$) (Supplementary Fig. S4), indicating that this PL state is associated with an increase in global order, whereas all other PL states are consistently found for epochs of lower OP. In Supplementary Fig. S4, we report the global OP obtained while each of the 7 PL states was active, according to the color-code used in Fig. 6B. This allows a visual representation of all PL state assignments in all subjects at the single TR resolution, showing that PL state 1 is the most frequently visited state - both before and after the psilocybin injection - and also occurs in epochs of high OP, indicating a high level of phase coherence across the network nodes.

Finally, we ran a paired-sample *t*-test to confirm that, at the individual subject level, the mean number of occurrences of PL state 3 (overlapping with the Frontoparietal network) was significantly decreased following the psilocybin injection relative to the pre-injection baseline from 14.3 ± 2.5% to 4.1 ± 1.2% ($t(8) = 3.88$, $p = 0.005$). Conversely, a paired-sample *t*-test showed a significant *increase* in the mean number of occurrences of PL state 1 (globally coherent state) following the psilocybin injection relative to the pre-injection baseline from 26.% ± 4.5% to 37.2 ± 6.0% ($t(8) = 2.75$, $p = 0.01$). These statistical results reinforce the validity of the findings reported in Fig. 6B.



Baseline

From PL state \ To PL state	1	2	3	4	5	6	7
1		0.33	0.08	*0.13	0.25	0.1	0.1
2	0.31		0.15	0.13	0.19	0.08	0.15
3	0.32	*0.22		0.11	0.08	0.08	0.19
4	0.23	0.25	*0.23		0.1	0.18	*0.03
5	*0.12	0.18	0.18	0.24		0.18	0.09
6	0.23	0.17	0.1	0.33	0.03		0.13
7	*0.11	0.11	*0.25	0.25	0.14	0.14	

Psilocybin

From PL state \ To PL state	1	2	3	4	5	6	7
1		0.21	0.07	*0.28	0.13	0.16	0.13
2	0.21		0.1	0.19	0.21	0.19	0.1
3	0.31	*0.06		0.31	0.06	0.06	0.19
4	0.30	0.26	*0.05		0.14	0.09	*0.16
5	*0.38	0.25	0.03	0.13		0.16	0.06
6	0.35	0.21	0.03	0.09	0.12		0.21
7	*0.38	0.09	*0.06	0.16	0.16	0.16	

Fig. 8. Subjective intensity rating of the psychedelic experience is related to dynamic exploration of PL states. After the infusion of either Psilocybin (red) or Placebo (blue), participants were asked to rate the subjective intensity of their experience which in each case was far stronger in the psilocybin condition (mean intensity = 6.9 ± 2.6) than placebo (mean intensity = 0.4 ±
0.6) on a scale from 0 to 10. We further investigated the relationship between the subjective ratings and the probability of occurrence of each of the 7 PL states. We found that the occurrence of the frontoparietal network (PL state 3) was negatively correlated with the ratings on psychedelic experience (correlation coefficient cc = -0.56; p = 0.0083, one-tailed), with higher intensity ratings being associated with a lower probability of occurrence of PL state 3 (black lines link the same participant in the placebo (blue) and psilocybin (red) conditions). Conversely, a near-significant positive correlation was found between the fractional occupancy of the globally coherent PL state 1 and the subjective intensity of the psychedelic experience (cc = 0.36, p = 0.073, one-tailed).

10.9. Effect of motion on PL state probabilities

We performed follow-up analyses to confirm that the observed effects of psilocybin on the fractional occupancy of PL state 1 and PL state 3 were not due to differences in participant motion during the scan. For the nine subjects included in the study, we assessed motion by calculating the mean framewise displacement (FD) for each subject. This variable measures movement of any given frame relative to the previous frame. We then conducted two separate analyses to examine the potential effects of motion. First, a paired *t*-test showed that the mean FD was not significantly different between the post-placebo and post-psilocybin injection conditions: t(8) = 1.28, p = 0.24. Furthermore, the fractional occupancy of PL state 3 post-psilocybin did not correlate with the mean FD (correlation coefficient, CC = -0.14, p = 0.72) and neither did the fractional occupancy of PL state 1 post-psilocybin (CC = 0.04, p = 0.91).

11. Discussion

The present study is one of the first to investigate how the exploration of the brain's repertoire of functional networks is rapidly modulated by a psychoactive molecule, here the serotonergic psychedelic psilocybin. Specifically, we found that the dynamical exploration of a fixed repertoire of discrete functional networks at rest, defined as recurrent BOLD phase-locking patterns over time (PL states), is significantly altered after a psilocybin infusion. The strongly reduced expression of a BOLD PL state overlapping with the previously described frontoparietal control system (Vincent *et al.*, 2008; Yeo *et al.*, 2011) suggests that this particular functional subsystem is related to the psychoactive effects of psilocybin. Moreover, we found that the decreased expression of the Frontoparietal network under the influence of the drug only increased the stability of a state of global coherence (PL state 1) and did not change the expression of the remaining PL patterns. These new findings represent one of the first attempts at bridging the gap between molecular pharmacodynamics and the brain's network dynamics.

The highly significant disruption of a BOLD PL pattern closely overlapping with the Frontoparietal control system is consistent with prior human neuroimaging studies of psilocybin's effects. Indeed, a previous analysis of the same dataset revealed that psilocybin modified the BOLD spectral content in a distributed Frontoparietal network. Specifically, the Frontoparietal system of interest showed significantly decreased power at low frequencies (and decreased power spectrum scaling exponent) under psilocybin (Tagliazucchi *et al.*, 2014). Similarly, an MEG study reported decreased oscillatory power under psilocybin in a bilateral Frontoparietal network derived from beta-band activity (Muthukumaraswamy *et al.*, 2013). Findings from these prior studies indicate a rapid desynchronization of the Frontoparietal control system under psilocybin and are thus consistent with the present results. Furthermore, the disengagement of the Frontoparietal system can be interpreted in light of the cognitive and behavioral effects of psilocybin reported by the study participants. Evidence suggests the Frontoparietal system plays a key role in cognitive control by focusing attention on goal-relevant information through top-down mechanisms (Cole and Schneider, 2007; Dosenbach *et al.*, 2008; Xin and Lei, 2015). Such goal-directed focus does indeed appear to be impaired under moderate-high doses of psilocybin (Bayne and Carter, 2018) - which would be a reasonable way of describing the present dosage. Declines in frontoparietal FC have been associated with difficulty suppressing goal-irrelevant information, and greater distractibility (Smallwood *et al.*, 2012). These observations are broadly consistent with the reports of increased freely wandering thoughts and hyper-associative cognition provided by participants in the present cohort (Carhart-Harris *et al.*, 2012; Turton *et al.*, 2014).

It is interesting to consider how the known pharmacodynamics properties of psilocybin could mechanistically explain its destabilizing effect on the Frontoparietal PL state dynamics described above. The psychoactive effects of psilocybin are primarily due to its agonist activity at the serotonin 2A (5-HT_{2A}) receptor (Vollenweider *et al.*, 1998; Kometer *et al.*, 2013). The distribution and density of 5-HT_{2A} receptors in the human brain (and other 5-HT receptor subtypes) were recently estimated in a high-resolution atlas using molecular and structural neuroimaging data in a large cohort of healthy individuals in combination with postmortem human brain autoradiography (Beliveau *et al.*, 2017); 5-HT_{2A} receptors are widely distributed across the brain but most densely expressed in the cortex. Interestingly, the 5-HT_{2A} receptor density map obtained by Beliveau and colleagues shows a strong qualitative overlap between 5-HT_{2A} receptor expression on the lateral surface of the brain, and the regions implicated in the Frontoparietal PL state detected in the present study. Moreover, an fMRI study of the synthetic 5-HT_{2A} receptor agonist and classical psychedelic lysergic acid diethylamide (LSD) has reported significantly increased functional connectivity density (FCD, quantified as the average functional connectivity to the rest of the brain) of a similar Frontoparietal network which, in turn, strongly overlapped with 5-HT_{2A} receptor concentrations (Tagliazucchi *et al.*, 2016). The increase in FCD of the Frontoparietal network can be interpreted as reduced within-network integrity and is thus consistent with the present findings, where the PL state 3 (high within-network coherence and low coherence with the rest of the brain, equivalent to lower FCD) is replaced by the globally coherent PL state 1 (equivalent to higher FCD).

At the cellular level, studies have shown that 5-HT_{2A} receptors are highly expressed in layer 5 pyramidal neurons (Andrade and Weber, 2010). Stimulation of 5-HT_{2A} receptors induces a slow depolarization of pyramidal cells via G-protein coupled signaling pathways as well as the inhibition of the calcium-activated after-hyperpolarization (Andrade, 2011); together these changes make these neurons more likely to fire. Our results are therefore consistent with a scenario in which psilocybin increases the excitability of layer 5 pyramidal neurons broadly in the brain, wherever they are expressed. However, if the expression of 5-HT$_{2A}$ receptors is especially high in lateral frontoparietal areas, then the dysregulated excitation that follows their stimulation (Carhart-Harris, 2019) may, in turn, destabilize this particular system, weakening its stability within the brain's broader repertoire. Supporting this idea, a recent modeling study showed that while the brain's structural connectome plays an important role in constraining and predicting brain dynamics, an additional layer of explanatory power is offered by considering energetic constraints on those dynamics (Gu *et al.*, 2018). Because maintaining functional connections is energetically costly, the brain normally favors efficient neural codes and wiring patterns (Attwell and Laughlin, 2001; Bullmore and Sporns, 2012; Lord *et al.*, 2013). In this framework, the metabolic costs of establishing and maintaining functional connections between anatomically distributed neurons in this Frontoparietal network may become too high following the psilocybin infusion, and brain activity might spend less time in this particular state as a result.

Consistent with this explanation, our analysis revealed increased stability of a functionally non-specific, globally coherent state (PL state 1) following the psilocybin injection. Previous work has indeed shown that the serotonergic psychedelics psilocybin and LSD induce an alternative type of functional integration, characterized by greater global integration (Petri *et al.*, 2014; Roseman *et al.*, 2014; Tagliazucchi *et al.*, 2016) as well as increases in the metastability of brain states (Carhart-Harris *et al.*, 2014). The results presented here not only align with these prior findings but also shed further light on their functional significance. Here we found that a globally coherent state, i.e., PL state 1, increased its predominance under psilocybin, not only statistically over time, but also dynamically, as revealed by the state-to-state switching matrix, where it became the 'state of choice' for inter-state transitions. In other words, under psilocybin the brain spent more time in a globally coherent, highly integrated state. This state therefore served as the dominant attractor, absorbing the majority of inter-state transitions. Residence in this particular, functionally non-specific state is consistent with a flattened attractor landscape where the dominant attractor reflects the relative absence of functionally specific attractors (Carhart-Harris and Friston, 2019). As was implied by previous analyses, this change in global brain dynamics may enable atypical patterns of interregional communication to occur in the psychedelic state (Petri *et al.*, 2014) alongside the breakdown of within-network integrity in favor of globally integrated brain dynamics (Muthukumaraswamy *et al.*, 2013; Carhart-Harris *et al.*, 2014; Petri *et al.*, 2014; Roseman *et al.*, 2014; Tagliazucchi *et al.*, 2016).

In addition to changing the relative stability of PL states and the directionality of state transitions, we found that psilocybin increased the global metastability of brain dynamics. This result is consistent with prior fMRI investigations of the same psilocybin dataset in which a greater diversity of functional connectivity motifs was observed after psilocybin infusion within a small network consisting of the bilateral hippocampal and anterior cingulate brain regions, thus reflecting increased variability in the collective repertoire of metastable states (Tagliazucchi *et al.*, 2014). This prior analysis had purposely limited the number of regions included in order to perform an exhaustive counting of all possible functional connectivity states. Another study had found increased metastability in several canonical resting-state networks as determined by the variance in the networks' intrinsic synchrony over time (relationship between the mean and variance of the signal over time) (Carhart-Harris *et al.*, 2014). Here we used a complementary analytical approach to demonstrate that increased metastability of BOLD phase coherence under psilocybin is generalizable at the whole-brain scale by calculating the standard deviation of the order parameter of the system over time.

The advantage of using a within-subject design (instead of a between-subject design) is that it improves the statistical power of the results. Indeed, despite the fact that there were only 9 subjects included in this fMRI dataset, our findings were strongly validated by the replication of results in the non-drug conditions across the two scanning days (i.e., no significant changes in the occupancy of network states in the placebo scanning session vs pre-psilocybin infusion), as well as the strong statistical effects observed in specific PL states after psilocybin injection (with $p < 0.0005$, surviving correction for the number of independent hypotheses tested). Importantly, since LEiDA compares the statistics between a discrete number of whole-brain PL patterns rather than individual functional links, the number of independent hypotheses tested is reduced from N(N-1)/2 (number of unique links in an NxN symmetric matrix) to the number of states K, which overcomes several of the statistical limitations associated with multiple comparisons in whole-brain dynamic connectivity analysis. Furthermore, given the instantaneous nature of LEiDA, we detected significant between-condition differences despite the fact that each scanning condition consisted only of 100 fMRI volumes, which would likely not have been sufficient for conventional sliding-window analysis (Hindriks *et al.*, 2015). Moreover, we have demonstrated that the changes in the fractional occupancy of specific PL states after the psilocybin infusion was unrelated to participant motion during the scan.

The significant overlap between the BOLD phase-locking patterns detected automatically with LEiDA (from just 1800 fMRI volumes on 9 subjects) and the canonical resting-state networks obtained from ICA analysis on >1000 subjects (Yeo *et al.*, 2011) suggests that the relative phase of the BOLD signals is sensitive to the same underlying patterns captured using ICA procedures, with the advantage that the networks can have spatial overlap and occur transiently at different frames in time. Although our approach did not reveal all the 7 RSNs reported in Yeo *et al.* (2011) - for instance, none of our PL states revealed the Dorsal Attention Network - this difference could be due to our limited sample size and the rather coarse parcellation scheme selected (AAL). Extending this methodological approach to parcellation schemes with a higher number of more homogenous areas (Craddock *et al.*, 2013; Shen *et al.*, 2013; Glasser *et al.*, 2016) is likely to reveal more fine-grained PL states and deserves further exploration. Considering larger sample sizes and higher spatial resolution has the caveat of increasing the computational cost, but as long as the clustering algorithm adequately converges, it is likely to provide additional insights on the mechanisms underlying the formation of these BOLD phase-locking patterns and their relation to well-established RSNs. Importantly, using the cosine function, we focus on phase-locked oscillatory states and do not consider any directed causal influence between BOLD signals, which is fundamentally different to approaches considering asymmetric connectivity measures (Gilson *et al.*, 2016). Regarding the temporal dynamics, we note that the LEiDA approach allows for the analysis of additional temporal properties of BOLD phase-locking patterns, including the dwell time of each state, as in Cabral *et al.* (2017b) and more recently in Figueroa *et al.* (2019). However, the temporal resolution used in the current dataset (TR = 3 s) was too slow to capture more rapid dynamics, which are suggested by MEG studies to operate at time scales of approximately 200 ms (Baker *et al.*, 2014; Vidaurre *et al.*, 2016). As such, we limited our study to the probabilities of occurrence and to the transition profiles occurring over these longer time scales.

The therapeutic potential of psilocybin in psychiatry has recently generated much interest. Indications of efficacy have been reported for conditions including treatment-resistant depression, anxiety related to end-of-life care and addictive disorders (Griffiths *et al.*, 2006; Grob *et al.*, 2011; Johnson *et al.*, 2014; Carhart-Harris *et al.*, 2016). The neural mechanisms underlying these clinical benefits, however, remain unclear. The present results provide some of the first evidence that a psychoactive compound modulates the brain's dynamical repertoire by selectively destabilizing a brain functional network (i.e., frontoparietal control system) and promoting transitions towards a globally coherent PL state. We believe this represents an exciting first step towards bridging molecular pharmacodynamics and dynamical measures of brain function in macro-scale networks, not only for serotonergic psychedelics but potentially across other classes of drugs and neuromodulators. This could have exciting implications for the design of novel therapeutics for neuropsychiatric disorders informed by patho-connectomics, which may be generally understood in terms of targeting the specific PL states affected by a particular disorder with neuromodulatory approaches. Moreover, despite the small sample size and the use of a coarse behavioral measure, we were nevertheless able to show strong associations between the fractional occupancy of certain PL states and the subjective intensity of the psychedelic experience. This interesting proof of concept study represents, to our knowledge, one of the first attempts at linking molecular pharmacodynamics, dynamical brain measures and behavior. We hope this work paves the way for fruitful future work in this direction.

In summary, the present study used a novel, data-driven dynamical functional connectivity analysis (LEiDA) to investigate how psilocybin rapidly modulates the exploration of the brain's repertoire of functional network states under task-free conditions. We found a PL state closely corresponding to a canonical frontoparietal control system to be markedly destabilized by the compound, while transitions toward a globally coherent PL state were enhanced. We also found an increase in the metastability of global brain dynamics following the psilocybin infusion. Taken together, these findings are consistent with prior neuroimaging studies suggesting that a different type of brain integration and increased neural signal complexity underlie the psychedelic state. The present results also suggest that characterizing neuromodulatory effects on the brain's dynamical repertoire may help guide circuit-specific pharmacological interventions in neuropsychiatric disorders.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgments

LDL is supported by the Canadian Institutes of Health Research, Canadian Centennial Scholarship Fund and the Mann Senior Scholarship from Hertford College, University of Oxford. JC is supported by the Portuguese Foundation for Science and Technology and by the project FronThera NORTE-01-0145-FEDER-000023 from the Northern Portugal Regional Operational Programme (NORTE 2020) under the Portugal 2020 Partnership Agreement through the European Regional Development Fund (FEDER). Dr. PE acknowledges support from the EPSRC award EP/N014529/1 funding the EPSRC Centre for Mathematics of Precision Healthcare at Imperial. MLK and SA are supported by the ERC Consolidator Grant CAREGIVING (n. 615539). MLK is also supported by the Center for Music in the Brain, funded by the Danish National Research Foundation (DNRF117). G.D. is supported by the Spanish Research Project PSI2016-75688-P (AEI/FEDER) and by the European Union's Horizon 2020 Framework Programme for Research and Innovation under the Specific Grant Agreement No. 785907 (Human Brain Project SGA2). RCH is supported by the Alex Mosley Charitable Trust, Ad Astra Chandaria Foundation and Tamas Foundation. The authors are grateful to the Beckley Foundation for funding the original research study, on which Amanda Feilding, Director of the Beckley Foundation, was a vital initiator and collaborative partner.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.neuroimage.2019.05.060.

References

1. Acebron, J.A., Bonilla, L.L., Vicente, C.J.P., Ritort, F., Spigler, R., 2005. The Kuramoto model: a simple paradigm for synchronization phenomena. Rev. Mod. Phys. 77, 137.
2. Acebron, J.A., Perales, A., Spigler, R., 2001. Bifurcations and global stability of synchronized stationary states in the Kuramoto model for oscillator populations. Phys. Rev. E, Stat. Nonlinear Soft Matter Phys. 64, 016218.
3. Andrade, R., 2011. Serotonergic regulation of neuronal excitability in the prefrontal cortex. Neuropharmacology 61, 382-386.
4. Andrade, R., Weber, E.T., 2010. Htr2a gene and 5-HT$_{2A}$ receptor expression in the cerebral cortex studied using genetically modified mice. Front. Neurosci. 4, 36.
5. Atasoy, S., Vohryzek, J., Deco, G., Carhart-Harris, R.L., Kringelbach, M.L., 2018. Common neural signatures of psychedelics: frequency-specific energy changes and repertoire expansion revealed using connectome-harmonic decomposition. Prog. Brain Res. 242, 97-120.
6. Attwell, D., Laughlin, S.B., 2001. An energy budget for signaling in the grey matter of the brain. J. Cereb. Blood Flow Metab. 21, 1133-1145.
7. Baker, A.P., Brookes, M.J., Rezek, I.A., Smith, S.M., Behrens, T., Smith, P.J.P., Woolrich, M., 2014. Fast transient networks in spontaneous human brain activity. eLife 3.
8. Bayne, T., Carter, O., 2018. Dimensions of consciousness and the psychedelic state. Neurosci. Conscious. 2018 niy008.
9. Beckmann, C.F., DeLuca, M., Devlin, J.T., Smith, S.M., 2005. Investigations into resting-state connectivity using independent component analysis. Philos. Trans. R. Soc. Lond. Ser. B Biol. Sci. 360, 1001-1013.
10. Beckmann, C.F., Smith, S.M., 2004. Probabilistic independent component analysis for functional magnetic resonance imaging. IEEE Trans. Med. Imaging 23, 137-152.
11. Beliveau, V., Ganz, M., Feng, L., Ozenne, B., Højgaard, L., Fisher, P.M., Svarer, C., Greve, D.N., Knudsen, G.M., 2017. A high-resolution *in vivo* atlas of the human brain's serotonin system. J. Neurosci. 37, 120-128.
12. Biswal, B., Zerrin Yetkin, F., Haughton, V.M., Hyde, J.S., 1995. Functional connectivity in the motor cortex of resting human brain using echo-planar MRI. Magn. Reson. Med. 34, 537-541.
13. Bressler, S.L., Menon, V., 2010. Large-scale brain networks in cognition: emerging methods and principles. Trends Cognit. Sci. 14, 277-290.
14. Brookes, M.J., Hale, J.R., Zumer, J.M., Stevenson, C.M., Francis, S.T., Barnes, G.R., Owen, J.P., Morris, P.G., Nagarajan, S.S., 2011. Measuring functional connectivity using MEG: methodology and comparison with fcMRI. Neuroimage 56, 1082-1104.
15. Bullmore, E., Sporns, O., 2012. The economy of brain network organization. Nat. Rev. Neurosci. 13, 336.
16. Cabral, J., Hugues, E., Sporns, O., Deco, G., 2011. Role of local network oscillations in resting-state functional connectivity. Neuroimage 57, 130-139.
17. Cabral, J., Kringelbach, M., Deco, G., 2017a. Functional connectivity dynamically evolves on multiple time-scales over a static structural connectome: models and mechanisms. Neuroimage 160, 84-96.
18. Cabral, J., Kringelbach, M.L., Deco, G., 2014a. Exploring the network dynamics underlying brain activity during rest. Prog. Neurobiol. 114, 102-131.
19. Cabral, J., Luckhoo, H., Woolrich, M., Joensson, M., Mohseni, H., Baker, A., Kringelbach, M.L., Deco, G., 2014b. Exploring mechanisms of spontaneous functional connectivity in MEG: how delayed network interactions lead to structured amplitude envelopes of band-pass filtered oscillations. Neuroimage 90, 423-435.
20. Cabral, J., Vidaurre, D., Marques, P., Magalhaes, R., Silva Moreira, P., Miguel Soares, J., Deco, G., Sousa, N., Kringelbach, M.L., 2017b. Cognitive performance in healthy older adults relates to spontaneous switching between states of functional connectivity during rest. Sci. Rep. 7, 5135.
21. Carhart-Harris, R., Friston, K.J., 2019 July. REBUS and the anarchic brain: towards a unified model of the brain action of psychedelics. Pharmacol. Rev. 71, 1-28. https://doi.org/10.1124/pr.118.017160.
22. Carhart-Harris, R.L., 2019. How do psychedelics work? Curr. Opin. Psychiatr. 32, 16-21.
23. Carhart-Harris, R.L., Bolstridge, M., Rucker, J., Day, C.M., Erritzoe, D., Kaelen, M., Bloomfield, M., Rickard, J.A., Forbes, B., Feilding, A., 2016. Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. The Lancet Psychiatr. 3, 619-627.
24. Carhart-Harris, R.L., Erritzoe, D., Williams, T., Stone, J.M., Reed, L.J., Colasanti, A., Tyacke, R.J., Leech, R., Malizia, A.L., Murphy, K., 2012. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. Proc. Natl. Acad. Sci. Unit. States Am. 109, 2138-2143.
25. Carhart-Harris, R.L., Leech, R., Hellyer, P.J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D.R., Nutt, D., 2014. The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. Front. Hum. Neurosci. 8.
26. Cavanna, F., Vilas, M.G., Palmucci, M., Tagliazucchi, E., 2017. Dynamic functional connectivity and brain metastability during altered states of consciousness. Neuroimage 180, 383-395.
27. Christoff, K., Irving, Z.C., Fox, K.C., Spreng, R.N., Andrews-Hanna, J.R., 2016. Mind-wandering as spontaneous thought: a dynamic framework. Nat. Rev. Neurosci. 17, 718-731.
28. Cole, M.W., Schneider, W., 2007. The cognitive control network: integrated cortical regions with dissociable functions. Neuroimage 37, 343-360.
29. Craddock, R.C., Jbabdi, S., Yan, C.-G., Vogelstein, J., Castellanos, F.X., Di Martino, A., Kelly, C., Heberlein, K., Colcombe, S., Milham, M.P., 2013. Imaging human connectomes at the macroscale. Nat. Methods 10, 524-539.
30. Damoiseaux, J.S., Rombouts, S.A., Barkhof, F., Scheltens, P., Stam, C.J., Smith, S.M., Beckmann, C.F., 2006. Consistent resting-state networks across healthy subjects. Proc. Natl. Acad. Sci. U.S.A. 103, 13848-13853.
31. De Luca, M., Beckmann, C.F., De Stefano, N., Matthews, P.M., Smith, S.M., 2006. fMRI resting state networks define distinct modes of long-distance interactions in the human brain. Neuroimage 29, 1359-1367.
32. Deco, G., Jirsa, V., McIntosh, A.R., Sporns, O., Kotter, R., 2009. Key role of coupling, delay, and noise in resting brain

fluctuations. Proc. Natl. Acad. Sci. U.S.A. 106, 10302-10307.
33. Deco, G., Kringelbach, M., 2016. Metastability and coherence: extending the communication through coherence hypothesis using a whole-brain computational perspective. Trends Neurosci. 39, 432.
34. Dosenbach, N.U., Fair, D.A., Cohen, A.L., Schlaggar, B.L., Petersen, S.E., 2008. A dual-networks architecture of top-down control. Trends Cognit. Sci. 12, 99-105.
35. Figueroa, C.A., Cabral, J., RJT, Mocking, Rapuano, K.M., van Hartevelt, T.J., Deco, G., Expert, P., Schene, A.H., Kringelbach, M.L., Ruhe, H.G., 2019. Altered ability to access a clinically relevant control network in patients remitted from major depressive disorder. Hum. Brain Mapp. 40, 2771-2786. https://doi.org/10.1002/hbm.24559.
36. Gilson, M., Moreno-Bote, R., Ponce-Alvarez, A., Ritter, P., Deco, G., 2016. Estimation of directed effective connectivity from fMRI functional connectivity hints at asymmetries of cortical connectome. PLoS Comput. Biol. 12, e1004762.
37. Glasser, M.F., Coalson, T.S., Robinson, E.C., Hacker, C.D., Harwell, J., Yacoub, E., Ugurbil, K., Andersson, J., Beckmann, C.F., Jenkinson, M., Smith, S.M., Van Essen, D.C., 2016. A multi-modal parcellation of human cerebral cortex. Nature 536, 171-178.
38. Glerean, E., Salmi, J., Lahnakoski, J.M., Jaaskelainen, I.P., Sams, M., 2012. Functional magnetic resonance imaging phase synchronization as a measure of dynamic functional connectivity. Brain Connect. 2, 91-101.
39. González-Maeso, J., Weisstaub, N.V., Zhou, M., Chan, P., Ivic, L., Ang, R., Lira, A., Bradley-Moore, M., Ge, Y., Zhou, Q., 2007. Hallucinogens recruit specific cortical 5-HT 2A receptor-mediated signaling pathways to affect behavior. Neuron 53, 439-452.
40. Griffiths, R.R., Richards, W.A., McCann, U., Jesse, R., 2006. Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology 187, 268-283.
41. Grob, C.S., Danforth, A.L., Chopra, G.S., Hagerty, M., McKay, C.R., Halberstadt, A.L., Greer, G.R., 2011. Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch. Gen. Psychiatr. 68, 71-78.
42. Gu, S., Cieslak, M., Baird, B., Muldoon, S.F., Grafton, S.T., Pasqualetti, F., Bassett, D.S., 2018. The energy landscape of neurophysiological activity implicit in brain network structure. Sci. Rep. 8, 2507.
43. Gutierrez-Barragan, D., Basson, M.A., Panzeri, S., Gozzi, A., 2018. Oscillatory Brain States Govern Spontaneous fMRI Network Dynamics bioRxiv 393389.
44. Hansen, E.C., Battaglia, D., Spiegler, A., Deco, G., Jirsa, V.K., 2015. Functional connectivity dynamics: modeling the switching behavior of the resting state. Neuroimage 105, 525-535.
45. Hellyer, P.J., Scott, G., Shanahan, M., Sharp, D.J., Leech, R., 2015. Cognitive flexibility through metastable neural dynamics is disrupted by damage to the structural connectome. J. Neurosci.: Off. J. Soc. Neurosci. 35, 9050-9063.
46. Hindriks, R., Adhikari, M.H., Murayama, Y., Ganzetti, M., Mantini, D., Logothetis, N.K., Deco, G., 2015. Can sliding-window correlations reveal dynamic functional connectivity in resting-state fMRI? Neuroimage 127, 242-256.
47. Hipp, J.F., Hawellek, D.J., Corbetta, M., Siegel, M., Engel, A.K., 2012. Large-scale cortical correlation structure of spontaneous oscillatory activity. Nat. Neurosci. 15, 884-890.
48. Jenkinson, M., Bannister, P., Brady, M., Smith, S., 2002. Improved optimization for the robust and accurate linear registration and motion correction of brain images. Neuroimage 17, 825-841.
49. Johnson, M.W., Garcia-Romeu, A., Cosimano, M.P., Griffiths, R.R., 2014. Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. J. Psychopharmacol. 28, 983-992.
50. Karahanoğlu, F.I., Van De Ville, D., 2015. Transient brain activity disentangles fMRI resting-state dynamics in terms of spatially and temporally overlapping networks. Nat. Commun. 6, 7751.
51. Kometer, M., Schmidt, A., Jäncke, L., Vollenweider, F.X., 2013. Activation of serotonin 2A receptors underlies the psilocybin-induced effects on α oscillations, N170 visual-evoked potentials, and visual hallucinations. J. Neurosci. 33, 10544-10551.
52. Lempel, A., Ziv, J., 1976. On the complexity of finite sequences. IEEE Trans. Inf. Theory 22, 75-81.
53. Liu, X., Duyn, J.H., 2013. Time-varying functional network information extracted from brief instances of spontaneous brain activity. Proc. Natl. Acad. Sci. U.S.A. 110, 4392-4397.
54. Lord, L.-D., Expert, P., Huckins, J.F., Turkheimer, F.E., 2013. Cerebral energy metabolism and the brain's functional network architecture: an integrative review. J. Cereb. Blood Flow Metab. 33, 1347-1354.
55. Lord, L.-D., Stevner, A.B., Deco, G., Kringelbach, M.L., 2017. Understanding principles of integration and segregation using whole-brain computational connectomics: implications for neuropsychiatric disorders. Phil. Trans. R Soc. A 375, 20160283.
56. Mantini, D., Perrucci, M.G., Del Gratta, C., Romani, G.L., Corbetta, M., 2007. Electrophysiological signatures of resting state networks in the human brain. Proc. Natl. Acad. Sci. U.S.A. 104, 13170-13175.
57. McKenna, D.J., Repke, D.B., Lo, L., Peroutka, S.J., 1990. Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. Neuropharmacology 29, 193-198.
58. Meltzer, H., Massey, B., Horiguchi, M., 2012. Serotonin receptors as targets for drugs useful to treat psychosis and cognitive impairment in schizophrenia. Curr. Pharmaceut. Biotechnol. 13, 1572-1586.
59. Menon, V., 2011. Large-scale brain networks and psychopathology: a unifying triple network model. Trends Cognit. Sci. 15, 483-506.
60. Musso, F., Brinkmeyer, J., Mobascher, A., Warbrick, T., Winterer, G., 2010. Spontaneous brain activity and EEG microstates. A novel EEG/fMRI analysis approach to explore resting-state networks. Neuroimage 52, 1149-1161.
61. Muthukumaraswamy, S.D., Carhart-Harris, R.L., Moran, R.J., Brookes, M.J., Williams, T.M., Errtizoe, D., Sessa, B., Papadopoulos, A., Bolstridge, M., Singh, K.D., 2013. Broadband cortical desynchronization underlies the human psychedelic state. J. Neurosci. 33, 15171-15183.
62. Newman, M.E., 2006. Finding community structure in networks using the eigenvectors of matrices. Phys. Rev. E, Stat. Nonlinear Soft Matter Phys. 74, 036104.
63. Passie, T., Seifert, J., Schneider, U., Emrich, H.M., 2002. The pharmacology of psilocybin. Addict. Biol. 7, 357-364.
64. Petri, G., Expert, P., Turkheimer, F., Carhart-Harris, R., Nutt, D., Hellyer, P.J., Vaccarino, F., 2014. Homological scaffolds of brain functional networks. J. R. Soc. Interface 11, 20140873.
65. Ponce-Alvarez, A., Deco, G., Hagmann, P., Romani, G.L., Mantini, D., Corbetta, M., 2015. Resting-state temporal synchronization networks emerge from connectivity topology and heterogeneity. PLoS Comput. Biol. 11, e1004100.
66. Roberts, J.A., Gollo, L.L., Abeysuriya, R.G., Roberts, G., Mitchell, P.B., Woolrich, M.W., Breakspear, M., 2019. Metastable brain

waves. Nat. Commun. 10, 1056.
67. Roseman, L., Leech, R., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2014. The effects of psilocybin and MDMA on between-network resting state functional connectivity in healthy volunteers. Front. Hum. Neurosci. 8, 204.
68. Schartner, M.M., Carhart-Harris, R.L., Barrett, A.B., Seth, A.K., Muthukumaraswamy, S.D., 2017. Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. Sci. Rep. 7, 46421.
69. Seeley, W.W., Menon, V., Schatzberg, A.F., Keller, J., Glover, G.H., Kenna, H., Reiss, A.L., Greicius, M.D., 2007. Dissociable intrinsic connectivity networks for salience processing and executive control. J. Neurosci.: Off. J. Soc. Neurosci. 27, 2349-2356.
70. Shanahan, M., 2010. Metastable chimera states in community-structured oscillator networks. Chaos 20, 013108.
71. Shen, X., Tokoglu, F., Papademetris, X., Constable, R.T., 2013. Groupwise whole-brain parcellation from resting-state fMRI data for network node identification. Neuroimage 82, 403-415.
72. Smallwood, J., Brown, K., Baird, B., Schooler, J.W., 2012. Cooperation between the default mode network and the frontal-parietal network in the production of an internal train of thought. Brain Res. 1428, 60-70.
73. Smith, S.M., 2002. Fast robust automated brain extraction. Hum. Brain Mapp. 17, 143-155.
74. Tagliazucchi, E., Balenzuela, P., Fraiman, D., Chialvo, D.R., 2012. Criticality in large-scale brain FMRI dynamics unveiled by a novel point process analysis. Front. Physiol. 3, 15.
75. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D., Chialvo, D.R., 2014. Enhanced repertoire of brain dynamical states during the psychedelic experience. Hum. Brain Mapp. 35, 5442-5456.
76. Tagliazucchi, E., Roseman, L., Kaelen, M., Orban, C., Muthukumaraswamy, S.D., Murphy, K., Laufs, H., Leech, R., McGonigle, J., Crossley, N., 2016. Increased global functional connectivity correlates with LSD-induced ego dissolution. Curr. Biol. 26, 1043-1050.
77. Tewarie, P., Abeysuriya, R., Byrne, Á., O'Neill, G.C., Sotiropoulos, S.N., Brookes, M.J., Coombes, S., 2019. How do spatially distinct frequency specific MEG networks emerge from one underlying structural connectome? The role of the structural eigenmodes. Neuroimage 186, 211-220.
78. Tononi, G., Edelman, G.M., 1998. Consciousness and complexity. Science 282, 1846-1851.
79. Turton, S., Nutt, D., Carhart-Harris, R., 2014. A qualitative report on the subjective experience of intravenous psilocybin administered in an FMRI environment. Curr. Drug Abuse Rev. 7, 117-127.
80. Tzourio-Mazoyer, N., Landeau, B., Papathanassiou, D., Crivello, F., Etard, O., Delcroix, N., Mazoyer, B., Joliot, M., 2002. Automated anatomical labeling of activations in SPM using a macroscopic anatomical parcellation of the MNI MRI single-subject brain. Neuroimage 15, 273-289.
81. Varela, F.J., 1979. Principles of Biological Autonomy.
82. Vidaurre, D., Quinn, A.J., Baker, A.P., Dupret, D., Tejero-Cantero, A., Woolrich, M.W., 2016. Spectrally resolved fast transient brain states in electrophysiological data. Neuroimage 126, 81-95.
83. Vidaurre, D., Smith, S.M., Woolrich, M.W., 2017. Brain network dynamics are hierarchically organized in time. Proc. Natl. Acad. Sci. Unit. States Am. 114, 12827-12832.
84. Vincent, J.L., Kahn, I., Snyder, A.Z., Raichle, M.E., Buckner, R.L., 2008. Evidence for a frontoparietal control system revealed by intrinsic functional connectivity. J. Neurophysiol. 100, 3328-3342.
85. Vollenweider, F.X., Vollenweider-Scherpenhuyzen, M.F., Bäbler, A., Vogel, H., Hell, D., 1998. Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 9, 3897-3902.
86. Watanabe, T., Hirose, S., Wada, H., Imai, Y., Machida, T., Shirouzu, I., Konishi, S., Miyashita, Y., Masuda, N., 2014. Energy landscapes of resting-state brain networks. Front. Neuroinf. 8, 12.
87. Xin, F., Lei, X., 2015. Competition between frontoparietal control and default networks supports social working memory and empathy. Soc. Cognit. Affect Neurosci. 10, 1144-1152.
88. Yeo, B.T., Krienen, F.M., Sepulcre, J., Sabuncu, M.R., Lashkari, D., Hollinshead, M., Roffman, J.L., Smoller, J.W., Zöllei, L., Polimeni, J.R., 2011. The organization of the human cerebral cortex estimated by intrinsic functional connectivity. J. Neurophysiol. 106, 1125.

The entropic brain - A theory of conscious states informed by neuroimaging research with psychedelic drugs

by

Robin L. Carhart-Harris[1]*, Robert Leech[2], Peter J. Hellyer[2], Murray Shanahan[3], Amanda Feilding[4], Enzo Tagliazucchi[5], Dante R. Chialvo[6] and David Nutt[7]

© 2014 Carhart-harris, Leech, Tagliazucchi, Hellyer, Chialvo, Feilding and Nutt

original source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3909994/pdf/fnhum-08-00020.pdf
backup source: http://www.psilosophy.info/resources/fnhum-08-00020.pdf

[1] Centre for Neuropsychopharmacology, Division of Brain Sciences, Imperial College London, UK
[2] C3NL, Division of Brain Sciences, Imperial College London, UK
[3] Cognitive robotics, Department of Computing, Imperial College London, UK
[4] The Beckley Foundation, Beckley Park, Oxford, UK
[5] Neurology Department and Brain Imaging Center, Goethe University, Frankfurt am Main, Germany.
[6] Consejo Nacional de Investigaciones Cientcas y Tecnologicas (CONICET), Buenos Aires, Argentina.

Edited by: Nikolai Axmacher, University of Bonn, Germany

Reviewed by: Samantha J. Brooks, Uppsala University, Sweden
Katherine MacLean, Johns Hopkins University School of Medicine, USA

***Correspondence**: Robin L. Carhart-Harris, Division of Brain Sciences, Department of Medicine, Centre for Neuropsychopharmacology, Imperial College London, Burlington Danes building, Du Cane Rd., W12 0NN London, UK
e-mail: r.carhart-harris@imperial.ac.uk

Robin L. Carhart-Harris

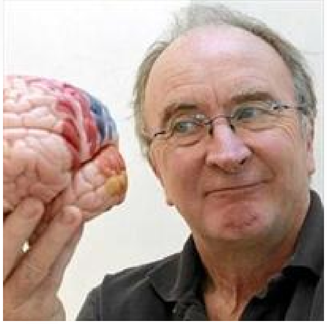
Robert Leech

Peter J. Hellyer

Murray Shanahan

Amanda Feilding

Enzo Tagliazucchi


Dante R. Chialvo

David Nutt

Received: 13 May 2013
Accepted: 10 January 2014
Published online: 03 February 2014

Citation: Carhart-harris RL, Leech R, Tagliazucchi E, Hellyer PJ, Chialvo DR, Feilding A and Nutt D(2014) The entropic brain: A theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front. Hum. Neurosci.* 8:20. doi:10.3389/fnhum.2014.00020

This article was submitted to the journal Frontiers in Human Neuroscience

This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Table of Contents:

- Abstract
- Introduction
- Notes
- The Research Value of Psychedelics
- The Pharmacology of Psychedelics
- Functional MRI and MEG Studies with Psilocybin
- Some Background on the Default Mode Network
- Introducing Primary Consciousness and Primary States
- The Medial Temporal Lobes and Primary Consciousness
- The Default Mode Network and the Ego
- The DMN, Introspection and Metacognition
- Increased Network Entropy in the Psychedelic State
- Criticality and Primary Consciousness
- The Therapeutic Potential of Psychedelics
- The Spiritual Experience and Primary Consciousness
- The System Mechanics of Primary States
- Developing the Construct Validity of Primary Consciousness
- Developing the Construct Validity of Secondary Consciousness and the Ego
- Conclusions
- Acknowledgments
- References

Abstract

Entropy is a dimensionless quantity that is used for measuring uncertainty about the state of a system but it can also imply physical qualities, where high entropy is synonymous with high disorder. Entropy is applied here in the context of states of consciousness and their associated neurodynamics, with a particular focus on the psychedelic state. The psychedelic state is considered an exemplar of a primitive or primary state of consciousness that preceded the development of modern, adult, human, normal waking consciousness. Based on neuroimaging data with psilocybin, a classic psychedelic drug, it is argued that the defining feature of "primary states" is elevated entropy in certain aspects of brain function, such as the repertoire of functional connectivity motifs that form and fragment across time. Indeed, since there is a greater repertoire of connectivity motifs in the psychedelic state than in normal waking consciousness, this implies that primary states may exhibit "criticality," i.e., the property of being poised at a "critical" point in a transition zone between order and disorder where certain phenomena such as power-law scaling appear. Moreover, if primary states are critical, then this suggests that entropy is suppressed in normal waking consciousness, meaning that the brain operates just below criticality. It is argued that this entropy suppression furnishes normal waking consciousness with a constrained quality and associated metacognitive functions, including reality-testing and self-awareness. It is also proposed that entry into primary states depends on a collapse of the normally highly organized activity within the default mode network (DMN) and a decoupling between the DMN and the medial temporal lobes (which are normally significantly coupled). These hypotheses can be tested by examining brain activity and associated cognition in other candidate primary states such as rapid eye movement (REM) sleep and early psychosis and comparing these with non-primary states such as normal waking consciousness and the anaesthetized state.

Keywords: serotonin, default mode network, criticality, entropy, 5-HT2A receptor, metastability, consciousness, REM sleep

Introduction

The main aim of this paper is to introduce a new theory of conscious states that incorporates principles of physics, neurobiology, and psychoanalysis. The theory is intended to assist our understanding of the makeup of the human mind, addressing such questions as: "how does the normal waking consciousness of healthy adult humans relate to other states of consciousness?" "how does the human brain maintain its normal state of waking consciousness?" and "what happens to the human brain's functionality when non-ordinary states such as rapid eye movement (REM) sleep/dreaming, early psychosis and the psychedelic state occur?"

At its core, the entropic brain hypothesis proposes that the quality of any conscious state depends on the system's entropy[1] measured via key parameters of brain function. Entropy is a powerful explanatory tool for cognitive neuroscience since it provides a quantitative index of a dynamic system's randomness or disorder while simultaneously describing its informational character, i.e., our uncertainty about the system's state if we were to sample it at any given time-point. When applied in the context of the brain, this allows us to make a translation between mechanistic and qualitative properties. Thus, according to this principle, increased subjective uncertainty or "puzzlement" accompanies states of increased system entropy. These ideas are consistent with Karl Friston's free-energy principle[2] and readers interested in Bayesian inference and the mechanisms by which the brain is hypothesized to minimize free-energy/surprise should consult this work (Friston, 2010).

System entropy, as it is applied to the brain, is related to another current hot-topic in cognitive neuroscience, namely "self-organized criticality"[3] (Chialvo *et al.*, 2007). The phenomenon of self-organized criticality refers to how a complex system (i.e., a system with many constituting units that displays emergent properties at the global-level beyond those implicated by its individual units) forced away from equilibrium by a regular input of energy, begins to exhibit interesting properties once it reaches a critical point in a relatively narrow transition zone between the two extremes of system order and chaos. Three properties displayed by critical systems that are especially relevant to the present paper are: (1) a maximum number of "metastable" or transiently-stable states (Tognoli and Kelso, 2014), (2) maximum sensitivity to perturbation, and (3) a propensity for cascade-like processes that propagate throughout the system, referred to as "avalanches" (Beggs and Plenz, 2003). There is growing evidence that brain activity, like much of nature, displays critical behavior (Beggs and Plenz, 2003) - and this raises some interesting questions: e.g., does the brain activity of healthy-adult-humans exhibit characteristics of criticality during normal waking consciousness, or are there other states of consciousness in which these characteristics are even more pronounced?

Another major topic that is covered in this paper is the psychoanalytic model of the structure of the mind (i.e., Freud's "metapsychology"). Specifically, we discuss some of the most fundamental concepts of Freudian metapsychology, with a special focus on the ego[4]. We focus on the ego because it is one of Freud's less abstract constructs and it is hypothesized that its disintegration is necessary for the occurrence of primary states. The ego can be defined as a sensation of possessing an immutable identity or personality; most simply, the ego is our "sense of self." Importantly however, in Freudian metapsychology, the ego is not just a (high-level) sensation of self-hood; it is a fundamental system that works in competition and cooperation with other processes in the mind to determine the quality of consciousness. It is because Freud described "the ego" in this mechanistic sense that it can be considered a useful complement to the more widely used concept of "the self." Effectively, the terms "ego" and "self" are synonyms, except that "the ego" has a background in Freudian metapsychology.

Finally, the shared topic that connects all of the above and offers a unique potential for their empirical study is the psychedelic drug state. In the following section we make the case that scientific research with psychedelics has considerable potential for developing aspects of psychoanalytic theory and for studying human consciousness more generally. Citing recent neuroimaging findings involving the classic psychedelic drug, psilocybin, the psychedelic state is described as a prototypical high-entropy state of consciousness (i.e., higher than normal waking consciousness). Intriguingly, we show evidence that the brain exhibits more characteristics of criticality in the psychedelic state than are apparent during normal waking consciousness. Moreover, this leads to the proposal that the brain of modern adult humans differs from that of its closest evolutionary and developmental antecedents because of an extended capacity for entropy suppression, implying that the system (i.e., the brain) gravitates away from criticality proper toward a state of slight sub-criticality. The psychological counterpart of this process is the development of a mature ego[5] and associated metacognitive functions (see below for relevant definitions of these terms). Specifically, we propose that within-default-mode network (DMN)[6] resting-state functional connectivity (RSFC)[7] and spontaneous, synchronous oscillatory activity in the posterior cingulate cortex (PCC), particularly in the alpha (8-13 Hz) frequency band, can be treated as neural correlates of "ego integrity." Evidence supporting these hypotheses is discussed in the forthcoming sections.

Before beginning it is important to address an initial point of potential ambiguity. The view taken here is that the human brain exhibits greater entropy than other members of the animal kingdom, which is equivalent to saying that the human mind possesses a greater repertoire of potential mental states than lower animals (see Giulio Tononi's information integration theory of consciousness cited below). Thus, if referring to human evolution beyond our closest *surviving* relatives then it would be misleading to suggest that entropy-suppression is the defining property of the human brain - indeed, it might be more accurate to speak of entropy-expansion. The evolution of human consciousness may have occurred through a process of relatively rapid entropy-expansion (with a concomitant increase in system disorder) followed by entropy-suppression (or system re-organization and settling). Thus, the proposal that normal waking consciousness in healthy, adult, modern humans depends on entropy suppression implies that there was a state relatively proximal to this (e.g., in archaic homo-sapiens and in infants) in which entropy was relatively elevated, as it is in primary states. The point is that the brain of adult modern-humans is in a settling rather than expanding phase.

The Research Value of Psychedelics

> "It does not seem to be an exaggeration to say that psychedelics, used responsibly and with proper caution, would be for psychiatry what the microscope is for biology and medicine or the telescope is for astronomy. These tools make it possible to study important processes that under normal circumstances are not available for direct observation." (Grof, 1980)

In 1953, the British research psychiatrist Humphrey Osmond was investigating the psychotomimetic (psychosis mimicking) effects of mescaline, a psychedelic drug derived from the peyote cactus. The British author Aldous Huxley learned of Osmond's work and struck up a correspondence, requesting that Osmond supervise a personal psychedelic experience. Huxley's subsequent mescaline experience would become the subject of his famous book "*The Doors of Perception*" (Huxley, 1954). Like many before and after him, Huxley was profoundly affected by his experiences with psychedelics and in 1956 sought with Osmond a satisfactory term for this class of drugs. At the time, "psychotomimetics" and "hallucinogens" were popular, but both men felt that these referred to mere aspects of the drug experience and not its essential character. Huxley suggested "phanerothyme," intending to mean "bringing forth the spirit or soul" (Huxley *et al.*, 1977), and Osmond offered "psychedelic" combining the Greek words for "mind" or "soul" (psyche) with "dclôs&emacr;," meaning "to manifest." While it was Osmond's "psychedelic" that would stick, it is telling that both men were searching for a word that could denote the same essential property, i.e., psychedelic's ability to make manifest latent aspects of the mind.

In 1943, Swiss chemist Albert Hofmann discovered the extraordinary psychological properties of lysergic acid diethylamide (LSD) (Hofmann, 1980) and the first reports on its effects appeared in scientific journals in the late 1940s. These papers immediately highlighted LSD's potential to be psychologically agitative. The first English language publication was released in 1950 and here the authors reported: "*the effect of LSD was a transitory toxic state, disturbing the barrier of repression and permitting a re-examination of significant experiences of the past that were sometimes relived with a frightening realism.*" (Busch and Johnson, 1950) In the following years, psychedelics became one of the most researched classes of psychoactive drug in science, with several hundred relevant publications (Grinspoon and Bakalar, 1979). During these years, the focus shifted from psychedelics as psychotomimetics to psychedelics as psychotherapeutic adjuncts, with major international conferences on the topic (Grinspoon and Bakalar, 1979) and even the construction of purpose-built psychedelic treatment centers (Sandison, 2001). Political pressure in the late 1960s led to the illegalization of psychedelics and this had a significant negative impact on legitimate scientific research (Grinspoon and Bakalar, 1979; Lee and Shlain, 1985) - a problem that continues today (Nutt *et al.*, 2013). Despite this however, there has been a resurgence of scientific interest in psychedelics in recent years (Vollenweider *et al.*, 1998; Nichols, 2004; Griffiths *et al.*, 2006, 2008; Moreno *et al.*, 2006; Gonzalez-Maeso *et al.*, 2007; Grob *et al.*, 2011; Carhart-Harris *et al.*, 2012a).

The dominant theoretical and therapeutic approach during the early era of psychedelic research was psychoanalytic. Psychedelics were used therapeutically under the rationale that they work to lower psychological defenses to allow personal con- flicts to come to the fore that can then be worked through with a therapist (Cohen, 1972). A related model was that the relinquishment of "ego" enabled profound existential or "peak" experiences to occur that could have a lasting positive impact on behavior and outlook (Savage, 1962). Innumerable cases of apparent spontaneous insights about "self" or "nature" exist in the literature on psychedelics (Cattell, 1954; Sandison, 1954; Sandison and Whitelaw, 1957; Denber, 1958; Hausner and Dolezal, 1965; Torda, 1969; Cohen, 1972; Grof, 1982) and reports of "ego-dissolution" or "disintegration" are commonplace among those who have experienced the effects of these drugs (Carhart-Harris and Nutt, 2010; Carhart-Harris *et al.*, 2012b). Some psychiatrists even believed that psychedelics could provide the necessary scientific evidence for major psychoanalytic hypotheses (Sandison, 1954; Cohen, 1972; Grof, 1982). For example, one enthused: "*The phenomenology of the psychodynamic experiences in LSD sessions is to a large extent in agreement with the basic concepts of classical psychoanalysis … Observations from LSD psychotherapy could be considered laboratory proof of the basic Freudian premises.*" (Grof, 1982).

Psychoanalytic theory dominated psychiatry in the 1950s but after influential critiques (Eysenck, 1973), the cognitive revolution (Neisser, 1967) and significant pharmacological developments in psychiatry (Ban, 2001a,b; Fink, 2010), its influence significantly waned. As illustrated in **Figure 1**, despite over a century since its inception, psychoanalysis has failed to establish itself as a science of the mind. This may be because its hypotheses are hollow (Webster, 1995) or because they do not easily lend themselves to controlled experiment. In contrast, cognitive psychology is a mechanistic framework for describing observable phenomena that has become the natural bedfellow for human neuroscience. In comparison with the spectacular success of cognitive psychology, what should we make of the relative stagnancy of psychoanalysis? Is psychoanalysis scientifically redundant? Its fiercest critics claim that it is a belief system, a tautology with untestable hypotheses (Webster, 1995) but others claim that it has considerable explanatory value but could benefit from a closer integration with cognitive neuroscience (Kandel, 1999; Carhart-Harris and Friston, 2010; Panksepp and Solms, 2012). The present article takes this latter view and argues that the most realistic way forward for psychoanalysis as a science is for its most tangible hypotheses to be simplified and applied within the framework of cognitive neuroscience. Here we take the view that this is a necessary concession for psychoanalysis if it is to develop its credibility as a model of the mind.

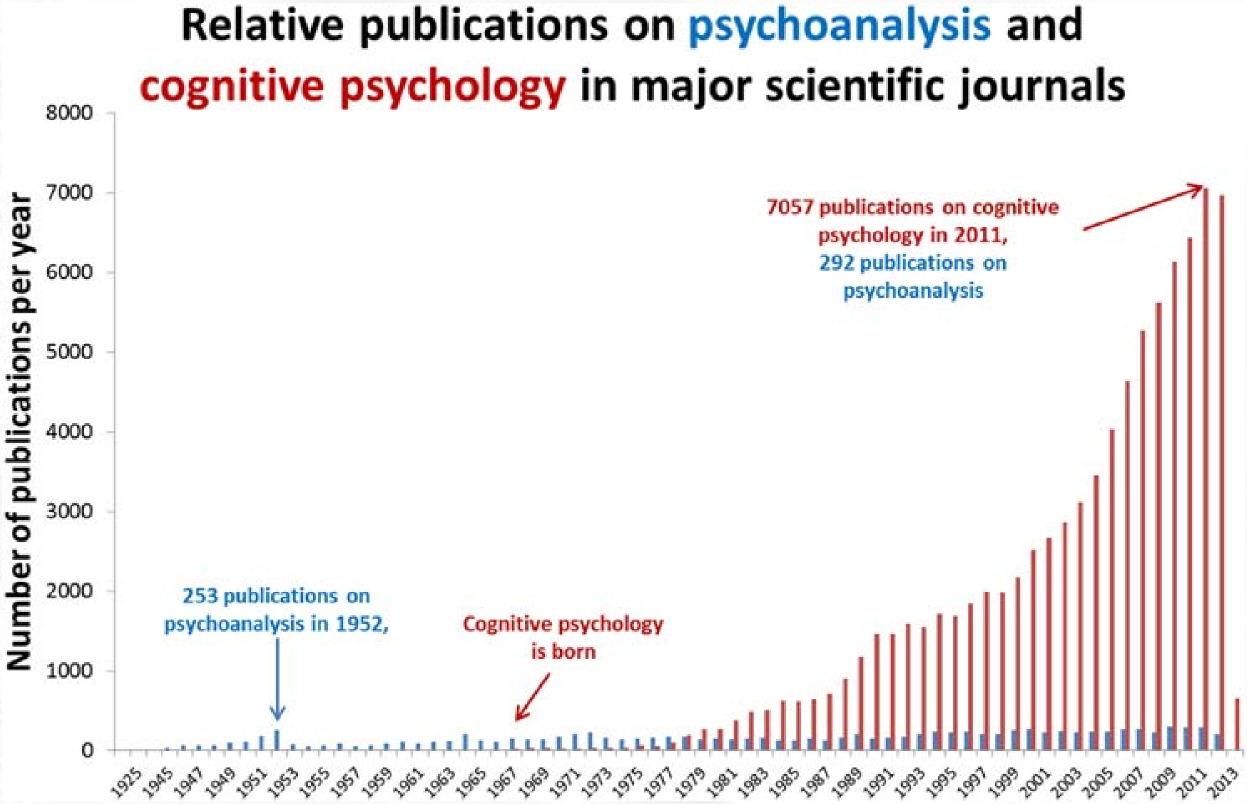


FIGURE 1 - Relative publications on psychoanalysis and cognitive psychology. Annual publications in major medical science journals referenced in the leading database, PubMed. Articles were retrieved by entering the search terms "psychoanalysis" and "cognitive psychology" in separate searches using the default search parameters of PubMed. It is worth noting that psychoanalysis has a different publication culture to cognitive neuroscience. Articles on psychoanalysis are not always available via PubMed and many psychoanalytic writings are published in books rather than academic journals. With these caveats entered however, the publication count shown above still helps to illustrate the general point that psychoanalysis has failed to gain a significant foothold in mainstream analytical science.

In what follows, a roadmap is presented for how scientific research with psychedelics can assist the integration of psychoanalysis with cognitive neuroscience in order to further our understanding of human consciousness. This is motivated by the view that psychoanalysis can contribute something substantial to the mind sciences because it bridges an explanatory gap that has been left vacant by cognitive psychology. This gap only exists because cognitive psychology (rightly) focuses on phenomena that can be observed and manipulated by controlled experiment but crucially, *without psychedelic drugs, it is virtually impossible to bring the core phenomena of psychoanalytic theory into an observable space*.

Freud famously said of dreams that they provide privileged access to the workings of the unconscious mind (Freud, 1937) but research on dreaming is fraught with difficulties because [despite the phenomenon of lucid dreaming (Ogilvie *et al*., 1982)] the dream experience cannot be easily reflected on and reported in real-time, and neither can its onset and offset be easily controlled. Thus, Freud's cherished "royal road" has not proved particularly regal and a more practical alternative is required if key psychoanalytic theories are to be incorporated into the mind sciences.

> "If, as Freud said, dreams are the royal road to the unconscious, is it possible that psychedelic drugs are a superhighway to the unconscious?" (Holden, 1980)

This article argues that controlled studies with psychedelics are capable of providing major new insights into the nature of the mind and how it arises from brain activity. This is because the mind must be thoroughly deconstructed in order for us to become cognizant of its constituents and how they interact to give rise to global phenomena. The unique scientific value of psychedelics rests on their ability to selectively target processes that appear to be critical for the maintenance of normal waking consciousness. In addressing the action of psychedelic drugs on the brain, this article begins at the cellular level before progressing to the systems level. The intention is to offer a comprehensive account of how psychedelics alter brain function to alter consciousness.

Somewhat uniquely, psychedelics can be studied at a range of epistemological levels; from molecular pharmacology (Gonzalez-Maeso and Sealfon, 2009) to psychoanalytic psychology (Cohen, 1964; Grof, 1982), few topics can engage scientists from as wide a range of disciplines. This reflects not only the special research value of psychedelics but also the immensity of the challenge involved in understanding them; especially, if the intention is to develop a comprehensive account of how psychedelics affect the brain to alter consciousness. The present article should therefore be read with an acknowledgement that this quest is on-going.

Before we begin, it is necessary to enter some important caveats. Firstly, it needs to be stated that those looking for evidence for the authenticity of aspects of Freudian theory will be left dissatisfied by this article. Categorically, this is not its aim. This challenge requires a thorough review of the phenomenology of relevant altered states of consciousness (e.g., the psychedelic state) and this is something that has been attempted before (Carhart-Harris, 2007; Carhart-Harris and Friston, 2010). Thus, due to space limitations, this article's treatment of the relevant phenomenology is relatively superficial. Instead it places its focus on the system-level mechanics of the psychedelic state as an exemplar of a regressive[8] style of cognition that can also be observed in REM sleep and early psychosis.

Some proponents of psychoanalysis may feel that this mechanistic approach has little relevance to psychoanalysis in its hermeneutic or interpretative guise. However, the inherent subjectivity of this aspect of psychoanalysis means that it is difficult to see how it can ever significantly impinge on the scientific study of the mind and brain. Indeed, Freud acknowledged that it was his "metapsychology" that had the most to offer science (Freud, 1949), and at least as a first step, this is where psychoanalytic theory (rather than psychoanalytic practice) should look to develop its scientific credibility. Briefly, for readers who are unfamiliar with Freudian metapsychology and wish to understand it better, his original material should be read (e.g., Freud, 1927, 1949; Freud *et al.*, 1957) and the following review articles may be useful (Carhart-Harris *et al.*, 2008; Carhart-Harris and Friston, 2010). For those interested in the rich phenomenology of the psychedelic experience and how this relates to Freudian and/or Jungian descriptions of "the unconscious mind," the following references may be of interest (Sandison and Whitelaw, 1957; Huxley, 1959; Cohen, 1964; Grof, 1982; Merkur, 1998; Sandison, 2001). Lastly, it is necessary to state that questions related to the safety of scientific research with psychedelics will not be addressed here. However, evidence strongly supports the position that, conducted with appropriate caution, research with psychedelics presents a low risk of harm to study participants (Johnson *et al.*, 2008; Morgan *et al.*, 2010; Carhart-Harris and Nutt, 2010; Studerus *et al.*, 2011; van Amsterdam *et al.*, 2011).

The Pharmacology of Psychedelics

Before introducing the focal topic of this paper, i.e., entropy and its relation to key brain imaging parameters, it is important to provide a brief introduction to the pharmacology of psychedelics. By definition, all classic psychedelic drugs are agonists at the serotonin 2A receptor (5-HT_{2A}R) (Glennon *et al.*, 1984). There is a strong positive correlation between a psychedelic's affinity for the 5-HT_{2A}R and its psychedelic potency (Glennon *et al.*, 1984). For example, LSD has a very high affinity for the 5-HT_{2A}R and is remarkably potent, being psychoactive in doses as small as 20µM (Hintzen and Passie, 2010). Blockade of the 5-HT_{2A}R with the 5-HT_{2A}R antagonist ketanserin, attenuates the principal hallucinogenic effects of psilocybin in humans (Vollenweider *et al.*, 1998). The 5-HT_{2A}R is primarily expressed in the cortex (Pazos *et al.*, 1987). In humans, the distribution of 5-HT_{2A}Rs is generally high throughout the cortex but is densest in high-level association regions such as the

PCC and lowest in the primary motor cortex (Erritzoe *et al*., 2009; Carhart-Harris *et al*., 2012a). This may explain why cognition and perception are so markedly affected by psychedelics whereas motor action is generally not. In terms of the cortex's laminar organization, 5-HT_{2A}Rs are most densely expressed post-synaptically on the apical dendrites of layer 5 pyramidal neurons (Weber and Andrade, 2010). These large excitatory neurons are the primary source of output from a cortical region, projecting to hierarchically subordinate cortical and subcortical regions (Spruston, 2008). 5-HT_{2A}R stimulation depolarizes the host cell, making it more likely to fire (Andrade *et al*., 2011) and this effect has been demonstrated in layer 5 pyramidal neurons in rodents (Aghajanian and Marek, 1997).

Functional MRI and MEG Studies with Psilocybin

Beginning in 2009, our research team embarked on a series of studies with the classic psychedelic, psilocybin (Carhart-Harris *et al*., 2012a), culminating in a recent MEG study (Muthukumaraswamy *et al*., 2013). Our first study utilized arterial spin labeling (ASL), an fMRI technique that measures changes in CBF. Specifically, we compared CBF before and after intravenous (i.v.) administration of 2 mg psilocybin and placebo (Carhart-Harris *et al*., 2012a). The onset of the subjective effects of psilocybin is rapid when it is administered intravenously, commencing within seconds of the end of the infusion (Carhart-Harris *et al*., 2011). The infusion occurred over 60 s, beginning 6 min into an 18 min resting state scan. Drug-induced changes in CBF were modeled based on psilocybin's rapid pharmacodynamics (Carhart-Harris *et al*., 2011). Fifteen healthy volunteers were scanned and the results revealed decreased CBF after psilocybin and no increases. The decreases were localized to high-level association cortices, including key regions of the DMN (see Some background on the default mode network (DMN) for an overview of this system) and subcortical hub structures such as the putamen and thalamus (Carhart-Harris *et al*., 2012a).

These findings were later replicated using the classic BOLD signal of fMRI. Another 15 healthy volunteers were scanned using a similar placebo-controlled design, with 60 s i.v. infusions beginning midway through two separate 12 min eyes-closed resting state scans on different days. Again, only signal decreases were observed after drug infusion. Moreover, the location of the BOLD signal decreases was consistent with the CBF decreases, e.g., in midline cortical nodes of the DMN (Muthukumaraswamy *et al*., 2013).

In addition to modeling changes in the direction of the BOLD signal post-infusion of psilocybin, we also measured changes in brain network integrity using resting-state functional connectivity. Three regions of interest were chosen for separate seed-based resting state functional connectivity (RSFC) analyses: a medial prefrontal cortex (mPFC) seed, a right middle frontal gyrus (mFG) seed, and a bilateral hippocampal seed. Decreased connectivity was observed within the DMN using the mPFC and hippocampal seeds and in a major task-positive network (TPN), the dorsal attention network (DAN), using the mFG seed (**Figure 2**).

In our third and most recent study, we used MEG to investigate the effects of psilocybin on neural activity. Broadband decreases in oscillatory power were observed after psilocybin, and again, these were localized to association cortices, including key regions of the DMN, such as the PCC (Raichle *et al*., 2001; Greicius *et al*., 2003) **- see Figure 2**.

These studies provide some useful clues about the mechanisms by which psychedelics alter brain function to alter consciousness. They imply that cerebral blood flow, BOLD signal, functional connectivity and oscillatory power are decreased in brain regions that are normally highly metabolically active, functionally connected and synchronous/organized in their activity. These results provided the kernel for our subsequent thinking about increased entropy in the psychedelic state. Although none of the analyses formally measured entropy, they spoke to a general principle that psychedelics alter consciousness by *disorganizing* brain activity.

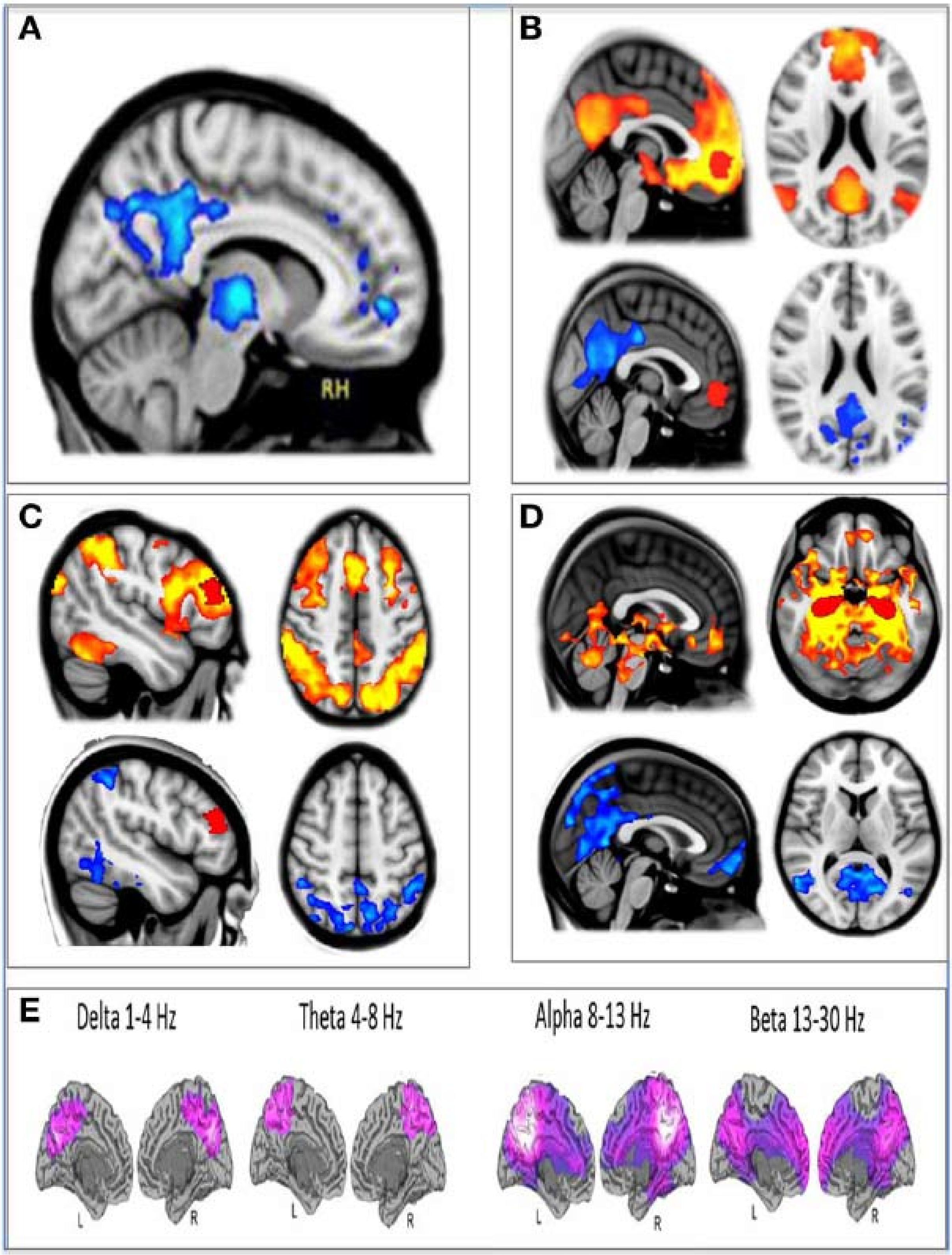


FIGURE 2 - **The effect of psilocybin on fMRI and MEG measures of brain activity**. **(A)** Decreased CBF post-psilocybin. **(B)** Ventromedial PFC (red) resting state functional connectivity (RSFC) at baseline (top, orange) and decreases post-psilocybin (bottom, blue). **(C)** Dorsolateral PFC (red) RSFC at baseline (top, orange) and decreases post-psilocybin (bottom, blue). **(D)** Hippocampal (red) RSFC at baseline (top, orange) and decreases post-psilocybin (bottom, blue). **(E)** Decreases in oscillatory power (purple) post-psilocybin measured with MEG. All spatial maps were whole-brain cluster corrected $Z > 2.3$. $p < 0.05$.

Some Background on the Default Mode Network

The DMN has become one of the most discussed topics in cognitive neuroscience over the last decade and there are several reasons why it is justified to consider it important (Guldenmund *et al*., 2012). DMN regions receive more blood flow (Zou *et al*., 2009) and consume more energy (Raichle and Snyder, 2007) than other brain regions. Indeed, CBF and metabolic rate are approximately 40% higher in the PCC than the average of the rest of the brain (Raichle *et al*., 2001). The magnitude of the DMN's energy consumption dwarfs the comparatively trivial energy changes induced by stimulus cues (Raichle, 2006, 2010). DMN regions are centers of dense connectivity (Hagmann *et al*., 2008),implying that they serve as important connector hubs for information integration and routing (van den Heuvel *et al*., 2012). Consistent with this, a major node of the DMN, the PCC, can be spatially segmented into sub-components that functionally couple to different brain networks (Leechetal.,2012). Similarly,during transient windows of especially high internal coupling (functional connectivity) within the DMN, coupling between the DMN and other brain networks is also markedly increased (de Pasquale *et al*., 2012). Importantly, this functional centrality of the DMN is not shared by other brain networks (de Pasquale *et al*., 2012; Braga *et al*., 2013), implying that, as the highest level of a functional hierarchy (Carhart-Harris and Friston, 2010), it serves as a central *orchestrator* or *conductor* of global brain function. Functionally, the DMN is relatively removed from sensory processing (Sepulcre *et al*., 2012) and is instead engaged during higher-level, metacognitive operations such as self-reflection (Qin and Northoff, 2011), theory-of-mind (Spreng and Grady, 2010) and mental time-travel (Buckner and Carroll, 2007) - functions which may be exclusive to humans. DMN connectivity increases through development from birth to adulthood (Fair *et al*., 2008; Gao *et al*., 2009) and DMN regions have undergone significant evolutionary expansion (Van Essen and Dierker, 2007). Despite our knowledge of these things however, it is poorly understood why the DMN consumes so much of the body's energy (Raichle and Mintun, 2006). This uncertainty regarding the nature of the DMN's disproportionate energy consumption has led to loose analogies being made between it and the *dark energy* of cosmology (Raichle, 2006, 2010). It is consistent with the hypotheses of this paper to suggest that this apparent excess energy of apparently unknown function, residing in the DMN, is in fact the physical counterpart of the narrative-self or ego - much of which is indeed unconscious or implicit.

Introducing Primary Consciousness and Primary States

This article proposes that states such as the psychedelic state, REM sleep, the onset-phase of psychosis and the dreamy-state of temporal lobe epilepsy are examples of a regressive style of cognition that is qualitatively different to the normal waking consciousness of healthy adult humans. We will refer to this mode of cognition as "primary consciousness"[9] and the states themselves as "primary states." To enter a primary state from normal waking consciousness, it is proposed that the brain must undergo a "phase transition" (Zeeman, 1973; Waddington, 1974), just as there must have been a phase-transition in the evolution of human consciousness with the relatively rapid development of the ego and its capacity for metacognition[10]. This implies that the relationship between normal waking consciousness and "primary consciousness" is not perfectly continuous.

Freud was a great admirer of Darwin and made several references to him throughout his work (Freud *et al*., 1953). Indeed, Freud considered his own hypotheses to be natural deductions from evolutionary theory. He argued that dreaming and psychosis typify a primitive style of thinking that is dominant in human infancy[11] and dominated the cognition of primordial man[12], preceding the development of the ego of modern adult humans. Primitive thinking is fundamentally different to the style of cognition possessed by healthy adult humans. This is because in healthy adults, the formation of a mature ego endows the mind with a capacity for metacognition i.e., an ability to reflect on one's own thoughts and behavior (Shimamura, 2000; Fleming *et al*., 2012).

These ideas form the core of this article's hypotheses. Thus, it is appropriate to clarify them here. A distinction is being made between two fundamentally different styles of cognition, one that is associated with the consciousness of mature adult humans, and another that is a mode of thinking the mind regresses to under certain conditions, e.g., in response to severe stress, psychedelic drugs and in REM sleep. The style of cognition that is dominant in normal waking consciousness will henceforth be referred to as *secondary consciousness*[13] and the (pre-ego) style of cognition that is associated with primitive states will be referred to as *primary consciousness*. It is acknowledged that these terms have been used before (Edelman, 2004) but their meaning in the present context is largely independent.

Consistent with Karl Friston's free-energy principle (Friston, 2010), this article takes the view that the mind has evolved (via secondary consciousness upheld by the ego) to process the environment as *precisely* as possible by finessing its representations of the world so that *surprise* and *uncertainty* (i.e., entropy) are minimized. This process depends on the ability of the brain to organize into coherent, hierarchically-structured systems (Bassett *et al.*, 2008; Friston, 2010), critically poised between order and disorder (Friston *et al.*, 2012b; Schwartenbeck *et al.*, 2013). In contrast, in primary states, cognition is less meticulous in its sampling of the external world and is instead easily biased by emotion, e.g., wishes and anxieties.

Later we finesse this basic model, arguing that secondary consciousness actually depends on the human brain having developed/evolved a degree of sub-criticality in its functionality, i.e., an extended ability to suppress entropy and thus organize and constrain cognition. It is argued that this entropy-suppressing function of the human brain serves to promote realism, foresight, careful reflection and an ability to recognize and overcome wishful and paranoid fantasies. Equally however, it could be seen as exerting a limiting or narrowing influence on consciousness.

This paper argues that the underlying neurodynamics of primary states are more "entropic" than secondary states i.e., primary states exhibit more pronounced characteristics of criticality and perhaps supercriticality than normal waking consciousness - implying that the latter is slightly sub-critical, if not perfectly critical. Secondary consciousness pays deference to reality by carefully sampling the world and learning from its encounters (Friston, 2010), whereas primary consciousness does this more haphazardly. Mechanistically, whereas the brain strives toward organization and constraint in secondary consciousness, processes are more flexible in primary consciousness. Freud outlined these ideas in his writings on "the reality principle" (Freud, 1927) and they are recast here in a more mechanistic form, tied to modern cognitive neuroscience.

The phenomenon of "magical thinking"[14] (Frazer, 1900; Subbotskii, 2010; Hutson, 2012) is a potential product of primary consciousness. Magical thinking is a style of cognition in which supernatural interpretations of phenomena are made. Magical thinking is more likely in situations of high uncertainty because there is a greater opportunity for dreaming up explanations that lack an evidence base (Friston, 2010). Wishful beliefs are a classic product of magical thinking because they interpret the world according to what an individual *wants* to be true (in Freudian terms, they adhere to the pleasure principle). Wishful inferences are quick-fixes that reduce uncertainty but via simplistic explanations that satisfy fancies or desires before careful reason. Another example of magical thinking is paranoia; in this case, an individual jumps to negative conclusions about a situation, even in the face of contradictory evidence, because to do so effectively suspends uncertainty while providing some narcissistic satisfaction. The popularity of magical thinking also suggests that there is some enjoyment in uncertainty, perhaps because it promotes imaginative and creative thinking - and that this is associated with positive affect.

In the forthcoming section we discuss the relationship between medial temporal lobe (MTL - i.e., specially the hippocampus and surrounding parahippocampal structures) activity and primary consciousness, highlighting a specific change in activity that may serve as a marker of primary states.

The Medial Temporal Lobes and Primary Consciousness

Recording directly from MTL circuits in different altered states presents a significant challenge for cognitive neuroscience, but not one that should deter us from trying to expand its reach into areas of relevance to psychoanalytic theory. Pioneering surgical interventions for epilepsy and Alzheimer's disease (Axmacher *et al.*, 2008, 2010; Fell *et al.*, 2011, 2012; Laxton and Lozano, 2012) are opening up new possibilities for depth recordings, and although it would be a challenge to defend the administration of psychedelics to such patients, recording from MTL circuits in other primary states, such as REM sleep, might be more feasible (Cantero *et al.*, 2003).

Another way to circumvent the problem of recording directly from limbic regions is to use non-invasive imaging with high spatial resolution. We recently used fMRI to investigate the involvement of the MTLs in the mechanism of action of psychedelics, performing a hippocampal functional connectivity analysis using the same psychophysiological interaction (PPI) model used in our previous analyses with psilocybin (Carhart-Harris *et al.*, 2012a). A combined bilateral hippocampal and parahippocampal mask was created on a standard brain and time-series were extracted from these regions for each subject and regressed against their functional data, with the pharmacodynamics of intravenous psilocybin modeled as an interaction term. Remarkably, decreases in functional coupling were observed after psilocybin that were selectively localized to the cortical nodes of the DMN (**Figure 2D**), entirely consistent with the hypothesis that decreased MTL-DMN coupling underlies phase transitions to primary consciousness.

In a separate analysis, we looked at changes in BOLD signal variance (i.e., amplitude fluctuations) after psilocybin and found significant increases in variance that were almost exclusively localized to the bilateral hippocampi and parahippocampal gyri. This result was important because it reinforced the impression given by the RSFC analysis that under psilocybin, the hippocampi become decoupled from the DMN. However, perhaps even more interestingly, the increase in MTL signal variance was consistent with some early depth electrode work with psychedelics that implicated the MTLs in their mechanism of action. This work is reviewed below.

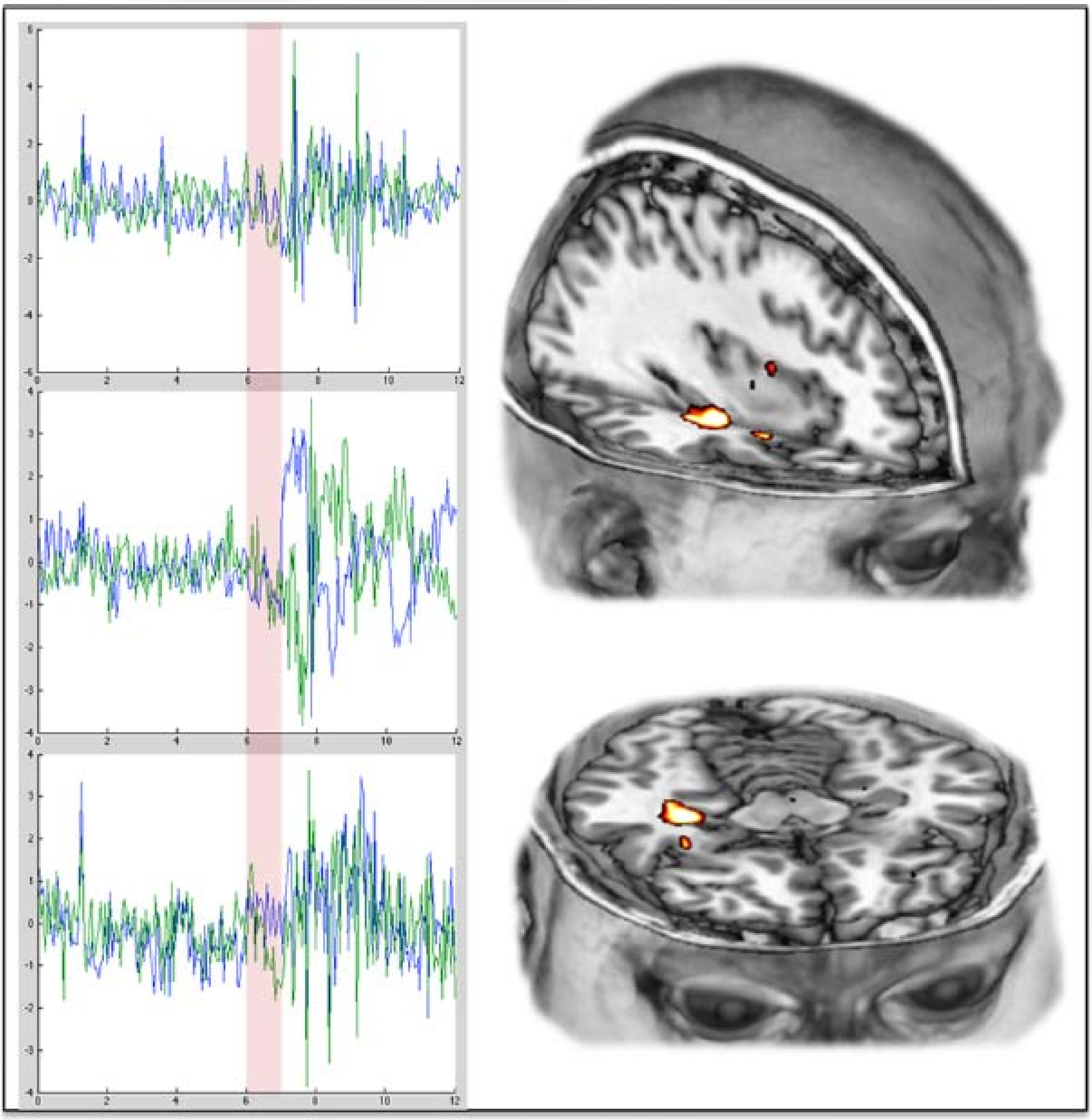


FIGURE 3 - Increased variance/amplitude fluctuations in the hippocampus post-psilocybin. The charts on the **left** show the complete time series from the hippocampus (**left** in blue, **right** in green) in 3 different individual subjects during the 12 min scan in which they received psilocybin. The transparent red vertical line indicates the beginning and duration of the 60 s infusion of psilocybin. The images on the **right** show the **right** hippocampal region where the increases in variance were especially marked.

Human depth recordings involving the insertion of electrodes into structures located deep in the brain (Ramey and O'Doherty, 1960) were not uncommon in the 1950s and 60s. Remarkably, some intracranial recordings were carried out during this period in individuals administered LSD and mescaline (Schwarz *et al.*, 1956; Monroe *et al.*, 1957; Monroe and Heath, 1961). The relevant reports document unusual phasic activities in the MTLs during the drug state that were difficult to detect at the scalp. Moreover, in separate studies, temporal lobectomy was found to abolish the effects of LSD in humans (Serafetinides, 1965) and chimpanzees (Ramey and O'Doherty, 1960) and frontal lobotomy was found to augment them (Keup, 1970). Further support for the involvement of MTLs in the mechanism of action of psychedelics comes from reports of similar phasic limbic activity in other altered states of consciousness that show phenomenological similarities with the psychedelic state, namely: REM sleep, acute psychosis and the so-called "dreamy-state" of temporal lobe epilepsy and electrical stimulation of the MTL (Carhart-Harris, 2007; Carhart-Harris and Friston, 2010). Importantly, these states are all characterized by a particular style of cognition that is fundamentally different from that of normal waking consciousness.

It is proposed here that coupling between the MTLs and the cortical regions of the DMN is necessary for the maintenance of adult normal waking consciousness, with its capacity for metacognition. Moreover, a breakdown in hippocampal-DMN coupling is necessary for a regression to primary consciousness. These hypotheses are motivated by our finding that DMN-hippocampal coupling is decreased under psilocybin (**Figure 3D**), and while DMN activity becomes desynchronous and therefore disorganized (**Figure 3E**), the amplitude of BOLD signal fluctuations increases in the hippocampus (**Figure 2**).

The Default Mode Network and the Ego

Layer 5 pyramidal neurons densely express 5-HT$_{2A}$ receptors (Weber and Andrade, 2010). These cells are an important target of psychedelics (Aghajanian and Marek, 1997) and are known to fire with an intrinsic alpha frequency (Silva *et al.*, 1991; Sun and Dan, 2009). Alpha oscillations are thought to be related to temporal framing in perceptual processing (Lorincz *et al.*, 2009; Klimesch *et al.*, 2011) but more intriguingly given the focus of the present article, a positive relationship has been found between self-reflection and alpha power (Knyazev *et al.*, 2011) and alpha synchronization during rest and Blood Oxygen Level Dependent (BOLD) activity in regions of the DMN (Jann *et al.*, 2009). Evidence implicates the DMN in self-reflective and introspective functions (Qin and Northoff, 2011) and the phase of fluctuating activity in the DMN is often inversely correlated (or "anticorrelated") with fluctuating activity in networks concerned with task-focused attention (task-positive networks, TPNs) (Fox *et al.*, 2005). Like the DMN, alpha oscillations mature developmentally and evolutionarily (Basar and Guntekin, 2009), tempting speculations that these rhythms have developed to reduce "entropy" [i.e., disorder or uncertainty (Ben-Naim, 2008)] by increasing mutual information among neuronal ensembles (Tononi *et al.*, 1994; Basar and Guntekin, 2009). With this in mind, it was remarkable that we recently found a highly significant positive correlation between the magnitude of alpha power *decreases* in the PCC after psilocybin and ratings of the item "I experienced a disintegration of my 'self' or 'ego'." Scores on this item also correlated positively with decreases in delta, theta, beta, and low gamma power, although alpha explained the most variance (a considerable 66%) see **Figure 4**. Twenty three subjective items 2012). Theta oscillations are a canonical rhythm of hippocampal circuits, at least in rodents (Buzsaki, 2002), and MTLs are known to be strongly connected to the PCC (Parvizi *et al.*, 2006) and DMN more generally (Kahn *et al.*, 2008). Thus, it is feasible that a function of PCC theta oscillations is to constrain the activity of limbic circuits, which reciprocally input to the PCC. Evidence that MTL activity exerts a *driving* influence on PCC activity comes from a recent report on deep brain stimulation for Alzheimer's disease. Chronic stimulation of the fornix, an important component of hippocampal circuitry, was associated with significantly increased glucose metabolism in the PCC (Laxton *et al.*, 2012).

In summary, interaction between different oscillatory rhythms introduces a structured quality to brain activity (Rumsey and Abbott, 2004), constraining the naturally stochastic firing of individual pyramidal neurons (Rolls and Deco, 2010) and so providing ideal conditions for the emergence of "complexity" (Tononi *et al.*, 1994) or "self-organized criticality" (Jensen, 1998). A key hypothesis of this article is that it is through the development of self-organized activity in the DMN [and concomitant entropy/uncertainty/disorder minimization (Friston, 2010)] that a coherent sense of self or "ego" emerges (Carhart-Harris and Friston, 2010). This process of maturational settling succeeds an earlier state of elevated entropy (primary consciousness) and psychedelic drugs induce a regression to this entropic brain state via the mechanisms outlined above.

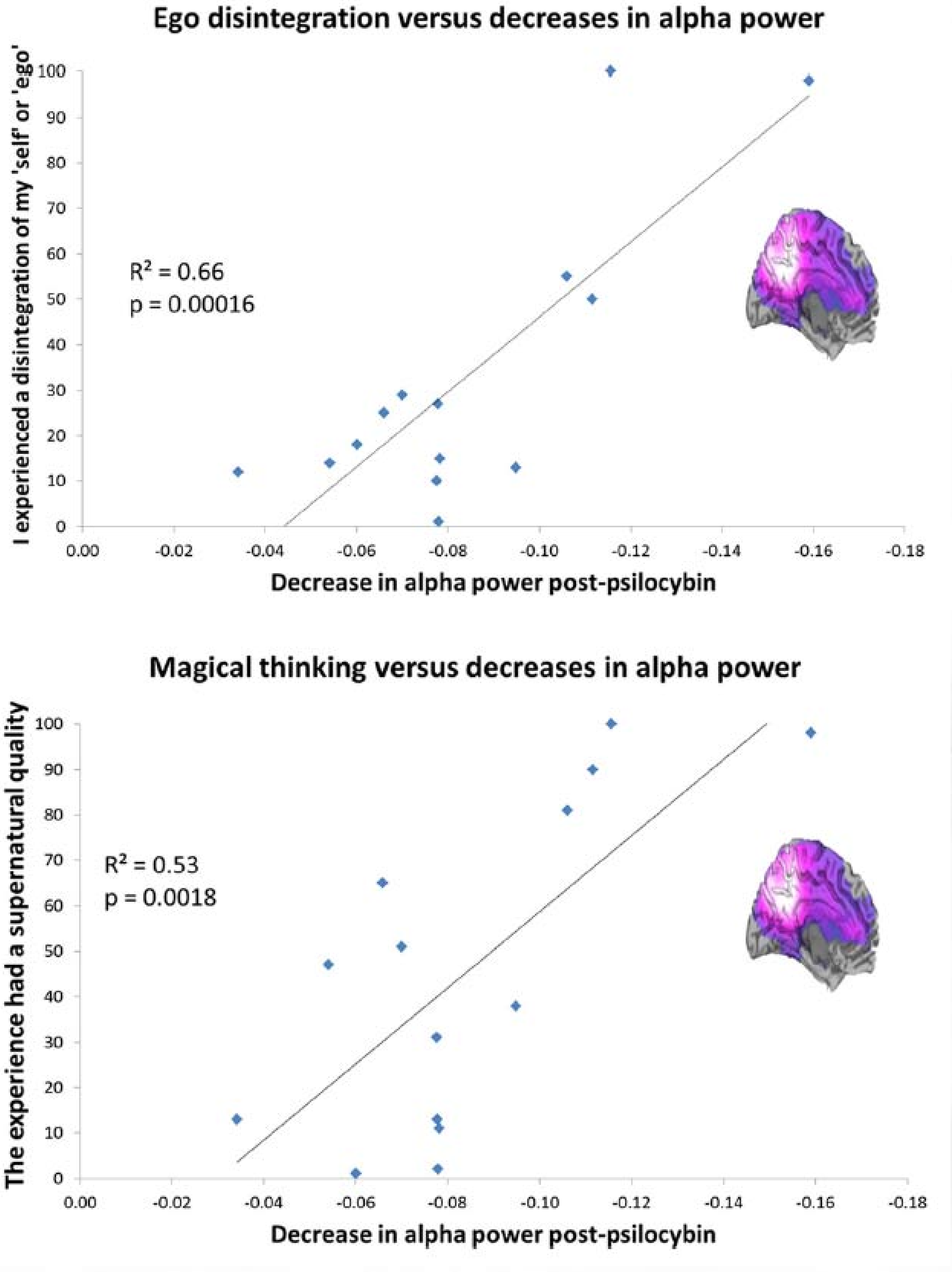


FIGURE 4 - **Decreased PCC alpha power predicts ego-disintegration and magical thinking after psilocybin. Top**: Decreased PCC alpha power vs. ratings of ego-disintegration. **Bottom**: Decreased PCC alpha power vs. ratings of magical/supernatural thinking. Both correlations were significant after correction for multiple comparisons (0.05/23 = 0.002). These charts are derived from data discussed in Muthukumaraswamy *et al*. (2013).

With these foundations laid, the following hypotheses can be proposed: (1) coupling within the DMN, and *especially* between the MTL and DMN, is a characteristic of maturational settling that is necessary for secondary consciousness and the development of an integrated sense of self; (2) a relative decoupling within the DMN and specifically between the MTLs and DMN occurs when secondary consciousness abates and there is a reciprocal increase in the influence of primary consciousness; (3) decreased MTL-DMN coupling allows the

MTLs to function more independently of the DMN and this can result in unusual MTL activities such as have been recorded with depth electrodes in primary states (see above and Grof, 1982; Bassett *et al.*, 2008; Axmacher *et al.*, 2010) and may have been detected in the BOLD signal amplitude increases in the MTL post-psilocybin (Figure 3); (5) unconstrained/disinhibited/anarchic MTL activity is a principal characteristic of primary states and the occurrence of these activities is consistent with a system at criticality; (6) brain activity in primary consciousness is closer to criticality-proper than it is during normal waking consciousness (which may be slightly sub-critical rather than perfectly critical).

The DMN, Introspection and Metacognition

DMN resting-state functional connectivity correlates positively with ratings of internal awareness (Vanhaudenhuyse *et al.*, 2011), depressive rumination (Berman *et al.*, 2011) and trait neuroticism (Adelstein *et al.*, 2011). DMN connectivity increases during mental time-travel (Andrews-Hanna *et al.*, 2010; Martin *et al.*, 2011) and activity in the medial prefrontal node of the DMN is reliably elevated in depression (Farb *et al.*, 2011; Lemogne *et al.*, 2012). These findings strongly implicate the DMN in introspective thought and suggest that hyper activity and connectivity in the DMN is related to a certain style of concerted introspection.

To step back, one of the primary hypotheses being developed here is that metacognition, and in particular, the human capacity for self-reflection, is an advanced behavior that rests on self-organized activity in the DMN and between the DMN and the MTLs. Thus, if the DMN is hyper-active and connected in depression, does this imply that mild depression is an evolutionarily advanced state? The phenomenon of "depressive realism" has been recognized for several decades (Dykman *et al.*, 1989; Haaga and Beck, 1995) and sits comfortably with the idea that a primary function of the DMN is to support metacognition (Fleming *et al.*, 2010). The suggestion is that increased DMN activity and connectivity in mild-depression promotes concerted introspection and an especially diligent style of reality-testing. However, what may be gained in mild depression (i.e., accurate reality testing) may be offset by a reciprocal decrease in flexible or divergent thinking (and positive mood).

The proposal that increased DMN activity and connectivity is a key functional correlate of concerted introspection, such as is seen in depression, may seem inconsistent with the association between DMN activity and mind-wandering (Mason *et al.*, 2007) but this is a conceptual problem that can be easily resolved. The positive relationship between increased BOLD signal in the DMN and the frequency of mind-wandering during task-performance (Mason *et al.*, 2007) tells us nothing about the nature or *style* of the cognition in the off-task state, it simply tells us that the mind has drifted off-task. It is known however, that the strength of inverse coupling between activity in the DMN and TPNs is increased when task performance is more consistent (Kelly *et al.*, 2008), implying increased focus and a relative decrease in off-task attentional lapses. DMN-TPN inverse coupling is decreased in patients with attention deficit/hyperactivity disorder (ADHD) (Hoekzema *et al.*, 2013) and increased after administration of the attention-enhancers modafinil (Schmaal *et al.*, 2013) and nicotine (Cole *et al.*, 2010). Thus, it is too simplistic to regard increased BOLD signal in the DMN as a correlate of freely-wandering cognition, and decreased inverse coupling between the DMN and TPN is probably a more informative index of this. As will be discussed later, this point is reinforced by findings that inverse coupling between the DMN and TPNs is decreased under psilocybin, and DMN activity and connectivity is also decreased. This is important because unconstrained, explorative thinking is a hallmark of the psychedelic state (see **Figure 5**).

In the next section we cite direct evidence for increased entropy in brain networks in psychedelic state and use this to support a general principle: that the transition from normal waking consciousness to primary consciousness is marked by an increase in system entropy.

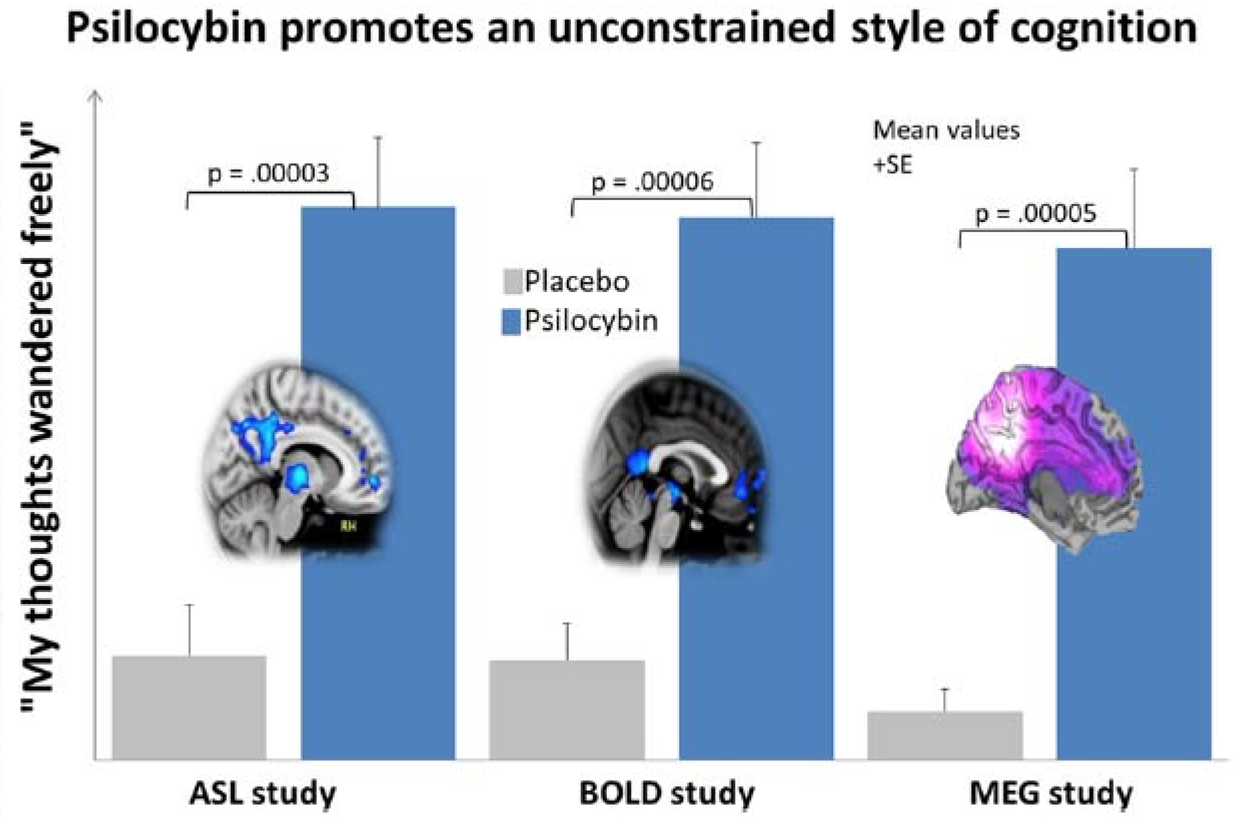


FIGURE 5 - Psilocybin promotes unconstrained thinking and decreases blood flow, venous oxygenation and oscillatory power in the DMN. This chart shows the average (+*SE*) ratings for the item "my thoughts wandered freely" in 3 neuroimaging studies, each involving the administration of psilocybin and placebo to 15 healthy volunteers. Ratings were given within 30 min of the end of the relevant resting state scans. This particular item was one of the highest rated items in all 3 studies and nicely communicates the quality of cognition that predominates in the psychedelic state. The brain image on the left displays the mean regional decreases in CBF post-psilocybin in the ASL study; the central image displays the mean regional decreases in BOLD signal post-psilocybin in the BOLD study; and the image on the right displays the mean regional decreases in alpha power post-psilocybin in the MEG study. All images were derived using a whole brain corrected threshold of $p < 0.05$.

Increased Network Entropy in the Psychedelic State

There is an emerging view in cognitive neuroscience that the brain self-organizes under normal conditions into transiently stable spatiotemporal configurations (Sporns *et al*., 2004; Shanahan, 2010; Deco and Corbetta, 2011; Tagliazucchi *et al*., 2012) and that this instability is maximal at a point where the global system is critically poised in a transition zone between order and chaos (Tononi *et al*., 1994; Shanahan, 2010; Deco and Jirsa, 2012; Tagliazucchi *et al*., 2012). In the present context, the "metastability" (Tognoli and Kelso, 2014) of a brain network is a measure of the variance in the network's intrinsic synchrony over time. That is, if the signal in all of the voxels within a given network deviates little from the network's mean signal, then variance is low, whereas if the signal in voxels fluctuate erratically, then variance is high. Thus, using the data from the BOLD fMRI study with psilocybin, we recently looked at changes in the variance of intra-network synchrony over time in nine canonical resting-state networks (Smith *et al*., 2009) pre and post placebo and psilocybin. Results revealed significantly increased network variance in high-level association networks after psilocybin but not in sensory specific and motor networks, and there were no changes after placebo. These results imply that activity in high-level networks becomes relatively disorganized under psilocybin, consistent with the entropic brain hypothesis.

To translate this result into a formal measure of entropy, we discretized the time course of intra-network synchrony over time into equal sized bins where each time-point could be entered into a bin depending on the variance in the network's synchrony at that time point. Doing this for each network, we built probability distributions of the variance of the intra-network synchrony across time from which we could then calculate the Shannon entropy for each network. Not surprisingly, increased entropy was observed in the networks in which there was increased variance post-psilocybin i.e., the high-level association networks (See **Figure 6**).

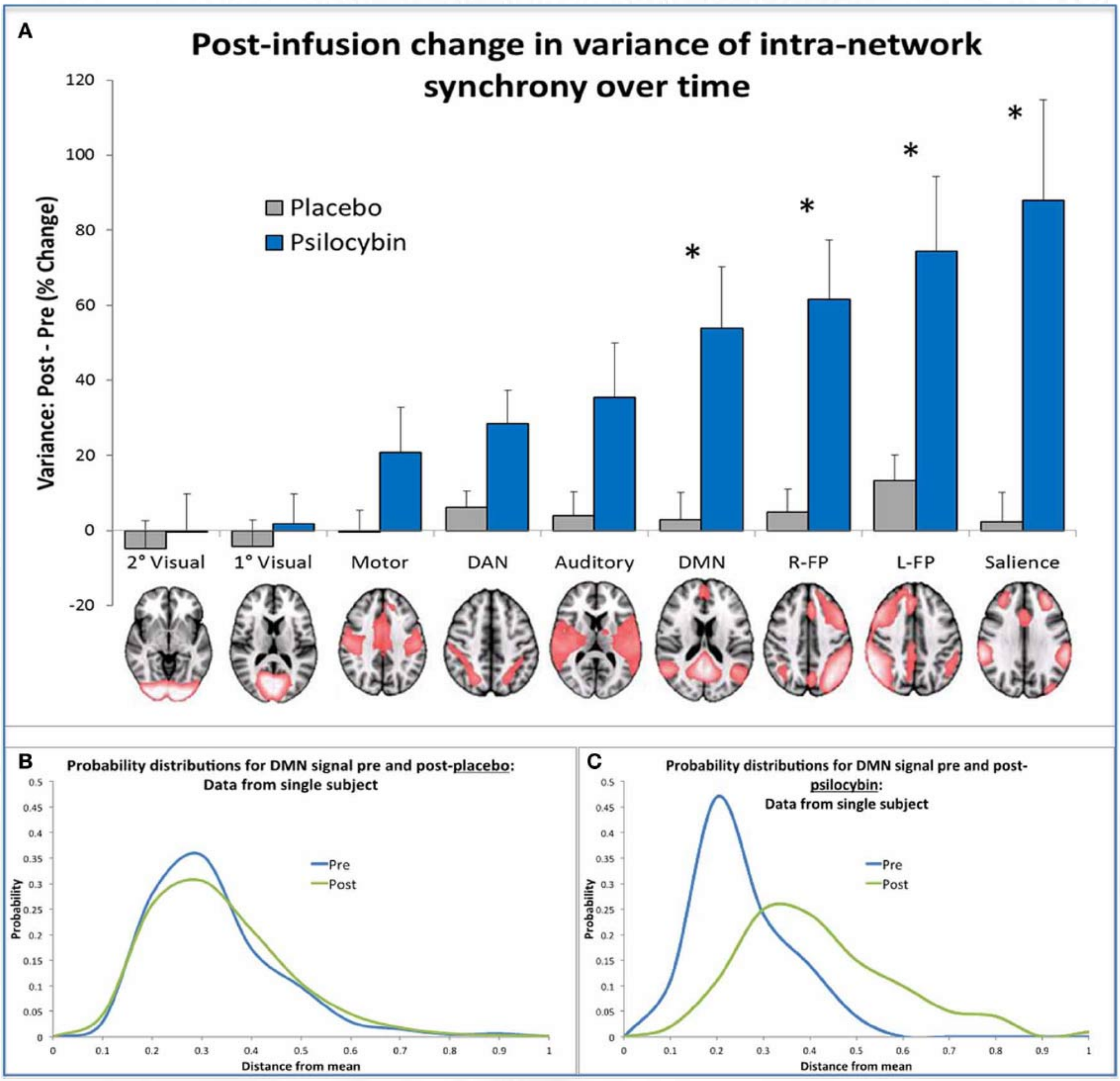


FIGURE 6 - **Changes in network metastability and entropy post-infusion of psilocybin. (A)** This chart displays the mean variance of the internal synchrony of 9 brain networks for the sample of 15 healthy volunteers, as a percentage change post vs. pre-infusion. A post-infusion increase in metastability for a specific network indicates that the mean signal in that network is a poor model of the activity in its constituent voxels, implying that the network is behaving more "chaotically" post-infusion than pre. Bonferonni correction gave a revised statistical threshold of $p < 0.006$ (0.05/9). One-sample (2-tailed) t-tests were performed, comparing the % change against zero. The significant networks are labeled with an asterisk. **(B,C)** These probability distributions were derived from data from the same single subject, by discretizing a measure of the internal synchrony of the DMN across time into bins. These bins reflect the distance a data point is from the mean and this gives a probability distribution of the variance of internal synchrony within a network for a given time period (e.g., a 5 min period of scanning). The probability distributions shown in **Chart B** were produced from placebo data where it is clear that prediction of internal network synchrony of the DMN across time is similar before and after infusion (i.e., the blue and green curves). The probability distributions shown in **Chart C** were derived using psilocybin data and here it is evident that following infusion of psilocybin (i.e., the green curve), prediction of internal network synchrony within the DMN is more difficult compared to pre infusion (the blue curve). When the entropy change was calculated for the group, significantly greater increases in entropy were found in the same networks highlighted in **(A)** (post-psilocybin vs. pre) vs. (post-placebo vs. pre).

To further assess entropy changes after psilocybin, we took a slightly different approach. Four regions were chosen from a limbic/paralimbic system based on prior knowledge that BOLD signal variance was increased in these regions under psilocybin. The regions included: the left and right hippocampi and the left and right anterior cingulate cortex (ACC). A threshold was set for connection strength such that only connections above a particular strength survived and were therefore said to "exist." This allowed functional connectivity motifs (connectivity graphs) to be identified at each time point in the time series. With 4 nodes, there were 64 possible connectivity motifs or graphs at any given time point. The results revealed a greater repertoire of motifs under psilocybin than either at baseline or after placebo. Indeed, a number of motifs were exclusive to the psilocybin condition. The entropy of a time series could then calculated by assessing the entropy of a sequence of motifs over a period of time (i.e., how easy/difficult is it to predict a sequence of motifs in a given state?). This is the same procedure one would follow in order to calculate the entropy of a transcribed passage of speech for example (i.e., the likelihood of certain words occurring in a coherent passage is not random, e.g., some words, such as "I," occur much more often than others). Thus, it was found that the sequence of motifs had significantly greater entropy under psilocybin than at baseline, meaning that a more random sequence of motifs played-out in the psychedelic state. This result implies that it is harder to predict the sequence of connectivity motifs in the psychedelic state because it is more random. This outcome is entirely consistent with the entropic brain hypothesis, which states that brain activity becomes more random and so harder to predict in primary states - of which the psychedelic state is an exemplar.

Criticality and Primary Consciousness

The DMN appears to have a consistently high level of activity, e.g., even when the DMN is relatively deactivated during goal-directed cognition, it is still receives more blood flow than elsewhere in the brain (Pfefferbaum *et al*., 2011). Thus, it can be inferred that one reason why the DMN is so highly and persistently active, is that it receive regular endogenous input from internal drivers. One such driver may be MTL activity (Laxton *et al*., 2010) and another may be input from brainstem nuclei such as the serotonergic raphe nuclei. Irrespective of what the specific drivers of the DMN are, its enduring presence fits comfortably with the idea that it is the seat of the ego (Carhart-Harris and Friston, 2010), as in healthy waking consciousness, one's sense of self is never far from consciousness:

> "Normally, there is nothing of which we are more certain than the feeling of our self, of our own ego." (Freud, 1930)

So how does the phenomenon of primary consciousness fit in here? The first thing to say is that primary consciousness may be a sub-optimal mode of cognition that has been superseded by a more reality-bound style of thinking, governed by the ego. However, if primary consciousness is a psychological atavism, and the psychedelic state is an exemplar of it, then how does this explain the putative utility of the psychedelic experience e.g., as an adjunct to psychotherapy (Moreno *et al*., 2006; Grob *et al*., 2011) and why do some people report being so profoundly affected by such experiences (and often seemingly for the better) (Griffiths *et al*., 2008; Carhart-Harris and Nutt, 2010; MacLean *et al*., 2011)?

The phenomenon of depression can help us here. Cognition during an episode of depression is characteristically inflexible; the patient's focus is almost entirely inward and self-critical, and *he/she is unable to remove him/herself from this state* (Holtzheimer and Mayberg, 2011). In the previous section, depressive realism was discussed in relation to hyper activity and connectivity within the DMN; however, in severe depression, cognition cannot be said to be optimal. Depressed patients typically perceive themselves and their world through an unyielding pessimism (Styron, 1992). Depressed patients' cognitive style may become too fixed, such that the patient loses the ability to think and behave in a flexible manner. Underlying this phenomenon may be a decrease in metastability, such that one particular state, e.g., the introspective default-mode, comes to dominate cognition. The aggressive self-critical focus that accompanies a loss or abandonment of object-cathexis in depression (i.e., interest in or focus on objects in the world, such as work and people) quite naturally leads to suicidal thoughts and acts (Carhart-Harris *et al*., 2008). In consideration of these things, narrow-mindedness is to pessimism what openness (MacLean *et al*., 2011) is to optimism and strategies that promote the latter may be effective treatments for depression (see MacLean *et al*., 2011).

This article proposes that primary consciousness rests on more metastable dynamics than secondary consciousness, i.e., brain sub-states are less stable in primary consciousness. Thus, by implication, a broader repertoire of transient states may be visited in primary consciousness because the system is closer to criticality-proper. Moreover, it is the ability of psychedelics to disrupt stereotyped patterns of thought and behavior by disintegrating the patterns of activity upon which they rest that accounts for their therapeutic potential. This principle implies that a brain at criticality may be a "happier" brain. The schematic below (**Figure 7**) illustrates differences between primary and secondary consciousness. The model describes cognition in adult modern humans as "near critical" but "sub-critical" - meaning that its dynamics are poised in a position between the two extremes of formlessness and Petrification where there is an optimal balance between order and flexibility. However, because of maturational settling, the brain in secondary consciousness gravitates toward "order" and thus, the dynamics in this state are more accurately, (slightly) sub-critical. Psychedelics may be therapeutic because they work to normalize pathologically subcritical styles of thought (such as is seen in depression, OCD or addiction/craving for example) thereby returning the brain to a more critical mode of operating. Indeed, if the principle holds that a critical brain is a happy brain, then it would follow that psychedelics could be used to enhance well-being and divergent thinking, even in already healthy individuals. One negative consequence of this however could be the neglect of accurate reality-testing.

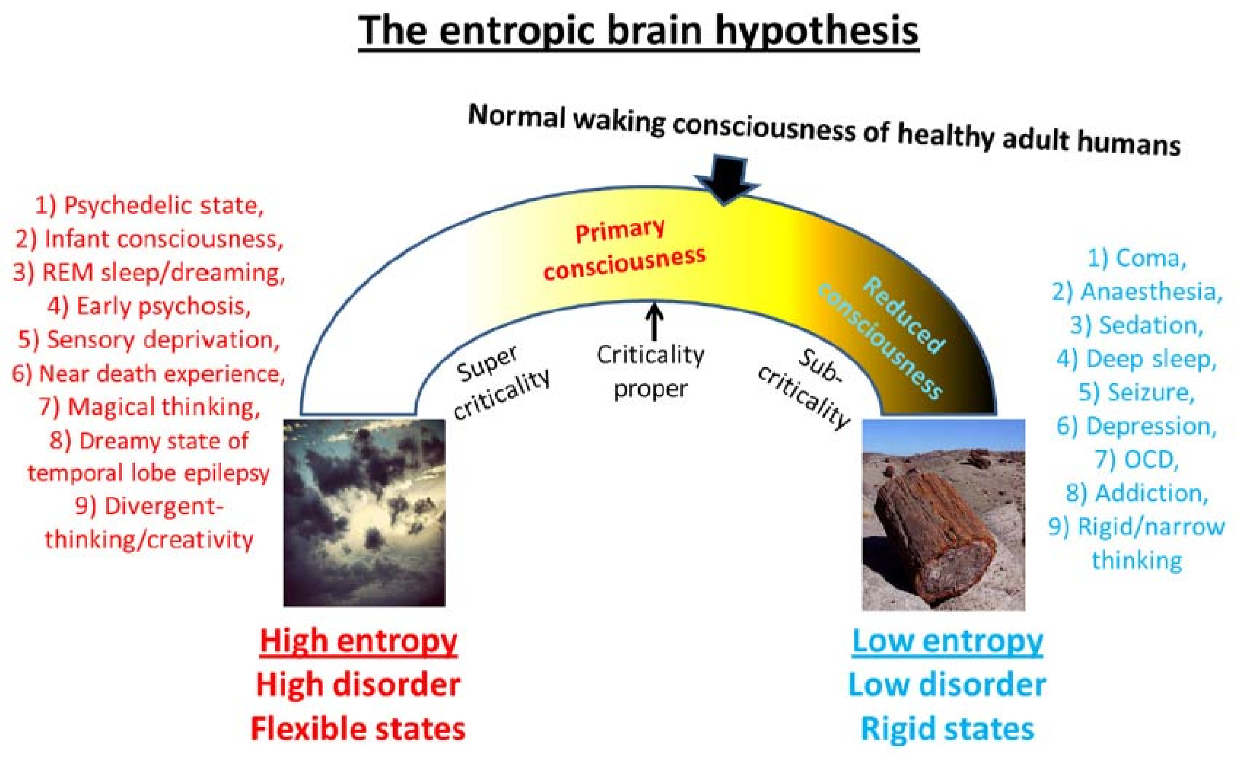

The entropic brain hypothesis
Normal waking consciousness of healthy adult humans
1) Psychedelic state,
2) Infant consciousness,
3) REM sleep/dreaming,
4) Early psychosis,
5) Sensory deprivation,
6) Near death experience,
7) Magical thinking,
8) Dreamy state of temporal lobe epilepsy
9) Divergent-thinking/creativity
Primary consciousness
Reduced consciousness
Super criticality
Criticality proper
Sub-criticality
1) Coma,
2) Anaesthesia,
3) Sedation,
4) Deep sleep,
5) Seizure,
6) Depression,
7) OCD,
8) Addiction,
9) Rigid/narrow thinking
High entropy
High disorder
Flexible states
Low entropy
Low disorder
Rigid states

FIGURE 7 - **Spectrum of cognitive states.** This schematic is intended to summarize much of what this paper has tried to communicate. It shows an "inverted u" relationship between entropy and cognition such that too high a value implies high flexibility but high disorder, whereas too low a value implies ordered but inflexible cognition. It is proposed that normal waking consciousness inhabits a position that is close to criticality but slightly sub-critical and primary states move brain activity and associated cognition toward a state of increased system entropy i.e., brain activity becomes more random and cognition becomes more flexible. It is proposed that primary states may actually be closer to criticality proper than secondary consciousness/normal waking consciousness.

Recent work has indeed supported the notion that brain activity is slightly sub-critical in normal waking consciousness (Priesemann *et al.*, 2013). One reason why it may be advantageous for the brain to operate just below criticality is that by doing so, it can exert better control over the rest of the natural world - most of which *is* critical. This may take the form of suppressing endogenous processes within the brain or interacting with the environment in order to shape it and thereby control it. Indeed, if control is the objective, then it makes sense that the brain should be more ordered than that which it wishes to control.

The idea that the brain is closer to criticality in the psychedelic state than in normal waking consciousness (**Figure 7**) has some intuitive appeal as some of the signatures of criticality, such as maximum metastability, avalanche phenomena and hypersensitivity to perturbation are consistent with the phenomenology of the psychedelic state. For example, if we consider just one of these: hypersensitivity to perturbation, it is well known that individuals are hypersensitive to environmental perturbations in the psychedelic state, which is why such emphasis is placed on the importance of managing the environment in which the psychedelic experience unfolds (Johnson *et al.*, 2008). Indeed, one explanation for why some people celebrate and romanticize the psychedelic experience and even consider it "sacred" (Schultes, 1980; McKenna, 1992), is that, in terms of criticality, brain activity does actually become more consistent closer with the rest of nature in this state i.e., it moves closer to criticality-proper and so is more in harmony with the rest of nature.

A final speculation that is worth sharing, is that the claim that psychedelics work to lower repression and facilitate access to the psychoanalytic unconscious, may relate to the brain moving out of a sub-critical mode of functioning and into a critical one, enabling transient windows of segregation or modularity to occur (e.g., with "anarchic" MTL activity) because of the breakdown of the system's hierarchical structure. Indeed, repression may depend on the brain operating in a sub-critical mode, since this would constrain consciousness and limit its breadth. Phenomena such as spontaneous personal insights and the complex imagery that often plays out in psychedelic state (Cohen, 1967) and dreaming, may depend on a suspension of repression, enabling cascade-like processes to propagate through the brain [e.g., from the MTLs to the association cortices (Bartolomei *et al.*, 2012)]. Such processes may depend on a reduction of DMN control over MTL activity.

The Therapeutic Potential of Psychedelics

Many psychiatrists working with psychedelics in the 1950s and 60s expressed great enthusiasm about their therapeutic potential (Crocket *et al.*, 1963; Abramson, 1967; Grinspoon and Bakalar, 1979; Grof, 1980) but there was an unfortunate failure to substantiate these beliefs with properly controlled studies. Subsequent reviews and meta-analyses have suggested an impressive efficacy, especially in relation to the use of LSD in the treatment of alcohol dependence (Mangini, 1998; Dyck, 2005; Krebs and Johansen, 2012) and modern trials have lent some support to this sentiment (Moreno *et al.*, 2006; Grob *et al.*, 2011). For example, a single high dose of psilocybin produced profound existential experiences in healthy volunteers that had a lasting beneficial impact on subjective well-being (Griffiths *et al.*, 2006, 2008) and a moderate single dose of psilocybin administered to patients with advanced-stage cancer significantly reduced anxiety and depression scores for months after the acute experience (Grob *et al.*, 2011). In another study, symptoms of obsessive compulsive disorder (OCD) were significantly reduced after psilocybin (Moreno *et al.*, 2006). Supplementing these controlled studies, we surveyed over 500 recreational drug users, and found that 67% of LSD users and 60% of psilocybin users claimed that use of these drugs had produced long-term positive effects on their sense of well-being (Carhart-Harris and Nutt, 2010), consistent with the results of the aforementioned controlled studies (Griffiths *et al.*, 2006, 2011). To place this in a context, only 6% of alcohol users claimed such improvements from alcohol use (Carhart-Harris and Nutt, 2010). One of the most remarkable properties of psychedelics is their potential to have a lasting impact on personality and outlook (McGlothlin and Arnold, 1971; Studerus *et al.*, 2011). Personality traits are known to be relatively fixed by adulthood (Costa and McCrae, 1997; McCrae and Costa, 1997), however, the personality trait "openness" was found to be significantly increased over 14 months after a single controlled administration of psilocybin (MacLean *et al.*, 2011). Moreover, neuroimaging studies (Carhart-Harris *et al.*, 2012a) have found decreased activity and connectivity after psilocybin in brain regions (e.g., the mPFC) and networks (e.g., the DMN) that are over-engaged in depression (Greicius *et al.*, 2007; Berman *et al.*, 2011) but normalized by a range of effective treatments (Goldapple *et al.*, 2004; Mayberg *et al.*, 2005; Kennedy *et al.*, 2007; Deakin *et al.*, 2008).

Classic psychedelics are all agonists at the serotonin 2A receptor (Glennon *et al.*, 1984; Vollenweider *et al.*, 1998) and 5-HT$_{2A}$R antagonism blocks the positive mood effects of psilocybin (Kometer *et al.*, 2012) and MDMA (van Wel *et al.*, 2012). 5-HT$_{2A}$R expression is upregulated in depression (Bhagwagar *et al.*, 2006) likely because of low synaptic 5-HT (Cahir *et al.*, 2007). Positron emission tomography (PET) studies in humans found positive correlations between 5-HT$_{2A}$R binding and trait neuroticism (Frokjaer *et al.*, 2008) and pessimism (Meyer *et al.*, 2003). This may imply that 5-HT$_{2A}$R upregulation, due to low synaptic 5-HT, reflects a state of chronically deficient post-synaptic 5-HT$_{2A}$R stimulation that contributes to inflexible patterns of (negative) thought such as are seen in depression. 5-HT$_{2A}$R-stimulation may therefore work to reverse this, effectively "lubricating" cognition.

Given our knowledge of the biological effects psychedelics, a comprehensive model can be presented in which psychedelics: (1) stimulate the 5-HT$_{2A}$ receptor (Glennon *et al.*, 1984), (2) depolarize deep-layer pyramidal neurons (Andrade, 2011), (3) desynchronize cortical activity, (4) "disintegrate" brain networks (Carhart-Harris *et al.*, 2012a), (5) increase network metastability and (6) increase the repertoire of connectivity motifs within a limbic/paralimbic network. The net effect of these processes is an increase in system entropy (formally reflected in points 5 and 6) as the system enters criticality-proper.

Thus, in summary, it is hypothesized that there is a basic mechanism by which psychedelics can be helpful in psychiatry, whether they be used to treat depression, OCD (Moreno *et al.*, 2006) or addiction (Krebs and Johansen, 2012). Specifically, it is proposed that psychedelics work by dismantling reinforced patterns of negative thought and behavior by breaking down the stable spatiotemporal patterns of brain activity upon which they rest. An important caveat however, is that in order for this process to be beneficial, the drug-induced transitions to, and the return from primary consciousness, must be mediated by appropriate therapeutic care (Johnson *et al.*, 2008). Moving the brain out of sub-critical modes and into unfamiliar terrain may present some risks (e.g., loss of contact with reality and persistent magical/delusional thinking) if not properly managed (Johnson *et al.*, 2008).

The Spiritual Experience and Primary Consciousness

> "If we consider contemporary accounts of the mystical consciousness, we can see that the individuality, the "I," disappears and is in a sense "annihilated." (Stace, 1961)

In the psychology of religion, one of the most remarkable findings has been that it is possible, by way of a single high dose of psilocybin, to reliably induce profound spiritual experiences in healthy volunteers that are effectively indistinguishable from spontaneously-occurring spiritual experiences (Griffiths *et al.*, 2006). Perhaps this finding should not be so surprising, psilocybin containing mushrooms have been used for centuries in shamanic "healing" ceremonies (Hofmann, 1980), and in a famous study in the 1960s, high-dose psilocybin was administered to theology students partaking in a religious service on Good Friday and emphatic spiritual experiences were reported (Doblin, 1991). The so-called "entheogenic" (generating the divine) properties of psilocybin appear to be shared by the other classic psychedelics such as LSD and DMT but not the "psychedelic-like" compounds, MDMA and cannabis (Carhart-Harris and Nutt, 2010; Lyvers and Meester, 2012). It is intriguing that entheogenic properties appear to be specific to 5-HT$_{2A}$R agonist classic psychedelics and this suggests a key role for this receptor in their genesis.

In William James' famous lectures on the psychology of religion he proposed that spiritual experiences depend on the emergence of what he referred to as the "subconscious" or "subliminal" mind into consciousness (James, 1968). Referring to what psychoanalysis calls "the unconscious." James said: "*[T]his is obviously the larger part of each of us, for it is the abode of everything that is latent and the reservoir of everything that passes unrecorded or unobserved… It is the source of our dreams… In it arise whatever mystical experiences we may have… It is also the fountain-head of much that feeds our religion. In persons deep in the religious life - and this is my conclusion - the door into this region seems unusually wide open.*" (James, 1968).

James' ideas are consistent with those of Carl Jung; however, Jung extended them, arguing that the unconscious hosts the psychological remnants of our phylogenetic ancestry. In dreams, psychosis and other altered states, archetypal themes shaped by human history emerge into consciousness (Jung, 1982a). Jung's account of the "collective" unconscious fits comfortably with the phenomenology of the psychedelic experience. Archetypal themes feature heavily in user "trip reports" (Masters and Houston, 1966; Shanon, 2002), as they do in religious iconography. For Jung, religion is a manifestation of the collective unconscious, expressed in a symbolic and ritual form: "*The brain is inherited from its ancestors; it is the deposit of the psychic functioning of the whole human race. In the brain, the instincts are preformed, and so are the primordial images which have always been the basis of man's thinking - the whole treasure-house of mythological motifs… Religious symbols have a distinctly "revelatory" character; they are usually spontaneous products of unconscious psychic activity … they have developed, plant-like, as natural manifestations of the human psyche.*" (Jung, 1982b).

Jung's ideas offer an appealing explanation for the content of religious experiences, as well as the content of high-dose psychedelic experiences; however, a more systematic treatise on the spiritual experience was provided by Walter Stace in 1960 (Stace, 1961). Stace's work is particularly useful because his ideas resonate with the findings of recent neuroimaging studies relevant to the neurobiology of spiritual experiences. Based on a thorough review of first-person accounts derived from individuals from a variety of different faiths, Stace identified seven universal components of the spiritual experience: 1) diminished spatial and temporal awareness, 2) diminished subjectivity (equivalent to increased objectivity), 3) feelings of profound joy and peace, 4) a sense of divinity, 5) paradoxicality (where two opposing things appear to be true), 6) ineffability (the difficulty of expressing the experience in words) and 7) a sense of oneness with the world, otherwise known as "the unitive experience."

Importantly, in Stace's synopsis, he identified the unitive experience as the core characteristic of the spiritual experience. Freud referred to the same phenomenon as the "oceanic state" (Freud, 1930). Stace explained that in profound spiritual experiences the complex *multiplicity* of normal consciousness collapses into a simpler state where a sense of an all-encompassing unity or "oneness" with others, the world and/or "God" is felt. He emphasized that there is a collapse in the most fundamental dualities of consciousness (i.e., *self* vs. *other*, *subject* vs. *object* and *internal* vs. *external*) in the unitive state. Moreover, he also showed that reports of unitary consciousness are consistent throughout the different religions - emphasizing its universality and cultural independence (Stace, 1961).

Freud had some important things to say about the unitive state that are directly relevant to the entropic brain hypothesis. For example, when discussing his friend's description of an "oceanic feeling" when in religious practice, Freud says: "*Pathology has made us acquainted with a great number of states in which the boundary lines between the ego and the external world become uncertain... Further reflection tells us that the adult's ego-feeling cannot have been the same from the beginning. It must have gone through a process of development... (For example,) an infant at the breast does not as yet distinguish his ego from the external world; he gradually learns to do so. Our present ego-feeling is therefore only a shrunken residue of a much more inclusive - indeed, an all-embracing feeling, which (early in development] corresponded to a more intimate bond between the ego and the world. If we assume that there are many people in whose mental life this primary ego-feeling has persisted to a greater or less degree, it would exist in them side by side with the narrower and more sharply demarcated ego feeling of maturity, like a counterpart to it. In that case, the ideational contents appropriate to it would be precisely those of limitlessness and of a bond with the universe - the same ideas with which my friend elucidated the "oceanic feeling.*"" (Freud, 1930).

Thus, Stace and Freud's descriptions of the spiritual experience are entirely consistent with the view of the primary state as being regressive. Moreover, they are also consistent with view that the human brain developed through ontogeny and phylogeny to minimize disorder/uncertainty (Friston, 2010). In the schematic presented in **Figure 7**, primary consciousness is depicted as being more supercritical than normal waking consciousness. Indeed, at the extreme end of supercriticality is maximum entropy, which is equivalent to formlessness or complete disorder. Formerly, there is no difference between entropy in this thermodynamic sense (depicted as complete disorder) and entropy in the information theory sense, where there is maximum uncertainty about the system - because there is no order on which to base any predictions.

The System Mechanics of Primary States

Extending this, the mechanics underlying the onset of true primary states (for which the spiritual experiences is an example) can be viewed in relation to the second law of thermodynamics. Explicitly, in the absence of a regular driving input, the system (i.e., self-organized brain activity) will inevitably degrade or collapse toward formlessness or maximum entropy. The interesting question that follows therefore is: *what is the driving input that ceases in primary states*? This paper proposes that regular MTL activity is a crucial driver of the DMN. Although, interestingly, there is also evidence that the usual clock-like firing of serotonin neurons in the dorsal raphe nuclei completely ceases in both the psychedelic state (Aghajanian *et al*., 1968; Aghajanian and Vandermaelen, 1982) and REM sleep (Trulson and Jacobs, 1979) and there is some indirect evidence that the DMN may be (at least partially) a serotonergic system coupled to dorsal raphe activity (Zhou *et al*., 2010).

During secondary consciousness, the brain can enter a *multiplicity* of different states and microstates (Tononi, 2010) but due to "winner-takes all," or more strictly, "winnerless" (Rabinovich *et al*., 2001) competition between states ["winnerless" because critical instability or metastability dictates that a state's "victory" is transient (Friston *et al*., 2012b)] the global system only ever entertains *one* winning state at any one time (Baars, 2005). However, according to the entropic brain hypothesis, in primary states, the potential multiplicity of possible states is not obliterated but rather extended because the *selectivity* and *conspicuity* of a winning state is reduced, and so more transient states may be visited. In dynamical terms, this would be expressed as attractor basins or valleys (defining transient states) becoming shallower in primary states, i.e., the attractor landscape is flattened in primary states.

Conversely, in depression, OCD and addiction, specific states (e.g., the default-mode in depression) may be frequented more regularly than others - and this may be observed as certain mental states (e.g., introspection in depression or craving in addiction) or behaviors (e.g., compulsive acts in OCD) being habitually revisited in a stereotyped fashion. Moreover, these states may be relatively stable i.e., their basins of attraction are relatively steep since the patterns of activity upon which they rest have become entrenched. In such scenarios, uncertainty about the system is minimized because we know that it possesses a particular character. It is intriguing to consider therefore that disorders such as depression, OCD and addiction could be functional in some sense, perhaps working to resist a more catastrophic collapse to primary consciousness (with the onset of a psychotic episode for example) by reinforcing stable patterns of activity.

The following example may help to illustrate what is meant by competition between conscious states - and the loss of it in primary consciousness. Functional brain imaging has identified distinct brain networks that subserve distinct psychological functions. For example, the DMN is associated with introspective thought (Andrews-Hanna *et al*., 2010) and a dorsal frontoparietal attention network (DAN) is associated with visuospatial attention (Corbetta *et al*., 1998; Fox *et al*., 2006) and is a classic example of a "task positive network" (TPN) - i.e., a network of regions that are consistently activated during goal-directed cognition. If the brain was to be sampled during a primary state (such as a psychedelic state) we would predict that the rules that normally apply to normal waking consciousness will become less robust. Indeed, we recently found this to be so when analysing the degree of orthogonality or "anti-correlation" between the DMN and TPN post-psilocybin. Post-drug there was a significant reduction in the DMN-TPN anticorrelation, consistent with these networks becoming less different or more similar (i.e., a flattening of the attractor landscape). The same decrease in DMN-TPN anticorrelation has been found in experienced meditators during rest (Brewer *et al*., 2011) and meditation (Froeliger *et al*., 2012). Moreover, decreased DMN-TPN inverse coupling is especially marked during a particular style of meditation referred to as "non-dual awareness" (Josipovic *et al*., 2011). This is interesting because this style of meditation promotes the same collapse of dualities that was identified by Stace (and Freud) as constituting the core of the spiritual experience. The DMN is closely associated with self-reflection, subjectivity and introspection, and task positive networks are associated with the inverse of these things, i.e., focus-on and scrutiny of the external world (Raichle *et al*., 2001). Thus, it follows that DMN and TPN activity *must* be competitive or orthogonal in order to avoid confusion over what constitutes *self*, *subject* and *internal* on the one hand, and *other*, *object* and *external* on the other. It is important to highlight that disturbance in one's sense of self, and particularly one's sense of existing apart from one's environment, is a hallmark of the spiritual (Stace, 1961) and psychedelic experience (Carhart-Harris *et al*., 2012b). Moreover, as in the psychedelic state (Carhart-Harris *et al*., 2012a; Carhart-Harris *et al*., 2012b), a number of studies have found decreased DMN activity (Farb *et al*., 2007; Brewer *et al*., 2011; Hasenkamp *et al*., 2012) as well as decreased DMN-TPN inverse coupling in meditation (Brewer *et al*., 2011; Josipovic *et al*., 2011; Froeliger *et al*., 2012).

The contravention or corruption of important rules about brain organization may explain the sense of confusion and uncertainty that accompanies a transition from secondary to primary consciousness. In the information theoretical sense, "uncertainty" is a synonym for entropy (Friston, 2010; Ben-Naim, 2012) - and disorder and uncertainty are effectively equivalents. Entropy in information theory is reflected in the shape of a probability distribution (Ben-Naim, 2012), i.e., we have less confidence (or more uncertainty) about something when the distribution is broader or more evenly spread. This is because it is more difficult to predict what the outcome of an individual sampling trial would be because the system behaves relatively randomly (Ben-Naim, 2012). Conversely, a probability distribution with a sharp peak would reflect a well-ordered system or high-precision, confidence or assuredness (Friston, 2010). In the specific context of the DMN and the psychedelic state, just as there is increased variance in parameters defining the DMN (e.g., coupling between the nodes of the DMN or rhythmic alpha oscillations in the PCC), so there is uncertainty about ones sense of self - typically described as "ego-disintegration." Thus, according to the entropic brain hypothesis, just as normally robust principles about the brain lose definition in primary states, so confidence is lost in "how the world is" and "who one is" as a personality.

In addition to the word "uncertainty," other terms that have been used as synonyms for entropy include: "freedom," "disorder" and "expansion." The example of a gas expanding post release of constraints is often used as a metaphor to help explain what is meant by entropy increasing [e.g., in relation to the second law of thermodynamics (Ben-Naim, 2012)] See **Figure 8**. In the information theoretical sense, entropy/uncertainty increases as the gas expands because with greater expansion, it is more difficult to predict the spatial location of a single molecule. It is probably not coincidental that these physical principles resonate with popular descriptions of the psychedelic experience (Huxley, 1959; Bowers and Freedman, 1966; Masters and Houston, 1972; Grinspoon and Bakalar, 1981; Merkur, 1998). For example, the term "consciousness-expansion" is often used to describe the psychedelic experience - and this may be an inadvertent reference to increased system entropy in the psychedelic state.

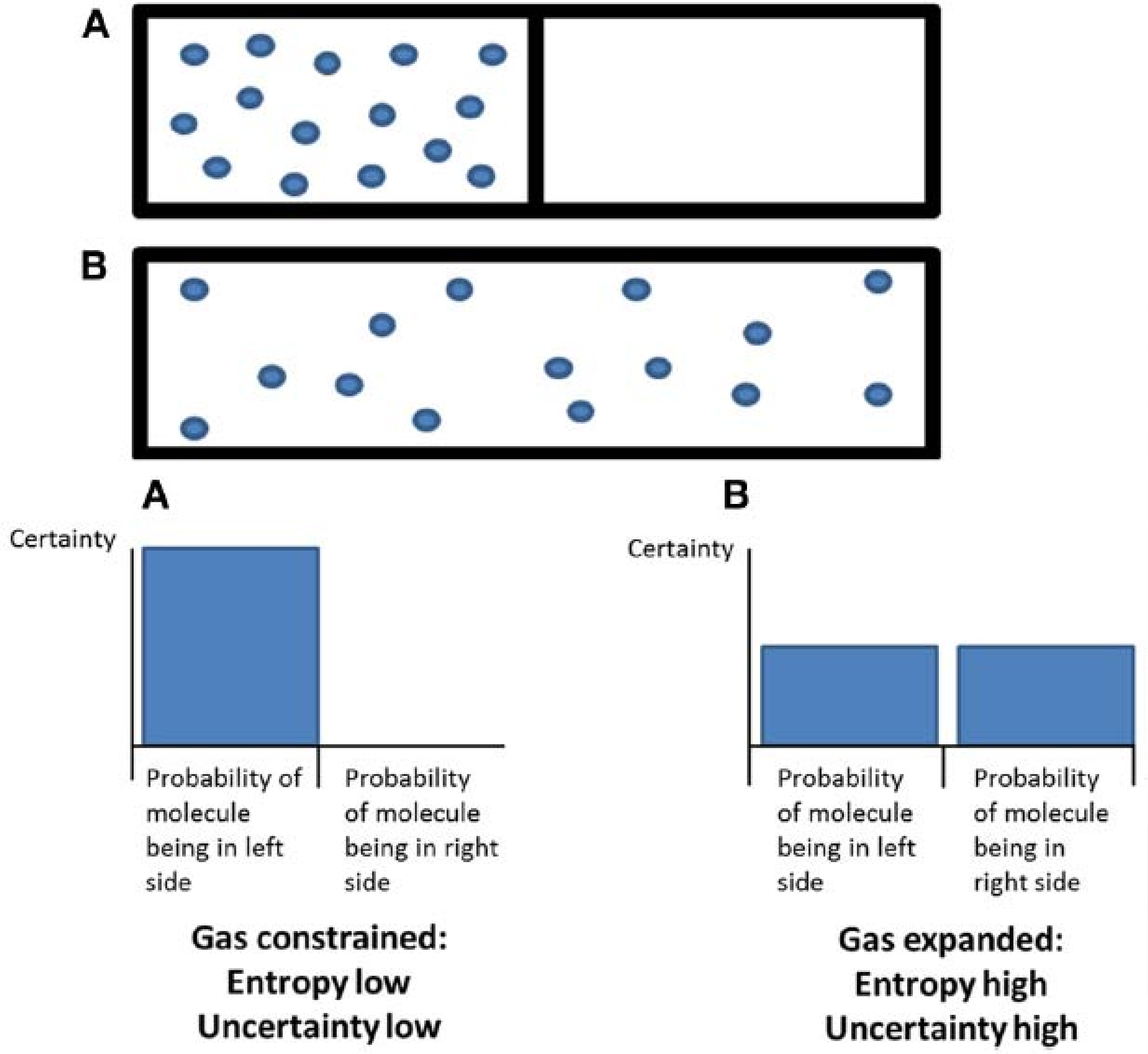

A
B
A
Certainty
Probability of molecule being in left side
Probability of molecule being in right side
Gas constrained:
Entropy low
Uncertainty low
B
Certainty
Probability of molecule being in left side
Probability of molecule being in right side
Gas expanded:
Entropy high
Uncertainty high

FIGURE 8 - Gas expansion post-release of constraints as a metaphor for increased entropy in primary states. (A) Entropy is low while the gas is constrained. **(B)** Entropy increases once constraints are released. In an information theoretical sense, entropy/uncertainty is increased post-expansion because it is more difficult to predict the spatial location of a single molecule. In primary vs. secondary states, it is hypothesized that the biological parameters known to define key brain states (e.g., the default-mode) become more variant or less predictable, thus causing the subject to become less certain in themselves and their experience of the world.

Developing the Construct Validity of Primary Consciousness

To develop the construct validity of primary consciousness, it will be necessary to show that the identified parameters of primary consciousness have high *internal* and *convergent* validity (i.e., properties of primary consciousness must be shown to exist in a range of different primary states) and sufficient *discriminant* validity (i.e., these properties must be shown to be sufficiently *specific* to primary states, i.e., to be absent in non-primary states). To assist this undertaking, it will be important to optimize subjective rating scales designed for assessing primary consciousness. For example, first it will be necessary to identify key experiences that are considered characteristic of primary states (i.e., visual analog scale items such as "my imagination was extremely vivid" or "the experience had a dreamlike quality" that can be rated during or after a candidate primary state) and then it will be important to test whether different candidate primary states (e.g., dreaming, onset-phase psychosis, the near death experience, the sensory-deprived state and the psychedelic drug state) score highly on these items - and that candidate non-primary states (e.g., normal waking consciousness, the anaesthetized or sedated state, and the depressed state) do not. This will enable the convergent and discriminant validity of these measures to be tested and developed. Similarly, by identifying neurobiological characteristics hypothesized to be essential to primary states (e.g., decreased DMN-MTL coupling, disinhibited MTL activity, decreased DMN-TPN anti-correlation, decreased alpha power in the PCC and increased metastability in resting-state networks), it will be important to determine those that most *reliably* and *specifically* identify primary over non-primary states.

As discussed in The research value of psychedelics, psychedelic drugs are especially useful tools for studying primary states as they allow for primary consciousness to be "switched on" with a relatively high degree of experimental control (e.g., with intravenous infusion of a classic psychedelic). Hypotheses about the neurobiological character of primary states can therefore be effectively tested by psychedelic drugs. However, in order to test and develop the generalizability of these hypotheses, research with alternative primary states are required. For example, it would be interesting to carry out simultaneous fMRI-EEG or MEG work with a focus on REM sleep, or to study patients exhibiting early-phase psychotic symptoms with these techniques. Longitudinal analyses looking at brain maturation would also be relevant, where infant consciousness is hypothesized to be reflective of primary consciousness.

Developing the Construct Validity of Secondary Consciousness and the Ego

As outlined above, a key distinction between the primary and secondary modes of cognition is that secondary consciousness pays deference to reality and diligently seeks to represent the world as *precisely* as possible, whereas primary consciousness is less firmly anchored to reality and is easily misled by simple explanations motivated by wishes and fears. One way this distinction could be tested would be to utilize a measure of metacognitive accuracy (Fleming *et al*., 2010). As outlined above, metacognition, and specifically the ability to reflect upon one's own introspection, is a particularly advanced behavior associated with the DMN (Fleming *et al*., 2010). For example, a behavioral paradigm could be designed that requires a participant's friend to rate the participant's personality, e.g., using a standard personality inventory. Then, during scanning, the participant could be asked to predict their friend's ratings - and crucially, to provide an additional confidence rating for their own predictions. This could be done under a psychedelic drug and under placebo in a within-subjects design with 2 different friends for each condition, counterbalanced for key factors (e.g., familiarity, intimacy, fondness, duration of relationship etc). This task would provide a behavioral index of a high-level metacognitive function associated with the ego (theory-of-mind). The hypothesis would be that participants would be *less confident* in their predictions of their friend's ratings post-psilocybin and that the accuracy of their predictions would also be compromised. Biologically, one would hypothesize decreased within-DMN coupling during the prediction process and a reduction in induced alpha-oscillations in the PCC.

Conclusions

This article has argued that scientific research with psychedelic drugs can have a revitalizing effect on psychoanalysis and an informing influence on mainstream psychology and psychiatry. Rather than discuss the content and interpretation of psychoanalytically-relevant material, we have adopted a mechanistic approach, in keeping with the mainstream cognitive neuroscience. This article proposes that a distinction can be made between two fundamentally different modes of cognition: primary and secondary consciousness. Primary consciousness is associated with unconstrained cognition and less ordered (higher-entropy) neurodynamics, whereas secondary consciousness is associated with constrained cognition and more ordered neurodynamics (i.e., that strikes an evolutionarily advantageous balance between order and disorder - that may or more not be perfectly "critical"). It is hoped that this mechanistic model will help catalyze a synthesis between psychoanalytic theory and cognitive neuroscience that can be mutually beneficial to both disciplines.

It is a fair criticism of this paper that it has given insufficient consideration to the phenomenological content of the relevant altered states of consciousness, and to the specifics of Freudian theory, and so by neglecting this, has failed to present a sufficiently compelling case that these states have anything to do with psychoanalytic theory. To some extent, this charge can be conceded; however, as outlined in the introduction, the intention of this paper was to develop a mechanistic account of altered states of consciousness based on the quantity of entropy, and this task has demanded a substantial amount of space. A more thorough discussion of the phenomenology of primary states is required to develop the case that they show characteristics that are consistent with Freudian accounts of "the unconscious" or "Id." The reader should be made aware however, that this has been attempted before (Carhart-Harris, 2007; Carhart-Harris and Friston, 2010).

To conclude, it is perhaps not surprising that with only dreaming and psychosis at its disposal, psychoanalysis has failed to convince the scientific community that the psychoanalytic unconscious exists (Hassin *et al.*, 2005). From a neuroscientific perspective, dreaming and psychosis are notoriously difficult to study. The occurrence of dreaming in sleep impedes experimental control and psychosis is an especially complex and variegated phenomenon. However, for those brave enough to embrace it, research with psychedelics could herald the beginning of a new scientifically informed-psychoanalysis that has the potential to influence modern psychology and psychiatry. The unique scientific value of psychedelics rests in their capacity to make consciously accessible that which is latent in the mind. This paper takes the position that mainstream psychology and psychiatry have underappreciated the depth of the human mind by neglecting schools of thought that posit the existence an unconscious mind. Indeed, psychedelics' greatest value may be as a remedy for ignorance of the unconscious mind.

> "He who would fathom the psyche must not confuse it with consciousness, else he veils from his own sight the object he wishes to explore." (Jung, 1961)
>
> "Man's worst sin is unconsciousness." (Jung, 1969)

Acknowledgments

We would like to thank the reviewers for their useful comments on previous versions of this manuscript. Robin L. Carhart-Harris would also like to acknowledge that Robert Leech coined the term "the entropic brain" when in conversation with him over the topic of his and David Nutt's psilocybin fMRI results. Robin L. Carhart-Harris is currently supported by the Medical Research Council.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Notes

1. Entropy in its purest information theoretical sense is a dimensionless quantity that is used for measuring uncertainty or ignorance about the state of a system. By implication, entropy/uncertainty is greater the more random a system is. Thus, entropy is most strictly a measure of uncertainty but it also reflects the degree of randomness or disorder in a system (Ben-Naim, 2012).
2. The free energy principle is an extension of predictive coding (Dayan *et al.*, 1995) and tries to explain how biological systems, such as the brain, maintain their order by developing inferences and behaviors that serve to minimize surprise and uncertainty. Free-energy is formally related to entropy in the information theoretical sense, where entropy (uncertainty) is the average of free-energy (surprise) (Friston, 2010). See also (Friston *et al.*, 2012a) for a philosophical discussion of free-energy.
3. Self-organized criticality (SOC) is a property of certain systems that gravitate toward a 'critical' point in a transition zone between order and disorder. Critical systems display certain characteristics such as power-law scaling (Bak *et al.*, 1987). SOC is typically observed in slowly driven non-equilibrium systems, with many units that interact in a non-linear fashion (Bak *et al.*, 1987; Jensen, 1998).
4. The ego can be defined as a sensation of possessing an integrated and immutable identity, i.e., "this is me" or "I am like this." It is equivalent therefore with one's sense of self. In psychoanalytical theory however, the ego is also a system which works in concert with and against other processes in the brain to determine the quality of consciousness. It is worth noting that Freud's term for the ego was 'the I' and it was only in the standard translation from German that the term "the ego" became associated with Freud (1927). In everyday (lay) usage, "ego" has become synonymous with exaggerated self-confidence or an inflated ego/sense of self.
5. A fully-developed, adult ego or sense of self.
6. A network of functionally and structurally connected brain regions that show high spontaneous or "on-

going" metabolism yet a relative deactivation during goal-directed cognition (Raichle *et al.*, 2001).

7. Functional connectivity is defined as temporal correlations between spatially distinct neurophysiological events (Karl Friston). Resting-state refers to task-free, unconstrained experimental conditions (typically sitting or lying still with eyes closed).
8. The quality of returning to an earlier state of development.
9. A regressive, pre-ego style of consciousness characterized by unconstrained brain dynamics and cognition. The psychedelic state is an exemplar of primary consciousness and REM sleep and early psychosis are others.
10. A cognitive capacity unique to adult humans and dependent on the formation of a mature ego. Metacognition means "cognition about cognition." Examples include: self-reflection, theory-of-mind and mental time-travel. (Fleming *et al.*, 2012).
11. The term "infancy" is used here in an extended sense to mean the period from birth to two years of age.
12. The earliest humans, i.e., archaic homo-sapiens.
13. The style of consciousness of healthy, adult, modern humans during waking. Secondary consciousness is "constrained" relative to primary consciousness, both in a mechanistic and qualitative sense
14. A style of cognition in which causal relationships between phenomena are assumed despite an absence of supportive scientific evidence. Examples include superstition, and metaphysical beliefs. Crucially, such beliefs usually honor an emotional sentiment such as a wish (or fear) that something is true.

References

1. (1957). PSYCHODYNAMIC and therapeutic aspects of mescaline and lysergic acid diethylamide: round table. *J. Nerv. Ment. Dis.* 125, 423-424. doi: 10.1097/00005053-195707000-00011
2. Abramson, H. A. (1967). *The Use of LSD in Psychotherapy and Alcoholism*. Indianapolis, IN: Bobbs-Merrill.
3. Adelstein, J. S., Shehzad, Z., Mennes, M., Deyoung, C. G., Zuo, X. N., Kelly, C., *et al*. (2011). Personality is reflected in the brain's intrinsic functional architecture. *PLoS ONE* 6:e27633. doi: 10.1371/journal.pone.0027633
4. Aghajanian, G. K., Foote, W. E., and Sheard, M. H. (1968). Lysergic acid diethylamide: sensitive neuronal units in the midbrain raphe. *Science* 161, 706-708. doi: 10.1126/science.161.3842.706
5. Aghajanian, G. K., and Marek, G. J. (1997). Serotonin induces excitatory postsynaptic potentials in apical dendrites of neocortical pyramidal cells. *Neuropharmacology* 36, 589-599. doi: 10.1016/S0028-3908(97)00051-8
6. Aghajanian, G. K., and Vandermaelen, C. P. (1982). Intracellular recordings from serotonergic dorsal raphe neurons: pacemaker potentials and the effect of LSD. *Brain Res.* 238, 463-469. doi: 10.1016/0006-8993(82)90124-X
7. Andrade, K. C., Spoormaker, V. I., Dresler, M., Wehrle, R., Holsboer, F., Samann, P. G., *et al*. (2011). Sleep spindles and hippocampal functional connectivity in human NREM sleep. *J. Neurosci*. 31, 10331-10339. doi: 10.1523/JNEUROSCI.5660-10.2011
8. Andrade, R. (2011). Serotonergic regulation of neuronal excitability in the prefrontal cortex. *Neuropharmacology* 61, 382-386. doi: 10.1016/j.neuropharm.2011.01.015
9. Andrews-Hanna, J. R., Reidler, J. S., Huang, C., and Buckner, R. L. (2010). Evidence for the default network's role in spontaneous cognition. *J. Neurophysiol.* 104, 322-335. doi: 10.1152/jn.00830.2009
10. Axmacher, N., Cohen, M. X., Fell, J., Haupt, S., Dumpelmann, M., Elger, C. E., *et al*. (2010). Intracranial EEG correlates of expectancy and memory formation in the human hippocampus and nucleus accumbens. *Neuron* 65, 541-549. doi: 10.1016/j.neuron.2010.02.006
11. Axmacher, N., Elger, C. E., and Fell, J. (2008). Ripples in the medial temporal lobe are relevant for human memory consolidation. *Brain* 131, 1806-1817. doi: 10.1093/brain/awn103
12. Baars, B. J. (2005). Global workspace theory of consciousness: toward a cognitive neuroscience of human experience. *Prog. Brain Res.* 150, 45-53. doi: 10.1016/S0079-6123(05)50004-9
13. Bak, P., Tang, C., and Wiesenfeld, K. (1987). Self-organized criticality: an explanation of the 1/f noise. *Phys. Rev. Lett.* 59, 381-384. doi: 10.1103/PhysRevLett.59.381
14. Ban, T. A. (2001a). Pharmacotherapy of depression: a historical analysis. *J. Neural Transm.* 108, 707-716. doi: 10.1007/s007020170047
15. Ban, T. A. (2001b). Pharmacotherapy of mental illness-a historical analysis. *Prog. Neuropsychopharmacol. Biol. Psychiatry* 25, 709-727. doi: 10.1016/S0278- 5846(01)00160-9
16. Bartolomei, F., Barbeau, E. J., Nguyen, T., McGonigal, A., Regis, J., Chauvel, P., *et al*. (2012). Rhinal-hippocampal interactions during deja vu. *Clin. Neurophysiol.* 123, 489-495. doi: 10.1016/j.clinph.2011.08.012
17. Basar, E., and Guntekin, B. (2009). Darwin's evolution theory, brain oscillations, and complex brain function in a new "Cartesian view." *Int. J. Psychophysiol.* 71, 2-8. doi: 10.1016/j.ijpsycho.2008.07.018
18. Bassett, D. S., Bullmore, E., Verchinski, B. A., Mattay, V. S., Weinberger, D. R., and Meyer-Lindenberg, A. (2008). Hierarchical organization of human cortical networks in health and schizophrenia. *J. Neurosci.* 28, 9239-9248. doi: 10.1523/JNEUROSCI.1929-08.2008
19. Beggs, J. M., and Plenz, D. (2003). Neuronal avalanches in neocortical circuits. *J. Neurosci*. 23, 11167-11177.
20. Ben-Naim, A. (2008). *A farewell to Entropy: Statistical Thermodynamics Based on Information: S=logW*. London: World Scientific, Hackensack, N.J.
21. Ben-Naim, A. (2012). *Entropy and the Second Law: Interpretation and Misss-Interpretationsss*. New Jersey; London: World

Scientific.
22. Berman, M. G., Peltier, S., Nee, D. E., Kross, E., Deldin, P. J., and Jonides, J. (2011). Depression, rumination and the default network. *Soc. Cogn. Affect. Neurosci.* 6, 548-555. doi: 10.1093/scan/nsq080
23. Bhagwagar, Z., Hinz, R., Taylor, M., Fancy, S., Cowen, P., and Grasby, P. (2006). Increased 5-HT(2A) receptor binding in euthymic, medicationfree patients recovered from depression: a positron emission study with [(11)C]MDL 100,907. *Am. J. Psychiatry* 163, 1580-1587. doi: 10.1176/appi.ajp. 163.9.1580
24. Bowers, M. B. Jr., and Freedman, D. X. (1966). "Psychedelic" experiences in acute psychoses. *Arch. Gen. Psychiatry* 15, 240-248. doi: 10.1001/archpsyc.1966.01730150016003
25. Braga, R. S. D., Leeson, C., Wise, R., and Leech, R. (2013). Echoes of the brain within default mode, association and heteromodal cortices. *J. Neurosci.* 33, 14031-14039. doi: 10.1523/JNEUROSCI.0570-13.2013
26. Brewer, J. A., Worhunsky, P. D., Gray, J. R., Tang, Y. Y., Weber, J., and Kober, H. (2011). Meditation experience is associated with differences in default mode network activity and connectivity. *Proc. Natl. Acad. Sci. U.S.A.* 108, 20254-20259. doi: 10.1073/pnas.1112029108
27. Buckner, R. L., and Carroll, D. C. (2007). Self-projection and the brain. *Trends Cogn. Sci.* 11, 49-57. doi: 10.1016/j.tics.2006.11.004
28. Busch, A. K., and Johnson, W. C. (1950). L.S.D. 25 as an aid in psychotherapy; preliminary report of a new drug. *Dis. Nerv. Syst.* 11, 241-243.
29. Buzsaki, G. (2002). Theta oscillations in the hippocampus. *Neuron* 33, 325-340. doi: 10.1016/S0896-6273(02)00586-X
30. Buzsaki, G., and Draguhn, A. (2004). Neuronal oscillations in cortical networks. *Science* 304, 1926-1929. doi: 10.1126/science.1099745
31. Cahir, M., Ardis, T., Reynolds, G. P., and Cooper, S. J. (2007). Acute and chronic tryptophan depletion differentially regulate central 5-HT_{1A} and 5-HT_{2A} receptor binding in the rat. *Psychopharmacology* 190, 497-506. doi: 10.1007/s00213-006-0635-5
32. Cantero, J. L., Atienza, M., Stickgold, R., Kahana, M. J., Madsen, J. R., and Kocsis, B. (2003). Sleep-dependent theta oscillations in the human hippocampus and neocortex. *J. Neurosci.* 23, 10897-10903.
33. Carhart-Harris, R. (2007). Waves of the unconscious: the neurophysiology of dreamlike phenomena and its implications for the psychodynamic model of the mind. *Neuropsychoanalysis* 9, 183-211. doi: 10.1080/15294145.2007. 10773557
34. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J. M., Reed, L. J., Colasanti, A., *et al*. (2012a). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl. Acad. Sci. U.S.A.* 109, 2138-2143. doi: 10.1073/pnas.1119598109
35. Carhart-Harris, R. L., Leech, R., Erritzoe, D., Williams, T. M., Stone, J. M., Evans, J., *et al*. (2012b). Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. *Schizophr. Bull.* 39, 1343-1351. doi: 10.1093/schbul/sbs117
36. Carhart-Harris, R. L., and Friston, K. J. (2010). The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. *Brain* 133, 1265-1283. doi: 10.1093/brain/awq010
37. Carhart-Harris, R. L., Mayberg, H. S., Malizia, A. L., and Nutt, D. (2008). Mourning and melancholia revisited: correspondences between principles of Freudian metapsychology and empirical findings in neuropsychiatry. *Ann. Gen. Psychiatry* 7, 9. doi: 10.1186/1744-859X-7-9
38. Carhart-Harris, R. L., and Nutt, D. J. (2010). User perceptions of the benefits and harms of hallucinogenic drug use: a web-based questionnaire study. *J. Subst. Use* 15, 283-300. doi: 10.3109/14659890903271624
39. Carhart-Harris, R. L., Williams, T. M., Sessa, B., Tyacke, R. J., Rich, A. S., Feilding, A., *et al*. (2011). The administration of psilocybin to healthy, hallucinogen-experienced volunteers in a mock-functional magnetic resonance imaging environment: a preliminary investigation of tolerability. *J. Psychopharmacol*. 25, 1562-1567. doi: 10.1177/0269881110367445
40. Cattell, J. P. (1954). The influence of mescaline on psychodynamic material. *J. Nerv. Ment. Dis.* 119, 233-244. doi: 10.1097/00005053-195403000-00003
41. Chialvo, D. R., Balenzuela, P., and Fraiman, D. (2007). "The brain: what is critical about it?" in *Collective Dynamics: Topics on Competition and Cooperation in the Biosciences*, eds L.M. Ricciardi, A. Buonocore, and E. Pirozzi (New York, NY: Vietri sul Mare), 28-45.
42. Cohen, S. (1964). *The Beyond Within: The LSD Story*. New York, NY: Atheneum.
43. Cohen, S. (1967). *The Beyond Within: The LSD Story*. New York, NY: Atheneum.
44. Cohen, S. (1972). *Beyond Within: The LSD Story*. New York, NY: Atheneum, SL 1967.
45. Cole, D. M., Beckmann, C. F., Long, C. J., Matthews, P. M., Durcan, M. J., and Beaver, J. D. (2010). Nicotine replacement in abstinent smokers improves cognitive withdrawal symptoms with modulation of resting brain network dynamics. *Neuroimage* 52, 590-599. doi: 10.1016/j.neuroimage.2010.04.251
46. Corbetta, M., Akbudak, E., Conturo, T. E., Snyder, A. Z., Ollinger, J. M., Drury, H. A., *et al*. (1998). A common network of functional areas for attention and eye movements. *Neuron* 21, 761-773. doi: 10.1016/S0896-6273(00)80593-0
47. Costa, P. T. Jr., and McCrae, R. R. (1997). Stability and change in personality assessment: the revised NEO Personality Inventory in the year 2000. *J. Pers. Assess.* 68, 86-94. doi: 10.1207/s15327752jpa6801_7
48. Crocket, R., Sandison, R. A., and Walk, A. (1963). *Hallucinogenic Drugs and Their Psychotherapeutic Use*. New York, NY: H. K. Lewis and Co Ltd SL.
49. Dayan, P., Hinton, G. E., Neal, R. M., and Zemel, R. S. (1995). The helmholtz machine. *Neural Comput.* 7, 889-904. doi: 10.1162/neco.1995.7.5.889
50. de Pasquale, F., Della Penna, S., Snyder, A. Z., Marzetti, L., Pizzella, V., Romani, G. L., *et al*. (2012). A cortical core for dynamic integration of functional networks in the resting human brain. *Neuron* 74, 753-764. doi: 10.1016/j.neuron.2012.03.031
51. Deakin, J. F., Lees, J., McKie, S., Hallak, J. E., Williams, S. R., and Dursun, S. M. (2008). Glutamate and the neural basis of the subjective effects of ketamine: a pharmaco-magnetic resonance imaging study. *Arch. Gen. Psychiatry* 65, 154-164. doi: 10.1001/archgenpsychiatry.2007.37
52. Deco, G., and Corbetta, M. (2011). The dynamical balance of the brain at rest. *Neuroscientist* 17, 107-123. doi:

10.1177/1073858409354384

53. Deco, G., and Jirsa, V. K. (2012). Ongoing cortical activity at rest: criticality, multistability, and ghost attractors. *J. Neurosci.* 32, 3366-3375. doi: 10.1523/JNEUROSCI.2523-11.2012
54. Denber, H. C. (1958). Studies on mescaline. VIII. Psychodynamic observations. *Am. J. Psychiatry* 115, 239-244.
55. Doblin, R. (1991). Pahnke good-friday experiment - a long-term follow-up and methodological critique. *J. Transpers. Psychol.* 23, 1-28.
56. Dyck, E. (2005). Flashback: psychiatric experimentation with LSD in historical perspective. *Can. J. Psychiatry* 50, 381-388.
57. Dykman, B. M., Abramson, L. Y., Alloy, L. B., and Hartlage, S. (1989). Processing of ambiguous and unambiguous feedback by depressed and nondepressed college students: schematic biases and their implications for depressive realism. *J. Pers. Soc. Psychol.* 56, 431-445. doi: 10.1037/0022-3514.56.3.431
58. Edelman, G. M. (2004). *Wider Than the Sky: The Phenomenal Gift of Consciousness*. New Haven, CT: Yale University Press.
59. Erritzoe, D., Frokjaer, V. G., Haugbol, S., Marner, L., Svarer, C., Holst, K., *et al*. (2009). Brain serotonin 2A receptor binding: relations to body mass index, tobacco and alcohol use. *Neuroimage* 46, 23-30. doi: 10.1016/j.neuroimage.2009.01.050
60. Eysenck, H. J. (1973). *Uses and Abuses of Psychology*. London: Penguin.
61. Fair, D. A., Cohen, A. L., Dosenbach, N. U., Church, J. A., Miezin, F. M., Barch, D. M., *et al*. (2008). The maturing architecture of the brain's default network. *Proc. Natl. Acad. Sci. U.S.A.* 105, 4028-4032. doi: 10.1073/pnas.0800376105
62. Farb, N. A., Anderson, A. K., Bloch, R. T., and Segal, Z. V. (2011). Moodlinked responses in medial prefrontal cortex predict relapse in patients with recurrent unipolar depression. *Biol. Psychiatry* 70, 366-372. doi: 10.1016/j.biopsych.2011.03.009
63. Farb, N. A., Segal, Z. V., Mayberg, H., Bean, J., McKeon, D., Fatima, Z., *et al*. (2007). Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference. *Soc. Cogn. Affect. Neurosci.* 2, 313-322. doi: 10.1093/scan/nsm030
64. Fell, J., Ludowig, E., Staresina, B. P., Wagner, T., Kranz, T., Elger, C. E., *et al*. (2011). Medial temporal theta/alpha power enhancement precedes successful memory encoding: evidence based on intracranial EEG. *J. Neurosci.* 31, 5392-5397. doi: 10.1523/JNEUROSCI.3668-10.2011
65. Fell, J., Staresina, B. P., Do Lam, A. T., Widman, G., Helmstaedter, C., Elger, C. E., *et al*. (2012). Memory modulation by weak synchronous deep brain stimulation: a pilot study. *Brain Stimul.* 6, 270-273. doi: 10.1016/j.brs.2012.08.001
66. Fink, M. (2010). Remembering the lost neuroscience of pharmaco-EEG. *Acta Psychiatr. Scand.* 121, 161-173. doi: 10.1111/j.1600-0447.2009.01467.x
67. Fleming, S. M., Dolan, R. J., and Frith, C. D. (2012). Metacognition: computation, biology and function. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* 367, 1280-1286. doi: 10.1098/rstb.2012.0021
68. Fleming, S. M., Weil, R. S., Nagy, Z., Dolan, R. J., and Rees, G. (2010). Relating introspective accuracy to individual differences in brain structure. *Science* 329, 1541-1543. doi: 10.1126/science.1191883
69. Foster, B. L., and Parvizi, J. (2012). Resting oscillations and cross-frequency coupling in the human posteromedial cortex. *Neuroimage* 60, 384-391. doi: 10.1016/j.neuroimage.2011.12.019
70. Fox, M. D., Corbetta, M., Snyder, A. Z., Vincent, J. L., and Raichle, M. E. (2006). Spontaneous neuronal activity distinguishes human dorsal and ventral attention systems. *Proc. Natl. Acad. Sci. U.S.A.* 103, 10046-10051. doi: 10.1073/pnas.0604187103
71. Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., Van Essen, D. C., and Raichle, M. E. (2005). The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proc. Natl. Acad. Sci. U.S.A.* 102, 9673-9678. doi: 10.1073/pnas.0504136102
72. Frazer, J. G. (1900). *The Golden Bough: A Study in Magic and Religion*. London; New York: Macmillan and Co. The Macmillan Company.
73. Freud, S. (1927). *The Ego and the id*. London: L. and Virginia Woolf at the Hogarth press, The Institute of psycho-analysis.
74. Freud, S. (1930). *Civilization and its Discontents*. London: Hogarth Press
75. Freud, S. (1937). *The Interpretation of Dreams*. London: Allen and Unwin.
76. Freud, S. (1949). *An Outline of Psycho-Analysis*. Hogarth Press, [S.l.].
77. Freud, S., Freud, A., Strachey, A., Strachey, J., and Tyson, A. W. (1957). *On the History of the Psycho-Analytic Movement, Papers on Metapsychology, and Other Works; Translated Under the General Editorship of James Strachey in Collaboration with Anna Freud, Assisted By Alix Strachey And Alan Tyson*. London: Hogarth Press.
78. Freud, S., Strachey, J., Freud, A., Rothgeb, C. L., Richards, A., and Scientific Literature Corporation. (1953). *The Standard Edition of the Complete Psychological Works of Sigmund Freud*. London: Hogarth Press.
79. Friston, K. (2010). The free-energy principle: a unified brain theory? *Nat. Rev. Neurosci.* 11, 127-138. doi: 10.1038/nrn2787
80. Friston, K., Thornton, C., and Clark, A. (2012a). Free-energy minimization and the dark-room problem. *Front. Psychol.* 3:130. doi: 10.3389/fpsyg.2012.00130
81. Friston, K., Breakspear, M., and Deco, G. (2012b). Perception and self-organized instability. *Front. Comput. Neurosci.* 6:44. doi: 10.3389/fncom.2012.00044
82. Froeliger, B., Garland, E. L., Kozink, R. V., Modlin, L. A., Chen, N. K., McClernon, F. J., *et al*. (2012). Meditation-state functional connectivity (msFC): strengthening of the dorsal attention network and beyond. *Evi. Based Complement. Alternat. Med.* 2012, 680407. doi: 10.1155/2012/680407
83. Frokjaer, V. G., Mortensen, E. L., Nielsen, F. A., Haugbol, S., Pinborg, L. H., Adams, K. H., *et al*. (2008). Frontolimbic serotonin 2A receptor binding in healthy subjects is associated with personality risk factors for affective disorder. *Biol. Psychiatry* 63, 569-576. doi: 10.1016/j.biopsych.2007. 07.009
84. Gao, W., Zhu, H., Giovanello, K. S., Smith, J. K., Shen, D., Gilmore, J. H., *et al*. (2009). Evidence on the emergence of the brain's default network from 2-week-old to 2-year-old healthy pediatric subjects. *Proc. Natl. Acad. Sci. U.S.A.* 106, 6790-6795. doi: 10.1073/pnas.0811221106
85. Glennon, R. A., Titeler, M., and McKenney, J. D. (1984). Evidence for 5-HT_2 involvement in the mechanism of action of hallucinogenic agents. *Life Sci.* 35, 2505-2511. doi: 10.1016/0024-3205(84)90436-3
86. Goldapple, K., Segal, Z., Garson, C., Lau, M., Bieling, P., Kennedy, S., *et al*. (2004). Modulation of cortical-limbic pathways in major depression: treatment-specific effects of cognitive behavior therapy. *Arch. Gen. Psychiatry* 61, 34-41. doi: 10.1001/archpsyc.61.1.34

87. Gonzalez-Maeso, J., and Sealfon, S. C. (2009). Agonist-trafficking and hallucinogens. *Curr. Med. Chem.* 16, 1017-1027. doi: 10.2174/092986709787581851
88. Gonzalez-Maeso, J., Weisstaub, N. V., Zhou, M., Chan, P., Ivic, L., Ang, R., *et al*. (2007). Hallucinogens recruit specific cortical 5-HT(2A) receptormediated signaling pathways to affect behavior. *Neuron* 53, 439-452. doi: 10.1016/j.neuron.2007.01.008
89. Greicius, M. D., Flores, B. H., Menon, V., Glover, G. H., Solvason, H. B., Kenna, H., *et al*. (2007). Resting-state functional connectivity in major depression: abnormally increased contributions from subgenual cingulate cortex and thalamus. *Biol. Psychiatry* 62, 429-437. doi: 10.1016/j.biopsych.2006.09.020
90. Greicius, M. D., Krasnow, B., Reiss, A. L., and Menon, V. (2003). Functional connectivity in the resting brain: a network analysis of the default mode hypothesis. *Proc. Natl. Acad. Sci. U.S.A.* 100, 253-258. doi: 10.1073/pnas.0135058100
91. Griffiths, R., Richards, W., Johnson, M., McCann, U., and Jesse, R. (2008). Mysticaltype experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J. Psychopharmacol.* 22, 621-632. doi: 10.1177/0269881108094300
92. Griffiths, R. R., Johnson, M. W., Richards, W. A., Richards, B. D., McCann, U., and Jesse, R. (2011). Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects. *Psychopharmacology* 218, 649-65. doi: 10.1007/s00213-011-2358-5
93. Griffiths, R. R., Richards, W. A., McCann, U., and Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187, 268-283. discussion: 284-292. doi: 10.1007/s00213-006-0457-5
94. Grinspoon, L., and Bakalar, J. B. (1979). *Psychedelic Drugs Reconsidered*. New York, NY: Basic Books.
95. Grinspoon, L., and Bakalar, J. B. (1981). Psychedelic drug therapies - should their use be reconsidered. *Interdiscipl. Sci. Rev.* 6, 191-194.
96. Grob, C. S., Danforth, A. L., Chopra, G. S., Hagerty, M., McKay, C. R., Halberstadt, A. L., *et al*. (2011). Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch. Gen. Psychiatry* 68, 71-78. doi: 10.1001/archgenpsychiatry.2010.116
97. Grof, S. (1980). *LSD Psychotherapy*. Pomona, CA: Hunter House.
98. Grof, S. (1982). Realms of the unconscious - the enchanted frontier - nalimov,Vv. *J. Transpers. Psychol.* 14, 186-188.
99. Guldenmund, P., Vanhaudenhuyse, A., Boly, M., Laureys, S., and Soddu, A. (2012). A default mode of brain function in altered states of consciousness. *Arch. Ital. Biol.* 150, 107-121.
100. Haaga, D. A., and Beck, A. T. (1995). Perspectives on depressive realism: implications for cognitive theory of depression. *Behav. Res. Ther.* 33, 41-48. doi: 10.1016/0005-7967(94)E0016-C
101. Hagmann, P., Cammoun, L., Gigandet, X., Meuli, R., Honey, C. J., Wedeen, V. J., *et al*. (2008). Mapping the structural core of human cerebral cortex. *PLoS Biol.* 6:e159. doi: 10.1371/journal.pbio.0060159
102. Hasenkamp, W., Wilson-Mendenhall, C. D., Duncan, E., and Barsalou, L. W. (2012). Mind wandering and attention during focused meditation: a finegrained temporal analysis of fluctuating cognitive states. *Neuroimage* 59, 750-760. doi: 10.1016/j.neuroimage.2011.07.008
103. Hassin, R. R., Uleman, J. S., and Bargh, J. A. (2005). *The New Unconscious*. Oxford; New York: Oxford University Press.
104. Hausner, M., and Dolezal, V. (1965). Psychodynamics of LSD hallucinations and their bearing on individual psychotherapy. *Act. Nerv. Super.* 7, 308-309.
105. Hintzen, A., and Passie, T. (2010). *The Pharmacology of LSD: A Critical Review*. Oxford: Beckley Foundation Press & Oxford University Press.
106. Hoekzema, E., Carmona, S., Ramos-Quiroga, J. A., Richarte Fernandez, V., Bosch, R., Soliva, J. C., *et al*. (2013). An independent components and functional connectivity analysis of resting state fMRI data points to neural network dysregulation in adult ADHD. *Hum. Brain Mapp.* doi: 10.1002/hbm.22250. [Epub ahead of print].
107. Hofmann, A. (1980). *LSD: My Problem Child*. NewYork, NY: McGraw-Hill.
108. Holden, C. (1980). Arguments heard for psychedelics probe. *Science* 209, 256-257. doi: 10.1126/science.7384800
109. Holtzheimer, P. E., and Mayberg, H. S. (2011). Stuck in a rut: rethinking depression and its treatment. *Trends Neurosci.* 34, 1-9. doi: 10.1016/j.tins.2010.10.004
110. Hutson, M. (2012). *The 7 Laws of Magical Thinking: How Irrational Beliefs Keep Us Happy, Healthy, and Sane*. New York, NY: Hudson Street Press.
111. Huxley, A. (1954). *The Doors of Perception. On the Author's Sensations Under the Influence of the Drug Mescalin*. London: Chatto and Windus.
112. Huxley, A. (1959). *The Doors of Perception and Heaven and Hell*. London: Penguin Books.
113. Huxley, A., Palmer, C., and Horowitz, M. (1977). *Moksha: Writings on Psychedelics and the Visionary Experience (1931-1963)*. New York, NY: Stonehill.
114. James, W. (1968). *The Varieties of Religious Experience: A Study in Human Nature*. New York, NY: Collins.
115. Jann, K., Dierks, T., Boesch, C., Kottlow, M., Strik, W., and Koenig, T. (2009). BOLD correlates of EEG alpha phase-locking and the fMRI default mode network. *Neuroimage* 45, 903-916. doi: 10.1016/j.neuroimage.2009.01.001
116. Jensen, H. J. (1998). *Self-Organized Criticality: Emergent Complex Behavior in Physical and Biological Systems*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511622717
117. Jensen, O., and Colgin, L. L. (2007). Cross-frequency coupling between neuronal oscillations. *Trends Cogn. Sci.* 11, 267-9. doi: 10.1016/j.tics.2007.05.003
118. Johnson, M., Richards, W., and Griffiths, R. (2008). Human hallucinogen research: guidelines for safety. *J. Psychopharmacol.* 22, 603-20. doi: 10.1177/0269881108093587
119. Josipovic, Z., Dinstein, I., Weber, J., and Heeger, D. J. (2011). Influence of meditation on anti-correlated networks in the brain. *Front. Hum. Neurosci.* 5:183. doi: 10.3389/fnhum.2011.00183
120. Jung, C. G. (1961). *Modern Man in Search of a Soul*. London: Routledge and Kegan Paul.
121. Jung, C. G. (1969). *The Archetypes and the Collective Unconscious*. New York, NY: Routledge and Kegan Paul.
122. Jung, C. G. (1982a). *Dreams*. London: Routledge and Kegan Paul.

123. Jung, C. G. (1982b). *Psychology and the Occult*. London: Routledge and Kegan Paul.
124. Kahn, I., Andrews-Hanna, J. R., Vincent, J. L., Snyder, A. Z., and Buckner, R. L. (2008). Distinct cortical anatomy linked to subregions of the medial temporal lobe revealed by intrinsic functional connectivity. *J. Neurophysiol.* 100, 129-139. doi: 10.1152/jn.00077.2008
125. Kandel, E. R. (1999). Biology and the future of psychoanalysis: a new intellectual framework for psychiatry revisited. *Am. J. Psychiatry* 156, 505-524
126. Kelly, A. M., Uddin, L. Q., Biswal, B. B., Castellanos, F. X., and Milham, M. P. (2008). Competition between functional brain networks mediates behavioral variability. *Neuroimage* 39, 527-537. doi: 10.1016/j.neuroimage.2007.08.008
127. Kennedy, S. H., Konarski, J. Z., Segal, Z. V., Lau, M. A., Bieling, P. J., McIntyre, R. S., *et al*. (2007). Differences in brain glucose metabolism between responders to CBT and venlafaxine in a 16-week randomized controlled trial. *Am. J. Psychiatry* 164, 778-88. doi: 10.1176/appi.ajp.164.5.778
128. Keup, W. E. (1970). *Origin and mechanisms of hallucinations*, Plenum., [S.l.],. doi: 10.1007/978-1-4615-8645-6
129. Klimesch, W., Fellinger, R., and Freunberger, R. (2011). Alpha oscillations and early stages of visual encoding. *Front. Psychol.* 2:118. doi: 10.3389/fpsyg.2011.00118
130. Knyazev, G. G., Slobodskoj-Plusnin, J. Y., Bocharov, A. V., and Pylkova, L. V. (2011). The default mode network and EEG alpha oscillations: an independent component analysis. *Brain Res.* 1402, 67-79. doi: 10.1016/j.brainres.2011. 05.052
131. Kometer, M., Schmidt, A., Bachmann, R., Studerus, E., Seifritz, E., and Vollenweider, F. X. (2012). Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol. Psychiatry* 72, 898-906. doi: 10.1016/j.biopsych.2012.04.005
132. Krebs, T. S., and Johansen, P. O. (2012). Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. *J. Psychopharmacol.* 26, 994-1002. doi: 10.1177/0269881112439253
133. Laxton, A. W., and Lozano, A. M. (2012). Deep brain stimulation for the treatment of alzheimer disease and dementias. *World Neurosurg.* 80, S28.e1-S28.e8. doi: 10.1016/j.wneu.2012.06.028
134. Laxton, A. W., Sankar, T., Lozano, A. M., and Hamani, C. (2012). Deep brain stimulation effects on memory. *J. Neurosurg. Sci.* 56, 341-344.
135. Laxton, A. W., Tang-Wai, D. F., McAndrews, M. P., Zumsteg, D., Wennberg, R., Keren, R., *et al*. (2010). A phase I trial of deep brain stimulation of memory circuits in Alzheimer's disease. *Ann. Neurol.* 68, 521-534. doi: 10.1002/ana.22089
136. Lee, M. A., and Shlain, B. (1985). Acid Dreams: The Complete Social History of LSD. The CIA, the Sixties and Beyond. London: Pan.
137. Leech, R., Braga, R., and Sharp, D. J. (2012). Echoes of the brain within the posterior cingulate cortex. *J. Neurosci.* 32, 215-222. doi: 10.1523/JNEUROSCI.3689- 11.2012
138. Lemogne, C., Delaveau, P., Freton, M., Guionnet, S., and Fossati, P. (2012). Medial prefrontal cortex and the self in major depression. *J. Affect. Disord.* 136, e1-e11. doi: 10.1016/j.jad.2010.11.034
139. Lorincz, M. L., Kekesi, K. A., Juhasz, G., Crunelli, V., and Hughes, S. W. (2009). Temporal framing of thalamic relay-mode firing by phasic inhibition during the alpha rhythm. *Neuron* 63, 683-696. doi: 10.1016/j.neuron.2009.08.012
140. Lyvers, M., and Meester, M. (2012). Illicit use of LSD or psilocybin, but not MDMA or nonpsychedelic drugs, is associated with mystical experiences in a dose-dependent manner. *J. Psychoact. Drugs* 44, 410-417. doi: 10.1080/02791072.2012.736842
141. MacLean, K. A., Johnson, M. W., and Griffiths, R. R. (2011). Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J. Psychopharmacol.* 25, 1453-1461. doi: 10.1177/0269881111420188
142. Mangini, M. (1998). Treatment of alcoholism using psychedelic drugs: a review of the program of research. *J. Psychoact. Drugs* 30, 381-418. doi: 10.1080/02791072.1998.10399714
143. Martin, V. C., Schacter, D. L., Corballis, M. C., and Addis, D. R. (2011). A role for the hippocampus in encoding simulations of future events. *Proc. Natl. Acad. Sci. U.S.A.* 108, 13858-13863. doi: 10.1073/pnas.1105816108
144. Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., and Macrae, C. N. (2007). Wandering minds: the default network and stimulusindependent thought. *Science* 315, 393-395. doi: 10.1126/science.1131295
145. Masters, R., and Houston, J. (1972). *Varieties of Psychedelic Experience*. New York, NY: Holt, Rinehart and Winston.
146. Masters, R. E. L., and Houston, J. (1966). *Varieties of Psychedelic Experience*. s.n. (New York, NY).
147. Mayberg, H. S., Lozano, A. M., Voon, V., McNeely, H. E., Seminowicz, D., Hamani, C., *et al*. (2005). Deep brain stimulation for treatment-resistant depression. *Neuron* 45, 651-660. doi: 10.1016/j.neuron.2005.02.014
148. McCrae, R. R., and Costa, P. T. Jr. (1997). Personality trait structure as a human universal. *Am. Psychol.* 52, 509-516. doi: 10.1037/0003-066X.52.5.509
149. McGlothlin, W. H., and Arnold, D. O. (1971). LSD revisited. A ten-year followup of medical LSD use. *Arch. Gen. Psychiatry* 24, 35-49. doi: 10.1001/archpsyc.1971.01750070037005
150. McKenna, T. (1992). *Food of the Gods: Search for the Original Tree of Knowledge - A Radical History of Plants, Drugs and Human Evolution*. New York, NY: Rider
151. Merkur, D. (1998). *The Ecstatic Imagination: Psychedelic Experiences and the Psychoanalysis of Self-Actualization*. Albany, NY: State University of New York Press.
152. Meyer, J. H., McMain, S., Kennedy, S. H., Korman, L., Brown, G. M., DaSilva, J. N., *et al*. (2003). Dysfunctional attitudes and 5-HT_2 receptors during depression and self-harm. *Am. J. Psychiatry* 160, 90-99. doi: 10.1176/appi.ajp.160.1.90
153. Monroe, R. R., and Heath, R. G. (1961). Effects of lysergic acid and various derivatives on depth and cortical electrograms. *J. Neuropsychiatr.* 3, 75-82.
154. Monroe, R. R., Heath, R. G., Mickle, W. A., and Llewellyn, R. C. (1957). Correlation of rhinencephalic electrograms with behavior; a study on humans under the influence of LSD and mescaline. *Electroencephalogr. Clin. Neurophysiol.* 9, 623-642. doi: 10.1016/0013-4694(57)90084-6
155. Moreno, F. A., Wiegand, C. B., Taitano, E. K., and Delgado, P. L. (2006). Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J. Clin. Psychiatry* 67, 1735-1740. doi: 10.4088/JCP.v67n1110
156. Morgan, C. J., Muetzelfeldt, L., Muetzelfeldt, M., Nutt, D. J., and Curran, H. V. (2010). Harms associated with psychoactive substances: findings of the UK National Drug Survey. *J. Psychopharmacol.* 24, 147-153. doi: 10.1177/0269881109106915

157. Muthukumaraswamy, S. D., Carhart-Harris, R. L., Moran, R. J., Brookes, M. J., Williams, T. M., Errtizoe, D., *et al*. (2013). Broadband cortical desynchronization underlies the human psychedelic state. *J. Neurosci*. 33, 15171-15183. doi: 10.1523/JNEUROSCI.2063-13.2013
158. Neisser, U. (1967). *Cognitive Psychology*. New York, NY: Appleton-Century-Crofts.
159. Nichols, D. E. (2004). Hallucinogens. *Pharmacol. Ther*. 101, 131-181. doi: 10.1016/j.pharmthera.2003.11.002
160. Nutt, D. J., King, L. A., and Nichols, D. E. (2013). Effects of Schedule I drug laws on neuroscience research and treatment innovation. *Nat. Rev. Neurosci*. 14, 577-585. doi: 10.1038/nrn3530
161. Ogilvie, R. D., Hunt, H. T., Tyson, P. D., Lucescu, M. L., and Jeakins, D. B. (1982). Lucid dreaming and alpha activity: a preliminary report. *Percept. Mot. Skills* 55, 795-808. doi: 10.2466/pms.1982.55.3.795
162. Panksepp, J., and Solms, M. (2012). What is neuropsychoanalysis? Clinically relevant studies of the minded brain. *Trends Cogn. Sci*. 16, 6-8. doi: 10.1016/j.tics.2011.11.005
163. Parvizi, J., Van Hoesen, G. W., Buckwalter, J., and Damasio, A. (2006). Neural connections of the posteromedial cortex in the macaque. *Proc. Natl. Acad. Sci. U.S.A*. 103, 1563-1568. doi: 10.1073/pnas.0507729103
164. Pazos, A., Probst, A., and Palacios, J. M. (1987). Serotonin receptors in the human brain-IV. Autoradiographic mapping of serotonin-2 receptors. *Neuroscience* 21, 123-139. doi: 10.1016/0306-4522(87)90327-7
165. Pfefferbaum, A., Chanraud, S., Pitel, A. L., Muller-Oehring, E., Shankaranarayanan, A., Alsop, D. C., *et al*. (2011). Cerebral blood flow in posterior cortical nodes of the default mode network decreases with task engagement but remains higher than in most brain regions. *Cereb. Cortex* 21, 233-244. doi: 10.1093/cercor/bhq090
166. Priesemann, V., Valderrama, M., Wibral, M., and Le Van Quyen, M. (2013). Neuronal avalanches differ from wakefulness to deep sleep-evidence from intracranial depth recordings in humans. *PLoS Comput. Biol*. 9:e1002985. doi: 10.1371/journal.pcbi.1002985
167. Qin, P., and Northoff, G. (2011). How is our self related to midline regions and the default-mode network? *Neuroimage* 57, 1221-1233. doi: 10.1016/j.neuroimage.2011.05.028
168. Rabinovich, M., Volkovskii, A., Lecanda, P., Huerta, R., Abarbanel, H. D., and Laurent, G. (2001). Dynamical encoding by networks of competing neuron groups: winnerless competition. *Phys. Rev. Lett*. 87, 068102. doi: 10.1103/PhysRevLett.87.068102
169. Raichle, M. E. (2006). Neuroscience. The brain's dark energy. *Science* 314, 1249-1250. doi: 10.1126/science. 1134405
170. Raichle, M. E. (2010). The brain's dark energy. *Sci. Am*. 302, 44-49. doi: 10.1038/scientificamerican0310-44
171. Raichle, M. E., and Mintun, M. A. (2006). Brain work and brain imaging. *Annu. Rev. Neurosci*. 29, 449-476. doi: 10.1146/annurev.neuro.29.051605.112819
172. Raichle, M. E., and Snyder, A. Z. (2007). A default mode of brain function: a brief history of an evolving idea. *Neuroimage* 37, 1083-1090. discussion: 1097-1099. doi: 10.1016/j.neuroimage.2007.02.041
173. Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., and Shulman, G. L. (2001). A default mode of brain function. *Proc. Natl. Acad. Sci. U.S.A*. 98, 676-682. doi: 10.1073/pnas.98.2.676
174. Ramey, E. R., and O'Doherty, D. S. (1960). *Electrical Studies on the Unanesthetized Brain*. New York, NY: AFCB Press.
175. Rolls, E. T., and Deco, G. (2010). *The Noisy Brain: Stochastic Dynamics as a Principle Of Brain Function. Oxford*: Oxford University Press. doi: 10.1093/acprof:oso/9780199587865.001.0001
176. Rumsey, C. C., and Abbott, L. F. (2004). Equalization of synaptic efficacy by activity- and timing-dependent synaptic plasticity. *J. Neurophysiol*. 91, 2273-2280. doi: 10.1152/jn.00900.2003
177. Salinas, E., and Sejnowski, T. J. (2001). Correlated neuronal activity and the flow of neural information. *Nat. Rev. Neurosci*. 2, 539-5350. doi: 10.1038/35086012
178. Sandison, R. (2001). *A Century of Psychiatry, Psychotherapy And Group Analysis: A Search For Integration*. London: Jessica Kingsley.
179. Sandison, R. A. (1954). Psychological aspects of the LSD treatment of the neuroses. *J. Ment. Sci*. 100, 508-515.
180. Sandison, R. A., and Whitelaw, J. D. (1957). Further studies in the therapeutic value of lysergic acid diethylamide in mental illness. *J. Ment. Sci*. 103, 332-343.
181. Savage, C. (1962). LSD, alcoholism and transcendence. *J. Nerv. Ment*. Dis. 135, 429-435.
182. Schmaal, L., Goudriaan, A. E., Joos, L., Kruse, A. M., Dom, G., van den Brink, W., *et al*. (2013). Modafinil modulates resting-state functional network connectivity and cognitive control in alcohol-dependentpatients. *Biol. Psychiatry* 73, 789-795. doi: 10.1016/j.biopsych.2012.12.025
183. Schultes, R. E. (1980). *Plants of the Gods: Origins of Hallucinogeneic Use*. London: Hutchinson.
184. Schwarz, B. E., Sem-Jacobsen, C. W., and Petersen, M. C. (1956). Effects of mescaline, LSD-25, and adrenochrome on depth electrograms in man. *AMA. Arch. Neurol. Psychiatry* 75, 579-587. doi: 10.1001/archneurpsyc.1956.02330240017002
185. Schwartenbeck, P., Fitzgerald, T., Dolan, R. J., and Friston, K. (2013). Exploration, novelty, surprise, and free energy minimization. *Front. Psychol*. 4:710. doi: 10.3389/fpsyg.2013.00710
186. Sepulcre, J., Sabuncu, M. R., Yeo, T. B., Liu, H., and Johnson, K. A. (2012). Stepwise connectivity of the modal cortex reveals the multimodal organization of the human brain. *J. Neurosci*. 32, 10649-10661. doi: 10.1523/JNEUROSCI.0759- 12.2012
187. Serafetinides, E. A. (1965). The EEG effects of LSD-25 in epileptic patients before and after temporal lobectomy. *Psychopharmacologia* 7, 453-460. doi: 10.1007/BF00402367
188. Shanahan, M. (2010). *Embodiment and the Inner Life: Cognition and Consciousness In The Space Of Possible Minds*. Oxford: Oxford University Press.
189. Shanon, B. (2002). *The Antipodes of the Mind: Charting the Phenomenology of the Ayahuasca Experience*. Oxford: Oxford University Press.
190. Shimamura, A. P. (2000). Toward a cognitive neuroscience of metacognition. *Conscious. Cogn*. 9, 313-323. discussion: 324-326. doi: 10.1006/ccog. 2000.0450
191. Silva, L. R., Amitai, Y., and Connors, B. W. (1991). Intrinsic oscillations of neocortex generated by layer 5 pyramidal neurons. *Science* 251, 432-435. doi: 10.1126/science.1824881
192. Smith, S. M., Fox, P. T., Miller, K. L., Glahn, D. C., Fox, P. M., Mackay, C. E., *et al*. (2009). Correspondence of the brain's

functional architecture during activation and rest. *Proc. Natl. Acad. Sci. U.S.A.* 106, 13040-13045. doi: 10.1073/pnas.0905267106

193. Sporns, O., Chialvo, D. R., Kaiser, M., and Hilgetag, C. C. (2004). Organization, development and function of complex brain networks. *Trends Cogn. Sci.* 8, 418-425. doi: 10.1016/j.tics.2004.07.008
194. Spreng, R. N., and Grady, C. L. (2010). Patterns of brain activity supporting autobiographical memory, prospection, and theory of mind, and their relationship to the default mode network. *J. Cogn. Neurosci.* 22, 1112-1123. doi: 10.1162/jocn.2009.21282
195. Spruston, N. (2008). Pyramidal neurons: dendritic structure and synaptic integration. *Nat. Rev. Neurosci.* 9, 206-221. doi: 10.1038/nrn2286
196. Stace, W. T. (1961). *Mysticism and Philosophy*. London: Macmillan.
197. Studerus, E., Kometer, M., Hasler, F., and Vollenweider, F. X. (2011). Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *J. Psychopharmacol.* 25, 1434-1452. doi: 10.1177/0269881110382466
198. Styron, W. (1992). *Darkness Visible: A Memoir of Madness, Pan.* (New York, NY).
199. Subbotskii, E. V. (2010). *Magic and the Mind: Mechanisms, Functions, and Development of Magical Thinking and Behavior.* New York: NY: Oxford University Press. doi: 10.1093/acprof:oso/9780195393873. 001.0001
200. Sun, W., and Dan, Y. (2009). Layer-specific network oscillation and spatiotemporal receptive field in the visual cortex. *Proc. Natl. Acad. Sci. U.S.A.* 106, 17986-17991. doi: 10.1073/pnas.0903962106
201. Tagliazucchi, E., Balenzuela, P., Fraiman, D., and Chialvo, D. R. (2012). Criticality in large-scale brain FMRI dynamics unveiled by a novel point process analysis. *Front. Physiol.* 3:15. doi: 10.3389/fphys.2012.00015
202. Tononi, G. (2010). Information integration: its relevance to brain function and consciousness. *Arch. Ital. Biol.* 148, 299-322. doi: 10.4449/aib.v149i5.1388
203. Tononi, G., Sporns, O., and Edelman, G. M. (1994). A measure for brain complexity: relating functional segregation and integration in the nervous system. *Proc. Natl. Acad. Sci. U.S.A.* 91, 5033-5037. doi: 10.1073/pnas.91. 11.5033
204. Torda, C. (1969). LSD users. Character structure and psychodynamic processes. *N.Y. St. J. Med.* 69, 2243-2247.
205. Trulson, M. E., and Jacobs, B. L. (1979). Raphe unit activity in freely moving cats: correlation with level of behavioral arousal. *Brain Res.* 163, 135-150. doi: 10.1016/0006-8993(79)90157-4
206. Tognoli, E., and Kelso, J. A. (2014). The metastable brain. *Neuron* 81, 35-48. doi: 10.1016/j.neuron.2013.12.022
207. van Amsterdam, J., Opperhuizen, A., and van den Brink, W. (2011). Harm potential of magic mushroom use: a review. *Regul. Toxicol. Pharmacol.* 59, 423-429. doi: 10.1016/j.yrtph.2011.01.006
208. van den Heuvel, M. P., Kahn, R. S., Goni, J., and Sporns, O. (2012). High-cost, highcapacity backbone for global brain communication. *Proc. Natl. Acad. Sci. U.S.A.* 109, 11372-1137. doi: 10.1073/pnas.1203593109
209. Van Essen, D. C., and Dierker, D. L. (2007). Surface-based and probabilistic atlases of primate cerebral cortex. *Neuron* 56, 209-225. doi: 10.1016/j.neuron.2007.10.015
210. van Wel, J. H., Kuypers, K. P., Theunissen, E. L., Bosker, W. M., Bakker, K., and Ramaekers, J. G. (2012). Effects of acute MDMA intoxication on mood and impulsivity: role of the 5-HT_2 and 5-HT1 receptors. *PLoS ONE* 7:e40187. doi: 10.1371/journal.pone.0040187
211. Vanhaudenhuyse, A., Demertzi, A., Schabus, M., Noirhomme, Q., Bredart, S., Boly, M., *et al*. (2011). Two distinct neuronal networks mediate the awareness of environment and of self. *J. Cogn. Neurosci.* 23, 570-578. doi: 10.1162/jocn.2010.21488
212. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F., Babler, A., Vogel, H., and Hell, D. (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9, 3897-3902. doi: 10.1097/00001756-199812010-00024
213. Waddington, C. H. (1974). A catastrophe theory of evolution. *Ann. N.Y. Acad. Sci.* 231, 32-42. doi: 10.1111/j.1749-6632.1974.tb20551.x
214. Weber, E. T., and Andrade, R. (2010). Htr2a Gene and 5-HT(2A) Receptor expression in the cerebral cortex studied using genetically modified mice. *Front. Neurosci.* 4:36. doi: 10.3389/fnins.2010.00036
215. Webster, R. (1995). *Why Freud was Wrong: Sin, Science and Psychoanalysis*. London: HarperCollins.
216. Zeeman, E. C. (1973). Catastrophe theory in brain modelling. *Int. J. Neurosci.* 6, 39-41. doi: 10.3109/00207457309147186
217. Zhou, J., Greicius, M. D., Gennatas, E. D., Growdon, M. E., Jang, J. Y., Rabinovici, G. D., *et al*. (2010). Divergent network connectivity changes in behavioural variant frontotemporal dementia and Alzheimer's disease. *Brain* 133, 1352-1367. doi: 10.1093/brain/awq075
218. Zou, Q., Wu, C. W., Stein, E. A., Zang, Y., and Yang, Y. (2009). Static and dynamic characteristics of cerebral blood flow during the resting state. *Neuroimage* 48, 515-524. doi: 10.1016/j.neuroimage.2009.07.006

The entropic brain - Revisited

by

Robin L. Carhart-Harris

Neuropharmacology (2018), doi: 10.1016/j.neuropharm.2018.03.010.

Psychedelic Research Group, Neuropsychopharmacology Unit, Imperial College London, London, United Kingdom

Received: 9 January 2018. Received in revised form: 15 February 2018. Accepted: 12 March 2018.

© Robin L. Carhart-Harris

original source: https://kalejdoskopet.blog/wp-content/uploads/2018/12/entropic_brain_revisited.pdf
backup source: http://www.psilosophy.info/resources/entropic_brain_revisited.pdf

E-mail address: r.carhart-harris [@] imperial.ac.uk.

Table of Contents:

Abstract
1. Introduction
2. An update on neuroimaging studies with psychedelics
3. The functional meaning of 'increased brain entropy'?
4. How might we better test the entropic brain theory?
4.1. Specific challenges
4.2. Proposed solutions
5. Do psychedelics facilitate emotional insight, and if so, how?
6. Can psychedelic-induced consciousness-enrichment be used to treat disorders of consciousness?
7. Criticality
8. Serotonin and the entropic brain
9. Discussion
10. Conclusions
Acknowledgements
References

Abstract

The entropic brain hypothesis proposes that within upper and lower limits, after which consciousness may be lost, the entropy of spontaneous brain activity indexes the informational richness of conscious states. Here the hypothesis is revisited four years on from its original publication. It is shown that the principle that the entropy of brain activity is elevated in the psychedelic state is increasingly well supported by separate and independent studies and analyses, and evidence for greater brain criticality under psychedelics is also highlighted. It is argued that heightened brain criticality enables the brain to be more sensitive to intrinsic and extrinsic perturbations which may translate as a heightened susceptibility to "set" and "setting". This updated version of the original entropic brain hypothesis now offers more concrete information on specific measures of brain entropy and suggests new studies to scrutinise it further, as well as examine its utility for describing and informing the treatment of psychiatric and neurological conditions such as depression and disorders of consciousness.

Keywords: Psychedelics, Serotonin, Criticality, 5-HT$_{2A}$, Depression, Entropy.

1. Introduction

This review aims to revisit and update a previous theory of conscious states, namely the 'entropic brain' hypothesis (Carhart-Harris *et al.*, 2014). The entropic brain proposes that the 'qualia' or subjective quality of any given conscious state, and specifically the 'richness' of its content, can be indexed by a quantitative measure of the magnitude of entropy (in the information theoretic sense) in a given parameter of spontaneous brain activity, such as oscillations in electrical potentials recorded with EEG or MEG. The hypothesis was, and is, heavily influenced by basic principles of information theory and more specifically, the notion that entropy indexes simultaneously both our uncertainty about the future behaviour of a dynamic system and its information content - such that greater entropy equals greater uncertainty and information-content. Thus, the entropic brain maintains that uncertainty and information-content are near equivalents and that entropic-brain-states are experienced as content-rich but unpredictable and uncertain. The theory lends heavily from research with 'classic' psychedelic[1] compounds, which have been shown to robustly and reliably increase brain entropy within the 'psychedelic state'.

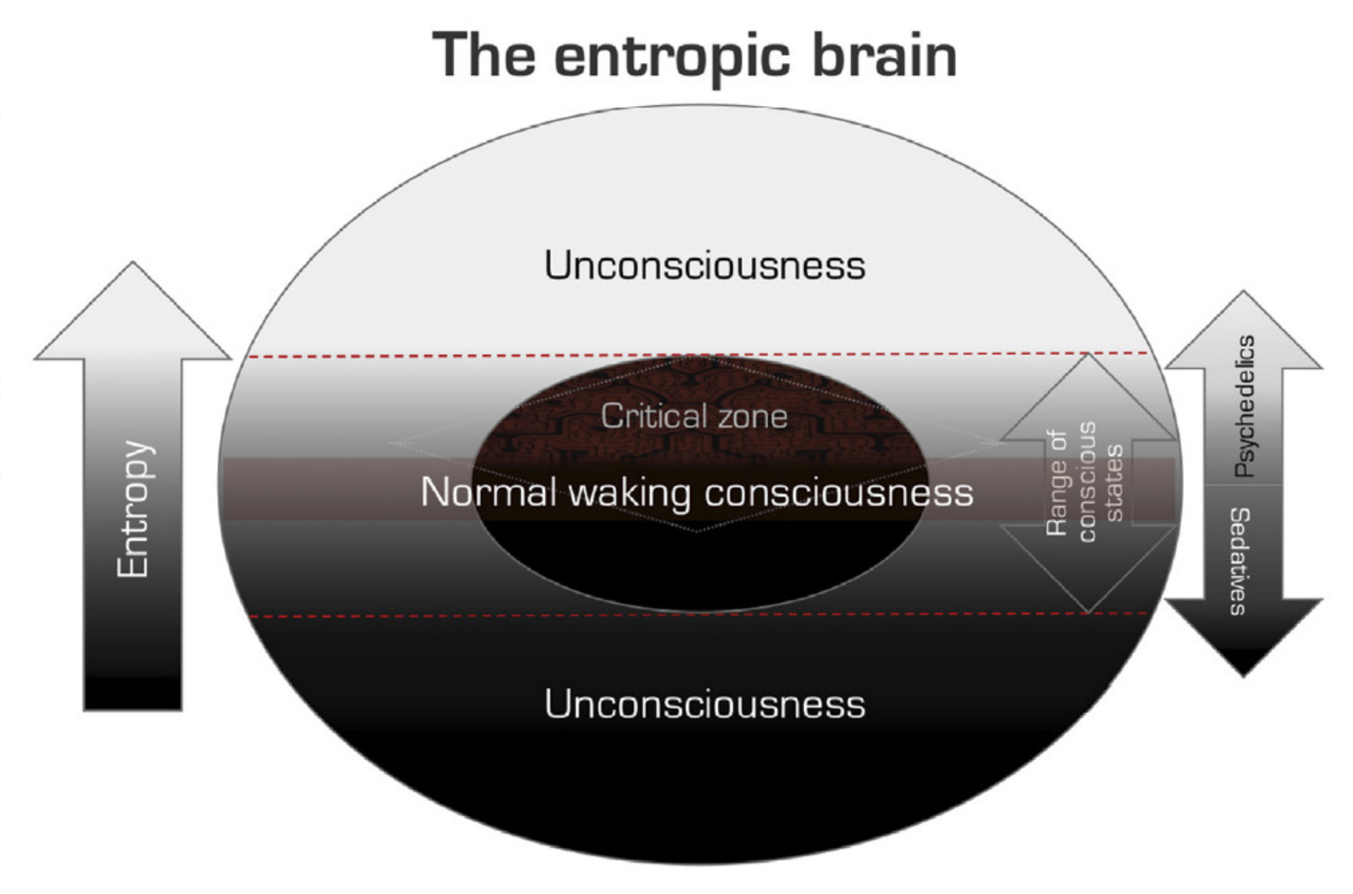


Fig. 1. The entropic brain. Consciousness is proposed to arise within a critical zone at which the entropy or complexity of brain activity is neither too ordered nor disordered. Normal waking consciousness is proposed to inhabit a band within this zone, albeit towards its upper end. Psychedelic compounds are proposed to shift brain entropy and conscious content upwards, higher within the zone of criticality, towards greater conscious content, flexibility of mind and emotional lability but with a trade-off on the preservation of assumptions or beliefs and the sense of familiarity and assuredness they confer. Brain entropy (and criticality) may reach an upper limit at which consciousness is effectively lost - perhaps because phenomenal experience cannot be preserved beyond this point and thus, remembered. Sedatives and anaesthetics shift the brain downwards, i.e. into a subcritical zone and eventual unconsciousness, through loss of content and phenomenal experience. N.B. This figure is intended to be a working schematic; no hard claims are made about the relative scale or dimensions of each domain.

The great merit of applying the measure of entropy in cognitive neuroscience is that it is uniquely adept at bridging the physical and subjective divide; mere flip sides of the same coin - but different sides nonetheless.[2] Since publication of the initial entropic brain paper in 2014 (Carhart-Harris *et al.*, 2014), a number of new functional brain imaging studies with psychedelics have been published (Alonso *et al.*, 2015; Atasoy *et al.*, 2017; Barrett *et al.*, 2017; Bouso *et al.*, 2015; Carhart-Harris *et al.*, 2016b, 2017c; Kaelen *et al.*, 2016; Kraehenmann *et al.*, 2015, 2016; Lebedev *et al.*, 2015, 2016; Mueller *et al.*, 2017; Muller *et al.*, 2017; Palhano-Fontes *et al.*, 2015; Petri *et al.*, 2014; Preller *et al.*, 2016, 2017; Roseman *et al.*, 2014, 2016, 2017; Sampedro *et al.*, 2017; Sanches *et al.*, 2016; Schartner *et al.*, 2017; Schenberg *et al.*, 2015; Schmidt *et al.*, 2017; Speth *et al.*, 2016; Tagliazucchi *et al.*, 2014, 2016b; Timmermann *et al.*, 2017; Valle *et al.*, 2016a; Viol *et al.*, 2017). These, plus time, reflection, and the publication of new imaging studies on other altered states e.g. (Schartner *et al.*, 2015) plus new research on serotonin function (e.g. (Matias *et al.*, 2017), have motivated the present revision.

Key components of this revision include: 1) a more explicit statement that the qualia of time-averaged conscious states can be predicted by brain entropy, 2) reference to specific measures of entropy thought to meaningfully index the qualia of conscious states, 3) a specific example of an important empirical, therapeutically relevant question that may be tackled by the hypothesis, 4) a specific example of a clinical problem (namely disorders of consciousness) where the hypothesis may inspire a novel intervention, 5) new data and thoughts on properties of brain criticality in the psychedelic state, 6) how heightened brain criticality confers maximal sensitivity to perturbation via intrinsic or extrinsic sources ("set" and "setting), 7) how there may be an upper bound to the entropic brain principle beyond which unconsciousness occurs (Fig. 1), and 8) how recent findings on brain serotonin encoding behavioural responses to uncertainty mesh well with the entropic brain hypothesis.

2. An update on neuroimaging studies with psychedelics

According to a PubMed search at the time of submission (January 2018), since the 2014 publication of the original entropic brain paper, there have been over 30 new empirical neuroimaging papers published on the effects of psychedelics on the human brain. Since there are relatively few human neuroimaging teams working with these compounds, it is relatively easy to locate where these have come from, namely: Spain (Alonso *et al.*, 2015; Bouso *et al.*, 2015; McKenna and Riba, 2017; Sanches *et al.*, 2016; Valle *et al.*, 2016b), Switzerland (Barrett *et al.*, 2017; Kraehenmann *et al.*, 2015, 2016; Mueller *et al.*, 2017; Muller *et al.*, 2017; Preller *et al.*, 2016, 2017; Schmidt *et al.*, 2017), Brazil (Palhano-Fontes *et al.*, 2015; Schenberg *et al.*, 2015; Viol *et al.*, 2017), and the UK (Atasoy *et al.*, 2017; Carhart-Harris *et al.*, 2016b, 2017c; Kaelen *et al.*, 2016; Lebedev *et al.*, 2015, 2016; Petri *et al.*, 2014; Roseman *et al.*, 2014, 2016, 2017; Schartner *et al.*, 2017; Speth *et al.*, 2016; Tagliazucchi *et al.*, 2016b; Timmermann *et al.*, 2017). One aspect of the present task is to digest these recent contributions and summarise what they have added to our understanding of the human brain effects of psychedelics. Given the focus of the present paper, this will be done with specific reference to the entropic brain hypothesis.

The first thing to note is that the theory has received significant empirical support since its introduction in 2014 (Atasoy *et al.*, 2017; Lebedev *et al.*, 2016; Schartner *et al.*, 2017; Tagliazucchi *et al.*, 2014; Viol *et al.*, 2017). For example, analyses of Lempel-Ziv complexity or entropy (in the extended sense) in MEG-measured spontaneous brain activity under a range of psychedelic (i.e. LSD and psilocybin) and psychedelic-like (i.e. ketamine) drugs revealed consistently increased brain entropy in the psychedelic state (Schartner *et al.*, 2017). Moreover, the magnitude of these increases in entropy correlated with the subjective intensity of the drug 'trips' (Schartner *et al.*, 2017). It was also found that fMRI-measured brain entropy was elevated acutely under LSD and that the magnitude of this, predicted subsequent changes in personality two weeks later (Lebedev *et al.*, 2016). In terms of outside replication, a separate team recently reported increased fMRI-measured brain entropy under a psychedelic, in this case, with the DMT-containing drink, ayahuasca (Viol *et al.*, 2017); moreover, an especially recent study by my group recorded increased brain entropy under intravenous DMT, using EEG and the Lempel-Ziv measure (Timmermann *et al.*, 2018).

[1] Classic psychedelics are perhaps best defined pharmacologically as drugs that have direct agonist properties at the serotonin 2A receptor subtype (Nichols, 2016). Classic examples include the major tryptamines: LSD, psilocybin and dimethyltryptamine

[2] The philosophical position that mind and brain are two aspects of or 'ways to look at' the same phenomenon, like two sides of the same coin, is known as 'dual-aspect theory' or 'dual-aspect monism'. The position of *the entropic brain* is that 'mind' is fundamentally 'information' but the informational 'code' is physically and dynamically instantiated in brain activity and can therefore be decoded. Ubiquitous contingencies may be key to how, at least theoretically, we may 'decode' brain to mind - but a difference in *aspect* will always exist, no matter how successful the decoding, as this difference is fundamental.

Another notable recent contribution relates to the novel application of connectome harmonics to the psychedelic state (Atasoy *et al.*, 2017). Consistent with the entropic brain hypothesis (Carhart-Harris *et al.*, 2014), as well as previous analyses with fMRI and psilocybin (Tagliazucchi *et al.*, 2014), this approach revealed an expanded repertoire of brain states under LSD, and again, this effect correlated with the intensity of the subjective experience (Atasoy *et al*., 2017). To our knowledge, this is the first time that a property of brain criticality under a psychedelic has been clearly and intentionally measured (here the power law distribution of connectome-harmonic brain states) and the results were intriguing, with an apparent enhancement of criticality under LSD relative to the normal waking state (Atasoy *et al*., 2017). As with findings of increased brain entropy under psychedelics (e.g. Schartner *et al*., 2017), increased brain criticality relative to normal waking consciousness (or indeed any other state of consciousness) is an anomaly in the scientific literature (Atasoy *et al*., 2017), and may therefore speak to the exceptionalness of the psychedelic state, something that is widely recognised by those who have experienced their remarkable subjective effects (Huxley, 1959) - but not so much by the broader cognitive neuroscience community. It would be encouraging to think that these novel neurobiological findings may pique the interest of mainstream 'psychedelic-experience-naive' cognitive neuroscientists in the same way that the remarkable psychological effects and clinical potential of psychedelics have piqued the interest of philosophers (Milliere, 2017; Letheby, 2016), psychologists (Watts *et al*., 2017) and psychiatrists (Carhart-Harris and Goodwin, 2017), regardless of firsthand experience.

3. The functional meaning of 'increased brain entropy'?

The first thing to note is that there is strong evidence that the entropy of spontaneous brain activity is reduced during states of reduced consciousness (Olofsen *et al*., 2008; Schartner *et al*., 2015; Zhang *et al*., 2001; Burioka *et al*., 2005) and that entropy measures can be used to accurately distinguish between waking consciousness, loss of consciousness and even the minimally conscious state (Casali *et al*., 2013; Schartner *et al*., 2015; Zhang *et al*., 2001). In this context, the discovery of a state in which brain entropy is elevated above its already high level at normal waking consciousness is truly noteworthy (Schartner *et al*., 2017). If entropy indexes the 'level of consciousness', does it not follow that higher entropy in the psychedelic state relates to an increase in some quality of consciousness above its (already high) level during the normal awake state? It is important not to romanticise the psychedelic experience here, with mystical-sounding notions of 'expanded-consciousness', but equally, one should not be shy of the result nor its functional implications. Accordingly, it seems entirely reasonable to infer that there is an expansion in some key property of consciousness under psychedelics, while another may be compromised, e.g. analytical and convergent thinking (Carter *et al*., 2005; Kuypers *et al*., 2016).

It is proposed here that, to a critical point, beyond which the ability to preserve phenomenal experience and thus consciously reflect on it may be entirely lost, the property of consciousness that is most reliably indexed by brain entropy and enhanced under psychedelics is its *richness*. Other terms that could refer to the same property might be: 'content', 'complexity' and 'information'. These largely interchangeable terms harmonise well with the nomenclature of the measures themselves. Indeed, this easy mapping between the measures' names and the subjective feeling states they invoke, was, and remains, an inspiration behind the original *entropic brain* idea. It is maintained that this mapping is robust against charges of category conflation as there is actually little extrapolation being done; even in the strictest mathematical sense, *entropy is uncertainty* (Ben-Naim, 2007). The interpretation of entropy as 'information' (in its familiar sense) may depend, in part, on the process of decoding, i.e. that a decoder be able to 'make sense' of the potentially rich information content of a complex, unpredictable phenomenon (Gleick, 2011). As with 'uncertainty', reference to entropy as 'information' (Shannon, 1949), has led to charges of anthropomorphism (Gleick, 2011). In this context, a key challenge for the entropic brain hypothesis is to decipher the complex code instantiated by brain activity in order to may make more specific and compelling mappings to the feeling states they encode.

4. How might we better test the entropic brain theory?

4.1. Specific challenges

Improving our mappings between spontaneous brain and mind phenomena is a major scientific challenge. Doing so will enable us to better characterise and predict properties of different conscious states, and where appropriate, treat psychiatric and neurological disorders. Since it is the spontaneous brain activity underlying conscious states about which we are most interested, our techniques for realising this mapping will benefit most from retaining an intimacy to the original phenomena of interest. By implication, the study of stimulus-evoked transients, including discrete perturbations - such as brain stimulation (Casali *et al*., 2013; Massimini *et al*., 2009) or responses within specific behavioural paradigms, may have relatively limited explanatory potential due to their being detached from the central phenomena of interest, i.e. spontaneous 'states' - naturally unfolding across time. In contrast, improving our methods of sampling spontaneous mind and brain states in situ may yield more relevant insights.

Studying spontaneous processes comes with major challenges however; for example, in contrast to carefully controlled manipulations, experimental control is ceded when we choose to sample spontaneous phenomena in their natural form. A related challenge, perhaps best known in the context of physics, is that in sampling phenomena, we may cause an unintended perturbation and thus confound what inferences can be made on the phenomenon of interest. This is known as 'the observer effect' and more strictly, 'the uncertainty principle', and it is not an easy problem to resolve.

> "*Nature is sensitive to our experiments.*" (Gleick, 2011)

Moreover, in the context of psychedelic research, it has proved apparent that instructing participants to engage in certain behaviours or with certain stimuli tends to suppress the intensity of the basal, 'ongoing' psychedelic state. Another issue is that interpretations of results based on controlled experimental perturbations should carry important caveats - and these are not always stated. More specifically, likely due to a generalised inability to engage with stimuli that are relatively unengaging and/or difficult to focus on when in the throes of an intrinsically stimulating psychedelic 'trip', it is typical for such experiments to yield (arguably uninteresting) negative findings - e.g. see (Muthukumaraswamy *et al*., 2013; Timmermann *et al*., 2017) for relevant discussions. Similar critiques have been made of findings of impaired cognition and brain responsiveness in pathological conditions such as schizophrenia and/or major depressive disorder - since the most plausible (but less exciting) interpretation of such negative findings is that the patient is simply less able and/or willing to engage with tasks and stimuli in question, and thus, the impairment(s) are generalised rather than specific. Caution is therefore advised when choosing to employ conventional behavioural paradigms in the context of acute administration studies with psychedelics, as this may encourage specific inferences to be made on what are in actuality, non-specific negative outcomes.

4.2. Proposed solutions

In the mid 1990s cognitive neuroscientist Francisco Varela conceded that no simple 'theoretical fix' or 'missing ingredient' could magically bridge the ontological divide between brain/ objective and mind/subjective phenomena (Varela, 1996). In conceding this simple but essential point, he was then able to promote a pragmatic approach to the problem. He proposed that it is still very much possible to make meaningful mappings between irreducible 'mind-stuff' and intimately associated 'brain-stuff' - such that translations between them become relatively seamless, and differences, unobvious. In making this point, Varela cited Edmund Husserl's notion of 'fundamental correlation' and he named his approach 'neurophenomenology' (Varela, 1996).

The pragmatism of *neurophenomenology* chimes well with that of *the entropic brain*. However, it is recognised that significant improvements must be made in our sampling of both brain and mind, if more compelling and specific *fundamental correlations* are to be discovered. Moving beyond the supportive findings that have already been cited (Atasoy *et al*., 2017; Lebedev *et al*., 2016; Schartner *et al*., 2017; Tagliazucchi *et al*., 2014;Viol *et al*., 2017), a significant advancement for the entropic brain will be to go beyond the general but important statement that entropy is a (perhaps uniquely) powerful mind-brain bridge, to highlight specific cases where it bridges in a way that other measures do not. To help with this, it is encouraging to note that significant progress is being made in functional neuroimaging to develop more dynamically sensitive measures, such as sliding windows (Nakai *et al*., 2006), point-process (Tagliazucchi *et al*., 2012) and intrinsic ignition (Deco *et al*., 2017; Deco and Kringelbach, 2017) analyses; and with regards to subjective measures, experience sampling (Christoff *et al*., 2009) and so-called 'microphenomenology' (Petitmengin, 2017) hold much promise, particularly if combined with the aforementioned dynamic brain measures.

5. Do psychedelics facilitate emotional insight, and if so, how?

In the interests of encouraging the testing of the entropic brain hypothesis, it may be especially constructive to offer a specific example here of a particular problem felt to be deserving of special attention and about which a potential solution may be proposed.

Thankfully, the true origin and meaning of neologism 'psychedelic' is becoming increasingly well recognised and understood. It dates back to the mid 1950s and an exchange between two Brits (one, the famous author - Aldous Huxley) in which they sought to find a more appropriate term for these compounds (Huxley *et al.*, 1977). The objective was to devise a word that would better capture their core psychological properties than the relatively shallow and arguably misleading alternative 'hallucinogen'. It was Huxley's interlocuter, the psychiatrist and psychedelic research pioneer Humphrey Osmond who would coin the term 'psychedelic' - combining two ancient Greek words for 'mind' or 'soul' (*psyche*, *ψυχή*) and 'to reveal' or make manifest' or 'visible' (delein, δηλειν) - to lay principal emphasis on these compounds' *mind-revealing* effects.

The notion that a principal property of psychedelics is their ability to reveal aspects of the mind that are normally not fully visible, was (Cohen, 1964; Grof, 1979; Sandison, 1954), and remains (Carhart-Harris and Friston, 2010; Kraehenmann *et al.*, 2017a,b; Richards, 2015), widely accepted among those most familiar with their effects, if through direct personal experience, or second or third-hand observation. Remarkably however, that psychedelics do this, remains a mere assumption/hypothesis that has never been systematically measured and tested, and therefore given an opportunity to be verified or falsified.

It seems reasonable to begin by acknowledging that this relatively major oversight may be explainable - if not excusable - by the unreasonable difficulty of conducting human research with psychedelics[3] (Nutt *et al.*, 2013), let alone testing such an abstract and paradigm-challenging idea.[4] Tackling this problem pragmatically however, we may begin by deconstructing it into simpler, more concrete and testable components. One such component is that psychedelics facilitate 'emotional insight', i.e. definable as the acquisition of new thoughts, ideas or realisations about one's self (or 'persona' - to use a Jungian term), assumptions and behaviour. Such insights may (or may not) then lead to subsequent *changes* in assumptions, perspectives and behaviour. We may operationally define emotional insight using a revised version of a scale previously devised and employed to test the notion that dreams facilitate emotional insight (Edwards *et al.*, 2013).[5] This measure could be employed within a placebo-controlled study with a psychedelic, with the hypothesis that scores would be significantly higher in relation to the psychedelic experience than with placebo. Moreover, to add specificity and thus, potential strength to subsequent inferences, a psychoactive control drug could be introduced, such as a benzodiazepine, stimulant or non-psychedelic dissociative. Interestingly, a recent study largely adhered to such a design and found greater reported psychological insight in relation to the psychedelic (psilocybin) experience than with experiences produced by an active control (dextromethorphan) (Carbonaro *et al.*, 2017)

If further positive findings were to be obtained, key questions would then ensue, such as: what underlies such emotional insight (e.g. in terms of brain activity), and are such events amenable to capture and measurement in real-time, i.e. as they arise, as opposed to merely in retrospect? If the insight arises as a discrete event or epoch in time, then it stands to reason that it is amenable to capture, but if it is protracted, even to the extent that it crystallises after the psychedelic 'trip' has ended, then capturing and measuring this seems less feasible. In the interests of pragmatism (and plausibility), let us imagine that the entropic beginnings of emotional insight, do occur in discernable epochs under psychedelics. If we accept this possibility, how then might we capture such epochs and assess their relationship to insight?

[3] The reasons for this are manifold but can perhaps most simply and accurately be traced to stigma and related conservatism affecting key decision makers within governments, funding bodies, ethics boards, mainstream scientific communities and senior institutional figureheads. From experience, psychedelic research is an endeavor the establishment is far readier to say "no" to than "yes".

[4] Paradigm-challenging because expressed in psychoanalytic or psychodynamic terms, it is the principle that the unconscious mind exists and its existence can be tested.

[5] To assist other researchers, a revised, albeit as yet unvalidated emotional insight scale is provided as a supplementary file attached to this paper. This scale is currently in the process of validation - but others are invited to contribute to this process.

Button-press to signify the occurrence of discrete spontaneous events is an approach that has been used in the past, e.g. in relation to auditory hallucinations in psychosis (Leroy *et al.*, 2017) and spontaneously arising thoughts (Ellamil *et al.*,2016) but the overhanging psychological influence of the instruction to button press, as well as the subsequent motor actions, associated artefacts and the preceding deliberation on and intention to act, may suppress and/or confound the target phenomenon and therefore create false and/or unreliable attributions. Thus, an alternative to button press may be needed and one such example may be 'experience sampling', i.e. the procedure of cueing participants to report on the content of their recent conscious experience at random or pseudo-random time intervals (Christoff *et al.*, 2009). Such reports may be brief and constrained, e.g. delivered in the form of simple ratings, or more open, e.g. delivered through free speech. Due to the importance of brevity and desire not to interfere with the naturally unfolding experience, simple ratings may be the most practical option, particularly if concomitant functional neuroimaging recordings are being made - which are time sensitive and expensive (e.g. especially with fMRI). Thus, a simple brief rating of 'strength of emotion' and/or 'richness of conscious experience' could be used which could be supplemented post-hoc by detailed microphenomenology interviews (Petitmengin, 2017) that seek to evoke the original feeling and probe its nature with strategic questioning.

Importantly, we might improve on this entire approach by twinning the psychedelic experience with conditions known to be especially amenable to emotional arousal and insight. As already touched upon, this is especially pertinent in the context of neuroimaging, and particularly fMRI, where due to expense, as well as mechanical and comfort-related issues, individual scans typically last for approximately 5-15 min, and complete scanning sessions cover a period of approximately 60 min. Thus, introducing conditions in which emotional arousal and insight can be more easily coaxed, would serve a valuable function.

This could be done efficiently with music, structured in such a way that one may predict a priori, where intense experience and related insight may be most likely to occur. Experience sampling could track emotional strength/richness of experience in real-time and cues to rate/report on this could be sufficiently interspersed in time, so as to minimise interfering with the natural experience itself while being sufficiently regular to capture the desired events (e.g. a simple rating every 90-150 s). Although unconventional, if using fMRI for example, one might dedicate an entire scanning session of e.g. approximately 45 min to so-called resting-state scanning with music playing throughout. Inherently varying qualities within the music, such as individual 'songs' or periods within them, may serve as temporal flags to direct post-hoc reporting, which could be complemented by microphenomenology techniques (Petitmengin, 2017). If the spatially confined and auditorily loud nature of fMRI is considered unconducive to immersion in the experience and associated emotional release, then MEG or high density EEG might be more effective modalities.

A critical reader may ask, why such concern for the subjective measures, especially in a paper concerned primarily with a theory on brain function? The simple response to this is that questions of how experience is sampled should be given equivalent weight to questions of how concomitant brain activity is recorded, as the aim is to optimize the strength of our correlations between the two (Petitmengin, 2017). By implication, improving the fidelity of our subjective measures will serve this agenda as effectively as utilising the most powerful neuroimaging technologies and analyses.

How might we tie-in the entropic brain theory to this hypothetical study and its outcomes, and what predictions would we make about the magnitude of brain entropy during periods of intensified experience in which subsequent insight is reported? The clue may be in how the question has been framed, i.e. that there is a temporal sequence to events - with an increase in brain entropy coinciding with a period of intense immersion and 'information download' (which also feels unpredictable, openly explorative and experientially 'rich') followed by a subsequent period of normalisation of or reduction in brain entropy, that relates to a process of 'integrating', 'decoding' or sorting this information - and its subsequent crystallisation as 'insight'. Mechanisms and measures of *self-organisation* may be relevant in this context (Bak, 1997).

In partial support of these ideas, we have previously found that acute entropy under a psychedelic predicts sub-acute and potentially long-term changes in personality (i.e. increases in the personality trait 'openness' to experience) (Lebedev *et al.*, 2016), and certain qualities of brain activity (i.e. functional connectivity) have been found to change in an opposite direction after a psychedelic experience than during it (Carhart-Harris *et al.*, 2017c). These mechanisms might be likened to those discussed in relation to the creative process (Lubart, 2001), in which an experience of insight is preceded by planning (intention), free-association-like 'brainstorming' and a subsequent, delayed process of evaluation or verification (integration). Loosely, these mechanisms might also be related to the phenomena of divergent versus convergent thinking (Guilford, 1967; Kuypers *et al*., 2016) as well as exploratory versus exploitative search (Cohen *et al*., 2007), in which there is an initial entropic state that is exploratory and divergent in nature which is then followed by more protracted processes of cognitive convergence and 'exploitation'.

Before concluding this section, it is worth considering a couple of additional novel analytical approaches, i.e. in addition to applying information theoretic measures of entropy to brain data, it may be possible to measure the entropy of subjective experience itself, e.g. through the richness of the language used to describe it and in properties such as the rarity of the adjectives and phrases used and contingencies between words, phrases and categories or themes. Efforts are currently being made to explore how this can be done in a useful and meaningful way - but serving as inspiration are the impressive developments in natural speech analytics that have been made in psychiatry and psychopharmacology in recent years (Bedi *et al*., 2014, 2015). Relatedly, one may also apply validated measures of cognitive bizarreness to accounts of the psychedelic experience, as has been done recently (Kraehenmann *et al*., 2017).

Both brain and free-speech data might also be combined with machine learning methodologies with the aim of predicting new datasets and outcomes (e.g. see Carrillo *et al*., 2018) - however, by implication, entropic brain and mind states will be harder to predict, and perhaps also to derive predictions from; thus, the unreliability of machine learning algorithms to predict entropic brain states may be a specific hypothesis of the entropic brain theory itself - and this effect could be visually displayed via 'noisier' brain-to-mind visual reproductions (Naselaris *et al*., 2009).

6. Can psychedelic-induced consciousness-enrichment be used to treat disorders of consciousness?

Beyond what has just been discussed, let us consider another specific example of an area in which the entropic brain theory may be effectively applied. Brain entropy or 'complexity' has been found to reliably index conscious level in healthy people during normal waking consciousness versus the anaesthetised state, as well as in disorders of consciousness (Casali *et al*., 2013; Olofsen *et al*., 2008; Schartner *et al*., 2015; Zhang *et al*., 2001). Perhaps the most impressive research in this regard has been performed by Casali *et al*. (2013) who used transcranial magnetic stimulation (TMS) to perturb the brain in healthy individuals and patients with disorders of consciousness of varying degrees of severity. The Lempel-Ziv measure was then applied to EEG recordings of TMS-pulsed brain activity to yield the so-called perturbational-complexity index or PCI; for detailed explanations of Lempel-Ziv measures of brain activity, see (Schartner *et al*., 2015; Zhang *et al*., 2001). This PCI approach was remarkably reliable at differentiating between disorders of consciousness, e.g. with vegetative state patients scoring lowest, followed by patients in the minimal conscious state, the emerging from minimally conscious state and finally, locked-in syndrome and healthy controls during normal wakefulness (Casali *et al*., 2013). An even more recent study showed that the same Lempel-Ziv measure applied to spontaneous (i.e. restingstate, non-TMS perturbed) brain activity effectively differentiated between consciousness and unconsciousness in healthy individuals (Schartner *et al*., 2015), and in a separate earlier study, the same basic measure was found to index depth of anaesthesia with an almost 100% sensitivity and specificity (Zhang *et al*., 2001).

To our knowledge, until recently, it was generally thought that normal waking consciousness represents the (conscious) state of maximal brain entropy, since all comparison states characterised by a relative loss of consciousness, such as sleep, the anaesthetised and sedated states and disorders of consciousness, feature a corresponding reduction in brain entropy (Burioka *et al*., 2005; Schartner *et al*., 2015). It was a remarkable discovery therefore that the psychedelic state bucks this trend, with robust increases in brain entropy exceeding the levels associated with normal waking consciousness observed with different psychedelic compounds (Schartner *et al*., 2017).

In addition to questions about what we are to make about these findings, are questions about what we are to do with them? Interventions for disorders of consciousness are relatively ineffective and/or unreliable and range from the pharmacological to surgical (Giacino *et al*., 2014). If reductions in consciousness relate to reductions in brain entropy (Schartner *et al.*, 2015), and psychedelics robustly and reliably increase brain entropy (Schartner *et al.*, 2017), then does it not follow that psychedelics may be used to elevate conscious content in patients with disorders of consciousness?

Pragmatics and need, rather than cynical conservatism, should dictate how we proceed with this idea. One logical place to start might be with non-human animal research where the hypothesis that psychedelics lift entropy and thus, conscious content, from a sedated baseline may be tested. However, since it is difficult to assess conscious content in non-human animals, and anaesthesia to assist with recordings can confound interpretations, a logical advance on this would be to test whether psychedelics can lift both conscious content and entropy from a sedated baseline in humans. We might also extend this line of enquiry to sleep, with the hypothesis that psychedelics lift entropy and conscious content in NREM sleep, perhaps by switching the sleeper into dreamful REM sleep. Support for the REM-promoting effects of acutely administered psychedelics can be found in literature from the 1960s (Muzio *et al.*, 1966; Torda, 1968) and recent work has leant support to the association between the phenomenology of the psychedelic state and the dream state (Kraehenmann *et al.*, 2017; Tagliazucchi and Sanz, 2018) - see also (Carhart-Harris, 2007; Carhart-Harris and Nutt, 2014).

If these proof-of-principle experiments were to yield positive results, we might then consider taking the intervention to patients with disorders of consciousness. The normal procedure for informed consent in such patients would apply, and given the positive safety profile of psychedelics, and association with positive mental health outcomes (Carhart-Harris and Goodwin, 2017), albeit with important caveats related to context of use (Carhart-Harris *et al.*, 2018), a logical and ethical case could be made in favour of conducting such a study. Again, if positive results were to be found, considerations may then turn to how the intervention could be given in a more manageable way, e.g. via adherence to a 'microdosing' protocol (Fadiman, 2017), where threshold perceptible doses of psychedelics are given 2-3 times per week to (putatively) modulate improvements in mood and cognition. Moreover, where there is sufficient residual consciousness for this to be appropriate, such a dosing regimen might also be combined with conventional rehabilitation therapy.

7. Criticality

It was an original hypothesis of the initial entropic brain paper (Carhart-Harris *et al.*, 2014) that psychedelics tune the brain even closer to criticality[6] than is evident in normal waking consciousness and importantly, recent findings with fMRI and LSD do seem to support this idea (Atasoy *et al.*, 2017). That the brain exhibits characteristics of criticality is now well established (Hahn *et al.*, 2012; Fregnac, 2017; Tagliazucchi, 2017; Tagliazucchi *et al.*, 2016a), and there is some evidence to suggest that the brain ordinarily resides towards the sub-critical end of a general 'zone of criticality' (Priesemann *et al.*, 2014), i.e. brain criticality may be better thought of as 'zone' than a discrete critical 'point' (Moretti and Munoz, 2013) and the waking brain seems to be positioned closer to 'extreme order' or sub-criticality within this zone than 'extreme disorder' or super-criticality (Atasoy *et al.*, 2017; Priesemann *et al.*, 2013, 2014). Brain dynamics have been shown to shift towards sub-criticality with increasing cognitive load (Fagerholm *et al.*, 2015) and into super-criticality in epileptic seizure (Meisel *et al.*, 2012). As with entropy, cases of enhanced criticality above the already high level associated with the normal waking brain are relatively unheard of in the scientific literature; thus, by implication, increased criticality under psychedelics is exceptional (Atasoy *et al.*, 2017).

What then are we to make of this? Criticality is known to confer functional advantages to a system in terms of maximising the capacity and efficiency of information processing through optimizing adaptability while preserving order (Shew and Plenz, 2013), and it stands to reason that a system moving closer to criticality and/or shifting closer to the super-critical end of a critical zone is likely to favour flexibility and susceptibility to perturbation over preservation - as well as exploration over exploitation (Cohen *et al.*, 2007). Reflecting on some of the recent findings with psychedelics, this principle makes sense: for example, psychologically supported treatment with psychedelics has been associated with impressive improvements in psychiatric conditions such as addictions (Bogenschutz and Johnson, 2016), obsessive-compulsive disorder (Moreno *et al.*, 2006), and depression (Carhart-Harris *et al.*, 2016a, 2017a; Sanches *et al.*, 2016). Moreover, several of these conditions have been associated with brain sub-criticality (Carhart-Harris *et al.*, 2014) - particularly depression (Pezard *et al.*, 1996; Thomasson and Pezard, 1999; Thomasson *et al.*, 2000, 2002; Zhang *et al.*, 2001; Akdemir Akar *et al.*, 2015) - although contradictory evidence (e.g. Méndez *et al.*, 2012 ; Akdemir Akar *et al.*, 2015) suggests that the relationship between entropy and depression maybe be subtype and state specific (e.g. see

Akdemir Akar *et al*., 2015 and Zhang *et al*., 2001), as well as sensitive to medication status (Méndez *et al*., 2012).

Regarding the dynamics of mood itself, it is intriguing to entertain the thought that, within certain bounds, the super-critical end of the zone of criticality may favour positive mood - and perhaps even be a fundamental property of it (Carhart-Harris and Nutt, 2017; Thomasson *et al*., 2000, 2002), although there may be a tipping point, where the hyper-flexible (instable) individual may become vulnerable to a mania-related condition exhibiting behaviours such as agitation, inappropriate elation and grandiosity. It is noteworthy that such symptoms can sometimes be seen acutely and even sub-acutely with psychedelics (e.g. see https://erowid.org/experiences/), perhaps most commonly when the experience has been poorly integrated (Carhart-Harris *et al*., 2017b). The notion of 'spiritual bypassing' may be relevant here, in which transpersonal and/or 'spiritual' notions and ideals are (unconsciously) used to distract ourselves from and thus avoid directly working on painful personal material and/or developmental needs (Masters, 2010).

One of the signature properties of a critical system is a maximal sensitivity to perturbation (Bak, 1997; Hesse and Gross, 2014; Tagliazucchi *et al*., 2016a). By this token, we may ask whether and how this translates to the psychedelic experience? The importance of 'set' and 'setting' to the quality of a psychedelic trip has long been raised (Leary *et al*., 1963, and see also Hartogsohn, 2016) and a recent perspective piece on the assumed importance of context, both to the quality of the acute psychedelic experience and subsequent long-term psychological outcomes, has recently been published (Carhart-Harris *et al*., 2018). Intriguingly, as discussed above, it seems that not all stimuli have added impact in the psychedelic state - but are dependent on being sufficiently captivating and immersive for the individual (Kaelen *et al*., 2018). For example, in a recent clinical trial of psilocybin for depression, music played to patients during the treatment session that was well liked and in resonance with their underlying emotional state was found to be strongly associated with the occurrence of so-called 'peak experience' and positive therapeutic outcomes; however, if the music was out-of-synch with the patient's tastes and or emotional state, then positive clinical outcomes were diminished (Kaelen *et al*., 2018) - see also (Roseman *et al*., 2018).

There have been a small number of recent (Frecska *et al*., 2012; Kuypers *et al*., 2016) and historical reports (Harman *et al*., 1966; Janiger and Derios, 1989; McGlothlin *et al*., 1967) on enhancements in creative thinking in relation to psychedelics. However, this effect appears to be reserved for the divergent, explorative component of the creative process rather than the convergent aspect (Kuypers *et al*., 2016), which may depend more on critical thinking - and which may be impaired (at least acutely) under psychedelics (Carter *et al*., 2005; Kuypers *et al*., 2016). Bold claims have been made about the potential of so-called psychedelic 'microdosing' to enhance cognition (Waldmana, 2017; Fadiman, 2017) but as yet, there has been no published scientific verifications of this. If evidence was to accrue however, attunement of brain dynamics closer to criticality and an associated flexibility of thought could be considered a candidate mechanism - see (Carhart-Harris and Nutt, 2017) for relevant discussions. We should also be mindful of some of the conceptual dangers of super-criticality raised above however, namely (hypo)mania and so-called 'spiritual bypassing'.

Lastly, it is worth reflecting whether enhanced criticality under psychedelics (Atasoy *et al*., 2017) may express in other functionally useful ways. As touched on earlier, the ability of psychedelics to relax prior assumptions may provide the necessary preconditions for the emergence of spontaneous insight. Conceptually, it seems reasonable to suppose that attunement of brain activity towards criticality may be a mechanism underlying spontaneous insight under psychedelics (Atasoy *et al*., 2017). Avalanche-phenomena and/or cascading processes in responses to intrinsic perturbation are signatures of critical systems (Petermann *et al*., 2009) and may be involved in the disinhibition and associated 'release' of previously inhibited information under psychedelics (Alonso *et al*., 2015; Carhart-Harris *et al*., 2014; Kaelen *et al*., 2016). The collapse of functional hierarchies that serve to maintain the status quo may also be key, enabling freer communication between the different levels - such as between the evolutionarily older emotional circuitry of the brain (e.g. the limbic system) and the cortex, perhaps through periodic cascades propogating through the system (e.g. see Kaelen *et al*., 2016). These matters are speculative but deserving of discussion - if only to earmark them for the future when it is easier to formulate our hypotheses more clearly and test them accordingly.

> "The unconscious is a thing of nature." (Carl Jung)
>
> "In all chaos there is cosmos, in all disorder, a secret order." (Carl Jung)

8. Serotonin and the entropic brain

Before concluding this paper, it seems appropriate to link in recent advances in serotonin research to the entropic brain hypothesis. A particularly exciting development is the discovery that unlike the dopamine system (Schultz, 2016), serotonin appears not to encode classic reward/punishment information but rather value-nonspecific 'surprise' (Matias *et al.*, 2017). More specifically, optogenetic techniques in mice have revealed that serotonin expressing neurons within the dorsal raphe nuclei fire in response to unexpected outcomes independent of their value sign (Matias *et al.*, 2017). This matter is particularly intriguing as averaged surprise is formally equivalent to uncertainty, and is therefore effectively synonymous with entropy (Bestmann *et al.*, 2008). Key questions then ensue, why does this happen, and what function does it serve?[7]

One possible interpretation is that serotonin works to relax prior assumptions so as to weaken perseverative/habitual responding (Carhart-Harris and Nutt, 2017; Matias *et al.*, 2017). This relaxation of prior assumptions may be done to facilitate new learning, in conditions where prior assumptions become counterproductive and/or when the agent's environmental conditions are so volatile and changeable that heightened flexibility and exploration become the optimal strategies (Carhart-Harris and Nutt, 2017). Related ideas were recently discussed in a major review paper on brain serotonin function, where the significant pro-plasticity effects of serotonin were ascribed to increased signalling at the excitatory serotonin 2A receptor subtype (Carhart-Harris and Nutt, 2017). Indeed, signalling at other serotonin receptors (e.g. the postsynaptic serotonin 1A receptor subtype) may similarly encode behavioural responses to uncertainty, albeit in a different way, e.g. through enhancing one's endurance of uncertainty through stress-moderation, rather than adaption to it through changes in outlook and behaviour (Carhart-Harris and Nutt, 2017). Mechanistically, serotonin 2A receptor signalling has been hypothesised to serve a function analogous to 'annealing' in metallurgy or system 'reset' in computing (Carhart-Harris and Nutt, 2017; Carhart-Harris *et al.*, 2017c) where through enhanced excitability, the influence of prior beliefs is relaxed - as per a flattened energy landscape - so that new learning can occur.

> "Your assumptions are your window on the world, scrub them off every once in a while, or the light won't come in." (Isaac Asimov)

---

[7] N.B. Even though psychedelics have been shown to suppress raphe firing, the consequences of such firing are mimicked by direct serotonergic agonism via the psychedelic (Nichols, 2016).

9. Discussion

This article has revisited the so-called entropic brain hypothesis (Carhart-Harris *et al.*, 2014). It has cited increasing empirical support for the idea since it was originally published in early 2014 (Carhart-Harris *et al.*, 2014) and highlighted a particularly promising measure of brain entropy, Lempel-Ziv, that has proved to be informative about conscious level in disorders of consciousness (Casali *et al.*, 2013), pharmacologically induced loss of consciousness (Schartner *et al.*, 2015; Zhang *et al.*, 2001) and psychedelicinduced consciousness 'enrichment' (Schartner *et al.*, 2017). It has attempted to tackle the question of *what* increased entropy in the brain relates to in terms of conscious experience, proposing that richness of conscious experience, *information content* and *subjective uncertainty* are all close relatives - if not direct counterparts - of increased brain entropy (at least within a critical zone). Specific challenges for the entropic brain theory, and ideas about how it may be tested and advanced, were discussed. Two specific examples were provided of how the entropic brain might be clinically applied, i.e. through using psychedelics to facilitate emotional insight and/or treat disorders of consciousness. The former may be likened to the use of free-association in psychoanalysis, where an open, free-flowing mindstate is encouraged so that the likelihood of spontaneous insight is enhanced. Closing sections focused on properties of criticality in the brain and how these may be accentuated under psychedelics (Atasoy *et al.*, 2017) as well as recent advances in serotonin research that chime well with *the entropic brain* and may be usefully combined with it to solve a major riddle in psychopharmacology, namely *what is brain serotonin for*? The proposed solution being: to differentially encode behavioural responses to uncertainty. See (Carhart-Harris and Nutt, 2017) for a more focused discussion of this matter.

Like the original entropic brain paper (Carhart-Harris *et al.*, 2014), this updated version can be considered speculative and forward looking. This approach is vulnerable to critique (Papo, 2016) but may also be a strength. It is worth reflecting that the major arguments and hypotheses of the original entropic brain paper have stood up well to empirical scrutiny, e.g. that brain entropy is enhanced under psychedelics (Lebedev *et al.*, 2016; Schartner *et al.*, 2017; Tagliazucchi *et al.*, 2014; Viol *et al.*, 2017) and that the 'psychedelic-brain' exhibits more pronounced signatures of criticality than normal waking consciousness (Atasoy *et al.*, 2017).

It may be noted however, that some of the themes and terminology used in the original paper, e.g. 'primary and secondary consciousness', 'the ego' and the default-mode network, have been omitted from the present contribution. There is no conscious agenda behind this, other than a desire to focus on the most pertinent and timely topics, done in the interests of parsimony and concision. What is left out of the present paper should not be considered 'retracted' but rather side-stepped for the time being, in the interests of expediency. It should be clearly stated however, that the position that psychedelic research offers a unique opportunity for major principles of psychoanalytic theory to be tested, verified and revived is still very much maintained. There is a door ajar here for psychoanalytically-minded experimental psychologists and neuroscientists to open and walk through.

> "Until you make the unconscious conscious it will direct your life and you will call it fate." (Carl Jung)
>
> "These substances [psychedelics] function as unspecific amplifiers that increase the energetic niveau in the psyche and make the deep unconscious dynamics available for conscious processing. This unique property of psychedelics makes it possible to study psychological undercurrents that govern our experiences and behaviors to a depth that cannot be matched by any other methods and tools available in modern mainstream science." (Stanislav Grof)

Briefly, one specific hypothesis contained in the original paper (Carhart-Harris *et al.*, 2014) that has not stood the test of time, can now be revised, namely that the brain during seizure is sub-critical in relation to normal waking consciousness; in fact, evidence suggests it is super-critical (Meisel *et al.*, 2012) - which, with the benefit of hindsight, makes much more sense.

About the specific limitations of the present paper, it has been selective in its focus, and unlike the original (Carhart-Harris *et al.*, 2014), has said little about other altered states of consciousness in which entropy may be elevated above the normal waking baseline. Befitting its richer content and emotional tone, it has been shown that REM sleep is more entropic than NREM sleep (Abasolo *et al.*, 2015; Burioka *et al.*, 2005) but what about psychosis? The variegated nature of this disorder means we must be cautious about making too general and therefore misleading statements about it. For example, we can speculate that whereas entropy/uncertainty/content may be elevated in manic states (e.g. see Thomasson *et al.*, 2002) and early and acute psychotic episodes, it may be suppressed once a fixed delusion has formed - and/or an antipsychotic and/or mood-stabilising medication is introduced and becomes effective - for example see (Méndez *et al.*, 2012) for evidence of decreased brain entropy after treatment with mirtazapine for depression.

Also, while the literature is replete with studies applying entropy/complexity measures to EEG data recorded in the context of anaesthetics and sedatives, it is surprisingly difficult to find studies in which the same measures have been applied to EEG data recorded after acute administration of a stimulant (although see - Sun *et al.*, 2007). Stimulants would be particularly interesting controls for psychedelics, in terms of demonstrating the specificity of the proposed relationship between brain entropy and richness of conscious experience and subjective uncertainty. Until such comparisons are made, it is not possible to reject the possibility that brain entropy is merely an index of "alertness" or "arousal" - as has been suggested previously (Mateos *et al*. 2018) - although indirect evidence tentatively suggests that this alternative explanation is not compelling (Sun *et al.*, 2007; Liu *et al.*, 1997; Zarjam *et al.*, 2012). It seems more reasonable to suppose however, that altered states of consciousness induced by non-serotonergic psychedelics, deliriants and/or dissociatives, that share some of the phenomenological features the classic serotonergic psychedelics, e.g. enriched and changeable contents of consciousness and a sense of uncertainty, might also exhibit heightened entropic brain activity, as was recently demonstrated with the NMDA receptor antagonist ketamine for example (Schartner *et al.*, 2017).

Another limitation of the present paper is that although explicit mention has been given to the Lempel-Ziv measure (Schartner *et al.*, 2015), only general statements about it have been made - for greater detail see (Schartner *et al.*, 2015; Zhang *et al.*, 2001). For example, perhaps there are reasons to focus on the compressibility of signals detected from specific spatial locations when studying specific subjective phenomena (e.g. occipital sensors and visual phenomena) or to improve the temporal precision of our sampling so as to more accurately map between neurophysiological and phenomenological events or epochs - as discussed above. It is hoped that more nuanced hypotheses arising from the entropic brain theory can be tested in the future.

rain theory can be tested in the future. Relatedly, brain entropy has been treated here as a global brain phenomenon but there are reasons to be believe that spatial localisation is relevant to both the action of psychedelics and the neurobiology of consciousness. For example, the serotonin 2A receptors that appear to be the key trigger receptors for the psychedelic experience (Nichols, 2016) have their densest expression in high-level cortical regions belonging to the default-mode network (Beliveau *et al*. 2017) and this network, as well as other fronto-parietal networks, have been closely implicated in consciousness regulation (Guldenmund *et al.*, 2016) - as they have in the psychedelic state (Tagliazucchi *et al.*, 2016b; Carhart-Harris *et al.*, 2016b).

Another key issue deserving of focus before closing, is the matter of the relationship between entropy and criticality. It seems reasonable to infer that such a relationship exists but nothing specific has yet been said about this. Is it more accurate to describe the psychedelic brain as 'critical' or 'dynamically instable' than 'entropic'? Is there a limit to the rule that increased brain entropy relates to increased richness of conscious content? The answer to this last question is "probably yes", and more specifically, it seems likely that there is a zone of criticality (Moretti and Munoz, 2013) above which any further increases in brain entropy create a state of mind and brain that is incapable of integrating information into coherent 'wholes' (Gallimore, 2015). Anecdotal reports of complete and/or near-complete loss of consciousness under psychedelics can be found (https://erowid.org/experiences/) but are rare. Thus, generally speaking, the entropic brain principle, that increased brain entropy relates to an increased richness of conscious experience, may be said to stand, but only within an upper as well as a lower limit (Fig. 1). It is interesting to reflect that identifying the point at which conscious awareness is lost with psychedelics may be informative about consciousness itself - in the same way that anaesthetic-induced loss of consciousness has been well used to study consciousness so effectively. Questions about the ethics and safety of giving sufficiently high enough doses of psychedelics to achieve loss of consciousness may preclude this work from ever being done however - at least for the foreseeable future; although potent short-acting psychedelics such as DMT and 5-MeO-DMT may help surmount this issue. Another intriguing question is whether so-called "access consciousness" is more readily lost than "phenomenal consciousness" (Block, 2005) in the extreme, high-entropy psychedelic state.

Finally, but importantly, it must be conceded that applying entropy measures to brain physiology is not a new endeavour (Klonowski *et al.*, 1999; Nandrino *et al.*, 1994; Papo, 2016; Zhang *et al.*, 2001) and theories on the relationship between brain functional complexity and subjective experience have a history that should be properly acknowledged (Barttfeld *et al.*, 2015; Basar and Guntekin, 2009; Seth *et al.*, 2011; Tononi and Edelman, 1998; Tononi *et al.*, 1994). Perhaps the most influential theory on the brain basis of consciousness, is the so-called 'integrated-information theory' of consciousness (Tononi *et al.*, 2016), and this includes as one part of it, a measure of brain entropy/complexity. Indeed, it has been said in a critique of the original entropic brain paper that entropy/complexity measures applied to brain function merely 'depurate' the integration term from the integrated-information theory (Papo, 2016). This charge is readily accepted but the position is taken here that the entropy/complexity component of the integrated-information theory provides the major share of its explanatory power. This position is empirically substantiated, since it is arguably the complexity/entropy more than the integration measures per se that are so impressively predicting conscious level (Casali *et al.*, 2013; Casarotto *et al.*, 2016; Schartner *et al.*, 2015; Zhang *et al.*, 2001). While the requirement for integration is not disregarded (e.g. see the discussion on entropy and criticality in the previous paragraph) and may indeed by critical for access consciousness particularly - it is felt that the key properties of such integration, necessary for consciousness, have not yet been clearly delineated - although see the Global Workspace theory (Baars, 1993) for an appealing model on the importance of integration to conscious experience, as well as more recent work on large-scale (Tagliazucchi *et al.*, 2016a) and long-range connectivity (Kotchoubey *et al.*, 2013). It also remains possible that a role for integration may be implied within entropy/complexity measures; for example, future work may discover the point or zone within which entropy exceeds a critical threshold at which no one coherent, large-scale spatiotemporal configuration can dominate the brain for a sufficiently long-enough for access consciousness to be possible.

All models are incomplete and the entropic brain is no exception - but it was conceived and intended to offer a simple and useful heuristic, enabling relatively seamless translations to be made between a quantitative measure of the richness of brain activity and the richness of subjective experience.

10. Conclusions

In summary, four years on from the publication of the original entropic brain hypothesis, the present paper has sought to reflect on its influence, reliability and future scientific and clinical value. The position is maintained that entropy represents a uniquely powerful bridging tool for human neuroscience that will enable a better understanding of the mind-brain relationship and mechanics of consciousness, including how we may treat its abnormalities.

Acknowledgements

Imperial College London's neuroscientific research with psychedelics has been funded entirely through charitable donations. In this regard, deserving special credit for their early and enduring support is the Beckley Foundation, and particularly its Founder and Director Amanda Feilding. The author is presently supported by the Alex Mosley Charitable Trust. He is deeply grateful to Professor David Nutt for his support for his research, and also grateful to Leor Roseman and Christopher Timmermann for reading and commenting on an earlier draft of this manuscript. Christopher Timmermann's comments on neurophenomenology and microphenomenology have been particularly helpful. The author would also like to acknowledge conversations with Enzo Tagliazucchi, Jacobo Sitt, Robert Leech and Gregory Scott regarding the idea of using psychedelics to elevate conscious content in disorders of consciousness. Conversations with Dr Scott (NIHR clinical lecturer) have been particularly advanced. This is a shared idea which we hope to pursue further in the future, pending funding and the relevant approvals.

References

1. Abasolo, D., Simons, S., Morgado da Silva, R., Tononi, G., Vyazovskiy, V.V., 2015. Lempel-Ziv complexity of cortical activity during sleep and waking in rats. J. Neurophysiol. 113, 2742-2752.
2. Akdemir Akar, S., Kara, S., Agambayev, S., Bilgiç, V., 2015 Dec 1. Nonlinear analysis of EEGs of patients with major depression during different emotional states. Comput Biol. Med. 67, 49-60. https://doi.org/10.1016/j.compbiomed.2015.09.019.
3. Alonso, J.F., Romero, S., Mananas, M.A., Riba, J., 2015. Serotonergic psychedelics temporarily modify information transfer in humans. Int. J. Neuropsychopharmacol. 18.
4. Atasoy, S., Roseman, L., Kaelen, M., Kringelbach, M.L., Deco, G., Carhart-Harris, R.L., 2017. Connectome-harmonic decomposition of human brain activity reveals dynamical repertoire re-organization under LSD. Sci. Rep. 7, 17661.
5. Baars, B.J., 1993. How does a serial, integrated and very limited stream of consciousness emerge from a nervous system that is mostly unconscious, distributed, parallel and of enormous capacity? Ciba Found. Symp. 174, 291-303, 282-290; discussion.
6. Bak, P., 1997. How Nature Works : the Science of Self-organized Criticality. Oxford University Press, Oxford.
7. Barrett, F.S., Preller, K.H., Herdener, M., Janata, P., Vollenweider, F.X., 2017. Serotonin 2A receptor signaling underlies LSD-induced alteration of the neural response to dynamic changes in music. Cerebr. Cortex 1-12.
8. Barttfeld, P., Uhrig, L., Sitt, J.D., Sigman, M., Jarraya, B., Dehaene, S., 2015. Signature of consciousness in the dynamics of resting-state brain activity. Proc. Natl. Acad. Sci. U. S. A. 112, 887-892.
9. Basar, E., Guntekin, B., 2009. Darwin's evolution theory, brain oscillations, and complex brain function in a new "Cartesian view". Int. J. Psychophysiol. 71, 2-8.
10. Bedi, G., Cecchi, G.A., Slezak, D.F., Carrillo, F., Sigman, M., de Wit, H., 2014. A window into the intoxicated mind? Speech as an index of psychoactive drug effects. Neuropsychopharmacology 39, 2340-2348.
11. Bedi, G., Carrillo, F., Cecchi, G.A., Slezak, D.F., Sigman, M., Mota, N.B., Ribeiro, S., Javitt, D.C., Copelli, M., Corcoran, C.M., 2015. Automated analysis of free speech predicts psychosis onset in high-risk youths. NPJ Schizophr 1, 15030.
12. Beliveau, V., Ganz, M., Feng, L., Ozenne, B., Højgaard, L., Fisher, P.M., Svarer, C., Greve, D.N., Knudsen, G.M., 2017. A high-resolution in vivo atlas of the human Brain's serotonin system. J. Neurosci. 37 (1), 120-128.
13. Ben-Naim, A., 2007. Entropy Demystified : the Second Law Reduced to Plain Common Sense. World Scientific, Hackensack, N.J.
14. Bestmann, S., Harrison, L.M., Blankenburg, F., Mars, R.B., Haggard, P., Friston, K.J., Rothwell, J.C., 2008. Influence of uncertainty and surprise on human cortico-spinal excitability during preparation for action. Curr. Biol. 18, 775-780.
15. Block, N., 2005 Feb. Two neural correlates of consciousness. Trends Cognit. Sci. 9 (2), 46-52.
16. Bogenschutz, M.P., Johnson, M.W., 2016. Classic hallucinogens in the treatment of addictions. Prog. Neuro-Psychopharmacol. Biol. Psychiatry 64, 250-258.
17. Bouso, J.C., Palhano-Fontes, F., Rodriguez-Fornells, A., Ribeiro, S., Sanches, R., Crippa, J.A., Hallak, J.E., de Araujo, D.B., Riba, J., 2015. Long-term use of psychedelic drugs is associated with differences in brain structure and personality in humans. Eur. Neuropsychopharmacol 25, 483-492.
18. Burioka, N., Miyata, M., Cornelissen, G., Halberg, F., Takeshima, T., Kaplan, D.T., Suyama, H., Endo, M., Maegaki, Y., Nomura, T., Tomita, Y., Nakashima, K., Shimizu, E., 2005. Approximate entropy in the electroencephalogram during wake and sleep. Clin. EEG Neurosci. 36, 21-24.
19. Carbonaro, T.M., Johnson, M.W., Hurwitz, E., Griffiths, R.R., 2017. Double-blind comparison of the two hallucinogens psilocybin and dextromethorphan: similarities and differences in subjective experiences. Psychopharmacology (Berlin). https://doi.org/10.1007/s00213-017-4769-4.
20. Carhart-Harris, R., 2007. Waves of the unconscious: the neurophysiology of dreamlike phenomena and its implications for the psychodynamic model of the mind. Neuro-psychoanalysis 9.
21. Carhart-Harris, R.L., Friston, K.J., 2010. The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. Brain 133, 1265-1283.
22. Carhart-Harris, R.L., Goodwin, G.M., 2017. The therapeutic potential of psychedelic drugs: past, present, and future. Neuropsychopharmacology 42, 2105-2113.
23. Carhart-Harris, R., Nutt, D., 2014. Was it a vision or a waking dream? Front. Psychol. 5, 255.
24. Carhart-Harris, R.L., Nutt, D.J., 2017. Serotonin and brain function: a tale of two receptors. J. Psychopharmacol. 269881117725915.
25. Carhart-Harris, R.L., Leech, R., Hellyer, P.J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D.R., Nutt, D., 2014. The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. Front. Hum. Neurosci. 8, 20.
26. Carhart-Harris, R.L., Bolstridge, M., Rucker, J., Day, C.M., Erritzoe, D., Kaelen, M., Bloomfield, M., Rickard, J.A., Forbes, B., Feilding, A., Taylor, D., Pilling, S., Curran, V.H., Nutt, D.J., 2016a. Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. Lancet Psychiatry 3, 619-627.
27. Carhart-Harris, R.L., Muthukumaraswamy, S., Roseman, L., Kaelen, M., Droog, W., Murphy, K., Tagliazucchi, E., Schenberg, E.E., Nest, T., Orban, C., Leech, R., Williams, L.T., Williams, T.M., Bolstridge, M., Sessa, B., McGonigle, J., Sereno, M.I., Nichols, D., Hellyer, P.J., Hobden, P., Evans, J., Singh, K.D., Wise, R.G., Curran, H.V., Feilding, A., Nutt, D.J., 2016b. Neural correlates of the LSD experience revealed by multimodal neuroimaging. Proc. Natl. Acad. Sci. U. S. A. 113, 4853-4858.
28. Carhart-Harris, R.L., Bolstridge, M., Day, C.M.J., Rucker, J., Watts, R., Erritzoe, D.E., Kaelen, M., Giribaldi, B., Bloomfield, M., Pilling, S., Rickard, J.A., Forbes, B., Feilding, A., Taylor, D., Curran, H.V., Nutt, D.J., 2017a. Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. Psychopharmacology (Berlin).
29. Carhart-Harris, R.L., Erritzoe, D., Haijen, E., Kaelen, M., Watts, R., 2017b. Psychedelics and connectedness. Psychopharmacology (Berlin).
30. Carhart-Harris, R.L., Roseman, L., Bolstridge, M., Demetriou, L., Pannekoek, J.N., Wall, M.B., Tanner, M., Kaelen, M.,

McGonigle, J., Murphy, K., Leech, R., Curran, H.V., Nutt, D.J., 2017c. Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. Sci. Rep. 7, 13187.
31. Carhart-Harris, R.,L., Roseman, L., Haijen, E., Erritzoe, D.E., Watts, R., Branchi, I., Kaelen, M., 2018. Psychedelics and the essential importance of context. J. Psychopharmacol. https://doi.org/10.1177/0269881118754710.
32. Carrillo, F., Sigman, M., Fernández Slezak, D., Ashton, P., Fitzgerald, L., Stroud, J., Nutt, D.J., Carhart-Harris, R.L., 2018. Natural speech algorithm applied to baseline interview data can predict which patients will respond to psilocybin for treatment-resistant depression. J. Affect. Disord. 230, 84-86. https://doi.org/ 10.1016/j.jad.2018.01.006, 2018 Apr 1.
33. Carter, O.L., Burr, D.C., Pettigrew, J.D., Wallis, G.M., Hasler, F., Vollenweider, F.X., 2005. Using psilocybin to investigate the relationship between attention, working memory, and the serotonin 1A and 2A receptors. J. Cognit. Neurosci. 17, 1497-1508.
34. Casali, A.G., Gosseries, O., Rosanova, M., Boly, M., Sarasso, S., Casali, K.R., Casarotto, S., Bruno, M.-A., Laureys, S., Tononi, G., Massimini, M., 2013a. A theoretically based index of consciousness independent of sensory processing and behavior. Sci. Transl. Med. 5, 198 ra105.
35. Casarotto, S., Comanducci, A., Rosanova, M., Sarasso, S., Fecchio, M., Napolitani, M., Pigorini, A.,A.,G.C., Trimarchi, P.D., Boly, M., Gosseries, O., Bodart, O., Curto, F., Landi, C., Mariotti, M., Devalle, G., Laureys, S., Tononi, G., Massimini, M., 2016. Stratification of unresponsive patients by an independently validated index of brain complexity. Ann. Neurol. 80, 718-729.
36. Christoff, K., Gordon, A.M., Smallwood, J., Smith, R., Schooler, J.W., 2009. Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. Proc. Natl. Acad. Sci. U. S. A. 106, 8719-8724.
37. Cohen, S., 1964. The beyond within; the LSD Story, by Sidney Cohen. Foreword by Gardner Murphy. Atheneum, New York.
38. Cohen, J.D., McClure, S.M., Yu, A.J., 2007. Should I stay or should I go? How the human brain manages the trade-off between exploitation and exploration. Philos. Trans. R. Soc. Lond. B Biol. Sci. 362, 933-942.
39. Deco, G., Kringelbach, M.L., 2017. Hierarchy of information processing in the brain: a novel 'intrinsic ignition' framework. Neuron 94, 961-968.
40. Deco, G., Tagliazucchi, E., Laufs, H., Sanjuán, A., Kringelbach, M.L., 2017. Novel intrinsic ignition method measuring local-global integration characterizes wakefulness and deep sleep. Eneuro 4 (5). ENEURO-0106.
41. Edwards, C.L., Ruby, P.M., Malinowski, J.E., Bennett, P.D., Blagrove, M.T., 2013. Dreaming and insight. Front. Psychol. 4, 979.
42. Ellamil, M., Fox, K.C., Dixon, M.L., Pritchard, S., Todd, R.M., Thompson, E., Christoff, K., 2016. Dynamics of neural recruitment surrounding the spontaneous arising of thoughts in experienced mindfulness practitioners. Neuroimage 136, 186-196.
43. Fadiman, J., 2017. Microdosing. Presentation at Psychedelic Science Conference. California, Oakland.
44. Fagerholm, E.D., Lorenz, R., Scott, G., Dinov, M., Hellyer, P.J., Mirzaei, N., Leeson, C., Carmichael, D.W., Sharp, D.J., Shew, W.L., Leech, R., 2015. Cascades and cognitive state: focused attention incurs subcritical dynamics. J. Neurosci. 35, 4626-4634.
45. Frecska, E., More, C.E., Vargha, A., Luna, L.E., 2012. Enhancement of creative expression and entoptic phenomena as after-effects of repeated ayahuasca ceremonies. J. Psychoact. Drugs 44, 191-199.
46. Fregnac, Y., 2017. Spontaneous cortical activity is transiently poised close to criticality. PLoS Comput. Biol. 13, e1005543.
47. Gallimore, A.R., 2015. Restructuring consciousness -the psychedelic state in light of integrated information theory. Front. Hum. Neurosci. 9, 346.
48. Giacino, J.T., Fins, J.J., Laureys, S., Schiff, N.D., 2014. Disorders of consciousness after acquired brain injury: the state of the science. Nat. Rev. Neurol. 10, 99-114.
49. Gleick, J., 2011. The Information : a History, a Theory, a Flood. Fourth Estate, London.
50. Grof, S., 1979. Realms of the Human Unconscious : Observations from LSD Research. Souvenir Press, London.
51. Guilford, J.P., 1967. The Nature of Human Intelligence. McGraw-Hill Book Co, New York.
52. Guldenmund, P., Gantner, I.S., Baquero, K., Das, T., Demertzi, A., Boveroux, P., Bonhomme, V., Vanhaudenhuyse, A., Bruno, M.A., Gosseries, O., Noirhomme, Q., Kirsch, M., Boly, M., Owen, A.M., Laureys, S., Gómez, F., Soddu, A., 2016 Apr. Propofol-induced frontal cortex disconnection: a study of resting-state networks, total brain connectivity, and mean bold signal oscillation frequencies. Brain Connect. 6 (3), 225-237. https://doi.org/10.1089/brain.2015.0369.
53. Hahn, G., Ponce-Alvarez, A., Monier, C., Benvenuti, G., Kumar, A., Chavane, F., Deco, G., Guldenmund, P., Vanhaudenhuyse, A., Boly, M., Laureys, S., Soddu, A., 2012. A default mode of brain function in altered states of consciousness. Arch. Ital. Biol. 150 (2-3), 107-121.
54. Harman, W.W., McKim, R.H., Mogar, R.E., Fadiman, J., Stolaroff, M.J., 1966. Psychedelic agents in creative problem-solving: a pilot study. Psychol. Rep. 19, 211-227.
55. Hartogsohn, I., 2016. Set and setting, psychedelics and the placebo response: an extra-pharmacological perspective on psychopharmacology. J. Psychopharmacol. 30, 1259-1267.
56. Hesse, J., Gross, T., 2014. Self-organized criticality as a fundamental property of neural systems. Front. Syst. Neurosci. 8, 166.
57. Huxley, A., 1959. The Doors of Perception and Heaven and Hell. Penguin Books, Harmondsworth.
58. Huxley, A., Palmer, C., Horowitz, M., 1977. Moksha : Writings on Psychedelics and the Visionary Experience (1931-1963). Stonehill, New York.
59. Janiger, O., Derios, M.D., 1989. Lsd and creativity. J. Psychoact. Drugs 21, 129-134.
60. Kaelen, M., Roseman, L., Kahan, J., Santos-Ribeiro, A., Orban, C., Lorenz, R., Barrett, F.S., Bolstridge, M., Williams, T., Williams, L., Wall, M.B., Feilding, A., Muthukumaraswamy, S., Nutt, D.J., Carhart-Harris, R., 2016. LSD modulates music-induced imagery via changes in parahippocampal connectivity. Eur. Neuropsychopharmacol.
61. Kaelen, M., Giribaldi, B., Raine, J., Evans, L., Timmerman-Slater, C., Rodriguez, N., Roseman, L., Feilding, A., Nutt, D., Carhart-Harris, R., 2018. The hidden therapist: evidence for a central role of music in psychedelic therapy. Psychophramrcology (Springer) 235 (2), 505-519. https://doi.org/10.1007/s00213-017-4820-5.
62. Klonowski, W., Jernajczyk, W., Niedzielska, K., Rydz, A., Stepien, R., 1999. Quantitative measure of complexity of EEG signal dynamics. Acta Neurobiol. Exp. 59, 315-321.
63. Kotchoubey, B., Merz, S., Lang, S., Markl, A., Müller, F., Yu, T., Schwarzbauer, C., 2013. Global functional connectivity reveals highly significant differences between the vegetative and the minimally conscious state. J. Neurol. 260 (4), 975-983.
64. Kraehenmann, R., Preller, K.H., Scheidegger, M., Pokorny, T., Bosch, O.G., Seifritz, E., Vollenweider, F.X., 2015. Psilocybin-

induced decrease in amygdala reactivity correlates with enhanced positive mood in healthy volunteers. Biol. Psychiatr. 78, 572-581.

65. Kraehenmann, R., Schmidt, A., Friston, K., Preller, K.H., Seifritz, E., Vollenweider, F.X., 2016. The mixed serotonin receptor agonist psilocybin reduces threat-induced modulation of amygdala connectivity. Neuroimage Clin 11, 53-60.
66. Kraehenmann, R., Pokorny, D., Aicher, H., Preller, K.H., Pokorny, T., Bosch, O.G., Seifritz, E., Vollenweider, F.X., 2017. LSD increases primary process thinking via serotonin 2A receptor activation. Front. Pharmacol. 8, 814.
67. Kraehenmann, R., Pokorny, D., Vollenweider, L., Preller, K.H., Pokorny, T., Seifritz, E., Vollenweider, F.X., 2017. Dreamlike effects of LSD on waking imagery in humans depend on serotonin 2A receptor activation. Psychopharmacology (Berlin) 13, 2031-2046. https://doi.org/10.1007/s00213-017-4610-0.
68. Kuypers, K.P., Riba, J., de la Fuente Revenga, M., Barker, S., Theunissen, E.L., Ramaekers, J.G., 2016. Ayahuasca enhances creative divergent thinking while decreasing conventional convergent thinking. Psychopharmacology (Berlin) 233, 3395-3403.
69. Leary, T., Litwin, G.H., Metzner, R., 1963. Reactions to psilocybin administered in a supportive environment. J. Nerv. Ment. Dis. 137, 561-573.
70. Lebedev, A.V., Lovden, M., Rosenthal, G., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2015. Finding the self by losing the self: neural correlates of ego-dissolution under psilocybin. Hum. Brain Mapp. 36, 3137-3153.
71. Lebedev, A.V., Kaelen, M., Lovden, M., Nilsson, J., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2016. LSD-induced entropic brain activity predicts subsequent personality change. Hum. Brain Mapp.
72. Leroy, A., Foucher, J.R., Pins, D., Delmaire, C., Thomas, P., Roser, M.M., Lefebvre, S., Amad, A., Fovet, T., Jaafari, N., Jardri, R., 2017. fMRI capture of auditory hallucinations: validation of the two-steps method. Hum. Brain Mapp. 38, 4966-4979.
73. Letheby, C., 2016. The epistemic innocence of psychedelic states. Conscious. Cognit. 39, 28-37. https://doi.org/10.1016/j.concog.2015.11.012.
74. Liu, J., He, T., Zheng, C., Huang, Y., 1997. Measuring EEG complexity for studying the state of mental load. Sheng Wu Yi Xue Gong Cheng Xue Za Zhi 14 (1), 33-37.
75. Lubart, T., 2001. Models of the creative process: past, present and future. Creativ. Res. J. 13, 295-308.
76. Massimini, M., Boly, M., Casali, A., Rosanova, M., Tononi, G., 2009. A perturbational approach for evaluating the brain's capacity for consciousness. Prog. Brain Res. 177, 201-214.
77. Masters, R.A., 2010. Spiritual Bypassing : when Spirituality Disconnects Us from what Really Matters. North Atlantic Books, Berkeley, Calif.
78. Mateos, D.M., Guevara Erra, R., Wennberg, R., Perez Velazquez, J.L., 2018. Measures of entropy and complexity in altered states of consciousness. Cogn Neurodyn 12 (1), 73-84.
79. Matias, S., Lottem, E., Dugue, G.P., Mainen, Z.F., 2017. Activity patterns of serotonin neurons underlying cognitive flexibility. Elife 6.
80. McGlothlin, W., Cohen, S., McGlothlin, M.S., 1967. Long lasting effects of LSD on normals. Arch. Gen. Psychiatr. 17, 521-532.
81. McKenna, D., Riba, J., 2017. New world tryptamine hallucinogens and the neuroscience of ayahuasca. Curr Top Behav Neurosci.
82. Meisel, C., Storch, A., Hallmeyer-Elgner, S., Bullmore, E., Gross, T., 2012. Failure of adaptive self-organized criticality during epileptic seizure attacks. PLoS Comput. Biol. 8, e1002312.
83. Méndez, M.A., Zuluaga, P., Hornero, R., Góomez, C., Escudero, J., Rodríguez-Palancas, A., Ortiz, T., Fernáandez, A., 2012. Complexity analysis of spontaneous brain activity: effects of depression and antidepressant treatment. J. Psychopharmacol. 26 (5), 636e-643.
84. Milliere, R., 2017. Looking for the self: phenomenology, neurophysiology and philosophical significance of drug-induced ego dissolution. Front. Hum. Neurosci. 11, 245.
85. Moreno, F.A., Wiegand, C.B., Taitano, E.K., Delgado, P.L., 2006. Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. J. Clin. Psychiatr. 67, 1735-1740.
86. Moretti, P., Munoz, M.A., 2013. Griffiths phases and the stretching of criticality in brain networks. Nat. Commun. 4, 2521.
87. Mueller, F., Lenz, C., Dolder, P.C., Harder, S., Schmid, Y., Lang, U.E., Liechti, M.E., Borgwardt, S., 2017. Acute effects of LSD on amygdala activity during processing of fearful stimuli in healthy subjects. Transl. Psychiatry 7, e1084.
88. Muller, F., Lenz, C., Dolder, P., Lang, U., Schmidt, A., Liechti, M., Borgwardt, S., 2017. Increased thalamic resting-state connectivity as a core driver of LSD-induced hallucinations. Acta Psychiatr. Scand. 136, 648-657.
89. Muthukumaraswamy, S.D., Carhart-Harris, R.L., Moran, R.J., Brookes, M.J., Williams, T.M., Errtizoe, D., Sessa, B., Papadopoulos, A., Bolstridge, M., Singh, K.D., Feilding, A., Friston, K.J., Nutt, D.J., 2013. Broadband cortical desynchronization underlies the human psychedelic state. J. Neurosci. 33, 15171-15183.
90. Muzio, J.N., Roffwarg, H.P., Kaufman, E., 1966. Alterations in the nocturnal sleep cycle resulting from LSD. Electroencephalogr. Clin. Neurophysiol. 21, 313-324.
91. Nakai, T., Bagarinao, E., Matsuo, K., Ohgami, Y., Kato, C., 2006. Dynamic monitoring of brain activation under visual stimulation using fMRIethe advantage of realtime fMRI with sliding window GLM analysis. J. Neurosci. Meth. 157, 158-167.
92. Nandrino, J.L., Pezard, L., Martinerie, J., el Massioui, F., Renault, B., Jouvent, R., Allilaire, J.F., Widlocher, D., 1994. Decrease of complexity in EEG as a symptom of depression. Neuroreport 5, 528-530.
93. Naselaris, T., Prenger, R.J., Kay, K.N., Oliver, M., Gallant, J.L., 2009. Bayesian reconstruction of natural images from human brain activity. Neuron 63, 902-915.
94. Nichols, D.E., 2016. Psychedelics. Pharmacol. Rev. 68, 264-355.
95. Nutt, D.J., King, L.A., Nichols, D.E., 2013. Effects of Schedule I drug laws on neuroscience research and treatment innovation. Nat. Rev. Neurosci. 14, 577-585.
96. Olofsen, E., Sleigh, J.W., Dahan, A., 2008. Permutation entropy of the electroencephalogram: a measure of anaesthetic drug effect. Br. J. Anaesth. 101, 810-821.
97. Palhano-Fontes, F., Andrade, K.C., Tofoli, L.F., Santos, A.C., Crippa, J.A.S., Hallak, J.E.C., Ribeiro, S., de Araujo, D.B., 2015. The psychedelic state induced by ayahuasca modulates the activity and connectivity of the default mode network. PLoS One 10, e0118143.

98. Papo, D., 2016. Commentary: the entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. Front. Hum. Neurosci. 10, 423.
99. Petermann, T., Thiagarajan, T.C., Lebedev, M.A., Nicolelis, M.A., Chialvo, D.R., Plenz, D., 2009. Spontaneous cortical activity in awake monkeys composed of neuronal avalanches. Proc. Natl. Acad. Sci. U. S. A. 106, 15921-15926.
100. Petitmengin, C., 2017. Enaction as a lived experience towards a radical neurophenomenology. Constructivist Foundations 12, 139-147.
101. Petri, G., Expert, P., Turkheimer, F., Carhart-Harris, R., Nutt, D., Hellyer, P.J., Vaccarino, F., 2014. Homological scaffolds of brain functional networks. J. R. Soc. Interface 11, 20140873.
102. Pezard, L., Nandrino, J.L., Renault, B., ElMassioui, F., Allilaire, J.F., Muller, J., Varela, F.J., Martinerie, J., 1996. Depression as a dynamical disease. Biol. Psychiatr. 39, 991-999.
103. Preller, K.H., Pokorny, T., Hock, A., Kraehenmann, R., Stampfli, P., Seifritz, E., Scheidegger, M., Vollenweider, F.X., 2016. Effects of serotonin 2A/1A receptor stimulation on social exclusion processing. Proc. Natl. Acad. Sci. U. S. A. 113, 5119-5124.
104. Preller, K.H., Herdener, M., Pokorny, T., Planzer, A., Kraehenmann, R., Stampfli, P., Liechti, M.E., Seifritz, E., Vollenweider, F.X., 2017. The fabric of meaning and subjective effects in LSD-induced states depend on serotonin 2A receptor activation. Curr. Biol. 27, 451-457.
105. Priesemann, V., Valderrama, M., Wibral, M., Le Van Quyen, M., 2013. Neuronal avalanches differ from wakefulness to deep sleep-evidence from intracranial depth recordings in humans. PLoS Comput. Biol. 9, e1002985.
106. Priesemann, V., Wibral, M., Valderrama, M., Propper, R., Le Van Quyen, M., Geisel, T., Triesch, J., Nikolic, D., Munk, M.H., 2014. Spike avalanches in vivo suggest a driven, slightly subcritical brain state. Front. Syst. Neurosci. 8, 108.
107. Richards, W.A., 2015. Sacred Knowledge : Psychedelics and Religious Experiences. Columbia University Press, New York.
108. Roseman, L., Leech, R., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2014. The effects of psilocybin and MDMA on between-network resting state functional connectivity in healthy volunteers. Front. Hum. Neurosci. 8, 204.
109. Roseman, L., Sereno, M.I., Leech, R., Kaelen, M., Orban, C., McGonigle, J., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2016. LSD alters eyes-closed functional connectivity within the early visual cortex in a retinotopic fashion. Hum. Brain Mapp.
110. Roseman, L., Demetriou, L.,Wall, M.B., Nutt, D.J., Carhart-Harris, R.L., 2017. Increased amygdala responses to emotional faces after psilocybin for treatment-resistant depression. Neuropharmacology.
111. Roseman, L., Nutt, D.J., Carhart-Harris, R.L., 2018. Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. Front. Pharmacol. 8, 974. https://doi.org/10.3389/fphar.2017.00974.eCollection.
112. Sampedro, F., de la Fuente Revenga, M., Valle, M., Roberto, N., Dominguez-Clave, E., Elices, M., Luna, L.E., Crippa, J.A.S., Hallak, J.E.C., de Araujo, D.B., Friedlander, P., Barker, S.A., Alvarez, E., Soler, J., Pascual, J.C., Feilding, A., Riba, J., 2017. Assessing the psychedelic "After-Glow" in ayahuasca users: post-acute neurometabolic and functional connectivity changes are associated with enhanced mindfulness capacities. Int. J. Neuropsychopharmacol. 20, 698-711.
113. Sanches, R.F., de Lima Osorio, F., Dos Santos, R.G., Macedo, L.R., Maia-de-Oliveira, J.P., Wichert-Ana, L., de Araujo, D.B., Riba, J., Crippa, J.A., Hallak, J.E., 2016. Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a SPECT study. J. Clin. Psychopharmacol. 36, 77-81.
114. Sandison, R.A., 1954. Psychological aspects of the LSD treatment of the neuroses. J. Ment. Sci. 100, 508-515.
115. Schartner, M., Seth, A., Noirhomme, Q., Boly, M., Bruno, M.A., Laureys, S., Barrett, A., 2015. Complexity of multi-dimensional spontaneous EEG decreases during propofol induced general anaesthesia. PLoS One 10, e0133532.
116. Schartner, M.M., Carhart-Harris, R.L., Barrett, A.B., Seth, A.K., Muthukumaraswamy, S.D., 2017. Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. Sci. Rep. 7, 46421.
117. Schenberg, E.E., Alexandre, J.F.M., Filev, R., Cravo, A.M., Sato, J.R., Muthukumaraswamy, S.D., Yonamine, M., Waguespack, M., Lomnicka, I., Barker, S.A., da Silveira, D.X., 2015. Acute biphasic effects of ayahuasca. PLoS One 10, e0137202.
118. Schmidt, A., Muller, F., Lenz, C., Dolder, P.C., Schmid, Y., Zanchi, D., Lang, U.E., Liechti, M.E., Borgwardt, S., 2017. Acute LSD effects on response inhibition neural networks. Psychol. Med. 1-13.
119. Schultz, W., 2016. Dopamine reward prediction error coding. Dialogues Clin. Neurosci. 18, 23-32.
120. Seth, A.K., Barrett, A.B., Barnett, L., 2011. Causal density and integrated information as measures of conscious level. Philos Trans A Math Phys Eng Sci 369, 3748-3767.
121. Shannon, C.E., 1949. The Mathematical Theory of Communication. The University of Illinois Press.
122. Shew, W.L., Plenz, D., 2013. The functional benefits of criticality in the cortex. Neuroscientist 19, 88-100.
123. Speth, J., Speth, C., Kaelen, M., Schloerscheidt, A.M., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2016. Decreased mental time travel to the past correlates with default-mode network disintegration under lysergic acid diethylamide. J. Psychopharmacol. 30, 344-353.
124. Sun, L.,Wang, Y.F., He, H., Chen, J., 2007. Changes of the alpha competitive structure after administration of single dose methylphenidate in different subtypes of attention deficit hyperactivity disorder boys. Beijing Da Xue Xue Bao Yi Xue Ban 39 (3), 289-292.
125. Tagliazucchi, E., 2017. The signatures of conscious access and its phenomenology are consistent with large-scale brain communication at criticality. Conscious. Cognit. 55, 136-147.
126. Tagliazucchi, E., Sanz, C., 2018. The experience elicited by hallucinogens presents the highest similarity to dreaming within a large database of psychoactive substance reports. Front. Neurosci. 12, 7. https://doi.org/10.3389/fnins.2018.00007.eCollection.
127. Tagliazucchi, E., Balenzuela, P., Fraiman, D., Chialvo, D.R., 2012. Criticality in largescale brain FMRI dynamics unveiled by a novel point process analysis. Front. Physiol. 3, 15.
128. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D., Chialvo, D.R., 2014. Enhanced repertoire of brain dynamical states during the psychedelic experience. Hum. Brain Mapp. 35, 5442-5456.
129. Tagliazucchi, E., Chialvo, D.R., Siniatchkin, M., Amico, E., Brichant, J.F., Bonhomme, V., Noirhomme, Q., Laufs, H., Laureys, S., 2016a. Large-scale signatures of unconsciousness are consistent with a departure from critical dynamics. J. R. Soc. Interface 13, 20151027.
130. Tagliazucchi, E., Roseman, L., Kaelen, M., Orban, C., Muthukumaraswamy, S.D., Murphy, K., Laufs, H., Leech, R., McGonigle,

J., Crossley, N., Bullmore, E., Williams, T., Bolstridge, M., Feilding, A., Nutt, D.J., Carhart-Harris, R., 2016b. Increased global functional connectivity correlates with LSD-induced ego dissolution. Curr. Biol. 26, 1043-1050.

131. Thomasson, N., Pezard, L., 1999. Dynamical systems and depression: a framework for theoretical perspectives. Acta Biotheor. 47, 209-218.
132. Thomasson, N., Pezard, L., Allilaire, J.-F., Renault, B.M., Martinerie, J., 2000. Nonlinear EEG changes associated with clinical improvement in depressed patients. Nonlinear Dynam. Psychol. Life Sci. 4, 203-218.
133. Thomasson, N., Pezard, L., Boyer, P., *et al.*, 2002. Nonlinear EEG changes in a 48-hour cyclic manic-depressive patient. Nonlinear Dynam. Psychol. Life Sci. 6, 259.
134. Timmermann, C., Spriggs, M.J., Kaelen, M., Leech, R., Nutt, D.J., Moran, R.J., Carhart-Harris, R.L., Muthukumaraswamy, S.D., 2017. LSD modulates effective connectivity and neural adaptation mechanisms in an auditory oddball paradigm. Neuropharmacology.
135. Timmermann, C., Roseman, L., Williams, L., Schartner, M., Leech, R., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2018. Enter the Void: EEG Correlates of the DMT Experience. (In prep).
136. Tononi, G., Edelman, G.M., 1998. Consciousness and complexity. Science 282, 1846-1851.
137. Tononi, G., Sporns, O., Edelman, G.M., 1994. A measure for brain complexity: relating functional segregation and integration in the nervous system. Proc. Natl. Acad. Sci. U. S. A. 91, 5033-5037.
138. Tononi, G., Boly, M., Massimini, M., Koch, C., 2016. Integrated information theory: from consciousness to its physical substrate. Nat. Rev. Neurosci. 17, 450-461.
139. Torda, C., 1968. Contribution to serotonin theory of dreaming (LSD infusion). N. Y. State J. Med. 68, 1135-1138.
140. Valle, M., Maqueda, A.E., Rabella, M., Rodriguez-Pujadas, A., Antonijoan, R.M., Romero, S., Alonso, J.F., Mananas, M.A., Barker, S., Friedlander, P., Feilding, A., Riba, J., 2016a. Inhibition of alpha oscillations through serotonin-2A receptor activation underlies the visual effects of ayahuasca in humans. Eur. Neuropsychopharmaco. J. Eur. Coll. Neuropsychopharmacol. 26, 1161-1175.
141. Valle, M., Maqueda, A.E., Rabella, M., Rodriguez-Pujadas, A., Antonijoan, R.M., Romero, S., Alonso, J.F., Mananas, M.A., Barker, S., Friedlander, P., Feilding, A., Riba, J., 2016b. Inhibition of alpha oscillations through serotonin-2A receptor activation underlies the visual effects of ayahuasca in humans. Eur. Neuropsychopharmacol 26, 1161-1175.
142. Varela, F., 1996. Neurophenomenology: a methodological remedy for the hard problem. J. Conscious. Stud. 3, 330-349.
143. Viol, A., Palhano-Fontes, F., Onias, H., de Araujo, D.B., Viswanathan, G.M., 2017. Shannon entropy of brain functional complex networks under the influence of the psychedelic Ayahuasca. Sci. Rep. 7, 7388.
144. Waldman, A.A., 2017. A Really Good Day : How Microdosing Made a Mega Difference in My Mood, My Marriage, and My Life.
145. Watts, R., Day, C., Krzanowski, J., Nutt, D., Carhart-Harris, R., 2017. Patients' accounts of increased "connectedness" and "acceptance" after psilocybin for treatment-resistant depression. J. Humanist. Psychol. 57, 520-564.
146. Zarjam, P., Epps, J., Lovell, N.H., Chen, F., 2012. Characterization of memory load in an arithmetic task using non-linear analysis of EEG signals. Conf Proc IEEE Eng Med Biol Soc 3519-3522.
147. Zhang, X.S., Roy, R.J., Jensen, E.W., 2001. EEG complexity as a measure of depth of anesthesia for patients. IEEE Trans. Biomed. Eng. 48 (12), 1424-1433.

A whole-brain model of the neural entropy increase elicited by psychedelic drugs

by

Rubén Herzog[1,✉], Pedro A. M. Mediano[2,3], Fernando E. Rosas[4,5,6,16], Paul Lodder[7], Robin Carhart-Harris[5,8], Yonatan Sanz Perl[9,10,11], Enzo Tagliazucchi[12,13] & Rodrigo Cofre[14,15]

Scientifc Reports - (2023) 13:6244
Received: 20 October 2022; Accepted: 30 March 2023; Published online: 17 April 2023

doi.org/10.1038/s41598-023-32649-7

© Authors 2023

original report: https://www.nature.com/articles/s41598-023-32649-7

[1] Centro Interdisciplinario de Neurociencia de Valparaíso, Universidad de Valparaíso, Pje Harrington 287, 2360103 Valparaíso, Chile.
[2] Department of Computing, Imperial College London, London SW7 2DD, UK.
[3] Department of Psychology, University of Cambridge, Cambridge CB2 3EB, UK.
[4] Department of Informatics, University of Sussex, Brighton BN1 9RH, UK.
[5] Centre for Psychedelic Research, Department of Brain Science, Imperial College London, London SW7 2DD, UK.
[6] Centre for Complexity Science, Imperial College London, London SW7 2AZ, UK.
[7] Informatics Institute, University of Amsterdam, P.O. Box 94323, 1090 GH Amsterdam, The Netherlands.
[8] Psychedelics Division, Neuroscape, University of California San Francisco, San Francisco, CA, USA.
[9] Computational Neuroscience Group, Center for Brain and Cognition, Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Catalonia, Spain.
[10] Universidad de San Andrés, Buenos Aires, Argentina.
[11] Institut du Cerveau et de la Moelle épinière, ICM, Paris, France.
[12] Buenos Aires Physics Institute and Physics Department, University of Buenos Aires, Buenos Aires, Argentina.
[13] Latin American Brain Health Institute (BrainLat), Universidad Adolfo Ibáñez, Santiago, Chile.
[14] CIMFAV-Ingemat, Facultad de Ingeniería, Universidad de Valparaíso, Valparaíso, Chile.
[15] Institute of Neuroscience (NeuroPSI), Paris-Saclay University, Centre National de la Recherche Scientifque (CNRS), Gif-sur-Yvette, France.
[16] Centre for Eudaimonia and Human Flourishing, University of Oxford, Oxford OX3 9BX, UK.
✉ email: ruben.herzog@postgrado.uv.cl

Table of Contents:

Open
Results
Discussion
Final remarks
Methods
Acknowledgements
References
Supplementary Information
Subsection 1. Model fit to empirical BOLD data
Supplementary References

Open

Psychedelic drugs, including lysergic acid diethylamide (LSD) and other agonists of the serotonin 2A receptor (5HT2A-R), induce drastic changes in subjective experience, and provide a unique opportunity to study the neurobiological basis of consciousness. One of the most notable neurophysiological signatures of psychedelics, increased entropy in spontaneous neural activity, is thought to be of relevance to the psychedelic experience, mediating both acute alterations in consciousness and long-term effects. However, no clear mechanistic explanation for this entropy increase has been put forward so far. We sought to do this here by building upon a recent whole-brain model of serotonergic neuromodulation, to study the entropic effects of 5HT2A-R activation. Our results reproduce the overall entropy increase observed in previous experiments *in vivo*, providing the first model-based explanation for this phenomenon. We also found that entropy changes were not uniform across the brain: entropy increased in all regions, but the larger effect were localised in visuo-occipital regions. Interestingly, at the whole-brain level, this reconfiguration was not well explained by 5HT2A-R density, but related closely to the topological properties of the brain's anatomical connectivity. These results help us understand the mechanisms underlying the psychedelic state and, more generally, the pharmacological modulation of whole-brain activity.

Psychedelic drugs provide a privileged opportunity to study the mind-brain relationship, and promise to revolutionise some of our current mental health treatments[1-3]. While some aspects of the neurochemical action of psychedelics at the neuronal and sub-neuronal level are well known[4,5], our current understanding of their action at the whole-brain level is still very limited. A deeper understanding of the mechanisms that trigger the changes in conscious experience produced by psychedelics would greatly advance our knowledge of human consciousness, as well as therapeutic development of psychedelics.

At a subjective level, serotonergic psychedelics (including LSD, dimethyltryptamine [DMT] and psilocybin, among others) potentially modulate mood, cognition, perception and self-awareness. At a neurophysiological level, recent research has identified (among many) two particularly prominent signatures of the psychedelic state: an overall dysregulation of neural population activity, most clearly seen as suppression of spectral power in the alpha (8-12 Hz) band[6-8]; and an increase in the signal diversity of the neural activity, measured through the information-theoretic notion of entropy[9]. In particular, this acute entropy increase has been linked to both short- and long-term effects of the psychedelic experience, including certain aspects of the reported subjective experience[9] and subsequent personality changes[10].

Interestingly, the opposite effects have been reported for states of loss of consciousness, where a strong *decrease* in brain entropy has been repeatedly observed. This seems to be a core feature of loss of consciousness, generalising across states such as deep sleep[11], general anaesthesia[12], and disorders of consciousness[13]. Together, these facts are yielding converging evidence that entropy and related measures offer simple and powerful indices of consciousness.

Based on these findings, Carhart-Harris and colleagues have put forward the *Entropic Brain Hypothesis* (EBH) an entropy-based theory of conscious states[1,14]. The EBH proposes the simple, yet powerful idea that the variety of states of consciousness can be indexed by the entropy of key parameters of brain activity; or, in other words, that the richness of subjective experience is directly related to the richness of on-going neural activity, where richness can be defined most simply as diversity. Note that even when different states can be indexed by their corresponding diversity, we are not claiming that one state is more conscious than other. Therefore, investigating the neurobiological origins of such changes in brain activity is a key step in the study of altered states of consciousness.

Multiple experiments in humans and animal models have established that the mind-altering effects of psychedelics depend on agonism specifically at the serotonin 2A receptor (5HT2A-R)[15-17]. A recent simulation study involving whole-brain computational modelling confirmed that the topographic distribution of 5HT2A-R in the human brain is critical to reproduce the functional connectivity dynamics (FCD) of human fMRI data recorded under the acute effects of LSD[18]. Here we build upon this model to characterise the interplay between the entropy of brain signals, the distribution of 5HT2A receptors, and structural connectivity properties of the brain, with the overarching goal of explaining the sources of entropic effects, and thus altered consciousness, elicited by psychedelic drugs.

Results

We simulated whole-brain activity using the Dynamic Mean-Field (DMF) model by Deco *et al.*[19,20], using parameter values fit to reproduce the dynamics of fMRI recordings in humans during wakeful rest, as well as under the acute effects of LSD (see Supplementary Figure 1)[18]. The model consists of interacting pools of excitatory and inhibitory neural populations, coupled via long-range excitatory connections informed by the anatomical connectivity of the brain. The DMF model combines a theoretical model of neural and synaptic dynamics with two empirical sources of information about the human brain: the human connectome, i.e. DTI-estimated connectivity between the 90 regions of the AAL[21] atlas; and average 5HT2A-R expression across the human brain obtained with Positron Emission Tomography (PET) scans[22].

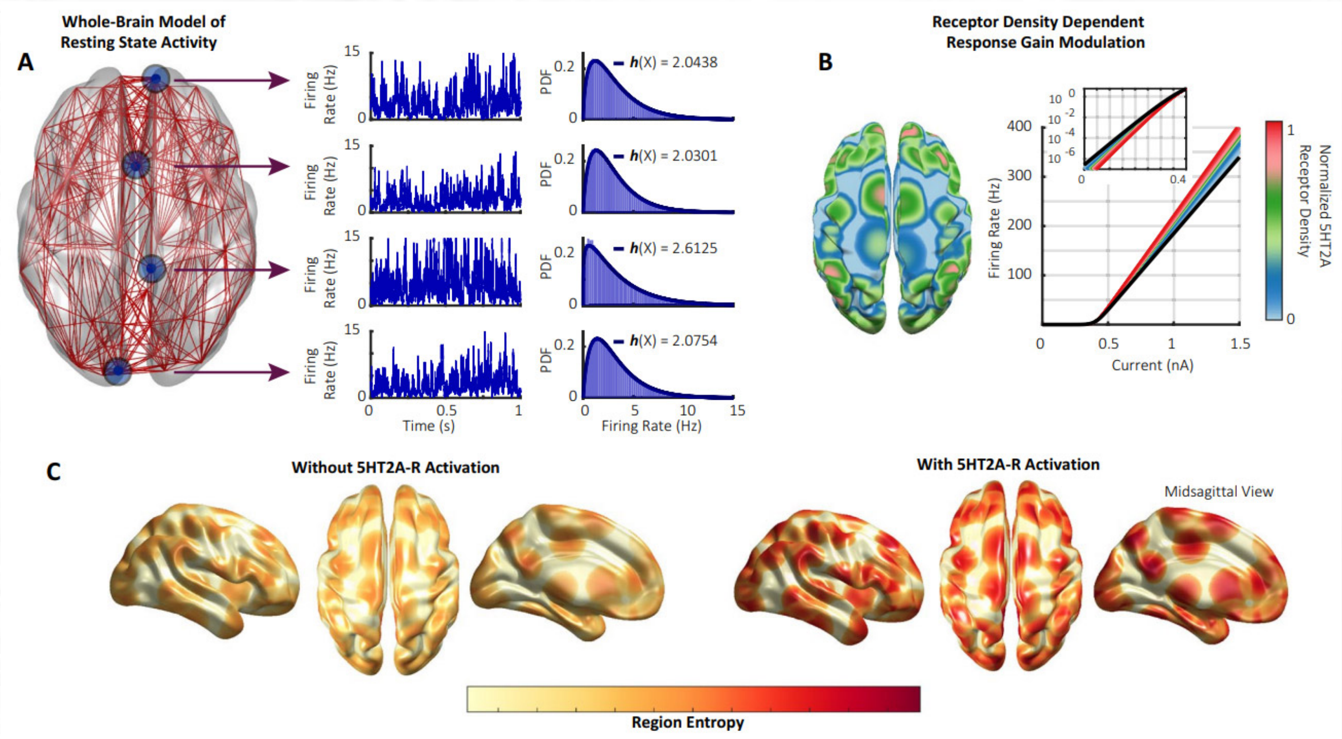


Figure 1. Modelling the effect of 5HT2A-R activation on the whole-brain topographical distribution of entropy. (**A**) Resting state activity is simulated using the dynamic mean-Field (DMF) model, in which each region's activity is represented by a time series of excitatory firing rates (constrained to 0-15 Hz for visualisation). The probability density function (PDF) and differential entropy ($\boldsymbol{h}$(X)) of each region is then estimated, obtaining a topographical distribution of entropy values. (**B**) 5HT2A-R agonism is modelled as a receptor-density-dependent response gain modulation. Black line is the frequency-current (F-I) curve of a population without 5HT2A-R agonism, and coloured curves show the resulting F-I curves of regions with increasing 5HT2A-R agonism. (**C**) 5HT2A-R activation changes the topographical distribution of entropy with respect to resting state activity, which constitutes the main subject of analysis in this study.

Each simulation of the DMF model generates 90 time series of excitatory and inhibitory firing rates, one of them for each region of the AAL atlas (Fig. 1A). These firing rates have a non-linear dependency on the local inputs, determined by a frequency-current (*F-I*) curve. Given that 5HT2A-R seems to modulate the sensitivity of neurons rather than driving them towards excitation or inhibition[4,23,24], we followed Deco *et al.*[18] and modelled 5HT2A-R activation as a response-gain modulation[25] of this F-I curve dependent on the receptor density at a given region (Fig. 1B).

We simulated the model in two conditions, with and without 5HT2A-R activation, which, in an analogy with neuroscientific terminology, we refer to as placebo (PLA) and 5HT2A-R conditions, respectively. In this way, we obtain 90 time series of excitatory firing rates for each condition, which we keep for further analysis.

Finally, using these time series, we estimate Shannon's differential entropy for each region under both conditions, yielding a topographical distribution of entropy values (Fig. 1C) that constitutes the main subject of analysis in this study. Further details about model specification and entropy estimation, as well as other methodological caveats, are presented in the Methods section at the end of this article.

5HT2A-R activation causes a heterogeneous, linear increase in the entropy of simulated brain activity. In our first analysis, we used the DMF model to test the main prediction of the EBH: that 5HT2A-R activation causes an increase in the overall entropy of neural signals (Fig. 2). In line with previous experimental findings with psychedelic drugs[9], the model shows a significant increase in the brain's entropy h due to 5HT2A-R activation, with an average entropy of $h^{\mathrm{PLA}} = 2.15$ nat in the placebo condition, and $h^{\mathrm{5HT2A}} = 2.25$ nat in the 5HT2A-R condition (dashed vertical lines in Fig. 2B, Wilcoxon signed-rank test $p < 10^{-6}$, Cohen's $d = 0.98 \pm 0.05$).

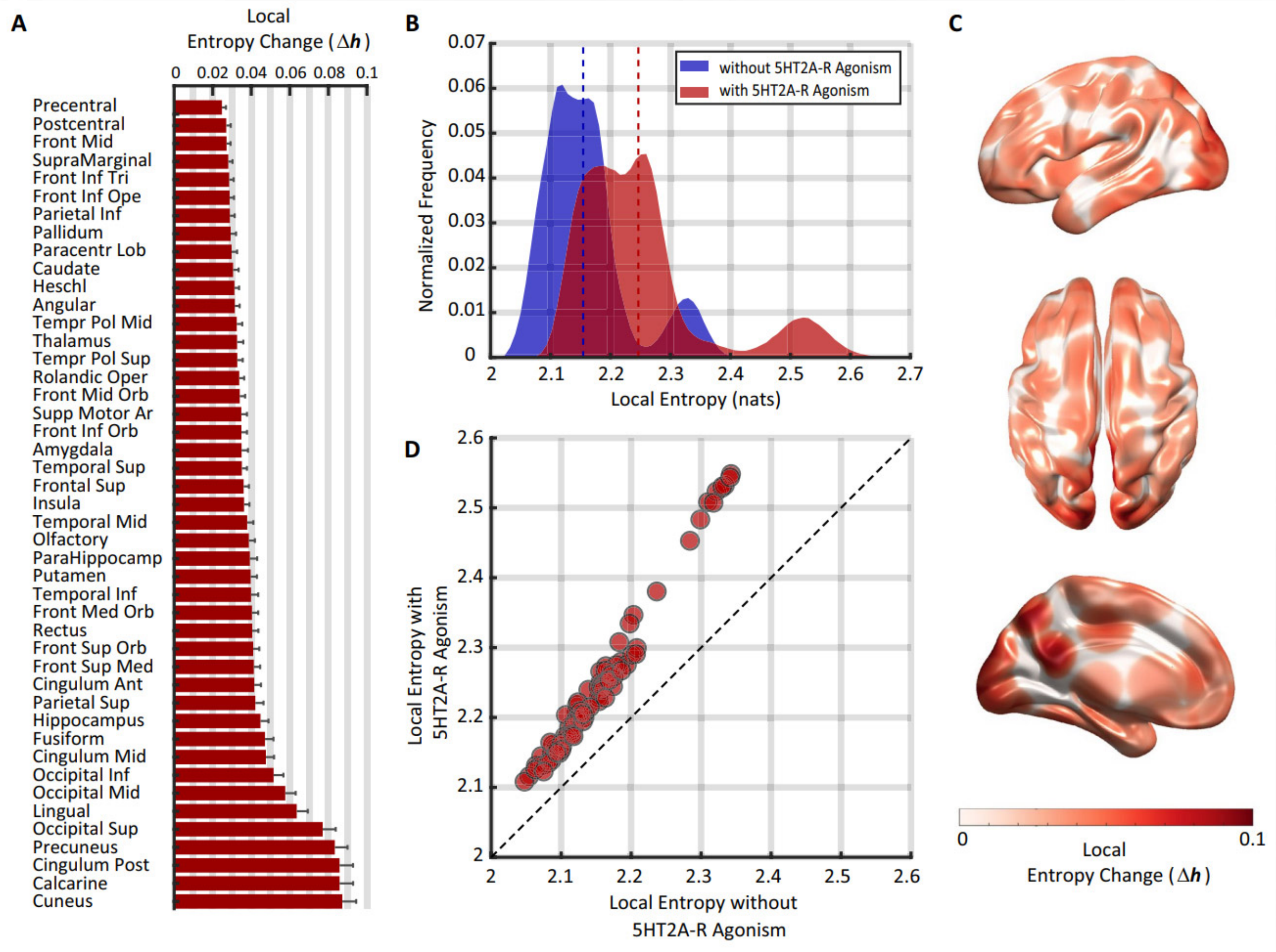


Figure 2. Linear heterogeneous increase of entropy following 5HT2A-R activation. (**A**) Effect of 5HT2A-R agonism on the local entropy each of region in the AAL atlas. See Supplementary Table 1 for abbreviations. Bars indicate the (bilateral) average relative change in local entropy, Δh_n, and error bars indicate 1 standard deviation across 1000 simulations. (**B**) Histograms of local entropy values for the condition with (red) and without (blue) 5HT2A-R activation. 5HT2A-R activation increased both the average and the spread of the local entropy distribution. (**C**) Topographical map of entropy changes. Brain regions are coloured according to their Δh_n values. (**D**) 5HT2A-R agonism changed the topographical distribution of entropy in linear manner. Each circle indicates the averages of each region across 1000 simulations.

A closer look at the distribution of entropy changes, however, reveals a more nuanced picture, entropy increases for all regions, but the effect is larger for visuo-occipital regions, compared to the rest of the regions (Fig. 2D, Supp. Fig. 2). This suggests that, according to the model, 5HT2A-R agonism might trigger a complex reconfiguration of the topographically specific distribution of entropy, and not a mere homogeneous overall increase.

To investigate this reconfiguration, we analysed the local changes in entropy by plotting the entropy of the nth region in both PLA and 5HT2A conditions, denoted by h_n^{5HT2A} and h_n^{PLA} respectively (Fig. 2D). Our results show that 5HT2A-R activation affects local entropy in a non-uniform and linear manner, especially in regions with high baseline resting state entropy. In particular, in such regions the effect of 5HT2A-R activation show a different tendency than the rest of the regions, such that the local entropy in the 5HT2A-R condition could not always be determined by the region's baseline entropy. This finding hints towards a more general theme: that local dynamical properties alone are not able to explain the local changes in activity induced by 5HT2A-R agonists like psychedelic drugs. We will explore this phenomenon in depth in the following sections.

Next, we studied the effect of 5HT2A-R agonism on local entropy by considering the relative change scores,

$$\Delta hn=hn5HT2A-hnPLAhnPLA\ .$$

Based on recent in vivo experiments with serotonergic psychedelics we expect to find localized entropy increases on occipital, cingulate and parietal regions[9,10] as well as several changes on regions belonging to Resting State Networks (RSNs)[7,26,27]. Accordingly, we split brain regions by standard anatomical and functional groupings, and found that the effect were localised specially in occipital areas, together with some cingulate and parietal regions. (Fig. 2A, Supp. Fig. 1). Additionally, regions participating in the primary visual and Default Mode (DMN) RSNs - including occipital and cingulate areas, respectively - showed a marked tendency to increase their entropy, as well as regions participating in the Frontoparietal Executive Network (FPN). Further discussion about the relation between these results and recent in vivo experiments with psychedelic drugs is presented in the Discussion section.

The topography of entropy changes is explained by local connectivity strength and 5HT2A-R density. Given the results above, and given the potential clinical and neuroscientific relevance of entropy reconfiguration in the psychedelic state, our next task is to elucidate what neurobiological factors underlie such phenomenon. In this section we investigate which structural and dynamical features of the model are able to predict local entropy changes due to 5HT2A-R activation, and what we can learn about the large-scale action mechanism of psychedelic drugs and other 5HT2A-R agonists.

To explain the effects of 5HT2A-R activation, the first natural step is to factor in the density of 5HT2A-R at each region. Somewhat surprisingly, at a whole-brain level, receptor density was a very poor predictor of the entropy change due to 5HT2A-R activation (Fig. 3A, $R^2 = 0.0053 \pm 0.0014$). In contrast, we found that the connectivity strength (based on the DTI human connectome), defined as the sum of all the weighted links connecting a given region, exhibited a moderate correlation with local entropy changes (Fig. 3B, $R^2 = 0.45 \pm 0.14$).

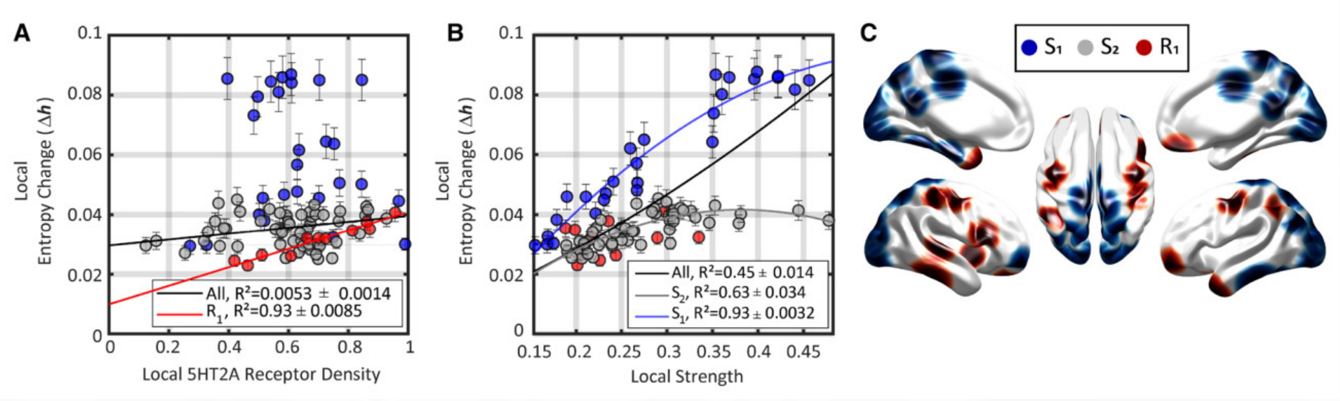


Figure 3. Changes in local entropy are explained best by connectivity strength, then receptor density. (**A**) Changes in entropy were overall independent from receptor density, although (**B**) they were well predicted by the connectivity strength of each region. We split into strength (blue and gray), and receptor dependent groups (red). The S_1 and S_2 groups showed no significant relationship with receptor density, while the R_1 group were highly correlated with it. (**C**) Topographical localisation of the three groups, following the same colour code. S_1 were mainly located in occipital, parietal and cingulate regions, while the R_1 ones were in temporal and frontal ones.

By visual inspection, however, it is clear that the relationship between DTI-informed connectivity strength and Δh_n is complex and can be split in two separate tendencies. To investigate this phenomenon, we implemented a simple optimisation algorithm to find the set of regions with the strongest relationship between strength and Δh_n. Tis yielded a set of regions with a higher strength-Δh_n correlation (S_1, $R^2 = 0.93 \pm 0.0032$, as opposed to $R^2 = 0.45 \pm 0.14$ for the whole-brain), and induced a partition of all brain regions into three groups: those highly dependent on strength (S_1, 27 regions, blue in Fig. 3A), those less dependent on strength (S_2, 42 regions, gray), and those highly dependent on receptors (R_1, 11 regions, red).

Building up on this partition, we studied the effect of receptor density on those regions where entropy change could not be predicted from connectivity strength - the R_1 group. We found a strong relationship between receptor density and entropy changes for the R_1 group, which resulted in positive correlation ($R^2 = 0.93 \pm 0.0085$). On the contrary, receptor density does not predict entropy changes for areas in the S_1 and S_2. This shows a complementary role of density and strength in S_1, S_2, and R_1 regions: entropy changes in R_1 regions strongly depend on the receptor density, but not connectivity strength; while changes in S_1, S_2 regions depend on connectivity strength, but not receptor density.

Overall, to assess the predictive power of connectivity strength and the receptor density on local entropy changes, we built a linear mixed model for Δh_n using connectivity strength, 5HT2A-R density, and the aforementioned three-way separation of brain regions as the predictor variables. Together these variables explain $94.5 \pm 0.002\%$ of the variance of Δh_n, confirming that they provide an accurate model for predicting the entropic effects of 5HT2A-R activation. This suggests that psychedelic drugs and other 5HT2A-R agonists do not have a simple, localised effect on brain activity, but instead amplify the fundamentally collective, emergent properties of the brain as a complex system of interacting elements.

The specific connectivity strength distribution explains relative changes in entropy. As a final analysis, we set out to investigate exactly which topological properties of the brain's structural connectivity explain the observed changes in entropy. With this exercise, we aim to answer two questions: whether any property simpler than connectivity strength *can* explain the results; and whether any property more complicated than connectivity strength is *needed* to do so.

To this end, we ran further simulations of the DMF model using suitable null network models of the human connectome (Fig. 4A), with the 5HT2A-R density map held fixed. In particular, we used three null models designed to test increasingly strict null hypotheses that preserved different network attributes of the original connectome: (1) the overall density and strength (RAND, Fig. 4B), (2) the degree distribution (degree-preserving randomisation [DPR], Fig. 4C); and (3) the strength distribution (strength-preserving randomisation, [DSPR], Fig. 4D). We simulated the DMF model in these surrogate networks, with and without neuromodulation, and computed the resulting entropy changes Δh_n.

Our first result is that random and degree-preserving surrogate networks are unable to reproduce the entropy changes observed in the human connectome: when compared against the Δh_n values obtained from the unperturbed network, neither of them produce values close to the original (Fig. 4E,F). This result asserts the findings in the previous section, showing that indeed node strength plays an important role in shaping the global pattern of entropy change associated with the action of psychedelics and other 5HT2A-R agonists. Simpler topological features, like the degree distribution, are not enough to explain such changes.

Perhaps more interestingly, the connectivity strength-preserving surrogate networks partially reproduced the entropy changes, suggesting that higher-order properties of the connectome are necessary (Fig. 4G). Furthermore, we repeated the analyses in the previous section trying to predict Δh_nusing other local connectivity measures (e.g. betweenness, eigenvector centrality), and none of them produced a model as accurate as strength (Supp. Fig. 2). Together, these results show that, once the receptor distribution is fixed, the network strength distribution is both *necessary* but not *suffcient* to explain the entropic effects of 5HT2A-R activation.

As previously suggested, other topological network features are known to mediate transitions of consciousness in other contexts[28], and investigating which network properties explain high-order dynamical signatures[29] of psychedelics remains an exciting avenue of future work.

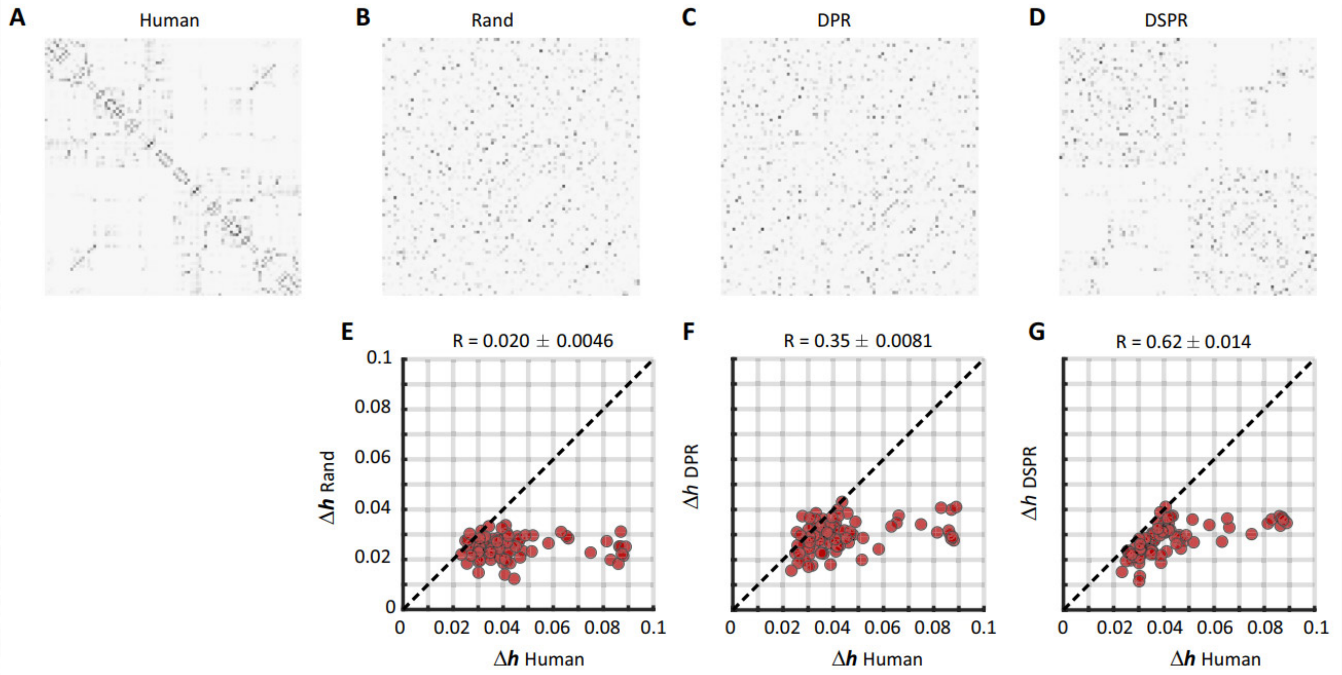


Figure 4. Relative changes in entropy are partially reproduced by a strength-preserving null model of the connectome. (**A-D**) Connectivity matrices used to control the role of local properties of the connectome on Δh_n. See main text for the description of the matrices and randomisation algorithm. (**E-G**) Scatter plots of Δh_n for the human connectome against the three null models. DSPR yielded a high but not perfect correlation showing that local network properties of human connectome are necessary but not suficient to capture the effect of 5HT2A-R activation.

Discussion

In this study, we investigated the brain entropy changes induced by serotonergic psychedelics by simulating whole-brain resting state activity with and without 5HT2A-R activation. In contrast to empirical studies, which usually only have access to coarse-grained fMRI or M/EEG data, our approach allows us to study firing rates of brain regions and hence to directly assess the effect of 5HT2A-R agonism at the level of neural population activity.

In agreement with the Entropic Brain Hypothesis[14], the model shows a significant increase of global brain entropy, with a inhomogeneous and linear reconfiguration. The diversity of effects stresses the importance of extending the scope of the EBH from a simple level-based approach towards a multi-dimensional perspective, which might better characterise the richness of 5HT2A-R activation effect both on the brain and consciousness.

We propose a possible mechanism in the sense that the average increase in neural entropy induced by serotonergic psychedelic drugs can be explained (in statistical sense) in terms of quantities that provide a neurobiological interpretation about how this phenomena could occur in the brain. These results have important consequences for our understanding of consciousness, neurodynamics, and the psychedelic state. In the following, we highlight some of those implications, and propose possibilities for future work.

5HT2A-R-induced entropy changes are regionally heterogeneous. Our main result in this study is a mechanistic explanation of the main prediction of the EBH that serotonergic psychedelics increase the entropy of brain activity. However, one of the main takeaways is that this overall increase is tied to a spatially heterogeneous reconfiguration, rather than a globally consistent increase, in entropy.

Our simulation results show that 5HT2A-R activation triggers an entropy increase in sensory areas, as observed in occipital cortices, as well as the primary visual RSN (Supp. Fig. 2). This agrees with the increased perceptual 'bandwidth' that characterises the psychedelic state[30], as higher entropy might be related to richer perceptual experience in a given moment of consciousness - potentially related to reduced gating. As a matter of fact, all the primary visual RSN regions are part of the S_1 group, suggesting that the effect of psychedelics on perceptual experience might be directly related to the connectivity of those regions. The localisation of the entropy increases may relate to domain-specific changes in consciousness, which could be interpreted as consistent with a recent dimensions of consciousness characterisation of the psychedelic experience[31].

Comparison to *in vivo* experiments with psychedelic drugs. Throughout the paper, we have focused on one particular signature of 5HT2A-R agonists on the brain - a global increase in average entropy. But much more is known about the effect of psychedelics on the brain, and studying these more nuanced effects is key to understanding the rich phenomenology of the psychedelic state. In this section we deepen this connection by providing a more detailed comparison between the behaviour of the model and experimental results with psychedelic drugs.

Our findings are in agreement with earlier studies where the effect of psychedelic drugs on the topographical distribution of entropy-related measures was correlated with subjective effects. For example, Schartner *et al.*[9] studied the effect of LSD, psilocybin, and ketamine on the entropy rate of binarized MEG signals, and found localised increases in entropy rate on occipital and parietal regions. Similarly, Lebedev *et al.*[10] analysed the sample entropy of fMRI recordings of subjects under the effect of LSD, finding localized increases on frontoparietal, medial occipital, posterior and dorsal cingulate regions. Many of those regions showed a consistent increase of their entropy with 5HT2A-R agonism in our study (Fig. 2A).

Moreover, many of those regions actually belong to the S_1 group (c.f. Fig. 3), which suggests that their entropy increase in experimental data might be directly related to the connectivity in those regions.

Together, these findings support the conclusion that the DMF model, once optimised, can reproduce not only functional connectivity[18], but also some of the most salient localised entropy increases found on in vivo human studies up to date.

Also, on a more fundamental level, our findings suggest that psychedelics disrupt the functional organisation of the brain with an especially focal and pronounced action on highly anatomically connected brain regions. In fact, experimental and modelling evidence points towards a key role of connector hubs on psychedelic and psychopatological states[32,33].

Perturbing the activity in these specific regions (via 5HT2A-R agonism) could have particularly profound implications for the regularity of brain activity and the quality of conscious experience. However, sub cortical regions may also play an important role on the modulation of brain activity, conscious experience, and the psychedelic state[34].

On a separate line of inquiry, there is strong evidence associating the DMN to high-level cognitive functions, including the sense of space, time and recognition of (self) boundaries.

Disruptions to the DMN have been linked to fundamental changes in experience, such as ego dissolution[14,35]. Our simulation results show that 5HT2A-R activation increases the entropy of all DMN regions, which is consistent with the reported decrease in the DMN network integrity[32] induced by psychedelic drugs. In contrast, low-level motor functions such as motor regulation remain largely unaffected during the psychedelic state[36], which is consistent with the modest entropy changes observed in the lingual and superior motor areas.

Current limitations and future research. The approach employed in this work presents certain limitations related to several aspects of the simulation and analysis. Acknowledging and understanding these limitations can help us extend and improve our approach, while introducing new questions in the field of psychedelic computational neuroscience.

To our knowledge, the DMF model is the only whole-brain model that implements neuromodulation and is capable of reproducing neuroimaging data in the placebo and psychedelic states. Nonetheless, it makes some important simplifications that are worth discussing. At the network level, the DTI-based connectome used here is known to be incomplete, thus improvements could be made to the model parameters of brain connectivity[37]. At the dynamical level, the DMF model models neuronal populations as perfectly homogeneous within a given region, and it is known that finer-grained local structure of certain brain regions is likely to be key to explaining certain subjective effects of the psychedelic state (e.g. lattice structure in the visual cortex and geometric visual hallucinations[38]). Additionally, the version of the DMF model used here only considers 5HT2A-

R agonism, while classic serotonergic psychedelic drugs also have high binding affinities for other receptors (e.g. in the case of LSD, the D1 and D2 dopamine receptors[39]).

These simplifications do not prevent the model from reproducing statistical features of brain signals under the placebo and 5HT2A-R conditions, but could result in an inability to reproduce finer aspects of the dynamics of the whole-brain activity in these conditions. Extending the model to reproduce other dynamical signatures of psychedelics (like alpha suppression[8] or reduced directed functional connectivity[40]) constitutes a natural extension of this work, with the recent example of Kringelbach *et al*.[41] where an extension of the DMF can reproduce dynamical features of the brain in placebo and in the psychedelic state.

Another potentially fruitful line of future work involves making more detailed comparisons with in vivo psychedelic neuroimaging data, and, potentially, subjective experience reports. For example, one natural option would be to use forward models of fMRI[42] or M/EEG[43] to bridge between the firing rates produced by the DMF model and other data modalities, to produce simulated data that is more directly comparable with available empirical data.

Another exciting possibility is to explore model parameters to examine potential non-linearities and their implications for different relevant aspects of brain function. For example, there are reasons to believe that the dose-response relationship is non-linear for psychedelics and that over a certain threshold dosage (level of 5HT2A-R stimulation) new subjective and global brain function properties can appear[44].

Most interestingly, a potentially very useful extension of this work would be to include individual subject-level connectome and receptor data to build personalised models of response to psychedelic drugs. This would enable a much more comprehensive modelling framework, capable of correlating structural brain features with subjective experience reports. Such a framework could potentially make individualised predictions of the action of serotonergic psychedelics on specific individuals, aiding patient stratification and treatment customisation[2].

Finally, it is worth noting that all our analyses here are based on the univariate statistics of individual brain regions, not including any correlation or information flow between them. However, it is known that some high-level subjective effects of psychedelics (such as complex imagery[7] and ego dissolution[35]) are related to network, as opposed to single region, dynamics. Therefore, building a richer statistical description of the brain's dynamics using recent information-theoretic tools (such as multivariate extensions of mutual information[29] or Integrated Information Theory, IIT[45]) remains an exciting open problem. In fact, recent attempts of unifying IIT and the EBH in a single framework to understand the effects of psychedelic drugs[46] are helping to bridge the gap between the univariate EBH and the multivariate IIT.

Final remarks

In this paper, we have provided the first mechanistic explanation of the neural entropy increase elicited by psychedelic drugs, using a whole-brain dynamical model with 5HT2A-R neuromodulation. Furthermore, we built a simple model able to predict a region's relative change in entropy from its local 5HT2AR density and topological properties, showing that, somewhat paradoxically, at a whole-brain level receptor density is a poor predictor of 5HT2A-R activation effect.

Key to developing this predictive model was a three-way partition of brain regions according to the dependency they exhibited with connectivity strength, suggesting a differentiated action mechanism of 5HT2A-R agonists that depends on the local topology of brain regions. In summary, our results suggest that the local changes in entropy, as well as the global entropy increase, induced by 5HT2A-R activation can be explained from a region-specific interplay between structural connectivity and receptor density. Finally, controlled experiments with null network models confirm that receptor density and connectivity strength are necessary, but not sufficient, to explain the entropic effects of 5HT2A-R activation.

Te spatially heterogeneous, complex nature of the observed effects of 5HT2A-R activation opens a challenging problem for understanding the clinical and scientific relevance of psychedelic drugs and their entropic effect. Furthermore, it stresses the necessity of moving beyond the current unidimensional approach to consciousness to a multi-dimensional one, that better captures the phenomenological and neurodynamical richness of psychedelic state.

Methods

Dynamic mean-field model with 5HT2A-R neuromodulation. The main computational tool used in this study is the Dynamic Mean-Field (DMF) model by Deco *et al.*[18,19] which consists of a set of coupled differential equations modelling the average activity of one or more interacting brain regions. In this model, each brain region n is modelled as two reciprocally coupled neuronal masses, one excitatory and one inhibitory, and the excitatory and inhibitory synaptic currents $I^{(E)}$ and $I^{(I)}$ are mediated by NMDA and GABA$_\text{A}$ receptors respectively. Different brain regions are coupled via their excitatory populations only, and the structural connectivity is given by the matrix C.

The full model, including the neuromodulatory effect described below, is given by

Above, for each excitatory (E) and inhibitory (I) neural mass, the quantities $I_n^{(E,I)}$, $r_n^{(E,I)}$, and $S_n^{(E,I)}$ represent its total input current (nA), firing rate (Hz) and synaptic gating variable, respectively. The function $F(\cdot)$ is the transfer function (or *F-I curve*), representing the non-linear relationship between the input current and the output firing rate of a neural population. Finally, J_n^{FIC} n is the local feedback inhibitory control of region n, which is optimized to keep its average firing rate at approximately 3 Hz (Supp. Fig 1), and v_n is uncorrelated Gaussian noise injected to region n. The interested reader is referred to the original publication for further details[19].

Key to this study is the recent extension of this model including neuromodulatory efects[18]. In the equations above, g_n^{NM} is a *neuromodulatory scaling factor* modulating the F-I curve of all brain regions in the model, which affects region n depending on its density of the receptor of interest, d_n^{rec}. Including neuromodulation, the free parameters of the model are G, the global coupling parameter, and s_{NM}, the neuromodulatory gain, that are set to 2.4 and 0.025, following our fitting procedure (Supp. Fig. 1). To simulate the expression of 5-HT$_{2A}$ receptor on the excitatory and inhibitory populations[47], neuromodulation was applied to both populations. The model was simulated using a standard Euler-Maruyama integration method[48], using the parameter values shown in Table 1.

Parameter	Symbol	Value
External current	I_0	0.382 nA
Excitatory scaling factor for I_0	W_E	1
Inhibitory scaling factor for I_0	W_I	0.7
Local excitatory recurrence	w_+	1.4
Excitatory synaptic coupling	J_{NMDA}	0.15 nA
Treshold for $F(I_n^{(E)})$	$I^{(E)}_{thr}$	0.403 nA
Treshold for $F(I_n^{(I)})$	$I^{(I)}_{thr}$	0.288 nA
Gain factor of $F(I_n^{(E)})$	g_E	310 nC^{-1}
Gain factor of $F(I_n^{(I)})$	g_I	615 nC^{-1}
Shape of $F(I_n^{(E)})$ around $I^{(E)}_{thr}$	d_E	0.16 s
Shape of $F(I_n^{(I)})$ around $I^{(I)}_{thr}$	d_I	0.087 s
Excitatory kinetic parameter	γ	0.641
Amplitude of uncorrelated Gaussian noise v_n	σ	0.01 nA
Time constant of NMDA receptor	τ_{NMDA}	100 ms
Time constant of GABA-A receptor	τ_{GABA_A}	10 ms

Table 1. Dynamic mean field (DMF) model parameters.

Parcellation, connectome, and 5HT2A receptor maps. In addition to the DMF equations above, to simulate whole-brain activity we need three more ingredients: a suitable parcellation of the cortex into well-defined regions, a structural connectivity matrix between those regions, and the density map of a receptor of interest - in our case, the serotonin 2A receptor. We clarify that all the empirical inputs of the model were produced elsewhere. For a detailed description of the procedure, please follow the corresponding references cited below.

As a basis for our simulation, we used the Automated Anatomical Labelling (AAL) atlas[21], a sulci-based parcellation of brain volume registered in MNI space. The AAL parcellation specifies a partition of the brain into 90 Regions Of Interest (ROIs), that provides sufficient level of detail to obtain a picture of the topographical distribution of entropy, while being suitable for computationally intensive simulations.

Structural connectivity data between the 90 AAL ROIs was obtained from 16 healthy subjects (5 female) using diffusion Magnetic Resonance Imaging (dMRI), registered to the MNI space and parcellated according to the AAL atlas on the subject's native space. Ten, for each subject the histogram of fiber directions at each voxel was obtained, yielding an estimate of the number of fibers passing trough each voxel. The weight of the connection between regions i and j was defined as the proportion of fibers passing through region i that reach region j, which (since the directionality of connections cannot be determined using dMRI) yields a symmetric 90 × 90 Structural Connectivity (SC) matrix. Finally, the SC matrix of each subject was thresholded, pruning any connection lower than 0.1%, and SC matrices of all subjects were averaged to obtain a single SC matrix used in all simulations. This average matrix was kindly provided by Deco *et al.*[18] For a detailed description of these methods see or refer to the Supplementary Subsection 7.

For the density map of 5HT2A receptors, we used the Positron Emission Tomography (PET) data made public by Beliveau *et al.*[22], which can be combined with the AAL parcellation to obtain an estimate of receptor density in every AAL region. Further details can be found in the original publications[18,22].

Together with the DMF equations, these three elements fully specify our whole-brain model and allow us to run simulations and obtain time series of excitatory firing rates, $r_n^{(E)}$, which we save for further analysis.

Estimating the differential entropy of firing rates. The result of each simulation is a set of 90 time series representing the firing rate of each excitatory population ($r_n^{(E)}$), which we analysed to measure the entropy of the activity of each ROI. For a continuous random variable X with associated probability distribution $p(x)$ and support X, its differential entropy is defined as[49]

$$h(X) = - \int_X p(x) \ln p(x) \, dx.$$

Estimating differential entropy from data is in general a hard problem, stemming (for the most part) from the difficulties in estimating a probability density from samples[50]. We found that the probability distributions of firing rates $r_n^{(E)}$ were well approximated by a gamma distribution: goodness-of-fit, measured with a standard Kolmogorov-Smirnov statistic, was satisfactory and comparable across brain regions and conditions (see Supp. Fig. 3).

This observation greatly simplifies the estimation of the differential entropy of each region, which is now reduced to estimating the shape and scale parameters of the gamma distribution, k and θ. Once these parameters are estimated (in our case by standard maximum likelihood estimation), the differential entropy of a gamma distribution can be computed analytically in closed form as

$$h(X) = k + \ln \Theta + \ln \Gamma(k) + (1 - k)\, \Psi(k),$$

where $\Gamma(\cdot)$ and $\Psi(\cdot)$ are the standard gamma and digamma functions, respectively.

Linear models for Δh_n and three-way separation of AAL regions. To explain the changes in differential entropy across regions and conditions, we trained several linear mixed-effects models[51] using different sets of covariates designed to test specific hypotheses about the relation between entropy, 5HT2A-R density, and network topology.

First, we implemented a simple algorithm to find the group of regions where the change in entropy depends on region strength. The model was fit by maximum likelihood using of-the-shelf software, and explanatory power measured using R^2. To do so, we designed an optimisation procedure to find the optimal fit between Δh_n and connectivity strength, using all occipital regions of the AAL90 atlas as a prior for a quadratic fit (i.e. the S_1 group). The rest of the regions were used for a linear fit between Δh_n and receptor density. Regions were assigned to the S_1 group if the residuals of the quadratic fit to strength were lower than the residuals for the linear fit to receptor density. An optimization algorithm randomly partitioned the remaining regions in two groups until a maximum in the R^2 of a linear mixed-effects model with 3 grouping variables (i.e. S_1, S_2, and R^2) is obtained. The model used a quadratic fit for strength-dependent regions, and a linear one for receptor-dependent regions.

This three-way separation of brain regions induces a model with 7 terms: a constant term and 2 fixed-effect terms for each group of regions: one for the connectivity strength and one for the receptor density.

Null network models of the human connectome. Null network models of the human structural connectivity were used to evaluate the role of the local connectivity properties[52,53] on the local changes in entropy induced by 5HT2A-R activation. To this end, we applied three different randomisation schemes to the structural connectivity in order to produce suitable surrogate networks. These surrogates were designed to preserve different network attributes of the original connectome: (1) the overall density and strength (RAND), (2) the degree distribution (degree-preserving randomisation [DPR]); and (3) the strength distribution (strength-preserving randomisation [DSPR]).

Afer randomisation, the DMF model was run with and without 5HT2A-R activation, and entropies estimated and analysed following the same procedure as in the rest of the article. Every surrogate model was run 120 times, and the results averaged across runs.

In addition to the network surrogates, we computed several topological measures to include in the linear model reported in Fig. 3. These measures included betweenness, eigenvector centrality, closeness, communicability, PageRank index, and sub-graph centrality. All of these computations, including the surrogate networks and the topology measures, were performed using the Brain Connectivity Toolbox[54].

Acknowledgements

A previous version of this article was published in Scientific Reports[55] but had to be retracted[56] due to a typo in the formula used to compute the differential entropy from Gamma distribution parameters. In this version the formula was corrected. R.H. was funded by CONICYT scholarship CONICYT-PFCHA/Doctorado Nacional/2018-21180428. P.M. is funded by the Wellcome Trust (grant no. 210920/Z/18/Z). F.R. is supported by the Ad Astra Chandaria Foundation. R.C. was supported by the Human Brain Project, H2020-945539. E.T. is funded by ANID/FONDECYT Regular 1220995.

Code availability

Te codes and data used for this article are available in the GitHub repository https://github.com/paulodder/dmf_entropy.

Author contributions

R.H. performed the numerical analysis and run the simulations. All the authors of this article conceptualized this research, design the methodology. All the authors carefully analysed the results, drafted and reviewed the manuscript.

Competing interests

Te authors declare no competing interests.

Correspondence and requests for materials should be addressed to R.H.

References

1. Carhart-Harris, R. L. *et al.* The entropic brain: A theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front. Hum. Neurosci.* **8**, 20. https://doi.org/10.3389/fnhum.2014.00020 (2014).
2. Scott, G. & Carhart-Harris, R. L. Psychedelics as a treatment for disorders of consciousness. *Neurosci. Consciousness https://doi.* org/10.1093/nc/niz003 *(2019).*
3. Carhart-Harris, R. L. *et al.* Psilocybin with psychological support for treatment-resistant depression: An open-label feasibility study. *Lancet Psychiatry* **3**, 619-627. https://doi.org/10.1016/S2215-0366(16)30065-7 (2016).
4. Grasso, C., Volsi, G. L. & Barresi, M. Serotonin modifies the spontaneous spiking activity of gracile nucleus neurons in rats: Role of 5-HT$_{1A}$ and 5-HT2 receptors. *Arch. Ital. Biol.* **154**, 39-49. https://doi.org/10.12871/00039829201621 (2016).
5. Wacker, D. *et al.* Crystal structure of an LSD-bound human serotonin receptor. *Cell* **168**, 377-389. https://doi.org/10.1016/j.cell. 2016.12.033 (2017).
6. Carhart-Harris, R. L. *et al.* Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl. Acad. Sci.* **109**, 2138-2143. https://doi.org/10.1073/pnas.1119598109 (2012).
7. Carhart-Harris, R. L. *et al.* Neural correlates of the LSD experience revealed by multimodal neuroimaging. *Proc. Natl. Acad. Sci.* **113**, 201518377. https://doi.org/10.1073/pnas.1518377113 (2016).
8. Timmermann, C. *et al.* Neural correlates of the DMT experience assessed with multivariate EEG. *Sci. Rep.* **9**, 16324. https://doi. org/10.1038/s41598-019-51974-4 (2019).
9. Schartner, M. M., Carhart-Harris, R. L., Barrett, A. B., Seth, A. K. & Muthukumaraswamy, S. D. Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. *Sci. Rep.* **7**, 46421. https://doi.org/10.1038/srep46421 (2017).
10. Lebedev, A. V. *et al.* LSD-induced entropic brain activity predicts subsequent personality change. *Hum. Brain Mapp.* **37**, 3203-3213. https://doi.org/10.1002/hbm.23234 (2016).
11. Schartner, M. M. *et al.* Global and local complexity of intracranial EEG decreases during NREM sleep. *Neurosci. Consciousness https://doi.org/10.1093/nc/niw022 (2017).*
12. Zhang, X.-S., Roy, R. J. & Jensen, E. W. EEG complexity as a measure of depth of anesthesia for patients. *IEEE Trans. Biomed. Eng.* **48**, 1424-1433. https://doi.org/10.1109/10.966601 (2001).
13. Casali, A. G. *et al.* A theoretically based index of consciousness independent of sensory processing and behavior. *Sci. Transl. Med.* **5**, 198ra105. https://doi.org/10.1126/scitranslmed.3006294 (2013).
14. Carhart-Harris, R. L. The entropic brain - revisited. *Neuropharmacology* **142**, 167-178. https://doi.org/10.1016/j.neuropharm. 2018.03.010 (2018).
15. Preller, K. H. *et al.* Changes in global and thalamic brain connectivity in LSD-induced altered states of consciousness are attributable to the 5-HT$_{2A}$ receptor. *eLife* **7**, e35082. https://doi.org/10.7554/eLife.35082 (2018).
16. Kraehenmann, R. *et al.* Dreamlike effects of LSD on waking imagery in humans depend on serotonin 2A receptor activation. *Psychopharmacology* **234**, 2031-2046. https://doi.org/10.1007/s00213-017-4610-0.
17. Quednow, B., Kometer, M., Geyer, M. & Vollenweider, F. Psilocybin-induced deficits in automatic and controlled inhibition are attenuated by ketanserin in healthy human volunteers. *Neuropsychopharmacology* **37**, 630-40. https://doi.org/10.1038/npp.2011. 228 (2011).
18. Deco, G. *et al.* Whole-brain multimodal neuroimaging model using serotonin receptor maps explains non-linear functional

effects of LSD. *Curr. Biol. https://doi.org/10.1016/j.cub.2018.07.083 (2018).*

19. Deco, G., Hagmann, P., Romani, G. L., Mantini, D. & Corbetta, M. How local excitation-inhibition ratio impacts the whole brain dynamics. *J. Neurosci.* **34**, 7886-7898. https://doi.org/10.1523/JNEUROSCI.5068-13.2014 (2014).
20. Herzog, R. *et al.* Neural mass modelling for the masses: Democratising access to whole-brain biophysical modelling with fastdmf. *Bioarxiv https://doi.org/10.1101/2022.04.11.487903 (2021).*
21. Tzourio-Mazoyer, N. *et al.* Automated anatomical labeling of activations in SPM using a macroscopic anatomical parcellation of the MNI MRI single-subject brain. *Neuroimage* **15**, 273-89. https://doi.org/10.1006/nimg.2001.0978.
22. Beliveau, V. *et al.* A high-resolution *in vivo* atlas of the human brain's serotonin system. *J. Neurosci.* **37**, 120-128. https://doi.org/10.1523/jneurosci.2830-16.2017 (2017).
23. Aghajanian, G. K. & Marek, G. J. Serotonin induces excitatory postsynaptic potentials in apical dendrites of neocortical pyramidal cells. *Neuropharmacology* **36**, 589-599. https://doi.org/10.1016/S0028-3908(97)00051-8 (1997).
24. Licata, F., Volsi, G. L., Maugeri, G. & Santangelo, F. Excitatory and inhibitory effects of 5-hydroxytryptamine on the firing rate of medial vestibular nucleus neurons in the rat. *Neurosci. Lett.* **154**, 195-198. https://doi.org/10.1016/0304-3940(93)90205-Y (1993).
25. Abbott, L. F. & Chance, F. S. Drivers and modulators from push-pull and balanced synaptic input. *Prog. Brain Res.* **149**, 147-155. https://doi.org/10.1016/S0079-6123(05)49011-1 (2005).
26. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D. & Chialvo, D. R. Enhanced repertoire of brain dynamical states during the psychedelic experience. *Hum. Brain Mapp.* **35**, 5442-5456. https://doi.org/10.1002/hbm.22562 (2014).
27. Lord, L. D. *et al.* Dynamical exploration of the repertoire of brain networks at rest is modulated by psilocybin. *Neuroimage* **199**, 127-142. https://doi.org/10.1016/j.neuroimage.2019.05.060.
28. Chennu, S., O'Connor, S., Adapa, R., Menon, D. K. & Bekinschtein, T. A. Brain connectivity dissociates responsiveness from drug exposure during propofol-induced transitions of consciousness. *PLoS Comput. Biol.* **12**, e1004669. https://doi.org/10.1371/journal.pcbi.1004669 (2016).
29. Rosas, F. E., Mediano, P. A. M., Gastpar, M. & Jensen, H. J. Quantifying high-order interdependencies via multivariate extensions of the mutual information. *Phys. Rev. E* **100**, 032305. https://doi.org/10.1103/PhysRevE.100.032305 (2019).
30. Bayne, T. & Carter, O. Dimensions of consciousness and the psychedelic state. *Neurosci. Consciousness https://doi.org/10.1093/nc/*niy008 *(2018).*
31. Bayne, T., Hohwy, J. & Owen, A. M. Are there levels of consciousness?. *Trends Cogn. Sci.* **20**, 405-413. https://doi.org/10.1016/j. tics.2016.03.009 (2016).
32. Muthukumaraswamy, S. D. *et al.* Broadband cortical desynchronization underlies the human psychedelic state. *J. Neurosci.* **33**, 15171-15183. https://doi.org/10.1523/JNEUROSCI.2063-13.2013 (2013).
33. Müller, F., Dolder, P. C., Schmidt, A., Liechti, M. E. & Borgwardt, S. Altered network hub connectivity after acute LSD administration. *NeuroImage Clin.* **18**, 694-701. https://doi.org/10.1016/j.nicl.2018.03.005 (2018).
34. Barrett, F. S., Krimmel, S. R., Griffiths, R., Seminowicz, D. A. & Mathur, B. N. Psilocybin acutely alters the functional connectivity of the claustrum with brain networks that support perception, memory, and attention. *NeuroImagehttps://doi.org/10.1016/j.neuro* image.2020.116980 *(2020).*
35. Tagliazucchi, E. *et al.* Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr. Biol.* **26**, 1043-1050. https://doi.org/10.1016/j.cub.2016.02.010 (2016).
36. Carhart-Harris, R. L. & Friston, K. J. REBUS and the anarchic brain: Toward a unified model of the brain action of psychedelics. *Pharmacol. Rev.* **71**, 316-344. https://doi.org/10.1124/pr.118.017160 (2019).
37. Markov, N. T. *et al.* A weighted and directed interareal connectivity matrix for macaque cerebral cortex. *Cereb. Cortex* **24**, 17-36. https://doi.org/10.1093/cercor/bhs270 (2014).
38. Ermentrout, G. B. & Cowan, J. D. A mathematical theory of visual hallucination patterns. *Biol. Cybern.* **34**, 137-150 (1979).
39. Carhart-Harris, R. L. & Nutt, D. J. Serotonin and brain function: A tale of two receptors. *J. Psychopharmacol.* **31**, 1091-1120. https://doi.org/10.1177/0269881117725915 (2017).
40. Barnett, L., Muthukumaraswamy, S. D., Carhart-Harris, R. L. & Seth, A. K. Decreased directed functional connectivity in the psychedelic state. *Neuroimage* **209**, 116462. https://doi.org/10.1016/j.neuroimage.2019.116462 (2020).
41. Kringelbach, M. L. *et al.* Dynamic coupling of whole-brain neuronal and neurotransmitter systems. *Proc. Natl. Acad. Sci. USA* **117**, 9566-9576. https://doi.org/10.1073/pnas.1921475117 (2020).
42. Stephan, K. E., Weiskopf, N., Drysdale, P. M., Robinson, P. A. & Friston, K. J. Comparing hemodynamic models with DCM. *Neuroimage* **38**, 387-401. https://doi.org/10.1016/j.neuroimage.2007.07.040 (2007).
43. Mosher, J. C., Leahy, R. M. & Lewis, P. S. EEG and MEG: Forward solutions for inverse methods. *IEEE Trans. Biomed. Eng.* **46**, 245-259. https://doi.org/10.1109/10.748978 (1999).
44. Madsen, M. K. *et al.* Psychedelic effects of psilocybin correlate with serotonin 2A receptor occupancy and plasma psilocin levels. *Neuropsychopharmacology* **44**, 1328-1334. https://doi.org/10.1038/s41386-019-0324-9 (2019).
45. Balduzzi, D. & Tononi, G. Integrated information in discrete dynamical systems: Motivation and theoretical framework. *PLoS Comput. Biol.* **4**, e1000091. https://doi.org/10.1371/journal.pcbi.1000091 (2008).
46. Swanson, L. R. Unifying theories of psychedelic drug effects. *Front. Pharmacol.https://doi.org/10.3389/fphar.2018.00172 (2018).*
47. De Almeida, J. & Mengod, G. Quantitative analysis of glutamatergic and gabaergic neurons expressing 5-ht2a receptors in human and monkey prefrontal cortex. *J. Neurochem.* **103**, 475-486. https://doi.org/10.1111/j.1471-4159.2007.04768.x (2007).
48. Kloeden, P. E. & Platen, E. *Numerical Solution of Stochastic Differential Equations* Vol. 23 (Springer, 2013).
49. Cover, T. M. & Thomas, J. A. *Elements of Information Theory* (Wiley, 2012).
50. Lizier, J. T. JIDT: An information-theoretic toolkit for studying the dynamics of complex systems. *Front. Robot. AI* **1**, 33. https://doi.org/10.3389/frobt.2014.00011 (2014).
51. McLean, R. A., Sanders, W. L. & Stroup, W. W. A unified approach to mixed linear models. *Am. Stat.* **45**, 54-64. https://doi.org/10.2307/2685241 (1991).
52. Rubinov, M. & Sporns, O. Weight-conserving characterization of complex functional brain networks. *Neuroimage* **56**,

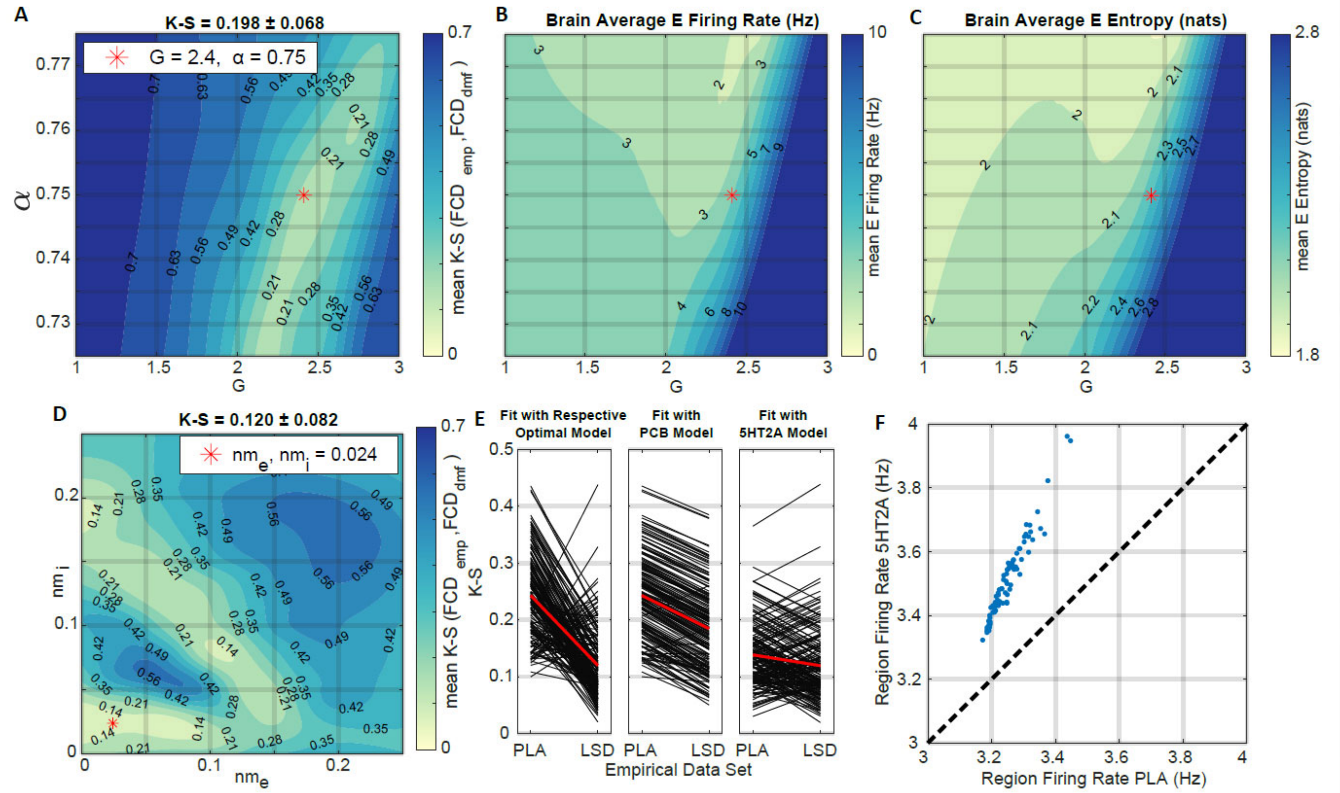
2068-2079. https://doi.org/10.1016/j.neuroimage.2011.03.069 (2011).

53. Luppi, A. I. *et al.* Dynamical models to evaluate structure-function relationships in network neuroscience. *Nat. Rev. Neurosci. https://*doi.org/10.1038/s41583-022-00646-w *(2022).*
54. Rubinov, M. & Sporns, O. Complex network measures of brain connectivity: Uses and interpretations. *Neuroimage* **52**, 1059-1069. https://doi.org/10.1016/j.neuroimage.2009.10.003 (2010).
55. Herzog, R. *et al.* A mechanistic model of the neural entropy increase elicited by psychedelic drugs. *Sci. Rep.* **10**, 1-12 (2020).
56. Herzog, R. *et al.* Retraction note: A mechanistic model of the neural entropy increase elicited by psychedelic drugs. *Sci. Rep.* **12**, 1 (2022).

Supplementary Information

Subsection 1. Model fit to empirical BOLD data

A Bayesian optimization algorithm was implemented to simultaneously optimize the global coupling parameter G, and α, a global parameter that controls the local inhibitory feedback parameter. The cost function was defined as the Kolmogorov-Smirnof distance (K-S) between the empirical and the simulated functional connectivity dynamics (FCD) distribution. Resting state BOLD signals of the placebo condition were used to fit the model associated to the non-drug condition. The data set and processing was exactly the same than the one used in Ref.[1]. The optimization stopped after 10 consecutive iterations with improvements lower than 1%. The optimal average K-S (0.198 ± 0.068) was found at G=2.4 and α 1.5 (Supplementary Figure 1A), where also the average firing rates fell within the biologically plausible[2] 3-4 Hz range (Supplementary Figure 1B,F). Once the model was fit to the placebo data, the neuromodulatory gain for the excitatory (nm_E) and the inhibitory (nm_I) population were optimized such that the K-S of the FCD between the model and the data associated to LSD BOLD signals is minimized. There was several regions where the K-S were minimized (Supplementary Figure 1D), so, for simplicity, we only used solutions were both neuromodulatory had the same magnitude, obtaining an average K-S of 0.120 ± 0.082. Then, we compared the K-S values of the models fitted to their respective data sets (Supplementary Figure 1E), finding an improvement of the goodness of fit of the model with neuromodulation to LSD data.

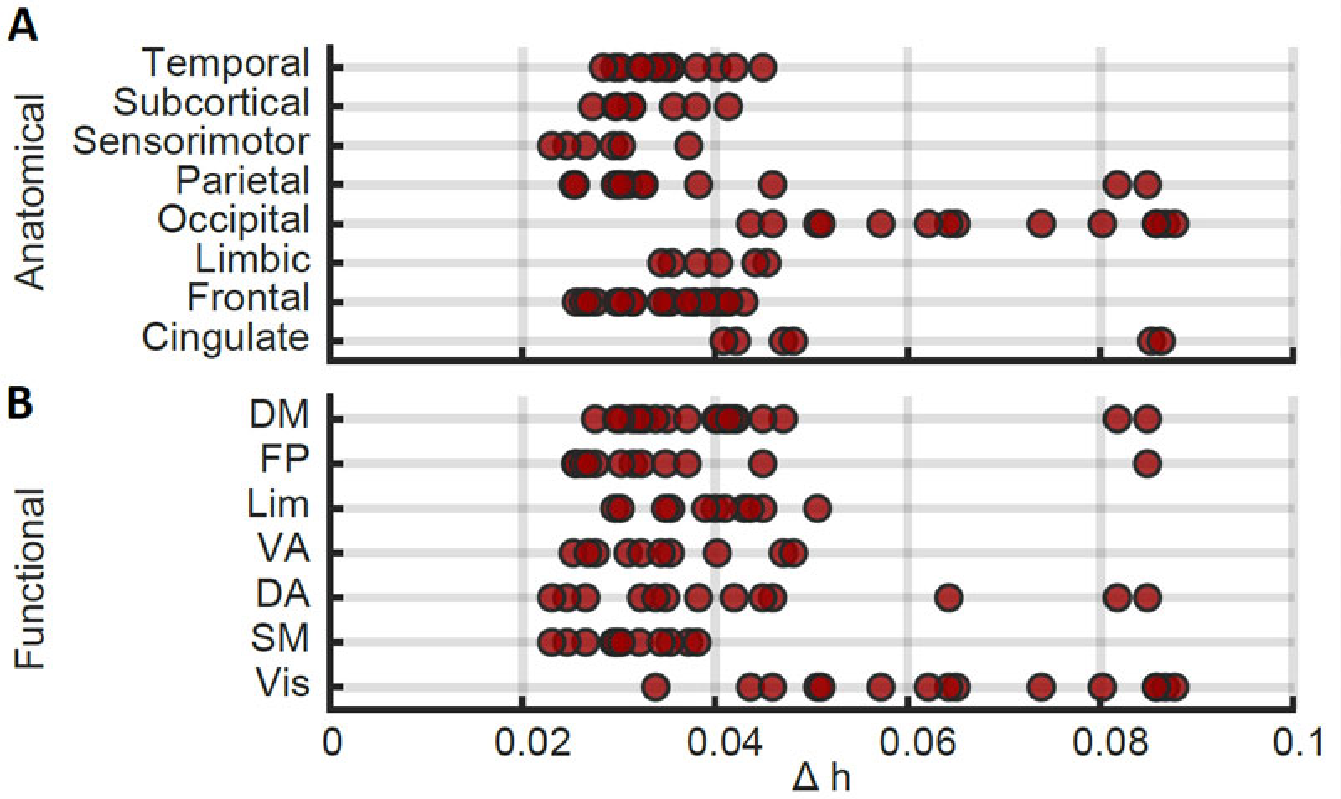


Supplementary Figure 1. Model fit to empirical BOLD data. (**A**) Estimated average K-S distance between the empirical FCD obtained from placebo resting state condition and the FCD obtained with the model. G and α were optimized by Bayesian optimization. The corresponding average excitatory firing rates, and entropies are shown in B and C, respectively. (**B,C**) Average firing rate and entropy for the excitatory pool, respectively, as a function of the two free parameters. (**D**) Estimated average K-S distance between the empirical FCD obtained from LSD resting state condition and the FCD obtained with the model with neuromodulation (5HT2A). nm_e and nm_i were optimized by Bayesian optimization. (**E**) Goodness of fit of models to their corresponding data sets, and cross-goodness of fit to data, i.e. using the placebo model for fitting LSD and the LSD model to fit placebo. The model with neuromodulation improves the goodness of fit to empirical LSD data, respect to the other comparisons. (**F**) Scatter plots of the excitatory firing rates in both simulated conditions.

Supplementary Subsection 2. Heterogeneous entropy changes induced by 5HT2A-R activation on anatomical and functional groupings of brain regions.

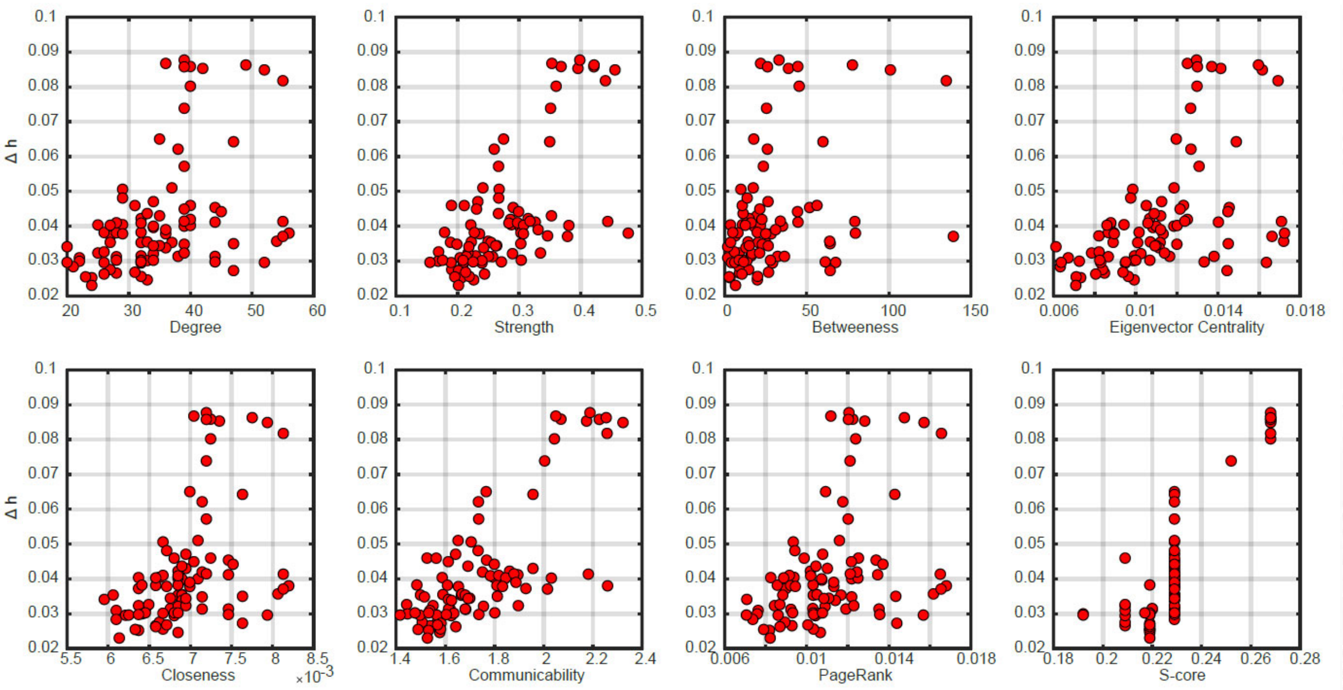
We asked whether the heterogeneous changes of entropy induced by 5HT2A-R activation could be explained by grouping the AAL brain regions according to anatomical and functional criteria. Regarding anatomical criteria brain regions can be spatially split into 8 major non-overlapping anatomical groups: Frontal, Temporal, Parietal, Occipital, Limbic, Sensorimotor, Cingulate and Subcortical.[3] Regarding the functional grouping, we used the Resting State Networks, a functional grouping of brain regions based on the observed spatio-temporal patterns of BOLD signals during resting state activity.[4] These groups are Salience (Sal), Fronto-Parietal (FPN), Default Mode (DMN), Primary Visual (Vis), Extrastiate Cortex (EC), Auditory (Aud), Sensorimotor (SM), and Executive Control (EC). The first one, Sal, was obtained from Lee *et al*.[5], the second and third, FPN and DMN, were obtained from Oliver *et al*.[6], and the rest from Beckmann *et al*.[4] Brain regions can potentially belong to different functional groups.

The effect of 5HT2A-R activation on entropy is heterogeneous also at the level of anatomical groups (Supplementary Figure 2A). However, Occipital and Cingulate regions show a strong tendency to increase their entropy, in agreement with entropy increases in these regions observed in human experiments with serotonergic psychedelics.[7, 8] Regarding the functional grouping (Supplementary Figure 2B), we also found that the effect of 5HT2A-R activation on regional entropy (Fig. 3B) is heterogeneous within groups. In particular, in the Vis networks showed the larger tendency to increase.



Supplementary Figure 2. The effect of 5HT2A-R activation is not explained by anatomical or functional groupings. (**A**) 5HT2A-R activation heterogeneously change entropy in regions belonging to the same anatomical group. (**B**) Entropy also changed in a heterogeneous way when functional grouping is considered. Note the special case of Vis network, which included region with larger increase. Circles are averages computed from 1000 simulations.

Supplementary Subsection 3. Connectivity strength is the best predictor for entropy changes among local connectivity measures. We control the role of local connectivity on the observed entropy changes (Δh_n) induced by 5HT2A-R activation using as predictors for Δh_n other local connectivity measures as: degree,[9] eigenvector centrality,[9] communicability,[10] page-rank,[9], closeness centrality,[11], and s-core[12]. Despite communicability exhibits a very similar pattern to strength, the latter has a simpler interpretation than the former. Thus, we confirmed that local connectivity strength is the best linear predictor of entropy changes among other centrality measures.

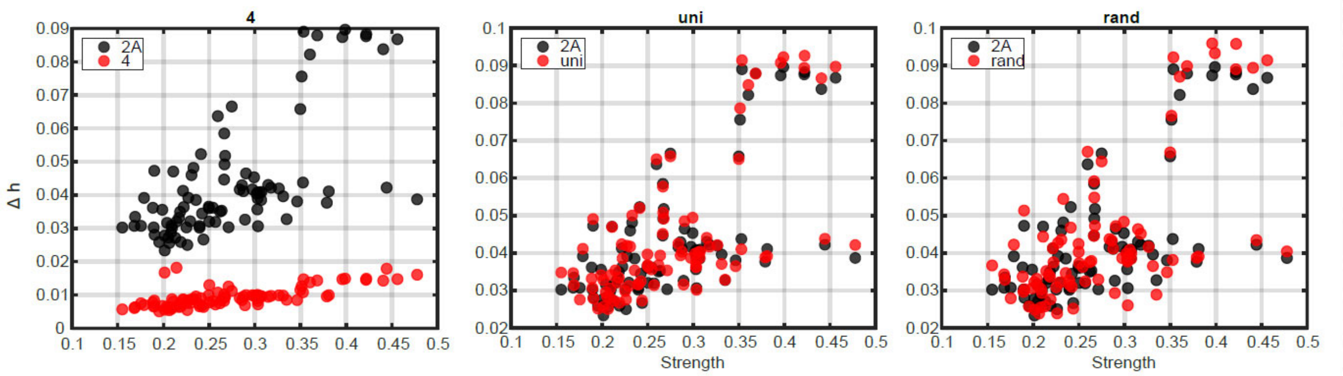


Supplementary Figure 3. Centrality measures as possible explanatory variables for Δh_n. Local connectivity strength is the best linear predictor of Δh_n among other centrality measures. Communicability also showed a good linear relationship with Δh_n, but strength has more interpretability in terms of the connectome. Circles are averages computed from 1000 independent simulations.

Supplementary Subsection 4. Receptors controls.

We controlled the role of receptor density distribution on the observed entropy changes (Δh_n) induced by 5HT2A-R activation by using alternative receptor distributions. To test the effect of the heterogeneous 5HT2A-R distribution on Δh_n, we used an uniform receptor distribution, where the receptor density for each region corresponds to the average 5HT2A-R density among all regions. To evaluate the role of the specific 5HT2A-R distribution, a randomised version of the 5HT2A-R was also used, where for each simulation the receptor expression is randomised. Finally, to evaluate the effect of activating other serotonin receptors, we used the 5HT4-R distribution, a receptor thought to play no role on the psychedelic state.

The Uniform and Random receptor distributions show almost the same complex behaviour than the 2A on average. The 5HT4-R distribution changes entropy but in a subtler manner, showing no complex dependency with the strength. On summary, the specific 5HT2A-R distribution does not impact critically on Δh_n values; rather, the average receptor density seems to capture most of the relationship with the connectivity strength. In addition, using other empirically-based distribution yields no significant change in average brain entropy, highlighting the key relationship between 5HT2A-R density and connectivity on the entropic effects induced by serotonergic psychedelic drugs.

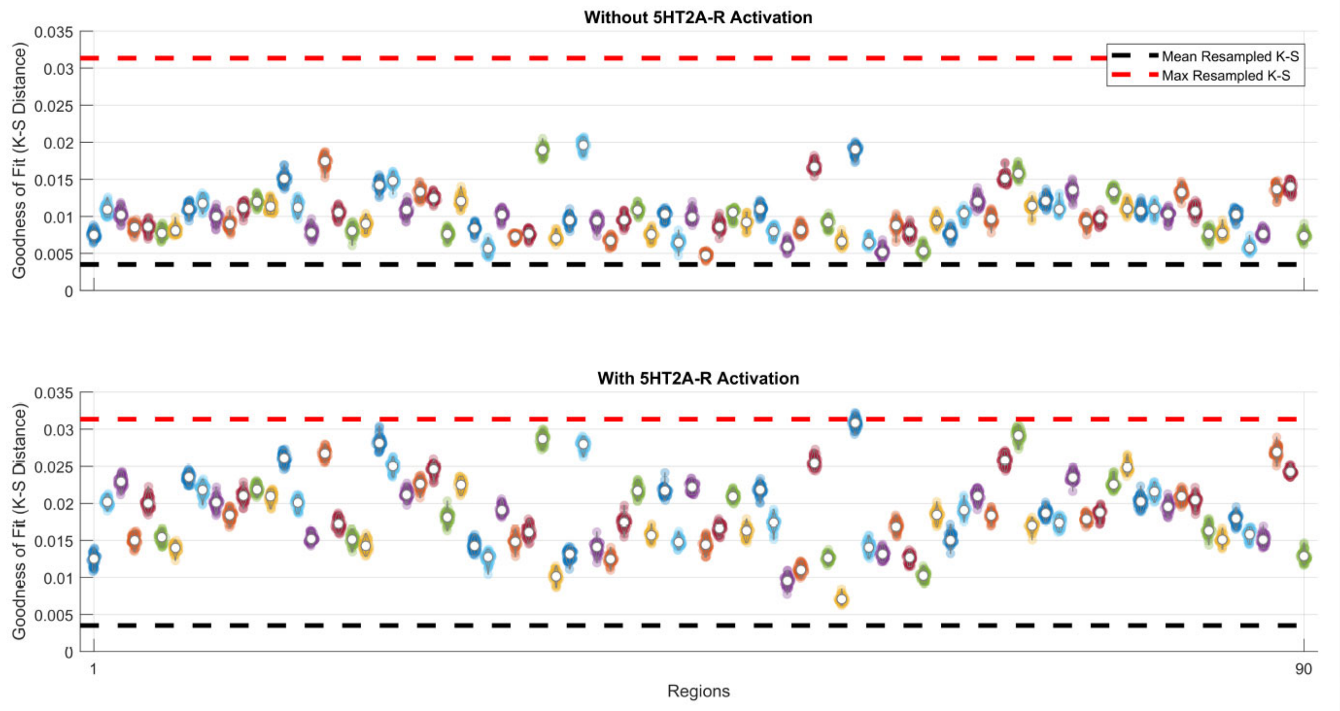


Supplementary Figure 4. Controls for receptor distribution vs Δh_n. Δh_n vs connectivity strength is plotted for 5HT2A-R, Uniform, 5HT4-R, and Random distribution of receptors (see text for details). The specific distribution of 5HT2A-R is critical both for the heterogeneity of Δh_n and for the average increase in local entropy. Circles are averages from 1000 independent simulations.

Supplementary Subsection 5. The probability distribution of excitatory firing rates can be well fitted by a Gamma distribution.

To check the goodness of fit (GOF) of Gamma distribution to the simulated excitatory firing rates of each region, we generated 10^6 simulation points for each region under both PLA and 5HT2A condition, then, a Gamma distribution was fitted and the Kolmogorov-Smirnov (K-S) distance between the firing rate distribution and 1000 random samples (same size) of the respective fitted Gamma distribution was computed. We summarise the Gamma GOF as the average K-S for each region under both conditions. To assess the significance of average GOF values, we generated an acceptance interval computing the K-S distance between 100 independent samples (same size) sampled from exactly the same Gamma distribution (re-sampled K-S). This procedure was repeated for different set of Gamma distribution parameters. If the average K-S distance of a given region falls below the maximum re-sampled K-S distance, we consider this region to be well fitted by the Gamma distribution.

Despite the decreased GOF under 5HT2A condition (compared to PLA) all regions fall within the acceptance interval under both conditions, enabling us to use the Gamma distribution parameters to estimate each region's Shannon's differential entropy.



Supplementary Figure 5. Goodness of fit of Gamma distribution to firing rates distribution are within confidence intervals. Distribution of K-S distance values for PLA (top) and 5HT2A-R (bottom) condition for each region are represented by violins, where white circle denotes average K-S. Black (red) dashed line represent the average (maximum) re-sampled K-S distance (see the text for details).

Supplementary Subsection 6. Brain Regions of the Automated Anatomical Labeling.

Supplementary Table 1. AAL regions and abreviations

AAL Abbreviation	Brain Regions
Precentral	Precental gyrus
Front Sup	Superior frontal gyrus, dorsolateral
Front Sup Orb	Superior frontal gyrus, orbital part
Front Mid	Middle frontal gyrus
Front Mid Orb	Middle frontal gyrus, orbital part
Front Inf Oper	Inferior frontal gyrus, opercular part
Front Inf Tri	Inferior frontal gyrus, triangular part
Front Inf Orb	Inferior frontal gyrus, orbital part
Rolandic Oper	Rolandic operculum
Supp Motor Ar	Supplementary motor area
Olfactory	Olfactory cortex
Frontal Sup Med	Superior frontal gyrus, medial
Frontal Mid Orb	Superior frontal gyrus, medial orbital
Rectus	Gyrus rectus
Insula	Insula
Cingulum Ant	Anterior cingulate and paracingulate gyri
Cingulum Mid	Median cingulate and paracingulate gyri
Cingulum Post	Posterior cingulate gyrus
Hippocampus	Hippocampus
ParaHippocamp	Parahippocampal gyrus
Amygdala	Amygdala
Calcarine	Calcarine fissure and surrounding cortex
Cuneus	Cuneus
Lingual	Lingual gyrus
Occipital Sup	Superior occipital gyrus
Occipital Mid	Middle occipital gyrus
Occipital Inf	Inferior occipital gyrus
Fusiform	Fusiform gyrus
Postcentral	Postcentral gyrus
Parietal Sup	Superior parietal gyrus
Parietal Inf	Inferior parietal, but supramarginal and angular gyri
SupraMarginal	Supramarginal gyrus
Angular	Angular gyrus
Precuneus	Precuneus
Paracentral Lobule	Paracentral lobule
Caudate	Caudate nucleus
Putamen	Lenticular nucleus, putamen
Pallidum	Lenticular nucleus, pallidum
Thalamus	Thalamus
Heschl	Heschl gyrus
Temporal Sup	Superior temporal gyrus
Temporal Pol Sup	Temporal pole: superior temporal gyrus
Temporal Mid	Middle temporal gyrus
Temporal Pol Mid	Temporal pole: middle temporal gyrus
Temporal Inf	Inferior temporal gyrus

Supplementary Subsection 7. Anatomical and Functional Grouping of Brain Regions.

Supplementary Table 2. Anatomical Grouping

Anatomical Group	AAL Regions
Cingulate	Cingulum Ant
	Cingulum Mid
	Cingulum Post
Frontal	Frontal Sup
	Front Sup Orb
	Front Mid
	Front Mid Orb
	Front Inf Ope
	Front Inf Tri
	Front Inf Orb
	Supp Motor Ar
	Olfactory
	Front Sup Med
	Front Med Orb
	Rectus
Limbic	Hippocampus
	ParaHippocamp
	Amygdala
Occipital	Calcarine
	Cuneus
	Lingual
	Occipital Sup
	Occipital Mid
	Occipital Inf
	Fusiform
Parietal	Parietal Sup
	Parietal Inf
	SupraMarginal
	Angular
	Precuneus
	Paracentr Lob
Sensorimotor	Parietal Sup
	Parietal Inf
	SupraMarginal
	Angular
	Precuneus
	Paracentr Lob
Sensorimotor	L Caudate
	Putamen
	Pallidum
	Thalamus
Sensorimotor	Insula
	Heschl
	Temporal Sup
	Tempr Pol Sup
	Temporal Mid
	Tempr Pol Mid
	Temporal Inf

Supplementary Table 3. Functional Grouping. If no hemisphere is specified, then regions from both left (L) and right (R) hemisphere are used.

Functional Group	AAL Regions
Visual (Vis)	Calcarine
	Cuneus
	Lingual
	Occipital Sup (L)
Extrastriate (ES)	Lingual (L)
	Occipital Sup
	Occipital Mid
	Occipital Inf
	Parietal Sup
Auditory (Aud)	Front Inf Ope (L)
	Front Inf Tri (L)
	Rolandic Oper
	Insula
	Cingulum Ant
	Cingulum Mid
	Amygdala
	SupraMarginal
	Putamen
	Pallidum
	Thalamus
	Heschl
	Temporal Sup
	Temporal Mid (R)
	Tempr Pol Sup (R)
Somatomotor (SM)	Heschl
	Paracentr Lob
	Parietal Sup
	Postcentral
	Cingulum Mid
	Rolandic Oper
	Precentral (R)
Excecutive Control (EC)	Precentral
	Frontal Sup
	Front Mid
	Supp Motor Ar
	Front Sup Med
	Front Med Orb
	Insula
	Cingulum Ant
	Cingulum Mid
	SupraMarginal (L)
	Precuneus
	Tempr Pol Sup
	Caudate (R)
Frontoparietal (FPN)	Front Mid
	Front Inf Ope
	Front Inf Tri
	Parietal Inf
	Angular

Default Mode (DMN)	Front Sup Med
	Cingulum Ant
	Cingulum Post
	Angular
	Precuneus
Salience (Sal)	Front Sup Orb
	Front Mid
	Front Mid Orb
	Front Inf Orb
	Supp Motor Ar
	Insula
	Cingulum Ant

Supplementary Subsection 8. Tractography

For the sake of completeness, in the following we describe in detail the methods used by Ref.[1] to obtain the human connectome. We clarify that we did not produce these connectome data sets, instead, we used data kindly provided by Gustavo Deco.

The structural connectivity between the 90 AAL regions was obtained from averaging across 16 healthy young adults (5 females, mean SD age: 24.75 2.54). The linear registration tool from the FSL toolbox (www.fmrib.ox.ac.uk/fsl, FMRIB, Oxford) was used to coregister the EPI image to the T1-weighted structural image. The T1-weighted image was co-registered to the T1 template of ICBM152 in MNI space. The resulting transformations were concatenated and inversed and further applied to warp the AAL template from MNI space to the EPI native space, where interpolation using nearest-neighbor method ensured that the discrete labeling values were preserved. Thus the brain parcellations were conducted in each individual's native space. The structural connectivity (SC) maps were generated for each participant using the dMRI data acquired. The two data sets acquired have different phase encoding to optimize signal in difficult regions. The construction of these structural connectivity maps consisted of a three-step process. First, the regions of the whole-brain network were defined using the AAL template as used in the functional MRI data. Second, the connections between nodes in the whole-brain network (i.e., edges) were estimated using probabilistic tractography. Third, data was averaged across participants.

The FSL diffusion toolbox (Fdt) was used to carry out the various processing stages of the diffusion MRI data using the default parameters of this imaging pre-processing pipeline on all participants. Following this preprocessing, we estimated the local probability distribution of fiber direction at each voxel. The probtrackx tool in Fdt was used to provide automatic estimation of crossing fibers within each voxel.

The connectivity probability from a seed voxel i to another voxel j was defined by the proportion of fibers passing through voxel i that reach voxel j using a sampling of 5000 streamlines per voxel. This was extended from the voxel level to the region level, i.e., in an AAL parcel consisting of n voxels, 5000x n fibers were sampled. The connectivity probability Pij from region i to region j is calculated as the number of sampled fibers in region i that connect the two regions divided by 5000 x n, where n is the number of voxels in region i. The SC matrix was thresholded at 0.1%, i.e., five streamlines.

For each brain region, the connectivity probability to each of the other 89 regions within the AAL was calculated. Due to the dependence of tractography on the seeding location, the probability from i to j is not necessarily equivalent to that from j to i. However, these two probabilities are highly correlated across the brain for all participants (the least Pearson $r = 0.70$, $p < 10^{-}50$). As directionality of connections cannot be determined based on diffusion MRI, the unidirectional connectivity probability Pij between regions i and j was defined by averaging these two connectivity probabilities. This unidirectional connectivity was considered as a measure of the structural connectivity between the two areas, with $Cij = Cji$. The regional connectivity probability was calculated using in-house Perl scripts. For both phase encoding directions, 90x90 symmetric weighted networks were constructed based on the AAL90 parcellation, and normalized by the number of voxels in each AAL region; thus representing the structural connectivity network organization of the brain.

Supplementary References

1. Deco, G. *et al*. Whole-brain multimodal neuroimaging model using serotonin receptor maps explains non-linear functional effects of LSD. *Curr. Biol.* 1-10, DOI: 10.1016/j.cub.2018.07.083 (2018).
2. Deco, G., Hagmann, P., Romani, G. L., Mantini, D. & Corbetta, M. How local excitation-inhibition ratio impacts the whole brain dynamics. *J. Neurosci.* 34, 7886-7898, DOI: 10.1523/JNEUROSCI.5068-13.2014 (2014).
3. Tzourio-Mazoyer, N. *et al*. Automated anatomical labeling of activations in SPM using a macroscopic anatomical parcellation of the MNI MRI single-subject brain. *NeuroImage* 15, 273-89, DOI: 10.1006/nimg.2001.0978 (2002).
4. Beckmann, C. F., DeLuca, M., Devlin, J. T. & Smith, S. M. Investigations into resting-state connectivity using independent component analysis. *Philos. Transactions Royal Soc. B: Biol. Sci.* 360, 1001-1013, DOI: 10.1098/rstb.2005.1634 (2005).
5. Lee, W. & Frangou, S. Linking functional connectivity and dynamic properties of resting-state networks. *Sci. Reports* 7, DOI: 10.1038/s41598-017-16789-1 (2017).
6. Oliver, I., Hlinka, J., Kopal, J. & Davidsen, J. Quantifying the Variability in Resting-State Networks. *Entropy* 21, 882, DOI: 10.3390/e21090882 (2019).
7. Schartner, M. M., Carhart-Harris, R. L., Barrett, A. B., Seth, A. K. & Muthukumaraswamy, S. D. Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. *Sci. Reports* 7, 46421, DOI: 10.1038/ srep46421 (2017).
8. Lebedev, A. V. *et al*. LSD-induced entropic brain activity predicts subsequent personality change. *Hum. Brain Mapp.* 37, 3203-3213, DOI: 10.1002/hbm.23234 (2016).
9. Zuo, X. N. *et al*. Network centrality in the human functional connectome. *Cereb. Cortex* 22, 1862-1875, DOI: 10.1093/cercor/bhr269 (2012).
10. Andreotti, J. *et al*. Validation of network communicability metrics for the analysis of brain structural networks. *PLoS ONE* 9, 1-26, DOI: 10.1371/journal.pone.0115503 (2014).
11. Rubinov, M. & Sporns, O. Complex network measures of brain connectivity: Uses and interpretations. *NeuroImage* 52, 1059-1069, DOI: 10.1016/j.neuroimage.2009.10.003 (2010).
12. Castro, S., El-Deredy, W., Battaglia, D. & Orio, P. Cortical ignition dynamics is tightly linked to the core organisation of the human connectome. *PLOS Comput. Biol.* 16, 1-23, DOI: 10.1371/journal.pcbi.1007686 (2020).

Was it a vision or a waking dream

by

Robin Carhart-Harris* and David Nutt

Division of Brain Sciences, Department of Medicine, Centre for Neuropsychopharmacology, Imperial College London, London, UK
**Correspondence: r.carhart-harris@imperial.ac.uk*

original source:
https://www.researchgate.net/profile/Robin_Carhart-Harris/publication/261923342_Was_it_a_vision_or_a_waking_dream/links/53e4bc730cf2fb748710de26.pdf
backup source: http://www.psilosophy.info/resources/53e4bc730cf2fb748710de26.pdf

Edited by:
Adam B. Barrett, University of Sussex, UK
Reviewed by:
Alexis Georges Hervais-Adelman, University of Geneva, Switzerland

Keywords: consciousness, REM sleep, dreaming, hallucinogens, posterior cingulate cortex, default mode network

A commentary on Disrupting posterior cingulate connectivity disconnects consciousness from the external environment *by Herbet, G., Lafargue, G., de Champfleur, N. M., Moritz-Gasser, S., le Bars, E., Bonnetblanc, F., et al. (2014). Neuropsychologia 56C, 239-244. doi: 10.1016/j.neuropsychologia.2014.01.020*

Reminiscent of Wilder Penfield's famous experiments, Neurologists in France have reported a remarkable case in which intraoperative electrical stimulations of the posterior cingulate cortex (PCC) in a conscious patient induced transient dreamlike states with vivid visual imagery (Herbet *et al*., 2014). The implicated circuitry and nature of the experiences evoked comparisons with findings from our own neuroimaging research with the hallucinogen and putative "oneirogen" (dream-inducer) psilocybin, strengthening what can be inferred about the importance of the PCC in mediating the quality of consciousness.

We were fascinated to read the case-report of a dreamlike experience evoked by direct electrical stimulation of the posterior cingulate cortex (PCC) in an epilepsy patient by Herbet *et al*. (2014). The PCC has attracted a lot of interest in recent years due to recognition of its high metabolic and vascular demand (Raichle *et al*., 2001) and importance as a cortical connector hub (Hagmann *et al*., 2008) and integration center (Leech *et al*., 2012). Perhaps due to its buffered location and rich vascular innervation, there is an absence of cases of focal PCC lesions (Leech and Sharp, 2014) and to our knowledge there are no reports on the effects of PCC stimulation in humans. There are a few case-reports of impaired spatial navigation and related symptoms of Balint's syndrome in patients with damage to the retrosplenial cortex (Leech and Sharp, 2014) but the stimulation site here was dorsal to the retrosplenial cortex, in white matter of the cingulum bundle, a major tract connecting the PCC with the medial prefrontal cortex (mPFC). This circuit constitutes the spine of the default-mode network (DMN), a system that has been associated with spontaneous cognition that is suspended or interrupted during periods of externally-directed attention (Raichle *et al*., 2001).

Upon reading Herbet *et al*.'s report, we were struck by similarities between the subjective reports given post-PCC stimulation and those we observed after controlled administration of the classic hallucinogen, psilocybin (Carhart-Harris *et al*., 2012; Muthukumaraswamy *et al*., 2013). As Herbet *et al*. discuss, stimulation of the PCC/cingulum bundle likely inhibited activity in this region and interrupted communication between the mPFC and PCC. Importantly, altered PCC activity (i.e., decreased blood flow and oscillatory power and mPFC-PCC functional connectivity) was the most conspicuous and reliable finding of our psilocybin imaging studies and volunteers reported experiencing a dreamlike state and vivid visual imagery (Carhart-Harris *et al*., 2012, 2014; Muthukumaraswamy *et al*., 2013). Moreover, sustained improvements in well-being (Griffiths *et al*., 2006) and lasting decreases in depressive symptoms have been reported post-psilocybin (Grob *et al*., 2011) and it was remarkable to read Herbet *et al.*'s patient describe an absence of rumination and "absolute happiness" for a sustained period after resection of the PCC. Is it possible that psilocybin produces a sustained alteration in PCC and/or DMN activity that could account for its putative therapeutic potential (Carhart-Harris *et al.*, 2014)? This is something we intend to test in a forthcoming trial of psilocybin as a treatment for major depression (Roiser and Rees, 2012).

Finally, the theoretical implications of Herbet *et al.*'s report are profound. The authors note that PCC cerebral blood flow is decreased in rapid eye movement (REM) sleep relative to waking (Braun *et al.*, 1997) and non-REM sleep (Maquet *et al.*, 1996). It has long been a matter of intrigue to us that LSD given just before sleep onset (Muzio *et al.*, 1966) or intravenously during sleep (Torda, 1968) markedly promotes REM sleep. The classic serotonergic hallucinogens LSD, psilocybin and dimethyltryptamine are known to produce vivid and complex imagery, especially with eyes-closed, that are often described as dreamlike (Grinspoon and Bakalar, 1979). Another common feature of the REM-sleep and hallucinogenic drug states is alterations in medial temporal lobe (MTLs) activity. For example, the MTLs are hyperactive in REM-sleep (Maquet *et al.*, 1996; Braun *et al.*, 1997; Miyauchi *et al.*, 2009) and show an increased amplitude in their signal fluctuations post-psilocybin (Carhart-Harris *et al.*, 2014) which correlates with reports of dreamlike phenomena (Figure 1). The MTLs are another area where electrical stimulation can produce vivid dreamlike visions of the sort reported by Herbet *et al.*'s patient (Vignal *et al.*, 2007). MTL stimulations producing dreamlike states have been found to induce a spreading activation from the stimulation site to the temporal and visual cortex (Barbeau *et al.*, 2005; Bartolomei *et al.*, 2012). However, the stimulations in the present case were in white matter and thus likely had an inhibitory rather than excitatory effect (Holtzheimer *et al.*, 2012).

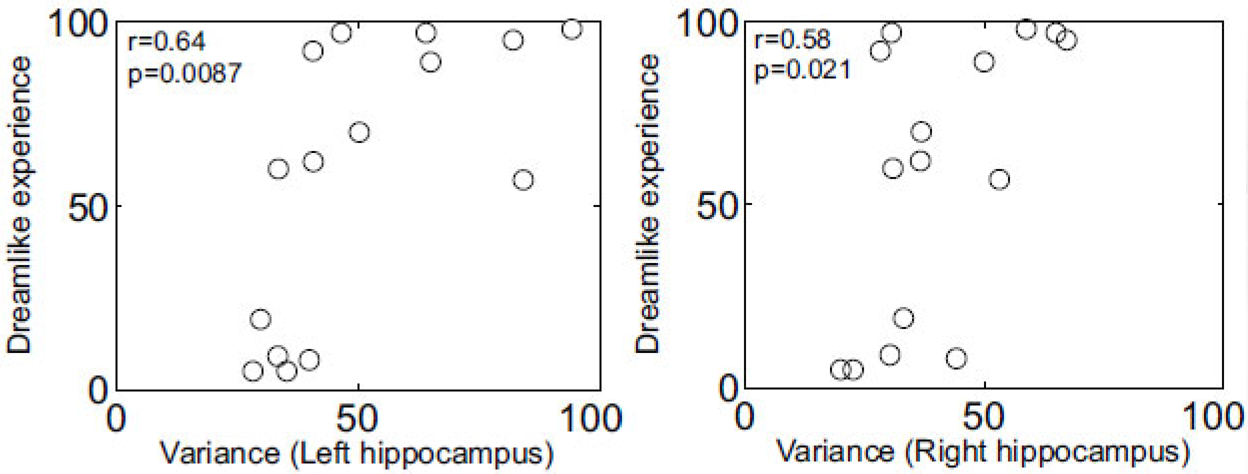


FIGURE 1 - Scatter plot of the increase in left and right hippocampal blood oxygen-level dependent signal variance/amplitude (after psilocybin infusion) vs. subjective ratings of the item: "the experience had a dreamlike quality." Both measures are expressed as a percentage increase from baseline. There were no changes in BOLD signal variance after placebo infusion ($n = 15$) (Carhart-Harris *et al.*, 2014).

So, how might disrupting DMN activity be the cause of dreamlike visions? One way to address this question is to look for clues from studies on REM-sleep and other dreamlike states. Firstly, it is worth noting that the MTLs are major subcortical nodes of the DMN (Supekar *et al.*, 2010) but under psilocybin, MTL-DMN coupling is decreased (Carhart-Harris *et al.*, 2014). Similarly, PCC activity is decreased in REM-sleep (Maquet *et al.*, 1996) and under psilocybin (Carhart-Harris *et al.*, 2014) but MTL activity is increased (Maquet *et al.*, 1996; Carhart-Harris *et al.*, 2014). Since MTL activity is coupled to phasic events in REM-sleep, including REMs (Bodizs *et al.*, 2001; Karashima *et al.*, 2007), the link between MTL activity and dreaming appears to be particularly intimate. Thus, disrupting DMN activity may have had a disinhibiting effect on MTL activity (Carhart-Harris *et al.*, 2014) and this may have been the cause of the ensuing dreamlike visions (Carhart-Harris, 2007; Carhart-Harris and Friston, 2010; Carhart-Harris *et al.*, 2014). Future neuroimaging work on dreaming and dreamlike states will help to inform these speculations.

In summary, we were struck by similarities between Herbet *et al.*'s findings with direct electrical stimulation of the PCC and those of our own with psilocybin and neuroimaging. Their case provides some causative support for the notion that the PCC is centrally involved in mediating the *quality* of consciousness (Carhart-Harris *et al.*, 2014), and more specifically, that inhibiting the PCC/disrupting DMN activity can induce dreamlike states. Moreover, we are intrigued by the possibility that drug and stimulation-induced dreamlike states are indeed truly dreamlike, i.e., in the neurophysiological sense as well as the phenomenological.

Acknowledgments

We would like to acknowledge the work of Enzo Tagliazucchi and Dante Chialvo in producing the results and plots displayed in **Figure 1**.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 18 February 2014; accepted: 10 March 2014; published online: 04 April 2014.
Citation: Carhart-Harris R and Nutt D (2014) Was it a vision or a waking dream? Front. Psychol. 5:255. doi: 10.3389/fpsyg.2014.00255 This article was submitted to Consciousness Research, a section of the journal Frontiers in Psychology. *Copyright © 2014 Carhart-Harris and Nutt. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.*

References

1. Barbeau, E., Wendling, F., Regis, J., Duncan, R., Poncet, M., Chauvel, P., *et al*. (2005). Recollection of vivid memories after perirhinal region stimulations: synchronization in the theta range of spatially distributed brain areas. *Neuropsychologia* 43, 1329-1337. doi: 10.1016/j.neuropsychologia.2004.11.025
2. Bartolomei, F., Barbeau, E. J., Nguyen, T., McGonigal, A., Regis, J., Chauvel, P., *et al*. (2012). Rhinal-hippocampal interactions during deja vu. Clin. *Neurophysiol*. 123, 489-495. doi: 10.1016/j.clinph.2011.08.012
3. Bodizs, R., Kantor, S., Szabo, G., Szucs, A., Eross, L., and Halasz, P. (2001). Rhythmic hippocampal slow oscillation characterizes REM sleep in humans. *Hippocampus* 11, 747-753. doi: 10.1002/hipo.1090
4. Braun, A. R., Balkin, T. J., Wesenten, N. J., Carson, R. E., Varga, M., Baldwin, P., *et al*. (1997). Regional cerebral blood flow throughout the sleep-wake cycle. An H2O PET study. *Brain* 120(Pt 7), 1173-1197. doi: 10.1093/brain/120.7.1173
5. Carhart-Harris, R. (2007). Waves of the unconscious: the neurophysiology of dreamlike phenomena and its implications for the psychodynamic model of the mind. *Neuro-Psychoanalysis* 9, 183-211. doi: 10.1080/15294145.2007.10773557
6. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J. M., Reed, L. J., Colasanti, A., *et al*. (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl. Acad. Sci. U.S.A.* 109, 2138-2143. doi: 10.1073/pnas.1119598109
7. Carhart-Harris, R. L., and Friston, K. J. (2010). The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. *Brain* 133, 1265-1283. doi: 10.1093/brain/awq010
8. Carhart-Harris, R. L., Leech, R., Tagliazucchi, E., Hellyer, P. J., Chialvo, D. R., Feilding, A., *et al*. (2014). The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front. Hum. Neurosci*. 8:20. doi: 10.3389/fnhum.2014.00020
9. Griffiths, R. R., Richards, W. A., McCann, U., and Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187, 268-283. discussion: 284-292. doi: 10.1007/s00213-006-0457-5
10. Grinspoon, L., and Bakalar, J. B. (1979). *Psychedelic Drugs Reconsidered*. New York, NY: Basic Books.
11. Grob, C. S., Danforth, A. L., Chopra, G. S., Hagerty, M., McKay, C. R., Halberstadt, A. L., *et al*. (2011). Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch. Gen. Psychiatry* 68, 71-78. doi: 10.1001/archgenpsychiatry.2010.116
12. Hagmann, P., Cammoun, L., Gigandet, X., Meuli, R., Honey, C. J., Wedeen, V. J., *et al*. (2008). Mapping the structural core of human cerebral cortex. *PLoS Biol*. 6:e159. doi: 10.1371/journal.pbio.0060159
13. Herbet, G., Lafargue, G., de Champfleur, N. M., Moritz-Gasser, S., le Bars, E., Bonnetblanc, F., *et al*. (2014). Disrupting posterior cingulate connectivity disconnects consciousness from the external environment. *Neuropsychologia* 56C, 239-244. doi: 10.1016/j.neuropsychologia.2014.01.020
14. Holtzheimer, P. E., Kelley, M. E., Gross, R. E., Filkowski, M. M., Garlow, S. J., Barrocas, A., *et al*. (2012). Subcallosal cingulate deep brain stimulation for treatment-resistant unipolar and bipolar depression. *Arch. Gen. Psychiatry* 69, 150-158. doi: 10.1001/archgenpsychiatry. 2011.1456
15. Karashima, A., Katayama, N., and Nakao, M. (2007). Phase-locking of spontaneous and tone-elicited pontine waves to hippocampal theta waves during REM sleep in rats. *Brain Res*. 1182, 73-81. doi:10.1016/j.brainres.2007.08.060
16. Leech, R., Braga, R., and Sharp, D. J. (2012). Echoes of the brain within the posterior cingulate cortex. *J. Neurosci*. 32, 215-222. doi:10.1523/JNEUROSCI.3689-11.2012
17. Leech, R., and Sharp, D. J. (2014). The role of the posterior cingulate cortex in cognition and disease. *Brain* 137, 12-32. doi:

10.1093/brain/awt162

18. Maquet, P., Peters, J., Aerts, J., Delfiore, G., Degueldre, C., Luxen, A., *et al*. (1996). Functional neuroanatomy of human rapid-eye-movement sleep and dreaming. *Nature* 383, 163-166. doi:10.1038/383163a0
19. Miyauchi, S., Misaki, M., Kan, S., Fukunaga, T., and Koike, T. (2009). Human brain activity time-locked to rapid eye movements during REM sleep. *Exp. Brain Res*. 192, 657-667. doi: 10.1007/s00221-008-1579-2
20. Muthukumaraswamy, S. D., Carhart-Harris, R. L., Moran, R. J., Brookes, M. J., Williams, T. M., Errtizoe, D., *et al*. (2013). Broadband cortical desynchronization underlies the human psychedelic state. *J. Neurosci*. 33, 15171-15183. doi: 10.1523/JNEUROSCI.2063-13.2013
21. Muzio, J. N., Roffwarg, H. P., and Kaufman, E. (1966). Alterations in the nocturnal sleep cycle resulting from LSD. *Electroencephalogr. Clin. Neurophysiol*. 21, 313-324. doi: 10.1016/0013-4694(66) 90037-X
22. Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., and Shulman, G. L. (2001). A default mode of brain function. *Proc. Natl. Acad. Sci. U.S.A*. 98, 676-682. doi: 10.1073/pnas. 98.2.676
23. Roiser, J. P., and Rees, G. (2012). Neuroimaging: scanner, a, colourfully. *Curr. Biol*. 22, R231-R233. doi:10.1016/j.cub.2012.02.033
24. Supekar, K., Uddin, L. Q., Prater, K., Amin, H., Greicius, M. D., and Menon, V. (2010). Development of functional and structural connectivity within the default mode network in young children. *Neuroimage* 52, 290-301. doi:10.1016/j.neuroimage.2010.04.009
25. Torda, C. (1968). Contribution to serotonin theory of dreaming (LSD infusion). *N.Y. State J. Med*. 68, 1135-1138.
26. Vignal, J. P., Maillard, L., McGonigal, A., and Chauvel, P. (2007). The dreamy state: hallucinations of autobiographic memory evoked by temporal lobe stimulations and seizures. *Brain* 130, 88-99. doi: 10.1093/brain/awl329

Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning

by

Briony J. Catlow, Shijie Song, Daniel A. Paredes, Cheryl L. Kirstein, Juan Sanchez-Ramos

original source: http://diyhpl.us/~bryan/papers2/paperbot/Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning.pdf
backup source: http://www.psilosophy.info/resources/Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning.pdf

Received: 9 February 2013 / Accepted: 13 May 2013

Table of Contents:

Abstract
Introduction
Materials and methods
 Animals
 Drugs
 General procedure
 Trace fear conditioning
 Immunofluorescence
 Quantitation
 Design and statistical analyses
Results
 Effects of PSOP administration on trace fear conditioning
  Acquisition of the conditioned fear response
  Contextual fear conditioning
  Extinction of the conditioned fear response
 Effects of PSOP, 25I-NBMeO and ketanserin in vivo on cell survival and neurogenesis in the hippocampus
Discussion
Acknowledgments
References

Abstract

Drugs that modulate serotonin (5-HT) synaptic concentrations impact neurogenesis and hippocampal (HPC)-dependent learning. The primary objective is to determine the extent to which psilocybin (PSOP) modulates neurogenesis and thereby affects acquisition and extinction of HPC-dependent trace fear conditioning. PSOP, the 5-HT_{2A} agonist 25I-NBMeO and the 5-$HT_{2A/C}$ antagonist ketanserin were administered via an acute *intraperitoneal* injection to mice. Trace fear conditioning was measured as the amount of time spent immobile in the presence of the conditioned stimulus (CS, auditory tone), trace (silent interval) and post-trace interval over 10 trials. Extinction was determined by the number of trials required to resume mobility during CS, trace and post-trace when the shock was not delivered. Neurogenesis was determined by unbiased counts of cells in the dentate gyrus of the HPC birth-dated with BrdU co-expressing a neuronal marker. Mice treated with a range of doses of PSOP acquired a robust conditioned fear response. Mice injected with low doses of PSOP extinguished cued fear conditioning significantly more rapidly than high-dose PSOP or saline-treated mice. Injection of PSOP, 25I-NBMeO or ketanserin resulted in significant dose-dependent decreases in number of newborn neurons in hippocampus. At the low doses of PSOP that enhanced extinction, neurogenesis was not decreased, but rather tended toward an increase. Extinction of "fear conditioning" may be mediated by actions of the drugs at sites other than hippocampus such as the amygdala, which is known to mediate the perception of fear. Another caveat is that PSOP is not purely selective for 5-HT_{2A} receptors. PSOP facilitates extinction of the classically conditioned fear response, and this, and similar agents, should be explored as potential treatments for post-traumatic stress disorder and related conditions.

Keywords Neurogenesis, Psilocybin, Serotonin, Hippocampus, Learning, Memory, Trace conditioning

Introduction

Psilocybin (4-phosphoryloxy-*N,N*-dimethyltryptamine, PSOP) was first isolated from *Psilocybe mexicana*, a mushroom from Central America by Albert Hofmann in 1957 and soon after produced synthetically in 1958 (Hofmann *et al*. 1958a, b). PSOP is an indole hallucinogen with potential clinical applications in the treatment for anxiety disorders, obsessive-compulsive disorder, major depression and cluster headaches (Moreno *et al*. 2006; Grob *et al*. 2011; Young 2013). PSOP is dephosphorylated in the body and converted into the active metabolite psilocin (4-hydroxy- *N,N*-dimethyltryptamine) which exerts psychoactive effects by altering neurotransmission through serotonin (5-HT) receptors 5-HT_{1A}, 5-HT_{1D}, 5-HT_{2A} and 5-HT_{2C}, but binds to 5-HT_{2A} receptors with high affinity (Ki = 6 nM) (McKenna *et al*. 1990; Passie *et al*. 2002). 5-HT_{2A} receptors are highly expressed throughout the hippocampus (HPC) in the dentate gyrus (DG), hilus, cornu ammonis (CA) 1 and CA3 and are colocalized on GABAergic neurons, pyramidal and granular cells (Luttgen *et al*. 2004; Morilak *et al*. 1993, 1994; Pompeiano *et al*. 1994; Shen and Andrade 1998; Cornea-Hebert *et al*. 1999). 5-HT_{2A} receptor down-regulation is thought to be an adaptive process triggered by chronic administration of selective 5-HT uptake inhibitors (SSRIs) (Eison and Mullins 1996).

Antidepressant medications which elevate 5-HT over prolonged periods such as SSRIs have been shown to enhance hippocampal neurogenesis (Malberg *et al*. 2000). Neurogenesis occurs throughout the life span in the adult brain, the subventricular zone (SVZ) and the subgranular zone (SGZ) in the DG (Altman 1962, 1969; Altman and Das 1965). The proliferation and survival of neural progenitors in the adult HPC can be influenced by a variety of stimuli including stress, age, drugs of abuse, physical activity and depression (Malberg *et al*. 2000; Van *et al*. 1999; Kempermann *et al*. 1998; Gould *et al*. 1992). The involvement of 5-HT in the regulation of neurogenesis may be mediated through different 5-HT receptor subtypes expressed on cells in the neurogenic microniche (Barnes and Sharp 1999).

Serotonin activates fifteen known receptors, many of which are expressed in the DG (Tecott *et al*. 1993; Vilaro *et al*. 1996; Djavadian *et al*. 1999; Clemett *et al*. 2000; Kinsey *et al*. 2001). Acute activation of the 5-HT_1 receptor has been shown to increase cell proliferation in the DG, whereas repeated inhibition of the receptor results in diminished neurogenesis (Klempin *et al*. 2010). Interestingly, both acute and repeated stimulation of the 5-HT_2 receptor attenuate proliferation and neuronal survival (Klempin *et al*. 2010). Studies investigating the effects of 5-HT_2 receptor subunits on proliferation and neurogenesis in the DG have found that acute activation of the 5-$HT_{2A/C}$ receptor via 2,5-dimethoxy-4-iodoamphetamine (DOI), the 5-HT_{2C} receptor agonist RO 600175 or the 5-HT_{2C} receptor antagonist SB-206553 had no effect on cell proliferation, whereas the 5-$HT_{2A/C}$ receptor antagonist ketanserin produced a 63 % decrease in BrdU incorporation (Banasr *et al*. 2004). Similarly, other investigators reported that acute ketanserin decreased proliferation, but chronic ketanserin increased proliferation in the DG (Jha *et al*. 2008). Additionally, no effect on proliferation was observed after DOI or lysergic acid diethylamide (LSD) was administered either acutely or once daily for seven consecutive days (chronic) (Jha *et al*. 2008). Administering LSD and PSOP by giving daily doses has been shown to produce rapid tolerance to the drug and results in a selective down-regulation of the 5-HT_{2A} receptor (Buckholtz *et al*. 1985, 1990).

The serotonergic system has been implicated in hippocampal (HPC)-dependent learning. Administration of SSRIs produces alterations in performance on learning tasks that require the HPC (Flood and Cherkin 1987; Huang *et al*. 2004). In a knockout (KO) mouse model, central 5-HT-deficient mice developed heightened contextual fear conditioning which was reversed by intracerebroventricular microinjection of 5-HT (Dai *et al*. 2008). An impairment in learning on the Morris water maze was observed in 5-HT_{1A} KO mice along with functional abnormalities in the HPC (Sarnyai *et al*. 2000). Activation of 5-HT_{1A} receptors in the medial septum alters encoding and consolidation in a HPC-dependent memory task (Koenig *et al*. 2008). In addition, LSD facilitated learning of a brightness discrimination reversal problem (King *et al*. 1972, 1974).

Evidence suggests that performance on HPC-dependent learning tasks is influenced by neurogenesis in the DG of the HPC (Van *et al*. 2002; Gould *et al*. 1999a, b; Nilsson *et al*. 1999; Shors *et al*. 2001, 2002). This was elegantly demonstrated by Shors *et al*. by treating animals with methylazoxymethanol acetate (MAM), an antimitotic agent which eradicates the progenitor cell population in the DG before testing mice on HPC-dependent and HPC-independent learning tasks (Shors *et al*. 2001, 2002). MAM-treated animals had significantly fewer BrdU+ cells in the SGZ but showed no impairment in the spatial navigation task (HPC-dependent) or delay eyeblink conditioning task (HPC-independent), demonstrating that the hippocampal progenitor cell population is not essential for these particular tasks (Shors *et al*. 2001, 2002). In contrast, MAM severely impaired performance on trace fear conditioning and trace eyeblink conditioning, providing evidence for the involvement of progenitor cells in the DG in trace classical conditioning.

The present study investigated the role of PSOP through the 5-HT_{2A} receptor on hippocampal neurogenesis and a HPC-dependent learning task, trace fear conditioning. The effects of single-dose injections of PSOP, the 5-HT_{2A} agonist 25I-NBMeO and the 5-$HT_{2A/C}$ antagonist ketanserin on the survival and phenotypic fate of progenitor cells in the DG were assessed using immunofluorescence techniques. The effects of single doses of PSOP on trace fear conditioning were chosen for this study because it has previously been demonstrated to be a HPC-dependent learning paradigm.

Materials and methods

Animals

C57BL/6J male mice (30-40 g) were housed in standard laboratory cages and left undisturbed for 1 week after arrival at the animal facility. All mice had ad libitum access to water and laboratory chow and were maintained in a temperature- and humidity-controlled room on a 12:12 light/dark cycle with light onset at 7:00 a.m. This study was carried out in strict accordance with the recommendations from the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health. The protocol was approved by the Institutional Animal Care and Use Committee at the University of South Florida (IAC UC #R3347).

Drugs

25I-NBMeO (4-iodo-2,5-dimethoxy-*N*-(2-methoxybenzyl) phenethylamine) was synthesized in the laboratory of Dr. David Nichols (Braden *et al*. 2006). PSOP was provided by Dr. Francisco Moreno from the University of Arizona. Ketanserin (+)-tartrate salt (#S006, St. Louis, MO) and 5-bromo-2′-deoxyuridine (#B5002, St. Louis, MO) were supplied by Sigma-Aldrich Inc.

General procedure

A total of 48 C57BL/6 mice received a single injection of 0.1 mg/kg PSOP ($n = 6$), 0.5 mg/kg PSOP ($n = 6$), 1.0 mg/ kg PSOP ($n = 6$), 0.1 mg/kg 25I-NBMeO ($n = 6$), 0.3 mg/ kg 25I-NBMeO ($n = 6$), 1.0 mg/kg 25I-NBMeO ($n = 6$), 1.0 mg/kg ketanserin ($n = 6$) or saline ($n = 6$). Mice received an intraperitoneal (i.p.) injection of 75 mg/kg BrdU once daily for 4 days following drug administration and were euthanized 2 weeks after drug injection. Mice were euthanized with nembutal and then transcardially perfused with 0.9 % saline followed by 4 % paraformaldehyde. Brains were stored in 4 % paraformaldehyde, transferred to 20 % sucrose solution, sectioned coronally using a cryostat (Leica, Germany) at 30 μM in a 1:6 series and stored in 24-well plates in cryoprotectant at -20 °C.

Trace fear conditioning

Mice (n = 9-10/condition) received an i.p. injection of PSOP (0.1, 0.5, 1.0 and 1.5 mg/kg), ketanserin (1.0 mg/ kg) or 0.9 % saline and 24 h later were habituated to the testing chamber for 30 min. The fear conditioning environment consisted of two chambers each placed inside a larger soundproof chamber. The 35.6 (W) × 38.1 (D) × 31.8 (H) cm freeze monitor box (San Diego Instruments, San Diego, CA) is a clear Plexiglas chamber with a removable lid which contains a metal grid floor (0.3-cm grids spaced 0.8 cm apart) through which a foot shock can be delivered. Photo-beam activity within the chamber recorded the vertical and horizontal movements of mice. Two minutes into the habituation period, a baseline (BL) measure of movement was recorded for 3 min and served as the habituation BL measure. Freeze monitor boxes were cleaned with quatricide between each mouse to prevent olfactory cues. Mice were returned to their home cage after habituation.

The next day mice were returned to the same freeze monitor chamber and underwent training to form CS-US associations. After a 2-min acclimation period, mice were exposed to 10 trials of trace fear conditioning, which is illustrated in Fig. 2. Each trial consisted of the CS (tone, 82 dB, 15 s) followed by a trace interval (30 s) and ended with the presentation of the US (shock, 0.5 s, 1 mA) delivered through the grid flooring. After each trial ended, there was a 210-s intertrial interval (ITI). Freeze monitor boxes were cleaned with quatricide between each mouse to prevent olfactory cues, and mice were returned to their home cage after training.

On day 3 of the task, retention and extinction of the conditioned fear response were assessed in three phases. First, mice were placed in the freeze monitor box for 5 min, and movement was recorded for the last 3 min and used to assess the measure of fear (immobility) associated with the training context. Mice were then returned to the home cage for 1 h. Second, the context was altered by replacing the grid floors with black Plexiglas flooring and adding a cotton ball with 1 ml vanilla essence inside the sound-attenuated chamber. Mice were placed inside the novel chamber, and after 2 min, movements were recorded for the next 3 min.

In the third phase, extinction of the conditioned fear response was determined by placing the animals in the freeze monitor boxes and running ten trials of CS presentation (auditory tone for 15 s) followed by a trace of silence for 30 s without delivery of the UCS (shock). As with the acquisition phase of the learning, a 210-s ITI separated each trial. The conditioned fear response was expressed as the percentage of time the mice were immobile during CS (tone; 15 s), during the trace interval (30 s) and for 30 s after the trace interval.

Immunofluorescence

For the double labeling of progenitor cells in the DG, free-floating sections were denatured using 2N HCl and neutralized in 0.15 M borate buffer and then washed in PBS. Tissue was blocked in PBS+ (PBS, 10 % normal goat serum, 1 % 100× Triton X, 10 % BSA) for 1 h at 4 °C and incubated for 48 h at 4 °C in an antibody cocktail of rat monoclonal anti-BrdU (AbD Serotec, Raleigh NC, #OBT0030G, 1:100) plus mouse anti-NeuN (Chemicon, 1:100) in PBS plus 2 % normal goat serum. Sections were washed in PBS and incubated in a secondary antibody cocktail of goat anti-rat IgG Alexa Fluor 594 (1:1,000, Invitrogen, Eugene OR) plus goat antimouse IgG Alexa Fluor 488 (1:400, Invitrogen) and coated with Vectashield mounting medium with DAPI (Invitrogen).

Quantitation

For the quantification of double-labeled cells using immunofluorescence, the number of BrdU+ - and BrdU/NeuN+ - labeled cells was estimated using every sixth section taken throughout the DG (every 180 microns). To avoid counting partial cells, a modification to the optical dissector method was used so that cells on the upper and lower planes were not counted. The number of BrdU+ cells counted in every sixth section was multiplied by six to get the total number of BrdU+ or BrdU/NeuN+ cells in the DG (Shors *et al*. 2002). Positive labeling was verified by confocal microscopy (Zeiss Model LSM510).

Design and statistical analyses

One-way analysis of variance (ANOVA) was used to evaluate the effects of PSOP, the 5-HT$_{2A}$ receptor agonist and an antagonist on hippocampal neurogenesis (proliferation and survival). Separate two-way repeated-measures ANOVA was used to evaluate the effect of Dose and Trial on each dependent variable in the trace fear conditioning task. Dependent measures recorded included percentage freezing during CS, during trace, after trace, during habituation baseline, during the context text and in response to the novel environment. When appropriate, post hoc analyses such as Bonferroni were used to isolate effects. All statistical analyses were determined significantly at the 0.05 alpha level.

Results

Effects of PSOP administration on trace fear conditioning

Acquisition of the conditioned fear response

Mice were placed in the freeze monitor box 24 h after injection of a single dose of PSOP (0.1, 1.0 and 1.5 mg/kg), ketanserin (1.0 mg/kg) or saline vehicle. Training consisted of a sequence of 10 trials of CS-UCS presentation. A single trial consisted of a 15-s auditory cue (CS) followed by a silent "trace" for 30 s terminating in a brief shock to the feet. The intertrial interval (ITI) was 210 s. After just a few trials, animals acquired the conditioned response, that is, freezing during presentation of the CS, trace and post-shock interval (Fig. 1). In trial 3, mice treated with low-dose PSOP (0.1 mg/kg) exhibited a trend toward less freezing (Fig. 1d). Two-way ANOVA showed a significant effect of Trial [$F(2,102) = 7.83$, $p < 0.0007$] with trials 2 and 3, eliciting significantly more freezing in response to the CS compared to trial one, but no significant effect of dose. Post hoc comparisons of each dose to vehicle, with Bonferroni correction, also did not reveal a significant difference between PSOP doses and saline. By trial 10, all mice froze for the same amount regardless of dose or drug treatment (Fig. 1e).

Contextual fear conditioning

Contextual fear conditioning was assessed by comparing percentage immobility in the freeze monitor box on habituation day to percentage immobility during the context test. There was no interaction between Dose and Trial [$F(5,90) = 0.95$, $p = 0.45$] and no effect of Dose during the habituation BL or context test [$F(5,90) = 1.15$, $p = 0.34$]. Notably, there was a significant effect of Trial [$F(1,90) = 105.85$, $p < 0.0001$], indicating that mice spent significantly more time freezing after the CS-US pairings during the context test compared to habituation baseline. These data show that all mice learned to fear the context in which they received the CS-US pairings (Fig. 2a, b).

Extinction of the conditioned fear response

A measure of the strength or durability of the conditioned fear response is the number of trials required to extinguish the conditioned response. This was determined by running a set of 10 extinction trials during which the CS and trace were not followed by shock. Two-way repeated-measures ANOVA of freezing after the trace interval revealed a significant interaction between Dose and Trial [$F(20,216) = 2.68$, $p < 0.0002$]. Mice that received low doses of PSOP (0.1 and 0.5 mg/kg) responded robustly to the CS and trace interval as well as to immediate post-trace interval of 30 s by freezing significantly greater than mice treated with vehicle in the very first extinction trial, indicating they "remembered" the link between the CS and the shock (Figs. 2c, 3c). However, by trial 3, the mice treated with low-dose PSOP no longer froze in the absence of the UCS, but adapted quickly to the new condition in which the CS and trace did not culminate in shock (Fig. 2e). Such rapid extinction of the fear response was not observed in mice treated with higher PSOP doses or with ketanserin. Mice that received higher doses of PSOP eventually decreased freezing, so that by trial 10 they no longer exhibited a fear response (Fig. 2f). Ketanserin treatment also produced a robust fear response through trial 3, but as with all mice treated with either PSOP or ketanserin, the fear response was significantly decreased compared to control by trial 10. These results indicate that low-dose PSOP facilitates extinction of the fear response in a hippocampal-dependent trace conditioning paradigm.

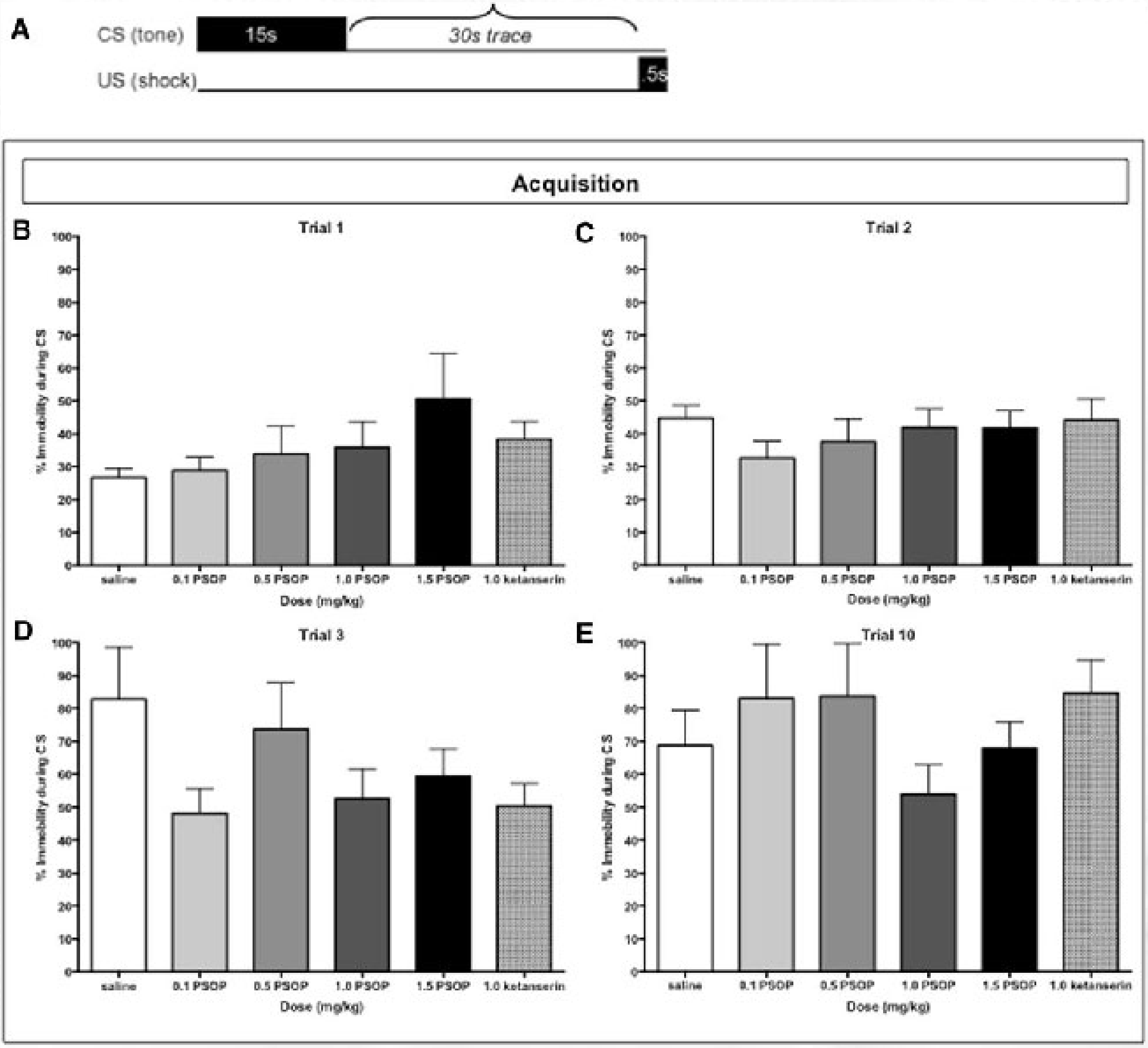


Fig. 1 Effects of psilocybin on acquisition of trace fear conditioning. **a** Schematic representation of the trace fear conditioning paradigm. Trace fear conditioning is a HPC-dependent task in which the presentation of the conditioned stimulus (CS, tone) is separated in time by a trace interval to the unconditioned stimulus (US, shock). **b-e** Percentage immobility during the CS is expressed on the *Y* axis and dose on the *X* axis. After trial 2 (**c**) animals acquired the conditioned response, freezing 34-45 % of the time during presentation of the CS. A quantitatively similar freezing response was observed during the trace and 30 s after the trace (data not shown). By trial 10 (**d**) all mice froze 55-80 % of the CS time interval regardless of drug dose. Two-way ANOVA showed a significant effect of Trial [$F(2,102) = 7.83$, $p < 0.0007$] with trials 2 and 3 eliciting significantly more freezing in response to the CS compared to trial 1 and dose [$F(5,51) = 4.96$, $p < 0.0009$]

Effects of PSOP, 25I-NBMeO and ketanserin in vivo on cell survival and neurogenesis in the hippocampus

To investigate the effects of a single dose of PSOP, the 5-HT$_{2A}$ receptor agonist 25I-NBMeO or antagonist ketanserin on cell survival and neurogenesis, mice (n = 6-7 per condition) were injected with PSOP (0.1, 0.5 or 1.0 mg/kg), 25I-NBMeO (0.1, 0.3 or 1.0 mg/kg), ketanserin (1.0 mg/kg) or 0.9 % saline solution followed by injections of the cellular birth-date marker BrdU (75 mg/kg) once daily for 4 days after drug administration. Animals were euthanized 2 weeks after drug injection. PSOP treatment produced a dose-dependent decrease in the number of surviving BrdU+ cells (Fig. 3). ANOVA showed a significant effect of dose on birth-dated cell survival, and post hoc comparison between doses and vehicle revealed a statistically significant decrease in cell survival following high doses of PSOP but not following the low doses of 0.1 and 0.5 mg/ kg (Fig. 3a). The phenotypic fate of BrdU-birth-dated cells was determined by immunofluorescent double labeling of BrdU+ and NeuN+ cells. There was a biphasic response of PSOP on neurogenesis, with the lowest dose (0.1 mg/kg) increasing number of BrdU/NeuN+ cells and the high dose (1 mg/kg) decreasing number of new neurons (Fig.

3b). One-way ANOVA revealed a highly significant effect of PSOP dose on the number of double-labeled neurons in the DG. Despite the trend toward stimulation of neurogenesis by 0.1 mg/kg PSOP, post hoc comparison of PSOP doses to vehicle did not reach statistical significance, but the depression of neurogenesis by the high dose of PSOP reached statistical significance. Ketanserin, like high-dose PSOP, also significantly decreased neurogenesis (number of BrdU/NeuN+ cells) compared to saline.

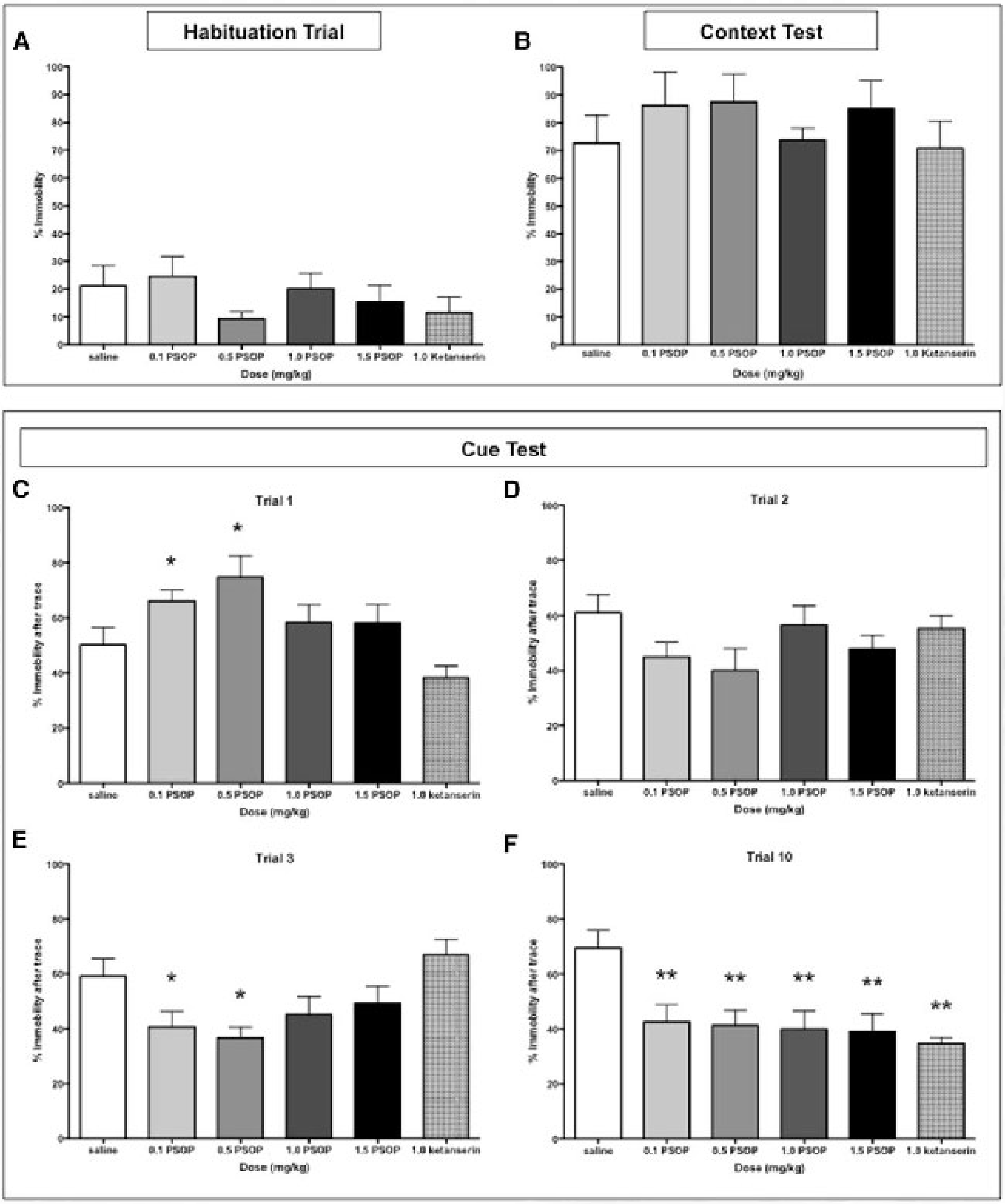


Fig. 2 Contextual fear conditioning and extinction. **a** Percentage immobility expressed during exposure to the freeze monitor box during habituation and b during the context test. All mice expressed contextual fear conditioning as indicated by a significant increase in percentage immobility during the context test ($p < 0.05$). **c-f** Cue test (presentation of CS and trace without shock; extinction protocol). *Y* axis shows percentage of time mice were immobile during the 30-s interval after the shock would have been delivered. Two-way repeated-measures ANOVA of freezing after the trace interval revealed a significant interaction between Dose and Trial [$F(20,216) = 2.68$, $p < 0.0002$]. **c** Mice treated with low-dose PSOP exhibited significant freezing on trial 1 of the extinction protocol. **d, e** By trials 2 and 3, low-dose-treated mice exhibited significantly less immobility. Control mice demonstrated robust fear conditioning throughout the entire test, whereas mice treated with PSOP or ketanserin froze significantly less by trial 10, indicating rapid extinction of the fear response. *Indicates a significant difference from ketanserin, **indicates a significant difference from saline.

Injections of 25I-NBMeO (0.1, 0.3 and 1 mg/kg) or of the antagonist ketanserin resulted in a significant decrease in the number of surviving BrdU+ cells and BrdU/NeuN+ neurons in hippocampus compared to saline injections (Fig. 3c, d). Unlike the PSOP injections, low doses of 25I-NBMeO did not produce a trend toward increased neurogenesis.

Discussion

The present investigation demonstrates that PSOP produces alterations in hippocampal neurogenesis and in a HPC-dependent learning paradigm of cue-associated fear conditioning. To evaluate the effects of PSOP on HPC-dependent learning, an acute treatment of PSOP or ketanserin was administered prior to trace fear conditioning. During the acquisition of the conditioned response, there was a striking increase in the amount of time spent freezing during the presentation of the CS and during the trace period and immediate post-trace interval from trial 1 to trial 3. These data demonstrate that the association between the CS and US promoted freezing in anticipation of the shock as well as during the period after the shock. Notably, the acquisition of the conditioned response was not impaired by acute administration of PSOP or ketanserin.

Regardless of the PSOP dose, mice displayed similar locomotor activity levels in the freeze monitor box during the habituation baseline exposure and during re-exposure to the same environment during the contextual fear conditioning test. As expected, mice froze substantially more during re-exposure to the same context after CS-US associations were formed compared to the habituation baseline, indicating that mice formed contextual fear conditioning regardless of their drug exposure. It is well known that contextual fear conditioning is a HPC-dependent learning task (Hirsh 1974; Kim and Fanselow 1992; McNish *et al*. 1997; Frohardt *et al*. 1999; Esclassan *et al*. 2009). The serotonergic system has been implicated in performance on the contextual fear conditioning task (Dai *et al*. 2008), and hippocampal neurogenesis is required for the expression of fear memory (Shors *et al*. 2001, 2002). The present investigation found that interaction with the 5-HT_{2A} receptor does not impair contextual fear conditioning since no differences were observed between controls and mice treated with PSOP or ketanserin.

Unlike the acquisition of the conditioned fear response, where drug had no significant effect on learning the association between CS, trace and shock (UCS), the extinction of the conditioned response was accelerated in mice treated with low doses of PSOP. This rapid reversal of fear conditioning was only observed with low-dose PSOP treatment and was not present with higher doses or with ketanserin. Thus, PSOP treatment does not alter acquisition of a conditioned fear response nor in remembering the link between the CS and UCs (contextual test), but low-dose PSOP facilitates extinction by disassociating the link between the CS, trace and the UCS (shock). Given that low doses of PSOP accelerated fear extinction, it is interesting to consider whether PSOP is blunting the emotional component of the fear memory which leads to rapid extinction. We observed that all mice freeze in response to each presentation of the shock during training and assume that for all mice regardless of the treatment, fear is evoked. In human studies, low doses of PSOP produce no differences in general well-being, emotional excitability, anxiety-depressiveness, plasma cortisol levels, heart rate, body temperature and blood pressure (Hasler *et al*. 2004). Taken together, we believe that the PSOP facilitation of fear extinction is not likely due to blunted emotion but instead caused by diminished neurogenesis and alterations in hippocampal neurotransmission.

The molecular basis for creating the links between CS and UCS in the trace conditioning paradigm is not completely understood. Clearly, synaptic plasticity in the HPC is critical for the acquisition of new associations (learning) and recall of those associations (memory). Brain-derived neurotrophic factor (BDNF) has been implicated in synaptic plasticity and memory processing (Kang *et al*. 1997; Pang *et al*. 2004; Tyler *et al*. 2002) through the modulation of synapse formation and dendritic spine growth in the HPC (Bamji *et al*. 2006; Tyler and Pozzo-Miller 2001, 2003). Chronic administration of 5-HT agonists (including SSRIs) upregulates BDNF mRNA expression in the HPC (Nibuya *et al*. 1995, 1996). Evidence suggests that the 5-HT_{2A} receptor is involved in the regulation of BDNF in the HPC (Vaidya *et al*. 1997). Specifically, DOI, a 5-$HT_{2A/C}$ receptor agonist, decreased BDNF mRNA expression in the granule cell layer of the DG, but not in the CA subfields of the HPC. Interestingly, the decrease in BDNF mRNA expression was blocked by the 5-HT_{2A} receptor antagonist, but not the 5-HT_{2C} receptor antagonist, implicating the 5-HT_{2A} receptor in the regulation of BDNF expression (Vaidya *et al*. 1997). The process of forgetting or breaking synaptic links in HPC is even less understood. One possible explanation for the findings presented here is that single low doses of PSOP acting via the 5-HT_{2A} receptors on HPC neurons inhibit BDNF expression and thereby decrease synaptic growth and neurogenesis.

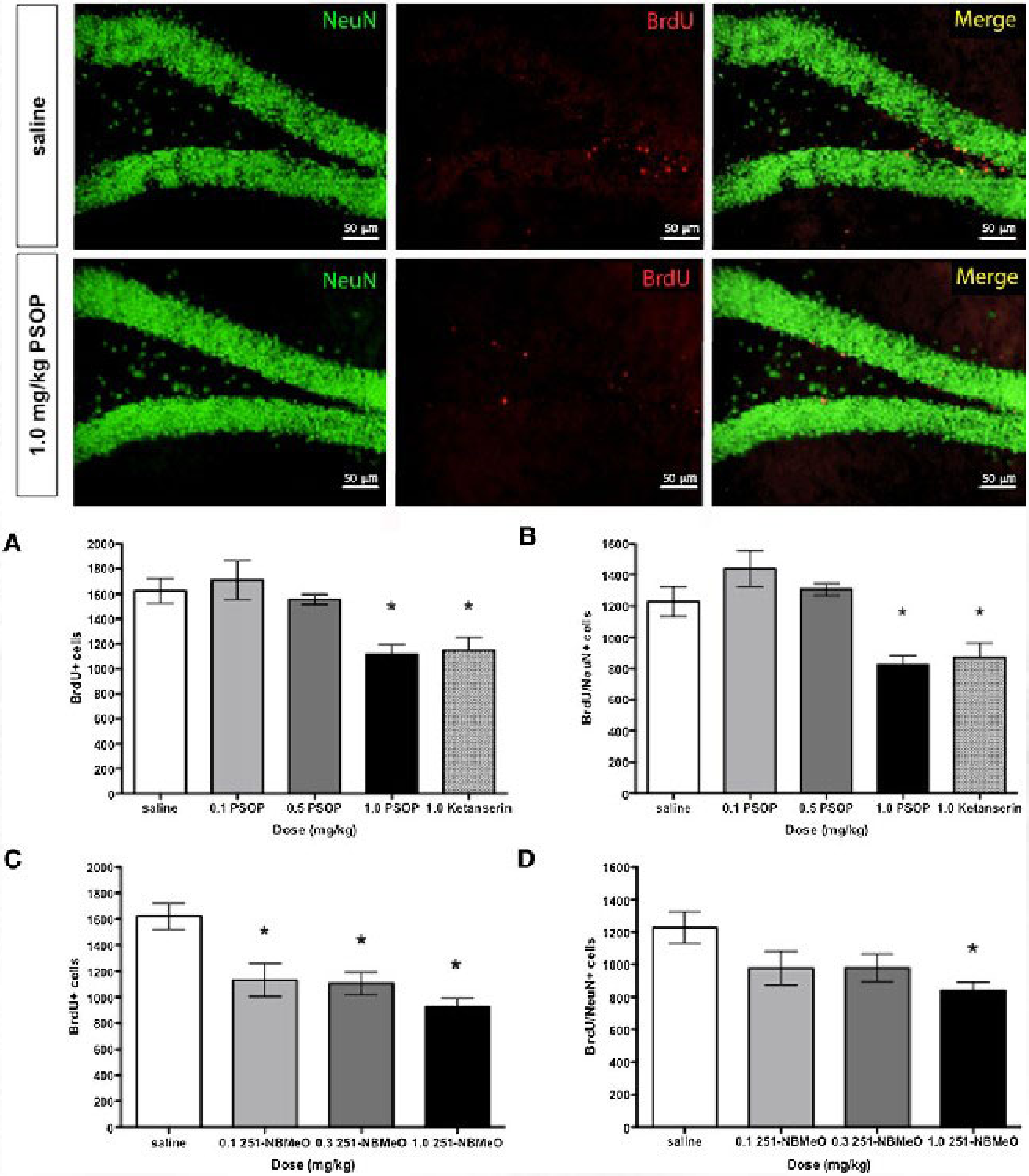


Fig. 3 Effect of acute 5-HT_{2A} receptor stimulation on hippocampal neurogenesis. Representative photomicrographs of NeuN+ cells (*left*), BrdU+ cells (*center*) and NeuN/BrdU+ cells (*right*) in the dentate gyrus from saline (*top*)- and 1.0 mg/kg PSOP (*bottom*)-treated mice, scale 50 µM. Mice (n = 6 per condition) were injected with **a, b** saline, PSOP (0.1, 0.5 or 1.0 mg/kg) or 1.0 mg/kg ketanserin **c, d** saline or 25I-NBMeO (0.1, 0.3 or 1.0 mg/kg) and then received 75 mg/kg BrdU once daily for 4 days after drug administration, followed by euthanasia 2 weeks after drug injection. **a, c** The total number of BrdU+ cells in the DG was significantly diminished after a single injection of 1.0 mg/kg PSOP, 25I-NBMeO or ketanserin ($p < 0.05$). **b, d** Acute administration of 1.0 mg/kg PSOP, 1.0 mg/kg of 25I-NBMeO and ketanserin significantly diminished the number of BrdU/NeuN+ cells compared to saline ($p <$ 0.05). These data suggest acute administration of 5-HT_{2A} receptor decreases progenitor cell survival (and/or proliferation) and attenuates the generation of new neurons in the HPC. *Indicates a significant difference from saline.

The data reported demonstrate that the administration of PSOP produced a biphasic response in hippocampal neurogenesis; a low dose (0.1 mg/kg) resulted in a trend toward increased neurogenesis, whereas the high dose of PSOP significantly decreased the formation of new neurons measured 2 weeks after drug exposure. In addition, all doses of the potent 5-HT_{2A} receptor agonist 25I-NBMeO and the 5-$HT_{2A/C}$ receptor antagonist ketanserin decreased hippocampal neurogenesis. A range of doses of ketanserin (1-5 mg/kg) administered within 4 h of killing has been reported to decrease the number of BrdU+ cells in the DG, indicating a reduction in cell proliferation (Banasr *et al*. 2004; Jha *et al*. 2008). The present study extends these findings by demonstrating that single doses of ketanserin decreased the number of BrdU+ and BrdU/NeuN+ cells 2 weeks after drug administration, indicating a reduction in both progenitor cell survival and formation of new neurons after exposure to a single dose of the 5-HT$_{2A/C}$ antagonist.

Using positron emission tomography (PET), Vollenweider *et al*. established that PSOP-induced schizophrenia, like psychosis, in humans is completely blocked by the 5-HT$_{2A}$ antagonist ketanserin, demonstrating that PSOP produces psychotropic effects mainly via 5-HT$_{2A}$ receptor activation (Vollenweider *et al*. 1998). However, PSOP administration decreases [^{11}C]raclopride receptor binding potential in the basal ganglia, which is indicative of increased DA levels (Vollenweider *et al*. 1999). Additionally, the D2 antagonist haloperidol attenuates the psychotomimetic effects of PSOP, clearly demonstrating that the DA system is involved in PSOP-induced psychotomimesis (Vollenweider *et al*. 1999). Interestingly, increases in DA disrupt fear extinction (Willick and Kokkinidis 1995; Borowski and Kokkinidis 1998); therefore, it is plausible that DA may contribute to PSOP facilitating the extinction of the fear response. Morrow and colleagues demonstrated that DAergic neurons which project to the medial prefrontal cortex (PFC) are critical in fear extinction and reduced rates of extinction are observed after 6-hydroxydopamine lesions to the PFC reduced DA levels to 13 % of control (Morrow *et al*. 1999). Furthermore, the activation of 5-HT$_{2A}$ receptors in the medial PFC increases extracellular glutamate levels (Aghajanian and Marek 1999), thereby affecting subcortical neurotransmission and increasing the activity of DA neurons in the ventral tegmental area (VTA), resulting in increased DA transmission in mesocortical and mesostriatal regions (Vazquez-Borsetti *et al*. 2009). Since drugs that increase DA bioavailability are involved in fear extinction, it is plausible that PSOP is facilitating fear extinction through an interaction between 5-HT and DA neurotransmitter systems in PFC, amygdala and HPC.

To summarize, the data reported in the present investigation demonstrate that PSOP at low doses facilitates extinction of a HPC-dependent classically conditioned fear response. Low dose of PSOP was also associated with a trend toward an increase, or no change, in hippocampal neurogenesis compared to vehicle treatment. In contrast, higher doses of PSOP (or of the 5-HT$_{2A/C}$ antagonist ketanserin) significantly depressed neurogenesis, and these doses had no impact on extinction of the conditioned fear response. Although previous studies have reported that ablation of hippocampal neurogenesis with a potent chemotherapeutic agent impaired acquisition of HPC-dependent fear conditioning (Shors *et al*. 2001, 2002), the present study did not reveal impaired acquisition of the trace fear conditioning response, likely due to modest inhibition of neurogenesis with the range of PSOP doses used. Importantly, studies of the effects of ablation of hippocampal neurogenesis focused on acquisition of the response and did not address extinction of a previously learned conditioned fear response as was done here. It is possible that the effect of low-dose PSOP on hippocampal neurogenesis, which was minimal, may not be the critical mechanism for forgetting or erasing the link between the noxious stimulus and the conditioned stimulus. PSOP clearly interacts with 5-HT$_{2A}$ receptors in other regions of brain known to mediate the emotion of fear such as amygdala (Ledoux 2003). However, one cannot invoke reduction in the fear emotion by PSOP because the acquisition of the conditioned fear response was not affected by PSOP administration at any dose. A final caveat is that PSOP is not a pure 5-HT$_{2A}$ agonist and may interact with other 5-HT receptor subtypes. In conclusion, low-dose PSOP which acts primarily on the 5-HT$_{2A}$ receptor facilitates extinction of a conditioned fear response and raises the possibility of targeting the 5-HT$_{2A}$ receptor to treat conditions where a previously neutral set of stimuli are associated with noxious, or life-threatening events, such as post-traumatic stress disorder.

Acknowledgments

This work was supported by the Helen Ellis Research Endowment (J.S.R.). Thanks to David Nichols Ph.D. for donating the selective 5-HT$_{2A}$ agonist 25I-NBMeO and Dr. Francisco Moreno from University of Arizona and Rick Doblin Ph.D. of the Multidisciplinary Association for Psychedelic Studies (MAPS) for donating the PSOP.

References

1. Aghajanian GK, Marek GJ (1999) Serotonin, via 5-HT2A receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release. Brain Res 825:161-171
2. Altman J (1962) Are new neurons formed in the brains of adult mammals? Science 135:1127-1128
3. Altman J (1969) Autoradiographic and histological studies of postnatal neurogenesis. IV. Cell proliferation and migration in the anterior forebrain, with special reference to persisting neurogenesis in the olfactory bulb. J Comp Neurol 137:433-457
4. Altman J, Das GD (1965) Autoradiographic and histological evidence of postnatal hippocampal neurogenesis in rats. J Comp Neurol 124:319-335
5. Bamji SX, Rico B, Kimes N, Reichardt LF (2006) BDNF mobilizes synaptic vesicles and enhances synapse formation by disrupting cadherin-beta-catenin interactions. J Cell Biol 174:289-299
6. Banasr M, Hery M, Printemps R, Daszuta A (2004) Serotonininduced increases in adult cell proliferation and neurogenesis are mediated through different and common 5-HT receptor subtypes in the dentate gyrus and the subventricular zone. Neuropsychopharmacology 29:450-460
7. Barnes NM, Sharp T (1999) A review of central 5-HT receptors and their function. Neuropharmacology 38:1083-1152
8. Borowski TB, Kokkinidis L (1998) The effects of cocaine, amphetamine, and the dopamine D1 receptor agonist SKF 38393 on fear extinction as measured with potentiated startle: implications for psychomotor stimulant psychosis. Behav Neurosci 112:952-965
9. Buckholtz NS, Freedman DX, Middaugh LD (1985) Daily LSD administration selectively decreases serotonin2 receptor binding in rat brain. Eur J Pharmacol 109:421-425
10. Buckholtz NS, Zhou DF, Freedman DX, Potter WZ (1990) Lysergic acid diethylamide (LSD) administration selectively downregulates serotonin2 receptors in rat brain. Neuropsychopharmacology 3:137-148
11. Clemett DA, Punhani T, Duxon MS, Blackburn TP, Fone KC (2000) Immunohistochemical localisation of the 5-HT2C receptor protein in the rat CNS. Neuropharmacology 39:123-132
12. Cornea-Hebert V, Riad M, Wu C, Singh SK, Descarries L (1999) Cellular and subcellular distribution of the serotonin 5-HT2A receptor in the central nervous system of adult rat. J Comp Neurol 409:187-209
13. Dai JX, Han HL, Tian M, Cao J, Xiu JB, Song NN, Huang Y, Xu TL, Ding YQ, Xu L (2008) Enhanced contextual fear memory in central serotonin-deficient mice. Proc Natl Acad Sci USA 105:11981-11986
14. Djavadian RL, Wielkopolska E, Bialoskorska K, Turlejski K (1999) Localization of the 5-HT1A receptors in the brain of opossum Monodelphis domestica. NeuroReport 10:3195-3200
15. Eison AS, Mullins UL (1996) Regulation of central 5-HT2A receptors: a review of in vivo studies. Behav Brain Res 73:177-181
16. Esclassan F, Coutureau E, Di SG, Marchand AR (2009) Differential contribution of dorsal and ventral hippocampus to trace and delay fear conditioning. Hippocampus 19:33-44
17. Flood JF, Cherkin A (1987) Fluoxetine enhances memory processing in mice. Psychopharmacology 93:36-43
18. Frohardt RJ, Guarraci FA, Young SL (1999) Intrahippocampal infusions of a metabotropic glutamate receptor antagonist block the memory of context-specific but not tone-specific conditioned fear. Behav Neurosci 113:222-227
19. Gould E, Cameron HA, Daniels DC, Woolley CS, McEwen BS (1992) Adrenal hormones suppress cell division in the adult rat dentate gyrus. J Neurosci 12:3642-3650
20. Gould E, Beylin A, Tanapat P, Reeves A, Shors TJ (1999a) Learning enhances adult neurogenesis in the hippocampal formation. Nat Neurosci 2:260-265
21. Gould E, Tanapat P, Hastings NB, Shors TJ (1999b) Neurogenesis in adulthood: a possible role in learning. Trends Cogn Sci 3:186-192
22. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstadt AL, Greer GR (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch Gen Psychiatry 68:71-78
23. Hasler F, Grimberg U, Benz MA, Huber T, Vollenweider FX (2004) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacology 172:145-156
24. Hirsh R (1974) The hippocampus and contextual retrieval of information from memory: a theory. Behav Biol 12:421-444
25. Hofmann A, Frey A, Ott H, Petr ZT, Troxler F (1958a) Elucidation of the structure and the synthesis of psilocybin. Experientia 14:397-399
26. Hofmann A, Heim R, Brack A, Kobel H (1958b) Psilocybin, a psychotropic substance from the Mexican mushroom Psilicybe mexicana Heim. Experientia 14:107-109
27. Huang SC, Tsai SJ, Chang JC (2004) Fluoxetine-induced memory impairment in four family members. Int J Psychiatry Med 34:197-200
28. Jha S, Rajendran R, Fernandes KA, Vaidya VA (2008) 5-HT2A/2C receptor blockade regulates progenitor cell proliferation in the adult rat hippocampus. Neurosci Lett 441:210-214
29. Kang H, Welcher AA, Shelton D, Schuman EM (1997) Neurotrophins and time: different roles for TrkB signaling in hippocampal longterm potentiation. Neuron 19:653-664
30. Kempermann G, Kuhn HG, Gage FH (1998) Experience-induced neurogenesis in the senescent dentate gyrus. J Neurosci 18:3206-3212
31. Kim JJ, Fanselow MS (1992) Modality-specific retrograde amnesia of fear. Science 256:675-677
32. King AR, Martin IL, Seymour KA (1972) Reversal learning facilitated by a single injection of lysergic acid diethylamide (LSD 25) in the rat. Br J Pharmacol 45:161P-162P
33. King AR, Martin IL, Melville KA (1974) Reversal learning enhanced by lysergic acid diethylamide (LSD): concomitant rise in brain 5-hydroxytryptamine levels. Br J Pharmacol 52:419-426
34. Kinsey AM, Wainwright A, Heavens R, Sirinathsinghji DJ, Oliver KR (2001) Distribution of 5-ht(5A), 5-ht(5B), 5-ht(6) and 5-HT(7) receptor mRNAs in the rat brain. Brain Res Mol Brain Res 88:194-198
35. Klempin F, Babu H, De Pietri TD, Alarcon E, Fabel K, Kempermann G (2010) Oppositional effects of serotonin receptors 5-

HT1a, 2, and 2c in the regulation of adult hippocampal neurogenesis. Front Mol Neurosci 3:1-11. Art No 14
36. Koenig J, Cosquer B, Cassel JC (2008) Activation of septal 5-HT1A receptors alters spatial memory encoding, interferes with consolidation, but does not affect retrieval in rats subjected to a watermaze task. Hippocampus 18:99-118
37. Ledoux J (2003) The emotional brain, fear, and the amygdala. Cell Mol Neurobiol 23:727-738
38. Luttgen M, Ove OS, Meister B (2004) Chemical identity of 5-HT2A receptor immunoreactive neurons of the rat septal complex and dorsal hippocampus. Brain Res 1010:156-165
39. Malberg JE, Eisch AJ, Nestler EJ, Duman RS (2000) Chronic antidepressant treatment increases neurogenesis in adult rat hippocampus. J Neurosci 20:9104-9110
40. McKenna DJ, Repke DB, Lo L, Peroutka SJ (1990) Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. Neuropharmacology 29:193-198
41. McNish KA, Gewirtz JC, Davis M (1997) Evidence of contextual fear after lesions of the hippocampus: a disruption of freezing but not fear-potentiated startle. J Neurosci 17:9353-9360
42. Moreno FA, Wiegand CB, Taitano EK, Delgado PL (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessivecompulsive disorder. J Clin Psychiatry 67:1735-1740
43. Morilak DA, Garlow SJ, Ciaranello RD (1993) Immunocytochemical localization and description of neurons expressing serotonin2 receptors in the rat brain. Neuroscience 54:701-717
44. Morilak DA, Somogyi P, Lujan-Miras R, Ciaranello RD (1994) Neurons expressing 5-HT2 receptors in the rat brain: neurochemical identification of cell types by immunocytochemistry. Neuropsychopharmacology 11:157-166
45. Morrow BA, Elsworth JD, Rasmusson AM, Roth RH (1999) The role of mesoprefrontal dopamine neurons in the acquisition and expression of conditioned fear in the rat. Neuroscience 92:553-564
46. Nibuya M, Morinobu S, Duman RS (1995) Regulation of BDNF and trkB mRNA in rat brain by chronic electroconvulsive seizure and antidepressant drug treatments. J Neurosci 15:7539-7547
47. Nibuya M, Nestler EJ, Duman RS (1996) Chronic antidepressant administration increases the expression of cAMP response element binding protein (CREB) in rat hippocampus. J Neurosci 16:2365-2372
48. Nilsson M, Perfilieva E, Johansson U, Orwar O, Eriksson PS (1999) Enriched environment increases neurogenesis in the adult rat dentate gyrus and improves spatial memory. J Neurobiol 39:569-578
49. Pang PT, Teng HK, Zaitsev E, Woo NT, Sakata K, Zhen S, Teng KK, Yung WH, Hempstead BL, Lu B (2004) Cleavage of proBDNF by tPA/plasmin is essential for long-term hippocampal plasticity. Science 306:487-491
50. Passie T, Seifert J, Schneider U, Emrich HM (2002) The pharmacology of psilocybin. Addict Biol 7:357-364
51. Pompeiano M, Palacios JM, Mengod G (1994) Distribution of the serotonin 5-HT2 receptor family mRNAs: comparison between 5-HT2A and 5-HT2C receptors. Brain Res Mol Brain Res 23:163-178
52. Sarnyai Z, Sibille EL, Pavlides C, Fenster RJ, McEwen BS, Toth M (2000) Impaired hippocampal-dependent learning and functional abnormalities in the hippocampus in mice lacking serotonin(1A) receptors. Proc Natl Acad Sci USA 97:14731-14736
53. Shen RY, Andrade R (1998) 5-Hydroxytryptamine2 receptor facilitates GABAergic neurotransmission in rat hippocampus. J Pharmacol Exp Ther 285:805-812
54. Shors TJ, Miesegaes G, Beylin A, Zhao M, Rydel T, Gould E (2001) Neurogenesis in the adult is involved in the formation of trace memories. Nature 410:372-376
55. Shors TJ, Townsend DA, Zhao M, Kozorovitskiy Y, Gould E (2002) Neurogenesis may relate to some but not all types of hippocampal-dependent learning. Hippocampus 12:578-584
56. Tecott LH, Maricq AV, Julius D (1993) Nervous system distribution of the serotonin 5-HT3 receptor mRNA. Proc Natl Acad Sci USA 90:1430-1434
57. Tyler WJ, Pozzo-Miller LD (2001) BDNF enhances quantal neurotransmitter release and increases the number of docked vesicles at the active zones of hippocampal excitatory synapses. J Neurosci 21:4249-4258
58. Tyler WJ, Pozzo-Miller L (2003) Miniature synaptic transmission and BDNF modulate dendritic spine growth and form in rat CA1 neurones. J Physiol 553:497-509
59. Tyler WJ, Alonso M, Bramham CR, Pozzo-Miller LD (2002) From acquisition to consolidation: on the role of brain-derived neurotrophic factor signaling in hippocampal-dependent learning. Learn Mem 9:224-237
60. Vaidya VA, Marek GJ, Aghajanian GK, Duman RS (1997) 5-HT2A receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. J Neurosci 17:2785-2795
61. Van PH, Kempermann G, Gage FH (1999) Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. Nat Neurosci 2:266-270
62. Van PH, Schinder AF, Christie BR, Toni N, Palmer TD, Gage FH (2002) Functional neurogenesis in the adult hippocampus. Nature 415:1030-1034
63. Vazquez-Borsetti P, Cortes R, Artigas F (2009) Pyramidal neurons in rat prefrontal cortex projecting to ventral tegmental area and dorsal raphe nucleus express 5-HT2A receptors. Cereb Cortex 19:1678-1686
64. Vilaro MT, Cortes R, Gerald C, Branchek TA , Palacios JM, Mengod G (1996) Localization of 5-HT4 receptor mRNA in rat brain by in situ hybridization histochemistry. Brain Res Mol Brain Res 43:356-360
65. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, Vogel H, Hell D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. NeuroReport 9:3897-3902
66. Vollenweider FX, Vontobel P, Hell D, Leenders KL (1999) 5-HT modulation of dopamine release in basal ganglia in psilocybininduced psychosis in man-a PET study with [11C]raclopride. Neuropsychopharmacology 20:424-433
67. Willick ML, Kokkinidis L (1995) Cocaine enhances the expression of fear-potentiated startle: evaluation of state-dependent extinction and the shock-sensitization of acoustic startle. Behav Neurosci 109:929-938
68. Young SN (2013) Single treatments that have lasting effects: some thoughts on the antidepressant effects of ketamine and botulinum toxin and the anxiolytic effect of psilocybin. J Psychiatry Neurosci 38:78-83

Involvement of 5-HT2A Receptor in the Regulation of Hippocampal-Dependent Learning and Neurogenesis

by

Briony J Catlow

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy
Department of Psychology College of Arts and Sciences University of South Florida

Date of Approval: November 7, 2008

© 2008, Briony J Catlow

original source: http://digital.lib.usf.edu/SFS0027045/00001/pdf

Major Professor: Cheryl Kirstein, Ph.D.
Michael Brannick, Ph.D.
Cindy Cimino, Ph.D.
Juan Sanchez-Ramos, M.D.
Toru Shimizu, Ph.D.

Keywords: neurogenesis, serotonin, hippocampus, fear conditioning, psilocybin

To anyone who overcomes obstacles to live out their dreams...

Table of Contents:

- **Acknowledgements**
- **Abstract**
- **Chapter One**
  - Introduction
  - The Anatomy of Hippocampal Neurogenesis
  - Regulation of Neurogenesis in the Dentate Gyrus
  - Hippocampal Neurogenesis and Learning
  - Assessing Neurogenesis
  - Serotonergic Innervation in the Dentate Gyrus
  - Serotonin and Neurogenesis in the Dentate Gyrus
  - Psilocybin (PSOP)
  - Specific Aims
    - *Specific Aim 1*
    - *Specific Aim 2*
- **Chapter Two - Involvement of the 5HT$_{2A}$ receptor in the Regulation of Adult Neurogenesis in the Mouse Hippocampus**
  - Abstract
  - Introduction
  - Materials and Methods
    - *Subjects*
    - *Drugs*
    - *General Procedure*
    - *Immunofluorescence*
    - *Quantitation*

Design and analyses
Results
Effects of Acute Administration of 5-HT2A receptor agonists and an antagonist in vivo on Cell Survival and Neurogenesis in the Hippocampus
Effects of Repeated Intermittent PSOP Administration on Progenitor Cell Survival and Neurogenesis in the Hippocampus
Discussion
Acknowledgments
Chapter Three - The Effects of Psilocybin on Trace Fear Conditioning
Abstract
Introduction
Materials and Methods
Subjects
General Procedure
Design and analyses
Results
Acquisition
Contextual Fear Conditioning
Cue Fear Conditioning
Discussion
Acknowledgments
Reference List

Acknowledgements

First and foremost thank you to Dr Kirstein and Dr Sanchez-Ramos for their complete support during my graduate studies. Dr Kirstein, you fought for me from the beginning and I am so grateful because I know none of this would have been possible without your advice and support. Dr Sanchez, you have taught me to think about the brain in a holistic way and with your passion for knowledge I learned that neuroscience is more than just a career, it is a way of life. Dr Paula Bickford, you are one of the most generous people I know, thank you for support and guidance and blessing me in so many ways. To Dr Brannick, Dr Cimino and Dr Shimizu, thank you for taking the time to serve on my committee and for your thoughtful consideration of my projects. I would also like to thank Dr Naomi Yavneh for chairing my defense.

On a personal level I am so grateful to have had the support of my family. To my Grandma, Nana, Mum, Dad, Pam, Steve, Jodi and Joanie you have all supported me in ways only family can and hope that I can do the same for you. To Anne, you have always been a role model to me with beauty, smarts, and positivity and I am so lucky to have you in my life. To Danielito, you opened my eyes and held my hand, ahora vamos!

Abstract

Aberrations in brain serotonin (5-HT) neurotransmission have been implicated in psychiatric disorders including anxiety, depression and deficits in learning and memory. Many of these disorders are treated with drugs which promote the availability of 5-HT in the synapse. Selective serotonin uptake inhibitors (SSRIs) are known to stimulate the production of new neurons in the hippocampus (HPC) by increasing synaptic concentration of serotonin (5-HT). However, it is not clear which of the 5-HT receptors are involved in behavioral improvements and enhanced neurogenesis. The current study aimed to investigate the effects of $5HT_{2A}$ agonists psilocybin and 251-NBMeO and the $5HT_{2A/C}$ antagonist ketanserin on neurogenesis and hippocampal-dependent learning. Agonists and an antagonist to the $5\text{-}HT_{2A}$ receptor produced alterations in hippocampal neurogenesis and trace fear conditioning. Future studies should examine the temporal effects of acute and chronic psilocybin administration on hippocampal-dependent learning and neurogenesis.

Chapter One

Introduction

The idea of new neurons forming in the adult central nervous system (CNS) is a relatively new one. In the 1960's Joseph Altman published the first evidence of neurogenesis, or the birth of new neurons in the adult mammalian brain (Altman, 1962; Altman, 1963; Altman & Das, 1965). Utilizing the tritiated thymidine method (Sidman *et al.*, 1959; Messier *et al.*, 1958; Messier & Leblond, 1960) Joseph Altman was able to demonstrate that the subventricular zone (SVZ) of the lateral ventricles and the dentate gyrus (DG) of the hippocampus (HPC) produce new neurons throughout the lifespan (Altman, 1962; Altman & Das, 1965; Altman, 1969). For years following Altman's discovery scientists acknowledged the possibility of the generation of new glial cells in the adult brain but rejected the concept of new born neurons. With the advent of new technologies such as the bromodeoxyuridine (BrdU) method of birth dating cells and double labeling using immunofluorescence, adult neurogenesis has been identified in many mammalian species including mice (Kempermann *et al.*, 1998), rats (Kaplan & Hinds, 1977), hamsters (Huang *et al.*, 1998), tree shrews (Gould *et al.*, 1997), nonhuman primates (Gould *et al.*, 1999b; Bernier *et al.*, 2002) and humans (Eriksson *et al.*, 1998). Peter Eriksson's discovery of new neurons in the human HPC changed the perception of neurogenesis in the scientific community so now the fact that new neurons are produced in the adult brain is firmly established.

The Anatomy of Hippocampal Neurogenesis

The HPC is divided into four areas: DG (also called area dentate, or fascia dentata), cornu ammonis (CA, further divided into CA1, CA2, CA3 and CA4), the presubiculum and the subiculum. This anatomical description of the HPC has been confirmed by both gene expression and fiber connections. The DG and areas CA form a trisynaptic circuitry within the HPC (see Figure 1.1). Neurons in the entorhinal cortex (EC) project to dendrites of the granule cells in the DG forming the perforant pathway. The granule cells extend their axons (Ramon, 1952) to pyramidal neurons in area CA3, forming the mossy fiber tract (Ribak *et al.*, 1985). CA3 pyramidal neurons project to the contralateral (via associational commissural pathway) and the ipsilateral CA1 region forming the Shaffer collateral pathway. Pyramidal neurons in CA1 extend axons to the subiculum and from the subiculum back to EC (for detailed descriptions of hippocampal circuitry see (Witter, 1993)).

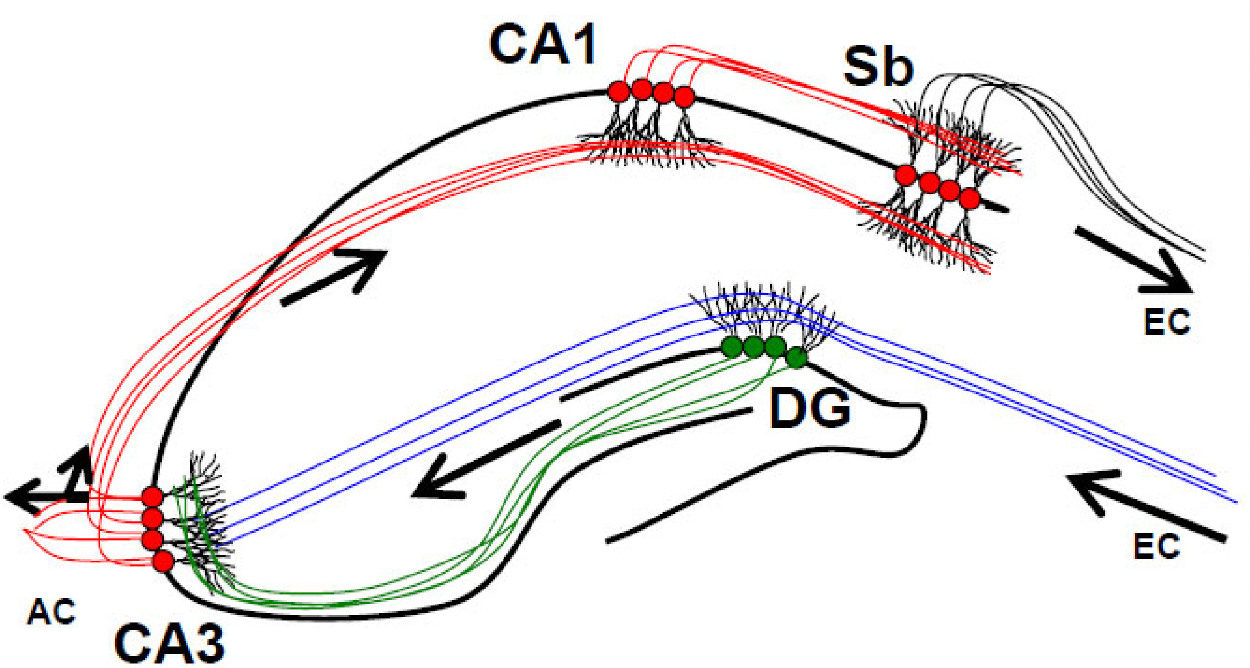


Figure 1.1. Anatomy of the Hippocampus. The HPC forms a trisynaptic pathway with inputs from the Entorhinal Cortex (EC) that projects to the Dentate Gyrus (DG) and CA3 pyramidal neurons via the perforant pathway. Granule cells in the DG project to CA3 via the mossy fiber pathway. Pyramidal neurons in CA3 project to both the contralateral (associational commissural pathway) and the ipsilateral CA1 region via the Schaffer Collateral Pathway. CA1 pyramidal neurons send their axons to the Subiculum (Sb) which in turn projects out of the HPC back to the EC.

In normal physiological conditions, neurogenesis that occurs in the HPC is found only in the DG and results in the generation of new granule cells. Within the DG, progenitor cells reside in a narrow band between the DG and the hilus (also called CA4 or plexiform layer) called the subgranular zone (SGZ) which is approximately 2-3 cells thick (20-25 µM) (see Figure 1.2). Neural progenitor cells (1) divide and form clusters of proliferating cells (2). Proliferating cells exit from the cell cycle and begin to differentiate into immature neurons (3). The immature granule cell forms sodium currents, extends dendrites and an axon to make connections with other cells and form synapses to become a mature neuron (4). The SGZ contains many cell types including astrocytes (Seri *et al.*, 2001; Filippov *et al.*, 2003; Fukuda *et al.*, 2003), several types of glial and neuronal progenitor cells (Filippov *et al.*, 2003; Fukuda *et al.*, 2003; Kronenberg *et al.*, 2003; Seri *et al.*, 2004) and neurons in all stages of differentiation and maturation (Brandt *et al.*, 2003; Ambrogini *et al.*, 2004).

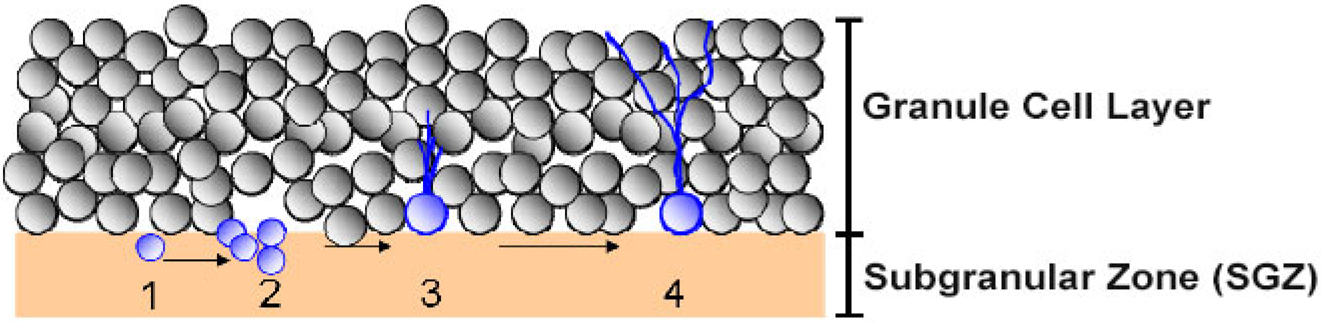


Figure 1.2. Neurogenesis in the Dentate Gyrus of the Hippocampus. Neural stem cells exist the SGZ of the DG, these cells then divide, differentiate and mature into their phenotypic fate. Neural progenitor cells (1) divide and form clusters of proliferating cells (2). Proliferating cells exit from the cell cycle and begin to differentiate into immature neurons (3). The immature granule cell forms sodium currents, dendrites and extends an axon out to make connections with other cells and form synapses to become a mature granule cell (4).

Regulation of Neurogenesis in the Dentate Gyrus

The proliferation and survival of neural progenitors in the adult HPC can be influenced in a positive and negative manner by a variety of stimuli. Factors as diverse as stress, odors, neurotrophins, psychoactive drugs such as antidepressants, opioids and alcohol, electroconvulsive therapy, seizures, ischemia, cranial irradiation, physical activity, learning, hormones and age amongst many others have been linked to the regulation of neurogenesis (Kempermann *et al.*, 1998; Van *et al.*, 1999b; Malberg *et al.*, 2000; Malberg & Duman, 2003; Tanapat *et al.*, 2001). Some of these factors have been studied extensively and their role in the regulation of neurogenesis is well defined. For example, environmental enrichment and physical activity are strong positive regulators of neurogenesis (Van *et al.*, 1999b; Kempermann *et al.*, 1997), while stress and age (Cameron *et al.*, 1993; Kempermann *et al.*, 1998) appear to be negative regulators of neurogenesis.

The first report of any factor increasing neurogenesis in the mammalian brain was an enriched environment. In an experimental setting a rodent enriched environment typically consists of a large cage, a large number of animals, toys and a tunnel system. In order to maintain the enrichment aspect novel toys are introduced and tunnel system is rearranged on a regular basis. Mice (Kempermann *et al.*, 1997) and rats (Nilsson *et al.*, 1999) living in an enriched environment exhibited a strong up-regulation of cell proliferation and neurogenesis in the DG of the HPC. The proneurogenic effects of environmental enrichment can be increased further depending on the age of the animal when exposure occurs. When late adolescent/young adult animals live in an enriched environment it enhances the ability of environmental enrichment to up-regulate cellular proliferation and neurogenesis in the DG. In fact, when the morphology of the HPC was examined later in life, a greater number of absolute granule cells was observed (Kempermann *et al.*, 1997). In aged animals (typically 18 months or older in rodents) lower levels of neurogenesis have been observed, however living in an enriched environment counteracts the effects of aging (Kempermann *et al.*, 1998). Kempermann and colleagues demonstrated environment enrichment during aging increases cell proliferation and neurogenesis in the DG (Kempermann *et al.*, 1998). Furthermore, if animals live in an enriched environment during mid age, basal levels of neurogenesis increase as much as five fold in old age.

When experimentation with environmental enrichment began, novel foods were included as apart of the environmental enrichment experience. When similar food was given to mice living either an enriched or control environment, the effect of environmental enrichment was still present. One type of diet however, has been found to have positive effects on neurogenesis specifically, caloric restriction (Lee *et al.*, 2000). As an experimental manipulation caloric restriction usually consists of limiting the amount of food an animal can eat by a third. Caloric restriction is the only factor that has been shown experimentally to increase the life span of animals and it is thought that caloric restriction actually acts as a mild stressor. It is of interest to note while environmental enrichment is a strong positive regulator of adult hippocampal neurogenesis, it does not affect adult neurogenesis in the olfactory system (Brown *et al.*, 2003).

Exposure to an enriched environment increases neurogenesis in the DG of adult rodents, however, environmental enrichment typically includes a running wheel and increased physical activity. Physical activity is known to up-regulate cell proliferation and neurogenesis in the DG. Rodents will take full advantage of the opportunity to exercise on a running wheel during their active phase of their day. Mice have been reported to run between 3 and 8 km per night on a running wheel (Van *et al.*, 1999a; Van *et al.*, 1999b). Voluntary physical activity has been shown to increase the number of progenitor cells and new neurons in the DG of the HPC (Van *et al.*, 1999a; Van *et al.*, 1999b). The effect of running on neurogenesis is acute so that running must continue to effect neurogenesis and once the animal no longer uses the running wheel the effect on neurogenesis will decline. The up-regulation of adult neurogenesis by physical activity also increases long term potentiation (LTP) in the DG and enhances performance on the Morris water maze (MWM) (Van *et al.*, 1999a). The MWM is a behavioral task that assesses memory and learning, but as part of the task the animals are placed into a pool of water and forced to swim. Some have argued that swimming, being physical activity, could also influence the outcome of the task. This point was addressed by Ehninger *et al.* who found involuntary physical activity (swimming in radial arm water maze (RAWM)) had no effect on hippocampal neurogenesis (Ehninger & Kempermann, 2003).

The mechanisms underlying the increase in neurogenesis by physical activity are unknown however, growth factors such as insulin growth factor -1 (IGF-1), vascular endothelial growth factor (VEGF), and brain derived neurotrophic factor (BDNF) have been strongly implicated. IGF-1 levels are increased in the HPC of running animals and running induced increases in cellular proliferation and neurogenesis (Carro *et al.*, 2001; Carro *et al.*, 2000; Trejo *et al.*, 2001). This increase in neurogenesis is blocked by scavenging circulating IGF-1 absent in IGF-1 mutants (Carro *et al.*, 2000). VEGF is necessary for the effects of running on adult hippocampal neurogenesis. Blocking peripheral VEGF abolished the running-induced induction of neurogenesis, however there were no detectable effects on baseline neurogenesis in non-running animal (Fabel *et al.*, 2003). Quantitative polymerase chain reaction analysis revealed BDNF mRNA levels are significantly increased in the DG of running rats (Farmer *et al.*, 2004). BDNF is a key factor involved in modulating neuroplasticity including LTP and neurogenesis. Infusions of BDNF into the lateral ventricles induced neurogenesis originating in the SVZ (Pencea *et al.*, 2001) and BDNF knockout (KO) mice have diminished levels of neurogenesis in the DG (Lee *et al.*, 2002). Like environmental enrichment, physical activity up-regulates adult hippocampal neurogenesis, however, it does not affect adult neurogenesis in the olfactory system (Brown *et al.*, 2003).

Stress severely impairs hippocampal neurogenesis. One of the first studies to link stress to hippocampal neurogenesis was conducted by Gould and colleagues (1992). They found stress increased the number of dying cells in the HPC but that the total number of granule cells in the dentate was not different from non-stressed controls and concluded neurogenesis must be occurring to maintain cellular balance (Gould *et al.*, 1992). They postulated the stress hormone, cortisol in humans and corticosterone in rodents mediates the stress effect on neurogenesis and went on to discover adrenalectomy (removing the adrenal gland hence the source of endogenous corticosterone) led to an up-regulation of neurogenesis and exogenous corticosterone down-regulated cellular proliferation and neurogenesis in the DG (Cameron *et al.*, 1993). Since these early experiments, severe stress has been shown to downregulate cell proliferation and consecutive stages of neuronal development using many different paradigms. Prenatal stress caused learning deficits and had detrimental effects on neurogenesis that lasted well into adulthood (Lemaire *et al.*, 2000). The effects of psychosocial stress on neurogenesis were demonstrated using the resident-intruder model of territorial tree shrews (Gould *et al.*, 1997). Tree shrews are extremely territorial and guard their environment so the introduction of an intruder to the resident's cage is extremely stressful. The territorial tree shrews compete for dominance and soon after the introduction of an intruder a dominant-subordinate relationship is established resulting in elevated cortisol and decreased neurogenesis in the subordinate tree shrew (Gould *et al.*, 1997). Predator odor triggered a stress response in prey and had detrimental effects on cell proliferation. In rodent models, fox odor has been shown to decrease cell proliferation and neurogenesis in the DG (Tanapat *et al.*, 2001). Both acute and chronic restraint stress have been shown to affect the rate of adult hippocampal neurogenesis. Pham and colleagues demonstrated that 6 weeks of daily restraint stress suppressed cell proliferation and attenuated survival of the newly born cells, resulting in a 47% reduction of granule cell neurogenesis (Pham *et al.*, 2003). Neurogenesis is not only affected by environmental stimuli, the absence of stimuli, such as social isolation, negatively regulated neurogenesis. Young rats reared in social isolation for 4-8 weeks showed decreased performance on the MWM and decreased hippocampal neurogenesis (Lu *et al.*, 2003). In the learned helplessness model of depression animals are exposed to an inescapable foot shock using avoidance testing. Exposure to inescapable shock decreased cell proliferation in the HPC, extending previous studies demonstrating downregulation of neurogenesis by exposure to acute stressors (Malberg & Duman, 2003).

The key mechanism underlying the negative impact that stress has on neuroplasticity appears to be stress hormone (glucocorticoid) secretion (Cameron *et al.*, 1993). Acute, severe and sometimes traumatic stress leads to chronically high levels of glucocorticoids and alters the functioning of the hypothalamic-adrenal-pituitary (HPA) axis resulting in disregulation of glucocorticoid secretion and receptor expression. Depression is an example of a clinical condition associated with disturbed regulation of the HPA axis which upsets the circadian rhythm of hormone secretion resulting in chronically elevated glucocorticoid levels and decreased neurogenesis (Jacobs *et al.*, 2000).

Aging is another factor known to have a strong negative influence on neurogenesis. This has been known since the discovery of adult neurogenesis by Altman and Das in 1965. In the original study a progressive decrease in the levels of neurogenesis was observed after puberty and continued into old age (Altman & Das, 1965) and this finding has been since replicated in both rats (Seki & Arai, 1995; Kuhn *et al.*, 1996; Cameron & McKay, 1999; Bizon & Gallagher, 2003), mice (Kempermann *et al.*, 1998) and humans (Eriksson *et al.*, 1998). The highest levels of adult neurogenesis occurred in young adulthood and steadily decreased over the lifespan. In old age (typically 18 months or older in rodents) baseline levels of neurogenesis are extremely low, however, there are ways to enhance neurogenesis in the aging hippocampus. Environment enrichment during aging increases cell proliferation and neurogenesis in the DG, however, the effect of an enriched environment is more robust in young animals (Kempermann *et al.*, 1998). Animals that lived in an enriched environment starting at mid age had five fold increases in basal levels of neurogenesis in old age (Kempermann *et al.*, 1998). Cortisol (or corticosterone in rodents) levels are elevated in aging which likely reduces baseline proliferation and neurogenesis. Adrenalectomy in aged animals restored adult neurogenesis in the DG to a level comparable to that of a much younger age, demonstrating corticosterone is at least in part responsible for the decline in neurogenesis observed in aging (Cameron & McKay, 1999). IGF-1 levels are increased in the HPC running animals and running induced increases in cellular proliferation and neurogenesis (Carro *et al.*, 2001; Carro *et al.*, 2000; Trejo *et al.*, 2001). Similarly, aged animals administered exogenous IGF-1 to restore endogenous IGF-1 levels to that of a younger age and induced neurogenesis above controls thus counteracted the negative effect of aging on neurogenesis (Lichtenwalner *et al.*, 2001).

BDNF is considered a critical secreted factor modulating brain plasticity. Physical activity, which is known to positively regulate neurogenesis and induce LTP, induces hippocampal BDNF mRNA expression. It is thought that BDNF may modulate the effect that physical activity has on LTP and neurogenesis (Farmer *et al.*, 2004). Infusions of BDNF into the lateral ventricles induced neurogenesis originating in the SVZ (Pencea *et al.*, 2001) and BDNF KO mice have diminished levels of hippocampal neurogenesis (Lee *et al.*, 2002). In pathological conditions such as depression, BDNF blocks neurogenesis (which is opposite to healthy animals) and it is now understood one of the critical functions of BDNF is to keep neurogenesis within a physiological range. BDNF function has been implicated in the neurogenesis hypothesis of depression, the idea being that the antidepressants enhance neurogenesis, and BDNF is a key regulator of this mechanism (Jacobs *et al.*, 2000; D'Sa & Duman, 2002). Antidepressants (including selective serotonin reuptake inhibitors (SSRIs)) induce the phosphorylation of CREB, after which CREB binds to the BDNF promoter and induces BDNF transcription. 5-HT_{2A} receptor agonists, such as 2,5-dimethoxy-4-iodoamphetamine (DOI), increase BDNF mRNA expression in the HPC (Vaidya *et al.*, 1997). BDNF is involved in inducing neuronal differentiation possibly through the induction of neuronal nitric oxide synthase (nNOS) which has been shown to stop proliferation and promote differentiation. In vitro BDNF is a differentiation factor that can down-regulate precursor cell proliferation (Cheng *et al.*, 2003).

Hippocampal Neurogenesis and Learning

Memory involves the encoding, storing and recalling of information. The HPC plays a critical role in learning and memory by converting short-term memories into long-term memories and is pivotal in the encoding, consolidation and retrieval of episodic memory (Squire *et al.*, 1992; Squire, 1992). Several studies have investigated the connection between learning and hippocampal neurogenesis. Hippocampal mediated learning and memory has been shown to be related to the generation of new neurons in the adult DG (Van *et al.*, 2002; Nilsson *et al.*, 1999).

It has been postulated only learning tasks which are hippocampal dependant affect progenitor cell proliferation and neurogenesis in the DG (Gould *et al.*, 1999a). This idea has since been demonstrated using a learning task that is easily manipulated to be either hippocampal dependent or independent. Hippocampal-dependent learning can be assessed using trace eye blink conditioning. In trace conditioning the conditioned stimulus (CS), a tone, sounds for 5 seconds, then after a 100-1000 ms interval, the unconditioned stimulus (US) an airpuff or eyelid shock is activated. In this way the CS and US do not overlap. Hippocampal-independent learning can be assessed using delay eyeblink conditioning. In delay eyeblink conditioning the tone (CS) sounds for 5 seconds and in the last 20 ms of the tone sounding the airpuff (US) is activated. In this way the CS and US overlap. Shors and colleagues used both trace and delay eyeblink conditioning to demonstrate that trace eyeblink conditioning, a hippocampal dependent task, is affected by neurogenesis whereas delay eyeblink conditioning is not. Mice were treated with methylazoxymethanol acetate (MAM), an anti-mitotic agent which wipes out the progenitor cell population in the DG and administered BrdU to birth date the cells then performed either trace or delay eyeblink conditioning. In both trace and delay eyeblink conditioning, saline treated mice performed well on the task and had similar numbers of BrdU positive cells in the DG. This is in contrast to mice treated with MAM which produced different results for trace and delay eyeblink conditioning. In trace eyeblink conditioning MAM severely impaired learning and obliterated BrdU incorporation in the DG, whereas, no impairment in learning was observed after delay eyeblink conditioning despite mice being treated with MAM, thus obliterating the progenitor pool and resulted in a dramatic reduction of BrdU positive cells in the DG (Shors *et al.*, 2001).These results clearly indicate that newly generated neurons in the adult DG are affected by the formation of hippocampal-dependent memory.

Only certain types of hippocampal dependent tasks have been shown to be involved in hippocampal neurogenesis (Shors *et al.*, 2002). This was demonstrated using two different learning paradigms known to require the HPC, the spatial navigation task and trace fear conditioning. Similar to the study mentioned earlier, mice were treated with MAM and BrdU then performance on either behavioral task was assessed. The spatial navigation task is performed in the MWM and required the mouse to use spatial cues in the environment (like a black square on a wall) to navigate to and find the platform. Over trials mice learned where the platform was located and spent less time trying to find it. MAM failed to result in impairment in escape latency but did significantly decreased BrdU+ cells in the SGZ, demonstrating that hippocampal progenitor cell proliferation is not essential for this hippocampal-dependent task (Shors *et al.*, 2002). In a separate group of mice trace fear conditioning, which like trace eyeblink conditioning involves a time gap between CS and US presentation was performed. In trace fear conditioning MAM severely impaired learning and significantly diminished BrdU incorporation in the DG, thus providing more evidence for the involvement of trace conditioning in hippocampal neurogenesis (Shors *et al.*, 2002). The above experiments clearly demonstrate that some forms of learning are dependent on the HPC but not all hippocampal-dependent learning tasks require neurogenesis.

The HPC is involved in the formation and expression of memory in the passive avoidance task in rats (Cahill & McGaugh, 1998). The logic underlying the passive avoidance (PA) task is that animals associate a particular environment with an unpleasant foot shock and learn by avoiding the environment they can avoid the aversive foot shock. Consequently, an increase in response latency is thought to reflect the strength of the memory for the aversive event (Sahgal & Mason, 1985). Specifically, the multi-herbal formula BR003 increased response latency, and hence the memory of the foot shock while also increasing the number of BrdU positive cells in the DG (Oh *et al.*, 2006). The PA task is relatively quick and simple but is limited in the information it provides regarding memory, that latencies increase following shock. A modified version of PA, the active avoidance paradigm measures acquisition (learning), retention (memory) and the extinction of the conditioned response.

Active avoidance is a fear-motivated associative avoidance task. In this task the mouse has to learn to predict the occurrence of an aversive event (shock) based on the presentation of a specific stimulus (tone), in order to avoid the aversive event by moving to a different compartment. The measures recorded include number of avoidances (the mouse crossing to the other compartment during the warning signal), number of non-responses (the mouse failing to cross to the other compartment during the trial), response latency (latency to avoid or escape), number of intertrial responses (i.e., crossing the barrier within the intertrial interval), and serve as an index of learning which allows memory to be assessed.

Many studies supported the role of the HPC in active avoidance learning. LTP via electrical stimulation to the perforant pathway is negatively correlated to learning in the shuttle box avoidance task, suggesting active avoidance training lowered the threshold frequency to induce LTP in the DG (Ramirez & Carrer, 1989). Active avoidance learning increased the length of the postsynaptic density in the molecular cell layer of the DG (Van *et al.*, 1992) and increased immunoreactivity for muscarinic receptors in the granular cell layer (Van der Zee & Luiten, 1999). Two-way Active avoidance also increased synthesis of BDNF (Ulloor & Datta, 2005) and cAMP response element binding (CREB) in the dorsal HPC (Saha & Datta, 2005). Rats that learned the active shock avoidance task (responders) had similar levels of Brdu positive and Ki67 positive cells in the DG as non-responders, suggesting ASA has no effect on hippocampal progenitor cell proliferation (Van der *et al.*, 2005).

Active avoidance testing is commonly used following exposure to severe inescapable foot shock in the learned helplessness model of depression. Exposure to inescapable foot shock decreased progenitor cell proliferation in the DG and this effect is reversed by chronic treatment with fluoxetine (Malberg & Duman, 2003). One target of antidepressant treatment is BDNF since antidepressants not only increase the expression of CREB in the rat HPC (Nibuya *et al.*, 1996) but also increase the expression of BDNF (Nibuya *et al.*, 1995). BDNF produced antidepressant like effects in the learned helplessness model of depression (Shirayama *et al.*, 2002).

Assessing Neurogenesis

The systemic injection of thymidine, radioactively labeled with tritium was the first method developed to label dividing cells (Messier *et al.*, 1958). Once in the bloodstream, tritiated thymidine competes with endogenous thymidine in all cells in the S phase of cell division and is permanently incorporated into the DNA. Labeled thymidine has a short half-life in vivo and labels all cells in the process of cell division when the label is injected. At a later time point, tissue sections are prepared and coated with a photo emulsion. The radiation from the labeled thymidine molecules blackens the photo emulsion, thus making visible the typical grains of thymidine autoradiography. Utilizing the tritiated thymidine method (Sidman *et al.*, 1959; Messier *et al.*, 1958; Messier & Leblond, 1960) Joseph Altman was able to demonstrate that the SVZ and the DG of the HPC produce new neurons throughout the lifespan (Altman, 1962; Altman & Das, 1965; Altman, 1969).

BrdU is a false base that competes with endogenous thymidine and becomes permanently incorporated in the DNA during the S phase of the cell cycle. BrdU is typically administered via injections of usually 50-250 mg/kg in a single bout or over several days depending on the experimental paradigm (Corotto *et al.*, 1993). BrdU is advantageous because it is a permanent marker so any cells that express BrdU can be directly related to the time BrdU was administered thus providing the birth date of the cell. It is important to note BrdU can be incorporated into cells that are on the verge of dying when cell death related mechanisms trigger DNA repair,therefore proper controls need to be included such as immunohistochemical stains for apoptosis (caspase-3 or TUNEL) and proliferative markers (Ki67) to determine if a cell is truly proliferative.

The rate of proliferation can be differentiated from the rate of survival by manipulating time between BrdU injection and sacrifice so proliferating cells can be determined by sacrificing animals 24 hours after a BrdU injection. In this way BrdU has time to incorporate into the cell but the cell does not have time to differentiate into a neuron, a process which takes a minimum of 72 hours. Survival can be determined by taking the brains of animals days, weeks or even months after BrdU injection. The phenotypic fate of the cell is determined in the survival condition by double labeling BrdU with another marker. Table 1 presents a summary of the common markers used to determine the phenotype of neural progenitors.

Marker	Significance	Reference
Ki67	Proliferation; late G1, S, G2 and M phases nuclear	(Scholzen & Gerdes, 2000)
Doublecortin (DCX)	Immature neuron; microtubule-associated protein enriched in migratory neuronal cells. Early neuronal marker with lineage determined and limited self-renewal dendritic	(Meyer *et al.*, 2002)
III β-tubulin (Tuj1)	Immature neuron; Tubulin protein soma and processes	(Uittenbogaard & Chiaramello, 2002)
Calretinin (CRT)	Immature neurons; calcium binding protein transiently	(Brandt *et al.*, 2003)
Neuronal nuclei (NeuN)	Mature neurons; mostly in nuclei but can be detected in cytoplasm nucleus	(Mullen *et al.*, 1992)
Glial Fibrillary Acidic Protein (GFAP)	Intermediate filament protein expressed in astrocytes.	(Fuchs & Weber, 1994)

Table 1. Antibodies used to assess phenotypic fate of progenitors.

If the cell expresses Ki67 it is an early progenitor since Ki67 is a protein expressed the G1, S, G2 and M phases of the cell cycle (Scholzen & Gerdes, 2000). Cells that express doublecortin (DCX), β-tubulin III (III β-tubulin, Tuj1), or calretinin (CRT) are immature neurons. DCX is a microtubule associated protein transiently expressed in immature neurons (Meyer *et al.*, 2002), Tuj1 marks tubulin in microtubules (Uittenbogaard & Chiaramello, 2002) and CRT is a calcium binding protein transiently expressed in immature neurons and is expressed in the developing neuron at a stage where DCX expression dissipates (Brandt *et al.*, 2003). The best and most widely used marker to identify mature neurons is neuronal nuclei (NeuN) (Mullen *et al.*, 1992). The expression of NeuN is restricted to post-mitotic neurons and is predominately located in the nucleus of neurons although it can occasionally be observed in the neurites. In order to convincingly demonstrate neurogenesis, cells are double labeled with BrdU plus NeuN, which clearly demonstrates that the cell was born around the time of BrdU injection and survived to differentiate into a neuron. Cell survival depends on many factors including the ability of the cell to form dendrites, an axon, synthesize neurotransmitter, receptors and establish functional connections with other cells. Cells that don't establish functional connections will most likely die.

It is possible to assess neurogenesis using methods other than the BrdU and tritiated thymidine methods. Using immunohistochemical and immunofluorescent techniques, cells can be stained for markers of immature neurons that are transient and only present in newly formed neurons. Brandt and colleagues (2003) elegantly demonstrated this method by defining time periods of development in which cells express particular markers double-labeled with BrdU (Brandt *et al.*, 2003). BrdU is still the only way to birth date cells so for establishing the method it was essential to know the exact age of cells. The expression of CRT plus BrdU positive cells was greatest 1 to 2.5 weeks after BrdU injection and the number of double-labeled cells was negligible at 4 weeks, demonstrating CRT is transient. If a cellexpressed DCX or CRT, that cell can be positively identified as an immature neuron, thus estimates of DCX or CRT positive cells in the DG represent estimates of neurogenesis.

Serotonergic Innervation in the Dentate Gyrus

Serotonin (5-HT) is a modulatory neurotransmitter in the central nervous system which is important in the regulation of vital brain functions such as feeding (Lucki, 1992), thermoregulation (Feldberg & Myers, 1964), sleep (Jouvet, 1967) and aggression (Sheard, 1969). In psychopathological states such as depression (Pinder & Wieringa, 1993), eating disorders (Leibowitz & Shor-Posner, 1986) and anxiety serotonergic signaling is disturbed.

In the mammalian brain 5-HT is produced by neurons in the raphe nucleus (RN) which project to many areas of the brain via the medial forebrain bundle (MFB) (Azmitia & Segal, 1978; Parent *et al.*, 1981). Neurons from RN innervate virtually all brain areas with dense innervation occurring in the HPC, cerebral cortex, striatum, hypothalamus, thalamus, septum and olfactory bulb (Jacobs & Azmitia, 1992; Leger *et al.*, 2001). The innervation of serotonergic fibers to areas within the HPC is variable (Moore & Halaris, 1975; Vertes *et al.*, 1999; Bjarkam *et al.*, 2003). The DG is innervated with serotonergic fibers in both the molecular layer and the hilus with particularly dense innervation projecting to the SGZ where they synapse with interneurons (Halasy & Somogyi, 1993).

5-HT activates fifteen known receptors, many of which are expressed in the DG (El *et al.*, 1989; Tecott *et al.*, 1993; Vilaro *et al.*, 1996; Djavadian *et al.*, 1999; Clemett *et al.*, 2000; Kinsey *et al.*, 2001). Most of the 5-HT receptors interact with G proteins except for the 5-HT$_{3A}$ receptors, which are ligand-gated ion channel receptors. The 5-HT$_3$ receptors (subtypes 5-HT$_{3A}$ and 5-HT$_{3B}$) are ligand-gated Na$^+$ ion channels and their activation leads to the depolarization of neurons (Barnes & Sharp, 1999). The 5-HT$_1$ family of receptors (including subtypes 5-HT$_{1A}$, 5-HT$_{1B}$, 5-HT$_{1D}$, 5-HT$_{1E}$ and 5-HT$_{1F}$) are coupled to the G$_i$ protein which, when activated decreases the activity of adenylyl cyclase thus decreasing the rate of formation of cyclic adenosine monophosphate (cAMP). Activation of 5-HT$_1$ receptors can lead indirectly to the opening of K$^+$ channels therefore increasing the conductance of the cell membrane for K$^+$ ions. Activation of 5-HT$_4$, 5-HT$_6$, 5-HT$_7$, receptors are coupled to G$_s$ proteins which have the opposite effect. They increase the activity of adenylyl cyclase, increase the rate of cAMP formation and decrease K$^+$ conductance (Thomas *et al.*, 2000; Raymond *et al.*, 2001). The 5-HT$_2$ receptors (including subtypes 5-HT$_{2A}$, 5-HT$_{2B}$, 5-HT$_{2C}$) are coupled to G$_q$ proteins and activate phospholipase C (PLC), increasing the rate of formation of inositol triphosphate (IP$_3$) and diacylglycerol leading to the increased formation of protein kinase C (PKC) (Kurrasch-Orbaugh *et al.*, 2003; Ananth *et al.*, 1987).

Serotonin and Neurogenesis in the Dentate Gyrus

While several factors regulate the rate of generation of new cells in the adult DG, one of the most important known factors is 5-HT. Malberg and colleagues found increased levels of 5-HT resulted in the increased rate of proliferation of neural progenitors in the DG (Malberg *et al.*, 2000). Administering 5,7-dihydroxytryptamine (5,7-DHT), a serotonergic neurotoxin into the RN and caused the destruction of axons and serotonergic cells and resulted in a decreased in the number of BrdU-labeled cells in the DG (Brezun & Daszuta, 1999). The 5,7-DHT lesion resulted in around a 60% depletion of the serotonergic innervation to the DG which lasted for one month. After two months, reinnervation to the DG was observed with the sprouting of serotonergic axons so that by the third month there was no observable difference between the 5,7-DHT and vehicle in newly generated cells or serotonergic innervation (Brezun & Daszuta, 2000).

Many serotonergic receptors have been implicated in the regulation of neurogenesis in the DG. In vitro, when the 5-HT$_{1A}$ receptor agonist, 8-OH-DPAT was added to a medium in which cultured fibroblasts transfected with the 5-HT$_{1A}$ receptor were present, the rate of cell divisions increased (Varrault *et al.*, 1992). In vivo, 5-HT$_{1A}$ receptor antagonists (NAN-190, *p*-MPPI and WAY-100635) decreased the number of progenitors in the DG by approximately 30% (Radley & Jacobs, 2002) and injections of 5-HT$_{1A}$ receptor agonists increased the number of BrdU positive cells in the DG (Santarelli *et al.*, 2003). Similarly, Banasr and colleagues showed various 5-HT$_1$ receptor agonists increase the number of BrdU labeled cells in the subgranular layer. Acute administration of the 5-HT$_{2A/C}$ receptor agonist 2,5-dimethoxy-4-iodoamphetamine (DOI), 5-HT$_{2C}$ receptor agonist RO 600175, and 5-HT$_{2C}$ receptor antagonist SB 206553 had no effect of cell proliferation in the HPC, whereas the 5-HT$_{2A/C}$ receptor antagonist ketanserin produced a 63% decrease in BrdU incorporation (Banasr *et al.*, 2004). A recent study found acute ketanserin decreased proliferation whereas chronic ketanserin increased proliferation in the DG (Jha *et al.*, 2008). No effect on proliferation in the DG was observed after DOI or lysergic acid diethylamide (LSD) were administered either acutely or once daily for seven consecutive days (chronic) (Jha *et al.*, 2008).

The 5-HT$_{2A}$ receptor is involved in the regulation of BDNF in the HPC (Vaidya *et al.*, 1997). DOI alone and in combination with selective 5-HT$_{2A}$ and 5-HT$_{2C}$ receptor antagonists decreased the expression of BDNF mRNA in the HPC. Interestingly, the decrease in BDNF mRNA expression was blocked by the 5-HT$_{2A}$ receptor antagonist but not the 5-HT$_{2C}$ receptor antagonist, implicating the 5-HT$_{2A}$ receptor in the regulation of BDNF expression. In addition, the stressinduced reduction in BDNF expression in the HPC was blocked by a 5-HT$_{2A/C}$ receptor antagonist (Vaidya *et al.*, 1997).

Psilocybin (PSOP)

PSOP (4-phosphoryloxy-*N,N*-dimethyltryptamine) is the main active agent in "magic mushrooms" and is categorized as a indole hallucinogen. First isolated from *Psilocybe mexicana*, a mushroom from Central America by Albert Hofmann in 1957, PSOP was then produced synthetically in 1958 (Hofmann *et al.*, 1958a; Hofmann *et al.*, 1958b). PSOP is converted into the active metabolite psilocin (4-hydroxy-*N,N*-dimethyltryptamine) which may produce some of the psychoactive effects of PSOP. The chemical structure of PSOP ($C_{12}H_{17}N_2O_4P$) and the metabolite, psilocin ($C_{12}H_{16}N_2O$) are similar to 5-HT ($C_{10}H_{12}N_2O$), the main neurotransmitter which they affect (see Figure 1.3).

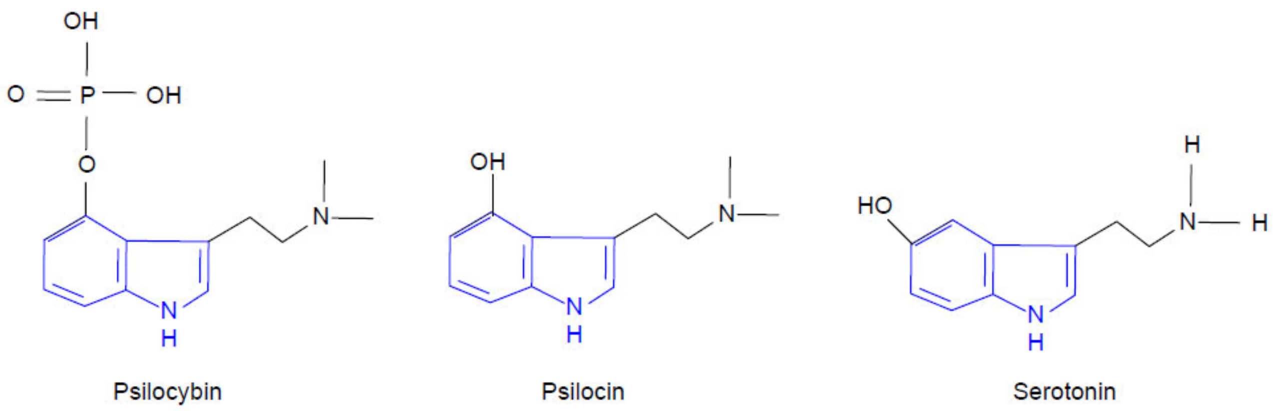


Figure 1.3. Chemical structure of Psilocybin, Psilocin and Serotonin.

In vivo studies in mice have shown the LD_{50} of PSOP via intravenous administration to be 280 mg/kg (Cerletti & Konzett, 1956; Cerletti, 1959). Autonomic effects of 10 mg/kg/sc in mice, rats, rabbits, cats and dogs include mydriasis, piloerection, irregularities in heart and breathing rate and hyperglycemic and hypertonic effects (Cerletti & Konzett, 1956; Cerletti, 1959). These effects were interpreted as an excitatory syndrome caused by stimulation of the sympathetic nervous system with one large exception being the absence of hyperlocomotion (Monnier, 1959).

PSOP exerts psychoactive effects by altering serotonergic neurotransmission by binding to 5-HT_{1A}, 5-HT_{1D}, 5-HT_{2A} and 5-HT_{2C} receptor subtypes (Passie *et al.*, 2002). PSOP binds to the 5-HT_{2A} receptor (Ki = 6 nM) with high affinity and to a much lesser extent to the 5-HT_{1A} receptor subtype (Ki = 190 nM) (McKenna *et al.*, 1990). However, PSOP has a lower affinity for 5-HT_{2A} and 5-HT_{2C} receptors compared to lysergic acid diethylamide (LSD), a similar indole hallucinogen (Nichols, 2004). In contrast to LSD, PSOP has a very low affinity to DA receptors and only extremely high doses affect NE receptors. PSOP has been shown to induce schizophrenia-like psychosis in humans, a phenomenon attributed to the action of PSOP through 5-HT_{2A} receptor action. Specifically, human volunteers were pretreated with ketanserin, an antagonist to the $5\text{-HT}_{2A/C}$ receptor, then administered 0.25 mg/kg p.o. PSOP and the psychotomimetic effects of PSOP were completely blocked (Vollenweider *et al.*, 1998). Since blocking the 5-HT_{2A} receptor prevented the psychotropic effect of PSOP it appears as though the actions of PSOP are mediated via the activation of 5-HT_{2A} receptors. A recent study tested PSOP-induced stimulus control and found 5-HT_{2A} receptor antagonists prevented rats from recognizing PSOP in a drug discrimination task, an effect which was not observed with 5-HT_{1A} receptor antagonists (Winter *et al.*, 2007). Repeated daily administration of PSOP selectively downregulated 5-HT_{2A} receptors in the rat brain (Buckholtz *et al.*, 1990; Buckholtz *et al.*, 1988; Buckholtz *et al.*, 1985). PSOP binds to the 5-HT_{2A} receptor and stimulates arachidonic acid and consequently, the PI pathway resulting in the activation of PKC (Kurrasch-Orbaugh *et al.*, 2003). This dissertation sought to evaluate the involvement of the 5-HT_{2A} receptor in the regulation of hippocampal neurogenesis and hippocampal-dependent learning.

Specific Aims

The present study investigated the role of 5-HT_{2A} receptor on hippocampal neurogenesis and hippocampal-dependent learning. The effects of acute and chronic 5-HT_{2A} receptor agonists and an antagonist on the survival and phenotypic fate of progenitor cells in the DG were assessed using immunofluroescent techniques.

In addition the effects of acute PSOP on trace fear conditioning were used to assess learning and memory.

Specific Aim 1

To evaluate the effect of acute 5-HT$_{2A}$ receptor agonists and an antagonist on the survival and phenotypic fate of hippocampal progenitor cells. It was hypothesized PSOP and 251-NBMeO, both 5-HT$_{2A}$ receptor agonists positively regulate neurogenesis in the DG of the HPC, and ketanserin, a 5-HT$_{2A/C}$ receptor antagonist downregulates hippocampal neurogenesis.

Specific Aim 2

To elucidate whether PSOP affects learning and memory using the trace fear conditioning paradigm. It was hypothesized acute exposure to PSOP would enhance hippocampal-dependent learning and ketanserin would impair learning on the trace fear conditioning task.

Chapter Two

Involvement of the 5HT$_{2A}$ receptor in the Regulation of Adult Neurogenesis in the Mouse Hippocampus

Abstract

Selective serotonin uptake inhibitors (SSRIs) are known to stimulate the production of new neurons in the hippocampus (HPC) by increasing synaptic concentration of serotonin (5-HT). The delay in the appearance of antidepressant effects corresponds to the time required to generate new neurons. However, it is not clear which of the many serotonergic receptors in the HPC are responsible for the enhanced neurogenesis. The current study evaluated the effects of the acute and chronic administration of 5-HT$_{2A}$ agonists psilocybin and 251-NBMeO and the 5-HT$_{2A/C}$ antagonist ketanserin on hippocampal neurogenesis. To investigate the effects of acute drug administration mice received a single injection of varying doses of psilocybin, 251-NBMeO, ketanserin or saline followed by i.p. injections of 75 mg/kg bromodeoxyuridine (BrdU) for 4 consecutive days followed by euthanasia two weeks later. For chronic administration 4 injections of psilocybin, ketanserin or saline were administered weekly over the course of one month. On days following drug injections mice received an injection of 75 mg/kg BrdU and were euthanized two weeks after the last drug injection. Unbiased estimates of BrdU+ and BrdU/NeuN+ cells in the dentate gyrus (DG) revealed a significant dose dependent reduction in the level of neurogenesis after acute 5-HT$_{2A}$ receptor agonist or antagonist administration. Interestingly, chronic administration of psilocybin increased the number of newborn neurons in the DG while the antagonist suppressed hippocampal neurogenesis, suggesting the 5-HT$_{2A}$ receptor appears to be involved in the regulation of hippocampal neurogenesis.

Introduction

Evidence suggests neurogenesis occurs throughout the lifespan in two specific regions of the adult brain, the subventricular zone (SVZ) and the subgranular zone (SGZ) of the DG (Altman J, 1962; Altman & Das, 1965; Altman J, 1969). The proliferation and survival of neural progenitors in the adult HPC can be influenced by a variety of stimuli including stress, age, physical activity and depression (Gould *et al.*, 1992; Kempermann *et al.*, 1998; Van *et al.*, 1999b; Malberg *et al.*, 2000). Antidepressant medications such as selective 5-HT uptake inhibitors (SSRIs) enhance the production of new born neurons in the DG of the HPC (Malberg *et al.*, 2000). However, this effect is time specific with chronic administration (14 days or more) enhancing neurogenesis but not acute treatment (Malberg *et al.*, 2000). Interestingly, there is a delay in the appearance of antidepressant effects which corresponds to the time required to generate new neurons (Santarelli *et al.*, 2003) suggesting an enhancement of neurogenesis may mediate the behavioral effects of antidepressants.

The requirement of chronic administration of antidepressant medications to enhance neurogenesis is likely due to number of factors. Antidepressant treatments upregulated the expression of brain-derived neurotrophic factor (BDNF) in the HPC (Nibuya *et al.*, 1995). BDNF knockout mice have diminished levels of neurogenesis in the DG (Lee *et al.*, 2002) and infusions of BDNF into the lateral ventricles induced neurogenesis originating in the SVZ (Pencea *et al.*, 2001).

The involvement of 5-HT in the regulation of neurogenesis may be mediated through different 5-HT receptor subtypes expressed on cells in the neurogenic microniche (Barnes & Sharp, 1999). The 5-HT$_{2A}$ receptor is involved in the regulation of BDNF in the HPC (Vaidya *et al.*, 1997). 2,5-dimethoxy-4- iodoamphetamine (DOI), a 5-HT$_{2A/C}$ receptor agonist decreased the expression of BDNF mRNA in the HPC (Vaidya *et al.*, 1997). Interestingly, the decrease in BDNF mRNA expression was blocked by the 5-HT$_{2A}$ receptor antagonist but not the 5-HT$_{2C}$ receptor antagonist, implicating the 5-HT$_{2A}$ receptor in the regulation of BDNF expression in the HPC (Vaidya *et al.*, 1997). Acute administration of DOI, 5-HT$_{2C}$ receptor agonist RO 600175, or the 5-HT$_{2C}$ receptor antagonist SB 206553 had no effect on cell proliferation, whereas the 5-HT$_{2A/C}$ receptor antagonist ketanserin produced a 63% decrease in BrdU incorporation (Banasr *et al.*, 2004). A recent study found acute ketanserin decreased proliferation whereas chronic ketanserin increased proliferation in the DG (Jha *et al.*, 2008). No effect on proliferation in the DG was observed after DOI or lysergic acid diethylamide (LSD) were administered either acutely or once daily for seven consecutive days (chronic) (Jha *et al.*, 2008). However, daily doses of LSD or psilocybin (PSOP) produce rapid tolerance to the drug and resulted in a selective downregulation of the 5-HT$_{2A}$ receptor (Buckholtz *et al.*, 1990; Buckholtz *et al.*, 1985). Therefore, in order to investigate the role of the 5-HT$_{2A}$ receptor in the regulation of hippocampal neurogenesis the current study evaluated the effects of acute and repeated intermittent administration of 5-HT$_{2A}$ agonists and the 5-HT$_{2A/C}$ antagonist ketanserin on hippocampal neurogenesis.

Materials and Methods

Subjects

C57BL/6J male mice (30-40g) were housed in standard laboratory cages and left undisturbed for 1 week after arrival at the animal facility. All mice had unlimited access to water and laboratory chow and were maintained in a temperature and humidity controlled room on a 12:12 light/dark cycle with light onset at 7:00 AM. All National Institutes for Health (NIH) guidelines for the Care and Use of Laboratory Animals were followed (National Institutes of Health, 2002).

Drugs

251-NBMeO was synthesized in the laboratory of Dr David Nichols (Braden *et al.*, 2006). PSOP was provided by Dr Francisco Moreno from University of Arizona. Ketanserin (+)-tartrate salt (#S006, St. Louis, MO) and 5-Bromo-2′-deoxyuridine (#B5002, St. Louis, MO) were supplied by Sigma-Aldrich Inc.

General Procedure

Acute Administration: A total of 48 C57BL/6 mice received a single injection of 0.1 mg/kg PSOP (n=6), 0.5 mg/kg PSOP (n=6), 1.0 mg/kg PSOP (n=6), 0.1 mg/kg 251-NBMeO (n=6), 0.3 mg/kg 251-NBMeO (n=6), 1.0 mg/kg 251-NBMeO (n=6), 1.0 mg/kg ketanserin (n=6) or saline (n=6). Mice received an intraperitoneal (i.p.) injection of 75 mg/kg BrdU once daily for 4 days following drug administration and were euthanized two weeks after the last drug injection. Mice were euthanized with nembutal then transcardially perfused with 0.9% saline followed by 4% paraformaldehyde. Brains were stored in 4% paraformaldehyde, transferred to 20% sucrose solution and sectioned coronally using a cryostat (Leica, Germany) at 30μM in a 1:6 series and stored in 24-well plates in cryoprotectant at -20°C. Repeated Intermittent Administration: A total of 31 C57BL/6 mice received 4 i.p. injections of either 0.5 mg/kg PSOP (n=6), 1.0 mg/kg PSOP (n=7), 1.5 mg/kg PSOP (n=6), 1.0 mg/kg ketanserin (n=6) or 0.9% saline solution (n=6) over the course of one month on days 1, 8, 15, and 22. Each day following drug administration 75 mg/kg BrdU was injected i.p. All mice were euthanized two weeks after the last drug injection according to the above procedures.

Immunofluorescence

For the double labeling of progenitor cells in the DG free-floating sections were denatured using 2N HCl and neutralized in 0.15M borate buffer then washed in PBS. Tissue was blocked in PBS+ (PBS, 10% normal goat serum, 1% 100x Triton X, 10% BSA) for 1 hour at 4°C and incubated for 48 hours at 4°C in an antibody cocktail of rat monoclonal anti-BrdU (AbD Serotec, Raleigh NC, #OBT0030G, 1:100) plus mouse anti-NeuN (Chemicon, 1:100) in PBS. Sections were washed in PBS and incubated in a secondary antibody cocktail of goat anti-rat IgG Alexa Fluor 594 (1:1000, Invitrogen, Eugene OR) plus goat anti-mouse (1:400, Invitrogen) and coated with vectorshield mounting medium (Invitrogen).

Quantitation

For the quantification of doubled labeled cells using immunofluroescence, the number of BrdU+ and BrdU/NeuN+ labeled cells were estimated using every 6th section taken throughout the DG (every 180 microns). To avoid counting partial cells a modification to the optical dissector method was used so that cells on the upper and lower planes were not counted. The number of BrdU+ cells counted in every 6th section was multiplied by 6 to get the total number of BrdU+ or BrdU/NeuN+ cells in the DG (Shors *et al*. 2002). Positive labeling was verified by confocal microscopy (Zeiss).

Design and analyses

Separate one-way analyses of variance (ANOVA) were used to evaluate the acute and chronic effects of 5-HT$_{2A}$ receptor agonists and an antagonist on hippocampal neurogenesis. For acute drug administration separate one-way ANOVA was used to determine the effects of Drug [PSOP (saline, 0.1 mg/kg, 0.5 mg/kg, 1.0 mg/kg), 251-NBMeO (saline, 0.1 mg/kg, 0.3 mg/kg, 1.0 mg/kg)] and a two-tailed *t*-test (saline, 1.0 mg/kg ketanserin) was used to establish differences in cell survival and neurogenesis. For chronic drug administration a separate one-way ANOVA was used to determine the effects of Dose (saline, 0.5 mg/kg PSOP, 1.0 mg/kg PSOP, 1.5 mg/kg PSOP, 1.0 mg/kg ketanserin) on cell survival and neurogenesis. When appropriate, post hoc analyses such as Bonferroni were used to isolate Drug effects. All statistical analyses were determined significant at the 0.05 alpha level.

Results

Effects of Acute Administration of 5-HT$_{2A}$ receptor agonists and an antagonist in vivo on Cell Survival and Neurogenesis in the Hippocampus

In order to investigate the effects of acute PSOP administration on cell survival and neurogenesis mice (n = 6-7 per condition) were injected with PSOP (0.1, 0.5, or 1.0 mg/kg), 251-NBMeO (0.1 mg/kg, 0.3 mg/kg, 1.0 mg/kg), ketanserin (1.0 mg/kg) or 0.9% saline solution then received 75 mg/kg BrdU once daily for 4 days following drug administration followed by euthanasia two weeks after the last drug injection. A one-way ANOVA detected significant differences in the total number of surviving BrdU+ cells in the DG as a result of acute PSOP treatment [$F(3,20)=6.64$, $p=0.003$]. As can be seen in Figure 2.1A a significant decrease in the number of surviving BrdU+ cells was observed after 1.0 mg/kg PSOP compared to saline (indicated by *).

The phenotypic fate of surviving cells was determined by immunofluorescent labeling of BrdU and NeuN. A one way ANOVA revealed a significant effect of dose on the number of double labeled neurons in the DG [$F(3,20)=10.26$, $p=0.0003$]. As can be seen in Figure 2.1B, acute administration of 1.0 mg/kg PSOP significantly diminished the number of BrdU/NeuN+ cells compared to saline ($p<0.05$). These data suggest acute administration of 1.0 mg/kg PSOP, a 5-HT$_{2A}$ agonist downregulated neurogenesis in the DG.

A one-way ANOVA detected significant differences in the total number of surviving BrdU+ cells in the DG as a result of acute 251-NBMeO treatment [$F(3,20)=9.00$, $p=0.0004$]. There was a significant decrease in the number of surviving BrdU+ cells after acute administration of 0.1, 0.3 and 1.0 mg/kg 251- NBMeO compared to saline (see figure 2.3A, indicated by *).

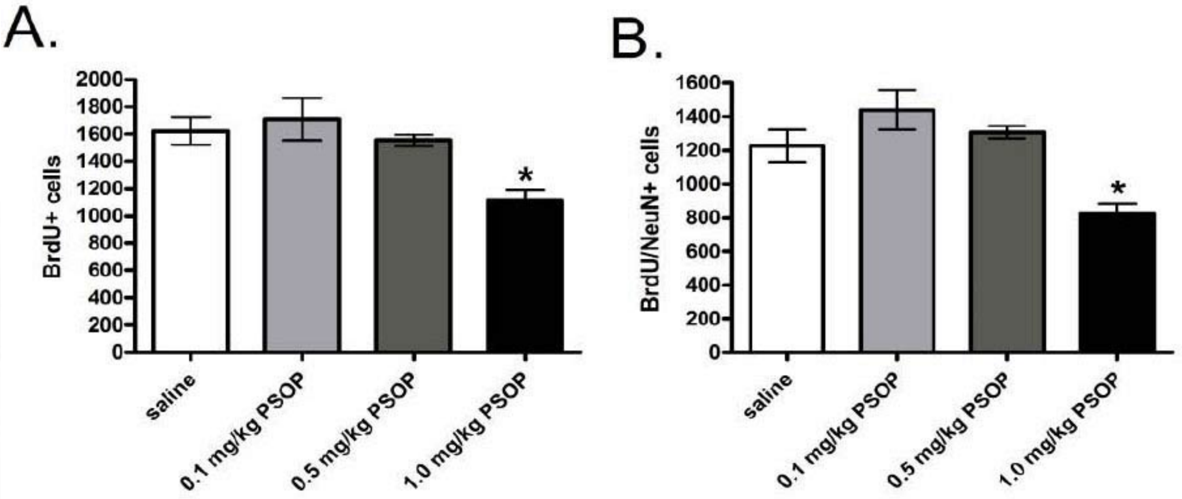


Figure 2.1. Effect of Acute PSOP Administration on Hippocampal Neurogenesis. Mice (*n* = 6 per condition) were injected with PSOP (0.1, 0.5, or 1.0 mg/kg) or saline then received 75 mg/kg BrdU once daily for 4 days following drug administration followed by euthanasia two weeks after drug injection. A) The total number of BrdU+ cells in the DG were significant diminished after a single injection of 1.0 mg/kg PSOP ($p<0.05$). B) Acute administration of 1.0 mg/kg PSOP significantly diminished the number of BrdU/NeuN+ cells compared to saline ($p<0.05$). These data suggest acute administration of 1.0 mg/kg PSOP, a 5-HT_{2A} agonist downregulated neurogenesis in the DG of the HPC.
* indicates a significant difference from saline.

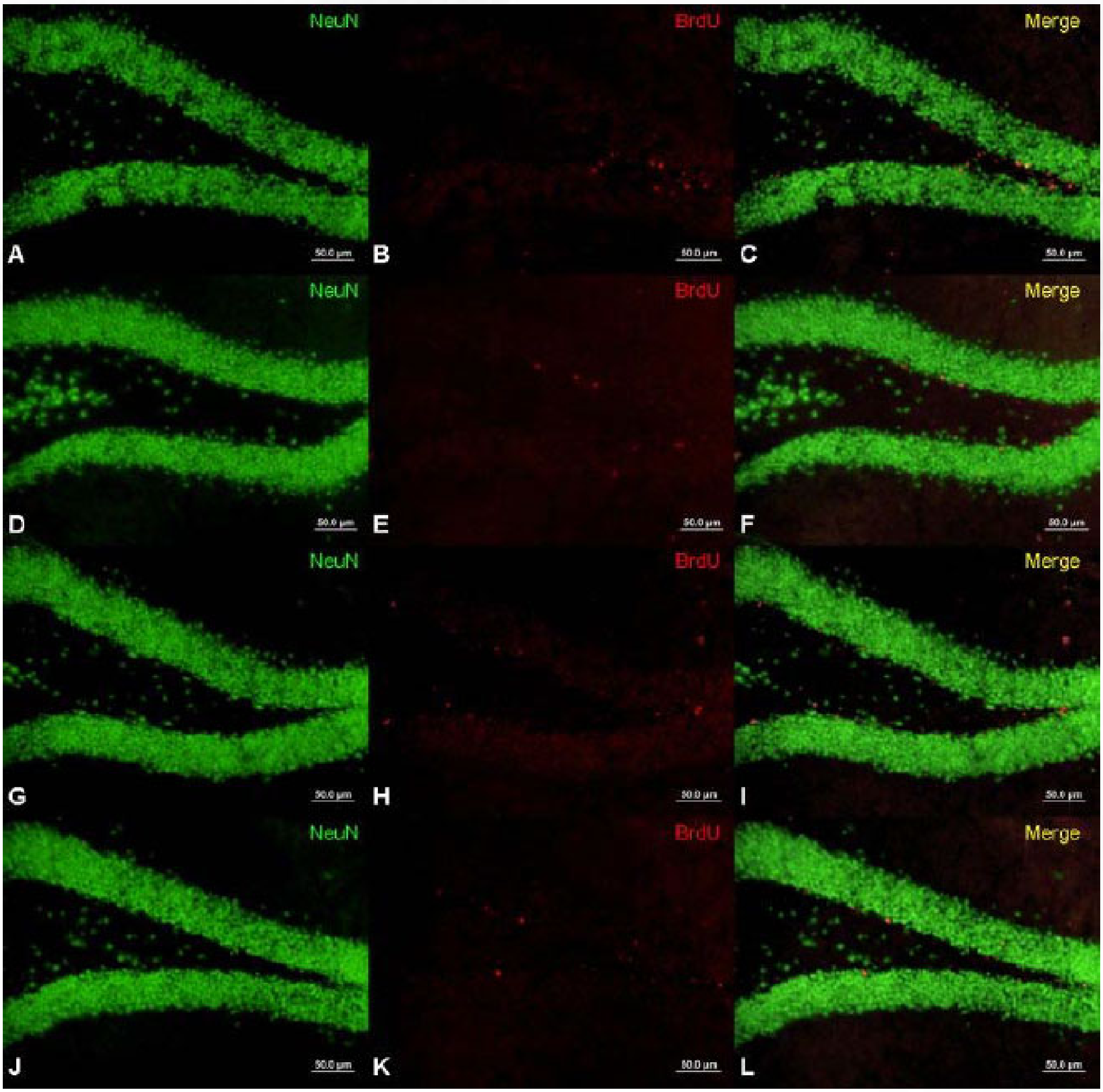

NeuN
BrdU
Merge
A
50.0 µm
B
50.0 µm
C
50.0 µm
NeuN
BrdU
Merge
D
50.0 µm
E
50.0 µm
F
50.0 µm
NeuN
BrdU
Merge
G
50.0 µm
H
50.0 µm
I
50.0 µm
NeuN
BrdU
Merge
J
50.0 µm
K
50.0 µm
L
50.0 µm

Figure 2.2. Representative photomicrographs showing the effects of acute PSOP on hippocampal neurogenesis. NeuN+ cells (left), BrdU+ cells (center) and NeuN/BrdU+ cells (right). Saline (A-C), 0.1 mg/kg PSOP (D-F), 0.5 mg/kg PSOP (G-I) and 1.0 mg/kg PSOP (J-L). Scale = 50 µM.

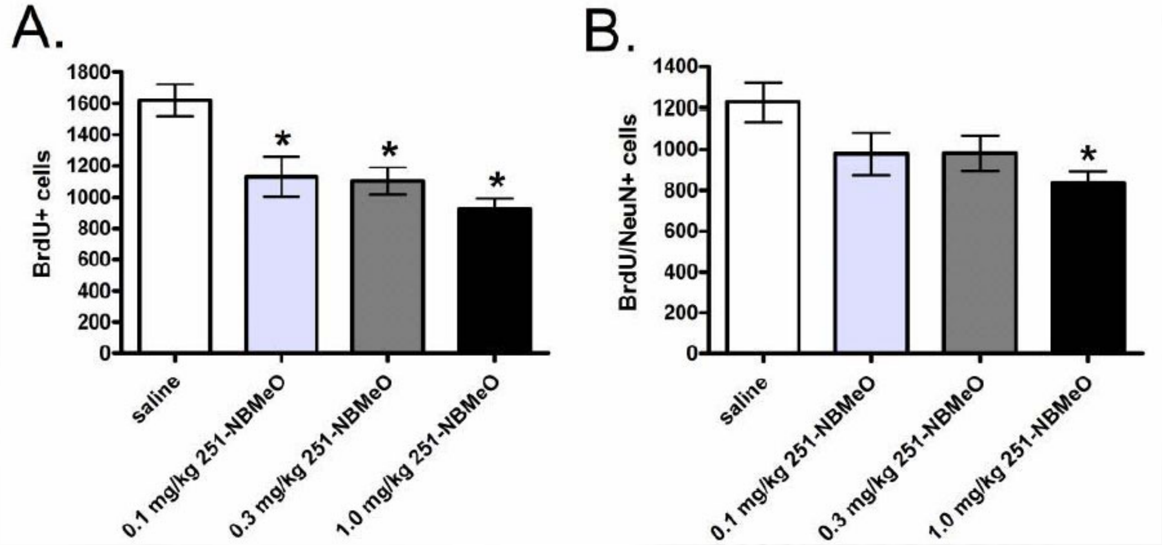


Figure 2.3. Effect of the selective 5-HT_{2A} receptor agonist, 251-NBMeO on hippocampal neurogenesis. Mice (*n* = 6 per condition) were injected with 251- NBMeO (0.1, 0.3, or 1.0 mg/kg) or saline then received 75 mg/kg BrdU once daily for 4 days following drug administration followed by euthanasia two weeks after drug injection. A) There was a significant decrease in the total number of BrdU+ cells in the DG after the administration of 251-NBMeO ($p<0.05$). B) The number of new born neurons was significantly decreased after 1.0 mg/kg of 251- NBMeO compared to saline ($p<0.05$), suggesting acute administration of the 5-HT_{2A} receptor agonist downregulated neurogenesis in the DG of the HPC.
* indicates a significant difference from saline.

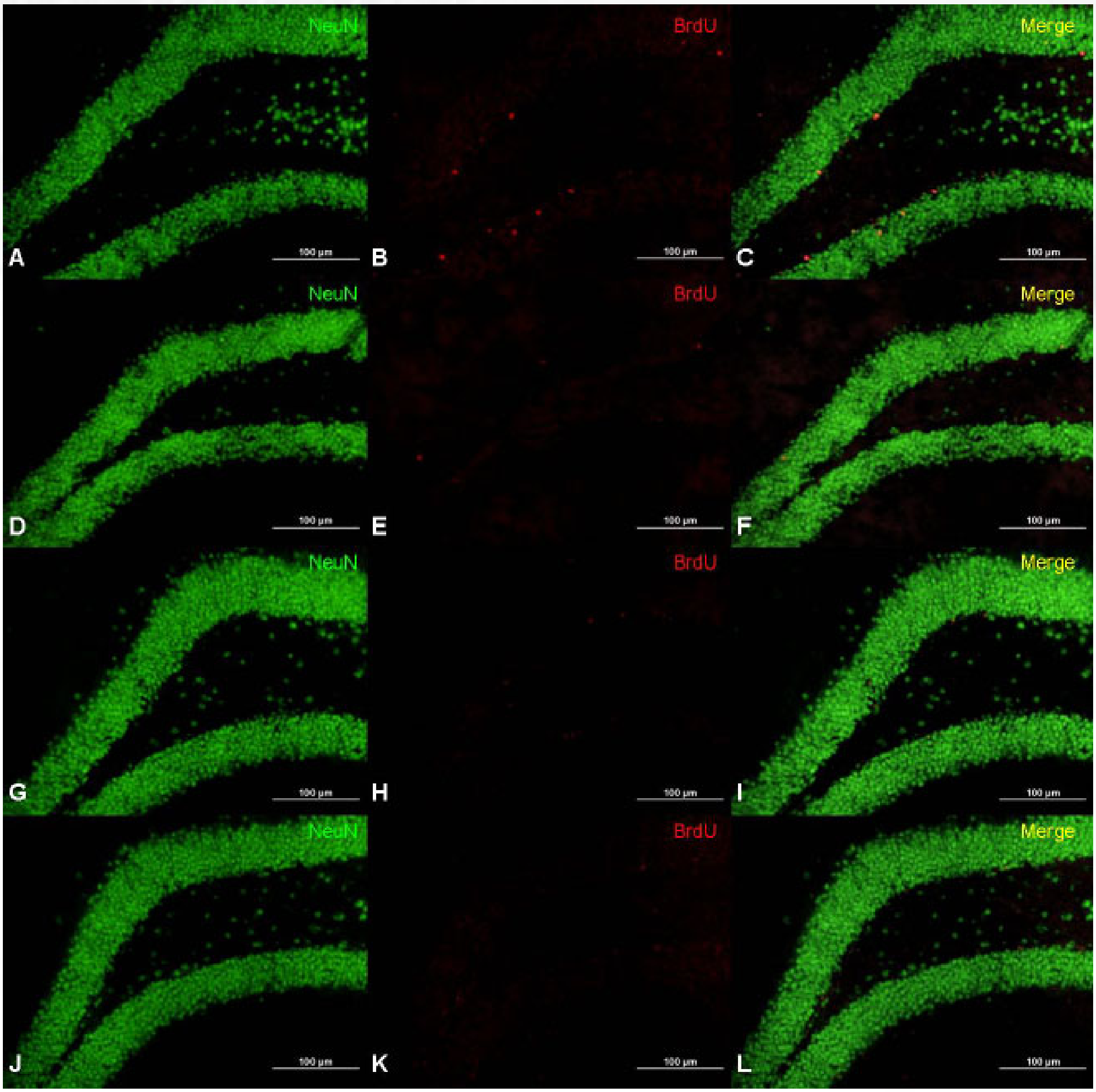


Figure 2.4. Representative photomicrographs showing the effects of the selective 5-HT_{2A} receptor agonist 251-NBMeO on hippocampal neurogenesis. NeuN+ cells (left), BrdU+ cells (center) and NeuN/BrdU+ cells (right). Saline (AC), 0.1 mg/kg 251-NBMeO (D-F), 0.3 mg/kg 251-NBMeO (G-I) and 1.0 mg/kg 251-NBMeO (J-L). Scale = 100 µM.

In addition, there was a significant effect of drug on the number of double labeled neurons in the DG [*F*(3,20)=3.00, *p*=0.03]. As can be seen in Figure 2.3B, 1.0 mg/kg 251-NBMeO significantly diminished the number of new born neurons in the DG compared to saline (*p*<0.05, indicated by *). These data suggest acute administration of the selective 5-HT$_{2A}$ receptor agonist, 251- NBMeO, attenuated hippocampal neurogenesis

Interestingly, acute administration of the 5-HT$_{2A/C}$ receptor antagonist ketanserin produced similar effects on neurogenesis as high doses of the 5-HT$_{2A}$ receptor agonists. As can be seen in figure 2.5, the total number of BrdU+ cells in the DG was significantly decreased after 1.0 mg/kg ketanserin [*t*(10)=3.0, *p*=0.008], suggesting that the 5-HT$_{2A/C}$ receptor is involved in the regulation of cell survival in the HPC. Furthermore, acute ketanserin decreased the total number of BrdU/NeuN positive cells compared to saline [*t*(10)=3.0, *p*=0.02] demonstrating that antagonism of the 5-HT$_{2A/C}$ receptor negatively regulated the number of new born neurons generated in the DG of the HPC.

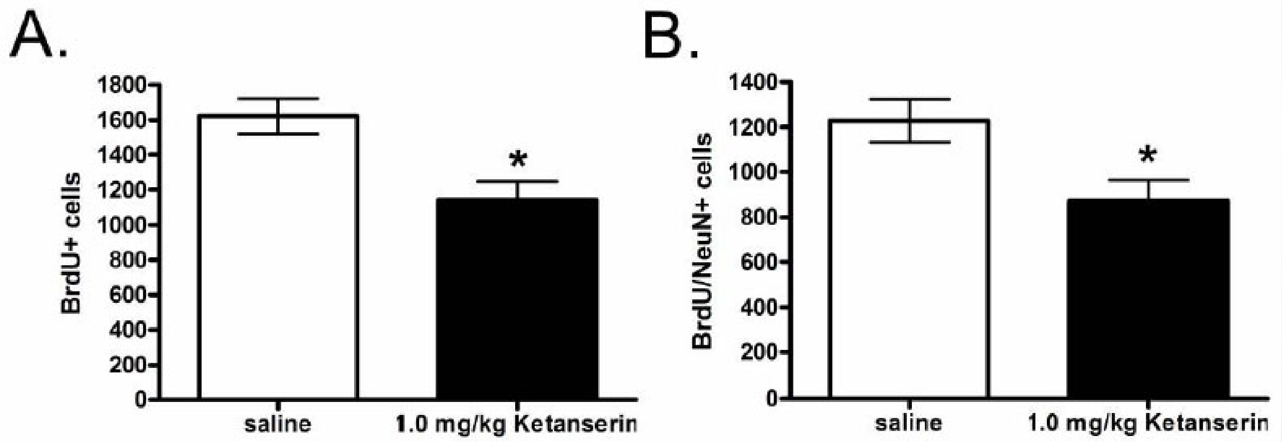


Figure 2.5. Acute Administration of the 5-HT$_{2A/C}$ receptor antagonist ketanserin negatively regulated cell survival and neurogenesis in the HPC. Mice (*n* = 6 per condition) were injected with 1.0 mg/kg ketanserin or saline then received 75 mg/kg BrdU once daily for 4 days following drug followed by euthanasia two weeks after drug injection. Ketanserin decreased the total number of BrdU+ (A) and BrdU/NeuN positive cells (B) suggesting that antagonism of the 5-HT$_{2A/C}$ receptor negatively regulated cell survival and neurogenesis in the HPC.

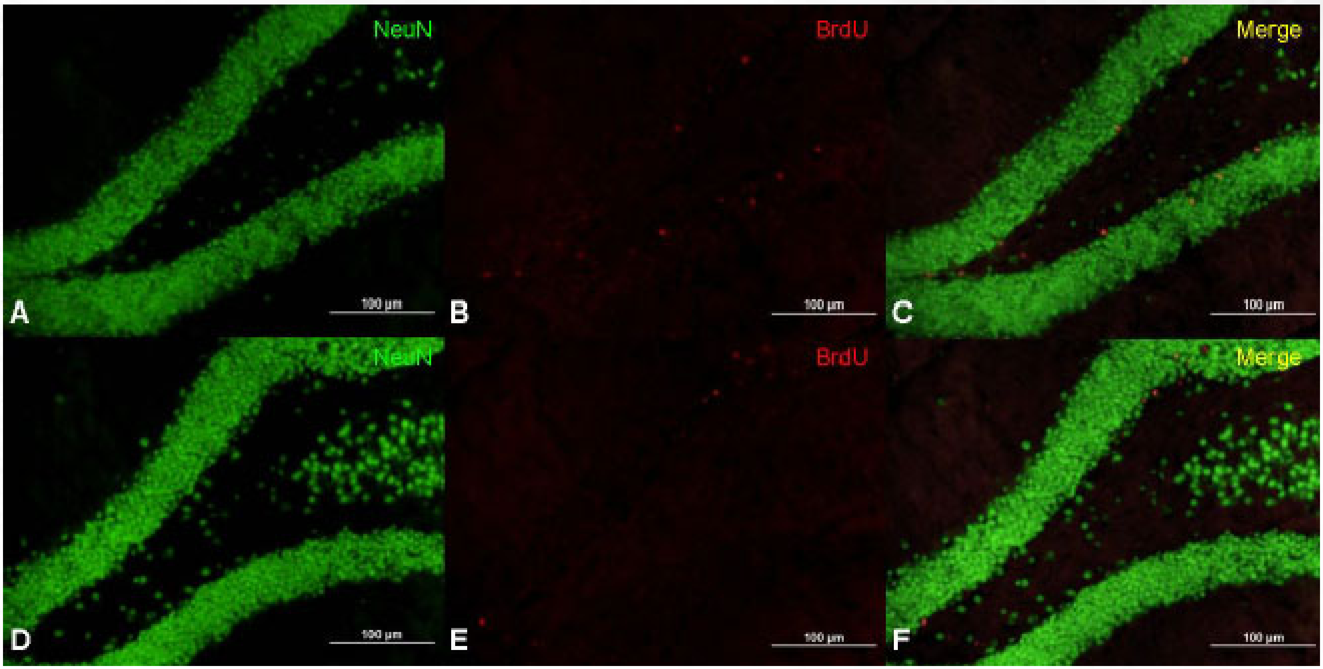


Figure 2.6. Representative photomicrographs showing the effects of the 5-HT$_{2A/C}$ receptor antagonist ketanserin on neurogenesis in the dentate gyrus. NeuN+ cells (left), BrdU+ cells (center) and NeuN/BrdU+ cells (right). Saline (A-C), 1.0 mg/kg ketanserin (D-F). Scale = 100 µM.

Effects of Repeated Intermittent PSOP Administration on Progenitor Cell Survival and Neurogenesis in the Hippocampus

In order to investigate the effects of repeated intermittent PSOP administration on cell survival mice (*n* = 6- 7 per condition) were injected with PSOP (0.5, 1.0, or 1.5 mg/kg), 1.0 mg/kg ketanserin or 0.9% saline solution once weekly for 4 weeks. Each day following drug administration, mice were administered 75 mg/kg BrdU and sacrificed two weeks after last drug injection. ANOVA failed to reveal differences in the total number of BrdU+ cells in the DG as a result of repeated intermittent drug treatment [$F(4,26)=2.20$, $p=0.09$]. As can be seen in Figure 2.7A a trend toward an increase in the number of surviving cells was observed after high doses of PSOP.

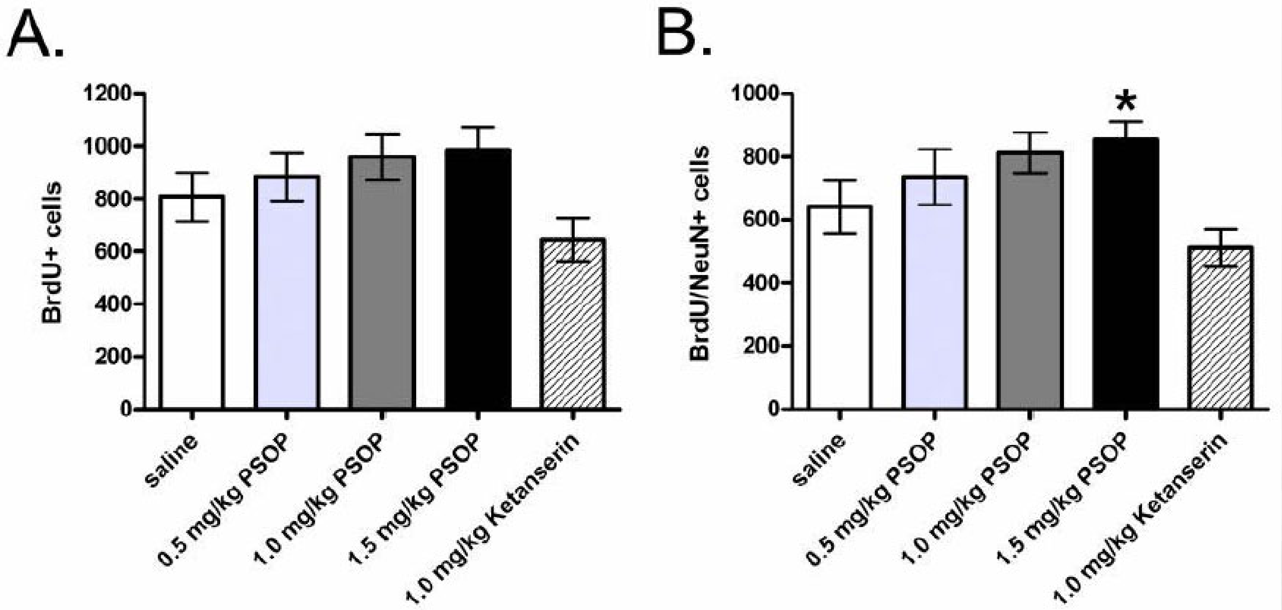


Figure 2.7. Effect of Repeated Intermittent PSOP Administration on Hippocampal Neurogenesis. Mice (*n* = 6-7 per condition) were injected with PSOP (0.5, 1.0, or 1.5 mg/kg), 1.0 mg/kg ketanserin or saline once weekly for 4 weeks. Each day following drug administration, mice were administered 75 mg/kg BrdU and sacrificed two weeks after last drug injection. A) The total number of BrdU+ cells in the DG did not differ as a result of repeated intermittent drug treatment, however, a trend toward an increase in the number of surviving cells was observed after high doses of PSOP. B) Repeated intermittent administration of 1.5 mg/kg PSOP significantly increased the number of BrdU/NeuN+ cells compared to saline and ketanserin ($p<0.05$). These data suggest repeated intermittent administration of high doses of PSOP, a 5-HT_{2A} agonist upregulated neurogenesis in the DG.
* indicates a significant difference from saline and ketanserin.

The phenotypic fate of surviving cells was determined by immunofluorescent labeling of BrdU and NeuN. ANOVA revealed a significant effect of Dose on the number of double labeled neurons in the DG [$F(4,26)=3.15$, $p=0.02$]. As can be seen in Figure 2.7B, chronic administration of 1.5 mg/kg PSOP significantly increased the number of BrdU/NeuN+ cells compared to saline and ketanserin ($p<0.05$) (indicated by *). These data suggest repeated intermittent administration of PSOP, a 5-HT_{2A} agonist upregulated neurogenesis in the DG of the HPC.

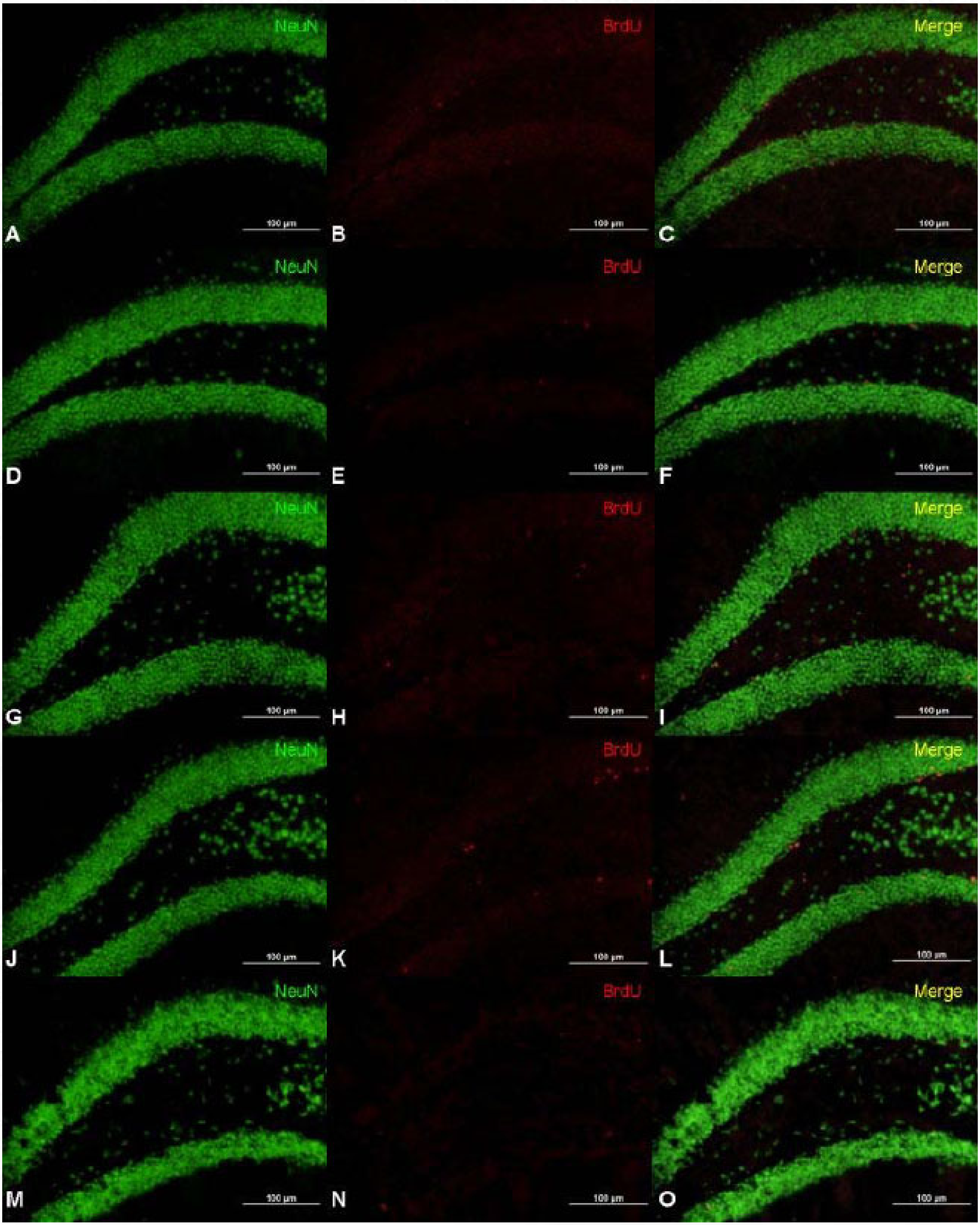


Figure 2.8. Representative photomicrographs showing the effects of repeated intermittent PSOP or ketanserin administration on neurogenesis in the DG. NeuN+ cells (left), BrdU+ cells (center) and NeuN/BrdU+ cells (right). Saline (AC), 0.5 mg/kg PSOP (D-F), 1.0 mg/kg PSOP (G-I), 1.5 mg/kg PSOP (J-L), and 1.0 mg/kg Ketanserin (M-O). Scale = 100 μM.

Discussion

The present investigation illustrates the involvement of the 5-HT$_{2A}$ receptor in the regulation of neurogenesis in the DG of the HPC. Acute administration of low doses of PSOP (0.1 and 0.5 mg/kg) did not alter neurogenesis, however, higher doses of PSOP (1.0 mg/kg) decreased neurogenesis two weeks after drug exposure (Figure 2.1). In addition, acute administration of the potent 5-HT$_{2A}$ receptor agonist 251-NBMeO (Figure 2.3) and the 5-HT$_{2A/C}$ receptor antagonist ketanserin (Figure 2.5) decreased hippocampal neurogenesis. Acute ketanserin (1-5 mg/kg) administered within 4 hours of sacrifice decreased the number of BrdU+ cells in the DG, indicating a reduction in cell proliferation (Banasr *et al.*, 2004; Jha *et al.*, 2008). The present study extends these findings by demonstrating that acute ketanserin decreases the number of BrdU+ and BrdU/NeuN+ cells 2 weeks after drug administration, indicating a reduction in cell survival and neurogenesis after exposure to acute ketanserin.

The current study reports that repeated intermittent administration of high doses of PSOP (1.5 mg/kg) increased neurogenesis in the DG (see Figure 2.7). A recent study investigated the effects of chronic DOI, LSD and ketanserin administration on the number of BrdU+ cells in the DG (Jha *et al.*, 2008). They report no effect of chronic DOI or LSD on progenitor cell proliferation but observed an increase in the number of BrdU+ cells in the DG after chronic ketanserin. There are several methodological differences between the studies which may account for the different results, namely drug administration protocol, doses of compounds administered and administration protocol of BrdU. Jha and colleagues administered DOI (8 mg/kg), LSD (0.5 mg/kg) or ketanserin (5 mg/kg) once daily for seven consecutive days for the chronic drug administration protocol (Jha *et al.*, 2008). The current investigation administered PSOP (0.5, 1.0 or 1.5 mg/kg) or ketanserin (1.0 mg/kg) 4 times over the course of one month so that injections were given one week apart. This was a critical consideration in our experimental design given that daily doses of LSD, PSOP or other 5-HT$_{2A}$ receptor agonists produce rapid tolerance to the drug and results in a selective downregulation of the 5-HT$_{2A}$ receptor (Buckholtz *et al.*, 1990; Buckholtz *et al.*, 1985; Buckholtz *et al.*, 1988). Jha and colleagues administered BrdU (200 mg/kg) 2 hours after the last injection of DOI, LSD or ketanserin and sacrificed the animals 24 hours later (Jha *et al.*, 2008). In the current study BrdU (75 mg/kg) was administered 24 hours after each drug injection and mice were sacrificed two weeks after the last drug injection so that time between the first BrdU injection and sacrifice was 6 weeks. This allowed for the assessment of neurogenesis giving time for the birth-dated cells (BrdU labeled) to mature into neurons.

Brain derived neurotropic factor (BDNF) has been implicated in synaptic plasticity (Kang *et al.*, 1997; Pang *et al.*, 2004; Tyler *et al.*, 2002) through the modulation of synapse formation and dendritic spine growth in the HPC (Bamji *et al.*, 2006; Tyler & Pozzo-Miller, 2001; Tyler & Pozzo-Miller, 2003). Chronic administration of 5-HT agonists (including SSRIs) upregulate BDNF mRNA expression in the HPC (Nibuya *et al.*, 1995; Nibuya *et al.*, 1996). Evidence suggests that the 5-HT$_{2A}$ receptor is involved in the regulation of BDNF in the HPC (Vaidya *et al.*, 1997). Specifically DOI, a 5-HT$_{2A/C}$ receptor agonist decreased BDNF mRNA expression in the granule cell layer of the DG but not in the CA subfields of the HPC. Interestingly, the decrease in BDNF mRNA expression was blocked by the 5-HT$_{2A}$ receptor antagonist but not the 5-HT$_{2C}$ receptor antagonist, implicating the 5-HT$_{2A}$ receptor in the regulation of BDNF expression (Vaidya *et al.*, 1997).

PSOP and 251-NBMeO exert their effects through binding to 5-HT receptors. PSOP binds to the 5-HT$_{2A}$ receptor (Ki = 6 nM) with high affinity and to a much lesser extent to the 5-HT$_{1A}$ receptor subtype (Ki = 190 nM) (McKenna *et al.*, 1990). The synthetic phenethylamine 251-NBMeO binds to 5-HT$_{2A}$ receptors (Ki = 0.044 nM) with an extremely high affinity (Braden *et al.*, 2006).

5-HT$_{2A}$ receptors are highly expressed throughout the HPC in the DG, hilus, CA1, and CA3 and are colocalized on GABAergic neurons, pyramidal and granular cells (Cornea-Hebert *et al.*, 1999; Morilak *et al.*, 1993; Pompeiano *et al.*, 1994; Shen & Andrade, 1998; Luttgen *et al.*, 2004; Morilak *et al.*, 1994). 5-HT$_{2A}$ receptor agonists stimulate arachidonic acid and consequently, the phosphoinositide (PI) pathway resulting in the activation of protein kinase C (PKC) (Kurrasch-Orbaugh *et al.*, 2003; Ananth *et al.*, 1987). Electrophysiological evidence suggests that 5-HT$_{2A}$ receptors stimulate GABAergic interneurons in the HPC (Shen & Andrade, 1998) and GABAergic interneurons in the hilus form connections with progenitor cells in the SGZ (Wang *et al.*, 2005). When progenitor cells are less than 2 weeks old the GABAergic input exerts an excitatory influence on the progenitor cells and as the cells establish glutamatergic synapses the GABAergic interneurons become inhibitory (Wang *et al.*, 2005; Zhao *et al.*, 2006; Aimone *et al.*, 2006). Given that 5-HT$_{2A}$ receptor agonists administered chronically downregulates receptor expression, and evidence suggests that the 5-HT$_{2A}$ receptor excites the GABAergic interneurons which stimulate progenitor cells in the SGZ, one might anticipate a reduction in neurogenesis after chronic PSOP. On the contrary, the present study reports high doses of PSOP upregulates neurogenesis. Based on this finding it is plausible to suggest the increase in neurogenesis observed may be attributed to the administration paradigm in which PSOP was given 4 times over the course of one month so that injections were given once a week. In this administration paradigm alterations in receptor levels may not have occurred to the extent that occurs with daily exposure and give this highly plastic microniche time to adapt between drug exposures.

The results shown provide evidence that the 5-HT$_{2A}$ receptor is involved in the regulation of hippocampal neurogenesis. The data suggest that acute administration of 5-HT$_{2A}$ receptor agonists and an antagonist downregulated neurogenesis in the DG. Whereas, chronic administration of high doses of 5-HT$_{2A}$ receptor agonists enhance hippocampal neurogenesis in the DG. Future studies should investigate the effects of chronic administration of PSOP and ketanserin on 5-HT$_{2A}$ receptor levels and neuroplasticity in the HPC.

Acknowledgments

This work was supported by the Helen Ellis Research Endowment (JSR). Thanks to David Nichols Ph.D. for donating the selective 5-HT$_{2A}$ agonist 251-NBMeO and Dr Francisco Moreno from University of Arizona and Rick Doblin Ph.D. of the Multidisciplinary Association for Psychedelic Studies (MAPS) for donating the PSOP.

Chapter Three
The Effects of Psilocybin on Trace Fear Conditioning

Abstract

Aberrations in brain serotonin (5-HT) neurotransmission have been implicated in psychiatric disorders including anxiety, depression and deficits in learning and memory. Many of these disorders are treated with drugs which promote the availability of 5-HT in the synapse. However, it is not clear which of the 5-HT receptors are involved in behavioral improvements. The current study aimed to investigate the effects of psilocybin, a 5-HT$_{2A}$ receptor agonist on hippocampal-dependent learning. Mice received a single injection of psilocybin (0.1, 0.5, 1.0 or 1.5 mg/kg), ketanserin (a 5-HT$_{2A/C}$ antagonist) or saline 24 hours before habituation to the environment and subsequent training and testing on the fear conditioning task. Trace fear conditioning is a hippocampal-dependent task in which the presentation of the conditioned stimulus (CS, tone) is separated in time by a trace interval to the unconditioned stimulus (US, shock). All mice developed contextual and cued fear conditioning; however, mice treated with psilocybin extinguished the cued fear conditioning more rapidly than saline treated mice. Interestingly, mice given the 5-HT$_{2A/C}$ receptor antagonist ketanserin showed less of cued fear response than saline and psilocybin treated mice. Future studies should examine the temporal effects of acute and chronic psilocybin administration on hippocampal-dependent learning tasks.

Introduction

The hippocampus (HPC) plays a critical role in learning tasks that involve temporal encoding of stimuli (Squire *et al.*, 1992; Squire, 1992). The trace classical conditioning paradigm requires temporal processing because the conditioned stimulus (CS) and the unconditioned stimulus (US) are separated in time by a trace interval. Lesions to the HPC prevent trace conditioning, indicating that it is a hippocampal-dependent task (McEchron *et al.*, 1998; Weiss *et al.*, 1999).

The serotonergic system has been implicated in hippocampal-dependent learning. Administration of selective serotonin (5-HT) uptake inhibitors (SSRIs) produce alterations in performance on learning tasks that require the HPC (Flood & Cherkin, 1987; Huang *et al.*, 2004). In a knockout (KO) mouse model, central 5-HT deficient mice developed heightened contextual fear conditioning which was reversed by intracerebroventricular microinjection of 5-HT (Dai *et al.*, 2008). An impairment in learning on the morris water maze was observed in 5-HT$_{1A}$ KO mice along with functional abnormalities in the HPC (Sarnyai *et al.*, 2000). Activation of 5-HT$_{1A}$ receptors in the medial septum alters encoding and consolidation in a hippocampal-dependent memory task (Koenig *et al.*, 2008). In addition, Lysergic acid diethylamide (LSD), a 5-HT$_{2A}$ receptor agonist facilitated learning of a brightness discrimination reversal problem (King *et al.*, 1972; King *et al.*, 1974).

Evidence suggests that performance on hippocampal-dependent learning tasks is influenced by neurogenesis in the dentate gyrus (DG) of the HPC (Van *et al.*, 2002; Nilsson *et al.*, 1999; Shors *et al.*, 2001; Shors *et al.*, 2002; Gould *et al.*, 1999a; Gould *et al.*, 1999c). This was elegantly demonstrated by Shors and colleagues by treating animals with methylazoxymethanol acetate (MAM), an anti-mitotic agent which eradicates the progenitor cell population in the DG before testing mice on hippocampal-dependent and hippocampal-independent learning tasks (Shors *et al.*, 2001; Shors *et al.*, 2002). MAM treated animals had significantly fewer BrdU+ cells in the subgranular zone (SGZ) of the DG but showed no impairment in the spatial navigation task (HPC-dependent) or delay eyeblink conditioning task (HPC-independent) demonstrating that the hippocampal progenitor cell population is not essential for these particular tasks (Shors *et al.*, 2002; Shors *et al.*, 2001). In contrast, MAM severely impaired performance on trace fear conditioning and trace eyeblink conditioning, providing evidence for the involvement of progenitor cells in the DG in trace classical conditioning (Shors *et al.*, 2002; Shors *et al.*, 2001). In addition, hippocampal neurogenesis is influenced by serotonergic agonists. Specifically, SSRIs enhance the production of new born neurons in the DG of the HPC (Malberg *et al.*, 2000; Santarelli *et al.*, 2003).

Psilocybin (PSOP), a tryptamine alkaloid, exerts psychoactive effects by altering serotonergic neurotransmission (Passie *et al.*, 2002). PSOP binds to the 5-HT$_{2A}$ receptor (Ki = 6 nM) with high affinity and to a much lesser extent to the 5-HT$_{1A}$ receptor subtype (Ki = 190 nM) (McKenna *et al.*, 1990). 5-HT$_{2A}$ receptors are highly expressed throughout the HPC in the DG, hilus, CA1, and CA3 (Cornea-Hebert *et al.*, 1999; Morilak *et al.*, 1993; Pompeiano *et al.*, 1994; Shen & Andrade, 1998; Luttgen *et al.*, 2004; Morilak *et al.*, 1994). 5-HT$_{2A}$ receptor agonists, including PSOP, stimulate arachidonic acid (AA) and consequently, the phosphoinositide (PI) pathway resulting in the activation of protein kinase C (PKC) (Kurrasch-Orbaugh *et al.*, 2003; Ananth *et al.*, 1987). Electrophysiological evidence suggests that 5-HT$_{2A}$ receptors stimulate GABAergic interneurons in the HPC (Shen & Andrade, 1998) and GABAergic interneurons in the hilus form connections with progenitor cells in the SGZ (Wang *et al.*, 2005).

The present study aimed to investigate the effects of the 5-HT$_{2A}$ receptor agonist PSOP on hippocampal-dependent learning. Mice received a single injection of psilocybin (0.1, 0.5, 1.0 or 1.5 mg/kg), 1.0 mg/kg ketanserin (a 5-HT$_{2A/C}$ antagonist) or saline 24 hours before habituation to the environment and subsequent training and testing on the trace fear conditioning task.

Materials and Methods

Subjects

C57BL/6J male mice (30-40g) were housed in standard laboratory cages and left undisturbed for 1 week after arrival at the animal facility. All mice had unlimited access to water and laboratory chow and were maintained in a temperature and humidity controlled room on a 12:12 light/dark cycle with light onset at 7:00 AM. All National Institutes for Health (NIH) guidelines for the Care and Use of Laboratory Animals were followed (National Institutes of Health, 2002).

General Procedure

Mice (n=9-10/condition) received an intraperitoneal (i.p.) injection of PSOP (0.1 mg/kg, 0.5 mg/kg, 1.0 mg/kg, 1.5 mg/kg), ketanserin (1.0 mg/kg) or 0.9% saline and 24 h later were habituated to the testing chamber for 30 min. The fear conditioning environment consisted of two chambers each placed inside a larger soundproof chamber. The 35.6 (W) x 38.1 (D) x 31.8 (H) cm freeze monitor box (San Diego Instruments, San Diego, CA) is a clear Plexiglas chamber with a removable lid which contains a metal grid floor (0.3 cm grids spaced 0.8 cm apart) through which a foot shock can be delivered. Photobeam activity within the chamber recorded the vertical and horizontal movements of mice. Two minutes into the habituation period a baseline (BL) measure of movement was recorded for 3 minutes and served as the habituation BL measure. Freeze monitor boxes were cleaned with quatricide between each mouse to prevent olfactory cues. Mice were returned to their home cage after habituation.

The next day mice were returned to the same freeze monitor chamber and underwent training to form CS - US associations. After a 2 minute acclimation period, mice were exposed to 10 trials of trace fear conditioning which is illustrated in Figure 3.1. Each trial consisted of the CS (tone, 82 dB, 15 s) followed by a trace interval (30 s) and ended with the presentation of the US (shock, 0.5 s, 1 mA) delivered through the grid flooring. After each trial ended there was a 210 s intertrial interval (ITI). Freeze monitor boxes were cleaned with quatricide between each mouse to prevent olfactory cues and mice were returned to their home cage after training.

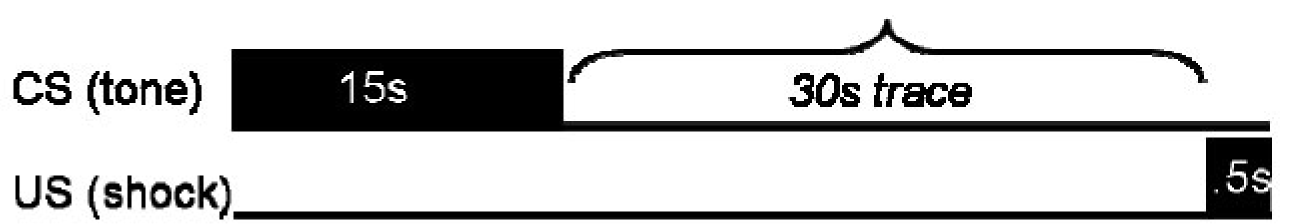


Figure 3.1. Schematic representation of the Trace Fear Conditioning Paradigm. Trace fear conditioning is a hippocampal-dependent task in which the presentation of the conditioned stimulus (CS, tone) is separated in time by a trace interval to the unconditioned stimulus (US, shock).

On day 3 of the task, testing of the fear conditioning response was assessed in 2 phases. First, mice were placed in the freeze monitor box for 5 minutes and movement was recorded for the last 3 minutes and used to assess the measure of fear associated to the training context. Mice were then returned to the home cage for 1 hour. Second, the context was altered by replacing the grid floors with black Plexiglas flooring and adding a cotton ball with 1ml vanilla essence inside the sound attenuated chamber. Mice were placed inside the novel chamber and after 2 minutes, movements were recorded for the next 3 minutes. Next 10 trials with the presentation of the CS only were delivered with an ITI of 240 s. Cue fear conditioning was measure by the percent freezing during the CS (tone; 15s), during the trace interval (30s) and after the trace when the US would have occurred. Conditioned fear was defined as an increase in percent immobility during the cue test. Percent immobility was calculated by dividing time spent immobile during stimuli (CS, trace or after trace) by the length of time the stimuli lasted multiplied by 100.

Design and analyses

Separate two-way repeated measure analyses of variance (ANOVA) were used to evaluate the effect of Dose and Trial on each dependent variable in the trace fear conditioning task. Dependent measures recorded included percent freezing during CS, during trace, after trace, during habituation BL, during the context test and in response to the novel environment. When appropriate, post hoc analyses such as Bonforreoni were used to isolate effects. All statistical analyses will be determined significant at the 0.05 alpha level.

Results

Acquisition

The acquisition of the freezing response is displayed in Figure 3.2 showing both the response to the CS (Figure 3.2A) and during the trace (Figure 3.2B). Using percent immobility in response to the CS for the first 3 trials of training, ANOVA showed that regardless of drug treatment there was a significant improvement across trial [$F(2, 108) = 40.0$, $p<0.0001$]. Specifically, immobility in response to the CS increased from trial 1 to trial 3 indicating the learned association between the stimuli during training ($p<0.05$). Additionally, ANOVA of the percent immobility during the trace interval revealed a significant effect of trial [$F(2, 108) = 20.0$, $p<0.0001$]. There was a striking increase in the amount of time spent immobile during the trace period from trial 1 to trial 3 demonstrating that the association between the CS and US promoted immobility in anticipation of the shock.

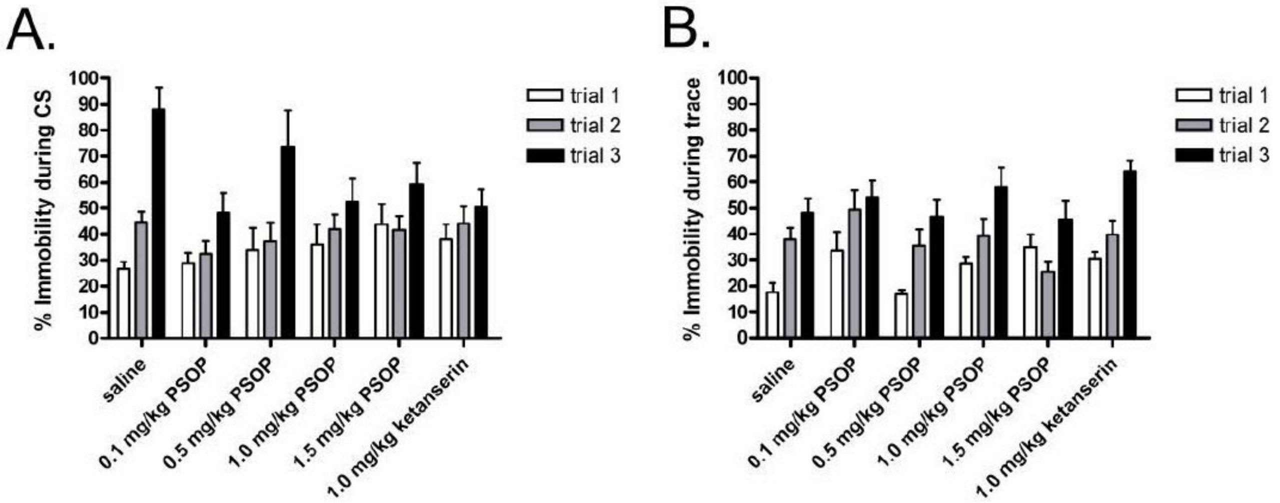


Figure 3.2. Effects of Psilocybin on the Acquisition of Trace Fear Conditioning. Mice underwent training to form CS - US associations by exposure to 10 trials of trace fear conditioning. Each trial consisted of the presentation of the CS (tone, 15-s) followed by a trace interval (30-s) and ended with the US (shock, 0.5-s). A) Percent immobility during presentation of the 15-s CS during the first three trials of CS - US pairing. B) Percent immobility during the 30-s trace interval during the first three trials of CS - US pairing.

Contextual Fear Conditioning

Contextual fear conditioning was assessed by comparing percent immobility in the freeze monitor box on habituation day to percent immobility during the context test. There was no interaction between Dose and Trial [$F(5,90) = 0.95$, $p=0.45$] and no effect of Dose during the habituation BL or context test [$F(5,90) = 1.15$, $p=0.34$]. However, there was a significant effect of Trial [$F(1,90) = 105.85$, $p<0.0001$] indicating that mice spent significantly more time freezing after the CS - US pairings during the context test compared to habituation BL. Figure 3.3 illustrates percent immobility during exposure to the freeze monitor box during the habituation test (A) and during the contextual fear conditioning test (B).

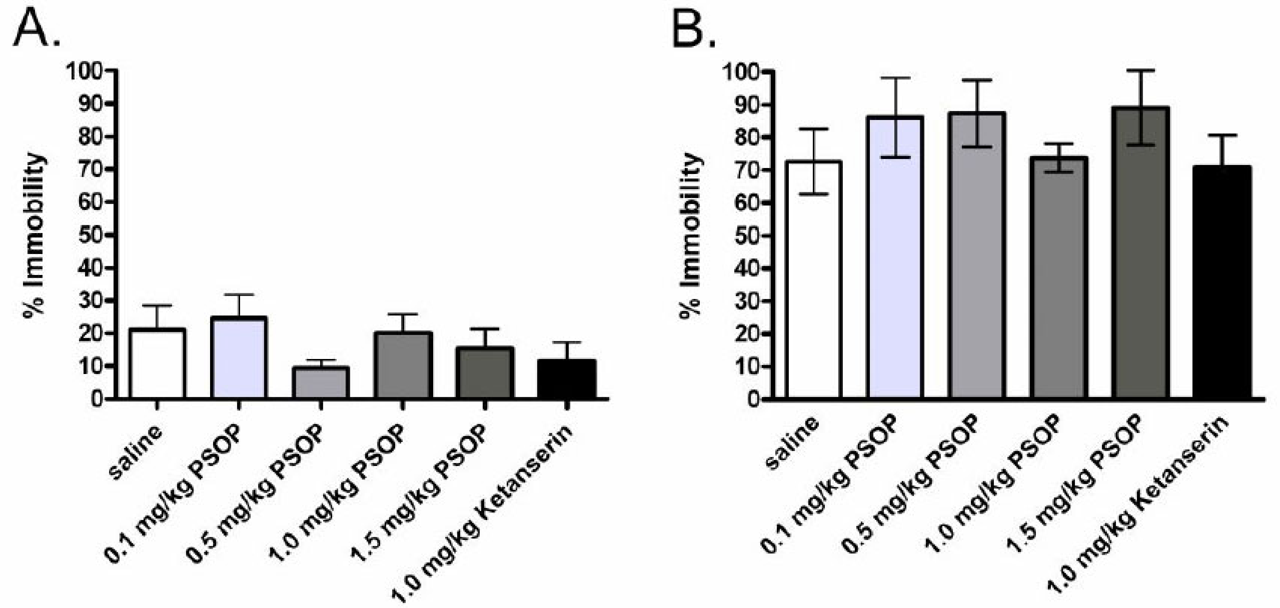


Figure 3.3. Contextual Fear Conditioning. Percent immobility expressed during exposure to the freeze monitor box during habituation (A) and during contextual fear conditioning (B). All mice expressed contextual fear conditioning as indicated by a significant increase in percent immobility during the context test ($p<0.05$).

Cue Fear Conditioning

Freezing responses (% immobility) during the CS only (tone) test are illustrated in Figure 3.4. There was a significant effect of Trial [$F(2,102) = 7.83$, $p<0.0007$] with trials 2 and 3 eliciting significantly more freezing in response to the CS compared to trial 1 (Figure 3.4A). There was also a significant effect of Dose [$F(5,51) = 4.96$, $p<0.0009$] revealing that control mice showed a greater fear response to the cue compared to 0.1 mg/kg

PSOP, 1.0 mg/kg PSOP, 1.5 mg/kg PSOP and 1.0 mg/kg ketanserin. ANOVA revealed a significant effect of Dose during the trace interval [$F(5,51) = 2.41$, $p<0.05$]. The fear associated with the trace interval during the first three trials on test day was reduced in mice treated with 1.0 mg/kg PSOP compared to saline and 1.5 mg/kg PSOP (Figure 3.4B). Figure 3.4C illustrates the fear response after the trace interval which coincides with the timing the US (shock) was delivered during the acquisition of the CS - US pairing phase. A two-way repeated measures ANOVA revealed a significant interaction between Dose and Trial [$F(10,100) = 3.53$, $p<0.0005$]. Interestingly, mice administered low doses of PSOP (0.1 and 0.5 mg/kg) froze more on trial 1 compared to trial 2 and 3 suggesting they are more apt to adapt to the absence of the US so that the fear response is diminished as the US is extinguished. This pattern was reversed in mice treated with ketanserin who increased fear responses from trials 1 to 3, indicating the robust memory for the US even in its absence. Taken together, these data suggest differential effects of PSOP on trace fear conditioning.

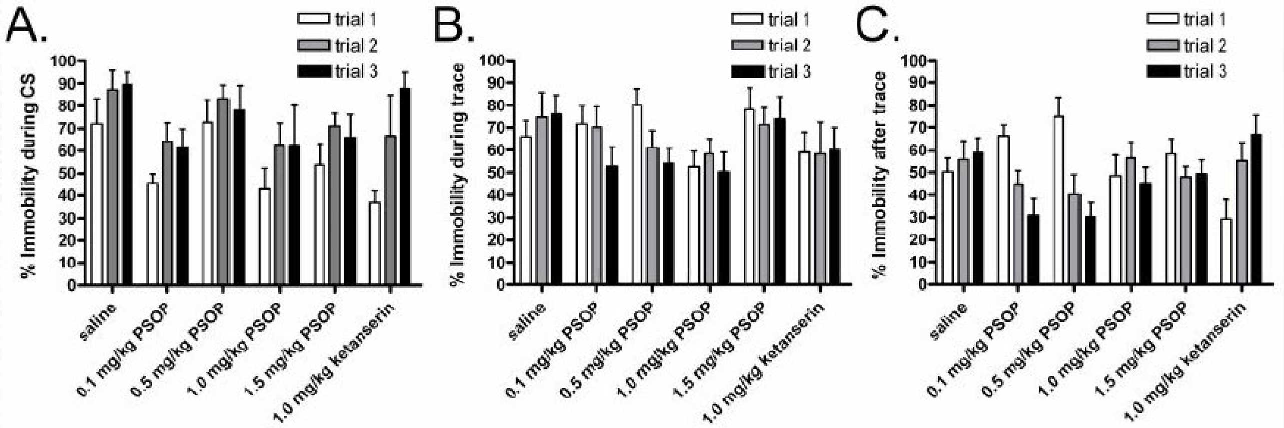


Figure 3.4. Effect of Acute PSOP on Cue Fear Conditioning. Cue fear conditioning was examined 24 hours after the training period in which mice were exposed to 10 trials of CS - US pairings. A) Percent immobility during presentation of the 15-s CS during the first three CS-only trials. B) Percent immobility during the 30-s trace interval during the first three trials. C) Percent immobility after the trace interval which coincides with the timing the US (shock) was delivered during the acquisition of the CS - US pairing phase.

Discussion

The present investigation illustrates the involvement of the 5-HT$_{2A}$ receptor in trace fear conditioning, a hippocampal-dependent learning task. During the acquisition of the freezing response there was a striking increase in the amount of time spent freezing during the presentation of the CS and during the trace period from trial 1 to trial 3 (see Figure 3.2). These data demonstrate that the association between the CS and US promoted freezing in anticipation of the shock, however, the acquisition of learning was not altered by acute administration of PSOP or ketanserin.

All conditions displayed similar locomotor activity levels in the freeze monitor box during the habituation baseline exposure and during re-exposure to the same environment during the contextual fear conditioning test. As expected mice froze substantially more during re-exposure to the same context after CS - US associations were formed compared to the habituation baseline, indicating that all groups formed contextual fear conditioning (Figure 3.3). It is well known that contextual fear conditioning is a hippocampal-dependent learning task (Kim & Fanselow, 1992; McNish *et al.*, 1997; Hirsh, 1974; Esclassan *et al.*, 2008; Frohardt *et al.*, 1999). The serotonergic system has been implicated in performance on the contextual fear conditioning task (Dai *et al.*, 2008). The present investigation found that the 5-HT$_{2A}$ receptor does not alter contextual fear conditioning since no differences were observed between controls and mice treated with PSOP or ketanserin.

The current study reports alterations in cue associated fear conditioning mediated by the 5-HT$_{2A}$ receptor. Independent of drug administered all mice developed cue-induced freezing during the presentation of the tone on the CSonly trial (see Figure 3.4). At the time coinciding with the expected US (shock) presentation low doses of PSOP (0.1 and 0.5 mg/kg) elicited a heightened freezing response on trial 1 compared to other trials suggesting they are more apt to adapt to the absence of the US so that the fear response is diminished as the US is extinguished. This pattern was reversed in mice treated with ketanserin who increased fear responses from trials 1 to 3, indicating the robust memory for the US even in its absence.

Synaptic plasticity in the HPC is critical for the acquisition of learning and memory. Brain derived neurotropic factor (BDNF) has been implicated in synaptic plasticity and memory processing (Kang *et al.*, 1997; Pang *et al.*, 2004; Tyler *et al.*, 2002) through the modulation of synapse formation and dendritic spine growth in the HPC (Bamji *et al.*, 2006; Tyler & Pozzo-Miller, 2001; Tyler & Pozzo-Miller, 2003). Chronic administration of 5-HT agonists (including SSRIs) upregulate BDNF mRNA expression in the HPC (Nibuya *et al.*, 1995; Nibuya *et al.*, 1996).

Evidence suggests that the 5-HT$_{2A}$ receptor is involved in the regulation of BDNF in the HPC (Vaidya *et al.*, 1997). Specifically DOI, a 5-HT$_{2A/C}$ receptor agonist decreased BDNF mRNA expression in the granule cell layer of the DG but not in the CA subfields of the HPC. Interestingly, the decrease in BDNF mRNA expression was blocked by the 5-HT$_{2A}$ receptor antagonist but not the 5-HT$_{2C}$ receptor antagonist, implicating the 5-HT$_{2A}$ receptor in the regulation of BDNF expression (Vaidya *et al.*, 1997).

5-HT$_{2A}$ receptors are highly expressed throughout the HPC in the DG, hilus, CA1, and CA3 and are colocalized on GABAergic neurons, pyramidal and granular cells (Cornea-Hebert *et al.*, 1999; Morilak *et al.*, 1993; Pompeiano *et al.*, 1994; Shen & Andrade, 1998; Luttgen *et al.*, 2004; Morilak *et al.*, 1994). Agonists to the 5-HT$_{2A}$ receptor stimulate AA and consequently, the PI pathway resulting in the activation of PKC (Kurrasch-Orbaugh *et al.*, 2003; Ananth *et al.*, 1987). Electrophysiological evidence suggests that 5-HT$_{2A}$ receptors stimulate GABAergic interneurons in the HPC (Shen & Andrade, 1998). Aberrations in GABAergic function in the HPC has been implicated in learning and memory due to the role of hippocampal GABA in temporospatial integration (Wallenstein *et al.*, 1998).

Taken together, the data reported in the present investigation implicate the 5-HT$_{2A}$ receptor in hippocampal-dependent learning. The present study reports that prior exposure to PSOP altered responsivity in a novel environment indicating an absence of a fear response, an effect not elicited by control mice. Furthermore, low doses of PSOP heightened cue elicited fear conditioning and antagonists to the 5-HT$_{2A/C}$ receptor diminished fear conditioning to the cue. Results of this study raise the possibility that 5-HT$_{2A}$ receptor activity could lead alterations hippocampal-dependent learning and memory.

Acknowledgments

This work was supported by the Helen Ellis Research Endowment (JSR). Thanks to Dr Francisco Moreno from University of Arizona and Rick Doblin Ph.D. of the Multidisciplinary Association for Psychedelic Studies (MAPS) for donating the PSOP.

Reference List

1. Aimone, J. B., Wiles, J., & Gage, F. H. (2006). Potential role for adult neurogenesis in the encoding of time in new memories. *Nat.Neurosci.*, 9,723-727.
2. Altman, J. (1962). Are new neurons formed in the brains of adult mammals? *Science*, 135, 1127-1128.
3. Altman, J (1969). Autoradiographic and histological studies of postnatal neurogenesis. IV. Cell proliferation and migration in the anterior forebrain, with special reference to persisting neurogenesis in the olfactory bulb. *J.Comp Neurol.*, 137, 433-457.
4. Altman, J. (1963). Autoradiographic investigation of cell proliferation in the brains of rats and cats. *Anat.Rec.*, 145, 573-591.
5. Altman, J. & Das, G. D. (1965). Autoradiographic and histological evidence of postnatal hippocampal neurogenesis in rats. *J.Comp Neurol.*, 124, 319-335.
6. Ambrogini, P., Lattanzi, D., Ciuffoli, S., Agostini, D., Bertini, L., Stocchi, V. *et al.* (2004). Morpho-functional characterization of neuronal cells at different stages of maturation in granule cell layer of adult rat dentate gyrus. *Brain Res.*, 1017, 21-31.
7. Ananth, U. S., Leli, U., & Hauser, G. (1987). Stimulation of phosphoinositide hydrolysis by serotonin in C6 glioma cells. *J.Neurochem.*, 48, 253-261.
8. Azmitia, E. C. & Segal, M. (1978). An autoradiographic analysis of the differential ascending projections of the dorsal and median raphe nuclei in the rat. *J.Comp Neurol.*, 179, 641-667.
9. Bamji, S. X., Rico, B., Kimes, N., & Reichardt, L. F. (2006). BDNF mobilizes synaptic vesicles and enhances synapse formation by disrupting cadherin-beta-catenin interactions. *J.Cell Biol.*, 174, 289-299.
10. Banasr, M., Hery, M., Printemps, R., & Daszuta, A. (2004). Serotonin-induced increases in adult cell proliferation and neurogenesis are mediated through different and common 5-HT receptor subtypes in the dentate gyrus and the subventricular zone. *Neuropsychopharmacology*, 29, 450-460.
11. Barnes, N. M. & Sharp, T. (1999). A review of central 5-HT receptors and their function. *Neuropharmacology*, 38, 1083-1152.
12. Bernier, P. J., Bedard, A., Vinet, J., Levesque, M., & Parent, A. (2002). Newly generated neurons in the amygdala and adjoining cortex of adult primates. *Proc.Natl.Acad.Sci.U.S.A*, 99, 11464-11469.

13. Bizon, J. L. & Gallagher, M. (2003). Production of new cells in the rat dentate gyrus over the lifespan: relation to cognitive decline. *Eur.J.Neurosci.*, 18,215-219.
14. Bjarkam, C. R., Sorensen, J. C., & Geneser, F. A. (2003). Distribution and morphology of serotonin-immunoreactive axons in the hippocampal region of the New Zealand white rabbit. I. Area dentata and hippocampus. Hippocampus, 13, 21-37
15. Braden, M. R., Parrish, J. C., Naylor, J. C., & Nichols, D. E. (2006). Molecular interaction of serotonin 5-HT$_{2A}$ receptor residues Phe339(6.51) and Phe340(6.52) with superpotent N-benzyl phenethylamine agonists. *Mol.Pharmacol.*, 70, 1956-1964.
16. Brandt, M. D., Jessberger, S., Steiner, B., Kronenberg, G., Reuter, K., Bick-Sander, A. *et al.* (2003). Transient calretinin expression defines early postmitotic step of neuronal differentiation in adult hippocampal neurogenesis of mice. *Mol.Cell Neurosci.*, 24, 603-613.
17. Brezun, J. M. & Daszuta, A. (1999). Depletion in serotonin decreases neurogenesis in the dentate gyrus and the subventricular zone of adult rats. *Neuroscience*, 89, 999-1002.
18. Brezun, J. M. & Daszuta, A. (2000). Serotonin may stimulate granule cell proliferation in the adult hippocampus, as observed in rats grafted with foetal raphe neurons. *Eur.J.Neurosci.*, 12, 391-396.
19. Brown, J., Cooper-Kuhn, C. M., Kempermann, G., Van, P. H., Winkler, J., Gage, F. H. *et al.* (2003). Enriched environment and physical activity stimulate hippocampal but not olfactory bulb neurogenesis. *Eur.J.Neurosci.*, 17,2042-2046.
20. Buckholtz, N. S., Freedman, D. X., & Middaugh, L. D. (1985). Daily LSD administration selectively decreases serotonin2 receptor binding in rat brain. *Eur.J.Pharmacol.*, 109, 421-425.
21. Buckholtz, N. S., Zhou, D. F., & Freedman, D. X. (1988). Serotonin2 agonist administration down-regulates rat brain serotonin2 receptors. *Life Sci.*, 42,2439-2445.
22. Buckholtz, N. S., Zhou, D. F., Freedman, D. X., & Potter, W. Z. (1990). Lysergic acid diethylamide (LSD) administration selectively downregulates serotonin2 receptors in rat brain. *Neuropsychopharmacology*, 3, 137-148.
23. Cahill, L. & McGaugh, J. L. (1998). Mechanisms of emotional arousal and lasting declarative memory. *Trends Neurosci.*, 21, 294-299.
24. Cameron, H. A. & McKay, R. D. (1999). Restoring production of hippocampal neurons in old age. *Nat.Neurosci.*, 2, 894-897.
25. Cameron, H. A., Woolley, C. S., & Gould, E. (1993). Adrenal steroid receptor immunoreactivity in cells born in the adult rat dentate gyrus. *Brain Res.*, 611, 342-346.
26. Carro, E., Nunez, A., Busiguina, S., & Torres-Aleman, I. (2000). Circulating insulin-like growth factor I mediates effects of exercise on the brain. *J.Neurosci.*, 20, 2926-2933.
27. Carro, E., Trejo, J. L., Busiguina, S., & Torres-Aleman, I. (2001). Circulating insulin-like growth factor I mediates the protective effects of physical exercise against brain insults of different etiology and anatomy. *J.Neurosci.*, 21, 5678-5684.
28. Cerletti, A. (1959). [Teonanacatl and psilocybin.]. *Dtsch.Med.Wochenschr.*, 84,2317-2321.
29. Cerletti, A. & Konzett, H. (1956). [Specific inhibition of serotonin effects by lysergic acid diethylamide and similar compounds.]. *Naunyn Schmiedebergs Arch.Exp.Pathol.Pharmakol.*, 228, 146-148.
30. Cheng, A., Wang, S., Cai, J., Rao, M. S., & Mattson, M. P. (2003). Nitric oxide acts in a positive feedback loop with BDNF to regulate neural progenitor cell proliferation and differentiation in the mammalian brain. *Dev.Biol.*, 258,319-333.
31. Clemett, D. A., Punhani, T., Duxon, M. S., Blackburn, T. P., & Fone, K. C. (2000). Immunohistochemical localisation of the 5-HT$_{2C}$ receptor protein in the rat CNS. *Neuropharmacology*, 39, 123-132.
32. Cornea-Hebert, V., Riad, M., Wu, C., Singh, S. K., & Descarries, L. (1999). Cellular and subcellular distribution of the serotonin 5-HT$_{2A}$ receptor in the central nervous system of adult rat. *J.Comp Neurol.*, 409, 187-209.
33. Corotto, F. S., Henegar, J. A., & Maruniak, J. A. (1993). Neurogenesis persists in the subependymal layer of the adult mouse brain. *Neurosci.Lett.*, 149,111-114.
34. D'Sa, C. & Duman, R. S. (2002). Antidepressants and neuroplasticity. *Bipolar.Disord.*, 4, 183-194.
35. Dai, J. X., Han, H. L., Tian, M., Cao, J., Xiu, J. B., Song, N. N. *et al.* (2008). Enhanced contextual fear memory in central serotonin-deficient mice. *Proc.Natl.Acad.Sci.U.S.A*, 105, 11981-11986.
36. Djavadian, R. L., Wielkopolska, E., Bialoskorska, K., & Turlejski, K. (1999). Localization of the 5-HT$_{1A}$ receptors in the brain of opossum Monodelphis domestica. *Neuroreport*, 10, 3195-3200.
37. Ehninger, D. & Kempermann, G. (2003). Regional effects of wheel running and environmental enrichment on cell genesis and microglia proliferation in the adult murine neocortex. *Cereb.Cortex*, 13, 845-851.
38. El, M. S., Taussig, D., Gozlan, H., Emerit, M. B., Ponchant, M., & Hamon, M. (1989). Chromatographic analyses of the serotonin 5-HT$_{1A}$ receptor solubilized from the rat hippocampus. *J.Neurochem.*, 53, 1555-1566.
39. Eriksson, P. S., Perfilieva, E., Bjork-Eriksson, T., Alborn, A. M., Nordborg, C., Peterson, D. A. *et al.* (1998). Neurogenesis in the adult human hippocampus. *Nat.Med.*, 4, 1313-1317.
40. Esclassan, F., Coutureau, E., Di, S. G., & Marchand, A. R. (2008). Differential contribution of dorsal and ventral hippocampus to trace and delay fear conditioning. *Hippocampus*.
41. Fabel, K., Fabel, K., Tam, B., Kaufer, D., Baiker, A., Simmons, N. *et al.* (2003). VEGF is necessary for exercise-induced adult hippocampal neurogenesis. *Eur.J.Neurosci.*, 18, 2803-2812.
42. Farmer, J., Zhao, X., Van, P. H., Wodtke, K., Gage, F. H., & Christie, B. R. (2004). Effects of voluntary exercise on synaptic plasticity and gene expression in the dentate gyrus of adult male Sprague-Dawley rats in vivo. *Neuroscience*, 124, 71-79.
43. Feldberg, W. & Myers, R. D. (1964). Effects on temperature of amines injected into the cerebral ventricles. A new concept of temperature regulation. *J.Physiol*, 173, 226-231.
44. Filippov, V., Kronenberg, G., Pivneva, T., Reuter, K., Steiner, B., Wang, L. P. *et al.* (2003). Subpopulation of nestin-expressing progenitor cells in the adult murine hippocampus shows electrophysiological and morphological characteristics of astrocytes. *Mol.Cell Neurosci.*, 23, 373-382.
45. Flood, J. F. & Cherkin, A. (1987). Fluoxetine enhances memory processing in mice. *Psychopharmacology (Berl)*, 93, 36-43.
46. Frohardt, R. J., Guarraci, F. A., & Young, S. L. (1999). Intrahippocampal infusions of a metabotropic glutamate receptor antagonist block the memory of context-specific but not tone-specific conditioned fear. *Behav.Neurosci.*, 113, 222-227.
47. Fuchs, E. & Weber, K. (1994). Intermediate filaments: structure, dynamics, function, and disease. *Annu.Rev.Biochem.*, 63, 345-382.

48. Fukuda, S., Kato, F., Tozuka, Y., Yamaguchi, M., Miyamoto, Y., & Hisatsune, T. (2003). Two distinct subpopulations of nestin-positive cells in adult mouse dentate gyrus. *J.Neurosci.*, 23, 9357-9366.
49. Gould, E., Beylin, A., Tanapat, P., Reeves, A., & Shors, T. J. (1999a). Learning enhances adult neurogenesis in the hippocampal formation. *Nat.Neurosci.*, 2, 260-265.
50. Gould, E., Cameron, H. A., Daniels, D. C., Woolley, C. S., & McEwen, B. S. (1992). Adrenal hormones suppress cell division in the adult rat dentate gyrus. *J.Neurosci.*, 12, 3642-3650.
51. Gould, E., McEwen, B. S., Tanapat, P., Galea, L. A., & Fuchs, E. (1997). Neurogenesis in the dentate gyrus of the adult tree shrew is regulated by psychosocial stress and NMDA receptor activation. *J.Neurosci.*, 17, 2492-2498.
52. Gould, E., Reeves, A. J., Graziano, M. S., & Gross, C. G. (1999b). Neurogenesis in the neocortex of adult primates. *Science*, 286, 548-552.
53. Gould, E., Tanapat, P., Hastings, N. B., & Shors, T. J. (1999c). Neurogenesis in adulthood: a possible role in learning. *Trends Cogn Sci.*, 3, 186-192.
54. Halasy, K. & Somogyi, P. (1993). Subdivisions in the multiple GABAergic innervation of granule cells in the dentate gyrus of the rat hippocampus. *Eur.J.Neurosci.*, 5, 411-429.
55. Hirsh, R. (1974). The hippocampus and contextual retrieval of information from memory: a theory. *Behav.Biol.*, 12, 421-444.
56. Hofmann, A., FREY, A., OTT, H., PETR, Z. T., & TROXLER, F. (1958a). [Elucidation of the structure and the synthesis of psilocybin.]. *Experientia*, 14, 397-399.
57. Hofmann, A., HEIM, R., BRACK, A., & KOBEL, H. (1958b). [Psilocybin, a psychotropic substance from the Mexican mushroom Psilocybe mexicana Heim.]. *Experientia*, 14, 107-109.
58. Huang, L., DeVries, G. J., & Bittman, E. L. (1998). Photoperiod regulates neuronal bromodeoxyuridine labeling in the brain of a seasonally breeding mammal. *J.Neurobiol.*, 36, 410-420.
59. Huang, S. C., Tsai, S. J., & Chang, J. C. (2004). Fluoxetine-induced memory impairment in four family members. *Int.J.Psychiatry Med.*, 34, 197-200.
60. Jacobs, B. L. & Azmitia, E. C. (1992). Structure and function of the brain serotonin system. *Physiol Rev.*, 72, 165-229.
61. Jacobs, B. L., Praag, H., & Gage, F. H. (2000). Adult brain neurogenesis and psychiatry: a novel theory of depression. *Mol.Psychiatry*, 5, 262-269.
62. Jha, S., Rajendran, R., Fernandes, K. A., & Vaidya, V. A. (2008). 5-HT$_{2A/2C}$ receptor blockade regulates progenitor cell proliferation in the adult rat hippocampus. *Neurosci.Lett.*, 441, 210-214.
63. Jouvet, M. (1967). Neurophysiology of the states of sleep. *Physiol Rev.*, 47, 117-177.
64. Kang, H., Welcher, A. A., Shelton, D., & Schuman, E. M. (1997). Neurotrophins and time: different roles for TrkB signaling in hippocampal long-term potentiation. *Neuron*, 19, 653-664.
65. Kaplan, M. S. & Hinds, J. W. (1977). Neurogenesis in the adult rat: electron microscopic analysis of light radioautographs. *Science*, 197, 1092-1094.
66. Kempermann, G., Kuhn, H. G., & Gage, F. H. (1997). More hippocampal neurons in adult mice living in an enriched environment. *Nature*, 386, 493-495.
67. Kempermann, G., Kuhn, H. G., & Gage, F. H. (1998). Experience-induced neurogenesis in the senescent dentate gyrus. *J.Neurosci.*, 18, 3206-3212.
68. Kim, J. J. & Fanselow, M. S. (1992). Modality-specific retrograde amnesia of fear. *Science*, 256, 675-677.
69. King, A. R., Martin, I. L., & Melville, K. A. (1974). Reversal learning enhanced by lysergic acid diethylamide (LSD): concomitant rise in brain 5-hydroxytryptamine levels. *Br.J.Pharmacol.*, 52, 419-426.
70. King, A. R., Martin, I. L., & Seymour, K. A. (1972). Reversal learning facilitated by a single injection of lysergic acid diethylamide (LSD 25) in the rat. *Br.J.Pharmacol.*, 45, 161P-162P.
71. Kinsey, A. M., Wainwright, A., Heavens, R., Sirinathsinghji, D. J., & Oliver, K. R. (2001). Distribution of 5-ht(5A), 5-ht(5B), 5-ht(6) and 5-HT(7) receptor mRNAs in the rat brain. *Brain Res.Mol.Brain Res.*, 88, 194-198.
72. Koenig, J., Cosquer, B., & Cassel, J. C. (2008). Activation of septal 5-HT$_{1A}$ receptors alters spatial memory encoding, interferes with consolidation, but does not affect retrieval in rats subjected to a water-maze task. Hippocampus, 18, 99-118.
73. Kronenberg, G., Reuter, K., Steiner, B., Brandt, M. D., Jessberger, S., Yamaguchi, M. *et al.* (2003). Subpopulations of proliferating cells of the adult hippocampus respond differently to physiologic neurogenic stimuli. *J.Comp Neurol.*, 467, 455-463.
74. Kuhn, H. G., ckinson-Anson, H., & Gage, F. H. (1996). Neurogenesis in the dentate gyrus of the adult rat: age-related decrease of neuronal progenitor proliferation. *J.Neurosci.*, 16, 2027-2033.
75. Kurrasch-Orbaugh, D. M., Parrish, J. C., Watts, V. J., & Nichols, D. E. (2003). A complex signaling cascade links the serotonin2A receptor to phospholipase A2 activation: the involvement of MAP kinases. *J.Neurochem.*, 86, 980-991.
76. Lee, J., Duan, W., Long, J. M., Ingram, D. K., & Mattson, M. P. (2000). Dietary restriction increases the number of newly generated neural cells, and induces BDNF expression, in the dentate gyrus of rats. *J.Mol.Neurosci.*, 15, 99-108.
77. Lee, J., Duan, W., & Mattson, M. P. (2002). Evidence that brain-derived neurotrophic factor is required for basal neurogenesis and mediates, in part, the enhancement of neurogenesis by dietary restriction in the hippocampus of adult mice. *J.Neurochem.*, 82, 1367-1375.
78. Leger, L., Charnay, Y., Hof, P. R., Bouras, C., & Cespuglio, R. (2001). Anatomical distribution of serotonin-containing neurons and axons in the central nervous system of the cat. *J.Comp Neurol.*, 433, 157-182.
79. Leibowitz, S. F. & Shor-Posner, G. (1986). Brain serotonin and eating behavior. *Appetite, 7 Suppl*, 1-14.
80. Lemaire, V., Koehl, M., Le, M. M., & Abrous, D. N. (2000). Prenatal stress produces learning deficits associated with an inhibition of neurogenesis in the hippocampus. *Proc.Natl.Acad.Sci.U.S.A*, 97, 11032-11037.
81. Lichtenwalner, R. J., Forbes, M. E., Bennett, S. A., Lynch, C. D., Sonntag, W. E., & Riddle, D. R. (2001). Intracerebroventricular infusion of insulin-like growth factor-I ameliorates the age-related decline in hippocampal neurogenesis. *Neuroscience*, 107, 603-613.
82. Lu, L., Bao, G., Chen, H., Xia, P., Fan, X., Zhang, J. *et al.* (2003). Modification of hippocampal neurogenesis and neuroplasticity by social environments. *Exp.Neurol.*, 183, 600-609.

83. Lucki, I. (1992). 5-HT1 receptors and behavior. *Neurosci.Biobehav.Rev.*, 16, 83-93.
84. Luttgen, M., Ove, O. S., & Meister, B. (2004). Chemical identity of 5-HT_{2A} receptor immunoreactive neurons of the rat septal complex and dorsal hippocampus. *Brain Res.*, 1010, 156-165.
85. Malberg, J. E. & Duman, R. S. (2003). Cell proliferation in adult hippocampus is decreased by inescapable stress: reversal by fluoxetine treatment. *Neuropsychopharmacology*, 28, 1562-1571.
86. Malberg, J. E., Eisch, A. J., Nestler, E. J., & Duman, R. S. (2000). Chronic antidepressant treatment increases neurogenesis in adult rat hippocampus. *J.Neurosci.*, 20, 9104-9110.
87. McEchron, M. D., Bouwmeester, H., Tseng, W., Weiss, C., & Disterhoft, J. F. (1998). Hippocampectomy disrupts auditory trace fear conditioning and contextual fear conditioning in the rat. Hippocampus, 8, 638-646.
88. McKenna, D. J., Repke, D. B., Lo, L., & Peroutka, S. J. (1990). Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. *Neuropharmacology*, 29, 193-198.
89. McNish, K. A., Gewirtz, J. C., & Davis, M. (1997). Evidence of contextual fear after lesions of the hippocampus: a disruption of freezing but not fear-potentiated startle. *J.Neurosci.*, 17, 9353-9360.
90. Messier, B. & Leblond, C. P. (1960). Cell proliferation and migration as revealed by radioautography after injection of thymidine-H3 into male rats and mice. *Am.J.Anat.*, 106, 247-285.
91. Messier, B., Leblond, C. P., & Smart, I. (1958). Presence of DNA synthesis and mitosis in the brain of young adult mice. *Exp.Cell Res.*, 14, 224-226.
92. Meyer, G., Perez-Garcia, C. G., & Gleeson, J. G. (2002). Selective expression of doublecortin and LIS1 in developing human cortex suggests unique modes of neuronal movement. *Cereb.Cortex*, 12, 1225-1236.
93. Monnier, M. (1959). [The action of psilocybin on the rabbit brain.]. *Experientia*, 15, 321-323.
94. Moore, R. Y. & Halaris, A. E. (1975). Hippocampal innervation by serotonin neurons of the midbrain raphe in the rat. *J.Comp Neurol.*, 164, 171-183.
95. Morilak, D. A., Garlow, S. J., & Ciaranello, R. D. (1993). Immunocytochemical localization and description of neurons expressing serotonin2 receptors in the rat brain. *Neuroscience*, 54, 701-717.
96. Morilak, D. A., Somogyi, P., Lujan-Miras, R., & Ciaranello, R. D. (1994). Neurons expressing 5-HT_2 receptors in the rat brain: neurochemical identification of cell types by immunocytochemistry. *Neuropsychopharmacology*, 11,157-166.
97. Mullen, R. J., Buck, C. R., & Smith, A. M. (1992). NeuN, a neuronal specific nuclear protein in vertebrates. *Development*, 116, 201-211.
98. Nibuya, M., Morinobu, S., & Duman, R. S. (1995). Regulation of BDNF and trkB mRNA in rat brain by chronic electroconvulsive seizure and antidepressant drug treatments. *J.Neurosci.*, 15, 7539-7547.
99. Nibuya, M., Nestler, E. J., & Duman, R. S. (1996). Chronic antidepressant administration increases the expression of cAMP response element binding protein (CREB) in rat hippocampus. *J.Neurosci.*, 16, 2365-2372.
100. Nichols, D. E. (2004). Hallucinogens. *Pharmacol.Ther.*, 101, 131-181.
101. Nilsson, M., Perfilieva, E., Johansson, U., Orwar, O., & Eriksson, P. S. (1999). Enriched environment increases neurogenesis in the adult rat dentate gyrus and improves spatial memory. *J.Neurobiol.*, 39, 569-578.
102. Oh, M. S., Park, C., Huh, Y., Kim, H. Y., Kim, H., Kim, H. M. *et al*. (2006). The effects of BR003 on memory and cell proliferation in the dentate gyrus of rat hippocampus. *Biol.Pharm.Bull.*, 29, 813-816.
103. Pang, P. T., Teng, H. K., Zaitsev, E., Woo, N. T., Sakata, K., Zhen, S. *et al*. (2004). Cleavage of proBDNF by tPA/plasmin is essential for long-term hippocampal plasticity. *Science*, 306, 487-491.
104. Parent, A., Descarries, L., & Beaudet, A. (1981). Organization of ascending serotonin systems in the adult rat brain. A radioautographic study after intraventricular administration of [3H]5-hydroxytryptamine. *Neuroscience*, 6, 115-138.
105. Passie, T., Seifert, J., Schneider, U., & Emrich, H. M. (2002). The pharmacology of psilocybin. *Addict.Biol.*, 7, 357-364.
106. Pencea, V., Bingaman, K. D., Wiegand, S. J., & Luskin, M. B. (2001). Infusion of brain-derived neurotrophic factor into the lateral ventricle of the adult rat leads to new neurons in the parenchyma of the striatum, septum, thalamus, and hypothalamus. *J.Neurosci.*, 21, 6706-6717.
107. Pham, K., Nacher, J., Hof, P. R., & McEwen, B. S. (2003). Repeated restraint stress suppresses neurogenesis and induces biphasic PSA-NCAM expression in the adult rat dentate gyrus. *Eur.J.Neurosci.*, 17, 879-886.
108. Pinder, R. M. & Wieringa, J. H. (1993). Third-generation antidepressants. *Med.Res.Rev.*, 13, 259-325.
109. Pompeiano, M., Palacios, J. M., & Mengod, G. (1994). Distribution of the serotonin 5-HT_2 receptor family mRNAs: comparison between 5-HT_{2A} and 5-HT_{2C} receptors. *Brain Res.Mol.Brain Res.*, 23, 163-178.
110. Radley, J. J. & Jacobs, B. L. (2002). 5-HT_{1A} receptor antagonist administration decreases cell proliferation in the dentate gyrus. *Brain Res.*, 955, 264-267.
111. Ramirez, O. A. & Carrer, H. F. (1989). Correlation between threshold to induce long-term potentiation in the hippocampus and performance in a shuttle box avoidance response in rats. *Neurosci.Lett.*, 104, 152-156.
112. Ramon, Y. C. (1952). Structure and connections of neurons. *Bull.Los.Angel.Neuro.Soc.*, 17, 5-46.
113. Raymond, J. R., Mukhin, Y. V., Gelasco, A., Turner, J., Collinsworth, G., Gettys, T. W. *et al*. (2001). Multiplicity of mechanisms of serotonin receptor signal transduction. *Pharmacol.Ther.*, 92, 179-212.
114. Ribak, C. E., Seress, L., & Amaral, D. G. (1985). The development, ultrastructure and synaptic connections of the mossy cells of the dentate gyrus. *J.Neurocytol.*, 14, 835-857.
115. Saha, S. & Datta, S. (2005). Two-way active avoidance training-specific increases in phosphorylated cAMP response element-binding protein in the dorsal hippocampus, amygdala, and hypothalamus. *Eur.J.Neurosci.*, 21, 3403-3414.
116. Sahgal, A. & Mason, J. (1985). Drug effects on memory: assessment of a combined active and passive avoidance task. *Behav.Brain Res.*, 17, 251-255.
117. Santarelli, L., Saxe, M., Gross, C., Surget, A., Battaglia, F., Dulawa, S. *et al*. (2003). Requirement of hippocampal neurogenesis for the behavioral effects of antidepressants. *Science*, 301, 805-809.
118. Sarnyai, Z., Sibille, E. L., Pavlides, C., Fenster, R. J., McEwen, B. S., & Toth, M. (2000). Impaired hippocampal-dependent learning and functional abnormalities in the hippocampus in mice lacking serotonin(1A) receptors. *Proc.Natl.Acad.Sci.U.S.A*, 97, 14731-14736.

119. Scholzen, T. & Gerdes, J. (2000). The Ki-67 protein: from the known and the unknown. *J.Cell Physiol*, 182, 311-322.
120. Seki, T. & Arai, Y. (1995). Age-related production of new granule cells in the adult dentate gyrus. *Neuroreport*, 6, 2479-2482.
121. Seri, B., Garcia-Verdugo, J. M., Collado-Morente, L., McEwen, B. S., & varez-Buylla, A. (2004). Cell types, lineage, and architecture of the germinal zone in the adult dentate gyrus. *J.Comp Neurol.*, 478, 359-378.
122. Seri, B., Garcia-Verdugo, J. M., McEwen, B. S., & varez-Buylla, A. (2001). Astrocytes give rise to new neurons in the adult mammalian hippocampus. *J.Neurosci.*, 21, 7153-7160.
123. Sheard, M. H. (1969). The effect of p-chlorophenylalanine on behavior in rats: relation to brain serotonin and 5-hydroxyindoleacetic acid. *Brain Res.*, 15,524-528.
124. Shen, R. Y. & Andrade, R. (1998). 5-Hydroxytryptamine2 receptor facilitates GABAergic neurotransmission in rat hippocampus. *J.Pharmacol.Exp.Ther.*, 285, 805-812.
125. Shirayama, Y., Chen, A. C., Nakagawa, S., Russell, D. S., & Duman, R. S. (2002). Brain-derived neurotrophic factor produces antidepressant effects in behavioral models of depression. *J.Neurosci.*, 22, 3251-3261.
126. Shors, T. J., Miesegaes, G., Beylin, A., Zhao, M., Rydel, T., & Gould, E. (2001). Neurogenesis in the adult is involved in the formation of trace memories. *Nature*, 410, 372-376.
127. Shors, T. J., Townsend, D. A., Zhao, M., Kozorovitskiy, Y., & Gould, E. (2002). Neurogenesis may relate to some but not all types of hippocampal-dependent learning. Hippocampus, 12, 578-584.
128. Sidman, R. L., Miale, I. L., & Feder, N. (1959). Cell proliferation and migration in the primitive ependymal zone: an autoradiographic study of histogenesis in the nervous system. *Exp.Neurol.*, 1, 322-333.
129. Squire, L. R. (1992). Memory and the hippocampus: a synthesis from findings with rats, monkeys, and humans. *Psychol.Rev.*, 99, 195-231.
130. Squire, L. R., Ojemann, J. G., Miezin, F. M., Petersen, S. E., Videen, T. O., & Raichle, M. E. (1992). Activation of the hippocampus in normal humans: a functional anatomical study of memory. *Proc.Natl.Acad.Sci.U.S.A*, 89,1837-1841.
131. Tanapat, P., Hastings, N. B., Rydel, T. A., Galea, L. A., & Gould, E. (2001). Exposure to fox odor inhibits cell proliferation in the hippocampus of adult rats via an adrenal hormone-dependent mechanism. *J.Comp Neurol.*, 437,496-504.
132. Tecott, L. H., Maricq, A. V., & Julius, D. (1993). Nervous system distribution of the serotonin 5-HT3 receptor mRNA. *Proc.Natl.Acad.Sci.U.S.A*, 90, 1430-1434.
133. Thomas, E. A., Matli, J. R., Hu, J. L., Carson, M. J., & Sutcliffe, J. G. (2000). Pertussis toxin treatment prevents 5-HT(5a) receptor-mediated inhibition of cyclic AMP accumulation in rat C6 glioma cells. *J.Neurosci*.Res., 61,75-81.
134. Trejo, J. L., Carro, E., & Torres-Aleman, I. (2001). Circulating insulin-like growth factor I mediates exercise-induced increases in the number of new neurons in the adult hippocampus. *J.Neurosci.*, 21, 1628-1634.
135. Tyler, W. J., Alonso, M., Bramham, C. R., & Pozzo-Miller, L. D. (2002). From acquisition to consolidation: on the role of brain-derived neurotrophic factor signaling in hippocampal-dependent learning. *Learn.Mem.*, 9, 224-237.
136. Tyler, W. J. & Pozzo-Miller, L. (2003). Miniature synaptic transmission and BDNF modulate dendritic spine growth and form in rat CA1 neurones. *J.Physiol*, 553, 497-509.
137. Tyler, W. J. & Pozzo-Miller, L. D. (2001). BDNF enhances quantal neurotransmitter release and increases the number of docked vesicles at the active zones of hippocampal excitatory synapses. *J.Neurosci.*, 21,4249-4258.
138. Uittenbogaard, M. & Chiaramello, A. (2002). Constitutive overexpression of the basic helix-loop-helix Nex1/MATH-2 transcription factor promotes neuronal differentiation of PC12 cells and neurite regeneration. *J.Neurosci*.Res., 67, 235-245.
139. Ulloor, J. & Datta, S. (2005). Spatio-temporal activation of cyclic AMP response element-binding protein, activity-regulated cytoskeletal-associated protein and brain-derived nerve growth factor: a mechanism for pontine-wave generator activation-dependent two-way active-avoidance memory processing in the rat. *J.Neurochem.*, 95, 418-428.
140. Vaidya, V. A., Marek, G. J., Aghajanian, G. K., & Duman, R. S. (1997). 5-HT$_{2A}$ receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. *J.Neurosci.*, 17, 2785-2795.
141. Van der Zee, E. A. & Luiten, P. G. (1999). Muscarinic acetylcholine receptors in the hippocampus, neocortex and amygdala: a review of immunocytochemical localization in relation to learning and memory. *Prog.Neurobiol.*, 58, 409-471.
142. Van der, B. K., Meerlo, P., Luiten, P. G., Eggen, B. J., & Van der Zee, E. A. (2005). Effects of active shock avoidance learning on hippocampal neurogenesis and plasma levels of corticosterone. *Behav.Brain Res.*, 157,23-30.
143. Van, P. H., Christie, B. R., Sejnowski, T. J., & Gage, F. H. (1999a). Running enhances neurogenesis, learning, and long-term potentiation in mice. *Proc.Natl.Acad.Sci.U.S.A*, 96, 13427-13431.
144. Van, P. H., Kempermann, G., & Gage, F. H. (1999b). Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. *Nat.Neurosci.*, 2, 266-270.
145. Van, P. H., Schinder, A. F., Christie, B. R., Toni, N., Palmer, T. D., & Gage, F. H. (2002). Functional neurogenesis in the adult hippocampus. *Nature*, 415,1030-1034.
146. Van, R. J., Dikova, M., Werbrouck, L., Clincke, G., & Borgers, M. (1992). Synaptic plasticity in rat hippocampus associated with learning. *Behav.Brain Res.*, 51, 179-183.
147. Varrault, A., Bockaert, J., & Waeber, C. (1992). Activation of 5-HT$_{1A}$ receptors expressed in NIH-3T3 cells induces focus formation and potentiates EGF effect on DNA synthesis. *Mol.Biol.Cell*, 3, 961-969.
148. Vertes, R. P., Fortin, W. J., & Crane, A. M. (1999). Projections of the median raphe nucleus in the rat. *J.Comp Neurol.*, 407, 555-582.
149. Vilaro, M. T., Cortes, R., Gerald, C., Branchek, T. A., Palacios, J. M., & Mengod, G. (1996). Localization of 5-HT4 receptor mRNA in rat brain by in situ hybridization histochemistry. *Brain Res.Mol.Brain Res.*, 43, 356-360.
150. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F., Babler, A., Vogel, H., & Hell, D. (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport*, 9, 3897-3902.
151. Wallenstein, G. V., Eichenbaum, H., & Hasselmo, M. E. (1998). The hippocampus as an associator of discontiguous events. *Trends Neurosci.*, 21, 317-323.
152. Wang, L. P., Kempermann, G., & Kettenmann, H. (2005). A subpopulation of precursor cells in the mouse dentate gyrus receives synaptic GABAergic input. *Mol.Cell Neurosci.*, 29, 181-189.
153. Weiss, C., Bouwmeester, H., Power, J. M., & Disterhoft, J. F. (1999). Hippocampal lesions prevent trace eyeblink conditioning

in the freely moving rat. *Behav.Brain Res.*, 99, 123-132.

154. Winter, J. C., Rice, K. C., Amorosi, D. J., & Rabin, R. A. (2007). Psilocybin-induced stimulus control in the rat. *Pharmacol.Biochem.Behav.*, 87, 472-480.
155. Witter, M. P. (1993). Organization of the entorhinal-hippocampal system: a review of current anatomical data. Hippocampus, 3 Spec No, 33-44.
156. Zhao, C., Teng, E. M., Summers, R. G., Jr., Ming, G. L., & Gage, F. H. (2006). Distinct morphological stages of dentate granule neuron maturation in the adult mouse hippocampus. *J.Neurosci.*, 26, 3-11.

Restructuring consciousness - the psychedelic state in light of integrated information theory

by

Andrew R. Gallimore*

Computational Neuroscience Unit, Okinawa Institute of Science and Technology Graduate University, Okinawa, Japan

original report: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4464176/pdf/fnhum-09-00346.pdf
backup source: http://www.psilosophy.info/resources/fnhum-09-00346.pdf

Edited by: Hauke R. Heekeren,
Freie Universität Berlin, Germany

Reviewed by: Robin Carhart-Harris,
Imperial College London, UK Tom Froese, Universidad Nacional Autónoma de México, Mexico

*__Correspondence__: Andrew R. Gallimore,
Computational Neuroscience Unit, Okinawa Institute of Science and Technology Graduate University,
1919-1 Tancha, Onna-son, Okinawa 904-0495, Japan
gallimore@cantab.net

Received: 06 January 2015
Accepted: 29 May 2015
Published: 12 June 2015

Citation: Gallimore AR (2015) Restructuring consciousness - the psychedelic state in light of integrated information theory. Front. Hum. Neurosci. 9:346. doi: 10.3389/fnhum.2015.00346

Copyright © 2015 Gallimore. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Table of Contents:

- Abstract
- Introduction
- Phenomenology of the Psychedelic State
- Functional Neuroimaging of the Psychedelic State
- Overview of Integrated Information Theory (IIT)
- The Psychedelic State and IIT
- The Effect of Psychedelic Drugs on Information
- The Effect of Psychedelic Drugs on Neural Integration
- Measurement of Integrated Information in the Psychedelic State
- Conclusions, Predictions, and Future Work
- Funding
- Acknowledgments
- References

Abstract

The psychological state elicited by the classic psychedelics drugs, such as LSD and psilocybin, is one of the most fascinating and yet least understood states of consciousness. However, with the advent of modern functional neuroimaging techniques, the effect of these drugs on neural activity is now being revealed, although many of the varied phenomenological features of the psychedelic state remain challenging to explain. Integrated information theory (IIT) is one of the foremost contemporary theories of consciousness, providing a mathematical formalization of both the quantity and quality of conscious experience. This theory can be applied to all known states of consciousness, including the psychedelic state. Using the results of functional neuroimaging data on the psychedelic state, the effects of psychedelic drugs on both the level and structure of consciousness can be explained in terms of the conceptual framework of IIT. This new IIT-based model of the psychedelic state provides an explanation for many of its phenomenological features, including unconstrained cognition, alterations in the structure and meaning of concepts and a sense of expanded awareness. This model also suggests that whilst cognitive flexibility, creativity, and imagination are enhanced during the psychedelic state, this occurs at the expense of cause-effect information, as well as degrading the brain's ability to organize, categorize, and differentiate the constituents of conscious experience. Furthermore, the model generates specific predictions that can be tested using a combination of functional imaging techniques, as has been applied to the study of levels of consciousness during anesthesia and following brain injury.

Keywords: integrated information theory, psychedelic state, psilocybin, ketamine, LSD, neural complexity, integration, neural entropy

Introduction

The psychological state elicited by the classic psychedelics drugs, such as LSD and psilocybin, is one of the most fascinating and yet least understood states of consciousness. Although biochemical and pharmacological studies of these drugs are detailed and extensive (Nichols, 2004), until recently, studies using human subjects have been limited. However, with the advent of modern functional neuroimaging techniques and the successful maneuvering around mulish political obstacles, the neural correlates of the psychedelic state in humans are now being revealed. This has prompted the development of new models of the effects of these drugs on neural function and their relationship to the phenomenological features of the psychedelic state (Vollenweider *et al*., 1997; Carhart-Harris *et al*., 2012, 2014).

Integrated information theory (IIT) is one of the foremost contemporary theories of consciousness (Oizumi *et al*., 2014). By mathematically formalizing the properties of subjective consciousness self-evident to humans, IIT attempts to explain the conditions under which systems, such as the brain, are conscious and for the phenomenological structure of conscious experience. Although IIT is continually under development, it is now a mature and rigorous theory that considers both the quantity and quality of consciousness in all its usual states, including waking, REM, and NREM sleep, during seizures and under anesthesia. As such, it would be extremely surprising if IIT had nothing to inform us about the nature of the psychedelic state. As we appear to be within a growing resurgence of psychedelic research in humans, it seems entirely appropriate and timely to analyze the psychedelic state from the perspective of IIT, with the aim of providing fresh insights into this beguiling state of consciousness. Furthermore, the mathematical rigor with which IIT is constructed might allow any such insights to be similarly formalized, perhaps pointing toward a more quantitative measure of the psychedelic state and an explanation for the range of effects of different psychedelic drugs. Importantly, the most recent models of the psychedelic state, developed based on functional imaging data (Carhart-Harris *et al*., 2014), will be shown not only to be compatible with IIT, but complemented by it. This analysis will also generate testable predictions regarding phenomenological features of the psychedelic state and its neural correlates, and suggest specific experiments to guide further research.

Phenomenology of the Psychedelic State

The effects of psychedelic drugs on consciousness, particularly at higher doses, can be both profound and varied (Masters, 1966). However, the effects can loosely be placed into three categories:

> Perceptual effects: altered shapes and colors (often appearing brighter, more vivid, and intense); visual distortions; visual hallucinations (open eye visuals and closed eye visuals); illusions; difficulty focusing; synaesthesias.
>
> Psychic effects: mood alterations (from ecstatic euphoria to panic); time distortion; thought alterations (difficulty concentrating, strange concepts, ideas, or connections, increases in creativity); dreamlike feelings; depersonalization; the sense that awareness is "expanded".
>
> Somatic effects: dizziness; tremors; nausea; drowsiness; blurred vision. (Masters, 1966; Hollister, 1984; Nichols, 2004).

The relative prominence of particular effects can be strongly dependent on the specific drug, the dosage and the setting in which the drug is used. As such, it is beyond the scope of this discussion to attempt an explanation for all the varying phenomenological features of the psychedelic state elicited by different psychedelic drugs. However, recent functional imaging studies suggest that, at relatively low doses of the classic psychedelic psilocybin, the psychedelic state is characterized by an unconstrained form of cognition (Carhart-Harris *et al.*, 2012, 2013; Roseman *et al.*, 2014); the stream of conscious experience appears more fluid and dynamic, with novel neural states being explored (Tagliazucchi *et al.*, 2014). It is straightforward to extrapolate this data to account for many of the perceptual and psychic effects that often manifest in the psychedelic state, although a more thorough and definitive treatment must await further human studies.

Functional Neuroimaging of the Psychedelic State

The classic psychedelic drugs are all partial agonists at the serotonin 5-HT$_{2A}$ receptor, and this site has been established as the major locus for their effects (Vollenweider *et al.*, 1998; Nichols, 2004). The earliest functional imaging studies suggested that psychedelic drugs, psilocybin specifically, are cortical activators and this was deemed to be consistent with the rich, heightened state of awareness characteristic of the psychedelic state (Vollenweider *et al.*, 1997). Further, activation of 5-HT$_{2A}$ receptors is known to depolarize cortical pyramidal neurons. As such, it was something of a surprise, and ostensibly paradoxical, when a groundbreaking functional magnetic resonance imaging (fMRI) study with psilocybin revealed a global decrease in cortical activation (Carhart-Harris *et al.*, 2012). However, recent magnetoencephalography (MEG) studies localized the activated pyramidal neurons to the deep layer V of the cortex, which provide predominantly inhibitory feedback, explaining why activation of this neural population results in a decrease in neural activity (Muthukumaraswamy *et al.*, 2013). The conflict with earlier data has been explained as an effect of the difference in temporal resolution between positron emission tomography (PET) and fMRI. It should be noted that, from the perspective of IIT, neural activation holds no primacy over deactivation, as both can be equally informative.

Maximal decreases in activation were observed in cortical "hubs," such as the anterior and posterior cingulate cortices (ACC and PCC) and the thalamus, as well as the medial prefrontal cortex (mPFC). Further, the intensity of the subjective effects of the drugs correlated with the magnitude of this deactivation (Carhart-Harris *et al.*, 2012). Functional connectivity analysis revealed an uncoupling of activity between the mPFC and the PCC, both key components of the default mode network (DMN), indicating a loss of network integrity (Carhart-Harris *et al.*, 2013; Muthukumaraswamy *et al.*, 2013). The DMN, also known as the task negative network (TNN), is preferentially activated during introspection, daydreaming and memory retrieval (Qin and Northoff, 2011). Activation of this network is normally anti-correlated (inversely coupled) with activation of task positive networks (TPNs) (Fox *et al.*, 2005), which are activated during attention-demanding tasks, such as attending to external visual stimuli. However, both fMRI and MEG revealed a decrease in the anti-correlation between the DMN and several TPNs, with an increase in the functional connectivity between these networks post-psilocybin. Overall, this functional imaging data indicates that psilocybin reduces the differentiation between brain networks and produces a "disorganized" brain state. This prompted Carhart-Harris and colleagues to propose that the psychedelic state is characterized by elevated neural entropy - the so-called "entropic brain" theory (Carhart-Harris *et al.*, 2014).

According to this model, during normal waking consciousness, the brain operates at a slightly subcritical state between a highly ordered, low entropy (sub-critical) state and a highly disordered, high entropy (super-critical) one (Chialvo, 2010). This optimal position between perfect order and complete disorder allows the brain to operate in a well-defined and organized manner whilst maintaining a degree of pliability, which is essential for flexible and adaptable cognition. Psychedelic drugs, such as psilocybin, increase the entropy of the brain and generate a more disordered and fluid state of consciousness, as revealed by the functional connectivity analyses. Further, more targeted analyses of the psilocybin fMRI data showed an increase in the variance of neural activation across voxels within networks associated with higher cognition, indicative of more erratic neural activity. A formal measure of Shannon entropy was also employed and, in line with the predictions of the entropic brain theory, entropy was indeed elevated in these networks (Carhart-Harris *et al.*, 2014).

A related approach was used to examine the entropy of the dynamic temporal sequence of states (discretized as functional connectivity motifs) explored by the brain post-psilocybin. Crucially, this analysis not only revealed that the sequence of states was more random (higher entropy) post-psilocybin, but also that specific connectivity motifs were exclusive to the psilocybin state (Carhart-Harris *et al.*, 2014; Tagliazucchi *et al.*, 2014). This indicates that psilocybin increases both the entropy of the brain and the size of its state repertoire, which will be of central importance when considering the psychedelic state from the perspective of IIT.

Overview of Integrated Information Theory (IIT)

Before examining the psychedelic state from the perspective of IIT, it is essential that the key ideas of IIT be presented, particularly those that will be used in the sections that follow. However, it is not the aim of this section to provide a detailed and thorough account of IIT and the reader is directed to Giulio Tononi's papers explaining the theory (Oizumi *et al.*, 2014). This section will serve merely as a simplified overview of IIT, with particular emphasis placed on those aspects of the theory most informative to the psychedelic state.

IIT provides a formal description of both the quantity of consciousness and its quality (structure), both of which might be affected by psychedelic drugs. In order for a system to be conscious, it must be both highly differentiated (informative) and integrated. This means the information generated by the system as a whole must be beyond that generated by its individual components. That is, it must be irreducible. IIT proposes that a set of neural elements (e.g., thalamocortical columns) with the special property of being a local maximum of integrated information, quantified by Φ (big phi), is conscious. This set of neural elements is known as a *maximally irreducible conceptual structure* (also known as a *complex*). Only a complex exists from its own perspective (there is *something-it-is-like-to-be it* Nagel, 1974). All conceptual structures, whether maximally irreducible or not, are defined as systems of *concepts*. Although a concept has a formal definition in IIT, this is simply a formalization of the more familiar definition: an abstract idea or an object of thought consisting of all the essential or characteristic features of that object. This could refer to a concrete object, such as an apple or a chair, but might also refer to something more abstract, such as the color red or the concept of freedom or happiness. As concept theory is a major branch of both classical and contemporary philosophy, it is perhaps safest to opt for the simplest definition - "concepts are the constituents of thoughts" (Margolis and Laurence, 2014), although "constituents of conscious experience" is perhaps a more helpful definition here.

As conscious experience is built as a system of concepts, understanding the definition of a concept is central to understanding how IIT describes the structure of consciousness and how psychedelic drugs can change it. Assuming the cortical column is chosen as the basic unit of functional segregation, each column is an *element* of the *system* under consideration (e.g., a region of the cerebral cortex). Elements can be combined with other elements to form *mechanisms* (e.g., a set of directly or indirectly connected cortical columns engaging in some sort of causal interaction) (**Figure 1**).

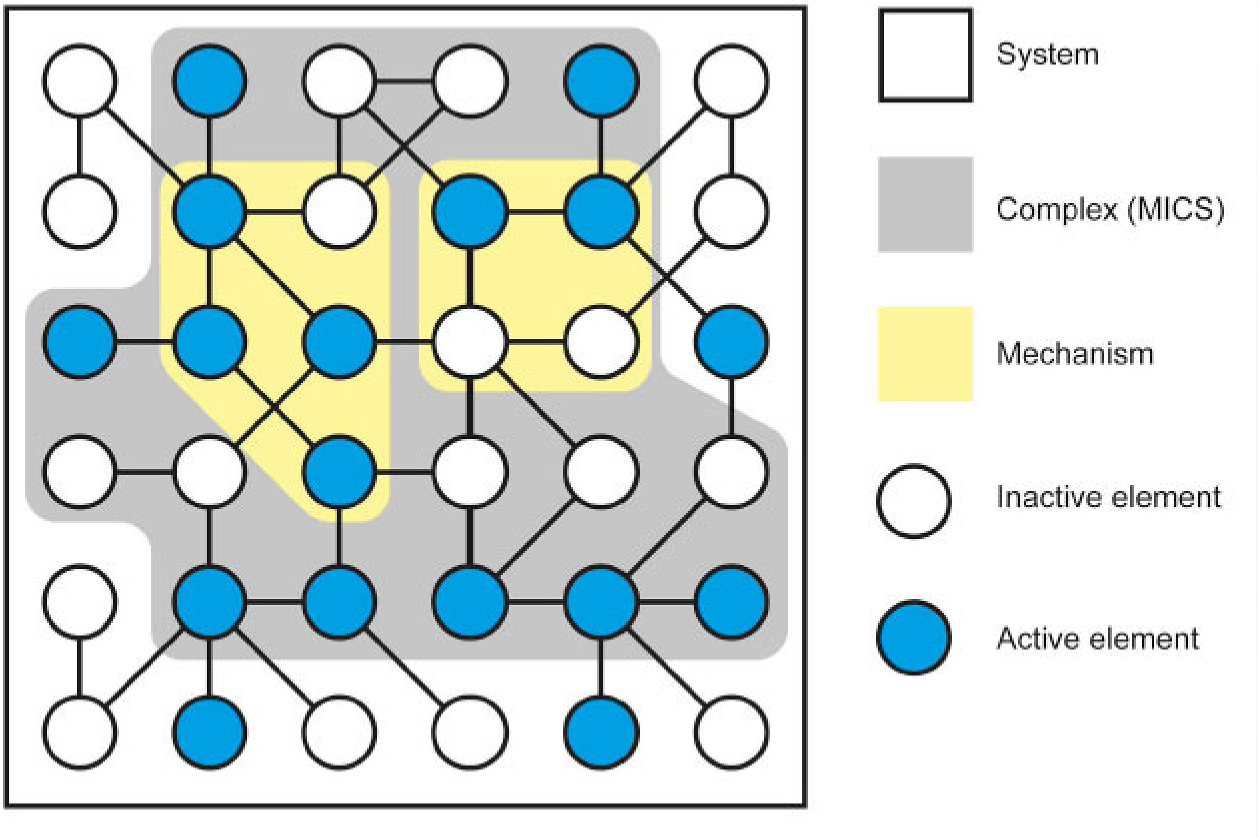


FIGURE 1 - Neural elements within the system form mechanisms (only 2 mechanisms within the power set are shown). The particular current state of the mechanism is defined by the activity or silence of individual neural elements and determined by their causal interactions. The complex comprises the set of neural elements in the system that forms a maximally irreducible conceptual structure (MICS).

The element itself is the most elementary mechanism and elements can combine to form higher order mechanisms. For any set of elements, all possible mechanisms are represented as the *power set*, which includes all possible combinations of elements, including the highest order mechanism, which is the set itself. Dependent on the interactions between the elements of the mechanism and, in fact, with the elements of the entire system (in the case of the brain, the synaptic connections, their type, and weight, etc.), every mechanism occupies a particular state at any point in time (hereafter its *current state*). For example, particular sets of neurons might be firing, whilst others are quiet. As the system consists of causal, deterministic interactions, only certain system states could have *caused* the mechanism to enter its current state. This set of system states is a discrete probability distribution called the *cause repertoire* (IIT uses the term *repertoire* to describe various discrete distributions of system states). Likewise, given the current state of the mechanism, only a specific set of immediate future states will be available to the system - this is the *effect repertoire*. Both of these repertoires may be referred to together as the *cause-effect repertoire* (**Figure 2**). So, by entering its current state, a mechanism *constrains* both the past and future states of the system. In actuality, each individual mechanism may not constrain the past and future states of the entire system, but rather of a specific subset of elements called the *purview*. Any elements outside of the purview are unconstrained by the mechanism. However, all of the mechanisms together will constrain the past and future states of the entire system.

Prior to considering the current state of any mechanisms, all the possible past and future states of the system form the maximal entropy *unconstrained past and future repertoires*, respectively (i.e., unconstrained by any mechanisms in any specific state). By entering a specific current state, a mechanism effectively rules out certain past and future system states (i.e., those past states that could not have caused the current state and those immediate future states that cannot follow) and thus generates information. The amount of information the mechanism specifies about the past state of the system is called the *cause information* and is obtained by calculating the [Earth Mover's] distance between the *cause repertoire* and the *unconstrained past repertoire*. The larger the difference between these distributions, the more the current state of the mechanism constrains the past states of the system and thus the more cause information is generated. If the cause information is zero (i.e., there is no difference between the distributions), the current state of the mechanism tells us nothing about the past state of the system. Likewise, the distance between the *effect repertoire* and the *unconstrained future repertoire* quantifies the *effect information*. The minimum of the cause and effect information is the *cause-effect information* (**Figure 2**). By systematically bipartitioning the mechanism, it is possible to calculate the *cause-effect information* specified by the whole mechanism above and beyond that specified by its parts. This is the integrated information specified by the mechanism and is known as φ (small phi). Overall, the elements of the mechanism, together with its cause-effect repertoire and associated value of φ, constitute a concept (Figure 3A). *The states of the cause-effect repertoire specify what the concept "is about" and φ quantifies the degree to which that concept is present within the conscious experience of the system*. Every possible mechanism may, in principle, specify a concept. However, if the mechanism fails to generate any integrated information (i.e., if φ = 0), then the concept does not exist from the subjective perspective of the complex (i.e., it is not present within the conscious experience).

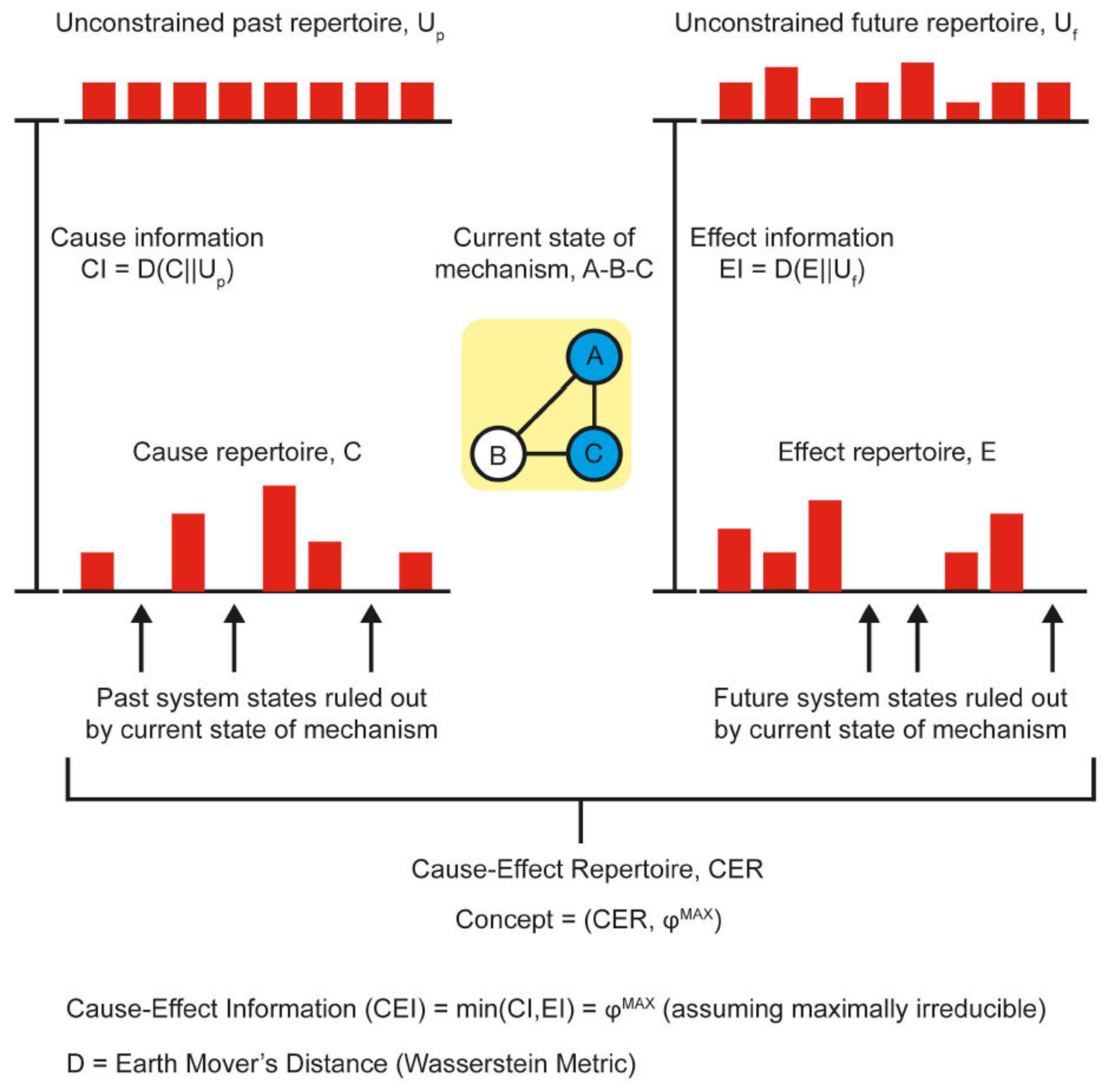

Unconstrained past repertoire, U_p
Unconstrained future repertoire, U_f
Cause information
$CI = D(C||U_p)$
Current state of mechanism, A-B-C
Effect information
$EI = D(E||U_f)$
A
B
C
Cause repertoire, C
Effect repertoire, E
Past system states ruled out by current state of mechanism
Future system states ruled out by current state of mechanism
Cause-Effect Repertoire, CER
Concept = (CER, φ^{MAX})
Cause-Effect Information (CEI) = min(CI,EI) = φ^{MAX} (assuming maximally irreducible)
D = Earth Mover's Distance (Wasserstein Metric)

FIGURE 2 - **The current state of a mechanism is associated with a specific cause-effect repertoire of past and future states of the system.** The mechanism generates information by ruling out certain past and future states, quantified as the distance between the cause-effect repertoire and the unconstrained past-future repertoire.

Of all the concepts specified by the system, subsets of these can form *conceptual structures*, with each concept represented as a point in *concept space*, a high-dimensional space in which each possible past and future state within the cause-effect repertoire is represented by one dimension (axis). The coordinates of the point are given by the probabilities of each past and future state in the cause-effect repertoire and φ is represented by the size of the point. A conceptual structure thus forms a constellation of points in concept space (**Figure 3B**). Whilst each concept specifies a quantifiable amount of cause-effect information, a conceptual structure generates *conceptual information*, which is the systems equivalent of cause-effect information. The conceptual

)

information of each concept is found by calculating the difference between the cause-effect repertoire of the concept and the unconstrained cause-effect repertoire (known as the *null concept*, a concept about nothing). This difference is then multiplied by the φ-value of the concept. Summing over all the concepts gives the conceptual information generated by the conceptual structure, denoted Φ (big phi). Clearly, a conceptual structure with many high-φ concepts that are well-separated from the null concept will generate a large amount of conceptual information. Conversely, a poorly integrated system with a limited repertoire of states will generate only a small amount of conceptual information (Oizumi *et al*., 2014).

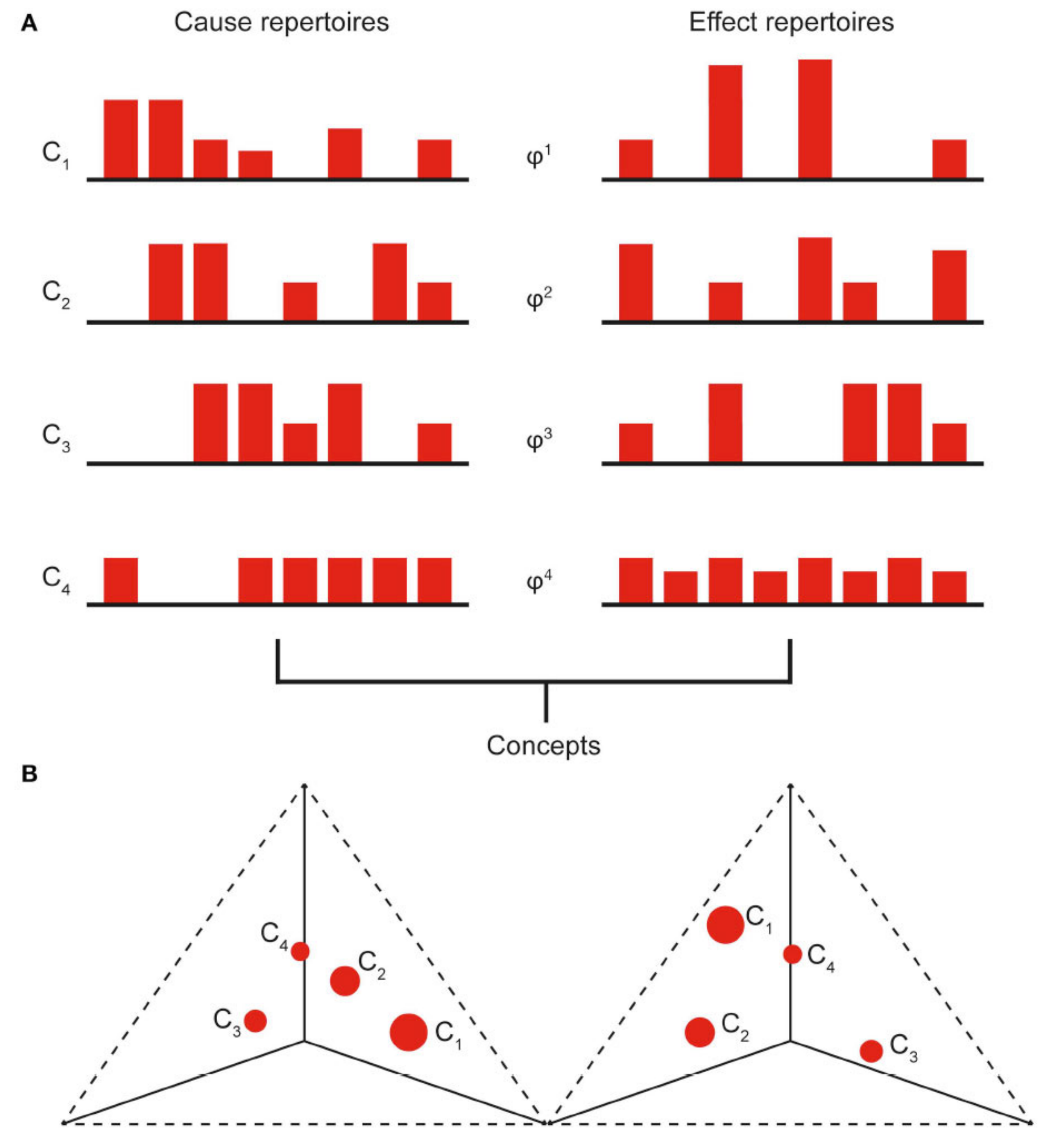


FIGURE 3 - **(A)** The cause-effect repertoire of each mechanism within a complex, together with its associated φ value, constitutes a concept. The states of the cause-effect repertoire define what the concept "is about" and φ quantifies the degree to which the concept is present in the experience. **(B)** Concept (qualia) space is a high-dimensional space with each cause-effect repertoire state occupying a single axis. Plotting the concepts on these axes, the conceptual structure forms a shape in this space that is identified with the conscious experience (qualia). (Only 3 axes shown with past and future states plotted on separate axes).

In principle, any subset of concepts within the power set of concepts specified by the system can form a conceptual structure. However, only one conceptual structure can exist at any time from the intrinsic perspective of the system - this is the MICS (complex), which specifies the maximal amount of integrated conceptual information (Φmax, hereafter simply Φ). Not all concepts with non-zero φ will form part of this irreducible conceptual structure. This is intuitively obvious, as conscious experience changes from moment to moment, as concepts continuously enter and leave consciousness. Concepts that leave the complex cease to exist from the subjective perspective of the complex, but may re-enter the complex at a later time.

The subjective conscious experience of the complex is identified with the complex itself - the level or quantity of consciousness is identified with the value of Φ, whereas the constellation of concepts determines the structure or quality of the experience (quale) (**Figure 4**). Each concept contributes to the overall experience, with its cause-effect repertoire determining what that concept "is about" and its φ-value quantifying the degree to which the concept is present in the experience. Each concept is a point in a high-dimensional *qualia space* (this is the same as concept space, except only complexes (MICS) have qualia) and thus the constellation of concepts form a "shape" in this space (Balduzzi and Tononi, 2009). It is this shape that is identified with the quality of the experience. The higher the dimensionality of the qualia space, the richer the experience (i.e., the experience is "about more things" at once).

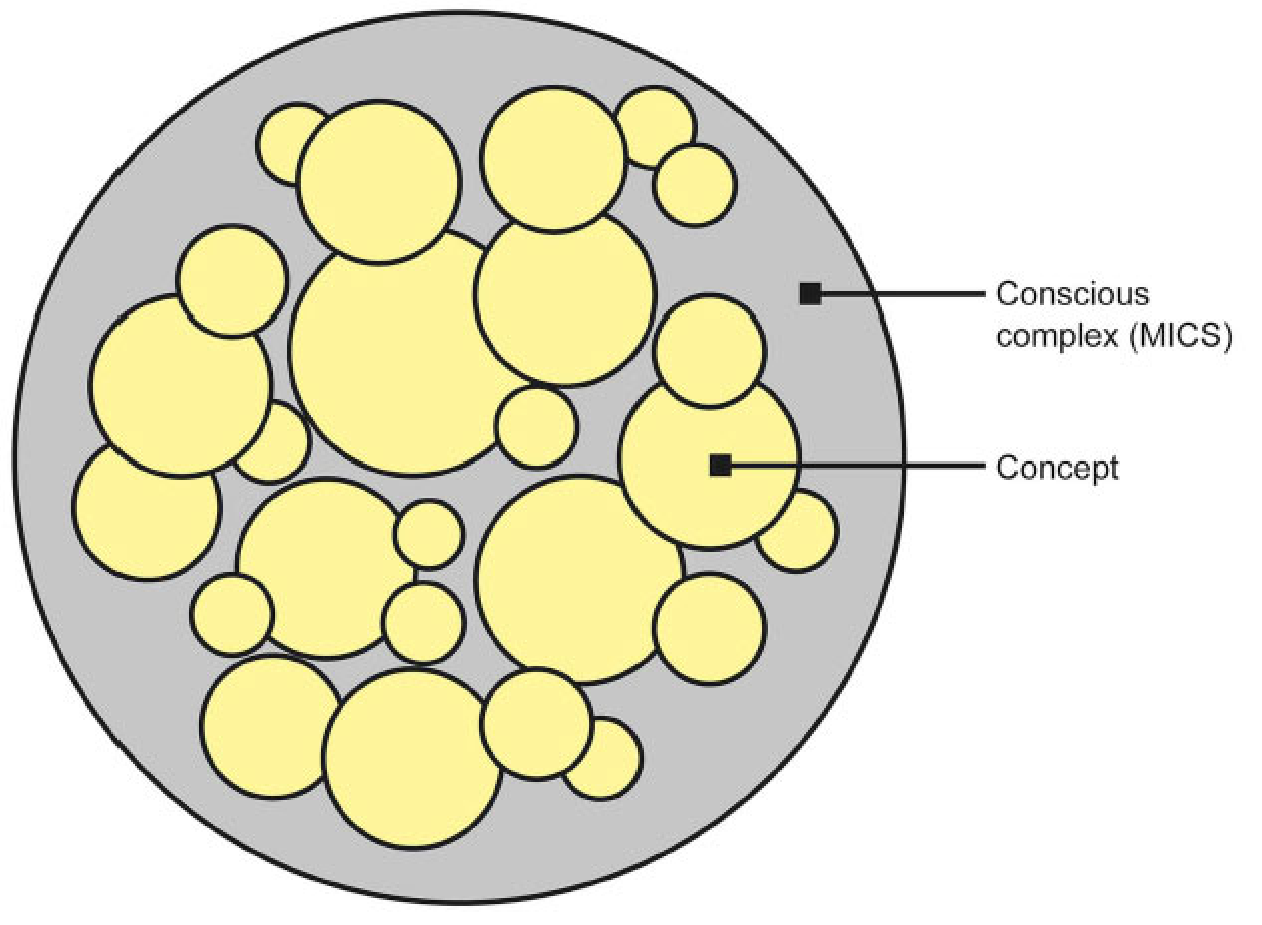


FIGURE 4 - The unified conscious complex (outer gray circle) is formed from a constellation of concepts (yellow circles). The degree to which each concept is present in the experience is quantified by φ (represented by the size of the circle), and the overall quantity of consciousness is quantified by Φ (represented by the size of the gray circle).

The Psychedelic State and IIT

IIT defines conscious experiences as a shape in qualia space. This applies to all conscious states, including the psychedelic state. To appreciate how IIT can provide an explanation for many phenomenological features of the psychedelic state, the following discussion will be separated into three sections. Firstly, using IIT and results from functional neuroimaging data, the effect of psychedelic drugs on neural differentiation (i.e., information) will be examined. Secondly, the effect of psychedelic drugs on neural integration will be addressed. Finally, experiments to test whether the psychedelic state is a state of increased consciousness (integrated information, Φ) will be suggested, together with predictions as to their outcome.

The Effect of Psychedelic Drugs on Information

Functional neuroimaging data and its analysis support the proposal that psychedelic drugs increase the entropy of the brain (Carhart-Harris *et al.*, 2014), producing a state of unconstrained cognition. More detailed analysis of this data revealed an increase in the repertoire of states explored by the brain, consistent with an increase in neural entropy (Tagliazucchi *et al.*, 2014). From the perspective of IIT, both of these observations can be further elucidated, both at the level of the mechanism (concept) and at the level of the conceptual structure (complex).

Before discussing the effect of psychedelic drugs at the level of the concept, it is important to clarify exactly how information is defined within IIT. It is erroneous, from the perspective of IIT at least, to equate the size of a system's state repertoire (i.e., the number of states it can potentially occupy) with the information it generates. Although a large repertoire of states is necessary for a system to generate a large amount of information, it is not sufficient. Stated equivalently, increasing the size of the state repertoire does not necessarily imply an increase in information as defined by IIT. The amount of cause-effect information generated by a mechanism depends on the number of past and future states it *rules out* by entering its current state. Simply adding noise to a system by, for example, allowing neural elements to be randomly activated, will increase the state repertoire but will not increase information. This is because the current state of the system is unable to *constrain* random past or future states. Equivalently, the current state gives no information about those states that had no causal effect on it, nor about randomly generated future states.

Any IIT derived model of the psychedelic state must account for the increase in entropy and size of the state repertoire explored by the brain. In fact, this functional imaging data can be regarded as axiomatic and used as a foundation upon which to develop an IIT-based model of the psychedelic state. As IIT constructs conscious experience as a system of concepts, it makes most sense to begin at the level of the mechanism and then move to the level of the conceptual structure (complex).

When a mechanism enters a specific state, the cause and effect repertoires of system states are specified as distributions with lower entropy than the corresponding unconstrained past and future repertoires. The cause-effect information generated by the mechanism entering the current state is the minimum distance between these repertoires, as explained earlier. This provides a measure of how much the mechanism constrains past and future states of the system. The functional imaging data described earlier revealed that, post-psilocybin, the brain explores a larger repertoire of states and in a more random fashion. From the perspective of IIT, this suggests that the brain's past and future states are less constrained by the states of its mechanisms. As will be shown, and in agreement with this imaging data, this is equivalent to stating that the entropy of the cause and effect repertoires is increased. This means that the cause and effect repertoires of the mechanisms in the complex are shifted toward the unconstrained past and future repertoires. Mathematically, this can be modeled by taking a linear combination of the cause repertoire and the unconstrained past repertoire to generate a *psychedelic cause repertoire* (**Figure 5A**). A *psychedelic effect repertoire* can be similarly generated, by taking a linear combination of the effect repertoire and the unconstrained future repertoire. This approach takes into account the repertoire of states available to the system without invoking additional states resulting from random noise, and can be applied to both the cause repertoire and the effect repertoire to generate a *psychedelic cause-effect repertoire* for every mechanism in the complex (Note that this model does not explain *how* neural entropy is increased by psilocybin, but predicts consequences of the entropy increase revealed by functional imaging data).

If the unconstrained repertoire (past or future), U, contains n states, then U can be described as a point within an (n-1)-dimensional n-simplex. The cause or effect repertoire, R, is another point within this simplex and extending a line between R and U generates a range of repertoires moving from R to U, all of them linear combinations of R and U with increasing *U-character*. According to this model, the psychedelic repertoire, R', lies somewhere on this *R-U* line (this is easier to understand using a diagram and is illustrated in **Figure 5B** for a system with only three possible states):

$$R' = (1 - t)\,R + tU$$

where t is the portion of U mixed with R and $0 \leq t \leq 1$. Clearly, if $t = 0$, then $R' = R$, and if $t = 1$, then $R' = U$.

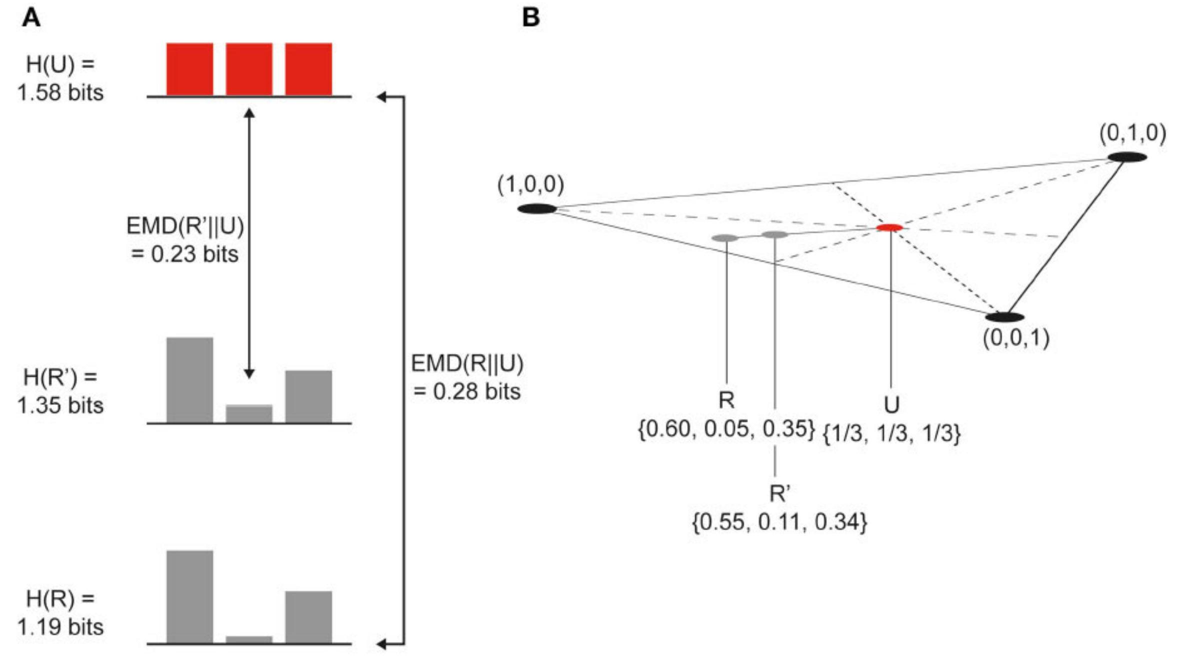


FIGURE 5 - **(A)** Simple 3-state system. A psychedelic (cause/effect) repertoire, R′, is generated using a linear combination of the (cause/effect) repertoire, R, and the unconstrained (past/future) repertoire, U. R′ has a higher entropy than R and is closer to U, generating less (cause/effect) information. **(B)** Each repertoire can be plotted on a 3-simplex. The psychedelic repertoire, R′, lies on a line between the (cause/effect) repertoire and the unconstrained repertoire.

As *U* is, by definition, the maximal entropy distribution, a linear combination of *U* and *R* will always generate a distribution with higher entropy than *R*. Furthermore, in order to move the cause-effect repertoire closer to these maximum entropy distributions, the probabilities of the individual states must be changed, such that formerly high probability states become lower probability and vice versa. Importantly, this is certain to include increasing the probability of certain states from zero or, at least, from a very low probability. In other words, new states would effectively be added to the cause-effect repertoire - the repertoire of potential system states, both past and future, is expanded (actually, the number of states does not increase, but certain states develop a non-zero probability). As this applies to all mechanisms in the complex, the brain would be observed to explore a larger number of states in a more random fashion. This is exactly what is observed in the functional imaging data. From a phenomenological perspective, this has important consequences for the structure of the concept itself. The states within the cause-effect repertoire define what the concept "is about" (Oizumi *et al.*, 2014) and so an expansion of these states essentially changes the nature of the concept and what that concept means to the individual - the psychedelic concept becomes "about more things" or acquires additional characteristics not present in normal consciousness (**Figure 6**). It is interesting to speculate that this might account for the feeling that the world appears somewhat altered in the psychedelic state. Concepts that were once clear and well-defined become novel, strange and perhaps even bizarre or ludicrous.

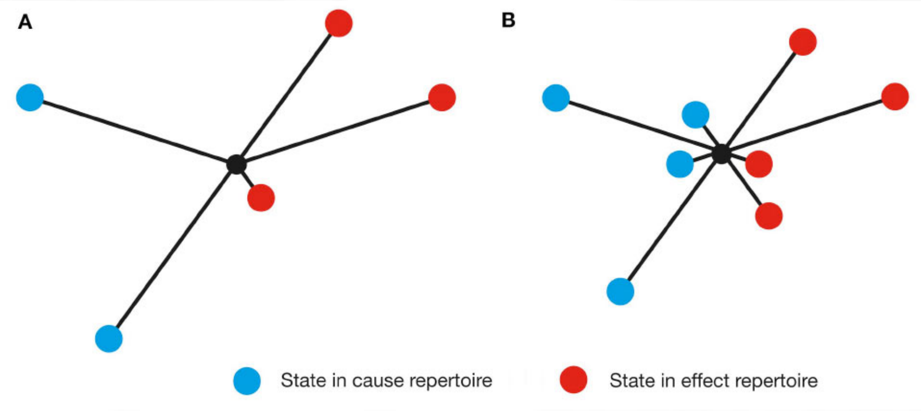


FIGURE 6 - A concept can be visualized by plotting the states of the cause-effect repertoire on a set of arbitrary axes, with the length of each line representing the probability of each state (φ not considered). (A) A concept in a normal waking state. **(B)** A higher-dimensional psychedelic state concept, derived using the linear combination method described in the text.

Further insights are obtained by examining the effect of psychedelic drugs on the cause-effect information specified by each mechanism. The current presentation of IIT uses the Earth Mover's Distance (EMD, aka Wasserstein metric) to measure the distance between the distributions in calculating the cause-effect information (Oizumi *et al.*, 2014). The EMD between the cause or effect repertoire, R, and the unconstrained repertoire, U, can be defined as follows:

If X and Y are random variables with distributions R and U, respectively, and $d(X,Y)$ is a [Euclidean] distance metric, then the infimum of the expectation, E, taken over all possible joint distributions of X and Y (with R and U being the marginal distributions, respectively), gives the EMD:

$$EMD(\mathrm{R}||\mathrm{U}) = inf\,\mathbb{E}[d\ (X, Y)]$$

Let X^* and Y^* be random variables with distributions R and U, respectively, which attain the infimum in the definition of the EMD, then:

$$EMD(\mathrm{R}||\mathrm{U}) = \mathbb{E}[d\ (X^*, Y^*)]$$

R is combined with U using the method described above to generate a new distribution (the psychedelic cause/effect repertoire), R':

$$R' = (1 - t)\ R + tU$$

where $0 \le t \le 1$.

Now, to calculate $EMD(R'||U)$ (i.e., the distance between the psychedelic repertoire, R', and the unconstrained repertoire, U), we must define a new random variable, X', with distribution, R', such that:

$$EMD(R'||\mathrm{U}) = inf\,\mathbb{E}[\mathrm{d}\ (X', Y^*)]$$

where,

$$X' = \begin{cases} X^*, & P(1\text{-}t) \\ Y^*, & P(t) \end{cases}$$

Since $EMD(R'||U)$ is, by definition, the infimum, it must always be the case that:

$$EMD(R'||U) \le \mathbb{E}[d(X', Y^*)]$$

Moreover:

$$\mathbb{E}[d(X', Y^*)] = (1 - t)\ \mathbb{E}[d(X^*, Y^*)] + t\mathbb{E}[d(Y^*,Y^*)]$$

And so, equivalently:

$$EMD(R'||U) \le (1 - t)\ \mathbb{E}[d(X^*, Y^*)] + t\mathbb{E}[d(Y^*, Y^*)]$$

Since, plainly:

$$\mathbb{E}[d(Y^*, Y^*)] = 0$$

This simplifies to:

$$EMD(R'||U) \le (1 - t)\ \mathbb{E}[d(X^*, Y^*)]$$

As defined earlier:

$$EMD(R||U) = \mathbb{E}[d(X^*, Y^*)]$$

So, substituting:

$$EMD(R'||U) \leq (1 - t)\ EMD(R||U)$$

And, since $0 \leq (1 - t) \leq 1$, it follows that:

$$(1 - t)\ EMD(R||U) \leq EMD(R||U)$$

And so:

$$EMD(R'||U) \leq EMD(R||U)$$

So, increasing the entropy of the cause-effect repertoire will always lead to a reduction in its distance, as measured using the EMD, from the unconstrained past and future repertoires and hence a reduction in the cause-effect information specified by the mechanism.

Without considering any effect on neural integration, this result suggests a continuum of consciousness between the normal waking state and unconsciousness, with the psychedelic state lying somewhere in between, perhaps at varying distances from normal consciousness depending on the drug and dose. However, there is no reason to assume that the classic psychedelics are capable of producing such a maximal entropy state. Indeed, even high doses of psychedelics, such as psilocybin or LSD, are not accompanied by any appreciable loss of consciousness. The N-methyl-D-aspartate (NMDA) receptor antagonist, ketamine, is an unusual drug in that low to moderate doses have a definite psychedelic effect (Krystal *et al*., 1994; Gunduz-Bruce, 2009; Murray *et al*., 2013), whereas higher doses induce anesthesia. It is tempting to suggest that lower doses have a moderate effect on neural entropy, producing a psychedelic state in the same manner as psilocybin, for example, whereas higher doses cause a more dramatic increase in neural entropy that reduces cause-effect information such that Φ becomes minimal and consciousness is lost. Additionally, or alternatively, ketamine may have a more profound disruptive effect on neural integration than the classic psychedelics, as is seen with other anesthetic agents (Ferrarelli *et al*., 2010). These different effects ought to be distinguishable using functional imaging techniques.

This reduction in cause-effect information will also affect its φ-value; the degree to which the concept is present in the experience will be altered. It is tempting to insist that the concept's φ will necessarily decrease owing to a reduction in the cause-effect information. However, φ depends not only on the cause-effect information, but also on the degree to which this information is integrated. If psychedelic drugs act to increase integration across the cortex (discussed later), then it is possible that φ may actually increase. Further, it is possible that concepts with zero or very low φ, which don't exist to any significant extent during normal waking consciousness, may become present during the psychedelic state. As such, certain concepts experienced during the psychedelic state might simply not be available to someone who hasn't taken the drug and these concepts could have no relation to anything within the individual's normal conscious experience.

In summary, the effect of a psychedelic drug at the level of the concept is to increase the entropy of the cause-effect repertoire and, effectively, expand the number of available states within the repertoire, but reduce the cause-effect information specified by each mechanism as it enters its current state. This means that the mechanisms constrain past and future states of the brain less stringently; the current state of each mechanism is less informative about the brain's past and future states. This result agrees with imaging data showing that the brain explores an expanded repertoire of states in a more random fashion (Tagliazucchi *et al*., 2014), and resting state functional connectivity analysis suggesting networks become less differentiated (less anti-correlated) from each other in the psychedelic state (Roseman *et al*., 2014). As the DMN and TPNs are strongly anti-correlated during normal waking consciousness, states involving the DMN effectively "rule out" many states involving the TPNs, and vice versa, thus generating a large amount of information. The decrease in anti-correlation observed post-psilocybin means that DMN states are less effective at ruling out TPN states, thus reducing the information generated.

From the level of the concept, it is straightforward to extrapolate to the level of the conceptual structure and thus the quale. Changing both the cause-effect repertoire and φ-values of the concepts within the conceptual structure, and perhaps also incorporating additional concepts (i.e., those whose φ-value becomes non-zero), changes the shape of the structure in qualia space. Whether the integrated conceptual information, Φ, increases or decreases will depend on the effect on the individual concepts and how the psychedelic drug affects information integration (discussed later). However, recall that the dimensionality of qualia space is equal to the total number of states in the cause-effect repertoires of the constituent concepts. It is this dimensionality that determines the "richness" (Tononi, 2012) of the experience. Whilst it is not trivial to predict the effect on Φ (although suggestions for experiments to probe this issue will be discussed later), expanding the cause-effect repertoires of the concepts within the conceptual structure will generate a higher-dimensional quale that is experientially richer than normal waking consciousness - the psychedelic state is "about more things" than the normal waking state. The enhanced richness and expanded awareness of the psychedelic experience can thus be explained as an increase in the dimensionality of qualia space, rather than an increase in cortical activation. However, it is important to note that a "richer" conscious state does not necessarily imply an increase in the overall quantity of consciousness (quantified by Φ). In fact, as shown above, there is an inherent tension between cause-effect information and the dimensionality of the concepts and thus the quale. Despite this, cause-effect information is specified at the level of the concept, and it is conceivable, if integration is enhanced, that an increase in the number of concepts [with non-zero φ] could result in elevated Φ, even though the φ associated with individual concepts might fall. It isn't, therefore, a contradiction to suggest that both the richness and the quantity of consciousness might increase in the psychedelic state.

Overall, this model suggests that the expanded awareness and enhancement of cognitive flexibility afforded by the psychedelic drugs comes at a functional cost: increasing the entropy of the cause-effect repertoires of mechanisms within a complex expands the characteristics and meaning of concepts and produces a richer, more flexible state of consciousness (a greater range of brain states can be explored), but this is at the expense of the cause-effect information associated with each concept. This provides an elegant explanation for the need to optimize neural entropy - a very low entropy (highly ordered) state would maximally constrain past and future states of the brain and thus maximize cause-effect information. However, this would collapse the number of states within the cause-effect repertoire of each mechanism and thus produce a highly inflexible state of consciousness with a rigid sequence of conscious states. At the opposite extreme, excessively high entropy would maximize the number of states within the cause-effect repertoire of each mechanism, producing a highly flexible state of consciousness with the potential for creative and novel cognition. However, the cause-effect information specified by each mechanism would be very low; the mechanisms would fail to constrain the past and future states of the brain. If entropy is optimal, cause-effect information is high whilst a degree of cognitive flexibility is retained. Psychedelic drugs push the brain into a slightly higher entropy state, which is experientially richer and more flexible, but not as informative as normal waking consciousness (**Figure 7**).

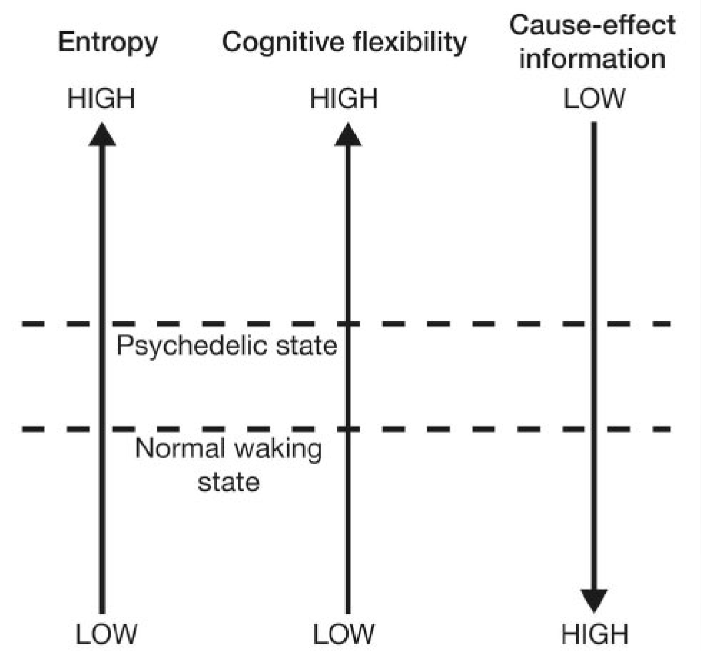


FIGURE 7 - Increasing neural entropy elevates cognitive flexibility at the expense of a decrease in the cause-effect information specified by individual mechanisms.

An intuitive way of appreciating this reduction in information is to consider that entropy is also a measure of uncertainty. High entropy states are less informative because they contain a greater uncertainty about the past states that caused the current state, and those states that will follow it. This potential for novel (and uncertain) state pathways makes it more difficult to make sense of the progression of conscious moments, and can be visualized by projecting forwards and backwards in time from the current state of the system. As one moves further from the current time, the number of potential system states increases. This generates a double "reality cone" projecting outwards from the current moment, representing the "spotlight" of consciousness into the past and future. By increasing the number of potential neural states, psychedelic drugs expand these reality cones, broadening the spotlight, but perhaps at the expense of focusing attention, organizing thoughts, and maintaining cognitive control (**Figure 8**).

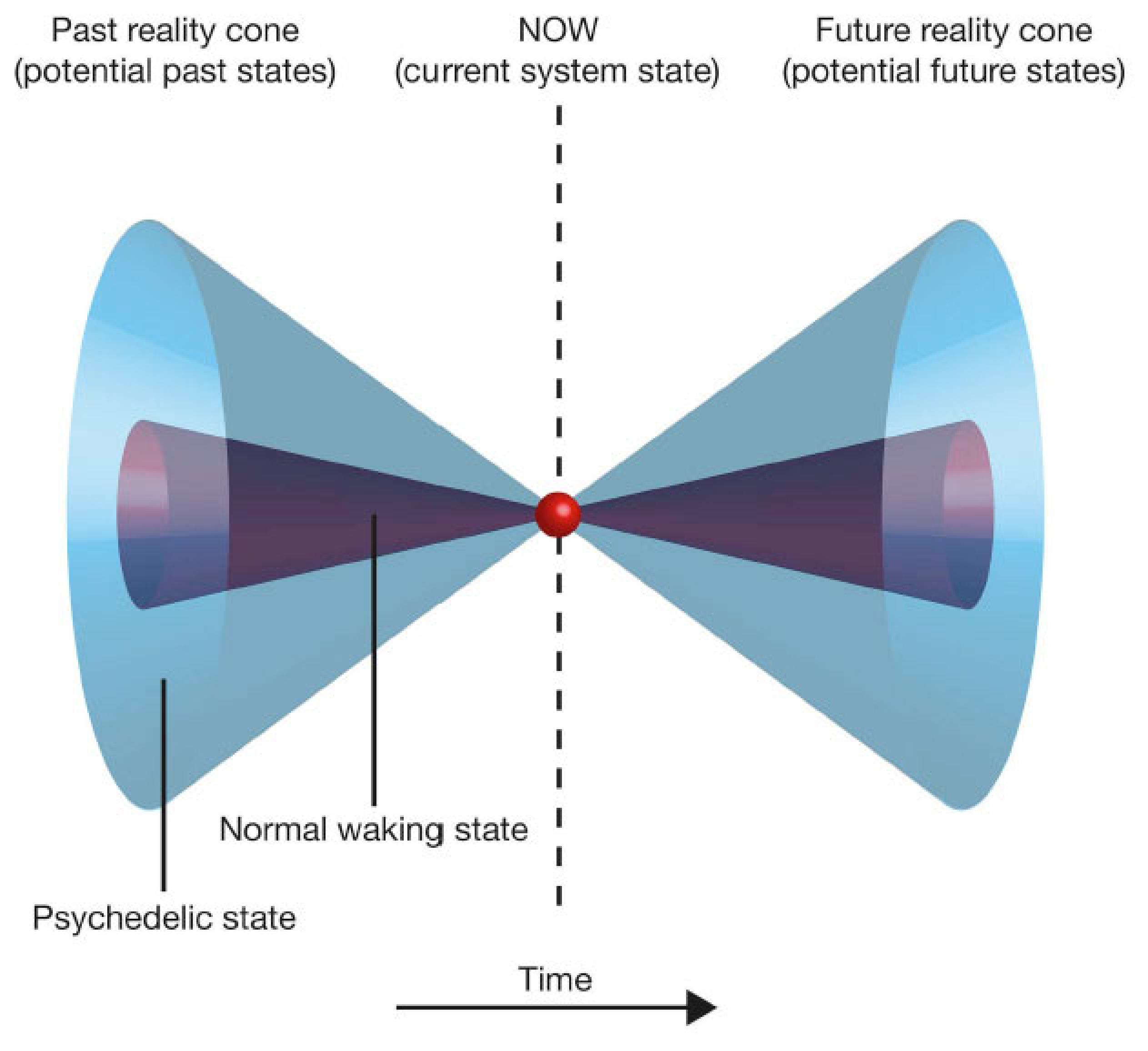


FIGURE 8 - **Moving backward or forward in time from the current state of the complex, the number of potential states increases, producing a double "reality cone" extending into the past and the future.** The area of the circular section at each time point represents the number of potential states. Psychedelic drugs increase the number of potential past and future states, expanding the reality cones.

By considering how psychedelics restructure concepts (and thus consciousness), it is possible to view the functional cost, and potential benefits, of psychedelics from a different perspective. We can use the example of two concepts in normal waking consciousness (**Figure 9A**). Although each concept forms a distinct shape in concept space, it is possible that they share a non-zero number of states. Some degree of *conceptual overlap* makes perfect sense, since not all concepts are independent. To use a trivial but concrete example from everyday life, the concept of an *apple* is not independent of the concept of an *orange*: they differ in enough characteristics such that they can be distinguished (e.g., color and texture), but they share enough that they can be connected and categorized (e.g., sweet, edible fruits). As demonstrated, the cause-effect repertoire representing a psychedelic concept possesses additional states not present in normal consciousness (**Figure 9B**). As these additional characteristics are not necessarily systematically acquired, but through an increase in entropy, conceptual overlap between certain concepts will inevitably increase, potentially even between those that are not normally related. This might explain why creativity, imagination, and novel thinking are enhanced during the psychedelic state (Sessa, 2008; Jones *et al*., 2009; Frecska *et al*., 2012), but it is straightforward to see how this could degrade the brain's ability to maintain the organization and differentiation of the concepts within conscious experience - an obviously essential adaptive skill. Small degrees of conceptual overlap could progress to a more outright *conceptual blending*, as the boundaries between concepts are dissolved, and might explain why Albert Hofmann, during the first ever LSD trip, was startled to observe:

> "*The lady next door, whom I scarcely recognized... was no longer Mrs. R., but rather a malevolent, insidious witch with a colored mask*." (Hofmann, 1980)

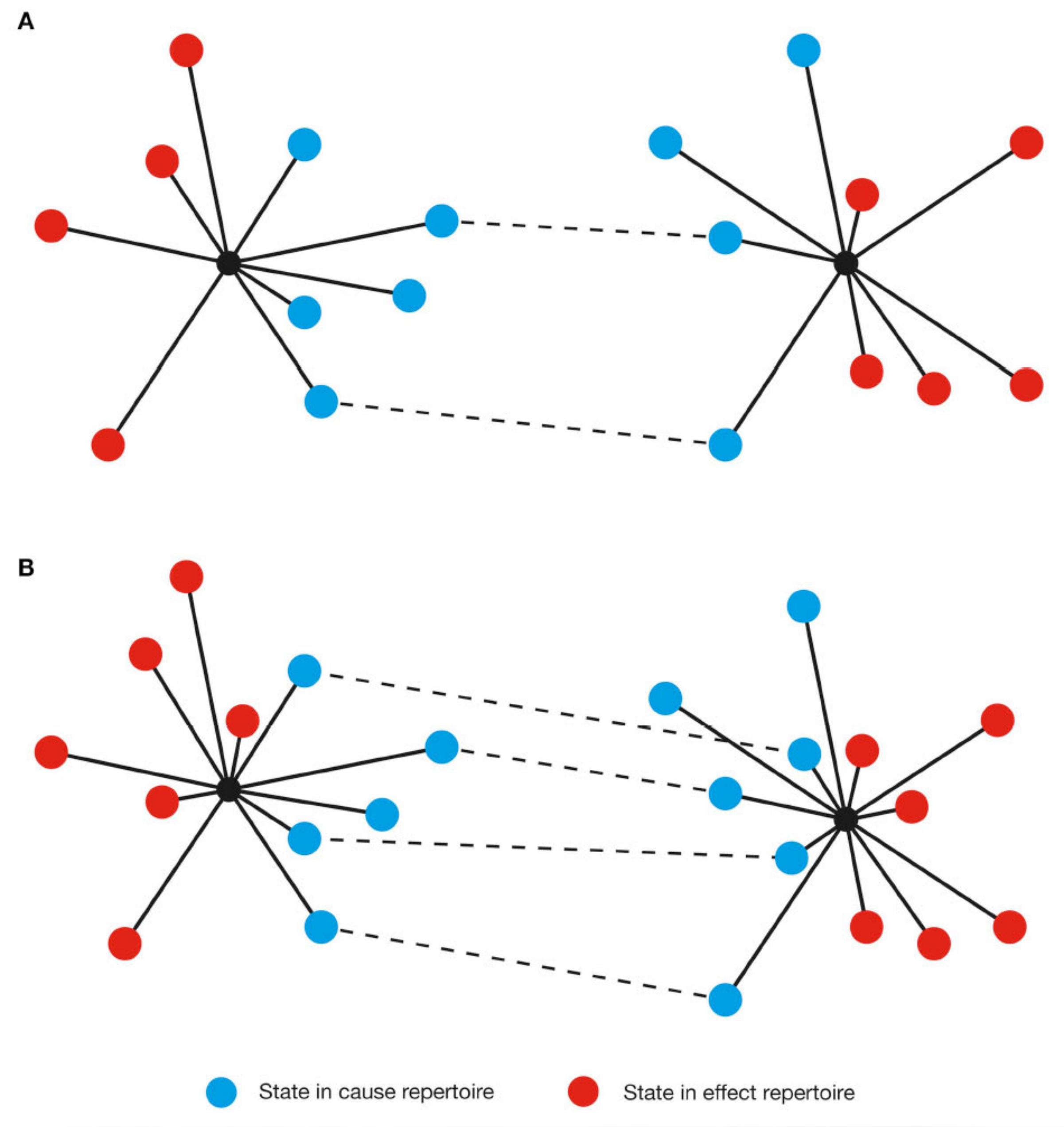


FIGURE 9 - **(A)** A pair of concepts with a degree of conceptual overlap (shared states [in cause repertoire only for clarity] are indicated by dashed lines). **(B)** In the psychedelic state, the concepts increase in dimensionality, acquiring additional states. This increases the degree of conceptual overlap (i.e., the number of shared states).

This experience could be interpreted as the conceptual blending of the concept of "Mrs. R" with the concept of a "malevolent witch." Although these are not fully independent concepts, meaning they have a degree of conceptual overlap (e.g., both are female, and certainly they shared additional characteristics not revealed in the text), they are held distinct in normal consciousness. As the concept of "Mrs. R" acquired additional characteristics in Hofmann's psychedelic state, conceptual overlap may have increased between these concepts, such that Hofmann failed to distinguish between them: from his perspective, Mrs. R effectively became the *malevolent* witch. It is also possible that conceptual blending could result in a failure to distinguish concepts related to *self* from concepts related to *other*, perhaps explaining the "ego dissolution" (Carhart-Harris *et al*., 2012; Muthukumaraswamy *et al*., 2013) and the sense of "oceanic boundlessness" (Vollenweider, 2001) that are often feature in high-dose psychedelic experiences.

Carhart-Harris *et al*. (2014) suggest that neural entropy must be suppressed to allow the brain to "organize and constrain cognition." This IIT-based model reaches an equivalent conclusion: entropy is suppressed to maximize cause-effect information and maintain the organization, categorization, and differentiation of concepts, which is essential for adaptively interacting with the world. However, this certainly doesn't mean that the psychedelic state of consciousness is without value. By expanding the reality cone and promoting conceptual overlap, the high entropy state facilitates creativity, novel thinking, and imagination, which are obviously of great importance in human cognition. Furthermore, psychedelics are beginning to show great promise as psychotherapeutic agents in the treatment of depression, anxiety, and obsessive compulsive disorder (Moreno and Delgado, 1997; Berman *et al*., 2000; aan het Rot *et al*., 2010; Buchborn *et al*., 2014), perhaps by allowing sufferers to break out of the inflexible and circular modes of thinking that characterize these conditions (Carhart-Harris *et al*., 2014).

The Effect of Psychedelic Drugs on Neural Integration

So far, only the effects of psychedelic drugs on neural differentiation has been considered and it has been implicitly assumed that the set of neural elements that constitutes the maximally integrated conceptual structure (complex) are unchanged by the drug. However, this is certainly an unreasonable assumption. At any point in time there should be a dominant complex of high Φ that comprises a specific set of neural elements across the cortex. However, even during normal waking consciousness, this is likely to be highly dynamic, with the composition of the complex changing from moment to moment, as certain subsets of neural elements are excluded from, or brought into, the complex (Oizumi *et al*., 2014). The phenomenology of the psychedelic state, which can include synesthesia and expanded awareness, might suggest that the integrated complex is more expansive during the psychedelic state, encompassing more of the cortex (i.e., more neural elements within the complex), but more empirical measures of integration are required.

Neural integration is commonly measured by the synchronization of neural activation-functional connectivity analysis using fMRI and coherence analysis to assess oscillatory synchrony using EEG or MEG. However, it is important to distinguish between functional and effective connectivity. Functional connectivity refers to *the temporal correlations between spatially remote neurophysiological events* (Friston, 1994), but provides no direct information about the origin of these correlations. Effective connectivity describes the causal influence of neural systems over each other (Friston, 1994). Once functional connectivity has been observed, measures of effective connectivity must be used to establish the nature of the causal interactions between neural systems (i.e., the effective connectivity); functional connectivity alone does not necessarily imply effective connectivity (Friston, 1994; Lee *et al*., 2003). In order to establish neural integration as defined by IIT, it is essential that effective connectivity be established, as it is the causal interactions between neural elements that are fundamental to generating an irreducible complex.

The phase synchronization of neural oscillations across a range of frequency bands has become the dominant model to explain how integration is achieved (Varela *et al*., 2001), as well as specific thalamocortical circuits regulating information transfer between disparate cortical regions (Guillery and Sherman, 2002). Phase locking allows disparate cortical columns to engage in synchronized causal interactions, and neural elements can exchange and share information via forced oscillations, resonant loops, and transient oscillatory coupling (Buzsaki, 2006). Synchronization can occur across a range of spatial scales; local integration might refer to synchronized activity within a single cortical column or within a tight cluster of functionally related columns. Large-scale integration can include the synchronization of neural assemblies separated by great distances, between lobes or across hemispheres. The dense and reciprocal connections between thalamocortical columns enable a large number of neural elements to synchronize within a few hundred milliseconds to generate a unified, integrated neuronal assembly (Tononi *et al*., 1998; Tononi and Edelman, 2000). Oscillations in the gamma range (30-100 Hz) have received the most attention with regards to perceptual integration (Varela *et al.*, 2001; Merker, 2013; Burwick, 2014) and such oscillations coexist with perceptual binding during normal waking consciousness (Gray and Singer, 1989; Joliot *et al.*, 1994) and during dreaming (Llinas and Ribary, 1993). In fact, the synchronization of gamma oscillations unconstrained by sensory input has been invoked as a model for hallucinations and perceptual aberrations that occur during psychosis and in certain psychedelic states (Behrendt, 2003; Behrendt and Young, 2004). Synchronous firing of fast-spiking inhibitory interneurons, which strongly inhibit cortical pyramidal cells, generates cortical gamma oscillations (Cardin *et al.*, 2009). Pertinently, these oscillations are regulated by 5-HT_{1A} and 5-HT_{2A} receptors on both pyramidal cells and their associated fast-spiking interneurons (Puig *et al.*, 2010). 5-HT_{1A} activation is largely inhibitory on both types of cell and 5-HT_{2A} activation is excitatory. By activating fast-spiking interneurons, 5-HT_{2A} activation potentiates cortical gamma oscillations and their synchronization, whilst 5-HT_{1A} activation suppresses them (Puig *et al.*, 2010; Puig and Gulledge, 2011). As the classical psychedelics are partial agonists at the 5-HT_{2A} receptor, it is tempting to suggest that the combination of pyramidal cell depolarization and the promotion of gamma oscillations might explain many of the perceptual effects of these drugs. Increased sensitivity to incoming sensory data coupled with the generation of highly coherent gamma oscillations less constrained by external sensory inputs might result in the perceptual distortions, illusions and even hallucinations observed in the psychedelic state. Furthermore, as gamma oscillations are closely associated with neural integration, it is reasonable to surmise that the psychedelic state might be characterized by an increase in integration compared to a normal waking state. Although limited to measuring temporal correlations, coherence analysis of EEG and MEG traces is often used to quantify neural integration and studies exist that employed this technology to measure the effect of psychedelic drugs, including psilocybin, LSD, and ayahuasca (containing *N*,*N*-dimethyltryptamine, DMT) on brain function. However, the effect of these drugs on coherence is not consistent across all studies. A small study employing quantitative EEG (QEEG) to measure changes in oscillatory power and coherence following ayahuasca ingestion observed a highly integrated brain state (Stuckey *et al.*, 2005). Dramatic increases in gamma coherence were widely distributed across the cortex, but especially over the occipital lobe (Stuckey *et al.*, 2005). This is consistent with an earlier study showing an increase in power in the gamma band in ayahuasca users (Don *et al.*, 1998). However, this result contrasts with other studies that found generalized decreases in power across all frequency bands (Riba *et al.*, 2002, 2004).

A more recent psilocybin MEG study (Muthukumaraswamy *et al.*, 2013) suggested that the psychedelic state is one of "disintegrated" neural activity, with reduction in both oscillatory power and synchronization observed across all frequency bands. The authors suggest that this desynchronization results from 5-HT_{2A}-mediated excitation of deep layer pyramidal cells. However, it is noteworthy that the fMRI functional connectivity motifs unique to the post-psilocybin state were the most highly connected possible (Tagliazucchi *et al.*, 2014). A disintegration of DMN integrity does not necessarily imply a reduction in overall neural integration and, indeed, an increase in between-network functional connectivity was consistently observed post-psilocybin (Roseman *et al.*, 2014). This is further supported by a later network analysis of the psilocybin fMRI functional connectivity data, which shows the post-psilocybin state to be characterized by an increase in the integration between cortical areas (Petri *et al.*, 2014). Together, this data suggests that psilocybin disrupts the *organization* of neural integration, but the overall effect appears to be an *increase* in the degree of integration.

Although this data is highly suggestive, the major limitation of functional connectivity and coherence analyses with regards to neural integration is that these temporal correlations do not necessarily imply effective connectivity. For example, propofol-induced anesthesia is associated with hypersynchronous oscillations in the alpha band (Supp *et al.*, 2011), and yet effective connectivity, and thus integration as defined by IIT, is markedly reduced (Schroter *et al.*, 2012; Casali *et al.*, 2013; Gomez *et al.*, 2013). Also, inferring causal interactions from functional imaging data requires additional techniques (Lee *et al.*, 2003), including cortical perturbation approaches, discussed below. The currently available functional imaging data falls short of providing a definitive account of the effect of psychedelic drugs on neural integration across the brain. If the psychedelic state is to be understood as either a state of heightened consciousness or, conversely, a state of lower consciousness that lies between wakefulness and sleep, then techniques for measuring both information and integration concurrently must be considered.

Measurement of Integrated Information in the Psychedelic State

Although the cause-effect information specified by individual mechanisms should be lower in the psychedelic state compared to normal waking consciousness, concomitant with increased neural entropy and reduced differentiation between network states, the psychedelic state is not associated with any experiential drop in consciousness. In fact, most individuals feel a heightened sense of alertness and awareness under the influence of a psychedelic drug, rather than feeling that their consciousness is fading (Carhart-Harris *et al.*, 2012). However, this is not a particularly reliable indicator of the effect of the drug on Φ and it isn't trivial to predict how integrated information might change when entering the psychedelic state from normal waking consciousness. As Φ is identified with the quantity of consciousness, an approximate measure of the effect of psychedelic drugs on this value would be extremely informative, revealing whether the psychedelic state is truly a state of increased or decreased consciousness and perhaps differentiating between the effects of classic psychedelics, such as psilocybin, and psychedelic anesthetics, such as ketamine.

Transcranial magnetic stimulation (TMS) coupled with EEG can be used to measure the response of the brain to direct perturbation of targeted cortical regions. Crucially, this approach separates effective connectivity (causal interactions) from functional connectivity (temporal correlations) (Massimini *et al.*, 2005). During wakefulness, TMS stimulation produces a complex (differentiated) pattern of activity that becomes widely distributed across interacting cortical areas (integrated). However, during NREM sleep, the activity generated by TMS remains localized to the stimulation area, indicating a loss of effective connectivity (integration) (Massimini *et al.*, 2005; Esser *et al.*, 2009). This effect is also observed in the loss of consciousness produced by general anesthetics (Ferrarelli *et al.*, 2010). Specific indices of cortical effective connectivity - and thus integration - can be used to quantify the spread of the TMS stimulus response (Ferrarelli *et al.*, 2010) and could be useful in measuring the effect of psychedelic drugs on neural integration.

The TMS-EEG technique has been used to develop the Perturbational Complexity Index (PCI), an empirical measure of integrated information designed to differentiate between levels of consciousness in both healthy individuals and those with severe neurological injury (Casali *et al.*, 2013; Sarasso *et al.*, 2014). The PCI is calculated using the algorithmic compressibility of the EEG data generated following TMS perturbation. If integration is low, the TMS response is spatially restricted and the PCI is low. Likewise, if the response is stereotypical and undifferentiated, the EEG data will be highly compressible and the PCI will also be low. However, if the TMS perturbation produces a complex spatiotemporal pattern of activity that spreads to a large set of integrated areas, then the data cannot be compressed and the resulting PCI is high. The PCI is thus a measure of both the informational content and the integration of neural activity. Other entropy measures fail to differentiate between the information generated by the causal interactions of neural elements and random noise. This technique, however, only measures information resulting from deterministic interactions between neural groups. The PCI is successful in distinguishing between wakefulness and unconsciousness, both during deep sleep and anesthesia, and appears to be sensitive to graded changes in the level of consciousness (Casali *et al.*, 2013). As such, it is conceivable that it could detect any difference in the level of consciousness between normal wakefulness and the psychedelic state.

Conclusions, Predictions, and Future Work

The task of the brain in shaping conscious experience has previously been framed as a problem of minimizing entropy whilst maintaining cognitive flexibility (Carhart-Harris *et al.*, 2014). By examining the psychedelic state from the perspective of IIT, we have been able to equivalently restate the problem as the optimization of cause-effect information and cognitive flexibility. Psychedelic drugs increase cognitive flexibility (enhancing creativity, novel thinking, and imagination) but sacrifice a degree of cause-effect information specified by each mechanism (concept) within the conscious complex; each mechanism constrains the past and future states of the brain less stringently. This is a novel insight, as it contrasts with a simple Shannon interpretation of entropy increase, which would equate it with an increase in information. A decrease in information makes more sense, as it explains why the psychedelic state, although being a state of "expanded awareness," might be non-optimal in terms of organizing and constraining cognition, categorizing, and differentiating concepts, and generally making sense of the progression of conscious moments. Furthermore, using this IIT-based model, it is possible to move beyond neural correlates and predict specific phenomenological features of the psychedelic state (**Table 1**).

TABLE 1 - Phenomenological features of the psychedelic state and their IIT correlates.

IIT Correlate	Phenomenological Features
Increased entropy of cause-effect repertoires, moving closer to unconstrained past-future repertoires	Conscious experience is more fluid, dynamic, and unconstrained
Number of non-zero probability states in cause-effect repertoires increases	Meaning of concepts is altered, acquiring additional characteristics. Some concepts become associated with others in unusual ways because of enhanced conceptual overlap. Imagination and creativity is enhanced
φ-value of mechanisms is altered. φ-value of some mechanisms may increase from zero	The relative prominence of concepts in the experience changes. Some concepts become less noticeable, whilst others "pop out." Completely novel concepts may also appear
Dimensionality of qualia space increased	Conscious experience seems richer and there is a sense of expanded awareness
Decrease in cause-effect information specified by individual mechanisms	Although awareness is expanded, there is a struggle to organize thoughts, to focus/concentrate, solve problems, and make sense of the world and the progression of conscious moments in the normal way

Despite reducing cause-effect information, from an experiential perspective, there is no indication that the classic psychedelics reduce the quantity of consciousness. In fact, quite the opposite appears to be the case - consciousness seems enhanced or elevated. Although this is not a reliable indicator as to the effect on Φ, which must be measured empirically, a tentative prediction can be made: any drug that increases neural entropy will produce a psychedelic state by expanding the number of states within the cause-effect repertoires of individual mechanisms, reducing the differentiation between network states and resulting in a state of unconstrained cognition and expanded awareness. However, the classic psychedelics (such as psilocybin) are able to maintain neural integration, and thus Φ and consciousness, whilst reducing cause-effect information. Although functional imaging data strongly supports this idea, it should be possible to test this more definitively using a TMS-EEG methodology. Psychedelic anesthetics, such as ketamine, whilst elevating neural entropy and so generating a form of psychedelic state, may lack the ability to maintain neural integration and, as with other anesthetics, lead to a breakdown of effective connectivity and unconsciousness in high doses (Ferrarelli *et al.*, 2010). Again, this distinction ought to be measurable using TMS-EEG and other functional neuroimaging techniques.

Funding

This work was supported in part by a funding from the Computational Neuroscience Unit of the Okinawa Institute of Science and Technology Graduate University.

Acknowledgments

The author would like to thank Dr. Stephen Connor, Dept. of Mathematics, University of York, UK, for helpful guidance in formulating the mathematical arguments in this article.

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. aan het Rot, M., Collins, K. A., Murrough, J. W., Perez, A. M., Reich, D. L., Charney, D. S., *et al.* (2010). Safety and efficacy of repeated-dose intravenous ketamine for treatment-resistant depression. *Biol. Psychiatry* 67, 139-145. doi: 10.1016/j.biopsych.2009.08.038
2. Balduzzi, D., and Tononi, G. (2009). Qualia: the geometry of integrated information. *PLoS Comput. Biol.* 5:e1000462. doi: 10.1371/journal.pcbi.1000462
3. Behrendt, R. P. (2003). Hallucinations: synchronisation of thalamocortical gamma oscillations underconstrained by sensory input. *Conscious. Cogn.* 12, 413-451. doi: 10.1016/S1053-8100(03)00017-5
4. Behrendt, R. P., and Young, C. (2004). Hallucinations in schizophrenia, sensory impairment, and brain disease: a unifying model. *Behav. Brain Sci.* 27, 771-830. doi: 10.1017/S0140525X04000184
5. Berman, R. M., Cappiello, A., Anand, A., Oren, D. A., Heninger, G. R., Charney, D. S., *et al.* (2000). Antidepressant effects of ketamine in depressed patients. *Biol. Psychiatry* 47, 351-354. doi: 10.1016/S0006-3223(99) 00230-9
6. Buchborn, T., Schroeder, H., Hoellt, V., and Grecksch, G. (2014). Repeated lysergic acid diethylamide in an animal model of depression: normalisation of learning behaviour and hippocampal serotonin 5-HT$_2$ signalling. *J. Psychopharmacol.* 28, 545-552. doi: 10.1177/0269881114531666
7. Burwick, T. (2014). The binding problem. Wiley *Interdiscip. Rev. Cogn. Sci.* 5, 305-315. doi: 10.1002/wcs.1279
8. Buzsaki, G. (2006). *Rhythms of the Brain*. Oxford: Oxford University Press.
9. Cardin, J. A., Carlen, M., Meletis, K., Knoblich, U., Zhang, F., Deisseroth, K., *et al.* (2009). Driving fast-spiking cells induces gamma rhythm and controls sensory responses. *Nature* 459, 663-667. doi: 10.1038/nature08002
10. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J. M., Reed, L. J., Colasanti, A., *et al.* (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl. Acad. Sci. U.S.A.* 109, 2138-2143. doi: 10.1073/pnas.1119598109
11. Carhart-Harris, R. L., Leech, R., Erritzoe, D., Williams, T. M., Stone, J. M., Evans, J., *et al.* (2013). Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. *Schizophr. Bull.* 39, 1343-1351. doi: 10.1093/schbul/sbs117
12. Carhart-Harris, R. L., Leech, R., Hellyer, P. J., Shanahan, M., Feilding, A., Tagliazucchi, E., *et al.* (2014). The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front. Hum. Neurosci.* 8:20. doi: 10.3389/fnhum.2014.00020
13. Casali, A. G., Gosseries, O., Rosanova, M., Boly, M., Sarasso, S., Casali, K. R., *et al.* (2013). A theoretically based index of consciousness independent of sensory processing and behavior. *Sci. Transl. Med.* 5, 10. doi: 10.1126/scitranslmed.3006294
14. Chialvo, D. R. (2010). Emergent complex neural dynamics. *Nat. Phys.* 6, 744-750. doi: 10.1038/nphys1803
15. Don, N. S., McDonough, B. E., Moura, G., Warren, C. A., Kawanishi, K., Tomita, H., *et al.* (1998). Effects of Ayahuasca on the human EEG. *Phytomedicine* 5, 87-96. doi: 10.1016/S0944-7113(98)80003-2
16. Esser, S. K., Hill, S., and Tononi, G. (2009). Breakdown of effective connectivity during slow wave sleep: investigating the mechanism underlying a cortical gate using large-scale modeling. *J. Neurophysiol.* 102, 2096-2111. doi: 10.1152/jn.00059.2009
17. Ferrarelli, F., Massimini, M., Sarasso, S., Casali, A., Riedner, B. A., Angelini, G., *et al.* (2010). Breakdown in cortical effective connectivity during midazolaminduced loss of consciousness. *Proc. Natl. Acad. Sci. U.S.A.* 107, 2681-2686. doi: 10.1073/pnas.0913008107
18. Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., van Essen, D. C., and Raichle, M. E. (2005). The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proc. Natl. Acad. Sci. U.S.A.* 102, 9673-9678. doi: 10.1073/pnas.0504136102
19. Frecska, E., More, C. E., Vargha, A., and Luna, L. E. (2012). Enhancement of creative expression and entoptic phenomena as after-effects of repeated ayahuasca ceremonies. *J. Psychoactive Drugs* 44, 191-199. doi: 10.1080/02791072.2012.703099
20. Friston, K. J. (1994). Functional and effective connectivity in neuroimaging: a synthesis. *Hum. Brain Mapp.* 2, 56-78. doi: 10.1002/hbm.460020107
21. Gomez, F., Phillips, C., Soddu, A., Boly, M., Boveroux, P., Vanhaudenhuyse, A., *et al.* (2013). Changes in effective connectivity by propofol sedation. *PLoS ONE* 8:e71370. doi: 10.1371/journal.pone.0071370
22. Gray, C. M., and Singer, W. (1989). Stimulus-specific neuronal oscillations in orientation columns of cat visual-cortex. *Proc. Natl. Acad. Sci. U.S.A.* 86, 1698-1702. doi: 10.1073/pnas.86.5.1698
23. Guillery, R. W., and Sherman, S. M. (2002). Thalamic relay functions and their role in corticocortical communication: generalizations from the visual system. *Neuron* 33, 163-175. doi: 10.1016/S0896-6273(01)00582-7
24. Gunduz-Bruce, H. (2009). The acute effects of NMDA antagonism: from the rodent to the human brain. *Brain Res. Rev.* 60, 279-286. doi: 10.1016/j.brainresrev.2008.07.006
25. Hofmann, A. (1980). *LSD: My Problem Child*. New York, NY: McGraw-Hill Book Company.
26. Hollister, L. E. (1984). "Effects of hallucinogens in humans," in *Hallucinogens: Neurochemical, Behavioral and Clinical Perspectives*, ed B. L. Jacobs (New York, NY: Raven Press), 19-33.
27. Joliot, M., Ribary, U., and Llinas, R. (1994). Human oscillatory brain activity near 40 Hz coexists with cognitive temporal binding. *Proc. Natl. Acad. Sci. U.S.A.* 91, 11748-11751. doi: 10.1073/pnas.91.24.11748
28. Jones, K. A., Blagrove, M., and Parrott, A. C. (2009). Cannabis and Ecstasy/MDMA: empirical measures of creativity in recreational users. *J. Psychoactive Drugs* 41, 323-329. doi: 10.1080/02791072.2009.10399769
29. Krystal, J. H., Karper, L. P., Seibyl, J. P., Freeman, G. K., Delaney, R., Bremner, J. D., *et al.* (1994). Subanesthetic effects of the noncompetitive NMDA antagonist, ketamine, in humans - psychotomimetic, perceptual, cognitive, and neuroendocrine responses. *Arch. Gen. Psychiatry* 51, 199-214. doi: 10.1001/archpsyc.1994.03950030035004
30. Lee, L., Harrison, L. M., and Mechelli, A. (2003). A report of the functional connectivity workshop, Dusseldorf 2002. *Neuroimage* 19, 457-465. doi: 10.1016/S1053-8119(03)00062-4

31. Llinas, R., and Ribary, U. (1993). Coherent 40-Hz oscillation characterizes dream state in humans. *Proc. Natl. Acad. Sci. U.S.A.* 90, 2078-2081. doi: 10.1073/pnas.90.5.2078
32. Margolis, E., and Laurence, S. (2014). *Concepts. The Stanford Encyclopedia of Philosophy* (Spring 2014 Edition). Available online at: http://plato.stanford.edu/ archives/spr2014/entries/concepts/. [Accessed 12 December 2014].
33. Massimini, M., Ferrarelli, F., Huber, R., Esser, S. K., Singh, H., and Tononi, G. (2005). Breakdown of cortical effective connectivity during sleep. *Science* 309, 2228-2232. doi: 10.1126/science.1117256
34. Masters, R. E. L. (1966). *The Varieties of Psychedelic Experience*. New York, NY: Henry Holt & Company, Inc.
35. Merker, B. (2013). Cortical gamma oscillations: the functional key is activation, not cognition. *Neurosci. Biobehav. Rev.* 37, 401-417. doi: 10.1016/j.neubiorev.2013.01.013
36. Moreno, F. A., and Delgado, P. L. (1997). Hallucinogen-induced relief of obsessions and compulsions. *Am. J. Psychiatry* 154, 1037-1038. doi: 10.1176/ajp.154.7.1037b
37. Murray, R. M., Paparelli, A., Morrison, P. D., Marconi, A., and di Forti, M. (2013). What can we learn about schizophrenia from studying the human model, druginduced psychosis? *Am. J. Med. Genet. B Neuropsychiatr. Genet.* 162, 661-670. doi: 10.1002/ajmg.b.32177
38. Muthukumaraswamy, S. D., Carhart-Harris, R. L., Moran, R. J., Brookes, M. J., Williams, T. M., Errtizoe, D., *et al.* (2013). Broadband cortical desynchronization underlies the human psychedelic state. *J. Neurosci.* 33, 15171-15183. doi: 10.1523/JNEUROSCI.2063-13.2013
39. Nagel, T. (1974). What is it like to be a bat? *Philos. Rev.* 84, 435-450. doi: 10.2307/2183914
40. Nichols, D. E. (2004). Hallucinogens. *Pharmacol. Ther.* 101, 131-181. doi: 10.1016/j.pharmthera.2003.11.002
41. Oizumi, M., Albantakis, L., and Tononi, G. (2014). From the phenomenology to the mechanisms of consciousness: integrated information theory 3.0. *PLoS Comput. Biol.* 10:e1003588. doi: 10.1371/journal.pcbi.10 03588
42. Petri, G., Expert, P., Turkheimer, F., Carhart-Harris, R., Nutt, D., Hellyer, P. J., *et al.* (2014). Homological scaffolds of brain functional networks. *J. R. Soc. Interface* 11:20140873. doi: 10.1098/rsif.2014.0873
43. Puig, M. V., and Gulledge, A. T. (2011). Serotonin and prefrontal cortex function: neurons, networks, and circuits. *Mol. Neurobiol.* 44, 449-464. doi: 10.1007/s12035-011-8214-0
44. Puig, M. V., Watakabe, A., Ushimaru, M., Yamamori, T., and Kawaguchi, Y. (2010). Serotonin modulates fast-spiking interneuron and synchronous activity in the rat prefrontal cortex through 5-HT$_{1A}$ and 5-HT$_{2A}$ receptors. *J. Neurosci.* 30, 2211-2222. doi: 10.1523/JNEUROSCI.3335-0 9.2010
45. Qin, P. M., and Northoff, G. (2011). How is our self related to midline regions and the default-mode network? *Neuroimage* 57, 1221-1233. doi: 10.1016/j.neuroimage.2011.05.028
46. Riba, J., Anderer, P., Jane, F., Saletu, B., and Barbanoj, M. J. (2004). Effects of the South American psychoactive beverage Ayahuasca on regional brain electrical activity in humans: a functional neuroimaging study using lowresolution electromagnetic tomography. *Neuropsychobiology* 50, 89-101. doi: 10.1159/000077946
47. Riba, J., Anderer, P., Morte, A., Urbano, G., Jane, F., Saletu, B., *et al.* (2002). Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers. *Br. J. Clin. Pharmacol.* 53, 613-628. doi: 10.1046/j.1365-2125.2002.01609.x
48. Roseman, L., Leech, R., Feilding, A., Nutt, D. J., and Carhart-Harris, R. L. (2014). The effects of psilocybin and MDMA on between-network resting state functional connectivity in healthy volunteers. *Front. Hum. Neurosci.* 8:204. doi: 10.3389/fnhum.2014.00204
49. Sarasso, S., Rosanova, M., Casali, A. G., Casarotto, S., Fecchio, M., Boly, M., *et al.* (2014). Quantifying cortical EEG responses to TMS in (Un)consciousness. *Clin. EEG Neurosci.* 45, 40-49. doi: 10.1177/1550059413 513723
50. Schroter, M. S., Spoormaker, V. I., Schorer, A., Wohlschlager, A., Czisch, M., Kochs, E. F., *et al.* (2012). Spatiotemporal reconfiguration of large-scale brain functional networks during propofol-induced loss of consciousness. *J. Neurosci.* 32, 12832-12840. doi: 10.1523/JNEUROSCI.6046-11.2012
51. Sessa, B. (2008). Is it time to revisit the role of psychedelic drugs in enhancing human creativity? *J. Psychopharmacol.* 22, 821-827. doi: 10.1177/0269881108091597
52. Stuckey, D. E., Lawson, R., and Luna, L. E. (2005). EEG gamma coherence and other correlates of subjective reports during ayahuasca experiences. *J. Psychoactive Drugs* 37, 163-178. doi: 10.1080/02791072.2005.10 399798
53. Supp, G. G., Siegel, M., Hipp, J. F., and Engel, A. K. (2011). Cortical hypersynchrony predicts breakdown of sensory processing during loss of consciousness. *Curr. Biol.* 21, 1988-1993. doi: 10.1016/j.cub.2011.10.017
54. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D., and Chialvo, D. R. (2014). Enhanced repertoire of brain dynamical states during the psychedelic experience. *Hum. Brain Mapp.* 35, 5442-5456. doi: 10.1002/hbm.22562
55. Tononi, G. (2012). Integrated information theory of consciousness: an updated account. *Arch. Ital. Biol.* 150, 56-90. doi: 10.4449/aib.v149i5.1388
56. Tononi, G., and Edelman, G. M. (2000). Schizophrenia and the mechanisms of conscious integration. *Brain Res. Rev.* 31, 391-400. doi: 10.1016/S0165- 0173(99)00056-9
57. Tononi, G., Edelman, G. M., and Sporns, O. (1998). Complexity and coherency: integrating information in the brain. *Trends Cogn. Sci.* 2, 474-484. doi: 10.1016/S1364-6613(98)01259-5
58. Varela, F., Lachaux, J. P., Rodriguez, E., and Martinerie, J. (2001). The brainweb: phase synchronization and large-scale integration. *Nat. Rev. Neurosci.* 2, 229-239. doi: 10.1038/35067550
59. Vollenweider, F. X. (2001). Brain mechanisms of hallucinogens and entactogens. *Dialogues Clin. Neurosci.* 3, 265-279.
60. Vollenweider, F. X., Leenders, K. L., Scharfetter, C., Maguire, P., Stadelmann, O., and Angst, J. (1997). Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16, 357-372. doi: 10.1016/S0893-133X(96) 00246-1
61. Vollenweider, F. X., Vollenweider-Scherpenhuyzen, M. F. I., Babler, A., Vogel, H., and Hell, D. (1998). Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9, 3897-3902. doi: 10.1097/00001756-199812010-00024

Psilocybin-induced spiritual experiences and insightfulness are associated with synchronization of neuronal oscillations

by

Michael Kometer[1] & Thomas Pokorny[1] & Erich Seifritz[2] & Franz X. Volleinweider[1]

© 2015 Michael Kometer

original report: http://www.ouramazingworld.org/uploads/4/3/8/6/43860587/kometer2015.pdf
backup source: http://www.psilosophy.info/resources/kometer2015.pdf

1. Neuropsychopharmacology and Brain Imaging Research Unit, Department of Psychiatry, Psychotherapy and Psychosomatics, University Hospital of Psychiatry Zurich, Lenggstrasse 31, CH-8032 Zurich, Switzerland 2
2. Department of Psychiatry, Psychotherapy and Psychosomatics, University Hospital of Psychiatry Zurich, Lenggstrasse 31, CH-8032 Zurich, Switzerland

Michael Kometer - mikometer@gmail.com

Received: 22 September 2014
Accepted: 6 July 2015
Published online: 01 August 2015

Table of Contents:

- **Abstract**
- **Introduction**
- **Materials and methods**
  - Subjects
  - Substance and dosing
  - Experimental design
  - Acute subjective drug effects
  - EEG recordings
  - EEG analysis
    - *Preprocessing of EEG data*
    - *Current source density of neuronal oscillations*
    - *Lagged phase synchronization of neuronal oscillations*
- **Results**
  - Acute consciousness-altering effects of psilocybin
  - Current source density of neuronal oscillations
  - Lagged phase synchronization of neuronal oscillations
- **Discussion**
- **Acknowledgments**
- **References**

Abstract

Rationale During the last years, considerable progress has been made toward understanding the neuronal basis of consciousness by using sophisticated behavioral tasks, brain-imaging techniques, and various psychoactive drugs. Nevertheless, the neuronal mechanisms underlying some of the most intriguing states of consciousness, including spiritual experiences, remain unknown.

Objectives To elucidate state of consciousness-related neuronal mechanisms, human subjects were given psilocybin, a naturally occurring serotonergic agonist and hallucinogen that has been used for centuries to induce spiritual experiences in religious and medical rituals.

Methods In this double-blind, placebo-controlled study, 50 healthy human volunteers received a moderate dose of psilocybin, while high-density electroencephalogram (EEG) recordings were taken during eyes-open and eyes-closed resting states. The current source density and the lagged phase synchronization of neuronal oscillations across distributed brain regions were computed and correlated with psilocybin-induced altered states of consciousness.

Results Psilocybin decreased the current source density of neuronal oscillations at 1.5-20 Hz within a neural network comprising the anterior and posterior cingulate cortices and the parahippocampal regions. Most intriguingly, the intensity levels of psilocybin-induced spiritual experience and insightfulness correlated with the lagged phase synchronization of delta oscillations (1.5-4 Hz) between the retrosplenial cortex, the parahippocampus, and the lateral orbitofrontal area.

Conclusions These results provide systematic evidence for the direct association of a specific spatiotemporal neuronal mechanism with spiritual experiences and enhanced insight into life and existence. The identified mechanism may constitute a pathway for modulating mental health, as spiritual experiences can promote sustained well-being and psychological resilience.

Keywords: Psilocybin, Consciousness, Spirituality, Oscillations, Serotonin, EEG, Resting-State, PCC, ACC, Delta.

Introduction

Spiritual experiences are rare but highly significant phenomena of consciousness, which have the capacity to promote sustained well-being and resilience (Maselko and Kubzansky 2006; Southwick and Charney 2012). Accordingly, these experiences have been the subject of countless psychological, religious, sociological, and philosophical discussions across human history. Nevertheless, their neuronal correlates are largely unknown, because systematic assessment is hampered by their infrequent and unpredictable occurrence. Questionnaire-based analyses, for example, have revealed that depending on the definition of spiritual experiences, only approximately one third to one half of healthy human subjects ever have an intense spiritual experience over the course of their entire lives (Levin 1993). Therefore, the few systematic neuroscience studies concerning spirituality have focused their attention on neuronal features that predispose subjects to a transcendent experience (Urgesi *et al*. 2010; Tenke *et al*. 2013; Miller *et al*. 2014). However, these studies did not address the question, which neuronal processes predominate during a spiritual experience and are therefore likely to be directly associated with this experience?

Interestingly, recent placebo-controlled studies showed that spiritual experiences, referring to profound experiences of awe and connectedness to a superior power, can be dose-dependently induced by the serotonergic hallucinogen psilocybin, often paired with a marked experience of unity, insightfulness, and bliss (Dittrich 1998; Studerus *et al*. 2010; Kometer *et al*. 2012). In a recent study, higher doses of psilocybin as used in the present study were found to induce a state that fulfilled according to Stace (1961) all criteria required to qualify for a "complete mystical experience" (Griffiths *et al*. 2006). At 14-month follow-up, subjects rated these experiences as both authentic (Griffiths *et al*. 2006) and among the most spiritually significant events of their lives (Griffiths *et al*. 2008). Thus, psilocybin constitutes a unique research tool that can be used to trigger selected and previously unexplored states of consciousness, including spiritual experiences and associated states, in a controlled experimental setting. In combination with neuroimaging techniques, the drug therefore permits a systematic assessment of neuronal processes behind these altered states of mind.

Neuronal oscillations and their phase synchronization across brain regions may be of particular importance for understanding psilocybin-induced states of consciousness, because neuronal oscillations are thought to represent a key mechanism of neuronal integration (Buzsáki and Draguhn 2004; Womelsdorf *et al*. 2007; Siegel *et al*. 2012) that shapes consciousness (Varela *et al*. 2001; Alkire *et al*. 2008). In line with this view, anesthesia-induced loss of consciousness is associated with changes in neuronal oscillations, including the appearance of high-amplitude alpha waves in frontal cortical areas (Ching *et al*. 2010), as well as an increase in the phase synchronization of gamma oscillations between the anterior and posterior cingulate cortices (Murphy *et al*. 2011). However, despite abundant experimental support for the critical role of oscillations in regulating levels of consciousness, whether neuronal oscillations also mediate specific states of consciousness (Shushruth 2013), as exemplified by spiritual experiences, remains unknown.

Studies exploring the effects of serotonergic hallucinogens on neuronal oscillations would undoubtedly contribute to our understanding of this issue, as serotonergic hallucinogens reliably induce distinctive states of consciousness. Nevertheless, the impact of serotonergic hallucinogens on neuronal oscillations, and particularly the association of these oscillations with identifiable conscious states, is unclear. Initial animal studies performed with the hallucinogenic serotonin (5-HT) 2A/2C agonist, 1-[2,5-dimethoxy-4-iodophenyl]-2-aminopropane (DOI), reported a DOI-induced reduction in delta (0.3-4 Hz) and gamma (30-80 Hz) oscillations in the prefrontal areas of the brain (Celada *et al*. 2008; Puig *et al*. 2010), in addition to a trend toward an increase in higher frequency (70-90 Hz) oscillations in subcortical structures (Goda *et al*. 2013). In humans, oscillations decreased across a broad frequency range (up to 20 Hz) during eyes closed resting state after the administration of ayahuasca, a plant brew containing *N,N*-dimethyltryptamine (DMT), another naturally occurring serotonergic hallucinogen (Riba *et al*. 2002; Riba *et al*. 2004). Furthermore, psilocybin decreased prestimulus-associated parieto-occipital alpha (8-12 Hz) oscillations, which in turn precluded the subsequent visual stimulus-induced modulation of alpha oscillations during visual processing (Kometer *et al*. 2013). Recently, a magnetoencephalography (MEG) analysis showed that psilocybin decreases the power of all neuronal oscillations of ≤100 Hz during the eyes open resting state (Muthukumaraswamy *et al*. 2013).

Taken together, the initial evidence provided by the studies described above suggests that the impact of serotonergic hallucinogens on neuronal oscillations is, to some extent, both species- and drug-dependent. However, in humans, serotonergic hallucinogens have a common tendency to decrease the power of lower frequency oscillations, especially alpha oscillations (8-12 Hz). The decrease may not be uniform across cortical areas, may differ in eyes open and eyes closed states, and may have different functional consequences depending on the cortical area of interest. The specific pattern of power decrease could potentially underlie various psilocybin-induced states of consciousness. Finally and most importantly, mounting evidence indicates that phase synchronization of neuronal oscillations plays a key functional role across brain areas in the formation of consciousness (Varela *et al*. 2001; Melloni *et al*. 2007; Busch *et al*. 2009; Dehaene and Changeux 2011; Hipp *et al*. 2011; Fahrenfort *et al*. 2012; Steinmann *et al*. 2014). For this reason, we suggest that not only regional power changes of oscillations but also phase synchronization of oscillations across brain regions may account for some hallucinogen-induced states of consciousness.

To explore this hypothesis, we conducted a double-blind, placebo-controlled study and administered psilocybin to 50 healthy human volunteers to alter consciousness and to induce spiritual experiences. We then used electrophysiological neuroimaging methods to characterize psilocybin-induced alterations in the current source density of neuronal oscillations during eyes-open and eyes-closed resting states. Furthermore, we assessed the dynamic coordination of oscillations across distributed brain regions by computing lagged phase synchronization of neuronal oscillations. Compared with other coordination measures (e.g., instantaneous connectivity), lagged phase synchronization provides a new measure that can capture nonlinear neuronal relationships. Furthermore, lagged phase synchronization is not affected by artifacts deriving from volume conduction, electromyographic activity, or by concomitant and unrelated power modulation in two regions (Pascual-Marqui *et al*. 2011). Lastly, we correlated lagged phase synchronization values with the subjective intensity of psilocybin-induced states of consciousness by using nonparametric permutation tests.

Materials and methods

Subjects

Fifty-five healthy human subjects were enrolled. The subjects' physical health was confirmed by a physical examination that included electrocardiography and detailed blood analysis. Pregnant women were identified using a urine test and then excluded. The Mini-International Neuropsychiatric Interview for DSM-IV (Sheehan *et al*. 1998), the Expert System for Diagnosing Mental Disorders (Wittchen and Pfister 1997), and the Hopkins System Checklist 90-Revised (Derogatis 1994) were used to identify subjects with present or antecedent psychiatric disorders or a history of major psychiatric disorders in first-degree relatives, and these subjects were excluded. Urine screening and a self-report drug use questionnaire were used to verify the absence of drug dependence.

Subjects were informed about the procedures of the study and the effects and possible risks of the administered substances. They were further asked to abstain from caffeine and to ingest no other psychoactive substance during the whole experimental days. Moreover, they were not allowed to drink alcohol within 48 h before measurements or to consume any illegal psychoactive substance within 3 weeks before measurements. This procedure was chosen to prevent any effect of this pharmacological substance on neuronal oscillations. All subjects were subsequently asked to give written informed consent to participate. The study was approved by the Ethics Committee of the Department of Public Health of the Canton of Zurich, Switzerland, and the use of psilocybin was authorized by the Swiss Federal Office of Public Health, Department of Pharmacology and Narcotics, Bern, Switzerland. Five subjects were excluded from the analysis because artifacts contaminated the majority of data in the psilocybin or the placebo condition. Thus, a total of 50 subjects were included in the statistical analysis (28 males, 22 females, mean age 24.8±4.0 years).

Substance and dosing

Each subject took part in one of three double-blind, placebo-controlled, within-subject, randomized pharmacological studies. In each of these three studies, subjects were tested on four different days, each separated by at least 2 weeks. The four testing sessions were placebo + placebo, placebo + psilocybin, drug 1 + placebo, and drug 1 + psilocybin, where drug 1 represents ketanserin, ergotamine, or buspirone according to the study. In the first study (study 1), the subjects (*N*=15) received placebo or ketanserin (50 mg peroral (p.o.)) followed by placebo or psilocybin (215 µg/kg p.o.) after 1 h. In the second study (study 2), the subjects (*N*=18) received placebo or ergotamine (3 mg p.o.), followed by placebo or psilocybin (170 µg/kg p.o.) after 1 h, and in the third study (study 3), the subjects (*N*=17) received placebo or buspirone (20 mg p.o.) followed by placebo or psilocybin (170 µg/kg p.o.) after 1 h. Thus, each of the 50 subjects received placebo + placebo and placebo + psilocybin on two separate days, and only the data from these two testing sessions were used for the analysis. This large number of subjects will allow to calculate robust correlations between the psilocybin-induced altered states of consciousness and neuronal oscillations. Furthermore, the doses of psilocybin (170 and 215 µg/kg p.o.) are rather moderate compared to some previous behavioral psilocybin studies (Griffiths *et al*. 2006) because it is conceivable that psilocybin-induced facial muscle tensions at high doses introduce too many EEG artifacts to be properly removed.

Experimental design

On each experimental day, subjects came to the laboratory between 8 and 9 a.m. and confirmed that they had not ingested caffeine that morning. Electroencephalography (EEG) recording took place in a sound-, light-, and electrically shielded room at 60 min post-administration of psilocybin/placebo. Subjects were instructed either to close their eyes (eyes-closed condition) or to keep their gaze fixed on a cross that appeared in the middle of the computer screen (eyes-open condition). This fixation cross was used to reduce eye movements and thus muscle artifacts. These two conditions were conduced twice in a randomized order in study 1 for 2 min each and in studies 2-3 for 2.5 min each. To prevent that subject fall asleep during the experiment, the study principal investigator verbally alerted the subject if any signs of strong drowsiness appeared in the behavior and EEG traces. This procedure was required for two subjects in the placebo condition. The self-reported questionnaire was given after all subjective effects of the drugs disappeared, to retrospectively rate the drug-induced conscious state.

Acute subjective drug effects

The Altered States of Consciousness questionnaire (5DASC), a well-validated self-rating scale with 94 visual analogue items, was used to quantify the subjective psychological effects of psilocybin (Dittrich 1998). This questionnaire and its short form OAV are to date the most widely used questionnaires to assess the structure and components of altered states of consciousness, including spiritual experiences (Dittrich 1998). The dimensional structure of the 5D-ASC/OAV was established in series of experiments and validated based on more than 1000 single trials using various non-pharmacological and pharmacological ASC-inducing methods (Dittrich 1998; Studerus *et al*. 2010). A confirmatory factor analysis of the 5DASC/OAV revealed 11 subscales, which can be measured across drug conditions, settings, and sexes: experience of unity, spiritual experience, blissful state, insightfulness, changed meaning of percepts, disembodiment, impaired control and cognition, anxiety, elementary imagery, complex imagery, audio-visual synesthesia (Studerus *et al*. 2010). Of particular interest with regard to the current study was the spiritual experience subscale, assessing experiences of awe and being connected with a superior power. This experience is thought to represent the core of spiritual experiences, as almost all definitions of spiritual experiences include this aspect. In addition, related subscales were of interest, including experience of unity, comprising the experience of oneness with the environment and the self, insightfulness, measuring profound insights into life and existence, blissful state, measuring experiences of pleasure, inner peace, and love (Studerus *et al*. 2010). Importantly, these additional subscales are related to spiritual experience subscale, but confirmatory factor analysis clearly indicate that they cannot be merged into the spiritual experience subscale and should therefore be regarded as separate component of altered states of consciousness.

EEG recordings

EEG data were recorded from 64 scalp electrodes using the BioSemi ActiveTwo electrode system (BioSemi, Netherlands). Additional electrodes were attached to the outer canthus of each eye and both infraorbitally and supraorbitally to the left eye to record the horizontal and vertical electroocculograms, respectively. Electrophysiological signals were sampled at a rate of 512 Hz.

EEG analysis

Preprocessing of EEG data

EEG data were filtered offline with a low cutoff of 0.5 Hz. Artifacts from eye movements, blinks, or muscle tensions were removed using the infomax independent component (ICA) analysis algorithm (Bell and Sejnowski 1995; Lee *et al*. 1999). Bad channels were interpolated using spherical splines (Perrin *et al*. 1989). Data were re-referenced to the average and segmented in 2-s epochs. Subsequently, data were carefully inspected by a trained researcher to remove epochs that were contaminated by sweat, technical, or remaining muscle artifacts. The mean±SD number of artifact free epochs per condition was 124±26 for placebo eyes-closed, 124±25 for placebo eyes-open, 121±25 for psilocybin eyes-closed, and 116±28 for psilocybin eyes-open. The number of artifact free epochs did not significantly differ between drug or eyes-open/closed conditions (all Ps=n.s.), as assessed by a repeated measure ANOVA using within-subject factor drug (placebo vs. psilocybin) and condition (eyes-open vs. eyes-closed).

Current source density of neuronal oscillations

Exact low-resolution brain electromagnetic tomography (eLORETA; publicly available free academic software at http://www.uzh.ch/keyinst/loreta.htm) was applied to compute the three-dimensional intracerebral current density values (μA/mm^2) of the scalp-recorded EEG rhythms (Pascual-Marqui *et al*. 2011). eLORETA is the newest version of LORETA, a linear minimum norm inverse solution that does not require any prior assumptions about the number or position of dipoles underlying the scalp-recorded EEG data (Pascual-Marqui *et al*. 1994; Pascual-Marqui 2002; Pascual-Marqui *et al*. 2011). The LORETA inverse solution is based on the assumption that synchronized discharge is required for generating cortical EEG rhythms, an assumption that has been consolidated in numerous intracerebral studies (Buzsáki *et al*. 2012). LORETA has been applied in almost thousand peer-review publication (Thatcher *et al*. 2012) and has received considerable cross-modal validation from several studies combining LORETA with more established localizing methods such as functional MRI (Vitacco *et al*. 2002; Mulert *et al*. 2004; Mulert *et al*. 2005; Olbrich *et al*. 2009; Neuner *et al*. 2014), structural MRI (Worrell *et al*. 2000; Babiloni *et al*. 2011; Babiloni *et al*. 2013; Vecchio *et al*., 2015), diffusion spectrum magnetic resonance imaging (Thatcher *et al*. 2012), or positron emission tomography (Pizzagalli *et al*. 2004; Horacek *et al*. 2007). We apply eLORETA, which has no localization bias even in the presence of structured noise (Pascual-Marqui *et al*. 2011) and, therefore, was found to have a slightly increase localization performance compared to the previous version, called sLORETA (Jatoi *et al*. 2014).

We used eLORETA with a three-shell spherical head model registered to the digitized MRI version of the Talairach and Tournoux atlas (Brain Imaging Centre, Montreal Neurological Institute). Electrode coordinates were calculated by cross-registration of spherical and realistic head geometry (Towle *et al*. 1993). The solution space was restricted to cortical gray matter and the hippocampus and included a total of 6239 voxels at 5×5×5-mm spatial resolution. The eLORETA intracranial spectral density was calculated separately for eyes-open and eyes-closed conditions with a resolution of 0.5 Hz for each of eight frequency bands: delta (1.5-4 Hz), theta (4-8 Hz), alpha1 (8-10.5 Hz), alpha2 (10.5-13 Hz), beta1 (13-20 Hz), beta2 (20-30 Hz), gamma1 (30-45 Hz), and gamma2 (55-100 Hz).

Nonparametric mapping was performed by eLORETA software package (Pascual-Marqui *et al*. 2011; Pascual-Marqui *et al*. 2014) to statistically assess all frequency bands in both the eyes-open and eyes-closed conditions while correcting for multiple comparisons across voxels and frequencies. The statistical difference in the three-dimensional current source density between the placebo and psilocybin condition, and the correlation between the current source density in the psilocybin condition and the 11 states of consciousness were evaluated for each frequency band in each condition. To this end, differences in current density values between the placebo and the psilocybin condition for each frequency band were calculated by voxel-by-voxel-dependent t tests (two-tailed). Furthermore, the voxel-wise product-moment correlations between current source density in the psilocybin condition and the 11 5D-ASC subscale scores were computed by regression analyses. To determine the cortical voxels with significant effects, we estimated the empirical probability distribution for the maximal statistics under the null hypothesis by 5000 permutations, a procedure that does not rely on Gaussian distribution of dependent variables (Nichols and Holmes 2002; Nichols 2012). The omnibus null hypothesis was rejected if the dependent sample t value (two-tailed) of at least one voxel was above the critical threshold for p=0.05.

Lagged phase synchronization of neuronal oscillations

The dynamic phase-synchronization of neuronal oscillations across cortical areas was assessed by computing lagged phase synchronization in the eLORETA source localization space (Pascual-Marqui *et al*. 2011). Lagged phase synchronization is a novel index based on normalized Fourier transforms and is, therefore, related to nonlinear functional connectivity. Lagged phase synchronization measures phase-synchronization between two regions of interests (ROIs) after removing the zero-lag contribution. Thus, it removes the instantaneous component, which is driven by non-physiological effects and intrinsic physical artifacts that occur due to volume conduction and low spatial resolution (Nolte *et al*. 2004; Stam *et al*. 2007; Schoffelen and Gross 2009; Pascual-Marqui *et al*. 2011). Accordingly, lagged phase synchronization has been increasingly used in recent studies (Canuet *et al*. 2011; Hilty *et al*. 2011; Canuet *et al*. 2012; Guggisberg *et al*. 2014; Kühnis *et al*. 2014; Olbrich *et al*. 2014; Ramyead *et al*. 2014; Steinmann *et al*. 2014; Elmer *et al*. 2015; Vecchio *et al*., 2015) and has received cross-modal validation by studies combining EEG-based lagged phase synchronization measurements with MRI-based diffusion tensor imaging (Vecchio *et al*. 2015).

To prevent a bias in selecting regions of interest for lagged phase synchronization analysis, we used a whole-brain Brodmann areas (BAs) approach by selecting the centroids of all 42 BAs in each hemisphere as regions of interest and computing lagged phase synchronization between all pairs of regions of interest (Canuet *et al*. 2011; Pascual-Marqui *et al*. 2011).

Statistical differences in lagged phase synchronization between placebo and psilocybin conditions were assessed separately for each frequency band and for eyes-closed and eyes-open conditions using dependent samples *t* tests (two-tailed). Randomization strategy with 5000 permutations was used to appropriately correct for multiple comparisons. Finally, the association between lagged phase synchronization and state of consciousness was assessed, firstly by computing the product-moment correlation between lagged phase synchronization values and the scores of the 11 subscales of the 5D-ASC in the psilocybin condition and secondly by using randomization strategy (5000 permutations) to determine the critical probability threshold values for $p=0.05$.

Results

Acute consciousness-altering effects of psilocybin

The subjective effects of psilocybin were assessed by a repeated-measures ANOVA on the Altered States of Consciousness questionnaire (5D-ASC) score with drug (psilocybin, placebo) and 5D-ASC subscale (spiritual experience, experience of unity, blissful state, insightfulness, disembodiment, impaired control and cognition, anxiety, complex imagery, elementary imagery and audio-visual synesthesia, changed meaning of percepts) as within-subject factors and dose (170 and 215 µg/kg p.o) as between-subject factor. There was a significant main effect of drug ($F(1,48)=64.23$, $p<0.00001$) and subscale ($F(10,480)=20.57$, $p<0.00001$), but not of dose ($F(1,48)=0.23$, $p=.63$). The significant interaction between drug×subscale ($F(10,480)=19.90$, $p<0.00001$) and Fischer's LSD post hoc analysis on this interaction revealed that psilocybin significantly increased scores of all subscales (all $p<0.05$), including spiritual experiences ($p<0.00001$), experience of unity ($p<0.00001$), blissful state ($p<0.00001$), and insightfulness ($p<0.00001$). Finally, LSD post hoc analysis on the significant interaction between drug×subscale×dose ($F(10,480)=2.00$, $p<0.05$) revealed that only the subscales elementary hallucinations ($p<0.05$) and blissful states ($p<0.01$) revealed high scores with higher doses. This was expected as the two doses are very similar.

Current source density of neuronal oscillations

In the eyes-closed condition, psilocybin significantly decreased current source density of oscillations in all frequency bands up to 20 Hz ($p_{max}=0.00020$, corrected; Fig. 1), and in the eyes-open condition, psilocybin significantly decreased current source density of oscillations in all frequency bands up to 30 Hz ($p_{max}=0.00020$, corrected; Fig. 2). In both the eyes-open and eyes-closed conditions, there was a consistent, significant psilocybin-induced reduction of current source density across low-frequency bands (<20 Hz) in the PCC (Brodmann area (BA) 23 and BA31) and the retrosplenial cortex (RSC; BA30) (Figs. 1 and 2). In addition, in both the eyes-open and eyes-closed conditions, there was a significant psilocybin-induced reduction of current source density across most frequency bands in the anterior cingulate cortex (BA24), the precuneus (BA31), the cuneus (BA30), the parahippocampal gyrus (BA27 and BA30), and additional areas of the RSC (BA29) (Figs. 1 and 2). In both the eyes-open and eyes-closed conditions, the psilocybin-induced decrease in current source density in the theta (4-8 Hz) and alpha1 (8-10.5 Hz) frequency bands was more widely distributed than in other frequency bands and included the insular cortex (BA13), the occipitotemporal area (BA37), and parahippocampal regions (BA35 and BA36) (Figs. 1 and 2). In the alpha1 frequency band and partially in the alpha2 frequency band (10.5-13 Hz), the psilocybin-induced decrease in current source density also occurred across large areas of the posterior occipital-parietal cortex (BA7, BA17, BA18, and BA19), particularly in the right hemisphere (Figs. 1 and 2).

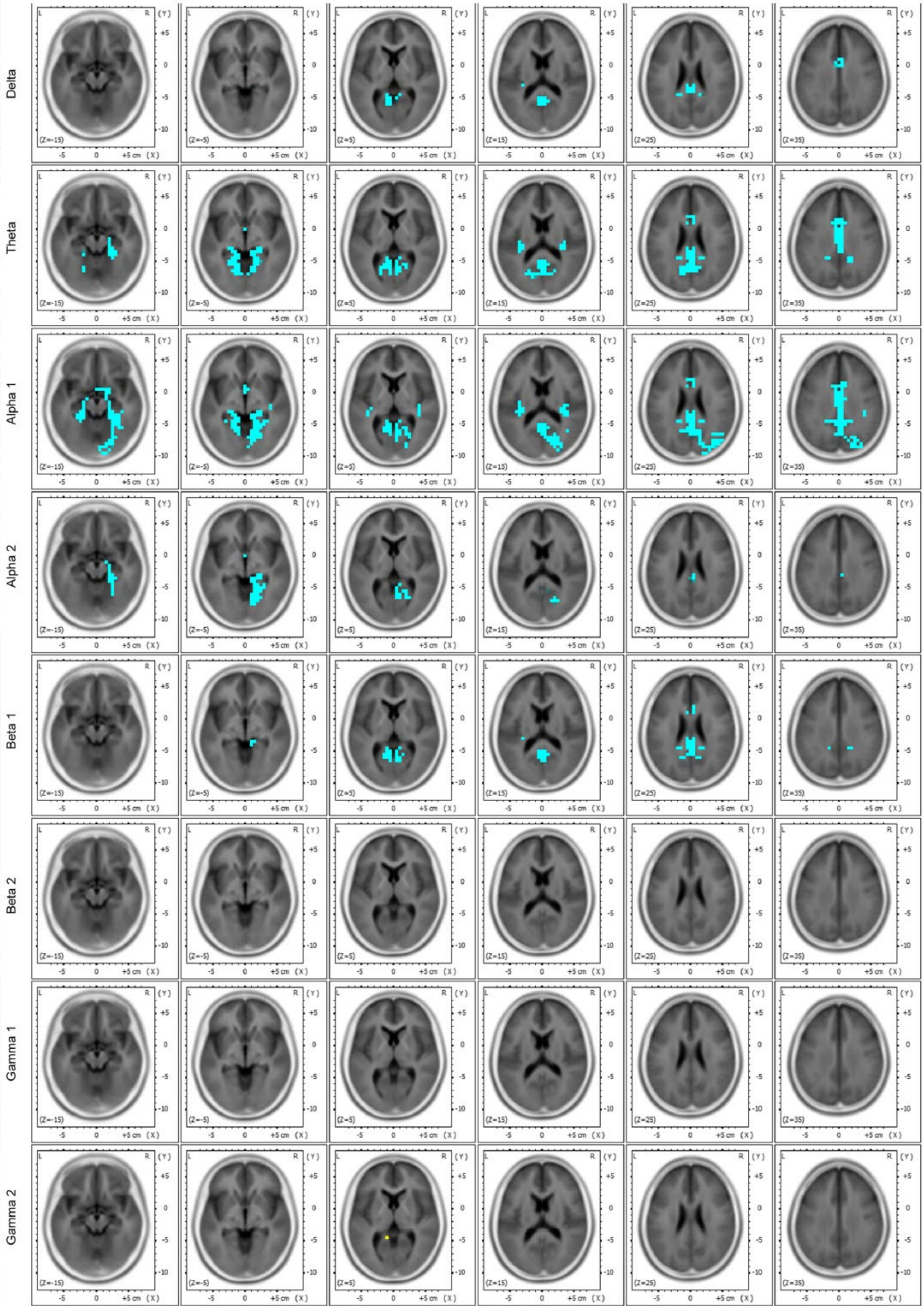


Fig. 1 - Statistical maps of the voxel-wise effect of psilocybin on neuronal oscillations at 1.5-4 Hz (delta; *top row*), 4-8 Hz (theta; *second row*), 8- 10.5 Hz (alpha1; *third row*), 10.5-13 Hz (alpha2; *fourth row*), 13-20 Hz (beta1; *fifth row*), 20-30 Hz (beta2; *sixth row*), 30-45 Hz (gamma1; *seventh row*), and 55-100 Hz (gamma2; *bottom row*) in the eyes-closed condition. *Blue* depicts voxels where neuronal oscillations were significantly decreased by psilocybin ($p<0.05$, corrected). *Yellow* depicts voxels where neuronal oscillations were significantly increased by psilocybin ($p<0.05$, corrected) (color figure online).

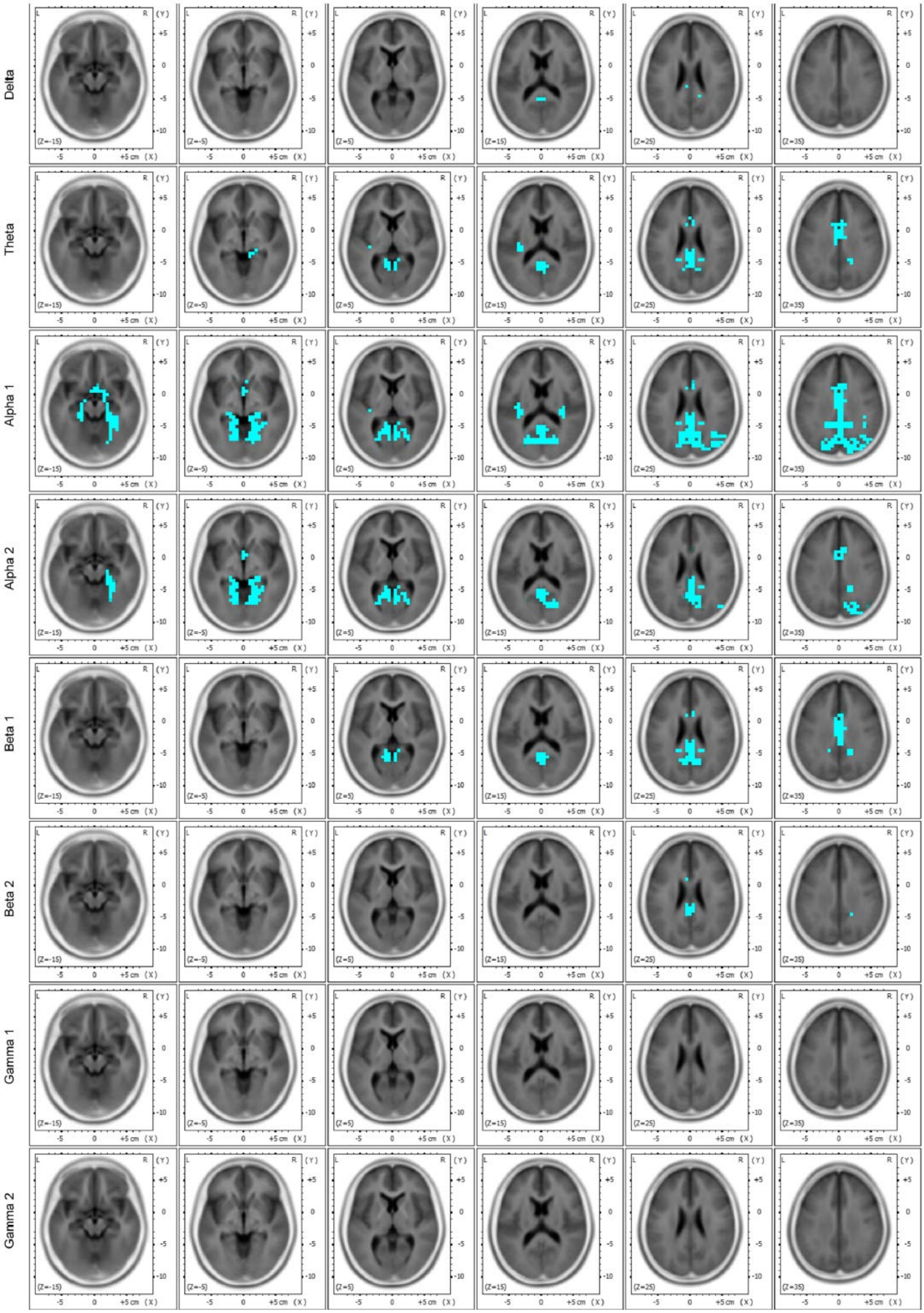

Delta
Theta
Alpha 1
Alpha 2
Beta 1
Beta 2
Gamma 1
Gamma 2
L
R
(Y)
+5
0
-5
-10
(Z=-15)
(Z=-5)
(Z=5)
(Z=15)
(Z=25)
(Z=35)
-5
0
+5 cm (X)

Fig. 2 - Statistical maps of the voxel-wise effect of psilocybin on neuronal oscillations at 1.5-4 Hz (delta; *top row*), 4-8 Hz (theta; *second row*), 8- 10.5 Hz (alpha1; *third row*), 10.5-13 Hz (alpha2; *fourth row*), 13-20 Hz (beta1; *fifth row*), 20-30 Hz (beta2; *sixth row*), 30-45 Hz (gamma1; *seventh row*), and 55-100 Hz (gamma2; *bottom row*) in the eyes-open condition. Blue depicts voxels where neuronal oscillations were significantly decreased by psilocybin (p<0.05, corrected) (color figure online).

In contrast to these strong decreases in low-frequency oscillations, there were no psilocybin-induced effects on current source density in the gamma1 frequency band (30-45 Hz; Figs. 1 and 2). High-frequency oscillations (55-100 Hz) were significantly increased by psilocybin in the left RSC (BA29) during the eyes-closed condition (p_{max}=0.020, corrected; Fig. 1). At a trend level (*p*=0.1, corrected), this psilocybin-induced increase extended into the parahippocampal gyrus (BA27, BA30). In the eyes-open condition, there was a trend (p_{max}=0.054, corrected) toward a psilocybin-induced increase in current source density in high-frequency oscillations (55-100 Hz) in the RSC (BA29).

Correlation analysis revealed that only the score of insightfulness significantly correlated with the current source density of neuronal oscillations during the eyes-open condition. That is, the current source density in the alpha2 frequency band in very posterior, medial parieto-occipital areas (maximal at x=-10, y=-85, z=40, *p*=0.012, corrected) in the psilocybin condition correlated with score on the insightfulness subscale of the 5D-ASC (Fig. 3). Interestingly, current source density in the alpha2 frequency band in this area was not reduced by psilocybin administration on a group level (Figs. 1 and 2), in contrast to the surrounding cortical areas, in particular the more anterior areas. This indicates that insightfulness during the eyes-open condition was precluded when the psilocybin-induced decrease in alpha oscillations covered the whole parieto-occipital cortex. There were no correlations between any other subscale of interest in the 5D-ASC and current source density of neuronal oscillations.

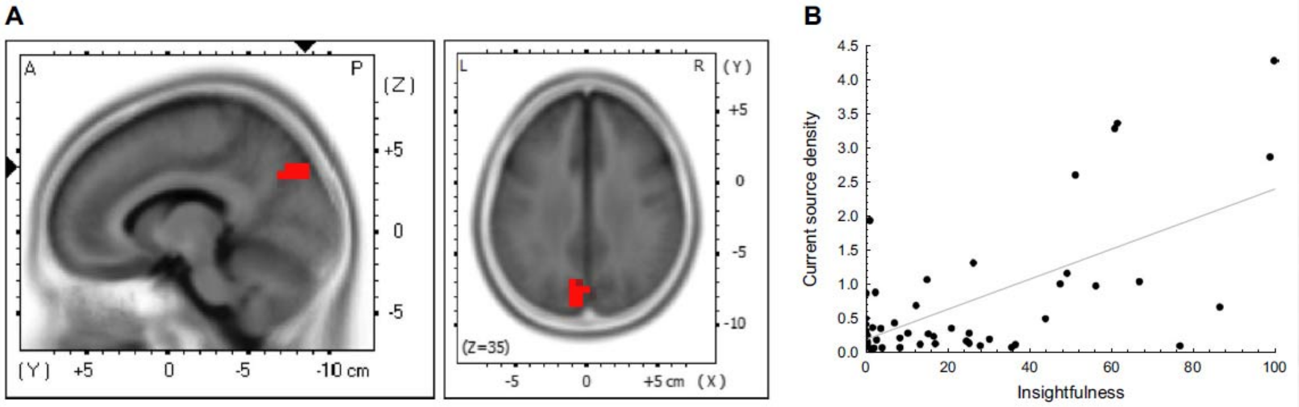


Fig. 3 - **a)** Statistical maps of the voxel-wise correlation between alpha2 oscillations (10.5-13 Hz) and score on the insightfulness subscale of the 5D-ASC in the eyes-open condition. *Red* depicts voxels where the correlation reached significance ($p<0.05$, corrected). **b)** Scatterplot of the relation between the current source density of alpha2 oscillations (10.5-13 Hz) at *x*=-10, *y*=-85, *z*=40 and score on the insightfulness subscale of the 5D-ASC in the eyes-open condition.

Lagged phase synchronization of neuronal oscillations

Analysis of lagged phase synchronization revealed that psilocybin slightly increased interhemispheric lagged phase synchronization of delta oscillations (1.5-4 Hz) during the eyes-open condition, reaching significance between right BA7 and left BA39 (p_{max}=0.017, corrected). Similarly, there was a trend toward a psilocybin-induced increase in the lagged phase synchronization of delta oscillations during the eyes-closed condition (p_{max}=0.063, corrected). Most interestingly, the extent of lagged phase synchronization within a network of deep cortical structures strongly and positively correlated with score on the insightfulness subscale of the 5D-ASC (p_{max}=0.0028, corrected) and spiritual experiences (p_{max}=0.029, corrected) subscales of the 5D-ASC during the eyes-closed condition. Specifically, the score on the insightfulness subscale of the 5D-ASC correlated with lagged phase synchronization of delta oscillations between BA27 and BA34, BA29 and BA34, and BA28 and BA47, and the score on the spiritual experiences subscale of the 5D-ASC correlated with lagged phase synchronization of delta oscillations between BA28 and BA29, BA34 and BA29, and BA20 and BA41 (Fig. 4). Scores of the remaining nine subscales of the 5D-ASC did not significantly correlate with neuronal oscillations in any frequency band (p_{max}=n.s.), suggesting that the above-mentioned correlation between neuronal oscillations and spiritual experiences/insightfulness is highly specific.

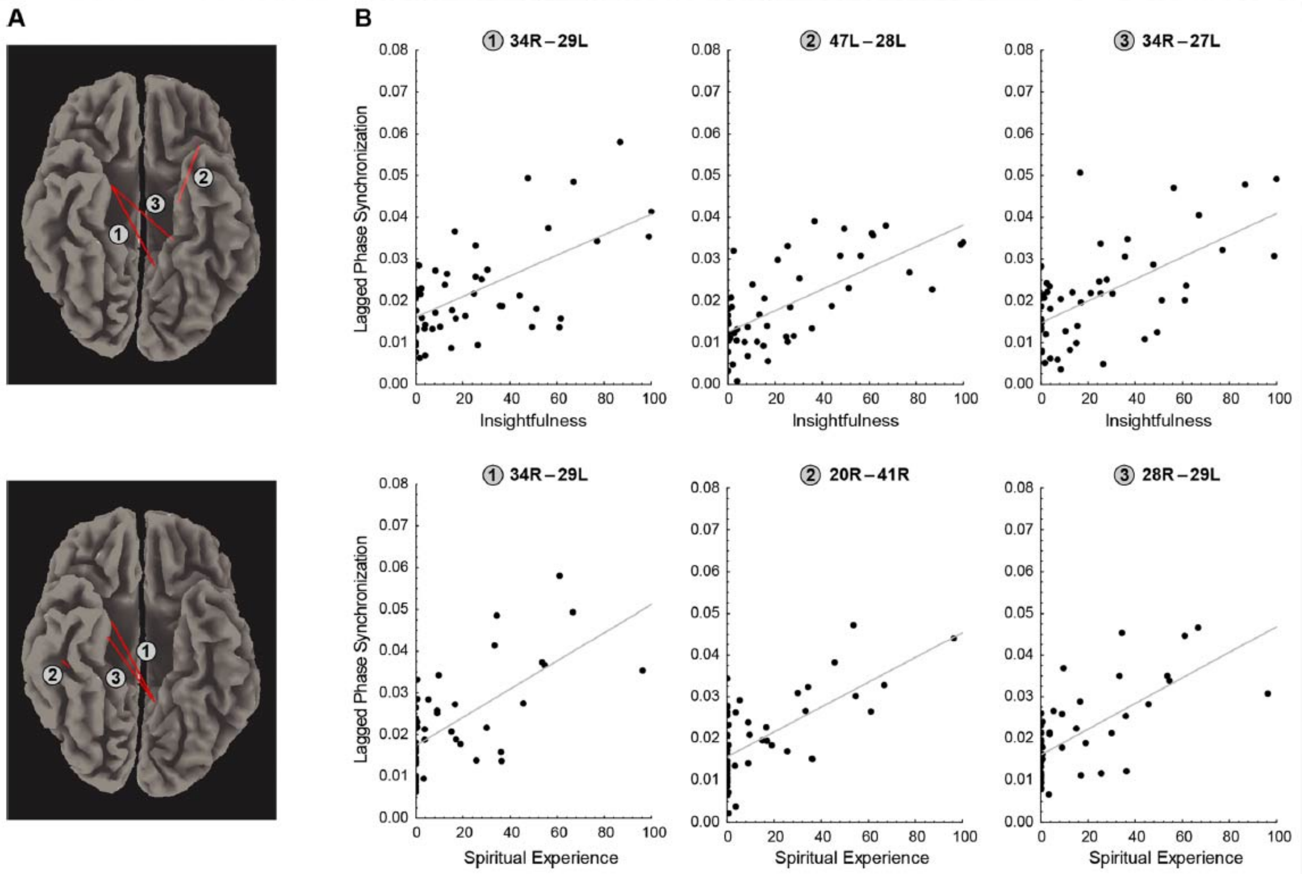


Fig. 4 - **a)** *Red lines* connects those pairs of Brodmann areas, where the correlations between lagged phase-synchronization values of delta oscillations (1.5-4 Hz) and score on the insightfulness (*top row*) and spiritual experiences (*bottom row*) subscales of the 5D-ASC reached significance during eyes-closed condition (p<0.05, corrected). Significant correlations are numbered from one to three to refer to the corresponding scatterplots displayed in **b**. **b)** Scatterplots on the significant correlations.

Discussion

Our data demonstrate that the serotonergic hallucinogen psilocybin decreased ongoing oscillations at 1.5-20 Hz within the PCC, the RSC, the anterior cingulate cortex (ACC), and parahippocampal regions during the resting state. This decrease was spatially most extended in the alpha and theta frequency bands and reached its maximum within the PCC, a key structure of the default-mode network. By contrast, high-frequency oscillations (55-100 Hz) within the RSC were slightly increased by psilocybin. Finally, and most interestingly, lagged phase synchronization of delta oscillations (1.5-4 Hz) within a network comprising the RSC, the parahippocampus, and the lateral orbitofrontal area were associated with spiritual experiences and insightfulness.

In line with the observed decreases in oscillations at 1.5-20 Hz, it has previously been reported that the serotonergic hallucinogenic brew ayahuasca attenuated ongoing oscillations up to 20 Hz, with similar maximum effects in the theta/alpha frequency range (Riba *et al*. 2002; Riba *et al*. 2004). Both psilocybin and the main psychoactive compound of ayahuasca, DMT, are thought to induce their psychological effect predominantly by activation of 5-HT_{2A} receptors (Vollenweider *et al*. 1998; Nichols 2004; Kometer *et al*. 2012), and activation of these receptors mediated the psilocybin-induced decrease in ongoing alpha oscillations (Kometer *et al*. 2013). Thus, our findings add to the evidence that a decrease of ongoing oscillations below 20 Hz, particularly theta/alpha oscillations, may be a common mechanism of action of serotonergic hallucinogens such as psilocybin and DMT.

Using source localization, we further revealed that this psilocybin-induced decrease in lower-frequency oscillations was localized within an extended network that included the PCC, the RSC, the ACC, and parahippocampal regions. Interestingly, this network strongly overlaps with the default-mode network (DMN), which has been shown to be modulated by psilocybin in PET and fMRI studies (Vollenweider *et al*. 1997; Gouzoulis-Mayfrank *et al*. 1999; Carhart-Harris *et al*. 2012). Activity within the DMN has been associated with lower-frequency oscillations (Lu *et al*. 2007) and with altered states of consciousness induced for instance by anesthetics (Boly *et al*. 2008), serotonergic hallucinogens (Carhart-Harris *et al*. 2012), and meditation (Brewer *et al*. 2011). Thus, our findings indicate that psilocybin modulates default-mode functions by decreasing ongoing lower-frequency oscillations within this network, which may contribute to the psilocybin-induced alterations in the state of consciousness. Specifically, lower frequency oscillations, particularly in the alpha range, mediate rhythmic cortical inhibition of neuronal ensembles (Klimesch *et al*. 2007; Schroeder and Lakatos 2009; Buschman *et al*. 2012). Thus, the strong decrease in lower-frequency oscillations seen in this study may be indicative of a psilocybin-induced shift of the resting excitation/inhibition balance (E/I balance) toward excitation. This interpretation is also supported by the slight psilocybin-induced increase in high-gamma oscillations because gamma oscillations have been strongly associated with neuronal excitation (Merker 2013). Given the crucial role of lower-frequency oscillations in structuring processes at the cellular level (Haegens *et al*. 2011), the systemic level (Hanslmayr *et al*. 2013), and in consciousness (VanRullen and Koch 2003; Schroeder and Lakatos 2009), any profound decrease in lower-frequency oscillations is likely to disrupt the ordinary temporal structure of neuronal processes.

Taken together, these findings suggest that psilocybin elevates the E/I balance and disrupts the temporal structure of neuronal processes by decreasing lower-frequency (<20 Hz) oscillations within the extended DMN. This network has been implicated in self-referential processing (Gusnard *et al*. 2001); therefore, the increased excitability and disrupted temporal structure of neuronal processes may alter self-referential processes and thereby lead to psilocybin-induced alterations in a state of consciousness such as an increased sense of unity with the environment. However, although these alterations may play a role in altering consciousness, correlation analysis indicated that these alterations are not sufficient to alter consciousness because only the correlation between psilocybin-induced insightfulness and alpha2 (10.5-13 Hz) oscillations in the posterior occipito-parietal region during the eyes-open condition was significant after correction for multiple comparisons.

In contrast to the weak associations between current source density and state of consciousness, lagged phase synchronization was strongly associated with the psilocybin-induced state of consciousness. Given the crucial role of phase-synchronization in coordinating activity across brain areas (Buzsáki and Draguhn 2004; Siegel *et al*. 2012), this finding supports the view that neural integration, rather than activity, underlies the state of consciousness (Alkire *et al*. 2008). Specifically, we found that the intensity of psilocybin-induced insightfulness was associated with lagged phase synchronization of delta oscillations between parahippocampal regions, between parahippocampal regions and the RSC as well as between parahippocampal regions and the lateral orbitofrontal cortex. Because phase synchronization of parahippocampal oscillations in this frequency range has previously been linked to autobiographical memory retrieval (Fell and Axmacher 2011; Foster *et al*. 2013) and to the attribution of valence in memory (Wallis 2007), our finding suggests that psilocybin-induced insightfulness may be associated with increased retrieval and reattribution of autobiographic memories. In addition, scores of the spiritual experiences subscale of the 5D-ASC questionnaire were associated with increased lagged phase synchronization of delta oscillations between parahippocampal regions and the RSC. The RSC has previously been implicated in coding the location of oneself within a global spatial context (Bar and Aminoff 2003; Vann *et al*. 2009), and therefore, our finding may suggest that with increasing intensity of spiritual experiences, the self is reorganized within the global spatial context through phase synchronization of delta oscillations.

These interpretations fit well with the phenomenological descriptions of hallucinogen-induced insightfulness and spiritual experiences. Hallucinogen-induced insightfulness is characterized by a deep understanding of personal life and existence (Cott and Rock 2008), which could well explain, why increased autobiographical retrieval and reattribution processes may be present during insightfulness. Furthermore, hallucinogen-induced spiritual experiences include a shift in the perception of one's self and one's existence (Grob *et al*. 2013) and were defined in our study according to the 5D-ASC questionnaire as a profound experience of awe and connectedness to a superior power (Studerus *et al*. 2010). These phenomenological descriptions match well with our interpretation that psilocybin-induced spiritual experiences are associated by a reorganization of the self within the global spatial context mediated by phase synchronization of delta oscillations. Finally, phenomenological studies found that psilocybin-induced insightfulness and spiritual experience often occur together (Studerus *et al*. 2011), which fits well with our finding that these states are mediated by phase-synchronization in a partially overlapping network.

Interestingly, the revealed network phase-synchronization processes were specifically associated with insightfulness and spiritual experiences, as defined by the 5D-ASC questionnaire, but not with other psilocybin-induced phenomena such as blissful states or disembodiment. Furthermore, after correction for multiple comparison, the correlation was only seen during eyes-closed condition. These findings suggest first that the revealed associations are specific for these two experiences, but likely additional network processes are implicated in a full blown mystical/spiritual experience that fulfills all the criteria by Stace (1961) and is quantified by the SOCQ questionnaires (Griffiths *et al*. 2006). Second, our results suggest that eyes-closed conditions might be particularly suitable to investigate the neuronal processes associated with insightfulness and spiritual experiences, which is in accordance with the use of eye-shades in some previous phenomenological studies that aimed to specifically investigate psilocybin-induced spiritual experiences (Griffiths *et al*. 2006).

The neuronal network processes we identified as underlying spiritual experiences and insightfulness may constitute a crucial pathway that can be modulated by serotonergic receptors to regulate mental health. This notion is supported by reports that spiritual experiences promoted sustained well-being and resilience (McClain *et al*. 2003; Southwick and Charney 2012) and that psilocybin had therapeutic effects in treating mood disorders (Vollenweider and Kometer 2010) and in reducing anxiety in terminal cancer patients (Grob *et al*. 2011). Thus, in future studies, it will be interesting to test whether lagged phase synchronization between the RSC, the parahippocampus, and the lateral orbitofrontal area can promote mental health through the activation and reattribution of autobiographical memory and the reallocation of the self in a global spatiotemporal context.

Acknowledgments

This work was supported by the Swiss Neuromatrix Foundation and the Heffter Research Institute. We thank Petra Schäfle for her assistance in recruiting and measuring.

Conflict of interests - Prof. Vollenweider is board member of Heffter Research Institute. None of the author has a conflict of interest with regard to this study.

References

1. Alkire MT, Hudetz AG, Tononi G (2008) Consciousness and anesthesia. Science 322:876-880
2. Babiloni C, Lizio R, Carducci F, Vecchio F, Redolfi A, Marino S, Tedeschi G, Montella P, Guizzaro A, Esposito F (2011) Resting state cortical electroencephalographic rhythms and white matter vascular lesions in subjects with Alzheimer's disease: an Italian multicenter study. J Alzheimers Dis 26:331-346
3. Babiloni C, Carducci F, Lizio R, Vecchio F, Baglieri A, Bernardini S, Cavedo E, Bozzao A, Buttinelli C, Esposito F (2013) Resting state cortical electroencephalographic rhythms are related to gray matter volume in subjects with mild cognitive impairment and Alzheimer's disease. Hum Brain Mapp 34:1427-1446
4. Bar M, Aminoff E (2003) Cortical analysis of visual context. Neuron 38: 347-358
5. Bell AJ, Sejnowski TJ (1995) An information-maximization approach to blind separation and blind deconvolution. Neural Comput 7:1129- 1159
6. Boly M, Phillips C, Tshibanda L, Vanhaudenhuyse A, Schabus M, DangVu TT, Moonen G, Hustinx R, Maquet P, Laureys S (2008) Intrinsic brain activity in altered states of consciousness: how conscious is the default mode of brain function? Ann N Y Acad Sci 1129:119-129
7. Brewer JA, Worhunsky PD, Gray JR, Tang Y-Y, Weber J, Kober H (2011) Meditation experience is associated with differences in default mode network activity and connectivity. Proc Natl Acad Sci 108:20254- 20259
8. Busch NA, Dubois J, VanRullen R (2009) The phase of ongoing EEG oscillations predicts visual perception. J Neurosci 29:7869-7876
9. Buschman TJ, Denovellis EL, Diogo C, Bullock D, Miller EK (2012) Synchronous oscillatory neural ensembles for rules in the prefrontal cortex. Neuron 76:838-846
10. Buzsáki G, Draguhn A (2004) Neuronal oscillations in cortical networks. Science 304:1926-1929
11. Buzsáki G, Anastassiou CA, Koch C (2012) The origin of extracellular fields and currents-EEG, ECoG, LFP and spikes. Nat Rev Neurosci 13:407-420
12. Canuet L, Ishii R, Pascual-Marqui RD, Iwase M, Kurimoto R, Aoki Y, Ikeda S, Takahashi H, Nakahachi T, Takeda M (2011) Resting-state EEG source localization and functional connectivity in schizophrenia-like psychosis of epilepsy. PLoS ONE 6:e27863
13. Canuet L, Tellado I, Couceiro V, Fraile C, Fernandez-Novoa L, Ishii R, Takeda M, Cacabelos R (2012) Resting-state network disruption and APOE genotype in Alzheimer's disease: a lagged functional connectivity study. PLoS ONE 7, e46289
14. Carhart-Harris RL, Erritzoe D, Williams T, Stone JM, Reed LJ, Colasanti A, Tyacke RJ, Leech R, Malizia AL, Murphy K, Hobden P, Evans J, Feilding A, Wise RG, Nutt DJ (2012) Neural correlates of the psychedelic state as determined by fMRI studies with

psilocybin. Proc Natl Acad Sci U S A 109:2138-2143
15. Celada P, Puig MV, Díaz-Mataix L, Artigas F (2008) The hallucinogen DOI reduces low-frequency oscillations in rat prefrontal cortex: reversal by antipsychotic drugs. Biol Psychiatry 64:392-400
16. Ching S, Cimenser A, Purdon PL, Brown EN, Kopell NJ (2010) Thalamocortical model for a propofol-induced alpha-rhythm associated with loss of consciousness. Proc Natl Acad Sci U S A 107: 22665-22670
17. Cott C, Rock A (2008) Phenomenology of *N,N*-dimethyltryptamine use: a thematic analysis. J Scientific Exploration 22:359-370
18. Dehaene S, Changeux JP (2011) Experimental and theoretical approaches to conscious processing. Neuron 70:200-227
19. Derogatis L (1994) SCL-90-R: Symptom Checklist-90-R. Administration, scoring and procedures manual. National Computer Systems Inc, Minneapolis
20. Dittrich A (1998) The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. Pharmacopsychiatry 31: 80-84
21. Elmer S, Rogenmoser L, Kühnis J, Jäncke L (2015) Bridging the gap between perceptual and cognitive perspectives on absolute pitch. J Neurosci 35:366-371
22. Fahrenfort JJ, Snijders TM, Heinen K, van Gaal S, Scholte HS, Lamme VA (2012) Neuronal integration in visual cortex elevates face category tuning to conscious face perception. Proc Natl Acad Sci U S A 109:21504-21509
23. Fell J, Axmacher N (2011) The role of phase synchronization in memory processes. Nat Rev Neurosci 12:105-118
24. Foster BL, Kaveh A, Dastjerdi M, Miller KJ, Parvizi J (2013) Human retrosplenial cortex displays transient theta phase locking with medial temporal cortex prior to activation during autobiographical memory retrieval. J Neurosci 33:10439-10446
25. Goda SA, Piasecka J, Olszewski M, Kasicki S, Hunt MJ (2013) Serotonergic hallucinogens differentially modify gamma and high frequency oscillations in the rat nucleus accumbens. Psychopharmacology (Berl) 228:271-282
26. Gouzoulis-Mayfrank E, Schreckenberger M, Sabri O, Arning C, Thelen B, Spitzer M, Kovar KA, Hermle L, Büll U, Sass H (1999) Neurometabolic effects of psilocybin, 3,4-methylenedioxyethylamphetamine (MDE) and d-methamphetamine in healthy volunteers. A double-blind, placebo-controlled PET study with [18F]FDG. Neuropsychopharmacology 20:565-581
27. Griffiths RR, Richards WA, McCann U, Jesse R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology (Berl) 187:268-283, discussion 284-292
28. Griffiths R, Richards W, Johnson M, McCann U, Jesse R (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. J Psychopharmacol 22:621-632
29. Grob C, S., Bossis A, P., Griffiths R, R. (2013) Use of the classic hallucinogen psilocybin for treatment of existential distress associated with cancer. In: Carr BI, Steel J (eds) Psychological Aspects of Cancer. Springer, USA
30. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstadt AL, Greer GR (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch Gen Psychiatry 68:71-8
31. Guggisberg AG, Rizk S, Ptak R, Di Pietro M, Saj A, Lazeyras F, Lovblad K-O, Schnider A, Pignat J-M (2014) Two intrinsic coupling types for resting-state integration in the human brain. Brain Topogr 1-12
32. Gusnard DA, Akbudak E, Shulman GL, Raichle ME (2001) Medial prefrontal cortex and self-referential mental activity: relation to a default mode of brain function. Proc Natl Acad Sci U S A 98:4259- 4264
33. Haegens S, Nácher V, Luna R, Romo R, Jensen O (2011) α-Oscillations in the monkey sensorimotor network influence discrimination performance by rhythmical inhibition of neuronal spiking. Proc Natl Acad Sci U S A 108:19377-19382
34. Hanslmayr S, Volberg G, Wimber M, Dalal SS, Greenlee MW (2013) Prestimulus Oscillatory Phase at 7 Hz Gates Cortical Information Flow and Visual Perception. Curr Biol 23(22):2273-8
35. Hilty L, Langer N, Pascual-Marqui R, Boutellier U, Lutz K (2011) Fatigue-induced increase in intracortical communication between mid/anterior insular and motor cortex during cycling exercise. Eur J Neurosci 34:2035-2042
36. Hipp JF, Engel AK, Siegel M (2011) Oscillatory synchronization in largescale cortical networks predicts perception. Neuron 69:387-396
37. Horacek J, Brunovsky M, Novak T, Skrdlantova L, Klirova M, Bubenikova-Valesova V, Krajca V, Tislerova B, Kopecek M, Spaniel F (2007) Effect of low-frequency rTMS on electromagnetic tomography (LORETA) and regional brain metabolism (PET) in schizophrenia patients with auditory hallucinations. Neuropsychobiology 55:132-142
38. Jatoi MA, Kamel N, Malik AS, Faye I (2014) EEG based brain source localization comparison of sLORETA and eLORETA. Australas Phys Eng Sci Med 37:713-721
39. Klimesch W, Sauseng P, Hanslmayr S (2007) EEG alpha oscillations: the inhibition-timing hypothesis. Brain Res Rev 53:63-88
40. Kometer M, Schmidt A, Bachmann R, Studerus E, Seifritz E, Vollenweider FX (2012) Psilocybin biases facial recognition, goaldirected behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. Biol Psychiatry 72:898-906
41. Kometer M, Schmidt A, Jäncke L, Vollenweider FX (2013) Activation of serotonin 2A receptors underlies the psilocybin-induced effects on α oscillations, N170 visual-evoked potentials, and visual hallucinations. J Neurosci 33:10544-10551
42. Kühnis J, Elmer S, Jäncke L (2014) Auditory evoked responses in musicians during passive vowel listening are modulated by functional connectivity between bilateral auditory-related brain regions. J Cogn Neurosci 26:2750-2761
43. Lee TW, Girolami M, Sejnowski TJ (1999) Independent component analysis using an extended infomax algorithm for mixed subgaussian and supergaussian sources. Neural Comput 11:417-441
44. Levin JS (1993) Age differences in mystical experience. Gerontologist 33:507-513
45. Lu H, Zuo Y, Gu H, Waltz JA, Zhan W, Scholl CA, Rea W, Yang Y, Stein EA (2007) Synchronized delta oscillations correlate with the restingstate functional MRI signal. Proc Natl Acad Sci U S A 104:18265-8269
46. Maselko J, Kubzansky LD (2006) Gender differences in religious practices, spiritual experiences and health: results from the US General Social Survey. Soc Sci Med 62:2848-2860
47. McClain CS, Rosenfeld B, Breitbart W (2003) Effect of spiritual well-being on end-of-life despair in terminally-ill cancer patients. Lancet 361:1603-1607
48. Melloni L, Molina C, Pena M, Torres D, Singer W, Rodriguez E (2007) Synchronization of neural activity across cortical areas correlates with conscious perception. J Neurosci 27:2858-2865
49. Merker B (2013) Cortical gamma oscillations: the functional key is activation, not cognition. Neurosci Biobehav Rev

37:401-417
50. Miller L, Bansal R, Wickramaratne P, Hao X, Tenke CE, Weissman MM, Peterson BS (2014) Neuroanatomical correlates of religiosity and spirituality: a study in adults at high and low familial risk for depression. JAMA Psychiatry 71:128-135
51. Mulert C, Jäger L, Schmitt R, Bussfeld P, Pogarell O, Möller HJ, Juckel G, Hegerl U (2004) Integration of fMRI and simultaneous EEG: towards a comprehensive understanding of localization and timecourse of brain activity in target detection. Neuroimage 22:83-94
52. Mulert C, Jäger L, Propp S, Karch S, Störmann S, Pogarell O, Möller H-J, Juckel G, Hegerl U (2005) Sound level dependence of the primary auditory cortex: simultaneous measurement with 61-channel EEG and fMRI. Neuroimage 28:49-58
53. Murphy M, Bruno MA, Riedner BA, Boveroux P, Noirhomme Q, Landsness EC, Brichant JF, Phillips C, Massimini M, Laureys S, Tononi G, Boly M (2011) Propofol anesthesia and sleep: a highdensity EEG study. Sleep 34:283-291A
54. Muthukumaraswamy SD, Carhart-Harris RL, Moran RJ, Brookes MJ, Williams TM, Errtizoe D, Sessa B, Papadopoulos A, Bolstridge M, Singh KD, Feilding A, Friston KJ, Nutt DJ (2013) Broadband cortical desynchronization underlies the human psychedelic state. J Neurosci 33:15171-15183
55. Neuner I, Arrubla J, Werner CJ, Hitz K, Boers F, Kawohl W, Shah NJ (2014) The default mode network and EEG regional spectral power: a simultaneous fMRI-EEG study. PLoS ONE 9:e88214
56. Nichols DE (2004) Hallucinogens. Pharmacol Ther 101:131-181
57. Nichols TE (2012) Multiple testing corrections, nonparametric methods, and random field theory. Neuroimage 62:811-815
58. Nichols TE, Holmes AP (2002) Nonparametric permutation tests for functional neuroimaging: a primer with examples. Hum Brain Mapp 15:1-25
59. Nolte G, Bai O, Wheaton L, Mari Z, Vorbach S, Hallett M (2004) Identifying true brain interaction from EEG data using the imaginary part of coherency. Clin Neurophysiol 115:2292- 2307
60. Olbrich S, Mulert C, Karch S, Trenner M, Leicht G, Pogarell O, Hegerl U (2009) EEG-vigilance and BOLD effect during simultaneous EEG/fMRI measurement. Neuroimage 45:319-332
61. Olbrich S, Tränkner A, Chittka T, Hegerl U, Schönknecht P (2014) Functional connectivity in major depression: increased phase synchronization between frontal cortical EEG-source estimates. Psychiatry Res Neuroimaging 222:91-99
62. Pascual-Marqui RD (2002) Standardized low-resolution brain electromagnetic tomography (sLORETA): technical details. Methods Find Exp Clin Pharmacol 24(Suppl D):5-12
63. Pascual-Marqui RD, Michel CM, Lehmann D (1994) Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. Int J Psychophysiol 18:49-65
64. Pascual-Marqui RD, Lehmann D, Koukkou M, Kochi K, Anderer P, Saletu B, Tanaka H, Hirata K, John ER, Prichep L, Biscay-Lirio R, Kinoshita T (2011) Assessing interactions in the brain with exact low-resolution electromagnetic tomography. Philos Trans A Math Phys Eng Sci 369:3768-3784
65. Pascual-Marqui RD, Biscay RJ, Bosch-Bayard J, Lehmann D, Kochi K, Kinoshita T, Yamada N, Sadato N (2014) Assessing direct paths of intracortical causal information flow of oscillatory activity with the isolated effective coherence (iCoh). Front Hum Neurosci 8
66. Perrin F, Pernier J, Bertrand O, Echallier JF (1989) Spherical splines for scalp potential and current density mapping. Electroencephalogr Clin Neurophysiol 72:184-187
67. Pizzagalli DA, Oakes TR, Fox AS, Chung MK, Larson CL, Abercrombie HC, Schaefer SM, Benca RM, Davidson RJ (2004) Functional but not structural subgenual prefrontal cortex abnormalities in melancholia. Mol Psychiatry 9(325):393-405
68. Puig MV, Watakabe A, Ushimaru M, Yamamori T, Kawaguchi Y (2010) Serotonin modulates fast-spiking interneuron and synchronous activity in the rat prefrontal cortex through 5-HT$_{1A}$ and 5-HT$_{2A}$ receptors. J Neurosci 30:2211-2222
69. Ramyead A, Kometer M, Studerus E, Koranyi S, Ittig S, Gschwandtner U, Fuhr P, Riecher-Rössler A (2014) Aberrant current source-density and lagged phase synchronization of neural oscillations as markers for emerging psychosis. Schizophr Bull 41(4):919-929
70. Riba J, Anderer P, Morte A, Urbano G, Jané F, Saletu B, Barbanoj MJ (2002) Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers. Br J Clin Pharmacol 53:613-628
71. Riba J, Anderer P, Jané F, Saletu B, Barbanoj MJ (2004) Effects of the South American psychoactive beverage ayahuasca on regional brain electrical activity in humans: a functional neuroimaging study using low-resolution electromagnetic tomography. Neuropsychobiology 50:89-101
72. Schoffelen JM, Gross J (2009) Source connectivity analysis with MEG and EEG. Hum Brain Mapp 30:1857-1865
73. Schroeder CE, Lakatos P (2009) Low-frequency neuronal oscillations as instruments of sensory selection. Trends Neurosci 32:9-18
74. Sheehan D, Lecrubier Y, Sheehan K, Amorim P, Janavs J, Weiller E, Hergueta T, Baker R, Dunbar G (1998) The Mini-International Neuropsychiatric Interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. J Clin Psychiatry 59:22-33
75. Shushruth S (2013) Exploring the neural basis of consciousness through anesthesia. J Neurosci 33:1757-1758
76. Siegel M, Donner TH, Engel AK (2012) Spectral fingerprints of large-scale neuronal interactions. Nat Rev Neurosci 13:121-134
77. Southwick SM, Charney DS (2012) The science of resilience: implications for the prevention and treatment of depression. Science 338: 79-82
78. Stam CJ, Nolte G, Daffertshofer A (2007) Phase lag index: assessment of functional connectivity from multi channel EEG and MEG with diminished bias from common sources. Hum Brain Mapp 28: 1178-1193
79. Steinmann S, Leicht G, Ertl M, Andreou C, Polomac N, Westerhausen R, Friederici AD, Mulert C (2014) Conscious auditory perception related to long-range synchrony of gamma oscillations. Neuroimage 100:435-443
80. Studerus E, Gamma A, Vollenweider FX (2010) Psychometric evaluation of the altered states of consciousness rating scale (OAV). PLoS ONE 5, e12412
81. Studerus E, Kometer M, Hasler F, Vollenweider FX (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. J Psychopharmacol 25:1434-1452

82. Tenke CE, Kayser J, Miller L, Warner V, Wickramaratne P, Weissman MM, Bruder GE (2013) Neuronal generators of posterior EEG alpha reflect individual differences in prioritizing personal spirituality. Biol Psychol 94:426-432
83. Thatcher RW, North DM, Biver CJ (2012) Diffusion spectral imaging modules correlate with EEG LORETA neuroimaging modules. Hum Brain Mapp 33:1062-1075
84. Towle VL, Bolaños J, Suarez D, Tan K, Grzeszczuk R, Levin DN, Cakmur R, Frank SA, Spire JP (1993) The spatial location of EEG electrodes: locating the best-fitting sphere relative to cortical anatomy. Electroencephalogr Clin Neurophysiol 86:1-6
85. Urgesi C, Aglioti SM, Skrap M, Fabbro F (2010) The spiritual brain: selective cortical lesions modulate human self-transcendence. Neuron 65:309-319
86. Vann SD, Aggleton JP, Maguire EA (2009) What does the retrosplenial cortex do? Nat Rev Neurosci 10:792-802
87. VanRullen R, Koch C (2003) Is perception discrete or continuous? Trends Cogn Sci 7:207-213
88. Varela F, Lachaux JP, Rodriguez E, Martinerie J (2001) The brainweb: phase synchronization and large-scale integration. Nat Rev Neurosci 2:229-239
89. Vecchio F, Miraglia F, Curcio G, Altavilla R, Scrascia F, Giambattistelli F, Quattrocchi CC, Bramanti P, Vernieri F, Rossini PM (2015) Cortical brain connectivity evaluated by graph theory in dementia: a correlation study between functional and structural data. J Alzheimers Dis 45(3):745-756
90. Vitacco D, Brandeis D, Pascual-Marqui R, Martin E (2002) Correspondence of event-related potential tomography and functional magnetic resonance imaging during language processing. Hum Brain Mapp 17:4-12
91. Vollenweider FX, Kometer M (2010) The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. Nat Rev Neurosci 11:642-651
92. Vollenweider FX, Leenders KL, Scharfetter C, Maguire P, Stadelmann O, Angst J (1997) Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. Neuropsychopharmacology 16: 357-372
93. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Bäbler A, Vogel H, Hell D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. Neuroreport 9:3897-3902
94. Wallis JD (2007) Orbitofrontal cortex and its contribution to decision-making. Annu Rev Neurosci 30:31-56
95. Wittchen H-U, Pfister H (1997) DIA-X-Interviews: Manual für ScreeningVerfahren und Interview. Swets & Zeitlinger, Frankfurt, Hesse
96. Womelsdorf T, Schoffelen JM, Oostenveld R, Singer W, Desimone R, Engel AK, Fries P (2007) Modulation of neuronal interactions through neuronal synchronization. Science 316:1609-1612
97. Worrell GA, Lagerlund TD, Sharbrough FW, Brinkmann BH, Busacker NE, Cicora KM, O'Brien TJ (2000) Localization of the epileptic focus by low-resolution electromagnetic tomography in patients with a lesion demonstrated by MRI. Brain Topogr 12:273-282

Effects of serotonin 2A/1A receptor stimulation on social exclusion processing

by

Katrin H. Preller[a,1], Thomas Pokorny[a], Andreas Hock[b,c], Rainer Kraehenmann[a], Philipp Stämpfli[c,d], Erich Seifritz[c], Milan Scheidegger[a], and Franz X. Vollenweider[a]

Edited by Andreas Meyer-Lindenberg, Central Institute of Mental Health, Medical Faculty Mannheim, University of Heidelberg, Mannheim, Germany, and accepted by the Editorial Board March 14, 2016 (received for review December 8, 2015)

PNAS - May 3, 2016 - vol. 113 - no. 18

original source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4983864/pdf/pnas.201524187.pdf
backup source: http://www.psilosophy.info/resources/pnas.201524187.pdf

[a] Neuropsychopharmacology and Brain Imaging, Department of Psychiatry, Psychotherapy and Psychosomatics, University Hospital for Psychiatry Zurich, 8032 Zurich, Switzerland;
[b] Institute for Biomedical Engineering, University of Zurich and Swiss Federal Institute of Technology Zurich, 8092 Zurich, Switzerland;
[c] Department of Psychiatry, Psychotherapy and Psychosomatics, University Hospital for Psychiatry Zurich, 8032 Zurich, Switzerland;
[d] Magnetic Resonance Imaging Center of the University Hospital for Psychiatry and the Department of Child and Adolescent Psychiatry, University of Zurich, 8032 Zurich, Switzerland

Author contributions: K.H.P. and F.X.V. designed research; K.H.P., T.P., A.H., P.S., and M.S. performed research; K.H.P. and A.H. analyzed data; and K.H.P., R.K., E.S., M.S., and F.X.V. wrote the paper.
The authors declare no conflict of interest.
This article is a PNAS Direct Submission. A.M.-L. is a guest editor invited by the Editorial Board.
[1] To whom correspondence should be addressed. Email: preller@bli.uzh.ch.
This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1524187113/-/DCSupplemental. [**Which has been implemented into this version of the report.**]

Table of Contents:

- **Introduction**
- **Results**
  - Subjective Effects and Physical Effects
  - Cyberball Task
    - *Posttask questionnaire*
    - *fMRI data*
  - Relationship Between Social Exclusion Processing and Subjective Effects
  - Relationship Between Social Exclusion Processing and Metabolite Concentrations
- **Discussion**
- **Methods**
  - Study Participants
  - Study Design
    - Cyberball Task
  - MRI Data Acquisition and Preprocessing
  - Statistical Analysis
    - *Questionnaires and physical effects*
    - *fMRI data*
    - *Correlation analyses*
- **Acknowledgments**
- **Supporting Information**
  - SI Results
    - *5D-ASC*

PANAS
MRS Data Quality
SI Methods
Participants
Study Design
Cyberball Task
Posttask Questionnaire
MRI Data Acquisition and Preprocessing
Statistical Analysis of Questionnaires
Statistical Analysis of fMRI Data
Correlational Analyses
References

Social ties are crucial for physical and mental health. However, psychiatric patients frequently encounter social rejection. Moreover, an increased reactivity to social exclusion influences the development, progression, and treatment of various psychiatric disorders. Nevertheless, the neuromodulatory substrates of rejection experiences are largely unknown. The preferential serotonin (5-HT) 2A/1A receptor agonist, psilocybin (Psi), reduces the processing of negative stimuli, but whether 5-HT$_{2A/1A}$ receptor stimulation modulates the processing of negative social interactions remains unclear. Therefore, this double-blind, randomized, counterbalanced, cross-over study assessed the neural response to social exclusion after the acute administration of Psi (0.215 mg/kg) or placebo (Pla) in 21 healthy volunteers by using functional magnetic resonance imaging (fMRI) and resting-state magnetic resonance spectroscopy (MRS). Participants reported a reduced feeling of social exclusion after Psi vs. Pla administration, and the neural response to social exclusion was decreased in the dorsal anterior cingulate cortex (dACC) and the middle frontal gyrus, key regions for social pain processing. The reduced neural response in the dACC was significantly correlated with Psi-induced changes in self-processing and decreased aspartate (Asp) content. In conclusion, 5-HT$_{2A/1A}$ receptor stimulation with psilocybin seems to reduce social pain processing in association with changes in self-experience. These findings may be relevant to the normalization of negative social interaction processing in psychiatric disorders characterized by increased rejection sensitivity. The current results also emphasize the importance of 5-HT$_{2A/1A}$ receptor subtypes and the Asp system in the control of social functioning, and as prospective targets in the treatment of socio-cognitive impairments in psychiatric illnesses.

Keywords: social cognition, serotonin, psilocybin, functional magnetic resonance imaging, magnetic resonance spectroscopy.

Introduction

Dysfunctional social cognition represents a central characteristic of various psychiatric disorders and critically impacts the development, progression, and treatment of psychiatric illnesses[1-3]. Impairments in social cognition are leading causes of disability and compromise real-world functioning, including independent living and productivity at work[2, 4, 5]. However, the neuronal and pharmacological bases of both normal and dysfunctional social cognition lack sufficient investigation, severely limiting current treatment approaches[1, 2]. Given the broad clinical relevance of dysfunctional social cognition in diverse psychiatric disorders, a better understanding of the neurobiological foundations of social cognition is urgently required for the development of novel and targeted therapies[6].

Pharmacological neuroimaging offers the opportunity to investigate the roles of specific neurotransmitter and receptor systems in a constrained hypothesis-driven manner[7, 8]. Recent evidence suggests that the serotonin [5-hydroxytryptamine (5-HT)] system encompassing 14 subtypes of 5-HT receptors not only plays a key role in the regulation of mood, affect, learning, and memory[2, 9, 10], but is also implicated in social cognition[11, 12]. Psilocybin

[4-phosphoryloxy-*N,N*-dimethyltryptamine (Psi)] is a serotonergic hallucinogen that induces an altered state of consciousness characterized by changes in sensory perception, emotion, thought, and the sense of self in a dose-dependent manner[13]. Psi binds with high affinity to 5-HT_{1A}, 5-$HT_{2A/C}$, 5-HT_6, and 5-HT_7 receptors (Psychoactive Drug Screening Program database at kidbdev.med.unc.edu/databases/kidb.php). In humans, Psi is rapidly dephosphorylated to psilocin (4-*N,N*-dimethyltryptamine), which acts as a partial agonist at 5-HT_{2A} and 5-HT_{1A} receptors[14, 15]. Therefore, the use of Psi provides a distinctive opportunity to explore the relative contribution of 5-HT receptors to social cognition.

Significance

Social cognition critically impacts the development, progression, and treatment of psychiatric disorders. However, social cognition skills are insufficiently targeted by current treatment approaches. By applying a multimodal brain imaging strategy, the present study demonstrated the importance of the serotonin 2A/1A receptor system in the modulation of social exclusion processing. Understanding the biochemical underpinnings of the social rejection experience is important for increasing our knowledge about social/emotional processing and the related neural responses. The identification of relevant neural responses is in turn crucial for the efficacious management of disorders influenced by social factors. Our findings may help to diminish a knowledge gap that currently restrains the development of pharmacotherapies for sociocognitive deficits in psychiatric disorders.

Notably, Psi modulates neural activity in prefrontal brain areas involved in social cognition[16-18]. In addition, recent evidence suggests that Psi at moderate doses can enhance mood and attenuate the processing of negative emotional stimuli (e.g., negative facial expressions or threat-related scenes)[10, 19-21] via 5-HT_{2A} receptor activation[20]. Thus, Psi may have antidepressant properties[10, 19-22]. Nevertheless, it is unclear whether this shift in emotional processing translates into the social domain, particularly regarding negative social interaction processing, and is therefore of relevance to real-life functioning in patients suffering from psychiatric disorders. To date, research efforts into the effects of Psi on emotional processing and cognition have solely focused on the individual's response to external stimulus manipulations[10, 20], as opposed to truly interactive, real-time social encounters. Indeed, studies investigating the neuropharmacological and neurochemical substrates of social interaction processing are rare.

The present study set out to assess the effect of 5-$HT_{2A/1A}$ receptor stimulation by Psi (0.215 mg/kg orally) vs. placebo (Pla) on social interaction processing via a multimodal brain imaging approach. Specifically, we used functional magnetic resonance imaging (fMRI) and proton magnetic resonance spectroscopy (^{1}H-MRS) to investigate the processing of ostracism generated by an interactive paradigm termed "Cyberball"[23]. Notably, an increased reactivity to social exclusion is clinically relevant in depression, borderline personality disorder, social anxiety disorder, and other psychiatric disorders[24-26]. Given previous reports of the capacity of Psi to attenuate negative stimulus processing[10, 20], we predicted a reduced response to social exclusion after Psi administration.

"Social pain," the painful feelings resulting from social exclusion, rejection, or loss[27], is consistently associated with increased brain activity. The increased activity is primarily observed in the anterior cingulate cortex (ACC)[17], but is also seen in the insula, the inferior orbitofrontal cortex (OFC), and the middle frontal gyrus (MFG)[28, 29]. Therefore, we hypothesized that these social pain-related brain regions would show less pronounced activation after Psi treatment. Furthermore, given that 5-HT_{1A} receptor stimulation has been associated with decreased, and 5-HT_{2A} receptor stimulation has been associated with both decreased and increased, neuronal excitation of medial prefrontal neurons at rest[30-32], we also used ^{1}H-MRS to determine whether Psi modulates the concentration of excitatory neurotransmitters and/or neurometabolic markers in the ACC. Our findings, presented below, assist in understanding the neurobiology of social processes relevant to the psychopathology of psychiatric disorders and contribute to a better mechanistic view of social cognition.

Results

Subjective Effects and Physical Effects

An ANOVA (treatment × scale) was conducted for the Altered States of Consciousness (5D-ASC) questionnaire, and revealed significant main effects for treatment [$F(1, 20) = 93.54$, $P < 0.001$] and scale [$F(10, 200) = 18.98$, $P < 0.001$] and a significant interaction of treatment × scale [$F(10, 200) = 19.67$, $P < 0.001$]. Simple main effect analyses showed increased ratings on all 5D-ASC scales after Psi vs. Pla treatment (all $P < 0.05$; Fig. S1). No order effects with regard to the sequence of substance administration were observed (SI Results). For Positive and Negative Affect Schedule (PANAS) ratings, see SI Results and Fig. S2. Systolic and diastolic blood pressure as well as pulse were slightly but significantly increased after Psi administration compared with Pla (all $P < 0.05$; Table S1).

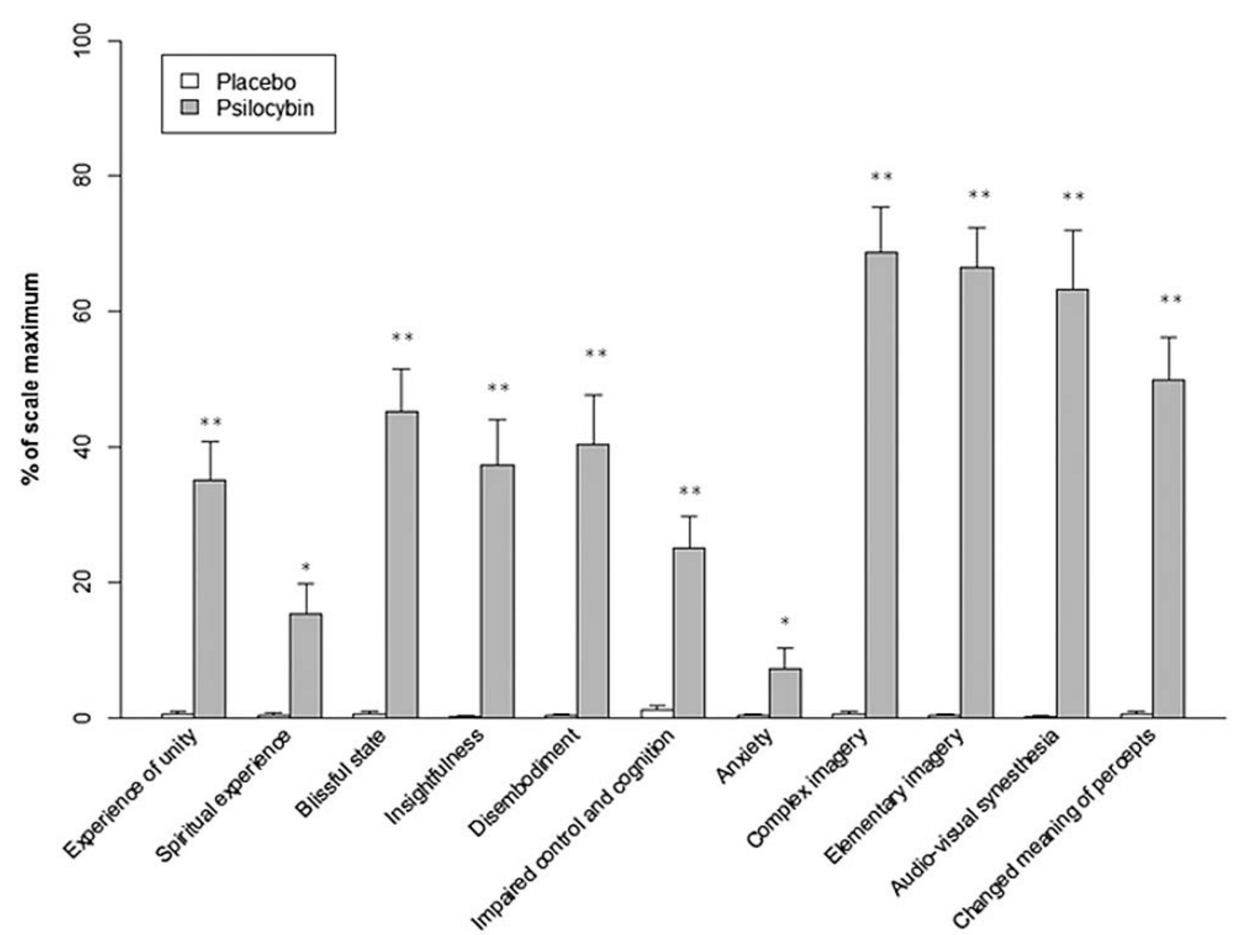


Fig. S1. Effect of Psi and Pla on 5D-ASC scores. Scores are expressed as a percent of the scale maximum. Ratings on all scales were significantly increased after Psi compared with Pla treatment. Data are expressed as means + the SEM ($n = 21$ subjects). Asterisks indicate significant differences between Psi and Pla conditions (**$P < 0.001$; *$P < 0.05$).

Table S1. Physical effects

Physical effects	Pla	Psi	*t* value	df	*P* value
Systolic blood pressure (mm Hg)	114.67 (14.40)	131.76 (13.45)	-7.46	20	**<0.001**
Diastolic blood pressure (mm Hg)	75.57 (12.48)	83.14 (11.90)	-2.69	20	**0.01**
Pulse	65.38 (12.50)	70.62 (12.53)	-2.15	20	**0.04**

Significant *P* values are shown in boldface type. Means and SDs are given in parentheses. Pla, placebo; Psi, psilocybin.

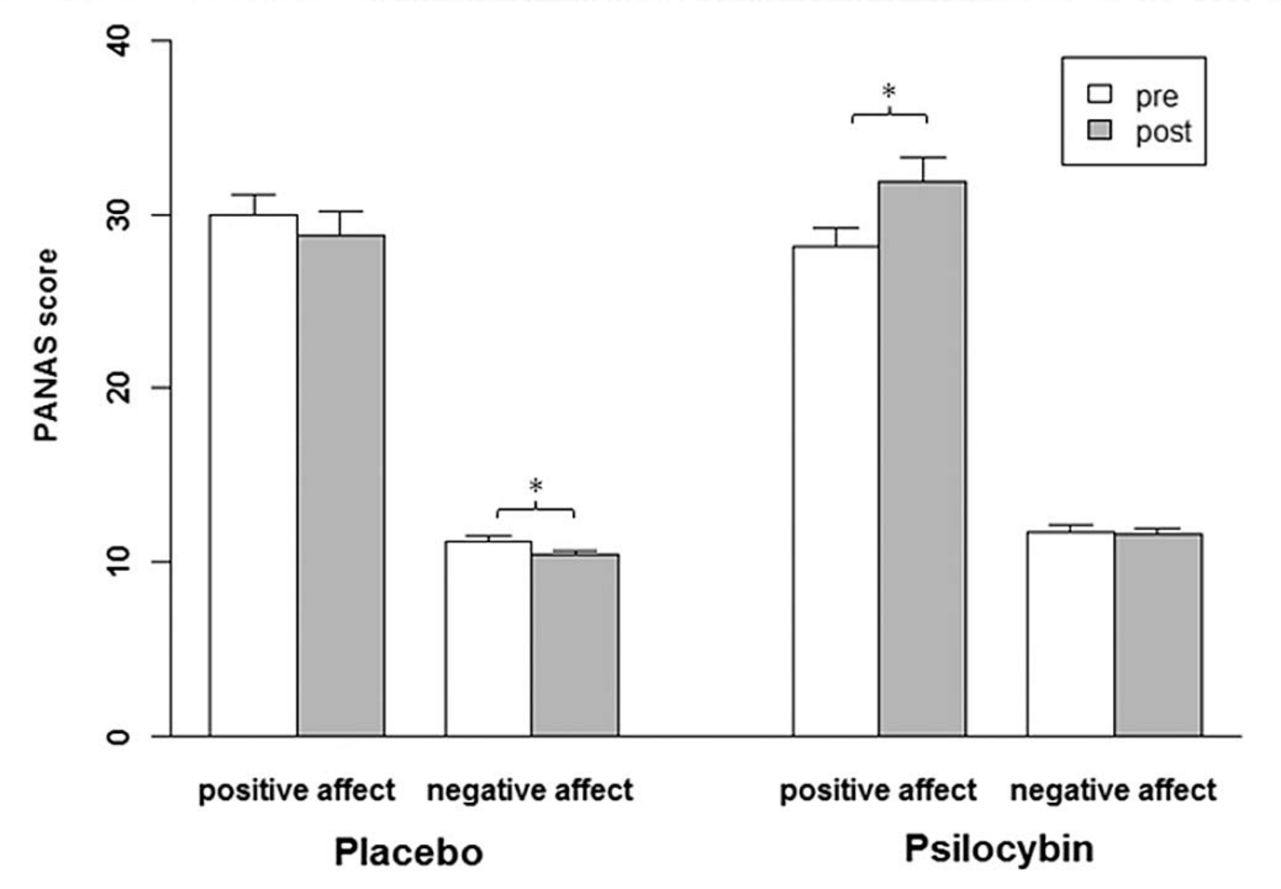


Fig. S2. Effect of Psi and Pla on mood state as assessed by PANAS. Mood state was assessed 75 min before (pre) and 360 min after (post) each drug treatment. Negative mood affects were significantly reduced after Pla treatment, whereas positive mood affects were increased after Psi treatment. Data are expressed as means + the SEM. Asterisks indicate significant differences between pre- and post-treatment conditions (*$P < 0.05$, $n = 20$).

Cyberball Task

Posttask questionnaire

Participants reported a reduced feeling of exclusion after Psi vs. Pla treatment [$t(20) = 2.71$, $P < 0.01$; Fig. 1A]. Additional posttask questionnaire (PTQ) items revealed no significant differences between Psi and Pla conditions (all $P > 0.1$). In particular, participants accurately gauged the number of throws received in each run, indicating equal awareness of exclusion under both treatment conditions (Table S2).

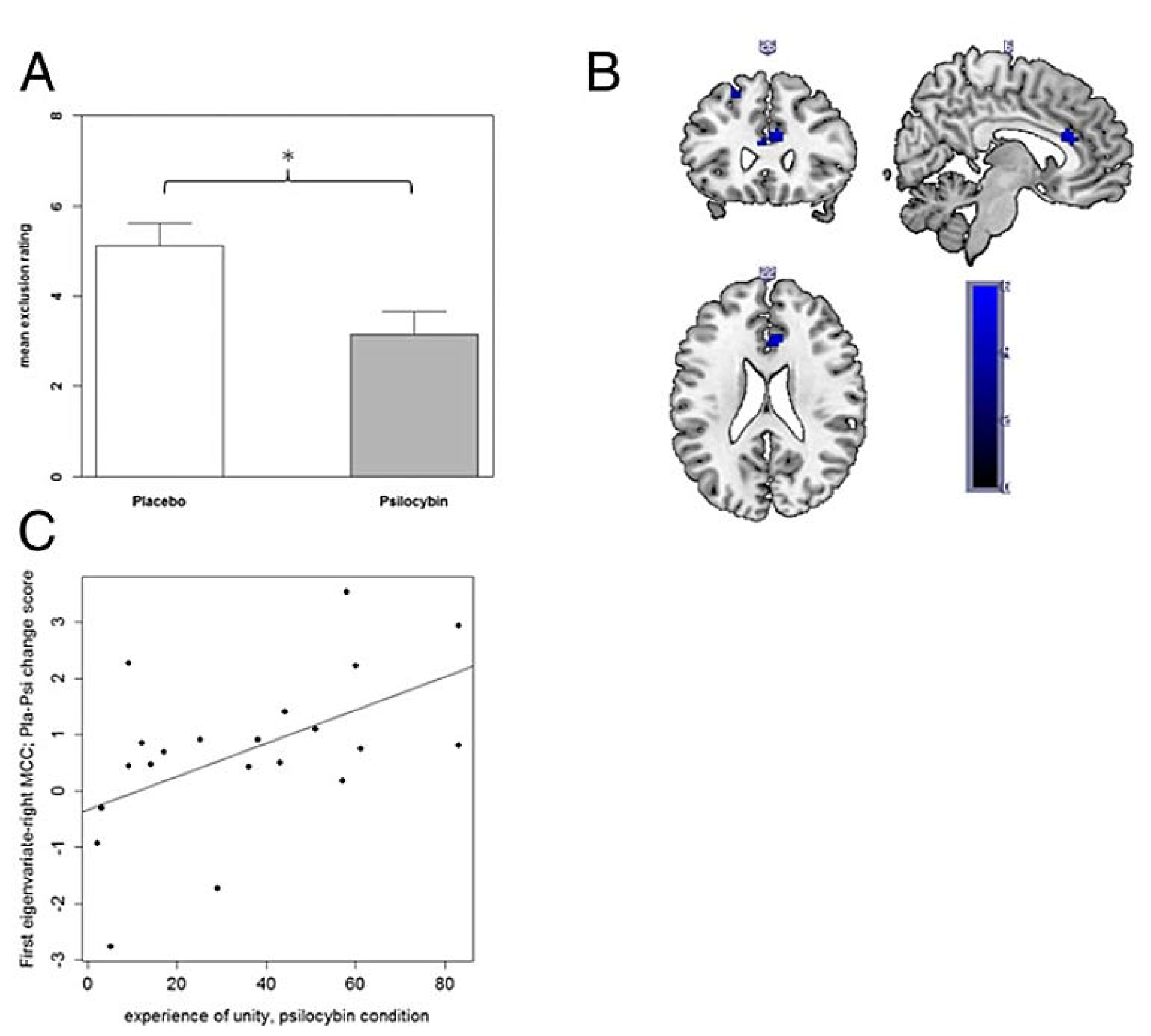


Fig. 1. (*A*) Social exclusion feelings were significantly reduced after Psi vs. Pla administration. Data are expressed as means + the SEM ($n = 21$ subjects). Asterisks indicate significant differences between Psi and Pla conditions (*$P < 0.05$). (*B*) fMRI activation data for Pla > Psi in the "not receiving ESE > receiving INCL" contrast. Blue shades represent significantly reduced activation in the Psi condition displayed at uncorrected $P < 0.001$ at peak aMCC voxel ($x = 6$, $y = 26$, $z = 22$). (C) Positive association between the experience of unity assessed by the 5D-ASC questionnaire and right MCC activation in the "not receiving ESE > receiving INCL" contrast ($r = 0.53$, $P < 0.02$, $n = 21$; first eigenvariate; Pla-Psi change score).

Table S2. PTQ results

Physical effects	Pla	Psi	*t* value	df	*P* value
Self-esteem (1-9)	6.14 (1.39)	6.62 (2.13)	-0.90	20	0.38
Meaningful existence (1-9)	1.76 (1.34)	1.81 (1.86)	-0.15	20	0.88
Control (1-9)	7.38 (1.24)	7.71 (1.10)	-1.05	20	0.31
Belongingness (1-9)	5.00 (2.00)	5.71 (2.53)	-1.09	20	0.29
Feeling of exclusion (1-9)	5.12 (2.27)	3.14 (2.39)	2.71	20	**0.01**
Feeling of inclusion (1-9)	5.40 (1.71)	.83 (2.09)	-0.77	20	0.45
Received throws (ISE)	0.00 (0.00)	1.67 (4.83)	-1.58	20	0.13
Received throws (INCL)	22.71 (9.59)	26.00 (21.53)	-0.90	20	0.38
Received throws (ESE)	4.53 (2.69)	8.14 (11.01)	-1.72	20	0.10
Liking of left player (1-5)	3.90 (0.83)	4.14 (0.85)	-1.42	20	0.17
Liking of right player (1-5)	3.62 (0.67)	3.71 (1.06)	-0.35	20	0.73
Liked by left player (1-5)	3.57 (0.68)	3.76 (0.70)	-1.07	20	0.30
Liked by right player (1-5)	3.38 (0.67)	3.52 (0.87)	-0.50	20	0.62

Significant *P* values are shown in boldface type. Means and SDs are given in parentheses. ESE, explicit social exclusion; INCL, inclusion; ISE, implicit social exclusion; Pla, placebo; Psi, psilocybin; PTQ, posttask questionnaire.

fMRI data

The "not receiving explicit social exclusion (ESE) > receiving inclusion (INCL)" contrast in the Pla condition revealed significant activation in brain regions of interest (ROIs) commonly associated with social exclusion processing: the bilateral anterior midcingulate cortex (aMCC), bilateral posterior MCC (pMCC), left inferior OFC, and bilateral MFG (see Table S3 for wholebrain results). To assess whether social exclusion was processed differently after Psi vs. Pla administration, we compared the "not receiving ESE > receiving INCL" contrast between Pla and Psi conditions. Brain activation was significantly less pronounced in the right aMCC and left MFG for Psi vs. Pla (Fig. 1B; see Table S4 for whole-brain results). Because these areas have been shown to represent key regions for social exclusion processing, these results suggest that Psi administration reduced the processing of social pain. No significant differences in activation were found for the inverse comparison (Psi > Pla) for the "not receiving ESE > receiving INCL" contrast.

Table S3. Whole-brain analysis under Pla condition for the contrasts not receiving ESE > receiving INCL, not receiving ISE > receiving INCL, and not receiving INCL > receiving INCL

Brain region	Hemisphere	*x*	*y*	*z*	*k*	*t*
Not receiving ESE > receiving INCL						
Anterior midcingulate cortex	R	6	23	19	13	4.66*
Anterior midcingulate cortex	L	0	26	19	10	4.52*
Posterior midcingulate cortex	L	0	-37	43	11	4.49*
Posterior midcingulate cortex	R	3	-40	43	7	4.45*
Inferior orbitofrontal cortex	L	-54	35	-5	20	4.91*
Middle frontal gyrus	R	48	44	7	57	5.17*
Middle frontal gyrus	R	33	23	49	5	4.03
Middle frontal gyrus	L	-39	44	1	13	4.97*
Middle frontal gyrus	L	-24	23	52	94	6.38*
Caudate nucleus	R	15	2	19	6	4.35

Temporal pole	R	27	5	-20	8	4.46
Fusiform gyrus	L	-39	-67	-20	5	3.95
Inferior occipital gyrus	R	45	-79	-8	46	4.80
Inferior frontal gyrus	L	-48	47	-2	117	5.61
Putamen	R	27	-16	4	64	5.55
Putamen	L	-27	-19	4	6	4.68
Superior occipital gyrus	L	-15	-91	4	82	5.55
Middle temporal gyrus	L	-57	-64	-2	4	3.70
Middle occipital gyrus	L	-48	-76	4	17	4.38
Cuneus	R	18	-85	7	16	4.61
Precuneus	L	-6	-52	13	7	4.48
Superior frontal gyrus	L	-6	65	19	19	4.38
Supramarginal gyrus	R	63	-46	31	40	4.99
Inferior parietal lobule	L	-51	-46	37	43	4.55
Angular gyrus	L	-42	-67	37	5	3.72
Paracentral lobule	L	-15	-31	64	29	4.97
Postcentral gyrus	R	15	-34	67	11	4.73
Not receiving ISE > receiving INCL						
Anterior midcingulate cortex	L	-3	20	22	93	5.17*
Pregenual anterior cingulate cortex	R	3	47	19	82	5.54*
Posterior midcingulate cortex	L	0	-40	40	19	4.39*
Posterior midcingulate cortex	R	3	-43	37	9	4.12
Middle frontal gyrus	L	-18	23	49	54	3.94
Middle frontal gyrus	R	48	44	10	4	3.96
Superior frontal gyrus	L	-21	50	25	7	4.37
Inferior frontal gyrus	L	-48	38	4	36	5.42
Inferior frontal gyrus	R	48	35	13	21	4.46
Temporal pole	R	33	17	-26	6	4.78
Middle temporal gyrus	L	-57	-46	-8	56	5.22
Cuneus	L	-15	-91	4	19	4.53
Precuneus	L	-6	-58	22	85	4.50
Postcentral gyrus	L	-48	-10	19	7	3.92
Postcentral gyrus	R	30	-28	64	7	4.22
Precentral gyrus	R	18	-31	67	43	4.29
Angular gyrus	L	-45	-70	34	109	5.29
Not receiving INCL > receiving INCL						
Subgenual anterior cingulate cortex	L	0	20	-8	8	5.28*
Pregenual anterior cingulate cortex	L	-3	44	13	7	4.16
Posterior midcingulate cortex	L	0	-40	43	8	4.19
Middle frontal gyrus	R	48	47	7	8	4.76

Middle frontal gyrus	L	-21	29	43	11	3.92
Inferior orbitofrontal cortex	L	-51	29	-5	8	4.00
Medial orbitofrontal cortex	R	6	50	-5	5	3.97
Superior frontal gyrus	L	-15	38	49	102	5.08
Superior frontal gyrus	R	27	23	55	25	4.41
Temporal pole	L	-39	14	-26	17	4.02
Superior temporal gyrus	L	-45	-1	-11	12	4.68
Inferior temporal gyrus	R	51	-70	-5	21	4.47
Middle temporal gyrus	L	-60	-46	-8	24	4.84
Middle temporal gyrus	L	-57	-61	-2	26	4.41
Middle temporal gyrus	R	54	-58	16	26	4.56
Calcarine gyrus	R	18	-88	4	81	5.06
Superior occipital gyrus	L	-12	-91	4	86	6.22
Superior medial gyrus	R	6	56	10	80	4.84
Precuneus	L	-6	-58	16	5	3.84
Angular gyrus	L	-42	-67	31	42	4.54
Angular gyrus	L	-39	-73	40	5	4.52
Superior parietal lobule	R	30	-67	55	13	4.93
Paracentral lobule	L	-9	-31	76	20	5.28

Statistical threshold: $P < 0.001$ (uncorrected), $k > 3$; *$P < 0.05$, FWE after SVC. MNI coordinates of peak voxels for each cluster are given. ESE, explicit social exclusion; FWE, family-wise error; INCL, inclusion; ISE, implicit social exclusion; MNI, Montreal Neurological Institute; Pla, placebo; SVC, small-volume correction.

Context-specific effects (33) were investigated by computing the "not receiving INCL > receiving INCL" contrast. This contrast revealed significant activation in the left subgenual ACC for Pla (Table S3). The same contrast showed no significant differences in activation for Psi vs. Pla administration (Table S4), indicating that Psi did not significantly modulate the processing of "not receiving the ball" without an exclusion context. Again, no significant differences in activation were found for the Psi > Pla comparison for the "not receiving INCL > receiving INCL" contrast.

Table S4. Whole-brain analyses for the Pla > Psi comparison for the contrasts not receiving ESE > receiving INCL, not receiving ISE > receiving INCL, and not receiving INCL > receiving INCL

Brain region	Hemisphere	*x*	*y*	*z*	*k*	*t*
Not receiving ESE > receiving INCL						
Anterior midcingulate cortex	R	6	26	22	34	5.79*
Anterior midcingulate cortex	L	0	23	22	13	3.91
Middle frontal gyrus	L	-27	44	7	27	4.98*
Middle frontal gyrus	L	-24	29	49	33	4.71
Middle frontal gyrus	L	-33	59	7	8	3.83
Middle frontal gyrus	L	-27	-1	67	52	4.68
Middle frontal gyrus	R	30	-4	64	18	4.22
Caudate nucleus	L	-9	20	-8	6	3.93
Middle temporal gyrus	R	54	-61	13	26	4.01
Middle temporal gyrus	R	33	58	13	20	5.03

Middle temporal gyrus	L	57	64	1	37	4.15
Thalamus	R	21	28	1	21	5.34
Putamen	R	30	16	10	11	4.00
Supramarginal gyrus	R	57	-43	34	22	5.23
Inferior parietal lobule	L	-54	-43	46	18	4.09
Inferior parietal lobule	R	45	-37	46	15	4.45
Postcentral gyrus	L	-48	-31	52	15	4.07
Not receiving ISE > receiving INCL						
Pregenual anterior cingulate cortex	L	0	47	16	8	4.33*
Anterior midcingulate cortex	R	6	29	22	35	5.69*
Anterior midcingulate cortex	L	0	23	25	12	4.15
Posterior midcingulate cortex	L	0	-40	43	26	5.19*
Posterior midcingulate cortex	R	3	-40	43	7	4.42*
Middle frontal gyrus	L	-33	44	25	5	4.08
Middle frontal gyrus	R	30	17	55	6	4.24
Precuneus	R	24	-55	43	5	3.99
Precuneus	R	33	-70	40	6	3.98
Fusiform gyrus	L	-45	-61	-17	4	3.90
Middle temporal gyrus	R	57	-64	-2	149	5.76
Middle occipital gyrus	L	-48	-73	1	96	5.79
Thalamus	R	21	-31	7	10	4.07
Calcarine gyrus	L	0	-94	13	10	5.46
Calcarine gyrus	L	-12	-52	10	39	5.10
Superior temporal gyrus	R	36	-52	13	49	4.79
Superior temporal gyrus	R	66	-31	19	11	5.59
Inferior parietal lobule	L	-51	-22	28	194	5.57
Superior parietal lobule	L	-30	-64	49	13	4.30
Not receiving INCL > receiving INCL						
Middle frontal gyrus	L	-30	14	58	6	4.45
Inferior occipital gyrus	R	39	-85	-8	17	4.71
Middle temporal gyrus	L	-48	-70	10	29	4.36
Superior frontal gyrus	L	-21	5	70	4	3.92

Statistical threshold: $P < 0.001$ (uncorrected), $k > 3$; $^*P < 0.05$, FWE after SVC. MNI coordinates of peak voxels for each cluster are given. ESE, explicit social exclusion; FWE, family-wise error; INCL, inclusion; ISE, implicit social exclusion; MNI, Montreal Neurological Institute; Pla, placebo; Psi, psilocybin; SVC, small-volume correction.

Relationship Between Social Exclusion Processing and Subjective Effects

A correlation analysis was conducted to evaluate the association between the difference between Pla > Psi conditions in (*i*) BOLD responses to the "not receiving ESE > receiving INCL" contrast in the right MCC and left MFG, and (*ii*) subjective drug effects (5D-ASC, PANAS) and PTQ items. A significant positive correlation was found between the difference in activation in the right MCC and the 5D-ASC scale "experience of unity" in the Psi condition ($r = 0.53$, $P < 0.02$; Fig. 1C). No other significant correlations between BOLD responses and subjective drug effects were observed (all $P > 0.08$), and no significant correlations were found between differences in BOLD responses and differences in PANAS scores or PTQ items (all $P > 0.1$).

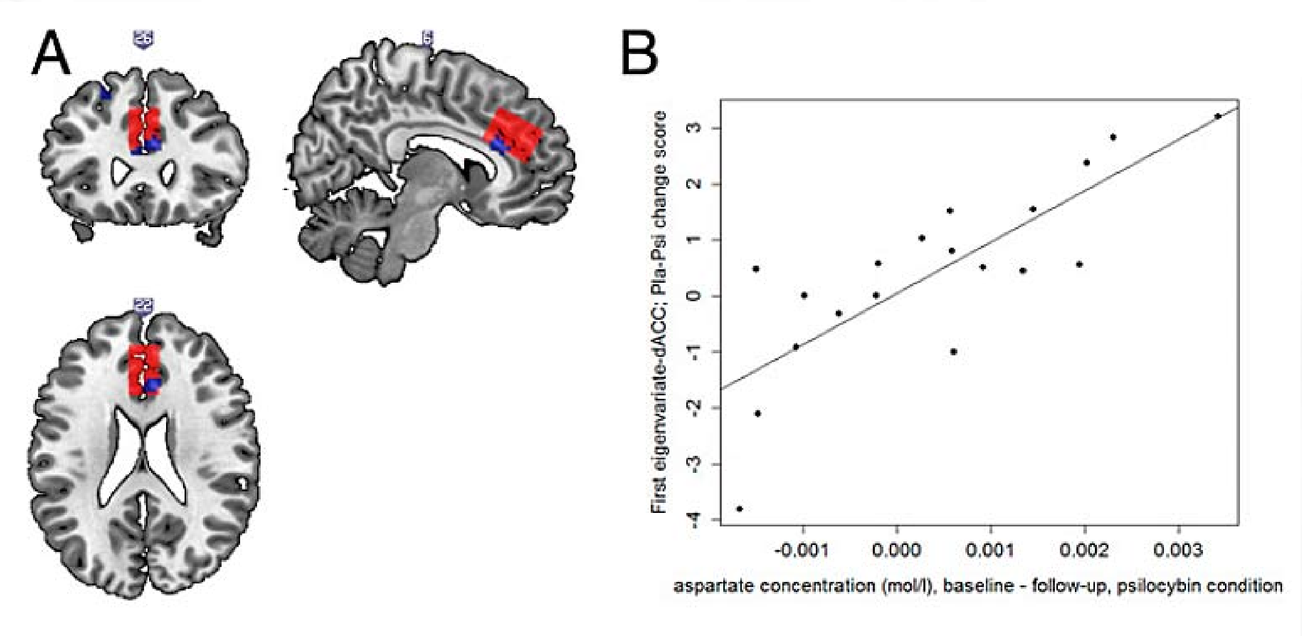
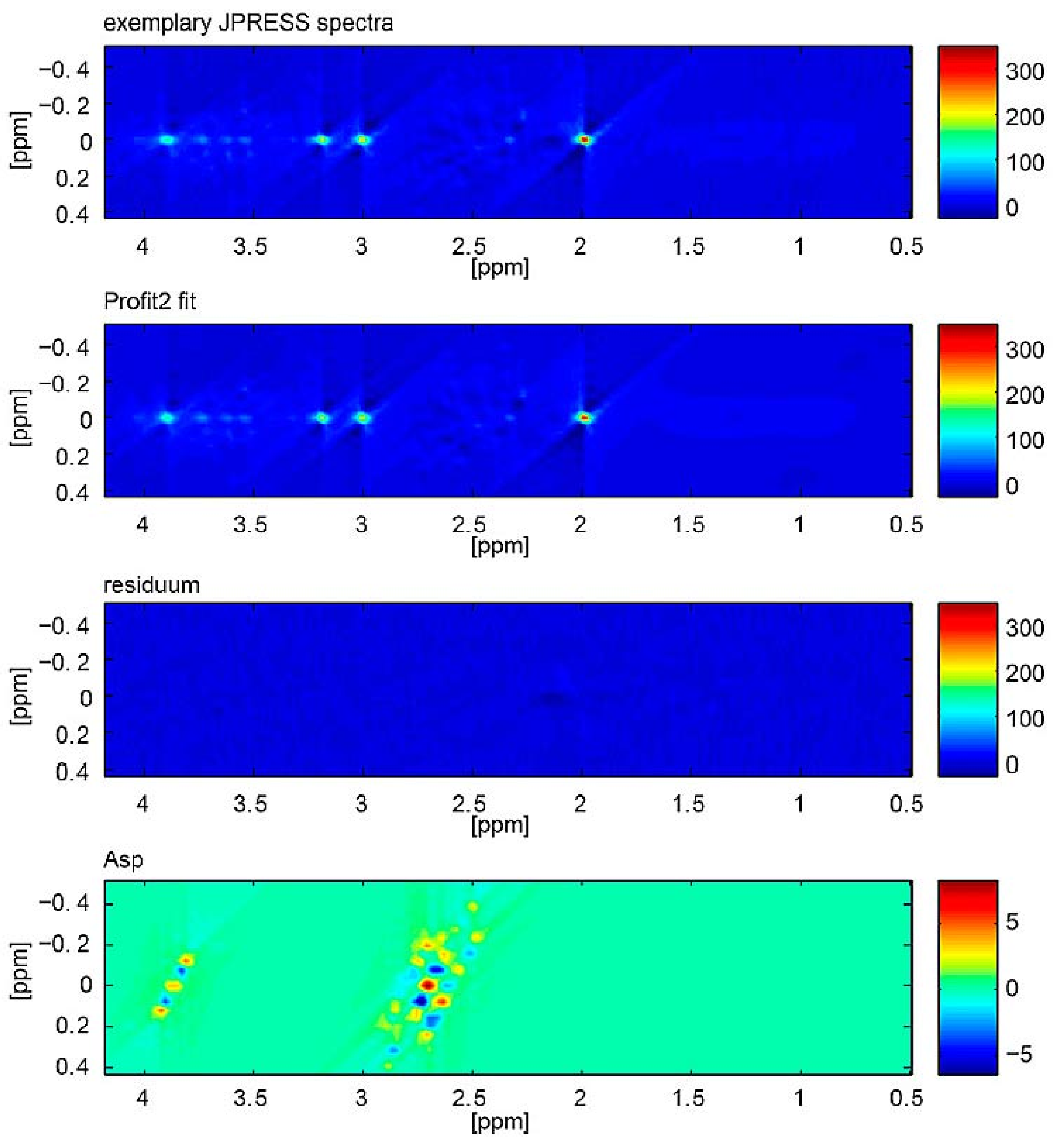


Fig. 2. (*A*) Overlap between activation for Pla > Psi in the "not receiving ESE > receiving INCL" contrast and the voxel established for MRS acquisition (red box). Blue shades represent significantly reduced activation in the Psi condition displayed at uncorrected $P < 0.001$. (*B*) Positive association between BOLD responses in the "not receiving ESE > receiving INCL" contrast (first eigenvariate extracted from the dACC ROI established for MRS acquisition; Pla-Psi change score) and changes in Asp concentration (baseline to follow-up) in the Psi condition ($r = 0.80$, $P < 0.001$, $n = 19$).

Relationship Between Social Exclusion Processing and Metabolite Concentrations

Brain region activation after Psi treatment was significantly reduced in response to the "not receiving ESE > receiving INCL" contrast in the aMCC, and overlapped with the dorsal ACC (dACC) voxel established for MRS acquisition (Fig. 2A). To explore the relationship between Psi-induced differences in social exclusion processing and metabolite concentrations, correlational analyses were computed for the difference in activity between the Pla and Psi conditions in the dACC voxel used for MRS measurement and the baseline-corrected metabolite concentration in the Psi condition as well as the metabolite concentrations in the Psi follow-up measurement. A significant correlation was obtained between activity in the dACC voxel computed for the "not receiving ESE > receiving INCL" contrast and baseline-corrected aspartate (Asp) concentration ($r = 0.80$, $P < 0.001$, $n = 19$; Fig. 2B). Congruently, a significant correlation was observed between Asp concentration in the Psi follow-up measurement and activity in the dACC voxel ($r = -0.56$, $P < 0.02$, $n = 19$). No significant correlations were found for other baseline-corrected or follow-up metabolite concentrations (all $P > 0.17$). For data and fit quality measures, see SI Results, MRS Data Quality and Fig. S3.


exemplary JPRESS spectra

Profit2 fit

residuum

Asp

Fig. S3. Two-dimensional JPRESS data from one exemplary participant, the Profit2 fit, the residuum of the fit, and the Asp component.

Discussion

The present study used a multimodal brain imaging approach to show that the processing of social pain is reduced after 5-HT$_{2A/1A}$ receptor stimulation by Psi; furthermore, this reduced response to social exclusion involved changes in cingulate Asp concentrations and changes in the experience of self. In agreement with previous studies of social exclusion and rejection[28, 29, 33-35; for reviews see refs. 27 and 36], we demonstrated that experiences of social exclusion vs. inclusion in the Pla condition involved the aMCC, pMCC, MFG, and inferior OFC. These brain areas are commonly associated with feelings of exclusion. Importantly, 5-HT$_{2A/1A}$ receptor stimulation by Psi significantly reduced activation of the aMCC and MFG in response to social exclusion. The aMCC, also termed the dACC[17, 37], represents a key region in social exclusion processing[17, 36]. In particular, dACC activation is related to experiences of fear and anxiety, emotional distress, and social pain[17, 29, 37]. Consistent with these observations, the current findings strongly suggest that Psi decreases the experience of social pain. Moreover, the frontal cortex also plays a regulatory role in social exclusion processing[29, 38]. More specifically, activation in the MFG can lead to inhibition of affective distress and social pain[29, 39]. Because Psi seems to reduce affective distress following social rejection, the decreased BOLD signal in the MFG observed herein after Psi administration possibly stemmed from a diminished need to block stressful experiences.

Here, implicit social exclusion relative to inclusion significantly recruited the aMCC, pMCC, and ventral ACC in the Pla condition. Activation in the MFG was not significant for ISE, contrary to ESE. This result supports previous findings showing increased ACC activity, but not self-regulatory responses, in frontal areas for ISE[29]. Psi treatment reduced the response to ISE in the aMCC, pMCC, and ventral ACC, suggesting that Psi diminishes reactions to social exclusion even in an implicit, and therefore possibly more subtle, context. To investigate whether Psi-induced alterations in neural responses to the event of "not receiving the ball" are attributable to this specific event or are instead sensitive to the game context, we also analyzed the "not receiving > receiving the ball" contrast while participants were included in the game[33]. In line with a previous study applying an event-related analysis to the Cyberball paradigm[33], this contrast recruited the subgenual ACC in the Pla condition. However, no significant differences were found between Pla and Psi for this contrast, indicating that Psi modulates the response to "not receiving the ball" only in conditions where the participant is actually excluded from the game, corroborating the interpretation that 5-$HT_{2A/1A}$ receptor stimulation by Psi apparently weakens the distressing affective response to social rejection.

In agreement with a decreased neural response to social exclusion, participants reported that they felt less excluded in the Psi vs. Pla condition on the PTQ. However, other ratings (e.g., self-esteem, meaningful existence, control, inclusion, belongingness, and liking) were not significantly altered by Psi; this suggests that Psi-mediated stimulation of the 5-$HT_{2A/1A}$ receptor may specifically reduce the feeling of being excluded, which is apparently not influenced by other social parameters. Additionally, no significant differences were found between Pla and Psi conditions for estimates of received throws, indicating that participants were equally aware of exclusion in both treatment conditions. Therefore, the reduced response to social exclusion is unlikely due to decreased attentiveness to the exclusion.

In the present study, the Psi-induced alterations on the 5D-ASC and increased scores for basic positive mood were generally similar to those observed in previous studies using comparable drug doses[10, 22]. The low ratings on the 5D-ASC scale "anxiety" (mean score: 7.5%, maximum score: 46%) are in accordance with previous studies suggesting that even during peak effects Psi is well tolerated and rarely produces profound or psychotic anxiety in a controlled clinical setting in healthy human subjects[13]. Moreover, the Psi-induced reduction in dACC activity in response to social exclusion showed significant correlations with scores for the feeling of unity. The 5D-ASC feeling of unity scale incorporates items assessing alterations in the sense of self/self-boundaries, such as feelings of being connected and/or one with the environment[40]. The correlation between experience of unity and social pain processing may indicate that alterations in the sense of self after Psi administration are important for changes in social interaction processing, adding empirical evidence to the notion that concepts of self and others are closely intertwined[41], which suggests that the sense of self can profoundly impact the experience of interpersonal relationships.

The Psi-induced feeling of being connected with and embedded in the environment may also lead to an intensified connection between oneself and other human beings, as well as stronger identification and empathic encounters with others. This feeling may assist in reducing egocentric bias and consequently render negative experiences more bearable. This interpretation is also supported by previous studies reporting that the ACC is particularly involved in self/other representations and theory of mind[42]. Moreover, the Psi-mediated feeling of being embedded in the environment may even be beneficial in therapeutic settings, supporting the relationship between patient and therapist, and facilitating the discussion of painful experiences in a protective and secure environment. In contrast to earlier work investigating the effect of Psi on nonsocial negative stimuli[10], the current data did not reveal any significant associations between BOLD responses and social exclusion or mood. Therefore, modulations of social interaction processing may be mostly independent of Psi-induced increases in positive mood.

To further examine the neurochemical substrates of altered social exclusion processing, changes in metabolite concentrations obtained by ^{1}H-MRS measurements were correlated with changes in the BOLD signal responses to social exclusion. These analyses showed that a reduction in Asp content between baseline (before drug administration) and follow-up (Psi condition, measured after subjects had completed the Cyberball task) was significantly correlated with a reduced BOLD signal in the dACC in response to social exclusion (Psi vs. Pla condition). Even though the complex resonance pattern of Asp showing overlaps with various other metabolites is difficult to quantify with in vivo MRS, the used JPRESS acquisition together with Profit2 fitting allowed an Asp quantification with CRLBs around 6% and low SD, indicating good and homogeneous data quality. Together, these findings may indicate that changes in Asp levels are related to social pain processing.

Glutamate (Glu) and Asp are present in high concentrations in the central nervous system; both have excitatory effects on neurons, with Asp preferentially activating NMDA receptors[43]. Moreover, functionally or pharmacologically induced changes in neurotransmission and brain energy metabolism underlying the origin of the BOLD signal are linked to changes in Glu and Asp concentrations as a consequence of an increased rate of the malate-aspartate shuttle, which is associated with the increased flux into the tricarboxylic acid cycle[44, 45]. Interestingly, the structurally related psychotropic 5-HT$_{2A/1A}$ agonist lysergic acid diethylamide increases extracellular medial prefrontal Glu release and prefrontal pyramidal cell activity in rodents[46, 47]. However, in our study, BOLD reductions to social exclusion in the dACC were related to changes in Asp content exclusively, and no correlations with changes in Glu concentrations were found. Hence, the interpretation of our findings remains somewhat speculative because the effects of Psi on Asp release are currently novel and have not yet been reported in animal and human studies and therefore require further investigation. Because extrasynaptic and intrasynaptic pools of Asp and Glu cannot be distinguished by spectroscopic imaging, no general conclusions can be drawn from metabolite concentrations to the process of neurotransmission. However, recent studies have consistently reported small concentration changes in lactate, Glu, Asp, and glucose in the human cortex during prolonged stimulation[48, 49]. Positive linear relationships between metabolic and BOLD responses in the presence of excitatory sensory inputs could be found for Glu and lactate concentrations[48]. In contrast, inverse correlations between BOLD responses and MRS measures were found for GABA concentrations[48, 50, 51]. In line with these findings, we argue in favor of an emerging conceptual framework to interpret multimodal imaging findings including changes in metabolite concentrations and BOLD signals in terms of brain energetics and neurotransmission. In addition, a recent study proposed the existence of a neuron-to-astrocyte Asp transcellular pathway required for astrocyte Glu synthesis and subsequent glutamine formation[52]. Accordingly, the relationship among decreased Asp levels, reduced BOLD responses, and social pain might indicate a possible role of glial Glu metabolism in the processing of social pain signals in the dACC. In conclusion, further studies would be needed to corroborate the hypothetical functional links between Asp levels and BOLD responses that we observed in our study.

To our knowledge, the current study represents the first multimodal brain imaging approach to investigate the neuropharmacological grounds of social exclusion processing, and particularly the influence of 5-HT receptor stimulation on negative social interactions. Evidence from animal studies suggests that the opioid system may similarly participate in the experience of pain and distress in response to maternal-infant separation[53]. Furthermore, another study showed that chronic administration of the analgesic acetaminophen reduced neural responses to social rejection in the dACC and anterior insula, but not self-reported social distress after exclusion[54]. However, the exact action mechanism of acetaminophen is still unclear. Additional behavioral analyses suggested that oxytocin does not buffer against the experience of social pain after social rejection[55]. Moreover, recent work[56] found that administration of 3,4-methylenedioxy-methamphetamine (MDMA), a 5-HT, dopamine, and norepinephrine releasing agent/reuptake inhibitor[57], decreased the effect of social exclusion on mood and self-esteem, but not on physiological measures. The authors proposed that MDMA selectively decreased the perceived intensity of rejection, as indicated by increased estimates of received throws in the exclusion condition. Therefore, whereas MDMA seems to affect the perception of social exclusion, Psi may actually reduce the experience of social pain itself without significantly influencing the awareness of being excluded. The current study therefore represents to our knowledge the first indication that stimulation of the 5-HT$_{2A/1A}$ receptor system can regulate social pain processing and experience. The results are consistent with previous reports suggesting that the 5-HT system plays a role in emotional regulation[10, 20, 21], and may also be relevant for social cognition and behavior[11, 12]; they likewise support earlier studies showing that 5-HT$_{2A}$ receptors are highly expressed in prefrontal brain areas and emphasize the importance of these receptors for prefrontal brain function[58]. Considering that most previous studies investigating the role of 5-HT in social processes were conducted by using selective serotonin reuptake inhibitors to increase 5-HT levels, the current study extends these findings by showing that direct receptor simulation contributes to modulations of social cognition. Furthermore, our work highlights the importance of the 5-HT$_{2A/1A}$ receptor system not only in perception but also in the actual experience of social encounters, as indicated by the interactive nature of the

Cyberball paradigm[27].

The multimodal brain imaging approach applied in this study offers the possibility of exploring neurobiological processes underlying the experience of social pain. Our findings indicate that Psi acts on brain areas associated with the experience of social pain via alterations in Glu/Asp metabolism. The current results must be interpreted with the following limitation in mind - namely, that the results of pharmacological MRI studies may be susceptible to drug effects on cerebral vasoactivity[8]. However, two previous fMRI investigations of Psi actions found no effect of nonneural physiological changes or Psi itself on the vascular system of the brain[10, 16]. Furthermore, psilocybin has been shown to reduce the BOLD signal in the dACC during resting state[16]. It is therefore possible that the reduction of BOLD signal in the dACC reported in the current study might relate to a general reduction of neuronal activity within this area; however, this is unlikely considering that no decrease in BOLD signal was found for the "not receiving INCL > receiving INCL" contrast after Psi administration compared with Pla, indicating that the decreased BOLD response is related to the exclusion context. Furthermore, conflicting results have been obtained between PET and fMRI regarding resting state activity in the ACC after Psi administration, with a previous study showing increases in glucose metabolism in the dACC PET[18]. However, the current study reports alterations in regional brain activity that are task specific and rely on contrasts between two conditions of this task. Therefore, we cannot make any conclusions about a general increase or decrease in neuronal activity in the ACC after Psi administration.

In summary, the present results suggest that 5-HT$_{2A/1A}$ receptor stimulation by Psi attenuates social pain processing, possibly in parallel with alterations in Glu/Asp metabolism and release. Furthermore, receptor stimulation is also associated with changes in self-processing, particularly the feeling of being connected with the environment. Social ties have repeatedly been shown to be crucial for physical and mental health[59, 60], and psychiatric patients often encounter social rejection[61]. Additionally, perceived social isolation has a negative impact on social and general cognition, often leading to negative social interactions and a vicious cycle of social rejection[62]. Patients suffering from major depressive disorder exhibit information acquisition and processing that is biased toward negative stimuli, which features predominantly in the development and maintenance of depression[63]. This negative emotional bias is related *inter alia* to functional alterations in the ACC and frontal brain areas[63]. Therefore, the current study validates reports suggesting that Psi may have antidepressant characteristics[10, 16], possibly by mitigating negative emotional bias[10, 20, 21]. Last, the present results show that Psi may normalize the processing of negative social interaction in disorders characterized by increased rejection sensitivity through the adjustment of dACC and frontal brain activity, and by changes in self-processing. However, because this study was conducted in healthy volunteers, it has to be interpreted with the limitation in mind that the results may not directly translate to psychiatric patients with severe social exclusion experiences, such as schizophrenia patients[3].

Understanding the neural and biochemical foundations of rejection experiences is important for increasing our knowledge about social and emotional processes, and is crucial for the treatment of conditions influenced by social factors[3, 35, 54]. Therefore, our findings may assist in diminishing a knowledge gap that restrains the development of pharmacotherapies for sociocognitive deficits in psychiatric disorders. The current results also emphasize the contribution of 5-HT$_{2A/1A}$ receptor subtypes and the Glu/Asp system in the regulation of social functioning, and their utility as prospective targets in the management of sociocognitive impairments.

Methods

Study Participants

The data of 21 healthy participants were included in the statistical analyses (n = 12 males and 9 females; mean age = 26.48 y; SD = 4.76 y; range = 20-37 y). For further details, see *SI Methods*. The MRS data of two subjects were excluded in the corresponding analyses due to premature termination of MRS acquisition. Subjects received written and oral descriptions of the study procedures, as well as details regarding the effects and possible risks of Psi treatment. All participants provided written informed consent statements in accordance with the declaration of Helsinki before participation in the study. The Swiss Federal Office of Public Health, Bern, Switzerland, authorized the use of Psi in humans, and the study was approved by the Cantonal Ethics Committee of Zurich.

Study Design

This study was designed as a randomized, double-blind, placebo-controlled, within-subject investigation. Subjects received either Pla (maltose) or oral Psi (0.215 mg/kg) in two separate sessions spaced at least 10 d apart. The dose of 0.215 mg/kg was chosen based on previous studies showing that it is well tolerated in healthy subjects[13] and attenuates the processing of negative emotional stimuli[20]. For details, see *SI Methods*.

Cyberball Task

While undergoing fMRI, participants completed an interactive virtual ball-tossing game called Cyberball that simulates a real-life interactive experience of social exclusion[23]. For details, see *SI Methods* and Fig. S4. Briefly, participants played three rounds of Cyberball during separate fMRI scans, each representing one of the following conditions: (*i*) ISE, where participants were informed that due to technical difficulties the internet connection could not be established, but that they could watch the other participants playing; (*ii*) INCL, where participants were told that they were connected and could join in with the other players; and (*iii*) ESE, where participants received five throws and were then excluded from the game (i.e., the other players stopped throwing the ball to the participant for the remainder of the scan). Immediately after the scanning session, participants completed the PTQ. For details, see *SI Methods*.

MRI Data Acquisition and Preprocessing

MRI data were acquired by using a Philips Achieva 3.0T whole-body scanner (Philips Healthcare). Care was taken to ensure the comfort of the study participants on the scanner bed. To this end, the study protocol used inflatable Multipad pillows (Pearltec). A 32-channel receive-only phased-array head coil and MultiTransmit parallel radio frequency transmission technology were used to collect the fMRI data. For further details, see *SI Methods*. A birdcage transmit-receive passed-array head coil with a maximum B1 = 20 µT was used for collection of MRS data. Therefore, subjects were repositioned in different coils between MRS and fMRI scans to gain optimal data quality for the different modalities. During the ^{1}H-MRS measurements, participants were not engaged in a task, but were instead instructed to lie as still as possible in the scanner. A 1-mm3 isotropic high-resolution T1-weighted image was used for voxel planning. A maximum echo J-resolved ^{1}H-MRS protocol[64] was established to acquire spectra from an anatomical ROI of 32 (AP) × 21 (RL) × 24 (FH) mm^3 in the dACC. The ROI was selected based on previous work highlighting the role of the ACC in social cognition[17], as well as changes in brain perfusion and glucose metabolism after Psi administration detected by PET[18]. Measured data were quantified by using Profit2 software[65] to enable the detection of up to 18 different metabolites (*N*-acetylaspartate, creatine, choline, myoinositol, Glu, glutamine, *N*-acetylaspartylglutamate, gamma-aminobutyric acid, glucose, lactate, scyllo-inositol, taurine, glycine, glutathione, phosphoethanolamine, Asp, ascorbate, and acetate). For details, see *SI Methods*.

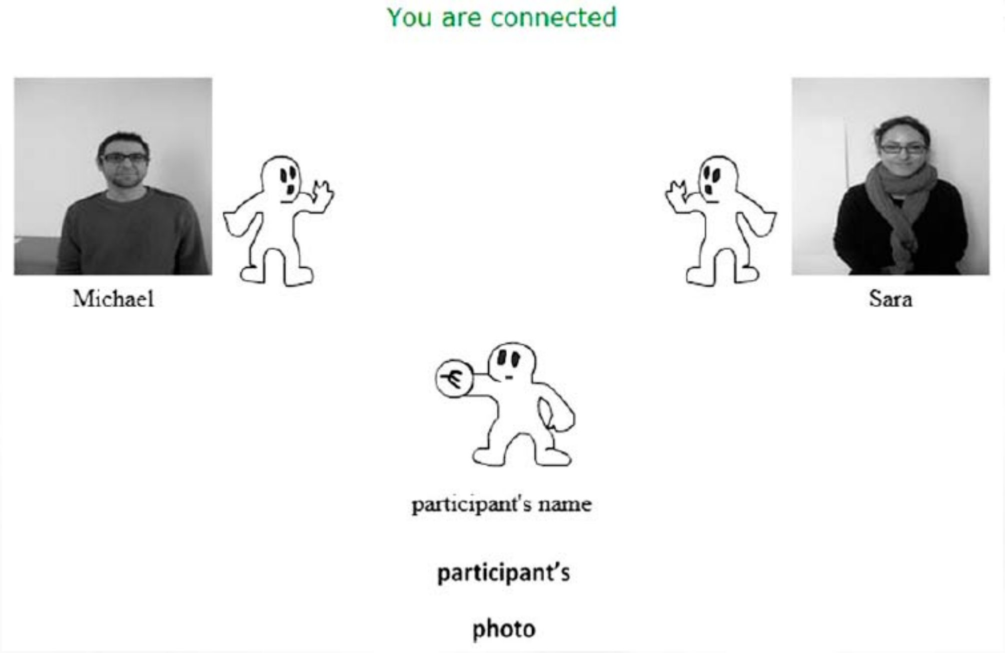


Fig. S4. Cyberball task display (inclusion and explicit social exclusion run). Participants were informed about the connection status on the top of the screen, which displayed "You are NOT connected" during the implicit social exclusion run; they also observed photographs and names of the other players, as well as their own name and photo at the bottom of the screen.

Statistical Analysis

Questionnaires and physical effects

Repeated-measures ANOVAs with treatment (Pla vs. Psi) and scale as within-subject factors were conducted to analyze 5D-ASC ratings. For analysis of PANAS ratings, time (pre-drug administration vs. post-drug administration) was introduced as an additional within-subjects factor. Paired *t*-tests were applied to analyze PTQ items as well as pulse and systolic/diastolic blood pressure. Significant main effects or interactions were followed by Bonferroni-corrected pairwise comparisons and simple main effects analyses, respectively. The confirmatory statistical comparisons of all data were carried out with a significance level of $P < 0.05$ (two-tailed test). Analyses were conducted by using IBM SPSS Statistics 21 software (IBM). For details, see *SI Methods*.

fMRI data

The fMRI images were analyzed by using a general linear model implemented in the SPM8 software package and an event-related design[33]. For details, see *SI Methods*.

Correlation analyses

Correlation analyses were conducted to further investigate the relationship between Psi-induced differences in social exclusion processing and subjective effects. Furthermore, the relationship between Pla-Psi differences in social exclusion processing and changes in metabolite concentrations was explored. For details, see *SI Methods*.

Acknowledgments

The study was supported by grants from the Heffter Research Institute and the Swiss Neuromatrix Foundation.

Supporting Information

SI Results

5D-ASC

To test for potential order effects with regard to the sequence of substance administration, MANOVAs were performed for the ratings on the 11 scales of the 5D-ASC in the Psi and the Pla condition. The analyses did not reveal significant differences in the experience of drug effects between participants who received Psi in the first session and those who received Psi in the second session [Psi condition ratings: $F(11, 9) = 1.18$, $P > 0.40$; Pla condition ratings: $F(7, 13) = 0.76$, $P > 0.62$.

PANAS

A repeated-measures ANOVA (time × treatment × scale) for the PANAS revealed a significant main effect for scale [$F(1, 19) = 307.83$, $P < 0.001$], indicative of higher ratings on the positive affect scale than on the negative affect scale. Furthermore, significant interactions were obtained for time × treatment [$F(1, 19) = 13.85$, $P < 0.01$] and time × treatment × scale [$F(1, 19) = 8.67$, $P < 0.01$]. Simple main effect analyses showed that negative affect was significantly reduced after Pla treatment ($P < 0.01$), whereas positive affect was increased after Psi treatment ($P < 0.05$; Fig. S2). No other main effects or interactions reached significance (all $P > 0.05$). PANAS scores of one subject could not be analyzed due to missing data.

MRS Data Quality

No artifacts were identified in the analyzed 2D plots and in the projections of the JPRESS spectra by the visual artifact inspection. *N*-acetylaspartate, creatine, choline, glutathione, Asp, Glu, glutamine, glycine, myo-inositol, scyllo-inositol, taurine, and ascorbate passed the stringent Cramer Rao lower bounds (CRLBs) quality criteria (all CRLBs <20% and mean CRLBs <15%). Mean CRLBs of glucose, γ-aminobutyric acid, lactate, *N*-acetylaspartylglutamate, and phosphoethanolamine were also below 15%, but some outliers exceeded 20%. Mean and SD of CRLBs of Asp of all measurements were 6.10 ± 0.87% (Psi) and 5.99 ± 0.79% (Pla). Fig. S3 shows the 2D JPRESS data from one exemplary participant, the Profit2 fit, the residuum of the fit and the Asp component.

SI Methods

Participants

Participants were recruited through advertisements in local universities. All subjects were healthy according to medical history, physical examination, blood analysis, and electrocardiography, and showed normal or corrected-to-normal vision. The Mini-International Neuropsychiatric Interview (MINI-SCID)[66], the DSM-IV self-rating questionnaire for axis II personality disorders (SCID-II)[67], and the Hopkins Symptom Checklist (SCL-90-R)[68] were used to exclude subjects with present or previous psychiatric disorders or a history of major psychiatric disorders in first-degree relatives. Participants were asked to abstain from the use of any prescription or illicit drug for a minimum of 2 wk before the first test day and for the duration of the entire study, and to abstain from drinking alcohol for at least 24 h before test days. Urine tests and self-report questionnaires were used to verify the absence of drug and alcohol use. Urine tests were also used to exclude pregnancy. Further exclusion criteria included left-handedness, poor knowledge of the German language, cardiovascular disease, history of head injury or neurological disorder, history of alcohol or illicit drug dependence, MRI exclusion criteria including claustrophobia, and previous significant adverse reactions to a hallucinogenic drug.

The initial study population consisted of 29 participants. Completion of the task was not possible for one participant because of technical problems. Two participants were excluded because they declared familiarity with the task and therefore did not complete the task appropriately. Five additional participants were excluded due to excessive head movement during scanning (> 3 mm), either at the first or second assessment. Finally, 21 participants were included in the study.

Study Design

The Cyberball paradigm was conducted 75 min after Psi/Pla administration, during the plateau of peak subjective Psi effects[40]. Two MRS scans were assessed per subject and per MRI session. A 40-min baseline MRS measurement [including survey scan, high-resolution T1, preparation scans (noise determination, resonance frequency determination, power optimization, higher order shimming) and JPRESS MRS] was conducted starting 50 min before substance administration. An additional (follow-up) MRS was assessed after completion of the Cyberball paradigm (i.e., 100 min after Psi/Pla administration). Pulse and blood pressure were measured after scanning (i.e., 150 min after Psi/Pla administration). Mood state was assessed by using the PANAS[69] 75 min before and 360 min after each drug treatment. The 5D-ASC (a retrospective self-report questionnaire)[40] was administered to participants 360 min after drug treatment to assess subjective experience after drug intake. Participants were required to abstain from smoking for at least 60 min before MRI assessments and from drinking caffeine during the test day.

Cyberball Task

Before administration of Psi or Pla, participants were told that they would be connected over the Internet with two other players (one male and one female). The participants were then shortly introduced to the other players. Two different players were introduced at the second assessment. The actions of the players were controlled by the computer. To ensure that the participants believed that the other players were real, they were told that the task was used to investigate mental visualization skills, and that they should try to imagine the game as vividly as possible[23, 29].

The Cyberball paradigm was presented in the scanner with MRI-compatible video goggles (Resonance Technology). Responses (from the right hand) were collected by using a two-button response box. Participants were represented as animated cartoon images at the bottom of the screen. The two other players were also shown as animated cartoon images on the left and right side of the screen. The female coplayer was always shown on the right side, whereas the male coplayer was always shown on the left side. Black-and-white photographs of all three players and the players' names were depicted beside each player's icon. The connection status ("You are NOT connected" for the ISE condition and "You are connected" for the INCL and ESE conditions) was displayed at the top of the screen (Fig. S4).

To prevent expectation effects, the order of the conditions was varied. At the first assessment, the participants completed the scans in the following order: (*i*) ISE, (*ii*) INCL, and (*iii*) ESE. At the second assessment, the order was (*i*) INCL, (*ii*) ESE, and (*iii*) ISE. Participants were only informed about changes in connection status, i.e., between ISE and INCL at assessment 1 and ESE and ISE at assessment 2, but not about changes in condition.

Each run was initiated with a loading screen informing the participants that the computer was trying to connect to the other players. The duration of each ball toss was fixed at 1.4 s. The reaction time of the computerized players varied randomly between 500 and 3,000 ms. The ISE condition consisted of 60 ball tosses between the computerized players, and lasted for 200 s. During the INCL condition, 90 ball tosses in total were administered, with participants receiving 33% of the throws. After receiving the ball, participants could throw the ball to one of the other players by pressing the left or right button on the response box with the right index finger. The INCL run lasted for 262.5 s. The ESE condition consisted of a total of 60 ball tosses and lasted for 200 s.

Posttask Questionnaire

The PTQ contained four questions of the Need Threat Scale[69] assessing participants' socially orientated self-esteem ("To what extent do you think the other participants value you as a person?"); meaningful existence ("How true is the statement: 'Life is meaningless'?"); control ("How true is the statement: I am in control of my life?"); and belongingness ("How much do you feel that you belonged to the group?"). Furthermore, the intensity of ostracism was measured by two questions ("To what extent did you feel that you were ignored or excluded by the other participants?" and "To what extent did you feel that you were noticed or included by the other participants?"). These questions were answered on a nine-point scale, ranging from 1 (not at all) to 9 (very much).

To assess the participants' awareness of social exclusion, they were asked to gauge how many throws they received during each of the runs. Participants were also asked to answer the questions "How much did you like the other player?" and "How much do you think the other player liked you?" for each of the other players on a five-point scale (1 = not at all; 5 = very much). Last, participants were permitted to submit any thoughts regarding the game on blank lines of the PTQ.

MRI Data Acquisition and Preprocessing

fMRI were acquired by using a whole-brain, gradient-echo planar imaging (EPI) sequence (repetition time = 2,500 ms; echo time = 30 ms; slice thickness = 2.75 mm; 40 axial slices; no slice gap; field of view = 220 × 220 mm^2; in-plane resolution = 2.75 × 2.75 mm^2; sensitivity-encoding reduction factor = 2.0). Additionally, high-resolution anatomical images (voxel size = 1 × 1 × 1 mm^3) were acquired by using a standard T1-weighted 3D MPRAGE sequence. Images were analyzed with SPM8 software (www.fil.ion.ucl.ac.uk). Preprocessing consisted of slice-time correction, realignment, spatial normalization to the standard EPI template of the Montreal Neurological Institute (MNI), and spatial smoothing with a Gaussian kernel of 8 mm full width at half maximum to meet the statistical requirements of the general linear model.

For MRS data, a minimum echo time of TE = 28 ms and a repetition time of TR = 1,600 ms was used. The echo increment to encode the indirect dimension was set to 2 ms. One hundred steps were acquired by obtaining eight average measurements plus one additional interleaved acquired non-water-suppressed spectrum with identical TE. The system's built in projection-based automatic second-order B0 shimming routine (described in detail in ref. 70) was used without electrocardiogram triggering. Water suppression was achieved by the variable pulse power and optimized relaxation delay, or VAPOR, method[71], and polynomial phase saturation pulses[72] were applied with interleaved inner-volume saturation (IVS). Due to IVS, the resulting voxel size was 29 (AP) × 19.8 (RL) × 21.8 (FH) mm^3. Based on high-resolution 3D T1 images, cerebral spinal fluid, gray matter, and white matter fractions were calculated by using SPM8 software, and the metabolite concentrations were corrected*. Visual assessment of the line shape of the unsuppressed water peak of the MRS preparation scan was used to guarantee good and consistent shim quality. In addition, a visual artifact inspection of 2D plots and deduced projections[65] was used for spectral quality control. CRLBs were used as quality criteria, but no exclusion of concentration values based on CRLBs was made to avoid bias toward higher concentrations[73]. Instead, a metabolite was marked as "reliably detected" if all CRLB values of all JPRESS measurements were below 20% and the mean concentration was below 15%.

Statistical Analysis of Questionnaires

The 5D-ASC comprises 94 items to be answered on visual analog scales. Scores were calculated for 11 recently validated scales[40]: experience of unity, spiritual experience, blissful state, insightfulness, disembodiment, impaired control and cognition, anxiety, complex imagery, elementary imagery, audiovisual synesthesia, and changed meaning of percepts. For PANAS ratings, scores were calculated for the positive and negative affect scales.

Statistical Analysis of fMRI Data

The onsets of ball movement were modeled as stick functions and convolved with a canonical hemodynamic response function in the first-level analysis for each subject. Low-frequency signal drifts were filtered with a 128-s high-pass filter. Events were divided into the following conditions. INCL and ESE: receiving, not receiving, or playing the ball; and ISE: not receiving the ball. The following contrasts were computed for each participant: (*i*) not receiving ESE > receiving INCL, (*ii*) not receiving ISE > receiving INCL, and (*iii*) not receiving INCL > receiving INCL. The individual contrasts were then entered into a second-level group analysis by using a paired t-test for the comparison between Psi and Pla conditions, and one-sample t tests for the within-Pla analysis with a threshold of uncorrected $P < 0.001$ and $k > 3$. Due to our *a priori* interest in social exclusion sensitive-areas, bilateral ROIs (ACC, MCC, insula, inferior OFC, and MFG) were defined that were previously identified to be involved in social rejection processing by metaanalysis[28]. Condition effects were analyzed by using small-volume correction (SVC) based on these anatomical ROIs[74]. Family-wise error (FWE) corrections were used in all SVC ROI analyses at a peak level-corrected threshold of $P < 0.05$. Uncorrected whole-brain results ($P < 0.001$) are shown in Table S3 (Pla) and Table S4 (Pla vs. Psi). All brain coordinates are reported in the MNI atlas space.

Correlational Analyses

Correlation analyses were conducted to further investigate the relationship between Psi-induced differences in social exclusion processing and subjective effects. BOLD signal responses (first eigenvariate) were extracted from the right dACC and left MFG anatomical ROIs for the "not receiving ESE > receiving INCL" contrast for Psi and Pla by using the same anatomical masks as described above. Pearson's product-moment correlations were conducted between the extracted BOLD responses in these ROIs (Pla-Psi change score) and the 5D-ASC scale scores (Psi condition, because 5D-ASC scores represent percent deviations from the normal waking state), PANAS ratings (Pla-Psi change score), and PTQ items (Pla-Psi change score). Finally, the relationship between Pla-Psi differences in social exclusion processing and changes in metabolite concentrations was explored. The BOLD response (first eigenvariate) was extracted from the dACC ROI established for MRS acquisition (Fig. 2A) for the "not receiving ESE > receiving INCL" contrast for Psi and Pla. Pearson's product-moment correlation analyses were computed between the extracted BOLD responses (Pla-Psi change score) and the baseline-corrected metabolite concentrations in the Psi condition (baseline-follow-up) as well as metabolite concentrations in the Psi follow-up measurement.

References

1. Patin A, Hurlemann R (2015) Social cognition. *Handbook Exp Pharmacol* 228: 271-303.
2. Millan MJ, *et al*. (2012) Cognitive dysfunction in psychiatric disorders: Characteristics, causes and the quest for improved therapy. *Nat Rev Drug Discov* 11(2): 141-168.
3. Green MF, Horan WP, Lee J (2015) Social cognition in schizophrenia. *Nat Rev Neurosci* 16(10):620-631.
4. Fett AK, *et al*. (2011) The relationship between neurocognition and social cognition with functional outcomes in schizophrenia: A meta-analysis. *Neurosci Biobehav Rev* 35(3):573-588.
5. Cusi AM, Macqueen GM, Spreng RN, McKinnon MC (2011) Altered empathic responding in major depressive disorder: Relation to symptom severity, illness burden, and psychosocial outcome. *Psychiatry Res* 188(2):231-236.
6. Crockett MJ, Fehr E (2014) Social brains on drugs: Tools for neuromodulation in social neuroscience. *Soc Cogn Affect Neurosci* 9(2):250-254.
7. Anticevic A, *et al*. (2013) Connectivity, pharmacology, and computation: Toward a mechanistic understanding of neural system dysfunction in schizophrenia. *Front Psychiatry* 4:169.
8. Honey G, Bullmore E (2004) Human pharmacological MRI. *Trends Pharmacol* Sci 25(7): 366-374.
9. Meneses A (2015) Serotonin, neural markers, and memory. *Front Pharmacol* 6:143.
10. Kraehenmann R, *et al*. (2015) Psilocybin-induced decrease in amygdala reactivity correlates with enhanced positive mood in healthy volunteers. Biol Psychiatry 78(8): 572-581.
11. Crockett MJ, Clark L, Hauser MD, Robbins TW (2010) Serotonin selectively influences moral judgment and behavior through effects on harm aversion. *Proc Natl Acad Sci USA* 107(40):17433-17438.
12. Canli T, Lesch KP (2007) Long story short: The serotonin transporter in emotion regulation and social cognition. *Nat Neurosci* 10(9):1103-1109.
13. Studerus E, Kometer M, Hasler F, Vollenweider FX (2011) Acute, subacute and longterm subjective effects of psilocybin in healthy humans: A pooled analysis of experimental studies. *J Psychopharmacol* 25(11):1434-1452. 14.
14. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101(2):131-181.
15. Halberstadt AL, Geyer MA (2011) Multiple receptors contribute to the behavioral effects of indoleamine hallucinogens. *Neuropharmacology* 61(3):364-381.
16. Carhart-Harris RL, *et al*. (2012) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 109(6):2138-2143.
17. Rotge JY, *et al*. (2015) A meta-analysis of the anterior cingulate contribution to social pain. *Soc Cogn Affect Neurosci* 10(1):19-27.
18. Vollenweider FX, *et al*. (1997) Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16(5):357-372.

19. Bernasconi F, *et al*. (2014) Spatiotemporal brain dynamics of emotional face processing modulations induced by the serotonin 1A/2A receptor agonist psilocybin. *Cereb Cortex* 24(12):3221-3231.
20. Kometer M, *et al*. (2012) Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol Psychiatry* 72(11):898-906.
21. Schmidt A, Kometer M, Bachmann R, Seifritz E, Vollenweider F (2013) The NMDA antagonist ketamine and the 5-HT agonist psilocybin produce dissociable effects on structural encoding of emotional face expressions. *Psychopharmacology (Berl)* 225(1): 227-239.
22. Vollenweider FX, Kometer M (2010) The neurobiology of psychedelic drugs: Implications for the treatment of mood disorders. *Nat Rev Neurosci* 11(9):642-651.
23. Williams KD, Jarvis B (2006) Cyberball: A program for use in research on interpersonal ostracism and acceptance. *Behav Res Methods* 38(1):174-180.
24. Platt B, Cohen Kadosh K, Lau JY (2013) The role of peer rejection in adolescent depression. *Depress Anxiety* 30(9):809-821.
25. Domsalla M, *et al*. (2014) Cerebral processing of social rejection in patients with borderline personality disorder. *Soc Cogn Affect Neurosci* 9(11):1789-1797.
26. Levinson CA, Langer JK, Rodebaugh TL (2013) Reactivity to exclusion prospectively predicts social anxiety symptoms in young adults. *Behav Ther* 44(3):470-478.
27. Eisenberger NI (2015) Social pain and the brain: Controversies, questions, and where to go from here. *Annu Rev Psychol* 66:601-629.
28. Cacioppo S, *et al*. (2013) A quantitative meta-analysis of functional imaging studies of social rejection. *Sci Rep* 3:2027.
29. Eisenberger NI, Lieberman MD, Williams KD (2003) Does rejection hurt? An fMRI study of social exclusion. *Science* 302(5643):290-292.
30. Celada P, Puig MV, Artigas F (2013) Serotonin modulation of cortical neurons and networks. *Front Integr Nueurosci* 7:25.
31. Puig MV, Watakabe A, Ushimaru M, Yamamori T, Kawaguchi Y (2010) Serotonin modulates fast-spiking interneuron and synchronous activity in the rat prefrontal cortex through 5-HT$_{1A}$ and 5-HT$_{2A}$ receptors. *J Neurosci* 30(6):2211-2222.
32. Riga MS, Soria G, Tudela R, Artigas F, Celada P (2014) The natural hallucinogen 5-MeO-DMT, component of Ayahuasca, disrupts cortical function in rats: Reversal by antipsychotic drugs. Int *J Neuropsychopharmacol* 17(8):1269-1282.
33. Moor BG, *et al*. (2012) Social exclusion and punishment of excluders: Neural correlates and developmental trajectories. *Neuroimage* 59(1):708-717.
34. Kross E, Berman MG, Mischel W, Smith EE, Wager TD (2011) Social rejection shares somatosensory representations with physical pain. *Proc Natl Acad Sci USA* 108(15): 6270-6275.
35. Woo CW, *et al*. (2014) Separate neural representations for physical pain and social rejection. *Nat Commun* 5:5380.
36. Eisenberger NI (2012) The pain of social disconnection: Examining the shared neural underpinnings of physical and social pain. *Nat Rev Neurosci* 13(6):421-434.
37. Shackman AJ, *et al*. (2011) The integration of negative affect, pain and cognitive control in the cingulate cortex. *Nat Rev Neurosci* 12(3):154-167.
38. Maurage P, *et al*. (2012) Disrupted regulation of social exclusion in alcohol-dependence: An fMRI study. *Neuropsychopharmacology* 37(9):2067-2075.
39. Kross E, Egner T, Ochsner K, Hirsch J, Downey G (2007) Neural dynamics of rejection sensitivity. *J Cogn Neurosci* 19(6):945-956.
40. Studerus E, Gamma A, Vollenweider FX (2010) Psychometric evaluation of the altered states of consciousness rating scale (OAV). *PLoS One* 5(8):e12412.
41. Decety J, Sommerville JA (2003) Shared representations between self and other: A social cognitive neuroscience view. *Trends Cogn Sci* 7(12):527-533.
42. Vogeley K, *et al*. (2001) Mind reading: Neural mechanisms of theory of mind and self-perspective. *Neuroimage* 14(1 Pt 1):170-181.
43. Cavallero A, Marte A, Fedele E (2009) L-aspartate as an amino acid neurotransmitter: Mechanisms of the depolarization-induced release from cerebrocortical synaptosomes. *J Neurochem* 110(3):924-934.
44. Mangia S, *et al*. (2009) Metabolic and hemodynamic events after changes in neuronal activity: Current hypotheses, theoretical predictions and in vivo NMR experimental findings. *J Cereb Blood Flow Metab* 29(3):441-463.
45. McKenna MC, Waagepetersen HS, Schousboe A, Sonnewald U (2006) Neuronal and astrocytic shuttle mechanisms for cytosolic-mitochondrial transfer of reducing equivalents: Current evidence and pharmacological tools. *Biochem Pharmacol* 71(4): 399-407.
46. Lambe EK, Aghajanian GK (2006) Hallucinogen-induced UP states in the brain slice of rat prefrontal cortex: Role of glutamate spillover and NR2B-NMDA receptors. *Neuropsychopharmacology* 31(8):1682-1689.
47. Muschamp JW, Regina MJ, Hull EM, Winter JC, Rabin RA (2004) Lysergic acid diethylamide and [-]-2,5-dimethoxy-4-methylamphetamine increase extracellular glutamate in rat prefrontal cortex. *Brain Res* 1023(1):134-140.
48. Bednařík P, *et al*. (2015) Neurochemical and BOLD responses during neuronal activation measured in the human visual cortex at 7 Tesla. *J Cereb Blood Flow Metab* 35(4):601-610.
49. Mangia S, *et al*. (2007) Sustained neuronal activation raises oxidative metabolism to a new steady-state level: Evidence from 1H NMR spectroscopy in the human visual cortex. *J Cereb Blood Flow Metab* 27(5):1055-1063.
50. Muthukumaraswamy SD, Edden RA, Jones DK, Swettenham JB, Singh KD (2009) Resting GABA concentration predicts peak gamma frequency and fMRI amplitude in response to visual stimulation in humans. *Proc Natl Acad Sci USA* 106(20):8356-8361.
51. Northoff G, *et al*. (2007) GABA concentrations in the human anterior cingulate cortex predict negative BOLD responses in fMRI. *Nat Neurosci* 10(12):1515-1517.
52. Pardo B, *et al*. (2011) Brain glutamine synthesis requires neuronal-born aspartate as amino donor for glial glutamate formation. *J Cereb Blood Flow Metab* 31(1):90-101.
53. Barr CS, *et al*. (2008) Variation at the mu-opioid receptor gene (OPRM1) influences attachment behavior in infant primates.

Proc Natl Acad Sci USA 105(13):5277-5281.
54. Dewall CN, *et al*. (2010) Acetaminophen reduces social pain: Behavioral and neural evidence. *Psychol Sci* 21(7):931-937.
55. Alvares GA, Hickie IB, Guastella AJ (2010) Acute effects of intranasal oxytocin on subjective and behavioral responses to social rejection. *Exp Clin Psychopharmacol* 18(4):316-321.
56. Frye CG, Wardle MC, Norman GJ, de Wit H (2014) MDMA decreases the effects of simulated social rejection. *Pharmacol Biochem Behav* 117:1-6.
57. Hysek CM, *et al*. (2012) Duloxetine inhibits effects of MDMA ("ecstasy") in vitro and in humans in a randomized placebo-controlled laboratory study. *PLoS One* 7(5):e36476.
58. Amargós-Bosch M, *et al*. (2004) Co-expression and in vivo interaction of serotonin1A and serotonin2A receptors in pyramidal neurons of prefrontal cortex. *Cereb Cortex* 14(3):281-299.
59. Eisenberger NI, Cole SW (2012) Social neuroscience and health: Neurophysiological mechanisms linking social ties with physical health. *Nat Neurosci* 15(5):669-674.
60. Keller MC, Neale MC, Kendler KS (2007) Association of different adverse life events with distinct patterns of depressive symptoms. *Am J Psychiatry* 164(10):1521-1529.
61. Feldman DB, Crandall CS (2007) Dimensions of mental illness stigma: What about mental illness causes social rejection? *J Soc Clin Psychol* 26(2):137-154.
62. Cacioppo JT, Hawkley LC (2009) Perceived social isolation and cognition. *Trends Cogn Sci* 13(10):447-454.
63. Disner SG, Beevers CG, Haigh EA, Beck AT (2011) Neural mechanisms of the cognitive model of depression. *Nat Rev Neurosci* 12(8):467-477.
64. Schulte RF, Lange T, Beck J, Meier D, Boesiger P (2006) Improved two-dimensional J-resolved spectroscopy. *NMR Biomed* 19(2):264-270.
65. Fuchs A, Boesiger P, Schulte RF, Henning A (2014) ProFit revisited. *Magn Reson Med* 71(2):458-468.
66. Sheehan DV, *et al*. (1998) The Mini-International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry* 59(Suppl 20):22-33, quiz 34-57.
67. Fydrich T, Renneberg B, Schmitz B, Wittchen H-U (1997) *SKID-II Strukturiertes Klinisches Interview für DSM-IV, Achse II: Persönlichkeitsstörungen* (Hogrefe, Göttingen, Germany) [SCID-II Structured Cinical Interview for DSM-IV, Axis II: Personality Disorders.].
68. Franke G (1995) *Die Symptom-Check-Liste von Derogatis: Deutsche Version* (Beltz Test Gesellschaft, Göttingen, Germany).
69. Williams KD, Cheung CK, Choi W (2000) Cyberostracism: Effects of being ignored over the Internet. *J Pers Soc Psychol* 79(5):748-762.
70. Hock A, Fuchs A, Boesiger P, Kollias SS, Henning A (2013) Electrocardiogram-triggered, higher order, projection-based B_0 shimming allows for fast and reproducible shim convergence in spinal cord ^{1}H MRS. *NMR Biomed* 26(3):329-335.
71. Tkác I, Starcuk Z, Choi IY, Gruetter R (1999) In vivo 1 H NMR spectroscopy of rat brain at 1 ms echo time. *Magn Reson Med* 41(4):649-656.
72. Schulte RF, Henning A, Tsao J, Boesiger P, Pruessmann KP (2007) Design of broadband RF pulses with polynomial-phase response. *J Magn Reson* 186(2):167-175.
73. Kreis R (2016) The trouble with quality filtering based on relative Cramér-Rao lower bounds. *Magn Reson Med* 75(1):15-18.
74. Tzourio-Mazoyer N, *et al*. (2002) Automated anatomical labeling of activations in SPM using a macroscopic anatomical parcellation of the MNI MRI single-subject brain. *Neuroimage* 15(1):273-289.

The serotonin 5-HT$_{2C}$ receptor and the non-addictive nature of classic hallucinogens

by

Clinton E Canal[1] and Kevin S Murnane[2]

Journal of Psychopharmacology 1-17

DOI: 10.1177/0269881116677104

© The Author(s) 2016

original report: https://pdfs.semanticscholar.org/39f4/85b6acf2bd17dace8cdc053ac0c164c1dbbe.pdf
backup source: http://www.psilosophy.info/resources/85b6acf2bd17dace8cdc053ac0c164c1dbbe.pdf

[1] Center for Drug Discovery, Department of Pharmaceutical Sciences, Northeastern University, Boston, USA
[2] Department of Pharmaceutical Sciences, Mercer University College of Pharmacy, Mercer University Health Sciences Center, Atlanta, USA

Corresponding author:
Clinton E. Canal, Center for Drug Discovery, Department of Pharmaceutical Sciences, Northeastern University, Boston, MA, USA.
Email: c.canal@northeastern.edu

Table of Contents:

Abstract
Classic hallucinogens are serotonin 5-HT$_2$ receptor agonists
Results from preclinical studies and reports from experienced hallucinogen users show that classic hallucinogens have low addiction liability
Why are classic hallucinogens nonaddictive? Focus on serotonin
Considerations of 5-HT$_{2A}$ receptor activation to addiction liability
Considerations of 5-HT$_{2B}$ receptor activation to addiction liability
Considerations of 5-HT$_{2C}$ receptor activation to addiction liability: Behavioral studies
Considerations of 5-HT$_{2C}$ receptor activation to addiction liability: Neurochemistry studies
The NAc is a key site for 5-HT$_{2C}$ receptor modulation of reward circuitry
5-HT$_{2C}$ modulation of intrinsic plasticity via inhibition of NAc Kv1.x channels: A novel hypothesized mechanism for psychostimulant addiction treatment
Caveat emptor
Classic hallucinogens treat addiction
Testable hypotheses for unraveling the anti-addictive effects of classic hallucinogens
Acknowledgements
References

Abstract

Classic hallucinogens share pharmacology as serotonin 5-HT_{2A}, 5-HT_{2B}, and 5-HT_{2C} receptor agonists. Unique among most other Schedule 1 drugs, they are generally non-addictive and can be effective tools in the treatment of addiction. Mechanisms underlying these attributes are largely unknown. However, many preclinical studies show that 5-HT_{2C} agonists counteract the addictive effects of drugs from several classes, suggesting this pharmacological property of classic hallucinogens may be significant. Drawing from a comprehensive analysis of preclinical behavior, neuroanatomy, and neurochemistry studies, this review builds rationale for this hypothesis, and also proposes a testable, neurobiological framework. 5-HT_{2C} agonists work, in part, by modulating dopamine neuron activity in the ventral tegmental area - nucleus accumbens (NAc) reward pathway. We argue that activation of 5-HT_{2C} receptors on NAc shell, GABAergic, medium spiny neurons inhibits potassium Kv1.x channels, thereby enhancing inhibitory activity via intrinsic mechanisms. Together with experiments that show that addictive drugs, such as cocaine, potentiate Kv1.x channels, thereby suppressing NAc shell GABAergic activity, this hypothesis provides a mechanism by which classic hallucinogen-mediated stimulation of 5-HT_{2C} receptors could thwart addiction. It also provides a potential reason for the non-addictive nature of classic hallucinogens.

Keywords: Hallucinogens, 5-HT2C, cocaine, Kv1, addiction

Classic hallucinogens are serotonin 5-HT_2 receptor agonists

Classic hallucinogens (CH) are powerful psychoactive substances that are categorized into two broad chemotype classes: indoleamines (including tryptamines and ergotamines) and phenylalkylamines (including phenethylamines and phenylisopropylamines; Halberstadt, 2015). Prototypical CH representative of each subclass include psilocybin, a tryptamine found in several genera of mushrooms (Stamets, 1996); lysergic acid diethylamide (LSD), an ergotamine originally derived from ergot fungi (Hofmann, 1970); mescaline, a phenethylamine found in peyote (Heffter, 1898) and other cacti; and 2,5-dimethoxy-4-bromoamphetamine (DOB), a phenylisopropylamine (substituted amphetamine) derived solely via synthetic schemes (Shulgin and Shulgin, 1991). Various analogues of these compounds have been synthesized and tested for bioactivity (Nichols *et al.*, 2015; Shulgin and Shulgin, 1991, 1997; Shulgin *et al.*, 2011), but for the focus of this paper, we confine classification of CH to those drugs that have been characterized extensively in both nonhuman animals and in humans (Bogenschutz and Johnson, 2016; Halberstadt, 2015). For example, we do not classify novel N-benzyl substituted phenethylamine hallucinogens as CH, because their receptor and behavioral pharmacology are not fully characterized or diverge from CH (Nichols *et al.*, 2008).

The fundamental, shared pharmacological property of all CH is high affinity and agonist activity at serotonin 5-HT_2 G proteincoupled receptor (GPCR) subtypes (5-HT_{2A}, 5-HT_{2B}, and 5-HT_{2C}), with most binding to and stimulating 5-HT_2 receptors at low nanomolar concentrations. However, depending on the CH examined, activities at other GPCRs have been identified, particularly other 5-HT receptors, and, most notably, 5-HT_1 receptor subtypes (Nichols, 2004; Roth *et al.*, 2000). Many attempts have been made to uncover additional molecular targets of CH. For example, tryptamine hallucinogens display activity at the sigma-1 receptor, the serotonin transporter (SERT), and the vesicular monoamine transporter (Cozzi *et al.*, 2009; Fontanilla *et al.*, 2009), but high concentrations, reaching micromolar levels, are required to elicit activity, which calls into question their contribution to psychoactive effects. Also, it was reported recently that certain substituted amphetamine hallucinogens, including 2,5-dimethoxy-4-iodoamphetamine (DOI) and DOB, bind with appreciable affinity at adrenergic GPCRs (Ray, 2010). However, using traditional radioligand competition binding assays, we did not replicate the observed effects at alpha-adrenergic receptors. We obtained micromolar affinity (K_i) values of (±)-DOI at each of the α-adrenergic receptor subtypes we screened (α1a, α1b, α2a, α2b, and α2c; unpublished observations; data available upon request).

Most germane to the psychoactive effects of CH is that they are blocked by 5-HT_2 antagonists in both rodents (Fantegrossi *et al.*, 2005) and humans (Kometer *et al.*, 2013; Vollenweider *et al.*, 1998). It should be noted, however, that there are exceptions wherein 5-HT_2 antagonism is insufficient to eliminate the discriminative stimulus properties of CH (e.g., psilocybin and LSD) in rodents (Benneyworth *et al.*, 2005; Winter *et al.*, 2007). Clearly, pharmacodynamics and pharmacokinetics across species play an important role, and may underlie observed discrepancies (Canal *et al.*, 2013). Nevertheless, adding to support that 5-HT_2 receptors are the predominant mediators of CH psychoactive effects are the observations that 5-HT_{2A} knockout mice do not exhibit behaviors, such as the head-twitch response (HTR; Gonzalez-Maeso *et al.*, 2007; Hanks and Gonzalez-Maeso, 2013), typically elicited by CH. Also, the DOI-elicited HTR is reduced in 5-HT_{2C} receptor knockout mice (Canal *et al.*, 2010). Collectively, it can be said with confidence that 5-HT_2 receptors predominantly mediate the psychoactive effects of CH. Here, we focus on interrogating 5-HT_{2A}, 5-HT_{2B}, and/or 5-HT_{2C} receptors as the elemental GPCRs that underlie their non-addictive nature.

Results from preclinical studies and reports from experienced hallucinogen users show that classic hallucinogens have low addiction liability

One of the fascinating aspects of CH, long recognized by experienced hallucinogen users and only recently gaining traction by the broader scientific community, is that compared with most other psychoactive drugs scheduled by federal governments in the most restrictive classes (e.g., heroin in Schedule 1 and cocaine in Schedule 2), they are relatively non-addictive (Bogenschutz and Johnson, 2016). As a caveat, we understand that there can be controversy defining what are and what are not addictive substances, including defining CH as addictive or not (Nutt *et al.*, 2010; Stone *et al.*, 2006). Considering the DSM-5 criteria for a diagnosis of a substance-use disorder (American Psychiatric Association, 2013), we narrowly define addictive drugs as those that induce craving or an impulse to re-dose after psychoactive effects have peaked or have begun to subside. Note, this feeling and impulse is also described in the literature as "wanting" or "increased incentive salience." Experienced drug users report that CH do not produce drug craving, which is typically elicited by other psychoactives of distinct chemical classes (e.g., methamphetamine, MDPV, nicotine, alcohol, cocaine, heroin; see erowid.org). Also, although tolerance to most CH, excluding short-acting *N,N*-dimethyltryptamine (DMT; Strassman *et al.*, 1996), is evident with repeated, continuous exposure, withdrawal symptoms are generally non-existent once effects subside, distinguishing CH from most other drugs of abuse, including closely related serotonin-releasing empathogens such as 3,4-methylenedioxymethamphetamine (MDMA) that also have activity at dopamine transporters (Ball and Slane, 2014; Meyer, 2013).

The relatively non-addictive characteristics of CH described by human users are recapitulated in well-controlled, preclinical animal studies, which provide reliable and conclusive evidence. Such animal studies typically employ intravenous self-administration, in which an operant response by the animal (e.g., pressing a lever) is reinforced by the delivery of a dose of drug. While intramuscular (Goldberg *et al.*, 1976), inhalation (Carroll *et al.*, 1990a), and oral (Gomez *et al.*, 2002) routes of administration also maintain drug-taking behavior, intravenous drug delivery is the most employed route of administration in self-administration studies, as intravenous delivery causes a rapid onset of action, facilitating learning of the association between the operant response and the psychoactive effects of the drug. Animal self-administration experiments demonstrate a very strong correlation between drugs that produce dependence in humans and those that are voluntarily consumed by laboratory animals (Brady *et al.*, 1984; Griffiths, 1980; Griffiths *et al.*, 1978, 1980).

One of the earliest studies on the reinforcing effects of drugs using the intravenous self-administration procedure in rhesus monkeys found that no animal initiated self-injection of mescaline either spontaneously or after one month of programmed administration, and this was apparent at doses that produced physiological and psychoactive effects such as salivation, mydriasis, pilo-erection, and apparent apprehension (Deneau *et al.*, 1969). The lack of mescaline self-administration stood in contrast to positive findings of self-administration of morphine, codeine, cocaine, amphetamine, pentobarbital, ethanol, and caffeine. A subsequent study with rhesus monkeys using 2,5-dimethoxy-4-methylamphetamine (DOM; Yanagita, 1986) provided similar results as the mescaline study. These findings have withstood the test of time, as the primary literature is virtually devoid of any accounts of self-administration of CH, suggesting that there are very limited conditions under which laboratory animals voluntarily consume CH. In one example, extreme environmental conditions were required to elicit self-administration of DMT in monkeys (Siegel and Jarvik, 1980). In this study, under baseline conditions, monkeys sampled DMT but did not engage in significant or persistent self-administration. However, following several days of sensory deprivation (i.e., the absense of light and sound), two of the three monkeys consistently self-administered DMT for up to 20 days (which was the *a priori* imposed endpoint of the experiment). These observations were conceptualized as the DMT engendering an internal or mental perceptual window with concomitant positive reinforcing effects in the context of sensory deprivation. In a second example, various hallucinogens were substituted in monkeys that were maintained on a baseline of (±)-MDMA self-administration. Although none of the subjects consistently self-administered any of the hallucinogens tested, all of the subjects transiently and sporadically self-administered psilocybin, mescaline, and DMT at response rates that were comparable to MDMA and up to the maximum number of infusions that were available (Fantegrossi *et al.*, 2004a). These effects, however, were transient and sporadic, and clearly unlike those seen across a broad range of other psychoactive drugs. In our studies, we observed very weak reinforcing effects of psilocybin in rhesus macaque monkeys. Once responding during saline administration was procedurally manipulated to an extradorinarily low level (approximately 0.01 responses per second), some positive reinforcing effects were apparent with psilocybin (unpublished observations; data available upon request), but yet again, these effects massively pale in comparison to other drugs of abuse (Murnane *et al.*, 2013b). Based on these studies, it is clear that conditions have not yet been found, despite decades of efforts, wherein CH are readily self-administered by laboratory animals. Given the very strong correlation between drugs that produce dependence in humans and those that are voluntarily consumed by laboratory animals (Brady *et al.*, 1984; Griffiths, 1980; Griffiths *et al.*, 1978, 1980), this is among the strongest evidence for the non-addictive nature of CH.

Despite the relative absence of addictive properties, observed in well-controlled preclinical studies and reported by human users, CH can dose-dependently elevate mood and produce a strong sense of well-being, depending on mental set and environmental setting (Studerus *et al.*, 2012). In fact, many people who have taken CH report that their experiences were of the most influential and positive of their lives (Griffiths *et al.*, 2011). These positive psychological effects of CH, nonetheless, do not qualify them as without risk, especially when taken without precaution, careful planning, and supervision. CH produce profound alterations in cognition and sensory perception and can produce emotional lability, fear, anxiety, and/or panic, among other adverse psychological and physiological effects. Nonetheless, if CH can elevate mood and produce a sense of well-being, why are they non-addictive?

Why are classic hallucinogens nonaddictive? Focus on serotonin

There are several biological possibilities to explore why CH are relatively non-addictive. For example, the long durations of action of many CH and their capacity to induce 5-HT$_{2A}$ receptor desensitizaton (Leysen *et al.*, 1989), which causes rapid, prolonged, and profound tolerance to their psychoactive effects (i.e., tachyphalaxis), may be factors. In support of these possibilities, it is well known that long pharmacokinetic profiles, including long durations of action, can minimize abuse liability (Abreu *et al.*, 2001; Fantegrossi *et al.*, 2004b; Marsch *et al.*, 2001; Nelson *et al.*, 2006; Volkow *et al.*, 2000; Woolverton and Wang, 2004). The psychedelic effects of LSD, which persist for approximately 8-12 hours, are greatly attenuated with repeated dosing; a few days of abstinence are required before subjective effects return to pre-exposure levels (Belleville *et al.*, 1956). Thus, spacing intake of LSD is necessary, which prevents the binge-like patterns of drug consumption often seen with highly addictive substances (Aarde *et al.*, 2015; Roberts *et al.*, 2007). However, effects of DMT are inconsistent with this explanation. The hallucinogenic effects of DMT commence within two minutes of intravenous administration, and subside by 30 minutes (Strassman and Qualls, 1994). Moreover, the psychedelic effects of DMT persist with repeated administration in a single drug-taking session (Strassman, 1996). This may generalize across some tryptamines, as a recent study shows profound tolerance in mice to two phenethylamines (DOI and 2C-T-7), but a lack of tolerance to two tryptamines (DPT and DIPT; Smith *et al.*, 2014). Despite their differerent durations of action and capacities to induce tolerance, none of the CH mentioned above are known to produce drug craving in human users. Comparatively, re-intoxication from addictive psychoactives can be achieved quickly after their effects subside, despite long durations of action (e.g., MDMA) combined with target densitization and/or internalization and tolerance. For example, cannabinoid CB1 receptor downregulation is evident with prolonged cannabis use (Ceccarini *et al.*, 2015), but the subjective high from cannabis persists, even with tolerance and daily use. To maintain scope, this review focuses on serotonin receptor targets of CH that likely underlie their non-addictive properties.

The reinforcing and addictive effects of psychoactive drugs are primarily attributed to drug-induced changes in central dopamine function. Pointedly, the transition to addiction is mediated by increases in firing of ventral tegmental area (VTA) dopamine neurons projecting to the nucleus accumbens (NAc), which increases dopamine release in the NAc (Cline *et al.*, 1992; Kuhar *et al.*, 1999; Pascoli *et al.*, 2015; Ritz *et al.*, 1989; Robison and Nestler, 2011); all addictive drugs increase dopamine release in the NAc. Serotonin, on the other hand, plays an important modulatory role in the behavioral effects of many psychoactive drugs. Serotonin neurons originate in the raphe nuclei in the brainstem, and send strong projections to the VTA, prefrontal cortex (PFC), amygdala, hippocampus, dorsal striatum, and NAc (Halliday and Tork, 1989). Serotonergic projections innervate cell bodies and terminals of dopamine neurons (Beart and McDonald, 1982; Geyer *et al.*, 1976; Nedergaard *et al.*, 1988; Parent *et al.*, 1981), often making direct synaptic contact (Herve *et al.*, 1987; Nedergaard *et al.*, 1988), and serotonin provides tonic and phasic control of dopaminergic systems within the limbic pathway (Alex and Pehek, 2007).

Converging results from many studies demonstrate that enhancing central serotonin release attenuates addictive behaviors (Muller and Homberg, 2015). For example, selective stimulation of serotonergic dorsal raphe nucleus afferents to the NAc, using designer receptors exclusively activated by designer drugs (DREADDs), abolishes cocaine-elicited conditioned place preference (You *et al.*, 2016). Furthermore, there is a negative relationship between the potencies of several cocaine- and amphetamine-like analogs in self-administration studies and their binding potencies as SERT inhibitors (Ritz and Kuhar, 1989; Ritz *et al.*, 1989). For example, rhesus monkeys self-administer more infusions of PAL-353, which has high selectivity for releasing dopamine versus serotonin, than PAL-313, which non-selectively releases dopamine and serotonin (Wee *et al.*, 2005). Similarly, rhesus monkeys do not self-administer PAL-287, which is relatively nonselective at releasing dopamine and serotonin, across a range of doses (Rothman *et al.*, 2005). Adding to the evidence, systemic administration of selective SERT inhibitors, which selectively increase extracellular levels of serotonin, decrease cocaine self-administration in rodents (Carroll *et al.*, 1990b; Richardson and Roberts, 1991) and nonhuman primates (Kleven and Woolverton, 1993). In nonhuman primates, SERT inhibitors, such as citalopram, fluoxetine, and alaproclate, attenuate the behavioral-stimulant effects of cocaine, cocaine self-administration, cocaine-induced increases in extracellular dopamine, and cocaine-induced activation of the PFC (Czoty *et al.*, 2002; Howell and Byrd, 1995; Howell *et al.*, 2002; Spealman, 1993). Additional studies show that SERT inhibitors attenuate drug-induced increases in dopamine levels in rodents and nonhuman primates (Czoty *et al.*, 2002; Di Matteo *et al.*, 2008) and cue-induced reinstatement of extinguished cocaine-maintained lever-pressing behavior in rats (Baker *et al.*, 2001; Burmeister *et al.*, 2003). Furthermore, an early study shows that serotonin infused directly into the NAc attenuates locomotor activity stimulated by direct infusions of dopamine into the NAc (Jones *et al.*, 1981). These studies demonstrate convincingly that serotonin opposes the effects of dopamine and attenuates the abuse-related and addictive effects of psychoactive drugs (for reviews, see Howell and Murnane, 2008; Murnane and Howell, 2011).

While it is well documented that serotonin attenuates the reinforcing effects of a variety of psychoactive drugs through suppression of dopamine neurotransmission, it is important to consider that there are 16 distinct serotonin receptors (not including splice variants or RNA-edited 5-HT_{2C} receptors) that are grouped into seven families: 5-HT_1-5-HT_7 receptors (Boess and Martin, 1994; Green, 2006; Hoyer *et al.*, 1994, 2002). Unique serotonin receptors can facilitate, inhibit, or have no effect on dopamine neurotransmission and on the reinforcing properties of a variety of psychoactive drugs. With particular relevance to the anti-addictive properties of CH, there are a number of reported observations of opposing effects between the 5-HT_{2C} and 5-HT_{2A} receptor subtypes, with 5-HT_{2A} receptors facilitating and 5-HT_{2C} receptors suppressing dopamine neurotransmission (Bubar and Cunningham, 2008; De Deurwaerdere and Spampinato, 1999; Filip *et al.*, 2004, 2006; Fletcher *et al.*, 2002; McMahon and Cunningham, 2001; McMahon *et al.*, 2001). The divergent effects of 5-HT_{2A} and 5-HT_{2C} on dopamine neurotransmission are at first consideration peculiar, since 5-HT_2 receptor subtypes couple to the same G-proteins (e.g., $G\alpha_{q/11/12/13}$) and activate the same intracellular signaling pathways (e.g., phospholipase C [PLC], mitogen-activated protein kinase, β-arrestin), with a few notable exceptions (Berg *et al.*, 1994, 2001; Chagraoui *et al.*, 2016; Knauer *et al.*, 2009; Sanders-Bush *et al.*, 2003). However, the differences observed may also be due to differences in the relative expression of 5-HT_{2A} and 5-HT_{2C} receptors across cell types and microcircuits that control unique aspects of neural function, a point discussed in greater detail in the 5-HT_{2C} sections below. Nonetheless, the differences between 5-HT_{2A} and 5-HT_{2C} modulation of dopamine neurotransmission provide a clear hypothesis for why CH, which do not provide a large spread between 5-HT_{2C} and 5-HT_{2A} receptor activation, do not induce craving. We argue that activation of 5-HT_{2C} receptors tempers the addictive liability of CH.

Considerations of 5-HT$_{2A}$ receptor activation to addiction liability

There is a substantial body of evidence that the 5-HT$_{2A}$ receptor facilitates dopamine neurotransmission. For example, systemic administration of DOI increases the firing rates of dopamine neurons in the VTA and induces dopamine release in the PFC, effects that are attenuated by selective antagonism of the 5-HT$_{2A}$ receptor (Bortolozzi *et al.*, 2005; Pehek *et al.*, 2006) or genetic deletion of the 5-HT$_{2A}$ receptor (Di Matteo *et al.*, 2000; Huang *et al.*, 2011). The preponderance of evidence for 5-HT$_{2A}$ receptor facilitation of dopamine neurotransmission emanates from studies of the mesocortical system because of the widespread interest in serotonin modulation of this system in schizophrenia. Nevertheless, some studies examined 5-HT$_{2A}$ receptor modulation of dopamine neurotransmission within the NAc, which is a key region in the mesolimbic dopamine pathway critical for addiction (Haber and Knutson, 2010; Russo and Nestler, 2013; Sesack and Grace, 2010). In this regard, direct administration of DOI into the posterior NAc significantly increases dopamine levels locally within the NAc, effects that are blocked by 5-HT$_{2A}$ antagonists (Bowers *et al.*, 2000; Yan, 2000). However, we recently showed that systemic administration of DOI in rhesus monkeys engenders only meager (~10% increase above baseline) elevations in dopamine levels in the NAc (unpublished observations; data available upon request), and similarly, previous studies in rats show that systemic DOI does not affect dopamine release in the NAc (Di Matteo *et al.*, 2000). This suggests that DOI acting on additional neural systems or microcircuits suppresses the increase in dopamine neurotransmission in the NAc.

That 5-HT$_{2A}$ receptors may contribute to drug seeking is further supported by studies employing neuroimaging, behavioral pharmacology, and genetic tools. A recent primate neuroimaging study shows that several months of cocaine self-administration increases the availability of 5-HT$_{2A}$ receptors in the PFC, suggesting that increased 5-HT$_{2A}$ receptor availability facilitates drug-taking behavior (Sawyer *et al.*, 2012). This is supported by observations that 5-HT$_{2A}$ knockout mice self-administer MDMA to a lesser degree than wild-type mice, and that the selective 5-HT$_{2A}$ inverse agonist, eplivanserin, blocks cue-induced reinstatement of MDMA seeking (Orejarena *et al.*, 2011). Other studies report that 5-HT$_{2A}$ receptor antagonists attenuate the stimulatory effects of cocaine, amphetamine, MDMA, and methamphetamine on dopamine neurotransmission as well as their locomotor stimulant and interoceptive effects (Auclair *et al.*, 2004; Broderick *et al.*, 2004). Intra-VTA microinjections of 5-HT$_{2A}$ receptor antagonists attenuate cocaine- and amphetamine-induced increases in motor activity in mice (Auclair *et al.*, 2004) and rats (McMahon *et al.*, 2001), and we showed recently that selective 5-HT$_{2A}$ receptor antagonism attenuates the dopamine releasing and behavioral effects of amphetamine in primates (Murnane *et al.*, 2013a). Systemic administration of 5-HT$_{2A}$ receptor antagonists (including SR 46349B, M100907, and MDL 11,939), in contrast to the effects of agonists, do not alter firing rates of dopamine neurons in the VTA or dopamine release in the NAc or PFC of rodents (Bonaccorso *et al.*, 2002; Di Giovanni *et al.*, 1999; Gobert *et al.*, 2000; Pehek *et al.*, 2006; Porras *et al.*, 2002). Therefore, although the 5-HT$_{2A}$ receptor does not appear to exert a tonic influence on dopamine neuronal firing or release, agonist stimulation of this receptor enhances dopaminergic activity (Bubar and Cunningham, 2008). Though, net effects may depend on specific cell types and circuits examined.

The use of reinstatement procedures provides an important complement to drug self-administration, as it is the most widely accepted model of drug relapse. As drug relapse is critically influenced by craving and withdrawal, reinstatement experiments have particular relevance for understanding the non-addictive nature of CH. Such studies show that 5-HT$_{2A}$ receptor antagonism prevents reinstatement of drug-seeking behavior. For example, the 5-HT$_2$ receptor antagonist ketanserin attenuates cue-induced reinstatement of extinguished cocaine self-administration in rats (Burmeister *et al.*, 2004), and the selective 5-HT$_{2A}$ receptor antagonist M100907 attenuates both drug- and cueinduced reinstatement of extinguished cocaine self-administration in rats (Fletcher *et al.*, 2002; Nic Dhonnchadha *et al.*, 2009). Consistent with these findings, we have shown that 5-HT$_{2A}$ receptor antagonism attenuates cue- as well as drug-induced reinstatement of extinguished behavior that was previously maintained by cocaine in rhesus monkeys (Murnane *et al.*, 2013b).

These studies suggest that selective activation of 5-HT$_{2A}$ receptors may induce craving and/or relapse. Nevertheless, it will be critical to assess empirically the addictive or anti-addictive potential of highly selective 5-HT$_{2A}$ agonists. A recent report shows that an analogue from the phenethylamine class of CH, (4-bromo-3,6-dimethoxybenzocyclobuten-1-yl) methylamine (TCB-2) that has high 5-HT$_{2A}$ agonist potency (McLean *et al.*, 2006) reduces intracranial self-stimulation (ICSS), but does not attenuate the potentiating effects of cocaine on

ICSS (Katsidoni *et al*., 2011). Its activity at 5-HT$_{2B}$ and 5-HT$_{2C}$ receptors, however, has not been reported to our knowledge. Finally, CH may be biased agonists (Gonzalez-Maeso and Sealfon, 2009; McLean *et al*., 2006; Wacker *et al*., 2013) that stabilize 5-HT$_{2A}$ receptor active conformations that block craving. Certainly, additional studies are warranted.

Considerations of 5-HT$_{2B}$ receptor activation to addiction liability

Owing to their low expression in the central nervous system (Bonhaus *et al*., 1995; Duxon *et al*., 1997; Kursar *et al*., 1994; Loric *et al*., 1992), much less attention has been given to the potential role of 5-HT$_{2B}$ receptors to the effects of psychoactive substances. Moreover, as prolonged activation of 5-HT$_{2B}$ receptors on heart valve leaflets is linked to valvular heart disease (Hutcheson *et al*., 2012; Roth, 2007; Rothman and Baumann, 2009), an impetus to develop highly-selective 5-HT$_{2B}$ agonists has been lacking. Indeed, there is not a highly selective 5-HT$_{2B}$ agonist probe that is a widely accepted tool of the scientific community. Thus, there are somewhat limited data regarding the contribution of 5-HT$_{2B}$ receptor activation to psychoactive substances. Much of what is known, however, emanated predominantly from the Maroteaux laboratory. Converging data from 5-HT$_{2B}$ receptor knockout mice and from use of 5-HT$_{2B}$ ligands show that central 5-HT$_{2B}$ receptors contribute to the psychomotor effects of MDMA (Doly *et al*., 2008), the anorexient effects of dexfenfluramine (Banas *et al*., 2011), and the antidepressant effects of selective serotonin reuptake inhibitors (Diaz *et al*., 2012; Hertz *et al*., 2015). Another recent study shows that LY266097, a selective 5-HT$_{2B}$ antagonist, reduces basal and amphetamine-stimulated dopamine release in the NAc, and also decreases amphetamine-elicited hyperlocomotion (Auclair *et al*., 2010), although others report that selective 5-HT$_{2B}$ antagonists, including SB 204741, do not affect cocaine-elicited hyperlocomotion or the discriminative stimulus effects of cocaine (Filip *et al*., 2004, 2006). In addition to the different neuropharmacological effects of amphetamine versus cocaine, the potential discrepancies in these studies could relate to the use of different 5-HT$_{2B}$ antagonist ligands, and consequently target selectivity or off-target liability.

Finally, Roth's group reported that the designer empathogen 1-(benzofuran-6-yl)propan-2-amine (6-APB), an MDMA analogue, binds with >100-fold selectivity to the 5-HT$_{2B}$ receptor compared to 5-HT$_{2A}$ or 5-HT$_{2C}$ receptors, and furthermore, 6-APB is a 5-HT$_{2B}$ receptor agonist (Iversen *et al*., 2013). Interestingly, 6-APB has higher affinity at 5-HT$_{2B}$ than any other target tested, including the dopamine transporter, a primary target of addictive psychostimulants (e.g., cocaine and methamphetamine). Anecdotal reports note that 6-APB produces subjective effects similar to MDMA, but according to some, it does not produce drug craving and has a low propensity to cause physical dependence (see bluelight.org and erowid.org). However, controlled tests of its addictive potential have not been reported. Additional studies assessing the contribution of 5-HT$_{2B}$ receptor activation to the low addiction liability of CH are warranted.

Considerations of 5-HT$_{2C}$ receptor activation to addiction liability: Behavioral studies

Numerous lines of evidence from multiple laboratories show that 5-HT$_{2C}$ receptor activation attenuates self-administration of addictive substances and also attenuates ICSS of the brain's primary reward circuitry, and there are a number of excellent recent reviews on the topic of 5-HT$_{2C}$ receptor agonists for addiction and mechanisms underlying their effects (De Deurwaerdere *et al*., 2013; Devroye *et al*., 2013; Di Giovanni *et al*., 2006; Higgins and Fletcher, 2015; Howell and Cunningham, 2015; Muller and Homberg, 2015). Selective agonists of the 5-HT$_{2C}$ receptor have generally been found to recapitulate the attenuating effects of indirect serotonin agonists on behavioral models of addiction, suggesting 5-HT$_{2C}$ receptor activation is a key molecular mechanism by which serotonin exerts its anti-addictive effects. For example, the rate-suppressing effects of both the indirect serotonin receptor agonist fenfluramine and the 5-HT$_{2C}$ receptor agonist Ro 60-0175 in an ICSS procedure are blocked by pretreatment with the 5-HT$_{2C}$ receptor selective antagonist SB 242084 (Bauer *et al*., 2015). Likewise, Ro 60-0175 blocks cocaine-seeking behavior in rats, an effect completely reversed by SB 242084 (Burbassi and Cervo, 2008). Acute VTA or systemic administration of a variety of relatively selective 5-HT$_{2C}$ receptor agonists in rodents suppress the locomotor stimulant effects of cocaine (Craige and Unterwald, 2013; Filip *et al*., 2004; Fletcher *et al*., 2004; Grottick *et al*., 2000), the discriminative stimulus effects of cocaine (Callahan and Cunningham, 1995; Cunningham *et al*., 2011; Fletcher *et al*., 2008; Frankel and Cunningham, 2004), cocaine self-administration (Cunningham *et al.*, 2011; Fletcher *et al.*, 2008; Grottick *et al.*, 2000), and reinstatement of cocaine seeking induced by exposure to cocaine and cocaine-associated cues (Burbassi and Cervo, 2008; Cunningham *et al.*, 2011; Fletcher *et al.*, 2008; Grottick *et al.*, 2000; Neisewander and Acosta, 2007). These findings have been extended to other classes of psychoactive drugs, including alcohol, cannabis, and nicotine (Higgins and Fletcher, 2015; Ji *et al.*, 2006; Marcinkiewcz, 2015; Quarta *et al.*, 2007; Zaniewska *et al.*, 2007).

In primates, recent studies show that Ro 60-0175 reduces psychostimulant effects of cocaine, cocaine self-administration, and cocaine-induced reinstatement (Manvich *et al.*, 2012b; RuediBettschen *et al.*, 2015). These effects do not appear to result from general suppression of operant responding, as the same dose of Ro 60-0175 has no effect on operant responding maintained by negative reinforcement (Manvich *et al.*, 2012b). Similarly, the highly-selective 5-HT$_{2C}$ receptor agonist lorcaserin attenuates the discriminative stimulus effects of cocaine and suppresses cocaine self-administration following acute or 14-day treatment in rhesus monkeys (Collins *et al.*, 2016). Clinical trials assessing lorcaserin's ability to reduce cocaine self-administration are now underway (e.g., ClinicalTrials.gov Identifier: NCT02537873).

The hypothesis that 5-HT$_{2C}$ receptors inhibit a variety of abuse-related effects of drugs is substantiated by the reliable finding that antagonists facilitate such effects. In rodents, systemic administration of 5-HT$_{2C}$ receptor antagonists enhance the locomotor stimulant effects of cocaine (Fletcher *et al.*, 2002, 2006), the discriminative stimulus effects of cocaine (Filip *et al.*, 2006), cocaine self-administration (Fletcher *et al.*, 2002), and cocaine-induced reinstatement (Fletcher *et al.*, 2002). Consistent findings are reported in primates, as SB 242084 increases rates of responding maintained under a fixed-interval schedule of stimulus termination, increases cocaine-primed reinstatement of cocaine self-administration, and, critically, maintains self-administration when substituted for cocaine (Manvich *et al.*, 2012a). Other studies also suggest that 5-HT$_{2C}$ antagonists themselves may be addictive substances (Di Giovanni *et al.*, 1999; Di Matteo *et al.*, 1999). Finally, 5-HT$_{2C}$ receptor knockout mice exhibit increased sensitivity to the effects of cocaine (Rocha *et al.*, 2002). Collectively, the literature is replete with evidence that activation of 5-HT$_{2C}$ receptors inhibits addictive effects of a variety of drugs. As CH activate 5-HT$_{2C}$ receptors, we surmise this property is an essential facet that renders CH non-addictive.

Considerations of 5-HT$_{2C}$ receptor activation to addiction liability: Neurochemistry studies

The most supported mechanism for the anti-addiction effects of 5-HT$_{2C}$ activation is inhibition of mesolimbic dopamine neurons, which decreases psychostimulant-elicited dopamine release in the NAc (Alex and Pehek, 2007; Bubar *et al.*, 2011; Collins *et al.*, 2016; Di Giovanni *et al.*, 2000; Di Matteo *et al.*, 2000; Fletcher *et al.*, 2008; Harvey-Lewis *et al.*, 2016; Howell and Cunningham, 2015; Manvich *et al.*, 2012b; Navailles *et al.*, 2008; Rocha *et al.*, 2002). Evidence suggests these effects are caused by 5-HT$_{2C}$ receptor-mediated activation of GABA neurons in the VTA, which directly inhibit VTA dopamine neuron activity (Bubar and Cunningham, 2007; Bubar *et al.*, 2011; Di Giovanni *et al.*, 2001; Howell and Cunningham, 2015). Conversely, inactivation of 5-HT$_{2C}$ receptors by antagonists or inverse agonists increases firing rates of VTA dopamine neurons, increasing dopamine levels in the NAc (Di Giovanni *et al.*, 1999; Di Matteo *et al.*, 2004). Identifying the specific neural circuitry examined in such studies, however, is important, as these observations ostensibly conflict with the conclusions from a new report about 5-HT$_{2C}$ receptor modulation of dopamine neurotransmission (Xu *et al.*, 2016). Specifically, using slice electrophysiology, the authors report that 5-HT$_{2C}$ receptors expressed on dopamine neurons stimulate a significant number of them. Collectively, the data suggest that the emergent effects of 5-HT$_{2C}$ activation on dopamine neurotransmission depend on the relative activation of 5-HT$_{2C}$ receptors on different cell types; for example, GABA neurons innervating dopamine neurons (resulting in dopamine neuron inhibition) relative to 5-HT$_{2C}$ receptors expressed directly on dopamine neurons (resulting in dopamine neuron activation). In support of this, in mice that express 5-HT$_{2C}$ receptors only on dopamine VTA neurons, 5-HT$_{2C}$ activation enhances dopamine neuron activity to a greater degree than in wild-type mice, suggesting that 5-HT$_{2C}$ receptors on other cell types have an inhibitory effect on dopamine neurotransmission (Xu *et al.*, 2016).

Other findings corroborate the view that 5-HT$_{2C}$ receptor activation impacts reward circuitry via multiple mechanisms. Recent studies point to direct modulatory effects of 5-HT$_{2C}$ receptor activation on dopamine signaling in the NAc as contributors to their anti-addiction properties, and these effects may have as much relevance for addiction treatment as the effects of 5-HT$_{2C}$ receptors in the VTA. For example, 5-HT$_{2C}$ receptors expressed in the NAc inhibit postsynaptic dopamine signaling by inhibiting phosphorylation of DARPP-32, independent of dopamine release (Cathala *et al.*, 2015; Devroye *et al.*, 2015). 5-HT$_{2C}$ receptor knockout mice also provide evidence for 5-HT$_{2C}$ negative modulation of dopamine neurotransmission in reward circuitry. 5-HT$_{2C}$ knockout mice are more sensitive to the psychostimulant effects of amphetamine, cocaine, and GBR 12909 (another dopamine reuptake blocker) and also exhibit increased cocaine-stimulated release of dopamine in their NAc (Abdallah *et al.*, 2009; Rocha *et al.*, 2002). Interestingly, the enhanced effects of cocaine on dopamine release in the NAc in 5-HT$_{2C}$ knockout mice are not observed in the dorsal striatum (Rocha *et al.*, 2002). Similarly, amphetamine's effects on dopamine release in the dorsal striatum are not potentiated in 5-HT$_{2C}$ knockout mice (Abdallah *et al.*, 2009). This neural system-specific effect is recapitulated using 5-HT$_{2C}$-selective ligands. For example, 5-HT$_{2C}$ agonists administered systemically attenuate cocaine-stimulated dopamine release in the NAc, but not the dorsal striatum in wild-type mice (Di Giovanni *et al.*, 2000) or in nonhuman primates (Manvich *et al.*, 2012b). Also, systemic treatment with 5-HT$_{2C}$ agonists alone reduces dopamine in the NAc, but not the dorsal striatum (Di Giovanni *et al.*, 2000; Marquis *et al.*, 2007), and the converse effects are observed after treatment with 5-HT$_{2C}$ antagonists or inverse agonists; that is, they increase dopamine release in the NAc, but again, they have minimal effects on dopamine release in the dorsal striatum (Di Matteo *et al.*, 1999). These data are confluent with the distribution of 5-HT$_{2C}$ receptors across neural systems, as 5-HT$_{2C}$ receptors are densely expressed in the NAc but not the dorsal striatum (Figure 1). These observations suggest that post-synaptic 5-HT$_{2C}$ receptors in the NAc may contribute strongly to the effects of selective 5-HT$_{2C}$ agonists, administered systemically, on dopamine release in reward circuitry, a hypothesis we build in the following sections. Overall, the data provide a mechanistic rationale for the efficacy of CH, as 5-HT$_{2C}$ agonists, to temper the rewarding effects of addictive drugs. As a recent optogenetic study showed exquisitely that dopamine cell firing in the medial forebrain bundle, including the VTA - NAc tract, is sufficient to cause a transition to addiction (Pascoli *et al.*, 2015), it is clear that 5-HT$_{2C}$ agonists have promise as tools in the treatment of addiction.

The NAc is a key site for 5-HT$_{2C}$ receptor modulation of reward circuitry

As noted above, much of the circuitry-related data supporting 5-HT$_{2C}$ receptor modulation of psychostimulant effects is focused on 5-HT$_{2C}$ receptors expressed on GABA neurons of the VTA. We do not discount these findings. However, important rationale for our focus on 5-HT$_{2C}$ receptors in the NAc are the observations that infusions of the selective 5-HT$_{2C}$ agonist, WAY 161503, into the NAc, but not the VTA, decrease the reward-facilitating effects of cocaine (Katsidoni *et al.*, 2011). Moreover, infusions of the selective 5-HT$_{2C}$ antagonist, SB 242084, into the VTA does not affect cocaine-induced dopamine release in the NAc, but when infused into the NAc, SB 242084 potentiates cocaine-induced dopamine release in the NAc (Navailles *et al.*, 2008). Also, the 5-HT$_{2C}$ inverse agonist, SB 206553 increases basal dopamine release in the NAc when it is infused there, but not when it is infused in the VTA, suggesting 5-HT$_{2C}$ constitutive activity in the NAc, but not VTA, modulates tonic NAc dopamine release (De Deurwaerdere *et al.*, 2013; Navailles *et al.*, 2006). In summary, these data suggest that activation of NAc 5-HT$_{2C}$ receptors negatively modulates the effects of cocaine.

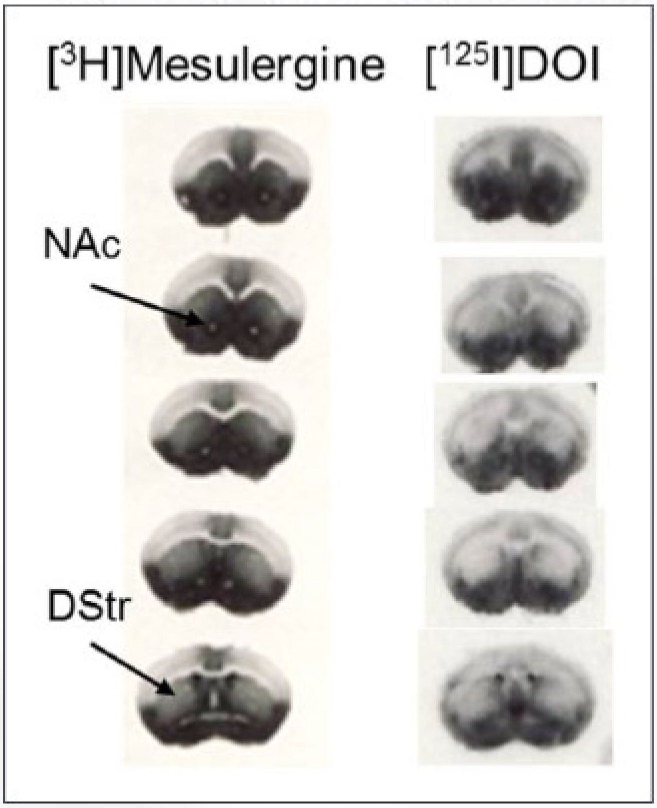


Figure 1. Autoradiographs of brain 5-HT$_{2C}$ receptors from mice that overexpress 5-HT$_{2C}$ (5-HT$_{2C}$-VGV) allowing clear observations of 5-HT$_{2C}$ receptor distribution in the brain. Notably, 5-HT$_{2C}$ is densely expressed in the nucleus accumbens (NAc), but not in the dorsal striatum (DStr); the darker the shade, the higher the receptor binding site density. [3H]Mesulergine (3 nM for eight weeks) or [125I]DOI (0.14 nM for 48 hours) was used in the presence of spiperone (100 nM) to label 5-HT$_{2C}$ receptors. These sections were part of a set collected by Dr. Canal (Olaghere da Silva *et al.*, 2010). All sections labeled with [3H] Mesulergine or with [125I]DOI are from the same brain. Pictures from the latter were cropped and pasted to align them vertically.

Raphe nuclei send strong 5-HT projections to the NAc (Van Bockstaele and Pickel, 1993), and 5-HT$_{2C}$ receptors are predominantly post-synaptic and excitatory (Austgen *et al.*, 2012; Invernizzi *et al.*, 2007), suggesting they reside on GABAergic MSN, which account for ~90% of NAc neurons (Meredith, 1999). Indeed, immunochemistry and neurophysiology studies show that 5-HT$_{2C}$ receptors are expressed on MSN of the NAc (Clemett *et al.*, 2000; Graves *et al.*, 2015; Santana and Artigas, 2016). Furthermore, autoradiography data from mice that overexpress 5-HT$_{2C}$ receptors (while maintaining the distribution pattern of 5-HT$_{2C}$ receptors across neural systems that is observed in wild-type mice; Olaghere da Silva *et al.*, 2010) show clearly that 5-HT$_{2C}$ receptors are densely expressed in the NAc, but not the dorsal striatum (see Figure 1; which receives dopaminergic projections from substantia nigra). This is particularly intriguing when considered in the context of observations of the effects of cocaine on dopamine release in the NAc compared with the dorsal striatum. As stated earlier, 5-HT$_{2C}$ knockout mice, relative to WT mice, show an increase in cocaine-stimulated dopamine release in the NAc, but this effect is not observed in the dorsal striatum (Rocha *et al.*, 2002). Furthermore, 5-HT$_{2C}$ agonists administered peripherally suppress cocaine-stimulated dopamine release in the NAc, but not the dorsal striatum (Manvich *et al.*, 2012b). Thus, we consider, like others (Navailles *et al.*, 2006, 2008), that 5-HT$_{2C}$ receptors expressed in NAc are contributing significantly to the anti-addiction effects of 5-HT$_{2C}$ agonists, with special relevance to cocaine addiction.

Several studies show that the shell region of the NAc is associated more closely than the core with the appetitive or reinforcing effects of addictive substances (Bari and Pierce, 2005; Di Chiara *et al.*, 2004; Ikemoto, 2010; Rodd-Henricks *et al.*, 2002; Sellings and Clarke, 2003). For example, non-contingent and self-administered cocaine preferentially increases dopamine in the NAc shell (Lecca *et al.*, 2004, 2007; Pontieri *et al.*, 1995), and a recent predictive model shows that cocaine treatment enhances the phasic signaling of dopamine neurons projecting to the NAc shell, but not to the core (Dreyer *et al.*, 2016). Also, others report, more generally, that the NAc shell codes reward value (Saddoris *et al.*, 2013). Furthermore, MSN of the NAc shell, specifically D1-containing MSN, send direct projections to the VTA, generating an inhibitory feedback circuit (Bocklisch *et al.*, 2013; Sesack and Grace, 2010); this circuit is necessary for the integration of our 5-

HT_{2C} mechanistic hypothesis, and 5-HT_{2C} regulation of NAc-VTA circuitry has been speculated (Filip and Cunningham, 2002). Interestingly, 5-HT projections to the NAc segregate in the core and shell regions; 5-HT terminals in the NAc shell are larger in diameter, contain more, large dense core vesicles, and form more symmetric contacts with dendrites (Brown and Molliver, 2000; Van Bockstaele and Pickel, 1993). Moreover, systemic administration of 5-HT_{2C} selective agonists decrease, and inverse agonists increase, dopamine release in the NAc shell (De Deurwaerdere *et al.*, 2004; Di Matteo *et al.*, 2000; Gobert *et al.*, 2000). Finally, immunohistochemistry results show that 5-HT_{2C} receptors are expressed at higher densities in the NAc shell, relative to the core (Clemett *et al.*, 2000). Thus, we speculate that 5-HT_{2C} receptors are expressed on D1-containing MSN of the NAc shell, and when activated, they enhance their activity, occluding effects of D1 activity, and thus increasing GABA release in the VTA. This is supported by the observations that 5-HT_{2C} receptor knockout mice show enhanced behavioral responses to the D1 receptor agonist SKF 81297 (Abdallah *et al.*, 2009).

5-HT_{2C} modulation of intrinsic plasticity via inhibition of NAc Kv1.x channels: A novel hypothesized mechanism for psychostimulant addiction treatment

Based on a synthesis of what is known in the literature regarding 5-HT_{2C} receptor function, neural circuitry, and neurochemistry underlying addiction, we hypothesize that activation of 5-HT_{2C} receptors, specifically on GABAergic MSN in the NAc shell (Graves *et al.*, 2015), inhibits Kv1.x channels, including Kv1.1, Kv1.2, and Kv1.3, leading to increased intrinsic activity (non-synaptic increases in neuronal firing capacity). Taken together with several reports that show NAc intrinsic activity is decreased by psychostimulant exposure (Coffey *et al.*, 2015; Graves *et al.*, 2015; Henry and White, 1995; Hu, 2007; Hu *et al.*, 2004; Zhang *et al.*, 2002), and germane to our hypothesis that Kv1.x channel conductance is enhanced by exposure to psychostimulants (Hu *et al.*, 2004; Kourrich and Thomas, 2009; Kourrich *et al.*, 2013, 2015), it is inferred that 5-HT_{2C} receptor activation may directly counteract effects of psychostimulants on intrinsic plasticity. Accordingly, the increase in NAc shell MSN cellular activity by 5-HT_{2C} receptor activation would directly counteract the decrease in NAc shell MSN activity caused by psychostimulants (Figure 2).

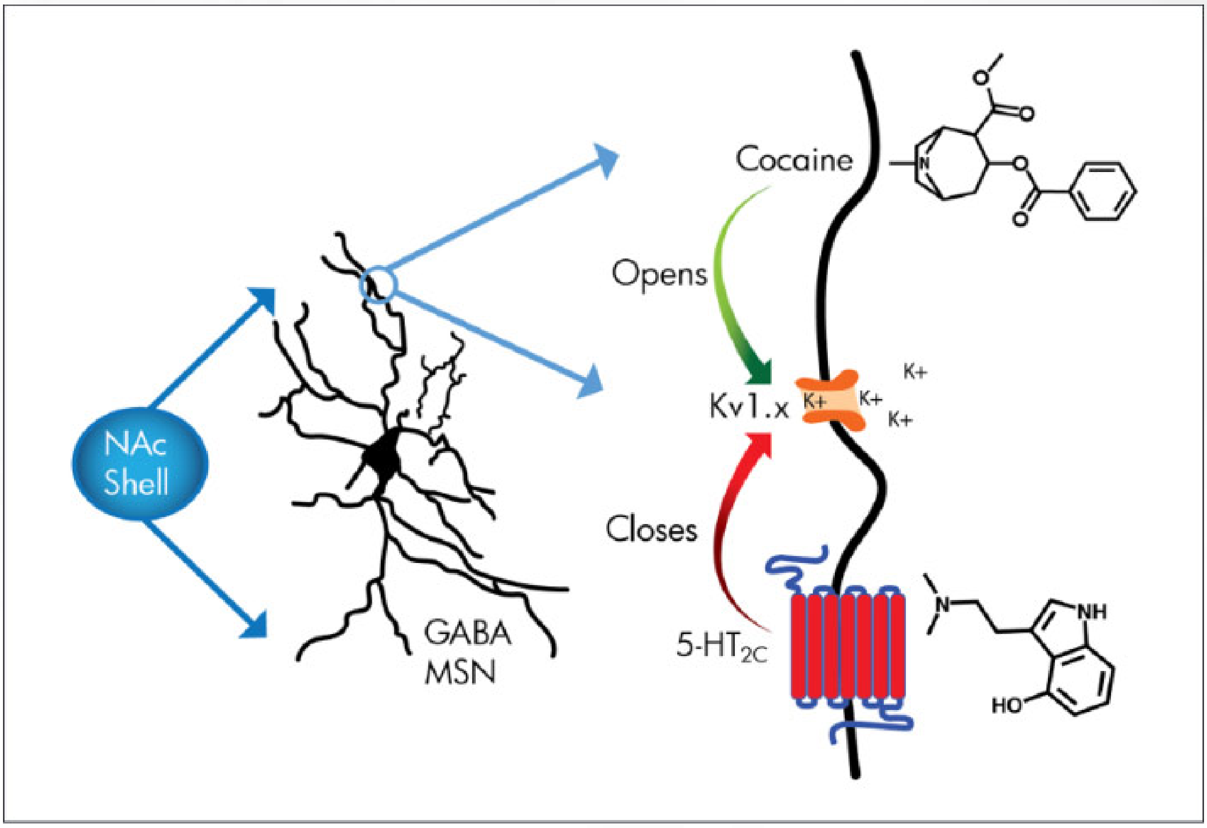


Figure 2. Proposed 5-HT_{2C} anti-cocaine addiction mechanism involving modulation of Kv1.x channels on GABAergic medium spiny neurons (MSN) of the NAc shell.

Potassium Kv1.x channels (Chandy and Gutman, 1993), Kv1.1-Kv1.8, are voltage-gated channels that regulate the intrinsic activity of neurons. Kv1.x channel conductance is critical for the generation and modulation of action potentials, regulating neurotransmitter release and neural circuit excitability. Kv1.x channels open upon membrane depolarization, permitting the flow of potassium ions from within the cell, leading to restoration of the resting membrane potential. In addition, activation of Kv1.x inhibits cell-firing frequency and delays the onset of action potentials (Lioudyno *et al*., 2013). Conversely, Kv1.x channel blockers prevent the flow of potassium ions, causing spontaneous depolarization and increasing, for example, action potential frequency and neurotransmitter release (Ramirez-Navarro *et al*., 2011; Simeone *et al*., 2013; Tibbs *et al*., 1996). There are several excellent reviews on Kv channel localization in the brain, their trafficking, structure, and function, and involvement in brain disease pathophysiology (D'Adamo *et al*., 2013; Heusser and Schwappach, 2005; Johnston *et al*., 2010; Robbins and Tempel, 2012; Robertson, 1997; Shah and Aizenman, 2014; Wang *et al*., 1994).

Several studies, using both ex vivo and in vitro cell systems show clearly that 5-HT$_{2C}$ activation suppresses Kv1.x channels. First, 5-HT$_{2C}$ receptors are expressed in neural systems where Kv1.x channels are also expressed (D'Adamo *et al*., 2013). For example, the choroid plexuses, where 5-HT$_{2C}$ receptor expression is dense (Hartig *et al*., 1990; Lopez-Gimenez *et al*., 2001; Marazziti *et al*., 1999), also robustly express Kv1.1 and Kv 1.3 channels (Speake *et al*., 2004). Application of 5-HT to choroid plexus cells abolishes potassium currents, an effect reversed by addition of the 5-HT$_{2C}$ antagonist, mesulergine (Speake *et al*., 2004). Similarly, in heterologous oocyte systems expressing 5-HT$_{2C}$ receptors and Kv1.1, Kv1.2, or Kv1.3 channels, application of 5-HT eliminates potassium generated currents from each channel (Aiyar *et al*., 1993; Imbrici *et al*., 2000). The effect of 5-HT$_{2C}$ may be relegated to Kv1.x type channels, as 5-HT activation of 5-HT$_{2C}$ receptors does not affect Kv3.1 channel activity (Aiyar *et al*., 1993). The exact cell signaling pathways underlying these effects remain unclear, but studies suggest 5-HT$_{2C}$-Gα_q-PLC signaling and activation of protein kinase C and tyrosine kinases PYK2 and Src are important contributors (Aiyar *et al*., 1993; Boland and Jackson, 1999; Imbrici *et al*., 2000; Speake *et al*., 2004).

Contrary to 5-HT$_{2C}$ receptor's effects on Kv1.x channels, exposure to cocaine increases potassium currents, as measured in the NAc shell. Recent studies examining NAc shell GABAergic MSN show that these effects are mediated by an increase in the activity of Kv1.2 channels, leading to a decrease in excitability and firing rate (Hu *et al*., 2004; Kourrich and Thomas, 2009; Kourrich *et al*., 2013; Mu *et al*., 2010). Furthermore, exposure to cocaine for 10 consecutive days increases the expression of Kv1.2 channels (Kourrich *et al*., 2013). Importantly, the cocaine-induced depression of firing rate of MSN of the NAc shell is persistent, and decreases in the excitability of the NAc shell lead to enhanced locomotor responses and behavioral sensitization to cocaine and are associated with enhanced cocaine self-administration (Guillem *et al*., 2014; Kourrich and Thomas, 2009). Moreover, cocaine's inhibitory effects on MSN activity are specific to the NAc shell, with cocaine actually increasing MSN firing in the NAc core (Kourrich and Thomas, 2009; Kourrich *et al*., 2013; Mu *et al*., 2010). Finally, overexpression of a hyperpolarizing, inwardlyrectifying potassium channel (Kir2.1) in NAc MSN enhances psychomotor effects of cocaine (Dong *et al*., 2006), whereas knockdown of the Kv1.1 channel blocks behavioral effects of another psychostimulant, amphetamine (Ghelardini *et al*., 2003). Thus, there is a strong argument that some psychostimulant effects are mediated by alterations in intrinsic plasticity in NAc shell MSN, driven by Kv1.x currents that decrease excitability (Kourrich *et al*., 2015), and CH-mediated 5-HT$_{2C}$ receptor activation may offset these effects (Figure 2).

Caveat emptor

5-HT$_{2C}$ receptors are expressed in several neural systems, including the frontal and cingulate cortices, that regulate impulsivity, approach, and reward behavior, and activation of these receptors impacts neural circuitry to modulate the effects of addictive drugs (Anastasio *et al*., 2014; Bubar and Cunningham, 2007; Daglish and Nutt, 2003; Liu *et al*., 2007; Nocjar *et al*., 2015). Our hypothesis regarding 5-HT$_{2C}$ modulation of Kv1.x channels could be extended to these other neural systems. However, to maintain scope, we have focused on the NAc shell. Despite the logic regarding 5-HT$_{2C}$ receptors and Kv1.x channels, there are reports that 5-HT$_{2A}$ receptor activation also decreases Kv1.x activity, specifically Kv1.5 channels in cardiac tissue (Cogolludo *et al*., 2006) and Kv1.2 channels in cortical pyramidal neurons (Lambe and Aghajanian, 2001). In this latter study, 5-HT blocked Kv1.2 currents in layer V pyramidal neurons; the authors concluded the effects were mediated by

5-HT_{2A} receptors because of their dense expression. Still, 5-HT_{2C} receptors are also expressed in the frontal cortex, and modulate excitatory activity there (Beique *et al.*, 2007). We acknowledge and appreciate that the modulatory activity of 5-HT_2 receptor subtypes that affects behavior is complex. 5-HT_2 receptor subtypes may modulate activity of unique Kv1.x channels, and the discovery of 5-HT_2 receptor subtype expression patterns within discrete neural circuits will likely lead to further elucidation of their individual functions. For example, 5-HT_{2A} receptors are found in the NAc shell and core (Lopez-Gimenez *et al.*, 2002; Mijnster *et al.*, 1997), but (like 5-HT_{2C}) the functions of 5-HT_{2A} receptors in subregions of the NAc are unclear. Additional studies are needed to cull the specific Kv1.x channel subtypes that may associate with 5-HT_{2C} to lead to suppression of addictive behaviors.

Many cell types and many unique afferents are found within the NAc and VTA (Russo and Nestler, 2013). Thus, a complete picture must show which cells express 5-HT_{2A}, 5-HT_{2B}, and 5-HT_{2C} receptors, the relative densities of receptors, and their unique contributions to network activity. Finally, 5-HT_{2C} chemical probes, including both agonists and antagonists, are, with few exceptions, notoriously non-selective (Canal and Morgan, 2012; Cussac *et al.*, 2002; Porter *et al.*, 1999). We have found, for example, that the "selective" 5-HT_{2C} agonist, Ro 60-0175, is a potent and efficacious 5-HT_{2A} agonist at the Gαq-PLC pathway, and when administered systemically at 3 mg/kg, Ro 60-0175 produces a HTR in C57BL/6J mice (unreported observations; data available upon request). It would be interesting to compare the behavioral and neurochemical effects of Ro 60-0175 directly to the more selective 5-HT_{2C} agonist lorcaserin, as well as to the recently reported selective 5-HT_{2A} agonist 25CN-NBOH (Fantegrossi *et al.*, 2015; Hansen *et al.*, 2014) to tease apart contributions of the 5-HT_2 receptor subtypes more clearly (see the section on testable hypotheses below).

Classic hallucinogens treat addiction

Literature from the 1950s through the 1970s, as well as modern reports, show that CH have positive effects on substance dependence (Bogenschutz and Johnson, 2016; Bogenschutz and Pommy, 2012; Dyck, 2006). Thus, not only do CH appear to be nonaddictive, several studies show that they reverse the addictive effects of other psychoactive drugs. CH have been used to alleviate neurotic symptoms by indigenous people for thousands of years (Grinspoon and Bakalar, 1986), and the discovery of LSD and its psychoactive effects sparked considerable interest in the therapeutic potential of CH. Most work focused on the use of these compounds as an adjunct to psychotherapy. Between 1950 and the mid-1960s, more than 1000 quasi-clinical trials were completed, several dozen books were published, and six international conferences were held providing data on approximately 40,000 patients that had undergone "psychedelic" therapy sessions (Grinspoon and Bakalar, 1986; Riedlinger and Riedlinger, 1994). In the context of the treatment of substance dependence, most studies focused on the use of LSD for the treatment of alcoholism (for reviews, see Abuzzahab and Anderson, 1971; Bogenschutz and Johnson, 2016; Dyck, 2005; Grinspoon and Bakalar, 1986; Mangini, 1998). These studies examined both single, high-dose, and repeated low-dose designs, follow-up periods of several years, control groups, and a total subject pool of well in excessive of 1000 individuals (Abuzzahab and Anderson, 1971). Between 50% and 70% of the subjects showed reduced drinking or sobriety and/or improved social or professional functioning. Such a treatment effect is exceptional compared to current Food and Drug Administration-approved medications for alcoholism (i.e., disulfiram, naltrexone, and acamprosate). However, the relatively low number of participants in each study, lax designs, and suspect claims led many to question whether accurate conclusions could be made. Nevertheless, results from the six randomized trials of LSD for alcohol dependence that reported drinking outcomes (Bowen *et al.*, 1970; Hollister *et al.*, 1969; Ludwig *et al.*, 1969; Pahnke *et al.*, 1970; Smart *et al.*, 1966; Tomsovic and Edwards, 1970) recently underwent a meta-analysis (Krebs and Johansen, 2012) that demonstrated consistent treatment effects supporting the efficacy of LSD.

Work with CH largely terminated by the 1970s due to the governmental regulatory response to advocates of the use of these drugs outside of the medical arena. Nonetheless, in the last decade, there has been a resurgence in the study of CH in general, and in the use of CH for the treatment of substance dependence in particular. This recent work has foregone the use of LSD in favor of psilocybin, and has extended our knowledge of the beneficial effects of CH to nicotine dependence (Bogenschutz *et al.*, 2015; Johnson *et al.*, 2014). We note that some researchers appreciate that stimulation of 5-HT_{2A} receptors (which are generally what come to mind when people think of CH) may exacerbate substance dependence (as discussed above) and have speculated that profound, rapid, and long-lasting agonist stimulated downregulation of 5-HT_{2A} receptors (i.e., functional antagonism) could be responsible for the anti-addiction effects of CH (Bogenschutz and Johnson, 2016).

Herein, we have proposed a non-exclusive and empirically testable hypothesis that the beneficial effects of CH for substance dependence are mediated by agonist stimulation of 5-HT_{2C} receptors. If, however, CH were both to stimulate 5-HT_{2C} receptors acutely and result in long-term downregulation of 5-HT_{2A} receptors, this may account for their purported therapeutic effects. Indeed, if CH treat addiction simply by stimulating 5-HT_{2C} receptors, it would likely be preferable to use a selective 5-HT_{2C} receptor agonist instead of CH. Although, others surmise that CH may be effective against addiction because of their psychedelic effects. They can elicit peak or mystical experiences, and afterglow effects, which can alter engrained personality domains such as openness (Maclean *et al.*, 2011; Majic *et al.*, 2015). These effects may be beneficial for psychotherapy and loosening relatively fixed behavioral patterns that underlie addiction.

Despite the potential for CH to treat addiction, it is important to caution that repeated exposure to CH could also chronically alter 5-HT_{2C} receptor expression and/or function, potentially leading to an enhanced susceptibility to addiction via a loss of intrinsic efficacy of 5-HT_{2C} receptors to modulate reward circuitry. Indeed, it does not escape our awareness that use of CH does not render persons immune to drug addiction, and a recent report shows that psilocybin users were significantly more likely to use addictive drugs (Hallock *et al.*, 2013). Thus, medical supervision, psychological support, and careful preparation to control for set and setting in the context of CH use are likely important requirements to produce therapeutic effects.

Testable hypotheses for unraveling the anti-addictive effects of classic hallucinogens

The literature we have reviewed above suggests a number of experiments that warrant testing in future studies. These experiments would serve to delineate more clearly the role of 5-HT_2 receptor subtypes underlying the low addiction liability of CH. Morever, they would elucidate our understanding of the mechanisms involved, and the results would provide new testable hypotheses. Among these experiments are: (1) to determine whether recently synthesized compounds such as 25CN-NBOH, which shows ~90-fold higher selectivity for activating 5-HT_{2A} over 5-HT_{2C}, also show higher abuse liabilities than CH (caveat: that first the pharmacology of 25CN-NBOH is assessed at off-targets, e.g., opioid receptors, which would confound conclusions); (2) to determine whether animals with genetic deletion of the 5-HT_{2C} receptor will self-administer CH; (3) to determine the abuse liability of CH in the presence of a selective 5-HT_{2C} receptor antagonist; (4) to determine the precise localization of 5-HT_{2C} receptors in cells of the NAc, with particular emphasis on whether 5-HT_{2C} receptors are expressed on D1-expressing GABAergic MSN of the NAc shell (Caine *et al.*, 2007; Lobo *et al.*, 2010; Pacheco-Cano *et al.*, 1996; Pisanu *et al.*, 2015) - these MSN are the predominant MSN afferents of the VTA that modulate dopamine release in the NAc (Bocklisch *et al.*, 2013); and (5) to determine the nature of 5-HT_{2C}-Kv1.x interactions in forebrain regions implicated in addiction. We believe that these experiments would add greatly to the literature, and are enthused to see them completed.

Acknowledgements

We wish to thank the Communications Office of the Mercer University College of Pharmacy for their professional work to enhance Figure 2. In particular, we wish to thank David Holland and Jennifer Brock for their work on improving the artistic design of the graphic.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article. However, while the manuscript was under review, Drs. Canal and Murnane received 1R21DA040907-01 from NIDA.

References

1. Aarde SM, Huang PK, Dickerson TJ, *et al.* (2015) Binge-like acquisition of 3,4-methylenedioxypyrovalerone (MDPV) self-administration and wheel activity in rats. *Psychopharmacology* (Berl) 232: 1867-1877.
2. Abdallah L, Bonasera SJ, Hopf FW, *et al.* (2009) Impact of serotonin 2C receptor null mutation on physiology and behavior associated with nigrostriatal dopamine pathway function. *J Neurosci* 29: 8156-8165.
3. Abreu ME, Bigelow GE, Fleisher L, *et al.* (2001) Effect of intravenous injection speed on responses to cocaine and hydromorphone in humans. *Psychopharmacology (Berl)* 154: 76-84.
4. Abuzzahab FS, Sr and Anderson BJ (1971) A review of LSD treatment in alcoholism. *Int Pharmacopsychiatry* 6: 223-235.
5. Aiyar J, Grissmer S and Chandy KG (1993) Full-length and truncated Kv1.3 K+ channels are modulated by 5-HT_1c receptor activation and independently by PKC. *Am J Physiol* 265: C1571-1578.
6. Alex KD and Pehek EA (2007) Pharmacologic mechanisms of serotonergic regulation of dopamine neurotransmission. *Pharmacol Ther* 113: 296-320.
7. American Psychiatric Association (2013) *Diagnostic and statistical manual of mental disorders*. 5th ed. Washington, DC: American Psychiatric Association.
8. Anastasio NC, Stutz SJ, Fox RG, *et al.* (2014) Functional status of the serotonin 5-HT_{2C} receptor (5-HT_{2C}R) drives interlocked phenotypes that precipitate relapse-like behaviors in cocaine dependence. *Neuropsychopharmacology* 39: 370-382.
9. Auclair A, Drouin C, Cotecchia S, *et al.* (2004) 5-HT_{2A} and alpha1b-adrenergic receptors entirely mediate dopamine release, locomotor response and behavioural sensitization to opiates and psychostimulants. *Eur J Neurosci* 20: 3073-3084.
10. Auclair AL, Cathala A, Sarrazin F, *et al.* (2010) The central serotonin 2B receptor: a new pharmacological target to modulate the mesoaccumbens dopaminergic pathway activity. *J Neurochem* 114: 1323-1332.
11. Austgen JR, Dantzler HA, Barger BK, *et al.* (2012) 5-hydroxytryptamine 2C receptors tonically augment synaptic currents in the nucleus tractus solitarii. *J Neurophysiol* 108: 2292-2305.
12. Baker DA, Tran-Nguyen TL, Fuchs RA, *et al.* (2001) Influence of individual differences and chronic fluoxetine treatment on cocaine-seeking behavior in rats. *Psychopharmacology (Berl)* 155: 18-26.
13. Ball KT and Slane M (2014) Tolerance to the locomotor-activating effects of 3,4-methylenedioxymethamphetamine (MDMA) predicts escalation of MDMA self-administration and cue-induced reinstatement of MDMA seeking in rats. *Behav Brain Res* 274: 143-148.
14. Banas SM, Doly S, Boutourlinsky K, *et al.* (2011) Deconstructing antiobesity compound action: requirement of serotonin 5-HT_{2B} receptors for dexfenfluramine anorectic effects. *Neuropsychopharmacology* 36: 423-433.
15. Bari AA and Pierce RC (2005) D1-like and D2 dopamine receptor antagonists administered into the shell subregion of the rat nucleus accumbens decrease cocaine, but not food, reinforcement. *Neuroscience* 135: 959-968.
16. Bauer CT, Banks ML, Blough BE, *et al.* (2015) Role of 5-HT_{2C} receptors in effects of monoamine releasers on intracranial self-stimulation in rats. *Psychopharmacology (Berl)* 232: 3249-3258.
17. Beart PM and McDonald D (1982) Neurochemical studies of the mesolimbic dopaminergic pathway: [3H]spiperone labels two bindings sites in homogenates of the nucleus accumbens of rat brain. *J Neurochem* 39: 1452-1460.
18. Beique JC, Imad M, Mladenovic L, *et al.* (2007) Mechanism of the 5-hydroxytryptamine 2A receptor-mediated facilitation of synaptic activity in prefrontal cortex. *Proc Natl Acad Sci U S A* 104: 9870-9875.
19. Belleville RE, Fraser HF, Isbell H, *et al.* (1956) Studies on lysergic acid diethylamide (LSD-25). I. Effects in former morphine addicts and development of tolerance during chronic intoxication. *AMA Arch Neurol Psychiatry* 76: 468-478.
20. Benneyworth MA, Smith RL, Barrett RJ, *et al.* (2005) Complex discriminative stimulus properties of (+)lysergic acid diethylamide (LSD) in C57Bl/6J mice. *Psychopharmacology (Berl)* 179: 854-862.
21. Berg KA, Clarke WP, Sailstad C, *et al.* (1994) Signal transduction differences between 5-hydroxytryptamine type 2A and type 2C receptor systems. *Mol Pharmacol* 46: 477-484.
22. Berg KA, Stout BD, Maayani S, *et al.* (2001) Differences in rapid desensitization of 5-hydroxytryptamine2A and 5-hydroxytryptamine2C receptor-mediated phospholipase C activation. *J Pharmacol Exp Ther* 299: 593-602.
23. Bocklisch C, Pascoli V, Wong JC, *et al.* (2013) Cocaine disinhibits dopamine neurons by potentiation of GABA transmission in the ventral tegmental area. *Science* 341: 1521-1525.
24. Boess FG and Martin IL (1994) Molecular biology of 5-HT receptors. *Neuropharmacology* 33: 275-317.
25. Bogenschutz MP, Forcehimes AA, Pommy JA, *et al.* (2015) Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *J Psychopharmacol* 29: 289-299.
26. Bogenschutz MP and Johnson MW (2016) Classic hallucinogens in the treatment of addictions. *Prog Neuropsychopharmacol Biol Psychiatry* 64: 250-258.
27. Bogenschutz MP and Pommy JM (2012) Therapeutic mechanisms of classic hallucinogens in the treatment of addictions: from indirect evidence to testable hypotheses. *Drug Test Anal* 4: 543-555.
28. Boland LM and Jackson KA (1999) Protein kinase C inhibits Kv1.1 potassium channel function. *Am J Physiol* 277: C100-110.
29. Bonaccorso S, Meltzer HY, Li Z, *et al.* (2002) SR46349-B, a 5-HT(2A/2C) receptor antagonist, potentiates haloperidol-induced dopamine release in rat medial prefrontal cortex and nucleus accumbens. *Neuropsychopharmacology* 27: 430-441.
30. Bonhaus DW, Bach C, DeSouza A, *et al.* (1995) The pharmacology and distribution of human 5-hydroxytryptamine2B (5-HT_{2B}) receptor gene products: comparison with 5-HT_{2A} and 5-HT_{2C} receptors. *Br J Pharmacol* 115: 622-628.
31. Bortolozzi A, Diaz-Mataix L, Scorza MC, *et al.* (2005) The activation of 5-HT receptors in prefrontal cortex enhances dopaminergic activity. *J Neurochem* 95: 1597-1607.
32. Bowen WT, Soskin RA and Chotlos JW (1970) Lysergic acid diethylamide as a variable in the hospital treatment of alcoholism: a follow-up study. *J Nerv Ment Dis* 150: 111-118.
33. Bowers BJ, Henry MB, Thielen RJ, *et al.* (2000) Serotonin 5-HT(2) receptor stimulation of dopamine release in the posterior but not anterior nucleus accumbens of the rat. *J Neurochem* 75: 1625-1633.
34. Brady JV, Griffiths RR, Hienz RD, *et al.* (1984) Abuse liability and behavioral toxicity assessment: progress report from the

behavioral biology laboratories of the Johns Hopkins University School of Medicine. *NIDA Res Monogr* 49: 92-108.

35. Broderick PA, Olabisi OA, Rahni DN, *et al*. (2004) Cocaine acts on accumbens monoamines and locomotor behavior via a 5-HT$_{2A}$/2C receptor mechanism as shown by ketanserin: 24-h follow-up studies. *Prog Neuropsychopharmacol Biol Psychiatry* 28: 547-557.
36. Brown P and Molliver ME (2000) Dual serotonin (5-HT) projections to the nucleus accumbens core and shell: relation of the 5-HT transporter to amphetamine-induced neurotoxicity. *J Neurosci* 20: 1952-1963.
37. Bubar MJ and Cunningham KA (2007) Distribution of serotonin 5-HT$_{2C}$ receptors in the ventral tegmental area. *Neuroscience* 146: 286-297.
38. Bubar MJ and Cunningham KA (2008) Prospects for serotonin 5-HT$_2$R pharmacotherapy in psychostimulant abuse. *Prog Brain Res* 172: 319-346.
39. Bubar MJ, Stutz SJ and Cunningham KA (2011) 5-HT(2C) receptors localize to dopamine and GABA neurons in the rat mesoaccumbens pathway. *PLoS One* 6: e20508.
40. Burbassi S and Cervo L (2008) Stimulation of serotonin2C receptors influences cocaine-seeking behavior in response to drug-associated stimuli in rats. *Psychopharmacology (Berl)* 196: 15-27.
41. Burmeister JJ, Lungren EM, Kirschner KF, *et al*. (2004) Differential roles of 5-HT receptor subtypes in cue and cocaine reinstatement of cocaine-seeking behavior in rats. *Neuropsychopharmacology* 29: 660-668.
42. Burmeister JJ, Lungren EM and Neisewander JL (2003) Effects of fluoxetine and d-fenfluramine on cocaine-seeking behavior in rats. *Psychopharmacology (Berl)* 168: 146-154.
43. Caine SB, Thomsen M, Gabriel KI, *et al*. (2007) Lack of self-administration of cocaine in dopamine D1 receptor knock-out mice. *J Neurosci* 27: 13140-13150.
44. Callahan PM and Cunningham KA (1995) Modulation of the discriminative stimulus properties of cocaine by 5-HT$_{1B}$ and 5-HT$_{2C}$ receptors. *J Pharmacol Exp Ther* 274: 1414-1424.
45. Canal CE, Cordova-Sintjago T, Liu Y, *et al*. (2013) Molecular pharmacology and ligand docking studies reveal a single amino acid difference between mouse and human serotonin 5-HT$_{2A}$ receptors that impacts behavioral translation of novel 4-phenyl-2-dimethylaminotetralin ligands. *J Pharmacol Exp Ther* 347: 705-716.
46. Canal CE and Morgan D (2012) Head-twitch response in rodents induced by the hallucinogen 2,5-dimethoxy-4-iodoamphetamine: a comprehensive history, a re-evaluation of mechanisms, and its utility as a model. *Drug Test Anal* 4: 556-576.
47. Canal CE, Olaghere da Silva UB, Gresch PJ, *et al*. (2010) The serotonin 2C receptor potently modulates the head-twitch response in mice induced by a phenethylamine hallucinogen. *Psychopharmacology (Berl)* 209: 163-174.
48. Carroll ME, Krattiger KL, Gieske D, *et al*. (1990a) Cocaine-base smoking in rhesus monkeys: reinforcing and physiological effects. *Psychopharmacology (Berl)* 102: 443-450.
49. Carroll ME, Lac ST, Asencio M, *et al*. (1990b) Fluoxetine reduces intravenous cocaine self-administration in rats. *Pharmacol Biochem Behav* 35: 237-244.
50. Cathala A, Devroye C, Maitre M, *et al*. (2015) Serotonin2C receptors modulate dopamine transmission in the nucleus accumbens independently of dopamine release: behavioral, neurochemical and molecular studies with cocaine. *Addict Biol* 20: 445-457.
51. Ceccarini J, Kuepper R, Kemels D, *et al*. (2015) [18F]MK-9470 PET measurement of cannabinoid CB1 receptor availability in chronic cannabis users. *Addict Biol* 20: 357-367.
52. Chagraoui A, Thibaut F, Skiba M, *et al*. (2016) 5-HT$_{2C}$ receptors in psychiatric disorders: a review. *Prog Neuropsychopharmacol Biol Psychiatry* 66: 120-135.
53. Chandy KG and Gutman GA (1993) Nomenclature for mammalian potassium channel genes. *Trends Pharmacol Sci* 14: 434.
54. Clemett DA, Punhani T, Duxon MS, *et al*. (2000) Immunohistochemical localisation of the 5-HT$_{2C}$ receptor protein in the rat CNS. *Neuropharmacology* 39: 123-132.
55. Cline EJ, Scheffel U, Boja JW, *et al*. (1992) Behavioral effects of novel cocaine analogs: a comparison with in vivo receptor binding potency. *J Pharmacol Exp Ther* 260: 1174-1179.
56. Coffey KR, Barker DJ, Gayliard N, *et al*. (2015) Electrophysiological evidence of alterations to the nucleus accumbens and dorsolateral striatum during chronic cocaine self-administration. *Eur J Neurosci* 41: 1538-1552.
57. Cogolludo A, Moreno L, Lodi F, *et al*. (2006) Serotonin inhibits voltagegated K+ currents in pulmonary artery smooth muscle cells: role of 5-HT$_{2A}$ receptors, caveolin-1, and KV1.5 channel internalization. *Circ Res* 98: 931-938.
58. Collins GT, Gerak LR, Javors MA, *et al*. (2016) Lorcaserin reduces the discriminative stimulus and reinforcing effects of cocaine in rhesus monkeys. *J Pharmacol Exp Ther* 356: 85-95.
59. Cozzi NV, Gopalakrishnan A, Anderson LL, *et al*. (2009) Dimethyltryptamine and other hallucinogenic tryptamines exhibit substrate behavior at the serotonin uptake transporter and the vesicle monoamine transporter. *J Neural Transm* 116: 1591-1599.
60. Craige CP and Unterwald EM (2013) Serotonin (2C) receptor regulation of cocaine-induced conditioned place preference and locomotor sensitization. *Behav Brain Res* 238: 206-210.
61. Cunningham KA, Fox RG, Anastasio NC, *et al*. (2011) Selective serotonin 5-HT(2C) receptor activation suppresses the reinforcing efficacy of cocaine and sucrose but differentially affects the incentive-salience value of cocainevs. sucrose-associated cues. *Neuropharmacology* 61: 513-523.
62. Cussac D, Newman-Tancredi A, Quentric Y, *et al*. (2002) Characterization of phospholipase C activity at h5-HT$_{2C}$ compared with h5-HT$_{2B}$ receptors: influence of novel ligands upon membrane-bound levels of [3H]phosphatidylinositols. *Naunyn Schmiedebergs Arch Pharmacol* 365: 242-252.
63. Czoty PW, Ginsburg BC and Howell LL (2002) Serotonergic attenuation of the reinforcing and neurochemical effects of cocaine in squirrel monkeys. *J Pharmacol Exp Ther* 300: 831-837.
64. D'Adamo MC, Servettini I, Guglielmi L, *et al*. (2013) 5-HT$_2$ receptors-mediated modulation of voltage-gated K+ channels and neurophysiopathological correlates. *Exp Brain Res* 230: 453-462.
65. Daglish MR and Nutt DJ (2003) Brain imaging studies in human addicts. *Eur Neuropsychopharmacol* 13: 453-458.

66. De Deurwaerdere P, Lagiere M, Bosc M, *et al*. (2013) Multiple controls exerted by 5-HT$_{2C}$ receptors upon basal ganglia function: from physiology to pathophysiology. *Exp Brain Res* 230: 477-511.
67. De Deurwaerdere P, Navailles S, Berg KA, *et al*. (2004) Constitutive activity of the serotonin2C receptor inhibits in vivo dopamine release in the rat striatum and nucleus accumbens. *J Neurosci* 24: 3235-3241.
68. De Deurwaerdere P and Spampinato U (1999) Role of serotonin(2A) and serotonin(2B/2C) receptor subtypes in the control of accumbal and striatal dopamine release elicited in vivo by dorsal raphe nucleus electrical stimulation. *J Neurochem* 73: 1033-1042.
69. Deneau G, Yanagita T and Seevers MH (1969) Self-administration of psychoactive substances by the monkey. *Psychopharmacologia* 16: 30-48.
70. Devroye C, Cathala A, Maitre M, *et al*. (2015) Serotonin2C receptor stimulation inhibits cocaine-induced Fos expression and DARPP-32 phosphorylation in the rat striatum independently of dopamine outflow. *Neuropharmacology* 89: 375-381.
71. Devroye C, Filip M, Przegalinski E, *et al*. (2013) Serotonin2C receptors and drug addiction: focus on cocaine. *Exp Brain Res* 230: 537-545.
72. Di Chiara G, Bassareo V, Fenu S, *et al*. (2004) Dopamine and drug addiction: the nucleus accumbens shell connection. *Neuropharmacology* 47 Suppl 1: 227-241.
73. Di Giovanni G, De Deurwaerdere P, Di Mascio M, *et al*. (1999) Selective blockade of serotonin-2C/2B receptors enhances mesolimbic and mesostriatal dopaminergic function: a combined in vivo electrophysiological and microdialysis study. *Neuroscience* 91: 587-597.
74. Di Giovanni G, Di Matteo V, Di Mascio M, *et al*. (2000) Preferential modulation of mesolimbic vs. nigrostriatal dopaminergic function by serotonin(2C/2B) receptor agonists: a combined in vivo electrophysiological and microdialysis study. *Synapse* 35: 53-61.
75. Di Giovanni G, Di Matteo V, La Grutta V, *et al*. (2001) m-Chlorophenyl-piperazine excites non-dopaminergic neurons in the rat substantia nigra and ventral tegmental area by activating serotonin-2C receptors. *Neuroscience* 103: 111-116.
76. Di Giovanni G, Di Matteo V, Pierucci M, *et al*. (2006) Central serotonin2C receptor: from physiology to pathology. *Curr Top Med Chem* 6: 1909-1925.
77. Di Matteo V, Di Giovanni G, Di Mascio M, *et al*. (1999) SB 242084, a selective serotonin2C receptor antagonist, increases dopaminergic transmission in the mesolimbic system. *Neuropharmacology* 38: 1195-1205.
78. Di Matteo V, Di Giovanni G, Di Mascio M, *et al*. (2000) Biochemical and electrophysiological evidence that RO 60-0175 inhibits mesolimbic dopaminergic function through serotonin(2C) receptors. *Brain Res* 865: 85-90.
79. Di Matteo V, Di Giovanni G, Pierucci M, *et al*. (2008) Serotonin control of central dopaminergic function: focus on in vivo microdialysis studies. *Prog Brain Res* 172: 7-44.
80. Di Matteo V, Pierucci M and Esposito E (2004) Selective stimulation of serotonin2c receptors blocks the enhancement of striatal and accumbal dopamine release induced by nicotine administration. *J Neurochem* 89: 418-429.
81. Diaz SL, Doly S, Narboux-Neme N, *et al*. (2012) 5-HT(2B) receptors are required for serotonin-selective antidepressant actions. *Mol Psychiatry* 17: 154-163.
82. Doly S, Valjent E, Setola V, *et al*. (2008) Serotonin 5-HT$_{2B}$ receptors are required for 3,4-methylenedioxymethamphetamine-induced hyperlocomotion and 5-HT release in vivo and in vitro. *J Neurosci* 28: 2933-2940.
83. Dong Y, Green T, Saal D, *et al*. (2006) CREB modulates excitability of nucleus accumbens neurons. *Nat Neurosci* 9: 475-477.
84. Dreyer JK, Vander Weele CM, Lovic V, *et al*. (2016) Functionally distinct dopamine signals in nucleus accumbens core and shell in the freely moving rat. *J Neurosci* 36: 98-112.
85. Duxon MS, Flanigan TP, Reavley AC, *et al*. (1997) Evidence for expression of the 5-hydroxytryptamine-2B receptor protein in the rat central nervous system. *Neuroscience* 76: 323-329.
86. Dyck E (2005) Flashback: psychiatric experimentation with LSD in historical perspective. *Can J Psychiatry* 50: 381-388.
87. Dyck E (2006) "Hitting highs at rock bottom": LSD treatment for alcoholism, 1950-1970. *Soc History Med* 19: 313-329.
88. Fantegrossi WE, Gray BW, Bailey JM, *et al*. (2015) Hallucinogen-like effects of 2-([2-(4-cyano-2,5-dimethoxyphenyl) ethylamino]methyl) phenol (25CN-NBOH), a novel N-benzylphenethylamine with 100-fold selectivity for 5-HT(2)A receptors, in mice. *Psychopharmacology (Berl)* 232: 1039-1047.
89. Fantegrossi WE, Harrington AW, Eckler JR, *et al*. (2005) Hallucinogen-like actions of 2,5-dimethoxy-4-(n)-propylthiophenethylamine (2C-T-7) in mice and rats. *Psychopharmacology (Berl)* 181: 496-503.
90. Fantegrossi WE, Woods JH and Winger G (2004a) Transient reinforcing effects of phenylisopropylamine and indolealkylamine hallucinogens in rhesus monkeys. *Behav Pharmacol* 15: 149-157.
91. Fantegrossi WE, Woolverton WL, Kilbourn M, *et al*. (2004b) Behavioral and neurochemical consequences of long-term intravenous self-administration of MDMA and its enantiomers by rhesus monkeys. *Neuropsychopharmacology* 29: 1270-1281.
92. Filip M, Bubar MJ and Cunningham KA (2004) Contribution of serotonin (5-hydroxytryptamine; 5-HT) 5-HT$_2$ receptor subtypes to the hyperlocomotor effects of cocaine: acute and chronic pharmacological analyses. *J Pharmacol Exp Ther* 310: 1246-1254.
93. Filip M, Bubar MJ and Cunningham KA (2006) Contribution of serotonin (5-HT) 5-HT$_2$ receptor subtypes to the discriminative stimulus effects of cocaine in rats. *Psychopharmacology (Berl)* 183: 482-489.
94. Filip M and Cunningham KA (2002) Serotonin 5-HT(2C) receptors in nucleus accumbens regulate expression of the hyperlocomotive and discriminative stimulus effects of cocaine. *Pharmacol Biochem Behav* 71: 745-756.
95. Fletcher PJ, Chintoh AF, Sinyard J, *et al*. (2004) Injection of the 5-HT$_{2C}$ receptor agonist Ro60-0175 into the ventral tegmental area reduces cocaine-induced locomotor activity and cocaine self-administration. *Neuropsychopharmacology* 29: 308-318.
96. Fletcher PJ, Grottick AJ and Higgins GA (2002) Differential effects of the 5-HT(2A) receptor antagonist M100907 and the 5-HT(2C) receptor antagonist SB242084 on cocaine-induced locomotor activity, cocaine self-administration and cocaine-induced reinstatement of responding. *Neuropsychopharmacology* 27: 576-586.
97. Fletcher PJ, Rizos Z, Sinyard J, *et al*. (2008) The 5-HT$_{2C}$ receptor agonist Ro60-0175 reduces cocaine self-administration and reinstatement induced by the stressor yohimbine, and contextual cues. *Neuropsychopharmacology* 33: 1402-1412.
98. Fletcher PJ, Sinyard J and Higgins GA (2006) The effects of the 5-HT(2C) receptor antagonist SB242084 on locomotor activity induced by selective, or mixed, indirect serotonergic and dopaminergic agonists. *Psychopharmacology (Berl)* 187: 515-525.

99. Fontanilla D, Johannessen M, Hajipour AR, *et al*. (2009) The hallucinogen *N,N*-dimethyltryptamine (DMT) is an endogenous sigma-1 receptor regulator. *Science* 323: 934-937.
100. Frankel PS and Cunningham KA (2004) m-Chlorophenylpiperazine (mCPP) modulates the discriminative stimulus effects of cocaine through actions at the 5-HT$_{2C}$ receptor. *Behav Neurosci* 118: 157-162.
101. Geyer MA, Puerto A, Dawsey WJ, *et al*. (1976) Histologic and enzymatic studies of the mesolimbic and mesostriatal serotonergic pathways. *Brain Res* 106: 241-256.
102. Ghelardini C, Quattrone A, Galeotti N, *et al*. (2003) Antisense knockdown of the Shaker-like Kv1.1 gene abolishes the central stimulatory effects of amphetamines in mice and rats. *Neuropsychopharmacology* 28: 1096-1105.
103. Gobert A, Rivet JM, Lejeune F, *et al*. (2000) Serotonin(2C) receptors tonically suppress the activity of mesocortical dopaminergic and adrenergic, but not serotonergic, pathways: a combined dialysis and electrophysiological analysis in the rat. *Synapse* 36: 205-221.
104. Goldberg SR, Morse WH and Goldberg DM (1976) Behavior maintained under a second-order schedule by intramuscular injection of morphine or cocaine in rhesus monkeys. *J Pharmacol Exp Ther* 199: 278-286.
105. Gomez TH, Roache JD and Meisch RA (2002) Orally delivered alprazolam, diazepam, and triazolam as reinforcers in rhesus monkeys. *Psychopharmacology (Berl)* 161: 86-94.
106. Gonzalez-Maeso J and Sealfon SC (2009) Agonist-trafficking and hallucinogens. *Curr Med Chem* 16: 1017-1027.
107. Gonzalez-Maeso J, Weisstaub NV, Zhou M, *et al*. (2007) Hallucinogens recruit specific cortical 5-HT(2A) receptor-mediated signaling pathways to affect behavior. *Neuron* 53: 439-452.
108. Graves SM, Clark MJ, Traynor JR, *et al*. (2015) Nucleus accumbens shell excitability is decreased by methamphetamine self-administration and increased by 5-HT$_{2C}$ receptor inverse agonism and agonism. *Neuropharmacology* 89: 113-121.
109. Green AR (2006) Neuropharmacology of 5-hydroxytryptamine. *Br J Pharmacol* 147 Suppl 1: S145-152.
110. Griffiths RR (1980) Common factors in human and infrahuman drug self-administration. *Psychopharmacol Bull* 16: 45-47.
111. Griffiths RR, Bigelow GE and Henningfield JE (1980) Similarities in animal and human drug-taking behavior. In Mello NK (ed) *Advances in Substance Abuse*. Greenwich, CT: JAI Press, pp.1-90.
112. Griffiths RR, Bigelow GE and Liebson I (1978) Experimental drug self-administration: generality across species and type of drug. *NIDA Res Monogr* 24-43.
113. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects. *Psychopharmacology (Berl)* 218: 649-665.
114. Grinspoon L and Bakalar JB (1986) Can drugs be used to enhance the psychotherapeutic process? *Am J Psychother* 40: 393-404.
115. Grottick AJ, Fletcher PJ and Higgins GA (2000) Studies to investigate the role of 5-HT(2C) receptors on cocaineand food-maintained behavior. *J Pharmacol Exp Ther* 295: 1183-1191.
116. Guillem K, Ahmed SH and Peoples LL (2014) Escalation of cocaine intake and incubation of cocaine seeking are correlated with dissociable neuronal processes in different accumbens subregions. *Biol Psychiatry* 76: 31-39.
117. Haber SN and Knutson B (2010) The reward circuit: linking primate anatomy and human imaging. *Neuropsychopharmacology* 35: 4-26.
118. Halberstadt AL (2015) Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behav Brain Res* 277: 99-120.
119. Halliday GM and Tork I (1989) Serotonin-like immunoreactive cells and fibres in the rat ventromedial mesencephalic tegmentum. *Brain Res Bull* 22: 725-735.
120. Hallock RM, Dean A, Knecht ZA, *et al*. (2013) A survey of hallucinogenic mushroom use, factors related to usage, and perceptions of use among college students. *Drug Alcohol Depend* 130: 245-248.
121. Hanks JB and Gonzalez-Maeso J (2013) Animal models of serotonergic psychedelics. *ACS Chem Neurosci* 4: 33-42.
122. Hansen M, Phonekeo K, Paine JS, *et al*. (2014) Synthesis and structure-activity relationships of N-benzyl phenethylamines as 5-HT$_{2A}$/2C agonists. *ACS Chem Neurosci* 5: 243-249.
123. Hartig PR, Hoffman BJ, Kaufman MJ, *et al*. (1990) The 5-HT$_1$C receptor. *Ann N Y Acad Sci* 600: 149-166; discussion 166-147.
124. Harvey-Lewis C, Li Z, Higgins GA, *et al*. (2016) The 5-HT$_{2C}$ receptor agonist lorcaserin reduces cocaine self-administration, reinstatement of cocaine-seeking and cocaine induced locomotor activity. *Neuropharmacology* 101: 237-245.
125. Heffter A (1898) Ueber Pellote. *Archiv für experimentelle Pathologie und Pharmakologie* 40: 385-429.
126. Henry DJ and White FJ (1995) The persistence of behavioral sensitization to cocaine parallels enhanced inhibition of nucleus accumbens neurons. *J Neurosci* 15: 6287-6299.
127. Hertz L, Rothman DL, Li B, *et al*. (2015) Chronic SSRI stimulation of astrocytic 5-HT$_{2B}$ receptors change multiple gene expressions/editings and metabolism of glutamate, glucose and glycogen: a potential paradigm shift. *Front Behav Neurosci* 9: 25.
128. Herve D, Pickel VM, Joh TH, *et al*. (1987) Serotonin axon terminals in the ventral tegmental area of the rat: fine structure and synaptic input to dopaminergic neurons. *Brain Res* 435: 71-83.
129. Heusser K and Schwappach B (2005) Trafficking of potassium channels. *Curr Opin Neurobiol* 15: 364-369.
130. Higgins GA and Fletcher PJ (2015) Therapeutic potential of 5-HT$_{2C}$ receptor agonists for addictive disorders. *ACS Chem Neurosci* 6: 1071-1088.
131. Hofmann A (1970) Notes and documents concerning the discovery of LSD. *Agents Actions* 1: 148-150.
132. Hollister LE, Shelton J and Krieger G (1969) A controlled comparison of lysergic acid diethylamide (LSD) and dextroamphetmine in alcoholics. *Am J Psychiatry* 125: 1352-1357.
133. Howell LL and Byrd LD (1995) Serotonergic modulation of the behavioral effects of cocaine in the squirrel monkey. *J Pharmacol Exp Ther* 275: 1551-1559.
134. Howell LL and Cunningham KA (2015) Serotonin 5-HT$_2$ receptor interactions with dopamine function: implications for therapeutics in cocaine use disorder. *Pharmacol Rev* 67: 176-197.
135. Howell LL, Hoffman JM, Votaw JR, *et al*. (2002) Cocaine-induced brain activation determined by positron emission tomography neuroimaging in conscious rhesus monkeys. *Psychopharmacology (Berl)* 159: 154-160.

136. Howell LL and Murnane KS (2008) Nonhuman primate neuroimaging and the neurobiology of psychostimulant addiction. *Ann N Y Acad Sci* 1141: 176-194.
137. Hoyer D, Clarke DE, Fozard JR, *et al*. (1994) International Union of Pharmacology classification of receptors for 5-hydroxytryptamine (serotonin). *Pharmacol Rev* 46: 157-203.
138. Hoyer D, Hannon JP and Martin GR (2002) Molecular, pharmacological and functional diversity of 5-HT receptors. *Pharmacol Biochem Behav* 71: 533-554.
139. Hu XT (2007) Cocaine withdrawal and neuro-adaptations in ion channel function. *Mol Neurobiol* 35: 95-112.
140. Hu XT, Basu S and White FJ (2004) Repeated cocaine administration suppresses HVA-Ca2+ potentials and enhances activity of K+ channels in rat nucleus accumbens neurons. *J Neurophysiol* 92: 1597-1607.
141. Huang M, Dai J and Meltzer HY (2011) 5-HT(2A) and 5-HT(2C) receptor stimulation are differentially involved in the cortical dopamine efflux-Studied in 5-HT(2A) and 5-HT(2C) genetic mutant mice. *Eur J Pharmacol* 652: 40-45.
142. Hutcheson JD, Setola V, Roth BL, *et al*. (2012) Serotonin receptors and heart valve disease - it was meant 2B. *Pharmacol Ther* 132: 146-157.
143. Ikemoto S (2010) Brain reward circuitry beyond the mesolimbic dopamine system: a neurobiological theory. *Neurosci Biobehav Rev* 35: 129-150.
144. Imbrici P, Tucker SJ, D'Adamo MC, *et al*. (2000) Role of receptor protein tyrosine phosphatase alpha (RPTPalpha) and tyrosine phosphorylation in the serotonergic inhibition of voltage-dependent potassium channels. *Pflugers Arch* 441: 257-262.
145. Invernizzi RW, Pierucci M, Calcagno E, *et al*. (2007) Selective activation of 5-HT(2C) receptors stimulates GABA-ergic function in the rat substantia nigra pars reticulata: a combined in vivo electrophysiological and neurochemical study. *Neuroscience* 144: 1523-1535.
146. Iversen L, Gibbons S, Treble R, *et al*. (2013) Neurochemical profiles of some novel psychoactive substances. *Eur J Pharmacol* 700: 147-151.
147. Ji SP, Zhang Y, Van Cleemput J, *et al*. (2006) Disruption of PTEN coupling with 5-HT_{2C} receptors suppresses behavioral responses induced by drugs of abuse. *Nat Med* 12: 324-329.
148. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al*. (2014) Pilot study of the 5-HT_{2A}R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
149. Johnston J, Forsythe ID and Kopp-Scheinpflug C (2010) Going native: voltage-gated potassium channels controlling neuronal excitability. *J Physiol* 588: 3187-3200.
150. Jones DL, Mogenson GJ and Wu M (1981) Injections of dopaminergic, cholinergic, serotoninergic and GABAergic drugs into the nucleus accumbens: effects on locomotor activity in the rat. *Neuropharmacology* 20: 29-37.
151. Katsidoni V, Apazoglou K and Panagis G (2011) Role of serotonin 5-HT_{2A} and 5-HT_{2C} receptors on brain stimulation reward and the reward-facilitating effect of cocaine. *Psychopharmacology (Berl)* 213: 337-354.
152. Kleven MS and Woolverton WL (1993) Effects of three monoamine uptake inhibitors on behavior maintained by cocaine or food presentation in rhesus monkeys. *Drug Alcohol Depend* 31: 149-158.
153. Knauer CS, Campbell JE, Chio CL, *et al*. (2009) Pharmacological characterization of mitogen-activated protein kinase activation by recombinant human 5-HT_{2C}, 5-HT_{2A}, and 5-HT_{2B} receptors. *Naunyn Schmiedebergs Arch Pharmacol* 379: 461-471.
154. Kometer M, Schmidt A, Jancke L, *et al*. (2013) Activation of serotonin 2A receptors underlies the psilocybin-induced effects on alpha oscillations, N170 visual-evoked potentials, and visual hallucinations. *J Neurosci* 33: 10544-10551.
155. Kourrich S, Calu DJ and Bonci A (2015) Intrinsic plasticity: an emerging player in addiction. *Nat Rev Neurosci* 16: 173-184.
156. Kourrich S, Hayashi T, Chuang JY, *et al*. (2013) Dynamic interaction between sigma-1 receptor and Kv1.2 shapes neuronal and behavioral responses to cocaine. *Cell* 152: 236-247.
157. Kourrich S and Thomas MJ (2009) Similar neurons, opposite adaptations: psychostimulant experience differentially alters firing properties in accumbens core versus shell. *J Neurosci* 29: 12275-12283.
158. Krebs TS and Johansen PO (2012) Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
159. Kuhar MJ, McGirr KM, Hunter RG, *et al*. (1999) Studies of selected phenyltropanes at monoamine transporters. *Drug Alcohol Depend* 56: 9-15.
160. Kursar JD, Nelson DL, Wainscott DB, *et al*. (1994) Molecular cloning, functional expression, and mRNA tissue distribution of the human 5-hydroxytryptamine2B receptor. *Mol Pharmacol* 46: 227-234.
161. Lambe EK and Aghajanian GK (2001) The role of Kv1.2-containing potassium channels in serotonin-induced glutamate release from thalamocortical terminals in rat frontal cortex. *J Neurosci* 21: 9955-9963.
162. Lecca D, Cacciapaglia F, Valentini V, *et al*. (2007) Differential neurochemical and behavioral adaptation to cocaine after response contingent and noncontingent exposure in the rat. *Psychopharmacology (Berl)* 191: 653-667.
163. Lecca D, Piras G, Driscoll P, *et al*. (2004) A differential activation of dopamine output in the shell and core of the nucleus accumbens is associated with the motor responses to addictive drugs: a brain dialysis study in Roman high- and low-avoidance rats. *Neuropharmacology* 46: 688-699.
164. Leysen JE, Janssen PF and Niemegeers CJ (1989) Rapid desensitization and down-regulation of 5-HT_2 receptors by DOM treatment. *Eur J Pharmacol* 163: 145-149.
165. Lioudyno MI, Birch AM, Tanaka BS, *et al*. (2013) Shaker-related potassium channels in the central medial nucleus of the thalamus are important molecular targets for arousal suppression by volatile general anesthetics. *J Neurosci* 33: 16310-16322.
166. Liu S, Bubar MJ, Lanfranco MF, *et al*. (2007) Serotonin2C receptor localization in GABA neurons of the rat medial prefrontal cortex: implications for understanding the neurobiology of addiction. *Neuroscience* 146: 1677-1688.
167. Lobo MK, Covington HE, 3rd, Chaudhury D, *et al*. (2010) Cell type-specific loss of BDNF signaling mimics optogenetic control of cocaine reward. *Science* 330: 385-390.
168. Lopez-Gimenez JF, Mengod G, Palacios JM, *et al*. (2001) Regional distribution and cellular localization of 5-HT_{2C} receptor mRNA in monkey brain: comparison with [3H]mesulergine binding sites and choline acetyltransferase mRNA. *Synapse* 42: 12-26.
169. Lopez-Gimenez JF, Tecott LH, Palacios JM, *et al*. (2002) Serotonin 5-HT (2C) receptor knockout mice: autoradiographic

analysis of multiple serotonin receptors. *J Neurosci Res* 67: 69-85.

170. Loric S, Launay JM, Colas JF, *et al*. (1992) New mouse 5-HT$_2$-like receptor. Expression in brain, heart and intestine. *FEBS Lett* 312: 203-207.
171. Ludwig A, Levine J, Stark L, *et al*. (1969) A clinical study of LSD treatment in alcoholism. *Am J Psychiatry* 126: 59-69.
172. Maclean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
173. Majic T, Schmidt TT and Gallinat J (2015) Peak experiences and the afterglow phenomenon: when and how do therapeutic effects of hallucinogens depend on psychedelic experiences? *J Psychopharmacol* 29: 241-253.
174. Mangini M (1998) Treatment of alcoholism using psychedelic drugs: a review of the program of research. *J Psychoactive Drugs* 30: 381-418.
175. Manvich DF, Kimmel HL, Cooper DA, *et al*. (2012a) The serotonin 2C receptor antagonist SB 242084 exhibits abuse-related effects typical of stimulants in squirrel monkeys. *J Pharmacol Exp Ther* 342: 761-769.
176. Manvich DF, Kimmel HL and Howell LL (2012b) Effects of serotonin 2C receptor agonists on the behavioral and neurochemical effects of cocaine in squirrel monkeys. *J Pharmacol Exp Ther* 341: 424-434.
177. Marazziti D, Rossi A, Giannaccini G, *et al*. (1999) Distribution and characterization of [3H]mesulergine binding in human brain postmortem. *Eur Neuropsychopharmacol* 10: 21-26.
178. Marcinkiewcz CA (2015) Serotonergic systems in the pathophysiology of ethanol dependence: relevance to clinical alcoholism. *ACS Chem Neurosci* 6: 1026-1039.
179. Marquis KL, Sabb AL, Logue SF, *et al*. (2007) WAY-163909 [(7bR,10aR)-1,2,3,4,8,9,10,10a-octahydro-7bH-cyclopenta-[b][1,4] diazepino[6,7,1hi]indole]: a novel 5-hydroxytryptamine 2C receptor-selective agonist with preclinical antipsychotic-like activity. *J Pharmacol Exp Ther* 320: 486-496.
180. Marsch LA, Bickel WK, Badger GJ, *et al*. (2001) Effects of infusion rate of intravenously administered morphine on physiological, psychomotor, and self-reported measures in humans. *J Pharmacol Exp Ther* 299: 1056-1065.
181. McLean TH, Parrish JC, Braden MR, *et al*. (2006) 1-Aminomethylbenzo-cycloalkanes: conformationally restricted hallucinogenic phenethylamine analogues as functionally selective 5-HT$_{2A}$ receptor agonists. *J Med Chem* 49: 5794-5803.
182. McMahon LR and Cunningham KA (2001) Antagonism of 5-hydroxytryptamine(2a) receptors attenuates the behavioral effects of cocaine in rats. *J Pharmacol Exp Ther* 297: 357-363.
183. McMahon LR, Filip M and Cunningham KA (2001) Differential regulation of the mesoaccumbens circuit by serotonin 5-hydroxy-tryptamine (5-HT)2A and 5-HT$_{2C}$ receptors. *J Neurosci* 21: 7781-7787.
184. Meredith GE (1999) The synaptic framework for chemical signaling in nucleus accumbens. *Ann N Y Acad Sci* 877: 140-156.
185. Meyer JS (2013) 3,4-methylenedioxymethamphetamine (MDMA): current perspectives. *Subst Abuse Rehabil* 4: 83-99.
186. Mijnster MJ, Raimundo AG, Koskuba K, *et al*. (1997) Regional and cellular distribution of serotonin 5-hydroxytryptamine2a receptor mRNA in the nucleus accumbens, olfactory tubercle, and caudate putamen of the rat. *J Comp Neurol* 389: 1-11.
187. Mu P, Moyer JT, Ishikawa M, *et al*. (2010) Exposure to cocaine dynamically regulates the intrinsic membrane excitability of nucleus accumbens neurons. *J Neurosci* 30: 3689-3699.
188. Muller CP and Homberg JR (2015) The role of serotonin in drug use and addiction. *Behav Brain Res* 277: 146-192.
189. Murnane KS, Andersen ML, Rice KC, *et al*. (2013a) Selective serotonin 2A receptor antagonism attenuates the effects of amphetamine on arousal and dopamine overflow in non-human primates. *J Sleep Res* 22: 581-588.
190. Murnane KS and Howell LL (2011) Neuroimaging and drug taking in primates. *Psychopharmacology (Berl)* 216: 153-171.
191. Murnane KS, Winschel J, Schmidt KT, *et al*. (2013b) Serotonin 2A receptors differentially contribute to abuse-related effects of cocaine and cocaine-induced nigrostriatal and mesolimbic dopamine overflow in nonhuman primates. *J Neurosci* 33: 13367-13374.
192. Navailles S, Moison D, Cunningham KA, *et al*. (2008) Differential regulation of the mesoaccumbens dopamine circuit by serotonin2C receptors in the ventral tegmental area and the nucleus accumbens: an in vivo microdialysis study with cocaine. *Neuropsychopharmacology* 33: 237-246.
193. Navailles S, Moison D, Ryczko D, *et al*. (2006) Region-dependent regulation of mesoaccumbens dopamine neurons in vivo by the constitutive activity of central serotonin2C receptors. *J Neurochem* 99: 1311-1319.
194. Nedergaard S, Bolam JP and Greenfield SA (1988) Facilitation of a dendritic calcium conductance by 5-hydroxytryptamine in the substantia nigra. *Nature* 333: 174-177.
195. Neisewander JL and Acosta JI (2007) Stimulation of 5-HT$_{2C}$ receptors attenuates cue and cocaine-primed reinstatement of cocaine-seeking behavior in rats. *Behav Pharmacol* 18: 791-800.
196. Nelson RA, Boyd SJ, Ziegelstein RC, *et al*. (2006) Effect of rate of administration on subjective and physiological effects of intravenous cocaine in humans. *Drug Alcohol Depend* 82: 19-24.
197. Nic Dhonnchadha BA, Fox RG, Stutz SJ, *et al*. (2009) Blockade of the serotonin 5-HT$_{2A}$ receptor suppresses cue-evoked reinstatement of cocaine-seeking behavior in a rat self-administration model. *Behav Neurosci* 123: 382-396.
198. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101: 131-181.
199. Nichols DE, Frescas SP, Chemel BR, *et al*. (2008) High specific activity tritium-labeled N-(2-methoxybenzyl)-2,5-dimethoxy-4-iodophenethylamine (INBMeO): a high-affinity 5-HT$_{2A}$ receptor-selective agonist radioligand. *Bioorg Med Chem* 16: 6116-6123.
200. Nichols DE, Sassano MF, Halberstadt AL, *et al*. (2015) N-Benzyl-5-methoxytryptamines as potent serotonin 5-HT$_2$ receptor family agonists and comparison with a series of phenethylamine analogues. *ACS Chem Neurosci* 6: 1165-1175.
201. Nocjar C, Alex KD, Sonneborn A, *et al*. (2015) Serotonin-2C and -2a receptor co-expression on cells in the rat medial prefrontal cortex. *Neuroscience* 297: 22-37.
202. Nutt DJ, King LA, Phillips LD, *et al*. (2010) Drug harms in the UK: a multicriteria decision analysis. *Lancet* 376: 1558-1565.
203. Olaghere da, Silva UB, Morabito MV, Canal CE, *et al*. (2010) Impact of RNA editing on functions of the serotonin 2C receptor in vivo. *Front Neurosci* 4: 26.
204. Orejarena MJ, Lanfumey L, Maldonado R, *et al*. (2011) Involvement of 5-HT$_{2A}$ receptors in MDMA reinforcement and cue-induced reinstatement of MDMA-seeking behaviour. *Int J Neuropsychopharmacol* 14: 927-940.
205. Pacheco-Cano MT, Bargas J, Hernandez-Lopez S, *et al*. (1996) Inhibitory action of dopamine involves a subthreshold Cs(+)-

sensitive conductance in neostriatal neurons. *Exp Brain Res* 110: 205-211.

206. Pahnke WN, Kurland AA, Unger S, *et al*. (1970) The experimental use of psychedelic (LSD) psychotherapy. *JAMA* 212: 1856-1863.
207. Parent A, Descarries L and Beaudet A (1981) Organization of ascending serotonin systems in the adult rat brain. A radioautographic study after intraventricular administration of [3H]5-hydroxytryptamine. *Neuroscience* 6: 115-138.
208. Pascoli V, Terrier J, Hiver A, *et al*. (2015) Sufficiency of mesolimbic dopamine neuron stimulation for the progression to addiction. *Neuron* 88: 1054-1066.
209. Pehek EA, Nocjar C, Roth BL, *et al*. (2006) Evidence for the preferential involvement of 5-HT$_{2A}$ serotonin receptors in stress- and drug-induced dopamine release in the rat medial prefrontal cortex. *Neuropsychopharmacology* 31: 265-277.
210. Pisanu A, Lecca D, Valentini V, *et al*. (2015) Impairment of acquisition of intravenous cocaine self-administration by RNA-interference of dopamine D1-receptors in the nucleus accumbens shell. *Neuropharmacology* 89: 398-411.
211. Pontieri FE, Tanda G and Di Chiara G (1995) Intravenous cocaine, morphine, and amphetamine preferentially increase extracellular dopamine in the "shell" as compared with the "core" of the rat nucleus accumbens. *Proc Natl Acad Sci U S A* 92: 12304-12308.
212. Porras G, Di Matteo V, Fracasso C, *et al*. (2002) 5-HT$_{2A}$ and 5-HT$_{2C}$/2B receptor subtypes modulate dopamine release induced in vivo by amphetamine and morphine in both the rat nucleus accumbens and striatum. *Neuropsychopharmacology* 26: 311-324.
213. Porter RH, Benwell KR, Lamb H, *et al*. (1999) Functional characterization of agonists at recombinant human 5-HT$_{2A}$, 5-HT$_{2B}$ and 5-HT$_{2C}$ receptors in CHO-K1 cells. *Br J Pharmacol* 128: 13-20.
214. Quarta D, Naylor CG and Stolerman IP (2007) The serotonin 2C receptor agonist Ro-60-0175 attenuates effects of nicotine in the five-choice serial reaction time task and in drug discrimination. *Psychopharmacology (Berl)* 193: 391-402.
215. Ramirez-Navarro A, Glazebrook PA, Kane-Sutton M, *et al*. (2011) Kv1.3 channels regulate synaptic transmission in the nucleus of solitary tract. *J Neurophysiol* 105: 2772-2780.
216. Ray TS (2010) Psychedelics and the human receptorome. *PLoS One* 5: e9019.
217. Richardson NR and Roberts DC (1991) Fluoxetine pretreatment reduces breaking points on a progressive ratio schedule reinforced by intravenous cocaine self-administration in the rat. *Life Sci* 49: 833-840.
218. Riedlinger TJ and Riedlinger JE (1994) Psychedelic and entactogenic drugs in the treatment of depression. *J Psychoactive Drugs* 26: 41-55.
219. Ritz MC, Boja JW, George FR, *et al*. (1989) Cocaine binding sites related to drug self-administration. *NIDA Res Monogr* 95: 239-246.
220. Ritz MC and Kuhar MJ (1989) Relationship between self-administration of amphetamine and monoamine receptors in brain: comparison with cocaine. *J Pharmacol Exp Ther* 248: 1010-1017.
221. Robbins CA and Tempel BL (2012) Kv1.1 and Kv1.2: similar channels, different seizure models. *Epilepsia* 53 Suppl 1: 134-141.
222. Roberts DC, Morgan D and Liu Y (2007) How to make a rat addicted to cocaine. *Prog Neuropsychopharmacol Biol Psychiatry* 31: 1614-1624.
223. Robertson B (1997) The real life of voltage-gated K+ channels: more than model behaviour. *Trends Pharmacol Sci* 18: 474-483.
224. Robison AJ and Nestler EJ (2011) Transcriptional and epigenetic mechanisms of addiction. *Nat Rev Neurosci* 12: 623-637.
225. Rocha BA, Goulding EH, O'Dell LE, *et al*. (2002) Enhanced locomotor, reinforcing, and neurochemical effects of cocaine in serotonin 5-hydroxytryptamine 2C receptor mutant mice. *J Neurosci* 22: 10039-10045.
226. Rodd-Henricks ZA, McKinzie DL, Li TK, *et al*. (2002) Cocaine is self-administered into the shell but not the core of the nucleus accumbens of Wistar rats. *J Pharmacol Exp Ther* 303: 1216-1226.
227. Roth BL (2007) Drugs and valvular heart disease. *New Engl J Med* 356: 6-9.
228. Roth BL, Lopez E, Patel S, *et al*. (2000) The multiplicity of serotonin receptors: uselessly diverse molecules or an embarrassment of riches? *Neuroscientist* 6: 252-262.
229. Rothman RB and Baumann MH (2009) Serotonergic drugs and valvular heart disease. *Expert Opin Drug Saf* 8: 317-329.
230. Rothman RB, Blough BE, Woolverton WL, *et al*. (2005) Development of a rationally designed, low abuse potential, biogenic amine releaser that suppresses cocaine self-administration. *J Pharmacol Exp Ther* 313: 1361-1369.
231. Ruedi-Bettschen D, Spealman RD and Platt DM (2015) Attenuation of cocaine-induced reinstatement of drug seeking in squirrel monkeys by direct and indirect activation of 5-HT$_{2C}$ receptors. *Psychopharmacology (Berl)* 232: 2959-2968.
232. Russo SJ and Nestler EJ (2013) The brain reward circuitry in mood disorders. *Nat Rev Neurosci* 14: 609-625.
233. Saddoris MP, Sugam JA, Cacciapaglia F, *et al*. (2013) Rapid dopamine dynamics in the accumbens core and shell: learning and action. *Front Biosci (Elite Ed)* 5: 273-288.
234. Sanders-Bush E, Fentress H and Hazelwood L (2003) Serotonin 5-ht2 receptors: molecular and genomic diversity. *Mol Interv* 3: 319-330.
235. Santana N and Artigas F (2016) Expression of serotonin2C receptors in pyramidal and GABAergic neurons of rat prefrontal cortex: a comparison with striatum. *Cereb Cortex*. Epub ahead of print 1 June 2016.
236. Sawyer EK, Mun J, Nye JA, *et al*. (2012) Neurobiological changes mediating the effects of chronic fluoxetine on cocaine use. *Neuropsychopharmacology* 37: 1816-1824.
237. Sellings LH and Clarke PB (2003) Segregation of amphetamine reward and locomotor stimulation between nucleus accumbens medial shell and core. *J Neurosci* 23: 6295-6303.
238. Sesack SR and Grace AA (2010) Cortico-basal ganglia reward network: microcircuitry. *Neuropsychopharmacology* 35: 27-47.
239. Shah NH and Aizenman E (2014) Voltage-gated potassium channels at the crossroads of neuronal function, ischemic tolerance, and neurodegeneration. *Transl Stroke Res* 5: 38-58.
240. Shulgin A and Shulgin A (1991) *PIHKAL: A Chemical Love Story*. Berkeley, CA: Transform Press.
241. Shulgin A and Shulgin A (1997) *TIHKAL: The Continuation*. Berkeley, CA: Transform Press, p.804.
242. Shulgin AT, Manning T and Daley PF (2011) *The Shulgin Index: Volume One*. Berkeley, CA: Transform Press.
243. Siegel RK and Jarvik ME (1980) DMT self-administration by monkey in isolation. *Bull Psychon Soc* 16: 117-120.

244. Simeone TA, Simeone KA, Samson KK, *et al*. (2013) Loss of the Kv1.1 potassium channel promotes pathologic sharp waves and high frequency oscillations in in vitro hippocampal slices. *Neurobiol Dis* 54: 68-81.
245. Smart RG, Storm T, Baker EF, *et al*. (1966) A controlled study of lysergide in the treatment of alcoholism. 1. The effects on drinking behavior. *Q J Stud Alcohol* 27: 469-482.
246. Smith DA, Bailey JM, Williams D, *et al*. (2014) Tolerance and cross-tolerance to head twitch behavior elicited by phenethylamine- and tryptamine-derived hallucinogens in mice. *J Pharmacol Exp Ther* 351: 485-491.
247. Speake T, Kibble JD and Brown PD (2004) Kv1.1 and Kv1.3 channels contribute to the delayed-rectifying K+ conductance in rat choroid plexus epithelial cells. *Am J Physiol Cell Physiol* 286: C611-620.
248. Spealman RD (1993) Modification of behavioral effects of cocaine by selective serotonin and dopamine uptake inhibitors in squirrel monkeys. *Psychopharmacology (Berl)* 112: 93-99.
249. Stamets P (1996) *Psilocybin Mushrooms of the World: An Identification Guide*. Berkeley, CA: Ten Speed Press.
250. Stone AL, Storr CL and Anthony JC (2006) Evidence for a hallucinogen dependence syndrome developing soon after onset of hallucinogen use during adolescence. *Int J Methods Psychiatr Res* 15: 116-130.
251. Strassman RJ (1996) Human psychopharmacology of *N,N*-dimethyl-tryptamine. *Behav Brain Res* 73: 121-124.
252. Strassman RJ and Qualls CR (1994) Dose-response study of *N,N*-dimethyltryptamine in humans: I. neuroendocrine, autonomic, and cardiovascular effects. *Arch Gen Psychiatry* 51: 85-97.
253. Strassman RJ, Qualls CR and Berg LM (1996) Differential tolerance to biological and subjective effects of four closely spaced doses of *N,N*-dimethyltryptamine in humans. *Biol Psychiatry* 39: 784-795.
254. Studerus E, Gamma A, Kometer M, *et al*. (2012) Prediction of psilocybin response in healthy volunteers. *PLoS One* 7: e30800.
255. Tibbs GR, Dolly JO and Nicholls DG (1996) Evidence for the induction of repetitive action potentials in synaptosomes by K+-channel inhibitors: an analysis of plasma membrane ion fluxes. *J Neurochem* 67: 389-397.
256. Tomsovic M and Edwards RV (1970) Lysergide treatment of schizophrenic and nonschizophrenic alcoholics: a controlled evaluation. *Q J Stud Alcohol* 31: 932-949.
257. Van Bockstaele EJ and Pickel VM (1993) Ultrastructure of serotonin-immunoreactive terminals in the core and shell of the rat nucleus accumbens: cellular substrates for interactions with catecholamine afferents. *J Comp Neurol* 334: 603-617.
258. Volkow ND, Wang GJ, Fischman MW, *et al*. (2000) Effects of route of administration on cocaine induced dopamine transporter blockade in the human brain. *Life Sci* 67: 1507-1515.
259. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, *et al*. (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9: 3897-3902.
260. Wacker D, Wang C, Katritch V, *et al*. (2013) Structural Features for Functional Selectivity at Serotonin Receptors. *Science* 340: 615-619.
261. Wang H, Kunkel DD, Schwartzkroin PA, *et al*. (1994) Localization of Kv1.1 and Kv1.2, two K channel proteins, to synaptic terminals, somata, and dendrites in the mouse brain. *J Neurosci* 14: 4588-4599.
262. Wee S, Anderson KG, Baumann MH, *et al*. (2005) Relationship between the serotonergic activity and reinforcing effects of a series of amphetamine analogs. *J Pharmacol Exp Ther* 313: 848-854.
263. Winter JC, Rice KC, Amorosi DJ, *et al*. (2007) Psilocybin-induced stimulus control in the rat. *Pharmacol Biochem Behav* 87: 472-480.
264. Woolverton WL and Wang Z (2004) Relationship between injection duration, transporter occupancy and reinforcing strength of cocaine. *Eur J Pharmacol* 486: 251-257.
265. Xu P, He Y, Cao X, *et al*. (2016) Activation of serotonin 2C receptors in dopamine neurons inhibits binge-like eating in mice. *Biol Psychiatry*. Epub ahead of print 9 June 2016. DOI: 10.1016/j.biopsych.2016.06.005.
266. Yan QS (2000) Activation of 5-HT$_{2A}$/2C receptors within the nucleus accumbens increases local dopaminergic transmission. *Brain Res Bull* 51: 75-81.
267. Yanagita T (1986) Intravenous self-administration of (-)-cathinone and 2-amino-1-(2,5-dimethoxy-4-methyl)phenylpropane in rhesus monkeys. *Drug Alcohol Depend* 17: 135-141.
268. You I-J, Wright SR, Garcia-Garcia AL, *et al*. (2016) 5-HT$_{1A}$ autoreceptors in the dorsal raphe nucleus convey vulnerability to compulsive cocaine seeking. *Neuropsychopharmacology* 41: 1210-1222.
269. Zaniewska M, McCreary AC, Przegalinski E, *et al*. (2007) Effects of the serotonin 5-HT$_{2A}$ and 5-HT$_{2C}$ receptor ligands on the discriminative stimulus effects of nicotine in rats. *Eur J Pharmacol* 571: 156-165.
270. Zhang XF, Cooper DC and White FJ (2002) Repeated cocaine treatment decreases whole-cell calcium current in rat nucleus accumbens neurons. *J Pharmacol Exp Ther* 301: 1119-1125.

REBUS and the Anarchic Brain - Toward a Unified Model of the Brain Action of Psychedelics

by

R. L. Carhart-Harris and K. J. Friston

Associate editor: Eric L. Barker
Pharmacol Rev 71:316-344, July 2019
https://doi.org/10.1124/pr.118.017160

This is an open access article distributed under the CC BY Attribution 4.0 International license

© 2019 The Author(s)

original report: http://pharmrev.aspetjournals.org/content/pharmrev/71/3/316.full.pdf
backup source: https://www.psilosophy.info/resources/316.full.pdf

Centre for Psychedelic Research, Division of Brain Sciences, Imperial College London, London, United Kingdom (R.L.C.-H.); and Institute of Neurology, Wellcome Trust Centre for Neuroimaging, University College London, London, United Kingdom (K.J.F.)

Address correspondence to: Dr. R. L. Carhart-Harris, Centre for Psychedelic Research, Department of Brain Sciences, Imperial College London, United Kingdom. E-mail: r.carhart-harris@imperial.ac.uk

R.L.C.-H. is supported by the Ad Astra Chandaria Foundation, the Singhal Health Foundation, Tim Ferriss, Anton Bilton, the Tamas family, and the Alex Mosley Trust. K.J.F. is supported by the Wellcome Trust.

The authors declare no conflicts of interest.

Table of Contents:

Abstract
Significance Statement
I. Introduction
II. The REBUS Model
- A. The Basic Neuropharmacology of Psychedelics
  - *1. Interim Summary*
- B. Rhythms, Networks, and the Relaxation of High-Level Priors
  - *1. Interim Summary*
- C. Plasticity and the Dissolution of (High-Level) Priors under Psychedelics
- D. Behavioral Evidence of Relaxed Priors under Psychedelics
- E. Comparisons with Other Altered States and Traits
  - *1. Psychosis*
  - *2. Hallucinogen-Persisting Perceptual Disorder*
  - *3. Autism*
  - *4. Other Disorders*
  - *5. Meditative States*
- F. Psychedelics and Insight
  - *1. Introduction*
  - *2. The Mechanics of Insight*
  - *3. Criticality and Optimality*
  - *4. Therapeutic and Epistemic Transformation*
  - *5. Are Psychedelic-Induced Insights Trustworthy?*
- G. What to Do About the "woo"?[29]
- H. The Anarchic Brain
- I. Summary

III. Conclusions
Acknowledgments

Authorship Contributions
References

Abstract

This paper formulates the action of psychedelics by integrating the free-energy principle and entropic brain hypothesis. We call this formulation relaxed beliefs under psychedelics (REBUS) and the anarchic brain, founded on the principle that - via their entropic effect on spontaneous cortical activity - psychedelics work to relax the precision of high-level priors or beliefs, thereby liberating bottom-up information flow, particularly via intrinsic sources such as the limbic system. We assemble evidence for this model and show how it can explain a broad range of phenomena associated with the psychedelic experience. With regard to their potential therapeutic use, we propose that psychedelics work to relax the precision weighting of pathologically overweighted priors underpinning various expressions of mental illness. We propose that this process entails an increased sensitization of high-level priors to bottom-up signaling (stemming from intrinsic sources), and that this heightened sensitivity enables the potential revision and deweighting of overweighted priors. We end by discussing further implications of the model, such as that psychedelics can bring about the revision of other heavily weighted high-level priors, not directly related to mental health, such as those underlying partisan and/or overly-confident political, religious, and/or philosophical perspectives.

Significance Statement

Psychedelics are capturing interest, with efforts underway to bring psilocybin therapy to marketing authorisation and legal access within a decade, spearheaded by the findings of a series of phase 2 trials. In this climate, a compelling unified model of *how* psychedelics alter brain function to alter consciousness would have appeal. Towards this end, we have sought to integrate a leading model of global brain function, *hierarchical predictive coding*, with an often-cited model of the acute action of psychedelics, *the entropic brain hypothesis*. The resulting synthesis states that psychedelics work to relax high-level priors, sensitising them to liberated bottom-up information flow, which, with the right intention, care provision and context, can help guide and cultivate the revision of entrenched pathological priors.

ABBREVIATIONS: 5-HT_{2A}R, serotonin 2A receptor; BMR, Bayesian model reduction; BMS, Bayesian model selection; DMN, default-mode network; EEG, electroencephalogram; HPPD, hallucinogen-persisting perceptual disorder; LSD, d-lysergic acid diethylamide; MDMA, *3,4-methylenedioxy-methamphetamine*; MEG, magnetoencephalography; REBUS, relaxed beliefs under psychedelics.

I. Introduction

Psychedelic (mind-manifesting) drugs such as d-lysergic acid diethylamide (LSD) and psilocybin are capturing people's imagination and permeating popular culture on a scale not seen since the 1960s (Hanks, 2010; Keshavan and Sudarshan, 2017; Bayne and Carter, 2018; Pollan, 2018). For those involved in research with these compounds, it seems likely that they will influence psychology and psychiatry in a major way in the coming decades - but there is still much that is uncertain. In the present climate of rapid development, a compelling unified model of the brain mechanisms of psychedelics would hold significant value.

In this work, we propose such a unifying model. We call this relaxed beliefs under psychedelics (REBUS)[1] and the anarchic brain or "REBUS" for short. The model takes inspiration from two formulations of brain function, namely: 1) the free-energy principle[2] (Friston, 2010) and 2) the entropic brain hypothesis[3] (Carhart-Harris, 2018a). The free-energy principle furnishes a unified description of the behavior of autopoietic or living (i.e., self-producing and maintaining) systems - that explains their development, processing, and behavior based on their inherent tendency to resist disorder and minimize uncertainty. This description of (self-evidencing) systems appeals to their inherent drive to optimize internal probabilistic representations - and sampling - of their environments (Friston, 2010). Hierarchical predictive coding forms a major part of the free-energy principle and, thus, the REBUS model also (see Fig. 1 and also the Supplemental Glossary for disambiguation of terms).

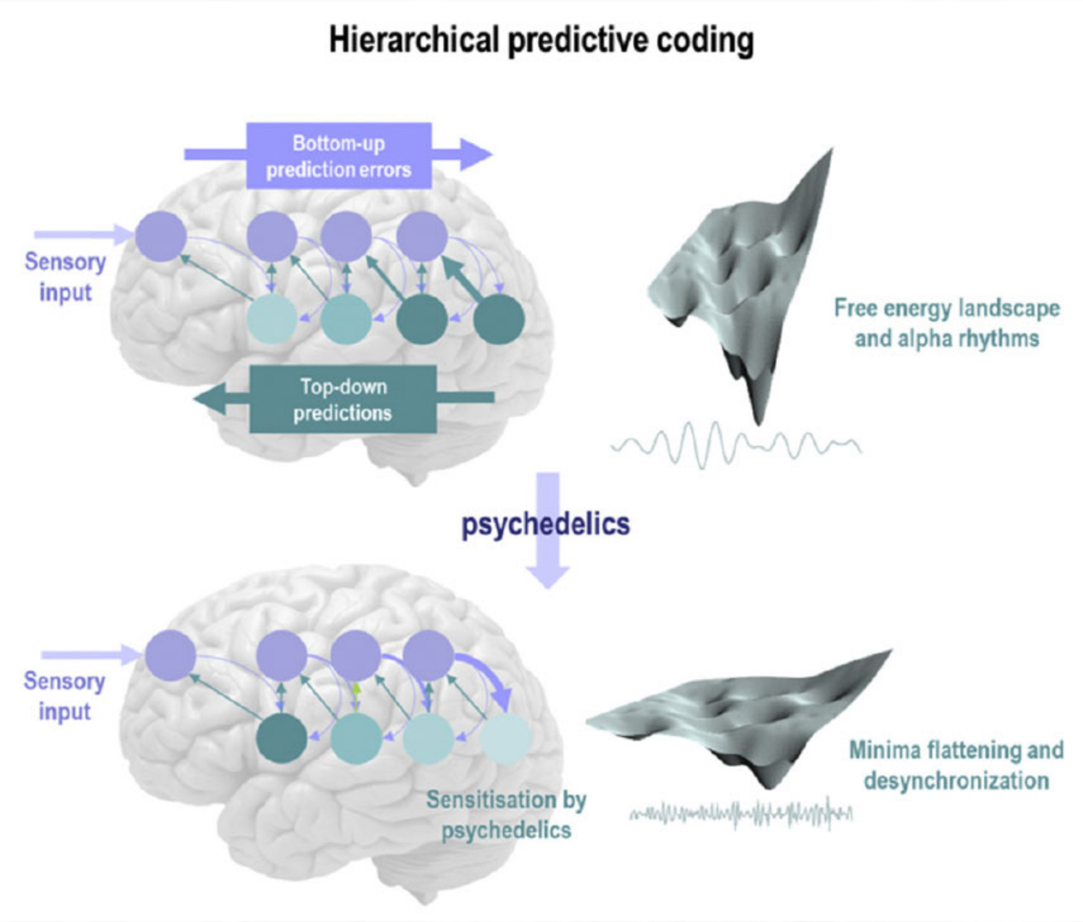

Hierarchical predictive coding
Bottom-up prediction errors
Sensory input
Top-down predictions
Free energy landscape and alpha rhythms
psychedelics
Sensory input
Sensitisation by psychedelics
Minima flattening and desynchronization

Fig. 1. This schematic illustrates the proposed effects of psychedelics on hierarchical predictive coding, a predominant process theory for Bayesian inference and variational free-energy minimization in the brain. Under these computational architectures, sensory input arrives at the sensory epithelia and is compared with descending predictions. The ensuing prediction error (blue circles; e.g., neuronal populations of superficial pyramidal cells) is then passed forward into hierarchies, to update expectations at higher levels (blue arrows). These posterior expectations (teal circles; e.g., deep pyramidal cells) then generate predictions of the representations in lower levels, via descending predictions (teal arrows). The recurrent neuronal message passing (i.e., neuronal dynamics) tries to minimize the amplitude of prediction errors at each and every level of the hierarchy, thereby furnishing the best explanation for sensory input at multiple levels of hierarchal abstraction. Crucially, this process depends upon the precision (ascribed importance or salience) afforded to the ascending prediction errors (surprise) and the precision (felt confidence) of posterior beliefs. The basic idea - pursued in this article - is that psychedelics act preferentially via stimulating 5-HT_{2A}Rs on deep pyramidal cells within the visual cortex as well as at higher levels of the cortical hierarchy. Deep-layer pyramidal neurons are thought to encode posterior expectations, priors, or beliefs. The resulting disinhibition or sensitization of these units lightens to precision of higher-level expectations so that (by implication of the model) they are more sensitive to ascending prediction errors (surprise/ascending information), as indicated by the thick blue arrow in the lower panel. Computationally, this process corresponds to reducing the precision of higher-level prior beliefs and an implicit reduction in the curvature of the free-energy landscape that contains neuronal dynamics. Effectively, this can be thought of as a flattening of local minima, enabling neuronal dynamics to escape their basins of attraction and - when in flat minima - express long-range correlations and desynchronized activity. This schematic uses the format in Bastos *et al*. (2012), to which the reader is referred for details.

The entropic brain hypothesis proposes that within upper and lower bounds, i.e., a critical zone (Hilgetag and Hutt, 2014), the entropy of spontaneous brain activity indexes the richness (i.e., the diversity and vividness) of subjective experience, within any given state of consciousness, and that psychedelics acutely increase both (Carhart-Harris *et al*., 2014; Carhart-Harris, 2018a). Crucially, both the free-energy and entropic brain formulations rest on quantifiable measures from information theory that are apt for empirical study.

The entropic brain hypothesis and free-energy principle are inter-related, not least because of their shared appeal to information theoretical metrics, closely linked to classic (Shannon) entropy. In its most basic information-theoretical form, entropy is a dimensionless measure of uncertainty about a dynamical phenomenon (Ben-Naim, 2007). The entropic brain measures the uncertainty of neuronal fluctuations across time, whereas free-energy measures the uncertainty of beliefs encoded by neuronal fluctuations. The entropic brain hypothesis proposes that a principal action of psychedelics is to increase the entropy of spontaneous brain activity, and that such effects are mirrored at the subjective level by an increase in the richness of conscious experience, assuming that the brain and mind are flip sides of the same coin, i.e., a position commensurate with so-called "dual aspect monism" (Solms and Turnbull, 2003).

The entropic brain hypothesis began as a largely conceptual offering (Carhart-Harris *et al*., 2014) but has since been substantiated by a number of empirical neuroimaging studies and quantitative analyses (Carhart-Harris, 2018a). It is intended that the neurobiological evidence base for the entropic brain hypothesis be supplemented by concomitant measures of subjective and behavioral complexity/entropy - as have been applied in the context of development and ageing (Gauvrit *et al*., 2017) and natural language (Hoffman *et al*., 2013). Thus, the entropic mind and behavior are natural extensions of the entropic brain hypothesis.

In this study, we integrate the entropic brain hypothesis and the free-energy principle framework, and in particular, exploit the latter's close links with predictive processing or coding and the so-called Bayesian brain hypothesis. Put simply, these closely related perspectives on brain and mind function maintain that the brain instantiates, within its hierarchical architecture, best-guess statistical approximations (generative models) of the causes of its sensorium based on Bayesian principles of empirically informed belief updating (Rao and Ballard, 1999). Predictive coding is a neuronally plausible theory for this belief updating - and has been used to account for a vast range of subjective and behavioral phenomena: from perceptual illusions in healthy individuals (Zeller *et al*., 2015) to a broad number of psychopathological states and disorders (Fletcher and Frith, 2009; Edwards *et al*., 2012). In fact, it is reasonable to say that hierarchical predictive coding now represents the predominant neurobiological and computational framework for describing psychological phenomena in health and disease.

The present work proposes that a principal action of classic psychedelics is to relax the precision weighting[4] of prior beliefs encoded in the spontaneous activity of neuronal hierarchies. Statistically, precision is equivalent to inverse variance (i.e., negative entropy), and, subjectively and intuitively, it can be regarded as commensurate with felt confidence, i.e., the closer data are to a given model, the smaller will be our errors of prediction and thus, the stronger will be our felt confidence in our model. More specifically, this study proposes that the effect of this relaxation process is felt most profoundly when it occurs at the highest or deepest level of the brain's functional architecture, i.e., the levels that instantiate particularly high-level models such as those related to self-hood, identity, or ego. Moreover, as outlined below, due to the distinct pharmacology of psychedelics - effects at high or deep levels of the brain's functional hierarchy happen quite readily (perhaps definitively so) with this category of drug, particularly at high doses (Milliere, 2017).

Functionally, the effect of relaxing the precision weighting of high-level priors is to create a state in which these priors are imbued with less confidence. As just touched on, an important example of a high-level prior is the belief that one has a particular personality and set of characteristics and views. This (umbrella) belief is commensurate with the narrative self (Milliere, 2017) or ego (Carhart-Harris and Friston, 2010). It is proposed in this work that dissolving high-level priors has implications for the functioning of the rest of the hierarchy - and indeed the integrity of the hierarchy itself. More specifically, we propose that the general (entropic) action of psychedelics is to render the brain/mind's (variational free) energy landscape flattened or opened up. It follows from hierarchical predictive coding that precise high-level priors or beliefs ordinarily have an important constraining influence on the rest of the hierarchy, canalizing lower components and inhibiting their expression and influence.

A corollary of relaxing high-level priors or beliefs under psychedelics is that ascending prediction errors from lower levels of the system (that are ordinarily unable to update beliefs due to the top-down suppressive influence of heavily-weighted priors) can find freer register in conscious experience, by reaching and impressing on higher levels of the hierarchy. In this work, we propose that this straightforward model can account for the full breadth of subjective phenomena associated with the psychedelic experience, including the following: ego dissolution (Nour *et al*., 2016; Milliere, 2017), the unitive and largely synonymous peak experience (Roseman *et al*., 2018b), near-death-like experiences (Timmermann *et al*., 2018), a sense of anxiety and uncertainty (Carhart-Harris *et al*., 2014), heightened suggestibility (Carhart-Harris *et al*., 2015), sensitivity to context (Carhart-Harris *et al*., 2018c), emotional lability (Carhart-Harris *et al*., 2016b), insight (Carbonaro *et al*., 2018), paranoid and delusional thinking (Carhart-Harris *et al*., 2016b), psychological age regression and vivid autobiographical recollection (Grof, 1979), recourse to magical thinking (Carhart-Harris *et al*., 2014), altered time perception (Wackermann *et al*., 2008), a sense of the ineffable (Pollan, 2018), entity encounters and sensed presence (Timmermann *et al*., 2018), eyesclosed dreamlike visions (de Araujo *et al*., 2012), geometric hallucinations (Bressloff *et al*., 2002), and more.

The hypothesized flattening of the brain's (variational free) energy landscape[5] under psychedelics can be seen as analogous to the phenomenon of simulated annealing in computer science - which itself is analogous to annealing in metallurgy, whereby a system is heated (i.e., instantiated by increased neural excitability), such that it attains a state of heightened plasticity, in which the discovery of new energy minima (relatively stable places/trajectories for the system to visit/reside in for a period of time) is accelerated (Wang and Smith, 1998). Subsequently, as the drug is metabolized and the system cools, its dynamics begin to stabilize - and attractor basins begin to steepen again (Carhart-Harris *et al.*, 2017). This process may result in the emergence of a new energy landscape with revised properties (Fig. 1).

Within the transient hot state of a psychedelic experience, a flattened landscape implies that attracting brain states (and accompanying mind states) encoding beliefs are less stable and influential, implying that interstate transitions can occur more freely. Thus, rather than the mind and brain being constrained to a small number of gravitationally dominant attractors (i.e., states or sequence of states), the mind and brain spontaneously transition between states with greater freedom - and in a less predictable way. These altered dynamics may be felt as an enriched or broadened global state of consciousness - and a sense of the mind opening up (Atasoy *et al.*, 2017). Equally, however, they may be felt as aversive and disconcerting (Carhart-Harris *et al.*, 2016b), especially given that small perturbations to the system can have large repercussions in such a flattened energy landscape, e.g., see the related themes of context sensitivity (Carhart-Harris *et al.*, 2018c) and critical slowing (Cocchi *et al.*, 2017); see Fig. 2.

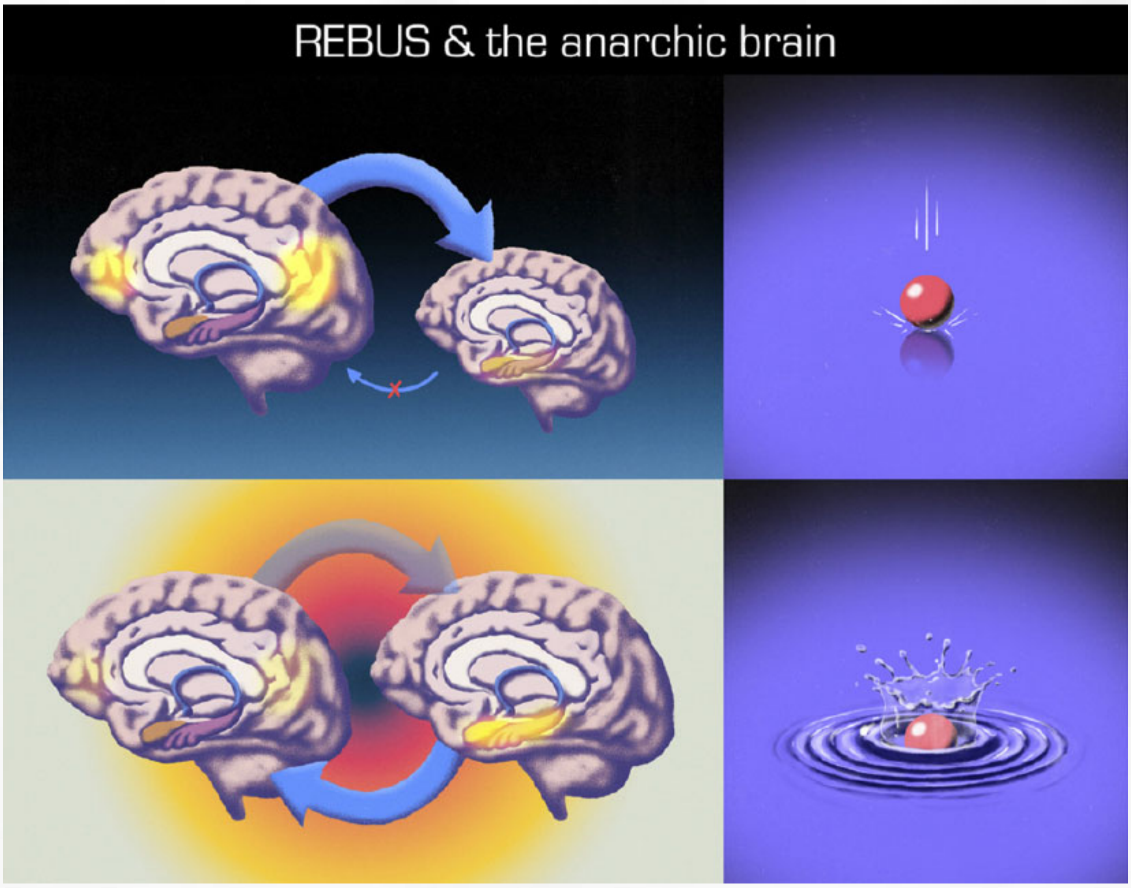


Fig. 2. These schematics depict: on the top row, brain organization in psychopathologies such as depression in which high-level priors (e.g., instantiated by the DMN) are overweighted (thick top-down arrow), causing a suppression of and insensitivity to bottom-up signaling (e.g., stemming from the limbic system). In this figure, we show compromised bottom-up signaling via a thin arrow with a red cross over its center. The graphic on the top right depicts a pathologically rigid or frozen system, insensitive to perturbation, represented in this figure as a heavy ball dropped on a solid surface having a minimal effect on the system, i.e., the ball lands with an uneventful thud. The bottom row depicts brain organization under a psychedelic. In this figure, the top-down arrow has been made translucent to reflect a deweighting or relaxation of high-level priors or beliefs (this component of the model is referred to by the acronym REBUS). The effect of this deweighting is to enable bottom-up information intrinsic to the system, to travel up the hierarchy with greater latitude and compass. We refer to this component of the model as the anarchic brain. That the two brains on the bottom row are on the same level and of the same size is intended to reflect a generalized decrease in hierarchical constraints under the psychedelic. The graphic on the bottom right represents a phenomenon known as critical slowing, i.e., systems at criticality display maximal sensitivity to perturbation. In this figure, one can see ripples appearing after a heavy ball is dropped into a liquid surface, reflecting how, in this particular system, and unlike its frozen counterpart above, there will be a slow recovery to the same perturbation. Illustrations by Pedro Oliveira, courtesy of Favo Studio.

Under psychedelics, one can view global brain function as entering a mode or state that: 1) features a lightening or relaxation of the precision weighting on priors and 2) allows for a (potentially enduring) revision of such priors, via the release of prediction error that impacts on the sensitized priors. Empirically,[6] findings of an enriched repertoire of connectivity motifs (Tagliazucchi *et al.*, 2014) and connectome harmonics under psychedelics (Atasoy *et al.*, 2017) may be seen as consistent with the notion of a flattened energy landscape under these drugs. We also go further to speculate that the influence of previously dominant attractors - including those that may be pathologic - perhaps erected in response to trauma-related uncertainty or ambiguity, whether acute or chronic (Carhart-Harris, 2019), may be relaxed in an enduring way after successful psychedelic therapy, potentially accounting for the so-called afterglow period (Majic *et al.*, 2015) and beyond.

In brief, our proposal is that psychedelics disrupt functioning at a level of the system (sensitivity of deep-layer pyramidal neurons, power of low-frequency rhythms, and integrity of large-scale networks) that encodes the precision of priors, beliefs, or assumptions. At low doses, subjective effects may be felt most tangibly at the perceptual level and particularly within the visual domain [serotonin 2A receptor (5-HT_{2A}Rs) are richly expressed within the visual cortex], but at higher doses, effects will become more profound as the functioning of higher levels of the global hierarchy become significantly disrupted, potentially accounting for phenomena such as the dissolution of ego boundaries[7] and potential (long-term) revision of high-level priors, perspectives, or beliefs.

Mechanisms of simulated annealing, the destruction of sharp minima, and Bayesian model reduction (BMR) can be raised in this work (and in more detail later on) to account for the rapid, marked, and enduring belief changes that can be seen after (high-dose) psychedelic experience (Friston *et al.*, 2017; Lyons and Carhart-Harris, 2018a) - and upon which the growing evidence for psychedelic therapy is based (Carhart-Harris and Goodwin, 2017; Rucker *et al.*, 2018). We propose that many, if not most, psychopathologies develop via the gradual (or rapid - in the case of acute trauma) entrenchment of pathologic thoughts and behaviors, plus aberrant beliefs held at a high level, e.g., in the form of negative self-perception and/or fearful, pessimistic, and sometimes paranoid outlooks. We also propose that these pathologic beliefs are ascribed excessive precision, weight, or influence in many psychiatric disorders (Clark *et al.*, 2018). This view overlaps somewhat with the so-called capture theory of mental suffering (Kessler, 2016) as well as Bayesian perspectives on delusional belief formation in psychosis (Adams *et al.*, 2018; Sterzer *et al.*, 2018).

The process of capture (Kessler, 2016) or tightening of beliefs (and behaviors) in uncertainty (Carhart-Harris, 2019) may begin with psychological injury (Hovens *et al.*, 2015; Peters *et al.*, 2017)[8] and then develop progressively, likely as an (functional) attempt to mitigate the averseness of felt uncertainty or ambiguity brought on by the relevant shock(s) and/or psychological injury or injuries. In this sense, the creation of the aberrant belief is self-protective and defensive (i.e., it is a coping mechanism), and, although pathologic, it may work to reduce an individual's felt uncertainty. Indeed, as a strategy for suppressing uncertainty, even aberrant belief formation is consistent with the uncertainty-resolving imperatives of the free-energy principle. However, because the relevant defensive belief(s) becomes defining of pathology, it follows that it must be revised to avoid becoming entrenched and thus resistant to treatment. Moreover, because the belief(s) is self-protective, it is natural that psychological resistance will be felt if its integrity is threatened, e.g., pharmacologically via a psychedelic, or in the context of psychodynamic psychotherapy. It also follows that the precision weighting of the relevant high-level prior(s) or beliefs must first be relaxed, before they can be revised, and that a safe container for such a potentially destabilizing process is essential (Carhart-Harris *et al.*, 2018c).

The ideal result of the process of belief relaxation and revision is a recalibration of the relevant beliefs so that they may better align or harmonize with other levels of the system and with bottom-up information - whether originating from within (e.g., via lower-level intrinsic systems and related interoception) or, at lower doses, outside the individual (i.e., via sensory input or extroception). Such functional harmony or realignment may look like a system better able to guide thought and behavior in an open, unguarded way (Watts *et al.*, 2017; Carhart-Harris *et al.*, 2018b). In what follows, we offer some speculations on how the proposed top heaviness underpinning much psychopathology[9] is biologically instantiated in the human brain - and potentially relieved by psychedelic therapy.

This work will endeavor to account for a broad range of phenomena associated with the psychedelic experience by first presenting the neurobiological case for the hypothesis that the precision weighting of beliefs is relaxed under these compounds (REBUS). We then focus on the phenomenology of the psychedelic experience and its consequences - and how this ties in with the relevant neurobiology. We hope to explain how a potential relaxation of the precision weighting of high-level priors or beliefs and subsequent opening up of mental content under a psychedelic is logically implied by our two main guiding formulations: the entropic brain hypothesis and the free-energy principle. An important complementary theme, inspired by the so-called algorithmic information theory account of consciousness (Ruffini, 2017), is that the brain's highest levels naturally envelope the content of levels below, thereby effectively suppressing their potential information content via the action of a summary model.[10] Such models are referred to as compressive because they compress the content of levels below, effectively causing their content to disappear or at least not be heard. By implication, the breakdown of a compressive model should have an expansive influence on the system's potential information content, as it would liberate suppressed information, enabling it to travel up through the hierarchy, impressing on higher levels as it does.

Our empirically informed theoretical treatment of psychedelics begins with a review of their pharmacology and associated behavioral research, both in animals and humans, making special reference to synaptic efficacy-enhancing effects (Ly *et al.*, 2018). We then address the important relationship between their key pharmacological action, namely, 5-HT$_{2A}$R agonism and sensitivity to context (Carhart-Harris *et al.*, 2018c). We place special emphasis on the interaction between perceived (or actual) environmental volatility, associated stress, upregulation of 5-HT$_{2A}$R functioning, and associated plasticity.

We argue that this upregulation of 5-HT$_{2A}$R functioning facilitates adaptability to environmental volatility (Carhart-Harris and Nutt, 2017). This property has also been attributed to other neuromodulatory systems, such as noradrenaline and acetylcholine (Yu and Dayan, 2002, 2005), but it may be an especially pronounced feature of the 5-HT$_{2A}$R system (Carhart-Harris and Nutt, 2017). We then turn to functional brain-imaging studies with psychedelics and what these tell us about the acute action of psychedelics and their potential longer-term effects. We conclude by focusing on recent evidence supporting the therapeutic potential of psychedelics and offer a unified account of their acute and therapeutic mechanisms based on an integration of the entropic brain hypothesis and free-energy principle.

[1] REBUS is an acronym for "RElaxed Beliefs Under pSychedelics."

[2] The phenomenon of free energy, as it relates to brain function, was first introduced by Karl Friston in 2005 [Friston K (2005) A theory of cortical responses. *Philos Trans R Soc Lond B Biol Sci* 360(1456):815-36] and later developed into the "free-energy principle" [Friston K, Kilner J, Harrison L (2007) A free-energy principle for the brain. *J Physiol Paris* 100(1-3):70-87]. The free-energy principle is closely related to hierarchical predictive coding and the Bayesian Brain. For comprehensive texts on these models, see: (Andy Clark, *Surfing Uncertainty*) and [Hohwy J (2014) *The Predictive Mind*] - and here: [Tappin BM, Gadsby S (2019) Biased belief in the Bayesian brain: A deeper look at the evidence. *Conscious Cogn* 68:107-114] for a useful critique and indication of the robustness of the model in the context of psychotic delusions. As a simple nontechnical rule, free energy can be thought of as a measure of surprise. Thus, it is intimately related to information theoretic entropy, which is a measure of uncertainty or average surprise.

[3] The entropic brain hypothesis (EBH) was first introduced in 2014 (Carhart-Harris *et al.*, 2014) and later revisited and updated in 2018 (Carhart-Harris, 2018a). A stern test of the EBH would be to assess the specificity of the relationship between brain entropy and richness of conscious content, and one way to do this would be to assess the question of whether stimulant drugs, which increase arousal but presumably not conscious content, increase brain entropy. If they do increase brain entropy (to a similar extent to psychedelics), then this would contradict and potentially falsify the EBH.

[4] Precision is formally inverse variance and can be thought of as synonymous with felt confidence.

[5] Technically, a loss of precision (confidence) in posterior beliefs corresponds to a decrease in the curvature or flattening of the freeenergy landscape associated with the neuronal activity encoding those beliefs. Free-energy minimization effectively tries to find flat minima in accord with Occam's principle and Jayne's principle of maximum entropy (Jaynes, 1957). Interestingly, the problem of sharp minima is still an area of active research in machine learning (Hochreiter and Schmidhuber, 1997) Flat minima lend neuronal activity a latitude for fluctuations that characteristically result in critical slowing, of the sort entailed by the entropic brain hypothesis. The "slow" in critical slowing can be thought of as a slow recovery from a perturbation, i.e., the system has a slower recovery rate. See Friston *et al*. (2012a) for a technical discussion.

[6] Physiologically, precision is thought to be encoded by the sensitivity or postsynaptic gain of neuronal populations encoding predictions and prediction errors. Generally, a loss of precision corresponds to an increased sensitivity to afferent, presynaptic input. In turn, this enables revision or updating of beliefs that are neuronally encoded. See Kanai *et al*. (2015).

[7] Note: we do not differentiate between different types of ego dissolution. For example, it has been argued that ego dissolution can be as follows: 1) incomplete: due to psychological resistance and/or insufficient drug dose, ensuing ego dissolution is experienced as a state of high anxiety and distress or 2) complete: felt as a state of complete surrender, associated bliss, and union with all things. We are currently developing a relevant emotional breakthrough inventory rating scale to better differentiate between these two types of ego dissolution. An argument could be made that only the latter is true ego dissolution, as it is an almost binary, qualitative phenomenon, i.e., it either happens or it does not. It is obviously of interest to better understand the neuronal correlates of these distinct experiences. Perhaps relevantly, recent positron-emission tomography imaging of 5-HT$_{2A}$R occupancy and its relationship to subjective effects supports the assumption that the dose-response curve for psychedelics is nonlinear: Madsen *et al*. (2019).

[8] Not discounting the relevance of differential sensitivities or vulnerabilities to the effects of injury, such as the role of genetic risk

factors.

[9] And perhaps individuals living within technologically and industrially advanced societies.

[10] Technically, this imperative is identical to that used in predictive coding and variational free-energy minimization, namely, the compression of information via the minimization of redundancy or complexity (Hinton and Zemel, 1993; MacKay, 1995; Schmidhuber, 2010).

II. The REBUS Model

A. The Basic Neuropharmacology of Psychedelics

Some classic psychedelics, such as LSD, have a rich pharmacology (Nichols, 2004, 2016); however, there is compelling evidence that activation of a specific serotonin receptor subtype, the 5-HT$_{2A}$R, is necessary for these compounds' subsequent psychedelic effects. The affinity of psychedelics for the 5-HT$_{2A}$R correlates strongly with their subjective and behavioral potency in humans and animals (Glennon *et al.*, 1992), and pretreatment with 5-HT$_{2A}$R antagonists markedly attenuates their characteristic psychological effects in humans (Vollenweider *et al.*, 1998).[11] The 5-HT$_{2A}$Rs are expressed most densely in the cortex and especially in high-level association regions, such as those belonging to the so-called default-mode network (DMN) (Beliveau *et al.*, 2017). Recently, it was found that 5-HT$_{2A}$R occupancy and plasma concentration of psilocin (the active metabolite of psilocybin) correlate with psilocybin's subjective effects - in a nonlinear way that matches the nonlinear nature of psychological phenomena such as ego dissolution (Madsen *et al.*, 2019).

The DMN is a high-level brain network that is exceptional for a number of reasons, including: 1) its high basal metabolism (Raichle, 2015), 2) dense interregional connectivity (Hagmann *et al.*, 2008), 3) extreme heteromodality (Margulies *et al.*, 2016), and 4) association with functionally high-level behaviors - falling broadly under the constructs of perspective taking and metacognition (Soto *et al.*, 2018). The DMN has been associated with arguably species-defining behaviors such as mental time travel (Ostby *et al.*, 2012), moral decision making (Kaplan *et al.*, 2017), counter-factual thinking (Van Hoeck *et al.*, 2013), and self-consciousness (Fingelkurts *et al.*, 2012). Some years ago, we nominated the DMN as the primary biologic substrate of the Freudian ego (Carhart-Harris and Friston, 2010), as well as a vital system for the maintenance of secondary process cognition (Carhart-Harris *et al.*, 2014). With some qualifications (Lebedev *et al.*, 2015) and an acknowledgment of the looseness of this attributional exercise (mainly due to the intrinsic abstraction of the constructs in question, which is a challenge to surmount), we still largely maintain these views (see also Davey *et al.*, 2016; Davey and Harrison, 2018). In simpler, more mechanistic terms, however, the human DMN can be considered to sit at the top end - or center - of a uniquely deep hierarchical system, i.e., the human brain, instantiating a uniquely deep and domain-general model of the embodied agent his- or herself (Friston, 2018; Friston *et al.*, 2018). See Becker (2011) for a reminder of the unique depth of human mental models and their psychological and sociological implications.

An important aspect of the present thesis is that the potential belief-revising effects of psychedelics occur via an action on the top end (or deepest aspect) of the brain's functional architecture, with high-level cortex being particularly implicated. This high-end locus of action is supported by the especially dense expression of 5-HT$_{2A}$Rs within high-level cortex (Beliveau *et al.*, 2017). Functional disintegration of the DMN[12] and changes in other high-level networks (Lebedev *et al.*, 2015; Tagliazucchi *et al.*, 2016) have been linked with the most abstract phenomenological features of the psychedelic experience, such as ego dissolution (Carhart-Harris *et al.*, 2016c); however, we also propose that the pronounced perceptual effects of psychedelics involve effects both within and above the relevant sensory modules. Consistent with the free-energy principle, we propose that the brain's highest levels provide an implicit, centralizing, and generalized compression of (potential) information held within and processed by subordinate levels; i.e., the high or deep hierarchical levels furnish beliefs about abstract, domain-general narratives regarding the world qualities of self and states of being. Moreover, these beliefs also offer the best explanation for inferences at lower levels (Ruffini, 2017), a rule that also applies to the extensive architecture dedicated to perceptual inference (Gregory, 1980). Relatedly, although the DMN is characteristically far removed from immediate sensory processing (Margulies *et al.*, 2016), evidence suggests that it contextualizes sensory processing, particularly in the visual modality (Huang and Sereno, 2013; Griffis *et al.*, 2017), suggesting there is little that is beyond the reach of the DMN (even if its influence is somewhat detached), which is what one would expect from a particularly high-level component of a system, i.e., an exceptionally broad executive reach or influence.

It is hypothesized that disrupting the broad compressive function of the DMN and related high-level networks has trickle-down effects on the functional organization of the global system. In addition to the brain's highest hierarchical levels, we highlight how intermediate hierarchical levels (i.e., those concerned with cognition, perception, and emotion) are likely to be affected by psychedelics. Although this rule may be true for much of the brain, the operation of its most rudimentary, domain-specific levels (e.g., those concerned with motor and autonomic functions) may remain largely immune from the influence of psychedelics - at least on an implementation level. For example, under the effects of a high dose of a psychedelic, an individual may report feeling as if they cannot move, vocalize, or even breathe properly, but, in practice, they can typically perform these functions almost as normal.

1. Interim Summary

Consistent with hierarchical predictive processing, we maintain that the highest level of the brain's functional architecture ordinarily exerts an important constraining and compressing influence on perception, cognition, and emotion, so that perceptual anomalies and ambiguities - as well as dissonance and incongruence - are easily and effortlessly explained away via the invocation of broad, domain-general compressive narratives. In this work, we suggest that psychedelics impair this compressive function, resulting in a decompression of the mind-at-large - and that this is their most definitive mind-manifesting action.

One cannot discount the possibility that a direct disruption of priors instantiated by lower levels of the functional hierarchy occurs with psychedelics, and, indeed, an intermediate-level locus of action is supported by the predominant expression of 5-HT$_{2A}$Rs on layer 5 pyramidal neurons throughout much of the cortex, e.g., with particularly high expression within the primary visual cortex (Beliveau *et al.*, 2017). This said, we still maintain that the especially high expression of 5-HT$_{2A}$Rs within high-level cortex is likely to be important. Moreover, this hierarchical view is consistent with the functional (hierarchical and recurrent message passing) asymmetries on which predictive coding depends. In short, although an intermediate action of psychedelics is plausible - if not likely - dysregulation of the highest hierarchical level may be the definitive action of psychedelics. See Pink-Hashkes *et al*. (2017) for discussion of a related and largely consistent hierarchical predictive-processing-based model of the action of psychedelics.

To illustrate this point, consider the example of hallucinated motion, e.g., perceiving motion in scenes that are actually static, such as seeing walls breathing, a classic experience with moderate doses of psychedelics. This phenomenon can be fairly viewed as relatively low level, i.e., as an anomaly of visual perception. However, we propose that its basis in the brain is not necessarily entirely low-level but may also arise due to an inability of high-level cortex to effectively constrain the relevant lower levels of the (visual) system. These levels include cortical regions that send information to V5, the motion-sensitive module of the visual system. Ordinarily, the assumption "walls don't breathe" is so heavily weighted that it is rendered implicit (and therefore effectively silent) by a confident (highly-weighted) summarizing prior or compressive model. However, under a psychedelic, V5 may be forced to interpret increased signaling arising from lower-level units because of a functional negligence, not just within V5 itself, but also higher up in the hierarchy. Findings of impaired high- but not low-level motion perception with psilocybin could be interpreted as broadly consistent with this model, namely, pinning the main source of disruption high up in the brain's functional hierarchy (Carter *et al.*, 2004). The exceptionally high expression of 5-HT$_{2A}$Rs in the brain's highest hierarchical levels provides a solid anatomic basis for this assumption, although we recognize expression is also particularly high in the primary visual cortex (Beliveau *et al.*, 2017). Finally, the predominantly high-level expression of 5-HT$_{2A}$Rs might also explain the phenomenon of microdosing, namely, the taking of subsensory-perceptible doses of psychedelics that nevertheless (allegedly) produce a discernible cognitive/emotional effect (Waldman, 2017) - presumably again, through a (subtle) flattening of the brain's functional hierarchy and associated (subtle) increase in bottom-up signaling.

B. Rhythms, Networks, and the Relaxation of High-Level Priors

Activation of 5-HT_{2A}Rs induces an increase in excitatory postsynaptic currents and discharge rates in pyramidal neurons (Celada *et al.*, 2008), causing an asynchronous mode of glutamate release (Aghajanian and Marek, 1999), also known as recurrent network activity (Aghajanian, 2009), and temporal dissociation between cortical pyramidal cell firing and the active phase of local field potentials, i.e., a spike-field decoherence (Celada *et al.*, 2008). This irregular excitation of deep-layer pyramidal neurons is likely to account for the highly reliable finding of psychedelic-induced decreases in oscillatory activity (particularly in its most prominent frequency bands, such as alpha) in animal and human cortex (Muthukumaraswamy *et al.*, 2013; Riga *et al.*, 2014), a view that is substantiated by our application of dynamic causal modeling to psilocybin magnetoencephalography (MEG) data, which implicated layer 5 pyramidal neuron excitation as the cause of broadband decreases in oscillatory power (Muthukumaraswamy *et al.*, 2013). From the perspective of predictive coding, these selective effects on deep pyramidal cells are particularly prescient because these populations are thought to encode expectations about the latent or hidden causes of the sensorium. Rendering them selectively more sensitive to ascending input (e.g., prediction errors) is precisely the neuromodulatory change that reduces the precision weighting of the expectations they encode. In other words, being more excitable is the physiologic mechanism that destroys sharp minima and underwrites a weakening of prior expectations.

It is well known that the brain's resting power spectrum exhibits stark nonuniformities in its oscillatory components, in the sense that certain rhythms are especially pronounced. This seems to be particularly the case when recording population-level activity in the cortex. Perhaps the most conspicuous example of a predominant rhythm is the α rhythm or Berger wave of about 10 Hz, which shows a striking prominence, especially, but by no means exclusively, during eyes-closed waking rest. The α rhythm has been associated with a range of functions, including top-down inhibition (Klimesch *et al.*, 2007). Evidence has been accumulating, however, that α also plays a more specific role in conferring top-down expectations about perceptual stimuli (Mayer *et al.*, 2016) that effectively silence more granular information processed by lower-level aspects of the system. The α power is known to correlate positively with DMN activity (Mantini *et al.*, 2007), as does β (Mantini *et al.*, 2007). Like alpha, the β rhythm has also been associated with a top-down function, albeit within the motor system (Fries, 2015).

Another interpretation of α is that it is associated with a resting, reflective brain that responds - electrophysiologically speaking - with the emergence of higher frequencies on stimulation. This is known as event-related desynchronization (Pfurtscheller *et al.*, 1996; Singh *et al.*, 2002) and typically involves a shift to broadband activity. In brief, high α activity would appear to correspond to a neurophysiological state of low entropy and strong or precise (i.e., heavily-weighted) top-down constraints - as maintained by the free-energy principle (Boly *et al.*, 2012; Bauer *et al.*, 2014; Bastos *et al.*, 2015).

Crucially, psychedelics have been found to dramatically decrease prominent low-frequency and therefore high-level brain rhythms such as α and β, and this effect appears to be both reliable and closely related to the intensity of their subjective effects (Muthukumaraswamy *et al.*, 2013; Carhart-Harris *et al.*, 2016c). Perhaps relatedly, psychedelics have also been found to tune brain activity closer to criticality (Atasoy *et al.*, 2017; Muthukumaraswamy and Liley, 2018; Varley *et al.*, 2019), such that it displays more of a scale-free organization (Muthukumaraswamy and Liley, 2018), an effect that may be mediated by α modulation (Muthukumaraswamy and Liley, 2018).

Using MEG, we found reduced α power in the posterior cingulate cortex under psychedelics, a major node of the DMN, and this effect correlated significantly with subjective ratings of ego dissolution under both psilocybin (Muthukumaraswamy *et al.*, 2013) and LSD (Carhart-Harris *et al.*, 2016c). The α rhythm is known to be especially highly expressed in humans relative to other animals, and especially so during maturity, with a peak at about 20 years of age (Basar and Guntekin, 2009), which, intriguingly, is approximately when the complexity of cognition has been found to be maximal (Gauvrit *et al.*, 2017). Although open to critique, a curious cross-cultural electroencephalogram (EEG) study sampling eyes-closed brain activity in more than 400 individuals has reported that α is most pronounced in the most technologically advanced and developed cultures (Parameshwaran and Thiagarajan, 2017).

1. Interim Summary

To summarize, evidence that psychedelics have a particular action on high-level cellular, oscillatory, and regional/network features of the brain's functional architecture, combined with evidence that these features are implicated in a top-down predictive function, converges on a key hypothesis of this work, namely, that psychedelics have an important dysregulatory effect on the highest levels of the brain, subverting the brain's ability to entrain and constrain emotion and perception to a central narrative:

> "*The Centre cannot hold*." (Yeats, 1865-1939) We maintain that the hierarchically high-level character of key sites of action of psychedelics, e.g., 5-HT$_{2A}$Rs on deep-layer pyramidal neurons in high-level cortex/systems, is important, and that activation of these receptors renders the high-level components on which they sit, sensitized and functionally dysregulated. We propose that this dysregulation of the highest levels of the brain's functional hierarchy is commensurate with a lightening of the precision weighting encoded by these levels and their associated dynamics. The effect of this, we propose, is to lighten the top heaviness of human cognition, by (temporarily) flattening the hierarchical organization that supports it. Although speculative, the alleged positive mood and procognitive effects of microdosing may depend on the same (temporary) antihierarchical effect, liberating brain and mind function, albeit with far greater subtlety than with higher doses.

At the other extreme, the sense of losing one's self or ego with higher doses of psychedelics may explain why one can feel as if one is dying while under the effects of these drugs (Timmermann *et al.*, 2018), despite the fact that peripheral physiology remains largely unaffected. Living systems adhere to the free-energy principle but dying systems do not (Friston, 2018). Indeed, a dying or dead brain/body is the very epitome of an entropic brain/body. The so-called entropic brain effect (Carhart-Harris, 2018a), exemplified by findings of increased brain complexity/entropy (Schartner *et al.*, 2017) and decreased modular differentiation (Petri *et al.*, 2014), provides an iconic image of dysregulated global brain function under psychedelics, with the 5-HT$_{2A}$R as the trigger point.

C. Plasticity and the Dissolution of (High-Level) Priors under Psychedelics

In this section, we address neurobiological and behavioral evidence for the hypothesis that psychedelics work by weakening the precision weighting of high-level priors and, thus, their ability to exert hierarchical control over and be impervious to the influence of lower-level components of the brain. Readers will note that psychedelics appear to affect predictive processing at a broad range of functional levels. It is our view that psychedelics affect not just high-level priors but intermediate-level priors also (e.g., those instantiated within the visual cortex). However, we maintain that the relaxation of precision on the high hierarchical levels has the most dramatic psychological consequences. One reason for this may be that these high levels encode cognition at a level of abstraction that is more removed from the (anchoring and entraining influence of) statistical regularities within the sensorium - and so are more able to change or undergo revision. Another reason why disruption at the highest levels may have special implications is that these high levels support domain-nonspecific narratives that influence the entire hierarchy. The principle is that the influence of the high levels runs deep, such that affecting them has particularly large or general implications.

Returning to a lower level, a recent study used optogenetics in mice to selectively measure the activity of serotonergic cells within the dorsal raphe nuclei (Matias *et al.*, 2017). The authors found that dorsal raphe nuclei cell firing increased significantly under conditions of uncertainty, being sensitive to surprising events irrespective of their reward value (i.e., value-nonspecific prediction error). The authors inferred from these results that serotonin transmission plays an important role in enhancing adaptability in the face of uncertainty, a theme that chimes well with the model we are presenting in this work, as well as another presented recently (Carhart-Harris and Nutt, 2017), which specifically associates 5-HT$_{2A}$R signaling with enhanced adaptability, particularly in situations of crisis. Thus, understanding the REBUS/anarchic brain model may have important implications for our understanding of brain serotonin function (Carhart-Harris and Nutt, 2017), a notable enigma in psychopharmacology.

The role of serotonin (Matias *et al.*, 2017) and, more specifically, 5-HT$_{2A}$R signaling (Boulougouris *et al.*, 2008), in cognitive flexibility, has been substantiated by numerous studies in animals and humans, e.g., see Carhart-Harris and Nutt (2017) for a review. Psychedelics have been found to promote divergent thinking (Kuypers *et al.*, 2016) - a key component of creative thinking - as well as an expansion of associative processing (Spitzer *et al.*, 1996), while (unsurprisingly) impairing conventional cognition (Bayne and Carter, 2018), including convergent/discriminatory cognition (Kuypers *et al.*, 2016). Recent (Berthoux *et al.*, 2018; Ly *et al.*, 2018) and older work (Vaidya *et al.*, 1997) provide convincing evidence that 5-HT$_{2A}$R signaling can enhance neural plasticity, as well as low-level learning and extinction learning, as reviewed in this study (Carhart-Harris and Nutt, 2017), suggesting that psychedelics promote a generalized plasticity via their agonist actions at the 5-HT$_{2A}$R (Carhart-Harris *et al.*, 2016b; Carhart-Harris and Nutt, 2017).

Serotonin transmission is known to play an important role in normal brain development (Azmitia, 2001; Maya Vetencourt *et al.*, 2008) and has been increasingly linked to enhanced sensitivity to environmental influences (Branchi, 2011; Alboni *et al.*, 2017). Relatedly, psychedelics appear to induce a regressive state, both behaviorally (Grof, 1979) and in terms of brain function (Roseman *et al.*, 2014; Carhart-Harris *et al.*, 2016c). Moreover, as in infancy, the influence of context has an exaggerated role under psychedelics (Carhart-Harris *et al.*, 2018c), a characteristic property of critical systems[13] linked to critical slowing[14] (see section *II.F.3. Criticality and Optimality* for further discussion of the theme of criticality). It is also worth noting that 5-HT$_{2A}$R densities are highest early in life, dropping significantly when adulthood is reached (Sheline *et al.*, 2002). Behavioral complexity also decreases at a similar age, after peaking at about 25 years of age (Gauvrit *et al.*, 2017). Lastly, that both children and individuals on psychedelics are hyper-suggestible (Nicolas *et al.*, 2011; Carhart-Harris *et al.*, 2015) is consistent with the principle that brain activity is tuned closer to criticality in these - likely related - brain states.

Taken together, the above-cited findings speak to the notion that the brain enters an entropic hot state under psychedelics in which synaptic efficacy and plasticity are elevated (Ly *et al.*, 2018). The result of this window of exceptionally high plasticity may be to leave a legacy of potentially enduring functional and perhaps anatomic change (Ly *et al.*, 2018). As the acute drug effects begin to subside, the system (brain) will settle back into its default regimen of efficient free-energy minimization, mirrored by a renewed subjective sense of familiarity and assuredness, but may not return entirely as before.

Recent functional imaging work with psychedelics suggests that large-scale intrinsic brain networks, such as the DMN, do indeed reintegrate after a psychedelic experience (Carhart-Harris *et al.*, 2017). It is tempting to speculate that profound psychedelic experiences have a residual impact on the DMN, perhaps pruning some of its (redundant) parameters, in a manner that is consistent with synaptic homoeostasis and BMR (Tononi and Cirelli, 2006; Friston *et al.*, 2017). Psychedelics may also lighten the precision weighting of DMN-related high-level priors in an enduring way. Further work is needed to test these hypotheses; however, we anticipate that long-term changes in DMN functioning may account for common reports of a lighter, freer state of mind after intense psychedelic experiences (Watts *et al.*, 2017), particularly in the context of psychedelic therapy. This postacute period of well-being is often referred to as the psychedelic afterglow (Sampedro *et al.*, 2017) and has been described in various ways: "I felt free, carefree, re-energized" (Watts *et al.*, 2017); "The concrete coat had come off" (Watts *et al.*, 2017); "All that day and well into the next, a high pressure system of well-being dominated my psychological weather" (Pollan, 2018).[15]

D. Behavioral Evidence of Relaxed Priors under Psychedelics

The relaxation of the precision weighting of high-level priors under psychedelics is a central theme of the REBUS model. But what behavioral evidence is there for the implicit dissolution of prior beliefs? Although not directly concerned with high-level priors,[16] one place we may find some relevant data is perceptual processing and, specifically, oddball paradigms such as the mismatch negativity, which directly engages predictive coding mechanisms (Garrido *et al.*, 2009), and the engagement of lower-level priors and sensory prediction error. Using auditory mismatch negativity during MEG scanning, a blunted surprise response to deviant tones was found under LSD relative to placebo, as was reduced neuronal adaptation (Timmermann *et al.*, 2017). This result makes sense based on the principle that psychedelics weaken expectations about standard tones in this paradigm, thus making deviant tones seem less anomalous or surprising. Using dynamical causal modeling, it was apparent that the diminished surprise signals could be best accounted for by reduced top-down information flow from the frontal cortex (Timmermann *et al*., 2017) - again consistent with the REBUS model of relaxed priors under psychedelics. Also consistent are findings from a study that measured visual evoked responses to Kanizsa triangles, a visual perceptual illusion requiring object completion via top-down perceptual priors. Results revealed reduced object completion and related evoked potentials under psilocybin (Kometer *et al*., 2011), and these effects correlated with the intensity of spontaneous visual hallucinations. Another visual perceptual phenomenon that probes predictive coding is binocular rivalry, in which the presentation of two different visual stimuli to each eye typically induces the alternation between one percept and another. Under psilocybin, participants were more likely to perceive mixed percepts, and switch between them, consistent with reduced perceptual constraints, presumably due to impaired top-down resolution of perceptual uncertainty (Carter *et al*., 2005, 2007). A number of other studies have demonstrated reduced prepulse inhibition under psychedelics (Quednow *et al*., 2012; Schmid *et al*., 2015) and a 5-HT$_{2A}$R-mediated augmentation of the startle response (Jiang *et al*., 2011), consistent with reduced top-down sensory inhibition or gating (Vollenweider and Geyer, 2001). Somewhat relatedly, we have seen increased information flow from the parahippocampus to the visual cortex during LSD-enhanced music listening (Kaelen *et al*., 2016), a phenomenon that can be linked to the hypothesized sensitization of cortex to bottom-up signaling under psychedelics, in this case stemming from a lower-level intrinsic system, i.e., the limbic system. It is noteworthy that the limbic system has been particularly implicated in the action of psychedelics (Carhart-Harris *et al*., 2014; Tagliazucchi *et al*., 2014; Lebedev *et al*., 2015).

An interesting study that directly addressed differential levels of perceptual processing under psilocybin found impairments in high- but not low-level motion perception (Carter *et al*., 2004). This finding makes sense given that prestimulus α oscillations have been found to assist high-level motion perception (Mayer *et al*., 2016) and α is known to be tonically reduced under psychedelics (Carhart-Harris *et al*., 2016c). The foregoing findings (Carter *et al*., 2004) could be interpreted as consistent with the notion that low-level autonomic functioning, which relies less on the invocation of complex internal models, is largely preserved under psychedelics, e.g., motor action is largely preserved, presumably because there is relatively low 5-HT$_{2A}$R expression in motor cortex (Beliveau *et al*., 2017). Moreover, this may explain why low-level processing and indeed low-level learning (including extinction learning) appear to be not just preserved but enhanced with increased 5-HT$_{2A}$R stimulation (King *et al*., 1972; Welsh *et al*., 1998; Harvey, 2003; Harvey *et al*., 2004; Romano *et al*., 2006, 2010; Gresch *et al*., 2007; Zhang *et al*., 2013), whereas conventional higher-level cognition is unsurprisingly impaired (Bayne and Carter, 2018).

Additional evidence for reduced top-down processing under psychedelics can be seen in changes in spontaneous brain activity, including the aforementioned reductions in the integrity of large-scale intrinsic networks (Carhart-Harris *et al*., 2016c), as well as the relative collapse of prominent oscillatory rhythms in the brain (Carhart-Harris *et al*., 2016c) that have been linked to these high-level networks (Laufs *et al*., 2003; Mantini *et al*., 2007). Additionally, decreased top-down information flow has been found when transfer entropy was applied to EEG data recorded under ayahuasca (Alonso *et al*., 2015) and when dynamic causal modeling was applied to resting-state functional magnetic resonance imaging data, suggesting reduced top-down flow from the posterior cingulate cortex to the thalamus (Preller *et al*., 2019). The potentially related finding of increased thalamic-cortical information flow in this study (Preller *et al*., 2019) also ties in with others (Muller *et al*., 2017) that have proposed (Geyer and Vollenweider, 2008) and demonstrated (Halberstadt and Geyer, 2018) reduced sensory gating with psychedelics. Increased flow of sensory information up the brain's functional hierarchy is consistent with the general hypothesis proposed in this work that relaxed high-level priors (REBUS) occur in parallel with increased bottom-up signaling (anarchic brain) - as the two model components are mutually dependent. Indeed, this intimate relationship between priors and prediction error is an integral part of the hierarchical prediction-processing model.

Psychedelics have, of course, also been found to affect higher level aspects of information processing, such as emotional (Kaelen *et al*., 2015) and social processing (Preller *et al*., 2016), mental time travel (Speth *et al*., 2016), imagination (Carhart-Harris *et al*., 2012b), and ego functioning in general (Nour *et al*., 2016; Milliere, 2017). We propose that the action of psychedelics on the precision weighting of high-level priors is (one-half of) their definitive psychological action (the other half being increased bottom-up signaling, hence the anarchic brain component). With sufficiently high doses, time and self are reported to lose meaning (Turton *et al*., 2014); emotions show greater lability (Carhart-Harris *et al*., 2016b), but can also be felt with greater depth and meaning (Preller *et al*., 2017); and a paradoxical intermixing of mood states can occur (Carhart-Harris *et* *al*., 2016b). Emotional responsiveness to conventional experimental stimuli, such as series of static facial expressions, appears to be reduced (Kraehenmann *et al*., 2015a), accompanied by reduced top-down connectivity (Kraehenmann *et al*., 2015b). However, this may relate to a generalized disengagement with conventional behavioral paradigms, which is a particular problem in psychedelic research. See Carhart-Harris (2018a) for a discussion of this matter.

As noted above and consistent with a relaxation of high-level priors, social processing appears to be affected under psychedelics. For example, reduced feelings of social exclusion were reported (under psilocybin) in a behavioral paradigm designed to induce relevant feelings of exclusion (Preller *et al*., 2016), and increased emotional empathy was seen in a separate paradigm (Pokorny *et al*., 2017). Reduced rejection of unfair monetary offers has been observed under psilocybin and *3,4-methylenedioxy-methamphetamine* (MDMA), whereas an additional increase in generosity was seen with MDMA (Gabay *et al*., 2018). The authors interpret these results as consistent with a prosocial effect, something that appears to be especially characteristic of the MDMA experience (Bedi *et al*., 2014). MDMA is not a classic psychedelic, but, like psilocybin (Kometer *et al*., 2012), its positive mood effects have been linked to increased 5-HT$_{2A}$R activity (van Wel *et al*., 2012). Although this may be so, it is essential to emphasize that MDMA is not a direct 5-HT$_{2A}$R agonist; rather, MDMA is likely to engage all serotonin receptors indirectly through its potent release of serotonin (Bradbury *et al*., 2014). We speculate that MDMA's prosocial effects, including its positive effects on social approach (Kamilar-Britt and Bedi, 2015), may relate (at least in part) to raised activity at 5-HT$_{2A}$Rs (via increased endogenous serotonin release), causing a relaxation of socially relevant assumptions (beliefs) that ordinarily inhibit social approach. This effect, combined with a reduction of anxiety via serotonin's action at its other receptors (e.g., postsynaptic serotonin 1A receptors in limbic circuitry) and an increase in arousal and confidence via its release of noradrenaline and dopamine, is likely to account for the characteristic subjective effects of MDMA; see Carhart-Harris and Nutt (2017) for a related discussion.

E. Comparisons with Other Altered States and Traits

1. Psychosis

It is natural to ask how the hypothesized changes in brain and mind function under classic psychedelics relate to other, perhaps scientifically and medically more familiar, and thus tangible, states and traits. The psychedelic state has traditionally been compared with psychosis, but this comparison needs to be carefully qualified (Carhart-Harris *et al*., 2016b). It is well known that there is considerable heterogeneity to psychosis. For example, within the same individual, periods of (near) remission can bookend acute psychotic episodes featuring florid symptomatology. Moreover, whereas one person may experience florid positive symptoms associated with his/her first psychotic episode, another may present with a complex, but stable delusional framework coexistent with predominantly negative symptoms.

It has previously been suggested and demonstrated (Gouzoulis *et al*., 1994; Carhart-Harris *et al*., 2016b) that the acute psychedelic experience is a much better model of the early (and perhaps acute) symptoms of an incipient psychosis than symptoms associated with chronic schizophrenia, presumably because the underlying brain states of early psychosis (but not developed) schizophrenia share similarities with those underlying the psychedelic state. We speculate that reduced precision weighting on high-level priors may underlie these commonalities. This speculation could explain common phenomenological features of early psychosis and the psychedelic state, such as a fragmented sense of self and a basal anxious uncertainty that, if sufficiently persistent and intolerable, may be brought under control through the formation of an overarching delusional belief system. See Carhart-Harris and Nutt (2017) for a relevant discussion. This schema of weak high-level priors concomitant with heavily weighted (i.e., precise) prediction errors, manifesting as aberrant salience (Kapur, 2003) in the early phase of a psychosis, followed by the formation of heavily weighted and therefore stabilizing, but delusional high-level priors, has been discussed before (Clark, 2016).

We posit that the key difference between the psychedelic state and schizophrenia is that a delusional belief system does not (typically) crystallize in the psychedelic state for the following reasons: 1) unlike in psychosis, in the psychedelic state, the system (typically) begins from a baseline state of stable high-level priors (e.g., a stable ego) to which it returns as drug effects subside; 2) drug effects typically subside (e.g., after about 3-5 hours in the case of psilocybin); thus, there is insufficient opportunity or need for a delusional belief system to close out uncertainty; 3) increased prediction error (and accompanying increased uncertainty) in the psychedelic state is typically seen as an acceptable, expected, and even valued part of the drug experience (see section *II.F.Psychedelics and Insight* on insight below) and thus is typically learned from, i.e., integrated rather defended against, possibly via the formation of delusional beliefs and flight from reality (as in schizophrenia); and 4) there is no evidence that prediction errors are overweighted in the psychedelic state; i.e., aberrant salient is not the rule.

Using Pavlovian conditioning, an impressive recent study entrained the acquisition of stimulus-driven auditory hallucinations in a range of participant groups (Powers *et al.*, 2017). This effect was linked to endogenously occurring hallucinations in pathologic conditions such as schizophrenia. This so-called strong priors model of hallucinations and delusions is relatively appealing (Sterzer *et al.*, 2018). Some might be tempted to extrapolate from the above study's findings to either perceptual abnormalities in the psychedelic state or indeed early psychosis. However, our position is that early psychosis and the psychedelic state do not fit the strong priors model well for the reasons discussed above.

In brief, our view of the etiology of schizophrenia is that, for whatever combination of developmental, environmental, and/or genetic reasons, within certain at-risk individuals, the brain's highest-level priors are ineffective, meaning bottom-up prediction errors travel more freely up the hierarchy, affecting it as it does.[17] This much is consistent with the psychedelic experience. However, in a developing psychosis, we assume that the cycle of weak priors, high prediction error is more sustained than in the psychedelic experience. This, combined with adverse contextual conditions (Zammit *et al.*, 2010), may contribute to ascending signals being ascribed greater precision in an emergent psychosis, e.g., due to the recruitment of dopaminergic mechanisms (Pehek *et al.*, 2006; Pehek and Hernan, 2015), manifesting in the classic phenomenon of aberrant salience (Kapur, 2003). These critical secondary factors that are not by default part of the psychedelic picture most likely serve to encourage (delusional) interpretation of the (amped-up) prediction errors in an effort to reduce free energy and thus subdue and stabilize the system.

2. Hallucinogen-Persisting Perceptual Disorder

Hallucinogen-persisting perceptual disorder (HPPD) is a Diagnostic and Statistical Manual of Mental Disorders, 5th Edition-listed disorder that relates to enduring visual perceptual abnormalities that persist beyond an acute psychedelic drug experience. Its prevalence appears to be low and its etiology complex, but symptoms can still be distressing for individuals (Halpern *et al.*, 2018). Under the REBUS model, it is natural to speculate that HPPD may occur if/when the collapse of hierarchical message passing does not fully recover. A compromised hierarchy would imply a compromised suppression of prediction error, and it is natural to assume that persistent perceptual abnormalities reflect attempts to explain away irreducible prediction errors. Future brain-imaging work could examine whether aspects of hierarchical message passing, such as top-down effective connectivity, are indeed compromised in individuals reporting HPPD.

3. Autism

Autism is another disorder in which aberrant high-level priors have been thought to play a role (Van de Cruys *et al.*, 2014; van Schalkwyk *et al.*, 2017). On first glance, the (hypothesized) mechanics of autism may appear to share similarities with those proposed in this work to underlie the psychedelic state, i.e., aberrant precision weighting on high-level priors (e.g., relevant to social processing). Added to this, in autism, there appears to be a compensatory upregulation of attention to and thus precision weighting of lower-level priors and sensory input. Consistently, in autism, imprecise and/or rigid high-level priors have been linked to deficient self-reflectiveness and theory of mind, as well as a biasing of attention toward the more elemental and domain-specific features of the sensorium (Van de Cruys *et al.*, 2014). Relatedly, a reduction in perceptual grouping has been observed in autism (Goris *et al.*, 2018), as it has in the psychedelic state (Kometer *et al.*, 2011). It is easy to intuit some important differences in the mechanics of autism and the psychedelic state, however, not least because the phenomenology appears so different. For example, people show increased interest in others under psychedelics and an enhanced awareness of emotion, self-schemas, and interpersonal relationships (Preller *et al.*, 2016; Pokorny *et al.*, 2017; Watts *et al.*, 2017; Pollan, 2018) - functions that are often deficient in people with autism.

A further important difference between the psychedelic state and autism is that autism, like chronic schizophrenia, presents more as a trait than state-like phenomenon. In autism, the predictive coding architecture is skewed toward lower levels of the hierarchy, and critically, becomes set or fixed this way. It is hypothesized that lower levels of the functional hierarchy are ascribed greater precision in autism, which is often cast as a failure to attenuate sensory precision. This is thought to occur alongside a deficient weighting of high levels of the hierarchy, e.g., cognition linked to complex emotion and social awareness (Van de Cruys *et al.*, 2014; van Schalkwyk *et al.*, 2017). The psychedelic state, in contrast, is, by definition, not a trait phenomenon. Moreover, it is also richly emotional and empathic (Watts *et al.*, 2017).

The psychedelic brain is likely to feature (at least in cases where the individual is healthy) a normally developed architecture that is transiently leveled, meaning that the brain's functional hierarchy temporarily flattens. Once the psychedelic itself has been sufficiently metabolized, this temporary flattening reverts back to its original state. In brief, the hierarchical abnormalities in the psychedelic state are hypothesized to be transient, whereas those in autism appear to be relatively intransigent and biased to the lower (i.e., sensory) hierarchical levels.

4. Other Disorders

Consistent explanations can be given for apparent phenomenological differences between other disorders such as Cotard delusion (Dieguez, 2018) and visual agnosia (Biran and Coslett, 2003), and the psychedelic state. Such disorders may, on first glance, appear to share some useful similarities with the psychedelic state, e.g., abnormal self-perception in Cotard delusion and an inability to group perceptual features in visual agnosia, yet they differ from the psychedelic state in the relative fixedness (Cotard delusion) and domain specificity of the relevant abnormalities.

5. Meditative States

Meditative states are a special corpus of states that, traditionally, have been compared with the psychedelic state (Badiner and Gray, 2002). Psychological and neurobiological similarities and differences between different meditative states and the psychedelic state have recently been the focus of an extensive review paper (Milliere *et al.*, 2018). One major psychological commonality is the relaxation of self-consciousness (Batchelor, 1998). The cessation of ego consciousness or attaining a state of "no self" is a core ideal of Buddhist philosophy and quality of effective meditation (Batchelor, 1998; Hanh, 2017). Importantly, the emergence of insight on cessation of ego-centered consciousness is another important component of Buddhist philosophy and practice, e.g., in Vipassana (i.e., Pali for insight meditation) (Batchelor, 1998). As we address in the forthcoming section, insight is also a core component of the psychedelic experience (Watts *et al.*, 2017; Noorani *et al.*, 2018).

In brief, key neurobiological similarities between meditative and psychedelic states that have been detected with brain imaging include the following: relative deactivation of the DMN (Carhart-Harris *et al.*, 2012a; Garrison *et al.*, 2013), reduced anticorrelation between the DMN and networks concerned with processing the extrinsic world (Carhart-Harris *et al.*, 2013; Josipovic, 2014), and, recently, the enhancement of signatures of criticality (Atasoy *et al.*, 2017). Important differences, such as the absence of decreased a power (Lomas *et al.*, 2015) with meditation, may depend on the conventional use of relaxation techniques to enter a meditative state, although see Kakumanu *et al.* (2018) for evidence of increased brain entropy in experienced meditators practicing Vipassana meditation.

Psychedelics arguably induce ego dissolution much more reliably than most individuals' meditations, albeit in a dose-dependent manner (Nour *et al.*, 2016). As has been discussed above in relation to psychosis, improving our methods of capturing phenomenologically-rich states while recording brain activity may help to reveal consistencies between brain changes that have been observed with EEG and MEG and psychedelics and those known to occur in relevant nondrug-induced states. Such an approach does, however, present significant pragmatic challenges centered on the problem of the uncertainty principle, i.e., that in the act of measuring, we affect the phenomenon of interest, e.g., see Carhart-Harris (2018a) for a relevant discussion.

F. Psychedelics and Insight

1. Introduction

"This was a vision, fresh and clear as a mountain stream; the mind revealing itself to itself." [18]

In this section, we address an assumption that is central to traditional psychedelic therapy, i.e., that psychedelics can facilitate psychological insight. Couched in the language of the dominant school of the day, psychoanalysis, clinicians conducting psychedelic therapy in the 1950s and 60s adhered to a model that maintained that these compounds work to relax the ego and its various defenses, such that unconscious material could emerge into consciousness. It is popularly commented that Freudian-minded therapists saw Freudian contents in their patients' psychedelic experiences, whereas Jungians saw Jungian material, as if priming and biased perspective and interpretation rendered the relevant theories mere tautologies. This view may be too absolutist, however, as these deep psychological models may well share important similarities with each other and be much more complementary than contrasting. The same content may indeed be interpreted differently depending on the influence of different theoretical frameworks, but this does not preclude the possibility that the genuine release of unconscious, or, at least, incompletely conscious psychological material takes place via the antihierarchical action of psychedelics.

Previous work has sought to examine the notion that psychedelics facilitate the emergence of unconscious material into consciousness (in the classic psychoanalytic sense) using a primarily qualitative approach, supplemented by neurobiological data (Carhart-Harris, 2007). One must be wary of the fallacy of inverse inference, however, as neither isolated phenomenology nor neurobiology alone renders first-person experience real in the veridical sense. Thus, an improved methodology is required if this important principle of psychedelic therapy is to be better tested.

Fortunately, such developments are presently underway. Perhaps the most appealing is to measure insight by its behavioral consequences - an ironically Skinnerian approach - that is meritorious for its pragmatism. For example, acute experiences of self-reported insight were found to predict subsequent long-term clinical improvements (Carhart-Harris *et al.*, 2018a) and changes in personality (Erritzoe *et al.*, 2018) in individuals treated with psilocybin for treatment-resistant depression. Moreover, the same individuals became more accurate at predicting future life events after this treatment, meaning they were less delusionally pessimistic and thus more clear-sighted (Lyons and Carhart-Harris, 2018b). Separately, in a double-blind study with an active comparator (dextromethorphan), greater psychological insight was reported with psilocybin than the control compound (Carbonaro *et al.*, 2018).

As with the replication of evidence, its convergence on a particular interpretation is another key indicator of its reliability and robustness - a process related to triangulation. Previous work has sought to demonstrate how numerous altered states, including dreaming (Carhart-Harris, 2007), exhibit a related phenomenology to the psychedelic state, including, of course, reports of the emergence of unconscious material into consciousness - alongside a related neurobiology (Carhart-Harris, 2007). However, we recognize that a stricter test of this principle will require the issuing of more structured assessments of insight and its consequences. The issuing of improved measures of insight has recently been addressed successfully in relation to dreaming (Edwards *et al.*, 2013) and is now being implemented in our own psychedelic research.

2. The Mechanics of Insight

What are the mechanics of insight? This matter has recently been approached from the perspective of the free-energy principle, both conceptually and computationally (Friston *et al.*, 2017). Key concepts to invoke in this work include the following: 1) curious behavior, explorative search, novelty seeking, and epistemic learning, plus 2) structure and fact-free learning, abductive reasoning, Bayesian model selection (BMS),[19] BMR,[20] and "aha" or "eureka" moments. We will now unpack these various concepts and explain how they speak to the psychedelic experience.

It is widely recognized in literature on creativity that insight often occurs as part of a process, the initial phase of which involves an intention or plan, e.g., to discover something new. One heuristic for doing this is to relax one's confidence in one's prior assumptions (i.e., high-level priors), and, in so doing, promote an open, inquiring state of mind. This approach is essentially epistemic in nature, i.e., it is a behavioral strategy intended for learning, under the assumption that there is something to be learnt, i.e., there is some expected uncertainty (Friston *et al.*, 2017).[21] More than this, however, the knowledge seeker hopes to learn in an optimal way, e.g., learning as much as possible, with the least amount of effort. He/She does this by sampling areas where this is an opportunity to resolve a lot of uncertainty, i.e., where there is a lot to be learnt (Friston *et al.*, 2017).

This is the essence of curious behavior (Friston *et al.*, 2017) and is consistent with an explorative search strategy, which entails exploring novelty for the sake of significant knowledge gain (also known as intrinsic motivation in robotics) (Oudeyer and Kaplan, 2007; Schmidhuber, 2010; Barto *et al.*, 2013). It is a strategy that dominates early in life and reduces later on, as exploitative searching becomes more relevant. Exploitative searching supersedes explorative search when the agent feels confident enough that some basic parameters have been established (Gopnik *et al.*, 2017).

These heuristics for promoting insight resonate with those used by practitioners working therapeutically with psychedelics; e.g., a popular mantra told to patients ahead of recent trials with psilocybin is as follows: "trust, let go, be open" (Richards, 2015). Moreover, it has long been assumed, and also recently demonstrated, that approaching a psychedelic session with a clear therapeutic intention is conducive to subsequent positive mental health outcomes (Haijen *et al.*, 2018). Perhaps relatedly, higher scores for trait absorption and lower scores for stubbornness have been found to predict consistent positive outcomes (Haijen *et al.*, 2018). It is natural to intuit that these findings point to a common early-phase component of insight, in which the relaxation of prior assumptions (high-level priors), whether done willfully or with the assistance of a psychedelic, heightens an individual's openness and receptivity to new perspectives.

The suggestion that the relaxation of (high-level) assumptions is conducive to insight is telling, as it implies that insight-related processes operate implicitly, i.e., without conscious awareness, and can be made more effective if executive function is suspended. It is worth noting that participants typically lie still with eyes closed during psychedelic treatment sessions and are advised to surrender their usual analytic thinking, in favor of a relaxed, freely-wandering mindset. This is consistent with itinerant processes characteristic of ordinary mind wandering - as well as dreaming - that are likely catalyzed further by psychedelics. Thus, rather than eagerly seeking out new data to resolve uncertainty, the agent is advised to forgo conventional epistemic foraging and instead allow processes to play out naturally and unconsciously, e.g., by sleeping on it (Friston *et al.*, 2017) or doing something else.

The concept of structure learning (Tervo *et al.*, 2016; Friston *et al.*, 2017) is relevant to the phenomenon of insight. This refers to the identification of high-level structure or patterns in large, complex data sets, i.e., it emphasizes "seeing the woods" or the "bigger picture," over getting "lost in the trees" or the details. An improved ability to see the "bigger picture" is logically implied by the energy landscape flattening effect of psychedelics discussed earlier. The notion of fact-free learning (Aragones *et al.*, 2004; Friston *et al.*, 2017) is also relevant. This refers to learning without necessarily accumulating new information or facts, i.e., because a fresh perspective or frame of reference, rather than more new data per se, may be more valuable for advancing understanding.

These concepts of structure and fact-free learning hint at something fundamental about the phenomenon of insight. Returning to the free-energy principle, we know that an agent can minimize free energy via perceptual (Friston and Kiebel, 2009) and active inference (Friston *et al.*, 2012b), both of which entail sampling and sculpting the world to refine internal representations of it and thus reduce uncertainty or enhance confidence. There is, however, another higher level at which free energy may be minimized, namely via the selection and/or revision of beliefs about the acquired models themselves. This is known as BMS and BMR.

BMR is a particularly intriguing form of BMS that is likely to play a central role in brain development, e.g., in the form of synaptic pruning (Piochon *et al.*, 2016) and formation of small-world architectures (Avena-Koenigsberger *et al.*, 2014). In brief, BMR is the hypothesized mechanism via which high-level models are stripped of their redundancy so that simpler, more refined solutions may be revealed. Again, we see the theme of complexity minimization and compression in play. In this setting, one can refine high-level models or narratives to make them simpler by removing redundant parameters, thereby revealing the underlying core structures and manifolds. Crucially, this mechanism can proceed without the need for new data (fact-free learning) and is thought by some to be the purpose of sleep and accompanying synaptic homoeostasis (Hobson *et al.*, 2014).

Importantly, optimal models must strike a balance between the following: 1) breadth or comprehension and 2) accuracy or precision. Broad (minimally complex) models can serve as catch-all representations that generalize across different scenarios. Meritorious for their generalizability, they may, however, suffer from oversimplicity, e.g., with too few parameters to say anything specific about a given phenomenon. Accurate models are naturally meritorious for their fidelity to a given phenomenon but can fall foul of overmodeling, in which an overparameterized model poorly translates from one phenomenon to another. It has been hypothesized that implicit processes of BMS and BMR underlie the experience of insight, with a particular emphasis on the latter. This is because the relevant "aha" or "eureka" experiences typically emerge spontaneously, "out of the blue," as simple, elegant solutions, presumably because redundant models and/or model parameters have been unconsciously stripped away, leaving the "bare truth beneath."[22] Computational simulations have recently leant support to this conception of insight (Friston *et al.*, 2017).

It is natural to speculate that BMS and BMR may underlie the occurrence of insight under psychedelics, and that psychedelics catalyze these processes of model refinement. Psychedelics have been shown to increase the entropy or complexity of spontaneous brain activity (Carhart-Harris, 2018a), which, on first glance, may be seen as inconsistent with BMS and BMR. Rather, we suggest that the acute psychedelic "hot state" reflects the preconditions for subsequent insight; i.e., it reflects a key phase of the process by which insight occurs in which confidence in high-level models is first relinquished so that content previously hidden from consciousness by the occluding influence of overly confident priors is now allowed to emerge, thereby enabling fresh perspectives to be entertained. Under conditions of relaxed high-level priors, disinhibited information is allowed to travel up the hierarchy and impress on consciousness as it does. In this way, one may be granted a fresh opportunity to cultivate changes to the relevant assumptions instantiated by high hierarchical levels.

Relatedly, in the acute hot state, the mind can explore its unfurled state space with fewer constraints, consistent with curious behavior (e.g., as in Fig. 1). In this way, the conscious explorer may discover novelty that was previously hidden from clear sight. Relatedly, he/she may report being able to see things from afar as per the overview effect originally described by astronauts (White, 1987). The overview effect is, of course, consistent with BMR and the pruning away of detail to see the bigger picture. Realizations of this sort are often felt as beautiful and transcendent in their simplicity and profundity but have also been queried as platitudinal:

"**Love is everything**... Is a platitude so deeply felt still just a platitude? No, I decided. A platitude is precisely what is left of a truth after it has been drained of all emotion. To resaturate that dried husk with feeling is to see it again for what it is: the loveliest and most deeply rooted of truths, hidden in plain sight. A spiritual insight? Maybe so" (Pollan, 2018). The following are further firsthand references to experiences of insight experienced under psychedelics, plus another, for the sake of comparison, from an Apollo-mission astronaut. It is easy to appreciate their resonance with the mechanics described in this section, in particular the experience of being able to see a bigger picture:

> "I was being reminded of things I already knew" (Watts *et al.*, 2017); "I was learning without being taught" (Watts *et al.*, 2017); "There had been, I felt, an opening of the heart" (Pollan, 2018); "Patrick described an epiphany having to do with simplicity: '...I was convinced in that moment I had figured it all out… It was right there in front of me… love… the only thing that mattered'" (Pollan, 2018); "Like google earth; I had zoomed out" (Watts *et al.*, 2017); "In my cockpit window, every two minutes: the earth, the moon, the sun, and whole panorama of the heavens… And suddenly I realised that the molecules of my body, the spacecraft, the body of my partners, were all manufactured in some ancient generation of stars. I felt an overwhelming sense of oneness, or connectedness...- an insight, an epiphany" (Pollan, 2018).

3. Criticality and Optimality

Criticality is a phenomenon described and studied within dynamical systems theory and complexity science that refers to complex dynamics that occur when a system nears a transition point between order and disorder. A self-organized critical system can exhibit complex emergent phenomena such as self-similarity, avalanching, long-range correlations, and critical slowing (Chialvo, 2010). The notion of a critical brain posits that neuronal activity is poised at criticality (Chialvo, 2004), and the entropic brain hypothesis states that psychedelics bring the brain closer still to such a critical point, as reflected by stronger signatures of criticality in the psychedelic state (Carhart-Harris *et al.*, 2014; Carhart-Harris, 2018a). These latter findings imply that normal brain function (at least in awake adults) can be tuned closer to criticality, meaning that, with respect to the psychedelic state, normal waking consciousness biases order over disorder, or preservation over adaptation (Carhart-Harris *et al.*, 2014; Carhart-Harris, 2018a) - at least in relation to the psychedelic state and even though it may still exhibit properties of criticality itself (Hilgetag and Hutt, 2014). The hypotheses that the waking brain can be tuned closer to criticality and that psychedelics do indeed do this have both recently been leant significant empirical support (Atasoy *et al.*, 2017; Tagliazucchi, 2017; Muthukumaraswamy and Liley, 2018; Varley *et al.*, 2019).

What is the relationship between criticality and model optimality? Are inequalities or asymmetries in the adult human brain's functional architecture, such as high a power and high degree centrality of and metabolism in DMN nodes,[23] indicative of a top-heavy system that biases high-level models (such as the ego and its various beliefs and defenses) over data? Does this top heaviness render the adult human mind somewhat impervious to the fullness of information contained within lower levels of the system, such as the classically mammalian system (MacLean, 1990) that is the limbic system? Is this top heaviness especially exaggerated in certain psychopathologies such as depression, obsessive-compulsive disorder, and eating disorders? These are examples of disorders that may rest on particularly rigid high-level priors that dominate cognition and likely serve a defensive function (Carhart-Harris, 2019).

These are important questions, and it is not difficult to imagine how they could be tested.[24] Little work has been done on enduring brain changes after a psychedelic experience, but what evidence there is does suggest potential thinning in the posterior cingulate cortex node of the DMN with repeated ayahuasca use (Bouso *et al.*, 2015) and also changes in DMN functional connectivity 1 day after psilocybin therapy for depression (Carhart-Harris *et al.*, 2017). If BMR does play a role in insight under or after a psychedelic experience, we might predict a flattening of the relevant free-energy (attractor) landscape postacutely, e.g., this might present as an attenuated vestige of the more dramatic flattening likely to characterize the acute psychedelic state (Atasoy *et al.*, 2018); e.g., see Fig. 1. Future work may focus on the DMN, with the prediction that its usual dominance is subdued post-treatment, e.g., with characteristic changes in time-series complexity and criticality that can be quantified empirically. If there is an enduring nature to the relaxation of high-level compressive models, we might also seek to test the notion that the brain is more sensitive to simple sensory prediction error post-treatment with a psychedelic. Such a finding would be consistent with a scenario in which a postacute relaxation of priors allows for an enhanced sensitivity to "data." Recent findings of increased amygdala responsivness to emotional faces post-treatment with psilocybin, for example, could be seen as consistent with such a scenario (Roseman *et al.*, 2018a). Other more classic prediction-error paradigms might also reveal an enhanced neuronal surprise signal post-treatment with psilocybin, consistent with a vestigial lightening of top-down constraints and concomitant sensitivity to bottom-up information flow.

4. Therapeutic and Epistemic Transformation

There is growing interest in the potential of psychedelics to treat various psychiatric disorders (Carhart-Harris and Goodwin, 2017; Rucker *et al.*, 2018). Evidence from a series of recent small-scale studies (Moreno *et al.*, 2006; Grob *et al.*, 2011; Gasser *et al.*, 2014; Bogenschutz *et al.*, 2015; Osório Fde *et al.*, 2015; Carhart-Harris *et al.*, 2016a, 2018a; Griffiths *et al.*, 2016; Ross *et al.*, 2016; Palhano-Fontes *et al.*, 2019), in addition to population studies (Krebs and Johansen, 2013; Hendricks *et al.*, 2015), controlled studies in healthy individuals (Griffiths *et al.*, 2006; Schmid and Liechti, 2018), conceptual and empirical mechanistic work (Carhart-Harris *et al.*, 2012a, 2014, 2017, 2018c; Carhart-Harris and Nutt, 2017; Roseman *et al.*, 2018), naturalistic and observational studies (Thomas *et al.*, 2013; Argento *et al.*, 2017; Lafrance *et al.*, 2017; Haijen *et al.*, 2018), and meta-analyses of historic trials from the mid-20th century (Krebs and Johansen, 2012; Rucker *et al.*, 2016) has leant collective support to the position that psychedelic therapy offers a promising new treatment option for patients and mental health care providers. The question now follows, how does it work (Carhart-Harris, 2019)?

Previous commentaries have hypothesized (Fletcher and Frith, 2009) and demonstrated aberrant predictive processing in a variety of psychopathologies, from autism (Van de Cruys *et al.*, 2017) and schizophrenia (Powers *et al.*, 2017) to addiction (Gu, 2018) and depression (Chekroud, 2015). Several factors support the notion that there exists a common mechanistic denominator underlying different expressions of mental illness. These include the following: 1) putatively high comorbidity (Maj, 2005), 2) the poor reliability of diagnoses across diagnosing clinicians (Richieri *et al.*, 2011), and 3) absence of specific and reliable biomarkers to bolster such diagnoses (Venkatasubramanian and Keshavan, 2016), and the fact that the same category of drug can be used to treat a number of different disorders (Kramer, 1994; Whitaker, 2010). If such a common denominator exists, however, what might it be? Some have suggested it may be a loss of meaning and associated sense of dislocation (Alexander, 2008) or disconnection (Watts *et al.*, 2017; Hari, 2018), others have proposed a narrowing of focus (or "capture") in a context of a perceived loss of control (Kessler, 2016), while still others have proposed pathologic precision weighting of priors (Friston *et al.*, 2014). See also Carhart-Harris (2019).

It is reasonable to suspect that these different models are largely inter-related, and, indeed, it is easy to see how they can be subsumed under the free-energy principle. In this study, we take the position that most, if not all, expressions of mental illness can be traced to aberrations in the normal mechanics of hierarchical predictive coding, particularly in the precision weighing of both high-level priors and prediction error. We also propose that, if delivered well (Carhart-Harris *et al.*, 2018c), psychedelic therapy can be helpful for such a broad range of disorders precisely because psychedelics work pharmacologically (5-$HT_{2A}R$ agonism) and neurophysiologically (increased excitability of deep-layer pyramidal neurons) to relax the precision weighting of high-level priors (instantiated by high-level cortex) such that they become more sensitive to context (e.g., via sensitivity to bottom-up information flow intrinsic to the system) and amenable to revision (Carhart-Harris, 2018b).

Consistent with the model presented in this work, overweighted high-level priors can be all consuming, exerting excessive influence throughout the mind and brain's (deep) hierarchy. The negative cognitive bias in depression is a good example of this (Beck, 1972), as are fixed delusions in psychosis (Sterzer *et al.*, 2018).[25] In this paper, we propose that psychedelics can be therapeutically effective, precisely because they target the high levels of the brain's functional hierarchy, primarily affecting the precision weighting of high-level priors or beliefs. More specifically, we propose that psychedelics dose-dependently relax the precision weighting of high-level priors (instantiated by high-level cortex), and in so doing, open them up to an upsurge of previously suppressed bottom-up signaling (e.g., stemming from limbic circuitry). We further propose that this sensitization of high-level priors means that more information can impress on them, potentially inspiring shifts in perspective, felt as insight. One might ask whether relaxation followed by revision of high-level priors or beliefs via psychedelic therapy is easy to see with functional (and anatomic) brain imaging. We presume that it must be detectable, if the right questions are asked in the right way.

It seems reasonable to suppose that the relevant transformations reported under and after a psychedelic experience (Griffiths *et al.*, 2006; Watts *et al.*, 2017) are principally epistemic in nature, i.e., manifesting as revisions in awareness or perspective, but it stands to reason that they must still register on some level as a change in brain function. It may be difficult, but not impossible, to identify the relevant neuronal changes, and doing so will be a particular challenge for psychedelic science. One difficulty may relate to the level of analysis. For example, the apparently fundamental nature of the long-term psychological changes seen with psychedelics (e.g., in personality and outlook) suggests that something particularly high level or large scale may also have transpired in the brain.[26] One thought is that we may need to look at trajectories of brain states rather than individual brain states per se, to see in high-level beliefs in action (Cabral *et al.*, 2017), how they change after psychedelics (Lord *et al.*, 2018), and how this relates to the relevant psychological change(s).

5. Are Psychedelic-Induced Insights Trustworthy?

Before closing this section, we wish to address a difficult question that is often raised in relation to psychedelic therapy and specifically the principle that psychedelics work to facilitate insight. This is the question of whether the reported insight is veridical - in the sense of reflecting things that are actually true or real. For example, it is not uncommon for patients to report apparent recovery of repressed memories under psychedelics (Sandison, 1954; Carhart-Harris, 2007), and indeed, we had one such case in our recent psilocybin for treatmentresistant depression trial (Carhart-Harris *et al.*, 2018a).

Without wishing to fall down a philosophical rabbit hole, the most pragmatic position may be to accept such experiences as psychologically real in the sense that they are inferences that serve to close an explanatory gap, and do so relatively effectively. In this sense, magical, religious, and delusional beliefs or interpretations may be considered psychologically real. That magical beliefs are common in situations of uncertainty (Bersabe and Arias, 2000) speaks to the principle that belief in magic can serve a psychological function. This sympathy with gap-filling, jumping to conclusions, or abductive reasoning (Friston *et al.*, 2017) is also a principle that governs care in the context of patients with psychosis, for example, where clinicians refrain from attempting to correct delusional beliefs because of an acknowledgment that doing so may be destabilizing for the patient.

This problem has recently been addressed in a thoughtful philosophical piece, entitled "the epistemic innocence of psychedelic states" (Letheby, 2016), which essentially takes a stance that is consistent with the one described above, i.e., that (apparent) insight be viewed with equanimity if it appears to mediate positive therapeutic outcomes, even if the apparent insight is founded on dubious (e.g., supernatural) assumptions. Technically, the philosophical rabbit hole dissolves further in the face of the free-energy principle. This follows because the free-energy principle maintains that there is no absolute truth that is knowable absolutely - there is only evidence for a set of plausible hypotheses. In other words, the best beliefs or models are simply those with the greatest evidence - or minimum free energy.

In essence, the free-energy principle works to approximate reality through invoking, testing, revising, and optimizing models. Effective approximations of reality are reliable and trustworthy, whereas less optimal models are flimsy and fragile, e.g., they may be overly complex and/or poorly translatable. If such models fail, this will expose their fallibility to the agent, together with a likely unpleasant rise in his/her sense of uncertainty. Thus, a commitment to the discovery of better models is important, as improved models will provide more robust and reliable approximations to reality, which are likely to support greater stability in terms of mental health.[27] These principles may be seen to speak to the merits of the scientific method for determining "what is best to believe." For example, although supernatural belief systems may have once been helpful for humans[28] - they are arguably less so today. Moreover, beliefs held as a matter of faith are less amenable to the mechanics of self-correction that underlie empirical approaches.

G. What to Do About the "woo"?[29]

Psychedelics have an interesting history of association with pseudoscience and supernatural belief. One interpretation of this is that a strong psychedelic experience can cause such an ontological shock that the experiencer feels compelled to reach for some kind of explanation, however tenuous or fantastical, to close an epistemic gap that the experience has opened up for them. This is an important matter, particularly as increasing numbers of people are likely to be experimenting with psychedelics in the coming years - but it is also a rich topic that deserves a separate discussion piece of its own.

It is important, however, to address this matter briefly in this work, as it is a problem that speaks to the special value of a naturalistic approach to psychedelics, as well as a responsible one that includes provision of education (e.g., about the importance of psychological preparation and integration) alongside careful engineering of the experience itself (Carhart-Harris *et al.*, 2018c). If done properly, tenuous magical explanations can then be challenged appropriately (although not during the experience itself - as to do so would be inappropriate) in the skeptical, self-correcting fashion that is intrinsic to the scientific method. Reliable and robust models of natural phenomena, of the sort that science endeavors to discover and finesse, serve us best, as they are less likely to betray us, leaving us open to logical fallacies, dogmatism, absolutism, and an emotional and existential instability.

The phenomenon of spiritual bypassing is relevant in this work. This refers to an ontology in which individuals receive so much (potential) information, rapidly, without sufficient time to properly integrate or assimilate it (Masters, 2010). In experiencing such information overload, the psychedelic initiate may reach for bizarre beliefs or poorly understood platitudes, in an effort to explain away his/her felt uncertainty - in a similar way as may occur in the incipient phase of a psychotic disorder. Spiritual bypassing may be understood as an escapist defense, dressed up as a spiritual awakening. Combining psychedelic therapy with a secular wisdom teaching, such as can be found in nonreligious Buddhism for example (Batchelor, 1998; Hanh, 2017), as well as depth psychology (Freud, 1934, 1949; Jung, 1960, 1969), may have considerable value in this regard, helping to ground psychedelic science and medicine, while inoculating against evangelism.

H. The Anarchic Brain

The anarchic brain principle is a natural counterpart to relaxed beliefs under psychedelics (REBUS). This is because the relaxation of high-level priors necessarily implies a liberation of bottom-up information flow (particularly from intrinsic sources). Thus, because top-down control is a defining property of hierarchy, REBUS is commensurate with a loss of functional hierarchy in the brain. The word "anarchy" has a Latin-Greek origin and means "without chief" or "ruler." It is most typically used in political contexts to refer to "a state of disorder due to absence or nonrecognition of authority or other controlling systems" or "absence of government and [thus] absolute freedom of the individual" (Oxford English Dictionary). The anarchic brain principle is a close complement to the entropic brain hypothesis. Both feature as part of their definition, the principle that psychedelics enhance brain entropy (e.g., as measured by Lempel-Ziv complexity) and bottom-up information flow (e.g., measurable via effective connectivity). Both principles are also intended to apply first and foremost to spontaneous brain activity - and are difficult to assess using classic stimulus-response paradigms - for reasons discussed elsewhere (Carhart-Harris, 2018a).

As an extension of the anarchic brain principle, in this final section, we speculate that the structural organization of brains (and minds) recapitulates the organization of social systems. Just as the free-energy principle recognizes the importance of hierarchy inside the brain, so it recognizes it elsewhere in nature. For example, we may think of individuals constrained by communities, constrained by nation states, constrained by unions of states, etc. We may also reflect on the hierarchy of beliefs at each level, e.g., with individual beliefs constrained by community beliefs, constrained by national beliefs, constrained by transnational beliefs. We do not wish to take this analogy too far, only to raise the idea, which, of course, is inherent in the free-energy principle, that beliefs are hierarchical, and humans are apparently unique among the animal species because of the temporal thickness of their beliefs, spanning greater periods of time than do the generative models of other species (Becker, 2011; Chouraqui, 2011; Seth and Friston, 2016).

Grounding these ideas in biology, neuroimaging research with psychedelics has revealed a breakdown in modular integration under these compounds that is superseded by a desegregated, more globally interconnected organization of brain function (Roseman *et al*., 2014; Carhart-Harris *et al*., 2016c). It has also been shown that these brain changes correlate with peoples' ratings of ego dissolution under the drug (Tagliazucchi *et al*., 2016), which, when it is surrendered to (Haijen *et al*., 2018), includes as a logical corollary of it, the so-called unitive experience, i.e., a sense of union and interconnectedness with objects and entities previously seen as external to oneself (Hanh, 2017; Roseman *et al*., 2018b). We have recently seen that a globally connected brain state is visited more regularly under psychedelics than other brain states, whereas certain high-level states/networks become neglected (Lord *et al*., 2018). Such an outcome can be seen as commensurate with a flattened energy landscape.

The unitive experience is closely related to the overview effect described in a previous section, and it is also the essential, defining characteristic of the mystical (Maclean *et al*., 2012) - or perhaps better-phrased peak experience (Roseman *et al*., 2018b). Note that whereas the peak experience itself can be treated as irreducible in the experiential sense, its occurrence may still depend on reaching a critical level of 5-HT$_{2A}$R occupancy and signaling (Madsen *et al*., 2019) - a useful reminder that however high level a psychological phenomenon is, it will still rest on discernable physical, energetic, and chemical processes.

A number of research teams have shown that the occurrence of peak experiences under psychedelics is predictive of long-term positive changes in psychological well-being [e.g., Roseman *et al*. (2018b)], as well as changes in personality in the direction of increased openness (MacLean *et al.*, 2011; Erritzoe *et al.*, 2018). It is a matter of some curiosity that the personality trait openness has reliably been shown to correlate with liberal political perspectives (Carney *et al.*, 2008), and a realization of this led to a series of studies by us (Nour *et al.*, 2017; Lyons and Carhart-Harris, 2018a) and others (Forstmann and Sagioglou, 2017) that have demonstrated long-term changes in political perspective in association with the use of psychedelics.

It is natural to speculate from these findings that changes in brain function that may be defining of the psychedelic state, e.g., heightened brain entropy, modular disintegration, increased global integration, and increased bottom-up information flow from intrinsic sources (Carhart-Harris, 2018a), may be involved in the mediation of (potentially) fundamental transformations in beliefs, including changes in personality and outlook. Providing initial support for this, we previously found a relationship between increased brain entropy under LSD, as measured with functional magnetic resonance imaging, and subsequent increases in trait openness (Lebedev *et al.*, 2016). Moreover, on a purely psychological level, we have found that ego dissolution mediates long-term increases in trait liberalism and decreased authoritarianism (Nour *et al.*, 2017).

How these acute brain changes and associated mind states trigger the relevant long-term changes in beliefs is, at this stage, not fully understood - but increased bottom-up information flow (i.e., from lower-level intrinsic systems such as the limbic system) impacting on sensitized high-level priors (e.g., high-level networks and their dynamics) are logical places to look. The relevant transformations themselves are epistemic in nature, e.g., taking the form of a revised awareness or perspective. Once discovered, the newly appreciated awareness cannot easily be forgotten, tantamount in some ways to the effect of trauma. However, how do these epistemic transformations register in the brain? Are they detectable in anatomy as well as function? Is there such a thing as a liberal or libertarian brain (Kanai *et al.*, 2011)? Is the brain's functional hierarchy organized differently in an individual with strong libertarian and/or liberal views, compared with someone holding strong authoritarian and/or conservative beliefs?

Two figureheads in psychedelic research and therapy, Stanislav Grof and Roland Griffiths, have highlighted how psychedelics have historically "loosed the Dionysian element" (Pollan, 2018) to the discomfort of the ruling elite, i.e., not just in 1960s America but also centuries earlier when conquistadors suppressed the use of psychedelic plants by indigenous people of the same continent. Former Harvard psychology professor, turned psychedelic evangelist, Timothy Leary, cajoled that LSD could stand for "Let the State Dissolve" (Pollan, 2018). Whatever the interaction between psychedelic use and political perspective, we hope that psychedelic science will be given the best possible opportunity to positively impact on psychology, psychiatry, and society in the coming decades - so that it may achieve its promise of significantly advancing self-understanding and health care. An ill-thought-through repoliticization of psychedelic use would likely be counterproductive in this regard.

Whatever the sensitivities surrounding these issues, it seems right to openly acknowledge the possibility that increased psychedelic use could have broader social and political implications. If rates of psychedelic use were to escalate, poorly integrated experiences could leave individuals awash in uncertainty and eager for solace in tenuous, or, worse, delusional beliefs that serve to stop-gap uncertainty. We advocate a commitment to the position that - however otherworldly it may feel - the psychedelic experience is a thing of nature, intimately linked to discernible changes in brain function. It is possible that such a naturalistic, scientific approach to psychedelics may spawn greater interest in deep ecology (Naess, 1984). Relatedly, integrating observations from psychedelic science, with insights from physics and life sciences (Bejan, 2016), depth psychology (Safran, 2003; Hill, 2013), and Buddhist philosophy (Hanh, 2017), may help to nourish and ground the field.

I. Summary

To summarize, the REBUS/anarchic brain model[30] is derived from a synthesis of the entropic brain hypothesis and free-energy principle, and particularly the latter's close links with hierarchical predictive coding. It recognizes that psychedelics induce an acute state of heightened brain entropy via their action on the serotonin system (Carhart-Harris, 2018a), then looks to prediction coding and hypothesizes that increased brain entropy reflects a relaxation of the precision weighting of priors (REBUS) that coincides with liberation of bottom-up signaling (anarchic brain).

To aid the testing of the REBUS/anarchic brain model, we propose a number of specific indices of priors and bottom-up signaling such as the functional integrity and dynamics of high-level brain networks (REBUS) and effective connectivity applied to relevant circuitry, such as circuitry connecting the hippocampus/parahippocampus with cortical nodes of the DMNs. More broadly, the model could be assessed by examining any of several aspects of hierarchy in the brain (Murray *et al.*, 2014; Margulies *et al.*, 2016; Deco and Kringelbach, 2017), with the simple hypothesis that key features of hierarchy will be diminished under a psychedelic.

We also dedicate significant discussion to implications of the REBUS/anarchic brain model. One of these is that the relaxation of priors implies that the system's (context) sensitivity will be enhanced - as it will be more receptive to bottom-up information, particularly from intrinsic sources such as the limbic system. Thus, if the belief relaxation process is combined with good contextual support, pathologic beliefs underlying psychiatric illness, for example, may be amenable to revision during and after a psychedelic experience. The ideal effect of such a belief revision process would be to make the updated priors resonate more harmoniously with previously hidden or silenced information. If mediated properly, this belief-recalibration process may have long-term positive consequences for mental health; indeed, the described process is the very essence of effective psychedelic therapy (Haijen *et al.*, 2018; Lyons and Carhart-Harris, 2018b).

Throughout this work, we have made reference to a prominent effect of psychedelics on hierarchically high-level priors. Although the REBUS model is not restricted solely to high-level priors, one compelling reason to place emphasis on hierarchically high or deep components of the brain is the especially high expression of 5-HT_{2A}Rs (the key target of psychedelics) on layer 5 pyramidal neurons within the brain's high-level cortical regions (Jakab and Goldman-Rakic, 1998; Beliveau *et al.*, 2017). Collectively, these high-level features of the brain are thought to encode expectations and beliefs about the lived world. Findings of dysregulated activity in pyramidal cell firing (Celada *et al.*, 2008), the DMN (Carhart-Harris *et al.*, 2012a), other high-level intrinsic networks (Lebedev *et al.*, 2015; Carhart-Harris *et al.*, 2016c), trajectories of brain states (Lord *et al.*, 2018), and hierarchically high-level (but relatively low-frequency) spontaneous neuronal oscillations (Muthukumaraswamy *et al.*, 2013) add further weight to the hypothesis that psychedelics have a particularly pronounced action high up in the brain's functional hierarchy.

In accordance with the free-energy principle (and with dual-aspect monism), one can view the dynamics of high-level intrinsic networks as the dynamic or energetic counterparts of high-level priors (e.g., see Carhart-Harris and Friston, 2010). Indeed, the DMN itself has been described as the brain's "Centre of Gravity" (Davey and Harrison, 2018). The self or ego is an important (perhaps central) high-level prior that DMN dynamics may instantiate (Carhart-Harris and Friston, 2010). The DMN is a particularly influential system, sitting atop a (uniquely) deep functional hierarchy in humans (Friston, 2018). We reason that high-level systems and the beliefs they encode have an informationally efficient, compressing influence on more elemental information held and processed below them. The high-level systems therefore function to route or canalize thought and behavior, sometimes in an overly constraining way that restricts self-awareness and obstructs new learning.[31] If the gravitational pull of beliefs or behaviors becomes excessive, this can leave an agent feeling estranged from deeper aspects of his or her self, as well as from other people - and from a sense of purpose and meaning in life (Watts *et al.*, 2017; Carhart-Harris *et al.*, 2018b; Hari, 2018).

Curiously, psychedelics appear to temporarily breach the free-energy principle, i.e., by relaxing priors and increasing brain entropy for a time-limited period, but, once the drug has been sufficiently metabolized, normal brain function resumes and systems reset, potentially (but by no means absolutely) in a healthier way (ideally), more in tune with each other and the sensorium. We propose that mechanisms of BMS and BMR are catalyzed by the time-limited entropic state induced by psychedelics, such that model redundancy can be minimized, and high-level priors refined or "spring-cleaned." The following is a first-person testimony that speaks to the hypothesized effect:

> "It was like when you defrag the hard drive on your computer, I experienced blocks going into place, things being rearranged in my mind, I visualized as it was all put into order, a beautiful experience with these gold blocks going into black drawers that would illuminate and I thought: 'My brain is bring defragged, how brilliant is that!'" (Watts *et al.*, 2017).

Whether model reduction necessarily leaves an agent with a robust, reliable, and refined statistical representation of the world is, however, an open question - as is what the specific mechanics of this model reduction process are, and how we can measure them in the brain.

Returning to psychology, in the previous section we addressed a phenomenon known as spiritual bypassing that can be observed among some (Western)[32] users of psychedelics. Magical beliefs may be helpful (via reducing free energy and associated uncertainty), particularly in cultures that support this, but it is difficult to see how the use of any belief as psychological escape can be regarded as optimal or sustainable. We anticipate that it may become possible in the future to demonstrate, via some particular metric, how harmony between different levels of the brain's functional hierarchy relates to a felt psychological harmony reflective of a well-integrated mind and brain. Doing so may require that we look at longitudinal data such as mood stability (and associated brain activity) over months, with the prediction that emotional escape or avoidance predicts long-term mood instability, even after a potential initial positive spike in mood. Although speculative, candidates for meaningful metrics of harmony in the brain/body may be found in the various signatures of criticality, such as long-range correlations, nesting of oscillatory rhythms (Murray *et al*., 2014), body-brain physiologic coupling (Richter *et al*., 2017), and environment-brain alignment (Lakatos *et al*., 2013). This notion of harmony may also relate to a previously discussed construct of connectedness and its special relevance to psychedelic therapy (Watts *et al*., 2017; Carhart-Harris *et al*., 2018b).

[11] For a more detailed account of the specific signalling pathways engaged by psychedelics, see Marek (2018) and [López-Giménez JF, González-Maeso J (2018) Hallucinogens and serotonin 5-HT(2A) receptor-mediated signaling pathways. *Curr Top Behav Neurosci* 36: 45-73]. Do note that these signalling pathways are complex as it is still not yet fully clear which signalling pathway or combination of them is necessary and sufficient for a psychedelic drug's typical effects to manifest. There is also the phenomenon of functional selectivity to consider, i.e., that psychedelics appear to activate 5-HT$_{2A}$Rs in a different way to the endogenous ligand, 5-HT [González-Maeso J, Sealfon SC. Agonist-trafficking and hallucinogens. *Curr Med Chem* 16(8):1017-27]. The context and location of the 5-HT$_{2A}$R-expressing neuron also needs to be factored in, e.g., highly 5-HT$_{2A}$R-expressing deep-layer pyramidal neurons appear to be those that are most likely to be directly activated by psychedelics [Martin DA, Nichols CD (2016) Psychedelics recruit multiple cellular types and produce complex transcriptional responses within the brain. *EBioMedicine* 11:262-277].

[12] We use the metric of within-network functional connectivity as an index of integrity within the DMN here.

[13] The "critical" here refers to a "critical point" in a phase transition between order and disorder in which interesting emergent phenomena such as critical slowing become evident; Chialvo (2010).

[14] Critical slowing refers to a property of critical systems in which they are especially sensitive to perturbation. The term slowing refers to the property of being slow to recover from the perturbation - analogous to a pebble causing persistent ripples on the surface of a lake - versus, e.g., a pebble having little impact on a thickly frozen (subcritical) lake.

[15] Ketamine has similarly been shown to have a rapid mood-lifting effect in depression; however, its ability to engender lasting psychological changes does not appear to be equivalent to that of the classic psychedelics. More work is needed to ascertain why this is the case, but one possibility is that (perhaps due to an absence of a significant gradient in the cortical-subcortical N-methyl-D-aspartate receptor profile) ketamine does not subvert hierarchical message passing in quite the same way as psychedelics, and thus the release of (precise) bottom-up influences on sensitized high-level priors - leading to their long-term revision - is less evident with ketamine. Relatedly, ketamine may not engage insight-related processes in the same way as classic psychedelics appear to.

[16] Indeed, there is comparatively little research on psychedelics affecting truly higher-level priors, although we looking to rectify this.

[17] Note an important nuance here: hypersensitivity to stimulation extrinsic to the system (i.e., via sensory stimulation) may only be the rule within a critical dose range, above which brain function is likely to be dominated by its intrinsic activity - and so become insensitive to extrinsic information (Michaiel *et al*., 2019), but still sensitive to bottom-up information flow from within the system itself, e.g., via the limbic system to the cortex.

[18] https://www.youtube.com/watch?v=kjeCNnbVYAQ

[19] BMS is a mechanism by which a best-performing model is identified from a set of models. Model performance is determined by a trade-off between model fit (specificity) and model complexity. Good models are those that fit data well enough, i.e., they do not overfit the data through the inclusion of too many parameters.

[20] Bayesian model reduction is a mechanism through which model parameters are pruned to reduce model complexity. It is a mechanism of model optimization done in aid of model selection.

[21] Expected uncertainty is a mindset that is encouraged ahead of psychedelic therapy and speaks to an important difference between the psychedelic experience and psychosis, i.e., where uncertainty is not expected and so prediction error is not accepted or integrated.

[22] Addressing the question of whether the unconscious in the classical psychoanalytic sense (regardless of specific schools) influences conscious cognition and behavior, we can answer that it is our assumption that the unconscious does indeed influence behavior. This assumption is consistent with the position of classical psychoanalytic thinkers such as Freud and Jung. Personal testimonies speak to this assumption when individuals report insights about how past events have led to current behaviors without

their conscious awareness. It is clearly important to consider how this assumption might be tested, so that stronger inferences can be drawn. One might construe implicit processing as a cognitive psychology homologue of this psychoanalytic idea, and implicit association paradigms could be used to probe it behaviorally.

[23] Marcus Raichle: "Chaos is averted because all systems are not created equal... At the top of hierarchy resides the DMN" - cited in Ref. 20.

[24] First one needs to provide a concrete definition of top heaviness and then test, e.g., that this is greater in relevant psychopathologies versus health and also that effective treatment with a psychedelic reduces them. One candidate for top-down influence might be DMN to limbic effective connectivity; another is a power; and yet another is to equate top heaviness with subcriticality, and thus state that stronger signatures of criticality reflect a less top-heavy system.

[25] To be clear, for reasons stated earlier, we are not, at this stage, proposing psychedelic therapy as a treatment of psychotic disorders. Such a proposition would require much careful thought and qualification - and even still, may not pass as feasible/indicated.

\

[26] Note also that preclinical molecular and cellular approaches can now detect long-term postpsychedelic changes, as might human positron-emission tomography and high-field magnetic resonance imaging. Although it is not always straightforward to decipher how molecular and cellular changes translate to human psychology, combining high-resolution measures with conventional functional brain imaging may be a potentially fruitful strategy.

[27] From a statistical perspective - and machine learning - this robustness is cast in terms of the ability to generalize to new data. This rests on flattening short minima to reduce model complexity and preclude overfitting.

[28] Note: we adopt the view that Buddhism (like science) is not a religion but a method and (like science) performs best when treated as such.

[29] "woo" or "woo-woo" is a slang term with an unknown etymology. It is assumed to stem from its jocular and often pejorative use, when imitating a sound effect or the music one might hear during the depiction of supernatural events on television, in theatre, or in films. Succinctly, "woo-woo" refers to belief in the supernatural, paranormal, occult, and has a particular association with pseudoscience, particularly in the West.

[30] We treat the two components as mutually dependent, i.e., relaxed priors naturally imply increased prediction error.

[31] One might think of the notion of the "ego tunnel" here (Metzinger, 2009).

[32] One could argue that spiritual bypassing is a distinctly Western phenomenon, as developments in scientific understanding in the West means that (unlike among indigenous tribes for example) the dominant culture is no longer set up to support magic. One may choose to ignore or reject scientific knowledge in the West, but to do so is contrary to evidence. Conversely, among indigenous cultures, magical explanations may be the best explanations available, and thus, no such accusations of willful ignorance can be made against these cultures.

III. Conclusions

This paper has sought to marry insights from the free-energy principle with those of the entropic brain hypothesis to account for the acute and longer-term brain and mind effects of psychedelics. We have named this synthesis REBUS and the anarchic brain. "REBUS" is an intentionally easy-to-remember acronym based on the key theme of RElaxed Beliefs Under pSychedelics, and the anarchic brain follows naturally from the liberation of bottom-up signaling - which is logically implied by relaxed precision on priors. We have described how this mechanism begins with agonist actions at the 5-$HT_{2A}R$ and can be reflected in the entropy of spontaneous cortical activity. The present model significantly advances on the entropic brain hypothesis, however, by introducing the notion of a relaxation of the precision weighting of priors - which concomitantly liberates bottom-up signaling that, with the right preparedness, care, and aftercare, can aid the revision of pathologically over-weighted priors.

We propose that the REBUS/anarchic brain model can explain the full gamut of phenomena associated with the psychedelic experience, including the emergence of previously unconscious psychological material into conscious awareness.33 We also propose that high-level priors confer a broad summarization of the mind and world, effectively suppressing away (potential) content. It therefore follows that if this suppression is relaxed, as it is under psychedelics, content will necessarily be released. It is an ideal of psychedelic therapy that this newly available content be appropriately integrated and assimilated into existing mental models so that more of the inner and outer world can be processed.

Importantly, we also propose that the acute brain conditions induced by the pharmacological action of psychedelics, increasing brain entropy and relaxing the precision weighting on priors, are ideal for working on the revision of high-level priors or beliefs. Consistent with recent work on the mechanics of insight, an entropic brain with relaxed high-level priors will be more amenable to curious behavior and Bayesian model optimization processes that can aid the occurrence of insight and perspective change. We suspect that this template of pharmacologically and contextually mediated belief relaxation and revision may serve a major role in the future of mental health care, potentially improving the efficacy of current treatment strategies by factoring in contextual variables when assessing the neurobiology of a given disorder and the viability of a specific intervention (Carhart-Harris, 2018b).

Finally, although we are optimistic about the potential of psychedelic therapy to positively impact on psychology and psychiatry in a major way in the coming decades, it feels prudent to consider complications that may arise as increasing numbers of people choose to undergo a psychedelic experience. In this study, we wish to highlight what the scientific model has to offer, i.e., via trial and error, forever improving models of mind and world. If integrated properly, psychedelics have every chance of becoming a legitimate, if not lauded, tool of science and medicine - capable of awakening us to the true depths of our being and continuousness with nature.

"Whether by their very nature or the way that first generation of researchers happened to construct the experience, psychedelics introduced something deeply subversive to the West that the various establishments had little choice but to repulse. LSD truly was an acid, dissolving almost everything with which it came into contact, beginning with the hierarchies of the mind... and going on from there to society's various structures of authority and then to lines of every imaginable kind... If all such lines are manifestations of the Apollonian strain in Western civilisation, the impulse that erects distinctions, dualities, and hierarchies, and defends them, then psychedelics represented the ungovernable Dionysian force that blithely washes all those lines away... But surely [it] is not the case that the forces unleashed by these chemicals are necessarily ungovernable" (Pollan, 2018).

[33] Consistent with basic tenets of psychoanalytic theory and Buddhist teaching, we adopt the position that much of the mind is indeed unconscious and what is kept from conscious awareness can be personal and collective as well as "once conscious - but now repressed" or simply "never conscious." We also maintain the unconscious often (but not always) drives conscious behavior in the absence of conscious awareness, in the way that a horse can steer its rider, without the rider realizing.

Acknowledgments

R.L.C.-H. thanks Shamil Chandaria, Leor Roseman, Fernando Rosas, Selen Atasoy, and Christopher Timmermann for discussions on earlier drafts of the manuscript. He thanks Pedro Oliveira, Gustavo Carreiro, and Hugo Raposo of Favo Studio for the illustrations in Fig. 2, and also gives special thanks to David Nutt and Amanda Fielding.

Authorship Contributions

Wrote or contributed to the writing of the manuscript: Carhart-Harris, Friston.

References

1. Adams RA, Napier G, Roiser JP, Mathys C, and Gilleen J (2018) Attractor-like dynamics in belief updating in schizophrenia. *J Neurosci* 38:9471-9485.
2. Aghajanian GK (2009) Modeling "psychosis" in vitro by inducing disordered neuronal network activity in cortical brain slices. *Psychopharmacology (Berl)* 206:575-585.
3. Aghajanian GK and Marek GJ (1999) Serotonin, via 5-HT$_{2A}$ receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release. *Brain Res* 825:161-171.
4. Alboni S, van Dijk RM, Poggini S, Milior G, Perrotta M, Drenth T, Brunello N, Wolfer DP, Limatola C, Amrein I, *et al*. (2017) Fluoxetine effects on molecular, cellular and behavioral endophenotypes of depression are driven by the living environment. *Mol Psychiatry* 22:552-561.
5. Alexander BK (2008) *The Globalisation of Addiction: A Study in Poverty of the Spirit*, Oxford University Press, Oxford.
6. Alonso JF, Romero S, Mananas MA, and Riba J (2015) Serotonergic psychedelics temporarily modify information transfer in humans [published correction appears in *Int J Neuropsychopharmacol* (2015) 19:pyv099]. *Int J Neuropsychopharmacol* 18.
7. Aragones E, Gilboa I, Postlewaite A, and Schmeidler D (2004) Fact-Free *Learning*, Cowles Foundation for Research in Economics, New Haven, CT.
8. Argento E, Strathdee SA, Tupper K, Braschel M, Wood E, and Shannon K (2017) Does psychedelic drug use reduce risk of suicidality? Evidence from a longitudinal community-based cohort of marginalised women in a Canadian setting. *BMJ Open* 7:e016025.
9. Atasoy S, Deco G, Kringelbach ML, and Pearson J (2018) Harmonic brain modes: a unifying framework for linking space and time in brain dynamics. *Neuroscientist* 24:277-293.
10. Atasoy S, Roseman L, Kaelen M, Kringelbach ML, Deco G, and Carhart-Harris RL (2017) Connectome-harmonic decomposition of human brain activity reveals dynamical repertoire re-organization under LSD. *Sci Rep* 7:17661.
11. Avena-Koenigsberger A, Goñi J, Betzel RF, van den Heuvel MP, Griffa A, Hagmann P, Thiran JP, and Sporns O (2014) Using Pareto optimality to explore the topology and dynamics of the human connectome. *Philos Trans R Soc Lond B Biol Sci* 369.
12. Azmitia EC (2001) Modern views on an ancient chemical: serotonin effects on cell proliferation, maturation, and apoptosis. *Brain Res Bull* 56:413-424.
13. Badiner AH and Gray A (2002) *Zig Zag Zen: Buddhism on Psychedelics*, Chronicle, San Francisco, CA.
14. Barto A, Mirolli M, and Baldassarre G (2013) Novelty or surprise? *Front Psychol* 4:907.
15. Bas¸ar E and Güntekin B (2009) Darwin's evolution theory, brain oscillations, and complex brain function in a new "Cartesian view." *Int J Psychophysiol* 71:2-8.
16. Bastos AM, Litvak V, Moran R, Bosman CA, Fries P, and Friston KJ (2015) A DCM study of spectral asymmetries in feedforward and feedback connections between visual areas V1 and V4 in the monkey. *Neuroimage* 108:460-475.
17. Bastos AM, Usrey WM, Adams RA, Mangun GR, Fries P, and Friston KJ (2012) Canonical microcircuits for predictive coding. *Neuron* 76:695-711.
18. Batchelor S (1998) *Buddhism without Beliefs: A Contemporary Guide to Awakening*, Bloomsbury, London.
19. Bauer M, Stenner MP, Friston KJ, and Dolan RJ (2014) Attentional modulation of alpha/beta and gamma oscillations reflect functionally distinct processes. *J Neurosci* 34:16117-16125.
20. Bayne T and Carter O (2018) Dimensions of consciousness and the psychedelic state. *Neurosci Conscious* 2018:niy008.
21. Beck AT (1972) *Depression; Causes and Treatment*, University of Pennsylvania Press, Philadelphia.
22. Becker E (2011) *The Denial of Death*, Souvenir, London.
23. Bedi G, Cecchi GA, Slezak DF, Carrillo F, Sigman M, and de Wit H (2014) A window into the intoxicated mind? Speech as an index of psychoactive drug effects. *Neuropsychopharmacology* 39:2340-2348.
24. Bejan A (2016) *The Physics of Life: The Evolution of Everything*, St. Martin's Press, New York.
25. Beliveau V, Ganz M, Feng L, Ozenne B, Højgaard L, Fisher PM, Svarer C, Greve DN, and Knudsen GM (2017) A high-resolution in vivo atlas of the human brain's serotonin system. *J Neurosci* 37:120-128.
26. Ben-Naim A (2007) *Entropy Demystified: The Second Law Reduced to Plain Common Sense*, World Scientific, Hackensack, NJ.
27. Bersabe R and Arias RM (2000) Superstition in gambling. *Psychol Spain* 4:28-34.
28. Berthoux C, Barre A, Bockaert J, Marin P, and Becamel C (2018) Sustained activation of postsynaptic 5-HT$_{2A}$ receptors gates plasticity at prefrontal cortex synapses. *Cereb Cortex* 29:1659-1669.
29. Biran I and Coslett HB (2003) Visual agnosia. *Curr Neurol Neurosci* Rep 3:508-512.
30. Bogenschutz MP, Forcehimes AA, Pommy JA, Wilcox CE, Barbosa PC, and Strassman RJ (2015) Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *J Psychopharmacol* 29:289-299.
31. Boly M, Moran R, Murphy M, Boveroux P, Bruno MA, Noirhomme Q, Ledoux D, Bonhomme V, Brichant JF, Tononi G, *et al*. (2012) Connectivity changes underlying spectral EEG changes during propofol-induced loss of consciousness. *J Neurosci* 32:7082-7090.
32. Boulougouris V, Glennon JC, and Robbins TW (2008) Dissociable effects of selective 5-HT$_{2A}$ and 5-HT$_{2C}$ receptor antagonists on serial spatial reversal learning in rats. *Neuropsychopharmacology* 33:2007-2019.
33. Bouso JC, Palhano-Fontes F, Rodríguez-Fornells A, Ribeiro S, Sanches R, Crippa JA, Hallak JE, de Araujo DB, and Riba J (2015) Long-term use of psychedelic drugs is associated with differences in brain structure and personality in humans. Eur Neuropsychopharmacol 25:483-492.
34. Bradbury S, Bird J, Colussi-Mas J, Mueller M, Ricaurte G, and Schenk S (2014) Acquisition of MDMA self-administration: pharmacokinetic factors and MDMA-induced serotonin release. *Addict Biol* 19:874-884.
35. Branchi I (2011) The double edged sword of neural plasticity: increasing serotonin levels leads to both greater vulnerability to depression and improved capacity to recover. *Psychoneuroendocrinology* 36:339-351.
36. Bressloff PC, Cowan JD, Golubitsky M, Thomas PJ, and Wiener MC (2002) What geometric visual hallucinations tell us about the visual cortex. *Neural Comput* 14:473-491.

37. Cabral J, Vidaurre D, Marques P, Magalhães R, Silva Moreira P, Miguel Soares J, Deco G, Sousa N, and Kringelbach ML (2017) Cognitive performance in healthy older adults relates to spontaneous switching between states of functional connectivity during rest. *Sci Rep* 7:5135.
38. Carbonaro TM, Johnson MW, Hurwitz E, and Griffiths RR (2018) Double-blind comparison of the two hallucinogens psilocybin and dextromethorphan: similarities and differences in subjective experiences. *Psychopharmacology (Berl)* 235:521-534.
39. Carhart-Harris R (2007) Waves of the unconscious: the neurophysiology of dreamlike phenomena and its implications for the psychodynamic model of the mind. *Neuropsychoanalysis* 9:183-211.
40. Carhart-Harris RL (2018a) The entropic brain - revisited. *Neuropharmacology* 142:167-178.
41. Carhart-Harris RL (2018b) Serotonin, psychedelics and psychiatry. *World Psychiatry* 17:358-359.
42. Carhart-Harris RL (2019) How do psychedelics work? *Curr Opin Psychiatry* 32:16-21.
43. Carhart-Harris RL, Bolstridge M, Day CMJ, Rucker J, Watts R, Erritzoe DE, Kaelen M, Giribaldi B, Bloomfield M, Pilling S, *et al*. (2018a) Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. Psychopharmacology (Berl) 235:399-408.
44. Carhart-Harris RL, Bolstridge M, Rucker J, Day CM, Erritzoe D, Kaelen M, Bloomfield M, Rickard JA, Forbes B, Feilding A, *et al*. (2016a) Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. *Lancet Psychiatry* 3:619-627.
45. Carhart-Harris RL, Erritzoe D, Haijen E, Kaelen M, and Watts R (2018b) Psychedelics and connectedness. *Psychopharmacology (Berl)* 235:547-550.
46. Carhart-Harris RL, Erritzoe D, Williams T, Stone JM, Reed LJ, Colasanti A, Tyacke RJ, Leech R, Malizia AL, Murphy K, *et al*. (2012a) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 109:2138-2143.
47. Carhart-Harris RL and Friston KJ (2010) The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. *Brain* 133:1265-1283.
48. Carhart-Harris RL and Goodwin GM (2017) The therapeutic potential of psychedelic drugs: past, present, and future. *Neuropsychopharmacology* 42: 2105-2113.
49. Carhart-Harris RL, Kaelen M, Bolstridge M, Williams TM, Williams LT, Underwood R, Feilding A, and Nutt DJ (2016b) The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol Med* 46:1379-1390.
50. Carhart-Harris RL, Kaelen M, Whalley MG, Bolstridge M, Feilding A, and Nutt DJ (2015) LSD enhances suggestibility in healthy volunteers. *Psychopharmacology (Berl)* 232:785-794.
51. Carhart-Harris RL, Leech R, Erritzoe D, Williams TM, Stone JM, Evans J, Sharp DJ, Feilding A, Wise RG, and Nutt DJ (2013) Functional connectivity measures after psilocybin inform a novel hypothesis of early psychosis. *Schizophr Bull* 39:1343-1351.
52. Carhart-Harris RL, Leech R, Hellyer PJ, Shanahan M, Feilding A, Tagliazucchi E, Chialvo DR, and Nutt D (2014) The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front Hum Neurosci* 8:20.
53. Carhart-Harris RL, Leech R, Williams TM, Erritzoe D, Abbasi N, Bargiotas T, Hobden P, Sharp DJ, Evans J, Feilding A, *et al*. (2012b) Implications for psychedelic-assisted psychotherapy: functional magnetic resonance imaging study with psilocybin. *Br J Psychiatry* 200:238-244.
54. Carhart-Harris RL, Muthukumaraswamy S, Roseman L, Kaelen M, Droog W, Murphy K, Tagliazucchi E, Schenberg EE, Nest T, Orban C, *et al*. (2016c) Neural correlates of the LSD experience revealed by multimodal neuroimaging. *Proc Natl Acad Sci USA* 113:4853-4858.
55. Carhart-Harris RL and Nutt DJ (2017) Serotonin and brain function: a tale of two receptors. *J Psychopharmacol* 31:1091-1120.
56. Carhart-Harris RL, Roseman L, Bolstridge M, Demetriou L, Pannekoek JN, Wall MB, Tanner M, Kaelen M, McGonigle J, Murphy K, *et al*. (2017) Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Sci Rep* 7:13187.
57. Carhart-Harris RL, Roseman L, Haijen E, Erritzoe D, Watts R, Branchi I, and Kaelen M (2018c) Psychedelics and the essential importance of context. *J Psychopharmacol* 32:725-731.
58. Carney DR, Jost JT, Gosling SD, and Potter J (2008) The secret lives of liberals and conservatives: personality profiles, interaction styles, and the things they leave behind. *Polit Psychol* 29:807-840.
59. Carter OL, Hasler F, Pettigrew JD, Wallis GM, Liu GB, and Vollenweider FX (2007) Psilocybin links binocular rivalry switch rate to attention and subjective arousal levels in humans. *Psychopharmacology (Berl)* 195:415-424.
60. Carter OL, Pettigrew JD, Burr DC, Alais D, Hasler F, and Vollenweider FX (2004) Psilocybin impairs high-level but not low-level motion perception. *Neuroreport* 15:1947-1951.
61. Carter OL, Pettigrew JD, Hasler F, Wallis GM, Liu GB, Hell D, and Vollenweider FX (2005) Modulating the rate and rhythmicity of perceptual rivalry alternations with the mixed 5-HT$_{2A}$ and 5-HT$_{1A}$ agonist psilocybin. *Neuropsychopharmacology* 30:1154-1162.
62. Celada P, Puig MV, Díaz-Mataix L, and Artigas F (2008) The hallucinogen DOI reduces low-frequency oscillations in rat prefrontal cortex: reversal by antipsychotic drugs. *Biol Psychiatry* 64:392-400.
63. Chekroud AM (2015) Unifying treatments for depression: an application of the Free Energy Principle. *Front Psychol* 6:153.
64. Chialvo DR (2004) Critical brain networks. *Physica* A 340:756-765.
65. Chialvo DR (2010) Emergent complex neural dynamics. *Nat Phys* 6:744-750.
66. Chouraqui F (2011) Temporal thickness in Merleau-Ponty's notes of May 1959. *Chiasmi Int* 13:407-427.
67. Clark A (2016) *Surfing Uncertainty: Prediction, Action, and the Embodied Mind*, Oxford University Press, Oxford.
68. Clark JE, Watson S, and Friston KJ (2018) What is mood? A computational perspective. *Psychol Med* 48:2277-2284.
69. Cocchi L, Gollo LL, Zalesky A, and Breakspear M (2017) Criticality in the brain: a synthesis of neurobiology, models and cognition. *Prog Neurobiol* 158:132-152.
70. Davey CG and Harrison BJ (2018) The brain's center of gravity: how the default mode network helps us to understand the self. *World Psychiatry* 17:278-279.
71. Davey CG, Pujol J, and Harrison BJ (2016) Mapping the self in the brain's default mode network. *Neuroimage* 132:390-397.
72. de Araujo DB, Ribeiro S, Cecchi GA, Carvalho FM, Sanchez TA, Pinto JP, de Martinis BS, Crippa JA, Hallak JEC, and Santos AC (2012) Seeing with the eyes shut: neural basis of enhanced imagery following Ayahuasca ingestion. *Hum Brain Mapp*

33:2550-2560.

73. Deco G and Kringelbach ML (2017) Hierarchy of information processing in the brain: a novel 'intrinsic ignition' framework. *Neuron* 94:961-968.
74. Dieguez S (2018) Cotard syndrome. Front *Neurol Neurosci* 42:23-34.
75. Edwards CL, Ruby PM, Malinowski JE, Bennett PD, and Blagrove MT (2013) Dreaming and insight. *Front Psychol* 4:979.
76. Edwards MJ, Adams RA, Brown H, Pareés I, and Friston KJ (2012) A Bayesian account of 'hysteria.' *Brain* 135:3495-3512.
77. Erritzoe D, Roseman L, Nour MM, MacLean K, Kaelen M, Nutt DJ, and Carhart-Harris RL (2018) Effects of psilocybin therapy on personality structure. *Acta Psychiatr Scand* 138:368-378.
78. Fingelkurts AA, Fingelkurts AA, Bagnato S, Boccagni C, and Galardi G (2012) DMN operational synchrony relates to self-consciousness: evidence from patients in vegetative and minimally conscious states. *Open Neuroimaging J* 6:55-68.
79. Fletcher PC and Frith CD (2009) Perceiving is believing: a Bayesian approach to explaining the positive symptoms of schizophrenia. *Nat Rev Neurosci* 10:48-58.
80. Forstmann M and Sagioglou C (2017) Lifetime experience with (classic) psychedelics predicts pro-environmental behavior through an increase in nature relatedness. *J Psychopharmacol* 31:975-988.
81. Freud S (1934) *The Future of an Illusion*, Hogarth Press, London.
82. Freud S (1949) *An Outline of Psycho-Analysis*, Hogarth Press, London.
83. Fries P (2015) Rhythms for cognition: communication through coherence. *Neuron* 88: 220-235.
84. Friston K (2010) The free-energy principle: a unified brain theory? *Nat Rev Neurosci* 11:127-138.
85. Friston K (2018) Am I self-conscious? (Or does self-organization entail self-consciousness?) *Front Psychol* 9:579.
86. Friston K, Breakspear M, and Deco G (2012a) Perception and self-organized instability. *Front Comput Neurosci* 6:44.
87. Friston K and Kiebel S (2009) Predictive coding under the free-energy principle. *Philos Trans R Soc Lond B Biol Sci* 364:1211-1221.
88. Friston K, Samothrakis S, and Montague R (2012b) Active inference and agency: optimal control without cost functions. *Biol Cybern* 106:523-541.
89. Friston KJ, Lin M, Frith CD, Pezzulo G, Hobson JA, and Ondobaka S (2017) Active inference, curiosity and insight. *Neural Comput* 29:2633-2683.
90. Friston KJ, Rosch R, Parr T, Price C, and Bowman H (2018) Deep temporal models and active inference. *Neurosci Biobehav Rev* 90:486-501.
91. Friston KJ, Stephan KE, Montague R, and Dolan RJ (2014) Computational psychiatry: the brain as a phantastic organ. *Lancet Psychiatry* 1:148-158.
92. Gabay AS, Carhart-Harris RL, Mazibuko N, Kempton MJ, Morrison PD, Nutt DJ, and Mehta MA (2018) Psilocybin and MDMA reduce costly punishment in the Ultimatum Game. *Sci Rep* 8:8236.
93. Garrido MI, Kilner JM, Stephan KE, and Friston KJ (2009) The mismatch negativity: a review of underlying mechanisms. *Clin Neurophysiol* 120:453-463.
94. Garrison KA, Santoyo JF, Davis JH, Thornhill TA IV, Kerr CE, and Brewer JA (2013) Effortless awareness: using real time neurofeedback to investigate correlates of posterior cingulate cortex activity in meditators' self-report. *Front Hum Neurosci* 7:440.
95. Gasser P, Holstein D, Michel Y, Doblin R, Yazar-Klosinski B, Passie T, and Brenneisen R (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202:513-520.
96. Gauvrit N, Zenil H, Soler-Toscano F, Delahaye JP, and Brugger P (2017) Human behavioral complexity peaks at age 25. *PLOS Comput Biol* 13:e1005408.
97. Geyer MA and Vollenweider FX (2008) Serotonin research: contributions to understanding psychoses. *Trends Pharmacol Sci* 29:445-453.
98. Glennon RA, Teitler M, and Sanders-Bush E (1992) Hallucinogens and serotonergic mechanisms. *NIDA Res Monogr* 119:131-135.
99. Gopnik A, O'Grady S, Lucas CG, Griffiths TL, Wente A, Bridgers S, Aboody R, Fung H, and Dahl RE (2017) Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood. *Proc Natl Acad Sci USA* DOI: 10.1073/pnas.1700811114 [published ahead of print].
100. Goris J, Braem S, Nijhof AD, Rigoni D, Deschrijver E, Van de Cruys S, Wiersema JR, and Brass M (2018) Sensory prediction errors are less modulated by global context in autism spectrum disorder. *Biol Psychiatry Cogn Neurosci Neuroimaging* 3:667-674.
101. Gouzoulis E, Hermle L, and Sass H (1994) [Psychedelic experiences at the onset of productive episodes of endogenous psychoses]. *Nervenarzt* 65:198-201.
102. Gregory RL (1980) Perceptions as hypotheses. *Philos Trans R Soc Lond B Biol Sci* 290:181-197.
103. Gresch PJ, Barrett RJ, Sanders-Bush E, and Smith RL (2007) 5-Hydroxytryptamine (serotonin)2A receptors in rat anterior cingulate cortex mediate the discriminative stimulus properties of d-lysergic acid diethylamide. *J Pharmacol Exp Ther* 320:662-669.
104. Griffis JC, Elkhetali AS, Burge WK, Chen RH, Bowman AD, Szaflarski JP, and Visscher KM (2017) Retinotopic patterns of functional connectivity between V1 and large-scale brain networks during resting fixation. *Neuroimage* 146:1071-1083.
105. Griffiths R, Carducci MJM, Umbricht A, Richards W, Richards B, Cosimano M, and Klinedinst M (2016) Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. *J Psychopharmacol* 30:1181-1197.
106. Griffiths RR, Richards WA, McCann U, and Jesse R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology (Berl)* 187:268-283, discussion 284-292.
107. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstadt AL, and Greer GR (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68:71-78.
108. Grof S (1979) *Realms of the Human Unconscious: Observations from LSD Research*, Souvenir Press, London.

109. Gu X (2018) Incubation of craving: a Bayesian account. *Neuropsychopharmacology* 43:2337-2339.
110. Hagmann P, Cammoun L, Gigandet X, Meuli R, Honey CJ, Wedeen VJ, and Sporns O (2008) Mapping the structural core of human cerebral cortex. PLoS Biol 6:e159.
111. Haijen ECHM, Kaelen M, Roseman L, Timmermann C, Kettner H, Russ S, Nutt D, Daws RE, Hampshire ADG, Lorenz R, *et al*. (2018) Predicting responses to psychedelics: a prospective study. *Front Pharmacol* 9:897.
112. Halberstadt AL and Geyer MA (2018) Effect of hallucinogens on unconditioned behavior. *Curr Top Behav Neurosci* 36:159-199.
113. Halpern JH, Lerner AG, and Passie T (2018) A review of hallucinogen persisting perception disorder (HPPD) and an exploratory study of subjects claiming symptoms of HPPD. *Curr Top Behav Neurosci* 36:333-360.
114. Hanh TN (2017) *The Art of Living*, Ebury Publishing, London.
115. Hanks C (2010) *Technology and Values: Essential Readings*, Wiley-Blackwell, Chichester, UK; Malden, MA.
116. Hari J (2018) *Lost Connections: Uncovering the Real Causes of Depression-and the Unexpected Solutions*, Bloomsbury, London.
117. Harvey JA (2003) Role of the serotonin 5-HT(2A) receptor in learning. *Learn Mem* 10:355-362.
118. Harvey JA, Quinn JL, Liu R, Aloyo VJ, and Romano AG (2004) Selective remodeling of rabbit frontal cortex: relationship between 5-HT$_{2A}$ receptor density and associative learning. *Psychopharmacology (Berl)* 172:435-442.
119. Hendricks PS, Thorne CB, Clark CB, Coombs DW, and Johnson MW (2015) Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *J Psychopharmacol* 29:280-288.
120. Hilgetag CC and Hütt MT (2014) Hierarchical modular brain connectivity is a stretch for criticality. *Trends Cogn Sci* 18:114-115.
121. Hill SJ (2013) *Confrontation with the Unconscious: Jungian Depth Psychology and Psychedelic Experience*, Muswell Hill Press, London.
122. Hinton GE and Zemel RS (1993) Autoencoders, minimum description length and Helmholtz free energy, in *Proceedings of the 6th International Conference on Neural Information Processing Systems*, pp 3-10, Morgan Kaufmann Publishers, Denver, CO.
123. Hobson JA, Hong CC, and Friston KJ (2014) Virtual reality and consciousness inference in dreaming. *Front Psychol* 5:1133.
124. Hochreiter S and Schmidhuber J (1997) Flat minima. *Neural Comput* 9:1-42.
125. Hoffman P, Lambon Ralph MA, and Rogers TT (2013) Semantic diversity: a measure of semantic ambiguity based on variability in the contextual usage of words. *Behav Res Methods* 45:718-730.
126. Hovens JG, Giltay EJ, Spinhoven P, van Hemert AM, and Penninx BW (2015) Impact of childhood life events and childhood trauma on the onset and recurrence of depressive and anxiety disorders. *J Clin Psychiatry* 76:931-938.
127. Huang RS and Sereno MI (2013) Bottom-up retinotopic organization supports topdown mental imagery. *Open Neuroimaging J* 7:58-67.
128. Jakab RL and Goldman-Rakic PS (1998) 5-Hydroxytryptamine2A serotonin receptors in the primate cerebral cortex: possible site of action of hallucinogenic and antipsychotic drugs in pyramidal cell apical dendrites. *Proc Natl Acad Sci USA* 95:735-740.
129. Jaynes ET (1957) Information theory and statistical mechanics. *Phys Rev* 106:620-630.
130. Jiang X, Zhang ZJ, Zhang S, Gamble EH, Jia M, Ursano RJ, and Li H (2011) 5-HT$_{2A}$ receptor antagonism by MDL 11,939 during inescapable stress prevents subsequent exaggeration of acoustic startle response and reduced body weight in rats. *J Psychopharmacol* 25:289-297.
131. Josipovic Z (2014) Neural correlates of nondual awareness in meditation. *Ann N Y Acad Sci* 1307:9-18.
132. Jung CG (1960) *On the Nature of the Psyche*, Routledge Classics, 2001, London.
133. Jung CG (1969) *Four Archetypes: Mother, Rebirth, Spirit, Trickster*, Ark, 1986, London.
134. Kaelen M, Barrett FS, Roseman L, Lorenz R, Family N, Bolstridge M, Curran HV, Feilding A, Nutt DJ, and Carhart-Harris RL (2015) LSD enhances the emotional response to music. *Psychopharmacology (Berl)* 232:3607-3614.
135. Kaelen M, Roseman L, Kahan J, Santos-Ribeiro A, Orban C, Lorenz R, Barrett FS, Bolstridge M, Williams T, Williams L, *et al*. (2016) LSD modulates music-induced imagery via changes in parahippocampal connectivity. *Eur Neuropsychopharmacol* 26:1099-1109.
136. Kakumanu RJ, Nair AK, Venugopal R, Sasidharan A, Ghosh PK, John JP, Mehrotra S, Panth R, and Kutty BM (2018) Dissociating meditation proficiency and experience dependent EEG changes during traditional Vipassana meditation practice. *Biol Psychol* 135:65-75.
137. Kamilar-Britt P and Bedi G (2015) The prosocial effects of 3,4-methylenedioxymethamphetamine (MDMA): controlled studies in humans and laboratory animals. *Neurosci Biobehav* Rev 57:433-446.
138. Kanai R, Feilden T, Firth C, and Rees G (2011) Political orientations are correlated with brain structure in young adults. *Curr Biol* 21:677-680.
139. Kanai R, Komura Y, Shipp S, and Friston K (2015) Cerebral hierarchies: predictive processing, precision and the pulvinar. *Philos Trans R Soc Lond B Biol Sci* 370.
140. Kaplan JT, Gimbel SI, Dehghani M, Immordino-Yang MH, Sagae K, Wong JD, Tipper CM, Damasio H, Gordon AS, and Damasio A (2017) Processing narratives concerning protected values: a cross-cultural investigation of neural correlates. *Cereb Cortex* 27:1428-1438.
141. Kapur S (2003) Psychosis as a state of aberrant salience: a framework linking biology, phenomenology, and pharmacology in schizophrenia. *Am J Psychiatry* 160:13-23.
142. Keshavan MS and Sudarshan M (2017) Deep dreaming, aberrant salience and psychosis: connecting the dots by artificial neural networks. *Schizophr Res* 188:178-181.
143. Kessler DA (2016) *Capture: Unraveling the Mystery of Mental Suffering*, Harper Wave, an imprint of HarperCollinsPublishers, New York.
144. King AR, Martin IL, and Seymour KA (1972) Reversal learning facilitated by a single injection of lysergic acid diethylamide (LSD 25) in the rat. *Br J Pharmacol* 45:161P-162P.
145. Klimesch W, Sauseng P, and Hanslmayr S (2007) EEG alpha oscillations: the inhibition-timing hypothesis. *Brain Res Brain Res Rev* 53:63-88.

146. Kometer M, Cahn BR, Andel D, Carter OL, and Vollenweider FX (2011) The 5-HT$_{2A/1A}$ agonist psilocybin disrupts modal object completion associated with visual hallucinations. *Biol Psychiatry* 69:399-406.
147. Kometer M, Schmidt A, Bachmann R, Studerus E, Seifritz E, and Vollenweider FX (2012) Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. *Biol Psychiatry* 72:898-906.
148. Kraehenmann R, Preller KH, Scheidegger M, Pokorny T, Bosch OG, Seifritz E, and Vollenweider FX (2015a) Psilocybin-induced decrease in amygdala reactivity correlates with enhanced positive mood in healthy volunteers. *Biol Psychiatry* 78:572-581.
149. Kraehenmann R, Schmidt A, Friston K, Preller KH, Seifritz E, and Vollenweider FX (2015b) The mixed serotonin receptor agonist psilocybin reduces threat-induced modulation of amygdala connectivity. *Neuroimage Clin* 11:53-60.
150. Kramer PD (1994) *Listening to Prozac*, Fourth Estate, London.
151. Krebs TS and Johansen PO (2012) Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. *J Psychopharmacol* 26:994-1002.
152. Krebs TS and Johansen PO (2013) Psychedelics and mental health: a population study. *PLoS One* 8:e63972.
153. Kuypers KP, Riba J, de la Fuente Revenga M, Barker S, Theunissen EL, and Ramaekers JG (2016) Ayahuasca enhances creative divergent thinking while decreasing conventional convergent thinking. *Psychopharmacology (Berl)* 233:3395-3403.
154. Lafrance A, Loizaga-Velder A, Fletcher J, Renelli M, Files N, and Tupper KW (2017) Nourishing the spirit: exploratory research on ayahuasca experiences along the continuum of recovery from eating disorders. *J Psychoactive Drugs* 49:427-435.
155. Lakatos P, Schroeder CE, Leitman DI, and Javitt DC (2013) Predictive suppression of cortical excitability and its deficit in schizophrenia. *J Neurosci* 33:11692-11702.
156. Laufs H, Krakow K, Sterzer P, Eger E, Beyerle A, Salek-Haddadi A, and Kleinschmidt A (2003) Electroencephalographic signatures of attentional and cognitive default modes in spontaneous brain activity fluctuations at rest. *Proc Natl Acad Sci USA* 100:11053-11058.
157. Lebedev AV, Kaelen M, Lövdén M, Nilsson J, Feilding A, Nutt DJ, and Carhart-Harris RL (2016) LSD-induced entropic brain activity predicts subsequent personality change. *Hum Brain Mapp* 37:3203-3213.
158. Lebedev AV, Lövdén M, Rosenthal G, Feilding A, Nutt DJ, and Carhart-Harris RL (2015) Finding the self by losing the self: neural correlates of ego-dissolution under psilocybin. *Hum Brain Mapp* 36:3137-3153.
159. Letheby C (2016) The epistemic innocence of psychedelic states. *Conscious Cogn* 39:28-37.
160. Lomas T, Ivtzan I, and Fu CH (2015) A systematic review of the neurophysiology of mindfulness on EEG oscillations. *Neurosci Biobehav Rev* 57:401-410.
161. Lord L-D, Expert P, Atasoy S, Roseman L, Rapuano K, Lambiotte R, Nutt DJ, Deco G, Carhart-Harris R, Kringelbach ML, *et al*. (2018) Altered trajectories in the dynamical repertoire of functional network states under psilocybin. *bioRxiv*.
162. Ly C, Greb AC, Cameron LP, Wong JM, Barragan EV, Wilson PC, Burbach KF, Soltanzadeh Zarandi S, Sood A, Paddy MR, *et al*. (2018) Psychedelics promote structural and functional neural plasticity. *Cell Rep* 23:3170-3182.
163. Lyons T and Carhart-Harris RL (2018a) Increased nature relatedness and decreased authoritarian political views after psilocybin for treatment-resistant depression. *J Psychopharmacol* 32:811-819.
164. Lyons T and Carhart-Harris RL (2018b) More realistic forecasting of future life events after psilocybin for treatment-resistant depression. *Front Psychol* 9:1721.
165. MacKay DJ (1995) Free-energy minimisation algorithm for decoding and cryptoanalysis. *Electron Lett* 31:445-447.
166. MacLean KA, Johnson MW, and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25:1453-1461.
167. MacLean KA, Leoutsakos JM, Johnson MW, and Griffiths RR (2012) Factor analysis of the mystical experience questionnaire: a study of experiences occasioned by the hallucinogen psilocybin. *J Sci Study Relig* 51:721-737.
168. MacLean PD (1990) *The Triune Brain in Evolution: Role in Paleocerebral Functions*, Plenum Press, New York.
169. Madsen MK, Fisher PM, Burmester D, Dyssegaard A, Stenbaek DS, Kristiansen S, Johansen SS, Lehel S, Linnet K, Svarer C, *et al*. (2019) Psychedelic effects of psilocybin correlate with serotonin 2A receptor occupancy and plasma psilocin levels. *Neuropsychopharmacology* DOI: 10.1038/s41386-019-0324-9 [published ahead of print].
170. Maj M (2005) "Psychiatric comorbidity": an artefact of current diagnostic systems? *Br J Psychiatry* 186:182-184.
171. Majić T, Schmidt TT, and Gallinat J (2015) Peak experiences and the afterglow phenomenon: when and how do therapeutic effects of hallucinogens depend on psychedelic experiences? *J Psychopharmacol* 29:241-253.
172. Mantini D, Perrucci MG, Del Gratta C, Romani GL, and Corbetta M (2007) Electrophysiological signatures of resting state networks in the human brain. *Proc Natl Acad Sci USA* 104:13170-13175.
173. Marek GJ (2018) Interactions of hallucinogens with the glutamatergic system: permissive network effects mediated through cortical layer V pyramidal neurons. *Curr Top Behav Neurosci* 36:107-135.
174. Margulies DS, Ghosh SS, Goulas A, Falkiewicz M, Huntenburg JM, Langs G, Bezgin G, Eickhoff SB, Castellanos FX, Petrides M, *et al*. (2016) Situating the default-mode network along a principal gradient of macroscale cortical organization. *Proc Natl Acad Sci USA* 113:12574-12579.
175. Masters RA (2010) *Spiritual Bypassing: When Spirituality Disconnects Us from What Really Matters*, North Atlantic Books, Berkeley, CA.
176. Matias S, Lottem E, Dugué GP, and Mainen ZF (2017) Activity patterns of serotonin neurons underlying cognitive flexibility. *eLife* 6.
177. Maya Vetencourt JF, Sale A, Viegi A, Baroncelli L, De Pasquale R, O'Leary OF, Castrén E, and Maffei L (2008) The antidepressant fluoxetine restores plasticity in the adult visual cortex. *Science* 320:385-388.
178. Mayer A, Schwiedrzik CM, Wibral M, Singer W, and Melloni L (2016) Expecting to see a letter: alpha oscillations as carriers of top-down sensory predictions. *Cereb Cortex* 26:3146-3160.
179. Metzinger T (2009) *The Ego Tunnel: The Science of the Mind and the Myth of the Self*, Basic Books, New York.
180. Michaiel AM, Parker PRL, and Niell CM (2019) A hallucinogenic serotonin-2A receptor agonist reduces visual response gain and alters temporal dynamics in Mouse V1. *Cell Rep* 26:3475-3483.e4.

181. Millière R (2017) Looking for the self: phenomenology, neurophysiology and philosophical significance of drug-induced ego dissolution. *Front Hum Neurosci* 11:245.
182. Millière R, Carhart-Harris RL, Roseman L, Trautwein FM, and Berkovich-Ohana A (2018) Psychedelics, meditation, and self-consciousness. *Front Psychol* 9:1475.
183. Moreno FA, Wiegand CB, Taitano EK, and Delgado PL (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J Clin Psychiatry* 67:1735-1740.
184. Müller F, Lenz C, Dolder P, Lang U, Schmidt A, Liechti M, and Borgwardt S (2017) Increased thalamic resting-state connectivity as a core driver of LSD-induced hallucinations. *Acta Psychiatr Scand* 136:648-657.
185. Murray JD, Bernacchia A, Freedman DJ, Romo R, Wallis JD, Cai X, Padoa-Schioppa C, Pasternak T, Seo H, Lee D, *et al*. (2014) A hierarchy of intrinsic timescales across primate cortex. *Nat Neurosci* 17:1661-1663.
186. Muthukumaraswamy SD, Carhart-Harris RL, Moran RJ, Brookes MJ, Williams TM, Errtizoe D, Sessa B, Papadopoulos A, Bolstridge M, Singh KD, *et al*. (2013) Broadband cortical desynchronization underlies the human psychedelic state. *J Neurosci* 33:15171-15183.
187. Muthukumaraswamy SD and Liley DT (2018) 1/f electrophysiological spectra in resting and drug-induced states can be explained by the dynamics of multiple oscillatory relaxation processes. *Neuroimage* 179:582-595.
188. Naess A (1984) A defense of the deep ecology movement. *Environ Ethics* 6:265-270.
189. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101:131-181.
190. Nichols DE (2016) Psychedelics. *Pharmacol Rev* 68:264-355.
191. Nicolas S, Collins T, Gounden Y, and Roediger HL III (2011) Natural suggestibility in children. *Conscious Cogn* 20:394-398.
192. Noorani T, Garcia-Romeu A, Swift TC, Griffiths RR, and Johnson MW (2018) Psychedelic therapy for smoking cessation: qualitative analysis of participant accounts. *J Psychopharmacol* 32:756-769.
193. Nour MM, Evans L, and Carhart-Harris RL (2017) Psychedelics, personality and political perspectives. *J Psychoactive Drugs* 49:182-191.
194. Nour MM, Evans L, Nutt D, and Carhart-Harris RL (2016) Ego-dissolution and psychedelics: validation of the ego-dissolution inventory (EDI). *Front Hum Neurosci* 10:269.
195. Osório Fde L, Sanches RF, Macedo LR, Santos RG, Maia-de-Oliveira JP, Wichert-Ana L, Araujo DB, Riba J, Crippa JA, and Hallak JE (2015) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. *Br J Psychiatry* 37:13-20.
196. Østby Y, Walhovd KB, Tamnes CK, Grydeland H, Westlye LT, and Fjell AM (2012) Mental time travel and default-mode network functional connectivity in the developing brain. *Proc Natl Acad Sci USA* 109:16800-16804.
197. Oudeyer P-Y and Kaplan F (2007) What is intrinsic motivation? A typology of computational approaches. *Front Neurorobot* 1:6.
198. Palhano-Fontes F, Barreto D, Onias H, Andrade KC, Novaes MM, Pessoa JA, MotaRolim SA, Osorio FL, Sanches R, Dos Santos RG, *et al*. (2019) Rapid antidepressant effects of the psychedelic ayahuasca in treatment-resistant depression: a randomized placebo-controlled trial. *Psychol Med* 49:655-663.
199. Parameshwaran D and Thiagarajan TC (2017) Modernization, wealth and the emergence of strong alpha oscillations in the human EEG. *bioRxiv*.
200. Pehek EA and Hernan AE (2015) Stimulation of glutamate receptors in the ventral tegmental area is necessary for serotonin-2 receptor-induced increases in mesocortical dopamine release. *Neuroscience* 290:159-164.
201. Pehek EA, Nocjar C, Roth BL, Byrd TA, and Mabrouk OS (2006) Evidence for the preferential involvement of 5-HT_{2A} serotonin receptors in stress- and drug-induced dopamine release in the rat medial prefrontal cortex. *Neuropsychopharmacology* 31:265-277.
202. Peters A, McEwen BS, and Friston K (2017) Uncertainty and stress: why it causes diseases and how it is mastered by the brain. *Prog Neurobiol* 156:164-188.
203. Petri G, Expert P, Turkheimer F, Carhart-Harris R, Nutt D, Hellyer PJ, and Vaccarino F (2014) Homological scaffolds of brain functional networks. *J R Soc Interface* 11:20140873.
204. Pfurtscheller G, Stancák A Jr, and Neuper C (1996) Event-related synchronization (ERS) in the alpha band - an electrophysiological correlate of cortical idling: a review. *Int J Psychophysiol* 24:39-46.
205. Pink-Hashkes S, van Rooij IJEI, and Kwisthout JHP (2017) Perception is in the details: a predictive coding account of the psychedelic phenomenon, in *Proceedings of the 39th Annual Meeting of the Cognitive Science Society (CogSci 2017)*; 2017 July 26-29; London, United Kingdom. pp 2907-2912, Cognitive Science Society, London.
206. Piochon C, Kano M, and Hansel C (2016) LTD-like molecular pathways in developmental synaptic pruning. *Nat Neurosci* 19:1299-1310.
207. Pokorny T, Preller KH, Kometer M, Dziobek I, and Vollenweider FX (2017) Effect of psilocybin on empathy and moral decision-making. *Int J Neuropsychopharmacol* 20:747-757.
208. Pollan M (2018) *How to Change Your Mind: The New Science of Psychedelics*, Penguin Press, New York.
209. Powers AR, Mathys C, and Corlett PR (2017) Pavlovian conditioning-induced hallucinations result from overweighting of perceptual priors. *Science* 357: 596-600.
210. Preller KH, Herdener M, Pokorny T, Planzer A, Kraehenmann R, Stämpfli P, Liechti ME, Seifritz E, and Vollenweider FX (2017) The fabric of meaning and subjective effects in LSD-induced states depend on serotonin 2A receptor activation. *Curr Biol* 27:451-457.
211. Preller KH, Pokorny T, Hock A, Kraehenmann R, Stämpfli P, Seifritz E, Scheidegger M, and Vollenweider FX (2016) Effects of serotonin 2A/1A receptor stimulation on social exclusion processing. *Proc Natl Acad Sci USA* 113:5119-5124.
212. Preller KH, Razi A, Zeidman P, Stampfli P, Friston KJ, and Vollenweider FX (2019) Effective connectivity changes in LSD-induced altered states of consciousness in humans. *Proc Natl Acad Sci USA* 116:2743-2748.
213. Quednow BB, Kometer M, Geyer MA, and Vollenweider FX (2012) Psilocybin-induced deficits in automatic and controlled inhibition are attenuated by ketanserin in healthy human volunteers. *Neuropsychopharmacology* 37:630-640.
214. Raichle ME (2015) The brain's default mode network. *Annu Rev Neurosci* 38: 433-447.
215. Rao RP and Ballard DH (1999) Predictive coding in the visual cortex: a functional interpretation of some extra-classical

receptive-field effects. *Nat Neurosci* 2:79-87.
216. Richards WA (2015) *Sacred Knowledge: Psychedelics and Religious Experiences*, Columbia University Press, New York.
217. Richieri R, Boyer L, and Lancon C (2011) [Analysis of the reliability of diagnostic criteria and classifications in psychiatry]. *Sante Publique* 23 (Suppl 6):S31-S38.
218. Richter CG, Babo-Rebelo M, Schwartz D, and Tallon-Baudry C (2017) Phaseamplitude coupling at the organism level: the amplitude of spontaneous alpha rhythm fluctuations varies with the phase of the infra-slow gastric basal rhythm. *Neuroimage* 146:951-958.
219. Riga MS, Soria G, Tudela R, Artigas F, and Celada P (2014) The natural hallucinogen 5-MeO-DMT, component of Ayahuasca, disrupts cortical function in rats: reversal by antipsychotic drugs. *Int J Neuropsychopharmacol* 17:1269-1282.
220. Romano AG, Quinn JL, Li L, Dave KD, Schindler EA, Aloyo VJ, and Harvey JA (2010) Intrahippocampal LSD accelerates learning and desensitizes the 5-HT(2A) receptor in the rabbit, Romano *et al*. *Psychopharmacology (Berl)* 212:441-448.
221. Romano AG, Quinn JL, Liu R, Dave KD, Schwab D, Alexander G, Aloyo VJ, and Harvey JA (2006) Effect of serotonin depletion on 5-HT$_{2A}$-mediated learning in the rabbit: evidence for constitutive activity of the 5-HT$_{2A}$ receptor in vivo. *Psychopharmacology (Berl)* 184:173-181.
222. Roseman L, Demetriou L, Wall MB, Nutt DJ, and Carhart-Harris RL (2018a) Increased amygdala responses to emotional faces after psilocybin for treatment-resistant depression. *Neuropharmacology* 142:263-269.
223. Roseman L, Leech R, Feilding A, Nutt DJ, and Carhart-Harris RL (2014) The effects of psilocybin and MDMA on between-network resting state functional connectivity in healthy volunteers. *Front Hum Neurosci* 8:204.
224. Roseman L, Nutt DJ, and Carhart-Harris RL (2018b) Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. *Front Pharmacol* 8:974.
225. Ross S, Bossis A, Guss J, Agin-Liebes G, Malone T, Cohen B, Mennenga SE, Belser A, Kalliontzi K, Babb J, *et al*. (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *J Psychopharmacol* 30:1165-1180.
226. Rucker JJ, Jelen LA, Flynn S, Frowde KD, and Young AH (2016) Psychedelics in the treatment of unipolar mood disorders: a systematic review. *J Psychopharmacol* 30:1220-1229.
227. Rucker JJH, Iliff J, and Nutt DJ (2018) Psychiatry & the psychedelic drugs: past, present & future. *Neuropharmacology* 142:200-218.
228. Ruffini G (2017) An algorithmic information theory of consciousness. *Neurosci Conscious* 2017:nix019.
229. Safran JD (2003) *Psychoanalysis and Buddhism: An Unfolding Dialogue*, Wisdom Publications, Boston.
230. Sampedro F, de la Fuente Revenga M, Valle M, Roberto N, Dominguez-Clave E, Elices M, Luna LE, Crippa JAS, Hallak JEC, de Araujo DB, *et al*. (2017) Assessing the psychedelic "after-glow" in ayahuasca users: post-acute neurometabolic and functional connectivity changes are associated with enhanced mindfulness capacities. *Int J Neuropsychopharmacol* 20:698-711.
231. Sandison RA (1954) Psychological aspects of the LSD treatment of the neuroses. *J Ment Sci* 100:508-515.
232. Schartner MM, Carhart-Harris RL, Barrett AB, Seth AK, and Muthukumaraswamy SD (2017) Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. *Sci Rep* 7:46421.
233. Schmid Y, Enzler F, Gasser P, Grouzmann E, Preller KH, Vollenweider FX, Brenneisen R, Müller F, Borgwardt S, and Liechti ME (2015) Acute effects of lysergic acid diethylamide in healthy subjects. *Biol Psychiatry* 78: 544-553.
234. Schmid Y and Liechti ME (2018) Long-lasting subjective effects of LSD in normal subjects. *Psychopharmacology (Berl)* 235:535-545.
235. Schmidhuber J (2010) Formal theory of creativity, fun, and intrinsic motivation (1990-2010). *IEEE Trans Auton Ment Dev* 2:230-247.
236. Seth AK and Friston KJ (2016) Active interoceptive inference and the emotional brain. *Philos Trans R Soc Lond B Biol Sci* 371.
237. Sheline YI, Mintun MA, Moerlein SM, and Snyder AZ (2002) Greater loss of 5-HT(2A) receptors in midlife than in late life. *Am J Psychiatry* 159:430-435.
238. Singh KD, Barnes GR, Hillebrand A, Forde EME, and Williams AL (2002) Task-related changes in cortical synchronization are spatially coincident with the hemodynamic response. *Neuroimage* 16:103-114.
239. Solms M and Turnbull O (2003) *The Brain and the Inner World: An Introduction to the Neuroscience of Subjective Experience*, Karnac, London.
240. Soto D, Theodoraki M, and Paz-Alonso PM (2018) How the human brain introspects about one's own episodes of cognitive control. *Cortex* 107:110-120.
241. Speth J, Speth C, Kaelen M, Schloerscheidt AM, Feilding A, Nutt DJ, and Carhart-Harris RL (2016) Decreased mental time travel to the past correlates with defaul-tmode network disintegration under lysergic acid diethylamide. *J Psychopharmacol* 30:344-353.
242. Spitzer M, Thimm M, Hermle L, Holzmann P, Kovar KA, Heimann H, Gouzoulis-Mayfrank E, Kischka U, and Schneider F (1996) Increased activation of indirect semantic associations under psilocybin. *Biol Psychiatry* 39:1055-1057.
243. Sterzer P, Adams RA, Fletcher P, Frith C, Lawrie SM, Muckli L, Petrovic P, Uhlhaas P, Voss M, and Corlett PR (2018) The predictive coding account of psychosis. *Biol Psychiatry* 84:634-643.
244. Tagliazucchi E (2017) The signatures of conscious access and its phenomenology are consistent with large-scale brain communication at criticality. *Conscious Cogn* 55:136-147.
245. Tagliazucchi E, Carhart-Harris R, Leech R, Nutt D, and Chialvo DR (2014) Enhanced repertoire of brain dynamical states during the psychedelic experience. *Hum Brain Mapp* 35:5442-5456.
246. Tagliazucchi E, Roseman L, Kaelen M, Orban C, Muthukumaraswamy SD, Murphy K, Laufs H, Leech R, McGonigle J, Crossley N, *et al*. (2016) Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr Biol* 26:1043-1050.
247. Tervo DGR, Tenenbaum JB, and Gershman SJ (2016) Toward the neural implementation of structure learning. *Curr Opin Neurobiol* 37:99-105.
248. Thomas G, Lucas P, Capler NR, Tupper KW, and Martin G (2013) Ayahuasca-assisted therapy for addiction: results from a preliminary observational study in Canada. *Curr Drug Abuse* Rev 6:30-42.
249. Timmermann C, Roseman L, Williams L, Erritzoe D, Martial C, Cassol H, Laureys S, Nutt D, and Carhart-Harris R (2018) DMT

models the near-death experience. *Front Psychol* 9:1424.
250. Timmermann C, Spriggs MJ, Kaelen M, Leech R, Nutt DJ, Moran RJ, Carhart-Harris RL, and Muthukumaraswamy SD (2018) LSD modulates effective connectivity and neural adaptation mechanisms in an auditory oddball paradigm. *Neuropharmacology* 142:251-262.
251. Tononi G and Cirelli C (2006) Sleep function and synaptic homeostasis. *Sleep Med Rev* 10:49-62.
252. Turton S, Nutt DJ, and Carhart-Harris RL (2014) A qualitative report on the subjective experience of intravenous psilocybin administered in an FMRI environment. *Curr Drug Abuse Rev* 7:117-127.
253. Vaidya VA, Marek GJ, Aghajanian GK, and Duman RS (1997) 5-HT$_{2A}$ receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. *J Neurosci* 17:2785-2795.
254. Van de Cruys S, Evers K, Van der Hallen R, Van Eylen L, Boets B, de-Wit L, and Wagemans J (2014) Precise minds in uncertain worlds: predictive coding in autism. Psychol Rev 121:649-675.
255. Van de Cruys S, Van der Hallen R, and Wagemans J (2017) Disentangling signal and noise in autism spectrum disorder. *Brain Cogn* 112:78-83.
256. Van Hoeck N, Ma N, Ampe L, Baetens K, Vandekerckhove M, and Van Overwalle F (2013) Counterfactual thinking: an fMRI study on changing the past for a better future. *Soc Cogn Affect Neurosci* 8:556-564.
257. van Schalkwyk GI, Volkmar FR, and Corlett PR (2017) A predictive coding account of psychotic symptoms in autism spectrum disorder. *J Autism Dev Disord* 47:1323-1340.
258. van Wel JH, Kuypers KP, Theunissen EL, Bosker WM, Bakker K, and Ramaekers JG (2012) Effects of acute MDMA intoxication on mood and impulsivity: role of the 5-HT$_2$ and 5-HT$_1$ receptors. *PLoS One* 7:e40187.
259. Varley T, Carhart-Harris R, Roseman L, Menon D, and Stamatakis E (2019) Serotonergic psychedelics LSD & psilocybin increase the fractal dimension of cortical brain activity in spatial and temporal domains. *bioRxiv*.
260. Venkatasubramanian G and Keshavan MS (2016) Biomarkers in psychiatry: a critique. *Ann Neurosci* 23:3-5.
261. Vollenweider FX and Geyer MA (2001) A systems model of altered consciousness: integrating natural and drug-induced psychoses. *Brain Res Bull* 56:495-507.
262. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Bäbler A, Vogel H, and Hell D (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9:3897-3902.
263. Wackermann J, Wittmann M, Hasler F, and Vollenweider FX (2008) Effects of varied doses of psilocybin on time interval reproduction in human subjects. *Neurosci Lett* 435:51-55.
264. Waldman AA (2017) *A Really Good Day: How Microdosing Made a Mega Difference in My Mood, My Marriage, and My Life*, Knopf Publishing Group, New York.
265. Wang L and Smith K (1998) On chaotic simulated annealing. *IEEE Trans Neural Netw* 9:716-718.
266. Watts R, Day C, Krzanowski J, Nutt D, and Carhart-Harris R (2017) Patients' accounts of increased "connectedness" and "acceptance" after psilocybin for treatment-resistant depression. *J Humanist Psychol* 57:520-564.
267. Welsh SE, Romano AG, and Harvey JA (1998) Effects of serotonin 5-HT(2A/2C) antagonists on associative learning in the rabbit. *Psychopharmacology (Berl)* 137:157-163.
268. Whitaker R (2010) *Anatomy of an Epidemic: Magic Bullets, Psychiatric Drugs, and the Astonishing Rise of Mental Illness in America*, Crown Publishers, New York.
269. White F (1987) *The Overview Effect: Space Exploration and Human Evolution*, Houghton Mifflin, Boston.
270. Yu AJ and Dayan P (2002) Acetylcholine in cortical inference. *Neural Netw* 15:719-730.
271. Yu AJ and Dayan P (2005) Uncertainty, neuromodulation, and attention. *Neuron* 46: 681-692.
272. Zammit S, Lewis G, Rasbash J, Dalman C, Gustafsson JE, and Allebeck P (2010) Individuals, schools, and neighborhood: a multilevel longitudinal study of variation in incidence of psychotic disorders. *Arch Gen Psychiatry* 67:914-922.
273. Zeller D, Litvak V, Friston KJ, and Classen J (2015) Sensory processing and the rubber hand illusion - an evoked potentials study. *J Cogn Neurosci* 27: 573-582.
274. Zhang G, Ásgeirsdóttir HN, Cohen SJ, Munchow AH, Barrera MP, and Stackman RW Jr (2013) Stimulation of serotonin 2A receptors facilitates consolidation and extinction of fear memory in C57BL/6J mice. *Neuropharmacology* 64: 403-413.

Psychedelics as a Treatment for Alzheimer's Disease Dementia

by

Simon Andrew Vann Jones* **and Allison O'Kelly**

Cornwall Partnership NHS Foundation Trust, Liskeard, United Kingdom

Frontiers in Synaptic Neuroscience

© Authors 2020

original report: https://www.frontiersin.org/articles/10.3389/fnsyn.2020.00034/pdf

Edited by: Christian Gonzalez-Billault, University of Chile, Chile
Reviewed by: Yasmin Schmid, University Hospital of Basel, Switzerland Charles D. Nichols, Louisiana State University, United States Jaime Eduardo Hallak, University of São Paulo, Brazil
***Correspondence**: Simon Andrew Vann Jones s.vannjones@nhs.net
Received: 07 May 2020 / **Accepted**: 28 July 2020 / **Published**: 21 August 2020
Citation: Vann Jones SA and O'Kelly A (2020) Psychedelics as a Treatment for Alzheimer's Disease Dementia. Front. Synaptic Neurosci. 12:34. doi: 10.3389/fnsyn.2020.00034

Copyright © 2020 Vann Jones and O'Kelly. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Table of Contents:

- Abstract
- Introduction
- Cognitive effects
- Longer-term effects
- Neurobiological effects
- Neurophysiological effects
- Neuroimaging
- Anti-inflammatory mechanisms
- Discussion
- Author contributions
- References

Abstract

Currently, there are no disease-modifying treatments for Alzheimer's disease (AD) or any other dementia subtype. The renaissance in psychedelic research in recent years, in particular studies involving psilocybin and lysergic acid diethylamide (LSD), coupled with anecdotal reports of cognitive benefits from micro-dosing, suggests that they may have a therapeutic role in a range of psychiatric and neurological conditions due to their potential to stimulate neurogenesis, provoke neuroplastic changes and reduce neuroinflammation. This inevitably makes them interesting candidates for therapeutics in dementia. This mini-review will look at the basic science and current clinical evidence for the role of psychedelics in treating dementia, especially early AD, with a particular focus on microdosing of the classical psychedelics LSD and psilocybin.

Keywords: psychedelic, Alzheimer's disease, dementia, plasticicity, microdosing

Introduction

Globally an estimated 50 million people have a diagnosis of dementia and population prevalence continues to increase (Alzheimer's Society, 2019; UK Government Web Archive, 2020). Alzheimer's disease (AD) accounts for approximately 50-70% of cases (Draper, 2013).

AD is a progressive neurological disorder characterized by extracellular amyloid protein deposition and intracellular tau protein aggregates (tangles) that, in accumulation, are associated with a variety of pathological processes including microtubular damage, axonal transport disruption and, ultimately, cell death. The hippocampus, a key structure in the ability to learn and retain information and a site for neurogenesis, is particularly vulnerable to AD pathology and one of the earliest parts of the brain to be affected by the disease (Mu and Gage, 2011; Pilly and Grossberg, 2012; Setti *et al.*, 2017).

Currently, there is a renaissance of research using psychedelics, potent 5-HT$_{2A}$ receptor (5-HT$_{2A}$-R) agonists, in psychiatric and neurological disorders (Nichols, 2004; Halberstadt, 2015; Aday *et al.*, 2020). The 5-HT$_{2A}$-R is found in high concentrations in regions of the brain vulnerable to dementia such as the prefrontal cortex and aforementioned hippocampus (Wood *et al.*, 2012; Catlow *et al.*, 2013; Bryson *et al.*, 2017). Psychedelics induce brain plasticity and modify connectivity between brain regions and there is considerable anecdotal evidence of cognitive benefits from micro-dosing - a dose that does not cause perceptual change or impair functioning (Carhart-Harris *et al.*, 2012; Wood *et al.*, 2012; Catlow *et al.*, 2013; Muthukumaraswamy *et al.*, 2013; Zhang and Stackman, 2015; Griffiths *et al.*, 2016; Carhart-Harris and Goodwin, 2017a; Carhart-Harris and Nutt, 2017; Johnstad, 2018; Fadiman and Korb, 2019; Kuypers *et al.*, 2019; Lea *et al.*, 2020a).

This mini-review will explore the role of classical psychedelics psilocybin and Lysergic acid diethylamide (LSD) in treating AD with a focus on sub-perceptual- or "micro"- dosing. Promoting neuroplasticity and neurogenesis via the 5-HT$_{2A}$-R in regions such as the hippocampus could theoretically help protect this and other brain structures and may, therefore, hold potential for treating AD.

Cognitive effects

High dose psilocybin reduces attention to both clinical and electrophysiological parameters. However, this may be due to an increased awareness of sensory stimuli that are usually filtered out (cost of attention) rather than reduced attentional ability *per se* (Carter *et al.*, 2005; Bravermanová *et al.*, 2018).

In younger adults, the only controlled studies of microdosing LSD to date (n = 20 and n = 24, respectively), both using a within-subjects design, found no effects either positive or negative on the cognitive function of healthy volunteers at different sub-perceptual doses (Bershad *et al.*, 2019; Hutten *et al.*, 2020). Participants had all previously experienced psychedelics. The former study used a placebo, 6.5, 13, and 26 µg, and the latter study placebo, 5, 10, or 20 µg. In the latter study, subjects had objective increases in psychomotor vigilance (and subjective happiness and mood scores) coupled with a paradoxical reduction in concentration and reduced set-shifting ability at the highest microdose (20 µg) hours after ingestion. Participants also reported subjectively greater productivity at 10 micrograms and no discernible subjective or objective differences at five micrograms compared to placebo (Hutten *et al.*, 2020). Importantly, subjects were aware that they were on the active drug at the two higher doses and had the experience of recreational drug use.

A 2018 uncontrolled, open-label naturalistic trial found increased cognitive fluency, flexibility, and originality amongst the 33 participants at various micro-doses of psilocybin (Prochazkova *et al.*, 2018). However, results should be interpreted with a degree of caution due to the risk of selection bias (the study was organized by the Dutch Psychedelic Society), a lack of a placebo control arm, risk of practice effect bias, and no intention-to-treat analysis.

In older adults, a recent double-blind placebo-controlled study in older adults (n = 48) who had not taken LSD for at least the past 5 years found no difference in the number of adverse events (including cognitive impairment) between those taking placebo, 5, 10, or 20 µg doses every 5 days for 28 days (Family *et al.*, 2020). Headaches were reported more often in those taking LSD however the small number of participants and non-linear dose-response makes this difficult to interpret. In general, the medication was well tolerated with no serious adverse events or drop-outs.

Longer-term effects

In rat models, 5-HT_{2A}-R activation with mid-dose psilocybin (0.13 mg/kg) enhances both prospective and retrospective learning with lesser effects at low-dose (0.06 mg/kg; Buchborn *et al.*, 2014; Cini *et al.*, 2019). Consecutive daily dosing diminished benefits, and older rodents learning was enhanced by an enriched environment (Buchborn *et al.*, 2014).

An observational study of 89 recreational users micro-dosing psychedelics found self-reported improvement across multiple psychological domains, including creativity and attention, with a sustained improvement over 6 weeks (Polito and Stevenson, 2019). Studies of recreational micro-dosing, highly vulnerable to bias but arguably self-selecting for longer-term users, report improvement in cognitive focus and attention (14-61% of users; Anderson *et al.*, 2019; Hutten *et al.*, 2019; Lea *et al.*, 2020b). However only one of these studies reported figures for the duration of use, with 60.5% of respondents using for 3 months or more (Lea *et al.*, 2020b).

There have been no properly controlled studies of microdosing in cognitively impaired humans or effects on cognition or mood beyond the acute phase. However, studies of high dose LSD and psilocybin have shown long-term benefits on mood. A study of 16 healthy subjects showed subjective benefits of a single dose of 200 µg LSD 12 months later, with 10 participants rating the experience as one of the top 10 most meaningful of their lives (Schmid and Liechti, 2018). In 10 patients with a life-threatening disease, LSD-assisted psychotherapy reduced anxiety significantly, an effect that persisted 12-months after therapy in 77.7%. Two-thirds of the respondents also reported that the experience has improved their quality of life (Gasser *et al.*, 2015).

Similar results have been observed following high dose psilocybin both in patients with anxiety related to life-threatening cancer, and cancer-related depression and anxiety (n = 51 and 29 respectively, both cross-over design; Griffiths *et al.*, 2016; Ross *et al.*, 2016). Both studies reported that approximately 60-80% of participants had a clinically significant response that was sustained some 6 months later. The latter study also followed up 4.5 years later and found that these results were sustained, with 71-100% of participants reporting the experience being one of the most meaningful of their lives (Agin-Liebes *et al.*, 2020).

In treatment-resistant depression, 10 mg and 25 mg of psilocybin given 1 week apart (n = 20), led to clinical response or remission in 14 participants sustained at assessment 5 weeks later. This effect persisted at 6 months follow up despite no further treatment (Carhart-Harris *et al.*, 2018).

These encouraging results have led, in part, to approval for a trial of high-dose psilocybin specifically targeting depression in early AD (Clinicaltrials.gov, 2020).

Neurobiological effects

Specific 5-HT_{2A}-R polymorphisms impair verbal memory recall and object recognition and reduced 5-HT_{2A}-R density in areas of the brain responsible for key memory processes are associated with worse cognitive performance (Schott *et al.*, 2011). Pre-task 5-HT_{2A}-R activation in mice enhances post-task hippocampal long-term potentiation and enables the re-consolidation of fear conditioning in the amygdala supporting a critical role in neuroplasticity (Catlow *et al.*, 2013; Zhang *et al.*, 2013). This effect can be reproduced in rats and rabbits by very low dose psychedelics but is abolished by higher doses (Romano *et al.*, 2010; Cameron *et al.*, 2019).

In rats, 5-HT_{2A}-R activation stimulates neurogenesis and brain-derived neurotrophic factor (BDNF) expression in the neocortex but appears to consistently inhibit the same process in the hippocampus (Vaidya *et al.*, 1997). This may be dose-dependent, with higher doses suppressing neurogenesis beyond a certain threshold. In cultured rat neurons, activation also stimulates dendritic spine proliferation and growth (Jones *et al.*, 2009; Yoshida *et al.*, 2011). In a mouse model of fear conditioning, both low and high dose psilocybin led to complete resolution of a cued fear response in animals that had been primed for a shock by an auditory tone (Catlow *et* *al*., 2013). This process was more rapid at lower doses where hippocampal neurogenesis was unimpaired. In rat cortical neuron cultures and drosophila larvae, LSD promotes neurogenesis and synaptogenesis in a dose-dependent manner suggesting both an important cross-species evolutionary pathway for this effect and that there may be an optimal dose to which it may be therapeutic for this purpose (Ly *et al*., 2018).

There is also likely to be an optimal dose spacing. Repeated administration of LSD and/or psilocybin leads to rapid tolerance, or tachyphylaxis, of mental effects from 24 h which peaks after just four consecutive daily doses, cannot be overcome even with substantial dose increases or switching to the other substance (cross-tolerance) and is completely reversed by 5 days of abstinence (Buchborn *et al*., 2016). In rats, high doses of LSD (0.16 mg/kg) given every 2 days for 90 days resulted in hyperactive and asocial symptoms (Martin *et al*., 2014). The aforementioned double-blind placebo-controlled safety study in older adults using a schedule of a dose every fourth day (Family *et al*., 2020). This may be optimal as tachyphylaxis is unlikely at this infrequency and, importantly, side effects were minimal and not significantly different to those on placebo.

Neurophysiological effects

Human gamma frequency oscillations (30-100 Hz) within neuronal networks are important for communication between brain regions, particularly those involving attention and memory (Jensen *et al*., 2007; Verret *et al*., 2012; Mably and Colgin, 2018). These networks become disrupted decades before the onset of symptoms in AD, possibly linked to dysfunctional inhibitory interneurons leading to the disruption of the gamma-mediated temporal structure for cortical processing which allows for the coherent packaging of sensory information (Weber and Andrade, 2010; Palop and Mucke, 2016).

Studies in mild cognitive impairment and AD show contradictory results on levels of gamma activity with some showing an increase and others a decrease in vulnerable brain regions and networks (König *et al*., 2005; Van Deursen *et al*., 2008; Basar *et al*., 2017; Wang *et al*., 2017). However, a recent study found that gamma frequency response is slowed in response to stimulus in Alzheimer patients suggesting that the increase in gamma power seen in some studies with AD patients may the greater use of brain resources to maintain resting state (Basar *et al*., 2016). The same researchers found that long-distance gamma-related connectivity was heightened in AD patients compared to controls (Basar *et al*., 2017). It is possible that this increase in gamma activity is an initial response to brain failure but that this process is fatigable.

In recent studies, enhancing gamma frequency oscillations via external stimuli reduced amyloid burden, possibly *via* increased microglia activity, and improved cognitive function in rodents (Laccarino *et al*., 2016; Martorell *et al*., 2019). 5-HT$_{2A}$-R agonists enhance the power of gamma-frequency recordings suggesting a role for the 5-HT$_{2A}$-R both in mediating long-range projections and reducing focal Alzheimer's pathology (Puig *et al*., 2010; Athilingam *et al*., 2017).

Neuroimaging

In AD there is a reduction in global brain glucose metabolism which is marked in frontal and temporal-parietal areas (Garibotto *et al*., 2017; Rice and Bisdas, 2017). In the only psilocybin FDG-PET study to date, in healthy volunteers, acute ingestion of a 15 mg or 20 mg dose increased global brain glucose metabolism by approximately 25%, particularly in the frontal and medial temporal cortex (Vollenweider *et al*., 1997).

A 2019 fMRI study showed lasting benefits 4 months after a single dose of 315 µg/kg psilocybin in a group of 38 meditators (Smigielski *et al*., 2019). Acute MRI changes - reduced connectivity between self-perceiving medial prefrontal and ventral cingulate areas - were associated with positive changes at 4 months. A 2020 fMRI study involving 16 patients with depression who took a single dose of 10 mg of psilocybin and 25 mg a week later, found increased functional connectivity between the ventromedial prefrontal cortex and the default mode network in responders the day following treatment completion, with changes sustained 5 weeks post-dosing (Carhart-Harris *et al*., 2017b). Functional connectivity was increased between regions with high 5-HT$_{2A}$-R density suggesting that reorganizing of dysfunctional neural circuitry is an important component of the neuroplastic effects of 5-HT$_{2A}$-R agonists (Tagliazucchi *et al*., 2016; Deco *et al*., 2018).

Studies suggest that at least some of the antidepressant effect from psilocybin may be mediated *via* improved top-down control of the limbic system, which holds significant promise for impulse control and well-being in dementia where this control has diminished. In healthy adults, high-dose psilocybin (16 mg/kg and) has been shown to attenuate amygdala reactivity to emotional stimuli (Kraehenmann *et al*., 2015). In 19 adults with treatment-resistant depression, 10 mg and 25 mg psilocybin given a week apart, improved functional connectivity between the cortex and amygdala a day after the higher dose (Mertens *et al*., 2020). In another study, also in healthy adults, sub-perceptual doses of LSD (13 µg) was shown to significantly influence functional connectivity between the amygdala and other key regions within the limbic system suggesting 5-HT_{2A}-R mediated reorganization of more primitive networks is possible without profound acute perceptual changes, although whether these changes were lasting is unclear (Bershad *et al*., 2020).

These imaging studies reveal the potent reorganization of dysfunctional brain networks in affective and anxiety states. Such changes may also yield improvements in cognition, mood, and behavior by ameliorating dysfunctional circuits in cognitive impairment and dementia.

Anti-inflammatory mechanisms

All known genetic and environmental risk factors for AD are associated with increased inflammation, suggesting that reducing inflammation could be a target for preventing AD (Jones and Kounatidis, 2017). Psychedelics have been shown to have potent anti-inflammatory properties and, given their affinity for the 5-HT_{2A}-R, may represent a unique anti-inflammatory overwhelmingly targeted to brain tissue (Flanagan and Nichols, 2018).

In a rodent model of AD induced by chronic intracerebral inoculation of streptozotocin, 5-HT_{1A}- and 5-HT_{2A}-R agonists had a significant independent and synergistic neuroprotective effect in hippocampal neurons at 35 days *via* anti-apoptotic pathways (Shahidi *et al*., 2019). This neuroprotection infers activation of anti-inflammatory pathways, the corollary to this being that activation of 5-HT_{2A}-R in rodent neurons protects against reactive oxygen species (ROS) *via* the upregulation of neuroprotective Sirtuin 1 expression (Fanibunda *et al*., 2019). This pathway simultaneously stimulates mitochondrial biogenesis leading to greater availability of adenosine triphosphate and suggesting the potential for psychedelics to address impaired energy metabolism, another key pathological pathway to cognitive dysfunction in AD (Kapogiannis and Mattson, 2011).

Discussion

After decades of repeated failure of treatments for dementia, there is an urgent need to develop new treatments for AD. The potential for psychedelic compounds to influence and enhance functional neuronal connectivity, stimulate neurogenesis, restore brain plasticity, reduce inflammation and enhance cognition provides a new therapeutic target and compelling argument for further investigation of the potential for psychedelics as a disease-modifying compound in conditions where currently none exists.

Animal models testing the neurobiological effects of psychedelic compounds have demonstrated hippocampal neurogenesis at lower doses and suppression at higher doses and potent neuroprotective properties. Studies in people suffering from depression and anxiety disorders have demonstrated lasting neuroplastic changes following just one or two large doses. This suggests a potential role for both sub-perceptual "micro"- and psychedelic-doses as a strategy for neuroprotection and cognitive enhancement in prodromal AD. For cognitive enhancement, the ideal dose and frequency have yet to be determined however the rapid desensitization of 5-HT_{2A} receptors by both psilocybin and LSD suggests that daily dosing is unlikely to be the optimal strategy.

Despite anecdotal evidence of widespread recreational use of micro-dosing for cognitive enhancement, robust scientific studies of the cognitive effects of micro-dosing in humans have so far been limited to acute changes in very small studies in cognitively normal individuals with no reports of persistent cognitive changes, either positive or negative, at psychedelic doses. Studies looking at both micro-dosing and psychedelic doses, longer-term, in cognitively impaired individuals are lacking and urgently needed.

Author contributions

SV came up with the idea for the review. Both SV and AO'K were involved in a review of the literature and writing and editing the final manuscript.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Aday, J. S., Bloesch, E. K., and Davoli, C. C. (2020). Can psychedelic drugs attenuate age-related changes in cognition and affect? *J. Cogn. Enhan.* 4, 219-227. doi: 10.1007/s41465-019-00151-6
2. Agin-Liebes, G. I., Malone, T., Yalch, M. M., Mennenga, S. E., Ponté, K. L., Guss, J., *et al.* (2020). Long-term follow-up of psilocybin-assisted psychotherapy for psychiatric and existential distress in patients with life-threatening cancer. *J. Psychopharmacol.* 34, 155-166. doi: 10.1177/0269881119897615
3. Alzheimer's Society. (2019). *Demography.* Available online at: http://www.alzheimers.org.uk/site/scripts/documents_info.php?documentID=412. Accessed May 20, 2019.
4. Anderson, T., Petranker, R., Christopher, A., Rosenbaum, D., Weissman, C., Dinh-Williams, L. A., *et al.* (2019). Psychedelic microdosing benefits and challenges: an empirical codebook. *Harm Reduct. J.* 16:43. doi: 10.1186/s12954-019-0308-4
5. Athilingam, J. C., Ben-Shalom, R., Keeshen, C. M., Sohal, V. S., and Bender, K. J. (2017). Serotonin enhances excitability and γ frequency temporal integration in mouse prefrontal fast-spiking interneurons. *eLife* 6:e31991. doi: 10.7554/elife. 31991.022
6. Basar, E., Emek-Savas, D. D., Güntekin, B., and Yener, G. G. (2016). Delay of cognitive γ responses in Alzheimer's disease. *Neuroimage Clin.* 11, 106-115. doi: 10.1016/j.nicl.2016.01.015
7. Basar, E., Femir, B., Emek-Savas, D. D., Güntekin, B., and Yener, G. G. (2017). Increased long distance event-related γ band connectivity in Alzheimer's disease. *Neuroimage Clin.* 14, 580-590. doi: 10.1016/j.nicl.2017. 02.021
8. Bershad, A. K., Preller, K. H., Lee, R., Keedy, S., Wren-Jarvis, J., Bremmer, M. P., *et al.* (2020). Preliminary report on the effects of a low dose of LSD on resting state amygdalar functional connectivity. *Biol. Psychiatry Cogn. Neurosci. Neuroimaging* 5, 461-467. doi: 10.1016/j.bpsc.2019.12.007
9. Bershad, A. K., Schepers, S. T., Bremmer, M. P., Lee, R., and de Wit, H. (2019). Acute subjective and behavioral effects of microdoses of LSD in healthy human volunteers. *Biol. Psychiatry* 86, 792-800. doi: 10.1016/j.biopsych.2019.05.019
10. Bravermanová, A., Viktorinová, M., Tyls·, F., Novák, T., Androvic·ová, R., Kor&ccaron;ák, J., *et al.* (2018). Psilocybin disrupts sensory and higher order cognitive processing but not pre-attentive cognitive processing - study on P300 and mismatch negativity in healthy volunteers. *Psychopharmacology* 235, 491-503. doi: 10.1007/s00213-017-4807-2
11. Bryson, A., Carter, O., Norman, T., and Kanaan, R. (2017). 5-HT$_{2A}$ agonists: a novel therapy for functional neurological disorders? *Int. J. Neuropsychopharmacol.* 20, 422-427. doi: 10.1093/ijnp/pyx011
12. Buchborn, T., Grecksch, G., Dieterich, D. C., and Höllt, V. (2016). "Tolerance to lysergic acid diethylamide: overview, correlates, and clinical implications," in *Neuropathology of Drug Addictions and Substance Misuse*, ed. V. R. Preedy (San Diego, CA: Academic Press), 846-858.
13. Buchborn, T., Schröder, H., Höllt, V., and Grecksch, G. (2014). Repeated lysergic acid diethylamide in an animal model of depression: normalisation of learning behaviour and hippocampal serotonin 5-HT$_2$ signalling. *J. Psychopharmacol.* 28, 545-552. doi: 10.1177/0269881114531666
14. Cameron, L. P., Benson, C. J., DeFelice, B. C., Fiehn, O., and Olson, D. E. (2019). Chronic, intermittent microdoses of the psychedelic *N, N* -Dimethyltryptamine (DMT) produce positive effects on mood and anxiety in rodents. *ACS Chem. Neurosci.* 10, 3261-3270. doi: 10.1021/acschemneuro.8b00692
15. Carhart-Harris, R. L., Bolstridge, M., Day, C. M., Rucker, J., Watts, R., Erritzoe, D. E., *et al.* (2018). Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. *Psychopharmacology* 235, 399-408. doi: 10.1007/s00213-017-4771-x
16. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J. M., Reed, L. J., Colasanti, A., *et al.* (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc. Natl. Acad. Sci. U S A* 109, 2138-2143. doi: 10.1073/pnas.1119598109
17. Carhart-Harris, R. L., and Goodwin, G. M. (2017a). The therapeutic potential of psychedelic drugs: past present and future. *Neuropsychopharmacology* 42, 2105-2113. doi: 10.1038/npp.2017.84
18. Carhart-Harris, R. L., Roseman, L., Bolstridge, M., Demetriou, L., Pannekoek, J. N., Wall, M. B., *et al.* (2017b). Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Sci. Rep.* 7:13187. doi: 10.1038/s41598-017-13282-7
19. Carhart-Harris, R. L., and Nutt, D. J. (2017). Serotonin and brain function: a tale of two receptors. *J. Psychopharmacol.* 31, 1091-1120. doi: 10.1177/0269881117725915
20. Carter, O. L., Burr, D. C., Pettigrew, J. D., Wallis, G. M., Hasler, F., and Vollenweider, F. X. (2005). Using psilocybin to investigate the relationship between attention, working memory and the serotonin 1A and 2A receptors. *J. Cogn. Neurosci.* 17, 1497-1508. doi: 10.1162/089892905774597191
21. Catlow, B. J., Song, S., Paredes, D. A., Kirstein, C. L., and Sanchez-Ramos, J. (2013). Effects of psilocybin on hippocampal neurogenesis and extinction of trace fear conditioning. *Exp. Brain Res.* 228, 481-491. doi: 10.1007/s00221-013-3579-0
22. Cini, F. A., Ornelas, I., Marcos, E., Goto-Silva, L., Nascimento, J., Ruschi, S., *et al.* (2019). d-Lysergic acid diethylamide has major potential as a cognitive enhancer. *bioRxiv* [Preprint].doi: 10.1101/866814
23. Clinicaltrials.gov. (2020). *Psilocybin for Depression in People With Mild Cognitive Impairment or Early Alzheimer's Disease.*

Available online at: https://clinicaltrials.gov/ct2/show/NCT04123314?term=psilocybinandcond=Alzheimer+Disease&draw=2&rank=1. Accessed June 24, 2020.

24. Deco, G., Cruzat, J., Cabral, J., Knudsen, G. M., Carhart-Harris, R. L., Whybrow, P. C., *et al.* (2018). Whole-brain multimodal neuroimaging model using serotonin receptor maps explains non-linear functional effects of LSD. *Curr. Biol.* 28, 3065.e6-3074.e6. doi: 10.1016/j.cub.2018.07.083
25. Draper, B. (2013). *Understanding Alzheimer's Disease and Other Dementias.* London: Jessica Kingsley.
26. Fadiman, J., and Korb, S. (2019). Might microdosing psychedelics be safe and beneficial? An initial exploration. *J. Psychoactive Drugs* 51, 118-122. doi: 10.1080/02791072.2019.1593561
27. Family, N., Maillet, E. L., Williams, L. T., Krediet, E., Carhart-Harris, R. L., Williams, T. M., *et al.* (2020). Safety, tolerability, pharmacokinetics, and pharmacodynamics of low dose lysergic acid diethylamide (LSD) in healthy older volunteers. *Psychopharmacology* 237, 841-853. doi: 10.1007/s00213-019-05417-7
28. Fanibunda, S. E., Deb, S., Maniyadath, B., Tiwari, P., Ghai, U., Gupta, S., *et al.* (2019). Serotonin regulates mitochondrial biogenesis and function in rodent cortical neurons via the 5-HT_{2A} receptor and SIRT1-PGC-1α axis. *Proc. Natl. Acad. Sci. U S A* 116, 11028-11037.doi: 10.1073/pnas.1821332116
29. Flanagan, T. W., and Nichols, C. D. (2018). Psychedelics as anti-inflammatory agents. *Int. Rev. Psychiatry* 30, 363-375. doi: 10.1080/09540261.2018.1481827
30. Garibotto, V., Herholz, K., Boccardi, M., Picco, A., Varrone, A., Nordberg, A., *et al.* (2017). Clinical validity of brain fluorodeoxyglucose positron emission tomography as a biomarker for Alzheimer's disease in the context of a structured 5-phase development framework. *Neurobiol. Aging* 52, 183-195. doi: 10.1016/j.neurobiolaging.2016.03.033
31. Gasser, P., Kirchner, K., and Passie, T. (2015). LSD-assisted psychotherapy for anxiety associated with a life-threatening disease: a qualitative study of acute and sustained subjective effects. *J. Psychopharmacol.* 29, 57-68. doi: 10.1177/0269881114555249
32. Griffiths, R. R., Johnson, M. W., Carducci, M. A., Umbricht, A., Richards, W. A., Richards, B. D., *et al.* (2016). Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. *J. Psychopharmacol.* 30, 1181-1197. doi: 10.1177/0269881116675513
33. Halberstadt, A. L. (2015). Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behav. Brain Res.* 277, 99-120. doi: 10.1016/j.bbr. 2014.07.016
34. Hutten, N. R., Mason, N. L., Dolder, P. C., and Kuypers, K. P. (2019). Motives and side-effects of microdosing with psychedelics among users. *Int. J. Neuropsychopharmacol.* 22, 426-434. doi: 10.1093/ijnp/ pyz029
35. Hutten, N., Mason, N., Dolder, P., Theunissen, E., Liechti, M., Feilding, A., *et al.* (2020). Cognitive and subjective effects of different low 'micro' doses of LSD in a placebo-controlled study. *Eur. Neuropsychopharmacol.* 31, S63-S64. doi: 10.1016/j.euroneuro.2019.12.086
36. Jensen, O., Kaiser, J., and Lachaux, J.-P. (2007). Human γ-frequency oscillations associated with attention and memory. *Trends Neurosci.* 30, 317-324. doi: 10.1016/j.tins.2007.05.001
37. Johnstad, P. G. (2018). Powerful substances in tiny amounts: an interview study of psychedelic microdosing. *Nordic Stud. Alcohol Drugs* 35, 39-51. doi: 10.1177/1455072517753339
38. Jones, S. V., and Kounatidis, I. (2017). Nuclear factor-κ B and Alzheimer disease, unifying genetic and environmental risk factors from cell to humans. *Front. Immunol.* 8:1805. doi: 10.3389/fimmu.2017.01805
39. Jones, K. A., Srivastava, D. P., Allen, J. A., Strachan, R. T., Roth, B. L., and Penzes, P. (2009). Rapid modulation of spine morphology by the 5-HT_{2A} serotonin receptor through kalirin-7 signaling. *Proc. Natl. Acad. Sci. U S A* 106, 19575-19580. doi: 10.1073/pnas.0905884106
40. König, T., Prichep, L., Dierks, T., Hubl, D., Wahlund, L. O., John, E. R., *et al.* (2005). Decreased EEG synchronization in Alzheimer's disease and mild cognitive impairment. *Neurobiol. Aging* 26, 165-171. doi: 10.1016/j. neurobiolaging.2004.03.008
41. Kapogiannis, D., and Mattson, M. P. (2011). Disrupted energy metabolism and neuronal circuit dysfunction in cognitive impairment and Alzheimer's disease. *Lancet Neurol.* 10, 187-198. doi: 10.1016/S1474-4422(10) 70277-5
42. Kraehenmann, R., Preller, K. H., Scheidegger, M., Pokorny, T., Bosch, O. G., Seifritz, E., *et al.* (2015). Psilocybin-induced decrease in amygdala reactivity correlates with enhanced positive mood in healthy volunteers. *Biol. Psychiatry* 78, 572-581. doi: 10.1016/j.biopsych.2014.04.010
43. Kuypers, K. P., Ng, L., Erritzoe, D., Knudsen, G. M., Nichols, C. D., Nichols, D. E., *et al.* (2019). Microdosing psychedelics: more questions than answers? An overview and suggestions for future research. *J. Psychopharmacol.* 33, 1039-1057. doi: 10.1177/0269881119857204
44. Laccarino, H. F., Singer, A. C., Martorell, A. J., Rudenko, A., Gao, F., Gillingham, T. Z., *et al.* (2016). γ frequency entrainment attenuates amyloid load and modifies microglia. *Nature* 540, 230-235. doi: 10.1038/nature20587
45. Lea, T., Amada, N., and Jungaberle, H. (2020a). Psychedelic microdosing: a subreddit analysis. *J. Psychoactive Drugs* 52, 101-112. doi: 10.1080/02791072. 2019.1683260
46. Lea, T., Amada, N., Jungaberle, H., Schecke, H., and Klein, M. (2020b). Microdosing psychedelics: motivations, subjective effects and harm reduction. *Int. J. Drug Policy* 75:102600. doi: 10.1016/j.drugpo.2019.11.008
47. Ly, C., Greb, A. C., Cameron, L. P., Wong, J. M., Barragan, E. V., Wilson, P. C., *et al.* (2018). Psychedelics promote structural and functional neural plasticity. *Cell Rep.* 23, 3170-3182. doi: 10.1016/j.celrep.2018.05.022
48. Mably, A. J., and Colgin, L. L. (2018). γ oscillations in cognitive disorders. *Curr. Opin. Neurobiol.* 52, 182-187. doi: 10.1016/j.conb.2018.07.009
49. Martin, D. A., Marona-Lewicka, D., Nichols, D. E., and Nichols, C. D. (2014). Chronic LSD alters gene expression profiles in the mPFC relevant to schizophrenia. *Neuropharmacology* 83, 1-8. doi: 10.1016/j.neuropharm.2014. 03.013
50. Martorell, A. J., Paulson, A. L., Suk, H. J., Abdurrob, F., Drummond, G. T., Guan, W., *et al.* (2019). Multi-sensory γ stimulation ameliorates Alzheimer's-associated pathology and improves cognition. *Cell* 177, 256-271. doi: 10.1016/j. cell.2019.02.014
51. Mertens, L. J., Wall, M. B., Roseman, L., Demetriou, L., Nutt, D. J., and Carhart-Harris, R. L. (2020). Therapeutic mechanisms of psilocybin: changes in amygdala and prefrontal functional connectivity during emotional processing after psilocybin for treatment-resistant depression. *J. Psychopharmacol.* 34, 167-180. doi: 10.1177/0269881119895520

52. Mu, Y., and Gage, F. H. (2011). Adult hippocampal neurogenesis and its role in Alzheimer's disease. *Mol. Neurodegener.* 6:85. doi: 10.1186/1750-1326-6-85
53. Muthukumaraswamy, S. D., Carhart-Harris, R. L., Moran, R. J., Brookes, M. J., Williams, T. M., Errtizoe, D., *et al.* (2013). Broadband cortical desynchronization underlies the human psychedelic state. *J. Neurosci.* 33, 15171-15183. doi: 10.1523/JNEUROSCI.2063-13.2013
54. Nichols, D. E. (2004). Hallucinogens. *Pharmacol. Ther.* 101, 131-181. doi: 10.1016/j.pharmthera.2003.11.002
55. Palop, J. J., and Mucke, L. (2016). Network abnormalities and interneuron dysfunction in Alzheimer disease. *Nat. Rev. Neurosci.* 17, 777-792. doi: 10.1038/nrn.2016.141
56. Pilly, P. K., and Grossberg, S. (2012). How do spatial learning and memory occur in the brain? Coordinated learning of entorhinal grid cells and hippocampal place cells. *J. Cogn. Neurosci.* 24, 1031-1054. doi: 10.1162/jocn_a_00200
57. Polito, V., and Stevenson, R. J. (2019). A systematic study of microdosing psychedelics. *PLoS One* 14:e0211023. doi: 10.1371/journal.pone.0211023
58. Prochazkova, L., Lippelt, D. P., Colzato, L. S., Kuchar, M., Sjoerds, Z., and Hommel, B. (2018). Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. *Psychopharmacology* 235, 3401-3413. doi: 10.1007/s00213-018-5049-7
59. Puig, M. V., Watakabe, A., Ushimaru, M., Yamamori, T., and Kawaguchi, Y. (2010). Serotonin modulates fast-spiking interneuron and synchronous activity in the rat prefrontal cortex through 5-HT$_{1A}$ and 5-HT$_{2A}$ receptors. *J. Neurosci.* 30, 2211-2222. doi: 10.1523/JNEUROSCI.3335-09.2010
60. Rice, L., and Bisdas, S. (2017). The diagnostic value of FDG and amyloid PET in Alzheimer's disease - A systematic review. *Eur. J. Radiol.* 94, 16-24. doi: 10.1016/j.ejrad.2017.07.014
61. Romano, A. G., Quinn, J. L., Li, L., Dave, K. D., Schindler, E. A., Aloyo, V. J., *et al.* (2010). Intrahippocampal LSD accelerates learning and desensitizes the 5-HT 2A receptor in the rabbit. *Psychopharmacology* 212, 441-448. doi: 10.1007/s00213-010-2004-7
62. Ross, S., Bossis, A., Guss, J., Agin-Liebes, G., Malone, T., Cohen, B., *et al.* (2016). Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *J. Psychopharmacol.* 30, 1165-1180. doi: 10.1177/0269881116675512
63. Schmid, Y., and Liechti, M. E. (2018). Long-lasting subjective effects of LSD in normal subjects. *Psychopharmacology* 235, 535-545. doi: 10.1007/s00213-017-4733-3
64. Schott, B. H., Seidenbecher, C. I., Richter, S., Wüstenberg, T., Debska-Vielhaber, G., Schubert, H., *et al.* (2011). Genetic variation of the serotonin 2a receptor affects hippocampal novelty processing in humans. *PLoS One* 6:e15984. doi: 10.1371/journal.pone.0015984
65. Setti, S. E., Hunsberger, H. C., and Reed, M. N. (2017). Alterations in hippocampal activity and Alzheimer's disease. *Transl. Issues Psychol. Sci.* 3, 348-356. doi: 10.1037/tps0000124
66. Shahidi, S., Hashemi-Firouzi, N., Afshar, S., Asl, S. S., and Komaki, A. (2019). Protective effects of 5-ht1a receptor inhibition and 5-ht2a receptor stimulation against streptozotocin-induced apoptosis in the hippocampus. *Malays. J. Med. Sci.* 26, 40-51. doi: 10.21315/mjms2019.26.2.5
67. Smigielski, L., Scheidegger, M., Kometer, M., and Vollenweider, F. X. (2019). Psilocybin-assisted mindfulness training modulates self-consciousness and brain default mode network connectivity with lasting effects. *NeuroImage* 196, 207-215. doi: 10.1016/j.neuroimage.2019.04.009
68. Tagliazucchi, E., Roseman, L., Kaelen, M., Orban, C., Muthukumaraswamy, S. D., Murphy, K., *et al.* (2016). Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr. Biol.* 26, 1043-1050. doi: 10.1016/j.cub.2016.02.010
69. UK Government Web Archive. (2020). *The National Archives. Life Tables.* Available online at: http://www.ons.gov.uk/ons/rel/lifetables/historic-and-projected-data-from-the-period-and-cohort-life-tables/2012-based/stb-2012- based.html. Accessed January 2, 2020.
70. Vaidya, V. A., Marek, G. J., Aghajanian, G. K., and Duman, R. S. (1997). 5-HT$_{2A}$ receptor-mediated regulation of brain-derived neurotrophic factor mRNA in the hippocampus and the neocortex. *J. Neurosci.* 17, 2785-2795. doi: 10.1523/JNEUROSCI.17-08-02785.1997
71. Van Deursen, J. A., Vuurman, E. F., Verhey, F. R., van Kranen-Mastenbroek, V. H., and Riedel, W. J. (2008). Increased EEG γ band activity in Alzheimer's disease and mild cognitive impairment. *J. Neural Transm.* 115, 1301-1311. doi: 10.1007/s00702-008-0083-y
72. Verret, L., Mann, E. O., Hang, G. B., Barth, A. M., Cobos, I., Ho, K., *et al.* (2012). Inhibitory interneuron deficit links altered network activity and cognitive dysfunction in Alzheimer model. *Cell* 149, 708-721. doi: 10.1016/j.cell.2012. 02.046
73. Vollenweider, F. X., Leenders, K. L., Scharfetter, C., Maguire, P., Stadelmann, O., and Angst, J. (1997). Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16, 357-372. doi: 10.1016/s0893-133x(96)00246-1
74. Wang, J., Fang, Y., Wang, X., Yang, H., Yu, X., and Wang, H. (2017). Enhanced γ activity and cross-frequency interaction of resting-state electroencephalographic oscillations in patients with Alzheimer's disease. *Front. Aging Neurosci.* 9:243. doi: 10.3389/fnagi.2017. 00243
75. Weber, E. T., and Andrade, R. (2010). *Htr2a* gene and 5-HT$_{2A}$ receptor expression in the cerebral cortex studied using genetically modified mice. *Front. Neurosci.* 4:36. doi: 10.3389/fnins.2010.00036
76. Wood, J., Kim, Y., and Moghaddam, B. (2012). Disruption of prefrontal cortex large scale neuronal activity by different classes of psychotomimetic drugs. *J. Neurosci.* 32, 3022-3031. doi: 10.1523/JNEUROSCI.6377-11.2012
77. Yoshida, H., Kanamaru, C., Ohtani, A., Li, F., Senzaki, K., and Shiga, T. (2011). Subtype specific roles of serotonin receptors in the spine formation of cortical neurons *in vitro*. *Neurosci. Res.* 71, 311-314. doi: 10.1016/j.neures.2011. 07.1824
78. Zhang, G., Ásgeirsdóttir, H. N., Cohen, S. J., Munchow, A. H., Barrera, M. P., and Stackman, R. W. Jr. (2013). Stimulation of serotonin 2A receptors facilitates consolidation and extinction of fear memory in C57BL/6J mice. *Neuropharmacology* 64, 403-413. doi: 10.1016/j.neuropharm.2012. 06.007

79. Zhang, G., and Stackman, R. W. Jr. (2015). The role of serotonin 5-HT_{2A} receptors in memory and cognition. *Front. Pharmacol.* 6:225. doi: 10.3389/fphar.2015. 00225

An introduction to psychedelic neuroscience

by

Tanya Calvey[*,1], **Fleur M. Howells**[†,‡]

© 2018 Tanya Calvey

original report:
https://www.researchgate.net/profile/Tanya-Calvey/publication/328974974_An_introduction_to_psychedelic_neuroscience/links/5c10df7ea6fdcc494fede2e6/An-introduction-to-psychedelic-neuroscience.pdf
backup source: http://www.psilosophy.info/resources/An-introduction-to-psychedelic-neuroscience.pdf

*Faculty of Health Sciences, University of the Witwatersrand Medical School, Johannesburg, South Africa
† Translational Neuroscience Group, Department of Psychiatry and Mental Health, University of Cape Town, Cape Town, South Africa
‡ Neuroscience Institute, University of Cape Town, Cape Town, South Africa
[1] Corresponding author: Tel.: 0027117172743, e-mail address: tanya.calvey@wits.ac.za

Table of Contents:

- Abstract
- 1. What are psychedelics?
- 2. Neurobiology of psychedelic therapy for depression and addiction
- 3. Additional therapeutic mechanisms of action
- 4. Neurobiology of the psychedelic experience
- 5. The link between psychosis and the psychedelic state
- 6. Future research
- 7. The mystery
- References
- Further reading

Abstract

This chapter is an introduction to the volume "Psychedelic Neuroscience" of Elsevier's Progress in Brain Research addressing the neurobiological mechanisms of psychedelic drugs, the resulting changes in brain activity and integration of traditional viewpoints. As the field is relatively new, there are discrepancies in the literature related to classification, composition and effects of the various psychedelics. Currently, psychedelics are grouped according to their neuro-receptor affinities into classic and atypical psychedelics, each with individual treatment potentials and abilities to elicit potent acute experiences and long-lasting changes in neurobiology through concurrent activation of several neuromodulatory systems. There is disparity in psychedelic brain imaging studies, delineating what is neural activity and hemodynamic needs further investigation for us to understand the brain "state" changes that are apparent. The psychedelic brain "state" is often compared to acute psychosis and we review the psychedelic animal models of psychosis and human brain imaging studies and contrast these to psychosis. The term "psychedelic" means mind-revealing and psychedelics have exceptional anti-amnesic effects and are able to "make conscious" that which was previously unconscious through changes in brain "state," but also there is growing evidence which demonstrates the role of epigenetic mechanisms. This supports traditional therapeutic use of psychedelics to heal ancestral trauma. Details of these mechanisms are provided along with suggestions for further research.

Keywords Psychedelic medicine, Consciousness, Psychosis, qEEG, MEG, fMRI, Neurobiology, Microdosing, Combination psychedelic therapy, Neuromodulators, Epigenetics

1. What are psychedelics?

The field of psychedelic neuroscience has witnessed a recent renaissance following decades of restricted research due to their legal status. As this is a relatively new field, there are incongruences in the literature related to terminology, classification, content and effect of the various psychedelics.

The currently accepted classification of psychedelics includes classic psychedelics and atypical/non-traditional/non-classical psychedelics. Classic psychedelics are the phenethylamines such as 3,4,5-trimethoxy-phenethylamine (mescaline, derived from *Cactaceas* plant family including peyote cactus), tryptamines such as 5-methoxy-dimethytryptamine (5-MeO-DMT; which can be synthetically produced, but also found in *Bufo alvarius* toad venom and several plants including *Anadenanthera peregrina*, derivative colloquially referred to as Amazonian yopo snuffs), *N,N*-dimethyltryptamine (*N,N*-DMT; found in ayahuasca a brew made with *Banisteriopsis caapi* vine and other ingredients), *N,N*-dimethyl-4-phosphoryloxytryptamine (*Psilocybe* genus of mushrooms) and ergolines such as lysergic acid diethylamide (LSD; derived from lysergic acid extracted from ergot fungus) (Barsuglia *et al.*, 2018; Murnane, 2018). Atypical psychedelics can be further divided into dissociative psychedelics (N-methyl-D-aspartate receptor-NMDA antagonists), e.g., phencyclidine (PCP; original synthesis was toward an anesthetic), ketamine (an amnesic surgical anesthetic) and ibogaine (derived from *Apocynaceae* family of plants), as well as cannabinoid agonists (e.g., Δ9-tetrahydrocannabinol (Δ9-THC) from cannabis), muscarinic receptor antagonists (e.g., scopolamine initially synthesized for anesthesia), and entactogens (e.g., 3,4-methylendioxymethampheamineMDMA-"ecstasy").

Problematic in the field, perhaps more so than in other fields, is the issue of conflicting results, likely due to the limited research. For example, there is conflicting evidence as to whether or not the low 5-HT$_{2A}$ affinity of ibogaine has any functional relevance. Ly *et al*. (2018) found that the 5-HT$_{2A}$ receptor antagonist, ketanserin, blocked the effect of noribogaine on structural plasticity yet both ibogaine and noribogaine failed to induce head-shake response in rats, a behavior which is seen to be comparable to hallucinations in humans and mediated by 5-HT$_{2A}$ activation (Barsuglia *et al.*, 2018; González *et al.*, 2018; Murnane, 2018). González *et al.* (2018) suggest that this result supports the subjective experiences in humans, where ibogaine does not produce the typical interferences in thinking, identity distortions, and space-time alteration, which are produced by the classic psychedelics. A second example, where there is confusion is the literature regarding 5-MeO-DMT. 5-MeO-DMT is described as being a constituent of ayahuasca (Murnane, 2018; Riga *et al.*, 2014), while it is evidenced that ayahuasca holds a high concentration of *N,N*-DMT, 5-MeO-DMT concentration is either non-existent or negligible in most brews (Barsuglia *et al.*, 2018; McKenna, 2004; McKenna *et al.*, 1984; Pires *et al.*, 2009) and the ayahuasca psychedelic experience bears little to no resemblance to an experience with 5-MeO-DMT. Then cannabis research is possibly the best example of conflicting psychedelic research. As reviewed in Colizzi and Bhattacharyya, 2018, evidence as to whether cannabis use is associated with adverse effects to mental health or cognition in humans is equivocal. There are also many divergent results in the functional human neuroimaging studies as detailed by Müller *et al*. (2018). Indeed, this is a new and growing field of research and more research is required to uncover the various psychedelics drugs, their active components and neurobiological effects.

2. Neurobiology of psychedelic therapy for depression and addiction

Classic psychedelics and dissociative psychedelics are known to have rapid onset antidepressant and anti-addictive effects, unlike any currently available treatment. Randomized clinical control studies have confirmed antidepressant and anxiolytic effects of classic psychedelics in humans (De Gregorio *et al.*, 2018; Murnane, 2018). Ketamine also has well established antidepressant and anti-addictive effects in humans mainly through its action as an NMDA antagonist (Gass *et al.*, 2018). Ibogaine has demonstrated potent anti-addictive potential in pre-clinical studies and is in the early stages of clinical trials to determine efficacy in robust human studies (Barsuglia *et al.*, 2018; Corkery, 2018).

Psychedelics are not only known to have rapid onset but their effects persist long after their acute effects; this includes changes in mood and brain function (Barsuglia *et al.*, 2018; Colizzi and Bhattacharyya, 2018; Corkery, 2018; De Gregorio *et al*., 2018; Erritzoe *et al*., 2018; Ly *et al*., 2018; Murnane, 2018). These effects are suggested to result from their unique receptor affinities which affect neurotransmission (Barsuglia *et al*., 2018; Corkery, 2018; De Gregorio *et al*., 2018; Murnane, 2018) via neuromodulatory systems which then serve to modulate brain activity, i.e., neuroplasticity (Atasoy *et al*., 2018; Barsuglia *et al*., 2018; Colizzi and Bhattacharyya, 2018; Müller *et al*., 2018). These lasting effects are reported to promote cell survival, be neuroprotective, and modulate neuroimmune systems of the brain (De Gregorio *et al*., 2018; Inserra, 2018; Ly *et al*., 2018). The mechanisms which lead to these long-term neuromodulatory changes have been linked to epigenetic modifications and gene expression changes (De Gregorio *et al*., 2018; Inserra, 2018). These psychedelic drug effects, previously under-researched, may potentially provide the next-generation of neurotherapeutics, where treatment resistant diseases, e.g., depression and addiction, may become treatable with attenuated pharmacological risk profiles (Ly *et al*., 2018; Murnane, 2018).

Classic psychedelics have been shown to stimulate the serotonergic system mainly via 5-HT$_{1A}$, 5-HT$_{2A}$, 5-HT$_{2C}$, and 5-HT$_7$ receptors, with the dopaminergic system primarily via D2 receptors, and indirectly with the glutamatergic and GABAergic systems (Barsuglia *et al*., 2018; De Gregorio *et al*., 2018). There is significant cross-talk between these neuromodulatory systems and classic psychedelics, and activation of 5-HT$_{1A}$ and 5-HT$_{2A}$ receptors modulates glutamatergic and dopaminergic neurotransmission in brain networks associated with depression and addiction (Barsuglia *et al*., 2018; De Gregorio *et al*., 2018; Guiard and Di Giovanni, 2015; Ly *et al*., 2018; Murnane; Sampedro *et al*., 2017). Then activation of 5-HT$_{2C}$ receptors localized in dopaminergic and GABAergic neurons in the ventral tegmental area (VTA) regulates motivation by modulating transmissions to the nucleus accumbens (NAc) and altered balance in this 5-HT$_{2C}$ receptor-associated network is postulated to cause reward-related disorders, such as schizophrenia, depression, and addiction (Sumiyoshi *et al*., 2014). Further, it is acknowledged that classic psychedelics have an extremely low potential for abuse (Nutt *et al*., 2007, 2010; UNODC, 2018), and it is suggested that stimulation of 5-HT$_{2C}$ receptors limits their potential for addiction and that their therapeutic effects are mediated by acute 5-HT$_{2C}$ receptor stimulation followed by sustained downregulation of 5-HT$_{2A}$ and 5-HT$_{1A}$ receptors (De Gregorio *et al*., 2018; Murnane, 2018). Investigation into the complex mechanisms of action of classic psychedelics which lead to its anti-depressant and anti-addiction properties via the serotonergic system continues to gain momentum, e.g., minimal research has investigated the role of 5-HT$_7$ activation by psychedelics, but has been suggested to play a role in classic psychedelic anti-addiction properties, specifically 5-MeO-DMT in alcohol use disorder (Barsuglia *et al*., 2018).

The classic psychedelics act directly via the serotonergic system whereas certain atypical psychedelics have direct affinity for numerous neuromodulatory systems. A remarkable example, ibogaine, addressed by Corkery and Barsuglia *et al*. (2018), demonstrates novel pharmacological mechanisms of action to be considered in the potential treatment of substance use disorders and depression (Alper, 2001; Barsuglia *et al*., 2018) through simultaneous activation of multiple neurotransmitter systems (Baumann *et al*., 2001a,b). This alkaloid has low micromolar affinity for mu and kappa opioid receptors, SIGMA-1 and SIGMA-2 receptors (SIGMAR1; SIGMAR2), serotonin reuptake transporter (SERT) and dopamine transporter (DAT), is an antagonist to NMDA and α3β4 nicotinic acetylcholine (nAChR) receptors and a weak 5-HT$_{2A}$ receptor agonist (Alburges *et al*., 2000; Barsuglia *et al*., 2018; Brown and Alper, 2017; Jacobs *et al*., 2007; Lavaud and Massiot, 2017; Mash *et al*., 1998). Drugs with similar NMDA affinity (e.g., such as ketamine and memantine) or NMDA regulators (e.g., such as acamprosate) have shown promise in reducing symptoms of substance use disorders and depression (Barsuglia *et al*., 2018; Corkery, 2018; Gass *et al*., 2018; Ron and Wang, 2009). The mu-opioid receptor has demonstrated a functional role in drug reward (Mendez and Morales-Mulia, 2008) as well as craving (Nutt, 2014). Further, ibogaine possesses an opiate replacement mechanism of action as reported for compounds such as methadone (Barsuglia *et al*., 2018; Baumann *et al*., 2001a,b; Corkery, 2018; Mash *et al*., 1995; Zubaran *et al*., 1999). However, neither ibogaine nor its principle psychoactive metabolite, noribogaine, activate G-proteins associated with morphine administration, or produce signs and symptoms of opioid intoxication in opioid naïve persons; therefore, it seems that ibogaine is able to produce a neuroadaptive effect on endogenous opioid systems which reverses opioid tolerance and may be implicated broadly in its "addiction-interrupting" effects (Barsuglia *et al*., 2018; Corkery, 2018).

3. Additional therapeutic mechanisms of action

There is strong evidence suggesting that various psychedelics influence the expression and modulation of genes, which in turn, may lead to long-term neurochemical and neuroplastic changes and modification of epigenetic mechanisms (De Gregorio *et al.*, 2018; Inserra, 2018; Ly *et al.*, 2018). When administered chronically, LSD has been shown to have effects on dopaminergic neurotransmission at the level of gene expression by decreasing the mRNA expression of the dopamine receptor genes DRD1 and DRD2 in the medial prefrontal cortex (mPFC) (De Gregorio *et al.*, 2018; Martin *et al.*, 2014). Classic and dissociative psychedelics lead to structural and functional changes in cortical neurons, with plasticity-promoting properties that rival brain-derived neurotropic factor (BDNF) (Ly *et al.*, 2018). LSD has demonstrated to be extremely potent in this regard possibly due to slow off kinetics of the LSD-bound 5-HT$_{2B}$ crystal structure (Ly *et al.*, 2018; Wacker *et al.*, 2017). Although the molecular targets of classic and dissociative psychedelics differ (5-HT and NMDA receptors, respectively), their plasticity promoting properties are similar and are known to activate TrkB, mTOR, and 5-HT$_{2A}$ signaling pathways, suggesting that these key signaling hubs may serve as potential targets for the development of "psychoplastogens," fast-acting antidepressants, and anxiolytics (Ly *et al.*, 2018). The mTOR signaling pathways may also play a role in certain psychedelics' ability to modify epigenetic mechanisms as mTORC1 is thought to be involved in regulating gene expression through epigenetic mechanisms or by directly affecting RNA stability/degradation (Laplante and Sabatini, 2013). Another relevant receptor involved in epigenetic modification is SIGMAR1 (Inserra, 2018). *N,N*-DMT and ibogaine both activate SIGMAR1 (Barsuglia *et al.*, 2018; Inserra, 2018) and recently, SIGMAR1 has been shown to modulate epigenetic processes by creating a dose-dependent interaction between emerin and histone deacetylase (HDAC)1, HDAC2 and HDAC3, affecting chromatin compaction and gene expression (Demmerle *et al.*, 2012;Inserra, 2018; Tsai *et al.*, 2015). At the nuclear envelope, SIGMAR1 recruits chromatin-remodeling molecules to regulate gene expression (Inserra, 2018; Tsai *et al.*, 2015) and at the synaptic level it interacts with voltage-gated ion channels, which leads to modification and reorganization of several homo- and heteroreceptor complexes which in turn modulates of neurotransmission, reviewed in Inserra (2018).

4. Neurobiology of the psychedelic experience

The psychedelic experience can produce eyes-closed and eyes-open imagery. The imagery can be clear and visual or it can have a dream-like quality with strong emotions and insights. There is also often heightened memory retrieval where long-forgotten memories are retrieved with exceptional clarity and detail. A common experience on ibogaine, for example, is that one's life flashes before their eyes as clear as if they were watching a movie about their life (Barsuglia *et al.*, 2018). The neurophysiological mechanisms that facilitate the psychedelic experience are largely unknown but progress is being made in understanding how the neurochemical profile of psychedelics elicits this effect, bringing that which was previously unconscious to the conscious mind. The differences in the psychedelic state elicited by the various classic and atypical psychedelics hold promise in differentiating the exact neuroreceptor-mind interactions. Neuroreceptors are coded by individual genes and extensive genetic variation exists in the population for these neuromodulatory systems. Variation in the neuroreceptor-mind interactions, thus, holds further promise for psychiatric neurogenomics research as it will uncover how individual genetic variation in the neuromodulatory systems affects different psychedelic states and changes in neurobiology.

The serotonergic system's involvement in the psychedelic state has received the most research attention, and has provided new insights related to the neurochemical mechanisms underlying changes in brain network activity and perfusion (Atasoy *et al.*, 2018; Barsuglia *et al.*, 2018; Colizzi and Bhattacharyya, 2018; De Gregorio *et al.*, 2018; Müller *et al.*, 2018; Murnane, 2018). Serotonin is involved in many neurological (e.g., epilepsy) and psychiatric (e.g., depression) diseases. Serotonin receptors may directly or indirectly depolarize or hyperpolarize neurons by changing the ionic conductance and/or concentration within the cells and is able to change excitability within brain networks (Guiard and Di Giovanni, 2015). For example, pharmacological magnetic resonance imaging (phMRI) in rats indicates that psilocin induces brain signal increases in olfactory and limbic areas and brain signal decreases in somatosensory and motor cortices (Murnane, 2018). 5-MeO-DMT disrupts cortical activity and low frequency cortical oscillations in the frontal cortex of rats with alternating activity in frontal and visual areas associated with psychedelic effects (Murnane, 2018).

In humans, activation of postsynaptic 5-HT_{2A} receptors in layer V of the medial prefrontal cortex mPFC is considered to be responsible for the visual hallucinations produced by classic psychedelics. Cortical 5-HT_{2A} hyper-activation affects corticostriatal-thalamo-cortical circuit functioning and triggers a disruption in the thalamic gating of sensory and cognitive information leading to perceptual distortions (Atasoy *et al.*, 2018; De Gregorio *et al.*, 2018).

Studies point toward not only brain network activity changes but also significant increases in hemodynamics (Coman *et al.*, 2015; Spain *et al.*, 2015). Increased cerebral blood flow has been reflected in temperature record of different brain areas with administration of MDMA, increased blood flow to the cortex correlated with increased neuronal activity as expected, however within the thalamus increased blood flow negatively correlated with increased neuronal activity (Coman *et al.*, 2015). Then a psilocin study reported decreased local field potentials to sensory stimuli while hemodynamic response was enhanced (Spain *et al.*, 2015). These data support a brain "state" change, but also require us to challenge our knowledge of the nature of this differential activity, neural versus hemodynamic, and their interplay which leads to the psychedelic experience (Lewis *et al.*, 2017).

Human brain imaging studies are limited, the neurophysiological underpinnings are largely speculative (Müller *et al.*, 2018), while the findings are interesting and need to be further investigated. For example, an LSD functional MRI (fMRI) study found increased hemodynamic activity within brain areas rich in 5-HT_{2A} receptors and globally, the authors conclude that this reflected increased functional connectivity and that this increased activity led to ego dissolution (Tagliazucchi *et al.*, 2016). Then a psilocybin fMRI study found decreased hemodynamic activity within the thalamus and anterior and posterior cingulate cortices, where the decreased activity in the anterior cingulate correlated with the psychedelic experience. They further report a decrease in resting state connectivity between the medial prefrontal cortex and posterior cingulate cortex; the authors conclude that psilocybin reduced connectivity, and this reduction enabled the psychedelic experience (Carhart-Harris *et al.*, 2012). A different psilocybin resting state fMRI study reported that connectivity increased in higher brain networks such as the default mode, executive control, and dorsal attention networks (Tagliazucchi *et al.*, 2014). Then an arterial spin labelling study found that post MDMA, hemodynamics decreased and this was localized to right medial temporal lobe (MTL), thalamus, inferior visual cortex, and somatosensory cortex (Carhart-Harris *et al.*, 2015). Then a spontaneous magnetoencephalographic (MEG) study investigated Lempel-Ziv (LZ) complexity, more commonly applied in EEG studies, to determine diversity of mixed-signal being recorded. Where they found three psychedelic drugs: psilocybin, LSD, and ketamine, increased signal diversity within occipital cortices, this extended over the parietal cortex with LSD, and even further with ketamine over the full cortex, excluding medial frontal brain areas (Schartner *et al.*, 2017), they were also able to support a reduction in alpha MEG activity for all three psychedelics tested. The authors concluded that their findings provide confirmation that psychedelics create a higher level of consciousness which is reflected in MEG LZ complexity (Schartner *et al.*, 2017). A second psychedelic MEG study, which investigated psilocybin, reported reduction in spontaneous cortical activity (1-50 Hz) in posterior association cortices, and (8-100 Hz) in frontal association cortices. Second, they reported hugely significant reductions within the default mode network (Muthukumaraswamy *et al.*, 2013). Then a low-resolution electromagnetic tomography (LORETA) study investigated ayahuasca and found reductions in delta, theta, alpha-2, and beta-1 frequency bands, these changes were predominantly evident over the temporo-parietal-occipital junction (Riba *et al.*, 2004). Overall, the brain imaging studies, which address hemodynamic activity in humans, support acute increases and decreases in several brain regions. Electromagnetic studies report reductions in neural activity, most notably evident for alpha band frequency, and not limited to specific brain areas, but potentially reducing frontal activity and increasing parietal activity. Together these findings support the conclusion Lebedev *et al.* (2015) drew in relation to psilocybin; that psychedelics lead to a "disintegration" of functional connectivity, and this permits ego-dissolution (Lebedev *et al.*, 2015). It is suggested that this "disintegration" is at least in part due to decreased connectivity between of the parahippocampal and retrosplenial cortex, as was reported in a resting state fMRI LSD study (Carhart-Harris *et al.*, 2016), which may serve to support the change in cortical activity.

Psychedelic electroencephalographic research supports a brain "state" change, with evidence of reduced neural activity frontally and support increased activity parietally. A quantitative EEG (qEEG) study, investigated the acute effects of *N*,*N*-DMT and 5-MeO-DMT, finding significant reductions in global absolute alpha activity, while moderate significant increases were seen in theta and beta (Acosta-Urquidi, 2015;

Barsuglia *et al.*, 2018). Then ayahuasca induced decreases in delta, theta, and alpha frequency activity, the power of alpha activity in parietal and occipital cortex was negatively related with the intensity of visual psychedelic experience (Valle *et al.*, 2016). Acute dosing of *N,N*-DMT showed reduction in coherence between anterior and posterior EEG recording sites, where anterior coherence decreased, permitting parietal coherence to drive the EEG activity (Alonso *et al.*, 2015). Psilocybin was reported to decrease 1.5-20 Hz frequency activity, and using source density EEG the neural networks which showed this decreased connectivity were in the anterior and posterior cingulate cortices and the parahippocampal regions (Kometer *et al.*, 2013). The authors also report that the psychedelic experience was related to delta (1.5-4 Hz) activity between the retrosplenial cortex, the parahippocampus, and the lateral orbitofrontal area (Kometer *et al.*, 2013). These data together support shifts in brain "state" with changes in cortical control from frontal brain areas to parietal and in part this is related to hippocampal network activity.

Further, EEG studies have investigated and contrasted MDMA, cannabis, and MDMA with cannabis use on EEG frequency where they show that MDMA with or without cannabis use increased delta band frequency, while cannabis use alone was found to increase high alpha band activity (Herning *et al.*, 2005). In addition, this study found that MDMA with or without cannabis use showed increased blood flow and diastolic blood velocity (Herning *et al.*, 2005). The increased alpha band activity in cannabis-alone users contradicts several papers which support attenuated alpha band activity (Hart *et al.*, 2010). Then other cannabis studies report no change in alpha, and only report reductions in delta and beta activity (Zuurman *et al.*, 2010). Cannabis has been shown to increase heart rate when alpha band activity is reduced (Hart *et al.*, 2010), CB1 antagonism prevents the increase in heart rate produced by cannabis (Zuurman *et al.*, 2010); however, this study which tested CB1 antagonism in acute cannabis use reported no change in alpha activity. Then an acute study investigated the effects of MDMA with and without ethanol or Δ9-THC, and MDMA alone was found to decrease theta and alpha power, when a combination of MDMA and Δ9-THC was taken together their attenuation of theta and lower-1-alpha (6.4-8.4 Hz) was less than when given alone, then the combination of MDMA with Δ9-THC lead to significant reduction in lower-2-alpha (8.4-10.4 Hz), but not when administered alone. Then a study in users of MDMA showed an incremental increase in alpha activity (11 Hz) as cumulative doses of ecstasy increased, with no effect on theta activity (Adamaszek *et al.*, 2010).

There is an absence of reliable ibogaine EEG studies in humans, a single study in cynomologus monkeys reported no effect (Binienda *et al.*, 2011), then several rat studies. These studies report increased low-frequency, delta and theta, activity, and found ibogaine pre-treatment lowered cocaine-induced seizure threshold, reflected in alpha1-frequency band activity (Binienda *et al.*, 2000, 2011). These data support changes in brain network activity, but are contradictory, and further investigation is needed. There are significant changes in alpha activity, which may be related to changes in thalamocortical gating activities.

Then event-related potential (ERP) EEG studies, which are few, report some discrete neural circuitry psychedelic effects, and the little evidence which is available suggests that exposure to psychedelic drugs impacts the relevant neural circuitry needed for specific cognitive tasks.

In a randomized, double-blind study, psilocybin, the preferential 5-HT$_{2A}$ antagonist ketanserin, or psilocybin with ketanserin was administered acutely, during the completion of a facial recognition task psilocybin enhanced positive mood and attenuated recognition of negative facial expression, which was reflected in P300 wave form amplitude, positive > negative (Kometer *et al.*, 2012). A second study by the same group which investigated the spatiotemporal dynamics of a modal object completion task found psilocybin to attenuate the N170 amplitude, particularly apparent during the processing of incomplete objects, while slightly enhancing P100 component (Kometer *et al.*, 2012). The authors found the attenuated N170 over right extrastriate and posterior parietal cortices correlated with intensity of visual hallucinations. The authors suggest this reduction in N170 reflects 5-HT$_{1A}$ and 5-HT$_{2A}$ receptor-mediated visual hallucinations (Kometer *et al.*, 2012).

Then ERP cannabis studies report on occasional versus heavy cannabis users which completed a divergent attention task with acute administration of Δ9-THC, occasional users showed reduced P100 amplitude; while both occasional and heavy users showed decreased P300 amplitudes, no effect on ERP waveforms were reported for their second task, the stop signal task, a task which measures activation of behavioral inhibitory circuitry (Theunissen *et al.*, 2012). A second study, which addressed acute dose-related effects of Δ9-THC on a three-stimulus oddball paradigm, found that with increasing dose of Δ9-THC, P300a increased and P300b decreased, latency of P300 and waveform of the N100 were not affected (D'souza *et al.*, 2012). The sparse ERP wave form findings suggest neural circuit function, versus "state," is dependent on psychedelic exposure and dosing, beyond this further research needs to be conducted to gain better insight to the effects of psychedelics on neural processing during cognition.

As the body of brain imaging and EEG data increase the discrepancies will narrow, refer to more insights from chapters in this volume (Atasoy *et al.*, 2018; Barsuglia *et al.*, 2018; Colizzi and Bhattacharyya, 2018; De Gregorio *et al.*, 2018; Murnane, 2018; Müller *et al.*, 2018).

5. The link between psychosis and the psychedelic state

A population study which investigated psychedelic use in Norway, in 2013, reported that from their 21,967 respondents, 13.4% reported lifetime psychedelic use, and found no significant association with mental health outcomes; in fact there were several instances where psychedelic use was associated with lower rate of mental health problems (Krebs and Johansen, 2013). The use of psychedelics, such as cannabis, when psychosis does develop and persists, is suggested to result from an interaction of genes and the environment, as an example; multiple natural genetic variations interact with cannabis and other environmental factors (stress) to increase the risk of developing psychosis (Cortes-Briones *et al.*, 2015). Ergo psychedelics alone do not produce psychosis or psychotic disorder, as an individual needs to be genetically predisposed or carry a greater risk profile or susceptibility to developing psychosis (Mason *et al.*, 2009).

This being said, basic animal researchers employ acute and chronic dosing of certain psychedelics to induce psychotic-like behaviors in their research animals, usually rat or mouse, to investigate the neurobiological mechanism of psychosis, e.g., NMDA antagonists ketamine and PCP (Forrest *et al.*, 2014). NMDA antagonists disrupt glutamatergic signaling, specifically reducing NMDA receptor function; this is a postulated mechanism which leads to the human psychotic state, at least in part (Colizzi and Bhattacharyya, 2018; Davison *et al.*, 2017; Frohlich and Van Horn, 2014) and conversion to psychosis in ultra-high risk for psychosis (UHR) individuals.

Importantly, for an animal to "serve" as a reliable model of a human condition it needs to meet several validity criteria (Belzung and Lemoine, 2011). Behavioral comparisons between PCP and schizophrenia-like behavior in rodents report, for example, deficits in the cognitive domain which are comparable to schizophrenia executive function deficits; these include deficits in novel object recognition, attentional set shifting and T-maze delayed alternation. Then PCP in primates reduces frequency and duration of social interaction which is comparable to social withdrawal in humans, a negative symptom of schizophrenia. Administration of antipsychotic medications has been shown to reverse these behavioral deficits produced by PCP, specifically deficits in reversal learning and locomotor sensitization (Jones *et al.*, 2011), where it is suggested that this reversal is achieved through the activation of muscarinic-1 receptors (Miyauchi *et al.*, 2017). However, as with all psychiatric animal models, there are limitations in their translation to the human condition, e.g., animals cannot communicate the experience of a hallucination or the retrieval of unconscious memory. Other psychedelic animal models of schizophrenia address serotoninergic dysfunction reported in schizophrenia, and have included acute and chronic administration of mescaline, psilocybin, and LSD (Halberstadt and Geyer, 2013; Marona-Lewicka *et al.*, 2011), and again lack full translation to the human condition.

Importantly, antipsychotic drugs are known to act on the dopaminergic and serotonergic systems; however, their full mechanism of action is still being discovered. Conventional typical antipsychotics have strong affinity to D_2 receptor, which are found in high concentrations within the mesolimbic and mesocortical pathways, which are seen as the primary pathways involved in schizophrenia, if following the dopamine hypothesis, and lead to the presentation of positive psychotic symptoms, i.e., hallucinations and delusions (De Gregorio *et al.*, 2018). New atypical antipsychotics, which are prescribed in lower dosages than typical antipsychotics, make the addition of acting on 5-HT receptors, e.g., 5-HT_{1A}, 5-HT_{2A}, and 5-HT_{2C} subtypes (Sumiyoshi *et al.*, 2014), as do classic psychedelics (De Gregorio *et al.*, 2018; Murnane, 2018). Clozapine, an atypical antipsychotic, which is effective in treating treatment resistant schizophrenia and negative symptoms of psychosis, may act as an inverse agonist on 5-HT_{2C} receptors (Meltzer *et al.*, 2012). Where, the 5-HT_{1A} receptor gene promotor polymorphism (rs6295, C-1019G) has been associated with treatment efficacy of negative symptoms in schizophrenia (Sumiyoshi *et al.*, 2014).

If we return to the atypical psychedelic cannabinoid Δ9-THC, it is known that via activation of opioid receptors it effects changes in several neurotransmitter systems and affects neuromodulation. Comparatively these same neural systems and many of the changes reported are comparable to those in schizophrenia, and include modulation of serotonergic, glutamatergic, and dopaminergic systems (Colizzi and Bhattacharyya, 2018; Lisman *et al*., 2008; van de Giessen *et al*., 2017). Clinically the psychotic symptom profile between cannabis-induced psychotic disorder (CIPD) and acute schizophrenia are very similar; however, CIPD report higher levels of antisocial behavior and cognition is less severely affected (El-Serafi and Hewedi, 2014; Núñez and Gurpegui, 2002).

In functional human neuroimaging studies of acute Δ9-THC, to induce the positive symptoms of schizophrenia acutely, report changes in hemodynamic response and these were associated with psychotic symptom experience. First, while completing a verbal learning task, behavioral performance was unaffected, then during the early stages of the task, parahippocampal gyri hemodynamics increased and this response tapered off as the task progressed, then ventrostriatal activation during retrieval of word pairs shortened, where ventrostriatal activation was correlated with psychotic symptoms experienced (Bhattacharyya *et al*., 2009). Second, while completing an oddball paradigm Δ9-THC improved behavioral response latency and the decreased hemodynamic response within the right caudate was negatively associated with psychotic symptoms experienced (Bhattacharyya *et al*., 2012). Yet, while completing a response inhibition task, Go/No-Go, with acute administration of Δ9-THC, psychotic experiences reported correlated with inhibition deficits, and were both correlated with decreased hemodynamic response in the left inferior frontal cortex (Bhattacharyya *et al*., 2015). These hemodynamic changes are similarly reported in studies investigating schizophrenia (Bhattacharyya *et al*., 2012; Kaladjian *et al*., 2007; Rubia *et al*., 2001) being an interplay and change in hemodynamic response within the front cortical brain areas and basal nuclei during processing of inhibition and attention/salience tasks (Murray *et al*., 2017).

Acute intravenous Δ9-THC infusion in healthy controls reports disruption of neural pathways, as measured by EEG; this includes: increased "randomness" of EEG activity, as measured by the LZ complexity algorithm, the "randomness" or noise produced correlated with the positive symptoms of psychosis, i.e., hallucinations and delusions (Cortes-Briones *et al*., 2015). A second study reported disruption and decreased power of theta band activity over the frontal hemispheres with reduced hemispheric communication (Henquet *et al*., 2008). A third study reported disruption of gamma band activity, 40 Hz, coherence between auditory evoked potentials, while no effect was noted at 20 and 30 Hz, where the reduced 40 Hz coherence was associated with the positive symptoms of psychosis (Cortes-Briones *et al*., 2015). Together these studies suggest a global disruption in expected neuronal activity with acute Δ9-THC, and this carries over to abusers of cannabis (Laprevote *et al*., 2017), where they suggest that the disruption in frequency band activity and coherence lead to the disinhibition of inhibitory functions in cannabis users (Prashad *et al*., 2018), supporting the clinical symptoms of CIPD. In schizophrenia and the psychotic disorders, it is purported that there is a disengagement of thalamocortical gating activity (Müller *et al*., 2018), this is classically and widely accepted to present with a significant increase in delta band activity and reduction in alpha band activity, and this is reported globally during rest and a cognitive active state (Howells *et al*., 2018). This suggests that the atypical psychedelic, cannabis does not produce a similar signature to schizophrenia, as the relationship between delta and alpha activity is not evident.

Albeit that cannabis may not yield similar electrophysiological signatures to schizophrenia, animal studies in ibogaine, which are incrementally growing, do show brain activity which is more comparable, where it is reported that delta activity increases and changes in alpha band activity are apparent, therefore potentially supporting changes in thalamocortical gating (Binienda *et al*., 2000, 2011; Govindaiah *et al*., 2010). Importantly, limited neuroimaging and electrophysiological studies have been conducted in the array of psychedelics due to their legal status. Further research is required as psychedelics may uncover unique biological mechanisms which may aid the development of improved medications to treat psychosis (De Gregorio *et al*., 2018; Müller *et al*., 2018).

6. Future research

The neuroimaging and electrophysiological research that has been performed clearly reports that there are changes in brain "state" and authors suggest that this may be related to de-coupling of certain brain networks, yet to be fully identified. One such network which is of interest is the para-hippocampal network (Carhart-Harris *et al.*, 2014). The hippocampus is a densely connected region that may coordinate interhemispheric cortical connectivity and sensory functioning (Chan *et al.*, 2017). The hippocampus forms part of the limbic system along with regions such as the cingulate gyrus, insular cortex, subcallosal gyrus, amygdala, septal nuclei, thalamic nuclei (e.g., anterior thalamic nucleus (ATN)), hypothalamus and the reticular formation in the brainstem (Mtui *et al.*, 2015). These are regions implicated in psychiatric disorders and the psychedelic state and many of them express the 5-HT$_{2A}$ receptor (Bombardi, 2014). An important limbic circuit which has received little attention in relation to the psychedelic state is the Papez circuit. The Papez circuit is a series of connections between the cingulate cortex, the entorhinal cortex, the hippocampus proper, the fornices of the hippocampus, the mammillary bodies, the mammillo-thalamic tract and the ATN (Mtui *et al.*, 2015). The ATN forms a pivotal part of the Papez circuit, with widespread limbic connections forming an "extended hippocampal formation" (Jankowski *et al.*, 2013). Studies of diencephalic amnesia reinforce the crucial role of the ATN for memory, although the ATN is also considered important for the pathophysiology of epilepsy and serves as a possible target for deep brain stimulation (DBS) treatment in this condition (Balak *et al.*, 2018; Jankowski *et al.*, 2013). The presence of slow- and fast-spiking bursting anterior thalamic units, which discharge within the theta frequency, suggests that the anterior thalamus is involved in the propagation of theta signals through the Papez circuit and such theta propagation could have resulting mnemonic functions (Jankowski *et al.*, 2013). In future research, it would be interesting to investigate the involvement of this circuit following psychedelic administration in animals.

The identification of non-psychedelic compounds with similar serotonergic and glutamatergic receptor affinities as psychedelics has been proposed to be an important area for future research, with view to potential anti-neuroinflammatory properties (De Gregorio *et al.*, 2018; Ly *et al.*, 2018; Murnane, 2018). An example given by Murnane is how DOI induces profound anti-inflammatory effects at doses below those required to induce rodent head-twitch behavior. If non-psychedelic agonists that share the anti-inflammatory effects of DOI could be developed, this may have significant therapeutic implications (Murnane, 2018) as would the identification of non-psychedelic analogs capable of promoting plasticity in the prefrontal cortex (Ly *et al.*, 2018). Such compounds would also be critical in resolving the debate as to whether the psychedelic state is necessary for their therapeutic effects (Ly *et al.*, 2018). As reviewed by Barsuglia *et al.*, 2018, the intensity of the mystical experience is a key predictor of therapeutic outcomes in psilocybin-assisted treatment of alcohol dependence. Perhaps, for certain disorders (inflammatory disorders or degenerative disorders, for example), non-psychedelic compounds would be effective. More research needs to focus on psychedelic "microdosing," as it is known in the field. As mentioned by Murnane, sub-psychedelic doses of psychedelic compounds have been found to assist with certain disorders or conditions which is common practice within the psychedelic communities; however, there is only one human study in the literature which demonstrated that microdosing psilocybin had a positive effect on creativity (Prochazkova *et al.*, 2018). Additional controlled studies in this area could be of tremendous value in the field.

Another promising line of research would be into ibogaine's ability to reverse opioid tolerance, ergo development of non-addictive chronic pain medication. It is suggested that ibogaine is able to produce a neuroadaptive effect on endogenous opioid systems likely due to its ability to reverse the effects of opiates on gene expression, returning the receptors to pre-addiction condition (Barsuglia *et al.*, 2018; Corkery, 2018). Ibogaine administered together with morphine potentiates the analgesic effects of morphine as well as reduce developing tolerance (Corkery, 2018; Kroupa and Wells, 2005; Schneider, 1957). Uncovering these mechanisms would be of great value to the field of pain management.

Another area that requires further research is combination psychedelic therapy. Traditional practitioners often use psychedelics in combination and have been doing so for many generations. Barsuglia *et al.* (2018) propose a theory as to how 5-MeO-DMT and ibogaine used in sequential administration would be more effective in treating addiction than either one on its own. The combined neurotransmitter profile of the two compounds would likely have an augmented effect when used in combination but as this is the first study of its kind assessing combined psychedelic therapy, more research is needed to uncover poly-psychedelic pharmacology.

Psychedelics remain largely illegal in many countries; limiting human research, the research findings to date suggest that psychedelics hold therapeutic benefit to several human conditions, psychiatric through to chronic pain. There would be benefit from preclinical studies in which multimodal neuroimaging and electrophysiological recordings are taken, while within a solid research design, which manages the diversity of human behavior (Murnane, 2018). Longitudinal research investigating single/multiple administration and at various doses, including microdosing, would greatly enhance our understanding. In humans, this longitudinal research design could be coupled with genomic analyses to understand inter-subject variation in acute and chronic psychedelic effect (Colizzi and Bhattacharyya, 2018).

7. The mystery

> *Wisdom requires not only the investigation of many things but contemplation of the mystery.*
> **Jeremy Narby**

Science is at the early stages of understanding psychedelic molecular mechanisms and even further from understanding the psychedelic state as any scientist who has experienced it is aware. Let us contemplate the mystery and try to imagine how psychedelics are able to "make conscious" previously subconscious information, which forms part of traditional practitioners' imperative in administering psychedelics for therapeutic purposes over the millennia. This may provide insight to the relevant brain changes needed to promote attenuation of anxiety and promote anti-addictive brain states.

> *At a 2-month follow-up, approximately 70 of the participants rated the psilocybin experience as among the most personally meaningful of their lives. A subsequent study documented that administration of psilocybin led to increases in the openness domain of personality that was stable for at least a year. This was notable because few, if any, previous studies had demonstrated that any discrete experimental manipulation was capable of yielding long-lasting changes in personality.*
> **Murnane**

The 5-MeO-DMT state "began with images of floating through the universe and being surrounded by the stars. He also described seeing a 'universal cosmic matrix' that had a central column of electric light and spiritual beings merging into the light. 'It's just love. Everything. All of it. That is all that exists. Love is it.' Upon debriefing from his session several hours afterwards, he believed this experience was the single-most peak transformational experience of his life. He reported he lost all sense of his body and surroundings, and was 'transformed on a cellular level into infinite energy and pure love,' and described, 'all of [his] stress and difficulties throughout [his] life felt like they occurred for a meaningful purpose, and the traumas of [his] past were washed over by an infinitely loving energy'" (Barsuglia *et al.*, 2018)

> *In individuals with substance use disorders, ibogaine stimulates heightened memory retrieval specifically related to drug abuse, the perception of one's own future with or without drug use, and visions which reveal powerful insights into the nature of the addiction such as personal traumas.*
> **Barsuglia *et al.***

Psychedelics are known to have exceptional anti-amnesic effects where memories are retrieved in great detail. In fact, all psychedelics have the ability to make conscious/reveal/retrieve that which was previously unconscious and the term, psychedelic, means mind-revealing.

The neurophysiological mechanisms that facilitate this anti-amnesic effect are largely unknown but progress is being made in identifying the molecular and cellular mechanisms and brain networks involved.

The anti-amnesic effect of psychedelics has also been supported in rodent studies where administration of ibogaine facilitated spatial memory retrieval (Popik, 1996), and low dose Δ9-THC has been shown to improve memory in aged rodents (Sarne *et al.*, 2018), and to enhance synaptic marker proteins and increase hippocampal spine density (Bilkei-Gorzo *et al.*, 2017). The anti-amnesic effect of ibogaine and ayahuasca is, partly, due to the SIGMAR1 affinity of both compounds. SIGMAR1 activation has been shown to reverse experimental-induced amnesia in rodents, via enhancement of the cholinergic and glutamatergic systems

(Antonini *et al.*, 2009; Earley *et al.*, 1991; Inserra, 2018; Maurice *et al.*, 1998). Peak densities of SIGMAR1 are found in brain areas relevant to traumatic memory formation, retrieval and updating, such as the amygdala and the hippocampal formation (Inserra, 2018).

Psychedelics also enhance synaptic plasticity and increase neurogenesis, processes known to be involved in memory reconsolidation and fear extinction (Inserra, 2018; Ly *et al.*, 2018). The fear response triggered by the memory can be reprogramed and/or extinguished through synaptic plasticity and changes in gene expression mediated by epigenetic modification via 5-HT$_{2A}$ and SIGMAR1 activation (Corkery, 2018; De Gregorio *et al.*, 2018; Inserra, 2018; Ly *et al.*, 2018).

Subsequently, the memory is reconsolidated and stored with updated significance via cortical mechanisms. As suggested, there is a change in cortical control from frontal brain areas to parietal brain areas and, in part, this is related to hippocampal network activity. For example, varying doses of PCP have been shown to change the functional connectivity (phMRI) between several brain areas, including the fronto-cortical and hippocampal brain regions (Paasonen *et al.*, 2017). Atasoy *et al.* (2018) report that changes in brain activity occur in a frequency-specific manner with LSD and psilocybin, and that these changes in power-law components lead to an expansion of the repertoire of active brain states and the emergence of more complex brain dynamics which heightens information processing capabilities.

Perhaps a similar mechanism may be involved in ancestral communication.

> *Higher doses of ibogaine generate its psychoactive effects, including hallucinations and the facilitation of communion with the spirits of the ancestors in rites of passage. Ibogaine ingestion in a religious context allows a bonding across time and space between consumers and their ancestors and fellow community members through a shared common experience of a distinctive system of belief and consciousness.*
> **Corkery**

Ayahuasca and ibogaine are the psychedelics most commonly associated with ancestor communication. Ayahuasceros and Bwiti tribesman summon the ancestors during ceremony. The Basotho people of southern Africa use *Boophone disticha*, a psychedelic bulb for ancestor communication as well. This may be culturally-specific interpretation but an alternate hypothesis proposed here is that the same mechanisms that are involved in psychedelics' anti-amnestic properties, i.e., their ability to retrieve and reconsolidate memories via changes in gene expression and brain activity, are the same mechanisms involved in "making conscious" information in our DNA and inherited epigenetic information. Genetic memory is a field of psychology and epigenetic modification from ancestral experience and/or trauma is now known to be heritable and able to affect offspring for many generations afterward (Klosin *et al.*, 2017; Mitchell *et al.*, 2016; Wei *et al.*, 2015). More research is required but if changes to our mind, memories and personality are due to changes in gene expression and epigenetic mechanisms and if psychedelics are able to "make conscious" stored neural information that is coded by genes and epigenetics, then it may be possible for information stored in our DNA and in our epigenome to be "made conscious" and in the case of the epigenome, reconsolidated in the same way as memories are. This is not a new concept in the psychedelic community. Psychedelics are said to heal ancestral trauma. After spending many years researching ayahuasca in South America, Narby (1999) concluded that ayahuasca used by shamans in the Western Amazon affords them access to knowledge coded in DNA. As more and more research uncovers the molecular mechanisms of psychedelic neuroscience, this does not seem like an impossible idea. Early psychedelic use in South America and Africa may be the origin of modern ancestor worship.

References

1. Acosta-Urquidi, J., 2015. QEEG studies of the acute effects of the visionary tryptamine DMT. Cosmos History: J. Natl. Soc. Philos. 11 (2), 115-129.
2. Adamaszek, M., Khaw, A.V., Buck, U., Andresen, B., Thomasius, R., 2010. Evidence of neurotoxicity of ecstasy: sustained effects on electroencephalographic activity in polydrug users. PLoS One 5 (11), e14097.
3. Alburges, M.E., *et al.*, 2000. Responses of the extrapyramidal and limbic substance P systems to ibogaine and cocaine treatments. Eur. J. Pharmacol. 390 (1-2), 119-126.
4. Alonso, J.F., Romero, S., Mañanas, M.À., Riba, J., 2015. Serotonergic psychedelics temporarily modify information transfer in humans. Int. J. Neuropsychopharmacol. 18 (8).

5. Alper, K.R., 2001. Ibogaine: a review. Alkaloids Chem. Biol. 56 (C), 1-38. Chapter 1.
6. Antonini, V., Prezzavento, O., Coradazzi, M., Marrazzo, A., Ronsisvalle, S., Arena, E., Leanza, G., 2009. Anti-amnesic properties of (±)-PPCC, a novel sigma receptor ligand, on cognitive dysfunction induced by selective cholinergic lesion in rats. J. Neurochem. 109 (3), 744-754.
7. Atasoy, S., Vohryzek, J., Deco, G., Carhart-Harris, R.L., Kringelbach, M.L., 2018. Common neural signatures of psychedelics: Frequency-specific energy changes and repertoire expansion revealed using connectome-harmonic decomposition. Prog. Brain Res. 242.
8. Balak, N., Balkuv, E., Karadag, A., Basaran, R., Biceroglu, H., Erkan, B., Tanriover, N., 2018. Mammillothalamic and mammillotegmental tracts as new targets for dementia and epilepsy treatment. World Neurosurg. 110, 133-144.
9. Barsuglia, J., Polanco, M., Palmer, R., Malcolm, B., Kelmendi, B., Calvey, T., 2018. A case report SPECT study and theoretical rationale for the sequential administration of ibogaine and 5-MeO-DMT in the treatment of alcohol use disorder. Prog. Brain Res. 242.
10. Baumann, M.H., Pablo, J., Ali, S.F., Rothman, R.B., Mash, D.C., 2001a. Comparative neuropharmacology of ibogaine and its O-desmethyl metabolite, noribogaine. Alkaloids Chem. Biol. 56, 79-113. PubMed PMID: 11705118.
11. Baumann, M.H., Rothman, R.B., Pablo, J.P., Mash, D.C., 2001b. *In vivo* neurobiological effects of ibogaine and its O-desmethyl metabolite, 12-hydroxyibogamine (noribogaine), in rats. J. Pharmacol. Exp. Ther. 297 (2), 531-539. May.
12. Belzung, C., Lemoine, M., 2011. Criteria of validity for animal models of psychiatric disorders: focus on anxiety disorders and depression. Biol. Mood Anxiety Disord. 1 (1), 9.
13. Bhattacharyya, S., Fusar-Poli, P., Borgwardt, S., Martin-Santos, R., Nosarti, C., O'Carroll, C., Allen, P., Seal, M.L., Fletcher, P.C., Crippa, J.A., Giampietro, V., 2009. Modulation of mediotemporal and ventrostriatal function in humans by Δ9-tetrahydrocannabinol: a neural basis for the effects of *Cannabis sativa* on learning and psychosis. Arch. Gen. Psychiatry 66 (4), 442-451.
14. Bhattacharyya, S., Crippa, J.A., Allen, P., Martin-Santos, R., Borgwardt, S., Fusar-Poli, P., Rubia, K., Kambeitz, J., O'carroll, C., Seal, M.L., Giampietro, V., 2012. Induction of psychosis by δ9-tetrahydrocannabinol reflects modulation of prefrontal and striatal function during attentional salience processing. Arch. Gen. Psychiatry 69 (1), 27-36.
15. Bhattacharyya, S., Atakan, Z., Martin-Santos, R., Crippa, J.A., Kambeitz, J., Malhi, S., Giampietro, V., Williams, S., Brammer, M., Rubia, K., Collier, D.A., 2015. Impairment of inhibitory control processing related to acute psychotomimetic effects of cannabis. Eur. Neuropsychopharmacol. 25 (1), 26-37.
16. Bilkei-Gorzo, A., Albayram, O., Draffehn, A., Michel, K., Piyanova, A., Oppenheimer, H., Dvir-Ginzberg, M., Rácz, I., Ulas, T., Imbeault, S., Bab, I., 2017. A chronic low dose of Δ 9-tetrahydrocannabinol (THC) restores cognitive function in oldmice. Nat.Med. 23 (6), 782.
17. Binienda, Z., Beaudoin, M.A., Thorn, B.T., Sadovova, N., Skinner, R.D., Slikker Jr., W., Ali, S.F., 2000. Application of electrophysiological method to study interactions between ibogaine and cocaine. Ann. N. Y. Acad. Sci. 914 (1), 387-393.
18. Binienda, Z., A Beaudoin, M., T Thorn, B., F Ali, S., 2011. Analysis of electrical brain waves in neurotoxicology: gamma-hydroxybutyrate. Curr. Neuropharmacol. 9 (1), 236-239.
19. Bombardi, C., 2014. Neuronal localization of the 5-HT$_2$ receptor family in the amygdaloid complex. Front. Pharmacol. 5, 68.
20. Brown, T.K., Alper, K., 2017. Treatment of opioid use disorder with ibogaine: detoxification and drug use outcomes. Am. J. Drug Alcohol Abuse 00 (00), 1-13.
21. Carhart-Harris, R.L., Erritzoe, D., Williams, T., Stone, J.M., Reed, L.J., Colasanti, A., Tyacke, R.J., Leech, R., Malizia, A.L., Murphy, K., Hobden, P., 2012. Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. Proc. Natl. Acad. Sci. U.S.A. 109 (6), 2138-2143.
22. Carhart-Harris, R.L., Leech, R., Hellyer, P.J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D.R., Nutt, D., 2014. The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. Front. Hum. Neurosci. 8, 20.
23. Carhart-Harris, R.L., Murphy, K., Leech, R., Erritzoe, D., Wall, M.B., Ferguson, B., Williams, L.T., Roseman, L., Brugger, S., De Meer, I., Tanner, M., 2015. The effects of acutely administered 3, 4-methylenedioxymethamphetamine on spontaneous brain function in healthy volunteers measured with arterial spin labeling and blood oxygen level-dependent resting state functional connectivity. Biol. Psychiatry 78 (8), 554-562.
24. Carhart-Harris, R.L., Muthukumaraswamy, S., Roseman, L., Kaelen, M., Droog, W., Murphy, K., Tagliazucchi, E., Schenberg, E.E., Nest, T., Orban, C., Leech, R., 2016. Neural correlates of the LSD experience revealed by multimodal neuroimaging. Proc. Natl. Acad. Sci. U.S.A. 113 (17), 4853-4858.
25. Chan, R.W., Leong, A.T., Ho, L.C., Gao, P.P., Wong, E.C., Dong, C.M., Wang, X., He, J., Chan, Y.S., Lim, L.W., Wu, E.X., 2017. Low-frequency hippocampal-cortical activity drives brain-wide resting-state functional MRI connectivity. Proc. Natl. Acad. Sci. 114 (33), E6972-E6981.
26. Colizzi, M., Bhattacharyya, S., 2018. Neurocognitive effects of cannabis: lessons learned from human experimental studies. Prog. Brain Res. 242.
27. Coman, D., Sanganahalli, B.G., Jiang, L., Hyder, F., Behar, K.L., 2015. Distribution of temperature changes and neurovascular coupling in rat brain following 3, 4-methylenedioxymethamphetamine (MDMA,"ecstasy") exposure. NMR Biomed. 28 (10), 1257-1266.
28. Corkery, J.M., 2018. Ibogaine as a treatment for substance misuse: potential benefits and practical dangers. Prog. Brain Res. 242.
29. Cortes-Briones, J., Skosnik, P.D., Mathalon, D., Cahill, J., Pittman, B., Williams, A., Sewell, R.A., Ranganathan, M., Roach, B., Ford, J., D'souza, D.C., 2015. Δ 9-THC disrupts gamma (γ)-band neural oscillations in humans. Neuropsychopharmacology 40 (9), 2124.
30. Davison, J., O'Gorman, A., Brennan, L., Cotter, D.R., 2017. A systematic review of metabolite biomarkers of schizophrenia. Schizophr. Res. 195, 32-50.
31. De Gregorio, D., Enns, J.P., Nuñez, N.A., Posa, L., Gobbi, G., 2018. D-Lysergic acid diethylamide, psilocybin, and other classic hallucinogens: mechanism of action and potential therapeutic applications in mood disorders. Prog. Brain Res. 242.

32. Demmerle, J., Koch, A.J., Holaska, J.M., 2012. The nuclear envelope protein emerin binds directly to histone deacetylase 3 (HDAC3) and activates HDAC3 activity. J. Biol. Chem. 287, 22080-22088. https://doi.org/10.1074/jbc.M111.325308.
33. D'souza, D.C., Fridberg, D.J., Skosnik, P.D., Williams, A., Roach, B., Singh, N., Carbuto, M., Elander, J., Schnakenberg, A., Pittman, B., Sewell, R.A., 2012. Dose-related modulation of event-related potentials to novel and target stimuli by intravenous Δ 9-THC in humans. Neuropsychopharmacology 37 (7), 1632.
34. Earley, B., Burke, M., Leonard, B.E., Gouret, C.J., Junien, J.L., 1991. Evidence for an antiamnesic effect of JO 1784 in the rat: a potent and selective ligand for the sigma receptor. Brain Res. 546 (2), 282-286.
35. El-Serafi, D., Hewedi, D., 2014. Clinical profile of cannabis-induced psychosis in comparison to schizophrenia. Middle East Curr. Psychiatry 21 (4), 230-236.
36. Erritzoe, D., Roseman, L., Nour, M.M., MacLean, K., Kaelen, M., Nutt, D.J., Carhart-Harris, R.L., 2018. Effects of psilocybin therapy on personality structure. Acta Psychiatr. Scand. https://doiorg/10.1111/acps.12904.
37. Forrest, A.D., Coto, C.A., Siegel, S.J., 2014. Animal models of psychosis: current state and future directions. Curr. Behav. Neurosci. Rep. 1 (2), 100-116.
38. Frohlich, J., Van Horn, J.D., 2014. Reviewing the ketamine model for schizophrenia. J. Psychopharmacol. 28 (4), 287-302.
39. Gass, N., Becker, R., Sack, M., Schwarz, A.J., Reinwald, J., Cosa-Linan, A., Zheng, L., von Hohenberg, C.C., Inta, D., Meyer-Lindenberg, A., Weber-Fahr, W., 2018. Antagonism at the NR2B subunit of NMDA receptors induces increased connectivity of the prefrontal and subcortical regions regulating reward behavior. Psychopharmacology 235 (4), 1055-1068.
40. González, J., Prieto, J.P., Rodríguez, P., Cavelli, M., Benedetto, L., Mondino, A., Pazos, M., Seoane, G., Carrera, I., Scorza, C., Torterolo, P., 2018. Ibogaine acute administration in rats promotes wakefulness, long-lasting REM sleep suppression, and a distinctive motor profile. Front. Pharmacol. 9, 374.
41. Govindaiah, G., Wang, Y., Cox, C.L., 2010. Dopamine enhances the excitability of somatosensory thalamocortical neurons. Neuroscience 170 (4), 981-991.
42. Guiard, B.P., Di Giovanni, G., 2015. Central serotonin-2A (5-HT_{2A}) receptor dysfunction in depression and epilepsy: the missing link? Front. Pharmacol. 6, 46.
43. Halberstadt, A.L., Geyer, M.A., 2013. Serotonergic hallucinogens as translational models relevant to schizophrenia. Int. J. Neuropsychopharmacol. 16 (10), 2165-2180.
44. Hart, C.L., Ilan, A.B., Gevins, A., Gunderson, E.W., Role, K., Colley, J., Foltin, R.W., 2010. Neurophysiological and cognitive effects of smoked marijuana in frequent users. Pharmacol. Biochem. Behav. 96 (3), 333-341.
45. Henquet, C., Di Forti, M., Morrison, P., Kuepper, R., Murray, R.M., 2008. Gene-environment interplay between cannabis and psychosis. Schizophr. Bull. 34 (6), 1111-1121.
46. Herning, R.I., Better, W., Tate, K., Cadet, J.L., 2005. Neuropsychiatric alterations in MDMA users. Ann. N. Y. Acad. Sci. 1053 (1), 20-27.
47. Howells, F.M., Temmingh, H.S., Hsieh, J.H., van Dijen, A.V., Baldwin, D.S., Stein, D.J., 2018. Electroencephalographic delta/alpha frequency activity differentiates psychotic disorders: a study of schizophrenia, bipolar disorder and methamphetamine-induced psychotic disorder. Transl. Psychiatry 8 (1), 75.
48. Inserra, A., 2018. Hypothesis: the psychedelic ayahuasca heals traumatic memories via a sigma 1 receptor-mediated epigenetic-mnemonic process. Front. Pharmacol. 9, 330.
49. Jacobs, M.T., *et al*., 2007. Ibogaine, a noncompetitive inhibitor of serotonin transport, acts by stabilizing the cytoplasm-facing state of the transporter. J. Biol. Chem. 282 (40), 29441-29447.
50. Jankowski, M.M., Ronnqvist, K.C., Tsanov, M., Aggleton, J.P., O'Mara, S.M., 2013. The anterior thalamus provides a subcortical circuit supporting memory and spatial navigation. Front. Syst. Neurosci. 7, 45.
51. Jones, C.A., Watson, D.J.G., Fone, K.C.F., 2011. Animal models of schizophrenia. Br. J. Pharmacol. 164 (4), 1162-1194.
52. Kaladjian, A., Jeanningros, R., Azorin, J.M., Grimault, S., Anton, J.L., Mazzola-Pomietto, P., 2007. Blunted activation in right ventrolateral prefrontal cortex during motor response inhibition in schizophrenia. Schizophr. Res. 97 (1-3), 184-193.
53. Klosin, A., Casas, E., Hidalgo-Carcedo, C., Vavouri, T., Lehner, B., 2017. Transgenerational transmission of environmental information in C. elegans. Science 356 (6335), 320-323.
54. Kometer, M., Schmidt, A., Bachmann, R., Studerus, E., Seifritz, E., Vollenweider, F.X., 2012. Psilocybin biases facial recognition, goal-directed behavior, and mood state toward positive relative to negative emotions through different serotonergic subreceptors. Biol. Psychiatry 72 (11), 898-906.
55. Kometer, M., Schmidt, A., Jäncke, L., Vollenweider, F.X., 2013. Activation of serotonin 2A receptors underlies the psilocybin-induced effects on α oscillations, N170 visual-evoked potentials, and visual hallucinations. J. Neurosci. 33 (25), 10544-10551.
56. Krebs, T.S., Johansen, P.Ø., 2013. Psychedelics and mental health: a population study. PLoS One 8 (8), e63972.
57. Kroupa, P.K., Wells, H., 2005. Ibogaine in the 21st century: boosters, tune-ups and maintenance. Multidiscip. Assoc. Psychedelic Stud. 16 (1), 21-25.
58. Laplante, M., Sabatini, D.M., 2013. Regulation of mTORC1 and its impact on gene expression at a glance. J. Cell Sci. 126, 1713-1719.
59. Laprevote, V., Bon, L., Krieg, J., Schwitzer, T., Bourion-Bedes, S., Maillard, L., Schwan, R., 2017. Association between increased EEG signal complexity and cannabis dependence. Eur. Neuropsychopharmacol. 27 (12), 1216-1222.
60. Lavaud, C., Massiot, G., 2017. The iboga alkaloids. Prog. Chem. Org. Nat. Prod. 105, 89-136.
61. Lebedev, A.V., Lövdén, M., Rosenthal, G., Feilding, A., Nutt, D.J., Carhart-Harris, R.L., 2015. Finding the self by losing the self: neural correlates of ego-dissolution under psilocybin. Hum. Brain Mapp. 36 (8), 3137-3153.
62. Lewis, C.R., Preller, K.H., Kraehenmann, R., Michels, L., Staempfli, P., Vollenweider, F.X., 2017. Two dose investigation of the 5-HT-agonist psilocybin on relative and global cerebral blood flow. Neuroimage 159, 70-78.
63. Lisman, J.E., Coyle, J.T., Green, R.W., Javitt, D.C., Benes, F.M., Heckers, S., Grace, A.A., 2008. Circuit-based framework for understanding neurotransmitter and risk gene interactions in schizophrenia. Trends Neurosci. 31 (5), 234-242.
64. Ly, C., Greb, A.C., Cameron, L.P., Wong, J.M., Barragan, E.V., Wilson, P.C., Burbach, K.F., Zarandi, S.S., Sood, A., Paddy, M.R., Duim, W.C., 2018. Psychedelics promote structural and functional neural plasticity. Cell Rep. 23 (11), 3170-3182.
65. Marona-Lewicka,D., Nichols, C.D.,Nichols,D.E., 2011.Ananimal model of schizophrenia based on chronic LSD administration:

old idea, new results. Neuropharmacology 61 (3), 503-512.

66. Martin, D.A.,Marona-Lewicka, D., Nichols, D.E., Nichols, C.D., 2014. Chronic LSD alters gene expression profiles in the mPFC relevant to schizophrenia. Neuropharmacology 83, 1-8.
67. Mash, D.C., Staley, J.K., Pablo, J.P., Holohean, A.M., Hackman, J.C., Davidoff, R.A., 1995. Properties of ibogaine and its principal metabolite (12-hydroxyibogamine) at the MK-801 binding site of the NMDA receptor complex. Neurosci. Lett. 192 (1), 53-56.
68. Mash, D.C., Kovera, C.A., Buck, B.E., Norenberg, M.D., Shapshak, P., Hearn, W.L., Sanchez-Ramos, J.U.A.N., 1998. Medication development of ibogaine as a pharmacotherapy for drug dependence. Ann. N. Y. Acad. Sci. 844 (1), 274-292.
69. Mason, O., Morgan, C.J.A., Dhiman, S.K., Patel, A., Parti, N., Curran, H.V., 2009. Acute cannabis use causes increased psychotomimetic experiences in individuals prone to psychosis. Psychol. Med. 39 (6), 951-956.
70. Maurice, T., Su, T.P., Privat, A., 1998. Sigma1 (σ1) receptor agonists and neurosteroids attenuate β25-35-amyloid peptide-induced amnesia in mice through a common mechanism. Neuroscience 83 (2), 413-428.
71. McKenna, D.J., 2004. Clinical investigations of the therapeutic potential of ayahuasca: rationale and regulatory challenges. Pharmacol. Ther. 102 (2), 111-129.
72. McKenna, D.J., Towers, G.N., Abbott, F., 1984. Monoamine oxidase inhibitors in south American hallucinogenic plants: tryptamine and β-carboline constituents of ayahuasca. J. Ethnopharmacol. 10 (2), 195-223.
73. Meltzer, H., Massey, B.W., Horiguchi, M., 2012. Serotonin receptors as targets for drugs useful to treat psychosis and cognitive impairment in schizophrenia. Curr. Pharm. Biotechnol. 13 (8), 1572-1586.
74. Méndez, M., Morales-Mulia, M., 2008. Role of mu and delta opioid receptors in alcohol drinking behaviour. Curr. Drug Abuse Rev. 1 (2), 239-252.
75. Mitchell, E., Klein, S.L., Argyropoulos, K.V., Sharma, A., Chan, R.B., Toth, J.G., Barboza, L., Bavley, C., Bortolozzi, A., Chen, Q., Liu, B., 2016. Behavioral traits propagate across generations via segregated iterative-somatic and gametic epigenetic mechanisms. Nat. Commun. 7, 11492.
76. Miyauchi, M., Neugebauer, N.M., Sato, T., Ardehali, H., Meltzer, H.Y., 2017. Muscarinic receptor signaling contributes to atypical antipsychotic drug reversal of the phencyclidine-induced deficit in novel object recognition in rats. J. Psychopharmacol. 31 (12), 1588-1604.
77. Mtui, E., Gruener, G., Dockery, P., 2015. Fitzgerald's Clinical Neuroanatomy and Neuroscience E-Book. Elsevier Health Sciences.
78. Müller, F., Liechti, M.E., Lang, U.E., Borgwardt, S., 2018. Advances and challenges in neuroimaging studies on the effects of serotonergic hallucinogens: contributions of the resting brain. Prog. Brain Res. 242.
79. Murnane, K.S., 2018. The renaissance in psychedelic research: what do preclinical models have to offer. Prog. Brain Res. 242.
80. Murray, R.M., Englund, A., Abi-Dargham, A., Lewis, D.A., Di Forti, M., Davies, C., Sherif, M., McGuire, P., D'Souza, D.C., 2017. Cannabis-associated psychosis: neural substrate and clinical impact. Neuropharmacology 124, 89-104.
81. Muthukumaraswamy, S.D., Carhart-Harris, R.L., Moran, R.J., Brookes, M.J., Williams, T.M., Errtizoe, D., Sessa, B., Papadopoulos, A., Bolstridge, M., Singh, K.D., Feilding, A., 2013. Broadband cortical desynchronization underlies the human psychedelic state. J. Neurosci. 33 (38), 15171-15183.
82. Narby, J., 1999. The Cosmic Serpent: DNA and the Origins of Knowledge, Penguin, pp. 1-245.
83. Núñez, L.A., Gurpegui, M., 2002. Cannabis-induced psychosis: a cross-sectional comparison with acute schizophrenia. Acta Psychiatr. Scand. 105 (3), 173-178.
84. Nutt, D.J., 2014. The role of the opioid system in alcohol dependence. J. Psychopharmacol. 28 (1), 8-22.
85. Nutt, D., King, L.A., Saulsbury, W., Blakemore, C., 2007. Development of a rational scale to assess the harm of drugs of potential misuse. Lancet 369, 1047-1053.
86. Nutt, D.J., King, L.A., Phillips, L.D., 2010. Independent Scientific Committee on Drugs. Drug harms in the UK: a multicriteria decision analysis. Lancet 376, 1558-1565.
87. Paasonen, J., Salo, R.A., Ihalainen, J., Leikas, J.V., Savolainen, K., Lehtonen, M., Forsberg, M.M., Gröhn, O., 2017. Dose-response effect of acute phencyclidine on functional connectivity and dopamine levels, and their association with schizophrenia-like symptom classes in rat. Neuropharmacology 119, 15-25.
88. Pires, A.P.S., De Oliveira, C.D.R., Moura, S., Dörr, F.A., Silva, W.A.E., Yonamine, M., 2009. Gas chromatographic analysis of dimethyltryptamine and β-carboline alkaloids in ayahuasca, an amazonian psychoactive plant beverage. Phytochem. Anal. 20 (2), 149-153.
89. Popik, P., 1996. Facilitation of memory retrieval by the anti-addictive alkaloid, ibogaine. Life Sci. 59 (24), L379-L385.
90. Prashad, S., Dedrick, E.S., Filbey, F.M., 2018. Cannabis users exhibit increased cortical activation during resting state. NeuroImage 179, 176-186.
91. Prochazkova, L., Lippelt, D.P., Colzato, L.S., Kuchar, M., Sjoerds, Z., Hommel, B., 2018. Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. bioRxiv, 384412.
92. Riba, J., Anderer, P., Jan⍰e, F., Saletu, B., Barbanoj, M.J., 2004. Effects of the south American psychoactive beverage ayahuasca on regional brain electrical activity in humans: a functional neuroimaging study using low-resolution electromagnetic tomography. Neuropsychobiology 50 (1), 89-101.
93. Riga, M.S., Soria, G., Tudela, R., Artigas, F., Celada, P., 2014. The natural hallucinogen 5-MeO-DMT, component of ayahuasca, disrupts cortical function in rats: reversal by antipsychotic drugs. Int. J. Neuropsychopharmacol. 17 (8), 1269-1282.
94. Ron, D., Wang, J., 2009. The NMDA receptor and alcohol addiction. In: Biology of the NMDA Receptor. CRC Press, pp. 60-70.
95. Rubia, K., Russell, T., Bullmore, E.T., Soni, W., Brammer, M.J., Simmons, A., Taylor, E., Andrew, C., Giampietro, V., Sharma, T., 2001. An fMRI study of reduced left prefrontal activation in schizophrenia during normal inhibitory function. Schizophr. Res. 52 (1-2), 47-55.
96. Sampedro, F., *et al.*, 2017. Assessing the psychedelic "after-glow" in ayahuasca users: postacute neurometabolic and functional connectivity changes are associated with enhanced mindfulness capacities. Int. J. Neuropsychopharmacol. 20, 698-711.
97. Sarne, Y., Toledano, R., Rachmany, L., Sasson, E., Doron, R., 2018. Reversal of age-related cognitive impairments in mice by

an extremely low dose of tetrahydrocannabinol. Neurobiol. Aging 61, 177-186.
98. Schartner, M.M., Carhart-Harris, R.L., Barrett, A.B., Seth, A.K., Muthukumaraswamy, S.D., 2017. Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. Sci. Rep. 7, 46421.
99. Schneider, J.A., 1957. Tabernanthine, Ibogaine Containing Analgesic Compositions. US patent 2817623, Ciba Pharmaceutical Products Inc. 22 March 1956. Available at http://www.freepatentsonline.com/2817623.pdf.
100. Spain, A., Howarth, C., Khrapitchev, A.A., Sharp, T., Sibson, N.R., Martin, C., 2015. Neurovascular and neuroimaging effects of the hallucinogenic serotonin receptor agonist psilocin in the rat brain. Neuropharmacology 99, 210-220.
101. Sumiyoshi, T., Kunugi, H., Nakagome, K., 2014. Serotonin and dopamine receptors in motivational and cognitive disturbances of schizophrenia. Front. Neurosci. 8, 395.
102. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D., Chialvo, D.R., 2014. Enhanced repertoire of brain dynamical states during the psychedelic experience. Hum. Brain Mapp. 35 (11), 5442-5456.
103. Tagliazucchi, E., Roseman, L., Kaelen, M., Orban, C., Muthukumaraswamy, S.D., Murphy, K., Laufs, H., Leech, R., McGonigle, J., Crossley, N., Bullmore, E., 2016. Increased global functional connectivity correlates with LSD-induced ego dissolution. Curr. Biol. 26 (8), 1043-1050.
104. Theunissen, E.L., Kauert, G.F., Toennes, S.W., Moeller, M.R., Sambeth, A., Blanchard, M.M., Ramaekers, J.G., 2012. Neurophysiological functioning of occasional and heavy cannabis users during THC intoxication. Psychopharmacology 220 (2), 341-350.
105. Tsai, S.Y.A., Chuang, J.Y., Tsai, M.S., Wang, X.F., Xi, Z.X., Hung, J.J., Chang, W.C., Bonci, A., Su, T.P., 2015. Sigma-1 receptor mediates cocaine-induced transcriptional regulation by recruiting chromatin-remodeling factors at the nuclear envelope. Proc. Natl. Acad. Sci. U.S.A. 112 (47), E6562-E6570.
106. UNODC, 2018. https://www.unodc.org/wdr2018/.
107. Valle, M., Maqueda, A.E., Rabella, M., Rodríguez-Pujadas, A., Antonijoan, R.M., Romero, S., Alonso, J.F., Mañanas, M.À., Barker, S., Friedlander, P., Feilding, A., 2016. Inhibition of alpha oscillations through serotonin-2A receptor activation underlies the visual effects of ayahuasca in humans. Eur. Neuropsychopharmacol. 26 (7), 1161-1175.
108. van de Giessen, E., Weinstein, J.J., Cassidy, C.M., Haney, M., Dong, Z., Ghazzaoui, R., Ojeil, N., Kegeles, L.S., Xu, X., Vadhan, N.P., Volkow, N.D., Slifstein, M., Abi-Dargham, A., 2017. Deficits in striatal dopamine release in cannabis dependence. Mol. Psychiatry 22 (1), 68-75.
109. Wacker, D., Wang, S., McCorvy, J.D., Betz, R.M., Venkatakrishnan, A.J., Levit, A., Lansu, K., Schools, Z.L., Che, T., Nichols, D.E., Shoichet, B.K., 2017. Crystal structure of an LSD-bound human serotonin receptor. Cell 168 (3), 377-389.
110. Wei, Y., Schatten, H., Sun, Q.Y., 2015. Environmental epigenetic inheritance through gametes and implications for human reproduction. Hum. Reprod. Update 21 (2), 194-208.
111. Zubaran, C., Shoaib, M., Stolerman, I.P., Pablo, J., Mash, D.C., 1999. Noribogaine generalization to the ibogaine stimulus: correlation with noribogaine concentration in rat brain. Neuropsychopharmacology 21 (1), 119-126.
112. Zuurman, L., Roy, C., Schoemaker, R.C., Amatsaleh, A., Guimaeres, L., Pinquier, J.L., Cohen, A.F., van Gerven, J.M.A., 2010. Inhibition of THC-induced effects on the central nervous system and heart rate by a novel CB1 receptor antagonist AVE1625. J. Psychopharmacol. 24 (3), 363-371.

Further reading

1. Riga, M.S., Llado-Pelfort, L., Artigas, F., Celada, P., 2017. The serotonin hallucinogen 5-MeO-DMT alters cortico-thalamic activity in freely moving mice: regionally-selective involvement of 5-HT_{1A} and 5-HT_{2A} receptors. Neuropharmacology. https://doi.org/10. 1016/j.neuropharm.2017.11.049.

Transient Stimulation with Psychoplastogens Is Sufficient to Initiate Neuronal Growth

by

Calvin Ly, Alexandra C. Greb, Maxemiliano V. Vargas, Whitney C. Duim, Ana Cristina G. Grodzki, Pamela J. Lein, and David E. Olson*

Special Issue: Psychedelics; Received: June 15, 2020; Published: September 11, 2020

https://dx.doi.org/10.1021/acsptsci.0c00065
ACS Pharmacol. Transl. Sci. 2021, 4, 452-460

© Authors, 2020

original report: https://pmc.ncbi.nlm.nih.gov/articles/PMC8033616/pdf/pt0c00065.pdf
backup source: http://www.psilosophy.info/resources/pt0c00065.pdf

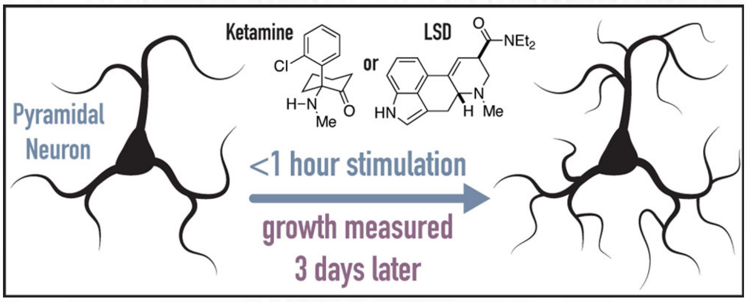
Table of Contents:

- Abstract
- Introduction
- Results
- Discussion
- Associated Content
- Author Information
- Acknowledgments
- Abbreviations
- References

Abstract

Cortical neuron atrophy is a hallmark of depression and includes neurite retraction, dendritic spine loss, and decreased synaptic density. Psychoplastogens, small molecules capable of rapidly promoting cortical neuron growth, have been hypothesized to produce long-lasting positive effects on behavior by rectifying these deleterious structural and functional changes. Here we demonstrate that ketamine and LSD, psychoplastogens from two structurally distinct chemical classes, promote sustained growth of cortical neurons after only short periods of stimulation. Furthermore, we show that psychoplastogen-induced cortical neuron growth can be divided into two distinct epochs: an initial stimulation phase requiring TrkB activation and a growth period involving sustained mTOR and AMPA receptor activation. Our results provide important temporal details concerning the molecular mechanisms by which next-generation antidepressants produce persistent changes in cortical neuron structure, and they suggest that rapidly excreted psychoplastogens might still be effective neurotherapeutics with unique advantages over compounds like ketamine and LSD.

Keywords: neural plasticity, psychoplastogen, psychedelic, LSD, ketamine, BDNF



Introduction

Depression is among the leading causes of disability worldwide, affecting over 300 million people.[1,2] Current treatments, such as the selective serotonin reuptake inhibitor (SSRI) fluoxetine, are only moderately effective, require daily administration for 2-4 weeks before producing beneficial effects, and are associated with a number of side effects leading to discontinuation of treatment regimens.[3,4] Moreover, approximately one-third of patients are unresponsive to these medicines,[4] highlighting the urgent need for new treatment approaches. A better understanding of depression pathophysiology will be necessary to rationally devise more effective therapeutics.

In recent years, it has become clear that depression results from deleterious structural and functional changes in key brain circuits. These include the retraction of dendrites, the elimination of dendritic spines, and the loss of excitatory synapses in the prefrontal cortex (PFC).[5-8] Psychoplastogens, small molecules that promote the rapid regrowth of atrophied cortical dendritic arbors,[9] represent the leading edge of antidepressant neurotherapeutics. They include ketamine,[10-13] scopolamine,[14-17] and serotonergic psychedelics.[18-25] These compounds rapidly promote structural and functional neural plasticity in the cortex[26-28] and produce long-lasting (>24 h) changes in mood and behavior without the need for chronic dosing,[29-34] presumably due to their ability to rewire pathological neural circuitry.

Induced plasticity (iPlasticity) has been proposed as a potential unifying mechanism to explain the efficacy of antidepressants from different chemical classes.[35,36] Traditional antidepressants like fluoxetine are believed to promote cortical neuron growth through transactivation of the tropomyosin receptor kinase B (TrkB),[37-39] the high-affinity receptor for brain-derived neurotrophic factor (BDNF). Psychoplastogens produce more rapid changes in cortical neuron structure, but their mechanisms of action are still opaque. Understanding how psychoplastogens produce enduring changes in cortical neuron structure, despite being rapidly cleared from the body, will be critical if we are to rationally engineer safer and more efficacious medicines for treating depression.

Previously, we demonstrated that psychedelics could increase cortical neuron growth when treated for extended periods of time (24-72 h). Here, we establish that very short stimulation periods (15 min to 6 h) are sufficient for ketamine and lysergic acid diethylamide (LSD), two psychoplastogens from distinct chemical classes, to initiate a neuronal growth response characterized by sustained α-amino-3-hydroxy-5- methyl-4-isoxazolepropionic acid (AMPA) receptor and mammalian target of rapamycin (mTOR) activation. This response persists even after the removal of the stimulating ligand. Our results indicate that ketamine and serotonergic psychoplastogens may lead to enduring changes in neuronal structure through a common downstream mechanism of action. Moreover, our results have important implications for central nervous system (CNS) drug development, as they suggest that intentional engineering of neurotherapeutics to be rapidly cleared from the body might be an effective strategy for maintaining efficacy while minimizing side effects.

Results

Transient Stimulation with Psychoplastogens Increases Dendritogenesis, Spinogenesis, and Synaptogenesis. Previously, we demonstrated that treatment of immature cortical cultures (3 days *in vitro*; DIV3) with psychoplastogens for 72 h significantly increased dendritic arbor complexity as measured via Sholl analysis.[28] However, most psychoplastogens are rapidly cleared from the body (i.e., they have half-lives of several hours),[40,41] with compounds such as *N,N*-dimethyltryptamine (DMT) and 5-MeO-DMT having half-lives less than 15 min.[42,43] To determine the shortest period of stimulation necessary to induce neuronal growth, we treated DIV3 cortical cultures with either ketamine or LSD for varying lengths of time, removed the drug, and let the cultures mature until DIV6 (Figure 1A). Remarkably, both drugs were able to robustly increase dendritic arbor complexity after only 15 min of stimulation (Figure 1D), while exogenous BDNF (50 ng/mL) required a full hour to produce effects (Figure S1A). Treatment of cortical cultures with psychoplastogens for 1 h followed by a 71 h growth period resulted in N_{max} values comparable to what we had previously observed using a 72 h treatment paradigm (Figure 1B,C). Concentration-response studies revealed that a concentration of 10 μM produced maximal effects on dendritic growth (Figure S2). When cortical cultures were fixed immediately following 1 h of treatment with psychoplastogens, no changes in dendritic arborization were observed (Figure 1E) indicating that there are distinct stimulation and growth phases.

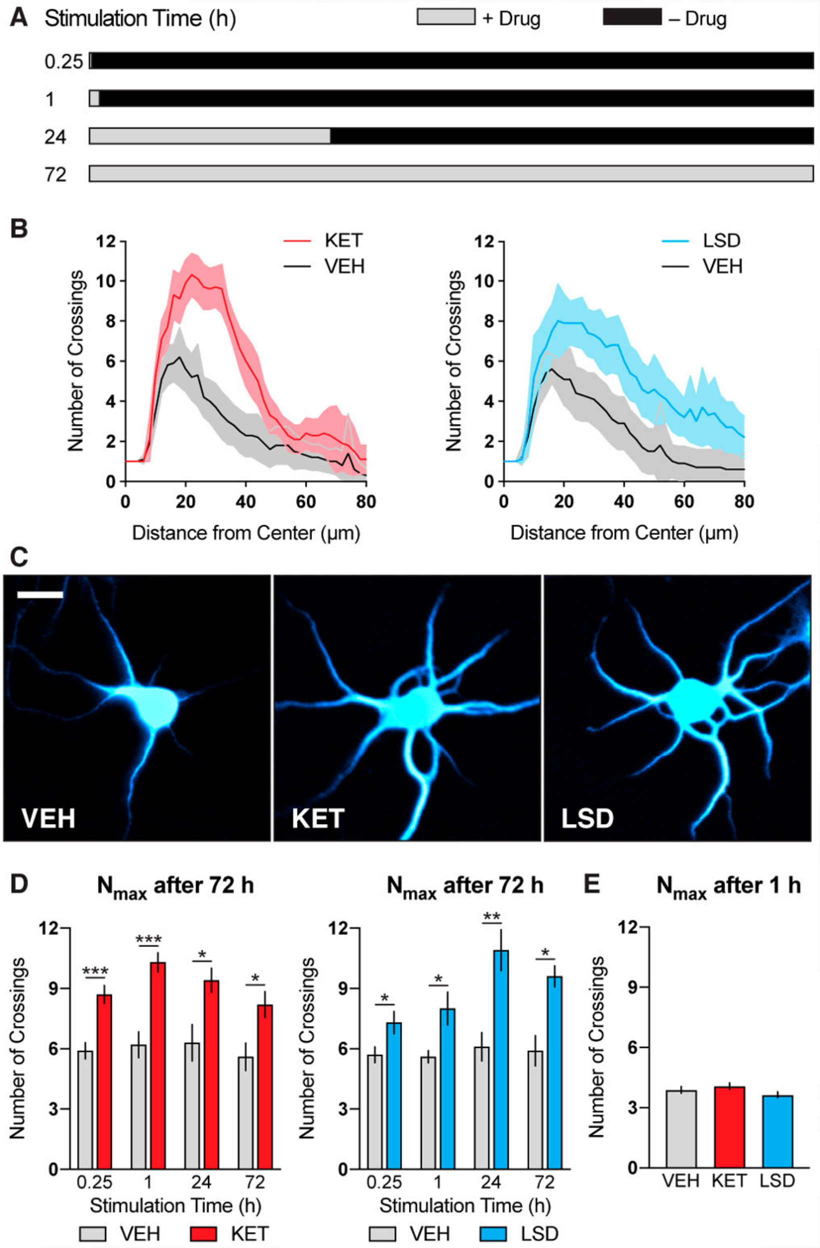


Figure 1. Transient stimulation with psychoplastogens is sufficient to induce dendritic growth. (A) Schematic illustrating experimental design. Cortical cultures (DIV3) were treated with psychoplastogens (10 μM) for short periods of time and then allowed to grow for a total of 72 h. (B) Sholl plots of DIV3 neurons stimulated with psychoplastogens for 1 h and then allowed to grow for 71 h. Shadings indicate 95% CI (C) Representative images of neurons used to make the Sholl plots in B. Scale bar = 10 μm. (D-E) Maximum number of crossings (N_{max}) of the Sholl plots obtained from neurons that experienced both transient stimulation and growth phases (D, $n = 10$ neurons) or only a 1 h stimulation (E, $n = 37$ neurons). Data are represented as mean ± SEM. *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$; ****, $p < 0.0001$, as compared to VEH control. For D, multiple t tests were performed, and p values were corrected for multiple comparisons using the Holm-Sidak method. For E, a one-way analysis of variance with Dunnett's post hoc test was utilized. VEH = vehicle; KET = ketamine; LSD = lysergic acid diethylamide. See also Figure S1.

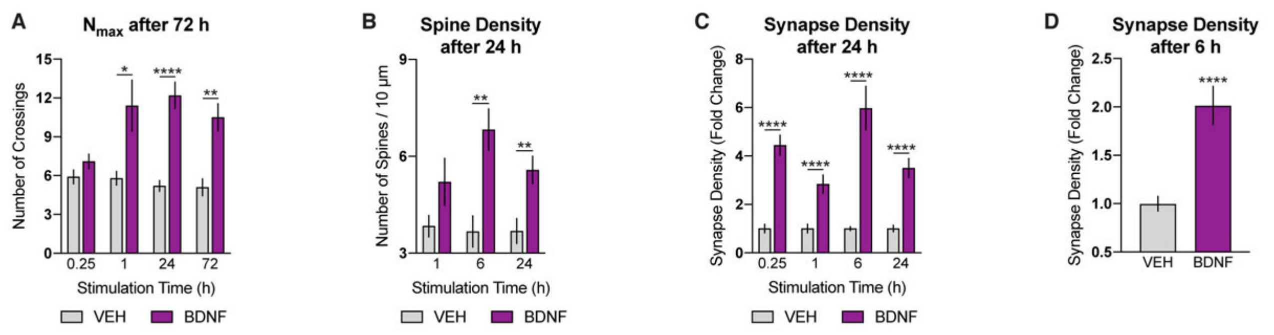


Figure S1. Transient stimulation with BDNF is sufficient to induce growth of cortical neurons, Related to Figure 1. (A) Cortical cultures (DIV3) were treated with BDNF (50 ng/mL) for short periods of time and then allowed to grow for a total of 72 h. Maximum number of crossings (N_{max}) of the Sholl plots are presented as a measure of dendritic arbor complexity (*n* = 10 neurons). (B) Cortical cultures (DIV19) were treated with BDNF (50 ng/mL) for short periods of time and then allowed to grow for a total of 24 h before dendritic spine density was assessed. (C) Cortical cultures (DIV19) were treated with BDNF (50 ng/mL) for short periods of time and then allowed to grow for a total of 24 h before synapse density was assessed via colocalization of pre- and postsynaptic markers (VGLUT1 and PSD-95, respectively). (D) Cortical cultures (DIV19) were treated with BDNF (50 ng/mL) for 6 h before synapse density was assessed. Data are represented as mean ± SEM. *p<0.05, **p< 0.01, ***p< 0.001, ****p < 0.0001, as compared to VEH control. For A-C, multiple t tests were performed and p values were corrected for multiple comparisons using the Holm-Sidak method. For D, a one-way analysis of variance with Dunnett's post hoc test was utilized. VEH = vehicle.

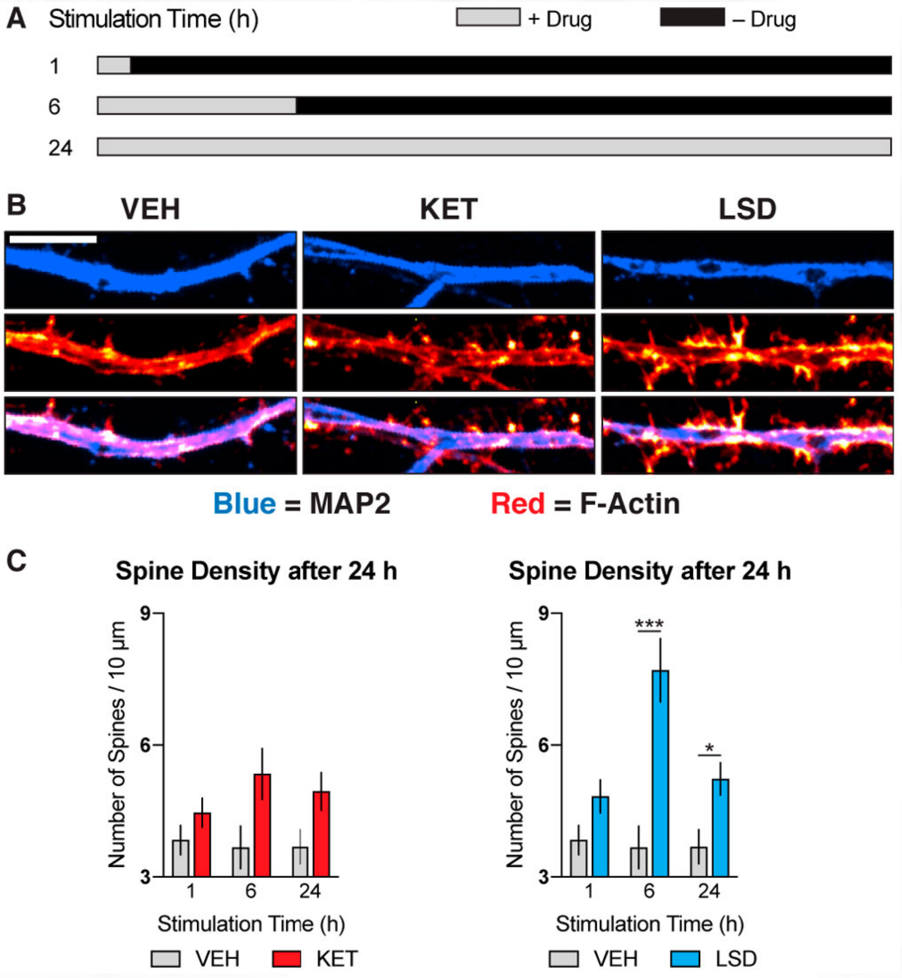


Figure 2. Transient stimulation with psychoplastogens is sufficient to induce spinogenesis. (A) Schematic illustrating experimental design. Cortical cultures (DIV19) were treated with psychoplastogens (10 µM) for short periods of time and then allowed to grow for a total of 24 h. (B) Representative images of secondary dendritic branches stimulated with psychoplastogens for 6 h and then allowed to grow for 18 h. Dendrites and F-actin were imaged using an anti-MAP2 antibody and fluorescent phalloidin conjugate, respectively. In the colocalization channel, dendritic spines can be visualized as red F-actin-rich protrusions emanating from blue dendrites. Scale bar = 5 µm. (C) Quantification of dendritic spine density. Data are represented as mean ± SEM (*n* = 11-30 neurons). *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$; ****, $p < 0.0001$, as compared to VEH control following multiple *t* tests and correction of *p* values for multiple comparisons using the Holm-Sidak method. VEH = vehicle; KET = ketamine; LSD = lysergic acid diethylamide. See also Figure S1.

Next, we determined whether transient psychoplastogen stimulation was sufficient to induce dendritic spine growth, as we have often observed parallels between compound-induced changes in spine density and dendritic arbor complexity. As with dendritic growth, transient stimulation of cortical neurons (DIV19) with ketamine or LSD followed by a growth period in the absence of drug was sufficient to induce large increases in dendritic spine density (Figure 2), with LSD producing effects similar in magnitude to those produced by BDNF (Figure S1B) and ketamine inducing more modest changes. A 6 h stimulation period appears to be optimal for increasing dendritic spine density. In general, longer stimulation periods produce smaller changes in both dendrite and spine growth, which we hypothesize might be due to homeostatic mechanisms resulting from excessive neuronal excitation.[44]

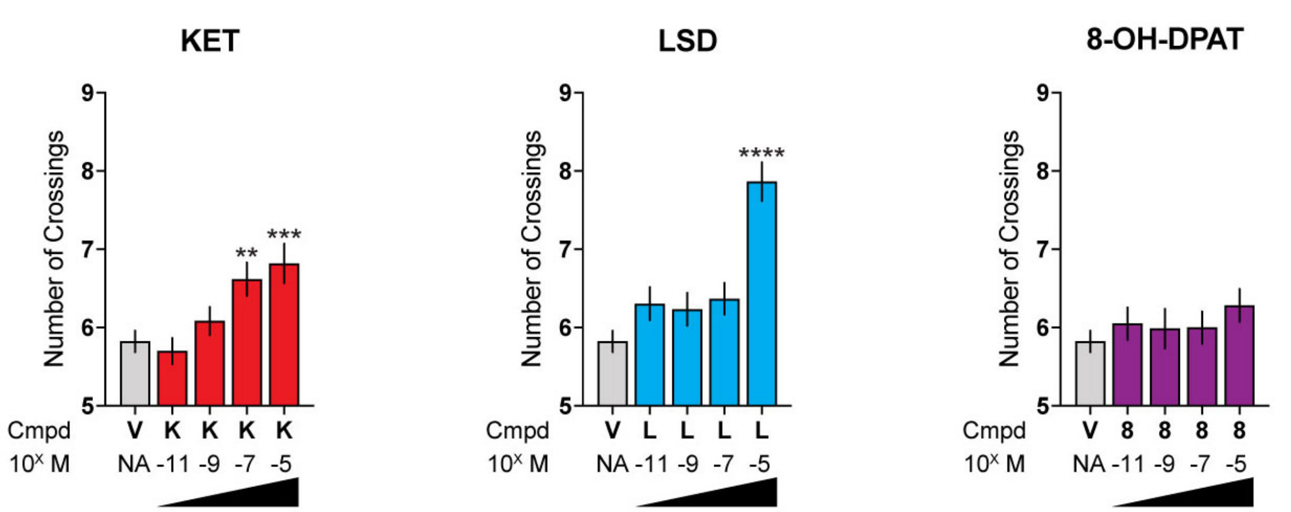


Figure S2. Transient stimulation with psychoplastogens increases dendritic growth in a concentration-dependent manner, related to Figure 1. Cortical cultures (DIV3) were treated with compounds at various concentrations for 1h and then allowed to grow for a total of 72 h. The maximum number of crossings (N_{max}) of the resulting Sholl plots are shown. Data are represented as mean ± SEM (n = 52-136 neurons). $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{*****}p < 0.0001$, as compared to VEH control following a one-way analysis of variance with Dunnett's post hoc test. V = vehicle; K = KET = ketamine; L = LSD = lysergic acid diethylamide; 8 = 8-OH-DPAT = 7-(Dipropylamino)-5,6,7,8-tetrahydronaphthalen-1-ol. See also Figure 1.

To determine the effect of transient psychoplastogen stimulation on synapse formation, we performed colocalization experiments of pre- (VGLUT1) and postsynaptic (PSD-95) markers. Psychoplastogen-induced increases in synapse density mirrored changes in spine density with a 6 h stimulation/18 h growth period producing the greatest effects (Figure 3). Stopping the experiment after 6 h of stimulation resulted in a much smaller change (Figure 3D), indicating that a growth phase following stimulation is necessary to achieve maximal increases in synapse density. While the effects of psychoplastogens on cortical structural plasticity (i.e., dendrite and spine growth) closely resemble those induced by BDNF, their effects on synaptogenesis are markedly distinct. BDNF induces a noticeably larger (~6-fold increase) and more rapid (15 min stimulation) increase in synaptogenesis (Figure S1C,D) than do psychoplastogens (~2-fold increase, 6 h stimulation). These results have important implications for the therapeutic properties of current and next-generation psychoplastogens. First, they suggest that psychoplastogens (10 µM) and BDNF (50 ng/mL) produce maximal increases in cortical structural plasticity (dendrite and spine growth) at these concentrations. Our previous work supports such a ceiling effect, as a combination of BDNF and a psychoplastogen did not result in additive or synergistic effects on neuronal growth.[28] Second, these results suggest that a psychoplastogen with BDNF-like synaptogenic efficacy has yet to be discovered, highlighting an important area for future drug discovery. As synaptogenic effects can be observed prior to substantial increases in spine growth (Figure S1), it appears that these two processes are distinct. This conclusion is further supported by the recent discovery of compounds capable of increasing synapse density while concomitantly decreasing spine density.[45]

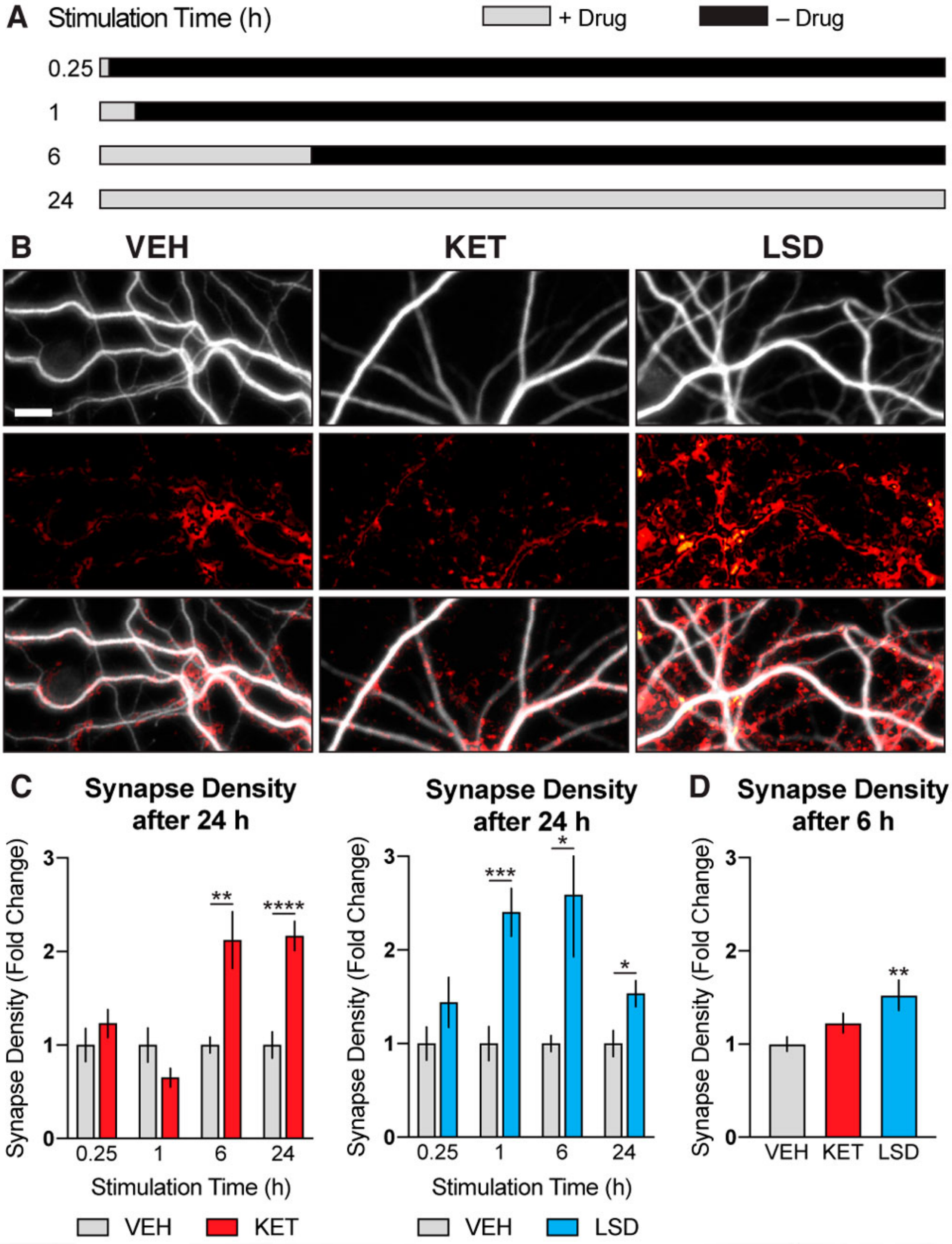


Figure 3. Transient stimulation with psychoplastogens is sufficient to induce synaptogenesis. (A) Schematic illustrating experimental design. Cortical cultures (DIV19) were treated with psychoplastogens (10 μM) for short periods of time and then allowed to grow for a total of 24 h. (B) Representative images of dendritic branches stimulated with psychoplastogens for 6 h and then allowed to grow for 18 h. Dendrites were imaged using an anti-MAP2 antibody (gray). Synapses are represented as colocalization of VGLUT1 and PSD-95 channels (red). Scale bar = 10 μm. (C) Quantification of synapse density (*n* = 25-27 neurons) from neurons that experienced both transient stimulation and growth phases. (D) Quantification of synapse density (*n* = 50-54 neurons) from neurons that experienced a 6 h stimulation only. Data are represented as mean ± SEM. *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$; ****, $p < 0.0001$, as compared to VEH control. For C, multiple *t* tests were performed, and *p* values were corrected for multiple comparisons using the Holm-Sidak method. For D, a one-way analysis of variance with Dunnett's post hoc test was utilized. VEH = vehicle; KET = ketamine; LSD = lysergic acid diethylamide. See also Figure S1.

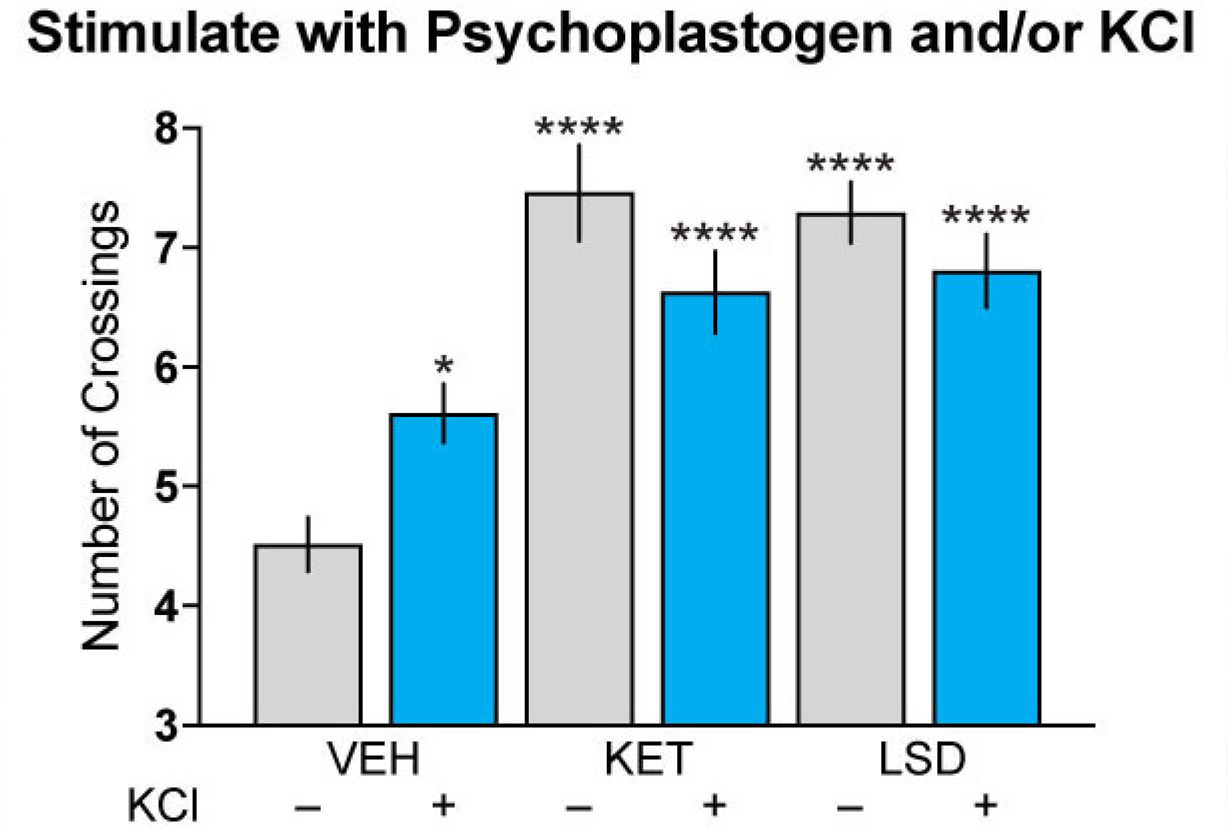


Figure S3. Stimulation with Potassium Does Not Produce Psychoplastogen-Like Effects on Dendritogenesis, Related to Figure 4. Cortical cultures (DIV3) were treated with psychoplastogens (10 μM) for 1 h in the presence or absence of KCl (40 mM) and then allowed to grow for 71 h. The maximum number of crossings (N_{max}) of the resulting Sholl plots are shown. Data are represented as mean ± SEM (n = 35-41 neurons). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$, as compared to VEH control without KCl following a one-way analysis of variance with Dunnett's post hoc test. VEH = vehicle; KET = ketamine; LSD = lysergic acid diethylamide; KCl = potassium chloride. See also Figure 4.

Psychoplastogen-Induced Growth Requires Sustained AMPA Receptor and mTOR Activation. Having firmly established that transient stimulation with ketamine and LSD is sufficient to induce cortical neuron growth, we next used several pharmacological inhibitors to probe which biochemical signaling pathways are essential during the stimulation and growth periods (Figure 4A). The leading hypothesis concerning the mechanism of antidepressant psychoplastogens involves a compound-induced glutamate burst in the cortex resulting in BDNF secretion, TrkB stimulation, and ultimately mTOR activation.[28,46] Duman and co-workers have proposed that ketamine and scopolamine initiate this glutamate burst by blocking NMDA and muscarinic receptors on inhibitory neurons, respectively,[47] while Aghajanian and co-workers have shown that psychedelics increase cortical glutamate levels by activating 5-HT_{2A} receptors on excitatory neurons.[48] Treating cortical neurons with DNQX, an AMPA receptor blocker, during the initial stimulation phase blocked dendritic growth, as expected (Figure 4B). However, we were surprised to find that treatment with DNQX during the growth period had a similar effect, indicating that sustained AMPA receptor activation is necessary for both the initiation and maintenance of psychoplastogen-induced neuronal growth.

Originally, we hypothesized that AMPA receptor activation would lead to BDNF secretion, ultimately stimulating TrkB receptors. As BDNF is well known to enhance its own expression through positive autoregulation,[49-52] we hypothesized that sustained TrkB signaling would be necessary for the long-lasting effects of transient psychoplastogen stimulation on dendritogenesis. However, this did not appear to be the case, as treatment with ANA-12, a selective TrkB antagonist,[53] only blocked pyschoplastogen-induced growth when applied during the initial stimulation period and was ineffective when applied in the absence of psychoplastogen during the growth phase (Figure 4C). Conversely, blocking mTOR during either the stimulation or growth periods was sufficient to abrogate neuronal growth (Figure 4D), likely due to the critical role that mTOR plays in the synthesis of structural proteins and ion channels necessary for neural plasticity.[54]

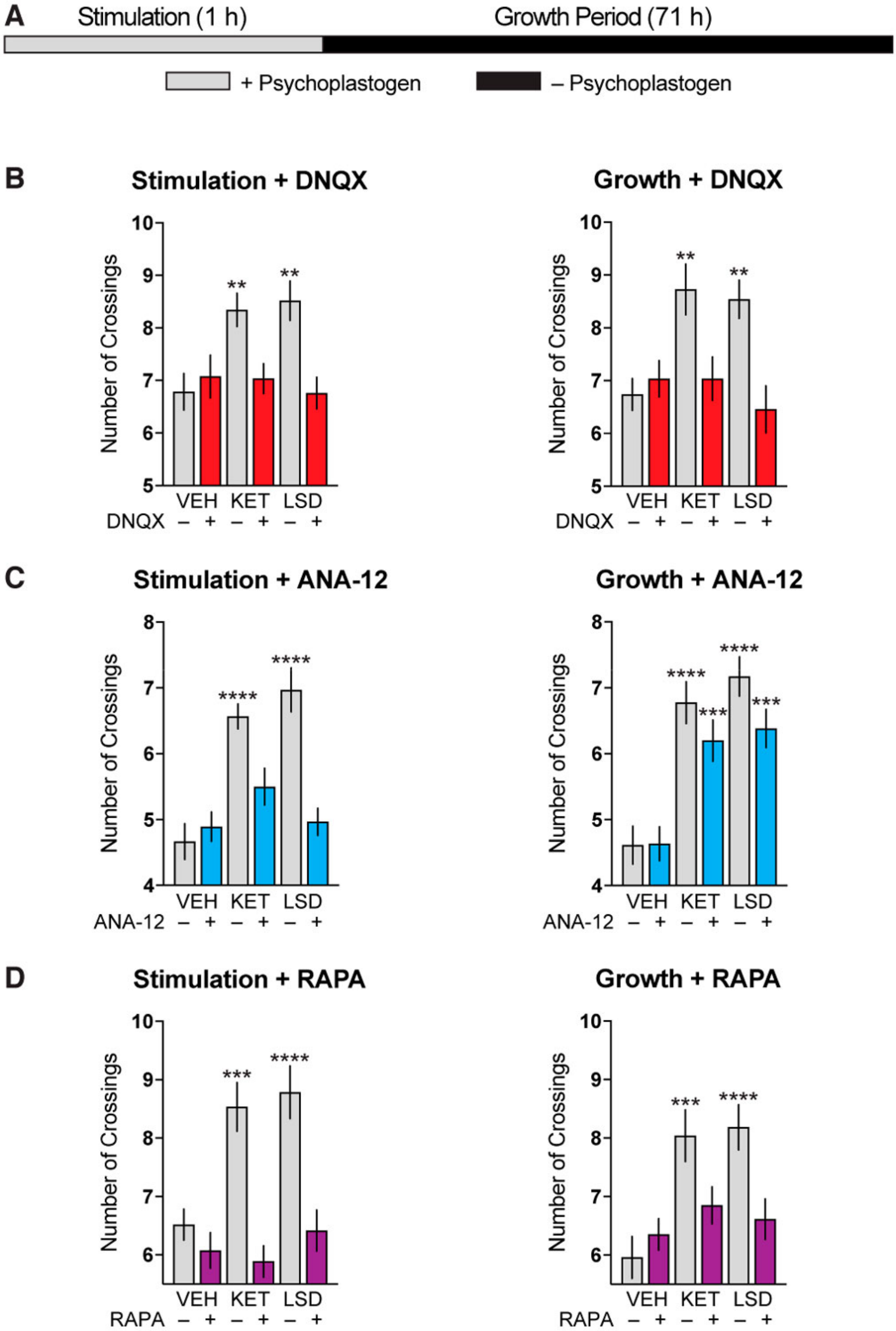


Figure 4. Sustained AMPA receptor and mTOR stimulation is necessary for psychoplastogen-induced dendritic growth. (A) Schematic illustrating experimental design. Cortical cultures (DIV3) were treated with psychoplastogens (10 µM) for 1 h (stimulation phase) and then allowed to grow in the absence of psychoplastogens for 71 h (growth phase). (B-D) Maximum number of crossings (N_{max}) of the Sholl plots obtained after the stimulation and growth phases. Pharmacological inhibitors of AMPA receptors (B), TrkB receptors (C), and mTOR (D) were applied during either the stimulation or growth phases. Data are represented as mean ± SEM (n = 22-37 neurons). *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$; ****, $p < 0.0001$, as compared to VEH control without inhibitor following a one-way analysis of variance with Dunnett's post hoc test. VEH = vehicle; KET = ketamine; LSD = lysergic acid diethylamide; DNQX = 6,7-dinitroquinoxaline-2,3-dione; RAPA = rapamycin. See also Figure S2.

Given the key role of AMPA receptor activation on both the initiation and maintenance of psychoplastogen-induced cortical neuron growth, we next sought to determine if neuronal activity in the absence of a psychoplastogen was capable of producing comparable changes in dendritogenesis. Stimulation of cortical cultures for 1 h with 40 mM KCl, a concentration known to induce glutamate release,[55] did not lead to a growth phenotype comparable to that produced by psychoplastogens (Figure S3). Moreover, the combination of KCl with either ketamine or LSD did not enhance psychoplastogen-induced dendritogenesis (Figure S3). These results suggest that psychoplastogens induce neuronal growth by engaging biochemical signaling mechanisms that are distinct from those activated simply through neuronal depolarization/overexcitation.

Discussion

Accumulating evidence has suggested that activation of AMPA receptors, TrkB, and mTOR are all critical for the effects of ketamine and other psychoplastogens on both cortical structural plasticity and behavior.[26,28,56-64] Recently, an elegant study by Liston and co-workers established a causal link between ketamine-induced spinogenesis in the PFC and antidepressant-like behavior in the tail suspension test.[65] However, the details of psychoplastogen-initiated biochemical signaling leading to sustained changes in neuronal structure/ function have remained poorly defined. Here, we demonstrate that transient stimulation with either ketamine or LSD, psychoplastogens from chemically distinct classes, trigger a growth phase that continues in the absence of drug.

Single administrations of psychoplastogens are well-known to produce effects in humans and rodents that persist long after the drug has been cleared from the body.[29-34] Pharmacokinetic studies in rodents have revealed that behaviorally relevant doses of ketamine and DMT yield brain concentrations >10 μM,[66,67] concentrations that are more than sufficient to trigger neuronal growth in culture. Psychoplastogen-induced growth of cortical neurons appears to require initial TrkB activation and is characterized by sustained AMPA receptor and mTOR activation. Though the exact details of this biochemical signaling network still remain elusive, it is clear that mechanisms exist for sustaining growth through an autoregulatory positive feedback loop. For example, initial activation of AMPA receptors is known to induce BDNF secretion, which in turn activates mTOR.[68,69] Activation of mTOR not only leads to the translation of proteins necessary for cell growth but also produces additional BDNF. Finally, BDNF itself is known to induce glutamate release in cortical neurons via a nonexocytotic pathway,[70] which could lead to sustained AMPA receptor activation. Superficially, it would appear that psychoplastogens merely catalyze this growth process by initiating a glutamate burst. However, psychoplatogen-induced neuronal growth cannot simply be the result of transient neuronal excitation, as a high concentration of potassium ions is not sufficient to produce similar changes in cortical neuron structure.

Though we know that psychoplastogens activate mTOR, it is still unclear how compounds with distinct primary targets (NMDA receptors for ketamine and 5-HT$_{2A}$ receptors for LSD) are capable of activating the same biochemical pathways. One hypothesis is that ketamine and LSD both induce glutamate bursts through their respective primary targets. Ketamine is believed to increase glutamate secretion by inhibiting NMDA receptors on inhibitory interneurons,[46] while serotonergic psychedelics like LSD have been shown to promote glutamate release by activating 5-HT$_{2A}$ receptors.[47] However, given the fact that increased neuronal activity is insufficient to produce psychoplastogen-like effects on neuronal growth, it is possible that ketamine and LSD could share an unidentified common target responsible for their psychoplastogenic effects. Given recent evidence suggesting that 5-HT$_{1A}$ receptors may play a role in the antidepressant effects of ketamine,[71] coupled with the fact that LSD has high affinity for 5-HT$_{1A}$ receptors, we decided to test the effects of 8-OH-DPAT (a selective 5-HT$_{1A}$ agonist) on dendritic growth. Treating cortical neurons with 8-OH-DPAT did not increase dendritic growth at any concentration (Figure S2), suggesting that 5-HT$_{1A}$ receptors do not play a role in the psychoplastogenic effects of ketamine or LSD. At this point, it seems the most likely mechanism explaining the shared plasticity-promoting properties of psychoplastogenic NMDA receptor and 5-HT$_{2A}$ receptor ligands is related to their shared abilities to promote glutamate secretion through different receptors.

Currently, it is unclear exactly how long psychoplastogen-induced plasticity lasts. Two-photon *in vivo* imaging experiments have shown that ketamine can increase the rate of dendritic spine formation for up to 2 weeks in rodents,[72] with behavioral effects often observed 1 week following administration.[64] However, not all psychoplastogens are equivalent, with some producing more enduring effects than others. Recently, the antidepressant-like behavioral effects of psilocybin in rodents were shown to last much longer than those produced by ketamine,[73] results that mirror the human clinical data for these two compounds.

Here, we have shown that like BDNF, psychoplastogens activate positive autoregulatory feedback loops leading to sustained neuronal growth. Small molecules offer significant advantages over protein- and peptide-based activators of neuronal growth signaling, as they can readily cross the blood-brain barrier. Moreover, our work suggests the potential for a paradigm shift in CNS drug development toward molecules that are intentionally designed to reach high brain concentrations and be rapidly cleared from the body in order to minimize side effects. One of the major concerns with using drugs like psilocybin and ketamine in the clinic is related to their relatively long-lasting hallucinogenic/dissociative properties, necessitating the hospitalization of patients for extended periods of time. In this regard, shorter acting plasticity-promoting psychedelics, such as DMT,[74] could offer significant advantages by reducing healthcare costs.[75] With the advent of nonhallucinogenic psychoplastogens,[76] it might be possible to produce a plasticity-promoting drug suitable for at home administration. The work described here suggests that infrequent administration of such compounds might be sufficient to produce sustained changes in neural circuitry, thus avoiding potential side effects from chronic daily use, such as those that have plagued patients using traditional antidepressants.

Data Analysis and Statistics. Treatments were randomized, and data were analyzed by experimenters blinded to treatment conditions. Statistical analyses were performed using GraphPad Prism (version 8.1.2). Data are represented as mean ± SEM, unless otherwise noted, with asterisks: *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$; and ****, $p < 0.0001$. Brightness and contrast were adjusted equally for all representative images.

Data Availability. The data sets analyzed as part of this study are available via Mendeley Data: https://data.mendeley.com/datasets/6f5wf65fbf/draft?a=5311108e-7332-4df8-9d4c86dcdd023cd0.

Drugs. The NIH Drug Supply Program provided (+)-lysergic acid diethylamide (+)-tartrate (2:1) (LSD). Other chemicals/proteins were purchased from commercial sources such as ketamine hydrochloride (KET, Fagron), (±)-8-hydroxy-2-(dipropylamino)tetralin hydrobromide (8-OH-DPAT, Sigma), brain-derived neurotrophic factor (BDNF, Sigma-Aldrich), ANA-12 (MedChem Express), DNQX (Sigma), and rapamycin (Alfa Aesar). For cell culture experiments, VEH = 0.1% (studies assessing the effects of psychoplastogen alone) or 0.2% (studies assessing the effects of psychoplastogen + inhibitor) molecular-biology-grade dimethyl sulfoxide (Acros).

Animals. All experimental procedures involving animals were approved by the University of California, Davis, Institutional Animal Care and Use Committee (IACUC) and adhered to principles described in the National Institutes of Health Guide for the Care and Use of Laboratory Animals. The University of California, Davis, is accredited by the Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC).

Cell Culture. Primary cortical cell cultures were prepared as described previously.[28] Briefly, pregnant Sprague Dawley dams were euthanized at embryonic day 18 (E18), and the cortices of the pups were harvested. Cells were plated on poly-D-lysine-coated plates at specific densities depending on the experiment (vide infra). Cultures were maintained at 37°C under an atmosphere containing 5% CO_2. Plating media consisted of 10% heat-inactivated fetal bovine serum (FBS; Life Technologies), 1% penicillin-streptomycin (Life Technologies), and 0.5 mM glutamine (Life Technologies) in Neurobasal (Life Technologies). After 16-24 h, media was exchanged for replacement media consisting of 1× B27 supplement (Life Technologies), 1% penicillin-streptomycin, 0.5 mM glutamine, and 12.5 μM glutamate in Neurobasal. For experiments requiring cells older than 7 days *in vitro* (DIV7), at 96 h postplating, 50% of media was removed, and feeding media containing 1× B27 supplement, 1% penicillin-streptomycin, 0.5 mM glutamine in Neurobasal was added with an additional 20% volume added to account for evaporation.

Dendritogenesis Experiments. The dendritogenesis experiments reported in Figures 1D and S1A were performed as previously described[28] with the exception that cells were treated with psychoplastogens or BDNF for short periods of time (15 min or 1, 24, or 72 h) prior to exchanging the media for replacement media devoid of psychoplastogen/BDNF. The dendritogenesis experiments reported in Figures 1E, 4, and S2 were performed as previously described[74] with the exception of the treatment conditions.

Spinogenesis Experiments. Spinogenesis experiments were performed as previously described[28] with the exception that cells were treated on DIV19 with psychoplastogens (10 µM) for short periods of time (1, 6, and 24 h) prior to exchanging the media for replacement media devoid of psychoplastogens. Cells were fixed on DIV20 (24 h following treatment). Images were taken on a Nikon HCA Confocal microscope a with a 100×/NA 1.45 oil objective.

Synaptogenesis Experiments. Synaptogenesis experiments were performed using 96-well plates coated with poly-D-lysine at a density of 15 000 cells per well. The outer wells were not used to avoid edge effects. On DIV7 and DIV14, 50% of the medium was removed (100 µL) and fresh feeding media containing Neurobasal, 1× B27 supplement (Life Technologies), 1% penicillin-streptomycin, and 0.5 mM glutamine was added (70%, 140 µL). Cells were treated with drugs on DIV19. First, 10 mM DMSO stock solutions were diluted 100-fold in Neurobasal, then diluted 10-fold into each well (1:1000 dilution, final concentration of DMSO = 0.1%). Cells were incubated with drug for 0.25, 1, and 6 h, then media was removed and replaced with fresh feeding media devoid of psychoplastogens. Cells were allowed to grow until a total of 24 h had elapsed. At this time, 80% of the media (160 µL) was removed, and a 50% volume of a 4% aqueous paraformaldehyde (PFA) solution (100 µL) at room temperature was added. The fixative was applied to the cultures for 20 min at room temperature. Cells were then washed two times with Dulbecco's phosphate-buffered saline (dPBS, Life Technologies) and permeabilized with 0.2% Triton X-100 (ThermoFisher, 85111) in dPBS for 20 min at room temperature without shaking. Plates were then blocked with antibody diluting buffer (ADB) containing 2% bovine serum albumin (BSA) in dPBS for 1 h at room temperature without shaking. Then, plates were incubated overnight at 4°C with gentle shaking in ADB and a chicken anti-MAP2 antibody (1:10 000; EnCor, CPCA-MAP2), a guinea pig anti-vGLUT1 antibody (1:1000; Millipore, AB5905), and a mouse anti-PSD-95 antibody (1:500; Millipore, MABN68). The next day, plates were washed three times in dPBS and once in ADB. Plates were then incubated in ADB at room temperature containing an anti-chicken IgG secondary antibody conjugated to Alexa Fluor 488 (1:500; LifeTechnologies), an anti-guinea pig IgG secondary antibody conjugated to Cy3 (1:500; Jackson ImmunoResearch Inc., catalog no. 706-165-148), and an anti-mouse IgG secondary antibody conjugated to Alexa Fluor 647 (1:500; Jackson ImmunoResearch Inc., catalog no. 715-605-151) for 1 h. Next, plates were washed five times with dPBS, and after the final wash, 100 µL of dPBS was added to each well. All images were obtained using a Molecular Devices ImageXpress Micro XLS Widefield High-Content Analysis System at 9 sites per well using 40× magnification. Image analysis was performed using MetaXpress software. Analysis was completed by first using the MAP2 channel to establish a mask of the neuron using thresholds between 0 and 30 µm. Then, the mask of the neuron was expanded by 1 µm. The size of the objects for the presynaptic and postsynaptic fluorescent images were established, and only signals of 0-1.5 µm punctate were used to generate a mask. To measure synaptic density, the presynaptic and postsynaptic masks were overlaid using the logical operation "and" to retain only signal that colocalized to form the synapse mask. The number of events occurring in this synapse mask was quantified and normalized to the MAP2 channel mask area (number of counts per µm2). Normalized data were then tested for outliers using the ROUT method in Graphpad Prism (version 8) at $Q = 1\%$. The outlier test was completed to remove artifacts in an unbiased manner. To prepare the representative images shown in Figure 3B, brightness/contrast was adjusted evenly across all images. After this, the vGLUT1 and PSD-95 channels were both processed using the "smooth" function in ImageJ (Fiji, Ver. 1.51v) followed by the plug-in "Image Calculator" with image1 corresponding to vGLUT1 and image2 corresponding to PSD95. The operation used was "And", and "Create new window" was checked. The resulting window contained all points of colocalization between the two images. This window was also processed through the "smooth" function once more. Next, the MAP2 channel was merged with the colocalization channel for a composite that was falsely colored to distinguish the two channels.

Associated Content

Supporting Information: included here above.

Author Information

Corresponding Author

David E. Olson - Department of Chemistry, Department of Biochemistry & Molecular Medicine, School of Medicine, and Center for Neuroscience, University of California, Davis, Davis, California, Davis 95616, United States; orcid.org/0000-0002-4517-0543; Email: deolson@ucdavis.edu

Authors
Calvin Ly - Department of Chemistry, University of California, Davis, Davis, California, Davis 95616, United States
Alexandra C. Greb - Department of Chemistry, University of California, Davis, Davis, California, Davis 95616, United States
Maxemiliano V. Vargas - Neuroscience Graduate Program, University of California, Davis, Davis, California 95618, United States
Whitney C. Duim - Department of Chemistry, University of California, Davis, Davis, California, Davis 95616, United States
Ana Cristina G. Grodzki - Department of Molecular Biosciences, School of Veterinary Medicine, University of California, Davis, Davis, California 95616, United States
Pamela J. Lein - Department of Molecular Biosciences, School of Veterinary Medicine, University of California, Davis, Davis, California 95616, United States; orcid.org/0000-0001-7665-7584

Complete contact information is available at:
https://pubs.acs.org/10.1021/acsptsci.0c00065

Author Contributions
CL performed the majority of the dendritogeneis, spinogenesis, and synaptogenesis experiments with assistance from ACG, MVV, and WCD. ACGG and PJL supervised the high-content imaging experiments. DEO conceived the project and supervised experiments. DEO and CL wrote the manuscript with input from all authors.

Notes
The authors declare the following competing financial interest(s): D.E.O. is the president and chief scientific officer of Delix Therapeutics, Inc.

Acknowledgments

This work was supported by funds from the National Institutes of Health (NIH) (R01GM128997 to D.E.O.), an NIH training grant T32GM113770 (to C.L.), and a UC Davis Provost's Undergraduate Fellowship (to A.C.G.). Several experiments utilized the Biological Analysis Core of the UC Davis MIND Institute Intellectual and Development Disabilities Research Center (U54 HD079125) or the Nikon high-content-analysis spinning-disk confocal microscope (1S10OD019980-01A1) located in the Light Microscopy Imaging Facility of the Department of Molecular and Cellular Biology at UC Davis. Lysergic acid diethylamide was generously provided by the NIDA Drug Supply Program.

Abbreviations

VEH - vehicle
KET - ketamine
LSD - lysergic acid diethylamide
DNQX - 6,7-dinitroquinoxaline-2,3-dione
AMPA - α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid
TrkB - tyrosine kinase B
mTOR - mammalian target of rapamycin
BDNF - brain-derived neurotrophic factor

References

1. James, S. L., *et al*. (2018) Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 392, 1789-1858.
2. Smith, K. (2014) Mental health: a world of depression. *Nature 515*, 180.
3. Cipriani, A., Furukawa, T. A., Salanti, G., Chaimani, A., Atkinson, L. Z., Ogawa, Y., Leucht, S., Ruhe, H. G., Turner, E. H., Higgins, J. P. T., Egger, M., Takeshima, N., Hayasaka, Y., Imai, H., Shinohara, K., Tajika, A., Ioannidis, J. P. A., and Geddes, J. R. (2018) Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network meta-analysis. *Lancet 391*, 1357-1366.
4. Rush, A. J., Trivedi, M. H., Wisniewski, S. R., Nierenberg, A. A., Stewart, J. W., Warden, D., Niederehe, G., Thase, M. E., Lavori, P. W., Lebowitz, B. D., et al. (2006) Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report. *Am. J. Psychiatry 163*, 1905-1917.
5. Duman, R. S., Aghajanian, G. K., Sanacora, G., and Krystal, J. H. (2016) Synaptic plasticity and depression: new insights from stress and rapid-acting antidepressants. *Nat. Med. 22*, 238-249.
6. Duman, R. S., and Aghajanian, G. K. (2012) Synaptic dysfunction in depression: potential therapeutic targets. *Science 338*, 68-72.
7. Autry, A. E., and Monteggia, L. M. (2012) Brain-derived neurotrophic factor and neuropsychiatric disorders. *Pharmacol. Rev. 64*, 238-258.
8. Pittenger, C., and Duman, R. S. (2008) Stress, depression, and neuroplasticity: a convergence of mechanisms. *Neuropsychopharmacology 33*, 88-109.
9. Olson, D. E. (2018) Psychoplastogens: A Promising Class of Plasticity-Promoting Neurotherapeutics. *J. Exp. Neurosci. 12*, 1-4.
10. Berman, R. M., Cappiello, A., Anand, A., Oren, D. A., Heninger, G. R., Charney, D. S., and Krystal, J. H. (2000) Antidepressant effects of ketamine in depressed patients. *Biol. Psychiatry 47*, 351-354.
11. Zarate, C. A., Jr., Singh, J. B., Carlson, P. J., Brutsche, N. E., Ameli, R., Luckenbaugh, D. A., Charney, D. S., and Manji, H. K. (2006) A randomized trial of an N-methyl-D-aspartate antagonist in treatment-resistant major depression. *Arch. Gen. Psychiatry 63*, 856-864.
12. Zarate, C. A., Jr., Brutsche, N. E., Ibrahim, L., Franco-Chaves, J., Diaz-Ggranados, N., Cravchik, A., Selter, J., Marquardt, C. A., Liberty, V., and Luckenbaugh, D. A. (2012) Replication of ketamine's antidepressant efficacy in bipolar depression: a randomized controlled add-on trial. *Biol. Psychiatry 71*, 939-946.
13. Diaz-Granados, N., Ibrahim, L. A., Brutsche, N. E., Ameli, R., Henter, I. D., Luckenbaugh, D. A., Machado-Vieira, R., and Zarate, C. A., Jr. (2010) Rapid resolution of suicidal ideation after a single infusion of an N-methyl-D-aspartate antagonist in patients with treatment-resistant major depressive disorder. *J. Clin. Psychiatry 71*, 1605-1611.
14. Furey, M. L., and Drevets, W. C. (2006) Antidepressant efficacy of the antimuscarinic drug scopolamine: a randomized, placebo-controlled clinical trial. *Arch. Gen. Psychiatry 63*, 1121-1129.
15. Drevets, W. C., and Furey, M. L. (2010) Replication of scopolamine's antidepressant efficacy in major depressive disorder: a randomized, placebo-controlled clinical trial. *Biol. Psychiatry 67*, 432-438.
16. Furey, M. L., Khanna, A., Hoffman, E. M., and Drevets, W. C. (2010) Scopolamine produces larger antidepressant and antianxiety effects in women than in men. *Neuropsychopharmacology 35*, 2479-2488.
17. Furey, M. L., Nugent, A. C., Speer, A. M., Luckenbaugh, D. A., Hoffman, E. M., Frankel, E., Drevets, W. C., and Zarate, C. A., Jr. (2012) Baseline mood-state measures as predictors of antidepressant response to scopolamine. *Psychiatry Res. 196*, 62-67.
18. Carhart-Harris, R. L., and Goodwin, G. M. (2017) The therapeutic potential of psychedelic drugs: past, present, and future. *Neuropsychopharmacology 42*, 2105-2113.
19. Nichols, D. E., Johnson, M. W., and Nichols, C. D. (2017) (2017). Psychedelics as medicines: an emerging new paradigm. *Clin. Pharmacol. Ther. 101*, 209-219.
20. Sanches, R. F., de Lima Osório, F., Dos Santos, R. G., Macedo, L. R., Maia-de-Oliveira, J. P., Wichert-Ana, L., de Araujo, D. B., Riba, J., Crippa, J. A., and Hallak, J. E. (2016) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a SPECT study. *J. Clin. Psychopharmacol. 36*, 77-81.
21. Osório, F. de. L., Sanches, R. F., Macedo, L. R., dos Santos, R. G., Maia-de-Oliveira, J. P., Wichert-Ana, L., de Araujo, D. B., Riba, J., Crippa, J. A., and Hallak, J. E. (2015) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. *Rev. Bras. Psiquiatr. 37*, 13-20.
22. Dos Santos, R. G., Osório, F. L., Crippa, J. A., Riba, J., Zuardi, A. W., and Hallak, J. E. (2016) Antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide (LSD): a systematic review of clinical trials

published in the last 25 years. *Ther. Adv. Psychopharmacol. 6*, 193-213.

23. Carhart-Harris, R. L., Bolstridge, M., Rucker, J., Day, C. M. J., Erritzoe, D., Kaelen, M., Bloomfield, M., Rickard, J. A., Forbes, B., Feilding, A., Taylor, D., Pilling, S., Curran, V. H., and Nutt, D. J. (2016) Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. *Lancet Psychiatry 3*, 619-627.
24. Carhart-Harris, R. L., Roseman, L., Bolstridge, M., Demetriou, L., Pannekoek, J. N., Wall, M. B., Tanner, M., Kaelen, M., McGonigle, J., Murphy, K., et al. (2017) Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Sci. Rep. 7*, 13187.
25. Rucker, J. J., Jelen, L. A., Flynn, S., Frowde, K. D., and Young, A. H. (2016) Psychedelics in the treatment of unipolar mood disorders: a systematic review. *J. Psychopharmacol. 30*, 1220-1229.
26. Li, N., Lee, B., Liu, R. J., Banasr, M., Dwyer, J. M., Iwata, M., Li, X. Y., Aghajanian, G., and Duman, R. S. (2010) mTOR-dependent synapse formation underlies the rapid antidepressant effects of NMDA antagonists. *Science 329*, 959-964.
27. Voleti, B., Navarria, A., Liu, R. J., Banasr, B., Li, N., Terwilliger, R., Sanacora, G., Eid, T., Aghajanian, G., and Duman, R. S. (2013) Scopolamine rapidly increases mammalian target of rapamycin complex 1 signaling, synaptogenesis, and antidepressant behavioral responses. *Biol. Psychiatry 74*, 742-749.
28. Ly, C., Greb, A. C., Cameron, L. P., Wong, J. M., Barragan, E. V., Wilson, P. C., Burbach, K. F., Soltanzadeh Zarandi, S., Sood, A., Paddy, M. R., Duim, W. C., Dennis, M. Y., McAllister, A. K., Ori-McKenney, K. M., Gray, J. A., and Olson, D. E. (2018) Psychedelics Promote Structural and Functional Neural Plasticity. *Cell Rep. 23*, 3170-3182.
29. Drevets, W. C., Zarate, C. A., Jr., and Furey, M. L. (2013) Antidepressant Effects of the Muscarinic Cholinergic Receptor Antagonist Scopolamine: A Review. *Biol. Psychiatry 73*, 1156-1163.
30. Carhart-Harris, R. L., Bolstridge, M., Day, C. M. J., Rucker, J., Watts, R., Erritzoe, D. E., Kaelen, M., Giribaldi, B., Bloomfield, M., and Pilling, S. (2018) Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. *Psychopharmacology 235*, 399-408.
31. Murrough, J. W., Perez, A. M., Pillemer, S., Stern, J., Parides, M. K., aan het Rot, M., Collins, K. A., Mathew, S. J., Charney, D. S., and Iosifescu, D. V. (2013) Rapid and longer-term antidepressant effects of repeated ketamine infusions in treatment-resistant major depression. *Biol. Psychiatry 74*, 250-256.
32. Ionescu, D. F., Swee, M. B., Pavone, K. J., Taylor, N., Akeju, O., Baer, L., Nyer, M., Cassano, P., Mischoulon, D., Alpert, J. E., Brown, E. N., Nock, M. K., Fava, M., and Cusin, C. (2016) Rapid and Sustained Reductions in Current Suicidal Ideation Following Repeated Doses of Intravenous Ketamine: Secondary Analysis of an Open-Label Study. *J. Clin. Psychiatry 77*, e719-e725.
33. Barrett, F. S., Doss, M. K., Sepeda, N. D., Pekar, J. J., and Griffiths, R. R. (2020) Emotions and brain function are altered up to one month after a single high dose of psilocybin. *Sci. Rep. 10*, 2214.
34. Aday, J. S., Mitzkovitz, C. M., Bloesch, E. K., Davoli, C. C., and Davis, A. K. (2020) Long-term effects of psychedelic drugs: A systematic review. *Neurosci. Biobehav. Rev. 113*, 179-189.
35. Castrén, E., and Antila, H. (2017) Neuronal plasticity and neurotrophic factors in drug responses. *Mol. Psychiatry 22*, 1085-1095.
36. Umemori, J., Winkel, F., Didio, G., Llach Pou, M., and Castrén, E. (2018) iPlasticity: Induced juvenile-like plasticity in the adult brain as a mechanism of antidepressants. *Psychiatry Clin. Neurosci. 72*, 633-653.
37. Rantamäki, T., Hendolin, P., Kankaanpää, A., Mijatovic, J., Piepponen, P., Domenici, E., Chao, M. V., Männistö, P. T., and Castrén, E. (2007) Pharmacologically diverse antidepressants rapidly activate brain-derived neurotrophic factor receptor TrkB and induce phospholipase-Cgamma signaling pathways in mouse brain. *Neuro-psychopharmacology 32*, 2152-2162.
38. Rantamäki, T., Vesa, L., Antila, H., Di Lieto, A., Tammela, P., Schmitt, A., Lesch, K. P., Rios, M., and Castrén, E. (2011) Antidepressant Drugs Transactivate TrkB Neurotrophin Receptors in the Adult Rodent Brain Independently of BDNF and Monoamine Transporter Blockade. *PLoS One 6*, No. e20567.
39. Fred, S. M., Laukkanen, L., Brunello, C. A., Vesa, L., Göös, H., Cardon, I., Moliner, R., Maritzen, T., Varjosalo, M., Casarotto, P. C., and Castrén, E. (2019) Pharmacologically diverse antidepressants facilitate TRKB receptor activation by disrupting its interaction with the endocytic adaptor complex AP-2. *J. Biol. Chem. 294*, 18150-18161.
40. Dolder, P. C., Schmid, Y., Haschke, M., Rentsch, K. M., and Liechti, M. E. (2016) Pharmacokinetics and Concentration-Effect Relationship of Oral LSD in Humans. *Int. J. Neuropsychopharmacol. 19*, pyv072.
41. Mathew, S. J., Shah, A., Lapidus, K., Clark, C., Jarun, N., Ostermeyer, B., and Murrough, J. W. (2012) Ketamine for Treatment-Resistant Unipolar Depression. *CNS Drugs 26*, 189-204.
42. Yanai, K., Ido, T., Ishiwata, K., Hatazawa, J., Takahashi, T., Iwata, R., and Matsuzawa, T. (1986) In vivo kinetics and displacement study of a carbon-11-labeled hallucinogen, *N,N*-[11C]dimethyltryptamine. *Eur. J. Nucl. Med. 12*, 141-146.
43. Sitaram, B. R., Lockett, L., Talomsin, R., Blackman, G. L., and McLeod, W. R. (1987) In vivo metabolism of 5-methoxy-N,Ndimethyltryptamine and *N,N*-dimethyltryptamine in the rat. *Biochem. Pharmacol. 36*, 1509-1512.
44. González-Burgos, I., López-Váquez, M. A., and Beas-Zárate, C. (2004) Density, but not shape, of hippocampal dendritic spines varies after a seizure-inducing acute dose of monosodium glutamate in rats. *Neurosci. Lett. 363*, 22-24.
45. Ly, C., Shimizu, A. J., Vargas, M. V., Duim, W. C., Wender, P. A., and Olson, D. E. (2020) Bryostatin 1 Promotes Synaptogenesis and Reduces Dendritic Spine Density in Cortical Cultures Through a PKC-Dependent Mechanism. *ACS Chem. Neurosci. 11*, 1545-1554.
46. Duman, R. S. (2018) Ketamine and rapid-acting antidepressants: a new era in the battle against depression and suicide.
47. *F1000Research 7*, 659.Wohleb, E. S., Gerhard, D., Thomas, A., and Duman, R. S. (2016) Molecular and Cellular Mechanisms of Rapid-Acting Antidepressants Ketamine and Scopolamine. *Curr. Neuropharmacol. 15*, 11-20.
48. Aghajanian, G. K., and Marek, G. J. (1999) Serotonin, via 5-HT_{2A} receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release. *Brain Res. 825*, 161-171.
49. Jiang, C., Lin, W. J., and Salton, S. R. (2019) Role of a VGF/ BDNF/TrkB Autoregulatory Feedback Loop in Rapid-Acting Antidepressant Efficacy. *J. Mol. Neurosci. 68*, 504-509.
50. Esvald, E. E., Tuvikene, J., Sirp, A., Patil, S., Bramham, C. R., and Timmusk, T. (2020) CREB Family Transcription Factors Are Major Mediators of BDNF Transcriptional Autoregulation in Cortical Neurons. *J. Neurosci. 40*, 1405-1426.

51. Tuvikene, J., Pruunsild, P., Orav, E., Esvald, E. E., and Timmusk, T. (2016) AP-1 Transcription Factors Mediate BDNF-Positive Feedback Loop in Cortical Neurons. *J. Neurosci. 36*, 1290-1305.
52. Bambah-Mukku, D., Travaglia, A., Chen, D. Y., Pollonini, G., and Alberini, C. M. (2014) A Positive Autoregulatory BDNF Feedback Loop via C/EBPβ Mediates Hippocampal Memory Consolidation. *J. Neurosci. 34*, 12547-12559.
53. Cazorla, M., Prémont, J., Mann, A., Girard, N., Kellendonk, C., and Rognan, D. (2011) Identification of a low-molecular weight TrkB antagonist with anxiolytic and antidepressant activity in mice. *J. Clin. Invest. 121*, 1846-1857.
54. Hoeffer, C. A., and Klann, E. (2010) mTOR signaling: at the crossroads of plasticity, memory and disease. *Trends Neurosci. 33*, 67-75.
55. Lingamaneni, R., and Hemmings, H. C., Jr. (1999) Effects of anticonvulsants on veratridine- and KCl-evoked glutamate release from rat cortical synaptosomes. *Neurosci. Lett. 276*, 127-130.
56. Koike, H., Iijima, M., and Chaki, S. (2011) Involvement of AMPA receptor in both the rapid and sustained antidepressant-like effects of ketamine in animal models of depression. *Behav. Brain Res. 224*, 107-111.
57. Zhou, W., Wang, N., Yang, C., Li, X. M., Zhou, Z. Q., and Yang, J. J. (2014) Ketamine-induced antidepressant effects are associated with AMPA receptors-mediated upregulation of mTOR and BDNF in rat hippocampus and prefrontal cortex. *Eur. Psychiatry 29*, 419-423.
58. Koike, H., and Chaki, S. (2014) Requirement of AMPA receptor stimulation for the sustained antidepressant activity of ketamine and LY341495 during the forced swim test in rats. *Behav. Brain Res. 271*, 111-115.
59. Li, S., Luo, X., Hua, D., Wang, Y., Zhan, G., Huang, N., Jiang, R., Yang, L., Zhu, B., Yuan, X., et al. (2020) Ketamine Alleviates Postoperative Depression-Like Symptoms in Susceptible Mice: The Role of BDNF-TrkB Signaling. *Front. Pharmacol. 10*, 1702.
60. Fukumoto, K., Fogaça, M. V., Liu, R., Duman, C., Kato, T., Li, X., and Duman, R. S. (2019) Activity-dependent brain-derived neurotrophic factor signaling is required for the antidepressant actions of (2R,6R)-hydroxynorketamine. *Proc. Natl. Acad. Sci. U. S. A. 116*, 297
61. Ghosal, S., Bang, E., Yue, W., Hare, B. D., Lepack, A. E., Girgenti, M. J., and Duman, R. S. (2018) Activity-Dependent Brain-Derived Neurotrophic Factor Release Is Required for the Rapid Antidepressant Actions of Scopolamine. *Biol. Psychiatry 83*, 29-37.
62. Autry, A. E., Adachi, M., Nosyreva, E., Na, E. S., Los, M. F., Cheng, P., Kavalali, E. T., and Monteggia, L. M. (2011) NMDA receptor blockade at rest triggers rapid behavioural antidepressant responses. *Nature 475*, 91-95.
63. Lepack, A. E., Fuchikami, M., Dwyer, J. M., Banasr, M., and Duman, R. S. (2015) BDNF Release Is Required for the Behavioral Actions of Ketamine. *Int. J. Neuropsychopharmacol. 18*, pyu033.
64. Björkholm, C., and Monteggia, L. M. (2016) BDNF - a key transducer of antidepressant effects. *Neuropharmacology 102*, 72-79.
65. Moda-Sava, R. N., Murdock, M. H., Parekh, P. K., Fetcho, R. N., Huang, B. S., Huynh, T. N., Witztum, J., Shaver, D. C., Rosenthal, D. L., Alway, E. J., *et al.* (2019) Sustained rescue of prefrontal circuit dysfunction by antidepressant-induced spine formation. *Science 364*, No. eaat8078.
66. Yang, Y., Cui, Y., Sang, K., Dong, Y., Ni, Z., Ma, S., and Hu, H. (2018) Ketamine blocks bursting in the lateral habenula to rapidly relieve depression. *Nature 554*, 317-322.
67. Cohen, I., and Vogel, W. H. (1972) Determination and physiological disposition of dimethyltryptamine and diethyltryptamine in rat brain, liver and plasma. *Biochem. Pharmacol. 21*, 1214-1216.
68. Jourdi, H., Hsu, Y. T., Zhou, M., Qin, Q., Bi, X., and Baudry, M. (2009) Positive AMPA Receptor Modulation Rapidly Stimulates BDNF Release and Increases Dendritic mRNA Translation. *J. Neurosci. 29*, 8688-8697.
69. Takei, N., Inamura, N., Kawamura, M., Namba, H., Hara, K., Yonezawa, K., and Nawa, H. (2004) Brain-derived neurotrophic factor induces mammalian target of rapamycin-dependent local activation of translation machinery and protein synthesis in neuronal dendrites. *J. Neurosci. 24*, 9760-9769.
70. Takei, N., Numakawa, T., Kozaki, S., Sakai, N., Endo, Y., Takahashi, M., and Hatanaka, H. (1998) Brain-derived neurotrophic factor induces rapid and transient release of glutamate through the non-exocytotic pathway from cortical neurons. *J. Biol. Chem. 273*, 27620-27624.
71. Fukumoto, K., Iijima, M., Funakoshi, T., and Chaki, S. (2018) Role of 5-HT$_{1A}$ Receptor Stimulation in the Medial Prefrontal Cortex in the Sustained Antidepressant Effects of Ketamine. *Int. J. Neuropsychopharmacol. 21*, 371-381.
72. Phoumthipphavong, V., Barthas, F., Hassett, S., and Kwan, A. C. (2016) Longitudinal Effects of Ketamine on Dendritic Architecture In Vivo in the Mouse Medial Frontal Cortex. *eNeuro 3*, No. ENEURO.0133-15.2016.
73. Hibicke, M., Landry, A. N., Kramer, H. M., Talman, Z. K., and Nichols, C. D. (2020) Psychedelics, but Not Ketamine, Produce Persistent Antidepressant-like Effects in a Rodent Experimental System for the Study of Depression. *ACS Chem. Neurosci. 11*, 864-871.
74. Cameron, L. P., and Olson, D. E. (2018) Dark Classics in Chemical Neuroscience: *N,N*-Dimethyltryptamine (DMT). *ACS Chem. Neurosci. 9*, 2344-2357.
75. Nutt, D., Erritzoe, D., and Carhart-Harris, R. (2020) Psychedelic Psychiatry's Brave New World. *Cell 181*, 24-28.
76. Dunlap, L. E., Azinfar, A., Ly, C., Cameron, L. P., Viswanathan, J., Tombari, R. J., Myers-Turnbull, D., Taylor, J. C., Grodzki, A. C., Lein, P. J., Kokel, D., and Olson, D. E. (2020) Identification of Psychoplastogenic *N,N*-Dimethylaminoisotryptamine (isoDMT) Analogs Throug Structure-Activity Relationship Studies. *J. Med. Chem. 63*, 1142.

From Relaxed Beliefs Under Psychedelics to Revised Beliefs After Psychedelics

From Relaxed Beliefs Under Psychedelics (REBUS) to Revised Beliefs After Psychedelics (REBAS): Preliminary Development of the RElaxed Beliefs Questionnaire (REB-Q)

by

Richard J. Zeifman,[1,2*] Meg J. Spriggs,[1] Hannes Kettner,[1,8] Taylor Lyons,[1,8] Fernando E. Rosas,[1,3,4,5] Pedro A.M. Mediano,[6,7] David Erritzoe,[1] & Robin L. Carhart-Harris[1,8]

Received: 9 November 2022; Accepted: 12 January 2023
Published online: 29 January 2025

Scientific Reports volume 15, Article number: 3651 (2025) doi: 10.1038/s41598-023-28111-3

© The Author(s), 2022

original report: https://www.nature.com/articles/s41598-023-28111-3.pdf
backup source: http://www.psilosophy.info/resources/s41598-023-28111-3.pdf

[1] Centre for Psychedelic Research, Department of Brain Sciences, Faculty of Medicine, Imperial College London, London, UK.
[2] NYU Langone Center for Psychedelic Medicine, NYU Grossman School of Medicine, 1 Park Avenue, Floor 8, New York, NY 10016, USA.
[3] Department of Informatics, University of Sussex, Brighton, UK.
[4] Centre for Complexity Science, Imperial College London, London, UK.
[5] Center for Eudaimonia and Human Flourishing, University of Oxford, Oxford, UK.
[6] Department of Computing, Imperial College London, London, UK.
[7] Department of Psychology, University of Cambridge, Cambridge, UK.
[8] Psychedelics Division, Neuroscape, University of California, San Francisco, USA.
*email: richard.zeifman@nyulangone.org

Table of Contents:

Abstract
Introduction
Results
  Self and other (negative/positive) belief confidence
  Changes in negative-self belief confidence and neural entropy
Discussion
  From belief relaxation to belief revision
  Belief relaxation, belief revision, and the unitive experience
  Belief relaxation, belief revision, and increases in well-being
  Belief relaxation, belief revision, and neural entropy
  Limitations and future directions
Conclusion
Methods
  Overview
  Participants
  Procedures
  Measures
    Belief confidence
    Acute experiences
    Well-being
    Entropy of neural signals
  Data availability
References

Abstract

The Relaxed Beliefs Under pSychedelics (REBUS) model proposes that serotonergic psychedelics decrease the precision weighting of neurobiologically-encoded beliefs. We conducted a preliminary examination of two psychological assumptions of REBUS: (a) psychedelics foster acute relaxation and post-acute revision of confidence in mental-health-relevant beliefs; which (b) facilitate positive therapeutic outcomes and are associated with the entropy of EEG signals. Healthy individuals (N= 11) were administered 1 mg and 25 mg psilocybin 4-weeks apart. Confidence ratings for personally held beliefs were obtained before, during, and 4-weeks post-psilocybin. Acute entropy and subjective experiences were measured, as was well-being (before and 4-weeks post-psilocybin). Confidence in negative self-beliefs decreased following 25 mg psilocybin. Entropy and subjective effects under 25 mg psilocybin correlated with decreases in negative self-belief confidence (acutely and at 4-weeks). Particularly strong evidence was seen for a relationship between decreases in negative self-belief confidence and increases in well-being. We report the first empirical evidence that the relaxation and revision of negative self-belief confidence mediates psilocybin's positive psychological outcomes, and provide tentative evidence for a neuronal mechanism, namely, increased neuronal entropy. Replication within larger and clinical samples is necessary. We also introduce a new measure for examining the robustness of these preliminary findings and the utility of the REBUS model.

Introduction

Psychedelic therapy is receiving increasing attention for its putative transdiagnostic action across mental health outcomes[1], including decreasing anxiety, depression, and suicidal ideation within clinical populations (e.g.,[2-12]), and enhancing well-being among healthy individuals[13-15]. In line with precision psychiatry[16] and process-based psychotherapy[17], identifying the mechanisms through which psychedelic therapy leads to positive therapeutic change may help to tailor, deliver, and maximise its therapeutic efficacy (see[18]).

The RElaxed Beliefs Under pSychedelics (REBUS) model[19,20] provides a unified theoretical account of the effects of psychedelics and the mechanisms through which they lead to positive therapeutic outcomes. Building on the Bayesian hierarchical predictive processing view of brain function[21], REBUS proposes that the "entropic" brain state induced by psychedelics[22,23] corresponds to a relaxation in the precision-weighting of neuronally encoded predictive models. REBUS also proposes that within the transient drug-induced state of enhanced neural and cognitive plasticity, there may be a reduction in the felt confidence associated with maladaptive beliefs and assumptions (that are ordinarily encoded with excessive precision-weighting and confidence; e.g., negative self-perceptions), and increased amenability to therapeutic change.

Neurobiological support for REBUS can be seen in multiple experimental findings, including reduced hierarchical organisation and top-down processing in the brain (e.g.,[24-26]). Perhaps most notably, neuroimaging experiments with psychedelics have revealed a consistent increase in markers of neural entropy[27,28], which predict behavioural reports during the experience29. This growing body of research contrasts with the lack of psychological research on the topic, which has not yet examined the effects of psychedelics on acute belief confidence, and whether this belief relaxation can serve as an opportunity for subsequent revision of these negative (self)beliefs and improved well-being; an important assumption of REBUS.

A key question related to the therapeutic application of psychedelics is how this putative acute relaxation translates into long-term therapeutic change. We refer to the post-acute revision of overweighted beliefs as REvised Beliefs After pSychedelics (REBAS) and propose that this is a fundamental feature of recovery from a broad swathe of mental illness. Within clinical and healthy populations, the administration of psychedelics is associated with decreases in negative attitudes toward the future[6,30-32], which correlate with reductions in depression severity[32] and suicidal ideation[7]. Similarly, the administration of a psychedelic is associated with self-reported increases in positive self-related beliefs (e.g.,[31,33,34]). However, research has not yet examined whether administration of a psychedelic leads to decreases in negative self-beliefs. Furthermore, research has been limited by the use of nomothetic (i.e., general) rather than idiographic (i.e., personally identified) measurement of self-related beliefs (for the benefits of idiographic approaches, see[35]). Accordingly, evidence supporting a relationship between negative belief relaxation and revision and neurobiological markers of REBUS (e.g., increased neural entropy as a corollary of relaxed precision weighting) or subsequent improvements in well-being remain elusive.

REBUS offers an account of much of the phenomenology of the psychedelic experience, including the unitive experience where discriminative beliefs diminish and are replaced by a sense of reciprocal interconnectedness[36]. Research supports a role for subjective unitive experiences in mediating long-term outcomes after psychedelics[37], as well as an association between neurobiological indices of REBUS (such as decreased top-down information fow and hierarchical organization in the brain) and properties of the acute experience - including the unitive experience[24,38,39]. However, research has not yet directly examined psychological indices of belief relaxation under psychedelics (REBUS), and revision after psychedelics (REBAS), nor whether these relate to the intensity of the acute unitive experiences elicited under psychedelics or subsequent enduring psychological changes.

In sum, the REBUS model suggests that psychedelics can potentially improve mental health by *relaxing* and *revising* the confidence associated with overweighted beliefs. However, there is still no evidence as to whether: (a) psychedelics acutely decrease confidence in (i.e. *relax*) negative self-beliefs; and (b) induce lasting decreases in negative self-belief confidence (i.e. *revision*); and (c) this *relaxation* and *revision* of overweighted beliefs are associated with neurobiological markers of REBUS, acute unitive experience, and long-term improvements in mental health. Therefore, in this paper we examined whether:

1. Administration of psilocybin leads to decreases in felt confidence in negative self-beliefs (a) acutely (*belief relaxation*; *REBUS*) and (b) 4-weeks later (*belief revision*; *REBAS*).
2. *Relaxation* (REBUS) and *revision* (REBAS) of confidence associated with negative self-beliefs are associated with: (a) neurobiological markers of REBUS (i.e., entropy), (b) the intensity of the acute unitive experience, and (c) increases in well-being 4-weeks after psilocybin administration.

Results

Self and other (negative/positive) belief confidence

For results of ANOVAs, effect sizes, and Bayes Factors examining changes in confidence related to participants' beliefs, see Table 1. For changes in belief confidence over time, see Fig. 1. A significant effect of time (anecdotal evidence) was observed for negative other-belief confidence following 1 mg psilocybin with significant (anecdotal evidence) acute reductions in confidence. A significant effect of time (moderate evidence) was observed for negative self-belief confidence following 25 mg psilocybin with significant (moderate evidence) reductions in confidence 4-weeks after 25 mg psilocybin. No other significant effects of time were observed across belief categories for 1 mg and 25 mg psilocybin. However, a significant (substantial evidence) increase in positive self-belief confidence was observed 4-weeks after 25 mg psilocybin.

Following the administration of 25 mg psilocybin, the effect size for the relationship between oceanic boundless and acute decreases in negative self-belief confidence was large (r=-0.502; Fig. 2A), but not statistically significant (p=0.116), with an anecdotal BF (BF_{10}=1.374). Interestingly, this association grew over time, exhibiting a large (r=-0.725; Fig. 2B) and significant (p=0.012) effect 4-weeks after the session. Te BF revealed substantial evidence towards the alternative hypothesis (BF_{10}= 4.750). In contrast, the relationship between oceanic boundlessness and decreases in acute negative self-belief confidence was small and non-significant both acutely (r=-0.176, p=0.604) and 4-weeks after 1 mg psilocybin (r=0.048, p=0.889). BFs were anecdotally in support of the null hypothesis (Acute BF_{10}=0.655; 4-week BF_{10}=0.601). See Fig. 2. For correlations between changes in negative self-belief confidence and additional ASC scales, see Supplementary Material.

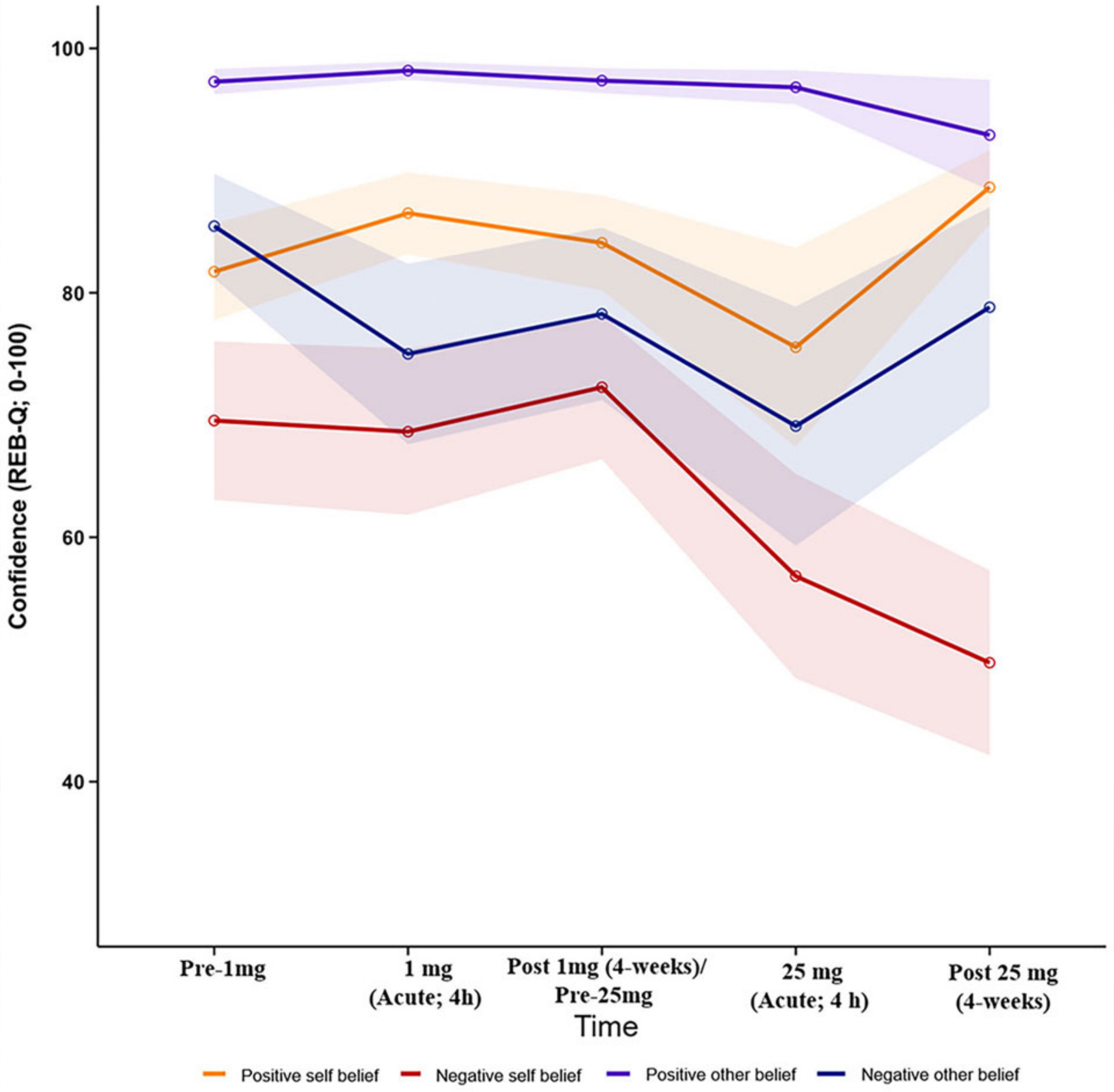


Figure 1. Changes in belief confidence following 1 and 25 mg psilocybin administration. Shaded areas represent standard errors. Acute confidence ratings were collected 4 h after administration of psilocybin.

Following 25 mg psilocybin, results showed a large (r=-0.815) and significant (p=0.002) association between decreases in acute negative self-belief confidence and increases in well-being 4-weeks later (Fig. 2C). Decreases in negative self-belief confidence measured at 4-week follow-up remained strongly associated with increases in well-being (r=-0.870, p<0.001; Fig. 2D). These findings were supported by strong BFs for the association between increases in well-being and decreases in negative self-belief confidence during the acute experience (BF_{10}=11.368) and 4-weeks after the session (BF_{10}=24.808).

For the 1 mg session, there was a small and non-significant association between decreases in acute negative self-belief confidence and decreases in well-being at 4-week follow-up (r=0.178, p=0.601). There was a moderate but non-significant association between increases in well-being and decreases in negative self-belief confidence at 4-week follow-up (r=0.546, p=0.082). The BFs were anecdotally in support of the null hypothesis for the association between changes in well-being and changes in negative self-belief confidence during the acute experience (BF_{10}=0.656) and anecdotally in support of the alternative hypothesis at 4-weeks (BF_{10}=1.645).

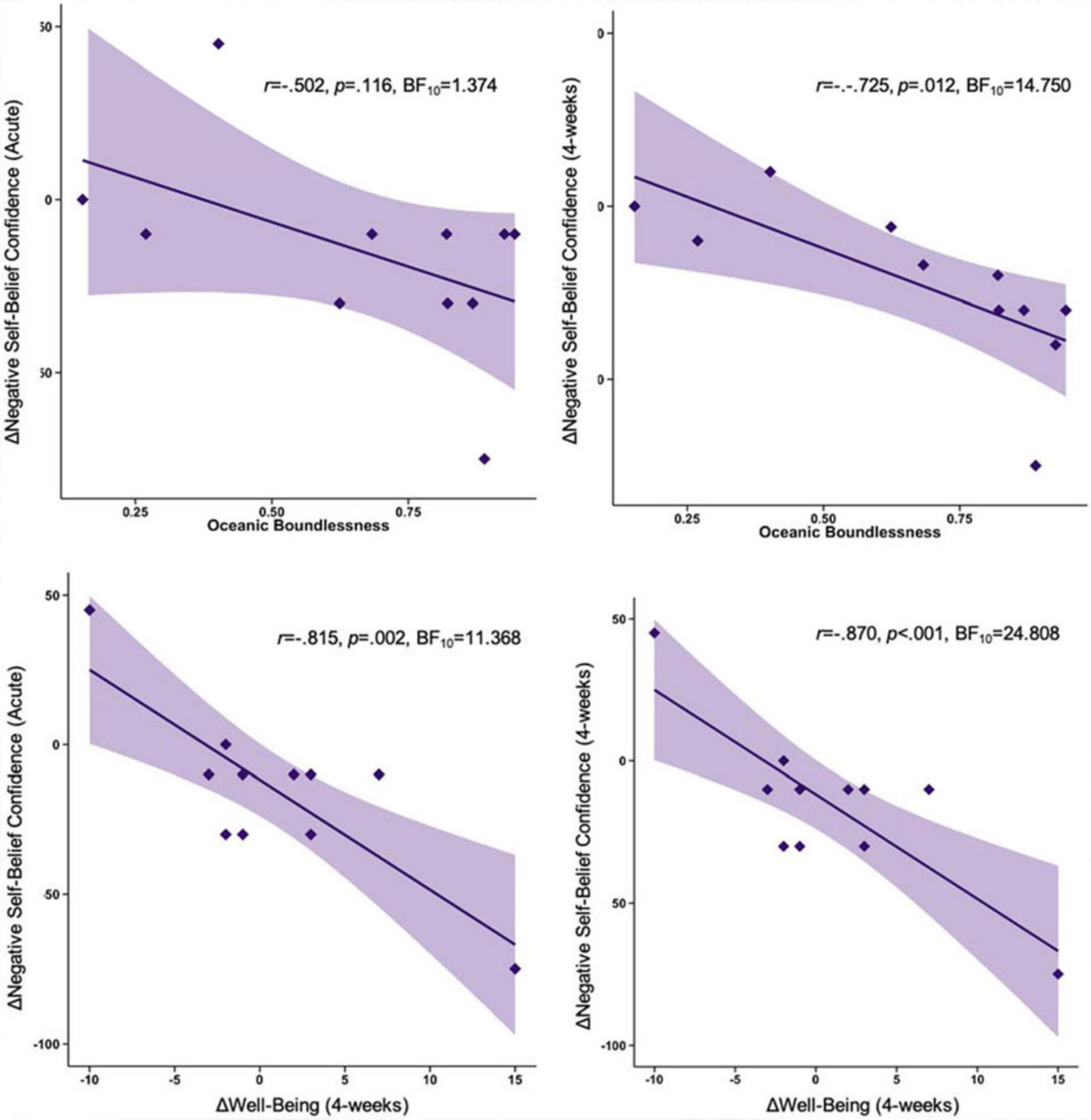


Figure 2. Association between decreases in negative self-belief confidence (acute and 4-week follow-up), acute oceanic boundlessness, and increases in well-being at 4-week follow-up. Shaded areas represent standard errors. ΔNegative Self-Belief Confidence (Acute)=Confidence at 4 h post-25 mg psilocybin - Confidence at pre-25 mg psilocybin. ΔNegative Self-Belief Confidence (4-weeks)=Confidence at 4-weeks post-25 mg psilocybin - confidence at pre-25 mg psilocybin.

Belief type		**1 mg psilocybin**			**25 mg psilocybin Negative self-belief**		
Negative self-belief		F(2, 20)=0.273, *p*=0.678, BF_{10}=0.237$^{\wedge}$			F(2, 20)=5.42, *p*=0.013*, BF_{10}=4.604$^{\wedge}$		
		Baseline	Acute	Post-acute	Baseline	Acute	Post-acute
	Mean	69.55	68.64	72.27	72.27	56.82	**49.73
	SD	21.50	22.59	19.54	19.54	27.77	25.11
	Cohen's d_z	-	0.05	0.17	-	0.54	0.98
	95% CI	-	-12.52 to 14.34	-8.14 to 13.60	-	-3.81 to 34.72	7.14 to 37.95
	BF_{10}	-	0.300$^{\wedge}$	0.3400		0.990	6.861$^{\wedge}$
Positive self-belief		F(2, 20)=0.913, *p*=0.417, BF_{10}=0.356			$^{\#}$F(1.16, 11.59)=3.69, *p*=0.076, BF_{10}=1.778		
		Baseline	Acute	Post-acute	Baseline	Acute	Post-acute
	Mean	81.73	86.52	84.09	84.09	75.55	*88.64
	SD	13.11	11.11	12.91	12.91	27.02	10.08
	Cohen's d_z	-	0.32	0.25	-	0.37	0.83
	95% CI	-	-5.18 to 14.76	-4.03 to 8.75	-	-7.11 to 24.20	0.87 to 8.22
	BF_{10}	-	0.477	0.396		0.667	3.453$^{\wedge}$
Negative other-belief		F(2, 20)=3.93, *p*=0.036*, BF_{10}=1.916			F(2, 20)=1.80, *p*=0.192, BF_{10}=0.597		
		Baseline	Acute	Post-acute	Baseline	Acute	Post-acute
	Mean	85.46	*75.00	78.27	78.27	69.09	78.82
	SD	14.22	24.50	23.41	23.41	32.47	27.17
	Cohen's d_z	-	0.74	0.56	-	0.63	0.03
	95% CI	-	1.01 to 19.90	-1.45 to 15.81	-	-0.65 to 19.02	-10.41 to 11.50
	BF_{10}	-	2.340	1.074		1.410	0.299$^{\wedge}$
Positive other-belief		F(2, 20)=0.89, *p*=0.425, BF_{10}=0.350			$^{+}$F(1.02, 10.24)=1.04, *p*=0.373, BF_{10}=0.417		
		Baseline	Acute	Post-acute	Baseline	Acute	Post-acute
	Mean	97.27	98.18	97.36	97.36	96.82	92.91
	SD	3.44	2.52	3.39	3.39	4.62	14.99
	Cohen's d_z	-	0.30	0.04	-	0.36	0.33
	95% CI	-	-2.93 to 1.12	-1.43 to 1.61	-	-0.47 to 1.56	-4.70 to 13.61
	BF_{10}	-	0.450	0.300$^{\wedge}$		0.533	0.482

Table 1. Changes in belief confidence over time, means, standard deviations, efect sizes, and Bayes factors. *$p<0.05$; **$p<0.01$; $^{\wedge}$strong evidence in support of the alternative (BF>3) or the null (B<0.3); $^{\#}$Huynh-Feldt correction applied due to violation of assumption of sphericity based on Mauchly's Sphericity Test (ε=0.580, $p<0.001$); $^{+}$Huynh-Feldt correction applied due to violation of assumption of sphericity based on Mauchly's Sphericity Test (ε=0.512, $p<0.001$).

Changes in negative-self belief confidence and neural entropy

Large associations were found between decreases in acute negative self-belief confidence and neural entropy at 1 (r=-0.837, p=0.003; Fig. 3A), 2 (r=-0.785, p=0.012; Fig. 3B), and 4.5 (r=-0.603, p=0.0496; Fig. 3C) hours after 25 mg psilocybin. This was supported by substantial BFs for 1 (BF_{10}=9.640) and 2 (BF_{10}=4.067) hours, and an anecdotal BF for 4.5 h (BF_{10}=2.121) after 25 mg psilocybin. Similarly, there were medium to large associations between neural entropy at 1 (r=-0.721, p=0.019; Fig. 3D), 2 (r=-0.652, p=0.005; Fig. 3E), and 4.5 (r=-0.385, p=0.242; Fig. 3F) hours after 25 mg psilocybin and decreases in negative self-belief confidence 4-weeks later (with significance at 1 h after administration but not at 2 and 4.5 h). This was reflected in a substantial BF at 1 h (BF_{10}=3.584), anecdotal/weak BF at 2 (BF_{10}=1.928), and no evidence at 4.5 h (BF_{10}=0.948).

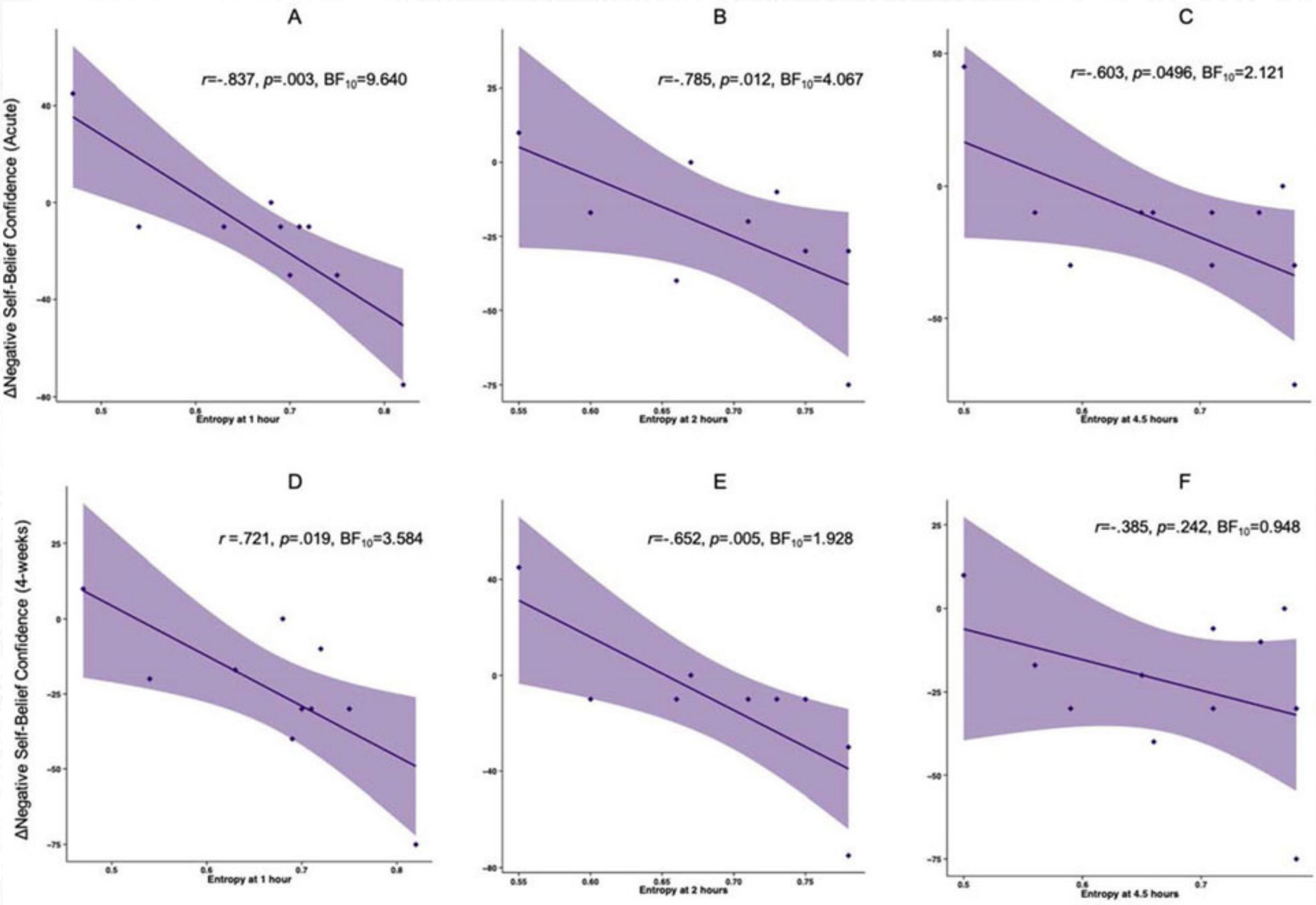


Figure 3. Association between decreases in negative self-belief confidence (acute and 4-week follow-up) and resting-state EEG entropy during the 25 mg psilocybin session. Shaded areas represent standard errors. ΔNegative Self-Belief Confidence (Acute)=Confidence ratings 4 h post-25 mg psilocybin - confidence at pre25 mg psilocybin; ΔNegative Self-Belief Confidence (4-weeks)=Confidence at 4-weeks post-25 mg psilocybin - confidence at pre-25 mg psilocybin. (**A,D**) *n*=10; (**B,E**) *n*=9; (Figs. 3C and 3F), *n*=11.

The associations between decreases in acute negative self-belief confidence and neural entropy after 1 mg psilocybin and were small and not significant for 1 (r=-0.078, p=0.830), 2 (r=0.250, p=0.517), and 4.5 (r=-0.024, p=0.944) hours after the beginning of the session. Evidence was very anecdotal towards the null (1 h BF_{10}=0.622, 2 h BF_{10}=0.735, 4.5 h BF_{10}=0.598). Similarly, the associations between acute neural entropy at 1 (r=-0.371, p=0.291), 2 (r=-0.184, p=0.636), and 4.5 (r=-0.338, p=0.310) hours after 1 mg psilocybin and decreases in negative self-belief confidence 4-weeks later were small to medium and not significant. Here, there was no evidence to either support or reject a relationship (1 h BF_{10}=0.873; 2 h BF_{10}=0.683; 4.5 h BF_{10}=0.849).

Discussion

The recently proposed REBUS model[20] provides a unified account of the effects of psychedelics and the mechanism through which they can potentially facilitate therapeutic change. Neuroscientific evidence for the REBUS model is growing, but little research has directly examined the model's psychological counterpart. This is an oversight, as the model hinges on its psychological validity to an equivalent extent (to its neurobiological validity). Here we conducted a preliminary examination of key components of the REBUS model, which suggest that (a) psychedelics allow for an acute *relaxation* and post-acute *revision* in confidence associated with strongly held beliefs, and (b) decreased confidence in maladaptive beliefs is associated with improvements in well-being and neurobiological markers of increased neural entropy

From belief relaxation to belief revision

Four weeks after the administration of 25 mg psilocybin, we found a moderate-substantial and significant decrease in confidence in negative self-beliefs. These results expand on past research showing significant decreases in pessimism (e.g.,[32]) and hopelessness[6] following psilocybin therapy. Further, we found evidence against the 1 mg of psilocybin inducing a change in negative self-belief confidence (i.e., BFs~0.3), particularly in the acute state. Additionally, we observed large and significant increases in positive self-belief confidence 4-weeks after the administration of 25 mg psilocybin, with a moderate BF. This result is consistent with suggestions that relaxed priors at the microscale level may also manifest in subjectively experienced strengthened beliefs[40] and past research indicating that psychedelics increase positive beliefs about the self (e.g.,[31,34]). This study is the first to include pre-post measurement of positive self-beliefs or personally identified positive self-beliefs. While the acute decreases in confidence for both categories of self-belief were not statistically significant, the effect size for negative self-beliefs was moderate. The BFs were fairly equivocal, suggesting that, rather than the data supporting an absence of effect, the current data are not sufficient to accept or reject either hypothesis. It will therefore be important for future studies to explore whether inference can be improved by increasing the sample size.

We observed weak evidence toward acute decreases in negative other-belief confidence, as well as evidence against changes in negative other beliefs 4-weeks after 25 mg psilocybin. We also did not find changes in confidence associated with positive other-beliefs and evidence against a change 4-weeks post 1 mg psilocybin. It is interesting to note that this was the only belief category with no apparent decrease in belief confidence in the acute state. There was little room for increases in belief confidence due to ceiling effects, and the BF indicates that the data are only anecdotally in support of the null hypothesis (i.e., no change). Nevertheless, this is interesting because it suggests that belief relaxation is not global and it is consistent with the tendency for psychedelics to induce a sense of social connectedness[41]. Conversely, these results may be due to these beliefs not having been salient enough for significant changes in confidence to occur, as we did not direct participant's attention toward the individual they had identified a belief about during the psilocybin experience.

Although there were generally decreases in acute certainty following 25 mg psilocybin (except for positive-other beliefs), changes in confidence 4-weeks after 25 mg psilocybin differ between belief categories. While these post-acute changes were generally in an adaptive direction (i.e., decreases in negative belief confidence and increase in positive belief confidence), this does not necessarily demonstrate that psychedelics inherently generate positive belief changes. Nevertheless, sensitisation of the brain to new evidence through the relaxation of high-level priors may sometimes be beneficial in itself (i.e., independent of the valence of the new evidence), especially given that positive (or desirable) evidence is typically overweighted and negative (or undesirable) evidence is typically underweighted in healthy individuals[42]. It is also likely that the administration of psilocybin in a comfortable and emotionally supportive environment contributed to the positive nature of the confidence change. While specific manipulations of the context (e.g., administering a psychedelic in an adverse or unsupportive environment) may be ethically problematic, measurement of individual's perception of the context (e.g., their relationship with their guides/therapists[43]), grading the extent of environmental support (e.g., from low to very high), and naturalistic research, may aid in understanding the effects of context on belief relaxation and revision[44].

Belief relaxation, belief revision, and the unitive experience

Following the 25 mg, but not the 1 mg psilocybin session, we found a strong relationship between participants' acute unitive experience and decreases in negative self-belief confidence (acutely and 4-weeks later). The unitive experience is a key predictor of psychedelic therapy outcomes[37] and has been framed as a phenomenological "proxy" for the entropic psychedelic state during which belief confidence is relaxed[20,39]. The current results provide further support for this interpretation and suggest that the unitive experiences may be associated with positive therapeutic outcomes *because* they are characterized by an acute relaxation of, and potential revision of, belief structures that maintain psychopathology.

Interestingly, relative to acute reductions in negative self-belief confidence, decreases in confidence were greater 4-weeks after 25 mg psilocybin and more strongly associated with the intensity of participants' unitive experience. This suggests that a yet uncaptured post-acute mediator may be implicated and it will be important for future research to explore the factors that facilitate the successful transition from REBUS to REBAS, such as the process of re-evaluating previously held beliefs or successfully integrating the psychedelic experience.

Belief relaxation, belief revision, and increases in well-being

We found a large and significant association between decreases in negative self-belief confidence (acute *and* at 4-weeks) and increases in well-being 4-weeks after the administration of 25 mg psilocybin. This is the first study to provide evidence for the association between psilocybin-modulated acute decreases in negative self-belief confidence and long-term improvements in well-being. The findings are in line with research indicating that decreased pessimism is associated reductions in depression severity[32] and provide further support for the role of the relaxation (REBUS) *and* revision (REBAS) of beliefs as putative mechanisms underlying the positive therapeutic effects associated with psychedelics.

Although our sample was comprised of healthy individuals, these finding suggest that psilocybin therapy may be especially promising for the treatment of psychiatric disorders characterized by especially rigid and infexible negative self-beliefs, such as depression[45] and anorexia (see[46,47]). Moreover, integrating psychedelic therapy within therapies that challenge and increase distance from such beliefs (e.g., cognitive behavioural therapies) may help to enhance the efficacy of psychedelic therapy (see[48-53]). Relatedly, identifying and examining confidence associated with salient maladaptive beliefs within the context of psychedelic therapy may help to more effectively target such maladaptive beliefs.

Belief relaxation, belief revision, and neural entropy

Previous research has suggested that the entropy-enhancing capability of psychedelics may be important for the decreases in subjective confidence in personally-held beliefs[20]. Bridging the neurobiological underpinnings of the REBUS model with its psychological implications, we found medium-large associations between neural entropy and reductions in negative self-belief confidence during 25 mg psilocybin and 4-weeks later. Neural entropy at 1, 2, and 4.5 h post-25 mg psilocybin was significantly associated with acute decreases in negative self-belief confidence. Additionally, neural entropy at 1 and 2 h post-25 mg psilocybin was significantly associated with reductions in negative self-belief confidence 4-weeks later. Nonetheless, due to the small sample size, we are more inclined to draw inferences from the BFs, rather than frequentist p-values, to (cautiously) qualify that these results provide very preliminary evidence in support of the REBUS model. These results are the first to find evidence for an association between the effects of psychedelics on neural entropy and both acute and sustained decreases in negative self-belief confidence.

Limitations and future directions

The present findings should be interpreted in line with their limitations; First, and most pertinent of which being the relatively small sample of 'healthy' volunteers who are less likely to have pathologically overweighted confidence in maladaptive negative self-beliefs than clinical samples[45.] Small samples are prone to overestimating effect sizes and poorer reproducibility[54]. Furthermore, due to the small sample size and exploratory nature of the present study, the present analyses were not corrected for multiple comparisons. Accordingly, confirmation of these results and their extrapolation to clinical contexts and psychiatric disorders characterized by negative self-beliefs (e.g., anorexia) must await replication in studies with both larger sample sizes and clinical samples. Such research will be necessary to increase the specificity of the REBUS model and to identify the specific types of maladaptive beliefs that psychedelics can reliably relax and revise, as well as for whom such changes may be beneficial or harmful (e.g., it is possible that destabilization of positive and/or negative self-related beliefs may be iatrogenic or require increased psychotherapeutic treatment[55]). Of note, even within a healthy sample, we observed a decrease in negative self-belief confidence that was associated with improved well-being, which speaks to the prophylactic potential of psychedelics. Second, the present findings may be limited by difficulties surrounding blinding due to psilocybin's acute psychoactive efects[56]. We attempted to control for possible expectancy effects by only including psychedelic naive individuals and a very low dose (1 mg) psilocybin session. Nonetheless, it will be worthwhile for future research to measure the strength of participant blinding (e.g., see[57,58]). Additionally, using other acutely psychoactive pharmacological agents as controls and designs with additional variable doses of psilocybin will add specificity to the relationship between dosing and changes in belief confidence (including belief relaxation [REBUS], strengthening, and revision [REBAS][20,40]). Identification of a "sufficient" dose will be important for therapeutic implementation. While the present results are generally consistent with the REBUS model, they may also be accounted for by alternative neural models of psychedelics' mechanism of action, such as the Altered Beliefs Under pSychedelics [ALBUS] model[40]; also see[59]. Finally, there is likely to be a psychological process (e.g., re-evaluation or refection of one's beliefs) that facilitates the transition from an experience of REBUS to post-acute REBAS[43] that has not yet been elucidated and will have implications for therapeutic application. In line with this hypothesis, several studies[60-62] have found that changes in well-being are predicted by active engagement in behaviours to integrate one's psychedelic experience (i.e., making meaning and applying insights from the experience in one's life[63]). To help facilitate this process, integration sessions are typically included in psychedelic research63 and their importance is often emphasized by participants[64].

To help future research address some of these questions, we utilised these preliminary results to further develop the Relaxed BEliefs Questionnaire (REB-Q[65]), which provides a structured approach to measuring the psychological assumptions of REBUS. The measure instruct participants to identify their core beliefs and provides an index of confidence change in these self-identified beliefs. The measure can be flexibly adapted for the specific study population, aims, and design. Working versions of the measure and manual are available online (https://doi.org/10.31234/osf.io/r597a), and we encourage feedback from those wanting to use it in their own studies.

Conclusion

In summary, REBUS is a recently proposed model that aims to account for the acute action of psychedelics and their potential to catalyze therapeutic change. In line with the REBUS model, we found that administration of a 25 mg dose of psilocybin was associated with specific decreases in negative self-belief confidence. Following 25 mg psilocybin, we found that decreases in negative self-belief confidence (acutely and 4-weeks after 25 mg psilocybin) were strongly associated with participants' acute unitive experience and increases in well-being 4-weeks later. These results provide preliminary support for the possibility that the therapeutic action of psychedelics may be linked to their relaxation, and subsequent revision of, overweighted beliefs. Additional research, including larger samples and that facilitated by use of the REB-Q, will be necessary to replicate and further elaborate on these findings.

Methods

Overview

This study was conducted as part of a larger trial focused on investigating long-term psychological and brain changes following a single 25 mg dose of psilocybin in healthy psychedelic naïve volunteers. Psilocybin (COMP360) was provided by COMPASS Pathways. The study received a favourable opinion from the NRES London-Surrey Research Ethics Committee and was carried out in accordance with Good Clinical Practice Guidelines. The National Institute for Health Research/Wellcome Trust Imperial Clinical Research Facility (ICRF) provided site-specific approvals, and a Home Office Licence was obtained for the storage and handling of psilocybin.

Participants

Participants were 11 healthy psychedelic-naïve individuals (4 females; age *M*=42 years, *SD*=10.12). For participant demographics, see Table 2. Inclusion criteria were: (a) physically and mentally healthy; (b) between 18 and 85 years old; (c) understanding of the English language; no experience with a psychedelic in the prior 12 months (11 participants had no lifetime experience with a psychedelic). Exclusion criteria included the presence of (a) a current or previously diagnosed psychiatric disorder; (b) current medically significant condition that renders them unsuitable for the study (e.g., diabetes, severe cardiovascular disease); (c) positive pregnancy test at screening or during the study; (d) excessive use of alcohol or other drugs (determined by study physician); and (e) no email access. All participants provided written informed consent.

Procedures

This study used a single-blind, fixed order, within-subjects design. Participants underwent two dosing sessions four weeks apart. The first session involved a 1 mg dose of psilocybin and the second, a 25 mg dose of psilocybin. Previous research has shown that 1 mg can be regarded as sub-perceptual/subthreshold for subjective effects and is regarded as an inactive or negligibly active dose, while 25 mg is the dose of choice in many therapeutic studies[1]. Participants were not informed of the dosing order or the psilocybin dosage for either dosing session. Dosing sessions were conducted in line with study protocols suggested by Johnson *et al.*[66], including preparation prior to, and integration session following, dosing sessions. Psilocybin administration occurred in a comfortable and dimly lit environment, and included a preselected music playlist, eyeshades, and two 'guides' (therapeutic support persons) to provide comfort and reassurance. Throughout dosing days, participants gave hourly ratings of drug intensity from 0 (not at all) to 10 (most intense drug effect imaginable). The end-of-dosing test battery started at least 4 h post-administration and only once participants gave a drug intensity rating of 4/10 or less.

Resting-state electroencephalogram (EEG) was measured with a 24-channel wireless EEG head cap (DSI24 System, Wearable Sensing; 0.317 µV resolution, 300 Hz sampling rate) with 21 active channels. Pz and FPz acted as reference and ground during recording respectively. EEG data were recorded (via Bluetooth using DSIStreamer-v.1.08.41) during the 1 mg and 25 mg psilocybin sessions at the following time points: (a) baseline (prior to the administration of psilocybin), (b) 1-h post-dosing, (c) 2-h post-dosing, and (d) approximately 4.5 h post-dosing and only once participants gave a drug intensity rating of 4/10 or less. During the EEG resting state recordings relevant for this manuscript, participants were instructed to focus on their intentions for their dosing session and to remain still with their eyes closed for four minutes.

Demographic	**Category**	**N(%)**	***M (SD)***
Age			42 (10.12)
Sex	Female	4 (36)	
	Male	7 (64)	
Nationality	United Kingdom	9 (82)	
	Israel	2 (18)	
Ethnicity	White British	8 (64)	
	Mixed other	2 (18)	
	Black African	1 (9)	
Employment	Unemployed	1 (9)	
	Part-time employment	1 (9)	
	Full-time employment	9 (82)	
Education	None	1 (9)	
	College Diploma	5 (45)	
	Associate Degree/Technical Degree	2 (18)	
	Doctorate or professional degree	3 (27)	

Table 2. Participant demographics.

Measures

Belief confidence

Idiographic beliefs and confidence associated with these beliefs were measured using the RElaxed Beliefs Questionnaire (REB-Q) developed for the present study (see Supplement). One day before the 1 mg psilocybin session (1 mg psilocybin baseline), participants were verbally instructed to identify: (a) a negative belief about themselves (negative self-belief); (b) a positive belief about themselves (positive self-belief); (c) a negative belief about a person they disliked (negative other-belief); (d) a positive belief about a person they loved (positive other-belief). In situations where participants found it difficult to identify one of these beliefs, they were guided by one of their guides to do so through examples and self-refection. Participants were also asked to rate the extent to which they were confident that each belief was true on a scale from 0 ("Not at all certain") to 100 ("Absolutely certain") at five time points: (a) 1 mg psilocybin baseline; (b) during the 1 mg psilocybin session/4.5 h after psilocybin administration (acute 1 mg psilocybin); (c) 4-weeks after 1 mg psilocybin/one day before 25 mg psilocybin (25 mg psilocybin baseline); (d) during the 25 mg psilocybin session/4.5 h after psilocybin administration (acute 25 mg psilocybin); and (e) 4-weeks after 25 mg psilocybin.

Acute experiences

Acute experiences were measured using the Altered States of Consciousness questionnaire (ASC)[67]. The oceanic boundlessness scale of the ASC was used as a measure of acute unitive experience and is the ASC scale most closely related to the positive therapeutic outcomes associated with psychedelics[68]. The scale measures the experience of unity, spiritual experience, blissful state, insightfulness, and disembodiment. Items were rated on a digitally-presented visual analogue scale from 0 ("no more than usual") to 100 ("much more than usual"). The ASC was completed following the 1 and 25 mg psilocybin sessions and within 1 h of participants rating their acute belief confidence.

Well-being

Well-being was measured using the Warwick-Edinburgh Mental Well-being Scale (WEMWBS)[69], a 14-item self-report measure of subjective hedonic and eudaimonic well-being over the past two weeks. The scale consists of positively worded items rated on a 5-point scale from 1 ("None of the time") to 5 ("All of the time"). The WEMWBS was completed at (a) 1 mg psilocybin baseline, (b) 4-weeks after 1 mg psilocybin/25 mg psilocybin baseline, and (c) 4-weeks after 25 mg psilocybin.

Entropy of neural signals

EEG data were used to calculate neural entropy during the 1 and 25 mg psilocybin dosing sessions. EEG data were missing from one participant at the 1 h post-administration time point and from two participants at 2 h post-psilocybin administration (both 1 and 25 mg psilocybin). Data were manually cleaned, low-pass flatered at 100 Hz, and subsampled at 200 Hz. The entropy of a signal corresponds to its level of unpredictability or diversity (i.e., how many different "patterns" are present in the signal). There are multiple methods to estimate the entropy of a signal, the most common of which is via a quantity known as Lempel-Ziv complexity (LZc). Here, we estimated entropy using the Context Tree Weighting (CTW) algorithm (based on the method described in[70]), which is known to outperform LZc in terms of bias, variance, and data-efciency[71].

We employed a combination of frequentist and Bayesian Hypothesis Testing for all analyses. To examine changes in confidence related to their identified beliefs during (acute) and 4-weeks after 1 and 25 mg psilocybin (Question #1), we conducted general linear model (GLM) repeated measures ANOVAs. Follow-up pairwise comparisons examined the relationship between the time point (acute and 4-weeks after psilocybin administration) and respective baseline. Effect sizes were calculated using Cohen's d_z for repeated measures. Pearson correlation coefficients were calculated to examine the association between changes in belief confidence and both (a) acute unitive experiences (Question #2b) and (b) changes in well-being (Question #2c). Changes in belief confidence and well-being were calculated by subtracting scores at each time point by their respective baseline (i.e., 1 mg/25 mg psilocybin baseline). Exploratory analyses also examined the strength of the association (Pearson correlation coefficients) between entropy and changes in negative self-belief confidence (Question #2a). The alpha level indicating significance was set at $p<0.05$. All frequentist analyses were conducted using IBM SPSS Statistics (Version 26).

The addition of Bayes Factors (BF) is relevant to the current analysis for two main reasons: (1) BFs represent the strength of the evidence *for or against* the null hypothesis, and (2) the strength of a BF scale with the evidence and can therefore be used with small sample sizes[72]. Bayesian ANOVA and Bayesian correlations were performed with default JZS and Jeffries-Beta priors, respectively. The further a BF is from 1, the stronger the evidence for either the model of interest ($BF_{10} > 1$) or the competing model ($BF_{10} < 1$). Rstudio (https://rstudio.com/) was used for generating figures and Bayesian analysis, using the packages ggplot2[73] and Bayes Factor[74], respectively.

Data availability

The data that support the findings of this study are available from the corresponding author, RJZ, upon reasonable request.

Acknowledgements
We thank the study participants for the contribution to this research study.

Author contributions
R.J.Z., M.J.S., H.K., F.E.R., and P.M. conducted the analyses. R.J.Z., M.J.S., H.K., T.L., and R.C.H. contributed to the design of the study. All authors contributed to the writing and reviewed the manuscript.

Funding
RJZ received funding from the Canadian Institutes of Health Research. PM is supported by the Wellcome Trust (grant no. 202110MFE-472921- HTB-272687).

Competing interests
RJZ is a post-doctoral fellow in the NYU Langone Psychedelic Medicine Research Training program funded by MindMed. DE is a paid advisor for Mydecine, Entheon, SmallPharma Ltd, and Field Trip Healthcare. RCH is a scientifc advisor to Usona Institute, Synthesis Institute, Mydecine, Maya Health, Osmind, Entheon, Beckley Psychtech, TRYP therapeutics, Journey Collab and Journey Space. MJS, HK, TL, FER, and PM report no conficts of interest.

Additional information
Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-023-28111-3.

Correspondence and requests for materials should be addressed to R.J.Z.

References

1. Nutt, D., Erritzoe, D. & Carhart-Harris, R. Psychedelic psychiatry's brave new world. *Cell* **181**, 24-28 (2020).
2. Carhart-Harris, R. L. *et al.* Psilocybin with psychological support for treatment-resistant depression: Six-month follow-up. *Psychopharmacology* **235**, 399-408 (2018).
3. Carhart-Harris, R. *et al.* Trial of psilocybin versus escitalopram for depression. *NEJM* **384**, 1402-1411 (2021).
4. Davis, A. K. *et al.* Effects of psilocybin-assisted therapy on major depressive disorder: A randomized clinical trial. *JAMA Psychiatry* **78**, 481-489 (2021).
5. Griffiths, R. R. *et al.* Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *J. Psychopharmacol.* **30**(12), 1181-1197 (2016).
6. Ross, S. *et al.* Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *J. Psychopharmacol.* **30**, 1165-1180 (2016).
7. Ross, S. *et al.* Acute and sustained reductions in loss of meaning and suicidal ideation following psilocybin-assisted psychotherapy for psychiatric and existential distress in life-threatening cancer. *ACS Pharmacol. Transl. Sci.* **4**, 553-562 (2021).
8. Zeifman, R. J. *et al.* Rapid and sustained decreases in suicidality following a single dose of ayahuasca among individuals with recurrent major depressive disorder: Results from an open-label trial. *Psychopharmacology* **238**(2), 453-459 (2021).

9. Zeifman, R. J. *et al.* Decreases in suicidality following psychedelic therapy: A meta-analysis of individual patient data across clinical trials. *J. Clin. Psychiatry* **83**, 21r14057 (2022).
10. Goodwin, G. M. *et al.* Single-dose psilocybin for a treatment-resistant episode of major depression. *NEJM* **387**(18), 1637-1648 (2022).
11. Raison, C. L. *et al.* Single-dose psilocybin treatment for major depressive disorder: A randomized clinical trial. *JAMA* **330**(9), 843-853 (2023).
12. Petridis, P. D. *et al.* Psilocybin-assisted psychotherapy improves psychiatric symptoms across multiple dimensions in patients with cancer. *Nat. Mental Health* **2**, 1408-1414 (2024).
13. Carhart-Harris, R. L. Implications for psychedelic-assisted psychotherapy: Functional magnetic resonance imaging study with psilocybin. *Br. J. Psychiatry* **200**(3), 238-244 (2012).
14. Haijen, E. C. *et al.* Predicting responses to psychedelics: A prospective study. *Front. Pharmacol.* **9**, 897 (2018).
15. Lyons, T. *et al.* Human brains change after first psilocybin use. *BiorXiv*. https://doi.org/10.1101/2024.10.11.617955 (2024).
16. Collins, F. S. & Varmus, H. A new initiative on precision medicine. *NEJM* **372**, 793-795 (2015).
17. Hofmann, S. G. & Hayes, S. C. The future of intervention science: Process-based therapy. *Clin. Psychol. Sci.* **7**, 37-50 (2019).
18. Kazdin, A. E. Mediators and mechanisms of change in psychotherapy research. *Annu. Rev. Clin. Psychol.* **3**, 1-27 (2007).
19. Carhart-Harris, R. L. How do psychedelics work?. *Curr. Opin. Psychiatry* **32**, 16-21 (2019).
20. Carhart-Harris, R. L. & Friston, K. J. REBUS and the anarchic brain: Toward a unified model of the brain action of psychedelics. *Pharmacol. Rev.* **71**, 316-344 (2019).
21. Friston, K. & Frith, C. A duet for one. *Consciousness Cogn.* **36**, 390-405 (2015).
22. Carhart-Harris, R. L. *et al.* The entropic brain: A theory of conscious states informed by neuroimaging research with psychedelic drugs. *Front. Hum. Neurosci.* **8**, 20 (2014).
23. Carhart-Harris, R. L. The entropic brain-revisited. *Neuropharmacology* **142**, 167-178 (2018).
24. Alamia, A., Timmermann, C., Nutt, D. J., VanRullen, R. & Carhart-Harris, R. L. DMT alters cortical travelling waves. *Elife* **9**, e59784 (2020).
25. Carhart-Harris, R. L. *et al.* Neural correlates of the LSD experience revealed by multimodal neuroimaging. *Proc. Natl. Acad. Sci. U.S.A.* **113**, 4853-4858 (2016).
26. Lord, L. D. *et al.* Dynamical exploration of the repertoire of brain networks at rest is modulated by psilocybin. *Neuroimage* **199**, 127-142 (2019).
27. Schartner, M. M. *et al.* Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. *Sci. Rep.* **7**(1), 1-12 (2017).
28. Timmermann, C. *et al.* Neural correlates of the DMT experience assessed with multivariate EEG. *Sci. Rep.* **9**, 1-13 (2019).
29. Mediano, P. A. *et al.* Effects of external stimulation on psychedelic state neurodynamics. *ACS Chem. Neurosci.* **15**(3) 462-471 (2020).
30. Carhart-Harris, R. L. *et al.* The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol. Med.* **46**, 1379-1390 (2016).
31. Griffiths, R. R. *et al.* Psilocybin-occasioned mystical-type experience in combination with meditation and other spiritual practices produces enduring positive changes in psychological functioning and in trait measures of prosocial attitudes and behaviors. *J. Psychopharmacol.* **32**, 49-69 (2018).
32. Lyons, T. & Carhart-Harris, R. L. More realistic forecasting of future life events after psilocybin for treatment-resistant depression. *Front. Psychol.* **9**, 1721 (2018).
33. Griffiths, R. R. *et al.* Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology* **218**, 649-665 (2011).
34. Mans, K. *et al.* Sustained, multifaceted improvements in mental well-being following psychedelic experiences in a prospective opportunity sample. *Front. Psychiatry* **12**, 1038 (2021).
35. Elliott, R. *et al.* Psychometrics of the Personal Questionnaire: A client-generated outcome measure. *Psychol. Assess.* **28**, 263-278 (2016).
36. Brouwer, A. & Carhart-Harris, R. L. Pivotal mental states. *J. Psychopharmacol.* **35**(4), 319-352 (2021).
37. Romeo, B., Hermand, M., Pétillion, A., Karila, L. & Benyamina, A. Clinical and biological predictors of psychedelic response in the treatment of psychiatric and addictive disorders: A systematic review. *J. Psychciatr. Res.* **137**, 273-282 (2021).
38. Girn, M. *et al.* Serotonergic psychedelic drugs LSD and psilocybin reduce the hierarchical differentiation of unimodal and trans modal cortex. *Neuroimage* **256**, 11920 (2022).
39. Tagliazucchi, E. *et al.* Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr. Biol.* **26**, 1043-1050 (2016).
40. Safron, A. On the varieties of conscious experiences: Altered beliefs under psychedelics (ALBUS). *PsyArXiv* (2020).
41. Carhart-Harris, R. L., Erritzoe, D., Haijen, E., Kaelen, M. & Watts, R. Psychedelics and connectedness. *Psychopharmacology* **235**, 547-550 (2018).
42. Sharot, T. & Garrett, N. Forming beliefs: Why valence matters. *Trends Cogn. Sci.* **20**, 25-33 (2016).
43. Murphy, R. *et al.* Therapeutic alliance and rapport modulate responses to psilocybin assisted therapy for depression. *Front. Pharmacol.* **12**, 788155 (2022).
44. Carhart-Harris, R. L. *et al.* Psychedelics and the essential importance of context. *J. Psychopharmacol.* **32**, 725-731 (2018).
45. Dozois, D. J. & Rnic, K. Core beliefs and self-schematic structure in depression. *Curr. Opin. Psychol.* **4**, 98-103 (2015).
46. Spriggs, M. J., Kettner, H. & Carhart-Harris, R. L. Positive effects of psychedelics on depression and wellbeing scores in individuals reporting an eating disorder. *Eat. Weight. Disord.* **26**, 1265-1270 (2021).
47. Spriggs, M. J. *et al.* Study protocol for "psilocybin as a treatment for anorexia nervosa: A pilot study". *Front. Psychiatry* **12**, 735523 021).
48. Agin-Liebes, G. *et al.* Prospective examination of the therapeutic role of psychological flexibility and cognitive reappraisal in the ceremonial use of ayahuasca. *J. Psychopharmacol.* **36**(3), 295-308 (2022).
49. Sloshower, J. *et al.* Psilocybin-assisted therapy of major depressive disorder using acceptance and commitment therapy as a

therapeutic frame. *J. Contextual Behav. Sci.* **15**, 12-19 (2020).
50. Wolff, M. *et al.* Learning to let go: A cognitive-behavioral model of how psychedelic therapy promotes acceptance. *Front. Psychiatry* **11**, 5 (2020).
51. Watts, R. & Luoma, J. The use of the psychological flexibility model to support psychedelic assisted therapy. *J. Contextual Behav. Sci.* **15**, 92-102 (2020).
52. Zeifman, R. J. *et al.* Post-psychedelic reductions in experiential avoidance are associated with decreases in depression severity and suicidal ideation. *Front. Psychiatry* **11**, 782 (2020).
53. Sloshower, J. *et al.* Psychological flexibility as a mechanism of change in psilocybin-assisted therapy for major depression: results from an exploratory placebo-controlled trial. *Sci. Rep.* **14**(1), 8833 (2024).
54. Button, K. S. *et al.* Power failure: Why small sample size undermines the reliability of neuroscience. *Nat. Rev. Neurosci.* **14**(5), 365-376 (2013).
55. Zeifman, R. J. & Wagner, A. C. Exploring the case for research on incorporating psychedelics within interventions for borderline personality disorder. *J. Contextual Behav. Sci.* **15**, 1-11 (2020).
56. Schatzberg, A. F. Some comments on psychedelic research. *Am. J. Psychiatry* **177**, 368-369 (2020).
57. Szigeti, B. *et al.* The difference between 'placebo group' and 'placebo control': A case study in psychedelic microdosing. *Sci. Rep.* **13**(1), 12107 (2023).
58. Wen, A. *et al.* A systematic review of study design and placebo controls in psychedelic research. *Psychedelic Med.* **2**(1), 15-24 (2024).
59. van Elk, M. & Yaden, D. B. Pharmacological, neural, and psychological mechanisms underlying psychedelics: A critical review. *Neurosci. Biobehav. Rev.* **140**, 104793 (2022).
60. Amada, N., & Shane, J. Self-actualization and the integration of psychedelic experience: The mediating role of perceived benefits to narrative self-functioning. *J. Humanist. Psychol* (2022). Advance online publication.
61. Frymann, T., Whitney, S., Yaden, D. B. & Lipson, J. The Psychedelic Integration Scales: Tools for measuring psychedelic integration behaviors and experiences. *Front. Psychol.* **13**, 863247 (2022).
62. St. Arnaud, K. O. & Sharpe, D. Contextual parameters associated with positive and negative mental health in recreational psychedelic users. *J. Psychoact. Drugs* **55**(1), 30-39 (2023).
63. Richards, W. A. Psychedelic psychotherapy: Insights from 25 years of research. *J. Humanist. Psychol.* **57**(4), 323-337 (2016).
64. Breeksema, J. J., Niemeijer, A. R., Krediet, E., Vermetten, E. & Schoevers, R. A. Psychedelic treatments for psychiatric disorders: A systematic review and thematic synthesis of patient experiences in qualitative studies. *CNS Drugs* **34**(9), 925-946 (2020).
65. Zeifman, R., Spriggs, M. J., Kettner, H. & Carhart-Harris, R. RElaxed Beliefs-Questionnaire (REB-Q) and REB-Q Self-Report (REB-Q-SR): Administration manual. *PsyArXiv* https://doi.org/10.31234/osf.io/r597a (2022).
66. Johnson, M. W., Richards, W. A. & Griffiths, R. R. Human hallucinogen research: Guidelines for safety. *J. Psychopharmacol.* **22**, 603-620 (2008).
67. Dittrich, A. The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. *Pharmacopsychiatry* **31**, 80-84 (1998).
68. Roseman, L., Nutt, D. J. & Carhart-Harris, R. L. Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. *Front. Pharmacol.* **8**, 974 (2018).
69. Tennant, R. *et al.* The Warwick-Edinburgh Mental Well-Being Scale (WEMWBS): Development and UK validation. *Health Qual. Life Outcomes* **5**, 63 (2007).
70. Begleiter, R., El-Yaniv, R. & Yona, G. On prediction using variable order Markov models. *J. Artif. Intell. Res.* **22**, 385-421 (2004).
71. Gao, Y., Kontoyiannis, I. & Bienenstock, E. Estimating the entropy of binary time series: Methodology, some theory and a simulation study. *Entropy* **10**, 71-99 (2008).
72. Keysers, C., Gazzola, V. & Wagenmakers, E. J. Using Bayes factor hypothesis testing in neuroscience to establish evidence of absence. *Nat. Neurosci.* **23**, 788-799 (2020).
73. Wickham, H. *ggplot2: Elegant Graphics for Data Analysis* (Springer, 2009).
74. Morey, R. D., Rouder, J. N. & Jamil, T. BayesFactor: Computation of Bayes factors for common designs. *R Package Version 0.9, 9 (*2015).

Mushrooms Russia and History

by

Valentina Pavlovna Wasson and R. Gordon Wasson

Volume I and II

Manufactured in Italy for the authors and Pantheon Books Inc. 333, Sixth Avenue, New York 14, N. Y.

© 1957 by R. Gordon Wasson

original text: http://www.newalexandria.org/archive/MUSHROOMS%20RUSSIA%20AND%20HISTORY%20Volume%201.pdf
backup source: http://www.psilosophy.info/resources/MUSHROOMS%20RUSSIA%20AND%20HISTORY%20Volume%201.pdf
original text: http://www.newalexandria.org/archive/MUSHROOMS%20RUSSIA%20AND%20HISTORY%20Volume%202.pdf
backup source: http://www.psilosophy.info/resources/MUSHROOMS%20RUSSIA%20AND%20HISTORY%20Volume%202.pdf

Changes to this edition:

1. Cyrillic has been added to the first occurrence of a simplified Russian pronunciation of a word. For example to *grib*, cyrillic is added in parenthesis - (**гриб**).
2. In chapter **I. Mushrooms and the Russians**, where authors mention about folk names for mushrooms, actual Latin name has been found and inserted into square brackets (but beside Appendix II where authors do this by themselves) for most of this names. Thus the name originally presented as *volnushki* will be *volnushki* (**волнушки**) [*Lactarius torminosus*].
3. Footnotes are numbered continuously, contrary to original version where footnote number starts from 1 on each page.
4. Latin names have been italicized.
5. Some latin synonyms are actuallized beneath plates, eg. *Psalliota campestris* Fr. ex L. has in description additionaly [Agaricus campestris (Bull.)].
6. Untranslated French text fragment has been rendered in English.
7. Polish official names for mushrooms have been added beneath plates.
8. Glottal stops in mazatec names for the mushrooms have been changed from ' to ˀ according to newer book of R.G.W "The Wondrous Mushroom".
9. Couple of notes have been added and labeled as *Note to the edition at Psilosophy/edition@psilosophy.*
10. Illustrations have been digitally whitened.
11. List of OCR errors to above source PDF has been added.
(*Undetected ones you may send in comments formulary underneath polish version of this book [see link above], thanks*).
12. Page number references in the text applies to the original edition.

Table of Contents:

List of Plates
List of Illustrations in the Text
Volume I
Preface
I. Mushrooms and the Russians
II. Mushrooms and the English
III. Mushrooms and History
IV. Mushrooms for Murderers
V. The Riddle of the Toadstool and Other Secrets Mushroomic
1. The Venomous Toad
2. Basques and Slovaks
3. The Cripple, the Toad, and the Devil's Bread
4. The 'Pogge' Cluster
5. Puff Balls, Filth, and Vermin
6. The Sponge Cluster
7. Punk, Fire, and Love
8. The Gourd Cluster
9. From 'Panggo' to 'Pupik'
10. Mucus, Mushrooms, and Love
11. The Secrets of the Truffle
12. 'Gripau' and 'Grib'
13. The Flies in the Amanita
Volume II
V. The Riddle of the Toadstool and Other Secrets Mushroomic (continued)
14. Teo-Nanacatl: the Sacred Mushrooms of the Nahua
15. Teo-Nanacatl: the Mushroom Agape
16. The Divine Mushroom: Archeological Clues in the Valley of Mexico
17. 'Gama no Koshikake' and 'Hegba Mboddo'
18. The Anatomy of Mycophobia
19. Mushrooms in Art
20. Unscientific Nomenclature
Vale
Bibliographical Notes and Acknowledgements
Appendix I: Mushrooms in Tolstoy's 'Anna Karenina'
Appendix II: Aksakov's 'Remarks and Observations of a Mushroom Hunter'
Appendix III: Leuba's 'Hymn to the Morel'
Appendix IV: Hallucinogenic Mushrooms: Early Mexican Sources
Index of Fungal Metaphors and Semantic Associations
Index of Mushroom Names
Index of Persons and Places

List of OCR errors

List of Plates

VOLUME I

Title page - Jean-Henri Fabre. *Coprinus nycthemerus* Fr.

PLATE I - Jean-Henri Fabre. *Boletus edulis* Fr. ex Bull. French: *cepe de Bordeaux*;. German: *Steinpilz*;. Italian: *porcine*;. Russian: *belyi grib* (***белый гриб***);. Polish: *Borowik szlachetny*.

PLATE II - Jean-Henri Fabre. *Coprinus comatus* Fr. ex Müll. French: *pisse-chien*;. Polish: *Czernidłak kołpakowaty*.

PLATE III - Jean-Henri Fabre. *Clathrus cancellatus* Lin. ex Tournef [*Clathrus ruber* Mich. ex Pers.];. Polish: *Okratek czerwony*.

PLATE IV - Jean-Henri Fabre. *Collybia fusipes* Fr. ex Bull.;. Polish: *Łysostopek wrzecionowatotrzonowy*.

PLATE V - Thomas Gainsborough. The Mushroom Girl. *Boston (Mass.), Museum of Fine Arts.*

PLATE VI - Jean-Henri Fabre. *Armillariella mellea* (Fr. ex Vahl) Pat. French: *pivoulade*;. Polish: *Opieńka miodowa*.

PLATE VII - Jean-Henri Fabre. *Rhodopaxillus nudus* (Fr. ex Bull.) R. Maire. [*Lepista nuda* (Bull.)]. English: *blewit*;. French: *pied bleu*;. Polish: *Gąsówka fioletowawa*.

PLATE VIII - Jean-Henri Fabre. *Boletus duriusculus* Kalchbr. [*Leccinum duriusculum* (Schulzer ex Kalchbr.) Singer)]. Polish: *Koźlarz topolowy*.

PLATE IX - Jean-Henri Fabre. *Amanita caesarea* Fr. ex Scop. French: *orange*;. Italian: *ovolo*;. Polish: *Muchomor cesarski*.

PLATE X - Jean-Henri Fabre. *Amanita phalloides* Fr. French: *orange cigue verte*;. Polish: *Muchomor zielonawy*.

PLATE XI - Jean-Henri Fabre. Danse Macabre. *Amanita verna* (Bull.) Lam. French: *orange cigue blanch*;. Polish: *Muchomor wiosenny*.

PLATE XII - Hieronymus Bosch. The Last Judgment. Detail: Spitting toad. *Munich, Bayerische Staatsgemäldesammlungen.*

PLATE XIII - Hieronymus Bosch. The Seven Deadly Sins. Detail: Superbia. *Madrid, Prado Museum*.

PLATE XIV - Conversion of Clovis. Tapestry in the Musee de Reims showing King Clovis in the battle of Tolbiac, his instruction in Christian doctrine by St. Remi, and his baptism. Woven in 1531.

PLATE XV - Hieronymus Bosch. The Hay Wain. Central Panel. *Madrid, Prado Museum*.

PLATE XVI - Hieronymus Bosch. The Hay Wain. Detail. *Madrid, Prado Museum*.

PLATE XVII - Hieronymus Bosch. The Hay Wain. Detail: Boletus. *Madrid, Prado Museum*.

PLATE XVIII - Jean-Henri Fabre. *Boletus Satanas* Lenz. Polish: *Borowik szatański*.

PLATE XIX - Jean-Henri Fabre. *Lycoperdon furfuraceum* Pers. ex Schaeff. English: *puffball, puckfist*;. French: *vesse de loup*;. Polish: *Kurzawka zmienna* (*purchawka*).

PLATE XX - Napoleonic caricature. *By courtesy of Frank Altschul, Esq., Overbrook Farm, Stamford, Conn.*

PLATE XXI - Etruscan Mirror. Ixion on his wheel. *London, British Museum*.

PLATE XXII - *Fomes officinalis*. Miniature from a 10th century Byzantine codex of Dioscorides. *By courtesy of The Pierpont Morgan Library, New York*.

PLATE XXIII - Jean-Henri Fabre. *Morchella vulgaris* Pers. English: *morel*;. French: *morille*;. Russian: *smorchok* (**сморчок**);. Polish: *Smardz jadalny*.

PLATE XXIV - Jan Fyt. Still life. *Brussels, Musees Royaux des Beaux-Arts de Belgique*.

PLATE XXV - Jan Davidsz. de Heem. Still life. *London, Wallace Collection*.

PLATE XXVI - Adriaen van Utrecht. Still life. *Brussels, Musees Royaux des Beaux-Arts de Belgique*.

PLATE XXVII - Frontispiece to Franciscus van Sterbeeck's *Theatrum Fungorum*, Antwerp, 1675.

PLATE XXVIII - Giuseppe Arcimboldo. Autumn. *Brescia, Pinacoteca*.

PLATE XXIX - Giuseppe Arcimboldo. Autumn: Detail. *Brescia, Pinacoteca*.

PLATE XXX - Jean-Henri Fabre. *Psalliota campestris* Fr. ex L. [*Agaricus campestris* (Bull.)]. English: *common field mushroom*;. French: *rose*;. Russian: *pecheritza*;. Polish: *Pieczarka łąkowa*.

PLATE XXXI - Jean-Henri Fabre. *Lactarius piperatus* Fr. ex Scop. French (east): *oberon*;. Russian: *gruzd'*;. Polish: *Mleczaj biel*.

PLATE XXXII - Tuber. Miniature from a 10th century Byzantine codex (No. 652) of Dioscorides. *New York, The Pierpont Morgan Library*.

PLATE XXXIII - Toads in Hell. Detail from a painting by the pseudo-Herri met de Bles. *Venice, Ducal Palace*.

PLATE XXXIV - Toad. Detail from a mosaic. *Florence, Battistero*.

PLATE XXXV - Jean-Henri Fabre. *Amanita muscaria* Fr. ex Pers. French: *tue-mouche, crapaudin, fausse*

oronge;. German: *Fliegenschwamm*;. Russian: *mukhomor*;. Polish: *Muchomor czerwony*.

PLATE XXXVI - Hieronymus Bosch. The Hay Wain. Left Panel. *Madrid, Prado Museum*.

PLATE XXXVII - Otto Marseus van Schrieck. Moth with mushrooms. *Bale, Offentliche Kunstsammlung*.

VOLUME II

Title page - Jean-Henri Fabre. *Coprinus tardus* Karst.

PLATE XXXVIII - Jean-Henri Fabre. *Boletus duriusculus* Kalchbr. Polish: *Koźlarz topolowy*.

PLATE XXXIX - Jean-Henri Fabre. *Panaeolus campanulatus* Fr. ex L.

PLATE XL - Ceremonial mushrooms. 1. *Psilocybe mexicana* Heim. 2. *Stropharia cubensis* Earle. 3. *Psilocybe caerulescens* Murr. var. *mazatecorum* Heim (in dried state). Water-color by Michelle Bory.

PLATE XLI - Accessories to the mushroom rite. *Pisiete, candil*, kernels of maize, *amate*, *guacamaya* feathers, cacao beans, tapers, eggs (chicken and turkey), and sacred mushrooms. Water-color by VPW.

PLATE XLII - Aurelio Carreras, curandero, and his son Mauro. Huautla de Jiménez, July 5, 1955.

PLATE XLIII - Mushroom stone. Attributed to early classic period, Highland Maya, c. 300 A.D. to c. 600 A.D. About 30 cm. high. *Zurich, Rietberg Museum*.

PLATE XLIV - Mushroom stone. *New York, Collection of Hans Namuth, Esq*.

PLATE XLV - Cayetano's House, Huautla de Jiménez. June 1955.

PLATE XLVI - María Sabina and her daughter Polonia, *curanderas*. Huautla de Jiménez, June 29, 1955.

PLATE XLVII - María Sabina, *curandera*, passing mushrooms over incense (copal); also her daughter Polonia and Cayetano's mother. Huautla de Jiménez, June 29-30, 1955.

PLATE XLVIII - Adoration of the mushroom. María Sabina, *curandera*, and her daughter Polonia. Huautla de Jiménez, June 29-30, 1955.

PLATE XLIX - Emilio Garcia taking *Teo-nanacatl* or 'God's Flesh'. Huautla de Jiménez, June 29, 1955.

PLATE L - María Sabina, *curandera*, and her son Aurelio under the influence of mushrooms. Huautla de Jiménez, June 29, 1955.

PLATE LI - Aristeo Matias with bowl of divine mushrooms. San Agustin Loxicha, July 22, 1955.

PLATE LII - Chinese sage contemplating *Ling-chih*, the Divine Mushroom. Painted by Chen Hung-shou (1599-1652), probably late in life in early years of Ching dynasty. This artist was an eminent figure - and landscape-painter, known as an individualist. 'Lao-lien' and 'Chang-hou' were his fancy names. 'Hua yu' means 'painted in', and 'Chu-ko' means 'Bamboo Pavilion', doubtless a studio that he frequented. Reproduced by courtesy of Wango Weng, Esq.

PLATE LIII - Teopancalco fresco. Teotihuacán, in the Valley of Mexico. From Teotihuacán III period, A.D. 300-600.

PLATE LIV - Detail of Tlaloc effigy. Tepantitla Fresco. (See text, page 324, and Fig. 24, page 327.). *Reproduced by Marilyn Weber*.

PLATE LV - Tepantitla Fresco. Detail: Soul arriving on the playing fields of Paradise. *Reproduced by Marilyn Weber*.

PLATE LVI - Illuminated initial from a 15th century manuscript (No. 165) of *Le Livre pour la Sante du Corps*, by Aldobrandino da Siena, 1256. *New York, The Pierpont Morgan Library*.

PLATE LVII-A - Mushrooms. Miniature from a 9th century codex (Grec 2179) of Dioscorides. *Paris, Bibliotheque Nationale*.

PLATE LVII-B - Mushrooms. Miniature from a 11th century manuscript (Arabe 4947) of Dioscorides. *Paris, Bibliotheque Nationale*.

PLATE LVIII - Mushrooms. Miniature from a 10th century manuscript (No. 652) of Dioscorides. *New York, The Pierpont Morgan Library*.

PLATE LIX - Pieter Brueghel the Elder. The Misanthrope. *Naples, Museo Nazionale*.

PLATE LX - Pieter Brueghel the Elder. The Misanthrope. Detail. *Naples, Museo Nazionale*.

PLATE LXI - Juan Bautista Mayno. The Adoration of the Magi, c. 1610. *Madrid, Prado Museum*.

PLATE LXII - Juan Bautista Mayno. The Adoration of the Magi, c. 1610. Detail. *Madrid, Prado Museum*.

PLATE LXIII - Herri met de Bles ('Civetta'). Christ bearing the Cross. *Vienna, Gemaldegalerie der Akademie der bildenden Künste*.

PLATE LXIV - Herri met de Bles ('Civetta'). Christ bearing the Cross. Detail. *Vienna, Gemaldegalerie der Akademie der bildenden Künste*.

PLATE LXV - Otto Marseus van Schrieck. Poppy with mushrooms. *New York, Metropolitan Museum of Art*.

PLATE LXVI - Otto Marseus van Schrieck. Mushrooms. *Brunswick, Herzog Anton Ulrich Museum*.

PLATE LXVII - Otto Marseus van Schrieck. Mushrooms. Detail. *Brunswick, Herzog Anton Ulrich Museum*.

PLATE LXVIII - Paolo Porpora, d. 1673. Still life. *Naples, Banco di Napoli*.

PLATE LXIX - Abraham Begeyn. Still life. *Rome, Galleria d'Arte Antica*.

PLATE LXX - Frans Hamilton. Still life. *Munich, Bayerische Staatsgemäldesammlungen*.

PLATE LXXI - Rachel Ruysch. Still life. *Oxford, Ashmokan Museum*.

PLATE LXXII - F. W. Tamm. Still life. *Private collection*.

PLATE LXXIII - Melchior de Hondecoeter. Still life. *Amsterdam, Rijksmuseum*.

PLATE LXXIV - Melchior de Hondecoeter. Still life. *London, National Gallery*.

PLATE LXXV - School of Zurbaran, 17th-18th century. Chestnuts, cheese, grapes, almonds, and mushrooms, sp. *Tricholoma personatum*. *Chicago Art Institute*.

PLATE LXXVI - Mushrooms. From a fresco found at Herculaneum, probably executed about A.D. 50. *By courtesy of the Museo Nazionale, Naples*.

PLATE LXXVII - The dream. Woodcut after J.J. Grandville. From the *Magasin Pittoresque*, 1847.

PLATE LXXVIII - Jean-Henri Fabre. *Lactarius deliciosus* Fr. ex Lin. French: *sanguin*;. Russian: *ryzhik*;. Polish: *Mleczaj rydz*.

PLATE LXXVIX - Jean-Henri Fabre. *Lactarius sanguifluus* Fr. ex Paul. French: *vineux*;. Catalan: *rovelu*;. Polish: *Mleczaj czerwieniejący*.

PLATE LXXX - Jean-Henri Fabre. *Cantharellus cibarius* Fr. French: *chanterelle, girole*;. Russian: *lisichka*;. Polish: *Pieprznik jadalny*.

PLATE LXXXI - Jean-Henri Fabre. *Boletus scaber* Fr. ex Bull. (= *B. leucophseus* Pers.);. Russian: **берёзовик** (*berjozovik*);. Polish: *Koźlarz babka*.

PLATE LXXXII - Jean-Henri Fabre. *Coprinus atramentarius* Fr. ex Bull.;. French: *pisse-chien*;. Russian: *opjonok*;. Polish: *Czernidłak pospolity*.

Jean-Henri Fabre. *Coprinus radiatus* Fr. ex Bolt.

All the colored reproductions of water-colors by Jean-Henri Fabre and Plates, XX, XL, XLI, LXXVI, were made by Daniel Jacomet, Paris. The other plates were printed by Fratelli Alinari, Florence.

List of Illustrations in the Text

VOLUME I

Fig. 1 - Earliest reference to Russian fungi in English. Page from Russian-English word-list of Richard James, 1619, citing five kinds of mushrooms without English equivalents:. *ryzhik* (**рыжик**), *guba* (**губа**), *gruzd* (**груздь**), *volonitsa* (**волоница**), *grib* (**гриб**). Bodleian, ms. James 43.

Fig. 2 - From *Theatrum chemicum Britannicum*, by Elias Ashmole, London, 1652.

Fig. 3 - Robin Goodfellow

Fig. 4 - Prince visiting fairy folk, *after* Olaus Magnus.

Fig. 5 - Fairy ring, *after* Olaus Magnus.

Fig. 6 - Description of *Fomes officinalis*. Last reported use in English of *swamm* (misspelled *swamp*) in the sense of mushroom, referring to fungal growth on larch.

Fig. 7 - 15th century woodcut of the Agaricum. from *Hortus Sanitatis*, Mainz, 1491

Fig. 8 - Map showing distribution of fungal designation in Europe and Asia.

Fig. 9 - Roman Tom Fool.

Fig. 10 - From *Hortus Sanitatis*, Mainz, 1491.

Fig. 11 - The Horned God. Prehistoric painting of a man disguised as animal. Caverne des Trois Freres, Montesquieu-Avantes, Ariege, France.

VOLUME II

Fig. 12 - Map of Central America.

Fig. 13 - The Mushroom cult in 16th and 17th centuries. Linguistic areas where contemporary reports establish use of divinatory mushrooms. As modern evidence indicates that the cult prevails only in uplands, all contours below, say, 600 meters should probably be excluded. Conversely, upland areas such as Mazatec and Chatino as to which early evidence is lacking undoubtedly used the mushroom. Northern limits are quite definitely fixed, but eastern limits in Chiapas are uncertain.

Fig. 14 - Teo-nanácatl - as represented by a 16th century Spanish artist. From Florentine Codex of Bernardino de Sahagun' *Historia de las Cosas de la Nueva España*, Biblioteca Laurenziana, Florence.

Fig. 15 - Teo-nanácatl - as represented by a 16th century Mexican artist. From Magliabechiano Codex, Biblioteca Nazionale, Florence.
Fig. 16 - Map of the Province of Oaxaca, with the Wasson journeys.
Fig. A
Fig. B
Fig. C
Fig. D
Fig. E
Fig. F
Fig. G
Fig. H
Fig. 17
Fig. 18 - Mayan 'Toadstool' - Represents a toad with anthropomorphic face; tentatively identified thus by Dr. Stephan F. Borhegyi because of the crouch and the four-digited front feet. Ht. 35 cm. Probably late pre-classic (500 B.C. - 200 A.D.). Cerro Alux, near Mixco, Guatemala. Museo Nacional 2209.
Fig. 19 - Mushroom stones - A. Represents a jaguar, traces of red paint still visible. Kaminaljuyú, Mound E-111-3, tomb I. Ht. 37 cm. Miraflores phase, 1000-500 B.C. Museo Nacional, Guatemala, 3450. B. Ocosingo, Chiapas, Mexico. Now in regional museum of Tuxtla Gutiérrez. Probably late pre-classic (1000 B.C. - 200 A.D.) or early classic (200-500 A.D.). C. Represents a pisote (*Nasua narica*) in characteristic pose with forefeet over nose. Salcaja, near Quetzaltenango. Ht. 25.5 cm. Late pre-classic or early classic (Vitalino Robles collection). D. Formerly in Museo Nacional, Guatemala. Probably late pre-classic.
Fig. 20 - Indian drinking from a Spanish Goblet. As represented by a 16th century Spanish artist; from Florentine Codex of Bernardino de Sahagun's *Historia de las Cosas de la Nueva España*. Biblioteca Laurenziana, Florence.
Fig. 21
Fig. 22
Fig. 23 - Teopancalco fresco - Detail, reduced to half of original size.
Fig. 24 - The Tepantitla fresco.
Fig. 25 - Two Tlaloc effigies.
Fig. 26 - Illustration from Matthiolus' Commentaries on Dioscorides, Paris 1578.
Fig. 27 - Earliest description of *Tricholoma gambosum* - by Carolus Clusius, in *Rariorum Plantarum Historia*, Antwerp, 1601.

Figures 14, 15 and 20 were reproduced in color by Fratelli Alinari, Florence.

Volume I

Preface

This book is addressed to those who love mushrooms, who love the whole rich world of wild mushrooms in the same way that many love the flowers of the field and the birds of the air. Our public is certainly one of the smallest in the English-speaking world, but no matter. We invite all to share our joys, and if few respond, we are not less happy for being few to savor the secret.

There is no shortage of writings about wild mushrooms. But in English and all other languages save French the thousands of pamphlets, books, and journals on this subject seem to fall naturally into one or the other of two clusters. Around one pole are gathered the manuals that teach beginners how to tell the species apart, and around the other are the treatises written by mycologists solely for other mycologists to read. Ours is one of the few books about mushrooms written for connoisseurs by amateurs. It is the first treatment in any language of the role played by mushrooms in the daily lives of the varied European peoples.

Strange disparities mark the attitude of these peoples toward mushrooms. There is a deep repugnance for 'toadstools' among the folk that dwell around the shores of the North Sea. The persistence of this repugnance bears witness, if witness were needed, to the extraordinary toughness of an emotional heritage coming down from remotest times. The 'mycophobia' of the North Sea peoples remains unshaken in the face of continuous exhortations, stretching over the past hundred years, from well-informed men of science. We suggest to the anthropologists that they will do well to include always in their cultural valuations the question whether a given people is 'mycophile' or 'mycophobe', and if 'mycophagous', what species they eat and love. Here is a subtle criterion for comparative observations all the more valuable because pitched on a lowly level, where man's superior faculties and conscious preoccupations seldom warp the ancient grain of impulses passed on to children in their early years.

Our essays began as a mere footnote on the gentle art of mushroom-knowing as practiced by the northern Slavs - a footnote in a larger work that was to have dealt with the Russians and their food. The footnote grew, and rose in status to a place in the body of the text, and then mushroomed into a whole chapter, and finally one chapter by fission made five. The manuscript has burst all its seams through successive revisions. If occasionally we wander from our theme, we hope the reader will be indulgent, bearing in mind that what we have written has been for our own pleasure in the spare hours of a busy life. And besides, to play a variation on a familiar French saying, je reviens toujours a mes *mousserons*; which is to say, we always hark back to our mushrooms. In a time of troubles and darkness, we wish this book to be a garland offered in tribute to those warm, rich qualities of the Russian people that wicked tyrants strive in vain to crush and extirpate.

The reader who girds his loins and stays our course to the end will perceive a progress in the range and depth of information as he proceeds from chapter to chapter. This is because he is following in the authors' footsteps. The chapters have been composed over a number of years, roughly in the order in which they appear; and because they break new ground in subject and treatment, it has seemed best to let them stand as they were written, for the reader to share in the sense of adventure that the authors experienced in navigating along uncharted coasts of cultural history, never knowing what fresh discovery lay just ahead.

Our subject takes us into history and folklore, into mythology and philology. The interloper treads these thickly-mined areas at his peril. We accept the risk, armed only with the caution that accompanies a full awareness of danger. We have tried to take counsel with the best authorities, and to shade our statements to conform to the evidence. We are more aware than our readers will be of the many areas of our subject that we have failed to explore. We wish we might without presumption draw an analogy between our book and those paintings of Watteau's where only a few patches of the canvas are illumined against the broad expanse of an undefined and shadowy background.

It is altogether fitting for an author to set forth his indebtedness to others, and we should do so fully here, were not the list so long and weighty that it would be unseemly and misleading on our part to associate such names with our efforts. The extent to which we have leaned on persons more knowledgeable than we will be apparent to all who know us. The patience of the learned fraternity with our questions has amazed us. Doctors and lawyers and engineers ask fees for their professional advice. But it seems that men of learning, like men of God, stand above these others, bestowing their counsel and blessings freely on all who turn unto them. In the bibliography and notes we have tried to pay our debts in full, and also to meet the needs of the more curious reader.

Without my husband's enthusiasm and help this book would never have come to term, and I insist on making clear that he is personally responsible for the recondite lore concerning toads, vanished words, poisons, and many other matters in chapters IV and V. The first-person pronouns in our text shift occasionally, and in chapters IV and V regularly, from the singular to the plural: there is method in this, for the plural pronouns usually evidence my husband's contributions to our joint undertaking.

We gladly make special mention also of our debt to Roman Jakobson, the Samuel H. Cross Professor of Slavic studies at Harvard University, who combines in equal degree vast erudition in things Slavic, exquisite standards of scholarship, and the infectious enthusiasm of the inspired teacher. Desiring to determine what the Basque language might have to contribute to our theme, we solicited the counsel of Professor Rene Lafon, holder of the Basque chair at the University of Bordeaux. Generously he lent us his collaboration in what he considered a novel area for research, and in a series of communications, admirable for their blend of imaginative insight and scholarly discipline, he undertook to explore with us, for the first time in Basque scholarship, the rich and tantalizing Basque mushroom vocabulary. Some of the fruits of that epistolary interchange will be revealed in the ensuing pages, but it is to be hoped that Professor Lafon himself will find time to incorporate the full results of our joint endeavors in a monograph that he alone is qualified to compose. We are specially beholden also to Robert Graves, novelist, scholar, and poet, who supplied to us, among other brilliant suggestions, the missing link that we had been seeking in order to round out our own conjecture concerning the death of the Emperor Claudius, and to render that conjecture not merely suggestive but (we make bold to hope) persuasive. We believe that by re-reading the age-worn texts in the light of present-day knowledge, we can state with some assurance exactly what lethal agents were used when, at the behest of the Empress Agrippina, Locusta undertook to dispose of Agrippina's august spouse. We are under obligations to many libraries for their cooperation, but most of all to The New York Public Library, equally rich in its treasures and in its always courteous and efficient personnel-a unique institution, which the community on whom it depends fails to esteem at its priceless worth.

We reserve the last paragraphs of this preface for our illustrations. The whole world knows that Jean-Henri Fabre was a close observer of insects, a distinguished writer, and a person of rare spiritual quality. Only a few know that he devoted many hours of his life, in the decade that followed 1885, to painting mushrooms in water-color. His accurate observation was matched by his artistic sensibility. Today hundreds of these pictures lie on the shelf of his study at Sérignan in the Provence, as fresh in color as the day he painted them, on excellent stock, assembled neatly in the folders where he laid them. He painted all his mushrooms in their natural size, save one that was too big for his paper and that he never succeeded in identifying. During his lifetime he sought a publisher for them, but when he failed to obtain the assurance that the colors would be truly rendered, he chose to leave them, on the shelf. He wrote little about mushrooms, but in *The Life of the Fly* he said they were his botanical joys from his earliest youth, and he went on to predict sadly that the pile of hundreds of sheets of his paintings would eventually be shifted from cupboard to cupboard and from attic to attic, to become dirtied and stained and for rats to gnaw, until finally they would fall into the hands of some little grandnephew, to be cut into paper caps.

The home of Fabre is now the property of the State, and comes under the jurisdiction of the Museum National d'Histoire Naturelle, Paris. To that institution we turned, and through the intercession of the Director of the Laboratoire de Cryptogamie, Professor Roger Heim, Membre de l'Institut, the Assemblee des Professeurs of the Museum graciously granted to us the privilege that we sought.

In May 1950 my husband undertook a pilgrimage to remote Sérignan to see the Fabre water-colors, and he picked out more than a dozen for our book. Two years later, finding himself again in Paris, he called once more on Professor Heim, who by now had become the Director of the Museum National, a worthy successor in that great post to the illustrious Buffon. Indeed, he sits at Buffon's very table, in Buffon's very room, where the elegant 18th century furnishings have remained unchanged, the walls adorned with the graceful 18th century oils of Jean-Jacques Bachelier, depicting the birds of the several continents. The Museum National d'Histoire

Naturelle is one of the fine expressions of French cultural achievement, wherein advanced research and teaching in the natural sciences are always suffused with a deep understanding of the humanities. In Professor Heim the Museum National has once again found a chief who combines in the highest measure those rare qualities of mind and heart that have long distinguished the faculty of that extraordinary institution.

Professor Heim proposed to my husband a second visit to Sérignan, and this time he himself could go too. Thus it came about that in July 1952 I joined them, and together we set out for the Midi, driving by easy stages so as to enjoy the lovely and storied landscapes through which we passed, and the food and wines as well. (Alas, around mid-July there is a dead-spell in the procession of mushroom growths, and we found none on the menus of the hostelries where we stopped.) Finally we arrived in the village of Sérignan.

When Fabre had acquired his *harmas*, as any miserable patch of arid land such as his was called in his native Provençal tongue, it was a waste, but with the passing years the bushes and trees that he planted have grown to their full height, beneath their foliage his fountain plays quietly in the basin, and what was long ago the parched *harmas* has grown into one of the most enticing, shaded recesses of the warm and caressing countryside of Provence. Fittingly, the property is in the custody of Henri Fabre's son Paul, and to this day it is called *l'Harmas*, though this is become a misnomer.

In Sérignan, with Professor Heim's help, we selected ten additional watercolors. Henri Fabre had not of course our needs in mind, and so it happens that in his whole wonderful collection we found no examples of two species of mushrooms about which we speak at length, the *Boletus aereus* and the *Tricholoma georgii* or *gambosum*. By way of compensation we reproduce a number of water-colors that are unrelated to our text, solely for their beauty. Professor Heim has been our guide in the scientific designations that we apply to the species pictured by Fabre.

At our request the Museum National handed over the water-colors that we had chosen to the atelier of Daniel Jacomet in Paris, for reproduction in their original size by the pochoir process. We should like to think that Henri Fabre, could he see the results, would be well pleased.

Valentina P. Wasson
New York, October 1953

I

Mushrooms and the Russians

> Mushrooms... the poor man's food, the rich man's dainties.
> SAMUEL COLLINS, *erstwhile physician to the Tsar, in 1671*.

I cannot recall the time when our mother first began to send us out into the woods and fields to gather mushrooms for the family table. In the summer of 1909, when I was almost eight and my sister was nearly seven, we were spending our summer holidays at a village called Majorenhof, near Riga on the Baltic Sea. We were surrounded by pine groves, the ground carpeted with needles and with blueberry and bilberry bushes. What a delight it was for Tanya and me to ramble through the clean, fragrant woods, filling our baskets with those aristocrats of the mushroom world, the noble *belye griby* (**белые грибы**) [*Boletus edulis*].

We were already proficient mushroom gatherers then, and we must have begun our apprenticeship long before. Our mother, Xenia Dimitrievna, was even more solicitous about her brood than most mothers, yet it never occurred to her to poison our young minds with warnings about 'toadstools'. All Russians know the mushrooms, not by dint of study as the mycologists do, but as part of our ancient heritage, imbibed with our mother's milk. A Russian nursery rime, tenderly humorous, tells of the mother who sends out her toddler to look for the *borovik* (**боровик**). Each time he returns with the wrong kind, perhaps a good kind, perhaps bad, but never the *borovik*. Each time she repeats her previous instructions, adding however an additional line of descriptive advice. In the end, off goes Mother herself, impatiently, and there, almost on her doorstep, she discovers a family of the ones she seeks.

We Russians love the whole mushroom world, and what a world it is! Almost endless in variety, every species expressing its individuality by its size and shape and stance, in the beauty of its evanescent colors, in the delicate perfection of its gills or pores or skin that are a joy to touch, and usually too in its scent and taste. The evil kinds, how they flaunt their wicked grace, like the harlots that they are! But we are fond even of them, in a way. Where is death more plainly writ than in the greenish pallor of the elegant *Amanita phalloides*, the 'destroying angel'? Where is to be found a better portrait of the Scarlet Woman than in Europe's *Amanita muscaria*, the 'fly amanita'? (As ofttimes happens with scarlet women, worse things by far are said of this dazzling wanton of the mushroom family than she deserves.) Mushrooms there are, such as the *Clathrus cancellatus*, so strange of line and hue that he who for the first time sees them is struck incredulous: can such things really be?

This love of Russians for the earthy tribe of mushrooms is, I suggest, a distinctive trait of the Slavs and a significant one. In the face of an ever mounting flood of printed matter and talk about Russia, that land remains for the Englishspeaking world as deep an enigma as ever. If among those who seek the key to the enigma there be some with an understanding heart and a poet's insight, let them lay aside for a while most of what is written and uttered, and consider the lesson in Russian history and Russian ways that the mushroom has to teach. Here is evidence of our visceral attachment to the bounteous soil that is our Mother Russia. In America, the hospitable land of my adoption, we sing hymns to our rocks and rills, to our wooded hills, but many, I think, sing with their voices and not with their hearts, for our rills we pollute and in our great paper mills we are speedily converting those wondrous forests into the stuff of which comics are made.

In France and Italy the peasants know many of the mushrooms and possess a rich vocabulary for them. The Germanic peoples are less informed than the French, and there is evidence that what they know is of modern acquisition. But when the traveler reaches the lands of the northern Slavic peoples and the Lithuanians, the folk knowledge concerning mushrooms broadens and deepens until it reaches astonishing proportions. The Russians find it as natural to know the mushrooms and to avoid the deadly kinds as do most Americans to distinguish poison ivy from other creepers. Take our family for instance. We were Muscovites. My parents belonged to the Russian intelligentsia, and were city bred. We children spent most of our childhood in the immense cities of Moscow and St. Petersburg, and only our vacations in the country. Yet to no one in all Muscovy could it have seemed strange that Tanya and I, and all our little playmates, made ourselves useful, when in the country, by gathering various kinds of mushrooms and bringing them home in childish rivalry and glee to the kitchen. When we were naughty, our mother would punish us by forbidding us to go mushrooming.

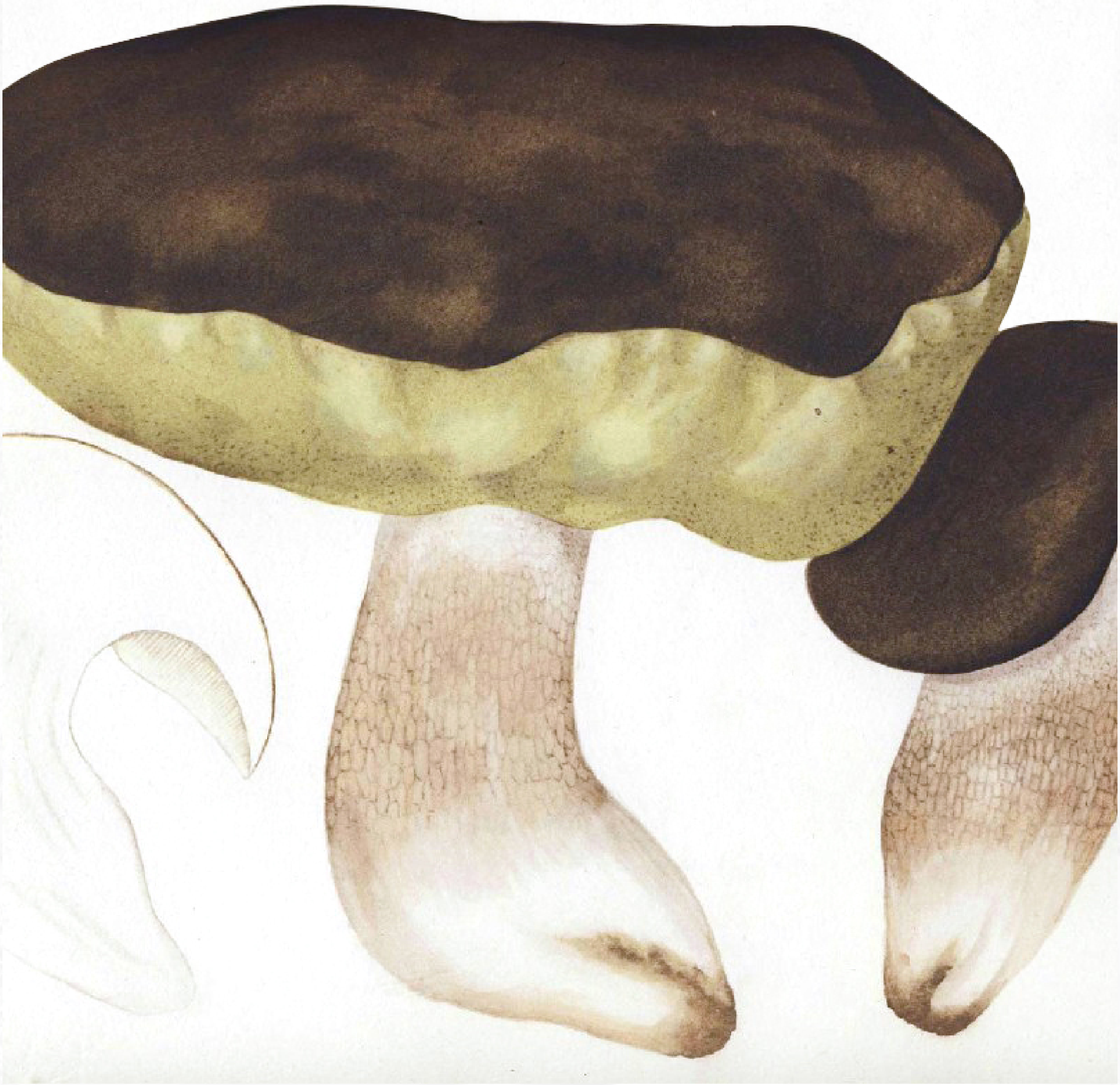


PLATE I
Jean-Henri Fabre
Boletus edulis Fr. ex Bull.
French: *cepe de Bordeaux;*
German: *Steinpilz;*
Italian: *porcine;*
Russian: *belyi grib* (**белый гриб**);
Polish: *Borowik szlachetny.*

The Catskill Mountains in August are filled with mushrooms, exquisitely beautiful. (We Russians are always finding mushrooms wherever we go, even where our American friends tell us there are none.) In 1927 I had just married my American husband, and we were spending our first holiday in the lodge of Adam Dingwall, a friend, near Big Indian. With what astonishment my husband saw me, on our first walk, dart with ecstasy to this fungus and that, and on bended knee strike what seemed to him poses of adoration! With what horror he strove, unsuccessfully, to keep me from bringing home and eating a mess of fragrant *lisichki* (**лисички**)! He behaved, as we both at once perceived, like the hen that has hatched ducklings and sees them swim away.

An absorbing work, perhaps rich in historical significance, needs to be written on the role of the mushrooms in the life of the peoples of Europe. There are already many scientific treatises on mycology, as the study of the fungi is called, but none on the cultural implications of the mushroom world in the history of our European ancestors. For every region there should be determined which mushrooms are familiar to the people of the locality, and what names they use, and how they prepare them for food, and the folklore attaching to them. Our theme is elemental, reaching back into the folkways of pre-history, and such a mushroomic map of Europe might well confirm folk-ties hitherto merely suspected, and disclose others. If only one could travel today throughout the Slavic lands in the mushroom months, traveling close to the moist Mother Earth, gathering mushrooms with the peasants, identifying them by their local names, eating them according to local recipes, assembling the folklore about them, and trying to catch their delicate beauty of line and color with paint and brush! When I was a child, anyone with the inclination and leisure could have indulged in this idyllic pursuit to his heart's content.

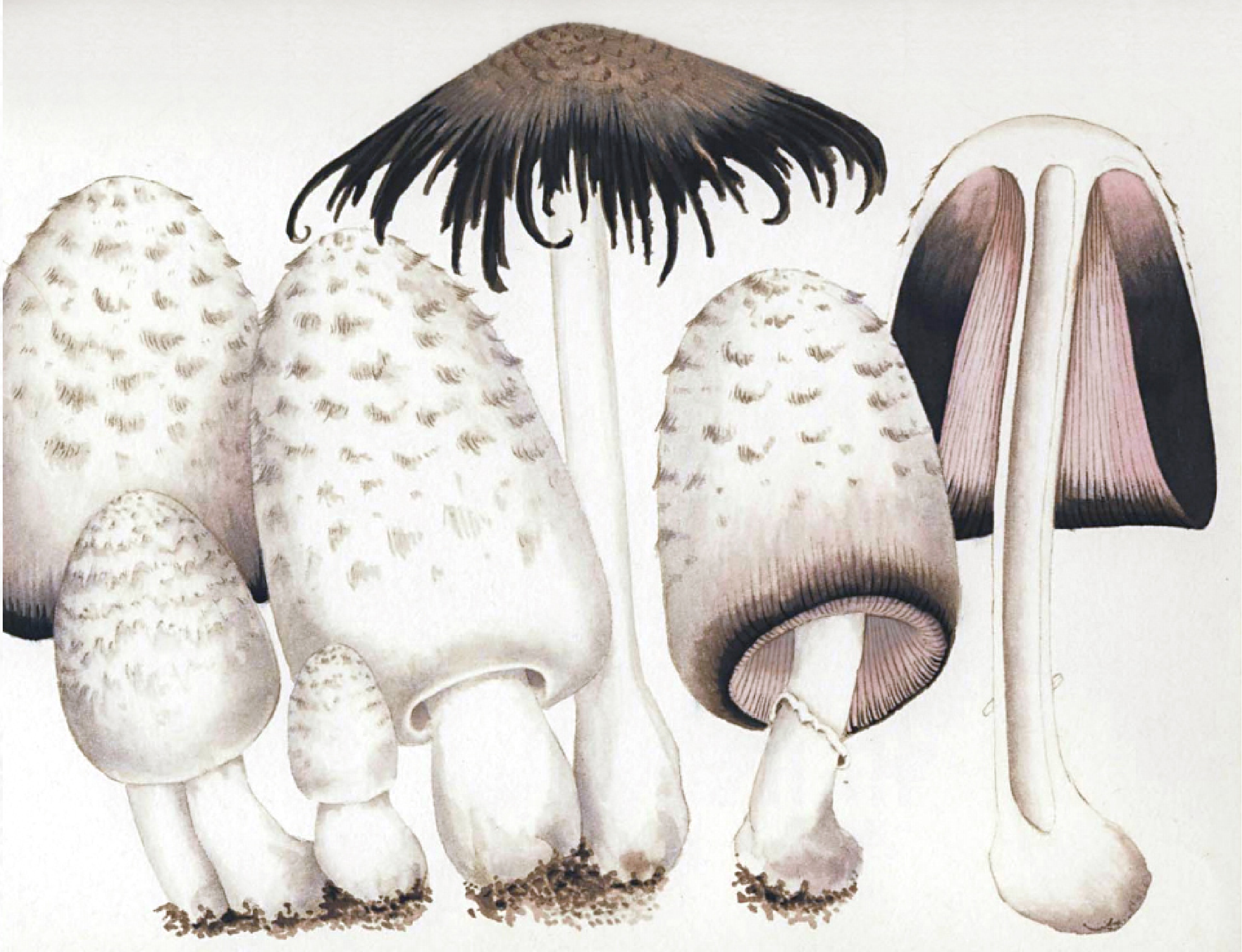


PLATE II
Jean-Henri Fabre
Coprinus comatus Fr. ex Müll.
French: *pisse-chien*;
Polish: *Czernidłak kołpakowaty*.

To what a world of wonder and delight the fungal vocabulary of Russia transports us! Every mushroom, good or bad, comes under the general name of *grib* (**гриб**). When the farm-boy of the American prairies returns home after a hard day hungry for his 'grub', he is using in all likelihood a word with the same origin as the Russian peasant child who gathers his *griby* (**грибы**) in the woods. Both words go back to a prehistoric root of the Indo-Germanic tribes that expressed the scratching and stirring and rooting and grubbing of the soil which gave to primitive man his vegetable food. Our archeologists piece together meanings deduced from the rubbed and worn artifacts of peoples who died long before the spoken word could be committed to posterity by writing. But the very words that those peoples spoke also come down to us. Likewise rubbed and worn, their sounds and meanings slowly changing on the tongues of numberless generations, yet still identifiable. In the linguistic cousinship of 'grub' and the Russian *grib* we see one example, out of an infinite number, of the common cultural heritage that unites at the deepest levels the Slavs and the West, kindred stock of one great Indo-European family.

Of the poisonous mushrooms, only one species in the Russian language bears a common name - the *mukhomor* (**мухомор**) or fly-killer, the *Amanita muscaria* of science. In America this knave wears a yellow cap necked with warts, but throughout Europe its color is a splendid red, and only one blind to nature's warnings could be seduced by its meretricious allurements. All merely tasteless or insignificant mushrooms we dismiss with affectionate contempt under the term *poganki* (**поганки**), the 'unworthy ones' or, as some interpret the word, 'little pagans'.

On the lowest level of culinary value we lump together a miscellaneous lot of gilled mushrooms by the name *syroezhki* (**сыроежки**). They can be eaten raw, as the name says, though seldom are they so eaten. To this humble group rightly belongs the common field mushroom, a poor thing owing its undeserved renown to a weakness in its character that makes it unique - it alone in the mushroom world of Europe and America stoops to man's will by lending itself to commercial cultivation in a big way.[1] Among Great Russians, this people preeminent in 'mycophagy' or mushroom-eating, the field mushroom enjoys little standing, not even possessing today a commonly used native name, being called *champignon* after the French. When gathered fresh in breeze-swept pastures, it still possesses traces of distinction, but through mass production on shelves in darkened cellars under controlled and uniform conditions the market product has long since lost such virtue as its wild ancestors once had, until today it is truly the slattern of the mushroom world, a sickly simulacrum of what mushrooms should be. (Actually, the cultivated mushroom and the field mushroom belong to different though closely related species. The beginnings of commercial cultivation offer a minor mystery. The French discovered the secret around Paris, whence the name *champignons* de Paris, but the exact time is unknown. There is a reference to them in *Le jardinier françois*, a book by N. de Bonnefons published in 1651. It seems likely that the art had sprung up in the previous half century. When Francis Bacon assembled his data for his *Sylva Sylvarum*, published in 1626, this well informed Englishman had never heard of cultivated mushrooms, for he wrote that a strange property of mushrooms is 'that they come up so hastily, as in a night, and yet they are unsowne'. It is clear also that John Parkinson when he wrote his *Theatrum Botanicnm*, published in 1640, was similarly unaware of the procedures for inducing field mushrooms to grow.)

Of the distinguished mushrooms, the first to appear in the spring of the year are the *smorchki* (**сморчки**), or morels. They are not uncommon in America too, but in the New World they are gathered and relished almost solely by transplanted sons of Europe. This is especially remarkable since no one could mistake so distinctive a mushroom, standing erect as it does with its honey-combed topknot exposing its windows to the breezes.

Through summer and fall the variety of succulent mushrooms that Russians gather is considerable. In ascending order of excellence, we begin with the *opjonki* (**опёньки**), the mushrooms that nourish on dead tree stumps. These are of various kinds, but the classical *opjonok* (**опёнок**), or *opjonka* (**опёнка**), is the common ink-cap, a delicate and lovely mushroom, the perfect expression in color and texture and line of transitory grace. For the span of a few hours these beautiful creatures, their highly convex bonnets supported on spindly legs, toss jauntily in the air, and then, by the action of their own enzymes, they curl up and dissolve into inky fluid. Large numbers often grow in a single colony, each day bringing forth a new generation. They must be cooked the instant they are gathered. More substantial is a second kind of *opjonka*, the *Armillariella mellea* of the mycologists. Large and fleshy, they lend themselves to drying.They too grow in family clusters, but less populous than the ink-caps; in Italy the peasants by happy inspiration call them, with an affectionate diminutive, the Holy Family - *famigliola buona*.

The mushrooms with a moist and sticky surface, which the English-born person is quick to scorn as "slimy', the Russians by a reverse semantic twist praise as the 'buttery ones'- the 'fat-of-the-earth', as Samuel Collins, erstwhile physician to the Tsar, put it in his book, *The Present State of Russia*, published in 1671. These are the *masljonki* (**маслонки**) and *masljaniki* (**масляники**) of the Russian kitchen, from the word *maslo*, meaning butter. Perhaps somewhat higher in the scale of merit are the *lisichki* and the *ryzhiki* (**рыжики**) - the 'little foxes' and the 'rusty ones'. The former are the chanterelles of the West. Few are the sights that nature offers more gladdening to the eye of man than a colony of chanterelles on the shaded floor of an evergreen forest, their brilliant yellow cups spattering a carpet of dry, dun-colored needles. True, they dance not, but for Russians they laugh like dancing daffodils. With fluted stems, they look like yellow parasols, blown inside out. Good as they are to eat, their beauty in their native setting transcends their taste. With Russians the chanterelle holds a more humble place in the hierarchy of mushroom values than among some of the Western peoples who know their mushrooms less well. The folk of Norway and Sweden - countries that abound in mushroom life - think of the chanterelle as the one edible mushroom of the forests, which goes to prove that an abundance of mushrooms does not suffice to bring about familiarity with them. The chanterelle is common in America. It is pungent and unpalatable until cooked.

---

[1] We are aware that the Italians in certain localities raise the clitocybe catinus and the polyporus tuberaster, but only on a modest scale. In Japan, however, the cultivation of the excellent shiitake is as important as the champignon industry in the West.

For the table, in my opinion, the chanterelle must yield pride of place to the *ryzhik* (**рыжик**) - identified by the lexicons with the *Lactarius deliciosus* but in fact embracing several of the edible lactarii - a fleshy mushroom whose funnelshaped cap is handsomely marked by concentric rings of red. We Russians love our *ryzhiki*. This is the famous mushroom that we gather in immense quantities and eat with affection and gusto. We prepare it in many ways, but chiefly we like it salted and pickled. By tradition the various Finnish peoples are not mycophagous, but the peoples of Finland and Estonia have learned from the Russians in modern times to harvest the *ryzhiki* of the forests and add them to the family menu. *Ryzhik*, as we have said, means the 'rusty one', a name derived from the color of the cap. At the other end of Europe the Catalans in their language have hit on the identical figure of speech: thus the *rovello* of Barcelona is our *ryzhik* - the word means the same thing, and the mushroom is almost the same. The Catalan prizes this mushroom highest of all: he honors it above the *cepe de Bordeaux*. He puts his mess of *rovellons* into a frying pan of very hot oil, and on top of the mushrooms he adds tomatoes and garlic and parsley and sausage made from pork, and after cooking the whole for ten minutes or less over a slow fire, he sits down to a dish that he considers fit for the gods. In Spanish the name of this classic mushroom is the *mizcalo*, apparently a pre-Latin word, indigenous in Iberia, its verbal kinships lost in antiquity. The very antiquity of this word bears witness to the hold that the mushroom has on the people of Castile. The peasants in the noble Sierra de Credos, to the west of Madrid, know the *mizcalo* well: they harvest it regularly and sell the crop to gentlemen who come out from Madrid to buy it for re-sale elsewhere in Spain and abroad.

As I said before, the lexicons tell us that the *ryzhik* is the mushroom known to science as the lactarius deliciosus. I shall let this identification pass for the present, merely remarking that a strange confusion bedevils the terminology here, a confusion that must be laid at the door of a naturalist who blundered. Later I shall try to untangle the error.

The *gruzdi* (**грузди**) [*Lactarius resimus*] are another famous mushroom tribe in northern Russia. This is the name properly belonging to the large, white, fleshy *Lactarius piperatus*, but apparently some Russians also use it for other lactarii and even some russulae. The word itself is peculiar to the Russian language (including White Russian and Ukrainian), being unknown elsewhere in the Slavic world. It is an honored name in our mushroom vocabulary, though rather for its role in folklore and proverbs, where the *gruzd*' (**груздь**) is the captain of the mushroom host,[2] than as a table delicacy.

With the *ryzhik* and the *gruzd*' we leave behind the whole tribe of gilled mushrooms and ascend the scale of values to the best varieties of the numerous genera of boleti. These are the mushrooms that, instead of radial gins on the underside of the cap, display sponge-like pores. Two of them that are esteemed by all Russians are the *berjozovik* (or *podberjozovik*) [**берёзовик** (or **подберёзовик**)] and the *podosinovik* (**подосиновик**), and concerning them there is a singular fact to be disclosed.

In recent times the mycologists of the West have discovered that an intimate tie of mutual help links certain mushrooms to certain kinds of trees, each of such mushroom species being thus related to one or more kinds of trees. These mushrooms may assume a slightly different appearance according to the kind of tree the individual specimen lives with. For this relationship to be understood, one must keep in mind that the mushrooms we see in woods and fields are merely the fruit thrown to the surface when all conditions are right: the life of these elementary organisms goes on chiefly underground; indeed, in the case of truffles, entirely so.

---

[2] There is the famous proverb: *Nazvahja gruzdjom, polezaj v kuzov*; which is to say, "If you call yourself a *gruzd*', into the basket you go!"; in other words, "If you give yourself airs, take the consequences."

Just as the therapeutic potency of certain moulds has been discovered only in this century, so the importance of mushrooms in life's great round begins now to be discerned. We know that the rootlets of many trees are often locked in symbiotic embrace with the subterranean 'mycelium' of the mushroom, and for this intimacy the mycologists have invented their special word - 'mycorrhiza', from the Greek words for fungus and root.

The painstaking observations of mycologists have proved that between the birch tree and the *Boletus scaber* there is such a relationship, and similarly between the aspen and the European *Boletus rufus*. Now it is an arresting fact, of which mycologists in the West are usually unaware, that the folk names in Russian for these very species of mushrooms are keyed to those same trees: the *berjozovik* lives with the *berjoza* (**берёза**), or birch tree; and the *podosinovik* grows under the *osina* (**осина**), or aspen. The *berjozovik* is the *Boletus scaber*, and the *podosinovik* is the *Boletus rufus*. The scientists now confirm what the peasants of Eastern Europe have sensed from time immemorial. The *berjozovik*, incidentally, is abundant in America, but in my opinion the true *podosinovik* does not occur here, and those that are gathered and eaten as such by Russians in the United States belong to other species somewhat resembling the red-capped aspen-mushroom of Europe. There is also in Russia a rare blue-capped *podosinovik*, whose scientific name I do not know: it would be interesting to identify it, to see whether the mycologists have yet confirmed its link with the aspen tree.

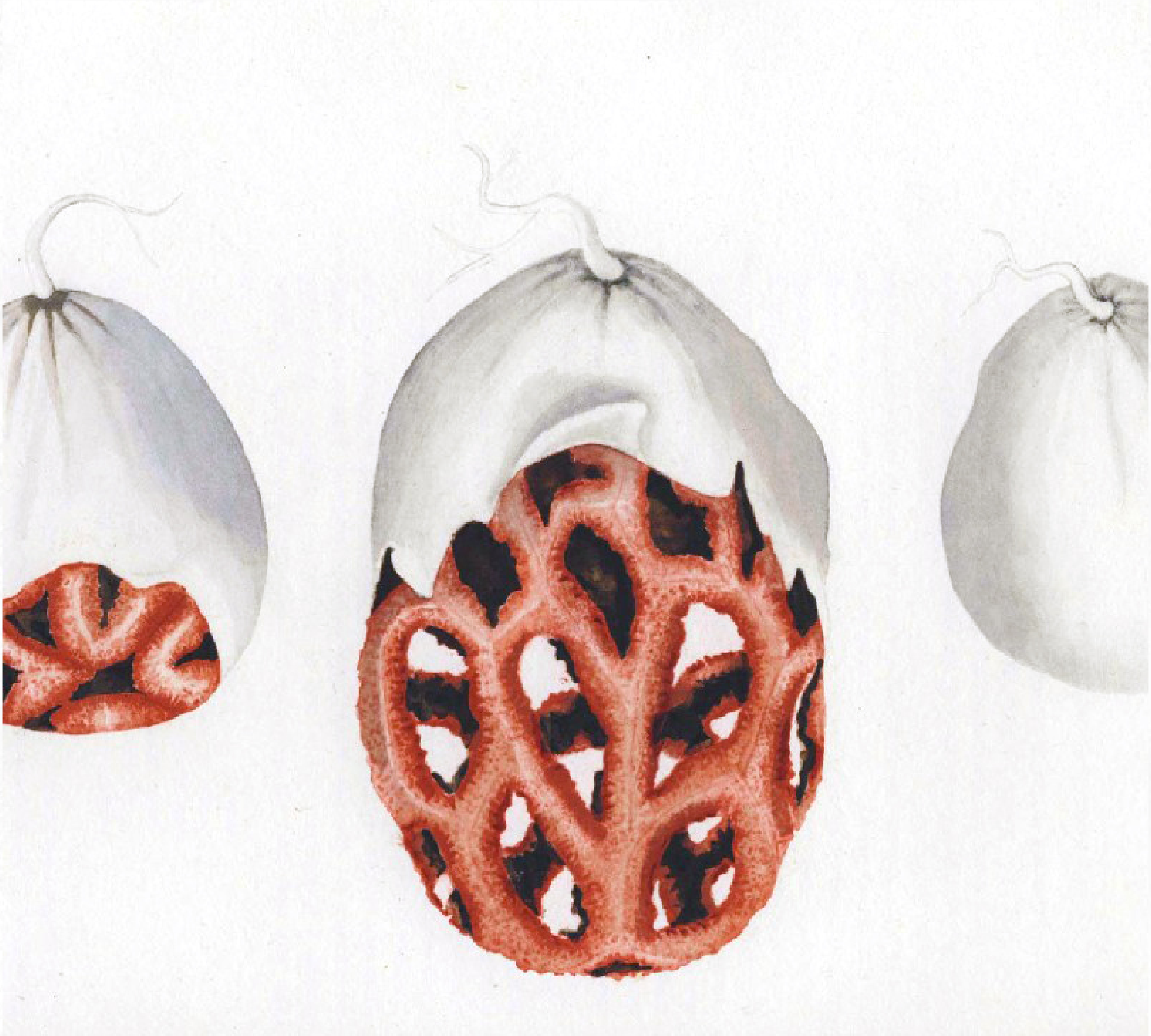


PLATE III
Jean-Henri Fabre
Clathrus cancellatus Lin. ex Tournef [*Clathrus ruber* Mich. ex Pers.];
Polish: *Okratek czerwony.*

Ranking above all the mushrooms so far mentioned come those aristocrats of the mushroom world, the *belye griby* or 'white mushrooms', known to the French as the *cepes de Bordeaux* and to the mycologist as the *Boletus edulis*. These are the most famous of common mushrooms, the delight of epicures, the 'cep' of English gourmets. The Russians call them 'white', not primarily because their flesh is white, but because in the Russian language 'white' connotes excellence.

And right here we come upon another of the strange parallels in fungal imagery that recur between peoples geographically and culturally remote from one another. We have seen that both the Russians and Catalans speak of certain lactarii as the 'rusty ones'. Now we observe that the Basques of Guipuzcoa, Upper Navarre, and the Labourd refer to the dun-colored cep as the 'white mushroom', just as the Russians do, the Basque term being *ondo zuri*. We have said that 'white' connotes excellence, but perhaps this is an understatement. There is an abundance of evidence that the primitive peoples of the Eurasian land mass, no matter how different culturally, were prone to associate whiteness and brightness with divinity, with the 'White Goddess' (as Robert Graves calls this creature), who possessed myriad shapes and names. Is it possible that in the 'white mushroom' of the Russians and Basques we discover a survival of a primitive divine kinship?

Truly senatorial in girth and mass, the splendid white mushroom or cep is supreme in fragrance and taste. It lends itself to pickling and drying, so that it keeps indefinitely and then may be served in soups and sauces. This is the mushroom that Russians used to eat in Lent in lieu of meat: little wonder that no one shrank from Lenten fare![3] This is the mushroom, packaged in cellophane envelopes, that is to be found on sale in the little Jewish food shops of New York. (How lovable are those shops, in the immense variety of their stores and the warmth of the welcome that the owners, hailing as they almost always do from Eastern Europe, extend to appreciative customers, and especially to Russians!) During the recent war with Germany, the importation of these mushrooms was interrupted, but new sources sprang up in Chile. The quality, however, was not the same, and with the return of peace, the flow of mushrooms from Poland and Italy was resumed. In New York there is one firm, the Reliable Mushroom Company in Rivington Street, that confines its business to dealing in these imported dried mushrooms. In November 1948 I priced the various grades that Mr. Fessel was offering: the shredded Chilean mushrooms were $2.75 a pound and the Italian were $4.00; but the long and handsome strings of dried Polish ceps were $6.00. In December 1950 the Polish product had risen to $8.00, and for caps alone (the stems being considered inferior and removed) the price was $12, but a year later, in October 1951, the market for these caps had fallen to $8.

In New York the cep is for sale only in its desiccated state, though it grows throughout the wooded countryside; and those who know it only dried will never divine the delicacy and richness of its taste when pickled in brine, or marinated, or preserved by boiling and sealing in jars, or better far, when fried fresh in butter, or, finally and best of all, sauteed in sour cream.

I respectfully suggest to the Wine and Food Society that some day they arrange to serve to their members, artfully prepared, a selection of all the mushrooms I have mentioned, accompanied of course by appropriate wines, and I predict that by a vote resembling a Soviet election the choice will run to the incomparable *belye griby*. I am not unmindful of the difficulties in arranging such an extraordinary culinary event. All the mushrooms must be served fresh, to do them all equal justice. A generous mess of the most ephemeral - the *opjonki* - would have to be rushed in at the last moment from close by, of course with motorcycle escort, sirens whining. A chef would be cooking them in a chafing dish en route. Other kinds of mushrooms would hail from Europe by plane. The chef in charge would thoroughly understand the personality of each of the kinds, and possess the skill to evoke its proper character. Nobly served, what a memorable spread we should have, and what a tribute to the folk-cookery of the Slavs!

I have one more name to add to the honor roll of the Russian mushroom world. If the *belye griby* are the aristocrats of that world, then the serene dignity of Prince must be bestowed on the *borovik*. By ancient tradition and common consent, it leads the roster. The Czechs, who vie with us in our enthusiasm for it, call it the Regal Mushroom, or *hřib královský*. Some Frenchmen know it too. They use for it various names - *tete de negre, cepe polonais, gendarme noir*, and *cepe bronze*. The name that the mycologists use is *Boletus aereus*.

---

3. These mushrooms were allowed by the Russian Church during all fasting periods save Holy Week - a subtle line of demarcation in religious discipline that will delight all amateurs of ethno-mycology.

Apparently it does not occur in the New World.[4] It is rare in Russia, so rare that many Russians apply the famous name erroneously to its close relative, the *belyi grib*. Perhaps it is not a distinct species, but only a variant of the other, a variant linked symbiotically with some kind of pine tree, for *bor* (**бор**) means pine-forest. The *borovik* owes its supreme rating with us to its rarity and to its breathtaking beauty: its 'head' (for one refrains from speaking of the 'cap' of such a majestic creature) is a deep brown approaching black, and in size and weight and stature it is the equal of the *belyi grib*. In fragrance and taste, perhaps only the most knowing epicures can distinguish the two, but however closely related the two kinds may be, and however much they look alike, to the *borovik* belongs the dignity of first place in the whole mushroom world.

The Russians never discuss the weather to make conversation, and our lack of interest in golf scores and sporting events generally, both amateur and professional, is complete. But mushrooms are different. They are not only raw material for the kitchen, they are a theme for endless discussion. They are ever present in our minds, even when we are not discussing them. They are so taken for granted that Russian authors seldom stop to discuss them systematically. But references to them are scattered everywhere in Russian literature - in poetry, fiction, essays. Three times in *Anna Karenina* does Leo Tolstoy bring them into his narrative, and the episodes, for the perceptive reader, are extraordinarily revealing. In one, a nursery full of tearful little children is turned in an instant from tears to joyous excitement with the announcement that they are to go mushrooming. The second episode, for our purpose, is even more startling. A land-owner is preparing to propose to a girl he loves, and with this intention goes into the woods to join her where she is gathering mushrooms. But he never gets to the point of proposing, for they begin by discussing mushrooms, and though both are longing to speak of love, once they are on mushrooms, like a cracked record they cannot get off that subject! In Appendix I we offer to our readers a rendering of these two passages from *Anna Karenina*. The third episode, though slight, is perhaps the most touching. The land-owner Levin goes out into his fields, where his peasants are mowing the hay, to join them in their labor. The day is hot and long and the work is hard, but they all press on to finish a big stint. As twilight comes they find themselves cutting grass among the trees of a wood where birch-mushrooms abound, big fellows that have fattened on the moist humus of the grassy places. In their rhythmic sweep the scythes cut the mushrooms as well as the grass. Levin, exhausted though he is by his unwonted effort, nevertheless notices that the oldest of the peasants, a grand old man who excels all the others in grace and endurance, never fails to lean over and pick up the mushroom that his blade has severed, then tucking it away in the fold of his blouse. "Another present for my old woman," he says. His scythe does not miss a single blade of grass, nor does a single mushroom escape him.

There are delightful verses about mushrooms in the poems of two of Russia's more accomplished poets, Lev Alexandrovich Mej and Viktor Vladimirovich Khlebnikov. I like particularly Khlebnikov's apostrophe to the mushrooms of the forest. The poetic virtue of his lines is lost in this literal translation:

> Here are syroezhki and the russet *ryzhik*
> With raspberry blood,
> Yellow *gruzd*', round and shaggy,
> And you, *pecheritza* (**печерица**),
> Simple and white like snow,
> And the firm white ones with the thick caps.

The 'firm white ones' are ceps of course, the thick-capped *belye griby*. Of special interest is Khlebnikov's description of the *ryzhik* as 'raspberry-blooded'. All the lexicons say that the *ryzhik* is the *Lactarius deliciosus*, a mediocre mushroom that exudes saffron drops. It is clear that the *ryzhik* of Khlebnikov is a variant, a lactarius that drips raspberry blood - *malinovaja krov*' (**малиновая кровь**).

Yet another Russian author, Sergey Timofeyevich Aksakov, late in his life wrote about mushrooms in a lovely essay that is little known. It merits attention for several reasons, and hi Appendix II we present what we believe is the first translation of it.

---

[4] A European mycologist has reported finding the *borovik* in Florida. See 'The Boletoideae of Florida', by Rolf Singer, in *The American Midland Naturalist*, January 1947, pp. 22-24. Until others confirm his findings, I hesitate to accept them.

The addiction to mushroom gathering is not a badge of politics or ideology. There was Aksakov, a superb figure of Old Russia. But there was also Lenin, whose fanaticism brought endless woe on Russia and the world, but whose dedication to wild mushroom hunting during one brief spell shows him hi a more winning light. His wife Nadezhda Krupskaya wrote in a letter in 1916 that he pretended to know nothing about wild mushrooms and to care less, but in fact he was seized at that time with a veritable passion for mushroom gathering. (He was possessed of a *razh*' (**ражь**), as she put it.) One day hi that fateful summer of 1916 they were hurrying along a mountain trail near Zurich to catch their train. A drizzle soon turned into a downpour. Suddenly among the trees Lenin caught sight of ceps. At once he turned aside after them, paying no attention to the wet. "We were drenched to the very marrow of our bones and of course missed our train." He did not quit until his sack was full and his *razh*' was quenched.[5]

By the Russian scale of values, all the wonderful golf courses of vast America are inviting more for the mushrooms that grow on them and in the woods along their well-tended borders, than for the game. You can always tell a Russian when you see her in wooded country: she progresses slowly, stooping and peering to right and left, with a low, circular, sweeping glance, as though she has lost something. She is armed with a hamper and a walking stick to poke here and there; and she springs forward occasionally with a happy pounce and kneels to gather in the prize.

When the Russian child learns his alphabet, he sees by a picture that 'g' stands for *grib*; this has been habitual at least since the 17th century. In his primer he reads of mushrooms. In his school he is like to find a playmate whose family name is taken from some mushroom, a boy named *Gribov* (**Грибов**), for example, or a *Gribunin* (**Грибунин**) or a *Borovikov* (**Боровиков**) or a *Gruzdjov* (**Груздёв**), or a *Ryzhikov* (**Рыжиков**), or an *Opjonkin* (**Опёнкин**), or a *Syroezhkovskij* (**Сыроежковский**), or a *Lisichkin* (**Лисичкин**). The *Maslenikovs* (**Масленникове**) are common, but that name might also be derived from the trade of the butter-churner. I am told that in Russia there are even *Mukhomorovs* (**Мухоморове**), but I myself have never run into this equivocal name. In the time of Catherine the Great there was a famous painter named *Borovikovskij* (**Боровиковский**), and a generation later the leading playwright was *Griboyedov* (**Грибоедов**), 'Mr. Mushroomeaterson'. Was there ever such a name in English, or a Mycophagenes in ancient Greece? In English the only parallel that I recall is the fine old medieval family name of Norman origin, still current I believe, of Muschampe, named after some field or meadow famous for its *mousserons* or mushrooms. At the imperial University of St. Petersburg there used to be a professor of law named *Gribovskij* (**Грибовский**) who would sign his articles with the pseudonym 'Muketov', thus giving a Greek twist to his Russian name.

Before long the Russian youngster learns by heart the stanzas of the childish mushroom marching poem, 'Panic among the Mushrooms'[6], wherein Colonel *Borovik*, Commander-in-Chief of the mushroom host, summons his minions to war. The red-coated *mukhomory* decline to serve, for they are senators. The *beljanki* (**белянкин**) [lactarius] say no, for they are aristocratic ladies and exempt. The *opjonki* refuse, since they must do duty as ladies-in-waiting. The morels beg off, for they are gray-headed oldsters. The *maslyata* (**маслята**) say they are needed in the factories, the ink-caps point to their spindly legs, the *volnushki* (**волнушки**) [*Lactarius torminosus*] call themselves old dowagers, and the *lisichki* profess to be nuns. The *ryzhiki* are just simple peasant folk and useless as soldiers, and the *volui* (**волуй**) [*Russula foetens*] duck their duty by reminding the Colonel that they are nothing but the village loafers. Then up step the valiant *gruzdi*, willing fellows, who will gladly go to war and smite the enemy. And so, with a loud 'Oo-rah! oo-rah! oo-rah!', off they march. These stanzas with their shrewd comments on the diverse species are the didactic and mnemonic device by which a people's rich mushroom lore is passed on to the next generation. Based I think on them, I recall a children's ballet and chorale impersonating the mushroom population; was it not composed by Cesar Cui, or perhaps Rebikov? The Czech composer Leos Janacek near the end of his opera, *Liška Bystrouška*, 'The Cunning Fox', has the Forester sing a lovely aria to the mushrooms as he goes through the woods.

No people talk and write more, or more enthusiastically, about good food than the Russians, and soon or late their conversation turns to mushrooms. Has the season been good? Who has found the biggest lot of the best

---

5. This curious episode is told by N. Valentinov in his *Meetings with Lenin (Vstrechi c Leninym)*, Chekhov Publishing Co., N. Y., 1953, p. 211.
6. The Russian name is *Perepolokh sredi gribov*. It exists in many variants and can be found in many Russian anthologies.

kinds? What about the best ways of preserving and cooking? In the Russian language the common term for a warm, soft rain in summer is 'mushroom-rain' - *gribnoi dozhd*' - used even when mushrooms are not under discussion. Among the country-folk, by immemorial right, the peasant who discovers a spot where morels or 'white mushrooms' abound, enjoys thereafter a first claim on the crop in that area. City folk who summer in the country eye one another furtively on their mushroom sorties, like rival spies intent on each other's secrets, and those who hit on good colonies often guard their secret jealously. The Czechs are also notable fanciers of mushrooms, vying in their enthusiasm with the Russians, and the Poles do not lag far behind. The outstanding Polish poet, Adam Mickiewicz, in the third book of his masterpiece, *Pan Tadeusz*, devotes some lines of unforgettable beauty to the gathering of wild mushrooms. But as a Russian I remark that he pays obeisance only to the *lisichki*, the *boroviki*, and the *ryzhiki*. Of the others he goes on to say that the people despise them. Not thus does a Russian speak. Another Pole, Stanisław Trembecki, a conspicuous literary figure in the Polish classicist period in the late 18th century, penned an astonishing diatribe against mushroom-eaters. He was a learned crank, to be sure, but belligerency on this theme has no parallel among Russians, not even Russian cranks.[7] Of course it is wrong to generalize from the utterances of intellectuals, and the peasants of Poland may well be free from the mycophobia that has infected Polish men of letters, but we are constrained to point out that as early as the 17th century that eminent Polish poet, a master of the baroque school, Wacław Potocki, in 'The Unweeded Garden' discusses wild mushrooms at some length, and the tenor of what he says is that mushrooms are an esoteric business, best left to the few who know the secrets!

Close to forty years have passed since I last gathered mushrooms in Russia, and reveled in the mushroom lore that we all shared. As I re-read the lines I have written, I become aware of receding planes of memory, on the periphery of my consciousness, strewn with visions of mushrooms that I can no longer identify by name, and with names of mushrooms that are no longer attached to clearly defined images. What were those *beljanki* [*Lactarius pubescens*] that refused to go to war because they were aristocratic ladies? The *volui* of the poem - *vol* means 'ox', and these are therefore 'bovine-mushrooms' - were, I remember, a lowly species, unwholesome until cooked, and utilized only in the absence of anything better. Then there were the *volnushki*, which might mean the 'wavy ones', but are more likely another 'bovine' species; the *sinjushki* (**синюшки**) [*Lepista nuda*] or blue-capped ones; the *svinushki* (**свинушки**) [*Paxillus involutus*] or swine-mushrooms; the *bolotovik* (**болотовик**) (*Suillus bovinus*] or swamp-mushroom; the *dubovik* (**дубовик**) [*Boletus luridus*] or oak-mushroom; and the *elovik* (**еловик**) [*Lactarius deliciosus*] or balsam-mushroom. There was the *mokhovnik* (**моховник**) [*Boletus subtomentosus*, or *Pseudoboletus parasiticus*, or *Xerocomellus chrysenteron*] or moss-mushroom. There was a big, ugly mushroom that grew in isolation and was never gathered: the *kozjol* (**козёл**) [*Cortinarius traganus*] or goat. The puff ball was the Devil's pepper-pot - *chortova perechnitza* (**чёртова перечница**). There was the *golubetz* (**голубец)** or pigeon mushroom, and the *obabka* (**обабка**) [*Leccinum scabrum*], of which only the name floats uncertainly to me. From earliest childhood I recall another curious name - the *skripitza* (**скрипица**) [*Lactarius vellereus*], or screeching mushroom: what could it have been? Gogol's immortal character in *Old World Squires*, Pulkheria Ivanovna, once started to tell how to preserve in vinegar a mushroom that she called the *travjanka* (**травянка**) [probably *Cortinarius triumphans*]. She had just reached the point where she had lined her keg with oak leaves and saltpeter and added some blossoms of the bird-cherry tree, the Russian *cherjomukha* (**черёмуха,)** which the botanists call the *Padus avium*, when she was diverted. (What can the world do about mischievous Persons from Porlock?) Never shall we know the rest of that enticing recipe, but someone at least can identify for us the *travjanka*.

One of the loveliest mushroom stories is the legend about their origin that we find in Bohemia, which we retell from the recension recorded by the Czech folklorist, Mrs. Božena Němcová.[8] It seems that Jesus and Peter were passing through a Czech village and heard the sound of wedding music in a humble cottage. They joined the party, but not before Jesus had warned Peter to accept no food save only bread and salt, for the people were poor. Jesus and Peter were made most welcome. They partook of the bread and salt that were offered to them, declining however the cakes [*koláce*]. But a little later, when no one was looking, Peter slipped some cakes into his pouch. After a while Jesus and Peter continued on their way, Jesus immersed in his thoughts and

---

7. The attack on mycophagists appeared posthumously in an article entitled *Pokarmy* [Food], edited from the writer's autograph by Franciszek Grzymała and published in *Astrea, Pamiętnik Narodowy Polski*, Warsaw, 1822, Vol. II, pp. 136-152. It was republished in *Pisma wszystkie*, edited by Jan Kott, Warsaw, Państwowy Instytut Wydawniczy, 1953, Vol. II, pp. 206-7.
8. *Národní báchorky a povìsti*, Prague, 1880, vol. II, pp. 302-4.

Peter lagging behind, that he might nibble on his cakes. But at each bite, Jesus would wheel around and ask him what he was eating. Peter would spit out the mouthful and reply, "Nothing." This happened again and again, until there was no cake left. Then Jesus said to Peter, "Go back, and pick up all that you have spat out, and I will wait for you." When Peter returned he said to Jesus, "I found nothing except this that I show you. I thought it was food, but no! it was a growth, rooted in the soil." Jesus said, "It is a growth, and it grew from the food you threw away." Then Peter asked for forgiveness, and it was granted to him. Then they went to the cottage of a poor woman and asked her to cook what Peter had found, and it turned out to be mushrooms, and they were good. Because the mushrooms had sprung from the food of poor people, Jesus bestowed them on the poor, and he taught the poor woman where to seek them. And because poor people need help, mushrooms multiply and abound. And because Peter, eating them, nevertheless remained hungry, mushrooms are not filling.

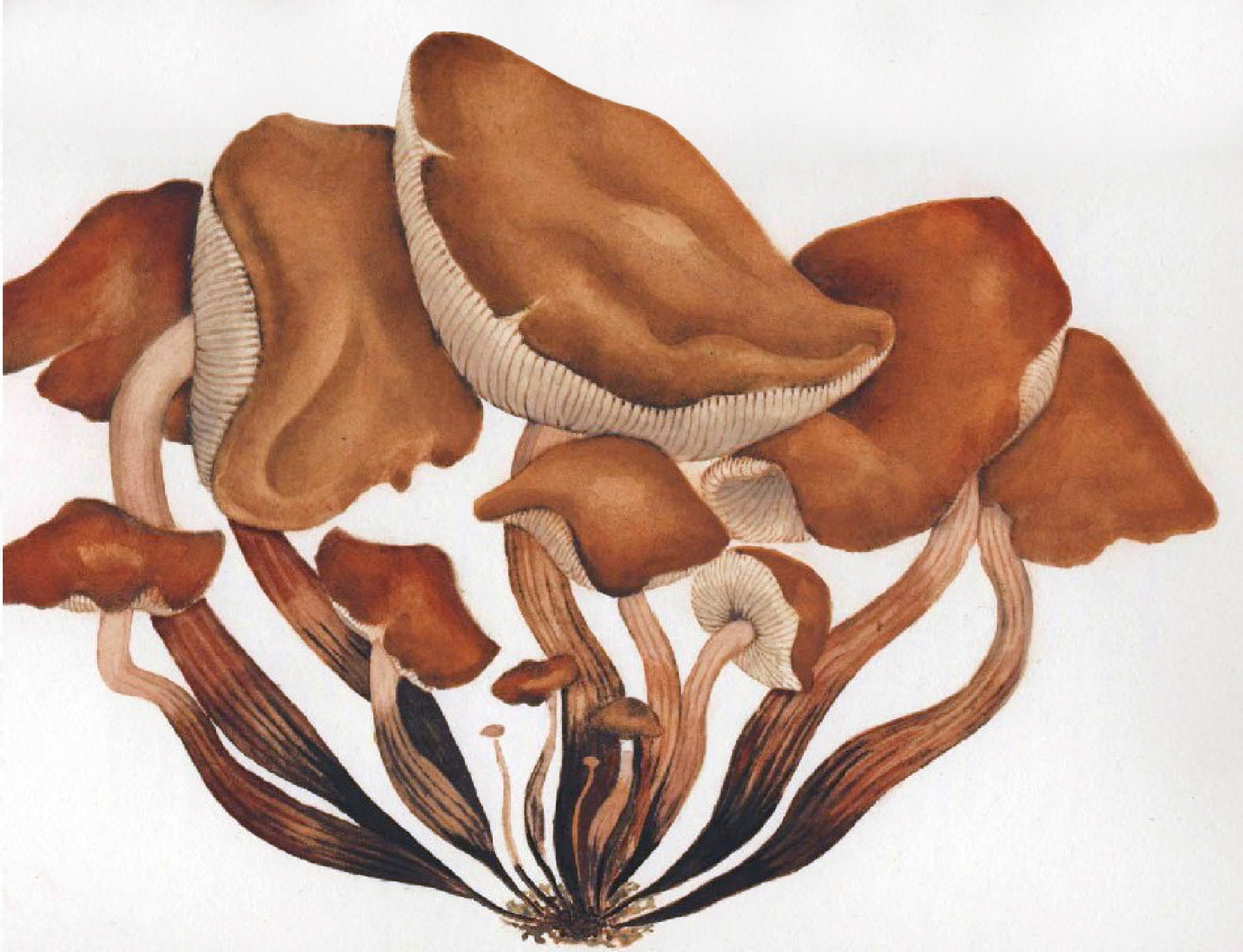


PLATE IV

Jean-Henri Fabre

Collybia fusipes Fr. ex Bull.;

Polish: *Łysostopek wrzecionowatotrzonowy.*

When we consider how gingerly even mycologists in America ofttimes handle the run of miscellaneous mushrooms gathered in fields and woods, the self-assurance of Russians as they by-pass the poisonous and foul-tasting ones, and grade the others according to their edible merits, and consume these wild mushrooms with impunity as an important ingredient in their daily diet, seems astonishing to other peoples. Here is a notable instance where folk-wisdom anticipates and overreaches the savants. I have surely strained the patience of my readers with the Russian vocabulary that I have recalled for the mushroom tribe, but there must be an endless glossary of other names that I have forgotten or never known. The wealth of the Russian nomenclature for the mushrooms is a measure of the role they have played in the social history of the Russian people. The names evoke for Russians the edible qualities of the various kinds, but semantically they refer primarily to the habitat and essential character of the species. Several of the folk-names for mushrooms in the

Russian language could have come into acceptance only after age-long intimacy. The scientific nomenclature of the Western mycologists, devised over the past century, is superficial by comparison with some of the Russian common names, the pseudo-classical terms of the scientists being keyed often to accidental attributes, the aspects that the untutored eye of the early mycologist first remarked.

In the English language the very word 'fungi' is an ugly, half-assimilated alien, detached and cold in its emotional personality; and apart from it there are in the common speech only 'mushroom' for the species that lends itself to cultivation and 'toadstool' of evil aura. 'Toadstool' has no precise meaning, but in ordinary usage it embraces all the wild mushrooms that the person born in the English-speaking world does not know and therefore fears and loathes. It is a word that most of those who love mushrooms refrain from using. Even if viewed as a fanciful term, it is inept, surviving only through the inadvertence of a great people whose attention has been elsewhere. With this single word 'toadstool', soaked in condescension and repugnance, the English-speaking world lumps together and dismisses without a second glance some of the richest and most varied embroidery doing honor to wild nature's glorious vesture.

II
Mushrooms and the English

> Beware of musherons, moch purslane, gourdes,
> and al other thinges, whiche wyll sone putrifie.
> SIR THOMAS ELYOT *in 'The Castel of Helth', 1541, folio 93.*

There is no doubt about it: from, earliest times the English have had little use for mushrooms. *The Grete Herball* of 1526, a translation from the French, voiced the hostility of both peoples:

> Fungi ben mussherons... There be two maners of them; one maner is deedly and sleeth them that eateth of them and be called tode stooles, and the other dooth not. They that be not deedly haue a grosse gleymy [slimy] moysture that is dysobedyent to nature and dygestyon, and be peryllous and dredfull to eate & therefore it is good to eschew them.

In the 16th century scientific thought had hardly begun to shake itself loose from folk-beliefs of unfathomed antiquity, and compilations such as *The Grete Herball* are a treasury of such beliefs. The printing press, fresh on the scene, captured and preserved for us the common content of men's minds at that moment in history when the Western World was beginning its slide into the modern era of big changes. And in the case of mushrooms, let us here salute a singular example of the tenacity with which even a great people sometimes clings to its primitive notions. For that naive division of the mushrooms between the 'two maners of them', the one deadly and the other not, and even these latter to be avoided - that elemental antipathy, captured for us in the text of the first comprehensive English herbal, has carried on with undiminished vigor through four centuries more, down to the present day. Learned mycologists write treatises and preach an enlightened gospel, but what do all their knowledge and all their cautious advice weigh? Small cliques of amateurs exist, but the public is not stirred. In a recent elaborate American work on mushrooms the author[9] brings himself to write a chapter on 'mycophagy', but confesses that he himself almost never lets mushrooms enter his mouth! Not thus does one inspire appetite in others. The repugnance for 'toadstools' is sometimes an aggressive thing. I have seen the English governess, her charges in tow, advance on the enemy (a lovely and innocent russula, as it happened), kick it over, and with shudder and grimace crush it with the heel of her big, low-heeled shoe; turning then to the children, she shepherded them away from the unclean thing. Thus by an unspoken lesson this creature unwittingly seared their young minds with the branding iron of an ancient curse. Where she and her tribe see, in the words of the herbalist, a slimy toadstool, a Russian beholds 'the fat of the earth'.

As the 16th century drew to a close, in 1597, John Gerarde brought out his famous *Herball or Generall Historie of Plantes*, an immense and delightful book. What he says of mushrooms may differ little in substance from *The Grete Herball*, but his opulent manner of expressing the same thing deserves the accolade of the reader's attention. The Englishman is venturesome in most things save food, and never before Gerarde nor since has that peculiar dietary conservatism of the race received more elegant and curious endorsement:

> Many wantons that dwell neere the sea, and haue fish at will, are for change of diet to feede vpon the birds of the mountaines; and such as dwell vpon the hils or champion grounds, do long after sea-fish; many that haue plenty of both, doe hunger after the earthie excrescences, called mushrums; whereof some are very venemous and full of poison; others not so noisome; and neither of them very wholesome meate ...

Master Gerarde then proceeds to describe one kind that is not bad and straightway a dozen that he condemns, saying about a certain species that grows in "mossie and shadowie woods" that he does "the more briefly passe them ouer, not purposing to use many words about such fruitlesse matters". Finally he comes to his sweeping and memorable conclusions:

---

[9] Alexander H. Smith in his *Mushrooms in their Natural Habitats* (Sawyer's Inc., Portland, Oregon, 1949) says as he engages in a lengthy discussion of mycophagy, pp. 121-2: "It is impossible for me to discuss the edibility of even the highly recommended species authoritatively from my own experience since I seldom eat them myself".

> Galen amrmeth that they are all very colde and moist, and therefore do approoch vnto a venemous and murthering facultie; and ingender a clammie, pituitous, and colde nutriment if they be eaten.
> To conclude, fewe of them are good to be eaten; and most of them do suffocate and strangle the eater. Therefore I giue my simple aduice vnto those that loue such a strange and newefangled meates, to beware of licking honie among thornes, least the sweetenes of the one do not countervaile the sharpnes and pricking of the other.
> [pp. 1384-6 of first edition]

A few years after Gerarde, in 1609, Sir Michael Scott said his say about mushrooms in *The Philosophers banquet*, and here and now we give to his words new wings:

> ... Sow-beard[10] or Mushrome, according to Rasis [the Arabian physician] is cold and grosse, and being taken raw ingenders flegme, and the chollike, and windinesse in the guts; neither is it to be eaten but with hot sauce or meate, but the red are not to be eaten at all. The Todestoole is much worse then the Mushrome: for it hath choaked and killed many that haue taken it, and the best that it doth, is to breed flegme in the body in aboundance ... [Verso of folio 36, wrongly numbered 33]

These famous herbalists whom I have quoted were leaning on the authority of Dioscorides, Galen, and Rhazes, but they elaborated richly on their sources, going far beyond the Greek and Arabic writers in maligning the mushroom tribe, and invoking the oracles only to clothe with their authority the loathing of the English, which they undertook to express in their full-bodied prose.

Half a century after Gerarde it was still possible for a well-born and educated Englishman to reach man's estate without having heard of truffles. John Evelyn at the age of 24 made their acquaintance in France. On September 28, 1644, he found himself in Vienne, a day's journey by river from Lyons, and there, as he says in his diary, he "supped and lay, having amongst other dainties, a dish of truffles, which is a certain earth-nut, found out by a hog trained to it, and for which those animals are sold at a great price. *It is in truth an incomparable meat*." (The emphasis is mine.)

The Englishman in Evelyn was being diluted by travel. His hospitality to strange and newfangled meats found no echo in his countryman Jeremy Taylor, who in 1650-1, in his *Holy Living and Dying*, strikes the less liberal note:

> Fly from all occasions, temptations, loosenesses of company, balls and revellings, indecent mixtures of wanton dancings, idle talk, private society with strange women, starings upon a beauteous face, the company of women that are singers, amorous gestures, garish and wanton dresses, feasts and liberty, banquets and perfumes, wine and strong drinks, which are made to persecute chastity; some of these being the very prologues to lust, and the most innocent of them being like condited [seasoned] and pickled mushrooms, which, if carefully corrected and seldom tasted, may be harmless, but can never do good. [Chap. 2, 'On Christian Sobriety', Sec. in, 'Remedies against Uncleanness']

It was Jeremy Taylor's privilege to believe in the mortification of the flesh, but why did he vent his spleen on the humble mushroom? I hope to show on a later page that he and the herbalists were voicing, unbeknownst to themselves, a pre-Christian tabu shared by all the peoples who dwell on the shores of the North Sea. The passage about the condited and pickled mushrooms follows hard on another that perhaps my readers will thank me for recalling. The stern author is listing his remedies against 'uncleanness', and here is what he recommends about food in general:

---

[10] Sow-beard = sow-bread; unreported in the Oxford Dictionary in this sense of mushrooms, but familiar as a name for the cyclamen. In Latin *tuber* meant both 'truffle' and 'cyclamen', and in Giuseppe Baretti's Italian-English dictionary, 1832, *tartufo* is translated by 'sow-bread, a kind of mushroom growing underground'. The addiction of pigs, especially sows, to underground fungi justified the use of this name for truffles.

> A spare diet, and a thin coarse table, seldom refreshment, frequent fasts, not violent, and interrupted with returns to ordinary feeding, but constantly little, unpleasant, of wholesome but sparing nourishment: for by such cutting off the provisions of victual, we shall weaken the strengths of our enemy.

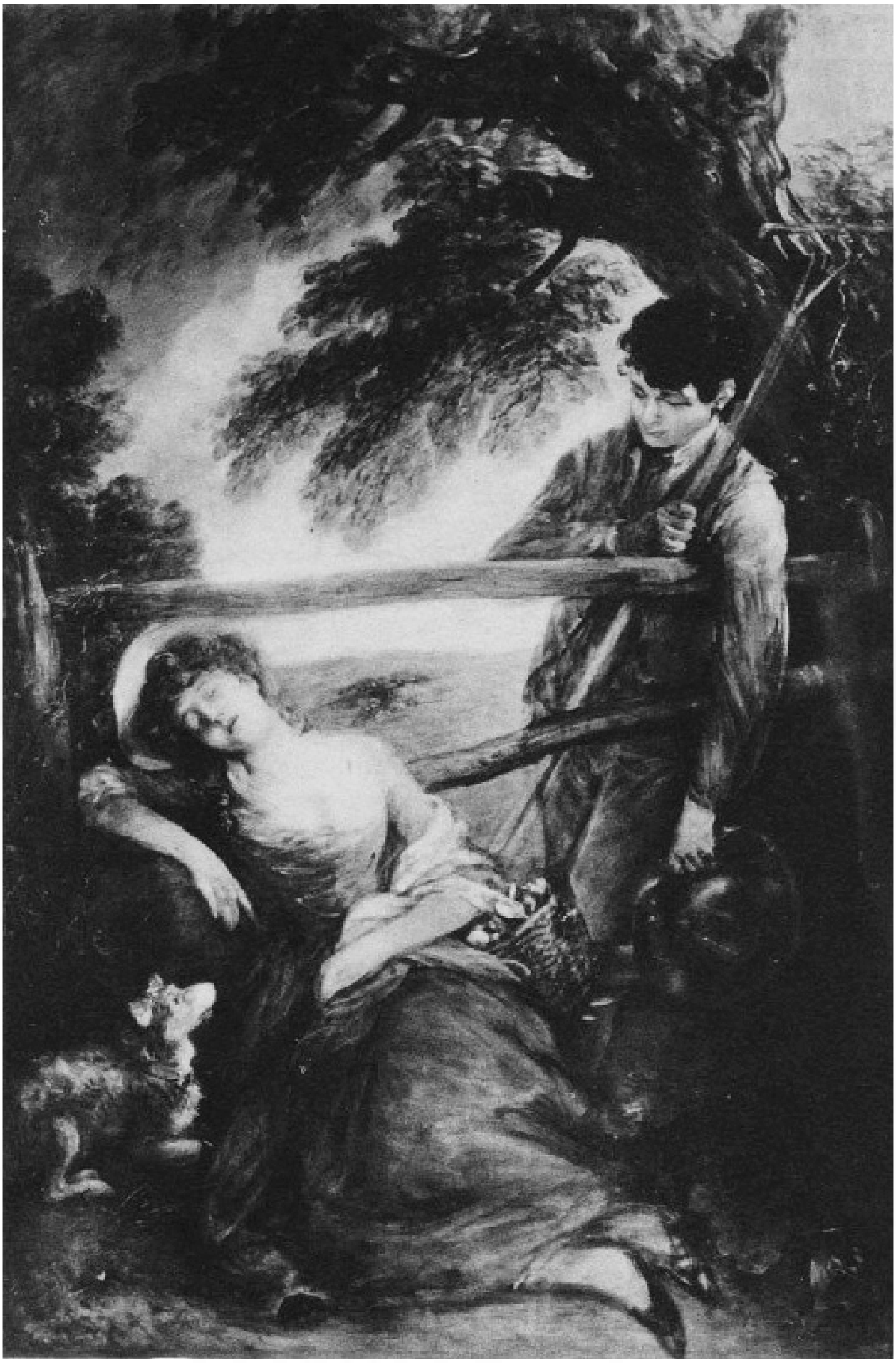


PLATE V

Thomas Gainsborough. The Mushroom Girl. *Boston (Mass.), Museum of Fine Arts.*

Is it uncharitable to venture the opinion that this exhortation to consume unpleasant food, from Jeremy Taylor's day even unto now, has been more honour'd by his countrymen in the observance than the breach?

Apparently the Stuarts on recovering the throne of England brought back with them from across the Channel an appetite for the mushroom world. How else shall we explain that before the end of the century the Englishman was commonly referring to the good earthy 'trubs'? A little later both truffles and morels began to figure in the cookbooks. For example, Patrick Lamb, who was for "near fifty years" master-cook to Charles II, James II, William and Mary, and Queen Anne, in his *Royal Cookery or the Compleat Court-Cook* (London, 1726) includes in his menus mushrooms (which he fails to identify), morels, and truffles. In the extracts filling five volumes that have been published of Parson James Woodforde's prodigious diary, he refers repeatedly to pickled mushrooms, to truffles, to morels. Toward the end of the 18th century they had become a regular feature of this country clergyman's fare, brought to his door by the folk who had gathered them. Gilbert White in his *Observations on Vegetables* reports that a truffle-hunter had called on him "having in his pocket several large truffles" found in the neighborhood of Selborne; the man was offering them to him at half a crown a pound. White speaks casually of the dogs that the truffle-hunter was using to smell out the truffles. It is clear that truffle hunting was no novelty for him. One might have expected to find the gentlemen of England in that urbane century relishing the table delicacies familiar to the French and Italians; and since they were also steeped in the classics, they must have known of the addiction of the epicures of ancient Rome to mushrooms. But it is startling now to discover from the casual observations of two rural clergymen that the English rustics in their time were gathering morels and truffles for the market. In the whole of the English-speaking world today, does there survive a single truffle-hunter? (Truffles grow in America also, but few pay attention to them, rarely even the mycologists. They are one of the New World's still untapped resources.) That strange false dawn of mycophagy which marked England's 18th century even attained expression in art when Thomas Gainsborough painted his *Mushroom Girl*, a sample of bucolic sentimentality typical of its time and milieu. Is not this the only occasion in the history of English art when a painter of the first rank has acknowledged the existence of the fungal world? And in this case the basket filled with field mushrooms is only a detail in the composition, an excuse for a title. There exists in a private collection a second work by Gainsborough with the same title, a wholly different composition, showing a child, close up, as she reaches out for mushrooms growing in a field.

Having once taken hold, why did this Arcadian pursuit, so noble in its simplicity, die out? Morels and truffles added variety to the Englishman's fare, but they were destined to vanish from his table in the course of the strange decay that overcame the English cuisine in the glorious Victorian era. In 1847 the mycologist Badham was saying of mushrooms that "England is the only country in Europe where this important and savoury food is, from ignorance or prejudice, left to perish ungathered."[11] Half a century later,in 1891, another mycologist who bore the arresting name of Mordecai Cubitt Cooke, in a delightful treatise on the edible fungi pointed out that "in the time of our grandfathers it was almost universally believed that our islands produced but one kind of fungus which was edible."[12] His words implied a growth in enlightenment in his own lifetime that few other observers have detected either then or since his day. Apart from occasional remarks in the writings of mycologists, the English have paid little attention to their blindspot concerning mushrooms. So far as I know, even among the mycologists only one has done justice to the subject, inveighing against his countrymen's prejudice - William Delisle Hay, who published *An Elementary Text-book of British Fungi* in London in 1887. His voice crying in the solitudes deserves to be recalled. Speaking of the fungi near the beginning of his book, he says:

> Among this vast family of plants... there is but one kind that Englishmen condescend to regard with favour. All the rest are lumped together in one sweeping condemnation. They are looked upon as vegetable vermin, only made to be destroyed. No eye can see their beauties; their office is unknown; their varieties are not regarded; they are hardly allowed a place among nature's lawful children, but are considered something abnormal, worthless, and inexplicable. By precept and example children are taught from earliest infancy to despise, loathe, and avoid all kinds of 'toadstools'. The individual who desires to engage in the study of them must boldly face a good deal of scorn. He is laughed at for his strange taste among the better classes, and is actually regarded as a sort of idiot among the lower orders. No fad or hobby is esteemed so contemptible as that of 'fungus-hunter' or 'toadstool-eater'.

---

[11] *A Treatise on the Esculent Funguses of England*, p. VII.

[12] *British Edible Fungi*, p. 17.

> This popular sentiment, which we may coin the word 'fungophobia' to express, is very curious. If it were human - that is, universal - one would be inclined to set it down as an instinct, and to reverence it accordingly. But it is not human - it is merely British. It is so deep and intense a prejudice that it amounts to a national superstition. Fungophobia is merely a form of ignorance, of course; but its power over the British mind is so immense, that the mycologist, anxious to impart the knowledge he has gleaned to others, often meets with scarcely credence or respect. The superstition strikes deep. He who would write or lecture about Fungi can scarce find readers or hearers. The English scientist investigates every domain of nature, but leaves this one coldly alone. The English medical man disdains to inquire into the chemical constitution of Fungi, and is indifferent to and unknowing of their relations in regard to medicine, toxicology, diet, or hygiene. It is surely high time that English intelligence should rise superior to this peculiar phase of ignorance. ...
>
> It is a striking instance of the confused popular notions of Fungi in England, that hardly any species have or ever had colloquial English names. They are all 'toadstools', and therefore are thought unworthy of individual baptism. Can anything more fully demonstrate the existence of that deep-rooted prejudice called here 'fungophobia'; ... In the countries of the Continent the greater number of species have each their particular local names. Even the Redskin of America and the Maori of New Zealand have specific names for their common Fungi. Only we prejudiced Britons have none.

More than six decades have passed since the above lines were penned, and though the English-speaking world has produced numbers of good mycologists since then, the substance of the indictment is as true today as when William Delisle Hay raised his voice in protest.

Hay could have cited Charles Darwin to illustrate his point. This observant and knowledgeable scientist, in that supreme book of travel, his diary of the voyage of H. M. S. BEAGLE, remarked in the entry for June 1, 1834, that the natives of Tierra del Fuego relied on a certain arboreal fungus (a species of the genus cyttaria) for an important part of their diet; and then, almost as though to supply me with a singularly happy illustration for my argument, our learned young man showed the limitations of his learning. "At the present time," said Charles Darwin in 1834, "I think Tierra del Fuego is the only country in the world where a cryptogamic plant [i.e., a fungus] affords a staple article of food." The young Charles Darwin knew more about the Fuegians than about the northern Slavs and Catalans.

As to mycophagy, Darwin revealed a strange lapse in knowledge that amounted to a failure of perception. In him the mycophobia of the English was a mild affliction, a recessive trait. Sometimes this racial infirmity erupts with terrifying ferocity. Let the reader consider the following quotation from Mrs. Gwen Raverat's *Period Piece*, a book of Victorian reminiscences published in 1953. Here we learn what mushroom gathering a l'anglaise can sometimes mean, to what mad purpose the gentle art of mushroom knowing may be perverted:

> In our native woods there grows a kind of toadstool, called in the vernacular THE STINKHORN, though in Latin it bears a grosser name [the *Phallus impudicus*, of course]. The name is justified, for the fungus can be hunted by the scent alone; and this was Aunt Etty's great invention: armed with a basket, and a pointed stick, and wearing a special hunting cloak and gloves, she would sniff her way round the wood, pausing here and there, her nostrils twitching, when she caught a whiff of her prey; then at last, with a deadly pounce, she would fall upon her victim, and poke his putrid carcass into her basket. At the end of the day's sport, the catch was brought back and burnt in the deepest secrecy on the drawing-room fire, with the door locked; *because of the morals of the maids*.
> [pp.135-6]

Who was Aunt Etty? She was Charles Darwin's daughter!

In all the enchanted pages about England's rural life that W. H. Hudson gave to the world around the turn of the present century, there are scarcely a half dozen references to mushrooms. Once he conveys in a sentence or two the magic spell cast on the perceptive beholder when he first discovers a 'fairy-ring' - those meadow mushrooms that ofttimes grow in perfect circles, the circles expanding by tiny stages each year through decades and even perhaps centuries. Elsewhere Hudson speaks of his having gathered mushrooms, but from the colorless reference it seems clear that he was speaking only of the ordinary field mushroom. Thus even Hudson, with all his sensibility to nature, never opened his eyes to the mushroom world.[13]

Thoreau did somewhat better. His allusions in *Walden* are trifling, but in his superb *Journals* he speaks of the fungi time and again. In passages of luminous beauty he vibrates to their visual appeal: suddenly he is off with a theme like this: "The most interesting domes I behold are not those of Oriental temples and palaces, but of the toadstools." He ponders over and over again on the strangeness of these lowly organisms. He philosophizes, and with his teetotaler's bias not always happily: "The life of a wine-bibber is like that of a fungus..." In all that Thoreau says of the mushrooms, for a Russian something is lacking. He views the mushrooms as he contemplates the stars, without touching or smelling or tasting them. Not once does he convey to the reader a carnal sensation. Somehow we cannot picture Thoreau greedily stirring a stew of savory mushrooms over his stove in his hermitage at Walden; that man's saliva never runs. There is something of the eunuchoid aesthete about him. He is too pure to be fun.

But a similar insensibility afflicts even those whose business it is to discuss culinary matters. As recently as 1943 an eminent American gourmet in a book about food declared that there were two schools when it came to preparing fresh mushrooms for the table - those who peeled them and those who didn't.[14] For the Russians, how irrelevant is this 'either-or' dichotomy as a key to the culinary possibilities of the multitudinous world of the mushrooms! It is as though a critic of music should say that when it comes to making music, there are two schools of performers - those who stand and those who sit. Whenever there is discussion of Russian cooking, it is easy, by a few discreet inquiries about mushrooms, to discover those who know whereof they speak.

The herbals of old served as botany books, medical books, and cookbooks; they were not composed as contributions to the *belles lettres*. It might be thought that in the flood-tide of English literature, the poets with their heightened insight would have shown themselves aware of the sensuous beauty of the mushroom world. Not at all. On this subject the English poets missed their chance to be emancipators. Chaucer and Milton ignore the mushrooms, and so I think does Wordsworth, the poet of nature and humble things. Thomas Gray seems to have overlooked those that adorned his country churchyards. Robert Burns brings them in, but only once, in his verses to William Creech, and they serve merely to turn a rime:

> Now gawkies, tawpies, gowks, and fools...
> May sprout like simmer puddock stools;

'puddock' meaning toads.

Shakespeare refers perfunctorily to mushrooms once, in *The Tempest*, and in *Troilus and Cressida* a character dismisses another with 'Toadstooll' as an epithet. Indeed, for Shakespeare the two words serve little use beyond swelling his already immense vocabulary count. Apparently 'toadstool' was an accepted term of abuse in the 17th century: William Penn in the hot flush of his then recent religious conversion denounced the Vice-Chancellor of Oxford as 'Thou poor mushroom!' - a form of address that a Russian would surely misconstrue as a term of endearment.

In the 18th century the British continued to belabor the poor fungal tribe with a cold, unrelenting hate marvelous to see. Tobias Smollett in 1757 produced in Drury Lane an extravaganza called *The Reprisal; or, the Tars of Old England*, a feeble satire on patriotism and the conventional ideas about the French. The villain is the commanding officer of a French frigate, on whose ship the action is laid. He is a "musty, vain, French martinet", a ridiculous cad, and he carries the name of Monsieur le Marquis de Champignon!

For this aspersion on mushrooms Smollett was to be repaid in kind, and with interest. He published his famous *Travels through France and Italy* in 1766, a narrative memorable for its angry comments on everything that the irascible Scottish physician saw and experienced. The critics took him to task especially for his inability to perceive any artistic virtue in the Pantheon or the Medicean Venus. Two years later, almost as a riposte to Smollett's book, Laurence Sterne brought out his sensationally successful *Sentimental journey*, and there near the beginning he pays his compliments to Smelfungus, the pseudonym that he bestows on Smollett and that Smollett to his dying day never lived down. The name is a key to the Englishman's attitude toward mushrooms: knowing Smollett as we do and Sterne's feelings about him, we discover what fungi and their smell meant for them and for Sterne's popular following. The earthy smell of decaying leaves and compost heap, of dank mushrooms growing in rich clusters, the smell that the French call l'odeur du terreau, is pleasing to all who love simple and genuine things. Moreover, the mushroom tribe in fact offers the widest range of smells, not just one and that one foul. Indeed, as connoisseurs know, each species breathes its individual olfactory signature. There was of course a phonetic echo of Smollett's name in Sterne's insulting epithet, the kind of punning suggestion that Sterne loved.

---

[13] *The Hind in Richmond Park*, Chap. IX; The Book of a Naturalist, Chap. XV.

[14] Richardson Wright, *The Bed-Book of Eating and Drinking*, Lippincott, Philadelphia, 1943, p. 26.

Here, then, is salacious Sterne on Smollett:

> The learned *Smelfungus* travelled from Boulogne to Paris - from Paris to Rome - and so on-but he set out with the spleen and jaundice, and every object he pass'd by was discoloured or distorted - He wrote an account of them, but 'twas nothing but the account of his miserable feelings.
> I met Smelfungus in the grand portico of the Pantheon - he was just coming out of it - '*Tis nothing but a huge cock-pit*, said he - I wish you had said nothing worse of the Venus of Medicis, replied I - for in passing through Florence, I had heard he had fallen foul upon the goddess, and used her worse than a common strumpet, without the least provocation in nature.
> I popp'd upon Smelfungus again at Turin, in his return home; and a sad tale of sorrowful adventures had he to tell, "wherein he spoke of moving accidents by flood and field, and of the cannibals which each other eat: the Anthropophagi" - he had been flea'd alive, and bedeviled, and used worse than St. Bartholomew, at every stage he had come at - I'll tell it, cried Smelfungus, to the world. You had better tell it, said I, to your physician.

In his next paragraph Sterne takes another traveler to task, some Croesus whom he dubs Mundungus, a word, now fallen into disuse, that meant 'offal', 'refuse', 'filth'. A few years later, in the 1760's, Sterne's Smelfungus and Mundungus turn up again, in a satirical poem, *The Children of Thespis*, by 'Anthony Pasquin', the pen-name of a shady journalist named John Williams. He too vents psychopathic loathing on the inoffensive fungi:

Thus scarceness gives value to dirt and mundungus,
And dignifies that Nature meant as a fungus.

But fungus and filth have their uses and buyers,
Hence oceans of urine are purchas'd by dyers;
And lawyers, who liv'd but to generate strife,
May serve when they're dead for th'Anatomist's knife.

Let not the squeamish reader shrink from the stench of Sterne's Smelfungus: it curls upward from the very viscera of the Englishman's mycophobia. Contrast that smell, if you please, with the Russian's scale of values. On August 22, 1851, Alexej Konstantinovich Tolstoy penned a letter[15] from the country to the young woman whom he later married and his subject was the odor of mushrooms:

> I have just returned from the forest where I went gathering mushrooms and found many. Once you and I discussed how odors evoke the memory of things forgotten for many a year. For me the smells of the forest possess this faculty more than any others, but perhaps this is only because I passed my whole childhood in the woods. Just now I smelled a *ryzhik*, and as in a flash of lightning I saw my whole childhood, in all its details, up to the age of seven. The vision came and was gone in a thousandth part of a second. Each kind of mushroom has its own odor, but always it brings back to us the past. ...

---

[15] See his collected works, Собрание сочинений Издание (*Sobranie Sochinenii Izdanie*), St. Petersburg, 1908, edited by A. F.

Marks, vol. IV, p. 37.

The common English names for the wild plants are rich in poetry, and perhaps no English poet of standing has made use of a wider variety of such names than John Clare, the farm-laborer who passed most of his adult life within the confines of a lunatic asylum. Yet in the two volumes of poor Clare's published poems I have discovered only one casual reference to 'mushroom buttons'. True, most of his verses still lie unpublished, and we must not exclude the possibility that this observant and original rustic poet somewhere paid fitting obeisance to the mushroom world. Possibly his learned editors, in making their selections, rejected some eloquent paean to the fungi, considering the mere choice of such an outlandish theme sure evidence of a weak mind wrestling with an access of lunacy.

On those rare occasions when the great English poets deign to pay serious attention to mushrooms, they habitually link these lovely creatures with death and decay. Keats refers to the 'cold mushrooms' in *Endymion*, and how deathly cold he makes them sound! Browning in *Paracelsus* strikes the same distressing mortuary note:

... as in the autumn woods
Where tall trees used to flourish, from their roots
Springs up a fungous brood sickly and pale, Chill
mushrooms coloured like a corpse's cheek.

Tennyson in *Gareth and Lynette* is as unpleasant about mushrooms as so decorous a poet knows how to be. The beautiful Lynette believes that Sir Gareth, the knight assigned to champion her cause, is a mere kitchen scullion, and she vents her contempt for him:

... She thereat, as one That
smells a foul-flesh'd agaric in the holt, And deems
it carrion of some woodland thing, Or shrew or
weasel, nipt her slender nose With petulant thumb
and finger, shrilling, 'Hence!'

'Agaric' meaning a gilled mushroom. How clear in this recurring image of the famous poets is the echo of that folk detestation which the herbalists first recorded! Keats and Browning and Tennyson may have recalled Edmund Spenser's lines, when in *The Shepheardes Calendar*, to heighten the sense of winter's gloom, he forces mushrooms to grow, contrary to nature, in cold dark December. Of course living fungi can sometimes be found in mid-winter but no observant person would think of associating the whole rich panoply of the mushroom world with the dying year. Spenser is contrasting the winter scene with summer:

Where I was wont to seeke the honey Bee
Working her formall rowmes in Wexen frame:
The grieslie Todestool growne there mought I see
And loathed Paddocks lording on the same. And
where the chaunting birds luld me asleepe, The
ghastlie Owle her grievous ynne doth keepe.

If Spenser is fantastical, just listen to Shelley. In a strange and disturbing poem entitled 'The Sensitive Plant', wherein he, exactly like Spenser, contrasts the beauty of a summer garden with its desolate winter state, he also does violence to nature by associating early winter with the growth of loathed weeds and fungi. England's poets of the romantic period have long been praised for their close attention to nature, but in the light of these stanzas of Shelley's, one is tempted to ask how far their observations went. Did they merely know more than their predecessors? However that may be, Shelley in this poem was so successful in inspiring disgust that his widow in 1839 took it upon herself to suppress one of the stanzas, which we print below in italics, and it was not restored to the canon of his works for almost a century. That long-suppressed stanza exhales the triple distillate of the Englishman's loathing for toadstools: it is the supreme literary expression of this violent Anglo-Saxon prejudice. Ariel, who at other times had caught in flight the skylark's ecstasy and divined the secret of the wild West Wind and breathed the magic spirit of Night, here chooses to plumb the abysses of physical revulsion, and in the very climax of his frenzy, the imagination of this Englishman calls forth rotting mushrooms! Yes, and rotting mushrooms make him think of rotting human flesh! How bizarre for a Russian is this association of ideas that is forever recurring in the English poets!

Between the time of the wind and the snow,
All loathliest weeds began to grow,
Whose coarse leaves were splashed with many a speck,
Like the water-snake's belly and the toad's back.

And thistles, and nettles, and darnels rank, And
the dock, and henbane, and hemlock dank,
Stretch'd out its long and hollow shank, And
stifled the air till the dead wind stank.

And plants, at whose name the verse feels loath,
Filled the place with a monstrous undergrowth,
Prickly, and pulpous, and blistering, and blue,
Livid, and starred with a lurid dew.

And agarics and fungi, with mildew and mould,
Started like mist from the wet ground cold; Pale,
fleshy, as if the decaying dead With a spirit of
growth had been animated!

Their moss rotted off them, flake by flake, Till the
thick stalk stuck like a murderer s stake, Where rags
of loose flesh yet tremble on high, Inspecting the
winds that wander by

Spawn, weeds, and filth, a leprous scum,
Made the running rivulet thick and dumb,
And at its outlet, flags huge as stakes
Dammed it up with roots knotted like watersnakes

And hour by hour, when the air was still, The
vapours arose, which have strength to kill: - At morn
they were seen, at noon they were felt, At night they
were darkness no star could melt.

Emily Dickinson, though dead, has become a major poet of our times, having emerged like a nova in our literary sky long after she herself had sunk back into darkness. Her idiom has caught the fancy of the modern world, but did she do more than clothe old emotions in a new dress? Among her poems is one about mushrooms, written around 1874 and first published in 1891. It consists of five quatrains, of which the last distils the essence of the whole. Listen to those concluding lines, and you will hear only the old, the benighted theme:

Had nature any outcast face,
Could she a son contemn, Had
nature an Iscariot, That
mushroom - it is him.

For 'Iscariot' there is a variant that reads 'Apostate'.

The mere thought of fungi seems enough to arouse loathing in an Englishman's breast. This revulsion is so dependable that when a novelist seeks to invoke horror, he need only drag in the toadstools. By this device A. Conan Doyle launches the story of *Sir Nigel*, on the eve of the Black Death, in October of the year 1348:

> ... the rain had ceased at last, and a sickly autumn sun shone upon the land which was soaked and sodden with water. Wet and rotten leaves reeked and festered under the foul haze which rose from the woods. The fields were spotted with monstrous fungi of a size and color never matched before - scarlet and mauve and liver and black. It was as though the sick earth had burst into foul pustules; mildew and lichen mottled the walls, and with that filthy crop, Death sprang also from the water-soaked earth.

How different would be the description of such a scene by a Russian, who loves his moist Mother Earth, the autumn haze, the 'mushroom-rain', the humus rotting in the woods, and above all a splendid crop of monstrous mushrooms! The Russian reader would put imperious questions to Conan Doyle. Would he please describe those mushrooms more satisfactorily? Were there four kinds each of a single color, or were all the specimens exhibiting all four colors? Precisely what species are we dealing with? Were not most of them edible or even delectable? Why did not the English countryfolk turn to and gather and preserve them, by drying or pickling, to fortify their larder for the winter, the better to stand off any perils that the season might bring? ... 'Foul pustules', forsooth!

In the whole rich world of English literature, I have happened on only two references to mushrooms that express an affection for the 'earthie excrescences' of the unfriendly herbalist, the 'corpse's cheek' of the poet. The writers of these lines were never famous and are now almost forgotten. The first was William Parkes, the author of one little book, *The Curtaine-Draiver of the World*, published in 1612 in London. His reference to mushrooms is slight, but who that loves them will ever forget this vignette, truly observed, of the mushrooms clustered around the trunk of a cedar tree:

> ... that Caedar ...
> Under whose girdle, nay beneath whose knee,
> The little Mesrumes lovingly agree, [p. 20]

The second was a cobbler named James Woodhouse who in 1787 penned an autumnal ode, to be found in a volume entitled *Norbury Park*, in which he first described the common field mushrooms which

> proudly spread their bonnets blythe, With
> coverings form'd of silk and snow And lin'd
> with brightening pink below.

He then goes on to the 'toadstools', in whose forms and hues this Englishman concedes that he finds 'some solace'. Their

> tapering stems, robust, or light, Like
> columns catch the searching sight; Like fair
> umbrellas, furl'd, or spread, Display their many-
> colour'd head; Grey, purple, yellow, white, or
> brown, Shap'd like War's shield, or Prelate's
> crown -
> Like Freedom's cap, or Friar's cowl, Or
> China's bright inverted bowl - And
> while their broadening disks unfold Gay
> silvery gills, or nets of gold, Beneath
> their shady, curtain'd cove, Perform all
> offices of love.

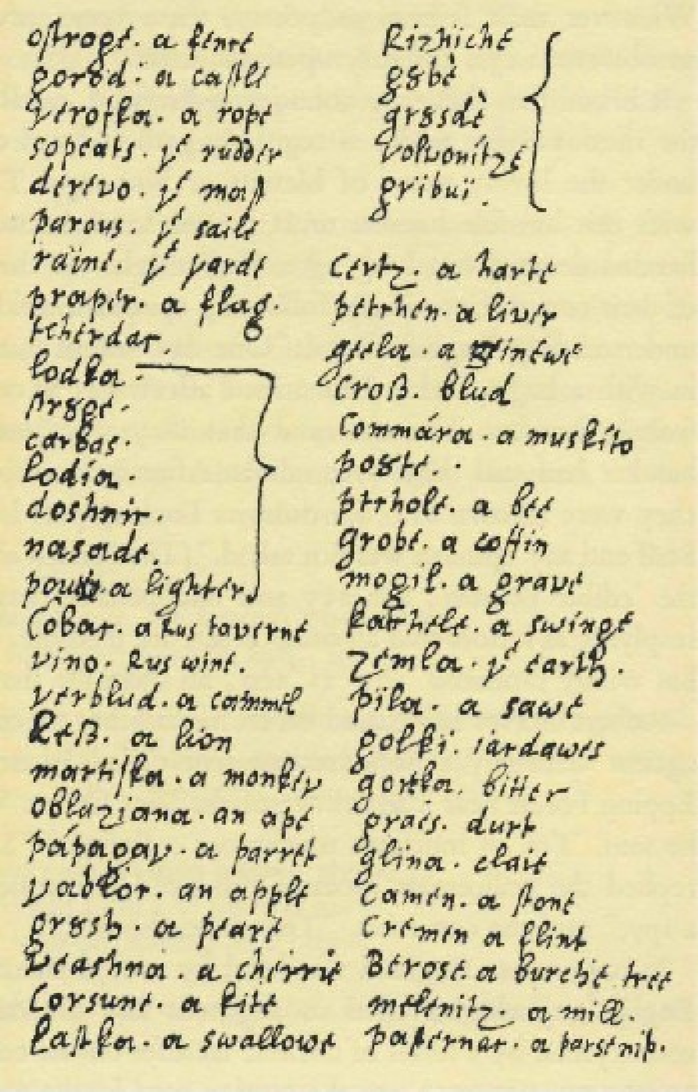
Whatever their failings as poetry, these verses reveal an independent mind, an observant eye, and a sympathetic heart.

It is said that there are counties in England, notably in the Midlands, where the *Rhodopaxillus nudus* is regularly gathered and offered in the market-places under the lovely name of blewits or blue-caps. The country-folk concerned with this humble harvest must possess some knowledge of wild mushrooms handed down from long ago. They might see the humor, invisible to most of their compatriots, in the following episode as told to me by Eric Whittle, an understanding English friend: "One day one of our lady audit assistants came in with a bag of what I identified afterwards as ceps, which she had bought from a hawker. She observed that they were unusual mushrooms but the hawker had said they were edible. After a discussion amongst my colleagues they were thrown into the dustbin. For my part I was a new member of the Staff and my opinion was not asked." (The French *cepe* is often called in English the 'edible boletus', a heavy and unappetizing name, and a misleading one, implying as it does that all other boleti are inedible. My friend in his anecdote has wisely rendered '*cepe*' as '*cep*', an example that our book follows.)

Robert Graves has passed on to me another anecdote. During the recent war against Germany a Soho restaurateur called Bozzini went gathering ceps in Epping Forest near a secret site of the War Office. When charged with spying he said, "I'm an innocent mushroom collector." "Show me the mushrooms!", replied the policeman. Bozzini produced a suitcase full. "That proves you're a spy," said the constable. "Them's toadstools!"

In 1943, when England was beset by mortal enemies, John Ramsbottom, the English mycologist, tried to augment and diversify the spare menu of his countrymen by a series of sensible lectures on the edibility of many wild fungi. EDIBLE TOADSTOOLS was the caption used by the great *Times* on September 29, 1943, in reporting one of these talks. Could a more uninviting headline be devised; Things that are merely edible may be scarcely palatable, and toadstools by the innermost meaning of the word are unfit for the table. Had a Russian been charged with editing that news item, he would have enticed his readers with some such headline as WILD MUSHROOMS IN FINE COOKERY.

For almost four centuries the Russians and the English-speaking world have been eyeing each other, and at one point or another, on one level or another, intermingling. Yet among all the many commentaries on Russia published in the course of that long association, I know of only four that draw attention to the Russian passion for mushrooms. The earliest was by an English traveler, Richard James, who in 1619, while visiting Muscovy, composed an extensive glossary of the Russian language, representing the Russian sounds by a system of transliteration of his own devising. He translated all of the Russian words into English, but when he came to the various kinds of mushrooms, he had to admit defeat: he lists five words and gives no translation! His glossary has never been published in full: the manuscript lies in the Bodleian Library.



oſtrog. a fence
gorod: a caſtle
verofka. a rope
sopeats. ye rudder
derevo. ye maſt
parous. ye saile
raine. ye yarde
prapor. a flag.
tcherdar.
lodka.
ſtrug.
carbas.
lodia.
doshnik.
nasade.
pouſo a lighter
Cobak. a Rus taverne
vino. Rus wine.
verblud. a cammel
lev. a lion
martiſka. a monkey
oblaziana. an ape
papagay. a parret
yablok. an apple
grush. a peare
veshna. a cherrie
Corsun. a kite
laſtka. a swallowe

Rizhicke
gube
grusde
volvonitze
gribui.

Certz. a harte
petchen. a liver
gzela. a ~~g~~winter
Crov. blud
Commara. a muskito
poste. .
pchole. a bee
grobe. a coffin
mogil. a grave
katchele. a swinge
zemla. ye earth.
pila. a sawe
golki. iardawes
gorka. bitter
prais. durt
glina. claie
camen. a ſtone
cremen a flint
Berose. a burche tree
melnitz. a mill.
pasternak. a parsnip.

Fig. 1 - Earliest reference to Russian fungi in English.
Page from Russian-English word-list of Richard James, 1619, citing five kinds of mushrooms without English equivalents:
ryzhik (**рыжик**), *guba* (**губа**), *gruzd* (**груздь**), *volonitsa* (**волоница**), *grib* (**гриб**). Bodleian, ms. James 43.

From 1660 to 1669 the Tsar Alexei maintained at his court an English physician, Samuel Collins, whose valuable little book, *The Present State of Russia*, appeared in London anonymously in 1671. The author, unfortunately, died before the manuscript was completed, and the concluding chapter, entirely devoted to Russian mushrooms, appears to have suffered peculiarly from the ministrations of an unhappy literary executor. The text of this chapter is a mixture of scientific pretensions and fancy, and the illustrations are quaint aberrations.

Of a different order are the observations of an English clergyman, William Coxe, who embarked on a tour of Eastern Europe in 1773 and who in 1784 brought out in three volumes his *Travels into Poland, Russia, Sweden and Denmark*. He was an honest, laborious, and careful observer, whose pedestrian mentality saved him from tincturing his observations with fancy. In the opening chapter of Book IV he describes the condition of the Russian peasants as he saw them. He brings in the mushrooms, and both for this reason and because the whole tenor of his favorable comments about the muzhiks runs counter to the preconceptions of the West on this subject, I shall quote the passage with its context:

> The peasants are well clothed, comfortably lodged, and seem to enjoy plenty of wholesome food. Their rye-bread, whose blackness at first disgusts the eye, and whose sourness the taste of a delicate traveller, agrees very well with the appetite; as I became reconciled to it from use, I found it at all times no unpleasant morsel, and, when seasoned with hunger, it was quite delicious: they render this bread more palatable by stuffing it with onions and groats, carrots or green corn, and seasoning it with sweet oil. The other articles of their food I have enumerated on a former occasion; in this place I shall only observe that mushrooms are so exceedingly common in these regions, as to form a very essential part of their provisions. I seldom enter a cottage without seeing great abundance of them, and in passing through the markets, I was often astonished at the prodigious quantity exposed for sale: they variety was no less remarkable than their number; they were of many colours, amongst which I particularly noticed white, black, brown, yellow, green, and pink. The common drink of the peasants is quass, a fermented liquor, somewhat like sweetwort, made by pouring warm water on rye or barley-meal; and deemed an excellent antiscorbutic. They are extremely fond of whiskey, a spiritous liquor distilled from malt, which the poorest can occasionally command, and which their inclination often leads them to use to great excess.

The worthy Archdeacon Coxe seems not to have asked himself the reason for the abundance of mushrooms in the peasants' fare, whether it was owing to a greater abundance of fungi in the woods and fields of Russia, or simply to the habitual gathering of a normal crop. There is no reason to suppose that Russia produces more mushrooms than the United States or England.

Almost forty years after Mr. Coxe published his *Travels*, another English physician, Dr. Robert Lyall, brought out in 1823 a volume entitled *The Character of the Russians*, in which he dwelt at length on the Russians' addiction to mushrooms. He even undertook to record the common names used by the Russians and to identify them.

> The knowledge of edible mushrooms [said Dr. Lyall], like a tradition, has been handed down, in Russia, from parent to child, through a series of ages; and the discrimination of these, from the hurtful or poisonous mushrooms, is learned by practice, in the years of infancy and youth... Indeed [he goes on], mushroom-gathering or hunting forms a great part of the occupation of the Russian peasants, boys and girls, as well as of the women at times, and is an amusement, in the country, of the nobility, males and females, old and young, who make short excursions to the woods in the neighborhood of their estates, and spend a few hours in selecting one of the greatest delicacies of the epicures.

With a rare perception of the realities of Muscovite life, Dr. Lyall continued:

> Besides the enormous quantities of mushrooms which are brought fresh to market during the summer months, and which are immediately bought up, the better sorts by the nobility, the inferior kinds by the lower classes and the peasantry, a great abundance is preserved by the peasants in the country, who, after retaining a quantity sufficient for their own consumption, bring the surplus to town. They are brought throughout the whole year, in a dried state on

> strings, in cart-loads, and sold in all the provision markets,... and in all the small grocery-shops in the city. Sometimes even salted and pickled mushrooms may be bought.

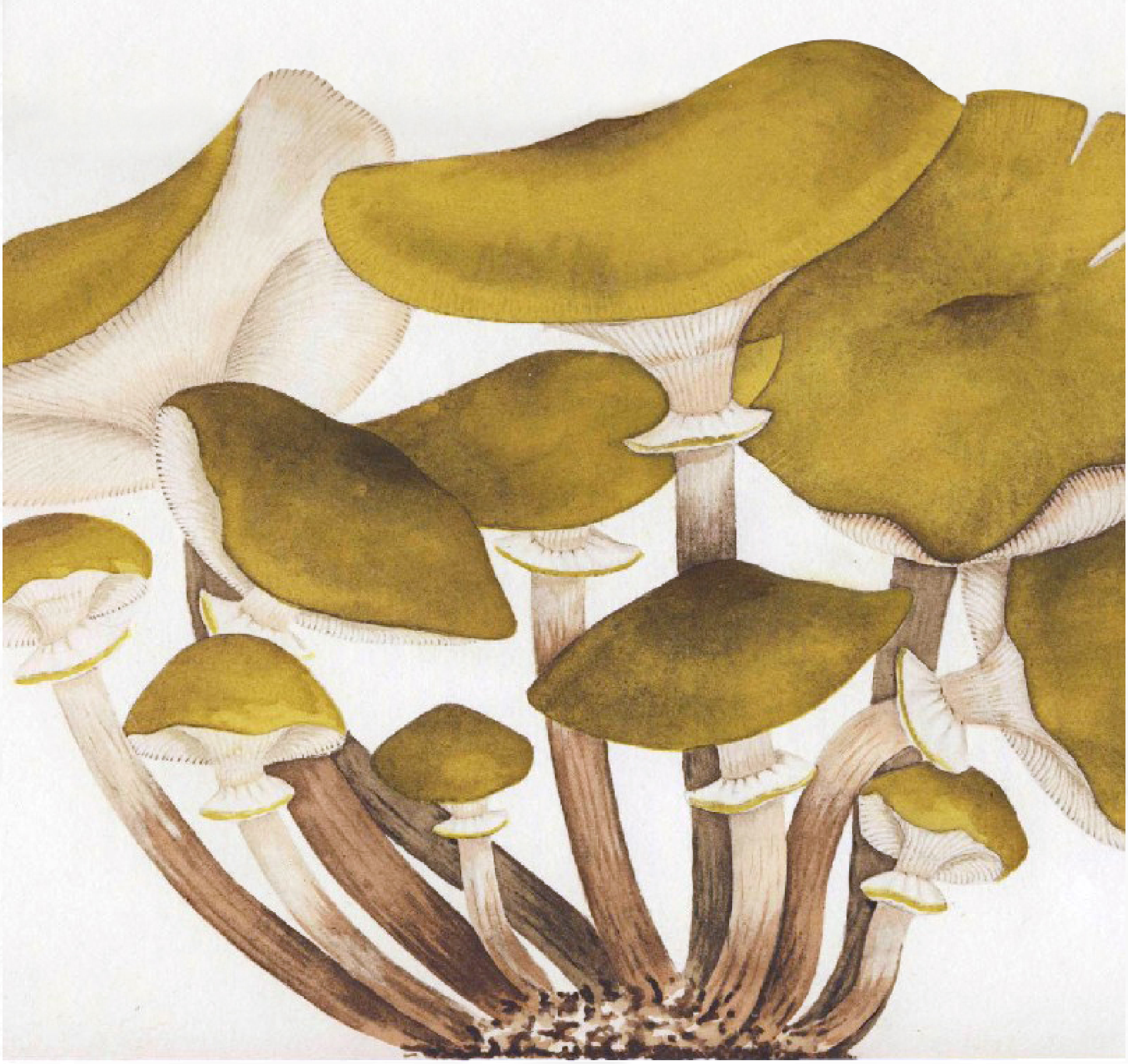


PLATE VI
Jean-Henri Fabre
Armillariella mellea (Fr. ex Vahl) Pat.
French: *pivoulade;*
Polish: *Opieńka miodowa.*

After a courageous effort to identify the various kinds of mushrooms, Dr. Lyall discusses mushroom cookery:

> Mushrooms are eaten fried, boiled or pickled, while their season endures, by all classes. ... They are fried on hot ashes, or in a frying-pan; they are boiled alone; they are boiled with *shchi* (**щи**) or cabbage soup; they are roasted with butter alone, or oftener with butter and *smetana* or sour cream. They also enter into the composition of some puddings and pies. The latter are generally eaten with soup or with *shchi*. Mushrooms are often served up with beef-steak, or roast beef sliced, either alone or mixed with potatoes, carrots, turnips, cabbage, asparagus, &c., and sauce. They are excellent when prepared with cutlets and rich sauce, duly seasoned.

Transfixed with apprehension, the Western world seems today in a horrid trance, stop-watch in hand, as it gazes on Russia. It is wholesome to read the many fine books about Russia that were written in less anxious times, when authors and readers were relaxed, and when there were opportunities for deliberate observation.

III

Mushrooms and History

> When mushrooms abound, there'll be war around.
> *An old Russian belief.*
>
> ... And to be briefe, only the Moscouites may seeme
> that nation which hath not felte the commodities
> of peace.
> RICHARDS EDEN in 1555.[16]

All this talk of mushrooms would be idle, were the contrast between Russian and Anglo-Saxon attitudes a random thing. But these mushrooms hint at the answer to bigger questions, far beyond food and cookery. A people who have always had an abundance of other foods are little tempted to brave the initial perils of the mushroom world. However, in the desperate exigencies of all-out war, of chronic war through decades and generations and centuries, of defensive warfare with homes ravaged and farms left untended, where the unslaughtered remnants of the population hide from the pitiless invader in woods and swamps and fields - under these conditions, I suggest, men and women will discover the humble mushroom, and will prove the various kinds by trial and error, and make friends among them in time of need. For mushrooms, springing up almost overnight, will be God's manna to a people driven from their homes into the wilderness. And the knowledge thus gained, joined with emotions of gratitude born of the circumstances, will not be soon lost. During the blessed intervals of peace when the fields yield their normal increase, the various mushrooms, along with the wild berries and fruits and the cultivated crops, will be assigned in men's minds their appointed stations in the annual procession of the seasons, and will be clothed with fond associations, and in every kitchen, on every stove, sundry ways will be devised to bring out the virtue peculiar to each friendly kind. There is an old belief in Russia that when mushrooms abound, war is in the offing. The thoughtless intellectuals of the world despise such homely sayings, which on the surface are nonsense. But ofttimes those sayings are the cryptic expression of experience graven deep in the recesses of a people's past. Mushrooms are not harbingers of war: it is the other way round. When the dogs of war are running loose across the fair countryside of Russia, the people, hard-pressed, know that mushrooms may soon be their mainstay.[17] Our theory finds disturbing support in a book published in Prague just as the Communist curtain was about to descend on that city. The book dealt with Czech folk food. A peasant speaking of a mushroom called *horyl* (from *hofeti*, 'to burn') [*Lactarius torminosus* - edition@psilosophy], said that it burnt the mouth even when thrice boiled, yet in the 'great hungers' it was always eaten, and when hunger and the pest would return, again it would be eaten.[18]

This link between war and mushrooms can be detected, albeit faintly, in the Anglo-Saxon world. It is said that during the final phases of the American Civil War the people in the devastated stretches of the South turned to mushrooms for sustenance. Certain it is that a famous botanist living at that time in the Carolinas, the Rev. M. A. Curtis, wrote how "during the late war I paid no attention to Botany, except to the edible mushrooms, from which I have gotten many a substantial and luxurious meal."[19] He gladly shared his esoteric lore with the neighbors, who, food being scarce, were apt pupils, and such was his success that he embarked on a book to spread the useful tidings. It was to be called *Mycophagia Americana*, but by the time it was ready, the war was over and publishers were not interested.

In England during the recent war there were public and private efforts to increase the consumption of wild fungi. We know one elderly Russian lady who for a time made good money gathering *belye griby* on Wimbledon Common, in full sight of the wondering English. She pickled or precooked them and sold them to a fashionable restaurant. But, although England's peril was acute, there was, as things turned out, little actual hunger; and furthermore, when measured against the long history of a people, the crisis was brief. The times were not bad enough for mushrooms to take hold. Today there are those who fear that England's bitterest trials lie ahead, in her peace-time efforts to feed herself. If chronic want, real want, should for the first time in history beset the English people, there will be the mushrooms to turn to, and a precious reserve they will prove to be.

---

[16] *Notes upon Russia*, Hakluyt Society, 1st Series, vol. 12, p. 197.

[17] But the Russian saying seems to be widely current in Europe. Consult the entry 'Pilze' in *Handworterbuch des Deutschen Aberglaubens*, by E. Hoffmann-Krayer, 1935-6, where we find the German dialectical *Viel Schwamma - viel Jamma*, the Italian *anno fungato - anno tribolato*, and the French an *de cepere - an de misere*, reported in the Basses Pyrenees.

[18] See Mrs. Marie Úlehlová-Tilschová *Česká strava lidová*, Prague, 1945, p. 57.

[19] Neil E. Stevens quotes Curtis in *The Scientific Monthly*, August 1919, p. 162.

More than a century ago a famous French chef, Louis Eustache Ude, propounded an ingenious and amusing theory to explain the lackadaisical attitude of the English toward food and cookery - an ingenious theory it was, but, as I shall show, completely unsound. He began by denouncing physicians as 'enemies of the art' of cooking, and then he went on:

> I am greatly concerned at being obliged to combat a still more powerful, though amiable, enemy to Cookery. The Ladies of England are unfavorably disposed toward our art; yet I find no difficulty in assigning the cause of it. It is particularly the case with them (and indeed it is so in some measure with our own sex) that they are not introduced to their parents' table till their palates have been completely benumbed by the strict diet observed in the nursery and the Boarding Schools.[20]

The baneful influence of the nursery and the boarding school is doubtless all that the author said, but one would have liked to remind the great Maitre that the rudiments of any distinguished cuisine grow out of the people, the whole people, and nothing but the people; that the leisure class merely spin refinements for the most democratic of the arts; and that the people by and large have never known either nursery or boarding school. If the English in general seem to the rest of us indifferent to good food, and some of them even disapproving of the fine art of pleasing the palate - if the English bill of fare lacks variety and the good ingredients are spoiled in preparation - these shortcomings of a noble people must go back to deeper, broader causes than the child-life of the well-to-do. For a thousand years England never knew war - war as others and especially the Russians suffered it - and England has never known prolonged, desperate want. Hardship is the school in which people forget food tabus, and acquire that deep reverence for food and its preparation that inspires a great cuisine. Everyone who knows anything about Russia will recall that simple and moving ceremony of hospitality in which bread and salt, symbols of food, are offered on a tray to the honored guest. That ceremony is an ancient, almost sacramental expression of reverence for food, and Russia's history gives meaning to that reverence. In the Anglo-Saxon world only prolonged want will, some day perhaps, bring about a comparable respect for food. If England, that land unique in moral resources and spiritual unity, be destined to endure privation over the coming generations, the hardships will most certainly give birth to new and lustrous chapters in her history, chapters of stirring and triumphant drama - and incidentally, I predict, they will bring about at last a worthy English cuisine. Perhaps the reader by now is protesting that I have overlooked England's famous warrior past. Oh, yes, I know that her history is studded with decisive battles. Crecy and Blenheim and Trafalgar and Waterloo, glorious victories and sometimes glorious defeats. But they were all fought abroad, by a handful of men at sea or in other people's homes. They were fought way down yonder among the heathen, somewhere off Flores in the Azores. Those wars were like big-game hunting, stepped up another dimension. Of course there were civil wars also, back in the 17th century, and the 15th, and under King Stephen, and there were border frays along the way. But civil wars, however cruelly fought, lack the ultimate sting, for, whoever wins, members of the family retain possession of the homestead. No intruder takes over the patrimony. These comments about wars go for the United States too; broadly speaking, the tally until our own generation adds up to two civil wars (including the War of Independence) and a few brief expeditionary ventures.

Yes, whoever seeks seriously to understand Russia must make the needed effort of intellect and imagination to comprehend the full and awful meaning of war in the history of the Slavs. This is the first and great imperative. (In the winter of 1939-40, when the Finnish army seemed for a time to hold its own with heroic courage against the Russian forces, how often did my American friends remark to me that, after all, the Finnish successes were not surprising, since Russia had had no warrior past!) As compared with the West, and especially the English-speaking world, war for the Russians has been a calamity of a wholly different and greater order of magnitude. Pause for a moment and consider this. In the wide range of the English vocabulary are there words of more awful potency than 'Huns' and 'Tartars'? It was in the fourth century that the Huns burst like a rocket out of Asia into Europe, and the Mongol hordes followed them seven centuries later. This was all long ago and far away. The Huns in the end were stopped on the fields of France, and the Tartars never got into the West. Yet the mere names of these far-off peoples of ages past still trail clouds of terror in the minds of nations then unborn, in continents then unknown. The earliest description of the Tartars by an unidentified Englishman who sojourned among them will explain in some measure the fearful impact of that strange and pitiless people on the European mind:

---

[20] *The French Cook*, by Louis Eustache Ude, one-time cook to Louis XVI and the Earl of Sefton. This work went through many editions in both England and the United States. The early editions carried an essay entitled, 'On Cookery and its imputed ill effects on health', whence I take my quotation.

> They be hardie and strong in the breast, leane and palefaced, rough and hufshouldred, having flatte and short noses, long and sharpe chinnes, their upper jawes are low and declining, their teeth long and thinne, their eye-browes extending from their foreheads down to their noses, their eies inconstant and blacke, their countenances writhen and terrible, their extreame joynts strong with bones and sinewes, having thicke and great thighes, and short legs, and yet being equall unto us in stature: for that length which is wanting in their legs is supplied in the upper parts of their bodies.[21]

The Slavs, let us remember, met the Huns face to face, and the Russians bowed to the yoke of the Tartars for three full centuries. Nowadays we hear glib talk of 'genocide', a new word meaning the murder of a people; but the Slavs dwelt for centuries on the highways of the Great Migrations, and, had their powers of survival been less, they would have been absorbed or exterminated many times over. Other nations and tribes did disappear in the ethnic maelstrom of the Steppes.

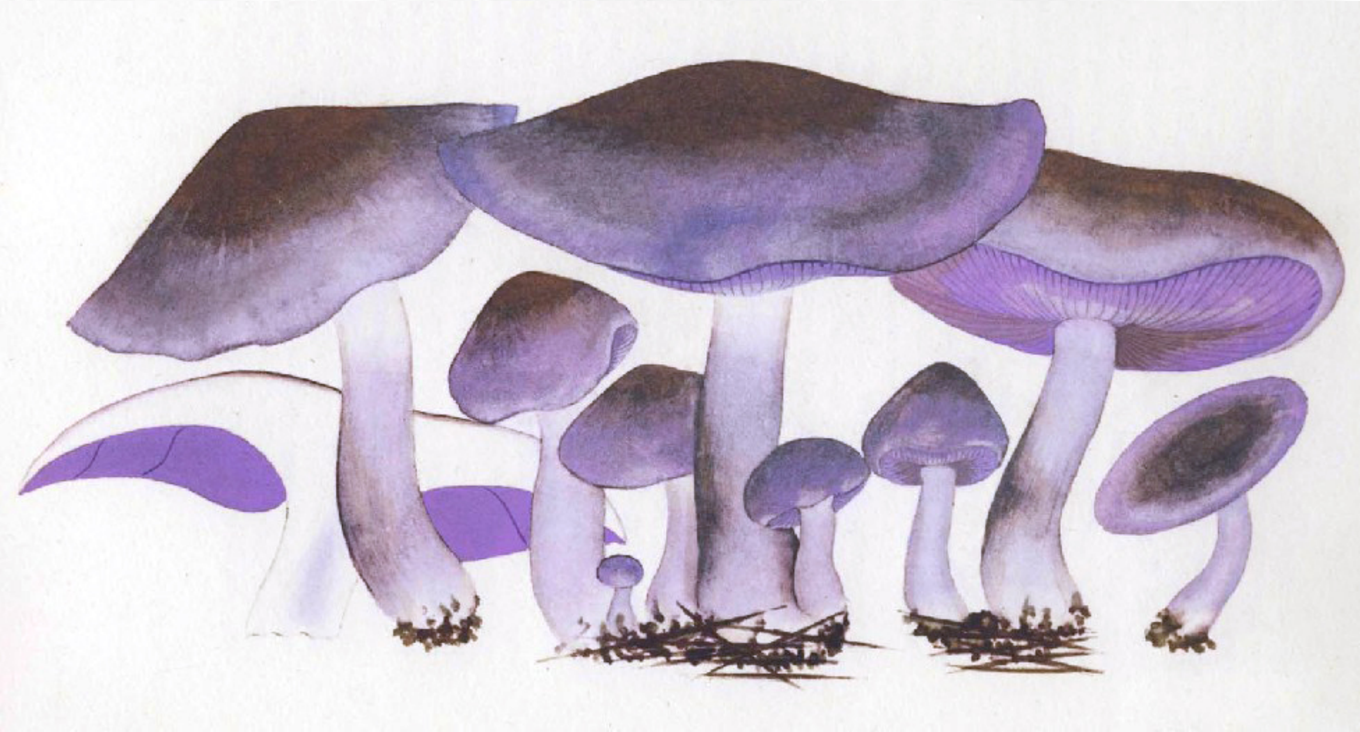


PLATE VII

Jean-Henri Fabre

Rhodopaxillus nudus (Fr. ex Bull.) R. Maire. [*Lepista nuda* (Bull.)]

English: *blewit*;

French: *pied bleu*;

Polish: *Gąsówka fioletowawa*.

---

[21] Richard Hakluyt's *Principal Navigations*, Hakluyt Society, extra series, Glasgow 1903-4, vol. I, pp. 50, 53.

'Huns' and 'Tartars' are not the only linguistic contribution to the West of the Asiatic invaders. No one knows for sure the origin of the word 'ogre'; it probably comes to us from the people called Ugri, known to us as the Hungarians, who drove or were pushed into the Danubian plain in the 9th century. Our word 'horde' comes from the language of the Tartars. For them (as for the Russians to this day) *ordd* is simply the headquarters of a marching host, and the Golden Horde was the supreme headquarters on the Volga of the Tartars who subjugated the Slavs of the steppes and of Moscow. In a lexicon that comes down to us from the library of the poet Petrarch (the *Codex Cumanicus*) we learn the curious fact that the Asiatic invaders referred to the Holy See of Rome as the Horde (*ordd*) of Christendom. The West in taking over the word changed its meaning to cover the swarms of ferocious invaders. In India the same word, now *Urdu*, came to mean the language of the nomad camps.

The Steppes - those moist, fertile plains that fan out to the north of the Black Sea - are the monumental stage on which from the beginnings of history East and West have clashed, in an historical drama of epic grandeur. Like the whirling waters of a rising tide that contend from divers directions for the mastery of a level beach, through thousands of years a succession of migrating tribes from East and South and West have flowed into the Steppes, and overrun them, and battled with each other for possession; and then with the passing of time have vanished into the earth. In recent centuries the Turks made their vain bid for title; before them, the Tartars, speaking a kindred dialect. Before the Tartars came the Polovtsi, and before them the Pechenegs. These last-named warrior peoples are scarcely known to Westerners, but they left dreadful, indelible scars on Russian memories. Before them came out of Asia the hard-riding Avars, and before the Avars the Huns. The Avars and the Huns made general use of bridles, stirrups, and saddles. With their horses these mounted warriors revolutionized warfare, and rendered the famed Roman legion obsolete. Before the Huns, from the Baltic, there swept down into the Steppes and Crimea the Visigoths, the Ostrogoths, and the Goths. Those Goths were securely settled in the Crimea by 250 A.D., and there they lingered on for a thousand years. In the middle of the 16th century a famous traveler, de Busbecq, encountered in the Turkish dominions a few individuals who still could recall some words of their ancestral Teutonic tongue. And down even to our own days, in the Caucasus, there is a fair-haired people whose neighbors call them, erroneously, the Goths. Before the Goths, the Sarmatians, of Persian origin, ruled the Steppes for centuries, and before them the Scythians, who were dwelling in the land when the Greek historian Herodotus went sightseeing up the Dniepr River. And before the Scythians legend tells us of the shadowy Cimmerians.

In thus spanning the millenniums we have omitted many famous peoples: the Scandinavians, who swept down from the North through the waterways of Russia to the very gates of Byzantium; the Greek and later the Italian colonial empires in the Black Sea; the Ugri or Magyars who crossed the Steppes to settle in what we call Hungary; the Bulgars who once dwelt in the Volga valley and now till their cherished Balkan soil; the strange and mighty Khazar Empire on the northern slopes of the Caucasus, whose sovereign had to be Jewish by religion; the Alani, and the Assi who gave their name to the Sea of Azov; and many another tribe of uncouth name - the Utiguri, the Kutriguri, the Onoguri - who lived out their day and vanished.

Compared with those Homeric dramas of the past, how fleeting and insignificant was Hitler's stab across the Steppes to Stalingrad. In the presence of those Great Migrations, the history of Western Europe, at least up to the Age of Exploration, seems to be acted out in miniature, and to give off a slightly foetid odor as of a hot-house. Viewed in the light of all human history, how unusual must be the introspective, intensively developed culture of the communities clustered along the Western fringes of the Eurasian Continent. The world is destined to devote ever more attention to the peoples of Eastern Europe and the Black Sea Basin, and if the West will unflex its intellectual muscles, and exercise its capacity for wonder, and lengthen the focus of its mental vision, what a panorama filled with color and drama will unroll itself!

In the folds of the Caucasus mountains there dwell to this day a score of isolated peoples, with strange languages many of them as curious as the Basque of the Pyrenees. Like the Ark on neighboring Mount Ararat, these peoples have survived the floods of Indo-European and Turkish migrations. They are the ethnographic moraines of the world that was old before the Old World was born. Sarmatians, Scythians, and Cimmerians - those ancient peoples are perhaps mere infants alongside these secluded tribes, whose secrets, if we but succeed in deciphering them, will make the millenniums seem like centuries. Little by little our scholars, in our own times, are piecing together the bits of evidence, and with their aid revising the perspectives in which we view both ancient Greece and Rome (and that means us their progeny also), against the background of earlier, Eastern cultures of unfathomed antiquity.

The Black Sea is a deep basin. Its deeper waters are so infused with chemicals that they sustain no life, and are a graveyard for the detritus of human cultures that have passed away. Its stormy surface waters forever rotate in a counterclockwise flow, suggestive of the human tides that have wheeled around its shores as around a hub from time immemorial. Behind Greece and Rome loom more and more, as our study of the past progresses, the cultures of the Black Sea basin; and the Black Sea becomes the enigmatic eye of history.

The peoples of the Great Migrations erupted into the Steppes explosively, and then in course of time faded away. The Slavs followed different tactics. Their entrance on the stage of history was inconspicuous - an odd thing for the Dramatist to have devised, when you consider the role they were destined to play. Emerging from the neighborhood of the Vistula, they stole imperceptibly into the consciousness of men. Perhaps they figure among the numerous tribes that Herodotus mentions, but he did not make the identification sure. Tacitus in 98 A.D. described the Slavs in his book on Germany, and that was their formal debut in history. A few centuries later, they had spilled out into the Balkans, and by the 9th century the Russians emerge securely established in Kiev. They were a prolific tribe of farmers, spreading like wire-grass along the water-courses. Geographically they were of course European, as European as the Anglo-Saxons. They were European settlers reaching out to the Eastern frontier, and bearing the brunt of Asiatic attacks. (How ironic it must sound in Asiatic ears when uninformed Westerners decry the Slavs as 'Asiatics'! In the course of ten centuries these European Slavs have pushed the Asiatics out of Europe, and then overrun their own vast Continent to the very shores of the Pacific.) Unlike the looting nomadic warriors from the East, they were a sedentary folk. They belonged to the land and the land belonged to them. There is evidence that in their pagan religion they deified the processes of nature, and above all their Moist Mother Earth. Their attachment to the fertile earth is a thing that Westerners, and especially the English-speaking world, can hardly grasp. The old religion perhaps still runs through their blood. It is the Russian in me that makes me love to plunge my bare hands in the moist warm fertile earth, mother earth, the earth that yields us our daily bread, the food that we reverence as a divine gift, that we worship in the Host. Perhaps we love our mushrooms the way we do because they seem the earthiest of nature's growths. From those pagan times a thousand years ago down to now, the Russians feel themselves attached to the earth viscerally, as by an umbilical cord. In the early Slavonic chronicles the Russians are depicted always as farmers, not traders or warriors, and their enemies habitually took advantage of this dependence on the soil to attack their homesteads and villages at harvest time. The Slavs were already then old hands at taking refuge in the woods, just as in the recent war, and those were the circumstances under which, ages earlier, they must have first come into intimate communion with their friends the mushrooms. As the successive waves of nomads spent their initial force, the Slavs resumed their steady pressure and retook the beloved land and pushed on. They were the resistant, tenacious, pushing tortoise, and the invaders were the showy, easy-come-easy-go hares. The Slavs made some progress in the West also, and as late as a few centuries ago, the peasants in Holstein and on the Baltic island of Bornholm were still speaking a Slavic tongue. To this day the Slav-speaking Wends survive in villages south of Berlin. Many of the place-names of Germany are Slavic; Stettin means bristles, and it was the port through which this commodity was exported; and Pomerania is merely Pomorjane - 'inhabitants of the sea-shore'.

The Russians today are a singularly uniform people, as compared with the extreme mixtures in Western Europe. The traits of the Russians are the traits of an Indo-European peasant people indigenous to Europe, first Christianized and civilized under Byzantine influences, and politically shaped by the stern necessity of waging incessant warfare on all sides for the sheer privilege of survival. It fell to them to occupy and defend a desirable land devoid of natural defenses, a rich, land-locked inheritance surrounded by covetous and arrogant enemies. One reason ofttimes given for the relative uniformity of the Russian people has been the absence of mountain barriers in their homeland: the geographical circumstances have encouraged a cultural and ethnic fluidity. But this explanation proves too much: for precisely the same reason they could have lost their identity in the vast steppes, exposed forever as they were to alien peoples on every side, tugging them in every direction. They survived as a homogeneous ethnic group and a cultural entity because, for reasons deeply hidden in the racial strain, they chose to resist foreign encroachments. This struggle has been the theme of Russia's history - the continual temptation to assimilate foreign influences, leading to violent rejection in the interests of self-preservation, and ending in every instance with a deepened sense of their folk identity, but an identity molded by the ordeal of the never-ending struggle, molded positively by acceptance in some measure of foreign influences, and negatively by the self-inflicted effects of violent resistance.

In one of the earliest accounts of Muscovy written by an Englishman, in Queen Elizabeth's time, there is an observation concerning the Tsar's wars that could have been repeated with other names at almost any other period:

> His enemies with whom he hath warres for the most part are these: - Litto, Poland, Sweden, Denmarke, Lifland, the Crimmes, Nagaians, and the whole nation of the Tartarians, which are a stoute and a hardie people as any under the Sunne.[22]

A Continental traveler, Sigismund von Herberstein, writing in Latin a half century earlier, had remarked of the Russians and their horses that "rest is seldom given them, for either they are waging war against the Lithuanians, or the Livonians, or the Swedes, or the Tartars of Cazan; or, if no war is going on, the prince generally appoints 20,000 men every year in places about the Don and the Occa, as guards to repress the eruptions and depredations of the Tartars of Precop."

We saw in the recent war the tough soldier that the Russian makes. His qualities were not born overnight, nor were they the fruit of a single generation. He was the heir to an old fighting tradition. Read, if you will, this account of the same soldier four centuries ago:

> They are a kinde of people most sparing in diet, and most patient in extremitie of cold, above all others. For when the ground is covered with snowe, and is growen terrible and hard with the frost, this Russe hangs up his mantle, or souldiers coate, against that part from whence the winde and Snowe drives, and so making a little fire, lieth downe with his backe towards the weather: this mantle of his serves him for his bed, wall, house and all: his drinke is colde water of the river, mingled with oatemeale, and this is all his good cheere, and he thinketh himselfe well, and daintily fedde therewith, and so sitteth down by his fire, and upon the hard ground, rosteth as it were his wearie sides thus daintily stuffed: the hard ground is his feather bed, & some blocke or stone his pillow: and as for his horse, he is as it were a chamberfellow with his master, faring both alike. How justly may this barbarous, and rude Russe condemne the daintinesse and nicenesse of our Captaines, who living in a soile & aire much more temperate, yet commonly use furred boots and clokes?

It is safe to assume, I think, that this hardy Russ knew his mushrooms.

---

[22] Richard Hakluyt's *Principal Navigations*, *op. cit.*, vol. II, p. 438; also, *Notes upon Russia*, Hakluyt Society, first series, vol. 10, p. 95. The concluding quotation in this chapter is also from *Principal Navigations*, vol. II, pp. 258-9.

IV
Mushrooms for Murderers

> Exquisitum aliquid placebat, quod turbaret mentem et
> mortem differret.
> TACITUS *on the death of Claudius,*
> *Annals, Book XII, Chap. 66.*

For murderers there is only one kind of mushroom worth considering: the *Amanita phalloides*. Almost everyone who dies from mushrooms dies from it; and most of those who have eaten it have died from it. Even a small piece of the cap may kill a grown man. Specimens are easy to identify and easy to find in season - from August into October. Their poisonous virtue survives cooking, freezing, and drying. To speak more accurately, the deadly species are three in number, for we must add the *Amanita verna* and the *Amanita virosa*, but all three resemble each other so closely both in appearance and toxic properties that the murderer, whose ends after all are empirical, will disregard the distinctions as academic. He looks for white gills, veil (or ring), and volva, taking care not to be misled by any of the innocent amanitas, such as the citrina. On the autopsy table the victim shows pathological lesions of the viscera, but unlike arsenic, the pathologist cannot isolate the lethal agent, whose identity he must infer from the case history supplied by the attending physician, plus such evidence as can be assembled to show that the victim had eaten the lethal fungi. From the murderer's point of view, the deadly amanita suffers from one shortcoming: some victims, after days or weeks or even months of shattering illness, slowly recover and return to circulation. True, they are only frail replicas of their former selves, but they are alive and have foiled the murderer's coup. On the other hand, if the murderer also hates his victim, and if success attends his undertaking, his worst instincts and hopes will have been more than quenched by the slow progress and horrible suffering that attend the victim's downward course into the grave. The symptoms of poisoning by the deadly amanita are distinctive, dramatic, and terrifying.

To begin with, the lethal amanitas taste good - on this the abundant testimony of victims shows no dissenting voice. Nothing arouses suspicion as the greedy diner consumes his fateful dish; nor does he suspect anything for many hours thereafter. Indeed, the distinctive mark of this poison, its 'veritable signature' as Dr. Dujarric de la Riviere has aptly called it, is the period of absolute quiescence that follows the ingestion of the mushrooms, a period that never lasts less than six hours, and usually ten or twelve, sometimes twenty or even forty or more. The victim goes about his affairs blissfully unaware that the fingers of death already entwine him. Perhaps he speaks with relish of the mushrooms he has eaten, even returning to another dish of the same kind at the next meal. If they have been served to him intentionally, his murderer, standing by, eyes him with wicked and dissembled solicitude, alert for the inevitable moment. Of a sudden the victim is gripped by appalling abdominal distress, followed by vomiting and *diarrhoea foetida*. Neither emetics nor purgatives can help him now, for his system has absorbed the venom, during the long period of silent invasion. The initial seizure is followed by utter prostration, which in turn is succeeded by another paroxysm like the first, and this alternation continues, perhaps for many days, until the victim, his pulse fast and weak, succumbs, usually after a delirious phase. The appearance of the patient meanwhile is marked by what the physicians describe as the Hippocratic facies - eyes sunken and staring as though with anxiety or even terror, skin over the cheekbones taut and parched, nose pinched, temples hollow, ears leaden and cold, their lobes turned out, lips relaxed, the whole face livid - an appearance that is clear harbinger of imminent dissolution.

Our lugubrious, even sinister, approach to the toxic fungi presents the elementary facts that should be known to any detective story craftsman who resorts to mushroom poison as a device in the construction of a plot. The art of the detective story is a minor literary genre proliferated by the English-speaking peoples. Its leading exponents are often conscientious in their scientific research. But when they invoke mushroom poisoning, they seem incapable of artistic performance, as though the mycophobia peculiar to the Celtic and Anglo-Saxon races inhibited all inquiry into the dark recesses of the repellent subject. Mushrooms remain a mystery even to mystery writers.

Before examining the texts, we must mention two other kinds of toxic mushrooms. First and foremost there is the *Amanita muscaria*, erroneously regarded by many laymen as the poisonous mushroom. Its evil reputation far outruns its deserts. It gives its name to 'muscarine', the agent that most physicians and even medical examiners in the English-speaking world regard as synonymous with mushroom poisoning. But the facts are that muscarine is seldom if ever fatal, that it is destroyed by cooking, and that it exists in the *Amanita muscaria* only in traces, being much stronger in the *Amanita pantherina*. The hallucinations and muscular exertions inspired by the *Amanita muscaria*, followed by a period of stupor, are attributable to the presence of a wholly different compound, which resembles atropin. The victim (or beneficiary) of this intoxicating mushroom is imbued with a new sense of dimensions, of physical powers, of miraculous mobility.

Of the remaining toxic mushrooms, there is a peculiar mystery about the *Gyromitra esculenta*, a common species much eaten (as its name suggests) in Europe. Certain it is that at intervals cases occur where an individual dies from it. The explanation may not yet be surely known, but if the best opinion available today proves right, the *Gyromitra esculenta* offers us a notable fungal peculiarity. It seems that everyone may eat this tasty mushroom with impunity for the first time. But there are rare individuals who, if they return to a mess of the same species shortly thereafter, and if the mushrooms are fresh rather than dried, suffer a dangerous and even fatal anaphylactic shock.

Dorothy L. Sayers with Robert Eustace in *The Documents in the Case* produced the supreme example in English of a mystery story based on fungal poisoning. An eccentric Englishman, George Harrison, made wild mushrooms his hobby (he was obviously eccentric), and in the end was found dead (as normal Englishmen would expect) in a lonely shack. The evidence indicated that he had recently eaten a mess of stewed mushrooms prepared by himself. The coroner after chemical analysis of the uneaten remains of the stew put the death down to accidental muscarine poisoning. The victim's son, Paul, was not satisfied, because he was certain his father, a careful man and excellent amateur mycologist, could never have confused the *Amanita muscaria* with an edible species, and in the end he ran down the real culprit, a lover of Paul's step-mother, a villain named Robert Lathom, who in due course was proved to have introduced synthetic muscarine into the stock that had served for the mushroom stew. He was tried, convicted, and hanged. The story is well told, with delightful touches revealing the mycophobic habits of mind of the run of Englishmen. But it suffers from one defect: muscarine is destroyed by cooking and could not have caused the victim's death. True, the muscarine here involved is synthetic, but no evidence is produced to show that, in resistance to heat, the synthetic product differs from the natural. Furthermore, the toxicity of fresh muscarine is exaggerated: the chances were excellent that Harrison would survive an uncooked dose. Lathom should have used amanitine, not muscarine - the *Amanita phalloides*, not the *Amanita muscaria* - and for informed readers, his execution was a painful miscarriage of justice, a tragic sequel to an incompetent performance by Defense Counsel.

Miss Sayers and Mr. Eustace used, or misused, a genuine mushroom. More often English authors create fictional species, tailored to fit their plots. Ernest Bramah in *The Eyes of Max Carrados* tells a story entitled 'The Mystery of the Poisoned Dish of Mushrooms'. It hinges on the peculiar properties of a nonexistent fungus on which he bestows a name unknown to mycology, the Amanita bhuroides. (This name sounds like a misspelled derivative of Burrhus, a personage in attendance at the imperial court of Claudius and Nero.) It is so deadly that the victim expires within a half-hour of his seizure.

More remarkable than the Amanita bhuroides is the Panaeolus sherriffoides, as we shall call the mushroom that the playwright R. C. Sherriff devises for his drama *Miss Mabel*. His plot is unhappy, for we are expected to sympathize with a kindly, somewhat demented heroine who poisons her wealthy and hateful sister, the widow Fletcher. The mycophile watches with astonishment as the author, by a very act of creation, invents his mushroom and clothes it with precisely those attributes that the plot requires. It appears in the spring: the daffodils are in bloom and Easter is yet to come. (In nature there are almost no mushrooms then.) It grows fast, progressing noticeably in the course of a night's rain. A cluster of nine serves as the lethal dose, but the playwright suggests that fewer would have sufficed. When cooked, these mushrooms smell like hot rubber, but the smell is successfully overlaid with onions and tomatoes. Most remarkable are the toxic properties. These fungi are a powerful narcotic and put the victim to sleep at once. The widow Fletcher departs this life without pain, her ugly, resentful face assuming in death 'a look of such peace and gentleness' that the audience is presumably reconciled to her hurried departure at the hands of her sister.

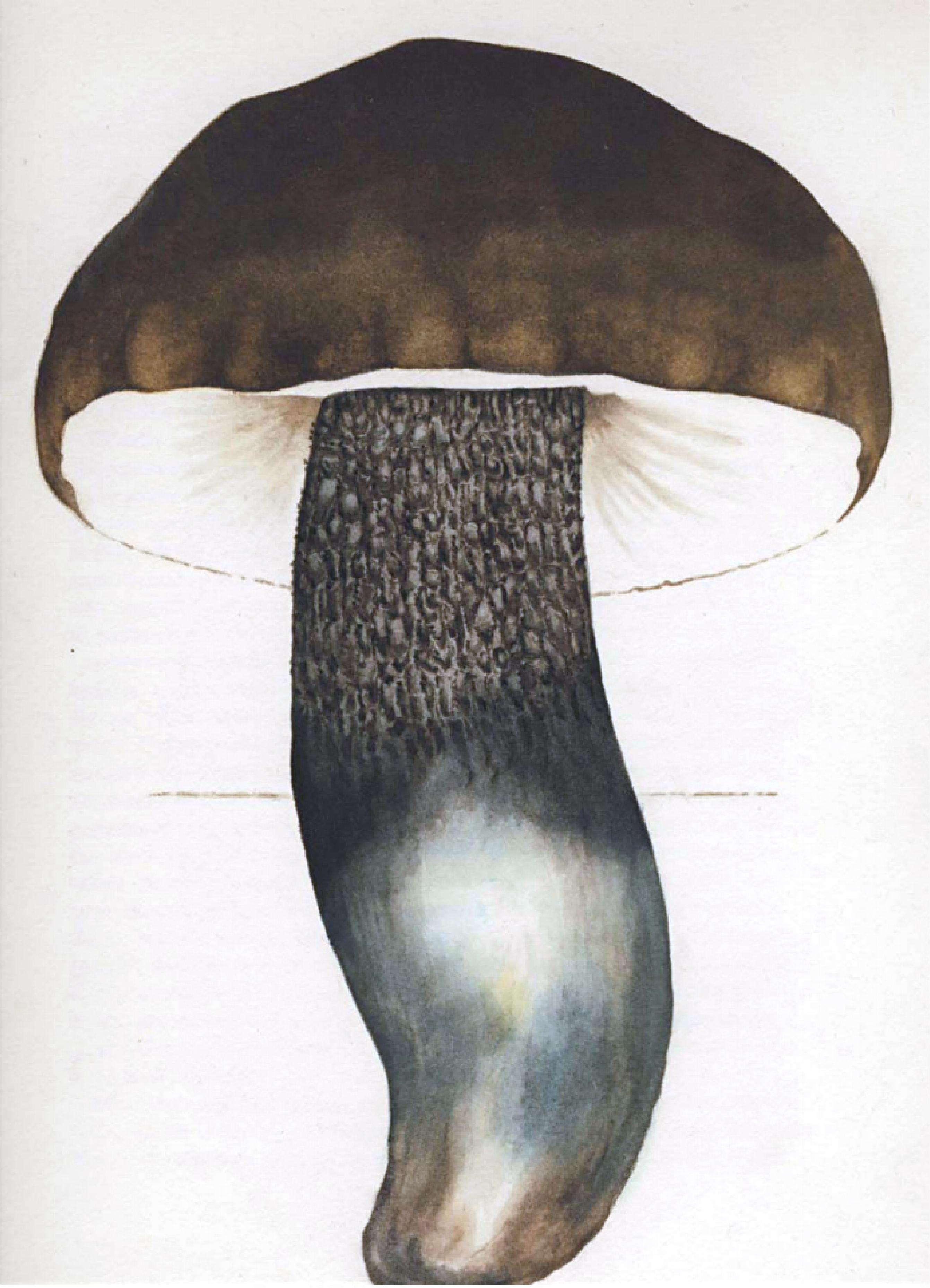


PLATE VIII
Jean-Henri Fabre
Boletus duriusculus Kalchbr. [*Leccinum duriusculum* (Schulzer ex Kalchbr.) Singer)]
Polish: *Koźlarz topolowy.*

Yet another inventor of mushrooms is H. G. Wells, in his short story, *The Purple Pileus*. Here a mild-mannered, milktoast of a man named Coombes, lower middle-class, finds himself browbeaten by his wife and her odious friend, Clarence, to the point of desperation and suicide. He rushes from the house into the woods. He thinks of drowning himself, but suddenly notices all the varied mushrooms around his feet. A purple pileus catches his eye, "a peculiarly poisonous looking purple", slimy, shining, emitting a sour odor but not disgusting. Coombes breaks off a piece, and the creamy white of the inside changes in ten seconds to a yellowish-green color. He remembers that his father had described this very species to him, and they were the deadliest poison. He tastes the thing. It is pungent and he almost spits it out, but then it seems merely hot to the taste and full-flavored, a kind of German mustard with horse-radish. He swallows it. There ensues a curious tingling sensation in his finger-tips and toes. His pulse quickens. The blood in his ears sounds like a mill-race. He loses his balance and falls, and forgets everything. While he lies there unconscious, a peculiar transformation takes place in his personality, for after a while he wakes up feeling bright and cheerful, his complexion a livid white, his eyes large and bright, his pale lips drawn in a cheerless grin. The mild little man is now a lion, fit to be the master of his house. He goes home, and in a scene of violent retribution he imposes his will on his wife and that noisome friend of hers. He is so successful that the reformation in his household proves lasting, and the whole course of Coombes's life is changed for the better.

Coombes's violence might suggest that he ate the *Amanita muscaria*, but Wells expressly distinguishes his purple pileus from that other species, "the red ones with white spots". Furthermore, the fly agaric produces a sleepy stupor after the spell of exhilaration, not before it. Wells, like Bramah and Sherriff, fills out the necessities of a given plot by inventing the needed mushroom, on which we here bestow the name of Boletus wellsoides.

Have English authors ever invented flowers or bushes or trees with which to adorn the English countryside? It seems unlikely. Surrounded by mushrooms that they never truly see, they usually ignore them, and on the rare occasions when 'toadstools' are needed, they blithely misrepresent them, to make them serve an odious or exotic purpose.

With Wells and Sherriff and Bramah, we observe a peculiar aspect of the mycophobia of the English in its unconscious and spontaneous workings. Doubtless many other examples could be assembled, and we shall mention a few. But first let us note and celebrate one exception. Anne Parrish in her novel *The Perennial Bachelor* dispatches one of her characters by means of a dish of mushrooms. Unlike all the other writers about whom we speak, she shows herself thoroughly versed in the properties of the deadly amanita. The episode is only incidental to her plot, and this makes the accuracy of her details even more astounding. It is not as though she had worked hard on mushrooms in order to hang her story on them.

In December 1949 *Ellery Queen's Mystery Magazine* published a yarn by August Derleth in which the murderer killed his victim by substituting for morels some specimens of the *Gyromitra esculenta* - a species that no villain bent on murder would ever rely on. In *Murder with Mushrooms*, Gordon Ashe has his victim die the same night that he dines on poisonous mushrooms - a tragic sequel that could not occur. In R. T. M. Scott's *Ann's Crime*, the victims inhale spores of the *Amanita phalloides* that have been concealed in a cheese cloth inside a pillow, and forthwith they die, for no doctor, we are told, could save a person whose head had once touched that pillow! ... Has there been a single writer of detective or mystery stories who has done justice to the genuine drama hidden in the properties peculiar to the *Amanita phalloides*; The German author Gustav Meyrink in his *Bal Macabre* deals with mushroom intoxication. The story is drenched with a pathological atmosphere artfully contrived. There is much about mushrooms in the narrative, but the hallucinations that hang over the whole story seem to us to be best explained by the effects of alcohol, an alcoholic's nightmare about toxic mushrooms. Meyrink reveals no knowledge of fungal toxicology. The prolific American writer Percival Wilde in his *Tinsley's Bones*, published in 1942, introduces as a witness a knowledgeable female mycologist who seems to be addicted to mushrooms of the genus panaeolus as a substitute for cocktails, the author and his character displaying thereby an astonishing command of mushroomic esoterica; but mushrooms in this yarn were not the agent used for the murder.

The facts about lethal mushrooms are to be found, not in standard medical reference works, but in mycological publications. They are well summarized in John Ramsbottom's *A Handbook of the Larger British Fungi*, an indispensable reference book, which however still characterizes the *Amanita mappa* (i. e., *citrina*) as poisonous, ignoring the work done by the French with this species. Good case histories in English of poisoning by the deadly amanitas appear in a Canadian Government publication, *Mushrooms and Toadstools*, by H. T. Gtissow and W. S. Odell. Certainly the best worked up case history in any language is the account of the tragic end of a Madame Boyer and her daughter Elodie, more than a century ago, retold with dramatic suspense and pathos by Camille Fauvel in his delightful little book, *Le Champignon aui tue*, published in Paris in 1926. The best single source of information about all the toxic mushrooms is, we believe, *Les Champignons Toxiques* (Paris, 1938), compiled jointly by Dr. R. Dujarric de la Riviere of the Pasteur Institute, and the mycologist Professor Roger Heim. Dr. Dujarric de la Riviere's promising efforts to produce an antitoxin for the deadly amanita were interrupted by the second World War, and intravenous injections of glucose are the only readily accessible palliative available to physicians today.

Mycologists are prone to exaggerate the importance of mushroom poisonings in history. In their writings we repeatedly find a list of eminent persons who have died allegedly from eating poisonous mushrooms, a list that they copy from each other without verification. Sometimes we read that Euripides lost his wife and two daughters thus, an assertion unsupported by any ancient text, apparently based on a misreading of Athenaeus. We read that Pope Clement VII - he who is remembered chiefly for his troubles with Henry VIII of England - was a victim of poisonous mushrooms. This Pontiff died on September 25, 1534. The date falls in the season of the deadly amanita, but the records show that Clement's symptoms first manifested themselves many months earlier, on May 30, and the course of his fluctuating illness from that moment is well documented. We discover in the record no trace of the telltale stigmata. As his biographer Emmanuel Rodocanachi wisely observes, "In accordance with the custom of those times, people attributed his death to poison."[23]

More remarkable still is the persistence in mycological writings of the assertion that Tsar Alexis of Russia or his widow died from mushrooms. Sometimes the texts name him, but more often her. As to the Tsar himself, the circumstances of his death are well known and are unrelated to fungi. His widow was an outstanding woman, the mother of Peter the Great, Natalija Naryshkina by name. She died on January 25,1694 (Russian style), after an illness of five days. Neither contemporary records nor the historians of the period tell us the nature of her ailment. If mushrooms were the cause, they must have been dried or pickled specimens from the previous autumn. What has given rise to the tradition among mycologists that mushrooms brought about her end? We believe the source is to be found in a footnote that appears on page in of Jean-Jacques Paulet's classic *Traits, des Champignons*, published in Paris in 1793, reading as follows:

> *L'accident arrivé à la veuve du czar Alexis, qui s'empoisonne avec des champignons qu'on avoit gardés pour le carême, et rapporté par Müller, est de notre siècle.*
>
> The accident that befell the widow of the Tsar Alexis, who was poisoned by mushrooms that had been set aside for Lent, as reported by Müller, belongs to our century.

The Müller to whom reference is made can only be Gerhard Friedrich Müller, a prolific 18th century writer about Russia who died in 1783. But his numerous works available to us make no mention of the death of Natahja Naryshkina, and Paulet's footnote remains uncorroborated.

Finally there was the case of the German Emperor Charles VI, father of Maria Theresa of Austria. He had been worried and run down. "On the 10th [of October] at night his complaint was increased by an indigestion, occasioned by a dish of mushrooms stewed in oil, of which he eat voraciously". So wrote that admirable man Archdeacon William Coxe, the same whom we quoted earlier, in his *History of the House of Austria*. Ten days later, on October 20, while the doctors were still arguing about the diagnosis, he surprised them by dying. The clinical details that Coxe supplies to us, including the patient's sudden death, are compatible with poisoning by the deadly amanita. There were no allegations that the poisoning, if such it was, was deliberate. If fungi were

---

23. *Histoire de Rome: Les Pontificals d'Adrien VI et de Clement VII*, Librairie Hachette, Paris, 1933. See also Ludwig Pastor, The History of the Popes, London, 1910, vol. 10.

the agent, he is the one modern personage thus killed. His end precipitated war and Voltaire declared that "a pot of mushrooms changed the history of Europe".

So much for the famous men and women whose deaths have been attributed rightly or wrongly to mushrooms. This mortuary procession of alleged mushroomie victims would be incomplete if we did not here add the murders revealed by l'affaire Girard. In this case, the victims were persons of no consequence: their very names are forgotten. But the circumstances that brought them to their deaths are, for mycophiles and epicures of crime, both instructive and fascinating.

The standard mushroom manuals of France, like those of England, have always been saturated with mycophobic caution. By overstating the toxic dangers of various species, they have aimed at assuring the safety of their readers. But, through a strange conjuncture of events, that very bias once contributed to the disastrous end of a man who trusted his mushroom manual too much. This is the lesson to be learned from l'affaire Girard.

Girard's murders would doubtless have drawn wide attention if the press stories had not broken at the precise moment of the great spring offensive of 1918, the final year of the first World War. Girard was a Parisian, and his accomplices were his wife and his mistress. He murdered only his friends, after insuring their lives in his own favor. Poisons were his instrument, and among other poisons he used toadstools gathered for him in the forest of Rambouillet by an old hobo known as le pere Theo, whose testimony later was damning to the accused. From time to time Girard would order from Theo a mess of amanitas: they had to have white gills, veil, and volva - the stigmata of the deadly amanita, but also of the *Amanita mappa* or citrina. Girard and his wife would serve these fungi to their victims at sumptuous dinners in their own apartment. Sometimes the guest went home and died, but on other occasions, doubtless to the surprise and discomfiture of the Girards, the intended victim suffered no ill effects whatever! Indeed, a number of them lived to give their evidence to the police.

In 1918 the standard mushroom manual of France was Paul Dumee's. Like all of the over-cautious manuals of that time, it condemned the *Amanita citrina* as deadly. Girard had not thought it necessary, therefore, to distinguish the two amanitas when instructing old Theo about the mushrooms to gather. Thus it came about that when Theo brought in a mess of the *Amanita phalloides*, the victim would enjoy a dish of tasty mushrooms and later die. But when Theo produced specimens of the innocent *Amanita citrina*, the intended victim must have found them a little unpleasant to the taste, and that was the end of the matter. For the deadly amanita makes a delectable dish, whereas its relative the innocent citrina scarcely rises palate-wise to the mediocre level.

Thus it may be said that Girard was deceived and misled by Dumee's overcautious manual, with the result that some of his friends and intended victims unwittingly survived his honest efforts to do them in, and he in turn was fatally entangled in the law's toils. Now that the French manuals have improved, Girard's mistake is unlikely to be repeated. Had Girard hailed from Sérignan, Henri Fabre's village in the Provence, he would have known from childhood not to rely on Dumee, for these peasants need no manuals.

Girard's crimes would have been forgotten, had it not happened that Camille Fauvel, that prodigious mycophile, was a *Commissaire de Police* in Paris at the time, and though he was not handling the Girard case, having lately been charged with the more famous and important but less interesting Mata Hari dossier, he followed it with expert attention, even interviewing Girard in Fresnes prison after the conviction, in the interests of mycological lore. Fauvel published an admirable narrative of the affair many years later, in the *Supplement* to the issues of June and August, 1936, of the *Revue de Mycologie*, and we have drawn our facts from his account. It should be added that Girard died in his prison bed of tuberculosis a few days after he was interviewed, never having admitted his guilt nor that he had relied on the unsound advice of Dumee. But Fauvel's inference is based upon evidence that leaves little room for doubt.

All that we have set forth in this chapter up to now - the description of the singular properties of lethal mushrooms, the inadequacy of mystery writers when they deal with this theme, our comments on alleged poisonings of eminent personages and the mushroomic murders of unimportant folk - has had only one purpose: to equip the reader for a reconsideration of the death of the Emperor Claudius in A.D. 54. On that occasion, for once in the course of recorded history, the whole of a great Empire and the known world swung on a dish of mushrooms. The accounts in the ancient writings of that famous event are an old, old story, familiar to all students of antiquity. Those texts have been parsed by students, dissected by historians, pondered by moralists for close on to twenty centuries. It would seem that by now every conceivable interpretation must have been hit upon, and the resources of scholarly inquiry exhausted. Indeed, the signs of exhaustion are not lacking: in our own generation Guglielmo Ferrero in his *The Women of the Cesars* has not only struggled to exonerate Agrippina of the dreadful charge laid at her door, but to portray her as a noble Roman matron!

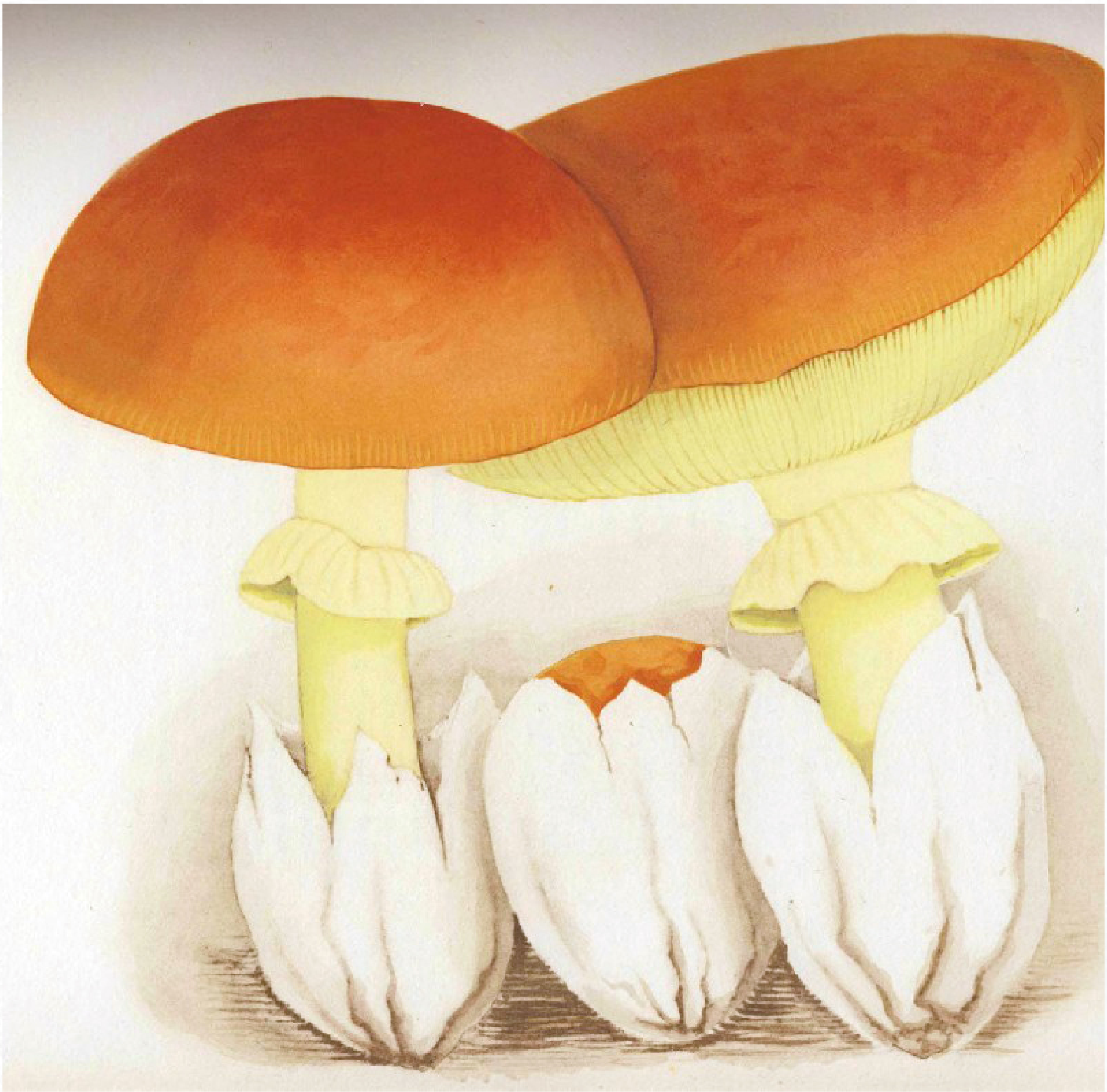


PLATE IX
Jean-Henri Fabre
Amanita caesarea Fr. ex Scop.
French: *orange;*
Italian: *ovolo;*
Polish: *Muchomor cesarski.*

It would be surprising if at this late date fresh evidence shedding light on Claudius's death were discovered, and yet this is what we think we have done. We rely solely on the same worn texts, and we entrust our fate to the verdict of scholars far more learned than we. Perhaps those old texts have a message to deliver to us that can be discerned only by one who is a lover of mushrooms, a physician, and above all an amateur of venomy - amateur in the sense of a critical but passive observer of those who have practiced that subtile art.

Let us recall the background of the crime. Claudius succeeded Caligula as emperor in the year 41, at the age of 51. By his third wife, Messalina, he had had a son, Britannicus, born the year before his accession. After executing Messalina for adultery, he married his niece Agrippina, who by a previous marriage had a son of her own, three years senior to Britannicus; and her son was destined to worldly immortality as the Emperor Nero. Indeed, Agrippina's motive in murdering her husband was to assure the succession to Nero, in which endeavor success crowned her efforts. Claudius at the time of his death was said to be favoring Britannicus, and it was even rumored that he had bequeathed the Empire to Britannicus in a will that Agrippina destroyed.

The young man who was to be known as Nero had as his tutor from A.D. 50 on the famous Seneca, and at the time of the crime Seneca was an intimate of the imperial circle, privy to all that went on. He could have left us an eye-witness account of what happened, but instead he veils his remarks in satire - a prudent evasion of one who undoubtedly knew too much. Three of the ancient historians have given us accounts of the event. Tacitus, who was probably born in the year after Claudius's death, wrote his narrative about sixty years later; Suetonius's version came a few years after that; and Dio Cassius told the story again almost two centuries after the event. These three secondary sources differ among themselves in details, which gives to their agreement on essentials a stamp of verisimilitude. In the main they were not copying each other, and they probably had the important facts right.

Claudius was exceedingly fond of mushrooms (*boleti*), and a plausible tradition has it that his favorite kind was what we know today as the *Amanita caesarea*. The dish of mushrooms that he ate on the fateful day consisted of poisoned, not poisonous, mushrooms. On this all three of the ancient historians agree, in different words. None identifies the poison that was used, but they are abundantly clear that poison was added to the Emperor's favorite dish. Here is Tacitus, Book XII, Chap. LXVII of the *Annals* in the Loeb edition:

> Adeoque cuncta mox pernotuere, ut temporum illorum scriptores prodiderint infusum delectabili cibo boleto venenum.
>
> So notorious, later, were the whole proceedings that authors of the period have recorded that the poison was sprinkled on an exceptionally fine mushroom.

Suetonius gives alternative versions, in Book V, Chap. XLIV, in the Loeb edition:

> Et veneno quidem occisum convenit; ubi autem et per quem dato, discrepat. Quidam tradunt epulanti in arce cum sacerdotibus per Halotum spadonem praegustatorem; allí domestico convivio per ipsam Agrippinam, quae boletum medicatum auidissimo ciborum talium optulerat.
>
> That Claudius was poisoned is the general belief, but when it was done and by whom is disputed. Some say that it was his taster, the eunuch Halotus, as he was banqueting on the Citadel with the priests; others that at a family dinner Agrippina served the drug to him with her own hand in mushrooms, a dish of which he was extravagantly fond.

Suetonius places the poisoned mushrooms only in his second version, but mushrooms could have been the vehicle that Halotus used too, and this may be implied. Dio Cassius comes down to us in a Greek summary. In Book LXI he accuses Agrippina of having put the poison into "one of the vegetables called mushrooms", using for mushroom the Greek word μύκης. A few pages later Dio Cassius refers again to the same poison when he says:

> Agrippina was ever ready to attempt the most daring undertakings; for example, she caused the death of Marcus Junius Silanus, sending him some of the poison with which she had treacherously murdered her husband.

What poison did Agrippina use? We think the answer is clear. She turned for advice and aid to a woman named Locusta, an experienced artist in the preparation of poisons, as Tacitus tells us; a famous dealer in poisons, as Dio Cassius puts it. According to Tacitus, the instructions of the Empress to Locusta were narrowly defined.

The poison was not to be sudden and instantaneous in its operation, lest the desperate achievement should be discovered. On the other hand, if the effect were slow and consuming, Claudius as his end approached might discover the treachery and take steps to thwart the perpetrators in their ultimate purposes. (He might, that is to say, proclaim Britannicus as his heir.) Something subtle was needed, which would take time but also deprive the victim of his faculties. As Tacitus goes on to say, by Locusta's skill the desired poison was prepared. This passage in the *Annals* of Tacitus being a crux in our argument, we give it in full:

> Tum Agrippina, sceleris olim certa et oblatae occasionis propera nec ministrorum egens, de genere veneni consultavit, ne repentino et praecipiti facinus proderetur; si lentum et tabidum delegisset, ne admotus supremis Claudius et dolo intellecto ad amorem filii rediret; exquisitum aliquid placebat, quod turbaret mentem et mortem differret.
>
> It was then that Agrippina, long since bent upon the impious deed, and eagerly seizing the present occasion, well furnished too as she was with wicked agents, deliberated upon the nature of the poison she would use, whether, "if it were sudden and instantaneous in its operation, the desperate achievement would not be brought to light: if she chose materials slow and consuming in their operation, whether Claudius, when his end approached, and perhaps having discovered the treachery, would not resume his affection for his son." Something of a subtle nature was therefore resolved upon, "such as would disorder his brain and require time to kill." [Oxford translation, *Annals*, Book XII, Chap. 66]

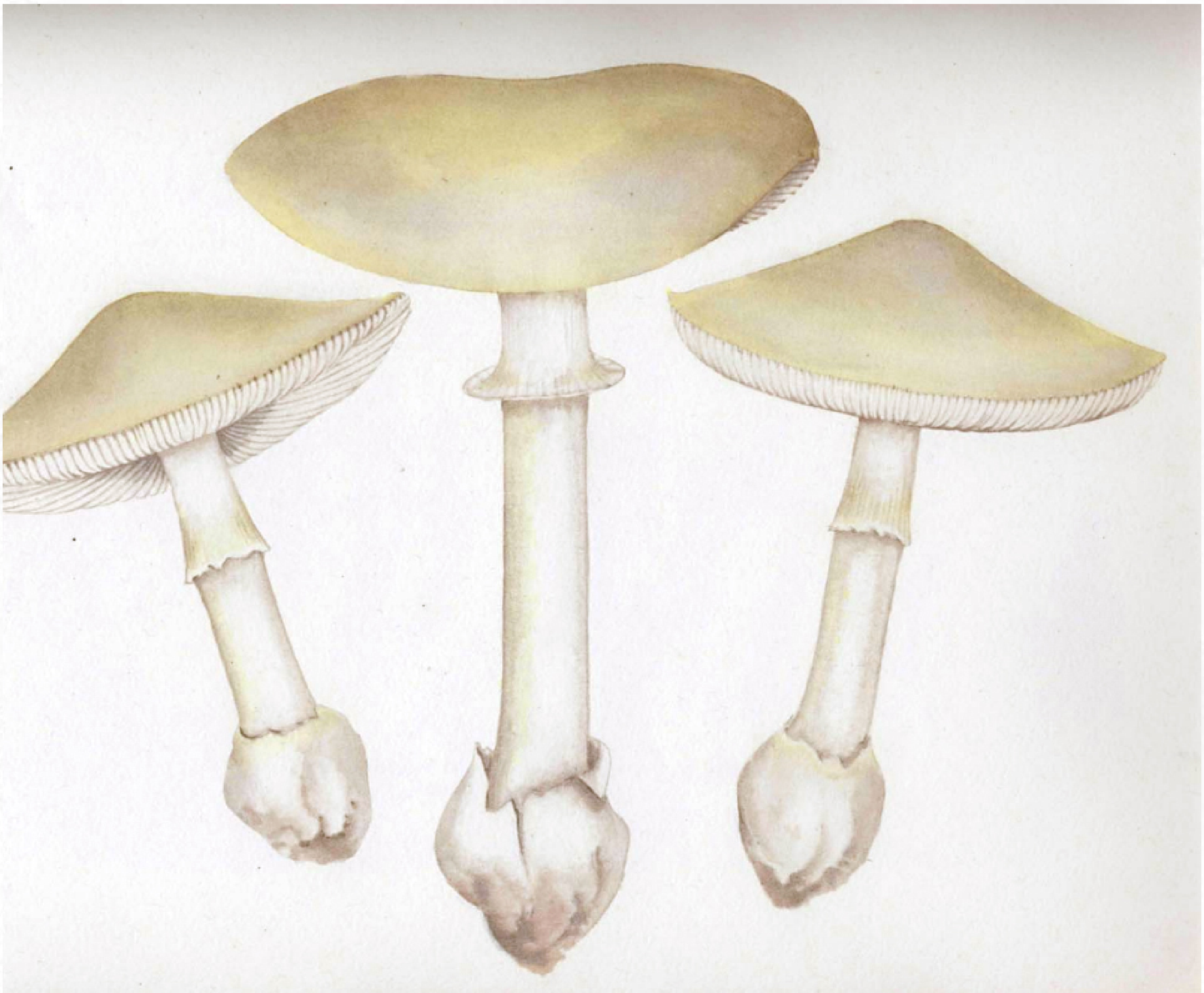


PLATE X

Jean-Henri Fabre
Amanita phalloides Fr.
French: *orange cigue verte;*
Polish: *Muchomor zielonawy.*

There was only one poison available to the ancients that would fulfill Agrippina's requirements - the poison of the deadly amanita. The victim would not give away the game by any abnormal indisposition at the meal, but when the seizure came, he would be so severely stricken that thereafter he would no longer be in command of his own affairs. For one familiar with the properties of the *Amanita phalloides* the text in Tacitus seems transparently clear. But for others than mycophiles there might remain a doubt: is it legitimate for us to infer that Locusta knew the deadly amanita and its secret virtue to which even now, after nineteen centuries, few are privy?

This question troubled and challenged us, not because we were uncertain but because it would be hard to carry conviction with an uninitiated public. Once more we reviewed all the principal sources, all the stray allusions in the classical writers. We concentrated especially on Seneca. After all, he was a witness whose testimony would have been competent in our own courts of justice; he was articulate, and had he not carried the secret etched sharp in his memory from that fateful October day in A.D. 54 until his death eleven years later? Somewhere, if only by inadvertence, he must have talked, and perhaps his revealing words had survived, their esoteric meaning hitherto unperceived. We embarked on a reading of all his extant writings. We began with his later works, composed after the death of the Emperor, and tried to orient each sentence toward that event. Suddenly one day we came upon the tell-tale phrase: it leaped at us from the page, fairly shouting at us. Yes, whether with sly intention or by inadvertence, Seneca had blurted out the fateful secret, imparting it to all knowing readers. And before us not a single commentator had ever caught the inner meaning of the plain words.

We refer the reader to Letter XCV that the old Stoic wrote to his friend Lucilius nine or ten years after the death of the Emperor and one or two years before he took his own life on Nero's orders. In it he describes and deplores the excesses of the Roman upper class. He refers to the late Emperor's gluttony:

> Dii boni, quantum hominum unus venter exercet! Quid? tu illos boletos, voluptarium venenum, nihil occulti operis judicas facere, etiam si praesentanei non fuerunt?
>
> Good gods! What a number of men does one belly employ! But can you think those mushrooms (a tasty poison) do not secretly and gradually operate, though no bad effect is immediately perceived from them? [Loeb translation]

Here is proof that Seneca knew the *Amanita phalloides*. The period of silent invasion, that *veritable signature* of the lethal mushroom, was familiar to him, and he even took pains to mention how tasty the wicked mushroom was! How much guilty knowledge packed into a few words! Read in conjunction with the Empress Agrippina's instructions to Locusta, we believe it clinches our case. The poison in the dish of Caesar's amanitas was the poison of the deadly amanita. Two of our authors, Suetonius and Tacitus, give us grounds for supposing that the administration of the poison was entrusted to the eunuch Halotus, whose office it was to taste the Emperor's food before serving it to him. Tacitus says that Halotus poured the poison into the dish of mushrooms. It would have been easy for Locusta to prepare a sauce from the deadly specimens, and by enlisting the aid of Halotus, no suspicion would be aroused by the failure to serve it to others at the feast. However, this is a detail, important at the time to the participants of course, but secondary to the primary fact that the ancient writers are telling us exactly how Locusta handled the assignment with which Agrippina charged her. We believe that the secret of those two fearless and wicked women is withheld from us no longer. (For Latinists and mycologists it is interesting to note that Seneca uses the word *boletus* for the deadly amanita: it was clearly the term for all amanitas, not merely the *Amanita caesarea*.)

We rest our case on the knowledge shown by Seneca and the quoted passage from Tacitus, taken together. But there is additional circumstantial evidence compatible with our theory. The crime was committed on October 12 - in the season when the deadly amanita could be easily found around Rome. On the morrow after Claudius had eaten the mushrooms and while he was yet alive, comedians were introduced into his presence to solace and delight him, as Suetonius says. Since any such kind intention was foreign to Agrippina's nature, and *a* *fortiori* at the dreadful moment that we are considering, we may assume that her purpose was different: the comic actors were to bear witness in the public market-place that the Emperor had not been killed but was in truth desperately ill, and the Hippocratic facies that we know he must have manifested gave them full warranty for such a report. Immediately after Claudius's death, he was proclaimed a god - a posthumous honor for emperors to which Romans were accustomed. Afterwards, when Nero was in secure possession of his imperial office, he was present at a certain banquet where mushrooms were brought in, and someone remarked that they were the gods' food, *cibus deorum*. To this Nero is said to have replied: "True enough: my father was made a god by eating a mushroom." (This story is told by Suetonius, Dio Cassius, and Petrus Patricius.) Nero's remark is more apt if he was referring to the deadly amanita, and not merely to a dish of edible mushrooms that had been poisoned; and Nero was in a position to know.

In spite of Locusta's artistry, we know that her bold stroke was botched, and this leads us to the second part of the crime. The time schedule alone tells us that something went awry. Claudius sat down to his fatal banquet at about 2.30 p.m. on October 12. At or shortly after noon the next day he was dead. The lethal amanitas do not kill so quickly. We do not know at what stage in the lengthy banquet he ate his mushrooms, but probably not at the beginning. His seizure could not have taken place before 9 p.m., and probably not before midnight or later, which would mean that his agony lasted only twelve hours! On its face this is impossible. We pointed out earlier that, for a murderer, the *Amanita phalloides* labors under one defect: occasionally a victim recovers. Agrippina could not afford this risk, and even if we had no evidence to support our theory, we might assume that she and Locusta, as their imperial patient lay at their mercy, resorted to direct methods to dispatch him. Fortunately, our texts come to our help.

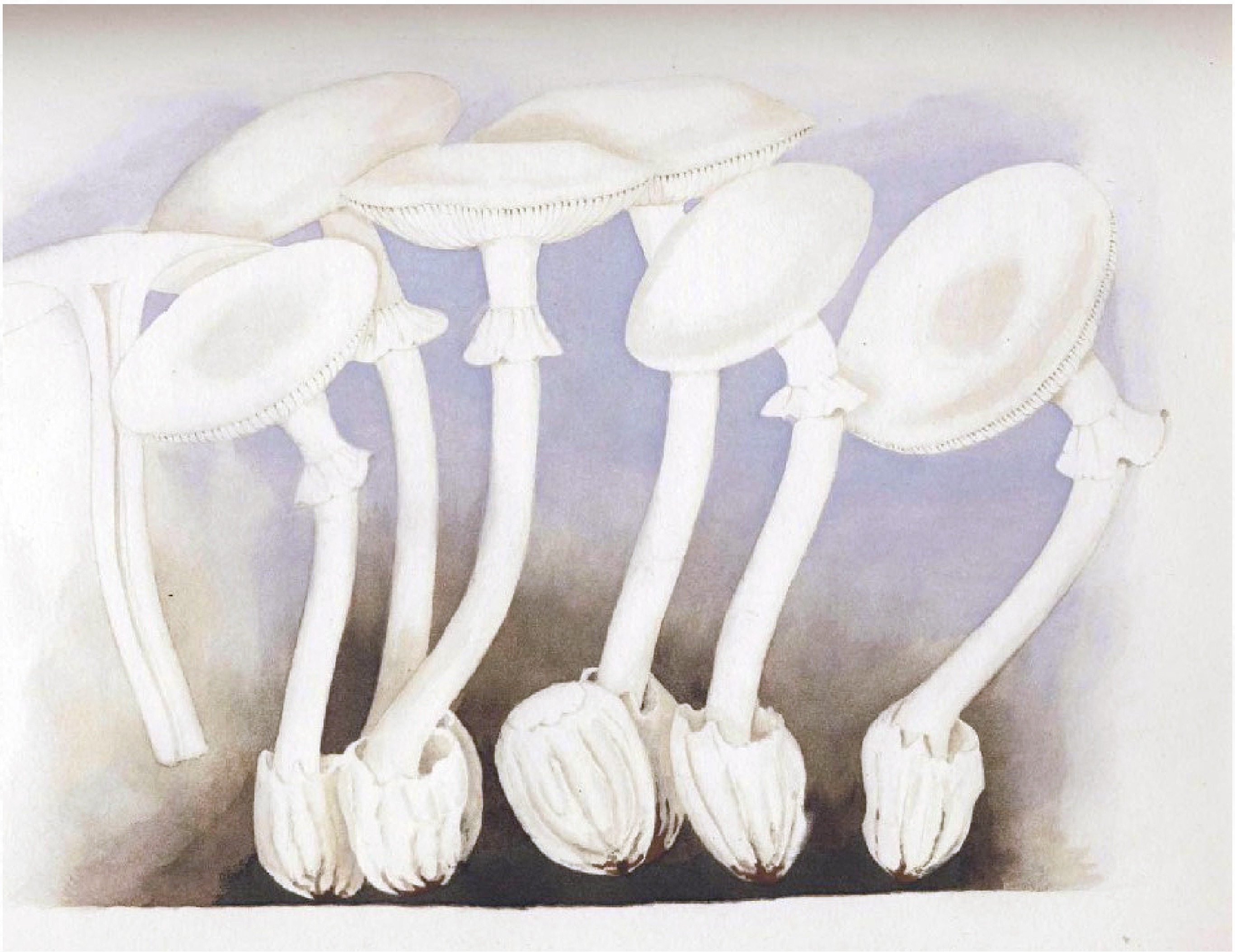


PLATE XI
Jean-Henri Fabre
Danse Macabre. *Amanita verna* (Bull.) Lam.
French: *orange cigue blanch*;
Polish: *Muchomor wiosenny*.

"The victim of the plot," says Dio Cassius, "was carried from the banquet apparently quite overcome by strong drink, a thing that had happened many times before." Suetonius's version is hesitant: "Of those accidents also which ensued hereupon [after eating the mushrooms] the report is variable. Some say that straight upon the receipt of the poison he became speechless, and continuing all night in dolorous torments died a little before day. Others affirm that at first he fell asleep, and afterwards, as the meat flowed and floated aloft, vomited all up." (If it is true that in his usual drunken stupor he threw up, this was enough to send the two women into a panic, for he might have rid himself of the fungal poison!) Tacitus is explicit: "Agrippina therefore became dismayed; but as her life was at stake, she thought little of the odium of her present proceedings, and called in the aid of Xenophon the physician, whom she had already implicated in her guilty purposes. It is believed that he, as if he purposed to assist Claudius in his efforts to vomit, put down his throat a feather besmeared with deadly poison; not unaware that in desperate villainies the attempt without the deed is perilous, while to insure the reward they must be done effectually at once." There was thus a second poisoning, with the Greek physician Xenophon replacing Locusta. Suetonius says that, according to one report, the second poisoning was by clyster.

What was that poison to which Xenophon had hurried recourse? Robert Graves in private correspondence offers us an answer that fits the circumstances perfectly. Not long after Claudius's death, Seneca published a satire on the emperor's deification to which he gave the title of *Apocolocyntosis*, an artificial word telescoping *apotheosis* and *colocynthis*. The colocynth (as we call this gourd in English) is far from being a pumpkin, and the traditional translation of this title, the *Pumpkinification* of Claudius, is indeed as insipid as the classical scholars have considered it. But if Mr. Graves is right, and we believe that he is, the scholars have missed the point.

The colocynth is not edible. It is exceedingly bitter, whence its name, 'the bitter gourd'. It is not native to Italy, but was imported from the arid areas of the Near East, notably Palestine. This is the famous gourd that responded to Elisha's miraculous powers in II Kings, Chapter 4, verses 38 to 41:

> And Elisha came againe to Gilgal, and there was a dearth in the land, and the sonnes of the Prophets were sitting before him: and hee said unto his seruant, Set on the great pot, and seethe pottage for the sonnes of the Prophets,
>
> And one went out into the field to gather herbes, and found a wild vine, and gathered thereof wilde gourds his lap full, and came and shred them into the pot of pottage: for they knew them not.
>
> So they poured out for the men to eat: and it came to passe as they were eating of the pottage, that they cried out, and said, O thou man of God, there is death in the pot. And they could not eate thereof.
>
> But he said, Then bring meale. And he cast it into the pot: And he said, poure out for the people, that they may eat. And there was no harme in the pot.

In minimal doses the colocynth is a violent purgative; in larger doses it is lethal. It happens that we know the history of this drug in surprising detail. In the first century of the Christian era the upper classes of Rome were much concerned with their health: hypochondriasis was rampant, and miracle drugs were being discovered one after the other.[24] Early in the reign of Claudius an apothecary named Scribonius Largus enjoyed immense vogue; possibly he attended Messalina, the mother of Britannicus and predecessor of Agrippina as wife of the Emperor. In the middle 40's of that century he assembled and published a collection of prescriptions that was destined to become famous, and among them was a formula, or *hiera*, that he had discovered among the papers of a deceased colleague, Paccius Antiochus. One of its ingredients was colocynth, a novel drug that thereupon quickly became the rage in the upper crust of Rome, a few years before the events that we are discussing. In the desperate extremity of that turbulent night of October 12, A.D. 54, when the Greek physician Xenophon was called in consultation and permitted himself to become a *particeps criminis*, it was natural for him to come to the rescue of Locusta and Agrippina by dispatching Claudius with an overdose of colocynth, administered by mouth or clyster or both. This explains the name that Seneca gave to his satire. Claudius's last words, as attributed to him by Seneca, were *Vae me! puto, concacavi me*, which would be apt for either colocynth or the deadly amanita.[25]

---

[24] Some of the drugs used in imperial Rome have survived in use until recent times. One such is the agaric, and another is colocynth, this latter having been the base for "general issue" purgative pills in the British army in the first world war. We too, in the mid-20th century, are witnessing a spate of miraculous pharmaceutical discoveries. Will a single one of them be remembered in A.D. 3850?

If then our reading of the texts is right, Claudius was done in with a one-two knock-out, first a dose of the deadly amanita, and then a dose of colocynth. As a pun on 'apotheosis', the name of Seneca's satire *Apocolocyntosis* at last becomes clothed with wit: the deification of an emperor is reduced to a repulsive scatological metamorphosis. When, later, Agrippina did away with Marcus Junius Silanus (as Dio Cassius tells us), it was the deadly amanita that she used, and not colocynth; for colocynth proclaims its presence by its bitterness, and an intended victim would spew it out forthwith.

At noon on October 13 the gates of the imperial palace in Rome swung open, and Nero, then a youth of 17, emerged and presented himself as the new emperor to the army detachment that was on guard there. The Emperor Claudius was dead, or *in extremis*. There could have been no reason, only danger, in prolonging the interval between the death of the old emperor and the assumption of authority by the new.

And so we bring our review of Claudius's death to an end. The three ancient historians who tell us the story were not clinicians. Their accounts, differing sharply in the unessential details, give us a surprisingly clear and consistent overall clinical picture. This is circumstantial evidence of virtually conclusive weight that they were telling the truth. They could not severally have invented a combination of symptoms, and a sequence of events, that two thousand years later would speak for themselves.

Our sources say that a curtain of secrecy had shrouded the palace during the illness of Claudius. It is tempting to try to reconstruct the scenes in the imperial palace before and during the crime. The plot had been laid earlier in whispered conversations between Agrippina and Locusta in some safe spot to which Locusta had been furtively summoned. How stirred Locusta must have been by her great assignment: the world offered none bigger for a person in her line of work. Locusta, if she possessed imagination as well as art, may well have leaped with excitement at the thought that this deed, artfully accomplished, would bring her immortality; and indeed it has done so. But during that fateful night the tension must have been unbearable. Had their victim foiled their efforts prematurely from drunkenness, by vomiting before the poisonous amanita had done its damage? Might he survive and resume the exercise of his imperial functions? Was Locusta vexed, her professional pride hurt, when Xenophon was called in, or was she relieved? With what anxious eyes Locusta and Agrippina must have searched each other's ill-lighted faces as the hours crept on! But in any case, with his enemies in command at his bedside, Claudius stood no chance.

The triumph of Agrippina and her fellow conspirators bestowed on them all power. They may well have gloated in their success, and were so situated that they could talk with a large measure of impunity. In the writings of Seneca and the three historians, one seems to hear echoes of veiled boasting, as though Locusta and Agrippina were dying to tell just how they had contrived their ends. Their words were veiled, in homage to virtue, but thinly, and lend themselves to understanding by the initiated, if only across a chasm of nineteen centuries.

---

[25] For information concerning the early use of colocynth in Rome, the best source is Wilhelm Schonack's scholarly study *Die Rezeptsammlung des Scribonius Largus*, published in Jena in 1912.

V

The Riddle of the Toadstool and Other Secrets Mushroomic

> [Fungi] quod comesti frequenter oppilant vias spirituum
> animalium in capite, et inducunt insaniam.
> ALBERTUS MAGNUS *De vegetabilibus*.

Toadstool is a strange term, and doubly strange because no one in our word-conscious times seems to have paused to look at it. Toads do not sit on wild fungi, nor under nor around them; neither do they eat them. Indeed toads and frogs have no direct physical or biological link with toadstools. Our word, with roots deep in our folkways, is not, in any way obvious to us, a distillate of man's observation of nature. The Oxford Dictionary says it is a 'fanciful' name, and thus sidesteps a riddle. Not infrequently commercial artists and fanciful illustrators of children's books represent toads with toadstools, and occasionally even photographers contrive by trickery[26] to juxtapose the two. In every such instance they draw their inspiration from the word, not from nature.

Why 'toadstool'; This question sank its spurs in us some years ago and pricked us onwards, until soon we found ourselves launched on a pilgrimage to far-off places and remote times, to the frontiers of men's knowledge and beyond, where we sought to discern vistas behind the beginnings of recorded history. Through the worn faces of familiar words we re-discovered things that civilized men had forgotten. We may have found, in the end, successive answers to our toadstool riddle, layer beneath layer, as well as answers to a number of other fungal mysteries that reared their challenging heads along our path. The measure of our success will be the cogency of certain problems of larger scope that seem to emerge from our argument, problems that we gladly bequeath to others.

---

[26] Thus on Nov. 8, 1930, *The Times* published a sequence of six photographs showing a toad as it approached a boletus, clambered up on the cap, and finally sat there. Dr. John Ramsbottom reprinted four of these in his *Mushrooms & Toadstools*, Collins, London, 1953, facing p. 287. The photographer, Neville Kingston, died in the 1930's. *The Times* kindly supplied us with his original series of seven photographs, and by internal evidence it is clear that they do not record a spontaneous happening in nature. Innocent and playful in intent, and delightful as one more example of man's undying loyalty to cherished error, these photographs must be docketed as nature fakes. Toads when slightly chilled become lethargic and lend themselves to posing, a secret undoubtedly known to Kingston.

1

The Venomous Toad

> He ordenit hir to hing, roist, and drop ane taid, and
> to lay the droppis of the taid in his hienes [=Highness']
> way, for his hienes distructioune.
> *Testimony in trial of Barbara Napier, May 8, 1591.*

The sinister mark of the toad is not confined to the English fungal vocabulary. You will find it in Norwegian and Danish, though not in Swedish; in Low German, Dutch, and Frisian; in Breton, Welsh, and Irish. The romance languages know it not, except for traces in French. Nor does it survive in standard High German, though it lingers on in High German dialects. Thus the citadel of the 'toadstool' is in the ring of peoples who dwell around the shores of the North Sea, a gigantic and evil Fairy Ring, as it were, embracing fringes of the Teutonic peoples and the surviving Celts, along with the French. (The Bretons, let it be remembered, emigrated from Britain to their present home across the Channel in the fifth and sixth centuries after Christ, and are thus remote heirs, folkwise, of old Britain.)

Not all of these peoples use the figure of the toad's stool. The Norwegians and Danes speak of the toad's hat; the Low Germans, of the frog's stool; the Dutch say toad's stool; and the Frisians refer to an old fungus as a toad's hide. The Irish term is the frog's pouch; the Welsh, toad's cheese; the Bretons, toad's cap, but by the addition of a single initial sibilant, their term becomes toad's stool, and this is a recognized variant in their language. Here are the words in these tongues: in Norwegian and Danish, *paddehat*; in Low German, *poggenstohl*; in Dutch, *paddestoel*; in Frisian, *poddehud*; in Irish, *bolg losgainn*, with *bolg* meaning pouch; in Welsh, *caws llyffant*, with *caws* meaning cheese; in Breton, *kabell tousec*, and also *skabell tousec*. The Pennsylvania Dutch speak a dialect of High German that comes down from the language of the Palatinate in the 18th century, and in Pennsylvania Dutch we find both toad's stool and toad's foot: *grottestuhl* and *grottefuss*. We know that toad's bread, *pain de crapaud*, was used for wild fungi in 16th century France, and this same expression has been reported in modern times in the Calvados region of Normandy. The *Amanita muscaria*, with its red cap flecked by warts, is called *crapaudin* in some parts of France and this word in the form *grapaoudin* has been reported as far south as the Herault, on the Mediterranean.[27]

All these words, in varying degrees, exhale a bad odor. They designate wild fungi that the speaker considers, rightly or wrongly, inedible and dangerous. The English toadstool, freighted with evil, is typical of the class. In the dialects of England there are numerous variants, and these are interesting because they echo the figures of speech that are current in our list of foreign words. Thus we find toadcheese or taddecheese, toad's bread, toad's cap or toadskep, and toad's meat. For the toad itself there is an ancient variant, pad or paddock, which gives us paddock-stool and puddock-stool. This 'pad' is the same word for toad that the Dutch and Frisians, the Norwegians and Danes, use. This is the witches' word in the opening scene of *Macbeth*:

> Padock calls anon: faire is foule, and foule is faire,
> Hover through the fogge and filthie ayre.

Here in our argument we interrupt its course for a necessary diversion.

Today civilized men have a kindly feeling for the toad. Lewis Carroll and Kenneth Grahame have planted the seeds of their benign influence in the minds of successive generations of well brought up English-speaking children. The Victorians were inclined to foster sympathy for the whole animal world. (Was this because the industrial revolution released increasing numbers of men from slavery to the soil, from intimate conflict with cantankerous nature?) As for the toad, there has been an additional influence: men of science have undertaken to show that it is the farmer's friend.

---

[27] Our source for the French mushroom vocabulary is *Flore Populaire ou Histoire Naturelle des Plantes dans leurs Rapports avec la Linguistique et le Folklore*, by Eugene Rolland, Paris, 1914; vol. XI, pp. 129 ff.

Far different was the repute of the toad in times past. There was no other member of the animal kingdom that inspired such revulsion and fear. Chaucer spoke of the 'foule tode', and Spenser of the loathly and venomous toad. 'A pad in the straw' was what our ancestors said when they meant 'a nigger in the woodpile'. (Now that this last phrase is banned in polite society and perhaps vanishing, why not revive the earlier expression?) Shakespeare reveled in the toad as a potent term of abuse. In *Richard III* the toad is a recurring theme, as is fitting for a play about a king described as:

That bottel'd Spider, that foule bunch-back'd Toad.

Among all of Shakespeare's many references to the toad, there is not one that is neutral, much less friendly. Edgar in *King Lear* denounces Edmund as 'a most toad-spotted traitor'; and the witches in *Macbeth*, when they concoct their hellish brew, give to the toad pride of place in the cauldron:

Toad, that under cold stone Days
and nights hast thirty-one
Swelter'd venom sleeping got, Boil
thou first i' the charmed pot.

Not only were toads venomous: to the medieval mind they were also a symbol of lechery, as were warts and moles, with which toads were supposed to be covered. We shall return to this matter of lechery; for the present we only direct the reader's attention to the visual use of the toad in this sense by Hieronymus Bosch, in his *Seven Deadly Sins*, of which we reproduce the pertinent detail in Plate XIII.

The evil repute of the toad is not yet dead. There are English circles where 'Toad!' flung in anger would be a fighting insult now. The derivative 'toady' brings to mind the sycophantic and hypocritical squat of the creature, with its upturned watchful eyes. The bad name of the toad survives among untutored countryfolk in England and the United States, where farmers cling to the belief that the spittle of toads is poisonous, and that warts will grow on the skin where a toad has touched. French peasants down to recent times, and perhaps even now, put toads to death by methods shocking for their cruelty, methods that reveal an ingenuity in torture ordinarily reserved by man for his fellow-men.[28] The venom-spitting toad in all his horrible lineaments was painted for us by Hieronymus Bosch in a detail of his *Judgment Day*. Summoned from his grave, a nude Cardinal (his worldly office proclaimed by his hat) is floating away to everlasting damnation as a squatting toad directs a shaft of his deadly saliva at the passing corpse.

Toads were closely linked with witchcraft. In France all witches harbored toads as their familiars, and this was common in England and Scotland too. In 1591, trials held in North Berwick elicited from the members of certain witches' covens clear testimony that they had tried to murder King James VI of Scotland, and that one of their plans had been to drop toad's venom on his head or body, and to smear his small clothes with it.[29] Presumably the poison was to invade the person of the king through abrasions of the skin, which in those days of absent hygiene and parasitic insects were taken for granted. From the contemporary records of this case we learn that 'to drop a toad' was the idiom used at that time for the milking of a toad's venom - a meaning of the verb 'to drop' that the Oxford Dictionary fails to record - and in one of the accounts of the trial we even learn the details of the method used. Here is a paraphrase of the testimony of Agnis Tompson, a defendant, as published in *Newes from Scotland Declaring the Damnable Life and death of Dr. Fian*, printed in London for William Wright in 1591:

> She confessed that she took a blacke Toade, and did hang the same up by the heeles, three daies, and collected and gathered the venome as it dropped and fell from it in an Oister shell, and kept the same venome close couered, untill she should obtaine any parte or peece of foule [soiled] linnen cloth, that had appertained to the Kings Maiestie, as shirt, handkercher, napkin or any

---

28. See *Le Folklore de France*, by Paul Sebillot, vol. III, *La Faune et la Flore*, Paris, 1906; pp. 280 ff.
29. See *The Witch-cult in Western Europe*, by Margaret Alice Murray, Clarendon Press, Oxford, 1921, p. 53; also *Life in Shakespeare's England*, an anthology compiled by John Dover Wilson, published in 1911 by the Cambridge University Press and reprinted repeatedly since then. For additional references to toad poisoning in England, see Miss Murray's latest work, *The Divine King in England*, 1954, Faber & Faber, London, p. 40; also p. 61.

> other thing which she practised to obtaine by meanes of one John Kers, who being attendant in his Maiesties Chamber, desired him for olde acquaintance betweene them, to helpe her to one or a peece of such a cloth as is aforesaide, which thing the said John Kers denyed to helpe her too, saying he could not help her too it.
>
> And the said Agnis Tompson by her depositions since her apprehension saith, that if she had obtained any one peece of linnen cloth which the King had worne and fouled, she had bewitched him to death, and put him to such extraordinary paines, as if he had beene lying upon sharp thornes and endes of Needles.

It comes as a shock to modern man to learn that his ancestors considered the common toad venomous as the adder. It comes as a double shock to him when he learns that these ancestors were probably right, and that on this subject they were better informed than he is. The toad has no fangs and cannot bite. But on his coarse skin are scattered numerous glands that look like warts or pustules; and when the creature is frightened or in pain, these glands exude a milky fluid, which is powerfully toxic. Hidden inside the skin, invisible to the naked eye, is another set of glands, which lubricate the skin with a slimy mucoid secretion, easily perceived by the human hand but perhaps not poisonous. The witches who kept toads as their familiars knew the wicked properties of the toad's milky secretion, and it is a fair surmise that the singular tortures reserved for toads by some countryfolk were originally devised to milk the toads of their deadly drops. The venom of the toad cannot penetrate healthy human skin, but takes hold of any mucous membrane, and if swallowed or absorbed through an abrasion of the skin, might well be lethal. Among those who work with toads, it is common knowledge that their secretions, if accidentally brought into contact with the eyelid, cause an acute burning irritation. (The inflamed swelling of the sebaceous gland at the margin of the eyelid, commonly known in English as a stye, is called in vulgar Dutch *paddescheet*, 'toad's excrement', even when no toad is involved.)

In the 15th century Chronicle of St. Albans there is an account of the death of King John of England that possesses extraordinary interest both for its own sake and for the role played in it by a toad. History relates that the King in the year 1216 was making his way north with his retinue, dogged by his enemies and ill. In crossing the Wash he lost much of his baggage train, to his great sorrow, and after lying at the Cistercian monastery at Swineshead, he progressed some distance beyond to the castle at Newark-on-Trent, where he died on October 19, on "the morrow after St. Luke's Day". The Chronicle of St. Albans says that his death was precipitated by a draught of poisoned ale served to him at Swineshead. Though perhaps the scribe was only giving currency to a malicious canard, this scarcely affects the interest of his narrative for us, because he was writing what he and his contemporary readers were ready to accept, and the role in the affair that he assigns to a toad conformed to common beliefs and probably to esoteric knowledge. The provocation that the scribe reports for the alleged regicide is curious. The King swore a great oath, says the chronicler, that if he was spared another six months, the loaf of bread then worth a ha'penny would be selling at 20 shillings! A modern reader may be excused if this passage conjures up for him the specter of runaway inflation, but for the chronicler and his public it meant famine and panic in the market place. Why should King John have foreseen famine and panic as the inevitable sequel to his own survival? And why should the chronicler, as well as the monk of Swineshead, have considered this sequence so obvious that it called for no explanation? Miss Margaret Murray in *The Divine King in England* uncovers the strange beliefs that seem to have underlain the King's great oath and justified the monk's deed in his own eyes and his superior's, a vignette of medieval behavior baffling for us but clear and simple then.

Here, then, is the story of King John's death as put down about the year 1483, more than 250 years after the event, by the chronicler of St. Albans:[30]

> The Kyng came by the Abbey of Swynesheade, and there hee abode two dayes; And as he sate at mete, he axed a Monke of the house, How moche that loof was worth that was sette before hym uppon the table? And the Monke said, That the loof was worth but an half-penny. O said the Kinge tho [then], Here is grete chepe of brede; Now sayd he tho, And if I may lyve ony while, such a loof will be worth XX. shillinges or half a year be gone. And so whan hee sayd this worde, moche hee

---

30. The extract from the *Chronicle* is copied from the *History of King John*, by William Prynne, London, 1670, pp. 36-7.

thought, and often hee sighed, and toke and etc of the brede, and sayd; By God, the worde that I have spoken, it shall be soth. The Monke that stode before the Kynge was for this worde full sory in his herte, and thought rather hee would hymselfe suffre deth, and thought yf he might ordeyne therefore some manere remedye. And anone the Monke wente unto his Abbot and was shriven of him, and tolde the Abbot all that the Kynge had sayd; And prayed his Abbot for to assoyle [absolve] him, for he would yeve the Kynge such a drynke, that all Englonde sholde be glad thereof and joyfull. Tho yede the Monke into a gardeyne, and founde a grete Tode therein, and toke her up and put her in a Cuppe, and prycked the Tode thorugh with a broche many tymes, tyll that the venym came out of every syde in the Cuppe, And tho toke the Cuppe and filled it with good ale, and brought it before the Kynge, knelynge sayenge; Sir, sayd hee, Wassayll, for never the dayes of all your lyfe dronke ye of so good a Cuppe. Begyn Monke, sayd the Kynge: and the Monke dranke a grete draught, and toke the Kynge the Cuppe, and the Kynge dranke also a grete draught, and set downe the Cuppe. The Monke anone ryght wente in to farmerye infirmary and there dyed anone, on whoos soule God have mercy, Amen. And fyve Monkes synge for his soul specially, and shall whyle that the Abbaye standeth. The Kynge rose up anone full evyll at ease, and commaunded to remove the table, and axed after the Monke; and men tolde him that hee was deed, for his wombe [belly] was broken in sundre. Whan the Kynge herde this, he commaunded for to trusse, but it was for nought, for his belly began to swelle for the drynke that he had dronke, and within two dayes hee deyed, on the morowe after saynt Lukis daye.

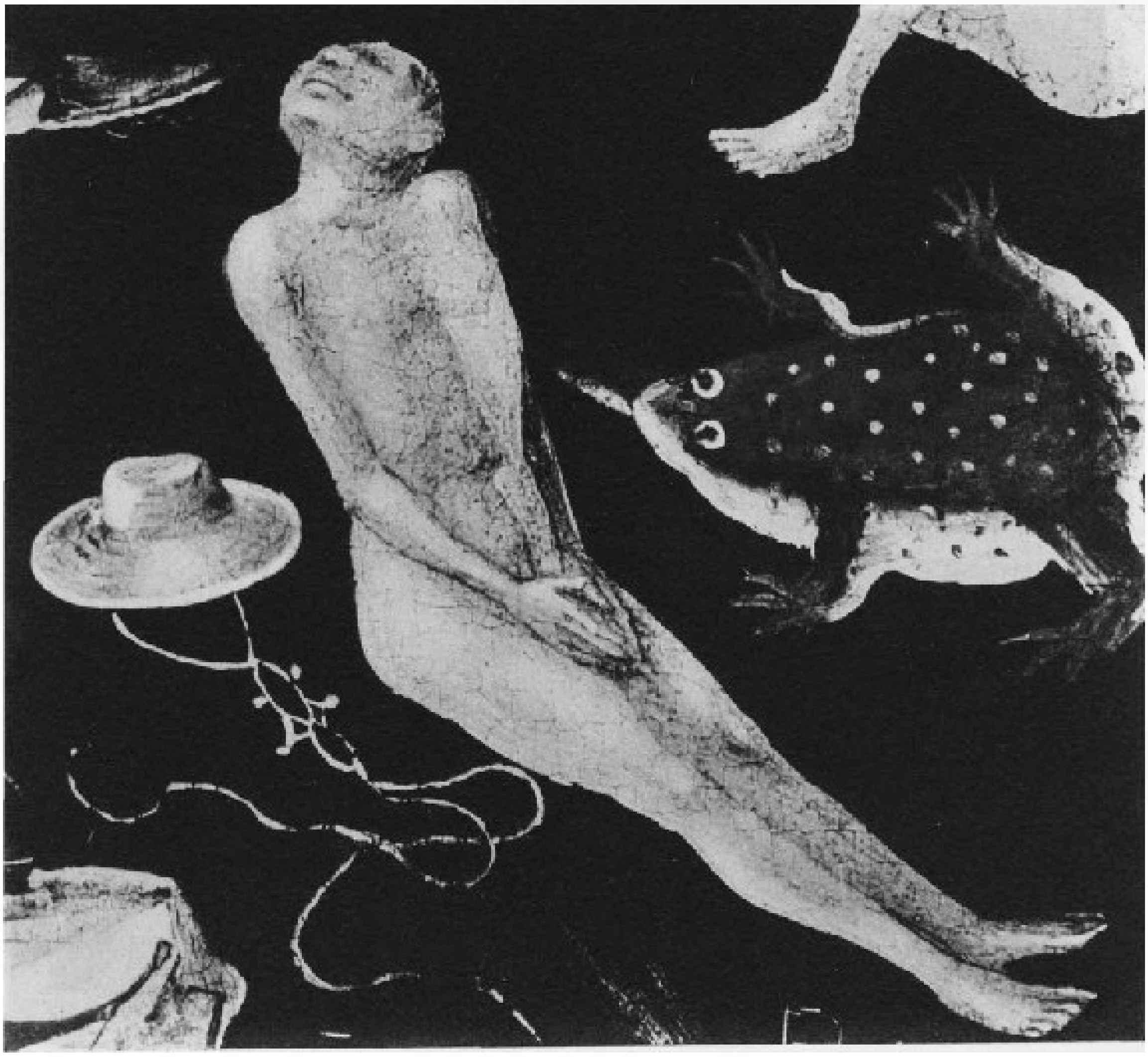


PLATE XII

Hieronymus Bosch. The Last Judgment. Detail: Spitting toad.

Munich, Bayerische Staatsgemäldesammlungen.

That 'great toad' found in the garden at Swineshead could only have been the common toad of western Europe, *Bufo vulgaris*. This is the same toad that George Ripley, a writer on alchemy, saw in a vision late in the 15th century, and commemorated in curious verse. His short poem, which we reproduce as it first appeared in print, eloquently expresses medieval man's repugnance for the toad, and reveals how intimate Ripley and his circle must have been with the toad's milky exudate and its fearsome virtue.

Our quotations concerning the toad go back to the Middle Ages and the Renaissance, but the ideas therein expressed lived on until recent times. One William Northcote, for many years a surgeon in His Majesty's Navy, published in London in 1770 a serious medical work, *The Marine Practice of Physic and Surgery*, a reference book for use on ships. In it there is a chapter on poisons, and coming to the toad, Mr. Northcote has surprising things to say:

> The toad is full of venom, and the very centre and repository of terrestrial poisons… they discharge their venom on herbs (particularly strawberries) by pissing, spitting, and vomiting; this is not only pernicious by getting into the body, but by being sprinkled on the skin, unless washed off immediately with urine and salt.
>
> When a person is infected, his skin turns yellow, his body swells universally, his lips and tongue grow black, and a stammering supervenes; he is seized with an asthmatic shortness of breath, vomiting, cold sweats, convulsions, fainting, and at length with death, if not timely remedied. [p. 421]

Mr. Northcote is guilty of patent absurdities, but the fact remains that we cannot deny for sure his clinical description of the victims of toad poisoning, for modern medical records offer us no histories of such cases. This seasoned practitioner of the 18th century was closer than we, chronologically, to the era when men knew the properties of the toad's venom, and his account of the symptoms is the only one emanating from a medical pen known to us. It stands thus uncorroborated and unchallenged, a wisp of dubious expert testimony in what would otherwise be a scientific vacuum.[31]

There exists an additional body of evidence of a different order testifying to the toad's sinister grip on the popular imagination in times gone by. Men take refuge in euphemisms when they talk about things that move them profoundly. People 'pass away' rather than 'die', and Satan becomes the 'Evil One'. Abhorred creatures are called out of their names, or else their names are subjected to irregular distortions in sound.

In the languages of Europe few creatures can compete with the toad for evasive nomenclature. The measure of this tabu lies in the number of etymologically unrelated words for it, not to speak of the variety of dialectical variants for each word. Here are a few of the important ones: in Latin *bufo*, and in Italian, *rospo* and *botta*; in Spanish, *sapo* and *escuerzo*; in French, *crapaud* and *bot*; in German, *Krote*; in Russian, *zhaba* (**жаба**); around the North Sea, *padde*; and in English, 'toad'. An abundance of diverse names like this makes difficulties for the philologist, who has more to show for his efforts when he goes coursing through the Indo-European languages after words like 'wolf and 'fox', words that turn up in more or less regular mutations in various languages. Some of the words for 'toad' defeat the philologists completely. Take 'toad' itself. It exists in several variations in English, of which 'tad', as in 'tadpole', is the most important. It is genetically related to the three-syllabled variants in Anglo-Saxon, *tadie* and *tadije*. There the trail is lost: no remoter ancestry is known for the word, and it has no kin in other tongues.

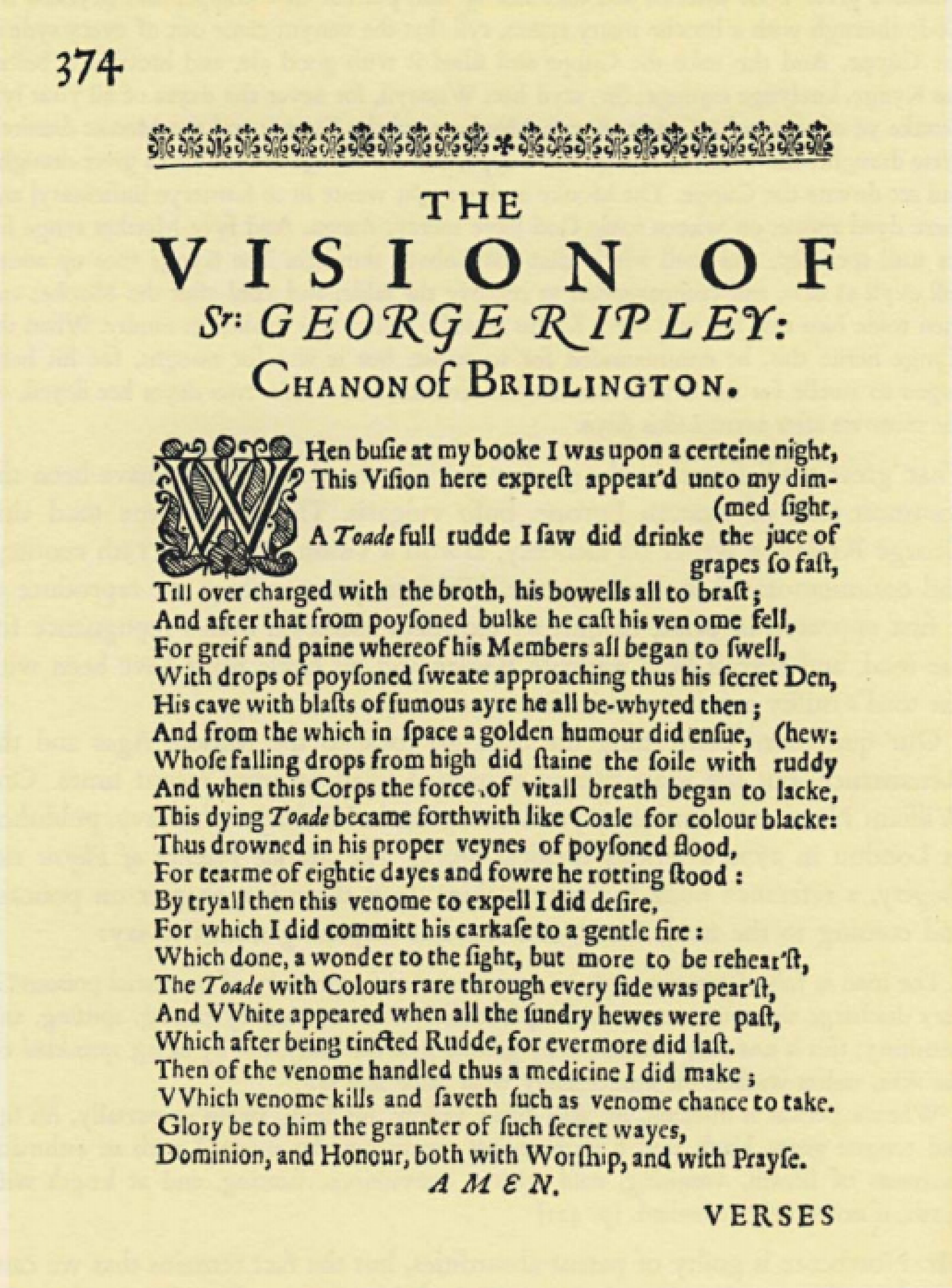
We believe that all, or almost all, of the words for 'toad' in Europe can be explained, if we look for the figures of speech that are latent in them by focusing our attention on the creature itself. Instead of attacking the 'toad' problem by frontal assault, let us approach by a postern gate, viz., through the Celtic languages. We know the words for 'toad' in five Celtic languages, and, as befits a creature veiled by tabu, the five words appear to be unrelated to each other. From ancient Gaul *craxantus*[32] survives in a single citation. In Cornish the toad was

---

[31] In the second century before Christ an Ionian Greek, Nikander of Colophon, composed a metrical essay entitled *Alexiphartnaca* on poisons and their antidotes, and in lines 567-594 he discusses toad poisoning. His observations are obscure, perhaps deliberately so, but in tone they are not far removed from Mr. Northcote's. As we go to press we learn that Howard F. Fabing, M. D., of Cincinnati, has been giving intravenous injections of bufotenine, the toxic agent secreted by the epidermal glands of the toad, to volunteers in the Ohio State Penitentiary.

[32] See *Französisches Etymologisches Wörterbuch*, by Walther von Wartburg.

croinoc or *cronec*, and this meant 'the skin' or 'the hide', from *croin*, meaning skin. The Cornishman referred to the toad by its skin, covered as it is with pustules, and notorious for the way the creature blows itself up with air like a sac when making its eerie call. In Welsh the toad is the *llyffant*; this appears to mean 'the slimy one,' with obvious reference to the slippery secretions of the skin. The common toad does not exist in Ireland, and the only toad reported there is the *Bufo calamita*, known in English as the natterjack. Its range in Ireland is so limited that almost no natives have ever seen a toad: the natterjack has been found in historic times only over an area of some twenty square miles, around Castlemaine Harbor at the head of Dingle Bay in Kerry. The expression for 'toad' in Irish is 'the poisonous frog' - *losgann nimhe*; and since the word for frog - *losgann* - means 'the burning one', we arrive ultimately at 'the poisonous burning one' - a doubled reference to the toxic, stinging secretion of the pustules.



374

THE
VISION OF
Sr: GEORGE RIPLEY:
CHANON OF BRIDLINGTON.

WHen buſie at my booke I was upon a certeine night,
This Viſion here expreſt appear'd unto my dim-
(med ſight,
A *Toade* full rudde I ſaw did drinke the juce of
grapes ſo faſt,
Till over charged with the broth, his bowells all to braſt;
And after that from poyſoned bulke he caſt his venome fell,
For greif and paine whereof his Members all began to ſwell,
With drops of poyſoned ſweate approaching thus his ſecret Den,
His cave with blaſts of fumous ayre he all be-whyted then;
And from the which in ſpace a golden humour did enſue, (hew:
Whoſe falling drops from high did ſtaine the ſoile with ruddy
And when this Corps the force of vitall breath began to lacke,
This dying *Toade* became forthwith like Coale for colour blacke:
Thus drowned in his proper veynes of poyſoned flood,
For tearme of eightie dayes and fowre he rotting ſtood:
By tryall then this venome to expell I did deſire,
For which I did committ his carkaſe to a gentle fire:
Which done, a wonder to the ſight, but more to be rehear'ſt,
The *Toade* with Colours rare through every ſide was pear'ſt,
And VVhite appeared when all the ſundry hewes were paſt,
Which after being tincted Rudde, for evermore did laſt.
Then of the venome handled thus a medicine I did make;
VVhich venome kills and ſaveth ſuch as venome chance to take.
Glory be to him the graunter of ſuch ſecret wayes,
Dominion, and Honour, both with Worſhip, and with Prayſe.
AMEN.

VERSES

Fig. 2 - From *Theatrum chemicum Britannicum*, by Elias Ashmole, London, 1652.

Now we turn to the Breton language, and here perhaps we discover a loose end to Ariadne's thread, a possible clue to our problem. The word for toad in Breton is *tousec*. It comes from the Latin *toxicum*, and therefore means 'the poisonous one'. On an earlier page we said that the standard word for 'toadstool' in Breton is *kabell* *tousec*, wherein *kabell* (from the Low Latin *cappa* and *capello*) means 'cap'. When the early Bretons spoke of the toadstool as the *kabell tousec*, the term meant to them 'the poison cap', as well as the toad's cap; and the variant *skabell tousec* could have meant 'the poison stool' as well as the toad's stool.[33]

In Britain, the island that the Bretons had left behind, are we surprised to discover that the Anglo-Saxon word *tosca* meant toad? It is, we submit, identical to the Breton word, offspring of *toxicum*, and another example of 'the poisonous one'. We have mentioned the English name for the *Bufo calamita* - the natterjack. We believe that the root of this word is to be found in the Anglo-Saxon word for poison - *ator*; a word that as 'etter' survived in English for centuries, and still circulates in dialect, to designate the venom of a reptile, and the corrupt matter that oozes from a suppurating ulcer or abscess. An 'attercop' is an old word for a (supposedly poisonous) spider. In modern Dutch *etter* still means pus. If we are right, what we now call 'a natterjack' was once 'an atterjack', the shuttling N being a well known linguistic quirk. The 'jack' is simply the same element that we find in the 'jumping-jack'. The 'atterjack' is then a 'poison jack', and an Anglo-Saxon rendering of the Latinism *tosca*.

Let us pause on *tosca*, that long forgotten word for the toad. It had a doublet in Anglo-Saxon, *taxe*, which survives in a single citation. The alternation in the vowels reminds us of 'toad' and 'tad', and also of a parallel in Latin: *toxicum* meaning 'poison' and *taxus*, 'yew'. In antiquity the yew was notorious as a poisonous tree, and the adjective *taxicus* was popularly associated with *toxicum*. In Greek τόξο meant 'bow' and 'arrow' and 'bow-and-arrows'. Philologists are inclined to deny a link between the Greek and the Latin words, and even between the Latin words themselves, but concede that the problem is unclear. Until we know more about the role of bows and poisoned arrows in early magic and myth, it is well to suspend judgment. Bows were made of yew, and arrow-heads were smeared with poison, perhaps from yew. Robert Graves has pointed out[34] that arrow-heads were sometimes knapped with double tangs to resemble the yew. The making of such arrow-heads demanded far more patience and skill than the simple willow-leaf and elder-leaf points, and would be less effective in hunting or fighting. They must have been ceremonial in function and were undoubtedly bathed in *mana*. As we look back in recorded history, our 'toad' or 'tad' emerges from the Anglo-Saxon world as the venomous helpmeet of sorcerers. The very name of the creature, *tousec* or *tosca* or *taxe*, is redolent with poison, potent with *mana*. Down through the Middle Ages and into modern times the toad was still freighted with this primitive cargo of evil. *Tosca* and *taxe* may have contributed to the shaping of our words 'toad' and 'tad'. As we said before, the etymology of 'toad' is unknown. We must consider the possibility that, by steps that may forever remain obscure, the Anglo-Saxon words come down to us in 'toad' and 'tad' by lineal descent. The irregular mutation of -*sc*- and -*x*- into 'd' could have been a euphemistic substitution.[35]

If 'toad' descends etymologically to us from *toxicum*, then in English as in the Breton tongue a 'toadstool' in its ultimate meaning is a 'poison stool', and the idea of poison, rather than the toad, may have been dominant in the minds of those who first applied this term to the wild fungi in the Anglo-Saxon world. In any case, whatever the etymology, the cultural soil in which 'toad' had its beginnings explains that aura of abhorrence which bathes the word to this day in the English language. We discover why the Oxford Dictionary fails to satisfy us when it dismisses the problem of the toadstool by calling it a 'fanciful' term. We realize why the headline in *The Times*, EDIBLE TOADSTOOLS, shocks us as a contradiction in terms.

We have already observed that the Irish word for 'frog' is the 'burning one'. Here again the reference is to the secretion of the epidermal glands of the amphibian, the secretion that stings when it comes into touch with a mucous membrane. This Irish word has its parallels in certain of the Germanic languages. In Old High German

---

33. See *Lexique Étymologique du Breton Moderne*, by Victor Henry, Rermes, 1900; p. 268.
34. See his *White Goddess, a Historical Grammar of Poetic Myth*, Creative Age Press, New York, 1948, footnote on p. 320; also p. 38.
35. If Latin -*x*- became -*s*- in *tosca*, then the Anglo-Saxon word results from the omission of the middle syllable, *toxicum* becoming *tosca*. But if -*x*- by phonetic transposition became -*sc*- we arrive directly at *tosca* by the erosion of the last syllable. If *taxe* or a hypothetical *toxe* became by euphemistic mutation *tadse* or *todse*, the evolution into 'toad' or 'tad' is easy, the sibilant being lost by a popular back-formation of an erroneous singular; cf. 'toad's stool' which becomes 'toad-stool'; also 'pea', 'asset', 'shay', 'sherry', 'cherry', etc., all of which have lost the sibilant with which they originally ended. The mutation of 'c' into 't' is not altogether conjectural. In the Anglo-Saxon dictionary of Joseph Bosworth and T. Northcote Toller, under *tosca*, we find a quotation in which the plural of *tosca* appears with 't', - *tostan*.

the verb 'to burn' was *zusken*, and by regular mutation of sounds this explains the Danish word for the toad, *tudse*, in which today the letter *d* is silent. In Swedish the corresponding word is *tossa*, with dialectical variants *tosk* and *tusk*; and there also survives a citation from 1652 in the form *tadza*, pronounced perhaps as 'totsa' would be in English. In all these words the toad is called the 'burning one', as the frog is in Irish. These words find their semantic parallel in the vulgar Dutch term *paddescheet*, the stye with its burning sting, to which we called attention earlier. In Greek the word for toad, φρύνος, is usually explained as meaning 'the brown one', but brown is the burnt color, and Professor Andre Martinet has suggested that φρύνος may refer to burning rather than to the color.

We know that the secretion of toads was used by the practitioners of witchcraft. We know that in ancient Rome the lethal properties of the wild fungus known as the deadly amanita or destroying angel or death cup were familiar to the practitioners of venomy, as we choose to call the art of murder by poison. But no positive evidence survives, so far as we know, to show that in the practice of witchcraft the secrets of the fungi were utilized; no evidence, that is, beyond 'toadstool' itself, this humble folkword with its secret message. Does the absence of positive evidence mean that the toadstool was not used in the practices of the Old Religion, or that the secret was successfully kept? For the present we leave the answer to the reader.

2

Basques and Slovaks

In research it is often the small remainder of unexplained evidence that points the road to further discoveries, and even perhaps to an abrupt step-up in the scope and thrust of the inquirer's purpose. We believe that we may have discovered for the first time the explanation for the 'toadstool', the secret lying in the original but now forgotten sense of 'poison-stool'. But our answer to this question leaves certain tantalizing facts unreconciled. Why do the Danes for 'toadstool' say *paddehat*, rather than *tudsehatt*.[36] Of their two words for 'toad', why do they link with the wild fungi the one that does not refer to the poisonous secretion? In English too we find paddock-stool. In Dutch there exists no name for the toad, so far as we know, that means 'the poisonous one'; yet the Dutch also say *paddestoel*.

In short, while we have perhaps explained the word 'toadstool', we have not answered the whole of our question, for we find toads linked with fungi where poison is not involved. We must ask ourselves whether there was not a deeper and broader association between toads and mushrooms, whether the two orders of living things did not possess in common some other attribute that originally struck the primitive fancy and led to verbal kinship. If this be so, then the words based on the common attribute of poison may have been a late development, restricted in area, superimposed on an older and broader verbal stratum, a verbal variation on an exceedingly ancient theme. The use of *toxicum* in the context of toads and fungi may have been merely a Latinism devised by practitioners of an esoteric witchcraft cult around the North Sea basin in the early centuries of the Christian era.

It turns out, indeed, when we look further afield, that the toad-fungus link is not confined to the North Sea countries. In two areas of the Continent, far removed from each other in every sense, the same semantic tie occurs. First, there is the Basque country of Spain (not France), where in the Basque language several names for wild mushrooms involve the Basque word for toad, which is *zapo* or *apo* or (in certain combinations) *amo*.[37] The *Amanita muscaria*, which in parts of France is sometimes called *crapaudin*, carries a Basque name in parts of the Biscay and Guipuzcoa country that is an exact semantic equivalent of the French word: viz., *amoroto*. In a contiguous area *apontto* is the name bestowed on a certain distrusted wild fungus, and this word also serves thereabouts as a term of personal abuse. The root is *apo*, 'toad', in both these words. Two excellent species of wild mushrooms, *Marasmius oreades* and *Marasmius urens*, are rejected by the Basques of the same provinces, who call them 'viper-fungus' and 'toad-fungus' - *suge-perretxiko* and *zapo-perretxiko*. (Note this our first encounter with the viper theme.) Except in the Basque country, we have found no trace of the toad figure in the fungal vocabulary of Spain, but we possess one straw of evidence indicating that formerly it was in use. Dr. Stephan F. Borhegyi, the Hungarian archeologist working in Guatemala, on a visit to the village of Jocotan in the Department of Chiquimula, discovered that the Spanish-speaking people in that community used neither *hongo* nor *seta* for 'mushroom': their pejorative term for species believed to be poisonous is *sombrilla de sapo*, 'toad's parasol'. Remote Jocotan is known to linguists for the Spanish archaisms that survive there, and one assumes that the *sombrilla de sapo* is a fossilized survival of an expression current somewhere in 16th century Spain.

Far from the Basque country, in the Ukraine, the natives speak of any wild mushroom that they reject as *zhabjachyj hryb* - the toad-like mushroom. A little to the West, in Slovakia near Tatra, a native informant reports to us that such despised fungi are variously called *žabací huby*, the toad-fungi [the frog-fungi - edition@psilosophy]; *hadácí huby* and *hadúnke huby*, both meaning viper-fungi; or *šialene huby*, mad fungi. We are unable to circumscribe the area in the Slav world where the toad theme survives in the mushroom vocabulary. It is unknown in Great Russia.

The semantic analogies between the Basque terms and those used in the Ukraine and Slovakia, combined with the evidence around the North Sea, suggest a profound substratum of folk associations between fungi and toads in the Indo-European world, a substratum that is today everywhere silted over except for the three

---

36. *Tudsehat*, reported in the Danish lexicons, appears to be obsolete and to have been always rare. But a reliable informant tells us that in the Low German dialect of Holstein *tutzenstol* is in current usage.
37. The mutation of *p* into *m* is well recognized in Basque; e. g., Pentecost becomes Mendekoste.

outcroppings on the map of Europe.[38] This inference finds support in a further surprising fact. Throughout the Slav world the most beloved general word for the edible mushroom of forest and field is, in its Russian form, *grib*. In the Slavic mind there is no association between this happy word and the creature we call *zhaba*, the toad [the frog - edition@psilosophy]. But now turn to the Catalan language. There we find that the word for toad is *gripau*. No Catalan connects it with wild fungi. Yet it seems clear that the etymological root of Catalan *gripau* and of Russian *grib* is identical! That root, surviving virtually unchanged from remote times in two widely separated languages in words with wholly different meanings, carries the sense of gripping, grabbing, seizing, scraping, grubbing, digging. Here is no allusion to poison, no kinship with *toxicum*. If 'toad' evolved from *toxicum*, it is a late and geographically circumscribed intruder in verbal history, by comparison with the perspectives that we now contemplate. Only by a kind of linguistic triangulation into the past can we arrive at a reconciliation of Russian *grib* and Catalan *gripau*. And we must defer this until we have explored certain other matters.

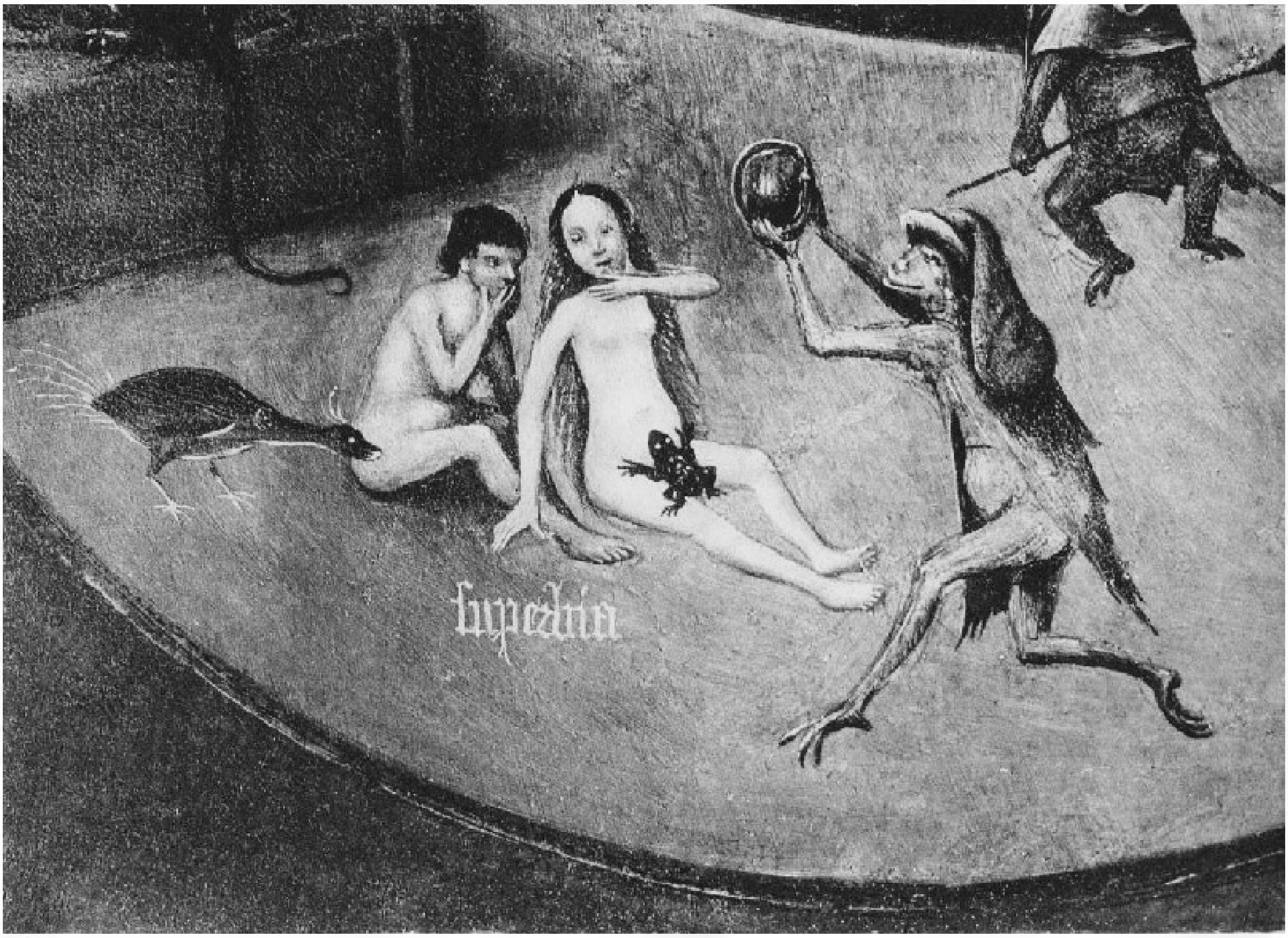


PLATE XIII

Hieronymus Bosch. The Seven Deadly Sins. Detail: Superbia. *Madrid, Prado Museum.*

It would be easy to spin an argument that in the early European mind toads and fungi shared a chthonian existence - toads hibernating in soft earth and then thrusting themselves to the surface; fungi living out the better part of their existence hidden in the soil, but, when circumstances are propitious, shouldering their way through the soil's crust to the light of day. One could even postulate a primitive earth-cult with its focus of worship in the earthy toad and the toadstool. But perhaps we can find a more solid basis for inquiries than such facile and unsubstantial speculations.

---

38. In the Romansch language *pawn de poder*, meaning 'monk's bread', is the general term for fungi. Could *póder* be a folk

corruption of Dutch *padde*? If so, the term is identical semantically to the French *pain de crapaud*. *Padde*, coming from Dutch, spread far beyond the confines of Low German, being recorded for Frankfurt and Leipzig as far back as the 16th century.

3

The Cripple, the Toad, and the Devil's Bread

In the Middle Ages the French viewed the toad somewhat differently from the English, and in this section we shall digress briefly to clarify the distinction. With the French the emphasis was not directly on the venom but on the creature as an incarnation of Satan.

In Old French there was a curious word, *le bot*, which according to the dictionaries meant 'toad', and they add that it fell into disuse in the 15th century. For a time it lingered on in a single phrase: *enfle comme une bote*, 'blown up like a female toad', a phrase that beyond the Loire had already become *enfle comme un crapault*. (The female is much bigger than the male, and the older simile thus carried a double superlative.) *Bot* in the sense of toad survives to this day in many regional dialects of France and also in the Italian *botta*. The word in a different meaning still circulates in standard French, in the fossilized term, *pied bot*, 'club foot'. What links toads to club feet?

The origin of this word is not in doubt. *Bot* comes down from a Germanic root meaning 'blunted', 'malformed', 'clumsy'. It exists in an English form: the pudgy, clumsy hands of babies are 'puds', as are the forefeet of certain animals. 'Puddifoot' is a family name, originally a nickname for a cripple. But why should a toad, with its delicately articulated extremities, be called a cripple?

We believe that the history of this little word is a chronicle of successive metaphors, and that its primary role was as a euphemism for Satan. The Foul Fiend in the Middle Ages possessed certain sharply defined attributes. He wore horns. He had a tail. For hands he showed claws. He was enveloped in the hairy hide of an animal. He was sometimes represented as glorying in shameless priapism. Finally, he was a cripple, one leg ending either in a club foot, or a splayfoot, or a bird's talons, or a paw, or a hoof - a cloven hoof. To this day horns and cloven hoof are familiar metaphors for wickedness in English. There are low circles in which 'cripple' serves as an epithet of singular viciousness, beyond anything that mere lameness justifies. Eric Partridge in his *Dictionary of Slang* cites what he calls a senseless phrase used by English schoolboys to spur their teammates to greater efforts: " Go it, you cripple!" Sometimes the language of children preserves words and phrases that have disappeared among adults, and we believe these schoolboys are in hopes that the very Devil will possess the players on their side. Perhaps our suggestion explains another folk belief that is still current, the notion that cripples are capable of more than normal sexual prowess.

In the first instance, then, *le bot* meant 'the Cripple', a euphemism for Satan.[39] In this sense it survived into the 16th century in the oath, *Vrai bot!* - 'by the very Devil'. Elizabethan England borrowed this French oath intact. The Oxford Dictionary gives as its earliest citation the following, dated 1584: "A bots on thy motley beard!", and the final citation is from 1719:

Bots on them all Both
great and small!

Unaccountably, the Oxford Dictionary says the origin of 'bots' is unknown.

Satan's sinister limp seems to have vanished today from men's memories. It was vanishing already in Napoleon's time. His coadjutor Talleyrand, notorious for his loose life and lack of scruples, limped from his earliest years; and this physical deformity did not escape his enemies, who dubbed him *le Diable boiteux*, 'the limping devil'. (*Boiteux*, by the way, is unrelated etymologically to *le bot*.) In earlier times either the noun or the adjective would have been redundant. An English caricaturist devised a satirical coat of arms for Bonaparte, supported on either side by a Devil, on the right by the Corsican Devil with a cloven hoof, and on the left by Talleyrand, the French Devil, with a reptilian extremity. Was it not Talleyrand's distinction to be the

---

[39] A parallel for *bot* is to be found perhaps in *bratze*, a colloquial name for the toad reported in Bavaria, which can mean 'paw',

'claw', 'clumsy foot'. But *bratze* must be considered in conjunction with certain other words for the toad: Bavarian *braste*, suggestive of the lamenting cry of the toad; the Bavarian *broz* and the Austrian *brotze* and *braitling*, these relating to the swelling of the toad.

last major figure with a limp whose infirmity was held against him as a demonic stigma? We reproduce this savage print in our Plate No. XX.

In the next stage, *le bot* underwent a shift from Satan himself to the creatures into which he was supposed to transform himself - the toad, a certain kind of nocturnal bird, and bats.[40] The nightjar, kin to the American whippoorwill, was known in parts of France up to recent times as *le bot volant*, and also as *le crapaud volant*, names so layered with metaphors that they could be fairly translated in any of three ways, the flying Devil, the flying Cripple, and the flying Toad. Even more interesting is the widespread use of *le bot volant* for the bat, a creature that was formerly steeped in sinister associations. Its nakedness, its blackness, its miraculous agility in night flight, its facial features stretched taut in a subhuman grimace, the strange profile of its wings with their articulated struts, its vampirish repute - all these attributes caused it to be feared and loathed as the very Devil himself, and justified medieval man, in his own eyes, in putting bats to death, whenever caught, by methods of hideous cruelty, similar to the treatment accorded to toads.

The English word 'bat' for the flying rodent is first recorded in the year 1523. Formerly the creature had been a *bakke*, and philologists have been at a loss to explain the irregular mutation in its ending. Have they not been looking in the wrong direction? Surely Tudor England borrowed the new word 'bat' from France, altering the vowel under the attraction of the native Middle English word. (The same vowel change was to take place shortly afterwards in God's name: in the profanity of the 17th century 'God' by a euphemistic mincing of the vowel became 'Gad'.)

'Old Boots' is one of the names by which the Devil has been known in English. Is it not a popular adaptation of 'bots'? When Bella, in *Our Mutual Friend*, calls her husband a 'Clumsy-Boots',[41] is not Dickens, all unawares, recapturing for us a faint echo of the stumping Cripple's awkward limp, now sugared down into a loving pet-name? Then there is Puss-in-Boots, *le Chat Botte*, the fairy tale that Charles Perrault first put on paper late in the 17th century, in which a cat displays superhuman acumen when shod in boots. Do we not detect here a punning echo, come down from much earlier, of the demonic Cripple's prowess?

Demonic possession connotes mental disturbance, and we think this is why 'bat' in English, especially in slang, is linked with lunacy. 'Bats' is a vulgar word for delirium tremens, and those who go 'on a bat' indulge in wild behavior, while the man with 'bats in the belfry' is quite 'batty'. If we are right, all these words, full of vigor in the spoken language, stem back to *le bot*, the limping Arch Cripple.

Satan today has degenerated into a pallid personification of evil. In the Middle Ages he was no abstraction, no mere Idea. He was hot flesh and blood. Miss Margaret A. Murray in her studies of witchcraft has shown that his bestial attributes - the horns and hoof, the claws, hide, and tail - were those of the celebrant in the nocturnal rites of the witches' coven, the rites belonging to the religion of the Horned God, as she calls this divinity, the autochthonous religion of Europe and the Near East which slowly gave ground before Christianity and on which in its expiring throes the triumphant enemy bestowed the condescending name of witchcraft. The master of the ceremonies was known to his followers by many names, such as Robin Goodfellow in England. On the tongues of his enemies in the Christian Church Militant he was Satan and the Devil, the Foul Fiend, the Seducer, he of the Horns and Cloven Hoof, *le Bot*. If Miss Murray is right, we are discussing a religion practiced by our ancestors for thousands of years, which expired just yesterday, and which we can now study only through the eyes of the Church that was its deadly foe, and through clues such as we are here discussing. It is not surprising that when Hieronymus Bosch painted his famous *Seven Deadly Sins*, the successive scenes swarm with toads, the incarnation of Satan, as well as other reptiles. We reproduce one of these vignettes, representing the sin of Pride or *Superbia*, with a peacock fittingly present. Satan in the shape of a great man-like toad holds up a mirror to the worldlings.

---

[40] It is permissible to conjecture that the Germanic etymon of *bot*, in the sense of a rough lump, attached itself directly to the toad, rather than through the mediation of Satan. There might even be a kinship with the Dutch *padde*, the English 'pad' and

'paddock'. But the application of the word to the nightjar and to bats is proof that in France in the Middle Ages the idea of Satan was uppermost.

41. Part IV, Chap. XI. For a study of names used for the Devil in English, see Charles P. G. Scott, 'The Devil and his Imps', *Transactions of the American Philological Association*, Vol. XXVI (1895), pp. 77-146.

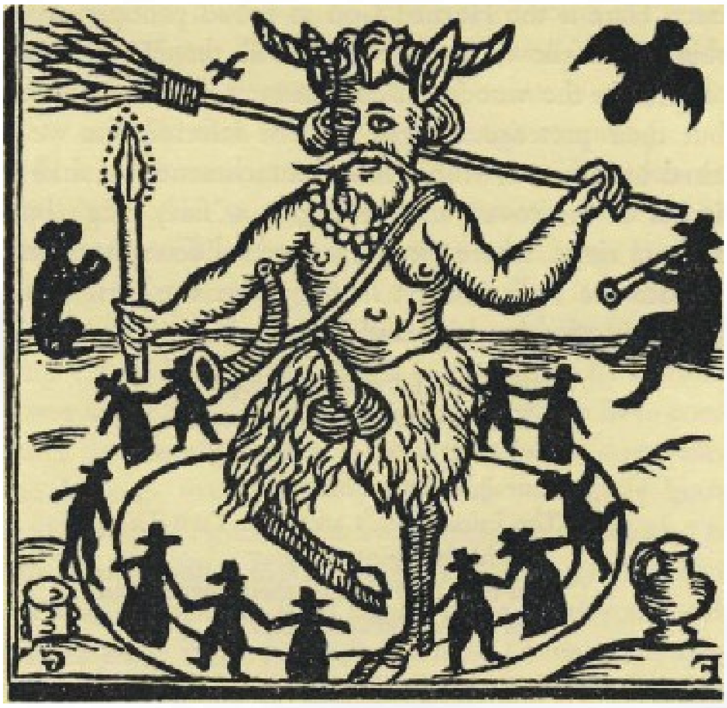


Fig. 3 - Robin Goodfellow

In Queen Elizabeth's reign, probably before 1588, there was published in England a poem entitled *The Mad Pranks and Merry jests of Robin Goodfellow*.[42] It seems to have appeared in a long succession of editions, of which the earliest known to survive bears, we believe, the date 1628. The verses are of little worth, but they and the illustration that accompanies them are valuable as one of the few spontaneous expressions of the witchcraft cult emanating from within the circle of sympathizers. Here is the Horned God in proud panoply, *le Bot* in action. Here is Robin Goodfellow, Hob-goblin, Will the Wisp, Mad Crisp. No mushrooms appear in the woodcut that illustrates the 1639 edition, which we reproduce, but their presence offstage may be inferred, for we are told that Robin was sired by Oberon, whose fungal attachments we shall shortly point out. The witches of the coven are dancing in a 'fairy ring', but there is no evidence that these rings, where the grass grows differently, were linked with mushrooms before the 15th century. In the poem we learn that Oberon had been looking for his offspring high and low:

> At last upon a summer's night
> King Oberon found him out, And
> with his elves in dancing wise
> straight circled him about, The Fairies danc't and little Tom Thumb
> on his bag-pipe did play And thus they
> danced their fairy round
> till almost break of day.

The artist who carved the woodcut, though crude in his technique, conveyed his message effectively. In the heavens fly two black birds, and he took sufficient pains for their silhouettes to be unmistakable. They are none other than nightjars, sometimes called goatsuckers or night ravens. These are the *bots volants* of evil augury, the sinister birds that held our ancestors in dread fascination:

> ...the night raven Which
> doth use for to call Men to
> Death's haven.

The toad appears as a visual symbol of Satan and the pagan god in French iconography in the late Middle Ages. One of the most famous episodes in early French history was the conversion of King Clovis to the

Christian faith. His wife Clotilde was a Christian, but he resisted the attractions of the new creed until he fought the battle of Tolbiac in the year 496. When the battle was going against him he swore that he would abandon the old religion if the Christian God would give him victory. The tide turned, and shortly thereafter he was baptized by St. Remi at Reims.

In that city there survive a number of tapestries woven in the 15th and early 16th centuries that depict the life of King Clovis. They show him fighting at Tolbiac as a pagan clothed in a surcoat adorned with toads, under a standard bearing the heraldic emblem of toads. The creatures are pictured as from above, their legs spread-eagled. In the next scene, where St. Remi is giving instruction to the King, the heraldic toads vanish. In the third scene the king is baptized, while high above the font an escutcheon appears bearing fleurs de lis, as though to give a stamp of lofty approval to the happy event. Nearby a dove descends bearing the holy ampulla with the oil for the king's anointing.

Heraldic emblems did not come into use until about A.D. 1100, and the tapestries in Reims are therefore an anachronism, a didactic invention of the Middle Ages.[43] Toads never figured in the arms of any French king. But those who designed these tapestries were not guilty of mendacity. It was their purpose to convey a simple message to the unlettered laity, and how better could the conversion of King Clovis be taught through pictures than by showing the pagan king waging war under Satan's banner? Here the symbols have come full circle: in the beginning the Foul Fiend was *le Bot* - the Cripple - and then this name jumped to the demonic toad, and now the toad, commonly known as *le bot*, stands for the club-footed Fiend. Heraldic creatures are mythical at best, and here we have myth compounding myth, a legend about a symbol that never was. The belief in Clovis's toads circulated chiefly among lowly and unlettered folk, "par le vulgaire et par le menu peuple", and *le bot* flourished in the same milieu.

We believe that we are the first to direct attention to the demonic multivalence of 'the Cripple' in medieval France, but the evil emanations of toads are well known. Dirk Bax, for example, in his recent book on Hieronymus Bosch[44] points out their malign meaning for this painter. He reminds his readers of the old belief that witches could transform themselves into toads. He recalls the papal bull published in the year 1233 by Gregory IX wherein toads were called the symbols of the Devil and magic. He reports an episode in 1610 when a French *sorcier* discovered a cast in the left eye of a child, the cast taking the shape of a toad's leg, and the child confessed that Satan had imprinted this *signum diabolicum* with his horn. According to an authority that Dr. Bax has found, St. Anthony beheld Satan in the shape of a toad with a human head, and if we accept the assertions of yet another writer, the toads in Hell torment the sinners, and in turn are food for the damned. To this day, Dr. Bax says, the Flemings believe that toads spit venom, just as Bosch shows us in *The Last Judgment*.

From Simin Palay's recent dictionary of the dialects of Gascony and Beam we learn that in former days the Gascons spoke of a cast in the eye as a 'toad' - *crapaud* - and considered it a distinctive sign of the witch and sorcerer. Here is that same *signum diabolicum* which Dr. Bax reported from a different source. A cast in the eye is a painless blemish, but it reminds us of the *paddescheet* of the Dutch, that stye, inflamed and stinging, which people call the toad's excrement. Suddenly there dawns on us a lively and sinister meaning behind these faint folkloric hints linking toads with the human eye. In the days of the Old Religion in western and northern Europe, the toad gripped the imagination of our ancestors with a dread fascination such as the serpent has always exercised in the East and in India to this day. Yes, in cultural history the toad was the European equivalent of the serpent in the East. On its face strange, the folkloric link between toads and the human eye becomes clear if our surmise be right that the venom of the toad was deliberately used by the priests of the ancient cult to inflame the eyeballs, and thus heighten the awesome spell of the rites. Here may lie the reason why a genuine stye suggests the toad's secretion, why the cast in someone's eye was for the beholders the reminder and sign of demonic power.

---

[42] The pamphlet was republished privately by the Percy Society, London, in 1840, using the text of the 1628 edition, with commentary by J. Payne Collier, Esq., F.S.A., on whose information we have relied.

By now the reader may fairly ask what our discussion of Satan and *le bot* has to do with the problem of the toadstool. In brief, toads figure in both the English and the French fungal vocabulary, but the figure of speech in English emphasizes poison, whereas in French demonic possession plays the dominant role. In the former, the 'toadstool' is a blanket malediction on all wild fungi, all of which are erroneously suspect as 'poison-stools'. In the latter, the *crapaudin* (like the Basque *amoroto*) is the name for a particular species, and this species is not one of the deadly mushrooms. It is the *Amanita muscaria*, the mushroom that intoxicates and exhilarates, that gives hallucinations. It is the mushroom of demonic possession. Bad as are both Satan and poison, there is a difference between the two. The whole world rejects poison, but Satan always has a goodly following. Unlike lethal poison, Satan is seductive. There is thus a distinction in the inner meaning between the toxic 'toadstool' and the demonic *crapaudin*. The distinction is in the emphasis: the associations of the two terms overlap but do not coincide.

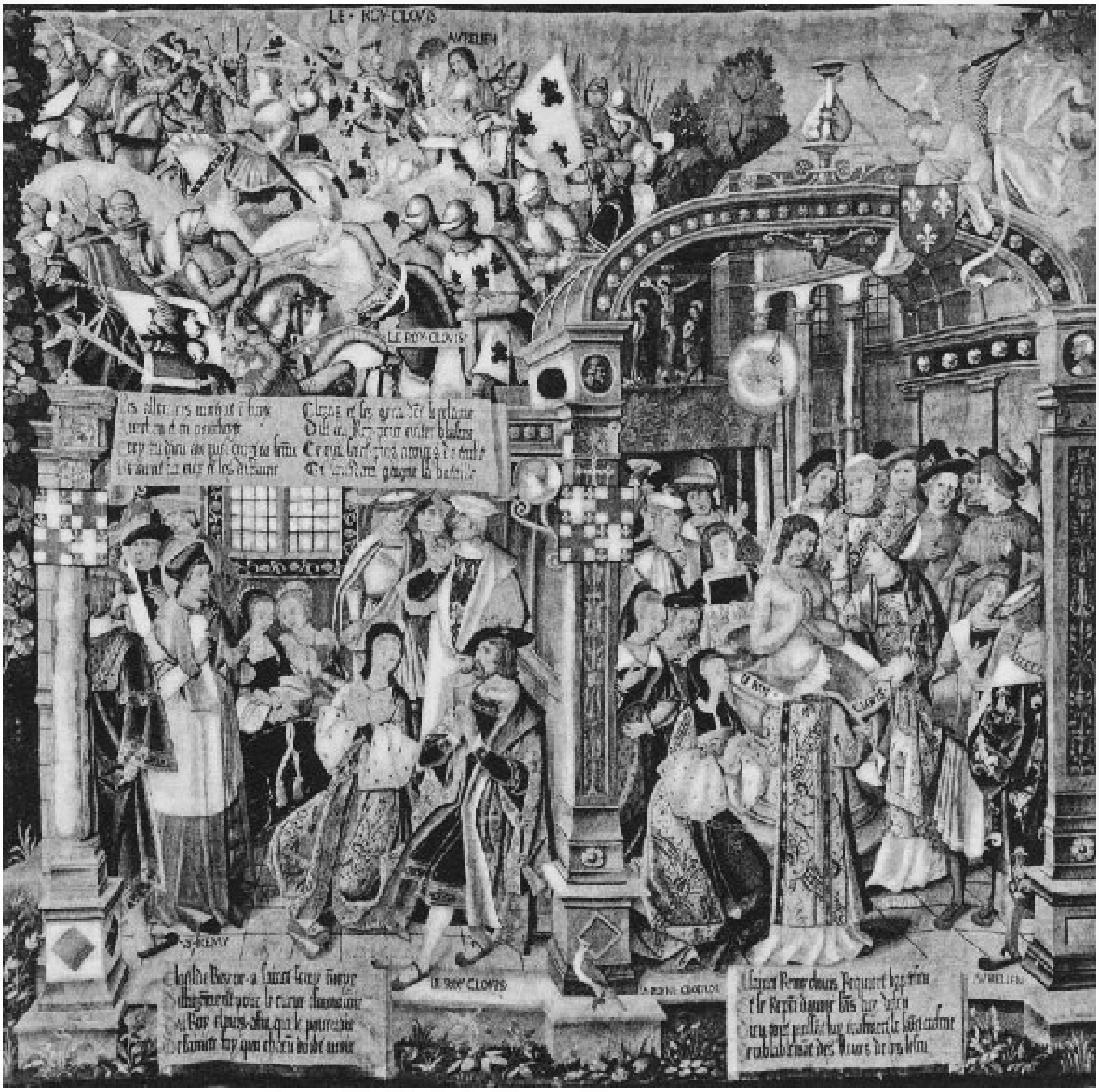


PLATE XIV

Conversion of Clovis. Tapestry in the Musee de Reims showing King Clovis in the battle of Tolbiac, his instruction in Christian doctrine by St. Remi, and his baptism. Woven in 1531.

If our interpretation of *le bot* is correct, why do we not find this word figuring in France's fungal vocabulary?

---

43. For a sceptical and charming discussion of these toads, see Claude Fauchet's *Origines des Chevaliers, Armoiries, et Heraux*, Paris, 1600, p. 17. See also C. Leber's *Collection des meilleurs dissertations, notices et traités particuliers relatifs à l'histoire de France*, Paris, 1838, vol. XIII, pp. 198 ff. Leber quotes from Scevole de Sainte-Marthe (1572-1650), and the evidence indicates that the popular belief in the heraldic toads of the pagan French kings goes back at least to the beginning of the 15th century. From the 16th century to the 18th we find in both English and French sources frequent references to Clovis's heraldic toads. Today they are forgotten by almost everyone, even historians.
44. *Ontcijfering van Jeroen Bosch*, The Hague, 1949, p. 33, where the author also gives the sources for his statements.

The answer is that we do. Eugene Rolland in his *Flore Populaire* reports *bo* as a designation for gilled mushrooms in the Haute Saone, and *botet* in the Loire. He gives no explanation for these words, whose inner meaning becomes obvious now for us. It would be well for specialists in French provincialisms to concentrate on *bo* and *botet*, to determine whether they still survive and where and with what precise fungal application and in what contexts. In the center and south of France there are regions where *boutarel*, *boutareu*, and *boutairoual* are general words for 'mushroom'. They also mean in the langue d'oc 'barrel' and 'basket', but we suspect that in the sense of 'mushroom' they are a popular corruption of *boterel*, a diminutive of *le bot* that is not uncommon in France as a family name. A close scrutiny of the French dialects will certainly uncover additional links, until now unnoticed by scholars, between toads and mushrooms. On page 73 we mentioned the Gallic word for 'toad', *craxantus*, obsolete these many centuries. Does it perhaps survive in the Gascon name used for the despised and rejected boleti whose flesh turns blue on exposure to air - *craaue-maudit*, which would then mean 'the cursed toad'?

I've conclude, then, that mushrooms and toads were linked together in France in former times as part of a cluster of folk beliefs having a demonic nucleus. The link was strongest, it seems, north of the Loire and faded out as one approached the Mediterranean. Apparently it stemmed from the Germanic or Celtic cultural strata that antedated Mediterranean influences, strata steeped in the blackest mycophobia. And this leads via again to Hieronymus Bosch.

One of Bosch's powerful paintings is the *Hay Wain*, to be seen in the Prado. It is a large triptych, and in the central panel, almost unremarked hitherto by commentators, there stands forth a giant boletus. So far as our inquiries have gone, this mushroom was the first significant representation of a fungus[45] after the ancient fresco of Herculaneum (which we reproduce on Plate LXXVI), a lapse of more than fourteen centuries. Let us see if we can arrive at the meaning of this extraordinary mushroom, so boldly painted, at first glance so enigmatic.

The *Hay Wains* left-hand panel, of which we reproduce the upper part on Plate XXXVI, depicts with idyllic beauty the momentous events that took place in Paradise in the Beginning, up through the final scene where the Angel of the Lord drives Adam and Eve forth from Eden into the wilderness. The right-hand panel depicts Hell. The central panel is occupied chiefly by a huge load of hay, which is the dominating feature of a procession that enters the scene from Paradise on the left and disappears on the right heading for Hell. The wagon is being hauled by a miscellany of grotesque creatures who are personifications of the Sins. With a dead switch the Devil in the foreground drives on these monsters. The withered branch, as always in Bosch's symbolism, signifies cursed sterility, recalling the withered vine of Christ's homily. Sceptred king and mitred churchmen with their trains follow the hay-wagon, which as it progresses crushes little men like a juggernaut. Jesus looks down in anguish from Heaven, and a strange group of merry-makers disport themselves a-top the hay.

The hay wain represents pleasure, but it remained for Mr. and Mrs. Nicolas Galas of New York, in the course of their studies of Bosch, to discover the precise text that is illustrated, a passage in a book with which Bosch was familiar, Gregory the Great's *Morals on the Book of Job*, written after A.D. 600. In Book 32, paragraph 7, Gregory is commenting on the Vulgate text of Job 40: 4 (King James Version, Job 40: 9):

> As he says by the Prophet, 'Behold, I will shriek over you, as a cart creaketh laden with hay' [Amos 2: 13], for since the life of the carnal is hay, as it is written 'All flesh is hay' [Isaiah 40: 6], in that the Lord endures the life of the carnal, he declares that he carries hay as a cart. And to creak under the weight of the hay is for Him to bear, with murmuring, the burdens and iniquities of sinners. [Vol. 3, Part 2, p. 514, of the English translation by J. H. Parker *et al.*, published in Oxford, 1844-1850]

---

[45] The *Bulletin of the Societe Mycologique de France* in 1911 (vol. XXVII, p. 31) announced to the mycological world the discovery of a 13th century fresco representing the temptation of Eve. The mycologists who focused their attention on this fresco persuaded themselves that the Tree of Good and Evil had been portrayed by the artist as an *Amanita muscaria*. The fresco, which we visited in the summer of 1952, is in a disaffected chapel in France, in the Berry, between Ingrandes and Merigny, near the Chateau de Plaincourault. The style is Romanesque, and this fits the date that the edifice bears - 1291.

Since the initial announcement there have been numerous references to the fresco in mycological publications; e. g., *The Romance of the Fungus World*, by R. T. and F. W. Rolfe, London, 1925, p. 291; also John Ramsbottom's *Mushrooms & Toadstools*, pp. 46-7 and illustration facing p. 34; also *The Illustrated London News*, Nov. 21, 1953. The mycologists would have done well to consult art historians. The Plaincourault fresco does not represent a mushroom and has no place in a discussion of ethno-mycology. It is a typical stylized Palestinian tree, of the type familiar to students of Byzantine and Romanesque art. The German art historians have even devised for this oft-repeated motif the technical designation of *Pilzbaum*.

On the right in front of the wagon the great procession is joined by a small confluent stream of people pouring from a door-way as the hay-wagon approaches their earthly abode. They too are damned souls, as is declared by their leader's reaching up for carnal hay on the wagon, and by another branch, withered and cursed, that holds up the trapdoor of the habitation out of which this secondary stream emerges. In the door can be seen the peephole used by the inmates when the door is closed. In our opinion the doorway gives access, not to a cave, but to a turf-covered dwelling, of which the roof rises to a clearly identifiable peak, made by the upright post that is presumably the structural support for the primitive structure. On the left of that peak there lies a fruit, symbol of man's First Fall. On the right stands our mushroom. Bosch has painted not a mushroom, but a gigantic effigy, a mushroom sculptured in stone or wood. It represents a boletus, perhaps the *Boletus satanas*, a species that to this day is popularly associated with Satan in Central Europe. The light color of the painted mushroom effigy is not significant, for it is the color of the material in which the mushroom is sculptured. The stem is covered with flecks like goose-flesh. The cap is disproportionately small, and from it emerges again the withered branch of the Biblical curse.

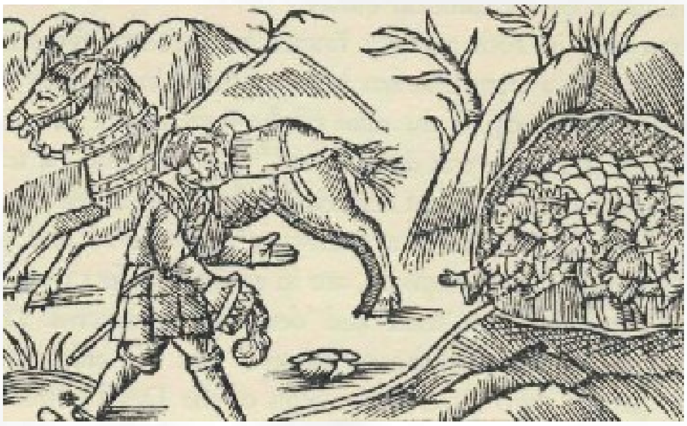


Fig. 4 - Prince visiting fairy folk, *after* Olaus Magnus.

We have seen that in 16th century France mushrooms were called *pain de crapaud*, 'toad's bread', a term that has been reported in modern times in Normandy. Contemporaneously, at the time of the Renaissance, the corresponding name in Flemish and Dutch was *duivelsbrood*,[46] 'devil's bread', a term now obsolete in the standard language, but historically documented in the larger Dutch and Flemish dictionaries. These two expressions, 'toad's bread' and 'devil's bread', superficially using different metaphors, are in essence perfect translations one of the other, for as we have seen 'toad' and 'devil' are synonyms. The effigy of a mushroom that Bosch the Dutchman painted was the effigy of the Devil's Bread, and the people who lived at the Sign of the Devil's Bread were bread for the Devil.

Our mushroom effigy is then a pictographic embodiment of a popular metaphor, and proclaims the curse that lies on the household dwelling within. This interpretation receives surprising support from an otherwise inexplicable detail of the painting. The base of the mushroom shows two flattened surfaces. Bread always bears the imprint of the vessel in which it is baked, and here we discover the beveled faces left by the Devil's bread-pan. How obvious this must have been for Bosch's neighbors in the Low Countries!

There remains a crucial question: why did Bosch introduce into this sermon in paint the minor tributary stream of Hell-bent sinners, emerging from the House of the Devil's Bread? Clearly this rather crowded detail of his exhortation on the carnal sins was not a capricious fancy. He was asserting something, but what; Here is our conjecture. The main stream of sinners is recruited from the Christian community, as evidenced by the trappings of the leaders. The tributary stream is fed by folk similarly damned but who have not belonged to the

Christian fold. The Devil is the hot-blooded Devil of the witches' covens. The people crowding forth from the hovel do not lend themselves to a precise count but they are about thirteen, the full complement of a witches' coven with their leader the Devil, whom we may perhaps distinguish in this group. Here are then the 'fairy folk', who were wont to dwell in the remote and desert places and who paid no obeisance to Pope or Christ.

---

46. See Hadrianus Junius' *Nomendator*, Paris, 1567, p. 144, where the word is spelled *duyuehbroot*; also the history of *duivelsbrood* in Dr. J. A. N. Knuttel's *Woordenboek der Nederlandsche Taal*.

They were described in vivid detail by the Swedish writer Olaus Magnus, whose *Historia de Gentibus Septentrionalibus* appeared in 1555 in Rome,[47] a generation after Bosch's death. The fairy folk dwelt in houses walled and roofed with turf, the roof being supported by a central post. A woodcut in Olaus Magnus shows the Swedish King Hotherus paying a visit on the fairy people and we reproduce it here, for we suggest that the house painted by Bosch springs from the same folk beliefs as the houses in the Magnus woodcut a half century later. Miss Margaret A. Murray may be right that a culturally distinct people, autochthonous, unlettered, and pagan, lived side by side with the Christian world in northern Europe down into Renaissance times. But whether that people existed or not, the belief in them existed and was generally accepted, and Bosch presents those cursed outcasts to us under the Sign of the Devil's Bread, a sinister and mycophobic Sign that marks for us the initial emergence of the mushroom world into the documentary annals of northern Europe.[48]

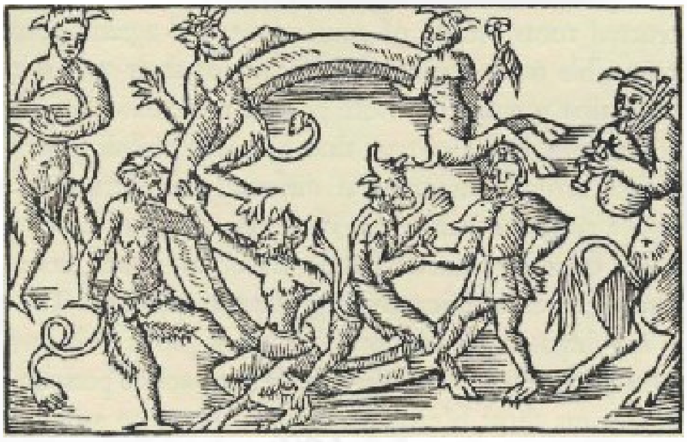


Fig. 5 - Fairy ring, *after* Olaus Magnus.

For the medieval world the fairies were sinister beings, at least in orthodox eyes, and down to recent times the flavor of the old belief could still be detected in Sussex, where 'fairy rings' long continued to be called 'hag tracks'. By the end of the 16th century the fairies had become the dulcified sprites of modern usage and this transformation has been attributed to the imposing genius of gentle Shakespeare. But the time has come to take new soundings in the social upheavals of that troubled 16th century. The Reformation turned society upside down and inside out, and perhaps layers of the community, formerly inarticulate, where the fairies had always been beloved rose to the top and through Shakespeare and others made their voices heard.

---

[47] The English edition was published in London in 1658 as *A Compendious History of the Goths, Swedes and Other Northern Nations*. See Book III, Chapters 9 and 10. See also Miss Murray's *The God of the Witches,* Oxford University Press, New York, 1952, Chapter II.

[48] The mushroom in the *Hay Wain* is not the only one painted by Bosch. In his ghostly portrayal of The World, strangely disturbing, on the back of the wings of the *Garden of Delights*, there are two unmistakable mushrooms, possibly three, all in the left-hand panel. Elsewhere we find shapes that suggest mushrooms, perhaps intended by Bosch to do so; e.g., one such shape in the left-hand panel of the *Garden of Delights* and two in the central panel, the table in the *Cure for Folly*, and various 'puckfist' shapes elsewhere. The demonic symbolism of the toadstool may have played an important and hitherto unsuspected role in Bosch's cosmos.

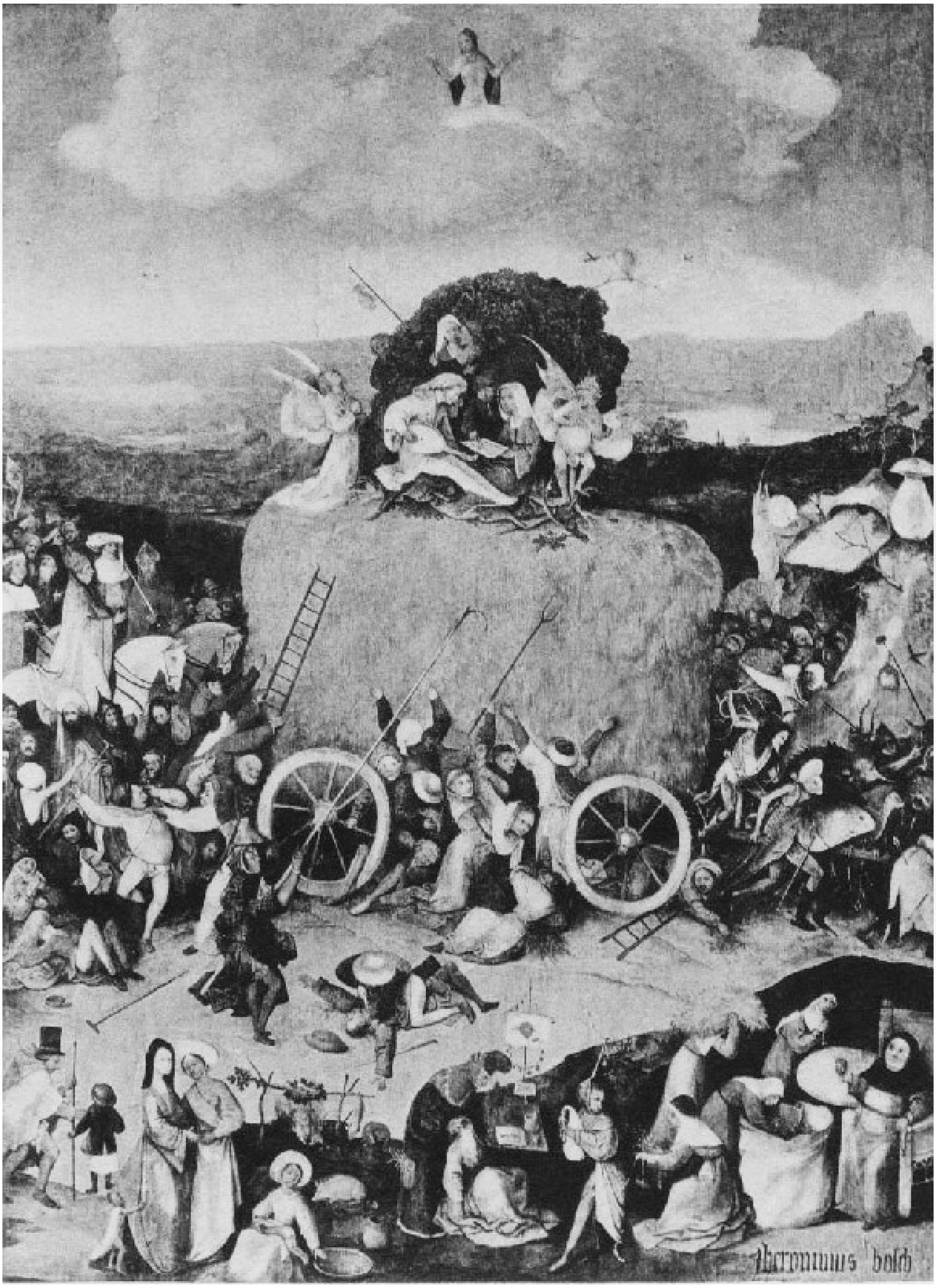


PLATE XV

Hieronymus Bosch. The Hay Wain. Central Panel. *Madrid, Prado Museum*.

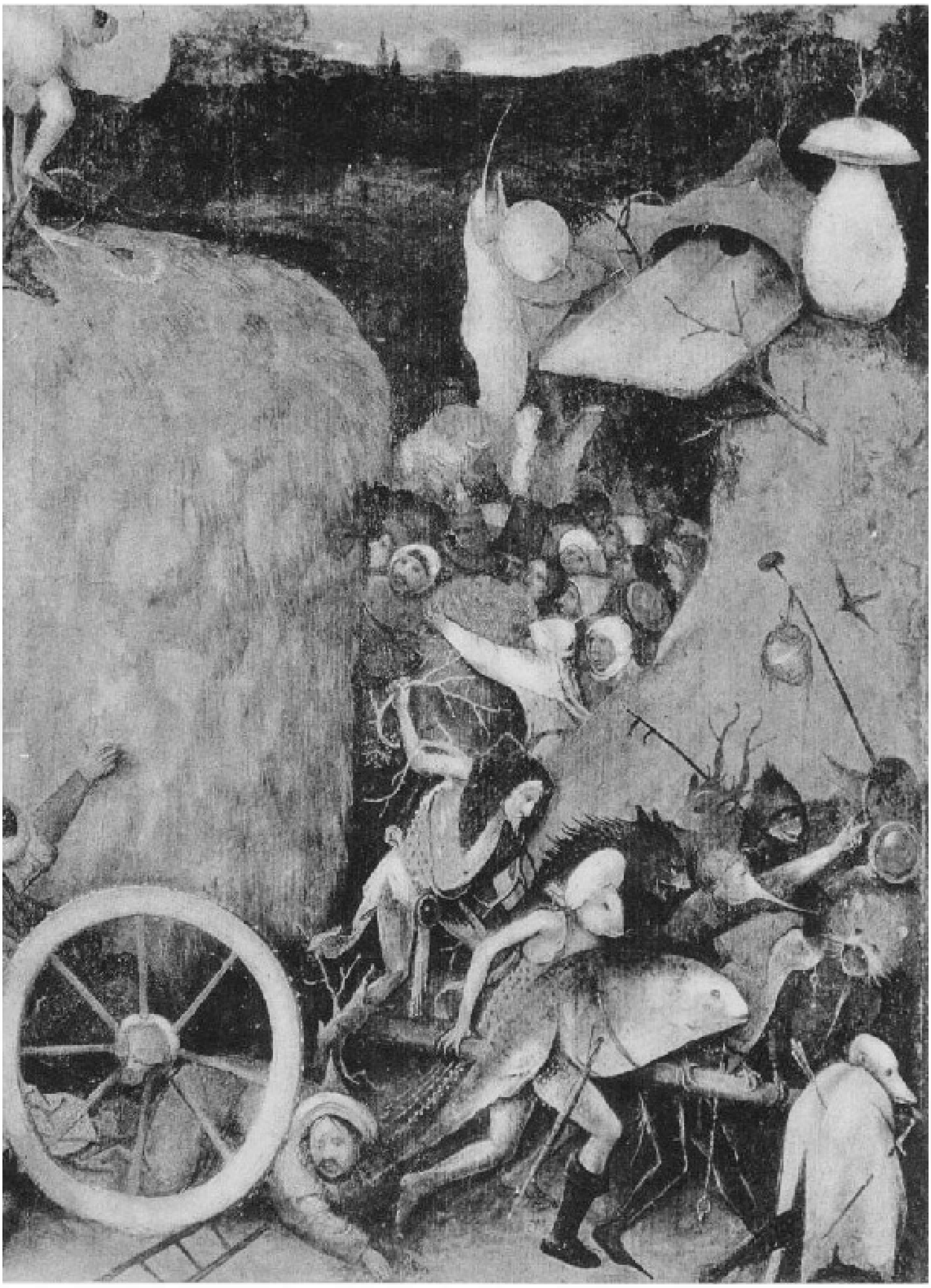


PLATE XVI

Hieronymus Bosch. The Hay Wain. Detail. *Madrid, Prado Museum*.

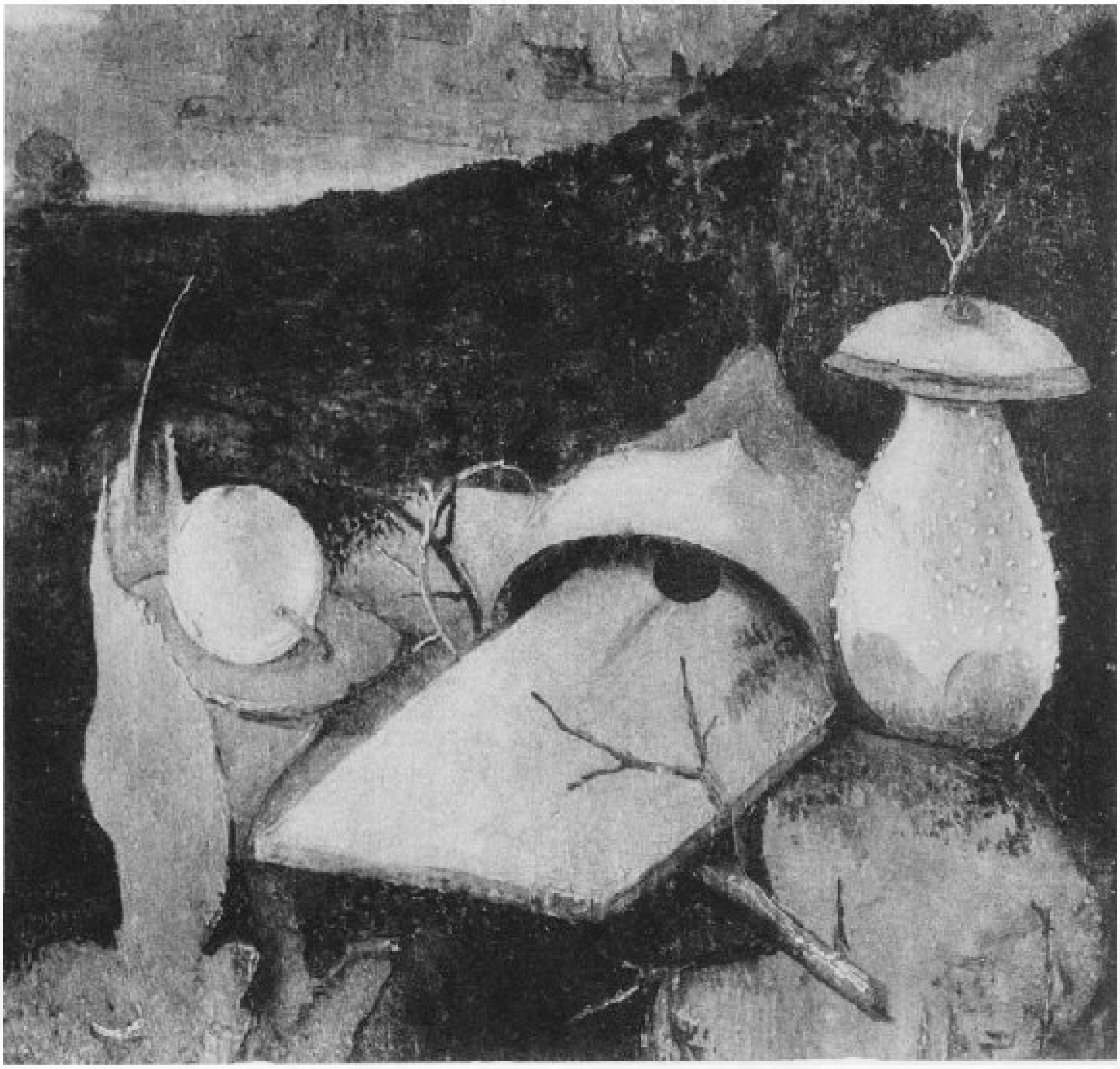


PLATE XVII

Hieronymus Bosch. The Hay Wain. Detail: Boletus. *Madrid, Prado Museum*.

4

The 'Pogge' Cluster

Just as we turned to the Breton word *tousec* for a clue to the inner meaning of 'toadstool', so now we invite our readers to look with us at the Low German word *pogge*, meaning frog or toad, and *poggenstohl*, 'frogstool'. *Pogge* exists in many a dialectical variant: *pogg*, *pagg*, *pugg*, *puck*, *pook*, *pauk*, *poch*, and *puch*.

One of the daring labors of modern philologists has been the reconstruction of the original Indo-European roots that lie behind our modern vocabularies. With the known vocabularies of some scores of languages, living and dead, to go by, they work back along converging lines of evolution to discover, as closely as the evidence permits, the roots that were current perhaps four thousand years ago, before the linguistic unity of our ancestors broke up. These reconstructed roots cannot of course be tested against actual usage, nor is it remotely possible to document the history of their verbal progeny back to them in a way that would constitute proof by the exacting standards of the etymological discipline. It is also true that different philologists working from the same evidence arrive sometimes at different reconstructions of the root, but often there is a consensus, and even if we consider the results only tentative and approximate, these hypothetical Indo-European roots serve, if cautiously used, to associate together significantly large clusters of words. The philologist of our time who has devoted his life to this work is Julius Pokorny. In his latest revision of his *Indogermanisches Etymologisches Worterbuch* he presents an important root that he represents thus: b(e)u-, bh(e)u-. It means to swell up, to puff up, to fill with wind, to inflate or expand or distend, and in origin it is imitative.[49]

Among the many words that Pokorny traces to this root is our Low German *pogge*, meaning frog or toad, and the semantic link here is clear. Of the aspects that the frog or toad presents to the human senses, two stand out, one aural and the other visual: the croak, and the astonishing distension of the creature with air in the act of croaking. A frog or toad suggests the idea of a sac that lends itself to gaseous distension. From Pokorny's root we derive also our English 'poke', meaning a bag, and 'pocket', and the French *poche*. To the same family belongs the Anglo-Saxon *buc*, meaning 'belly' and also any bellied container such as a pitcher. To these we would venture to add a curious trio of English words, the obsolete 'pung' and 'bung' and the Scottish 'spung', all three meaning 'purse', words that picked up somewhere along the road a nasal infix, as the philologists say. In Swedish *pung*, meaning 'pouch', is in current use.[50] There exists, we believe, abundant evidence that latent *inpogge* is the metaphor of an inflatable sac. In the eastern part of the Dutch province of Gelderland, the same word *pogge* means, not a frog, but a young pig, a creature notorious for its fat rotundity.[51] The same figure of speech underlies the words for 'toad' in other languages. Thus bufo in Latin suggests the blown-up cheeks of the buffoon. In ancient Greek a kind of toad that was said to puff itself up to bursting and to exhale a poisonous breath was the βάτραχος, a word derived from φυσσας, meaning a bellows, a wind, a blast, a breath; and it is related to a Greek word for bladder and bubble. In the Tosk dialect of Albanian, a toad is a *thithelope*, or 'cow's udder', *thithe*- being the udder. The inflated pouch of a toad suggests an udder. Now we turn to the Irish language, and here our wild fungi re-enter the scene in a strange blending of metaphors already familiar to us. In Irish there are two words for a bag or pouch, *bolg*, which is related to the Latin *bulga*, and *puca*, which was probably borrowed between A.D. 800 and 1050 from Scandinavian sources. They are two further examples of words belonging to the family of our familiar Pokorny root. In Irish one way to refer to a wild fungus is *bolg losgainn*, literally 'frog's pouch', and another way is *pucán beireach*, 'heifer's pouch'. If the 'heifer's pouch' refers to the udder, as we suppose, the same figure of speech that in Albanian means 'toad'

---

49. Pokorny offers two additional, somewhat similar roots conveying the same meanings: (1) ba^xb-, bha^xbh-, pa^xp-; and (2) ba^xmb-, bha^xmbh-, pa^xmp-, pha^xmph. See first two fascicles of his revision, published in Bern in 1949. The possible kinships between these three roots need not concern us.
50. High German *Pocke*, English 'pock' and 'pox', the erupting pustule, belong to the same verbal family. It has been suggested that Low German *pogge* means the 'pock-marked one", rather than the 'bag'. But this is belied, as we shall see, by the metaphors latent in other languages and dialects. Furthermore, the principal meaning of *pogge* is 'frog', and the common frogs of Central Europe, unlike toads, are free of warts and pustules. The usual words for 'toad' in Low German are *padde* and *utze*.
51. For this information we are indebted to Professor G. G. Kloeke, of Leiden, who refers us to his *Taalatlas van Noorden Zuid-Nederland*, Lief, n. 1, in the '*Ferkel*' chart.

turns up in Irish meaning 'toadstool'. In Irish, *bolg seidte*, 'blown-up bag', is a term for the puffball. It is easy to see why the fungi figure in all these metaphors: puff balls, toadstools, all the wild fungi of forest and field, impress the visual sense as creatures that quickly swell up.[52] Francis Bacon in his *Sylva Sylvarum* described the puffball as a 'cod', or 'bag'; in Bacon's time 'cod' meant both 'pouch' and 'scrotum'. In Latin *bulga* was a humorous metaphor for the womb, and the bagpipe down through Renaissance times was a symbol of lust and wantonness.[53] In Slavic our Pokorny root erupts directly in to the fungal vocabulary. An ancient word for 'mushroom' survives in the Czech *bedla*, in the Polish *bedła*, and in *blitza* (**блица**), a term reported in certain parts of Russia. From these words Roman Jakobson reconstructs the hypothetical *bii-dla* for primitive Slavic, descended in its turn from our Indo-European root, with the addition of the Slavic instrumental suffix *-dl-*. The philologists link these Slavic words with an Indie word meaning 'bubble', wherein the idea of the swelling sac recurs in purest form.

I've have pursued our Low German *pogge* on the humble and earthy level of toads and frogs, udders, bags, and fungi. But the underlying metaphor, keyed to gaseous distension and gaseous collapse, lends itself to images on a wholly different plane, and our same Indo-European root proliferated verbal progeny in the incorporeal world, the world of imps, sprites, and goblins. Here we find our 'spooks', and Shakespeare's Puck, and Kipling's '*Puck* of *Pook's* Hill', malicious forces of the unseen world, unaccountable, like Hamlet's ghost *hic et ubique*, the bugbears and bugaboos of cowering minds. In Irish, *puca* circulates as two distinct words, meaning 'bag' and 'sprite', though in our opinion they are etymologically and metaphorically identical. The Pooka of Mary Chase's play *Harvey* is a wise but mischievous spirit, an imaginary rabbit blown up to more than human size. In English 'puck' refers only to imps, but here, as in Irish, we find it associated with the fungal world, for 'puckfist', now fallen into disuse, was once a common name for the puff ball. The second element in the word, '-fist', meant a silent expulsion of hind wind, and so a puffball was an imp's flatus. In Russian a 'flatus' is a *puk* (**пук**), riming with 'juke' (**йуке**), and the word is another of our *pogge* cluster intimately linked with a family of Russian words relating to gaseous distension, swelling, bursting, ripping open; but the Russian word is not associated with fungi or amphibians.

Like the weaver's threads shuttling in and out in warp and woof, we have seen how words and meanings play hide-and-seek: frogs and toads are inflatable sacs, and these are sprites, and bags and sprites are fungi. Today the meanings are compartmented, their latent metaphors forgotten. But there was a time when the metaphors were living, the words fluid. We have said that 'puckfist', referring to a puffball, meant an imp's flatus. Did it once, long ago, mean 'toad's flatus'? There is no evidence in surviving English documents for this. Yet we know that the toad was the habitation of the Evil One. We know that in the southwest of England toadstools to this day are called 'pixie-stools', with a puckish pixie thus doing service for the toad.[54] We know more: the language closest to English is Frisian, and in the dialect of Frisian spoken on the island of Terschelling the puff ball is called the *podde-fyst*, toad's flatus, and in the neighboring island of Schiermonnikoog it is the pare-puster, toad's puff. But the association with imps is also not absent from Frisian, for in the town of Dokkum the puffball is called the *spoekebal*, or 'spookball'. With what regularity the semantic themes recur! In German we face a pretty problem: the puffball is the *Bovist* or *Bofist*, and in Low German we find *pofist*: the second syllable in these words is clear, but what idea hides behind the first syllable? No one knows, but we think it is safe to assume that it meant either frog or toad, or an imp, or a sac, or a puff, or a blending of these. And whichever it was, behind it lay the primal idea of a gaseous swelling, an exhalation; and emotionally, all of these terms connoted something vile.

---

52. For hobgoblin there are words in Manx, *boag*, *boagane*, and in Irish, *bocán*, that seem to belong to the same family, though the kinship is obscure. They recall a cluster of Irish words for mushrooms - *beác* and its diminutives *biocán* and *beacán*. Perhaps Irish scholars will tell us whether these fungal words do not also harbor ideas of sprites and of bellies, and thus link them with our *pogge*- cluster. There is an Irish term, *beacán bearaigh*, which on its face would seem to mean 'heifer's mushroom', but underneath the surface is it not analogous to *pucán beireach*, 'heifer's pouch', and parallel in meaning?
53. For a discussion of the erotic associations of the bagpipe as found in art and literature, see Edward A. Block's 'Chaucer's Millers and Their Bagpipes', *Speculum*, April 1954, pp. 239 ff.
54. Richard C. A. Prior pointed this out close to a century ago in his *On the Popular Names of British Plants, London*. He also suggested an etymological tie between 'puck' and *pogge*. See entries under 'pixie-stool', 'puckfist', and 'toadstool'. We consulted the edition of 1879.

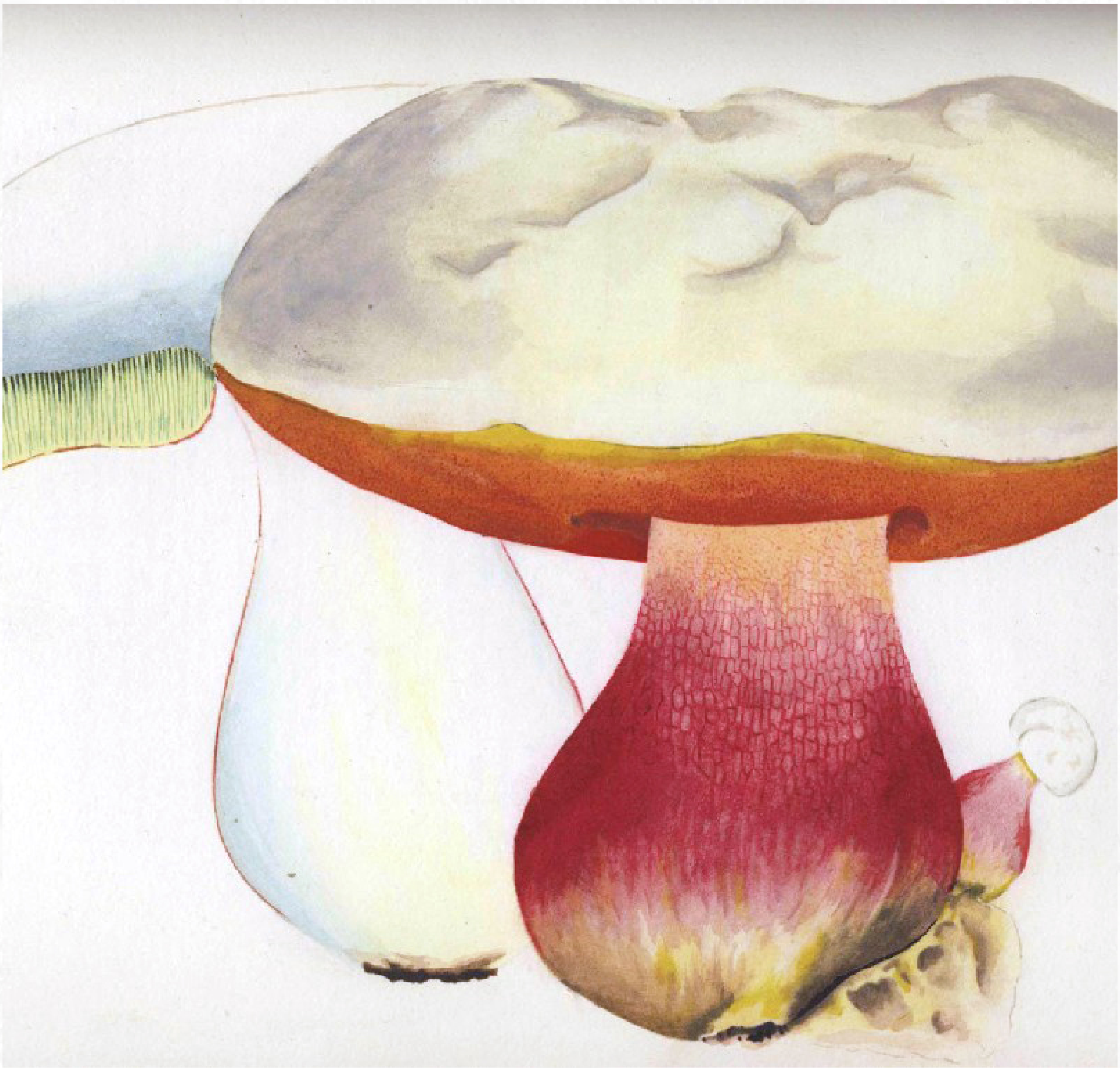


PLATE XVIII
Jean-Henri Fabre
Boletus Satanas Lenz.
Polish: *Borowik szatański*.

In the first stage of our 'toadstool' pilgrimage, we identified what we call the poison-cluster of toad and fungal words. Now we have gone on to identify the *pogge-* cluster, wherein, through the mediation of the evil spirit with which both toads and fungi were felt to be instinct, we find these lowly creatures linked together verbally in the untutored minds of early men inhabiting the dark forests of northern Europe from Ireland to Russia. Here we discern the deep folk associations that caused and expressed the mycophobia of the Celtic and Germanic peoples. In the Mediterranean world, a kindred idea of the breath, the exhalation, gave rise to metaphors of the loftiest associations - the Holy 'Spirit' and Divine Inspiration. In Russia the word for the soul - *dusha* (**душа**) - flows from *dukh* (**дух**), the word for breath. But by an initial turning in the wrong direction, the metaphorical use of gaseous distension and exhalation in the world north of the Alps reduced the Holy Spirit to a sprite, and the Divine Afflatus into an imp's flatus. The northern metaphor was keyed to frogs and toads, and they to swollen fungi, and both to the Devil.

Earlier we saw how toads and fungi and venom executed a kind of triangular measure in the minds and words of the peoples who dwelt on the shores of the North Sea. Against the vaster background of a still more ancient world, we have seen how a common idea underlay the words for things as disparate as toads, sacs, fungi, and imps, and how meanings and metaphors criss-crossed in the figures of an antique quadrille. The poison-cluster of words was superimposed, so to speak on the *pogge*-cluster. In France the toad and the Devil coalesce, with fungi joining the company.

We have seen that an Irish expression for the mushroom is the frog's pouch, *bolg losgainn*. *Bolg* is cousin to the English words 'belly', 'bulge', and 'bilge'.[55] ('Bilge' is the ship's belly where bilge-water collects.) *Bolg* also means belly or womb, bag or pouch or pocket, bellows, bladder, pimple, blister. It is kin to the Latin *bulga*, which meant a leathern pouch or reticule (in lieu of the pockets that the Romans did not have) carried over the forearm, a word that the second century lexicographer Festus traced to an origin in Gaul. It is the same word as the French *bouge*, which has had a succession of meanings down the centuries - a concavity, a dump, a miserable habitation, the belly of a cask, a leathern bag, a valise. Another word of the same clan is 'budget', that most distended of all wallets, always 'bulging'.

If, as we have seen, frogs and toads were often called 'pouches' or 'bags', then by a reverse semantic transfer, we might discover that on occasions some word for 'toad' that had no semantic or etymological kinship with the *pogge*-cluster, might be used for a pouch or wallet. The word for pocket in High German today is *Tasche*, and we can trace it back to Old High German *tasca*, where the trail is lost. The Italian *tasca* means a pouch or wallet. Some have considered the Italian word distinct from the German, but no satisfactory etymology has been found for it either. We now put to the philologists the question whether both the German and the Italian words are not simply our old friend *tosca*, the Anglo-Saxon word for toad. We are not obliged to assume that *tosca* or *tasca* in the sense of toad was ever current in Old High German: it could have been borrowed in the Old High German period (not earlier than about A.D. 800) from some other area where *tasca*, meaning toad, had already taken on as a second meaning the sense of *bulga* or wallet. Nor was it borrowed necessarily from Anglo-Saxon, of course, since the area where this word circulated in various forms was much more extensive; just how extensive we do not know. There could have been, for a time, a style of *bulga* - a leathern scrip hanging from the forearm - designed to imitate a toad, and a term that began as a nonce-word could have struck permanent root in Germany and Italy.[56]

---

[55] The Irish chronicles refer to the aborigines of Ireland as the *Fir Bolg*, 'pouch men', of which the meaning is obscure. *Bolg* here may be related to *bog*, an Irish word meaning 'soft', and to the Irish words *began* and *bogac*, 'bog', 'quagmire'. Cf. the undoubted etymological kinship between German *Schwamm*, 'mushroom', and English 'swamp'.

[56] The presence of *a* in both the Italian and Old High German words reminds us of the Anglo-Saxon variant *taxe* (see p. 75, footnote), and lends weight to Victor Henry's suggestion that confusion arose in Latin between *toxicum* on the one hand and *taxus*, *taxicus* on the other. Our suggested etymology might be valid for Italian *tasca* even if invalid for the Old High German word. This brings us to an obstacle in the way of our theory that philologists will quickly bring up. The authorities cite an Old Saxon word *dasga* meaning 'pocket'. This would correspond by normal transition to Old High German *tasca*, and the pair of words would point to a purely Teutonic root. But the Old Saxon word appears, not in a text, but in a gloss; see J. H. Gallee's *Altsächsische Sprachdenkmäler*, p. 287, 11, 26-27. The source is there given as a Karlsruhe ms. that is not further identified. An exhaustive examination of all the evidence supporting the existence of Old Saxon *dasga* needs to be made. The gloss may reflect a false back-formation from the Old High German word, a pedant's error; or it could be a copyist's misreading. In addition to the doubtful Old Saxon form *dasga*, there are various citations of an Old High German form *dasga*.

5

Puff Balls, Filth, and Vermin

More names are reported in English for the puffball than for any other kind of mushroom. There is the fanciful 'devil's snuffbox', which recalls the corresponding *chortova perechnitza* or 'devil's pepperpot' of the Russians. There is 'frogcheese', designating the young puffball before it dries up. There is that curious word 'bunt', now dying out. In the Oxford Dictionary it follows hard on another word, identically spelled, that is defined as 'a swelling, a pouchor bag-shaped part of a net, sail, etc.', and both words are put down as of unknown etymology. Surely, from the swelling growth of the puffball and the many associations of the fungi with the idea of pouches and bags and swellings, we may regard these words as one.

However, in England and throughout western Europe the distinctive association of the puffball is scabrous. 'Puckfist' is the English archetype, whence depend a number of variants: puff-fist, bullfist, fistball, fuzzball, pixie-puff, and finally the cleansed and devitalized survivor of the lot, our puffball, of which the bad-smelling origin is lost almost from memory. In human speech as in the physical world there operates a law of entropy that saps the strength from once virile metaphors, until only bookworms (ourselves perhaps devitalized!) detect and relish with rarefied connoisseurship the faded flavors that have lain stale for centuries. 'Feist' was the word once commonly used for the silent flatus; it and the noisy 'fart' are simply different phases or 'grades' of the same word, etymologically identical. ('Feist' rimes with 'enticed', but in 'puckfist' the V is short.) They correspond respectively to the French *vesse* and *pet*. Just as the Latin *p* of *pater* corresponds to the 'f' of 'father', so the *p* of the French verb *peter* in all likelihood corresponds to the 'f' of our English words. One of the famous creations of the French pastry-cook is the *pet de nonne*[57]: here in this single term, as in a capsule, the spirit of Gallic humor was caught, though today it trips off the tongue of Frenchmen with no thought of its pristine flavor. A French wine that is *pétillant* is one that fizzes slightly, and originally 'to fizz' was the English verb that corresponded in scabrous meaning to the noun 'feist'. In the beginning the *petard* was an enormous *pet*, and he who is hoist by his own petard is the victim of a peculiarly personal rocket action such as Hieronymus Bosch actually depicted in his *Last Judgment*.

The metaphor of the silent flatus appears to have attached itself to the puffball in earliest times, before the linguistic break-up of the Indo-European peoples. For the English, as we have seen, the puffball used to be the puckfist or imp's silent flatus. In French it is the *vesse de loup*, or wolf's silent flatus, and similarly in Dutch, *wolfsveest*; and in Danish the sources give the corresponding *ulve-fiis*, but this is not a drawing-room word. Some Frisian islanders speak of the toad's flatus, but the more common Frisian term is *ulefyst*, or owl's flatus, which may be traceable to an erroneous popular rendering of the Danish term. In Russia the genteel name for the puffball is the devil's pepperpot, as we have seen; but there circulates an earthier term, *bzdjukha* (**бздюха**), the silent flatus. The Basques speak of the ass's flatus, *astaputz*; and in Romansch we find in the Engadine, wolf's flatus, *toffas d'luj*, and in the Surselva, *cacs tgapper*, or crow's droppings. The mushroom manuals report *cuesco de lobo*, wolf's flatus, for the Spaniards, and we ourselves report *pedo de lobo* in use in the Castilian countryside. The standard name in Italian is *vescia di lupo*, but in the Trentino dialect we have *slofa*, which is a low word for the *membrum virile*. In Catalonia we find *pet de hop* and *pet de bou*, wolf's flatus and ox-flatus, this latter paralleling the English bullfist. By far the most interesting of all, however, are two other Catalan terms: *bufa del diable* and *bufa del dimoni*. *Bufa* like 'feist' is a silent flatus, and so in both these Catalan expressions we find exact equivalents of the obsolete English puckfist. But the ramifying interplay of semantic and phonetic associations does not stop there, for in the Catalan language *bufa* also means 'bladder' and a cluster of kindred things, and this transports us at once to the maze of meanings that we found clinging to the Irish *puca*, the Latin *bulga* and its derivatives, and indeed the whole cluster of *pogge* words. In Irish, according to a reliable source, the puffball is *cos-a-phouka*,[58] 'Puck's foot', which reminds us of the Old French word, *le bot*, meaning both Satan and 'toad'.

---

57. Cf. Dutch *hoerendrcetje* and *nonnenfortje* for similar delicacies, words that, if literally rendered, would shock the English ear and turn the stomach.
58. See A. B. Steele, 'Fungus Folklore', in *Transactions* of the 'Edinburgh Field Naturalists' and Microscopical Society, vol. 2, 1887, pp. 175-183.

In the puffball vocabulary we discover a subtle interplay of sounds and meanings, where strict etymologies are lost in a common pool. The idea of the devil underlies all-in pixie and puck and the *diable* and *dimoni* of the Catalans; and, as it were behind a mask, the Evil One is hidden in toad and wolf, those creatures steeped in terrible folk associations. The owl of the Frisians is an evasive substitute for the wolf, and the crow of the Surselva may hide, through translation and metamorphosis, the German *Krote* or the French *crapaud*. In addition to the devil, the scabrous exhalation of gas is everywhere - in feist, fuzz (i.e., fizz), puff, *vesse*, *pet*, *bufa*, and behind the euphemistic face of the bull and *bou*, and probably behind the enigmatic *Bo*- of B0f zsL 'Ball' in 'puffball' is a happy dilution of the same theme, an acceptable alliterative substitute. In 'puff' there is the phonetic overlap with 'puck' and the semantic overlap with 'feist'. Like those modern clutches in automobiles that move imperceptibly from speed to speed, the peoples of western Europe, when they speak of the lycoperdon, slip from sound to sound and metaphor to metaphor, under pressures of primitive tabu and the modern sense of propriety. On this phenomenon suggestive of punning the scholars bestow the name of paronomasia. There is in our case a pool of sounds and a pool of meanings and a pool of evasive substitutes, mingling together in step with the pulsation of underlying ideas and emotions. Our own inquiry is keyed to the association of fungi with toads, and here there remains one notable observation to add. So far as we know, *bufa* has never designated the toad in Catalonia. But phonetically and semantically (because of the toad's aptitude for prodigious inhalation of air and exhalation), the Latin *bufo*, meaning toad, and the Catalan *bufa* are close kin, and etymologically, though neither is derived from the other, they must both spring genetically from the same verbal tree. Thus there is a further strange analogy between 'puckfist' and *bufa del dimoni*: 'puck' and *bufa* mean 'imp' and 'feist' respectively, but in addition each is pregnant, so to speak, with the latent idea of 'toad'.[59]

Our survey of the puckfist names has been confined to the Indo-European peoples and Basques, and chiefly to Europe. Think of the horizons for research that open up when we ask ourselves what metaphors are used for the puckfist elsewhere in the Eurasian land-mass, and then in the other continents. What a field for scholarly enterprise is here, and how learned and mad must that inspired scholar be, after the manner of a Norman Douglas character, who will devote himself to this pursuit, his journeyings and questionings to be financed of course by some noble Foundation with a nose for the more subtile cultural aromas!

Throughout the puffball world there is present one element that we did not find in the *pogge* words, and this new element is the scatological. The puffballs, which in their 'frogcheese' phase make good eating, despite this virtue are linked throughout western Europe with the filth of hindwind. And this leads us into a fresh area for exploration. The High German word for 'toad' is *Krote*, of which the etymology has defied the efforts of massive German scholarship.

We dare not aspire to trace this word to its lair, but as a fresh approach to a vexed problem, we submit that German *Krote* is the same as the Rhineland word *krotz*, meaning originally the dung of domesticated animals; i.e., dung with value for the farmer. The same word appears in Flemish *krotte*, and it turns up also in the familiar French *crotte* and *crottin*, whose primary meaning was also 'dung'. Indeed, if this surmise be well received, we venture further. The French word for 'toad', *crapaud*, is certainly not related etymologically to any root meaning dung, being akin to the Provençal word *grapal*, but the precise shape that this word has taken in modern French seems to be traceable to popular pressures that seek to associate the loathsome creature and its name with *crape*, a French word whose scatological English counterpart is known wherever the English language is spoken. The Oxford Dictionary offers us a Scottish and English dialectical word for the dung of domesticated animals, 'tath' or 'tathe', which in Norwegian and Swedish dialects becomes *tad*. Do we not here find the identical semantic transfer? Perhaps we are in the presence of three doublets, the Germans referring to the toad as 'dung', the English and Scandinavians doing likewise, and the French word for toad being re-shaped to resemble *crape*. In the Danish pattern of fungal metaphors, we find that dung is an alternative to the toad in a pair of fungal words - *paddehat*, 'toad's hat', and *skarnhat*, 'dung hat'. How felicitous for our argument is the word 'cowpad', wherein the second element here means 'dung', but

---

59. The flatus metaphor is also found in the Panjabi fungal vocabulary: *padd bahera*, 'gall-nut flatus', is a mushroom name. The *bahera* is a tree famous in the India trade and known in botany as 'belleric myrobalan'. It yields a kind of gall-nut used in dyeing and tanning, and also in Indian medicine. It would be tempting to associate the Panjabi *padd*, 'flatus', with Dutch *padd*, 'toad', but no kinship is possible. The Panjabi word is cognate with the two English words of the same meaning discussed on p. 97 [of oryg. edit.].

elsewhere as we know means 'toad'![60] On an earlier page we considered the possibility that 'toad', a word of unknown origin, might be descended from a Celtic adaptation of the Latin word for 'poison', and certainly in Anglo-Saxon times the loathed creature was linked with venom. But on balance the Nordic *tad*, meaning 'dung', seems to us the likelier source.[61]

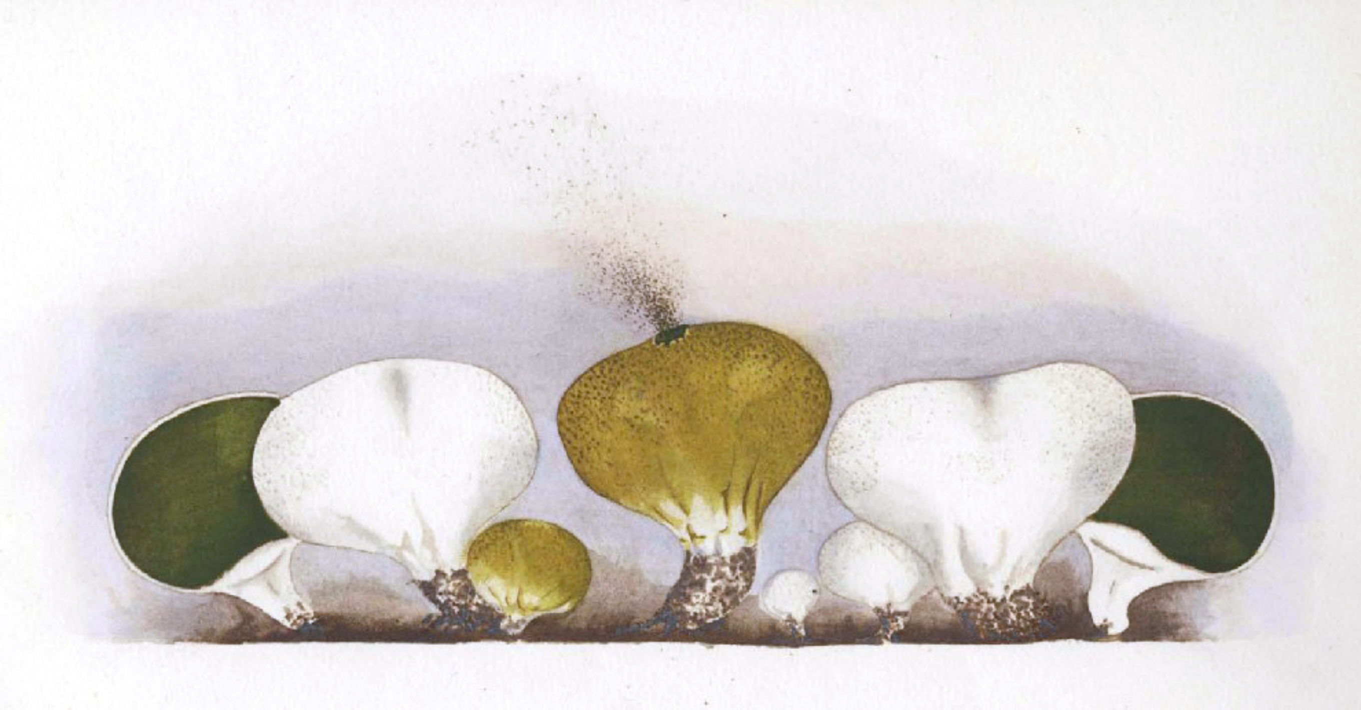


PLATE XIX
Jean-Henri Fabre
Lycoperdon furfuraceum Pers. ex Schaeff.
English: *puffball, puckfist*;
French: *vesse de loup*;
Polish: *Kurzawka zmienna* (*purchawka*).

In modern English no filthier word for the fungi exists than 'smut', the name of the fungal parasite that afflicts corn. It is cousin to the German word *Schmutz*, 'dirt', and its evil potency comes out in its figurative use for condemning scabrous language. To the Englishman the two meanings of 'smut' seem so fittingly wedded that he could not imagine things otherwise. Yet the Englishman's disgust with fungal smut is an acquired cultural trait, not instinctive in the human species. The Indians of the Valley of Mexico have always considered smut a culinary delicacy. The kind they use grows on maize, and '*Ustilago maydis*' seems to be its scientific designation. But in the market place the Nahuatl name, *cuitlacoche*, circulates in Spanish too, and the best families of Spanish descent delight in eating *cuitlacoche* prepared in a variety of ways. Moreover, when English-speaking guests taste the *cuitlacoche*, perhaps served like *piroshki* (**пирошки**) with cocktails, it moves them to rapture - until they discover that they are eating smut. The Nahuatl word is built from *cuitlatl*, 'excrement'. Today, as we have already said, in standard High German the toad is no longer linked with the fungi, though traces of this association survive in Pennsylvania Dutch. Yet in the German mushroom manuals we occasionally find *Krotenschwamm* as a common name for the poisonous *Amanita pantherina*. Perhaps this

---

60. 'Cowpad' is in wide use throughout the English and American countryside, and it is therefore surprising that neither the Oxford Dictionary nor Webster's reports it; nor do we find it in Wright's *English Dialect Dictionary*. Wright reports a single citation for 'pad' in the sense of 'dried cow's dung as formerly used for fuel'. This citation is from East Anglia, and Wright declares the word obsolete.
61. Franciscus van Sterbeeck in his *Theatrum Fungorum*, Antwerp, 1675, said on p. 227 that in France a certain mushroom considered foul by him was called *la crate*. If true this would add striking additional evidence for our thesis of a common pool of words and meanings for toads, mushrooms, and excrement. We have not yet found corroboration for Van Sterbeeck's statement in French sources. Van Sterbeeck relied heavily on the great *Historia Plantarum Universalis*, 1650-1, of Jean Bauhin, who on p. 846 described a certain mushroom that he had gathered on a hill in Montbeliard called La Crotte. Did Van Sterbeeck misconstrue Bauhin's Latin text and think the name belonged to the mushroom? Professor Georges Becker, the great mycophile, is a citizen of Montbeliard, and he has confirmed to us the former existence in that city of a hill called La Crotte, razed to make way for railroad facilities.

is one of those mushroom names that circulate only in manuals. But the same word applied to the same species appeared in the treatise on mushrooms by Carolus Clusius published in 1601,[62] and we suspect that it was current in his day. If so, and if we are right about the source of *Krote*, it follows that toads and dung were intermingled in the minds of simple Germans, and both were linked with fungi in *Krotenschwamm*. If we have successfully recaptured the semantic associations and feelings of the people who used these humble words, then here we discover a very citadel of mycophobia, where toads and fungi with loathing were spewed forth on the dungheap. Against this background, it becomes clearer that 'frogcheese', 'toadsmeat', and the Welsh 'toad's cheese', as well as the French *pain de crapaud*, hark back to excretions of toads, rather than to food that toads were supposed to eat. We have seen that the Surselva countryman thinks of puff balls as the droppings of crows. R. C. A. Prior in his treatise on English plant names, published almost a century ago, suggested that the stool of 'pixie-stool' referred to the devil's droppings.

He was mistaken, but doubtless in the long course of English speech there have been others whose mycophobic thoughts turned to dung as they spat out the expletive 'toadstool'. When the English caricaturist devised a satirical coat of arms for Bonaparte, his symbol for the Corsican Devil was a toadstool, and it sprang from dung, the lineage that he thought befitted his villain. True to the Englishman's unfailing ignorance in fungal matters, the artist did not limn a deadly species, or even a fly amanita, as the reader will observe in the reproduction of this old print that we present.

Some years ago an episode took place in France that was curious for various reasons, and not least because it linked birds' droppings with mushrooms. On Sunday, January 6, 1926, in the village of Bombon (550 inhabitants, eleven miles from Melun in the Department of Seine-et-Marne) the beloved and respected cure of the parish church, the Abbe Desnoyers, 50 years of age, had retired to his sacristy after Mass when twelve persons, ten women and two men, strangers to the community, burst in upon him, seized, gagged, and bound him, threw him to the floor, and proceeded to flog him with knotted cords until he almost fainted. A few minutes later the twelve assailants quietly submitted to arrest. It developed that the twelve had come by car all the way from distant Bordeaux, that they were members of a religious circle known as the Groupe de Notre-Dame des Pleurs, that they were the disciples of the founder of this little sect, one Madame Marie Mesmin, formerly a concierge, and that they attributed Madame Mesmin's bad health to spells cast upon her by the Abbe of Bombon across hundreds of miles of intervening countryside. One of the two men, the street-sweeper Maurice Lourdin, at the Magistrate's hearing on January 24, had no trouble in identifying the Abbe Desnoyers as Satan himself, one of the most powerful sorcerers of the age. Only by flagellation could the demon that possessed this priest be exorcised. Lourdin bore witness that the priest of Bombon had sent birds (we are not told the species, alas!) to Bordeaux carrying diseases. They had flown over Madame Mesmin's garden, and from their droppings had sprung up a crop of fungi that took obscene shapes, whose appalling stench had smitten all and sundry with horrible diseases.[63] For a brief spell the Parisian press was agog with amused excitement about the happening in Bombon, and cabaret singers made much of it. Thirty years have passed, but there are those who still remember it: Aldous Huxley has recalled for us one of the refrains:

Frappons, frappons, en union
Sur le Curé de Bombon.

---

62. His *Rariorum Plantarum Historia* (Antwerp) contained a section on mushrooms of Hungary. Clusius was Charles de Lecluse, a Frenchman of Arras. He is sometimes called the father of scientific mycology. *Krotenschwamm* has appeared recently in the *Kleiner Pilzatlas* of H. Strohschneider, Vienna, 1948, p. 22. We have discovered no modern citation of the word in High German other than in mushroom manuals. Clusius' work was a treatise on the mushrooms of the Pannonian plain (Hungary) and he gives Krottenschwammen [sic] as the German name of the mushroom (*Amanita pantherina*) that in Magyar was called *bagoly gomba*, or 'owl mushroom'. Thus the German word was certainly not a translation out of the Hungarian. Clusius also reports *Froschemtuel* [sic] as the German name for another mushroom. Here he may have been translating the Low German *poggenstul*, thus spelled by Valerius Cordus in the middle of the 16th century when he called it to the attention of the learned world in his *Adnotationes* on Dioscorides. Our own view is that these words were still current, though disappearing, in standard High German in the time of Clusius; that they have long been obsolete; and that the compilers of manuals retain them by oversight.
63. There may be an echo of the same association between birds' droppings and fungi in a curious theory advanced to explain fairy rings by a Mr. Johnson of Wetherby, England, early in the 19th century. He thought they were caused by starlings which "when in large flights frequently alight on the ground in circles, and sometimes are known to sit a considerable time in these annular congregations". This reference is to be found in the edition of Gilbert White's *Selborne* annotated by Captain Thomas Brown, of which the first printing appeared in 1833, on p. 327.

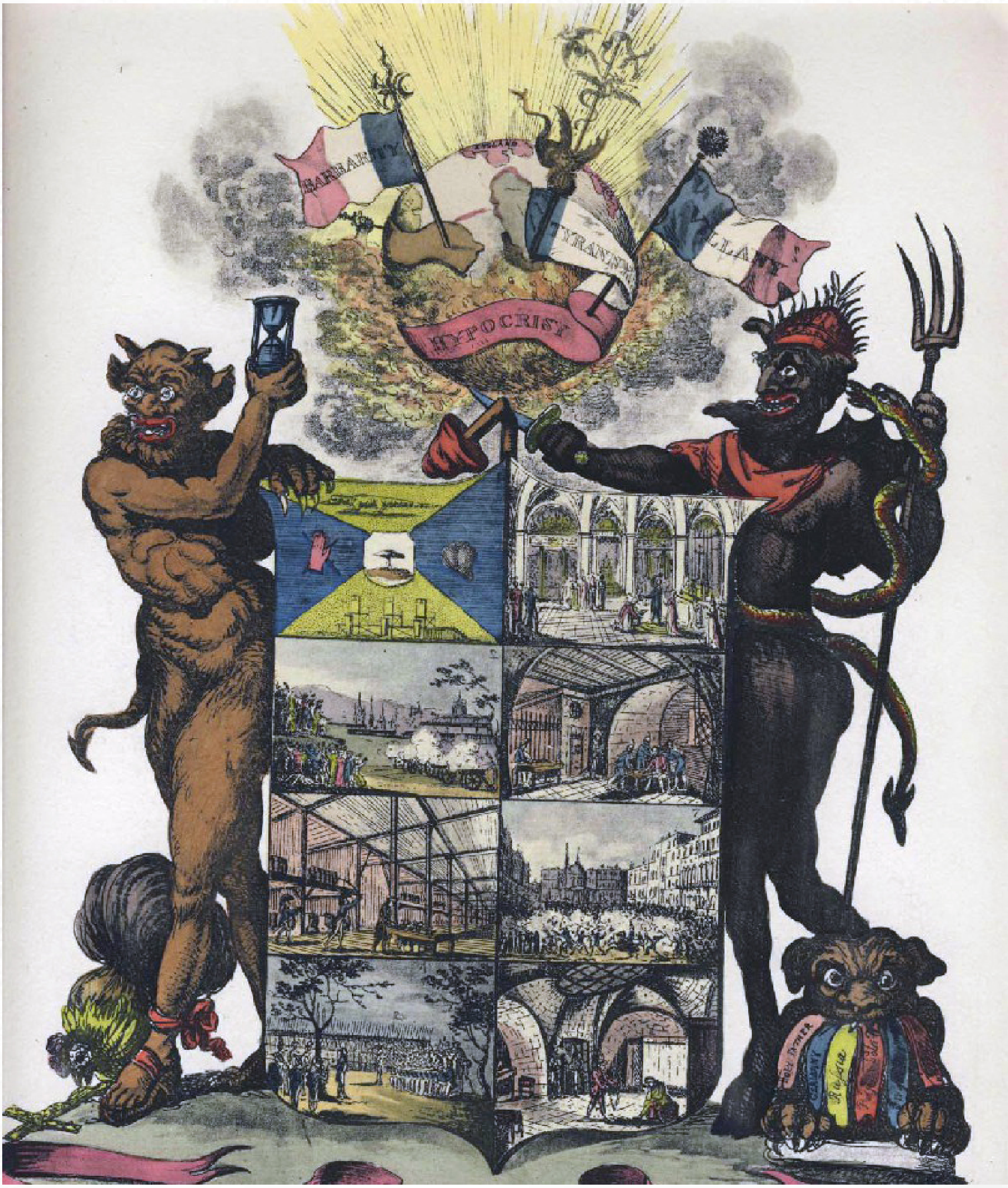


PLATE XX
Napoleonic caricature.
By courtesy of Frank Altschul, Esq., Overbrook Farm, Stamford, Conn.

The account of this anachronistic episode can be found in *The Times* in the issues of January 6, 7, and 25, 1926. The obscene fungi could only have been stinkhorns. *The Times* correspondent did not remark on the number of the assailants: twelve. With Madame Mesmin their leader, this made thirteen, the full complement of a witches' coven. We seem to be in the presence here of the posthumous twitchings of witchcraft, the religion of the Horned God, and of the folk association of fungi with excrement.

In the Italian language there is a word to designate a venomous snake, *scorzone*, which is etymologically identical with one of the Spanish words for 'toad', *escuerzo*. The Basques, as we have seen on page 78 [of oryg.

edit.], sometimes call the *Marasmius oreades* the 'viper-fungus', *suge-perretxiko*, and sometimes the *zapo-perretxiko*, or 'toad-fungus'. According to Clusius, in the 16th century two innocent kinds of mushrooms bore in German the name of *Natterschwamm*, or adder-fungus,[64] and the Magyar term was a translation of this - *kigyo gomba*. Traveling farther east, we have already called attention to the 'toad-fungus' and 'viper-fungus' of Slovakian usage. Far more important is the Russian word *poganka* (**поганка**), the supreme expression among the Slavs of the folk association between the fungi and vermin. In Great Russia, *poganka* is a term of condescending affection for the inedible mushrooms: the word has lost some of its sting among the mycophilic Russians. But this same word *poganka*, derived from the Latin word for 'pagan', circulates throughout the Slavic world, and in one region or another it designates not inedible mushrooms but all things unclean: mice, rats, snakes, pimples and other organic swellings and tumors, and (in Serbia) dung. The inedible mushrooms are unclean, they are vegetable vermin, so to speak, and the word used for them was also transferred to all other vermin and filth. The presence of pimples and tumors among these meanings arrests attention, for here we hark back to our familiar theme of the *pogge* cluster.

Farther east, in the Indo-Aryan world of Asia, the theme of the serpent recurs in the fungal vocabularies of various peoples, but there is no trace of the toad. The oldest figure in the fungal metaphors of these Eastern peoples is neither the hat nor the stool, but the parasol - Sanskrit *chattra*. Perhaps the earliest surviving reference to mushrooms in Sanskrit, going back several centuries before Christ, is *ahi-chattra(ka)*, 'snake's parasol', in the text called Nirukta. The same word is found in Pali, and in the Hindi *sap ki chain*, all with the same meaning; and also the Persian *catr-i-mar*. Another Hindi word for the fungi is *sap kiroti*, 'snake's bread', and a Sindhi expression is *sapido*, a diminutive of *sapu*, 'snake'.[65] It is curious that elsewhere than in the Indie languages we find the 'parasol' figure applied to fungi only in the Spanish dialect of Jocotan, Guatemala, as we mentioned earlier: *sombrilla de sapo*, wherein *sapo* means 'toad' and not 'snake'.

---

[64] *Natterschwamm* is unrelated to the 'natterjack' (vide p. 74 [of oryg. edit.]); the English equivalent of *Natter* drops the initial letter to become 'adder'; by contrast, what was originally an 'atterjack' in early English added an initial 'n' to become the 'natterjack'.

[65] This Eastern word for 'snake' recalls the Spanish word for 'toad', *sapo*, and suggests an analogy between this pair of words and the alternative Spanish word, *escuerzo*, 'toad', with its Italian cousin, *scorzone*, meaning 'viper'. But the Spanish *sapo* and its Eastern homonym are not directly related to each other. The Spaniards could have borrowed the Eastern word only from the Spanish Gypsies, who in fact use it in the sense of 'snake'. However, the Gypsies did not arrive in Spain until the 15th century, and the Spaniards were applying *sapo* to the toad long before then. We find the word in Don Juan Manuel's *Libra del Caballero et del Escudero*, written at the beginning of the 14th century. The Hindi word comes down from the Sanskrit *sarpa*, and 'serpent' belongs to the family.

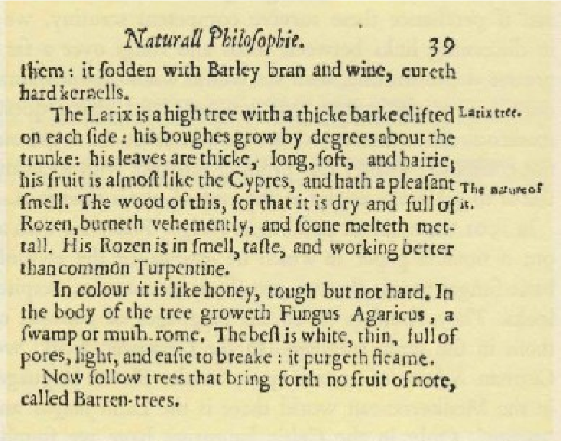
6

The Sponge Cluster

Now the moment has arrived to examine the basic fungal words of Europe. The tie that joins toad and fungus continues to be our theme. But for a few paragraphs we shall immerse ourselves in evidence that may seem remote to our readers - if readers there be who are still with us. Some of that evidence is well attested, but we are going to advance certain conjectures of our own, and if perchance these survive competent scrutiny, we shall have succeeded in discerning links between toads and fungi over a far wider area, and at a greater depth in time, than we would willingly have imagined when we asked ourselves, at the outset, our innocent and casual question about the lowly toadstool. As amateurs, we are rash in what we are about to do, and if we do not constantly qualify our probing remarks with locutions of modest timidity, this is to spare the reader at the cost of our inclinations.

In 1901 the eminent philologist Holger Pedersen, then a young man, brought out a notable paper[66] in which he established the etymological identity of the basic fungal words that we are about to consider, despite the disparity in their looks. They circulate in all the languages of Europe, often two or three of them in the same language. In the Germanic world we may take the High German *Schwamm* as our type; in the Slavic languages, the Russian *guba* (**губа**); in the Mediterranean world there is the Latin *fungus* and the Greek σπόγγος, 'sponge'. Only in the Celtic languages have we found no native examples. In Germanic and Slavic the words mean both fungus and sponge. In the Mediterranean, by semantic differentiation the Greeks confined their word to the sponge, and the Romans theirs to the fungus, the Romans borrowing the Greek word for the other sense.[67] There is no evidence that any of these words in recorded history has ever been linked in the minds of Europeans with the toad. But there is abundant evidence that all of these words have carried, in their very core, the idea of an organic swelling or excrescence or tumor. Thus the Greeks spoke of scrofula and of the tonsils as sponges, and parallel examples are common for the other words of the group.

There is one remarkable quality that distinguishes all the words of our sponge cluster: they are emotionally neutral, by contrast with the pejorative flavor of the fungal words heretofore discussed. It is as though this whole family of words had always possessed a tough underlying personality persisting through the centuries, over immense areas, among peoples in every stage of cultural development. Even when a word of this group describes something disagreeable like a tumor, it retains a detached tone, by contrast for example with 'cancer'. In the English language the Anglo-Saxons used *swamm* for 'mushroom', and this member of our sponge cluster lingered on through Middle English into early Modern English. We can pinpoint its last recorded appearance:



Naturall Philoſophie. 39

them: it ſodden with Barley bran and wine, cureth hard kernells.

The Larix is a high tree with a thicke barke clifted on each ſide: his boughes grow by degrees about the trunke: his leaves are thicke, long, ſoft, and hairie, his fruit is almoſt like the Cypres, and hath a pleaſant ſmell. The wood of this, for that it is dry and full of Rozen, burneth vehemently, and ſoone melteth mettall. His Rozen is in ſmell, taſte, and working better than commõn Turpentine.

Larix tree.

The nature of it.

In colour it is like honey, tough but not hard. In the body of the tree groweth Fungus Agaricus, a ſwamp or muſh-rome. The beſt is white, thin, full of pores, light, and eaſie to breake: it purgeth fleame.

Now follow trees that bring forth no fruit of note, called Barren-trees.

Fig. 6 - Description of *Fomes officinalis*
Last reported use in English of *swamm* (misspelled *swamp*) in the sense of mushroom, referring to fungal growth on larch.

---

66. Published in Polish: 'Przyczynki do gramatyki porównawczej języków słowiańskich', in Materyały i Prace Komisyi Językowej Akademii Umiejętności w Krakowie, vol. I, no. I, pp. 167-176; Cracow.
67. But the morel appears to have been called by the Romans *spongiolus*, which comes down into modern Italian as *spugnolo*.

In the second edition of *Naturall Philosophy* or *A Description of the World*, by Daniel Widdowes, published in London in 1631, where it is used in describing the *Fomes officinalis*, the *agaricum* of Pliny. *Swamm* in the end surrendered the field to the loathsome 'toadstool', to the toothsome 'mushroom', and to the learned 'fungus'. But another word of our cluster is current in the name that the English give to wet, spongy land - the swamp. And perhaps there survives yet another word, of greater importance.

On an earlier page we saw that the idea lying behind the *pogge* cluster was a distensible sac, a bag or pocket or pouch, a belly or bulge or bilge. The English word 'womb' comes down from the Anglo-Saxon *wamb*, and this in turn is cognate with various Germanic words of similar sound and meaning, including the Gothic *wamba*. As the Oxford Dictionary points out, the same root turns up in the rare word 'gameson', designating the quilted or padded garment that medieval knights wore under their armor to avoid chafing. This garment tended to bulge and belly, being designed to do so. Philologists have been uncertain about the ultimate affiliations of the underlying root of 'womb' and 'gameson'. We suggest that 'womb' and our sponge cluster spring from the same source, and that in 'womb' and the sponge cluster we discover a perfect semantic parallel for those elements in the *pogge* cluster that relate to distensible bags and fungi, and also for the Irish fungal *bolg*.

Perhaps there is another extraordinary example, hitherto unidentified, of the same Indo-European root in Late Latin. During the early centuries of the Christian era the Roman legions were being hard pressed by the barbarian horsemen erupting out of Asia. In the art of warfare the innovation of the day was the cavalry, and the Roman authorities were struggling to overtake the alarming lead of the enemy in the handling of horses. Whenever they could, they incorporated into their own forces barbarian elements versed in horsemanship. It is not surprising that at this time important texts by veterinaries make their appearance in Latin. One of these veterinaries, Vegetius by name, writing in the early 5th century, describes a pathological swelling above the hoof of a horse by the adjective *gambosus*, the first recorded appearance of this word in Latin. Surely this is our familiar *gamba*, borrowed from the barbarians, used in its essential sense of 'swelling', under historical circumstances that make its appearance natural.[68] (There is a curious and significant analogy for *gamba*, in the sense that we suggest, in the modern Dutch word *hanekam*, of which the primary sense is 'cock's comb'. It carries two other meanings: it is the vulgar name of the chanterelle, and it also designates a swelling on the hock of a horse.)

The words of our sponge cluster have displayed a singular potency in grafting themselves into the vocabularies of alien peoples. Thus in Basque one of the three generic words for mushrooms is *ondo*, borrowed from the Spanish *hongo*, which in turn descends from the Latin *fungus*. (This borrowing, must have been relatively recent - in the course of the past millennium or so. Of more subtle interest is the fact that the Basque word for 'toad', *apo*, possesses as a secondary meaning the idea of sponginess. We shall revert to this.) The Magyar *gomba* or *gamba* was drawn from the Slavic, as was we believe the Lappish *guobbar*. In Armenian our sponge cluster turns up in *sunk*, meaning mushroom, and this Armenian word was the source of the Georgian *soko*, which in the neighboring Svanetian language becomes *sok*. On the northern side of the Caucasus the Ossetians speaking the Iranian dialect of their language borrowed their word *zoko* from the Georgians, and by a not abnormal transposition, the other Ossetians of the Digorian tongue say *kozo* - a far cry from *Schwamm* and *fungus* perhaps, yet genetically stemming from the same ancestry.

In the valley of the Volga, to the east of the Slavic homelands, there live the Chuvash people. They are probably the descendants of the original Bulgars. When a part of the tribe, some fifteen centuries ago, began their slow trek to the land that we now call Bulgaria, the others remained behind and they retain to this day their non-Indo-European tongue. In the Chuvash language the word for 'fungus' is *kampa*. The nasal sound in the middle of that word is of singular interest. The Chuvashi could have borrowed *kampa* only from the eastern Slavs, who for a thousand years and perhaps more, ever since the Russian language was first put on parchment, have been saying *guba*. The Chuvash word offers proof that long ago, when the Chuvash people took over the word - we cannot say when this happened - the Russian *guba* was pronounced *gomba*. Like the fly caught and held in amber, the Chuvashi have held for us the ancient and lost form of the Russian word. That Chuvash word is noteworthy also for its other meanings. It is used for certain tumors of the human body. It is also used for the genitalia of the cow, and thus recalls the Gothic *wamba* and the English 'womb'.[69]

---

[68] This etymology, original with us, must stand up against the conventional one. French *jambe* and Italian *gamba*, 'leg', are usually traced through Vegetius' *gamba* to a Celtic root meaning 'bend' or 'curve'. That the words for 'leg' come from the Celtic root we do not question. It is less clear why a veterinary writing in the 5th century should refer to a swelling on a horse's leg as a 'leg' or as a 'bend'. We know that there was a close homonym for the Celtic word in Germanic and Slavic, that homonym meaning 'swelling' or 'tumor' or 'womb'. We are not inventing a homonym for our argument. If we are right, the form of the word as used by Vegetius would indicate that it was borrowed, not from Germanic, but from Slavic, and this would confer on *gamba* the distinction of being the earliest recorded loan-word from Slavic in the Western languages. Heretofore the earliest recorded Slavic word is *strava*, 'funeral banquet', used by Jordanis in his account of the funeral of Attila in A.D. 453. For the crisis in war technology precipitated by the barbarians' use of the horse, see the opening pages of Ferdinand Lot's *L'Art Militaire et les Armées du Moyen Age*, Pans, 1946.

In the Indo-Aryan languages of the Middle East and India there is a startling family of words that seem both phonetically and semantically to belong to our sponge cluster. Thus in Hindi we find that *khumbi* means 'mushroom'; in Sindhi, *khumbhi*; in Panjabi, *khumb*; in Lahnda, *khumb*. These are all traceable to a Sanskrit word, *kumbhika*, meaning 'pot' or 'jar' - the bellying utensil that we have already encountered in the Anglo-Saxon *bile*, meaning both 'belly' and 'pitcher'. In Sindhi we also find *phungi*, which is seemingly a mutation by metathesis of *khumbhi*, paralleling the identical mutation in Europe, where 'sponge' and *gomba* are identical etymologically, as are *Schwamm* and *fungus*.

In the Waziri dialect of the Afghan language known as Pashto we find for 'mushroom' the word *xomba*, and in the Mohmand dialect *xumburi*, both derived from *xumb*, 'pot'. Surely all these words bear witness to the ubiquity of the idea that underlies the thinking about fungi throughout the Indo-European world, and of the verbal root that expresses the idea. These Eastern words stir up a further reflection. A few pages back, when we were discussing the *pogge* cluster, we saw how Puck and other imps and sprites resided in the distensible sacs, the toads, and the puffballs that we were examining. If we may rely on the Arabian Nights, the jinn of the East were confined in pots and jars, whence they would escape, rising wraith-like in gaseous wisps, to condense into organic shapes and wreak their will on men. Is there here too a common denominator in the Satanic association of the fungi, linking the East with Europe?

Up to this point we have shown the diffusion of our basic fungal words throughout the Indo-European world and among a few small adjacent tribes of other origins. How about the Semitic peoples; Here we uncover a surprising thing. Of the important words for 'mushroom' in Arabic, one is *kam* or *kam'a*. Its etymology is unknown. It belongs both to classical or literary Arabic and to the colloquial language. In its application it is both generic and specific, sometimes embracing the whole mushroom world, but also designating that species of *Terfezia* which among Arabs holds pride of place as a gustatory delight. It is reported in modern Persian, where loan words from Arabic are numerous, and in its specific sense is said to be commonly used by the market vendors of Damascus. Nor is this root confined to Arabic. In the Old Testament no word for 'mushroom' occurs, but in the Babylonian Talmud and the Midrashic literature we find the cognate root KMH in both Aramaic and Hebrew forms. If our Semitic root was borrowed from the Indo-European world, it goes back far.[70] Or are both words descended from a pre-Indo-European root? Or are we dealing with unrelated words that happen to resemble each other?

---

69. Our information about the Chuvash *kampa* comes from N. I. Ashmarin's *Thesaurus Linguce Tschuvaschorum*, Book VII, p. 142, published in 1934.
70. The Arabic *kam*' suggests the Germanic and Slavic forms of the Indo-European words, rather than the Greek or Latin. In the Jerusalem Talmud we find the root SPG in the form *s'fog* meaning 'a porous luxuriant growth, mushroom, sponge', but this was undoubtedly a Hellenistic borrowing of the Greek σπόγγος. The parallel between the Arabic and Russian words for 'mushroom' reminds us of an astonishing parallel in fungal metaphors. A certain mushroom is called in Arabic *shahinat al-ard*, literally 'fat-of-the-earth'. This corresponds to the Russian *maslenok*, which James Collins in *The Present State of Russia* translated by 'fat-of-the-earth' in the 15th century. Yet another basic fungal word in Arabic, classical and colloquial, is *faq*', *fuqqa*', *orfaqqd*', from the root *FQ*', meaning 'whiteness'. Whether this name designates a white kind of mushroom, or whether, as in Russian and Basque fungal names, whiteness here connotes excellence, we do not know. See pp. 7 and 10.

Now we return to Pedersen's classic paper.[71] He undertook to reconstruct the lost Indo-European root that was the progenitor of our sponge cluster. He considered several possibilities differing only in details, and of these 'sgwombho' may be considered typical. And at this precise point, after a long absence, our toad rears its head and thrusts itself once more into the stream of our argument. Curious about the origin of the Latin word for toad, *bufo*, we turned to Walde's Latin etymological dictionary, and discovered to our surprise that philologists are disposed to consider it genetically related to the Russian word for toad, *zhaba*, through an intermediate form, *gabawo*, found in the dead Baltic language known as Old Prussian. For *bufo* Walde devises a hypothetical Indo-European ancestor, 'guobho'. Thus leading scholars, without regard for each other's problem, arrive at hypothetical archetypes:

sjgwombho as
the ancestor for 'fungus' and
guobho

as the ancestor for *bufo*, which thus differ in only one essential respect - the presence of the nasal infix in the word for mushroom! Though we are the first to propose that these two words are doublets distinguished only by the nasal infix, the Indo-European languages offer other examples that parallel ours perfectly.[72]

This ancestral convergence of the two words could be regarded as accidental, provoking perhaps an ancient semantic overlap through paronomasia or punning, were it not for the weight of evidence that we have already developed, indicating an association of toads with fungi in the minds of primitive Europeans. In the face of this evidence, accident becomes the long and unlikely arm of coincidence. Perhaps traces of the underlying unity of *zhaba* and *gamba* survive in the vernacular terms of the Ukraine and Slovakia that we cited on page 78. Perhaps there is a trace of that unity, hidden behind translated words, in the Basque word for 'toad', *apo*, linked as it is semantically with both 'sponginess' and certain wild mushrooms.

According to Pedersen's analysis, *Schwamm* and *gamba* differ from the Latin *fungus* and *spongia* only by a transposition of consonants, the common phenomenon known as metathesis. Thus *gamba* becomes *[s]pongos* in Greek. Pedersen chose to reconstruct his Indo-European archetype, the hypothetical 'sgwombho', from the northern forms. But was he justified in this; The northern forms have shown themselves fluid throughout the fifteen centuries of their recorded history. The Greek σπόγγος attested in Homer, has displayed a notable stability throughout the twenty-five centuries of its recorded history. May we not suppose that the Greek word is nearer to the archetype? If so, we suggest our own reconstruction of the hypothetical root:

(s)p(h)ong-

And at this point the attentive reader will perceive that we are back in the company of those words that we associate with the Low German *pogge*, meaning 'frog' and 'toad', the essential difference being the nasal infix that distinguishes all words of the sponge cluster.

---

71. Pedersen's careful and elaborate argument in favor of a common origin for Slavic *gomba*, German *Schwamm*, Latin *fungus*, and Greek σπόγγος seems to us conclusive, and is accepted in substance by Émile Boisacq in his Greek etymological dictionary. A. Ernout and A. Meillet in their Latin etymological dictionary suggest a Medi terranean origin for the Latin and Greek words, without however dealing with Pedersen's argument, which is available only in Polish. Occasionally there are clusters of words that the philologist ought to study together, and such is the fungal vocabulary of Europe, a semantic field pervaded by related figures of speech and emotional responses. No philologist has pursued this method. Our basic fungal words of northern and southern Europe possess identical semantic attributes. They mean the same things - organic excrescence, sponge, fungus. They evoke identical turns of phrase, proverbs, epithetical use. In short, the words occupy the same semantic terrain, which would be unlikely if they descended from unrelated sources. We offer this as additional evidence, circumstantial in character, in support of the Pedersen thesis. As we shall see on p. 144, this does not altogether rule out the possibility that the same root is native to languages outside the Indo-European family. In short, both Pedersen and the Latin philologists could conceivably be right.
72. The interested reader will find a detailed survey of such nasal infixation in the book of the distinguished Polish linguist Jan Otrębski, *Z badań nad infiksem nosowym w językach indoeuropejskich*, published by the Polish Academy of Sciences as the 15th issue of the Transactions of its Linguistic Commission, Kraków, 1929.

And so we now emerge from our arduous excursion among the words of the sponge cluster with a theory of our own. We believe that these words - *Schwamm*, *gamba*, *fungus*, σπόγγος - stem from the same genetic root as the basic word 'womb', and that all these stem from the same genetic root as the words of the *pogge* cluster. That root was imitative in origin, and keyed to the idea of swelling. The progeny of that root has peopled the vocabularies of Europe with numerous words embracing bags, pockets, toads and frogs, imps, tumors, mushrooms, wombs, and sponges.

Just as physicists discover the 'unified field' where, at great depth, the disparate phenomena of matter and force turn out to be one and the same, so in our linguistic pursuit we may have arrived at the unified field underlying all of those disparate phenomena that, as we have seen, men associate together, subtly and half unconsciously, to this very day.

7

Punk, Fire, and Love

About the things that man eats he is acutely sensitive. The mere thought of inviting food starts up his salivary glands, and puts him on tiptoe of eager expectation. By contrast, the suggestion that he consume things unclean gives him a spasm of revulsion. [Note to the edition at Psilosophy: To solve it by jogin way see e.g. "Buddha's Lions - The lives of The Eighty-Four Siddhas", where Daikini says to jogin L&umacr;yipa: "If you have not abandoned the conception of good and bad food, how can the Dharma come to you?", in James B. Robinson translation.] The attitudes that we have called mycophilia and mycophobia hinge on whether fungi are considered delectable food or foul and filthy poison. But primitive man had other uses for wild fungi, and he was capable of regarding these growths from a detached utilitarian point of view without regard to ingestion. We believe this explains the neutral tone of the sponge cluster of words. These words are often bestowed on edible fungi, but they usually yield place to others in the context of food - *Pilz*, *grib*, *champignon*. If we try to see the fungi as our ancestors saw them, we may divide their thoughts and feelings about them according to the ends they had in mind:

I. INGESTION

1. As poison (a) accidental
   (b) for murder
2. As intoxicant (*Amanita muscaria*), and for divination
3. As aphrodisiac (including perfume)
4. As medicine-purgative, styptic, etc. (*Fomes officinalis*); for contraception
5. As food.

II. OTHER

1. As tinder or touchwood, to catch the spark and start the fire, and to keep a fire in a smouldering state.
2. To produce a stupefying smoke, effective with bees when extracting honey from the hive, etc.

Modern man, especially the urbanized literate, is almost incapable of imagining the importance to his ancestors of fungi for the making of fire. One species was especially prized for this purpose - the *Fomes fomentarius*, the *amadouvier* of France, the *Zunderschwamm* or *Feuerschwamm* of Germany. But many other kinds served this purpose too, such as 'bunts' or dried puffballs, and the dry, friable innards of fungous-infested tree-stumps.

This brings us to a curious trio of English words, 'punk', 'spunk', and 'funk'. We believe all three are members of our sponge cluster, siblings descended from the Mediterranean *fungus* - σπόγγος word family. All three possess one thing in common: they designate, or at some time in the past have designated, the shelf-fungi that serve as touchwood for making fire. This meaning is not the oldest recorded use of any of them, but nevertheless as a working hypothesis we propose that 'touchwood' be regarded as their primary sense, in which sense they circulated in humble discourse for untold centuries, accumulating derived and metaphorical meanings as time went on, until finally, when the words were consigned to paper, it was these secondary and more fashionable meanings that first achieved the dignity of writing.

Let us take 'spunk', for example. That it belongs to our sponge cluster is attested by the corresponding Irish word *sponnc*, which means both sponge and touchwood. (We find a similar semantic association in Dutch, where *zwam* means both fungus and tinder; for 'sponge' the Dutch resort to *spons*. [Note to the edition at Psilosophy: in Polish, the word for sponge is "gąbka" while the word for tinder is "hubka" whereas the word for shelf-fungus is "huba".]) In the Oxford Dictionary's earliest citation of 'spunk', in 1536, the word meant 'spark'; to this day it is still occasionally so used. In 1582 it appears in the sense of tinder, and in 1665 as the name of the fungus that makes tinder. Oliver Goldsmith toward the end of the 18th century offers us the earliest known use of 'spunk' as the moral quality of mettle or pluck. Here in the word 'spunk' we have a name for touchwood that gathered to itself nobler secondary meanings derived from the spark that was the end-product of its use. The word 'spark' itself is mysterious: it is known only in the English, Frisian, and Low German languages. The question suggests itself whether it is not simply a different phase or grade of 'spunk' - touchwood in its final act of transfiguration.

'Funk' also meant 'spark' in the earliest citations, in the 14th century. We first hear of it as fungous touchwood in 1673. Half a century earlier it was being used in the sense of a strong smoke and stench, as from tobacco. This use stems back to the shelf-fungi that served to generate a stupefying smoke, to put bees to sleep when extracting honey from hives. Before modern sugars became common, honey was a commodity of notable importance, both for its sweetness and as the base for mead, and in the apiculture of the time, the part played by fungal smoke was important and a commonplace. It was natural that those who disapproved of tobacco in the early days should have first associated this smoking plant with the familiar smoke-generating fungus. The depressing moral connotations of 'funk' first appear in the 18th century: he who languishes in a funk is in a moral stupor, overcome in a smoke-cloud.

Most interesting of the three words is 'punk', which in the sense of touchwood first appears about 1707. As with the other two words, the lexicographers say that the origin of 'punk' is obscure, but they give reserved recognition to a theory that it was borrowed in colonial times from an Algonquin word, phonetically similar, meaning dust or ashes. 'Punk' is the ordinary English word for touchwood today, and it is *prima facie* incredible that an Algonquin term for so ancient and domestic a commodity should have swept the English-speaking world and won general acceptance late in cultural history. We think there is circumstantial evidence to show that the word was securely established in English in Elizabethan times, and this leads us directly into the strange erotic associations of our punk-spunk-funk triplets.

In the 16th century 'punk' meant a strumpet, as it still does, and what is a strumpet but the tinder that whips into flame the gay young spark allured by her favors? Let no one dismiss this figure as fanciful. For 'touchwood' the French say *amadou*, which is simply the Provençal word for 'lover'. Lovers, like tinder, are quick to take fire. The French verb *amadouer* means to coax, just as we 'coax' a fire with tinder. In modern English slang 'punk' is a contemptuous adjective for things of low quality - a natural semantic extension of the brothel word. The erotic association of 'punk' is feminine. That of 'spunk' is primarily masculine: in certain English circles and at certain levels of conversation, it is the accepted word for the seminal fluid of the human male. 'Sparking' a girl used to mean 'courting' in American slang, and the *Dictionary of American English* also records the far stronger 'spunking'. We have seen how the nasal infix of the words of our sponge cluster comes and goes, associating this large verbal family with the *pogge* constellation. If we drop from 'funk' its nasal infix, we are in the presence of the supreme erotic word of the English language. The Russian word for touchwood is *trut* (**трут**) (riming with 'brute'), and it is directly derived from the Russian word for 'rub'. Though *trut* itself carries no erotic meaning, it is the key to certain ancient Russian riddles where the erotic sense lies hidden. The generating of fire by the friction of wooden surfaces - a technique in which one wood must be soft and the other hard - may explain why, among the many forms that 'mushroom' has taken in English, we find 'mushrub'.

And now the thread of our argument leads us from philological clues over the threshold into anthropology, where we begin to discover the deep erotic symbolism of the mushroom world.

Throughout most of human history and down into our own times, men have usually made fire by either of two methods - by percussion, striking flint against pyrites or (in later times) against iron to generate sparks that will ignite tinder, or by the friction of wood on wood through the aid of a simple device for which the English anthropologist Edward B. Tylor devised the name 'fire-drill' in the last century. The usual fire-drill consists of two wooden members, a flat smooth piece of soft wood held horizontal, and a round stick of harder wood. The stick is pivoted perpendicularly in a notch on the horizontal face of the soft wood, and then rapidly rotated, sometimes between the hands but more often with the aid of an ingeniously disposed thong or strap or bowstring. A pulsating pressure is applied to the rotating stick, as it rotates first clockwise and then counter-clockwise. The stick by friction widens and deepens the hole in the soft wood, and fine wood-dust gathering in the hole becomes red hot, until when tinder is applied to it, by blowing the tinder catches fire. For us the interesting thing is that among the peoples who use the fire-drill, the horizontal piece of soft wood is called the 'female' and is sometimes even carved crudely to suggest a human figure, and the stick is called the 'male'. The engendering of the fire is regarded as a sexual act, and is pregnant with emotional significance and hallowed by mythological overtones.

Over the past century there have been published a number of papers by anthropologists on the methods used by our ancestors and other early peoples for kindling fire.[73] The percussion method can be traced to remote times, thanks to the survival of the artifacts employed - the flints and the irons, and the masses of decomposing pyrites used before the iron age. By contrast, the perishable fire-drill - the wooden members that by friction yield fire - must generally be studied among our primitive contemporaries, although Egyptian records establish its use in ancient Egypt. These two primitive methods for making fire, percussion and friction, survive to this day by lineal descent in our 'lighters' (the French *briquets*) and matches.

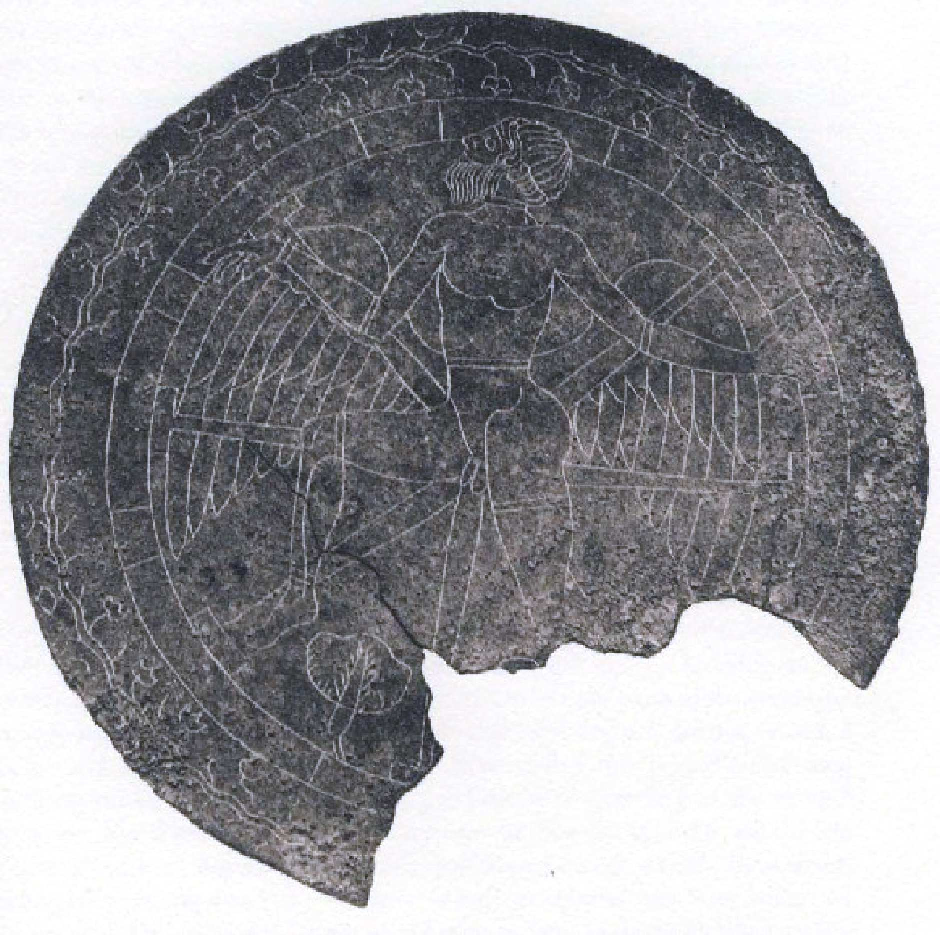


PLATE XXI

Etruscan Mirror. Ixion on his wheel. *London, British Museum*.

Our own interest lies in tinder, that humble but indispensable condiment in the generation of fire, the highly inflammable material, otherwise worthless, that is the nexus between the spark on the one hand and the kindling on the other. The kinds of tinder that have been used in various parts of the world are many: charred rags, lint, down, the flower stalk of the agave, dried moss, dried bark, and fungi. Many kinds of fungi have served this purpose, including ordinary mushrooms in a dried state, puffballs, and, according to the classical lexicons, the *Fomes officinalis* - the *agaricum* or 'female agaricke' of the old pharmacopoeias. (While this medicinal shelf fungus could certainly have served the spark-catching function, we have found no classical text supporting the lexicons, and its value as medicine would seem to have made the humbler service unlikely, especially as it had to be imported from beyond the Bosphorus.) Down to our own times the writers about tinder have almost always been confusing in their use of fungal names: they have seldom been competent in the technicalities of the industry that served the market with commercial tinder. We believe, however, that there is agreement among competent students: in medieval and renaissance times, and indeed into our own era, the best commercial tinder of Northern Europe was always made from the shelf-fungus known to mycologists as the *Fomes fomentarius*, a species that must not be confused with the mis-named *Fomes*

---

[73] For a recapitulation of the subject and further references, see Arthur Bernard Cook's *Zeus God of the Bright Sky*, Cambridge University Press, 1914, vol. I, pp. 325-330.

igniarius. Indeed, today we know that this use of the *Fomes fomentarius* for tinder goes back far. It has been found in the human settlements at Maglemose, on the island of Seeland in Denmark, in conjunction with flint and the remains of pyrites.[74] It has been found repeatedly in the Danish peat bogs of the same era. The Maglemose finds go back to the oldest stone age in Denmark, c. 6,000 B.C. The final ice age had drawn to a close c. 12,000 B.C., and after an interval of tundra ecology, a forest growth succeeded, including the birch trees with which invariably the early specimens of *Fomes fomentarius* have been associated. The making of tinder from this particular fungus may well be the oldest surviving industry with a continuous history in northern Europe. We suggest as an hypothesis that this fungus was the object to which the name *Schwamm* or 'punk' in earlier forms was originally bestowed. These words dealt with the fungal world from a utilitarian point of view, not gustatory; with inedible shelf fungi, not mushrooms. This would account for the emotional neutrality of the sponge cluster of words, as contrasted with the pronounced values, negative or positive, of 'toadstool', '*champignon*', and many others. Or rather, to speak with more precision, this would account for the two distinct emotional responses evoked by mushroomic words. Where ingestion is concerned, the response, whether favorable or unfavorable, is sharp and keyed to the gustatory sense. Where fire-making is concerned, the archaic emotion that lingers on in such words as 'punk' and 'spunk' is an erotic transfer.

In ancient Greece the god of fire-making was Ixion. He hailed from Mount Pelion, a center of Helladic culture, where he fathered the Lapiths, the Satyrs, and the Centaurs, tribes that were kin to the Etruscans and that enjoyed singular repute for sexual potency. According to the myth, Ixion was bound to a great wheel (the sun-wheel) and sent spinning for eternity into space because he had permitted himself to become enamored of Hera. Before this sentence was meted out, unbeknownst to him his guilt was proven by trickery: a cloud was made to condense into the figure of Hera, and Ixion did not resist temptation. In the British Museum there is an Etruscan mirror, variously attributed to the 3rd, 4th, or 5th centuries B.C., on which Ixion is depicted undergoing his punishment. Nude, bound to a seven-spoked wheel, he is in the running posture that denotes speed. Between the spokes of the wheel we discover two designs, of which one is almost entirely lost. The scholar A. B. Cook, describing this mirror in his work on Zeus, dismissed these signs as meaningless. But it will be observed that the two designs are not components of the ornamental border. They are functional elements in the iconographic message. They possess a meaning, but what meaning? Robert Graves, who drew them to our attention, suggests that they are mushrooms. He is surely right, and if so, this Etruscan mirror offers us the earliest known representations of fungi in European art; and we observe that the role they here play is related not to food or poison but to the generation of fire. The eroticism of the design tells us a story intimately linked with the Ixion myth. On one level we see a capped mushroom representing no particular species. On another level we observe that the mushroom consists of two members, symbolizing the male and female organs of a fire-drill, and they are engaged in the supreme act of fire generation. Earlier we have suggested that certain basic words for the fungi are keyed to words for the womb. We now remind our readers that the Greek word for mushroom, μύκης, also means the *membrum virile*.[75] There are the same bi-sexual correspondences in the mushroom vocabulary that anthropologists discover in the names for the two parts of the fire-drill. The pattern that we discover on the Etruscan mirror is, we think, a pictograph symbolizing the generation of fire, the function of Ixion. This interpretation is in harmony with the verbal and semantic ties that, by independent evidence, we have discovered in Europe's mushroom vocabulary. The artist of the Etruscan mirror offers us three messages in one design - a fire-drill in the act of generating fire, a sexual performance, and the mushroom with stipe stabbing the pileus (i.e., μύκης and vulva) that is the symbol of the other two.[76]

---

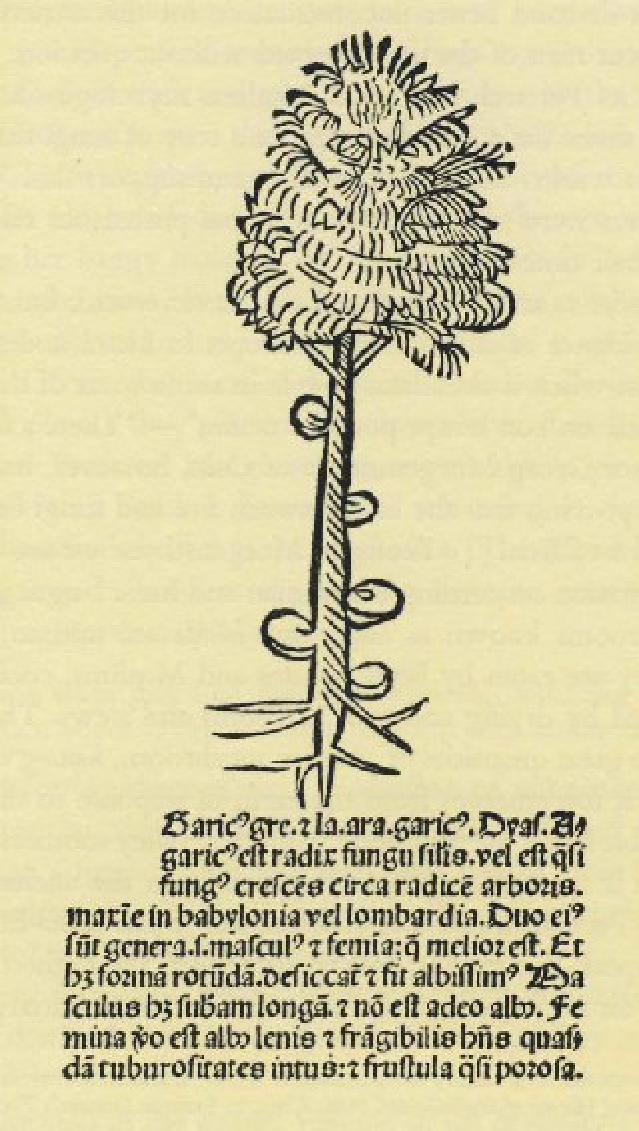
[74] The *Fomes fomentarius* found at Maglemose was described by the Danish scholar, Dr. G. F. L. Sarauw: "Le feu et son emploi dans le Nord de l'Europe, aux temps prehistoriques et protohistoriques", in the *Annales du XX Congres archeologique et historique de Belgique*, I., pp. 196-226. His use of the name *Fomes igniarius* was erroneous, as Professor N. Fabritius Buchwald, of the Kgl. Veterinær- og Landbohøjskole, Copenhagen, pointed out in his superseding papers, which in the present state of our knowledge are the latest word on our subject. See his paper on the history and use of the tinder fungus published in 1930 in *Meddelelser fra Foreningen til Svampekundskabens Fremme*, Copenhagen; also his later paper, written with Sigurd Hansen, on post-glacial finds of the tinder fungus, 1934, *Danmarks geologiske Undersøgelse*, IV Række, Bd. 2, Nr. II, Copenhagen. The Danish title of this paper is, 'Om Fund af Tøendersvamp (*Polyporus fomentarius* [L.] Fr.) fra Postglacialtiden i Danmark'.

[75] This double meaning survives in the scientific name for certain microscopic fungi, 'penicillium' (whence the popular 'penicillin'), which like 'pencil' is derived from a diminutive of 'penis'.

[76] Pertinent to our argument is a representation of Ixion on an Etruscan vase from Cuma;, reproduced in A. Baumeister's *Denkmäler des klassischen Altertums*. In this case, in place of the mushroom theme, the figure on the wheel is enclosed in a double aureole of flames.

The medicinal shelf fungus known today as the *Fomes officinalis* used to be called in English the 'female agaricke'. This sexual attribution in one form or another goes back to Dioscorides and Pliny. The explanation that they offer for it seems a little forced. According to them, the female agaric possessed straight veins resembling the teeth of a comb, and was white and light throughout, at first sweet to the taste and then bitter - an observation that suggests a cynical view of womankind. This was the only kind recommended for medicinal use, and the description fits the *Fomes officinalis*. The 'male agaricke', which seems to have been a term applicable to the *Fomes fomentarius* and *Fomes igniarius*, was brown or reddish, sticky, long, hard, and heavy. These descriptions, more suggestive erotically than enlightening mycologically, originated in the ancient authorities, but were repeated tirelessly until we find them in such English pharmacopoeias as William Salmon's *Pharmacopoeia Londinensis*, or the *New London Dispensatory*, London, 1682, and *A Treatise on Foreign Vegetables*, by Ralph Thicknesse, M.D., London, 1749.

We can adduce startling evidence proving the hold on the Greek imagination of the sexual associations of shelf fungi. In a 10th century Byzantine codex of Dioscorides now owned by The Pierpont Morgan Library, the section on the ἀγαρικόν is illustrated by the miniaturist, but his design bears no resemblance to the *Fomes officinalis*! He must have been totally ignorant of it. Drawing his knowledge solely from the text with its account of the male and female kinds, he has given us two drawings inspired by the male and female genital organs! Our 10th century miniaturist may have been copying an earlier manuscript, but we know not how far back this aberration goes. Some five centuries later, in the year 1491, in the earliest printed book carrying fungal illustrations, the artist was clear and accurate in his delineation of the *agaricum* (Fig. 7).



Garic⁹ gre. ꝛ la. ara. garic⁹. Dyaſ. A-
garic⁹ eſt radix fungu ſilis. vel eſt q̄ſi
fung⁹ creſcēs circa radicē arboꝛis.
marie in babylonia vel lombardia. Duo ei⁹
ſūt genera. ſ. maſcul⁹ ꝛ femia: q̄ melioꝛ eſt. Et
hꝫ foꝛmā rotūdā. deſiccat̄ ꝛ fit albiſſim⁹ Ma-
ſculus hꝫ ſubam longā. ꝛ nō eſt adeo alb⁹. Fe-
mina ꝟo eſt alb⁹ lenis ꝛ frāgibilis hn̄s quaſi-
dā tuburoſitates intus: ꝛ fruſtula q̄ſi poroſa.

Fig. 7 - 15th century woodcut of the Agaricum
from *Hortus Sanitatis*, Mainz, 1491

Fungi and fire - the tie that weds these two disparate elements was indeed old, strong, and far-reaching. Consider the following additional evidence. In ancient Greece there was a mushroom that bore the name κεραύνιον. This word, like *joudre* in French, conveys the idea of both thunder and lightning, and the mushroom designated by it was therefore the 'thunderbolt-fungus'. We do not know exactly what species it was, but in Latin it was rendered contemporaneously by *tuber*, and therefore it was probably an underground growth, perhaps a truffle or a species of *Terfezia*. Many ancient writers refer to the common belief that thunderbolts made this fungus grow plentifully. Galen speaks of it. Plutarch in his *Convivial Essays* devotes a table conversation to the question why thunder should engender 'thunderbolt' fungi, an essay both graceful and unenlightening. Pliny the Elder in his *Historia Naturalis*, in Book XIX, is careful to distinguish between the influence of the rain and of the thunderbolts: it is not the rain but the thunder that makes the mushrooms grow. Pliny sounds as though he were simply repeating a tiresome adage, after the manner of those who say it is not the heat but the humidity that causes distress in summer. Juvenal in *Satire* V: 116 speaks of the longed-for thunder in springtime that replenishes the table with mushrooms:

> Post hunc tradentur tubera, si ver tune erit et facient optata tonitrua cenas maiores.

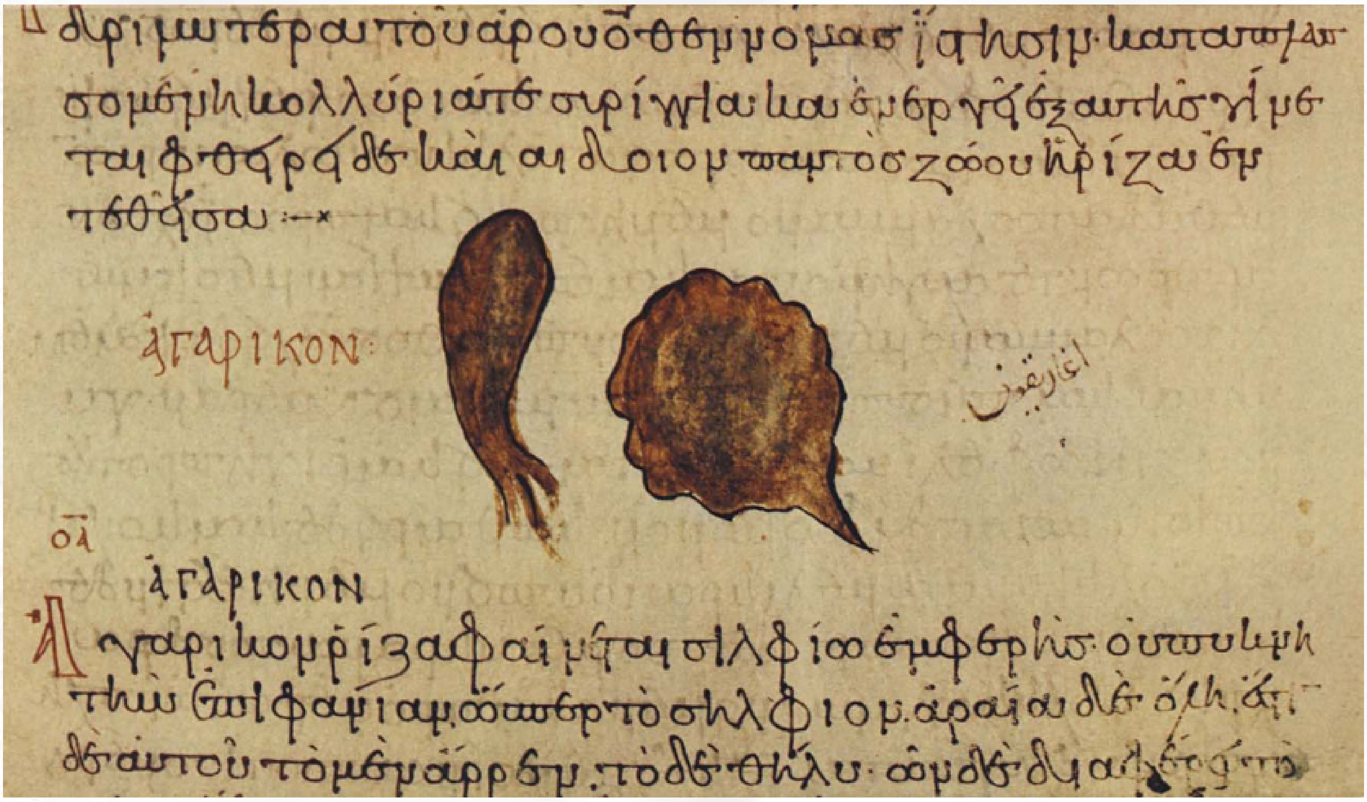


PLATE XXII
Fomes officinalis. Miniature from a 10th century Byzantine codex of Dioscorides.
By courtesy of The Pierpont Morgan Library, New York.

Athenasus, writing in the 3rd century after Christ, quotes Theophrastus five centuries earlier on certain unidentified underground fungi called οἰτόν in Thrace:

> Concerning these a singular fact is related, viz., that they grow when autumn rains come with severe thunderstorms; the more thundering there is, the more they grow, the presumption being that this is the more important cause. [BOOK II: 62]

One could not demand better documentation for this ancient notion which the most intelligent men of the day accepted without question. What explanation is there for it; Plutarch had none. Modern mycologists have none. Does thunder perhaps shake the soil and precipitate a crop of fungi that would otherwise emerge over weeks? There is no evidence to support this. [Note to the edition at Psilosophy: According to Japanese research studies from 1996 "Effects of Ozone Exposure during the Different Cultivation Processes of Winter Mushroom (*Flammulina velutipes*) on their Chemical Components" - "A significant increase was observed in weight when fruit body primodia in early stage were exposed to ozone, while, a significant decrease was observed in it when fruit bodies in early stage of development were exposed to ozone". So one may assume that first thunderstorm which generates ozone in the air favors mushroom primordiation, but next ones may weaken formation of fruitbodies which are growing from it, albeit after the last thunderstorm, mushrooms grown from ozone strengthened primordia of first thunderstorm should be bigger.] We believe that the classical writers were repeating words whose portentous religious meaning was already in their time forgotten.

The ancient belief must have survived the classic world, but we have found only one sure evidence of it in modern Europe. In Littre under *tniffe* we read the statement that when it thunders, people in some parts of the French countryside say, "Voila un bon temps pour les truffes" - "There's fine weather for truffles."[77] Professor Georg Morgenstierne of Oslo, however, has turned up for us amazing data proving that the link between fire and fungi lingers on to this day in certain parts of Asia. (To Professor Morgenstierne we are deeply indebted for all our information concerning the Iranian and Indie languages.) In Kashmir the gilled mushrooms known as *hedur* and *henda* are said to be engendered by thunder. They are eaten by both Hindus and Muslims, cooked with ghee; they are preserved by drying and used in broths and stews. The mountains of Kashmir produce great quantities of another mushroom, *kana-g^{a}ch*, which means 'ear-morel', and it too emerges from the earth in response to thunder.

More remarkable still is the testimony from that valley southeast of Samarkand where Yaghnobi is spoken, a dialect descended from the ancient Sogdian language, related to Persian and of course belonging to the Indo-European family. The folk who speak this tongue believe that when the highest god shakes his winter coat, the air is rent with thunder, and then the children must say:

> Katta xarcak man, pullja xarcak tau.
> The big mushroom is for me, the small one for you.

Not far away, in the upper Zarafshan valley where we find a Persian dialect known as Tadzhik, the children cry, "Puri, puri, xorc", 'xorc' meaning 'mushroom' and *puri* being a thick-stalked annual that springs up early in the season and quickly dies away, both stalk and root being eaten raw by the natives. Someone should tell us which mushroom these children near the Pamirs have in mind. In Yaghnobi, and also in Tadzhik as spoken in the vicinity of the town of Match, there survives an old belief that when the divinity known as *Mama*, 'Grandmother', shakes her baggy trousers, she lets fly a swarm of lice to the earth, and from those lice, after thunder storms, an abundance of mushrooms spring up.[78]

Today in Persia the common word for 'mushroom' is *qarc*, but there is one kind, perhaps a *Terfezia*, that is called *dumbalan* (plural of *dumbal*, 'boil', 'pustule', 'bubo'), and people say they grow in the desert 'after thunderstorms'.

Again thanks to Professor Morgenstierne, we are able to pin-point the earliest reference in surviving Sanskrit literature to this belief in the 'thunder-mushroom'. It is in Kalidasa's lyrical poem *Meghaduta*, 'The Cloud Messenger', written about A.D. 400. In verse 11 the exiled *yaksha* or demigod addresses the rain-cloud drifting northward over India:

---

[77] From the 16th through the 18th century various English writers attributed 'fairy-rings' to lightning; thus Robert Plot's *The Natural History of Stafford-shire*, 1686, Chap. I; Erasmus Darwin's *The Botanic Garden*, London, 1791, I: 36:

> So from dark clouds the playful lightning springs,
> Rives the firm oak, or prints the Fairy-rings.

The evidence indicates that this belief had no roots in folklore but sprang from the New Learning, a 'scientific' explanation to replace outworn notions about the dancing of midnight fairies. Moreover, whereas today 'fairy-ring' immediately suggests mushrooms, the early writers such as Robert Plot discuss fairy-rings at length without mentioning fungi. It was the grass of darker green that made the ring, not mushrooms, and the link between the two is first mentioned, so far as our knowledge goes, in a book published in London in 1717-18, Richard Bradley's *New Improvements of Planting and Gardening*. Therefore, despite superficial appearances, we think we must rule out the English fairy-ring association with lightning in our discussion of the ancient belief in a thunder-mushroom.

[78] See Heinrich F. J. Junker, *Arische Forschungen*, 'Yaghnobi-Studien', I, p. 106 (*Abhandlungen d. philol. hist. Klasse d. sächsischen Akademie d. Wissenschaften*, Band XLI, No. II, Leipzig, 1930). His source was M. S. Andreev, 'Po ėtnografii tadzhikov', in *Tadzhikistan, sbornik statej*, edited by N. L. Korzhenovskij, Tashkent, 1925, pp. 172-3.

> ... and when they hear thy sweet-sounding, fertilizing
> thunder, which is able to cover the earth with mushrooms ...

The word used for 'mushroom' here is *silmdhra*, of unknown derivation, probably taken over by Sanskrit from some earlier unrelated tongue of India. '*Sili*' might mean a frog or toad, and then *-dhra* would mean 'carrying': 'toad-carrier' or something akin to our 'toadstool'. But this tempting explanation of the ancient word is far from established.

Is it not deeply stirring to contemplate these surviving traces of a folk association uniting thunderbolts with fungi - a belief accepted by ancient Greece and Rome, queried by Plutarch, and holding on in Kashmir and the Pamirs? Angelo de Gubernatis in the second volume of his *Mythologie des Plantes* (Paris, 1882), when he discusses mushrooms, observes that the solar hero was said sometimes in antiquity to hide behind a mushroom, and he supposes that by 'mushroom' a cloud was meant. The direct and simple meaning seems preferable. The solar hero, a projection of divine fire, lies dormant for the nonce in fungal tinder, ready to leap forth on divine command, just as the dormant φαλλός rises in ίθύ-φαλλος. Here then is a partial answer to Plutarch's question: the fungi, saturated in sexual associations, are intimately associated as tinder with the making of fire, and fire expresses metaphorically the procreative act. On every plane the fungal world is redolent with the spirit of generation. Even the phosphorescence that some fungi emit must have deepened the mystery, augmented the awe. The very fungi were called into being by the gods, by those bolts of celestial fire hurled to earth with the crackling and deafening roar of thunder.

Let us pursue this theme further, to the very core of ancient Rome's religious beliefs. Rome's eponymous heroes sprang from the union of divine fire with vestal virgins, and fungi seem to have been officially present at the consummation. Sir James Frazer in *The Golden Bough* summarized the legends and pointed out their meaning.[79] It seems that when Ocrisia, handmaiden to Tanaquil the wife of King Tarquin the Elder, was offering cakes and libations of wine on the royal hearth, a flame assumed the shape of the male member and shot forth from the fire, impregnating her with a child who was destined to reign as Servius Tullius. The child's divine paternity was well attested later when an aureole of lambent flame was seen to play around his head. Concerning Romulus and Remus Plutarch records a similar legend, which he took from Promathion's *History of Rome*: in the house of the king of Alba there hovered over the hearth for days a phantasma in the shape of the male organ of generation, which in the end, by one of the handmaidens, gave being to the twins.[80]

Nowhere in surviving versions of these legends are fungi mentioned. What then was our surprise when we discovered that Professor Arthur Stanley Pease of Harvard University, in a note in *Classical Philology* in 1947, urged that a natural phenomenon be sought to explain these miracles and volunteered the surmise that the key would be found in the mushroom that he called the *Ithyphallus impudicus*, that astonishing fungus which from its sac or cod shoots forth to its proud height in the course of minutes. This, says Professor Pease, is what underlay Ovid's line in the *Fasti*, VI: 631:

> ... hie inter cineris obsceni forma virilis

Professor Pease's happy suggestion may be refined. The morel, though far removed in mycological classification from the *Phallus impudicus*, embodies in its shape the same erotic symbol, and unlike the phalloidaceae shows a remarkable predilection for sites of wood fires. J. G. Gleditsch in his *Methodus Fungorum*, published in Berlin in 1753, told[81] how just recently the old peasant women of Brandenburg, observing this predilection, had taken to making bonfires in the woods to induce the growth of morels, causing thereby so many forest fires that the authorities had banned the practice. Dr. Ramsbottom in his *Mushrooms & Toadstools* reports that during and after the first World War the sites of burned houses in northern France and of abandoned trenches became veritable gardens of morels, and he also relates a personal experience confirming this biological nexus between morels and fired places. Indeed this affinity is a commonplace of fungal lore.

---

[79] See *The Golden Bough*, vol. II of *The Magic Art and the Evolution of Kings*, pp. 195 ff, where he also gives the sources; a fuller discussion appears in Frazer's translation and discussion of Ovid's *Fasti*, published by Macmillan in 1929, vol. IV, pp. 300-304. For Arthur Stanley Pease's note, see *Classical Philology*, vol. 42 (Oct. 1947), p. 253.

[80] Plutarch for the phallic apparition used μόρτον άνθρός. (Plutarch's *Moralia*, Loeb edition, vol. IV, p. 360) If μόρτον by etymology or punning was linked with μορύσσω (*vide* É. Boisacq's *Diet. Etym. de la Langue Grecque*), the association with the phallic morel would be clinched. See discussion of 'morel', pp. 153-4.

[81] p. 60; the references in Dr. Ramsbottom's book are on pp. 76-77.

We place then a morel rather than the stinkhorn in those ancient hearths of Rome's eponymous founders. And this leads us to venture a daring conjecture concerning the origin of the Greek work for 'mushroom', μύκης. In modern times we are in a position to observe how the words of the sponge cluster - the basic words for the fungi in common Indo-European - yield place sometimes to other words that express a fashionable facet of man's evolving attitude toward the fungal world. From a name for a single edible species, *mousseron* in 'mushroom' becomes a designation for any edible species and even for all species. The French *champignon*, once applied only to the common field mushroom, acquired overshadowing importance when the art of its cultivation was mastered, and now this word embraces in French all fungi, even the microscopic kinds. In German *Pilz* is a newcomer, but already competes with *Schwamm*, and in Russian *guba* has largely surrendered the field to the toothsome *grib*. Thanks to the importance of a particular mushroom species, its specific name can become generic. In Greek σπόγγος lost its fungal meaning early - the surviving records never report it - and its terrain was wholly occupied by μύκης. What potent forces could have caused this early substitution? Our surmise is that μύκης originally was the name of the morel, and that its awesome religious and magical meaning, its link with the generation of fire and divine procreation, so far eclipsed all other fungal associations that it took over the whole semantic area of the fungi. The Greeks never won honors in mycophagy and there was no competition from fungi as food. Let us see whether, as we progress in our argument, we come upon supporting evidence for this possibility. The sacred role of the μύκης as we envisage it, could have been a legacy of the Etruscans or some other Mediterranean culture. In neither ancient nor middle Greek is there any word that scholars translate by 'morel', so that the way is open for our suggestion. The specific name in Latin was *spongia* or *spongiolus* in imperial times, a survival in Latin of the lost fungal meaning of σπόγγος.

Just as in French one distinguishes the specific and the generic uses of *champignon*, so in ancient Greek the reader must decide whether in a given context μύκης meant the morel or the whole fungal tribe. As an example let us take a text from the *Geoponica*, an agricultural treatise assembled in its present form before the end of the first millennium A.D. In Book XII Chapter 41 we find a passage that reads thus:

> If you would have μύκητας to grow from the ground, you must select a spot of light soil on a hill where reeds grow; there you must collect together twigs and other burnable things, and set all on fire just before rain is expected. If rain come not, you must sprinkle the place with pure water, but the μύκητας thus produced are poor ones.

How reminiscent this is of Gleditsch and Ramsbottom! The Greeks also knew what the German and the Englishman tell us, and in this Greek text μύκης, in our opinion, must carry the specific meaning of 'morel'.

Up to this point we have linked fungi only with the gods of thunder and lightning in the Indo-European world. But the association is far more extensive. On a later page we shall see that the Bedouin of the desert, when electric storms are severe in our month of October, know for sure that the crop of esteemed *Terfezia* will be heavy *four months later*, and at the appointed time they make their way to those places where experience has taught them to seek this delectable fare.

A Philippine mycologist, Jose Miguel Mendoza, reports[82] that the natives throughout the islands commonly believe that thunder and lightning cause the generation of mushrooms, and in the spring of the year when they hear the thunder roll, they rush into the meadows to gather the edible kinds. In the Pampango tongue, spoken in central Luzon, the *Collybia albuminosa* is called the *payungpayungan kulog*, the first word meaning 'parasol-like', and the second being 'thunder' in both Tagalog and Pampango. The culture of the Philippines is an accretion of many layers, and this belief in the thunder-mushroom could be Malayan or Indian or Chinese.

---

[82] See his 'Philippine Mushrooms', published in *The Philippine Journal of Science*, vol. 65, Jan.-April 1938, which the author has supplemented for us in private correspondence.

Yes, Chinese. By good fortune we are able to document the Chinese association of certain mushrooms with thunder. There came into our possession in 1951 a rare, 8-volume work on ethno-mycology entitled *The History of Mushrooms*, dated 1811 and written by Ishiwara Gusha ('the Fool from the town of Ishiwara'), a pen-name for the Japanese classical scholar Katashi Masujima, professor in Yedo at the school for samurai called Shoheiko. (Another of his pen-names was Ran-en, 'Orchid Garden'.) In this curious, hand-written work the author gathered together everything that had been said about mushrooms by Chinese and Japanese authors, and it is our hope to present it some day to our readers in an annotated translation. With the help of our friends Mr. and Mrs. Wango Weng, we have discovered in the sixth volume extensive discussions of three kinds of thunder-mushrooms. All three make excellent eating. First there is the *lei-ching t'an*, 'thunder-aroused mushroom':

雷驚蕈

which springs forth when the worms are stirring and the east wind brings the thaw and the earth loosens and the air grows warm. (This suggests the morel, but later the author speaks of the 'parasol' of the mushroom.) The second is the *lei-sheng chün*, 'thunder-peal mushroom':

雷声菌

which grows in the grass after thunder and rain in summer and autumn, 'leaping forth when the thunder calls'. Finally we have the *lei chün*, the simple 'thunder-mushroom':

雷菌

Though our Japanese author quotes Chinese sources that refer only to the regions of Soochow and Kwangsi Province, this does not mean that the association of thunder with mushrooms is confined to those parts of China. Indeed, we can document the survival of this theme on the very periphery of the Chinese cultural world. In a letter written to us by Charles Evans, the Himalayan explorer and climber, he tells us that the Sherpas, who culturally are Tibetans, believe that thunderstorms make mushrooms grow. On the other hand Masujima, himself a Japanese, is silent on the thunder theme in his treatment of Japanese mushrooms: apparently the Japanese know it not.

But this is not all. In the language of the Maori of New Zealand, the word for mushroom is *whatitiri*. The word for thunder is the same: *whatitiri* or *whaitiri*. As a proper noun Whaitiri is the name of the mythical ancestress of the Maori people and all the other branches of the Polynesian race. People think of her as the thunderer, and her grandchild, Tawhaki, shoots forth bolts of lightning from beneath his armpits. Eponym, fire, fungi - how astonishing that we should find the same pattern in Oceania as in the Mediterranean! Some years ago Professor Heim drew attention to a curious belief in Madagascar, where Polynesian influences have been strong.[83] He is describing the mushroom *Lentinus tuber-regium* Fr., called *olatafa* by the natives of the Tanala country. According to the local chief, the practice is to dry this fungus, and shred and rub it to a powder with the aid of a hard stone, and then to the powder the natives add a little water. When a thunder storm breaks and reaches alarming violence, it is the custom to take some of the paste into the mouth, and when the lightning flashes, spit it forth into the sky, crying out "Fotaka!", or else, "Fotaka malemy!", which means, "Earth!" or "Soft earth!", thereby giving utterance to a prayer that the thunder will be mild as mud. Professor Heim confirmed this practice with other informants in the region of Fort-Carnot. It seems that *tafa* in the native language designates a person momentarily off balance, and this word may underlie the name of the

---

83. 'L'Olatafa', by Roger Heim, published in the *Archives du Museum National d'Histoire Naturelle*, in the Volume du Tricentenaire, 6th series, Tome XII, 1935, pp. 549-554.

mushroom and the incantation. Whatever the layers of meaning that underlie the Tanala practice, for us its importance is the tie that binds certain mushrooms with bolts of celestial fire. The explanation given to Professor Heim is not convincing: it sounds like a rationalization by people who have forgotten. That mushroomic spittle tossed into the teeth of the storm, into the flash of lightning - may it not incorporate the seminal idea, the procreative aspiration, a prayer to the divine begetter? This is not a rhetorical question. It is a suggestion for anthropologists working in Madagascar.

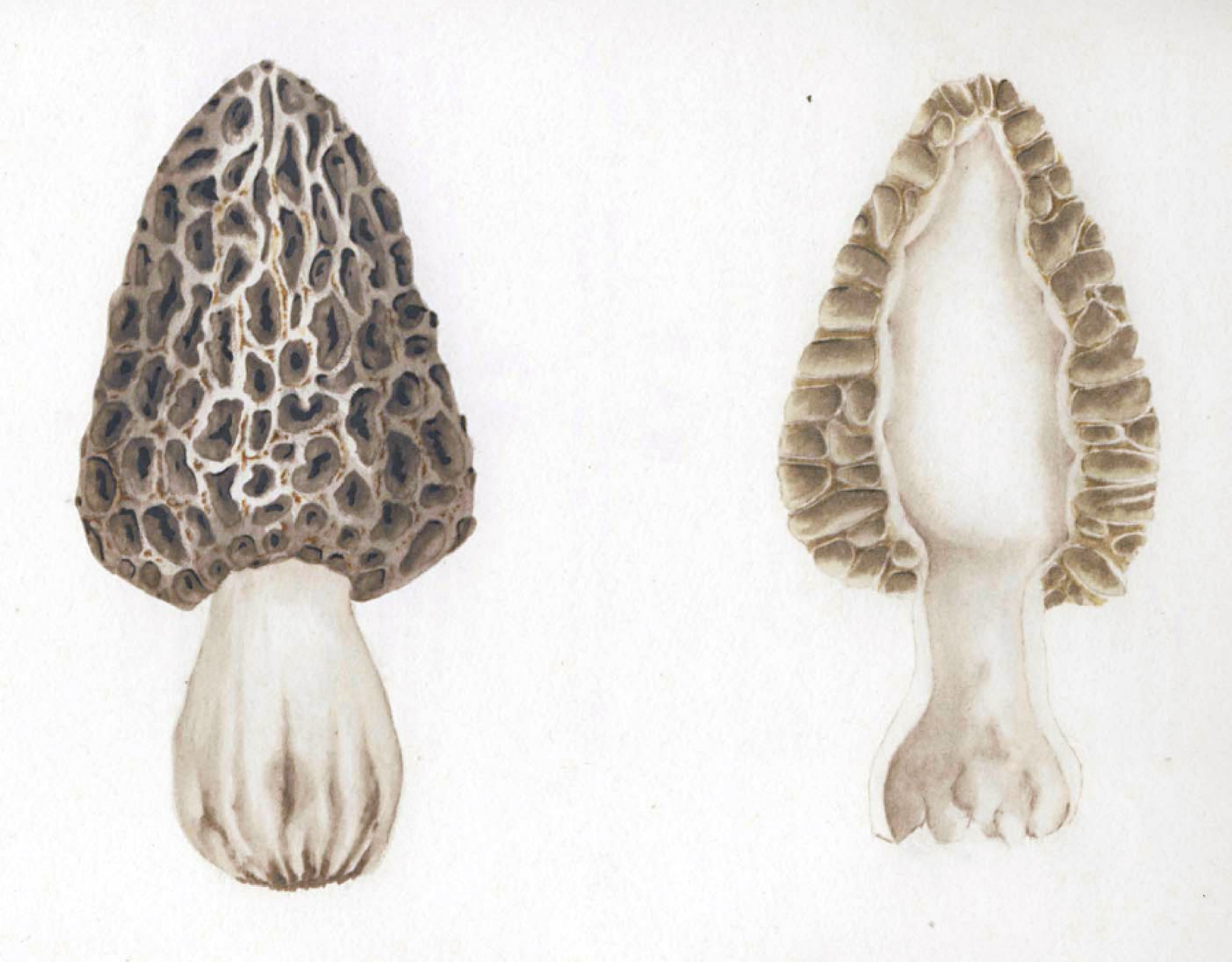


PLATE XXIII
Jean-Henri Fabre
Morchella vulgaris Pers.
English: *morel*;
French: *morille*;
Russian: *smorchok* (**сморчок**);
Polish: *Smardz jadalny*.

Here we bring to an end, but only for the present, our discussion of the cultural tie that links mushrooms with lightning. On page 316 [of original vers.] we shall return to this mystery, and with the aid of further evidence of our pandemic theme in archaic cultures, we shall submit a surmise to explain it.

8

The Gourd Cluster

The French word *potiron* means 'pumpkin'. In the West of France and as far south as the Garonne it also means any large mushroom. The word presents what is perhaps the prettiest problem in the whole fungal vocabulary of Europe. No one has hitherto determined its origin. Littre originally quoted Gilles Menage's suggestion of a word found in the writings of the Arabic thinker Avicenna - *alphotie*. Later in his *Supplement* he added Marcel Devic's alternative Arabic source, the word *futr* meaning 'mushroom'. Oscar Bloch in his turn favored the Syriac *paturta*, which he said meant 'morel'. These bizarre suggestions with their curious bias for the Near East offer no explanation for *potiron* in the sense of 'pumpkin'. They only illustrate how even philologists, when at a loss, give recognition to the flimsiest guesses. The Arabic and the Syriac words are etymologically identical, based on a Semitic root meaning 'to split' or 'to cleave'.

In Latin *cucutna* means a kettle, *cucumis* a cucumber, and *cucurbita* a gourd. Among primitive communities living in the climatic zone where gourds nourish, these have always served for cooking fluid food and boiling water. This primitive practice must still have been alive in the minds of the ancient Romans when they used words for kettles and gourds that closely resembled each other, and we think that *potiron* is a translation (*pot* meaning 'kettle') of the Latin words, preserving for us the semantic link that was obvious in Latin. But this does not explain the use of *potiron* for 'mushroom'.

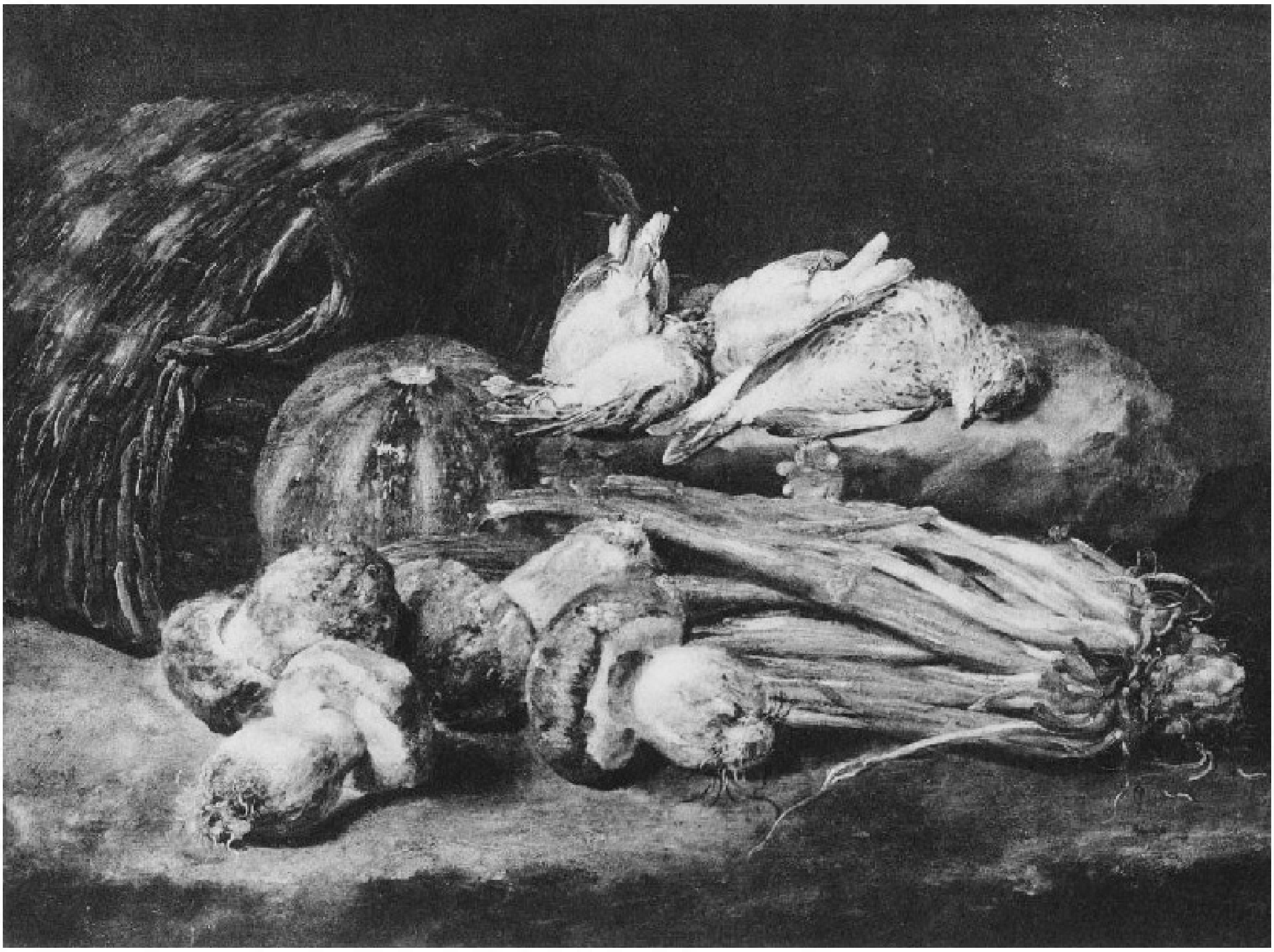


PLATE XXIV

Jan Fyt. Still life. *Brussels, Musees Royaux des Beaux-Arts de Belgique*.

The pumpkin-mushroom link is not confined to *potiron*. We discover it in Provençal, where *coucourlo* means both the common field mushroom and the pumpkin. The Italian *cocomero* means 'pumpkin' but not mushroom; the Provençal *cougoumello* is the name of certain mushrooms, but does not mean pumpkin. The general word for all mushrooms in Portuguese is *cogumelo*; it is not, however, linked with any gourd. We seem to be in the presence here of a variety of words derived from one or the other of the Latin *cucuma*, *cucumis*, and *cucurbita*. But why are mushrooms found in this company?

All words such as these, which live out their lives for the most part in oral usage, lend themselves to popular contamination with other words. Some mushrooms when they first break the soil look like eggs, and this is why the *Amanita caesarea* is called in standard Italian the *ovolo* and the *Amanita muscaria* the *ovolaccio*. The French word *coque* means 'eggshell' and there are colloquial words in Italian, *cocco* and *cucco*, meaning 'egg'. In standard Italian *cocco* is sometimes used as another name for the *Amanita caesarea*, and this word takes various local forms in the North: in Piedmont *cocon* or *coc* or *cucon*; in Lombardy, *jung cocch*; in Venice, the *boleo coco* or *coco bon*; in Genoa, the *cucun*. (Our English 'cocoon' belongs to the same family.) The names of the *Amanita muscaria* in northern Italy bear the same stamp: *cocch fals* or *cocch velenos*, or *cocch bastard* in Milan. The *Lepiota procera* is the *coccomelle* or *cuccamele* in Piedmont; in France this species is called in some regions the *coulemelle* and in others the *potiron*. It would appear that all of these names stem ultimately from the Latin word for kettle, but have been influenced in their shape by words for eggs or egg-shells.

But all this still leaves unexplained why, in the first place, pumpkins and mushrooms got mixed up together.

Another word for 'pumpkin' in French is *pepon*, for which Frederic Godefroy gives the following early variants: *popon, poupon, pompon, ponpon*. 'Pumpkin' in English is a popular form of the Middle English 'pumpion', which in turn comes from the French word that we are now discussing. For the sake of our argument and in advance of our supporting evidence, let us assume that the French word *pepon* originally carried two meanings, 'pumpkin' and 'mushroom'. It has retained only one in French, and bequeathed only that one to English. But in Basque *papun* and *panpun* mean 'mushroom', and could represent the lost meaning of *pepon*. The French philologists have been baffled by the word *pompon*, which is the English 'pompom', since its semantic tie with gourds is not clear. But the difficulty is solved if the old French word also meant 'mushroom', for what is a *pompon* but a 'mushroom'?[84]

This hypothesis, supported so far by only two strands of circumstantial evidence, still does not tell us why gourds were linked with mushrooms.

This link is deep-seated, but we believe we can put our finger on it.

At the outset let us examine the word *potiron* more closely, and especially its use in the 16th century.

In the sense of 'mushroom' *potiron* was in use at least as far back as the 15th century, according to Albert Dauzat. This is the older meaning, antedating the discovery of America. *Potiron* as a designation for gourds is confined to squashes and pumpkins, and they are of New World provenience. In the 16th century these vegetables were called *courges d'Inde* and *courges d'outre-mer*, but *potiron* began to supersede those nonce names in the 17th century. If there was a metaphorical transfer, we must conclude that the New World squash suggested a mushroom to the French and was therefore called a mushroom. This explanation seems to have satisfied the philologists Albert Dauzat and Oscar Bloch, but it leaves us sceptical. To be fair we must point out that there is one small squash with scalloped edges that in color and even in external texture might suggest certain mushrooms. This is the kind of squash, a variety of *Cucurbita pepo*, known formerly as the simlin or cymling and today as the patty pan squash or white bush scallop. A further circumstance might support the philologists' position. The French were discovering how to cultivate the *champignon de couche* at the very moment when they were learning to cultivate the squash, in the first half of the 17th century, and there is reason to believe that the manured hills of the squash-patch served simultaneously as mushroom beds. For centuries the country folk of some parts of western Europe had been encouraging the growth of various kinds of edible fungi by bringing about the conditions under which they might spontaneously appear. In the 17th century it was known in France that parings of the *Psalliota campestris* rejected in the kitchen could be thrown on horse manure with a reasonable expectation that they would produce a crop of mushrooms in the warm fermenting dung.[85] As we have mentioned before on page 6, N. de Bonnefons described this practice for the first time in print in his *Le Jardinier françois* in 1651, and he added the significant advice that the beds prepared for melons could serve this double purpose. In our mind's eye we can see the mushrooms growing in the same beds or hills with melons, pumpkins, and other gourds, and this was taking place at the very moment when *potiron*, an old word for 'mushroom', was beginning to be used as the name for certain exotic gourds, lately introduced from overseas. It was therefore not unnatural for farmers to associate mushrooms with gourds. Furthermore, the readiness of both squashes and mushrooms to putrefy rather soon into a watery mess[86] might have suggested a kinship that expressed itself in the use of the same name for both, a similarity in putrefaction that Sir Thomas Elyot pointed out in 1541 in the words that we quoted on page 19. All in all, the evidence assembled in this paragraph would seem to offer an explanation for the dual use of *potiron*.

---

[84] In the United States and Canada, the ordinary woodsman's word for any shelf fungus is 'conk', and because of the shape of the growth, the word is supposed to come from 'conch'. But woodsmen do not know the molluscs and are unlikely to turn to them for metaphors. The *Dictionary of American English* gives grounds for supposing that 'conk' is a shortened form of 'conkus' or 'konkus'. In the English counties from Lincolnshire to the Scottish border there has long been a word used for cucumbers: 'congers', 'cungers', and 'conkers'. Is the American word for the fungus cognate with the name for the cucumber, and do we find here another example of the association of fungi with gourds? In the absence of a better etymology, we offer this as a conjecture, to be tested by further inquiry.

But let us not forget the suggestion inherent in the older forms of the word *pepon* indicating that the association of gourds and mushrooms long antedated the 16th century and the cultivation of the field mushroom.

There is a source of promising evidence relevant to our theme of surprising and fascinating quality in the still-life paintings of the Low Countries in the 17th century. This was the epoch when the Flemish and Dutch schools were producing innumerable canvases representing the foods of the times - fish, game, meats, vegetables, fruits. The number of accomplished artists who devoted their talents to paintings of food is astonishing, and apparently they never tired of their theme. We have combed these still-lifes for mushrooms, and while of necessity we cover only a small part of the source materials, it is clear that paintings of food with mushrooms are exceedingly rare. We have found only four, of which not one is Dutch. All four are Flemish, or from the Catholic side of the religious line that bisected then as now the Low Countries. On a later page we shall revert to the significant absence of fungi as food from paintings of the Dutch school.

Of the four paintings we reproduce one by Jan Fyt, and details from a canvas by Jan Davidsz de Heem and from one by Adriaen van Utrecht. All three of these painters were in the plenitude of their powers at the precise time when N. de Bonnefons was composing his book on gardening and describing for the first time the preparation of mushroom beds. A fourth painting, attributed to the Antwerp artist Frans Snyders, shows a young market woman surrounded by baskets of divers vegetables and fruits with one basket of ceps; it hangs in the art gallery at Schloss Pommersfelden, Germany. Snyders was a slightly older contemporary of the other three. Of this painting a 17th century variant is in the Louvre. All four artists worked in Antwerp or Brussels.

The startling feature of the three paintings that we reproduce is that in all three we find a *potiron* or squash, and in two the *potiron* is juxtaposed to mushrooms. In the light of the dual meaning of *potiron*, this juxtaposition justifies a conjecture that it was not accidental. Thanks to the gracious help of Dr. Hugh C.

---

[85] The use of fungal 'spawn' came later, as did the discovery that mushrooms lent themselves to cultivation in caves and cellars. But there is a baffling sentence in the *Satyricon* of Petronius Arbiter, written in the first century: Ecce intra hos dies scripsit, ut illi ex India semen boletorum mitteretur [Loeb Library, p. 59], 'Within a few days, I may say, he has written for a cargo of mushroom seed from India'. If *boletus* here carries its usual meaning of the Caesar's amanita, it indicates a mastery in the cultivation of these delectable mushrooms wholly unknown today and never elsewhere mentioned in surviving records of ancient times.

[86] Shakespeare uses 'squash' on several occasions. Thus in Act. III, Sc. I of *A Midsummer Night*'s *Dream* Bottom is asking the names of various characters and from one learns that he is Pease Blossom, whereupon Bottom retorts:

> I pray you commend me to Mistress Squash your mother
> and to Master Peascod your father.

'Squash' as a name for the American gourd is derived from a Narragansett Indian word, and Shakespere could not have known the word and probably did not know the gourd. 'Squash' in the sense of 'squeeze' is European in origin, and specifically it meant for Shakespere an unripe pea pod or 'peascod'. The pea pod played a familiar role in amatory folklore in Shakespere's day, and 'peascod' was heavily charged with genito-urinary puns and symbols; cf. 'cod', 'codpiece', etc. Mistress 'Squash' invokes a parallel female metaphor equivalent to Shakespere's erotic use of 'medlar' in *Romeo and Juliet* and elsewhere. Though 'cod', as we have seen, sometimes meant 'puffball, in Bottom's words there is no link with the fungal world or gourds.

Cutler, Assistant Director of the Missouri Botanical Garden, St. Louis, we can identify the squashes, and he points out that they are the only vegetables of New World provenience in these paintings. In the Van Utrecht the squash is the *Cucurbita moschata*, and belongs to the variety now called Dickinson Field pumpkin, familiar in the American Southwest and in central and southern Mexico. The squash in the Fyt is probably a *Cucurbita moschata* but might be a pumpkin, i.e., *Cucurbita pepo*. In Heem's painting we clearly find the pumpkin. Both squashes and pumpkins may be called *potirons* in modern French. As for the mushrooms, Snyders, Fyt, and Heem give us ceps; Van Utrecht offers us ceps and three apparently gilled mushrooms. If as we believe these latter are very ripe *champignons* or *roses*, they are the earliest known representation of the common mushroom by an accomplished artist.

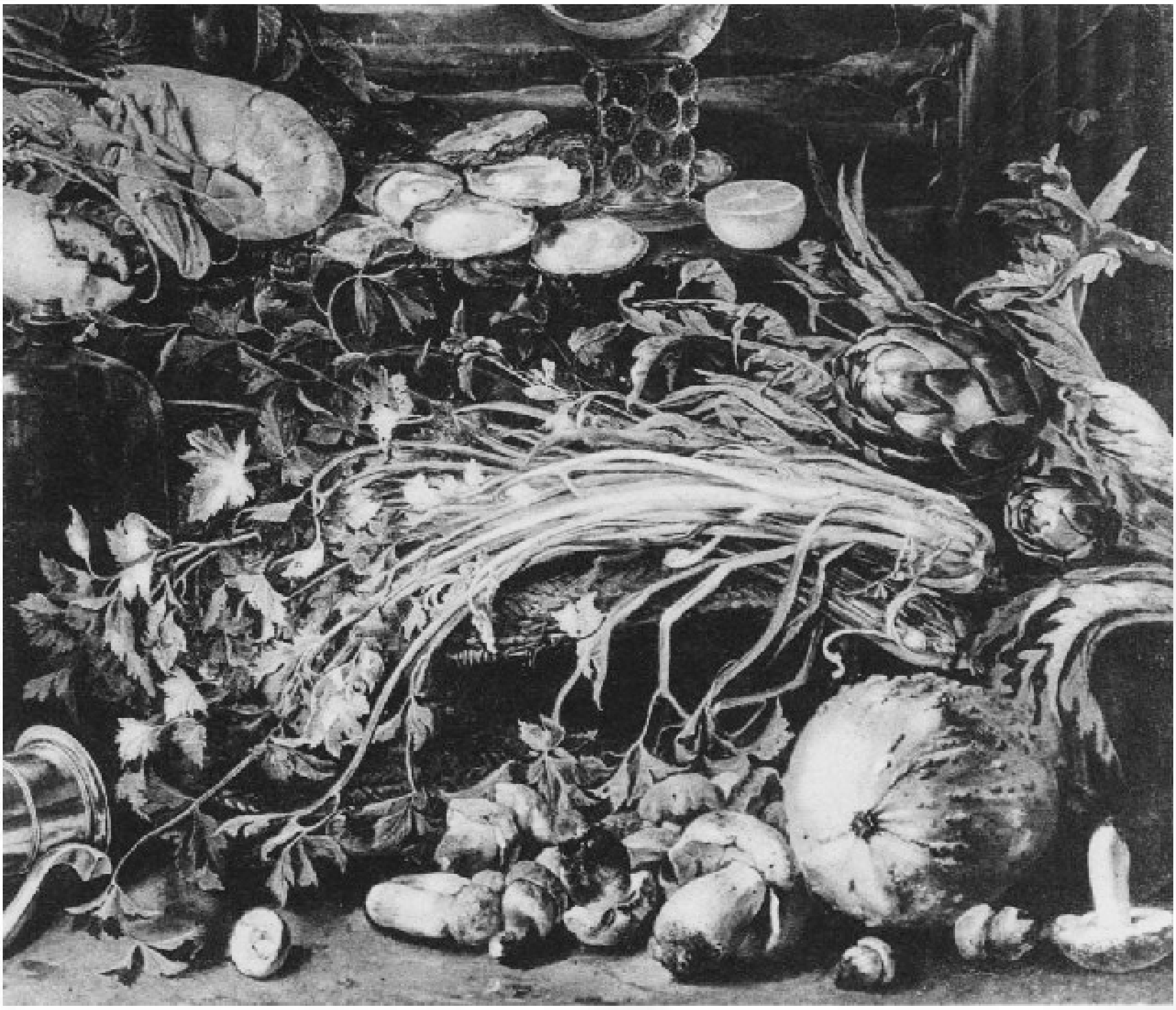


PLATE XXV

Jan Davidsz. de Heem. Still life. *London, Wallace Collection*.

The mute testimony of these paintings is of extraordinary interest. It might seem probable that in the painters' minds the squash and mushrooms had an affinity for each other, and the squashes in question were certainly of American origin. At the same time the mushrooms painted by them as food were chiefly boleti, and boleti never grew in a pumpkin patch. Clearly the *champignon de couche* played little or no role in the market places of Flanders and Brabant, and the affinity of mushrooms with the squash was unrelated to the mushroom beds described by Bonnefons. The cucurbitaceae painted by the Flemish artists did not include the patty pan squash, with its superficial resemblance to a mushroom. *Potiron* in the sense of 'mushroom' has never been known in the Walloon dialect of French.

The key to the four Flemish paintings is to be found in Franciscus van Sterbeeck's *Theatrum Fungorum*, published in Antwerp in 1675, the earliest book dealing solely with mushrooms. The author never refers to the still-life painters, who were his older contemporaries, but he divulges a precious item of ethnomycological lore.

He informs us that the Flemings were mycophobes until the beginning of the 17th century, at which time certain Italian merchants came to take up residence in Flanders, and by their example they showed that mushrooms could be eaten. They launched a vogue for this novel victual, gathering mushrooms themselves, importing dried ones from Italy and Burgundy, and teaching all and sundry how to distinguish the many good kinds from the bad. In fact, Van Sterbeeck's treatise is itself a tribute to this budding mycophilia, written by an enthusiast to spread the good tidings, the first of hundreds of such missionary efforts brought out in the mycophobic North in the past three centuries. As there was no Flemish word to designate mushrooms suitable for the dining room, the Flemings had lately borrowed *kampernoeljes* from, the French dialect spoken in nearby Picardy,[87] and applied it to all the edible kinds, especially ceps. Afterwards it gave way to *champignons*. We reproduce the frontispiece of Van Sterbeeck's work, with its quaint commentary on early mycophagy among the Flemings. The author portrays himself in a bust at the top of the architectural design, helpfully telling us that his age was 44. On one side of him are effigies of happy infants nourished doubtless on the wholesome fungi; on the other side the corresponding amori are in acute distress from the other kind. Below we see two gentlemen responding to aggressive selling tactics of the mushroom vendors. We suspect that the vendors on the right are ready to sell the evil wares descending from the wretched infants above.

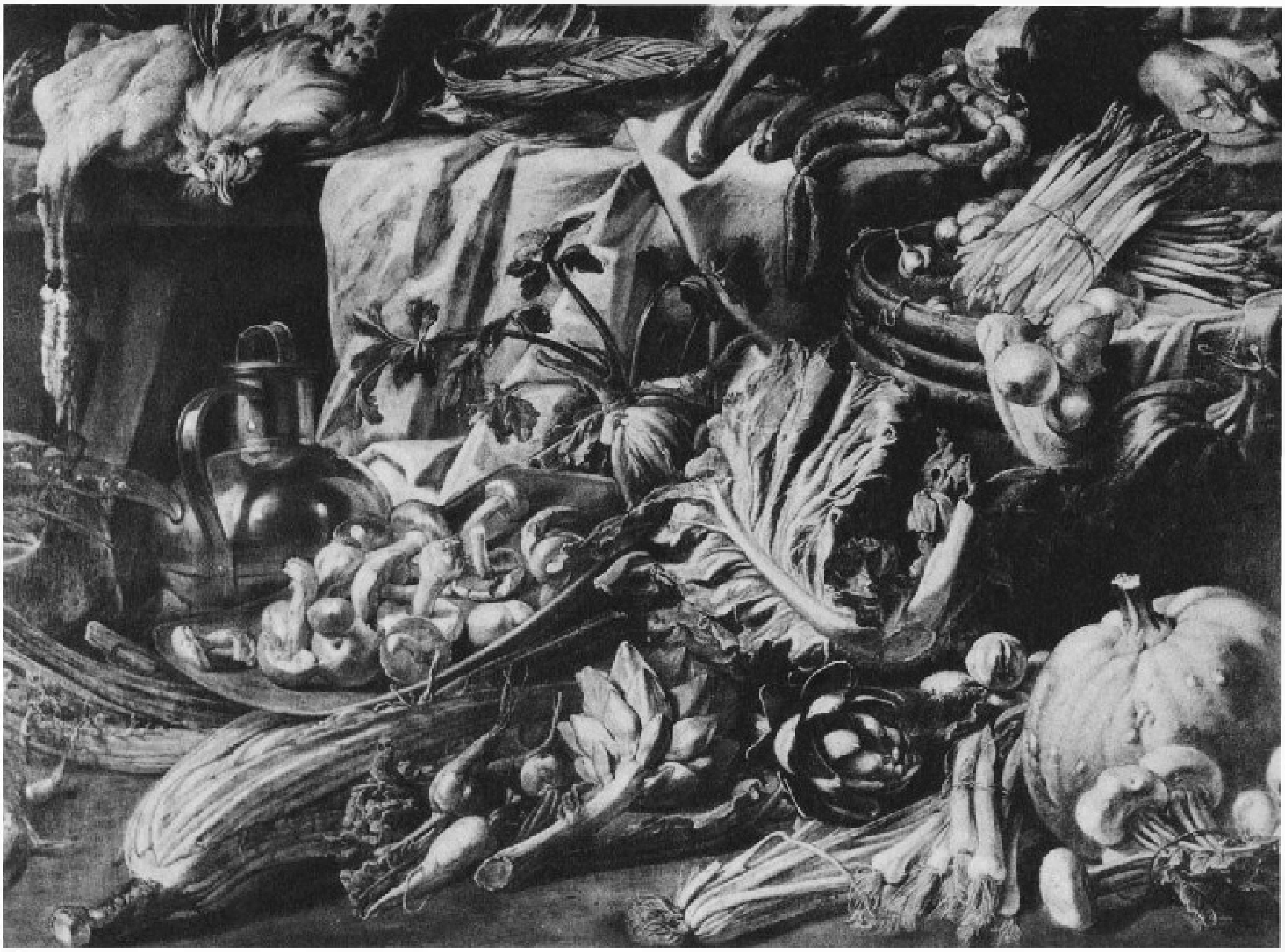


PLATE XXVI

Adriaen van Utrecht. Still life. *Brussels, Musees Royaux des Beaux-Arts de Belgique*.

For Van Sterbeeck, for Jan Fyt and his colleagues, mushrooms were a novelty like the squashes from the New World. This must have been one reason for juxtaposing them. Just as the Italians brought mycophagy to Flanders, so they may have been addicted to the new-fangled gourds. Indeed, Italian artists may have suggested to the Flemings the very theme for the paintings that we are discussing. Already in the 16th century the Italian painter Giuseppe Arcimboldo was giving eloquent expression to the same idea.

---

[87] The use in the Low Countries of *kampernoeljes* dates back at least to 1567, for we find it cited in Hadrianus Junius' *Nomendator* published in that year.

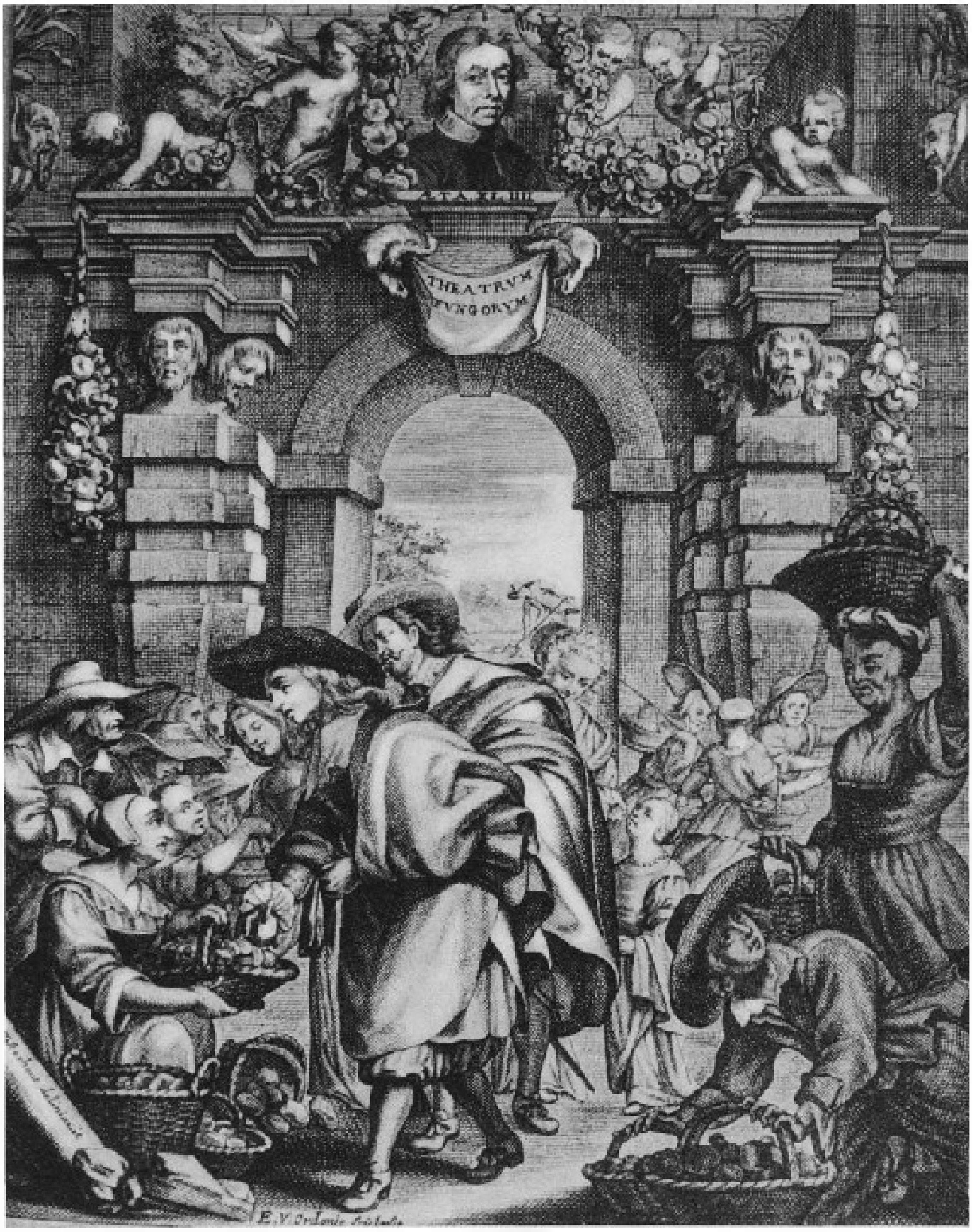


PLATE XXVII
Frontispiece to Franciscus van Sterbeeck's *Theatrum Fungorum*, Antwerp, 1675.

Arcimboldo was born in 1527 and died in 1593. He delighted in allegorical figures representing the Seasons, the Four Elements, and the cardinal points of the compass, which he would contrive to represent by an ingenious arrangement of fruits, vegetables, meats, animals, fishes, or utensils, his selection harmonizing with his allegory. We reproduce one of his paintings, a reclining figure that embodies the spirit of Autumn. Until a few years ago it belonged to a parish church near Brescia, and it now hangs in the Pinacoteca of that city, not far from Milan. However deficient Arcimboldo was in intellectual and emotional depth, he was an accomplished craftsman, and this painting constitutes a document of singular value for the ethno-botanist. Most of the vegetables and fruits are of Mediterranean provenience, including the medlars of which no fewer than four are present. The egg plant had been lately introduced into Italy from the East. The tuberoses in the figure's hair, the squashes, and the maize come from America, the first two from Mexico. The maize is of a Mexican variety also, though it could come from further south.

Our painting is undated, but perhaps we can fix with reasonable certainty the period of its execution. From

1562 to 1587 Arcimboldo lived in Central Europe, except for a visit to Milan in 1566. Both by its traditional location and by the artist's choice of vegetables and fruits, it is clear that the painting was done in Italy. From what we know about the arrival in Italy of the exotic plants that we find in the painting, it is far more likely that the artist worked on it after 1587 than before 1562. This means that it was a product of his last years, between 1587 and his death in 1593. These were the very years when potatoes were becoming known in northern Italy, and their absence from our painting favors an early date within these permissible limits. For the past half century ethno-botanists and cultural historians have been studying the impact on the Old World of the plants discovered in the New, especially tobacco, potatoes, and maize. To document the first phases of these profound innovations they have combed the writings of the explorers and historians, and searched through the 16th century herbals. The herbalist Leonhard Fuchs in his *De Historia Stirpium,* published in 1542, was the first to offer his readers a picture of maize, a woodcut. Thereafter such woodcuts appeared in almost all herbals, often copied not from life but from a preceding herbal, and often deficient botanically. For workers in this field the 16th century still-life painters offer an additional source of evidence that seems to have been ignored. We do not know whether our *Autumn* by Arcimboldo is the earliest still-life with maize, but we submit that his painting of it is incomparably superior to any pictures of maize that have hitherto been painted out from the 16th and even 17th centuries. The artist's eye was truer than the herbalist's, his technique superior to the woodcutter's.[88]

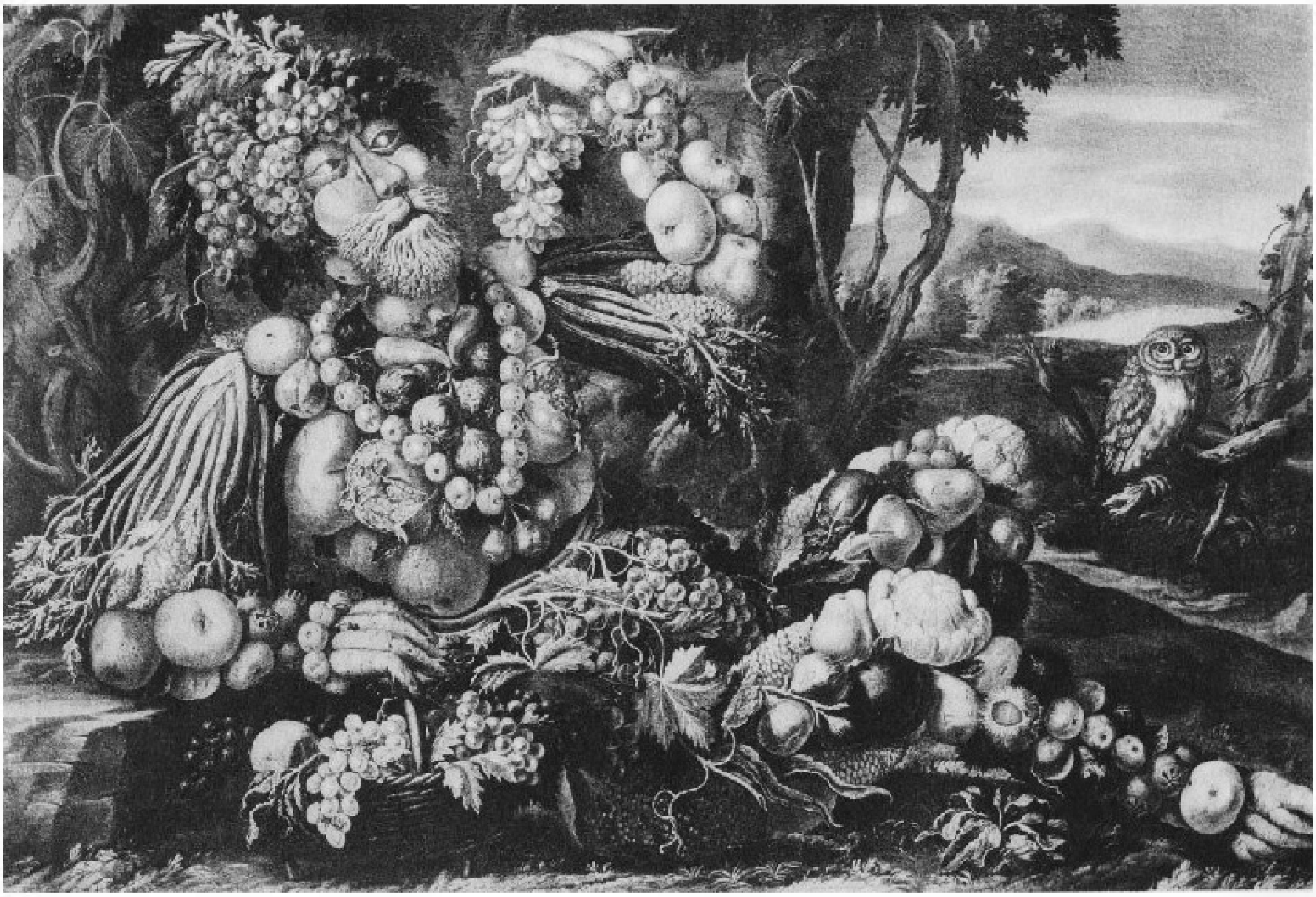


PLATE XXVIII

Giuseppe Arcimboldo. Autumn. *Brescia, Pinacoteca.*

---

[88] For data about Arcimboldo's life we have relied on Benno Geiger's monograph, *Dipinti ghiribizzosi di Giuseppe Arcimboldo*, Florence, 1954. Plates 47, 52, 54, and 69 contain mushrooms. One of these hangs in the John and Mable Ringling Museum of Art, Sarasota, Florida, and another of them is the one we reproduce. A painting by Arcimboldo that closely parallels the one in Brescia is owned by Edward James, Esq., of Chichester, England, who has kindly furnished us with photographs of it. (Geiger mentions but does not reproduce this work.) In this variant the *Clavaria* plays the same role. Instead of an *ovolo* in the thigh, we discover two *ovoli*, each constituting a cheek of the recumbent god. For the early history of maize in Europe we turned to John J. Finan's study, 'Maize in the Great Herbals', published in 1948 in the *Annals of the Missouri Botanical Garden*, pp. 149-191.

Our own interest in the Arcimboldo lies in his mushrooms. Mycophiles will be delighted with the *Clavaria* that serves the recumbent Autumn for beard and mustachios. In the middle of the left thigh is an *ovolo* or Caesar's amanita. These are the earliest mushrooms known to us that we can say are well painted, and their like was not to be seen again for a full half century. We now draw our reader's attention to the proximity of the squash to the *ovolo*, and that squash happens to be the very one that, on an earlier page, we likened in texture and shape to mushrooms. It is the squash of American provenience variously called the cymling, the patty pan, and the white bush scallop. What urge prompted the artist to place mushroom and squash together? The scallop was an exotic, but in Italy the edible mushroom was not. Must we fall back on an accidental juxtaposition as our only resort; Or do we discover here an expression, possibly only half conscious on the artist's part, of an ancient association of ideas, such as we adumbrated earlier and will shortly pursue further? But before we revert to that theme, we shall conclude our discussion of the mushroom-gourd link in 17th century paintings by briefly mentioning another aspect under which mushrooms and gourds were viewed together, the aspect that led Sir Thomas Elyot in 1541 to warn the readers of his *Castel of Helth* to beware of 'musherons, ...gourds, and al other thinges, whiche wyll sone putrefie'.

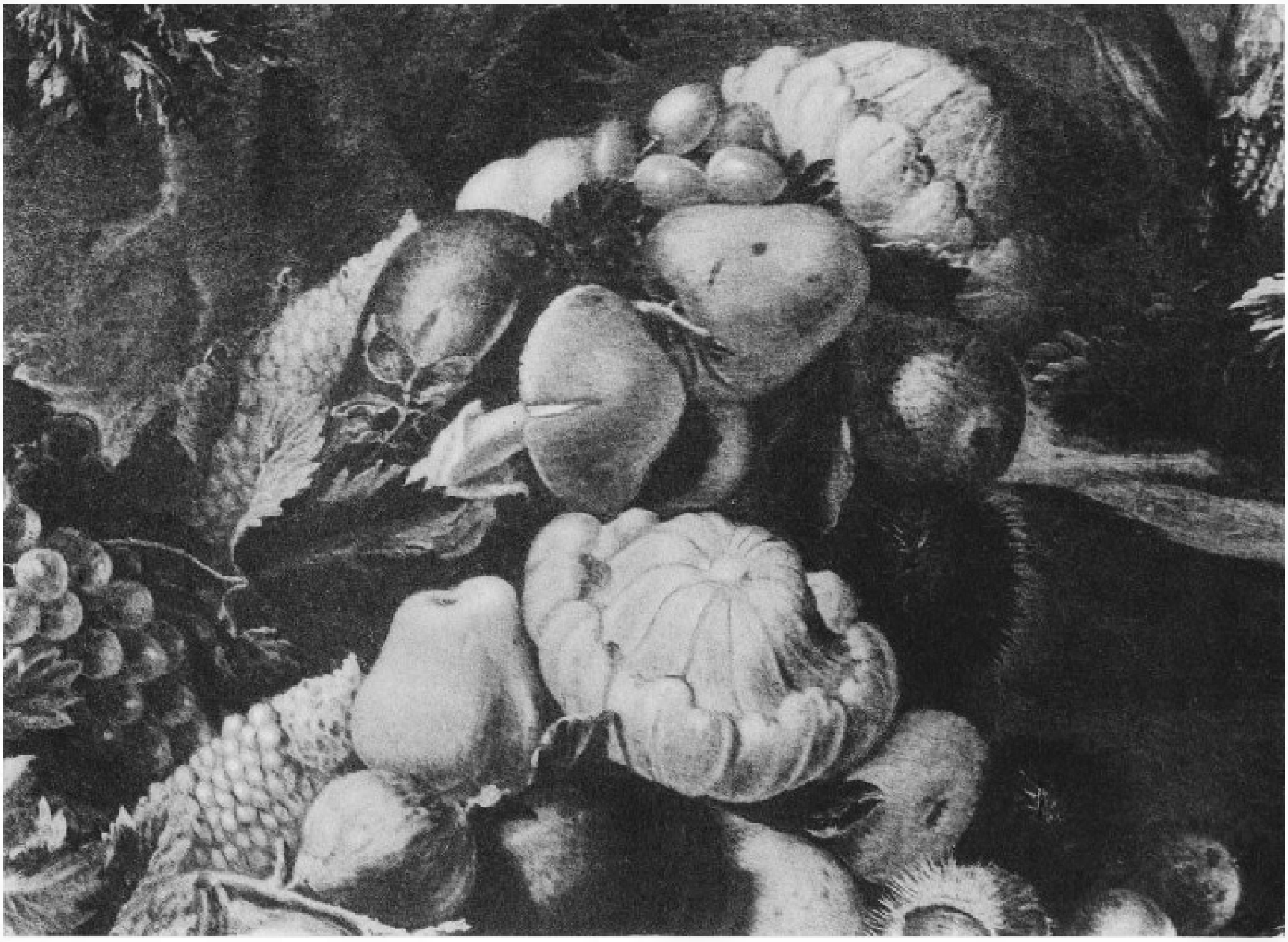


PLATE XXIX

Giuseppe Arcimboldo. Autumn: Detail. *Brescia, Pinacoteca*.

A favorite theme of some 17th century still-life painters in the Low Countries was the transitory nature of all living things, the vanity of this world as contrasted with the eternal values of the next. In a private collection known to us there is a painting by Cornelis de Heem, son of Jan Davidsz. and identified with the Dutch school, in which this *vanitas vanitatis* chord finds graceful expression. A shaft of light penetrates from an aperture above to a sepulchral setting where a lovely flower arrangement is juxtaposed to a bisected gourd and some growing mushrooms. Unfortunately we have been denied permission to reproduce this extraordinary canvas. The mushrooms are in a shadow and scarcely lend themselves to identification. They are not pictured as food, but instead as the symbol of decay and death. From the glory of the flowers in their beauty the eye passes to the doomed segment of the disintegrating melon and on to the fungal expression of the grave. In this painting putrefaction and death are the meanings that underlie both gourd and mushroom.

If we are right, there emerged in the 17th century new reasons for associating mushrooms and gourds. But the association in men's minds was far older. Some indications of this older tradition seem to emerge in the ancient writers. Take for example the work known in English as *Etymologies* composed by St. Isidore of Seville around A.D. 600. He has occasion to list the vegetables with all their names. Is it by chance that immediately after the cucumbers (*cucumeres*) and gourds (*cucurbitae*) he adds the *fungi* and *tubera* or truffles;[89] Athenaeus in the second book of *The Deipnosophists* also discusses numerous vegetable foods, and what is our surprise to discover that here also the comments on the mushrooms and truffles follow hard upon the paragraphs dealing with the gourds! It is a commonplace of reference works that the order of the alphabet constantly juxtaposes disparate words and ideas, but the alphabet offers us no explanation for the sequence of vegetables that we find in St. Isidore and Athenaeus. Pliny is yet another witness to the tie that binds mushrooms to gourds. In a sentence in his *Historia Naturalis* hitherto unremarked by commentators and ignored by the editors of Liddell & Scott's Greek lexicon, he tells us, in Book XX, in the chapter that discusses the gourd (*cucurbita*), about a wild gourd, hollow, on which he says the Greeks have bestowed the name *spongos*, a gourd growing only on stony soil, of which the walls are of the thickness of a finger, which when chewed yields a juice wholesome for the stomach.[90] Here then in ancient times is a wild gourd that shares with sponges and mushrooms a name belonging to the cluster of basic words for the fungal tribe. The dual function of *potiron* in the 17th century was a revival and not an innovation, and we believe that in the root of the Latin word *pepo* we shall find mushrooms and gourds conjoined.

Throughout the Slavic lands there is a distinctive name for the common field mushroom. It takes various forms, but in the Ukraine it is *pecheritza*, and *pecharka* (**печарка**) may be taken as a typical variant in other Slavic countries. The uniformity of this name throughout the Slavic world and its invariable application to the common field mushroom are remarkable evidences of its antiquity: it must antedate the dispersion of the Slavs and the differentiation in Slavic languages. The Lithuanians do not use the word, nor do the Germanic peoples; but the Jews of Eastern Europe have adopted it in Yiddish, and refer to a girl dressed up 'like a *pecheritza*', as an American might say, 'like a Christmas tree'. With a transposition of consonants, the word has been taken into both Rumanian, *ciuperca*, and Magyar, *csöpörke*. Its derivation has never been clear. Some have suggested that it came from *pechora*, meaning a cave, since the *Psalliota campestris* lends itself to cultivation in cellars and caves. But this is unacceptable, for the wild field mushroom does not grow in caves and its artificial cultivation began in France only after the year 1700. Others have suggested a derivation from *peek*', meaning oven, and gone on to assume that the *pecheritza* was normally roasted. This is hardly satisfying, for the field mushroom lends itself to roasting no better than other kinds, and furthermore in the whole rich mushroom vocabulary of Europe there is no other name derived from a method of culinary preparation.

But let us take another look at that Slavic word *peek*', 'oven'. It is cognate with the Greek itsztov, the Latin *pepo*, whence through the French *pepon* to the English 'pumpion'. These are all of ancient and well attested lineage, coming down to us from an Indo-European root that the French philologists Ernout and Meillet reconstruct as pek^{w}o, which became k^{w}ek^{w}o in the Italian peninsula and in Celtic. The Latin *coquo*, meaning to cook, and all its kin and progeny are of this family. Whether *cucuma* and *cucumis* belong here, we do not know, but even if they do not, a semantic blend is possible, for cookery is the common denominator of them all. Baking and roasting and cooking are the ideas that underlie the root. That which is baked rises, expands, swells, grows brown and ripe and mature. It is therefore not surprising to discover that from the earliest times the word carried a second related meaning, the idea of 'ripening in the sun'. As Ernout and Meillet say, "La notion de 'maturite' est liée à la racine depuis l'indo-europeen." Whence the application to gourds, and - we submit - to that species of mushroom, the *Psalliota campestris*, which comes to maturity in the open fields under the sun. Pumpkins and these mushrooms swell and ripen in the sun. The Provençal *concourlo*, meaning both field mushroom and pumpkin, is a breath-taking word, for in its specific application to the field mushroom we witness the toughness of a semantic theme running through long stretches of time and space.

---

[89] See J. P. Migne, *Patrologia Cursus Completus*, vol. 82, column 637.

[90] Many editions of Pliny give *somphos* instead of *spongos* as the name of this wild gourd. For our purpose the difference in words is unimportant, since they are cognate. According to the footnote of L. Desfontaines commenting on this textual question (Paris, 1829, vol. 6 of an edition with commentary by various hands, Bk. XX, Chap. VII [III]), all Pliny mss. carry *spongos*.

If our argument prove sound, we have established from evidence gathered in Eastern Europe the explanation for the link between mushrooms and gourds that crops out in the French *potiron* and in the Provençal *coucourlo*. Just as we have earlier established what we call *apogge* cluster of mushroom words, and a sponge cluster, so now we discover the existence of a gourd cluster. All three appear to go back to Indo-European roots that resemble each other and that convey the same innermost idea of a growth or swelling. But only the first of these clusters directly involves the frogs and toads. In the French word *potiron*, wherein mushrooms are called pots, metaphorically speaking, the attentive mind catches a recurrence of the semantic theme that we found in the Indo-Aryan languages, where a Sanskrit word for 'pot' or jar' has fathered numerous progeny among the fungal words of various languages, the theme of the gourd, the swelling organism.

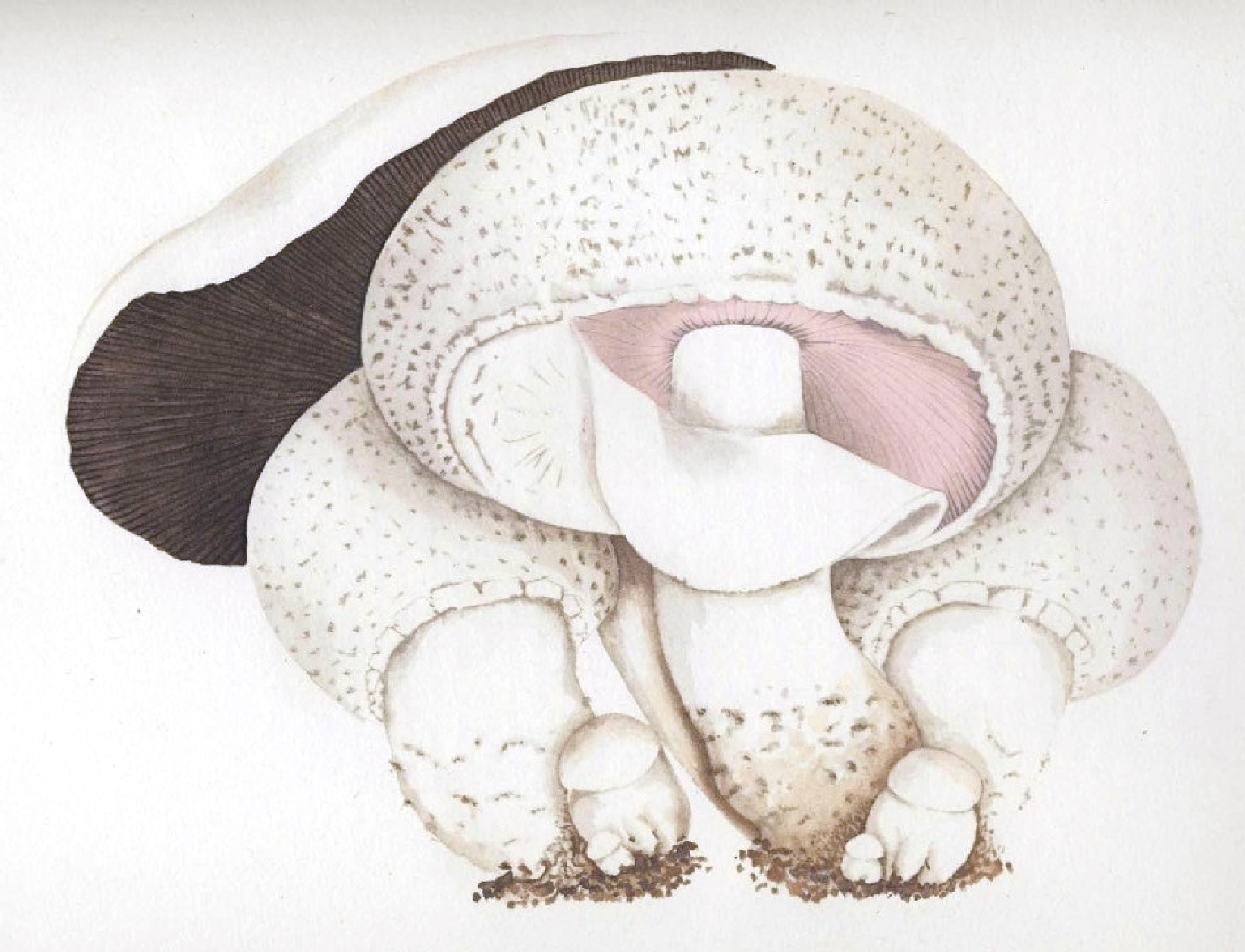


PLATE XXX
Jean-Henri Fabre
Psalliota campestris Fr. ex L. [*Agaricus campestris* (Bull.)]
English: *common field mushroom*;
French: *rose*;
Russian: *pecheritza*;
Polish: *Pieczarka łąkowa*.

Here we might end this section, were it not that in the Basque language we discover an amazing thing. In the Labourdin dialect of Basque the name of the common field mushroom is *paratxiko*, the *-tx-* in Basque being pronounced like 'ch' in 'cheek'. By a transposition of consonants we arrive at the Slavic *pecharka*, with identical meaning! This is not all. In various parts of Europe there has always been a tendency for the name of the best known species of mushroom to be used as a word for mushrooms generally. If, as seems likely, the general word used for mushrooms in Basque, *perretxiko*, is a variant of *paratxiko*, this would indicate that when the Basques acquired the word, the field mushroom was for them the dominant species. It is clear that these words cannot be native to the Basque language, for no native words begin with the letter p. In Catalonia *paratge* circulates as a mushroom name, but its specific application seems to be variable; we suggest that this Catalan word was borrowed from Basque. How then does it come about that the Basques use a word that seems to lend itself to identification with a Slavic term?

After pondering this curious question for some time, it occurred to us that the Gypsies could have borrowed the Slavic word and then, in the course of their wanderings, delivered it to the Basques. There are numerous lexicons of the various dialects of Romany, but none of them seem to have been composed by scholars interested in mushrooms. In the end we addressed a blind inquiry to that specialist in all matters pertaining to Gypsies, the Irish scholar Walter Starkie, whose experience with the Gypsies goes back over forty years. The reader will imagine our surprise and pleasure when we learned for the first time from Dr. Starkie's reply that the Gypsies are great lovers of all kinds of edible mushrooms, and that one mushroom name used by the Spanish Gypsies is *perrechites*!

This is not of course a conclusive explanation of the Basque word. We should learn more about that Gypsy term - over how much of Europe the Gypsies use it, and what variations it manifests. The fact that the Gypsies are mycophiles is important. If the fruits of recent scholarship are sound, the Basques are linguistically related to the Caucasian peoples, and all the Caucasian peoples are mycophobes; this is true at least of the Georgians, Mingrelians, and Svanetians, and of the Circassians and Ossetians and Chechens, among whom we have had an opportunity to locate informants. The mushroom vocabulary of the Basques is reasonably rich, but consists mostly of borrowed or translated words, as though they too had once been mycophobes. The Basque country has long been a habitat for Gypsies. A people like the Basques not steeped in mycophagy is unlikely to bestow on the mycophilic Gypsies an important word for mushrooms, and perhaps least of all a word that is itself a loan word in Basque. On the other hand, mycophilic sojourners in the Pyrenees might have given to the Basques some lessons in mycophagy. Our hypothesis, after we formulated it, has received startling collateral support in an observation volunteered to us by a Swedish friend, the banker Frithiof Ahren. "I have been told", said he, "that the Gypsies taught us in Sweden to eat mushrooms, in times when food was scarce."

9

From 'Panggo' to 'Pupik'

East of Moscow live a Finnish people on the Volga known as the Mordvines. In their language *panggo* is the word for mushrooms. North of them and a little to the east are another Finnish tribe, the Cheremissians, and 'mushroom' for them is *ponggo*. Beyond the Urals are the settlements of the Voguls, who say *pangkh*; and farther east, on the banks of the River Ob, dwell the last of the Finnish folk, the Ostjaks, with *pongkh*. Scholars are disposed to accept the likelihood that these Finno-Ugrian peoples have borrowed these words from the West.[91] Somewhat further to the east, in the valley of the Yenisei, the small tribe known as the Yenisei-Ostjaks are familiar with the *Amanita muscaria* and call it the *hanggo*. They are unrelated ethnically or linguistically to the Finnish peoples, but they too have borrowed the same mushroomic word.

But the diffusion of the word does not stop on the banks of the Yenisei. Far to the east of them are the Yukaghirs, a tribe culturally and geographically midway between the Finns and the primitive Paleo-Siberian tribes on the Pacific coast. According to Waldemar Jochelson, they are mycophobes, considering all mushrooms unclean, springing up from dogs' urine. They have a word for fungus, *can-pai*, of which the first element means 'tree'. Is *-pai* related to our Finnish words?

If we may digress for a moment, the pejorative association of mushrooms with dogs' urine is not peculiar to the Yukaghirs; far from it. One of the fungal words in Hindi is *kukar-muta*, 'dog's urine', and this corresponds with the Marathi term, *kutrya-cem mut*. The Jews of eastern Europe refrain from eating the mushrooms that they call in Yiddish *hintishe shvemlekh*, 'dog mushrooms', according to an informant from Chotin in Bessarabia; these are mushrooms that grow in damp places at the foot of trees, and that are believed to be contaminated by dogs. We suspect that the same idea lies behind the generic word for mushrooms of the mycophobic Ingush tribe in the Caucasus. Their word is *dzhahnuskul'*, 'dog's bride', in which *dzhali* means 'dog'. In the Germanic language of the Faeroe Islands, *hunda-land*, 'dog's urine', is a word for mushroom. For 'dog' the Poles say *pies*; the feminine form of this word, *psica*, is not used, but its plural, *psice*, is a name bestowed on certain small mushrooms, probably coprini [Note to the edition at Psilosophy: in fact, *psica* is somethimes used in Poland for feminine form of a dog (**pies**=dog) and it is emotionally tinged somehow being an obsolete insulting term for a woman meaning "bitch" just as an official feminine word *suka* possessing the same pejorative meaning, moreover all unedible mushrooms we call, among others, *psiaki*, which means small dogs - pup**pies** - but ***pies**ki* also means small dogs but this form is never used for any mushroom.]. In France fungi of this genus are known popularly as the *pisse-chien*, and we suspect that the deliquescent ink-caps underlie the other examples that we have cited. The *pisse-chien* of the French becomes the *pixacan* in the langue d'oc: we have found it in Gascon, in Catalan, and in Majorcan, and doubtless it occurs elsewhere. The ending *-can* comes down from the Latin *caninus*, of course. When we go further afield, we discover that in the Arabic spoken by the Sudanese there is a mushroom called the 'tree-of-the-dogs', *shajarat al-kilab*. Arabic scholars have been puzzled by it, but surely the meaning is clear. Indeed, the association of the coprini with dogs is not without justification. Those who care to get to the bottom of the matter will find shrewd and amusing observations on the subject by Camille Fauvel in the *Supplement* to the *Revue de Mycologie* of December 1, 1946, wherein this former Commissaire de Police and counter-espionage agent reveals his discovery that the distribution of urinals and of the *Coprinus atramentarius* in the environs of Paris is complementary: i.e., the fungi are seldom found within a reasonable range of a urinal, but abound beyond that range.

In the Kamchatka peninsula there live, among other tribes, the folk known as Korjaks. The word for mushroom in their language is *pion* - yet another example of our word. For more than two centuries the Korjaks have enjoyed a peculiar renown among anthropologists, ever since the Swedish traveler Philip Johan von Strahlenberg discovered that they eat the dried *Amanita muscaria* for its intoxicating virtue. It is to be observed that the Korjaks do not use the word *pion* for the fly agaric. This they call *wapaq*, meaning whalebone, and here is why. The tribesmen of eastern Siberia bend spits or skewers of whalebone, insert them thus into tallow, freeze the tallow, and then scatter the lumps of frozen tallow for hapless wolves to swallow. The death-throes of the stricken beasts explain the use of the word for the fly amanita, the trigger that sends men into frenzy.[92]

---

[91] The diffusion of the word for 'fungus' among the eastern Finnish peoples and eastward in Siberia to the Chukchees was pointed out by Karl Bouda in his treatise, *Das Tschuktschische*, Leipzig, 1941, pp. 35-36. He does not mention the Yukaghirs. We owe our information about them to Waldemar Jochelson's *The Yukaghir and the Yukaghirized Tungus*, published by the American Museum of Natural History, N. Y., 1926, as vol. IX in the series of the Jesup North Pacific expedition, pp. 334, 340-1, 419. For information about the Yenisei-Ostjaks, see Kai Donner's ethnological notes published in the *Memoires* of the Societe Finno-Ougrienne, vol. LXVI, Helsinki, 1933.

North of the Korjaks, in the extreme eastern corner of Siberia, facing Alaska, lie the settlements of the Chukchees, a tribe related to the Korjaks. For 'fungus' they say *pongpong* or *pompong*. This doubling of a syllable is characteristic of the Chukchee tongue. Here, then, we find the same word that we have now followed from the Mordvines in Europe across all of Siberia.

The range of this word of European origin for 'mushroom' is a breathtaking thing. What is the explanation? Why should it have stabbed its way across the frozen wastes of the North to the Bering Strait? Unfortunately we know nothing about the use of our word among these remote and primitive peoples. We do not know its precise applications in the fungal world. The lexicons say that in Ostjak and Vogul it designates the fly amanita, and this is certainly true of the *hanggo* of the Yenisei-Ostjaks. We do not know which uses of fungi are in the minds of the people when they utter these words, nor what other meanings they may carry, nor the figures of speech in which they play a part, nor their role in proverbs and folklore. We know nothing of their emotional flavor. They were not borrowed from Russian, for the Russian language possesses no word that could have been their source. We do not know whether they are associated with toads.

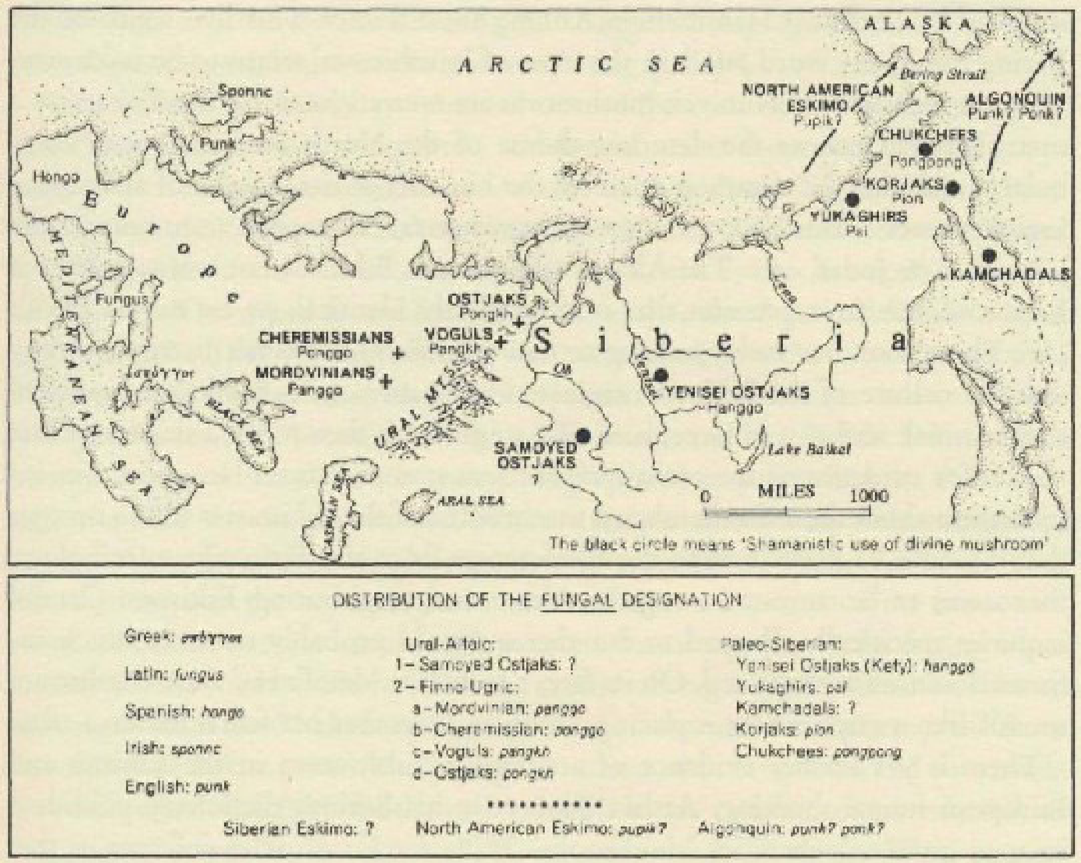

ALASKA
ARCTIC SEA
Bering Strait
NORTH AMERICAN ESKIMO Pupik?
ALGONQUIN Punk? Ponk?
CHUKCHEES Pongpong
KORJAKS Pion
YUKAGHIRS Pai
KAMCHADALS
Sponne
Punk
Hongo
Europe
MEDITERRANEAN SEA
Fungus
σφόγγος
BLACK SEA
CHEREMISSIANS Pongo
MORDVINIANS Panggo
OSTJAKS Pongkh
VOGULS Pangkh
URAL MTS.
Siberia
Ob
Lena
Yenisei
YENISEI OSTJAKS Hanggo
Lake Baikal
SAMOYED OSTJAKS ?
CASPIAN SEA
ARAL SEA
0 MILES 1000
The black circle means 'Shamanistic use of divine mushroom'
DISTRIBUTION OF THE FUNGAL DESIGNATION
Greek: σφόγγος
Latin: fungus
Spanish: hongo
Irish: sponnc
English: punk
Ural-Altaic:
1 – Samoyed Ostjaks: ?
2 – Finno-Ugric:
a – Mordvinian: panggo
b – Cheremissian: ponggo
c – Voguls: pangkh
d – Ostjaks: pongkh
Paleo-Siberian:
Yenisei Ostjaks (Kety): hanggo
Yukaghirs: pai
Kamchadals: ?
Korjaks: pion
Chukchees: pongpong
Siberian Eskimo: ?
North American Eskimo: pupik?
Algonquin: punk? ponk?

Fig. 8 - Map showing distribution of fungal designation in Europe and Asia.

---

92. Waldemar Bogoras in his treatise on the Chukchees assumes that the primary meaning of *wapaq* was 'fly agaric', the word being then transferred to the whale-bone spit used in killing wild beasts. He offers 110 supporting evidence. Since words for the divine usually recede from common use and give place to euphemisms, we suggest that the primary sense of *wapaq* was the whale-bone spit and that it was transferred as a vigorous metaphorical euphemism to the psychogenic mushroom. We know of one expression derived from fungal *wapaq*: the spirits of the fly agaric are called *wapdqual(fnu*, but as this means simply 'fly-agaric men', it tells us nothing about the origin of the word.

Clearly these Finnish and Siberian words come down from one of our three fungal clusters - the *pogge* or the sponge or the pumpkin group - or from a common ancestor. Is it possible that the word sped east long ago, along with a new technique for making fire - the use of punk for tinder. This would suggest that the sponge cluster was the source of the word. (In considering this possibility we must keep in mind that the superior virtue of the *Fomes fomentarius* for tinder was known in northern Europe in neolithic times, some 8,000 years ago. Perhaps punk was one of Europe's earliest export products.) But there is no evidence known to us to support this inviting surmise, which remains to be tested in the field. Not only should every aspect of the words for mushroom and fungus be examined, but the whole vocabulary for the primitive methods of fire-making as well - spark, tinder, flame, dust (soot), and ashes. In the course of our inquiries we have assembled straws of superficial evidence indicating a common phonetic element in the words for tinder, dust, and ashes running all the way from Europe through Siberia into the Algonquin languages. When the English colonists found the Algonquin Indians referring to ashes or dust as 'punk', could they have been confronting their own word, after a journey around the world?

By good fortune we do know that the Korjaks use punk for tinder, though we do not know their word for it. Waldemar Jochelson in his treatise on the Korjaks, page 565, has this to say:

> The ancient method of making fire, by means of a drill, is at present employed only in religious ceremonies. Since the fire-drill is esteemed as the most important protector of the family, it may be concluded that the Korjaks looked upon fire as a beneficent agent. There are sacrifices in honor of the fire; fire is also a mediator between man and the deities, since offerings are burned in it... Tinder is prepared from a fungus that grows on the stumps of birch trees. The fungus is stripped of its hard outer layer, and the inner spongy mass is boiled in water. Then it is dried, and a light, brittle, and highly inflammable punk is thus obtained.

At this point our excursion into the Arctic would have ended, had not the demon of our curiosity driven us to address a letter of inquiry to Professor L. L. Hammerich of Copenhagen, the authority on Eskimo linguistics and cultural traits. We asked him what word the Eskimos use for 'mushroom'. He replied that from Northwest Alaska to Greenland the word is *pupiki*. Here we seem to discover once again the phonetic unit that by now we know so well. Professor Hammerich went on to say that the word is used for various diseases - in Greenland for leprosy; in the Kuskokwim district of Alaska for an eruption, itch, or small-pox. (The reader will recall that Low German *pogge* is etymologically cognate with 'pox', and the European words are constantly associated with tumors and organic growths. Leprosy is often accompanied by gross physical deformities.) At Nelson Island *pupiki* is a person with small-pox. Then Professor Hammerich continues:

> In the mind of an Eskimo the word *pupik* must needs associate itself with the root *pu*, 'inflate, rise to the surface'; cf., e. g., Greenland *pue*, 'tumor'; *puak*, 'lung'; *poq*, 'inflated bag'; *puisse*, 'seal' (which pops out of the sea); Kuskokwim *pugoq*, 'rises to the surface'; *pugtartoq*, 'the seal emerges from the water for air'; and *pugtaun*, 'inflated bladder'.

The reader who has followed step by step our argument will share the excitement that Professor Hammerich's letters justify. Phonetically and semantically the information that he supplies seems to place the Eskimos with the Europeans in what we might call the same mushroom orbit. What is the explanation?

Before suggesting certain possibilities, there is additional evidence to submit, also supplied by Professor Hammerich. Among the Eskimos who live south of the Bering Strait, the word *pupik* in the sense of 'mushroom' seems to be unknown. Thus on the island of Nunivak mushrooms are *tumrat ciutait*, or 'devil's ears' - a metaphor that echoes the demonic theme of the North Sea mushroom vocabulary, and also the common name of the *Hirneola auricula-judae* of the mycologists, a species of edible tree fungus known in certain European vernaculars as the Jew's ears or Judas' ears. The Aleuts, who are not Eskimos but whose culture is Eskimoid, use an expression that is semantically identical, *quâni tutusi*, 'devil's ear'. There is current today among certain specialists in Eskimo matters a theory that the culture of the Eskimos originated in Southwestern Alaska and radiated thence north and east to Greenland. We might look then to the Eskimos of that region for evidence of the archaic mushroom nomenclature. However, our information about the attitude toward mushrooms of the Eskimos is still so meager that it would be premature to draw inferences from the distinctive terminology that seems to be current among the Aleuts and neighboring Eskimos. Careful inquiries specifically directed to our theme would probably uncover much information now unsuspected. On its face, a term like 'devil's ear' for a mushroom sounds like a euphemism replacing an older term that has fallen under a tabu.

There is yet further evidence of a common substratum in the Eskimo and European fungal thinking. Arthur Thibert in his Eskimo dictionary published in 1954 gives *tunnuksak* for 'mushroom'. Professor Hammerich informs us that this word means literally 'something like a tallowy boil'. In the old dictionary of Eskimo as spoken in Northern Alaska, by R. Wells and John W. Kelly, published in 1890, the word for 'mushroom' is *ahyo''ok*, where again the sense is 'swelling', 'boil'. Thibert also gives *puyut* in the sense of 'dried mushroom'; the Eskimo word's literal meaning is 'means of making smoke'. Do we not rediscover here the early use of dried mushrooms for generating smoke that gave to English the word 'funk'? We can carry these recurring themes to a higher plane. In the Eskimo dialect of East Greenland the earliest Danish scholars concerned with Eskimo linguistics discovered a word for mushroom that is written thus: *tarndydp poqattd*. It has been closely examined by a long series of eminent authorities: John Petersen, William Thalbitzer, L. L. Hammerich, and Erik Holtved. They agree that it means 'the hunting bag of the little robber of souls', the second element, which begins with our familiar syllable *poq-*, being the bag and the first element being derived from *tame*, 'soul'. Here then, exactly as in northern Europe, is an association of mushrooms with psychic or demonic powers.

The Eskimos thus link mushrooms with tumors, small-pox, and inflated bladders, and on another level with psychic disturbance, and phonetically we rediscover among the Eskimos words that suggest our *pogge* cluster. There are several possible explanations for this surprising parallel.

First, the word that we have pursued across Siberia to the Chukchee *pongpong* may have leaped the Bering Strait and spread across the top of America, bypassing the southwestern Eskimos. On the western shores of the Bering Strait live the Asiatic Eskimos, in cultural contact with the Chukchees. To weigh our initial hypothesis, we should ascertain the word used by the Asiatic Eskimos for mushroom. This word is not known to us, and as the Asiatic Eskimos cannot now be reached, the question remains unanswerable. Phonetically, *pongpong* could become *pupik*, for Professor Hammerich points out to us that the Asiatic Eskimo *saming*, 'wherewith', becomes *sumik* in Greenland, and the Asiatic Eskimo *tamlaxtoq*, 'brings to the shore', becomes *tulagtoq* in Greenland. But the difficulties with the loan surmise are serious. When a people absorb into their vocabulary a word taken from their neighbors, they do so to fill a specific need, and they care nothing for the etymological and semantic associations of the borrowed word. Such associations become dilute or are lost altogether, and *a fortiori* when the borrowed word has filtered through a series of languages. If, then, the Eskimo took *pupik* from the Chukchee *pongpong*, we are constrained to divorce *pupik* from the cluster of Eskimo words referring to tumors, skin eruptions, and distensible sacs with which the Eskimos themselves, with happy insight, consciously link it.

A second possibility is that the Eskimos once dwelt far to the West, in contact with peoples of European cultural stock, and took over the word and its associations intact, and then preserved them in a singular deep-freeze, until today we of European stock have re-discovered this cultural common denominator with us. Fanciful as such a suggestion sounds, serious scholars such as C. C. Uhlenbeck have discovered numerous verbal roots that seem to be identical in Eskimo and in the Indo-European languages, and have postulated a remote period of cultural contiguity between the two worlds.

Third, we must consider multiple genesis: that is, the possibility that an onomatopoeic root could spring up in more than one place in response to an identical imitative instinct. If this were the explanation, we should expect to find yet other peoples as remote culturally as the Eskimos from Europe who will be found to possess indigenous *pupik* clusters of mushroom words.

Each of these explanations, examined severally, inspires little confidence. There remains a fourth possibility.

Let us go behind the common Indo-European language that is the hypothetical ancestor of all the Indo-European tongues of today, to that earlier linguistic stratum from which common Indo-European was itself descended. The archetype of our mushroomic root may descend lineally to us and to the Eskimos, as well as those Siberian peoples that possess it, from the era before our own linguistic family was differentiated from an earlier stock. In this case the Eskimo *pupik* is not a loan word from Indo-European, nor is (s)p(h)ongo a root borrowed by Indo-Europeans from some other linguistic family. We are simply carrying back our linguistic tree to a remoter generation.

On page 109 in a footnote [footn. 70 in this edition] we pointed out that certain philologists consider *fungus* and σπόγγος as words of pre-Indo-European origin, taken originally from some lost Mediterranean language. They question the identity of these words with the German *Schwamm* and the Slavic *gamba*. The conjecture that we now offer would reconcile the apparent contradiction. We would concede that in languages remote from the Indo-European family we find true cognates of σπόγγος. We would suppose that this word, as it descended through the Indo-European line, assumed a variant aspect in the Germanic and Slavic worlds.

The persistence through many millennia of a recognizable root for the word that signifies 'fungus' would be a remarkable thing. It might testify to the singular importance of the role of the fungal world in the culture of these exceedingly remote ancestors of ours. The religious and mythological and erotic associations of the mushrooms would explain this role, associations that we are still able to detect, though today they fade from men's memories and must be sought by combing the oldest records. Furthermore, these associations are of the very kind that would explain the dichotomy between mycophobic and mycophilic peoples. Things that involve man's deepest emotions are viewed by him through a *mana* of supernatural potency. That which is tabu is both feared and loved, unclean and holy, shunned and worshipped. As the old beliefs slowly faded away, each cultural community, no longer able to maintain alive the balanced tensions of the original involvement, clung to one face or the other of the primitive emotions, either rejecting the mushroom world or embracing the strange growths with a quasi-erotic devotion.

10

Mucus, Mushrooms, and Love

Scholars have not found the derivation of 'mushroom', and therefore the field lies open for amateur inquirers. The word has circulated in English for some five centuries at least, in many forms, and the variant 'musheron' is still often heard in the United States. It is clear that the English borrowed the word from the French language spoken at court in the Middle Ages, the French word surviving in modern French as *mousseron*. Either the Normans or French showed the English for the first time that certain wild fungi could be eaten, and the need for a name for the edible fungi was met by 'mushroom'. In the course of time it has come to designate edible fungi in general and specifically the *Psalliota campestris*.

This specific use developed later, after the art of cultivating the field mushroom gave to it unique importance - such importance, indeed, that its French name, *champignon*, superseded *mousseron* as the generic word for mushrooms in France. It used to be thought that *mousseron* sprang from *mousse*, meaning 'moss', but for a long time not a single French philologist has espoused what is certainly a popular etymology, which was first propounded in print in 1651 by N. de Bonnefons, the gardener. It is clear that the present spelling of *mousseron* has come about to satisfy the popular association of ideas. Among the oldest forms of the word in French are two - *moisseron* and *meisseron* - that could not be linked to moss.[93] Both Oscar Bloch and Albert Dauzat arrive at the conclusion that the word is of pre-Latin origin - a convenient catchbasin, in the world of Romance languages, for all problem children of etymology.

Our word is not confined to English and French. Jean-Baptiste Barla, a first-class mycologist and faithful observer, reported that in the Provence, around Nice, the natives say *moussairoun* and *mousselet*.[94] The Catalans speak of the *moixerno*. The word also appears in a single dialect of Basque, in Lower Navarre, where it takes the form of *motxolon*. Wherever the word is used on the Continent, in French, Provençal, Catalan, and Basque, it designates the species of mushroom known as the *Tricholoma gambosum* or *georgii*. The dialectical variants of 'mushroom' in English have been numerous, and among them several stem back to the obsolete French forms: mesheroom, mesheroon, and mishroom. There is a Welsh form, *maesrin* (pronounced 'mice-rin'), which may have been only a bookish word, but which preserves for us the early sound as known to the Welsh when they borrowed it.

Some years ago Robert Graves suggested to us that we consider the Greek word for mushroom as the source of the French and English terms. We think he was right. Our readers will recall that in German *Schwamm* means both fungus and sponge, but that the Greeks limited the corresponding word in their language, σπόγγος, to 'sponge'. For mushroom they used μύκης, whence the science of 'mycology'. The Greek word is inextricably associated with μύζα, which in Latin becomes *mucus*, or when referring to nasal mucus, *muccus*. All these words are repulsive for us. For the Greeks mushrooms were mucoid things, slimy growths, a far remove from the Russians' 'fat of the earth'. There is abundant evidence that the Greeks were and remain mycophobes. The evolution of Greek μύκης into the Provençal, Catalan, and obsolete French words is not hard to reconstruct, so far as the first syllable goes.[95]

But this does not solve our problem, for we must still explain the ending -(e)ron of the French word. Proceeding on the surmise that it is a suffix, we sought to determine its value by assembling a list of as many French words ending with it as we could find. (It is surprising that in a language so thoroughly dissected as French no one had done this before.) Our inquiry was fruitful. The nouns ending in -(e)ron fall into three groups, according to the purpose served by the suffix. First are the words that designate an occupation:

---

[93] French philologists cite a Latin passage in the 6th century medical writer Anthimus wherein occurs *mussirionem*, standing in the accusative case. This would be the oldest citation of our word. But Professor Joshua Whatmough of Harvard has shown that it is an interpolation. Of the seven ms. sources for Anthimus, five that go back in part independently to the archetype do not include the passage in which this word occurs. Of the other two, one is an 11th century ms. and the other refers to an event that took place in A.D. 849. The evidence seems to point to the 9th century for the interpolation.

[94] *Les Champignons des Alpes*, Nice, 1888.

[95] It is necessary to assume that the Greek word passed through unrecorded popular Latin forms in *mux-* and *mix-*, sound mutations that can be paralleled in other words.

1. *bucheron*, woodcutter,
2. *forgeron*, blacksmith, and
3. *vigneron*, vine-grower.

There is a second group in which the ending is a diminutive, a variant of the diminutive -*on*, as in *ourson*, little bear, and *raton*, 'little rat'. The variant in -*ron* is used where there is need to preserve the value of the final silent *e* of the original noun:[96]

1. *aileron*, small wing,
2. *boteron*, small toad,
3. *chaperon*, small headgear,
4. *coteron*, *cotteron*, diminutive of cotte, English 'coat',
5. *courgeron*, kind of *courge* or gourd,
6. *laideron*, an ill-favored woman,
7. *lisseron*, *liceron*, diminutive of *lisse*, *lice*,
8. *mancheron*, short sleeve,
9. *moucheron*, gnat,
10. *napperon*, napkin,
11. *paleron*, shoulder-blade,
12. *pelleron*, baker's scoop,
13. *piqueron*, diminutive of *pique*,
14. *puceron*, plant-louse, aphis, and
15. *vesceron*, a small species of vetch, diminutive of *vesce*.

The third group, which is the one relevant to our argument, consists of the following words, of which no less than four refer to mushrooms:

1. *auburon*,
2. *mousseron*,
3. *potiron*, and
4. *sauceron*,
5. *biberon*,
6. *bourgeron*,
7. *culeron*,
8. *fumeron*,
9. *grateron* and *glouteron*,
10. *laiteron*, *laceron*, and *lacheron*,
11. *liseron*,
12. *longeron*,
13. *quarteron*, and
14. *secheron*.

In every instance the suffix adds particularity to a less determinate idea conveyed by the stem. The general condenses into the particular. A 'mass' noun becomes a 'countable' one.

Let us examine these fourteen words one by one. A *biberon* is a feeding-cup or baby's bottle, from the Latin verb *bibere*. A *bourgeron* is a jacket made from a material formerly called *borge*. A *longeron* is a girder that runs lengthwise. A *fumeron* is the half-burnt charcoal that gives off smoke. A *quarteron* is a quadroon. *Secheron* is the word used in the mountainous east of France to designate a meadow that is chronically parched. The *culeron* is the 'crupper loop' that passes around the horse's tail. The other words are all names of species of plants. *Grateron* (= *glouteron*) is a kind of briar. *Laiteron* (= *laceron, lacheron*) is milk-weed. *Liceron*, from *lis*, is the bindweed or morning-glory. *Potiron* is a species of gourd and a fungus. *Sauceron* is a regional word reported in the Saone-et-Loire for 'mushroom', presumably from the verb *saucer*, to sop or soak or dunk, referring to the wetness of many wild mushrooms. *Auburon* is the most interesting of all. It is current in the East, where the French and German worlds meet. It designates the *Lactarius piperatus*, and it comes down from the Latin *albus*, white. Sometimes it is written *oberon*. This is a large, fleshy, white mushroom. In a good mushroom season, when the forest floor is carpeted with an immense number of mushrooms of many kinds, the big, sturdy *oberon* dominates its world, king of its realm. From afar it can be sighted, and as the sun sets and the shadows deepen, its brilliant whiteness seems to catch and hold the light a little longer. It is no wonder that Oberon is king of the fairies. Yet so far as we can discover, no one has hitherto recognized the fungal ties of this famous character in French and German folklore, whom Shakespeare summoned to his stage.[97] In Russia the *auburon* or *Lactarius piperatus* is called the *gruzd'*, and, as we have seen on an earlier page, the *gruzd'* plays a role in Russia's fungal folklore that recalls Oberon's. Our common nouns ending in *-(e)ron* are mostly rare and archaic words. Since our etymology for *mousseron* is persuasive only to the extent that we succeed in explaining its suffix, we welcome the abundant additional testimony supplied to us by a different category of words - family names. With these proper nouns lies the primary role of our suffix, and it is precisely here that particularity is of the essence: the general term is reduced in its application to a distinctive family unit. Attributes of physique or personality, occupation, geographical origin, social status - the common nouns and place names become individualized as family names by the addition of *-(e)ron*. Furthermore, in this list we sense the common denominator that links together the three divisions of our common nouns, and find that they all belong really to a single class, not three. Our suffix, in essence, contributes particularity to the primary word. The reader who desires to arrive at the meaning of these proper nouns will consult Albert Dauzat's *Dictionnaire Etymologique des Noms de Famille et Prenoms de France*, published by Larousse in 1951.

---

[96] *Cuceron*, *cusseron*, the insect, an enemy of vegetable gardeners, seems to have developed from *cusson*, *cosson*, by a false popular analogy with *puceron*.

Bauberon
Biberon
Boucheron
Bouveron
Brosseron
Brugeron
Chalveron
Chaperon
Chaumeron
Chauveron
Chaveron
Cucheron
Fougeron
Gagneron
Goutteron
Guederon
Langeron
Legeron
Ligneron
Manceron
Mancheron
Manseron
Marceron
Marcheron
Masseron
Merceron
Moucheron
Pailleron
Percheron
Rongeron
Secheron
Vacheron

If, then, we are right in our argument, the mushroom or *mousseron* was once, metaphorically, a glob of mucus.[98] Its original meaning long forgotten, the word has shifted in status (as occasionally words do), and from its mucoid origins has become appetizing. We believe that the Basque language offers us circumstantial evidence in support of our theory. As we have seen, in the Basque dialect of Lower Navarre our word appears as *motxolon*, and it carries the same meaning as *mousseron* in French. In the Souletin dialect the same species is the *buxeti*; we trace this also to *mousseron*, for the Romance letter 'm' can become 'b' in Basque; e.g., the Spanish word for 'mill', *molino*, appearing as *borin* or *bori* in certain Basque dialects; also the French word for 'cabinet-maker' or 'joiner', *menuisier*, becoming in Soule *benuse*. In many other sections of the Basque country, *ziza* takes the place of *motxolon*, designating the *Tricholoma gambosum* and also tending to associate itself with other edible species. Thus it is a precise translation of *mousseron*. The derivation of *ziza* has never been determined. But we discover that in the Souletin dialect of Basque, *zintz* means 'nasal mucus', and is probably a word of imitative origin. Professor Rene Lafon informs us that phonetically *ziza* could be related to *zintz*. We suggest that it is derived from *zintz* or an earlier form of that word, and that it was thus a translation of *mousseron* made at a time when the original meaning of the French word was still present in men's minds. If we are right, *mousseron* appears in Basque as *motxolon*, a borrowed word, in Lower Navarre; as *buxeti*, also a borrowing, in the Soule; and as *ziza*, a translation, elsewhere. Thus, if this argument stands up under scrutiny, we provide a satisfying etymology for the Basque *ziza* and simultaneously buttress our fungal word pattern derived from μύκης.

---

[97] Oberon in English is a literary character, without indigenous roots, borrowed from the French, where he appears in Old French in *Huon de Bordeaux*. He is 'Alberich' in the medieval German poem *Ortnit*, a name that suggests the German *Alp*, 'elf'. But Jacob Grimm in his *Teutonic Mythology*, London, 1883, vol. II, p. 453, links 'Alberich' with whiteness, from the Latin *albus*, a view that, as we now discover, is reinforced by the vernacular name given to the dazzling-white *Lactarius piperatus* along the eastern marches of the French-speaking world.

[98] And also a glob of froth, if our suspicion is right that *mousse*, 'froth', has the same origin. But this word *mousse* and its homonym meaning 'moss' are so tangled together in their histories that we merely mention the possibility without arguing the case.
The obsolete *meckeron*, 'wick', 'little wick', was derived through Latin from Gr. φυτίλι, and is cousin therefore to *meisseron, moisseron, mousseron*. Surely the obsolete adjective *mescheros*, 'dirtied', 'blackened', has the same derivation and refers to the wick's snuff. Philologists have been baffled by the origin of *mâchurer*, 'to blacken with soot', and *mâchuron*, 'smudge' or 'smut' (on the face), 'smudged impression' (in printing). Should they not consider *mecheron* and the wick's snuff as the key to the etymon? The vowel change paralleles *tache*, 'stain', descended from the older *teche*.

For 'mushroom' and *mousseron* we have dared to propose an etymology and a latent meaning where scholars have been at a loss. There is another French fungal word, *le cepe de Bordeaux*, where we shall challenge the conventional etymology. The standard sources have accepted the popular notion that *le cepe* is the same word as *le ceps de vigne*, 'vine-stock', both descended from the Latin *cippus*, 'stake'. As to *le cepe*, we think the case has gone by default, the philologists having admitted a popular etymology by inattention. The *Boletus edulis* does not suggest a stake, nor has such a metaphor any parallel in the fungal vocabulary of Europe.

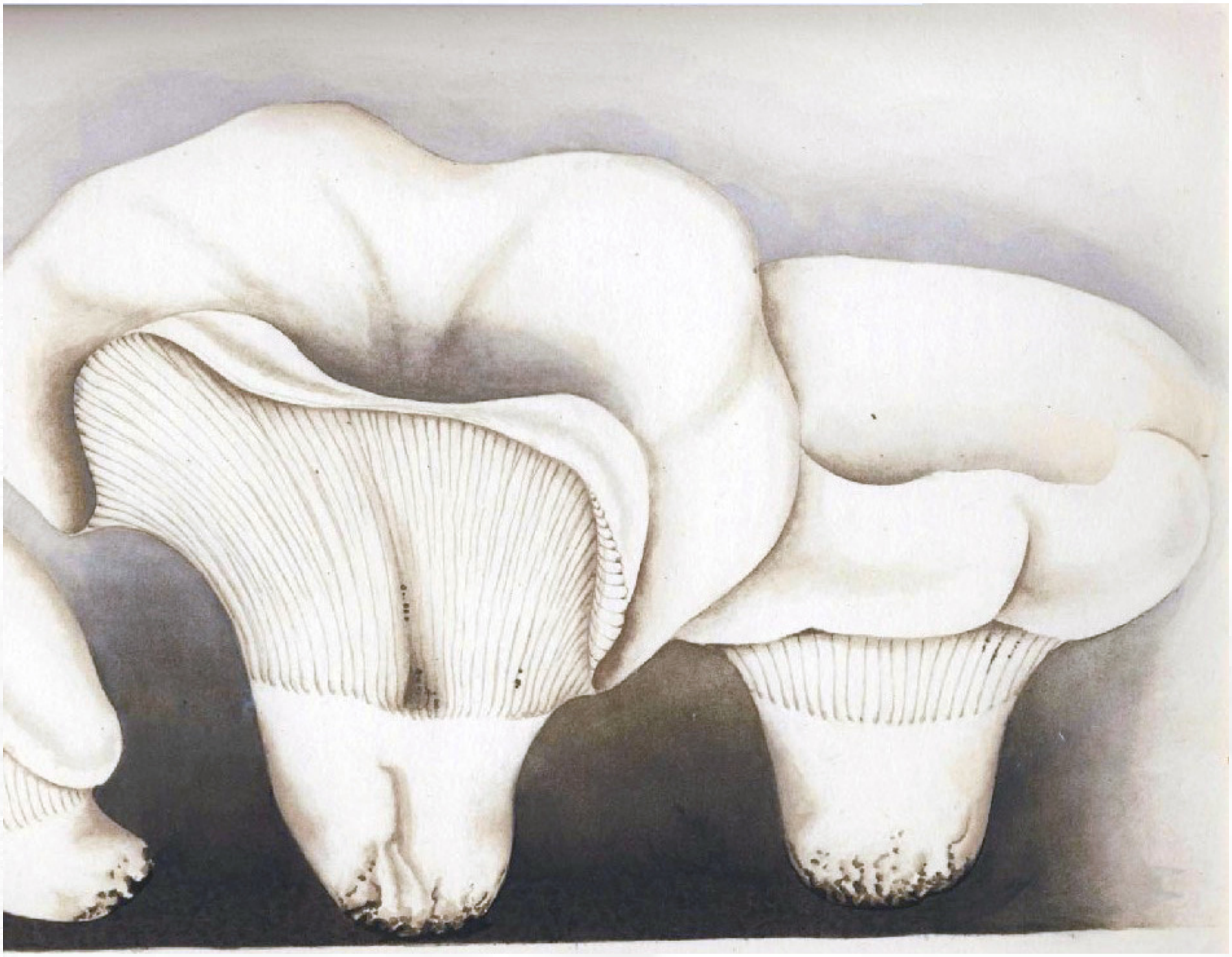


PLATE XXXI
Jean-Henri Fabre
Lactarius piperatus Fr. ex Scop.
French (east): *oberon*;
Russian: *gruzd'*;
Polish: *Mleczaj biel*.

We know much about the role of the *Boletus edulis* in the social history of Western Europe. The Romans called it the *snillus*, 'swine-mushroom', a word that apparently survived as *silli* in the dialect of Naples down to the end of the 18th century.[99] In standard Italian it is the *porcino*, 'porcine' mushroom. Why these names? Some say the mushroom in its appearance suggests the swarthy, rotund rear-end of a porker. Some point to its greasiness when cooked fresh: it exudes quantities of viscid fluid that gastronomes associate with rich, melted butter, but that to mycophobes suggests loathsome mucus. When dried the *Boletus edulis* tastes like meat, which explains the addiction to it of the monks in the Russian church during the long fasts. We have seen how the Flemings began to eat ceps in the 17th century, a cultural innovation inspired by Italian merchants. The progress of the cep in the kitchens of the great elsewhere was slow. We have combed upwards of a score of French cookbooks of the 17th and 18th centuries and found no mention in them of the cep, though they all speak of morels, truffles, *champignons*, and *mousserons*. Brillant-Savarin ignored it, but he ignored all mushrooms save truffles. The earliest French writers on fungi laid no stress on its culinary virtues. Clusius in

---

[99] See Jean Jacques Paulet's *Traite des Champignons*, Paris, 1793, p. 44.

1601 described it without embellishment as a species belonging to his Genus XX of the edible mushrooms. He said the Germans called it *Btiltz*, a Germanized form of the recently borrowed Latin *boletus*. Clearly the word met the need for an appetising name for mushrooms that were being eaten for the first time. Later *Pilz* came to embrace the whole edible mushroom world, and the *Boletus edulis* is today the *Steinpilz*. No one seems to have explained why this mushroom is likened to a stone. Do we have here an evasive substitute for a lost '*Schweinpilz*'? Clusius gave *vargdnya* as the Magyar name, and he added that it was obscene. Today this word still circulates but its obscene association is lost. Perhaps it suggested *valag*, 'arse', of which we may have caught an echo in *suillus*. We shall revert to Clusius' curious remark about obscenity on a later page. Just as baffling is his statement that in French the cep in his day was called *materaz*. This is a hapax legomenon that both mycologists and lexicographers have overlooked. In what provinces, in what classes, did it circulate?[100]

Cepe entered standard French late. Its earliest known appearance in print was in 1791, in Pierre Bulliard's classic *Histoire des Champignons de la France*, where he mentions *cepe* as a provincialism for the edible boletus. In 1835 the French Academy placed on it the stamp of its approval by admitting it to the edition of the *Dictionnaire* published in that year. There are regions of France where it is still unknown. It entered French from the Gascon dialect, and its diffusion in the 19th century may have been encouraged by a profound man-made change in the ecology of that province. In the late 18th century the French engineer Nicolas-Thomas Bremontier undertook to fix the shifting dunes of the Landes, south of Bordeaux, by planting them to conifers. While ceps are mostly associated with deciduous trees, the variety pinicola lives in symbiosis with conifers. Was Bremontier's famous achievement responsible for a surplus of ceps which, funneled through Bordeaux, reached the Paris markets and became the *cepes de Bordeaux* of today?

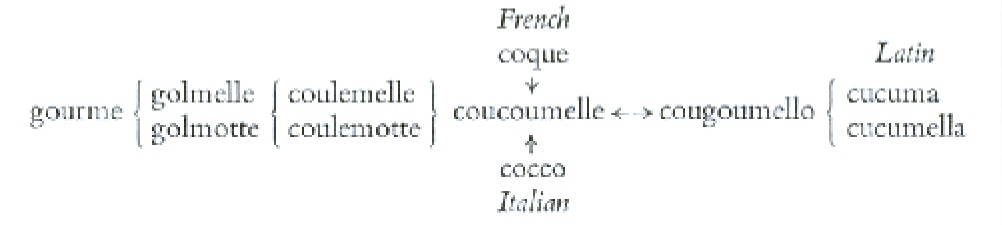
Among the mycophagous Gascons the parent word of *cepe* carries two meanings. It is the specific name of the *Boletus edulis* and it is a general term for all mushrooms. Here is one more instance where the dominant edible species has given its name to the whole fungal race. The word in Gascon takes two forms, *sep* and *set*, and this leads us at last to consider the etymon for *cepe*. In Spanish there are two general words for 'mushroom', *hongo* and *seta*. Today in Castilian the two words are synonyms, but from the early dictionary compiled by Sebastian de Covarrubias and published in 1611 we learn that at that time *seta* meant the *hongo de puerco*, i. e., the *porcino* or *suillus*. In short its meaning was identical with the specific meaning of the Gascon *sep* or *set*. The Spanish word circulates up to the very borders of Gascony, and thus the areas of distribution are contiguous. There is a further relevant fact: the word for the *Boletus edulis* is not the only fungal term shared by Gascons and Spaniards. A Spanish word for the puff ball, *bejm*, is also the Gascon word, and this points to a common background of the two peoples in mushroomic matters. Juan Corominas traces the Spanish *seta* to a Greek origin, σήπτα, 'rotten things', to which the English word 'septic' is kin. The name for the cep in classic Greek does not survive, and the way is open for us to suggest that σήπτα already carried its mushroomic meaning before it was borrowed by Gascons and Spaniards. It must have been a learned word of physicians and naturalists steeped in the lore of Dioscorides and Nikander, and it would have reached Gascony, with other Greek cultural contributions, from the Greek colonies in the Gulf of Marseilles, ascending the Rhone valley and crossing westward by the water-ways to the Bay of Biscay. We do not contend that the Gascons borrowed *set* from the Spaniards, nor that the Spaniards borrowed the Gascon word, but that both came from the same source, borrowed concurrently.[101] We have pointed out that the Greek μύκης likened mushrooms to mucus. Semantically the Greek σήπτα likens the cep to putrid things and to pus. There is a kinship here: thus in French the word *morve*, nasal mucus, according to the most eminent philologists comes down from the same source *asgourme*, 'pus'. The ancient background of *seta* and *set*, of *cepe* and 'cep', is now forgotten, and the mushrooms that they designate have risen to high esteem, like *mousseron*, but all these words carry concealed the curse of their mycophobic conception. It is unkind, but piquant, at this late date, to expose their original sin. As for the *cepe de Bordeaux*, we believe that all those who relish the innocent delights of pedantry may safely speak, in place of *cepes*, of *setes*; or, to be more precise, since *cepe* is a Parisian misspelling of a Gascon *cep*, we will say *les sets de Bordeaux*.

---

[100] Van Sterbeeck in his *Theatrum Fungorum* quoted *materaz* from Clusius, but Jean Bauhin, the French contemporary of Clusius, ignored it. *Materaz* was a variant spelling of *matras*, a familiar word in medieval French. It meant (a) one shape of distiller's flask, and (b) in archery, the particular kind of blunt head for the 'bolt' or arrow used with the cross-bow when the purpose was to stun and incapacitate an enemy or animal without penetrating the armor or hide. We have found no *matras* of either kind that suggests a cep.

[101] For the etymology of Sp. *seta* see Juan Corominas' note in *Romance Philology*, Nov. 1947, pp. 97-100. For *cepe* see Jean Seguy's magisterial treatment of the Gascon fungal vocabulary in vol. I of his *Atlas Linguistique de la Gascogne*, maps 193-201, especially those dealing with *cepe* and *champignon*. In certain sub-dialects of Gascony the terminal *p* of a Latin etymon becomes *ts* in the Gascon plural; e. g., French *coups* appears as *cots*. Our initial supposition that the variation between *sep* and *set* was traceable to this phenomenon collapsed when we discovered from Seguy's maps that the distribution of the two forms did not correspond at all to those sub-dialects. We suggest that the alternation between *p* and *t* in *sep* and *set* marks a variable survival of the *p* and *t* of the Greek etymon σήπτα, plus contamination with the *ceps de vigne*. For the cultural background of Greek words in Gascon and Spanish the authoritative study in Walther von Wartburg's paper, 'Die griechische Kolonisation in Südgallien und ihre sprachlichen Zeugen im Westromanischen', in *Zeitschr. f. rom. Phil.*, LXVIII, 1952, pp. 1-48. He does not mention any fungal words.

In certain localities of France the *Amanita rubescens* is called *golmotte* and in certain others *golmelle*. Perhaps the root of these words, *golm-* was originally *gorm-*, and if this surmise prove right, then here we have further examples in French of mushroom names nourished on pus. In words of this kind, which live out their lives in humble currency, on tongues of country folk rather than on the written page, remote from the cerebrations of book-men, all sorts of 'contaminations' and blends take place, through semantic or phonetic associations that are hard to trace. Take *golmelle* and *golmotte* as examples. Let us assume that *gourme*, 'pus', is their point of departure. By gradations, and probably under the pressure of lateral influences, these words pass through a spectrum of identifiable shadings until they emerge as the Provençal *cougoumello*, already discussed on an earlier page:



We have discovered no evidence that the detached attitude of the Greeks toward the fungi, which they expressed by calling them globs of mucus, was ever associated with toads. But the figure of speech latent in their word suggests certain names for toads current among the northern peoples. The Welsh *llyffant* seems to be cognate with either 'slime' or 'lymph' - it makes little difference for our purpose, for both would refer to the mucoid secretion of the toad's epidermal glands. There was an Anglo-Saxon word for toad, *yce*, which survives to this day through collateral descent in the Low German *utze* and the High German *Unke*. These words appear to be related to the Latin *uvidus*, moist, and are thus semantically parallel to the Welsh term. In the vast reaches of uncharted cultural history - who knows; - the mucus-exuding toad and the glob of Hellenic mucus that the English call a toadstool may have mingled in the thoughts of men.

Now we arrive at another area in Europe's mushroom vocabulary where a theme semantically related to mucus may survive. We refer to the neglected problem presented by the word 'morel'. In French this is the *morille*, in Catalan *murgula*, in German *Morchel*. The Romansch *murachel* or *burachel* (with the stress on the second syllable) is another form. Western philologists assert that these words come to us from the Old High German *morha* and its diminutive counterpart, *morhila*, both of which are known to us only in the sense of 'carrot' or 'parsnip'. The semantic link with carrots or parsnips is an unhappy one and hardly persuasive. The Western philologists who have considered the problem seem not to have stretched their inquiry to embrace the Slavic field. We do not believe that the morel was called a parsnip, nor the parsnip a morel. We believe that both owe their names to the same antecedent metaphor, phallic in inspiration. There is a single name for the morel throughout the Slavic area, and the Russian *smorchok* may be taken as representative of the various forms that the word assumes. Slavic philologists are agreed on its origin. They say its root is *smurk*, and semantically it is associated with sniffling, with resin in the tree, with a water-spout. The Russian verb *smorkat*' (**сморкать**) means to blow the nose. The Slavic root is derived from a hypothetical Indo-European root, *[s]mer*, denoting an oily or buttery or resinous or viscid exudate. It is exemplified by the English word 'smear', the Scandinavian *smjor*, meaning 'butter', and the Greek αλείφω, 'ointment'. If 'morel' and the other Western names for this fungus are not genetically identical with the Slavic word, we are faced with a surprising accidental similarity between the two names for the identical fungal species.[102] Surely a more sensible explanation is at hand. In his beautiful monograph on the aphrodisiacs entitled *Paneros*, Norman Douglas pointed out that both carrot and parsnip were formerly esteemed for their love-inciting virtue, and is it not reasonable to suppose that the Old High German *morha* and *morhila*, like the phallic 'morel', were verbal progeny of the same erotic root?

We have suggested that the specific name in ancient Greek for the morel was μύκης a word that we think doubled for 'morel' and 'mushroom' generally. Here let us recall a curious episode told by Pausanias in his *Description of Greece* which reminds us of the idea lying behind *smorchok*. Pausanias offers his readers a legendary explanation for the founding of the famous city of Mycenae. It seems that Perseus chose the site. "Perseus was thirsty, and the thought occurred to him to pick up a mushroom [μύκης] from the ground. Drinking with joy the water that flowed from it, he gave to the place the name of Mycenae." This is a false popular etymology for the name of the city, but the story itself, attributing a life-giving fluid to the mushroom, reminds us of *smorchok* and its congeners, and links them semantically, though not etymologically, with the Greek μύκης. We feel sure that μύκης here meant 'morel'. In the light of the evidence developed on earlier pages, it is singularly appropriate that our eponymous hero should found his race by imbibing strength from the phallic mushroom. Fortifying our argument, Ovid in *Metamorphoses* VII: 392 recalls the legendary origin of Corinth: "Here, according to ancient tradition, in earliest time men's bodies sprang from mushrooms":

> ... hie aevo veteres mortalia primo corpora
> vulgarunt pluvialibus edita fungis.

Fungis here stands for μύκης and μύκης for 'morel'. The children of Corinth, like the children of Mycenas and of Rome, are sprung from the fungal phallus, from the fire-born tinder quickened into flame by the touch of the divine spark. Corinth was a center of the sun-cult, and it is fitting that the children of Corinth should owe their genesis to the μύκης.

We have seen on an earlier page that 'spunk' in English is a name for the seminal flow of the human male, that the ordinary mushroom stipe sunk in the pileus is the symbol of the sexual act, and that the Greek μύκης means not only 'mushroom' (or 'morel') but the *membrum virile*. Perhaps the same idea lies enfolded in the Indo-European root of the Russian *smorchok*. There is a Norwegian word, *troll-smor*, or the demon's butter, for the yellowish slime-moulds that are often found spilling over rotten stumps and that scientists call 'myxomycetes'. We find the identical fungal figure of 'demon's butter' in the non-Indo-European Burushaski language: *pfute maltas*, the first element meaning 'demon'. It is our suggestion that 'butter' in such fungal words scarce conceals the erotic meaning, corresponding to the erotic vulgarism *frontage* in the French *langue verte*, and the special meaning of 'spunk' in England. In low English 'cheese' is the designation for smegma. In Syriac there is a word for 'mushroom', *s^{e}mama*, that C. Brockelman in his *Lexicon Syriacum* (1928) derives from the Greek words for 'ointment', 'unguent': a|i^[jLa and ojjLvjy^a.

In Russian the word *nasmork* (**насморк**) (with stress on the first syllable) designates a cold accompanied by a running nose - the French *chandelle*. According to Dal', the Russian lexicographer, impudent Russian seminarists used to refer to an *arkhierejskij nasmork* (**архиерейский насморк**), 'archpriest's rhinitis', when speaking of gonorrhoea.

The full sweep of the erotic associations of the fungi in men's minds emerges with laconic clarity in Pliny's description of them in Book 22, Chapter 46 of his *Natural History*. Indeed his few words touch on almost all the scatological and genito-urinary aspects of our subject that we have had occasion to uncover, a prescient precis of this aspect of our subject written eighteen centuries ago. The Elizabethan translators, culturally far closer to the Romans than we, sometimes caught overtones that our modern scholars, with all their erudition, miss, and therefore we supply Philemon Holland's expansive rendering of the passage in Pliny, and we underline the words that may refer to the seminal fluid:

---

[102] The name of the morel seems to have invaded various non-Indo-European languages. Clusius tells us that in his time the Hungarians called this mushroom *szemerchyek*, obviously a borrowing from Slavic. In the 12th century Maimonides writing in Hebrew refers to some sort of fungus, possibly a morel, by a word having the root SHMRQ', which we think must be a borrowing, but precisely whence and when and by what channels?

> Volvam enim terra ob hoc prius gignit, ipsum postea in volva, ceu in ovo est luteum ... Origo prima causaque e limo, et acescente succo madentis terrae, aut radicis fere glandiferae: initioque spuma lentior, dein corpus membranae simile, mox partus.
>
> And in truth, before that the Mushrome is formed, the earth bringeth forth a certain pellicle or coat first, called in Latine Volva; for this purpose, that the Mushrome should lie in it: and then afterwards shee engendreth it enclosed within, much like as the yolke of an egg couched within the white ... Moreover, these Mushromes take their first original and beginning of a slimie mud, and the humor of the earth that is in the way of corruption: or else of some root of a tree, and such for the most part as bear Mast. *It seemeth at the first, as if it were a kind of glutinous fame or froth*: then it groweth to the substance of a pellicle or skin, and soone after sheweth the Mushrome indeed, bred, formed and consummat within, as beforesaid.

Sensitive as is Philemon Holland's rendering, we think that in Pliny's own words our ear detects, clear albeit faint, a double layer of meaning that escaped the English translator. Pliny mentions no particular kind of tree, such as the oak. He links mushrooms with such trees as bear 'mast', i.e., acorns. The acorns are the thing. His word is *glandiferce*., 'acorn-bearing'. Already in Pliny's time the word for 'acorn' - *glans* - also designated the glans penis. This we know from the writings of his contemporary, the physician Celsus. It was natural for Pliny to place mushrooms, soaked as they were with erotic meaning, at the foot of trees yielding equally erotic acorns. The ancient association of ideas survived into the 17th century when John Parkinson referred to the glans penis as 'the nut of the yard'.

At this point in our argument the reader may protest that our interpretation of Pliny's text is over-bold. But before he leaps to his conclusion let him consider the following evidence. We have seen that in the Greek mind 'mucus' and 'mushroom', μύζα and μύκης, were yoked together, perhaps with the morel playing a phallic role as an intermediary. We have seen that the word for mushroom also meant the *membrum virile*, and if our interpretation of the Etruscan mirror is sound, the mushroom and *membrum virile* were intimately associated with the making of fire. We now call to the reader's attention certain further semantic associations with fire that link together the two Greek words. The word for mushroom also meant the half-carbonized end of a wick, which in English is called the snuff - a word with nasal ties. This half charred end of a wick is of course tinder. The Greek word for mucus also meant the nozzle of a lamp. This same Greek word for mucus crops out in Latin as *myxa*, and in Latin it meant 'wick', and we discover that in Latin *fungus* was the snuff of a wick. The Latin word for 'wick' in turn gave to the French their *meche*, and from the French the English acquired 'match'. Why should the match that we strike come down to us from Greek words for mucus and mushroom? Why this persistent association between fire on the one hand, and mucus and mushrooms on the other, with the *membrum virile* also playing a role in the same affair? In low English 'wick' is still potent with erotic meaning, as the English soldier lets us know when he 'dips his wick' or complains that someone 'gets on his wick'. The cap of a morel suggests a burnt clump of tinder, and what is a nozzle but a 'cock'? Both 'nozzle' and 'schnozzle' are variants of 'nose'.

For the burnt end of a candle-wick the Spaniards have two expressions: *moco de pábilo*, 'mucus of the wick', and *seta*, the word for mushroom that Corominas traced to the Greek word for putrid things. In French the corresponding word is *moucheron*, from *moucher*, meaning to snuff and to wipe the nose. When a lighted candle sputters and gutters because of the presence of a foreign particle, called in English the 'thief' or the 'stranger', the French speak of it as the *champignon*; and the French call a running nose a *chandelle*, or candle. In English until modern times the burnt end of a candle-wick was a 'snot', but when this word in its primary sense fell into disrepute around A.D. 1800, its place was taken by 'snuff'. The Danish verb *snyde*, from the same root as the English 'snot', means both to snuff a candle and to wipe the nose; and the Dutch *snotneus* is an old-fashioned oil lamp with a long spout. But in the Germanic languages the fungal association seems to be absent. We have mentioned the word for 'mushroom' in Syriac, *s*^{e}*mama*: we now point out that it carries the additional meaning of 'lamp black'.

Here then is a persistent association of ideas, triangular in design, between mucus, mushrooms, and candles or lamps. Like the candle-wick itself, the ideas are plaited together, weaving in and out in a slow measure down the centuries. It is easy to see why the mycophobic Greeks regarded mushrooms as globs of mucus. But why the lamp nozzle? Why the burnt end of the wick? Why the candle?

Perhaps the reader has already discovered the common denominator that underlies these disparate ideas. Relying on certain straws of evidence, we have conjectured a deep-seated semantic association between nasal mucus and seminal fluid. The primary use of the fungi among the primitive Europeans was for the making of fire, a rite instinct with sexual associations. The Greek member of our 'sponge' cluster, σπόγγος, was deprived in Greek of its other meaning of 'fungus', and we discover its normal fungal meanings in [ifoojc;, semantically yoked with the *membrum virile* and a burnt lamp-wick, a word adapted from λάμπα, meaning 'mucus' and also 'lamp-nozzle'. In the burning candle guttering with heat, in the dripping nozzle of the hot antique lamp, we discover the supreme figure of dynamic sexual metaphor, wherein the discordant ideas of mucus and fire are suddenly and boldly reconciled. In Hungary there are to this day women mindful of their reputation who will refrain from offering a light for a man's cigarette, lest their act suggest an improper invitation. Early in 1955 a late evening television program on channel KABC in Hollywood was abruptly discontinued because of public protests that it offended decency. In it a statuesque blonde called Voluptua would prepare for bed while she chatted invitingly with a man offstage. Just before slipping into her big bed, she would breathe on unlighted candles and they would leap into flame.[103] When Rabelais' Friar John, near the end of Book V, swears by the faith of a Lanterner, the attentive reader has learned to catch the meaning, for Rabelais has made a great play with lanterns and candles in this book, especially in chapter 33, where the Queen is served a huge stiff flaming taper of white wax somewhat red at the end, and everyone else has flaming *chandelles*. 'Heaven knows', says Rabelais, 'what a glorious light they gave.'

As we have already said, the Greeks did not link mushrooms with toads but instead with lamps. In Egypt we discover that lamps, in turn, were linked with frogs. (We seem forever discovering new permutations of the same symbols.) For the Egyptians the frog was a symbol of Hiqit, goddess of birth and rebirth, and in various collections of Egyptian artifacts are to be found lamps in the shape of frogs dating from the early centuries of the Christian era.[104] On these lamps is written in Greek: 'I am the resurrection', and sometimes they bear a cross. They appear to have been artifacts of an heretical sect denounced in the Code of Justinian under the name of Batrachitse, but their batrachian error was certainly of pre-Christian lineage. Just as in Greece the mushroom and the lamp stood for the engendering of life, so in Egypt a similar message found expression in the frog-borne flame. Toads are of the order of frogs, of course. The womb that lies behind certain names for the toad and toadstools in northern Europe reappears in the frog-womb of the Egyptian cult.

Some of the terms of the science of mycology are neo-classicisms, the inventions of modern workers in the field. But others perpetuate ancient usage. In Pliny's text we have discovered that 'volva' was already familiar to him as the designation of the cup out of which some mushrooms grow. Do not the 'ring', the 'veil', and the 'hymenium' belong to the same vintage? Here are sexual metaphors applied to mushrooms that reinforce our argument, and what an astonishing concentrate of sexuality they all evoke! If we are right about the sponge cluster of fungal words - *Schwamm*, *fungus*, *gomba*, and σπόγγος - they enfold within themselves the idea of the womb. The Greeks in μύκης substituted for the womb the idea of the phallus. The French, by some quirk in cultural history, followed the Greek example, preferring *mousseron* to a derivative of *fungus*, and in the second element of *champignon* is the same phallic idea latent? Not etymologically, of course, but by phonetic association. Gastronomically the Greeks, as we said, were mycophobes. Their interest in the fungi was less aural and gustatory than erotic. In Arabic the basic word for a mushroom is *futr*, as we saw on page 127, with the initial *f* by normal mutation often yielding place to *p*. The Arabists seem in no doubt about its etymology: it comes from the verb 'to split', 'to cleave', and they suggest that this recalls the breaking of the earth as the mushroom emerges. But so jejune a notion does less than justice to the virile Arabian mind. Here also we think we detect a metaphor of generation, probably at the deepest layer onomatopoeic in origin, paralleling in sense and sound the Greek φιτύω, Latin *futuere*, and French *foutre*, though etymologically unrelated to these.

Mushroom, candle, nose: down to today these metaphors have retained their phallic potency. The phallus is called a mushroom, and on certain mushrooms even mycologists bestow phallic names: the *Phallus impudicus* and the *Mutinus caninus*. A learned friend of ours, always on the alert on our behalf for tidbits of fungal knowledge, was thumbing one day through a native Pashto dictionary, when in its pages he came upon a name, not Pashto but Persian, for a mushroom, small and edible but not otherwise identified: *qabih-ker i xarak*, which means the *Phallus erectus* of a jackass. A few months later he came upon the exact equivalent in Pashto: *xargina*. In Sudanese we find a mushroom called *zibb al-wata*, 'penis of the earth', and in Persian the identical fungal metaphor is *kulahi zamin*.

---

[103] *New York Herald Tribune*, February 2, 1955, p. 14.

[104] See *La Revue Critique d'Histoire et de Littérature*, New Series, vol. VII, 1879, report on sessions held Feb. 21 and 28, pp. 175 and 199.

There must be many such terms that have escaped the nets of word-collectors. For metaphorical usage in the reverse order we find ample documentation, notably in the *langne verte* of France as captured and delicately served up in Alfred Delvau's *Dictionnaire Érotique Moderne*, an undated work published in Bale. To one Alexander Pothey he ascribes this ditty on the *champignon de couched*

Si son champignon Ressemble
a son piton [nose], Quel
champignon -gnon, -gnon,
Qu'il a, Gandon -don, -don![missing footn. reffer. at the original page][105]

In the early days of motor cars the accelerator was called in French a *champignon*, and 'to step on the gas' was *ecraser le champignon*, an expression that French gentlemen hesitated to use in the presence of ladies.

As for *la chandelle, elle brule, elle coule, et ensuite elle fond*. It is noteworthy that in this erotic sense, only *chandelle* is used and never *bougie* nor *cierge*. Thus when a Frenchman with generous courtesy disclaims knowledge of an alleged adulterous liaison, he is almost certain to remark that *il ne tenait pas la chandelle* - an observation that refers to either of two degrees of intimate knowledge. Shakespeare knew well this double meaning. In *The Merchant of Venice* Lorenzo addresses his mistress:

> Descend, for you must be my torch-bearer. To which that provocative minx Jessica, fully alert, replies:
> What, must I hold a candle to my shames?

That same candle burns fiercely when Falstaff erupts with his thunderous pasan to carnal love in the *Merry Wives*, which he rounds off with a staggering line:

> Send me a coole rut-time, Jove, or who can blame me to pisse my Tallow?

The burning tallow-candle is the symbol of office carried by Robin Goodfellow when he enters upon the nocturnal rites of his coven, as is shown in the woodcut that we have reproduced on an earlier page. Who can hold a candle to this proud Devil?

A proverb dating back to ancient Rome and Ennius observes that when a lantern gives light to a candle, the giver by the gift is made none the poorer. Innocent in itself, this old saw takes on an erotic sense when Chaucer's Wife of Bath in her *Prologue* admonishes her doddering husband not to begrudge her dalliance with other men. Here the candle is phallic and the lantern is the 'queynte' or pudendum:

For, certeyn, old dotard, by youre leve,
Ye shul have queynte right ynogh at eve.
He is to greet a nygard that wolde werne [forbid]
A man to lighte a candle at his lanterne.

Let us revert to Pothey's suggestion about Gandon's *piton*. He was echoing an ancient folk-belief general in Europe and also in America:

Regarde au nez et tu verras combien Grand
est celui qui aux femmes fait bien. Regarde au
pied pour au rebours connaitre Quel le
vaisseau d'une femme doit etre.

---

[105] Is it by coincidence that 'conk' means 'nose' in American slang, and 'shelf-fungus' in the parlance of American woodsmen? See Note 1, page 128 [of original version, here footnote 84].

Thomas Wright in *A History of Caricature and Grotesque in Literature and Art*, published in London in 1875, reproduced the figure of a Roman *mimus* as preserved for us in an engraved onyx. A vulgar character given to indecent roles in the low comedy of the time, the *mimus* in this case is adorned with a pendulous nose that speaks eloquently for its lengthy alter ego, and in his whole get-up he seems intended to illustrate the quatrain found in Delvau:

Œil étincelant, Doigt
vif et galant, Nez de
bon augure Et bonne
figure.

Let no reader balk at these baudy citations, for they serve only to confirm the continuing vitality of the layers of meaning that we suggest for Pliny and Pausanias, and that without these citations might appear to secluded scholars both tenuous and wilfully indelicate. All things sprout from the μύζα and the μύκης, in union with σήπτα.

Yes, σήπτα, the Greek word that has given us the Spanish *seta* and we think the French *cepe*, words whose primary fungal meaning was the *Boletus edulis*. Corominas in his note on *seta* pointed out that in widely scattered parts of Spain it has also designated the cunnus.[106] We suspect that in this sense also *seta* goes back to an original Greek usage, and that σήπτα stood symbolically for the female counterpart of the μύκης, 'cep' and 'morel' being sexually complementary. Under its swarthy mons the cep when heated turns soft and yields a mucoid exudate. In the fungal vocabulary of the Gascons we discover the same obscene figure of speech, though a different word is used. This pejorative term is for the boleti that turn blue on exposure to air. Professor Jean Seguy in his Gascon linguistic map 201 reports it as *kunsanmas*, and behind the face of this strange word he discovers *cunnu sagma*, which in French would be *con d'ânesse* [turd jackass].

We are far from having exhausted the complex of interrelated meanings. In various parts of Spain *seta* carries the sense of 'swollen lips', 'snout'. With the other erotic meanings before us, we suggest that it is impermissible innocence not to see in these lips the labia majora and ring.[107]

In Middle Flemish there was a word *sete* that was used in the oath *bi Cools sete*, 'by Nick's arse', corresponding to the Old French *por le cul lien*. Apparently the origin of the Flemish word has not been determined. When we have in mind the sexual associations of the cep in Spanish and the obscene association that Clusius pointed out in Magyar, we suggest that the Flemish word is another semantic extension of our mushroomic word, with a scatological rather than an erotic emphasis.

In Old French we also find a word *sete*. It survives in seven or eight citations. Its meaning has never been certain. It was used always as a simile for stench: the leper's boils stink like *sete*. In recent years several scholars have examined the word and suggested that it might mean 'excrement' or 'latrine' or 'privy seat' or 'arse'. One of them linked it with the Flemish word. Surely here also we discover our mushroomic word, in its scatological phase. If we are right, the word was circulating in French seven centuries ago, disappeared, and then reentered as cepe in the 18th century.[108]

Today in southern Europe the fig is used metaphorically as the *Boletus edulis* used to be. To the mushroom and fig we must add the third of the trinity, the medlar, that fruit which is properly enjoyed only when rotten ripe. Down to Shakespeare's time it was known also as the openarse, a name that survives in dialectical use until now. Shakespeare played with the words in what are perhaps his most scabrous lines, in Act II, Sc. I of *Romeo and Juliet*, the lines that are said to have prompted Logan Pearsall Smith, in his little book on Shakespeare, to exclaim how lucky it was that only specialists sensed the range and depth of Shakespeare's indecencies:

---

[106] For an analogy among the Quiche Indians of Guatemala, see p. 280 [of orig. vers., here ctrl+f+"Quiche specialists"].

[107] The basic Slavic word for mushrooms, which survives in Russian as *guby* (**губы**), means 'lips' in that language today, with *gubka* (**губка**) meaning 'sponge'. The primary sense of 'mushrooms' also lingers on, but for this meaning *griby* is ordinarily used in the standard language.

[108] For our case to be valid, the value of the vowel in Old French *sete* must have been *e*, and this is what it was. We know this by the variant spellings *seite* and *sette* in the mss. We also know it by the words with which it was made to rime in verse fête from Latin festum, degete from Latin jactare, neste from Latin uvidus. We postulate the missing π of σήπτα. For discussions of Old French *sete* see Erik von Kraemer's critical editions of two 'Miracles' of Gautier de Coinci, *Du clerc qui fame espousa et puis la lessa*, 1950, p. 114, and *De la bonne empereris qui garda loiaument sen manage*, 1953, pp. 244-5, both published in Helsinki in the *Annales Academiæ Scientiarum Fennicæ*; also see the review of the latter in *Speculum*, Jan. 1955, p. 110, by Professor Urban T. Holmes.

> 'He can't mean that', the shocked reader cries out; but oh, my dear reader, he does mean it, and his meaning, if you are a nice person, will make you blush all over.
> [*On Reading Shakespeare*, p. 9]

But Shakespeare was not inventing his imagery. He was drawing on a fund of erotic symbolism of immemorial antiquity. In English the word 'medlar' was re-shaped to pun with the verb 'to meddle', in the erotic sense now little used; but etymologically medlar was identical with the French *nèfle* and the Spanish *níspero*, and all three descend from the Greek μέσπιλον, where the philologists stop, saying they find no earlier root. But surely the Greek word, broken down into its two elements, incapsulates our same erotic metaphor, meaning 'amidst the hair', where the second element, πιλον, is the word that comes down to us in the mushroomic 'pileus'. Just as the erotic association of the *Boletus edulis* seems to have passed over to the scatological in Flanders and France, so the *nèfle* becomes the *cul-de-chien* in the east of France.

When Corominas hit on σήπτα as the etymon for *seta*, he may not have divined the nest of felicitous semantic associations that support his discovery. The Greek word belongs to a cluster that includes σηφ, the designation of a poisonous serpent. The Greeks believed that mushrooms and serpents and the holes of serpents had an affinity for each other, just as the peoples of northern Europe link mushrooms with toads. In the Dorian dialect we discover the variant σάπω, identical phonetically though not semantically with the Spanish word for 'toad', *sapo*. We submit that just as the Italian *scorzone*, 'poisonous serpent', gives us the Spanish *escuerzo*, a second word for 'toad', so the Greek word offers us a parallel herpetological metamorphosis.[109] The snake-mushroom association of Greece and the Indie world, with all its baggage of associations, becomes the toad and toadstool glyph of the West. With all these symbols woven together, we are hardly surprised when we discover that Émile Boisacq in his Greek etymological dictionary links the Greek words that we are now discussing with the Sanskrit *kydku*, 'mushroom'.

As for phallic 'noses', surely nowhere in literature is there another such apostrophe to them as Laurence Sterne composed in Part IV of *Tristram Shandy*, along with the chapters that lead up to and away from that noble excursus. Here indeed is a savory dish of salacious mushrooms, a display of candles enflamed. The baby Tristram, we learn, had got his 'nose' smashed at birth, whereupon his father, all disconsolate, had embarked on an exhaustive study of 'noses' and their sizes. He read Erasmus, with scant satisfaction, and then turned to the authors that had concentrated on his topic, to wit, Prignitz, Scroderus, Andrea Paraeus, Bouchet's *Evening Conferences*, and finally the unrivalled Hafen Slawkenbergius, who in the course of his stupendous opus pauses at one point to recall how for a full month all Strasbourg, both the Lutheran and Catholic factions, had once been set by the ears because of a certain long 'nose' and the awe and incredulity with which everyone, of every age, in every walk of life, of low and high degree, viewed its dimensions.

In a paragraph of concise and damning irony Tristram describes the monumental 'nasal' monograph of Slawkenbergius, and what he says causes us to tremble, for his words are equally applicable to this our own beloved treatise. If the reader will substitute us for Slawkenbergius, and mushrooms for the noses that are their metaphorical synonyms, he will learn what we consider a truthful and humiliating appraisal of our own enterprise:

---

[109] The philologist Meyer-Lubke in his *Romanisches etymologisches Wörterbuch* dismisses out of hand σάπο as an etymon for Sp. *sapo*, but perhaps here, as elsewhere, his fiat calls for re-examination. The obstacles to our etymology are two-fold, phonological and cultural. (In Spanish the names of plants are often of Greek origin, but not animals.) But philologists should give full weight to the *mana* in which all words relating to toads were bathed in the early centuries, and such words, subjected to pressures of *tabu*, commonly exhibit irregular word-histories. Until the philologists find positive evidence favoring an alternative etymology, they should not close their minds to the semantically felicitous Gr. σάπω. Whether the Basque *apo*, 'toad', is borrowed from Spanish or (as Karl Bouda surmised) is related to apxw, the word for 'frog' in the Caucasian language known as Svanetian, need not concern us here.

> And to do justice to Slawkenbergius [says Tristram], he has entered the list with a stronger lance, and taken a much larger career in it than any one man who had ever entered it before him, and indeed, in many respects, deserves to be enrich'd as a prototype for all writers, of voluminous works at least, to model their books by - for he has taken in, Sir, the whole subject - examined every part of it dialectically - then brought it into full day: dilucidating it with all the light which either the collision of his own natural parts could strike - or the profoundest knowledge of the sciences had impowered him to cast upon it - collating, collecting, and compiling - begging, borrowing, and stealing, as he went along, all that had been wrote or wrangled thereupon in the schools and porticos of the learned: so that Slawkenbergius his book may properly be considered, not only as a model - but as a thorough - stitched DIGEST and regular institute of *noses* [that is, *mushrooms*], comprehending in it all that is or can be needful to be known about them.

Defying Tristram, we return to trie 'long nose'. When a German *macht eine lange Nase*, he is doing what a Frenchman does when the latter *fait un pied de nez*, for in this expression the Frenchman speaks not of a pedal extremity but of twelve good inches and true. For the same rude gesture the Englishman says that he cocks a snook, and the American thumbs his nose. On July 4, 1936, a certain Nazi official known as Herr Greiser drew world attention to himself by thumbing his nose at the League of Nations in Geneva. The correspondent Vernon Bartlett in his dispatch to the London *News Chronicle*, using the English idiom, declared baldly that the man had 'cocked a snook'. There followed a lively discussion in the British press. Winston Churchill used the vulgar term in Commons, and thus it gained a nosehold in Hansard. For a month readers of *The Times* addressed letters to their editor about the episode and the gesture, letters urbane and amusing, but sadly genteel. Only the most knowledgeable and perceptive reader could have detected the obscene inspiration of the antique gesture. Yet in those circles where low words pass as common coin, the fleeting passage of thumb and fingers across the nose finds its natural accompaniment in two terse English syllables that tell the story. Here once more we come up against that *chandelle*, that *champignon*, that *pied de nez*, of the vulgar Roman mimus. The 'snook' is a pendulous appendage. From the main body of the Holy Isle of Lindisfarne there stretches out a lengthy promontory, and we understand, when we look at the chart, why the Northumbrian folk know that promontory as 'The Snook'. He who cocks a snook cocks a 'nose'.

If there be those who are sceptical of this meaning, let them read Chapter XIX of Rabelais' *Pantagruel*, wherein Panurge and the Englishman engage in a unique colloquy. As neither speaks the other's language, the conversation goes forward with gestures, in the presence of the villagers, who follow it with rapt attention and the enjoyment that is the proof of understanding. Panurge starts off by cocking a snook at the Englishman, who replies in kind. Never have there been more eloquent performances of the ancient sign, nor description thereof put on paper with such solemn elaboration of detail. Here is Rabelais' text, which we offer with only one further comment: where Rabelais speaks of *la pinne du nez*, W. F. Smith in his admirable translation hit on 'the gristle of the nose', an inspired rendering, since in certain English dialects 'gristle' means 'nose' and also the *membrum virile*:

> Panurge soubdain leva en l'aer la main dextre, puis d'icelle mist le poulce dedans la narine d'icellui costé, tenant les quatre doigts estendus et serrés par leur ordre en ligne parallèle à la pinne du nez, fermant l'œil gausche entièrement, et guignant du dextre avec profonde dépression de la sourcille, et paulpière. Puis la gausche leva hault, avecques fort serrement et extension des quatre doigts et élévation du poulce, et la tenoit en ligne directement correspondante à l'assiète de la dextre, avec distance entre les deux d'une coubdée et demie. Cela faict, en pareille forme baissa contre terre l'une et l'aultre main: finablement les tint on milieu comme visant droict au nez de l'Anglois.
> ... Lors feist l'Anglois tel signe: la main gausche toute ouverte il leva hault en l'aer, puis ferma au poing les quatre doigts d'icelle, at le poulce estendu assit sus la pinne du nez. Soubdain après leva la dextre toute ouverte, et toute ouverte la baissa, joignant le poulce au lieu que fermoit le petit doigt de la gausche, et les quatre doigts d'icelle mouvoit lentement en l'aer. Puis au rebours feit de la dextre ce qu'il avoit faict de la gausche, et de la gausche ce que avoit faict de la dextre.

> Panurge suddenly raised in the Air his right Hand, then placed its Thumb within his Nostril on that Side, holding his four Fingers extended and closed in their order in a Line parallel with the

Gristle of the Nose, shutting the left Eye entirely, and blinking with the right with a profound Depression of the Eyebrow and Lid; then he raised the left Hand aloft with hard Clinching and Extension of the four Fingers and Elevation of the Thumb, and he held it in a Line directly corresponding to the Position of the right Hand, with a Distance between them of a Cubit and a half. This done, in like form he lowered towards the Earth both one and the other Hand; lastly, he held them in the Midst as though he were aiming straight at the Nose of the Englishman.

... Then the Englishman made a Sign like this: His left Hand wide open he raised high in the Air, then closed into his Fist the four Fingers thereof, and placed the Thumb extended on the Gristle of his Nose. Suddenly afterwards he raised the Right wide open, and while wide open lowered it, joining the Thumb at the Place where the little Finger of the left Hand closed, and the four Fingers thereof he moved slowly in the Air; then reversing them he did with the Right what he had done with the Left, and with the Left what he had done with the Right. [Translation by W. F. Smith]

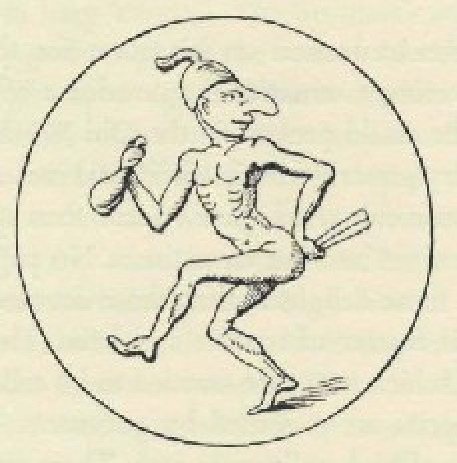


Fig. 9 - Roman Tom Fool.

11

The Secrets of the Truffle

It might seem that by now we had exhausted the erotic imagery of the fungal world, wherein fire, mucus, noses, candles, and mushrooms dance together in a throbbing surrealist fandango, the whole obscene performance conducted inside the uterine envelope of the primeval *gamba*. But not so. We have yet to speak of truffles.

The Greeks used various words for underground fungi, but we think we can prove that the ύδνον was our truffle. In the Morgan codex of Dioscorides there is a miniature accompanying the section on the ύδνον that gives us our earliest pictorial representation of a *tuber* buried in the earth, and an excellent representation it is.

The truffle in Latin was the *tuber*, which took the form of *tufer* in an Oscan or Umbrian dialect. The Romans knew various kinds of *tuber*. The most esteemed were from Africa, and were probably not true truffles but an underground fungus known to science today by the name of *Terfezia*. From the Latin word came the French *truffe*, the Spanish *trufa*, and the English 'truffle'. From a form supposed to have been *terrae tufer* the Italians arrived at the modern *tartufo* and a diminutive *tartuffola*. The surprising thing is that this last word turns up in German as the name for the potato, *Kartoffel*, and from there spread eastward throughout the Slavic lands, until today half of Europe calls the potato by the word that originally meant 'truffle'! In our view the explanation for this curious transfer of meaning lies in the preoccupation with aphrodisiacs of 16th century Europe.

When Ponce de Leon embarked on his quest for the Fountain of Youth, he was bent on discovering a sensational aphrodisiac of lasting virtue. What a prize would be his if he could present to the Old World a miraculous bath to supersede all the amatory prescriptions in traditional use! Among those traditional inciters to venery none enjoyed higher esteem than truffles, and indeed this reputation of theirs survives into our own times. No pages in Brillant-Savarin's *Physiologie du Goût* are more delightful than those devoted to a judicial weighing of the evidence in this matter of truffles and love. There are many kinds of subterranean fungi, of which some are entitled to be called truffles; and of these true truffles, a few species are esteemed by gourmets. In Spanish, *trufa* is the name given to a truffle of high culinary worth. There are two other terms used generally for the underground fungi: *turma* and *criadilla de tierra*. These are both interesting, expressing as they do the aphrodisiacal virtue attributed to the whole tribe of underground fungi. *Turma* in Catalan means 'testicle', and in Spanish it means both 'testicle' and 'truffle'. It is an old word, probably of pre-Roman origin, coming down from the same Indo-European root 'tu' that gives to Latin *tuber* and *tumor*, the idea of organic swelling being inherent in them all. *Criadilla* is the standard word in Spanish for 'testicle'. It is the word used for lamb's fries, the French *amourette*. The Spaniards' words for the truffle reveal the precious virtue that these earthy growths were supposed to possess.

Immediately after the Spaniards fell on America in the 16th century, they discovered in the New World first the sweet potato[110] and then the potato, the *batata* and the *papa*. They found the *batata* in the Antilles, probably in Hispaniola: the word first appears in 1516, a borrowing from the Taino Indians who were then living in the Greater Antilles and Bahamas. (Their name should be pronounced in three syllables, as though written 'Taino'.) The Tainos deserved a kinder fate than was theirs: they and their language are now dead these many generations, and few today know even the tribal name of these first victims of the invaders from Europe. The Tainos possessed a tongue belonging to the Arawakan family of Indian languages, which were spoken by tribes scattered at the time of the Conquest all the way from Florida and the Bahamas on the north through the Greater Antilles and across the tropical belt of South America as far south as what is now known as Matto Grosso. These Tainos of the Islands were a gentle folk: they seemed to lend verisimilitude to the medieval dreams of a Golden Age, and gave impetus to the notion of the Noble Savage that was destined to captivate intelligent men in the Age of Reason. The blameless Taino cultivated sweet potatoes and maize, smoked tobacco, slept in a hammock, and plied the sea ways in long 'canoas'. The Spaniards remarked on the uniformity of the Taino language throughout the various Islands - clearly in the Taino world the sea was a highway to speed communications and not an insulating barrier. Today even scholars often confuse the winsome Tainos with their ferocious enemies, known variously in the 16th century as the Caribs or Calibs or Canibs, a race of savage warriors who when the Spaniards arrived had already seized the Lesser Antilles and were harassing the Tainos on the larger islands. The Europeans quickly overwhelmed them both. But all unawares, by a natural filtering of the Indian vocabularies, the world distinguishes to this day between these two lost and almost forgotten peoples. From the language of the Tainos we possess a legacy of five common and friendly words: potato, maize, tobacco, hammock, and canoe. From the Canibs came our 'cannibals', and the bestial Caliban whom Shakespeare placed in the still-vex'd Bermoothes was the literary scion of the Calibs.

---

[110] We are familiar with the evidence indicating prior knowledge of the sweet potato in Polynesia, which has stirred up discussions that do not concern us.

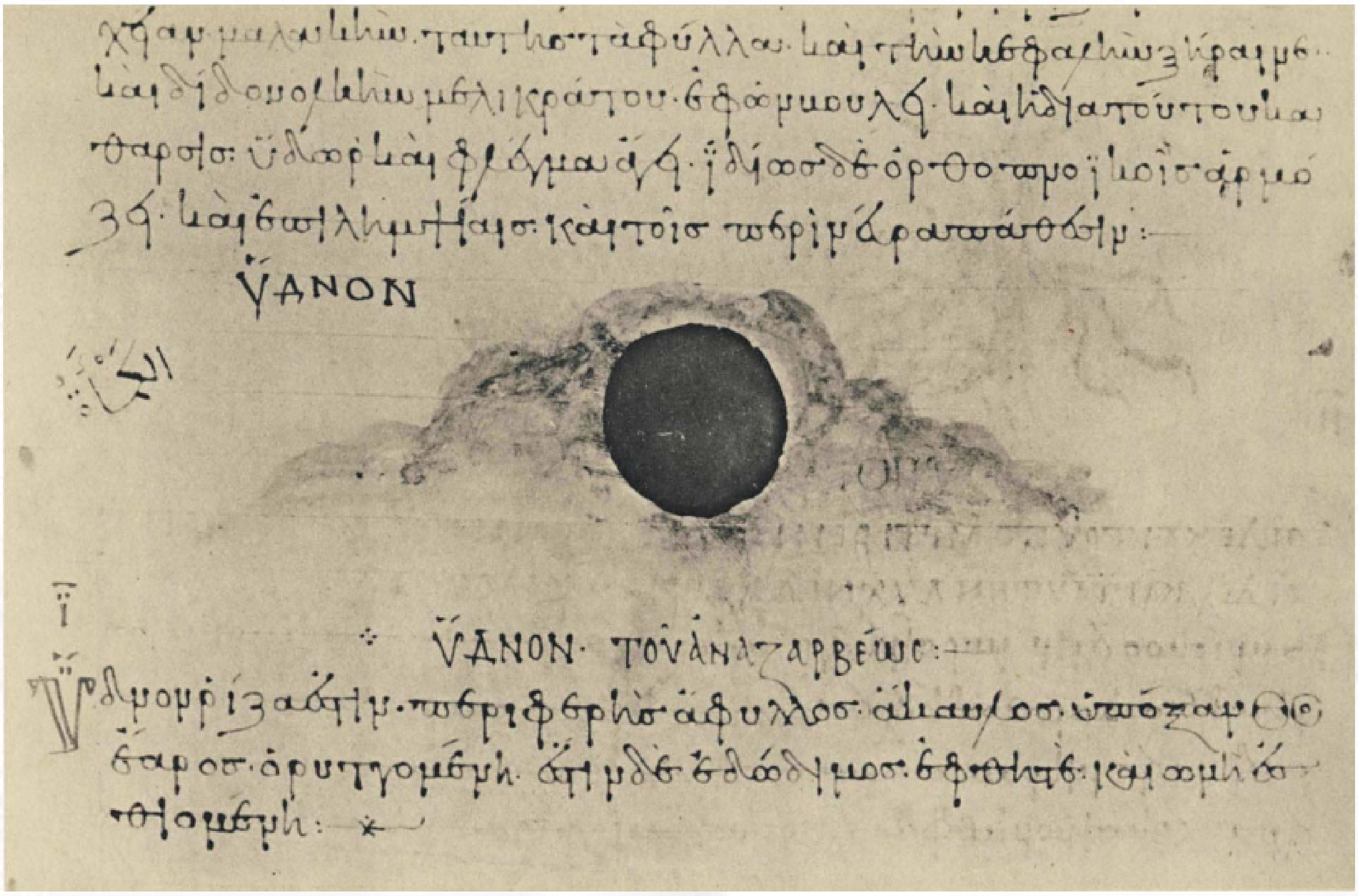


PLATE XXXII
Tuber. Miniature from a 10th century Byzantine codex (No. 652) of Dioscorides.
New York, The Pierpont Morgan Library.

The Tainos certainly did not attribute aphrodisiacal powers to the *batata* or sweet potato. They could not have been under illusions about this humble vegetable, so commonplace for them. But the Spaniards, obsessed by the idea of aphrodisiacs, were quick to discover in the *batata* a new and more potent truffle. (Were they under a temptation to hold the novel food to blame for their excesses with the native womenfolk?) A few years later they discovered the white potato in the Andean highlands, the *papa* as it was called in Quechua, the language of the Inca and his people. Now the story repeats itself: Agustin de Zarate, in his classic account of the conquest of Peru, published in 1555, informs his readers that the white potato is like the *turma de tierra*, 'earth's testicle', the truffle of precious virtue:

> ... y los indios comen unas rakes que llaman *papas*, que son de hechura y aun casi sabor de turmas de tierra... [BOOK, III, Chap. 12]

This work was promptly translated by Thomas Nicholas and published in London in 1581. Since truffles were unknown to the English, we were eager to see how the excellent Nicholas met his difficulty in rendering the sentence where they are mentioned:

> ... The Indians of this province eateth certaine Rootes called *Papas*, whiche are verie like bothe in makynge and taste Turnepes.

How the humble turnip is here exalted, and the truffle humbled! Were truffles ever so grossly maligned before or since?

Shortly after the batata, the Spaniards brought back from the New World the white potato, and from Spain it reached Italy before 1588, where it was called *taratouffli*, the Italian word for 'truffles', a translation of the Spanish name but without the strong erotic association of *turmas*. Quickly thereafter it appeared in the Low Countries, Switzerland, and Germany, and then in France. It arrived in England after the sweet potato but before the end of the century. The two vegetables became deeply entangled in verbal confusion. In Spanish-speaking America the white potato is widely known to this day as the *papa*, a name clothed with all the rights of chronological and topographical primacy. But this word took no hold in Europe and batata served for both vegetables, finally in England attaching itself for good to the wrong plant. The Spaniards compounded the confusion by also bestowing on the new vegetables their own name for truffles. To this day in some parts of Colombia potatoes are *turmas* or 'testicles', and in Spain they were known as *criadillas* and *trufas*. In the dialect of Aragon *trufa* has been reported in the form *triunfa* - a popular malformation that suggests the amorous triumph assured to the hopeful consumer of *criadillas*.[111]

For a time potatoes remained a rarity, priced high in keeping with the virtue attributed to them. Their appearance in England points up a curious cultural phenomenon. Reaching England by way of Spain, both kinds of potatoes while in transit assumed like changelings the amatory reputation of the truffle. Thus it came about that England took delivery of America's gifts with a Spanish billing, never suspecting that the humble vegetables from the New World were now sailing on a false invoice, their genuine virtues lost from view in the resplendent aura befitting a newly discovered and miraculous aphrodisiac.

The craze for aphrodisiacs seized England too. Falstaff in *The Merry Wives of Windsor* invokes them. "Let the skie raine Potatoes", he exclaims, and "haile kissing-Comfits, and snow Eringoes", these latter being the candied root of the sea-holly, known to science as the *Eryngium maritimum*. Caviar in Elizabethan times was yet another erotic stimulant, as Sir John Harington, godson of the Queen, reminds us in his unabashed epigram 'Against an Old Letcher':

> Since thy third cariage of the French infection
> Priapus hath in thee found no erection: Yet eat'st
> thou Ringoes, and potato Rootes, And Gaueare
> [caviar], but it litle bootes. Besides at thy beds-heads',
> a bottle lately found, Of Liquor that a
> quart cost twenty pound.
>
> For shame, if not more grace, yet shew more wit,
> Surcease, now sinne leaues thee, to follow it. Some
> smile, I sigh, to see they madness such That that
> which stands not stands thee in so much.

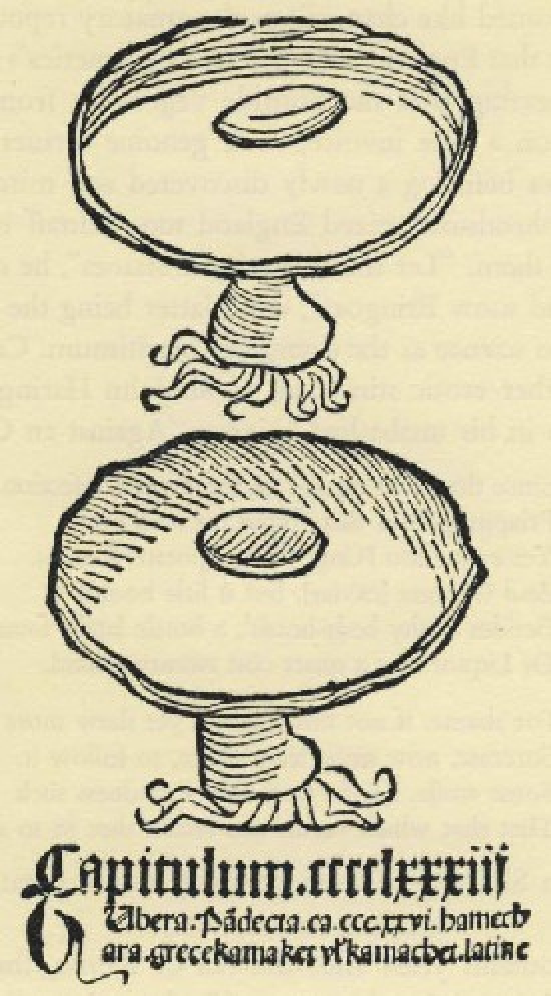
Those 'potatoes' in Shakespeare were certainly sweet potatoes; in Harington, we are not sure.

For almost a thousand years after the fall of Rome, there seems to be no mention of truffles in surviving documents.[112] In the 13th century Albertus Magnus speaks of them in *De Vegetabilibus*, but hesitantly and vaguely, and without reference to aphrodisiacal properties. This vagueness seems not to have been accidental. In the *Hortus Sanitatis*, printed in Mainz in 1491, the artist who made the woodcuts showed more courage than discretion when he illustrated the section on the *tuber*. Never has there been a more grievous misrepresentation of a fungus. We know not whether Albertus Magnus and he had never seen a truffle, or whether, knowing truffles, they failed to identify them with the Latin *tuber*. In the earliest of printed cookbooks, *De Honesta Voluptate*, published in Rome in the middle 1470's and attributed to Bartolomeo de' Sacchi called Platina, there is a short section on truffles. The author speaks of those that come from Africa and the Near East, and then he refers to the species that sensual men of fashion consume to whet their appetite for love-making. With an amusing lack of humor he goes on to observe that if this is done for procreation, it is praiseworthy, but if for debauchery, as is the case (he says) with many idle and intemperate persons, it is to be altogether despised. No trace of scepticism diluted the faith of this author in the peculiar virtue attributed to truffles. Doubtless there are earlier references to these as aphrodisiacs, but we have not come upon them.

---

[111] We are indebted to Professor Juan Corominas for the etymology of *turma*. For the early usage of names for potatoes and sweet potatoes, there is a beautiful monograph by Pedro Henriquez Urefia, *Para la Historia de los Indigenismos*, published by the Institute de Filologia, under the auspices of the Facultad de Filosofia y Letras of the University of Buenos Aires, 1938, to which Professor Yakov Malkiel called our attention. See also entry under *Criadilla* in C. Torres Fornes' *Sobre Voces Aragonesas usadas en Segorbe*, Valencia, 1903. But neither Henri quez Urefia nor Torres Fornes mentions the erotic theme injected into the potato nomenclature by the Spaniards. The early references to the potato in the herbals are fully discussed by Redcliffe N. Salaman in his *History and Social Influence of the Potato*, Cambridge University Press, 1949.

[112] We except of course the references in copies of the ancient authors. The reference in the *Etymologies* of St. Isidore of Seville is no more than a repetition of ancient sources.



Capitulum.cccclxxxiij
Tubera.Pādecta.ca.ccc.xxvi.hamech
ara.grece kamaket vl' kamachet.latine

Fig. 10 - From *Hortus Sanitatis*, Mainz, 1491.

By the 16th century the fashion for truffles was at its height. They reached this peak of esteem at the moment when potatoes arrived from the Andes, via Spain. The two were confused in Spain, as we have seen, and it is hardly surprising to find that they came to be confused in France, Italy, and Germany. *Tartufi bianchi* has been an alternative designation for potatoes in Italy down to recent times, a use of *tartufo* that is facilitated by the supremacy in Italy of a white truffle, the *Tuber magnatum*. This is the truffle that in Italian restaurants is commonly served raw, in thinnest slices. It suggests the flavor of garlic, but unlike garlic does not repeat itself. Across the Alps in the Dauphine, the peasants in their patois have been reported in modern times as using the term *triffe niere* to designate both the truffle and a kind of potato with a purplish flesh.[113] In Germany there is a common fungus, with white flesh, about five inches in diameter, that grows either half-buried or just under the ground in oak forests. It is aromatic and edible, and mycologists know it as the *Choiromyces meandriformis* - the meandering pig-fungus. It looks like a potato, and the initial confusion between the familiar fungus and the novel potato must have contributed to the permanent hold of the word *Kartoffel* in

---

[113] See *La Truffe*, by Adolphe Chatin, Paris, 1892, pp. 303 ff.

Germany, whence it spread with the potato in due course to Scandinavia and the Slavic lands. In turn the Russians carried the word across Siberia and to the Eskimos of Alaska, where in various dialects of the Eskimo language we find the potato of the Andes called by names that reach straight back to the *tuber* of Pliny: *kaltu:jilaq* and *kaltu:jaq* and *kaltuvaq* and *kaltu:xaq*.[114]

That initial confusion of potatoes with truffles which began in Spain in Renaissance times has never completely died. Van Sterbeeck surprises and amuses the modern reader when in his *Theatrum Fungorum*, a work exclusively dealing with fungi published in 1675, he devotes a section to potatoes and other members of the nightshade family! If the reader will examine again the frontispiece to Van Sterbeeck's book, which we reproduce on Plate XXVIII, he will discover among all the mushrooms one basket that is spilling potatoes on the ground. In Russia down into the present century the Old Believers of the Moscow region were still rejecting potatoes, which they would spurn as *sobach'i mude* (**собачьи муде**), dog's testicles; this was recorded in 1915 by Roman Jakobson in the neighborhood of Vereja. We discover the same associations lingering on in certain metaphors current in Spanish America, but here we arrive at the inner meaning only by a series of transitions. The Spaniards thought truffles were aphrodisiacs, and they considered sweet potatoes, the *batatas* of the Antilles, a superior truffle. The word *batata* never spread much on the American mainland, where sweet potatoes came to be called *camotes*, the name for the vegetable in Nahuatl, the language of the Aztecs. Today in many parts of Spanish-speaking America *camote* is a metaphor used for 'being in love'. It also means a lie or exaggeration, and thus recalls the disillusion of those who relied on the virtue attributed to the sweet potato.[115] Finally, the old error, fossilized, persists to this day in circles where one might least expect it: botanists and mycologists use the word 'tuber' for both potatoes and truffles, thus embalming in their unhappy nomenclature the hoary blunder.

There is a tradition that the vogue of the truffle in France and Italy came from Spain during the Renaissance, and that it attained its exalted place on the tables of the mighty in the reign of Francois I. It certainly soared to new renown in the 16th century, but the survival in France and Italy of the local names derived from the Latin *tuber* is evidence that on humbler and less articulate levels the truffle had not been wholly forgotten in the silent centuries reaching back to Roman times. In Paris, however, the truffle was adorning only the most aristocratic tables down almost to the French Revolution, Brillat-Savarin asserts that the

> revival of the truffle is quite recent... One can even say that the present generation has almost witnessed it. Toward 1780 truffles were rare in Paris, to be found, and then in small quantities, only at the Hotel des Americains and the Hotel de la Provence. A turkey stuffed with truffles was a luxury to be found only on the tables of the great, or in the homes of kept women... At the moment when I write these lines [1825] one can say that the glory of the truffle has reached its apogee.

With the rise of the bourgeoisie following the French Revolution, new layers of society acquired a taste for the delicacy and by their demand for it brought about an immense increase in the harvest. In the 16th century various kinds of truffles had competed for favor in France, but by Brillat-Savarin's time the *Tuber melanosporum* of Perigord had established its primacy and become perhaps the supreme delight of the haute cuisine. Meanwhile that other tuber, the potato, thanks to the ingenious and bold promotion of the famous Antoine-Augustin Parmentier, had finally, in the 1770's, gained acceptance as a worthy food for a gentleman's table in France.

The reputation of the truffle as an erotic stimulant has an elusive history. This reputation was certainly endemic in Spain, expressing itself as it did in the names *criadilla* and *turma*. The culture of the Iberian peninsula is strong in archaic traits, and this would suggest that the peculiar repute of the truffle goes back far. We have not arrived at the indigenous names for the truffle in the other Indo-European languages, such as those of India. In the Sind, as an example, there is a fungus that in Sindhi is called *saitan jo pelo*, Satan's

---

114. See L. L. Hammerich's paper on 'The Russian Stratum in Alaskan Eskimo', *Slavic Word* No. 3, Dec. 1954, published by The Linguistic Circle of New York, p. 409.
115. The metaphorical meanings of *camote* are cited by Hennquez Urefia in his monograph to which we acknowledged our indebtedness in a footnote on page 169 [of original version, here footnote 111], but he does not try to explain those meanings.

testicles. But we know not its identity: is it a truffle?

Perhaps the Spaniards in their century of great influence were responsible for spreading the belief that truffles were aphrodisiacs. This is a tempting hypothesis. Yet there is certain subtle evidence suggesting that an indigenous tradition of the same kind prevailed in Central Europe, notably in Germany and Bohemia.

For centuries the hunting of the stag in Europe was the noblest expression of the chase. This stag was the male of the red deer. Norman Douglas in *Paneros* has pointed out that the genitalia of the stag were coveted as precious inciters to venery. Now here is an interesting fact that Douglas did not know: there exists an underground fungus distinct from the truffle that is called in German the *Hirschtrüffel* - the stag's truffles. In English botanical works already a century ago it was called 'hart's truffle', and also 'hart's balls' and 'deer balls'. The corresponding names in French and Spanish are *truffe du cerf* and *criadilla de ciervo*. We have no evidence that these words circulated outside the covers of books: they could be bookish renderings of the German term. One should look for such terms in the vocabulary peculiar to traffickers in aphrodisiacs and their clientele, and source materials for this dubious area of cultural activity have eluded us. We suspect that our hart's truffles would be found therein. The scientist's name for this genus of fungus is a scientist's neo-Greek rendering of the German name: *elaphomyces*.

As to the ripe age of the German name there can be no doubt. Before 1544 Valerius Cordus, in his *Adnotationes*, commented most curiously on the stag's truffle. Truffles were thought to be earth's testicles and aphrodisiacs, and the stag's testicles were also aphrodisiacs. From this it was only a step to suppose that the underground fungi were generated from the spilled seed of stags! Here is a pretty illustration of the way men's minds work by false analogies, taking figures of speech literally. But this is not all. Why were these underground fungi related to the genitalia of stags and no other animals? We believe that beneath the surface of the words of Valerius Cordus we detect a further punning analogy, a foolish confusion caused by homonyms, and yet a confusion possessing a certain extraordinary iridescence.

There are two words spelled 'Venery' in English. One of them is derived from 'Venus' and means sexual lust. The other is derived from the Latin *venari*, meaning 'to hunt'. In sound these two words run parallel to each other throughout the Romance languages and medieval Latin. Indeed, when we go back behind Latin, we discover that both words, Venus and *venari*, descend from the same root, a root cousin to the English verb 'to win'. He who pursues and brings down the game is engaged in the same order of activity as he who brings down a mate. 'Venery' in its application to the chase relates to the noblest kind of hunting, the coursing of the stag. And this leads us to suggest the play on words that probably explains the kinship of truffles to stags. The aphrodisiacal truffles in the earth are earth's testicles, fruit of the stag's truffles, and both are shot through with venery. Venery in both senses loomed large in the consciousness of the 16th century European. We suggest that this common denominator of the homonyms, albeit unexpressed in the text of Valerius Cordus, was in the back of his mind, consciously or unconsciously, as he wrote out his quaint observations about hart's truffles:

> Pharmacopolae etiam in suis officinis Fungos habent, quos Boletos et Fungos ceruinos vocant. Ferunt eos in sylvis ex semine cervorum enasci, et propterea Venerem stimulare: sed falsum hoc est. Inueni enim hos Ceruinos fungos in praeruptissimis montium syluis, quo ne Damae et Rupicaprse quidem peruenire possent, nedum cerui. Nee verisimile est eos venerem stimulare, cum frigidum, pituitosum, crudum, et malignum succum in humane corpore gignant. Quae enim Venerem accendere debent, contrarias facultates et qualitates habere necesse est.
>
> Apothecaries, in fact, have in their establishments fungi which they call boleti and stag fungi. They say that these originate in the woods from the seed of stags, and hence excite the sexual impulse; but this is false. For I have found these stag fungi in the densest mountain groves, which not even fallow deer and chamois could reach, not to mention stags. Nor is it likely that they excite the sexual urge, as they engender cold, phlegmy, raw, and evil humor in the human body. Things that are to inflame the sexual impulses must have opposite faculties and characteristics.

Cordus, who was German, was writing this passage shortly before 1544, the year of his premature death. His text does not suggest that the lust-inciting virtue attributed to the fungi was a novelty for him, nor foreign in inspiration. He was clearly challenging a tradition native to his German world. But Cordus, steeped from his earliest years in the New Learning, was far removed from the well-springs of the primitive beliefs of his race. Perhaps he was revealing the innocence that often goes with education when he labored his point about the stags in the mountain groves. Did not the erotic names for the truffles refer rather to the Horned God of the pagan world? In 1920 the Abbe Breuil and Count Begouen published[116] a prehistoric design that they had discovered engraved on the walls in the innermost recess of the Caverne des Trois Freres, at Montesquieu-Avantes, Ariege. It represented a man costumed for a primitive religious rite. On his head he wore antlers. The upper part of his face was owlish, the lower part covered by a long beard. The skin of a wild beast, perhaps a stag, is swung over his body. His hands are in a clawing posture. A horse's tail protrudes from the rear. He could easily be the remote progenitor of the Robin Goodfellow illustrated on page 83. The ancient artist leaves the beholder in no doubt concerning the importance that he attributes to *las criadillas de ciervo*, the hart's truffles. By this interpretation the aphrodisiacal metaphor suddenly takes on a pulsating vitality, and the two meanings of 'venery' coalesce. The horns of Robin Goodfellow and of the god of the prehistoric cave also appear in a new light. Our ancestors never tired of their jokes about the cuckold's horns - the symbols of his humiliation. R. Lowe Thompson in his *History of the Devil*, published in New York in 1929, suggested that originally these horns were the horns of the 'Satan' who officiated at the rites of the witches' coven. Certainly this interpretation quickens a stale figure of speech, and gives added piquancy to the priapism of Robin Goodfellow.

We might now call a halt to our discussion of fungal aphrodisiacs, were it not for a singular phenomenon that we discover in the Czech language. Alone among the Slavs, the Czechs pay attention, by native tradition, to the world of truffles. For the underground fungi they possess two words, both native. The true truffle is *lanýž*, and the hart's truffle is the *jelenka*. The name of the true truffle comes from *lan*, the word that designates the roe or hind of the red deer. The name of the hart's truffle comes from *jelen*, which designates the stag. A peculiar aspect of these words is the shift in genders that takes place:

MASCULINE	FEMININE
jelen (stag)	*lan* (hind)
lanýž (true or hind's truffle)	*jelenka* (hart's truffle)

What lies behind this criss-crossing of genders? In some medieval Czech text someone may discover the answer, perhaps in a manuscript dealing with love philtres. Meanwhile we suggest as a working hypothesis that the hart's truffle, *jelenka*, was prescribed for women, and the hind's truffle, *lanýž*, for men. In addition to the hart's truffle, *jelenka* is the Czech name for the mushroom known as the *Phallus impudicus*, and a related name, *jelenice*, is used for the *Hydnum imbricatum*, a species that by its shape is also erotically suggestive.

The Czech *jelenka* in its fungal application is semantically and mycologically a precise equivalent of the German *Hirschbrunst*, 'hart's rut', showing that Czechs and Germans shared a faith in the aphrodisiacal virtues of the *Phallus impudicus* (*Hirschbrunst über der Erde*) and the hart's truffles (*Hirschbrunst unter der Erde*). J. G. Gleditsch in his *Methodus Fungorum* (1753) wrote condescendingly of the Moravian peasant girls who used certain dried phalloidaceae to cure warts and corns, according to him without success; and how these fungi, air-dried or smoked, were thought to stimulate venery in dogs and horses. He added that rustics used them even on themselves. Mrs. Úlehlová-Tilschová in her book on Czech folk food, *Česká strava lidová*, has lately reported an East Moravian name for true truffles, *barani vajca*, 'lamb's fries' or testicles.[117] Later in the same work she calls attention to the important role played by fungi in the ritual dinner on Christmas eve in Bohemia, when the mushrooms are served in a soup or as gravy or mixed with cereal. The precise meaning of the mushrooms consumed on this annual occasion survives in men's memories in southern Bohemia, near Tabor, where the mushrooms are served with millet and the dish is called *kuba* or *manas*. The word *manas* means a lusty male, and he who eats of the dish is imbued with extra virility for the coming year.

---

[116] Comptes rendus des Seances de l'Academic des Inscriptions et Belles-Lettres, Institut de France, 1920, pp. 303-310. Our reproduction is from the half-tone there published.

[117] See pp. 54-5 for this and other examples of the rich popular terminology for fungi in Czech; for the references to the mushrooms served on Christmas Eve see pp. 345 ff. In standard Czech *barani vajca* would be *berani vejce*.

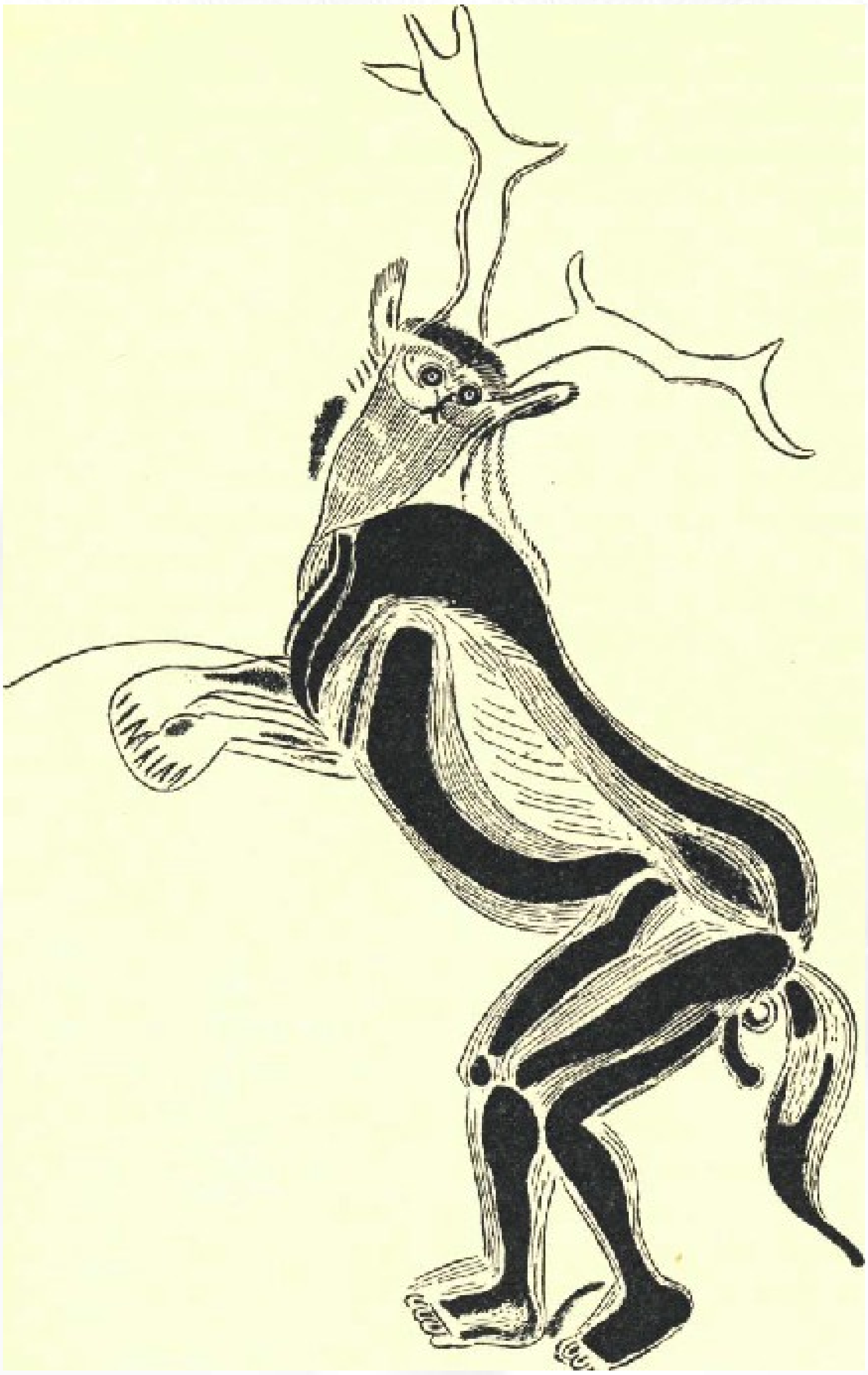


Fig. 11 - The Horned God. Prehistoric painting of a man disguised as animal.
Caverne des Trois Freres, Montesquieu-Avantes, Ariege, France.

John Parkinson, obviously relying on Central European sources, published in his *Theatrum Botanicum*[118] in 1640 certain curious facts about the use of hart's truffles or *elaphomyces* as aphrodisiacs and in medication:

> These be not eaten in the same manner as the former [true truffles], that is for meate or food, but as a medicament being cut into peeces, and dryed upon strings put through them to be used upon occasion: while they are fresh they have a strong and evill sent, which they lose in the drying, and are used either alone one dramme and a halfe in pouther, taken with sweete wine or with other things as provoke venery, as also to increase milke in Nourses breasts, taken in some *ptisane*

---

[118] Parkinson in this work offers us the first reference in English to truffles, which he calls 'Spanish trubbes'. 'Trub' would suggest a Spanish form *truba*, which has never been reported. Parkinson cites a passage in Athenaeus as authority for the aphrodisiacal virtue of truffles, but we have not found it. The ancients probably held such a belief, but we know of not a single reference in ancient writers to fungi as aphrodisiacs, in spite of the phallic symbolism of the μύκης.

> drinke, and a little long pepper added thereto: the smoake thereof when it is burned taken underneath, helpeth women troubled with the mother, and openeth the passages when they are close: they are thought also to expell poyson, and the venome of creatures, to be taken in pure wine, and also applyed outwardly.

Both Gleditsch and Parkinson were unfriendly informants repeating hearsay. Mrs. Úlehlová-Tilschová, centuries later, is at last tapping the genuine sources of folk beliefs, of which many in the intervening generations must have vanished forever. In low English the word 'hart' preserves to this day an erotic sense, unrecorded in the dictionaries.

Here our story of the truffle would end, had not Moliere by a stroke of genius created the character of Tartuffe. By the criterion of price, by the prestige of its *parfum*, by its erotic associations, the truffle holds a position of primacy in the fungal world. To all these distinctions it adds literary immortality: in Tartuffe hypocrisy finds its supreme artistic incarnation. In Tartuffe's fungal name the truffle was woven into the very warp and woof of Europe's cultural tapestry.

What led Moliere to 'Tartuffe'? This is not a French family name: the nearest approach to it is 'Truffier', which might be rendered 'Truffleman'. At first blush truffles do not suggest hypocrisy. Moliere's choice was brilliant. But why does it ring so true, and how did he arrive at it?

Scholars have applied themselves to this problem, but with meager results.[119] More than a century ago Francois Genin diverted into a fresh channel the flow of speculation on this subject. He announced that Moliere had not invented the name, but had borrowed it ready-made from the Italians. He had discovered a line in the lengthy 17th century poem, *Il Malmantik*, by Lorenzo Lippi, wherein one of the characters is called *il mal tartufo*. These words are to be found in Canto XI, stanza 47. They refer to a dwarf, by name Batistone, whose behavior makes him ridiculous and gets him into trouble. However, whatever his faults, the misshapen little man was no hypocrite and therefore no true precursor of Tartuffe. Moreover, Lippi's work came from the press only in 1676, seven years after *Tartuffe* was first presented on the stage, and we should have to assume that Moliere read it in manuscript, which he could have done but for which there is no evidence. Genin made a virtue of this chronological difficulty, observing that here was proof of Moliere's alertness to everything affecting his art!

Carrying Genin's line of inquiry further, Max J. Wolff in 1916 improved on the citation in Lippi's poem.[120] In a play by Giambattista della Porta, *L'Astrologo*, dating from 1606, *tartufo* occurs in a curious context. One of the characters suffers from amnesia. In Act IV: 7 he is asked whether he is a horse, or an ox, or an ass, and finally, "*Sei tu tartufo*?", to which the unhappy man replies, "*Sto fresco*", which is to say, "I'm in for it now." However, here again no one knows what double meaning this *tartufo* conveyed to the early 17th century audience; but it was certainly unrelated to hypocrisy.

Della Porta superseded Lippi in the quest for Tartuffe's progenitor, and recently Della Porta in his turn has had to give way before a fresh find. Our contemporary scholar Alfred Rebelliau has drawn attention to a pamphlet published in 1609 entitled *Le Mastigophore auquel sont brisées les brides à veaux de Maistre Juvain Solanicque*, written by Antoine Fusy, a parish priest of Paris. In it he vituperated against the warden of his church, Nicolas Vivian:

> Tu n'es qu'un tartuffe, qu'un butor, qu'une happelourde.
>
> You're nothing but a *tartuffe*, a lout, a paste-jewel.

Butor means a bittern, but metaphorically it means a churl, lout, clodhopper, oaf, dolt. What did this angry priest mean by *tartuffe*? If *butor* was a synonym, he meant what Lippi may have meant by *tartujo* - a dunce,

---

119. For summaries of the discussions, see *Grand Dictionnaire Universel* (Larousse) under 'Tartufe'; also the note by Casimir Jarecki, 'Sur l'Origine, la Signification, et l'Orthographe du Nom de Tartufe', in *Archivum Neophilologicum*, I: I, Kraków, 1930, pp. 38-42.
120. See *Archiv fur das Studium der neueren Sprachen und Literaturen*, vol. 134, p. 148.

with bad manners to boot. If *happelourde* developed the sense, then pretense and hypocrisy begin to appear. In Moliere's 'Tartuffe' there might be an echo of the colloquialism that survives for us in Antoine Fusy's diatribe. But Tartuffe was no dunce, and anyway the question still stands for us: why should hypocrisy have attached itself to the truffle?

We have pursued the thread of scholarly research from Genin to Wolff, and from Wolff to Rebelliau, from Lippi to Della Porta to Fusy, from one dubious clue to another. This evidence is relevant but secondary, and suggests a fallacious analogy with the philologist's quest for the etymon of a word. Surely the problem calls for different handling. We have to do with a creative mind in the act of choosing a name for a great dramatic character.

But before we venture our own comments on the origins of 'Tartuffe' let us return for a moment to Genin. In the course of his discussion of Lippi's *tartufo*, he suggested that the Italian word corresponded to the use of *fungus* as an epithet in ancient Rome. He recalled a character in a play by Plautus who, when he discovered how he had been hoodwinked, exclaimed:

> Adeon' me fuisse fungum ut qui illi crederem.
>
> Was I such a fungus as to believe him!

an exclamation that Genin rendered in French:

> Aije été assez *cornichon* ...

Then Genin made a remarkable observation: for the Latin use of *fungus* as an epithet signifying stupidity, said he, the French substitute *cornichon*, *melon*, *citrouille* - names of gourds. Thus it comes about that Genin discovered a common denominator between fungi and gourds in their metaphorical use, and so he furnishes startling circumstantial evidence in support of our thesis, developed on pages 127 ff., of a deepseated association in men's minds between gourds and fungi.

There is another passage in Plautus that leaves no doubt as to the meaning of *fungus* in contexts such as we are discussing. Act V of *Bacchides* opens with it, Nicobulus senex bursting upon the stage with these verses:

> Quicumque ubi ubi sunt, qui fuerunt quique futuri sunt posthac
> stulti, stolidi, fatui, fungi, bardi, blenni, buccones,
> solus ego omnis longe antideo stultitia et moribus indoctis.
>
> Of all the fools, chumps, dolts, *fungi*, oafs, drivelers, and mouthing
> idiots, wherever or whenever - single-handed I top the lot
> of them in folly and clumsy behavior!

Genin could have cited parallel examples in English - Shakespeare's 'toadstool' as an epithet, and Sir William Perm's 'mushroom'. We will go further and make bold to suggest that the perfect translation of *fungus* as Plautus used it is the colloquial 'gump', a humble word that in a wide variety of forms circulates in England, Scotland, Ireland, and America. Its wide use and many forms testify to its long lineage. In Wright's *English Dialect Dictionary* we find gump(h), gomf, gamp, gamf, gaump, gawmp. We find also sumf and sumph. All these connote human stupidity. As we have seen, words etymologically identical to *fungus* are the Slavic *gamba*, German *Schwamm*, and the English 'swamp'; there is another cognate in English - 'sump', a water-filled trap or excavation. Are not 'gump' and 'sumph' etymologically the progeny of the same verbal family? In Plautus' *Bacchides* are not *fungi* simple 'gumps'?

But however fascinating for mycophiles and ethno-mycologists these fungi of Plautus and ancient Rome are, what have they to do with truffles, hypocrisy, and Tartuffe? Was not Genin pursuing the wrong scent - barking up the tree where Sterne's Smelfungus grows, rather than grubbing for the habitat of Moliere's truffle?

The creative mind in literature is often made manifest in the selection of names for the characters. Dickens is famous for his names. Take Tulkinghorn in *Bleak House*: who has not had the misfortune of meeting his replica in the legal profession? The syllables of that name, savored singly or together, suggest by homonymic echo other words and ideas that become a harmonious composite of the repugnant human being to whom Dickens introduces us. When Tristram Shandy's father sought out the treatises on 'long noses' that would help him in coping with his infant's problem, Sterne characteristically devised names faintly smelling of his salacious theme: Prignitz, Scroderus, Parseus, not to speak of the *Evening Conferences* of Bouchet - names of such subtle craftsmanship that only the attentive reader catches the message, and then only if he is already familiar with Sterne's prurient nose. The art of devising names for fictitious characters lies in choosing sounds that suggest the sense without declaring it baldly, sounds that reach out like antennae to catch meanings and emotional associations which of themselves go far toward evoking the character whose acquaintance the reader is invited to make. Shakespeare's Caliban and Ariel, by an alchemy of phonetic and semantic echoes, offer in their names a foretaste of their roles, and those roles in turn fulfill, richly amplify, and clinch the names, until names and character so thoroughly and unforgettably interpenetrate each other that they are one.

Truffles live out their lives in the dark, dank, cold underground, a fit habitat for repugnant things. The truffle of France is almost black, like the sombre habit and soul of Tartuffe. He was a lecher, and in the 17th century truffles were the supreme aphrodisiac of France. The big, congested nose that we associate with gluttony and wine-bibbing is today in France *une bonne truffe*: Tartuffe never missed a chance to gorge himself at others' tables. There may even have been a Germanic influence in Tartuffe: the German name for the Devil, *der Teufel*, gave to French the oath *tarteifle*, recorded in Larousse. If this was known in Moliere's time, the phonetic echo would have been felicitous.

Underlying all these, however, was another idea - fraud. In Old French *truffe* and *truffer* meant 'fraud' and 'to defraud'. *Truffa* in Italian and *trufa* in Spanish signify 'swindle' to this day, and the parallel *truhán*, meaning 'scoundrel', has had a long and vigorous history in the Iberian peninsula. These various forms of the same word turned up in Middle English as the verb 'to truffle' and 'to trifle', as when one speaks of trifling with a girl's affections. In Scottish cant 'to truff' has meant 'to befool' since before A.D. 1500, somewhat before the 'Auld Alliance' with France. There is no evidence that Chaucer was conscious of the existence of truffles, but he knew the word in its derived meaning, for in *The Canterbury Tales* his Parson defines the sin of idleness as:

> the thurrok [i.e., bilge, or sump, or sink] of alle wikked and vileyns thoghtes, and of alle jangles, trufles, and of all ordure, [line 715]

wherein jangles, trufles mean idle chatter and deceits.

All of those words stem back to the Low Latin *truffactor*, a swindler. There is also the Italian *truaare*, the French *troauer*, which give to English the verb 'truck', meaning 'trade'. Equally striking is the Italian *trafficare*, the French *trajiquer*. The unpleasant flavor of these words survives in some contexts in the English 'traffic', but, as befits a nation of shopkeepers, with diminished intensity. 'Traffic' and 'truck' are sometimes synonyms, as when the righteous man declares he will have no traffic (or truck) with yonder early prowling, base informing, sly, litigious, plaguy knave. The origin of *truccare* and *trafficare* has remained obscure. We suggest that they are related to *truffactor*, and that they and *truffactor* itself are all secondary meanings originally derived from the Latin *tuber*, *tufer*, the word for the truffle. The truffle-dealer was a notorious tradesman, and he became a by-word. If we are right, the verbal progeny of the truffle, in the figurative sense, arrived in English in the 13th century, almost four centuries before the Englishman came to know the truffle that was the origin of the word.

The Oxford Dictionary in tracing the history of 'trifle' points out that some philologists have suggested an association with the truffle, but adds that no one has ever proposed a semantic connection. We believe that we can supply such a connection. There is a reason why truffles are associated in some regions with fraud to this day, and why 'truffle' at an early date became a colloquial metaphor signifying fraud. This reason is one that neither philologists nor professional mycologists are best attuned to catch.

When truffles are for sale in the market places of the Mediterranean, *caveat emptor*! The truffle dealer is even now a by-word among his fellows. He mixes dirt with his truffles to add to their weight. He includes truffles in bad condition. He sells inferior species for the best. He adds swarthy fungi that are not truffles. Truffles, in short, are merchandise that lends itself to fraud. They call for unusual experience in the buyer who would avoid deception. In Adolphe Chatin's *La Truffe*, already cited, the author devotes a whole chapter to frauds habitually perpetrated in the retailing of truffles. He reports that in the Dauphine, the Provence, and Perigord, where *triffe* means 'truffle', the ordinary locutions for calling a man a swindler are "T'es un trufier" and "T'es un truffaire". Every truffle fancier teaches his disciples in the first lesson to be on their guard against these perils of the truffle traffic, lest haply they be (as one might say) trifled with and *truffled*.

This proverbial dishonesty of the truffle merchant has escaped the notice of the philologists who have wrestled with our cluster of words. It supplies the link that the Oxford Dictionary found wanting. It plumbs in depth, back through centuries, the mores of the small-town market-places of Italy, the Provence, and Spain. It supplies the background of double-dealing that appealed to Moliere when he hit on the doublet 'Tartuffe' for the name of his character. To have used 'Truffe' or 'Truffier' would have been crudely blunt and a flaw. The Italian *tartufo* never took to itself the secondary meaning of fraud. By resorting to it Moliere was achieving his purpose - hitting on a name that evoked a penumbra of subtle associations, none obvious but all of them of a kind to conjure up the villainy of his hero; associations that are felt rather than thought out, a *parfum* so elusive that it works its influence and passes undetected. All words are enveloped in such a penumbra, which no lexicographer can pin down, and the essence of great writing is the art of utilizing to the full these emanations, which after all express the most intimate emotions of men in communion with one another.

In 1836 there appeared in Paris a book entitled *De la Truffe*, the authorship of which is attributed on the title page to 'M.M. Moynier', about whose identity we have discovered nothing further. Early in that book the reader is told how Moliere came to choose the name 'Tartuffe'. The episode is believable and rings true, but there is no way to verify it. All of the influences and 'sources' that scholars laboriously unravel and dissect and ticket are here synthesized for Moliere in a flash, and the *tuber* of the Romans, the *turma* of the Spaniards, the *trujfe* of the French rises from the crucible of the playwright's mind sublimated and transfigured, imbued as by magic with the immortal attributes of Tartuffe. For Moliere's Tartuffe possesses an eternal vitality, of an order far different from and superior to that other tawdry lure of eternal youth which spurred on Ponce de Leon and his companions, beguiled as they were by childish illusions about *batatas* and miraculous fountains, doomed as they were in this world, like Tantalus in another, to an endless round of recurring hope and recurring frustration.

Here then is the genesis of 'Tartuffe', as related by M.M. Moynier: The authors begin by informing their readers that the story is told to them by the Superior of a congregation of Capuchin friars who in 1826 were still living in Aix-en-Provence. The Father Superior explains that from earliest days the truffle was known to the members of his order, and also its renown as an aphrodisiac. In the course of time, he says, it came about that on a particular occasion Moliere was observing one of the worthy fathers consuming some truffles. Moliere was struck by the rotundity of the friar's face and the vermillion coloring of his cheeks, as he sat there ingesting the truffles at his superior's board. He was swathed and muffled in an enormous woollen habit, and the garment even seemed to envelop a goodly part of the table over which he was hunched. He was a picture of deep meditation. As he savored his truffles, the holy man appeared to be either in a state of ecstatic contemplation before a vision of the Blessed Virgin, or else relishing in deep, long draughts certain intimate internal pleasures artfully contrived. "What do you call this thing?", said Moliere to him. "A truffle, my dear Sir," replied the contemplative. Then said Moliere to himself: "Of *truffe* I shall make Tartuffe, and thou, poor fellow, shalt be he."

12

'Gripau' and 'Grib'

For 'toad' the Catalans say *gripau*, and a word of the same root, *grib*, is reserved by Russians to designate the mushrooms that they esteem most highly. What is the common semantic theme here, and do these words point to a commingling of toads with mushrooms in primitive thinking, long ago? Early in our argument we mentioned this strange evidence and promised to return to it.

The words for 'toad' in Europe, as we have seen, are numerous. They are all, we believe, evasive in character, euphemisms resorted to as a refuge from an early word that fell under tabu. That archaic term is unknown to us - unless it be the Gallic *craxantus*, which comes down to us in a single citation. If our findings prove acceptable, there are about ten basic euphemisms for 'toad' in Europe. We discover 'the Poisonous One' in 'natterjack', in the Anglo-Saxon *tosca*, Breton *tousec*; and 'the Burning One' in the Danish *tudse* and Swedish *tossa*. The Irish combine these two when they say 'the Poisonous Burning One' - *losgann nimhe*. There is 'the Moist - or - Slimy One': Welsh *llyffant*, Anglo-Saxon *yce*, Low German *utze*, and High German *Unke*. To these we add a cluster of words for 'toad' from Eastern Europe: the Czech and Polish *ropucha*, Lithuanian *rupuze* and *krupe*, and Slovenian *rapuch*, stemming back to words meaning pus, foul eruption, rash, coarseness.

The Spaniards see in the toad a skin or hide - *escuerzo*; and so did the Cornishmen when they still spoke their own tongue - *croinoc*. The idea of gaseous distension lies behind the Latin *bufo* and the Russian *zhaba* (**жаба**), the Greek βάτραχος; and the 'cow's udder' of the Albanian *thithelope*. We hazard the suggestion that the *padde* of the Low Countries, Scandinavia, and the British Isles is the same word as the 'padding' of a padded garment. The color of the toad finds expression in the Latin *rubeta* and the Greek φρύνος; - unless this latter means 'the Burning One'. The idea of excrement hides behind the German *Krote*, and was responsible, we think, for shaping the French word *crapaud*, and between these two lie the Romansch forms *cratun* and *crapun*. A third Romansch form, *rustg*, is mysterious; it could have lost an initial *k* or *g*, and in that case might have been originally *krustg*[121] which reminds us of the Lithuanian word for toad, *krupe*. Or has it the same origin as the Italian *rospo*, which by its Latin root conveys the idea of scratching? The Spanish *sapo* is, we think, a Greek borrowing, meaning 'snake' in Greek. The idea of swelling and inflation underlie the Austrian words, *brattling* and *brotze*, and the Bavarian *broz* and perhaps *braste* also. Finally there is the Old French word, *le bot*, 'the Cripple', with its demonic associations, for which a parallel may be found in the Austrian *bratze*.

There remains to be considered the Catalan *gripau* with its Provençal cousin *grapal*. The French *crapaud* evolved from the latter, and we find an additional derivative in the Romany dialect of central Europe, where the toad is called *grapodo*. Perhaps there are other traces of the same word. The Latin *rana*, frog, would normally evolve in French into *renouille* but the actual word is *grenouilk*, and that initial g has given rise to considerable learned discussion. Surely it is borrowed from the name of the toad. There is a familiar French saying: 'Fin comme Gribouille qui se jette à l'eau de peur de la pluie', or else 'de peur de se mouiller': 'As clever as Gribouille who jumps into the water for fear of the rain', or 'for fear of getting wet'. Scholars have debated the origin and meaning of Gribouille. Who was this immortal simpleton? We suggest that he was merely a personification of the toad, which jumps into the water when disturbed by rain-drops, and that in Gribouille we discover the unique survival in French of the variant of *crapaud* that is still current in Catalonia, viz., *gripau*.

The root behind *gripau* is *grip*-, and it means what it says: to grip, to seize, to hold, to grab. There is one act in the life of the toad that is marked by a vice-like grip of altogether astonishing strength and duration. This is the act of mating. Everyone who comes upon toads at that moment in their life cycle, in the spring of the year, is held in horrid fascination by the spectacle. Countrymen know the sight from childhood. The smaller male climbs on the back of his mate and embraces her around the armpits. There he chugs for days and sometimes for weeks, and cannot be detached from her by any interruption, even permitting himself to be cut up alive rather than let go. Instances have been reported where the forearms of the male have become ankylosed from their prolonged immobility. When the males outnumber the females, then the males clamber over each other on the single mate, and cling to each other and to her, even smothering her to death, and still they cling in a cluster to the corpse as it begins to decompose. These knotted clusters of toads find apt expression in the Provençal *grapal*, related as this word is to the idea of a cluster, as of grapes.[122]

---

[121] Cf., e.g., German *Kreide*, chalk, which becomes Romansch *rida*.

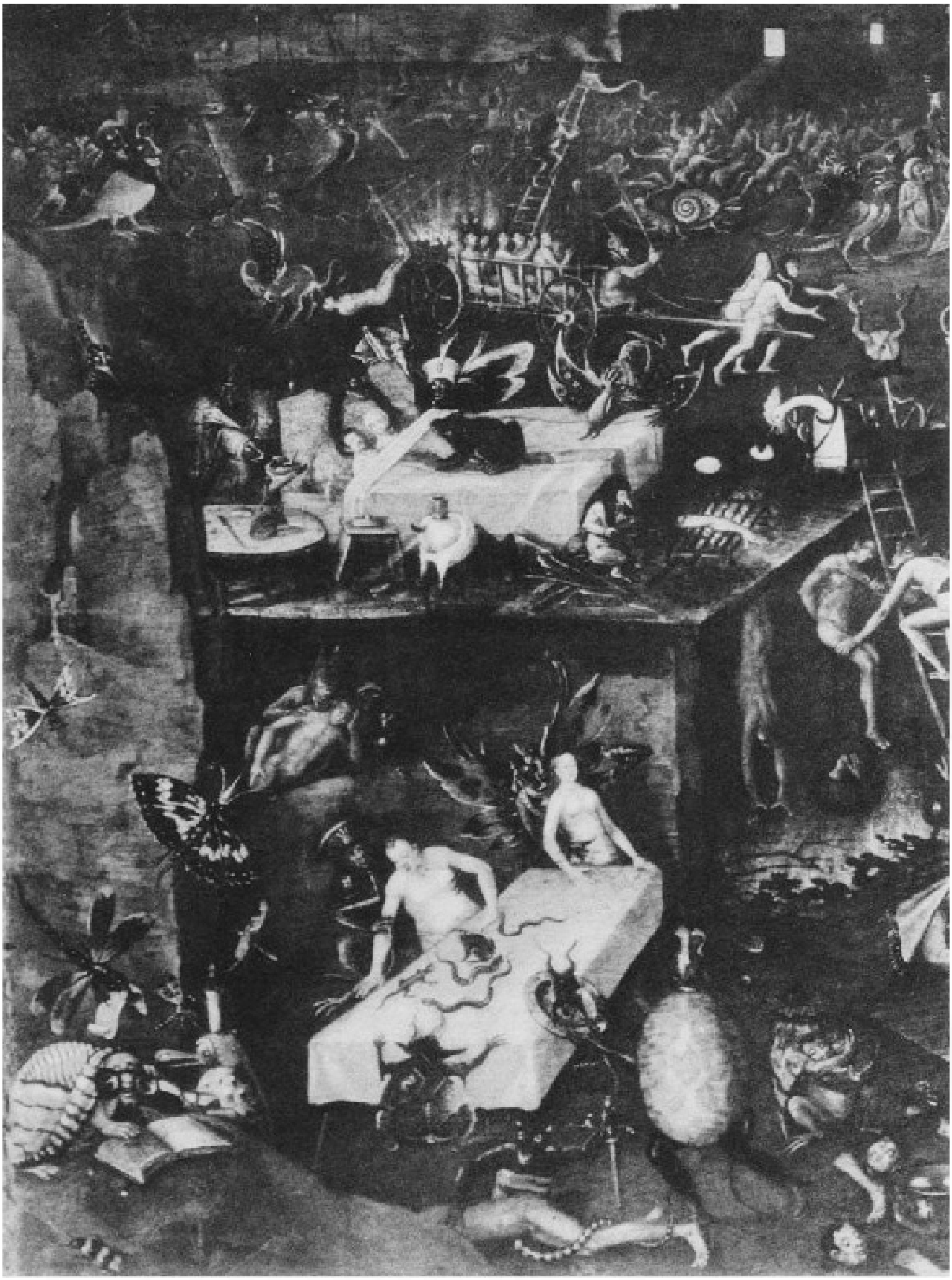


PLATE XXXIII

Toads in Hell. Detail from a painting by the pseudo-Herri met de Bles.

Venice, Ducal Palace.

---

[122] See F. Angel's *La Vie et les Moeurs des Amphibiens*, Paris, 1947, pp. 153-155, for a vivid account of the manifestations of the mating instincts in toads.

There is abundant evidence that the sex habits of toads gripped the imagination of our ancestors. Toads were a symbol of lechery, and so were warts and moles, with which toads were associated. Professor Meyer Schapiro has pointed out that "the conception of the unchaste woman tormented by serpents at her breasts and sometimes toads at her private parts is common in Romanesque and Moslem fantasy".[123] Probably the supreme expression of this association of ideas is in Shakespeare, when Othello, obsessed with jealousy, confronts Desdemona with his monstrous charge, and then in a terrifying passage drains the very dregs of his tormented being, rising to his climax when, at the end, he invokes the image of mating toads in a figure that would be foully obscene in any context but this:[124]

> Had it pleas'd Heaven
> To try me with Affliction, had they rain'd
> All kind of Sores, and Shames on my bare head.
> Steep'd me in povertie to the very lippes,
> Given to Captivitie, me, and my utmost hopes,
> I should have found in some place of my Soule
> A drop of patience. But alas, to make me
> The fixed Figure for the time of Scorne,
> To point his slow, and moving finger at!
> Yet could I beare that too, well, very well:
> But there where I have garnerd up my heart,
> Where either I must live, or beare no life;
> The Fountaine from the which my currant runnes,
> Or else dries up: to be discarded thence,
> Or keepe it as a Cesterne, for foule Toades
> To knot and gender in!

Bosch shows us this lecherous toad in the detail of his *Seven Mortal Sins* that we have reproduced on Plate XIII. In Venice there hangs in the ducal palace a singular painting of demonic import, crowded with the creatures of Hell. It is attributed to a painter of unknown identity who is known as the pseudo-Herri met de Bles. In one detail we discover our giant toad squatting on the double bed and staring at its sinful occupants. In the mosaics of the Battistero in Florence, executed early in the 13th century, a supine toad is superimposed on the body of a supine woman, and here the meaning is revoltingly clear.

There emerges, then, a clear picture of the toad as seen through medieval eyes - poisonous, pustulous, lecherous, possessed of a strange capacity to innate itself with air; in its facial expression and in the disposition of its torso and limbs, the very incarnation of a soulless homunculus, crouching and jerking and functioning like human kind on the animal level of man's dual nature; a horrible caricature in miniature of sensual man and miserable sinner.

We suggest that the Catalan and Provençal words for 'toad' were originally keyed to the mating act. In the fungal world there are many erotic and phallic associations, as we have seen. It would have been a happy solution to our problem of *grib* and *gripau* if we could have discovered in the Russian word *grib* the erotic associations that would have linked it with our interpretation of *gripau*, but they do not exist.

The story of *grib* in the Slavic world is the same that we know well from the West. At one time the word designated a particular class of mushrooms. By its pre-eminence this class came to stand for the whole mushroom world, and its name became generic, usurping the semantic terrain originally occupied by the Indo-European words, *gomba* and the hypothetical *bu-dla*, which we discussed on pages 93-94 [of orig. edit.]. A glimpse into this curious history is offered to us by the *Book of Rules* of the Josif Volokolamskij Monastery for the 16th and 17th centuries,[125] wherein we learn from the refectory diary that the monks were served mushrooms regularly on Wednesdays and Fridays, the fast days. The amanuensis records sliced mushrooms, boiled sliced mushrooms,

---

123. Quoted from his article, 'From Mozarabic to Romanesque in Silos', *The Art Bulletin*, vol. XXI, no. 4, December 1939, p. 328. See also Walter Clyde Curry's *Chaucer and the Medieval Sciences*, Oxford University Press, N. Y., p. 84 ff.
124. *Othello*, sc: 2, 61; on one other occasion Shakespere refers to mating toads, *Troilus and Cressida* II: 3, 170: "I do hate a proud man, as I hate the ingendring of Toades." See also Waldemar Deonna's paper on 'La Femme et la Grenouille', in *La Gazette des Beaux-Arts*, November 1952.
125. See *Chtenija v Obshchest've Istorii i Drevnostej pri Moskovskom Universitete* (**Чтения в Обществе Истории и Древностей при Московском Университете**), 1880, bk. 3, p. 113.

chopped mushrooms, mushrooms with sauce, and mushrooms with garlic. For 'mushrooms' he uses only two words: *griby* and *gruzdi*, and it is clear that all kinds belonged to one or the other. Apparently all boleti were *griby* and all gilled mushrooms were *gruzdi*. *Gruzd*' still carries traces of this old meaning: it floats uncertainly in its specific application among various lactarii and russulas, though it belongs specifically to the *Lactarius piperatus*.

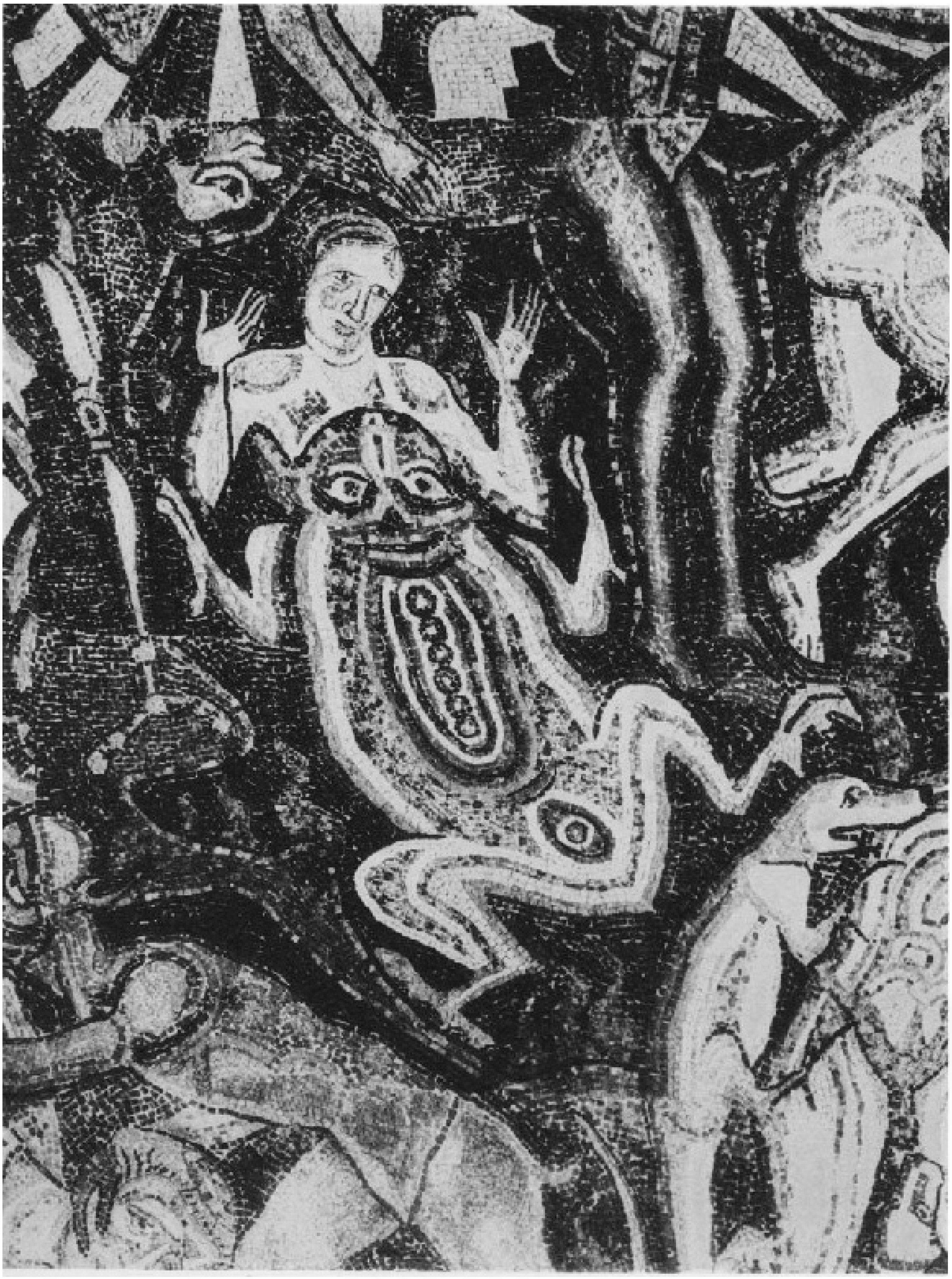


PLATE XXXIV
Toad. Detail from a mosaic.
Florence, Battistero. Photo by Fratelli Alinari, Florence

Grib circulates chiefly among the mycophilic northern Slavs and the Slovenians. We think it is unknown in Serbian and Bulgarian, but it appears in Polish as *grzyb*, in Czech as *hrib*, in Ukrainian as *hryb*, and in

Slovenian as *grib*. The idea inherent in the root is familiar to us: grubbing, rooting, scraping, digging, grabbing, gripping.[126] It evokes the activity of the mushroom gatherer in the forest. Down into Renaissance times the Germans used *Grübling* as a name for some kind of underground mushroom, perhaps a truffle, and of course its etymology is identical. Was it accident that led to the use of the same root in the East for 'mushroom' and in Catalonia for 'toad'? Did not this usage emerge from the common pool of ideas that we have traced at length, a unified field of associations, albeit discordant associations inasmuch as the Slavs loved their mushrooms whereas all peoples rejected the toad?

---

[126] Max Vasmer in his new Russian etymological dictionary suggests a novel root for *grib*, linking it with certain words signifying 'slime'. While slime, as we have shown, is semantically appropriate for a fungal word, the etymology that we espouse is semantically felicitous, and we are fortified in our position by the comments of Roman Jakobson, which he allows us to quote:
"As to^n'fc, I have not the slightest doubt about its origin. The Slavic languages clearly attest all vocalic grades of the root *greb*; - (1) *greb-*, (10) the corresponding prolonged grade *greb-*; (2) *grab-*, (20) the corresponding prolonged grade *grab-*; (3) *gr'b-*, (30) the corresponding prolonged grade *grib-*. Thus: (1) Russ. *grebti* (**гребти**), *gresti* (**грести**), Old Church Slavonic *greti*, to dig up, dig in, rake, spade, shovel, scratch, scrape, row; Bulgarian *greblo*, rake, oar; Russ. *grebat'* (**гребать**), to disdain, *grebta* (**гребта**), sorrow, *greben'* (**гребень**), comb; (la) O Ch SI, *pogrebati* (**погребати**) to bury. (2) Russ. *grab* (**гроб**), grave; (20) Russ. *grabit'* (**грабить**), to snatch, grab, *iobgrabli*, rake. (3) Czech *h&rcaron;biti*, to lie buried; *h&rcaron;belec*, curry-comb; (30) Serbo-Croatian *griblja*, furrow, *gribati*, to furrow; Russ. *grib*, mushroom. Similar vowel alternations are present in other Slavic roots."
When Professor Jakobson worked out the foregoing etymology, neither he nor we had discovered the obsolete German word *Grübling*, for which German philologists give the same origin as he for *grib*. German mushroom manuals give *Grubenlorchel* as the common name of the *Helvella lacunosa*; if this name is in actual circulation, it is a survival in Germanic of the *grib* root.

13

The Flies in the Amanita

In Europe the *Amanita muscaria* is one of the most widely known of the wild mushrooms. It is the archetype for the 'toadstool' tribe in mycophobic countries, being the first gilled mushroom that the mycophobe learns to recognize, that he may the better curse it. In mycophagic lands all country folk know it, and have devised for it a diverse popular nomenclature. The esteem in which the various edible species are held differs in different parts of Europe, but the obloquy meted out to the fly amanita is uniform and heavy. Its evil reputation far outruns its deserts. There is a general belief that the victim who eats it dies; yet we believe that this murderous accusation is unsupported by a single trustworthy case history. How strange it is that the fly amanita should be far better known than its truly lethal cousins, which in some parts of Europe, such as Great Russia, possess no common name!

A mushroom that is merely lethal is less interesting than one possessed of the devil. Here lies, we believe, the explanation for the singular reputation of the *Amanita muscaria*. This mushroom inebriates, it does not kill, and in all primitive societies inebriation, like delirium and even insanity, is held in awe as a manifestation of divine powers. The problem of the *Amanita muscaria* is one of the most elusive that ethno-mycology has to offer, and one of the most fascinating. Can we show that its intoxicating virtue was known to our remote ancestors and that they made use of it? Did it play the role of an important hallucinogen in the early social history of Europe? For almost two centuries the slow debate has gone on, and the issue is still moot. Perhaps it is possible to adduce fresh evidence, but first we shall sum up the discussion to date.

In the early 18th century, the Swedish traveler Philip Johan von Strahlenberg journeyed extensively in Russia, Tartary, and Siberia. His admirable report, written in German, appeared first in Stockholm in 1730, and an English translation came out in London in 1736, bearing the lengthy title: *An Historical and Geographical Description of the North and Eastern Parts of Europe and Asia particularly of Russia, Siberia, and Tartary*. Von Strahlenberg was a thorough and conscientious observer. From his pages the western world learned for the first time of the Korjak tribesmen of Kamchatka, and how they consumed the fly amanita for its intoxicating effect. This nugget of curious anthropological information drew wide attention throughout the literate world, and the interest then aroused has continued up to now. Indeed, a bibliography dealing with this Korjak practice would be surprisingly long. Today we know that traces of it survive also among the neighboring communities of Kamchadals, and also among the Chukchees, the primitive people living in sparse and tiny villages at the easternmost tip of Siberia, across the Bering Strait from Alaska.

Indeed, we know more. Far to the west of the Korjaks and Chukchees, in western Siberia, in the northern lands lying between the Ob and Yenisei rivers, we have fragmentary but reliable reports that the shamanistic use of the inebriating fly amanita has survived into our own times. Kai Donner, the Finnish scholar, states that the Samoyeds in this region eat the mushroom, and also the people known as the Yenisei-Ostjaks.[127] The Samoyeds are not of the Finno-Ugrian culture, but the Samoyeds and Finno-Ugrians together make up the family of peoples known as Uralic. The Yenisei-Ostjaks, though neighbors, are of different cultural lineage, being one of those now scattered tribes, inhabiting the most inhospitable and remote corners of Siberia, grouped together for convenience by anthropologists as 'Hyperborean' or 'Paleo-Siberian'. Donner reports that the shamans of the Yenisei-Ostjaks, to achieve the desired psychic effect, eat seven mushrooms, for which their name is *hanggo*, a word clearly related to the Latin *fungus* like the other variants mentioned on pages ijSff. Well to the east of the Yenisei-Ostjaks, east of the Lena River, but to the west of the Chukchees and Korjaks, there is another Paleo-Siberian people, the Yukaghirs. According to Jochelson in his study of this people, made two generations ago, they no longer used the fly amanita in his time but they preserved a tradition of its use in earlier days. Jochelson unfortunately failed to note the Yukaghir name for it, nor did he record the details of the tradition.

---

127. See Donner's *Bei den Samojeden in Sibirien*, Stuttgart, 1926, p. 110; also his 'Ethnological Notes about the Yenisey Ostjak (in the Turukhansk region)', published in the *Memoires de la Societe Finno-ougrienne*, vol. LXVI, Helsinki, 1933, pp. 81-82. The former study has been translated and published (New Haven, 1954) with the title *Among the Samoyed in Siberia*, in the series of Behavior Science Translations, Human Relations Area Files. With that disregard for precision in matters mushroomic which afflicts most Anglo-Saxon work, the translator rendered *Fliegenschwamme* by 'toadstools'.

More than two centuries have passed since von Strahlenberg published his book, and for the role of the fly amanita as an inebriant in Siberia we still must rely on stray data that anthropologists have happened to catch. A desideratum for Russian and Finnish workers should be an intensive ethno-mycological survey of all the peoples of Siberia, to discover every trace of the inebriating mushroom. In folklore, in linguistics, and in the details of contemporary usage, there must be much evidence concerning it that we now ignore. If we assume, as some anthropologists have done, that the Paleo-Siberian peoples (Korjaks, Kamchadals, Chukchees, Yukaghirs, Yenisei-Ostjaks, etc.) once roamed over most of northern Siberia, and that they were then sent scattering to their present peripheral habitats by irrupting Mongol and Turkic invaders from the south, then the use among them of a common Indo-European word for the fly amanita would certainly date back to the time before they were blown to the four corners. The specific application to the fly amanita by certain of these vestigial peoples of a word that in Indo-European is generic for all mushrooms poses an exciting question: did these Siberian tribesmen borrow the use of the inebriating mushroom, and with it the name, from the Indo-Europeans?

Before the 18th century was out, in 1784, von Strahlenberg's compatriot, the scientist Samuel Odman, advanced the thesis that 'going berserk' in early Norse times had been a state of excitement produced by the fly amanita.[128] The Odman suggestion was taken up and elaborated more than a century later, in 1886, by the Norwegian botanist Fredrik Christian Schübeler in his *Viridarium Norvegicum I*. The Odman-Schübeler theory took popular hold in parts of Scandinavia and even gained acceptance there among writers of scientific and popular handbooks, school textbooks, and encyclopaedias. Indeed, many educated Swedes and Norwegians seem to take the theory as accepted fact.

In 1929, a specialist in the medical history of Norway, Dr. Fredrik Gron, undertook to challenge Odman and Schübeler.[129] He dismissed the fly-amanita explanation for 'berserk-raging' as weakly founded and improbable, pointing out that nowhere in sagas or other early Nordic source is there a reference to the fly amanita. In this he has been recently sustained by Professor Magnus Olsen, the outstanding authority today on Norse literature and traditions. Furthermore, the ancient writings of the Mediterranean basin make no allusion to fungal hallucinogens nor is there a single mention of inebriating mushrooms in the voluminous source materials available to us concerning the witchcraft cult. Odman and Schübeler had relied solely on the analogy of modern practices observed among the Siberian tribes.

But their side of the argument has not lacked champions. On November 1, 1918, the famous Swedish meteorologist H. Hildebrandsson read a paper before the Royal Scientific Society in Upsala in which he recounted an extraordinary episode. It seems that in the war between Sweden and Norway in 1814, some soldiers of the Swedish Varmland regiment were observed by their officer to be seized by a raging madness, foaming at the mouth. On inquiry, it was learned that the soldiers had eaten of the fly amanita, to whip up their courage to a fighting pitch. We have not seen the Hildebrandsson paper, nor discovered the evidence contemporary with the alleged episode on which he relied, but both he and the society before which he appeared enjoy the highest standing in scientific circles, and his paper was quoted by Professor Carl Th. Morner, a distinguished Swedish physiologist, whose avocation was the study of botany and the higher fungi, in two of his publications on mushrooms.[130] The Odman-Schübeler thesis received further endorsement from Professor Rolf Nordhagen, the Norwegian botanist, in an article in the Norwegian newspaper *Aftenposten* of January 11, 1930.

There is a tradition in Russia that the fly amanita was once used in folk medicine. N. Annenkov refers to this former usage as a fact in his *Botanicheskii Slovar*' (**Ботанический словарь**), published in St. Petersburg in 1878. Rudolph Krebel in his *Volksmedicin und Volksmittel verschiedener Volkerstamme Russlands*, published in 1858, said that it had been used to treat lameness, but he is not precise in citing his authority nor in identifying the practice with a particular place or period. In some kinds of arthritis the exertions stimulated by the fly amanita might indeed be helpful. Perhaps there exist earlier treatises on Slavic folk medicine that will amplify these insufficient hints. In Professor C. Hartwich's great work, *Die menschlichen Genussmittel*, published in Leipzig in 1911, we find on page 256 a sentence which, translated, says: "In a letter from a native of Zurich in 1799, in which year a Russian army under Korsakov was stationed there, the amazing statement was made that the Russians gathered and ate fly amanitas on the Zürichberg. Of course, the Russians must have learned to do this in their own country." The pharmacologist Emil Eidenbenz of Zurich has gone to considerable pains for us in looking for the letter on which Professor Hartwich relied, but with no success. Thus a promising hint, on inquiry, yields meager results.

---

[128] His paper was entitled 'Försök at utur Naturens Historia förklara de nordiska gamla Kämpars Berserka-gang' ('An attempt to explain the berserk-raging of ancient Nordic warriors through natural history'), published by the Kungliga Vetenskaps Akademien, Nya Handlingar, vol. 5, pp. 240 et seq. For all of our references to the Scandinavian pronouncements on the fly amanita we are indebted to Professors Georg Morgenstierne and Rolf Nordhagen.

[129] In a paper entitled 'Berserk-gangens vesen og årsaksforhold' ('The nature and causes of berserk-raging'), Throndhjems Videnskabers Selskabs Skrifter, No. 4.

[130] 'Några erfarenhetsrön om de högre svamparna: Kritisk öfversikt,' in *Upsala Läkareförenings Förhandlingar*, Bd. XXIV, Heft 1-2, 1918; also, the same author's *Om de högre svamparna*, 1919.

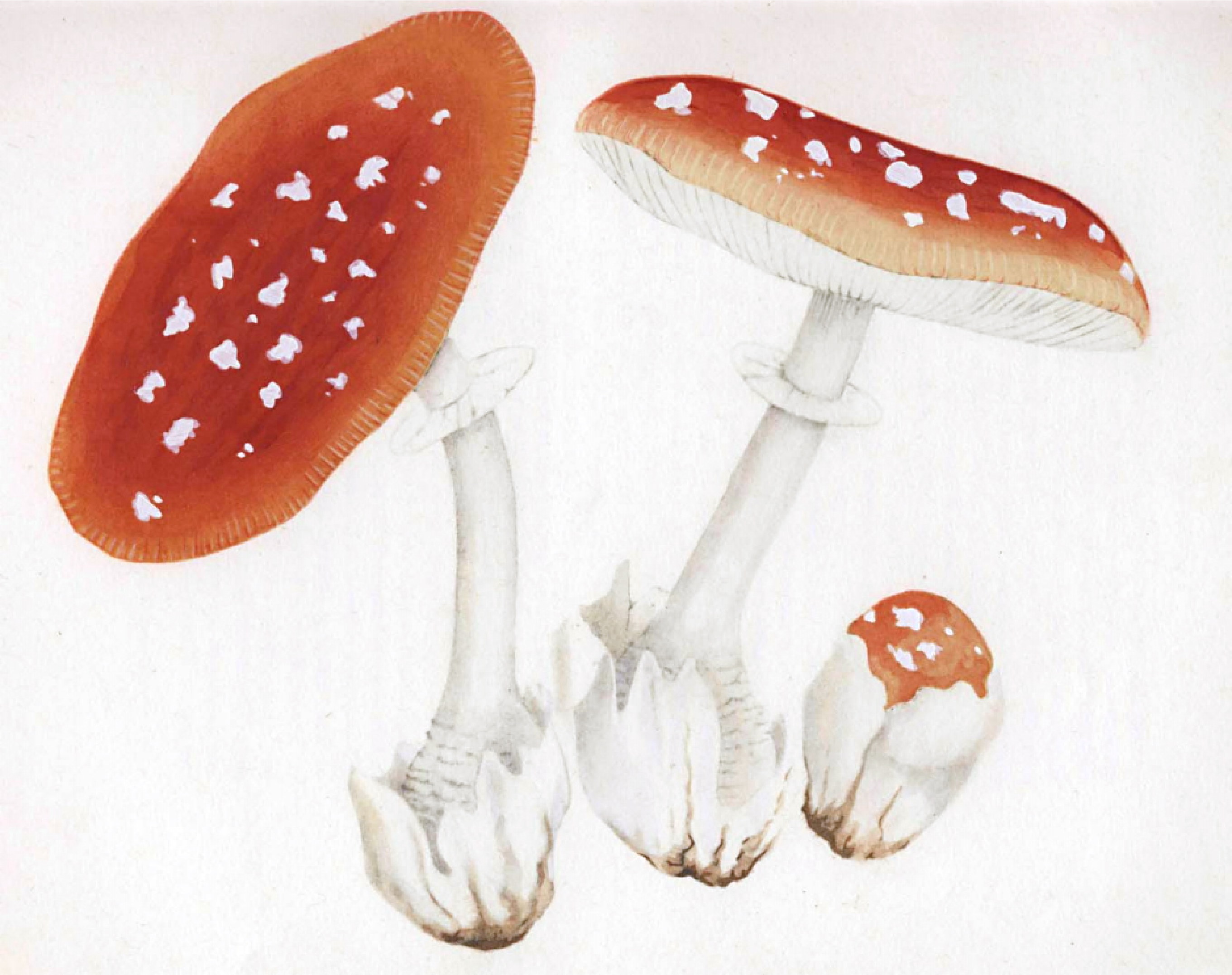


PLATE XXXV
Jean-Henri Fabre
Amanita muscaria Fr. ex Pers.
French: *tue-mouche, crapaudin, fausse oronge*;
German: *Fliegenschwamm*;
Russian: *mukhomor*;
Polish: *Muchomor czerwony*.

Our European ancestors had opportunities to witness the inebriation caused by the fly amanita, it only when accidents occurred. There are numerous medical case histories of such episodes. One of the best is to be found in a paper by Dr. M. Roch, a physician attached to the Cantonal Hospital in Geneva, entitled 'Les Empoisonnements par les champignons', published in the *Bulletin* of the Societe Botanique de Geneve, 2nd series, 1913, where he reports on the wild delirium of four Italian laborers in the Canton of Neuchâtel after they had eaten a mess of fly amanitas. The delirium was followed by sleep, and sleep by a return to normal sobriety. Such episodes must have occurred from earliest times, and must have aroused the awe that the astonishing symptoms would naturally inspire among people whose lives were shaped by beliefs in supernatural forces. But in the early treatises on mushrooms, before von Strahlenberg's journey into Siberia, we find no intoxicating properties attributed to the *Amanita muscaria*.

It seems clear that cooking attenuates or kills the distinctive virtue of the fly amanita. In Italy and France it is not rare to find individuals who habitually eat this mushroom with impunity. Our friend Camille Fauvel, the mightiest mycophage of us all, informs us that he has sat down to a mess of fly amanitas scores of times. He gathers the mushrooms, peels the caps, discards the stems, and cooks the peeled caps in any of the usual ways. Holger Lundbergh of New York reports to us that his mother in Sweden was taught by the famous painter Anna Boberg, nee Scholander, to add a snippet of the cap of a fly amanita in preparing all mushroom dishes, in order to point up the flavor. Whence came this astonishing culinary secret, uncovered thus in the heart of mycophobic Sweden? Mrs. Boberg can hardly have hit on it herself. Did she pick it up elsewhere in Europe? Or was it indigenous to Sweden, the final emanation of some ancient esoteric lore, possibly distorted beyond recognition from its original purpose and aspect?

For the best accounts of the symptoms of fly-amanita inebriation, we turn to the observations of Waldemar Bogoras and Waldemar Jochelson during their visits to Kamchatka a generation ago. (Their studies were published by the American Museum of Natural History as parts of the memoirs of the Jesup North Pacific Expedition.) On eating the mushrooms a period of exaltation ensues, in which the chewers of the raw mushrooms shout and rage. Then they engage in feats of prodigious physical exertion and experience illusions of radical changes in all dimensions, of miraculous mobility, of metamorphosis. The folklore of northern Europe is filled with supernatural phenomena that remind us of these symptoms, as for example the powers of mobility attributed to witches and werewolves. But are mushrooms ever mentioned in those tales?

Of themselves, these analogies from folklore carry no weight, and indeed we must be cautious about false clues. Take for example the strange case of Alice in Wonderland. Shortly after her adventures begin, this enchanting child nibbles at a mushroom, and it produces in her the typical sense of changed dimensions that we recall in the horrifying accounts of the amanita-eating Korjaks. All of Alice's subsequent distortions, softened by the loving irony of Lewis Carroll's imagination, retain the flavor of mushroomic hallucinations. Is there not something uncanny about the injection of this mushroom into Alice's story? What led the quiet Oxford don to hit on a device so felicitous, but at the same time sinister for the initiated readers, when he launched his maiden on her way? Did he dredge up this curious specimen of wondrous and even fearsome lore from some deep well of half-conscious folk-knowledge? On first reflection that mushroom in *Alice*, so innocent for the uninformed, seems like a gentle aftermath, a distant reminder, of awful rumblings from barbaric times now forgotten; like the long, harmless swell that rocks the sea many days after the havoc of the hurricane. The temptation is strong to espouse this romantic hypothesis, and for the purposes of the controversy among Scandinavian scholars, this would tilt the balance, and the ayes would have it.

But we think that Alice's mushroom grew in Kamchatka, not in the forests of primeval Europe. It was on July 4, 1862, while rowing gently up the Isis to Godstow, that Lewis Carroll embarked on Alice's adventures, holding three little maidens spellbound by the tale. Over the following months he put the story into final form, and presented the completed manuscript to Alice for Christmas in the same year. Now it so happens that the earliest popular manual on mushrooms in the English language made its appearance in that same year, M. C. Cooke's *A Plain and Easy Account of British Fungi*. We do not know exactly when it came on the market, but we know that it was the subject of a lengthy review in the October 4 issue of *The Gardeners' Chronicle and Agricultural Gazette*. (The reviewer commended Cooke's efforts, and then conceded the hopeless mycophobia of the English: "... notwithstanding all that is said in favour of mushrooms, we suspect it will take a long time to remove the deep rooted prejudice that exists against them in this country, and teach our rustic population those that are harmless.") Cooke's little volume describing strange fungal growths was of a kind to attract Alice's creator. On pages 20-21 Cooke discusses the use to which the fly amanita is put by the Korjaks, and its effects on the eater: "The natural inclinations of the individual become stimulated. The dancer executes a *pas d'extravagance*, the musician indulges in a song, the chatterer divulges all his secrets, the orator delivers himself of a philippic, and the mimic indulges in caricature. *Erroneous impressions of size and distance are common occurrences*, a straw lying in the road becomes a formidable object, to overcome which a leap is taken sufficient to clear a barrel of ale or the prostrate trunk of a British oak." (The italics are ours; the reader will note the Gilbertian flavor of the oak that had to be 'British'.) In Lewis Carroll's diaries we learn that he began putting Alice's adventures on paper on November 13, well after Cooke's volume was on the market. For more than four months his tale had been taking shape in his mind, a period when he must have been ripe for such suggestions as Cooke had to offer.

With a shout of discovery we leap to the conclusion that Alice's mushroom is the one that Cooke serves us. The timing is perfect. Surely the progenitor of Alice, in the cloistered retreat of Christ Church, with Cooke's manual at hand, transmuted the untamed practices of the uncivilized Korjaks into the poetry of wonderland.[131] But no sooner do we reach this presumption than doubt re-enters, raising an admonitory finger. Can we be sure there was no native memory of a miracle-working mushroom? We turn to the English translation of Jacob Grimm's *Teutonic Mythology*, and there in volume 4, on page 1412, we find the following statement, based on an Irish fairy-tale that we have not succeeded in locating: "The Elf-King sits under a great toadstool, and whoever carries a toadstool about him grows small and light as an elf." Certainly Lewis Carroll never read this reference in Grimm, but Grimm's wonder-working fungus of Irish lineage long antedated Cooke and von Strahlenberg, and Alice on her journey may have encountered this native mushroom. Once again our inquiries leave us poised between yes and no.

If on balance we incline to the view that Cooke inspired the mushroom episode in *Alice*, this is because Cooke's influence is clearly felt in Charles Kingsley's famous novel, *Hereward, the Last of the English*, published in 1866. In Chapter 10 Kingsley introduces to his readers an old Lappish nurse, living in England, who possessed the secret of the "scarlet toadstools". She adds their juice to the men's ale, and makes them laugh and roar, "merry-mad everyone of them", and thus she extracts from them their secrets. Kingsley in the story expressly denies that the English of pre-Conquest times knew the virtues of the "strange fungus, with which Lapps and Samoiedes have, it is said, practised wonders for centuries past". In any case, the historical novelist is not an historical source. He too had read his Cooke, or some other of the earlier writers about the Korjaks, and to adorn his plot he fathered on the Lapps the practices of the Siberian tribes remote from them and remoter still from England. But today we know that he was right about the Samoyeds. Will some persistent inquirer someday discover that the Lapps knew the secret too?

In the annals of Europe's cultural history it is hard to find a parallel for the polemic over the fly amanita's role in the Viking world. Odman published the initial paper in 1784, and at a glacial pace the controversy has simmered since then in Scandinavia and nowhere else. In English and German mycological writings one sometimes happens on allusions to it, but only allusions. Yet for the ethno-mycologist and the student of northern Europe's early culture the problem will not stay laid, so long as the meager and tantalizing evidence hangs balanced as it does today.

We believe a new approach to the enigma of the fly amanita is to be found in the history of word meanings. We intend to propose a novel reason for the link that binds the famous mushroom with the fly. This is a bold undertaking, for the traditional explanation, the official and orthodox explanation, has seemed to everyone for centuries to be full, perfect, and sufficient. Indeed, the argument in favour of orthodoxy in this instance is so strong that if we should succeed in our challenge, our triumph in this our secluded garden of intellectual disputation would be high drama, even if only in a minor key: caviar for initiates.

Everyone who knows the first thing about wild mushrooms knows why the fly amanita is so called: it kills the flies that feed on it and until modern times it was used as a household insecticide on the Continent. This is what all the books say. What is more, there is a large part of Europe where the untutored rustics, the people who read no books, also accept the story as part of their legacy of folk knowledge. It belongs to that curious fund of 'facts' that people keep repeating to each other and believing, without verification or analysis, like the saying that all Russians are good linguists. The area of Europe where our folk belief prevails is extensive but not all-inclusive. It embraces the Slavic world, the Germanic world except the British Isles, the Vosges, where Franco-German bilingualism prevails, and one or two enclaves elsewhere in France. The ancient authors, though they have much to say about the fungi, never refer to a fly-killer, and in modern Italy among the country folk we believe the association with the fly is unknown, but our inquiry has not been exhaustive. It is unknown among the Basques, and apparently to all the rural population of the Iberian peninsula. If we judge by Eugene Rolland's evidence in his *Flore Populaire*, in France the name *tue-mouche*, 'kill-fly', is indigenous only in Alsace and the Aude, though thanks to the mushroom manuals, it is now familiar to a sprinkling of educated Frenchmen elsewhere. (Rolland reports that at Val-d'Ajol in the Vosges the natives hang the fly amanita from the ceiling, where, he says, it draws flies to their death.) By contrast the German *Fliegenschwamm* or 'fly-fungus' has its variants in all the German dialects, and also in Dutch and the Germanic languages of Scandinavia, but not in English. (The 'fly agaric' and 'fly amanita' of England are learned inventions of the past two centuries.) The Russians say *mukhomor* or 'fly-killer', and parallel terms are found on the tongues of other peoples of the Slavic family.

---

[131] We cannot prove that M. C. Cooke's book was in C. L. Dodgson's possession. We learn from W. G. Hiscock, assistant librarian of Christ Church, Oxford, that Dodgson's library was dispersed after his death, and in the auction sale many books were put up in lots with only one or two titles itemized in the catalogue.

In short, the fly amanita is linked with the fly almost solely among the Germanic and Slavic peoples of northern Europe. We can trace it back six centuries, and in a series of quotations we are going to document this folk belief from the Middle Ages down to the Age of Science. We shall prove that its credentials have been seasoned with time. We shall suggest that what has long been believed may be only part of the truth, or even wholly false.

The earliest reference to the fly amanita known to us is in *De Vegetabilibus*, the considerable work on the vegetable kingdom written in the 13th century by Albertus Magnus. Twice he speaks of it and on each occasion refers to its fly-killing powers:

> [1]
>
> Tuber enim, quod vocatur muscarum, venenosum est; et si lacti immisceatur, et muscae cadant super lac illud, gustantes ipsum, inflantur et moriuntur. Est autem illud tuber in superficie latum, et ad rubedinem declinans, habens in superficie ampullas, sicut sunt ampullae in pelle valde leprosi hominis, in quibus non est humor, sed ventositas quaedam interclusa. - *De Vegetabilibus*, BOOK II, Chap. 6: 87.
>
> For the mushroom that is called flies' [mushroom] is poisonous; and if it be mixed with milk, and flies fall upon that milk, upon tasting it they swell up and die. Moreover, that mushroom is broad, and tends to redness, having on the surface vesicles, such as are the vesicles on the skin of a very leprous man, in which not moisture, but a certain windiness is enclosed.
>
> [2]
>
> In nostris autem habitationibus invenitur fungus, qui latus est et spissus, aliquid ruboris habens in superficie, et in illo rubore habet multas ampullas elevatas, quarum quaedam fractae sunt, quaedam non: et ille mortalis est, et statim interficiens, et vocatur fungus muscarum, eo quod in lacte pulverizatus interficit muscas. *Idem*, BOOK VI, Chap. 7: 345.
>
> Among our dwellings, moreover, there is found a fungus that is wide and thick, having a little ruddiness on its surface; and in that ruddiness it has many raised vesicles, of which some are broken, some not; and that [fungus] is death-dealing, and kills immediately, and is called flies' fungus for this reason, that when pulverized in milk it kills flies.

The quotations are taken from pages 136 and 517 of the text edited by Carl Jessen and published in Berlin in 1867.

A century later, in the years 1349-50, another German, Konrad von Megenberg, wrote *Das Buch der Natur*, the earliest work on natural science in the German language. He devotes a paragraph to various fungi, and ends up with some quaint sentences about the *Amanita muscaria*. Writing in the Bavaro-Austrian dialect, he said:

> Es ist auch einer anderley schwammen die seind zuomal unreyn die seind breit und dick und oben rot mit weyssen bleyterlen. Wann man die zuo milch mischt so deet er die muggen. Darumb heyssen es muggennschwammen. Und zuo latein mustineti[?].
>
> There is also another kind of fungi which is wholly unclean; they are broad and on top red with white little plaques. When one mixes them with milk, they kill flies. Therefore are they called muggennschwammen [i.e., 'fly-fungi'] and in Latin *mustineti*[?].

We have taken our text from the earliest printed edition, dated 1475.

Our third author is likewise German, Valerius Cordus, known sometimes as the father of modern pharmacology, whose untimely death at the age of 29 in the year 1544 was considered by his Renaissance contemporaries, the scholars of the New Learning, as the crudest of blows and an irreparable loss. In his *Adnotationes* or commentaries on Dioscorides he too devotes one paragraph to mushrooms, and one sentence to the fly amanita. In his text we find the earliest use known to us of the modern German name *Fliegenschwamm*:

> Sub Betulis arboribus in candido & rufo colore varii nascuntur Fungi, quos *Fliegenschivemme*, id est, Muscarios fungos vocamus, quoniarn muscas lacte intriti occidunt.
>
> Under birch trees, white and red in color, spring up various fungi that we call *Fliegenschwamme*, that is, 'fly-fungi', since when crumpled in milk they kill flies.

The father of the science of mycology is the designation that has often been bestowed on Charles de Lecluse, a Frenchman of Arras, whose contributions to botany make him a major figure in the history of that branch of knowledge. The year 1601 saw the publication in Antwerp of his *Rariorum Plantarum Historia*, an important work in which a sizeable section was devoted to the fungi of Hungary, or 'Pannonia' as the region was called. Carolus Clusius, the name by which De Lecluse is better known, was the first writer on mushrooms who fixed on them his gaze, describing them with the fidelity of a man who sees and puts down on paper what he sees. His description of the *Amanita muscaria* is exact, and then he refers to the flies:

> Invenitur etiam hsec species in caeduis silvis Francofurto ad Mcenum vicinis, unde rustics mulieres lectam, in urbem deferunt venalem, cum non ignorent plerosque empturos ad muscas necandas: nam cum, ut dixi, muscse libenter illi insideant, divulsam in fragmenta, varijs in conclavi locis ante fenestras spargere solent, ad quae invitatae & excitae muscas, succum sugunt ipsis perniciosum, & paulo post etiam lethalem.
>
> This species is also found in the aged forests around Frankfort-on-the-Main, where it is collected by peasant women and brought to the city for sale. Since most of the buyers know it well, they buy it to kill flies with. And so, as I said before, since the flies like to sit [on these mushrooms] people scatter them in pieces around the room and strew them before the windows; the flies, attracted and excited, suck the juice which is poisonous for them and soon die.

Albertus Magnus, von Megenberg, Valerius Cordus, Carolus Clusius - here is a formidable foursome supporting with their testimony the traditional view of the fly amanita. A critic, however, might find occasion for certain reservations. All four were Germans or writing against a background of German experience.[132] Why did not the Greek, Latin, French, and Italian writers report the same phenomenon? The credibility of Albertus Magnus is somewhat impugned by his description of the mushroom: the *Amanita muscaria* has no windy pustules suggestive of lepers. The Doctor Universalis must never have focused his eyes on the fungus he was describing: at least part of what he said was hearsay. Von Megenberg exposes himself to the same criticism. Just before the sentences about the fly amanita, he has described another species, the *Pfifferling*, which in his day meant the *Lactarius piperatus*, and he erroneously declares that it is a mortal poison. Here, translated, are his words: "One must watch out, for they are often most poisonous and can sometimes make a man deathly ill... We have an instance of this in Austria: a man ate a dish of *Pfifferling* and then drank strong mead, and he died at once in front of the barrel. This is true, by God!" As witnesses, both Albertus Magnus and von Megenberg would be in trouble on cross-examination by opposing counsel: their writings are a blend of the learning and the hearsay of their time. Valerius Cordus' brief statement adds nothing beyond his own adherence to a popular belief. Clusius introduces a new note: he is the first to inform us that the use of the fly amanita as an insecticide was exceptional: he places the custom around Frankfort, and by implication tells us that it was not known elsewhere. He was a traveled man, and he lived in Frankfort from 1587 to 1593.

---

[132] The largest and most popular old Polish herbal, written by a Cracow Professor of medicine named Syrenius (f 1611) and published in 1613 in Cracow, says under *muchomor* on p. 1394: "One boils fly amanitas in sweet milk; then one pours it into bowls. Flies fly down to the milk and perish." We have not seen this work. The reader will observe that Syrenius boils his concoction, which would certainly not help its insecticidal powers.

There is a peculiar thing about Clusius' remarks on the fly fungi. He does not consider these mushrooms a species. He describes them under the heading of Genus XII of pernicious mushrooms, and this genus he subdivides into five or six species, all of which he says kill flies. With the aid of Clusius' watercolors preserved in Leiden, the Hungarian scholar Dr. Gy. Istvanffi de Czik-Madefalva has identified these species, two of them being russulas, one of them certainly a cortinarius, and two of them amanitas.[133] When Clusius reports the use of a fly fungus by the housewives of Frankfort, he is referring to the *Amanita muscaria*. As Clusius was a reliable reporter, we must keep in mind that in former times, when the tradition of fly-killing fungi was still strong in folklore, not one but several species probably bore this designation.

This leads us to Linnaeus. The great Swedish scientist in his *Flora Svecica* repeated the statement about killing flies, but instead of placing the custom in Frankfort, he said it prevailed in Smolandia, a Swedish province where he had spent his childhood:

Cum lacte occidit Muscas in Smolandia.

This is not the only reference to the insecticidal amanita in Linnaeus. In his famous *Skanske Resa* ('Journey through Scania'), published in 1751, on page 430, he tells how a certain Swede in Upsala got rid of bedbugs from two of his rooms by the use of the *Amanita muscaria*. He describes the remedy and then concludes with what we consider a most significant statement:

> One takes in the autumn fresh specimens of the fly amanita, pounds them with a pestle quite small in a jar, lets them stand well closed until they become slimy or like gruel. Then one takes a feather or brush and smears all the cracks and corners where they [the bedbugs] keep themselves, and this procedure is repeated several times at monthly intervals. The room stinks for two or three days, but then the smell disappears. These nasty creatures die of it as if the plague had come amidst them, and whole bug-families perish as if from the Black Death. Although this remedy is simple, it is surer than anything else hitherto invented, and with its aid several houses in Upsala have now become free of bugs.

In a note on the next page Linnaeus adds that he has learned of this method for the first time from a Mr. Bern, Cashier of Interests in Upsala. The text is in Swedish.

For us the striking thing about this description is that it is a report on a novelty. Certain families of Upsala were putting the popular reputation of the fly amanita to a test, and their first impression was enthusiastic. Why had they not been using it for centuries? What were their final conclusions, say five years later? The answers to these questions are not vouchsafed to us.

After Linnaeus the references to the fly-killing potency of the fly amanita in mushroomic writings are innumerable. All the mycologists believe in it - with one dissenting voice. None puts it to a test - with one exception. The French mycologist Jean Baptiste Bulliard, in his *Histoire des Plantes Vénéneuses et Suspectes de la France*, which he finished in 1779, dares to strike a sceptical note. Speaking of the fly amanita, he says:

> I have never noticed that it kills flies, as several authors assert. I have had specimens, raw and cooked, for long periods in my apartment. Flies light on them, and seem even to eat them, without bad effects. But I intend to repeat this experiment with certain new precautions.

We know not the results of the promised experiments, but we know that when Bulliard died in 1793, he held the view that a new scientific name should be bestowed on the *Amanita muscaria*, and he suggested '*Agaricus pseudoaurantiacus*,' presumably because he considered the old name false. The mycological world has not deferred to his wishes, nor even tested his premises.

---

133. See this author's *Etudes et Commentaires sur le Code de l'Ecluse Augmentés de Quelques Notices Biographiques*, Budapest, 1900.

Bugs, flies, moths, and all kinds of larvae - in short, the insect world - constituted for our ancestors until recent times an order of nature instinct with supernatural powers, mostly malevolent and always awesome. Their strange shapes and stranger behavior, their incredible numbers and countless kinds, perhaps most of all their undeniable faculty of metamorphosis, may be at the root of this role that they played in the thinking of untutored mankind. The fly was demonic, and we believe that the 'fly-fungus' originally meant the demonic mushroom, a name that fittingly designated a mushroom with the virtue of causing inebriation. We believe that the insecticidal meaning has encroached upon the ancient and primary sense, and finally shut it out.

We know that bugs and flies were linked with supernatural spirits a long time ago. The dung beetle or scarab played a conspicuous part in the religion of the ancient Egyptians. The neighbors of the Israelites in the Old Testament worshipped Beelzebub, whose name meant the Lord of Flies. In the Greek New Testament, where that heathen god does not appear, the same name was used as a synonym for the Prince of Demons. The Biblical term crops out in modern literature, as in line 1334 of Goethe's *Faust*: Wenn man Euch Fliegengott, Verderber, Lügner heisst... "When one calls you Fly-god, Destroyer, Liar." In Nordic mythology the god Loki assumes the appearance of a 'fly' to enter the tightly closed apartment of the sleeping goddess Freya. He pricks her, and when she starts, deftly detaches her necklace and steals it. Whatever that 'fly' was, no one thought of it as a housefly, for the housefly does not bite.

In English the word 'bug' until the 17th century meant an evil spirit. Then, when that meaning fell from grace in good society, the word came to designate a creeping insect of the beetle class. Its etymology is unknown. It is current in Welsh in both meanings, in the simple form *bwg* and in compounds. It seems to correspond to Cornish *bucca* and to Irish *bocán*, both meaning hobgoblin. We suggest that all these words are related to Anglo-Saxon *hue*, meaning 'belly'. The semantic link between inflatable sacs and demonic spirits would parallel the same double layer of meanings in our *pogge-* cluster of words. The 'Bugge' that in Shakespeare's *Henry VI Part III* 'fear'd [= frightened] us all' would stand revealed as an uncouth relative of the nimble Puck in *The Midsummer Night's Dream*, and in these latter days of the Pooka that bathes the stage with benign mischief in Mary Chase's *Harvey*, and of Milne's Winnie the Pooh. Ernest Weekley in his *Etymological Dictionary of the English Language* says that 'bug' in the supernatural sense is obsolete, except in the compounds 'bugbear' and 'bugaboo', and other lexicographers lean to the same view. Surely they are mistaken: the tabu that hangs over words in low and colloquial use sometimes shuts off the minds of scholars from rich evidence. Few words are so dynamic and versatile as this one is in the United States. Besides bugbear and bugaboo, in compounds we have humbug, firebug, jitterbug, and that contemptuous word for an insane asylum, bughouse. There are of course the variants in *-o-*, - bogey, bogeyman, boggart (in England's North Country), possibly bogus, and the verbs to bogle and to boggle. The Oxford Dictionary in one citation offers grounds for supposing that 'buggy' was a nickname bestowed in the 18th century on a new design of two-wheeled vehicle, presumably because the makers had not yet got rid of the 'bugs' and the vehicle was insecure. In the United States a Big Bug used to be a common designation for an important person, a madman is 'bugs' and fit for the bughouse, a newly designed engine is usually full of 'bugs', and a specialist in any field is a 'bug' on the subject. In the course of casual reading in the American press, we pick out repeated uses of 'bug' that suggest demonic inspiration. From the Saturday Evening Post on March 10, 1951, we learn that all Dixie is bitten by the basketball bug. On March 15 of the same year the *New York World-Telegram and Sun* launches a drive for circulation with a 'Bugs Bunny Coloring Contest', the 'bugs' in question being demonic imps and not insects. On May 8, 1953, *The New York Times* in its 'Topics' says that Vice President Nixon has been bitten by a golf bug. On the same date the afternoon newspaper reports that the Allies seek to clear up the 'bugs' in the truce terms in Korea. On May 17, we learn in a book review in *The New York Times* that the defeated United Nations troops in Korea, when they were falling back as best they could in late 1950, referred to their retreat as 'bugging out', a term that suggested both devilish resourcefulness and the goddess Luck. On July 14 the *Daily News of New York* reported in big headlines that the 'boat bug bites thousands', meaning that summer throngs seek to go boating. The idea of distension is dominant in the vulgar American verb 'to bug out', meaning 'to bulge'. Tennessee Williams in his short story, 'Three Players of a Summer Game', has one of his characters say: "I walked straight up to them both, and you should of seen the eyes of them both bug out!".[134] If we are right, in this vulgarism the word preserves its pristine meaning, today largely superseded by a specific and secondary application to tiny, crawling vermin. On the campus of Wayne University, in Detroit, 'buggy' has been reported in recent years as a students' word for 'upset' or 'mentally disturbed'.[135]

---

[134] The story was published by Intercultural Publications Inc. in *Perspectives USA* II, pp. 15-39; see p. 25.

It is easy to see how Bugg came to be an English family name, for it enjoys to this day a vigorous existence, with an *-s* attached, as a respected nickname; e.g., Bugs Raymond the once mighty baseball pitcher, Bugs Baer the beloved cartoonist and Hearst writer, and Bugsy Siegel, the gangster who died a sudden and violent death in surroundings of gaudy splendor. In June 1941 Charles Workman, known as 'the Bug', stood trial in the New Jersey Court of Common Pleas for the murder of Arthur (Dutch Schultz) Flegenheimer. When one of the Bug's witnesses reversed his own testimony, the defendant changed his plea from not guilty to non vult, and thereby avoided the death penalty but bowed to an inevitable life sentence. In the course of that trial one of the off-stage figures was Martin (Buggsy) Goldstein.

Let it be noted that in the minds of those who bestow these bug-inspired nicknames, they are titles in which affection, awe, and envy are mixed. They are an expression of deference toward the ingenious demons that possess the honored person. Let it be further noted that current usage inclines toward a plural visitation of imps, though in the case of Bugs Baer we can testify that in his immediate circle he like Charles Workman is often simply 'the Bug'.

'Bug' also turns up in place-names, as in Bugtussle, in Cullman County, Alabama. Curious about the origin of such a name, we addressed our inquiry to a citizen in nearby Bremen, whose reply deserves preservation:

> Some forty years ago we had a postoffice here: Wilburn. Two drunks were fighting, Will James and Charles Campbell. James called it Bugtussle. So it has been called Bugtussle by a part of the people ever since that time. 12-20-49.
> [Signed] G. C. Florence.

May Bugtussle forever remain faithful to a name born in Homeric circumstances, commemorating the spot where once strove together the two Big Bugs. In England we find a Buglawton in Cheshire and a Bugthorpe in the East Riding of Yorkshire, and Eilert Ekwall in his dictionary of English place-names permits us to associate these towns with our 'bug' of supernatural powers. 'Bug' displays a singular aptitude in America for assuming new meanings derived from its original sense, a power of verbal metamorphosis that befits the world of six-legged creatures. Take telegraphy, for example. In the early days of the telegraph, the transmitting key worked perpendicularly, and the telegrapher had to lower and release his hand for every dot and every dash. Later, perhaps half a century ago, a device appeared that permitted much faster manual transmission. The new key worked horizontally, to left and to right of a neutral position, making dots continuously as long as it was pressed to one side. The hand no longer moved for each dot, but only when dots changed to dashes. The thing seemed possessed of the devil, it went so fast, and everyone in the craft was soon calling it the 'bug'.

With the verb 'to bugger' a double problem presents itself. The meaning that is written into the criminal law comes from the French *bougre*, and seems to have emerged at the time of the Albigensian heresy in referring to the perverted practices attributed, unjustly, to the devotees of that sect. But throughout the English-speaking world there has always been an innocent use, as when the sailor says of his gear that it is all buggered up,[136] and when a Lancashireman pays another the compliment of calling him a 'rare old bugger'. In circles where an improper word is excluded, this verb has nourished down to our own times. We suggest that this innocent use offers us a verbal form derived from 'bug' as a sprite, that it is native in English, and that the younger word imported from France has led until recently a segregated existence. Today the bad word, becoming more widely known, is driving out the good (as Gresham says), to the detriment of the language. For education as it spreads breeds new misunderstandings and new ignorances.

In an English translation of the Bible that bears the date 1549, it was possible for pious scholars to render Psalm XCI: 5 thus:

---

[135] See William White's article, 'Wayne University Slang', in *American Speech*, vol. XXX, no. 4, December 1955.

[136] See Joanna Carver Colcord's *Sea Language Comes Ashore*, Cornell Maritime Press, N. Y., 1945, p. 43, for comments on the innocent use of the term by seamen.

> … thou shalt not need to be afrayed for any bugges by night nor for the arrowe that flyeth by daye;

a verse that emerges cleansed in the Authorized Version:

> Thou shalt not be afraid for the terror by night; nor for the arrow that flieth by day.

'Bug' in the sense of a creeping, six-legged creature is first recorded early in the 17th century, but it may have been long in use on the tongues of the untutored people who made up most of the population of England. Are we dealing here with two words or one? The Oxford Dictionary reserved judgment on this nice point, but in a study of the word published in December 1935 and 1936 in the *PMLA* (the journal of the Modern Language Association of America), Miss Hope Emily Allen established beyond reasonable doubt that the two meanings belong to a single word. The six-legged beetle was felt to be the habitation of a demon, and took his name. The Oxford Dictionary reveals a parallel association of ideas in the word 'fly', for this word not only refers to insects but also has always meant a 'familiar spirit', a usage that survives to this day in the adjective 'fly', rated as slang by some, meaning nimble, dexterous, sharp.

In the Russian language there is an astonishing parallel for the two meanings of these English words. Children in Muscovy are admonished to behave lest the *buka* (**бука**) get them. The *buka* is the children's bugbear. The *bukashka* (**букашка**) is any small flying buzzing beetle. Slavists consider that the two words are related to each other, and that both are keyed to the basic word *byk* (**бык**), 'bull'. Until a thorough study of the demonic vocabulary of Northern Europe has been made, perhaps the door should be left open for alternative possibilities.

When Albertus Magnus and Valerius Cordus referred in Latin and German to the 'flies' killed by the fly amanita, what insect had they in mind? What meanings and associations did the words possess for them? Today 'fly' means the housefly, or, by extension, other species of two-winged insects. But this is a modern concentration of the meaning, the result of increasingly precise observations in the insect world. The Oxford Dictionary establishes the fact that in former times 'fly' ordinarily designated insects as divergent as locusts, moths, gnats, and the whole dipterous order. To this day there are High German dialects in which *Fliege* and *Mucke* mean both 'fly' and 'mosquito', as does the word *mich* in Frisian. The older usage survives in the angler's 'flies', which descend from all kinds of flying insects. In the Indian and Iranian languages the words for 'fly' are often used for 'bee' or are the base from which their words for 'bee' are formed.

Good illustrations of this early generic usage are to be found in Basque, where the primitive form of the word 'fly' was *uli*. In a variety of forms this word enters into the names of many insects: *eltxo*, mosquito; *uli farfalia*, butterfly; *eltzar*, caterpillar; *eltxu*, locust; and, perhaps the most interesting of all, a word used by the Basques of Guipuzcoa, *eultza*, meaning a bee-hive, the second syllable being simply a collective suffix. A bee-hive is a 'fly-hive', and in the dialect of Bermeo in the same province, a wasp is an *ulabio*, the first element meaning 'fly' and the second being derived from the Romance word for 'bee', *abeille* and *abeja*.[137]

The variable application of the words for 'fly' in former times was not a conscious use of a general term. It is to be explained rather by the ordinary man's inability to distinguish among flying insects, so that he was disposed to use without precision such words as he possessed for the insect world. This was common to the period, and therefore to all languages. The ordinary syrphus or carrion fly was considered for thousands of years to be the same as the honey bee and bore the same name: this is the insect that Samson found swarming in the carcass of a lion. The fact of metamorphosis in the insect world was known, and maggots and other carrion worms were known to be kin to the insect world, but the successive transformations were not carefully distinguished by species. In Dutch the word for 'moth', which is *mot*, serves for maggots also. Sometimes accidents of sound led to confusions in names. In English 'flea' and 'fly' are words of different origins, but the phonetic similarity caused them to be used interchangeably. In *Henry V* we learn that when Falstaff lay dying, he saw a 'Flea' stick upon the toper Bardolph's flaming nose, whereupon he said it was a 'blacke Soule burning in Hell'. What he saw was of course a fly, and the black soul in hell was, according to the beliefs of that day, its incorporeal counterpart, the Demon domiciled in every fly.

---

137. See Gerhard Bahr, 'Nombres de animales en vascuence', in *Revue Internationale des Etudes basques*, vol. XXVII, 1936, pp. 73-118, especially p. 77.

For all insects used to be considered agents of demonic powers and were clothed in a fearsome aura of mystery and magic. We believe we can adduce new and striking evidence of this. On an earlier page we pointed out that Satan was known in France at one time as *le Bot*, 'the Cripple'; and that this name came to be transferred to the toad, and in the form *bot volant* to the nightjar and the bat, nocturnal flying creatures of evil omen. We suggested that the form of the English word 'bat' is attributable to the French word, but we did not then point out the wider applications in English of the French word. 'Bot' in English is the larva of the gadfly; it occurs also in 'botfly'. What was originally a euphemism for Satan himself thus turns up in English as a word of the insect world. Satan resides in the botfly and in the larva of the gadfly. In Joseph Wright's *English Dialect Dictionary* we find that 'bot' and 'bat' are dialectal variants of each other, and that in various parts of the United Kingdom 'bat' is used for 'moth'. (The larger moths, nocturnal in habit, were formerly 'flies' of specially evil potency.) In many counties of England 'bot' has been used colloquially for all kinds of grubs and larvas, even turning up in Wright's pages as a designation for the flying 'bat'. The dictionaries declare that the origin of 'bot' is unknown; we think they have overlooked the multivalent service rendered by the French *bot* and failed to detect the common Satanic denominator between it and the English term.

The word 'maggot', in turn, besides designating larvae, has always meant an evil caprice. John O'Donnell in the New York *Daily News* on October 28, 1952, devoted his column to 'Mr. Truman's Maggot', by which he meant "a maggotty individual full of whims", and the use of the word in this sense is richly documented in the Oxford Dictionary. In Smollett's *The Reprisal; or, The Tars of Old England* one of the characters says that "now we man [must] ... defend her from the maggots of this daft Frenchman", who had been "sent away with a flea [sic] in his bonnet". The etymology of 'maggot' is unknown, according to the dictionaries. But if we view this word against the background of double meanings that it and 'bot', 'fly', and 'bee' carry, the likelihood presents itself that 'maggot' (which was spelled 'magot' in its first recorded appearance around the year 1400) is related to 'magic', and both are then to be explained as derived, via French, from the Necromancers known as the Magi. When the Flemings and Dutch in former times called mushrooms the devil's bread, they must have had in mind the demonic larvae, maggots, and 'flies' that batten on the flesh of many wild fungi.

In the Middle Ages delirium, drunkenness, and insanity were attributed to insects that were loose inside the head of the victim. This belief, strange for the modern mind, survives in many familiar locutions. A man has a bee in his bonnet, a fly (or bug) in his ear, or demonic bats (= 'bots') in his belfry. The Norwegians get flies into their heads or put flies into others' heads. To 'put a bee on someone' means to fix him willy nilly for a given purpose: in this locution the demonic intent is scarcely fossilized. It used to be said in French, when a man was getting excited, that 'la mouche lui monte a la tete', a fly is getting up into his head. Down to recent times *avaler les mouches* was a phrase for saying that someone had summoned up his courage, and the flies thus swallowed were of course demonic. Rabelais at the very end of Book IV makes the coward Panurge protest that, far from being afraid, he is braver than if he had eaten all the flies cooked in the pastries of Paris betwixt St. John's Day and All Saints'. There is a colloquial expression that circulates around Lyons and perhaps elsewhere: 'Ne prends pas la mouche': don't catch a fly, don't get excited. Of a man who is unbalanced one says, 'Il a l'araignée dans le plafond', he has a spider in his ceiling, i.e., in his upper story. The Czechs use an identical phrase: *miti mouchu* (or *pavouka*) *na mozku*, 'to have a fly (or spider) on the brain'. In Russian, we say of a man who is tipsy: *on c mukhoj*, (**он с мухой**), so-and-so is 'with fly'. There is a gesture peculiar to the Russians that we feel sure stems from this association of psychic possession with flying insects. The Russian when he suggests having an alcocholic drink is like as not to perform a fillip against his neck below the ear: this is so habitual that it is become a Pavlov reflex. Does not that familiar fillip invoke the demonic 'fly' entering the mind? According to the Icelandic-English lexicon of Cleasby-Vigfusson, under *fluga*, in Icelandic belief sorcerers would bewitch flies and send them to kill their enemies. This explains the modern Icelandic phrases, 'to swallow the fly' or 'to carry the fly', meaning 'to be the tool of another man in a wicked business'. In Basque folklore, sorcerers and other malevolent beings would work their will through demons that assumed the shape of flies, and sorcerers would carry the demonic creatures in a sheath such as anglers use for their flies today. In America little children to this day sing a nonsense ditty that invokes the 'bug' of demonic possession:

It's raining, it's pouring,
The old man is snoring,
He went to bed
With a bug in his head, And
didn't get up until morning.

Hieronymus Bosch, the greatest of Europe's painters of the demonic world, presents us with a superb illustration of flies in their demonic role. We find it in the left hand panel of the *Hay Wain*, where the momentous events that took place in Paradise leading up to Man's First Fall are portrayed with moving beauty. We reproduce the upper portion of that panel, wherein the observer sees that the angels tumbling down from Heaven assume the form of 'flies' - a diverse lot of winged demons, Beelzebub's host. The old meaning is far from dead even today. Recently *The Times Literary Supplement* published a poem by H. S. Mackintosh containing these sprightly lines:

> Has Freud not hit the Devil on the snout?
> Is not Beelzebub destroyed by Flit?
> Are we important? Do we really sprout
> Immortal souls that priests may manumit?
> [Issue of Oct. 2, 1953]

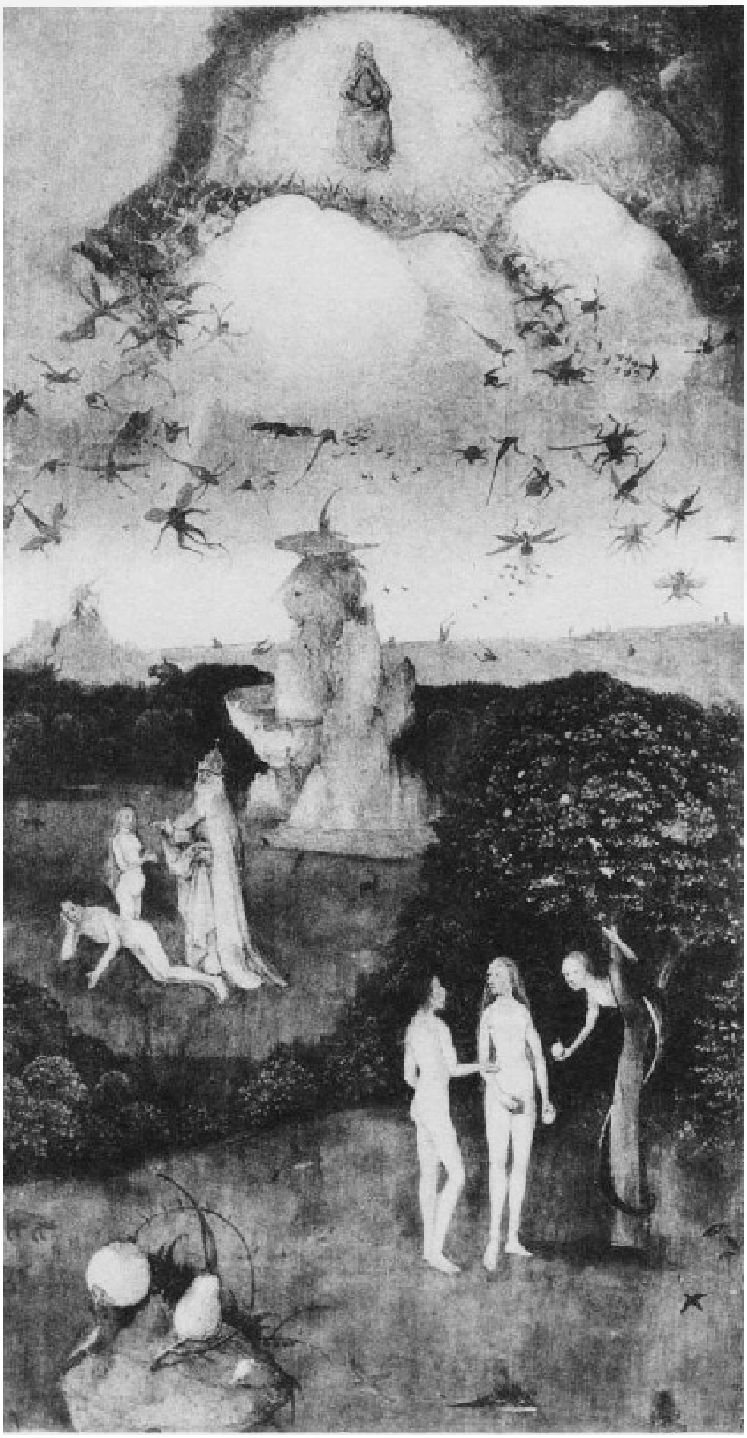
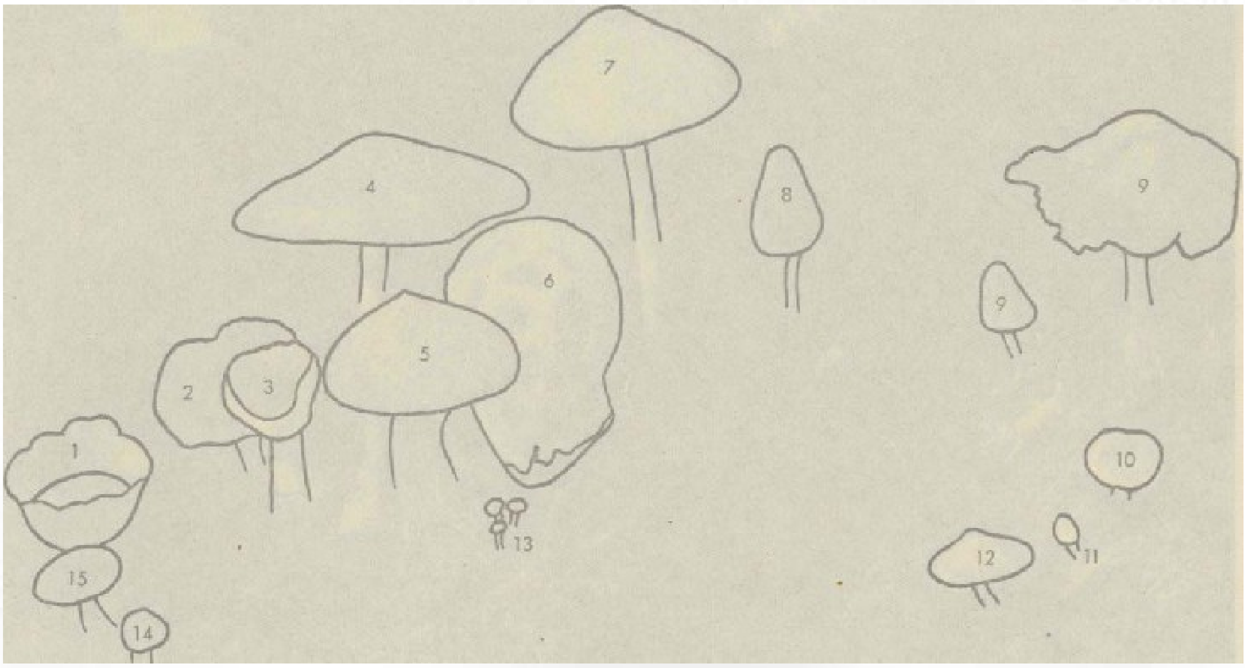


PLATE XXXVI
Hieronymus Bosch. The Hay Wain. Left Panel.
Madrid, Prado Museum.



1. Sterile base of *Lycoperdon* or of *Calvatia* sp.
2. *Russula* (*palumbina*?)
3. *Russula emetica*
4. *Amanita muscaria*
5. *Psalliota* (*sylvicola*?)
6. *Clathrus cancellatus*
7. *Volvaria speciosa*
8. *Coprinus micaceus*
9. *Coprinus micaceus*
10. Young *Bovista* or *Lycoperdon*
11. *Coprinus niveus*
12. *Mycena* (*galericulata*?)
13. *Cladonia* sp.
14. ?
15. ?

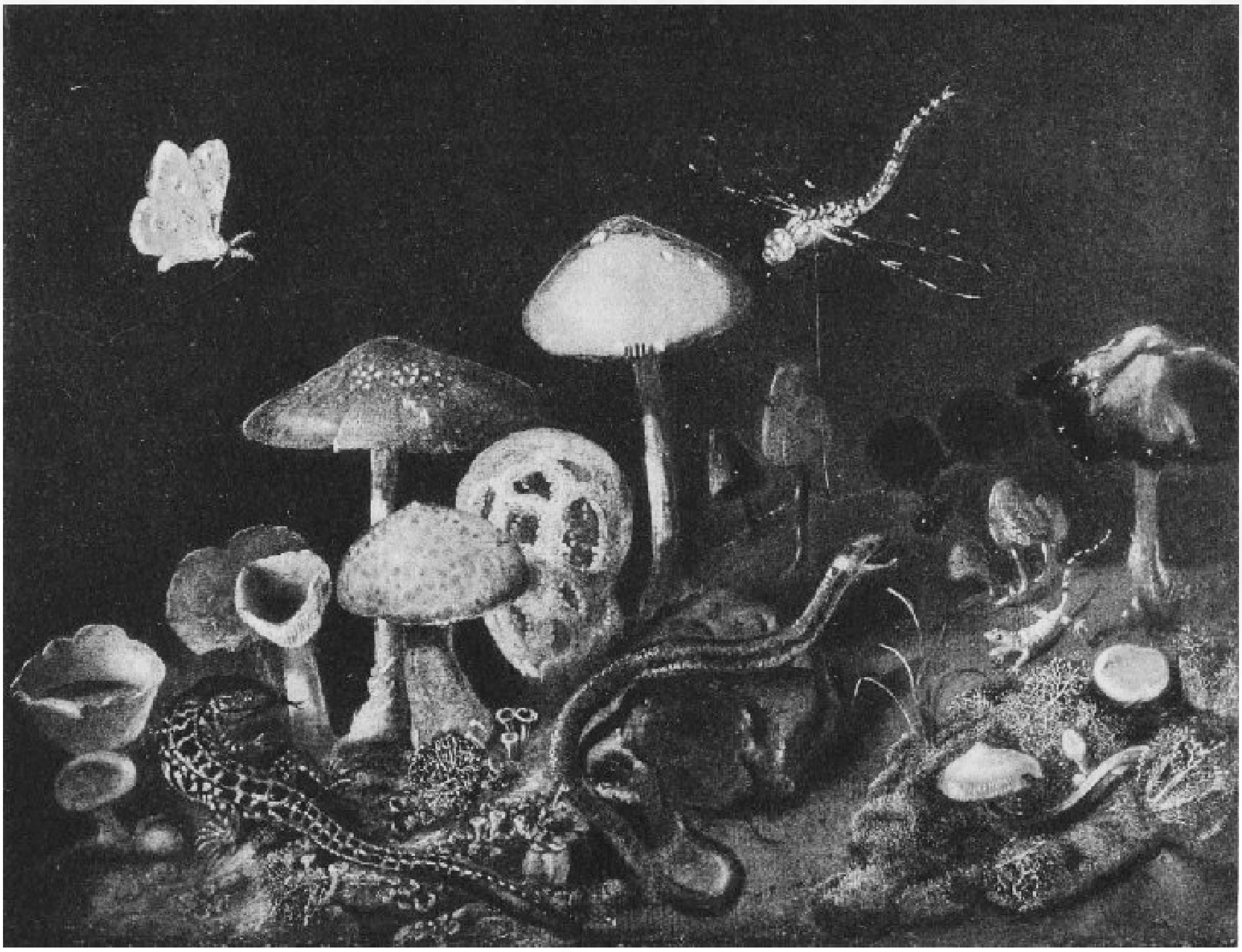


PLATE XXXVII

Otto Marseus van Schrieck. Moth with mushrooms.

Bale, Offentliche Kunstsammlung.

Perhaps the reader will perceive the direction in which our argument is heading. We have seen on an earlier page that when the French refer to the *Amanita muscaria* as the *crapaudin*, this by way of the Old French word for toad, *bot*, means the demonic mushroom. It is a word unrelated to insecticidal uses. In English that demonic word *bot* is transferred to the insect world, and shares with 'maggot', 'bee', and 'fly' the idea of demonic possession. When we find the *crapaudin* called the *Fliegenschwamm* in German, we sense a semantic identity. Both words are singularly appropriate for the inebriating mushroom, and they inform us that long ago, much earlier even than Albertus Magnus, the secret of this mushroom was known. And if it was known, why should it not, on appropriate occasions, have been put to its own great, even fearsome, use?

One of the most interesting examples of the Satanic fly in European literature is to be found in that classic of the Danish stage, Ludvig Holberg's *Jeppe of the Hill*, first produced in 1722. Two physicians are conversing. One of them speaks of his Lordship, who has had a strange, ugly dream, which so excited him that he imagines himself a peasant. Whereupon the other physician recalls a remarkable case ten years back: "... a man who thought his head was full of flies. He could not rid himself of the delusion, until a most clever doctor cured him in the following manner. He covered his patient's whole head with a plaster in which he had embedded masses of dead flies. [Query: were they the Spanish flies of the Pharmacopoeia?] After a while he removed the plaster and showed the flies to the patient, who naturally believed that they had been drawn from his own head and therefore concluded that he was cured." Here is a beautiful instance of the way a dramatist (or physician) puts to use an outworn belief that lingers on in the penumbra of man's consciousness.

Old and forgotten beliefs often survive in strange places, in usages that on their face are baffling. Miss Allen has pointed out that in the nursery language of little children, the homely words used for dried or inspissated nasal mucus, such as 'buggy bear' and 'bug', are linked with the spirit world. In Russian the corresponding word is *kozjavka* (**козявка**), which means larva or any small creeping thing. There is an expression, *vsjakaja kozjavka lezet v bukashki* (**всякая козявка лезет в букашки**) - 'every larva would be a fly'; and *bukashka* (**букашка**) is a diminutive of *buka*, bugbear. We believe that these nursery words for dried nasal mucus are a legacy of the medieval belief that when sanity returns to a man who has been out of his mind, an observant attendant can catch sight of an insect emerging from the nostril of the patient. Thus that escaping bug or maggot or bot or fly survives to this day in a metaphor on the tongues of unknowing children. We should add that this interpretation is ours, and not Miss Allen's.[138]

This belief in the demonic role of flying and creeping insects is not confined to Europe and the Mediterranean. We think we find telling evidence in favor of our argument in that the area of diffusion of this belief embraces the Chukchees and Korjaks, the very peoples where the use of the fly amanita survives. Jochelson in his treatise on the Korjaks reports that if the eater of the fly amanita vomits, the people believe that the spirits of the demonic mushroom can be found in the vomit as 'worms' which then quickly vanish into the earth.[139] Bogoras in his study of the Chukchees says that the shamans think psychic disturbances are caused by insects, and they use insects in their treatment of mental disorders. The shaman catches an insect from off his drum, swallows it, spits it up, and applies it to the head of the victim; he then sucks the sick man's head. Sometimes the insect is imaginary, sometimes real.[140]

It befits the *Amanita muscaria*, with its unique prestige among country-folk as the villain of the fungal world, that the pattern of vernacular names for it should be correspondingly subtle. Over large areas it is the mushroom with 'flies' in its cap. In France it is the domicile of the *bot* or toad, by which is meant Satan; and in the Basque *amoroto* we find the same presence. This raises the question whether the English 'toadstool' was not once the specific name of the fly amanita, just as in the Haute Saône Eugène Rolland reports *bo* as a designation for any gilled fungus, and in the Loire, *botet*, both presumably meaning, by way of 'toad', the Satanic fungus. We have said before that Rolland reports *tuo-mouscos*, 'fly-killer', in the Aude, and there this name, significantly, competes with another, *mijoulo folho*, the 'mad-mushroom', as though the two were

---

138. For material relating to our discussion, see E. Hoffmann-Krayer's *Handwörterbuch des Deutschen Aberglaubens*, in the article *Fliege*, also the papers by Miss Hope Emily Allen to which we have already referred, as well as her paper on *Bogus* in *American Notes & Queries*, Sept.-Oct. 1941, and on the wood-louse in the *Journal of American Folklore*, April-June 1935.
139. Jochelson, *op. cit.*, pp. 582-4.
140. Bogoras, *op. cit.*, p. 464.

synonyms. The idea of madness is reported in several other common names for the fly amanita: *mujolo folo* around Toulouse, *coucourlo fouolo* in the Aveyron, and *oriol foil* in Catalan, 'mad oriole', the oriole being the *Amanita caesarea*. In the dialect of Fribourg, Switzerland, the *Amanita muscaria* is the 'devil's hat', *tsapi de diablhou*. In all this nomenclature the toad and the fly are synonyms and complementary, and both mean madness and Satanic possession.

On a later page we shall discuss the small group of painters, mostly Dutch, who devoted their talents in the 17th century to still-life studies of demonological subjects. These painters, superb technicians, have seldom been surpassed in their solicitude for portraying nature faithfully. They assembled their curious compositions, not capriciously, but to express folk-beliefs that were already waning, and therefore their canvases offer us folkloric documentation of high value. So far as we know, this aspect of their art has not yet been studied. We reproduce one of these paintings, a canvas by Otto Marseus van Schrieck, which hangs today in the Bale art museum. The composition is admirably handled. In a small field there are more than twenty mushrooms, most of them identifiable. Dominating the center of the scene is the latticed fungus known as the *Cathrus cancellatus*, here slightly constrained to suggest a death's head. On the extreme right is one of the coprini, caught in its moment of active deliquescence. There is a grass snake (*Natrix natrix*), a green or wall lizard of the lacerta genus, and a gecko not native to the Netherlands. The snake is about to seize a beetle. A dragon fly with a pronounced curvature approaches the large mushroom that seems to be a *Stropharia semiglobata*. Of highest interest for us is the 'fly' that descends on the amanita. The Bale museum calls this insect a butterfly (*Schmetterling*), but this is an error. It is a moth, the most sinister of the 'flies', and the painter was so intent on an accurate statement of his message that he permits us to identify the moth as belonging to the family called saturnine, i.e., one of the saturniidae. Thus here in this nocturnal gathering heavy with demonic import we discover a 'fly', - the 'fly' that gives its name to the fly amanita, a 'fly' that for our ancestors was saturated with magical potency. Missing from the scene are the amphibia: neither toad nor frog do we see. Van Schrieck knew the virtue of economy in utterance, and the omission of the toad was for him obligatory. In the presence of the 'fly', the *padde* or *bot* would have been redundant, iconographically otiose, an intruder speaking the same message but in a different idiom. Its presence would mean piling not Pelion on Ossa, but *paddestoel* on *vliegenzwam*. The fly amanita holds an altogether extraordinary place in the folk culture of northern and eastern Europe. The deadly fungi are as nothing in comparison, and in the mycophobic world of the Germanic peoples no edible kind was of importance until recent times. For us it is altogether incredible that the grip of this *Fliegenschwamm* on the imaginations of countless generations sprang from any insecticidal power that it may have. It possessed in men's minds a supernatural potency, the potency of the 'flies', and though direct, affirmative testimony is meager, we believe that the prestige of the fly amanita descended from a knowledge, in at least some circles at some period, of its divine or demonic powers.

Up to this point our argument about the fly amanita has been an intellectual exercise. We have offered an alternative explanation for the name. We have impugned the traditional explanation by challenging the credibility of the witnesses. Albertus Magnus and Von Megenberg were relying on hearsay, and so indeed was Linnaeus when he quoted a Mr. Bern about the bedbugs. Most writers place the fly-killing use at a distance from themselves in time or space, Clusius in Frankfort, Linnaeus in Smolandia, John Ramsbottom in Poland, Bohemia, and Rumania. Mr. Ramsbottom[141] also says that the fly amanita was 'formerly' used in England and Sweden for killing bedbugs, and thus he justifies the occasional occurrence of the name 'bug agaric'. But this term can not be really old, for Linnaeus by his great authority imposed the name 'agaric' on the gilled fungi and the use of 'bug' for 'bedbug' appears to be a modernism, whereas 'fly' and 'bug' in their demonic sense are truly old. Only Bulliard put the fly amanita to the test, and his findings seem to have been cleanly negative. But in support of Bulliard's scepticism we can add a story told to us by a Russian friend, Ekaterina Apollinarievna Bouteneff. Her nurse in childhood was an unlettered peasant woman from the region of Riazan. Our friend remembers having seen this good woman time and again put out a saucer with a crushed cap of the fly amanita in it, a lump of sugar on top of the fungal mess. This was going to kill the flies, she would always say. But our friend always observed that the flies did not die. When she would ask her nurse why they did not die, the reply was always the same: "They are sure to die later."

---

[141] See his *Poisonous Fungi*, Penguin Books Limited, 1945, p. 21.

In the summer of 1953, on our suggestion, the mycologist F. E. Eckblad of the Botanical Museum in Oslo, working under Professor Nordhagen, undertook the experiments that were a desideratum for our case. In a letter addressed to us on September 8 he sent us his preliminary conclusions. They, like Bulliard's, were negative: "The fly amanita may contain matters poisonous to flies. But flies are not attracted to it, perhaps avoid it, and are not killed by it when used in the old way", i.e., mixed with sugar or milk or both. Mr. Eckblad warns that his findings must be considered tentative, both because his supply of the mushrooms had not been so plentiful as he had hoped and because several species of flies were present in insufficient numbers. But on the strength of the first season's experiments there was no evidence of insecticidal virtue in the fly amanita. On the other hand, experiments carried out during the same season at the Laboratoire de Cryptogamie of the Museum National d'Histoire Naturelle in Paris gave different results: the flies were drawn to the concoction and died from it, and they died more quickly when the milk was sweetened with sugar. Once again the evidence leaves us in suspense, and the experiment calls for retrial by various workers.

Even if the fly amanita kills flies, our conclusions will not be invalidated, for the name could carry two layers of meaning, one for housewives and the other for those initiated in sacred mysteries.

However, if it should develop that the fly amanita never harmed a fly, we should find ourselves confronted with a new question: how do we explain the legend? Why did Albertus Magnus give it the endorsement of his immense renown? Why is the *Fliegenschwamm* called 'fly-killer' throughout the Slavic world and by the peasants in certain provinces of France?

Let us assume for the purposes of our argument that we are right, and that the fly amanita was really the 'demonic fungus' of northern Europe for untold centuries of unrecorded history. Let us suppose that it was utilized for its inebriating virtue. Such use was certainly veiled in awe and mystery, and the secret was the precious possession of esoteric and (need we add?) illiterate circles. As the missionaries of Mediterranean culture and religion probed the northern forests and gained adherents, the custodians of the old culture, retreating before the new, would guard ever more zealously the lore that was their exclusive possession and that survived solely by oral transmission from generation to generation. From earliest times, in the pagan era, an alternative explanation for *Fliegenschwamm* must have been a convenience in satisfying the curiosity of the laity, and this popular rationalization was all that reached the ears of bookworms like Albertus Magnus. The use of the fly amanita as an inebriant may always have been reserved for rare occasions.[142]

Students of cultural history must ever keep in mind the fact, abundantly established, that in a single population, living together contemporaneously, distinct cultures can co-exist largely insulated from each other, like the droplets in an emulsion, juxtaposed but never mingling. Albertus Magnus, though German-born, was culturally a child of the Mediterranean. The universal knowledge of which he was repository and teacher was the legacy of classic antiquity and the Church. He and his like rejected the old culture and were certainly not privy to its innermost secrets, whatever they were. In the end the churchmen conquered, of course, and the contents of the modern mind are the fruit of the cultural invasion of northern Europe by such missionaries as he. The nether face of northern Europe before the advent of the alphabet and the printing press, the autochthonous culture, is known to us imperfectly, in fragments. By the time of the witchcraft trials in the 16th and 17th centuries, the distillation process was common property throughout northern and eastern Europe, and *aqua vita*, costing almost nothing, had certainly swept away and obliterated any surviving use or even memory of the secret virtue of the fly amanita.

If the meaning that we have read into *Fliegenschwamm* should win approval, we still could not assert that when the Vikings went 'berserk', the fly amanita was the cause. The debate among Scandinavian scholars would not be settled. But the affirmative argument would be greatly strengthened.

---

[142] The Russian symbolist, Andrej Belyj, in his novel Vozvrat (**Возврат**), published in 1902, has his hero, Professor Trupov, write a work entitled *Mukhomory*, 'Fly Amanitas'; furthermore, in the delirium of the mad hero centaurs appear that are obsessed with *mukhomory*. We assume that the author was drawing his material, not from Slavic folk memories, but from Korjak practices.

Volume II

V
The Riddle of the Toadstool and Other Secrets Mushroomic (continued)

14
Teo-Nanacatl: the Sacred Mushrooms of the Nahua

There are three cultural areas in the world where men consume mushrooms for psychic effects. We have just dealt with one of these - the eating of the fly amanita by the Hyperboreans of Siberia.

The second area is in New Guinea, in the northeastern part of that island, at the headwaters of the Wahgi River. The practice is reported among the natives living in the Mount Hagen range of mountains, but it may well be more widespread. The Mount Hagen natives are a mixture ethnically of Negritos and Papuans, with some Melanesian blood. Concerning their use of an intoxicating mushroom the available evidence is clear but pitifully meager. In 1947 the American Ethnographical Society published as its Monograph No. 12 a paper by Abraham L. Gitlow entitled 'Economics of the Mount Hagen Tribes'. He devoted one brief paragraph to intoxicants, and said that one of the three in current use was a mushroom called *nonda*. Then he continued:

> The wild mushroom incites fits of frenzy and has even been known to result in death. It is taken before going out to kill an enemy, or in times of anger, sorrow, or excitement.

That is all. We are vouchsafed no information about the mushroom itself, or its manner of preparation, or the dosage, or the meaning of its native name; nor any hint of the folk associations that must cling to this potent fungal growth. How odd that professional anthropologists should so often ignore in this way the obvious questions about fungi.

Thomas Gilliard, an ornithologist of the American Museum of Natural History specializing in the birds of New Guinea, first drew our attention to the Mount Hagen reference. He did more: he suggested that we address a letter to a Catholic missionary working downstream from the Mount Hagen range and inquire about a peculiar fungal practice among the natives there. The Wahgi is a river that runs east and then south into the Gulf of Papua. Below Mount Hagen but still far from the sea it drains a valley shut in on the north by the Bismarck range and on the south by the Kubor mountains. The natives, known as the Chimbu people, are linguistically and culturally distinct from the Mount Hagen tribesmen, though ethnically similar. It seems that among them chastity is not prized as a virtue in young unmarried women, and that to avoid children they eat a certain fungus. Later, when they marry, they give up the fungus and proceed to bear children without let or hindrance. We sent off our letter to Father John Nilles, a member of the Society of the Divine Word, to his station at Mingende, in the Central Highlands of the Territory of New Guinea, and in due course his reply confirmed Mr. Gilliard's report:

> I know [he wrote] of one kind of mushroom that is used by women as a means of preventing conception or procuring abortion. A native has brought me two specimens of that kind, of which I send you two cross sections. It grows on old tree stumps in the bush from 6,000 feet up on the slopes of the Chimbu and Wahgi valleys. When fresh the color on top is brown, and white underneath. Small slices are cut off, cooked by the woman between hot stones, and eaten with cooked sweet potatoes.

On receiving this gracious communication from Father Nilles, we forwarded the mushroom samples at once to Professor Roger Heim in Paris. They were insufficient for definitive identification, but Professor Heim felt confident that the specimens belonged to a genus known in France as *Ungulina*, and probably to the species called by French mycologists the *Ungulina auberiana* (Mont.) Pat. This particular species is abundant throughout the tropics and belongs to the polypores with rigid trama. It staggers under the burden of twenty or thirty competing scientific names; in the collections of the New York Botanical Garden the specimens carry the designation *Rigidoporus microporus*.

The watershed of the Wahgi, in the light of the tantalizing information at hand, holds exciting secrets for the exploring ethno-mycologist. But we must leave New Guinea behind and turn to Middle America, the third of our areas. Here we discover the most dramatic story in the whole field of ethno-mycology. There survives to this day in Mexico, within a few hours' flight of New York, the living cult of a sacred mushroom, a mushroom to which is attributed the power of bestowing on the eater extraordinary faculties. We know that this cult was nourishing when the Spaniards conquered Mexico and we believe there is evidence indicating that it was then millenniums old. For three centuries this cult lay forgotten by the world in the old writings of the 16th and 17th centuries, while Indians in remote corners of Mexico continued to believe in the mushroom and practice the cult. Only in the last twenty years has the cult come to light again, and even today its existence is known to few. After we had examined the available evidence old and new, we found ourselves succumbing to the spell of the mysterious mushroom with its strange powers and uncertain identity. The possibilities of further exploration in the field drew us more and more, and we proceeded with the pleasant task of laying plans for a trip to the remote Indian tribes of the mountains of Oaxaca. These plans we carried out in 1953.

Our readers must be patient with us if we develop our story deliberately, laying the groundwork for our own inquiries by first assembling the evidence previously available - evidence of the highest intrinsic value and not alone for ethno-mycologists. Ten early writers speak of the mushroom cult. We shall translate what they had to say, but as the original sources are often hard to come by, for the convenience of students we supply these texts in Appendix IV on pages 404-407 [of oryg. edit.], keyed numerically to the translations in the following pages. Those who read Spanish will relish the style of the old authors, terse, supple, free of literary artifice, the testimony of witnesses putting down on parchment for posterity what they saw and heard and experienced, usually coloring their comments with the religious feelings proper to their age. How exciting it is to exhume from the grave of centuries these almost forgotten voices telling us of the sacred mushroom and the powers attributed to it! This was the age of Richard Hakluyt, and our quotations belong to the world of exploration and discovery that we associate with his name.

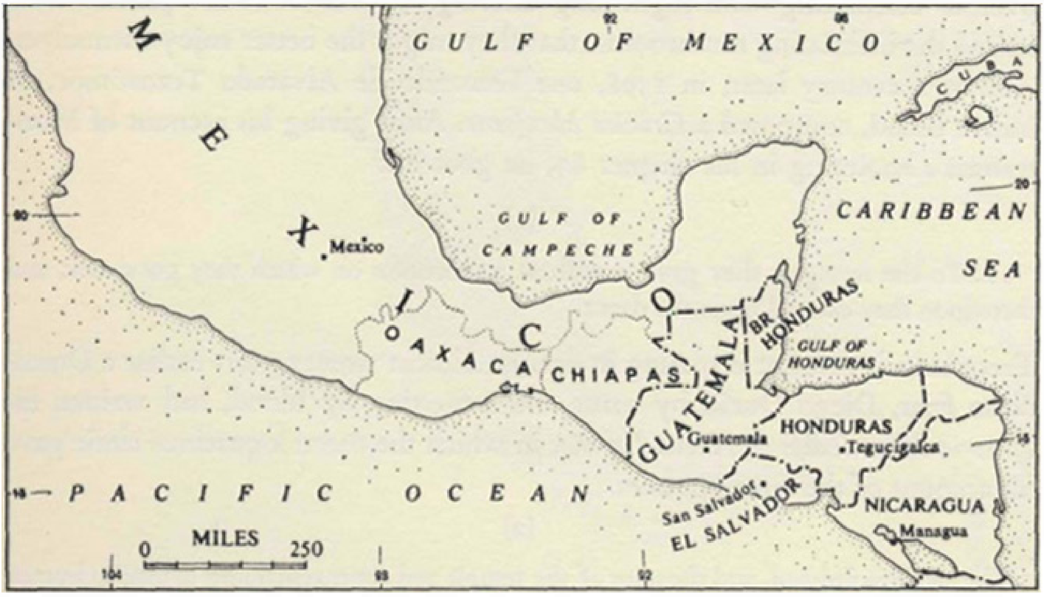


Fig. 12 - Map of Central America.

Montezuma,[143] most famous of Aztec kings, assumed his regal office in the year 1502, and the event was celebrated with exceptional pomp. The Spaniards' carvels were already probing the Caribbean, but Cortez' landing at Vera Cruz was still seventeen years off. The ceremonies and festivities of the new monarch's installation were so spectacular that visitors arrived from far and wide, and even certain of Montezuma's traditional enemies, princes of the Tlascalan people, came in disguise to witness the great event. They were discovered, but the magnanimous Montezuma, instead of exploiting their capture, had them royally entertained. After his induction into office, the whole city gave itself over to celebrating with night-long dancing. To the Tlascalan princes were served the inebriating mushrooms, that they might the better enjoy themselves. Almost a century later, in 1598, one Fernando de Alvarado Tezozomoc, of Indian blood, composed a *Cronica Mexicana*. After giving his account of Montezuma's anointing in his chapter 87, he goes on:

---

[143] We adopt the popular spelling. Scholarly usage would require 'Moctezuma II'.

[1]

> ... To the strangers they gave woodland mushrooms on which they got drunk, and thereupon they entered upon the dance.

Tezozomoc's account is sparing in details. Almost twenty years earlier a Dominican friar, Diego Duran by name and a mestizo by blood, had written his *Historia de las Indias de Nueva España* in which the more loquacious cleric gave his account of the same episode:

[2]

> The sacrifice finished, and the steps of the temple and court remaining bathed in human blood, they all went off to eat raw mushrooms, on which food they all lost their senses and ended up in a state worse than if they had drunk much wine; so drunk and senseless were they that many of them took their own lives, and by dint of those mushrooms, they saw visions and the future was revealed unto them, the Devil speaking to them in that drunken state.

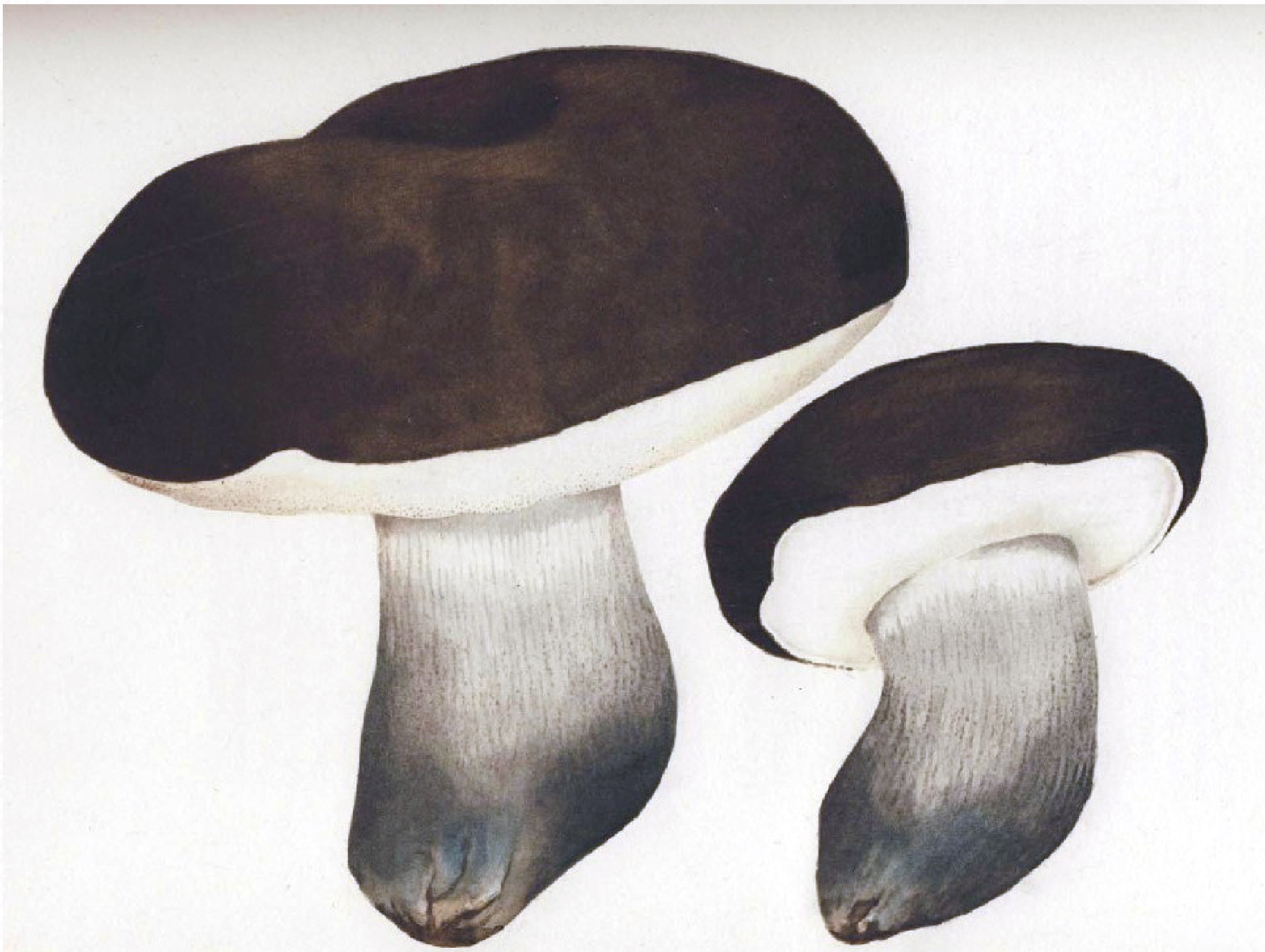


PLATE XXXVIII
Jean-Henri Fabre
Boletus duriusculus Kalchbr.
Polish: *Koźlarz topolowy.*

Both Tezozomoc and Duran seem to have relied on a single source, now lost to us. Neither described the mushroom nor gave it a name, though we learn that it was associated with the woods and that it was eaten raw. Furthermore, through the friar's priestly bias and exaggeration one perceives an important fact: the mushroom was more than an intoxicant, for to it were attributed divinatory powers and these powers were thought by the Catholic chronicler to stem from Satan. How strange that Gitlow in his New Guinea observations should have similarly mentioned a fungal frenzy that led even to suicide.

Our third witness is Toribio de Benavente called Motolinia, a Franciscan friar who died in 1569. He was the author of a work whose lengthy title begins thus: *Ritos antiguos, sacrificios e idolatnas de los Indios de la Nueva España*, and in it he gave further details about the extraordinary mushroom. Perhaps one senses behind his words the same lost source on whom the other writers relied, and he ends his account with words that could only have had horrifying connotations for the believing Spaniard of the 16th century, for he says that the mushroom in the Indians' religion played the role of the Host in Christian rites:

[3]

> They possessed another method of intoxication, which sharpened their cruelty: for it they used certain mushrooms or small toadstools, for such there are in this land even as in Castile; but those of this land are in such wise that, eaten raw and by reason of their bitterness, [the Indians] drink after them or eat with them some bees' honey; and shortly thereafter they would see a thousand visions and especially snakes; and as they completely lost their senses, it would seem to them that their legs and body were full of worms eating them alive, and thus half raving they would go forth from their houses, wanting someone to kill them; and by reason of this bestial drunkenness and travail that they underwent, it could happen on occasion that someone would hang himself, and furthermore toward others they would be more cruel. They called these mushrooms in their language *teunamacatlth*, which means 'God's flesh', or of the Devil whom they worshipped, and in this wise with that bitter victual by their cruel God were they houseled.

Motolinia informs us that the inebriating mushroom is small, bitter, and quick to act. He tells us also the name in Nahuatl of the mushroom, and the meaning of that name as he understood it.

Our fourth witness was, as it happens, a sworn witness in a judicial proceeding. What is more - and this is significant in delimiting the cultural areas where the inebriating mushroom was in use - we are now transported to the Mixtec country. The Indians of the land that the world calls Mexico have always been divided among many cultures speaking utterly unrelated languages. At the time of the Conquest the dominant language was Nahuatl and the various tribes speaking it may be called collectively the Nahua; of these the politically dominant tribe was the Aztec. The Mixtec country lies far to the south of the valley of Mexico, in what is today the state of Oaxaca, on the road to the Zapotec country and the Isthmus of Tehuantepec. But linguistically the Mixtecs are unrelated to the Nahua and distinct from the Zapotecs.

On October 15, 1544, in the town of Etlantongo, Esteban Marbán, Scribe and Notary Public in the service of their Majesties of Spain, was taking depositions in a case involving the alleged apostasy of three notables, all of them Indians, principal men of Yanhuitlan, Don Domingo the Cacique and the two *Gobernadores*, Don Francisco and Don Juan. It seems that, according to report, with 'diabolic ostentation' for many years they had persisted in invoking their idols and demons after the manner of their ancestors, with all the idolatrous trappings of the old religion. The crux of their offense lay in the fact that they had been baptized in 1527 and they were therefore apostates. The depositions in this case survive, and lengthy extracts were published in 1940 by the Museo Nacional in Mexico as an appendix to one section of the Codex of Yanhuitlan, in an edition of this manuscript edited by Wigberto Jimenez Moreno and Salvador Mateos Higuera. The witness that interests us was one Don Diego, Cacique of the town of Etlantongo, and we note that an interpreter served him: Don Diego must have been at home only in his native Mixtec tongue. After lengthy testimony that we would call hearsay, Don Diego continues:

[4]

> … and [the witness] knows and saw that some 14 years since, in a fiesta he saw said Don Francisco and Don Juan drunk, and that they had taken *nanacates* in order to invoke the Devil as their forbears had done, and that it is common knowledge and notorious that whenever it does not rain or when the maize is gathered in, they cry out to the Devil, and when they gather in the

> maize, they hold their drunken parties.

Nanacate is the hispanicized form of the Nahuatl *nanacatl*, 'mushrooms'.

Our fifth witness is one Gaspar de Covarrubias, Governor of the mines of Temazcaltepec, reporting in 1579 on conditions in his area in a document known as the *Relation de las Minas de Temazcaltepec*.[144] The working of the mines under the Spaniards had led to an influx of Nahuatl speakers, but Don Gaspar expressly says that the tongue of the native-born population was *matalpnga*, i.e., Matlatzinca, which today we identify with the Otomi group of languages. Our informant says that in the old days, when the people were still heathen,

[5]

> ... they were wont to pay in tribute [to the Lord of Mexico], whenever they were asked to do so, two or three loads of hempen blankets, which are made from, a tree that is called *maguei*, and they would give mushrooms on which people get drunk, and *ocote* ...

Additional curious evidence turns up in our sixth source, a book printed in Mexico in 1637 entitled *Doctrina y Enseñanza en la Lengua Mazahua de Cosas muy Útiles y Provechosas para los Ministros de Doctrina*, written by the Licentiate Don Diego de Nágera (or Nájera) Yanguas, incumbent of Xocotitlan. This is a manual for the clergy working among the Indians speaking the Mazahua tongue, which belongs to the Otomi linguistic family. It gives in Spanish and Mazahua, in parallel columns, the questions that a father confessor directs to the penitent, and the various possible responses of the penitent. On folios 27-29 the father confessor catechizes his penitent as to whether he has eaten mushrooms and got drunk on them, or given them to others to get drunk on; and if so, why, whether to find lost objects or for illness. The following extract shows the tenor of the questions, the column in English being added by us:

[6]

SPANISH	**MAZAHUA**	**ENGLISH**
por que	yoqhenangueze	why
querías	daguiminemaha	didst thou want
comer	togniça	to eat
essos hongos?	mayho yocho?	those mushrooms?
por que	nangueze	because
estaba enfermo	darimiçhoye	I was ill
quería comer	dariminemaha rogoza	I wanted to eat
hongos	yocho	mushrooms
para ver	maqheranuu	to see
lo que perdí	maqhe peqherobexi	what I had lost
quantas vezes?	hançhanixi?	how often?
no los comiste?	que higuiza?	didst thou not eat them?
no los comí	hiroza	I ate them not
solamente	anguechco	I only
quería	dariminemaha	wanted
comerlos	togoza	to eat them.

Our seventh witness belongs in a different class. Francisco Hernandez, a botanist, went out to Mexico in the year 1570 to study and describe the flora of that new world. He devoted seven years to the undertaking, returning in 1577 to Spain with an immense manuscript. Much of it got copied and printed and published in three divergent editions, but the manuscript was lost in a fire in the Escorial without ever being properly edited. Hernandez seems to have devoted only a brief section to the mushrooms. We find this passage in Volume II of his *Opera* brought out in Madrid in 1790, as Chapter 95 of Book IX of the *Historia plantarum Novae Hispaniae*. Alone among our witnesses, Hernandez might be expected to focus attention on the appearance of the sacred mushrooms, and what he says is significant though tantalizingly inadequate. He clearly speaks, not of one, but of three species of mushrooms that either cause psychic symptoms or are clothed in a halo of supernatural associations. The *teyhuinti* provoke uncontrolled laughter. Another kind conjures up spectacles of war or the likeness of demons. The search for the third species, bespoken for the tables of the rich and mighty, is attended by all-night vigils, and the mushrooms themselves are saturated in what the anthropologists today call *mana*. In his manuscript Hernandez included illustrations of his mushrooms, but alas! those precious illustrations were apparently lost in the Escorial fire. After describing a lethal species named *citlalnanacáme*, Hernandez goes on:

---

[144] The text appears in *Papeles de Nueva España*, Paso y Troncoso, Madrid, 1905, vol. VII, p. 20. We are indebted to Robert J. Weitlaner for this reference, as well as for the following one.

[7]

> ... others when eaten cause not death but madness that on occasions is lasting, of which the symptom is a kind of uncontrolled laughter. Usually called *teyhuinti*, these are deep yellow, acrid, and of a not displeasing freshness. There are others again which, without inducing laughter, bring before the eyes all kinds of things, such as wars and the likeness of demons. Yet others are there not less desired by princes for their fiestas and banquets, of great price. With night-long vigils are they sought, awesome and terrifying. This kind is tawny and somewhat acrid.

Our eighth and leading witness is the Franciscan friar, Bernardino de Sahagun, who by reason of his moral and intellectual qualities towers over all his contemporaries who were writing about Mexico in the 16th century. He devoted his many years in Mexico, from 1529 to 1590, to the systematic and sympathetic study of the Indians among whom he lived and labored. He was the editor and author of an immense work, a major historical document, the *Historia General de las Cosas de Nueva España*. Published in Spanish in several editions and translated also into French and English, this source is familiar to all historians interested in Mexican culture and the Conquest. Despite its standing as a classic, there is one fact about this book that is sometimes forgotten. It was a bilingual composition, being composed in parallel Nahuatl and Spanish texts. The two texts, while parallel, are not identical. The Nahuatl version preserves the very words of the native informants as they spoke with Fray Bernardino, and to it priority should be given over the Spanish text. There are four brief passages in Sahagun where the inebriating mushrooms figure. The Nahuatl recension differs sufficiently to justify us in offering it, as well as the Spanish text, to our readers, especially as the Nahuatl passages have remained until now hidden behind their linguistic barrier. For locating and translating the Nahuatl passages we are greatly indebted to Professor Charles E. Dibble of the University of Utah, to Dr. Arthur J. O. Anderson of the Museum of New Mexico in Santa Fe, and to Miguel Barrios of Mexico City.

From the sources already quoted it is clear that the Indians regarded their inebriating mushrooms with reverence, and this called down on their heads the execrations of professional Christians. The unintentional effect of these denunciations is perhaps to whet the reader's appetite for the mysterious fungi. Sahagun's Indian informants were doubtless baptized, and perhaps for this reason or perhaps because of the artful simplicity of Fray Bernardino himself, they scarcely link the mushroom with native religious beliefs or divinatory practices, and the hallucinations that they attribute to the eating of mushrooms are so horrible for the most part that one asks why anyone should ever have been tempted by them.

We shall now offer the four quotations from Sahagun, each of them in duplicate, the translation from the Spanish version followed by the translation from the Nahuatl. The first and longest describes a mushroom party. Merchants have returned from a long and successful journey and they are giving the party to celebrate their success. While the text itself does not hint at religious associations and certainly precludes priestly direction, the context in Book IX is saturated with supernatural beliefs and practices, and leaves the attentive reader in no doubt that the mushroom gathering itself was similarly instinct with the divine presence.

[8 A. *From the Spanish*]

> The first thing eaten at the gathering were certain black little mushrooms, which they call *nanacatl*, which inebriate and cause hallucinations, and even excite lust. These they ate before dawn, and they also drank cacao before dawn. The mushrooms they ate with honey, and when

> they began to get heated from them, they began to dance, and some sang and some wept, for now were they drunk from the mushrooms. And some cared not to sing, but would sit down in their rooms, and stayed there pensive-like. And some saw in a vision that they were dying, and they wept, and others saw in a vision that some wild beast was eating them, others saw in a vision that they were taking captives in war, others saw in a vision that they were to be rich, others saw in a vision that they were to own many slaves, others saw in a vision that they were to commit adultery and that their heads were to be bashed in therefor, others saw in a vision that they were to steal something, wherefore their heads were to be bashed in, others saw in a vision that they were to kill someone, wherefore they were to be killed, others saw in a vision that they were drowning in water, others saw in a vision that they would live and die in peace, others saw in a vision that they were falling from on high and would die from the fall. All the disastrous happenings that are wont to happen, these they saw in visions. Others saw themselves sinking in water as in a vortex. Then when the drunkenness of the mushrooms had passed, they spoke one with another about the visions that they had seen.
>
> [8 B. *From the Nahuatl*]
>
> Coming at the very first, at the time of feasting, they ate mushrooms when, as they said, it was the hour of the blowing of flutes. Not yet did they partake of food; they drank only chocolate during the night. And they ate mushrooms with honey. When already the mushrooms were taking effect, there was dancing, there was weeping. And some still in their right senses sat in their places leaning against their houses; there they merely sit, nodding their heads. Some saw in a vision that already they would die [so] they sat weeping. Some saw in a vision that they would die in war. Some saw in a vision that they would be devoured by wild beasts. Some saw in a vision that they would take the enemy captive in war. Some saw in a vision that they would become rich, wealthy. Some saw in a vision that they would buy slaves, would become slave owners. Some saw in a vision that they would commit adultery [and so] would have their heads bashed in, would be stoned to death. Some saw in a vision that they would steal; [so] also would they be stoned to death. Some saw in a vision that their heads would be crushed with a stone, would be imprisoned. Some saw in a vision that they would perish in the water. Some saw in a vision that they would pass to tranquillity in death. Some saw in a vision that they would fall from the housetop, tumble to their death. All such things would happen to them at this time; all such things they saw, or else they sank into oblivion. And when [the effect of] the mushrooms ceased, they conversed one with another, spoke of what they had seen in visions.

Sahagun tells us that the *nanacatl* were small and black; that the Indians indulged in them in gatherings assembled for the purpose; and that the intoxicating effects were generally unpleasant for the eaters, which we may doubt. The Spanish text says that they excited lust, an observation calculated to tease the 16th century Spaniards, but this observation is missing in the Nahuatl version.

Sahagun's second and third references to the inebriating mushrooms occur in passages primarily concerned with *peiotl* or 'peyote', the cactus product long used by certain Indians for its psychic and other effects, and in recent years an object of intensive study and discussion among anthropologists, biological chemists, psychologists, neurologists, and even literary thinkers like Aldous Huxley. The use of peyote was endemic among the Indians of Mexico north of the Valley of Mexico and of what is now the Southwest of the United States. Sahagun composed his work primarily from within the framework of the Nahua culture with its cultural center in the Valley of Mexico. In the passages that we are about to give, he is speaking of the northern Indians, known to the Nahua collectively as the Chichimecas, a term applied to nomadic Indians generally. The Chichimecas, whatever the language or tribe, were hunters and food-gatherers, nomads, savages to be feared and also despised. Among them there were some, such as the people now known as Otomi, who in historic times had become settled on the land; but they were still by habit called 'Chichimecas'. To distinguish them from the true nomads, the latter were called the 'genuine' or Teochichimecas. While there is some ambiguity in the following quotations, we think that, carefully studied, they yield a sensible meaning only if we understand Sahagun as describing the use of peyote among the Northern nomads, and comparing that use with the use of inebriating mushrooms among the Aztecs. It is as though the Aztec compilers were saying, "The Chichimecas have their peyote just as we have our mushrooms." This interpretation, which we accept, was offered to us as a tentative suggestion by Dr. Anderson. If it is right, then apparently the northern limit of the use of the inebriating mushrooms was roughly the Valley of Mexico and the Nahua civilization.

[9 A. *From the Spanish*]

> [The Teochichimecas] also possessed great knowledge of herbs and roots, and knew their properties and virtues: It was they who discovered and first used the root they call *peyotl*, and those who ate and took it, made it serve in place of wine and in place of what are called *nanacatl* [?], which are the evil mushrooms that inebriate just like wine. And they would gather together on a level spot after having drunk and eat, where they would dance and sing a night and a day, according to their pleasure, and this for one day, for on the morrow they wept much, and they would say that they were cleansing and washing their eyes and faces with their tears.

[9 B. *From the Nahuatl*]

> And the Teochichimecas had knowledge of the herbs, the roots; how they were, how they propagated. These people discovered the so-called peyote. They esteemed it in place of wine or mushrooms [?]. They gathered somewhere, assembled on the plain. At that place there was song and dance all night and all day. And on the morrow once again they gathered; wept, wept copiously. It was said their faces were washed. With their tears they cleansed their eyes.

[10 A. *From the Spanish*]

> There is another herb, like earth's testicles [truffles], which is called peyotl. It is white and grows in the direction of the north. Those who eat and drink it see frightful visions, or laughable ones. This state of drunkenness lasts two or three days and then goes away ...

[10 B. *From the Nahuatl*]

> Peyote: this peyote is white and it grows only in the land of the Chichimecas, the land of the god Mixcoatl, which is called the land of the dead north. Whoever eats or drinks of it becomes intoxicated as if by mushrooms. Likewise he sees many things which are frightening or laughable. Perhaps one day or two days he is intoxicated ...

The fourth and final passage in Sahagun is the most interesting of all. Here he calls the inebriating mushroom by the name that Motolinia used - *teonanacatl* - which in its first element carries the religious association that Sahagun avoided elsewhere. Here the mushroom is described in some detail, and the Nahuatl text is much longer and more interesting than the rather arid Spanish:

[11 A. *From the Spanish*]

> In this land there are certain little mushrooms that are called *teonanacatl*. They grow beneath the grass in fields or moors. They are round, have a long little stem, thin and round. When eaten they have a bad taste, hurt the throat, and inebriate. They are medicinal for fevers and the gout. Only two or three are to be eaten, not more: those who eat them see visions and feel palpitations of the heart. The mushrooms incite lust in those who eat many, or even be they few. To wild or mischievous youngsters people say that they have eaten *nanacatl*.

[11 B. *From the Nahuatl*]

> One mushroom is called *teo-nanacatl*. It grows in the waste places, under the grass. The cap is round, the stem is elongated. By its bitterness it hurts, it hurts the throat. It intoxicates one, makes one dizzy, makes one violent. It helps in fevers, gout. Only two or three are to be eaten. It makes one suffer, causes affliction, makes one restless, causes one to flee, frightens one, makes one hide. He who eats many, many things sees. He terrifies people, makes them laugh. He strangles himself, hurls himself from high places, cries out, is afraid. When he eats it in honey he says, I eat mushrooms, I bemushroom myself. Of the boaster, the braggart, the vain one it is said, "He bemushrooms himself."

So far we have quoted only from 16th century sources. Our ninth witness belonged to a later generation. He is Jacinto de la Serna, a cleric who in the middle of the 17th century composed a guide for clergy ministering to the Indians. His work was entitled *Manual de Ministros de Indios para el Conocimiento de sus Idolatrías y Extirpacio de Ellas*. He was a garrulous busybody, zealous in rooting out and extirpating all expressions of the Indians' old religion, and eager in his narrative to leave a record of his own zeal. Chapter IV of his work continues a recital of incidents that had happened to the author proving (as he says) that idolatry was still rampant among the Indians in his own time. In Section 3 of this chapter he is discussing native physicians and midwives, especially the role of 'witchcraft' in their practices, and certain goings on in his own household that had aroused his liveliest suspicions. A certain Indian, master of the native lore, had lately arrived in the village and had officiated at a religious rite in which the intoxicating mushrooms had been a central feature. The description of the religious ceremony reaches us through Don Jacinto by hearsay only, as of course he was not present, but it carries a ring of authenticity, and reminds us of the stirring words with which Motolinia ended his observations on the mushroom:

[12]

> And what happened was that there had come to [the village] an Indian, a native of the village of Tenango, great maestro of superstitions, and his name was Juan Chichiton, which means 'little dog', and he had brought the red-colored mushrooms that are gathered in the uplands, and with them he had committed a great idolatry, and before I tell of it, I wish to describe the property of said mushrooms, which are called in the Mexican language *Quautlannanaçatl*, and having consulted the Licenciate Don Pedro Ponce de Leon, the great Minister and Master of Masters as I said in Chapter II, he told me that these mushrooms were small and golden, and to gather them it was the custom for the priests and old men deputized as ministers for this kind of humbuggery to go up into the mountain, and they remained almost the whole night in prayer and superstitious entreaties, and at dawn, when there sprang up a certain breeze that they knew, then they gathered the mushrooms, attributing divinity to them, possessing as they did the same effect as *ololiuqui* [*Rivea corymbosa* (L.) Hallier filius] or *peyote* [*Lophophora williamsii* (Lem.) Coulter], because whether eaten or drunk, it intoxicates them and deprives them of their senses, and makes them believe a thousand foolish things. And so this Juan Chichiton, having gathered the mushrooms on a certain night, in the house where everyone had gathered on the occasion of a saint's feast, the saint was on the altar, and the mushrooms with *pulque* and a fire beneath the altar, the *teponastli* [a percussion instrument peculiar to the Aztecs] and singing going on the whole night through, after most of the night had passed, said Juan Chichiton, who was the priest for that solemn rite, to all those present at the fiesta gave the mushrooms to eat, after the manner of Communion, and gave them *pulque* to drink, and finished off the festivities with an abundance of *pulque*, so that what with the mushrooms on the one hand and the *pulque* on the other, they all went out of their heads, a shame it was to see.

Don Jacinto goes on to relate how he had made utmost efforts to ferret out and lay his hands on Chichiton. There was a hot chase, but by the skin of his teeth the 'Little Dog' had eluded his pursuer's clutches - to the considerable relief of the modern reader, who hopes that Chichiton lived to preside over many another mushroomic agape.

Our tenth and final source is French: the *Histoyre du Mechique*, written by Andre Thevet not later than 1574. His text is a translation or paraphrase of a lost work, *Antiguedades Mexicanas*, written about 1543 by the Spanish cleric Andres de Olmos. The historian is speaking of events that had taken place in the middle of the 15th century, and thus he is placing the use of our mushrooms earlier than any of our other sources, and he places them in an Otomi context. Thevet's manuscript lies in the Bibliotheque Nationale and was first published in 1905, edited by Ed. de Jonghe, in the *Journal de la Societe des Americanistes de Paris* (Nouvelle Serie, vol. II). Our quotation is from the fourth chapter, page 18:

[13]

> ... Said Lord of Tezcuq [Tezcoco] ... paid great reverence to the gods and took great care of the temples and ceremonies; he commanded also that the youths and maidens should dance in the temples, ... that they should strew the temple with roses and flowers, dancing constantly before them, both those of the city and the near neighbors, whom the devil abused making them eat some herb that they call *naucatl*, which made them lose their senses and see many visions.

Our ten documentary sources treating of the divine mushrooms are supported by other linguistic evidence. There are several early lexicons to cite. The year 1571 saw the publication in Mexico of a Nahuatl dictionary, *Vocabulario en lengua castellana y mexicana*, compiled by Alonso de Molina. In its pages we discover under *hongo* a series of names for mushrooms that inebriate, *hongos que emborrachan* or *que embeodan*. Here are these words, with their literal translation:

xochi nanacatl:	'flower mushrooms'
tepexi nanacatl:	'cliff mushrooms'
ixtlauacan nanacatl:	'savannah mushrooms'
maçauacan nanacatl:	'mushrooms of the stag's places'
teyuinti nanacatl:	'mushrooms of the divine inebriation' with *te-* derived from *teotl*, 'god', and *-yuinti* from *yuintia*, 'inebriation'.

Molina, born in Spain, arrived with his parents in Mexico in 1523 and after learning Nahuatl served the Franciscan friars as interpreter. We know not how reliable his mushroom names are. Hernandez, as we have seen, also mentions the *teyuinti*, but neither Hernandez nor Molina uses *teo-nanacatl*, which we find only in Sahagun and Motolinia.

More interesting for us than Molina's work is a Zapotec lexicon, Vocabulario Castellano-Zapoteco, compiled by Fray Juan de Cordoba and published in 1578 in Mexico. In it we find the words *peaño*, *peyaño*, which he defines as *honguillo o xeta con que se emborracha*, 'little mushroom or toadstool on which one gets drunk'. (The accents on his words appear to represent glottal stops.) Under *xeta* he reports an intoxicating mushroom that grows in trees, which he calls *nocuana peneeche*, a designation that the Zapotec of today fails to recognize.[145]

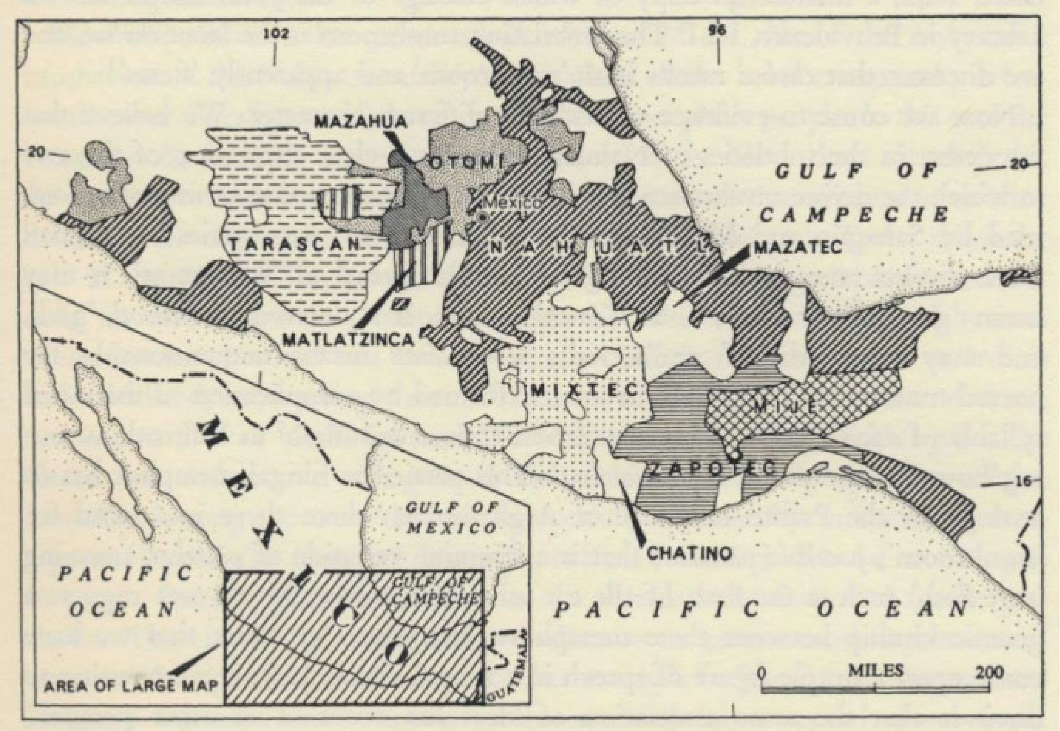

102
96
20
20
16
MAZAHUA
OTOMI
Mexico
GULF OF CAMPECHE
TARASCAN
NAHUATL
MAZATEC
MATLATZINCA
MIXTEC
MIJE
ZAPOTEC
CHATINO
PACIFIC OCEAN
PACIFIC OCEAN
MEXICO
GULF OF MEXICO
GULF OF CAMPECHE
GUATEMALA
AREA OF LARGE MAP
0
MILES
200

Fig. 13 - The Mushroom cult in 16th and 17th centuries.
Linguistic areas where contemporary reports establish use of divinatory mushrooms. As modern evidence indicates that the cult prevails only in uplands, all contours below, say, 600 meters should probably be excluded. Conversely, upland areas such as Mazatec and Chatino as to which early evidence is lacking undoubtedly used the mushroom. Northern limits are quite definitely fixed, but eastern limits in Chiapas are uncertain.

Here then is proof that the inebriating mushroom was familiar to the Zapotecs, and thus we establish as a minimum range for the use of the inebriating mushroom an area that includes the Nahua and Otomi peoples, the Mixtecs, and southeastward to the Zapotecs of the Valley of Oaxaca and probably the Isthmus of Tehuantepec. If our interpretation of Sahagun is right, the use of the mushroom petered out as one advanced north from the Valley of Mexico, being replaced by the peyote of cactus origin. To the southward we cannot define the boundaries. Our information about the important Zapotecs is relatively rich, by comparison with the complicated mosaic of other Indian cultures on all sides of them.

---

[145] Pedro Carrasco reports that in old Otomi lexicons, under *hongo*, there are names for the inebriating mushrooms. This would support the testimony concerning the Otomies that we have quoted in our text. See Carrasco's *Los Otomies*, Mexico, 1950, p. 230. We have had no access to these lexicons. All old dictionaries for the Indian languages of Mexico and Guatemala should be combed for such references.

But there are a few other old lexicons that document the use of our mushrooms. Some years ago Walter Miller discovered the manuscript of an early Mije dictionary in the Mije village of San Lucas Camotlán. It now lies in the Museo Nacional. In it 'the little mushroom with which people get drunk', *el honguitto con que se emborrachan*, is rendered by the Mije word *maxmux*. The manuscript may date from the 18th century. A Tarascan lexicon composed by Fray-Maturino Gilberti and published in 1559 translates 'the mushroom that inebriates' by the expression *cauiqua terequa*, wherein the second element means 'mushroom'. The Tarascans live in Michoacan, to the west of Mexico City. Already we have placed the mushrooms in the Matlatzinca country: our previous evidence is confirmed by the Matlatzinca lexicon of Fray Diego Basalenque, dated 1642, a manuscript copy of which belongs to the John Carter Brown Library in Providence, R. I. The inebriating mushroom is the *intza chohui*, and we discover that *chohui* means both 'mushroom' and apparently 'fiesta'!

Now we come to evidence of a wholly different character. We believe that we detect in the subtleties of Nahuatl grammar a clear expression of the awe in which the divine mushroom was held. Let us examine that term *teo-nanacatl*, used by Sahagun and Motolinia. The initial element *teo-* carries in Nahuatl three distinct meanings. It can signify simply 'great' or 'important'. It may mean 'genuine' or 'real', as in *Teo-chichimecas*. It is derived from *teotl*, 'god', and may mean 'divine' or 'sacred'; *teo-nanacatl* means unquestionably the 'sacred mushrooms'. *Nanacatl*, in turn, is formed by a duplication of the initial syllable of *nacatl*, 'flesh'. Thus mushrooms are called 'flesh' in Nahuatl, assuming however the plural form *nanacatl*. This particular fungal metaphor has its analogy in the Pashto language of Afghanistan, where there is a word for 'mushroom', *poczksi* (*potsakdi*) that is a feminine variation of *potsdkai*, meaning 'soft flesh' such as the flesh of the ear lobe. (Of course we do not suggest a genetic kinship between these metaphors, but when we think that we have come upon a simple figure of speech in a fungal vocabulary, it is reassuring to discover that the same association of ideas has occurred to other peoples.) The figure of speech in *teo-nanacatl* was a living one in the 16th century, for Motolinia translates the term as *came de dies*, 'god's flesh', and then immediately this good Catholic offers his own substitute, *came del demonio*, 'Satan's flesh', thus illustrating the old truth that one man's God is another man's Devil. Perhaps the interesting thing about *nanacatl* is its plural form. In Nahuatl nouns representing inanimate things are invariable as to number, and by this grammatical convention the vegetable world is inanimate. But there are significant exceptions, of which the following three are outstanding:

	SINGULAR	PLURAL
Sky	*ilhuicatl*	*ilhuicame*
Mountain	*tepetl*	*tetepe*
Star	*citlalin*	*citlaltin*

These exceptions are apparent rather than real, for the Nahua personified the sky, mountains, and stars, and the plural form simply expresses the way of feeling that attributed to these cosmic beings a soul. There are other exceptions similarly suggestive. For example, *tetl*, 'stone', becomes *teme* in the plural, but only when it refers to graven images. We believe that another exception is our *nanacatl*, a plural form expressive of the divine afflatus dwelling in the inebriating mushrooms.[146]

How impressive is this grammatical evidence of the role of the mysterious mushroom in the Nahua mentality! It becomes all the more noteworthy when we discover a perfect parallel among another mycophilic people, in this case the Russians. At an early stage in the evolution of the Slavs there developed a tendency to substitute the genitive case for the accusative when a masculine noun representing an animate creature was the goal of the verb. Today this is the rule in the various Slavic languages. In folk Russian this genitive is used not only for nouns denoting animate beings, but also for the names of various mushrooms and sometimes for certain trees, when the mushroom or tree is individualized, i.e., is a single entity.[147] This use is widespread in Russian dialects, and occurs also in Ukrainian and White Russian. One hears *nashol griba* (**нашол гриба**), 'he found the mushroom', with *griba* in the genitive case; *nashol grusdja, ryzhika, borovika* (**нашол груздя**, **рыжика**, **боровика**). Among the trees the oak is especially favored by similar treatment, e.g., *srubil duba* (**срубил дуба**), 'he chopped down the oak'. The oak used to be worshipped in pagan times by the eastern Slavs as the thunder tree dedicated to the god Perún. Thus in the folk language we discover a grammatical expression of animism. It is possible to offer yet another example in Russian. In the standard language the mushroom known as the *masljenik* (**масленик**) has a special plural form, *masljata* (**маслята**), and the plural of another mushroom name is *opjata* (**опята**) in certain uneducated circles. The plural suffix here used is normal only with certain nouns designating young animals, birds, and children! These peculiarities in Russian grammar show that our interpretation of *nanacatl* does not strain credulity. Parallels in unrelated languages and cultures of this kind reinforce each other; that is, they illuminate a common trait, in this case the inclination of peoples strongly mycophile to personify their beloved mushrooms.

---

[146] It goes without saying that for our discussion of Nahuatl linguistics we have relied on several of the outstanding Nahuatl specialists of our time, to wit, Professor Wigberto Jimenez Moreno of Mexico, Professor Charles E. Dibble of the University of Utah, and Dr. Arthur J. O. Anderson of the Museum of New Mexico in Santa Fe. We are the first to point out the significance of the plural form that we discover in *nanacatl*, a thesis to which the aforementioned authorities give their reserved and tentative blessing.

After our long parade of early authorities and learned analysis, let us sum up what we have discovered. When the Spaniards arrived in Mexico, they found an inebriating mushroom in wide use among the Indians from the Valley of Mexico southwards. This mushroom produced hallucinations that the Indians thought were divinely inspired. One author, Hernandez, says expressly that there were various species of such mushrooms, and as he was a botanist his testimony is weighty. The lexicographer Molina mentions five species. There is a multiplicity of names for the inebriating mushrooms in Nahuatl, for which various explanations may be offered. Each species would have its own name, of course, and furthermore the names might vary according to the region. A third possibility is that the divine aura bathing the mushrooms might cause people to take refuge in euphemistic alternative names. The mushrooms of course were wild and seem to have grown both in meadows and in the woods. (Jacinto de la Serna refers to them as *Quautlannanaçatl*, 'woodland mushrooms'.) As to one species, Sahagun says that they were small, with a stipe long for the height, thin and round. Sahagun describes these as black, but others speak of the inebriating mushrooms as golden or tawny or approaching red. In two authors we hear of ceremonies attending the gathering of mushrooms - nights of prayer and vigil. Four clearly associate the mushrooms with religious rites. Six agree that it was used in communal festivities that bordered on orgies and led to wild excesses. The mushrooms were eaten raw, and the taste was acrid or bitter, honey being used as the vehicle for swallowing them. There is no reason to believe that our Spanish witnesses tasted the mushrooms, for (unless they came from Catalonia) they were mycophobes and this cultural heritage would reinforce an initial repugnance for native 'idolatries'. But some of our witnesses were Indians, albeit converted, and they must have known the taste and accurately described it. Sahagun alone speaks of a medicinal virtue in the mushrooms: he says that the *teo-nanacatl* were good for gout and fevers. But on this point it is noteworthy that the mushrooms are not even mentioned in the great medicinal herbal of the Aztecs, known as the Badianus manuscript, which was compiled in Sahagun's own convent, the Colegio de la Santa Cruz at Tlaltelulco, and doubtless under his supervision.[148]

There may well be references to our sacred mushrooms in the old writers that we have not come upon, and in the voluminous archives of unpublished documents in Mexico additional references will surely be discovered. At the same time we must also stress the fact that by our method of culling and distilling the references to the sacred mushrooms we inevitably convey an impression of their importance that is scarcely supported by the whole corpus of documents relating to 16th century Mexico. That documentation is immense. Other narcotic herbs also play a role therein: *poyomatl, ololiuqui, peiotl*; and tobacco (*pisiete*) was also treated as though it belonged in the same category. There are important 16th century sources dealing with such matters where

---

147. For guidance on this feature of Russian grammar see A. A. Shakhmatov's *Kurs Istorii Russkogo Jazyka* (**Курс истории русского языка**), St. Petersburg, 1911, vol. III, p. 338. We are also indebted to Prof. Roman Jakobson for his elaboration of the same theme in private correspondence.
148. The authors were Indian converts, Martinez de la Cruz and Badianus the translator. The ms. lies in the Vatican, but was published in facsimile by the Johns Hopkins Press in 1940, edited by Emily Walcott Emmart.

references to the inebriating mushrooms are strangely absent: one of these is that valuable work, *Problemas y Secretos Maravillosos de las Indias*, written by Juan de Cardenas and published in Mexico in 1591.

From the beginning of our inquiries into the sacred mushroom of the Nahua we were on the lookout for 16th century illustrations of it. The botanist Hernandez in his text said that he was depicting four kinds of mushrooms including the *teyhuinti*, but the 1790 edition carried no illustrations, and his drawings, which would have been precious for us, must have been consumed in the Escorial fire. However, our searches have not been bootless. In the Florentine Codex we have discovered one picture, hitherto unremarked by students, and Robert J. Weitlaner has drawn our attention to a second in the Magliabechiano Codex.[149] We take pleasure in reproducing both in faithful color, this being facilitated by a happy chance: the two codices, though lying in different libraries, are both in Florence.[150] The illustrations are singularly significant for us, being complementary, one of them executed by a Spanish artist and the other by an Indian in the tradition of his people, though he shows traces of Spanish influence. Both illustrations are in the nature of pictographs, vignettes intended to convey almost a verbal message. Neither tells the mycologist anything mycological about the sacred mushrooms, but both are eloquent and curious expressions of the contrasting attitudes of the two peoples toward them.

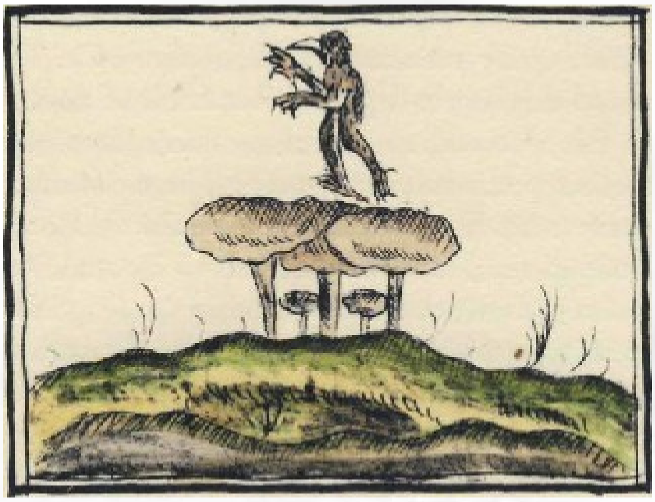


Fig. 14 - Teo-nanácatl
as represented by a 16th century Spanish artist. From Florentine Codex of Bernardino de Sahagun' *Historia de las Cosas de la Nueva España*, Biblioteca Laurenziana, Florence.

Sahagun's great work survives in two principal codices, of which the Florentine Codex, profusely illustrated, ranks first. Although most of the illustrations were done by native artists, some were by Spaniards, and it was a Spaniard who made the five small pictures representing various mushrooms that Sahagun mentions. A close inspection of the five pictures and Sahagun's text makes it clear that the artist worked from the text, and possessed no knowledge of the mushrooms outside the text. When he came to the inebriating mushroom, he undertook to convey his iconographic message in a way natural to a 16th century Spaniard: a demon is portrayed rising from a cluster of tawny (not black) mushrooms, and the demon carries those conventional stigmata that commonly identified Satan in the Gothic and Spanish worlds. He is clothed cap-a-pie in fur, a huge beak emerging from his fur-enclosed face. For hands he has claws. One foot is unformed or malformed,

---

149. In 1952 Mr. Weitlaner discovered an old topographical codex or *lienzo* in the possession of the local authorities in the village of Tlacoatzintepec, three days'journey by foot or animal from Chiltepec, in the State of Oaxaca, where the people belong to the Chinantec culture area. A copy was made and is now preserved in the Museo Nacional. At one place in this chart, in a glade, there is a pair of crossed mushrooms. They might represent *teo-nanacatl*, but as the Indians are generally mycophagous, they might simply indicate a good spot for gathering edible fungi. That a *pair* of mushrooms is pictured may, however, be significant, as will become evident later in our argument.
150. What we call the Florentine Codex lies in the Biblioteca Laurenziana, Florence, where it is designated Med. Pal. 218-220. The Magliabechiano Codex is in the Biblioteca Nazionale, Florence, and carries the designation B. R. 232. The miniatures of the former were badly reproduced in the Paso y Troncoso edition (uncompleted) of Sahagun, Madrid, 1905-6. The Magliabechiano Codex has been twice published in facsimile, the so-called Loubat edition, Rome, 1904; and by the University of California, Berkeley, 1903, under the guidance of Zelia Nuttall.

perhaps a splay foot. This is the malformed foot that survives in the English 'cloven hoof', that led the French to speak of the Devil as *le Bot*, the Cripple.[151] In this French word and in this picture we find blended the recurring themes of our book - Satan portrayed as *le Bot*, a demonic mushroom, and offstage, by metaphoric transfer, the toad called *le bot* that constitutes the third of our unholy trinity.

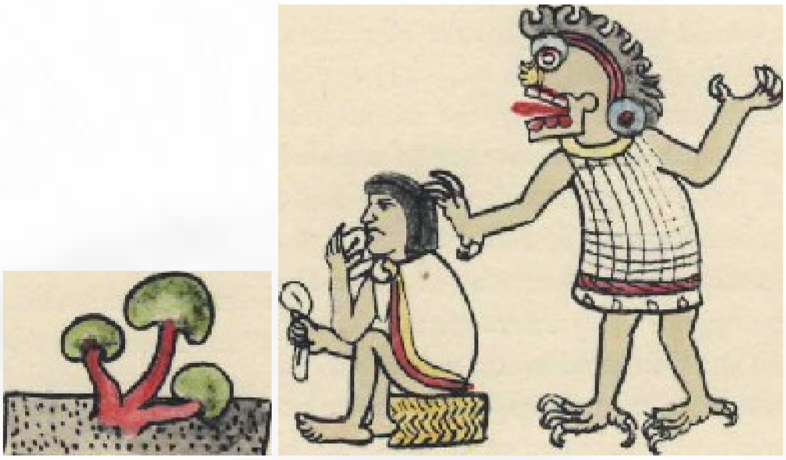


Fig. 15 - Teo-nanácatl
as represented by a 16th century Mexican artist. From Magliabechiano Codex, Biblioteca Nazionale, Florence

The second illustration offers us three elements - mushrooms, a man eating mushrooms, and behind and over him a ghost. The reader will notice that the man holds a mushroom in each hand. According to Professor Jimenez Moreno, the ghost is probably Mictlantecuhtli, Lord of the Underworld, who is depicted on other pages of the same Codex. How far removed from the Spaniard's conception is the Indian's! Not only is the craftsmanship of these artists, contemporaries of each other, poles apart; their message is likewise. The Spaniard reports rather prosaically the existence of a demonic mushroom to his European public. The Indian, though undoubtedly a baptized Christian, conveys a sense of the awe that he still felt in the presence of the mysterious *teo-nanacatl*. That the mushrooms in this miniature are green should not disconcert the mycologist: green, the color of jade, meant in Mexican iconography that the object so depicted was of great worth.

The last of our citations from old Spanish documents was from the mid-seventeenth century: Jacinto de la Serna's episode with Chichiton. With him the references to the inebriating mushrooms ended. Thereafter observers no longer reported on the mushroom cult, and except in new editions of old books and in works based on them, the cult was never more mentioned. The cult itself was apparently extinct, and only a handful of specialists knew that it had ever existed. For example, Francisco A. Flores, when in 1886-8 he brought out in Mexico his three volume *Historia de la Medicina en Mexico* listed the Nahuatl names for the inebriating mushrooms as given by Molina, translated them, and then rashly by sheer guesswork tried to identify them according to the classifications of mycologists. William H. Prescott in his classic *Conquest of Mexico* ignored the subject. Yet we know that he was familiar with it. He drew on most of the sources that we have cited, and in particular the two accounts of Montezuma's assumption of office. In Book II Chapter 6 he speaks of the 'honorable entertainment' offered to the Tlascalan princes by Montezuma, but he deftly excises the reference to the sacred mushrooms. By now one is so used to the subconscious rejection of mushrooms by the mycophobic Anglo-Saxons that it would be more a matter of remark if Prescott had mentioned the *teo-nanacatl*.

Then suddenly one day the sacred mushrooms sprang to life again. On May 4, 1915, an ethno-botanist of established and deserved reputation, W. E. Safford, read a paper before the Botanical Society in Washington in which he flatly and sweepingly denied that there had ever been an inebriating mushroom in the indigenous cultures of Mexico. His paper was published later in that year in the *Journal of Heredity*, and it was a full-dress presentation, richly illustrated and documented. Dr. Safford said that the Spanish 'padres' (as he somewhat condescendingly called them) had been confused: they had taken for mushrooms what had really been dried buttons of a cactus, the *Lophophora Williamsii*, the *peyotl* of Aztec times, the mescal button of Texas. He declared that three centuries had failed to reveal a fungal intoxicant in Mexico. He quoted Sahagun as saying that the Chichimecas had been the first Indians to discover the alleged intoxicating property of the 'mushroom'; he went on to say that the Chichimecas had occupied northern Mexico, that that was therefore the region where to seek the mushroom, that he had pushed his own researches exhaustively in those areas and in the Southwestern states of the United States, and that he had found nothing.

---

[151] Malformed and bestial feet characterize various Aztec divinities. Thus the demon Tezcatlipoca was distinguished by a club-foot, and Mictlantecuhtli had the claws of a gigantic bird. But in the demon of the Florentine miniature we think it is rash to perceive any influence of Mexican divinities. The craftsmanship reveals a European mind, and the imp is the obvious visual expression corresponding to the verbal denunciations that the clergy, as we know, were heaping on the demonic mushrooms.

Dr. Safford's paper drew wide attention and was widely accepted. Many learned from it for the first time that there had been a belief in an inebriating mushroom, at the same time that they learned the mushroom had never existed. How ironic it will be if Dr. Safford himself, in the long run, should be remembered chiefly because of this resounding blunder that he made, a classic example of the fallibility of the specialist! For of course the Spanish 'padres' were right and Dr. Safford was wrong. Dr. Safford's paper was extraordinary for the vehemence (may we say 'telltale' vehemence?) that this Anglo-Saxon showed in rejecting the *teo-nanacatl*. It never occurred to him that he had to demolish not only the Spanish 'padres' but also all the native informants on whom they relied, and even the Nahuatl vocabulary that they used!

The source of Dr. Safford's error lay in his misreading of Sahagun's sentence about the Chichimecas and the emphasis that he placed on this single misconstrued passage. Loosely constructed though the sentence is after the fashion of 16th century prose, its meaning is clear. The Chichimecas were the first to use the *peyotl*, says Sahagun, and they used it in the way that we the Nahua (Sahagun's informants) use the inebriating mushroom. We may be sure that Dr. Safford canvassed the Chichimeca country thoroughly, and his negative findings there and in the Southwest of the United States tend to confirm our interpretation of Sahagun.

Just as toxins appropriately administered stimulate the growth of anti-bodies, so the Safford paper served a useful purpose in stimulating the inquiries of Mexican workers, who properly resented the charge that early Spanish observers could not tell a mushroom from a cactus button. The details of this inquiry need not detain us here. To Dr. Bias Pablo Reko, a Mexican of Austrian birth and Slavic provenience, belongs the primary accolade for persisting in the search for the mushroom cult. He was the first to declare his belief that the cult still survived. He so expressed himself shortly after the Safford lecture, and he began to look for the cult in the State of Oaxaca. To Robert J. Weitlaner goes the distinction of having first re-discovered the sacred mushrooms themselves. This excellent anthropologist and tireless worker laid his hands on samples in the remote town of Huautla de Jiménez, Oaxaca, in 1936. He sent them to Dr. Reko who in turn forwarded them to the botanical authorities at Harvard. They arrived in bad condition but could be identified as a species of panaeolus. Huautla is the chief town of the Indians known as Mazatecs.

In that same year Dr. Reko's cousin, Victor A. Reko, had published in Stuttgart the first paper challenging the Safford argument, *Magische Gifte: Rausch- und Betäubungsmittel der Neuen Welt*. In 1938 a young Harvard ethno-botanist, Dr. Richard Evans Schultes, visited Huautla and obtained additional samples of the mushrooms and photographs of them in a fresh state. With the help of Dr. David Linder of the Farlow Herbarium, Harvard University, he identified them as *Panaeolus campanulatus* L. var. *sphinctrinus* (Fr.) Bresadola. His specimens, carefully preserved, were again examined in the fall of 1955 by Roger Heim, who confirmed without hesitation the previous identification. In that same year 1938, on the night of Saturday-Sunday, July 16-17, four white persons in Huautla attended a mushroom rite performed expressly for them. The four were the promising young anthropologist Jean Bassett Johnson, his wife Irmgard Weitlaner-Johnson, Bernard Bevan, and Louise Lacaud. In a paper published the following year Mr. Johnson gave to the world the first account of the ancient rite: there is no evidence that any white persons had ever before attended it.[152] He did not identify the mushrooms that were used.

---

[152] The Johnson paper is important. Entitled 'The Elements of Mazatec Witchcraft', it was published by the Gothenburg Ethnographical Museum in Sweden in 1939 as Ethnological Studies 9. Dr. Schultes published two papers, one as a Botanical Museum Leaflet, Harvard University, Feb. 21, 1939, vol. 7, no. 3, *The Identification of Teonanacatl*; the other, 'Teonanacatl:

In European sources there is some evidence of inebriating mushrooms in addition to the fly amanita. Indeed, the earliest recorded reference to psychic symptoms caused by mushrooms clearly did not relate to the *Amanita muscaria*. Before describing the fly amanita Albertus Magnus in *De Vegetalibus* remarks on the propensity of certain mushrooms to bring about mental disturbance:

> Signum autem, quod habent humidum vaporosum, est, quod comesti frequenter oppilant vias spirituum animalium in capite, et inducunt insaniam. [*Op. cit.*, Book 2, Chap. 6:87]
>
> Moreover, an indication that they [fungi] are of a moist humor is that when eaten they often stop up in the head the mental passages of the creatures [that eat them], and bring on insanity.

The great Clusius may have described, an inebriating mushroom. In the section on the *Fungi perniciales* of Hungary he arrives at the eleventh of the evil species and says this concerning it:

> Hungaricum nomen nullum intellexi, sed Germanicum est *Narrenschlvammen* ac si diceres fatuum vel fatuorum fungum, quoniam forte, si quis vescatur, mente turbetur ... Corpore dum e sua volva erumpit, est boleto dissimili, longiore pediculo subnixum minimo digito graciliore, sescuncialis latitudinis, in metam assurgens, superna parte *Candida*, inferna camerata, & multis striis, a pediculo in ambitum productis, notata.
>
> I did not learn its Hungarian name, but in German it is *Narrenschwamm*, i.e., 'foolish fungus' or 'fungus of fools', since one may see that he who eats becomes mentally upset... Its body, when once it has broken its volva, is unlike the *Boletus*, with a stipe thinner than the little finger, [the cap] less than 4 cm. in diameter, heading up into a conical top, white above, partitioned below with multiple furrows, radiating from the stem in a circle.

Our Hungarian friend, Dr. Stephan F. Borhegyi, has supplied us with the Magyar name that Clusius failed to get: *bolondgomba*, 'fool-mushroom', a term still familiarly used in Hungary, especially in the rural areas, as when one asks of a person behaving foolishly, "Have you eaten the fool's mushroom;", or when one rejects a proposition by saying, "Do you think I have eaten a fool-mushroom, that I should do such a thing?" Or again:

---

the Narcotic Mushroom of the Aztecs', in the *American Anthropologist*, n.s., 42, 1940. These three and Dr. Reko's *Mitobotanica Zapoteca*, published by himself in 1945, constitute our basic modern bibliography. Victor A. Reko's *Magische Gifte*, of which a third edition appeared in Stuttgart in 1949, must be read with caution. For example, he guesses at the identity of the inebriating mushroom, postulating an '*Amanita muscaria* var. *mex*.' More disturbing is his assertion that *poyomatli*, a narcotic plant, was a mushroom. He arrives at this conclusion by misquoting a passage in Sahagun (substituting llamados for *llamada*), and by ignoring another passage in Sahagun where the *poyomatli* is described in detail as a plant. (See *Magische Gifte*, 1949, p. 126; Sahagun, Book X, Chap. 24, Canute de Humo; also Book XI, Chap. 7, Sec. 7.) Since Victor Reko published his work in German, German writers frequently cite him and are misled by him. The modern discussions of our subject are also bedeviled by two idle conjectures of the late Marshall H. Saville, the archeologist, who without a shred of supporting evidence suggested (1) that the Aztec ruler Tizoc had been murdered with poisonous mushrooms, and (2) that the astonishing dental work found in the teeth of Zapotec skeletons had been performed with the aid of mushrooms as narcotics. For the Tizoc reference, see J. Eric Thompson's *Mexico before Cortez*, Scribner's, New York, 1933, p. 31. As for the Zapotec dental work, Saville tossed out his fanciful notion in an extempore, unrecorded talk before the Explorers' Club, New York (*Explorers Journal*, 1934, vol. 12, p. 7) and a subsequent interview (*The New York Times*, April 11, 1934). The Swedish archeologist S. Linne took Saville's dental suggestion seriously; see *Ethnos*, Stockholm, Jan.-June 1940, p. 7. Schultes in his two papers quotes Saville (via Thompson) on Tizoc. Safford's mushroomic nihilism may have led, by reaction, to Saville's postulating mushroomic agents right and left in pre-Conquest Middle America. As Saville never offered his mushroomic ideas formally, we infer that he regarded them as speculative. Bias Pablo Reko in his *Mitobotanica Zapoteca* (pp. 13, 14, 44, 53, and 95) reported names for inebriating mushrooms in contemporary Zapotec, but he failed to place his informants. In a typewritten note of his left with Mr. Weitlaner he states that in 1935 he found the divinatory mushrooms in use among the Zapotecs of Santiago Yaveo and the Chinantecs of Teocalcingo, two villages situated hard by the Mije country. He gives Chinantec names for these mushrooms (*a-ni* and *a-mo-kia*). The Chinantecs generally do not know the mushrooms, and if Dr. Reko's report is reliable, we suspect a cultural borrowing from the neighboring Mijes. Our own efforts to discover knowledge of the divinatory mushrooms among the Zapotecs of Tehuantepec and the Valley of Oaxaca have been unsuccessful. Pedro Carrasco reports the present day use of the divinatory mushroom in Zapotec country, among the Zapotecs of the southern coast, in the western part of the district of Pochutla, in the village of San Bartolo Loxicha, where he says it is called the *santo nanacate*. See his 'Una Cuenta Ritual entre los Zapotecos del Sur' in the Festschrift entitled *Homenaje al Doctor Alfonso Caso*, Mexico, 1951, p. 93. On the strength of his evidence we visited the southern Zapotec country in 1955, with successful results. See pp. 307 ff.

"He is laughing as though he had eaten fool's mushrooms." In Hungary the 'wise-woman', *javas asszony*, is said to use this same mushroom in love philtres, and the angry lover sends the philtre on to the object of his passion. We think this is the same mushroom that, as we saw on page 78 [of original vers.], the Slovakian peasant calls *salene huby*. The Slovakian word finds a surprising echo in the 17th century verses of the Polish poet Waclaw Potocki, which we mentioned on page 15. He is advising his readers about mushrooms, and warns them against a kind called *szmer*, [Note to the edition at Psilosophy: szmer/szmyr/szemrzyk it is (also?) Old Polish name for *Thymus serpyllum* - elfin thyme] lest it render the reader foolish (*szaleć*) 'as from opium'! In Vienna one may hear the saying, *Er hat verrückte Schwammerln gegessen*, 'He has eaten the mad mushrooms.' Whether this is native to the Austrian countryside, or a loan made in imperial times from Hungary or the Carpathians, we do not know.

Thanks to Clusius and the Continental usage, John Parkinson in his *Theatricum Botanicum* (1640) speaks of the 'foolish mushroom', describing it rather well:

> ... about half an inch broad, spiring a little at the toppe, and being of a whitish colour, with a long stalke, of the thicknesse of ones little finger: this is called the foolish or the fooles Mushrome. [p. 1321]

What was and is this fool's mushroom that Albertus Magnus mentioned and Clusius described and the peasants of central Europe invoke in their old saws? Our only good clue lies in the paintings that Clusius made, now preserved in Leiden: for Clusius the *Narrenschwamm* was, beyond a doubt, the *Amanita vaginata*. Is it possible that this edible mushroom, if eaten raw, causes psychic disturbance? Clusius' identification is uncorroborated. Is it possible that he made a mistake, that his informants in Hungary were not heirs to the true tradition, that they were not privy to the secret? Perhaps the folklorists of Central Europe can yet run to earth the haunting reference incapsulated in the *Narrenschwamm*, with its echoes of far-off fungal knowledge.

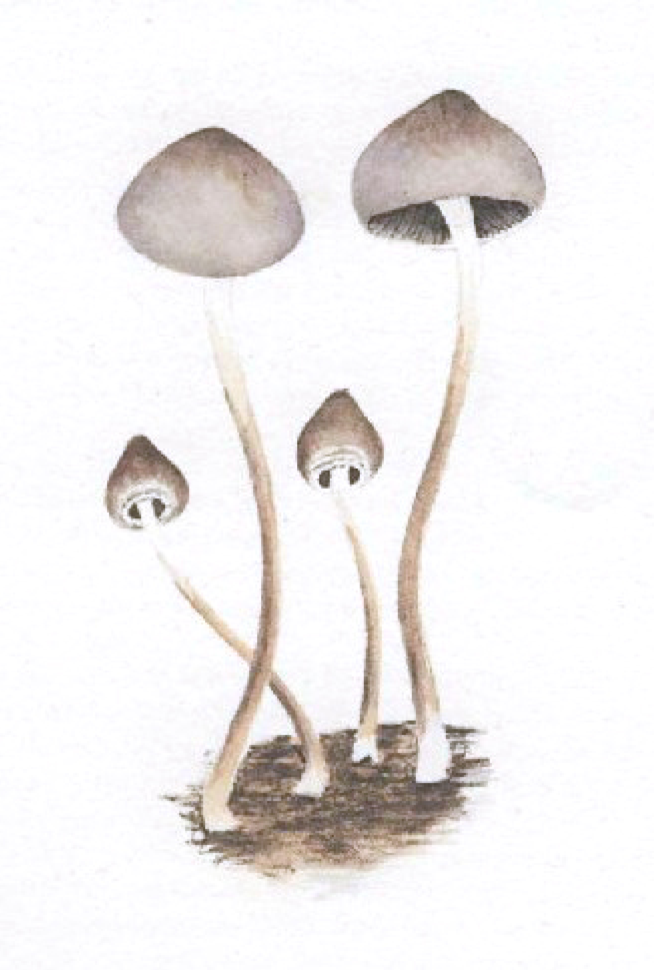


PLATE XXXIX
Jean-Henri Fabre
Panaeolus campanulatus Fr. ex L.

We might have expected the 'fool's mushroom' to be a species of panaeolus, for there is medical evidence to support the intoxicating virtue of this genus of mushrooms. A surgeon named G. Glen, Esq., reported on a case in the *London Medical and Physical Journal*, 1816, on pages 451-3. It seems that on October 16 of that year a poor man living in Knightsbridge gathered a mess of mushrooms around a copse behind the Horse Guards barracks in Hyde Park. He thought they were field mushrooms, and after stewing them, proceeded to eat them. About eight or ten minutes later, when only six or eight mushrooms were left on his plate, he was seized with giddiness, dimness of vision, and a general loss of power. With utmost difficulty and only by the help of a friend whom he met, he made his way to Mr. Glen's consulting room five hundred yards away. He was reeling like a drunken man. It is noteworthy that Mr. Glen says his patient spoke with hesitation and reluctantly, and was greatly inclined to sleep. There was no nausea. By the next day the patient was well on the road to recovery, and Mr. Glen was inclined to the view, natural to medical men under the circumstances, that his own ministrations had either saved the poor man's life or spared him a prolonged illness. Mr. Glen examined the mushrooms left from the stew and also gathered fresh ones from the place where the first had been found. He identified them as *Panaeolus campanulatus* Linn., and this was confirmed by a Mr. William Salisbury of Sloane Street, a person deemed competent in the matter. Mr. Glen drew attention to the fact that two parallel cases had been summarily reported in the August 1815 issue of the *Gentleman's Magazine*, the same species being held accountable in those instances also.

Exactly one century after Mr. Glen's experience, in the summer of 1916, an American surgeon, Dr. Beaman Douglass, gathered a mess of mushrooms that he believed were of the genus panaeolus, though the species remains uncertain. He, his wife, and the maid ate them, spreading the cooked mushrooms on toast. One hour later Mrs. Douglass developed psychic symptoms, and his followed shortly afterwards. Both lost their sense of balance and mental control. There was pronounced stimulation. Mrs. Douglass manifested "a tendency to be jolly, hilarious - she laughed and talked inordinately and foolishly." As for Dr. Douglass, this is what he recalled, "I wished to be noisy, to laugh and joke. My own trivial remarks met with my own warm personal appreciation... Thoughts flew through my brain... Objects near seemed far away, sounds were diminished... ." The maid underwent a similar experience. Six hours after eating and five hours after the first symptoms all evidence of intoxication had disappeared. At no time had there been nausea.[153]

Mushrooms of the genus panaeolus are found everywhere in the temperate and tropical zones, and there are many species. Henri Fabre knew them, of course, and we offer to our readers a reproduction of his painting of the *Panaeolus campanulatus*. To us it seems outstanding in artistic composition, in the delicacy of the curves, the lilt of the caps. This mushroom is not normally eaten in France, but so far as we can learn it is not regarded as inebriating even by the mycophilic country folk of the Provence. There is no reason to think that Fabre considered it uncanny. Yet is there not something eerie about the cobra-curves of the little mushrooms in his painting, as though he sensed a secret?

There is a reproach to mycologists in these unexplored hints and evidence of psychic effects caused by mushrooms, hints deeply rooted in Europe's folkways, evidence clearly reported over centuries from Kamchatka, New Guinea, and Middle America. It seems strange that archaic peoples should still possess secrets of this kind that our laboratories have not exhaustively analyzed. Indeed, Swiss and English workers may lately have arrived, at last, on this exciting terrain for scientific inquiry. From the fungus known as ergot Swiss pharmacologists have recently isolated an alkaloid that causes massive psychic reactions in human beings, including hallucinations that duplicate with astonishing fidelity the testimony of our old Spanish writers. Experiments with this alkaloid in England and America seem to open up promising vistas for its use in the treatment of psycho-neurotic disorders.[154]

---

[153] For the Douglass episode see his papers on 'Mushroom Poisoning', published in *Torreya*, vol. 17, No. 10 and No. 12, Oct. and Dec. 1917. See also Louis C. C. Krieger, *A Popular Guide to the Higher Fungi (Mushrooms) of New York State*, Albany, N. Y., 1935, p. 147.

[154] See, e.g., *Journal of Mental Science*, vol. 100, No. 419, April 1954: 'The Therapeutic Value of Lysergic Acid Diethylamide in Mental Illness', by R. A. Sandison, A. M. Spencer, and J. D. O. Whitelaw, pp. 491-507; and 'Psychological Aspects of the LSD Treatment of the Neuroses', by R. A. Sandison, pp. 508-515, being reports on the treatment of certain neurotic patients at Powick Mental Hospital, Worcestershire.

That Dr. Reko and Dr. Schultes brought back a panaeolus from their quests for the divinatory mushrooms was not the full answer to our problem. Were there not other divinatory species, belonging to different genera? Both Dr. Reko and Dr. Schultes thought so, and the former even obtained specimens of two other genera. Further questions suggested themselves, and we resolved to pursue our inquiry on our own account.

In response to an inquiry of ours, Dr. Reko wrote us on February 12, 1953, that he had nothing further to add to the information he had published, but suggested that we address ourselves to a Miss Eunice Victoria Pike, an American linguistic student and Bible translator who had been living for many months each year since 1936 among the Mazatec Indians, with her headquarters in Huautla. She spoke Mazatec, he added, and thus she had access to the thoughts and feelings of the monolingual elements in the population. Immediately after thus introducing us to Miss Pike, Dr. Reko died. We wrote to her, and she has proved a most helpful and understanding correspondent. Even Miss Pike after all these years has never attended a performance of the divinatory rite, but speaking the language and living among the people, she reports the words of those who know and understand, and their words are more valuable than would be the uncomprehending testimony of an outsider witnessing the event. Is there anything more difficult than to enter intelligently into the inner religious experience of a people far removed culturally from one's own; We reproduce in full Miss Pike's letter to us, as a primary source on a theme of absorbing anthropological interest, superior by far in quality to anything on the *teo-nanacatl* given to us either by the early Spanish writers or recent inquirers. There is an immediacy of experience, an intimacy, about this report that carries its own proof of credibility.

Here is Miss Pike's letter:

> Huautla de Jiménez
> Oaxaca, Mexico
> March 9, 1953
>
> Dear Mr. Wasson:
>
> I'm glad to tell you whatever I can about the Mazatec mushroom. Some day I may write up my observations for publication, but in the meantime you may make what use of it you can.
>
> Mazatecs seldom talk about the mushroom to outsiders, but belief in it is widespread. A twenty-year old boy told me," I know that outsiders don't use the mushroom, but Jesus gave it to us because we are poor people and can't afford a doctor and expensive medicine."[155]
>
> Sometimes they refer to it as 'the blood of Christ' because supposedly it grows only where a drop of Christ's blood has fallen. They say that the land in this region is 'living' because it will produce the mushroom, whereas the hot dry country where the mushroom will not grow is called 'dead'.
>
> They say that it helps 'good people' but if someone who is bad eats it, 'it kills him or makes him crazy.' When they speak of 'badness' they mean 'ceremonially unclean'. (A murderer if he is ceremonially clean can eat the mushroom with no ill effects.) A person is considered safe if he refrains from intercourse five days before and after eating the mushroom. A shoemaker in our part of town went crazy about five years ago. The neighbours say it was because he ate the mushroom and then had intercourse with his wife.
>
> When a family decides to make use of the mushroom they tell their friends to bring them any they see, but they ask only those whom they can trust to refrain from intercourse at that time, for if the person who gathers the mushroom has had intercourse, it will make the person who eats it crazy.
>
> Usually it is not the sick person nor his family who eat the mushroom. They pay a 'wiseman' to eat it and to tell them what the mushroom says. (He does so with a loud rhythmic chant.) The wiseman always eats the mushroom at night, because it 'prefers to work unseen'. Usually he eats it about nine o'clock and it starts talking about a half an hour or an hour later. The Mazatecs speak of the mushroom as though it had a personality. They never say, "The wiseman said the mushroom said..." They always quote the mushroom direct.

---

[155] Miss Pike informed us later that this and other translations were from the Mazatec, not from Spanish.

The wiseman always eats the mushroom raw; "If anyone cooks or burns the mushroom it will give them bad sores." There is no specified number of how many he should eat, some wisemen eat more than others, usually they eat four or five. If he eats a lot, it 'wants to kill him'. At such a time the wiseman falls down unconscious, and comes to little by little as the other people in the room 'pray for him'. This may also happen 'if he has had intercourse too recently'.

When all goes well, the wiseman sees visions and the mushroom talks about two or three hours. "It is Jesus Christ himself who talks to us!" The mushroom tells them what made the person sick. He may say the person was bewitched; if so, he tells who did it, why, and how. He may say the person has 'fear sickness'. He may say it is a sickness curable by medicine and suggest that the person call a doctor.

More important, he will tell whether or not the person is going to live or die. If he says he will live, then "he gets better even though he has been very sick". If he says he will die, then the family start making arrangements for the funeral and he tells who should inherit his property. (One of my informants admitted, however, that the mushroom occasionally makes mistakes.)

One of the "proofs" that it is "Jesus Christ himself" who talks to them is that anyone who eats the mushroom sees visions. Everyone we have asked suggests that they are seeing into heaven itself. They don't insist on that point, and as an alternative they suggest that they are seeing moving pictures of the U.S.A. Most of them agree that the wisemen frequently see the ocean and for these mountain people that is exciting.

I have asked what the wiseman looks like while under influence of the mushroom. They say that he is not sleeping, he is sitting up, with his eyes open, "awake". They say he does not drink liquor at the time, but that he may in the morning. Some of them go right out to work the next day, but some stay home and sleep "because they have been awake all night".

Although we have never been present when the mushroom was eaten, we have observed the influence it has on the people. One of our neighbors had tuberculosis and was coming to us for medical help. Then one night they called in the wiseman to eat the mushroom in his behalf. It told them that he would die.

The next day the patient no longer had any interest in our medicines; instead he began to set affairs in order for death. He quit eating solid food, restricting himself to corn gruel. About two weeks later he refused even gruel, accepting only an occasional sip of water. A few days later even water was rejected. In less than a month after he had consulted the mushroom he was dead.

Another neighboring family had a series of sicknesses. They consulted the mushroom for their twenty-two year old son. The mushroom said he would get better, and he did. When their eighteen-year old daughter became ill, they consulted the mushroom. It said she would get better and she did.

Then the ten year old daughter became ill. The mushroom said that this one would die. The family were amazed because her illness had not seemed serious. Of course they were grief stricken, but the mushroom said, "Don't be concerned, I'll take her soul to be with me." So, following her mother's instructions the little girl prayed to the thing talking to her, "If you don't want to cure me, take my soul." A day or two later she was dead.

Not all the Mazatecs believe that the mushroom's messages are from Jesus Christ. Those who speak Spanish and have had contact with the outside world are apt to declare, "It's just a lot of lies". Most monolinguals, however, will either declare that it is Jesus Christ who speaks to them, or they will ask a little doubting, "What do you say, is it true that it is the blood of Jesus?"

I regret the survival of the use of the mushroom, for we know of no case in which it has had beneficial results. I wish they'd consult the Bible when they seek out Christ's wishes, and not be deceived by a 'wiseman' and the mushrooms.

In answer to your questions:

The mushroom (called $si^{3}tho^{3}$, or affectionately ˀ$nti^{1}si^{3}tho^{3}$) is brown in color and grows biggest in June and July when the rainfall is heaviest. At that time they may be four inches across and about four inches tall. They are still plentiful in September and October. By March and April, the dry season, the mushroom is scarce, but small ones may still be found.

The mushroom grows in the grass, but when people are hunting for it, they look first in the places where cattle have been, because the mushroom is most frequently found growing out of

> cow manure.
>
> They do not dry the mushroom. If they cannot find one growing, they go without. The person I asked doubted that it was possible to dry them. At first she thought they would not. Then she said that maybe they could be dried, but she doubted that they would serve as medicine that way.
>
> I do not know that the Mazatecs ever use the mushroom in connection with a fiesta. For the most part it is used in connection with sickness. I have heard of one other minor use however. They say a man may slip a piece into an enemy's liquor while he is drinking in a saloon. If he drinks it while ceremonially unclean, he may go crazy. Or he might go crazy because the man who gathered it was ceremonially unclean. Wishing you success in your research,
>
> Sincerely,
> (Signed) Eunice V. Pike

Miss Pike's letter settled one question for us. For some time we had been considering a visit to Huautla. Now we were resolved to make it. Much of her information was of that precious kind which can only be obtained when one speaks with the Indians in their own language on terms of long standing friendship and complete mutual confidence. We could not hope to improve on her contribution. But there were many unanswered questions. For one thing, her mushrooms reached four inches in diameter; they could not belong to the genus panaeolus. What then were they?

In the Mazatec country there are two seasons of the year when mushrooms should be abundant, at the beginning and at the end of the rains, in June and in the first half of August. We decided on August for our trip. Miss Pike would be absent then, but her colleague in Mexico City, Mrs. George Cowan, proficient in Mazatec and intimate with Huautla, would know how to help us get there. We also were successful in exciting the interest of Mr. Weitlaner, who agreed to accompany us. This was our greatest stroke of fortune, for with his knowledge of the country and the Indians, at least some measure of success was assured. Our objectives were simple: to obtain specimens of the sacred mushrooms, for purposes of identification and trial consumption by ourselves, to learn about the present state of the cult, and to attend the mushroom rite.

We set out from Mexico City on Saturday morning, August 8, 1953. Apart from the chauffeur we were four - Robert Weitlaner, whom we shall call hereafter Don Roberto, VPW, RGW, and our sixteen year old daughter Masha. On that day we drove through Puebla to Tehuacan, a watering resort, where we dismissed the car and spent the night. On Sunday we took the train to San Antonio, about two hours away, and from the mournful railroad station reeking in the torrid heat of a semi-arid countryside we drove a mile or so in a ramshackle bus, loaded with Spanish-speaking Indians and their worldly goods, over the worst road in the world to Teotitlan del Camino, a bustling market town and the stepping off place for the Mazatec country. We spent Sunday night there, in the inn kept by Julia Martinez, a woman unforgettably obese. Early the next morning Victor Hernandez was at the door with six animals, five mules and a horse, all of them miserably small and thin. He was a Mazatec from Huautla who spoke a fair amount of Spanish. He had come for us in response to a telegram that Mrs. Cowan had sent to a friend in Huautla, the school teacher Herlinda Martinez Cid. Our belongings in duffle bags and knapsacks were soon loaded, and off we started up the steep trail into the mountains east of Teotitlan. After two hours of climbing we reached San Bernardino, a village superbly perched on a mountain spur looking back over the hot low country that we had left behind. There we breakfasted on tortillas and beans and then off we went again, on a long steady climb until we arrived at the first of the passes, known as La Cumbre, perhaps 9,000 feet high. Here we thought to stop for a bite to eat from our provisions, but Victor would not hear of it. He said the Cumbre was a favorite spot for robbers, who would beset the wayfarers on animals spent from the long climb and then vanish in any of various directions down the slopes. We noticed for the first time that Victor was armed with a revolver at his waist. Later we learned that four robbers, many years before, had been hanged on the Cumbre, and their bodies left swinging for months in that desolate wind-swept place. And so we hurried on down into the next valley, and up again to a second pass, and down again, and finally up the last steep climb into the town of Huautla, itself perched on a mountain side at an altitude ranging from 5,500 to 6,000 feet. We had been on the road for eleven hours through country of wild grandeur, the mountains covered with vegetation, with only two or three thatched villages discerned in the distance. But on the trail itself there had been considerable traffic, as strings of animals kept passing us, laden with sacks of coffee and other produce bound for the market in Teotitlan. Like our Victor, the drivers were all on foot, barefoot or wearing sandals, hurrying along at a dogtrot. Their animals gave us some trouble in the narrow way, as the beasts, stepping along, would brush us with their heavy sacks and push us uncomfortably toward the precipitous outer edge of the path. Victor observed our difficulty, and soon it dawned on us that on-coming drivers were halting their animals and letting us pass. Victor had been notifying them of our approach and bespoken their consideration. He had not uttered a word, or so we thought. But we had read, in preparation for our trip, about the Mazatecs, and knew that the language could be whistled as well as spoken. Yes, in a well-modulated, penetrating whistle Victor had been conversing about us with the on-coming muleteers, even before they would come around a bend into view, and at his request they were letting us pass! At the end of the day, as night was falling, we walked our animals slowly up through the town of Huautla, across the public plaza, up the hill to the house where Herlinda was waiting for us, standing in her door and smiling at us.

We were tired out, and the warm reception that this Indian school-teacher cheered us with was most welcome. That night we all slept on the packed-earth floor of one of her three rooms. Herlinda's aged mother lay moaning, critically ill, in the front room. On the following day we rented a new, unoccupied house nearby, paying five pesos (or fifty-five U.S. cents) for a week's use. There we also slept on the ground, and we had our meals with Herlinda, who stayed home from school to take care of us. From Victor and others during our stay we heard stories of the lawlessness of these Mazatec Indians, and it is true that no one goes abroad after nightfall, whether on the trails from one town to another or within the town itself; and armed with their machetes the Indians looked to us fearsome enough, when we would meet them on the road. But the fact is that they treated us always with perfect courtesy and gentleness, and those few whose aid we sought in confidence in our mushroomic inquiries were most understanding in their efforts to help us.

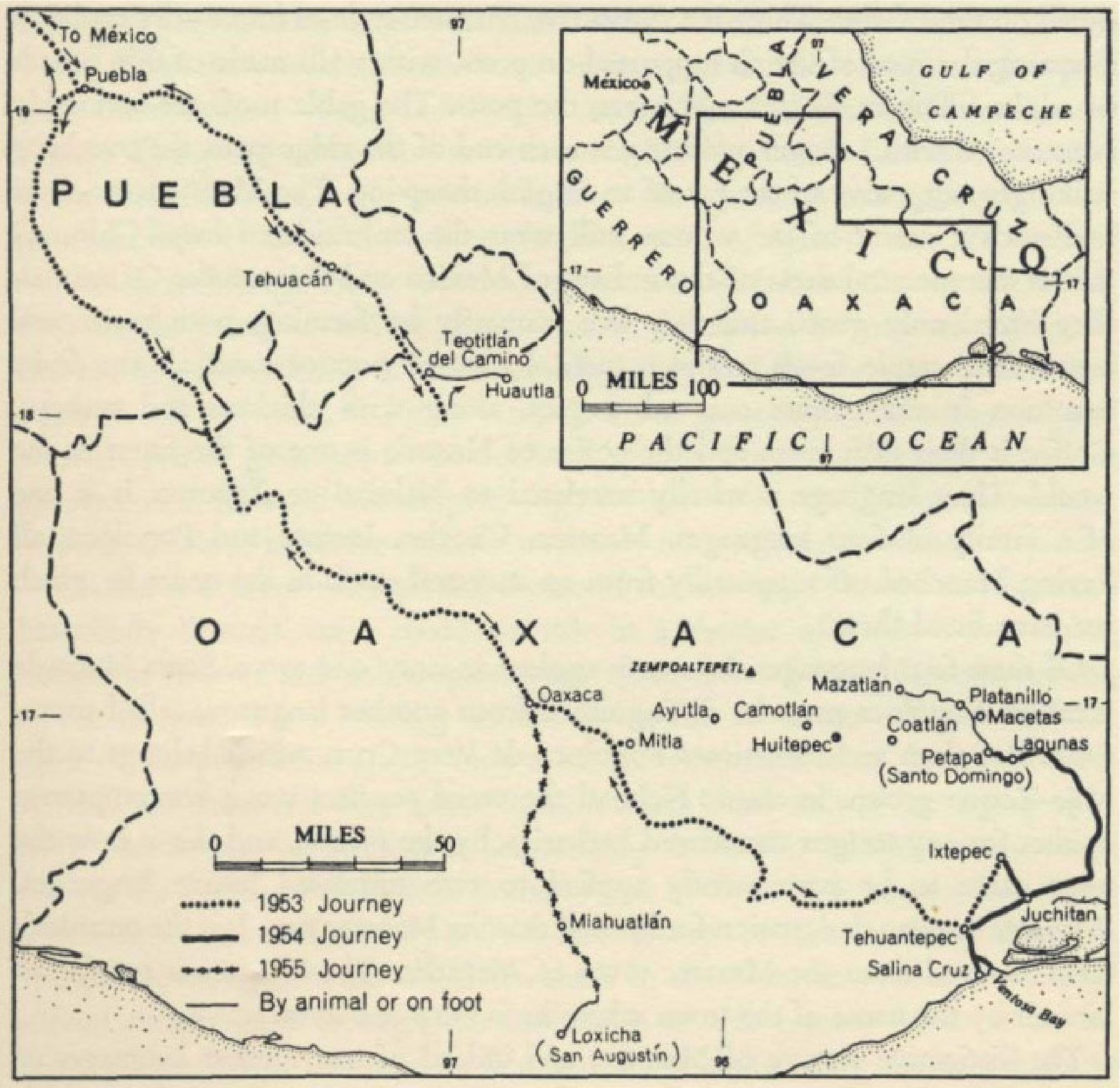

To México
Puebla
PUEBLA
Tehuacán
Teotitlán del Camino
Huautla
OAXACA
ZEMPOALTEPETL
Oaxaca
Mitla
Ayutla
Camotlán
Huitepec
Mazatlán
Coatlán
Platanillo
Macetas
Lagunas
Petapa (Santo Domingo)
Ixtepec
Juchitan
Tehuantepec
Salina Cruz
Ventosa Bay
Miahuatlán
Loxicha (San Augustín)
MILES 0 50
1953 Journey
1954 Journey
1955 Journey
By animal or on foot
México
PUEBLA
VERACRUZ
GUERRERO
MEXICO
OAXACA
GULF OF CAMPECHE
PACIFIC OCEAN
MILES 0 100
97
96
18
17

Fig. 16 - Map of the Province of Oaxaca, with the Wasson journeys.

The Mazatec Indians number about 60,000, all of them concentrated in the mountains of north central Oaxaca. They live chiefly in villages, though some dwell on their farms. There is a distinctive Mazatec style of house - by tradition a rectangular roof of thatch supported on posts, with walls made of thin boards or adobe filling in the space between the posts. The gable roofs are invariably constructed with a thatch overhang at each end of the ridge pole, the overhang strikingly suggestive of the ear of an English sheepdog. The Mazatecs are short and stocky; many of the women still wear the embroidered *huipil* ('blouse') that is the ancestral dress of the Indians of Mexico and Guatemala. Of animals they breed only goats, and they live primarily by farming, with maize and beans their staple foods, supplemented by sweet potatoes and all the fruits common in the tropics and sub-tropics, along with chickens and turkeys. Coffee is their cash crop, and the coffee of Huautla is one of the finest in the world. Their language is wholly unrelated to Nahuatl or Zapotec. It is one of a family of four languages, Mazatec, Chocho, Ixcatec and Popoloca, all having branched off supposedly from an ancestral stock in the order in which we have listed them.

Of these four languages, Ixcatec is spoken in only one town, Santa Maria de Ixcatlan. Popoloca must be distinguished from another language, called sometimes Popoluca and sometimes Popoloca de Vera Cruz, which belongs to the Mije-Zoque group. In classic Nahuatl the word *popoloca* was a contemptuous epithet for any tongue considered barbarian by the Nahua, and this is how the term came to be permanently applied to two unrelated Indian languages. 'Mazatec' is not a designation for himself that the Mazatec uses. It is the outsider's term, derived from the Mazatec town of Mazatlan. The Mazatec is apt to call himself by the name of the town where he is born and lives.

The distinctive feature of Mazatec, and indeed of many other languages of the Oaxaca cultural mosaic, is the tonal system. In Mazatec the pitch at which successive syllables are uttered is of primary semantic importance. This is what makes communication by whistling or humming simple. The Chinese is a tonal language too, but the 'contour' tones of Chinese are basically different from the 'registered' tones of constant pitch in the language of the Mazatecs. When the Mazatec muleteer initiates a whistled conversation with a friend some distance away, the key that he adopts sets the key for his friend's answer and the whole conversation follows in that key. Anything that can be said in the language can be said whistling. Mrs. Johnson had sent by us some trinkets - earrings, a ring, a bracelet - to an Indian godchild of hers, living outside the village of San Andres, a few miles from Huautla. With Victor we walked thither along the ancient mountain path. He found the Indian cottage, high above the path. He tilted his head far back, and in a pleasant whistled discourse explained the circumstances - certainly unusual ones for this isolated Indian family. Soon there were signs of activity above, and down a precipitous footpath came three women - the grandmother, the mother, and the child herself, now sixteen. The grandmother and mother were bearing simple homespun textiles across their forearms, a gift to send back to Mrs. Johnson in exchange for her remembrance. None of the women knew a word of Spanish, and after a brief conversation through Victor as our interpreter, we withdrew, the women raising their hands, palms turned to us at shoulder level, and bowing us a friendly and moving farewell. By Victor's whistling they had learned exactly who had come to call and why, and they came down to greet us on the path equipped with reciprocal gifts, not to be outdone by our courtesy. There is a curious convention in Mazatec whistling: though women understand it and know how to do it, a rule of behavior makes it improper for a woman to whistle in public.

Huautla is a town with several thousand inhabitants. It could not be more beautifully situated, on a mountain side in a theater of verdant mountains, bathed in flowers and sub-tropical vegetation, free of mosquitoes by reason of the altitude. It is a bustling market town, full of movement and life. Yet most of the population speaks only a tongue that, until now, has never been written, and those few who know Spanish often know only a smattering of it. Most Mazatecs never sleep in a bed, rolling themselves in their sarapes on a mat on the beaten earth in their houses. Most of them have never worn shoes. Victor could not read time by a clock-face. Except in Huautla where there are wheelbarrows, there is no wheeled vehicle in the Mazatec country, and until a road thrusts itself through the mountains to this remote Mazatec world, most Mazatecs will continue to live and die without using the wheel. How strange to come upon a people remote from the modern world, still shut in by their mountains and the barrier of their difficult language, where we can see' how our own ancestors lived for most of human history, living almost solely in and for the present, but pursuant to patterns transmitted orally from one generation to another, a people abounding in vitality, intelligent, yet still largely untouched by the currents of the modern world!

At breakfast on the morrow after our arrival Don Roberto and RGW took Herlinda into their confidence and told her the purpose of our visit. She admitted that she, like her neighbors, had wondered why we were coming. A close friend of Victoria Pike and Florence Cowan, she had no faith in the sacred mushrooms, but she said she would ask her brother-in-law, Aurelio Carreras, widower of her late sister, to help us. He turned out to be a one-eyed Indian, about 45 years old, the owner of two or three houses built around a patio almost next door. He had learned Spanish from his wife, but could not read or write it. We bespoke his help to get the sacred mushrooms for us, and he promised to do his best, but the rains had ended prematurely and the mushrooms might be hard to find. He warned us to discuss the mushrooms with no one.

We walked through the town. Don Roberto dropped in at a little general store, and introduced RGW to the ancient woman behind the counter, Cleofas Cid, an aunt of Herlinda's. When no other customers were about, he asked her whether she could find the mushrooms for us. She told us that the *curandero*[156] who had officiated for the party in 1938 had died, and she knew not where to turn for another who would accommodate us, but there was Concepción, the wife of a *curandero* who had taken to drink and gone to the dogs. She knew the mushrooms and would get them for us. Concepción did not speak a word of Spanish. When approaching the Indians with our inquiries, we were careful to speak of the mushrooms with the deepest respect. (After all, it was a bold thing that we were doing, strangers probing the innermost religious secrets of this remote people. How would a Christian priest receive a pagan's request for samples of the Host?)

On Wednesday word reached us from the priest of the huge church on the plaza that he would like to see us. We had already paid a courtesy visit on the Presidente, a big, tough-looking cacique who spoke good Spanish. Now we called on Father Alfonso Aragon. He turned out to be Indian, but Zapotec not Mazatec, and with most of his parishioners he could not converse. (In man's memory there had never been a Mazatec priest in Huautla.) He was curious about our visit. We explained our interest in the old customs of the Mazatecs, and then on his initiative he told us of the strange faith, ridiculous in his eyes, that the townspeople placed in certain mushrooms. Lately a physician in Puebla had asked him to forward a kilogram of them. Father Alfonso had succeeded in laying his hands on the mushrooms, and had wrapped them up. The parcel was still there, on the shelf in front of us, for he had lost the address of the Puebla physician. Did we care to examine them? We did not conceal our interest, and quickly untied the parcel. Alas, as was to be expected, the contents were reduced to a black and putrid mass.

We talked with Victor the muleteer about the mushrooms, and how we hoped we could consult a *curandero* in the course of our visit, and he set off full of promises, saying he would seek out either of two *curanderos* whom he knew in San Andres.

Then we waited.

And as we waited, we picked up more and more information about the sacred mushrooms. Herlinda talked freely with us. She knew much, though she professed to have little knowledge and certainly she had no faith in them. Victor the muleteer was captivated by our interest. He and Aurelio and Concepción would come to us separately, often after dark, Aurelio and Concepción with little parcels of a few mushrooms wrapped in banana leaves or a cloth, which they would deliver to us secretively and reverently. Aurelio and Victor would warn us to speak of the matter to no one, for it was *muy delicado*, very perilous. This was the expression they used independently of each other, for we talked with them always individually, but in the case of Concepción, as she was monolingual, we had to bring in Herlinda to interpret for us.

We learned that the Mazatecs are mycophagous and many kinds of edible mushrooms are offered on market day in the plaza. Each has its own name and the general word for 'mushroom' is *tai*^{3}, the *t* being explosive and each of the vowels being nasalized.[157] But this word embraces only mushrooms other than the sacred ones. Each of the sacred kinds has its own name, and all together they are called *si*^{3}*to*^{3}. This name is invariably preceded by another verbal element so that the normal expression is, as Miss Pike had told us, ^{ʔ}*nti*^{1}*si*^{3}*to*^{3}, the first syllable conveying a sense of deference and affection. (^{ʔ} represents a glottal stop.) The word *si^{3}to^3* means literally 'that which springs forth', and while it is impossible for us to prove that this sense explains the name, in the context of the sacred mushrooms it is a felicitous mystical metaphor. Victor explained the name as meaning "that which comes of itself, no one knows whence, like the wind that comes without our knowing whence nor why" - *que viene por sí mismo, no se sabe de dónde, como el viento que viene sin saber de dónde ni porqué*. The word is saturated with mana: it is uttered in a whisper and Victor was loath to pronounce it at all; when he had to use it, he would substitute a gesture - his gathered fingers making an eating motion before his mouth.

---

[156] We have found no English word that renders *curandero*. Medicine man, shaman, witch doctor, sorcerer all are misleading. The *curandero* heals with herbs and engages in divination. *Curandero* is the respectful designation of which *brujo* is the pejorative counterpart.

[157] The superscript digits in Mazatec words indicate the pitch, '1' being the highest and '4' the lowest.

In the Mazatec language there seems to be no name for the occupation of the shaman or *curandero*. In the proper context one speaks of him as 'he who knows', *co'ta'ci'ne'*. Only on his advice should one eat the sacred mushrooms. The *curandero* himself does not necessarily gather the mushrooms; others may do this for him. Nor is the gathering attended by prayers and vigils. But according to Concepción the best time to find them in good condition is early in the morning "when the air is fresh" - *con el fresco* - a turn of phrase that reminds us of the 'little breeze before dawn' that Jacinto de la Serna mentioned. The best time to find them is when the moon is new - *la luna tierna*. According to Aurelio, in and around Huautla there are today about twenty or thirty *curanderos*, roughly the same number as in the past, and women are as acceptable as men in this function. Usually the *curandero* takes in hand the instruction of his son or relative who will succeed him, but this presents no problem, for the neophyte learns in two or three months. After all, it is the mushroom that speaks, the mushroom that teaches the beginner what to say and do. The rite of the sacred mushroom is performed only as an *ad hoc* consultation, and the prevailing fee when we were in Huautla was from twenty to twenty-five pesos, from $2.50 to $3.00. For this service the *curandero* must fast from noon to noon, and drink no alcohol. He must be (ceremonially) clean, *nta^{3}co^{4}ta^4*. He begins his session between nine and ten o'clock in the evening, and does not finish before three in the morning. But the trance leaves no unhappy aftereffects. He can work the next day, and his head is so clear that he remembers all that he has said in the course of the night.

The *curandero* eats the mushrooms raw and unwashed and preferably fresh, but he may conserve them in a dried state for as long as six months. The *curandero* eats the mushrooms near the beginning of the seance, and at his discretion he may offer them to the family who is in attendance or to the patient whose fate is in the balance. Among our informants we found no one who had ever heard of a public communal feast of sacred mushrooms. This feature of the cult, so eloquently described by the old writers, seems obsolete. Here is an important alteration in the old customs, and for the change two explanations suggest themselves, either of which would be sufficient of itself. For public celebrations the mushroom could hardly stand the competition of distilled alcohol, and the unhappy addiction of the Mazatecs today to strong liquor is sufficient evidence of this. But there may be another reason. We know that from the earliest times the Catholic Church exerted itself to the utmost to extirpate the mushroom cult, and under that threat the use of the mushroom would be driven into hiding. Indeed this may be the forgotten but once powerful motive behind the atmosphere of secrecy that hung over all our discussions during our brief sojourn in Huautla, and what on its face looks like a reverential tabu may be merely a legacy of persecution.

How shall we convey the sense of gravity and doom that seemed to hang on Aurelio's words when he would whisper to us about the sacred mushrooms in the evening? The mushroom itself 'is speech', *es habla*, he would say, and it speaks of many things, of God, of the future, of life and death, and also it tells where to find things that are lost. One sees everything, one sees where God is also - *se ve todo*; *se ve donde esta Dios tambien*. These were our good friend Aurelio's very words. We discovered that it is usual to talk of these mushrooms in pairs. The *curanderos* use four kinds, and each kind has its valence, so to speak, measuring its potency, and the *curandero* eats so many pairs of this kind, and a different number of pairs of another; or in case of a shortage, he can use two or more kinds, calculating the valence of each to arrive at the right dose. We discovered also that each of the four kinds has various specific names, and not all of our informants knew all of these names, but each was certain in his own mind of his own names. It is as though in a single community of a few thousand souls there were various oral traditions using different names, and the traditions did not intermingle and coalesce. On the last day of our stay in Huautla, Victor arranged for us to pay a visit to Teodoro Garcia, and it was obvious to us from his installation and bearing that he was a 'fashionable' *curandero*. He told us he was a native of Huautla, yet later we learned from Herlinda and Aurelio that neither had ever heard of him, and Herlinda suggested that he must hail from San Lucas, a Mazatec village some distance away speaking a dialect different from the dialect of Huautla. More probably 'Teodoro Garcia' was a fictitious name, invented on the spur of the moment. For the Mazatec his name is part of his very being. He is loath to disclose it, for he thereby places himself in the other person's power.

It was interesting to watch the behavior of our Indian friends as one by one they would talk to us about the mushrooms lying on the table before us in the shelter of our house. Victor would hold them to his nose and sniff them, and then report how much *gaz* the specimens contained. Aurelio would say of the little ones that they had a higher rating - *ten tan mas grades* - than the larger ones. They would tell us how many pair were to be eaten of each kind, and the maximum that a strong man might cope with. They told us the specific names for each kind, and from the variety of these it was clear that the names were euphemistic escapes, metaphors rather than names, metaphors expressing respect and affection. As soon as our friends would leave us, we would lay out the specimens, some to be photographed, and all of them to be either dried and packed in cotton batting or else sealed in bottles with a formalin solution. In the course of our expeditions to Mexico we have collected hallucinatory mushrooms of many species, belonging to four genera. Professor Heim has defined them mycologically in the *Comptes rendus* of the Academic des Sciences, Institut de France, vol. 242, pp. 965-8 and 1385-95, sessions of March 12 and February 20, 1956. Here we add only these notes on the kinds used in Huautla.

1. Our Huautla specimens included many small mushrooms, some with black and others with purple-brown spores. The Indians esteem them highly and the *curandero* will take up to 15 or 20 pair. They grow in pastures and in the vicinity of dung but not in dung. They belong to various species but the Indians do not distinguish among them mycologically. In Spanish they are called *angelitos*; in Mazatec ^{ʔ}*nti*^{1}*si*^{3}*tho*^{3} *ni*^{4}*se*$^{3\text{-}4}$, of which the distinguishing final element means 'bird'.[158]
2. *Stropharia* sp. This is the largest of the hallucinatory mushrooms used in Huautla, and the least esteemed. It grows directly out of cow's dung. In Spanish it is called the *honguillo de San Isidro Labrador*, the little mushroom of St. Isidore the Plowman. In Mazatec, Concepción called it the sacred mushroom of the bull's dung, ^{ʔ}*nti*^{1}*si*^{3}*tho*^{3} and ^{ʔ}*e*^{4}*le*^{4}*nta*^{4}*ha*^{4}. Concepción added that inasmuch as these grow in dung and the first kind around but not in dung, people say in Mazatec that these two kinds talk to each other. (See Fig. A).
3. *Psilocybe* sp. This is an ochraceous spored agaric. It is called in Mazatec ^{ʔ}*nti*^{1}*si*^{3}*tho*^{3} *ki*^{3}*so*^{1}, the 'landslide'.
4. We were told repeatedly that another kind of mushroom growing on dead or dying trees is used, but we saw no specimens nor could we arrive at the native name.

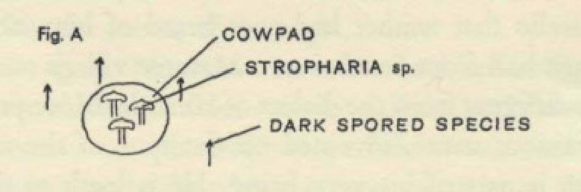


Fig. A

As the days went by we felt increasingly disappointed that we were not amassing an abundance of the sacred mushrooms. The early ending of the rains had made them scarce. RGW depleted our precious store by eating three of the small ones and one of the large, but more could not be spared. Bitter to the taste, they were not sufficient to cause psychic symptoms.

We were even more disappointed by our inability to meet any of the *curanderos* and to engage one to perform the ritual for us. Our Mazatec friends seemed slow to bring us into contact with them. Apparently the initial pourparlers had to be conducted through an intermediary. At any rate, for days no one gave us so much as the name of one, and our friends spoke of them like real but rather mysterious characters who forever remained off stage. Here again there is perhaps a legacy of the era of persecution. Twice Victor disappointed us. He announced to us that first one and later another *curandero* of San Andres would minister to us, for a fee somewhat larger than the standard one. In each, case the *curandero* failed to keep the engagement.

---

[158] In Mazatec words the apostrophe represents a glottal stop. In *si*^{3}*to*^{3} the letter Y has the same value as in English, the value that linguistic specialists conventionally represent by 'th'. Cf. spelling of this word in Miss Pike's letter.

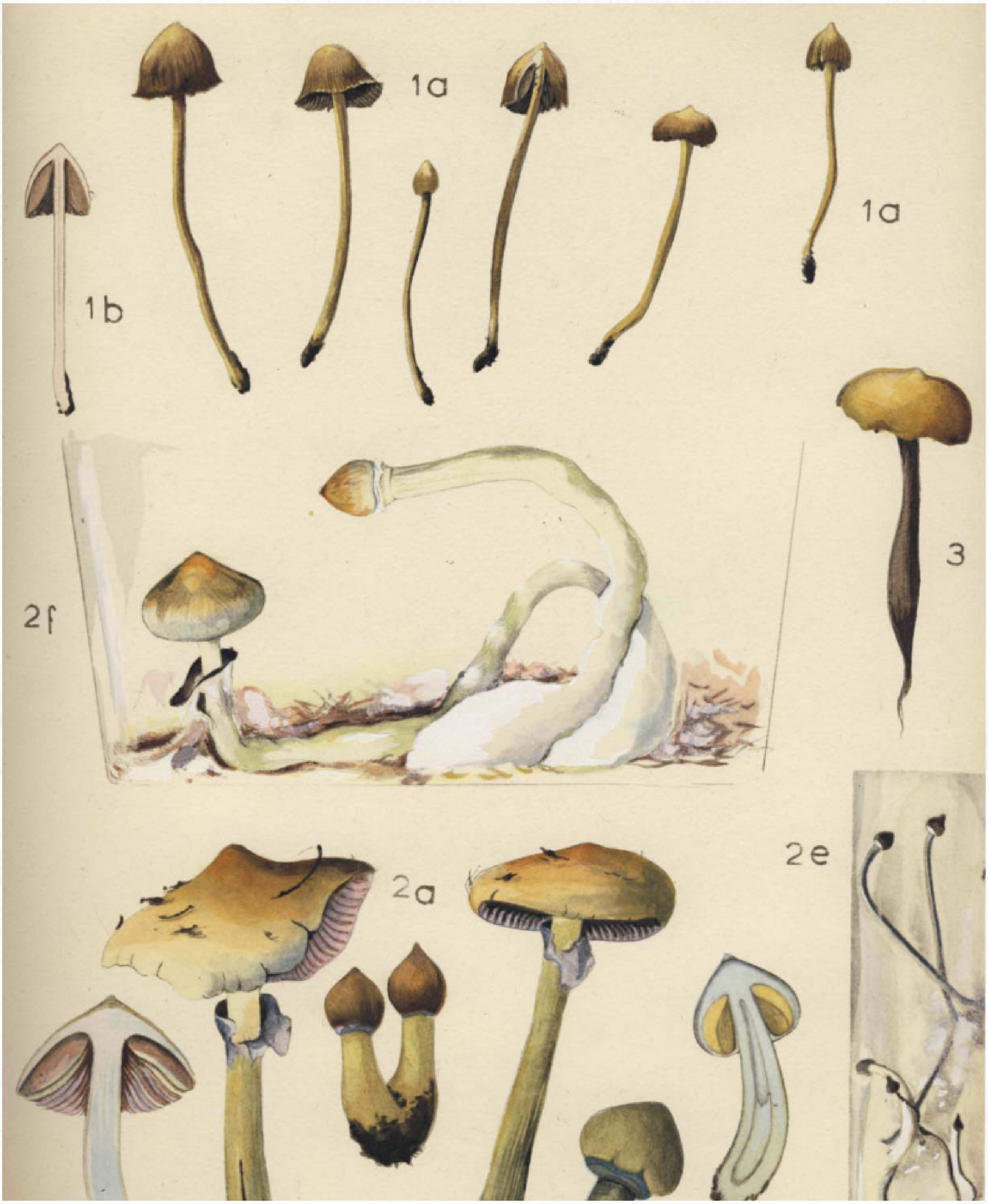


PLATE XL

Ceremonial mushrooms.

1. *Psilocybe mexicana* Heim.

2. *Stropharia cubensis* Earle.

3. *Psilocybe caerulescens* Murr. var. *mazatecorum* Heim (in dried state).

Water-color by Michelle Bory.

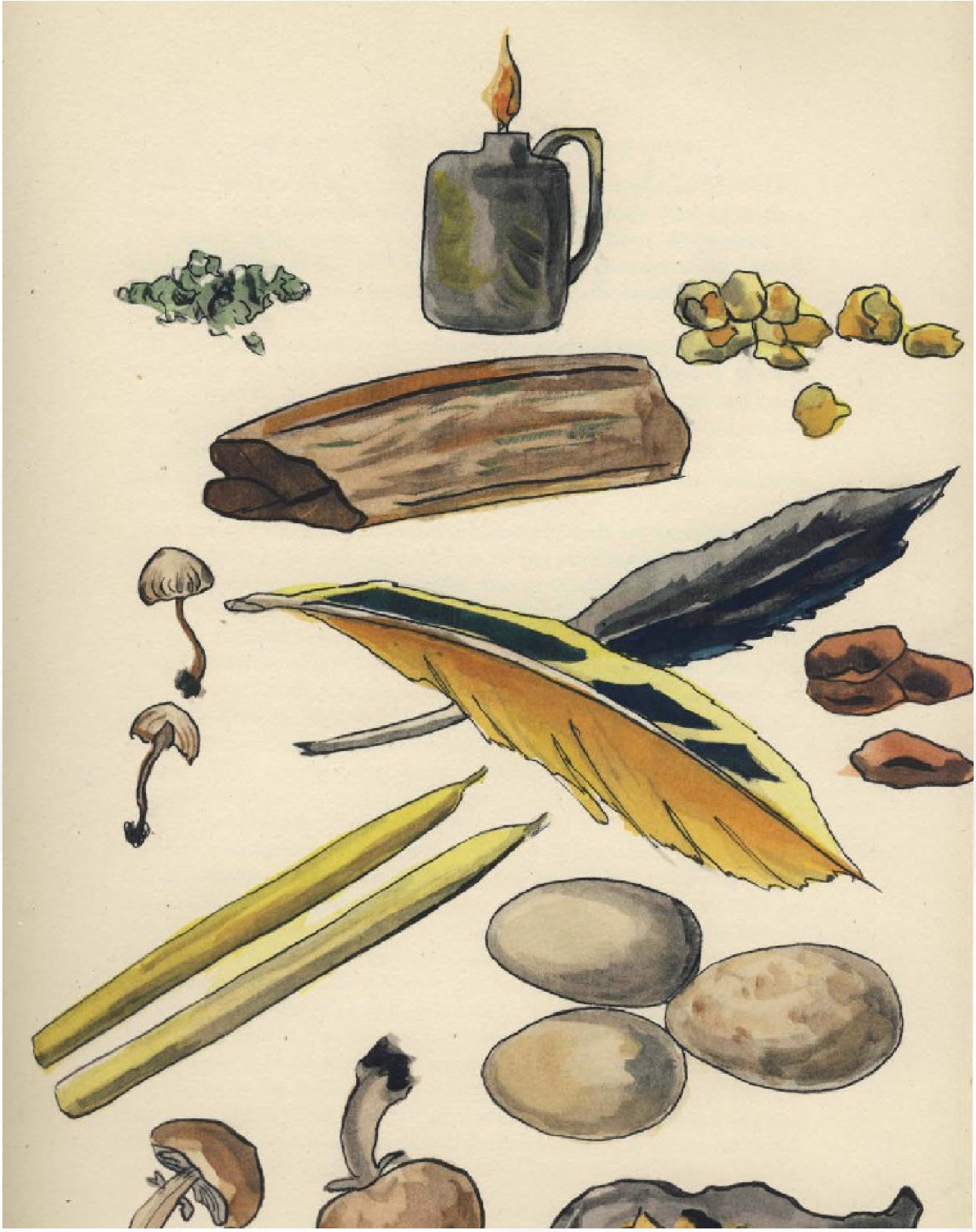


PLATE XLI

Accessories to the mushroom rite.

Pisiete, candil, kernels of maize, *amate*, *guacamaya* feathers, cacao beans, tapers, eggs (chicken and turkey), and sacred mushrooms.

Water-color by VPW.

To justify the ministrations of a *curandero*, the suppliant must present a specific problem on which he needs the advice of the divinatory mushroom. We had resolved that our problem lay in our anxiety over our 18 year old son Peter, working in an industrial plant outside Boston, from whom no news had reached us (naturally enough) since we had left home a few days before. This was not a good excuse, but it was the best we could conjure up and it seemed legitimate to our Indian friends.

Our itinerary was going to compel us to leave Huautla not later than Sunday morning the 16th. Saturday came, and we still had failed in our efforts to engage a *curandero*. At that point a brilliant idea came to Don Roberto: was it possible that Aurelio himself, our one-eyed Indian friend, was a *co*^{4}*ta*^{4}*ci*^{4}*ne*^{4}? Hardly had Don Roberto advanced this conjecture than Aurelio himself came into view, his sarape over his shoulder, approaching us discreetly with that quiet measured gait that by now we knew so well. We felt indebted to him for all he had done for us. Now the big test was to come. We chatted with him, and then, quite casually, Don Roberto asked:

"And tell us, Aurelio, when you give treatments [*hace curaciones*], are they successful?"

"Yes", he answered, "always."

For days we had been talking with a *curandero* all unawares.

Don Roberto went right on. "Will you help us tonight?" Aurelio hesitated. He needed time to think the matter over. Why was he undecided? Was he perhaps ceremonially unclean? Was it because we were aliens to him and his people? Or was it because Herlinda's mother lay dying in the house and he was not in the mood? He went away and consulted Herlinda. This she told us later, explaining that her mother's condition was what had held him back, but she had advised him that we had come from afar, in need of the secret of his people, and he should help us. He came back to us, and told us to be ready at 9 o'clock in the evening. Then he went on to explain to us that different *curanderos* had different styles in performing the ritual. Some chant and sing and even shout. His own style, he said, was simple: he always remained composed and never raised his voice. But the mushroom speaks only in Mazatec, and he would have to have his son Demetrio with him, to interpret the mushroom's words for us. Before leaving us he obtained our assurance that we would discuss the matter with no outsiders in Huautla.

On the dot of 9 o'clock that evening Aurelio called for us, just as the last rays of daylight were vanishing. He led us by a short-cut across a corn patch or *milpa* to his houses, and we entered the door that he led us to. For hours we were to remain in the little room, perhaps eight feet square, where we now found ourselves. In front of us was a kind of shelf or mantel or altar. On the right there was a crudely carpentered wooden bedstead. Under it lay two small children, Aristeo and Julia Elvira, sleeping on a mat. Someone gently pulled the mat with them on it over the dirt floor to the other side of the partition that bisected the house. We were four in our own party. Then there was Aurelio and his grown-up son Demetrio (Figure B, 1), and Demetrio's young and pretty wife Clara (2), who lay on the floor in her clothes and wrapped in her sarape, and who seemed to doze through the night. Next to her lay her baby, born on June 4 and still nameless, for she was as yet unbaptized. Clara seemed to doze, but when her husband Demetrio faltered in translating the words of the mushroom, she had a way of interposing the Spanish words that he was seeking. We were eight in all, with the two children around the corner making ten. The setting for us, strangers had its unusual aspects. Throughout the long ceremony the only illumination inside the room came from tapers or an oil wick, and sometimes from a single taper, and for more than an hour we sat in complete darkness and silence. The air grew foul, for the bean-eating Indians are not an inhibited people. After 11 o'clock a terrifying rain storm with thunder and lightning broke on Huautla, and through the knot-holes and chinks of the flimsy board walls of our hut the lightning would suddenly reveal every detail of the room and the huddled figures in it. After the storm ended there was more excitement. A shot was fired in the night and Demetrio cried out, "*Un homicidio*" - a murder! Then there was the running of naked feet in the path outside our house, a loud knocking at a door not far away, and three more shots, but not a single human voice. Throughout the storm and the shooting Aurelio proceeded

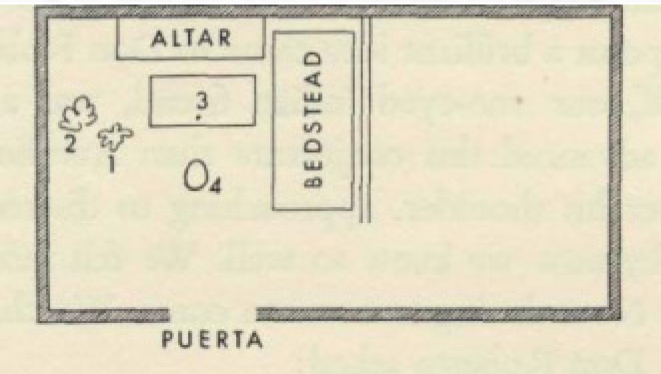


Fig. B

deliberately with the ritual.

With Aurelio's permission Don Roberto and RGW were taking notes, Roberto's being especially full and accurate. The following description is based on the notes that we both took. The successive steps seemed interminable, so slow were they, but each was executed with nice care for detail. There were knots to be tied, and then Aurelio sought the aid of his son, doubtless because his single eye made the tying too difficult. We shall describe the ritual as accurately as we can, and analogies with other religions may occur to the reader at certain points, especially when the mushrooms are consumed. But need we warn him that such analogies and correspondences are superficial; Students of religious rituals often observe similar gestures and acts in unrelated religions. The similarity is accidental. A given ritual is stamped with meaning by the myths, the theology, the creed, the emotional responses, the whole cosmology peculiar to the culture that has evolved it. The ritual of the divinatory mushroom must be interpreted against the background of all the religious beliefs and practices of the Indians of Middle America, an absorbing subject far too complex and difficult for us to cope with. Though we could not enter into the subjective associations that the ritual evokes in Mazatec believers, it was easy for us to perceive the mystery that bathes each successive step in the ceremony. For us as mycophiles and ethno-mycologists it was a stirring event to see our Mazatec *curandero* reverently raise the mushrooms from the cloth, pair after pair, a mushroom in either hand held by the stipe; and then see him eat the pair, first one and then the other, beginning with the pileus and then the greater part of the stipe, masticating each mouthful of the fresh raw mushroom a long time and then swallowing it, and depositing the stub of the stipe carefully in a piece of paper on one side. Yes, the *curandero* eats first one mushroom and then the other, holding one of the pair in either hand, exactly as the illustrator represented the act in the Magliabechiano manuscript. What we saw confirmed the meaning of that picture. What we saw was consistent with the hearsay accounts of the ritual handed down to us by Motolinia and Jacinto de la Serna. It confirmed in all essentials the account given by the late Jean Bassett Johnson of the performance that he and his party attended in Huautla on the night of July 16, 1938, fifteen years and one month before our experience.

Here then is the order of the ritual of the divinatory mushroom as we witnessed and recorded it in Huautla de Jiménez. Our drawings were made by Robert Weitlaner, and we are grateful to him for allowing us to use them and his notes. Our plate in color giving an impressionistic grouping of the accessories of the rite was done by VPW.

Though the room has a kind of altar, the entire ritual takes place on the floor, with Aurelio seated most of the time on a small, low stool (Figure B, 4). Later, when he consumes the mushrooms, he is kneeling on his folded sarape. In front of the altar and slightly to the right of center, he begins by laying a sack on the ground, and on it a square of cheap yellow sateen, and on top of this another layer of heavier material, dark blue, probably from a *rebozo* or shawl (3). We are lighted at first by a wick in an oil tin. Someone brings in a few glowing embers, which are placed in an old potsherd on the ground between the altar and the blue material. From first to last, except for the utterances and the long silences, the ritual consists of the ceremonial handling of accessories that are laid out on the blue cloth. Of these accessories all save the mushrooms can be seen for sale in the market place every day and are familiar to students of Middle American religious practices. These accessories are:[159]

1. Lumps of copal, a pale resin used as incense.
2. A handful of cacao beans.
3. A handful of maize kernels. (The precise number in our case is 53.)
4. A heap of *pisiete* - ground green tobacco.
5. Four hen's eggs.
6. Two speckled *guajolote* (Mexican turkey) eggs.
7. Two brilliant feathers of the *guacamaya* bird, a kind of parrot.
   Six rolls of bark paper, called *amate*. Also tapers of virgin wax.

---

[159] One of the *curanderos* in San Andres had told us through Victor that, in addition to the other accessories, we should provide a chicken. This suggests the possibility that some *curanderos* sacrifice a fowl during the rite.

These with fourteen pair of mushrooms make up the accessories, and initially they are laid out on the blue material as shown in Figure C. Aurelio takes a long time to arrange all this. He counts the mushrooms and the cacao beans, and then places five cacao beans next to each hen's egg and 13 next to each of the two turkey eggs. He divides the maize kernels roughly in half, picks up half, shakes them from hand to hand, casts them on the cloth, contemplates them, repeats the same steps with the other half, and separates out the two grains that he says are the Wasson children. He asks whether we are in agreement with what goes on and we say yes. He casts the kernels again, and a third time. Speaking of Peter, Aurelio says, in Demetrio's translation, "*Esta, pero iquien sake donde esta?*" - He is, but who knows where he is? It is now 10.15 o'clock.

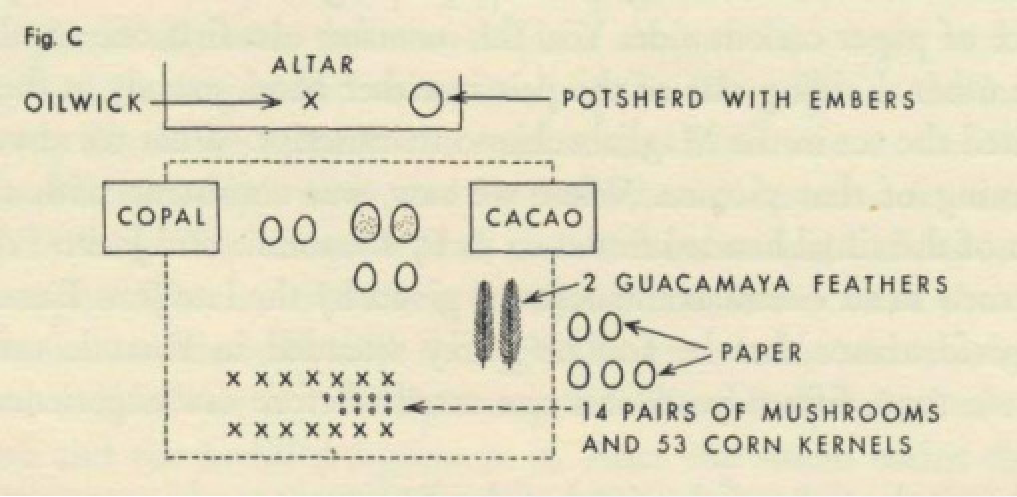


Fig. C

To each of us he gives a piece of *copal* to hold in a clenched fist, and to VPW he gives two, one for Peter; then on his bidding we toss the copal into the embers glowing in the potsherd.

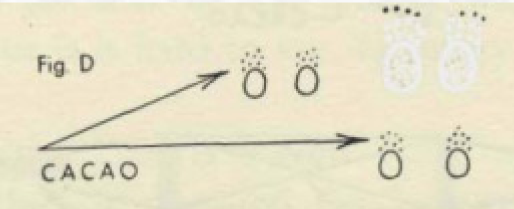


Fig. D

Aurelio kneels on his folded *sarape*, crosses himself, invokes the Trinity and some of the saints, takes a pair of mushrooms, holds them briefly over the burning copal, and begins to chew them. Now only a single taper is burning, aided by light from the embers. After chewing for a time, he swallows, and then does the same with the rest of the mushrooms, pair by pair, until 14 pair are consumed. He finishes eating them at 10.30 o'clock. He has now eaten 11 pair of the large ones and three pair of the others. Having finished the mushrooms, he binds his head tightly in a kerchief.

Throughout the night Aurelio's utterances are in a conversational tone, in Mazatec for the most part but toward the end in Spanish. VPW, being a physician, has arrived in Huautla equipped to examine the *curandero* during the performance with stethoscope, thermometer, blood-pressure gauge, and ophthalmoscope. Now that the moment has come, for many reasons each alone sufficient it seems hardly wise to inject these extraneous and exotic utensils into the proceedings. Aurelio breathes heavily and audibly, and his single eye often disappears for long stretches behind its closed lid. Aurelio's whole demeanor expresses concentration of mental effort. From first to last he manifests no unmistakable symptoms of trance or inebriation, but by this we do not wish to be understood as denying psychic effects from the mushrooms. Here is a matter that calls for serious study under controls.

Immediately after consuming the 14 pair of mushrooms Aurelio takes the *amate*, rips off a part of a *guacamaya* feather, places it on the paper near the edge, and along with 13 cacao beans wraps it tightly in the paper, the end of the feather extending beyond the paper wrapping. He makes a neat little bundle, which he ties up with cotton threads that Clara has been preparing for him (Figure E).

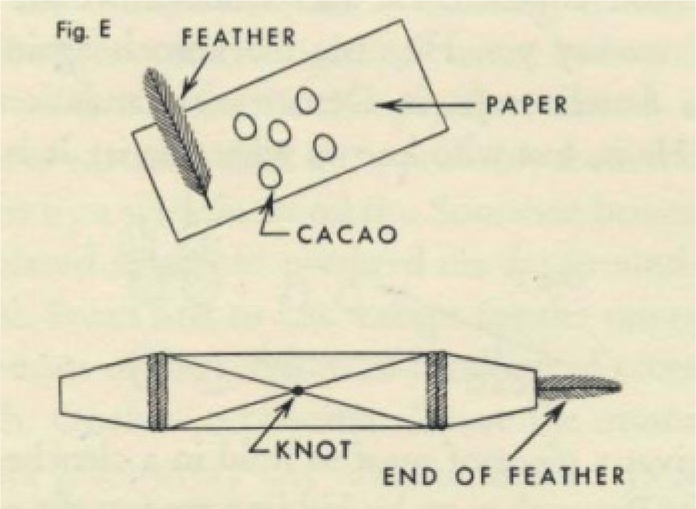


Fig. E

He puts the parcel by the side of one of the turkey eggs. He repeats this with a second parcel and the second turkey egg. He puts the eggs back where they have been with the two parcels lying between them. Then Aurelio makes four smaller bundles, cutting out small rectangular pieces of *amate*, wrapping up in each one the piece of feather and five (instead of 13) cacao beans. The six parcels and the eggs are now disposed of as in Fig. F. We assume that the inebriating mushrooms are producing the desired effects while Aurelio busies himself with these duties.

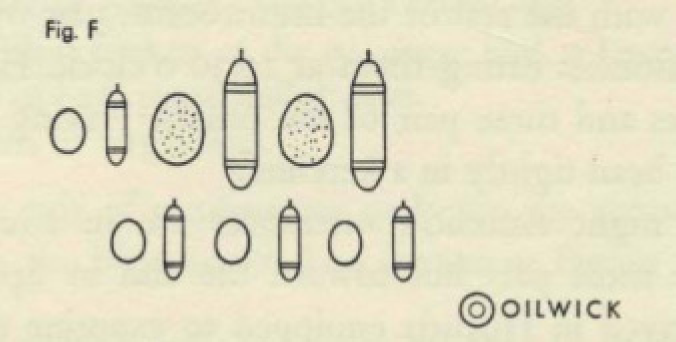


Fig. F

Aurelio rolls up his sleeves, takes the *pisiete* or finely ground green tobacco, rubs it on his forearms, then on his exposed belly, the top of his head, and the back of his neck. He takes matches and places them beside the eggs. He picks up the kernels of maize and casts them with the right hand. He pauses as in thought, breathes deeply and audibly. He rises and then sits down on the stool, wrapping his sarape around him. He sits in thought. He asks where Peter is, and RGW replies that Peter is in Boston. It is now 11.05 o'clock.

Aurelio rises and goes to the dark corner near the door, where he sits down on a chair. The last waxen taper is now extinguished and we remain in complete darkness until 1.05 o'clock in the morning. The storm breaks on Huautla. Aurelio spits on his hands and rubs them together. He asks where we left Peter, in whose house. We tell him. He asks if it is agreeable to us that he should ask these questions, and we say yes. At about this time the shooting and the running by our hut take place.

Wrapped in his sarape, Aurelio sits on his chair deep in thought. He asks a series of simple questions about Peter, says he has trouble seeing Peter because he is so far away in a city big and strange. Finally he says that Peter is alive but 'they' are reaching out for him to send him to war. Possibly 'they' won't 'get' (= *aganar*) him, but it is hard to say. Germany seems to enter into the situation.

Then Aurelio declares that Peter is in New York, not in Boston; that Peter's thoughts are on us, that he is in a turmoil, that he is well but in a difficulty that he can hardly cope with, that his thoughts are on us to the point of tears, that he is stumbling, that he is not used to this difficulty where he finds himself, and does not know how to go about writing us about it. Then Aurelio says suddenly that we may smoke, and the room is soon illuminated faintly by two cigars.

At about this point VPW and Masha, tired and sleepy, express a wish to go home. We have been warned by Victor that no one is ever allowed to leave the ritual before it is done, even to the point that necessities must be performed in the room itself with rude accommodations there provided. But Aurelio says that he can conjure away any dangers. RGW is uncertain whether Aurelio is referring to supernatural dangers, or the dangers on the path to the other house. Apparently to assure their protection, Aurelio holds each of them in turn for a long time by her right forearm, rubs the forearm with *pisiete*, and takes the pulse *with his thumb*. (Physicians always take the pulse with the fingers, for in the thumb there is a pulse beat that would confuse the count of the patient's pulse.) Demetrio accompanies them through the *milpa* to the cottage.

At 1.05 Aurelio lights the four tapers and contemplates the flames. He gives to Don Roberto and RGW a piece of copal each, stirs the embers in the potsherd, asks us to throw our copal on the embers, and under his breath utters a prayer or incantation. He asks us if we believe in one true God, and we so affirm. He holds the four tapers in his two hands, and then asks Demetrio to hold them, declaring then that nothing bad has happened to Peter. He asks how many are present - "Only four?" He asks whether one o'clock has passed, and when we say yes, he comments, "*Ya es buena hora*" - now a good hour has come. Then he asks RGW whether he believes in all that is going on here. Inexperienced, RGW begins to reply weakly that he thinks he believes, whereupon the experienced Don Roberto overtakes his words and in a deep, resonant, loud voice declares, "*Creemos*". Then Aurelio declares in a sure voice that nothing is wrong with Peter and that all goes well. A little later he says that what we are all witnessing is "*muy delicado*" - most perilous, and that of course we are not used to all this. He says that he can render treatment in absentia on our behalf, after we leave Huautla, and in fact he recommends that we ask him to do this. It is now 1.30 o'clock.

Aurelio mixes the maize kernels in his two hands, casts half of them and then the other half, and then all the kernels at one time, and then all the kernels a second time. He places one of the hen's eggs toward the left side of the cloth and casts the kernels for the fifth time. He places one of the large eggs on the right hand side, and points it in the direction that he says is east. He asks RGW when he will arrive in Mexico City and whether he has a house there. He casts the kernels again, for the sixth time, and then arranges the eggs and bundles in the fashion indicated in Figure G. Then he declares that a relative of RGW is destined to fall seriously ill within the year, and he gravely fixes on RGW his single eye. It is now 1.45 o'clock.

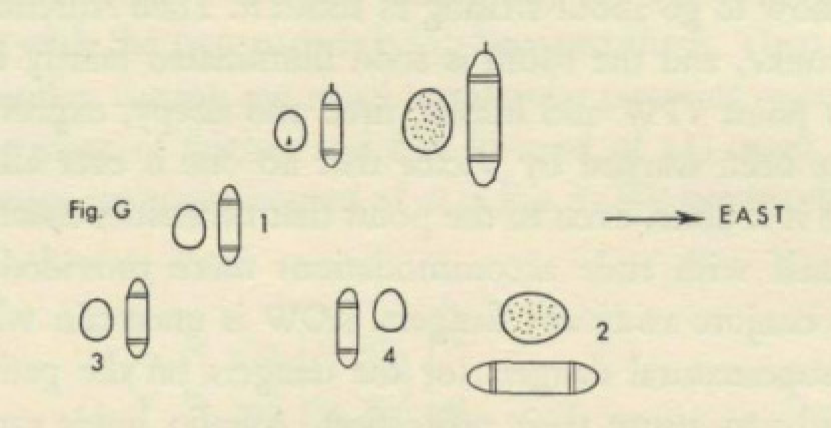


Fig. G

Demetrio replenishes the supply of copal in the potsherd. Aurelio leaves the room a moment, taking some *pisiete* with him. He returns and again casts the kernels. One kernel happens to stand on end. Aurelio concentrates his attention on it, saying it is RGW's son. Then he repeats that a relative of RGW is destined to fall ill within the year. Then he asks RGW whether he can carry bundle no. 1 to his home and keep it for 13 days, along with the corresponding egg. On the 14th day RGW may throw them into water or bury them. Aurelio takes one of the turkey eggs and to the blunt end affixes a small lump of copal, which being hot and soft appears to adhere to the egg shell securely. He does the same with each of the hen's eggs and finally the other turkey egg. He places the eggs and bundles as shown in Fig. H, but immediately shifts three of the small bundles to the places shown by the arrows. It is now 2.10 o'clock.

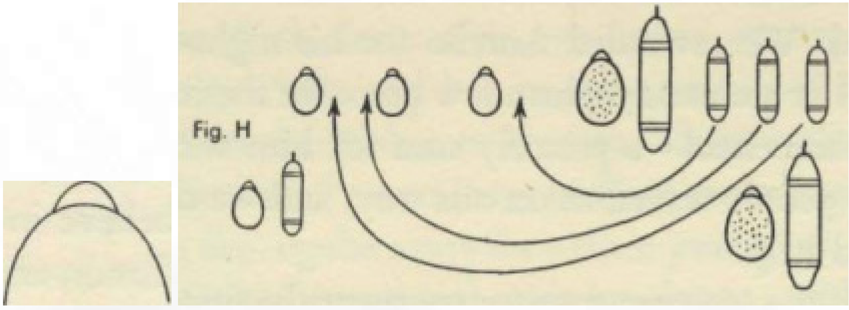


Fig. H

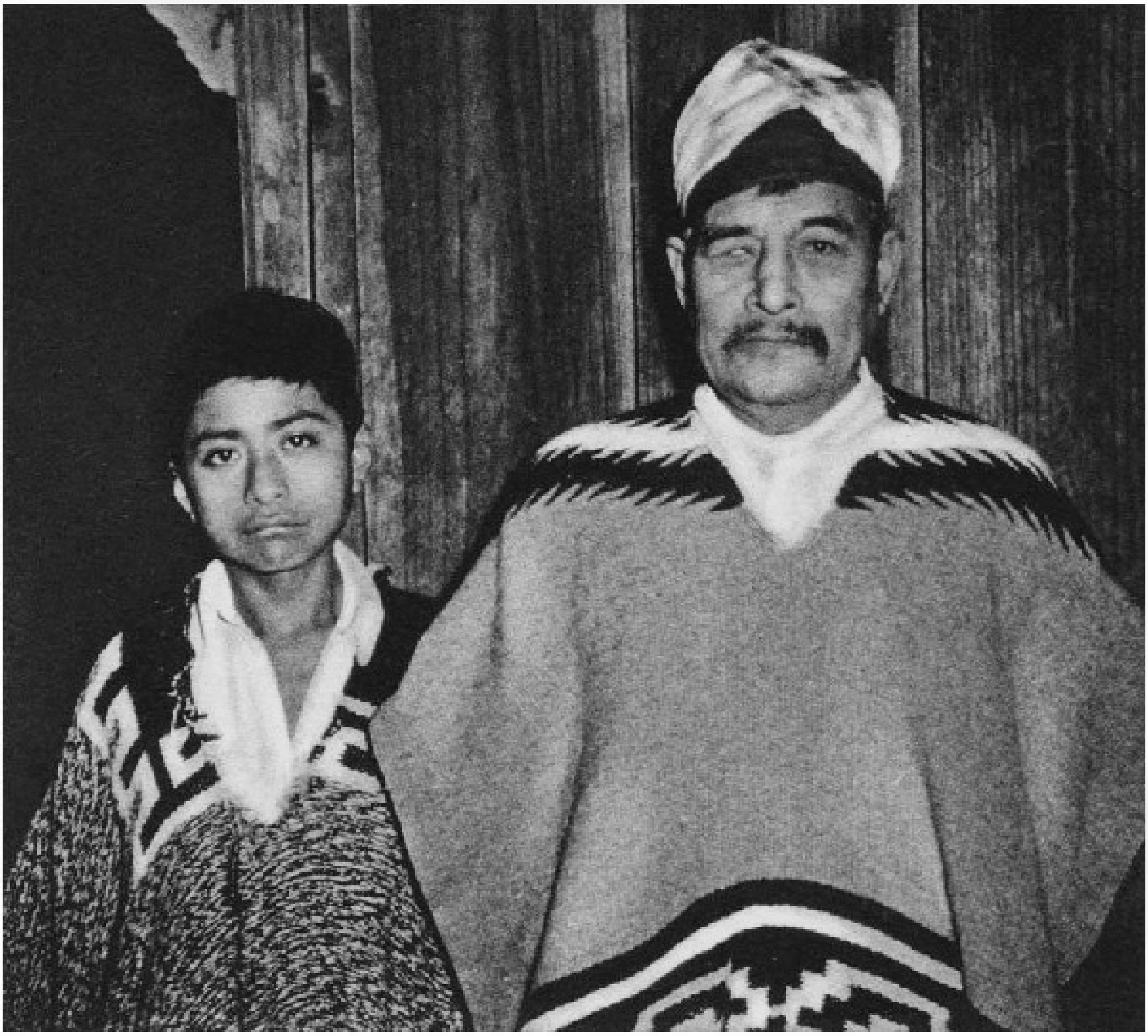


PLATE XLII
Aurelio Carreras, *curandero*, and his son Mauro.
Huautla de Jiménez, July 5, 1955.

In another potsherd Aurelio stands the four tapers upright, and he asks RGW to sit on the chair and roll up his sleeves. Aurelio passes the potsherd with embers over RGW's head, along with two of the eggs and two bundles, praying the while, and then he gives the two bundles and eggs to RGW to hold in both his hands. He passes the potsherd under RGW's hands, and Demetrio stirs the embers. Aurelio then passes the potsherd with copal over RGW's head, then over the ground, then over his head and under his hands, repeating all this several times, relieving RGW of the eggs and bundles but only to hand him another pair of eggs and bundles; asking him then the name of his daughter and repeating the various passes, always making all the passes counter-clockwise. Then Aurelio empties the paper containing the stubs of mushrooms into the fire of the potsherd. He gives this little paper bag to RGW along with a second one, both containing now some *pisiete*, and he says to RGW that they contain something good from St. Peter and St. Paul. At this stage in the night Aurelio is speaking Spanish or Mazatec, passing from one to the other without apparent reason, and he addresses RGW with the familiar *tu* instead of the formal *Usted*. It is now 2.25 o'clock.

Then Aurelio gives RGW certain specific instructions. The turkey egg with copal on the blunt end is for him, and similarly a chicken egg for VPW, each with its respective bundle. These are to be held for 13 days, and then the eggs must be buried with the pointed end down and with the corresponding bundle buried next to each, perpendicularly, the bundle to be carefully placed on the *eastern* side of the respective egg. In the course of the closing phases of the ritual, Aurelio observes that *pisiete* is excellent for stomach troubles and that one may eat a little of it. He himself puts something in his mouth, between teeth and cheeks, and presumably this is *pisiete*.

At 2.30 o'clock the session draws to a close, and Don Roberto with RGW leave the house to return to their own.

Before 7 o'clock on the following morning we were all in the saddle and away. Aurelio and Herlinda had arisen betimes, Herlinda to serve us breakfast and bid us godspeed. We rewarded Aurelio for his night-long vigil with us, giving him 120 pesos or about $ 15, plus a few pesos for the cost of the accessories that he had used in the ritual - a princely sum for him which we did not begrudge. These good people waved us on our way, and we shall long remember their friendliness and help.

On our way out of the Mazatec country we spent the first night in the village of San Bernardino, lodging with the owner of the general store, Doña Toribia Cid de Mendes. This is the village, perched high on the edge of the mountains, that looks far down over the low-lying plain to the west of the Mazatec country. After we had eaten our tortillas and eggs and as we sipped our coffee and mescal, Doña Toribia captured our attention with stories of the Mazatecs. She was herself a Spanish-speaking Mazatec from Mazatlan. Before long she got on the subject of the miraculous mushrooms, and she went on and on until late in the night about the miracles they had worked in those mountains to the east, now sleeping in darkness, until in the end it seemed as though the very hills themselves, where the little mushrooms grow, were bewitched by them.

Here we should prefer to bring our story of Huautla to an end, but candor compels us to add a few more lines. Our attitude toward the divinatory performance and especially the oracular utterances had been one of kindly condescension. We said to ourselves that it was cruel on our part to ask Aurelio, locked up in his unlettered Indian world, to enter understandingly into the problems of the Wassons of New York. His divinatory powers, put to this appalling test, had seemed to us pitifully thin, but of course we had duly entered in our notes all that he had said. In brief, he had declared that Peter was not in Boston but in New York, that Peter was alive but in a deep emotional crisis and longing for our help, and finally that the army was reaching out for him and might yet get him. There was a hint of foreign military service - Germany was mentioned. Later in the night Aurelio predicted ominously that a member of the Wasson family would be gravely ill within the year.

We reached home in the second week of September. In the kitchen of our New York apartment we found the leavings of a party that during our absence Peter and his friends had held. The bills from the purveyors supplied the date: the weekend of August 15-16! Peter easily confirmed this when we saw him. Laughingly we credited the sacred mushrooms with a hit, a palpable hit, and then gave the matter no more thought.

Aurelio's prediction about the army had seemed badly aimed. After all, Peter at the age of 17 had enlisted in the National Guard, and this gave him exemption from the draft. Soon after our return to New York, RGW left for Europe on a business trip, and late in the morning of Monday, October 3, he arrived at the Hotel du Rhone in Geneva. There a cablegram from home awaited him with sensational news: Peter had just made known his settled determination to enlist in the regular army for a three year term. He had come to this decision after a prolonged emotional crisis involving a girl, and that crisis, we now learned, had been boiling while we were in Mexico. Would RGW please send a cablegram at once begging Peter to postpone his rash step? RGW sent the message but, before it reached Peter, he had signed up. The army, after all, had reached out and got hold of him! At the moment of the October crisis our thoughts were so far removed from Huautla that days passed before suddenly Aurelio's pronouncement came to mind. Another hit, a palpable one indeed!

A few months later, after the usual training period, the army sent Peter abroad for duty, but to Japan not Germany.

There remained one final prediction: grave illness was to strike the Wasson family within the twelvemonth. (In the Mazatec world the 'family' embraces all the kin.) This seemed on its face unlikely, for our families are unusually small. No one of the previous generation survives. VPW had only a brother and a sister and some nieces, as well as a few cousins and their children. RGW had only five first cousins and four first cousins once removed. In January one of RGW's first cousins, in his 40's and abounding in vitality, suddenly died from heart failure.

We record, as in duty we are bound to do, but without further comment, these strange sequelae to our Huautla visit.

On January 14, 1954, Robert Weitlaner wrote us exciting news: his daughter Irmgard Johnson had recently returned from a journey through the Mije country, and in San Juan Mazatlan a *curandero*, through an interpreter, had told her about two kinds of sacred mushrooms. The Mije are known as a remote people, shut off from the world and in turn disposed to shut out the world. Among them the mushroom cult might manifest archaic traits, and in any case would give us perspective on the Mazatec practices. Would we care to join him on a second pilgrimage in quest of the secrets of the sacred mushrooms? The proposal was too tempting to resist, and through further correspondence the details were worked out for a fast incursion into the Mijeria, as the land of the Mije is called.[160] It proved impossible for VPW and Masha to leave New York, but others were recruited to take their places. Allan B. Richardson, a friend and photographer of New York, eagerly accepted the challenge and prepared himself to serve as official photographer. The Summer Institute of Linguistics consented to let Walter S. Miller join us: a professional linguist, he is the foremost student of the Mije language and culture. For guide, Don Roberto enlisted Francisco Ortega, known as Chico, a thirty-nine year old Zapotec living in Tehuantepec, whose extraordinary talents and character have given him an outstanding reputation among all who explore seriously in the remoter regions of Oaxaca and Chiapas. He in turn engaged a boy named Filemon to help with the animals, three horses and a mule.

Among those who know about the Indians of Mexico, the Mije enjoy a legendary reputation. It is said of them that in the old days of Zapotec power, centuries ago, the Mije stood off the Zapotecs, and the Spaniards never subdued them in war. They are seldom visited. Even famous writers about the Mexican Indians like Miguel Covarrubias discuss them by hearsay, never undertaking the arduous journey to their mountain villages. Their language for Europeans is of the utmost difficulty, with stress, quantity, and tone, palatalization, glottal stops, retroflexion, and numerous consonants unfamiliar to English or Russian ears. It belongs to a group of which the others are the Popoluca of Vera Cruz, Zoque, and the dying or extinct Tapachultec. Some 60,000 in number, the Mije live in the mountains of northeastern Oaxaca, these mountains rising to their peak in the famed Zempoaltepetl, almost 3,400 meters high. These mountains constitute part of the rugged massif where the Mazatecs live also, but the two peoples are far removed from each other. By comparison the Mazatecs are well advanced toward incorporation in the great world, and the two peoples are separated from each other by no less than three tribes. Next to the Mazatecs on the east live the Cuicatecs, then the Chinantecs, then a swath of Zapotecs, and at last come the Mije. To the east of the Mije he their kin the Zoques in Chiapas and the whole world of the Maya. For us it might prove significant that this people shut off from the world had always been a culture contiguous with the Maya tribes. The reputation of the Mije is that while not aggressive they are uncommunicative with outsiders and even surly. For the most part they live at altitudes below 1,500 meters, and their mountains are clothed in tropical vegetation and abound in wild life. They live on maize and beans, chickens and turkeys, and they sell to the outside world a small amount of good coffee. In all of the Mijeria there is not a single road for wheeled vehicles.[161]

---

[160] We use the spelling 'Mije' rather than 'Mixe', favored of scholars, because the value of the 'j' is that of standard Spanish, whereas 'x' in Mexico represents any of three consonants. The Mije must not be mistaken for the unrelated Mixtecs, of course.

On Friday, May 21, RGW flew to Mexico City with Allan Richardson. On the following day, by the gracious generosity of the Banco Nacional de Mexico, the bank's De Havilland Dove with Captain Carlos Borja piloting lifted us to the airstrip at Ixtepec in the Isthmus, having stopped at Oaxaca on the way to pick up Walter Miller. At Ixtepec we met Don Roberto and Chico. After laying in some provisions at Ixtepec and Juchitan, we drove by car eastward along the Pan American highway, then north on the Trans-Isthmian highway, and finally westward down an execrable road through Laguna to Santo Domingo Petapa, a stretch of about fifty-five miles. This Zapotec village was our stepping-off point. Next day we set out for San Juan Mazatlan, sometimes called Mazatlan de los Mijes. After a long day we spent the first night sleeping in the school house at Platanillo. Then followed another long day of slow progress up mountains and down, and across *arroyos* (streams). We slept the second night in the forest, and the following day shortly after noon we entered Mazatlan. From Platanillo to Mazatlan we had met only four Indians and had not seen a single habitation.

We happened on Mazatlan during the annual fiesta in honor of the Virgen de la Soledad. The village was thronged with Indians bedecked in their finest garbs and there was much music, dancing, and drinking. The thatched houses of the village, perhaps two hundred in number, are strung along the ridges of radiating mountain spurs, the mountain sides themselves being clothed in tropical vegetation and alive with brilliantly colored and highly vocal birds. On all sides the distant horizon is closed in with superb mountains. The altitude of the town is about 3000 feet.

We made our way to the Municipio, where we found the Presidente, the Secretario, and the Sindico busily engaged in supervising the progress of the fiesta. They received us with reserve, but after we showed our credentials they informed us that we might occupy the *curato*, the house that would belong to the priest if there were one, a one-room thatched adobe structure adjacent to the thatched church. This suited us admirably, and there we stayed for six days while we pursued our inquiries and took photographs. Allan Richardson with his cameras proved a sensational attraction for the Indians, whose reserve broke down as they besought him for *retratos* or 'portraits', and paved the way for our inquiries. We found that there were eleven *curanderos* in Mazatlan, four of them women. We talked with four of the men. Don Roberto and RGW called on one of the oldest, Francisco Policarpo, in his home, where we found him reclining in his hammock. He knew no Spanish, and through a feeble interpreter we finally learned that in his practice he had long since given up the use of mushrooms, relying instead on a certain *bejuco*, a plant of some kind, either a creeper or a climber, perhaps the *ololiuqui*. We also visited the *curandero* from whom Irmgard Johnson had learned in January of the use of the divinatory mushroom among the Mije, a discovery for which priority goes to her. She had known him as Francisco Jose, but with us he was Francisco Claudio. He remembered Mrs. Johnson's visit well. He spoke almost no Spanish, and his brother Alvaro was to interpret for us, but Alvaro was so sullen that our interview was a failure. We were fortunate, however, when another of the *curanderos*, Manuel Agustin, came to us with various ailments for treatment: Walter was skillful with massage and manipulation, and also relieved his pains with analgesics, whereupon the old man answered patiently all our inquiries. The *Vocal* of the town, Felipe Luciano, a leading citizen, also proved friendly, and persuaded the *curandero* Timoteo Quirino to discuss mushrooms with us. In addition to these local informants, we were the beneficiaries of a windfall, a delegation from another Mije village of whom we shall speak later.

The divinatory mushrooms play a role among the Mije as important as among the Mazatecs, with many similarities and many important differences. Like the Mazatecs, the Mije always speak of these mushrooms in pairs. For 'pair' they use in their language a word borrowed from Spanish, *casada*, which is invariable as to number and which in Mije is used only when 'pair' means a couple of opposite sexes. Here then is evidence suggesting that in the Middle American mushroom cult, the habitual pairing of the sacred mushrooms carries a sexual connotation. For this there is support also in a folk tale from the town of San Lucas Camotlan, which we shall recount shortly. But we must add that in Mazatec the word for a 'pair' of mushrooms, *nka*^{2}, has apparently no sexual association.

---

[161] There exists one excellent study of the Mije and their culture, *Ethnology of the Western Mixe*, by Ralph L. Beals, University of California Press, 1945. Being of Anglo-Saxon origin, this excellent and respected ethnologist naturally failed to inquire about the role of mushrooms in the Mije culture. The divinatory cult completely eluded his attention. He dealt only with the western Mije, in Ayutla and thereabouts. The Popoluca-Zoque cultures were described by Frans Blom and Oliver La Farge in *Tribes and Temples*, Tulane University, Louisiana, 1926. They also seem to have made no ethno-mycological inquiries.

In Huautla our *curandero*, as he ate the mushrooms, bit off the caps and all but the butt of the stipes, chewing them thoroughly and then swallowing them. Among the Mije this is done differently. The caps are severed by hand from the stipes; the stipes are firmly attached to the caps and, for their size, tough. The stipes are put back into the *jicara* or gourd bowl, while the caps are quickly swallowed, without chewing, one after the other. If the mushrooms do not take effect, then the suppliant addresses a prayer to the stipes in their *jicara*, and eats more caps. Afterwards the *jicara* with the stipes is carried to a nearby cross and there, reverently, the stipes are spilled out as an offering, and a *vela* is lighted. All of our informants stressed the separation of the caps from the stems and the separate use of each.

The mushrooms come only during the rains of June and July, and they can be kept in a dried condition for only fifteen or twenty days. This limits their use to a short season. We arrived unhappily before the rains and we saw no specimens, nor could we see them in use. We were told that in the hot low country the mushrooms do not grow. The atmosphere of secrecy about the mushrooms that was so striking in Huautla is less heavy in Mazatlan, perhaps because this remoter people had never come under such close control by the ecclesiastical authorities. Indeed, there seemed no particular reluctance to discuss the mushrooms. On the other hand, the mushrooms are consumed in private, in the dead of night, if possible under conditions of absolute quiet, usually with only two persons present, the one who eats them and another. As in the Mazatec country, among the Mije we discovered no trace of a communal agape such as the early writers described.

In Huautla the *curandero* eats the mushrooms on behalf of his patient or client. Here lies the vital difference with the Mije. For in the Mije country the *curandero* never eats the mushrooms, except as he himself may wish to consult them. The sick person eats them, or the person who seeks tidings of absent relatives or help in finding lost and stolen property. Among the Mije the divinatory mushroom carries no hieratic attributes; it is secular. Everyone knows how to use the mushroom and the *curandero* is not usually a party to the performance.

Like the Mazatecs, the Mije possess a general term that embraces all of the divinatory species, but unlike them the Mije consider these species as a subdivision of the order of mushrooms. In Mije the word for 'mushrooms' is *mus*, and the collective word for all divinatory mushrooms is *na:swin mus*, of which the first word means the World, the Universe. This word enfolds a curious figure of speech: *na:s* means 'ground' and *win* means 'eye'. (Here and in other words the colon means that the preceding vowel is long in quantity.)

Manuel Agustin, an old man, disclosed to us a surprising fact: for *na:swin mus* there is a synonym, *tu:muh*. Our friend Felipe was helping Walter as our interpreter with Manuel, and Felipe changed the word to *tu:m 'ungk*, which another elder of the town, Geronimo Antonio, later confirmed. They and others knew the word and its meaning, and they all agreed that its inner sense was 'that which is born of itself', *lo que nace por si mismo*. Here is the same figure that we find in the Mazatec *si*^{3}*to*^{3}. *Tu:m* of itself means nothing in Mije and occurs elsewhere only in the distinctive Mije calendar of day names, where in the complicated rotation of the native calendar it might turn up in the combination *tu:m 'uh*. The term seems to be an archaism, with mystical implications that will have to be explored by further study.

Both Manuel and Timoteo agreed that there are three species of divinatory mushrooms, and their descriptions tallied also:

1. *pi:tpa*, 'thread-like', the smallest, perhaps two horizontal fingers high, with a cap small for the height, growing almost anywhere, often by the side of the mountain trails. Where one is found more should be sought. The cap is yellowish above and blackish below, and hemispherical.
2. *atka:t*, 'alcalde' or Mayor; like the *pi:tpa* but bigger, three or four fingers high, with a flatter cap.
3. *kong* or *kongk*, the 'chief' or 'head-man', which is the biggest, perhaps eight fingers high with a stem % inch in diameter, the color of the cap being more yellow than the others.

Our informants agreed that the three kinds differ as to species and not merely in age. They agreed that these mushrooms, eaten raw (either fresh or dried), have an agreeable odor like flowers. The taste is like nothing else. One informant said that in the throat they felt like soda water. As for the dose, every man figures it out according to his tolerance for *mescal*. Of the *pi:tpa*, some take six pair, but others take eight, ten, or even twelve; of the *atka:t*, from three to six pair; of the *kong*, if two mushrooms are available, one eats around the edge of the two caps; but if only one is available, then one entire cap.

Anyone may gather the mushrooms. On finding them you may send a sigh of thanks to God, but this is as you please. On the evening when they are to be eaten, toward nightfall, you carry them in a *jicara* to the church. If the church is locked, you seek out the *fiscal* or *mayordomo* and he opens it for you. On the altar you place the *jicara* with the mushrooms, and burn *copal* or incense, and either one *vela* or three. You invoke God's blessing and his permission to consult the mushrooms, and you promise him alms, one peso or two or two and a half. Then you bear the mushrooms to the house. A house on the edge of the village is best, where all will be quiet. You place the mushrooms in the *jicara* on the ground before the household altar, with one *vela* burning. Someone now goes back to the church with the promised alms.

The person who is to eat the mushrooms has been on a ceremonially restricted diet for four days. According to Timoteo, for four days you cannot take coffee or liquor, nor eat of any fowl, nor eggs, nor anything fat, nor flesh of pig. But you may eat beef and beans and maize (*tortilla* and *atole*), and cheese. During this period you must have no carnal relations. On the morning of the appointed day you may breakfast on the fourth part of a tortilla, a little *atole*, and a bite of cheese. From then on you fast, eating no lunch or dinner or supper, so that you eat the mushrooms on an empty belly, *barriga vacia*. Then for the four ensuing days you are on the same diet. A woman with child must never take the mushrooms, for she is sure to go raving mad for good, but they cause no abortion. Our informants were ready with specific instances where this person or that had gone mad for breaking the rules. There was that woman in Platanillo, for example. Being ill, she took the mushrooms, and then, feeling better, she ate chicken forthwith, whereupon she went mad. That was around 1947. She wandered raving through the Mijeria for a long time, until finally she disappeared in the mountains. If a woman with child needs to consult the mushrooms she may take them vicariously, a relative or friend eating them for her.

The reader will observe that the Mije sense no impropriety between the ancient cult of the divinatory mushroom and the cult of the Christian God. In Mazatlan the pagan and the Christian legacies - the latter a comparatively recent innovation - seem fully blended, to a degree remarkable even for Latin America. No priest is in residence in Mazatlan and visits by one are rare. The Sunday services, well attended, consist of readings by a cantor, while the *curanderos*, men and women, at the very altar, under the compassionate countenance of the Virgen de la Soledad, treat the sick and infirm and halt with prayers and ritualistic gestures and the application of eggs to the ailing organs according to pagan rites of great antiquity. To all this we ourselves were witnesses.

Now we return to the mushroom ceremony. It is night and you hope that all will be quiet. You have eaten the mushroom caps, swallowing them fast, one after the other. The stipes lie in the *jicara* on the ground in front of the household altar, with one *vela* burning. You and a friend or relative are alone, the second person to watch over you and listen to you, but he says nothing. If the mushrooms work, they work rather fast, in fifteen minutes or a half hour. If they don't work, then you make supplication to the stipes, and perhaps light three *velas* instead of one, and perhaps then they will work. When they work, you begin to talk and you ask questions of the mushrooms and the mushrooms answer. You go on and on with this dialogue until the cock crows, when the talking ends. The person who is with you hears everything but never says anything. It is good to have a relative or friend with you. The whole performance is *muy delicado*, not to be taken lightly. If someone happens to pass by and perceives what goes on, he withdraws quietly. Afterwards you are faint and weak, and for a time you cannot walk, but you remember all that was said.

When the mushrooms do not work one should look for either of two explanations. Perhaps there was an interruption. Any undue noise, the wailing of a cat, the braying of an ass, a child bursting in - these things are enough to put the mushrooms off. Or again if the person eating the mushrooms has spoken ill of them, or even thought disrespectfully of them, there will be no success. If he is guilty of this sin, then the mushrooms cause him to see horrible visions of snakes, *tigres*, and such like. But when all is well, then he who eats the mushrooms begins by invoking San Juan, the patron saint of Mazatlan, and then says the Pater Noster, the Credo, and the Confiteor, and the mushrooms begin to speak, and they are likely to answer not merely the questions put, but all other questions too. Manuel remembers when the prayers were all said in Mije, but now they are said in Spanish, even by people who know no Spanish. All is according to the ordinance of God and the World, says Timoteo. Here again the World - *na:swin* - appears. With good fortune a virtuous man hears music and may see heaven. As the evening wears on, the mushrooms themselves dictate the program, ordaining such things as the number of *velas* to be lighted.

In Mije the cap of the mushroom is called the 'head' - *kobahk* in the dialect of Mazatlan. The top of the cap is the *kopk* or summit. The stipe is the *tek* or leg. The edge of the cap is the '*ai*', leaf. It will be recalled that in the case of the *kong*, sometimes only this edge is eaten. The lamella or gill is *pa:t*. Let the reader bear in mind that the cap or pileus is called the 'head'.

To the south of Mazatlan, ten hours away by foot, lies the Mije village of Santa Maria Nativitas Coatlan. One of Walter's colleagues, Searle Hoogshagen, is working there, and we had been in Mazatlan only a few hours before he called on us. Moreover, on his bidding two Mije boys of Coatlan came too, Severiano Sanchez, age 33, and Candido Faustino, age 25. Both of these young men proved first rate as informants, speaking Spanish and understanding the purport of our questions. They described vividly the effect of the mushrooms, how the eater behaves like a drunken man, and how he carries on both sides of a colloquy, posing questions to the mushrooms and then voicing the mushrooms' answers, for hours on end, in the presence of a relative or friend. They also knew the *pi:tpa*, the *atka:t*, and the *kong*. Of the former the dosage in Coatlan is significant - for children, 6 pair; for grown-ups, 9 pair, or if this be not enough, 13 pair, or at most 18. The dosage jumps thus from 6 to 9 to 13 to 18. According to native belief, the World or Universe - *na:swin* - is served by nine Lesser Servants and by thirteen Major Servants. The nine pair and the thirteen pair of mushrooms represent the Lesser and the Major Servants. The word for 'Servant' is *tungmi:tpa*. Is it a coincidence that the Mije calendar has eighteen months, and that the Mije week consists of thirteen days, each with its name? A number of other native calendars in Middle America likewise divide the year into eighteen months and the week into thirteen days. Dr. Borhegyi makes a further observation. In the cosmology of the Maya there were nine gods of the Underworld and thirteen gods of Heaven. Are not these the Lesser Servants and the Major Servants of the World of the Mije? If so, we discover here a significant cultural correspondence between the Mije and the Maya.

Candido and Severiano told us an extraordinary story of a recent development in the use of the divinatory mushroom in their town of Coatlan. These boys, cousins, have an uncle, Feliciano Faustino. In former times only the *curanderos* knew the secrets of the mushrooms, but this changed in 1943, when their uncle, Don Feliciano, took in hand a famous *curandero* of the neighboring town of Santa Margarita Huitepec, by name Pe:t Murnt. (Pedro Mundo in Spanish, 'Mundo' rendering the Mije word *na:swin*.) One day at about three in the afternoon Don Feliciano with *mescal* put Pedro Mundo into a state where he disclosed all the secrets of the mushrooms, and straightway the whole of Coatlan learned the story. From that day on the use of the divinatory mushrooms in Coatlan has become general, everyone invoking the aid of the *na:swin mus* when they are available and needed. Both Don Feliciano and Pedro Mundo are still alive and they will tell you about all this. (We do not-question the good faith of our informants when we suggest that their story is a myth-in-the-making to explain the secular possession of holy mysteries.)

Long before Walter Miller had heard of the mushroom cult or of us, he was living in the Mije town of Camotlan, twenty walking hours to the west of Mazatlan.[162] There he had put down on paper the folk tales that he heard from the mouths of the Mije, and in the course of that work he came upon tales of strange mushrooms, some with a power to heal, and others divinatory, and others of a kind to drive people mad for good. Here is what he heard:

---

[162] Enigmatic but relevant to our theme is the following information supplied by Walter Miller. Just to the east of Camotlan, in the *llano*, there is a hill (*kopk*) that the people call *muzut kopk*. No one recalls the origin of the first part of this name, but it could be *mus hut*, 'mushroom cave'. In this hill there is a cave that the villagers call *muzut hut*. The supposition suggests itself that the hill was called after the 'mushroom cave", and long afterwards, when the origin of the name had been forgotten, the cave in turn was called after the hill. Deep in the cave the floor is strewn with fragments of ancient pottery and other artifacts, but there are no representations of mushrooms. A local informant has told Mr. Miller that on the top of the hill can be seen a stone shaped to resemble a gigantic spindle whorl, *malacate*.

> Of mushrooms there are various kinds. One kind has been used as a medicine, says Jose Trinidad. His own nephew, Alefonsa, had been ill for five years with an unnamed illness. He could not walk but moved around on a stool. He would sit in the patio and slide the stool from place to place. Then they gave him a kind of mushroom to eat, and he was cured and began to walk as before.
>
> Jose says there is another kind of mushroom about which there is a belief that it will induce a dream, a particular kind of dream, one in which two *duendes* or spirits appear to the eater, one male and the other female. They talk with him, and he asks questions and they answer. They will tell you where lost things may be found, and name the thief who has stolen something and say where the stolen thing is. When you plan a trip, they will tell you what luck you will have on the journey. Cerilo of Santa Margarita Huitepec has eaten these mushrooms several times. The first time they didn't give the result. Cerilo has a son named Delfino. When he was about to eat the mushrooms, he was afraid and so he had Delfino watch over him. When he had eaten them, sure enough the spirits appeared. He talked with them and asked about the trip he was going to make, for he had five burros and was about to set out for the Isthmus with Delfino. The spirits told him not to go for the burros would all die. They talked about different things. Then the spirits said, 'We must go, for the cock is crowing.' The spirits disappeared and Cerilo awoke. Straightway he asked his son if the cock had crowed and was told that it had. But he didn't believe the spirits and went on his trip anyway. Just as the spirits had said, all five of his burros died on that trip.
>
> Another who used these mushrooms was a woman of Camotlan named Rosa. She was of a family from Zacatepec who had moved to Camotlan to live. Later she lived with her own father as his woman. He finally died in Huitepec. So Rosa ate the mushrooms and began to tell the people that the world was coming to an end. And she began to say that she was the mother of the Virgin. She was really deceiving the people very much. Many folk went to her place daily and there they were all day, waning and weeping about their sins. Then some of the younger ones who had been to school talked to the town authorities and got them to threaten to jail her if she didn't stop it. The authorities told her they'd run her out of town if she ate any more of those mushrooms. Why, people were taking offerings to her and getting her to pray for them. That was in 1945. She stopped it then, but some say she seemed to go crazy and wandered around in the woods. She died several years later.

Here end, for the present, our notes on the role of mushrooms in the Mije culture. On Monday, June 1, we set out on our return journey, and Allan Richardson and RGW reached New York on June 5.

We have now brought to a close our account of the divinatory mushroom cult in Mexico, insofar as it is known to exist today and is recorded in the annals. Here we would stop, were it not for evidence of an order different from anything so far mentioned, evidence that, if relevant, vastly extends the former range of the Middle American mushroom cult both in time and space. If this enigmatic evidence really relates to mushrooms, as we believe it does, a cult of the sacred mushroom goes back among the highland Maya of Guatemala at least to B.C. 1000, and in that area persisted for close to 2,000 years, until the archeological evidence fades out in what is known as the late classic period, around A.D. 900.

On September 9, 1952, Dr. Hans Mardersteig of Verona wrote us that he had observed in the new Rietberg Museum of Zurich a curious stone statuette, about one foot high, representing a mushroom with a human face carved in high relief on the stipe. The Museum attributed this artifact to Middle America but seemed to know no more. It had come to the Museum as one of many items in the collection of a private donor. With this letter and this artifact our inquiries into Middle American ethno-mycology began. We reproduce photographs of the remarkable Rietberg mushroom stone.

By almost the same post Robert Graves sent us a cutting from a pharmaceutical publication[163] referring to the 16th century use of an inebriating mushroom among the Indians of Mexico. This was our first intimation of a mushroom cult in Mexico. At once we embarked on a double-barreled inquiry, pursuing on the one hand the secret of the mushroom stone and on the other hand the cult of the mushroom in Mexico.

---

[163] CIBA *Symposia*, vol. 5, Feb. 1944, No. II, published in Summit, New Jersey.

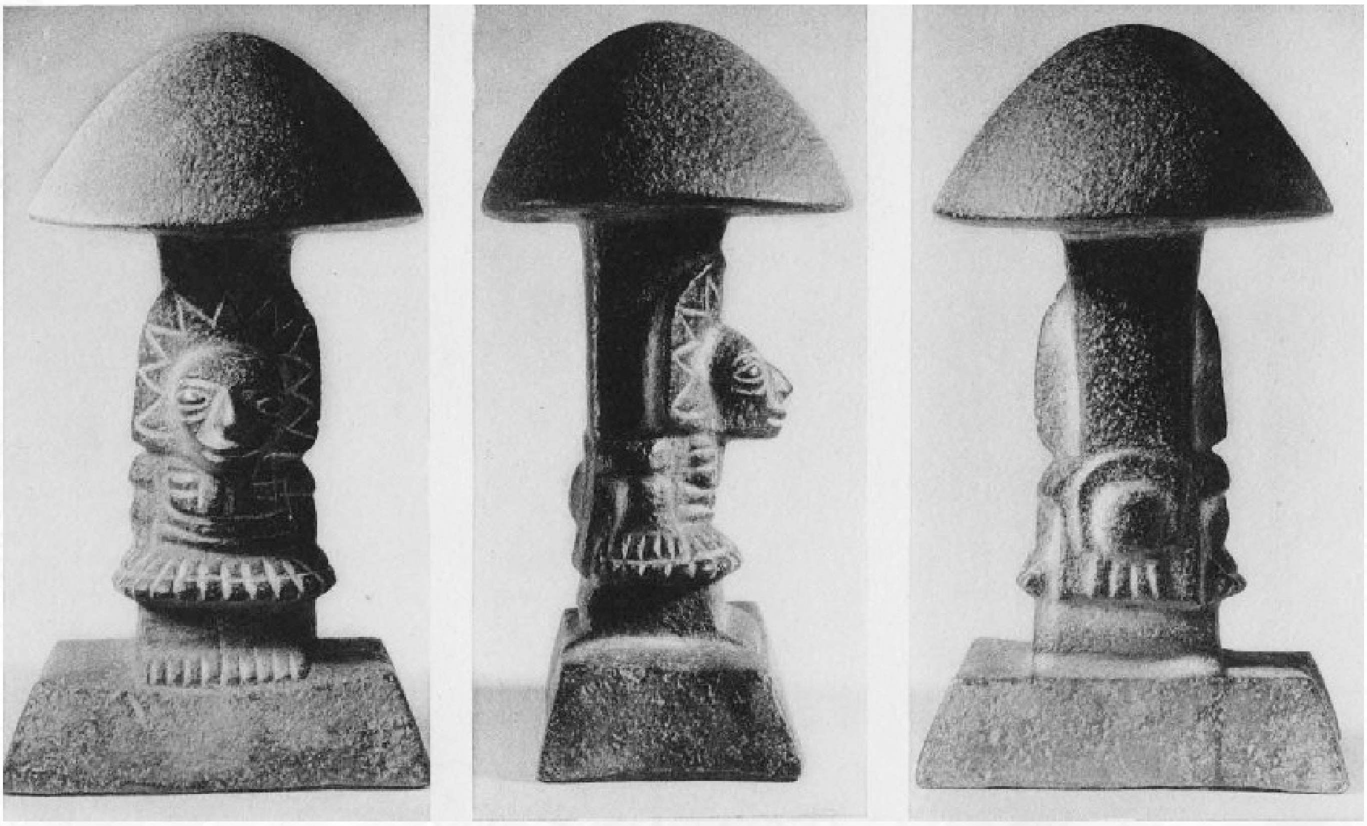


PLATE XLIII
Mushroom stone. Attributed to early classic period, Highland Maya, c. 300 A.D. to c. 600 A.D.
About 30 cm. high. *Zurich, Rietberg Museum*.

From Dr. Gordon Ekholm of the American Museum of Natural History we quickly learned that the Rietberg artifact was one of many 'mushroom stones' known to Middle American archeologists, almost all of them discovered in the highlands of Guatemala, most of them in that part of the highlands now inhabited by the Quiche Indians, but a few apparently found to the east across the border in Salvador and to the west in the Ocosingo region of Chiapas, the Mexican state adjoining Guatemala. We quickly made another discovery. In scanning the references to the mushroom stones in specialized publications, we came upon a reproduction of our Zurich artifact in *Globus*, a learned periodical published in Brunswick, with commentary by the geographer and ethnologist Carl Sapper. The notice appeared in 1898, and it turned out that this Rietberg specimen, unbeknownst to the Rietberg Museum itself, was the earliest mushroom stone to have drawn the attention of the learned world. In its excellent state of preservation and the bold simplicity of its lines, it remains to this day one of the most striking examples of its kind.

Dr. Sapper described the artifact as mushroom-shaped but he did not suggest that the carving might really represent a mushroom. From Dr. Sapper's day to now all archeologists know these artifacts as 'mushroom stones', but not, one has ever come to grips with the possibility that they represent what they look like. Indeed it is customary to set off the designation in inverted commas and the learned writers often add a safety clause expressly saying that of course the designation is only one of convenience. Have we not here yet another example of the subconscious rejection of mushrooms by scholars of the mycophobic West; The pattern is too consistent to be accidental. Gitlow shows no curiosity about the mysterious inebriating mushroom in New Guinea. Prescott in his *Conquest of Mexico*, exercising his editorial discretion, chooses to pass over in silence the inebriating mushrooms of the Nahua. Safford denies their very existence with vehemence suggestive of a violent gastrocolic upset. Beals overlooks the mushrooms in the Mije culture. The archeologists fail to see mushrooms in the 'mushroom stones'. But, after all, are not these the phenomena that we should expect? The anthropological traits of the anthropologists (which of course they ignore) poise them in a precarious relativity vis-a-vis the cultures that they observe with a god-like superiority, and introduce into their findings a big coefficient of defective perception.

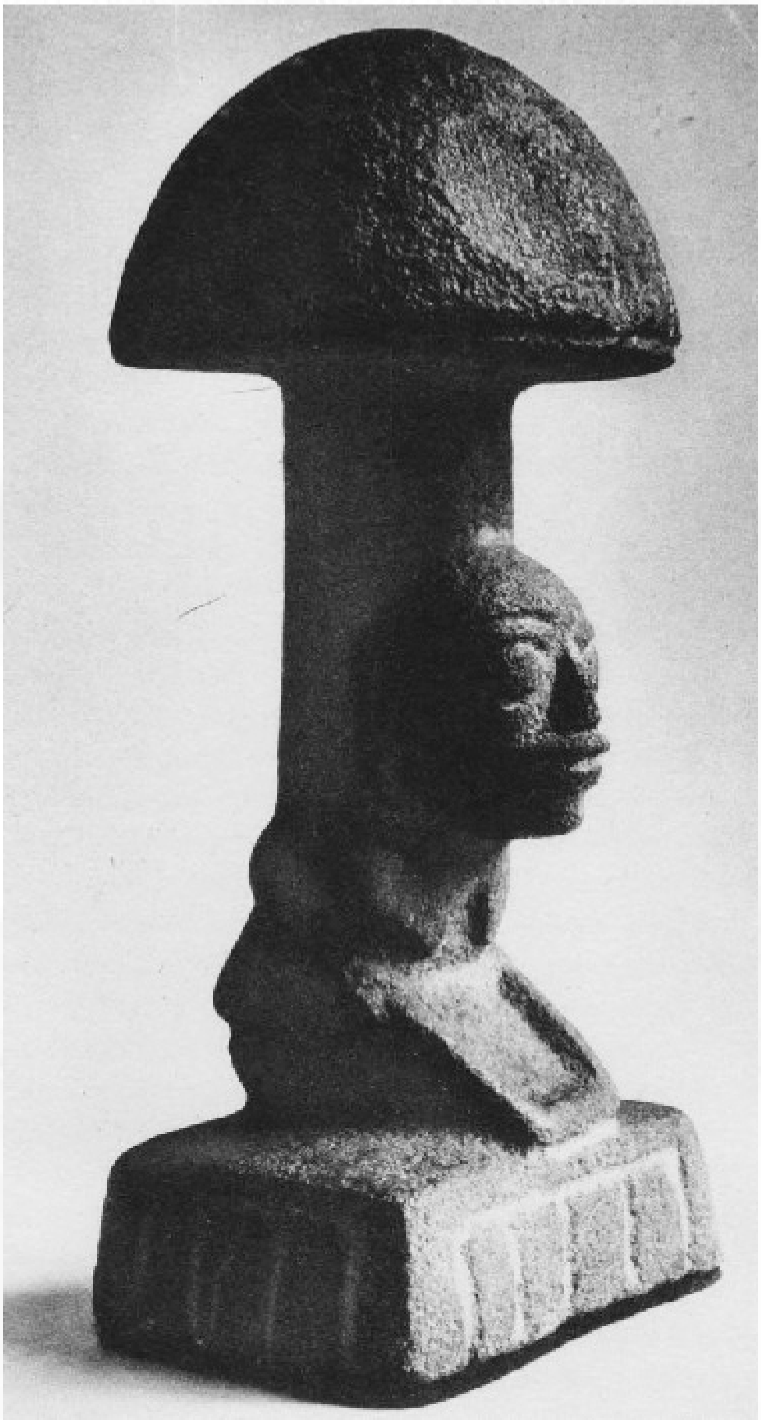


PLATE XLIV
Mushroom stone. *New York, Collection of Hans Namuth, Esq.*

As we progressed in our inquiries we made a further discovery. None of the archeologists who had contemplated the mushroom stones had ever heard of the mushroom cult of the Indians in Mexico. Conversely, none of the anthropologists of Mexico who knew about the divinatory mushroom had ever paid attention to the mushroom stones of Guatemalan provenience. Apparently we were the first to suggest (be it noted: we do not *assert*) that the 'mushroom stones' were actually stone effigies of mushrooms, that there had been at one time a cult of the mushroom in the highlands of Guatemala, and finally that the possibility should be considered of a kinship between such a cult and the surviving divinatory rite of the inebriating mushrooms in Mexico.

No sooner had we raised the question of the mushroom stones with Dr. Ekholm late in 1952, than he informed us that a brilliant young anthropologist and archeologist of Hungarian origin, Dr. Stephan F. Borhegyi, was at that moment engaged on the first comprehensive and intensive study of all the mushroom stones known to exist. He was in Guatemala City on a Bollingen Foundation grant, engaged primarily in a reorganization of the collections of the Museo Nacional. We communicated at once with him, contributing our mushroomic suggestions, and thus there began a collaboration that for us was most fruitful and exciting. After our visit to

Huautla in August 1953, we motored down through the valley of Oaxaca to Tehuautepec and the famous Isthmus. There, on the airstrip at Ixtepec, the private plane of the Banco Nacional de Mexico met us and lifted us to Guatemala City, a few hours away. Thereupon for almost three weeks we devoted ourselves with Dr. and Mrs. Borhegyi to an intensive ethno-mycological inquiry among the Indians of the Guatemalan highlands, to discover whether there was any surviving trace of a mushroom cult.

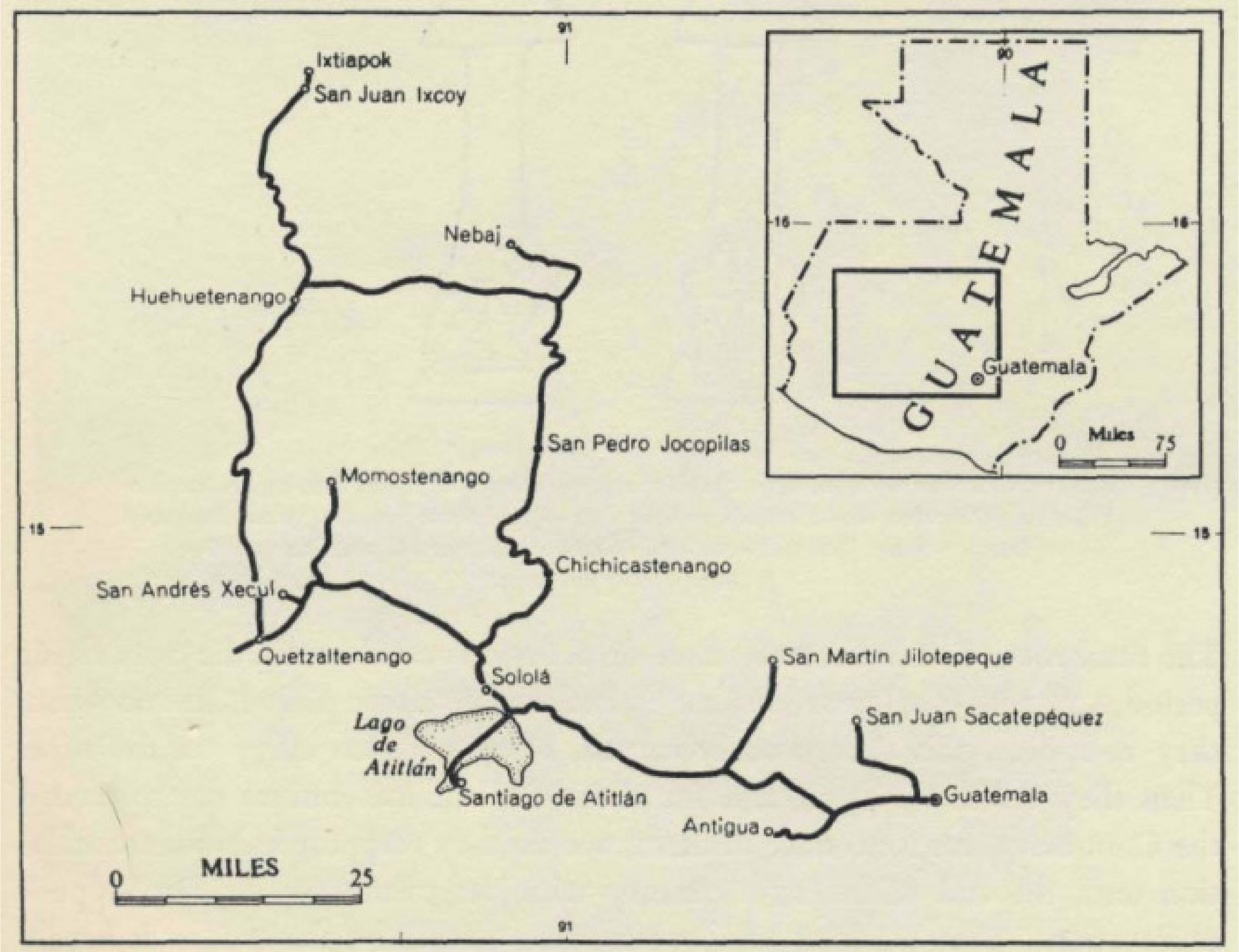

91
Ixtiapok
San Juan Ixcoy
Nebaj
Huehuetenango
San Pedro Jocopilas
Momostenango
15
15
Chichicastenango
San Andrés Xecul
Quetzaltenango
Sololá
San Martín Jilotepeque
San Juan Sacatepéquez
Lago de Atitlán
Santiago de Atitlán
Guatemala
Antigua
0
MILES
25
91
90
16
16
GUATEMALA
Guatemala
0
Miles
75

Fig. 17

Dr. Borhegyi had already brought close to completion his minute examination of all the known mushroom stones, totalling more than a hundred. Additional ones are certain to be discovered as time goes on. They are an extraordinary cultural expression for several reasons. The earliest seem to go back to the period known to Maya students as the early pre-classic or developmental era, in the second millennium B.C. In general the early ones for the layman are the most striking: they are beautifully carved and the figure jutting out from the stipe is often gripping in the vitality of the facial expression. We reproduce one of the best of these, from the collection of Mr. Hans Namuth of New York. This one is late pre-classic, that is, dating from the long stretch of years from B.C. 500 to A.D. 200. The Rietberg specimen appears to be also from the same period. Instead of a human figure, the carved effigy is often of an animal or bird - a jaguar, *pisote*,[164] deer, a stylized bird impossible for us to identify, and - here is for us a surprising discovery - the toad! We reproduce by line block the best example of a toad mushroom-stone known to us, in profile and full face. The face itself is anthropomorphic, but the four toes are the sure stigma of the amphibian. Dr. Borhegyi considers this specimen pre-classic.

---

[164] This is the native name of the coatimundi (*Nasua narica*), of the same family as the raccoon, a family distinguished anatomically by the fact that the males possess a phallic bone. The *pisote* was associated with phallic matters by the Maya, but no phallus is present in any mushroom stone so far discovered. In Mexico the *pisote* is called the *tejon*.

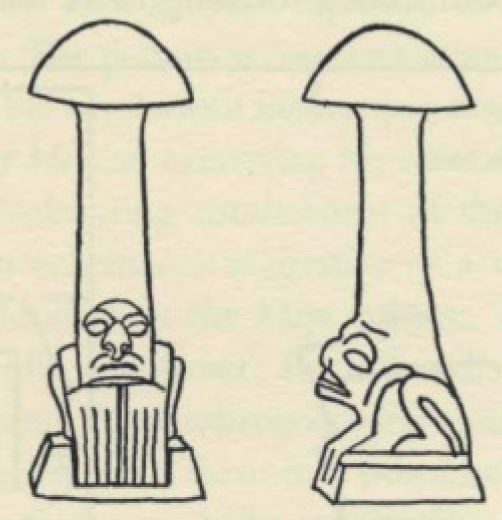


Fig. 18 - Mayan 'Toadstool'
Represents a toad with anthropomorphic face; tentatively identified thus by Dr. Stephan F. Borhegyi because of the crouch and the four-digited front feet. Ht. 35 cm. Probably late pre-classic (500 B.C. -200 A.D.). Cerro Alux, near Mixco, Guatemala. Museo Nacional 2209.

PLATE XLV
Cayetano's House, Huautla de Jiménez. June 1955.

The mushroom-stones become scarce or perhaps even absent in the early classic period, A.D. 200-500, but around the end of the late classic period, A.D. 600-900, they re-appear, this time crudely carved, often with no effigy on the stipe. Then they vanish for good, and for about the half millennium that preceded the Conquest there is no trace of them, nor do they reappear in human circulation until the end of the 19th century with the publication of Dr. Sapper's observations. That the later mushroom stones should be the crudest is hardly surprising: a cult in its pristine vigor expresses itself most freshly.

Dr. Borhegyi has generously made available to us his chart of the mushroom stones, typing them by chronological and geographical provenience, and we reproduce it here for the first time folded in the pocket at the end of our book.

The Maya still live in the Yucatan peninsula, Chiapas, Tabasco, and Guatemala. All of the many Indian languages spoken in Guatemala today, both in the low-lying Petén and the Highlands, belong to the Maya family. In the Highlands there are several linguistic families, but three of the languages form a contiguous and kindred nucleus, the Quichoid family - the Quiche, Kakchiquel, and Tzutujil. Most of the prehistoric mushroom-stones have been found roughly in the area known today as the Quiche and Kakchiquel country. We visited Indian villages of these three peoples, and also Nebaj and San Juan Ixcoy, where Ixil and Kanjobal are spoken, languages related to the important Mam-Maya group. We did not visit the Petén or Yucatan, as no mushroom stones have yet been reported from those regions.

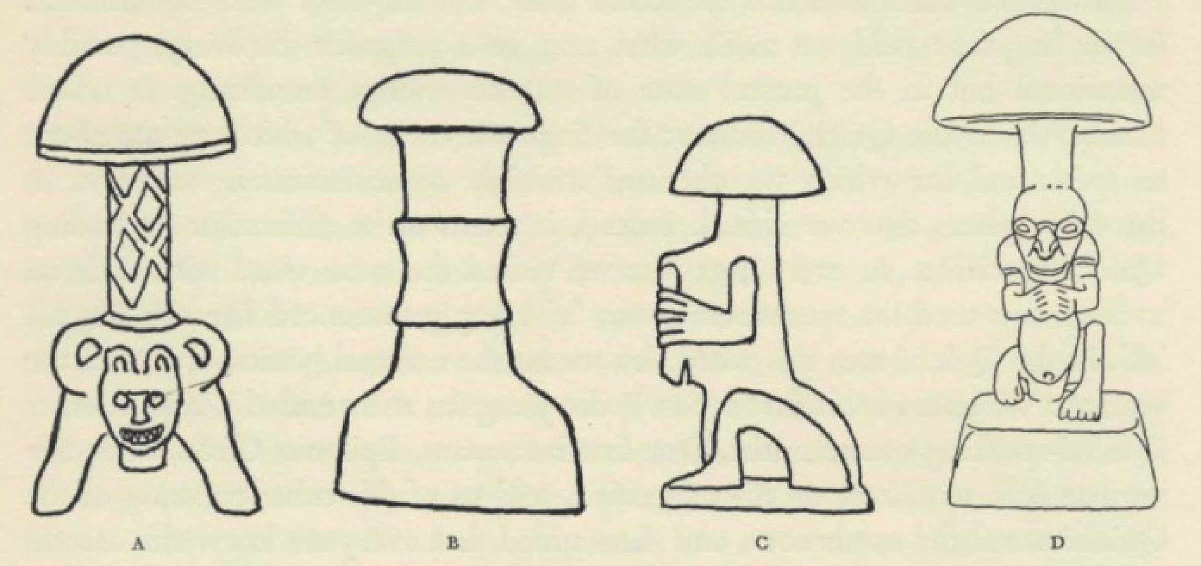


Fig. 19 - Mushroom stones
A. Represents a jaguar, traces of red paint still visible. Kaminaljuyú, Mound E-111-3, tomb I. Ht. 37 cm. Miraflores phase, 1000-500 B.C. Museo Nacional, Guatemala, 3450.
B. Ocosingo, Chiapas, Mexico. Now in regional museum of Tuxtla Gutiérrez. Probably late pre-classic (1000 B.C. - 200 A.D.) or early classic (200-500 A.D.)
C. Represents a pisote (*Nasua narica*) in characteristic pose with forefeet over nose. Salcaja, near Quetzaltenango. Ht. 25.5 cm. Late pre-classic or early classic (Vitalino Robles collection).
D. Formerly in Museo Nacional, Guatemala. Probably late pre-classic.

So far as a living mushroom cult or knowledge of such a thing is concerned, our findings were conclusively negative. The elders in the villages that we visited[165] were friendly and not reticent. We would bring the conversation around to mushrooms, collect vocabulary, and finally begin to discuss the inebriating virtue of certain kinds. Our informants were invariably surprised to learn that such mushrooms existed, and showed themselves most curious and even envious as we described the divinatory mushrooms of the Mazatecs.

---

[165] For workers in the field we supply the names of our informants and their towns. Kakchiquel-speaking: San Juan Sacatepequez, the official interpreter Bravlio; San Martin Jilotepeque (the language here influenced by ancient Pokomam occupation), Don Francisco Martinez del Rosal, owner of finca Las Pilas, and Alberto Calan, 3rd regidor; Solola, Nicolas Akichi, textile vendor. Quiche-speaking: Chichicastenango, Miguel Ignacio, the maker of wooden dance masks, and Diego Panjojehan, who lives in Chujupen; San Pedro Jocopilas, Epilonio Giron, head of the municipal guard, and Don Ignacio Barrios, Mayor; San Andres Xecul, Pedro Raimundo Hernandez; Momostenango, Aparecio and Santiago Lajpop. Tzutujil-speaking: Santiago de Atitlan, the cripple Don Salvador Ramirez and the artist Juan Sisay. The following are sub-divisions of the Mam group. Ixil-speaking: Nebaj, Trinidad Gomez, candle-maker. Jacalteca-speaking: Concepción Huista, Antonio Ramirez Paz, former alcalde. Kanjobal-speaking: San Juan Ixcoy, Mateo Velazquez, alcalde, and F. Ruben Gonzalez, first official.

Though of direct evidence we found none, our inquiries were not fruitless. In the linguistic field we made what may be a pregnant discovery, possibly sensational but in the present state of our knowledge tantalizing. It relates exclusively to the Quiche Indians: the linguistic usage of which we are about to speak and for which we obtained multiple confirmation is unknown in the other places that we visited. Indeed, it seems to be unfamiliar to leading Quiche specialists. In every area that we visited the same word with dialectal variants was used for mushroom: *ocox*, V being pronounced like the English 'sh'. In the Quiche area this word also means the external genital organs of the woman. We learned this first in San Pedro Jocopilas and verified it later in other Quiche-speaking communities. Our first informant, Epilonio Giron, after our women folk withdrew on his suggestion, told us of this other meaning of the Quiche word for mushroom, and then added that everyone knew this second sense, but that one should never use it. In short, it is tabu. In Momostenango Suzanne Borhegyi and Masha, off on their own, accompanied by a young Indian woman as interpreter, broached the subject with a flock of Indian women there, whom they discovered washing clothes in the rushing stream. Their inquiries evoked peals of merry laughter, but no elucidation whatever. The women refused to develop the subject, and who shall blame them?

In our Mazatec inquiries we had uncovered a curious linguistic usage concerning mushrooms. The reader will recall that there is no single Mazatec word that embraces all the mushrooms. There are two, one for all kinds save the divinatory species, and another general term for the various species held in honor as vehicles of divine inspiration. The Indians of Guatemala are not so mycophagic as the Mexicans, but in the market places there mushrooms of various kinds are on sale, and we were startled to discover in Guatemala city that the Spanish word *hongo* covers all species except one. That one is the favorite for the table and its common name is *anacate*. In all likelihood *anacate* is an eroded form of the Nahuatl *nanacatl*. Whether the borrowing took place before or after the Conquest, we do not know, but already when the Spaniards arrived the Nahuatl influences in the Maya area were powerful. This verbal fission, dividing the mushroom world into two without an overriding collective term, is a curious thing, especially as it recurs in two places as far removed from each other as Huautla and Guatemala City. We took pains to identify the *anacate* of Guatemala, eating it in quantity and in San Juan Sacatepequez going out after them in the woods with our interpreter Bravlio. We found them exactly where the market women of Guatemala City had said we should, among the *encinos blancos*, 'white oaks', which turned out to be the oak known to botanists as the *Quercus fulva*. The mushroom could be taken either for a large cantharellus or for a craterellus, and it is in fact the *Craterellus cantharellus* Fr. ex Schw. It is a chanterelle without lamellae.[166]

Dr. Borhegyi later combed the Quiche and Kakchiquel chronicles and legends for references to mushrooms. There come down to us from early times two native narratives of the Highland Maya, one in Quiche and the other in Kakchiquel, the *Popol Vuh* and the *Annals of the Kakchiquels*. Written in the native languages, they have been translated into Spanish and English. Dr. Borhegyi discovered in each of them one reference to mushrooms, and in each case mushrooms are associated with religious observances. These texts were certainly composed after the era we assign to the mushroom stones, but they give us documentary evidence that mushrooms played a role in the religious life of the Highland Maya. (We realize that the ancestors of the Quiche and Kakchiquel peoples are supposed to have arrived in their present location as conquerors around the 12th century, but whoever the conquerors may have been, it is probable that the indigenous culture absorbed them.) Here is the passage in the *Popol Vuh*, as presented in the English text by Delia Goetz and Sylvanus Griswold Morley:

> And when they found the young of the birds and the deer, they went at once to place the blood of the deer and of the birds in the mouth of the stones, that were Tohil and Avilix. As soon as the blood had been drunk by the gods, the stones spoke, when the priests and the sacrificers came, when they came to bring their offerings. And they did the same before their symbols, burning *pericon* and *holom ocox*. [University of Oklahoma Press, 1950, p. 192]

---

[166] Our specimens of the *anacates* were the subject of a note by Professor Roger Heim that appeared in the *Revue de Mycologie*, April 1954, Tome XIX, Fasc. I, pp. 53 ff.

We do not know what *pericon* was.[167] 'Tohil' was the Quiche variant of the Toltec Quetzalcoatl, the 'feathered serpent', but we know not how the god Avilix looked. *Holom ocox* means 'mushroom head'. In San Martin Jilotepeque our informant Alberto Calan had told us of an unwholesome mushroom known to him as the *holom ixpek*, 'toad's head', a name doubly interesting for us because it links the mushroom with the toad and because of the fungal use of the word for 'head', reminding us of the passage in *Popol Vuh*.[168]

The passage in the *Annals of the Kakchiquels* as translated from the original by Adrian Recinos and into English by Delia Goetz reads thus:

> At that time, too, they began to worship the devil. Each seven days, each thirteen days, they offered him sacrifices, placing before him fresh resin [i.e., *copal*], green branches, and fresh bark of the trees [i.e., *amate*?], and burning before him a small cat, image of the night. They took to him also the mushrooms of the trees, and drew blood from their ears.

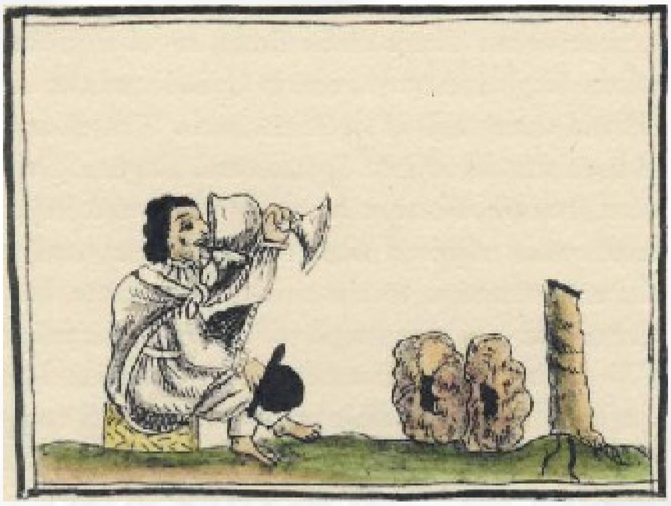


Fig. 20 - Indian drinking from a Spanish Goblet.
As represented by a 16th century Spanish artist; from Florentine Codex of Bernardino de Sahagun's *Historia de las Cosas de la Nueva España*. Biblioteca Laurenziana, Florence.

Again the words in the original tongue are *holom ocox*, 'mushroom heads', and they are described as 'of the trees'.[169] We had learned in Huautla that one of the four kinds of sacred inebriating mushrooms grows in trees, and Juan de Cordoba in his Zapotec lexicon calls it the *nocuana peneeche*. Here then in the Kakchiquel text, which was put down on paper after the Conquest under Spanish influences but which recalls pre-Conquest events, we read of a religious rite in which arboreal mushrooms were used.

Both the Quiche and the Kakchiquel narratives use the same expression - *holom ocox*. Obviously this should be translated as 'mushroom caps', and we know from our Mije notes that the cap in Mije is a 'head'. We find the same metaphor in Mazatec, where the cap of the mushroom is the *hko⁴*, meaning 'head'. Perhaps the reader has hit on the further observation that we now make. The Mije and Mazatecs in their mushroom cult lay stress on the separation of pileus from stipe, and the virtue lies primarily in the pileus. They are still following the practice recorded for us by the ancient Quiche and Kakchiquel narrators, still decapitating their ceremonial mushroom.

---

[167] If it is the plant known commonly in Mexico today by the same name, it is the *Tagetes lucida* Cav.

[168] The Quiche word for 'toad', *ixpek*, is startling because of its superficial resemblance to the Indo-European root discussed on pp. 92 ff. We found several variants - *xepek, ixpuk, xpuk* - in the towns we visited. In all cases V has the phonetic value of English 'sh'. The word carries other meanings, such as 'cave' in Quetzaltenango. In Chichicastenango we found that a similar word relates either to the vagina or the womb. We are told that in the Zapotec dialect spoken at Mitla *xkep* means 'womb'. We had neither time nor competence to explore the suggestion here of a cultural association linking toads to fertility such as we find in Europe. In the Recinos-Goetz translation, University of Oklahoma Press, 1953, pp. 82-83, the passage is rendered thus:
... the mushrooms (which grow at the foot) of the trees ...
The interpolated words are obviously superfluous, the translators presumably not knowing that many mushrooms grow in trees. This reference to tree fungi reminds us of a curious passage in the *Relation de las Minas de Temazcaltepec*, where Caspar de Covarrubias enumerates briefly the kinds of food that the people eat, and in the brief list he finds place to include *ongos de arboles*, 'tree-mushrooms'. See *Papeles de Nueva España*, Paso y Troncoso, Madrid, 1905, vol. VII, p. 31.

[169] Juan de Cordoba's 16th century Zapotec lexicon refers to arboreal fungi, and in Huautla our *curandero*, Aurelio Carreras, spoke of a divinatory species growing on wood. It seems probable that arboreal fungi play a distinct role in Middle-American fungal lore, one that remains to be explored.

As we thumb through the pages of Sahagun's immense work, in the Florentine Codex, we discover yet another miniature relevant to our argument. Executed by an Indian under Spanish influence, it is pregnant with mushroomic meaning. On the left we discover an Indian drinking from a Spanish goblet. On the right are two mushroom caps, 'heads', the Quiche *holom ocox*, the Mije *kobahk*, the Mazatec *hko⁴*. There are a pair of these caps, i.e., the Mije *casada*. A decapitated stipe stands on one side. Thus in this picture we come upon themes familiar to us from present-day usages among the Mije and Mazatecs and in the pre-Conquest annals of the Quiche and Kakchiquel peoples. We have found in Sahagun's text no passage that this miniature illustrates. What does it mean? We venture a rash but tempting guess. There must have been a moment in the social history of 16th century Mexico when the fire-water of the Spaniards confronted the inebriating mushrooms of traditional use with a challenge deeply disturbing to the emotions of the conservative Indians. Does not this miniature illustrate that moment of challenge? The mushroom caps are disproportionately big: this is the artist's device for showing their subjective importance, just as in the earlier miniature, on page 235 [fig. 15], Mictlantecuhtli, Lord of the Underworld, hovers with giant stature over the Indian who is eating his pair of *teonanacatl*.

In the indigenous cultures of Middle America one of the crucial problems for anthropologists is the interplay, over thousands of years, between hieratic cultures on the one hand, rising and falling spasmodically and sporadically and often leaving behind spectacular monuments, and on the other hand, the folk cultures of the farming population, simple, relatively homogeneous, and singularly tough in resisting outside influences.[170] Humble artifacts such as incense burners, figurines, and clay effigies fashioned so as to serve also as whistles have been made in virtually the same styles for three thousand years and are still being sold at the present hour in the native market places. The mushroom stones do not belong to this folk culture. If they are a clue to a mushroom cult, we must suppose that the cult was hieratic, the attribute of a priestly elite, and that that cult passed away with that elite. The highest achievements of the Mayan culture, which are known to have been hieratic, belonged to the lowland Maya of the Petén and Yucatan, where no mushroom stones have been found.[171] However, there could also have been priest-governed societies in the Highlands, and in fact in the Highland excavations at Kaminaljuyú, near Guatemala City, there has been found in a pre-Classic tomb that was probably sacerdotal one of the effigy mushroom stones, representing a jaguar.[172] We suggest that there was once a mushroom cult in the Highlands in the formal, organized sense, a liturgy administered by priests on set occasions, perhaps for the laity to join in. How different such a cult would be from the intimate, family use of the divinatory mushrooms that we have witnessed among the Mazatecs and Mije, where the mushrooms are consulted, when available, if needed, in the dead of night, with only two or three gathered together! But there is no necessary contradiction here. Our 16th century writers tell us of the large gatherings where the mushrooms were consumed in public. And what could have been more inviting to a priestly elite than to take over from the folk culture their divinatory mushrooms, and clothe the deeply stirring faith of the people in those divine mushrooms with the ceremonial habiliments that an elaborate ritual would have required? As we review our evidence, we discern an endemic use of inebriating mushrooms from earliest times in the enduring folk culture of Middle America, not in the low, hot country, but throughout the higher country, over an area

---

170. For an illuminating discussion of this problem see Stephan F. Borhegyi's "Cultura Folk y Cultura Compleja en el Area Maya Meridional", *Ciendas Saddles*, published by the Pan-American Union, Washington, D. C., vol. V, No. 26, April 1954.
171. Is it coincidence that, just as the mushroom stones are found only at a certain altitude and never in the hot, low country, so according to our informants in Huautla and Mazatlan, the use of the divinatory mushroom is unknown among the Mazatecs and Mije living today in the *tierra caliente*?
172. For further illustrations and discussion of this remarkable specimen, one of the oldest known, see Publ. 596 of the Carnegie Institution of Washington, 1952, which is vol. XI of the series of *Contributions to American Anthropology and History*, paper No. 53, 'Mound E-III-3, Kaminaljuyú, Guatemala', by Edwin M. Shook and Alfred V. Kidder, fig. y8f and 13 (No. 193), and p. 112. We reproduce this mushroom stone in fig. 19 A.

extending from the Valley of Mexico into Guatemala and Salvador. We see this endemic folk usage seized upon, taken over, lifted up, and reverently exploited by the sophisticated priestly elite in certain hieratic phases of the upland cultures.

Certainly we have not discovered the tie that would unequivocally bind the mushroom stones of Guatemala and Chiapas with today's intimate folk cult. That such a link will be discovered is unlikely but not impossible. Perhaps on some holy hill or *ce.no*, or deep in the recesses of some cave, in a remote corner of Oaxaca or Chiapas, the Indians still direct their humble supplications to a stone image of a mushroom, unbeknownst to circumambulating ethnologists. Unless someone discovers such a survival, how can we hope to establish a connection between the ancient stone carvings and the divinatory mushrooms.

Yet the evidence that we have assembled points toward such a connection. We know that the Indians of Middle America are mycophiles with extensive knowledge of mushroomic properties and corresponding vocabularies. In their cultures mushrooms have always been emphasized, not ignored. Among these Indians religious associations have always interpenetrated every aspect of human existence, and it would be rash to assume that this fusion of daily life with religious beliefs excluded the fungal world at the time when the mushroom stones were carved. We know furthermore what a profound hold the ceremonial mushrooms have to this day on certain of the remoter Indian tribes, and the range of this cult doubtless runs beyond the limits that we have had opportunity to explore. In the case of the Mije, their country overlaps the area where the later mushroom stones seem to have been found. We know from surviving annals that before the Conquest ceremonial mushrooms were used in religious observances in the Guatemalan Highlands, where most of the earlier stones have been found. A divinatory mushroom grips the imagination, and it would justify the functional use, in religious ceremonies, of the mushroom stones. The presence of a divinatory mushroom is rare in human cultures: would it not be extraordinary to find a mushroom cult in the same area with the mushroom carvings - themselves unique - and yet unrelated to them? Whereas in the past no one was suggesting a mushroomic explanation for the mushroom stones, we think that the presumption favors such an explanation now, and that the burden of the argument must be on those who oppose it.

Meanwhile many exciting questions remain unanswered and cry for the further field work that we cannot undertake. We have not fully identified the divinatory mushrooms that the Mazatecs and Mije use, to say nothing of other peoples where the cult may survive. They must be securely identified, with multiple corroboration. Their specific properties as understood by the Indians must be fully set down. Then they must be proved empirically, under controlled conditions. The Mije have developed sweeping explanations for any failures in the use of their divinatory mushrooms: this suggests that auto-suggestion plays a role, or that sometimes the wrong mushroom is taken, or that the virtue varies under differing circumstances. The difficult task of chemical analysis, with the isolation of the active agents, will be the final achievement.

The Mije are related linguistically to the Zoques, their neighbors to the east in Chiapas. What do the Zoques know of the divinatory mushrooms? If they use them, perhaps we shall discover, after all, that the Maya peoples immediately to the east of them also share the cult, or remember having practiced it in the past.[173] Robert Weitlaner knows the Chinantecs as well as any other living anthropologist. Among them he has failed to find any trace of the divinatory mushroom, though they live between the Mazatecs and the Mije. How strange this is! But it only points up the importance for all workers among the Indians of Middle America, both linguists and anthropologists, to include the divinatory mushrooms in their inquiries, and to report their findings whether negative or positive. Where the cult does not survive, memories of it may, and where no memories exist, perhaps in the names for mushrooms the linguists may trace forgotten knowledge. Slowly we should begin to pinpoint the results of such inquiries on a cultural map of Mexico keyed to the mycological lore of the Indians. But the search for evidence should not be limited to our contemporary world. The whole corpus of surviving pre-Conquest artistic expression in the highland areas of Middle America should also be reviewed, on the chance that divine mushrooms figuring therein have hitherto escaped detection. Later we shall venture some suggestions of our own in this archeological field.

---

[173] There are grounds for linking together the Maya and the Mije-Zoque cultures, the two linguistic groups being perhaps descended from a common parent stock. See J. Alden Mason's paper on Middle American linguistic groupings in *The Maya and Their Neighbors*, D. Appleton-Century, N. Y., 1940 (a Festschrift in honor of A. M. Tozzer), p. 72.

15

Teo-Nanacatl: the Mushroom Agape

With the concluding words of the previous section we had thought to end our discussion of the divine mushrooms. But in 1955 we returned again to Mexico to push our inquiries, and, at last breaking through the barrier of native shyness, we penetrated into the mushroom cult much more deeply than before, eating the mushrooms ourselves as participants in a communal agape. We experienced subjectively for the first time what we had previously been able to describe only as witnesses from the outside or at second hand by the testimony of informants. Just as our book goes to press we add the following notes on our 1955 adventures.

On Friday, June 24, VPW, Masha, and RGW flew to Mexico City. We installed ourselves in a small villa in San Angel, at Reyna 9, which we had rented with servants as a base for our excursions. Thither we could return and relax in the quiet of a lovely garden, the high walls festooned with blooming bougainvillea, after our sorties into the Indian country. Two days later Allan Richardson joined us, to serve again as our photographer, and on Monday he and RGW set out for the heart of the Mazatec country. By Tuesday night we were bedded down with a Mazatec family in one of the villages of that remote world in northern Oaxaca. On this trip Robert Weitlaner was prevented by other duties from accompanying us, and we therefore considered ourselves doubly fortunate when almost at once, in a new circle of Indians, we found ourselves received as friends.

We shall call our host Cayetano and his wife Guadalupe. Intelligent, vigorous, and gentle, this couple, in their thirties, were the key to the success of our expedition. As soon as RGW imparted to them in confidence his interest in the sacred mushrooms, they pledged their cooperation, and they more than made good their pledge.

Cayetano and Guadalupe's house is on the outskirts of Huautla de Jiménez and opens directly on the village thoroughfare that runs along a mountainside. With roof of thatch and adobe walls, it has two storeys. You enter on the upper level from the street, and then by a small trap-door in one corner you climb down a steep and twisting stairway to the floor below, where the events that we shall relate took place. This lower storey is built on one side against the mountain face, and on the other side by a door it opens on a terrace perhaps six feet wide, which then falls sharply away to the ravine hundreds of feet below.

Across the valley and beyond, the Sierra Mazateca in all its verdant glory fills the distant view. On the terrace at one end of the house a flimsy wooden and thatch annex has been constructed to serve as kitchen. The interior is divided by a whitewashed adobe wall into two rooms. There is no window in either room, but over the door on the terrace an aperture allows in some light. This room was well sheltered from the life of the village, and doubly so at night when Mazatec villagers refrain from stirring abroad. The family circle was large: our hosts' small children were numerous, and Cayetano's brothers and parents were also much in evidence, as well as other kin. Chickens and turkeys had the run of the lower floor. A hen sitting on her eggs on one of the cluttered tables was a silent witness to all that went on.

On the day after our arrival, early in the afternoon of Wednesday June 29, Cayetano and his brother Genaro took us down the mountain side to the edge of the stream in the gully. In the lower reaches of our descent we skirted a field planted to sugar cane, and then arrived at the spot where it is the custom to mill the cane, a flat space the size of a threshing floor, thick with rotting bagasse, as the refuse from the mill is called. There in the bagasse, just as Cayetano had promised, we found an immense crop of mushrooms, of the sacred kind known to our Mazatec friends as *ki^{3}sol* 'landslide'. We photographed them to our hearts' content. We gathered them in a pasteboard box: the sacred mushrooms must always be carried in a closed parcel, never exposed to the view of passers-by. They were a noble lot, mostly young, all of them perfect in their moist health and fragrance. Then we carried them up the steep mountain side to the house. We were warned that if we saw any dead animal on the way, the mushrooms would lose their virtue - happily we saw none. It was in the rainy season, and in the humid heat of that sunny afternoon the climb was long and exhausting.

Hardly had we arrived back when Cayetano sent us, with his brother Emilio as interpreter, to a cottage some distance farther up, where he said we would find a *curandera de primera categoria*, a *curandera* of the first class, María Sabina by name. We were to ask her whether she would help us that night. We found the Señora, as our hosts always called her, resting on a *petate*, or mat made of a certain palm. She was alone with a daughter who was up and about. After introducing ourselves through Emilio, we showed them our mushrooms, whereupon the two women went into raptures over their fine condition and beauty. We put our question to the Señora, and without hesitation, looking steadily at us, she said yes. Neither she nor her daughter spoke a word of Spanish. We do not know whether they had been told to expect our visit.

María Sabina is a woman in her fifties, grave in demeanor, with a grave smile, short of stature like all Mazatecs, dressed in the Mazatec *huipil*. Her daughter is in her thirties and in all respects takes after her mother. She is following her mother's vocation. The Señora herself is at the peak of her powers, and it is easy to see why Guadalupe had said to us of her that she was *una Señora sin mancha*, a lady without blemish, immaculate, one who had never dishonored her calling by using her powers for evil. She alone, said Guadalupe, had brought the latter's children through all the diseases that take a frightful toll in early childhood in the Mazatec country. After that initial talk we were to pass two all-night vigils with Doña María and her daughter, and we can testify that she is a woman of rare moral and spiritual power, dedicated in her vocation, an artist in her mastery of the techniques of her office. It was her example that drove home for us for the first time a rule that must govern all field anthropologists. In the archaic cultures as among advanced peoples, there is a hierarchy of excellence when it comes to the individuals who are the culture-bearers. It is not sufficient to rely on the first informants that present themselves, on any shaman who is willing to talk. The whole cultural area must be discreetly surveyed and communication must be established with the finest exponents of the old traditions. None of the formidable difficulties of physical existence in these remote regions nor of communication should be permitted to blunt this obligation.

On that last Wednesday of June, after nightfall, we gathered in the lower chamber of Cayetano's house. In all, at one time or another, there must have been twenty-five persons present, mostly members old and young of Cayetano's family. The Señora came with her daughter Polonia. They and all the others were pleased when we photographed them, and we took numerous pictures throughout the preliminaries. But the Señora requested through Cayetano that when the power would seize her - *cuando la fuerza le aganara* - we should desist, and of course we did so. Cayetano served us chocolate to drink, somewhat ceremonially. (RGW's thoughts went back to Sahagun in the l6th century, who had said that chocolate was served before the mushrooms were taken. Cayetano also offered us coffee and sweet wheaten bread, neither of which had been known to his ancestors in pre-Conquest Mexico.) Both Allan Richardson and RGW were deeply impressed by the mood of the gathering. We were received and the night's events unrolled in an atmosphere of simple friendliness that reminded us of the agape of early Christian times. There was no familiarity. The mushrooms were treated respectfully, as sacred, but without marked formality. The proceedings went forward with an easy decorum. Neither on this occasion nor at any other time or place did we ever see or hear the mushrooms treated as a subject for jocular vulgarity, of the kind that often marks the use of alcohol among fully civilized peoples. The atmosphere of respectful friendliness was infectious, and we enjoyed reciprocating the welcome extended to us. There is no record that any white men had ever attended a session of the kind that we are going to describe, nor that white men had ever partaken of the sacred mushrooms under any circumstances. For reasons deeply rooted in the mortal cultural conflict of Spaniards and Indians, it is unlikely that any unrecorded event of the kind had ever taken place. By hearsay the early Spanish writers had reported gatherings of Indians where the mushrooms were served to many, but we had thought from our previous visits to Mexico that such observances were today unknown. We were now to learn that they still go on, and that they are even today a central experience in the culture of the Mazatec people. The only change is that the gatherings now are held behind closed doors. Cayetano told us early in the evening that no one on any account should leave the house before break of day, and for the necessities of nature he showed us the rudimentary provision that had been made in one corner of the other room. The contempt of the Spaniards for indigenous rites and the Church's condemnation of them as idolatrous heresies have not killed these assemblies of ancient lineage, but have driven them under cover.[174] Our hosts were obviously pleased by our intense and sympathetic interest in all that went on before our eyes. The very fact of our participation must have made the evening memorable for them. They were dressed up for the occasion. Genaro in particular was resplendent in his handsome striped sarape and his freshly washed white cotton trousers or bags, which Indian-style were buttonless, being supported by strings tied around the waist. By our respectful behavior we did all we could to make clear that for us the rite we were witnessing possessed full religious stature. We were mindful of the drama of our situation. We were attending as participants a mushroomic Supper of unique anthropological interest, which was being held pursuant to a tradition of unfathomed age, possibly going back to the time when the remote ancestors of our hosts were living in Asia, back perhaps to the very dawn of man's cultural history, when he was discovering the idea of God.

---

[174] Dr. Harold Alexander Abramson of New York, a specialist in psychotic research who has studied the action of lysergic acid diethylamide and other hallucinogens, believes that persecution was certainly not the only reason for holding the mushroomic agape behind closed doors. He is sure that the participants, if released from the centripedal influences of the intimate circle, would sometimes behave in extreme ways, even killing themselves or murdering others or engaging in assaults. When he expressed this view, Dr. Abramson knew nothing of the 16th century accounts of those very excesses perpetrated by persons who, having eaten the mushrooms, went out on the town.

There were a few home-made wooden chairs in the room, and in the beginning Allan and RGW used them. Cayetano's brother Genaro and possibly one other remained seated on chairs the whole night through. The others lay or reclined on mats on the floor, wrapped in *sarapes*, except of course for the Señora and her daughter, who, wearing clean *huipiles* with identical reddish-yellow birds embroidered on them in front, sat before the altar-table on mats. They sat with what seemed a half-studied formality, the daughter a little behind her mother and slightly to her mother's right. Later, in the dark, we could barely discern their triangular shadows as first one and then the other lifted her voice in song. It was then, when the details were erased by night and only the geometric mass persisted, that they suddenly reminded RGW of the pyramids that are the outstanding feature of architecture in pre-Conquest Mexico. Could the pyramids have been originally a geometric stylization of the worshipping Indian seated on his mat, of the gods that were his magnified projection of himself?

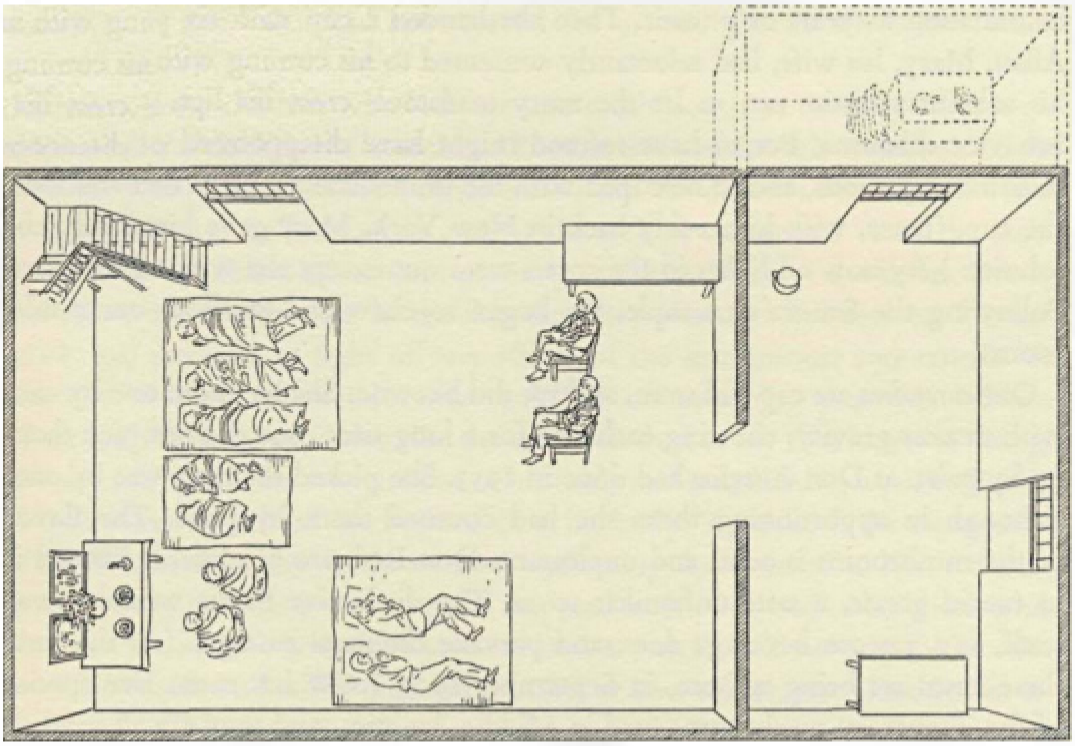


Fig. 21

At about 10.30 o'clock the Señora and her daughter took their positions before the small table that served for an altar. On it were two holy pictures, on the left the child Jesus and on the right the Baptism in Jordan, with a bouquet in front of them, a crucifix hidden in the flowers, three lighted candles of virgin beeswax, and a lighted wick in a glass of wax. There were also two pottery bowls and some cups. The Señora then went through our box of mushrooms, brushing off with her fingers the grosser pieces of dirt and passing them in her hand over copal that was burning on a metal lid on the floor. Into each of the two bowls she put 13 pair of mushrooms; one bowl was for her and the other for her daughter. Into each cup she put four pair, or five, or six, and then handed the cups to the grown-ups that were to take them. The children received none, and we were told that she never gave mushrooms to children. To RGW she handed a cup with six pair. Our readers will imagine his joy at this dramatic culmination to years of pursuit. Then she handed a cup with six pair to poor Allan. Mary, his wife, had reluctantly consented to his coming with us only on his solemn promise not to let the nasty toadstools cross his lips. He faced a behavior dilemma, but to have refused might have disappointed our friendly Indian companions, and so he coped with the immediate problem first and took the cup. (Later, with him safely back in New York, Mary gave him ready absolution.) By now all lights in the room were out except the wick in the glass. Following the Señora's example, we began to chew and swallow our mushrooms.

Our *curandera* ate cap and stem, and we did likewise. She ate them one by one, with utmost gravity, chewing each one for a long time. She did not pick them up by pairs, as Don Aurelio had done in 1953. She picked them up one by one, although in apportioning them she had counted them by pairs. The flavor of the mushrooms is acrid and unpleasant. Don Roberto afterwards likened it to rancid grease, a taste unfamiliar to us. The distinctive flavor would repeat itself, as a gaseous beverage does, and pervade the nasal passages. (At the time these notes are being written, in September 1955, RGW has eaten five species of the divinatory mushrooms used in Middle America, and they are all marked by this singular and unforgettable taste and after-taste, which seem to be the veritable signature of the divine species.)

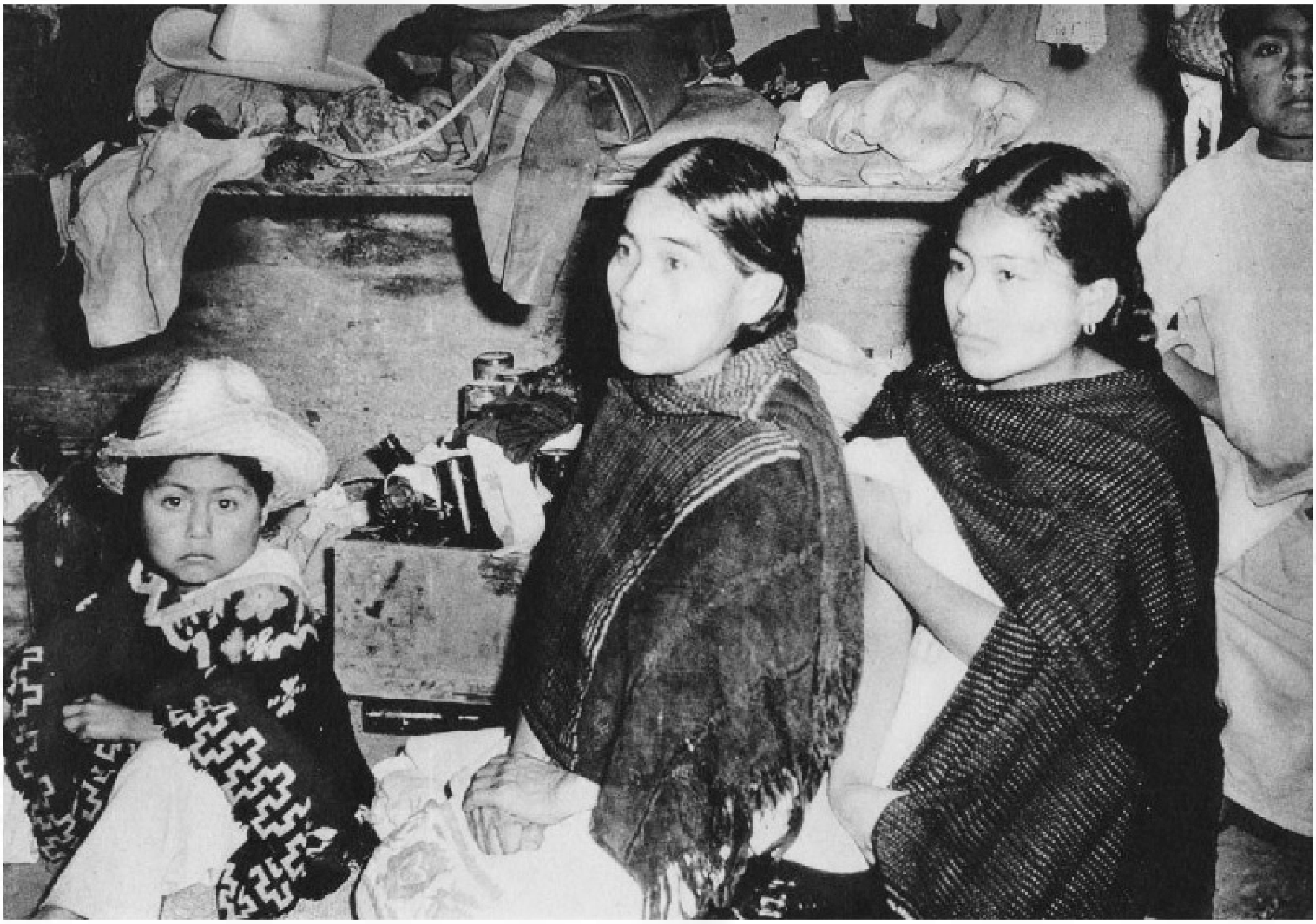


PLATE XLVI

María Sabina and her daughter Polonia, *curanderas*.
Huautla de Jiménez, June 29, 1955.

We all ate our mushrooms facing the wall where the small altar table stood. We ate them in silence, except for Cayetano's father, Don Emilio, who was consulting the mushrooms about his infected left-forearm. He would jerk his head violently with each mushroom that he swallowed, and utter a smacking noise, as though in acknowledgement of their divine potency. The Señora had asked us to take care not to invade the corner of the room on the left of the altar table, for down that corner would descend the Holy Ghost. We sat near-by, taking about a half hour to eat our six pair of mushrooms. By 10.40 o'clock we had all finished our respective portions, the Señora crossing herself with the last swallow. Then we waited in silence. After about twenty minutes the Señora plucked a flower from the bouquet and with it put out the last of the *velas*. We should have been in Stygian darkness, but by good fortune the night was clear and a gibbous moon, by the opening above the door, gave us just enough light to make our darkness visible.

At about 11.20 o'clock Allan leaned from his chair and whispered to RGW that he was having a chill. We wrapped him in a blanket. A little later he leaned over again and said, 'Gordon, I am beginning to see things,' to which RGW gave him the comforting reply that he was too. Allan lay down along the wall on the large *petate* that had been spread for us, and shortly afterwards RGW joined him.

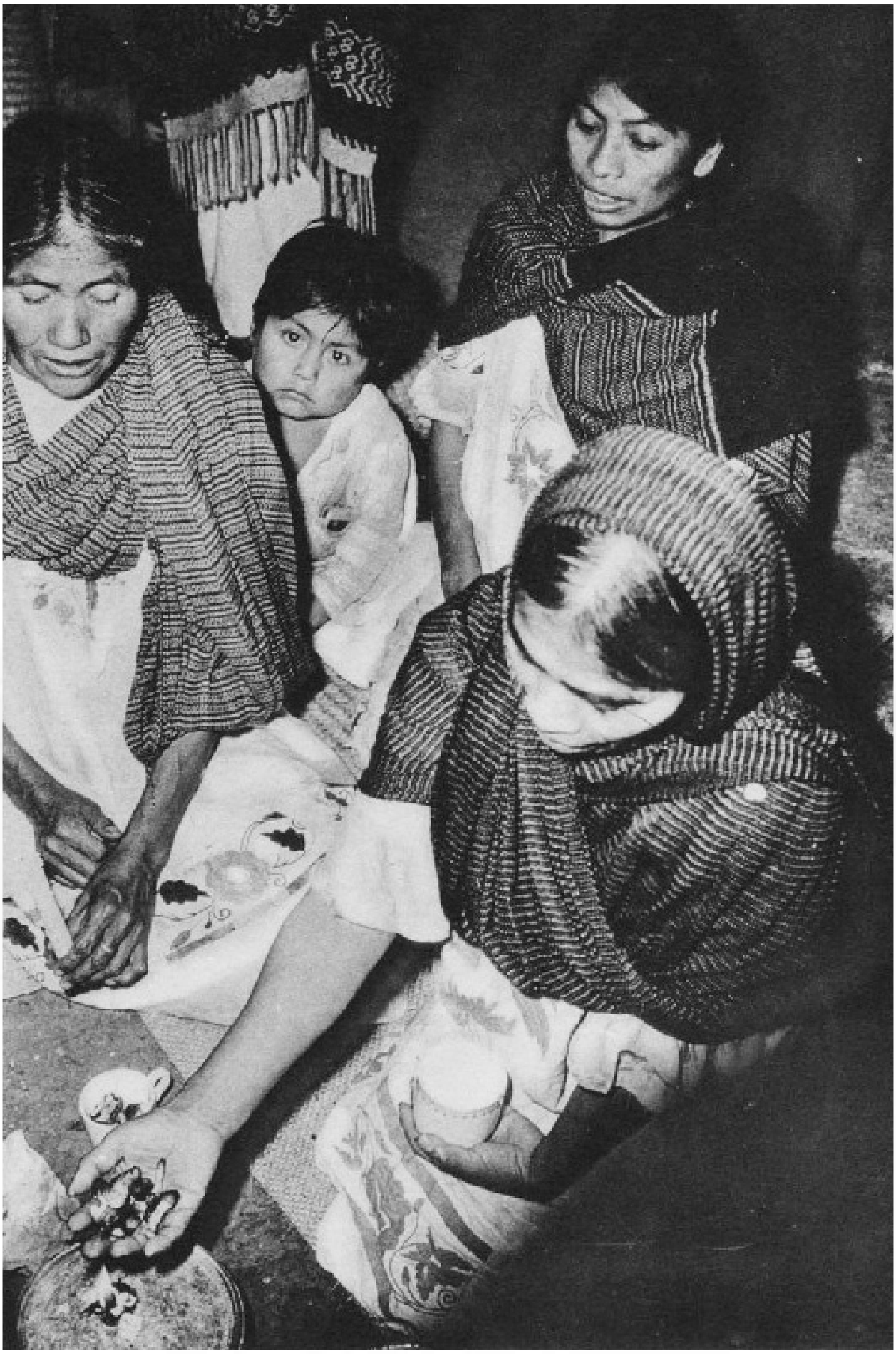


PLATE XLVII
María Sabina, *curandera*, passing mushrooms over incense (copal); also her daughter Polonia and Cayetano's mother.
Huautla de Jiménez, June 29-30, 1955.

Except for the children who had eaten no mushrooms, no one slept that night until about 4 o'clock in the morning. (The last entry in RGW's notebook carries the hour 3.50.) There was no inclination to sleep. At all times we were alert both to our subjective hallucinations and to the goings-on around us in the dark. RGW took imperfect notes intermittently and kept track of the hours. But he and Allan were both alive to the fact that they were not themselves. Though RGW had resolved to fight off any effects of the mushrooms and remain the detached observer, the mushrooms took full and sweeping possession of him. There is no better way to describe the sensation than to say that it was as though his very soul had been scooped out of his body and translated to a point floating in space, leaving behind the husk of clay, his body. 'Landslide', the designation of the Mazatecs for the mushroom we were using, had seemed to him a clumsy name before; now its awesome truth imposed itself. Our bodies lay there while our souls soared. We both felt nauseated; RGW twice made his way to the other room to vomit, and Allan three times. One or two others, not identified in the darkness, did likewise. But these episodes seemed of no moment. For we were both seeing visions, similar but not identical visions, and we were comparing notes in whispered interchanges. At first we saw geometric patterns, angular not circular, in richest colors, such as might adorn textiles or carpets. Then the patterns grew into architectural structures, with colonnades and architraves, patios of regal splendor, the stone-work all in brilliant colors, gold and onyx and ebony, all most harmoniously and ingeniously contrived, in richest magnificence extending beyond the reach of sight, in vistas measureless to man. For some reason these architectural visions seemed oriental, though at every stage RGW pointed out to himself that they could not be identified with any specific oriental country. They were neither Japanese nor Chinese nor Indian nor Moslem. They seemed to belong rather to the imaginary architecture described by the visionaries of the Bible. In the aesthetics of this discovered world attic simplicity had no place: everything was resplendently rich.

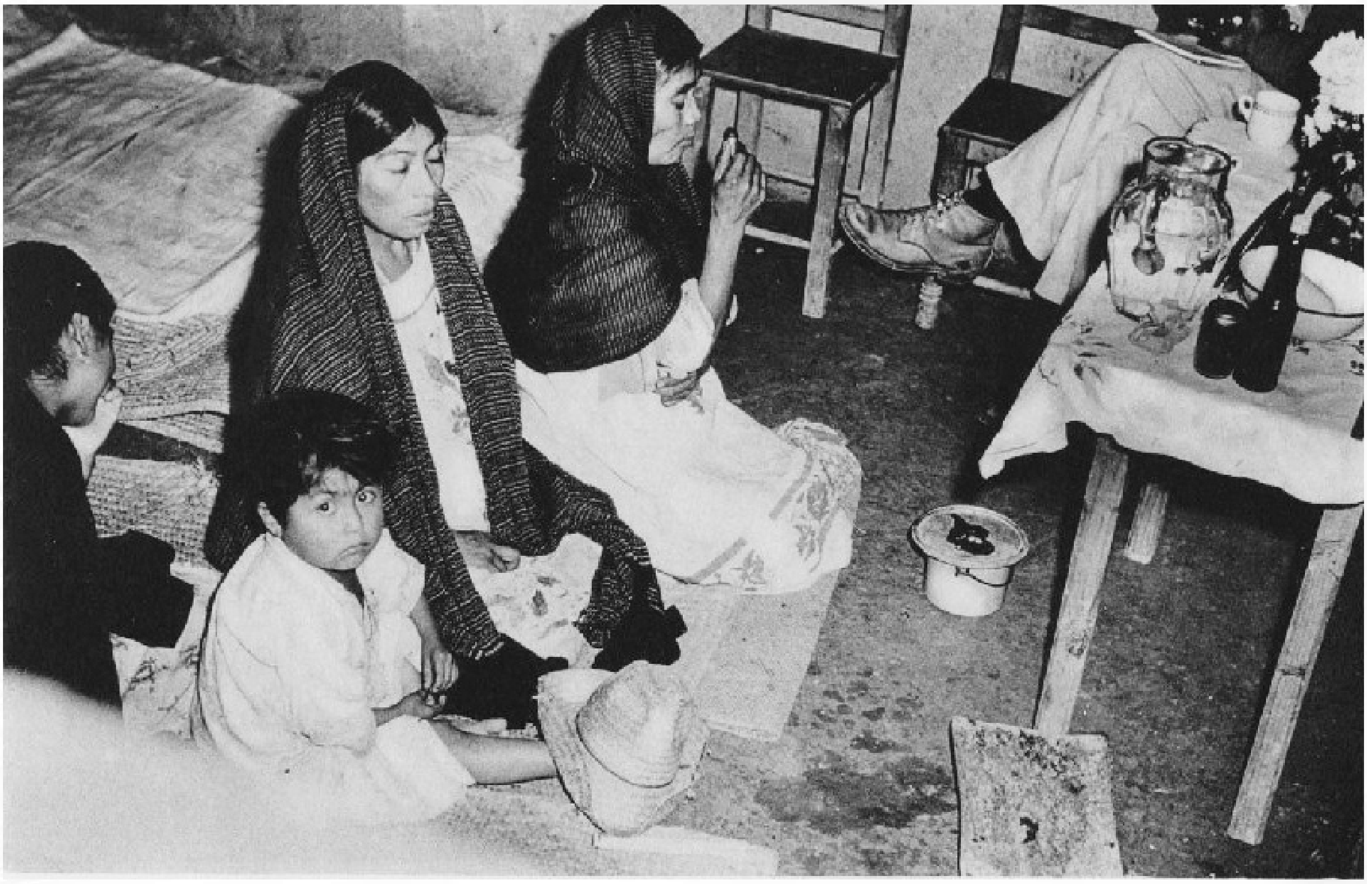


PLATE XLVIII

Adoration of the mushroom. María Sabina, *curandera*, and her daughter Polonia.
Huautla de Jiménez, June 29-30, 1955.

At one point in the faint moonlight the bouquet on the table assumed the dimensions and shape of an imperial conveyance, a triumphal car, drawn by living creatures known only to mythology. With our eyes wide open, the visions came in endless succession, each growing out of the preceding one. We had the sensation that the walls of our humble house had vanished, that our untrammeled souls were floating in the universe, stroked by divine breezes, possessed of a divine mobility that would transport us anywhere on the wings of a thought. Now it was clear why Don Aurelio in 1953 and others too had told us that the mushrooms would take you *ahi donde Dios esta* - there where God is. Only when RGW by an act of conscious effort touched the wall of Cayetano's house, would he be brought back to the confines of the room where we all were, and this touch with reality seemed to be what precipitated nausea in him.

PLATE XLIX
Emilio Garcia taking *Teo-nanacatl* or 'God's Flesh'.
Huautla de Jiménez, June 29, 1955.

On that night of June 29-30 we saw no human beings in our visions. On the night of July 2-3 RGW again took mushrooms in the same room, with the Señora again serving as votary. If we may anticipate our story, on that second occasion RGW's visions were different. There were no geometrical patterns, no edifices of oriental splendor. The patterns were replaced by artistic motifs of the Elizabethan and Jacobean periods in England - armor worn for fashionable display, family escutcheons, the carvings of choir stalls and cathedral chairs. No patina of age hung on them. They were all fresh from God's work-shop, pristine in their finish. The beholder could only sigh after the skill that would have fixed those beauteous shapes on paper or in metal or wood, that they might not be lost in a vision. They too grew one out of the other, the new one emerging from the center of its predecessor. Here as in the first night the visions seemed freighted with significance. They seemed the very archetypes of beautiful form and color. We felt ourselves in the presence of the Ideas that Plato had talked about. In saying this let not the reader think that we are indulging in rhetoric, straining to command his attention by an extravagant figure of speech. For the world our visions were and must remain 'hallucinations'. But for us they were not false or shadowy suggestions of real things, figments of an unhinged imagination. What we were seeing was, we knew, the only reality, of which the counterparts of every day are mere imperfect adumbrations. At the time we ourselves were alive to the novelty of this our discovery, and astonished by it. Whatever their provenience, the blunt and startling fact is that our visions were sensed more clearly, were superior in all their attributes, were more authoritative, for us who were experiencing them, than what passes for mundane reality.

Following the visions that we have already described, on both occasions RGW saw landscapes. On Wednesday they were of a vast desert seen from afar, with lofty mountains beyond, terrace above terrace. Camel caravans were advancing across the mountain slopes. On Saturday the landscapes were of the estuaries of immense rivers brimming over with pellucid water, broad sheets of water overflowing into the reeds that stretched equally far from the shore line. Here the colors were in pastel shades. The light was good but soft as from a horizontal sun. On both nights the landscapes responded to the command of the beholder: when a detail interested him, the landscape approached with the speed of light and the detail was made manifest. There seemed to be no birds and no human life in the river estuary, until a rude cabin suddenly appeared with a woman motionless nearby. She was a woman by her figure and face and costume, and of course the vision was in color. But she was a statue in that she stood there without expression, doing nothing, staring into the distance. She might be compared to those archaic Greek sculptures where the woman gazes into space, or, better yet, the departing woman on the Greek funerary stele who looks into eternity, except that our vision was of a living woman whereas the Greek sculptures, marble white, are mere imitations in stone of what we were seeing.

On both nights RGW stood up for a long time in Cayetano's room, at the foot of the stairway, holding on to the rail, transfixed in ecstasy by the visions that he was seeing in the darkness with his open eyes. For the first time that word 'ecstasy' took on subjective meaning for him. 'Ecstasy' was not someone else's state of mind. It was no longer a trite superlative cheapened by overuse. It signified something different and superior in kind, about which RGW could now testify as a competent witness. There came one moment when it seemed as though the visions themselves were about to be transcended, and dark gates reaching upward beyond sight were about to part, and we were to find ourselves in the presence of the Ultimate. We seemed to be flying at the dark gates as a swallow at a dazzling lighthouse, and the gates were to part and admit us. But they did not open, and with a thud we fell back, gasping. We felt disappointed, but also frightened and half relieved, that we had not entered into the presence of the Ineffable, whence, it seemed to us at the time, we might not have returned, for we had sensed that a willing extinction in the divine radiance had been awaiting us.

We know not what manner of visions is induced by opium or hashish or coca or mescalin, nor whether the agent in our mushrooms that releases the visions is related to the agents in them. Later in the Zapotec country, the *curandero* Aristeo Matias told us that it takes three or four experiences with mushrooms to overcome the initial surprise and the disorder that marks the sequence of visions on the first occasions. (Here was fatherly advice from an old hand to us who had told him that we aspired to enter upon his vocation.) This would suggest that there is or at least can be a growth, an evolution, in the hallucinatory experiences induced by the mushrooms.

Throughout the night we were strangely split in the very core of our being. On one level space was annihilated for us and we were traveling as fast as thought to our visionary worlds. On another level we were lying there on our *petates*, trying to take notes, RGW and Allan exchanging whispered comments, alive to every twitch and twinge in our heavy (oh so heavy!) earth-bound bodies of clay. At the same time we were both held in thrall by what was going on in the room around us. For the Señora and her daughter were engaged all night in a religious performance that we had not expected and that no one had ever described to us.

Before we go further we must mention that when we had bespoken the Señora's services in the afternoon, she had asked us what problem was troubling us. Once again RGW trotted out the question of his son Peter, now in the army. How was he? Alive or dead, or ill, or in good spirits, or in some trouble; This had seemed to her a sufficient justification. We had counted on Cayetano to stay with us through the night as our guide and interpreter. We observed that neither he nor Guadalupe were taking the mushrooms. As we were finishing ours, Cayetano informed us that he and his wife were withdrawing up the stairs and through the trap-door to the room above, where they would guard us against interruptions from the street. He was leaving his brother Emilio to act as our mentor. We sensed that each of the other adults who were taking the mushrooms was consulting them, as we were, about individual problems.

After the Señora had put out the last *vela*, a silence of perhaps twenty minutes followed. The moon was shining brightly outside, and its orbit was such that the shaft of moonlight entering above the door fell squarely on the altar-table, but it did little to relieve the general darkness in the room. Suddenly the Señora began to moan, low at first, then louder. There were silent pauses, and then renewed humming. Then the humming stopped and she began to articulate isolated syllables, each syllable consisting of a consonant followed by a vowel, sharply pronounced. The syllables came snapping out in rapid succession, cutting the darkness like a knife, spoken, not shouted. After a time the syllables coalesced into what we took for words, and the Señora began to chant. The chanting continued intermittently all night, first by the Señora and then by her daughter, and afterwards alternately by one or the other. The chanting was in Mazatec, and there was no one to translate the words for us. Neither Allan nor RGW is instructed musicologically, and we cannot say whether the provenience of the music was European or indigenous. That the chanting was in Mazatec, and not in Latin or Spanish learned by rote, adds point to this question. (If the chants are old, the language may be archaic, which would be a discovery of high interest for the handful of first-rate scholars who have devoted themselves to Mazatec linguistics.) Both women chanted in that distinctive way which seems always to mark the intoning of age-old chants; the singing was soaked in weary melancholy. Our Señora's voice was not loud, probably not loud enough to be heard in the village thoroughfare. But there was a confidence and resonance in her primitive utterance that imposed itself. There came a moment late in the night when the Señora made her way to the door on the terrace and went outside, holding her hand on the door. (To this extent she was free of the prohibition laid on the rest of us not to leave the house.) When she re-entered, she left the door slightly ajar, and we saw her advance *on her knees* across the open space in the room, and then turn to the right toward the altar-table. Her hands were uplifted to shoulder-level, palms exposed. As she slowly progressed, she sang a canticle that seemed like an introit, indescribably tender and plaintive in its musical phrases. Her daughter sang well too, but lacked her authority. From time to time, as they sang, the men who had taken the mushrooms, notably Genaro and young Emilio, ejaculated words, groans, short sentences, and vocal noises. We know not what they said, but they seemed to intervene with their voices to suit the singing, in such a way as to produce a strange, barbaric harmony.

The singing was not continuous. For stretches the Señora would talk, as though invoking the Spirits or as though the Holy Ghost was speaking through the mushrooms. We heard the names of Christ (which she pronounced with an intrusive R, *Khristros*), of St. Peter and St. Paul. We heard her cry out 'Pedro' repeatedly in an imploring tone, and knew that the mushrooms were wrestling with the problem of Peter. Emilio made his way to us and whispered that Peter was alive and well, and contrite for not having let us hear from him. We asked for further details, but Emilio said that since we ourselves had eaten the mushrooms, we could expect them to speak to us directly. Our interpreter Emilio then vanished into the darkness for the rest of the night.

Unlike the chants, the spoken utterances were fresh and vibrant and rich in expressiveness. The mushrooms were talking to the point. We had never suspected how sensitive and poetic an instrument the Mazatec language could be. The intermittent snatches of the Señora's monologue seemed quick with subtle feeling, laden with dramatic import. In our very presence a priestess of the old religion was pronouncing oracular dictates in spurts, hot and firm with authority. How we regretted that we had no means to record her voice! (At the time we asked ourselves, and we have repeated the question often since then, whether our critical faculties were deranged by the effects of the mushrooms, so that we over-rated the quality of the Señora's performance. Perhaps so. But if this is an aberration typical of the syndrome of mushroomic ecstasy, our account at least serves to document it for the record, and to establish that our hallucinations were auditory as well as visual.)

The chanting and the oracular utterances turned out to be only a part of what we were to witness. At an early stage we sensed that the Señora was either kneeling or standing before the altar-table gesticulating with her arms. We detected this by ear and confirmed it uncertainly with the aid of the meager moonlight. Then, much later in the night when her daughter took over the chanting, the Señora made her way to the open space between us and the door, and she embarked on a kind of dance that must have lasted for two hours or more. We do not know precisely what she did, because of the darkness, but she was between us and the aperture above the door, and we could just make out that she was turning clock-wise, facing in succession each of the four compass points, at the same time raising and lowering her arms. Her daughter was singing, but she was not silent. She was engaged in a lengthy, rhythmic percussive utterance of a kind unfamiliar to us. There was a differentiation in the pitch of the beats, and at times the pattern or phrases seemed to us complex. We cannot say for sure how she made her sounds, but we are almost sure that she clapped her hands, slapped her knees, smacked her forehead, and whammed her chest. We were impressed by the cleanness of the utterance. Every clap or slap or smack or wham was resonant. Remembering the role played by pitch in the Mazatec language, we asked ourselves whether the Señora was speaking percussively. On each of our two nights with her, she rinsed her mouth once with water, and the gargling was also rhythmic, and perhaps tonally differentiated. Then she would spit out the water on the ground unrhythmically. On Saturday night, in a moment of illumination by flashlight, we saw and heard her twicking her long finger nails rhythmically. A remarkable feature of her percussive utterance on Wednesday night was its ventriloquistic property. For a long stretch we were in the blackest darkness while the daughter sang and the Señora was performing her strange dance with percussive accompaniment. As she would snap out her resonant claps and smacks, we seemed to catch them out of the night from various directions. Let the reader remember that all the while we were seeing our visions *and* attending to the auditory sensations served to us by the two women. There we were, visually suspended in space before the vast panorama of, say, the Gobi Desert, with a singing accompaniment and with percussive cracks assailing us, now from above, now here, now there, exactly like Hamlet's ghost *hic et ubique*, hitting us with a cutting crispness from unpredictable quarters, as though an air-borne choir of invisible creatures was peopling the dark void around us, perplexing us with their assorted and shifting cries. Possibly this ventriloquistic effect was caused by the Señora's turning in different directions as she performed, so that the sound caromed to us from the ceiling or walls. And all the while there was the irregular chorus, subdued in volume, of ecstatic exclamations from the Indians reclining on the ground. Confined though we were in a room without windows or open door, at one point we felt a swish of air, just as though we were really suspended in the great outdoors. Was this too an hallucination? If so, all shared it, for when the wind blew on us, there was general excitement, flashlights were switched on, and our Indian friends were sitting up, amazed at being stroked by the Divine Afflatus.

At one point in the night RGW made a discovery. In the light of a cigarette that someone was inhaling, he saw the Señora, who was performing her dance, lift a small bottle to her lips. From her posture the bottle seemed almost empty. A few minutes later she began to thump the butt end of the bottle on the *petate*. She did this with a fast, uniform, perfect beat, perhaps a hundred to the minute, and she kept at it for an eternity, minutes on end, until Allan and RGW could hardly stand it any longer and groaned in agony. The iterated thump, somewhat resonant, became excruciatingly painful, a torture such as Poe might have described. After the night had passed and we were all getting up, RGW made a point to find the bottle and smell it. There could be no doubt: it was the familiar six-ounce bottle of *aguardiente*, a distillate of cane. Presumably the Señora had shared it with her daughter, but of this we are not sure. We asked Cayetano about it. Yes, invariably the person who retains the Señora is expected to present her in advance with a *cuarto* (fourth of a litre) of this strong drink. We in our ignorance had neglected our duty, but Cayetano had come to our rescue. Recalling as we did how Don Aurelio and our friends in the Mije country had all said that alcohol was tabu before, during, and after the consumption of the mushrooms, we are still at a loss how to reconcile the conflicting evidence. But of course the Señora's performance from first to last had differed from what Don Aurelio had shown us in 1953. We had now attended two all-night vigils, both using the sacred mushrooms, but otherwise utterly different from each other. Don Aurelio's divinatory liturgy, with the elaborate role in it of accessories, could conceivably go on without mushrooms, but in Cayetano's house the mushrooms were the key to everything. We spoke to Cayetano about that other performance that we had seen in the Mazatec country in 1953. He knew all about that kind too, and he told us that the Señora was equally proficient in both ceremonies. We failed to learn, however, when one method is used in preference to the other.

At intervals throughout the night, perhaps every forty minutes or so, there would be what we can only describe as intermissions. After working up to a powerful climax in utterance, the Señora and her daughter would subside into silence. We recall one such climax when the Señora, half-singing, half declaiming, spat forth in endless repetition and with barbaric violence the two syllables *chung-ha* (the first element riming, not with 'sung', but with the Chinese 'Sung'); we were never able to learn what this meant. After such climaxes our two votaries and our reclining Indian friends would light cigarettes (ordinary ones) and smoke and engage in the most animated conversation. Clearly they were discussing what was happening, but we had no interpreter. They would light the electric torches. We took advantage of these moments to study the Señora. She was not in a trance. That is to say, she was one of us, talking and smoking. But she was in a state of excitement, her eyes flashing, her smile no longer that grave smile which we had observed before, but now quick with animation and, if we may use the word, *caritas*. For there is another aspect to the mushrooms that we must mention. The spirit of an agape of which we have already spoken was a prelude to a wave of generous or tender feelings that the mushrooms aroused in everyone. To illustrate this, we recall how, when nausea first sent one of us into the adjoining room to vomit, the Señora, who had been in full song, immediately stopped the performance, and she and the others manifested the most embarrassing solicitude about the unhappy episode, which after all was wholly unimportant. On the two nights that we passed in Cayetano's house, we were aware of no erotic stimulation among those present and we think there was none. But the feeling of brotherly affection was strong indeed. Twice in the course of that first night the Señora reached out her right hand to RGW and sought contact with his fingers in friendly greeting, across the chasm of the language barrier. The Indians of Middle America are known for their reticence in the display of affection, even within the family circle. It was now clear that the mushrooms emancipate them from inhibitions of this kind, and what we witnessed on Wednesday night was abundantly confirmed during our second session on Saturday, July 2.

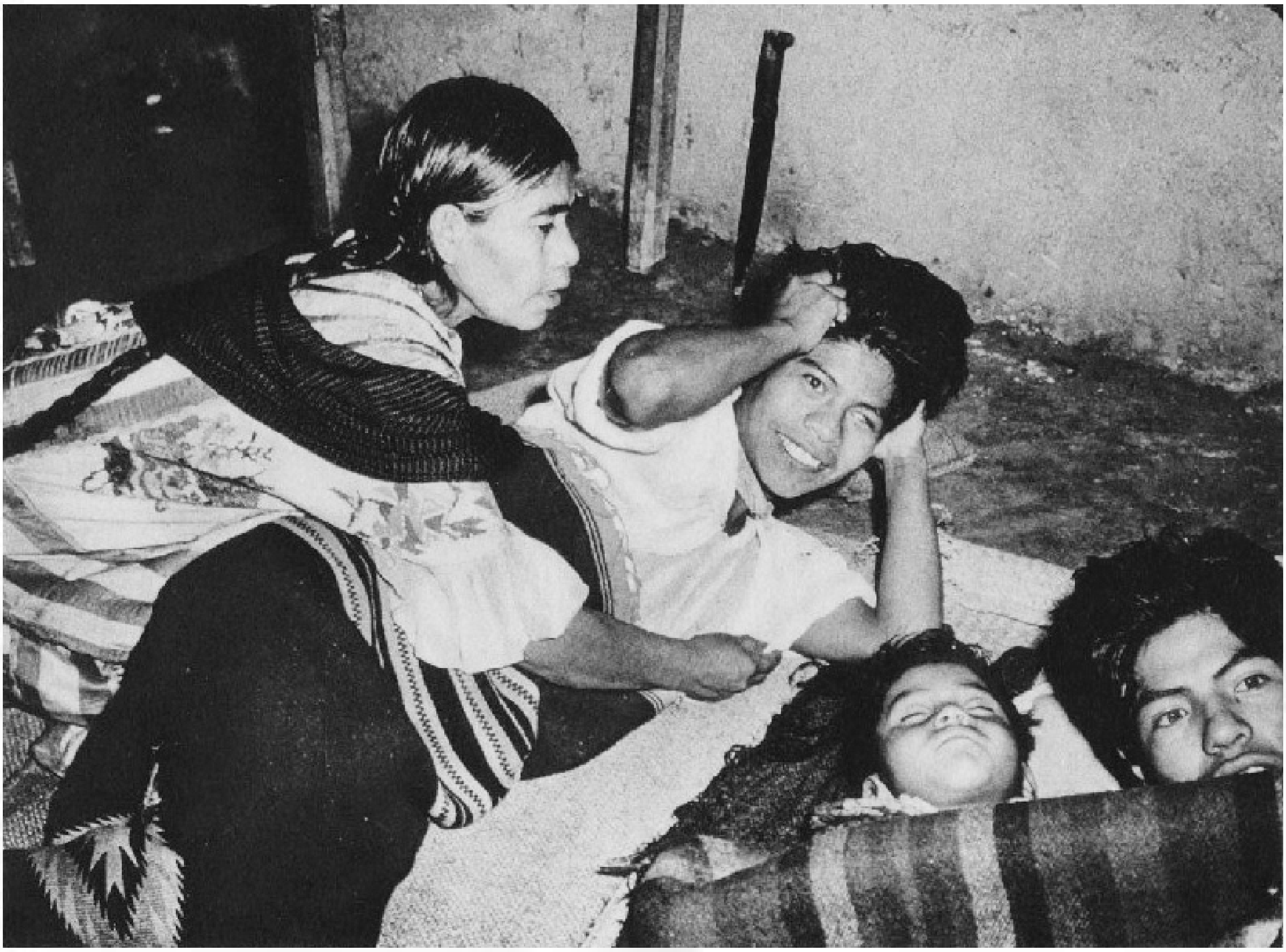


PLATE L

María Sabina, *curandera*, and her son Aurelio under the influence of mushrooms.
Huautla de Jiménez, June 29, 1955.

After the first performance Allan and RGW, quite stunned and even numbed by what we had witnessed, were disposed to say, 'Never again'. But by Saturday morning there were many questions that we needed to clarify, and so through Cayetano we asked the Señora if she would give us a repetition. This she agreed to do. We pled with her to let us take a few photographs by flashlight while the power was on her. She said yes, and in the course of that night from Saturday to Sunday Allan took perhaps twenty pictures in the darkness, guessing of necessity as to the distance and direction. (It was raining in torrents all that night, and so there was no moon.) But the Señora's behavior differed much from what we had seen the first time. Everything was reduced in scale. There was no dancing and virtually no percussive utterance. Only three or four other Indians were with us, and the Señora brought with her, not her daughter, but her son Aurelio, a youth in his late teens who seemed to us in some way ill or defective. He and not we were the object of her attention. All night long her singing and her words were directed to this boy. Her performance was the dramatic expression of a mother's love for her child, a lyric to mother-love, and interpreted in this way it was profoundly moving. The tenderness in her voice as she sang and spoke, and in her gestures as she leaned over Aurelio to caress him, moved us profoundly. As strangers we should have been embarrassed, had we not seen in this *curandera* possessed of the mushrooms a symbol of eternal motherhood, rather than the anguished cry of an individual parent. But by any interpretation this untrammeled and beautiful outpouring, touched off in all likelihood by the sacred mushrooms, was behavior of a kind that few Middle American anthropologists would ever expect to see.

On this second occasion Allan took no mushrooms, for the sake of his photography. The Señora asked RGW how many pair he would take, which he interpreted as a compliment to his status as one already initiated, and he said five. The effect seemed as strong as he had experienced from the larger dose on Wednesday, but this time there was no nausea.

Both of our nights with the Señora drew to a close in the same way. On the night of Wednesday-Thursday, our last notes seem to have been scribbled a few minutes before 4 a.m., and soon afterwards we slipped off imperceptibly into a dreamless slumber. Apparently everyone else did likewise. At any rate, at about 6 o'clock we woke up, our heads clear. Some of the others were already stirring, and in a few minutes everyone was on his feet. RGW changed the roll in his camera and resumed picture-taking, as did Allan. Cayetano and Guadalupe asked after our welfare but were discreet in their inquiries about the night's doings. They served us coffee and bread. By 7 o'clock we were ready to sally forth into the world. We felt no untoward sleepiness that day.

Perhaps in some respects we can define better than we have done the psychic disturbance caused by the sacred mushrooms. On the one hand, they unhinge one's sense of time. Visions that seem to last an aeon run their course in a minute or so. Only by reference to a time-piece does one keep track of the passing hours. On the other hand, the faculty of memory is heightened by the mushrooms. All the impressions, visual and auditory, are graved as with a burin in the tablet of the memory. Our narrative of what took place has been checked with the notes that we jotted down at the time, but our memory is far richer and fuller than those notes.

What can we say about the source of our visions; Did they bubble up out of our own past; We have no conscious memory of having viewed previously the scenes that we saw. There was nothing in them that repeated themes familiar to us in our adult experience, no modern highways, cars, cities. Yet all that we saw could be related to themes latent in our imagination, not necessarily things seen, nor even things seen in graphic representation, but those things transmuted afterwards in the imagination, imagined from reading, seen in the mind's eye. All of the visions had that pristine quality which we associate most often with the magic of supreme literary expression, especially great poetry. In the lives of us all, even those who are most earth-bound, there are moments when things, even the most humdrum, suddenly and unaccountably clothe themselves with beauty, haunting and ravishing beauty. It now seems to us that all such flashes must emerge from the subconscious well where our visions have all this time been stored, for the mushroomic visions are an endless sequence of those flashes. There are those like Keats who have possessed the power to see such visions in abundance without the mushroomic stimulus. Could the mushrooms have done better by Keats than he did without them; What would they have shown him that he did not see; What precisely do our Indian friends see, with their different background; Clearly the visions come from within the beholder, either from his own unconscious or, as some will surely think, from an inherited fund of memories of the race. What an amazing thing that we should all be carrying this inventory of wonders around with us, ready to be tripped into our conscious world by mushrooms! Are the Indians far wrong in calling these divine; We suspect that, in its fullest sense, the creative faculty, whether in the humanities or science or industry, that most precious of man's distinctive possessions and the one most clearly partaking of the divine, is linked in some way with the area of the mind that the mushrooms unlock.

We believe that the mushrooms are not habit forming. If we are right, they differ in this respect, not only from alcohol, but from the drugs such as opium and marihuana that are reputed to stimulate beatific visions. In the course of our three expeditions to Mexico, covering four cultural areas, we never heard of a mushroom addict. We believe that use of the mushrooms does not affect the threshold of tolerance for them; that is to say, one does not raise the dose on successive occasions to obtain the same effect, either for the short run as when we used them twice in four days, or over the long term. Our Señora and her daughter took more than twice the dose of the others, but this quota goes with their vocation. Everyone's dose seems to remain constant throughout life, though the dose varies somewhat from person to person. We have seen no evidence that the mushrooms can cause harmful psychic effects but our experience is too limited for us to generalise about this. Are persons with neurotic or psychotic inclinations endangered by the mushrooms? After a life-time of use do mushroom-eating *curanderos* show mental deterioration; May there be individuals whose mushroomic visions are horrifying and who are stimulated to violence by them; We do not know. In considering the clinical effects of the mushrooms, let us not overlook the extraordinary performance of the Señora and her daughter. They had each eaten more than twice as many pair of mushrooms as the rest of us, and they not only kept hold of themselves: they staged a liturgy that called for disciplined virtuosity of a high order.

On Friday, July 1, VPW and Masha joined us in our village. We had all planned to leave immediately after the Saturday night experience, but the rains came and we found ourselves marooned among our Mazatec friends for most of the following week. On Tuesday the 5th VPW and Masha, having nothing else to do, took the mushrooms in the afternoon, VPW five pair and Masha four, and then they lay down in their sleeping bags. This was the first occasion on which white people ate the mushrooms for purely experimental purposes, without the aura of a native ceremony. They too saw their visions, for hours on end, all pleasant, mostly of a nostalgic kind. They felt little or no nausea. Their pupils dilated and failed to respond to our flashlights. The pulse showed a tendency to slow down. There were no auditory hallucinations. But six weeks later, when RGW in New York took the mushrooms for the third time on August 12, his visions were accompanied by an insistent beat with variation of pitch, perhaps an evocation of the Señora's percussive performance. The beat was not unpleasant. It seemed freighted with meaning, as though it was the rhythmic pulse of the universe. When the Señora had performed for us, we had passed most of the night in virtual darkness - an environment adapted to dilated eyes. Our experience in New York took place in a room illuminated by lights from the street, and moreover on that night of the 12th a hurricane known at the time as Connie was brushing by the city. We found that the mushrooms had retained their full potency in a dried state, if indeed their power had not increased. We made another discovery. As we stood at the window and watched the gale tossing the trees and the water of the East River, with the rain driven in squalls before the wind, the whole scene was further quickened to life by the abnormal intensity of the colors that we saw. We had always thought that El Greco's apocalyptic skies over Toledo were a figment of the poet's imagination. But on this night we saw El Greco's skies, nothing dimmed, whirling over New York.

Now we come to the end of our Mazatec experience. We had agreed from the beginning to pay the Señora her usual fee for her services. We paid her fifty pesos for each night, which was somewhat more than she expected. In dollars this meant $ 4.00 a night, but in her world the fee meant much more, perhaps subjectively as much as $ 50.00 in New York. Before we left the village we asked Cayetano what we could pay him for his contribution to the success of our visit. He turned to his wife and let her speak. '*No hicimos esto par dinero*', she said, which is to say, 'We did not do this for money', and they would accept none. We were especially grateful to the Señora for having allowed us to take photographs while the power of the mushrooms was on her, during that second night. It had not been easy for her to consent to the rude interruption of the flashlight, and we ourselves knew also that the pictures would be misleading, as they would convey no idea of the darkness that Allan and RGW will always associate with the mushroomic agape. We noticed at the time that the flashlights upset the pace of her performance, interrupted the spontaneity of her singing. On the morning after, a messenger came to us from her. We were welcome to the pictures, she said, but would we please refrain from showing those particular ones to any except our most trusted friends, for if we showed them to all and sundry, *sena una traidon*, it would be a betrayal. We are doing as the Señora asked us, showing these photographs only in those circles where we feel sure she would be pleased to have them shown. In order that she be not disturbed by the importunities of commercially-minded strangers, we have withheld the name of the village where she lives, and we have changed the names of the characters in our narrative. On our next visit we shall ask for permission to publish our pictures for general circulation.

On Friday evening, July 8, we all arrived back in our home in San Angel, and after a good night's sleep we were ready on the following day to pursue our quest for the divine mushrooms in new directions. RGW had received a letter in May from Mrs. Carmen Cook de Leonard of Mexico City, the well known student of indigenous cultures, with surprising information. It seemed that she and her colleague, Miss Bodil Christensen, had discovered that the use of the divine mushrooms still survived in a village not far from the capital city. They would be glad to place their information at our disposal, and to try to arrange for a *curandera* to consult the mushrooms on our behalf. After our arrival in Mexico and while we were in the Mazatec country, Mrs. Cook de Leonard and Miss Christensen talked with their *curandera* and she agreed to serve us on the evening of Saturday, July 9.

On that Saturday afternoon we drove out to the town of Amecameca some forty miles away, and thence by a dirt road three miles to the bleak forbidding Indian village of San Pedro Nexapa. (The -*x*- in this name has the sound of a Spanish -/'-.) We were now on the slopes of the volcano Popocatepetl, at about 8,000 feet altitude, above the Valley of Mexico. This was Aztec country, where even now the old people still can speak classic Nahuatl. We sought out the humble house where the *curandera* Marina Rosas lives, a flimsy wooden structure that freely admitted the cold, dank breezes. We found the aged lady seated on a *petate* and wrapped tight in her shawl near the wood fire on the floor. Though she must have known Nahuatl, Spanish was clearly her language of preference. She informed us that she was ill and therefore could not help us. She was sorry, but what could she do? She was ready to appoint another day, and we settled on Saturday, July 30. If we may anticipate the later events, we returned three weeks later, on that appointed day, only to discover that Marina Rosas, seated on the same *petate* in the same place, was again unable to help us, not because of illness this time but because, doubtful whether we were really going to arrive, she had broken her fast and eaten a midday meal. *Para que contesten ellos, ha de ser limpio el estomago* - for the mushrooms to reply, the stomach must be clean. The old lady was lovable in her excuses and protestations, but RGW felt that she really did not wish to eat the mushrooms for us.

But our visits to San Pedro Nexapa were not fruitless. We learned from Marina that only one kind of divinatory mushroom is known in the village and we obtained a small packet of dried specimens. As in the Mije and Mazatec regions, one considers that the mushrooms speak, not the person who eats them. The mushrooms are gathered in September, around the time of the Cholula fair, above the village on the slopes of the volcano, perhaps as high as 10,000 feet. In the Mije and Mazatec regions we had learned that in the hot low country the mushrooms are not used. Now we discovered that the higher limits are high indeed. They are eaten only in a dried condition and they keep for a year, until the next ones are gathered. According to Marina, the whole mushroom is eaten, pileus and stipe. Marina never used the word *curandero*. He who knows how to use the mushrooms is a *trabajador del cielo*, a heavenly worker. Sometimes the *trabajador* gives them to the sick person to eat, but the mushrooms will not speak through the sick person because he is not chosen. We discovered from Marina that she customarily takes six pair, but with the six pair she also takes twelve seeds possessed of parallel psychic powers. These seeds are called in Nahuatl 'bird's-eyes' and in the Spanish of Mexico *colorines*. To botanists they are the seeds of the *Rhynchosia pyramidalis* (Lam.) Urban, also known as the *Rhynchosia phaseoloides* (Sw.) DC. They are bright red with a large black spot, the size of a bird's eyes. The black spot does not cover the hilum or eye of the seed, and this is precisely what distinguishes the seeds used by Marina from the poisonous seeds of the *Abrus precatorium* L., which superficially look alike but whose hilum is black. Marina spoke of the divinatory mushrooms as *los niños*, 'the children'. The significance of this name becomes apparent only when we learn that the Nahuatl term in Marina's village is *apipiltzin*, wherein -*tzin* is the diminutive suffix, -*pipil*- means 'children', and *a*- stand for *atl*, 'water'. In this village high in the mountains where classical Nahuatl is spoken, our mushrooms are the 'little children of the waters'. There will be occasion elsewhere to revert to this name. Marina told us that the mushrooms 'speak' only in Nahuatl. If she is right, the divinatory mushrooms would seem to be linked irrevocably with the fate of the old language, and doomed to disappear when the old generation fades out.

For some years Robert Weitlaner had been hearing rumors, which he conveyed to us, that the mushrooms were still being used in the Valley of Toluca about two hours by car from Mexico City, where the altitude is also around 8,000 feet. During our stay in Mexico Donald Leonard, the husband of Carmen Cook, made two trips thither for us, accompanied on one occasion by Don Roberto. They went first to Tenango del Valle, the very town mentioned by Jacinto de la Serna in his account of mushroomic idolatries in the 17th century. In the market place of that town they learned from an old woman that two kinds of divinatory mushrooms are still being used thereabouts, the larger known as *mujeradas* and the smaller as *hombreados*, the little women and little men. Collectively they are called *niños* or *nanácatl*. These mushrooms are not exposed in the market place but are obtainable there. The supply comes from a village called San Pedro Tlanixco, only a few miles away, where it seems that the people make a specialty of gathering and preparing these 'children of the waters'. Mr. Leonard brought back specimens of both kinds.

Thus thanks to the diligence of the Leonards and Miss Christensen we have discovered the mushroom cult surviving to this day in the very land of the Nahua. Whereas forty years ago W. E. Safford was denying that any such cult had ever existed, we now find it on the door-step of the capital city of Mexico. In the Valley of Toluca the Aztecs overran and superseded the earlier Matlatzinca population, of whom there still exists one village speaking the old tongue, and the region where the people speak Mazahua is hard by. We know from our early quotations that both these peoples knew the mushroom. Where is the anthropologist who will do the study that cries for doing in the Valley of Toluca and thereabouts? He might well start in San Pedro Tlanixco. Here apparently he would confront a most curious problem in economics, a village that specializes in supplying consumers with a sacred product that never enters the ordinary channels of trade. The student should try to discover the circumstances surrounding the mushroom harvest, attend the drying of them, learn where and how they are stored, and as best he can trace them to the ultimate consumers, recording for us all the associations, religious, social, folkloric, and linguistic, that accompany them on their way. Here is a study in little things pregnant with cultural meaning. Who knows? Perhaps he would discover that some of the product reaches Mexico City itself, and that heavenly workers in its very precincts are still consulting the little children of the waters.

In 1949 Dr. Pedro Carrasco, the gifted Mexican anthropologist, visited a number of villages in the coastal sierra of southern Oaxaca, a region almost unknown to travelers. He gave his account of this trip in the paper that he contributed to the Festschrift honoring Dr. Alfonso Caso, which appeared in 1951, and in it he dropped the remark that the villagers were still using the sacred mushrooms, as well as other hallucinogens. One of the goals of our 1955 trip was to repeat Dr. Carrasco's visit and amplify his observation. For our guide we engaged once again our friend from the Mije trip, Francisco Ortega, known as Chico, who at our behest made a quick trip to the area early in June to learn whether it was at all accessible in the rainy season. He reported that the trip was feasible, but that the villagers were suspicious of strangers and inhospitable, and that we should not think of going unless we carried letters of commendation to the local authorities from the Governor of the State and the Commanding General of the Military Zone.

Equipped with these credentials, we set out from the city of Oaxaca on Friday morning, July 15. Our party, in addition to Chico, consisted of our old friend and mentor Robert J. Weitlaner, Professor Howard E. Brunson of the East Los Angeles Junior College, and RGW. In the afternoon of the following day we reached the town of San Agustin Loxicha,[175] a cluster of houses on a mountain ridge, some 1,700 meters high, that looks south across rugged and verdant terrain to the Pacific Ocean some ten or fifteen miles away. The town is almost due south from Oaxaca and about 100 miles by road and trail. In the rainy season the mornings are usually bright and clear, so clear that the breaking surf can be descried in the distance. But soon the clouds roll in from the sea and the rain is likely to come down in torrents for hours on end. The town is idyllic in its loveliness, almost all of its houses of adobe with roofs either of thatch or homemade shingles beautifully weathered, everything washed clean by the rain, the air pellucid in the morning sun, the whole sparkling community perched as it were in an upper balcony of a vast amphitheater of mountains overlooking the distant Pacific sea. We arrived at the moment when the *floripundio* was in bloom, a tree arrayed in trumpet-like blooms, dazzling white, that greets the eyes at every turn. This is the angels' trumpet of Florida, the *Datura suaveolens* of botanists.

The people of this area are Zapotecs, speaking one of the several Zapotec languages. But these languages differ much from each other, and Chico, versed in the tongues of the Isthmus and the Valley, could not cope with the speech of San Agustin. There was an element in the village who were hostile to us from the beginning, just as Chico had warned us to expect, and we were glad for the measure of protection that our letters gave us. The hostility grew as the days passed, but the concern that we felt at times for our safety is, in retrospect, merely an incidental phase of travel such as this, and we shall not dwell on the details beyond saying that we were all relieved when we had left the town behind us on Saturday morning, July 23, after we had stayed there one week. All the experience and tact of Don Roberto and Chico had been needed to keep the hostility in bounds.

In June Chico had made contact with a leading villager of San Agustin, Ismael Jimenez Reyes, a store-keeper and coffee grower, who had promised Chico the cooperation of a *compadre* of his, a *curandero* of the first rank, Aristeo Matias by name. We called on Ismael at once. In fluent Spanish he told us that he himself never has recourse to the mushrooms, but he knew much about them by hearsay and he told us all he knew. What he said echoed many things that we had heard in the Mije and Mazatec country, in Miss Pike's letter, and in the

---

175. This is one of nine towns or settlements in the region to the names of which 'Loxicha' is added, the others being Santa Catarina, San Bartolo, Magdalena, San Francisco, Buena Vista, Candelaria, Santa Marta, and San Baltasar. Scholars seem not to have arrived at the meaning of 'Loxicha', in which the 'x' has the phonetic value of V.

old books. Like our Mije friends, he said that if a dog barks or if a cock crows nearby, nothing can be expected from a mushroom vigil thus interrupted. Reminding us of the 16th century botanist Francisco Hernandez, he said that one kind of mushroom makes the eater give himself over to sheer laughter, *pura risa*. (Later Don Aristeo corrected this. There is no such species, he explained, but any of the divinatory mushrooms can provoke this effect when taken by weaklings or cowards.) Ismael told us a story that reminded us of an episode in Miss Pike's letter. On his farm Ismael had once had a hired hand, a *mozo*, who fell ill. "'They will never cure me with medicine,' the *mozo* said: 'I am going to take me a mushroom.' And so he did. Then he said, 'Give up hope. I am going to die.' Still possessed by the mushroom, he added, 'I no longer live'. 'They have already come, and taken hold of me, and are carrying me away.' Shortly afterwards he really died. Yes, with the mushrooms he saw how his soul was already being torn from his body. His soul was already in the other world."[176] This episode, told to us with moving simplicity by Ismael, serves to illustrate a fact about the use of divinatory mushrooms in Middle America that all our evidence supports. The mushrooms play a major role in the folk medicine of the various archaic cultures where they are used, but in native thinking never as therapeutic agents. The Indians use them for diagnosis and prognosis. The mushrooms are expected to reveal the cause, nature, and course of the illness, and if the outlook is not hopeless, to declare what must be done for the patient to recover. Under the spell of the mushrooms, the *mozo* in the story saw himself die, and he accepted the death verdict. (Of course by modern medical criteria the mushrooms produce a powerful psycho-catharsis with somatic consequences.)

Aristeo Matias the *curandero* was working his acres when we arrived in San Agustin. Ismael sent his son-in-law Pedro Garcia to fetch him, first to a *rancho* three hours below, and then, not finding him there, to another *rancho* high in the mountains in a different direction and also far away. At last he found Don Aristeo and they arrived back in San Agustin on Sunday evening, joining us where we were all huddled together in Ismael's little store. Don Aristeo presented an extraordinary appearance, a little man, clearly weighing less than a hundred pounds, in his fifties, with an expressive little face and almost no teeth. He had no Spanish whatever, and during the long hours that we were to pass with him during the following week, we had as our interpreters Ismael, Pedro, and his own son Serafin. Don Aristeo was an informant of value in the sense that he was a product of his world little touched by outside influences, but his responses were slow, it was difficult for him to grasp the import of our questions, and patience was often needed to arrive at his meaning.

We told Don Aristeo that we had come from far away to learn the secrets of the sacred mushrooms with the idea that we might take up his vocation, and we asked him also for news about the fate of RGW's son Peter. All this seemed reasonable to him, but the Zapotecs are a race notorious for their hypertrophied pocket nerve, and the next day, before we got down to work, Don Aristeo sent us word by Ismael that he would help us for 1,000 pesos. There were further interchanges through our intermediaries Ismael and Chico, and we finally settled on 500 pesos, or about $40 U.S. How different from the nobility of Cayetano and Guadalupe in the Mazatec country! But when we had once agreed on the price, Don Aristeo kept his bargain, and some days later, on the eve of our departure, we kept ours, paying him off, and our interpreters too, with solemn formality, by the light of a candle, in Ismael's store.

The *curandero* in San Agustin is called *menjak*,[177] 'he who knows', exactly the same figure of speech that we had found in the Mazatec country. The designation *menjak* retains its literal sense, so that instead of *menjak*, in the appropriate context one uses *sanjak*, 'that man knows'. In speaking Spanish Ismael rendered the Zapotec words by *sabio*, the wiseman, rather than by *curandero*. Don Aristeo told us that his father had given him the mushrooms for the first time at the age of 12. His father had been a *menjak*, and his father's father before him. But his son Serafin showed little promise; alcohol was his undoing. Women are just as good as men in this vocation, perhaps better, he said, for they are not given to alcohol; and he cited one Ebrigida Santiago, in the village, to illustrate his point. The woman who pursues this calling is a *ngol'njak*. Don Aristeo said that the beginner must take the mushrooms several times before he can cope with them as a *menjak*. 'On taking the

---

176. In Ismael's words: Tuve una vez un mozo en la rancheria, y se enfermo. 'No me curan con la medicina,' me dijo. 'Me voy a tomar un hongo.' Tomo. Entonces me dijo, 'Pierda la esperanza. Yo me voy a morir.' Y murio. Antes de morir dijo, 'Yo ya no vivo,' y despues, 'Ya vinieron y me agarraron y me llevaron.' Le habian ya sacado el alma. El alma ya estaba en el otro mundo.

177. In Zapotec there are three tones: high indicated by ', low by ', middle by no accent. In our spelling, 'j' is as in 'judge'. A synonym for *menjak* is *ngwe'dz*, the apostrophe here as elsewhere representing a glottal stop.

mushroom for the first time, the mushroom introduces himself to the novice, *Así me llamo yo* ['thus am I called'; note the parallel with Exodus 3:14]. Then terrible things happen, but one must not be afraid. You rush to the sea, you plunge in, you go up to heaven, there where Jesus Christ is, and then to hell where the criminals are. You see the whole world lying in the middle of the sea. On the second try you are thrown into the sea, but be not afraid. Then you see two women and two men who are gathering up the blood where Christ was born [sic]. On the third try everything changes, and now you are strong and the voices begin to come. Then on the fourth try you arrive there where the Virgin Mary is, and the Lord Jesus Christ, and then they explain good things. Then all the Spirits come, all the Virgins, all the Saints. Then you know, and you are *menjak*. From that moment the mushroom teaches you all things.'

Don Aristeo told us that all the *curanderos* of the region are known to each other, and that there are three elders among them, of whom he is one. The three take counsel together from time to time, when questions come up, and in difficult cases one of them calls in another, who takes the mushrooms and wrestles with the problem. For four days before taking the mushrooms the *menjak* must refrain from alcohol, even beer, and also from sexual relations. But you may eat any food and smoke tobacco. The four day period is called a *noven*, adapted from the Spanish *novena*, and you count back from the end of the mushroom session. Thus if the session ends at dawn on Friday, then Friday, Thursday, Wednesday, and Tuesday are the four days, and you begin to observe the regime from Tuesday noon on.

The word for 'mushroom' in the Zapotec of San Agustin is *mbey*, and this appears to be the basic word in all the Zapotec languages. There is no other word to designate the sacred mushrooms, but this function is served in some measure by *mbeydo*', an important and curious term that is a 'collective': it means a batch or lot or mess of sacred mushrooms. It is never used for mushrooms other than the sacred ones. The cap or pileus of the mushroom is the *yek*, 'head', the same figure that we have found in the Mije and Mazatec country. The stipe is the 'leg' and the gills are the 'inside' of the mushroom.

Don Aristeo uses four kinds of mushrooms for divinatory purposes. First, there is the *piule de churls*, wherein *churls* means 'the small ones'. *Piule* is a word widely used in Mexico in the vocabulary for the hallucinogens, but its etymology, range, and application seem not to have been a subject of study. In this case the *piule de churls* is a mushroom that grows in pastures and cultivated fields. Don Aristeo gave us samples. (Query: Is *piule* derived from *peyote*.)

The second and third kinds are both called *piule de barda*, wherein *barda*, 'thorn', stands for Christ's crown of thorns. One of these species grows in clumps near but not in marshy ground, and it is black, and it stains the ground and plants nearby with its own blackness. It appears to be abundant, and Don Aristeo had a large supply which he had gathered lately and dried in the sun. The other kind is much larger, rising to six or seven inches in height. It grows in the shallow water of marshy land, singly, and it is much harder to gather in quantity. The upper surface of the cap is bright yellow, but the gills and stipe are dark. To distinguish this from the first, it is called in Spanish the *grandote*, 'big fellow'. It is said to appear on the day of St. Anthony, June 13. In the Zapotec country the marshy places are considered holy, and these two kinds of mushrooms are linked with the holy marsh land. They told us that beneath the marsh a great *culebra* or serpent (*mjd'mdo*' in Zapotec) lives. I asked what it looked like, and they said no one had ever seen it. Thus the belief in the Middle American serpent deities lives on to this day.

The fourth kind of divinatory mushroom, of which we saw no specimens, is the *ndotan de venado*, the Lord of the Deer. While all four kinds can be used in substitution for each other for all purposes, this one is especially good for help in hunting, because you see in your visions where all the animals are, in a great corral, shepherded by the *Dueno de Todos los Animales*, Lord of all Animals, another survivor of the pre-Columbian divinities of Middle America. According to Don Aristeo, this mushroom is some five inches across, and yellow above and below, growing in dry earth near any ditch, along any roadside, especially in low country.

Don Aristeo said that the mushrooms were just as potent when dried as fresh and that they keep for months. When there are no mushrooms, the *menjak* uses instead either of two kinds of seeds, and by extension the word *mbeydo*' embraces a dose of divinatory seeds, just as though they were *mbey* or mushrooms. This usage indicates that in the thinking of these Zapotecs the role of the vegetable hallucinogens is secondary. Both in San Agustin and in the Mazatec country it seems that there is recourse to the seeds or leaves only when the mushrooms are not available. In the Zapotec of San Agustin the two kinds of seeds are called the yellowish piule and the black piule, *men nagadz* and *men nagat*; in Spanish, 'the male' and 'the young lady', *el macho* and *la Señorita*. We brought back with us seeds and leaves of the second kind, and they were later identified by Joseph Monachino of the New York Botanical Garden as *ololiuqui*, the famous Aztec hallucinogen known to botanists as *Rivea corymbosa*.

Early in our visit we asked Don Aristeo to give us a mushroom session, and this he did on the night of Thursday, July 21. Don Roberto called on him that afternoon to pursue further the calendar problem, and found him casting kernels of corn. There was a heap of 51 kernels disposed in little piles, and he went through the casting five times, to learn what fortune he would have with us that night.

We arrived at Don Aristeo's house shortly before nine o'clock in the evening. We were eight, our *menjak*, Don Roberto, Howard Brunson, RGW, and Chico; Ismael, Serafin, and Pedro. The house was on the outskirts of town, down the mountain side, well secluded. It was a typical one-room adobe cottage with thatch roof, no windows, and a door in the middle of the long side. There was a table on the right as one entered, and a wood fire was burning in a circle of stones in front of the table. Don Aristeo's place was next to the fire, where he alternately lay and sat on a *petate* covered with sacks. There was a bench for some of us to sit on, and the rest lay on *petates* where they pleased. The embers of the fire and a candle were our only illumination.

Slowly the program got under way. Don Aristeo prayed at length under his breath, and then opened a paper wrapping in which he had a large supply of *piule de barda*. He took out the mushrooms pair by pair, rinsed each pair well in a bowl of water, and placed the clean mushrooms in another empty bowl, praying the while. Having rinsed enough mushrooms, he tied up the rest in the paper wrapping, poured out the water on the ground, and then, pair by pair, took the mushrooms from the second bowl, severed the caps from the stems, placed the caps in the empty bowl, and held the stems in his hand. To our surprise he severed the caps of 25 pair of mushrooms. He explained to us that the stems are never eaten: they are respectfully laid aside and on the following day they are scattered (not buried) in any place off the beaten track where people will not pass.

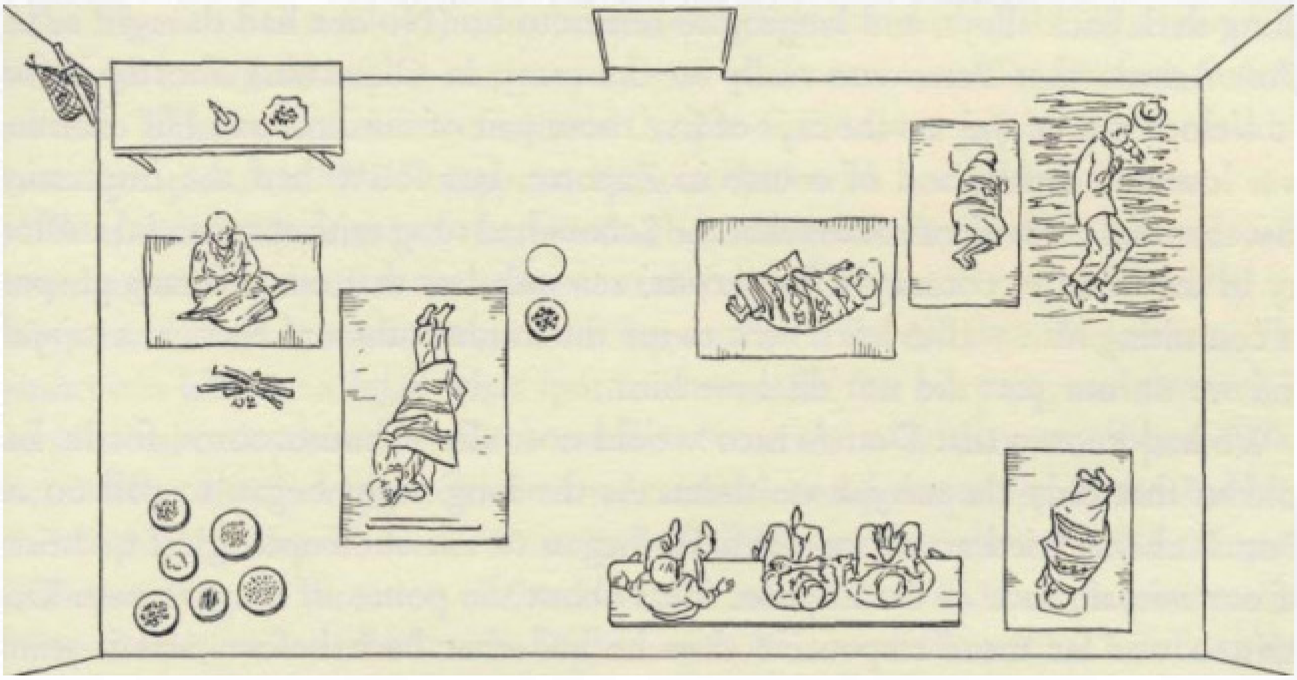


Fig. 22

Shortly after 9 o'clock, seated on the sack, he began to chew and then swallow the mushroom caps, scooping them out of the bowl in one big handful after another, seven mouthfuls in all, chewing them at length. By 9.35 he had finished them. He lay down for a time, his head on a rolled blanket. Then he sat up, lighted a cigarette, and spoke conversationally. Toward 10 o'clock he began to hum, and this became a musical hum, which in turn grew into a chant. He was lying on his right elbow and made sweeping gestures with his left arm. He asked our religion, and we thought it best to say Catholic. Then he said in Zapotec that our son Peter was alive and would return to us, that we should address prayers to St. Augustine, the Holy Virgin, and St. Joseph; and that we should burn votive candles of virgin wax in Oaxaca before the Virgin of Solitude and later make a similar pilgrimage to the Virgin of Guadalupe. He said that Peter was in Vera Cruz, plunged in sadness, living a hidden life, slinking along dark back alleys, and longing to return to us. (No one had thought to tell Don Aristeo that Peter was really in the army in Okinawa.) Shortly before 11 o'clock our *menjak* ate the caps of five more pair of mushrooms. His chanting was low and feeble, and of course in Zapotec, but RGW had the impression that the music was identical to what the Señora had sung with magisterial authority in the Mazatec country. Don Aristeo reminded us that our primary purpose in consulting him was to learn how to use the mushrooms and become a *menjak*, and we on our part did not disabuse him.

We had known that Don Aristeo would not offer us mushrooms, for he had told us that only the *menjak* ate them. As the long night began to pall on us, Don Roberto tried an experiment. He began to ask anthropological questions of our *menjak*, such as the Zapotec ideas about the points of the compass. Don Aristeo was far more responsive than he had ever been before, and it seems possible that the mushrooms offer a key to half-remembered things, a key that might be used in anthropological inquiries. But when all is said, it must be admitted that Don Aristeo's performance dragged, his vitality seemed low, and we were heavy with sleep. At one o'clock he told us we could go home. We think he felt the evening was unsuccessful: the initial dose of mushrooms that he took was abnormally large, and he followed it with a booster dose, as though the response was not to his liking. However, we were well pleased with the rich evidence that he had given us of the mushroom cult in this Zapotec area, the fourth cultural area in Middle America where we now know that it survives.

But we have not done with Don Aristeo. In the course of our talks with him he had made a revelation to us that was so startling, so enigmatic in its implications, that we have left our discussion of it to the last.

Two of our early Spanish authors wrote of the religious observances that accompanied the gathering of the sacred mushrooms. The 16th century botanist Francisco Hernandez spoke of the 'night-long vigils, awesome and terrifying', that accompanied the quest. Half a century later, Jacinto de la Serna said that the priests spent the whole night in prayer and entreaties before going out at dawn to look for the mushrooms. Our informants in the Mije and Mazatec regions had known of no such religious practices, but Don Aristeo did.

Our *menjak* told us that when he gathered the sacred mushrooms, he would cross himself, kiss the mushrooms seven times, and say in Spanish or Latin (learned by rote, of course) five Pater Nosters, seven Ave Marias, five Credos, and seven Salve Reina Madres. He would place the mushrooms before the image of the Virgin of Guadalupe in his house, and each day during the observance of the *noven* he would repeat the prayers and wash ceremonially his face, hands, and feet. Thus in Don Aristeo's world the pre-Columbian practices recorded by the early Spanish authors reappear, but overlaid with a Christian veneer.

When the mushrooms of the fourth class, the hunter's mushrooms, are consumed, immediately after they are eaten the *menjak* places five righted candles on the ground, one at each corner of a square with the fifth in the center. The mushroom tells the *menjak* what spot to choose for this purpose, and flowers or leaves are also deposited with the candles. From the way they are disposed, the five candles clearly represent the five cardinal compass points of the Indians' world - North, South, East, West, and Zenith - and are the *menjak*'s compass for discovering the direction of the deer. The *menjak* then addresses an invocation to five divinities: to *mdldo*' or the 'lightning bolt', to *mdida* or 'Our Lord', to the Divine Pastor, to the Divine Huntsman, and to San Pedro Chapa in the Church of San Pablo Mitla. Only two of these five divinities bear a Christian aspect. (The Divine Pastor belongs to the Middle American pantheon.) Here we discover our first association in Middle America of the sacred mushrooms with the lightning bolt, *el rayo*.

There is a third rite. Four days after the *menjak* gathers any of the divine mushrooms, he returns to the spot where he has found them and with candles and flowers he gives voice to a supplication for an increased yield of mushrooms in the following year. He addresses his prayers to five divinities:

1. the earth,
2. God the Father Most Holy,
3. the Trinity,
4. the Great Lightning Bolt that bred [*crio*] the *piule* (*mdi*'*nda*' *pse*' *btul*), and

5. the Great Lightning Bolt that put blood into the *piule* (*mdi'ndo' bio ren blul*).
   In Spanish: *El gran rayo que le echo sangre al piule*.

The second and third of this quintet are, clearly, Christian interpolations. Omitting them, we have left a religious explanation, wholly pre-Columbian, for the generation of the divine mushrooms, and that explanation lies in the union of the lightning bolt with the fecund mother earth. As Don Aristeo put it through our interpreters, *el rajo es la fuerza de la tierra*, the lightning bolt is the earth's force.

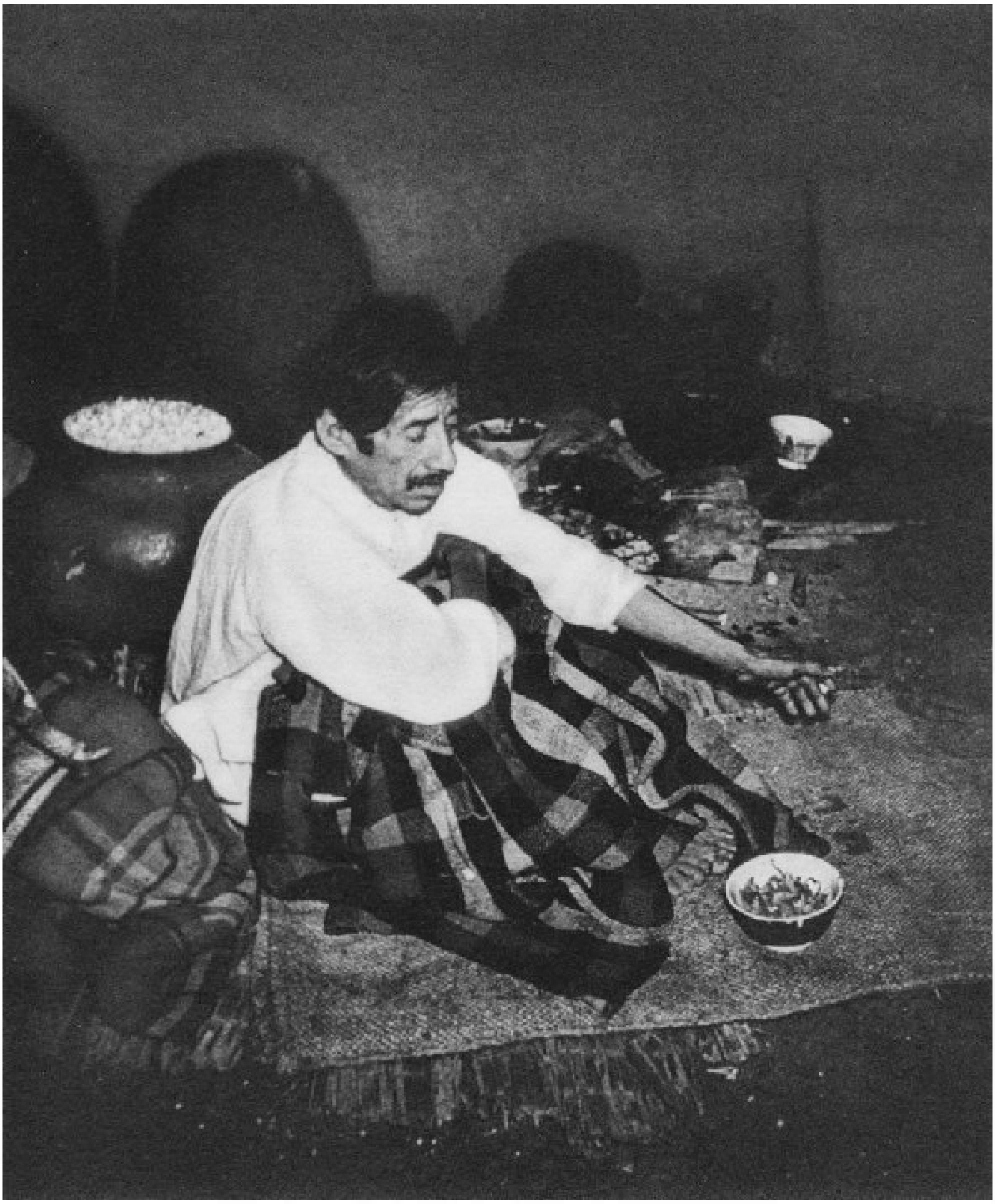


PLATE LI
Aristeo Matias with bowl of divine mushrooms.
San Agustin Loxicha, July 22, 1955.

Those of our readers who have long memories will recall that in Section 7 we drew attention to the extraordinary range of the archaic belief in lightning as the generative agent for mushrooms. We documented this belief in ancient India, Greece, and Rome, and in modern Kashmir, Persia, and the Pamirs. Outside the Indo-European world, we found it among the Semitic Bedouin, the Chinese, and the Polynesians of New

Zealand. Now, thanks to the experienced handling of our difficult informant by Robert Weitlaner, we rediscover this self-same belief in a Zapotec village where the ancient Zapotec culture strongly survives. And in this Zapotec recension we pinpoint it with greater precision than elsewhere: for Don Aristeo and his people the divine mushrooms are the progeny of coitus between the lightning bolt and our mother earth.

At once the question posed by our evidence assumes new and deeper meaning. Parallels in mythic beliefs among archaic peoples are of course numerous, but is there any other example that is as specific in explaining a simple phenomenon in nature? Plutarch pondered over the very belief that Don Aristeo, the Zapotec *menjak*, holds today, and Plutarch's puzzlement is as nothing compared with ours, now that we discover the belief even in Middle America. Plutarch asked why men believed that lightning made mushrooms grow. Have we perhaps, at the end of a long trail, discovered the answer?

No mycologist thinks that lightning causes or encourages mushrooms to grow. It is therefore impermissible to suppose that the various branches of the human family arrived independently at this notion by close attention to nature. (We must not wholly exclude the possibility that the mycologists will change their minds. Scientists are as dogmatic about the knowable as churchmen about the unknowable, but there is a difference: the dogmas of the Church are immutable, whereas men of science change theirs daily without a blush.) Perhaps someone will suggest that just as men of science, unknown to each other, often hit on the same idea at about the same time, so archaic cultures may hit on the same mythic beliefs. But the analogy in its application to our enigma is invalid. Scientists are working in a closely integrated, homogeneous intellectual atmosphere, and even if two workers have never heard of each other, they handle identical data and ideas. But who will assert that cultures far removed from each other in time and space must inevitably, in an early phase of their evolution, link lightning with fungal procreation? Surely independent genesis is highly improbable.

But how about a simple diffusion of the idea? Today students of the neolithic and later cultures know that cultural communication was active in those early times over large areas. Technological discoveries, artistic and magical motifs, and certain kinds of products would spread quickly to distant parts, thanks to contacts from village to village or to travelers plying the trade routes. The alphabet was invented only once, in the Near East, and by diffusion, that first alphabet led to the birth of scores of alphabets elsewhere. When tobacco was released from the New World, it penetrated everywhere in a few years, faster than explorers and geographers could travel. But was it not always the new idea or gadget that spread thus by diffusion, rather than mythic beliefs as old as the hills? Sometimes with the birth of a new and aggressive religion, its mythology would burst forth like a tidal wave and inundate an area before its strength was spent. But if anyone is bold enough to say that the link between lightning and mushrooms was a belief propagated in this way, at what point in time did the diffusion take place and from what focus?

There is the third possibility. Was not our belief handed down lineally for many thousands of years? Do we not discover in it a surviving trace of an early cosmology elaborated when the ancestors of the Zapotecs and Greeks and Semites and Polynesians and Chinese were neighbors, were not yet differentiated, in their Eurasian home-land? The Zapotecs link lightning, not with all mushrooms, but only with those that by divine grace translate the eater to Paradise. Perhaps their belief is the original one. On an earlier page we saw how mushrooms as primary tinder were linked with fire, and the procreation of fire with their aid was a divine event and a sexual act. Was it not a natural extension of ideas to suppose that the spark or spunk of fulminating Jupiter procreated the divine mushrooms? The Zapotecs could have answered Plutarch's question, but he clearly had never heard of our miracle-working mushrooms. The popular belief that puzzled him was an archaic survival in Greece that had lost its meaning. If the divine mushrooms were still being used in the Aegean, they were the secret of initiates in the mysteries. When myths lose their vitality like molluscs their shells last on, and the figures of speech, the anecdotes, being curious in themselves, inspire popular etymologies, those explanations that are more or less inept after-thoughts. In this way the lightning that had once generated only the divine mushrooms became associated with truffles and *Terfezia*, with mushrooms generally. The 'fly-mushroom', which we think had once harbored the demonic fly of our sacred mushrooms, shrank to an ineffectual insecticide.

With our Mexican experiences fresh in mind, we re-read what Jochelson and Bogoras had written about the Korjaks and Chukchees. We discovered startling parallels between the use of the fly amanita in Siberia and the divine mushrooms in Middle America. In Mexico the mushroom 'speaks' to the eater; in Siberia 'the spirits of the mushrooms' speak. Just as in Mexico, Jochelson says that among the Korjaks "the agaric would tell everyman, even if he were not a shaman, what ailed him when he was sick, or explain a dream to him, or show him the upper world or the underground world, or foretell what would happen to him." Just as in Mexico on the following day those who have taken the mushrooms compare their experiences, so in Siberia, according to Jochelson, the Korjaks, "when the intoxication had passed, told whither the 'fly-agaric men' had taken them, and what they had seen." In Bogoras we discover a link between the lightning-bolt and the mushroom. According to a Chukchee myth, lightning is a One-Sided Man who drags his sister along by her foot. As she bumps along the floor of heaven, the noise of her bumping makes the thunder. Her urine is the rain and she is possessed by the spirits of the fly amanita.

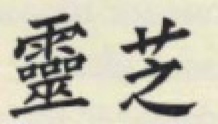
There must have been a potent reason why from western Europe to Eastern Greenland people have believed down to our own days in the demonic nature of mushrooms, and we think that reason lies in the strange hallucinatory powers of certain species. From Eastern Siberia to France these mushrooms are linked with 'flies', i.e., the insect world that is itself saturated in demonic *mana*. Suddenly the Tadzhik myth of the falling 'lice' which give rise to a crop of mushrooms takes on meaning. Those lice are falling demons, falling 'angels' if you will, and naturally they yield a crop of demonic mushrooms. And now suddenly Bosch's painting of those falling angels as 'flies' (= lice) takes on fresh meaning. In that left-hand panel of the Hay Wain God sits on a thunderhead, and from the billowing folds of his garments tumble forth the expelled 'angels' that will yield the crop of demonic growths, where the demonic toads dwell. The Tadzhik myth, the falling 'flies' of Bosch, the 'flies' of the Paleo-Siberian tribesmen, all begin to relate themselves to the primitive myths of our own tradition.

Our divine mushrooms, along with the secondary vegetable hallucinogens, may have played a role in the origins of human culture. How the strange virtue of those little children of the lightning must have stirred the soul of early man! Here is our remote ancestor of the Old Stone Age emerging from the mental confines of his animal background, possessed of only the most rudimentary tools and skills, knowing the emotion of fear but not yet acquainted with awe. He discovers the secret of our mushrooms. They produce in him a self-limiting pseudo-psychosis, the fission of his soul. (How cold, condescending, and dubious do such medical labels as 'psychosis' seem to one who has known the truth of the divine mushroom!) He experiences self-perception. He visits heaven and perhaps hell, he holds the key to the miraculous. Yes, our mushrooms must have unlimbered the imagination of those first men who ate them, stirred their curiosity and speculative faculties. Our mushrooms could have sparked in them the very idea of God. When Don Aurelio and our other friends tell us that the mushrooms translate them to God's domain, perhaps this is no modern figure of speech devised for our benefit. The phrase that seems to us fresh and arresting may have been the conventional one for thousands of years. We may be tapping the very well-spring of the religious idea.

Let us pause for a moment to consider the name that the Nahua gave to the divine mushroom - *teo-nanacatl*, God's flesh! How those words echo down the centuries of religious experience! (In the Book of Common Prayer, in the Prayer of Humble Access, the faithful are summoned to eat 'the flesh of thy dear son Jesus Christ'.) The Christian doctrine of Transubstantiation is a hard saying, calling for great faith. (Who was that Saint who, in piety, said that of the miracles there were three above all the rest, the Virgin Birth, Transubstantiation, and, the greatest of the three, the faith given to man that enables him to believe in the other two?) The Mexican Indian with his *teo-nanacatl* has no need for Transubstantiation because his mushroom speaks for itself. By comparison with the mushroom, the Element in the Christian agape seems pallid. The mushroom holds the key to a mystical union with God, whereas only rare souls can attain similar ecstasy and divine communion by intensive contemplation of the miracle of the Mass. Our Señora took of two elements, the mushrooms and *aguardiente*, but the second she withheld from the laity.

Is not the odd phenomenon of mycophilia vs. mycophobia a latter-day echo of early man's shattering experience when he discovered the potent mushrooms, a response, positive and negative, divine and diabolic, to these holy miracle-workers? The toad of our 'toadstool' is that daemon which the Great Lightning Bolt seeded in the mother earth and which sprang forth in the little mushrooms.

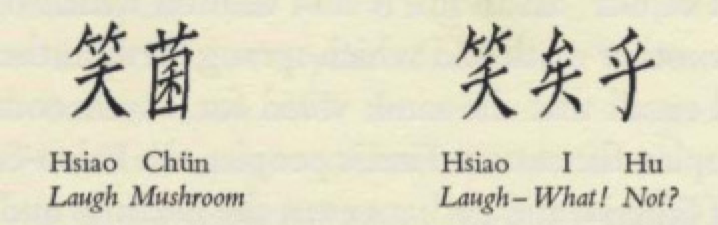
Our readers will recall that the same word for 'mushroom' is shared by the Indo-European peoples, the eastern Finnic peoples, the Paleo-Siberian tribes as far as the eastern tip of Siberia, and perhaps even the Eskimos and the Arabs. Do we not now discover the potent secret of the mushrooms that might explain the wide dissemination of a single pre-Indo-European word? For the cultural historian it becomes imperative that the surviving traces of the mushroom cult among the peripheral peoples of Siberia be minutely and sympathetically examined on the ground by anthropologists and linguists, and likewise the similar use of a mushroom in the interior of New Guinea. It becomes imperative for the anthropologists everywhere to take cognizance of ethno-mycology as an avenue for promising cultural inquiry. In various directions there seem to be fruitful areas for the re-study of ethno-mycological evidence, such as, for example, the strange absence of mushrooms from the immense corpus of ancient Egyptian art and texts. Is this because the Egyptians ignored the fungal world or because Egyptologists have ignored it; In China, long before the Buddhist era, in the Taoist philosophy of Lao-Tse, we discover the theme of the *ling-chih*:



靈芝

wherein 'ling' means spiritual or potent or divine, and 'chih' is a word for 'mushroom'. According to the legend as it survives today, the *ling-chih* was a mushroom that conferred immortality on the eater. Overlaid in the course of time by the artificialities of Chinese literary and artistic sublimation, this theme must have had its genesis in the country-folk and in a mycological fact. Was not the divine mushroom of the early Chinese our divine mushroom? Modern commentators such as S. Wells Williams in his *Syllabic Dictionary of the Chinese Language* (1909) report that the *ling-chih* was the *Fomes fomentarius* or *Fomes igniarius*. This could hardly have been so in the beginning, for these hard, bitter tree fungi are inedible; though they could have been ground to a powder and drunk in a potion. Perhaps it is significant that as the source of primary tinder they are linked with fire, and thus with the lightning bolt, and this may explain why they were chosen as evasive substitutes for hallucinatory mushrooms.

Dr. Hu Shih, alive to our interest in mushrooms, has given us additional evidence of a knowledge of hallucinatory mushrooms in China. In the *Ching-i lu*, usually attributed to T'ao Ku who lived in the 10th century, there is a reference to a mushroom which, when eaten, will cause the disease of the dry laugh.



笑菌	笑矣乎
Hsiao Chün	Hsiao I Hu
Laugh Mushroom	*Laugh – What! Not?*

The natives call it the *hsiao-i-hu*, which can be translated either by 'Shall-we-laugh?' or by 'Laugh - What! Not?' But Dr. Hu tells us that such a name is on its face a literary invention. This mushroom is the 'Laugh-mushroom', as it is more commonly called, of which the statesman and writer Yeh Meng-te (A.D. 1077-1148) speaks in the *Pi-shu lu-hua*, 'Notes of a Summer Vacation':

> ... the Maple tree Mushroom which, when eaten, causes the eater to laugh without stopping, and is called the *hsiao chün*.

or 'Laugh-mushroom'. What can this be but the mushroom *de pura risa* of our friends Ismael and Don Aristeo, of the botanist Hernandez, the *Lachenschwamm* of Germany and the *bolondgomba* of Hungary?

In the Buddhist world there is another clue to explore. According to orthodox tradition, the Buddha died after a Last Supper with his disciples at which he reserved for himself a dish of tender boar's flesh, *s&umacr;kara-maddava*. Some have seen not pig but mushrooms on that fateful plate. *S&umacr;kara* is cognate with the Latin *sus*, English 'swine'; our readers will recall that *suillus* in Latin is also a fungal name. In Russia there is also a 'swine-mushroom', the *svinukha* (**свинуха**). In the light of our discoveries, should not this problem in exegesis be re-examined? That the Buddha should have died as a sequel to eating bad pork seems a shocking discord in the rarefied spirituality of the Buddhist legend. What could be more fitting than for the Master to be translated to Nirvana by the divine mushroom?

16

The Divine Mushroom: Archeological Clues in the Valley of Mexico

If, as we believe, the hallucinatory mushroom persists even today as a major theme in the emotional and religious lives of many of the more withdrawn Indian peoples of Oaxaca, and if, as we believe, the 16th century writers bear witness to the important role of the mushroom in the Indian cultures as far north as the Valley of Mexico and among the Otomi and Tarascan peoples, it is fair to look for the mushroom also in the archeological evidence of far earlier times. That archeologists have not revealed it to us is not necessarily conclusive - they have not been on the lookout for it. Furthermore, in spite of the spectacular discoveries made in Middle America by archeologists in the past, what they have done until now may some day seem only a beginning by comparison with the discoveries that be in the future, so many are the major sites that have not been fully explored or even touched.

There is the further question of the role that the mushroom might be expected to have played in Middle American art. On this *a priori* opinions are of little value. In Christian art the cross as a symbol is all-pervasive, and it would be natural to look for the mushroom in a similar role. If we are right, the mushroom stones of the early Maya periods in the highlands confirm this analogy. But it does not follow that a major idea always receives corresponding direct emphasis in art. Take for example the Host in the Christian world, the Divine Wafer that is the daily reiteration of the Christian's faith in the miracle of Christ's unique mission on earth. The Mass is the very heart of all Christian liturgy, and the Mass hangs on the elements of Bread and Wine. By comparison with its importance the bread of the Sacrament appears surprisingly seldom in religious paintings. In representations of the Last Supper the faces of Christ and the Apostles take priority over the loaf. For more than a thousand years the best artistic talent was occupied with representing altars, ecclesiastics habited to officiate at Mass, and churches that housed the altar and the Sacrament. All of this pictorial eloquence took for granted the central feature, the miracle of transubstantiation and the Holy Communion. How seldom, relatively, did the artist stop to paint the Host itself! So may it have been with the mushrooms in pre-Columbian Mexico. We may discover its accidental appearance and at the same time begin to sense its constructive presence there where it does not appear.

In 1954 Mrs. Irmgard Johnson drew our attention to certain mushroomic shapes in the border of the famous Teopancalco (or Teopancaxco) fresco in Teotihuacán. Discovered in 1894, this fresco was carefully copied soon afterwards by Dr. Antonio Penafiel and Miss Adela Breton.[178] Two pre-Columbian priests facing each other are engaged in a rite, wearing the vestments of their office, their heads burdened with serpent masks. It is supposed that they are pouring *pulque* on the ground, and if so the rite is associated with inebriation and divine possession. In the center, between the two priests, is a motif of interlaced cords, symbol of the mat (*petate*) that is in its turn a symbol of authority in Middle America. It is surrounded by a circle of outward pointing triangles, and this design rests on a ceremonial stand. The border consists of a sequence of repeated motifs. On the right hand side are three shapes that look mushroomie, separated from each other by designs that we know represent seashells. The sea-shells are of two kinds, conch and bi-valve.[179] The shells and the mushroomic shapes stem from a stream of water that flows around the outside border of the fresco. No Americanist has ever suggested that the mushroomic discs are mushrooms and at first the idea seems unlikely. The combination of mushrooms with sea-shells is, *a priori*, disparate. Why should not these discs be some other sea growth, not yet identified? There seems a further objection to the mushroomic possibility. The 'stipes' of the 'mushrooms', if we judge by the sea-shells, are simply streamlets from the mother stream, so that we are left with mushroomic discs balanced on the end of these little tributaries. But then we remember that the virtue of the hallucinatory mushrooms resides in the pileus or 'head', and the stipe is secondary, and these 'stipes' could serve a dual purpose, as stipes and as the umbilical cord through which the life-giving 'blood' (to use the word of our Zapotec *curandero*) flows into these 'children of the waters'.

---

[178] See Teotihuacán, *Estudio histórico-arqueológico*, by Dr. Penafiel, Mexico City, 1900, chap. XIII, plates 81 ff. Dr. Eduard Seler's analysis of the fresco will be found in *Gesammelte Abhandlungen zur Amerikanischen Sprachund Alterthumskunde*, Berlin, 1915, vol. V.

[179] For an excellent discussion of the role of sea-shells in the culture of the Valley of Mexico, see Hasso von Winning's paper, 'Shell Designs on Teotihuacán Pottery', in *El Mexico Antigua*, vol. 7, Dec. 1949. Possibly we discover the explanation for the shells in the Valley of Mexico in William E. Safford's paper on the psychogenic snuff derived from the plant known as *Piptadenia peregrina*, which is used by the Indians of the Orinoco. Safford drew attention to the use of snail shells in conjunction with the snuff, the shells being burned to quicklime whiter than snow, and then mixed with the yupa, as the natives call their product. See Safford's 'Identity of cohoba, the narcotic snuff of ancient Haiti', *Journal of Washington Academy of Sciences*, 1916, pp. 547 ff. Could a similar use of lime have been known in Mexico in former times?

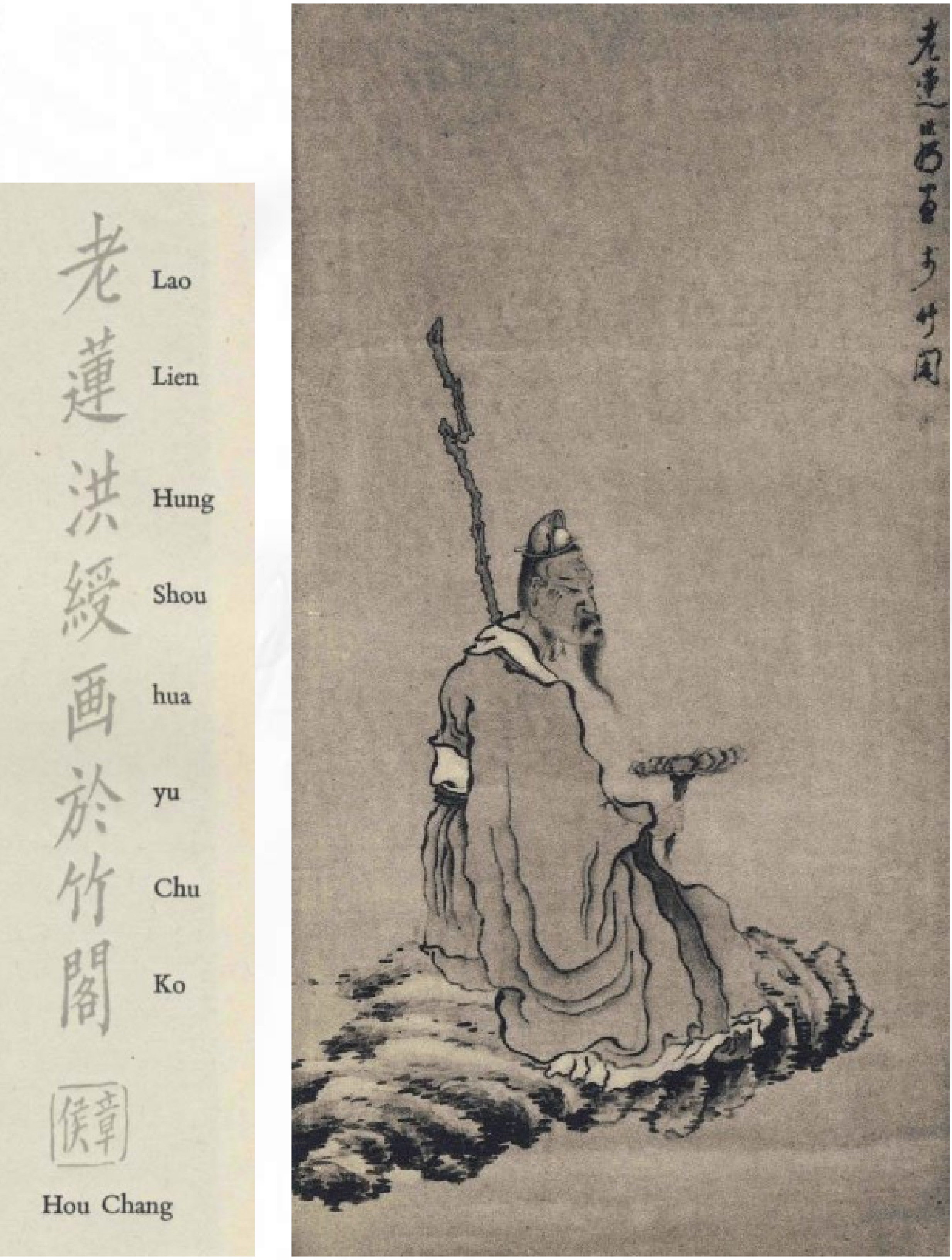


PLATE LII

Chinese sage contemplating *Ling-chih*, the Divine Mushroom.

Painted by Chen Hung-Shou (1599-1652), probably late in life in early years of Ching dynasty. This artist was an eminent figure - and landscape-painter, known as an individualist. 'Lao-lien' and 'Chang-hou' were his fancy names. 'Hua yu' means 'painted in', and 'Chu-ko' means 'Bamboo Pavilion', doubtless a studio that he frequented.

Reproduced by courtesy of Wango Weng, Esq.

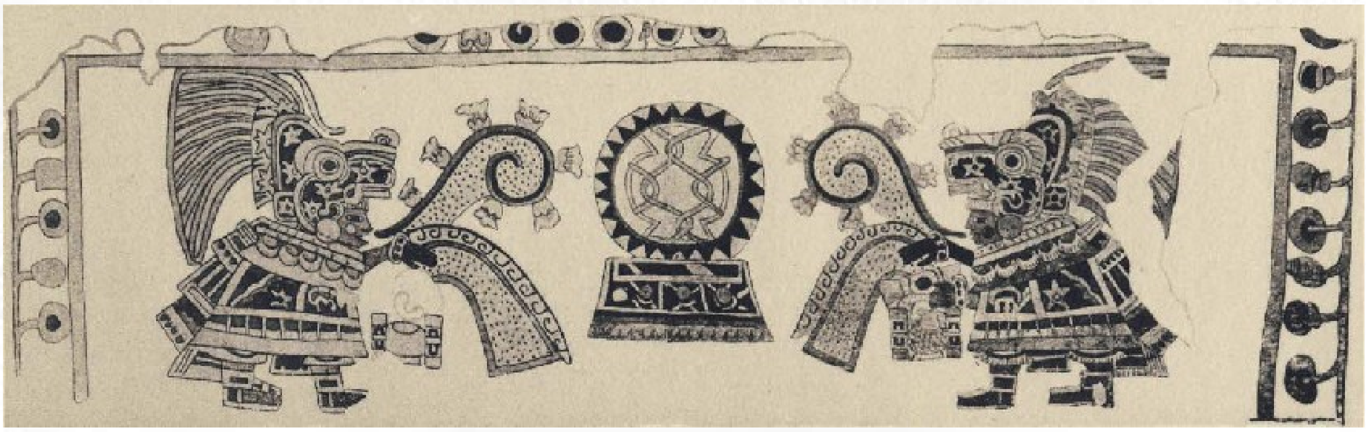


PLATE LIII
Teopancalco fresco. Teotihuacán, in the Valley of Mexico.
From Teotihuacán III period, A.D. 300-600.

This fresco dates from the period known as Teotihuacán III, extending from c. 300 A.D. to 600 A.D. This was a period rich in cultural achievements. There is no way to determine what language was then spoken in the Valley of Mexico, but it could have been an early form of the classical Nahuatl. The archeological excavations of this period in the Valley have produced large numbers of seashells, and whoever the people were, it is clear that in their ceremonials seashells played a conspicuous, if for us undefined, role. In Plate XLI we have illustrated the accessories of the divinatory mushroom rite as it is practiced today in the Mazatec country: these accessories, for one unfamiliar with Middle American anthropology, make up a disparate lot. If we postulate for the Teotihuacán period a liturgical use of shells with hallucinatory mushrooms, this border becomes intelligible. The fresco itself, according to Seler, invokes the rites of inebriation, which is consonant with our hypothesis of hallucinatory mushrooms.

We examined the Teopancalco fresco in the summer of 1955, and found it sadly deteriorated but with the surviving portions now well protected. On the wall of the little room immediately to the right of our fresco, there had once been another one of which only a stretch of the border survives in good condition, and this border repeats the motif of the one we already know! Mr. Eduardo Noguera has graciously copied it for us, and we publish this design here for the first time. Again the mushroomic meaning suggests itself, tempting but uncertain.

Dr. Gordon Ekholm has drawn our attention to the identical pattern of motifs in the Tepantitla fresco, dating from the same period and only a mile or so away from the first. This is an elaborate composition sufficiently well preserved for its meaning to be analyzed.[180] There is a representation of the rain god Tlaloc, and a more aquatic divinity was never portrayed. From his hands drip great drops of water, and a stylized river with star fish and shells flows in both directions from the base of the figure. Beyond the big drops of water, on both sides, from the fingers of other hands drop streamlets of water, and from the side of these streams nearest to the central figure we discover the same series of shell and disc motifs with which we are already familiar. Seeds are scattered on the other side of one of these streamlets. Were these seeds mere symbols of fertility, one would look for kernels of maize among them. But maize is absent. If our surmise about the divine mushrooms is justified, we should expect hallucinatory seeds. The ones in the fresco are diverse, but among them we discover some that forcibly suggest the *colorines* used with mushrooms for divinatory purposes in the Valley of Mexico to this day. They are red and black, with the hilum, quite properly, in the red field.

Tlaloc was one of the most popular and important of Mexican deities. He was the god of the waters, of the clouds and mist and sleet and hail, of the lightning bolt, of rain and the streamlets and torrents and rivers and lakes and the ocean. His home, Tlalocan, was thought to be in the verdant uplands, where the clouds would gather and water was abundant. How was Tlaloc related to our mushrooms? Look at the curious pattern that emerges from the philological evidence. We know that today, in this Valley of Mexico where the fresco is, the mushrooms are called in classic Nahuatl *apipiltzin*, 'children of the waters', and this name could have embraced the sea-shells too. The name 'Tlaloc' comes from the Nahuatl root *tlal*, 'earth', and according to the etymology elaborated by Seler in the work already cited, the god is 'he who makes things sprout'. "We recall that in Mazatec the word for the hallucinatory mushrooms means 'that which springs forth', i. e., 'sprouts' and in Mije we discovered a word for the same mushrooms that carries the same meaning. How felicitous are these names, both mycologically and psychologically, for the divine mushrooms with delphic powers! The very names seem to be translations of 'Tlaloc'. When our Zapotec *curandero* invokes the Great Lightning Bolt for a larger yield of these mushrooms, is he not invoking Tlaloc? With the lightning bolt Tlaloc engenders the divine mushrooms in *tlal*, the mother earth. We know that one of the emblems of Tlaloc consisted of three small conches in a triangular sac. What could be more appropriate, now that we perceive the context, than hallucinatory mushrooms alternating with sea-shells in a fresco honoring Tlaloc?

---

[180] This has been done with magisterial authority and consummate literary grace by Dr. Alfonso Caso in his paper entitled 'El Paraiso Terrenal en Teotihuacán', published in *Cuadernos Americanos*, Nov.-Dec. 1942, Mexico City. For an earlier analysis of the role of Tlaloc in the pre-Conquest religion of Middle America, see Eduard Seler's volume entitled *Codex Vaticanus* No. 2775, published in German and English in Berlin and London in 1902-3, pp. 106 ff.

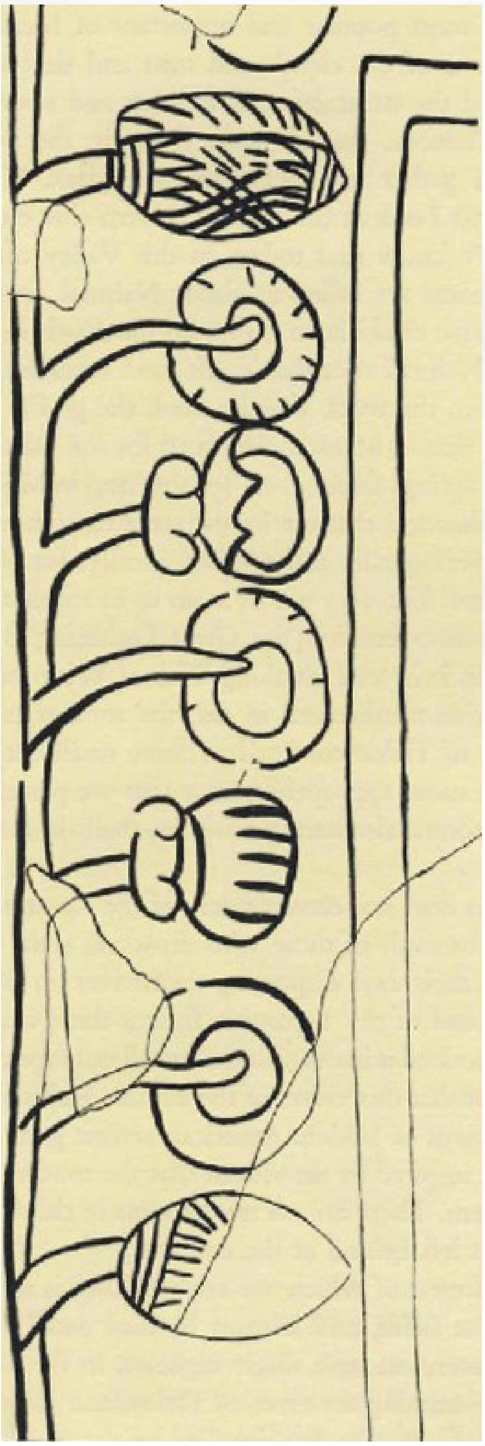


Fig. 23 - Teopancalco fresco
Detail, reduced to half of original size.

The fresco of Tepantitla does not consist solely of the figure of Tlaloc. It was the Mexican belief that the souls of those who drowned went directly to Tlalocan, where they passed their days disporting themselves on the playing fields of Paradise. In another panel of the Tepantitla frescos there is a picture of this Paradise. Dr. Caso has described it in detail and we shall not repeat the description here, beyond pointing out that this vision of the Elysian Fields is one of the few lovely and gentle expressions of Middle American artistic genius. We ask ourselves whether it was not inspired by the visions that the mushrooms of Paradise give to those who eat them. There are no mushrooms in this vision, of course, for the key to Paradise is left behind at the entrance.

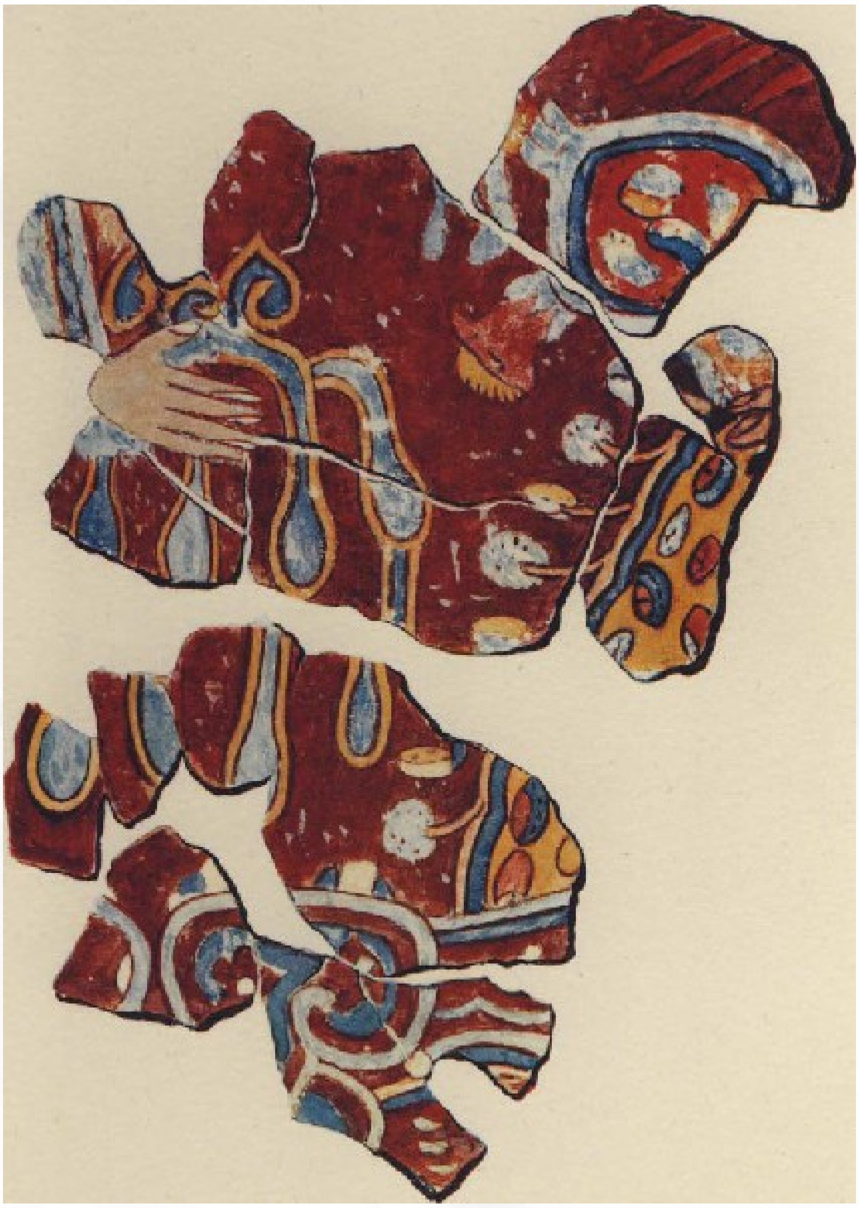


PLATE LIV
Detail of Tlaloc effigy. Tepantitla Fresco.
(See text, page 324, and Fig. 24, page 327.)
Reproduced by Marilyn Weber.

The panorama in the fresco of which we are speaking is made up of small figures scattered across the fields, and it must be read detail by detail, pictographically. We shall concentrate on a single vignette. In the lower right hand corner there is a lake replenishing the river of Tlaloc, and from it there emerges the unclothed figure of one who has just died by drowning, the water still gushing from his lungs. Facing toward the left where lie the fields of Paradise, two great tears of nostalgia still falling from his eyes, with a branch of luxuriant foliage in his uplifted right hand, confidently he advances singing an anthem, which is represented by the five-fold scroll emerging from his mouth. Above that scroll is the emblem of Tlaloc (the three-fold sea-shell) and a butterfly, which in Middle America (as in European folklore) is frequently the reincarnation of a defunct soul. In the lake, below the human figure, we are delighted to discover, thrice repeated, what we will tentatively call the shell-and-mushroom motif. How fitting that the divine mushrooms should have been present when our hero takes leave of this world to enter the Paradise of Tlaloc!

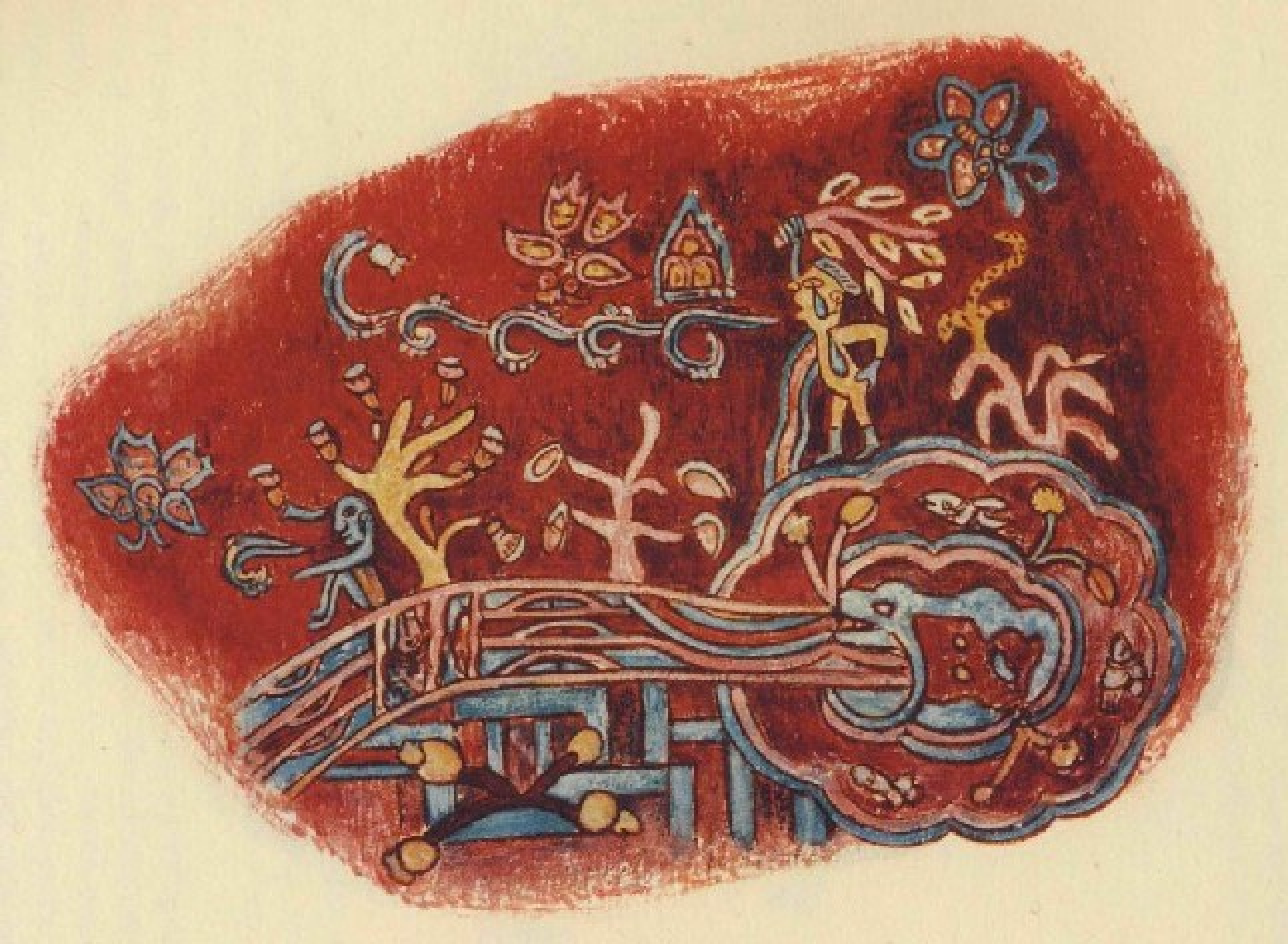


PLATE LV
Tepantitla Fresco.
Detail: Soul arriving on the playing fields of Paradise.
Reproduced by Marilyn Weber.

Seler found that the stylized features of Tlaloc evolved in the beginning from intertwined serpents, perhaps the very serpents that specialists identify in the headdresses of the priests in the Teopancalco fresco. He also pointed out that the effigies of Tlaloc are often surmounted by a crown of triangular peaks, and with some supporting evidence he ventured the suggestion that these peaks were stylized mountain heights around which the waters of the god would gather. Seler in his work on the Vatican Codex accompanied his exposition with cuts of two such effigies, which we here reproduce. The crowns remind us of the circle of triangular peaks that is an obvious symbol of divinity in the Teopancalco fresco. As others have pointed out, this fresco manifests Maya influence. The Teotihuacán III period, contemporary with classic Maya, was notable for the cultural interchanges that were taking place between the two civilizations. Kidder has shown how the butterfly symbol of the Valley of Mexico at that very time made its appearance in the Highland Maya area.[181] In the light of these circumstances and particularly the notched crowns of Tlaloc, how startling it is to look again at the notched aureole of the god emerging from the stipe of the Rietberg mushroom stone, reproduced on Plate XLIII. By the Borhegyi dating, the Rietberg artifact would be either late pre-classic highland Maya, or early classic. And there is that other mushroom stone, much earlier, found at Kaminaljuyú, with the triangular design on the stipe, which we reproduced on page 279. This last one is early pre-classic, c. 1000 B. C.

The use of the mushrooms distinguished the upland cultures, the very slopes of Tlalocan, the home of Tlaloc, where mushrooms abound. The kinship of sea-shells with mushrooms, which left us at first nonplussed, now seems natural. If we were to postulate mushrooms in pre-Conquest art in Mexico, we would direct our search precisely to frescos dealing with Tlaloc and the Paradise of our mushroomic visions, to the very frescos where we have found mushroomic shapes. The mushrooms here are casual, incidental, like the bread in paintings of the Last Supper. In the notched motif of the Rietberg mushroom stone we may even have hit on a direct link between the mushrooms of the Valley of Mexico and the mushroom stones of the Guatemala highlands.

---

[181] See *Excavations at Kaminaljuyú, Guatemala*, by Alfred V. Kidder, Jesse D. Jennings, and Edwin M. Shook, Carnegie Institute of Washington, 1946; p. 220.

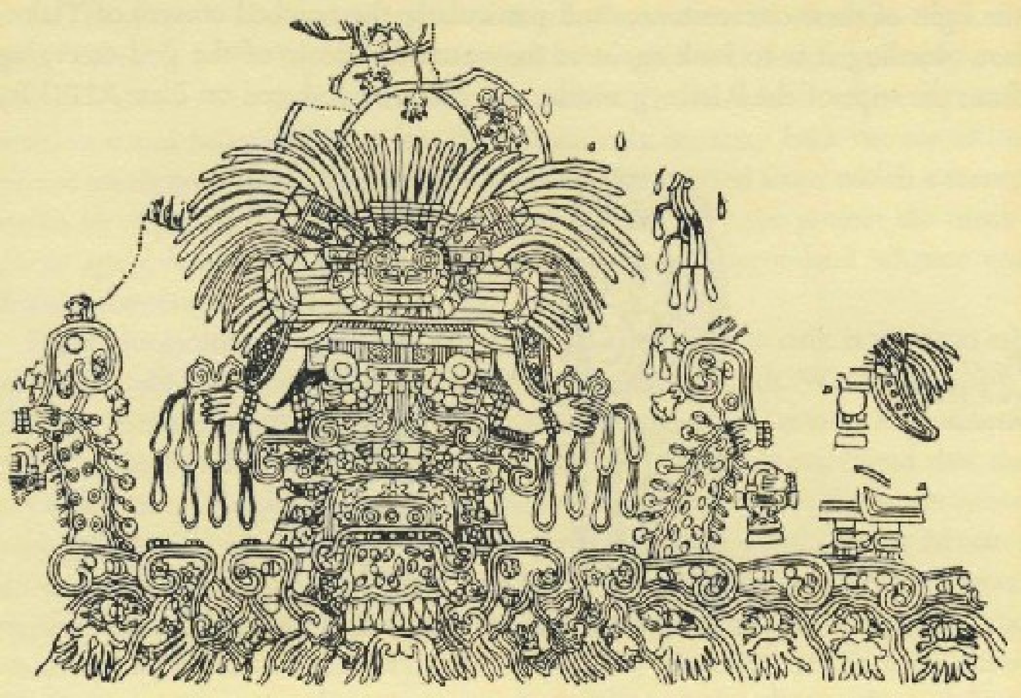


Fig. 24 - The Tepantitla fresco

The little houses where the Tepantitla and Teopancalco frescos survive may have been two of many where the devout once gathered to receive and consult the divine mushrooms in the sacred purlieus of Teotihuacán. If sea-shells were used in the rites, this explains the large numbers still found in those precincts, within sight of the great pyramids.

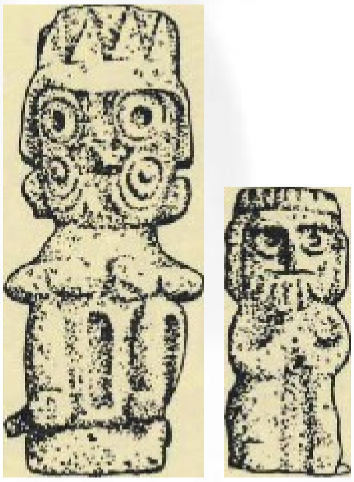


Fig. 25 - Two Tlaloc effigies

Dr. Borhegyi's chart suggests to us that hallucinatory mushrooms were the focus of a cult in the highland Maya world that goes back at least to early pre-classic times, to B.C. 1000 or earlier, the earliest period when technically such artifacts could be carved in stone. Thus tentatively we trace back the use of the divine mushroom in Middle America to the earliest period from which a record could be expected to survive. Beyond that horizon may we project the mushroom agape back through millennia, to the Eurasian home-land whence our Indians' ancestors migrated?

If the 'mushroom stones' were accessories in a mushroom cult, it is fair to ask why that cult disappeared long ago from the Maya highlands. We do not know, but the social institutions of the Maya world suggest an answer. Let us look again at the Mexican evidence. In the remote Mije country we found that the use of the sacred mushrooms was secular. Everyone there knows the mushrooms, and gathers and uses them. No *curandero* is needed for them. In the Mazatec country we find a dual cult. There was the superb performance by the Señora, sharing the mushrooms with her coven and leading it by song and dance; and there was an intricate divinatory rite celebrated by Don Aurelio, with the aid of divers accessories, according to a complicated liturgical sequence. Don Aristeo in the Zapotec country followed the Señora's procedure, but withheld the Element from his congregation. Do we not discern here, in contemporaneous celebrations, the distinct phases of a cult that might mark a chronological evolution and in certain circumstances lead to its extinction? The sacred mushrooms with their miraculous powers could have been bathed in *mana* from an early time, and become the exclusive privilege of the priesthood, and ultimately of the highest priest-kings. As the mushrooms are not habit forming, there was no popular addiction to them that would have been an obstacle to this trend. When the regime of the priest-kings toppled over, the secret of the mushrooms, like so many other secrets of the Maya theocrats, disappeared with them.

17

'Gama no Koshikake' and 'Hegba Mboddo'

Our inquiries into the toadstool world are mostly confined to Europe and the Indo-European fungal vocabulary, including the diffusion of the European words across Siberia. We have brought in the Eskimos, the Maoris, and the Tanala people of Madagascar; and we have traveled in Middle America. But the extent to which toads and fungi are associated with each other in the minds of other branches of the human family remains unanswered, and offers endless perspectives for research. We leave most of those inviting prospects for others to explore. (If this announcement inspires in the reader heartfelt Hosannas, let him imagine how much greater is our relief!) For those who take up the pursuit, we here submit two tantalizing items of information, plus a note on Chinese mycophagy.

The Japanese people are mighty mycophiles, possessing a large mushroom vocabulary and an especially warm affection for several edible species. In the hierarchy of esteem, they place first the *matsutake*, a gilled species that grows in red-pine woods, related to the genus *armillariella*, and famous for its inviting aroma. The *matsutake* of the Kyoto woods are the most highly prized, and in the fall of the year picnics are organized to hunt them. Old records speak of *matsutake* as far back as the 13th century; before then a species known as the *hiratake* appears to have occupied the premier position among the Japanese. The *shiitake* is a related species that grows on the trunks of certain trees, and that is cultivated in large quantities on trunks cut down for that purpose. Both the *matsutake* and the *shiitake* are species peculiar to Japan and perhaps Korea. The *Collybia velutipes*, gathered young and small, is a favorite in soup; it bears many names, of which *nameko* is the commonest. An important role is also played by the *Rhizopogon rubescens*, known as the *shoro*. But the species that is of immediate interest for our purpose is the inedible shelf-mushroom known normally in Japanese as the *saru no koshikake*, the 'monkey's stool'. We have discovered that in certain villages of Chiba prefecture, across the bay from Tokyo, the peasants call this fungus the *gama no koshikake*, or toad's stool; notably in three northern *gun* or townships of the prefecture, by name Imba, Katori, and Sousa. *Gama* is the name for 'toad' in the Kanto dialect of Japanese, spoken in Tokyo and thereabouts. On pushing our inquiries, we discovered that *gama no koshikake* was an alternative expression for *kama no koshikake*, which would mean the stool of the household furnace god *o-kama-sama*, and the longer expression and more old-fashioned would be *o-kama-sama no koshikake*. Toads are associated in the peasants' minds with the big stove that occupies an unfloored part of their houses, and there may be a genetic relationship, or at least a semantic association, between the word for toad in the Kanto dialect and the names of the furnace god. The peasants regard the toad with no repugnance; its presence is even considered auspicious in some regions.[182]

---

[182] We are indebted for our information to Professor Kunio Yanagita, the eminent Japanese authority on folklore and dialects, to Mrs. Chiyo Omachi who assembled and interpreted in English the evidence, and to Professor Toyohiko Kawabata of Chiba University for verifying the usage in the various *gun* of his prefecture.

Thus in Japan we have irrefutable evidence of an association between toads and fungi of indigenous inspiration, and for us the astonishing feature is that this association is tied to fire and a fire divinity.

Professor Roger Heim described in his *Revue de Mycologie* in February 1936 three giant boleti of Madagascar and tropical Africa. One of these bears the scientific name of Boletus (Xerocomus) sudanicus Har. et Pat., and is native to Central Africa. In the course of Professor Heim's article there appears a footnote wherein the reader is told that in the region known as the Chari the native name for this edible and highly esteemed boletus is *hegba mboddo*, and that this means literally 'toad's stool'. The Chari is an important river running north and west through French Equatorial Africa, emptying into Lake Chad. For our inquiries Professor Heim's report was of the highest interest. Was it conceivable that a people in the heart of Africa used the same fungal metaphor as the peoples in the North Sea basin? In the cultural crazy quilt of darkest Africa could we discover the race for whom *hegba mboddo* was a fungal designation? Our explorations (by correspondence) covered the Sara and certain other Sudanese languages, and also five of the languages of the Sudan central tribes: Kara, Banu, Gbe, Kaba, and Sango. In every case the results were negative, as they were at first among the Bantu peoples. At this point we consulted Professor Archie N. Tucker, of the School of Oriental and African Studies at the University of London, and he knew the answer at once: *hegba mboddo* is a term used by the little known people of Bongoland, described by the German explorer Georg Schweinfurth following his visit to the Bongo country in the 1860's. His book appeared in English in 1874 as *The Heart of Africa*, and he is the authority for the use of the term that interests us. In Schweinfurth's time no white men had previously visited the Bongo people and observed them, and there can be no possibility of European influence. The Bongo live in the very heart of Africa, in two enclaves, north of the 7° parallel North and to the westward of the 29° East longitude. They are a farming folk. Here is what Schweinfurth had to say about the mycophilia of the Bongo people:

> During the rainy season the country is prolific in many kinds of funguses. The Bongo have a great fancy for them; they keep them until they are on the verge of decay, and then dry and pound them. They use them for the purpose of flavouring their sauces, which in consequence are enriched by a *hautgout*, which without depreciation may perhaps be compared to rotten fish. Throughout the country I never saw any funguses but what were perfectly edible, and some of them I must confess [sic] were perfectly palatable. The natives call them all 'kahoo', while to the larger species they give the special name of 'hegba-mboddoh', which is synonymous with the Low German 'poggen staul', or with the English 'toadstool'. 'Hegba' is the name which the Bongo give to their little carved stools, and 'mboddoh' is the generic term for all frogs and toads, and the proper name for the *Bufo pandarinus* in particular. This 'hegba mboddoh' which has thus suggested the same idea in very remote parts of the world, is here a gigantic polyporus; not infrequently specimens may be found of it which grow to a height of nine inches, and a foot in diameter and weigh nearly fifty pounds. In form, size, and color they are not unlike the grey clay edifices of the *Termes mordax* ... The funguses which are the most common, and which are moreover the most preferred, are the different species of coprinus, marasmius, rhodoporus, and the tough but aromatic lentinus.

The Bongo have been neglected by anthropologists: Schweinfurth is still the principal authority on them. His testimony about the *hegba mboddo* is certainly trustworthy, but it should be verified and amplified. The giant fungus is eaten by the Bongo: for them the association with the toad is not an epithet of mycophobic rejection. Who will discover for us the full meaning of the toad in the culture of the natives of Bongoland? Must we go there ourselves to arrive at the answer? The language of the Bongo is one of a large group including Sara (of which Kaba is a member), Kenga, and Bagirmi.

The discovery of the 'toadstool' in Bongoland is sensational for us with our peculiar interest, but this is not the end. Professor Tucker happened to lay our question before Mr. Jalo Gombe, an African in London at the time our letter reached him. He belongs to the Fulani people, in Nigeria, far to the west of the Bongo and separated from them by many African peoples. He is a teacher in the senior high school at Gombe, a community that one reaches by way of Jos. 'Fulani' is the name of this people in the Hausa language. The French call them 'Peul'; in their own language one Fulani is 'Pullo', more than one 'Fulbe', and they call their tongue 'Fulfulde'. It is essential to set forth these various words, as they are all in current use and can cause confusion. Mr. Gombe in a long and informative letter apprises us that in his native language the general word for all wild mushrooms is *koro:wal pa:bi*. (The colon indicates a long vowel; the *b* in this word, like the *dd* in *hegba mboddo*, is what linguists call 'implosive' or 'ingressive'.) *Koro:wal* means 'stool' and *pa:bi* is the word for frogs and toads. Mr. Gombe further informs us that wild mushrooms are not eaten by the Fulani, nor do they eat frogs or toads though certain neighboring tribes do so. The Fulani consider toads unclean and some, especially among the women, fear them. Toads are used in folk medicine. There is a disease of the forehead called in Hausa 'monkey's forehead' (*goshin* Inn); to treat it the Fulani rub the forehead with the belly of a living toad, and it is said that the patient then recovers and the toad, thrown away, dies. The skin of the toad is used as a charm and when "placed somehow may cause someone impotency". A certain toadstool mixed with a certain tree fungus and soaked in water is used in treating venereal disorders.

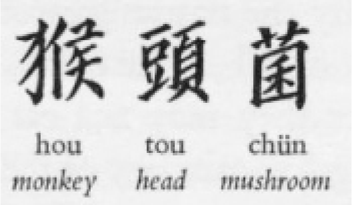
Our African inquiries led us to a third discovery. In Uganda the principal province is Buganda (of which 'Uganda' appears to be a corruption), and the principal native clan in that province is known as the Baganda, whose language, called Luganda, belongs to the immense Bantu family. All of the clans of Buganda are valiantly mycophagous, according to our gifted native informant, M. B. Nsimbi, of Kampala. The Baganda are known as the 'mushroom clan', for they have as their totem two kinds of mushrooms, known in Luganda as the *bubaala* and the *namulondo*. By the native gastronomes of Buganda the *bubaala* are the most highly prized of all mushrooms, but the Baganda must deny themselves these delights, for they may not eat their own totems. For us the interesting feature of the fungal vocabulary of the Baganda is the presence of the toad. There is a mushroom known in Luganda as the *ngngoma-ya-kikere*, which means 'drum-of-toad', and which no one eats. In shape it suggests the native drum, which in Africa is traditionally a symbol of authority, analogous to the parasol in India.

In conclusion, then, we discover in the interior of Africa two peoples, both of them remote from each other geographically, linguistically, and culturally, who possess indigenous terms for mushrooms that are semantically identical to the 'toadstool' of the North Sea basin. One of these peoples, the Bongo, appear to be mycophiles, and the other, the Fulani, are mycophobes. In addition, we discover a third people, who associate a drum-shaped mushroom with the toad. Among Africans both the drum and the stool sometimes symbolize authority.

Up to this point in our book we have only touched on China and the cult of the mushroom in the Chinese cuisine. The subject is vast and the sources of information are inaccessible. We shall do no more than offer two samples of Chinese lore that have happened to come to our attention.

There is the problem of *mo-gu*. This is the colloquial name in northern China of the *Clavaria pistillaris*, one of the mushrooms most highly esteemed by Chinese epicures. In the Mongolian language we discover a general word for mushrooms, *rndgti*, and the Chinese word may have been imported with the *Clavaria pistillaris* from Mongolia. Is it possible that the Mongolian word was a borrowing from Indo-European, being in short another member of our sponge cluster of fungal words descended from the same root as σπόγγος? The phonetic evolution in Mongolian is not impossible. An initial 'p', passing through 'b', would become 'm'. The alternation between 'b' and 'm' in Mongolian is well attested, e.g., *becin* and *mecin*, meaning monkey. There is also precedent in Mongolian for dropping an internal nasal in borrowed words.

In the fungal hierarchy of the Chinese cuisine the highest rating belongs to the Monkey Head Mushroom, concerning which Mr. K. C. Wu, the former governor of Formosa, has given us curious information. This is a rare mushroom, sells at a high price, and never passes through the vulgar marketplaces. Its *parfum* is of exquisite delicacy, and it transforms any dish that it flavors. So precious is it that only the best cooks are entrusted with it. The Monkey Head Mushroom is represented in Chinese characters thus:



猴	頭	菌
hou	tou	chün
monkey	*head*	*mushroom*

It is found only in the high mountains of Central China, and the best come from the sacred range of Sung

Mountains:

嵩	山
sung	shan
sung	*mountain*

They grow out of the trunks of trees, and are of the size of small monkey heads, with yellow hair, two dots for eyes, and curves that are singularly suggestive of a nose and mouth. We are told that where one grows another is always to be found, and they are considered mates, male and female. When you find one, you follow the direction of its eyes, and there on another tree is the other one. They gaze on each other in a perpetual trance. Who is the mycologist that will identify for us the Monkey Head Mushroom?

18

The Anatomy of Mycophobia

In the course of these pages we have often spoken of the different emotional attitudes toward wild mushrooms that mark the members of the European family of peoples. Heirs of a common Indo-European culture, sharing the same linguistic heritage and folklore, their diversity of response to the fungi is amazing, and, we must admit, baffling. Our information is insufficient in extent and precision for the compilation of a *carte mycophagique* of Europe. But by pulling together the threads of evidence available to us we may suggest what such a map would show, and draw attention to the curious traits that compose the mycophobic syndrome.

In the first place, the feelings of a people for wild mushrooms are unrelated to the supply. Wonderful mushrooms are abundant in both Norway and Muscovy, but the mushroom lore of the Norwegians is poor. The Portuguese are almost as steeped in mycophobia as their neighbors in Castile, though Portugal is by comparison rich in fungi. The Catalans live next door to the mycophobic Spaniards, and yet the Catalans are to be numbered amongst those rare peoples whose folk knowledge of the wild mushrooms is breath-taking in range and subtlety. But perhaps the classic illustration of the point we are making is to be found outside Europe.

The Arabian desert is not a land that mushroom-eaters would think to visit on pilgrimage; nonetheless, we discover that the Bedouin are passionate mycophiles. An authority on the Arabian nomads, Colonel H. R. P. Dickson, mentions this repeatedly in his admirable work on *The Arab of the Desert*, and in a letter to us he has nobly developed the theme. While the Arab eats various kinds of mushrooms with relish, the desert 'truffles' are his favorites. These fungal growths, which never emerge to the surface of the earth, are usually called 'truffles' by Europeans, but in fact they belong to a different genus, the *Terfezia*. From classical times they have been esteemed in northern Africa, and in the market of Damascus they are sold in quantity under the local name of *kame*.

According to Colonel Dickson, scattered over Northeast Arabia, on Bahrain Island, and in the Qatar peninsula, there are spots well known to the Arabs where *Terfezia* grow, always in the company of the rug-rug bush, known to science as the *Helianthemum lippi*. The Arab cannot count on his mushrooms. He keeps on the lookout for heavy rainfalls in the *wasm* season, which corresponds to our October, and if the rains then are heavy, and if they are accompanied by thunder and lightning, and especially if the rains recur throughout winter and spring, then the Arab knows the year will be good for mushrooms. When the conditions are propitious, in February and March the black-tent folk strike their tents, and journey to the familiar places, and then the women and children go forth early in the morning for the sunrise, or late in the day for sunset; and the shepherd boys, out with their flocks, are on the lookout too. For as the slanting rays of the twilight sun streak across the horizontal earth, the practiced eyes of the women and children detect the slight shadows cast by the monticules that the swelling *Terfezia* are pushing up. During the spring months of a good year, these growths are as satisfying as meat to the Bedouin. He eats them roasted in hot ashes and dipped in salt, or fried slightly (after soaking in water with a pinch of salt) in clarified or fresh butter. The Arab women also slice them and dry them in the sun, and then keep them for eating in summer, or even for years as a food reserve. There are two kinds of these *Terfezia* known to Colonel Dickson, the white *zobaidi*, which are the best, and the *khlas*, smaller, brown, and less tasty.

Europe is sharply polarized, mycophagously speaking. At opposing ends of the Continent there are two areas where the folk knowledge about mushrooms is prodigious, sometimes truer than the manuals, and where the affection for them is wide and deep. There are also two areas of Europe, poles apart, where mushrooms are generally ignored or loathed. In between are all the other peoples, with varying degrees of knowledge and subtle gradations of feeling.

The Great Russians are a mycolatrous folk, and of this some readers will consider our book manifest proof. The Poles, the Slovaks, and the Czechs are ardent mycophiles, and are sure to resent as an impudent and even imperialistic pretension my view that the Great Russians are in a class by themselves in this respect. I have never heard a contemptuous remark about mushrooms from a Great Russian; I recall none in our literature. But on an earlier page we have seen what Poland's greatest poet says. The Czechs know their mushrooms like few others; but why are they in deadly dread of the *Boletus satanas*? This is a mushroom that, properly cooked, strong stomachs can tolerate; yet the Czechs shun it like the deadly amanita. Our neighbors the Lithuanians are great mushroom eaters. I do not know enough about them to give them a rating. Is their appetite for mushrooms indigenous or borrowed from the Slavs? Here is a pretty problem to be coolly considered. It is certain that the interest in mushrooms among the Slavs slides off as one goes South. The Ukranians show less interest, and the Balkan Slavs are almost apathetic; it is said that the monastic clergy in Rumania and the other Balkan countries maintain a mycophagous tradition well above the level of the surrounding peasantry.

The Finns present an interesting pattern. By tradition mycophobes, they still reject most mushrooms. But over much of the country they have learned from the Russians to eat lactarii, and in Carelia, where Russians used to go on vacations, they know and love many species. In the south-west there is a small area where only the chanterelle is eaten - clearly a cultural emanation from Sweden.[183]

The focus of mycophagy in the West lies in that stretch of Mediterranean littoral which embraces Catalonia and the Provence. In what is perhaps the best list of vernacular names for mushrooms ever assembled, the Catalan savants Joaquim Codina and P. Font Quer brought together a vocabulary of about 220 words, all of them genuine, identified with the localities where they were heard.[184] The country folk of Provence are similarly proficient in mushroomic lore. Whether this intensive mycophilic knowledge prevails west of the Rhone and in Roussillon, thus linking Provence with Catalonia, we do not know.

Just as Muscovy and Catalonia may be taken as the citadels of mycophagy, so as to mycophobia the foci of infection are found on the one hand among the Celts and Frisians along the shores of the Atlantic and the North Sea, and on the other hand in Greece. The Greeks have always been mycophobes. All of the early Greek poets - Homer through the dramatists - ignore the mushrooms. The earliest references to them are in the fifth century, and, as is fitting in a mycophobic world, both refer to poisonings.[185] Next we encounter Nikander of Colophon, the didactic poet of the 2nd century B.C. whom we have already cited. In his *Alexipharmaca* he speaks thus of the mushroom tribe:

> Let not the evil ferment of the soil injure a man; it will often swell up in his chest, at other times it will choke him, when it is fostered over the viper's coil deep in its lair, sucking up the monster's venom and the noxious breath from its mouth. This is the evil ferment which they call Fungi in general. [Quoted by courtesy of Cambridge University Press from translation by A. S. F. Gow and A. F. Scholfield]

From beginning to end in the writings of the ancient Greeks we find not one enthusiastic word for mushrooms. Even Athenaeus, that addict to the fleshpots whose lengthy writings give us an invaluable picture of daily life in ancient Greece, was no friend of the mushroom world. "Mushrooms grow on the ground," he said, "and few of them are edible. Most of them cause death by choking." The botanist Theophrastus was incompetent in his discussions of the fungi, and while Dioscorides and Galen were better, many of their observations were grossly inaccurate, and they are interesting on this subject chiefly for the further proof they offer that the Greeks were mycophobes. To this day the Greeks pay no attention to wild mushrooms, like the English eating only the *Psalhota campestris*, which they call μανιτάρι, a word descended from the classical ἁμανῖται.[186]

---

[183] The Finnish attitude toward mushrooms is discussed in detail in Toivo Rautavaara's *Suomen Sienisato*, published in Helsinki; for English summary see pp. 420-1.

[184] See the botanical journal *Cavanillesia*, vol. III, Barcelona, 1931.

[185] Athenaeus quotes Eparchides concerning a tragic episode that came to the attention of Euripides. The other early reference is in Hippocrates, *Epidemicorum*, Book VII, par. 102.

We believe that this mycophobia of the Greeks holds the key to the meaning, hitherto unperceived, of a famous anecdote about Nero that Suetonius recorded. Suetonius, writing a half century after the event, accused Nero of having been privy to the murder of Claudius, supporting his charge by an inference: "for Nero used afterwards to laud mushrooms, the vehicle in which the poison was administered to Claudius, as gods' food [*deorum cibum*], as the Greek proverb has it." This witticism, alluding to the posthumous deification of Claudius, is stale now from age and repetition, but thanks to it we possess a Greek saying nowhere else recorded. Dio Cassius told the same story later, and later still we find it in the writings of Petrus Patricius, a contemporary of Belisarius,[187] who adds a telling detail. When the mushrooms came on, a guest remarked that they were gods' food, θεῶν βρῶμα. This gave Nero his opening, and how the murderous implications of his retort must have chilled the sycophantic company! What did the Greeks mean by 'gods' food'? Certainly not 'food fit for the gods', which would have called for different phrasing. Robert Graves suggests an answer. We know from Pliny that in the fashionable circles of Rome mushrooms were all the rage. But not so with the Greeks. It was surely a mycophobic Greek who interposed the Greek saying when he saw the mushrooms arrive, just as an Englishman on the Continent turns from a dish of morels because for him they are toadstools, or just as a Fleming in former times would have scorned *duivels-brood*, 'devils' bread'. 'Gods' food' and 'devils' bread', in their innermost meaning are synonyms, verbalizing the ancient tabu. We suggest that they go back to the time when the divine mushroom was holy and therefore unclean for all save the king-priest.

In one striking respect the lands of extreme mycophilia and extreme mycophobia are alike: they are equally free of mushroom poisonings. Your Frisians never die from toadstools, for they never touch any wild fungi. And your Provençal villagers are equally safe, for they know which to eat. Henri Fabre in *The Life of the Fly* tells us that during his thirty years in the Provençal village of Sérignan, he had never heard of even the mildest indisposition from mushrooms, and this in face of the fact that his neighbors habitually ate many species described in the manuals of the day as poisonous or suspect! Fatalities from mushrooms take place where peoples are in transition, moving up in the scale of mycophagy.

There is abundant evidence that slowly, very slowly, the peoples of Europe are learning to eat wild mushrooms. Their progress is reflected in their vocabulary. Some words that were born with a pejorative curse rise in status and acquire excellence in the course of centuries; such, we believe, are *mousseron* and *cepe* in French, and *boletus* in Latin. More often a new and appetizing word is borrowed from a mycophagic people to designate a mushroom that, seen in a new light, has come to be esteemed for food. Such is 'mushroom' in English, and *champignon* throughout the other Germanic lands, and *boletus*, which in German has become *Pilz*. Specially interesting is the Swedish name for the cep: *Karl Johans-svamp*, named after the founder of the present royal family, King Charles XVI John, a Frenchman, who having risen from the ranks to become Napoleon's General Bernadotte, was elected to Sweden's throne in 1818. It was he who drew the attention of Swedes to the succulent properties of the *Boletus edulis*. We discover without surprise that the Bernadottes were a Gascon family, hailing from that province of France which is renowned for ceps. A good Gascon, General Bernadotte was a missionary of mycophagy to the mycophobic Swedes.

The mycophobic peoples seem to acquire their knowledge in little leaps, suggestive of the quantum theory, learning to like one species after another. The English generally know only the *Psalliota campestris*, and the Norwegians the *Cantharellus cibarius*; the Spaniards of Castile eat two kinds, the *mizcalo* (a lactarius) and the

---

186. On Mount Athos Russian and Greek monastic communities have lived in close proximity for centuries. In the Eastern Church the dietary rules and customs of the monks play a big role, and it would be interesting to learn how the addiction of the Russian monks to mushrooms has affected their mycophobic Greek brethren. We have done our utmost, by correspondence, to arrive at the facts concerning this cultural tide-rip on Mount Athos, but without success: the good monks seem unable to enter into the spirit of our humanistic inquiry.
187. The three versions of the episode are to be found in the Loeb editions of Suetonius and Dio Cassius.

seta de cardo (*Pleurotus eryngii*), by contrast with the vast command of the subject enjoyed by the Catalans. The poverty of the Spanish language when it comes to mushrooms occasionally works a hardship on Spanish writers: in the Spanish encyclopaedias the authors of the articles on *hongos* must resort to Catalan and Basque words to piece out the poor Castilian vocabulary. The Spanish public has never been offered a Spanish mushroom manual, and if a Spaniard should seek to explore the mushroom world, he must resort to a Basque work, *Setas u Hongos del Pais Vasco*, a treatise in two slim volumes written in Spanish by Telesforo de Aranzadi and published in 1897. Based entirely on observations in the Basque country, it is precious especially for the wealth of Basque vernacular names that it records. The public demand for this work must have been modest, for the original edition is still in print and copies are available generally in Spanish book shops.

In Portugal the peasants know chiefly the *Lepiota procera*, which they call the *nisco* or *centeiro*. The Basques, with a substantial vocabulary, are well advanced in mycophagy, but many of their words are borrowed, and mycophagy among them is perhaps not indigenous. Strangely, they possess no name for the *Lactarius sanguifluus*, which is esteemed by both Catalans and Castilians. On the other hand, we can testify that in Viscaya the Basques manifest an addiction for the *Russula virescens*. In the west of that western Basque province, this mushroom, which is the best of the russulas, is called by a specific name - *guibelurdina*, but in Guernica it appears to so dominate the field of mycophagy that it becomes simply the 'mushroom' - *perretxiko*.

Various strands of evidence support our view that Western Europe is progressing in mycophagy. Take Italy, for example. Today immense quantities of mushrooms are eaten there, and the local names are numerous. But we observe that poisonings often occur - a sure sign of imperfect knowledge. From Pliny and other ancient writers we know that certain mushrooms were fashionable among the fastidious elite in imperial Rome, but if we ask our question about the rest of the population, we must admit that we know little. Apicius gives us various mushroom recipes, and Pliny describes several kinds with sufficient detail for us to guess at their identity, in two or three cases with confidence. But Pliny himself looked down his nose at mushrooms, and there is one sentence in his *Natural History* that, almost by inadvertence, reveals his own mycophobic leanings. With some impatience he admits that others know more about mushrooms than he. "Who, in fact," says he, "is able to distinguish among them, except those who dwell in the country, and those who are in the habit of gathering them?" That is, who knew the mushrooms except the untutored rustics, mute for us, and the minions of the epicures in the great city? As to the epicures, Pliny with disdain tells us that mushrooms were the only dish they would prepare with their own hands, thus relishing them twice over, once in anticipation and once in the eating. Here are the rich phrases of Pliny's Elizabethan translator, Philemon Holland:

> ... our fine-mouthed and daintie wantons who set such store by their tooth, take so great delight to dresse this onely dish with their owne hands, that they may feed therupon in conceit and cogitation all the while they bee handling and preparing the same, furnished in this their businesse with their fine knives and razors of amber, and other vessels of silver plate about them.

On an earlier page we saw that *fungus* was an epithet in ancient Rome, the equivalent of 'dunce' or 'gump' in English - an indication that the people who so used the word had little esteem for mushrooms.

Jumping now to Renaissance times, we open the earliest printed cookbook, entitled *De Honesta Voluptate*, attributed to a Vatican dignitary named Platina and printed in Rome c. 1474. There we find a section on mushrooms, and it is a farrago of mycophobic nonsense, of a kind that would not be tolerated by discriminating Italians today. It must have expressed more or less the sentiments of the upper crust in the Rome of Platina's day. This work was translated into many languages and it almost monopolized the cookbook market for a century and more. The French version, of which we have consulted an edition published in Lyons in 1505, has a peculiar linguistic interest: the translator uses various words for 'mushroom' and among them is *fonge*. This may have been the translator's bookish invention; at any rate *fonge* never took hold in France, the only part of Romanic Europe where *fungus* has had no verbal progeny in the vernacular.

Two centuries before Platina another Italian, Aldobrandino da Siena, composed in French a medical treatise, *Le Livre pour la Sante du Corps*, at the behest of the Countess of Provence, Beatrice of Savoy. It appears to have been finished in the year 1256 and it survives in many manuscripts copied in the course of the ensuing centuries. Aldobrandino relied heavily on the writings in Arabic of a 10th century physician living in Egypt, Isaac Judaeus. Here too we find a chapter on mushrooms. Aldobrandino writes in the purest mycophobic vein, the best that he can say of mushrooms being this, that some there are which are not so bad. Though written in

French, the Aldobrandino work cannot of course be taken as an expression of a French attitude. It is of special interest to us for the illuminated initial with which the chapter on mushrooms begins.

Coming to France itself, we begin by observing that the French Canadians know nothing of wild mushrooms and never eat them. Their ancestors came largely from Poitou, with a sprinkling of Basques, Bretons, Channel Islanders, and Normans. A conservative people, the *habitants* would not have given up mycophagy in the New World, where the forests are rich in kinds that are common in France. It seems probable that in their ancestral lands mushrooms were not eaten three centuries ago, and certainly this is still true of the Bretons. Mycophagy in France is spreading north from the Midi and Gascony. The reports of poisonings, the modern diffusion of new names like *cepe*, the constant revision of municipal regulations governing the sale of mushrooms - these all bear witness to growing pains as mycophagy gains ground. Though wild mushrooms are commonly offered in the marketplaces of France in the appropriate seasons, it is not unusual to meet French folk who know nothing whatever about them, not even the names of some of the common kinds. Van Sterbeeck in his *Theatrum Fungorum* on page 117 quotes Clusius, native of the French city of Arras and father of modern mycology, as saying that he had never eaten a mushroom! An underlying mycophobia would explain the readiness of the French to associate wild mushrooms with toxic properties. The king of the elephants in *Babar* dies, in defiance of nature, from eating a fly amanita; and the death of this beloved albeit imaginary beast implants the microbe of mycophobia in the defenceless minds of countless children. One of the best French movies, Sacha Guitry's *Le Tricheur*, hangs its story on the death of a whole family from mushrooms. Jules Romains in his play, *Knock ou le Triomphe de la Médecine*, introduces a lady of the French landed aristocracy who sells a property called la Michouille where mushrooms never grow, the very name being derived from *mycodium*, 'hate of mushrooms', a strange conceit that we think only a mycophobic writer would invoke. But in Marcel Moussy's *Arcole ou la Terre Promise* there is an idyllic setting in which a young couple go mushroom gathering.

Certain *gastronomes* among our French friends resent our imputation of mycophobia to the French. But take Montaigne. This giant of the Renaissance, who poured the rich contents of his mind and feelings into his essays, ignores the fungal world. Not even truffles are so much as mentioned by this son of Perigord. True, Montaigne had apparently little interest in food and drink of any kind. But then let us look at his elder contemporary, whom he admired, François Rabelais. When Epistemon visits the abode of the damned, he discovers there all the personages of antiquity, and finds that for all eternity they are condemned to menial and insignificant occupations: Alexander the Great darns breeches while Dido peddles mushrooms! Elsewhere Rabelais presents to his readers an obnoxious character called Lent-observer whose pinched soul knows only denial. He had a *potiron*, mushroom, for a chin, and his excrement consisted of morels and toadstools. There is never a kind word for mushrooms in Rabelais, this native of Chinon in the very heart of France.[188]

It is never easy to trace down the centuries the gastronomic role of a kind of mushroom. Perhaps the distinctive truffle offers us the best opportunity for such a chronicle, yet here too we encounter contradictions. According to M. G. Malençon in *Les Truffes Europeennes*,[189] for a thousand years after the fall of the Roman Empire no one in Italy or France paid attention to truffles. In the 14th century they reappeared. During the Renaissance the truffle of Perigord - *Tuber melanosporum* - established its ascendancy, and with some ups and downs thereafter maintained a secure place high in the firmament of gastronomic values in the most exalted circles of France. We have already seen that the English diarist Evelyn was making the acquaintance of truffles in Vienne in the 17th century, and after the Restoration in England they begin to appear in cookbooks across the Channel. Yet we have also seen that Brillat-Savarin in the early 19th century considered the truffle a modern innovation in Paris. These seeming contradictions can be reconciled when we remind ourselves that we are dealing with accidental references by writers belonging to the articulate elite of France and England. In our section on the truffle we produced linguistic evidence showing that the truffle was always an article of commerce in the humble marketplaces of the Mediterranean peoples, bought and sold and consumed by countless generations of unlettered folk.

---

188. Rabelais refers to mushrooms in Book II, chap. 30; and in Book IV, chapters 31, 50, 57, and 60.
189. Published as Memoir hors-serie N° I by the *Revue de Mycologie*, April 1, 1938.

In the beginning the Germanic world was steeped in darkest mycophobia. Certainly nowhere in European literature is there a more perfect expression of loathing for mushrooms - all the more eloquent because taken for granted - than in the writings of Saxo Grammaticus, the Danish historian who flourished about A.D. 1200. He was telling of a military campaign waged in Sweden by Hadding the Dane in the 10th century, and how the Danes ran out of provisions, and were driven to the last extremities of hunger. Here in Book I: VIII: 7 of his *Saxonis Gesta Danorum* we discover the low opinion in which the Danes of olden times held wild mushrooms:

> ... After the spring thaw, Hadding returned to Sweden and there spent five years in warfare. By reason of this lengthy campaign, his soldiers, having consumed all their provisions, were reduced virtually to starvation, and resorted to forest mushrooms to satisfy their hunger. Finally under pressure of extreme necessity they ate their horses, and in the end they satisfied themselves with the carcasses of dogs. Even worse, they did not scruple to eat human limbs.

Now that the passing centuries have dimmed for us the personal sufferings of Hadding's host, we may permit ourselves to be amused by the graduated stages[190] of their desperation as reflected in their diet, and our thoughts turn to what soldiers of other origins would have done in a like pass. Had they been Celts, they would surely have eaten horses, dogs, and each other before turning to the foul fungi of the forest. If they had been Slavs of the North, they would have been feasting on those noble mushrooms from the outset of their long campaign, and, fortified by the delectable fare, would have engaged the enemy like lions, and most certainly turned the tide of war. Until General Bernadotte, when King of Sweden, spoke well of ceps, neither Lapps nor Swedes ate mushrooms. We know this because Linnaeus tells us so. In the section on the fungi in his *Flora Lapponica*, he observes that in Sweden only foreigners consider mushrooms fit for eating, nor does he except himself from the general rule. What a pity that the great Linnaeus was a mycophobe!

As for the Lapps, Linnaeus in the same work tells us where their fungal interest lay, and the passage is unique in ethno-mycological records. Linnaeus devotes a lengthy section of his work to the fungi of Lappland, and as he comes to the end and is describing *Boletus* spp., which he calls 'suavaeolens', he reports that the young Lappish swains when stepping out to keep company with the Lappish girls would carry this fungus in a little bag over the male member, that its scent might please the nymphs. The 'boletus' used in this way, according to Professor Heim, was undoubtedly the *Trametes suavaeolens* Fr. ex Linn., conspicuous for its strong odor of anise. Linnaeus was frank in his description:

> Adolescentes hunc inventum sollicite servant in *marsupio ante pubem pendulo*, ut gratiorem odorem spirantes nymphis suis placeant. [Italics ours.]

When Knut Hagberg brought out his life of Linnaeus in 1939 he deprived this delightful passage of its sap by translating *ante pubem pendulo* as 'on the stomach' (*pa magen*), and his English translator further diluted Linnaeus by hanging the fungus 'from the waist'! Such is the prudery that censors the classics! The Lappish custom moved the mycophobic Linnaeus to indulge in a discursive rhapsody of the kind that lesser scientists frown upon:

> O ridicula Venus, tibi, quse in exteris regionibus uteris caffea & cocholata, conditis & saccharatis, virus & bellariis, gemmis & margaritis, auro et argento, serico et cosmetico, saltationibus & conventiculis, musica & comoediis, tibi sufficit his solus exsuccus fungus.
>
> O whimsical Venus! In other climes you ask for coffee and chocolate, pickles and sweetmeats, wines and goodies, gems and pearls, gold and silver, silks and cosmetics, balls and parties, music and the theater. Here your wants are met with a little withered fungus!

---

[190] An amusing parallel to the plight of Hadding's host is to be found in the Spanish classic, *El Viaje Entretenido*, by Agustin de Rojas, a contemporary of Shakespeare. This narrative gives a vivid picture of the miseries and adventures that were the lot of strolling players in Spain at that time. The troupe are making their way from Barcelona towards Madrid: After having exhausted our money [five *reales*], sold everything that we had left, *often eaten of the mushrooms that we gathered along the way*, slept on the ground, tramping barefoot (not for the mud but because we had no footwear), helped muleteers load their beasts, fetched water for the mules, and sustaining ourselves on turnips for four days and more - stealthily one night we came up to an inn - The italics and translation are ours.

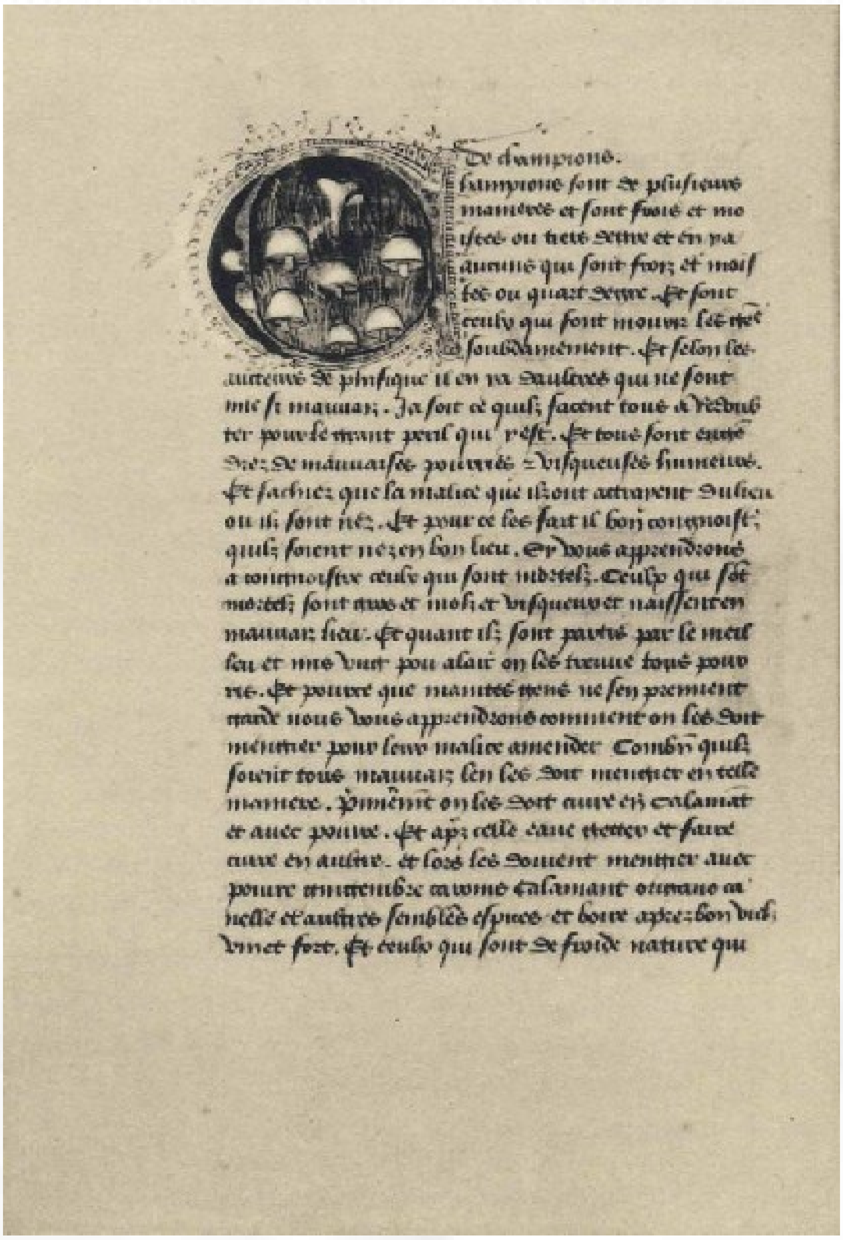


PLATE LVI

Illuminated initial from a 15th century manuscript (No. 165) of *Le Livre pour la Sante du Corps*, by Aldobrandino da Siena, 1256.
New York, The Pierpont Morgan Library.

We can show that long after Saxo Grammaticus, and even after the Reformation, mycophobia was still rampant in Germany. A few years ago there was discovered in the Copenhagen Royal Library a document of high cultural interest. It was penned early in the 17th century by a Hanseatic merchant of Lubeck who had sojourned long enough in Pskov to learn the Russian dialect of that city. The manuscript is a textbook of colloquial Russian, giving as exercises in Russian phraseology authentic dialogues recorded by the author. Among them are a few between Russians and Germans in which each side praises the life of his own home town. In the course of one such colloquy we come upon a German mycophobic boast of priceless value for our argument, proving as it does the contrast between Russian and German attitudes toward the fungal world. Here are the texts in the Russian dialect of Pskov and the German dialect of Lubeck, along with an English translation by Mrs. Elizabeth van Schooneveld, who is now editing the manuscript for publication:

> Nashi nemetzkie ljudi zhivut kak [g]ospodari, svezhe mjaso da svezhi ryby jedja[t] da vina da pivo p'ju[t], da vashi ljudi kak psy borzye, ryzh[i]ki griben jedja[t] da p'ju[t] vodu i kvas.
>
> (**Наши немецкие люди живут как господари, свежее мясо да свежи рыбы едят да вина да пиво пьют, да ваши люди как пси борзые рыжики гривен едят да пьют воду и квас.**)

> Unse dutsche lude leuen alse heren ehten fersch flesch und fersche fische, und drincken wyn und beer, und juwe volk alse beste und wynthunde ehten poggenstole und drinken wahter und qwasz.
>
> Our German people live like lords, eat fresh meat and fresh fish and drink wines and beer, and your people like beasts and coursing hounds, eat toadstools and drink water and kvas.

The aspersion thrown into the teeth of the Russians by the merchant of Lubeck is corroborated by linguistic evidence of singular probative value. The Jews of Germany some centuries ago migrated east into the Slavic lands, taking with them their language based on medieval German dialects, which we know as Yiddish. The mushroom vocabulary in Yiddish is largely Slavic, borrowed after the migration. The generic term for 'mushroom', however, is *shveml*, a diminutive form from the German *Schwamm*; the favorable *Pilz* has no continuation in Yiddish. It is clear that when the Jews migrated to Poland, they took no tradition of mycophagy with them. Apparently the Germans began eating mushrooms late in the Middle Ages, and needing a word to dignify the new dish, they turned to the Latin *boletus*, which in Valerius Cordus (1551) had become Boltz and in Clusius (1601) was *Btiltz* and is today *Pilz*. Thus *Pilz* entered Germany's fungal vocabulary at the top, to suit the dinner-table, while at the lower end of the scale the pejorative *Krotenschwamm*, also recorded by Clusius as current in his day, fell into disuse and finally disappeared from High German. Here we see how a change in names reflected, and at the same time encouraged, a change in attitude toward the eating of wild fungi. It is noteworthy that the growth of mycophagy in Germany appears to have been a response to Mediterranean influences descending culturally from above, rather than an eruption of the Slavic substratum that was still strong in Central Europe.

Today in Sweden and Denmark and Southern Germany and German Switzerland, bands of young people go out in season from the cities to gather mushrooms. The market places of Southern Germany and Switzerland are well stocked with many kinds of wild mushrooms. Is not this interest a modern thing, perhaps as modern as the sport of mountain-climbing? Do the rustics know their mushrooms as these city youths do - except as the market demand of the cities has led the country folk to respond by gathering the appropriate kinds? Is there not here a cultural penetration that began with the sophisticated city circles and spread thence to the countryside? Dr. J. Schlittler, Pilzkontrolleur of Zurich, confirms our suspicion. He tells us that in the back valleys of the Alps the peasants still reject all mushrooms, still view them through medieval eyes, clinging to the old mycophobic beliefs. We also learn that the Romanschspeaking country folk of the Surselva and the Engadine know nothing of edible wild mushrooms and care nothing, though in these lovely valleys they grow in abundance. There is evidence that while Otto Bismarck was serving as Ambassador in Russia around 1860 he discovered and mastered the art of mushroom knowing, and acquired a taste for mushroom hunting and marinated mushrooms that he took back with him to Germany.[191]

Though we think mycophagy among the Swiss is a modern growth, its hold is already secure. A story, told to us in Geneva as true, bears witness to this. An aged countryman in the Suisse Romande found himself borne down by the infirmities of age and the loss of those dearest to him. There came a time when he invited a young friend to pass a long and arduous day with him in the mountains. A glorious day it was, in the course of which the old man took pains to reveal to his companion with painstaking precision all of the spots known to him where mushrooms grew, various kinds of mushrooms but especially morels, knowledge slowly gathered on solitary rambles made for that purpose over the course of a long life. Marveling to himself at this untoward behavior, the young man showed proper appreciation and made careful note of all the locations. That night the unhappy octogenarian took his own life. His penultimate act had been to pass on to the youth of his choice his precious possession, a worldly legacy that no testamentary provision could have conveyed.

Indifference that overlies a sleeping hostility is the attitude toward wild mushrooms of the typical mycophobe in a country like England. He and his neighbors think alike about these creatures; rather, they react alike, for they do not think, ignoring as they do their own infirmity. The mycophobe does not initiate a discussion about wild mushrooms. If the subject comes up in his presence, instantly he is on his guard. He is almost sure to recall some fatal episode involving poisonous mushrooms that, he says, came within his personal experience. He admits grudgingly that some good wild mushrooms exist, but his strongly held view is that all are dangerous save a few, and these no amateur can be relied upon to identify. Yes, identification is difficult and never sure. As like as not, the mycophobe will tell you that every good kind has its deadly counterpart, as though Divine Providence had deliberately laid booby traps to catch the fool who insists upon hunting mushrooms. He is apt to go on and suggest that kinds familiar to you in your country may well be deadly hereabouts. He volunteers his advice for your own good, as one who wishes to be clearly on record that your death will be on your own head. He is dogmatic, his voice has a cutting edge. If you are bold and put questions to him, you discover at once that he knows nothing about wild mushrooms, and that he is happy and even determined to remain in invincible ignorance, feeling that that way safety lies. Furthermore, this mycophobia of the North Sea basin is a dominant trait. The English-speaking mycophobe when he goes to live in a mycophagous country seldom learns to know the mushrooms and avoids eating them. By contrast, the mycophagous Slavs who live in England or the United States sometimes succumb, albeit slowly, to the steady pressure of the hostile environment, weakly accepting the facile advice of well-meaning but ignorant neighbors who assure them that the species they knew and loved in the lands of their childhood become deadly, for some mysterious reason, inside the political frontiers of an English-speaking world. How truly John Parkinson spoke for his countrymen when in 1640, in his *Theatrum Botanicum*, he begins his chapter on the 'Dangerous Mushrooms' with the observation that he can be brief about them, for it would be to little purpose (as he says) to dwell on them, inasmuch as the English need no caution "to beware of the bad, seeing our Nation is not so enclined to the good".

---

[191] See letter written by Konstantin Leont'ev dated Dec. 3, 1887, published in *Bogoslovskij Vestnik* (**Богословский Вестник**), 1914, No. 4, pp. 776-7. Professor Cizevsky, who discovered this reference, raises the further question whether the sour cream often served with 'Bismarck herring' was not borrowed from the Russian cuisine, perhaps from a favorite way of serving mushrooms.

The Englishman's rejection of the mushroom tribe is a Pavlov reflex. We have known Englishmen who retch at the thought of eating a wild mushroom, just as some orthodox Jews do at the thought of pork. Wilmarth Lewis, presiding over the world of Horace Walpole, has drawn to our attention a delightful passage in a letter that Walpole wrote on October 17, 1758, to Lady Hervey. On the flimsiest provocation, the Duke of Newcastle had lately given an exhibition of violent mycophobia that must be considered classic. For the sake of a quotation from Jeremiah, Walpole changes Newcastle's famous chef Chloe into a woman. Here is the episode in Walpole's words:

> This will be a melancholy letter, for I have nothing to tell your Ladyship but tragical stories. Poor Dr Shawe being sent for in great haste to Claremont (it seems the Duchess had caught a violent cold by a hair of her own whisker getting up her nose and making her sneeze) - the poor Doctor, I say, having eaten a few mushrooms before he set out, was taken so ill, that he was forced to stop at Kingston; and being carried to the first apothecary's prescribed a medicine for himself which immediately cured him. This catastrophe so alarmed the Duke of Newcastle that he immediately ordered all the mushroom beds to be destroyed, and even the toadstools in the park did not escape scalping in this general massacre. What I tell you is literally true. Mr. Stanley, who dined there last Sunday, and is not partial against that court, heard the edict repeated, and confirmed it to me last night. And a voice of lamentation was heard at Ramah in Claremont, *Chloe* weeping for *her* mushrooms, and they are not!

There is a striking contrast between mycophobic and mycophilic peoples when it comes to fungal vocabularies. In Muscovy and Provence and Catalonia the countryfolk possess a huge vocabulary, familiar to all, and ancient. If in those countries there be any who do not know their mushrooms, these benighted individuals are pitiful city-bred waifs, cut off from the land that gave them birth and from their proper cultural heritage. In mycophobic countries, the farmers know almost nothing about wild mushrooms and speak of them with two or three undiscriminating words. But in the cities there will be found little circles of amateurs who make a hobby or cult of their mushroomic knowledge, and who learn from manuals a large vocabulary that circulates only on their lips. The run of rustic English folk know 'toadstool', 'mushroom', 'puffball', and possibly a few localisms. If the countryman knows 'fungus', it is as a learned word. Only in cities and in esoteric circles, does one hear of truffles and morels and ceps, not to speak of death-cups, destroying angels, shaggy-manes, and all the other book-words that the manuals carry. The reader of these manuals is at a loss about these so-called vulgar names. Some are clearly of venerable lineage. For example, no mycologist would have invented the 'horse mushroom' for the *Psalliota arvensis*; the term belongs with 'horse-radish', 'horse chestnut', and 'horse mussel', wherein the first element means 'large' or 'coarse'. We think also that 'shaggy mane' for the *Coprinus comatus* may be a word of respectable lineage: as long ago as 1802 A. F. M. Willich in *The Domestic Encyclopedia* was writing about the 'shaggy spunk', a mushroom known to science in his day as the *Boletus* *hirsutus*. On the other hand, where a common name is wanting, the mycologists seem to have invented fanciful neologisms to meet the need, without troubling to distinguish genuine localisms from the fruit of their own fancies. Today there are excellent mushroom manuals in France and England, but until our generation the manuals in those countries were often saturated with mycophobic caution. I possess the Russian manual, published in 1903, that originally belonged to Tatiana, daughter of Nicholas II, in which in childish handwriting she wrote her name. It is a delightful book, full of friendliness for wild mushrooms, all of which seem to be considered good except two or three kinds that are cursorily dismissed. By contrast, some of the older manuals of France and England deliberately set out to frighten the reader. They are filled with labored warnings, giving the impression that all mushrooms are bad except a few kinds that even the careful reader can hardly hope to learn, even if he uses utmost care. By a curious twist of fate, this excess of caution in the manuals once accidentally contributed to the undoing of a murderer, as we have seen in our account of l'affaire Girard.

Wild fungi are an emotional trip-hammer for mycophile and mycophobe alike, and in the poets with their heightened sensibilities the contrast in the response to fungi is sharpest. Professor Roman Jakobson was spending the summer of 1919 in Pushkino, near Moscow, with the poet Vladimir Majakovskij, who would go out almost daily into the forest to look for mushrooms. He would usually return with a large basket full of them. He knew them all and where to look for every kind. He told his companion that mushroom gathering offered the ideal accompaniment for the composition of poetry, and in the course of that summer he composed the best parts of his epic, *150 Million*, while engaged in this pastime. During the previous season, in 1918, he had conceived his play *Mystery Bouffe* in the woods among the mushrooms.

Now contrast Majakovskij's feelings with those of D. H. Lawrence. Not long after the scene in Pushkino, the Englishman wrote his poem entitled *How Beastly the Bourgeois Is*, and to match the repugnance that he felt for his subject, he resorts to mushrooms for his analogy:

> How beastly the bourgeois is
> especially the male of the species -
>
> Nicely groomed, like a mushroom
> standing there so sleek and erect and eyeable -
> and like a fungus, living on the remains of bygone life,
> sucking his life out of the dead leaves of greater life than his own.
>
> And even so, he's stale, he's been there too long, Touch
> him, and you'll find he's all gone inside just like an old
> mushroom, all wormy inside, and hollow under a smooth
> skin and an upright appearance.
>
> Full of seething, wormy, hollow feelings
> rather nasty -
> How beastly the bourgeois is!
>
> Standing in their thousands, these appearances, in damp England
> what a pity they can't all be kicked over
> like sickening toadstools, and left to melt back, swiftly
> into the soil of England.

Here then in these two literary artists we discover the perfect mycophile and the perfect mycophobe. For the Russian a world carpeted with mushrooms is Elysium. For the Englishman that same world conjures up foul exhalations rising wraith-like from rotting swamps, and the mephitic horror turns his stomach.

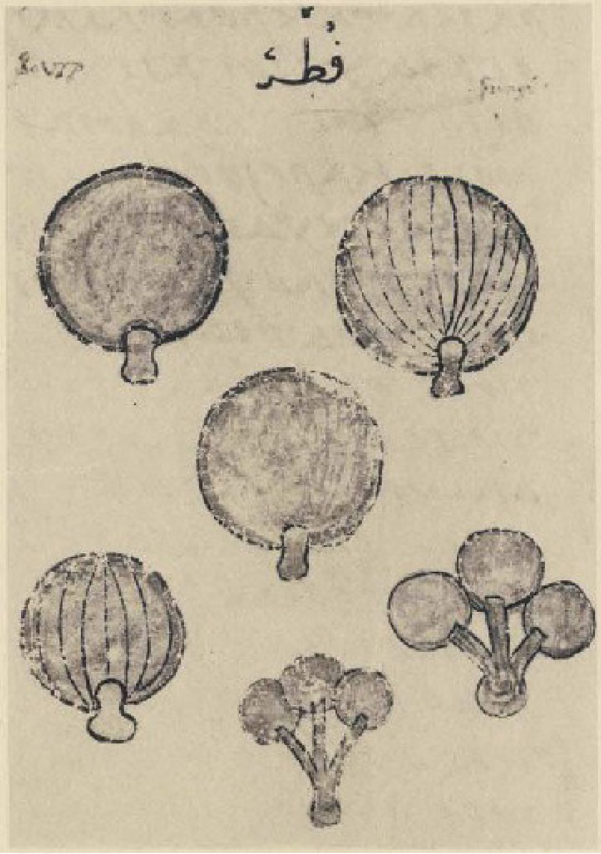


PLATE LVII-A
Mushrooms. Miniature from a 9th century codex (Grec 2179) of Dioscorides. *Paris, Bibliotheque Nationale*.

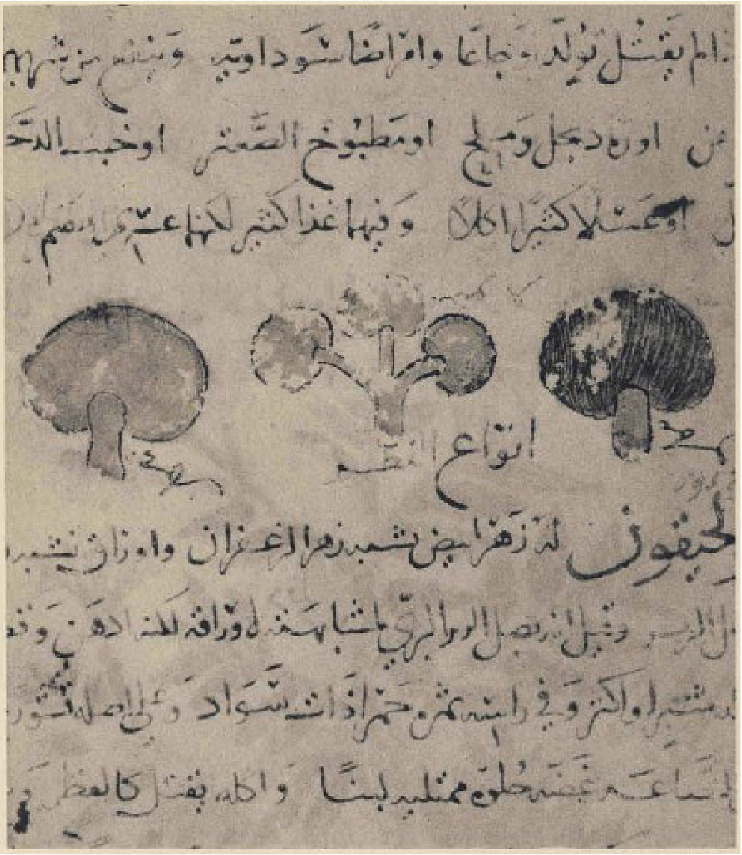


PLATE LVII-B
Mushrooms. Miniature from a 11th century manuscript (Arabe 4947) of Dioscorides. *Paris, Bibliotheque Nationale*.

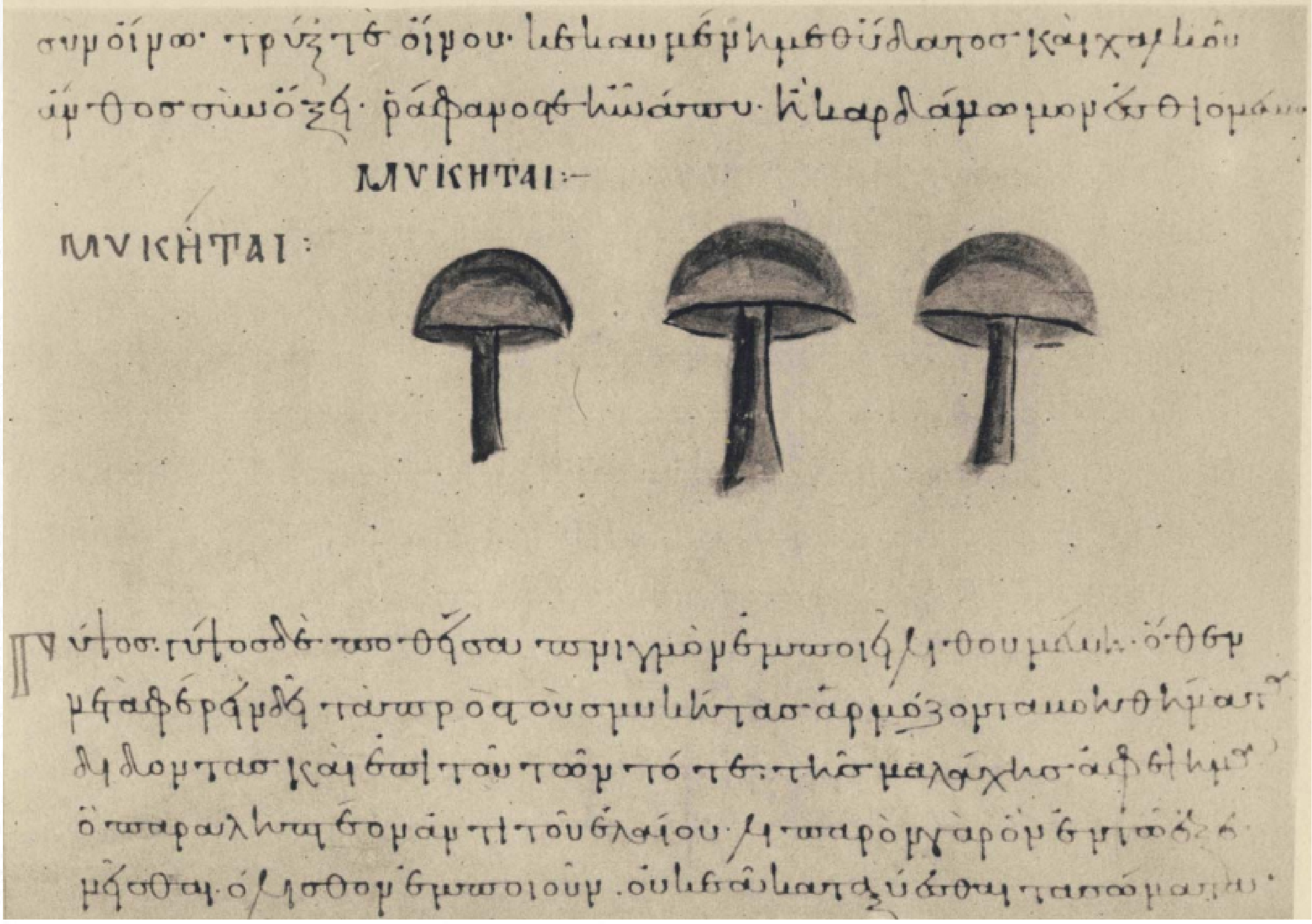


PLATE LVIII
Mushrooms. Miniature from a 10th century manuscript (No. 652) of Dioscorides. *New York, The Pierpont Morgan Library*.

19
Mushrooms in Art

Mushrooms are rare in art. In the Christian world they appear first and chiefly as illustrations for mycological texts, primarily utilitarian in purpose. Today our mycological illustrations approach perfection in some of the slick color engravings of modern mushroom manuals. Henri Fabre's water colors might also fall under this heading. But Fabre succeeded in doing more than merely catch the details significant for the student of mushrooms. He perceived and caught with his brush the eerie strangeness of these diverse creatures, he caught their grace and mystery, and in his finest compositions he far transcended the humble functions of the faithful illustrator.

In the earliest illustrations of mushrooms there was a singular unevenness of quality. Already in Plate XXXII we have shown how excellently a miniaturist in the 20th century represented the truffle, and how absurd was the first printed representation of that same truffle (fig. 10), published in Mainz in 1491. On Plate XXII we reproduced from the same 10th century Codex the illustration of the *Fomes officinalis*, and in contrast with the excellence of the truffle, the miniaturist here indulged in a startling aberration based on a popular notion that this shelf fungus possessed sexuality of a quasi-human kind. On the other hand, in the *Hortus Sanitatis* where the ill-begotten truffle appeared, the *Fomes officinalis* was rather well portrayed, growing correctly on the trunk of a larch.

The successive scribes who copied the manuscript of Dioscorides seem to have followed various traditions in their illustrations, imitating the predecessor whose work lay before them. The earliest mushroom miniature known to us is in the 9th century codex of Dioscorides now lying in the Bibliotheque Nationale.[192] There the mushrooms look like balloons or cherries or gooseberries. In the same library there is an 11th century (or slightly later) Arabic manuscript of Dioscorides, and it is clear that here the miniaturist was working in the same uninspired tradition, if indeed he was not copying from the 9th century manuscript directly. The Freer Gallery in Washington possesses a page from yet another Arabic version, this one written in the year 1224, and here the same globular forms have degenerated far indeed.

CHAMPIGNONS.

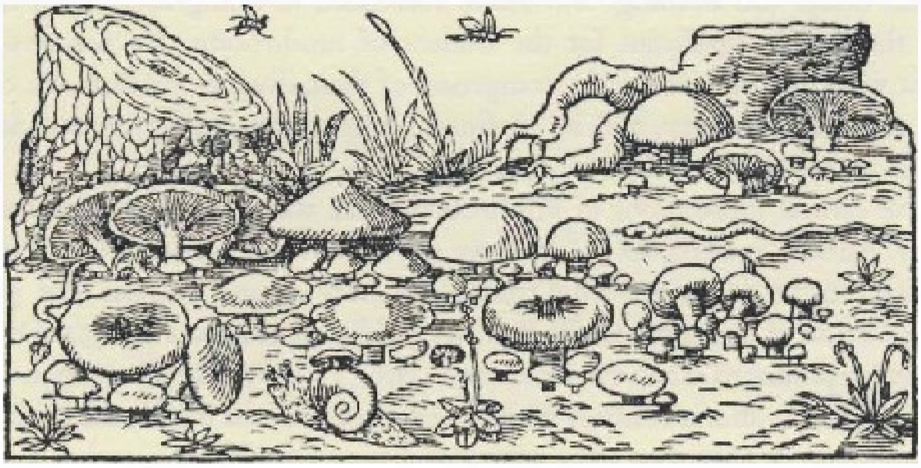


Fig. 26 - Illustration from Matthiolus' Commentaries on Dioscorides, Paris 1578.

On the other hand, in the Morgan 10th century codex there appear three capped mushrooms of superior lineage, and we permit ourselves to believe that they originated with the same artist who depicted the truffle. How exciting it would be to discover who he was and when he lived, the original begetter of this truffle and these mushrooms! Was he perhaps Dioscorides himself, or that mysterious master whom Dioscorides revered - Cratevas, attendant at the Court of Mithridates Eupator a century before Christ? Except in the various recensions of Dioscorides, we have found mushrooms in only one medieval manuscript, the illuminated initial in Aldobrandino da Siena's *Le Livre pour la Sante du Corps*. And here we discover for the first time a sense of composition. Six of the mushrooms in this initial might stem back to the illustrations in the Morgan Dioscorides, but boldly rising above them is a good representation of a craterellus. We reproduce on Plate LVI this illuminated initial from the Aldobrandino manuscript in the Morgan collection, written probably in Rouen about the year 1450, but copied perhaps from earlier versions going back a century or two.

---

[192] In our quest for early mushroom miniatures we have concentrated on mss. of Dioscorides. There are other promising possibilities that we have not explored, i.e., the mss. of Theophrastus, Nikander, Athenaeus, Galen, Pliny, and St. Isidore.

With the *Hortus Sanitatis* in 1491, the tradition of the printed illustration of mushrooms began. In the 1550's the Italian Pietro Andrea Mattioli brought out his *Commentaries* on Dioscorides, and this important book quickly passed through many editions. From the French version published in Lyons in 1578 we reproduce the woodcut accompanying the chapter on mushrooms. Here for the first time we discover mushrooms in their habitat, growing around a stump, with snakes about and 'flies' in the air. The illustrator was doing his best to cope with his text and for the first time mushrooms were being portrayed against their natural background, as it was then conceived.

Europe's storehouse of art is primarily religious in inspiration, and the religious art of Europe ignores the whole fungal world. This is not surprising, for mushrooms are not mentioned in the Bible[193] nor in the Apocrypha nor in the writings of the Early Church Fathers. Unless we make an exception for the Czech folk tale that we recounted in Volume I, mushrooms seem never to figure in hagiographical legends. The deplorable truth must be faced: the Christian religion has no mushrooms in it anywhere. True, four Saints speak of them, but of these, three were scholars writing on natural history.[194] This leaves the fourth, and let us turn to what that great man had to say.

We have seen on an earlier page in what low esteem the Protestant divine Jeremy Taylor held mushrooms. Only a few decades before Taylor's disparaging remarks, St. Francis of Sales in Geneva was giving vent to kindred emotions in that extraordinary classic of Catholic piety, the *Introduction to the Devout Life*. St. Francis and the Protestant clergyman speak from the identical mycophobic tradition, and undoubtedly in the case of these moralists the vogue in their day of certain fungi as aphrodisiacs reinforced their natural feelings. In Chapter 33 of Part 3 of St. Francis's book, he turns his attention to 'balls, and other permissible but dangerous pastimes', and then he goes on:

> I say to you about dances, Philotee, what the doctors say about *potirons* and *champignons*, the best are worthless... If nevertheless you must eat mushrooms, see to it that they are well prepared. If for some reason you cannot get out of going to a dance, see to it that your dancing is well considered ... Eat few mushrooms and eat them seldom, say the doctors, for no matter how well prepared they are, in quantity they are venomous. Dance little and seldom, Philotee, for otherwise you expose yourself to the danger of becoming addicted thereto. According to Pliny, mushrooms being spongy and porous easily draw to themselves any infection in the neighborhood, so that when near serpents they draw to themselves the serpents' venom.

Similarly, continues St. Francis, dances attract vice and sin. And just as after mushrooms it is wise to drink precious wine as an antitoxin, so after dances one should concentrate on holy thoughts.

With mushrooms virtually ignored in Christian writings, it is not surprising that they hardly figure in the mighty river of traditional European art. When once we leave aside the illustrations to mycological texts and turn to the main corpus of European painting, they are almost wholly absent until the 16th century. We have already discussed on pages 87 ff. the effigy of a Satanic boletus in Bosch's Hay Wain. This is the earliest mushroom known to us by an Old Master.

---

193. In Leviticus XIV: 34-53, there is a description of a 'plague of leprosy in a house' and some mycologists have seen in it a visitation of the fungus known as the *Merulius lacrymans*. The difficulty with this conjecture is that the house in question was constructed primarily of stone and mortar, as the text itself makes clear, and the stone and mortar were infected. The *Merulius lacrymans* attacks timber.
194. St. Isidore of Seville, St. Hildegard, and Albertus Magnus. St. Hildegard was a German nun who in the 11th century composed a medical work entitled *Liber Subtilitatum Diversarum Naturarum Creaturarum*. In Book I, 'De Plantis', she described the physiological effects (as she understood them) of the kinds of fungi that grow on the different species of trees. See J. P. Migne: *Patrologics*, vol. 197, col. 1194.

The second is in the same tradition, by a Fleming who was surely a mycophobe, Peter Brueghel the Elder. In his allegorical painting *The Misanthrope*, dated 1568 and now hanging in the Museo Nazionale in Naples, an aged man clothed in mourning advances to the left across the open fields, leaving behind him an horizon apparently aflame with fire and war. A thief, having overtaken him from behind, is slyly cutting the cord from which the old man's purse is hanging. The thief is enframed in a shadowy sphere that represents The World. Beneath the painting is an inscription in Dutch:

Om dat de Werelt is soe ongetru
Daer om gha ic in den ru.

Because the world is so untrue
Therefore go I in mourning.

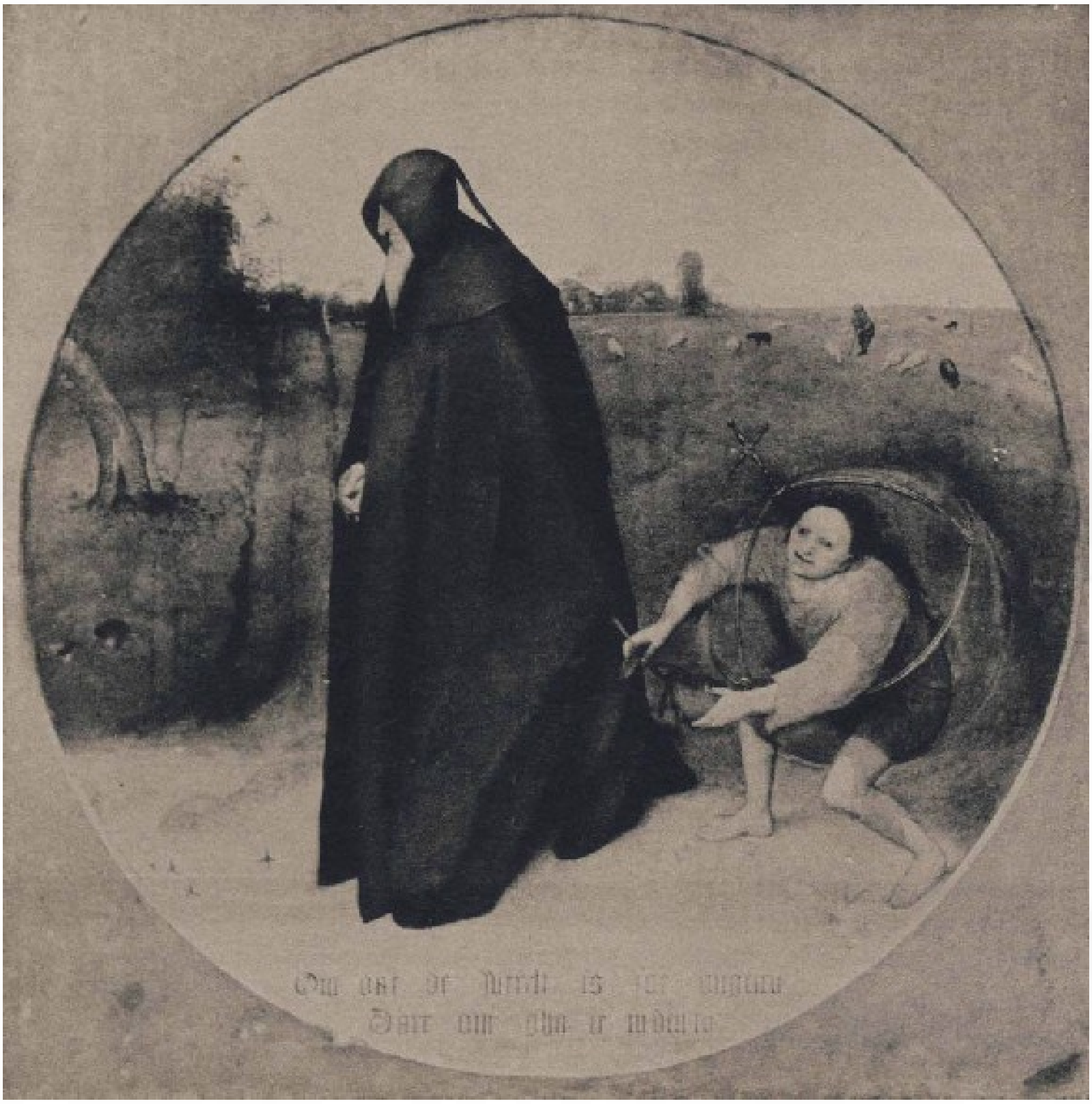

Om dat de Werelt is soe ongetru
Daer om gha ic in den ru

PLATE LIX
Pieter Brueghel the Elder. The Misanthrope. *Naples, Museo Nazionale*.

The face of the old man is not saintly, and it is said that Brueghel himself hesitated about the name to give to the picture: *False Hermit* and the *Hypocrite* were two of his choices. (Here is our perfect illustration for *Tartuffe*!) On the path before the pilgrim are three caltrops, sharp metal points of the kind that the soldiery in Brueghel's time would strew for enemy horses to step on. For us the exciting detail in this picture is the presence, close above the metal points, of two mushrooms, and a cluster of vaguely discernible mushrooms to the immediate right of the tree stump. Here again is the 'Devil's bread' of Bosch. These mushrooms suggest boleti, but with the passing centuries the painting has deteriorated and the species cannot be identified.

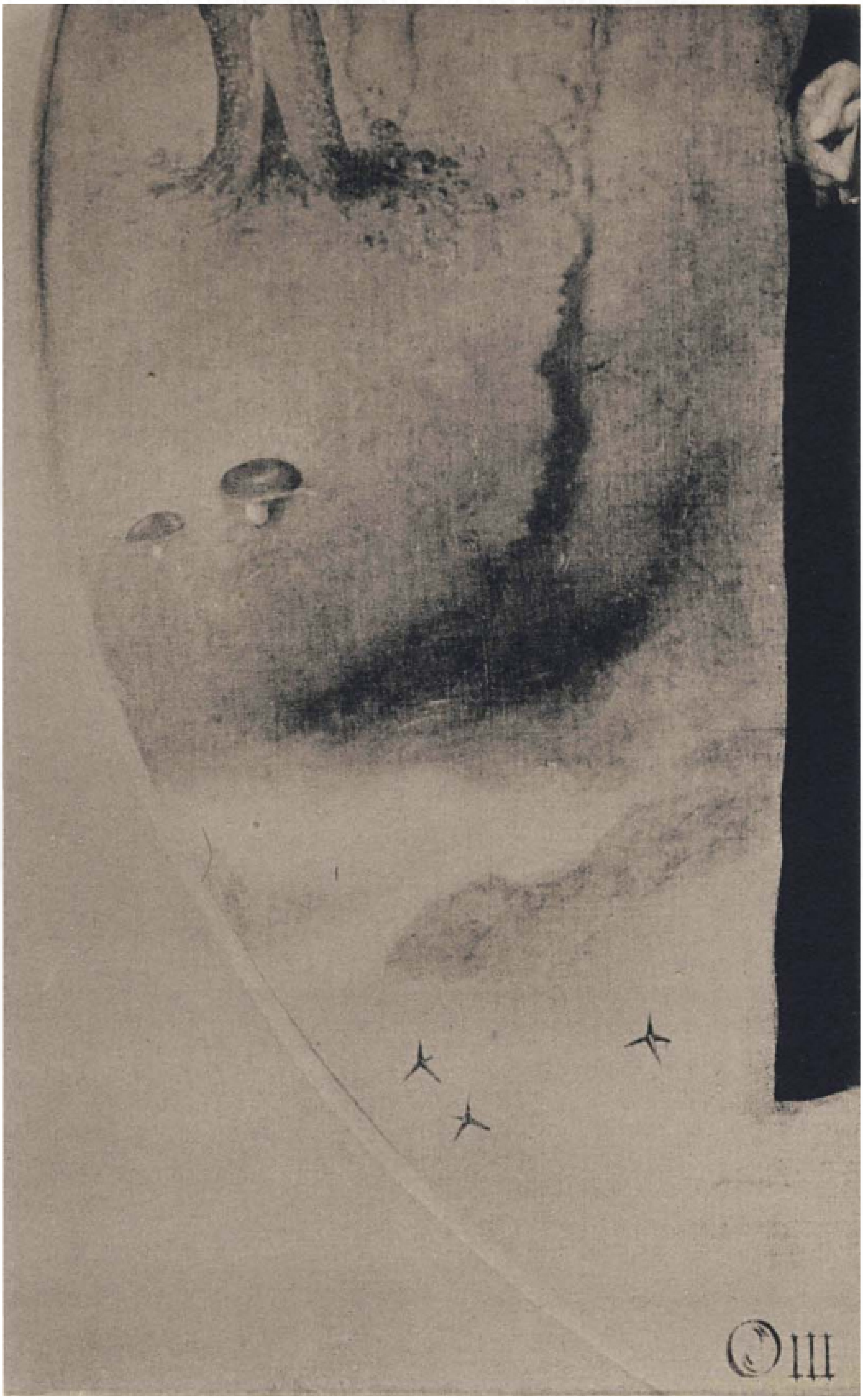


PLATE LX
Pieter Brueghel the Elder. The Misanthrope. Detail. *Naples, Museo Nazionale*.

Surely it is fair to assume that they are the *heksenzwam* or *satanzwam*, bathed in the aura of witches or Satan. Bosch in his painting developed his own iconographic idiom. It is Christian but unconventional: the *Hay Wain* is a strange allegory framed inside the Christian cosmogony. Brueghel's mushrooms are an iconographic symbol in a painted homily of profane rather than sacred inspiration. Within the confines of conventional Christian iconography we know of only two paintings, in all the wealth of Christian art, where mushrooms figure. We are indebted to the Director of the Prado Museum, Dr. Sanchez Canton, for drawing to our attention one of them. In the Prado there hangs a superb *Adoration of the Magi*, painted c. 1610 by Juan Bautista Mayno, an artist of the Spanish school about whom little is known beyond the fact that he was a Spanish Dominican born in Italy. His *Adoration* bears witness to his high quality as a painter. His craftsmanship is impeccable, his composition noble, the delicacy of the figures and faces breathtaking. In the foreground, down below, are two inconspicuous mushrooms growing among some leaves by the side of an unhewn stone. The mushrooms belong to the agaricaceae, for one of them shows a ring. The base of the stipe is concealed by vegetation: we cannot say whether there is a volva. The mushrooms and their boulder are a sinister counterpoise to the Light of the World shining through the aperture from above. Exactly what do they mean?

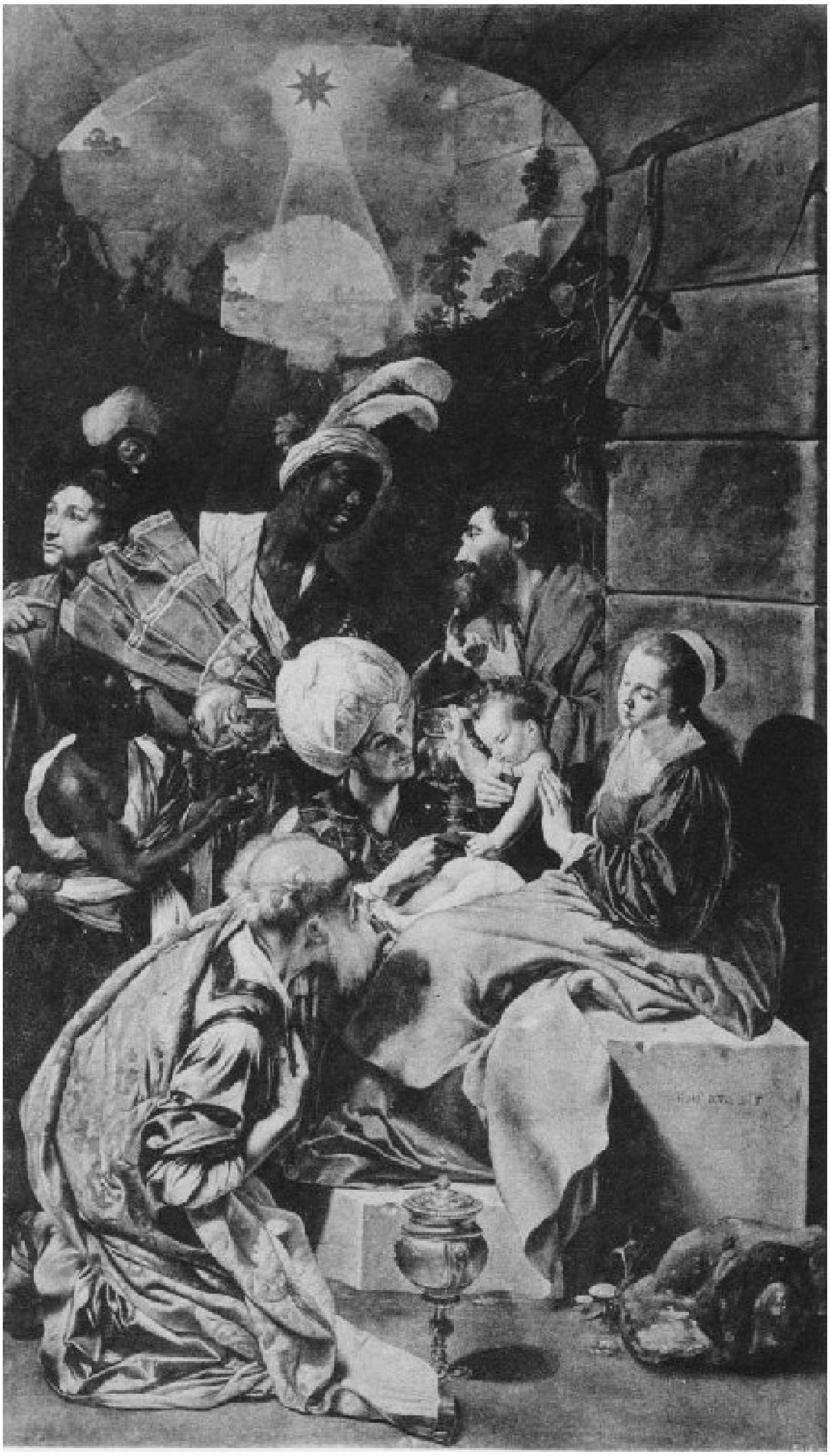


PLATE LXI

Juan Bautista Mayno. The Adoration of the Magi, c. 1610. *Madrid, Prado Museum*.

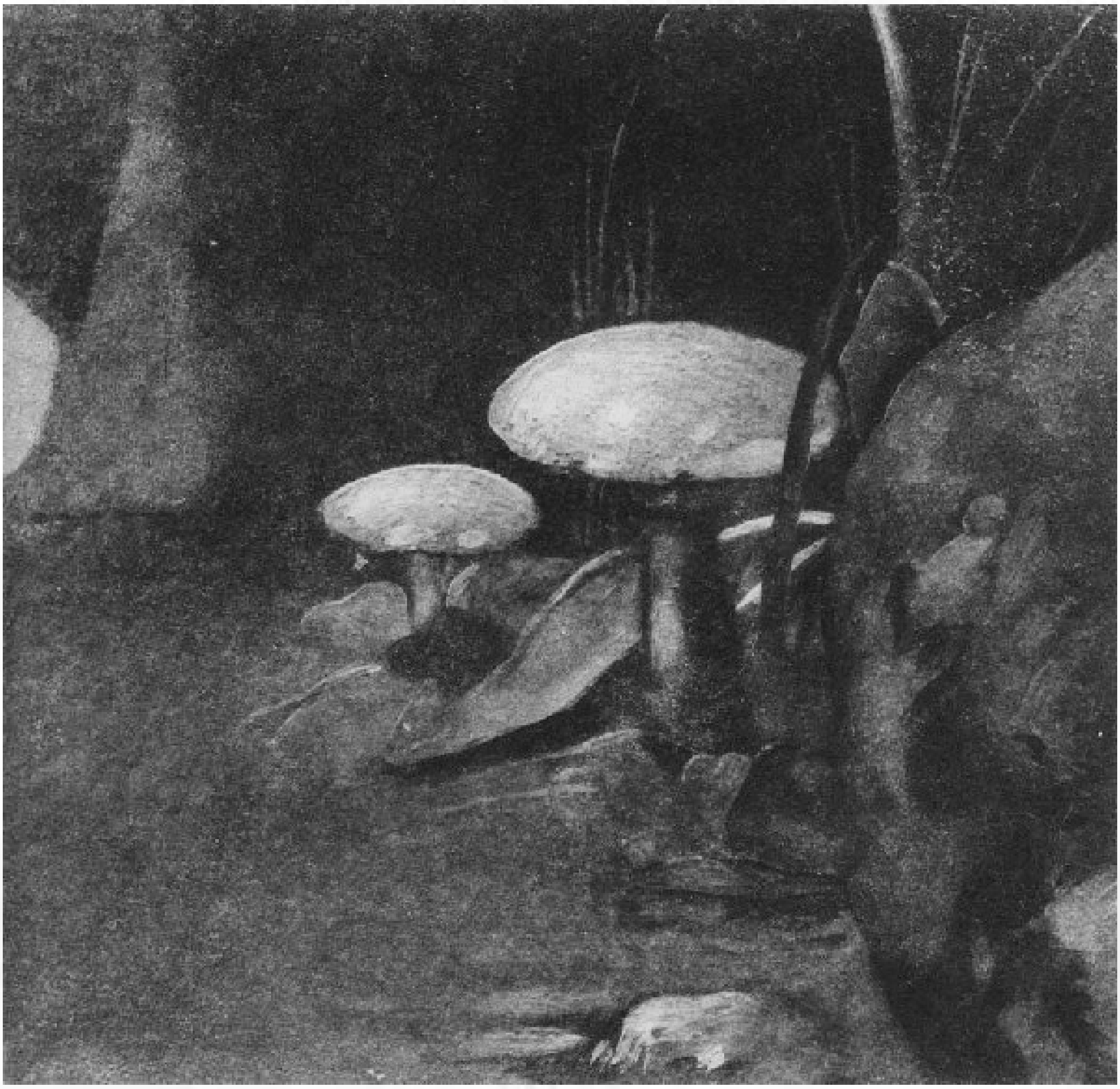


PLATE LXII

Juan Bautista Mayno. The Adoration of the Magi, c. 1610. Detail. *Madrid, Prado Museum*.

For Bosch in the *Hay Wain*, for Brueghel in *The Misanthrope*, mushrooms were a symbol of the forces of Satan, and we think that the same meaning attaches to the mushrooms in Mayno's painting.

The Virgin on her finely chiseled block of stone is goodness, truth, and beauty. The boulder with the mushrooms growing in a marshy spot is the realm of unregenerate nature that is now to be offered redemption. Mushrooms belonged to that armory of demonic symbols which painters used in the 15th and 16th centuries when preaching to the world about Satan and his works. It is true that they used mushrooms sparingly, but the symbolism is abundantly clear. Much more common as symbols of the infernal forces were serpents, lizards, frogs and toads, beetles, and flying insects; in short, all those creatures commonly thrown together under the pejorative name of 'Vermin'.[195]

---

[195] The corpus of paintings and sculpture expressing the demonic theme from those centuries is considerable, and has been the subject recently of an illuminating monograph, Enrico Castelli's *Il Demoniaco nell'Arte*, Milan and Florence, 1952.
But mushrooms in the 16th century were not always the stigmata of Satan. In the only etching executed by Peter Brueghel the Elder, *The Rabbit Hunt*, dated 1566, two mushrooms appear in the lower right foreground. They carry no iconographic message. Albrecht Dürer was responsible for a mediocre woodcut of a polypore, dated 1513; see F. Lippmann's corpus of his works, No. 912, or F. Winkler's, No. 632. In Michel Angelo Caravaggio's *Christ with Disciples at Emmaus* (National Gallery, London) there is a basket of fruit among which the mycologist will detect an apple infected with a fungal parasite.

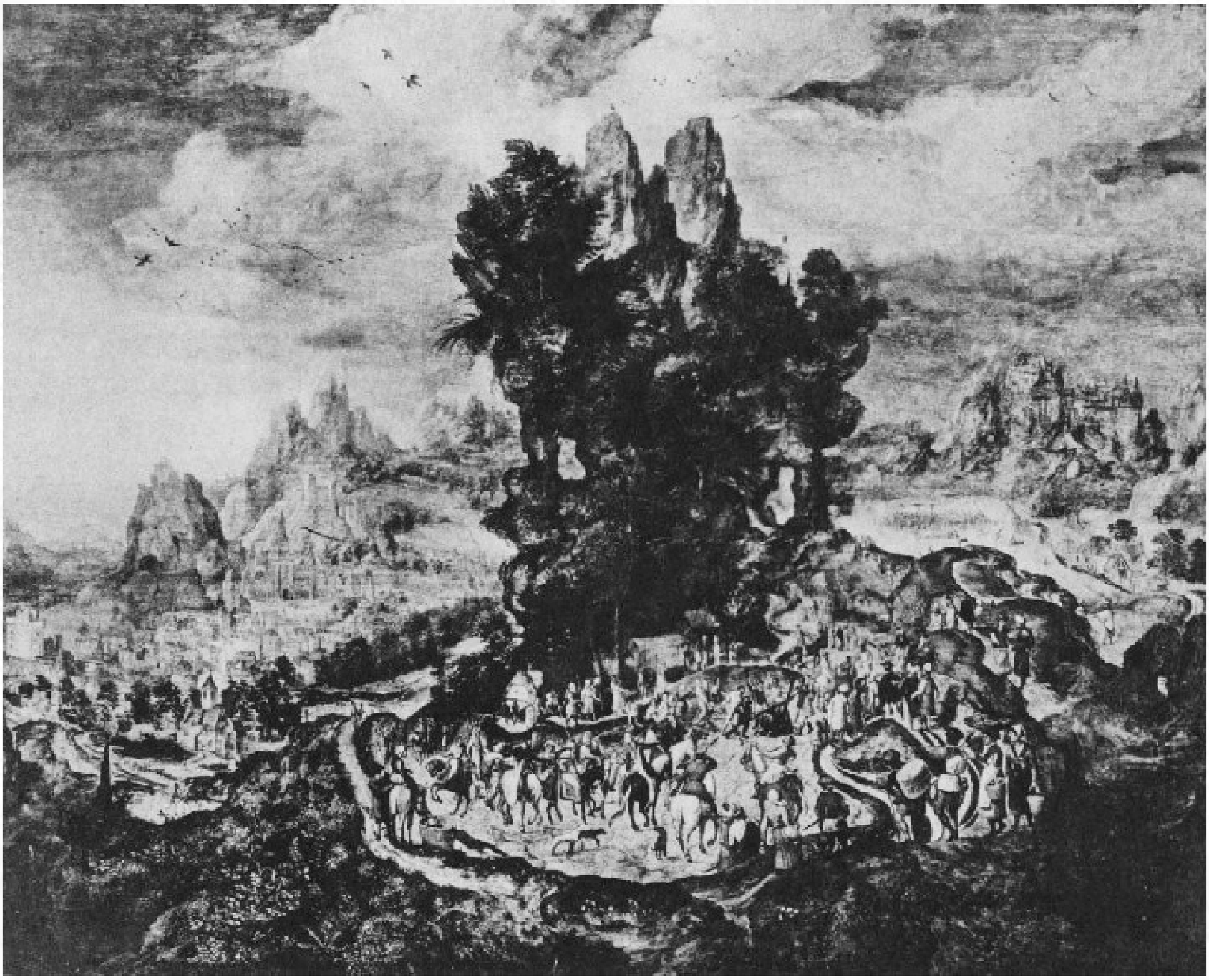


PLATE LXIII
Herri met de Bles ('Civetta'). Christ bearing the Cross.
Vienna, Gemaldegalerie der Akademie der bildenden Künste.

Our interpretation of these early mushrooms finds support in a painting by a fourth master, Herri met de Bles known as Civetta, 'the Owl', who died in 1550. Of the Flemish school, by cultural heritage he belonged to the world of Bosch and Brueghel. In the Gemaldegalerie der Akademie der bildenden Künste, Vienna, there hangs his *Christ Bearing the Cross*, a small and exquisite canvas. The field of the iconographic message in this painting is enframed in the foreground by a close-up of rough untilled land. We were the first to detect in this foreground, near the center, two clumps of minute and delicately delineated mushrooms, and a third clump of the same genus is in the lower right hand corner. Only by the aid of a powerful magnifying glass can they be fully perceived and properly admired. These mushrooms are off-stage, so to speak, and they might be dismissed as a graceful but meaningless phantasy, did we not recall the sinister meaning of the mushrooms in the works of Bosch and Brueghel. We lean to the view that here also the mushrooms are symbolic of the Powers of Darkness, who in this case are working out their woeful role on the highway to Golgotha.[196]

In the Dutch still-life paintings of the 17th and 18th centuries there was a delayed manifestation of the demonic theme in art, a strange and lovely afterglow that is of peculiar interest to us for the role in it of mushrooms. Among the scores of accomplished Dutch artists who were at work between 1640 and 1770 were a handful who chose woodland settings for subjects, closeups of woodland undergrowth, in which we discover serpents, lizards, frogs and toads, beetles, and flying insects. Often the artists added mushrooms of various species. These Dutch masters were offering to their customers paintings of 'Vermin', creatures that from earliest times had symbolized the Satanic powers. A century had elapsed since the elder Brueghel's day, and the world had gone through the spiritual upheaval of the Reformation. The minor creatures of the woodland still trailed clouds of evil, but the dark emotions that they now evoked were only reflexes of the former nightmares. They were terrors recalled in tranquillity and suitable for esthetic delectation.

---

[196] The Art Museum of Princeton University has lately acquired a companion painting by Civetta, representing also the procession on the road to Calvary. Strikingly similar in many respects, it even includes mushrooms, in the foreground on the right hand side, below the owl that is the artist's signature. But they are hesitant and uncertain as compared with the authority of those in the Vienna painting.

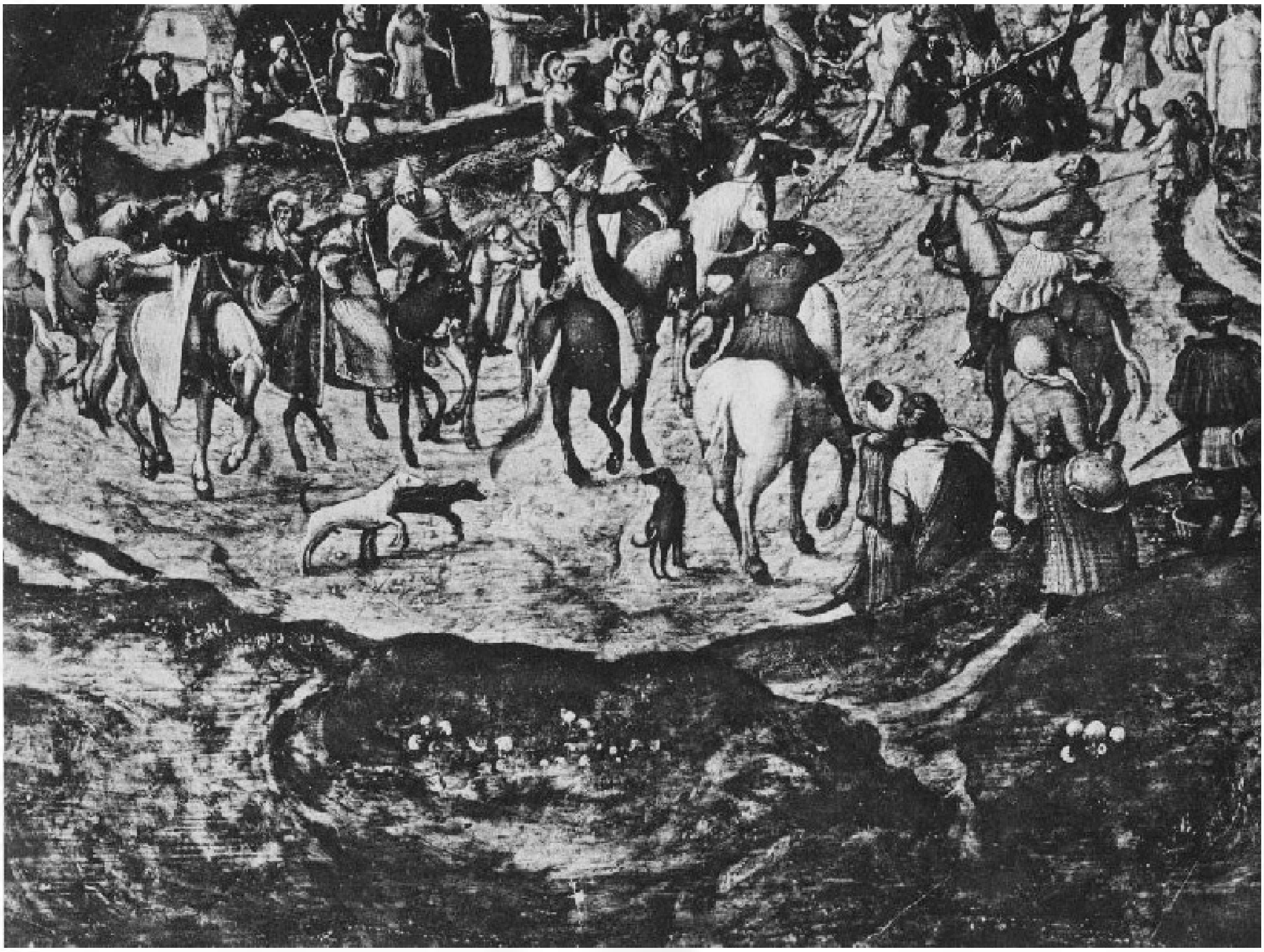


PLATE LXIV

Herri met de Bles ('Civetta'). Christ bearing the Cross. Detail.
Vienna, Gemaldegalerie der Akademie der bildenden Künste.

The originator of this theme in Dutch still-lifes was none other than Otto Marseus van Schrieck, whose *Moth with Mushrooms* we have already discussed. Born in the second decade of the 17th century, he died in the late 1670's. No one knows under what master he studied. Little is certain about his life beyond the fact that he lived long in Italy, that he was in Rome in 1652, that he enjoyed considerable success in his day, and that his peculiar choice of subjects set a fashion which persisted for a century and more. It is said that, after his return to Holland, he kept a small private zoo in the garden of his home near Amsterdam where the creatures that he loved to paint were always ready for his brush. He was surnamed 'Snuffelaar', one who ferrets.

Van Schrieck was an artist whose work records a deep cultural transition. On the one hand, he was saturated in the sinister folklore attaching to the humble creatures that he put on canvas, the dark heritage of past beliefs. Was he not in fact the last genuine painter of the demonic tradition? On the other hand, he was the discoverer of beauty in the lowliest and most despised woodland creatures. He raised even Vermin' to the democracy of the artist's beauteous world. For the first time snakes and toads were to give esthetic pleasure. He was the first European to perceive and proclaim the visual beauty of mushrooms. He studied nature with minute care. A snake was no longer just a snake: it was a particular species of snake. A mushroom was not just a toadstool, not the Idea of a fungus such as Bosch had given us. The mushroom world was peopled with an infinite variety of discrete growths, each worthy of distinct and precise delineation.

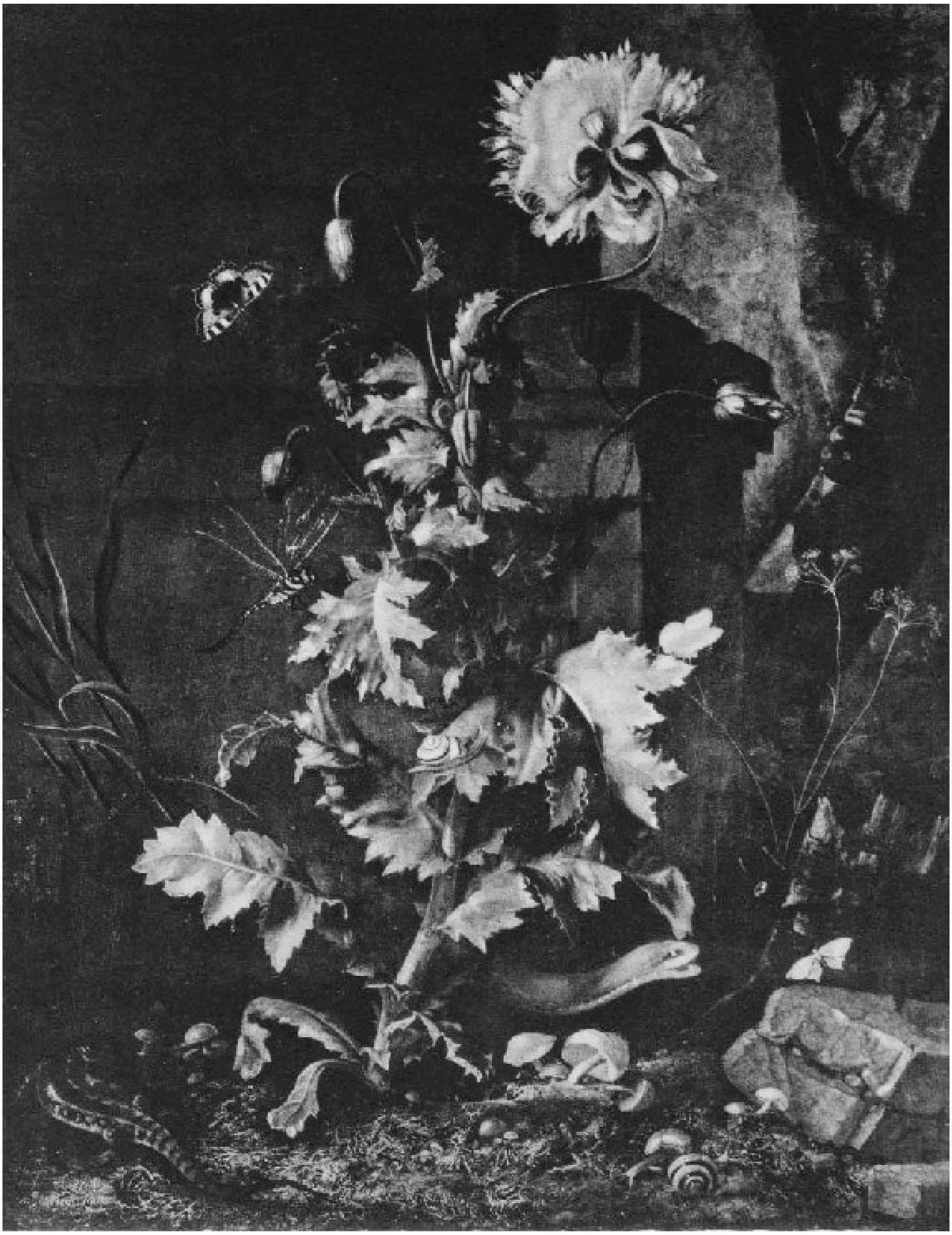


PLATE LXV
Otto Marseus van Schrieck. Poppy with mushrooms.
New York, Metropolitan Museum of Art.

Was not Van Schrieck, in a significant sense, the earliest of the nature painters? Of course many artists before him had caught the beauty of a landscape. Giants like Dürer and Leonardo had executed superb studies of individual plants or animals. Various miniaturists had ornamented the margins of manuscripts with the profile of a bird or bush, catching to perfection the distinctive line of each. But Van Schrieck added a new element: centuries before Audubon and before scientists began to talk about 'ecology', this Dutch painter sensed the importance of the ensemble of nature, the interdependence of plants and insects and mushrooms and the wild creatures that lived in the undergrowth. Long before Linnaeus and the classification of species, he was distinguishing the species with his artist's eye, and observing the cycle of life in which each lives as a link. He was the first artist whom naturalists can call their own. All those who hold wild nature in honor, and especially all amateurs of mushrooms, will pay homage to this neglected Dutch master, this pioneer in the exploration of nature's wonders.

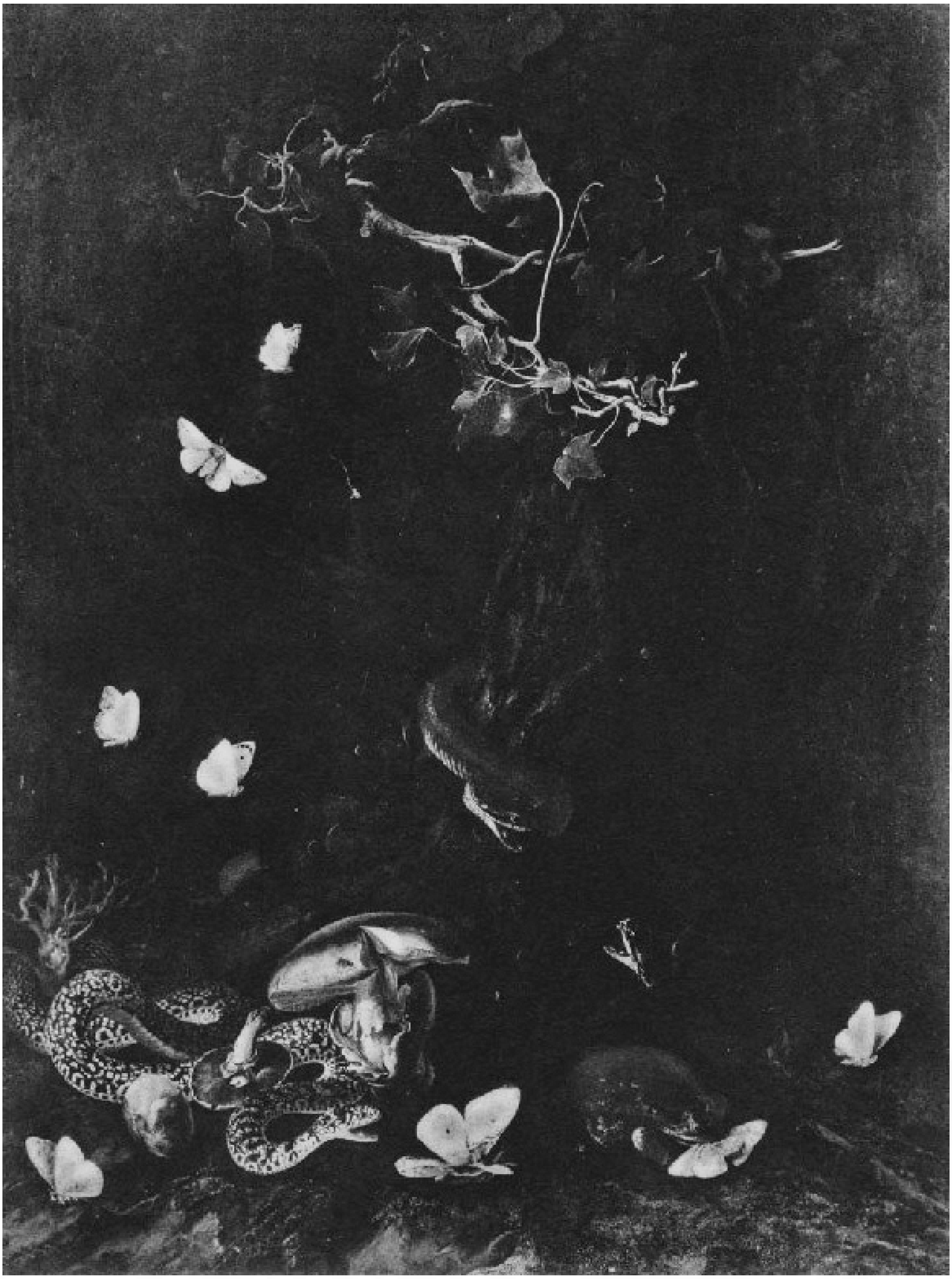


PLATE LXVI

Otto Marseus van Schrieck. Mushrooms. *Brunswick, Herzog Anton Ulrich Museum.*

A peculiarity of Van Schrieck was his addiction to nocturnal settings. Was there ever other artist who so specialized in painting the night? How sensitive his imagination was to the Stygian blackness of deep night in the woodland undergrowth! He seems to begrudge even that light which he is forced to use to give us a picture at all. What we discover in his paintings is caught by the dazzling illumination from an off-stage light, and the shaft that comes from off stage stops short with the creatures that he paints. The moth is caught in air as by a flashlight, but the light does not race on around the moth to strike elsewhere. This effect reminds us of those modern spotlights designed with mathematical nicety to illuminate the exact area of a canvas or a sculpture. Of course Van Schrieck's settings are artificial, like most settings in museums of natural history, but each component in the picture is vibrant with life and individuality. The artist is not content with painting symbols and effigies as iconographs. He is not content with dead models. The demonic message is there in the nocturnal scene, but conveyed by living individuals caught in the dance of life and death. His settings suggest in a way an aquarium, for the buoyancy of the night air makes itself felt in the way all the creatures and the vegetation seem to float in a life-sustaining medium. The three Van Schriecks that we reproduce are chosen for their emphasis on mushrooms. Almost all his paintings include mushrooms, but these are extreme in this respect, as also for the blackness of the night.

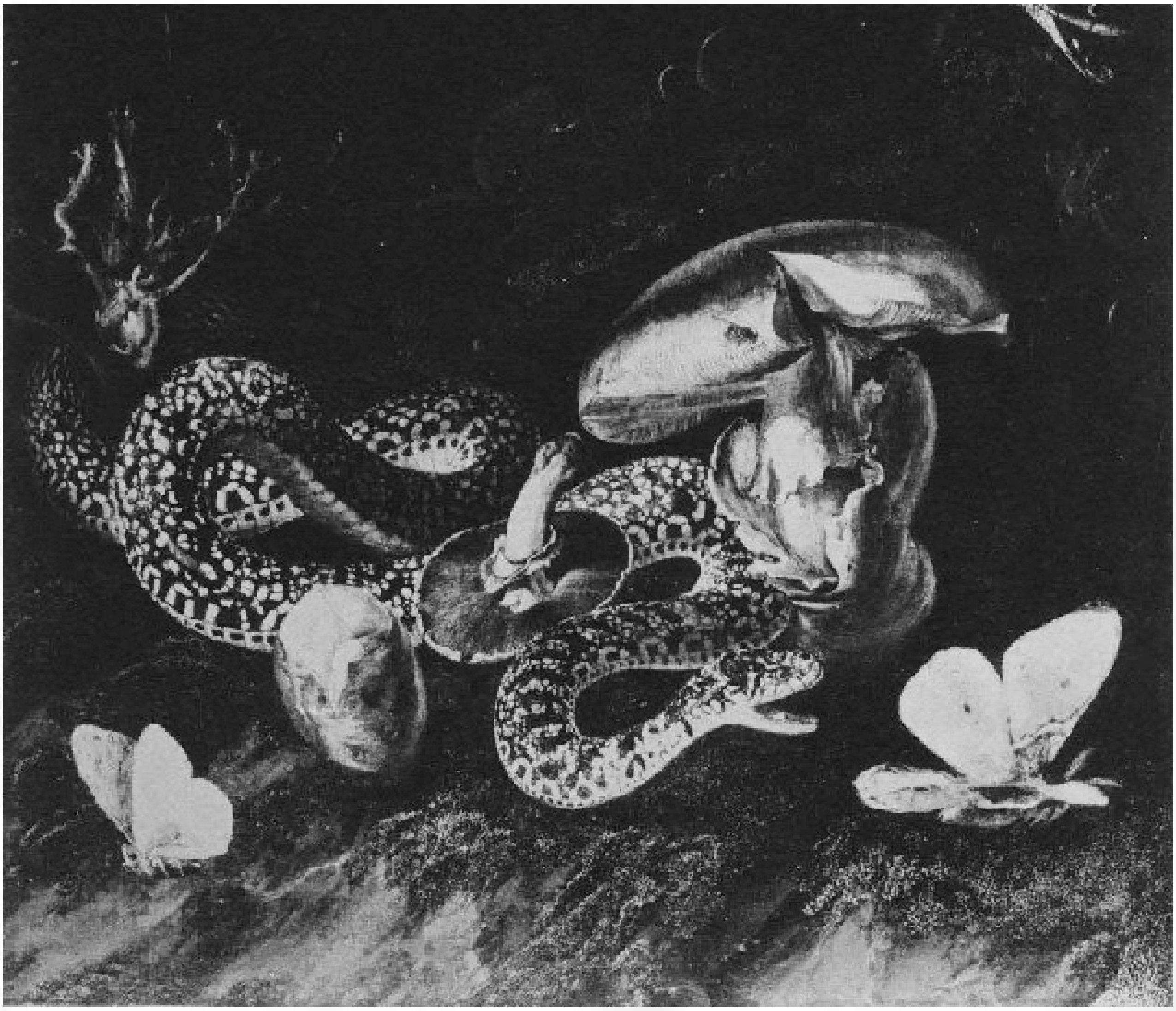


PLATE LXVII

Otto Marseus van Schrieck. Mushrooms. Detail. *Brunswick, Herzog Anton Ulrich Museum.*

Our artist's peculiar qualities find full expression in the painting that hangs in the Herzog Anton Ulrich Museum in Brunswick. Dated 1662, it was probably executed in Amsterdam. Van Schrieck had just returned from his long sojourn abroad. As usual, the setting is crepuscular. A tulip is overborne in the coils of a snake of the species *Elaphe quatuor-lineata*. To the right flies one of the saturnine moths. A viper is hissing below, and on the ground we discover a *Bufo calamita* ('calamity toad') licking up a slug. This is the toad that the English name the natterjack. On the left a snake that herpetologists call the *Coluber viridi-flavus* emerges from behind a *Clavaria botrytis* and then curls through a cluster of three mushrooms, of which the one in the middle is a russula and the others are Caesar's amanitas. Flies are crawling on the amanitas, and as *Fliegenschwamm* in Van Schrieck's day was a name bestowed on various species, he may have expected his public to call these mushrooms by that name. The air hangs thick with evil import, yet each detail is executed with the care of one who enters fully into the beauty of nature's cruel cycle. Van Schrieck's painting long antedated the scientists' nomenclature, of course; with the artist's eye he was anticipating their labors.

Van Schrieck's success in his lifetime should not surprise us. He was born into circles with a sophisticated palate for art, and his contribution was an original and notable one. He disclosed the beauty of the wilderness with a subtlety that far surpassed his predecessors. The labored efforts of the early scientific writers were tedious by comparison with his discourses on wild nature expressed in line and color. His mushrooms are incomparably superior to those of the professional illustrators who supplied woodcuts for the text of Clusius, Bauhin & Co. His influence soon took hold of other artists, some of whom achieved a more lasting reputation than he. The Neapolitan painter Paolo Porpora surnamed Pavoluccio Napolitano, a contemporary, imitated Van Schrieck repeatedly: two Porporas painted in this vein hang in the gallery of the Banco di Napoli in Naples, and of these we reproduce one.[197] Abraham Begeyn, about twenty years younger than Van Schrieck, revelled like him in woodland subjects and mushrooms, as did also the mysterious Frans Hamilton,[198] Anthonie van Borssom, and the German, Johann Albert Angermayer. Later in the same vein came Rachel Ruysch, who lived into the mid-18th century, and Franz Werner Tamm, born in 1724. All of these distinguished artists loved their mushrooms and knew them, though not like Van Schrieck. Van Schrieck's influence went even beyond them. It may be said of him that he effected the integration of mushrooms into the idiom of painters. Before him in all of the painting of Europe the absence of mushrooms is conspicuous, if not absolute. In settings where mushrooms would seem almost compulsory, there were none, as though good taste compelled good artists to rub them out. After Van Schrieck, mushrooms are never again a surprise. Though rare, they recur sporadically and naturally whenever barnyard and outdoor themes seem to call for them.

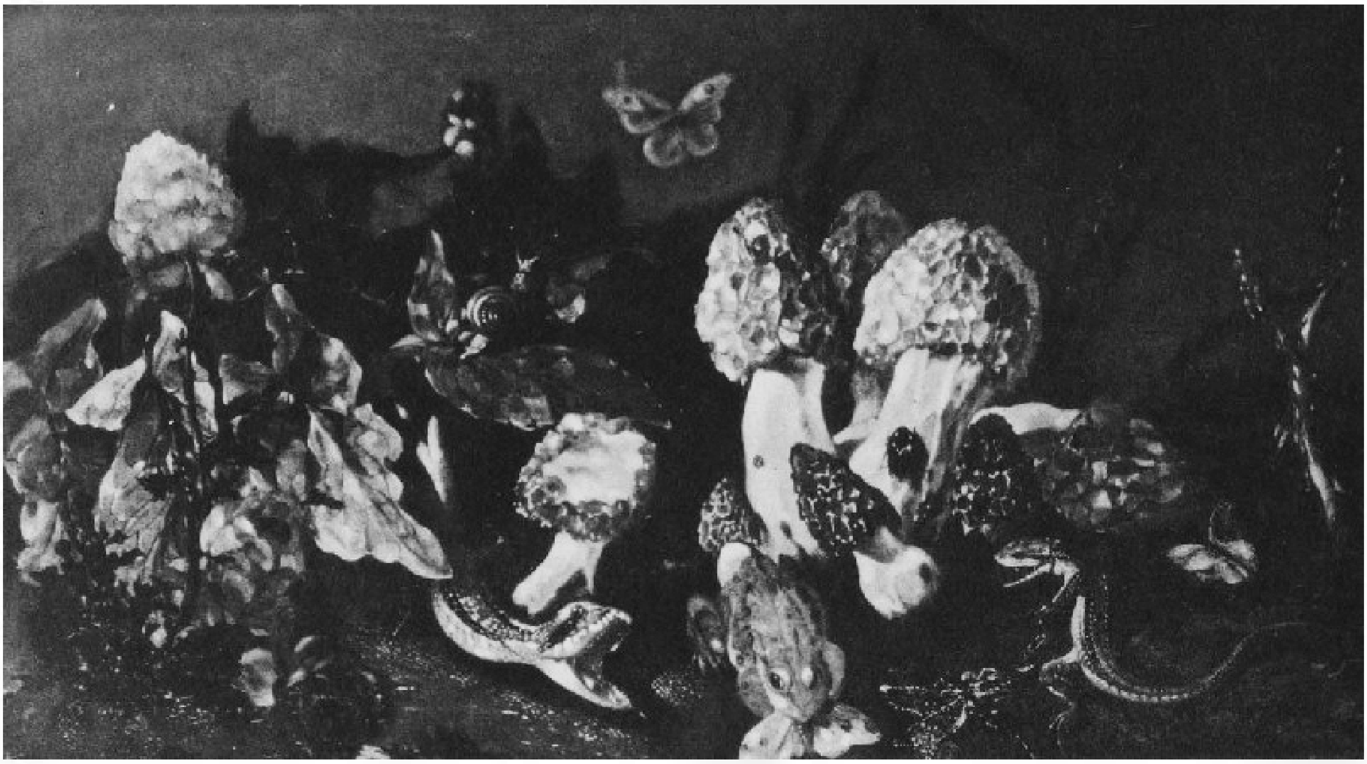


PLATE LXVIII

Paolo Porpora, d. 1673. Still life. *Naples, Banco di Napoli*.

---

[197] This little known artist is the subject of a study by Raffaello Causa in Paragone (published in Florence by Casa Editrice Sansoni), March 1951.

[198] At a time when painting in Scotland was still in its infancy, a cluster of accomplished artists bearing the name of Hamilton were in fashion in central Europe, exponents of the Dutch school. There were James and Frans, whose earliest works seem to date from the 1660's, and James in time gave to the world three sons and one grandson who were painters. James and Frans were presumably kin, but this is an inference unsupported by evidence. It is a fair surmise that they emigrated from Scotland as small children under the Commonwealth, for their schooling in art was wholly Continental. Such biographical data as appear in the reference works about them are meager and dubious. It is strange that Scottish genealogists have failed to identify these distinguished Continental Scots.

Those other painters who borrowed Van Schrieck's peculiar theme were less attached to the demonic import of the subject matter than he was. They admitted more light than he did. They would show a patch of daylight sky. They introduced daytime birds. They prettified the whole setting. Van Schrieck's paintings repel the uninitiated by their darkness, while his followers' possess a superficial charm as quaint period pieces. But what they gained in gentleness they lost in focus. They were satisfied with fewer species of mushrooms, and showed a tendency to stylize them, like stage properties. Their snakes and insects tend to be less sharply delineated. In those art circles where the extraordinary merits of the Dutch still-life painters are esteemed, Mignon and Ruysch today rank above Van Schrieck. From one point of view this is a mistake. For connoisseurs both of cultural history and natural history Van Schrieck should stand first. He is unique, a cultural *trait d'union* between the world of demonic folk beliefs and the beautiful world of nature, where even the lowliest creatures are infinitely precious for the understanding eye.

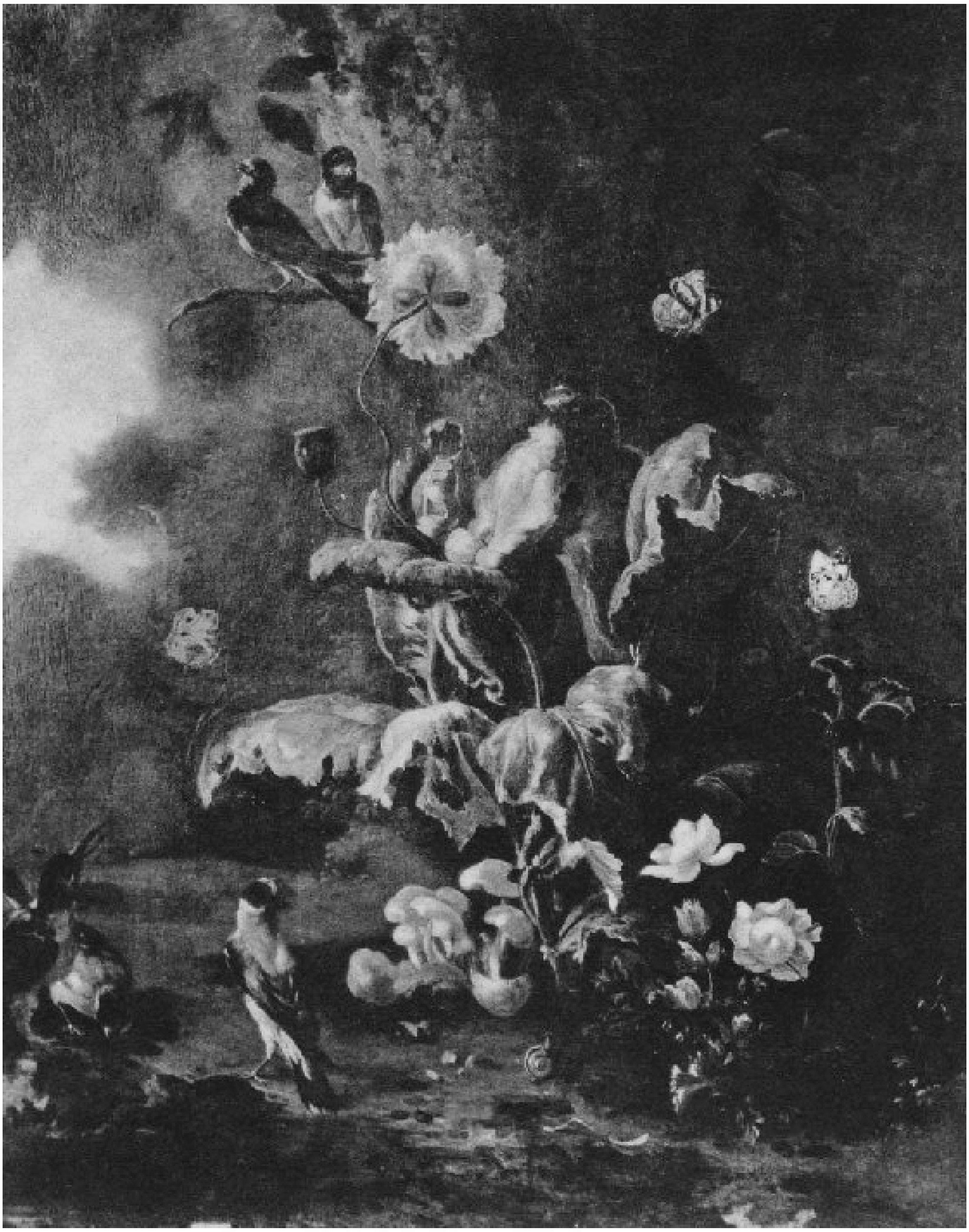


PLATE LXIX

Abraham Begeyn. Still life. *Rome, Galleria d'Arte Antica.*

By good fortune we are privileged to attend the very act of artistic alchemy by which Van Schrieck's peculiar quality was transmuted to suit the conventional taste. The year is 1668. Van Schrieck after years of wandering is back in Amsterdam, active and honored, in his early 50's. Melchior de Hondecoeter, a brilliant young artist of 34, paints a picture after the Van Schrieck manner, with mushrooms, lizard, and butterflies. We can study it today in the Rijksmuseum in Amsterdam. He retains Van Schrieck's nocturnal effect, devising a powerful off-stage light to the left to bathe with dazzling effulgence the foliage and mushrooms on the right. The mushrooms, well delineated, belong to the genus hypholoma and are probably of the species *Hypholoma fasciculare*. Finches in full panoply occupy the center of the canvas, aroused by the presence of a lizard. Some daylight enters from the upper right. The artist signs his painting on the tree-trunk below the knot-hole, and no one challenges the attribution. Hondecoeter was destined to win renown for his skill in painting birds. Almost two centuries before Audubon, he achieved the impossible by catching the stance of a bird in its moment of intense vital performance, and in this work he was already on his chosen path of special achievement.

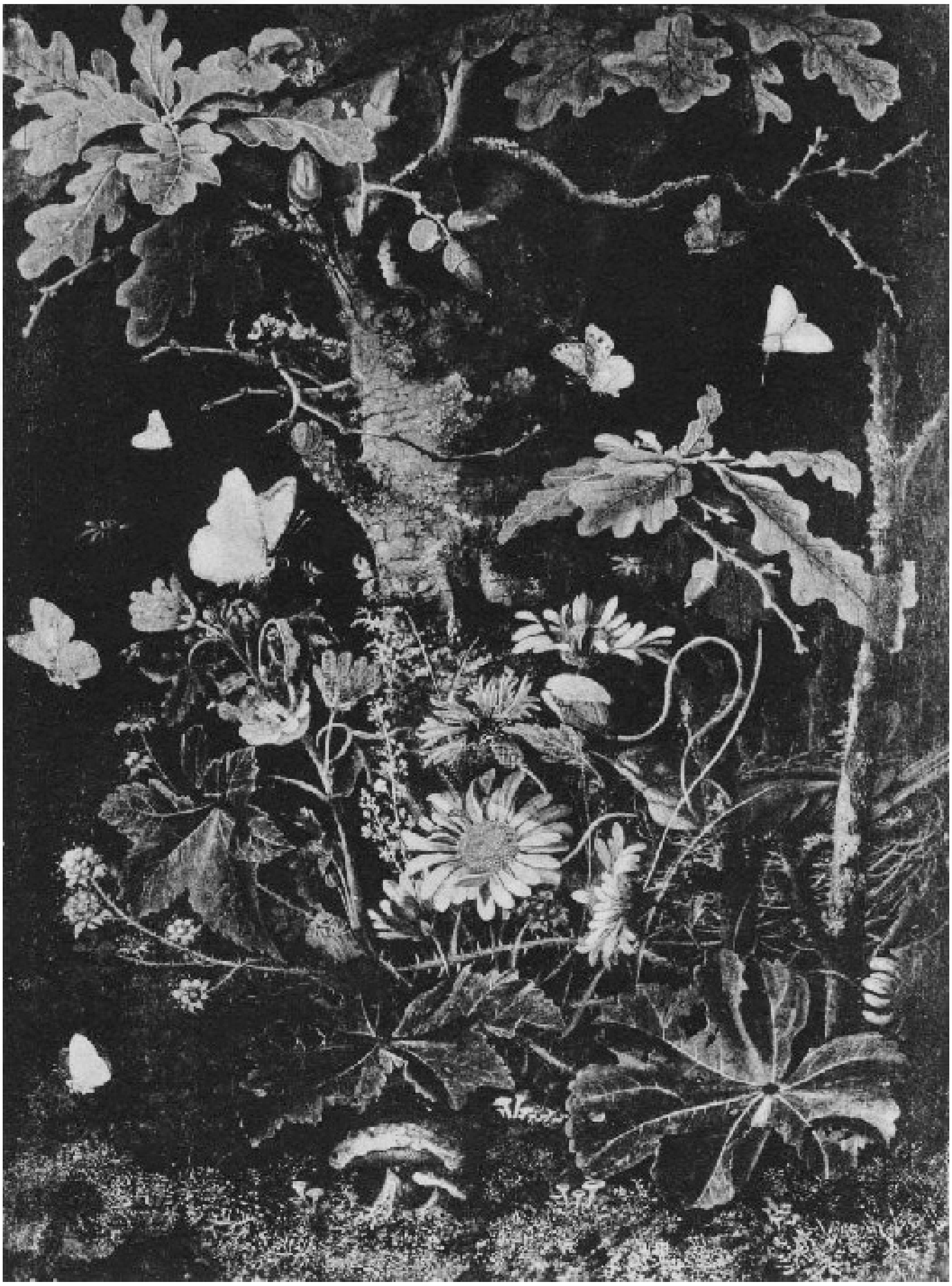


PLATE LXX

Frans Hamilton. Still life. *Munich, Bayerische Staatsgemäldesammlungen*.

Now let us turn from the Hondecoeter in the Rijksmuseum to another version of the same painting in the National Gallery in London. It is signed above the knot-hole and dated 1668.[199] Here the artist has reassembled the mushrooms, foliage, birds, butterflies, tree-trunk, and patch of sky. Each of the elements carries the same light effects as in the Amsterdam work, but with the redistribution of the parts, the Van Schrieck effect of concentrated off-stage highlighting is sharply diminished. In these two paintings we see the brilliant artist of the younger generation, still under the spell of Van Schrieck, experimenting with the master's methods. In the second he retains mushrooms and Vermin, but abandons the nocturnal trance.

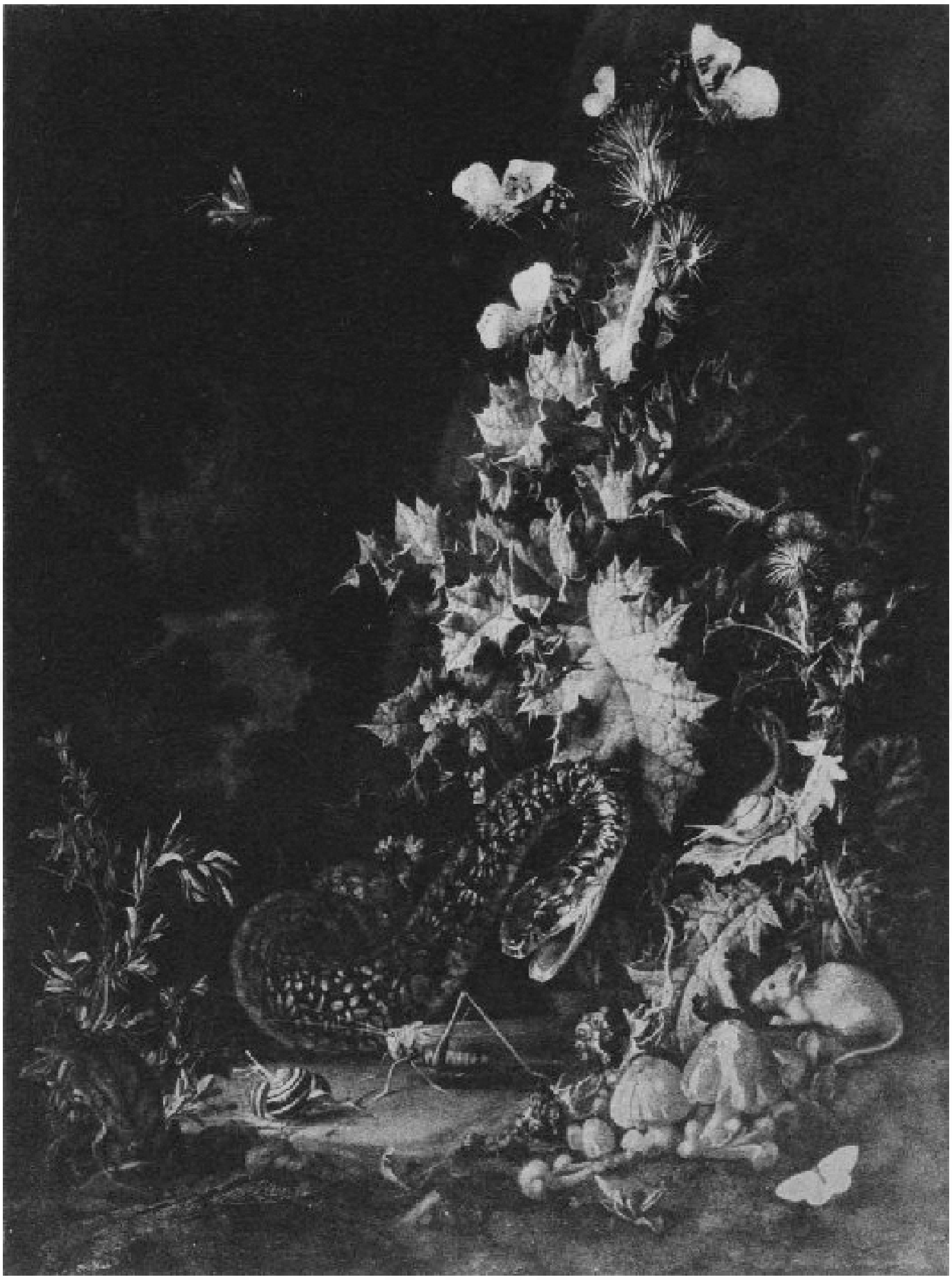


PLATE LXXI

Rachel Ruysch. Still life. *Oxford, Ashmokan Museum.*

---

[199] In the past this painting has been attributed to Abraham Mignon. We discovered its kinship with the Hondecoeter in Amsterdam and submitted to Frits Lugt, the authority on Dutch still-lifes, the problem presented by the diverse attributions. After carefully examining the picture in London, Professor Lugt wrote us that he failed to see in it the harder, more metallic style of Mignon. Of the signature in the London painting, only 'M' clearly survives, and he interpreted this as the 'M' of 'Melchior d'Hondecoeter'. Afterwards, applying a lens to the area of the signature, we clearly distinguished also the 'd' that precedes the artist's surname. The traditional attribution to Mignon is certainly erroneous, based on a mistaken interpretation of the surviving initial of the name.

There is a noteworthy thing about the mushrooms painted by Van Schrieck and those who followed in his wake: for them all, the attraction of the mushroom seems to have been visual. They discovered that mushrooms, bathed in folklore, were also beautiful, and then they stopped. Is there a single Dutch or German painting of the 17th or 18th century in which mushrooms appear in a context of food; These hereditary mycophobes permitted themselves to be seduced by mushrooms, but not all the way. More than a century before Van Schrieck, Jan Brueghel the Elder, known as Velvet Brueghel, executed two series of paintings to illustrate the corporeal senses, and today they hang in the Prado. Twice he represented the delights of the palate in a riot of foods of all kinds, but among them are no mushrooms. Admirable as Van Schrieck and his followers were, it seems certain that they followed in Jan Brueghel's train and never knew the epicure's delight in a cep or morel. As in the case of Thoreau, mushrooms never made their saliva run. When they painted mushrooms with exquisite perception, they made no distinction between the edible and the inedible: clearly for them all were inedible. Thus Paolo Porpora in his canvas that we reproduce coils his serpents and lizards through a cluster of delectable morels. A painter discovers and reveals such truth as lies within the compass of his visual dimension, and these Dutch artists triumphed over their ancestral mycophobia within the medium at their command but no further.

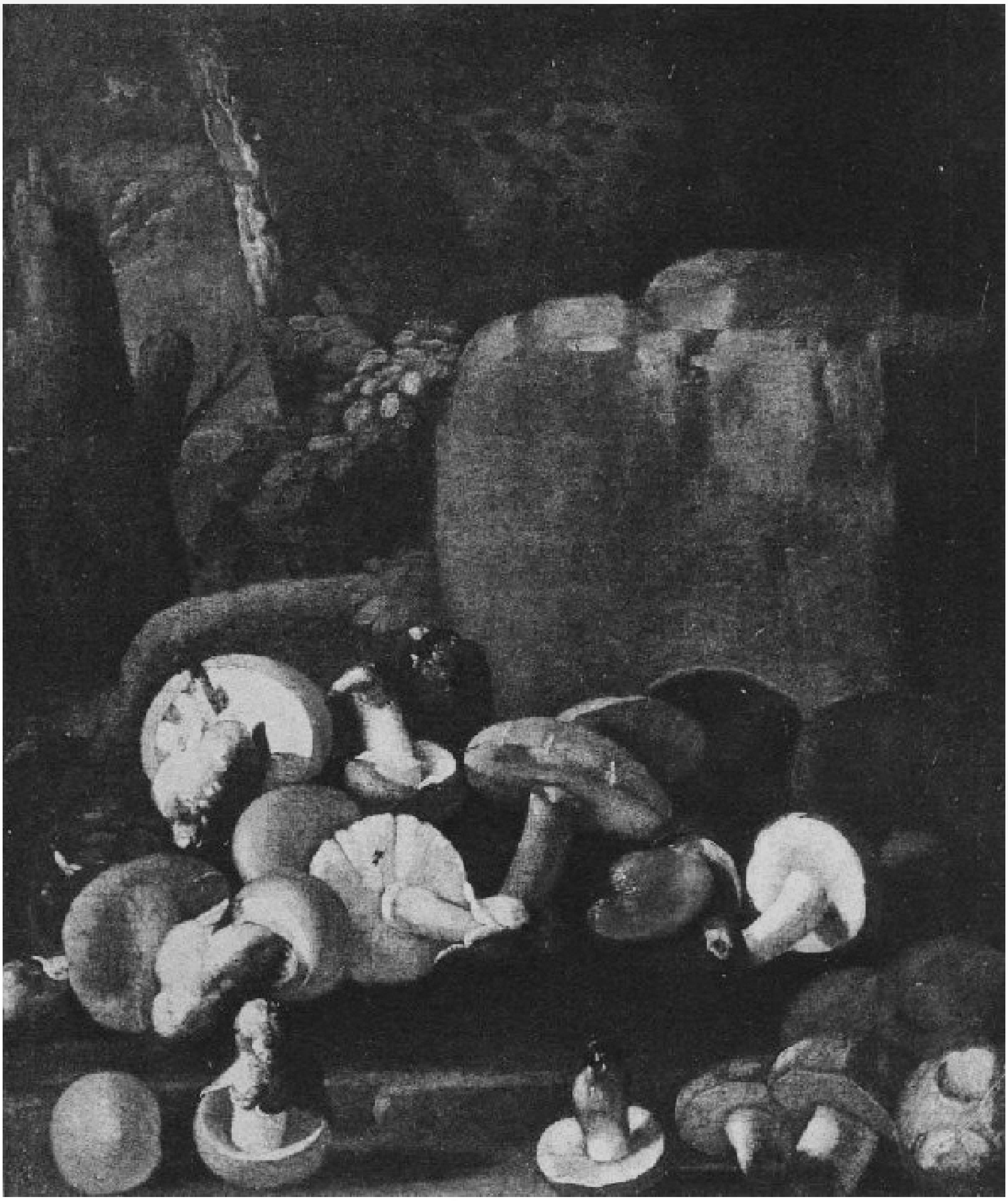


PLATE LXXII

F. W. Tamm. Still life. *Private collection.*

In Van Schrieck's time we have seen that mycophagy was burgeoning among the Flemings, but this cultural innovation seems to have had no parallel among the Dutch. How odd that the line of demarcation between the Protestant and Catholic worlds should also separate the mycophobes from the mycophagists! There must be exceptions, but just as no Dutchman or German seems to have painted mushrooms in a context of food, so we have found no painter after Brueghel identified with Brussels or Antwerp who used mushrooms as a demonic symbol. Though the still-life artists of the 17th century never tired of painting food, it is a fact that even in Flanders mushrooms figure seldom in those paintings. In addition to those that we have discussed on pages 130 ff., there is a superb still-life of the school of Zurbaran in the Art Institute of Chicago, wherein two specimens of the *Psalliota arvensis* (as we think them to be) appear, along with chestnuts, cheese, almonds, and grapes. Robert Graves in Majorca possesses a canvas dated 1656 with a fine show of *rovellons* (*Lactarius sanguifluus*), which the Catalans esteem above all others, and this canvas is attributed to the Majorcan artist Antonio Mesquida.

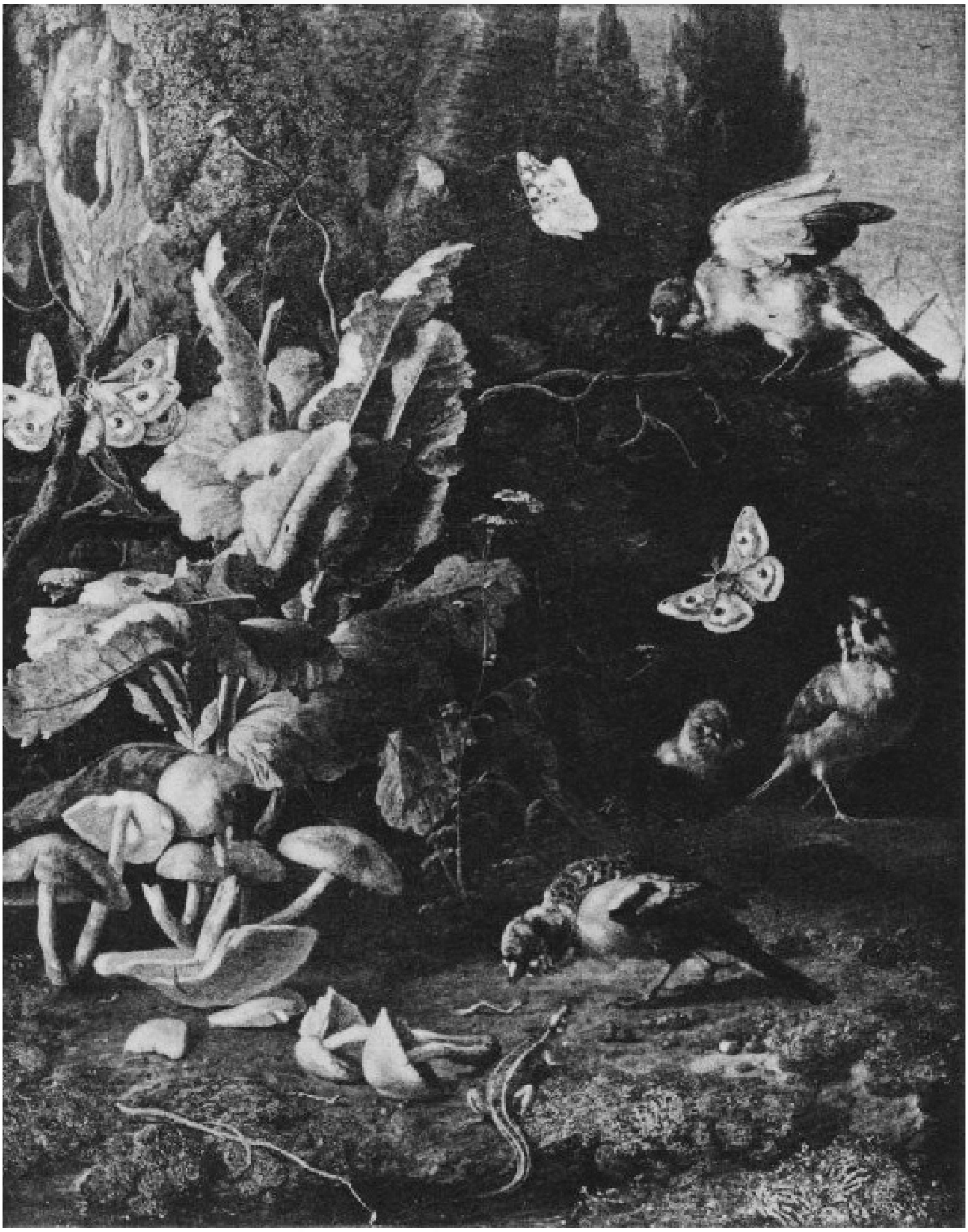


PLATE LXXIII

Melchior de Hondecoeter. Still life. *Amsterdam, Rijksmuseum.*

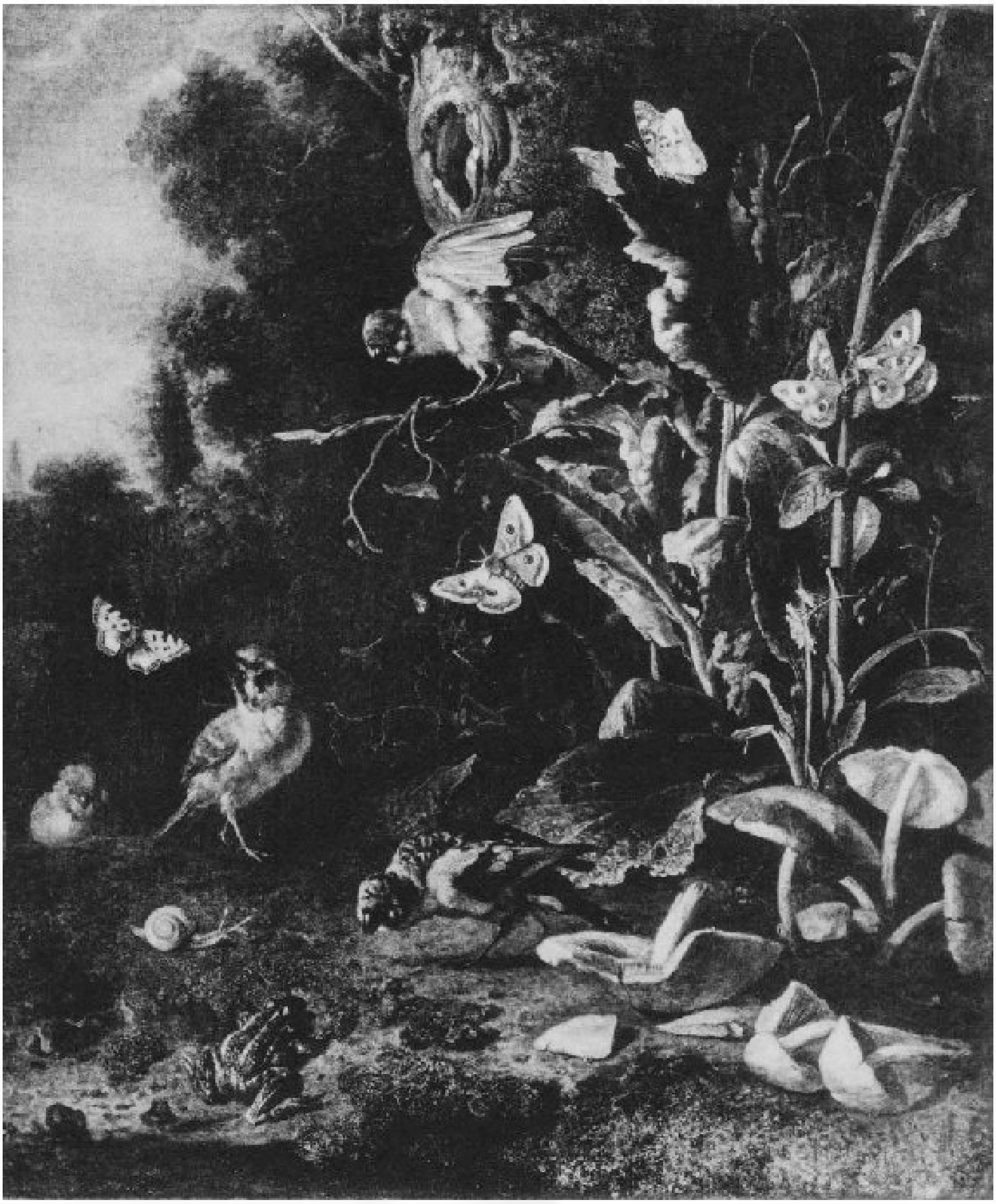


PLATE LXXIV

Melchior de Hondecoeter. Still life. *London, National Gallery.*

The oldest painting of mushrooms in the world is a fresco discovered in the excavations at Herculaneum early in the 18th century and now hanging in the Museo Nazionale in Naples. It must have been executed around A.D. 50, perhaps at the very moment when Pliny was composing his chapters on the fungi for his *Historia Naturalis*. These mushrooms seem to belong to the genus lactarius and are obviously for eating. All of the specific names for mushrooms that we know from classical Latin have been securely identified, and there is none that we can attach to those in this ancient fresco. Here is a wholesome reminder of how little we really know about the mycological knowledge of the ancients, for we may consider it virtually certain that the ancient inhabitants of Herculaneum knew the mushrooms of the fresco well and had a name for them.

There is a remarkable thing about this Herculaneum fresco. Let the reader compare our reproduction of it with Jan Fyt's canvas, Plate LXXIV. In both, mushrooms are scattered in the foreground. In both there are thrushes, stiff in death, laid out on a ledge above and behind, in the fresco mistle thrushes or *Turdus viscivorus*, in Fyt both mistle thrushes and fieldfares or the *Turdus pilaris*. These artists separated by sixteen centuries hit on the same objects for their two still-lifes, and the same composition. The fresco could not have influenced Fyt, of course, for apparently it was not exhumed from its volcanic grave until a century after Fyt's time.

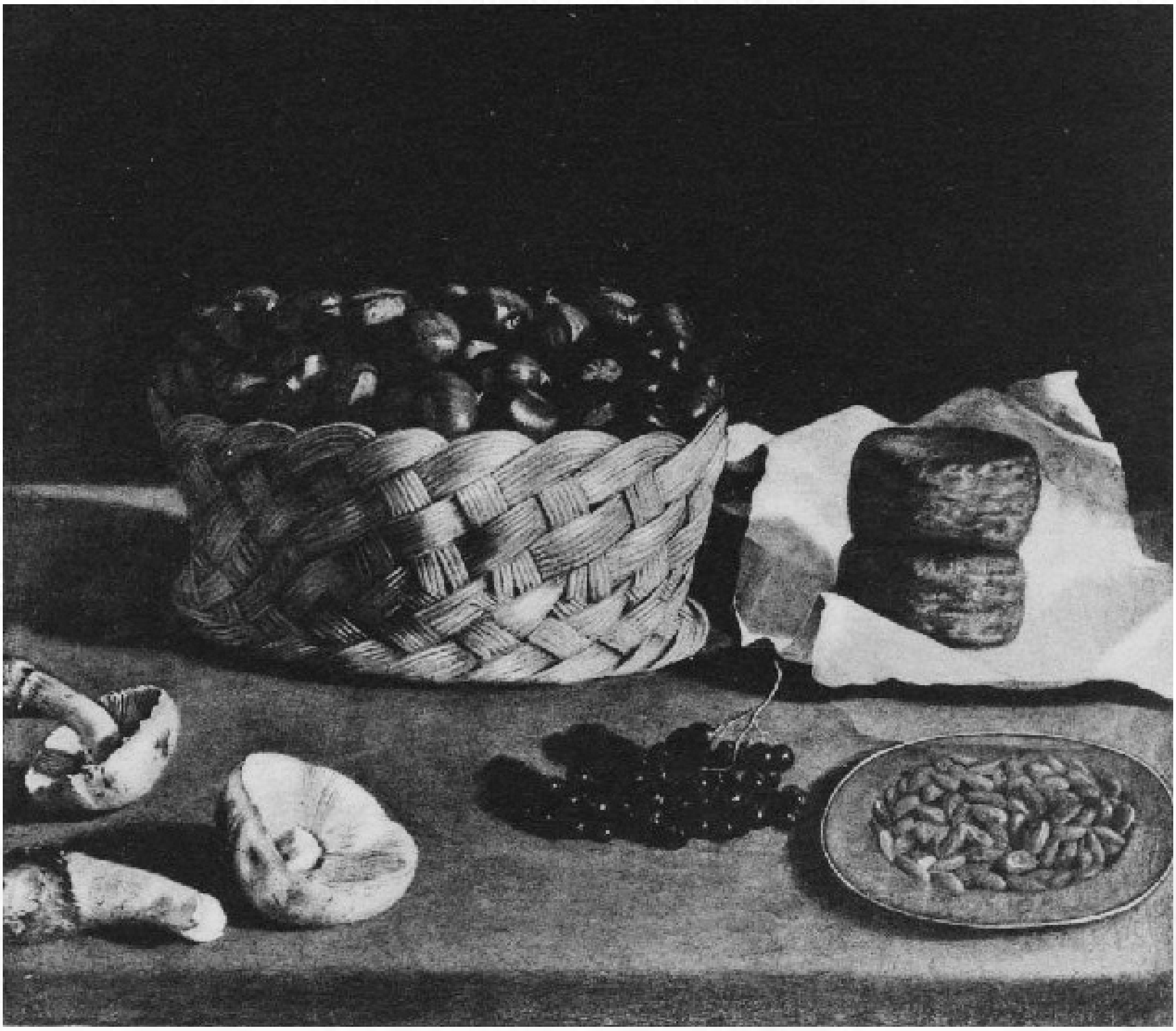


PLATE LXXV

School of Zurbaran, 17th-18th century. Chestnuts, cheese, grapes, almonds, and mushrooms, sp. *Tricholoma personatum*.
Chicago Art Institute.

The mushroom in Renaissance art was originally and principally demonic in suggestion, as we have seen. In the lovely paintings of Rachel Ruysch and F. W. Tamm this demonic vein had spent itself, petering out in the placid calms of the 18th century enlightenment. Mycophagy was gaining ground, and in addition Gainsborough and later Corot discovered the idyllic beauty of mushroom gathering - a far cry from the terrors of the mushroom in the world of Bosch and Brueghel and Civetta. But the old theme was not altogether dead: after all, it had sprung from the very tap roots of Europe's earliest cultural world, the mycophobia of the Germanic world that gave us Bosch and Brueghel. One of the eminent illustrators in 19th century France was the artist J.J. Grandville. He died in the spring of 1847, at 44 years of age. On the eve of his death he submitted to the *Magasin Pittoresque* two woodcuts of astonishing quality, which in due course that journal published.[200] These last works of his were pictorial representations of dreams. The first does not concern us. We reproduce the second and suggest that the reader examine it with some attention. Grandville submitted his explanation for this dream, a banal sequence of meaningless images, as he thought. Perhaps this design expressed more than even so sensitive an artist as Grandville was aware of. Reading from top to bottom, the sliver of a moon emerges as a mushroom. By way of an intermediate metamorphosis, the mushroom becomes a parasol, the *chattra* that was the Sanskrit metaphor for the mushroomic world. The parasol then transforms itself into a bat, *le bot volant* of French demonic folklore. The bat, in turn, becomes a bellows, one of that family of distensible sacs which we found metaphorically linked with the fungal world in various primitive usages. By a strange chance, a number of these successive designs are emitting a flame, that very flame which with its supernatural and erotic meaning seems to have been at the taproot of Europe's fungal associations. The bellows, indeed, becomes two flaming hearts transfixed by a sword, which in turn give way to a rolling spindle, and then a four-wheeled chariot drawn by flaming steeds in the direction of a starry firmament.

---

[200] pp. 210-214, 1847.

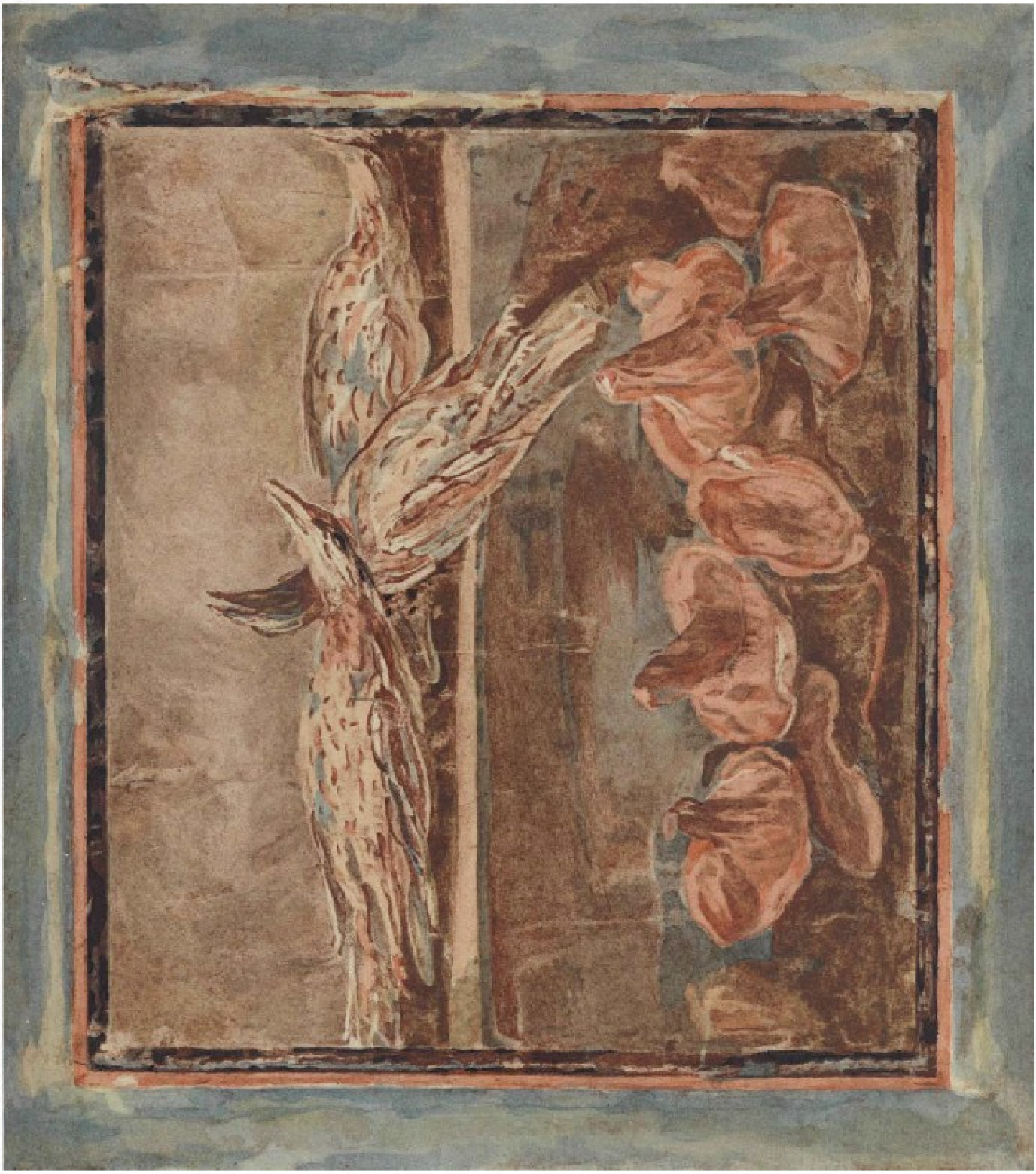


PLATE LXXVI

Mushrooms. From a fresco found at Herculaneum, probably executed about A.D. 50.

By courtesy of the Museo Nazionale, Naples.

How strange it is that Grandville in the final emanation of his genius should have struck a chord so nicely attuned to the whole argument of our book! It is as though in his subconscious being this 19th century Frenchman recapitulated the emotions of his race vis-a-vis the fungal world since earliest times, and then gave those emotions expression in a design of breathtaking simplicity and beauty. It is almost as though, with a hundred years of anticipation, he was putting the seal of his subconscious approval on a number of our suggestions.

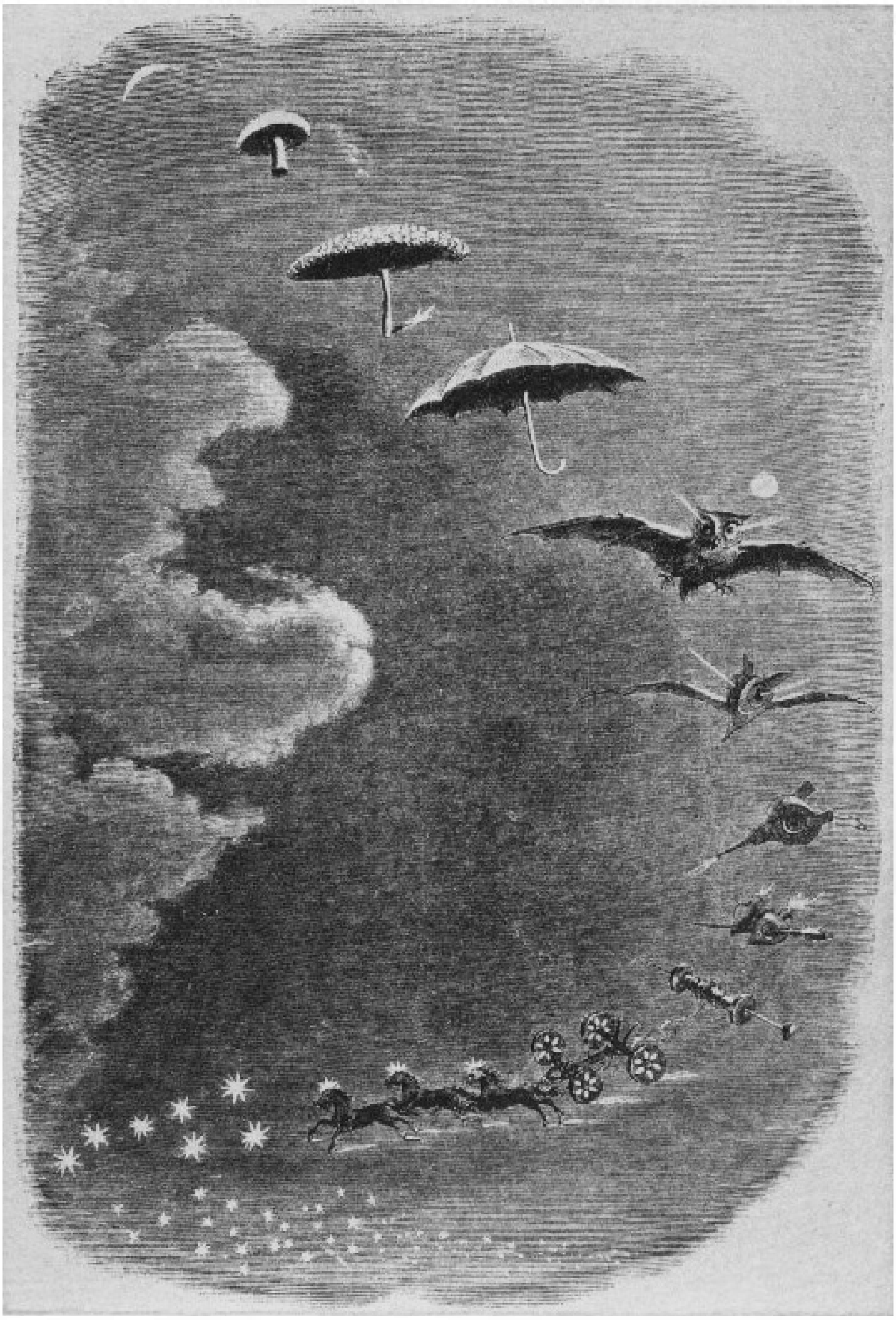


PLATE LXXVII

The dream. Woodcut after J.J. Grandville. From the *Magasin Pittoresque*, 1847.

20

Unscientific Nomenclature

Mycologists sensitive to the fitness of things are the first to admit that their nomenclature for mushrooms offers a spectacle of unscientific confusion, an accumulation of infelicities. Scientific names should be keyed to significant aspects of the organisms that they designate, and there should be uniformity in use. Instead, many of the scientific names for mushrooms serve only to remind us of the errors of early mycologists, and any given species is likely to carry two or more names that are in simultaneous currency in different countries. It even happens that a single scientific name is commonly employed for different kinds! (It seems certain, for example, that two of the famous mushrooms, the *Amanita muscaria* and the *Amanita phalloides*, are different species in Europe from their American namesakes and it is perilous to assume that attributes securely established for them in one continent hold true across the ocean.)

In formal use, following each name is the surname of the mycologist who described it, or perhaps two such names, and so the objectivity that is the proper virtue of science becomes tinctured with the frailty of those who gladly permit their names to be hitched to a mushroom, perhaps tempted by a vain hope for worldly immortality, if only in union with a fungus.[201]

Mycological nomenclature got off to a bad start with Carolus Linnaeus, the 18th century Swedish name-giver. Like Adam he surveyed the living world and bestowed names on all the flora and fauna, but he seems to have hurried a little impatiently over the numerous and baffling and humble fungi. He chose to make use of terms drawn from ancient Greek and Latin, but did not pause to ascertain their rightful meanings. He misapplied almost every one of them. But by the weight of his immense prestige, he stamped the old words with his new meanings, and these are now current the world over. They are current the world over - save here and there among the peasants of Greece and Italy and France, where vernacular variants of the words used by their ancestors two thousand years ago still circulate with their ancient sense, and hold their own against the new-fangled meanings that prevail in learned circles.

In extenuation of the Linnaean terminology it can be pleaded that the classical words had already been misused by his precursors, such as Clusius and the Bauhins, and that he merely refined the application of names accepted in scientific circles since the Renaissance. Even if this be true, we may regret that the great Linnaeus did not rise to the occasion, and with his papal authority impose a sound system of names conforming to the classical meanings of the words that he was using. There was no difficulty about those classical meanings. Before the century was out, the French mycologist, Jean-Jacques Paulet, in his *Traite des Champignons* published in Paris in 1793, was discoursing on the nonsense of the official nomenclature and elucidating the classical usage.[202]

Take the Latin *boletus*, for example. In imperial Rome this was the name of the superb *Amanita caesarea*, that yellow-capped gilled mushroom which was the favorite of emperors and epicures. It was undoubtedly borrowed from the Greek βωλίτης which in turn was derived from βῶλος, meaning a clod of earth. Mushrooms smell and sometimes look like earthy excrescences, and in *boletus* we discover another of the basic metaphors used in the fungal world, of which we have already identified many others. The same figure underlies the famous Russian *gruzd*', a derivative of *gruda* (**груда**), meaning 'clod'. The Greek term must have been pejorative, but when fashionable Rome took to mycophagy, *boletus* acquired an aura of excellence that survives to this day. Caesar's *boletus* is said to be still called the *fongo bolado* or *bole* around Verona, and *boule* in some parts of Provence. *Bolet* is the general term for fungi, especially those with gills, among the mycophilic Catalans. When the Germans needed a new and favorable word to make mushrooms acceptable on

---

201. In this book we have not capitalized scientific names, thereby wilfully violating accepted practice. Only in High German are common nouns capitalized, and this German usage disfigures the page with capital letters; it is not to be encouraged. Scientific names are not proper nouns: they designate congregations of similar individuals. There is no more reason why 'lycoperdon' should be capitalized than the synonym 'pufifball'.
202. The meanings of the classical words for the fungi have been examined twice by English students: (1) by the Rev. Wm. Houghton, 'Notices of Fungi in Greek and Latin Authors', in the *Annals & Magazine of Natural History*, Series V vol. 15, Jan. 1885, pp. 22 ff; and (2) by Prof. A. H. R. Buller, 'The Fungus Lore of the Greeks and Romans', *Transactions of the British Mycological Society*, vol. V, part I, May 10, 1915, pp. 21 ff.

the table, we have seen that they turned *boletus* into *Pilz*; and one of the general words for 'mushroom' in Rumanian is *burete*, with the same etymology.

In the light of this history, it is disappointing that Linnaeus ratified the severance of that fine old *boletus* from its ancient moorings, and assigned it to capped mushrooms with a spongy undersurface. The untutored peasants of the Mediterranean lands who still apply the word to gilled mushrooms speak with an authority derived from far older credentials than the mycologists can show, and - who knows? - possibly their usage will outlast the new.

The mushrooms that mycologists call 'boleti' were the *suilli* of the Romans, the swine-fungi, a name that comes down to us in modern Italy in the translation *porcino* (*Boletus edulis*) and *porcinello* (*Boletus scaber*). The books are wrong when they explain these names by an alleged fondness among pigs for the boleti. These are the species that develop a greasy texture suggestive of pork when cooked in the fresh state; and when dried, they taste like dried meat. This meatiness explains why they are great favorites among the monks of the Russian Church in the long fasts. Today these 'swine-fungi' are considered *kosher* among the Jews of Eastern Europe, but our friend Professor Uriel Weinreich, authority on the Ashkenazic culture, reports to us a curious fact. From an informant of Polotsk he learned that in that area the Jews down to modern times have regarded the *Boletus edulis* as *treyf*, or unclean, and have not eaten it. May not this be a survival of a very old tradition? For the Jews of Russia mostly migrated thither from the West, passing a long stage in Germany on the way, and the association of these mushrooms with the pig in Italy may well have eliminated them from the diet of Jews.

Reverting now to the mycologists, we find that they have borrowed the Greek word for truffle, ὕδνον, to apply to the wholly different hydnaceae family, and the Greek word for puffball, πέζις, to apply to the wholly different peziza group, and the Greek word for the field mushroom, ἁμανῖται, to apply to the clan known nowadays as the amanitas. The Latin word for truffle, *tuber*, alone survives in its original meaning. No purpose was served by these shifts in meaning: they were merely an evidence of bad classical education and an unscientific carelessness with words.

Another example of this abuse of language is the fate of the Latin word *agaricum*, the Greek ἀγαρικόν. Surprising as it may seem, the ancient Romans were not unfamiliar with the fungi of the region that we call Russia. Today 'agaricus' is the name for the gilled fungi, but it was Linnaeus who imposed this meaning. The ancients applied the word to the shelf-fungus that grew on the larch, now known as the *Fomes officinalis*, used since ancient times medicinally. Dioscorides explained for us that the name was taken from the land of Agaria, lying on the northern shores of what we call the Sea of Azov, there where mariners would steer their course by Point Agarum, halfway between the mouth of the River Don and the ragged peduncle by which the Crimean peninsula hangs from the Continental land-mass. The physicians of Agaria enjoyed renown in those times, and at the Court of Mithridates the Great some of them were always in attendance. Probably the medical school of Agaria was the first to discover the medicinal virtue of the ancient *agaricum*.

On the shaky foundation of Linnaeus' basic names for the mushrooms, errors and infelicities have continued to pile up. There is the spring-tide amanita, or *Amanita verna*, which grows in the autumn. There is the *Amanita phalloides*, which ought to be 'phallus-like'. Not at all! To explain that name we must look at another fungus, most distantly related, which does resemble a phallus and which is called the *Phallus impudicus*. Around the base of the stem of the *Amanita phalloides* there grows a 'cup' that superficially resembles the 'cup' of the *Phallus impudicus*, and this feature, unrelated to any phallus but shared by the two species, is the trivial justification for the name of the *Amanita phalloides*! There is the *Gyromitra esculenta*, widely sold in the market places of Europe, but whose esculent virtues have been occasionally tarnished by mysterious fatalities. Linnaeus himself bestowed on the *Lactarius deliciosus* its misleading name. It seems that reports reached him of the esteem in which a certain lactarius was held in the south of Europe, and he assumed that it was the one with which he was familiar in Sweden, and so bestowed on the kind he knew the name that rightfully belonged to another.[203] By this blunder he started endless confusion and misunderstanding. The *Lactarius deliciosus* is not delicious, and the species that Linnaeus thought he was baptizing is now known as the *Lactarius*

---

203. Roger Heim retells the story of the misnaming of the *Lactarius deliciosus* in the *Revue de Mycologie*, vol. XV, fasc. 2, July 1950.

sanguifluus, the *rovello* of the Catalans, the species on which the Majorcans bestow the delightful name of *exclatasangs*, or 'blood-spatterers'. The milk of this kind is reddish, whereas the so-called *Lactarius deliciosus* yields saffron droplets.

One of the greatest of mycologists was Elias Fries, also a Swede. About him there is a story to tell that, so far as we know, has never been told before. Men of learning are sometimes inclined to patronize lesser mortals, but they are themselves subject to occupational hazards of their own, pedantic errors and odd manifestations of ignorance, and Fries offers us an instructive example of the pedantic fallacy.

It was in 1601, as we have said on an earlier page, that the Frenchman known as Carolus Clusius published his great herbal, *Rariorum Plantarum Historia*, in which he devoted many pages to descriptions of the fungi of Hungary. Among others, he discussed the species known to the French as the *mousseron*, and to science as the *Tricholoma gambosum* or *Tricholoma georgii*. We reproduce in facsimile the relevant passage of his text. The reader will observe that Clusius begins by giving the Hungarian and German names of the mushroom, *Szent Gyewrgi gambaia* and *Sant Georg schwammen* respectively. Both names mean the same thing, viz., St. George's mushroom, *gambaia* being the appropriate grammatical form of the Magyar word *gamba* or *gomba*, 'mushroom', a word borrowed from the Slavs and cousin to the Russian *guba*.

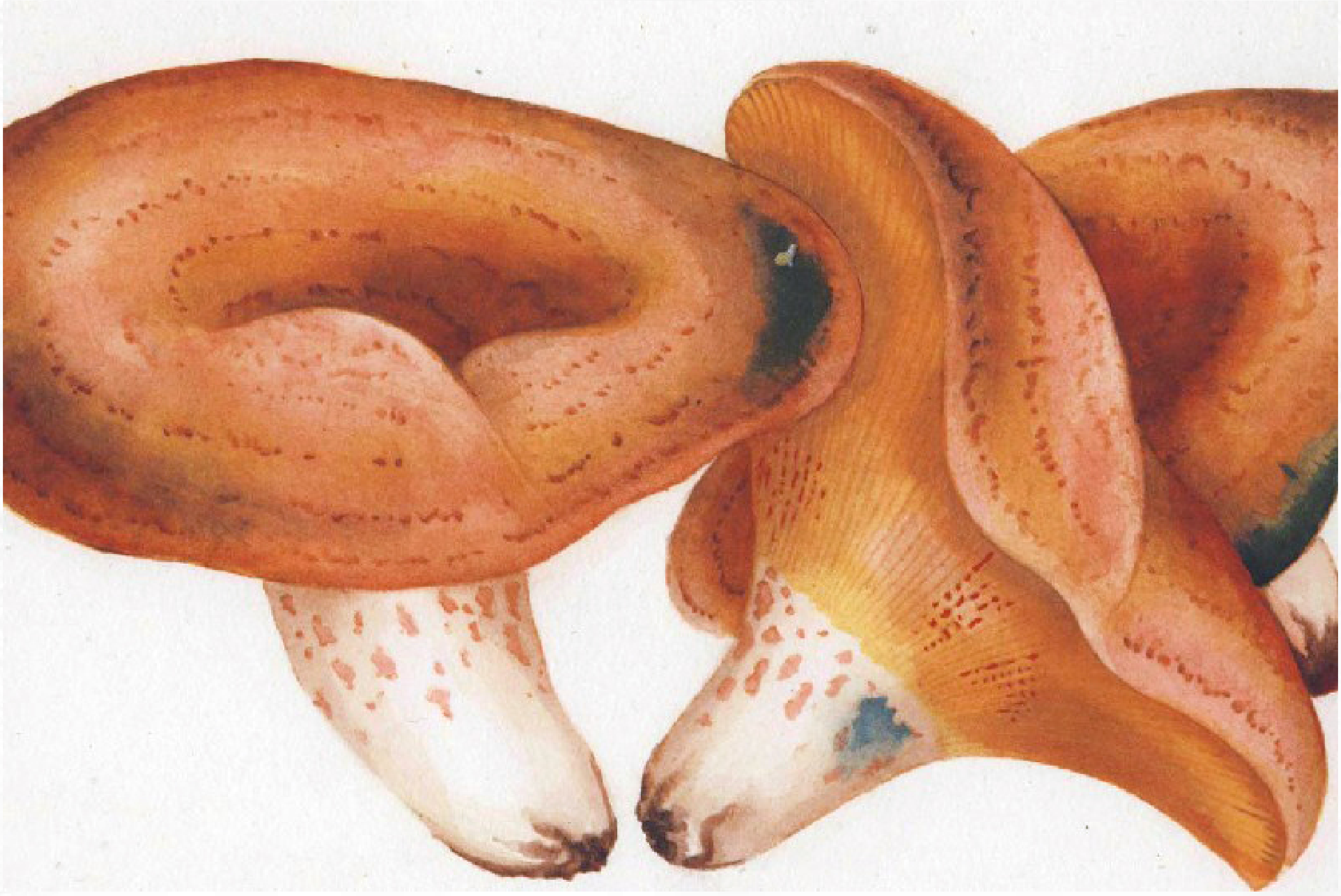


PLATE LXXVIII
Jean-Henri Fabre. *Lactarius deliciosus* Fr. ex Lin.
French: *sanguin*;
Russian: *ryzhik*;
Polish: *Mleczaj rydz*.

More than two centuries later, in 1821, Elias Fries published his *Systema Mycologicum*, one of the classics of mycological writing. In it he bestowed on the species that Clusius had already described the name *Agaricus gambosus*, adding the comment that he suspected this was edible because of its odor of fresh flour! (There speaks the mycophobic Swede.) He thought it was the true *Agaricus georgii*, as to which there had been much confusion. Here are Fries's words:

> Hunc pro vero A. Georgii, quo nil magis confusum,
> et ob odorem farinse recentis edulem suspicor.

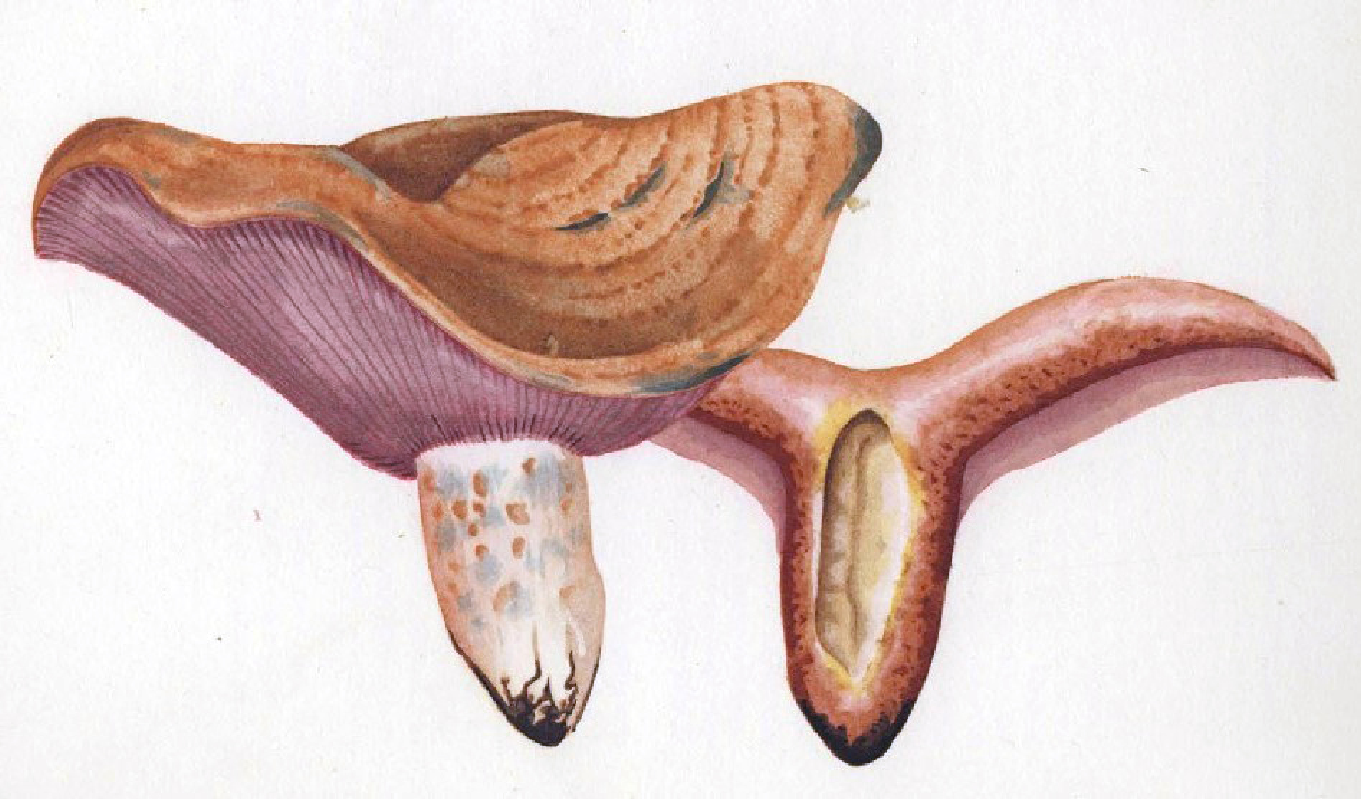


PLATE LXXVIX
Jean-Henri Fabre. *Lactarius sanguifluus* Fr. ex Paul.
French: *vineux*;
Catalan: *rovelu*;
Polish: *Mleczaj czerwieniejący*.

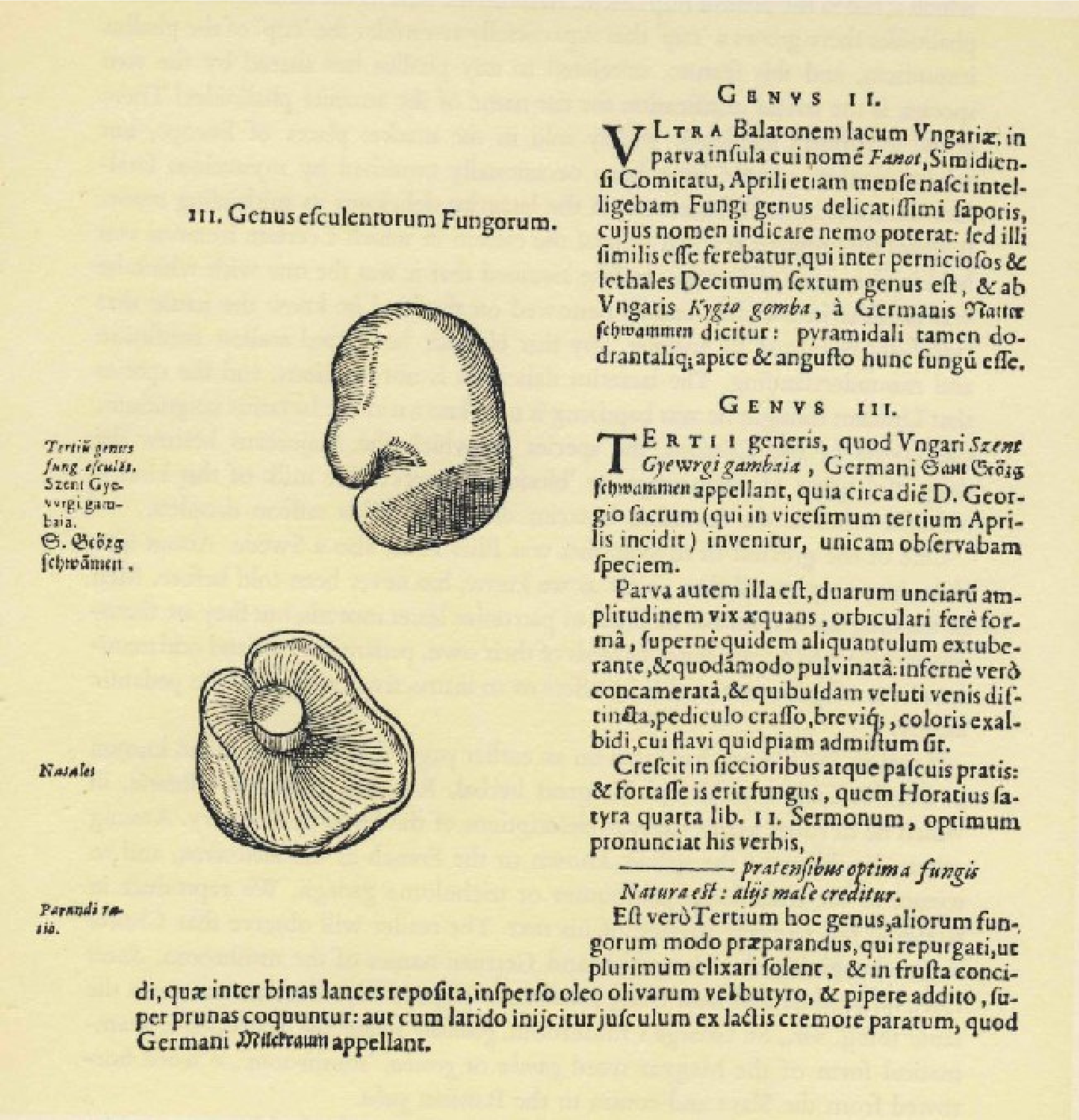
Fries did not explain his use of *gambosus*, but he referred to the very passage in Clusius that we have reproduced, and therefore it was not at all surprising when, in 1827, a learned confrere, Kurt Sprengel, in editing the 16th edition of Linnaeus' *Systema Vegetabilium*, retained the older name, *Agaricus georgii*, and then added, again in Latin, a slighting reference to Fries's term, saying that it was derived from the Hungarian word in Clusius and that it was an unhappy choice; which indeed it was.

In the following year, 1828, Fries gave vent to his pique at this reprimand in his *Elenchus Fungomm*. Again using Latin, he said that Sprengel, 'most learned in botanical literature', was mistaken in tracing the excellent name, *Agaricus gambosus*, to the Hungarian *gambaia*, which he had never thought nor even heard of. Instead, the nature of the mushroom had inspired him to borrow from the Latin author Vegetius the word *gamba*!

This was a most unwise assertion for the great Fries to make. Despite his assertion to the contrary, he was, as his text had expressly said, familiar with Clusius. He had clearly misread Clusius, construing *gambaia* as a specific name rather than the Magyar word for 'mushroom'. When challenged, he took refuge in a late Latin writer's use of *gamba*, which in Vegetius, as we have seen, meant a swelling on the hock of a horse. Certainly no one, not even a Swedish mycologist, would associate by first intention the lovely *mousseron* with a swelling on the hock of a horse! Nor even with a hoof of a horse, which is an alternative meaning. By devising the name 'Agaricus gambosus', Fries unwittingly was describing the *mousseron* as of the genus 'agaricus', species 'fungus'.

By reason of Fries's error, the mycologists have inherited, apparently in perpetuity, an absurd scientific name for the simple *mousseron*, a name that survives in the modern *Tricholoma gambosum*. If, as we argued on an earlier page, the word *gamba* in Vegetius was a borrowing from the barbarians of Central and Eastern Europe, then that was the same *gamba* that appears in Clusius, and Fries did not advance his cause in the slightest by digging up the writings of the Roman veterinary.

How refreshing it is to turn from the unhappy nomenclature of the mycologists to the genuine words devised over the ages by humble peoples! Some of these hide their secret meanings successfully, such as *mizcalo* in Spanish, and the generic word for mushrooms in Romany, *x* or *xuxur*. To illustrate the complexity of the problems presented by popular mushroom names, we shall cite the case of the delectable mushroom known to science as the *Tricholoma equestre*, which in the mushroom world holds the rare distinction of growing in sand. It enjoys great renown along the coast of the Landes, in Gascony, under the name *bidaou*. Some miles to the east, in the sauterne country around Podensac, this same mushroom, highly esteemed, is the *pied d'ane*, or ass's hoof. In the neighboring region of Entre-deux-mers, famous among wine-lovers, it is the *Catalan*, a name used elsewhere in the Gironde for the *Lactarius deliciosus*. Beyond the Dordogne around St. Andre de Cubzac, it becomes the *jaunisson*. Nearby, in the canton of Cavignac, where the *langue d'oïl* is spoken, our *Tricholoma equestre* is known as the *bourseau*, from a local word meaning to swell or distend. Thus here in an area of France that could be covered by a pocket handkerchief, so to speak, a single species of mushroom, well known to everyone, bears five distinct names.



III. Genus eſculentorum Fungorum.

GENVS II.

VLTRA Balatonem lacum Vngariæ, in parva inſula cui nomẽ *Fanot*, Simidienſi Comitatu, Aprili etiam menſe naſci intelligebam Fungi genus delicatiſſimi ſaporis, cujus nomen indicare nemo poterat: ſed illi ſimilis eſſe ferebatur, qui inter pernicioſos & lethales Decimum ſextum genus eſt, & ab Vngaris *Kygio gomba*, à Germanis Natter ſchwammen dicitur: pyramidali tamen dodrantaliq; apice & anguſto hunc fungũ eſſe.

GENVS III.

Tertiũ genus fung. eſculẽt. Szent Gyevrgi gambaia. S. Görg ſchwãmen.

TERTII generis, quod Vngari *Szent Gyewrgi gambaia*, Germani Sant Görg ſchwammen appellant, quia circa diẽ D. Georgio ſacrum (qui in viceſimum tertium Aprilis incidit) invenitur, unicam obſervabam speciem.

Parva autem illa eſt, duarum unciarũ amplitudinem vix æquans, orbiculari ferè formâ, supernè quidem aliquantulum extuberante, & quodãmodo pulvinatâ: infernè verò concameratâ, & quibuſdam veluti venis diſtincta, pediculo craſſo, brevíq;, coloris exalbidi, cui flavi quidpiam admiſtum ſit.

Natales

Creſcit in ſiccioribus atque paſcuis pratis: & fortaſſe is erit fungus, quem Horatius ſatyra quarta lib. II. Sermonum, optimum pronunciat his verbis,

——— *pratenſibus optima fungis*
Natura eſt: aliĳs male creditur.

Parandi ratio.

Eſt verò Tertium hoc genus, aliorum fungorum modo præparandus, qui repurgati, ut plurimùm elixari ſolent, & in fruſta concidi, quæ inter binas lances repoſita, inſperſo oleo olivarum vel butyro, & pipere addito, ſuper prunas coquuntur: aut cum larido inijcitur juſculum ex lactis cremore paratum, quod Germani Milchraum appellant.

Fig. 27 - Earliest description of *Tricholoma gambosum*
by Carolus Clusius, in *Rariorum Plantarum Historia*, Antwerp, 1601.

Wherever the latent metaphor in a popular name for a mushroom can be deciphered, it is invariably accurate in observation and true in feeling. In the course of these pages we have uncovered many of these inner meanings, but there has been no occasion to refer to some of the best. Take the curious case of the *Cantharellus cibarius*. No one has discovered the name for it in ancient times, but since it carries today more names by far than any other wild mushroom of Europe, we must suppose that it was known to our remote ancestors also. In most of the Slavic countries its name is keyed to the fox, e.g., the Russian *lisichki*, 'little foxes', and the Hungarians translated this to arrive at their *rokagomba*. The Lithuanian *lapelaizis* means the 'fox-licked one': foxes like squirrels are great mycophages. In Old Czech of the 14th century we find the term *lisa huba*, 'fox's mushroom'. The Bulgarians use an expression that is wholly their own, *pachi kraka*, the 'duck's foot', a happy figure of speech, as will be perceived by any mycophile who recalls the color and shape of the webbed foot of a duck, idly suspended in air or water.

The German *Pfifferling* or 'peppery one' is an inappropriate changeling. This name rightly belonged to the *Lactarius piperatus*, as we can prove by the description of it given in the *Adnotationes* of Valerius Cordus in the 1530's:

> Sunt enim quidam Piperis sapore et lacteo liquore manant. Hos German! *Pfifferlinge* vocant.
>
> For there are some with the taste of pepper, and they flow with a milky fluid. These the Germans call *Pfifferlinge*.

Two centuries earlier Konrad von Megenberg in his *Das Buch der Natur* also speaks of the *Pfifferling*, which he says is of questionable edibility. It seems that when the Germans began to take to mycophagy, they appropriated an existing name of another mushroom to apply to the *Cantharellus cibarius*, a small mushroom that all true mycophiles hold in modest esteem; wherefore in time the German name acquired a secondary meaning, to designate anything trivial, and in this sense the German word turns up in French in a single expression: cela ne vaut pas un fifrelin.[204] In Austria our little chanterelle is the *Eierschwamm*, suggestive of the scrambled eggs that these mushrooms resemble and with which in Austria they are often prepared.

Of the many names for the *Cantharellus cibarius* in France, the *girolle* and the *chanterelle* are the most widely known. The French philologists Oscar Bloch and Albert Dauzat both assert that *chanterelle* entered the French language in the middle of the 18th century, and that it was taken from the scientific name bestowed on the mushroom by Linnaeus - 'cantharellus' - which in turn (according to the French philologists) he devised from a Latin word *cantharella*, a little cup. This etymology is *prima facie* suspect, for popular names bestowed on mushrooms by French peasants are not normally derived from learned terms of Linnaean inspiration. In fact, the philologists are mistaken. Jean Bauhin in his great *Historia Plantarum Universalis*, published in 1650-1 and written a half century earlier, reported that *chanterelle* was in his time the popular name of the mushroom around Montbeliard, in the east of France. Clearly the mycologists Latinized the word as they found it. *Chanterelle* is a name of popular inspiration descended from the Latin diminutive *cantharulus*, formed from *canthams*, which in turn was borrowed from the Greek κάνθάρος, drinking cup. Possibly there is collateral evidence of this origin in a word that survives in the archaic Spanish spoken in Jocotan, Guatemala - *canturula*, the name of an ear-shaped fungus that grows on old trees.[205] Words that circulate chiefly on the tongues of humble people undergo subtle pressures and transformations, being re-shaped to conform to punning suggestions and metaphorical associations. Perhaps there is evidence of this in *chanterelle*. This little mushroom in Italian is the *gallinaccio*, 'turkey-cock'. In Dutch it is the *hanekarn*, 'cock's comb', though Dutchmen, being mostly mycophobes, often know not the word in this sense. The Dutch and Italian words suggest the masculinity of the cock. In Catalan the *chanterelle* is the *rossinyol*: this is said to be derived from *ros*, *rossa*, an adjective that describes to a nicety the red-gold color of the lovely mushroom. But *rossinyol* also means 'nightingale', and it happens that, just as the dove or *paloma* is the symbol of the beloved in French and Spanish popular tradition, the nightingale is the symbol of the lover.[206] In Bulgaria, as we have seen, the *chanterelle* is linked with the drake. These ornithological ties, always masculine, are curious. Does not *chanterelle* itself suggest singing and *chantecler*? Are we not in the presence of an eruption, subtle and unconscious, of the old erotic theme, by way of the cock's comb, the gobbler's wattles, the crowing chanticleer, the virile *rossinyol*? If our surmise be right, confirmation must be sought, not in the sophisticated ratiocinations of scholars, but rather in the emotional associations of the untutored folk when they use their homely words for the little yellow mushroom. If our surmise be right, the deep-seated eroticism of the fungal consciousness of Europe is erupting again, before our eyes, in the words born of popular fancy or reshaped by popular pressure to designate the *Cantharellus cibarius*. Like murder, the shameless μύκης will out. Our straws of evidence permit us to discern the erotic theme as through a glass, darkly. How pleasing it is for us, then, our surmise having been formulated, to discover corroboration for it in eastern Europe. In the Latvian language the name of the *Cantharellus cibarius isgailene*, derived immediately from *gailis*, 'cock', a word that is kin to the Latin *gallus*.

---

[204] The mushroom seems to have been widely used as a symbol of worthlessness. We have seen that the English 'trifle' was a truffle, the word having been borrowed long before the truffle rose to its present heights in social esteem and market value. Juan Corominas in his note on the Spanish *seta* points out that it has carried the same metaphoric meaning.

[205] See Lisandro Sandoval's *Semantica Guatemalense o Diccionario de Guatemaltequismos*, Guatemala, April 1941.

[206] See Wm. J. Entwistle's comments on *El Conde Olinos* in *Romance Philology*, vol. VII, No. I, Aug. 1953, p. 13.

The alternative word in French for the chanterelle is *girolle*. French philologists seem satisfied that this word shares the same root as 'gyrate', but there is no evidence for this. *Girolle* is a borrowing from Provençal, where the name is current in many variations extending over the langue d'oc area of France and throughout Catalonia and the Balearic Islands. *Jirgola* in Majorca corresponds to *girbola* in Catalan, and in Frederic Mistral's Provençal dictionary we find the word in myriad forms. No other mushroom anywhere seems to possess so many names, of which here are the ones we have collected:

biroudelo
bouchinguello
caramillo
crahilho
escarabiho
escrabilho
gerilho
ghidorelo
ghirolou
giraudello
girbouleto
girello
girgouleto
girgoulo
iredela
jargouleto
jirboulelo
jotrel
ziraoudela
zitello

Here we leave an enigma for ethno-mycologists to apply themselves to - in an area unsurpassed for mycophagy, an important mushroom parades an unrivalled diversity of interrelated popular names, all of unknown meaning and all reduced in French to the lovely but deceptively simple *girolle*.

So much for the chanterelles. In Swiss German the *Clavaria* or coral mushroom is known as the *Ziegenbart*, or goat's beard, which is a good metaphor, but it is topped, we think, by the happiest name in all of Europe's mushroom vocabulary, the Catalan word for the same fungus, which is *pens de rata*, or rat's paws. The soft, marvelously fine articulation of the paws of a rat are the perfect analogy for the corresponding extremities of the coral mushroom, and in this mushroomic name we possess a supreme example of the perception of peasants.

Sometimes the mycologists have paid obeisance to popular terminology. For example, the name of the puffball, lycoperdon, is a learned back-formation to a non-existent Greek term that would mean 'wolf's flatus'. How much better it would have been to use the genuine Greek name for the same fungus, πέζις, which harbors the same indelicate idea!

It might be thought that the mycologists of the world, being a relatively small group, could agree together to wipe the slate clean and begin anew, giving no hostages to vested interests, and devise a system of solidly grounded mushroomic names. But such reforms seem beyond the capacity of men, even scientists, and perhaps this is just as well. A nomenclature that is encumbered with barbarisms, pedantic fallacies, and infelicities is a perpetual and humbling reminder that scientists themselves are ordinary clay, even when they are cultivating their own garden.

Vale

Now our excursion among the mushrooms has ended. Free of professional inhibitions, we as amateurs have traveled far and wide, brazenly suggesting novel etymologies and theories of our own. Some of these, when put to further test, are sure to crumble. But our argument is a frontal one, and does not depend on single links. Beginning with an addiction to wild mushrooms and keeping our eye always on them, we have compared the words used for fungi by the various Indo-European peoples, concentrating on the metaphors that are latent in them. We have found a series of semantic themes recurring throughout these fungal vocabularies, and these themes have suggested origins for many words that have heretofore baffled the philologists. If this approach through semantic themes should prove to have been successful, it could be applied to other specialized vocabularies for elementary things and activities that our remotest ancestors must have talked about.

We began by asking what lay behind the English word 'toadstool'. In the course of our inquiry we discovered several attributes common to wild fungi and toads. The peoples of the North Sea basin think of both tribes - fungi and amphibia - as venomous. Over a broader area and running back deeper into the past, the peoples of northern Europe think of fungi and toads as organisms that swell up, and also as dunglike vermin. We find that both toads and fungi inspire revulsion and fear, and naturally our ancestors considered them instinct with evil spirits. Both are slimy and mucoid. Fungi are tumor-like, clodlike; and toads are misshapen growths, foul and ugly. Fungi are aphrodisiacs, and toads are lecherous. Both suggest the idea of procreation, in a variety of ways. On a larger stage, we have found that in the cultures of Europe, where deadly serpents are few, the toad is the indigenous equivalent of the serpent of the East. Eve's serpent, exercising its horrid and fearsome spell, was a creature of the East. In the eastern Mediterranean the two creatures competed for dominion over men's souls, but in the West the toad was supreme. The 'toadstool' of the West emerges as the mycological and cultural equivalent of the *ahi-chattra(ka)* or 'snake's parasol' of the Sanskrit writings. A common fund of words for all these ideas is drawn upon, in the various Indo-European languages, to refer to the fungi, and also to toads, and when in a given language the same or similar words are drawn down from the common fund for the two orders of creatures, the peoples speaking that language associate toads and fungi together, and by reason of the words that overlap, and the common attributes, their feelings toward them take on the same tone. Similar metaphorical transfers appear to be indigenous also in human societies far removed from the Indo-European world.

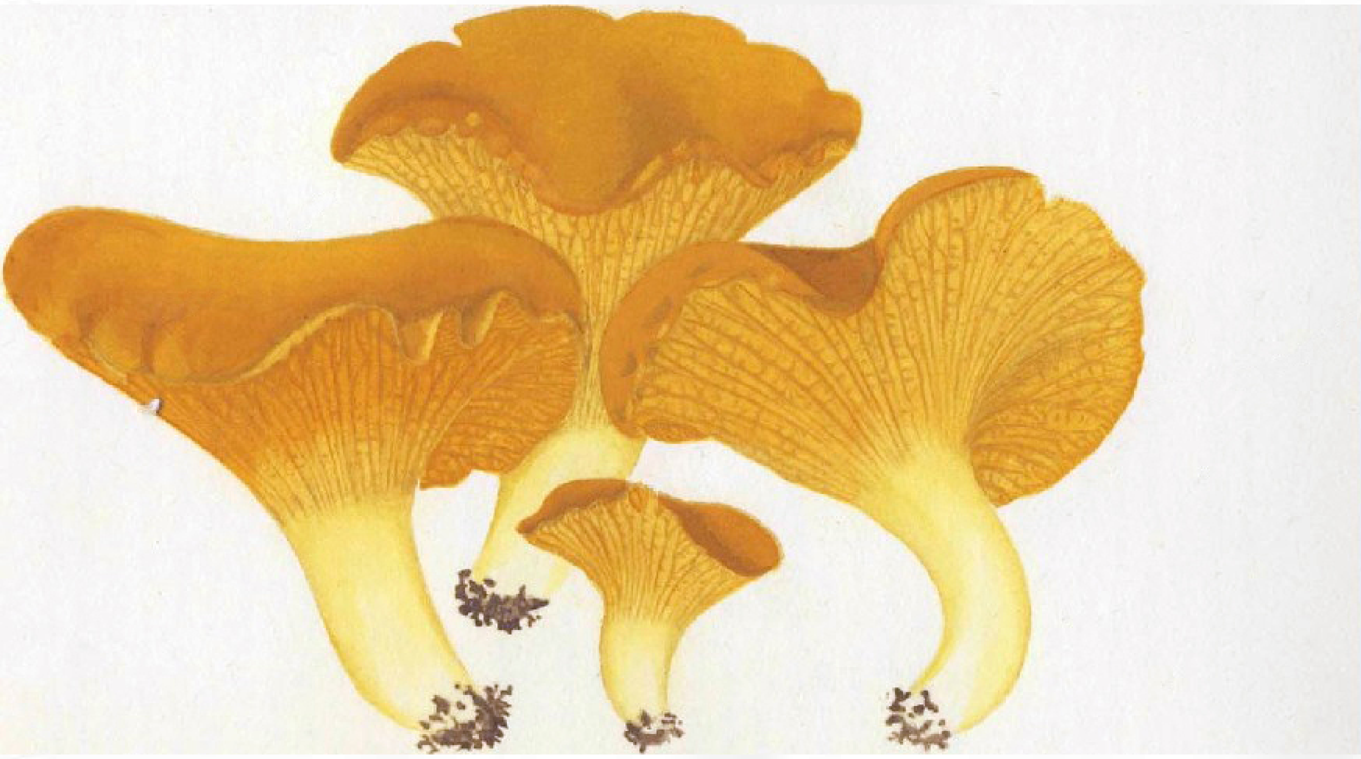


PLATE LXXX
Jean-Henri Fabre. *Cantharellus cibarius* Fr.
French: *chanterelle, girole*;
Russian: *lisichka*;
Polish: *Pieprznik jadalny.*

But behind the interweaving of these innumerable words and ideas, there lies the Mystery of the divine mushrooms. We have now learned that many species of these strange growths possess a power such as early man could only have regarded as miraculous. Indeed they may have given to him the very idea of the miraculous, and inspired many of the themes that come down to us in our heritage of folklore. Mushrooms were doubly associated with fire. They were used as primary tinder in that miracle of divine copulation, the generation of fire by the fire-drill, and the divine mushrooms were the offspring of the union of the Lightning Bolt with the Mother Earth. We have suggested that the divine mushrooms played a vital part in shaking loose early man's imagination, in arousing his capacity for self-perception, for awe, wonder, and reverence. They certainly made it easier for him to entertain the idea of God. In Europe the secret of the mushrooms was lost long ago, but it lingers on, fossilized and misunderstood, in our vocabulary, as when the Greeks spoke of mushrooms as the 'gods' food', the Flemings of 'devils' bread', the demonic *crapaudin* of France, the demonic 'toad's stool' of the English, yes and the 'fly' of the German *Fliegenschwamm*. Our legacy of mycophobia, what is it but a simple tabu, the aftermath of the emotional hold of those mushrooms on our own ancestors? There were other hallucinogens in the vegetable world, but we think the mushrooms were primary.

Men ordinarily think of words as combinations of sounds that can be visualized with the aid of letters, and listed alpabetically in dictionaries, and there neatly defined and ticketed with their histories. But the words in dictionaries correspond only to 'stills' in photography: the dictionaries catch them in a given posture, at a particular moment in time and space. This is true even of the largest dictionaries, which try to cover meanings over centuries and which cite a few outcroppings of the same word in other languages; for the center of gravity even in these big dictionaries is still in a single language, and therefore their angle of vision is self-centered and Ptolemaic. Moreover, no dictionary can hope to deal with all of the subtle semantic associations, and all the gradations of feeling, that the sound (which is the word made manifest) evokes. But these associations and feelings are the life and soul of the word, of which current usage in a single community may be only a passing phase. A word is a thin thread of sound coming down to us from earliest human times, a sound passed on from mouth to mouth, slowly changing, assuming different contours in the mouths of different communities, each of these variants remaining a strand of the original thread, these different strands plaited in and out among themselves, tangling with other threads of similar sounds but different meanings; impalpable, visible (through writing) only in recent millennia and until yesterday only to a few; thin as air; but solidly joined in the alembic of the human mind to particular perceptions of the senses and keyed to particular feelings; this link between sound on the one hand, and meaning and feeling on the other, displaying a tough continuity down the river of time and across vast stretches of diverse cultural expression, a continuity that stands in amazing contrast with the airy nothing of the words themselves. Words are a secretion peculiar to the human organism, and though uttered through a localized vocal mechanism, a secretion attuned to the whole organism.

A.E. Housman in his famous Leslie Stephen lecture on the nature of poetry startled his public by asserting that for him great poetry was measurable by physiological reflexes. The shiver down his spine, his beard that bristled at the thought of great lines while he was shaving, the catch in his throat, sudden activity in his lachrymal ducts - these were his poetical touchstones. Could he not have carried his idea further? Was he not fixing his attention only on those rare conjunctures of grosser reflexes that are the fruit of the greatest utterances? In less degree does not every word possess its visceral counterpart, emanating from the pit of the stomach but registering itself in localized manifestations - in the stimulation or inhibition of glandular activity or incipient muscular twitches, in sights or sounds perceived only by the mind's eye or mind's ear, in imaginary tactile or olfactory or gustatory sensations? Teeth are set on edge by sour grapes, and also by hearing sour grapes mentioned, and even by the silent passage of those two words through the attuned mind. Perhaps in the long run the stability that is the astonishing property of words is traceable to the solar plexus, to this conditioned reflex, which is the obverse side of the audible entity. The great speaker or writer - the composer or conductor - is the master who manipulates these responses with supreme artistry, playing on the human instruments that are his audience, the instruments knowing they are in ecstasy but blissfully unaware of the infinitely subtle physiological wherefore. Here is a sense in which the kingdom of heaven is within us; and the music of the spheres turns out to be a physiological symphony. Let not this reflection disturb the believer in a Supreme Architect, for the ultimate enigma always remains close by, and man's most searching inquiries are always confined within the bounds of the flexible but impenetrable envelope of the unknown, of that dark, distensible womb that is our prison and our Eden.

By assaying the words used among various peoples for the fungi, we have perhaps suggested reasons for the mycophobia that afflicts most of the Western peoples. The semantic associations of these words, their emotional coloring, are rooted in the fears and beliefs of our ancestors in the earliest ages, perhaps when they were what we call Palaeolithic men. We study them objectively by digging up their artifacts and applying the highest order of intelligent curiosity to these old stones. But within ourselves, in our emotional responses, in our words that come down from long ago, we bear within us as part of us the evidence for a subjective understanding of those our forebears. Our elementary words with their emotional evocation are oral artifacts descended from those remote times, and like palimpsests occasionally permit themselves to be read layer beneath layer. Our words are a repertory of wood-notes wild, if only we attune ourselves to the faint descant that rises from them. How amusing it has been to discover in mycophobia the willing, nay determined, subservience of many Europeans to a simple tabu such as we like to associate with primitive peoples, a subservience to emotional responses that seem to stem back to the day when our ancestors found themselves face to face with the miraculous powers of the sacred mushroom! The secret lost, the tabu survives. Like the tribes that our anthropologists study, we cling to our own tabus and seek to justify them by rationalizing them. Few men want freedom, however they may talk. But then again perhaps man is free in his choice when he chooses to abide within the confines of his unreason.

Bibliographical Notes and Acknowledgements

The amateur of wild mushrooms is interested in everything written on the subject. Few scientific papers are too refined for his palate. The strange blunders often cropping out in popular writings delight him for their piquancy. In cut-and-dried mushroom manuals he always knows that at any moment he may come across wayward remarks of the compilers that show how even they are moved by the beauty or strangeness of the creatures they describe. An extraordinary example of this eruption of the poetic muse in the course of a pedestrian text about mushrooms is to be found in a certain Swiss manual published more than sixty years ago: it is so unusual that we offer it in full to our readers in Appendix III.

In general the mushroom amateur, when it comes to his library, must be content with fare served for others - texts written for beginners or treatises for scientists. The writings about mushrooms aimed at the informed amateur are few. As he embarks on the assembling of a collection, he will do well to begin by acquiring a complete set of the publications since 1936 of the Laboratoire de Cryptogamie, at the Museum National d'Histoire Naturelle in Paris. This is the period of Professor Roger Heim's editorship of the *Revue de Mycologie*. Professor Heim is a leading mycologist. What is more rare, he is a scientist steeped in the humanities who writes with style. He has the magnetism of the great teachers, and has drawn into the circle of subscribers to his *Revue* a group of enthusiasts who contribute delightful and sophisticated articles to various *Supplements* of the review, which are expressly directed to initiated amateurs. Two outstanding members of this select fraternity are Georges Becker and Camille Fauvel, whose essays on wild mushrooms, poles apart in style and mood, are destined to be regarded as classics by the devotees of our avocation. The *Revue de Mycologie* offers its readers a *Chronique de l'amateur, La Chronique anecdotique*, a practical course in mycology for amateurs, excellent color plates of mushrooms, scientific supplements shedding light on the fascinating jungle of tropical mushroom life, and finally occasional treatises on special topics. Who will ever match that Savoyard, the prodigious Dr. Paul Ramain, for example, who in his *Essai de Mycogastronomie* sets forth with delicate discrimination the merits (or shortcomings) for gastronomes of each of 245 species of edible mushrooms, all from his personal experience! He sets forth the astonishing facts about what we might call the 'vintage years' for mushrooms: it is clear that mushrooms taste better in some years than others, and in some regions than others. No mushroom fancier should rest content so long as he is unfamiliar with the breathtaking performance of Dr. Ramain.[207] The presiding genius in this circle of mycophiles is of course the Maitre, Professor Heim, whose own contributions are always notable events. Especially among English readers, nature writing enjoys high status as a genre of belles lettres. Roger Heim is to be ranked with the aristocrats of this goodly company. His paper delivered in February 1946 on 'Les Rapports entre les Insectes et les Champignons' displayed a dual excellence, scientific and literary, of the highest order, all the more moving for the informed few who know that this essay, for all its air of serene detachment, was read in the wake of a terrible ordeal. Two years later Professor Heim published a book, *Les Champignons*, original in conception, of rare quality, which is a treasure for connoisseurs of nature writing and for all lovers of mushrooms.

Outside of the Heim circle there are other mushroomic publications for amateurs, but few in number and uneven in quality. One of the good books, in its way, is Jules Amann's *Mes Chasses aux Champignons*, published in Lausanne in 1925. In English there is *The Romance of the Fungus World*, by R. T. and F. W. Rolfe, published in London in 1925, written without literary distinction but containing an immense amount of information never theretofore assembled. We gladly acknowledge our debt to the Rolfes for various data and historical references; as we do also to John Ramsbottom, best known of contemporary English mycologists, for the wealth of information in his *Mushrooms & Toadstools*, London, 1953, which reached us just in time for us to make some use of it.

---

[207] In the spring of 1954 there appeared Paul Ramain's *Mycogastronomie*, published in Paris in a limited edition by Les Bibliophiles Gastronomes. Here we find scores of princely recipes for different species of mushrooms, including even two desserts: Salades d'Oronges a l'Orange and Pezizes Orangees Ali-Bab.

In America the amateur of mushrooms is hobbled by the lack of a first-class field manual, comparable in the mycological field to Roger Tory Peterson's manual for the birds. America's library of nature books is rich in quality and quantity, but a good mushroom manual is a prime desideratum. This deficiency is itself evidence of the wide-spread mycophobia in America, and serves to perpetuate it. There are excellent works by American mycologists that cover various parts of the vast terrain, but no all-embracing pocket guide in a class with *Les Champignons de France*, by A. Maublanc, or *A Handbook of the Larger British Fungi,* by John Ramsbottom, in England. In the absence of a manual for America, these two European works, which are complementary rather than overlapping, are in our opinion the most serviceable for the United States and Canada, in spite of the differences in the fungal population of the two continents.

The compilation of our book has proved an easier and pleasanter task than the reader might suppose. Our secret lay in formulating the right questions, and then submitting them to the right specialists, in whom knowledge and graciousness were equally blended. Such learning as we may have appeared to possess in Chapters IV and V is thus no more than a synthesis of other people's; but the responsibility for the synthesis, for better or for worse, must rest with us. In our preface and in the course of our pages we have already recognized our obligations to many. We now give ourselves the pleasure of acknowledging our debts to some of the others.

We are grateful to Professor Georg Morgenstierne of Oslo not only for the rich budget of data concerning the Iranian and Indie peoples that he sent us over the course of many months, but even more for the constant interest that he displayed in our researches. We are grateful to Dr. Hans Mardersteig for his patience in handling our printing problems. We are especially grateful to Mr. Ronald H. Boothroyd of Verona, who not only nursed our proofs into final shape but by his perspicacious reading of our manuscript saved us from pitfalls and suggested to us new avenues of inquiry.

In our African inquiries we are primarily indebted to Professor Archie N. Tucker of London; to Mr. Jalo Gombe, in North Nigeria; and to Mr. M. B. Nsimbi of Kampala, Uganda. But we wish also to acknowledge the negative evidence produced for us through inquiries in the field by Monsieur R. Hainaut, manager of the Banque Beige d'Afrique in Bangui; by the Reverend Father Tisserant, resident specialist in the native languages of that area; and by the Rev. Paul F. Metzler at Fort Archambault, the Rev. Dr. O. D. Jobson at Bozoum, and the Rev. T. B. Wimer. Mr. Stavro Skendi of New York supplied us with our information about Albanian usages. Professor Elliott V. K. Dobbie of Columbia University advised us in Anglo-Saxon matters; Mons. l'Abbe Falc'hun of the Faculte des Lettres in Rennes replied to our questions concerning the Breton vocabulary; and Professor Dr. G. G. Kloeke of the University of Leiden kindly assembled for us a wealth of dialectical terms in Dutch. Professor Joshua Whatmough of Harvard was especially helpful on two Late Latin problems, and Professor Taylor Starck on questions of Low German dialects. The Rev. Dr. Edgar F. Romig turned up certain words in Pennsylvania Dutch for us, and on Frisian questions we relied on our friends M. Wiegersma of Drachten and J. J. van Weringh of Leeuwarden. Professor Dimitry Cizevsky of Harvard, Mrs. Michael Karpovich, and Countess Alexandra Tolstoy were generous in suggestions drawn from their rich experience and fabulous knowledge concerning Russian and Ukrainian traditions. On various Slavic matters we were the grateful recipients of many suggestions and help from Professor Wiktor Weintraub of Harvard University, Madame Milada Souckova, Max Eastman, and the late Professor Alexander A. Vasiliev. Dr. John P. Hughes gave us aid with Irish problems; as did with respect to Welsh Professor Robert A. Fowkes of Columbia University, Professor T. H. Parry Williams of the University College of Wales, and Miss Nansi Pugh of the Brearley School. We turned to Professor Yakov Malkiel of the University of California and Professor Juan Corominas of Chicago for help in Spanish and Portuguese linguistics; and our friend Luiz Marques, of Lisbon, also supplied us with information. We are indebted to Don Felix Martorell, distinguished son of Constanti near Tarragona, and to his daughters for having made known to us by infectious demonstration the passion for mushrooms that possesses the Catalan people. Our loyal friend Andre Chavaneau, bowing to our mania for recondite pursuits, graciously conducted us on our first pilgrimage to Sérignan, in the Vaucluse. Mr. Peter D'Albert of New York was our informant about Romansch. Madame Elisabeth Kayaloff and Fat'ma Hanoum Natirbov guided us in Circassian questions, and facilitated our access to information about certain other Caucasian peoples. On Eskimo matters Professor L. L. Hammerich of Copenhagen was our mentor, and for Aleutian words we consulted Dr. Gordon

H. Marsh.

In the Finno-Ugric field we relied on Professor Paavo Ravila of Helsinki and Professor John Lotz of Columbia University. Professor Georges Dumezil of the College de France drew our attention to the passage in Saxo Grammaticus that we quote. We are indebted to Dr. Kaj Jespersen of Copenhagen for clarifying certain Danish usages, and to Professor Rolf Nordhagen of Oslo for Norwegian dialectical terms. Raymond T. Bond, John D. Gordan, and Alexander Pinney, all of New York, will discover traces of their influence in our pages, as will Mrs. Arthur L. Goodhart of Oxford, Eric Whittle of Foulby, near Wakefield, in Yorkshire, and Professor Georges Malvesin-Fabre of Bordeaux. Dr. Frederick D. Lascoff and Professor Fanchon Hart of New York helped us with certain pharmacological questions. Our friend Nicholas Kazenchak, native of Slovakia, and Mrs. Irene Pulaski guided us in the mycological folk knowledge of the Slovakian peasants. We also received help from individuals inside Rumania, Bulgaria, and Hungary, whom we must thank anonymously.

In Semitics we are under great obligations to Professor Thomas W. Thacker, head of the School for Oriental Studies in the University of Durham, and to his colleagues, A. J. M. Craig and E. Birnbaum. Others of the same distinguished faculty who gave us valuable suggestions in oriental languages other than Semitic were Arabinda Basu, C. G. Simpson, J. A. Emerton, and R. Dawson. When it came to the kinship of Tartuffe with truffles, we addressed our questions to Professor Frederic G. Hoffherr, then at Columbia University; to Professor Alfredo Schiaffini of the University of Rome; and to Professor Vincenzo Perniconi, the authority on Lorenzo Lippi. Dr. Giorgio Cigliana-Piazza cooperated with us in other inquiries in Italy.

Dr. C. J. Abegg of Zurich introduced us to Professor Dr. Phil. Leonhard von Muralt of the University of Zurich, who in turn enlisted for us the aid of the apothecary Emil Eidenbenz of that city in connection with the odd mushroomic behavior attributed to Russian troops who occupied Zurich in 1799. Mr. Hans Müller and Mr. H. de Mandach of the Union Bank of Switzerland introduced us to Dr. J. Schlittler, Pilzkontrolleur of Zurich, who gave us his valued opinion on the 'mushroom stone' in the Rietberg Museum. To the authorities of that Museum we are indebted for their cooperation in obtaining photographs of the artifact. Mr. Felix Schulthess of the Credit Suisse has given us both encouragement and important help.

In the introduction to our book we have spoken of our obligation to the staff of the New York Public Library. We have also been generously helped by Miss Elizabeth C. Hall, Librarian of the New York Botanical Garden; Miss Hazel Gay, Librarian of the American Museum of Natural History, New York; Miss Meta Harssen of the Pierpont Morgan Library; and the staff of the Frick Library, New York. Mr. Herman Sharon aided us with the text of Konrad von Megenberg's *Das Buch der Natur*.

Charles M. Bogert, Chairman and Curator of the Department of Amphibians and Reptiles at the American Museum of Natural History, New York, demonstrated some of the ways of toads to us, and his staff were also patient with our inquiries. Dr. Donald P. Rogers, Curator of the New York Botanical Gardens, kindly replied to our various mushroomic questions, as did a number of other American mycologists: Dr. Carroll W. Dodge, Mrs. Alma H. Beers, and Clyde M. Christensen. Mademoiselle Suzanne Pretot was similarly helpful in Paris. On all ethno-botanical matters, Dr. Hugh C. Cutler, Assistant Director of the Missouri Botanical Museum, was a fount of valuable information, graciously given.

In matters of art, Gaston van Camp, Conservateur of the Musees Royaux des Beaux Arts de Belgique, turned up much of the material for our discussion of mushrooms in painting. Professor Erwin Panofsky of the Institute for Advanced Study at Princeton and Professor Meyer Schapiro of Columbia University were gracious and helpful in responding to all our inquiries. Miss Margaret Alice Murray referred us to the two passages in English chronicles and trials where toads figured in attempts at murder. Mr. Edouard de Cosse Brissac was the first to bring to our attention the tapestries at Reims depicting Clovis in his pagan days going forth to war under the standard of the toads or *bots*. In the realm of medieval science, Professor Lynn Thorndike put his great erudition at our service. Mrs. Michael Majolier ran down certain elusive facts for us in London, and Mr. and Mrs. Hugh Kelleher in Italy. Mr. Roger Tory Peterson has identified for us certain birds in the Old Masters. Mr. David McCurrach and Mr. Ronald G. Cant, both of St. Andrews, Fife, have done their best to trace for us the Scottish origins of the Hamilton dynasty of painters. Mr. & Mrs. Warren Delano Robbins kindly pursued certain inquiries for us in Paris.

We submitted our theory (originally suggested by Mr. Robert Graves) concerning the Etruscan mirror to a number of specialists in the field: Mr. Bernard Ashmole, Keeper of Greek and Roman Antiquities of the British Museum, Professor Axel Boethius of Goteborg University, Professor Waldemar Deonna of Geneva, and Professor Charles Picard of Paris. They were hospitable to our suggestions, and without committing themselves encouraged us to pursue our inquires and publish our conclusions. Mr. W. T. O'Dea of the Science Museum, South Kensington, helped us with problems of tinder and fire-making, as did Professor N. Fabritius Buchwald of Copenhagen. Professor Boethius was helpful to us on many occasions when we turned to him for advice. David Murison, editor of the Scottish National Dictionary, volunteered various references that proved fruitful, and Mr. Peter Cooper of Bristol, England, helped to clarify certain confusing aspects of Devonshire usage. We thank Mr. David Chandler for his enthusiastic support of our inquiries.

Professor Sanchez Canton, head of the Prado Museum, and his colleague Don Manuel Lorente Junquera, facilitated our inquiries in Madrid in every way. We are grateful to the former for drawing our attention to Mayno's *Adoration*, and to the latter for revealing to us the mushrooms on the back of the panels of Bosch's *Garden of Delight*.

The General Director of the Bavarian State Gallery at Munich, Professor Dr. Ernst Buchner, helped and encouraged us in our quest for old masters with mushrooms, as did also Dr. Ludwig Münz, the Director of the Picture Gallery of the Academy of Plastic Arts in Vienna. Professor Amedeo Maiuri of the Museo Nazionale in Naples was indispensable in enlisting the skilled services of Comm. Professor Gennaro Luciano for the reproduction of the Herculaneum fresco, as well as in other ways. We are also grateful to Mr. Carlo Pascal and Mr. Enzo Rossi of the Banco di Napoli for their patience in pursuing the answers to our various inquiries concerning art treasures in the Naples area. Mr. C. A. Wertheim Aymes of Amsterdam was tireless in turning up Old Masters with mushrooms in the Netherlands and Germany, and we are similarly indebted to Dr. Carlo Bombieri of the Banca Commerciale Italiana in Milan. Dr. William E. Suida of the Kress Foundation drew our attention to the oeuvre of Giuseppe Arcimboldo. Mr. Wango Weng executed the Chinese characters that we use, and for other help in the Chinese field we thank Dr. Chih Meng, Director of the China Institute in America. We are grateful to Mr. & Mrs. Pierre Chadenet for their timely help. Our five maps were executed for us by our friend John P. Tremblay of the American Geographical Society.

In the section on our Middle American inquiries we have mentioned most of those who helped us, but we should be derelict if we did not add the names of certain others: Lic. Alfonso Caso, Director of the Institute Nacional Indigenista, Arq. Ignacio Marquina, Director of the Institute Nacional de Antropologia e Historia, and for his great erudition in Nahuatl linguistics Professor Wigberto Jimenez Moreno, all of Mexico. Above all we wish to express our deepest appreciation to Don Agustin Legorreta, President of the Banco Nacional de Mexico, and his colleague Don Ladislao Lopez Negrete, as well as to the Bank itself, for the way in which they furthered our plans by introducing us to the appropriate persons and by placing at our disposal their private plane, piloted by that excellent airman, Captain Carlos Borja. Without such hospitable cooperation we could have accomplished little. In Mexico we were pressed for time, and Mexico is not a country that takes time into account. Don Agustin and his Bank knew how to gear our necessities with Mexican ways. In Guatemala, in addition to the Borhegyi's, we were helped and encouraged by Mr. and Mrs. Charles Salino. In both Mexico and Guatemala the General Motors Acceptance Corporation saw to it that we never lacked means of highway locomotion, for which we thank them. At the New York end of our Middle American quest, Dr. Gordon F. Ekholm of the American Museum of Natural History gave us indispensable assistance, as did also the American Geographical Society and its director, Mr. Charles Hitchcock. We have mentioned repeatedly the help given to us by various members of the Summer Institute of Linguistics. To those already named we now gladly add John McIntosh, the Director of the Mexican activities, which he supervises from the headquarters in Mexico City known as 'the Kettle'. Mr. Alexander C. Herman, vice president of the National Container Corporation, helped us solve a troublesome logistical problem on our Mexican trips.

By their pressing encouragement and the stream of their fruitful suggestions for further inquiries on our part, made we hope without malice prepense, a number of our friends allowed us no alternative but to complete our undertaking. However questionable their intentions and judgment, we are grateful to them: Roman Jakobson, Rene Lafon, Adriaan Barnouw, Andre Martinet, Kurt Wolff, and Robert Graves, all of whom read our manuscript or the proofs. In a special category we acknowledge our heavy indebtedness to Edwin Way Teale and to Evgenia Lehovich.

Appendix I
Mushrooms in Tolstoy's 'Anna Karenina'

Thrice in Anna Karenina Leo Tolstoy brings mushroom-gathering into his story, and on each occasion with a naturalness, a tenderness, that any perceptive reader will find memorable. We have summarized one of these citations in our text. Here are the other two.

In Chapter 8 of Part III we discover Darya Alexandrovna in the country with her brood of small children and the English Governess, Miss Hull. It is the month of May. The children have returned from Church, where, according to the Orthodox custom, they have taken Holy Communion. At first, under the influence of that solemn occasion, they were models of behavior. But at dinner Grisha whistled, and besides he was rude to Miss Hull. As a punishment, she deprived him of his tart. There were tears, and cries of injustice, and Grisha left the table, seeking the consolation of solitude by the window in the drawing room. His elder sister Tanya, under the pretext that she wished to share her tart with her dolls, also departed. Darya Alexandrovna felt that Miss Hull had been too severe, but of course supported her authority. Afterwards she was on her way to ask the governess to relent and forgive the culprit, when she discovered Tanya sharing her tart with Grisha in the drawing room, both of the children sobbing from shared emotion. She was overcome by the touching spectacle. On the spot she forgave Grisha, and then dispersed the clouds by laughing at the way their faces were smeared with tart and tears, and making them laugh too, and then, to cap it all, she gave orders for everyone to put on old clothes and go mushroom-gathering. At once the nursery was filled with shrieks of ecstasy. Soon they were all in the woods. They filled a basket with mushrooms. Even little Lily found a birch-mushroom. In the past Miss Hull had always found mushrooms for Lily to pick, but this time Lily really found a big one all by herself, and everyone screamed with delight: "Lily has found a mushroom!"

The second episode, in Chapter 5 of Part VI, is an exquisite vignette of distinctive Russian behavior. Sergej Ivanovich, a landowner, is in love with the governess Varvara Andreevna and wishes to propose to her, and with this intention goes out to find her in the woods where she is gathering mushrooms with the children. She senses his purpose and is receptive. As he starts out looking for her, he talks to himself, rehearsing the little speech that he wishes to make. And now we shall translate Tolstoy's words.

"Varvara Andreevna, when I was still young, I conceived the ideal woman whom I should love and be happy to call my wife. I have lived a long time and now at last in you I discover what I have always sought. I love you and offer you my hand."

This is what Sergej Ivanovich was saying to himself as he approached Varen'ka, who was shielding a mushroom from Grisha and calling to little Masha: "Look! Look! Lots of little mushrooms!" her voice warm and throaty.

When she saw Sergey Ivanovich coming up to her, she did not rise, nor even change her position, yet something told him she knew he was there and was glad.

"Have you found any?" she asked, turning up to him her beautiful, soft, smiling face, rimmed with a white kerchief.

"Not one," said he. "And you?"

She did not answer but busied herself with the children. "There is another, near the branch," and she pointed out to Masha a small *syroezhka* (**сыроежка**), whose stalwart pink cap had been bisected by a blade of grass. Varen'ka rose when Masha picked up the *syroezhka*, breaking it in two. "This brings back childhood days," she added, and walked away from the children by the side of Sergej Ivanovich.

They took a few steps in silence. Varen'ka saw that he wished to talk, and guessed about what. She was breathless with excitement, joy, and fear. They had gone far enough so that no one could hear them, yet he did not speak. It would have been best if Varen'ka had kept still. After a spell of silence, it would have been easier for them to say all they had to say. But against her will, as if by accident, Varen'ka spoke.

"So you found nothing? Of course, they are always scarcest in the middle of the woods."

Sergej Ivanovich sighed and said nothing. He was vexed: why had she brought back the subject of mushrooms? He would have liked her to return to what she had said about childhood. But then he also, after a pause, and as though against his will, went on where she left off:

"I had thought that only the cep was confined to the fringes of the woods, but then I can't recognize a cep."

More minutes passed. They were far from the children and quite alone. Varen'ka felt her heart beating. She felt that she was turning red, then white, and then red again.

To be the wife of a man like Koznyshev, after her situation in the household of Mrs. Stahl, seemed to her like the peak of happiness. Besides, she was almost sure that she was in love with him. And now all this was to be decided. She felt frightened, frightened at what he might or might not say.

His declaration had to be made now or never: so Sergej Ivanovich said to himself. Everything in her looks - her blush, her lowered eyelids - showed Varen'ka's painful expectation. Sergej Ivanovich noticed it and pitied her. He also realized that if he said nothing, his silence would hurt her. Again he repeated to himself all the reasons in favor of proposing, he repeated to himself the little speech that was to express his intentions. But instead, under some strange impulse, he finally asked, "And what is then the difference between the cep and the birch-mushroom?"

Varen'ka's lips trembled as she replied: "There is almost no difference in the cap. The difference is in the stem."

And the instant she uttered those words, she knew and he knew that everything was over, and that what ought to have been said would never be said. Their tension, having reached its peak, began to subside.

"The birch-mushroom-its stem reminds one of a two-days' beard on a swarthy man," said Sergej Ivanovich, quite calmly.

"You are quite right!" said Varen'ka, and she smiled. Without thinking they turned their steps back to the children. Varen'ka felt hurt and ashamed, and at the same time a sense of relief came over her.

Translated by VPW *and* EGW.

Appendix II
Aksakov's 'Remarks and Observations of a Mushroom Hunter'

The following essay, by Sergej Timofeevich Aksakov, appeared in 1856 in the *Vestnik Estestvennykh Nauk* (**Вестник естественных наук**), the publication of a group of nature students who constituted the Moscow Imperial Society. Aksakov was a Russian country squire whose *Memoirs* are classics of Russian literature, valued alike for their honest and detailed picture of daily life in a by-gone world and for the lovable self-portrait that their author unconsciously paints. His forgotten paper on mushrooms possesses in rich measure the virtues that made his major works famous, and in translating it we have tried our best to preserve the flavor of the original. On its first appearance nearly a century ago, the editor, K. F. Rouille, drew attention to what would be called today its ecological implications, which he referred to as nature's 'law of interrelations'. Specifically, Aksakov, though only an amateur, seems to have been precocious in insisting on a biological tie between certain fungi and the roots of some kinds of trees. The peasants in the Slavic lands from time immemorial and recently the mycologists of the West had observed that some mushroom species are always found close to certain kinds of trees, but not until 1885 did A. B. Frank publish in *Berichte der Deutschen Botanischen Gesellschaft* the notable paper on truffles that securely established the symbiotic kinship between trees and fungi - a relationship that came to be known as mycorrhiza. Apparently Aksakov's further observations concerning a difference in the growth of mushrooms on various sides of a given tree, according to the compass points, are unknown to mycologists. Was the behavior that he remarked peculiar to the trees in his grove, or was he calling attention to a significant phenomenon that others have overlooked to this day; ... Here is Aksakov's essay.

Among the sorts of hunting in which men engage, place must be made for the peaceful quest of mushrooms, or 'mushroom-taking'. This cannot compare with other kinds of hunting that are more lively because they involve the animal world, but it can hold its own among many so-called secondary hunts, each of which offers its own interest. I give preference to mushroom-hunting because you must look for mushrooms and it follows that you may not find them. There is needed in addition a certain skill - knowledge about where mushrooms grow, familiarity with the terrain - and luck! No wonder that the proverb says, "With luck even mushroom-hunting is good."[208] In mushroom-hunting there are elements of the unknown, the unexpected; there is success and there is failure. These are the things that incite a man to the pursuit and give to it a special interest. The gathering of berries or nuts, also a hunt of the second class, at first glance might resemble mushroom-hunting, but on closer inspection we shall see that the latter possesses great advantages. Mushroom hunters will surely share my view, and with them I wish to have a chat and tell them of my observations over many years.

Mushrooms are the most nourishing, tasty, and wholesome food, if they are not eaten to excess nor smothered in too much fat, but perfectly fried or boiled or thoroughly pickled in brine. Pickling in brine is employed with those mushrooms that are conserved in the raw state, such as those of the lactarius and russula families and others. For city folk mushrooms are a delicacy; to the country people they are food and in some regions a source of income. The mushroom is a child of the forest.[209] The steppe has no mushrooms except the common field mushrooms and the *lugoviki* (**луговики**) [*Marasmius oreades*], and even these are born only in the fertilized soil of cattle-pens, pastures, and roads, and always close to the dwellings of men and cattle. It is known to all that if you raise trees in a bare field, either from seed or by transplanting, mushrooms will surely start growing there, the kind depending on the kind of trees. But, contrary to the opinion of many, the mysterious power of trees to bring forth mushrooms around themselves does not be merely in the shade that is produced by the branches. Shade is the first requisite, it is true, but only the first. Shade protects the earth from the scorching rays of the sun, produces humidity and even wetness in the soil, and this is essential for both the woods and the mushrooms. But their real source, it seems to me, lies in the roots of the trees, which humidifying in their turn the surrounding earth, impart to it the arboreal sap; and it is in the roots that in my opinion lies the key to the mystery of the birth of mushrooms. This is most convincingly shown by the fact that around stumps of trees where a certain species formerly grew in the life-giving shade, the same kind will continue to grow for as long as ten years or more. Roots die slowly. Finally they rot and dry, and the mushrooms cease. Many a time I have observed tree stumps standing quite far apart in meadows where the influence of neighboring trees could not be suspected. As proof of the fact that shade and moisture are not sufficient for the growth of mushrooms, one could point to certain species of trees such as the alder, black poplar, poplar, and bird-cherry [*Padus avium*], under and near which no genuine mushrooms spring up. The complete dependence of mushrooms on the particular sap of a tree firmly establishes the fact that certain trees produce only their own kind of mushroom. If only moisture, shade, and coolness were needed, all kinds of mushrooms would grow under all kinds of trees.

The country-folk recognize well the influence of trees over mushrooms and therefore have given to some of them names associated with trees, such as the birch-mushroom, the aspen-mushroom, the hazel-mushroom, the oak-mushroom.

Mushrooms are divided between the edible and the inedible. The latter are generally called *poganki*, which includes poisonous mushrooms such as the *dubovik* ['oak-mushroom', *Boletus luridus*], the mukhomor ['fly-killer', *Amanita muscaria*], and others. Among the *poganki* are mushrooms that in some parts of Russia are considered poisonous, and elsewhere are considered good for food; for example, the *svinukhi* or 'cow's ears' [both names are Aksakov's; a *Paxillus sp.*]; *volui* [*Russula foetens*]; *mochjonki* (**мочонки**) ['the sopping ones';]; *chernukhi* (**чернухи**) [*Russula adusta*]; etc. In order to be eaten without harm, these must be first parboiled or soaked and then salted. I even knew one man who, apart from the *mukhomor* and *dubovik*, considered all mushrooms edible, and as living evidence to support his faith in their innocence, he had himself and his family to show. He even asserted that the so-called *poganki* were as tasty as other mushrooms. This is hard to believe, because most *poganki* not only have an unpleasant color and appearance, but also smell bad.

---

[208] I have heard this proverb in an inverted form: "Without luck it's no use to go mushroom-hunting". S. T. A.

[209] In Japanese the generic word for mushrooms is kino-ko, 'forest's child'. V. P. W.

It is worthy of note that many edible or so-called 'good' mushrooms have their counterpart in the *poganki*, somewhat resembling them in shape and color. Even more remarkable is the fact that when *poganki* make their appearance among good mushrooms, the latter begin to disappear. Finally the wave of good mushrooms passes, and the *poganki* complete the conquest of the site. This is especially true of mushrooms that grow up in large clusters, such as *masleniki* [various viscid boleti], *ryzhiki* [various lactarii], and *beljanki* [*Lactarius pubescens*].

All hunters know that mushrooms have their 'favorite spots', where each year they grow in varying quantity. No doubt there must be natural causes for this, but to an uninformed mind this phenomenon is striking and inexplicable. In a thick forest where the branches and the roots of the trees meet, it is hard to determine the places favored by mushrooms even if such places exist, but in open forests or clearings they are obvious and beyond doubt. I have a wood with two thousand oaks, old and young. The old ones numbering about 200 stand far apart in a large hay-field. Under certain of them, few in number, there have grown from time immemorial an immense quantity of caps of a somewhat distinctive form and size, unusually firm and strong, with caps of rare bronze and steel-like color, and sometimes multi-colored and shiny like marble. Their size and vigor are probably traceable to the nature of the root sap, and their color to the effects of sunlight, because oaks set far apart give little shade. Around the other oaks in the same clearing there are very few mushrooms, and around some, none at all. I have in my garden and park more than 300 spruces, and only under four of them do *ryzhiki* spring up. The location, the soil, the species of trees - all these are the same, and nevertheless for twelve years now I observe and yearly confirm my observation that my mushrooms are born exclusively in the same favorite spots under the same oaks and spruces.

Different species of mushrooms coming up under different trees exhibit a remarkable trait in preferring to appear on the north side of the tree, much less often on the east and west sides, and on the south side, especially during a dry summer, they are almost totally absent. This influence of the four compass points and the position of the sun is best observed with the *ryzhiki*. The red *ryzhiki* [*Lactarius deliciosus*] around a given spruce always appear on the north side and halfway around to the east and west, whereupon, as if by a drawn line on approaching the south, their caps become greenish blue with a somewhat roughened surface, as though dried out; although the stem and the inside of the broken cap remain equally red and juicy. From this we see that the circumference of the tree is divided into equal sectors, the red *ryzhiki* being on the north side, the greenish on the south, while east and west are equally divided between both kinds, with the fewest specimens on the south side.

There is no doubt that, as people believe, in rainy, soggy years mushrooms spring up in greater numbers, especially if bad weather is accompanied by warmth. But here too there are exceptions, not understood by the ordinary observer and only to be explained by science. I have often noticed that in spite of very warm air, rains may be harmful to mushrooms. At times this harmful effect works slowly and imperceptibly, but at times it acts with amazing rapidity, before your very eyes, especially with young mushrooms just emerging from the earth. Four times during the last twelve years I have seen devastation wrought by rain that fell apparently in conditions of propitious warmth. Twice the rain was accompanied by a sort of dry fog with a nasty burning smell; and twice the rains were downpours which thoroughly soaked the earth, with sunshine following immediately afterwards. Visiting every day about noon all the mushroom-bearing spots of my garden and park, there where on the eve I had left a host of young ceps, I was struck by the sudden change in their appearance. More or less all the young baby-mushrooms had become wrinkled and dried out, and the smallest ones, the size of a pea, and even those the size of a hazel-nut, had disappeared, and only a half-rotted dust, which was hard to identify, lay where the mushroom buds had been. Some of the more adult mushrooms revived and reached their usual size, but in a somewhat deformed shape. Others rotted away and collapsed. Such harmful effects were observed and recorded by me each time. A similar influence but noticeably slower is at times brought about by an excessive dew at night, which produces yellowish spots on the grass. Furthermore, let it here be set down that the current popular belief according to which a mushroom duly noted and marked by man will not grow up but will shrivel up, is, according to my observations, wholly unjust. I have always marked a goodly number of mushrooms, especially ceps, in order to gather them at the age which I consider most desirable, or else I leave them to reach their full development and beauty. I will not conceitedly assert that the gaze of man may not produce a magnetic influence in the vegetable world. All I can say is that my innumerable experiments led me to conclude that at least *my* glance never did any harm to mushrooms.[210] I have even tried to touch the mushrooms lightly and free them from the leaves and grass which at times hamper their growth. I have gone so far as to break off bits of their caps, and they continued to grow as before. One thing is true: if you shake the stem of the mushroom, it wilts and perishes.

In bad weather and toward fall the mushrooms give wider berth to the trees and more willingly grow along the edges of woods and on naked hills - they 'leap away', as the people express it; but in the dry and hot weather the mushrooms cling to the shade and even take shelter under the branches of the trees, especially the spruces that spread their branches like paws along the earth. That is why peasants call such branches *lapniki* (**лапники**) [paws], and chop them off for various needs without mercy and without harm to the tree. They even assert that the spruce reaches its full size for lumber if you groom it by chopping down the lower branches.

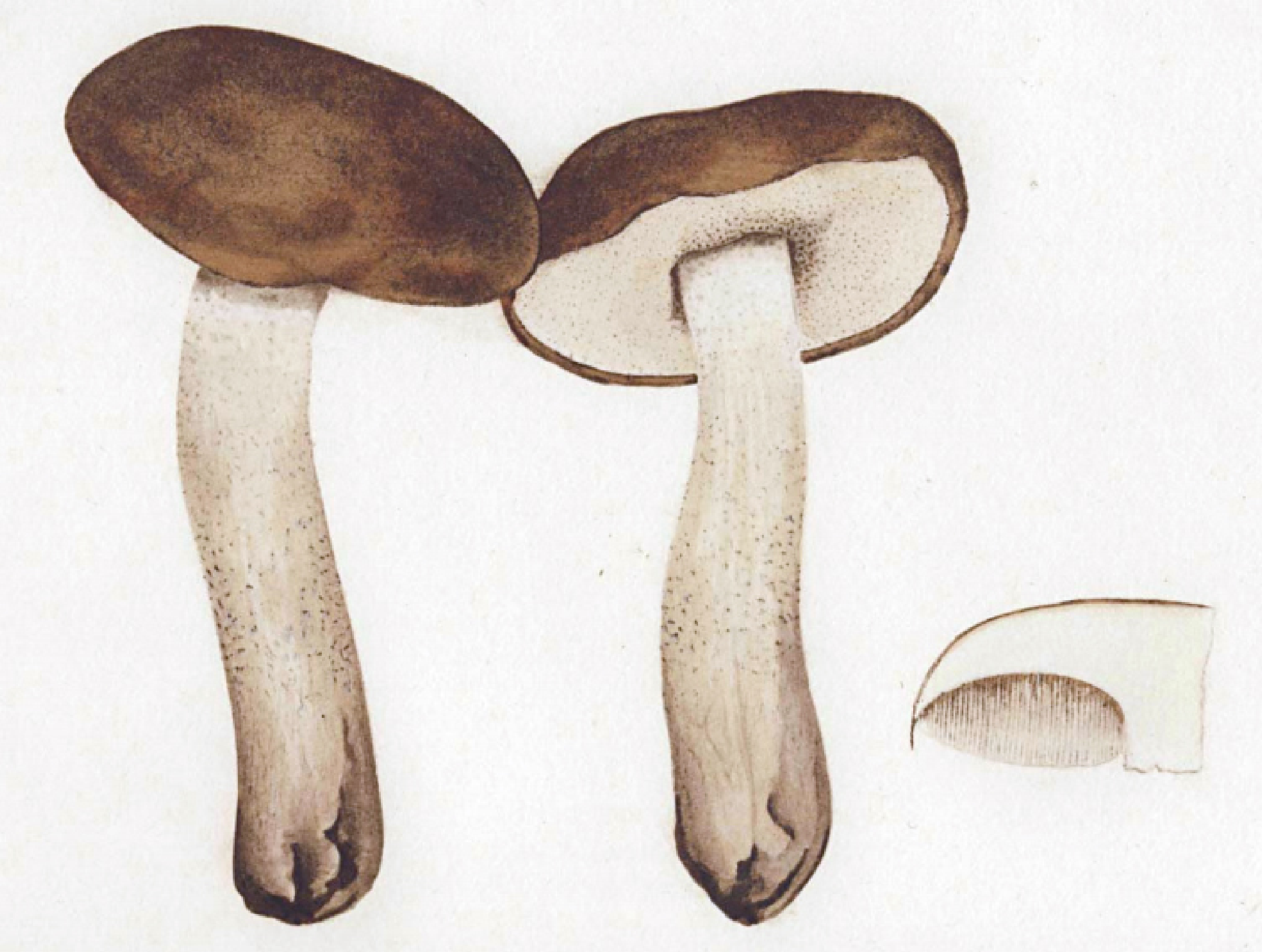


PLATE LXXXI

Jean-Henri Fabre. *Boletus scaber* Fr. ex Bull. (= *B. leucophseus* Pers.);
Russian: **берёзовик** (*berjozovik*);
Polish: *Koźlarz babka*.

Apart from harmful rains and dew, mushrooms are damaged in clearings by the hot rays of the midday sun. Such rays scorch their caps, and although the coolness of the night, the dew, and an occasional rain freshen them up, the daily sun-burn makes them shrivel before they reach their full maturity. Lengthy and frequent rains in their turn damage the growth of mushrooms, especially in the shade, in thick grass and overgrown spots. The mushrooms rot, grow mouldy, and perish. They are also spoiled and destroyed by living enemies.

---

[210] The Swiss mycologist F. Leuba, in discussing the morel, refers to the same popular belief, which he must have encountered in his native country. See *Les Champignons Comestibles et les Especes Veneneuses*, Neuchatel, 1890, footnote p. 87. V. P. W.

Slugs and snails firmly attach themselves to mushrooms, eating and boring through the caps and stems. In years of poor mushroom harvests, it is rare to find one not harboring two or three slugs. Squirrels are also mushroom hunters, going out especially for ceps, and often you will find marks of sharp teeth on their chewed caps. But the worst pest of mushrooms is a small white worm. Some years there are so many that the stem of every cep, strong and healthy on the outside, is inevitably undermined inside, and falls to pieces if picked up carelessly or firmly. Fortunately the caps are the last to be attacked by worms, and often remain healthy and intact with the stem completely eaten away. It is surprising how mushrooms in such a condition continue to receive nourishment.

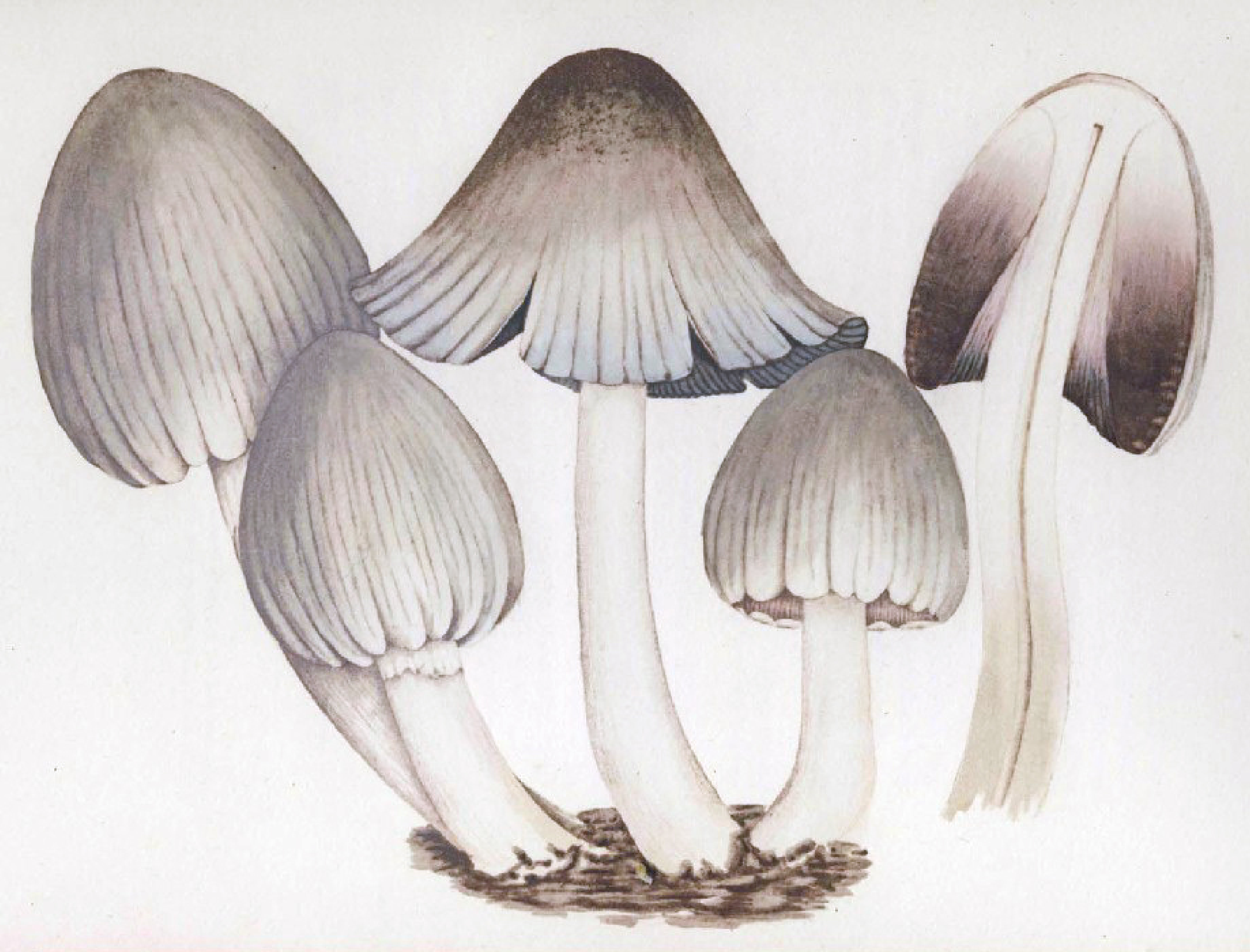


PLATE LXXXII
Jean-Henri Fabre. *Coprinus atramentarius* Fr. ex Bull.;
French: *pisse-chien*;
Russian: *opjonok*;
Polish: *Czernidłak pospolity*.

The current notion that, especially after a rain, mushrooms spring up overnight, is not true. Nevertheless, it is true that at times one finds young mushrooms where none were seen the night before. They were there, however, but remained unnoticed, because they were hardly above the ground, and covered with leaves and grass. Those quickest to mature or rather to grow up, such as the *berjozoviki* [*Boletus scaber*] and *syroezhki* [various russulse], reach full development in three days, but the ceps take a week or more. The slowest to grow is the *dubovik*, a worthless mushroom and even poisonous, as I said before.

In good harvest years mushrooms may be seen in clusters and families. They even grow as twins or triplets or more. I speak of those mushrooms that usually grow single, such as the ceps, the birch-mushrooms, the aspen-mushrooms, etc. I once made a sketch of an aspen-mushroom that showed six stems covered by one cap. A superabundance of mycelium and of the earth's sap at times produces freakish and ugly forms. Once I found a russula with another russula growing out of its cap. I made a drawing of this curious monstrosity. More than once I have found in the earth large lumps of the mycelium of the cep, a mass much resembling a root and the size of a man's head.

This is the order of the appearance of mushrooms. As soon as it begins to thaw in the spring, the morels appear in the meadows and the open woods. At first the *glukhie* (**глухие**) ['deaf ones', an helvella], then the *strojki* (**стройки**) [*Morchella esculenta*]. They grow even under a crust of snow with water rushing beneath. After the morels a month elapses, or more if there is drought, during which there are no mushrooms whatever. Then come the *masljaniki*, *berjozoviki*, *syroezhki*, *osinoviki* [*Boletus versipellis*], then the first wave of *gruzdi*, *podgruzdki* (**подгруздки**) [various kinds of lactarii], and ceps; then follow the *lisichki* [chanterelles], and field mushrooms; finally come the autumn mushrooms, viz., *volzhanki* (**волжанки**) [*Lactarius torminosus*], *beljanki*, *ryzhiki*, and *opjonki*. This whole order is upset at times, and it always depends on the weather and the atmospheric influences. I must add that each species appears in two or three waves during summer and fall, and until frequent and strong frosts, especially during droughts, finally kill off the mushroom growth. Speaking of each species of mushroom separately, I shall tell in more detail of the occasional mutations in their growth.

Translated by VPW *and* RGW

> Aksakov's essay ends here. Apparently he never returned to the subject, and his observations on growth 'mutations' are lost to us. He died in 1859, three years after the publication of the paper. VPW.

Appendix III
Leuba's 'Hymn to the Morel'

In the realm of belles letters the writings about mushrooms are few. Only in French and only in recent decades do we find this theme chosen for deliberate literary effort; among the handful of writers on mushrooms are Georges Becker, Camille Fauvel, and J. Amann. To this group we should add Roger Heim, who, though primarily a professional mycologist of supreme attainments, possesses the humanist point of view and the literary graces to qualify him for highest honors in the genre we are discussing. Beyond the output of this small circle, the mushroomic bibliophile must content himself with incidental references down through the centuries, in verse and prose, by writers whose thoughts were primarily directed elsewhere.

There is, however, much enjoyment to be gleaned also from the older books about mushrooms, composed in times when the austerity of the utilitarian and scientific approach had not yet forbidden the writers to indulge in occasional digressions. Such incidental passages are all the more enjoyable for the way they sometimes interrupt and enliven a dreary and pedestrian text. Perhaps the supreme example of this intruding Muse is to be found in the work entitled *Les Champignons Comestibles et les Espèces Vénéneuses*, written by F. Leuba, a Swiss pharmacist, and published in Neuchatel in 1890. The author of this large work proceeds methodically to describe all kinds of wild fungi, faithfully organizing his labors according to the conventional break-down of family, genus, and species. He comes in due course to the various morels, and then, all of a sudden, he is off, as though kidnapped by Pegasus, in a flight of eloquence that has surely never been equalled on the theme of mushrooms. He apostrophizes the morel, and then subtly characterizes the various types of morel-hunters - the amateur, the professional, the *gastronome*, and finally the simple lover of nature who discovers in morel-hunting an excuse for indulging his passion. After his excursion into Parnassian realms, our staid Swiss pharmacist slowly recovers his native poise, subsiding into the humdrum pace of one who with minute accuracy and crushing drudgery describes the fruiting bodies of the fungal world - their respective habitats, and the distinctive features of stipe and pileus and spores.

We think that Leuba's prose *Hymn to the Morel* deserves to be rescued from the tomb in which it has been gathering dust these sixty years and more, and we offer it now to our readers. We are not undertaking to do it into English, for in that rarefied world of mycophiles to whom we offer our book, are we not safe in supposing that many read French? They would resent the impertinence of any translation. The additional readers to be gained by our supplying a text in English will surely concede with good grace that their loss is outweighed by the pain that a translation, no matter how skillful, would impose on the larger number. Here, then, is the discourse of F. Leuba, Swiss *pharmaden*, on morels and morel-hunters.

[Note to the edition at Psilosophy: French has been rendered here in English someway; after that the original text.]

Here is the morel! Is there a single one of us in whom this name does not evoke delicious memories of happy harvests, of enchanted races, of the smell of fir trees, of pink clouds of dawn, of spring gentians, of cuckoo calls, and all the intoxicating procession of spring; Whose heart does not tremble with joy at the sight of one of these beautiful morels that we contemplated for a moment before daring to lay a sacrilegious hand on it? Who among us has not been impatiently awaiting for it in this maze of cold classifications that we have traveled so far? Who doesn't know the morel and who, knowing it, doesn't like it? Indeed, of all mushrooms, none excites the amateur more, none is sought after with as much pleasure and determination, none interests such diverse categories of people. From the businessman to the inactive annuitant, from the amateur artist to the sedentary worker, everyone likes to find it. I know individuals who, during the morel season, devote ten to fifteen consecutive days to their favorite hunt, traveling the Jura from one end to the other and sometimes not failing to spend very profitable days.

The true moreler is a type who is generally recruited among mountain watchmakers; he devotes himself without a second thought to this hunt all the time of the season, searching the woods and the thickets and leaving no chance to chance. His long experience and his scrutinizing and infallible eye make him a feared competitor for ordinary amateurs who have a good chance of returning empty-handed if they had the misfortune of meeting him in their course. Although as a moreler of some merit, I still envy this hunter's eye, and the rapidity with which he takes inventory of the place has always confused me.

In general, when arriving to a spot or a patch, the moreler stops for a moment and begins its searching; he discovers a morel, then several... When he is sure that there are no others, he takes them up slowly and continues on his path like an ordinary walker. Usually, the moreler picks the morel by taking it from above, so that once detached from its root, he holds it in his hand; it is a psychological moment, the one where the touching of the end of the morel in the palm of the hand of the person who picks it, communicates to the body the spark that makes its heart beat and transmits to the soul the state of enjoyment which is the charm of this finding.

The passion that morel hunting can inspire is extraordinary and manifests itself differently depending on the character of the individuals who engage in it. In addition to the large number of people who go to morels for relaxation[[211]], we distinguish the professional moreler, that is to say the one who goes to morels sometimes for trading from which he lives all the time that this vegetation lasts, sometimes for the pure and simple pleasure of finding them, because it is rare that this amateur likes to eat them.

The most favorable time of the day to find the morel is in the morning, when the light does not yet flood the forest; when the imagination of the moreler often represents him the ground littered with morels, at this season of the year when the gray tone still dominates, it takes a certain time to familiarize the eye with the terrain and the play of light, and we always experience some difficulty in finding the first morel. This is where we recognize the real moreler. Sure of his assessment, of his terrain, he is there, concentrating his view on each point of the terrain, observing each crack in the rock, not allowing a single blade of emerging grass to escape his investigations; very few morels escape this eye. So the moreler gets up early in order to reach at dawn the place which he plans to exploit more particularly that day and where he often finds already a number of other amateurs. It is when this frantic hunting begins, these marches and ascents, these minute explorations of all the nooks and crannies, of all the stones, of all the folds of the ground, in a word, it is a war of extermination against the poor who have committed no other crime than that of being excellent and suitable for all kinds of sauces.

After the professional moreler comes the gourmet moreler. Although of a certain skill, it is not to be feared like the previous one, and there is still a chance of making a reasonable harvest after its passage. Before his departure, he did not fail to equip oneself with a *good bottle* and fill his bag with various canned foods; there are even some who have regular stops in the forest stocked with wines and liqueurs. Constantly preoccupied with how he will prepare his harvest in the evening, when he returns home, he is already attending an imaginary feast; his ears hear the crackling of fresh butter in the smoking pan, his nostrils dilate at the exhaling scent of parsley; the musky scent of the morel which jolts on this bed of herbs intoxicates him; the taste buds of his tongue quiver and rejoice at perceiving this very sweet sensation, already transmitted to the brain even before being conceived; the physiological phenomenon is accomplished: the wretch ate it before finding it.

In addition to these different classes of morelers, there is also that of friends of beautiful nature for whom morels are not so much a subject of research as a pretext to devote themselves to their favorite cult and spend a moment in contemplation in intimate communion with their Creator, admiring his works. The great charm of the morel is that it comes in spring and grows in the woods; now, if the woods are no longer the abode of the gods, they are still and will always be the refuge where man, tired of the pace of this world, injured in the struggles of social life, is happy to find solitude and peace, silence, self-possession, intimacy with a harmless, discreet and charming nature that soothes his soul and enchants his eyes. The trees are not only the necessary decoration of the forest; it is they who make it a retreat, an asylum; it seems that, without them, souls could not promise to meet their God there and enjoy themselves; they are the essential condition of meditation and peace. Also, when the spring sun begins to melt the snow on the summits of our mountains, when nature wakes from its long sleep and a magic hand sows greenery and flowers in the valleys, the moreler-amateur wakes up early in the morning and slowly takes the path to the pastures. This is the moment when the pink clouds of the east announce the approach of the sun... It is where the happiness of living inspires in the heart of man these passionate impulses of gratitude and love and, forgetting the miseries of the world, the moreler, pushed by a mysterious and powerful force, joins his voice to this universal concert, to this eternal hymn to the Creator. For him, the supreme good at this moment is the enjoyment without ulterior motive of this healthy and comforting poetry which arises from all the beauty of this nature, and if, in the course of his work, he has lingered to look at a bee brushing pollen, to examine a primrose corolla which blossomed in the sun, or if sometimes it even happen to mistake from a distance a morel with a toad warming itself in the sun[212] with its arms crossed on its chest; in a word, if the harvest was almost zero, he nevertheless return home happy: he learned a lesson of pleasure, wisdom and love.

Regardless of the qualities that are the privilege of the morel, what gives it prestige is the season in which it grows. In the high valleys of the Jura, it is considered, so to speak, as the harbinger of beautiful days. It is not uncommon to see the moreler setting off after a few days of hot March sunshine and visiting the large isolated fir trees and the edges of the woods exposed to the sun; these searches are generally successful. It is then a triumph that the local paper announces to its readers who greet with pleasure this promise of the next return of spring; but unfortunately! not all achieve honor; at this season of the year when the nights are still so cold, the greatest number perish, of victims of their eagerness to salute this spring sun so often betrayed by its forces, and when later, the beautiful days arrive, oftentimes the moreler, sensitive to the misfortune of these unfortunate beings, sighs sadly when he finds their corpses lying on the ground.

[End of translation; edition@psilosophy]

Voici la morille! En est-il un seul d'entre nous chez lequel ce nom n'évoque des souvenirs délicieux de cueillettes heureuses, de courses enchantées, d'odeurs de sapins, de nuages roses d'aurore, de gentianes printanières, d'appels de coucous, et de tout le cortège enivrant du printemps; Quel est celui dont le coeur ne tressaille d'aise au souvenir de la vue d'une de ces belles morilles que nous avons contemplée un instant avant d'oser y porter une main sacrilège? Quel est celui d'entre vous qui ne l'ait attendue avec impatience dans ce dédale de classification froide que nous avons parcouru jusqu'ici? Qui ne conna&iacirc;t la morille et qui la conna&iacirc;t sans *l'aimer*? En effet, de tous les champignons, aucun ne passionne davantage l'amateur, aucun n'est recherche avec autant de plaisir et d'acharnement, aucun n'intéressé des catégories de gens aussi diverses. Depuis le négociant affaire au rentier inactif, de l'artiste amateur a l'ouvrier sédentaire, tous aiment a la trouver. Je connais des individus qui, a la saison des morilles, se livrent dix a quinze jours consécutifs a leur chasse favorite, parcourant le Jura d'un bout a l'autre et ne laissant pas quelquefois de faire des journées très rémunératrices.

Le vrai morilleur est un type qui se recrute généralement parmi les horlogers montagnards; il se livre sans arrière-pensée a cette chasse tout le temps de la saison, fouillant les bois et les taillis et ne laissant aucune chance au hasard. Sa longue expérience et son ceil scrutateur et infaillible en font un concurrent redoute des amateurs ordinaires qui ont bien des chances de rentrer bredouille s'ils ont eu le malheur de le rencontrer dans leur course. Quoique morilleur de quelque mérite, j'ai toujours en vie le coup d'oeil de ce chasseur, et la rapidité avec laquelle il fait l'inventaire de la place m'a toujours confondu.

En général, arrive devant une *tache* ou un *coin*, le morilleur s'arrête un moment et commence ses recherches; il découvre une morille, puis plusieurs... Quand il s'est assuré qu'il n'y en a pas d'autres, il les prend lentement et continue sa route comme un promeneur ordinaire. Habituellement, le morilleur cueille la morille en la prenant par dessus, de manière a ce

qu'une fois détachée de sa racine, il la tienne dans sa main; c'est le moment psychique, celui ou l'attouchement de l'extrémité de la morille dans le creux de la main de celui qui la cueille, communique au corps l'étincelle qui fait battre son coeur et transmet a l'âme l'état de jouissance qui fait le charme de cette trouvaille.

La passion que peut inspirer la chasse aux morilles est extraordinaire et se manifeste différemment selon le caractère des individus qui s'y adonnent. Outre le grand nombre de personnes qui vont aux morilles par délassement[211], on distingue le morilleur de profession, c'est-a-dire celui qui va aux morilles tantôt pour en faire le commerce dont il vit tout le temps que dure cette végétation, tantôt pour le plaisir pur et simple de les trouver, car il est rare que cet amateur-la aime a les manger.

Le moment le plus favorable de la journée pour trouver la morille, c'est le matin, alors que la lumière n'inonde pas encore la foret; si l'imagination du morilleur lui représente souvent le sol jonche de morilles, a cette saison de l'année ou le ton gris domine encore, il faut un certain temps pour familiariser l'oeil avec le terrain et les jeux de la lumière et l'on éprouve toujours quelque difficulté a découvrir la première morille. C'est la que l'on reconnait le vrai morilleur. Sur de son appréciation, sur de son terrain, il est la, concentrant sa vue sur chaque point du terrain, suivant chaque fissure de rocher, ne laissant échapper aucun brin d'herbe naissante a ses investigations; bien peu de morilles échappent a cet oeil-la. Aussi le morilleur se leve-t-il de bonne heure afin d'arriver avec l'aurore a l'endroit qu'il a l'intention d'exploiter plus particulièrement ce jour-la et ou il trouve souvent déjà nombre d'autres amateurs. C'est alors que commencent cette chasse effrénée, ces marches et contremarches, ces explorations minutieuses de tous les coins et recoins, de toutes les pierres, de tous les plis de terrain, en un mot, cette guerre d'extermination a ces pauvrettes qui n'ont commis d'autre crime que celui d'être excellentes et de se laisser accommoder a toutes sauces.

Après le morilleur de profession vient le morilleur gastronome. Bien que d'une certaine habileté, il n'est pas a redouter comme le précédent, et l'on a encore des chances de faire une cueillette raisonnable après son passage. Celui-ci n'a pas manque, avant son départ, de se munir d'une *bonne bouteille* et de garnir son sac de diverses conserves alimentaires; il en est même qui ont, dans la foret, des étapes régulières approvisionnées de vins et de liqueurs. Constamment préoccupe de la manière dont il apretera sa cueillette le soir, en rentrant au logis, il assiste déjà a un festin imaginaire; ses oreilles entendent le crépitement du beurre frais dans la poêle fumante, ses narines se dilatent au parfum de persil qui s'en exhale; les effluves musquées de la morille qui fait des soubresauts sur ce lit d'herbettes l'enivrent; les papilles de sa langue tressaillent et se réjouissent de percevoir cette sensation si douce, déjà transmise au cerveau avant même d'etre conçue; le phénomène physiologique est accompli: le misérable l'a mangée avant de l'avoir trouvée.

Outre ces différentes classes de morilleurs, il existe encore celle des amis de la belle nature pour lesquels les morilles ne sont pas tant un sujet de recherche qu'un prétexte pour se vouer a leur culte favori et passer un instant dans le recueillement en communion intime avec leur Créateur en admirant ses oeuvres. Le grand charme de la morille, c'est qu'elle vient au printemps et qu'elle croit dans les bois; or, si les bois ne sont plus le séjour des dieux, ils sont encore et seront toujours le refuge ou l'homme, fatigue du train de ce monde, blesse dans les luttes de la vie sociale, est heureux de trouver la solitude et le silence, la possession de soi-même, l'lntimite avec une nature inoffensive, discrète et charmante qui soulage son âme et enchante ses yeux. Les arbres ne sont pas seulement le décor nécessaire de la foret; ce sont eux qui en font une retraite, un asile; il semble que, sans eux, les âmes ne pourraient se promettre d'y rencontrer leur Dieu et dejouir d'elles-mêmes; ils sont la condition indispensable du recueillement et de la paix. Aussi, quand le soleil du printemps commence a fondre la neige sur le sommet de nos montagnes, quand la nature se réveille de son long sommeil et qu'une main magique semé dans les vallons la verdure et les fleurs, le morilleur amateur se levé de bon matin et prend doucement le chemin des pâturages. C'est le moment ou les nuages roses de l'Orient annoncent l'approche du soleil... C'est la que le bonheur de vivre inspire au coeur de l'homme de ces élans passionnes de reconnaissance et d'amour et, qu'oubliant les misères du monde, le morilleur, pousse par une force mystérieuse et puissante, joint sa voix a ce concert universel, a cet hymne éternel au Créateur. Pour lui, le bien suprême en ce moment, c'est la jouissance sans arrière-pensée de cette poésie saine et réconfortante qui découle de toutes les beautés de cette nature, et si, dans sa course, il s'est attarde a regarder une abeille brossant du pollen, a examiner une corolle de primevère qui s'épanouissait au soleil, si parfois même, il lui est arrive de prendre de loin, pour une morille, un crapaud se réchauffant au soleil,[212] les bras croises sur sa poitrine; en un mot, si la récolte a été presque nulle, il n'en rentre pas moins heureux a la maison: il a pris une leçon de plaisir, de sagesse et d'amour.

---

211. In the high-placed valleys and scattered hamlets of the Jura, everyone is a bit of a moreler; it is an enjoyment that I have seen shared by children and young girls as well as by older people.
Dans les hautes vallées et les hameaux disséminés du Jura, tout le monde est un peu morilleur; c'est une jouissance que j'ai vu partager aussi bien par des enfants et des jeunes filles que par des personnes plus âgées.
212. Let the reader note this observation, apposite for our theme: the *morilleur* mistakes a toad, sunning itself with arms crossed, for a morel. V. P. W.

Indépendamment des qualités qui sont le privilège de la morille, ce qui fait son prestige, c'est la saison ou elle croit. Dans les hautes vallées du Jura, elle est pour ainsi dire considéréd comme la messagère des beaux jours. Il n'est pas rare de voir le morilleur se mettre en route après quelques jours de chaud soleil de mars et visiter les gros sapins isoles et les lisières des bois exposées au soleil; ces recherches sont généralement couronnées de succès. C'est alors un triomphe que la feuille locale annonce a ses lecteurs qui saluent avec plaisir cette promesse du prochain retour du printemps; mais hélas! toutes n'arrivent pas al'honneur; a cette saison de l'année ou les nuits sont encore si froides, le plus grand nombre périssent, victimes de leur empressement a saluer ce soleil printanier si souvent trahi par ses forces, et quand plus tard, les beaux jours arrivent, plus d'une fois le morilleur, sensible au malheur de ces infortunées, soupire tristement en retrouvant leurs cadavres étendus sur le sol.

Appendix IV
Hallucinogenic Mushrooms: Early Mexican Sources

Here follow in the original tongues the various texts relating to the use of inebriating mushrooms by Indians in Mexico in the 16th and 17th centuries. Each passage is keyed to the corresponding translation on pp. 218-28. For the translations from the Spanish and French the authors are solely responsible.

[1]

… los estranjeros les dieron a comer hongos montesinos que se embriagan con ello, y con esto entraron a la danca. [Folio 1251, H. P. Kraus ms.]

[2]

Acabado el sacrificio, y quedando las gradas del templo y patio bañadas de sangre humana, de allí iban todos a comer hongos crudos, con la cual comida salían todos de juicio y quedaban peores que si hubieran bebido mucho vino; tan embriagados y fuera de sentido que muchos dellos se mataban con propria mano, y con la fuerza de aquellos hongos, veían visiones y tenían revelaciones de lo por venir, hablándoles el demonio en aquella embriaguez.

[3]

Tenían otra manera de embriaguez que los hacía más crueles: era con unos hongos o setas pequeñas, que en esta tierra los hay como en Castilla; mas los de esta tierra son de tal calidad, que comidos crudos y por ser amargos, beben tras ellos y comen con ellos un poco de miel de abejas; y de allí a poco rato veían mil visiones y en especial culebras; y como salían fuera de todo sentido, parecíales que las piernas y el cuerpo tenían llenos de gusanos que los comían vivos, y así medio rabiando se salían fuera de casa, deseando que alguno los matase; y con esta bestial embriaguez y trabajo que sentían, acontecia alguna vez ahorcarse, y también eran contra los otros más crueles. A estos hongos llámanles en su lengua *teunanacatlh*,[213] que quiere decir carne de Dios, o del Demonio que ellos adoraban y de la dicha manera con aquel amargo manjar su cruel Dios los comulgaba.

[4]

… y sabe e vió que habrá 14 años que en una fiesta vió beodos a los dichos Don Francisco e Don Juan é habian tomado *nanacates* para invocar al demonio como lo hacían los antepasados, e que es público y notorio que siempre cuando no llueve o cuando se cogen los maíces llaman al diablo e que cuando cogen los maíces hacen sus borracheras… [p. 38]

[5]

… Tributauanle [al Señor de Mexico] cada ues que se lo pedian dos o tres cargas de mantas de *nequen*, que se haze de un arbol que se llama maguei, y dauan ongos con que emborrachan y *ocote* …

---

213. This reading of the name is found in the Rich ms. in the New York Public Library, which is a transcript of an early ms. in the Escorial. The scribe who penned the Rich ms. evidently had trouble in deciphering the original; he was certainly striving to arrive at the word that appears, as we shall see, in Sahagun as *teonanacatl*. See p. 24 of Rich ms.

[7]

… alii, qui mortem ingesti non inferant, sed amentiam aliquandiu permanentem, incondito quodam risu testatam, inducant, quos *Teyhuinti* vocare mos est, fulvi, acres, et non ingrati cujusdam viroris. Sunt et alii, qui citra risum nihil non versari sub oculos cogant, velut bella, et dæemonum simulacra, atque alii non minùs a viris hisce principibus per sua præcipuè festa, et convivia exoptati, et pretio maximo, et pervigili cura conquisiti, quam immanes, atque horrendi: quod genus fuscum est, et quadam acrimonia præditum.

[8 A]

La primera cosa, que se comja en el combite: eran vnos hungujllos negros que ellos llaman nanacatl, emborrachan: y hazen ver visiones, y aun provocan a luxuria: esto comjan ante de amanecer y tambien beujan cacao, ante de amanecer: aquellos hungujllos comjan con mjel, y quando ya se començavan a escalentar con ellos, com&emacr;çavan a baylar: y algunos cantauan, y algunos llorauan: porque ya estauan borrachos, con los hungujllos: y algunos no querian cantar, sino sentauanse, en sus aposentos: estauan alli como pensatiuos, y algunos vian en vision que se murian, y lloraron: otros vian en vision, que los comja alguna bestia fiera: otros vian en vision, que captiuavan en la guerra: otros vian en vision que avian de ser ricos: otros vian en vision que avian de tener muchos esclavos: otros vian en vision que avía de adulteral [adulterar]: y les avian de hazer tortilla la cabeça por este caso: otros vian en vision, que avian de hurtal [hurtar] algo: por lo qual, lo aujan de hazer tortilla la cabe;ça: otros vian en vision, que avian de matar a alguno y por el caso, aujan de ser muertos: otros vian en vision, que se ahogauan en agua: otros vian en vision, que vivirian, y murieran en paz: otros vian en vision que cayan de alto, y murieran de la cayda: todos los acontecimjentos desastrados, que suelen auer los vian en vision: otros vian que se sumjan en el agua, en algun remolino. Desque auja passado la borrachera de los hungujllos hablauan los vnos, con los otros, cerca de las visiones que avian visto. [BOOK IX, Flor. Codex, fol. 3II-3IV; Chap. XIII]

[8 B]

Vel iacattiiui in tequaltiloia nanacatl in qujquaia, icoac in quitoaia tlatlapitzalizpan aiamo tlc tlaqualli qujquaia, çan oc iio in cacahoatl conia ioaltica. Auh in nanacatl necuio in quiquaia: in icoac ie intech quiça nanacatl, in oncan mitotia, oncan choca: Auh in cequintin in oc iniollo quimati, in oncan inieian motlalia caltech aocmo mitotia, ça oncan oaltolotimotlatia. In aca conmottilia ie miquiz oncan chocatica: in aca conmottilia iaumiquiz: in aca conmottilia tequanqualoz: in aca conmottilia tlamaz iauc: in aca conmottilia iehoatl in mocuilltonoz in motlacamatiz in aca conmotilia tecohoaz tlacooa iez, in aca conmottilia tetlaximaz, tetzotzonaloz tetepacholoz: in aca conmottilia ihichtequiz no tetepacholoz: in aca conmottilia tequatepachoz quitzacutiaz in aca conmottilia atlan miquiz: in aca conmottilia iehoatl in iuian iocosca monemitiz ipan miquiz: in aca conmottilia tlapanco oaluetziz mictiuetziz. J çaço quesquich tepan mochioaz: mochi oncan conittaia, in anoço ilaquiloz. Auh in oquincauh nanacatl: mononotza quimolhuia in tlein oconmottilique.

[9 A]

Tãbien tenjan gran conoscimjento de yeruas, y rayzes, y conoscian sus calidades, y virtudes; ellos mesmos descrubrieron, y vsaron primero la rayz que llaman peyotl: y los que la comjan, y tomauan: La tomauan en lugar de vino. Y lo mjsmo hazian de los que llaman nanacatl: que son los hongos malos, que emborrachã, tambien como el vino: y se iuntauã en vn llano despues de lo auer comjdo, donde baylauan, y cantauan de noche, y de dia a su plazer: y esto el primero dia, y luego el dia sigujente llorauan todos mucho, y dezian: que se limpiauan, y lauauan los ojos, y caras con sus lagrimas. [Book X, Flor. Codex, fol. 122 v]

[9 B]

Ioan qujximati in xiujtl, in tlanelhoatl in quenamj, in quen ihiio, iehoantin in tlaiximach in mjtoa peiotl, vctli ipan in qujpoa, in anoço nanacatl, mocentlalia cana ixtlaoacan, monechicoa: vncan mjtotia, cujca ceioal, cemjlhujtl: auh in jmuztlaioc, oc ceppa mocentlalia choca, cenca choca, qujl mjxpaca, ic qujchipaoa im jmjxtelolo.

[10 A]

Ay otra yerva, como turmas de tierra, que se llama peyotl: es blanca, hazese hazia la pãrte del norte: los que la comen o beben ven visiones espantosas, o de rrisas, dura este emborrachamjento dos o tres dias, y despues se qujta ... [Book XI, Flor. Codex, fol. 129v-130r]

[10 B]

Peiotl: inin peiotl iztac: auh çan yio vmpa in mochioa in tlacochcalcopa, in teutlalpã in mjtoa mjctlanpa. In aqujn qujqua in, in anoço quj; itech qujça, iuhqujn nanacatl: no mjec tlamantli qujtta in temamauhti, anoço tevetzqujti: aço cemjlhujtl, anoço omjlhujtl in jtech qujca,...

[11 A]

Ay vnos hongujllos en esta tierra que se llamã, teonanacatl: crianse debaxo del heno en los campos o paramos son redondos, y tiene el pie altillo y delgado, y redondo comjdos, son de mal sabor daña la garganta, y enborrachã son medicinales contra las calenturas y la gota anse de comer, dos o tres no mas: los que los comen veen visiones, y sienten vascas del coraçon, y veen visiones a las vezes espantables y a las vezes de rrisa, a los que com&ecaron; muchos dellos provocan a luxuria y aunque sean pocos. Y a los moços locos o traviesos, dizenles que an comjdo nanacatl. [Book XI, Flor. Codex, fol. 130v-131r.]

[11 B]

Nanacatl: mjtoa teunanacatl, ixtlaoacan, çacatzontitlan in mochioa, quamalacachton, xopiazton, chichicacococ, tozcacococ: teivinti teiollo malacacho, tetlapololti: atonaviztli, coaciviztli ipaio, çan ontetl, etetl in qualonj, teiolpatzmjcti, tetequjpacho, teamã, techololti, temamauhti, tetlatiti. In oqujn mjec qujqua mjec tlamãtli qujtta temamauhti, anoço tevetzqujti: choloa, momecanja motepexivia, tzatzi, momauhtia. Injc qujqua necutli ipan: njnanacaqua, njnonanacavia. In mopoanj, in atlamatinj cuecuenotl: ipan mjtoa monanacavia.

[12]

Y el caso fué que á él había venido un indio natural del pueblo de *Tenango*, gran maestro de supersticiones, y se llamaba Juan *Chichiton*, que quiere decir *perrillo*, el cual había traído los hongos colorados que se cogen en el monte, y con ellos había hecho una gran idolatría, y antes de decirla, quiero explicar la calidad de los dichos hongos, que se llaman en la lengua mejicana *Quautlannanaçatl*, y habiendo consultado al licenciado don Pedro Ponce de León, el gran Ministro y maestro de los maestros, que dije en el capítulo II, me dijo que estos hongos eran pequeños y dorados, y que para cogerlos iban al monte los sacerdotes y viejos deputados Ministros para estos embustes, y estaban casi toda la noche en oración y deprecaciones supersticiosas, y al amanecer, cuando comenzaba cierto vientecillo que ellos conocen, entonces los cogían, atribuyéndoles deidad, y teniendo el mismo efecto que el *ololiuqui* ó el *peyote*, porque comidos ó bebidos, los embriaga y priva de sentido, y les hacen creer mil disparates. Este, pues, Juan *Chichiton*, habiendo cogido los hongos una noche, en la casa donde se juntaron con ocasión de la fiesta de un santo, el santo estaba en el altar, y los hongos con el pulque y con el fuego debajo del altar, anduvo toda la noche el *teponastli* y el canto, y habiendo pasado la mayor parte de ella el dicho Juan *Chichiton*, que era el sacerdote de aquella solemnidad, les dió á todos los circunstantes que se habían juntado á la fiesta á comer de los hongos como á modo de comunión, y á beber del pulque, y rematar la fiesta con abundante cantidad de pulque; que los hongos por su parte, y el pulque por la suya, los sacó de juicio que fué lástima.

[13]

... Ce dict seigneur de Tezcuq ... Il pourtoyt gran révérence aux dieux et avoyt grand soing des temples et cérémonies; il ordona aussi que les jeunes hommes et filles dancessent aux temples pour donner plaisir aux dieux leur sement le temple de roses et de fleurs et dançant tousiours davant eux tant ceux de la ville que les prochains voisins, les quels le diable abeusoyt leur faisant manger quelque herbe quils noment *nauacatl* la quelle les faisoyt hors de sens et voyr beaucoup de visions.

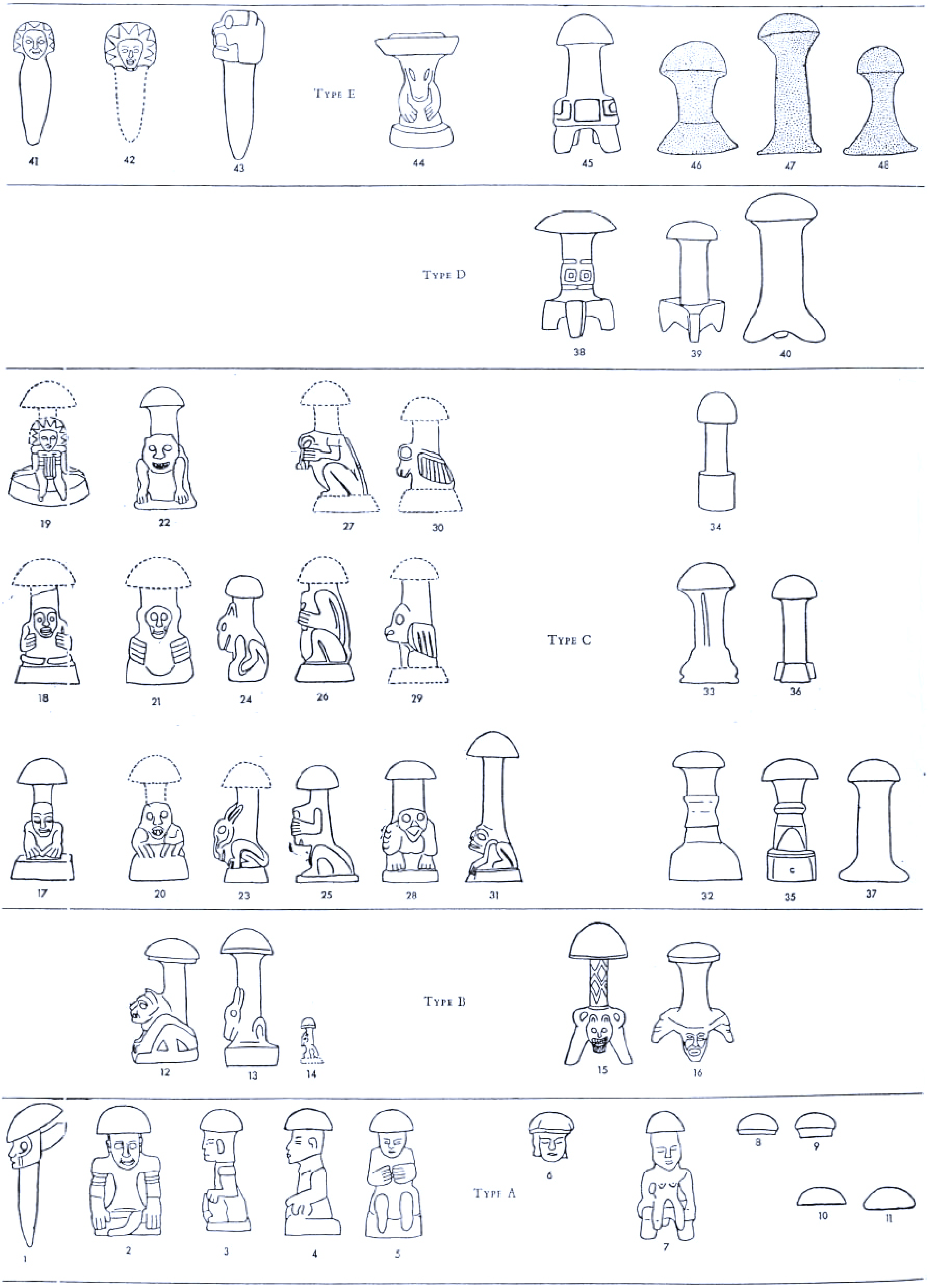

41
42
43
Type E
44
45
46
47
48
Type D
38
39
40
19
22
27
30
34
18
21
24
26
29
Type C
33
36
17
20
23
25
28
31
32
35
37
12
13
14
Type B
15
16
1
2
3
4
5
Type A
6
7
8
9
10
11

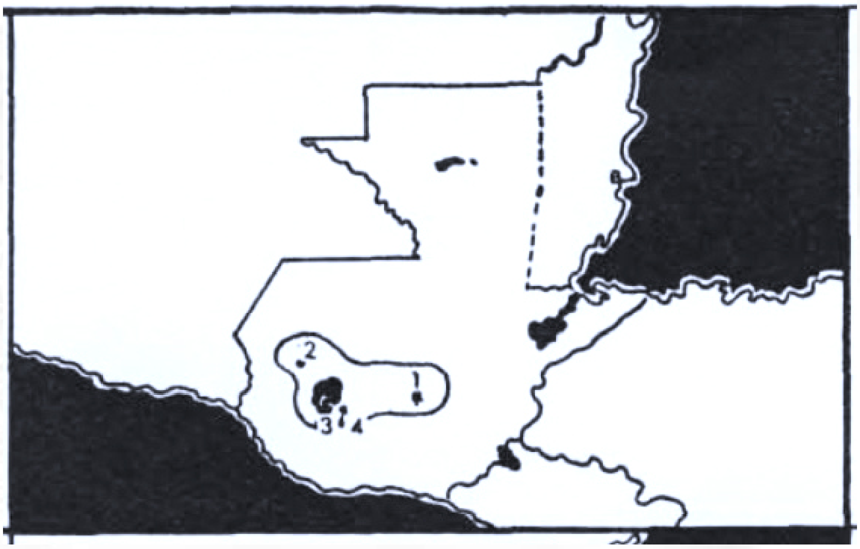
Fig. 28 - Mushroom Stones.
Chart of types by provenience and age. Compiled by Stephan F. de Borhegyi.

"MUSHROOM STONES" OF MIDDLE AMERICA

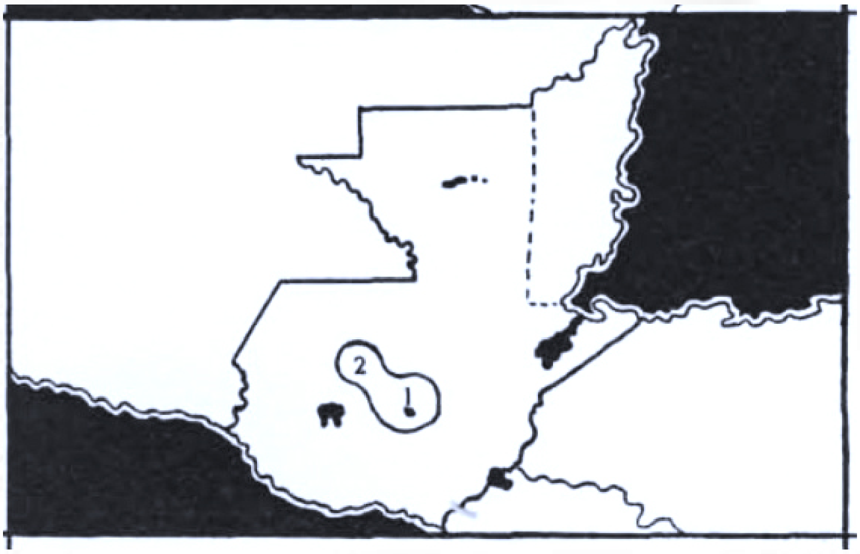
Arranged by Stephan F. de Borhegyi geographically and chronologically by types

Typology	Tentative Chronology
Type E Miscellaneous and possibly related stone (41-45) and pottery (46-48) objects.	Chronological position uncertain.
Type D Tripod mushroom-stones with plain (Nos. 39, 40) or carved stem (No. 38) and with clubby (No 40) or sharp angled feet (Nos. 38, 39).	Late Classic 600-900 A.D.
Type C Effigy (Nos. 17 to 31) or plain (Nos. 32 to 37) mushroom-stones with square or rounded base and without circularly grooved top. Square bases: Nos. 17, 18, 20, 21, 22, 23, 25, 26, 28, 31 and 35. Rounded bases: Nos. 19, 24, 32, 33, 34, 36 and 37.	Late Preclassic 500 B.C. - 200 A.D. and probably Early Classic 200 - 600 A.D.
Type B Effigy mushroom-stones with circularly grooved top and square (Nos. 12 to 14) or tripod (Nos. 15 to 16) base.	Early and Late Preclassic 1000 B.C. - 200 A.D.
Type A Anthropomorphic stone sculptures with plain (Nos. 1 to 5 and 7) or circularly grooved (No 6) mushroom hats. Plain (Nos. 10, 11) and circularly grooved (Nos. 8, 9) stone mushroom tops.	Chronological position uncertain.

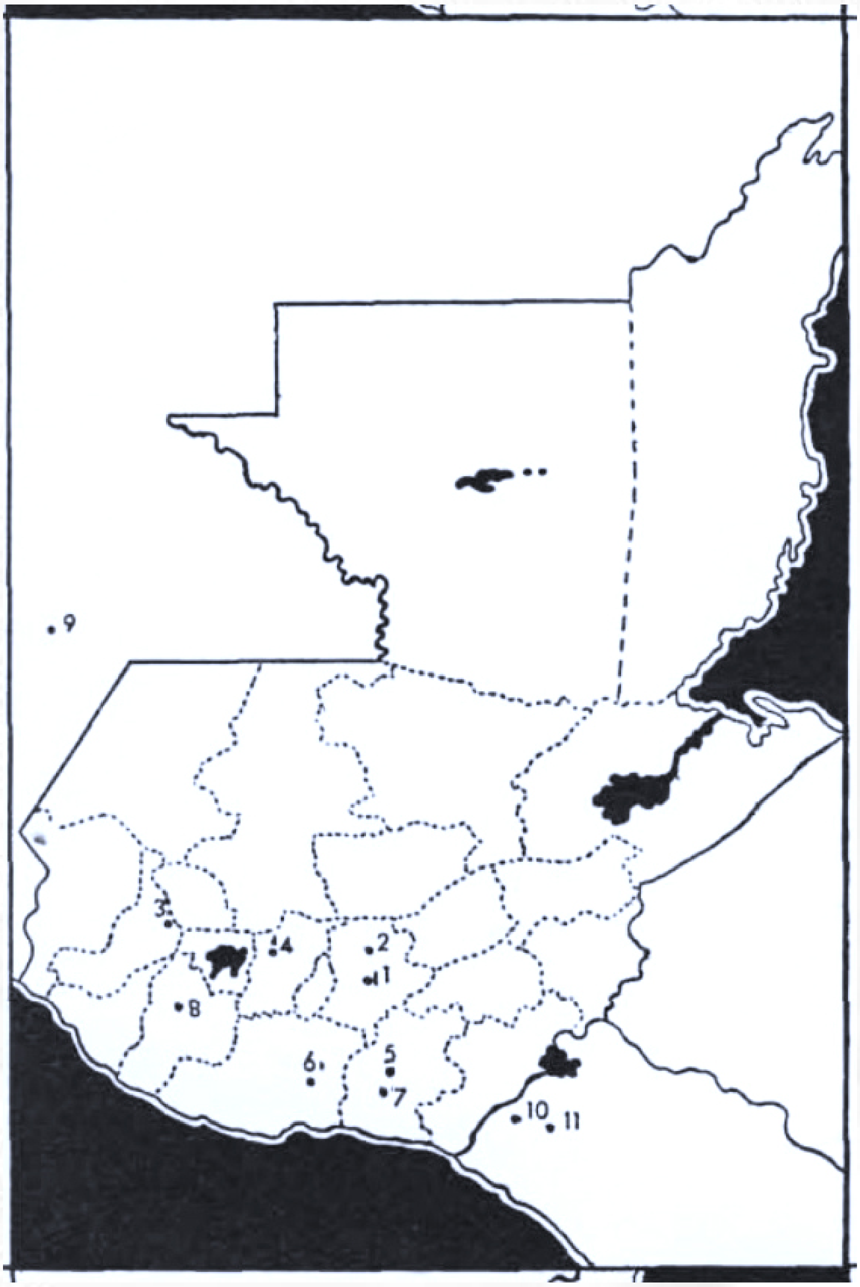
DISTRIBUTION



a) *Central Guatemalan Highlands*:
1. Kaminaljuyú (Nos. 2, 3, 4, 8, 10)
2. Salcaja (No. 6)
3. Chukumuk (No. 9)
4. Xikomuk (No. 11)
Uncertain locality (Nos. 1, 5, 7)



a) *Central Guatemalan Highlands*:
1. Kaminaljuyú (Nos. 12, 13, 15)
2. Quiche (No. 16)
Uncertain locality (No. 14)



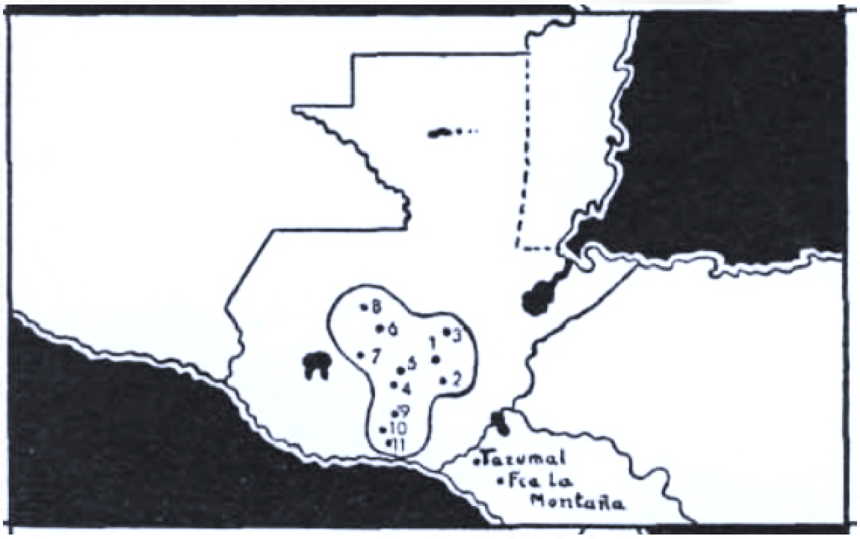
a) *Central Guatemalan Highlands*:
1. Kaminaljuyú (Nos. 17, 18, 19, 20, 27, 28, 29)
2. Cerro Alux, Mixco (No. 31) Salcaja (No. 25)
4. Tecpan-Iximche (not ill., cf. No. 36)
Uncertain locality (Nos. 21, 22, 23, 24, 26, 30)

b) *Pacific Coastal Plains, Guatemala*:
5. Lago Ixpaco (No. 36)
6. El Salto (not ill., cf. No. 21.)
7. Guazacapan (not ill., cf. No. 31.)
8. Retalhuleu (not ill., cf. No. 28)

c) *Mexico*:
9. Ocosingo, Chiapas (No. 32)
Oaxaca (not ill., cf. Nos. 32, 33, 36, 37)

d) *Western El Salvador*:
10. Tazumal (No. 33)
11. Las Victorias (No. 35)
Uncertain locality (No. 37)
(probably Chalchuapa area)

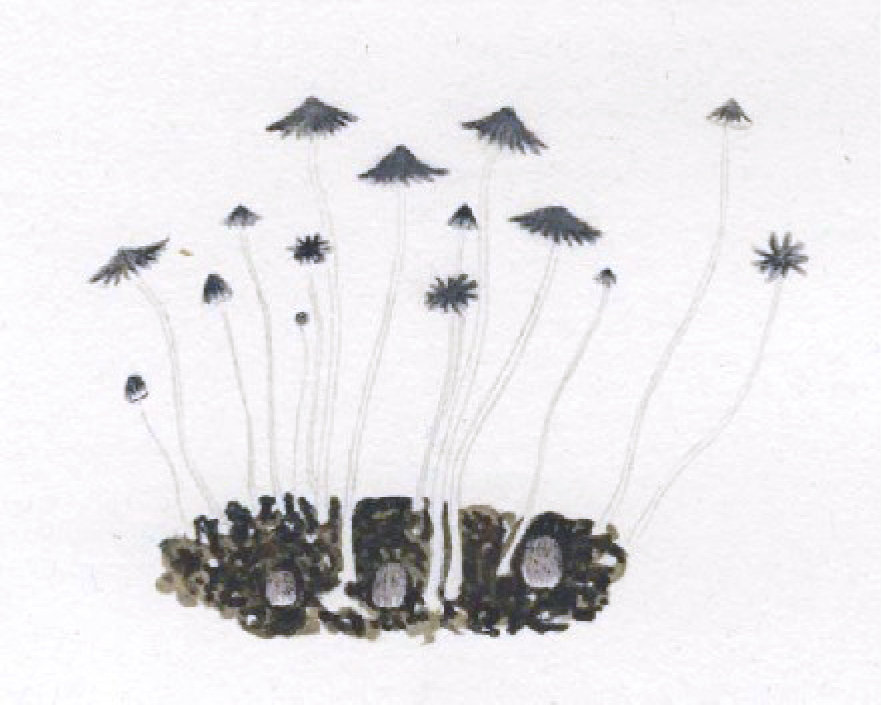
e) *Bolivia, South America*:
Inca-Uyu, Chucuito (No. 34)



a) *Central Guatemalan Highlands*:
1. Kaminaljuyú (Nos. 38, 39, 40)
2. Eucaliptus (not ill., cf. No. 39)
3. Agua Caliente (not ill., cf. No. 39)
4. Pompeya (not ill., cf. No. 39)
5. Antigua (not ill., cf. Nos. 38, 39, 40)
6. San Martin Jilotepeque (not ill., cf. No. 39)
7. Tecpan-Iximche (not ill., cf. No. 39)
8. Zacualpa (not ill., cf. Nos. 39, 40)

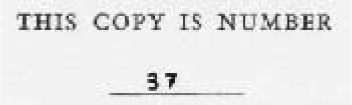
b) *Pacific Coastal Plains, Guatemala*:
9. El Baul (not ill., cf. No. 39)
10. Los Diamantes (not ill., cf. No. 39)
11. El Carmen (not ill., cf. No. 39)

INDICES



VOLUME I contains Pages I-XXI, 1-214, Plates I-XXXVII and Figures 1-11.
VOLUME II contains Pages 215-407, Plates XXXVIII-LXXXII and Figures 12-28.

OF THIS BOOK THERE HAVE BEEN MADE 512 COPIES OF WHICH TWO ARE DESIGNATED A AND B AND THE REST ARE NUMBERED FROM 1 THROUGH 510. THE BOOK WAS DESIGNED BY HANS MARDERSTEIG. THE TEXT WAS PRINTED BY THE STAMPERIA VALDONEGA, VERONA. THE ILLUSTRATIONS IN COLOR AND COLLOTYPE WERE EXECUTED BY DANIEL JACOMET, PARIS, AND BY FRATELLI ALINARI, FLORENCE. THE PAPER WAS MADE BY HAND BY FRATELLI MAGNANI, PESCIA, AND THE BINDING IS THE WORK OF TORRIANI & C., MILAN. THE PRINTING WAS FINISHED IN JANUARY 1957.



THIS COPY IS NUMBER

37

Above refers to original version of this reedition.

Index of Fungal Metaphors and Semantic Associations

Index page numbers refers to original version of this reedition.

Accelerator, 159
Alice in Wonderland, 194-6
Angels, little (Angelitos), 254
Aphrodisiac, 112, 153-41 166 ff, 344, 353, 374
Arse, 161-2
Aspen, 9

Bag, 93, 96, 106, 111, 142, 143
Bagpipe, 93
Balsam, 16
Bat, 81, 82, 207, 362
Beelzebub, 202, 209
Bellows, 93, 96, 362
Belly, 92, 95-6, 106, 108, 202
Berserk-going, 192 ff
Birch, 9
Bird, 254
Bird's eyes, 306
Bladder, 93, 96, 98, 142
Blister, 96
Blood-spatterers, 367
Blue, 16, 33
Boil, 121, 142
Bourgeois, beastly, and toadstools, 349-50
Bubble, 93, 94
Bubo, 121
Buffoon, 93
Bug complex, 202 ff
Butter, 7, 153; Demon's butter, 154

Candle, 155, 156 ff
Carrot, 153; *see* Aphrodisiac
Children of the waters, 306, 326
Cleave, 127,158
Clod (of earth), 365
Cock, 371-2
Cock's comb, 107, 371
Contraceptive, 112, 215-6
Crown of thorns, 311

Death, 29-31, 47 ff, 134
Decay, 19, 29-31, 134, 151-2
Deer, 173 ff, 228, 312
Demonic (= Divine) symbolism and possession, 86-7, 94 ff 109 ff, 374-5; in Siberia, Europe, 142, 190 ff, 318; among Eskimos, 142-3, 318; in New Guinea, 215; in Middle America, Chap. V Sections 14, 15, 16; in European painting, 87 ff, 354 ff; in China, 320-1; in Buddhist tradition, 321; in art, 87 ff, 354 ff; *See also* Devil, Toad
Devil's bread, 89-90, 338, 375 butter, 154 ears, 142 foot, 66, 98 pepper-pot, 16, 98 snuff-box, 97
Distension, 92 ff, 105, 142, 167, 185, 369, 370, 374
Divination, 112, 218, 226, 243, 261, 264-5, 297 ff, 309
Divine associations, *see* Demonic symbolism and possession
Divine generation, 251, 270, 326; *see* Lightning bolt
Divine possession, 48; *see* Demonic symbolism and possession

Eggs, egg-shells, 127-8
Epithet, use of fungus as, *see* Stupidity
Erotic associations, 114 ff, 153 ff, 166 ff, 186 ff, 344, 372
Excrement, 100-1, 185, 342, 374
Excrescence, *see* Tumor
Fairy folk, 90
Fairy-ring, 25, 66, 91, 102 n., 120 n.
Family names, 14
Famine, 38
Fart, *see* Flatus
Fat-of-the-earth, 7, 20, 109 n., 146
Feist, *see* Flatus
Ferment, evil, of the earth, 337; Fig, 161-2
Filth, 28, 97 ff
Fire, 118 ff, 363, 375
Fire, making of, 114 ff, 156 ff

Flatus, 94 ff, 97 ff
Flesh, God's, 219, 230, 319
Flies, 5, 190-214, 318, 352, 358, 375
Fly-killer, 5, 197 ff
Food, 112
Fools' mushroom, 78, 239-241
Fox, 7, 370
Fraud, 181-184
Frog, 66, 111, 157
Frog cheese, 97, 99
Frog's stool, 66, 92
Frog's pouch, 66
Fungophobia, 19; *see* Mycophobia
Funk, 112 ff, 142

Genitalia, Female: bovine, 108; cunnus, 160-1; hymenium, 158; pudendum, 160, 280; ring, 158, 161; veil, 158; vulva, volva, 117, 155, 158; womb, 93, 96, 106-7, 108, 111, 117; Male: glans penis, 155; membrum virile, 98, 117-8, 123-4, 154 ff; testicles, 166 ff
Goat, 16
Goat's beard, 373
Goatsucker, 84
Gods' Food, 60, 338, 375
Gourd, 127 ff, 180
Grabbing, gripping, grubbing, 5, 78-9, 188-9
Grub, 5
Gump, 180
Hair, pubic, 162
Hallucinations, 48-9; *see* Demonic symbolism and possession
Hart, *see* Deer Hind, *see* Deer Hindwind, *see* Flatus
Holy Family, 7
Horse mushroom, 348
Hypocrisy, 178 ff

Imp, 94 ff, 109; *see* Demonic symbolism and possession
Inebriation, 112; Chap. V, Sections 13, 14, 15, 16
Ink, 7
Intoxication, 112; *see* Inebriation

Jar, 108-9, 136

Lamp, 157-8; nozzle, 156 ff
Landslide, 254, 288, 293
Laughter, 222, 309
Leprosy, 141
Lice, 121, 318; *see* Flies
Lightning bolt, 118 ff, 315 ff, 335-6, 375
Lymph, 153

Mad mushroom, *see* Fool's mushroom
Madness, 243, 271, 274
Maggot, 209, 248
Meat, *see* Flesh, Frog
Medlar, 162
Membrum virile, *see* Genitalia, male
Monkey head, 334
Morel gathering, attributes of, 400 ff
Moss, 16, 145
Moths, 202, 207, 212, 356
Mucus, 146 ff, 153, 157
Murder, 47 ff, 112
'Mushroom stones', 275 ff, 329
Mycolatry, 336
Mycophagy, XVII, 19, 24, 37 ff, 56, 280, 330-334, 335-350
Mycophile, Mycophilia, XVII, 3 ff, 56, 330-334, 335-350, 353 ff
Mycophobe, Mycophobia, XVII, 19 ff, 335-350, 353 ff
Mycorrhiza, 9, 394, 395-7

Nightjar, 81
Night raven, *see* Nightjar
Nose, 156, 158-160, 163 ff
Nozzle, 156-7

Oak, 16
Oberon, 84, 147-8; cf. Gruzd', 8, 14
Owl, 101 n.
Ox, 16

'Pagans, little', 6
Parasol, 103-4, 362, 374
Parsnip, 153; *see* Aphrodisiac
Penis, *see* Genitalia, male
Pepper, 200, 370-1
Perfume, 112, 344
Pig, *see* Swine
Pigeon, 16
Pimple, 96
Pine, 11
Pitcher, 92, 108, 204
Pixie, 94 ff; pixie-stool, 101; *see* Demonic symbolism and possession
Pock, pox, 93 n., 141
Pocket, poke, 92, 106, 111
Poison, 20, 47 ff, 112, 185, 374
Pompom, 128
Pork, *see* Swine
Pot, 108-9, 127-136; *see* Jar, Pitcher
Potatoes, 166 ff
Pouch, 66, 93, 96, 106; heifer's, 93

Puck, 94 ff, 97 ff; *see* Demonic symbolism and possession
Pudendum, *see* Genitalia, female
Puff, *see* Distension
Pumpkin, *see* Gourd
Punk, 112 ff, 140-1
Purse, 92
Pus, 74, 152, 185
Pustule, 121, 187
Putrid, *see* Decay

Rain, 15
Rat's paws, 373
Raw, 6
Regal, 11
Ripening in the sun, 136
Rotten, *see* Decay
Rust, 7, 8, 10

Sac, inflatable, *see* Distension
St. George, 367-369
St. Isidore the Plowman, 254
Sea shells, 323 ff
Semen, 154 ff; *see* Tallow
Shaggy, 348
Sin and mushrooms, 353
Slime, 7, 19, 20, 153, 154, 185, 188 n.
Small-pox, *see* Pock
Smelfungus, 27
Smoke-generating, *see* Funk
Snakes, 78, 103, 104, 162-3, 374
Sop, 147
Sow, *see* Swine
Spark, 113 ff
Sponge, 105 ff
Spook and Sprite, 94 ff, 109; *see* Demonic symbolism and possession
Spunk, 112 ff
Squash, *see* Gourd
Stag, *see* Deer
Stumps, 7
Stupidity, 26-29, 179-80
Swamp, 16, 106
Swelling, *see* Distension
Swine, 16, 21, 149 ff, 171, 321, 365-6

Tallow, 142, 159-60; *see* Semen
Testicles, *see* Genitalia, male
Therapeutic uses, 112
Thorns, crown of, 311
Thrushes, 362
Thunderbolt, *see* Lightning bolt
Tinder, 112, 156 ff
Tlaloc, god of the waters and lightning bolt, 324 ff
Toad and demonic symbolism, 80 ff
  and gaseous distension, 74, 80, 111
  and lechery, 68, 186 ff
  burning sensation, caused by, 69, 74, 76, 86, 185
Toad's bread, 66, 78 n., 89, 101

cap, 66, 67
cheese, 66, 67, 97
drum, in Africa, 333
foot, 66
hat, 66, 67, 77
hide (skin), 66, 74, 185
meat, 101
stool, XVII, 3, 17, 21, 23, 24, 25, 65 ff, 75 ff, 86, 92, 93, 106, 116, 190, 342, 374-5; and the beastly bourgeois, 349-50 in Africa, 331-3 in Japan, 330-1 in Middle America, 278
venom, 67 ff, 74-5, 77, 86, 112, 185 ff, 374
Touchwood, *see* Tinder
Tumor, 103, 105 ff, 111, 141-2, 369, 374

Udder, 93, 185
Urine, 138-9

Venery, 174
Vermin, 356 ff, 374; vegetable, 23
Viper, *see* Snakes

War, 37 ff
Water-spout, 153
Whalebone spit, 139
Whiteness, 9-10, 109 n.
Wick, 148 n., 156
Winter, 29, 30-1
Womb, *see* Genitalia, female
Worthlessness, 371

Index of Mushroom Names

Index page numbers refers to the original version of this reedition.

ALEUTIAN
quyam tutusi, 142

ARABIC
alphotie, 127
faq (*fuqqa or faqqd'*), 109 n.
futr 127, 158
kam' (*kam'd*), 109
kame, 335
Mas, 336
shahmat al-ard, 109 n.
shajarat al-kilab (Sudan), 139
zibb al-wata (Sudan), 159
zobaidi, 336

ARMENIAN
sunk, 108

BASQUE
amoroto, 77, 86, 211
aponnto, 77
astaputz, 98
buxeti (Souletin), 149
guibelurdina, 340
motxolon (Navarre), 145, 149
ondo, 107
ondo zuri, 10
papun, panpun, 128
paratxiko (Labourde), 136-7
perretxiko, 137, 340
suge-perretxiko, 78, 103
zapo-perretxiko, 78, 103
ziza, 149

BONGO
hegba mboddo, 331, 332
kahoo, 332

BRETON
kabell tousec, 66, 74
skabell tousec, 66, 74

BULGARIAN
pachi kraka, 370

BURUSHASKI
pfute maltas, 154

CATALAN
bolet, 365
bufa del diable, 98
bufa del dimoni, 98, 99
exclatasangs (Majorca), 367

girbola, 372
jirgola (Majorca), 372
moixerno, 145
murgula, 153
oriol foil, 211
paratge, 137
pet de bou, 98
pet de hop, 98
pens de rata, 373
pixacan, 139
rossinyol, 371-2
rovello, 8, 361, 367; Pl. LXXIX

CHINANTEC
a-mo-kia, 238
a-ni, 238 n

CHINESE
hou tou chün, 334
hsiao chün, 320-1
hsiao-i-hu, 320
lei-ching t'an, 125
lei chün, 125
lei-sheng chün, 125
ling-chih, 320; Pl. LII
mo-gu, 333
monkey head mushroom, 334

CHUKCHEE
pompong, 139
pongpong, 139, 143

CHUVASH
kampa, 108

CZECH
barani vajca (Moravia), 177
bedla, 94
horyl, 38
hřib, 188
hřib královský, 11
jelenice, 177
jelenka, 176-7
lanýž, 176-7
lisa huba, 370

DANISH
hunda-land (Faeroe Islands), 138
paddehat, 66, 77, 100
skarnhat, 100
udsehat, 77
ulve-füs, 98

DUTCH & FLEMISH
duivelsbrood, 89, 338, 375
hanekam, 107, 371
heksenzwam, 354

paddestoel, 66, 77, 212
satanzwam, 354
vliegenzwam, 212
wolfsveest, 98
zwam, 113

ENGLISH
agaric, 29, 30, 61, 115, 118, 318
blewit, 33; Pl. VII
blue-cap, 33
bullfist, 97-8
bunt, 97, 112
cep, 10, 11, 13, 33, 131, 132, 150-2, 161, 344, 348, 392, 393, 396-9; Pl. I
conk, 128, 159 n.
death-cup, 348
deer balls, 173
destroying angel, 3, 348
devil's snuffbox, 97
edible boletus (= cep), 33
ergot, 241
female agaricke, 115, 118
field mushroom, 6, 23, 25, 32, 123, 135-7, 145, 366, 395, 399; Pl XXX
fatball, 97
fly agaric, 51, 139, 197, 318
fly amanita, 3, 102, 140, 190-214, 215, 238, 317, 342; Pl. XXXV
frogcheese, 97, 99, 101
fungus, 17, 23, 24, 348, 374
funk, 113, 142
fuzzball, 97
hart's balls, 173
hart's truffle, 173-4, 176-7
horse mushroom, 348
ink-cap, 7, 139
male agaricke, 118
mesheroom, 145
mesheroon, 145
mishroom, 145
morel, 6, 14, 15, 22, 23, 105 n., 120, 122 n., 123-5, 150, 153-4, 156, 161, 338, 346, 348, 398 o., 399, 400-3; Pl. XXIII
musheron (U.S.A.), 145
mushroom, 17, 123, 145, 339, 348
mushrub, 114
paddock-stool, 26, 67, 77
pixie-puff, 97
pixie-stools, 94, 101
pompom, 128
puckfist, 90 n., 94, 97-9; Pl. XIX
puddock-stool, 67
puffball, 93-5, 91-101, 109, 112, 115, 129 n., 151, 348, 364 n., 366, 373; Pl. XIX
punk, 113-4, 116
shaggy-mane, 348
shaggy spunk, 348
shelf fungi, 113, 115-8, 128, 159 n., 366
smut, 100-1
sow-bread, 21 n.
Spanish trubbes, 177 n.

spunk, 113-4, 116, 154-5
stag fungi, 174
stinkhorn, 25, 105, 123
swamm, 106
swamp, 106, 180; Fig. 6
taddecheese, 67
toadcheese, 67
toad's bread, 67
toad's cap, 67
toadskep, 67
toad's meat, 67, 101
toadstool, XVII, 3, 17-21, 23-6, 29-30, 32-3, 51, 54, 65-97, 153, 158, 162, 190, 196, 211, 319, 332-3, 348, 374-5
trubs, 22, 177
truffle, 9, 21, 22-3, 118, 134, 150, 166-84, 225, 317, 335, 342-3, 348, 351-2, 376, 371 n., 384-5, 394

ESKIMO
ahyo'ak, 142
kaltu:faq, 171
kaltu:jilaq, 171
kaltuvaq, 171
kaltu:xaq, 171
pupik, 141-4
puyut, 142
tarnaydp poqattd, 143
tunsrat ciutait, 142
tunnuksak, 142

FINNIC LANGUAGES
panngo (Mordvine), 138
pangkh (Vogul), 138
ponggo (Cheremissian), 138
pongkh (Ostjak), 138

FLEMISH, *see* Dutch & Flemish

FRENCH
amadouvier, 112
auburon, 147-8
bidaou (Gascony), 370
bo (Haute-Saone), 87, 211
botet (Loire), 87, 211
bourseau, 370
boutairoual, 87
boutarel, 87
boutareu, 87
Catalan, 370
cepe, 8-9, 33, 149-52, 160-1, 339, 341; Pl. I
cepe bronze, 11
cepe polonais, 11
champignon, 6, 27, 112, 116, 123-4, 131, 145, 150, 151 n., 156, 158-9, 164, 339, 353
champignon de couche, 129, 131, 159
chanterelle, 7, 107, 281, 337, 371-2, 399; Pl. LXXX
coucourlo fouolo (Aveyron), 211
coulemelle, 128, 162
crapaudin, 66, 77, 86, 209, 375; Pl. XXXV
craque-maudit (Gascony), 87
crote, 100 n.

fausse orange, Pl. XXXV
fonge, 341
gendarme noir, 11
girolle, 371-3
golmelle, 152
golmotte, 152
grapaoudin, 66
jaunisson, 370
kampernoeljes (Picardy), 131-2
kunsaumas (Gascony), 161
materaz, 150
meisseron, 145, 148 n.
mijoulo folho (Aude), 211
moisseron, 145, 148 n.
morille, 153, 400-3; Pl. XXIII
mousseron, XVIII, 14, 123, 145, 147-50, 152, 158, 339, 367, 369
mujolo folo (Toulouse), 211
oberon, 147-8; Pl. XXXI
orange, 382 n.; Pl. IX
orange cigue blanche, Pl. XI
orange cigue verte, Pl. X
pain de crapault, 66, 78 n., 89, 101
pepon, 128, 130, 135
pezizes, 382 n.
pied bleu, Pl. VII
pied d'ane, 370
pissechien, 139; Pl. II, LXXXII
pivoulade, Pl. VI
pixacan (Gascony), 139
potiron, 127-31, 135-6, 147, 342, 353
rose, 131, Pl. XXX
sanguin, Pl. LXXVIII
sauceron, 147
sep (Gascony), 151, 152 n.
set (Gascony), 151-2
sete, 161
tete de negre, 11
triffe niere (Dauphine), 171, 183
truffe, 120, 166, 181-4, 342
truffe du cerf, 173
tsapi de diablhou (Fribourg), 211
tue-mouche, 187; Pl. XXXV
tuo-mouscos (Aude), 211
vesse de loup, 98; Pl. XIX
vineux, Pl. LXXIX

FRISIAN
parepuster, 95
poddefyst, 95
poddehud, 66
spoekebal, 95
ulefyst, 98

FULANI, FULFULDE
koro:wal pa:bi, 332

GEORGIAN
Soko, 108

GERMAN
Boltz, 345
Bovist (or *Bofist*), 95, 98
Btiltz, 150, 345
Eierschwamm (Austria), 371
Feuerschwamm, 112
Fliegenschwamm, 191 n., 197, 199, 209, 212-3, 358, 375; Pl. XXXV
Froschenstuel, loin. grottefuss (Pennsylvania Dutch), 66
Grottestuhl (Pennsylvania Dutch), 66
Grubenlorchel, 189 n.
Grübling, 188-9
Hirschbrunst über der Erde, 177
Hirschbrunst unter der Erde, 177
Hirschtrüffel, 173
Kartoffel, 166, 171
Krotenschwamm, 101, 345
Morchel, 153
Narrenschwamm, 239-40, 321
Natterschwamm, 103
Pfifferling, 200, 370-1
Pilze, 38 n., 112, 123, 150, 339, 345, 365
pofist (Low German), 95
poggenstohl (Low German), 66, 92, 101 n., 332, 345
Sant Georg schwamm, 367
Schwamm, 38 n., 96 n., 105, 108, 109 n., 110-1, 116, 123, 144, 146, 158, 180, 345
Schwammerln (Austria), 239
Steinpilz, 150; Pl. I
Tutzenstol (Low German), 77 n.
Ziegenbart (Switzerland), 373
Zunderschwamm, 112

GREEK
άγαρικόν, 118, 366
άμανῖται, 338, 366
βωλίτης, 365
θεῶν βρῶμα, 338, 375
κεραύνιον, 118
μανιτάρι, 338
μύκης, 57, 117, 123-4, 146, 149, 151-2, 154, 156-8, 160-1, 177 n., 372
οἰτον, 119-20
πέζις, 366, 373
σήπτα, 151-2, 160-2
σπόγγος, 105, 109 n., 111-2, 123-4, 144, 146, 157-8, 334
ύδνον, 166, 366

HEBREW
KMH, 109
s'fog, 109 n.

HINDI
hedur, 120
henda, 120
kana-g^{a}ch, 120
khumbi, 108

kukar-muta, 138
sa ki roti, 104
sap ki chain, 104

INGUSH
dzhahnuskul', 138

IRISH
beác, 93 n.
beacán, 93 n.
beacán bearaigh, 93 n.
biocán, 93 n.
bolg losgainn, 66, 93, 95
bolg seidte, 93
cos-a-phouka, 98
pucán beireach, 93
sponnc, 113

ITALIAN
bole (Verona), 365
boleo coco (Venice), 128
cocch bastard (Milan), 128
cocch fals (Milan), 128
cocch velenos (Milan), 128
cocco, 127, 152
coccomelle (Piedmont), 128
coco bon (Venice), 128
cocon, *coc* or *cucon* (Piedmont), 128
cuccamele (Piedmont), 128
cucun (Genoa), 128
famigliola buona, 7
fongo bolado (Verona), 365
fung cocch (Milan), 128
gallinaccio, 371
ovolaccio, 127
ovolo, 127, 133; Pl. IX
porcinello, 365
porcino, 150-1, 365; Pl. I
silk (Naples), 149
slofa (Trentino), 98
spugnolo, 105 n.
taratouffi, 168
tartuffola, 166
tartufo, 21 n., 166, 171, 179, 183
vescia di lupo, 98

JAPANESE
gama no koshikake, 330
hiratake, 330
kama no koshikake, 330
kino-ko, 395 n.
matsutake, 330
nameko, 330
saru no koshikake, 330
shiitake, 6 n., 330
shoro, 330

KORJAK
pion, 139
wapaq, 139

LAHNDA
khumb, 108

LAPPISH
guobbar, 108

LATIN (including modern scientific names)
agaricum, 106, 115, 118, 366, 369; Fig. 7
agaricus gambosus, 367, 369
agaricus georgii, 369
amanita caesarea, 56, 59, 127, 129 n., 133, 211, 358, 365; Pl. IX
amanita citrina, 47, 52, 54-5
amanita mappa, 52, 54
amanita muscaria, 3,5, 48-9, 51, 66, 77, 86, 87 n., 112, 127-8, 138-9, 190-214, 239, 364, 396; Pl. XXXV, XXXVII
amanita pantherina, 48, 101
amanita phalloides, 3, 47, 51, 54-5, 58-60, 62, 336, 364, 366-7; Pl. X
amanita rubescens, 152
amanita vaginata, 240
amanita verna, 47, 366; Pl. XI
amanita virosa, 47
armillariella mellea, 7; Pl. VI
boletus, 9, 56, 59, 65 n., 87, 129 n., 131, 161, 174, 188, 239, 331, 339, 345, 354, 365, 396; Pl. XVII
boletus aereus, XXI, 11
boletus duriusculus, Pl. VIII, XXXVIII
boletus edulis, 9, 149, 150, 151, 161-2, 339, 365-6; Pl. I
boletus hirsutus, 348
boletus luridus, 396
boletus rufus, 9
boletus satanas, 89, 336, 354; Pl. XVIII
boletus scaber, 9, 365, 399; Pl. LXXXI
boletus suaveolens, 344
boletus versipellis, 399
boletus (Xerocomus) sudanicus,331
calvatia, Pl. XXXVII
cantharellus cibarius, 281, 339, 370-2; Pl. LXXX
choiromyces meandriformis, 171
cibus deorum, 60
cladonia, Pl. XXXVII
dathrus cancellatus, 4, 211; Pl. III, XXXVII
clavaria, 133, 373
clavaria botrytis, 358
clavaria pistillaris, 333-4
clitocybe catinus, 6 n.
collybia albuminosa, 124
collybia fusipes, Pl. IV
collybia velutipes, 330
coprini, 139, 211, 332
coprinus atramentarius, 139; Pl. LXXXII
coprinus comatus, 348; Pl. II
coprinus micaceus, Pl. XXXVII
coprinus niveus, Pl. XXXVII
coprinus nychthemerus, title-page Vol.1
coprinus radiatus, half-title p. 409

coprinus tardus, title-page Vol. II
cortinarius, 200
craterellus cantharellus, 281, 352
cyttaria, 24
deorum cibum, 338
elaphomyces, 173, 177
fomes fomentarius, 112, 116, 118, 140, 320
fomes igniarius, 116, 118, 320
fomes officinalis, 106, 112, 115, 117-8, 351, 366; Pl. XXII; Fig. 6
fungi perniciales, 239
fungus, 105, 107-8, 109 n., 111-2, 144, 156, 158, 179-80, 191, 340-1
gyromitra esculenta, 49, 51, 367
Helvetia sp., 399
helvella lacunosa, 189 o.
hirneola auricula-judae, 142
hydnacece, 366
hydnum imbricatum, 177
hypholoma fasciculare, 360
ithyphallus impudicus, 122
lacterii, 8, 10, 337, 339, 395-6, 399
lactarius deliciosus, 7, 8, 13, 367, 370, 397; Pl. LXXVIII
lactarius piperatus, 8, 147-8, 188, 200, 370; Pl. XXXI
lactarius pubescens, 396
lactarius sanguifluus, 340, 361, 367; Pl. LXXIX
lactarius torminosus, 399
lentinus tuber-regium, 126
lepiota procera, 128, 340
lycoperdon, 99, 364 n., 373; Pl. XXXVII
lycoperdon furfuraceum, Pl. XIX
marasmius oreades, 78, 103, 395
marasmius urens, 78
merulius lacrymans, 353 o.
morchella esculenta, 399
morchella vulgaris, Pl. XXIII
mussirionem, 145
mutinus caninus, 158
mycena galericulata, Pl. XXXVII
panaeolus (genus), 52, 238, 240, 246
panaeolus campanulatus, 237, 240-1; Pl. XXXIX
paxillus, 396
penicillium, 117 n.
peziza, 366
phallus impudicus, 25, 123, 158, 177, 367
pinicola, 151
pleurotus eryngii, 339
polyporus fomentarius, 116 n.
polyporus tuberaster, 6 n.
psalliota arvensis, 348
psalliota campestris, 129, 135-6, 145, 338-9; Pl. XXX
psalliota sylvicola, Pl. XXXVII
psilocybe, 254
psilocybe caerulescens var. *mazatecorum*, Pl. XL
psilocybe mexicana Heim, Pl. XL
rhizopogon rubescens, 330
rhodopaxillus nudus, 33; Pl. VII
rigidoporus microporus, 216

russula (genus), 8, 20, 188, 200, 340, 358, 395, 399; Pl. XXXVII
russula adusta, 396
russula fastens, 396
russula virescens, 340
spongia, 110, 124
spongiolus, 105 o., 124
stropharia sp., 254
stropharia cubensis, Pl. XL
stropharia semiglobata, 212
suillus, 149-51, 321, 365
terfezia, 109, 118, 121, 124, 166, 317, 335-6
trametes suaveolens, 344
tricholoma equestre, 370
tricholotna gambostim or *georgii*, XXI, 145, 149, 367, 369; Fig. 27
tuber, 21 n., 118, 166-7, 171-2, 182-3, 366; Pl. XXXII; Fig. 10
tuber magnatum, 171
tuber melanosporum, 172, 342
tufer, 182-3
ungulina auberiana, 216
ustilago maydis, 101
volvaria spedosa, Pl. XXXVII

LATVIAN
gailene, 372

LITHUANIAN
lapelaizis, 370

LUGANDA
bubaala, 333
namulondo, 333
ngngoma-ya-kikere, 333

MAGYAR
bagoly gomba, 101 n.
bolond gomba, 240, 321
csoporke, 135
gomba or *gamba*, 107-8, 109 n., 110-1, 144, 158, 180, 367, 369
kigyo gomba, 103
roka-gomba, 370
szemerchyek, 153 n.
szent Gyewrgi gambaia, 367
vargdnya, 150

MAORI
whatitiri, 125

MARATHI
kutrya-cem milt, 138

MATLATZINCA
intza chohui, 230

MAZAHUA
yocho, 221

MAZATEC
hko^{4}, 283
ki^{3}*sol*, 288
nka^{2}, 268
ˀnti^{1}*si*^{3}*tho*^{3}, 244, 251
ˀnti^{1}*si*^{3}*tho*^{3} *ki*^{3}*sol*, 254
ˀnti^{1}*si*^{3}*tho*^{3} *ni*^{4}*se*$^{3\text{-}4}$, 254
ˀnti^{1}*si*^{3}*tho*^{3} and *ˀe*^{4}*le*^{4}*nta*^{4}*ha*^{4}, 254
si^{3}*tho*^{3}, 244
si^{3}*to*^{3}, 251, 270
to^{3}, 251

MIDDLE AMERICAN LANGUAGES
see Chinantec, Matlatzinca, Mazahua, Mazatec, Mije, Nahuatl, Quiche, Tarascan, Zapotec

MIJE
atka:t, 270, 272
kobahk, 272, 283
kong or *kongk*, 270, 272
maxmux, 229
mus, 269, 273 n.
na:swin mus, 269, 273
pi:tpa, 270, 272
tu:muh, 269
tu:m 'ungk, 269

MONGOLIAN
mecin, 334

NAHUATL
apipiltxin, 306, 326
citlalnanacáme, 222
cuitlacoche, 101
ixtlauacan nanacatl, 228
maçauacan nanacatl, 228
nanacatl, 220, 222-4, 225, 230-1, 280, 306
naucatl, 228
quautlannanaçatl, 227, 232
teonanacatl, 225-6, 228, 230, 232, 233 n., 234-6, 238 n., 242, 283, 319, 404 n.; Pl. XL, XLVII, XLIX; Fig. 14, 15
fepexi nanacatl, 228
teunamacatlth, 219
teyhuinti, 221-2, 233
teyuinti nanacatl, 228
xochi nanacatl, 228

NEW GUINEA
nonda, 215

NORWEGIAN
paddehat, 66
troll-smor, 154

OSSETIAN
kozo (Digorian), 108
zoko (Iranian), 108

PAMPANGO (LUZON)
payungpayungan kulog, 124

PANJABI
khumb, 108
padd bahera, 99 n.

PASHTO
poczksi, 230
xargina, 159
xomba (Waziri), 108
xumburi (Mohmand), 108

PENNSYLVANIA DUTCH
see German

PERSIAN
catr-i-mar, 104
dumbalan, 121
kulahi zamin, 159
qabih-ker i xarak, 159
qarc, 121
xorc (Tadzhik), 121

POLISH
bedła, 94
grzyb, 188
muchomor, 200 n.
psice, 138-9
szmer, 239

PEUL
see Fulani, Fulfulde

PORTUGUESE
centeiro, 340
cogumelo, 127
nisco, 340

PROVENCAL
biroudelo, 372
bouchinguello, 372
boule, 365
caramillo, 372
coucourlo, 127, 136
cougoumello, 127, 152
crahilho, 372
escarabiho, 372
escrabilho, 372
gerilho, 372
ghidorelo, 372
ghirolou, 372
giraudello, 372
girbouleto, 372
girello, 372
girgouleto, 362
girgoulo, 372

irodela, 372
jargoukto, 372
jirboulelo, 372
jotrel, 372
moussairoun, 145
mousselet, 145
ziraoudela, 372
zitello, 372

QUICHE
anacate, 280-1
holom ocox, 281-3
holom ixpek, 281
ocox, 280-1

ROMANSCH
burachel, 153
cacs tgapper, 98
murachel, 153
pawn de póder, 78 n.
toffas d'luj, 98

ROMANY
perrechites (Spain), 137
xuxur, 370

RUMANIAN
burete, 365
duperca, 135

RUSSIAN
beljanka, 14, 16, 396, 399
belyigrib, 3, 9, 11-3, 38; Pl. I
berjozovik, 9, 399; Pl. LXXXI
blitza, 94
bolotovik, 16
borovik, 3, 11-2, 14-5
bzdjukha, 98
chernukha, 396
chortova perechnitza, 16, 97-8
dubovik, 16, 396, 399
elovik, 16
glukhie, 399
golubetz, 16
grib, 5, 14, 78-9, 112, 123, 161 n., 185-9, 231; Fig. 1
gruzd', 8, 9, 13-4, 148, 188, 231, 365, 399; Pl. XXXI; Fig. 1
guba, 105, 108, 123, 161 n., 367; Fig. 1
kozjol, 16
lisichka, 5, 7, 14-5, 370, 399; Pl. LXXX
lugovik, 395
maslenik, maslenok, masljata etc., 7, 14, 110 n., 231, 396, 399
mochjonki, 396
mokhovnik, 16
mukhomor, 5, 14, 197, 214, 396
obabka, 16
opjata, opjonok, 7, 11, 14, 231, 399; Pl. LXXXII
osinovik, 399

pecharka, 135, 136
pecheritza, 13; Pl. XXX
podberjozovik, 9
podosinovik, 9
podgruzdki, 399
poganki, 6, 103, 396
ryzhik, 7-9, 13-5, 28, 231, 345, 396-7, 399; Pl. LXXVIII; Fig. 1
sinjushki, 16
skripitza, 16
smorchok, 6, 153-4; Pl. XXIII
strojki, 399
svinukha, 321, 396
svinushka, 16
syroezhka, 6, 13, 392, 399
travjanka, 16
trut, 114
valui, 396
volnushka, 14, 16
volonitsa, Fig. 1
volui, 14, 16
volzhanki, 399

SANSKRIT
ahi-chattra(ka), 104, 374
chattra, 103, 362
kyaku, 163
silindhra, 121
sukara maddava, 321

SINDHI
khumbi, 108
phungl, 108
saitan jo pelo, 173
sapido, 104

SLOVAK
hadácí huby, 78
hadúnke huby, 78
salene huby, 78, 240
žabací huby, 78

SLOVENIAN
grib, 188

SOGDIAN
xarcak (Yaghnobi), 121

SPANISH
angelitos, 254
bejm, 151
canturula (Guatemala), 371
criadilla de ciervo, 173, 176
criadilla de tierra, 166-7, 169, 173
cuesco de lobo, 98
grandote, 311
hombreados, 306
hongo, 78, 107, 151, 221, 228, 280, 282 n., 339

hongo de puerco, 151
honguillo, 228, 229
honguillo de San Isidro Labrador, 254
mizcalo, 8, 339, 370
mujeradas, 306
nanacate (Mexico), 220
ninos, 306
pedo de lobo, 98
perrechites (Gypsy), 137
seta, 78, 151-2, 160-2, 371 n.
seta de cardo, 339
sombrilla de sapo, 78, 104
triunfa (Aragon), 169
trufa, 166, 169, 181
turma de tierra, 166-8, 173, 183
xeta, 228

SVANETIAN
sok, 108

SWEDISH
Karljohansswamp, 339

SYRIAC
paturta, 127
s^{e}*mama*, 155, 157

TAINO
batata, 167-8, 172, 183

TANALA (MADAGASCAR)
olatafa, 126

TARASCAN
cauiaua terequa, 229-30

UKRAINIAN
hryb, 188
pecheritza, 135
zhabjachyj hryb, 78

WELSH
caws llyjfant, 66
maesrin, 146

YENISEI OSTJAK
hanggo, 138, 140, 141, 191

YIDDISH
hintishe shvemlekh, 138
pecheritza, 135
shveml, 345

YUKAGHIR
can-pai, 138

ZAPOTEC
mbey, 311-2
mbeydo, 311-2
ndotan de venado, 312
nocuana peneeche, 228, 282
peaño, 228
peyaño, 228
piule de churls, 311, 315
piule de barda, 311, 313, 315

Index of Persons and Places

Index page numbers refers to original version of this reedition.

Abegg, C.J., 385
Abramson, Harold Alexander, 290 n.
Adam, 88, 364
Aegean, the, 317
Afghanistan, 230
Agaria, 366
Agrippina, Empress, XIX, 56-60, 62, 63
Agustin, Manuel, 268-70, 272
Ahren, Frithiof, 137
Aix-en-Provence, 184
Akichi, Nicolas, 279 n.
Aksakov, Sergej Timofeevich, 13, 394-9
Alani, the, 42
Alaska, 139, 141-2, 171, 191
Albertus Magnus, 65, 169-70, 198, 200, 206, 210, 212-14, 238, 353 n.
Aldobrandino da Siena, 341, 352; Pl. LVI
Aleuts, the, 142
Alexander the Great, 342
Alexei, Tsar, 35, 53
Algonquin Indians, 140
Allen, Hope Emily, 206, 210
Alps, the, 95, 171, 346
Alsace, 197
Altschul, Frank, Pl. XX
Alvaro, 268
Amann, Jules, 382, 400
Amecameca, 305
America (=USA), 4, 6, 7, 9, 13, 17, 22-3, 38, 40, 68, 128 o., 159 n., 203-4, 382
Amsterdam, 356, 358, 359, 387; Rijksmuseum, 360; Pl. LXXIII
Anderson, Arthur J. O., 222, 225, 231 n.
Andes, the, 168, 171
Andreev, M. S., 121 n.
Angel, F., 186 n.
Angermayer, Johann Albert, 359
Anne, Queen, 22
Annenkov, N., 193
Anthimus, 145 n.,
Anthony, St., 85, 312
Antilles, 167, 172
Antonio, Geronimo, 269
Antwerp, 130, 199, 361
Apicius, 340
Arabian Nights, the, 109
Arabs, 109, 158, 319, 335-6
Aragon, 169
Aragon, Father Alfonso, 250
Aranzadi, Telesforo de, 339
Ararat, Mount, 42
Arawakan, 167
Arcimboldo, Giuseppe, 132-3, 387; Pl. XXVIII-XXIX
Ariege, 176
Arras, 101 n., 199, 342

Ashe, Gordon, 51
Ashkenazic culture, 366
Ashmarin, N. I., 108
Ashmole, Bernard, 386
Ashmole, Elias, Fig. 2
Assi, the, 42
Athenasus, 52, 119-20, 134, 177 n., 337, 351 n.
Athos, Mount, 338 o.
Attila, 107 n.
Aude, 197, 211
Audubon, 357, 360
Augustine, St., 314
Austria, 200, 371
Avars, the, 41
Aveyron, 211
Avicenna, 127
Avilix, 281
Aymes, C. A. Wertheim, 386-7
Ayutla, 267 n.
Azov, Sea of, 42, 366
Aztecs, the, 172, 217, 219, 225, 227, 232, 234 n., 236, 305, 307, 312

Bachelier, Jean-Jacques, XX
Bacon, Francis, 6, 93
Badham, 23
Badianus, 232
Baer, Bugs, 204
Baganda, 333
Bahamas, 167
Bahr, Gerhard, 206 n.
Bahrain Island, 335
Bale, 159, 211, 212; Pl. XXVII
Balkan Slavs, the, 336
Bangui, 383
Banque Beige d'Afrique, 383
Bantu peoples, 331, 333
Barcelona, 8, 343 n.
Baretti, Giuseppe, 21 n.
Barla, Jean-Baptiste, 145
Barnouw, Adriaan J., 388
Barrios, Ignacio, 279 n.
Barrios, Miguel, 222
Bartlett, Vernon, 164
Basalenque, Diego, 230
Basques, the, 10, 42, 77-8, 99, 103, 136-7, 149, 206, 339-41
Basu, Arabinda, 384
Batrachitas, 158
Bauhin Jean, 100 n., 150 n., 358, 365, 371
Baumeister, A., 117 n.
Bavaria, 81 n.
Bax, Dirk, 85, 86
Beals, Ralph L., 267 n., 276
Beam, 86
Beatrice of Savoy, 341
Becker, Georges, 100 n., 381, 400
Bedouin, the, 124, 316, 335, 336

Beers, Alma H., 385
Begeyn, Abraham, 358-9; Pl. LXIX
Begouen, Count, 176
Belisarius, 338
Belyj, Andrej, 214
Benavente, Toribio de, *see* Motolinia
Bering Strait, 140, 142, 143, 191
Berlin, 44, 123, 198
Bermeo (Guipuzcoa), 206
Bern, 92 n.
Bern, Mr., 201, 212
Bernadotte (Charles XVI, King of Sweden), 339, 344
Bessarabia, 138
Bevan, Bernard, 238
Big Indian, 4
Birnbaum, E., 384
Biscay, 77, 151
Bismarck, Otto von, 346
Bismarck Mountains, 215
Black Sea, 41, 42, 43
Blenheim, 39
Bles, Herri met de (Civetta), 355-6, 362; Pl. LXIII, LXIV
Bles, pseudo-Herri met de, 187; Pl. XXXIII
Bloch, Oscar, 127, 129, 145, 371
Block, Edward A., 93 n.
Blom, Frans, 267 o.
Boberg, Anna, 194
Boethius, Axel, 386
Bogert, Charles M., 385
Bogoras, Waldemar, 139 n., 194, 211, 318
Bohemia, 16, 173, 177, 212
Boisacq, Émile, 109 n., 122n., 163
Bombieri, Carlo, 387
Bombon (Seine-et-Marne), 102, 103
Bonaparte, *see* Napoleon
Bond, Raymond T., 384
Bongoland, 331-2, 333
Bonnefons, N. de, 6, 129, 130, 131, 145
Boothroyd, Ronald H., 383
Bordeaux, XIX, 102, 151, 384
Borhegyi, Stephan F., 78, 239, 273, 276-8, 281, 283 n., 328, 329, 387; Fig. 18, 28
Borhegyi, Suzanne, 277, 280, 387
Borja, Carlos, 267, 387
Bornholm, 44
Borovikovskij, 14
Borssom, Anthonie van, 358
Bory, Michelle, Pl. XL
Bosch, Hieronymus, 68, 83, 85-90, 97, 187, 209, 318, 354-7, 362, 386; Pl. XII, XIII, XV-XVII, XXXVI
Boston (Mass.), 255, 260-1, 264; Museum of Fine Arts, Pl. V
Bosworth, Joseph, 75 n.
Bouda, Karl 138 o., 162 n.
Bouteneff, Ekaterina Apollinarievna, 213
Boyer, Madame, 52
Bozoum, 383
Bozzini, 33
Brabant, 131

Bradley, Richard, 120 n.
Bramah, Ernest, 49, 51
Brandenburg, 123
Bravlio, 279 n., 281
Brearley School, 384
Bremen (Alabama), 204
Bremontier, Nicolas Thomas, 151
Brescia, 132; Pl. XXVIII-XXIX
Breton, Adela, 323
Bretons, the, 66, 74, 341
Breuil, Abbe, 176
Brillat-Savarin, Anthelme, 150, 166, 172, 343
Brissac, Edouard de Cosse, 385-6
Bristol, 386
Britannicus, 56, 57, 62
Brockelman, C., 155
Brown, Captain Thomas, 102 n.
Browning, Robert, 29
Brueghel, Jan the Elder, 360-1
Brueghel, Peter the Elder, 354, 355, 356, 362; Pl. LIX-LXI
Brunson, Howard E., 307, 312
Brunswick, Globus, 275; Herzog Anton Ulrich Museum, 358; Pl. LXVI, LXVII
Brussels, 130, 361; Musees Royaux des Beaux-Arts, 385; Pl. XXIV, XXVI
Buchner, Ernst, 386
Buchwald, N. Fabritius, 116 n. 386
Buddha, 321
Buena Vista Loxicha, 308 n.
Buffon, George, XX
Buganda, 333
Buglawton (Cheshire), 204
Bugthorpe (Yorkshire), 204
Bugtussle (Alabama), 204
Bulgaria, 42, 108, 372, 384
Buller, A. H. R., 365 n.
Bulliard, Jean-Baptiste (Pierre), 150, 201-2, 213
Burns, Robert, 26
Burrhus, 50
Busbecq, de, 41
Byzantium, 42

Calan, Alberto, 279 n., 281
Calas, Mr. & Mrs. Nicolas, 88
California, University of, 233 n., 384
Caligula, Emperor, 56
Calvados, 66
Cambridge University Press, 337
Camotlan, *see* San Lucas Camotlan
Camp, Gaston van, 385
Canada, 128 n., 341, 382
Candelaria Loxicha, 308 n.
Cant, Ronald G., 386
Caravaggio, Michel Angelo, 355 n.
Cardenas, Juan de, 233
Carelia, 337
Caribs, the, 167 n.
Carolinas, the, 38

Carpathians, 239
Carrasco, Pedro, 228 n., 238 n., 307
Carreras, Aurelio, 250-3, 255-65, 282 n., 292, 294, 299, 319, 329; Pl. XLII
Carreras, Clara, 256, 260
Carreras, Demetrio, 256, 257, 259, 261-3
Carroll, Lewis (C. L. Dodgson), 67, 194-6
Caso, Alfonso, 307, 324 n., 326, 387; Fig. 24
Castelli, Enrico, 355 n.
Castlemaine Harbor, 74
Catalans, the, 8, 10, 24, 78, 185-6, 335, 337, 339, 340, 348, 361, 365, 384
Catherine the Great, 14
Catskill Mountains, 4
Caucasus, 42, 137, 138, 384
Causa, Raffaello, 358 n.
Cavignac, 370
Cayetano, 287-304, 310; Pl. XLV; Fig. 21
Cazan, 45
Celsus, 155
Celts, the, 66, 95, 337, 343
Cerro Alux, Fig. 18
Chad, Lake, 331
Chadenet, Mr. & Mrs. Pierre, 387
Chandler, David, 386
Chari district, 331
Charles VI, Emperor, 53
Charles II, King, 22
Chase, Mary, 94, 203
Chatin, Adolphe, 171 n., 182-3
Chaucer, Geoffrey, 26, 67, 160, 182, 187 n.
Chavaneau, Andre, 384
Chechens, the, 137
Cheremissians, the, 138
Chiapas, 266, 275, 278-9, 284-6
Chiba, 330, 331 n.
Chicago, 384; Art Institute, 361; Pl. LXXV
Chichester, 133 n.
Chichicastenango, 279 o., 282 n.
Chichimecas, 224, 225, 236-7
Chichiton, Juan, 226-7, 235
Chile, 10
Chiltepec, 233 n.
Chimbu Valley, 216
Chimbus, the, 215
Chinantec country, 233 n., 238 n., 266, 286
Chinese, the, 124-5, 316, 317, 320, 333-4
Chinon, 342
Chiquimula, 78
Chloe, 348
Cholula, 305
Chotin, 138
Christensen, Bodil, 305, 306
Christensen, Clyde M., 385
Chujupen, 279 n.
Chukchees, the, 138 o., 139, 143, 191, 210, 211, 318
Churchill, Winston, 164
Chuvashi, the, 108

Cid, Cleofas, 250
Cid de Mendes, Toribia, 264
Cigliana-Piazza, Giorgio, 385
Cimmerians, the, 42
Cincinnati, 73 n.
Circassians, the, 137, 384
Civetta, *see* Bles, Herri met de
Cizevsky, Dimitry, 346 n., 383
Clare, John, 28-9
Claremont, 348
Claudius, Emperor, XIX, 50, 55-63, 338
Cleasby-Vigfusson, 209
Clement VII, Pope, 52-3
Clotilde, Queen, 84
Clovis, King, 84-5, 386; Pl. XIV
Clusius, Carolus (Charles de Le-cluse), 101, 103, 150, 153 n., 161, 199, 200, 212, 239, 240, 342, 345, 358, 364, 367, 369; Fig. 27
Codina, Joaquim, 337
Coinci, Gautier de, 161 n.
Colcord, Joanna Carver, 205 n.
Collier, J. Payne, 83 n.
Collins, Samuel, 3, 7, 35
Colombia, 168
Conception, 250-2, 254
Conception Huista, 279 n.
Constanti, 384
Cook, Arthur Bernard, 115 n., 117
Cooke, Mordecai Cubitt, 23, 195, 196
Cooper, Peter, 386
Copenhagen, 116 n., 141, 384, 386; Royal Library, 344-5
Cordoba, Juan de, 228, 282
Cordus, Valerius, 101 n., 173-4, 176, 199, 200, 206, 345, 370
Corinth, 154
Cornishmen, 73-4, 185
Corominas, Juan, 151, 156, 161, 162, 169 n., 371 n., 384
Corot, 362
Cortez, 217
Covarrubias, Caspar de, 220, 282 n., 405
Covarrubias, Miguel, 266
Covarrubias, Sebastian de, 151
Cowan, Florence, 245, 246, 250
Coxe, William, 35-6, 53
Cracow, 200 n.
Craig, A.J. M., 384
Cratevas, 352
Crecy, 39
Creech, William, 26
Crimean peninsula, 41, 366
Cui, Cesar, 15
Cuicatecs, the, 266
Cumas, 117 n.
Cumbre, La, 246
Curry, Walter Clyde, 187 n.
Curtis, Rev. M.A., 38
Cutler, Hugh C., 130-1, 385
Czechs, the, 11, 15, 38, 176-7, 208, 336

Czik-Madefalva, Gy. Istvanffi de, 200

Dal', 155
D'Albert, Peter, 384
Damascus, 109, 335
Danes, the, 66, 67, 77, 343, 346, 384
Darwin, Charles, 24, 25
Darwin, Erasmus, 120 n.
Dauphine, 171, 183
Dauzat, Albert, 128, 129, 145, 148, 371
Dawson, R., 384
Delvau, Alfred, 159, 160
Deonna, Waldemar, 187 o., 386
Derleth, August, 51
Desfontaines, L., 135 o.,
Desnoyers, Abbe, 102
Detroit, Wayne University, 204
Devic, Marcel, 127
Devonshire, 386
Dibble, Charles E., 222, 231 n.
Dickens, Charles, 82, 181
Dickinson, Emily, 31
Dickson, H. R. P., 335, 336
Dictionary of American English, 114
Dido, 342
Diego, Don (Cacique of Etlantongo), 220, 404
Dingwall, Adam, 4
Dio Cassius, 56-7, 60, 62, 338
Dioscorides, 21, 101 n., 118, 151, 166, 199, 337-8, 351, 352, 366; Pl. XXII, XXXII, LVII, LVIII; Fig. 26
Dniepr, River, 42
Dobbie, Elliot V.K., 383
Dodge, Carroll W., 385
Dodgson, C. L., *see* Carroll, Lewis
Dokkum, 95
Don, River, 45, 366
Donner, Kai, 138 n., 191
Dordogne, 370
Douglas, Norman, 99, 153, 173
Douglass, Beaman, 240-1
Doyle, A. Conan, 31-2
Drachten, 383
Dumee, Paul, 54, 55
Dumezil, Georges, 384
Duran, Diego, 218, 404
Dürer, Albrecht, 355 n., 357
Durham, University of, 384
Dutch, the, 66-7, 130-2, 208, 211-12, 361

Eastman, Max, 384
Eckblad, F. E., 213
Eden, Garden of, 88, 376
Eden, Richarde, 37
Egyptians, the, 115, 157-8, 202, 320
Eidenbenz, Emil, 193, 385
Ekholm, Gordon F., 275-6, 324, 387
Ekwall, Eilert, 204

Elisha, 61
Elizabeth I, Queen, 45, 83, 169
Elyot, Sir Thomas, 19, 130, 134
Emerton, J. A., 384
Emmart, Emily Walcott, 232 n.
Engadine, 98, 346
English, the, 7, 19-36, 38-40, 67-71, 80, 82, 97, 101, 106-7, 114, 120 n., 145, 156, 169, 205, 338, 339, 347-9
Ennius, 160
Entre-deux-mers, 370
Entwistle, Wm. J., 372 n.
Eparchides, 337 n.
Epping Forest, 33
Erasmus, 163
Ernout, A., 109 n., 136
Escorial, 233, 221-2, 404 n.
Eskimos, the, 141-4, 171, 319, 330, 384
Estonia, 8
Etlantongo, 219, 220
Etruscans, the, 116, 117, 123, 156, 386; Pl. XXI
Euripides, 52, 337 n.
Eustace, Robert, 49
Evans, Charles, 125
Eve, 87 n., 88, 374
Evelyn, John, 21, 343

Fabing, Howard F., 73 n.
Fabre, Jean-Henri, XIX-XXI, 55, 241, 338-9, 351; Pl. I-IV, VI-XI, XVIII, XIX, XXIII, XXX, XXXI, XXXV, XXXVIII, XXXIX, LXXVIII-LXXXII
Fabre, Paul, XXI
Faeroe Islands, 138
Falc'hun, Abbe, 383
Fauchet, Claude, 85 n.
Faustino, Candido, 272, 273
Faustino, Feliciano, 273
Fauvel, Camille, 52, 55, 139, 194, 381, 400
Ferrero, Guglielmo, 55
Fessel, Mr., 10
Festus, 96
Filemon, 266
Finan, John J., 133 n.
Finns, the, 8, 138, 191, 337, 384
Flegenheimer, Arthur (Dutch Schultz), 204
Flemings, the, 86, 130-2, 150, 208, 338, 361, 375
Florence, 27, 233; Battistero, 187; Pl. XXXIV; Biblioteca Laurenziana, 233 o., 282; Fig. 14, 20; Biblioteca Nazionale, 233 n.; Fig. 15
Florence, G. C., 204
Flores (Asores), 39
Flores, Francisco A., 235
Florida, 11 n., 167, 308
Formosa, 334
Fornes, C. Torres, 169 n.
Fort Archambault, 383
Fort-Camot, 126
Foulby, 384
Fowkes, Robert A., 384
France, 4, 21, 66, 68, 80-1, 87, 97, 102, 123, 127-30, 145-9, 152, 156, 159, 172-3, 186, 194, 208, 318, 341-3,

349, 364
Francis of Sales, St., 353
Francisco Claudio, 268
Francois I, King, 172
Frank, A. B., 394
Frankfort (Main), 78 n., 199, 200, 201, 212
Frazer, Sir James, 122
French Canadians, the, 341
Fresnes, 55
Freya, 202
Fribourg (Switzerland), 211
Fries, Elias, 367, 369
Frisians, the, 66, 67, 98, 337, 338
Fuchs, Leonhard, 133
Fulani, the, 332-3
Fusy, Antoine, 179
Fyt, Jan, 130-2, 362; Pl. XXIV

Gainsborough, Thomas, 23, 362; Pl. V
Galen, 20, 21, 118, 337-8, 351 n.
Gallee, J. H., 960.
Garcia, Emilio, 288, 292, 296, 297; Pl. XLIX
Garcia, Pedro, 309, 312
Garcia, Teodoro, 253
Garonne, 127
Gascony, 86, 87, 151, 161, 339, 341, 370
Gaul, 96
Gay, Hazel, 385
Geiger, Benno, 133 n.
Gelderland, 93
Genaro, 288, 290, 297
Geneva, 164, 193, 265, 346, 353, 386
Genin, Franfois, 178-9, 180
Genoa, 128
Geoponica, 124
Georgians, the, 137
Gerarde, John, 20, 21
Germans, the, 4, 66, 95, 135, 173-4, 177, 345-6, 361, 365
Gilberti, Maturino, 229
Gilliard, Thomas, 215, 216
Girard (l'affaire), 54, 55, 349
Giron, Epilonio, 279 n., 280
Gironde, 370
Gitlow, Abraham L., 215, 218, 276
Gleditsch, J. G., 123, 124, 177-8
Glen, G., 240
Gobi Desert, 299
Godefroy, Frederic, 128
Godstow, 195
Goethe, Johann Wolfgang, 202
Goetz, Delia, 281, 282
Gogol, 16
Goldsmith, Oliver, 113
Goldstein, Martin (Buggsy), 204
Gombe, 332
Gombe, Jalo, 332, 383

Gomez, Trinidad, 279 n.
Gonzalez, F. Ruben, 279 n.
Goodhart, Mrs. Arthur L., 384
Gordan, John D., 384
Goteborg University, 386
Goths, the, 41, 42
Gow, A. S. F., 337
Grahame, Kenneth, 67
Grandville, J.-J., 362-3; Pl. LXXVII
Graves, Robert, XIX, 10, 33, 61, 75, 117, 146, 275, 338, 361, 386, 388
Gray, Thomas, 26
Greco, El, 304
Gredos, Sierra de, 8
Greeks, the, 105, 118, 121, 123-4, 135, 146, 152, 154, 156, 157, 158, 162, 316, 317, 337-8, 364, 375
Greenland, 141-3, 318
Gregory IX, Pope, 85, 88
Greiser, 164
Gresham, Sir Thomas, 205
Grete Herball, The, 19, 20
'Gribouille', 186
Gribovskij, 14
Griboyedov, 14
Grimm, Jacob, 148 n., 196
Gron, Fredrik, 192
Grzymala, Franciszek, 15 n.
Gtissow, H. T., 52
Guadalupe, 287-304, 310
Guadalupe, Virgin of, 314, 315
Guatemala, 78, 104, 161 n., 248, 275-85, 329, 371, 387; Fig. 17
Guatemala City, 276, 277, 280, 281, 284; Museo Nacional, 276, 279; Fig. 18, 19
Gubernatis, Angelo de, 121
Guernica, 340
Guipuzcoa, 10, 77, 206
Guitry, Sacha, 342
Gusha, Ishiwara, *see*, Masujima, Katashi
Gypsies, 104 n., 137

Hadding the Dane, 343
Hagberg, Knut, 344
Hagen, Mount, 215
Hainaut, R., 383
Hakluyt, Richard, 40 n., 45 n., 217
Hall, Elizabeth C., 385
Halotus, 57, 59
Hamilton, Frans, 359, 386; Pl. LXX
Hamilton, James, 359 n., 386
Hammerich, L.L., 141-3, 171 n., 384
Hansen, Sigurd, 116 n.
Harington, Sir John, 169
Harssen, Meta, 385
Hart, Fanchon, 384
Hartwich, C., 193
Harvard University, XIX, 122, 145 n., 237, 238 n., 383, 384
Hay, William Delisle, 23-24
Heem, Cornelis de, 134
Heem, Jan Davidsz. de, 130, 131, 134; Pl. XXV

Heim, Roger, XX, XXI, 52, 126, 216, 237, 254, 281 n., 331, 344, 367 n., 381, 382, 400
Helsinki, 161 n., 337 n., 384
Henriquez Urefia, Pedro, 169 n., 172 n.
Henry VIII, King, 52
Henry, Victor, 74 n., 96 n.
Hera, 117
Herault, 66
Herberstein, Sigismund von, 45
Herculaneum, 87, 361-2, 386; Pl. LXXVI
Herman, Alexander C., 387
Hernandez, Francisco, 221-2, 228, 232, 233, 309, 315, 321, 405
Hernandez, Pedro Raimundo, 279 n.
Hernandez, Victor, 245, 246, 247, 249, 251, 253, 255, 258 n., 261
Herodotus, 42, 43
Hervey, Lady, 347
Higuera, Salvador Mateos, 220
Hildebrandsson, H., 192-3
Hildegard, St., 353 n.
Hippocrates, 337 n.
Hiqit, 157
Hiscock, W. G., 196 n.,
Hispaniola, 167
Hitchcock, Charles, 387
Hitler, Adolf, 42
Hoffherr, Frederic G., 38
Hoffmann-Krayer, E., 38 n., 210 n
Holberg, Ludvig, 210
Holland, Philemon, 155, 340
Hollywood, 157
Holmes, Urban T., 161 n.
Holstein, 44, 77 n.
Holtved, Erik, 143
Homer, 111, 337
Hondecoeter, Melchior de, 359-60; Pl. LXXIII, LXXIV
Hoogshagen, Searle, 272
Hortus Sanitatis, 170, 351, 352; Fig. 7, 10
Hotherus, King, 90
Houghton, Wm., 365 n.
Housman, A. E., 376
Huautla de Jiménez (Oaxaca), 237, 242, 245-65, 268, 269, 276, 280, 282, 284 n., 287-304; Pl. XLII, XLV-L
Hudson, W. H., 25
Hughes, John P., 384
Hungary, 41, 42, 101 n., 153 n., 157, 199, 239, 321, 367, 384
Hung-shou, Chen, Pl. LII
Huns, the, 40, 41
Hu Shih, Dr., 320
Huxley, Aldous, 103, 224

Ignacio, Miguel, 279 o.
Imba, 330
India, 41, 86, 104, 121, 129 n., 173, 316
Indo-European peoples, 5, 42, 44, 78, 99, 109, 124, 144, 191, 319, 330, 374
Ingrandes (Berry), 87 n.
Ingush tribe, 138
Irish, the, 66, 74, 95
Isaac Judasus, 341

Isidore of Seville, St., 134, 169 n., 351 n., 353 n.
Italy 4, 6 n., 7, 10, 133, 168, 171-2, 183, 194, 340, 364, 385, 386
Ixion, 116-7; Pl. XXI
Ixtepec, 267, 276
Ixtiapok, 279 n.

Jacomet, Daniel, XXI
Jakobson, Roman, XIX, 94, 172, 188 n., 231 o., 349, 388
James II, King, 22
James VI, King, 68
James, Edward, 133 n.
James, Richard, 34-5; Fig. 1
Janacek, Leos, 15
Japan, 6 n., 125, 265, 330-1
Jarecki, Casimir, 178 n.
Jennings, Jesse D., 328 n.
Jeremiah, 348
Jespersen, Kai, 384
Jessen, Carl, 198
Jesup North Pacific expedition, 138 n., 194
Jesus Christ, 16-17, 242, 243, 244, 245, 291, 297, 310, 311, 319, 322, 352
Jews, the, 135, 138, 202, 345, 347, 366
Jobson, Rev. O. D., 383
Jochelson, Waldemar, 138, 140-1, 191, 194, 210, 211 n., 318
Jocotan, 78, 104, 371
John, King, 69-70
Johnson, Jean Bassett, 237, 238 n., 248-9, 257
Johnson, Mr. (of Wetherby), 102 n.
Jonghe, Ed. de, 227
Jordanis 107 n.
Jos, 332
Joseph, St., 314
Josif Volokolamskij Monastery, 188
Juchitan, 267
Junius, Hadrianus, 89 n., 132 n.
Junker, Heinrich F. J., 121 n.
Junquera, Manuel Lorente, 386
Jupiter, 317
Jura mountains, 401-3
Justinian, 158
Juvenal, 119

Kakchiquels, the, 279; Annals of the, 281, 282-3
Kalidasa, 121
Kamchadals, 191
Kamchatka, 139, 190, 194, 195, 241
Kaminaljuyú, 284, 328; Fig. 19
Kampala, 333, 383
Karlsruhe, 96 n.
Karpovich, Mrs. Michael, 383
Kashmir, 120, 121, 316
Katori, 330
Kawabata, Toyohiho, 331 n.
Kayaloff, Elisabeth, 384
Kazenchak, Nicholas, 384
Keats, John, 29, 302

Kelleher, Mr. & Mrs. Hugh, 386
Kelly, John W., 142
Kers, John, 69
Khazar Empire, 42
Khlebnikov, Viktor Vladimirovich, 13
Kidder, Alfred V., 284 n., 328
Kiev, 43
Kingsley, Charles, 196
Kingston (on Thames), 348
Kingston, Neville, 65 n.
Kipling, Rudyard, 94
Kloeke, G. G., 93 n., 383
Knuttel J. A. N., 89 n.
Korea, 203, 330
Korjaks, the, 139, 140-1, 190-1, 194, 195-6, 210, 214 n., 318
Korsakov, General, 193
Korzhenevskij, N. L., 121 n.
Kott, Jan, 15 n.
Kraemer, Erich von, 161 n.
Krebel, Rudolph, 193
Krieger, Louis C. C., 241 n.
Krupskaja, Nadezhda, 13
Kubor Mountains, 215
Kuskokwim, 141, 142
Kutriguri, the, 42
Kwangsi, 125
Kyoto, 330

Labourd, 10, 136
Lacaud, Louise, 238
La Farge, Oliver, 267 n.
Lafon, Rene, XIX, 149, 388
Laguna, 267
Lajpop, Aparecio, 279 n.
Lajpop, Santiago, 279 n.
Lamb, Patrick, 22
Landes, the, 151, 370
Lao-Tse, 320
Lapps, the, 196, 344
Lascoff, Frederick D., 384
Lausanne, 382
Lawrence, D. H., 349-50
Leber C., 85 n.
Lecluse, Charles de, *see* Clusius, Carolus
Leeuwarden, 383
Legorreta, Agustin, 387
Lehovich, Evgenia, 388
Leiden, 200, 240, 383
Leipzig, 78 n., 193
Lena, River, 191
Lenin, 13
Leonard, Carmen Cook de, 304-5, 306
Leonard, Donald, 306
Leonardo da Vinci, 357
Leont'ev, Konstantin, 346 n.
Leuba, F., 398 n., 400-3

Lewis, Wilmarth, 347
Liddell & Scott's Greek lexicon, 135
Lincolnshire, 128 n.
Linder, David, 237
Lindisfarne, 164
Linnaeus, Carolus, 201, 212, 213, 344, 357, 364-7, 369, 371
Linne, S., 238 n.
Lippi, Lorenzo, 178-9, 385
Lisbon, 384
Lithuanians, the, 4, 45, 135, 336
Littre, Maximilian, 120, 127
Livonians, the, 45
Locusta, XIX, 57-63
Loire, 80, 87, 211
Loki, 202
Lombardy, 128
London, 90, 382-3, 386; British Museum, 117, 386; Pl. XXI; Gentleman's Magazine, 241; Illustrated London News, 87 n.; Medical & Physical Journal, 240; National Gallery, 355 n., 360; Pl. LXXIV; Science Museum, South Kensington, 386; The Times, 33, 650, 76, 103, 164; Times Literary Supplement, 209; University, 331; Wallace Collection, Pl. XXV
Lot, Ferdinand, 107 o.
Lotz, John, 384
Louis XVI, King, 39 n.
Lourdin, Maurice, 102
Low Countries, 130-2, 134
Lubeck, 345
Luciano, Felipe, 268-9
Luciano, Gennaro, 386
Lucilius, 58-9
Luganda, 333
Lugt, Frits, 360 n.
Lundbergh, Holger, 194
Luzon, 124
Lyall, Robert, 36
Lyons, 21, 208, 341, 352

Mackintosh, H. S., 209
Madagascar, 126, 330-1
Madrid, 8, 221, 343 n.; Prado Museum, 87, 354-5, 361, 386; Pl. XIII, XV-XVII, XXXVI, LXI, LXII
Magdalena Loxicha, 308 n.
Maglemose, 116
Magnus, Olaus, 90; Fig. 4, 5
Maimonides, 153 n.
Mainz, 170, 351
Maiuri, Amedeo, 386
Majakovskij, Vladimir, 349
Majolier, Mrs. Michael, 386
Majorca, 361
Majorenhof, 3
Malencon, M. G., 342
Malkiel, Yakov, 169 n., 384
Malvesin-Fabre, Georges, 384
Mandach, H. de, 385
Manuel, Don Juan, 104
Maori, the, 24, 125-6, 330
Marbán, Esteban, 219

Mardersteig, Hans, 275, 383
Maria Theresa, Empress, 53
Marks, A. F., 28 n.
Marques, Luiz, 384
Marquina, Ignacio, 387
Marseilles, 151
Marsh, Gordon H., 384
Martinet, Andre, 76, 388
Martinez, Julia, 246
Martinez Cid, Herlinda, 246, 247, 250, 251, 253, 255, 264
Martinez de la Cruz, 232 n.
Martorell, Felix, 384
Mary II, Queen, 22
Mary, Virgin, 311, 314, 354
Mason, J. Alden, 286 n.
Masujima, Katashi, 125
Mata Hari, 55
Match, 121
Matias, Aristeo, 295, 308-16, 321, 329; Pl. LI; Fig. 22
Matias, Serafin, 309, 310, 312
Matlatzinca, 220, 230, 307
Mattioli, Pietro Andrea, 352; Fig. 26
Matto Grosso, 167
Maublanc, A., 382
Maya, 266, 273, 275, 277-8, 280-1, 284, 286, 322, 328, 329
Mayno, Juan Bautista, 354-5, 386; Pl. LXI, LXII
Mazahua, 220-1, 307
Mazatecs, the, 242-5, 246-51, 264, 266, 268-9, 283, 284-304, 305, 308, 310-2, 314, 315, 324, 329
Mazatlan de los Mijes, 248, 264-5, 267-73, 284 n.
McCurrach, David, 386
Mclntosh, John, 387
Megenberg, Konrad von, 198-9, 200, 212, 371, 385
Meillet, A., 109 n., 136
Mej, Lev Alexandrovich, 12
Melanesians, the, 215
Melun, 102
Menage, Gilles, 127
Mendoza, Jose Miguel, 124
Meng, Chili, 387
Merigny, 87 n.
Mesrnin, Marie, 102, 103
Mesquida, Antonio, 361
Messalina, 56, 62
Metzler, Rev. Paul F., 383
Mexico, 101, 131-2, 216-74, 276, 278 n., 283, 284, 286, 287-319, 322-9
Mexico City, 220, 222, 230, 231 n., 233, 245, 262, 267, 287, 305, 306, 307, 387; Banco Nacional de Mexico, 267, 276, 387; General Motors Acceptance Corporation, 387; Museo Nacional, 220, 229, 233 n.
Meyer-Lübke, W., 162 n.
Meyrink, Gustav, 52
Michoacan, 230
Mickiewicz, Adam, 15
Mictlantecuhtli, 234 n., 235, 283
Migne, J. P., 134 n., 353 n.
Mignon, Abraham, 359, 360 o.
Mije country (Mijeria), 229, 238 n., 265, 266, 267-9, 271, 284-6, 299, 305, 308, 311, 315, 329
Milan, 128, 132; Banca Commerciale Italiana, 387

Miller, Walter S., 229, 266, 267, 268, 269, 272, 273
Milne, A. A., 203
Milton, John, 26
Mingende, 216
Mingrelians, the, 137
Mistral, Frederic, 372
Mithridates Eupator, 352
Mithridates the Great, 366
Mitla, 282 n.
Mixco, Fig. 18
Mixtec country, 166 n., 219, 228
Moliere, 178-9, 181, 183, 184
Molina, Alonso de, 228, 232, 235
Momostenango, 279 n., 280
Monachino, Joseph, 312
Mongolia, 334
Montaigne, Michel de, 342
Montbeliard, 371
Montesquieu-Avantes, 176; Fig. 11
Montezuma, King, 217-8, 236
Moravia, 177
Mordvines, the, 138, 139
Moreno, Wigberto Jimenez, 220, 231 n., 235, 387
Morgenstierne, Georg, 120, 121, 192 n., 383
Morley, Sylvanus Griswold, 281
Morner, Carl Th., 193
Moscow, 4, 41, 138, 172, 349; Imperial Society, 394
Motolinia (Toribio de Benavente), 218-9, 225-6, 228, 230, 257, 404
Moussy, Marcel, 342
Moynier, MM., 183-4
Müller, Gerhard Friedrich, 53
Müller, Hans, 385
Mundo, Pedro (Pe:t Mu:nt), 273
Munich, Bavarian State Gallery, 386; Pl. XII, LXX
Münz, Ludwig, 386
Muralt, Leonhard von, 385
Murison, David, 386
Murray, Margaret Alice, 68 n., 70, 82, 83, 90, 385
Muschampe, 14
Mycena, 154

Nagera Yanguas, Diego de, 220
Nahua, the, 219, 220, 223-6, 228-35, 319
Namuth, Hans, 277; Pl. XLIV
Napier, Barbara, 66
Naples, 149; Banco di Napoli, 358, 386; Pl. LXVIII; Museo Nazionale, 354, 361, 386; Pl. LIX, LX, LXXVI
Napoleon, 81, 102, 339; Pl. XX
Naryshkina, Natalija, 53
Natirbov, Fat'nia Hanoum, 384
Navarre, 10, 145, 149
Nebaj, 279
Negrete, Ladislao Lopez, 387
Negritos, the, 215
Nelson Island, 141
Nemcova, Mrs. Bozena, 16
Nero, Emperor, 50, 56, 59, 60, 62, 338

Neuchatel, 193, 400
Newark-on-Trent, 70
Newcastle, Duke of, 347-8
New Guinea, 215-6, 241, 276, 320
New York, 10, 11, 83, 261, 264-6, 274, 292, 303-4, 383-4, 387; American Geographical Society, 387; American Museum of Natural History, 275, 385, 387; Botanical Garden, 216, 312, 385; Columbia University, 383-5; Frick Library, 385; Metropolitan Museum, Pl. LXV; National Container Corporation, 387; New York Times, 239 n.; Pierpont Morgan Library, The, 118, 166, 351-2, 385; Pl. XXII, XXXII, LVI, LVIII; Public Library, XIX, 385, 404 n.; Reliable Mushroom Company, 10.
New Zealand, 24, 125-6, 316
Nice, 145
Nicholas II, Tsar, 349
Nicholas, Thomas, 168
Nigeria, 332, 383
Nikander of Colophon, 73 n., 151, 337, 351 n.
Nilles, Father John, 216
Nixon, Vice President, 203
Noguera, Eduardo, 324; Fig. 23
Nordhagen, Rolf, 192 n., 193, 213, 384
Normandy, 66, 89
North Berwick, 68
Northcote, William, 71-2
North Sea XVII, 22, 66, 77, 78, 95, 142, 331, 333, 337, 347, 374
Norwegians, the, 7, 66, 67, 191, 208, 335, 339, 384
Nsimbi, M. B., 333, 383
Nunivak, 142
Nuttall, Zelia, 233 n.

Oaxaca, 217, 219, 228, 233 n., 237, 238 n., 248, 266, 267, 276, 285, 287, 307, 308, 314, 322; Fig. 16
Ob, River, 138, 191
Oberon, 84, 148
Occa, the, 45
Ocosingo, 275; Fig. 19
Ocrisia, 122
O'Dea, W. T., 386
Odell, W. S., 52
Odman, Samuel, 192, 193, 196
O'Donnell, John, 208
Ohio State Penitentiary, 73 n.
Okinawa, 314
Olmos, Andres de, 227
Olsen, Magnus, 192
Omachi, Mrs. Chiyo, 331 n.
Onoguri, the, 42
Orinoco, 323 n.
Ortega, Francisco (Chico), 266, 267, 307-8, 310, 313
Oslo, 120, 213, 383, 384
Ossetians, the, 108, 137
Ostjaks, the, 138, 140
Ostrogoths, the, 41
Otomi, the, 220, 224, 228, 322
Otrebski, Jan, now. Ovid, 122, 154
Oxford, 88, 194, 384; Ashmolean Museum, Pl. LXXI; Bodleian Library, 35; Fig. 1; Oxford Dictionary, 21 n., 65, 68, 76, 81, 97, 100, 106, 113, 182, 183, 203, 205-6, 208

Paccius Antiochus, 62

Palay, Simin, 86
Paleo-Siberian tribes, 138, 191, 318, 319
Pamir Mountains, 121, 316
Panjojehan, Diego, 279 n.
Panofsky, Erwin, 385
Papua, Gulf of, 215
Papuans, the, 215
Paris, XX, 6, 139, 151, 172, 183, 208, 216, 343, 365, 385-6; Bibliotheque Nationale, 227, 251, 351; Pl. LVII; College de France, 384; Institut de France, Academie des Sciences, 254; Louvre, 130; Museum National d'Histoire Naturelle, XX, XXI, 213, 381; Societe Mycologique de France, 87 n.
Parker, J. H., 88
Parkes, William, 32
Parkinson, John, 6, 156, 177, 178, 239, 347
Parmentier, Antoine-Augustin, 173
Parrish, Anne, 51
Partridge, Eric, 80
Pascal, Carlo, 386
Paso y Troncoso, 233 n., 282 n.
'Pasquin, Anthony', *see* Williams, John
Pastor, Ludwig, 53 n.
Patricius, Petrus, 60, 338
Paul, St., 263, 297
Paulet, Jean-Jacques, 53, 150 n., 365
Pausanias, 154, 160
Pavlov reflex, 209, 347
Pavoluccio Napolitano, *see* Porpora, Paolo
Paz, Antonio Ramirez, 279 n.
Pease, Arthur Stanley, 122, 123
Pechenegs, the, 41
Pedersen, Holger, 105, 109-11
Pedro Chapa, San, 315
Pelion, Mount, 116
Penafiel, Antonio, 323; Pl. LIII
Pennsylvania Dutch, 66, 101
Perigord, 172, 183, 342
Perm, William, 26, 180
Perniconi, Vincenzo, 385
Perrault, Charles, 82
Perseus, 154
Persia, 121, 316
Peru, 168
Peten, 278, 279, 284
Peter, St., 16-17, 263, 297
Peter the Great, Tsar, 53
Petersen, John, 143
Peterson, Roger Tory, 382, 386
Petrarch, 41
Petronius Arbiter, 129 o.
Philippines, the, 124
Picard, Charles, 386
Picardy, 132
Piedmont, 128
Pike, Eunice Victoria, 242-5, 246, 250, 251, 308, 309
Pinney, Alexander, 384
Plaincourault, Chateau de, 87 n.
Platanillo, 267, 271

Platina, *see* Sacchi, Bartolomeo de'Plato, 294
Plautus, 179-80
Pliny (the Elder), 106, 118, 119, 134-5, 155-6, 158, 160, 171, 338, 340, 351 n., 353, 361
Plot, Robert, 120 n.
Plutarch, 118, 120-2, 316, 317
Pochutla, 238 o.
Podensac, 370
Poe, Edgar Allan, 299
Point Agarum, 366
Poitou, 341
Pokorny, Julius, 92, 93
Poles, the, 10, 15, 138, 212, 336, 345
Policarpo, Francisco, 268
Polotsk, 366
Polovtsi, the, 41
Pomerania, 44
Pommersfelden, Schloss, 130
Ponce de Leon, Pedro, 166, 183, 227
Popocatepetl, 305
Popol Vuh, 281, 283
Porpora, Paolo (Pavoluccio Napolitano), 358, 361; Pl. LXVIII
Porta, Giambattista della, 179
Portuguese, the, 335, 340
Pothey, Alexander, 159, 160
Potocki, Waclaw, 15, 240
Powick (Worcs.), 241 o.
Prague, 38
Precop, 45
Prescott, William H., 236, 276
Pretot, Suzanne, 385
Princeton University, Art Museum, 356 n.; Institute for Advanced Study, 385
Prior, Richard C. A., 94 n., 101
Promathion, 122
Provence, XIX, XX, 55, 183, 241, 337, 338-9, 348, 365, 372
Providence, R. I., John Carter Brown Library, 230
Prynne, William, 70 n.
Pskov, 345
Puck, 94, 203
Puebla, 245, 250
Pugh, Nansi, 384
Pulaski, Irene, 384
Pushkino, 349
Pyrenees, 38 n., 42, 137

Qatar peninsula, 335
Quer, P. Font, 337
Quetzalcoatl, 281
Quetzaltenango, 279, 282 n.; Fig. 19
Quiche country, 161 n., 275, 279, 280
Quirino, Tinioteo, 268, 270-2

Rabelais, Francois, 157, 164-5, 208, 342
Ramain, Paul, 381-2
Rambouillet, 54
Ramirez, Salvador, 279 n.
Ramsbottom, John, 33, 52, 65 n., 87 n., 123, 124, 212, 382

Rautavaara, Toivo, 337 n.
Raverat, Mrs. Gwen, 25
Ravila, Paavo, 384
Raymond, Bugs, 204
Rebelhau, Alfred, 179
Rebikov, 15
Recinos, Adrian, 282
Redskins (of America), 24
Reims, 84, 85, 386; Pl. XIV
Reko, Bias Pablo, 237, 238 n., 241, 242, 243
Reko, Victor A., 237, 238 o.
Remi, St., 84, 85; Pl. XIV
Remus, 122
Rennes, 383
Reyes, Ismael Jimenez, 308-10, 312, 321
Rhazes, 21
Rhone valley, 151, 337
Riazan, 213
Richardson, Allan B., 266-8, 274, 287, 289, 290, 292, 293, 296, 299-301, 304; Pl. XLII, XLVI-L
Richardson, Mary, 292
Riga, 3
Ripley, George, 71; Fig. 2
Riviere, Dr. Dujarric de la, 47, 52
Robbins, Mr. & Mrs. Warren Delano, 386
Roberto, Don, *see* Weitlaner, Robert J.
Robin Goodfellow, 83, 84, 160, 176; Fig. 3
Robles, Vitaliano, collection, Fig. 19
Roch, M., 193
Rodocanachi, Emmanuel, 52
Rogers, Donald P., 385
Rojas, Agustin de, 343 n.
Rolfe, R. T. & F. W., 87 n., 382
Rolland, Eugene, 66 n., 86, 197, 211
Remains, Jules, 342
Rome, 22, 27, 41, 43, 59, 62, 76, 121-2, 123, 149, 154, 160, 169, 170, 179, 180, 316, 338, 340, 341, 356, 365; Galleria d'Arte Moderna, Pl. LXIX; University 385; Vatican, 232 n.
Romig, Rev. Edgar F., 383
Romulus, 122
Rosal, Don Francisco Martinez del, 279 n.
Rosas, Marina, 305, 306
Rossi, Enzo, 386
Rouen, 352
Rouille, K. F., 394
Roussillon, 337
Rumania, 212, 336, 384
Russians, the, XVII, 3-18, 26, 34, 35, 36, 37, 39, 43, 44, 45, 95, 103, 148, 153, 154, 193, 208-9, 231, 321, 336, 337, 345, 348, 366, 385
Ruysch, Rachel, 359, 362; Pl. LXXI

Sabina, María (the Señora), 288-304, 314, 319, 329; Pl. XLVI-XLVIII, L
Sabina, Polonia, 288-303; Pl. XLVI-XLVIII
Sacclii, Bartolomeo de' (Platina), 170, 341
Safford, W. E., 236-8, 276, 307, 323 n.
Sahagun, Bernardino de, 222-6, 228, 230, 232-5, 236-7, 238 n., 282, 283, 289, 404 n., 405-7; Fig. 14, 20
Sainte-Marthe, Scevole de, 85 n.
Salaman, Redcliffe N., 169 n.

Salcaja, 279; Fig. 19
Salino, Mr. & Mrs. Charles, 387
Salisbury, William, 240
Salmon, William, 118
Salvador, 275, 284
Samarkand, 120
Samoyeds, the, 191, 196
Samson, 207
San Agustin Loxicha, 308-12; Pl. LI; Fig. 22
San Andres, 249, 251, 255, 258 n.
San Andres Xecul, 279 n.
San Angel, 287, 304
San Antonio, 245
San Baltasar Loxicha, 308 n.
San Bartolo Loxicha, 238 o., 308 n.
San Bernardino, 246, 264
Sanchez, Severiano, 272, 273
Sanchez Canton, F. J., 354, 386
Sandison, R. A., 241 n.
Sandoval, Lisandro, 371 n.
San Francisco Loxicha, 308 n.
San Juan Ixcoy, 279
San Juan Mazatlan, *see* Mazatlan de los Mijes
San Juan Sacatepequez, 279 n., 281
San Lucas, 253
San Lucas Camotlan, 229, 268, 273-4
San Martin Jilotepeque, 279 n., 281
San Miguel Acatan, 279 n.
San Pablo Mitla, 315
San Pedro Jocopilas, 279 n., 280
San Pedro Nexapa, 305
San Pedro Tlanixco, 306-7
Santa Catarina Loxicha, 308 n.
Santa Fe (New Mexico), 222, 231 n.
Santa Margarita Huitepec, 273, 274
Santa Maria de Ixcatlan, 248
Santa Maria Nativitas Coatlan, 272-4
Santa Marta Loxicha, 308 n.
Santiago de Atitlan, 279 n.
Santiago, Ebrigida, 310
Santiago Yaveo, 238 o.
Santo Domingo Petapa, 267
Saone, Haute, 87, 211
Sapper, Carl, 275-278
Sarasota (Florida), Ringling Museum, 133 n.
Sarauw, G. F. L., 116 n.
Sarmatians, the, 42
Saville, Marshall H., 238 n.
Saxo Grammaticus, 343, 344, 384
Sayers, Dorothy L., 49
Scandinavians, the, 42
Schapiro, Meyer, 186-7, 385
Schiaffini, Alfredo, 385
Schiermonnikoog, 95
Schlittler, J., 346, 385
Scholfield, A. F., 337

Schonack, William, 62 n.
Schooneveld, Elizabeth van, 345
Schrieck, Otto Marseus van, 211-2, 356-60, 361; Pl. XXXVII, LXV-LXVII
Schübeler, Fredrik Christian, 192, 193
Schultes, Richard Evans, 237, 238 n., 241, 242
Schulthess, Felix, 385
Schweinfurth, Georg, 331-2
Scotland, 68-9, 128 n., 359 o.
Scott, Charles P. G., 82 n.
Scott, R. T. M., 51
Scott, Sir Michael, 19-20
Scribonius Largus, 62
Scythians, the, 42
Sebillot, Paul, 68 n.
Sefton, Earl of, 39 n.
Seguy, Jean, 151 n., 161
Selborne, 22
Seler, Eduard, 323 n., 324, 326-9; Fig. 25
Seneca, 56, 58, 59, 61-3
Serbia, 103
Sérignan, XIX-XXI, 55, 339, 384
Serna, Jacinto de la, 226-7, 232, 235, 252, 257, 306, 315, 407
Servius Tullius, 122
Shakespere, William, 26, 67, 91, 94, 129 n., 148, 159, 162, 168, 169, 180, 181, 187, 203, 207, 343 n.
Shakhmatov, A. A., 231 o.
Sharon, Herman, 385
Shawe, Dr., 348
Shelley, Percy Bysshe, 30
Sherriff, R. C., 50, 51
Shook, Edwin M., 284 n., 328 n.
Siberia, 138, 139, 140, 143, 171, 191, 215, 319, 320, 330
Siegel, Bugsy, 204
Sierra Mazateca, 288
Silanus, Marcus Junius, 57, 62
Simpson, C. G., 384
Sind, the, 173
Singer, Rolf, 11 n.
Sisay, Juan, 279 n.
Skendi, Stavro, 383
Slavs, the, XVII, 4, 5, 11, 23, 39, 41, 43, 44, 78, 135, 187, 231, 336, 344, 347, 394
Slovaks, the, 78-9, 336, 384
Smith, Alexander H., 19 n.
Smith, Logan Pearsall, 162
Smith, W. F., 164-5
Smolandia (Sweden), 201, 212
Smollett, Tobias, 27, 208
Snyders, Frans, 130, 131
Solola, 279 n.
Soochow, 125
Souckova, Milada, 384
Soule, the, 149
Sousa, 330
Spaniards, the, 8, 78, 104 n., 151, 156, 167-71, 172, 173, 183, 185, 216-7, 220, 231, 290, 335, 339, 340
Spencer, A. M., 242 n.
Spenser, Edmund, 29, 30, 67
Sprengel, Kurt, 369

St. Albans, 69, 70
St. Andre de Cubzac, 370
St. Andrews (Fife), 386
St. Louis, Missouri Botamical Garden, 131, 385
St. Petersburg, 4, 14, 193
Stalingrad, 42
Stamford (Conn.), Pl. XX
Stanley, Mr., 348
Starck, Taylor, 383
Starkie, Walter, 137
Steele, A. B., 98 n.
Stephen, King, 40
Steppes, the, 41, 42, 43
Sterbeeck, Franciscus van, 100 n., 131-2, 150 n., 171, 341-2; Pl. XXVII
Sterne, Laurence, 27, 28, 163, 181
Stettin, 44
Stevens, Neil E., 38 n.
Stockholm, 190
Strahlenberg, Philip Johan von 139, 190-4, 196
Strasbourg, 163
Strohschneider, H., 101 n.
Stuttgart, 237, 238 n.
Sudan, 139, 159, 331
Suetonius, 56, 57, 59-61, 338
Suida, William E., 387
Summer Institute of Linguistics, the, 266, 387
Sung mountains, 334
Surselva, 98, 101, 346
Sussex, 91
Svanetians, the, 137
Swedes, the, 7, 45, 137, 192-4, 201, 337, 339, 343-4, 346, 367
Swineshead (monastery), 70, 71
Switzerland, German, 346, 373; French, 346
Syrenius, 200 n.

Tabasco, 278
Tabor (Bohemia), 177
Tacitus, 43, 47, 56-60
Tadzhiks, the, 121, 318
Taino Indians, 167, 168
Talleyrand, 81; Pl. XX
Tamm, Franz Werner, 359, 362; Pl. LXXII
Tanala, 126, 330
Tanaquil, 122
T'ao Ku, 320
Tarascans, the, 229-30, 322
Tarquin the Elder, King, 122
Tarragona, 384
Tartars, the, 40, 41, 45
Tartuffe, 178, 181, 183-4, 354, 384-45
Tatiana (Romanov), 349
Tatra, 78
Taylor, Jeremy, 21, 22, 353
Teale, Edwin Way, 388
Tehuacan, 245
Tehuantepec, Isthmus of, 219, 228, 238 o., 266, 276

Temazcaltepec, 220
Tenango del Valle, 226, 306
Tennyson, Alfred, 29
Teocalcingo, 238 n.
Teochichimecas, 224, 225
Teopancalco (Teopancaxco), 323-5, 327-9; Pl. LII; Fig. 23
Teotihuacán III period, 323-4, 328-9; Pl. LIII
Teotitlan de Camino, 245, 246
Tepantitla, 324, 326-9; Pl. LIV, LV; Fig. 24
Terschelling, 95
Texas, 236
Tezcatlipoca, 234 n.
Tezcoco, 227
Tezozomoc, Fernando de Alvarado, 218, 404
Thacker, Thomas W., 384
Thalbitzer, William, 143
Theo, le pere, 54
Theophrastus, 119-20, 337, 351 n.
Thevet, Andre, 227-8, 407
Thibert, Arthur, 142
Thicknesse, Ralph, 118
Thompson, J. Eric, 238 n.
Thompson, R. Lowe, 176
Thoreau, Henry David, 25, 26, 361
Thorndike, Lynn, 386
Tibetans, the, 125
Tierra del Fuego, 24
Tisserant, Father, 383
Tizoc, 238 n.
Tlacoatzintepec, 233 o.
Tlaloc, 324, 326-8; Fig. 25
Tlalocan, 326, 328
Tlaltelulco, Colegio de la Santa Cruz, 232
Tlascalan, 218, 236
Tohil, 281
Tokyo, 330
Tolbiac, 84, 85; Pl. XIV
Toledo, 304
Toller, T. Northcote, 75 n.
Tolstoy, Alexandra, 383
Tolstoy, Alexej Konstantinovich, 28
Tolstoy, Leo, 12, 391-3
Toluca, Valley of, 306, 307
Tompson, Agnis, 69
Trafalgar, 39
Trembecki, Stanislaw, 15
Tremblay, John P., 387
Trinidad, Jose, 274
Tucker, Archie N., 331-2, 383
Turks, the, 41, 42
Tuxtla Gutiérrez, 279; Fig. 19
Tylor, Edward B., 114

Ude, Louis Eustache, 38-9
Uganda, 333, 383
Ugri, the, 41, 42

Ukrainians, the, 78, 336
Úlehlová-Tilschová, Mrs. M., 38 n., 177, 178
Uhlenbeck, C. C., 143
Upsala, 192, 201
Ural Mountains, 138
Utah, University of, 222, 231 n.
Utiguri, the, 42
Utrecht, Adriaen van, 130, 131, Pl. XXVI

Val d'Ajol (Vosges), 197
Valentinov, N., 130
Vasiliev, Alexander A., 384
Vasmer, Max, 188 n.
Vegetius, 107, 369
Velazquez, Mateo, 279 n.
Venice, 128, 187; Pl XXXIII
Vera Cruz, 217, 248, 266, 314
Vereja, 172
Verona, 275, 365, 383
Vienna, 239; Akademie der Bildenden Künste, 355, 356 n., 386; Pl. LXIII, LXIV
Vienne, 21, 343
Viscaya, 340
Visigoths, the, 41
Vistula, River, 43
Vivian, Nicolas, 179
Voguls, the, 138, 140
Volga, 41, 42, 138
Voltaire, 54
Vosges, 197

Wahgi River, 215, 216
Wakefield, 384
Walde (dictionary), no Walden, 25, 26
Wales, University College of, 384
Walpole, Horace, 347-8
Wartburg, Walther von, 73 n., 152 n.
Washington (D. C.), Botanical Society, 236; Freer Gallery 351
Wasson, Masha, 245, 261, 266, 280, 287, 303
Wasson, Peter, 255, 259-62, 264-5, 296-7, 310, 314
Waterloo, 39
Watteau, Antoine, XVIII
Weber, Marilyn, Pl. LIV, LV
Weekley, Ernest, 203
Weinreich, Uriel, 366
Weintraub, Wiktor, 383-4
Weitlaner, Robert J. (Don Roberto), 220 n., 233, 237, 238 n., 245, 249, 250, 255, 257, 258, 261, 262, 264-8, 286, 287, 292, 306-8, 312-4, 316
Weitlaner-Johnson, Irmgard, 237, 249, 265, 268, 322
Wells, H. G., 50, 51
Wells, R., 142
Welsh, the, 66, 74, 146, 153
Wends, the, 44
Weng, Mr. & Mrs. Wango, 125, 387; Pl. LII
Weringh, J. J. van, 383
Whaitiri, 125
Whatmough, Joshua, 145 n., 383

White, Gilbert, 22, 102 n.
White, William, 204 n.
Whitelaw, J. D. O., 241 n.
Whittle, Eric, 33, 384
Widdowes, Daniel, 106; Fig. 6
Wiegersma, M., 383
Wilde, Percival, 52
William III, King, 22
Williams, John ('Anthony Pasquin'), 28
Williams, S. Wells, 320
Williams, Tennessee, 203-4
Williams, T. H. Parry, 384
Willich, A. F. M., 348
Wilson, John Dover, 68 n.
Wimbledon Common, 38
Wimer, Rev. T. B., 383
Winning, Hasso von, 323 n.
Wolff, Kurt, 388
Wolff, Max J., 179
Woodforde, Parson James, 22
Woodhouse, James, 32
Wordsworth, William, 26
Workman, Charles ('the Bug'), 204
Wright, Joseph, 180, 207
Wright, Richardson, 26 n.
Wright, Thomas, 160; Fig. 9
Wright, William, 69
Wu, K. C., 334

Xenophon (Greek physician in Rome), 60-3
Xocotitlan, 220

Yanagita, Kunio, 331 n.
Yanguas, Diego de Nagera, 220
Yanhuitlan, 219, 220
Yell Meng-te, 320-1
Yenisei Ostjaks, the, 138, 140, 191
Yenisei Valley, 138, 191
Yucatan, 278, 279, 284
Yukaghirs, the, 138, 191

Zacatepec, 274
Zapotecs, the, 219, 228, 229, 238 n., 266, 295, 308-17, 329
Zarafshan, 121
Zarate, Agustin de, 168
Zempoaltepetl, 266
Zoque country, 266, 286
Zurbaran, School of, 361; Pl. LXXV
Zurich, 13, 193, 346, 385; Credit Suisse, 385; Rietberg Museum, 275, 277, 328, 385; Pl. XLIII; Union Bank of Switzerland, 385; University, 385

List of OCR errors

Most of errors that has been spoted.

Errors corrected in vol I:
I5th - 15th
i6th - 16th
i8th - 18th
zyth - 17th
iyth - 17th
I7th - 17th
pictures he on the shelf - pictures lie on the shelf
Hsichki - lisichki
ryzliiki - ryzhiki
her hi wooded country - her in wooded country
Pul'kheria Ivanovna - Pulcheria Ivanovna
hfib krdlovsky - hřib královský
Bozena Nemcova - Božena Němcová
Ndrodni bdchorky a povesti, Prague, 1880, vol. n, pp. 302-4. - *Národní báchorky a pověsti*, Praga, 1880, vol. II, pp. 302-4.
I thought it was food, but lo! - I thought it was food, but no!
The Castd of Helth - The Castel of Helth
Crete Herball - Grete Herball
Herball or General! Historie of Plantes - Herball or Generall Historie of Plantes
does there survive a single truffle-hunter e - does there survive a single truffle-hunter?
for June i, 1834 - for June 1, 1834,
gathering a 1'anglaise can - gathering a l'anglaise can
with ah[1] his sensibility to nature - with all his sensibility to nature,
Ihe herbals of old served as botany books - The herbals of old served as botany books
term of abuse in the lyth century - term of abuse in the 17th century
French call 1'odeur du terreau - French call l'odeur du terreau
to Paris - from Paris to Rome - and so on-but ---- to Paris, from Paris to Rome, and so on. But
years later, in the lySo's, - years later, in the 1760's,
Tennyson in Gareth andLynette - Tennyson in Gareth and Lynette
'agaric' meaning a gilled mushroom - 'Agaric' meaning a gilled mushroom
1 he mere thought of fungi - The mere thought of fungi
subject,! shall quote the passage - subject, I shall quote the passage
thek variety was no less remarkable than their number - they variety was no less remarkable than the number
in tbe neighborhood - in the neighborhood
tbe enormous - the enormous
Mesrumes louingly - Mesrumes lovingly
RICHARDS EDEN in J555 - RICHARDS EDEN in 1555
Hakluyt Society, ist Series - Hakluyt Society, 1st Series
M. Ulehlova-Tilschova's Ceskd strava lidovd - Marie Úlehlová-Tilschová, *Česká strava lidová*
vieljamma - viel Jamma
inHandworterbuch des - in Handwörterbuch des
jiupov - αλείφω
somewhere off Flores in the A9ores - somewhere off Flores in the Azores
wars also, back in the lyth century - wars also, back in the 17th century
Danubian plain in the pth century - Danubian plain in the 9th century
In the middle of the idth century a famous - In the middle of the 16th century a famous
and by the pth century the Russians - and by the 9th century the Russians
in every dkection - in every direction
op. tit., vol. n, p. 438; also, Notes upon Russia - op. cit., vol. II, p. 438; also, Notes upon Russia
Principal Navigations, vol. n, - Principal Navigations, vol. II,
diarrhoea fcetida - Diarrhoea foetida

the other writers about whom - Unlike all the other writers about whom
Ellery Queen s Mystery Magazine - Ellery Queen's Mystery Magazine
L'accident arrive a la veuve du czar Alexis (...) - L'accident arrivé à la veuve du czar Alexis, qui s'empoisonne avec des champignons qu'on avoit gardés pour le carême, et rapporté par Müller, est de notre siècle.
The Miiller to whom reference is made can only be Gerhard Friedrich Miiller - The Müller to whom reference is made can only be Gerhard Friedrich Müller
run down. "On the loth - run down. "On the 10th
and the niushroomic murders - and the mushroomic murders
The Women of the Ccesars - The Women of the Caesars
XII, Chap. Ixvii of the - XII, Chap. LXVII of the
Arnanita csesarea - Amanita caesarea
Book V, Chap, xliv - Book V, Chap. XLIV
Ironian - Iranian
grottestuhl andgrottefuss - *grottestuhl* and *grottefuss*
1'affaire Girard - l'affaire Girard
IndogermanischesEtymologischesWorterbuch - Indogermanisches Etymologisches Worterbuch
cpuaaXoc - βάτραχος
cpuaaXog - βάτραχος
hie et ubique - hic et ubique

Et veneno quidem occisum convenit; (AND THE REST) - Et veneno quidem occisum convenit; ubi autem et per quem dato, discrepat. Quidam tradunt epulanti in arce cum sacerdotibus per Halotum spadonem praegustatorem; alii domestico convivio per ipsam Agrippinam, quae boletum medicatum auidissimo ciborum talium optulerat.

Turn Agrippina sceleris olim certa et oblatas occasionis (AND THE REST) - Tum Agrippina, sceleris olim certa et oblatae occasionis propera nec ministrorum egens, de genere veneni consultavit, ne repentino et praecipiti facinus proderetur; si lentum et tabidum delegisset, ne admotus supremis Claudius et dolo intellecto ad amorem filii rediret. exquisitum aliquid placebat, quod turbaret mentem et mortem differret.

Annals, Book xn, Chap. 66 - Annals, Book XII, Chap. 66
the poison of the deadly anianita - the poison of the deadly amanita
embarked on a reading of ah1 - embarked on a reading of all
Quid 2 Tu illos - Quid? Tu illos
praesentanei non fuerunt. - praesentanei non fuerunt?
Amanita cassarea - Amanita caesarea
the middle 40'$ of tha - the middle 40's of tha
Polish bedla - Polish bed&lstrok;a
bhtza - blitza
kuldhi zamin - kulahi zamin
survived iii use - survived in use
and another *wayis pucan* - another way is *pucan*
for 'general issue" purgative - for "general issue" purgative
In the middle 40'$ of that century - In the middle 40's of that century
Vce me! puto, concacavi me - Vae me! puto, concacavi me
I93o's. The Times kindly - 1930's. The Times kindly
the i8t - 18th century
Shakespere - Shakespeare
Plate xm - Plate XIII
Veterinaer- og Landbohoejskole - Veterinær- og Landbohøjskole
Nr. n, Copenhagen - Nr. II, Copenhagen
glandiferas - glandiferae
membranse - membranae
Korzhencvskij - Korzhenovskij
Tome xn - Tome XII

we *fmdpofist* - we find *pofist*
Paul Sebillot, vol. in - Paul Sebillot, vol. III
three dales - three daies
In verse n the - In verse 11 the
Damnable Lif and death - Damnable Life and death
a ha'penny would - a hapenny would
le Dliable boiteux - *le Diable boiteux*
own survival > And why should the - own survival? And why should the
And [=if] I may - And if I may
The[n] yede [went] the Monke - Tho yede the Monke into
to farmerye [infirmary] and - to farmerye infirmary and
PLATE xn - PLATE XII
1 here exists an additional body of - There exists an additional body of
crapaud and hot; - crapaud and bot;
Franzosisches Etymologisches Worterbuch - Französisches Etymologisches Wörterbuch
and capello] means - and capello) means
Lexique Etymologique du Breton Modcrne - Lexique Étymologique du Breton Moderne
Bufo calamita - *Bufo calamita*
bufo calami ta - *Bufo calamita*
shuttling V being - shuttling N being
characters surfers - characters suffers
TO^OV - τόξο
eppOvo? - φρύνος
cppuvoc - φρύνος
cpptivoc; - φρύνος
Of their two words - . Of their two words
He the settlements of the - lie the settlements of the
The use oftoxicum - The use of *toxicum*
village ofJocotan - village of Jocotan
zabaci huby - *žabací huby*
had'ad huby - *hadácí huby*
had'unke huby - *hadúnke huby*
salene huby - *šialene huby*
word, le lot, which - word, *le bot*, which
then, le hot meant - then, *le bot* meant
lots volants - bots volants
le (liable boiteux - le Diable boiteux
etymologically to le hot - etymologically to *le bot*
stage, le lot underwent - stage, *le bot* underwent
fungum est qui illi crederem - fungum ut qui illi crederem
times as le hot volant - times as *le bot volant*
widespread use of le hot volant - widespread use of *le bot volant* for
In ear her times - In earlier times
for hot is to be - for *bot* is to be
etymon of hot - etymon of *bot*
stem back to le bat, the - stem back to *le bot*, the
Robin Goodfelloiv - Robin Goodfellow
sorrier - sorcier
the iSth century - the 15th century
originall and beginning - original and beginning
slinlie mud - slimie mud
Physiologic du Gout - Physiologie du Goût
until about A.D. noo, and - until about A.D. 1100, and
known as le. hot, stands - known as *le bot*, stands
and le hot flourished - and *le bot* flourished
Collection des Meilleurs Dissertations, Notices et Traites Particuliers

relatifs a I'Histoire de la France - Collection des meilleurs dissertations, notices et traités particuliers relatifs à l'histoire de France
sources for his state ments - sources for his statements
(like the Basque amoroto] is - (like the Basque amoroto) is
and le hot has to do with - and *le bot* has to do with
Vve conclude, then, that mushrooms - I've conclude, then, that mushrooms
I3th - 13th
this leads vis again - this leads via again
See Book m, Chapters - See Book III, Chapters
[Vot. 3, Part 2 - [Vol. 3, Part 2
pain de crapault - pain de crapaud
Woordcnboek der Nederlandsche - Woordenboek der Nederlandsche
1952, Chapter n. - 1952, Chapter II.
PLATE xvn - PLATE XVII
Meyer-Lubke - Meyer-Lübke
J ust as we turned - Just as we turned
Sylva Sylvamtn - Sylva Sylvarum
Vv e have pursued - I've have pursued
principal mean ing - principal meaning
Lief, n, 1, - Lief, II. 1,
pogge-clustei - pogge-cluster
pogge-duster - pogge-cluster
A/Lore names are reported - More names are reported
in ah1 likelihood - in all likelihood
o?pogge words - of *pogge* words.
journeyirigs and questionings - journeyings and questionings
Schtmttz - Schmutz
the igth century - the 19th century
sent awa' with a flea - sent away with a flea
ahi-chattra(ka] - ahi-chattra(ka)
beginning of the I4th century - beginning of the 14th century
JN ow the moment - Now the moment
porownawczej jezykow slowiariskich - porównawczej j&eogon;zyków s&lstrok;owia&nacute;skich
Materyaly i Prace Komisyi Jgzykowej Akadetnii Umieigtnosci - Materya&lstrok;y i Prace Komisyi J&eogon;zykowej Akademii Umiej&eogon;tno&sacute;ci
in the iSth century - in the 15th century
Otr^bski, 2 Baddn ttad infikscm nosowym u> jgzykach - Otr&eogon;bski, Z bada&nacute; nad infiksem nosowym w j&eogon;zykach
of'spunk'- of 'spunk'
in the I4th century - in the 14th century
Proven9al - Provençal
petillant - pétillant
briquets] and matches - *briquets*) and matches
Nord de 1'Europe - Nord de l'Europe
Meddeleher fra foreningen til svampckundskabcns fretnmc - Meddelelser fra Foreningen til Svampekundskabens Fremme
Dcmmarks geologiske Undersoegelse, IV Rskke - Danmarks geologiske Undersøgelse IV Række
Om Fund af Toendersvamp - Om Fund af Tøendersvamp
membmm virile - membrum virile
P.UXYJ? - μύκης
diminutive of'penis' - diminutive of 'penis'
Denkmdlcr des Klassischen Altertums - Denkmäler des klassischen Altertums
fomes fornentarius - *Fomes fomentarius*
fomes officinahs - *Fomes officinalis*
In a loth century Byzantine - In a 10th century Byzantine
divine kinship> - divine kinship?

preserving and cooking > - preserving and cooking?
boots and clokes > - boots and clokes?
hym uppon the table > - hym uppon the table?
the divine begetter > - the divine begetter?
candle to my shames> - candle to my shames?
to pisse my Tallow > - to pisse my Tallow?
no other animals > - no other animals?
did he arrive at it > - did he arrive at it?
the idea of scratching > - the idea of scratching?
from the Indo-Europeans > - from the Indo-Europeans?
maiden on her way > - maiden on her way?
report the same phenomenon > - report the same phenomenon?
did the words possess for them > - did the words possess for them?
flies of the Pharmacopoeia > - flies of the Pharmacopoeia?
Our loth century miniaturist - Our 10th century miniaturist
from a loth century - from a 10th century
BOOK n: 62 - BOOK II: 62
kana-g"ch - kana-g^{a}ch
the ifith through - the 16th through
s'ilmdhra - silmdhra
Arische Forschungcn - Arische Forschungen
sachsischen Akademie - sächsischen Akademie
No. n, Leipzig - No. II, Leipzig
Po etnografli tadzhikov - Po ėtnografii tadzhikov
N. L. Korzhencvskij - N. L. Korzhenevskij
Bough, vol. n of The - Bough, vol. II of The
Loeb edition, vol. rv, p. 360 - Loeb edition, vol. IV, p. 360
la Langue Grccque - la Langue Grecque
of'morel'- of 'morel'
Mohere - Moliere
Book xn Chapter 41 - Book XII Chapter 41
he tells ut that the - he tells us that the
1 he French word - The French word
discover it in Provenfal - discover it in Provensal
name for the Amanita csesarea - name for the Amanita caesarea
of'conkus' - of 'conkus'
and'conkers' - and 'conkers'
a bettter etymology - a better etymology
Le Jardinier fran^ois - Le jardinier françois
of'squeeze' - of 'squeeze'
J_ here is a source - There is a source
in large nights frequently - in large flights frequently
Jan Fy t - Jan Fyt
find a. potiron - find a potiron
of'mushroom' - of 'mushroom'
PLATE xxvui - PLATE XXVIII
Castel ofHelth - Castel of Helth
of'musherons - of 'musherons
cucurbitce - cucurbitae
wild gour/1, hollow - wild gourd, hollow
in the ryth century - in the 17th century
Patrologia Cursus Cotnpletus - Patrologia Cursus Completus
Pliny rnss. - Pliny mss.
1 hroughout the Slavic - Throughout the Slavic
andpecharka - and pecharka
csoporke - csöpörke

Rariomm Plantarum Historia - Rariorum Plantarum Historia
frompechora - from pechora
These are ah1 of - These are all of
Frenchpotiron - French potiron
coucourlo.]ust as - coucourlo. Just as
rlere we might end this - Here we might end this
-Cast of Moscow - East of Moscow
thepixacan - the pixacan
December i, 1946 - December 1, 1946
as vol. rx in the series - as vol. IX in the series
for tinder» This - for tinder. This
is pupikl Here - is pupiki. Here
Islandpupiki - Island pupiki
andpugtaun - and pugtaun
qu^ani tutusi - quâni tutusi
tookpupik - took pupik
ocholars have not found - Scholars have not found
Schivamm - Schwamm
Feuerschivamm - Feuerschwamm
tnuccus - muccus
(e}ron - (e)ron
n. liseron - 11. liseron
name should he pronounced - name should be pronounced
laceron, lacheron} - laceron, lacheron)
memiisier - menuisier
beniise - benuse
Jan. 1955, p. no - Jan. 1955, p. 110
1883, vol. n, p. 453 - 1883, vol. II, p. 453
Gr. |iu?a, - Gr. φυτίλι
tnoisseron - moisseron
mdchuron - mâchuron
oftndchurer - of mâchurer
parallelcs - paralleles
lost'Schweinpilz' - lost 'Schweinpilz'
in the ipth century may - in the 19th century may
like ntousseron - like mousseron
ccps de vigne - ceps de vigne
Siidgallien und ihre sprachlichen - Südgallien und ihre sprachlichen
originally gortn-, and - originally gorm-, and
JNow we arrive at another - Now we arrive at another
If'morel' and - If 'morel' and
In the I2th century - In the 12th century
Greek P.UXYJC; - Greek μύκης
fmama - s^{e}mama
of'nose' - of 'nose'
de pdbilo, 'mucus - de pábilo, 'mucus
from [Au?a - from λάμπα
discovered that Volva' was - discovered that 'volva' was
the 'ring', the Veil', and - the 'ring', the 'veil', and
onomatopceic - onomatopoeic
et de Litteratllre - et de Littérature
vol. vrr, - vol. VII,
Dictionnaire Erotiaue Moderne - Dictionnaire Érotique Moderne
CEil etincelant - Œil étincelant
in Russian asguby - in Russian as guby
:fete from Latin/arfwm - fête from Latin festum

Du dcrc quifatne espousa - Du clerc qui fame espousa
De la bonne enpercris - De la bonne empereris
Annales Academics Sdentiarum Fennicce - Annales Academiæ Scientiarum Fennicæ
in Act n, Sc. i - in Act II, Sc. I
Romanisches Etymologisches Wortenuch - Romanisches etymologisches Wörterbuch
not conceni us - not concern us
the initial /by normal mutation - the initial *f* by normal mutation
of'noses' - of 'noses'
in them ah1 - in them all
America in the idth century - America in the 16th century
variously in the idth century as the Caribs - variously in the 16th century as the Caribs
BOOK, in, Chap. 12 - BOOK, III, Chap. 12
from a loth century - from a 10th century
middle 1470'$ and - middle 1470's and
in the lyyo's - in the 1770's
du cerfznd criadilla - *du cerf* and *criadilla*
in suis OfEcinis Fungos - in suis officinis Fungos
prseruptissimis - praeruptissimis
who ofEciated - who officiated
Vv e might now call - We might now call
thejelenka - the jelenka
comes from *Ian* - comes from *lan*
faomjelen - from *jelen*
Hirschbrunst iiber der Erde - Hirschbrunst über der Erde
Ceska strava lidovd - Česká strava lidová
barant vajca - barani vajca
Dugs, flies - Bugs, flies
word *ntanas* - word *manas*
beranl vejce - berani vejce
Pharmacopolse - Pharmacopolae
rdere our story - Here our story
II Malmantik - Il Malmantik
after Tartujfe - after Tartuffe
Grand Dictionnaire Universe! - Grand Dictionnaire Universel
auauel Tout brisees les brides a veaux de maistre Ivvain Solanicqiie - auquel sont brisées les brides à veaux de Maistre Juvain Solanicque
mean by tartuffe 2 If - mean by tartuffe? If
Aije etc - Aije été
offungus - of fungus
meanning - meaning
he chngs for - he chugs for days
hitherto been pointed out from - hitherto been painted out from
La Vie et les Mceurs des Atnphibiens - La Vie et les Moeurs des Amphibiens
Plate xm - Plate XIII
ofgrib - of grib
Gmzd' - Gruzd'
"Tes un trrrier" and "Tes un trurfaire" - "T'es un trufier" and "T'es un truffaire"
root ?01 grib - root for grib
Griibling - Grübling
(i) greb-, (id) - (1) greb-, (10)
(i) Russ - (1) Russ
Russ. grebdt' - Russ. grebat'
grebtd - grebta
grdbit' - grabit'
pogrebdti - pogrebati
iob;grdbli - iobgrabli

PLATE xxxin - PLATE XXXIII
boagdne - boagane
bocdn - bocán
biocdn and beacdn - biocán and beacán
beacdn bearaigh - beacán bearaigh
pucdn beireach - pucán beireach
1926, p. no; - 1926, p. 110;
Finno-ougrimne - Finno-ougrienne
Schiibeler - Schübeler
On November i, - On November 1,
of January n, - of January 11,
Ziirichberg - Zürichberg
Bd. xxrv - Bd. XXIV
bom - *bori*
ofversikt - öfversikt
Forhandlingar - Förhandlingar
from *Us* - from *lis*
hogre - högre
Account oj British - Account of British
the Last oj the English - the Last of the English
but ouf inquiry has - but our inquiry has
BOOK n, Chap. - BOOK II, Chap.
o? Pfifferling - of Pfifferling
Commentaries sur le Code de I'Eduse Augmentes - Commentaires sur le Code de l'Ecluse Augmentés
Veneneuses - Vénéneuses
se$^?$ P- ^{2}5- - see p. 25.
vol. xxvn - vol. XXVII
hot volant - bot volant
of'bot' - of 'bot'
11 a 1'araignee - Il a l'araignée
Handivorterbuch - Handwörterbuch
op. tit. - op. cit.
cpDasc - φυσσας
domicile of the *hot* or toad - domicile of the *bot* or toad
saturniidse - saturniidae
aqua vitcz - aqua vita
dedans la navire d'icelluy coste - dedans la narine d'icellui costé
doigtz estendus & serrez - doigts estendus et serrés
Liigner heisst - Lügner heisst
dank forests - dark forests
Divine Imp/ration - Divine Inspiration
courtesy oj Frank - courtesy of Frank
lei chun - lei chün
Fredrik Christian Schiibeler - Fredrik Christian Schübeler
lei-sheng chun - lei-sheng chün
nitidus - uvidus
lanyz - lan'ž
fimgus - fungus
perrechitesl - *perrechites*!
fomes omcinalis - Fomes officinalis
kaltu:jaq - kaltu:faq
Syrinc pdturtd - Syriac paturta
truhdn - truhán
puffbair - buffball
poff'rott - potiron
Das Buck der Natur - Das Buch der Natur

tmffe du cerf - truffe du cerf
one is an nth century ms. - one is an 11th century ms.
tsapl de diablhou - tsapi de diablhou
Act. m, Sc. i of - Act. III, Sc. I of
Cressida n: - Cressida II:
Pfijferling - Pfifferling
mussirionetn - mussirionem
Haifa century - Half a century
in kuldhi zamin.105 (footnote lack in original)
les Armies du Moyen - les Armées du Moyen
unh'kely - unlikely
Videnskapsselskaps skrifter - Videnskabers Selskabs Skrifter
Forsok at utur Naturens Historia forklara de nordiska gamla Kampars Berserkagarig - Försök at utur Naturens Historia förklara de nordiska gamla Kämpars Berserka-gang
hfbiti - h&rcaron;biti
hrbelec - h&rcaron;belec
modem citation - modern citation

Unknown errors in vol I:
B0f zsL
sjgwombho
tniffe
itsztov
wapdqual(fnu
the V is short
ahyo''ok
tarndydp poqattd
linguistic map 201
Syrenius (f 1611)
a|i^[jLa and ojjLvjy^a
[ifoojc; - μύκης ??????
apxw
kaltu:jilaq and kaltu:jaq
kaltu:xaq
trrrier
7 he is asked whether
Karlsruhe ms
chngs
to render Psalm xci: 5 thus
As to^n'fc
pfute maltas
on pages ijSff
sa ki roti <> sap kiroti
(la) O Ch SI

Errors corrected in vol II:
1 here are three cultural areas in the world where - There are three cultural areas in the world where
1 he watershed of the Wahgi - The watershed of the Wahgi
I3th - 13th
I4th - 14th
i6th - 16th
ijth - 16th
iyth - 17th
lyth - 17th
ipth - 19th
loth - 10th

zoth - 20th
Relation de las Minas de Temazcaltepec - Relation de las Minas de Temazcaltepec
Doctrina y Ensenan$a en laLengua Mazahua de Cosas muy [...] - Doctrina y Enseñanza en la Lengua Mazahua de Cosas muy Útiles y Provechosas para los Ministros de Doctrina
Nueva Espana - Nueva España
1905, vol. vn, p. 20 - 1905, vol. VII, p. 20
Manuel de Ministros de Indies para el Conocimiento de sus Idolatnas y Extirpation de Ellas - Manual de Ministros de Indios para el Conocimiento de sus Idolatrías y Extirpacio de Ellas
querias - querías
togui9a - togniça
darimi^hoye - darimiçhoye
mayho yocho - mayho yocho?
han^hanixi? - hançhanixi?
queria comer - quería comer
lo que perdi - lo que perdí
no los comiste - no los comíste
queria - quería
Historia Plantamm Novce Hispanicz - Historia plantarum Novae Hispaniae
dtlalnanacame - citlalnanacáme
nandcatl - nanácatl
tRe 'genuine' or Teochichimecas - the 'genuine' or Teochichimecas
[pB. From the Nahnatl] - [9B. From the Nahuatl]
the god MixcoatJ - the god Mixcoatl
teonandcatl - teonanacatl
Rausch- und Betaubungsmittel - Rausch- und Betäubungsmittel
HA. From the Spanish - 11A. From the Spanish
IIB. From the Nahuatl - 11B. From the Nahuatl
Manuel de Ministros de Indies para el Cono (AND THE REST) - Manual de Ministros de Indios para el Conocimiento de sus Idolatrías y Extirpacio de Ellas
Nouvelle Serie, vol. n - Nouvelle Serie, vol. II
ma$auacan nanacatl - maçauacan nanacatl
words pea$6o, peya$6o - words *peaño*, *peyaño* ????????
Fig. 1^. THE MUSHROOM CULT - Fig. 13. THE MUSHROOM CULT
date from the i8th century - date from the 18th century
Sahagiin - Sahagun
form nandcatL This - form nanacatl. This
dtldlin - citlalin
1911, vol. m, p. - 1911, vol. III, p.
(pisiete] - (pisiete)
Problemas y Secretes Maravillosos de las Indias - Problemas y Secretos Maravillosos de las Indias
Cosas de la Nueva Espafia - Cosas de la Nueva España
of the Devil as k Bot, the Cripple - of the Devil as *le Bot*, the Cripple
1 he last of our citations from old Spanish - The last of our citations from old Spanish
Mictlanteculltli - Mictlantecuhtli
Historia de la Medidna en Mexico - Historia de la Medicina en Mexico
journal of Heredity - Journal of Heredity
quod habcnt humidum - quod habent humidum
in Stuttgart in 194.9 - in Stuttgart in 1949
evidence suggested (i) that - evidence suggested (1) that
Mitobotdnica Zapoteca - Mitobotanica Zapoteca
April n, 1934 - April 11, 1934
in 193 5 he found - in 1935 he found
Chiiiantecs - Chinantecs
Ungaricum nomen nullum - Hungaricum nomen nullum
verruckte Schwammerln - verrückte Schwammerln
szalec - szaleć

panseolus campanulatus - *Panaeolus campanulatus*
genus panasolus - genus panaeolus
1 hat Dr. Reko - That Dr. Reko
panasolus - panaeolus
ih your research - in your research
on the Curnbre - on the Cumbre
Very perilous'. - very perilous.
that jwhich comes - that which comes
the pitch, V being the - the pitch, '1' being the
co'td'ci'ne - co'ta'ci'ne
donde estd Dios - donde esta Dios
though he sensed a secret > - though he sensed a secret?
the divinatory mushrooms> - the divinatory mushrooms?
Who knows > - Who knows?
discovered the answer > - discovered the answer?
by the divine mushroom > - by the divine mushroom?
lead to its extinction > - lead to its extinction?
dread of the boletus satanas > - dread of the boletus satanas?
borrowed from the Slavs > - borrowed from the Slavs?
the appropriate kinds > - the appropriate kinds?
of the demonic tradition > - of the demonic tradition?
connait sans Y aimer > - connait sans l'aimer?
'nti1 si3 tho3 y'e4 le* nca*ha* - ˀ*nti*^{1}*si*^{3}*tho*^{3} and ˀ*e*^{4}*le*^{4}*nta*^{4}*ha*^{4}
mexicaiia Heirn - mexicana Heim
cxrulescens Murr. var. maxatecorum Heirn - caerulescens Murr. var. mazatecorum Heim
por si mismo - por sí mismo
donde - dónde
porque - porqué
hie et ubique - *hic et ubique*
with an intrusive V - with an intrusive R
co4ta*ci*ne4 - co^{4}ta^{4}ci^{4}ne^{4}
with him. to interpret - with him, to interpret
(Figure B, i) - (Figure B, 1)
setting for us' strangers - setting for us, strangers
After n o'clock - After 11 o'clock
Jrlere then is the - Here then is the
Estd, pero iquien - Esta, pero iquien
He has now eaten u - He has now eaten 11
part o£ a guacamaya - part of a guacamaya
mushrooms grows hi trees - mushrooms grows in trees
then hi the - then in the
Jhlere we should prefer - Here we should prefer
his 4o's and - his 40's and
in theMije culture - in the Mije culture
into *thcjicara* - into the *jicara*
jtcara - *jicara*
in *ajicara* - in a *jicara*
June i, we set - June 1, we set
vv e have now - We have now
1944, No. n, published - 1944, No. II, published
Quautlannamacatl - Quautlannanaçatl
witli^ vehemence - with vehemence
Fig. I). - Fig. 19
Mound £-111-3 - Mound E-111-3.
3rdregidor - 3rd regidor
Papelcs de Nueva Espaiia - Papeles de Nueva España

Juan de Cordoba's i6th century - 1. Juan de Cordoba's 16th century
vol. vn, p. 31. - vol. VII, p. 31.
mrandero - curandero
discord hi the rarefied - discord in the rarefied
Historia dc las - Historia de las
ticrra caliente - tierra caliente
Mound E-m-3 - Mound E-III-3
VS/ith the concluding - With the concluding
cumndera - curandera
Seiiora - Señora
Sefiora - Señora
ahi donde Dios estd - ahi donde Dios esta
PLATE XLvn - PLATE XLVII
On Friday, July 1, - On Friday, July 1,
the I2th a hurricane - the 12th a hurricane
Para aue contesten - Para que contesten
mujerdtas - mujeradas
hombredtos - hombreados
Datura suavaeolens - Datura suaveolens
spelhng - spelling
Exodus 3 :i4 - Exodus 3:14
peyotb.} - peyote.)
I3ut we have not done - But we have not done
mdi'ndd' - mdi'nda'
es lafuerza - es la fuerza
Nanenschwamm - Lachenschwamm
Estudio HistSrico y Arqueologico - Estudio histórico-arqueológico
chap, xm, plates 81 fT - chap. XIII, plates 81 ff
Hasso von "Winning's - Hasso von Winning's
F'S- 23 - Fig - 23
1 he Japanese people - The Japanese people
.r rofessor Roger - Professor Roger
i86o's - 1860's
hegba tnboddo - hegba mboddo
/ie?&a mboddo - hegba mboddo
from its moutn - from its mouth
vol. m, Barcelona - vol. III, Barcelona
Book vn, par. 102 - Book VII, par. 102
Proven^al - Provençal
rate/onge - rate *fonge*
ofSavoy.lt appears - of Savoy. It appears
in Book rv, chapters - in Book IV, chapters
M. G. Malen9on - M. G. Malençon
early iQth century - early 19th century
El Viage Entrctenido - El Viaje Entretenido
Agusrin de Rojas - Agustin de Rojas
in Book n, chap. 3 - in Book II, chap. 3
I to his home and keep it - 1 to his home and keep it
ryby jedjaft] - ryby jedja[t]
Theatrum Botanicutn - Theatrum Botanicum
'puffbalT - 'puffball'
JVLushrooms - Mushrooms
a pth century - a 9th century
P^m, Bibliotheque Nationale - Paris, Bibliotheque Nationale
nth century - 11th century
the Qth century - the 9th century

In the 1550'$ - In the 1550's
Leviticus xrv - Leviticus XIV
Liber Subtilitatutn - Liber Subtilitatum
idth century - 16th century
II Demoniaco - Il Demoniaco
bildenden Kiinste - bildenden Künste
late i67o's - late 1670's
valui - volui
Diirer - Dürer
Csesar's amanitas - Caesar's amanitas
their rrmshrooms - their mushrooms
pubhshed - published
('Civetta% - ('Civetta').
lie is discussing - he is discussing
lyth-iSth century - 17th-18th century
the i66o's, and - the 1660's, and
his early 5o's - his early 50's
dated I668 - dated 1668
1 here is a noteworthy - There is a noteworthy
1 he mushroom in - The mushroom in
JVLycologists - Mycologists
'pufifbalT - 'pufifball'
thefongo bolado - the *fongo bolado*
pordnello - porcinello
Sy'sterna Mycologicum - Systema Mycologicum
the I53o's: - the 1530's:
Pffferlinge - Pfifferlinge
ling-chili - ling-chih
Semantica Guatemalense o Diaionario de Guatemalteqitismos - Semantica Guatemalense o Diccionario de Guatemaltequismos
vol. vil, - vol. VII,
la connait sans Y aimer? - la connait sans l'aimer?
JNow our excursion - Now our excursion
theglukhie - the *glukhie*
[Morchella esculentaj - [Morchella esculenta]
Les Champignons Comestibles et les Especes Veneneuses - Les Champignons Comestibles et les Espèces Vénéneuses
d'etre con9ue - d'etre conçue;
riere follow - Here follow
3ir-3iv - 3II-3IV
se comen9avan a - se començavan a
la cabe^a por este - la cabeça por este
intech qui9a nanacatl - intech quiça nanacatl
J 9390 quesquich - J çaço quesquich
[IDA] - [10A]
[HA] - [11A]
[I3l - [13]
Boos xi, Flor. Codex, fol. I29v-i30r - Book XI, Flor. Codex, fol. 129v-130r
auh $an yio vmpa - auh san yio vmpa
Flor. Codex, fol. I3ov-i3ir. - Flor. Codex, fol. 130v-131r.
9acatzontitlan in mochioa - çacatzontitlan in mochioa
qujtta temamauhti, ano9O - qujtta temamauhti, anoço
el *ololiuqui* 6 el *peyote* - el *ololiuqui* ó el *peyote*
comidos 6 bebidos - comidos ó bebidos
et dan^ant tousiours - et dan^ant tousiours
94 ff, ip9 - 94 ff, 199

Fehciano - Feliciano
fefl&e// toHsec - kabell tousec
p/Mte maltas - pfute maltas
607e? - bolet
iw/a del dirnoni - bufa del dimoni
jlrgola - Jirgola
pet t/e tow - pet de bou
pef Je //op - pet de hop
pe«5 rfe rata - pens de rata
pixacdn - pixacan
a-mo-kid - a-mo-kia
a-m, - a-ni,
/!ow fot(C/JMW - hou tou chün
/!5/flO C/!«W - hsiao chün
lei-ching fan - lei-ching t'an
/e/ c/!MM - lei chün
lei-sheng chiin - lei-sheng chün
baram vajca - barani vajca
fcerf/a - bedla
/iory/ - horyl
W6 - hrib
/flnyf - lanýž
ulve-fiis - ulve-füs
i/ew/f - blewit
fe«///i5f - bullfist
owfe - conk
tw«< - bunt
Jeer fcfl//s - deer balls
«ftWe boletus - edible boletus
e/gctf - ergot
_/feW mushroom - field mushroom
fcor.se mushroom - horse mushroom
mfe-cap - ink-cap
ma/e agaricke, n 8 - male agaricke, 118
more/, - morel,
pwnk - punk
sm«? - smut
carltas - caritas
toflff s cap - toad's cap
pixacdn - pixacan
tsapi de dialUhou - tsapi de diablhou
stipes he in *thejicara* - stipes lie in the *jicara*
kow.wal pa:bi - koro:wal pa:bi
?ro«esft;W - grottestuhl
Grtibling - Grübling
Hirschbnmst iiber der Erde - Hirschbrunst über der Erde
Hirschtriiffel - Hirschtrüffel
Pffferling - Pfifferling
Allan and ROW - Allan and RGW
Pi'te - Pilze
s^/ofT - s'fog
ship kt chatrl - sap ki chain
dzhalinuskul - dzhahnuskul
6o/e/«5 versipellis - boletus versipellis
amanita ccesarea - amanita caesarea
boletus xreus - boletus aereus

boletus asreus - Boletus aereus
boletus suavceolens - boletus suaveolens
CI'&MS deorum - cibus deorum
dathrus cancellatus - clathrus cancellatus
davaria botrytis - clavaria botrytis
davaria pistillaris - clavaria pistillaris
ditocybe catinus - clitocybe catinus
^/ome5 igniarius - fomes igniarius
_/omes offidnalis - fomes officinalis
Fungi pernidaks - Fungi perniciales
ithyphallus itnpudicus - ithyphallus impudicus
/acterii - lacterii
mutinus ccminus - mutinus caninus
panceolus - panaeolus
psilocybe ccerulescens - psilocybe caerulescens
trametes suavczolens - trametes suaveolens
&i?yo gomba - kigyo gomba
Sze«(Gyewrgi gambaia - Szent Gyewrgi gambaia
ki^{3}so\ - ki^{3}sol
ki^{3}sV - ki^{3}sol
nkcf - nka^{2}
Haifa century later - Half a century later
fe/^{3}5V - ki^{3}sol
'nti^{1} &tho^{3} ki^{3} sV - ˀnti^{1}si^{3}tho^{3} ki^{3}sol
'nti^{1}si^{3}tho^{3} m'%$^{3-4}$ - ˀnti^{1}si^{3}tho^{3}ni^{4}se$^{3-4}$
'nti^{1}si^{3}tho^{3} y'e*k^{4} nca^{4}ha^{4} - ˀnti^{1}si^{3}tho^{3} y'e^{4}le^{4}nta^{4}ha^{4}
na:swin mu$ - na:swin mus
na :su>in mus - na:swin mus
m«/ - mus
ftcm '«/; - tu:muh
(«:m 'utigk - tu:m 'ungk
mc^M - mecin
must he on those - must be on those
apipiltxin - apipiltzin
ma^auaccm nanacatl - maçauacan nanacatl
fepexz' nanacatl - tepexi nanacatl
xoc/z/ nanacatl - xochi nanacatl
«<Wa - nonda
from what focus; - from what focus?
he in the future - be in the future
&0ZO - kozo
2:0^0 - zoko
pa<W bahera - padd bahera
xargma - xargina
xomtu - xomba
Fran9ois Rabelais - François Rabelais
Boletus 522 - *Boletus* spp.
poczl&i - poczksi
pOC3ksi - poczksi
^corc - xorc
<2<j»r - qarc
JeJ/a - bedla
lo aue nace - lo que nace
5^mer - szmer
?/re//o - girello
;ofre/ - jotrel

2;i'te//o - zitello
/io/om ocox - holom ocox
/io/om i^pefe - holom ixpek
wa tgapper - cacs tgapper
pawn (/e pfl'Jer - pawn de póder
fq^iw </'/»(/ - toffas d'luj
X"X"«> X"Xf"'. 3?o - xuxur, 370
?/wfc/»'e - glukhie
golnbetz - golubetz
?nW - gruzd'
?«&<? - guba
tnaslenik - maslenik
tnokhovnik - mokhovnik
podgmzdki - podgruzdki
ryzfo'fe - ryzhik
rfr<y'K - strojki
svimikha - svinukha
Shortly before ii - Shortly before 11
Miraflores phase, 1000-5003.0. - Miraflores phase, 1000-500 B.C.
zabad huby - žabací huby
Ludwig Münz - Ludwig Münz
nauacatl - nanacatl
^ri6 - grib
fce/Yn - bejm
/JOH^O Je puerco - hongo de puerco
CKWCO Je /oio - cuesco de lobo
hfyb - hryb
hmtishe shvemlekh - hintishe shvemlekh
»!&?}> - mbey
pi'ff/e </e c/!«n5 - piule de churls
pi'w/e </e 6Wa - piule de barda
A/tecs - Aztecs
ottJo 2«n - ondo zuri
/('/« huba - lisa huba
ffl/M/ - valui
S<itt£ Georg schwamm - Sant Georg schwamm
Barctti, Giuseppe - Baretti, Giuseppe
Bamouw, Adriaan - Barnouw, Adriaan
Galas, Mr. - Calas, Mr.
Entrc-deux-mers - Entre-deux-mers
Gilbert! - Gilberti
!'affaire - l'affaire
Giissow, H. T. - Gtissow, H. T.
Heem, Cornehs de - Heem, Cornelis de
Jcssen - Jessen
Ltibeck - Lubeck
Marquiiia - Marquina
Linnseus - Linnaeus
for Unking together - for linking together
Rernus - Remus
Liibke - Lübke
Girard (!'affaire) -Girard (l'affaire)
there is an nth century - there is an 11th century
Cliico - Chico
Jcssen, Carl - Jessen, Carl
Pomrnersfelden - Pommersfelden

Recinos, Adridn - Recinos, Adrian
Rojas, Agustfn - Rojas, Agustin
Dtirer - Dürer
Sahagiin - Sahagun
Ebn'gida - Ebrigida
Schiaffrni - Schiaffini
Fetincelle - l'étincelle
Tame - l'âme
Fannee - l'année
efnuves - effluves
Ton eprouve - l'on éprouve
ses ceuvres - ses oeuvres
dieron a coiner - dieron a comer
los estrangeros - los estranjeros
vian visiones - veían visiones
hablandolos - hablándoles
hongos 6 setas pequenas - hongos o setas pequeñas
alii - allí
sentfan - sentían
teunamacatlh - *teunanacatlh*
inspire au cceur - inspire au coeur
l'liomme - l'homme
Ponies - Fornes
Te/coco - Tezcoco
C. Jans - Catalans
Akademie der bil-denden Kiinste - Akademie der bil-denden Künste
Wolff, Max]. - Wolff, Max J.
Pennyslvania - Pennsylvania
Chapter 8 of Part in - Chapter 8 of Part III
Lie. Alfonso Caso - Lic. Alfonso Caso

Unknown errors in vol II:
potsdkai
potsakdi
wither/fed - with *griba*
matalpnga
fe/35V, the 'landslide'.
letter Y has
Mazatec si3to31 Tu:m of itself
cases V
intrusive V
value of V
with a stem % inch in
fig. y8f
ce.no
Spanish -/'-
ngwe'dz
mjd'mdo'
kow.wal pa:bi
rndgti
tarnaydp poqattd
sa ki roti <> sap kiroti
indicated by', low by'
a stem % inch in diameter

The Wondrous Mushroom

Mycolatry in Mesoamerica

by

R. Gordon Wasson

Ethnomycological Studies No. 7

© 1980, R. Gordon Wasson

original source: https://www.scribd.com/document/480809425/R-Gordon-Wasson-The-Wondrous-Mushroom-Mycolatry-in-Mesoamerica-pdf

"From now on any comprehensive study of Ancient Mexican civilisation must start from (and with) your discoveries."
- Octavio Paz, leading Mexican intellectual, scholar, poet.

"**AMAZING!**... The exactness of the reasoning! The rigor of the demonstrations!... Absolutely convincing... beautifully written... deeply moving!... I could not leave the book until I had finished it."
- Claude Levi-Strauss, College de France

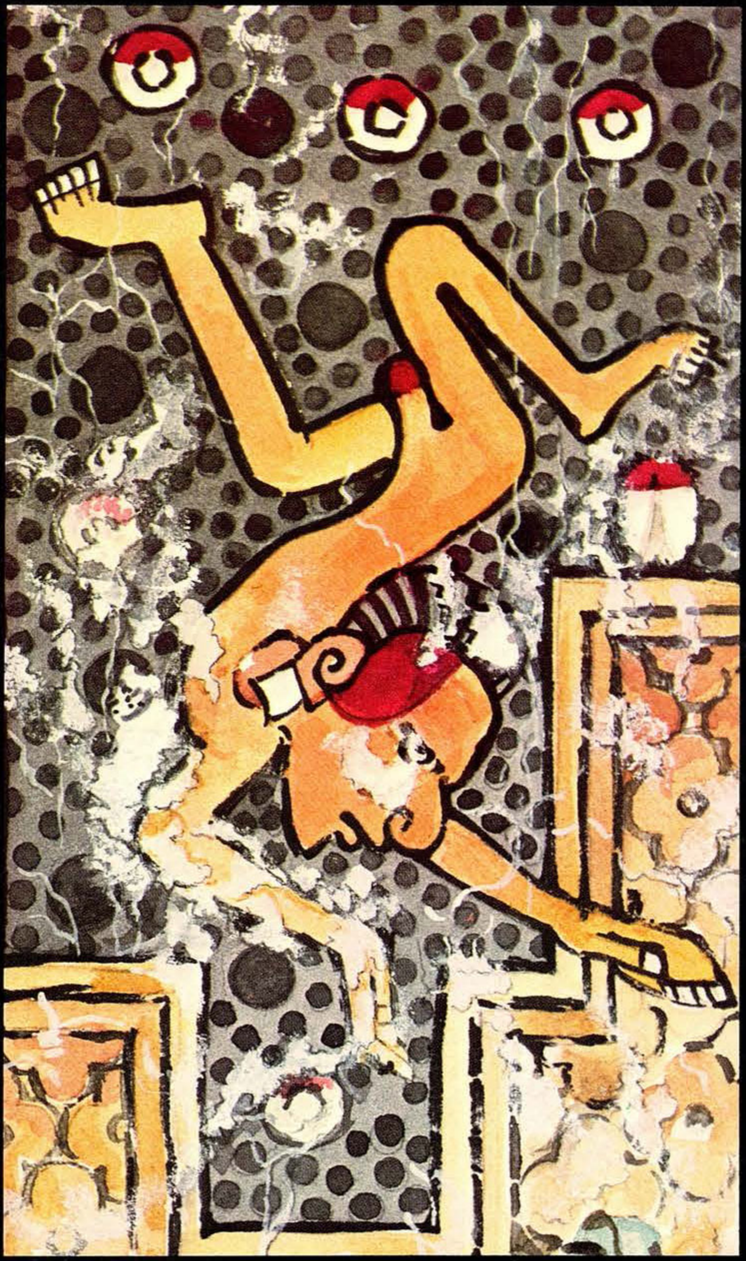
"**SPARKLES WITH POETIC SIMPLICITY!**... Will take its place as one of the foremost interdisciplinary analyses of a deeply significant cultural complex... [it is] characterized by a profound psychological insight."
- Richard Evans Schultes, Harvard University

"**WASSON'S BOOKS STAND OUT AS REAL CLASSICS!**... [They] have caused the histories of India, Greece, and now Mexico to be reconsidered."
- Michael Aldrich, The Fitz Hugh Ludlow Memorial Librar

"**PURE GOLD!**... Interweaving science, artistry, and an almost uncanny sense of where hidden veins of pure gold lie... [the book] adds another novel and major chapter to our knowledge of the history of Early Man."
- Huston Smith, Syracuse Universit

THE WONDROUS MUSHROOM

Mycolatry in Mesoamerica



R. GORDON WASSON

Table of Contents:

Prelude
The Present
CHAPTER 1 - A *Velada* in Huautla
CHAPTER 2 - Traits of the Mesoamerican *Velada* and Kindred Topics
- Allocation of mushrooms
- 'Eating' or 'drinking' the mushrooms
- Purpose of the *Velada*
- *Velada* essentials: 1. Darkness and isolation
- *Velada* essentials: 2. The monitors
- *Velada* essentials: 3. Prohibitions
- The shaman's ventriloquism
- The designation of the shaman
- The sacred mushroom: the 'small fry' or 'little tykes'
- The mushroom 'speaks', not the shaman
- Antiquity of mycolatry in mesoamerica
- A question of grammar
- 'God's flesh'
- The mazatec mushroom world
- The art of the mushroom *velada*
- Work to be done
- Siberian and eurasian parallels

The Past
CHAPTER 3 - Xochipilli, 'Prince of Flowers': a new interpretation
CHAPTER 4 - The *flowers* in pre-conquest nahuatl poetry
- The meaning of *cueponi*
- *Flowers* foster friendship
- Sights and sounds become one
- *Anelhuayo*: without roots

CHAPTER 5 - The inebriating drinks of the Nahua
CHAPTER 6 - Códices, lienzos, mapas
- Codex Vindobonensis
- Códice indígena no 27
- Sahagún's Florentine Codex and the Magliabechiano Codex
- Matrícula de Huexotzinco
- Lienzo de tlacoatzintepec
- Mapa Quinatzin

CHAPTER 7 - Piltzintli, Child God of the Nahua, and his Christian progeny
- Santa María Tonantzintla
- The Nicho de Hueyapan
- Santo Niño de Atocha

CHAPTER 8 - Teotihuacán and the wondrous mushroom
- The meaning of the murals
- Teopancaxco and the water glyphs
- Tepantitla
- Zacuala
- Chalchihuitl and Tonallo: a speculation

CHAPTER 9 - The Mushroom Stones Of The Maya Highlands
CHAPTER 10 - The historical record
- Diego Durán, O.P.
- Bernardino de Sahagún
- Nanacatl
- Book 10 of Sahagún's *Historia General*
- The holy office of the inquisition
- The mycophobic syndrome: our supreme example
- The range of mushroom use in mesoamerica

CHAPTER 11 - The shaman and the mushroom: new perspectives
Fly-agaric in the new world
Consulted texts
Ethnomycological bibliography of R. G. and V. P. Wasson. July 1979
Index

To the memory of
Roger Heim
1900-1979
First among Mycologists of his Time
President, Academie des Sciences: 1963
Directeur, Museum National d'Histoire Naturelle: 1951-1965

Tireless in the Defense of Nature
Quick to Grasp the Perspectives of Ethnomycology
Loyal Collaborator, Valiant Friend

Mycolatry (m&imacr;·cŏl´&abreve;·tr&emacr;) *nov. verb.*: Worship of a mushroom; specifically, worship of entheogenic mushroom species in proto- and prehistory as a means for communicating in grave circumstances with the Almighty Powers.

Mushroom: This word today covers widely different areas in different circles of the English-speaking world. In Great Britain many apply it only to the cultivated marketplace mushroom *Agaricus* (or *Psalliota*) *hortensis*, also perhaps *Agaricus campestris*; others, to any edible species including the morels and even the truffles; others, to any fleshy-capped fungus, whether edible or inedible; others try to apply it only to the Basidiomycetes, which excludes *eg* the morels. Mycologists tend to broaden the field. In this book 'mushroom' embraces all the higher fungi, whether Basidiomycetes or Ascomycetes, with conspicuous fruiting bodies.

Entheogen *nov. verb.*: 'God within us', those plant substances that, when ingested, give one a divine experience, in the past commonly called 'hallucinogens', 'psychedelics', 'psychotomimetics', *etc etc*, to each of which serious objections can be made. A group headed by the Greek scholar Carl A. P. Ruck advances 'entheogen' as fully filling the need, notably catching the rich cultural resonances evoked by the substances, many of them fungal, over vast areas of the world in proto- and prehistory. See *Journal of Psychedelic Drugs* Vol 1 t.1-2, 1979, pp 145-6. We favor the adoption of this word. Early Man, throughout much of Eurasia and the Americas, discovered the properties of these substances and regarded them with profound respect and even awe, hedging them about with bonds of secrecy. We are now rediscovering the secret and we should treat the 'entheogens' with the respect to which they were richly entitled. As we undertake to explore their rôle in the early history of religions, we should call them by a name unvulgarized by hippy abuse.

Prelude

From the beginning the entheogenic mushrooms have interested me solely for their rôle in Early Man's religious life. My wife Valentina Pavlovna and I discovered, in the course of decades of observation and study, the division of European peoples between mycophobes and mycophiles and this, plus an abundance of linguistic and folkloric evidence, led us to make (to ourselves only) the bold surmise that mushrooms (of all plants!) had once played a center-stage part in the worship of our remote ancestors - we knew not how nor why nor which mushrooms. Then, crossing the Urals, we discovered the mycolatry that had prevailed in the northern belt of peoples bordering on the Arctic Ocean, all the way to the Bering Strait. So our surmise was vindicated and our goal was reached, or so we thought.

But more discoveries were to come. On the eve of World War II there were ethnomycological stirrings in the study of the cultural entity known to anthropologists as Mesoamerica - an area from Nicaragua west and north to a wavy line that runs across Mexico north of Mexico City, an area marked by distinctive cultural traits even though it embraced peoples speaking a multitude of languages. We learned of these stirrings only in 1952 but from then on we pursued them hard. On the night of 29 June 1955 in a remote Indian village of Oaxaca I achieved our goal: I participated with a handful of Mazatec Indians in a shamanic mushroom agape and caught from them, young and old, the awe and reverence that has always imbued these gatherings. In *Life*, 13 May 1957, I published an account of our adventure and at the same moment we brought out, my wife and I, our two-volume work, *Mushrooms Russia & History*, detailing the chronicle of our pursuit up to that date.

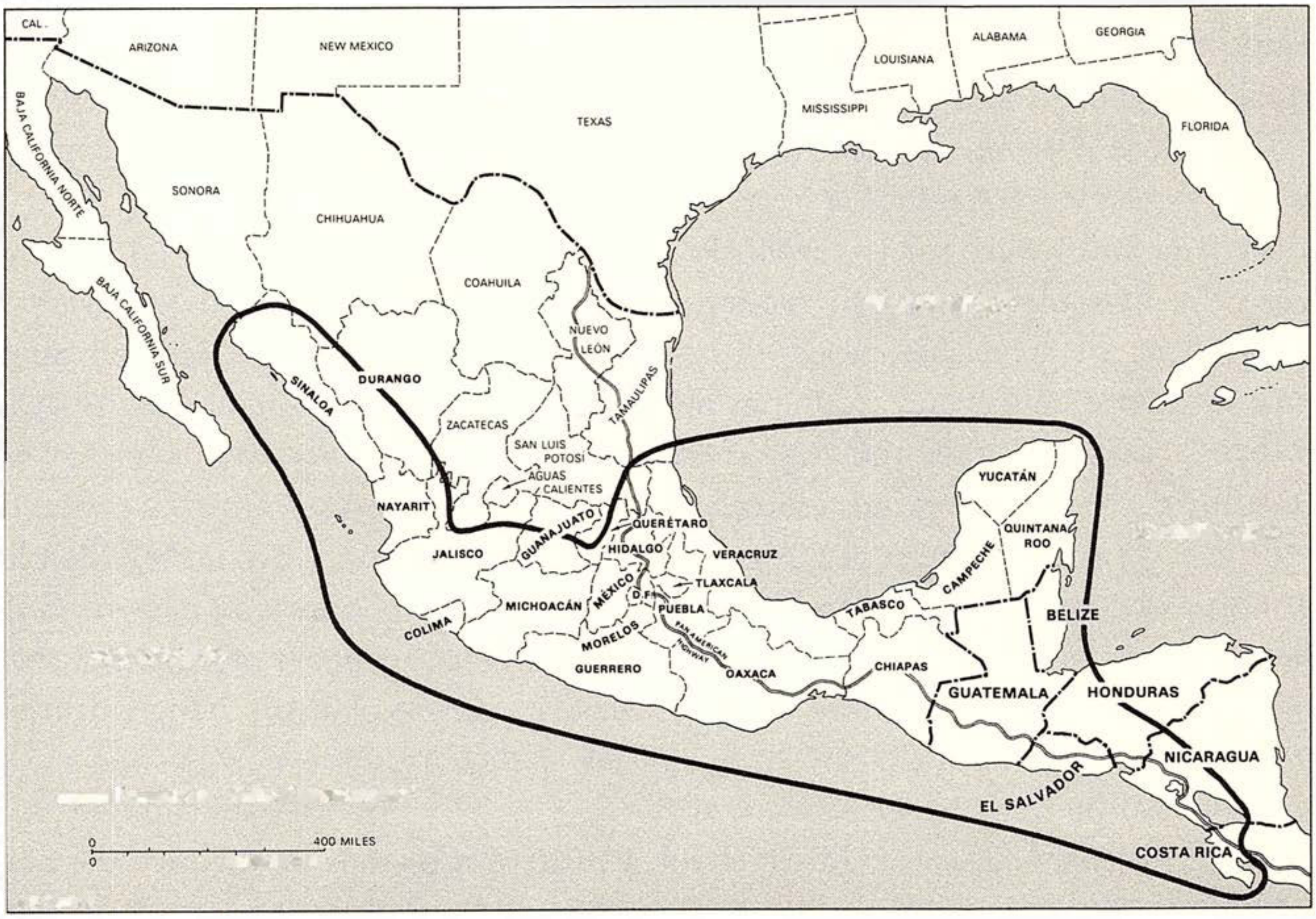

CAL.
ARIZONA
NEW MEXICO
TEXAS
LOUISIANA
ALABAMA
GEORGIA
MISSISSIPPI
FLORIDA
BAJA CALIFORNIA NORTE
SONORA
CHIHUAHUA
COAHUILA
BAJA CALIFORNIA SUR
NUEVO LEÓN
TAMAULIPAS
SINALOA
DURANGO
ZACATECAS
SAN LUIS POTOSÍ
AGUAS CALIENTES
NAYARIT
YUCATÁN
QUINTANA ROO
QUERÉTARO
GUANAJUATO
JALISCO
HIDALGO
VERACRUZ
CAMPECHE
MÉXICO
TLAXCALA
D.F.
MICHOACÁN
PUEBLA
TABASCO
BELIZE
COLIMA
MORELOS
PAN AMERICAN HIGHWAY
GUERRERO
OAXACA
CHIAPAS
GUATEMALA
HONDURAS
NICARAGUA
EL SALVADOR
COSTA RICA
0
400 MILES
0

Fig 1 Map of 'cultural' Mesoamerica

I have often taken the sacred mushrooms, but never for a 'kick' or for 'recreation'. Knowing as I did from the outset the lofty regard in which they are held by those who believe in them, I would not, could not, so profane them. Following my article in *Life* a mob of thrill-mongers seeking the 'magic mushrooms' descended on Huautla de Jiménez - hippies, self-styled psychiatrists, oddballs, even tour leaders with their docile flocks, many accompanied by their molls - upsetting and abusing the quiet tenor of life in what had been, superficially at least, an idyllic Indian village. Countless thousands elsewhere have taken the mushrooms (or the synthetic pills containing their active agent) and the chatter of some of them fills the nether reaches of one segment of our 'free press'. I deplore this activity of the riffraff of our population but what else could we have done? Had we refrained from presenting to the world the facts as we knew them to be, a novel and I think a major chapter in Early Man's cultural history, not only in Mexico, would have perhaps vanished unnoticed. (In this book I define 'Early Man' as humankind before there was reading and writing.) We knew and weighed the objections: had not our shaman María Sabina said that to give out photographs of her performance 'would be a betrayal'?

My wife and I were solely responsible for the present development of what we were the first to call ethnomycology. Wherever we have studied the story of Early Man, we have discovered entheogenic mushrooms in use, hedged about with awesome beliefs and trappings of the Holy. Of course there are many other entheogens, but I think the part these have played in Early Man's history has been for each of them geographically circumscribed. The use of mushrooms, if I am right, spread over most of Eurasia and the Americas, and as Stone Age Man has emerged into the light of proto-history these strange fungi may well have been the primary secret of his sacred Mysteries. To document this belief of ours (and held only by us) seemed worthwhile, and to dissect the corpus of a still living culture, *ie* in Mesoamerica, where the mushrooms played their traditional rôle, was an opportunity to be quickly seized.

In the successive chapters of this book I present a picture of the sacred mushrooms in Mesoamerica that is quite other than the world has known. Before the Conquest they were a major element in public celebrations. Ample evidence also exists that they played a widespread shamanic rôle in private gatherings, and I will show that this use can be traced back for centuries, in all likelihood for many millennia. The Conquest put an abrupt end to the public celebrations. The private gatherings, by reason of their privacy and in spite of harassment by the Inquisition, have survived to this day. But from 1726 until 1915 we have discovered only trifling mention of them in public prints or documents: the world had virtually forgotten them.

We will show that in 1953, when we embarked on our Mesoamerican inquiries, many of the leading authorities in such studies were ignoring the sacred (or entheogenic) mushrooms.

As I read the pre-Conquest Nahuatl poetry, at last made accessible to us in the *versión* given to us by Father Garibay, the poets speak eloquently and repeatedly of the exalted status in which mushrooms were held: '*Tell us, oh Priests, whence come these inebriating flowers?*' to which the Priests, via the poet, reply: '*From God's house in Heaven.*'

(There emerges from the pre-Conquest poetry of the Nahua a hierarchy of quality for the entheogens, the mushrooms figuring in the highest class, the daturas in the lowest. As we shall see, 'flowers' is a figure of speech for all of the superior ones.)

The mushrooms transport one for the nonce to heaven, where all the senses unite in a joyous symphony shot through with an overwhelming feeling of *caritas*, of peace and affection for the fellow communicants.

This touched an acutely sensitive nerve in the newly arrived Catholic missionaries and we catch a taste of their panic, their indignation and fury, in these words, wholly misleading as we will see later, of Fray Toribio de Benavente called Motolinía:

> They had another way of drunkenness that made them more cruel and it was with some fungi or small mushrooms, which exist in this land as in Castilla; but those of this land are of such a kind that, eaten raw and being bitter, they drink after them or eat with them a little bees' honey; and a while later they would see a thousand visions, especially serpents, and as they would be out of their senses, it would seem to them that their legs and bodies were full of worms eating them alive, and thus half rabid they would sally forth from the house, wanting someone to kill them; and with this bestial drunkenness and travail that they were feeling, it happened sometimes that they hanged themselves, and also against others they were crueler. These mushrooms they called in their language *teunanacatlth*, which means 'flesh of god', or the devil whom they worshipped; and in this wise with that bitter victual by their cruel god were they houseled.
> [For the Spanish original, *vide Memoriales*, UNAM, Mexico, 1971, p 32]

Here is indeed *odium theologicum*.

In short, for the friars the Nahua[1] celebrated an appalling simulacrum of Holy Communion with these mushrooms. One can imagine the many trembling confabulations of the friars as they would whisper together how to meet this Satanic enemy. The *teonanácatl* struck struck at the heart of the Christian religion. I need hardly remind my readers of the parallel, the designation of the Elements in our Eucharist: 'Take, eat, this is my Body...', and again, 'Grant us therefore, gracious Lord, so to eat the flesh of thy dear Son... and to drink His blood...'. But the truth was even worse. The orthodox Christian must accept on faith the miracle of the conversion of the bread and wine into God's flesh and blood: that is what is meant by the Doctrine of Transubstantiation. By contrast the sacred mushroom of the Aztecs carries its own conviction: every communicant will testify to the miracle that he has experienced.

The friars were conscientious chroniclers of Mesoamerican culture and they have left us many long and absorbing accounts of Indian life and of the New World that they were the first to study. But about the sacred mushrooms they are sparing of words or, as in the famous Badianus manuscript, silent. Nor are the inebriating mushrooms even mentioned (contrary to what the title would lead one to expect) in *Problemas y Secretos Maravillosos de las Indias*, by Juan de Cárdenas, published in 1591 in Mexico. The best of the churchmen are neutral, but all their testimony is hearsay sometimes mixed with prejudice: they neither ingested them nor witnessed their ingestion, if we judge by their writings. The testimony of their informants, insofar as we possess it, must be read with caution: the witnesses used by Bernardino de Sahagún were the most honorable, intelligent, and well informed natives that could be found and they occupied a privileged position with the friars that they would fain keep. They knew what the friars would have them say about the entheogens. When these informants testify in Nahuatl about the mushrooms, their words occasionally disclose an embarrassing torque between, on the one hand, what the friars expected them to say and, on the other, their strong leaning in favor of the truth: but their words always wind up on the side of the friars.

Another source of information lies in the Proceedings of the Holy Office of the Inquisition, now housed in the Archivo General de la Nación: for the sixteenth and seventeenth centuries they give us a taste of what was happening in the humble homes of the *indigenas*, as the Indians are called today, of *mestizo* families, and in that part of the creole world living in intimacy with the *indigenas*. The coverage of the Inquisition was spotty, as one would expect, but would have permitted an historian of imagination to surmise the truth. We now know, thanks to our own soundings of the Indian world in the highlands of the States of Oaxaca, Puebla, Veracruz, and Mexico, and thanks also to the mycologists, anthropologists, and linguists who have followed our trail, how widespread and firm a hold until recent times the mushrooms have had on the imaginations and practices of the indigenous world of monoglot Indians. The public celebrations of pre-Conquest times are long since gone for good, but the midnight *veladas* continue even now in lowly homes, in *rancherias*, a major feature in the lives of the Indians. They continue today, but as the country is fast opening up, this unique survival of a practice going back to the Stone Age is disappearing.

The Indians of Mesoamerica, as I have said, discovered the amazing properties of the entheogenic mushrooms. The friars learned of them from the Indians and tell us a little about them by hearsay. They were re-discovered in our times by a dramatic event: a United States Government botanist of established reputation, William E. Safford, on 4 May 1915 in a formal address delivered before the Botanical Society of Washington, D. C., said that he had searched for inebriating mushrooms and found none. As was not uncommon in those days in botanical and ethnological circles, he was contemptuous of the herbal knowledge of the Indians and said they had confused the dried cactus peyote (*Lophophora Williamsii*) buttons with mushrooms. (It is the fate of some worthy scientists and scholars to be remembered for the blunders they make.) Later in that year his address was published, lavishly illustrated and documented, with the express approval of the Department of Agriculture, in the *Journal of Heredity*. Most of those who listened to him or read him learned of the supposed existence of inebriating mushrooms only to learn in the same breath that they had never really existed. His paper was a major effort on his part, but contrary to his expectation, some time later a still small voice of an obscure ethnobotanist in Mexico, Blas Pablo Reko, made itself heard, faintly, persistently, protesting that the mushrooms were still being used in the State of Oaxaca, and little by little other voices joined his - Robert J. Weitlaner, Jean Bassett Johnson, and the Harvard botanist Richard Evans Schultes. In 1938 Schultes took back to Harvard from Huautla de Jiménez specimens of the mushrooms and Johnson with his companions succeeded in enlisting a shaman for a midnight session. This session turned out to be one where grains of corn were used for divination. There was no singing and the mushrooms were ingested by the shaman alone.

---

[1] At the time of the Conquest Mesoamerica was dominated by the Nahua, native speakers of the Nahuatl language, the *lingua franca* of the area, and the Nahua were dominated in turn by the Nahuatl-speaking Aztecs living in an island city in the Valley of Mexico called Tenochtitlan, now known as Mexico City. The prestige of the Nahua ran far beyond the confines of Mesoamerica. The distinguished Ojibway Keewaydinoquay calls my attention to an Ojibway legend that starts with these ringing words:

> Mewija shabwasong Nahuwahinawinnini... Long long ago, far away to the South, in the land of the people called Nahua...

The Ojibway are an Algonkian people living in the Great Lakes area. Until I told her Kee had never known who the Nahua were.

World War II broke out. All thought of the mushrooms dried up until Valentina Pavlovna and I, approaching the subject from a far different angle, turned up in Huautla in the middle 1950's. We had been alerted by two articles that Schultes had published following his field trip, by the pencil sketch of a 'mushroom stone' that our printer Giovanni Mardersteig had found in the Rietberg Museum of Zurich, and later by an extraordinary letter written to us by Eunice V. Pike, a Protestant missionary to the Mazatecs.

And so it came about that Safford's resounding blast in 1915 served as the catalyst that triggered the investigation among our ethnobotanists, starting Mesoamerican studies on their way to a just appraisal of the part played by the entheogenic mushrooms in pre-Conquest history.

In 1971 Benjamin Keen published his The Aztec Image in Western Thought in which he presented, in a fascinating way, the attitude of successive generations and of different segments of each generation toward the Aztec civilization. He mentions the 'magical mushrooms' only once in 600 pages and they are not even cited in his index. Keen was right: the mushrooms have played no part in the world's appraisal of Mesoamerican culture. In the first instance the Catholic clergy were responsible for playing down and misrepresenting this major element in the complex pattern of Mesoamerican life. But I believe the mushrooms were ignored for an additional reason: the deep-seated mycophobic strain in the West-European elements that have studied or observed the Nahuatl culture, a latent mycophobia, a subliminal rejection, that runs through much of Western civilization and that dates from a time in prehistory when the cult of assorted entheogenic mushroom species was superseded by other religious foci and ultimately by the Christian religion. I only cite this as a possibility here but will return to the theme later.

When we first went down to Mexico in 1953, we felt certain, my wife and I, that we were on the trail of an ancient and holy Mystery and we went as pilgrims seeking the Grail. To this attitude of ours I attribute such success as we have had. It was not easy. For four and a half centuries the rulers of Mexico, men of Spanish blood or at least of Spanish culture, have never entered sympathetically into the ways of the Indians, and the Church regarded the worship of the sacred mushroom as an idolatry. The Protestant missionaries of today are naturally intent on carrying the Gospel to the Indians, not on absorbing the religion of the Indians. Nor are most Mesoamerican anthropologists good at this sort of thing. Their frequent failure to enter into the religious life of the peoples they study, their frequent inability to cope with the higher reaches of the cultures that absorb their attention, reveal a disconcerting lacuna in their work, an anthropological fact about the anthropologists that should alert the rest of us.[2]

For more than four centuries the Indians have kept the divine mushroom close to their hearts, sheltering it from desecration by white men, a precious secret. We know that today there are many shamans who carry on the cult, each according to his lights, some of them consummate artists, performing the ancient liturgy in remote dwellings before minuscule congregations. With the passing years they will die off, and, as the country opens up, the cult is destined to disappear. They are hard to reach, these shamans. Almost invariably they speak little or no Spanish. To them, performing before strangers seems a profanation. They will refuse to meet with you, much less discuss the beliefs that go with the mushrooms and perform for you. Perhaps you will learn the names of a number of renowned shamans and your emissaries will even promise to deliver them to you, but then you wait and wait and they never come. You will brush past them in the marketplace and they will know you but you will not know them. The cobbler across the way may be the very man you are seeking: you may pass the time of day with him, yet never learn that he is the shaman you need. In the writings on shamanism I have never seen mentioned this reluctance of the gifted shamans to perform before outsiders. Yet it seems unlikely that such reluctance is confined to the mountains of Oaxaca, for it is the natural response of a believing religious leader to the importunities of non-believers and thrill-mongers. A Catholic priest will scorn to say Mass expressly to satisfy the curiosity of non-believers. In some accounts of shamanic performances held in various parts of the world I have asked myself what category of shaman we are dealing with: they behave like the charlatans in Huautla, eager to perform for outsiders but who are *embusteros*, *farsantes*, frauds. They have leaped into existence to meet the demands of the visitors following in our trail. The true shaman believes in the mushrooms, believes in himself, and believes in the handful of poor Indians who constitute his following.

---

[2] I. M. Lewis, Professor of Anthropology in the London School of Economics, draws attention also to the frequent inability of anthropologists to sense the religious aspect of the people they are studying; see *Ecstatic Religion*, a Pelican book published in London by Penguin Books in 1971, p. 14 and later. Similarly, P. Gelling and Hilda Ellis Davidson: *The Chariot of the Sun*, pp 5-6, J. M. Dent Sons, Ltd, 1969.

The genuine shamans, as I have said, shun contact with strangers. But this is not so with the 'laymen', especially the elderly men and women of a village. They do not initiate a conversation with you about the mushrooms. But after you have made a good impression on them and won their confidence, then late in the evening, by the light of a fire and *velas*, if you bring the conversation around to the sacred mushrooms, it is astonishing how freely they discuss them, how they will stay up late full of the subject, and how glad they are to meet a stranger who shows a sympathetic and lively interest in the miraculous 'little things'. Though Sahagún and many other sixteenth century friars gave leads aplenty, our anthropologists have traditionally shown no curiosity about them.

Not that the shamanism as practiced in Oaxaca has been unaffected by four centuries and more of contact with Christianity: Catholic elements blend with the pagan mushroom rite and the Indians see no incompatibility. María Sabina, our now famous shaman, sings chants that are full of Christian locutions - names of saints, the Lord's Prayer in Spanish that she has learned by rote, *etc*. These Christian locutions in her singing jostle with the forces of nature, with professions of humility, and later in the session with bold assertions of her authority. The mushrooms are the 'dear little children', *ˀnti*^{1}*xti*^{3}, the 'clowns', *sa*^{4}*se*^{1}, but at the climax of the *velada* they pronounce dread judgement with the voice of Jesus Christ![3] The synthesis is complete. When I have been present she has always begun her performance with a cheap chroma of the *Santo Niño*, the 'Holy Child', on the altar in front of her. But when she has inverted a flower over the last wick and thus extinguished it, from then on the proceedings take place, pagan-fashion, on the floor, the habitual practice of the American Indian. We are now in darkness. There can be no question: her verses come down to her from a rite that Ruiz de Alarcon reported to us in the early seventeenth century and of necessity, her singing and the verses being inseparable, her music dates also from the same remote period. They are of great antiquity, pre-Cartesian, going back surely for millennia.[4]

María Sabina, herself an eminent shaman of the mushroom rite, is a church member in good standing. She has belonged to the Asociación del Sagrado Corazón de Jesús, and has been not only a member - *socia* - but a captain of ten, a *celadora*. The Church has ceased to fight the mushrooms. It is even rumored, perhaps falsely, that in some remote parishes the priest himself has officiated at the mushroom rite. It was not always so. In the sixteenth and seventeenth centuries, when the secular arm placed itself at the disposal of the Church, the Inquisition saw to it that those who used the mushrooms suffered the harsh rigors of the law. Curiously, the Church did not dispute the efficacy of the mushrooms, their capacity to reveal the truth. But the Church said the mushrooms were the Devil's minions and so the idolatrous practices invoking them had to be extirpated.

---

[3] Mazatec is a tonal language with 4 tones, ^{1} being the highest. There are also glides from one tone to another, the glides being represented by two or, rarely, three digits. 'ˀ' represents a glottal stop, as in the Scottish pronunciation *bott'l*.

[4] See *María Sabina and Her Mazatec Mushroom Velada*, by Wasson *et al*., Harcourt Brace Jovanovich, Inc., New York, 1974; pp XXV ff. In the Zapotec country on the Pacific Coast, far removed from Huautla, speaking of Aristeo Matías, the shaman, in 1957 I wrote: 'His chanting was low and feeble, and of course in Zapotec, but I had the impression that his singing was identical to what the Señora had sung with magisterial authority in the Mazatec country.' *Mushrooms Russia & History*, p. 314. The Zapotec and Mazatec languages are perhaps unrelated, and if related, only most distantly so.

To win the confidence of the Indians and to gain access to a superior shamanic performance one must possess two qualities in high degree: patience and tact, and then in addition a bountiful measure of luck. Our first stroke of fortune was winning the cooperation of the late Robert J. Weitlaner, Austrian-born engineer who gave up that profession to study the Indians. He led us by the hand on our first excursion on muleback into the Sierra Mazateca and later he accompanied us on many other explorations. For ten years we had repeated recourse to him, tapping his immense knowledge of the Indians, their ways, their languages, their history. His patience, good humor, and *joie de vivre*, in the sierra sierra and in Mexico City, were unfailing. But above all else we learned from him how to handle ourselves with the Indian. The Indians are simply living by the conventions of an orally transmitted culture such as our own forebears lived by not so long ago - not long ago as compared with the long stretch of time that our ancestors have been on the earth. When you visit the Indian villages you make allowances for this time lag. You do not treat them as inferiors or children. You do not treat them kindly *as though* they were equals. (The Indians are quick to see through you.) Weitlaner taught us to treat the Indians as equals: a secret simple yet elusive. As the poet said, truly 'this is the famous stone that turneth all to gold'.

I am repeatedly asked what the future holds for our entheogenic mushrooms and the other entheogens. My interest being in proto-history and Early Man, this question is beyond the scope of my inquiry. Whether chemists and therapists will find some lasting use for the extraordinary substances that we have discovered in these strange plants, I will not predict. Today we know, as Early Man did not, that the active agents are certain chemicals with a precisely defined molecular structure. Early Man thought they were miracle plants that spoke to him with the voice of God. In these times we cannot accept this, though there is a possibility that these chemicals in some way unlock the door to extrasensory perception in some people. The awe and reverence that these plants once evoked seem to me gone for good. Their utilization for 'recreation' is, certainly, a passing fad. The world offers too many opportunities for exciting explorations and discoveries to justify any such activity on a large and lasting scale.

More than fifty years have passed since Valentina Pavlovna and I started on mushrooms. She was a Russian, a Muscovite, and a practicing pediatrician in New York. I began life as a newspaper man and after almost ten years switched to banking, where I stayed for more than thirty-five years, retiring for age on 30 June 1963. Neither of us was qualified in any of the disciplines that the pursuit of our avocation called for. Neither of us was a mycologist nor even a botanist, nor archæologist, nor anthropologist, nor folklorist, nor in the technical sense a linguist, nor had we made of literature or history any special study. I suppose most persons would call us deeply religious, though we did not really adhere to any creed. She was a member of the Russian Orthodox Church and I am an Episcopalian, my father having been a minister. We began our inquiries among our friends and almost before we knew it our circle of friends began to expand. As questions arose we directed them, at first by letter, to those best qualified to answer them, and on our far-ranging travels we sought the acquaintance of those who seemed to be promising sources of information. This we did with unremitting zeal. Many of our new friends were academicians, others were amateurs in the original meaning of that word, but many were humble people often unlettered and these included some of our most valued informants: one of these was a Slovak, a cleaning man in my bank, who opened the doors for me to the Slovakian mushroom vocabulary, my excellent friend Nicholas Kazenchak. My wife died on 31 December 1958 late in the evening and after her death I carried on alone.

In this book the attentive reader will observe that I avoid certain words commonly used in treating our subject. We do not call the entheogens 'narcotics': the etymology from 'narcosis', sleep, is so obvious that the word is inappropriate and misleading for substances that keep one, willy-nilly, wide awake. We refrain from using 'witch doctor', a denigrating term for the herbalist who in his day knew the plant world well and has taught our medical profession many secrets, some of major importance. Nor do I speak of the peoples who are my subject as 'barbarians' or 'savages', as used to be our wont, epithets of contempt that ill become anyone in our day to apply to other peoples. We of the twentieth century have earned a prior lien on those titles of dishonor.

I cannot even guess how many advisers and informants we have had. If we have contributed something to man's understanding of his past, we may fairly say, I think, that this is due to our not being specialists and to our faculty for tapping information from all sources, of low and high degree. We often said to each other that we were only *rapporteurs* digesting as best we could what our sources had to say. Naturally there are half a dozen counsellors who loom large in our thinking, who indeed were indispensable to us in making headway. Conspicuous among them is Roger Heim to whom this book is dedicated.

What guardian angel had me in his keeping when, after the Second World War, I ascended the steps of Professor Heim's laboratory in Paris to meet him for the first time, a stranger, an American, an ignoramus in the intricate, the vast, the exacting discipline that was his! At once he made me feel at home and soon he came to share our enthusiasm for ethnomycological inquiries. (At that time we had no inkling of our future Mexican discoveries.) With Valentina Pavlovna and our daughter Masha, in the early '50's, we made an excursion together to Serignan near Orange in the Rhone Valley, to the home of Henri Fabre (his '*harmas*') where we selected the Fabre watercolors that we reproduced with infinite care in *Mushrooms Russia & History*. Roger Heim was electrified by our discoveries in the seasons 1953, 1954, and 1955 in Mexico and he accepted at once my suggestion that he join us on field trips to the Mazatec country, the Mixeria, and the Chatino enclave in 1956, 1959, and 1961. When we brought out early in 1959 our joint work, *Les Champignons hallucinogènes du Mexique*, it was he who, without my knowledge, dedicated it to the memory of Valentina Pavlovna, and who in its pages and also in his *Revue de Mycologie* carried to a successful conclusion a minor but vexatious mycological polemic that threatened to disturb the even tenor of our work. Later, again on my initiative, we made two extraordinarily fruitful field trips, one to the Kumá people below Mount Hagen in New Guinea in 1963 and the other in 1967 to the Simlipal Hills and thereabouts in Orissa (India) and the Santal Parganas in Bihar. Altogether our trips, our thick files of correspondence, our many publications vastly enriched Valentina Pavlovna's life and mine.

For upwards of forty years Roger Heim was the chief in Paris of the Laboratoire de Cryptogamie and the editor of the *Revue de Mycologie*. From 1951 to 1965 he also bore the burden of the direction of the Muséum National d'Histoire Naturelle, that renowned center for advanced teaching and research in biological studies, one of the glories of French culture, and for a term he was also Président of the Académie des Sciences. But these titles to academic distinction, though themselves of the highest order, do not tell the whole story. Vast as is his learning and experience in field and laboratory, sound as is his judgement in the vexed problems that beset mycologists, formidable as he is in polemic, it is as a rare human being that I best remember him. Patient with the beginner, inspiring as a teacher, model of generosity toward others, prodigious worker, classical stylist in the French language, who could be more delightful whether in his published writings, or in his correspondence, or as a companion in the field? In the presence of Roger Heim, the timeworn conflict between science and the humanities fades away. One senses that the field of science for him is merely the New World that civilized man, the exponent of the humanities, is exploring and assimilating. It is an honor for me to be privileged to record thus publicly our debt to this beloved friend, this distinguished French scientist and Academician.

★

Chapter 1 tells the story of the all-night shamanic vigil of Mesoamerica where the divine mushrooms (or other entheogens) are 'consulted'. I have often told what happens at these *veladas* and for some of my readers this covers ground more or less familiar, but Chapter 2 dealing with the traits of the *velada* and kindred topics is largely new. Here I begin to present a fresh interpretation of the rôle of the entheogenic mushrooms in the life of the Mesoamerican Indians before and after the Conquest. I have relied heavily on the detailed studies of specialists, many of which, in the past twenty years, have revealed telling evidence, linguistic, archæological, anthropological. It seems to me that a common denominator unites these studies, a common denominator overlooked by the scholars who have not seen the wood for the trees. But they have supplied the indispensable components for the portrait that I offer of mycolatry in Mesoamerica, and I seize this opportunity to express my boundless gratitude to each of them. They alone have made this book possible.

My argument is many-faceted. I treat one facet in each chapter and each chapter is complete in itself. But this means that occasionally, for the reader's convenience, the same evidence is repeated in the new context. I repeat the evidence and remind the reader that it has appeared before. The 'Consulted Texts', beginning on p 231, consist of sources actually used and quoted in my book and, to reduce the footnotes, I have added to the entries therein the pages that I cite without precise source in the text.

The following abbreviations, familiar to all students of Mexico's past, occur from time to time in our text and often in the 'Consulted Texts':

AGN: Archivos Generales de la Nación
INAH: Instituto Nacional de Antropología e Historia
INI: Instituto Nacional Indígenista
UNAM: Universidad Nacional Autónoma de México

R. GORDON WASSON
Honorary Research Fellow, Botanical Museum, Harvard University
Honorary Research Associate, New York Botanical Garden

The Present

CHAPTER 1
A *Velada* in Huautla

My first encounter with María Sabina was on Wednesday 29 June 1955, late in the afternoon. Allan Richardson, my friend and photographer, and I had arrived in Huautla the day before and Valentina Pavlovna with our daughter, Masha, was expected toward the end of the week. It was my third trip to Mexico in quest of the sacred mushrooms and our second visit to Huautla. Before noon I made my way down the steep, rough alleys to the town hall, called in Mexico the *municipio*. Unsuccessful in finding any first class shaman who would talk with us, much less celebrate the rite for us, I was increasingly impatient. I was even willing to present myself to the town officials, and if they seemed propitious, to solicit their help. I found only one man in the bare barn-like loft that served as the office of the *Presidente*: a man about thirty-five years old, athletic, with a genial, outgoing, honest smile. He was the *síndico* of the town, the No 2 man, Cayetano García Mendoza, now acting *Presidente* in the absence of his chief. After we had exchanged greetings, we discussed the outlook for the maize crop, the prices of coffee. Then and there, encouraged by the frankness of this excellent man, I made up my mind to put to him the vital question. (I had been cautioned never to consort with town officials: they are often a bad lot, sly, self-seeking, sometimes downright dishonest or unfriendly.) I leaned over the table and in a low voice said, 'May I take you into my confidence?' At once he was all curiosity, his face suddenly grave. 'Will you help me to learn the secrets of the *ˀnti*^{1}*xi*^{3}*tjo*^{3}?' I remember the way he threw his arms back in surprise at the question and at my knowing the Mazatec word for the sacred mushrooms. Without hesitating he said that nothing was easier, and to come to his house at the hour of the siesta. He lived at the other end of town, called *el Plan de la Salida*, about a mile away. Later, when I joined Allan Richardson, he was as excited as I at the possibility that, finally, we were to make a break-through.

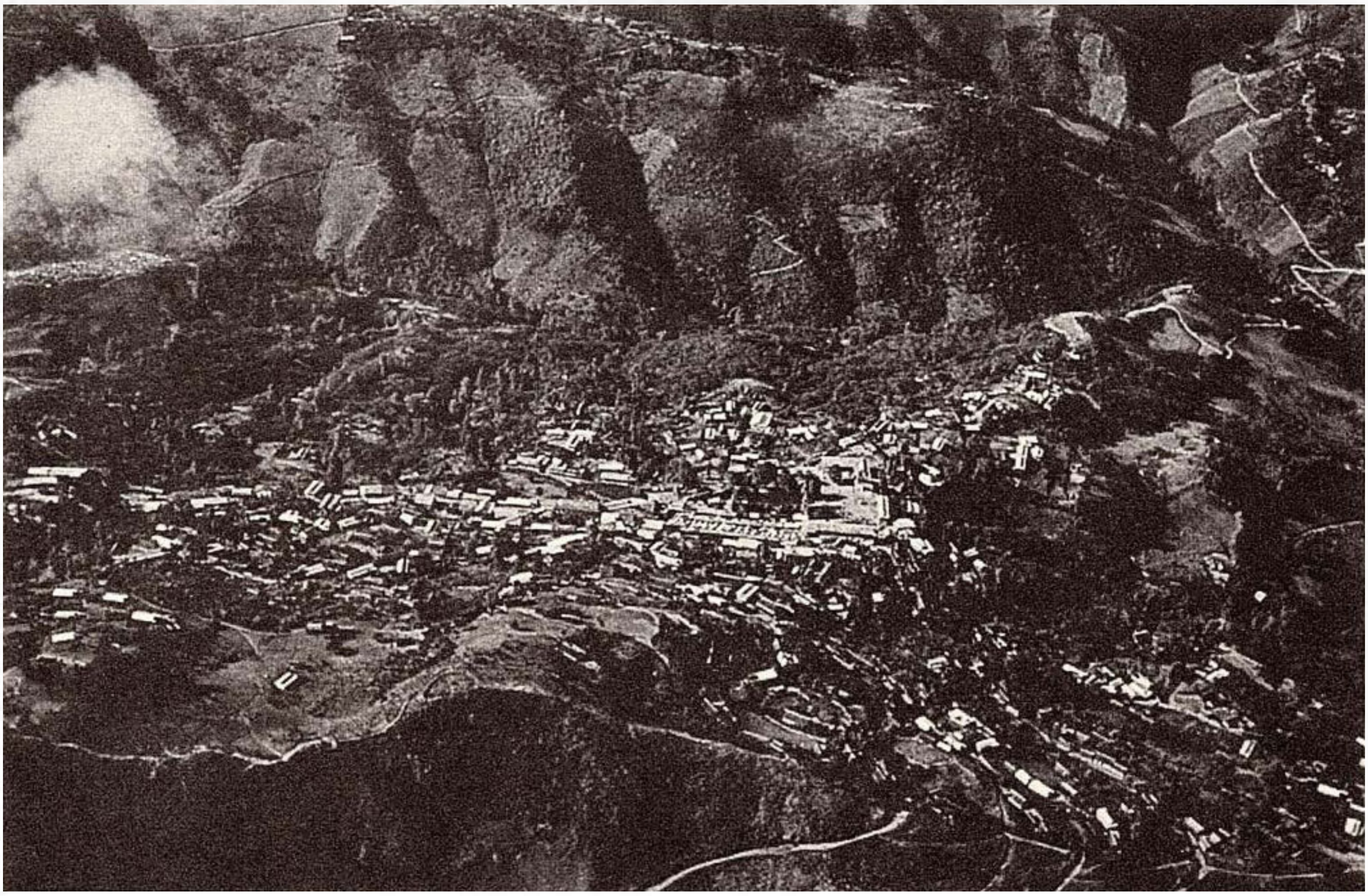


Fig 1 Huautla de Jiménez as seen from the air in 1956

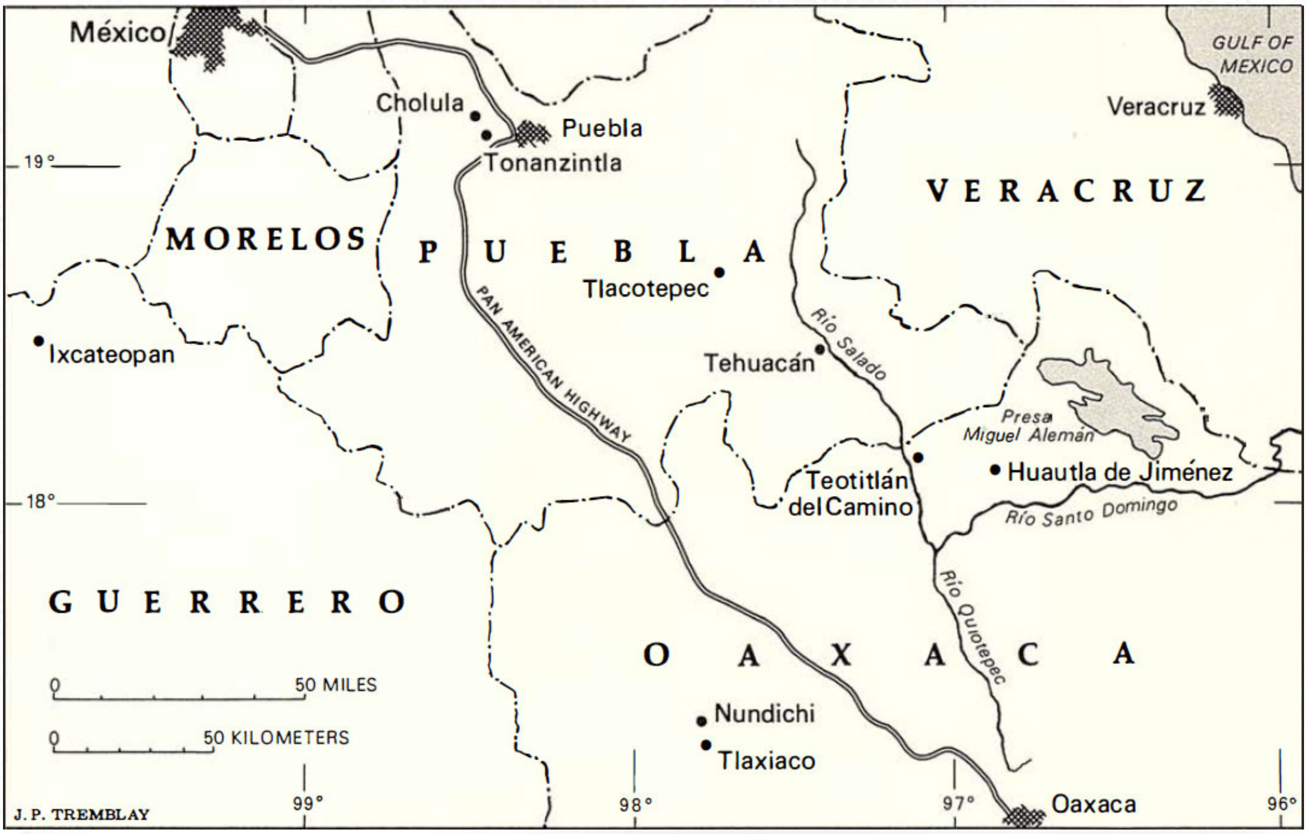

México
Cholula
Puebla
Tonanzintla
GULF OF MEXICO
Veracruz
VERACRUZ
19°
MORELOS
PUEBLA
Tlacotepec
PAN AMERICAN HIGHWAY
Río Salado
Ixcateopan
Tehuacán
Presa Miguel Alemán
Teotitlán del Camino
Huautla de Jiménez
Río Santo Domingo
18°
Río Quiotepec
GUERRERO
OAXACA
0
50 MILES
0
50 KILOMETERS
Nundichi
Tlaxiaco
J. P. TREMBLAY
99°
98°
97°
Oaxaca
96°

Fig 2 Map of central Mexico with the Mazatec country shown in relation to Mexico City, the city of Oaxaca, and Veracruz

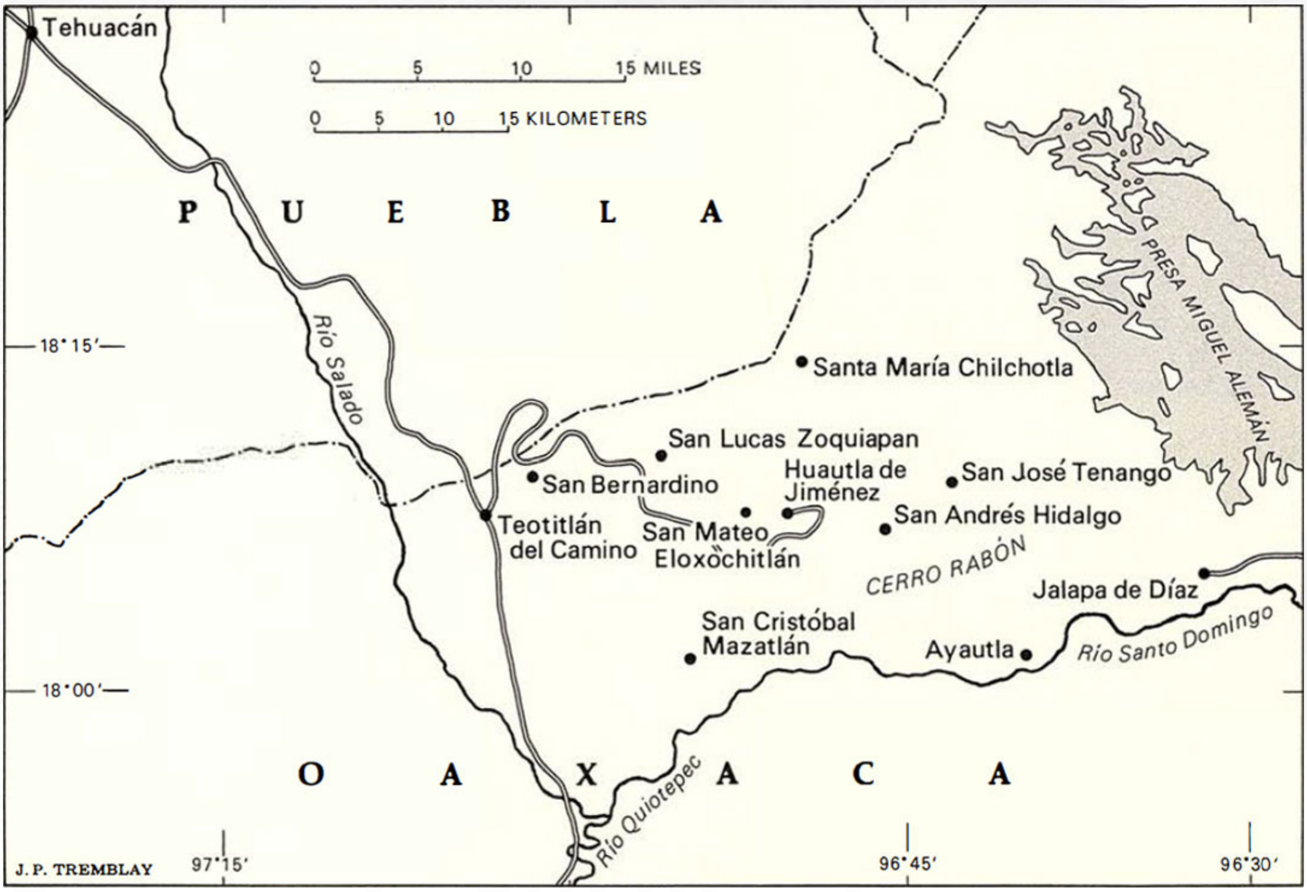

Tehuacán
0
5
10
15 MILES
0
5
10
15 KILOMETERS
PUEBLA
PRESA MIGUEL ALEMÁN
18°15′
Río Salado
Santa María Chilchotla
San Lucas Zoquiapan
San Bernardino
Huautla de Jiménez
San José Tenango
Teotitlán del Camino
San Mateo Eloxochitlán
San Andrés Hidalgo
CERRO RABÓN
Jalapa de Díaz
San Cristóbal Mazatlán
Ayautla
Río Santo Domingo
18°00′
OAXACA
Río Quiotepec
J. P. TREMBLAY
97°15′
96°45′
96°30′

Fig 3 Map of Mazatec country. The villages shown are those named in our text

A little after 4 o'clock Allan and I found Cayetano at home reclining in his hammock and taking his ease. Cayetano's house opens directly on the village thoroughfare running along the mountain side. You enter on the upper level from the road, and then inside the house, by a small trap-door in one corner, you make your way down a steep and twisting stairway to the floor below, where the events that we are about to relate took place. (See chart, Fig 5)

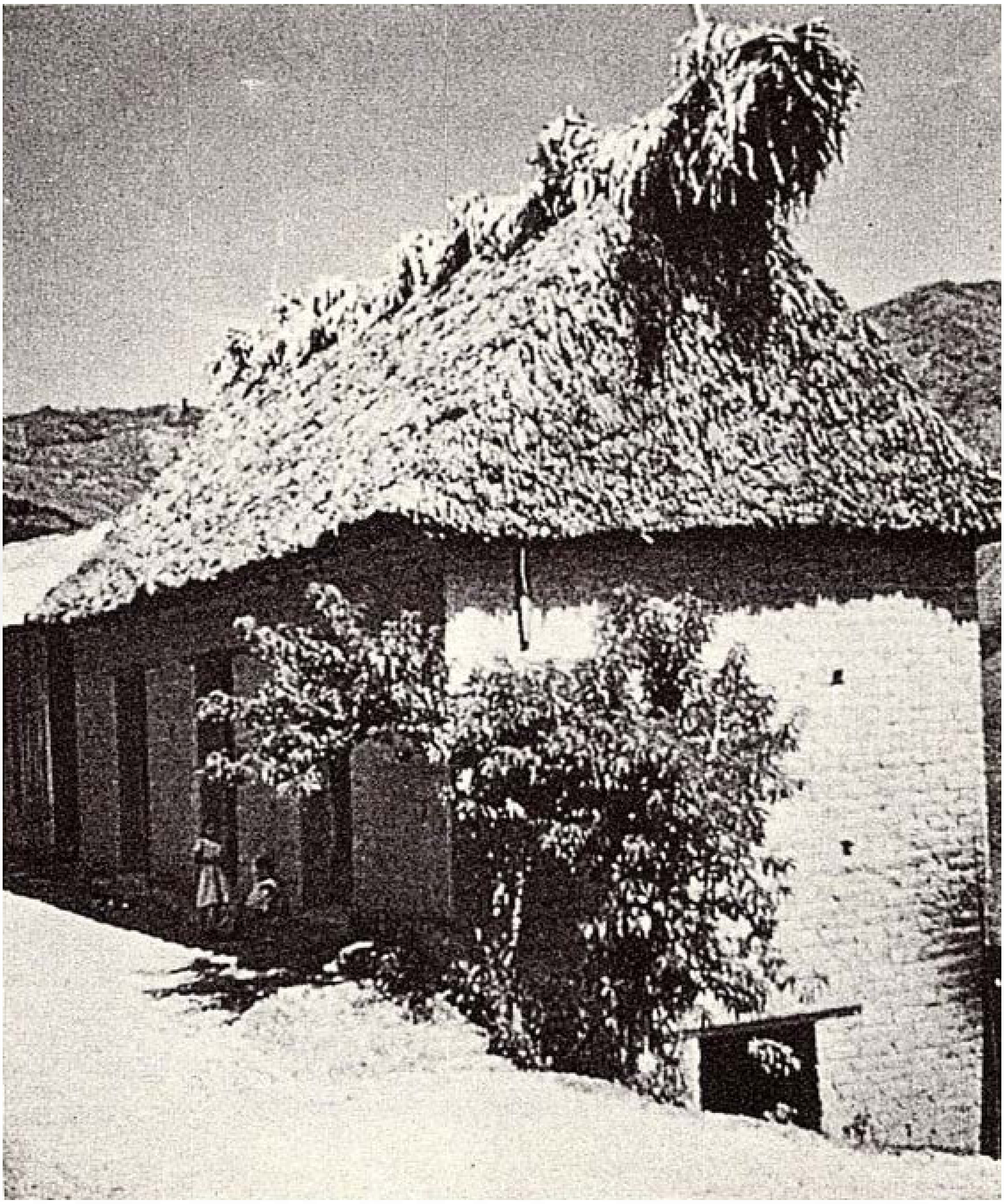


Fig 4 The home of Cayetano García in which the *velada* took place. Door leading to lower chamber is partly visible. Photo taken in 1955

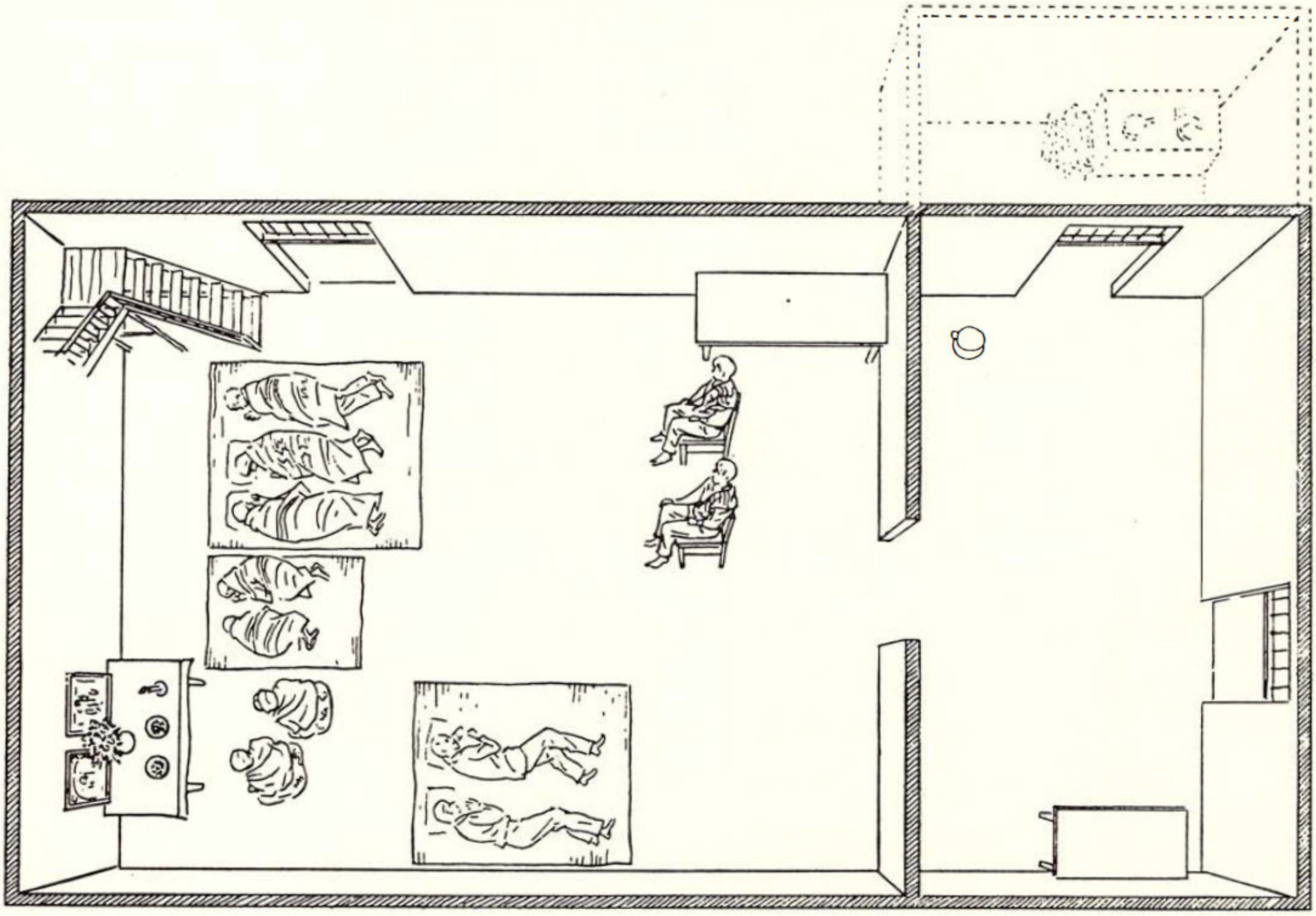


Fig 5 Chart of the room where the *velada* took place

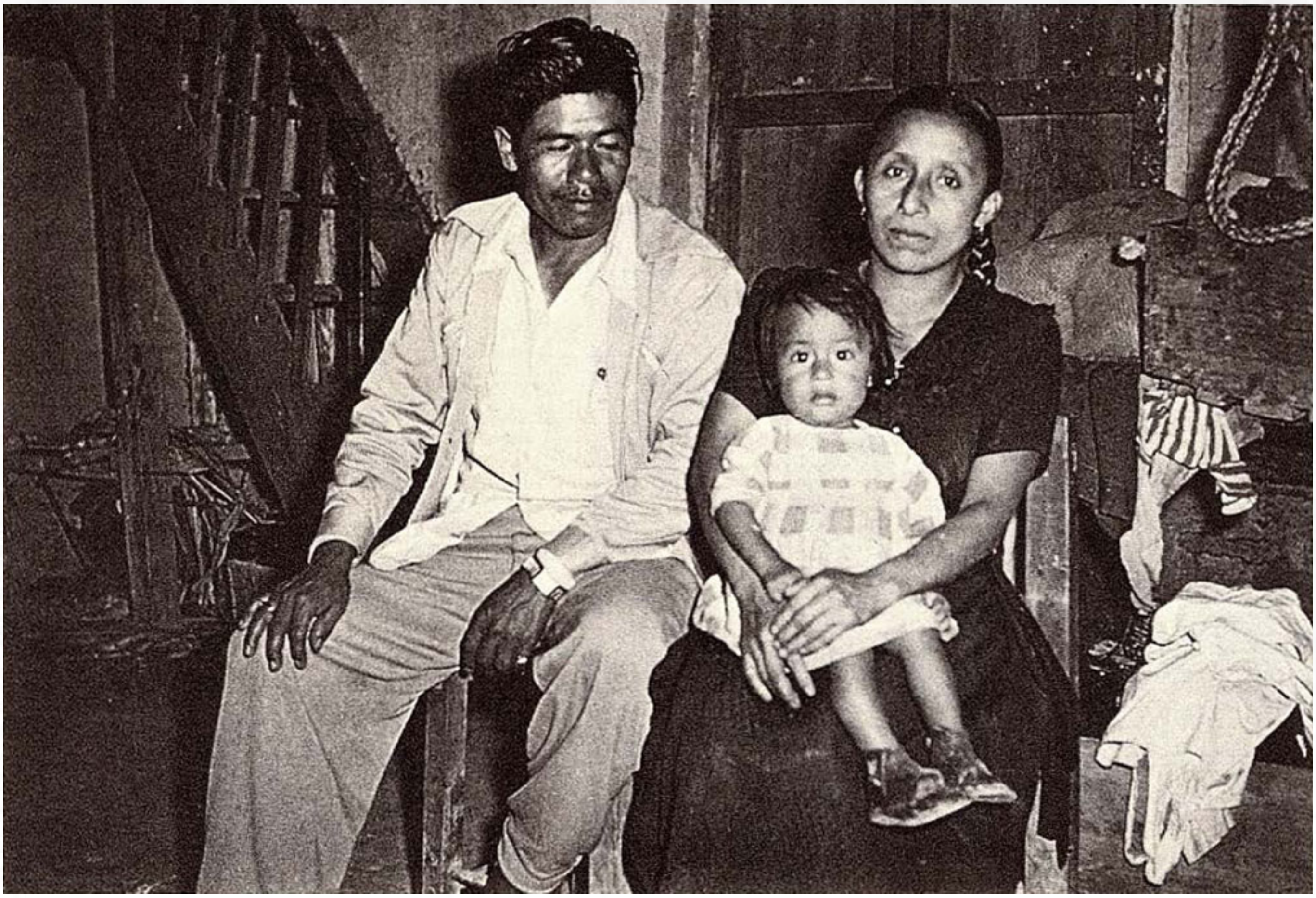


Fig 6 Cayetano García and Guadalupe his wife, with infant

Without leaving his hammock, Cayetano asked his younger brothers Genaro and Emilio to take us down into the gully and show us the mushrooms. And so, a little past 4 o'clock on that Wednesday, down we went perhaps a hundred yards below, to the edge of the stream in the gully. How hot and muggy it was! In the lower reaches of our descent we skirted a field planted to sugar cane, and then arrived at the spot where the cane had been milled, a flat space the size of a threshing floor, thick with rotting bagasse, as the refuse from the mill is called. There in the previous year's bagasse, just as Cayetano had promised, we found an immense crop of mushrooms growing in clusters, of the sacred kind known to our Mazatec friends as *^{ʔ}nti^{1}ki^{3}xo^{3}*, 'landslide', but a mushroom then unknown to me. We photographed them to our hearts' content. We gathered them in a pasteboard box: the sacred mushrooms must always be carried in a closed parcel, never exposed to the view of the passer-by. They were a goodly lot, mostly young, all of them perfect in their moist health and fragrance. With our pasteboard box filled and closed, we carried them up the steep mountainside to the house. We were warned that if we saw arty dead animal on the way, the mushrooms would lose their virtue - happily we saw none. It was in the rainy season, and in the humid heat of that sunny afternoon the climb was long and exhausting.

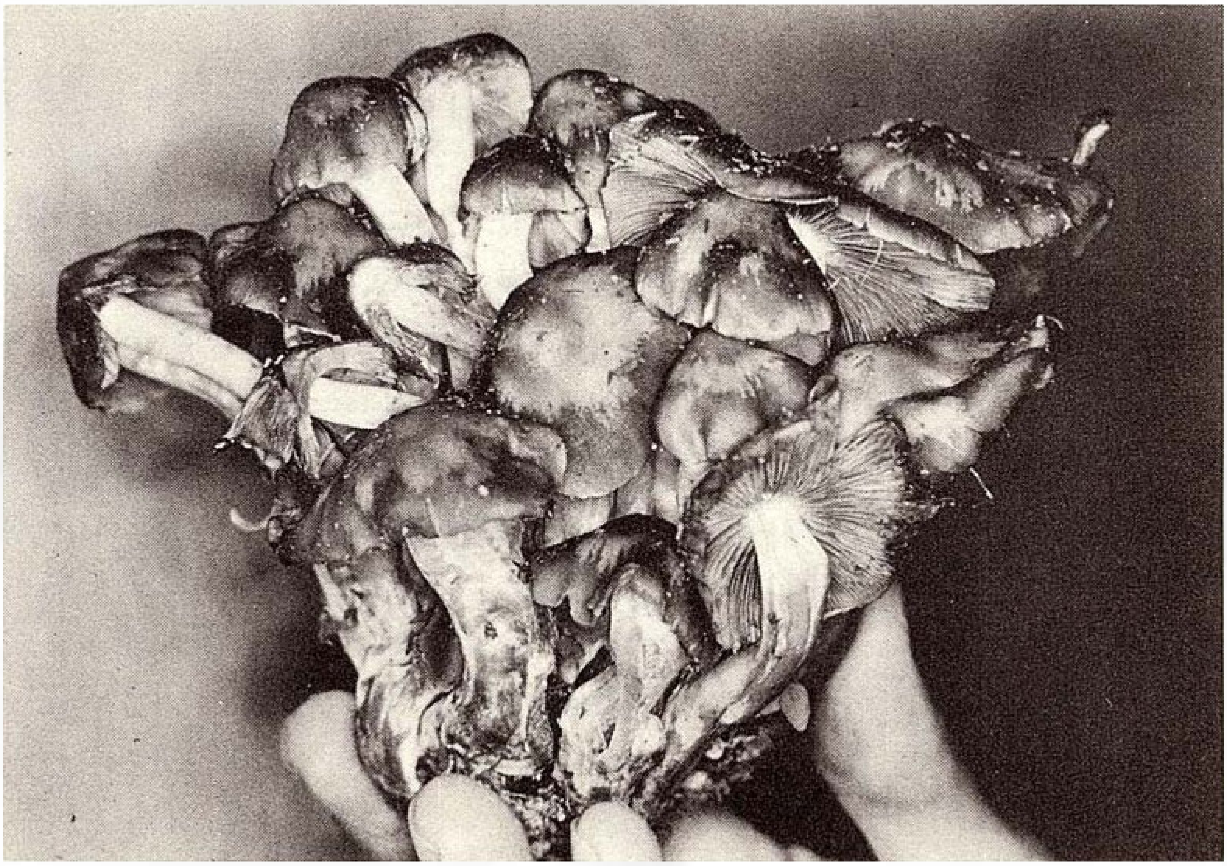


Fig 7 The Sacred Mushroom used in the *velada*, *Psilocybe caerulescens* Murrill var. *mazatecorum* Heim; called in Mazatec 'Landslide Mushroom': *^{ʔ}nti^{1}xi^{3}tho^{3}, ^{ʔ}nti^{1}ki^{3}xo^{3}*

Hardly had we arrived back when Cayetano sent us, with his brother Emilio as interpreter, to a cottage some distance farther up, where he said we would find a *curandera de primera categoría*, a top flight shaman, María Sabina by name. We were to ask her whether she would help us that night. We found the Señora, as our hosts always called her, resting on a *petate*, or mat woven of a palm. She was alone with a daughter who was up and about. After introducing ourselves through Emilio, we showed them our mushrooms, whereupon the two women went into joyful exclamations over their fine condition and beauty. We put our question to the Señora, and without hesitation, looking steadily at us, she said yes, and would we please be in Cayetano's lower room after dark. Neither she nor her daughter spoke a word of Spanish. We do not know whether they had been told to expect our visit. (After writing this I came upon a remarkable interview with María Sabina, written by Alberto Ongaro and published in *L'Europeo* in Milan on 25 November 1971, sixteen years and more after the event, in which she said that the Syndic of Huautla, don Cayetano, had asked her to serve me, why she knew not, and she had felt she had no choice. '*I should have said no.*')

María Sabina was a woman in her fifties, grave in demeanor, with a grave smile, short of stature like all

Mazatecs, dressed in the Mazatec *huipil*. Her daughter was in her thirties and in all respects took after her mother. She was following her mother's vocation. The Señora herself was at the peak of her powers, and it was easy to see why Guadalupe, Cayetano's wife, had said to us of her that she was *una Señora sin mancha*, a lady without blemish, immaculate, one who had never dishonored her calling by using her powers for evil. She alone, said Guadalupe, had brought the latter's children through all the diseases that take a frightful toll in early childhood in the Mazatec country. After that initial talk we were to pass many all-night vigils[5] with María Sabina and her daughter, and we can testify that she was a woman of rare moral and spiritual power, dedicated in her vocation, an artist in her mastery of the techniques of her office. It was her example that drove home for us for the first time a rule that must govern all field anthropologists. In the archaic cultures as among advanced peoples, there is a hierarchy of excellence when it comes to the individuals who are the culture bearers. It is not sufficient to rely on the first informants who present themselves, on any shaman who is willing to talk. The whole cultural area must be discreetly surveyed and communication must be established with the finest exponents of the old traditions. None of the formidable difficulties of physical existence in these remote regions nor of communication should be allowed to blunt this obligation.

On that last Wednesday of June, after nightfall, we gathered in the lower chamber of Cayetano's house. This lower story is built on one side against the mountain face, and on the other side by a door it leads to a terrace perhaps six feet wide, which then falls sharply away into the ravine about 300 feet below. Across the valley and beyond, the Sierra Mazateca in all its verdant glory fills the distant view. On the terrace at one end of the house a flimsy wooden thatched annex had been constructed to serve as a kitchen. The interior was divided by a whitewashed adobe wall into two rooms. (Chart p. 6, Fig. 5) There is no window in either room, but over the door on the terrace a transom admits some light. This room was well sheltered from the life of the village and doubly so after dark when the villagers refrain from stirring abroad. The family circle was large: our hosts' small children were numerous and Cayetano's brothers and parents were also much in evidence. Chickens and turkeys had the run of the lower floor. A black hen sitting on her eggs on one of the cluttered tables was a silent witness to what went on. In all, at one time or another, there must have been a dozen persons present, mostly members old and young of Cayetano's family. The Señora came with her daughter Apolonia. They and all the others were pleased when we photographed them, and we took numerous pictures throughout the preliminaries, except for Cayetano's father and mother, who steadfastly refused. But the Señora requested through Cayetano that when the power would seize her - *cuando la fuerza le agarrara* - we should desist, and of course we did so. Cayetano had his ten-year-old daughter serve us chocolate to drink, graciously but somewhat ceremonially. (We learned later that the daughter must be a virgin, *una doncella*.) At once my thoughts flashed back to Bernardino de Sahagún in the sixteenth century, who quoted his informants as saying that chocolate was served before the mushrooms were taken. I turned to my companion: 'Allan', I said, 'this is it. We are in for it, for better or for worse!' Cayetano also offered us coffee and sweet wheaten bread, neither of which had been known to his ancestors in pre-Conquest Mexico, which we declined. Both Allan Richardson and I were deeply impressed by the mood of the gathering. We were received and the night's events unrolled in an atmosphere of simple friendliness that reminded us of the agapé of early Christian times. There was no familiarity. The mushrooms were treated respectfully, as sacred, but without marked formality. The proceedings went forward with an easy decorum. Neither on this occasion nor at any other time or place have we ever seen or heard the mushrooms treated as a subject for jocular vulgarity, of the kind that often marks the use of alcohol among 'civilized' peoples. The atmosphere of respectful friendliness was infectious, and we enjoyed reciprocating the welcome extended to us. There is no record that any white men had ever attended a session of the kind that we are going to describe, nor that white men had ever partaken of the sacred mushrooms under any circumstances. For reasons deeply rooted in the mortal cultural conflict of Spaniards and Indians, it is unlikely that any unrecorded event of the kind had ever taken place. By hearsay Sahagún, Ruiz de Alarcon, and other early Spanish writers had reported gatherings of Indians where the hallucinogen was served to many, but we had thought from our previous visits to Mexico that such observances were today unknown. We were now to learn that they still go on, and that they are even today a central experience in the culture of the Mazatec people. The gatherings now are held behind closed doors, but as the 'consultation' with the Sacred Mushroom is a private, domestic matter, must not such gatherings always have been private?

---

[5] We picked up from Spanish-speaking Mazatecs of Huautla the word *velada* as the designation of the all-night vigil of the shaman. Only years later did we learn from Alvaro Estrada, a Mazatec, that María Sabina used the Mazatec equivalent, *je^{2}xi^{3}vi^{3}jna^{3}choan^{3}-ve^{4}*, meaning 'what keeps us awake', *eso que nos desvela*.

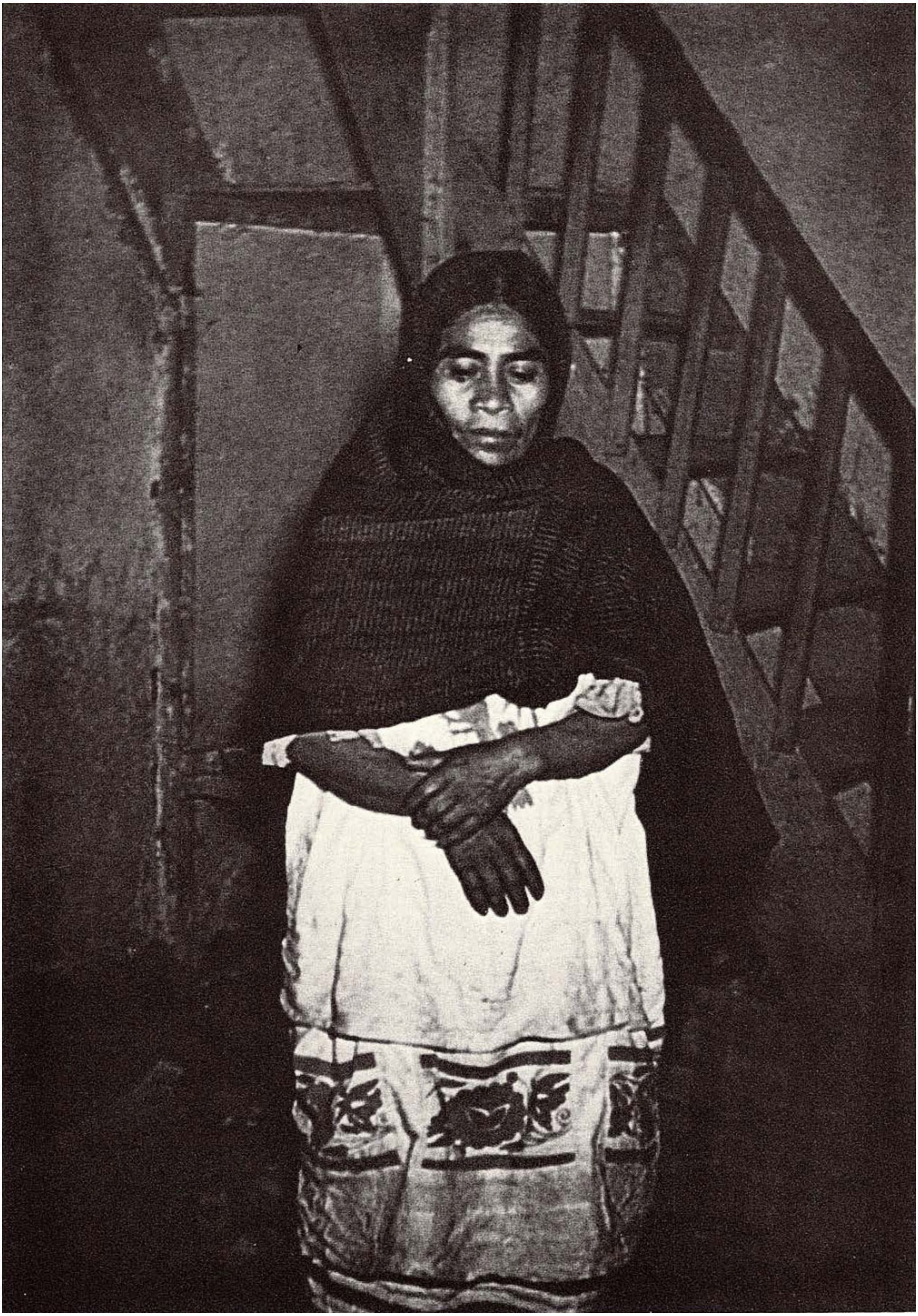


Fig 8 María Sabina

Cayetano told us early in the evening that no one on any account should leave the house before break of day, and for the necessities of nature he showed us the rudimentary provision that had been made in one corner of the other room. The contempt of the Spaniards for indigenous rites and the Church's condemnation of them as idolatrous heresies have not killed these assemblies of ancient lineage but have certainly driven them under deeper cover. Our hosts were obviously pleased by our intense and sympathetic interest in all that went on before our eyes. The very fact of our participation must have made the evening memorable for them. They were dressed up for the occasion. Genaro in particular was resplendent in his handsome striped *sarape* and his freshly washed white cotton trousers or bags, *bombachas*, which Indian-style were buttonless, being supported by strings tied around the waist. By our respectful behavior we did all we could to make clear that for us the rite we were witnessing possessed full religious stature. We were mindful of the drama of our situation. We were attending as participants a mushroomic Supper of unique anthropological interest, which was being held pursuant to a tradition of unfathomed age.

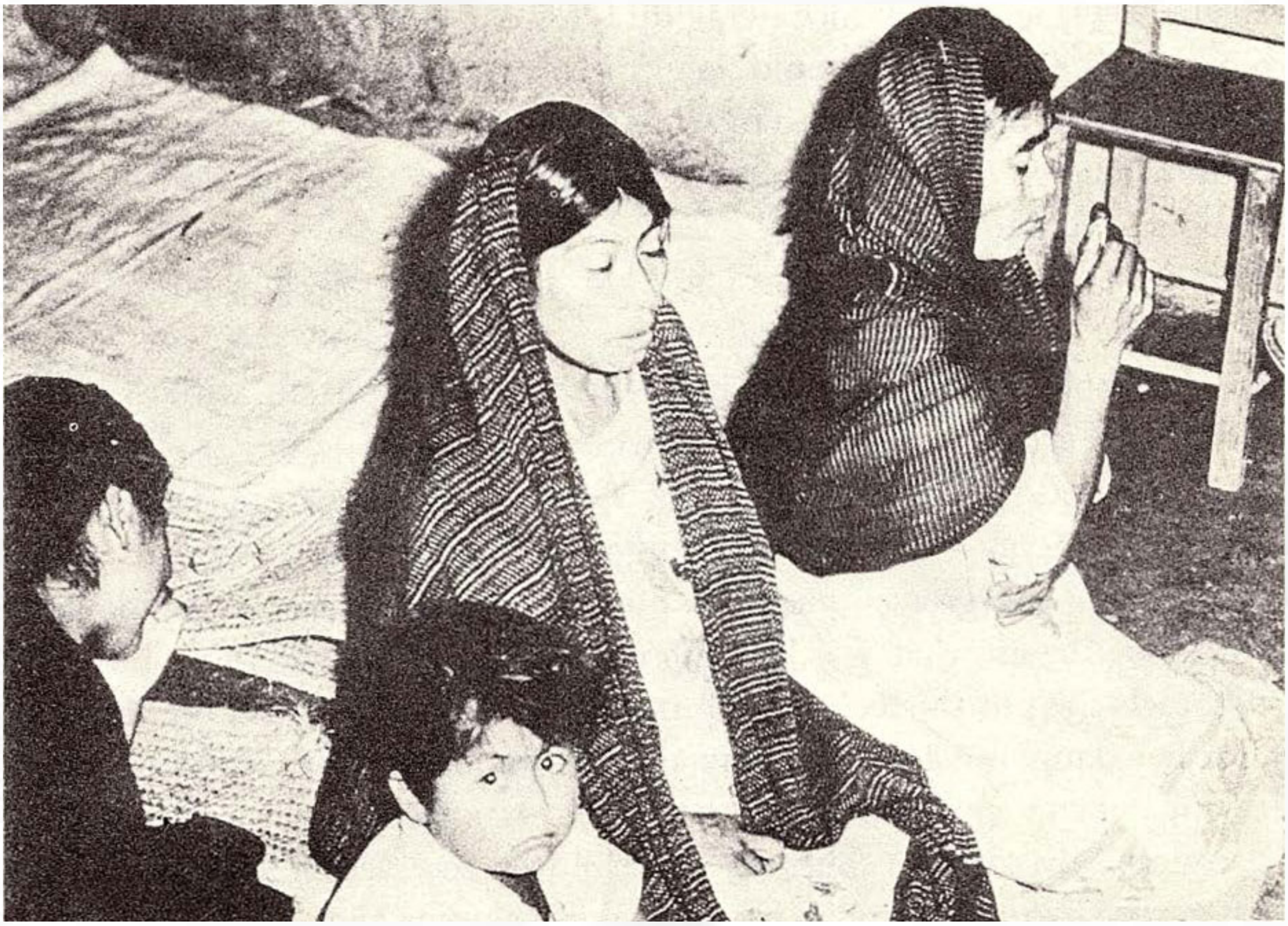


Fig 9 Adoration of the Mushroom. María Sabina, *sabia*, and her daughter Apolonia. Huautla de Jiménez, June 29-30, 1955

There were a few home-made wooden chairs in the room, and in the beginning Allan and I used them, my chair in the corner of the room to the left of the altar table. Cayetano's brother Genaro and possibly one other remained seated on chairs the whole night through. The others lay or reclined on mats on the floor, wrapped in *sarapes*, except of course for the Señora and her daughter, who, wearing clean *huipiles* with identical red birds embroidered on them, sat before the altar table on mats. They sat with what seemed a half-studied formality, the daughter a little behind her mother and slightly to her mother's right. Later, in the dark, we could barely discern their triangular shadows as first one and then the other lifted her voice in song. It was then, when the details were erased by darkness and only the geometric mass persisted, that they forcibly reminded me of the pyramids that are the outstanding feature of architecture in pre-Conquest Mexico. Might not the pyramids have been originally a geometric stylization of the worshipping Indian seated on his mat, of the gods that were his magnified projection of himself?

Before we go further we must mention that when we had bespoken the Señora's services in the afternoon, she had asked us what problem was troubling us. Prepared for this, I asked about our son Peter, then in the army.

How was he? Alive or dead, or ill, or in good spirits, or in some trouble? This had seemed to her a sufficient justification. We had counted on Cayetano to stay with us through the night as our guide and interpreter. We observed that neither he nor Guadalupe were taking the mushrooms. As we were finishing ours, Cayetano informed us that he and his wife were withdrawing up the stairs and through the trap-door to the room above, where they would guard us against interruptions from the street. He was leaving his brother Emilio to act as our mentor. We sensed that each of the other adults who were taking the mushrooms was consulting María Sabina, as we were, about individual problems.

At about 10: 30 o'clock the Señora and her daughter took their positions before the small table that served for an altar. On it were two holy pictures, on the left the Holy Child of Atocha and on the right the Baptism in Jordan, with a bouquet in front of them, a crucifix hidden in the flowers, three lighted candles of virgin beeswax, and a lighted wick in a glass of wax. There were also two pottery bowls and some cups. The Señora then went through our box of mushrooms, brushing off with her fingers the grosser pieces of dirt and passing them in her hand over *copal* (incense of resin) that was burning on a metal lid on the floor. Into each of the two bowls she put thirteen pair of mushrooms; one bowl was for her and the other for her daughter. Into each cup she put four pair, or five, or six, and then handed the cups to the grown-ups who were to take them. (The mushrooms are always counted by pairs, in couples.) The children received none. They were profoundly moved by the singing and events taking place in their presence. To me she handed a cup with six pair. Our readers will imagine my joy at this dramatic culmination to years of pursuit. Then she handed a cup with six pair to poor Allan. Mary, his wife, had reluctantly consented to his coming with me only on his solemn promise not to let those nasty toadstools cross his lips. He faced a behavior dilemma, but to have refused might have disappointed our friendly Indian companions, and so he coped with the immediate problem first and took the cup. (Later, with him safely back in New York, Mary gave him ready absolution.) By now all lights in the room were out except the wick in the glass. Following the Señora's example, we began to chew and swallow our mushrooms.

Our *curandera* ate cap and stem and we did likewise. She ate them one by one, with utmost gravity, chewing each one for a long time. She did not pick them up by pairs, as Aurelio Carreras had done in 1953. She picked them up one by one, although in apportioning them she had counted them by pairs. The flavor of the mushrooms is acrid and unpleasant. The distinctive flavor would repeat itself, as a gaseous beverage does, and pervade the nasal passage. I have since discovered that the Indians, by contrast with us, find the taste delectable. (Long afterwards Robert Weitlaner likened the taste to rancid grease, a taste unfamiliar to us. At the time this narrative is being written, in 1977, I have eaten many species of the divinatory mushrooms used in Mesoamerica, and they are all marked by this singular and unforgettable taste and aftertaste, which seem to be the veritable signature of the divine species.)

We all ate our mushrooms facing the wall where the small altar table stood. We ate them in silence, except for Cayetano's father, don Emilio, who was consulting the mushrooms about his infected left forearm. He would jerk his head violently with each mushroom that he swallowed, and utter a smacking noise, as though in acknowledgement of their divine potency. As I said before, I had been seated in the corner of the room on the left of the altar, a vantage point from which I could observe everything that was happening. Through Cayetano, the Señora asked me to move because the Word would come down there.

Twenty years later, in telling the story of her life to Alvaro Estrada, the Señora explained her conception of 'the Word': in a notable passage she says:

> ... veo que el Lenguaje cae, viene de arriba, como si fuesen pequenos objetos luminosos que caen del cielo. El Lenguaje cae sobre la mesa sagrada, cae sobre mi cuerpo. Entonces atrapo con mis manos palabra por palabra.
> [*La Vida de María Sabina*, p 58, 126]
>
> ... I see the Word fall, come down from above, as though they were little luminous objects falling from heaven. The Word falls on the Holy Table, on my body: with my hand I catch them, Word by Word.

The Señora conceives a mystical opening ('*boquete*') in the roof or high up in the wall. In her mind she adds another dimension to the matters that we discuss further in Chapter 7.

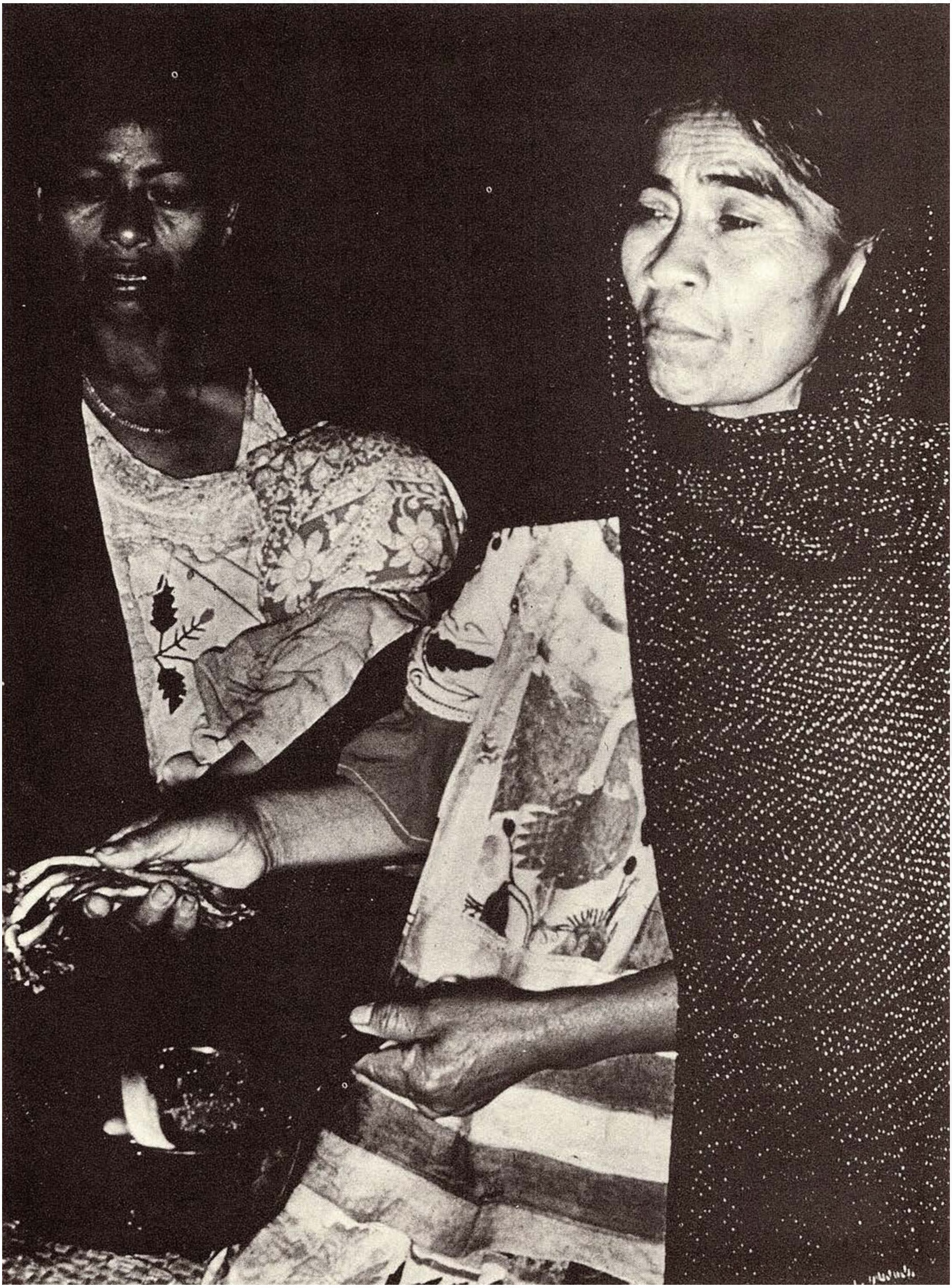


Fig 10 María Sabina incensing the mushroom, 12-13 July 1958, with Apolonia

I joined Allan on my chair immediately behind the Señora. We took about a half hour to eat our six pair of mushrooms. By eleven o'clock we had all finished our respective portions, the Señora crossing herself with the last swallow. Then we waited in silence. After about twenty minutes the Señora plucked a flower from the bouquet and with it inverted as an extinguisher put out the last of the *velas*. We should have been in stygian darkness, but by good fortune the night was clear and a gibbous moon, by the transom above the door, gave us just enough light to make our darkness visible.

At about 11:20 o'clock Allan leaned from his chair and whispered to me that he was having a chill. We wrapped him in a blanket. A little later he leaned over again and said, 'Gordon, I am beginning to see things', to which I gave him the comforting reply that I was too. Allan lay down along the wall on the large *petate* that had been spread for us, and shortly afterwards I joined him.

Except for the children who had eaten no mushrooms, no one slept that night until about 4 o'clock in the morning. (The last entry in my notebook carries the hour 3:50.) There was no inclination to sleep. At all times we were alert both to our subjective experiences and to the goings-on around us in the dark. I took imperfect notes intermittently and kept track of the hours. But Allan and I were both alive to the fact that we were not ourselves. I was of two minds about the mushrooms. On the one hand I wished to experience them to the full, to know what the Indians were experiencing, and on the other hand I wished to fight off any effects and remain the detached observer. But the mushrooms gave me no choice. They took full and sweeping possession of me. There is no better way to describe the sensation than to say that it was as though my very soul had been scooped out of my body and translated to a point floating in space, leaving behind the husk of clay, my body. Our bodies lay there while our souls soared. We both felt nauseated; twice I made my way to the other room to vomit, Allan three times. One or two others, not identified in the darkness, did likewise. (I remember how disappointed I was at throwing up: I feared I would not feel the full effect!) But these episodes seemed of no moment. For we were both seeing visions, similar but not identical visions, and we were comparing notes in whispered interchanges. At first we saw geometric patterns, angular not circular, in richest colors, such as might adorn textiles or carpets. Then the patterns grew into architectural structures, with colonnades and architraves, patios of regal splendor, the stone-work all in brilliant colors, gold and onyx and ebony, all most harmoniously and ingeniously contrived, in richest magnificence extending beyond the reach of sight. For some reason these architectural visions seemed oriental, though at every stage I pointed out to myself that they could not be identified with any specific oriental country. They were neither Japanese nor Chinese nor Indian nor Moslem. They seemed to belong rather to the imaginary architecture described by the visionaries of the Bible. In the aesthetics of this discovered world Attic simplicity had no place: everything was resplendently rich.

At one point in the faint moonlight the bouquet on the table assumed the dimensions and shape of an imperial conveyance, a triumphal car, drawn by zoological creatures conceivable only in an imaginary mythology, bearing a woman clothed in regal splendor. With our eyes wide open, the visions came in endless succession, each growing out of the preceding one. We had the sensation that the walls of our humble house had vanished, that our untrammeled souls were floating in the empyrean, stroked by divine breezes, possessed of a divine mobility that would transport us anywhere on the wings of a thought. Now it was clear why don Aurelio in 1953 and others too had told us that the mushrooms *le llevan ahí donde Dios está* - would take you there where God is. Only when by an act of conscious effort I touched the wall of Cayetano's house would I be brought back to the confines of the room where we all were, and this touch with reality seemed to be what precipitated nausea in me.

On that night of 29-30 June we saw no human beings in our visions. (The woman in regal attire was certainly not human.) On the night of 2-3 July I again took mushrooms in the same room, with the Señora again serving as votary. If we may anticipate our story, on that second occasion my visions were different. There were no geometrical patterns, no edifices of oriental splendor. The patterns were replaced by artistic motifs of the Elizabethan and Jacobean periods in England - armor worn for fashionable display, family escutcheons, the carvings of choir stalls and cathedral chairs. No patina of age hung on them. They were all fresh from God's workshop, pristine in their finish. The beholder could only sigh after the skill that might have fixed those beauteous shapes on paper or in metal or wood, that they might not be lost in a vision. They too grew one out of the other, the new one emerging from the center of its predecessor. Here as in the first night the visions seemed freighted with significance. They seemed the very archetypes of beautiful form and color. We felt ourselves in the presence of the Ideas that Plato had talked about. In saying this let not the reader think that we are indulging in rhetoric, straining to command his attention by an extravagant figure of speech. For the world our visions were and must remain 'hallucinations'. But for us at that moment they were not false or shadowy suggestions of real things, figments of an unhinged imagination. What we were seeing was, we knew, the only reality, of which the counterparts of every day are mere imperfect adumbrations. At the time we ourselves were alive to the novelty of this our discovery, and astonished by it. Whatever their provenience, the blunt and startling fact is that our visions were sensed more clearly, were superior in all their attributes, were more authoritative, for us who were experiencing them, than what passes for mundane reality.

Following the visions that we have already described, on both occasions I saw landscapes. On Wednesday they were of a vast desert seen from afar, with lofty mountains beyond, terrace above terrace. Camel caravans were making their way across the mountain slopes. On Saturday the landscapes were of the estuaries of immense rivers brimming over with pellucid water, broad sheets of water overflowing into the reeds that stretched equally far from the shore line. Here the colors were in pastel shades. The light was good but soft as from a horizontal sun. On both nights the landscapes responded to the command of the beholder: when a detail interested him, the landscape approached with the speed of light and the detail was made manifest. When I was seeing the camel caravans in the distance, an impulse seized me: right away I was upon them, listening to the sounds of their heavy breathing, to the camel bells, to their lurching with their loads, smelling their stench. On Saturday there seemed to be no birds and no human life in the river estuary, until a rude cabin suddenly appeared with a motionless woman nearby, seated on a block of stone. She was a woman by her figure and face and costume, and of course the vision was in color. I could see her breathing. But she was a statue in that she sat there without expression, doing nothing, staring into the distance. She might be compared to those archaic Greek sculptures where the woman gazes into space, or, better yet, the departing woman on the Greek funerary stele who looks into eternity, except that our vision was of a living woman whereas the Greek sculptures, marble white, are mere imitations in stone of what we were seeing. Elsewhere I once wrote that the bemushroomed person is poised in space, a disembodied eye, invisible, incorporeal, seeing not seen. In truth he is the five senses disembodied, all of them keyed to the height of sensitivity and awareness, all of them blending into one another most strangely, until the person, utterly passive, becomes a pure receptor, infinitely delicate, of sensations. What you are seeing and what you are hearing appear as one: singing and percussive beat assume harmonious shapes, giving visual form to their harmonies, and what you are seeing takes on the modalities of music - the music of the spheres. Likewise with your sense of touch, of taste, of odor: all your senses seem to function as one. My olfactory sense has always been weak, but now for the first time I entered into the world of odors, delicate iridescent harmonies in which other creatures spend their lives.

On both nights I stood up for a long time in Cayetano's room, at the foot of the stairway, holding on to the rail, transfixed in ecstasy by the visions that I was seeing in the darkness with open eyes. For the first time that word 'ecstasy' took on subjective meaning for me. 'Ecstasy' was not someone else's state of mind. It was no longer a trite superlative cheapened by overuse and abuse. It signified something different and superior in kind, about which I could now testify as a competent witness. There came one moment on Saturday when it seemed as though the visions themselves were about to be transcended, and dark gates reaching upward beyond sight were about to part, and I was to find myself in the presence of the Ultimate. I seemed to be flying toward those august gates as a swallow at a dazzling lighthouse, and the gates were to part and admit me. But they did not open, and with a thud I fell back breathless and gasping. I felt disappointed, but also frightened and half relieved, that I had not entered into the presence of the Ineffable, whence, it seemed to me at the time, I might not have returned, for I had sensed that a willing extinction in the divine radiance had been awaiting me.

(Later in the Zapotec country, the shaman Aristeo Matías told us in a stirring parable the four stages that one must go through from the initial surprise and mental disorder until one finally arrives at the mastery of the mushroom. Here was fatherly advice from an old hand to us who had told him that we aspired to enter upon his vocation. He was telling us that there is or at least can be a growth, an evolution, in the entheogenic experiences induced by the mushrooms. After many experiences with the mushrooms I do not doubt what don Aristeo said. At first the beginner is confused and lost in wonder, but with repeated experience he comes to deal with the mushrooms on equal terms. His initial disorientation contrasts sharply with the discipline that the shaman shows, who has taken an immense dose and whose performance is timed to a nicety, even syncopated.)

Throughout that night in June we were split in the very core of our being. On one level, space was annihilated for us and we were traveling as fast as thought to our visionary worlds. On another level we were lying there on our *petates*, trying to take notes, Allan and I exchanging whispered comments, alive to every twitch and twinge in our heavy (oh so heavy!) earth-bound bodies of clay. At the same time we were both held in thrall by what was going on in the room around us. For the Señora and her daughter were engaged all night in a religious performance that we had not expected and that no one had ever described to us.

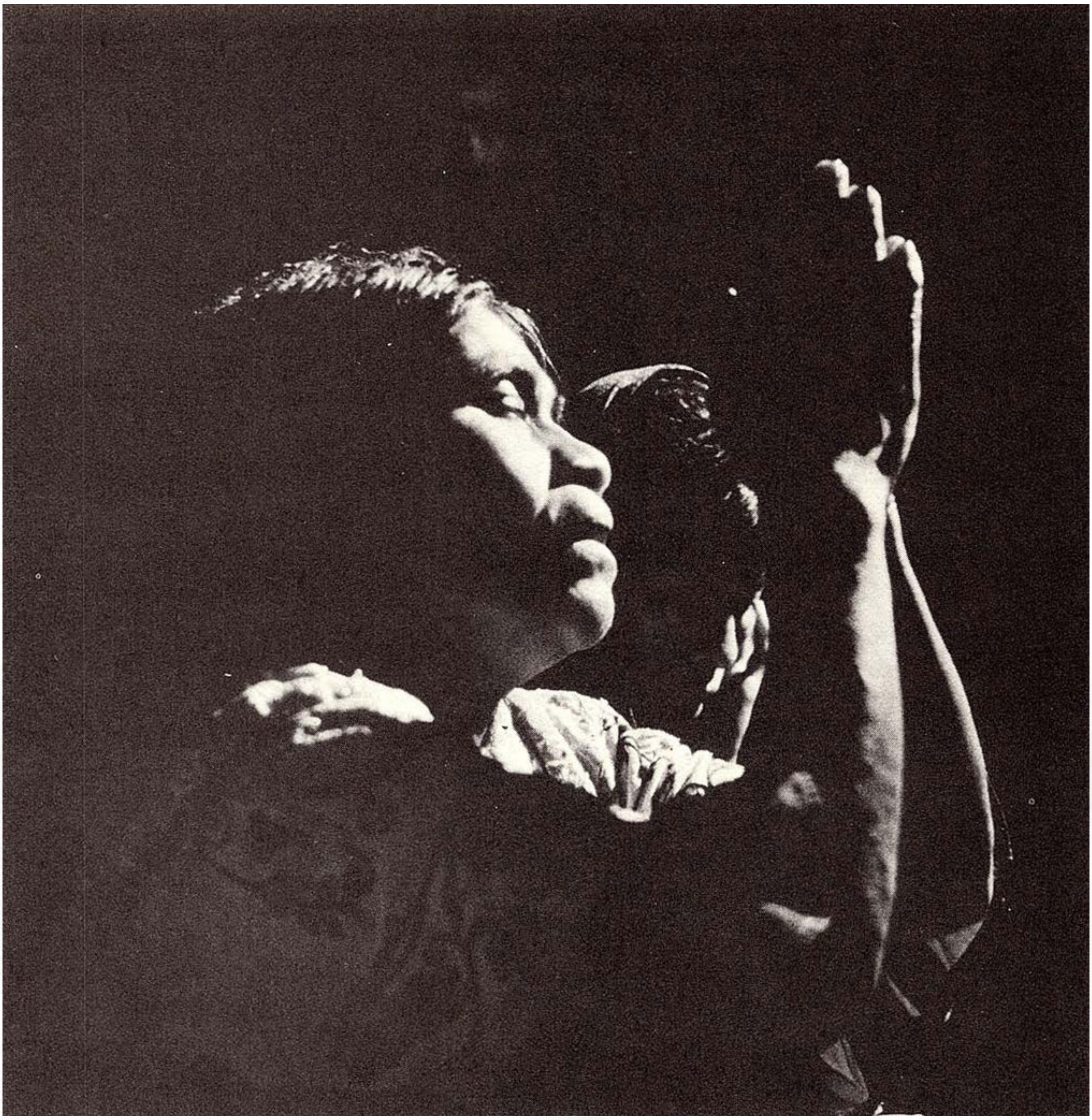


Figure 11 María Sabina invoking the Sacred Mushrooms

After the Señora had put out the last *vela*, a silence of perhaps twenty minutes followed. The moon was shining brightly outside, and its orbit was such that the shaft of moonlight entering above the door fell squarely on the altar table, but it did little to relieve the general darkness in the room. Suddenly the Señora began to moan, low at first, then louder. There were silent pauses, and then renewed humming. Then the humming stopped and she began to articulate isolated syllables, each syllable consisting of a consonant followed by a vowel, sharply pronounced. The syllables came snapping out in rapid succession, cutting the darkness like a knife, spoken, not sung. After a time the syllables coalesced into what we took for words, and the Señora began to chant. The chanting continued intermittently all night, first by the Señora and then by her daughter, and afterwards alternately by one or the other. The chanting was in Mazatec, only occasionally in Latin or Spanish learned by rote, and there was no one to translate the words for us. I have since learned that most of the music was native in provenience. Both women chanted in that distinctive way which seems always to mark the intoning of age-old chants; much of the singing seemed to me soaked in weary melancholy. Our Señora's voice was not loud, probably not loud enough to be heard in the village thoroughfare. But there was a confidence and resonance in her utterance that imposed itself. There came a moment late in the night when the Señora made her way to the door on the terrace and went outside, holding her hand on the door. (She was free of the prohibition laid on the rest of us not to leave the house.) When she re-entered, she left the door slightly ajar, and we saw her advance on her knees across the open space in the room, and then turn to the right toward the altar table. Her hands were uplifted to shoulder level, palms exposed. As she slowly progressed, she sang a canticle that seemed like an introit, indescribably tender and plaintive in its musical phrases. Her daughter sang well too, but lacked her authority. From time to time, as they sang, the men who had taken the mushrooms, notably Genaro and young Emilio, ejaculated words, groans, short sentences, and vocal noises. We know not what they said, but they seemed to intervene with their voices to suit the singing, in such a way as to produce a strange harmony.

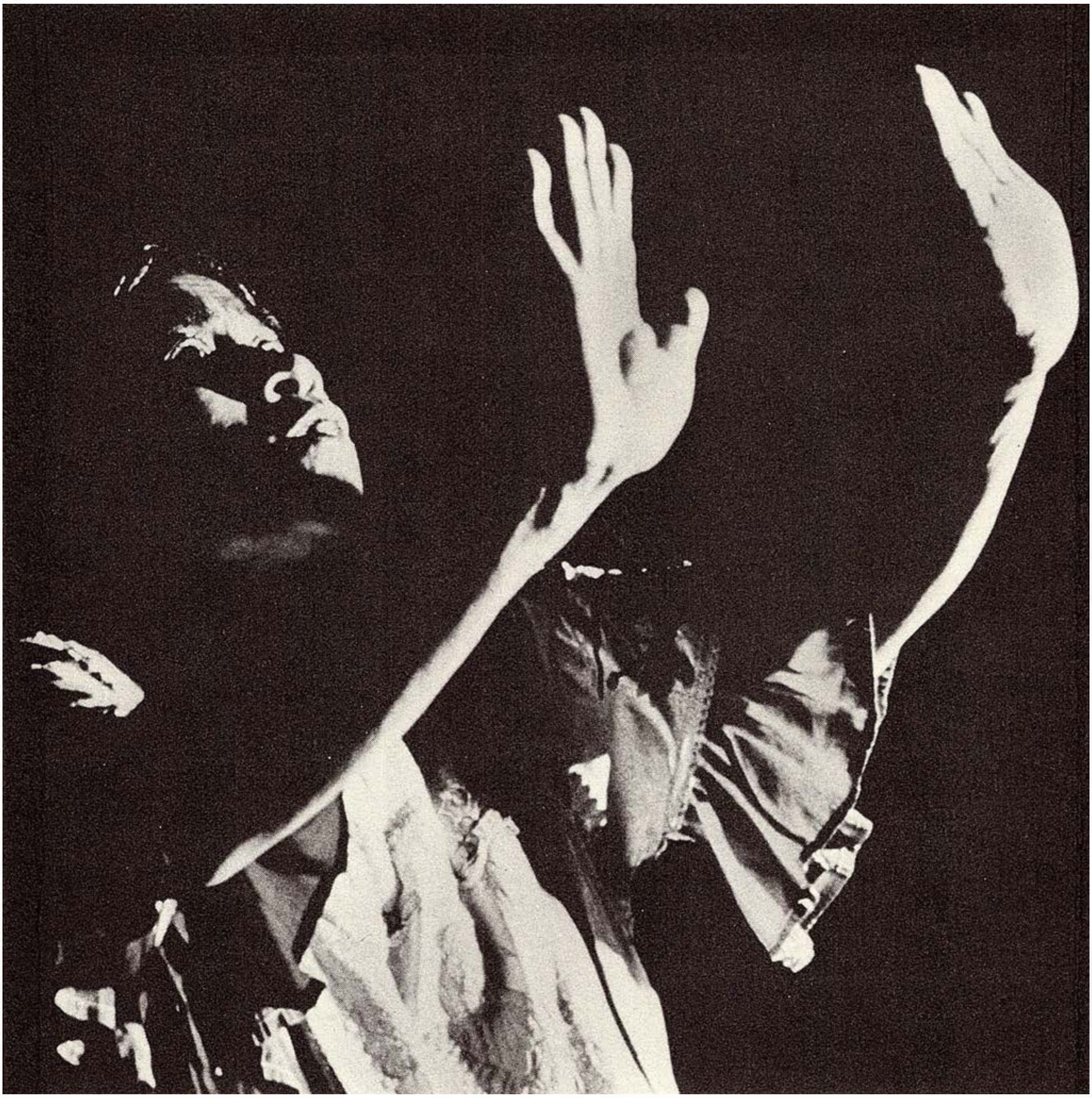


Figure 12

The singing was not continuous. For stretches the Señora would talk, as though invoking the Spirits or as though the Holy Ghost was speaking through the mushrooms. We heard the names of Christ (which she pronounced with an intrusive 'r', *Khristros*), of St Peter and St Paul. We heard her cry out 'Pedro' repeatedly in an imploring tone, and knew that the mushrooms were wrestling with the problem of Peter. Emilio made his way to us and whispered that Peter was alive and well, and contrite for not having let us hear from him. We asked for further details, but Emilio said that since we ourselves had eaten the mushrooms, we could expect them to speak to us directly. Our interpreter Emilio then vanished into the darkness for the rest of the night.

Unlike the chants, the spoken utterances were fresh and vibrant and rich in expressiveness. The mushrooms were talking to the point. We had never suspected how sensitive and poetic an instrument the Mazatec language could be. The intermittent snatches of the Señora's monologue seemed quick with subtle feeling, laden with dramatic import. In our very presence a priestess of the old religion was pronouncing oracular dictates in spurts, hot and firm with authority. How we regretted that we had no means to record her voice![6] (At the time we asked ourselves whether our critical faculties were deranged by the effects of the mushrooms, so that we overrated the quality of the Señora's performance. Later when we taped the singing, we found this was certainly so. But here is an aberration typical of the syndrome of mushroomic ecstasy, and our account at least serves to document it for the record, and to establish that our hallucinations were of all the senses, not merely visual.)

The chanting and the oracular utterances turned out to be only a part of what we were to witness. At an early stage we sensed that the Señora was either kneeling or standing before the altar table gesticulating with her arms. We detected this by ear and confirmed it uncertainly with the aid of the meagre moonlight. Then, much later in the night when her daughter took over the chanting, the Señora made her way to the open space between us and the door, and she embarked on a kind of dance that must have lasted for two hours or more. This is the only occasion when I have seen her dancing: in retrospect, clearly she was putting on for us a very special performance. We do not know precisely what she did, because of the darkness, but she was between us and the aperture above the door, and we could just make our that she was turning clock-wise, facing in succession each of the four compass points, at the same time raising and lowering her arms. Her daughter was singing, but she was not silent. She was engaged in a lengthy rhythmic percussive utterance of a kind unfamiliar to us. There was a differentiation in the pitch of the beats and at times the pattern or phrases seemed to us complex. We cannot say for sure how she made her sounds, but we surmised that she clapped her hands, slapped her knees, smacked her forehead, and whammed her chest. We were impressed by the cleanness of the utterance. Every clap or slap or smack or wham was resonant. The percussive effect varied sharply in timing and in volume, and was frequently syncopated. Remembering the rôle played by pitch in the Mazatec language, we asked ourselves whether the Señora was speaking percussively. On each of our two nights with her, she rinsed her mouth once with water, and the gargling was also rhythmic, and perhaps tonally differentiated. Then she would spit out the water on the ground unrhythmically. On Saturday night, in a moment of illumination by flashlight, we saw and heard her twicking her long finger nails rhythmically. A remarkable feature of her percussive utterance on Wednesday night was its ventriloquistic property. For a long stretch we were in the blackest darkness while the daughter sang and the Señora was performing her strange dance with percussive accompaniment. As she would snap out her resonant claps and smacks, we seemed to catch them out of the night from various directions. Let the reader remember that all the while we were seeing our visions *and* attending to the auditory sensations served to us by these two women. There we were, visually suspended in space before the vast panorama of, say, the Gobi Desert, with a singing accompaniment and with percussive cracks assailing us, now from above, now here, now there, exactly like Hamlet's ghost *hic et ubique*, hitting us with a cutting crispness from unpredictable quarters, from underneath us in a whisper, beyond our feet on the *petate*, out of the night, as though an air borne choir of invisible creatures was peopling the dark void around us, perplexing us with their assorted and shifting cries. Possibly this ventriloquistic effect was caused by the Señora's turning in different directions as she performed, so that the sound caromed to us from the ceiling or walls.[7] And all the while there was the irregular chorus, subdued in volume, of ecstatic exclamations from the Indians reclining on the ground. Confined though we were in a room without windows or open door, at one point we felt a swish of air, just as though we were really suspended in the great outdoors. Was this too an hallucination? If so, all shared it, for when the wind blew on us, there was general excitement, flashlights were switched on, and our Indian friends were sitting up, amazed at being stroked by the Divine Afflatus.

---

6. We published a partial recording of a *velada* held in 1956, Folkways Record and Service Corporation FR 8975. The translation and commentary were done by Eunice V. Pike and Sarah C. Gudschinsky. This was followed by a full-dress edition of a complete *velada* that took place in 1958: *María Sabina and her Mazatec Mushroom Velada*, Harcourt Brace Jovanovich, Inc., New York, 1974. George and Florence Cowan served as our linguists, Willard Rhodes as our ethno-musicologist. The translation of the 1956 *velada* was done afresh, into Spanish, by Alvaro Estrada with the cooperation of María Sabina and certain senior Huautecos, and published in 1977 in *La Vida de María Sabina*, pp 133-160.
7. Written in 1956 or 1957. But see pp 34-35 for the explanation of the ventriloquism.

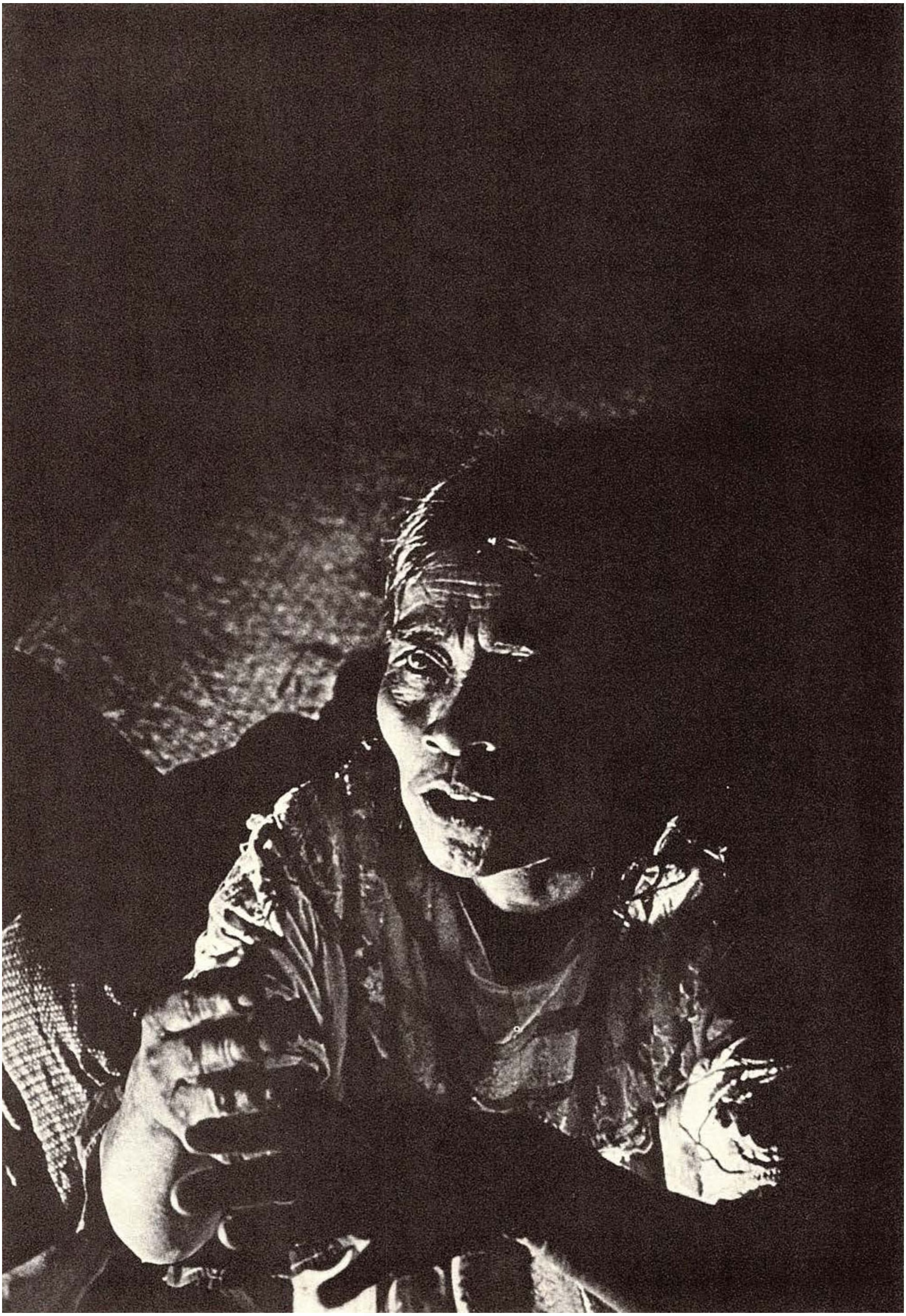


Figure 13

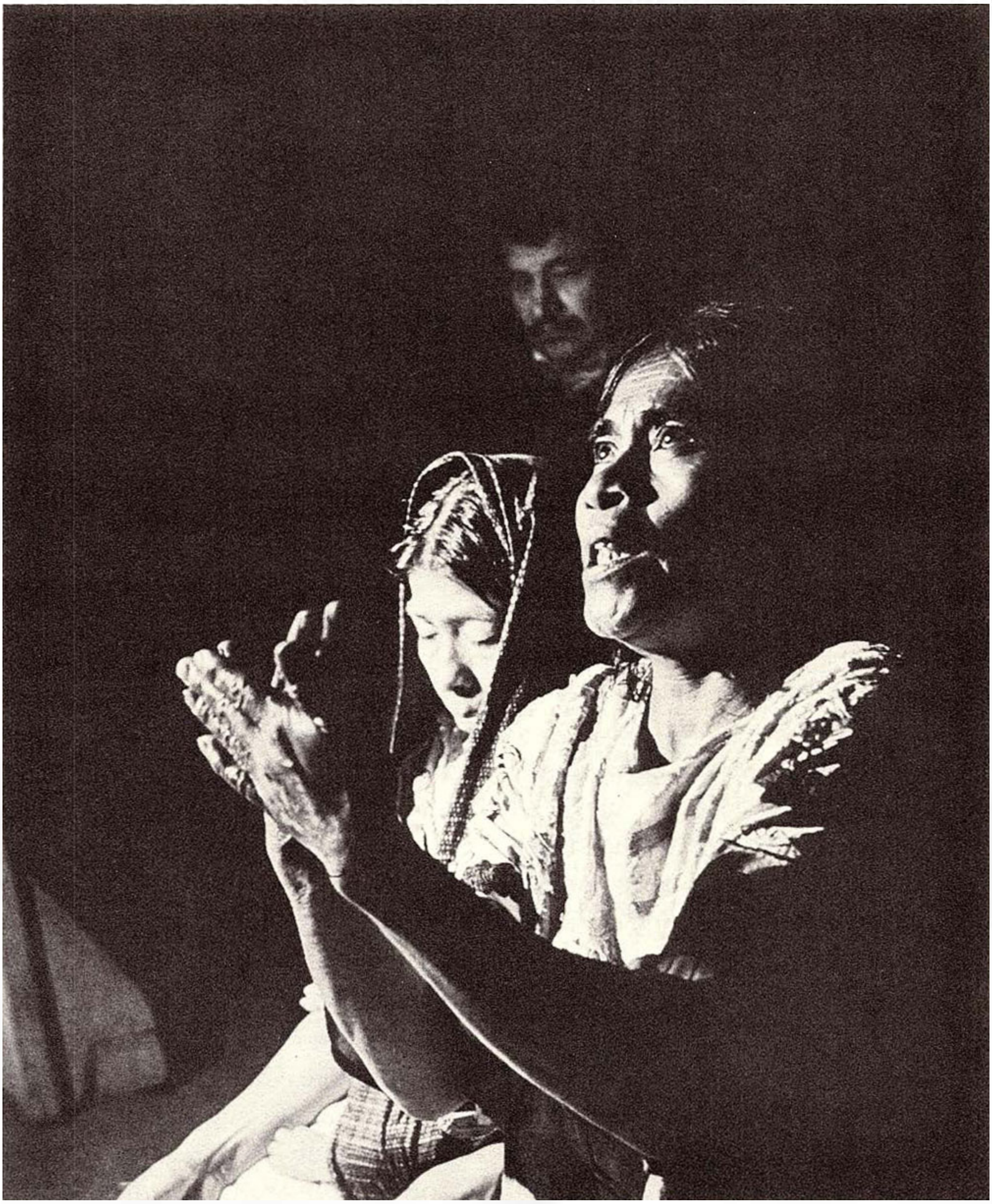


Fig 14 María Sabina invoking the Sacred Mushroom. Aurelio in background.

Suddenly in the night I made a discovery. In the light of a cigarette that someone was inhaling, I saw the Señora, who was performing her dance, lift a small bottle to her lips. From her posture the bottle seemed almost empty. A few minutes later she began to thump the butt end of the bottle on the *petate*. She did this with a fast, uniform, perfect beat, perhaps a hundred to the minute, and she kept at it for an eternity, minutes on end, until Allan and I could hardly stand it and groaned in agony. The iterated thump, somewhat resonant, became excruciatingly painful, a torture such as Poe might have described. After the night had passed and we were all getting up, I made it a point to find the bottle and smell it. There could be no doubt: it was the familiar six-ounce bottle of *aguardiente*, a distillate of cane. Presumably the Señora had shared it with her daughter, but of this we cannot be sure. We asked Cayetano about it. Yes, invariably the person who retains the Señora is expected to present her in advance with a *cuarto* (fourth of a litre) of this strong drink. We in our ignorance had neglected our duty, but Cayetano had come to our rescue. Recalling as we did how Aurelio and also our friends in the Mixe[8] country had all said that alcohol was tabu before, during, and after the consumption of the mushrooms, we are still at a loss how to reconcile the conflicting evidence. But of course the Señora's performance from first to last had differed from what Aurelio had shown us in 1953. We had now attended two all-night vigils, both using the sacred mushrooms, but otherwise utterly different from each other. Aurelio's divinatory liturgy, with the elaborate rôle in it of accessories, could conceivably go on without mushrooms, but in Cayetano's house the mushrooms were everything. We spoke to Cayetano about that other performance that we had seen in the Mazatec country in 1953. He knew all about that kind too, and he told us that the Señora was equally proficient in both ceremonies. We failed to learn, however, when one method is used in preference to the other.

At intervals throughout the night, perhaps every forty minutes or so, there would be what we can only describe as intermissions. After working up to a powerful climax in utterance, the Señora and her daughter would subside into silence. (We recall one such climax when the Señora, half singing, half declaiming, spat forth in endless repetition and with wild violence the syllable *chjon*. Afterwards we learned that this *chjon* meant 'Woman', and she was listing her own credentials as a shaman in addressing her supplications to the mushroom.) During such intermissions our two votaries and our reclining Indian friends would light cigarettes (ordinary ones) and smoke and engage in the most animated conversation. Clearly they were discussing what was happening but we had no interpreter. They would flash on electric torches. We took advantage of these moments to study the Señora. She was not in a trance. That is to say, she was one of us, talking and smoking. But she was in a state of excitement, her eyes flashing, her smile no longer that grave smile which we had observed before, but now quick with animation and, if we may use the word, *caritas*. For there is another major aspect to the mushrooms that we must mention. The spirit of an agapé of which we have already spoken was a prelude to an upsurge of generous or tender feelings that the mushrooms aroused in everyone. To illustrate this, we recall how, when nausea first sent me into the adjoining room to vomit, the Señora, who had been in full song, immediately stopped the performance, and she and the others manifested the most embarrassing (for me) solicitude about the unhappy episode, which after all was trivial. On the two nights that we passed in Cayetano's house, we were aware of no erotic stimulation among those present. But those who were present felt that we had entered into a warm bond together, by reason of the momentous night that we had spent in each other's company, and this bond I still feel. Twice in the course of that first night the Señora reached out her right hand to me and sought contact with my fingers in friendly greeting, across the chasm of the language and culture barrier. The Indians of Mesoamerica are known for their reticence in the display of affection, even within the family circle. It was now clear that the mushrooms emancipate them from inhibitions of this kind, and what we witnessed on Wednesday night was abundantly confirmed during our second session on Saturday, 2 July.

After the first performance Allan and I, quite stunned and even numbed by what we had witnessed, were disposed to say, 'Never again'. But by Saturday morning there were many questions that we needed to clarify, and so through Cayetano we asked the Señora if she would give us a repetition. This she agreed to do. We pled with her to let us take a few photographs by strobe flash while the power was on her. She said yes, and in the course of that night from Saturday to Sunday Allan took perhaps twenty pictures in the darkness, guessing of necessity as to the distance and direction. (It was raining in torrents all that night, so there was no moon.) But the Señora's behavior differed much from what we had seen the first time. Everything was reduced in scale. There was no dancing and virtually no percussive utterances. Only three or four other Indians were with us, and the Señora brought with her, not her daughter, but her son Aurelio, a youth in his late teens who seemed to us in some way ill or defective. He was now the object of her attention, not I. All night long her singing and her words were directed to this poor boy. Her performance was the dramatic expression of a mother's love for her child, an anguished threnody to mother love, and interpreted in this way it was profoundly moving. The tenderness in her voice as she sang and spoke, and in her gestures as she leaned over Aurelio to caress him, moved us profoundly. As strangers we should have been embarrassed, had we not seen in this shaman possessed by the mushrooms a symbol of eternal motherhood, rather than the cry of an individual parent. But by any interpretation this untrammeled and beautiful outpouring, incited by the sacred mushrooms, was behavior of a kind that few Middle American anthropologists would ever see.

On this second occasion Allan ingested no mushrooms, for the sake of his photography. The Señora asked me how many pair I would take, which I interpreted as a compliment to my status as one already initiated, and I

---

8. A remote people believed by some to be related to the Maya, having separated from them before the Maya culture had attained the heights that archæologists study and admire. We visited the Mixe in 1954 and again in 1959.

said five pair. The effect seemed as strong as I had experienced from the larger dose on Wednesday, but this time there was no nausea.

Our two nights with the Señora drew to a close in the same way. On the night of Wednesday-Thursday, our last notes seem to have been scribbled a few minutes before 4 a m, and soon afterwards we slipped off imperceptibly into a dreamless slumber. Apparently everyone else did likewise. At any rate, at about 6 o'clock we woke up, our heads clear. Some of the others were already stirring, and in a few minutes everyone was on his feet. I changed the roll in my camera and resumed picture-taking, as did Allan. Cayetano and Guadalupe asked after our welfare but were discreet in their inquiries about the night's doings. They served us coffee and bread. By 7 o'clock we were ready to sally forth into the world. We felt no untoward sleepiness that day.

Perhaps in some respects we can define better than we have done the psychic disturbance caused by the sacred mushrooms. On the one hand, they unhinge one's sense of time. Visions that seem to last an æon run their course in a minute or so. Only by reference to a time-piece does one keep track of the passing hours. On the other hand, the faculty of memory is heightened by the mushrooms. All the impressions, visual and auditory, are graved as with a burin in the tablet of my memory. My narrative of what took place has been checked with the notes that I jotted down at the time, but my memory is far richer and fuller than those notes.

What can we say about the source of the visions? Did they bubble up out of my own past? I have no conscious memory of having viewed previously the scenes that I saw. There was nothing in them that repeated themes familiar to me in my adult experience, no modern highways, cars, cities, no faces of friends or acquaintances. Yet all that I saw could be related to themes latent in my imagination, not necessarily things seen, nor even things seen in graphic representation, but those things transmuted afterwards in the imagination, imagined from reading, seen in the mind's eye.[9] All of the visions had that pristine quality which we associate most often with the magic of supreme literary expression, especially great poetry.

In the lives of us all, even those who are most earthbound, there are moments when the world stops, when the most humdrum things suddenly and unaccountably clothe themselves with beauty, haunting and ravishing beauty. It now seems to me that such flashes must emerge from the subconscious well where our visions have all this time been stored, for the mushroomic visions are an endless sequence of those flashes. There are those like Blake who have possessed the power to see such visions in abundance without the mushroomic stimulus. Could the mushrooms have done better by Blake than he did without them? What would they have shown him that he did not see? What precisely do our Indian friends see, with their different background? Clearly the visions come from within the beholder, either from his own subconscious or, as some will surely think, from an inherited fund of memories of the race. What an amazing thing that we should all be carrying this inventory of wonders around with us, ready to be tripped into our conscious world by mushrooms! Are the Indians far wrong in calling these divine? We suspect that, in its fullest sense, the creative faculty, whether in the humanities or science or industry, that most precious of man's distinctive possessions and the one most clearly partaking of the divine, is linked in some way with the area of the mind that the mushrooms unlock.

I have mentioned William Blake. Many years after the events here narrated I came upon a quotation from Blake that is directly relevant to this discussion:

> The Prophets describe what they saw in Vision as real and existing men, whom they saw with their imaginative and immortal organs; the Apostles the same; the clearer the organ the more distinct the object. A Spirit and a Vision are not, as the modern philosophy supposes, a cloudy vapour, or a nothing: they are organized and minutely articulated beyond all that the mortal and perishing nature can produce. *He who does not imagine in stronger and better lineaments, and in stronger and better light than his perishing eye can see, does not imagine at all*.
> [Italics mine. From *The Writings of William Blake*, ed by Geoffrey Keynes, vol 3, p 108]

---

[9] This interpretation was confirmed later by the highly significant testimony of a Mixe Indian in the Mixe country: when we asked him what he saw after taking the mushrooms, he replied that he saw Zempoaltepetl (the sacred mountain of the Mixe) open up, and on entering it he there saw paved streets lined with great houses and cars were plying back and forth on the streets. This Indian had never left the mountains where he lived, far away from highways and towns, but he had heard tell of these modern marvels.

This must sound cryptic to one who does not share Blake's vision or who has not taken the mushroom. The advantage of the mushroom is that it puts many, if not everyone, within reach of this state without having to suffer the mortifications of Blake. It permits you to see, more clearly than our perishing mortal eye can see, vistas beyond the horizons of this life, to travel backwards and forwards in time, to enter other planes of existence, even, as the Indians say, to go there where God is.

I will anticipate my story by telling here of an episode that took place in 1956, when Professor Roger Heim on my invitation had joined us. The *velada* in this case took place in a neighboring house. The effect of the mushrooms was at their peak. The Señora was singing with magisterial authority and we were all lying awake, keyed up (so it seemed to us) to the highest possible point of ecstasy. Suddenly, I do not know why, someone on one side on the room felt called upon to light a match. There was not the slightest interruption in the Señora's performance: she continued singing, clapping, gesticulating as though there was no light. But on the whitewashed wall beyond there appeared her shadow-profile, magnified perhaps by four, her triangular shape angled precisely like a Mexican pyramid, the temple on the top being the projection of her head, her gesticulations keeping slow, measured time with her singing. In the brief light of that match I was living through centuries, millennia, even decades of millennia. María Sabina was The Shaman, the focus for the woes and longings of mankind back, back through the Stone Age to Siberia. She was Religion Incarnate. She was the hierophant, the thaumaturge, the psychopompos, in whom the troubles and aspirations of countless generations of the family of mankind had found, were still finding, their relief. All this I saw in the light of that one match, in the shadow performance of María Sabina. The light of that match seemed to last an æon of time, and then, suddenly, it was out.

The mushrooms are not habit forming. They differ in this respect, not only from alcohol and tobacco, but from the drugs such as opium that are narcotics stimulating beatific dreams. In the course of our many expeditions to Mexico covering seven cultural areas, we have never heard of a mushroom addict. We believe that use of the mushrooms does not affect the threshold of tolerance for them; that is to say, one does not raise the dose on successive occasions to obtain the same effect, either for the short run as when we used them twice in four days, or over the long term. Our Señora and her daughter took more than twice the dose of the others, but that quota goes with their vocation. Everyone's dose seems to remain constant throughout life, though the dose varies somewhat from person to person. We have seen no evidence that the mushrooms can cause harmful psychic effects. Are persons with neurotic or psychotic inclinations endangered by the mushrooms? After a lifetime of use do mushroom-eating shamans show mental deterioration? May there be individuals whose mushroomic visions are horrifying and who are stimulated to violence by them? We do not know, but think not. The reports to the contrary in the writings of the early friars were prompted by their *odium theologicum*, by their own ignorance, and by their need to divert the faithful from the 'devil's food'. In considering the clinical effects of the mushrooms, let us not overlook the extraordinary performance of the Señora and her daughter. They had each eaten thirteen pair of mushrooms, as compared with five or six pair for the rest of us, and they not only kept hold of themselves: they staged a liturgy that called for disciplined virtuosity of a high order. In the mushroom season they may be called upon to perform every night.

On Friday, 1 July, Valentina Pavlovna and our thirteen-year-old daughter Masha joined us in our village. We had all planned to leave on horseback immediately after the Saturday night experience at break-of-day on Sunday, but the rains came and we found ourselves marooned among our Mazatec friends for most of the following week. On Tuesday the 5th VPW and Masha, having nothing else to do, took the mushrooms in the afternoon, VPW five pair and Masha four, and then they lay down in their sleeping bags, the doors and windows of the room closed. This was the first occasion on which white people were eating the mushrooms experimentally, without the setting of a native ceremony. They too saw visions, for hours on end, all pleasant, mostly of a nostalgic kind. VPW at one point thought she was looking down into the mouth of a vase, and there she saw and heard a stately dance, a minuet, as though in a regal court of the seventeenth century. The dancers were in miniature and the music was oh! so remote, but also so clearly heard. VPW smoked a cigarette: she exclaimed that never before had a cigarette smelled so good. It was beyond earthly experience. She drank water, and it was superior to Mumm's champagne - incomparably superior. She and Masha felt little or no nausea. Their pupils dilated and failed to respond to our flashlights. The pulse showed a tendency to slow down. But six weeks later, when I in New York took the mushrooms for the third time on 12 August, my visions were accompanied by an insistent beat with variation of pitch, perhaps an evocation of the Señora's percussive performance. The beat was not unpleasant. It seemed freighted with meaning, as though it was the rhythmic pulse of the universe. When the Señora had performed for us, we had passed most of the night in virtual darkness - an environment adapted to dilated eyes. My experience in New York took place in a room illuminated by lights from the street, and moreover on that night of the 12th a hurricane known at the time as Connie was brushing by the city. I found that the mushrooms retained their full potency in a dried state if indeed their power had not increased. I made another discovery. As I stood at the window and watched the gale tossing the trees and the water of the East River, with the rain driven in squalls before the wind, the whole scene was further quickened to life by the abnormal intensity of the colors that I saw. I had always thought that El Greco's apocalyptic skies over Toledo were a figment of the painter's imagination. But on this night I saw El Greco's skies, nothing dimmed, whirling over New York.

Now we come to the end of our initial Mazatec experience. We had agreed from the beginning to pay the Señora her usual fee for her services. We paid her fifty pesos for each night, which was somewhat more than she expected. In dollars this meant $ 4.00 a night, but in her world the fee meant much more, perhaps subjectively as much as $ 50.00 in New York. Before we left his house we asked Cayetano what we could pay him for his contribution to the success of our visit. He turned to his wife and let her speak. '*No hicimos esto por dinero*', she said, which is to say, 'We did not this for money', and they would accept none. (For those who know the Mazatec need and appetite for money this remark of Guadalupe's will indeed be amazing.) We were especially grateful to the Señora for having allowed us to take photographs by strobe flash while the power of the mushrooms was on her, during that second night. It had not been easy for her to consent to the rude, and for her, novel interruption of the flashlight. On the morning after, a messenger came to us from her. We were welcome to the pictures, she said, but would we please refrain from showing those particular ones to any except our most trusted friends, for if we showed them to all and sundry, *sería una traición*, it would be a betrayal.

CHAPTER 2

Traits of the Mesoamerican *Velada* and Kindred Topics

In the preceding chapter I have given a largely subjective account of *veladas* that I have attended. There are at least two manners of night-time divination with hallucinogens in Mesoamerica. In one the shaman casts corn kernels and by the way they fall on the cloth spread before him he learns the answers to the questions put to him. He smokes a strong cigar and to reinforce his divinatory strength he may consume mushrooms or other hallucinogens. His answers come forth after long periods of silence and as he concentrates on the questions he sweats profusely. Valentina Pavlovna and I attended this style of *velada* in Huautla on the night of Saturday, 15 July 1953, the shaman being Aurelio Carreras. Robert Weitlaner was with us, and our account of it in *Mushrooms Russia & History*, pp 255 ff, was made up from his notes and drawings.

The other manner of *velada* is sung by the shaman as we have described it in the preceding chapter. The shaman ingests the mushrooms and decides who among those present will take the mushrooms and how many pair each. There are a number of prescriptions, proscriptions, and attributes of the *velada* that I will list and discuss here.

Allocation of mushrooms

María Sabina and her daughter María Apolonia each take thirteen pair of the *derrumbe* mushrooms (*Psilocybe caerulescens* Murrill var. *mazatecorum* Heim), thirteen being a favorable number in Mesoamerica. As for her allocations to the other participants, this is based, as a rule of thumb, on their weight and their resistance to alcohol. Naturally the allocation depends on the species of mushroom. The 'landslide' (*derrumbe*) mushroom is large. The *ˀnti*^{1}*xi*^{3}*tho*^{3}, *ˀnti*^{1}*ni*^{4}*se*$^{3/4}$ (*pajaritos*, 'dear little birdies') are tiny and the dosage correspondingly bigger, perhaps twenty pair for an adult suppliant of normal weight.

'Eating' or 'drinking' the mushrooms

In every *velada* that I have attended except one the mushrooms have been eaten fresh and with only the grossest dirt brushed off. They are always ingested raw. On 5-6 July 1960 in Juxtlahuaca, in the Mixteca, the *curandera* (aunt of our host Guadalupe González) had had the little girl Juventina, youngest daughter of the house, clearly a *doncella* ('maiden'), grind the mushrooms on a *metate* (grinding stone) and catch the juice with the mushroom pulp in glasses. My companion Robert Ravicz and I drank the potion. We were told that in former times it was the custom for the *doncella* to gather the mushrooms before sunrise, when the pre-dawn breezes swept the mountain sides and dew lay heavy on the slopes. This practice seems to have died out in Juxtlahuaca, but (who knows?) it may still survive in remote *rancherías*. We were told in Tenango del Valle, in 1957, that the mushrooms could be ground on a *metate*, or (perhaps if dried) pulverized by hand, or torn to little pieces, and then drunk in pulque or *aguardiente* ('fire water'). In Tenango the mushrooms are also rubbed on an injured place in the body. In Amatlán de los Reyes, far away in the State of Veracruz but also Nahuatl country, our story teller Rufina de Jesús, on the weekend of 4-6 June 1960, told us in Nahuatl a story involving the sacred mushrooms, which we taped and filed. Later the Nahuatlato (specialist in Nahuatl) Luis Reyes, a native of that town, transcribed and translated for us her narrative and we came upon the following interchange, speaking of the mushrooms:

'Y ¿como, acaso los vas a moler?'	'And how, perhaps you will grind them?'
'No, así nada más me comeré cuatro docenas.	'No, I'll just eat four dozen. But first I will go to Mass,
Pero ahora primero me voy a misa, los llevará.'	I'll carry them there.'

I find also in my files a memorandum dated 26 June 1962 written by one of our informants for the Chinantla, himself a Chinantec, in which he quotes a *curandero* in the Chinantla as saying that 'four or five mushrooms well ground are taken in water'. I do not know how common this practice was or is among the Chinantecs.

Afterwards I came upon the pre-Conquest Nahuatl poem that starts off:

'I have drunk [*sic*] the inebriating liquor of mushrooms.'

In aristocratic circles of pre-Conquest times the mushrooms were often taken with the cold chocolate drink and mixed with maize and with flowers of *Quararibea funebris* called *poyomatli* but never with alcoholic beverages. The drinking of the crushed mushrooms seems to have been more common formerly; I am inclined to think it was the normal practice. This crushing on a *metate* supplies us with crucial evidence in favor of our obvious interpretation of the famous 'mushroom stones', as will be explained later.

Purpose of the *Velada*

A *Velada* is held in response to a request by someone who wishes to consult the mushrooms about a grave family worry. A husband may be lying sick or injured on a *petate* ('mat'): will he live or die? If he will live, what must he do to recover? What herbs must be rubbed on the injured spot, or should he eat them? What saints must be invoked? Or perhaps he must make a solemn *promesa* to go on pilgrimage (always on foot) to a specific shrine, when he recovers.

Or again the donkey has disappeared. Did he fall into a ravine and break his leg? Or was he stolen and toward which market is he being hied for sale?

Or again money hidden in the thatch of the roof has disappeared. Who took it and where is he now?

Or again a son has gone out into the world, perhaps as a wetback to the States. Neither he nor anyone else in the family can write and naturally there is no news of him. His mother worries. Is he alive or dead? If alive, is he in jail? (This question is always asked.) Is he married? Has he children? Is he well or sick? The mushroom will tell. If the question is put with a pure heart by a believer, the mushroom will not lie: so say the Indians. Only after I came to know the Indian country was it driven home to me how every Chicano falling foul of the law has a family somewhere in Mexico who cares for him and worries about him.

A *velada* must be held for a worthy reason. It will be of no help in frivolous matters or for selfish ends. Trippers who engage a shaman to hold a *velada* out of curiosity miss the point completely.

Velada essentials: 1. Darkness and isolation

One invariable rule governing *veladas* is that they should take place at night, in the dark, in a house removed from other dwellings, where quiet will reign. Noise and light severely cripple, may render useless a *velada*. The house of the shaman is usually situated somewhat apart from the village, secluded from town folk, so that the mushrooms work free of untoward interruptions. Some natural noises are not regarded as interruptions: a dog baying at the moon, the braying of an ass in the pasture, even torrential rains and terrifying thunder and lightning are not objectionable interruptions: on the contrary, these forces of nature accentuate the spell of the *velada*.

Velada essentials: 2. The monitors

At every *velada* there must be one or two persons who do not take the inebriant, whether mushroom or other, but who serve as monitors, listening to what is said, handling interruptions and intruders, seeing that no mischance overtakes anyone during the night hours in the dark. These monitors are an invariable post in the *velada* tradition. The doors are securely fastened at the outset of the *velada* and no one (except the shaman) may sally forth into the night or until the cock crows before dawn. (Once in San Andrés Hidalgo there was an exception to this rule: the door was left wide open.)

Velada essentials: 3. Prohibitions

Participating in a *velada* requires abstinence of certain kinds. From breakfast on you must fast until the night and until preparations for the *velada* are under way. Then you may drink chocolate, or nowadays coffee, a post-Conquest innovation. For four days before the *velada* you must abstain from alcohol of all kinds, from eggs, from sexual intercourse; and after the *velada* for four days more. (These four days seem to have been a basic pre-Conquest ritual pattern of Mesoamerica. I can think of no reason why eggs are banned.) A pregnant woman must never take the entheogen. If you are a novice, the shaman or your sponsor will inform you of these requirements. To drive home the various injunctions your sponsor will always have ready an admonitory tale to tell you, showing you the penalty paid once by a violator. But it is left to you whether you comply: no questions are asked. The practice reported to us from Tenango del Valle of mixing the entheogen with pulque or distilled alcohol is, so far as my experience goes, unique: it may be a legacy from the Matlatzinca (closely related to the Otomí) who once peopled this area.

The liturgy should never be sung facing the west; east is the preferred direction. Outsiders attending the rite should be as inconspicuous as possible, and silent. They should be outnumbered by natives familiar with what is going on.

The shaman's ventriloquism

A strange feature of the successful *velada* (and one mentioned also in the Siberian accounts of their shamanic vigils) is the ventriloquistic effects. Lying there relaxed in the dark, the utterance of the shaman for long intervals being the only sound, you are surprised by the changes in the direction and volume of the rhythmic song and the percussive beats. They jump, not continually, but as it were in quantum leaps, now from beyond your feet, then from above your head, from outside the hut, even accompanying you on your flight through space, again from beneath your head, whispering in your ear so close that you feel the singer's breath on your lobes buried in the softness of your sleeping bag; or again it reaches you from the depths of the earth, faint from distance. I had never before noticed the difference in the quality of sounds of equal volume - a whisper in the ear and the same voice diminished by distance from the bowels of the earth: the two sounds seem worlds apart.

Gonzalo Aguirre Beltrán in his invaluable *Medicina y Magia* has combed the manuscript sources in the Archivo General de la Nación for documentary evidence of practices in the seventeenth century revealed in the Proceedings of the Inquisition bearing directly on our subject. (His work is indispensable as a point of departure for anyone exploring this field.) Concerning the ventriloquism he suggests that it was introduced by the post-Conquest Negro immigration from Africa. But he is mistaken. The hallucinogens contain within themselves the agent that, working in the inner ear, produces this startling effect. Here is the perfect example of the weakness of research done in the study to the exclusion of field experience. Had Aguirre Beltrán attended *veladas* in the Indian country surrounding Mexico City and had he ingested the entheogens, his observations on ventriloquism would have been utterly different.

In my first *velada* with María Sabina I had been puzzled by the ventriloquistic effects and had gradually come to tentative conclusions, but the darkness made it difficult to be certain. Later an opportunity presented itself. On Monday 12 June 1960 we found ourselves in Huautla when word reached us from Herminio Figueroa of San Andrés Hidalgo that his neighbor the *curandero* Crescencio Martínez would serve us that very night. Irmgard Weitlaner Johnson, Herlinda Martínez Cid, and I forthwith set out walking, our sleeping bags and other impedimenta being carried by two young boys. Herminio was the nephew of Herlinda, and his grandfather, the shaman Manuel Figueroa, had taught don Crescencio his art. We found Crescencio waiting for us in his house somewhat removed from the village. Of middle age, he spoke not a word of Spanish. We passed the night with him, he reciting (not chanting) prayers in a low, clear voice. The night was clear, the stars and Milky Way were brilliant. Whether there was a moon I do not remember. The light shone through the open door and one could make out the people and objects in the room. Here then was my opportunity. Irmgard and I, after ingesting the mushrooms and after they had taken effect, both observed a powerful ventriloquistic result. (They were '*derrumbes*', my quota being six pair, Irmgard's four, and the shaman's nine. Irmgard did not find the mushrooms disagreeable or nauseating.) I was in a relaxed trance, the voice, distinct and crisp, coming at me from different directions in succession, in different volume. I had only to open my eyes to see the shaman on his little stool before the dead or dying fire. To shake off my trance I would seize some wooden struts that lay to hand and reach for the wall: there was a touch of nausea and then I was in full possession of my faculties, my eyes open and all ventriloquism gone, and I would see and hear don Crescencio saying his *oraciones* in his natural voice. Again I would let myself sink back into trance. The voice once again would flit from place to place. I did this several times: don Crescencio was unaware of my surveillance.

Irmgard later told me what had happened to her: she had suddenly felt with a start that the singing was close by, the singer bending over her. She quickly and quietly turned, her eyes now wide open, only to discover that he was seated on his stool by the fire some seven feet away, paying no attention to her.

The designation of the shaman

Mesoamerica is a complex of related and unrelated languages, but through them all the same metaphorical meanings seem to prevail. Thus 'shaman' in classical Nahuatl is '*tlamatini*', in Mazatec *cho*^{4}*ta*^{4}*chi*^{4}*ne*^{4}, and in the Zapotec of the Sierra Costera *mènjak*.[10] All of them mean 'one-who-knows'. These terms are broader than 'shaman': they include the herbalists and formerly the priests of the native religion. It would be important to learn how far this 'one-who-knows' extends, and whether it may not reach beyond Mesoamerica, possibly everywhere in the Americas of the Indian, perhaps in Siberia too. The Mazatec and Zapotec terms have another thing in common: they are not nouns like 'shaman'. They are verbal phrases and they conjugate and decline depending on the meaning to be conveyed. In Zapotec for example *sanjak* is 'that man knows' = 'that man is a shaman'. These terms of respect in the linguistic subcultures of Mesoamerica correspond to 'Wiseman' or 'Soothsayer' used long ago among our own remote cultural ancestors for the *élite* of their unlettered world. 'Witchdoctor' is a contemptuous name for the wiseman invented by the white man.

In María Sabina's mind those who follow her calling are sharply divided into three categories. She is a *cho*^{4}*ta*^{4}*chi*^{4}*ne*^{4}, 'one-who-knows', a *sabia* ('wisewoman') in Spanish, and belongs in the highest class. She says she cures by the mushroom alone, the mushroom serving for diagnosis and guidance in treatment. She has never used her power for evil. In the second class is the 'healer', *cho*^{4}*ta*^{4} *xi*^{3}*v*^{ʔ}*e*^{1}*nta*^{3}, which means 'one-who-builds'; he is the *curandero*. He uses massage with *pisiete* (*Nicotiana rustica*), also potions with incantations, invoking the spirits of well known mountains, neighboring springs, and other holy places. The third class is the *tji*^{2ʔ}*e*^{2}, in Spanish *brujo*, *hechicero*, or *zahorí*, in English the sorcerer or witch. In María Sabina's mentality this is a class of practitioners who use their magical powers only to work evil. Whether such a tripartite grouping is exclusively María Sabina's or whether it is held by Mazatec *sabios* generally, or whether it is even more widespread having until now escaped detection by anthropologists, we do not know. There must be elasticity in these categories. We know for example that in Mesoamerica there is a technique for curing by 'sucking out the evil', which is practiced by the second category. Some *curanderos* apply their lips directly to the spot on the body where they think the sickness or injury lies and suck audibly. Some interpose between their lips and the place on the body a *carrizo* or tube made of a reed, and then suck. Others suck audibly without moving from their position and María Sabina is one of these. This sucking is the act of a *chupador*, and from our own tape recordings we know that María Sabina is a *chupadora*. Many *chupadores* are prepared to show those in attendance the object(s), whether animate or inanimate, that they have sucked from the body. Belief in the *chupador* is old and widespread: it has been traced across much of Eurasia. Someone has asked whether this could have been the ancestor of 'cupping'.

Now we come to the individual names of shamans. There was a famous shaman in Santa María Huitepec in the Mixería, whom the Mixe called *Pe:t Munt* in speaking with us. In Spanish this would be plain 'Peter World'. But in Mixe his cognomen was *Na:šwin*, meaning 'World' or 'Universe' and for the Mixe carrying a potent mystical idea. It seems to me unlikely that he was given this name in babyhood. It must have been assumed when in his career he reached a point where his quality justified the new name, just as do the actors in Japan when they assume the name of a great predecessor on attaining his stature in the profession. In San Pedro Nexapa we made the acquaintance of Marina Rosas, a Nahuatl shaman. In sixteenth century Spanish *rosa* was a synonym for 'flower' and thus 'Rosas' means 'flowers', translating *xochitl* in Nahuatl, a word weighted with all the magic of the entheogens, as will be demonstrated in the next chapter. In Mexico City I have met those who assert with assurance that 'Sabina' is borne by María Sabina because she is a *Sabia*, a 'Wisewoman', but this turns out to be impossible because Alvaro Estrada has found her baptismal record in the parish register of Huautla and there she is entered as having been baptized 'María Sabina' in infancy. María Sabina's maternal grandfather and great grandfather, and a granduncle and a grandaunt, were famous shamans, and the only possibility is that she (as well perhaps as Marina Rosas) was dedicated to her calling by her parents and then grew into the shaman that they were hoping for.

---

10. In our spelling of Zapotec words there are three tones: high represented by ', low by `, middle without accent. 'J' is pronounced as in 'judge'. An apostrophe, ', means a glottal stop, as in the Scottish pronunciation of *bott'l*.

The sacred mushroom: the 'small fry' or 'little tykes'

Across linguistic lines throughout Mesoamerica the sacred mushrooms are called 'little children' by names that are always both affectionate and respectful.

Marina Rosas of San Pedro Nexapa, a village in the direction of the Paso de Cortés and near the great volcanoes, in the heart of the classical Nahuatl country, spoke of the mushrooms as *a-pipil-tz-in*, the 'little children of the waters'. She is a *sabia*. In Tlanixco, a village near Tenango del Valle, in a Nahuatl-speaking district, the divine mushrooms known to the villagers are called *mujercitas* (= 'little women') or *señoritas* (= 'young ladies') or *niñas* (= 'little girls') when they use the Spanish words, and when speaking of the sacred mushrooms in general, they say *niños* (= 'children'). The sacred mushrooms are always paired off with *Cordyceps capitata* growing on another fungus, *Elaphomyces granulatus*, and this Cordyceps is the masculine element: it has no hallucinogenic potency whatever but is strikingly phallic in appearance. In Nahuatl the townsfolk of Tlanixco call these mushrooms *nanacatzintzintli*, a word that is pronounced hesitatingly and only in a whisper, and that simply means the 'dear and venerated little mushrooms'. In Amatlán de los Reyes, a village in Veracruz where Nahuatl is also spoken, the sacred mushrooms are spoken of by either of two names:

tlacatzitzen, or = little men
chocotzitzen = little children

María Sabina in Mazatec sings of the *ˀnti^{1}xti^{3}*, the *niñitos*, 'dear little children'; and also of the *sa^{4}se^{1}*, the *payasos* or 'clowns', the *ˀnti^{1}tso^{3}jmi^{2}*, the *cositas* or 'little things'; also of the 'little nuns', uttered with caressing love and reverence, little creatures (they tell us) the size of mushrooms and up to all sorts of tricks. The names for the mushrooms are all evasive. María Sabina never uses in her chanting the most holy name of all, *ˀnti^{1}xi^{3}tho^{3}*, 'the dear little ones that spring up', and when in conversation she does so, she lowers her voice as though it were too holy to utter, although this is obviously an evasive term for a prior name now forgotten.

In the Zapotec country we learn from Thomas MacDougall that the entheogenic morning-glory seeds, *ololiuhqui*, are ground on the *metate*, the resulting flour then poured into water, the solid particles strained out, and the cold liquid drunk. A little girl, *una doncella*, serves the drink to the patient. The seeds number either seven or fourteen or twenty-one. A *curandero* or a friend is present to watch over the proceedings and note what is said. Solitude and silence are essential, and without them the *badu-win*, two little girls dressed in white, will not appear. The seeds of *Turbina corymbosa* (formerly *Rivea corymbosa*) are called *badoh*, and the alternative stronger seeds of *Ipomæa violacea*,[11] either *badoh-negro* or by their full rendering in Zapotec, *badungás*. (We visited the Zapotec country early in our Mesoamerican peregrinations and did not know enough to ask about the tiny folk evoked by the entheogens but we did learn that the morning-glory seeds are called by the same name as the sacred mushrooms, *mbèydó*.) The two little girls are evoked by the accepted entheogen, whether mushroomic or other.

In the Chinantla Arthur J. Rubel reports that when the mushrooms take effect, children, boys and girls, appear. In Rubel's *velada* only the shaman ate the mushrooms. Professor Rubel sent me samples of the mushrooms and Roger Heim's laboratory identified them as *Psilocybe hoogshagenii*.

The Matlatzinca, once a numerous people living to the west of Mexico City, are now reduced to about 2,500 in a single village, San Francisco Oxtotilpan. They still speak their own language belonging to the Otomí linguistic stock. In Spanish the sacred mushrooms are called by them the 'little saints', *santitos*. To one who has eaten them the *santitos* appear as tiny beings the size of playing card kings. This we learn from the study of Roberto Escalante of the mushroom vocabulary in the language of the Matlatzinca. The old name in the Matlatzincan language is *neto&ccaron;^{h}utata*, *ne-* being the plural, *-to-* a reverential diminutive, *-&ccaron;^{h}u-* the root for sacred, and *-tata* being lord: 'the most holy little Lords'.

---

[11] In *Medicina y Magia* Aguirre Beltrán calls attention (p 136) to the use of the adjective *moreno* with *ololiuhqui*, 'black morning-glory seeds', and thinks that the seed grows black with age. But they do not change in color with time. When he worked on his excellent book we were just learning of *Ipomæa violacea* whose seeds are black and more powerful than those of *Turbina corymbosa*. Both are morning-glories.

In the Mixe country Searle Hoogshagen reports that the sacred mushrooms, when consumed under the proper circumstances and in the right number (all as we have said), put one in a trance whereupon little men known as *los Señores* emerge and deal with the problems that concern you.

The mushroom 'speaks', not the shaman

A feature of the Mesoamerican *velada* is that the mushroom is thought to speak through the voice of the shaman who is merely the conduit for the utterances of the mushroom. We recall the words of Aurelio Carreras: the mushroom *es habla*, 'is the Word'. Verses ending with *tso*^{2} in the Mazatec *velada* are not the shaman's, they are the mushroom's: *tso*^{2} means '[he] says'. From Siberia we learn that this is the way with the mushroom there: it speaks, it utters the Word. The first impression of Westerners with the mushrooms seems generally to be different: they are struck, often stunned, by the kaleidoscopic shapes that they see in the darkness, eyes open or closed. The voice is secondary to the visions. But the testimony of the Indians, including the shamans, on this is conclusive: the *Word* is the thing, just as in Sanskrit it is the *Văc* and in Greek the *Logos*.

Antiquity of mycolatry in mesoamerica

The records of the past in Mexico are uneven, areas of brilliant illumination alternating with others that run all the way to darkest night. The widespread use of inebriating mushrooms in Mesoamerica, rediscovered and for the first time explored in our own day, is cursorily documented in the sixteenth and seventeenth centuries in the writings of the friars and parish priests of that time, and also in the somber Proceedings of the Holy Office of the Inquisition. Before then for the shamanic use of mushrooms there is nothing. True, such evidence might compel alert scholars to postulate a widespread ancient use of entheogenic mushrooms. But this evidence, strong though it may be, is immeasurably broadened and strengthened by the shamanic performances that still survive throughout the highlands of southern Mexico. These survivals permit us to gain a perspective on the antiquity of the use of the mushrooms. María Sabina's chants in the Mazatec country and Aristeo Matías' far away in the Sierra Costera in Zapotec country, linguistically far removed from each other, seemed to me (as I wrote down at the time and we suggested in *Mushrooms Russia & History*) musically the same. I taped María Sabina's singing but did not tape Aristeo Matías'.

Moreover, María Sabina's Mazatec liturgy and the liturgy that we discern in the writings of Ruiz de Alarcón in the early seventeenth century for the Nahuatl world are unmistakably founded on the same oral traditions. I have documented these parallels in *María Sabina and Her Mazatec Mushroom Velada* and will not repeat the demonstration here. With these benchmarks we may legitimately triangulate deep into Mesoamerican prehistory to arrive at the age of the divinatory mushroom rite. (We must always keep in mind how slowly cultural changes took place in proto- and prehistory.) When words and music are so wedded that the words cannot be divorced from the melody, nor the melody from the words, as with the ṚgVeda hymns and the chants of the Mesoamerican *velada*, we possess in these verbalized musical expressions probably the most ancient of surviving anthropological evidence. It takes only a modicum of historical imagination to perceive a shamanic tradition invoking the mushrooms reaching back for millennia, probably back to Siberia and the cult that survived there until only a few years ago. And this tradition is buttressed on either hand by the same little tykes and clowns and tricksters tumbling around and then, on request, coming and speaking with the voice of authority to us through the shaman, precisely as in Siberia.

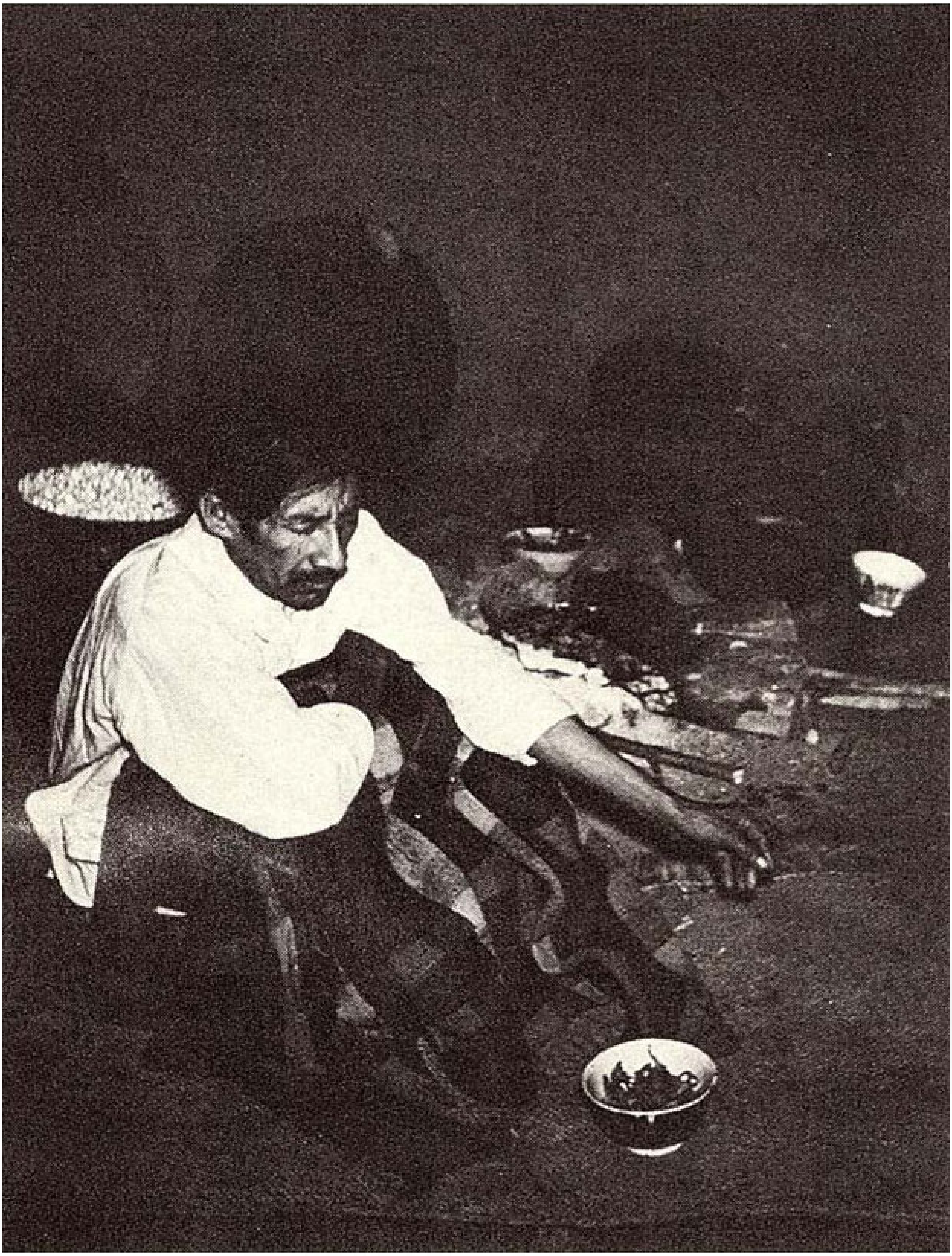


Fig 1 Aristeo Matías with bowl of sacred mushrooms. San Agustín Loxicha, 22 July 1955.

Fig 2 Aurelio Carreras

A question of grammar

But for the antiquity of the entheogenic mushroom use we are not confined to the living chants and Ruiz de Alarcón's writings: the very grammar and usages of the native languages through fossilized forms testify to it.

In Nahuatl, the language of the Aztecs and all other Nahua, nouns representing inanimate things are invariable as to number. There are seeming exceptions of which here are three:

	Singular	*Plural*
Sky	*ilhuicatl*	*ilhuicame*
Mountain	*tepetl*	*tetepe*
Star	*citlalin*	*citlaltin*

These exceptions are apparent rather than real, for the Nahua personified the sky, mountains, and stars, and the plural form simply expresses the way of feeling that attributed to these cosmic beings a soul. Other exceptions are similarly suggestive. For example, *tetl*, 'stone', becomes *teme* in the plural, but only when it refers to graven images.

For the Nahua the whole vegetable kingdom is construed as inanimate and therefore all herbs, shrubs, and trees are invariable as to number. Grammarians say that there *may be* one exception: 'mushroom' is *nanácatl* and this could be the plural form for *nácatl*, 'flesh'. Grammarians concede this much but their discipline does not permit them to go further. I am prepared to advance ethnomycological background supplementing the data of the grammarians and converting what they say is, grammatically, a possibility into virtual certainty. The sacred mushrooms, possessing a soul, are responsible for the plural shape of *nanácatl*.

In many languages the mushroom vocabulary includes a generic word for that which is eaten - 'meat', 'bread', 'cheese', 'flesh', and 'food' itself. Thus in dialectal English we find 'toadsmeat' and 'toadscheese'; in Norman French, *pain de crapaud*, 'toad's bread'; in Dutch, *duyvelsbroot*, 'devil's bread', which in classic Latin becomes *cibus deorum* and in Greek *br&omacr;ma the&omacr;n*, 'food of the gods'. (As the Greeks were mycophobes, the 'food of the gods' gave the mushroom an exalted tabu status that served to exclude men from eating it.) In Pashto, a major Indo-European language of Afghanistan, *pocəkəí* is the name of an important edible mushroom and that name means 'flesh', the same meaning that appears in Nahuatl *nanácatl*. Of course we are not suggesting a genetic kinship of these words with Nahuatl but when we come upon a simple figure of speech in a mushroom vocabulary and find a parallel association of ideas in other languages, a pattern of human thinking begins to emerge. *Nanácatl* is built on *nácatl*, the word in Nahuatl for 'flesh', a generic metaphor like 'food', 'victuals', 'bread', 'meat'; and by doubling the initial syllable it assumes a pluralized form that gives to the mushroom a soul, a status unique in the vegetable world. All mushrooms - *nanácatl* - are endowed with a soul, a unique status granted to the non-hallucinogenic species by reason of their kinship to the divine kinds, the divine kinds dominating by their overwhelming importance the whole fungal world. The root meaning, 'flesh', is emotionally colorless, neutral (like eg 'meat', 'bread', 'cheese' as given above), but it becomes exalted when the plural form - *nanácatl* - is preceded by *teo*- or *xochi-*, the designation of the entheogenic kinds.

There is a striking parallel in the Santal language, a non-Indo-European tongue spoken by a tribe scattered in villages in Orissa, Bihar, and West Bengal. In Santal as in Nahuatl, the whole of the vegetable kingdom is viewed as inanimate, but in Santal there is a startling exception: a single species of mushroom, the *putka*, which is animate and being animate possesses a soul. I made a preliminary visit to what are called the Santal Parganas in 1965 to inquire about the *putka*. Again in 1968 Roger Heim from Paris and I from New York journeyed to Orissa and Bihar for the express purpose of studying this mushroom, which Professor Heim identified, but no one could remember why it alone of the mushroom tribe was animate! It is not entheogenic and in the season when it abounds is much eaten with rice. Professor Stella Kramrisch in a paper resulting from our inquiry arrived at the etymology of *putka*: not of Santal origin, it is a loan word from the Sanskrit *p&umacr;tika*, the first surrogate for the Soma of the Vedic hymns, a loan word that survives to this day only in Santal and possibly other tongues of the Munda family. (Mayrhofer, compiler of the recent *Concise Etymological Sanskrit Dictionary*, has referred to the Kramrisch explanation in the addenda to his lexicon.) Thus the parallel with Nahuatl is close: the divinity that glows in a mushroom, in each case, gives to the mushroom a soul; in one instance (Santal) the specific kind, in the other (Nahuatl) the whole tribe of mushrooms embracing perhaps a score of entheogenic species.

An arresting grammatical status for mushrooms exists also in certain Slavic languages. At an early stage in the evolution of the Slavs there developed a tendency to substitute the genitive case for the accusative when a masculine noun representing an animate creature was the goal of the verb. In folk Russian this genitive is used not only for nouns denoting animate beings, but also for the names of various mushrooms and for the oak, when the mushroom or tree is individualized, *ie* is a single entity.[12] This use is widespread in Russian dialects, and occurs also in Ukrainian and White Russian. One hears *nashol griba*, 'he found the mushroom', with *griba* in the genitive case; *nashol grusdja*, *ryzhika*, *borovika*. Among the trees the oak is especially favored by similar treatment, *eg*: *srubil duba*, 'he chopped down the oak'. The oak used to be worshipped in pagan times by the eastern Slavs as the thunder tree dedicated to the god Perún. Thus in the folk language certain mushrooms attract a grammatical expression of the animism that survives from prehistory. It is possible to offer yet another example in Russian. In the standard language the mushroom known as the *masljenik* has a special plural form, *masljata*, and the plural of another mushroom name is *opjata* in certain uneducated circles. The plural suffix here used is normal only with certain nouns designating young animals, birds, and children!

---

[12] For guidance on this feature of Russian grammar see A. A. Shakhmatov's *Kurs Istorii Russkogo jazyka*, St. Petersburg, 1911, Vol 3, p 338. We are also indebted to Roman Jakobson for his elaboration of the same theme in private correspondence.

Clearly this personification of the divine mushrooms is a fading survival from the time in prehistory when the northern Slavs knew the virtues of entheogenic mushrooms. Professor Marija Gimbutas, the renowned Lithuanian prehistorian, has reported to us on the use down to our own day of *Amanita muscaria* (*ie* 'Soma') in the remoter parts of Lithuania at wedding feasts and the like when the mushrooms were mixed with vodka, and also how the Lithuanians used to export quantities of *A. muscaria* to the Lapps in the Far North for use in their shamanic practices. Here in the Lithuanian festivities is the only report that I have so far received of the ingestion of the fly-agaric in Eastern Europe for jollification ends. Early Man survived longer in Lithuania than almost anywhere else in Europe.

These parallels in unrelated languages and cultures reinforce each other and drive home the powerful spell (sometimes reaching to divinity) that the entheogenic mushrooms cast over diverse peoples in prehistory.

'God's flesh'

As we have seen on p XVII, Motolinía in the sixteenth century said that *teonanácatl* meant 'god's flesh' and this has been widely accepted ever since as its meaning. But Thelma Sullivan in a closely reasoned personal communication (13 May 1975) has demonstrated to me that that translation is wrong. The teo- of *teonanácatl* means divine or wondrous or awesome, and so *teonanácatl* means the divine or wondrous or awesome mushroom, nothing more and nothing less. This adjective *teo*- cannot be construed as the genitive - whether objective or subjective - of 'god'. Motolinía was overreacting: he gave the word a meaning with a direct bearing on the Elements in the Mass, a theological meaning that sacrilegiously and blasphemously (as he saw it) set the mushrooms up in competition with the body and blood of Christ, in competition with the bread and wine of our Christian sacrament. The sixteenth century Spanish friars arrived in the New World encumbered with the theological baggage of their place and time and they saw *nácatl* as an appalling simulacrum of the Eucharistic sacrament rather than a colorless word for the texture of the fungal flesh. That innocent word suddenly became charged with the high voltage of sixteenth century *odium theologicum*. Motolinía's mistake was shared by the clergy of his time: given the doctrines prevailing in the Catholic world, their mistake was natural. In 1537 it finds expression in the Proceedings of the Inquisition, and in the mid-seventeenth century in the writings of Jacinto de la Serna. The leading Nahua, not grasping the theological affront that this innocent term, misinterpreted, carried to the Christian hierarchy, must have quailed at the fury of the friars over their *teonanácatl*.[13] No theologian seems to have challenged this meaning and we have had to wait four centuries until a grammarian and an ethnomycologist have clarified the confusion. The Nahua from their position of weakness would not have dared to argue their case and the friars with the passing generations have thrust their erroneous interpretation on the Christianized Indians.

But though the friars were wrong in saying that *teonanácatl* meant 'god's flesh' (*carne de dios*), they did indeed find the Mesoamerican Indians adoring mushrooms that could lift them to a superior world where, for the nonce, they were on a level (as they thought) with the gods; where the Greeks were when they drank the potion at Eleusis, and where the Aryans were after ingesting their *amrita*. What a strange confrontation, the sixteenth century friars facing the Wisemen of a culture of Early Man who possessed a secret far older than theirs, neither group understanding the other but the Spaniards backed up by the grim secular arm of the Inquisition.

---

[13] In sixteenth century Mexican writings I have found the word *teonanácatl* only twice, in Motolinía and Sahagún. But it still survives: priority goes to Gastón Guzmán Huerta, Mexican mycologist, for having rediscovered it. In August 1958 in Necaxa, Puebla, he heard Nahuatl speakers using *teotlaquilnanácatl* for the enrheogenic mushrooms. (*Ciencia*, Mexico, 20: 3-4; pp 85-88; 10 June 1960) Thelma Sullivan suggests as a possible translation the 'divine sunset mushroom'. On 19 Sept. '72, Irmgard Weitlaner Johnson, Guy Stresser-Péan, and I learned in Xolotla, Puebla, from a shaman of prestige, Bernardo de la Cruz Tecalco, that the sacred mushrooms are known there as *tenanacatzitzi*. The *te*- is the eroded *teo*- and the suffix - *tzitzi* is a diminutive of reverence and endearment.

The mazatec mushroom world

In the Mazatec world the sacred mushrooms also enjoy a unique status but it is verbal and not grammatical. The word for 'mushroom' in Mazatec is *thain*^{3}, in which the t is aspirated, the vowels are nasalized, and the word is pronounced in the third tone. The word covers the whole of the mushroom world - edible, inedible, poisonous, whether growing in the earth or on vegetation. It includes the whole mushroom world except the sacred mushrooms. The sacred mushrooms are ^{2}*nti*^{1}*xi*^{3}*tho*^{3}, an arresting expression. The initial syllable is a particle expressing endearment and respect. The rest of the word means 'what leaps forth'. I have already rendered the whole: 'the dear little tykes that leap forth'. In her first letter to me, 9 March 1953, Eunice V. Pike gave me this Mazatec term and added that she could not explain it. But Early Man, as I well knew, always perceives that mushrooms do not grow from seed, and it seemed to me that the miracle (as Early Man construed it) of their birth found expression in this term. Some months later, when we entered the Sierra Mazateca for the first time we found that our muleteer Victor Hernández had travelled the mountain trails all his life and spoke Spanish though he could neither read nor write nor even tell time by the clock's face. As we were making our way out of the mountains after our visit, we asked him why the mushrooms were called 'what springs forth'. His answer, breathtaking in its spontaneity, its sincerity, was filled with the poetry of religion, and I wrote down what he said word for word as he uttered it:

> El honguillo viene por sí mismo, no se sabe de dónde,
> como el vienro que viene sin saber de dónde ni por qué.
>
> The little mushroom comes of itself, no one knows whence,
> like the wind that comes we know not whence nor why.

My interpretation had found confirmation in Victor's words. Almost a quarter of a century later María Sabina, in her story of her life, dictated in Mazatec to Alvaro Estrada and translated by him into Spanish, disclosed in an extraordinary passage how always present in her mind was the wonder of the birth of the sacred mushrooms. In reading her words we must remember that in the Mazatec mind the sacred mushrooms have sprung, not from seed (which of course they do not possess), but from the falling drops of Christ's blood or spittle. In what she says she is impersonating the sacred mushrooms.

> Las cositas son las que hablan. Si digo 'Soy mujer que sola caí, soy mujer que sola nací,' son las cositas quienes hablan. Y dicen así porque brotan por sí solas. Nadie las siembra. Brotan porque así lo quiere Dios. Por eso digo: soy la mujer que puede ser arrancada, porque las cositas pueden ser arrancadas... y ser tomadas... Deben ser tomadas tal y como son arrancadas... No deben ser hervidas ni nada. No se les necesita hacer nada. Como son arrancadas así deben ser tomadas... con todo y tierra. Deben ser comidas por completo, porque si se tira un pedazo, los honguitos preguntan en la velada, '¿Donde están mis pies? ¿Porque no me comiste por completo?' Y ordenan, 'Busca el resto de mi cuerpo y tómame...' Deben obedecerse las palabras de las cositas. Habrá que buscar y tomar entonces los pedacitos que no fueron comidos antes de comenzar la velada.
> [Estrada: *La Vida de María Sabina*, pp 82-3]
>
> The *little things* [sacred mushrooms] are the ones that speak. If I say, 'I am the woman who alone came down, who alone was born', it is the *little things* that speak. And *they say so because they sprout by themselves. No one sows them. They sprout because God so wills*. That is why I say: I am the woman who can be pulled up, because the *little things* can be pulled up... and be taken... They should be taken just as they are pulled up... They should not be boiled nor anything. There is no need to do anything. As they are pulled up, so should they be taken... with dirt and everything. They must be completely eaten, because if a piece is thrown away, the *little things* ask in the *velada*, 'Where are my feet? Why did you not eat all of me?' And they command, 'Find the rest of my body and take me...' The words of the *little things* must be obeyed. Then you must look and find the pieces that were not eaten before the *velada* began.

The art of the mushroom *velada*

A salient fact about the sacred mushrooms has almost escaped remark up to now: the beginner gives the appearance of one drunk and this may easily outlast several trials. But then by dint of practice he takes hold of himself and discovers that he is able to time his movements, his thoughts, his impressions, under the guidance of the shaman. Finally he achieves complete self-control. He learns until he and the mushroom perform in harmony. María Sabina, after taking thirteen pair of the big *derrumbe* mushroom, goes through a four or five hour performance as taut as a violin string, every note, every motion, timed to a nicety. She neither stammers nor stumbles.

Listen now to what the Zapotec shaman (= *mènjak*) Aristeo Matías told us when we asked him what we should do to learn the secrets of the shaman and become one. His answer was a disquieting parable, telescoping the apprenticeship into four stages:

> On taking the mushroom for the first time the mushroom introduces himself to the novice: *Así me llama yo* ('thus am I called'[14]). Then terrible things happen but be not afraid. You rush to the sea, you plunge in, you go up to heaven, there where Jesus Christ is, and then to hell where the malefactors are. You see the whole world lying in the middle of the sea. On the second try you are thrown into the sea, but be not afraid. Then you see two women and two men who are gathering up the blood where Christ was born [*sic*]. On the third try everything changes, and now you are strong and the voices begin to come. Then, on the fourth try you arrive there where the Virgin Mary is, and the Lord Jesus Christ, and then they explain good things. Then all the Spirits come, all the Virgins, all the Saints. Then you know and are a *mènjak*. From that moment the mushroom teaches you all things.

Aristeo was voicing a mystical picture. He was describing the confusion - even panic - felt by the novice on first taking the mushroom, and how after many tries and after weathering many storms (divided into the four stages) the aspirant might finally reach his goal, become *one-who-knows*.

The shaman, as also his tiny flock of tried participants, has weathered the initial chaotic and troubling effects. They and the mushrooms consider themselves a brotherhood. Henry Munn describes the effect in his unpublished essay on María Sabina, laying stress on the powerful, all-possessing rhythmic beat that sweeps over not only the shaman but the whole gathering. His description, which he permits me to quote, is utterly different from mine and equally valid:

> Throughout the 1958 *velada* [of the shaman María Sabina] the image of an old eagle always occurs in association with a watch. 'Woman-watch am I, / Primordial Eagle am I'. I submit that the watch is an image for the clockworks of consciousness, the minute wheels and springs of the cerebral machinery, which under the mushroom influence can even become acoustic in the ticking heard in the inner ear. The image of the watch, recurring throughout her chants, introduced by María Sabina from the world of technology, expresses by metaphor the neural, cellular, biochemical processes revealed by psilocybin, which not only manifest the mind but the dynamic, rhythmical functioning of the whole body. 'Woman-watch am I', says she. The microscopic machinery, the clockwork of the cells with its fine timing, is what she means, the complex, infinitely mysterious, marvelous workings of the human cerebrum and nervous system. Images such as these do not come from knowledge but from the phenomena themselves. It is as though the mind senses by intuition its own nature by metaphor, in advance of science... These are transcendental themes, in which one has a sense of flight through the air. This is what she means by the ancient eagle, the celestial bird... [Under the influence of entheogens,] many feel as though they are rushing through the air, riding a great bird with wide wings, whirling high in the sky in wide gyres, looking down on the earth far below.

---

[14] Note the parallel with Exodus 3:14: 'And God said unto Moses, I AM THAT I AM; and he said, Thus shalt thou say unto the children of Israel, I AM hath sent me unto you.' It is incredible that Aristeo was familiar with this Bible passage.

In Munn's words we catch the voice of proto-history, of prehistory: the shaman and his flock, having taken the mushrooms, lifted to skies of ecstasy, translated from our world to the pure empyrean, throbbing with the beat of the universe.

Since that night of 29-30 June 1955 in Huautla many Westerners have attended a Mesoamerican *velada* and many of them have ingested the mushrooms or morning glory seeds. Many others without attending a shamanic session have tried the entheogens. Even artists have sometimes tried the mushrooms to see whether their creative faculties would be heightened. These are all mere novices. We must remember the words of Aristeo Matías and know that to cope with the mushrooms one must survive one's astonishment and take them repeatedly to work in beat with them under the shaman's guidance. Thrill-mongers debase the mushrooms and themselves. In María Sabina's *velada* we are permitted to sense one aspect of religion as it irradiated the lives of our remote ancestors during millennia in our own prehistory. The Indian believes in the mushrooms, believes that in the course of these *veladas* he is granted what we call extrasensory perception, what he views as divine guidance. Can we be sure he is wholly wrong? I do not profess to know. But to dismiss these beliefs out of hand is, clearly, a sign of intellectual arrogance born of ignorance.

When Alberto Ongaro inquired of María Sabina how she became a shaman, she gave an answer in equally poetic language but subjective and personal:

> The secrets that the mushrooms revealed to me are enclosed in a big Book that [the mushrooms] showed to me... My sister Ana María [years before] fell ill... I loved my sister and I took many, many more [mushrooms] than I had ever taken before. My soul was entering the world of the mushrooms and I was seeing landscapes in the deepest depths of their world... At one point a sprite came toward me. He asked a strange question, 'But what do you wish to become, you, María Sabina?' I answered him without thinking that I wished to become a Saint. Then the spirit smiled and immediately he had in his hands something that was not there before, a big Book with many written pages. 'Here', he said, 'I am giving you this Book so that you can work better and help the people who need help and know the secrets of the world where everything is known'. I thumbed through the leaves of the Book, many and many written pages, and alas I thought I did not know how to read... And suddenly I realized I was reading, and understanding all that was written on [*sic*] the Book, and it was as though I had become richer, wiser, and in a moment I learned millions of things.

These quotations lead us to a major aspect of the mushroom *velada*, both in Mesoamerica and Siberia. Almost all the accounts published so far have been written by witnesses new to the experience, whether they ingested the mushrooms or watched those who did. Aristeo Matías told us that the novel effects on the initiate are overwhelming, sometimes terrifying. Nausea is the least of these distressing effects. Double vision has often been noted, and the non-participating stranger is apt to mistake the external symptoms for a drunken stagger. Voices come in sequence from near and far, from all directions. Aristeo warns the beginner that he may see 'visions of hell'. Most of those of our White race who have entered the magic world of the mushrooms are still in the beginners' class: they little suspect what they have yet to learn.

There is no 'catechism' class in the religion of the sacred mushroom. Children seem always to be present at the *velada*. I am astonished, as I look over my slides, to see how children, small and big, are present during the *velada*. María Apolonia carried an infant in her *rebozo* (shawl) throughout the *velada* that she and her mother sang on the night of 13-14 July 1958: the sleeping babe, close held against its mother's body, must have *felt* her singing throughout. In my photos tots are there, and small children also, their faces filled with wonder as they stay close to María Sabina. They do not take the mushroom but go to sleep with the chanting in their ears.

We know that the performance of the *voladores* in pre-Conquest times (as well as now where it still survives) was steeped in religious feeling. The performers would swing down and around a pole some sixty feet high. The head of this troop would stand on a tiny platform on top of the pole and there he would perform a dance to music. Here we find precisely what I think an accomplished shaman, under the influence of the mushrooms, would aspire to do. We know that the ball game of the Mesoamericans was played by youths under powerful religious influence: was their skill enhanced by taking mushrooms? There seems reason to think that the now famous 'mushroom stones' were in some way connected with the ball court, and this then would be the link.

(*Infra* pp 195 *ff*) We know the glow of religious feeling that follows the ingestion of the entheogens. We know how marvelously disciplined the mushroom adept becomes. The ball court player, the *volador* performer, were both saturated with religious feeling. The Conquest of course put an end to the public use of the entheogens and the informants of the friars were often tongue-tied where these plants played a rôle. I do not say mushrooms were used in these events. But the possibilities of the entheogens in these situations make inevitable the question, and I think the mushrooms may well have been so used.

Wherever they are known among the Indians the sacred mushrooms inspire awe and wonder. They are *muy delicados*, a word semantically akin to 'dangerous', and the mushrooms call for utmost care in handling. The mushroom *es habla*, is the Word.

Se ve todo, se ve donde Dios está también: 'You see everything, you see where God is also'. Among the Mixe and as we have seen among the Mazatecs, and undoubtedly among other Mesoamerican people, the sacred mushroom *nace por sí mismo*, 'is born of itself'. In San Juan Mazatlán of the Mixería, after the mushrooms are gathered, they are taken straight in a covered *jícara* (gourd) to the village church, where there is no incumbent, only a local *sacristán* (sexton) who has the keys, and with a lighted candle of virgin beeswax they are left on the altar until they are used. In the Nahuatl country of Veracruz, Rufina de Jesus told us the story of a young man who said he was taking the mushrooms to Mass before ingesting them. I report only the instances that I have witnessed: there must be hundreds of village churches where similar practices are customary. In Huautla, María Sabina, though her calling is universally known, has been a church member in the best of standing all her life. The mushrooms have come full circle since the friars stormed against them in the sixteenth century: the fury of Motolinía and his colleagues against them could scarce find words to express itself. Today, in the Indian villages, the mushrooms share the same altar with the Host.

Work to be done

On 13 May 1957 we published our account of María Sabina's mushroom *velada* in *Life* and, expanded, in *Mushrooms Russia & History*. Later the *Life* article appeared in Spanish and yet later Roger Heim and I told the story once more in *Les Champignons hallucinogènes du Mexique*. These brought favorable reviews not only in the lay press but in scholarly journals, and they drew world wide attention. In the outside world untold thousands down the years have ingested the sacred mushrooms or psilocybin their active agent. Mycologists, chemists, pharmacologists, and psychiatrists have worked on and with them. There have been a number of valuable contributions to our own work:

a. Fernando Benítez, professional writer, in Vol. 3 of *Los Indios de México*, devoted a long essay to María Sabina, accurate and rich in fresh insights; also in *Los Hongos Alucinantes* published in 1974 in the Bibliografía Era;
b. Alberto Ongaro, an Italian journalist with *L'Europeo*, came expressly from Milan to Huautla de Jiménez to interview María Sabina, to whom through an interpreter he put a number of cogent questions: her answers of high value carry the ring of poetic and dramatic truth;
c. Alvaro Estrada, a Mazatec who has taken down from her mouth and translated into Spanish, in simple words catching the very flavor of her Mazatec tongue, the story of her life and her conception of the sacred 'little things';
d. Henry Munn from whose unpublished manuscript with his generous permission I have already quoted;
e. I recorded on tape the entire *velada* sung by María Sabina on the night of 12-13 July 1958; it was translated by the Mazatec specialists George and Florence Cowan; the Mazatec text, and the Spanish and English translations, in three parallel columns, were printed in full, the music transcribed by Willard Rhodes the renowned ethnomusicologist, the photographs of the *velada* by Allan Richardson illustrating the text; with every aspect of the performance duly commented on by us and by Robert J. Weitlaner. Harcourt Brace Jovanovich Inc published the production, with either tapes or recordings, in 1974.

Alberto Ongaro and Fernando Benítez showed what first class writers can do in treating shamanism, but as journalists theirs were one-shot affairs and we can hardly expect anything further from them.

After the reviews no word has reached me of any further response from academia, *ie* anthropologists, archæologists, linguists, Mesoamerican historians, faculties of religion.

In recent decades shamanism has evoked much discussion from academic circles and far beyond. Yet our knowledge of shamanism has suffered from a vital, a fatal defect: the absence of familiarity with the provenience of the singing and with the content of the verses in the remote tongues that the singers use. Moreover, the difficulties do not stop there: in the liturgical verses of the shaman there often occur obsolete or obsolescent turns of phrase that the shaman himself may be at a loss to understand. The help of the elders in the community is needed in trying to render them. In the Mazatec world with Estrada's and Muon's help there is more than a possibility that we shall soon have unprecedented access to the full meaning of the Mazatec singers' chants. Strangely, the response in the universities to our 1974 publication dealing with the heart of shamanism, itself a product of sixteen years of labor by a team of recognized specialists, has apparently been zero. It was a windfall that Alvaro Estrada, himself a Mazatec, should have offered to us on his own initiative a book on María Sabina, and a double windfall that it should be as perfect as it is, capturing in Spanish her way of speaking and thinking, without a trace of vulgarization. Henry Munn's approach is different but no less valid, as we have seen in his paragraph of lyrical prose that I have quoted, and these two men, close friends, constitute an admirable team to do serious work in the Mazatec area.

There is left a whole world of field studies crying to be done before rapidly developing mankind blots out the Old Order, field studies not primarily in the mycological and chemical fields, where Professor Heim and Dr Hofmann and their teams have arrived at the major discoveries, but in the linguistic area and the world of the Indian mind. We know virtually nothing about the mushroom vocabulary in the languages of the highland Maya: this is a big desideratum. Here is an area to be explored until we arrive at the answers as well as we now know the Mazatec. The same holds true with the seven mutually unintelligible Zapotec dialects: a good anthropologist with a passion for linguistics should master this complex, bring back tape recordings of shamanic sessions, take charge of translating them into Spanish and perhaps English as well, and compare the usages with the Mazatec. We know nothing about the rôle of mushrooms among the Otomi, who played an important part in pre-Conquest times, little about the Totonacs, nothing about the Tarascans. These peoples all once used the mushrooms and perhaps they all do to this day. And how about the Zoque? As the mushrooms are sacred and hedged about with profound tabus, no novices in linguistics and anthropology should enter this field: they only muddy the waters. What is needed are accomplished scholars, young, hardy, dedicated, who are capable of a sympathetic approach to religious beliefs that they cannot share.

Siberian and eurasian parallels

As we have seen, the Sacred Mushroom complex of Mesoamerica seems to be linked with the Siberian, suggesting forcibly, perhaps ineluctably, that they have a common origin.

a. Throughout Mesoamerica the Sacred Mushrooms evoke an imaginary world of little people, girls and boys, more or less the size of mushrooms, given to pranks when not engaged in their serious business. They are the spirits of the mushrooms. The same holds true in Siberia.
b. The mushroom speaks through the voice of the shaman in Mesoamerica and also in Siberia.
c. In several of the Uralic languages a person inebriated on mushrooms is said to be 'bemushroomed': the tribes speaking those languages before the arrival of the Russians seem to have not known alcoholic inebriation. (In this they are like most North American Indians and Eskimos before the White Man arrived.) In Nahuatl, though the Nahua made fermented drinks from of old, they also have had recourse to a similar word for mushroom inebriation:

   > In mopoanj, in atlamatink in cuecuenotl: ipan mjtoa *monanacavia*.
   > Of one who is haughty, presumptuous, vain, of him it is said: 'he is bemushroomed'.
   > [*Flor. Codex*, Dibble & Anderson, Bk 11 'Earthly Things', p 132]

   Unfortunately we do not know whether the Paleosiberian tribes - Ket, Yukagir, Gilyak, Chukchi, *etc* - using the mushroom made a verb of it. If Russian linguists have explored this area in the languages of those peoples, their findings have not reached me.
d. In Nahuatl there is linguistic evidence for the special status of entheogenic mushrooms in the very grammar of the language. This corresponds to our similar discoveries in the Santal languages spoken by

a tribe in India and in the languages of the East Slavic group - Russian, Belorussian, and Ukrainian. The unique status of mushrooms in Nahuatl must carry us back far indeed, perhaps to the migrations from Siberia. It speaks for the religious awe felt for the Sacred Mushroom among these peoples far removed from each other.

e. In Mesoamerica we have developed and published evidence that the music of the chants sung in the *velada*, and also many of the verses, are of ancient indigenous origin, and that evidence is further supported (as we shall see) by the murals of Teotihuacán. This points to an origin lying deep in prehistory. We need for comparison the recordings of the chants sung in Siberia by the shamans who formerly used the mushrooms.
f. In 1956 in my first paper dealing with ethnomycology I developed evidence that linked mushrooms with the lightning bolt. I will return to this subject in my next book, which will be a sequel to my *SOMA: Divine Mushroom of Immortality*. For the present I will only say that in Mesoamerica the tie that binds the lightning bolt to the hallucinogenic mushrooms is strong: I find it among the Nahua, the Mazatecs, and the Zapotecs. Here is a powerful folk belief that survives in many places in the Northern Hemisphere, in the Old World and the New. It must go back far into prehistory.

We must not forget the slowness of change in proto- and prehistory. There were perhaps, even probably, other plants to which supernal powers were attributed, but the Wondrous Mushroom seems to have enlisted virtually universal adoration in the Northern Hemisphere. This mushroom may have been a *Psilocybe*, or the *pongo* (*Amanita muscaria*) of the Siberians, the *miskwedo* of the Algonkians, or a *Claviceps*, or yet others still unknown to us. Here was the Secret of Secrets of the Ancients, of our own remote forebears, a Secret discovered perhaps sporadically in Eurasia and again later in Mesoamerica. The Secret was a powerful motive force in the religion of the earliest times. By refraction and reflection the Secret crops out in fossil meanings, fossil sayings, fossilized folkloric bits of our various languages.

One question confronts us: our folkloric world, appealing nowadays chiefly to children, of fairies, elves, gnomes, of Queen Mab and the goblins, of leprechauns and trolls, of *duendes* and *trasgos* in the Spanish world, etc, are they descended directly from the world to which the Wondrous Mushroom introduced our remote forebears, the Little People, sometimes endearing, sometimes infuriating, of a Magical Eden?

The Past

CHAPTER 3

Xochipilli, 'Prince of *Flowers*': a new interpretation

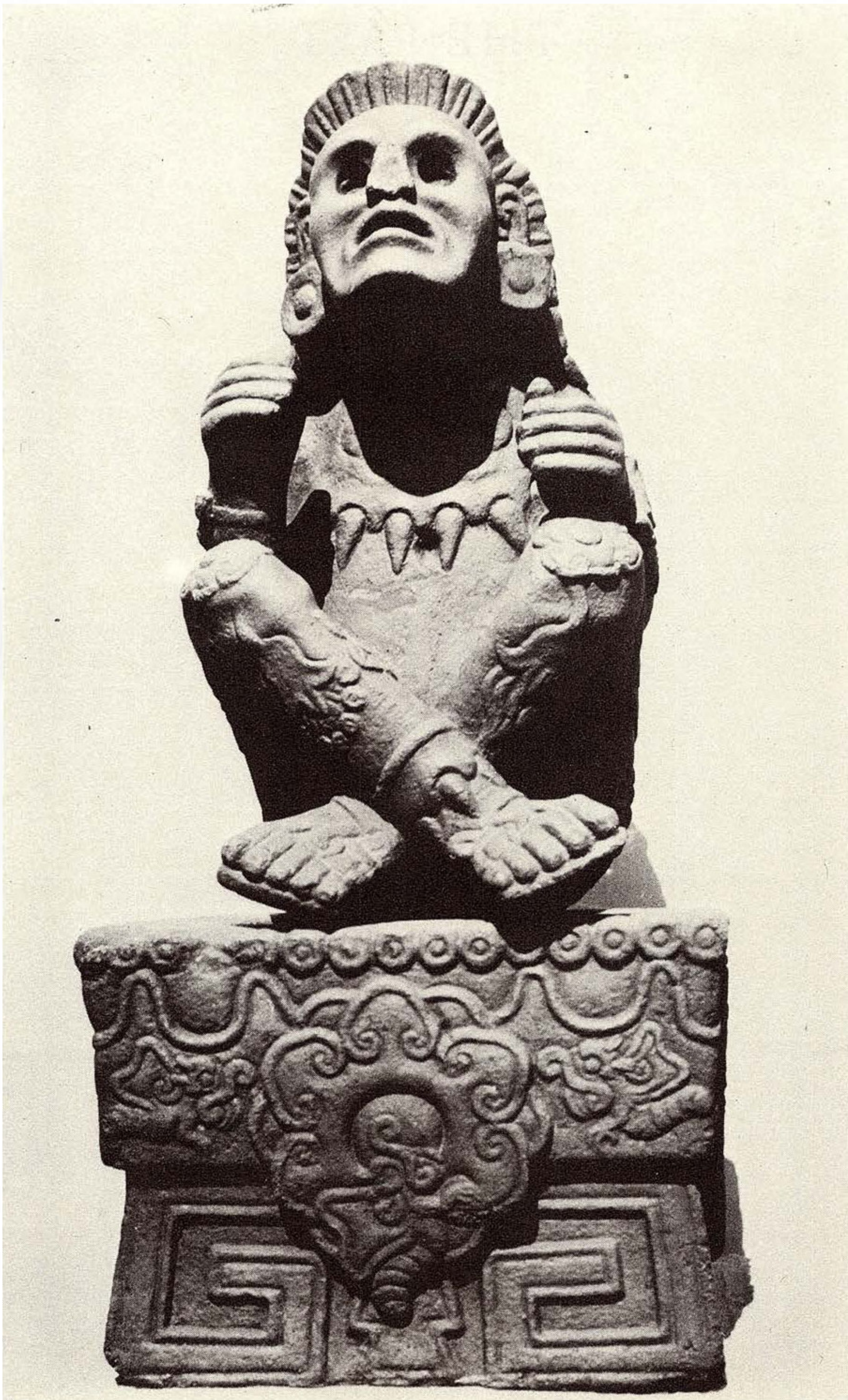


Fig 1 Fullface view of Xochipilli

In the Museo Nacional de Antropología of Mexico there stands a remarkable piece of statuary known as Xochipilli, the 'Prince of Flowers'. So far as I know, only in Mesoamerica does the pantheon of Early Man include a divinity dedicated exclusively to 'flowers'. 'Xochi-' is from Nahuatl *xochitl*, 'flower'; '*pilli*' means either 'Prince' or 'child', and parallels our former use in English of 'child' as a high-born youth (*eg* Byron's *Childe Harold*), and also the use of *Infante* in Spanish. No one disputes the meaning of Xochipilli. But do the 'flowers' of which Xochipilli is Prince mean flowers?

The statue and what we call its base were unearthed at Tlalmanalco on the approaches to the volcano Popocatepetl in the middle of the last century. The 'base' in reality is an integral part of the statuary, being a reproduction in miniature of the lower part of an Aztec temple on which Xochipilli, life-size, is seated.[15] On the strength of stylistic features it is believed that the statue was carved a generation or so before the arrival of the Spaniards.

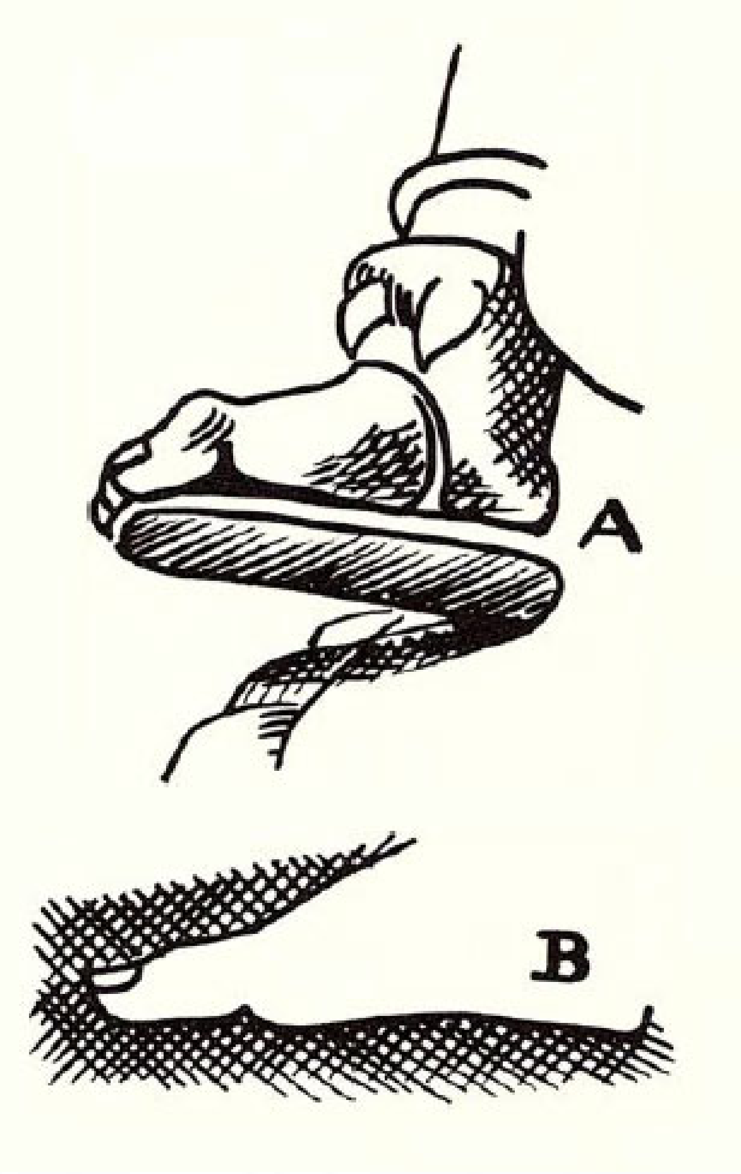


Fig 2 a) Retracted big toe of Xochipilli;
b) normal foot

---

[15] One side of the base differs in design from the other three, bearing two butterflies where the others carry *tonallo* glyphs. (See p 64) Over the decades the side with butterflies has sometimes faced forward and sometimes backward, the fit of the statue in its 'base' being perfect either way. In our Figure 1 showing the front view of Xochipilli, butterflies flank each side of the mushrooms. Since that photo was taken, the 'base' has been reversed and now displays the *tonallo* insignia, as seen in the Nicholson photos. The 'base' is carved to represent the *talud* and *tablero*, the 'batter' and 'entablature', of the typical Mesoamerican temple.

The overall expression of this Prince of Flowers is breathtaking. The skyward tilt of the head and eyes, tense half-open mouth, jutting jaw, hands poised at different levels, crossed legs with feet almost wholly off the ground, the strain expressed by the retraction of the right big toe - they are all of a piece. (Margaret Seeler, who has done almost all my black-and-white drawings, went expressly to Mexico City to study the statue of Xochipilli. It was she who discovered the retracted big toe: the pre-Conquest sculptor spoke alone to her, the artist, across a chasm of half a millennium.) They are far from conveying the quiet joy of a flower buff. The eyes then would be turned earthwards and a feeling of repose should suffuse the whole figure.

One key to the enigma of this figure lies in the mask that the man is wearing. It can be seen in the eye-sockets and better still under the chin. (Fig 3) In the cultures of the West masks are no longer important: they are relegated to children or to light-hearted merry-making as in masked balls and frivolous festivities that welcome in the New Year. But in antiquity and virtually all the other cultures of the world the mask takes on grave import. It shows the salient trait of character that the wearer portrays, being the personification of that trait. In our statue the mask portrays a god living in ecstasy and does so with the power of genius. Here is one who is not seeing, not living as ordinary mortals see and live, who is seeing direct with the eyes of the soul. This being is not with us, is in a far-off world. He is absorbed by *temicxoch*, 'dream flowers' as the Nahua say describing the awesome experience that follows the ingestion of an entheogen. I can think of nothing like it in the long and rich history of European art: Xochipilli absorbed in *temicxoch*.

The late Justino Fernández has given us a detailed description and explanation of this statue in 'Una Aproximación a Xochipilli' in Vol I of *Estudios de Cultura Nahuatl*. His study is a first class professional dissection of the statue following conventional standards of the past. I have learned much from it, as anyone familiar with it will discover from my text, but I disagree with his overall interpretation. It becomes clear that Fernández had never enjoyed the experience of the entheogens, had never even given the rôle of entheogens in Mesoamerican culture serious thought.

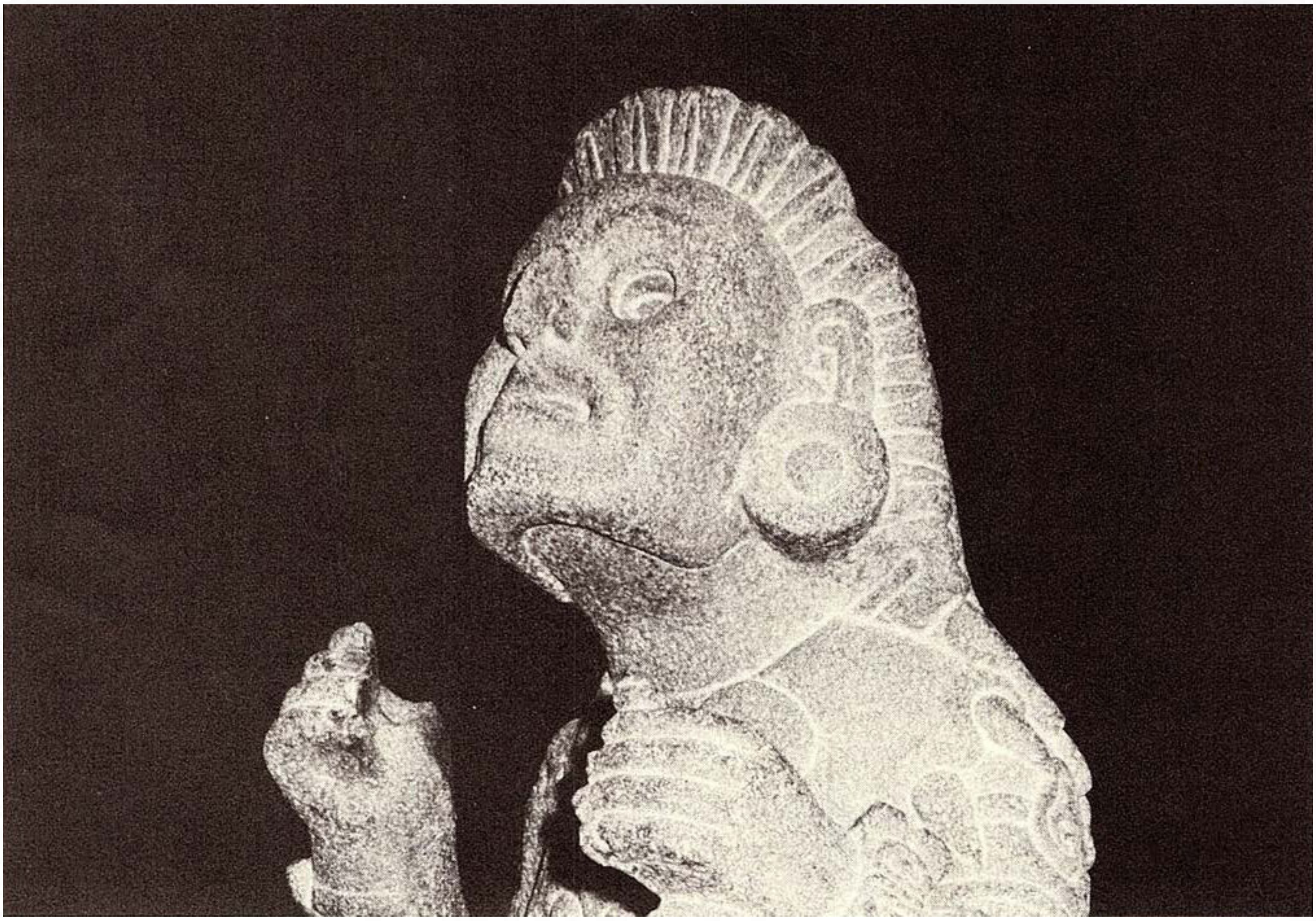


Fig 3 Detail of Xochipilli showing mask

Fernández could not help seeing the 'ecstasy' (this is *his* word) in the expression on the man's face, but for his explanation ecstasy is superfluous, even out of place, and he would minimize the trance-like pose for the viewers by suggesting that if the eye-sockets were filled with turquoises or other gems, as he is compelled to think they once were, this impression would be reduced or even eliminated. For me it would be surprising if gems had ever filled the eye-sockets. The figure indeed wears a mask, but in this style of mask the sockets are normally empty to allow the wearer to see.

The ecstasy in this figure is of the essence. Here is the work of a master, a supreme carving of a man in the midst of an unearthly experience, the formal hieratic effigy of the God of Rapture, the God of 'Flowers' (as the Aztecs put it): the god of youth, of light, of the dance and music and games, of poetry and art; the Child God, the god of the rising sun, of summer and warmth, of flowers and butterflies, of the 'Tree-in-*Flower*' (*Xochicuahuitl* or *Arbol Florido*) that the Nahuatl poets frequently invoke, of the inebriating mushrooms (*las Flores que embriagan*), the miraculous plants that transport one to a heavenly Paradise.

The exposed parts of the body as well as the 'base' are covered with carvings of flowers. Strange that no one, from Seier and Gamio to Justino Fernández, no archæologist, no botanist, no art historian, has stopped to identify them! The carved flowers are the unique feature of this statue, but no scholar, no scientist, has entered into this unique feature! From earliest times Mexico has abounded in excellent botanists, Spanish and Mexican and later from the whole world. (An imperative though unconscious inhibition seems to grip scholars when their natural instincts would lead them into the Paradise - the *Tlalocan* - of the entheogens.) Those flowers carved on the body of Xochipilli hold the key to the meaning of the statue and moreover to the metaphorical meaning of 'flowers' in Nahuatl and Mesoamerican culture.

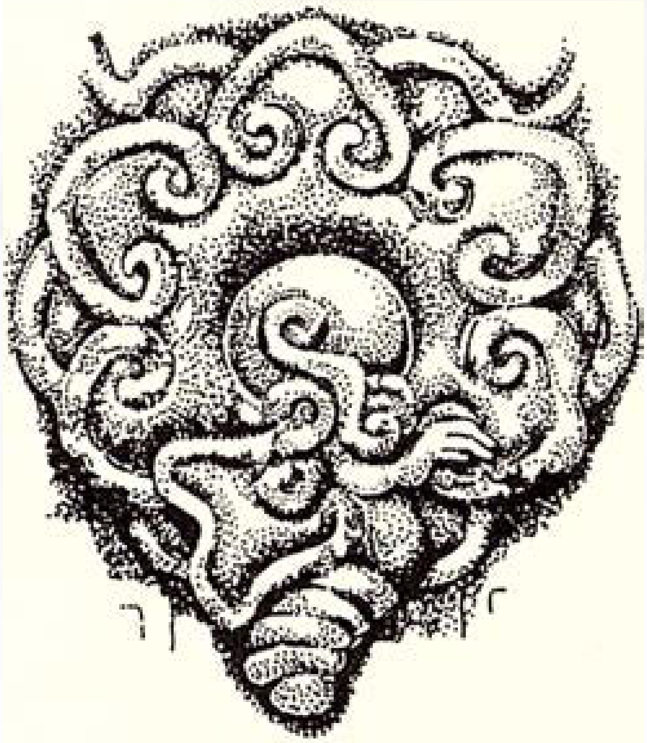


Fig 4 Mushroom emblem on base of statue

Since I first fixed my gaze on this statue of Xochipilli in the late 1950's, the emblem adorning all four sides of the base, obviously a plant motif, caught my attention. (Fig 4) Many have referred to it as a 'flower', but what flower? From the beginning I felt the five convex devices with inturned margins arranged in a circle were mushrooms. They represent the mushrooms in profile. A sixth is hidden by the carving of a mythic butterfly. The caps of mushrooms offer us an infinite variety of shapes, in the wide variety of species and the different stages of the life cycle of each species.

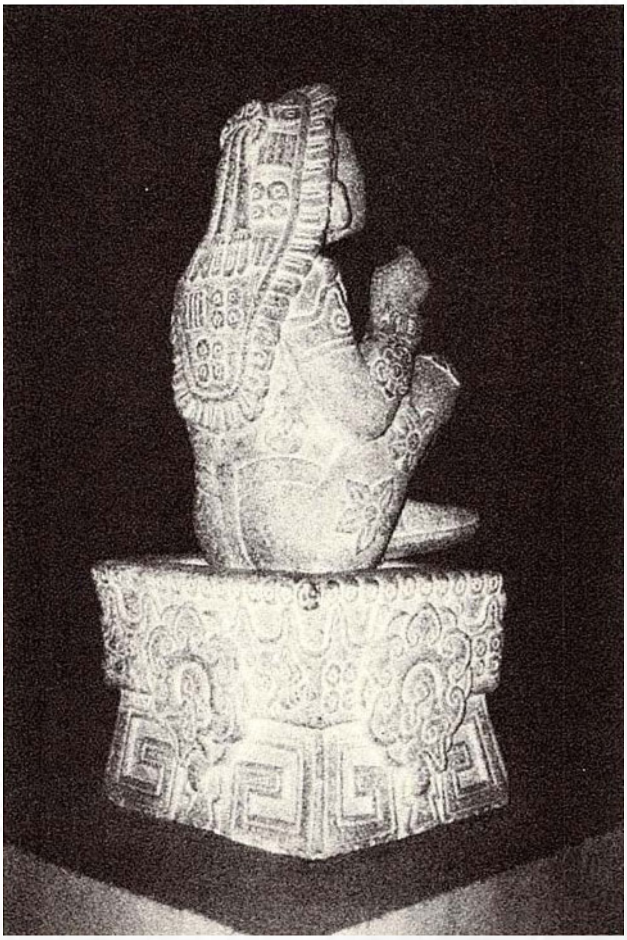


Figure 5

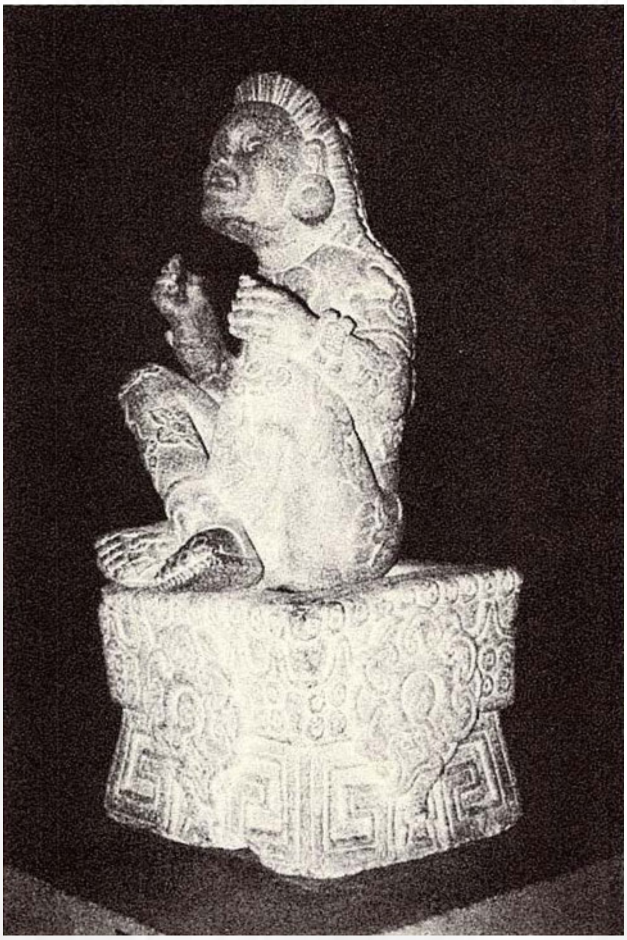


Figure 6

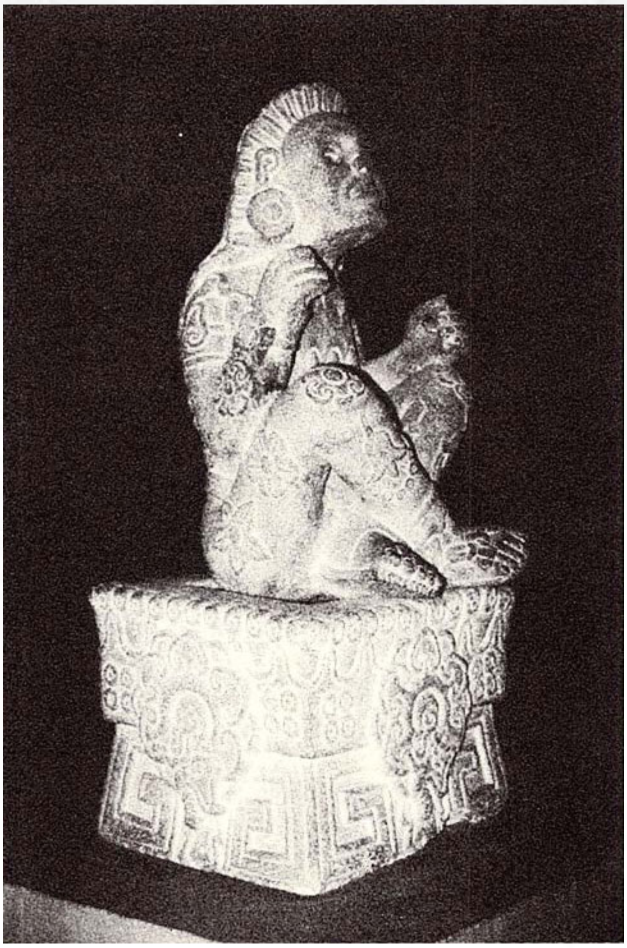


Figure 7

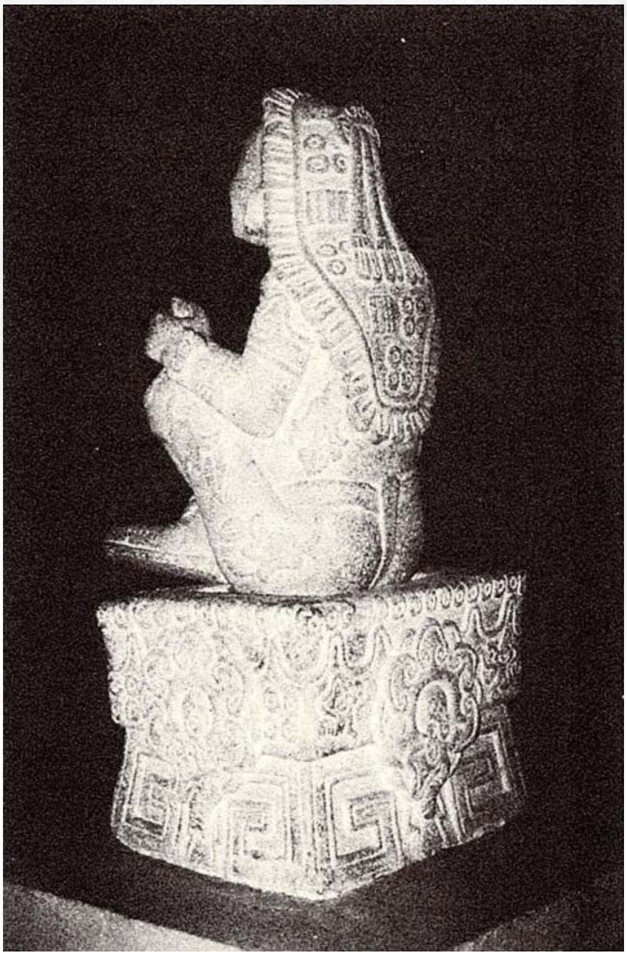


Figure 8

Even among the entheogenic species of Psilocybe, Stropharia, and Conocybe there is endless diversity. Let us remember that the statue comes from the slopes of Popocatepetl. In the beliefs of the Mesoamericans, Paradise - their *Tlalocan* - was situated on the slopes of a verdant mountain to the East and for the Aztecs the towering massif topped by the volcano Popocatepetl was their *Tlalocan*, their Garden of Eden. Here is where our statue was found, in the heart of the sacred mushroom country. Here in this precise vicinity was where Professor Roger Heim discovered, thanks to the indispensable help of descendants of Nahua Indians, *Psilocybe aztecorum* Heim, a species then new to science, illustrated in color in *Les Champignons hallucinogènes du Mexique*,[16] Plate XV, with the description on pp 154-158. His figures 15 and 16 of specimens found in their natural habitat show the cap (or 'pileus') at the moment when it breaks forth into maturity. The mushrooms in the refractory stone medium catch admirably the precise convex shape of the actual pileus of the living plant. Henry B. Nicholson in his photograph (Fig 15) brings out not only the profile that had caught my eye: his lens gives body to the stipe and flesh of the cap. The inturned margins (*la marge... incurvée*, as Professor Heim says) are one of the specific characteristics distinguishing this species of *Psilocybe*. The left-hand Fig. 9a reproduces what we find on the statue and the right-hand Fig 9b the illustration in *Les Champignons hallucinogènes du Mexique*:

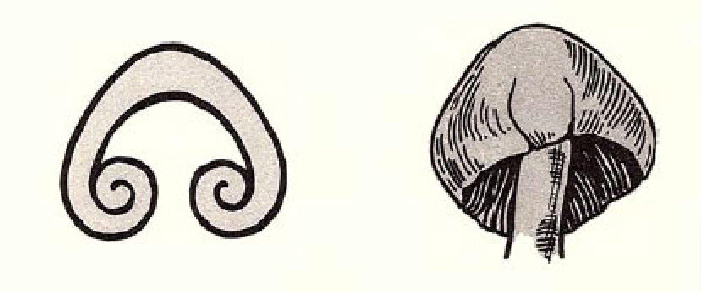


Fig 9 Profile of a) design on 'base' of Xochipilli and b) *Psilocybe aztecorum*

Mushrooms also appear on the body of our man in rapture - on both his knees, on his right forearm, on the top of his head. (Fig 13) There are three in each case, instead of six, and just as on the *tablero* we see the caps of another row of mushrooms behind and between the mushrooms in the foreground. But on the body the carving is not done with such care. We cannot hazard a specific designation as we did for the one in Fig 9a. I think the mushroom designs on the body of Xochipilli express rather a glyph for any of the many species of entheogenic mushrooms, a glyph that we might expect to find elsewhere. (Fig 10)

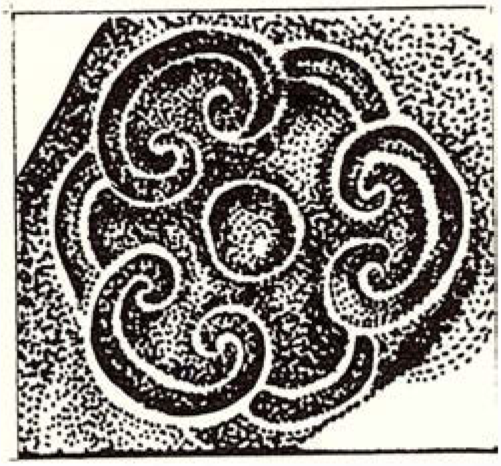


Fig 10 Glyph of the mushrooms

On the base of our Xochipilli we find what everyone familiar with Mesoamerican art will recognize as a highly stylized butterfly, perched among the mushrooms and concealing the sixth one, apparently feeding on them. Why the butterfly? In our world of nature mushrooms seldom or never draw butterflies, but in Mesoamerican iconography butterflies play an important mythic rôle, as we see in the butterflies of the famous mural of

---

[16] By Roger Heim, R. G. Wasson, and others, published in 1958 as a *Mémoire* by the Muséum National d'Histoire Naturelle in Paris.

Tepantitla in Teotihuacán, showing us (according to Alfonso Caso) *Tlalocan*, the paradise of the Nahua for certain selected individuals. Butterflies are associated with the land of fortunate departed spirits. They embody the spirits of the dead. George Cowan in *Yan* (1953 No 2) has told us that in some parts of the contemporary Mazatec world butterflies are still considered to be the souls of the departed revisiting their native haunts. On the base of the statue of Xochipilli the butterfly is feasting on *teonanácatl*, which may have been considered the food of the gods, to whose world the mushrooms transport for a brief spell the people of this sad workaday world. Mrs. Seeler has reproduced our mythic butterfly, the symbol that ratifies our identification of the sacred mushrooms.

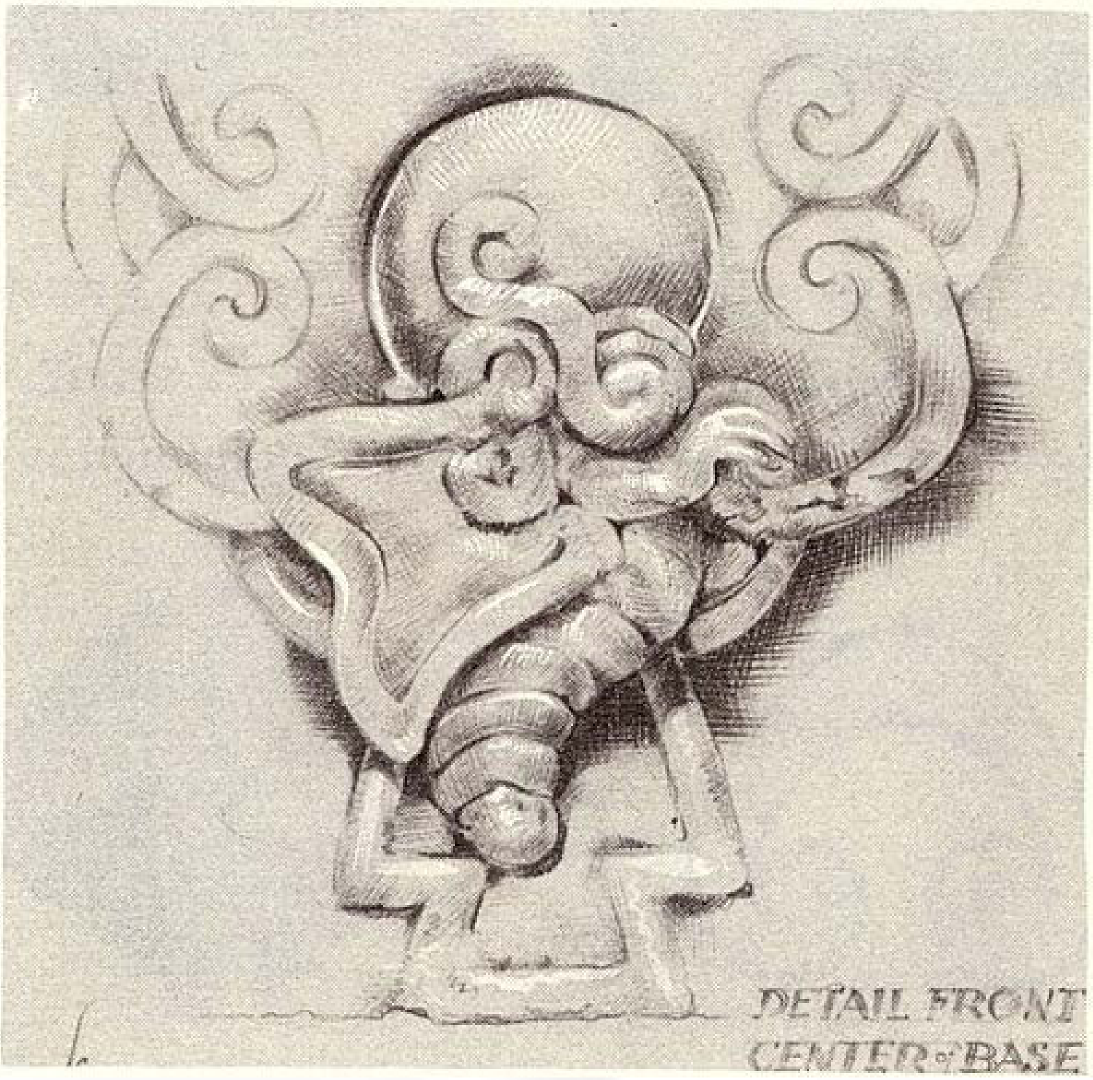


Fig 11 Butterfly on 'base'

There survives a poem from Chalco, close by to Tlalmanalco where our Xochipilli statue was found, and the carving might have been inspired by these lines:

The flowery butterfly passes and repasses.	Xochin papalotl tepanahuia
May it suck honey from our *flowers*	Ma in tlachichina Aya toxochiu
Twisting in and out of our bouquets!	O tomac xochiuh in!

(As we shall see, '*flowers*' in pre-Conquest Nahuatl poetry is a metaphor meaning the entheogens. When so used I italicize it.)

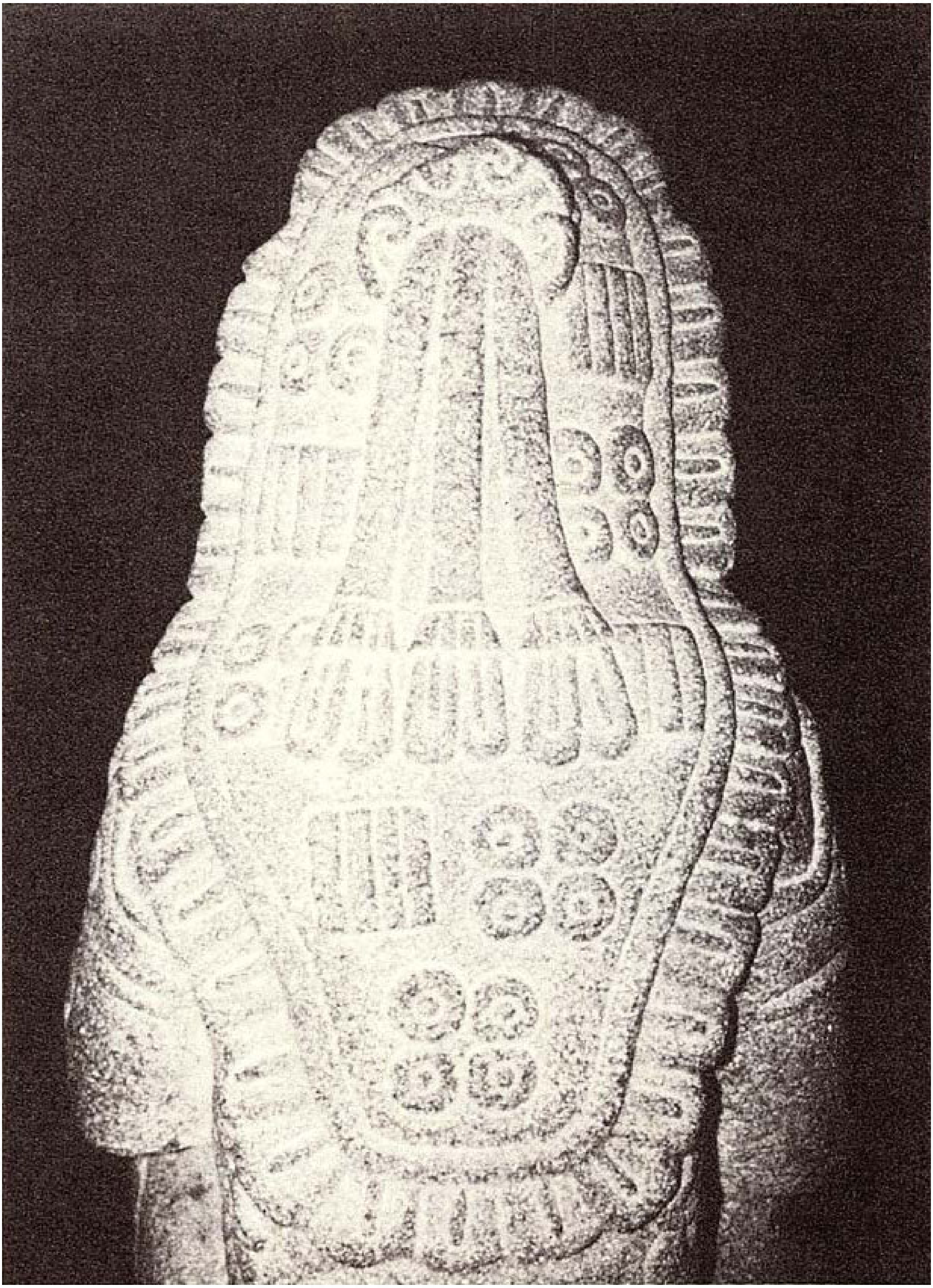


Fig 12 Xochipilli headdress

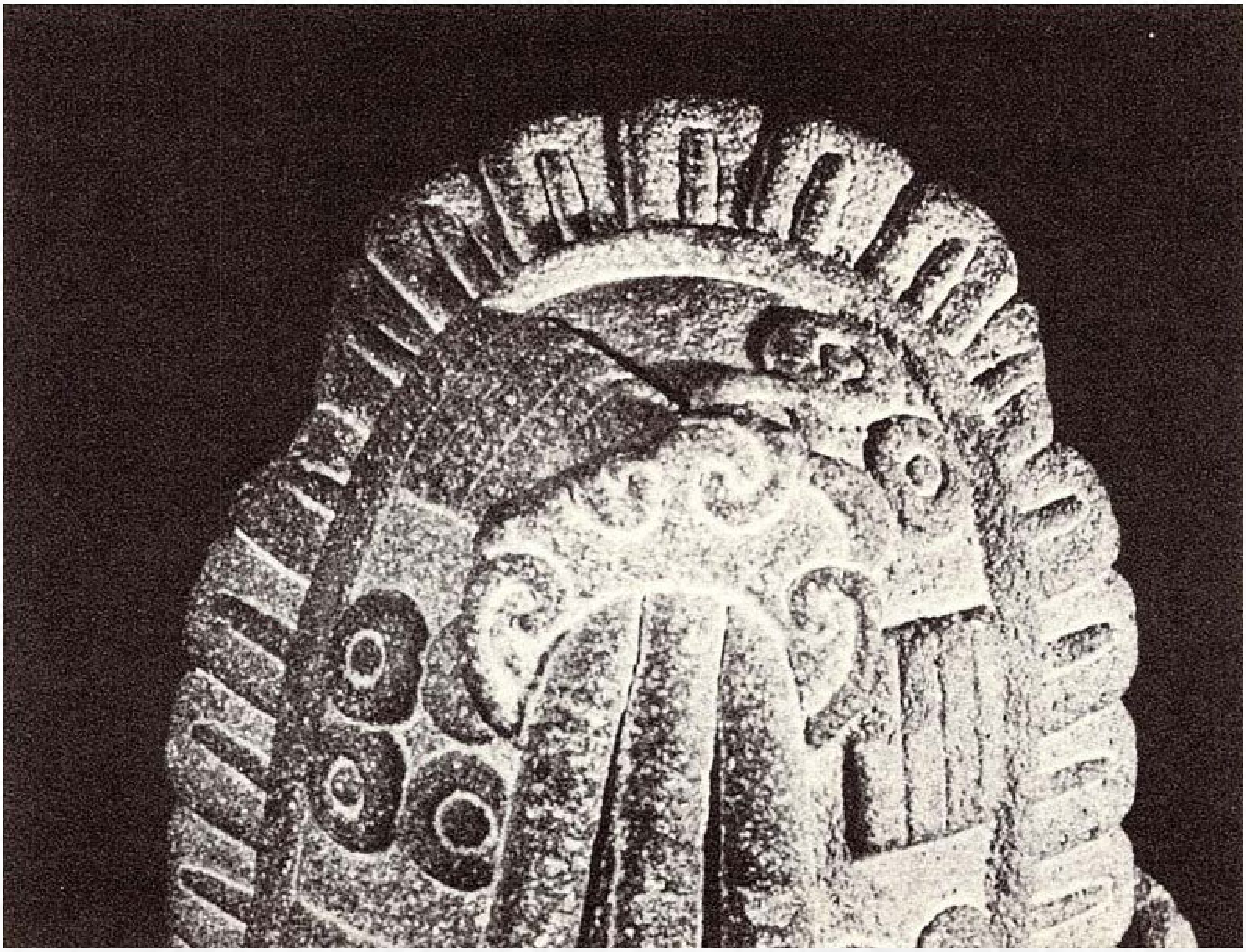


Fig 13 Detail of headdress

On three of the four sides of the base, flanking what are the sacred mushrooms, we find two groups of four concentric circles or balls. Xochipilli's formal headdress (and what a lordly headdress it is, his chief article of apparel!), viewed from behind, carries six such sets of four circles or balls. This is the Nahuatl *tonallo*, the symbol that connotes the summer season, solar warmth, light, butterflies, and *xochitl* (marvelous word!) in its several senses. On his headdress there are no fewer than five balancing symbols - quadrilateral fields divided into four stripes, which probably were once in diverse colors (the whole statue having been painted) - the symbol called *tlapapalli* - a symbol reinforcing the *tonallo* and meaning supreme joy, bliss incomparable. Are not the *tonallo* and *tlapapalli* felicitous for my reading of this statue of Xochipilli as embodying the Aztec esteem for the wondrous entheogen?

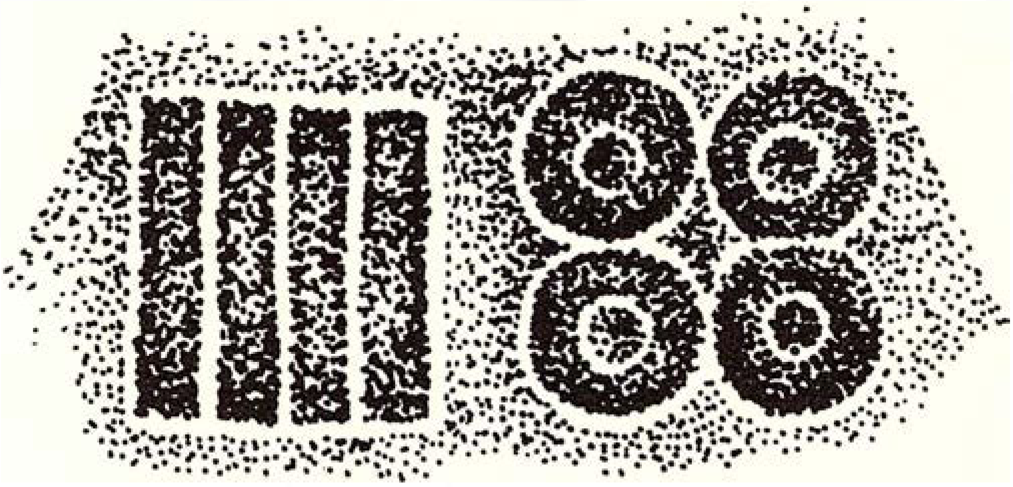


Fig 14 *Tlapapalli* and *Tonallo*

Above the circles of mushrooms on the sides of the 'base' we see a wavy line all around the four sides. Others have suggested that this meant water - a happy suggestion since mushrooms are always associated with showers, rain, moisture, mountain seepage. Along the top rim of the *tablero* there is an endless sequence of concentric circles. These have been called 'solar symbols' and this would not be an incongruous meaning but I will show later (p 170) that they can be differently construed in a way to reinforce my mushroom interpretation.

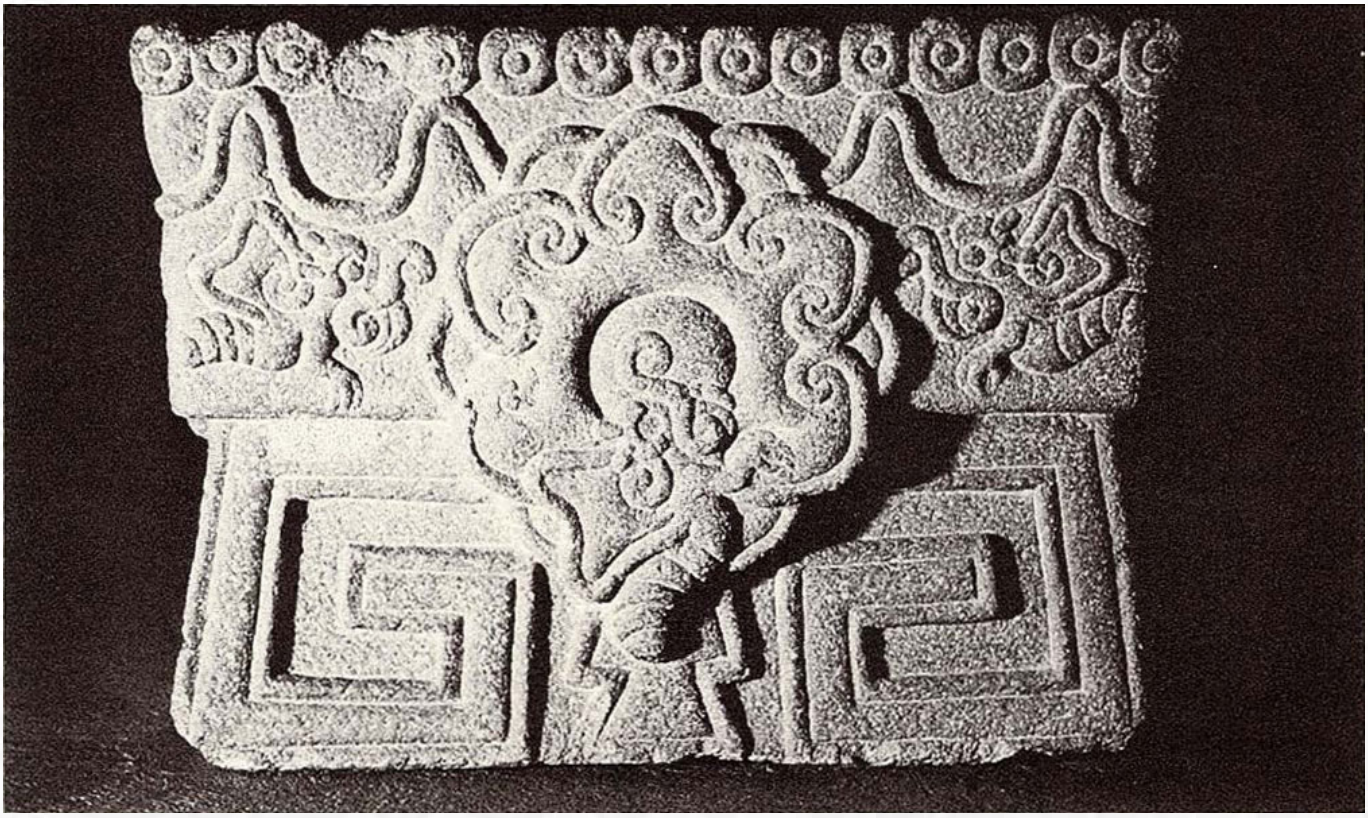


Fig 15 'Base' of statue

Let us now look at the 'flowers' carved on the body of the god. As I am not a botanist, I invoked the help of Richard Evans Schultes, holder of the Paul C. Mangelsdorf chair in Natural Sciences at Harvard and Director of the Botanical Museum there, who with his students, Dr Timothy Plowman and the late Dr Tommie Lockwood, and his colleague the scientific artist Mr Elmer C. Smith, together with me, have come up with the following identifications.

On the statue's right haunch there is a five-petaled carving, the petals being pointed. Schultes and his associates are confident that this is *Nicotiana tabacum*, our common tobacco plant, one of the sacred plants of all Amerindian cultures not only in Meosamerica but throughout the Americas. For four centuries observers of the Amerindians have been telling us that they reverence tobacco as a plant endowed with mystical powers, what we now call an entheogen. Mrs Seeler here reproduces the design on the right haunch, Fig 16a, and also when it is repeated on the left forearm, Fig 16b. Fig 16c is *N. tabacum* as shown in the Britton and Brown *Illustrated Flora*, edited by Henry A. Gleason, Vol 3, p 205.

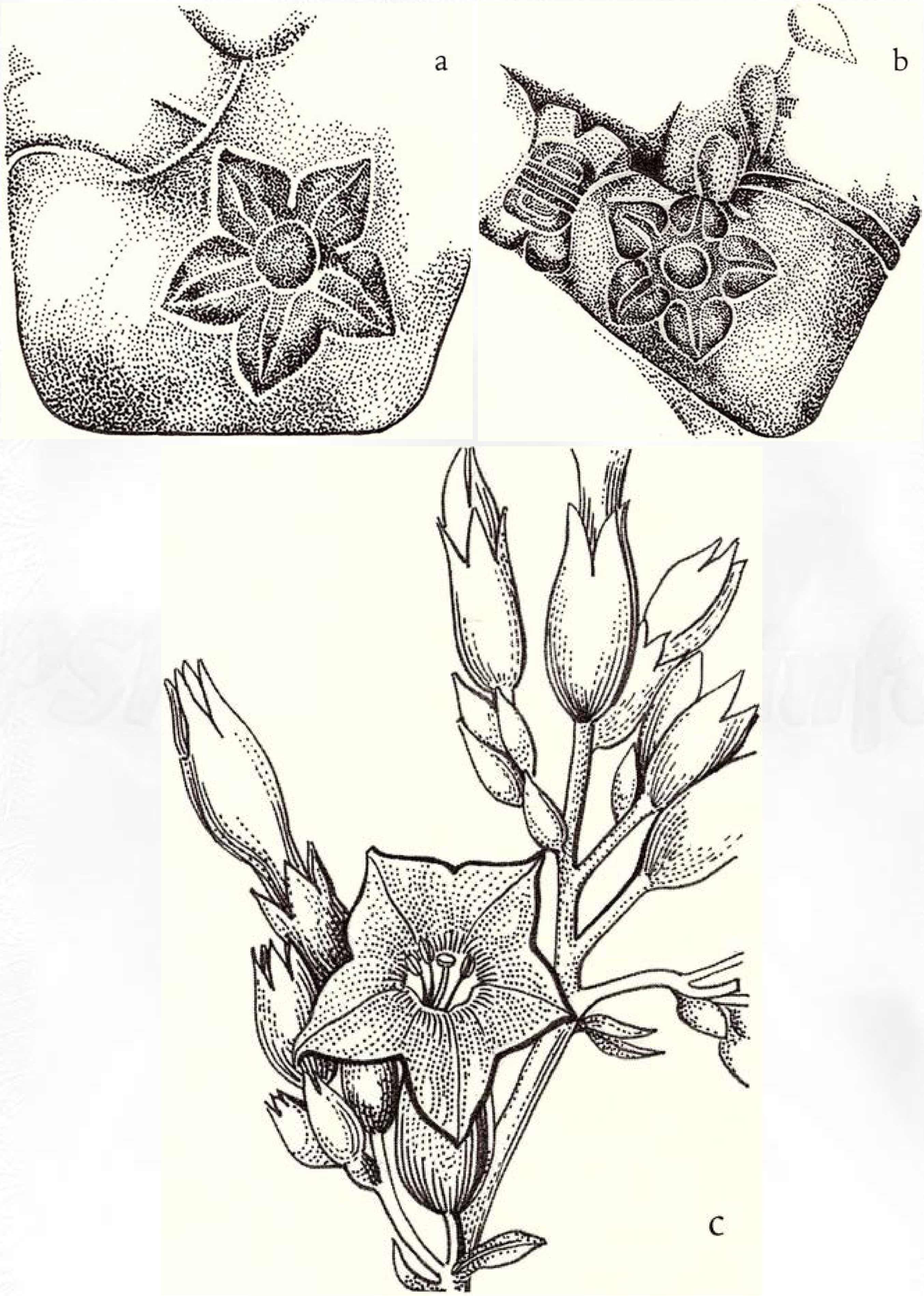


Fig 16 a) Tobacco flower from right haunch of Xochipilli b) Same from left forearm c) Same from drawing of living plant

Let us now turn our attention to *Turbina corymbosa* (L.) Raf., formerly *Rivea corymbosa*, the *ololiuhqui* of the Nahua, the entheogenic morning-glories identified with Mesoamerican cultures. On the right thigh near the knee there is a carving of the morning-glory flower as one views it looking into the cup.[17] Mrs Seeler reproduces the carving on the thigh and also copies the illustration of *Turbina corymbosa* from the same angle as shown in Schultes' classic paper, 'A Contribution to our Knowledge of *Rivea corymbosa*, the Narcotic *Ololiuqui* of the Aztecs', published by the Botanical Museum of Harvard University in 1941. (Fig 17)

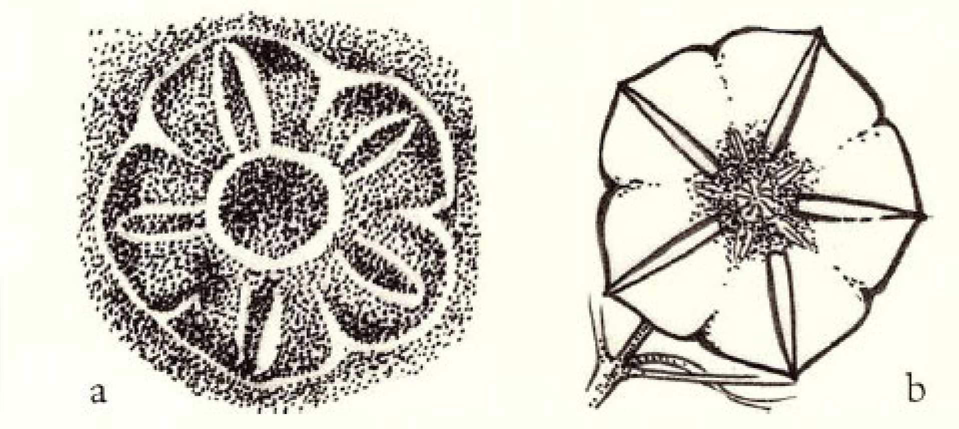


Fig 17 Morning-glory (*Turbina corymbosa*) a) on statue, b) drawn from life

On the left leg below the knee, and again just above the knee on the left thigh, there are, we think, carvings of the emerging morning-glory flower that show the plaiting and convolutions characteristic of that stage in the blossom's life cycle. Fig 18 is Mrs Seeler's design on the left thigh.

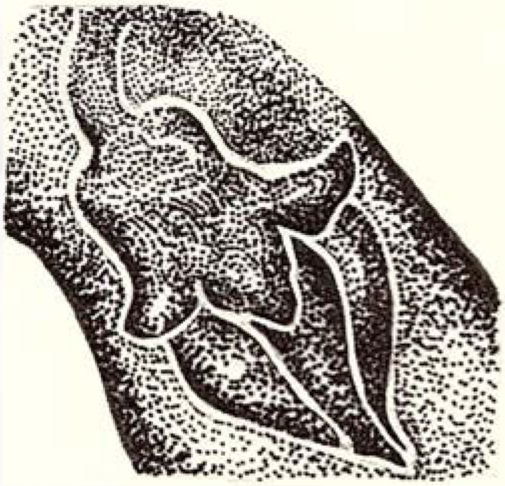


Fig 18 Design on left thigh

So much for *Turbina corymbosa* or *ololiuhqui*.

Schultes is confident that he has identified the flower carved on the right leg below the knee: *Heimia salicifolia*, the *sinicuichi* of the Mexican highlands. Here is Mrs Seeler's comparison of the carving and the actual plant:

---

[17] In *Archeology*, Jan 1973, Vol 26.1, William D. Sturdevant arrived at the same identification of this flower some months before the first version of my chapter appeared in the Harvard *Botanical Museum Leaflets* (Vol 23.8). I gladly point out his priority and would have done so in the *Leaflet* had I known of it. I believe his was the first identification of any flower carved on the Tlalmanalco statue of Xochipilli. But he calls it an 'opiate' which it is not, either botanically or in psychic effect.
One anthropologist insists that this same flower is the *toloache* of Mesoamerica, *Datura inoxia* (= formerly *D. meteloides*). Impossible: the petals of *D. inoxia* are pointed whereas our carvings are rounded, a typical morning glory. *Nicotiana tabacum* and *D. inoxia* are both of the nightshade family, but the carving that we have defined as *N. tabacum* cannot be *toloache*, for the petals of our tobacco carving are acute whereas *D. inoxia* would be attenuate.

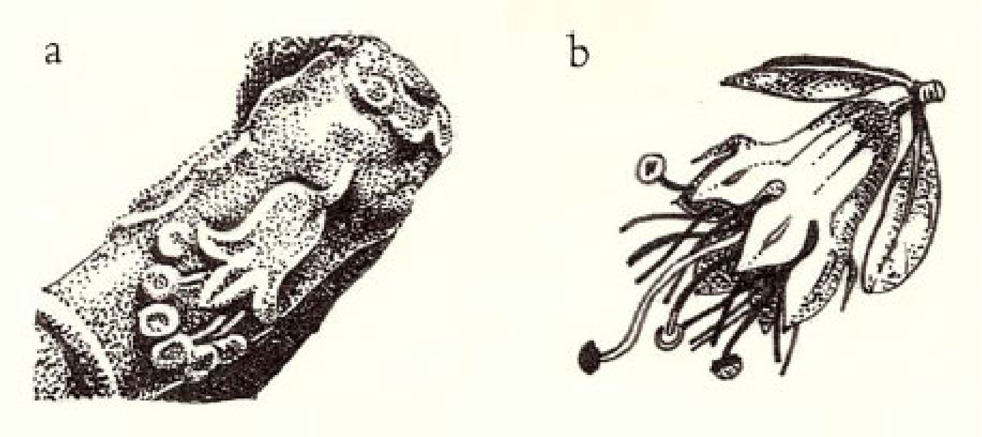


Fig 19 *Heimia salicifolia* a) on statue, b) drawn from life

Schultes says that the plant has 'mildly intoxicating properties', and adds these details:

> Sounds seem to come distorted from a great distance. This plant typifies an hallucinogen of which the hallucinogenic characteristics are auditory, not visual. The natives believe that *sinicuichi* has sacred or supernatural qualities, since they hold that it helps them recall events which took place many years earlier as if they had happened yesterday; others assert that they are able, with *sinicuichi*, to remember pre-natal events.

On contemplating the statue anew one is tempted to see in the tilt of the head and above all in the open mouth that Xochipilli is listening to the far-off voices of *sinicuichi*. Margaret Seeler's drawing is taken from the illustration in the *Bulletin on Narcotics*, Vol XXII, No 1, Jan-March 1970, p 38, in the article by Professor Schultes.

On the left side of our statue, just where buttock and thigh meet, a well delineated flower holds our attention. Schultes, somewhat uncertain, asks whether it could be a swollen bud of *Heimia salicifolia*, just about to open up. As we have seen, *ololiuhqui* (the morning-glory: *Turbina corymbosa*) is probably present on the statue at two stages of its growth: why not *sinicuichi* also? The same flower is carved on the inside of the left calf (Fig 20), and apparently on the right torso. (Here the carving seems unfinished.)

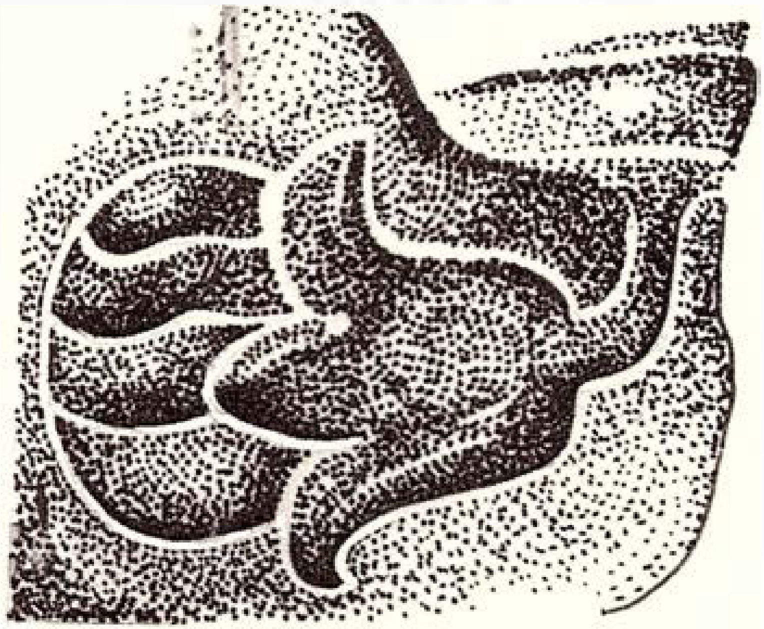


Fig 20 Swollen bud of *Heimia salicifolia* (?)

On the left torso of our Xochipilli, above the belt, there is the carving of an extraordinary flower. When I suggested to Professor Schultes that it might be the flower of the *cacahuaxochitl*, nowadays known to botanists as *Quararibea funebris*, and told him my reasoning, I was delighted that he thought it an excellent possibility, the best so far advanced.

The *cacahuaxochitl* occupied a unique place in the culture of the Nahuatl aristocrats. The pre-Conquest poets speak with almost breathless enthusiasm of it in their verses and also of its flower, the *poyomatli*,[18] which at last we can now link with the tree. The sculptor of the Prince of *Flowers*, having undertaken to carve on Xochipilli's body the *flowers* that figured large in the cultural life of the Nahua, could not sidestep the *poyomatli*. It was a must. The artist, unfamiliar with the flower in its native habitat, did the best he could. Here is Mrs Seeler's drawing of the actual flower, done after the illustration in *Arboles Tropicales de México*, by J. D. Pennington and José Sarukhan:

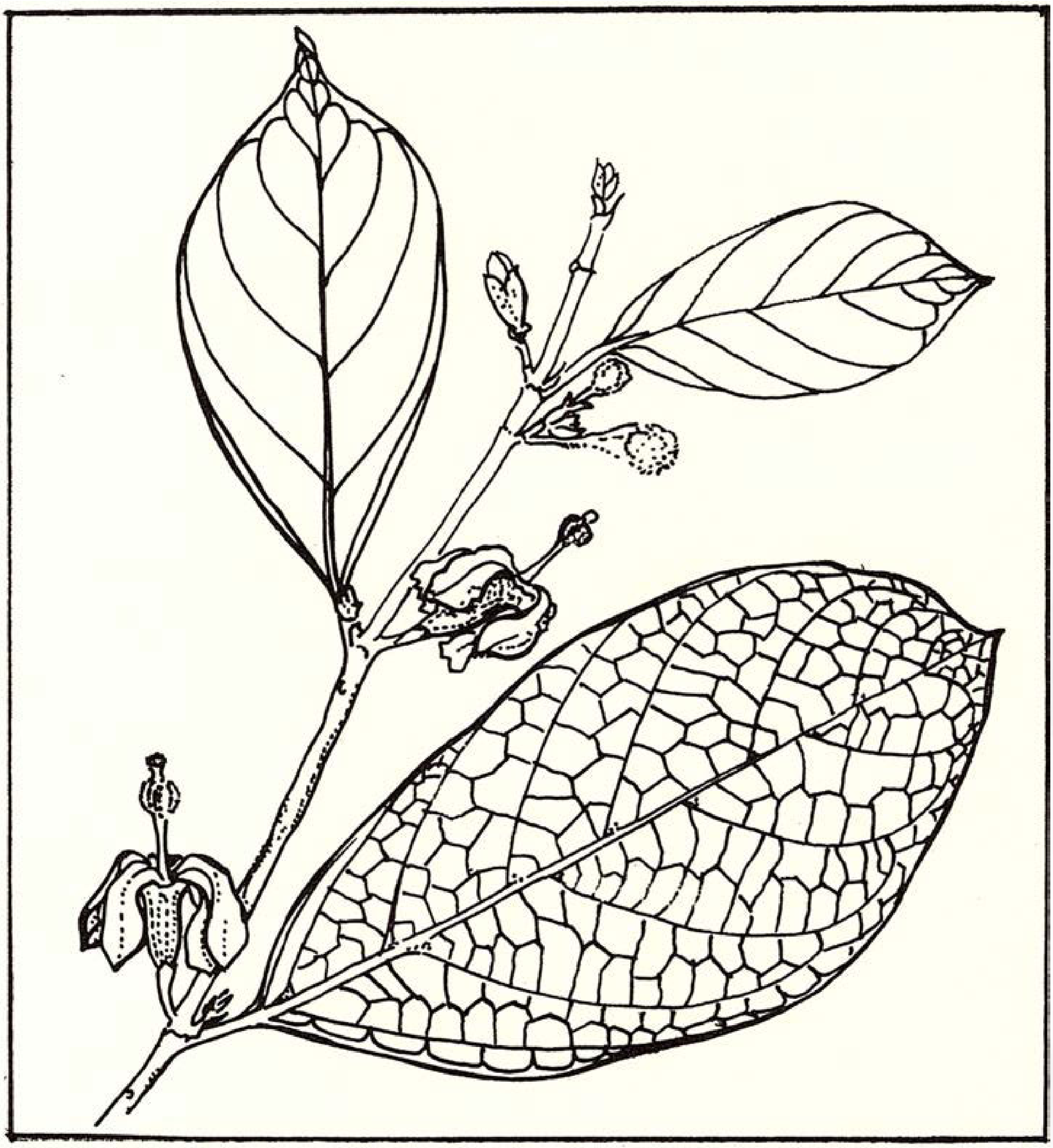


Fig 21 *Quararibea funebris* in flower

The flower is marked by two features - a bold stamineal tube, and *retroussés* petals that leave the tube quite naked. The sculptor of Xochipilli just before the Conquest and Sahagún's artist for the *Florentine Codex* shortly after the Conquest seem to have done their best to do precisely this, though they fell short of the goal they were striving to reach.

---

[18] Though botanists have known the tree for generations, the *poyomatli* has been identified with it only since 1963, when Dibble & Anderson, plodding ahead in their translation of the Nahuatl text of the *Florentine Codex*, came across two independent passages that defined it as the flower of the *cacaltuaxochitl*. Did Sahagún in his paraphrase of the Nahuatl text deliberately omit the identification of this flower that stirred the most intense rapture in Nahuatl circles? See pp 88, 89, 91, also 97 *ff* for further discussion.

We know that the artist in the *Codex* was drawing the *cacahuaxochitl* because the drawing is so labeled. Admittedly the two artists pictured the flowers wretchedly. But let us remember that this tree grows in Veracruz and Oaxaca, not in the Valley of Mexico. Unless the artists knew well the flower *in situ*, they could represent it only by hearsay and by examining the dried pressed blossoms that were carried by porters in bales to the Valley of Mexico. Both artists, after a fashion, managed to catch the distinguishing features - the stamineal tube and the *retroussés* petals - but neither dared picture these as extreme as they really are. Both showed the stamineal tube and Sahagún's artist catches its blunt end. The Xochipilli carving is slightly better than the artist of the *Florentine Codex* in presenting us with the *retroussés* petals. On p 70 we show the flowers as the artists would be familiar with them in dried and pressed condition. With our quick transportation facilities today, we may forget that in pre-Conquest times one had to travel between Mexico-Tenochtitlan and the lands of the *cacahuaxochitl* on foot.

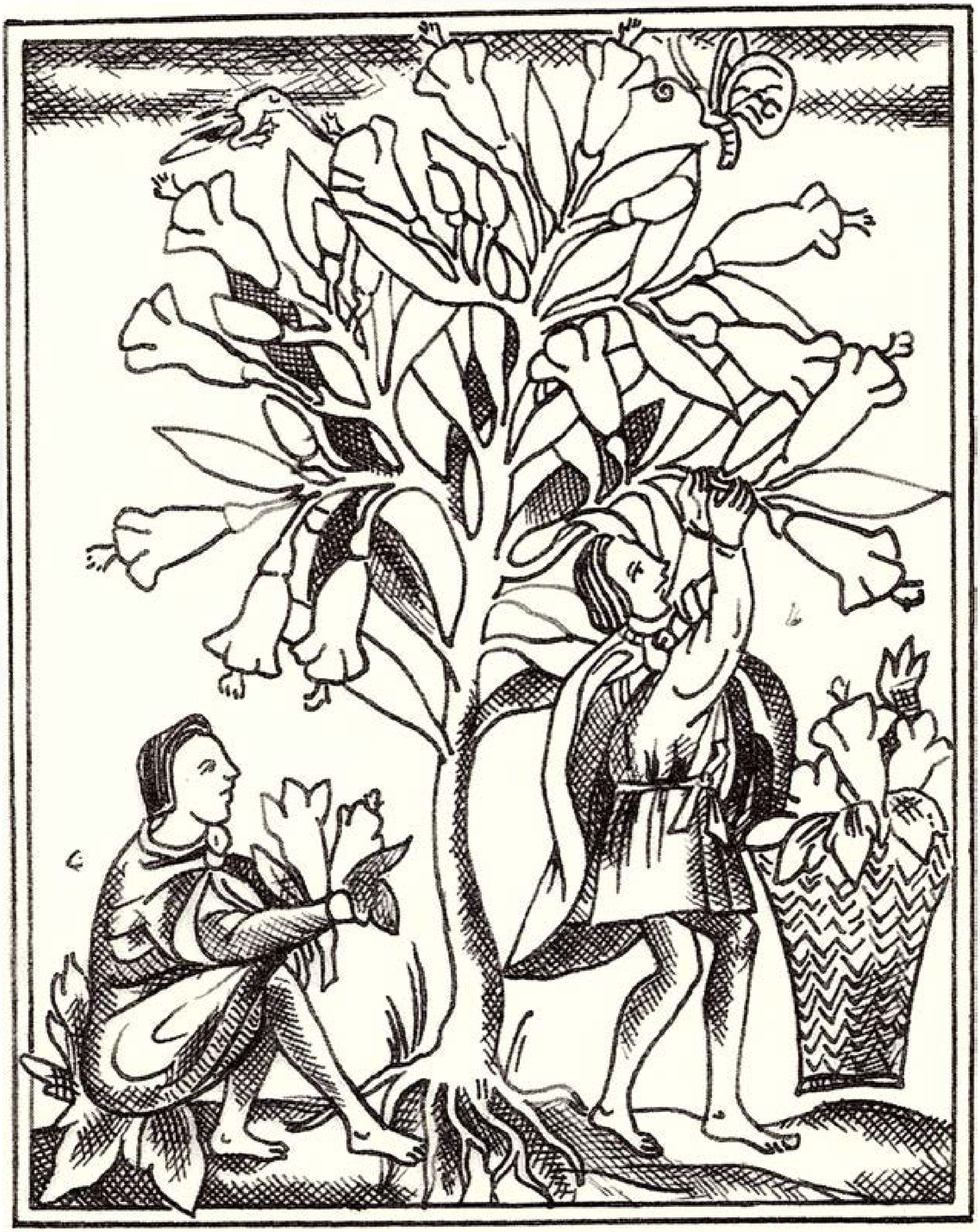


Fig 22 Sahagún's illustration of *Q. funebris*

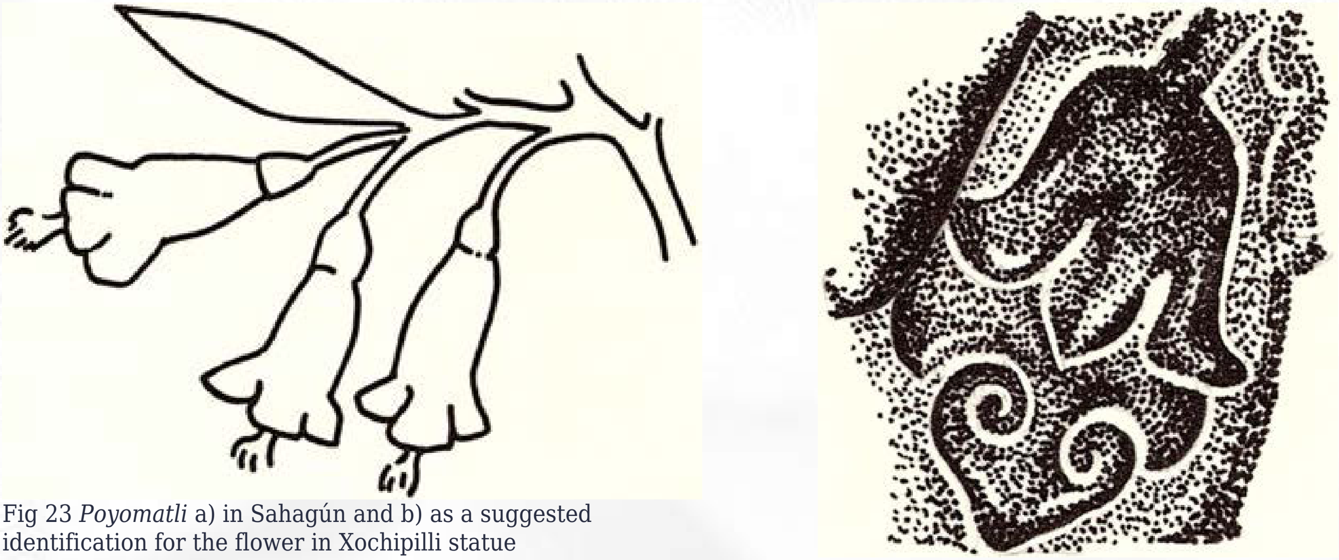


Fig 23 *Poyomatli* a) in Sahagún and b) as a suggested identification for the flower in Xochipilli statue

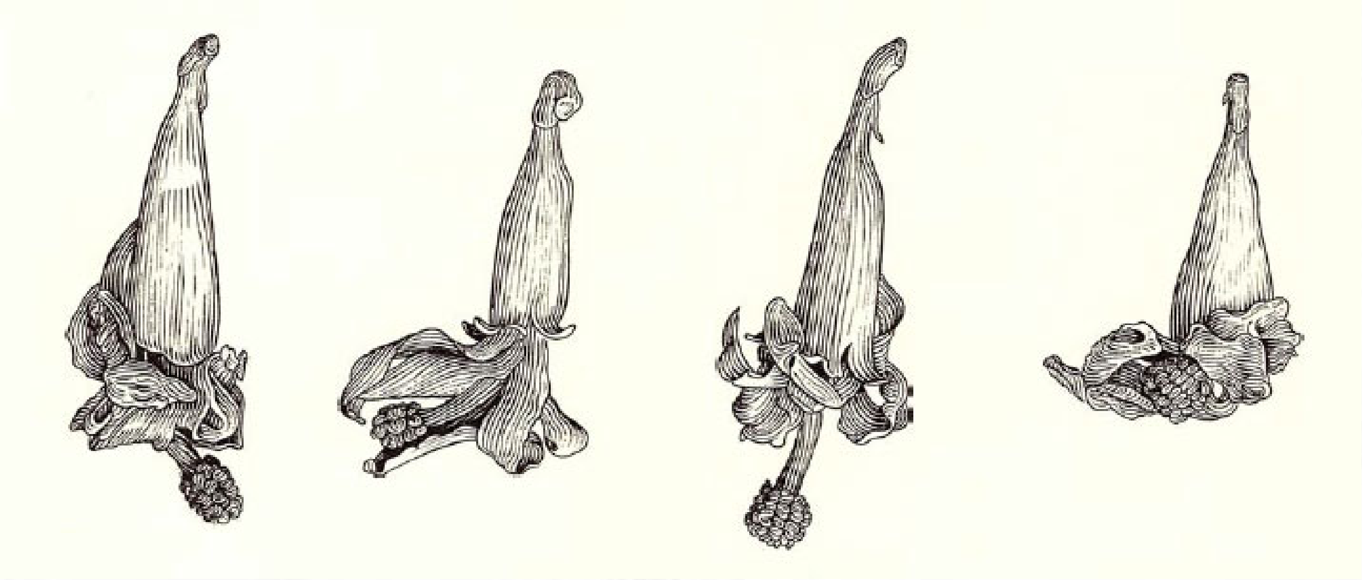


Fig 24 Dried *Poyomatli* flowers

Finally, we discover on our Xochipilli statue, on the inner calf of the right leg, a four-petaled flower. As to its identity we are at a loss. We hope that our readers will come up with a happy suggestion, a flower probably entheogenic, at least a focus of reverence among the Nahua of the Valley of Mexico. Here is Margaret Seeler's drawing of this carving:

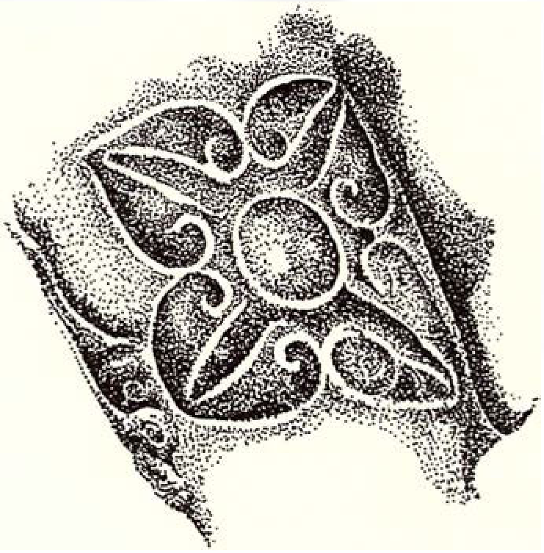


Fig 25 Unidentified carving of flower on Xochipilli

The photograph of this baffling flower was taken especially for us by the Museo Nacional de Antropología.

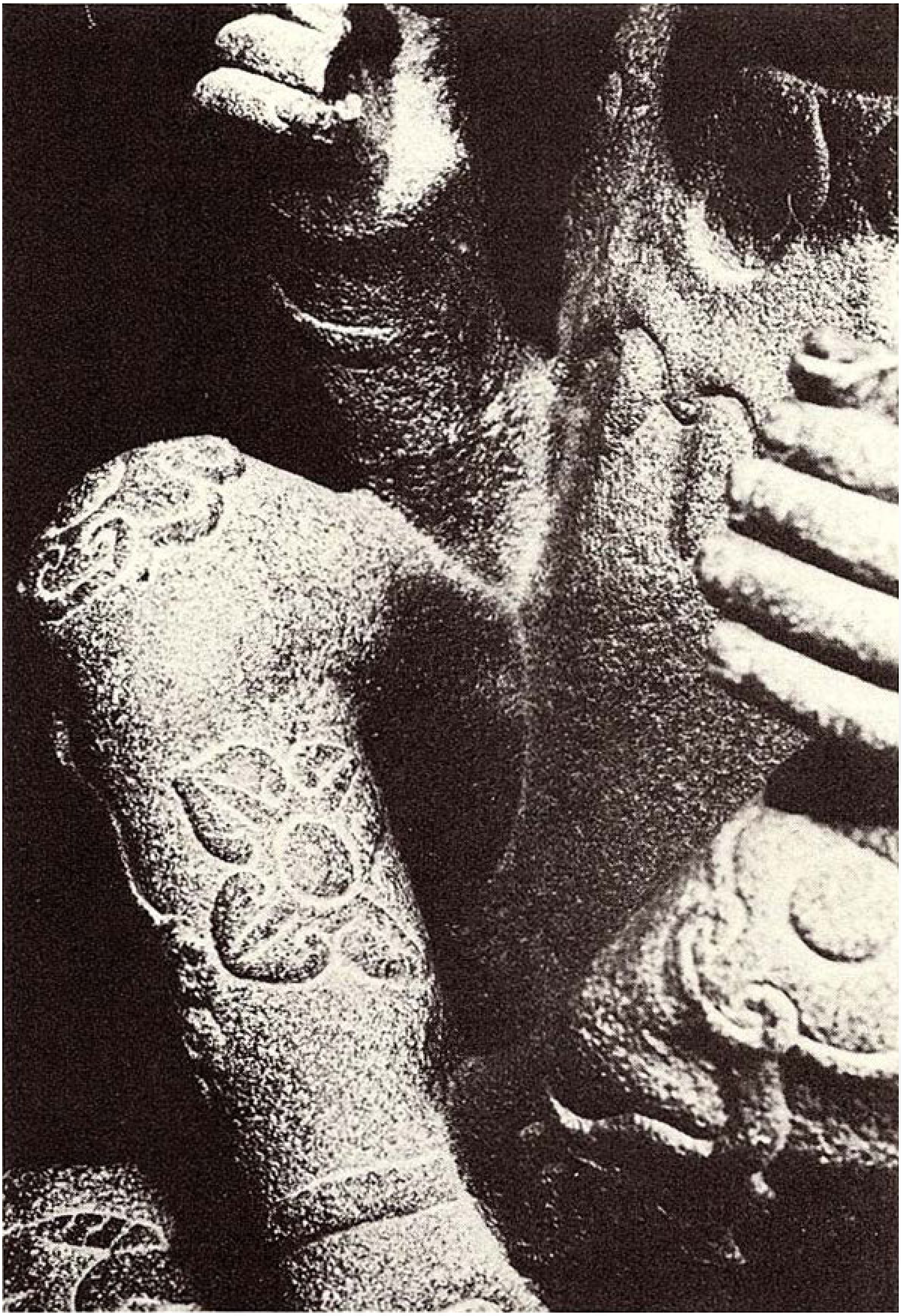


Fig 26 Photo of enigmatic flower

★

The reader will have observed that the 'flowers' carved on Xochipilli bear no fixed relation in size to the flower or mushroom that is portrayed: each flower fills suitably the space allotted to it. The reader will also observe that among the flowers carved on Xochipilli no Datura is represented. The statue expressed the culture of the Princes and Nobles of the Nahua, and the Daturas did not rank with the entheogens of the aristocrats. We also observe that no plant linked with alcoholic beverages - neither pulque nor maize beer - is present.

⋆

About twenty years have passed since I first saw the mushrooms on the 'base' of our statue, but as time has gone by, the mushrooms and other *flowers* have taken second place in my thinking: here in this statue is Rapture itself delineated in stone, and the *flowers* only serve to confirm its meaning. The *flowers* on the *tablero* and body (among which the mushrooms receive pride of place!) amply ratify, for doubting Thomases, the identification I have given to Xochipilli, the God of Rapture. The elegance of this statue, its subtlety, its nobility, speak for the exalted place accorded to the entheogens by the *élite* in pre-Conquest Mesoamerica. They emphasize the surprising ignorance and lack of respect shown by all Mesoamericanists for this major manifestation of the civilization that is their special field of study. In his paper on our statue of Xochipilli Justino Fernández begins by denying the ecstasy of this statue and to that end would introduce turquoises into the eye-sockets, but even he finally compromises his position by succumbing to the enchantment of the face:

> Por último, el gesto de la máscara tiene tensión dramática y cierta ternura, pues la mirada está pendiente de algo 'más allá', que parece mirar fijamente...; el gesto de la boca tensa horizontalmente y con los labios un poco entreabiertos sugiere cierto esfuerzo de elevación,...
>
> Finally, the mask shows dramatic tension and a certain tenderness, since the look is one of expectancy of something from 'out yonder', where its gaze seems fixed...; the expression of the horizontally taut mouth with half open lips suggests a certain effort at elevation,...

How close did this able academic art critic come to the esoteric meaning of the statue! Here he seems to have finally abandoned his notion of turquoises in the eye-sockets: he concedes that the 'gaze' is fixed 'out yonder'. If only he had had the entheogenic experience, or alternatively if only he had stopped to examine the botanical specimens carved on this ensemble of noble statuary!

Perhaps the reader will have allowed himself to be persuaded by my presentation of Xochipilli without due regard to the consequences: let him be warned. If he accepts my interpretation, he will be committing himself to a reappraisal of pre-Conquest Mesoamerican culture. For going on five centuries those interested in Mesoamerica have ignored the entheogens. The Indian informants of the Spanish chroniclers, knowing well where their bread was buttered, gave accounts of the entheogens that lent themselves to due execration by the ecclesiastical scribes. We must be grateful that the informants tell us as much as they do and that the friars pass on to us, more or less faithfully, what they were told.

Xochipilli appears often in the pre-Conquest codices and sculptures of Mesoamerica but the artists naturally felt no need to spell out his meaning. Let me suggest an analogy: the ancient Egyptians used methods of writing that no one could interpret until there was found in 1799 a stone in the delta of the Nile with a text engraved for contemporaries in three modes of writing, in Greek, and in Egyptian hieroglyphics and demotic script. From this bilingual inscription the Frenchman Champollion started us on the road to reading the vast corpus of ancient Egyptian texts. Those who carved the Rosetta stone were not thinking of the use to which it would be put by learned men in distant lands far in the future; neither could the artist carving Xochipilli have imagined, if I am right, what a sensational disclosure his work would be making to strangers from another world half a millennium later. Here Xochipilli discloses the exalted view of the entheogens held by the Mesoamericans in pre-Conquest times: the nobility of this statue speaks loud and clear, with the honesty of all outstanding works of art. Later, some of the friars with distinguished talents and extraordinary zeal leavened with compassion and even admiration for the conquered, wrote down lengthy accounts of life in Mesoamerica before and after the Conquest, but always filtered through the theology of their time and circumstance: inevitably they gave no quarter to the entheogens. Our statue of Xochipilli serves us as a touchstone, as a cultural Rosetta Stone, bypassing the friars encumbered with their theological preconceptions, speaking to us directly with the voice of the pre-Conquest Aztecs.

As an artist's expression of ecstasy in Mesoamerica our Xochipilli is far from unique. He is unique only in that his body bears carvings of the miraculous plants that transport him and us to another reality and that spell out for us his message. In Colima Dr Isabel Kelly has unearthed a number of small stone statues bespeaking rapture with a breathtaking eloquence perhaps unmatched even in our Xochipilli. They date from the end of the seventh century A D. Surely the absence of the plant carvings on their bodies does not negate for us their meaning. Their eyes are open, as is not unnatural in a nocturnal *velada* held in the dark. Two of them are on exhibit in the Museo Nacional de Antropología. (Figs 27, 28)

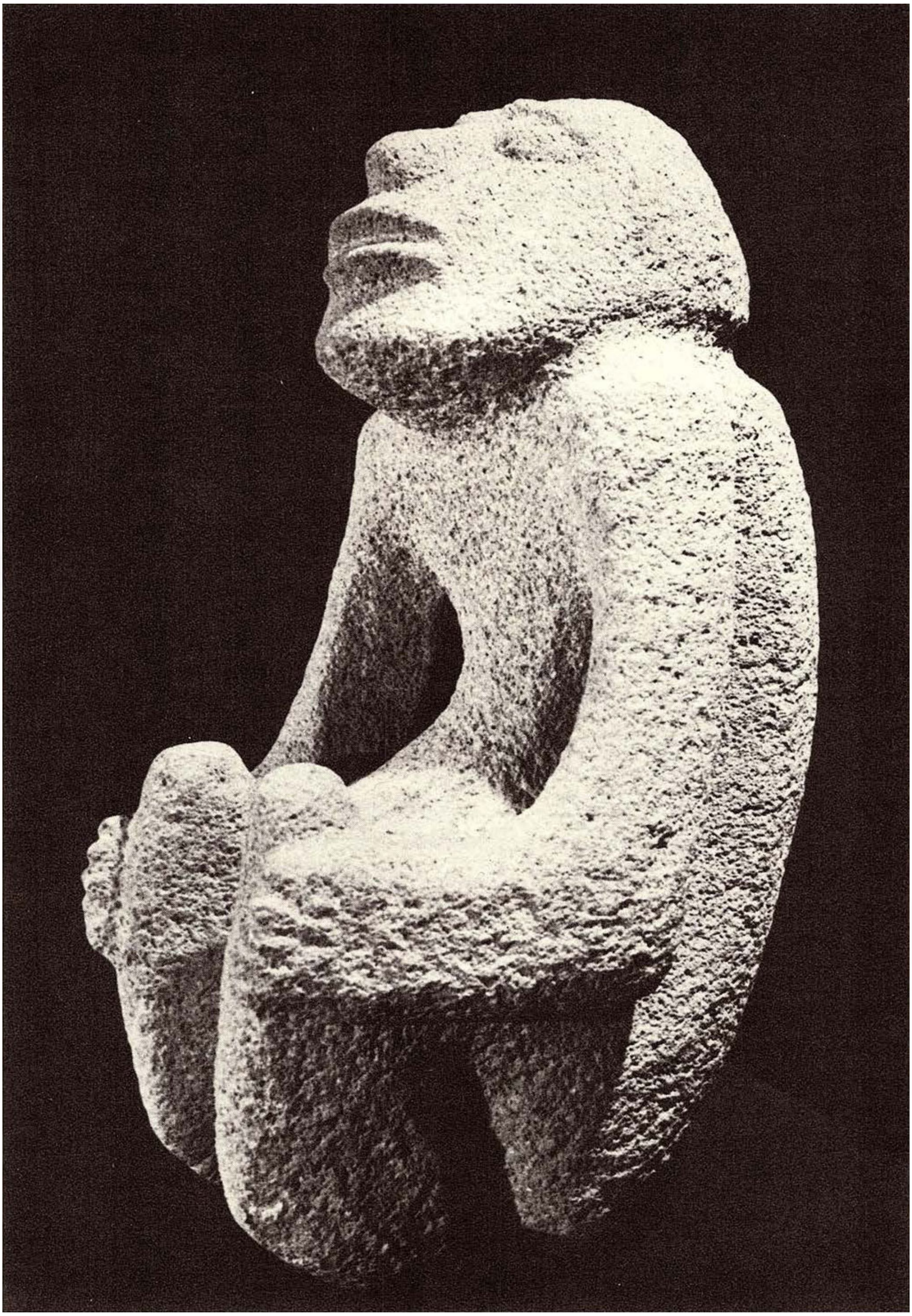


Fig 27 Stone carving of ecstasy

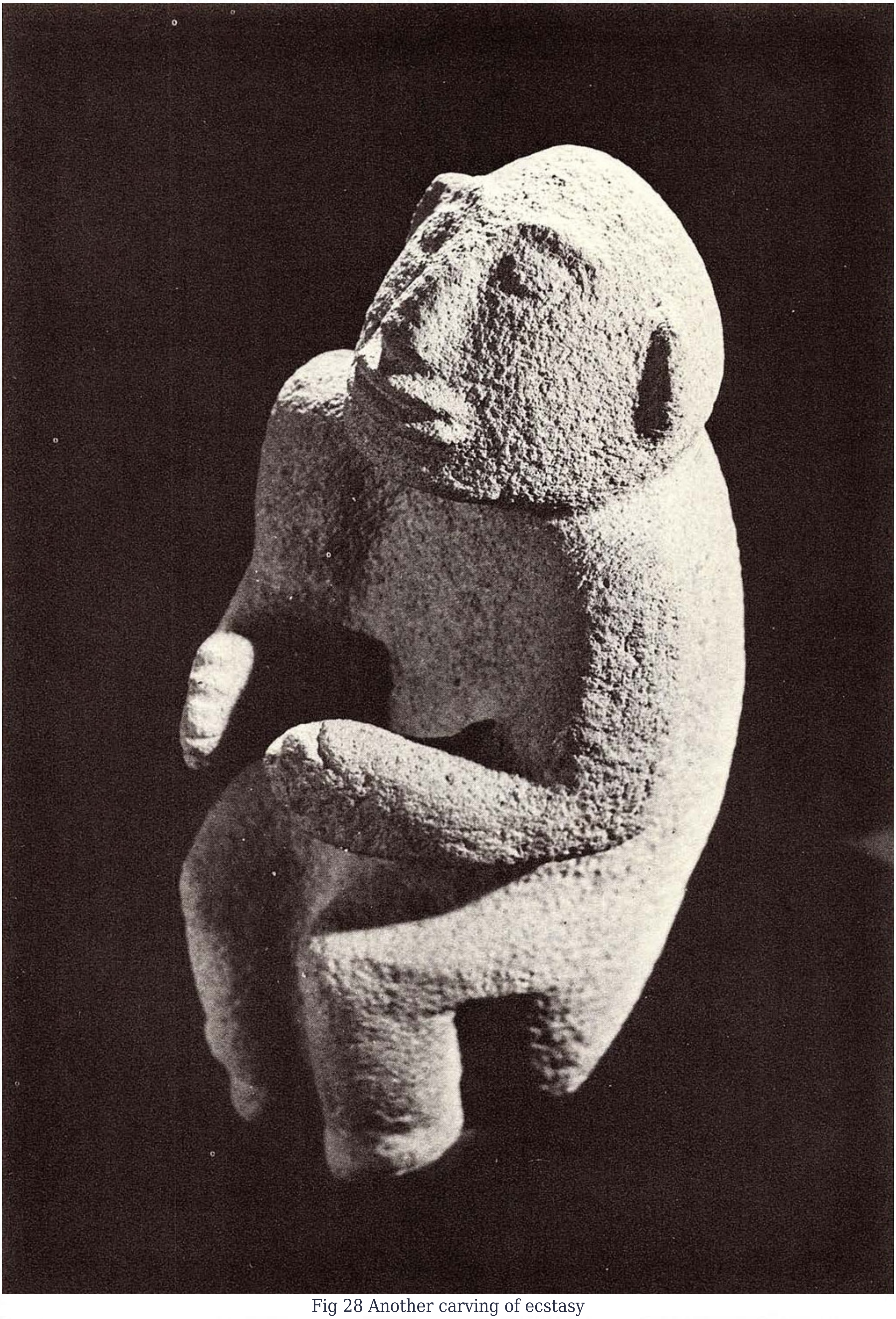


Fig 28 Another carving of ecstasy

I think there were two ways of presenting ecstasy in pre-Conquest Mesoamerica. We have seen the grand manner in the Tlalmanalco Xochipilli and the two Colima figurines. This style conveys to the spectator the awesome experience that follows ingestion of the entheogens, but in doing so it translates reality on to a transcendental plane. Those who are experiencing the entheogens actually sit as in a stupor, rapt in their own sensations, their facial expression introverted. In the Museo Nacional there is a Mezcala figurine (Fig 29), eyes closed, carved in hard stone, and dating from the late pre-classic period, B C 600-100. Some may question whether this Mezcala artifact is an embodiment of rapture, so blank and negative is his expression, but I ask what else can it be? For those who have known the mushrooms or the morning-glory seeds, it takes no effort to imagine his state of mind. The artist who carved Xochipilli was giving us reality transfigured, was giving us what the Indian would feel that he was living through, was giving us Rapture petrified. The mask tells us what the man in ecstasy felt. The artist of the Mezcala figurine tells us what the same man looked like to others.

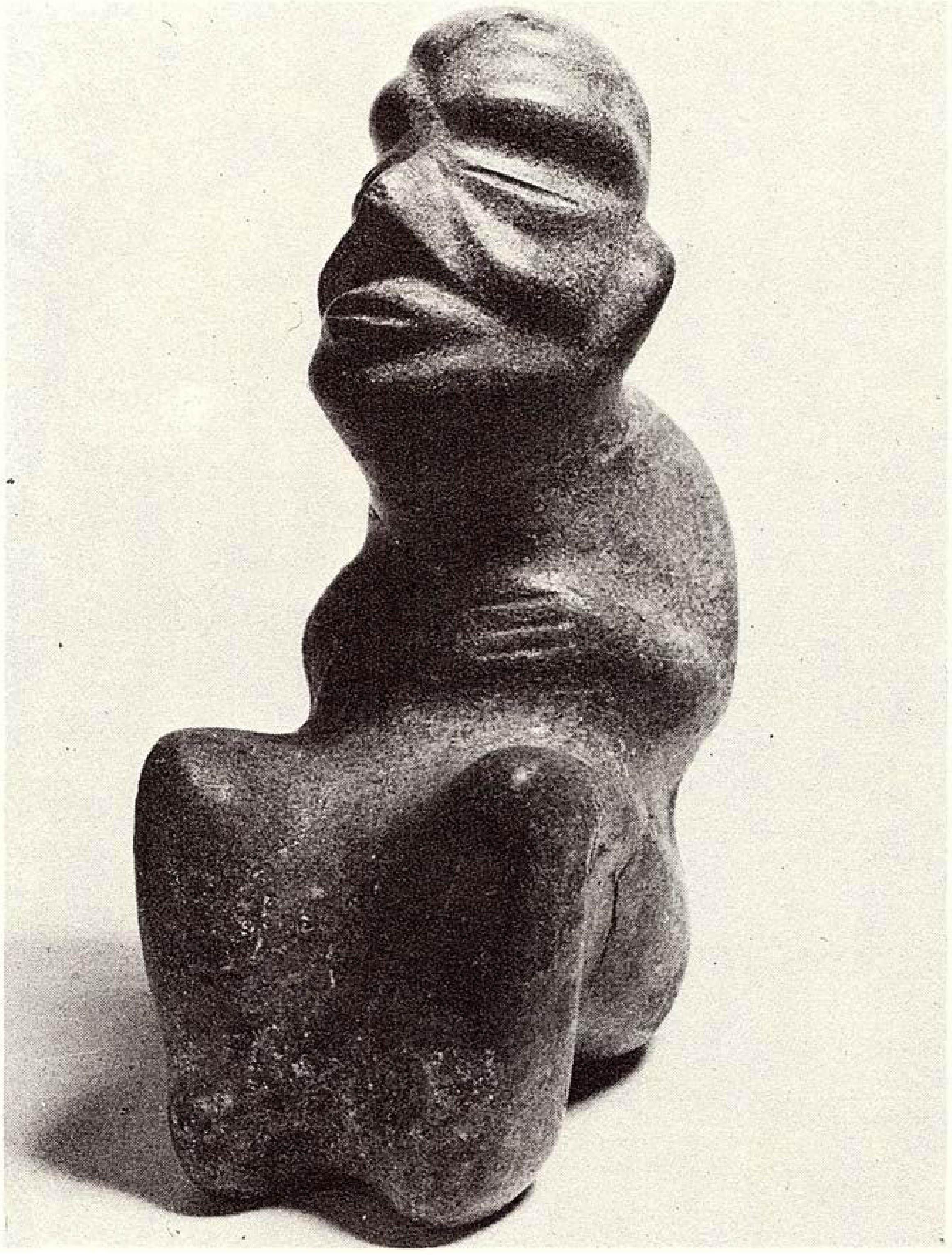
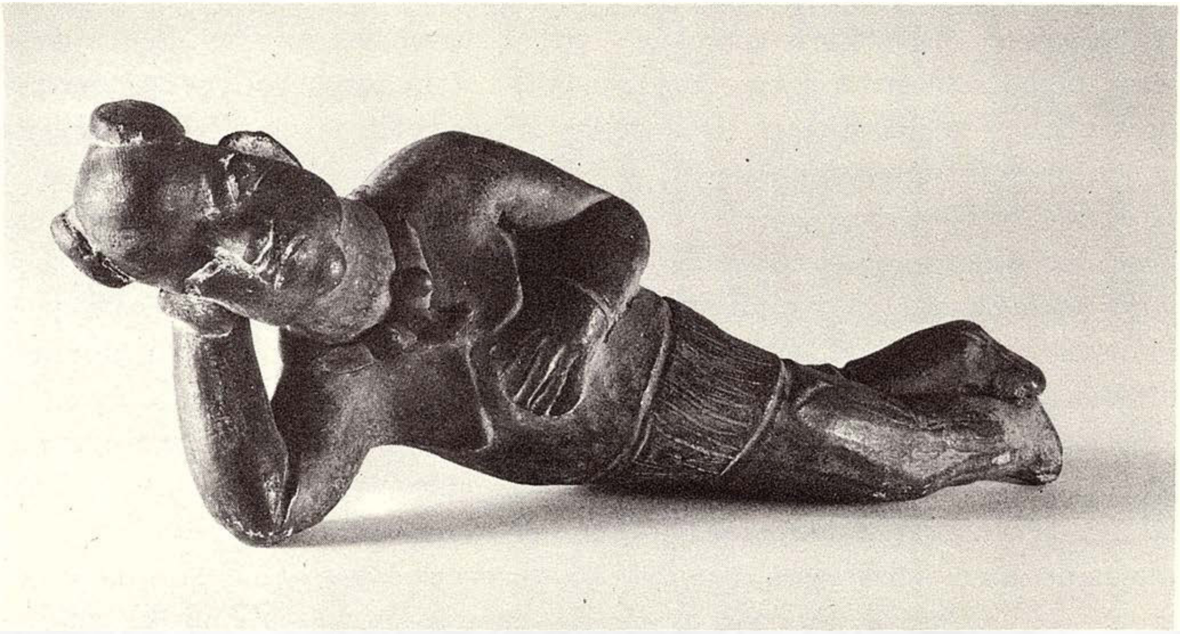
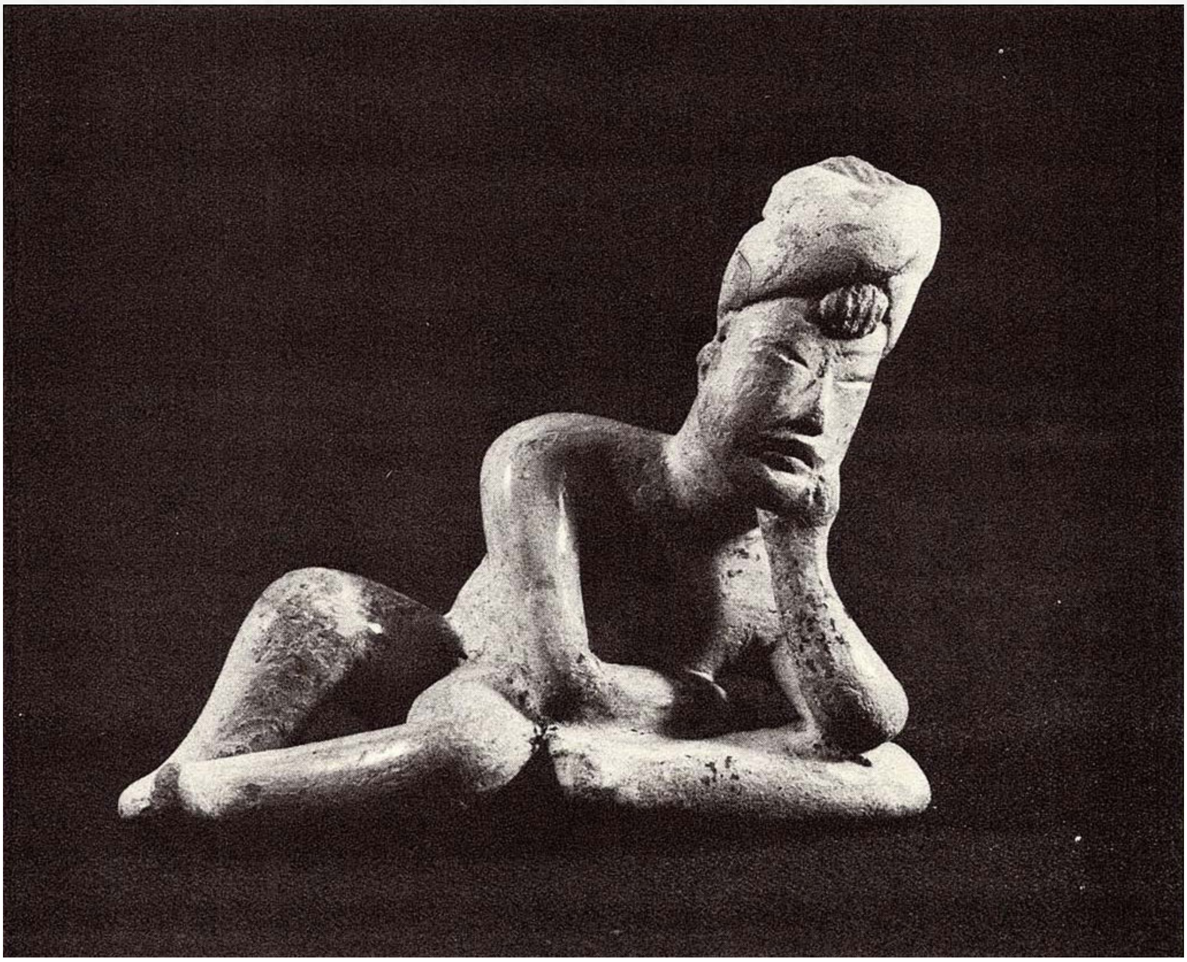


Fig 29 Another interpretation of ecstasy

The late Dudley Easby and his widow Elizabeth, with the prescience that always characterized their work in Mesoamerican archæology, grouping together a number of small reclining figures, suggested that these particular figures and others like them might well represent ordinary people enjoying the entheogenic experience. Those that they reproduced in the Catalogue of the *Before Cortés* exhibition in the Metropolitan Museum were in jade (possibly Olmec) or clay. (Figures 30 and 31) They range from 3½ to 8½ inches long and date from the middle or late preclassic period (BC 1150-100), hailing from Honduras, Central Mexico, and Guerrero. I have no reason to think that the Easbys had ever known a *velada*, had ever taken the entheogens, but they were gifted with rare intuition and their surmise may well have been right.



Figures 30 and 31 Figurines expressing ecstasy (?)



How different all these expressions of the ineffable are from the manner of the European religious painters of the late Middle Ages and early Renaissance! For them the Saint is leaning forward on his knees, arms outstretched, his eyes lifted heavenward, perhaps toward a vision in the radiant sky of the Virgin with her supporting heavenly host singing sweetly to the accompaniment of divers musical instruments and with *putti* scattered among the clouds. This was the Western conception of beatitude, of bliss, executed often by able artists but artists who had never experienced what they were painting. In Mexico the artists knew what it was they were carving and by the simplicity of their execution they succeeded in conveying to the viewer (who also knew) the sense of the rapture that their opposite numbers in Western Europe could not approach.

The statue of Xochipilli tells us that *xochitl* could mean in Nahuatl, as a figure of speech, the entheogens and the incomparable wonder-world to which they invite us. The *flowers* carved on the body of this our exemplar of ecstasy are what the Mesoamerican Indians regarded as sacred entheogens. Miguel León-Portilla comes as near to arriving at the truth as one can hope to do who has not known the miraculous plants, has not allowed for their existence: he skirts, but only skirts, in every word of the following eloquent passage, the genuine meaning for the Nahua of *xochitl* in its metaphorical sense:

> La expresión idiomática, *in xóchitl*, *in cuícatl*, que literalmente significa 'flor y canto', tiene como sentido metafórico el de poema, poesía, expresión artística, y, en una palabra, simbolismo. La poesía y el arte en general, 'flores y cantos', son para los *tlamatinime* [wisemen, Magi, soothsayers], expresión oculta y *velada* que con las alas del símbolo y la metáfora puede llevar al hombre a balbucir, proyectándolo más allá de sí mismo, lo que en forma misteriosa, lo acerca tal vez a su raíz. Parecen ['flor y canto'] afirmar que la verdadera poesía implica un modo peculiar de conocimiento, fruto de auténtica experiencia interior, o si se prefiere, resultado de una intuición.
> [Los Antiguos Mexicanos, Chap 4, p 128 in my reprint; Fondo de Culrura Económica, Mexico, 1961.]
>
> The idiomatic expression, *in xóchitl*, *in cuícatl*, which literally means 'flower and song', has the metaphorical sense of poem, poetry, artistic expression, in a word, symbolism. Poetry and art, 'flowers and songs', are for 'those-who-know' [wisemen, Magi, soothsayers] an occult and veiled term that may sweep man off on the wings of symbol and metaphor, stammering, may project him beyond himself, thus perhaps in a mysterious manner bringing him nearer to his origins. '*Flower and song*' *seem to affirm that true poetry implies a peculiar way of knowledge, the fruit of an authentic interior experience*... [Italics mine]

This 'peculiar way of knowledge', this 'fruit of an authentic interior experience'! Leon-Portilla divined the truth. Without knowing it, he was describing a *velada* with entheogens.

CHAPTER 4

The *flowers* in pre-conquest nahuatl poetry

The corpus of pre-Conquest Aztec poetry began to be accessible to the West only a few years ago and almost at once it was remarked that this poetry possessed a feature peculiar to it: on 15 May 1961 *The Times* (London) in a dispatch from Mexico City observed that the Aztec poets never tired of talking about 'flowers' but that they seldom distinguished one species from another. Since poets are prone to subtleties in thought and feeling, this lumping together of 'flowers' was odd. No explanation was forthcoming from the Nahuatlatos (as specialists in Nahuatl are called) and none has been advanced since then. But if the Aztec Princes and Nobles, who were the poets that we are speaking about, used 'flowers' as a figure of speech for the entheogens and the entheogenic experience, in short if the poets understood 'flowers' as the Xochipilli carvings say they were to be understood, all becomes clear. (I am printing *flowers* in italic when we deal with a trope for the entheogens.) The *flowers* were the breathtaking experience of their lives, supreme and miraculous. The *flowers* took them to another world where they sang their Aztec poetry to the music of their Aztec instruments, a world that they called their Tlalocan (or sometimes their Tamoanchan), a world of strange and wondrous beauty, where they reveled in sensations beyond imagining. It is not surprising that these Princes and Nobles, able and sophisticated men, composed poetry weighted with *flowers*.

The Times's correspondent exaggerated: specific flowers are cited in Nahuatl poetry as often as in any other. What is distinctive is the recurrence of *flowers*. In the four volumes of Nahuatl poetry that I shall discuss *flowers* are iterated and reiterated times without number. *Flor* y canto, '*flower* and song', drew the poets, according to Diego Durán, to their periodical gatherings around their symbolic 'Tree-in-*Flower*' - *xochicuahuitl*, *Arbol Florido* - and to the house of flowers - *xochicalli* - where on the feast of Xochipilli a 'tree' was erected *ad hoc* and laden with flowers, where children dressed as birds and butterflies gamboled among the flowers, and where everyone sang and danced. This custom had been going on for perhaps a thousand years, for at Tepantitla, in Teotihuacán, the fragments of a mural of this stylized 'tree' were found in the late 1930's, and Villagra Caleti conscientiously restored it for display in the Museo Nacional de Antropología. Peter T. Furst suggests that this tree represented the morning-glory. He is certainly right in part: the interlacing branches take their inspiration from the twining climber of the Nahuatl *coaxihuitl*, 'snake plant', the morning-glory, whose seeds are known as *ololiuhqui*. But this 'Tree-in-*Flower*' is a symbolic tree built for the occasion, and the Nahua erected it to the glory of all the superior entheogens among which the morning-glory held a most honored place. Diego Durán does not say that at this celebration the participants consumed entheogens but his failure to do so leaves the question open and in the light of our meaning for Xochipilli, Prince of *Flowers*, and of Durán's obvious implication (discussed on p 201) that *flowers* were present when he does not expressly mention them, it is not an abuse to surmise that *flowers* were there consumed. Indeed, their presence is compelling.

We reproduce Villagra's repainting of this 'Tree-in-*Flower*' in Fig 1. The Mesoamerican conception of such a tree reminds us forcibly of the Maypole in northern Europe, where in Sweden it is still decorated with branches of birch. Those who celebrate the Maypole no longer remember that the birch is the host of choice to the entheogenic *Amanita muscaria*.

All students of Nahuatl culture have become familiar in recent times with the word *teonanácatl*, the name used for the entheogenic mushrooms that was used by Sahagún and Motolinía. But we ask ourselves why this word is not to be found in Fray Alonso de Molina's big lexicon of the Nahuatl language published in 1571. He gives us another word, *xochinanácatl*, '*flower* mushroom' from *xochitl*, 'flower', precisely the word that the statue of Xochipilli tells us to expect. *Xochinanácatl* survives to this day in a place name, 'Xochinanacatlán', a *muncipio* of Tlaola, District of Huachinango, State of Puebla. 'Nanacamilpa' is a place name near Tlaxcala even now and there is authority for the belief that in Veracruz a village existed in the sixteenth century called 'Nanacatlan'. One Antonio Xochinanácatl figures in a Tlaxcala law suit that Thelma Sullivan is translating. In the *Matrícula de Huexotzinco* (a bilingual list of that town's inhabitants in 1560 composed in Nahuatl picture-writing and in Spanish) two men bear the name Xochinanácatl. (See p 114)

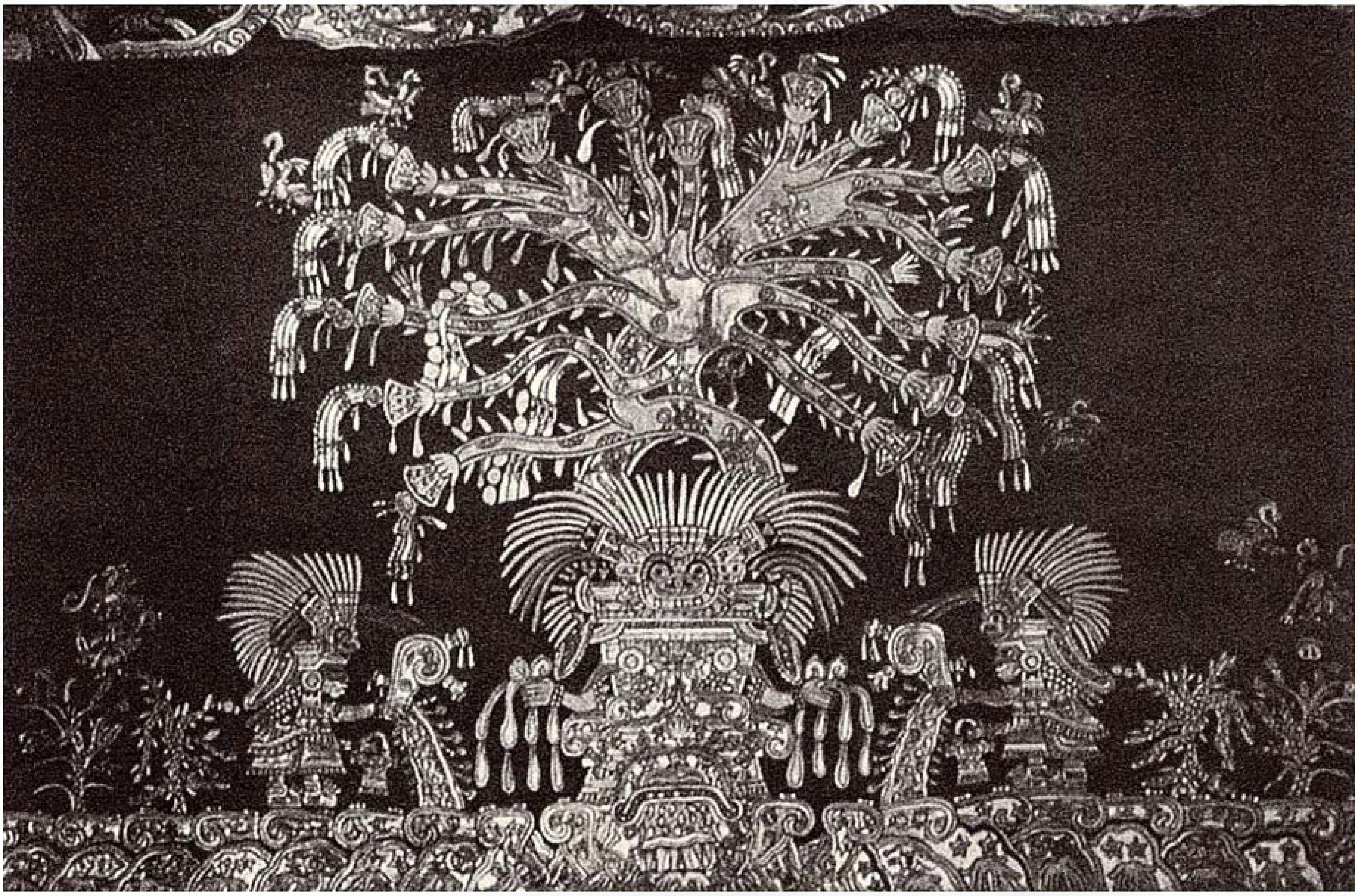


Fig 1 The Tree-in-*Flower*, repainted after Tepantitla, Teotihuacán

In Mesoamerica we enjoy an inestimable privilege: we have spread out before us the life style of a branch of Early Man possessing an advanced culture, the leader among the cultures round about, where any immediate influence of Eurasia is most unlikely, where earnest and zealous scholars believing in such influences work all their lives to establish threads of ancient contact, where such contacts (and certainly there may well have been some) do not materially affect the pure strain of what the Spaniards found flourishing in Mesoamerica. They found a people for whom religion was everything, perhaps even more so than for the sixteenth century Spaniards: no human act was performed untinctured by religious beliefs. Their religion evoked reverence, adoration, awe, but also fear, yes, and terror; as do all religions gripping Early Man. Their 'wars' were often waged solely to take prisoners to sacrifice to their gods. The frenzy, the delirium, of these wars, the dangers that every warrior ran, the courage that the prisoner was expected to show on the sacrifice day, added to life the ultimate in awesome terror. Their cruelty was clean, elegant. When prisoners were being sacrificed with the obsidian knife on a stone slab carved for that purpose, on top of the pyramids, the enemy's leaders would be invited to attend and from behind blinds they would watch the victims climb the long, steep, shallow steps without balustrade to meet their end at the top. (How bitter-sad and proud must their compatriots have been on watching the behavior of their friends and loved ones on this, their last glorious day!) The Nahua were cruel, but who are we to reproach them?

We discover that '*flower*' was also used as a trope for their warfare, just as it was for the entheogens. The Nahua exalted their 'wars' with this their supreme metaphor of enhancement, taken from the metaphor for the entheogens. The entheogenic experience was the supernal event of their lives and it supplied them with a storehouse whence they drew their ultimate in verbal praise, redolent with religious feeling. They believed in the reality of that other world of the entheogens, and anyone who knows the mushrooms and is also imbued with historical imagination will understand why. We must always keep in mind what Early Man did *not* know: the Nahua did *not* know they were dealing with a mere 'drug', as we say, a chemical compound with a known molecular structure and a known impact on the human mind. They were dealing with a miraculous, a divine gift. The two tropes - primary and secondary - became interchangeable in a way sometimes difficult for us to follow: there is interplay between them, to the point where we can sometimes only guess at the meaning.

Father Garibay expressly denies to his four volumes of poetry any involvement with the entheogens, even when the inebriating mushrooms (*eg nanacaóctli*, 'mushroom liquor') are specifically mentioned, saying that here we have to do with poetic metaphor. But how jejune, how flaccid, is this poetry stripped of the divine inebriants! In these verses our Nahua, Princes and Nobles, are treating us to the hot afflatus of poetic passion, courtly poets living in their own proto-history without the alphabet, composing and singing their own verses before they knew that Europe existed, and what preoccupied them? The Mystery of the entheogens. Here lie the bone and sinew, the blood and muscle of their poetry. They were aglow with the rapture of the entheogenic experience, the religious surge that welled up in them. In this corpus of Mesoamerican poetry we discover Early Man's poetic drive uninfluenced by Eurasian peoples. We surmise a practice and an intellectual legacy from those migrants who came across the Bering Strait, but this takes us back many, many millennia.

If there are any who question my meaning for these poems, I urge them to read the first four poems that I off er in this chapter and then to say whether the poets were singing merely to the fragrance of flowers. They were not only cultivated men but men of power in their world. Effeminacy is not a word that could be linked to them.

The paradise of the Nahua is mysterious alike for them and for us, but the questions it poses for them and for us are radically different. Knowing nothing of this other-world of Mesoamerica, our Mesoamerican scholars are stopped short before its closed portals asking what there is beyond, misunderstanding and baffled by the hints they hear in the verses. The Nahuatl poets, having often penetrated that 'beyond', are on the other hand awestruck by its overwhelming impact on all their senses, on their emotional being, by the certainty they feel that they have here touched base with Truth, by the further question it poses for them about the Absolute and the Ultimate, and by the extraordinary feelings of friendship that it breeds among those who have shared in the common experience. The quality of the singing, the poetry, is enhanced beyond measure by this shared experience, which we in the West have declined to share with them. The poetry, the singing, though they seem to us merely good, take on under the influence of the entheogen the tongues of archangels: both music and verses are of the highest anthropological interest, when understood in the light of the entheogens.

Like almost all of the other top flight Mesoamerican scholars, Father Garibay was ignorant of the wondrous mushrooms and morning-glory seeds. The Nahuatl poems present obscurities and difficulties aplenty, as he makes clear in his commentary. In addition to all the others there is one fabricated by Mesoamerican scholars: Father Garibay fails to realize that *flores* is the trope for the entheogens. They pervade these volumes of verse with obsessional intensity. Here we are for the first time listening in to the aristocrats of pre-Conquest Mesoamerica, without intervention of friars or *conquistadores*, singing the glories of their own entheogens. It proves to be, for us, an amazing experience. Whatever the obscurities and ambiguities of the poetry, one thing seems to me clear: these Princes and Nobles, men of courage and discernment, find on earth little to live for, other than their vistas of Tlalocan made possible by *flowers* and the songs that they composed and sang together. Here there is no ambiguity, no obscurity.

In the following poems, which we have selected from the whole published corpus, Father Garibay's *versión* is on the left, my rendering of his Spanish into English is on the right. These poems reflect the thoughts, the feelings, of the *élite* of the Nahuatl pre-Conquest world. A few words to which I give a different meaning from Father Garibay's are printed in small capitals, and I explain in each case my disagreement. The references in this chapter are to Father Garibay's three volumes of *Poesía Nahuatl* and to the page number.

1. 'Sacerdotes, yo os pregunro: ¿De dónde vienen las flores que embriagan? ¿De dónde vienen las cantos que embriagan?'	'Tell us, O priests, whence come The *flowers* that inebriate? The songs that inebriate?'
'Los bellos cantos sólo vienen De su casa, de dentro del cielo Sólo de su casa vienen las bellas flores.'	'The lovely songs come solely From His house, from within the sky Solely from His house come the lovely *flowers*.'

Poesía Nahuatl 1 p 77

(I interrupt my argument for a moment to call the attention of the reader to a startling circumstance. María Sabina, when repeating the Lord's Prayer in Mazatec, alters the text: 'Our Father Who art *in Thy house* in heaven..', she says, thus interpolating the phrase used in the above Nahuatl poem, also in the poems 3 and 1 quoted below, and frequently elsewhere. I am told this interpolation is frequent among Mazatec speakers and it supplies us with an apt illustration of the cross-linguistic unity known to the cultural student as 'Mesoamerica', Nahuatl and Mazatec being wholly unrelated languages. It speaks for the high antiquity and strength of that cultural entity.)

2. ¿Pero en verdad se vive?
Perecerán las flores que en nuestra mano estaban:
También con ellas se irán embriagando nuestros amigos:
Hemos de perecer en la tierra.

But are we truly alive?
The *flowers* lately in our hands will perish.
Our friends with *flowers* will go on
inebriating themselves:
Our destiny is to perish on the earth.

Poesía Nahuatl 1 p 48

3. Ando en el patio florido,
en el patio florido alzo mi canto.
...
He llegado a su presencia
y hago estremecer ... mis flores embriagadores:
es que alzo mi canto!
...
Llegaron acá nuestros cantos,
llegaron acá nuestras flores...
De dentro del cielo vienen:
allí busco yo mis cantos,
allí busco yo mis flores.
...
De la casa del dios vienen las flores,
en su casa ha de buscarse el canto.

I stroll in the flowery patio,
in the flowery patio I raise my song.
...
I have arrived in your presence,
I wave my inebriating *flowers*,
as I raise my voice in song.
...
Our songs are arrived here,
Our flowers are arrived here...
From within heaven they come;
There is where I seek my songs,
There is where I seek my *flowers*.
...
From the House of God come the *flowers*,
In His house song is to be sought.

Poesía Nahuatl 2 p 34-35

4. Deleitaos con las embriagadores flores
que estan en nuestras manos.
¡Vengan a ponerse en los cuellos
collares de flores:
nuestras flores de tiempo de lluvia:
estén frescas, CUEPONIA
ABRAN SUS CAPULLOS!...
Sólo con nuestras flores démonos placer;
Sólo con nuestros cantos vaya desapareciendo
nuestra tristesa, príncipes:
Con ellas huya vuestro hastío.

Las crea él que hace vivir todo,
Las hace nacer el Arbitro Supremo:
Flores placenteras:
Con ellas huya vuestro hastío.

Take delight
in the inebriating *flowers*
that we hold in our hands.
May they come and encircle our throats,
the garlands of *flowers*!
Our *flowers* of the rainy season,
May they be fresh, may they spring forth!
Only in our *flowers*, let us take delight
Only with our songs, O Princes, may our
sadness vanish.
With them [the *flowers*] may your ennui take
flight!

By Him who makes all live are they created;
The Supreme Arbiter gives them birth.
The joyous *flowers*
With them may your ennui fly away!

Poesía Nahuatl 1 p 50

In these four poems the singers speak to us repeatedly of '*flowers* that inebriate'. The *flowers* are the plant entheogens, the inebriating mushrooms or morning-glory seeds. *Flowers* is a metaphor but 'inebriate' is not. (Father Garibay thought 'inebriate' a metaphor and '*flowers*' just flowers.) Support for my thesis lies in the carvings of the statue of Xochipilli, in the iteration without parallel of *flowers* in the songs of the Nahua, in the word xochi*nanácatl* that Molina gives us for the inebriating mushrooms, and finally in the added muscle and sinew that my interpretation gives to the poems.

Unexpected and telling support for my reading of these poems appeared some years ago in Marino Benzi's book on the rôle of peyote in the culture of the Huichol. The name for the inebriating cactus in Huichol is *jíkuri*, as is well known. But Benzi tells us that in their chants the *jíkuri* is called *totó* and sometimes *rutúri*, both of these words meaning 'flower'. When the Huichol wish to designate the plant to a stranger, they call it by the Spanish word *rosita*, 'the little flower'. In the sixteenth and seventeenth centuries *flor* and *rosa* were used indifferently for 'flower'. (See p 337 in Benzi's *Les derniers adorateurs du peyotl*.)

⋆

The meaning of *cueponi*

In line 7 of our Poem 4 we discover the Nahuatl verb *cueponi* which Father Garibay renders by *abran sus capullos*. The word recurs often in the Nahuatl poetry before us and he almost always renders it by this expression, which in English means 'open their corollas'. I submit that *cueponi* must be translated differently. In Molina's lexicon the first meaning of *cueponi* is to burst forth as a chick from the egg. The second meaning is to burst open as a chestnut when it is roasted. The chick makes its first sounds on this earth as it cracks its shell; the chestnut pops its cuticle as it roasts. This audible effect seems basic to the meaning of *cueponi*. Only the third rendering covers the flowers that emerge from their buds. If my reading of the statue of Xochipilli is right, if *xochinanácatl* means what Molina says it means, if my meaning for 'flowers' is right, then the meaning in the poetry of the Nahua of *cueponi* must often be the bursting forth of the divine mushrooms from the 'egg' that marks their first appearance on earth. And as we all know, at first they do look like eggs, round and white, and they do burst forth overnight. The spirited crackling of the shell as the vigorous chick thrusts its way into the world, the bursting of the chestnuts in the heat of the fire - are not these fitting poetic analogies of the songs, the drum beats, that the divine mushrooms inspire? *Cueponi* occurs so frequently and *cueponi* fits the mushroom world so nicely that it is as if made to order for my argument.

Note that in this last poem the poet links the growth of *flowers* with the rainy season. While of course we know that rain is always associated with the growth of plant life, especially is it so with mushrooms: rains must come before we go on foray to look for mushrooms. In Mesoamerica the Indians await the rains eagerly, knowing that they bring forth the divine mushrooms.

In another poem that Father Garibay gives us (No 5), the second verse, speaking of *flowers*, reads as follows:

Cueponticac xochitl ixpan ipalnemoani

which he translates:

Flowers open their corollas before the Life-giver

But this is obviously a mistake. 'The *flowers* spring forth [like chicks from the egg] before the Life-giver.' The first verse of this poem reads:

Panhuetz panhuetz xochitl

and Father Garibay translates it:

Brotaron las flores, brotaron las flores,

meaning, 'Flowers spring forth, flowers spring forth.' According to Molina, 'panhuetz' means 'to surmount', and the first two lines of this poem should be rendered:

Surmounting, surmounting all *Flowers*
spring forth [like chicks from the egg]
before the Life-giver.

The entheogenic mushrooms, in the poet's mind, surmount everything else in this world. The poem that we are discussing draws a brief note from Father Garibay. He says it is undeniably obscure but that none more merits study. I agree with the latter remark but does not my interpretation clarify the sense?

Here are the verses of this poem to which I would draw the reader's attention. I give Father Garibay's version and then my own:

5. Brotaron las flores, brotaron las flores,
Abren sus corolas ante él que da vida.
...
Ricas olientes flores se van esparciendo,
van al patio enflorado de las mariposas.
Todas allá llegan de donde está La Flor enhiesta:
Flores que trastornan, flores que perturban,
Los humanos corazones de los que se afirman.
Vienen a derramarlas, vienen a esparcirlas,
Cual tejido de flores que embriagan.

Surmounting all, all *flowers* spring forth
like chicks from the egg before the Life-giver.
...
Rich fragrant *flowers* are being strewn,
They go to the patio bedecked with flowery butterflies.
They all arrive from there where *The Flower* stands high:
Flowers that upset, *flowers* that perturb,
Human hearts of those who command.
They come to strew them, come to scatter them,
Even as a web of *flowers* that inebriate.

Poesía Nahuatl 2 p 113

The coming of the *flowers* (= entheogens) is analogous to the birth of life. Raising the voice in song is an offering that serves to express our appreciation of them, our feeling for them. The reader will have observed that in this poem the butterfly figures as in our statue of Xochipilli. This song may have been composed to be sung on the Feast of Xochipilli: it harmonizes well with Diego Durán's description of that amazing annual celebration, which seems to have had as its focus a gigantic effigy of a *flower* raised on high. That effigy could well have been an enormous mushroom made of the stuff of beaten bark, *amate*.

For me, of English ancestry and by deepest cultural inheritance a mycophobe, the divine mushrooms smelled sickening, and on the first occasion I had difficulty in swallowing them. But the Indians, to my surprise, praise smell and taste! Their attitude justifies 'the rich, fragrant *flowers*' of the poem. (Recently I have found some Westerners who also find the taste not bad.)

6. Llegaron las flores:
Que sean ellas gala
Que sean ellas riqueza, Oh príncipes.
Bien nos muestran su faz,
vienen a CUECUEPONTIHUITZ
ABRIR SUS COROLAS
Sólo en primavera alcanzan su perfección,
las innumerables flores,
Llegaron las flores al borde de la montaña.

The *flowers* have arrived:
May they bring joy
May they be our wealth, O Princes!
Well do they show their faces [caps],
They have just burst forth

Only in spring do *they* reach perfection,
The *flowers* without number,
Flowers have arrived on the approaches to the mountain!

Poesía Nahuatl 2 p 131

★

Flowers foster friendship

7. Sólo las flores son nuestra riqueza:
Por medio de ellas nos hacemos amigos
y con el canto nuestra pesadumbre se disipa,
Y en las flores preciosas se ven sus flores en la tierra.
Lo sabe el corazón nuestro.
Cantad como lo quiere el corazón de
aquel por quien vivimos en la tierra.

Only *flowers* are our wealth:
Through them friendship between us grows,
And through song our sadness vanished
And by the *Precious Flowers* we are permitted to see your *flowers* on earth.
We know it in our hearts.
May you sing according to His heart's
desire by Whom we live on earth.

Poesía Nahuatl 1 p 47

The opening lines of this Poem call attention to the effect of the entheogens on friendship: those who share in the entheogenic experience feel tied to each other for evermore by the warmest fraternal bonds. They need never mention to each other the shared experience: each knows it. In Siberia the fly-agaric had the same effect: it allayed animosities, encouraged friendship and understanding. Also in classical sources the annual Mystery of Eleusis gave rise to a bond of friendship among those who had passed that momentous night together. Here is a spontaneous and mighty source for the feeling of *compadrazco*, a Spanish word that I have difficulty in rendering into English.

'Precious Flowers', in the Nahuatl original, is *xochicacahuatl* and this is the name of the tree growing in the state of Oaxaca, in the ancient towns of Huayapan and Zaachila, known to botanists as *Quararibea funebris*, the tree that yields flowers called in Nahuatl *poyomatli*, a flower to which marvelous virtues were attributed, in the first instance having a powerful, lasting fragrance. Its flowers were always mixed with chocolate, a drink that accompanied the ingestion of the sacred mushrooms. These flowers ranked in esteem with the entheogens and seem to have been considered hallucinogenic also. They will be discussed further in the next chapter.

The warmth of fraternal feeling generated by *flowers* is a repeated theme, as illustrated here in this verse:

8. También con flores
allí entonces hay abrazos de unos a otros
Con cantos allí se cargan unos a otros.
Es embelesadora vuestra palabra, Oh príncipes,
se deleitan unos a otros los príncipes.

Also with *flowers* they embrace one another;
With songs they there treat one another.
Your word, O Princes, is enchanting,
The Princes delight in each other.

Poesía Nahuatl 1 p 34

Another poem that Father Garibay calls 'The Tree-in-Flower of Friendship' starts out thus:

9. Ya abre sus corolas el Arbol Florido de la Amistad.

Already burst into bloom the Tree-in-*Flower* of friendship.

Poesía Nahuatl 2 p 5

★

Sights and sounds become one

In my first *veladas* with María Sabina in 1955, I observed that melodies seemed to take on shapes and colors, and sights assumed the modalities of music. Imagine then my surprise when I discovered, in the '60's with the publication of Father Garibay's rendering of the pre-Conquest poems, that these poets had recorded the same phenomena.

10. En estera de flores
pintas tú
tu canto, tu palabra,
Oh príncipe mío, Nezahualcóyotl.

Se va pintando tu corazón
con flores policromas;
pintas tú
tu canto, tu palabra,
Oh príncipe mío, Nezahualcóeyotl.

On a mat of *flowers*
thou paintest
thy song, thy word,
O my Prince, Nezahualcóyotl.

Thy heart is being painted
with polychrome *flowers*;
thou paintest
thy song, thy word,
O my Prince, Nezahualcóyotl.

Poesía Nahuatl 1 p 49

The same theme recurs in this poem:

11. Oh, tú con flores
pintas las cosas,
Dador de la Vida:
con cantos tú las metes en tinte,
las matizas de colores ...
Sólo en tu pintura hemos vivido
aquí en la tierra.

O, thou with *flowers*
paintest things,
Giver of Life:
with songs thou tintest things,
blendest colors ...
Solely in thy paintings have we
lived here on earth!

Poesía Nahuatl 1 p 85

12. Libro de cantos es tu corazón
Has venido a hacer oír tu canto.
Tañendo estás tu atabal
eres cantor,
entre flores de primavera
deleitas a las personas.
Ya estás repartiendo
Flores de fragancia embriagadora,
flores preciosas.
...
Flores ofreces,
variadas flores:
Con ellas deleitas a los hombres
Oh príncipe Nezahualcóyotl.

Your heart is a book of songs;
You have come to let us hear your song.
You are sounding your drum.
You are a singer,
among *flowers* of spring
you delight people.
You are apportioning
Flowers of inebriating fragrance,
precious flowers.
...
You offer *flowers*,
diverse *flowers*:
With them you delight men
O Prince Nezahualcóyotl.

Poesía Nahuatl 1 p 93

'Your heart is a Book of Songs', - the 'book' is *amoxtli*, the codices in picture writing some of which have survived. This is the 'Book' of which María Sabina sings repeatedly, four centuries later and in a tongue utterly different from Nahuatl. Such was the fame of the 'books' of the Nahua and Mixtecs! Father Garibay gives us evidence that this poem was composed almost certainly by Nezahualcóyotl, renowned king of Texcoco.... 'Flowers of inebriating fragrance, precious flowers'. In the Nahuatl text these flowers are the flowers of *Quararibea funebris*: *poyomatli* and *cacahuaxochitl*.

13. Soy cantor y me deleito
Cuando miro las flores y cuando alzo mi canto.
¡Deleitaos con él, Oh príncipes!
De la casa de dios vienen las flores, en
su casa ha de buscarse el canto:
No lo sabían acaso vuestras corazones,
Oh príncipes?

I am a singer and I take delight
When I look on *flowers* and when I raise my song.
Rejoice in my song, O Princes!
From the House of God come the *flowers*,
In His house one must look for song:
Do not your hearts perhaps tell you so,
O Princes?

Poesía Nahuatl 2 p 35

Another Nahuatl poet asks:

14. ¿Acaso de veras viene
desde el cielo florida pintura
en media de las flores?

Is it indeed true that from Heaven
comes the *flowery* painting
in the midst of *flowers*?

Poesía Nahuatl 2 p 88

Surely this poet is recalling in tranquillity his emotions on experiencing an entheogenic *velada* and asking inevitable questions.

And as though answering him another poet sings:

15. De dentro del cielo es de donde vienen
estos bellos cantos, estas bellas flores,
Destruyen nuestra amargura, destruyen nuestra
tristeza.

From innermost Heaven come these lovely
songs, these lovely *flowers*:
They destroy our bitterness, our sadness.

Poesía Nahuatl 2 p 99

Support for the view that *Quararibea funebris* was considered an entheogen is to be found in this poem:

16. Bebamos ahora
Comamos ahora
Cacahuaxochitli.
Con el deleitémonos.
Que ya CUEPUNQUI
SUS COROLAS ABRIERON
tus flores.

Cacahuaxochitla
embriaga mi corazón,
embriaga mi corazón,
Con él ande yo adornado
yo de igual modo también
pueda ir mi corazón.
¡Que no se marchiten las flores!

Poesía Nahuatl 1 p 23

Now let us drink,
Now let us eat
Quararibea funebris:
Let us revel together.

For already thy *flowers* have
burst forth.

Quararibea funebris
inebriates my heart,
inebriates my heart.
May I go about adorned with it,
and also my heart!

May the *flowers*not wither!

In 'A Monologue of Nezahualcóyotl' he exalts the '*flowers* that inebriate':

17. Hay cantos floridos: que se diga yo bebo
flores que embriagan,
ya llegaron las flores [*poyoma*] que
causan vértigo,
ven y serás glorificado.

Poesía Nahuatl 3 p 11

There are songs in *flower*: let it be said
I drink *flowers* that inebriate,
Already came *flowers* causing vertigo.

Come! and you will be in glory

and he continues singing the glory of the blossoms (*poyomatli*) of *Quararibea funebris* that 'color his heart'.

* * *

Anelhuayo: without roots

I now call attention to a stanza that Father Garibay gives us:

18. Vengo presuroso a entretejer
al Arbol Florido
flores rientes.
In Tamoanchan
en alfombra florida
hay flores perfectas
hay 'flores ANELHUAYO
SIN RAICES'

Poesía Nahuatl 1 p 29

I come hastening to interweave
on the Tree-in-*Flower*
laughing *flowers*.
In Tamoanchan
on *flowered* carpets
there are perfect *flowers*,
there are '*flowers* without roots'.

Flowers without roots! What does this mean?

And again:

> 19. Diferentes flores yo estoy esparciendo,
> vengo a ofrendar cantos, *flores*
> embriagantes:
> Soy cara traviesa y vengo de
> allá donde el agua sale;
> vengo a ofrendar cantos, flores
> embriagantes.
> Diferentes flores, aún, aún tu corazón
> lo sabe:
> para tí las traiga, para tí las venga
> yo cargando.
> Vamos a tu casa, vamos,
> traigo como carga
> 'flores ANELHUAYO
> DESARRAIGADAS'
> traigo como carga flores perfumadas:
> Ésta es tu casa: aquí se yergue
> la Flor Blanca.
>
> *Poesía Nahuatl* 3 p 39

> Diverse *flowers* I scatter,
> I come offering songs, inebriating
> *flowers*;
> With mischievous face I come from
> afar where gushes forth the water,
> I come to offer songs, inebriating
> *flowers*.
> Diverse *flowers*, already, already,
> your heart knows,
> May I bring them to you, come loaded
> with them.
> Let us go to your house, come,
>
> I come loaded with '*flowers* without roots',
>
> I come loaded with aromatic *flowers*,
> Here is your home: here stands high the
> *White Flower*.

Again we find 'flowers without roots', *anelhuayo* in Nahuatl!

And a third citation:

> 20. Tu estás enlazado al Arbol Florido
> a las flores que ríen en Tamoanchan:
> sobre estera de flores medran
> aquellas flores,
> y ANELHUAYO
> RAIZ NO CONOCEN.
>
> Garibay, *Hist. Nahuatl Lit*. 1, p 181

> You are enlaced with the Tree-in-*Flower*,
> *flowers* laughing in Tamoanchan:
> On a carpet of *flowers*
> those *flowers* prosper,
> and roots they have not!

In none of these three instances does Father Garibay add a note of comment on 'flowers without roots', an odd expression. For me there is no doubt: we possess here another instance where Early Man perceived the distinctions that mark the mushroomic world. Fungal growths multiply without seed and are without roots. The Mazatec herbalists stressed the seedlessness: in *^{1}nti^{1}xi^{3}tho^{3}*, the formal way of referring to the divine mushrooms, they are saying, 'the dear-little-ones that leap forth', ie come up miraculously, suddenly, without seed. The Nahua, as we see in these poems, emphasized their rootlessness.

Father Garibay explicitly apologizes for the inadequacy of his version of the Nahuatl original of his verses, and now I, *a fortiori*, for my English rendering of Garibay's Spanish. I trust no reader will think that he has been in contact with the Nahuatl poets. But in this chapter I am confident that I have caught and revived an old and major meaning for *xochitl* in the language of the Nahuatl aristocrats, perhaps also (thanks to the distinguished Nahuatlata Thelma Sullivan) come closer to the meaning of the word *cueponi*, and finally given a sense to the word *anelhuayo* in the verses before us. Moreover, when I was first under the influence of the potent mushrooms in *veladas* in the late 1950's, long before I had access to the poetry that we have been discussing, I reported repeatedly the powerful spirit of the ancient agapé that came over us in those gatherings. I also reported how hearing and seeing coalesce. What you are seeing and what you are hearing appear as one: the music assumes harmonious shapes, giving visual form to its harmonies, and what you are seeing takes on the modalities of music - the music of the spheres, is what I then said and published (Harvard *Botanical Museum Leaflet* 19: 7 p 156). Imagine my surprise on finding the Nahuatl poets so impressed by these same phenomena that they felt impelled to dwell on them in their verses.

CHAPTER 5
The inebriating drinks of the Nahua

In *Poesía Nahuatl* 2 there is a poem that begins with this verse as rendered by Father Garibay:

He bebido vino de hongos y llora mi corazón. [page 55]	I have drunk wine of mushrooms and my heart weeps.

This single verse reveals the need for disentangling the words used in Nahuatl and Spanish for the inebriating drinks of Mesoamerica. In Nahuatl it reads:

Oyanoconic in *nanacaoctli*, ya noyol in choca.
I have drunk the liquor of mushrooms and my heart weeps.

Here we find the clue to the full meaning of *octli* in Nahuatl: it was applicable to any inebriating drink, whether alcoholic or entheogenic. In the past *octli* has been taken as the Nahuatl word for any fermented drink, especially *pulque*, the fermented drink of the succulent *maguey*, but *nanacaoctli* is also clearly the [inebriating] liquor of [entheogenic] mushrooms: *nanaca*- from *nanácatl*, 'mushroom', and -*octli*, 'liquor'. For centuries we have simply ignored the entheogens.

When Cortés and his men mingled with the Aztecs in the Valley of Mexico, they found themselves before a complex of strange inebriating drinks for which they had no Spanish names. The common drink was the fermented sap of a succulent (not a cactus) classified by botanists as a species of Agave, made according to complicated steps elaborated through millennia of cultivation. The plant today is known in Spanish as *maguey*, a word introduced into Mesoamerica by the Spaniards from Taíno, a language of the Antilles. (The specific name in Nahuatl is *metl*.) This drink is familiar to us as *pulque* but where *pulque* comes from no one knows for certain. It is not a Nahuatl word. The earliest citation for it is in a letter that Cortés addressed to his Emperor Charles V dated 15 October 1524, a date so early that it precludes a borrowing from any South American Indian language. An ingenious suggestion is that it was a deformation on the rude tongues of the Spanish soldiery of Nahuatl *puliuhki* meaning 'perish', 'gone to waste', a pejorative characterization of the native drink. Pulque is fit (and excellent) for human consumption for only a little more than 24 hours, whereupon it does degenerate into a decomposed, rotten, stinking fluid. We may assume that this is probably the origin of pulque until a better explanation presents itself.

The Nahua called pulque *octli*, but as we have seen this was the name given to inebriating drinks in general, of which there were many, alcoholic and entheogenic. Father Garibay followed the practice of the Spanish friars in translating *nanacaoctli* by *vino de hongos*, 'mushroom wine', a grave mistake for it plants in the mind of the uninformed that the mushrooms were either alcoholic or bore an analogy to fermented grape juice. For the Spanish soldiery wine was the common inebriating drink, beer and brandy hardly being known in Spain in the early 1500's and not known at all in the New World, and naturally the friars with their poor vocabulary for inebriating drinks and their non-existent experience with the mushrooms resorted to 'wine' for the entheogenic mushroom juice. But it is surely time that we do better.

Father Garibay did not enter into the intricacies of Nahuatl drinks, which were alien and confusing for him. It seems to me certain that the *flowers* (*xochitl*) of the Nahua were used for what we would call today the entheogens, and furthermore limited to those entheogens considered fit for the aristocrats. Father Garibay says that a plebeian who drank chocolate (with *flowers*?) exposed himself even to the penalty of death.[19] He does not cite his authority for this and neither I nor my acquaintance among Mesoamerican scholars can supply it. The Nahua paid high honors to pulque in certain religious celebrations but by comparison with -*xochi*- potions it was a vulgar beverage, easily accessible to anyone and a source of much drunkenness. The -*xochi*- beverages were not drunk by the *élite* at the same time as pulque. Father Garibay says that the *flowers* were drunk with pulque or alone, but in the four volumes of poems that he has given us only two seem to mix *flowers* with pulque, and those two serve but to prove my rule, for they are expressly composed (though by

---

19. Garibay [4] 1 p 109.

Nahuatl poets) in the Huastecan and Chichimecan manner.[20] These peoples were considered barbarians by the Aztecs, possibly admired in some contexts in a condescending way but with a reputation for wild drinking habits. Our two poems, then, even in the Spanish rendering, reflect this change of pace and tone well, especially when a vulgar woman of low degree, a Huasteca, declares herself drunk on a mixture seemingly of *flowers* and pulque. (Her part was probably played by a Nahuatl man dressed to fit the rôle.) The incessant reiteration of *xochitl* and *-xochi-* in this body of poetry astonishes the reader today, mostly in a context of drinks, but in the elegant poetry of the Princes and Nobles there is never an instance where pulque is linked to *flowers*.

The anthologies that are represented in Father Garibay's volumes serve us admirably in conveying the poetic voices of the *élite* of the Nahuatl world. The collections were assembled for us by leading survivors of the defeated race and these survivors must have enlisted the cooperation of many eager to contribute the poems that they had memorized to those who had succeeded in learning our alphabet and who could write them down. What pathos! With their world laid waste, their own exalted position in it destroyed, yet their precious heritage of verse, esteemed by them above all else, was put down on paper for someone, somewhere, sometime, somehow to decipher (and with what labor!) and then for this shadowy audience to enter into their magic world and relive what they had experienced and thought. What likelihood did they think there was that these verses in Nahuatl would be read? Yet today we can listen to the poets of this extinct world in proto-history speaking and singing to each other. What we hear is surprising: awe and wonder at what the *flowers* disclosed to them, the excitement and delirium of their 'wars', and the somber shadow of human sacrifice against which there is no whiff of opposition though the poets themselves were sometimes destined to be its victims. There is even a poem composed probably by a captive already awaiting the obsidian knife.[21]

We have the best of outside evidence that alcohol was not mixed with the entheogens in the festivities of the upper caste of the Aztecs and others in the Valley of Mexico and thereabouts. Diego Durán, the chronicler who relied heavily on the now lost *Crónica X* written in Nahuatl by someone who moved in the highest circles in pre-Conquest times, is giving us a detailed account of the coronation of Ahuitzotl ca AD 1486 and then Durán adds:[22]

> In this whole story I have noted one thing: mention is never made that anyone drank wine of any kind to get drunk, but only woodland mushrooms, which they ate raw, on which, says the History [*ie Crónica X*], they were happy and rejoiced and went somewhat out of their heads, and of wine no mention is ever made, unless for sacrifices or funerals; mention is only made of the abundance of chocolate that was being drunk in these solemnities.

When Durán here speaks of 'wine', he means alcoholic beverages such as pulque, and the chocolate was taken with *flowers*. This quotation will be further discussed later, p 201 [of orig. vers.].

In our own explorations through Mesoamerica we found repeatedly that alcohol was expressly forbidden to those who were ingesting the sacred mushrooms. The duration of this alcoholic abstinence varied: for one day before, or two, or three, or most often four. These were norms; I do not say they were always observed. And María Sabina always looked to her host at her *veladas* to supply *un cuartito* of *aguardiente* (a half pint of alcohol) for her to drink when her strenuous night's work was drawing to a close. (This was obviously a post-Conquest innovation.) In Mesoamerica there were two categories of inebriation, divine inebriation from the superior entheogens (*ie* mushrooms or morning-glory seeds) and alcoholic inebriation from pulque and the like.

The whole world today knows the cactus *Lophophora williamsii* as *peyote*, or in standard Nahuatl as *peyotl*, the whole world except the Indian peoples (Huichol and Tarahumara) in whose religious life it figures large and who have their own names for it. But I raise the question whether the meaning of *peyotl* in Nahuatl was confined to the cactus *Lophophora williamsii* in pre-Conquest days. This word circulates throughout much of Mesoamerica in regions where the importation of the cactus from the far arid north seems highly improbable.

---

20. Garibay [4] 3 pp 28, 32.
21. Garibay [4] 2 p CXXVIII (30).
22. Garibay [5] 2 p 236 § 16.

It takes various shapes as it passes from one linguistic area to another. Aguirre Beltran documents it in the Proceedings of the Inquisition in these forms: *peotl*, *piot*, *piyolli*, *peyori*, *peiot*, and above all *piule*. There is no reason to think that the meaning of these words is confined to the cactus. In our own day the lexicographer Santamaría says that *piule* is used in Oaxaca for the entheogenic morning-glories. Richard Evans Schultes found it thirty years ago applied to entheogenic Rhynchosia seeds in the market place of Villa Alta, in Zapotec country, and also in the market of the city of Oaxaca. In 1955 Robert J. Weitlaner and I were in San Agustín Loxicha, in the Sierra Castera south of Miahuatlan, and we found that *piule* was applied here by the *sabio* don Aristeo Matías to two species of entheogenic mushrooms and also that it figured in the powerful myth linking the origin of the mushrooms to thunderbolts. May not *piule*, derived as it is from *peyotl* in pre-Conquest times, have been used for any entheogen in the vulgar language, called *macehuallatolli*, and then have spread far and wide, being deformed on alien tongues as it crossed linguistic frontiers?

But if *peyotl* was any entheogen, why do we never find it in the four volumes of verse that Father Garibay has given us in Nahuatl? Perhaps the answer lies here: the Nahua of the highest social class spoke their language in an elegant manner known as *tecpillatolli*. Was it not this manner of speaking that our poets were giving us? And for them in *tecpillatolli* the entheogens (or the superior entheogens) were as we have seen *flowers*. *Peyotl* or *piule* was left to the masses, whence they were borrowed by the linguistic groups of Oaxaca and perhaps beyond.[23]

The Nahuatl poetry available to us is filled with entheogenic drinks. One verbal element is common to all of them: -*xochi*-, the various drinks in the -*xochi*-cycle having effects on the human psyche that are indistinguishable. The other verbal elements linked to -*xochi*- are *teo*-, 'divine' or 'wondrous', *octli*, any inebriating drink, and the word for water, *atl*, often reduced to *at* or its root *a*. To this day on the slopes of Popocatepetl the divine mushrooms are called in Nahuatl the 'little children of the waters', *a-pipil-tzin*, *a*- for 'water', -*pipil*- for 'children', and -*tzin*, a diminutive of endearment and respect.

Are not the drinks to which water is linked the ones made from the sacred mushrooms? Only those who, like the Russians, are brought up to love and crave mushrooms, the mycophilic peoples, know the meaning of rain for their adored mushrooms. In Russia there is a special rain, - 'mushroom rain', *gribnoi dozhd*' - that everyone knows is specially favorable to mushrooms. And *a fortiori*, raised to the nth power, is the joy in mushroom rain of a folk who know and make use of their own entheogenic mushrooms. A rain peopling the land with the divine mushrooms, the little-children-of-the-waters, is a gift that only a god can give.

Here then in Father Garibay's four volumes in Nahuatl verse are the words for inebriating drinks of which many specifically mention, if we are right, the entheogenic mushroom *flowers*.

Poesía Nahuatl 3 (No. of poem and line)		
13.92, 99; 14,21	*xochi*-octla	entheogenic potion
8.9; 14.7	*xochi*-octli	entheogenic potion (not 'pulque' as Father Garibay renders it in 8.9)
2.26; 5.7; 14.99; 23-I.8	*xochi*-atl	wondrous mushroom potion
13.103	*xochi*-a ihuintimetl	wondrous mushroom potion with pulque
16.12, 14	*xochi*-a ihuintihus	wondrous mushroom potion
13.30, 36, 117	*xochi*-a-octli	wondrous mushroom potion
13.106	i-*xochi*-cuaxoxome	???
11.1	*xochi*-a-tototl	???
14.71	a-*xochi*-octli	wondrous mushroom potion
13.63; 19.24	teo-a-*xochitl*	wondrous mushroom potion
13.38	teo-a-*xochitica*	wondrous mushroom potion
13.87	teo-a-*xochi*-octli	wondrous mushroom potion
13.11	teo-a-*xoch*-octla	wondrous mushroom potion

---

[23] After writing this I came upon R. E. Schultes' *Harvard Botanical Museum Leaflet* Vol 5 No 5, 19 Nov 1937 wherein he informs us that B. P. Reko had reached conclusions parallel to mine about the pre-Conquest meaning of *peyotl*. Reko made chis discovery a half century ago. *El México Antiguo* Vol 3 Nos 3/4 Dec 1934: 'Das Mexicanische Rauschgift Ololiuqui' pp 1-7; also Schultes, Harvard *Botanical Museum Leaflet* Vol 4 No 8 12 April 1937.

13.37	teo-atl	divine water (mushroom potion?)
Poesía Nahuatl 2, 1st sec.		
13.37	cacahua-octli	chocolate with flower petals and entheogens

★

But the question remains how it came about that *xochitl* acquired its unique status as the symbol of the divine draught among the Princes and Nobles of the Nahua. The evidence for this status in the carvings on the statue of Xochipilli, in the name *xochinanácatl* for the sacred mushroom that Molina gives us, in the poetry of the upper caste of Nahua, where the theme of the '*flowers* that inebriate' is insistent, is I think conclusive: the *flowers* enjoyed exalted, even divine status and lent themselves to a further level of metaphorical use when they served for the 'wars' or raids for sacrificial captives, a constant activity of these Indian peoples, for their war gear, and for the captives themselves.

Up to now we have not mentioned *xochitl* in a verbal combination that occurs more frequently than any other: *cacahua-xochitl* or occasionally *xochitl-cacahuatl*. *Cacahuatl* is none other than the chocolate or cacao tree, the *Theobroma cacao* L. of botanists. (Linnaeus gave the name 'Theobroma', the 'food of the gods', to the cacao tree allegedly because of the esteem in which it was held by the Indians.) Chocolate was drunk cold and mixed with aromatic flower petals of which the overwhelming favorite was *cacahua-xochitl*. Indeed it seems as though these particular petals were indispensable. Our poets' 'chocolate flowers' had nothing to do botanically with *Theobroma cacao*, but everything to do with the chocolate beverage as drunk by the aristocrats, according to Father Garibay. If he is right, we find here additional underpinning for my belief that the *flowers* of the Nahuatl poets come from their exclusive privilege for indulging in the flower petals of the *cacahua-xochitl*. Here we are dealing with a tree that grows in Veracruz and Oaxaca, known today to botanists as *Quararibea funebris*. Whether the petals of these flowers were entheogens such as the mushroom and morning-glory seeds, I do not know, but that the lords of Nahua so regarded them seems virtually certain. That these mushrooms or the *ololiuhqui* seeds (ground to fine powder on the *metate*) were often or perhaps always drunk with the cacao potion is also certain: when they are not mentioned, the poets may well have taken them for granted. After all, the poets were writing for each other, certainly not to inform us. Sometimes we read that the mushrooms were *eaten* but then mention is usually made of the chocolate-flower beverage accompanying the mushrooms. In glowing terms the poets speak of this chocolate drink as an excitant, an aphrodisiac, possibly an entheogen. It inspired them to compose their poetry and music, to dance, to sing. So far as the evidence goes, we should not think of these celebrations as riotous drinking parties: they were suffused throughout with religious feeling and with the melancholy that, soon or late, attends man's thinking here below. The poems bear witness to this.

There comes down to us in the writings of the friars the name of a mysterious vegetable product, *poyomatli*, but they never identify it. Everything concerning *poyomatli* written by the friars is enigmatic, tantalizing, mysterious. Did they not deliberately conceal its identity, feeling it was best for them to hide from the laity a product of such enticing potency?

Yet already in 1963 its identity was accessible to us: Dibble and Anderson, slowly and carefully progressing in the difficult translation of the Nahuatl text of the celebrated *Florentine Codex*, came at last to the description of the tree called *cacahuaxochitl* (our *Q. funebris*) and here is our answer:

> [This tree] has cup-like [blossoms]; the name of its cup-like [blossoms] is *poyomatli*; a really pleasing odor is their aroma. The tree, the blossoms, its foliage, all are of pleasing odor, all perfumed, all aromatic. I cut [the blossoms], spread them out, arrange them, cover them with leaves, thread them, make a flower mat of them, make a bed of flowers with them, spread them over the land. [The perfume] spreads over the whole land, swirls, constantly swirls, spreads constantly swirling, spreads billowing.
> [Bk 11, *Earthly Things*, p 202]

And so to the long list of references to *cacahua-xochitl* we must now add all *poyomatli* citations!

Ten pages later Sahagún's Nahuatl informant dictated this additional comment on *poyoma-xochitl*:

> This is the cup of *cacahua-xochitl*. They say it makes one falter, it deranges one, provokes one. It makes one falter, it deranges one, it provokes one.
> [*ibid*, p 212]

'*They say*...'! Who are '*they*'?

Let us pause a moment and examine that brief, innocent-looking phrase.

On the heels of the Conquest, Bernardino de Sahagún, the Franciscan friar, spent his entire adult life, about half a century, studying the Nahuatl-speaking Indians. He chose his informants carefully for their maturity, their experience, their character and knowledge. The *Florentine Codex* and the priceless manuscripts in Madrid are an invaluable treasury, in Nahuatl and Spanish, concerning the history, the customs and manners, of the Nahua, assembled under Sahagún's editorial supervision. Many other friars concerned themselves with writing about the Mexican Indians but Sahagún and Diego Durán are outstanding in the extent and thoroughness of their work and in their underlying sympathy for the people they were studying. The Spanish text has long been avail able to scholars but the Nahuatl text giving the very words taken down from the lips of the informants has just in recent decades gradually become accessible to Western scholars. The Nahuatl texts must be read in the light of the circumstances under which they were written down. There were subjects that no sixteenth century friar, not even Sahagún, could tolerate and one of them was the entheogens. Knowing nothing personally about *poyomatli* (nor about the entheogens), the friars had damned it (and them) sight unseen: the entheogens meant trafficking with Satan. We are grateful to the churchmen for what they tell us about these plant products but we must be on our guard. The Nahuatl texts of the informants sometimes give us a clue to what they were really thinking. Take for instance what one informant said about *poyoma-xochitl*: '*They* say it makes one falter, it deranges one, provokes one'.

The informant had doubtless accepted the Christian faith. An intelligent, well-informed Indian, he held a position that was enviable, one who was serving Sahagún and his team. There can be no doubt that he had known the entheogens personally or at least the reputation that they enjoyed among his people. He was testifying on a delicate subject. He knew that the friars looked to him for an unfavorable characterization of *poyomatli*, but in complying with their wishes he succeeded in slipping in, '*They say*...'. Who are '*they*'? Certainly not informed Indians: they would have answered in line with the exalted tone of the Nahuatl songs that we have reviewed. Was not the informant escaping responsibility by quoting the friars? Confronted with a dilemma, he was deftly showing his regard for the truth by an attribution of his statement to his ecclesiastical mentors.

Here in this text, as elsewhere, we feel the pressure that the informants were under, when discussing sensitive topics, to comply with the prejudices of their interrogators. I do not mean that they were in fear of harsh legal sanctions but as informants of Sahagún they enjoyed a privileged status in the Nahuatl community that they would fain keep. Our Nahuatl poems, written by free and intelligent men before the Conquest, suggest no 'faltering', no 'derangement', no 'provocation'. Their praise of this tree and its flowers knows no limit. The only 'derangement' would be analogous to the derangement of a Saint in ecstasy. In this passage our informant managed to reconcile what he knew with what he was supposed to say. In the earlier quotation the concluding lines convey eloquently the praise of *cacahua-xochitl* blossoms that expressed what all Indians felt: the perfume of these flowers 'spreads over the whole land, swirls, constantly swirls, spreads constantly swirling, spreads billowing'.

Here then are the *poyomatli* citations that I have caught in the four volumes of Nahuatl verse given to us by Father Garibay:

Poesía Nahuatl 1 (No. of poem and line)		
1.20	xochi-*poyon*:cuica	
1.21	*poyon*-cuica	
56.31	*puyuma*-xochitli	
Poesía Nahuatl 2, 1° sección		
8.27	*poyoma* in ye nochicuacol	
17.6	*poyoma*-xochiuh	
23.33	in-*poyon*	(Tamoanchan)
Poesía Nahuatl 2, 2° sección		
14.5	*poyon*	(cacahua-xochin-poyon)
14.24	*poyon*	(quetzalin-poyon)
Poesía Nahuatl 2, 3° sección		
13.3	xochin *poyon poyon*	
21.16	xochi-*poyon*	
Poesía Nahuatl 3		
1 iii.28	in ahuiyac *poyomatli* in pixahuia	
4.35	ye nican *poyoma*	
4.42	in-quetzal-*poyomatl*	
9.19	*poyoma*-xochitl	
12.44	in-quetzal-*poyoma*-xochitl	
Veinte Himnos Sacros		
p 117	*po[yo]ma*	(Father Garibay's reading, p 121)

In the writings of the Conquistadores - as distinct from the friars and priests - I know of only one reference to the entheogens, a glancing inadequate observation in Bernal Díaz de Castillo's memoirs. Speaking of Montezuma he wrote:

> Traían en unas como a manera de copas de oro fino con cierta bebida hecha del mismo cacao; decían que era para tener acceso con mujeres, y entonces no mirábamos en ello.
> [Chap xci]
>
> They would bring in to Montezuma something after the style of cups of fine gold with a certain drink made from the same cacao; they would say it was to have access to women, and so we did not inquire further.

Here is the chocolate beverage surely spiked with *poyomatli* and perhaps other superior hallucinogens. But Bernal Díaz says no more.

The poetry of the Nahua aristocrats supports with overwhelming evidence the hold on their imaginative life of *Quararibea funebris* and its flower *poyomatli*: I suggest that therein lies the origin of the metaphorical use of *xochitl* ('flower', *flor*) for the hallucinogens and for the dominance of '*flower*' in the poetry of the Nahua. This dazzling yellow flower swirls, constantly swirls, spreads constantly swirling, spreads billowing over the whole land.

★

Father Garibay was helpless before the inebriants of the Nahua. He called *xochioctli* 'pulque'. (*Poesía Nahuatl 3* 17.9) He described *poyomatli* as a 'stupefier', again as a root, again as a 'species of *peyotl*', all in one breath. (*Poesía Nahuatl 3*, p xxv) He said in 1967 that *ololiuhqui*, the entheogenic morning-glory, was a 'stupefier' and probably a Datura (*Poesía Nahuatl 1*, p 226), though its identity had been established with finality by Richard Evans Schultes as long ago as 1941. He translated *poyomatli* as a '*narcotic* of flowers' (*Poesía Nahuatl 3*, pp 11, 19), as '*lethargy* producing' (*Poesía Nahuatl 1*, p 1), as '*enervating*' (*Poesía Nahuatl 3*, p 5). He thinks that the poets with all their talk of the entheogens were engaging in metaphorical wordplay! At least he says so in his commentary. He never tells us where they gained their experience of those other worlds of Tamoanchan and Tlalocan.

True, in the past many have called drugs with mental effects by terms such as these without discrimination. But plants that inspired an outpouring of extraordinary poetry, of music, of dancing, are hardly stupefiers, narcosis-producing, enervating, or lethargy-producing. It is time that we learn to characterize our mental states with feeling for the words we use, and also that the Nahuatlatos learn to talk with living botanists, rather than rely on obsolete botanical sources.

But let me hasten to add that we all and I in particular owe an immeasurable debt to Father Garibay. He marked an *étape* in Nahuatl studies that will never be forgotten. He has triggered a new interest in pre-Conquest Nahuatl culture that promises to illuminate a field of proto-history of incalculable cultural importance. These chapters of my book obviously could not have been written had he not provided the Nahuatl text of the poems I discuss.

Furthermore, Father Garibay's unfamiliarity with the inebriants of the Mesoamerican Indians in no way differentiates him from scholars past or present in this field of inquiry. If he shows up worse than others, it is only because he had the courage to confront texts that deal directly with the entheogens.

Now it is urgent that the entire corpus of Nahuatl poetry, most of it pre-Conquest, be transcribed and published, and that it be rendered into a modern language, presumably Spanish, not in verse but in a scholarly translation. Father Garibay has whetted our appetite: we wish to listen to the pre-Conquest Aztecs speaking freely with each other, without the intervention of even the best of the friars. The number of our Nahuatlatos is slowly increasing, and the ideal would be to find the one who combines in himself (or herself) the severe discipline of an exegete and the afflatus of the poet.

⋆

In the earlier chapters I have given a picture of the shamanic use of the entheogenic mushrooms in Mesoamerica as it survives into our own times. How widespread was this shamanic use? In Mazatlán de los Mixes we discovered that a shaman was not needed for consulting the mushrooms: there was a lay use of them. Anyone facing a grave problem would consult them, or perhaps a friend on his behalf and in his presence, also with a monitor, and then the mushroom would converse audibly with the eater and the monitor would make mental note of what was said. This might be regarded as a degeneration of an earlier shamanic practice, but Mazatlán de los Mixes is secluded, far from the beaten track, and may not their ways be rather an archaic survival in the Indian world?

An essential of shamanism is conformity, in the flow of words from the shaman's lips, in the music of his chants, in the percussive beats that accompany the singing. In each performance the shaman is limited in the deviations that he may introduce by the circumstances of the particular consultation that he is giving. He invokes a ritual whose authority lies in its antiquity and its universality, and the vocation of a shaman is essentially anonymous. True, in a given generation such-and-such a shaman is said to be of *primera categoría*, 'top category', but this is simply because he performs better than others a fairly rigid procedural canon, not because of innovations in that procedure, and when he is gone his memory lingers only for a few years among those who were his contemporaries.

Now let us contrast our shamanic *veladas* with the Nahuatl poems that Father Garibay has enabled us to examine. These are as far removed as can be from the chants of María Sabina, the unlettered shaman of the Sierra Mazateca. They are poems written in the decades that preceded the Conquest by the Princes and Nobles in the cities in and around the lakes of the Valley of Mexico. Each poem is an individual's studied composition. In some cases the poets are known: their names, when they lived, and some of the circumstances of their lives. Their poems are sophisticated literary productions of individual poets, and the *élite* of the Nahuatl world were immensely proud of them. Many, perhaps all, of them were recited or sung at gatherings of the poets around the *Xochicuahuitl*, the *Arbol Florido*, the Tree-in-*Flower*. This was an idealized tree, set up *ad hoc* for such festivities. If Peter Furst is right, it was an ancient institution and we find it represented in a painting at Teotihuacán, which Villagra Caleti has reproduced for all to see in the Museo Nacional de Antropología. Furst goes further: he argues that it is a highly stylized morning-glory (*ololiuhqui*) 'tree' and as I have said I think he is partly right.

The question is how to reconcile, on the one hand, the *veladas* held by shamans throughout Mesoamerica for millennia, in the dead of night, to help all kinds of humble suppliants facing life's problems, and on the other the festive open-air performances with music, dancing, singing, and poetry readings by the self-assured princes and aristocrats around the Tree-in-*Flower* and on other grand occasions, these performances going back, back beyond memory, if our interpretation of the Tepantitla 'Tree-in-*Flower*' is right. Both were inspired by *flowers*. In sophistication they were at opposite ends of the spectrum: would not the teeth of the aristocrats have been set on edge by the shamanic chants, so self-conscious were their highly spontaneous verses? Individual poets achieved fame for their excellence but in a culture where there was no way other than human memory to preserve the words of a poem, the fame of even the best poets was not likely to endure for more than a few decades. Is there any reason why the Tree-in-*Flower* could not have been celebrated every year, perhaps in every important community, from the days of Teotihuacán and long before, down to the Conquest? Social institutions and customs evolved slowly before easy writing came to mankind.

María Sabina and the poets of the two sixteenth century Nahuatl anthologies express the same profound reverence for the 'Book', *amoxtli*, by which the poets meant the superbly painted picture-writing codices, kept beyond the reach of the masses in the *Amoxcalli*, the House of the Books, the Holy of Holies. And what that reverence must have been! It survived in María Sabina's chants into the late twentieth century, though for her it is become a purely mystical book, as it may well have been for her predecessors. For when a provincial shaman, even one of exceptional quality, visited Tenochtitlan, what access had that shaman to see and examine the Treasures of the *Amoxcalli*?

CHAPTER 6
Códices, lienzos, mapas

Codex Vindobonensis

The documentary sources for the pre-Conquest history of Mesoamerica include a considerable number of what are called in Spanish *códices*, texts painted in picture-writing that are being progressively deciphered by scholars dedicated to that task: they do not lend themselves to easy and assured reading. They were painted by priests of the Old Religion and were originally accessible only to the priesthood, but their renown was breathtaking. It seems to have run far and wide throughout Mesoamerica and we find the shaman María Sabina even today singing (and in Mazatec!) of the *Libro* with its numinous message, by which scholars seem agreed that she means, transmuted through more than four centuries of oral tradition, what were called by the Nahua *amoxtli* and by us in English the painted codices of pre-Conquest times. The memory lingers on, severed from its roots, having had no contact for almost half a millennium with the documentary sources that originally inspired it.

We had refrained from tackling these codices in our quest of mushrooms partly because our hands were full with other sources easily accessible to us but chiefly from a feeling of inadequacy. What then was our surprise and delight when Dr Alfonso Caso, dean of Mesoamerican scholars, published a paper in the 1963 number of *Estudios de Cultura Nahuatl*, Vol IV, revealing our entheogenic mushrooms on a page of the celebrated *Codex Vindobonensis*, the 'Vienna Codex'. This Codex was painted, not in a Nahuatl but in a Mixtec scriptorium, and it gives the mythological Origin of Things. (Fig 1) Our interest is in the origin of the entheogenic mushrooms. The reader enters p 24 at the lower right hand and reads upwards in the right-hand column until, reaching the top, the mushroom agapé of the gods fills both columns.

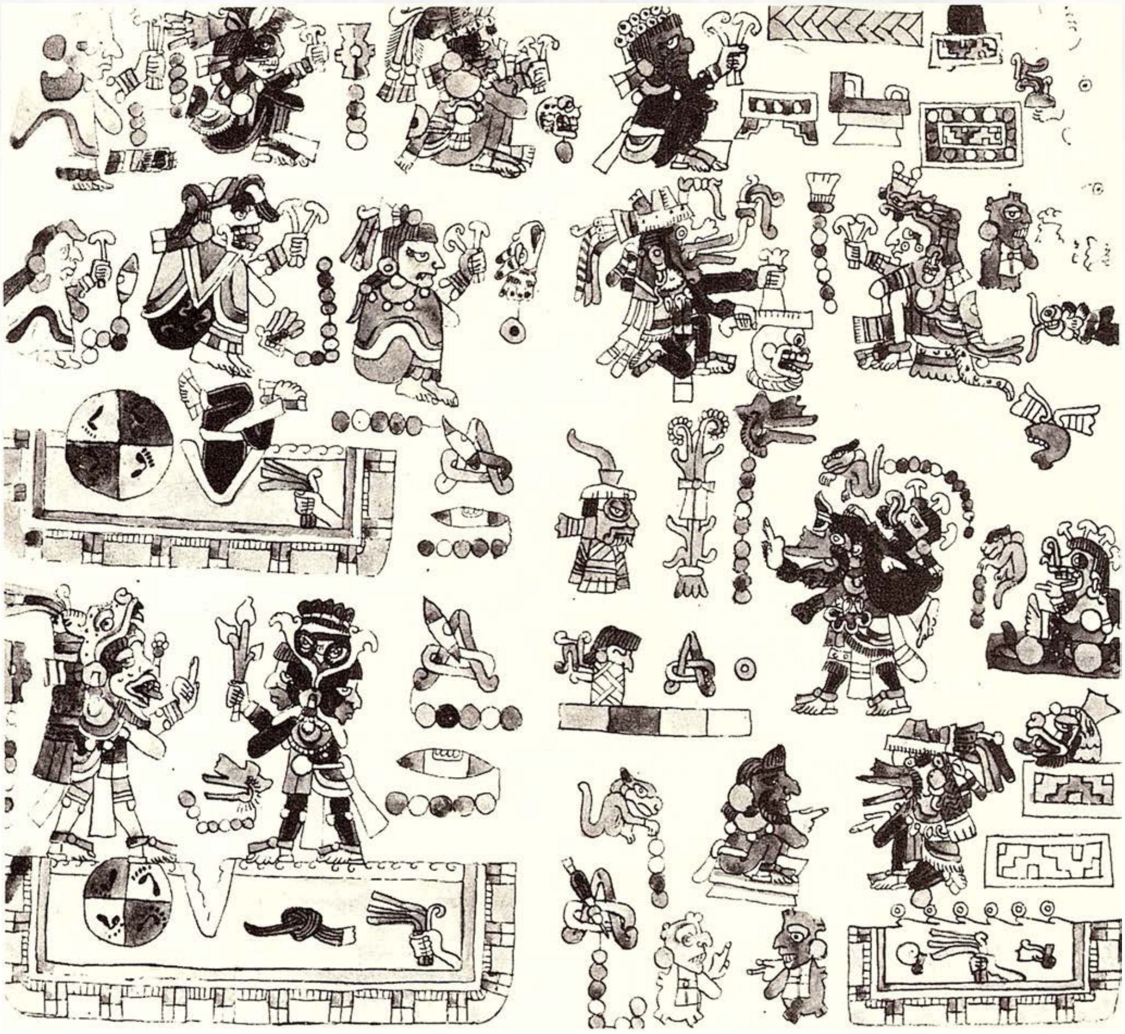


Fig 1 *Codex Vindobonensis*, p 24

Abbreviating the story, we find near the bottom the god Quetzalcóatl in full panoply and wearing a mask with a bird's beak. He is listening respectfully to an aged god who is, it seems, giving him instructions. On the next level up and to the right a woman in a mask sits next to two burning incense (*copal*) balls. She is the incarnation of the spirit of the mushrooms and she wears four mushrooms in her hair. To the left we find Quetzalcóatl carrying this woman on his back after the manner of a bridegroom carrying his bride. Her headdress still carries mushrooms. On the level above, Quetzalcóatl, now facing to the right, is singing and beating time on a sinister musical instrument, a skull resting on a corded ring. He faces Piltzintecuhtli, 'Most Noble Prince', securely identified by his calendar sign Seven Flower, and this divinity is now holding aloft a pair of mushrooms. From his eye falls a tear, in response to the song of Quetzalcóatl. Let the reader note that Piltzintecuhtli is an aspect of Xochipilli, Sun God, the Prince of *Flowers*. We shall return to Piltzintecuhtli in Chap 7. Above and to the left of this scene we see seven gods and goddesses all bearing in their raised left hands a pair of mushrooms that (presumably) they are about to ingest. (There is one exception: a crone at the extreme left in the second row holds, strangely, only one mushroom. The second divinity on the top level also seems to hold but one: however, in the codex itself the figure is seriously eroded and we cannot say what she holds.) I take it this scene is not a banquet but a *velada*, the religious rite held at night.

There can be no question: in this Mesoamerican document we find full dress recognition of the major place occupied by mushrooms in the culture of the Mixtecs; in what we, being alien to that culture, would call their mythology but what the Mixtecs would have regarded as a feature in the story of their origins. W. Lehmann published a commentary in 1929 on this codex and he remarked on the 'objects in the shape of mushrooms', but as he (as well as everyone else at that late date) was living in ignorance of the rôle of mushrooms in Mesoamerican culture, he did not link this lordly scene with the mushrooms of the friar chroniclers.

(Since I wrote the foregoing paragraphs Mr Frank Lipp, associated with the New York Botanical Garden, has called my attention to another Mixtec pictogram in the *Lienzo de Zacatepec* No I, which lies today in the Museo Nacional de Antropología. It repeats the message of the woman bearing mushrooms in her hair, except that here the head is a man's. The head rests on top of *cerro* (hill). May it not represent a sacred mountain on the summit of which *sabios* or wisemen were accustomed to celebrate the mushroom agapé?)

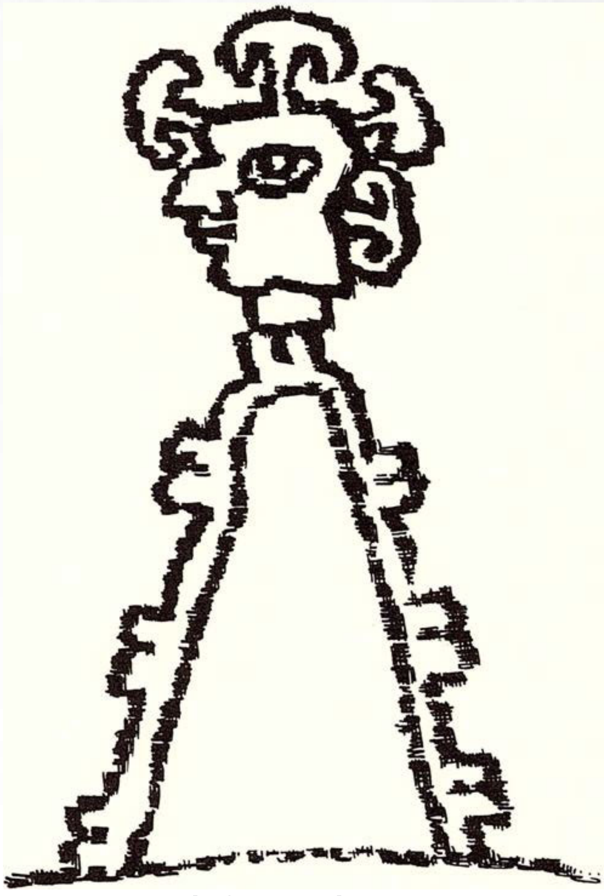


Fig 2 Detail of *Lienzo de Zacatepec* No I

In the opening paragraph of his paper Dr Caso recognized his indebtedness to Roger Heim and us for calling attention to the entheogenic fungi. He even specifies our reproduction of five Teotihuacán murals and endorses our identification of mushrooms in them. This was a gratifying accolade, all the more so because of his authority. But I would point out that there are in his paper marked traces of the legacy of the sixteenth century Spanish friars. Our writings (Heim's and the Wassons')

> ... han dado a conocer ampliamente este aspecto de la hechicería que se ha conservado en algunas panes del país...
>
> ... have amply made known this aspect of the witchcraft that has been retained in some parts of the country...

'*Amply made known*'! He seems to have thought that we had exhausted our theme in what we had already published. But we had only opened up a vast subject, not merely in the Indian world of Mesoamerica but in the Americas and Eurasia, and perhaps elsewhere. He did not sense the implications of the entheogens in Early Man's life. Dr Caso treats our mushrooms gingerly. With the tips of his fingers, he advances his interpretation of the mushroom scene in the Codex tentatively: it is an 'hypothesis', it 'may be' right, although he has copper-riveted his proofs as we shall see shortly. He echoes the friars when he expresses his antipathy to the realm that he denominates by the pejorative, question-begging epithet 'witchcraft' and when he speaks of the mushrooms as *esta práctica mágica*, 'this magical practice'. Only in recent decades have scholars made serious inquiries into the peculiar 'witchcraft' phenomena of the late Middle Ages and Renaissance, and the panic that they provoked in the Churches, Catholic and in the later stages Protestant.[24] There was no witch-hunting in Eastern Orthodoxy.

Let us pause a moment and develop this thought. For some centuries there had been in Western Europe a polarization between the Established Church on the one hand and an amorphous body of 'witches', whose beliefs such as they were had nothing in common with native Mesoamerican beliefs. The Spaniards brought over to the New World the religious beliefs held in Western Europe, including Catholicism and *brujería*: both were equally strange to the natives and, as coming with the Spanish Conquerors, enjoying equal prestige. By grafting on to the unknowing Indians the old-world *brujería* and later reproaching the Indians for entertaining it, are we not supplying a supreme example, a textbook case, of anatopism, an error in space corresponding to an anachronism in time? What of witchcraft or magic is to be found in entheogenic mushrooms? In psilocybin? (The 'witchcraft' of the time had nothing to do, of course, with the heresies that preoccupied some of the best minds of the age in Western Europe and that culminated in the Reformation.)

The clergy treated alcoholic inebriation as a venial sin. It was condemned severely by the Nahua in pre-Conquest times, when pulque was expressly reserved for the oldsters who had passed their period of usefulness and were awaiting their end. (Of course the official attitude may not have reflected the practice: prohibition was probably a failure with them as with us.) Inebriation from mushrooms and certain other hallucinogens, on the other hand, was confused by the clergy, not with alcoholism, but with *brujería* and heresy.

As for the pre-Conquest codices, I looked at them and could not read them, but I was approaching them from a new perspective, the perspective of one who knew the entheogens from many years back. The variegated colors, the play of angles and curves, the interlacing of planes, the reduced figures, the complicated masks and vestures - these all seemed somehow familiar to me. It came over me gradually: the dancing kaleidoscopic designs of the mushroomic experiences were what inspired the painter of the *amoxtli*. Henri Michaux and many others have attempted to find artistic inspiration in entheogenic drugs, but to discover an art that was saturated with their influence and at the same time under the disciplined control of masters with a lifetime of entheogenic experience, we must look to pre-Conquest codices. Here is no fumbling of the novice. Many have been awestruck by the haunting beauty of these codices but until now it seems not to have occurred to anyone that they were painted by priests whose lives were constantly illumined by the unearthly glow of the divine *piule*. From childhood the priests were brought up in its ambiance. Whether the codices were painted while

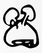
---

24. For an introduction to this subject the reader is referred to the *Times Literary Supplement*, 5 Jan 1975, 'Communities and their witches', by Robin Briggs, pp 13-14; and 23 July 1976, 'Powers of darkness' by Norman Cohn, pp 902-903.

the priestly scribes were bemushroomed we will never know but I think this may have been possible for the trained *élite*. The *amoxtli* enjoyed a prestige that we sense to this day in María Sabina's chants: the gods themselves dictated these picture writings. This is an æsthetic judgement and is not open to demonstrable proof. On the other hand only those who have known the hallucinogens well and under the right circumstances are qualified to assay my view... How startled and fascinated would Dr Caso have been at our new perspective on his codices!

Códice indígena no 27

Dr Caso began his paper on the *Codex Vindobonensis* with a discussion of another Codex, post-Conquest, dating from 1549, a legal document written in picture writing on one side and in Spanish on the other. He found here solid grounding for his interpretation of the Vienna Codex. (Fig 3) This second Codex was an extraordinary discovery.

The Indians of Tetla in Morelos were filing a complaint alleging that Cortés in 1532 had taken some lands of theirs to make a road running to Mexico City. (Fig 3) The road is plainly indicated bisecting the land with human footprints marking the trail. On the left is a field apparently sown to sugar cane, on the right a terrain bearing the name 'Nanacatepeque'. The glyph for this name appears *inside* the land in question. In picture writing 'Nanacatepec' consists of three words: *nanácatl* meaning 'mushroom', *tépetl* meaning 'hill', and *c*, a locative meaning 'place' - 'Mushroom Hill', . The farmlands that adjoin Mushroom Hill are identified by other glyphs, all of which Dr Caso explains, his explanation being supported by the Spanish summary. In the glyph for Mushroom Hill the mushrooms are shown by a pair of mushrooms represented in cross section emerging from the hill. Dr Caso sees in the pair of mushrooms the identical glyph that we find in the Vienna Codex.

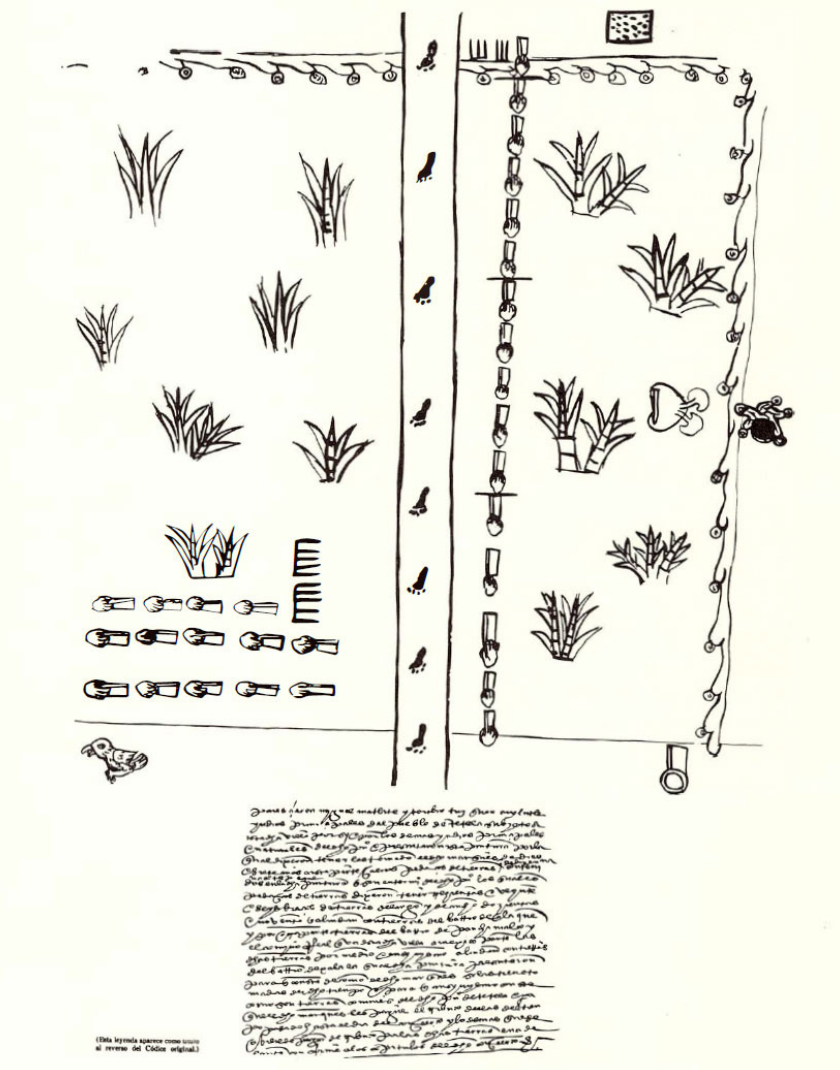

(Esta leyenda aparece como texto al reverso del Códice original.)

Fig 3 *Códice Indígena* No 27

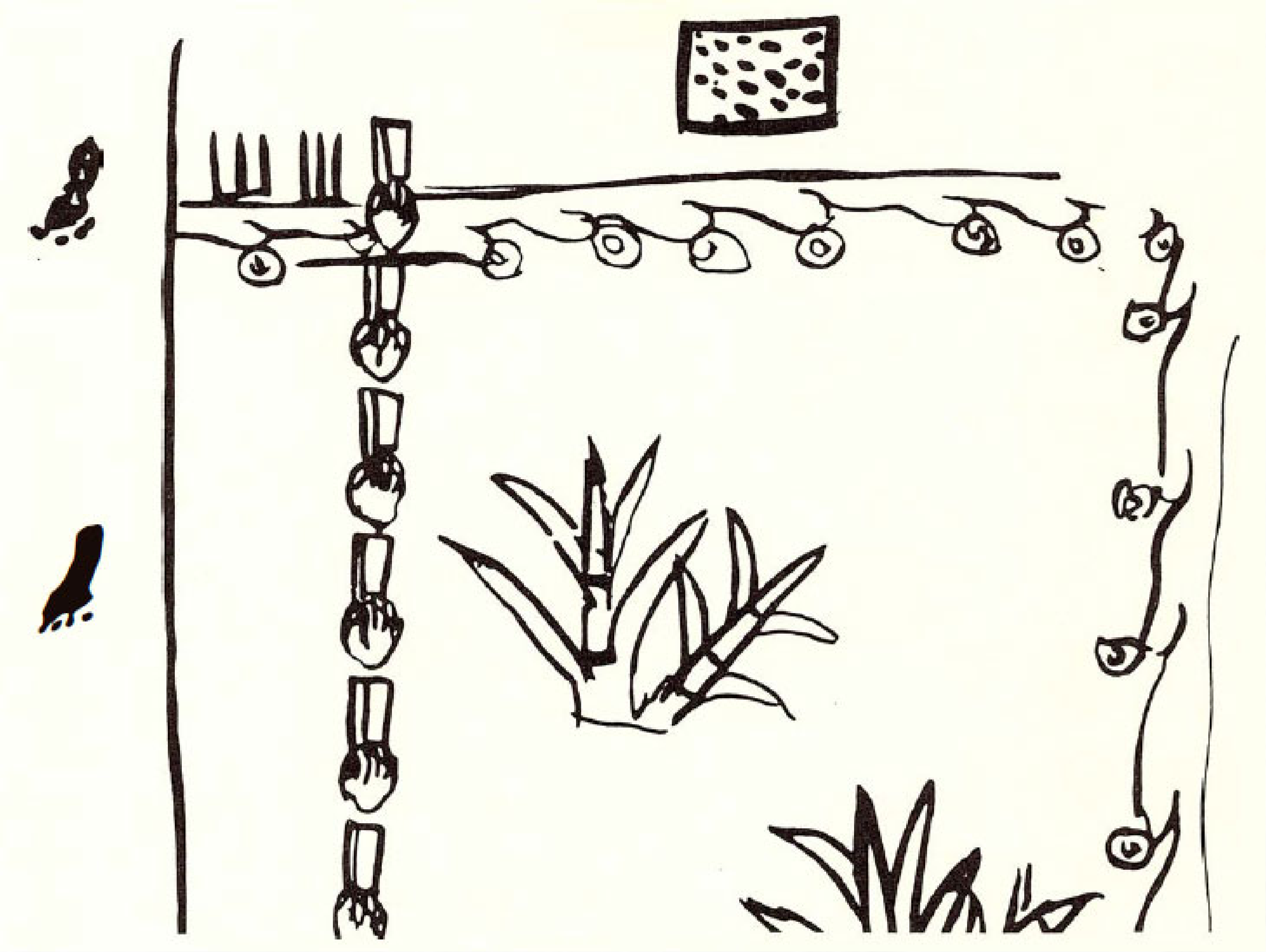
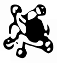


Fig 4 *Códice Indígena* No 27

Before we leave this *Códice indígena* No 27, I will call attention to the two glyphs that mean running water, one along the top of the field and the other down its right side. The wavelets along the top are linked to snails alternating with circles, the circles in turn containing tiny concentric circles, reduced occasionally to a mere dot. Down the right side we find similarly flowing water but expressed here by the circle-and-dot. In the pictographic 'shorthand' the snails are dropped and the inner circle is hardly more than a dot. There is no commoner glyph in the picture writing of Mesoamerica than the one of water represented precisely as here. In this same Codex No 27 it occurs again to the right of Mushroom Hill, in the rebus glyph,  which means 'Olaque', the name of the adjoining village. This glyph consists of *Ol-*, taken from *ollin* meaning rubber, *a* for *atl* meaning water, and the locative *que*. The place name 'Olaque' is thus expressed by a ball of rubber and the symbol for water.

I will revert to these glyphs for water when we come to discuss the Teotihuacán murals.

Sahagún's Florentine Codex and the Magliabechiano Codex

From the beginning of our inquiries into the mushrooms of the Nahua we were on the lookout for sixteenth century illustrations of them. The botanist Hernández in his text said that he was depicting four kinds of mushrooms including the *teyhuinti*, the inebriating one, but the 1790 edition carried no illustrations, and his drawings, which would have been precious for us, must have been consumed in the Escorial fire. However, our quest has not been bootless. In the *Florentine Codex* of Bernardino de Sahagún's famous chronicle and account of the Mexican world we discovered one picture theretofore unremarked by students, and Robert J. Weitlaner has drawn our attention to a second in the *Magliabechiano Codex*. We here reproduce both of them, this having been facilitated by a happy chance: the two codices, though lying in different libraries, are both in Florence. The illustrations are singularly significant for us, being complementary, one of them executed by a Spanish artist and the other by a native in the tradition of his people, though he may show traces of Spanish influence. Both illustrations are in the nature of pictographs, vignettes intended to convey a verbal message. Neither tells the mycologist anything about the sacred mushrooms, but both are eloquent and curious expressions of the contrasting attitudes of the two peoples toward them.

Sahagún's writings survive in several depositories, the *Florentine Codex* in the Biblioteca Laurenziana being the best known. Although most of the many illustrations in it were done by native artists, some were by Spaniards, and it was a Spaniard who made the five small pictures representing various mushrooms that Sahagún discussed. A close inspection of the five pictures and Sahagún's text makes it clear that the artist worked from the text and possessed no knowledge outside the text. (Did Fray Bernardino think it safer not to turn to a native of Mesoamerica to depict the dangerous mushroom?) When he came to the inebriating mushroom, the painter undertook to convey his iconographic message in a way natural to a sixteenth century Spaniard: a demon is portrayed rising from a number of nondescript tawny mushrooms and the demon carries those conventional stigmata commonly identified with demons in the Gothic and Spanish worlds. He is clothed cap-à-pie in fur, a huge beak emerging from his fur-enclosed face. For hands he has claws. One foot is unformed or malformed, perhaps a splayfoot. This is the malformed foot that survives in the English 'cloven hoof', that led the French to speak of the Devil as *le Bot*, the Clubfooted One, the Cripple.[25] In *le Bot* as in this picture we find blended the themes recurring in our writings - Satan portrayed as *le Bot*, a demonic mushroom, also called *le Bot* in Old French, and offstage, by metaphoric transfer, the toad again in Old French called *le bot*. The common toad was a focus of execration in Western Europe at that time, an attitude that runs back far and deep in West European history. In the 'witchcraft' trials of the Middle Ages I have nowhere found reference to mushrooms, but as a common denominator lying behind ordinary words of everyday use, we find Devil, toad, and toadstool. Did the Catholic clergy in Mesoamerica sense this ancient layer of meaning linking these three - Devil, toad, and toadstool - in an unholy trinity?

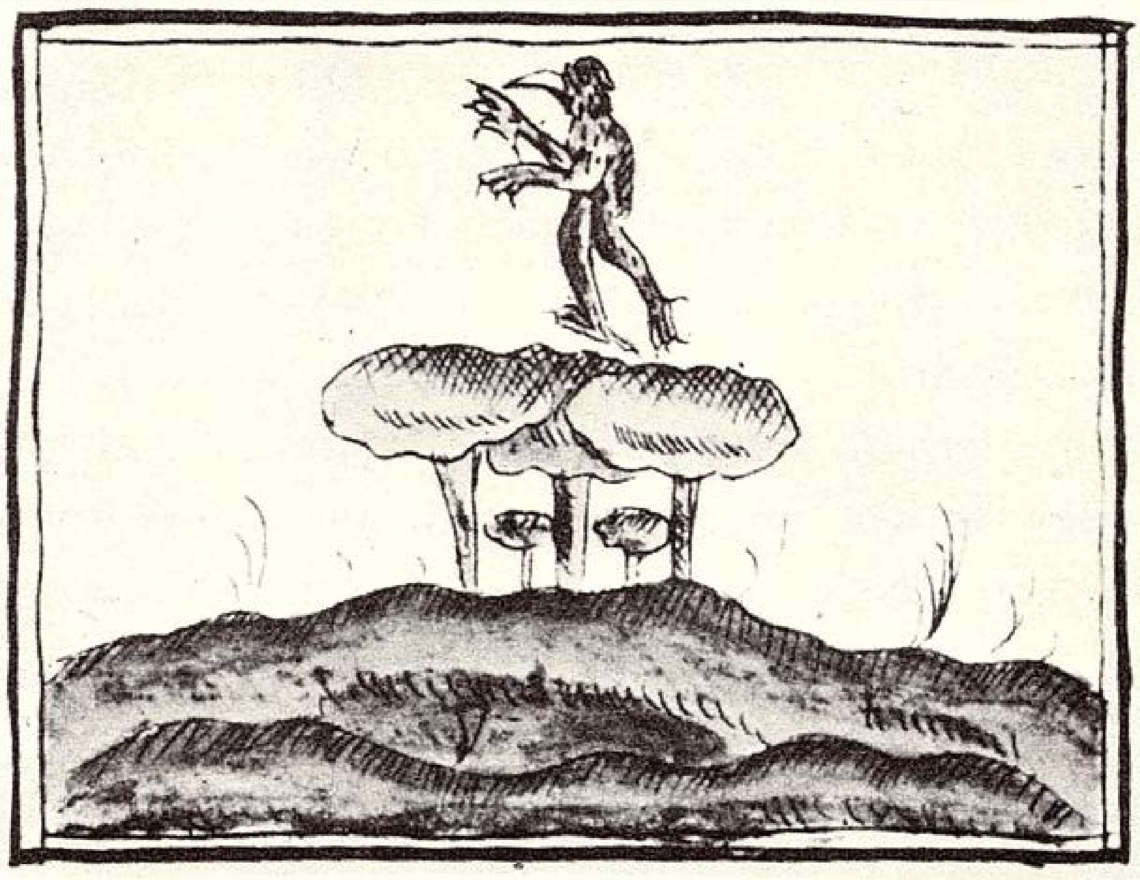


Fig 5 Illustration of Satanic Mushroom. *Florentine Codex*

---

[25] Malformed and bestial feet characterize several Aztec divinities. Thus the god Tezcatlipoca was distinguished by a missing or

> deformed foot. But it would be rash to assume that the demon of the *Florentine Codex* was influenced by Nahuatl artistic conventions. The craftsmanship reveals a European mind, the dubious visual expression corresponding to the verbal denunciations that the clergy were heaping on the 'demonic' mushrooms.

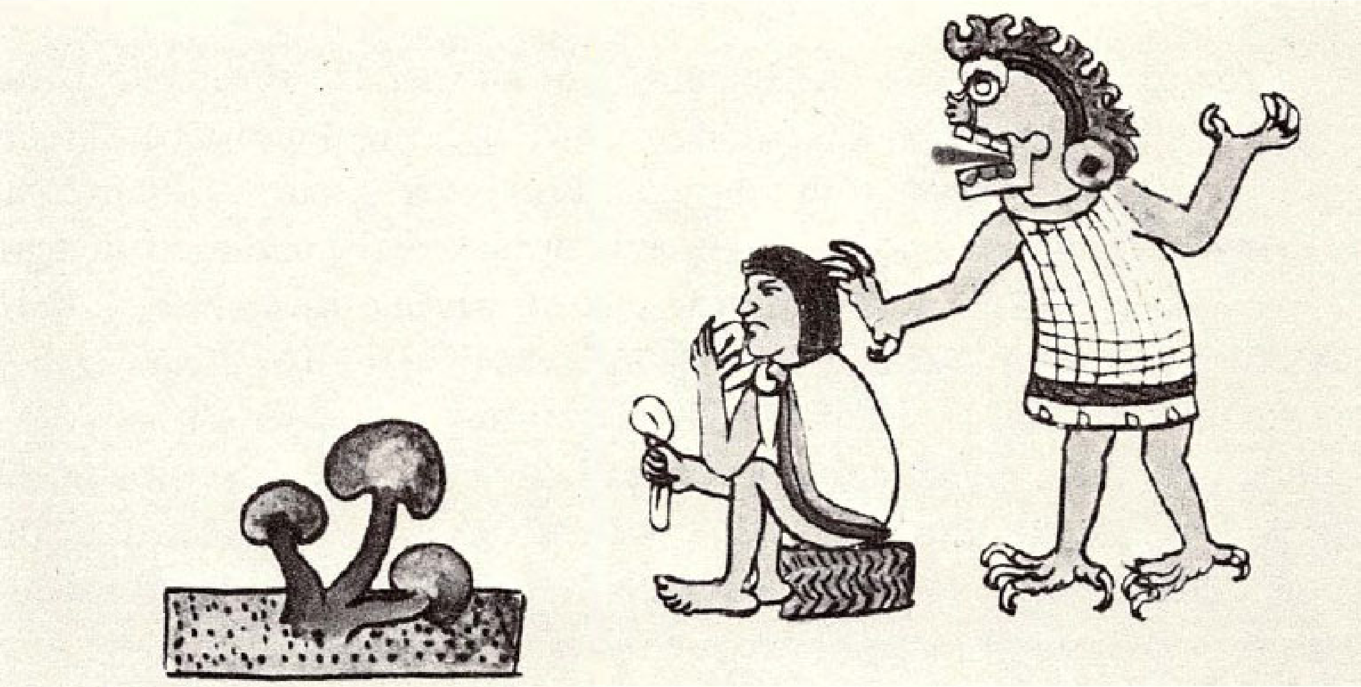


Fig 6 Illustration from *Magliabechiano Codex*

The second illustration, in the *Magliabechiano Codex*, offers us three elements - mushrooms, a man eating the mushrooms, and behind and over him a supernatural figure. The reader will note that the man holds a mushroom in each hand, *ie* a pair. According to Professor Jiménez Moreno, the spirit is probably Mictlantecuhtli, Lord of the Underworld, who is depicted on other pages of the same Codex. The Codex is painted on European paper, and dates probably from shortly after 1528. How far removed from the Spaniard's conception is the native's! Not only is the craftsmanship of these artists, contemporaries of each other, poles apart: their message is likewise. The Spaniard is reporting prosaically the existence of a demonic mushroom to his European public. The Indian, though undoubtedly a baptized Christian, conveys a sense of the reverence that he still feels in the presence of the awesome *teonanácatl*. That the mushrooms in this miniature are green should not disconcert the mycologist: green, the color of the precious jade, meant in Mexican iconography that the object so depicted was of great worth, was holy.

Matrícula de Huexotzinco

In 1560 a census was taken of Huexotzinco, not only of the town but of the whole province. In pre-Conquest times Huexotzinco was a famous city not many miles from the lake, also famous, in which Mexico-Tenochtitlan was built. The census of everyone in Huexotzinco was written in duplicate, the names spelled out in Roman characters and also drawn in the picture writing of the Nahua. Karl-Herbert Mayer has drawn my attention to two individuals in the list of names called *Xochinanácatl*, a word that, as we already know, means 'sacred mushroom'. We do not know why these individuals were so called. Were they specialists in the gathering and use of the mushrooms? Or were these names unrelated to the mushrooms? Here are the pictographs for Luis and Diego Xochinanácatl, two of the entries in the Census of Huexotzinco for 1560:

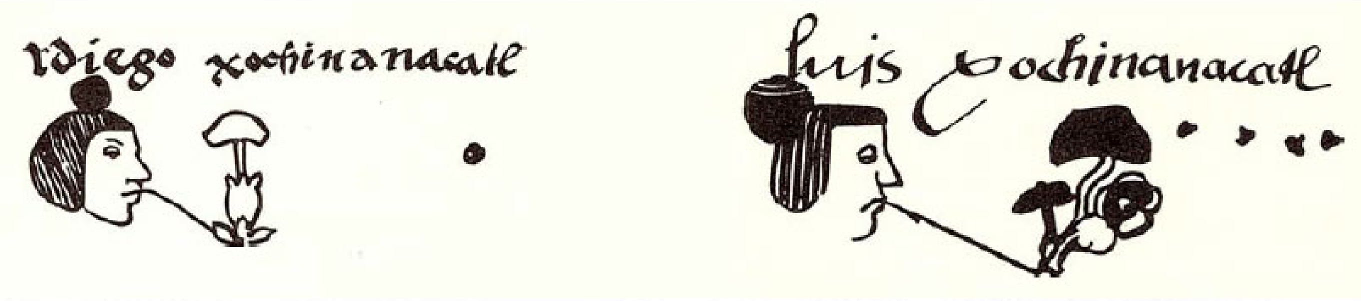


Fig 7 Men named for the Sacred Mushroom. *Matricula de Huexotzinco*

In each case, as well as all other cases in this census record, a line invariably connects the face to the drawing that represents him. It will be noted that one spot on the right distinguishes the pictograph of Diego who is represented by one mushroom, and four spots accompany the pictograph of Luis who seems to be blessed with four mushrooms. What this means we know not, but it certainly meant something to the artist.

Lienzo de tlacoatzintepec

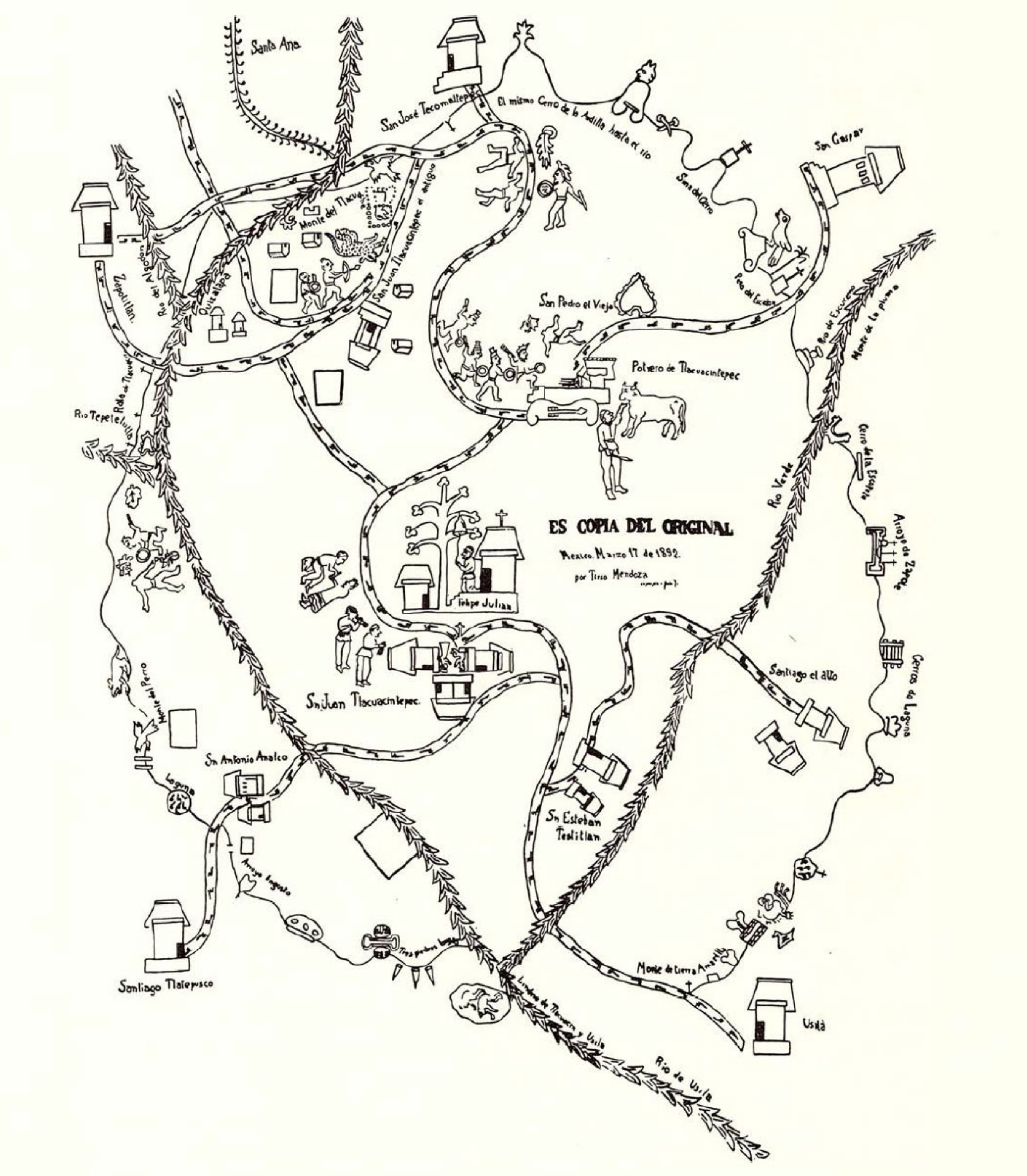

Santa Ana
San José Tecomaltepec
El mismo Cerro de la Ardilla hasta el rio
Sima del Cerro
San Gaspar
Peña del Escobo
Monte del Tlacua
San Juan Tlacuacintepec el antiguo
Zapotitlan
Rio del Algodon
Quetzalapa
San Pedro el Viejo
Potrero de Tlacuacintepec
Rio de Escurero
Monte de la pluma
Rollo de Tlacuatzin
Rio Tepetelutla
Cerro de la Escalera
Rio Verde
ES COPIA DEL ORIGINAL
Mexico. Marzo 17 de 1892.
por Tirso Mendoza
Felipe Julian
Arroyo de Zapote
Santiago el alto
Cerros de Laguna
SnJuan Tlacuacintepec.
Monte del Perro
Sn Antonio Analco
Laguna
Arroyo Angosto
Sn Esteban Teotitlan
Tres piedras largas
Santiago Tlatepusco
Monte de tierra Amarilla
Lindero de Tlacuatzin y Usila
Usilá
Rio de Usila

Fig 8 *Lienzo de Tlacoatzintepec*

In April 1952 Robert J. Weitlaner discovered a *mapa* in the Chinantec village of San Juan Tlacoatzintepec, a map drawn in the picture-writing of the Indians dating back perhaps to the late sixteenth century or the early part of the seventeenth. The original, badly dilapidated from age, was drawn on tightly woven cotton cloth.

Fortunately it was copied in March 1892, and a tracing of this copy was made by Carlo Antonio Castro, Weitlaner's colleague. This typical post-Conquest Codex is reproduced in Fig 8. It represents a momentous event in the history of the village, a battle over lands between the village of Tlacoatzintepec and a neighboring town. We will dispense with the reading of the *mapa*, of interest to specialists, and concentrate on the crossed mushrooms in the upper right-hand corner, of which we supply the detail in Fig 9. Weitlaner was in no doubt that they represented the sacred mushrooms: ordinary mushrooms would never enjoy the prestige to be included in a *mapa* esteemed and guarded by the villagers as this one was. The same would hold true of the *Códice* No 27 previously described. No mountain or hill would be named after ordinary mushrooms edible or inedible. In examining the *Lienzo*, the reader will smile on noting that the divine mushrooms are next to a Christian cross.

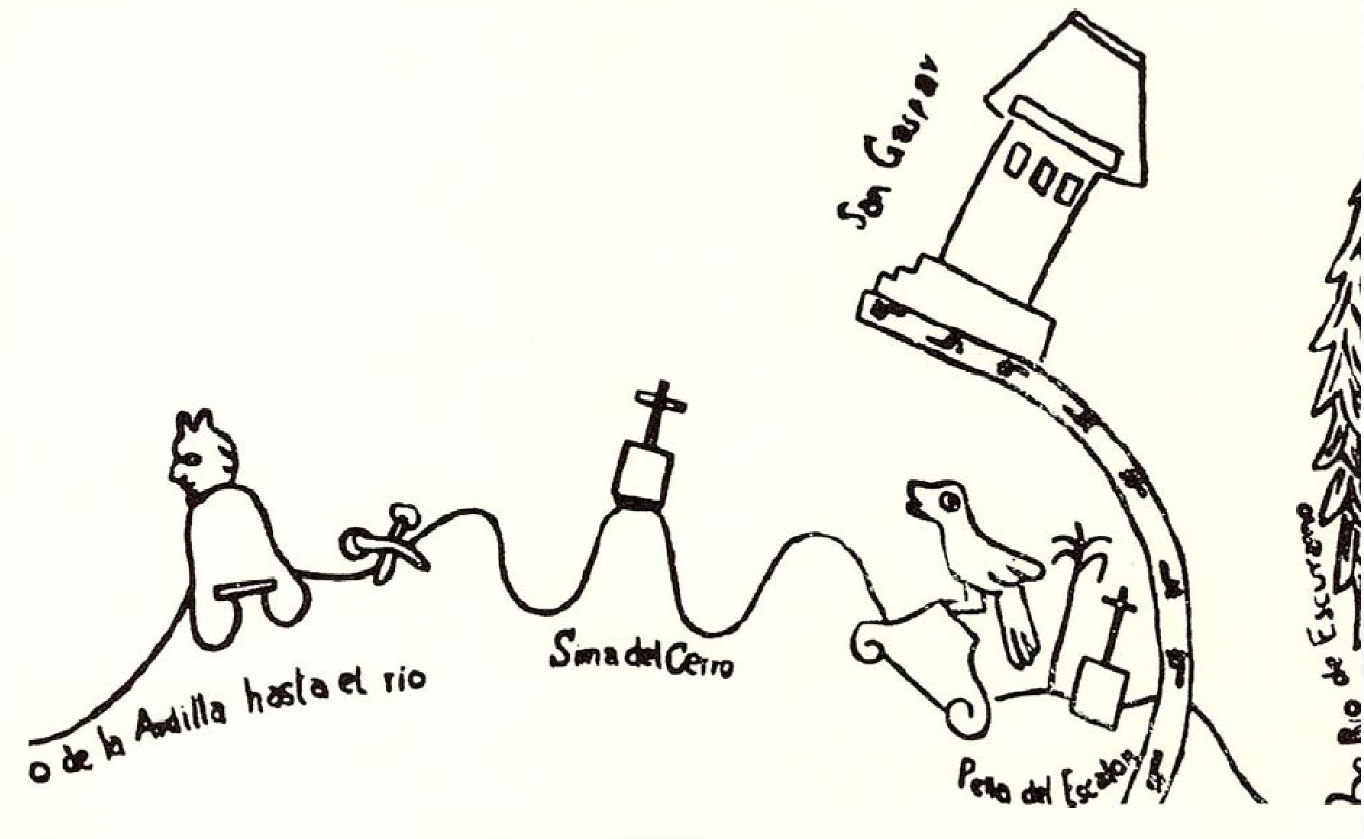


Fig 9 Detail of *Lienzo de Tlacoatzintepec*

Mapa Quinatzin

In the Bibliothèque Nationale, Paris, there survives a post-Conquest Codex with this title executed shortly after 1540. It is on *amate*, the native beaten bark paper, and shows Indian-style the disposition of the official buildings around a court of the city of Texcoco. The Lord of Texcoco and his son occupy the central chamber of the upper tier of rooms. (Fig 11) Karl-Herbert Mayer of Graz called my attention, in the upper left-hand quarter of this chart, to what he thought might be mushrooms, only to revise his opinion on closer inspection, under magnification, of these four curious objects. (Fig 12) He discovered that the stipes (or stems) of the 'mushrooms' were all separated from the 'caps'. When he first wrote me I was inclined to accept his identification, and when I discovered that the stipes were on their own, so to speak, contrary to his reaction, I was sure that we were dealing with mushrooms.

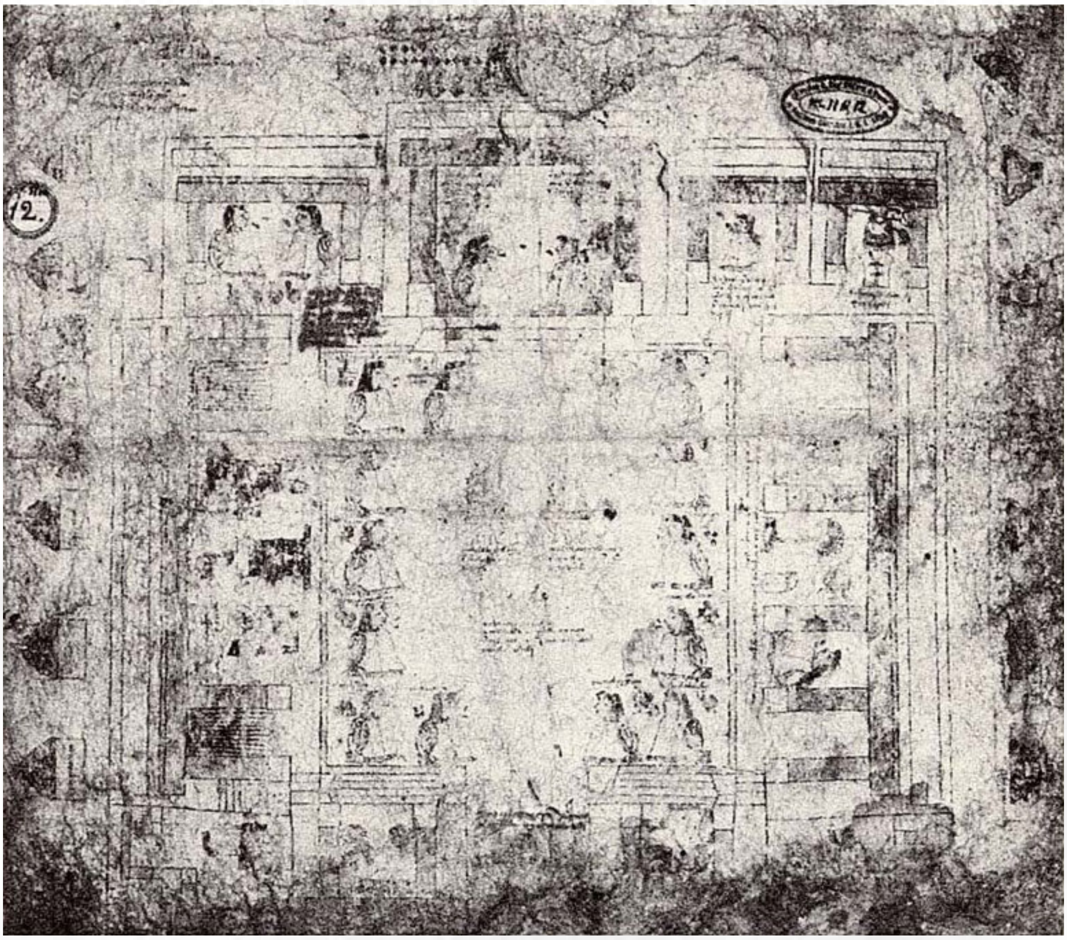


Fig 10 Photograph of original *Mapa Quinatzin*, Bibliothèque Nationale, Paris

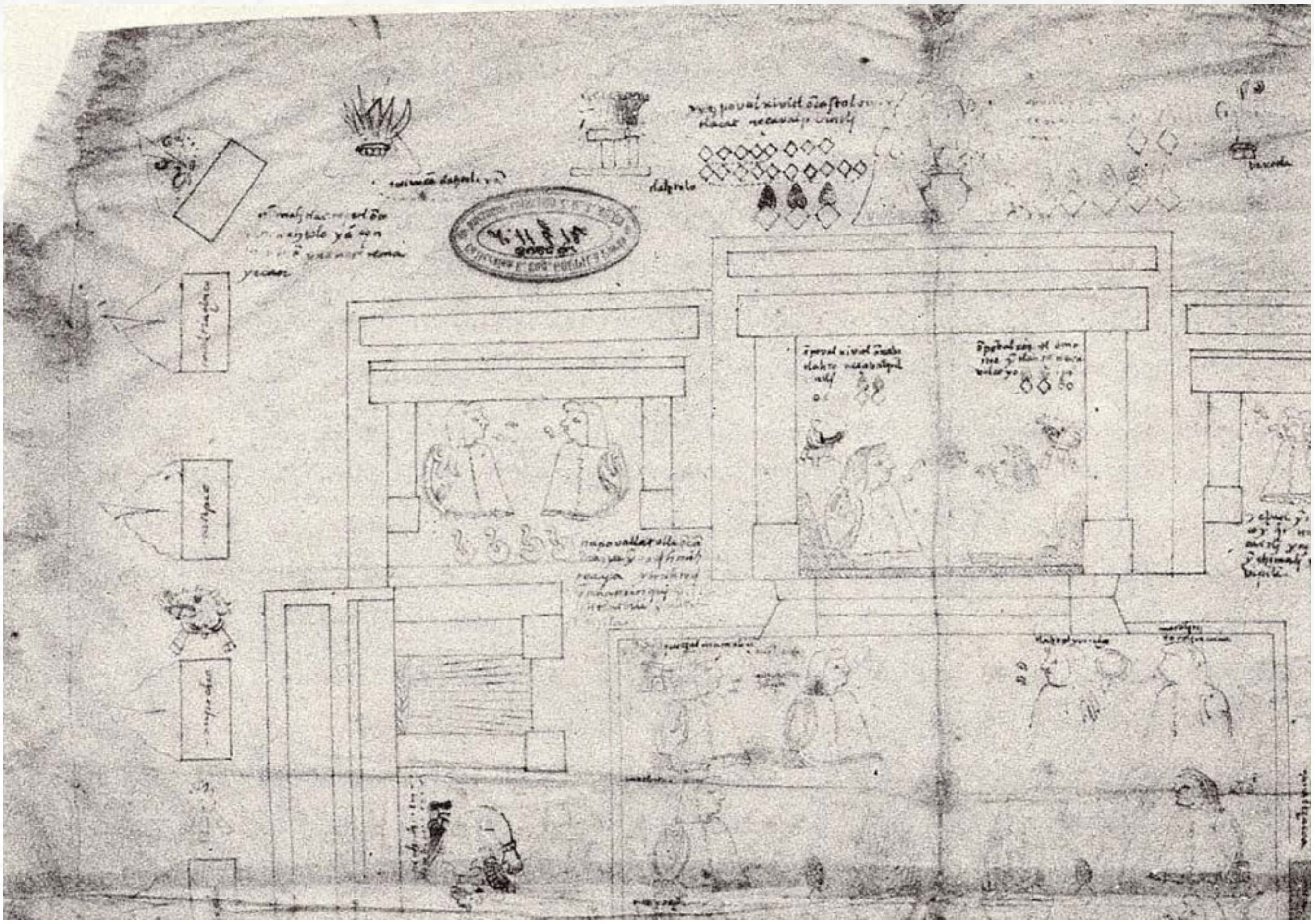


Fig 11 Drawing after *Mapa Quinatzin*, detail of upper left hand corner

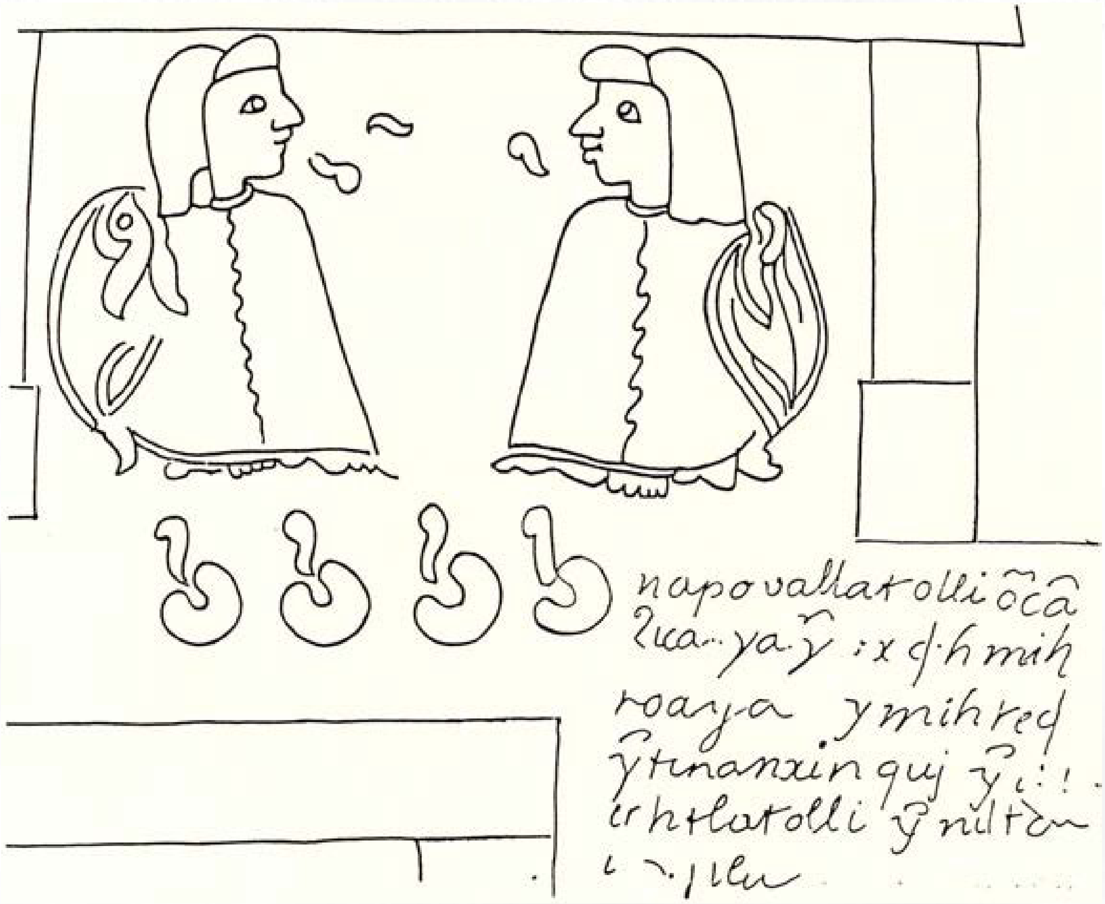


Fig 12 Further detail of drawing after *Mapa Quinatzin*

This chart bears explanatory comments and one of them deals with the two individuals seated in the room above our mushrooms. It explains that this is the audience chamber where justice is rendered: an audience in which the rights in certain lands are being adjudicated. The comments are in Nahuatl written in our alphabet. There is agreement on the translation as far as it goes.

Whether the two figures are colleagues discussing the merits of the case, or whether one is a judge (presun1ably the one on the left) and the other the plaintiff or the defendant, I would not say. They are both speaking, the one on the left uttering two *vírgulas de habla*, 'commas of speech', the other only one. *Vírgulas de habla* is the customary way to designate in Spanish these common glyphs for speech in Mesoamerican writing. And *vírgulas de habla* are what the mushrooms are uttering, the divinatory mushrooms, speaking with the voice of the gods. The court is having recourse to *xochinanácatl* to arrive at the just decision. The mushrooms are playing their proper rôle.

This *Mapa Quinatzin* has been described at length by Mesoamerican scholars, the Nahuatl comments translated, but apparently no exegete has ever remarked on these mushrooms uttering their *vírgulas de habla*. I shall never forget Aurelio Carrera's arresting characterization of the sacred mushroom: *es habla*, it is speech, it is the Word.

CHAPTER 7
Piltzintli, Child God of the Nahua, and his Christian progeny

Santa María Tonantzintla

A reader unfamiliar with the world of the Middle American Indian and acquainted only with the text of our *veladas* might jump to the conclusion that the divine mushrooms are primarily a device for predicting the outcome of a particular illness in a particular individual. True, this was the purpose of the shamanic sessions that we have offered to the public. But the horizons conjured into being by the mushrooms are far wider in time and space, and beyond time and space, than the mere outlook for a stricken patient. They translate one to a prismatic, iridescent, pristine world, a Garden of Eden and a Tlalocan, fields of asphodel, well watered, clean, where the air and the breezes are good, where birds and butterflies and flowers abound, where men live off nectar and ambrosia. The divine mushrooms step up our drab existence to heights of great poetry and music. Those who commune with them find opening before them the portals to the playing fields of the gods.

And here I will interrupt my exposition to recapitulate certain developments in recent Middle American studies.

In 1942 Alfonso Caso brought out a brilliant paper[26] in which he reported on the uncovering of a mural in the sacred precincts of Teotihuacán, a mural that he called Tepantitla after the *solar* or villa where it was found. Enough of the mural (painted probably between A D 300 and 600) survived to show that it portrayed Tlaloc the Rain-god, and Tlalocan his heaven. This heaven was a lovely scene of natural beauty where the chosen among the dead disport themselves in various games and pastimes. The Aztecs placed Tlalocan traditionally in the folds of the mountains below Popocatepetl.

In some quarters doubts have been expressed as to whether Dr Caso was justified in assuming that the ideas and ideology of the Nahua of the fifteenth century could be projected back a thousand years into the Teotihuacán culture. I do not share these doubts. In our days of dizzy and accelerating technological change we must make an effort to picture a stable world of unchanging ways, a world without an alphabet, without even draft animals to help in the performance of manual labor. Though we are not sure what language was native to Teotihuacán, we can be reasonably certain that, whatever the tongue spoken there, the ideas and habits of life were substantially unchanged until the arrival of the Spaniards - figures of Outer Space - erupted on the scene early in the sixteenth century.

In 1951 there was published a collection of papers in honor of Dr Caso and among them was a brief one contributed by Francisco de la Maza in which for the first time the Tlalocan of pre-Columbian days was linked with the Christian church of Santa María Tonantzintla near Cholula, a nineteenth century church that is almost in the shadow of the great Cholula pyramid and is within a long day's walk from the upland valleys where lay the Tlalocan of the pre-Columbian beliefs. There lie, over the crest of the mountains, San Pedro Nexapa and Amecameca where the sacred mushrooms are still consumed and consulted. Cholula is only a short distance away in every direction from the *teonanácatl* and *ololiuhqui* country. Each year in mid-September when the sacred mushrooms abound the Indians still go on pilgrimage to Cholula and thereabouts. Tonantzintla is also near Puebla, about a third of the way from Mexico City to Huautla. De la Maza perceived that the remarkable interior of the church of our 'Little Mother' is decorated, not precisely in baroque or Churrigueresque style, but in a folk style consonant with the astonishing display of Churrigueresque extravagances manifesting themselves at that moment in Puebla. Those extravagances - did they not give an opportunity to the parishioners of Tonantzintla to indulge in aberrations of their own that were wholly of pre-Conquest inspiration? Throughout the interior of the church of Tonantzintla, De la Maza saw the Nahua *xochime* (flowers), *piltontli* (children), *ixtli* (faces), their wide-open eyes speaking for their amazement at finding themselves in Paradise, *xayacatl* (masks) covered with *ihuitl* (feathers) feasting on *xochicualli* (fruits). De la Maza's discovery deserves conspicuous honor, associating as he dared to do the pre-Columbian culture of the Indians with an eighteenth to nineteenth century expression of that same culture in a Christian temple. Here, he thought, was the key to what had been an amazing riddle. In retrospect his reading of the *décor* of this church seems obvious, as all major discoveries seem, once they have been made.

---

[26] 'El Paraiso Terrenal en Teotihuacán', *Cuadernos Americanos*, Nov-Dec 1942, pp 128-136. His identification of the central figure as Tlaloc has been formidably challenged by George Kubler in *The Iconography of the Art of Teotihuacán* published by Dumbarton Oaks, 1967, and by Peter T. Furst in *Mesoamerican Archeology, New Approaches*, ed by Norman Hammond, Duckworth, 1974, pp 187 ff. This question is irrelevant to my argument.

Then, in 1956, there came a little book by Pedro Rojas, *Tonantzintla*, illustrated with seventy-six of his photographs. It was a spectacular essay on the parish church of Santa María. The idea only adumbrated by De la Maza here unfolds, fills out, and takes flight. In words of extraordinary eloquence, interlaced with Father Garibay's translations of Nahuatl poetry, he discourses in minute detail and with authority on the decorations of this famous fane, a supreme expression of the religious belief and aspirations conceived and executed by the humble parishioners of this neighborhood.

Caso, De la Maza, Rojas - these men went far in interpreting Tepantitla and Tonantzintla. They omitted only one element, an element that supplies the keystone to the arch - the sacred mushrooms, *teonanácatl* and *xochinanácatl* of the Nahua, ˀnti^{1}xi^{3}tho^{3} of the Mazatecs.

I had visited Tonantzintla before attending a *velada* conducted by María Sabina. Here was a simple village church where the folk art of the parishioners ran riot over ceilings, walls, and sanctuary, *hauts-reliefs* of flowers and fruit, of children and faces mostly young, some singing, some with masks, others making music on stringed instruments, many joyfully naked, the whole area of walls and vaults, columns and pilasters, crowded with these figures in a riotous display of vivid colors and bewildering curves. I had already stood, like thousands before me, struck dumb at the spectacle, wondering what *genius loci* had inspired the farmers and artisans of this neighborhood to let themselves go, decorating their church in so unorthodox, so dazzling, a fashion, with no parallel in Mexico, in the whole world. What a spontaneous outpouring of joy in life!

On returning to Tonantzintla in 1955 after attending two *veladas* and sharing in the mushrooms (but not understanding what María Sabina was singing), it came over me as a revelation, when entering the church, that these were the color values, the phantasmagoria, of the mushroom world. There was not the slightest doubt in my mind. But how could I prove this to people who had never taken the mushrooms, would never do so?

★

In 1957 Valentina Pavlovna and I brought out our *Mushrooms Russia & History*. In it we presented our reasons for believing that the Tepantitla and Teopancaxco murals, both from roughly the same period perhaps fifteen or sixteen centuries ago, are shot through with unmistakable mushrooms. The mushrooms alternate with marine snails and bivalves, in a manner that we all recognize at a much later date as a glyph for water. In these murals the mushrooms, not yet stylized beyond recognition, are mushrooms, not the 'jade rings' that some have surmised, nor the water lilies that others have suggested, for they lack the deep cleft in the leaves that characterize the water lily. In *Les Champignons hallucinogènes du Mexique* that Roger Heim and I with others published at the end of the following year, I told the story again, now adding to my illustrations a mural from the *solar* of Zacuala, in Teotihuacán, which was called to my attention by Mme Laurette Séjourné. In this mural we find the same symbol representing, as I believe, *teonanácatl*, a Nahuatl name for the sacred mushrooms, or *xochinanácatl*, that other name supplied in the great sixteenth century lexicon of Nahuatl by Alonso de Molina. But here in Zacuala the symbol stands alone, not with seashells as a glyph for water. Though our book drew wide attention from laity and specialists both, the particular pages in which we pointed out the *teonanácatl* in the murals of the sacred precincts of Teotihuacán seem to have drawn comment from no one: no one except Dr Alfonso Caso who, in the opening paragraph of his paper on the mushrooms in the *Codex Vindobonensis*, referred to us (Heim & the Wassons) as having drawn his attention to the fungal representations in the murals of Teotihuacán.

★

I then went to the Far East and concentrated almost exclusively on the rôle of mushrooms in the cultures of India, China, Japan, New Guinea, and elsewhere. Toward the end of the '60's and early '70's I returned to the Mexican field, re-read Francisco de la Maza's paper and Pedro Rojas's book dealing with the church of Tonantzintla, admired the care with which Fernando Benítez followed in our footsteps and, giving us full credit for our discoveries, reported his talks (through Herlinda Martínez Cid, his and our interpreter) with María Sabina. Above all I studied the *veladas* that Henry Munn, Alvaro Estrada, and we have had rendered from the Mazatec tapes. There is no need for further documentation: on the strength of these *veladas*, whatever Christian overlay it may show, the parish church of Tonantzintla is a pæan to the inebriating mushrooms of Middle America, a pæan almost as inebriating as the mushroom itself, a pæan that surpasses by far even Tepantitla in its exuberant eloquence.

When asked by Fernando Benítez how she viewed the sacred mushrooms, María Sabina had said, as rendered into Spanish by Herlinda Martínez:

> Yo veo a los hongos coma niños, coma payasos. Niños con violines, niños con trompetas, niños payasos que cantan y bailan a mi alrededor. Niños tiernos como los retoños, como los botones de las flores: niños que chupan los malos humores, la sangre mala, el rocío de la mañana. El pájaro que chupa la enfermedad, el chupamirto bueno, el chupamirto sabio, la figura que limpia, la figura que sana.
> [*Los Indios de México*, 3, p 243]
>
> I see the mushrooms as children, as clowns. Children with violins, children with trumpets, child-clowns who sing and dance around me. Children tender as sprouts, as flower buds, children that suck out the evil humors, the bad blood, the morning's dew. The bird that sucks out illness, the good hummingbird, the wise hummingbird, the face that cleans, the face that heals.

María Sabina has never visited Santa María Tonantzintla but do not her words fit that church's delirious *décor*? We recall how in the *velada* María Sabina and her daughter María Apolonia kept singing of the many 'children', ^{ʔ}*nti*^{1}*xti*^{3}, of the 'clowns', *sa*^{4}*se*^{1}.

Pedro Rojas says of the interior of Santa María Tonantzintla words that echo María Sabina's conception of her romping children:

> Niñitos y flores y más niñitos aparecen por doquiera... Es un espectáculo hecho de jardines de niños. Y a todo costo, porque acuden tantos actores que donde no se ven ángeles y amores es porque aparecen caras y más caras y hasta máscaras... Ahí está Tonantzintla con tantos niños y flores que con palabras cantan unos la flor de la vida y otras la vida en flor.
> [Pedro Rojas, *Tonantzintla*, UNAM, 1956, pp 33, 40]
>
> Little children and flowers and more little children appear wherever you will.... It is a pageant of gardens of children. And at whatever cost, for so many actors hasten hither that where angels and winged children are not seen it is because faces and more faces and even masks appear.... There stands *Tonantzintla* with so many children and flowers that in words the children sing of the flower of life and the flowers sing of life in flower.

All these children of Santa María Tonantzintla, who are they? Who but the 'children' of María Sabina's chants and the Benítez interview with her? In her talk with Alberto Ongaro, already cited, she also stressed the 'children' that are the spirits of the mushrooms. Signor Ongaro told me that in Huautla a second shaman (whose name he could not recall) emphasized the same theme. Who are these children but the *a-pipil-tzin*, the 'little children of the waters', of Marina Rosas, the shaman of Aztec lineage, living on the slopes of Popocatepetl a day's walk from Tonantzintla?

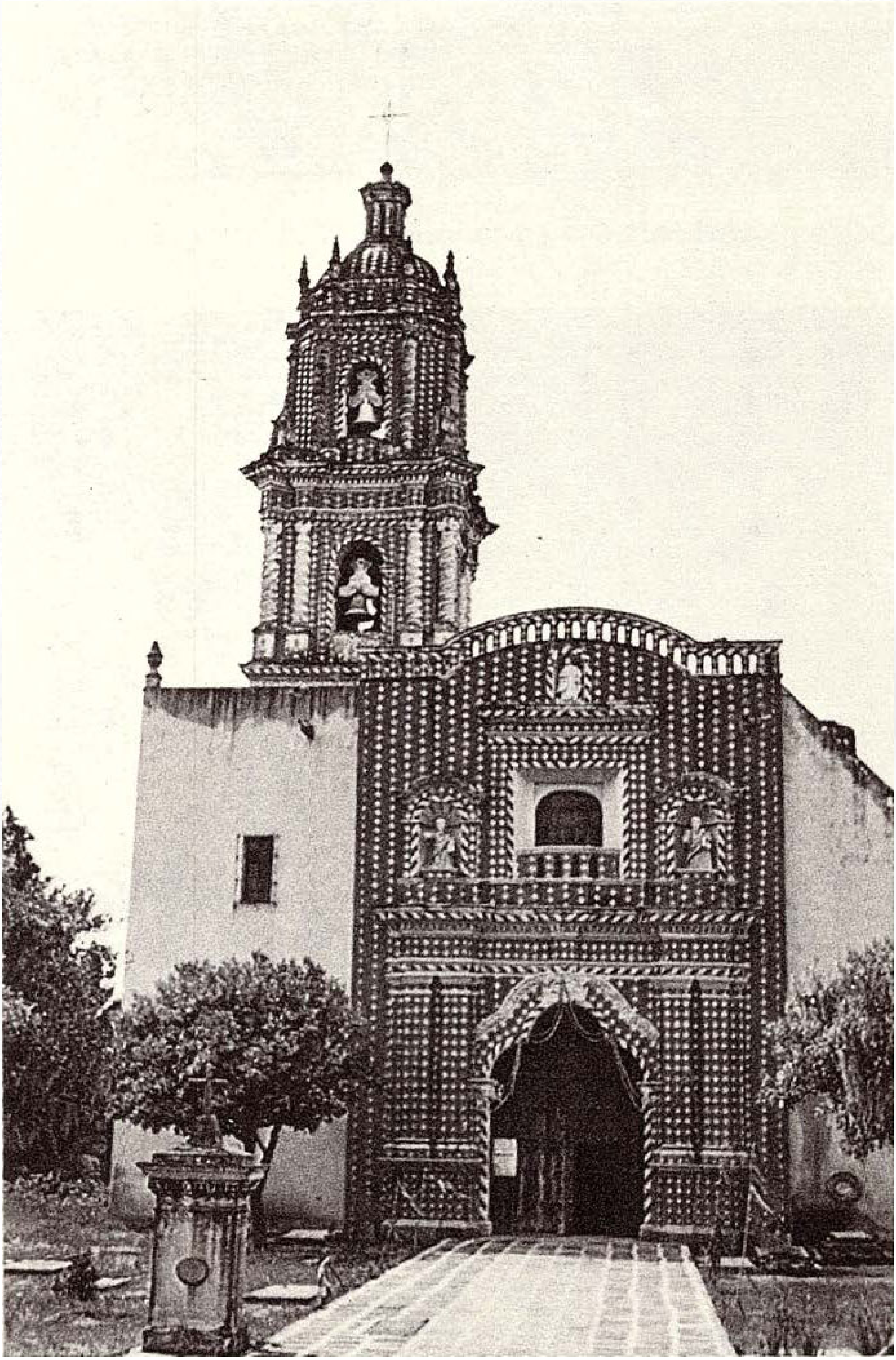


Fig 1 Parish Church of Santa María Tonantzintla near Puebla

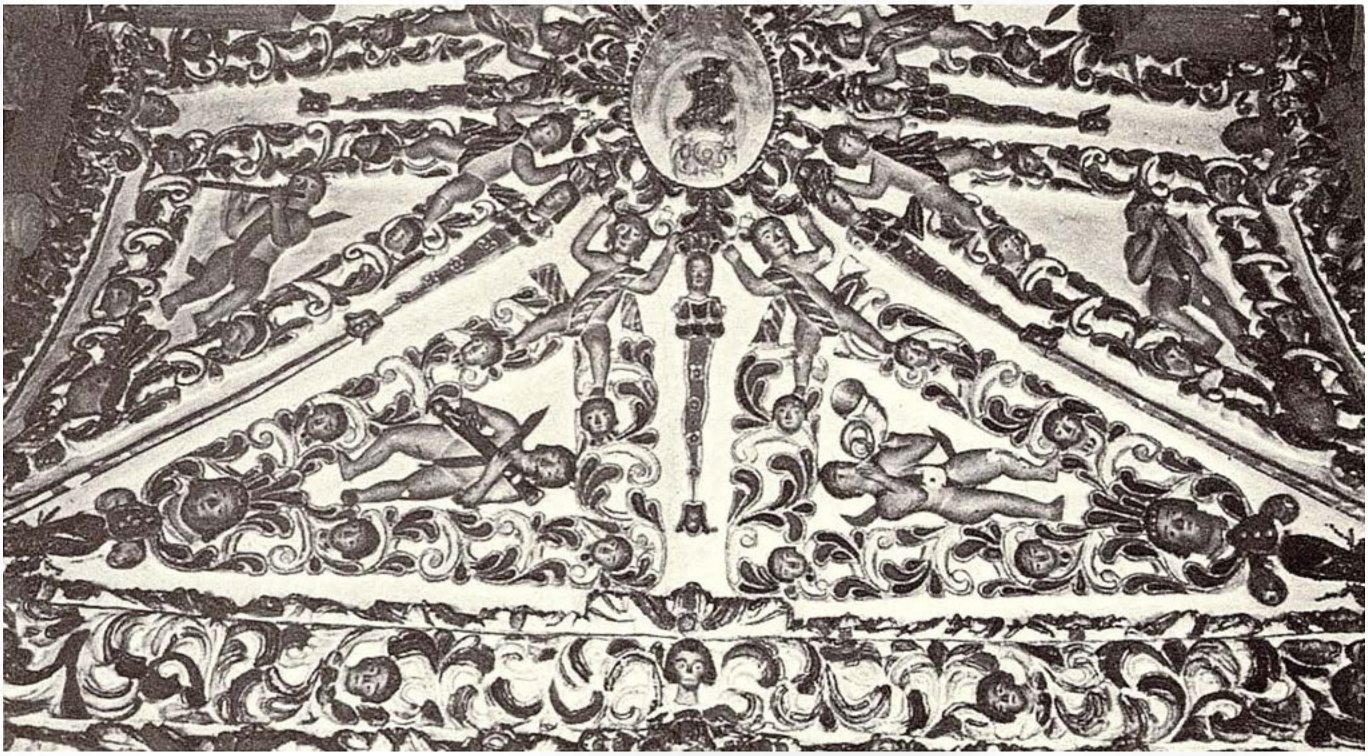


Fig 2 Children's Orchestra on Ceiling beneath Choir Loft in Narthex of Church

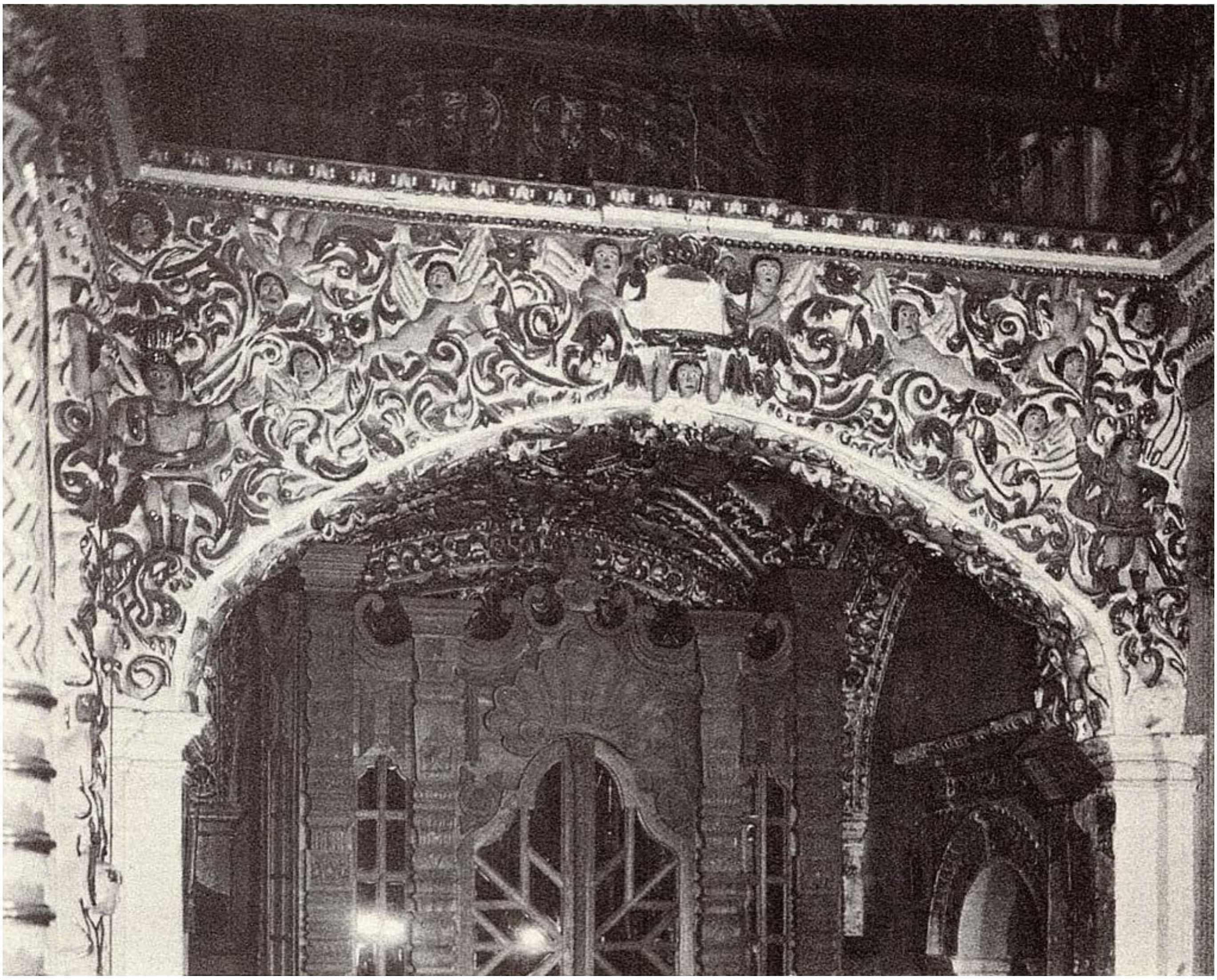


Fig 3 Archway under Choir Loft

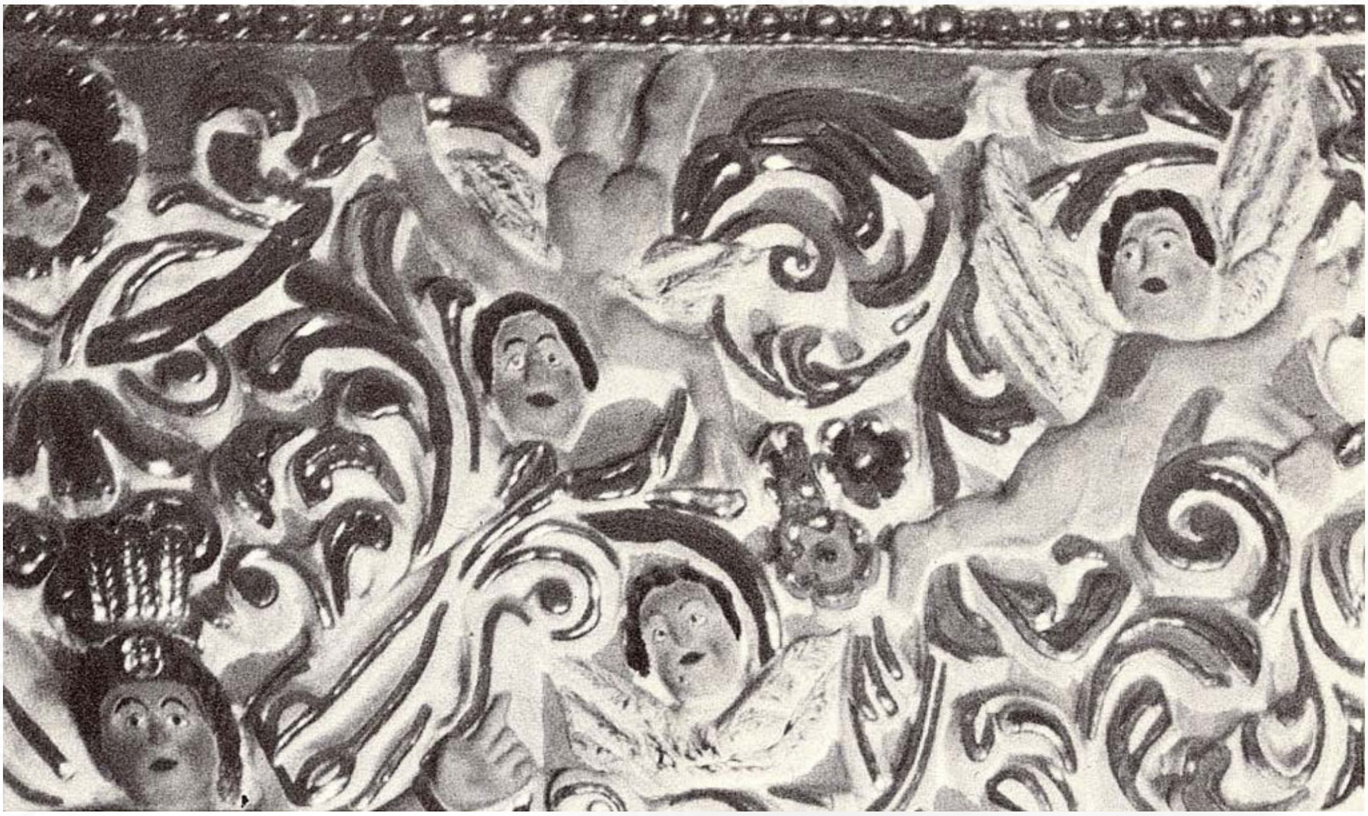


Fig 4 Detail of Archway

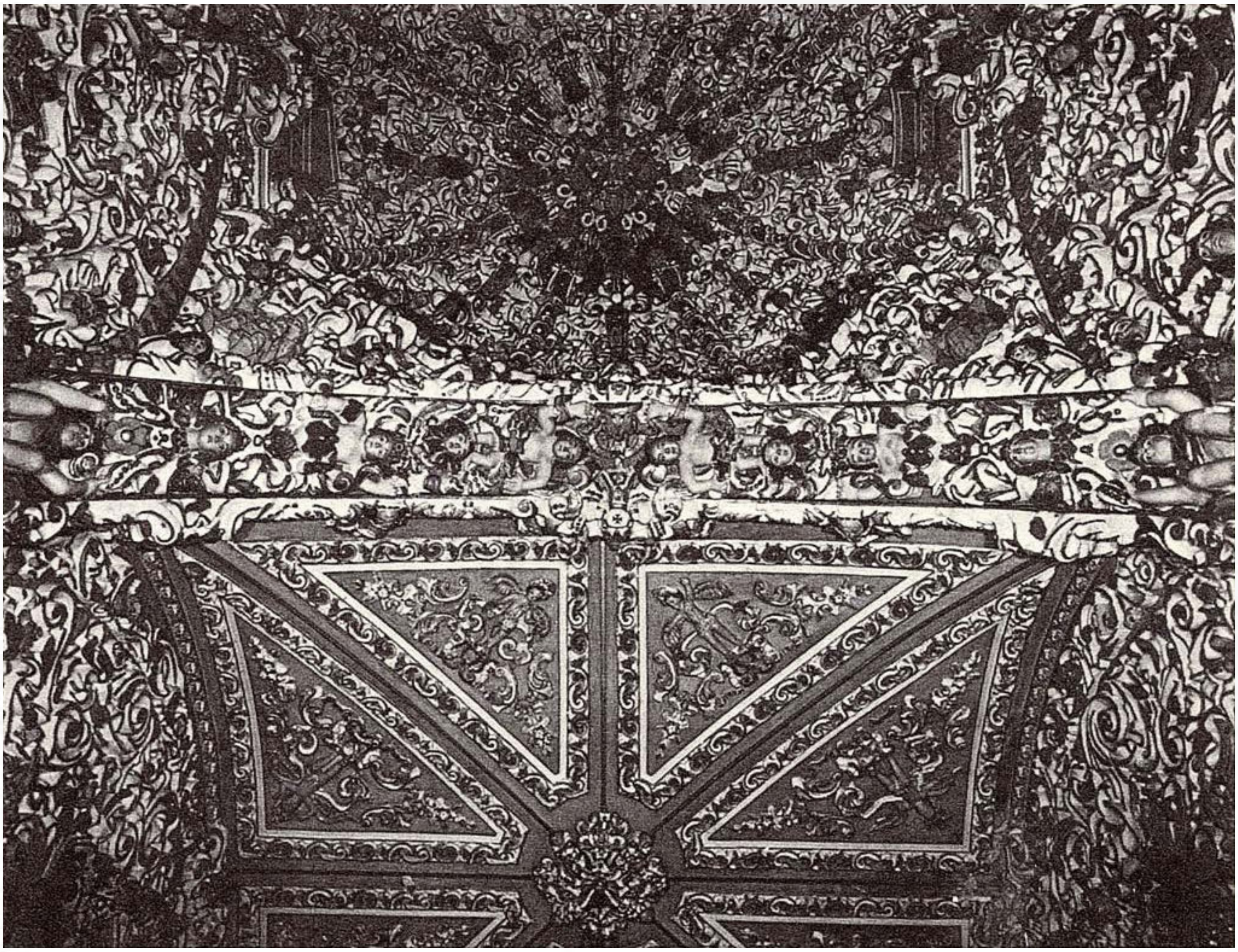


Fig 5 Arch leading from Nave into Crossing

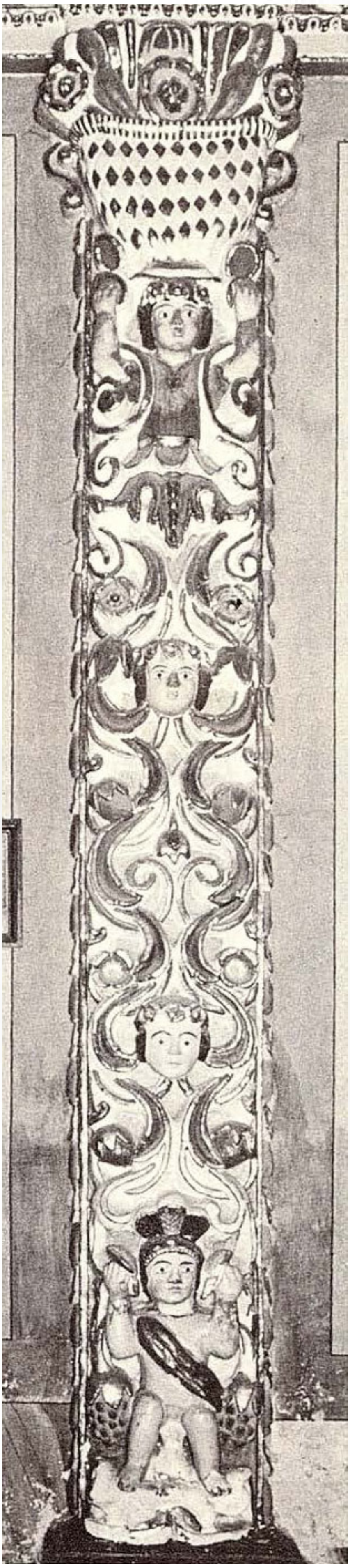


Fig 6 Pilaster, north side of Nave

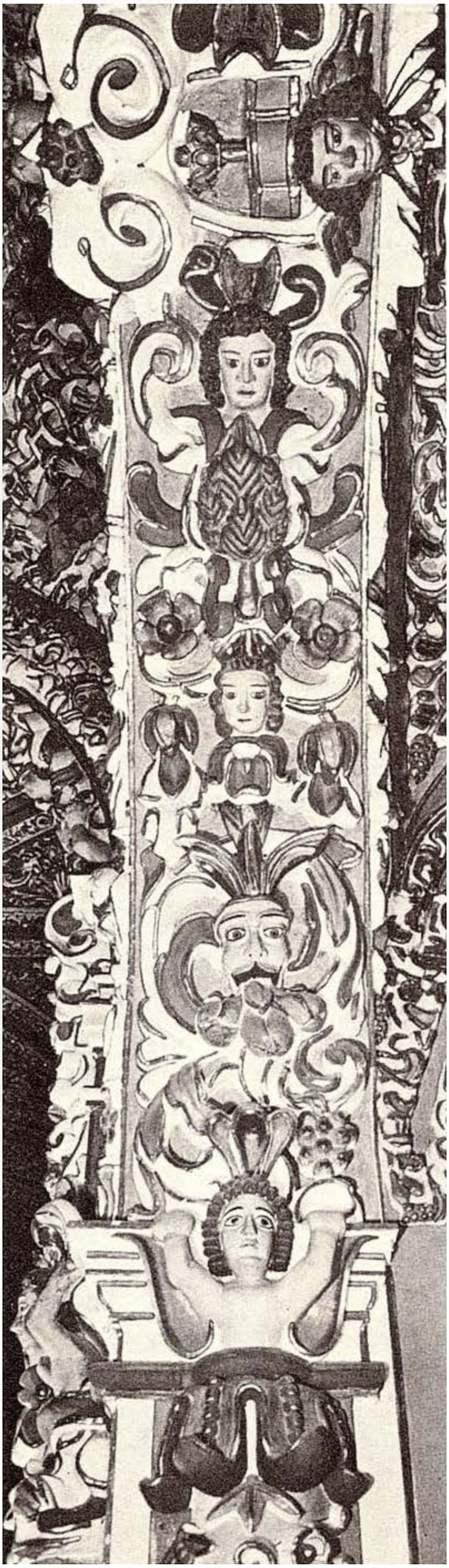


Fig 7 West side of arch leading into North Transept

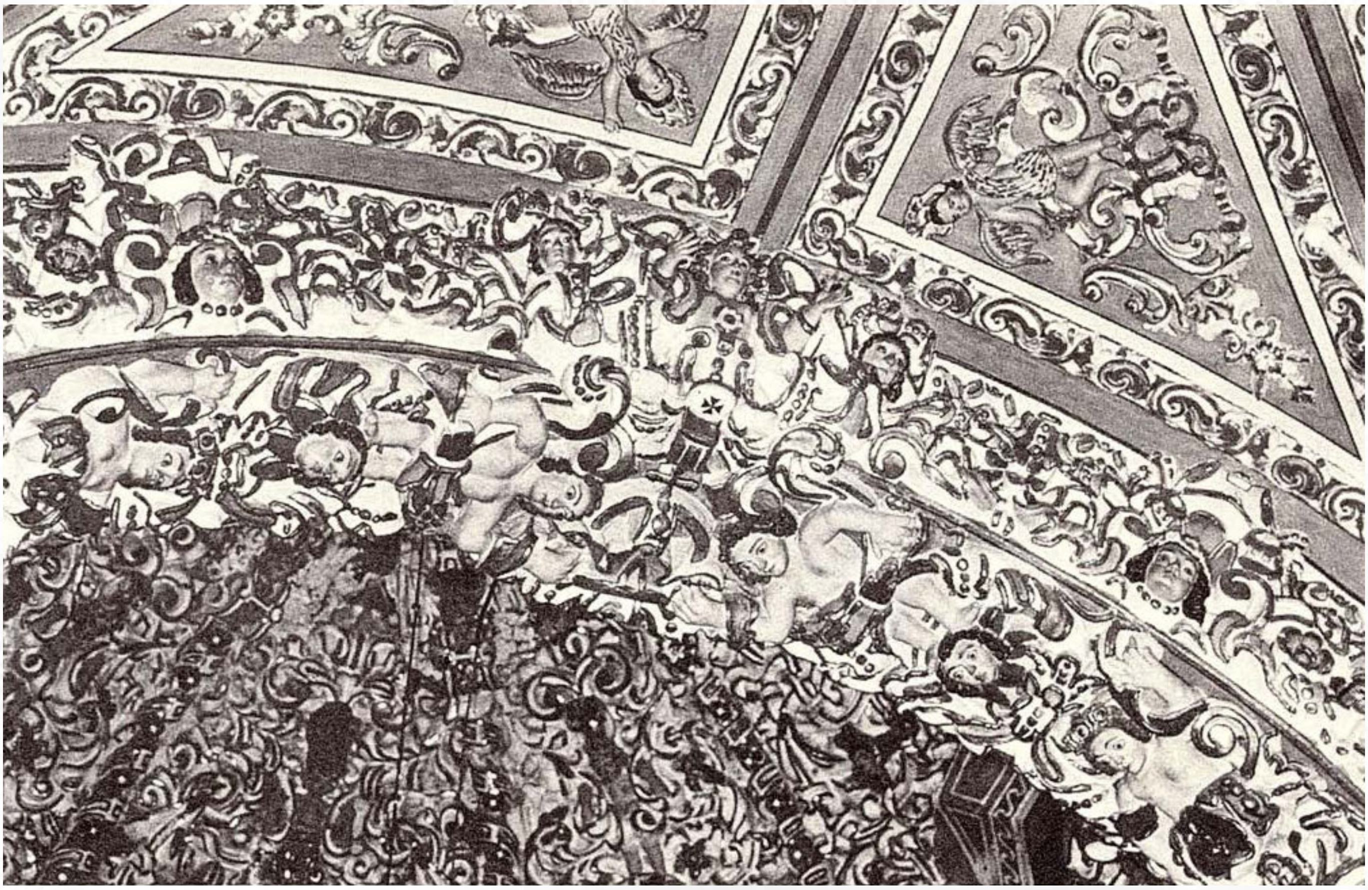


Fig 8 West side of arch leading from Nave into Crossing

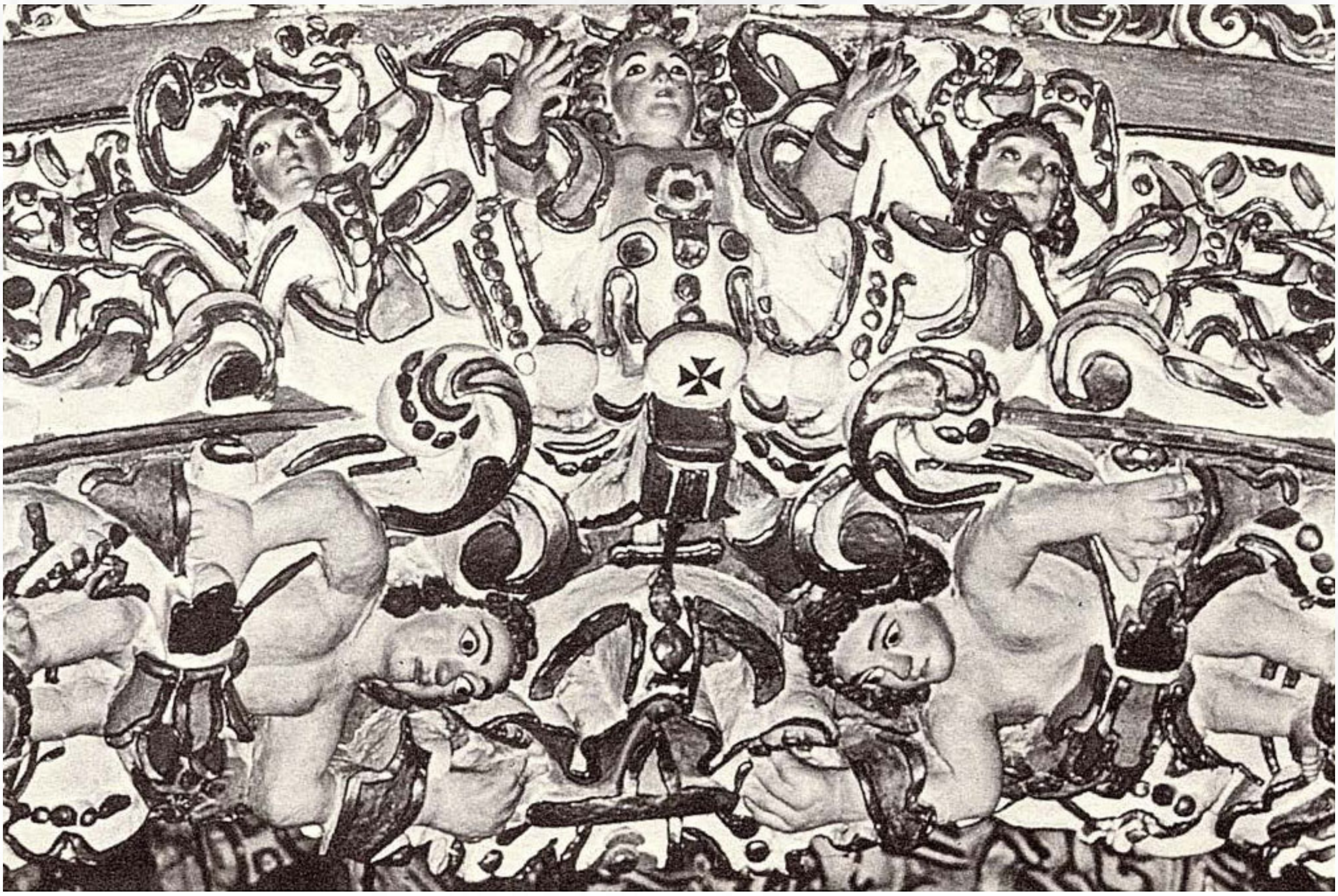


Fig 9 Detail of same: Child Preacher Expostulating

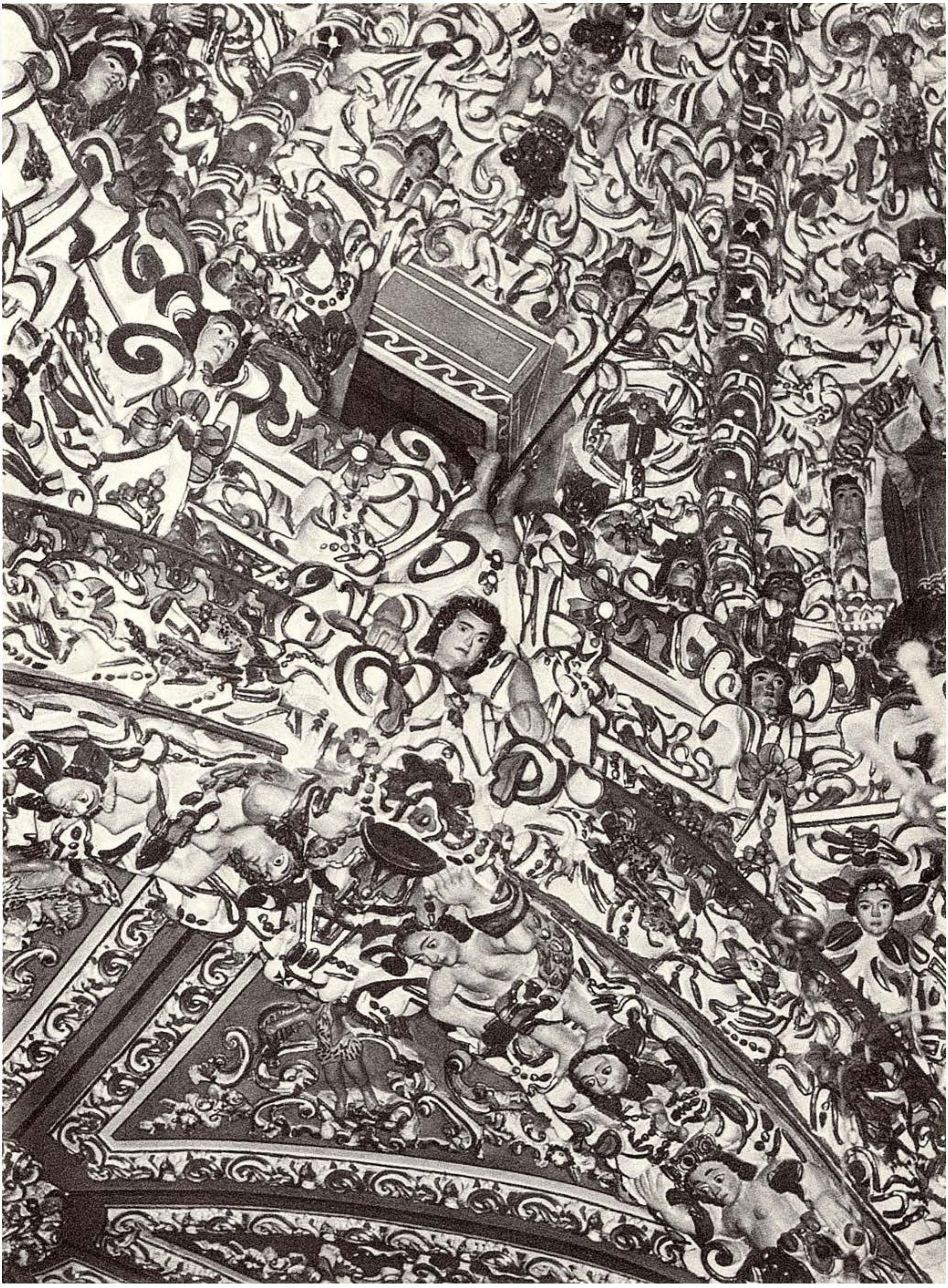


Fig 10 View facing west from Altar steps of ceiling with figure of Plunging Youth

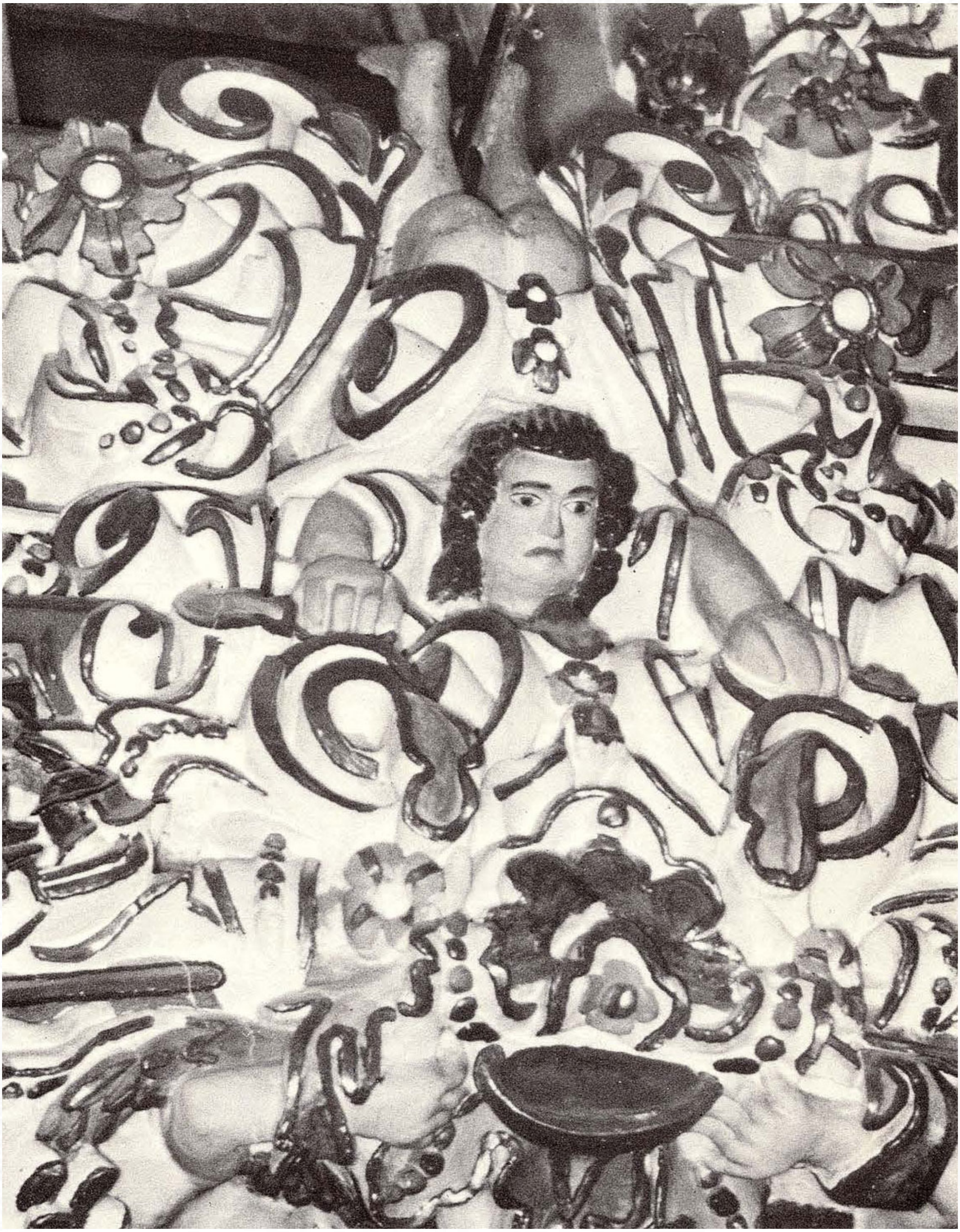


Fig 11 Detail of Same: Plunging Youth

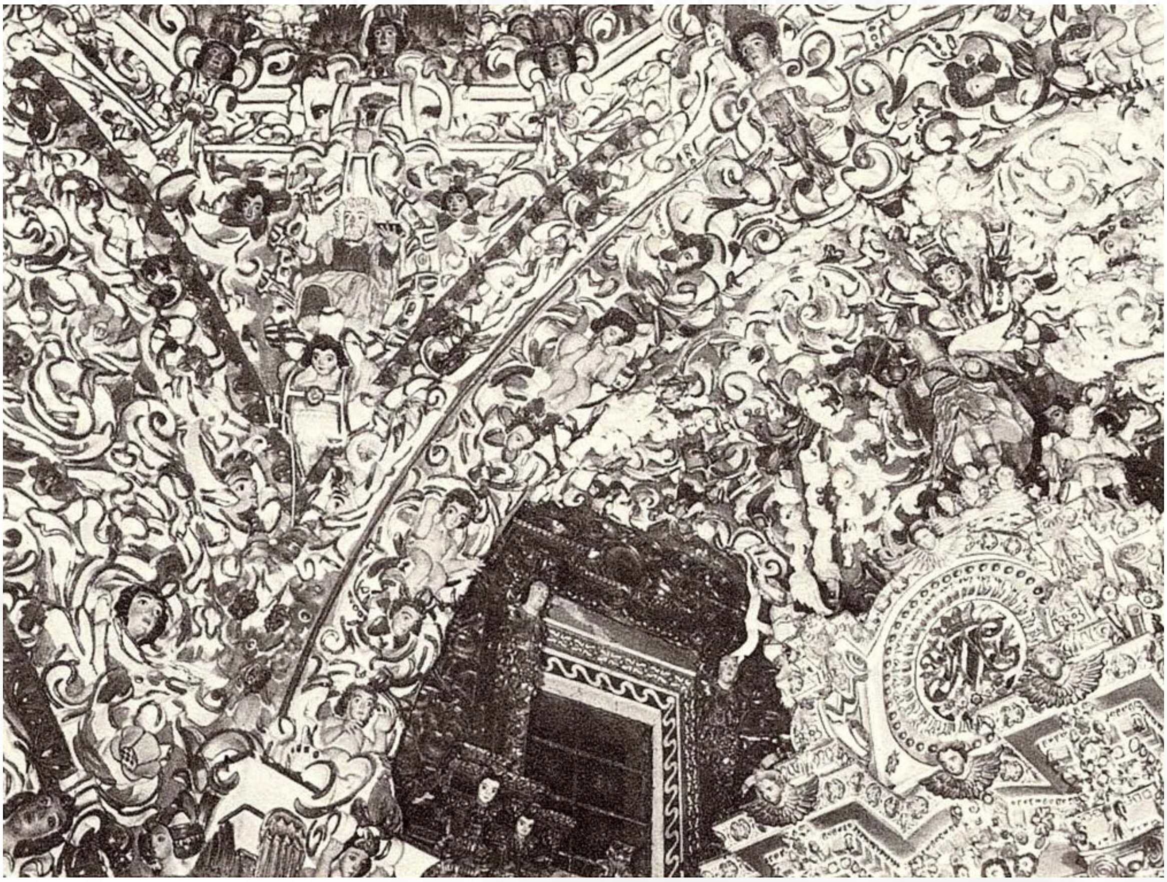


Fig 12 View of Archway and Ceiling, looking North and East from Crossing. St. Mark is Figure in Blue

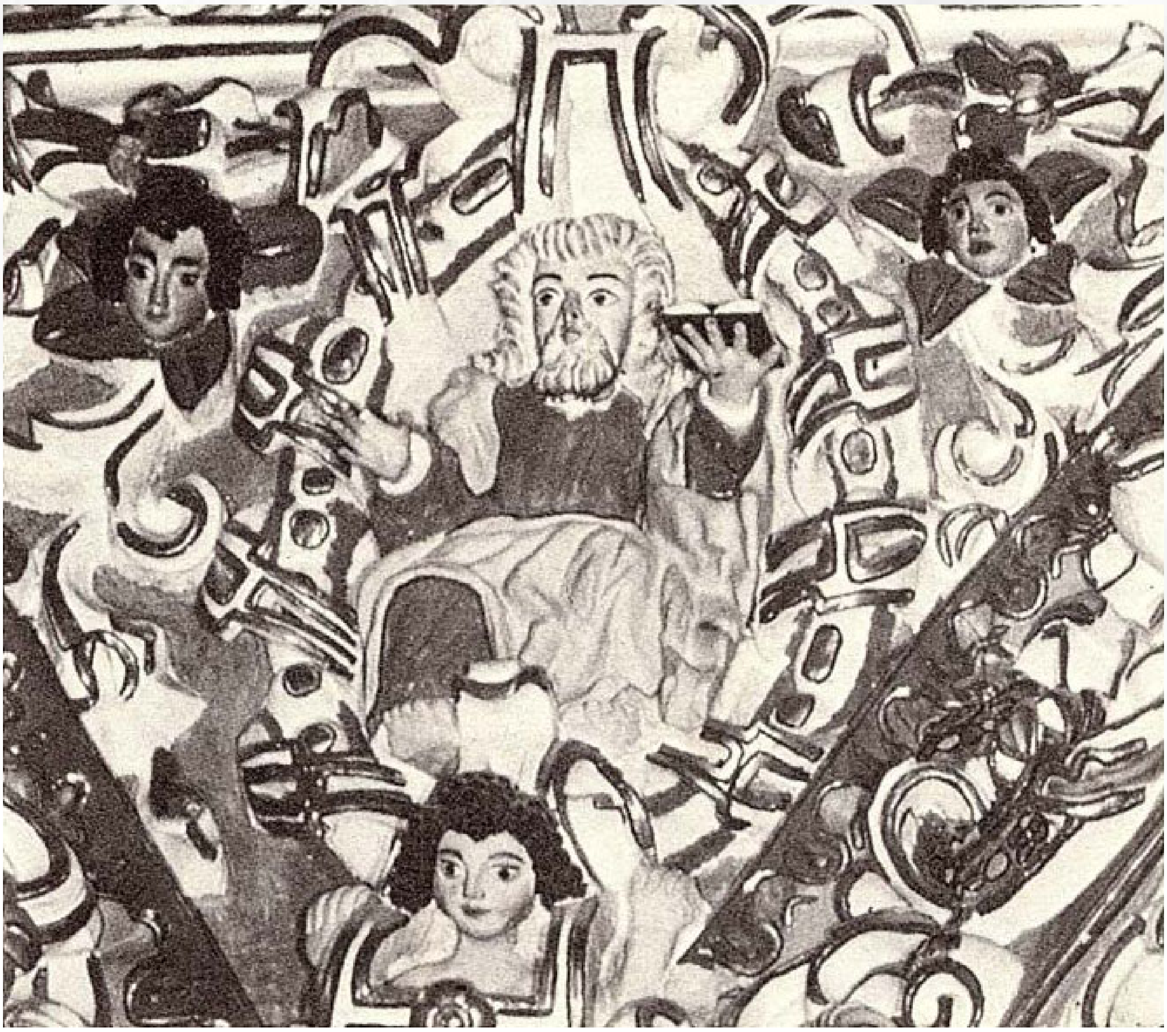


Fig 13 Detail of above: St. Mark the Evangelist

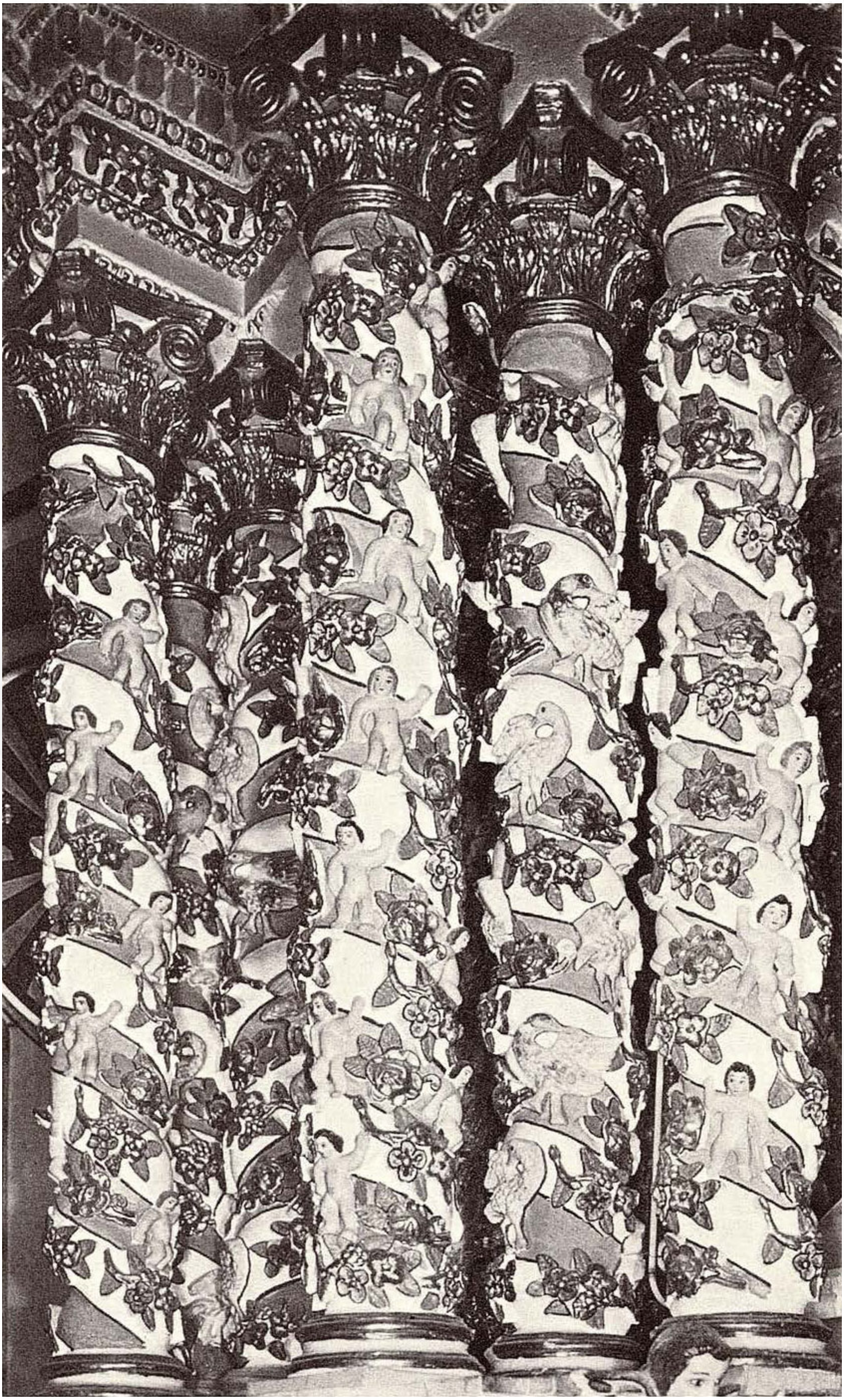


Fig 14 Six columns supporting north side of Ciborium

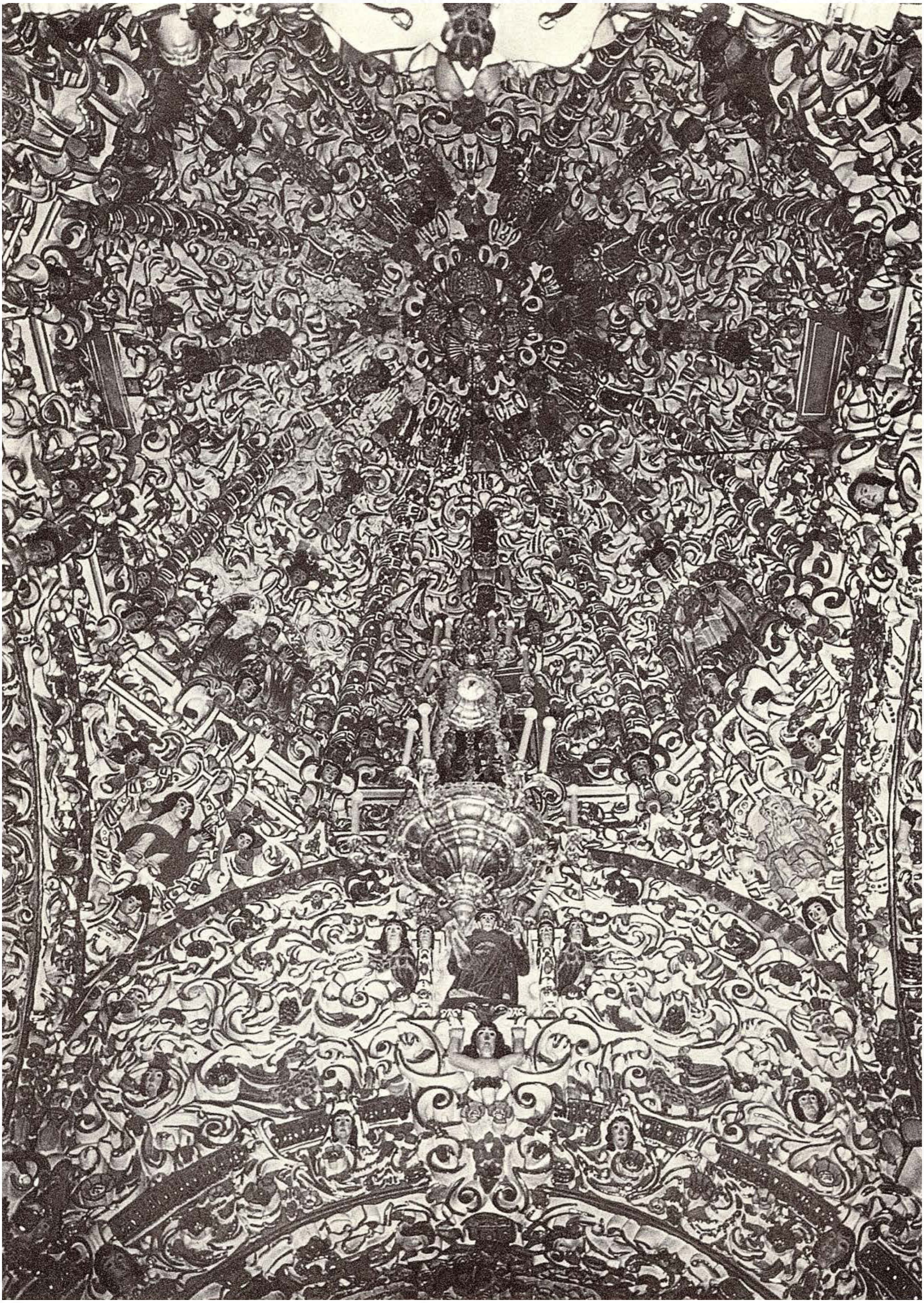
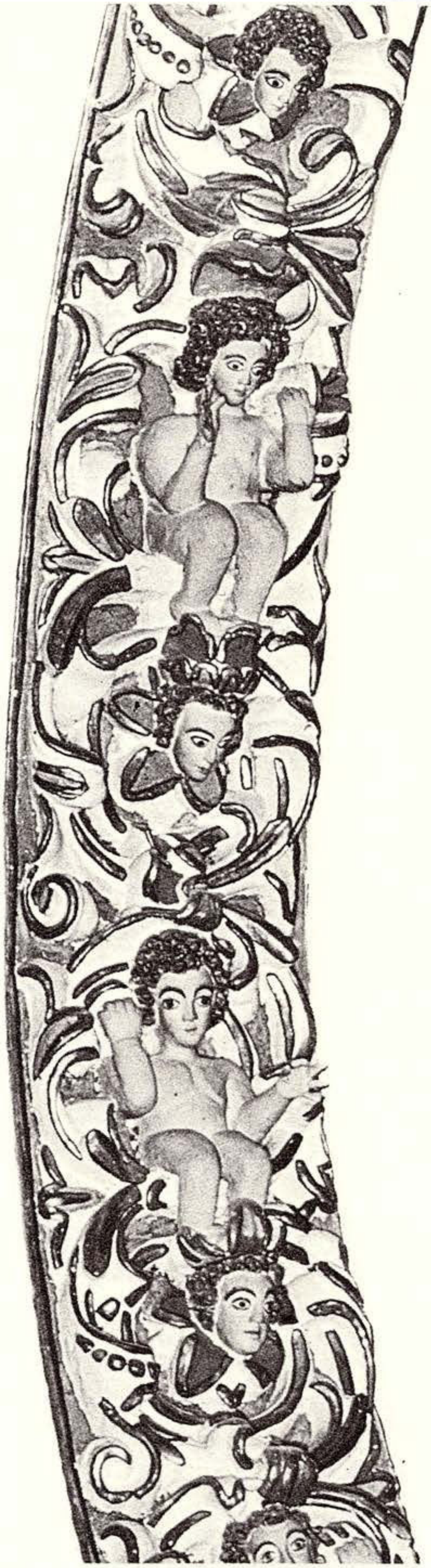


Fig 15 View of Cupola and Ceiling of South Transept



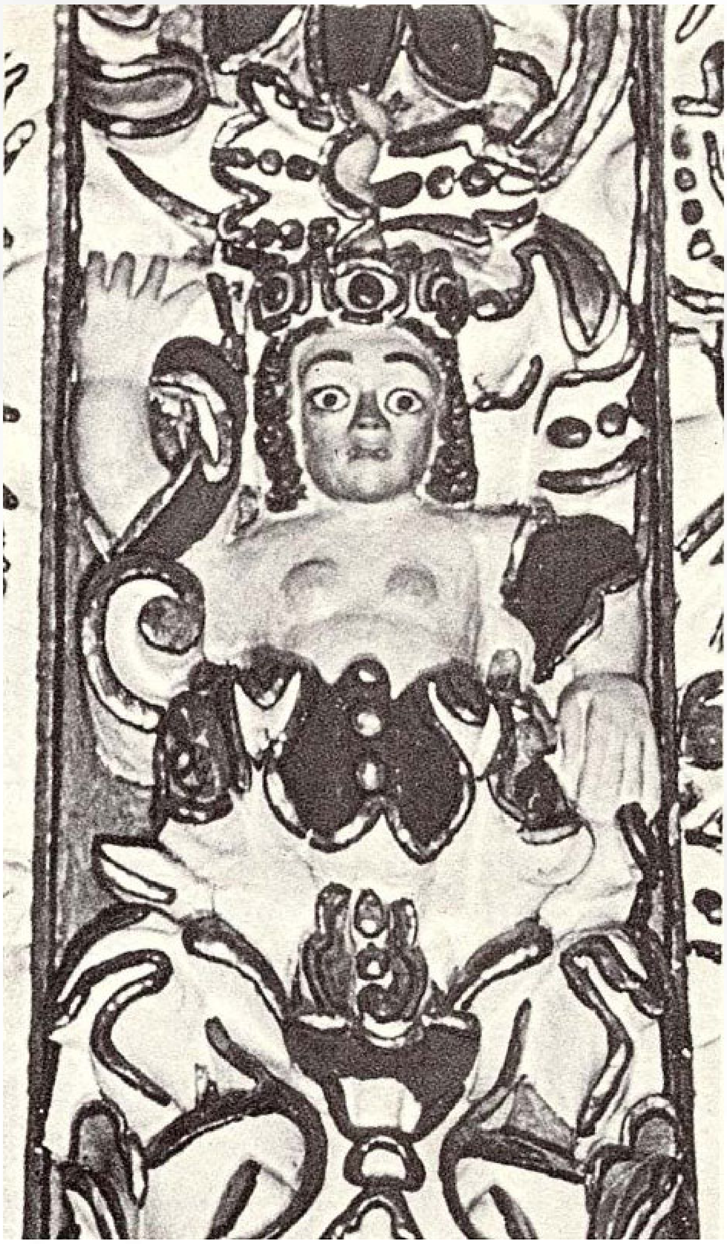


Fig 16 Children carved in arch (North Half) leading from Crossing into Sanctuary

Fig 17 Detail, one of several girls carved in Arch leading from Nave into Crossing

Let us carry our inquiry into the 'children' of Tonantzintla further. In the Christian tradition angels, seraphs, cherubs, are all male, reflecting the male-oriented culture that is dominant with us. But in Santa María Tonantzintla little girls with budding breasts bared to the world are there along with the naked boys. We may assume that among the children who are clothed there are girls and boys. In Tlanixco, a Nahuatl-speaking community on the other side of Mexico City near Tenango del Valle, the entheogenic mushrooms are called *siwatzitzintli*, a word meaning 'little women' and conveying a feeling of affection and respect. In Spanish they are *mujercitas*, *señoritas*, or *niñas*, and sometimes the Spanish words are used when the village folk speak in Nahuatl, the hispanicisms nowadays coming natural to the villagers even when they use their native tongue. In June 1960 I taped a discourse in Nahuatl on the sacred mushrooms in Amatlán de los Reyes, Veracruz, by the informant Felipe Reyes F., 60 years old, and when the text was translated by Luis Reyes G., we find the 'young people' answering the questions put to them by the shaman. In a footnote to the translation Luis Reyes, a Nahuatl speaker himself, adds this comment in Spanish on the youths who appear:

> These youngsters in other contexts are called *xocoyome* and they dwell in Tlalocan with Tlaloc and his wife. They are children who die unbaptized and for that reason go to Tlalocan and there become blue in color. They hold in their hands snakes that serve as whips to drive the clouds. By another name these children are known as Lightning Bolts.

But these figures of speech are not confined to the Mazatec and Nahuatl worlds. In my early Mesoamerican peregrinations I did not know enough to inquire of my informants and shamans about the 'children': they are probably present wherever entheogens are used. In the Zapotec country, Thomas MacDougall reported in 1960 that after the inebriating seeds of the morning-glory are taken, and where silence and solitude reign, the *badu-win* (two little girls) appear dressed all in white to reply to the questions that are put to them. Arthur Rubel has said that in the Chinantla in 1971, when he attended his mushroom session, 'little people' answered the questions put to them by the shaman. They are *chamacos* ('children') of both sexes but are small, of the height of the mushrooms themselves.

Perhaps a related association with children is found to this day in the Mixtec culture: the sacred mushrooms were formerly gathered just as day was breaking by *doncellas* ('maidens', 'virgins'), and even now the mushrooms are still ground on the *metate* by *doncellas*. We learned all this when we visited the Mixteca in 1960 with Robert Ravicz. In outlying *rancherías* of the Mixteca it seems likely that even now *doncellas* still gather the mushrooms on the dewy mountain slopes as the sun is about to come up.

María Sabina's *velada*, sung in the depth of night in the distant mountains of the Mazatec country, turns out to evoke responsive chords from diverse quarters of the Mesoamerican world and far beyond, even to the far reaches of the Siberian forest belt, where the 'fly-agaric girls' respond to the shaman's summons. They answer questions and play all sorts of tricks.

The artisans of the parish of Santa María Tonantzintla conceived the design of their church in the second half of the eighteenth century and work on it continued until around 1900. Over this long period the unity lay not in a plan laid down by some famous architect but in the continuing conception of their church held by the community. When the work began, all over Mexico the prestige of the style of architecture known as Churrigueresque was at its apogee, and a supreme example of this extravagant variation on the baroque is to be seen in the Capilla del Rosario in the Church of Santo Domingo in Puebla only a few miles away. We may safely assume that the parishioners of Tonantzintla were familiar with what was going on in this famous *capilla*. There also *angelitos*, cherubs and seraphs, are scattered about, their faces peering forth from nooks and crannies, many flying through the air usually with wings. In the Capilla there are differences, however. The figures are less numerous and they look alike, bland, devoid of expression, repetitive. (Perhaps the craftsmen were paid by the piece.) Here indeed we find 'cherubim and seraphim' who 'continually do cry, "Holy, Holy, Holy"' in a boring Christian heaven. In Tonantzintla every child is bursting with joy each in his own way, excited, gesticulating, addressing the onlooker wholly absorbed in the astonishing pleasure of living. There are fewer of the figures with the conventional wings of European style. The Churrigueresque of the Capilla del Rosario certainly put ideas into the heads of the Tonantzintla parishioners, but then they stretched those ideas to the limit.

When we took our photographs of Santa María Tonantzintla we dealt with the lay officials of the church whose names spoke for their Nahua origin: the *Jefe de Iglesia*, Fiscal Amado Moyd, the *Mayordomo* Onésimo Teconquey, the *Segundo-Teniente* Crescencio Topia, the *portero* Cecilio Ixmoyotl. They informed us that the old people thereabouts still spoke *mexicano* (Nahuatl). Down through the nineteenth century Nahuatl must have been the tongue of everyone.

In that eighteenth century generation of luxuriant ecclesiastical architecture the Nahua of Tonantzintla must have felt safe in expressing heretical concepts when decorating their church. But were they even aware of their heresy? As in María Sabina's mind, were not the two streams of religious tradition already thoroughly blended and did they not do honor to the Virgin Mother by expressing their reverence for the *Santo Niño* plunging headlong into the center of her temple?

We have linked her *velada* with the thinking and feeling of the shamans of the Nahua, as preserved for us in Ruiz de Alarcón's treatise, rendered into Spanish by the distinguished Nahuatlato Alfredo López Austin. María Sabina fills out with flesh and blood the interpretation of Santa María Tonantzintla that had been adumbrated by Francisco de la Maza and fully developed by Pedro Rojas. Her world of the entheogens, gay with creatures and flowers, is peopled with the same order of little sprites that are equally active in the vast reaches of Siberia, where the 'little girls' evoked by *Amanita muscaria* play the rôles that we know are also elicited by the species of Psilocybe of Mexico. Her extraordinary world completes with eloquence what we are already perceiving among the Nahua, the Otomí, the Mixtec, the Zapotec, the Chatino, the Mixe, the Matlatzinca, and the Chinantec. She clothes with rich vesture what were little more than the dry bones of their vocabularies for the entheogens.

★

Listen now to this: Pedro Rojas is baffled by a theological enigma. Occupying a key position in the church is a figure that has no Christian interpretation. Our Lady is enshrined, and properly so, in a ciborium that rises above and behind the altar. Directly in front and above Our Lady, at the peak of the dome of the crossing, is the Holy Ghost naturally embodied in a dove. This dove turns his head to the entrance of the church, and is regarding the conspicuous figure of a naked youth plunging head down, back towards us, over the key to the arch of the crossing that leads to the nave. The head is framed with black curly hair. The large size of this figure and its conspicuous location rule out the possibility that we have here a purely decorative motif. A puzzle in Christian iconography, as Pedro Rojas freely declares.

In the parish church of Tonantzintla the 'little children' are scrambling, scampering, all over amidst the fruits and flowers. These *niños* are gesticulating to us, those yonder are trying to explain to us and we almost catch their voices, others are climbing the walls, crossing the arches, swimming in space, flying through the air, all over the inside of the cupola or dome, even up the columns that embrace the ciborium high above and behind the altar. The figure plunging head down that baffles Pedro Rojas is surely the leader of this band, this rout, of children. True, he is not to be reconciled with Christian iconography. But need we confine ourselves in this superb church to Christian iconography? Is he not the 'young, well developed man' of María Sabina's chant, whom she, by an act of religious syncretism has identified with Jesus Christ? Here is the *Príncipe niño* of the Nahuatl world, the Child God of Mesoamerica, the divinity known to the Nahua under various names:

Pilzintecuhtli, or *Teopiltzintli*, or
Piltzinteotl, or *Piltzintli*,

all of them embodying a different aspect of Xochipilli. But today he is also, surely, the Santo Niño de Atocha of María Sabina's *velada*, the Sacred Mushroom, and we discover him as captain of the romping children, the world of the 'dear little people' of the entheogens. In Santa María Tonantzintla even the Evangelists are young. They are bearded, to be sure, but are not grave and venerable oldsters weighed down with their assignments. Their beards are neatly groomed, their garments clean and tidy. They are in their early thirties.

Here then we find the solution to Pedro Rojas' theological enigma: in this Christian Church, dedicated to the Holy Mother of God in our Christian religion, the Holy Child, the Child God, receives equal honor with her. The Holy Child is the Child Piltzintli of the Mesoamerican pantheon, surrounded on all sides by his supporting cast of 400 joyous boys and girls, he himself being the young Sun God, the God of Springtime, of light and warmth and flowers and butterflies and hummingbirds, of music and dancing and song, of the Tree-in-*Flower*, yes of Ecstasy, the god of the miraculous entheogens, the Master of the Divine Revels of Santa María Tonantzintla. The answer to Pedro Rojas' riddle lies in the pre-Conquest pantheon of Mesoamerica.

★

I have reserved until now evidence of a nature to speak only to those who have experienced and are familiar with the divine inebriation of the mushrooms, of *teonanácatl*.

The folk art of Santa María Tonantzintla testifies admirably, in an unexpected way, to the truth of my thesis that it was inspired by the entheogens. Most of the children are blonds, obviously not Indians. Those who ingest the mushrooms do not see what they see in everyday life. They see life immeasurably enhanced, transfigured. They enter into a supernal world that is normally on the subliminal fringes of their consciousness. Of course the Indians would not see Indians. They see (as Henry Munn puts it) important people, high class people, people with power. These people are white, *gente de razón*, *gente güera*. (In Mexican Spanish *güero* has come to mean 'paleface'.) This conception may go back to pre-Conquest times: Quetzalcóatl, the banished god, was to return some day from the East and it is said that Montezuma expected him and his fellows to be white. Here is one of the meanings conveyed to this day in Huautla by that extraordinary multifaceted word of exaltation, ^{2}*nti*^{1}*chi*^{3}*con*^{3}, 'white', the lords and masters of this world, the ultimate in Mazatec terms of enhancement.

Only those who are at home with the mushroom experience are in a position to feel how securely this throng of white children in the Church of our Little Mother of Tonantzintla favors our interpretation.

The Nicho de Hueyapan

In the vicinity of Tonantzintla, within a radius of ten miles, there are churches innumerable, mostly today in ruins. Cholula was a center of religious devotion in pre-Conquest times, and throughout this rich agricultural valley the same devotion prevails today, though the Indians have changed their religion. Yet of all the churches only one other bears a few carvings that are unmistakably of the same inspiration as Santa María Tonantzintla: San Francisco Acatepec, about a mile away on the highway from Mexico and Puebla to Oaxaca.

But Gutierre Tibón has lately drawn my attention to another cluster of carvings of children, markedly different from Santa María Tonantzintla, though in the same lively and highly individual style. They adorn the Nicho de Hueyapan, executed in 1828 by the anonymous Master of Zacualpan. (The date is consonant with Santa María Tonantzintla.) The Nicho was removed from its Church in Hueyapan to the Museo de Cortés in Cuernavaca almost ten years ago. Many of the older inhabitants of Hueyapan still speak Nahuatl and they occasionally go on pilgrimage to Cuernavaca to visit their Nicho. I do not suggest that the Master of Zacualpan was influenced by those who were embodying their conception of Paradise in the children of Tonantzintla. But for his inspiration was he not drawing on the same reserve of winning 'small fry' that we have seen in Tonantzintla and have felt in the words of María Sabina?

As this Nicho de Hueyapan deserves far more attention than it has received, I offer some views of it in Figures 18 to 24. The artist's conception of St John the Evangelist as a lad in his teens (Fig 19) is perhaps unique. In these children, if I am right, is another instance of the happy synthesis of Christian and pre-Christian feelings.

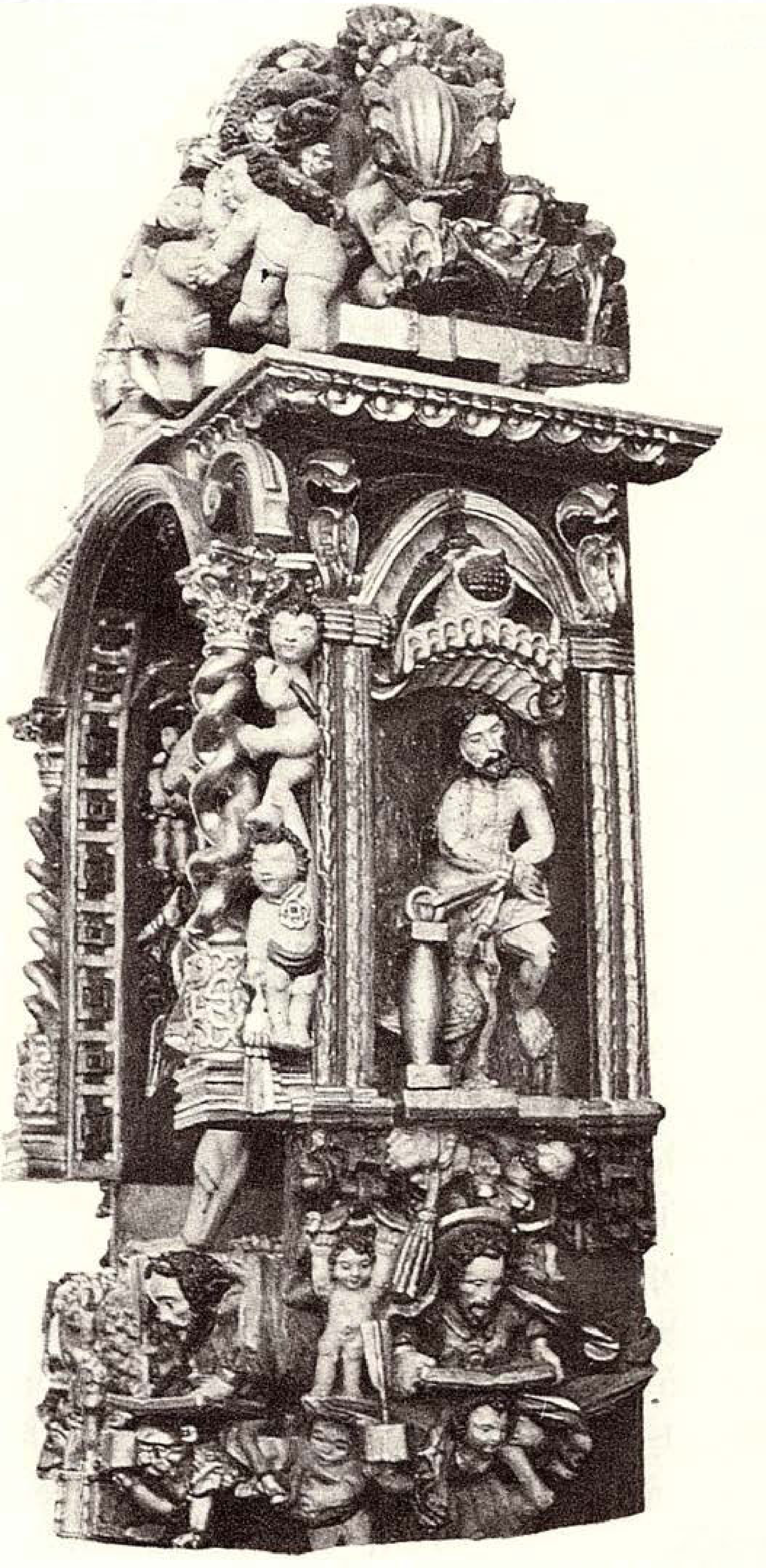


Fig 18

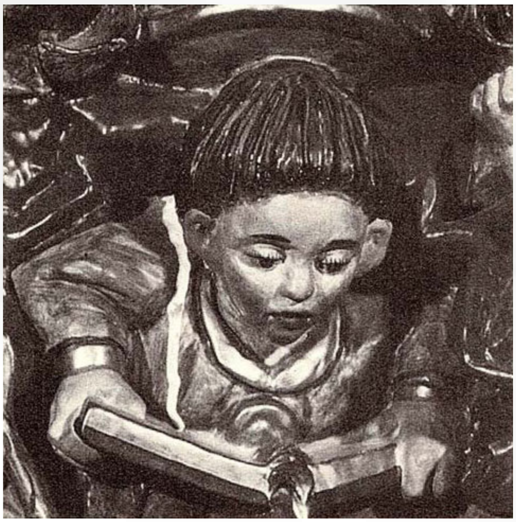


Fig 19

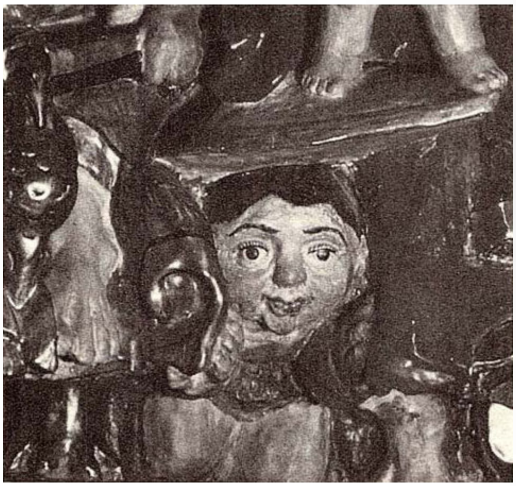


Fig 20

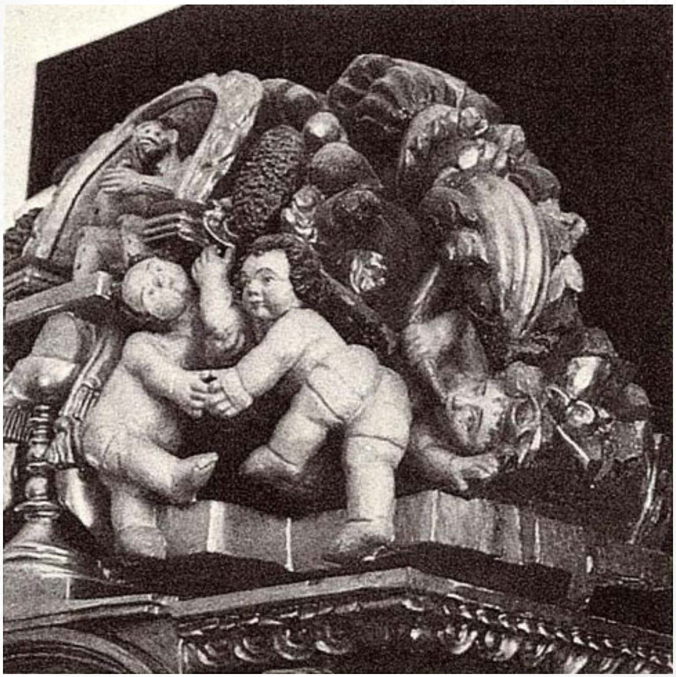


Fig 21

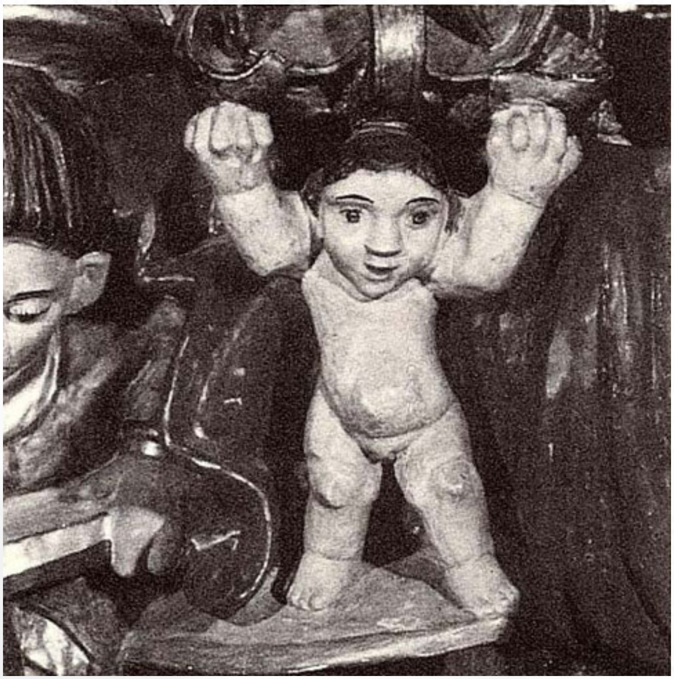


Fig 22

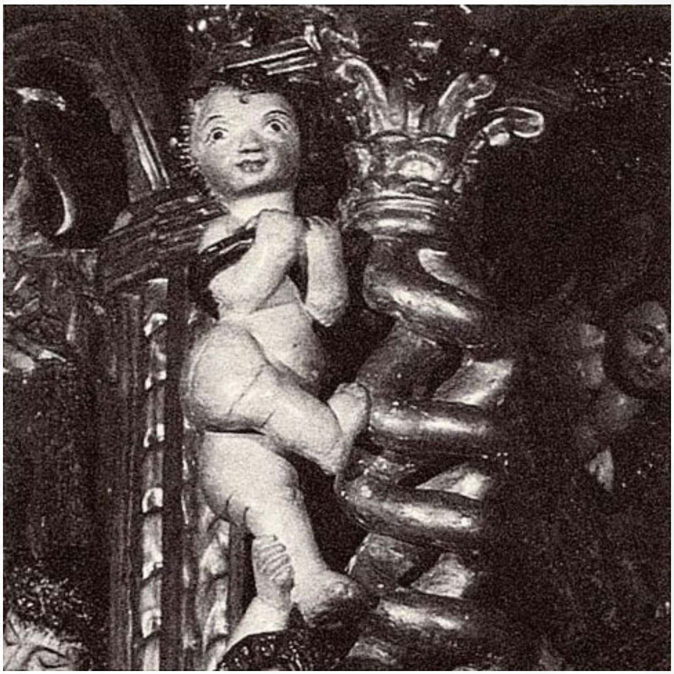


Fig 23

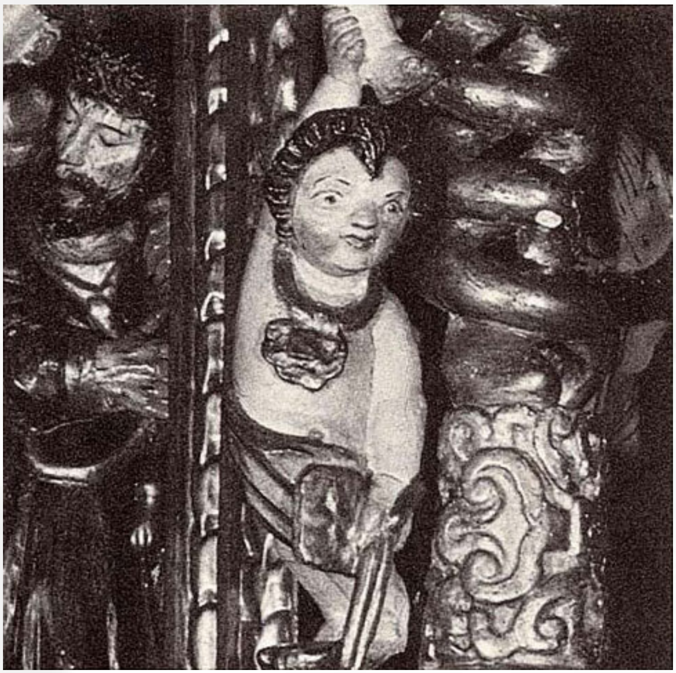


Fig 24

Santo Niño de Atocha

In his *Historia del Nombre y de la Fundación de México*, Gutierre Tibón cites a tradition preserved for us by Fray Antonio Tello (one of the less read early friar chroniclers) that it was the child god Teopiltzintli who guided the Aztecs, somewhere between the third and sixth centuries, on their migration from their ancestral home of Aztatlan ('Aztlan' in today's spelling) to their new site of Santiago Ixcuintla in what is now Nayarit. Here is Tello's text:

> … y el dios que adoraban era una estatua, hecha á manera de un hombre, al cual llamaban Teopiltzintli, que quiere decir nino dios, que es él que guió á sus antepasados cuando los trajo de Aztatlan para que poblasen aquellas tierras; á éste le ofrecían cuentas, conchas y algodón, no le sacrificaban gente, como en otras partes hacían a otros ídolos; sólo le adoraban é incensaban.

> … and the god that they worshipped was a statue, made in the manner of a man, whom they called Teopiltzintli, which means 'child god', who is he who guided their ancestors when he brought them from Aztatlan for them to populate those lands; to him they offered beads, shells

> and cotton; they did not sacrifice people to him, as was done elsewhere to other idols. Only him they worshipped and to him offered incense.

Knowing as we do that the 'Child God' of the Nahua was the spirit of the entheogens, we find him here exercising his proper rôle as the divinatory scout selecting the spot for the new home of his followers. I will now suggest that the Holy Child of Atocha embodies in the Christian era the Child God of pre-Conquest times, the Child God known in Nahuatl under various closely related names. We shall call him Piltzintli.

In the Indian country of Mexico everyone knows the Santo Niño de Atocha but in the villages I have never found anyone, whether Indian or *mestizo*, who could explain what 'Atocha' meant. Often the word is deformed as *eg* 'Antocha'. In the Spanish of Spain *atocha* is a tough esparto grass from which brooms are made, and 'Antocha' as a place name was an area just outside of Madrid where that grass grew in abundance. (Madrid has long since absorbed this *barrio*.) Since the Middle Ages and perhaps beyond there has been in Atocha a basilica dedicated to Nuestra Señora de Atocha, 'Our Lady of Atocha', the Virgin bearing the Holy Child on her knees. In 1523, at the very moment of the Conquest, the Dominican Order received charge of this basilica, and Our Lady of Atocha appears to have been a focus of devotion throughout Spain, perhaps second only to Santiago de Compostela. The present effigy in wood of Our Lady with the Holy Child on her left knee is said to have been carved in the thirteenth century, replacing an earlier one that presumably had become dilapidated, where Our Lady was holding the Child seated on both her knees. There is a tangled fragmentary record of various secondary images in the round (*de bulto*), one of them an effigy for pregnant women who would call for her presence as the labor pains began. This effigy would be borne to the prospective mother's bedside. The figure in the Basilica of Our Lady has always been carved from a single block of black wood and the Holy Child is inseparable from Our Lady. It seems that the cult of Nuestra Señora de Atocha is today in decline. This is as much as I have learned about Our Lady of Atocha in Spain.[27] (Fig 25)

We do not know at what date the Dominicans introduced their cult of Our Lady of Atocha into the New World, nor when Our Lady with the Holy Child ceded her place to the Child alone. The Dominican fathers in Mexico and Spain, though with utmost courtesy, have seemed unable to help us and indifferent to our theme. Somewhere in the archives of the Vatican or of the Dominican Order there must be documentation that will unfold the story. A moment must have come when the Holy Child was wrested from Our Lady's knees (or arms) and elevated to the High Altar in solitary splendor. The deviation clearly responded to a popular need, and the need, I feel sure, was for the Christian Church to supply a Piltzintli incarnate, or rather a Christian surrogate for Piltzintli.

The Dominicans must have formally approved of this substitution, either locally or by an Act of the Order. Did they substitute the Child for the Virgin-and-Child all unknowing? And did they discover the appalling link to the execrated entheogens too late? Was not this discovery behind the queer Spanish costume and accoutrements that the Niño possesses in the stereotyped icon that we all know? The Holy Child is here represented (Fig 26) as wearing a plumed hat, of a style in vogue in Europe in the late seventeenth century, a long gown and cape, sandals on his feet, carrying a shepherd's staff with a basket for flowers in his right hand, and for good measure a sheaf of wheat (rather than an ear of maize) along with a bottle gourd and a *venera*. (A *venera* is the scallop shell that pilgrims to Santiago de Compostela always carried, to eat and drink from and for alms, and as a symbol of their mission.) To this icon there were often added, in the upper corners, tiny insets that illustrate the Holy Child performing the miracles habitual with him, consoling or curing the ill, thwarting crimes of violence, and such like. ('*Santoniño*' is the name of the burglar's 'jimmy' in Mexican Spanish, opening as they both do all doors!) The icons in quantity were crudely painted on tin and in recent decades, as racial amalgamation has progressed and religious indifference has spread, they have made their way in countless numbers into the flea markets of Mexico, grimy from the smoke of centuries of tapers burning in the humblest homes. The costume of the Child in the typical icon did not antedate the last quarter of the seventeenth century and this may indicate when the worship of the Child, rather than Mother and Child, became definitive.

---

[27] For our information about Nuestra Señora de Atocha we are indebted to José Muñoz Rojas of Madrid, and through him to Fray Angel R. Serrano, O.P., and to a religious publication, *La Virgen de Atocha*, issues of December 1971 and February 1972, published in Madrid.

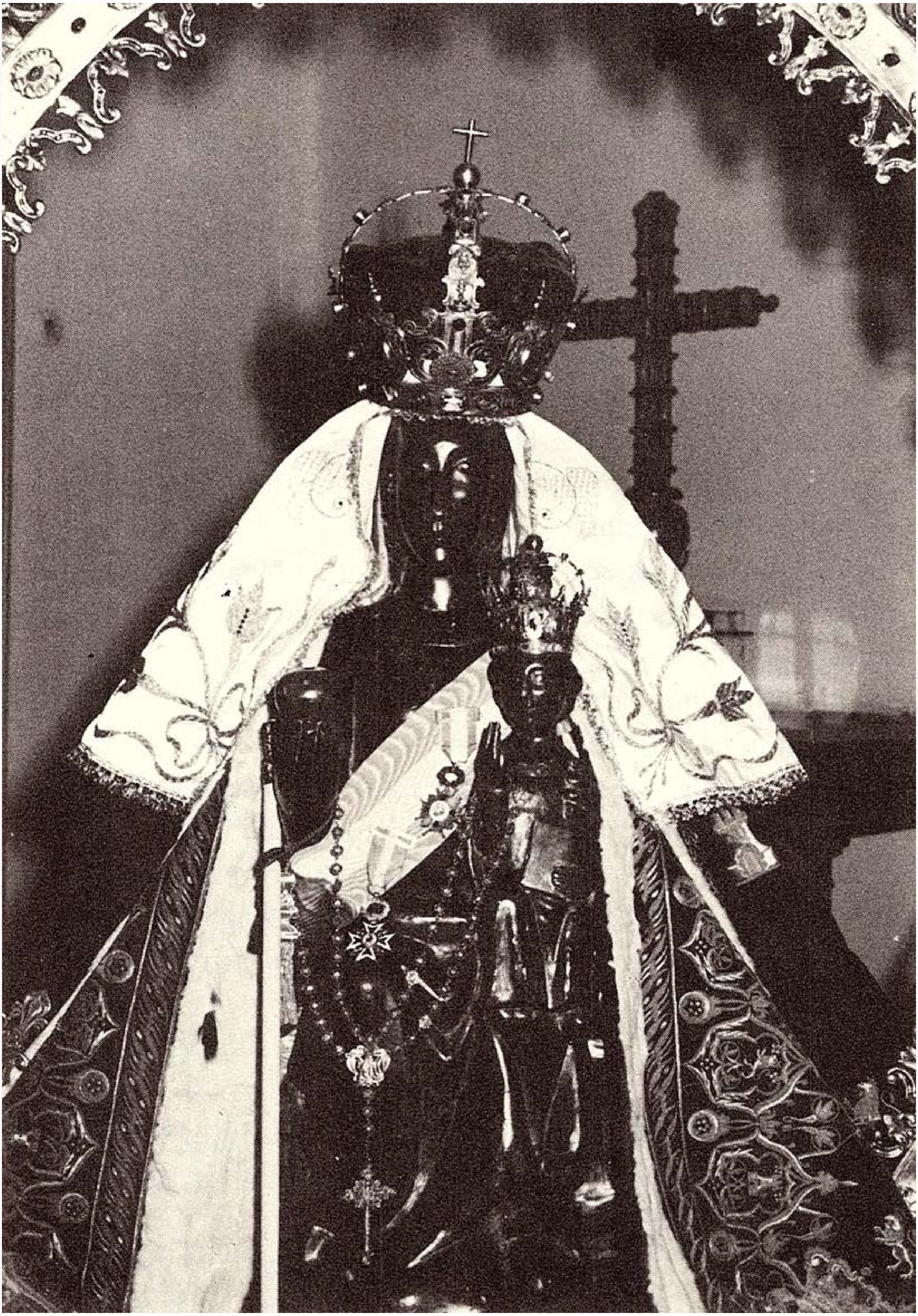


Fig 25 Nuestra Señora de Atocha, in Madrid

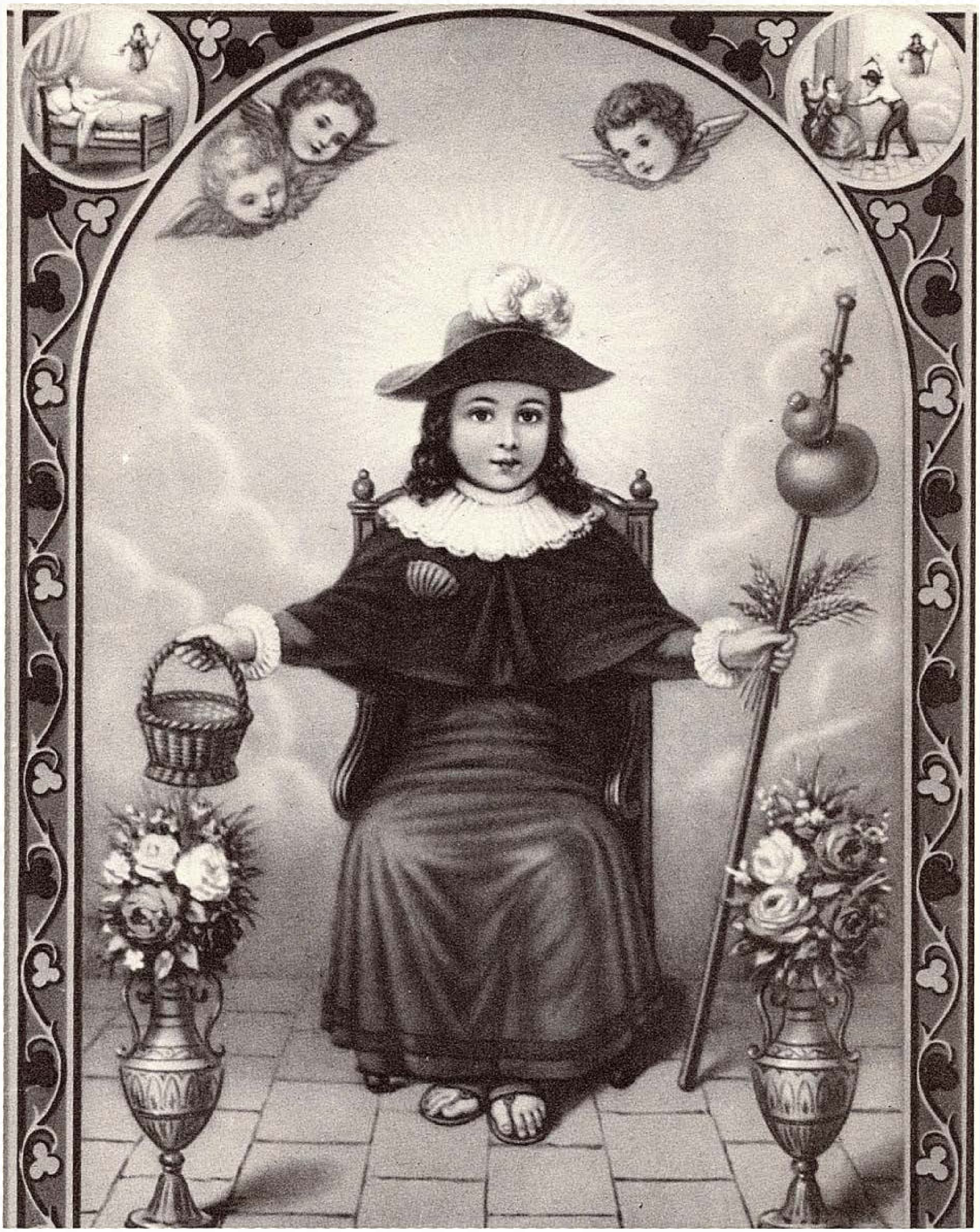


Fig 26 Santo Niño de Atocha. Traditional icon familiar throughout Mesoamerica.

Aguirre Beltrán in *Medicina y Magia* gives us a lively account drawn from the Archives of the Inquisition of the various thrusts made by the Indians to find in the new religion of the Conquerors a way to still adore their Piltzintli, although it must be said that the author never suspects the presence of the Child God of the Indians as the motivating force behind their manœuvres. In the early years of the seventeenth century the Holy Office forbade the use of *peyote* (a word that certainly included all the entheogens), and from then until 1630, and again at intervals later for a century, the Inquisition administered by the Dominicans prosecuted those who resorted to *peyote*. As early as 1617 the Indians identified *peyote* with the Niño Jesús, the Child Jesus, in the guise of a lad. Then it is reported that *peyote* became the Holy Trinity, appropriately enough because the Indians, especially the Huichol, linked the cactus with the deer and maize in a mystical triune being. From 1625 to 1665 *peyotl* became identified with Nuestra Señora [de Atocha?], Our Lady. In 1692 we find the entheogen emerging as Santa Rosa María: in those days *rosa* meant 'flower' in Spanish, and 'flower' was *xochitl* in Nahuatl, which as we have seen was a figure of speech for the superior entheogens. In 1713 it figured in the Proceedings as Santa María del Peyote. In 1742 *peyotl* is being called Señor don Pedro, Our Lord St. Peter: who but St Peter holds the keys to Paradise? There have been reports in recent times of a mission in Durángo bearing the name of El Santo Nombre de Jesús Peyotes: this arid region is rich in the famous cactus *Lophophora williamsii*.

In Mexico the cult of the *Santo Niño* has its center, ostensibly, in Plateros, a mining village near Fresnillo in Zacatecas, a dry region where the cactus *peyotl* abounds. The *Santo Niño* is the patron of miners, but the mines around Plateros have declined in importance. The annual festival takes place on Christmas Eve, *la Noche Buena*, and from 20 December on the faithful gather. Here there are no mushrooms nor *ololiuhqui*. In Plateros the immense popularity of the Child Jesus is not among the *indígenas*: his appeal today is exclusively to the *mestizos* and the lower class of Spanish blood, where we do not find the entheogenic plants put to use.[28] Father Miguel Martínez, the incumbent, deprecated to us the 'miracles' attributed to the Child Jesus: *Son creencias populares*, 'They are popular beliefs.' He would have none of them. The Virgin - *Nuestra Señora del Refugio* - is now high up, standing with her arms outstretched, to the left of the altar as the worshipper looks on her. But we see another Virgin on the same plane as the altar and to the worshipper's right as one faces the altar, standing in a white gown with a long blue cape, her arms placed as though holding a baby towards which she directs her gaze with love and adoration. But the babe is gone. We find him above and behind the altar: he is the infant Jesus and his garments are changed daily, according to Father Martínez, being garbed in clothes donated by the faithful. He does not bear the slightest resemblance to the cheap icon representing the traditional *Santo Niño de Atocha*. Being only an infant, he is incapable of performing the miracles expected of the Spanish child-pilgrim of the familiar icon and still more incapable of the feats of the pagan sprites of the entheogens. He is in short finally and completely dissociated from Piltzintli. Are we not justified in supposing that the Dominican friars were aware from an early date of the ambiguity of their Santo Niño, and that in two stages, first as an exotic Spanish pilgrim, lately as an infant, they were interposing distance between their Santo Niño and the Child God of the Mesoamerican world?

There is one other church in Mexico where the Santo Niño is the primary object of adoration: the church of Nundichi, a village high in the hills above Tlaxiaco northeast of this town in the State of Oaxaca, south of the Pan American Highway and halfway to the Pacific Coast. We are here in the Mixteca. The annual feast of this *Niño* is on the first Sunday in January. The *Niño* carries a cross, not a staff, and his head wears a regal *resplandor* (a variety of halo) instead of the plumed hat. (Fig 27) Innumerable pieces of paper with writing on them are pinned to his garment - expressions of gratitude for miracles that he has effected and that are set down for all to read. (These pieces of paper are themselves known familiarly as *milagros*, 'miracles'.) Here also the appeal today is chiefly to *mestizos*. In both centers the *Santo Niño*, according to the popular belief dating from the time when the Infant was a lad, sallies forth from his throne at night to succor the faithful who are in trouble, returning to the church before daylight. The proof (so people say) that these stories are true is the mud (in Plateros) or sand (in Nundichi) that sometimes clings to the sandals when he resumes his place on the altar. But Father Martínez in Plateros dismisses these stories with a wave of the hand. The *sacristán* of the church in Nundichi pointed to another church in a village some miles away across the valley, San Antonio Indoajico, where there is, he said, the cult of a Virgin of Atocha.

---

[28] On our visit to Plateros in January 1972 we were told by Father Martínez that this church draws no *indígenas*. *Sólo la gente adora al Niño*, 'Only people worship the Child', Indians not being people in his mentality. His offhand use of this contemptuous expression is a legacy of Colonial Mexico and is seldom heard now.... Two centuries ago, of course, the mining population of Plateros and the Fresnillo area may have included large numbers of monoglot Indians who adored a 'Santo Niño del Peyotl'.

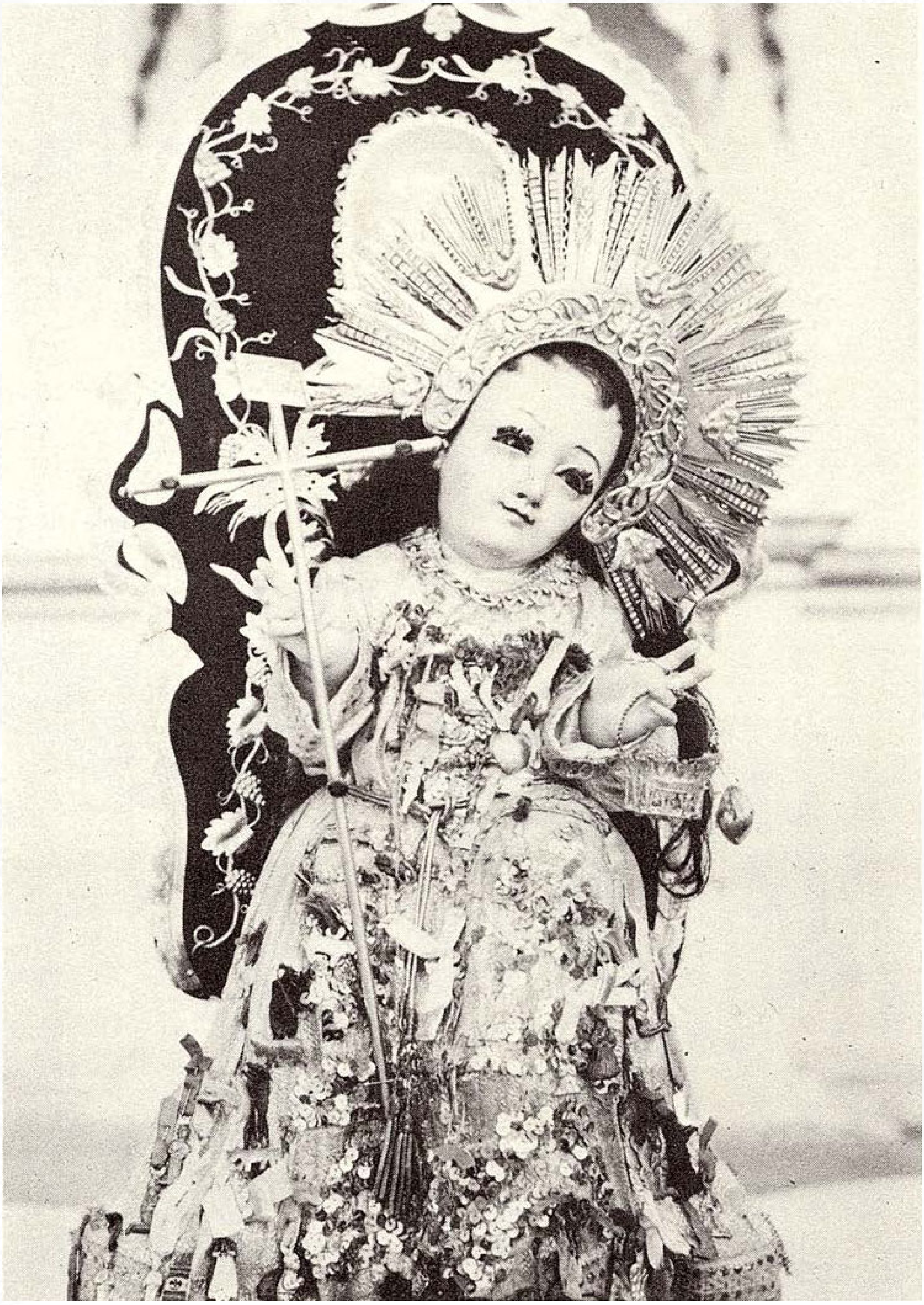


Fig 27 Santo Niño de Nundichi

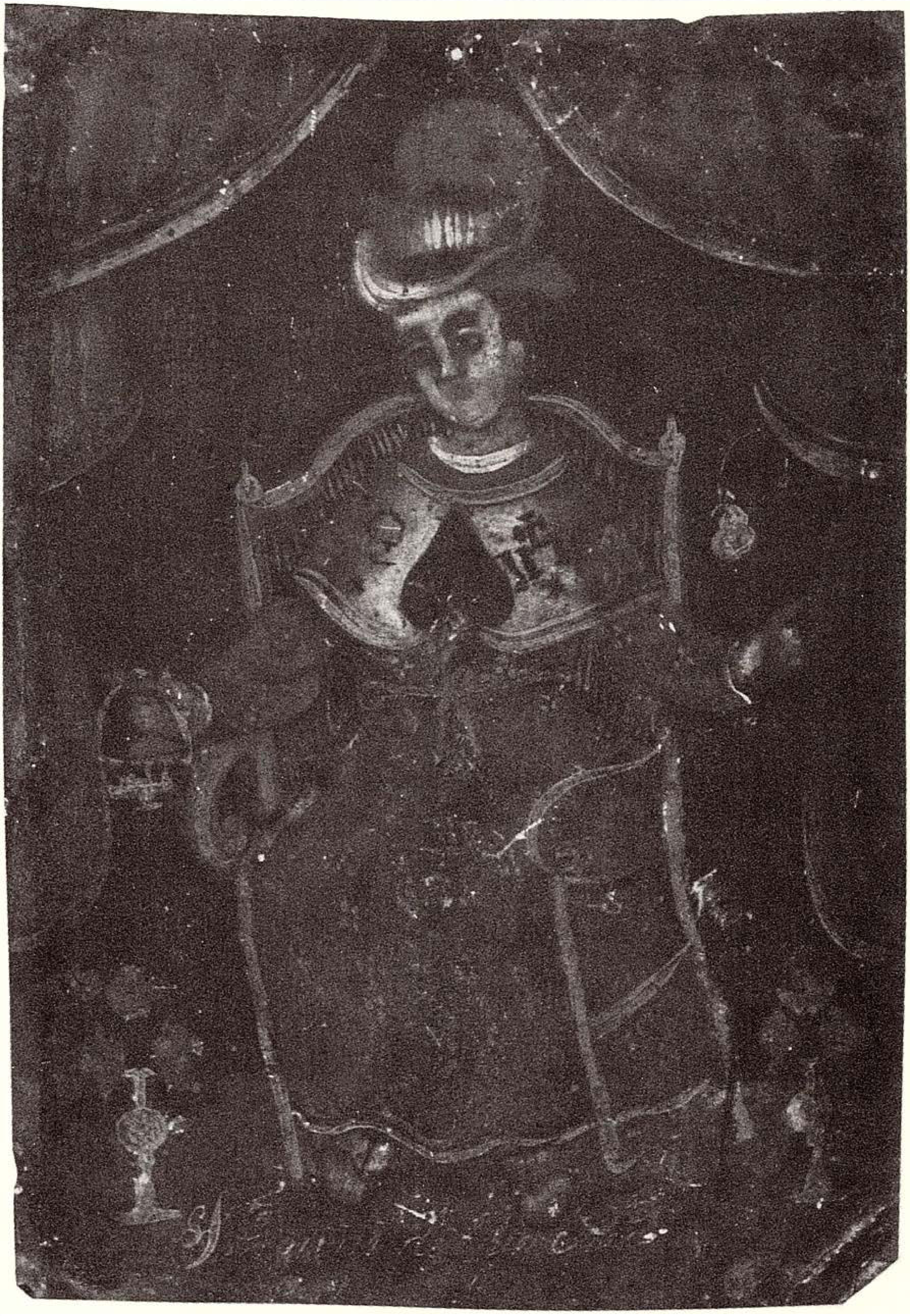


Fig 28 Santo Niño de Atocha, bought in the Flea Market in Mexico City

In San Juan Amatitlán, on the shores of Lake Amatitlán in Guatemala, we find also a famous cult of the *Santo Niño* in a church founded by the Dominicans. The day of the *Santo Niño* in Amatitlán is May 3.

In Huautla de Jiménez the parish church displays a *Santo Niño* in traditional style. Nearby, also in Mazatec country, in the village of San Mateo Eloxochitlán, not long ago, well within the memory of those still living, there was a *Santo Niño* who was an Indian child, barefooted, wearing breeches, a shirt with a check pattern, a sash, and a rosary. But one day, without consulting the parishioners, the priest replaced him with the effigy of the *Santo Niño* of Prague. The parishioners still speak with nostalgia of their former *Santo Niño* and express resentment at his kidnapping. In Tlacotepec on the road from Puebla to Tehuacán there is a Holy Child and in Puebla itself, in the Church of San Marcos, 2 January is set aside for the celebration of the Holy Child before his icon. Formerly he was *de bulto* also, but the figure disappeared during the religious persecution under Elías Calles, or so it is said. There must be churches without number in Mesoamerica where the cult of the Holy Child is a focus of devotion: I have cited only those that I know about along my routes in Mexico.

The pagan cult of Piltzintli still survives in the *rancherías* and villages where on altars in the humblest homes of monoglot Indians the traditional icon of the *Santo Niño* has the place of honor, a bouquet of flowers before him, perhaps a *vela* of virgin wax lighted in his honor, and from time to time a *velada* being sung all night by an hierophant to invoke his aid in the extremities of life. In these Indian homes lies the real focus of the cult of the *Santo Niño*, a cult of immemorial antiquity that is now fast dying out; here, not in Plateros nor in Amatitlán nor in Nundichi, where the acculturated worshippers have never heard of the Child God of the Mesoamerican Indians. In 1955, when I attended the *velada* sung by Aristeo Matías, in San Agustín Loxicha, a Zapotec village in the Sierra Costera, I was struck by his invocation in Zapotec of the *Santo Niño de Atocha* and in my field notes jotted down that observation. At the time I knew nothing about the *Santo Niño de Atocha* other than his name and did not link him with the entheogens. Today we possess the text translated into Spanish of three *veladas* sung by María Sabina in Huautla, one from 1956, another from 1958, and the third from 1970, the first two recorded by me and the third by a Mazatec at a *velada* where no outsider was present. In each of them, toward the end of the *velada*, she invoked the *Santo Niño de Atocha*. Many saints such as St Peter and St Paul enter into her singing repeatedly, as though she had recourse to them when her verses were running thin. But the *Santo Niño* occurs only once, near the end. For her as for Aristeo Matías, and doubtless for all other Mesoamerican shamans, the invocation is, I think, a structural feature of the pre-Conquest *velada*. Piltzintli - the 'Holy Childe' - was there from the start. He is there to this day, for all to see, as he dives down head first to the High Altar of Santa María Tonantzintla.

By divine grace we are given the supreme example in ecclesiastical architecture of the adoration of the *Santo Niño del Peyotl* (in its broadest sense) in the Church of Santa María Tonantzintla. In it the Christian and pagan elements achieve an harmonious blend. Here the little sprites, youths and maidens, are peopling the enchanted scene. Here there is no brutality - no Holy Office, no human sacrifice - only a garden that surpasses all dreams where mankind lives off the rich produce of the fields round about and on the entheogens of Mesoamerica, entheogens that the Greeks knew as ambrosia, the Aryans as *amrita*, the Siberian tribesmen as *pongo*. The Aryans used another word for their divine inebriant, *ándhas*, cognate with the Greek word for 'flower', ἄνθος, and both of them are the equivalent of the Nahuatl metaphor *xochitl*. The *veladas* of María Sabina and the inebriating world of Santa María Tonantzintla have led us to see with the eyes of Early Man a major aspect of his life that we did not know before, a vision of another world whose very existence remained almost hidden from us, a world surcharged with the vitality of youth and of incomparable beauty. In the fertile valley of Cholula religion meant much to the Indians before the Conquest and it suffuses their lives to this day. Here we find the answer to the theological enigma that Pedro Rojas put to us with extraordinary acumen: Piltzintli, the Master of Revels, the Holy Child, is plunging down to the altar where his mother the Virgin Mary is enthroned.

But let us go further. Is not this divinity the same as the plunging figure in the *Codex Borgia*, the *niño dios*, Piltzintli, that we display in Fig 29? Is he not the same that María Sabina had in mind, at an early point in her *velada*, when she asked me to vacate my seat because I would obstruct the descent of the divine spirit who was to arrive from above by way of the very corner that I occupied? (See p 13) There is a possibility that she speaks of the same divine epiphany in Chapter VI of the story of her life that Alvaro Estrada has given us. And what of the Diving God murals of Teotihuacán to which Arthur Miller draws our attention? Nor should we overlook one striking style of mushroom stone, from the Maya Highlands, of which we reproduce two examples on page 192. Are not these Maya effigies siblings to the plunging god of the *Codex Borgia*, of Santa María

Tonantzintla, of María Sabina's world? This *niño dios*, wherever we find him, is the god of the entheogen, is one aspect of Xochipilli.

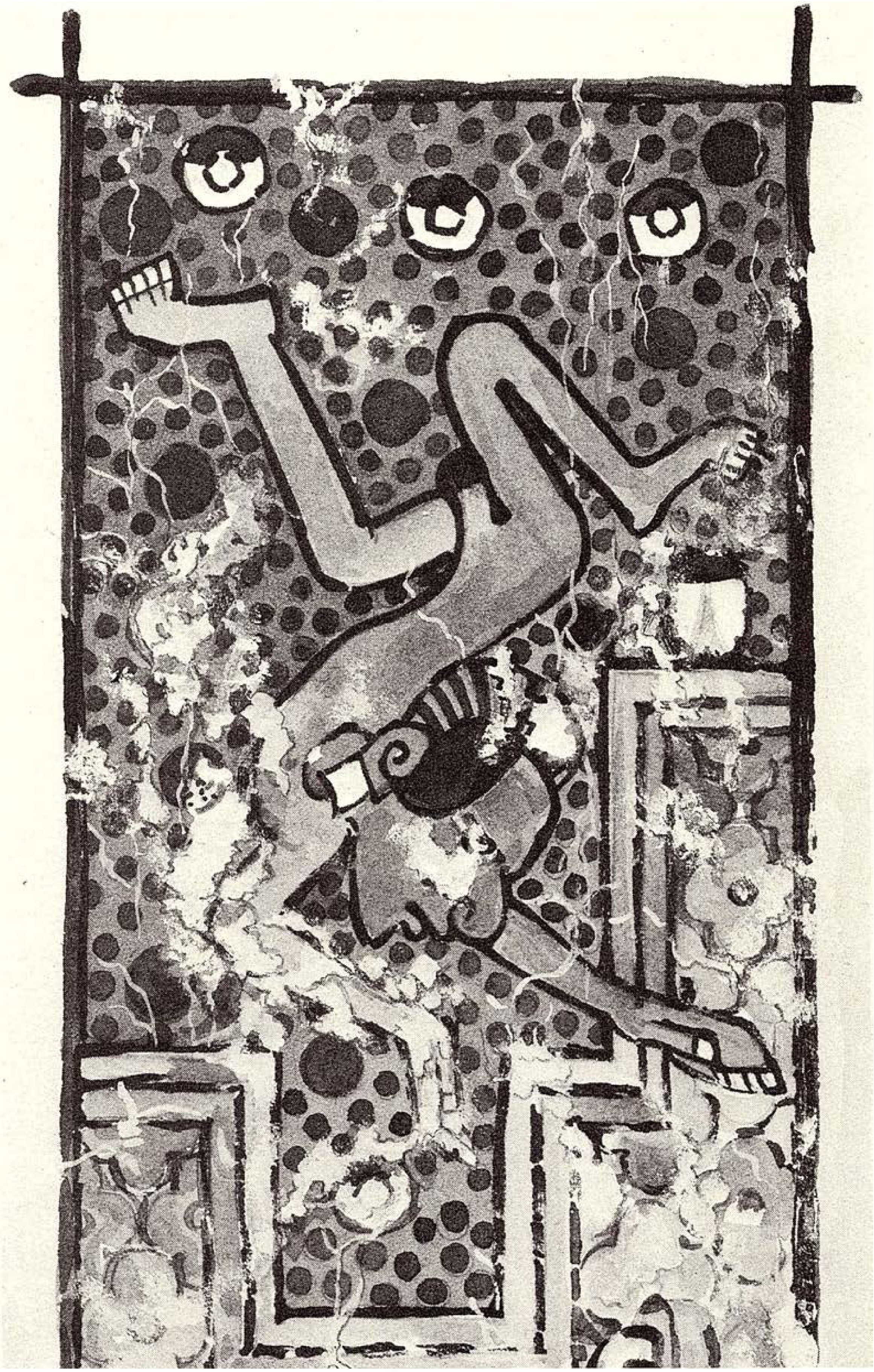


Fig 29 Plunging Piltzintli. *Codex Borgia* (Folio 8, Fig 50) × 2 ½

CHAPTER 8

Teotihuacán and the wondrous mushroom

The meaning of the murals

In *Mushrooms Russia & History* (1957) Valentina Pavlovna and I set forth our reasons for thinking that certain details of the murals of Teotihuacán represented inebriating mushrooms. With one notable exception no Mesoamerican scholar has publicly commented on our discoveries although twenty years have elapsed and our findings elsewhere in Mexico have not gone unnoticed. The exception is Dr Alfonso Caso, who in his paper on the *Codex Vindobonensis* ratified our identification, specifying the murals that in this Chapter appear as Figures 1, 2, 7, and 12. His endorsement was unequivocal, although (as I have already pointed out) he dropped our mushrooms then and there. Apparently he felt that this theme, far from calling for further inquiry, was exhausted. Caso was like all other scholars in the Mesoamerican field: inhibited when dealing with the divine inebriants. Archæologists, the clergy, anthropologists, linguists - all touch them gingerly or not at all. They respond to my inquiries most courteously but on their own initiative do nothing. The exceptions are few.[29] It would seem as though there were a subconscious reluctance on the part of our Western society to recognize the rôle played in prehistory by entheogens.

I will now go further than we did in our 1957 book. Arthur G. Miller's *The Mural Painting of Teotihuacán* appeared in 1973. That ancient city, covering eight square miles in its heyday (ca AD 450-650), counted a population of at least 70,000 and perhaps up to 200,000, according to the careful study of R. Millon. In Miller's book, beautifully laid out, he gives a comprehensive survey of most of what had been discovered in the ruins up to the time of its publication: plans of the structures that had been excavated from the start of archæological inquiry about a century ago, photographs of their famous murals, black-and-white drawings to help the reader see in the photographs what the specialist sees in the murals, floor plans of the various edifices, and finally numerous and skillful repaintings of the murals by Felipe Dávalos G. to recapture the full effect on the worshippers of the originals when these were fresh. Anyone endowed with imagination is certain to be profoundly moved and also mystified by a school of sophisticated painting the like of which exists nowhere else in the world. One can see a kinship only with the art of the Maya and the codices of the Nahua and Mixtecs.

Miller plants squarely the basic questions. What was the purpose of the labyrinthine building complexes where the murals have been found? What was the meaning of the strange, the haunting Teotihuacán paintings? He does not hazard so much as a guess. He says no one knows. But in a fecund paragraph Miller draws attention to the often elaborate borders of the murals, with broad curvilinear and rectilinear bands braided together at intervals in sweeping rhythm (as he says) *that is almost musical*. And he adds:

> I do not mean to suggest that lines in Teotihuacán murals are recorded music, but I do suggest that they can have values which are musiclike *and may have been so to the Teotihuacános*.
> [Italics mine; Miller, p 29 col 1]

What astonishing perspicacity! Miller lacked only the key to the mystery. Here again in our inquiry we are finding the same missing clue: the Wondrous Mushroom.

The reader will recall how María Sabina in her *velada* intones chants that for the bemushroomed person assume rhythmic shapes, curving in and out of each other, and how the kaleidoscopic play of colors that the bemushroomed see in their visions pulsate with musical rhythm. The artists of Teotihuacán succeeded in conveying this sensation to Miller who knew not the mushrooms! (My impressions are paralleled by Henry

---

[29] The botanist Richard Evans Schultes and the anthropologist Weston La Barre among the older scholars have devoted much of their professional careers to the entheogens. Among the coming generation there has been promising initiative in various directions: Alvaro Estrada, Peter T. Furst, Michael Harner, Reid Kaplan, Henry Munn, Carl A. P. Ruck, and others. Many members of the Summer Institute of Linguistics have provided us with invaluable help, including Eunice V. Pike, George and Florence Cowan, Bill Upson, and Searle Hoogshagen.

Munn's, though he conveys them in utterly different language.) Miller speaks of the 'vibrantly colored shapes' of the murals of Teotihuacán, their 'intensity and vivid colors'. He cites Miguel Covarrubias who dwelt on their 'intensely religious' message, 'austere and distinguished, gay and graceful'. What a tribute to the ancient artists are these sensitive responses to their murals by acute observers who were ignorant of the entheogens!

Imagine then my astonishment when I found Miller saying that the 'disembodied eyes are important' both in the main composition and the border of a mural in the complex known as Zacuala.[30] Why was I astonished?

In my *Life* article, 13 May 1957, describing my own experience when I was bemushroomed in my first *velada* with María Sabina two years earlier, I wrote:

> There I was, poised in space, a *disembodied* eye, invisible, incorporeal, seeing not seen.

I had myself been the *disembodied* eye that Miller discovered some dozen years later in the murals of Teotihuacán painted a millennium and a half before!

Miller perceived the 'disembodied eyes' peopling the entire corpus of Teotihuacán painting, not merely in the Zacuala complex. When I wrote my *Life* article, Zacuala had not been excavated and Miller's book lay some sixteen years ahead. Miller did not remember my text: on the contrary, had he remembered it his text would have been utterly different. But had he even seen it?

In 1957 my knowledge of Teotihuacán was cursory. I had paid one visit to Teopancaxco and to the fragmentary murals of Tepantitla left *in situ*. (I did not see, much less take in, the 'disembodied eyes' in the lower register of the Paradise scene. Fig 12) Miller speaks of the 'disembodied eyes' mainly when he is discussing Zacuala, but, as many of his illustrations show, they permeate the murals of the city-sanctuary of Teotihuacán. The 'disembodied eyes' are the mushroom worshipper's eyes, whether open or shut, contemplating the scenes of another world, three dimensional, unearthly yet more real to the bemushroomed viewer than our world of everyday experience.

Miller was on the brink of discovering the answer to both his major questions: the purpose of the labyrinthine building complexes and the meaning of the Teotihuacán paintings. Neither in his text nor in his captions nor in his bibliography does he cite any of our writings, which have been numerous and circulate widely, nor Roger Heim's, equally numerous, nor (somewhat later) Peter T. Furst's and others'. He speaks in a caption of a personal communication from Furst in 1971 identifying certain flowers in the paintings as morning-glories but fails to explain to his readers the meaning here of morning-glories. He is certainly not at home in botanical iconography nor the entheogens.

My thesis is simple. For centuries Teotihuacán was a vast sanctuary dedicated to the two or three hallucinogens that enjoyed superlative prestige. What we have been calling the building complexes were simply groups of cenacula where small gatherings of pilgrims would assemble to consult the entheogen under the direction of one or two or more hierophants. The number and elaboration of the building complexes speak for the ritual activity that went on over centuries at Teotihuacán. Pilgrims came from near and far. The permanent population of hierophants and their families, augmented by the host of personnel needed to provide services for the pilgrims, accounts for the 70,000 that R. Millon puts as his minimum figure, and the transitory pilgrims may have occasionally pushed that figure as high as 200,000. There were the rudimentary hostels to house and feed the pilgrims: their needs were simple. There must also have been a mechanism to pay in kind for board and lodging, for the services of the hierophants, for the use of a chamber, and for the consumption of the holy elements of the divine office - the mushrooms or morning-glory seeds, copal, cacao for drinking with dried *poyomatli* flowers, guacamaya feathers, *pisiete* with lime, perhaps turkey eggs. I should suppose the hierophants were recruited from the various linguistic groups of Mesoamerica and if so, the pilgrims might then choose one from his own country, even his own village, possibly a kinsman. After dark on the appointed night the pilgrims would make their way to the building complex where they were expected: the thoroughfares were narrow, but there was no need for wider passages as there were no horses nor hand-drawn 'rickshaws'. Carrying flares (properly speaking, 'links'), the little company of pilgrims, on arriving at their building complex, would be guided through the passageways, sometimes along lengthy corridors, where by their flickering lights they would see murals of hierophants, in their impressive vestments, until finally they would arrive at the cenaculum where they were expected.

---

[30] Miller p 29 col 2, p 23 col 1.

The chambers were small after the layout of Cayetano García's, suggesting rather a group confessional than a vast church or temple. The murals on the walls were painted in flat two-dimensional colors devoid of perspective, as Miller's book shows us, the hierophants in their vestments more or less as in our Figure 2. Each chamber had its own band of suppliants, perhaps hailing from the same neighborhood. The worshippers, often after days of walking, would finally arrive, keyed to the highest state of expectancy, at the appointed cenaculum. The vast amphitheater of Teotihuacán supplied the noblest of settings and the celebrants were masters of their craft - greeting the worshippers, asking each what problem preoccupied him, administering the mushrooms (or infusion of morning-glory seeds), ushering in the period of silence and darkness while the entheogen took over the company. In Teotihuacán the celebration of the sacrament must have been a model of excellence, the liturgy being elaborated with all sorts of subtleties and refinements: the superb vestments and masks of the celebrants, their bearing and gestures, their voices beautifully trained.

Before the lights were extinguished the murals and the celebrants were the last visual impressions. As the entheogens took effect, the next sights the pilgrims saw, in the dark, eyes open or closed, were the murals springing to three-dimensional life, far more real than what they knew from the workaday world. Then they heard the chants intoned by the celebrants, the percussive beat of the small drum, the sounds being tempered to the small room, subtly played in syncopation, the sights and sounds being bathed in the fragrance of burning copal, of *poyomatli*, of other aromatic herbs, the sounds coming ventriloquistically, from suddenly shifting directions, in suddenly shifting volume, the whole blending inextricably into one harmonious sensation uniting sight, sound, fragrance. At that moment in the night when the entheogens reach their peak effect, then would come the oracular utterances of the hierophant, sweating profusely, perhaps having inhaled draughts of tobacco smoke, in response to the specific problems preoccupying the individual worshippers, each verse ending with 'so says the mushroom', just as I have heard it in Huautla.

All this is gone now: all that is left are what remain of the murals of Teotihuacán rendered by Miller in his noble book and the chanting of shamans like María Sabina. We know that her chants are of immense antiquity and they may well preserve the melodies and even the meaning of the words of the hierophants of Teotihuacán.

Were the Teotihuacán paintings, or some of them, executed while the painter was under the influence of the entheogen? They tell us vividly what the Mesoamerican saw and sensed when he was bemushroomed. They are done with such disciplined control that one would think they must have been accomplished by sober artists working in the full flood of their immediate memories. But this may be a Western point of view: the discipline that the bemushroomed acquires with practice is a marvel, and the artist (himself a hierophant?) may have prided himself on having painted them under the immediate dictation of the entheogen.

There was no vast edifice for corporate worship in Teotihuacán, no 'cathedral' or 'temple'. If there was human sacrifice, this was performed in the open, atop either of the two pyramids, the one to the sun and the other to the moon. These pyramids antedated by centuries the time of which we are speaking, and the cathedral of Teotihuacán was truly these pyramids set against the heavenly panorama of the hills and sky encircling the vast theater of that wondrous sanctuary.

I am sorry Arthur Miller did not know our writings for he would then have answered his own questions and rounded out his impressive work. By an heroic feat of disciplined imagination an occasional Mesoamerican scholar with the soul of a poet might be able to enjoy the shadow of a *velada* without ingesting entheogens. But why make this effort? For most there is no substitute for the real thing. The day is arrived when no one who would learn what Mesoamerican culture meant to the Mesoamericans, what the murals of Teotihuacán meant, what the picture writing of the codices meant, what the surviving Nahuatl poetry meant, what the intoning of the chants meant - that is to say, no aspiring Mesoamerican scholar - will deny to himself *the* key to this understanding.

Teopancaxco and the water glyphs

One of the earliest murals of Teotihuacán to become known, in the late 1880's, is in a chamber - a cenaculum, as I believe - of a structure called Teopancaxco. On one wall of this small chamber is a mural painting that we reproduce in our Fig 2. There can be no doubt that its reconstruction by Agustín Villagra Caleti conveys the effect of the original mural. Damage through the centuries and neglect since it was rediscovered had taken their toll. In our reproduction the darker field shows the portions that were well preserved when Villagra undertook his task, and he also had access to paintings of other hierophants in procession. Almost all of the border had disappeared, and of the murals that had originally covered the other three walls there was virtually nothing left. When we visited Teopancaxco in the middle fifties we noticed, on the wall to the right as one faced the surviving mural, a small stretch of the original border (including an angle) of the lost mural of that wall. Though many must have seen it, no one had yet copied it. At our request Eduardo Noguera took the task in hand and gave the commission to Villagra. This border fragment will be found in Fig 1, and as that portion of the mural is an authentic Teotihuacán painting, in no way retouched, it serves well to demonstrate my thesis. We discover here the glyph for water in Mesoamerica at an earlier stage of its pictographic evolution.

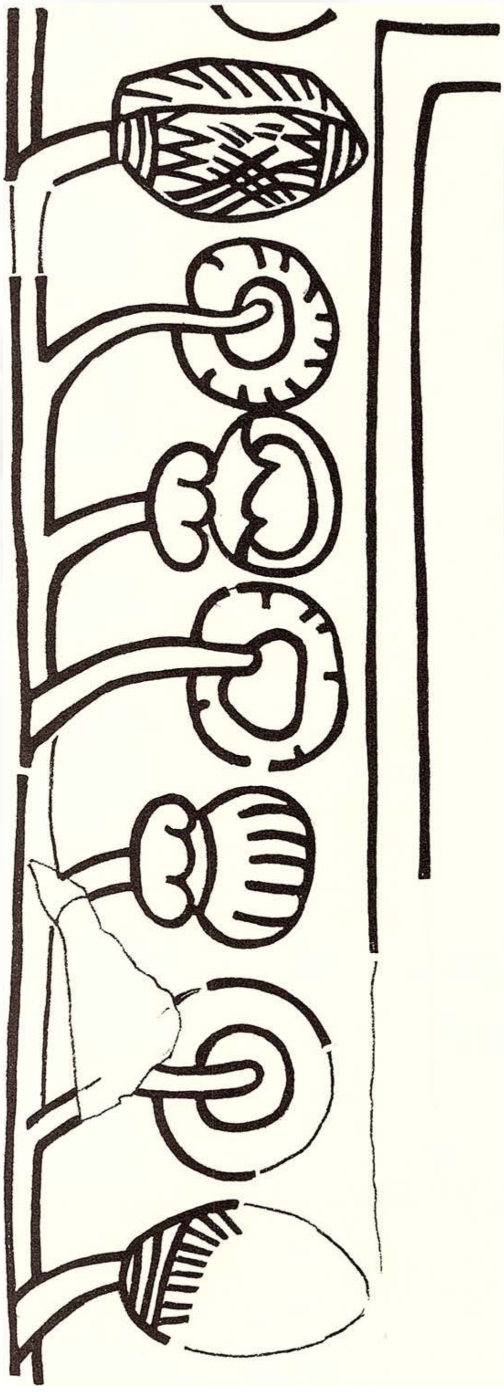


Fig 1 Teopancaxco mural. Detail, reduced

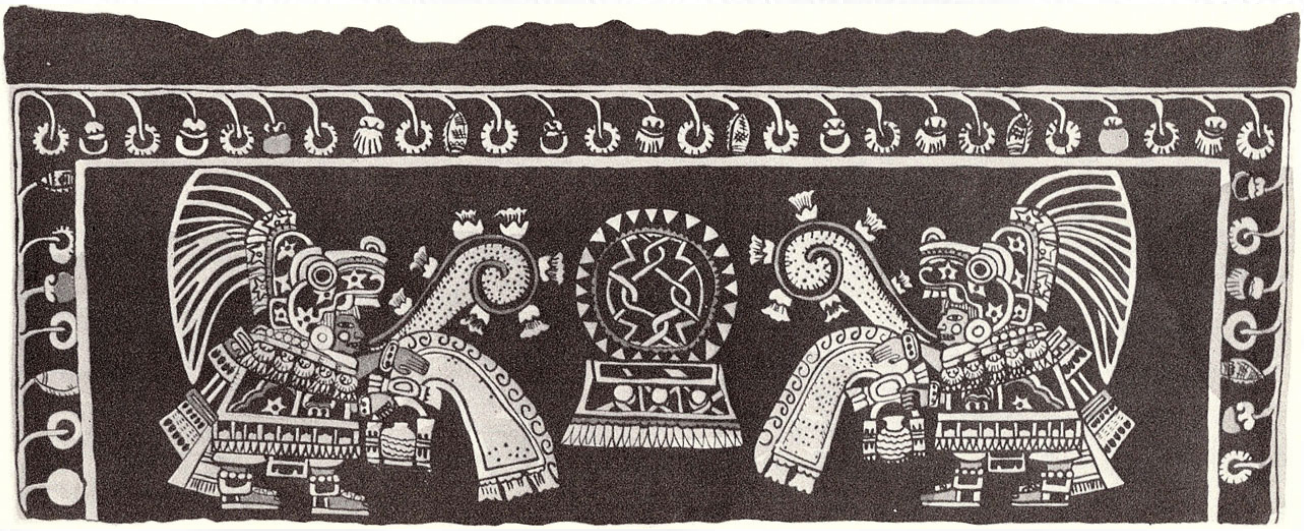


Fig 2 Teopancaxco mural. Teotihuacán, in the Valley of Mexico. From Teotihuacán III Period, AD 300-600

Working down from the top, first we find a well delineated marine snail. I think no one has ever disputed this identification. Next comes what is for me plainly the undersurface of the cap ('pileus') of a mushroom showing the gills ('lamellæ'). The stem ('stipe') emerges from the center of the cap and runs like an umbilical cord to a stream of water, the waters of life, the waters that one links inevitably with shells and mushrooms. In the mural itself there survived the faintest traces of green paint on the mushrooms, signifying holiness. As for the third and fifth glyphs, prevailing opinion is that they are bivalves, but in the glyph for water do they ever recur in Mexico? The murals of Teotihuacán are clearly the product of a long evolution in picture writing of which no one has yet found examples, and these two 'shells' may well have been obsolescent elements in the water glyph. The marine snail, however, often accompanies the mushroom, even in post-Conquest times, as we saw in the pictogram for water in the mid-sixteenth century *Códice indígena* No 27, p 110. But the mushroom is always present, simplified, reduced finally to two concentric circles or even to a circle around a dot. The overwhelming importance of the divine mushroom in pre-Conquest Mesoamerica finds fitting expression here in the link between water and mushroom, in the glyph for water, in a glyph that sanctifies water by tying it to the divine *flower*, a *flower* that is green for holiness.

Alfonso Caso accepted our identification of the symbol as a mushroom, and I think this is hard to challenge. Why should it not be the mushroom that plays so big a rôle in Mesoamerica? Some have suggested in conversation that it might be the leaf of a water-lily. But the water-lily, as we see in Fig 3, has a deep cleft where the stem leads off and the veins of the leaf assemble. The water-lily belongs to the genus Nymphæa and all species of that genus have the cleft leaf. A pictographic artist catches the significant lines of the model. Those lines persist through generations and no artist portraying the water-lily could miss the distinctive cleft. What the artist does catch are the radiating gills of the entheogenic mushroom around a blank center where the round stipe is reduced to a circle. How different would be the veins in the water-lily leaf gaining strength as they assemble at the point where the stem leads off! Some ask why the 'mushroom' could not be a flower or seashell, but they do not suggest the species and are idly guessing. Why is there this reluctance to recognize the Wondrous Mushroom when the pictogram is so consistently displayed? A survival of the age-old mycophobic syndrome?

Every pictogram has its origin in a specific object and here we have the sacred mushroom. Much later, when his reading clientèle had become used to the lines, the scribe simplifies them until at last the lines are so abbreviated as to make the glyph obscure for the outsider. At Teopancaxco we possess a pictographic artist's work when the mushroom was still easy to recognize. In the evolution of the pictogram the stipe disappears, leaving a round inner ring, and the gills disappear, leaving the outer ring. The two rings persist to the end, but the inner one is sometimes reduced to a dot, as we saw in *Códice indígena* No 27, p 110.

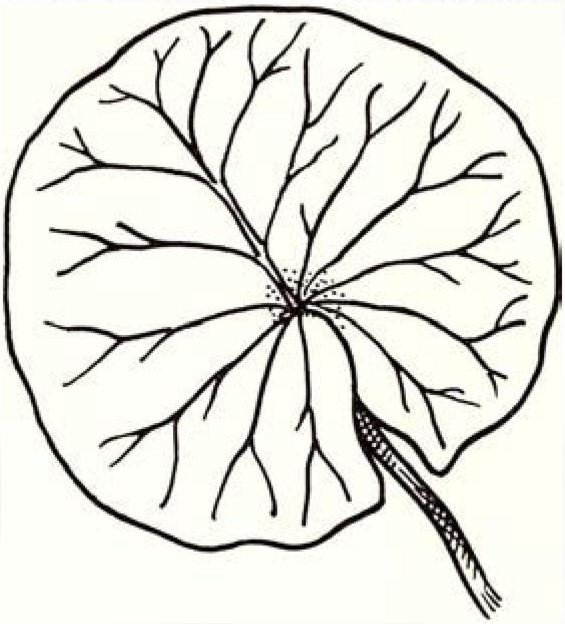


Fig 3 *Nymphæa tuberosa*

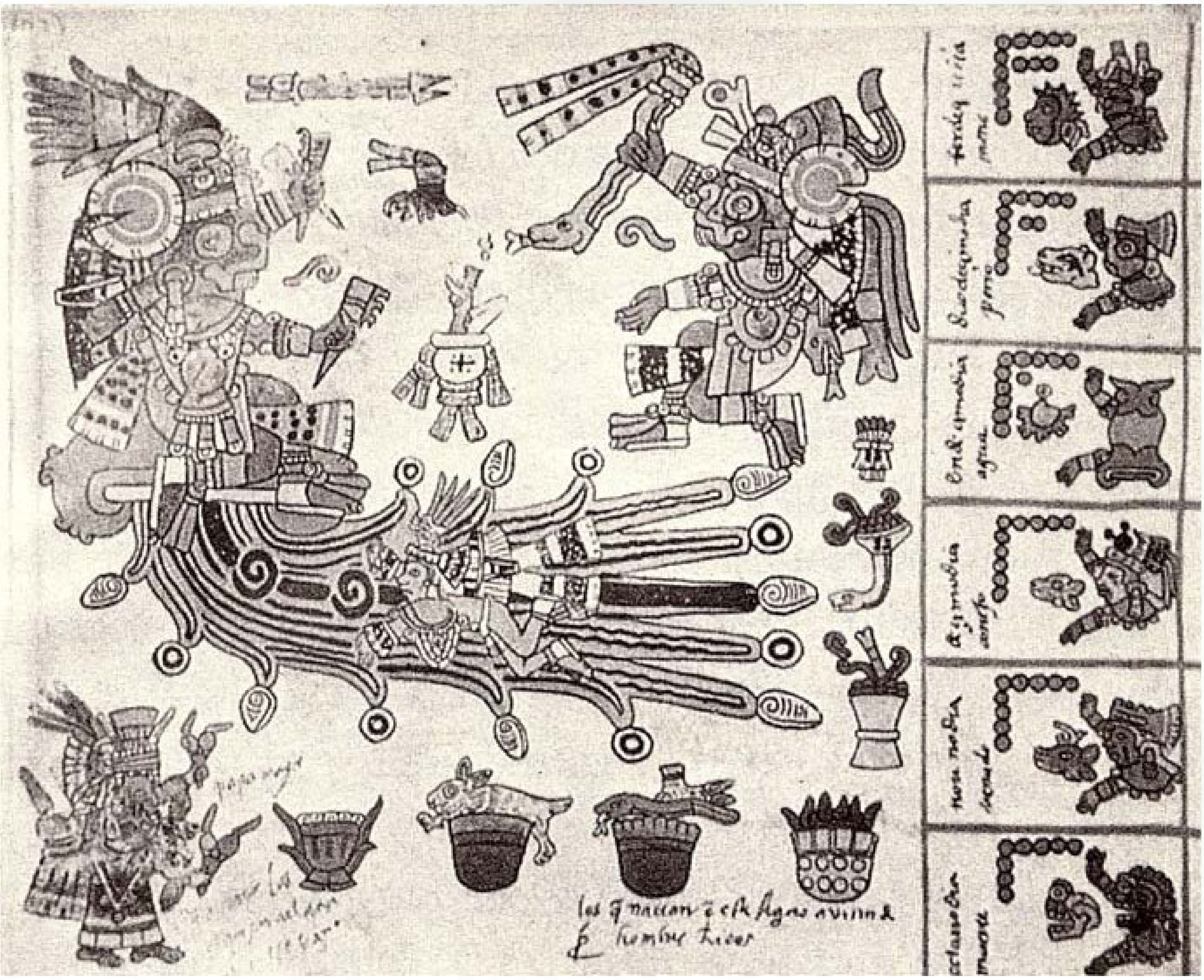

papa mayor
los q nacian e esta agua avrian a
hombre ricos

Fig 4 *Codex Borbonicus*: Tlaloc. Note symbols for water at end of streamers, here and below

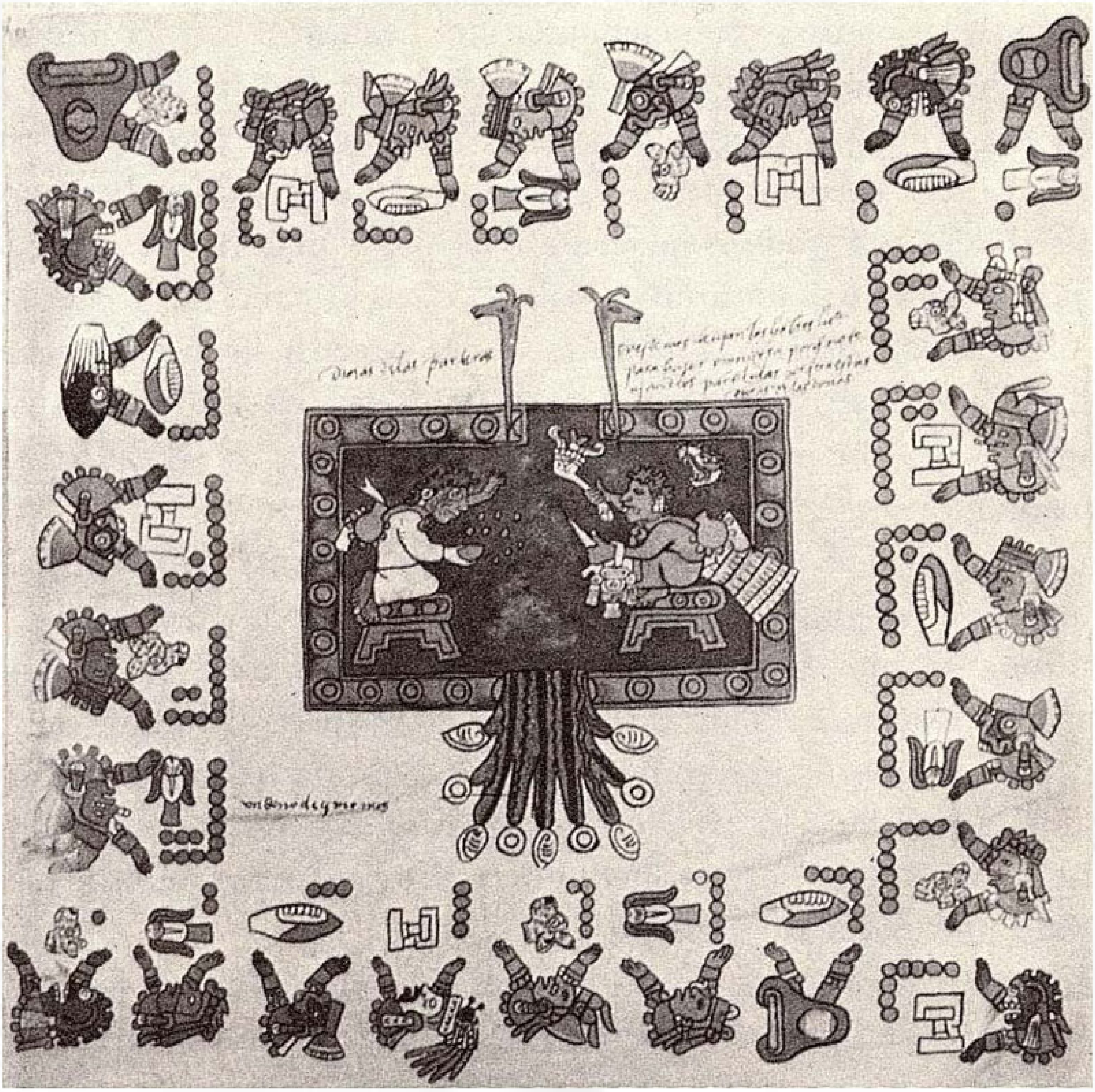


Fig 5 *Codex Borbonicus*: Two Ancients

Why did the hierophants and pilgrims stress seashells in their murals? The sea is hundreds of miles from Teotihuacán. There seem to be no midden heaps in the ruins of that ancient city. Perhaps the pilgrims took shells back home as a lasting souvenir of their pilgrimage. But such a practice would be a by-product of the main use, and might relate only to the elaborate and beautifully structured shells that are frequently seen in many of the Teotihuacán murals. The main use would be different: lime, ground fine, is mixed with *Nicotiana rustica* to make the bright green *pisiete*, widely used in Mesoamerica for rubbing on the body in healing rites and often held as a wad in the cheek. The shells may have supplied lime for adding to *pisiete*. Lime was naturally available close at hand but to get lime from either sea - Pacific or Caribbean - from the clean pure shells in their amazing and endless shapes, abundantly illustrated in the murals of Teotihuacán, would be a telling refinement in the entheogenic rite. No honor was too great for the sacred mushrooms or morning-glory seeds.

In the surviving mural of Teopancaxco two hierophants are facing each other and chanting. Their singing scrolls are adorned with *flowers*. We assume that they are bemushroomed and chanting to a tiny band of suppliants also enjoying their 'dream flowers', *temicxoch*. They are pouring a libation including seeds on the ground but what it is we do not know. With our Western fixation on alcohol, some have said it was pulque. On excellent authorities, contemporary and historical, alcoholic inebriants and the divine inebriants were not mixed and the hierophants were certainly not under the influence of alcohol.

Skipping now forward a thousand years, let us look at a few instances of the water glyph in pre- and post-Conquest codices, where the examples are innumerable. In Figure 4 we show a representation of Tlaloc, the god of rain, taken from the pre-Conquest *Codex Borbonicus*. The water with which he is identified carries our glyph repeatedly, shell and mushroom alternating at the end of the streamers leading to the flowing water. In Figure 5, again from the *Codex Borbonicus*, two ancients are casting kernels of grain in a cave from which a stream emerges, the stream being similarly identified by shell and mushroom. Our third, Figure 6, is post-Conquest, in the *Atlas* of Diego Durán. It shows the founding of Tenochtitlan-Mexico City, and the lake where the city was built carries on its edges the glyph now reduced to nine 'mushrooms', insignificant in size, but seemingly necessary; the shell has vanished. The mushrooms in these codices no longer wear the color green. In the post-Conquest *Códice indígena* No 27 (p 111) we follow the evolution of the glyph for water from (1) the shell-and-concentric circles to (2) the concentric circles alone, and finally to (3) a mere dot in the center of a little circle.

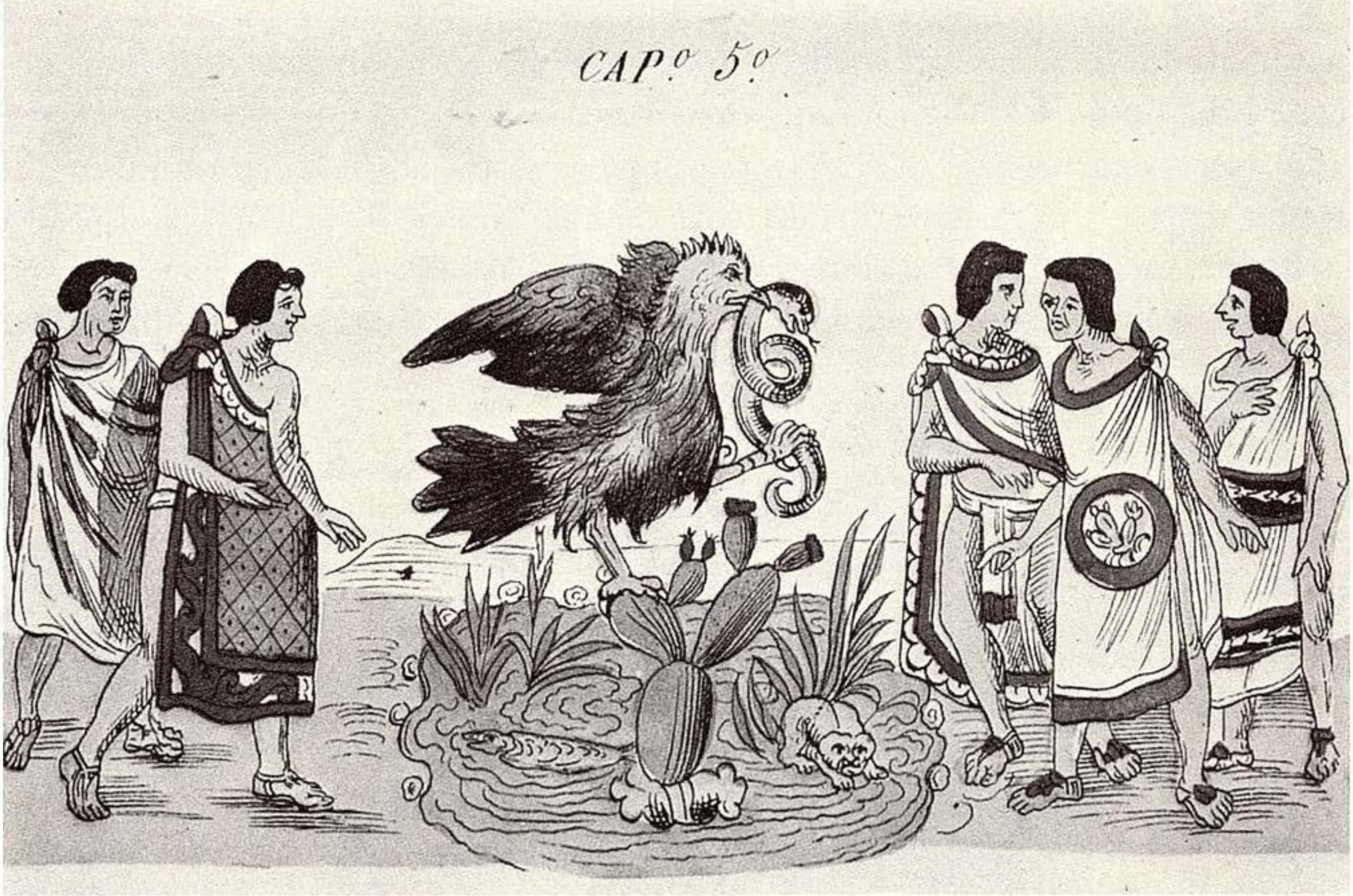


Fig 6 Diego Durán: Founding of Tenochtitlan (Mexico City)

Tepantitla

Perhaps the best known of the murals of Teotihuacán are those of the building complex called Tepantitla, restored by Agustín Villagra Caleti, now displayed for all to see on a wall of the Museo Nacional de Arqueología in Mexico City. The word 'restoration' calls for a word of explanation. When Mexican murals some 1500 years old are discovered, they are never in prime condition. At best the colors are faded beyond the layman's understanding, and the lines are obscure. It takes long experience to read the lines and colors. In those murals that lend themselves to restoration, the specialists familiar with the colors that the ancient painters had at their command can often say precisely which colors were used. By minute inspection they can read the original outlines and also the colors of what survives and give us again the artist's intention. There lies the duty of the restorer and beyond that limit, if he is a good restorer, he will not go. Villagra is an experienced, conscientious painter who does not invent motifs: here is the verdict of outside judges who have minutely examined his work at Teotihuacán. He makes the murals live again for us in the colors close to or perhaps the same as the pilgrims in A D 500 saw. His restoration of Tepantitla took place almost twenty years before our 'hallucinogenic mushrooms' came to be discussed.

Some years ago Dr Efrén del Pozo and I visited Villagra in his studio-home. Sr Villagra was glad to show us the stages of his restoration of Tepantitla, a series of draft-studies that he had made immediately after the archæologists had uncovered the originals. (The murals, when exposed once again to daylight and the atmosphere, deteriorate rapidly.) In the upper register of the main mural of Tepantitla there is the massive divinity that George Kubler, Peter Furst, and others take to be female (Fig 7) and above her head is the 'Tree-in-*Flower*', a 'tree' painted in Teotihuacán perhaps fifteen hundred years ago, which Diego Durán describes when he tells us of the celebration of the Feast of Xochipilli and which we link to the texts of Nahuatl poetry given us by Father Garibay. It is a 'tree' made *ad hoc*, not a living tree. This interpretation seems to be the consensus of informed belief today. Dr del Pozo photographed some of Sr Villagra's early drafts and we reproduce them in Figures 8-11, showing something of the many stages by which he arrived at his 'Tree-in-*Flower*'. First he restores the patches where colors and lines are unmistakable. He studies those lines and colors and extends them, helped by vestiges and by the artist's grasp of the original artist's conception. Where there is nothing left, he leaves nothing.

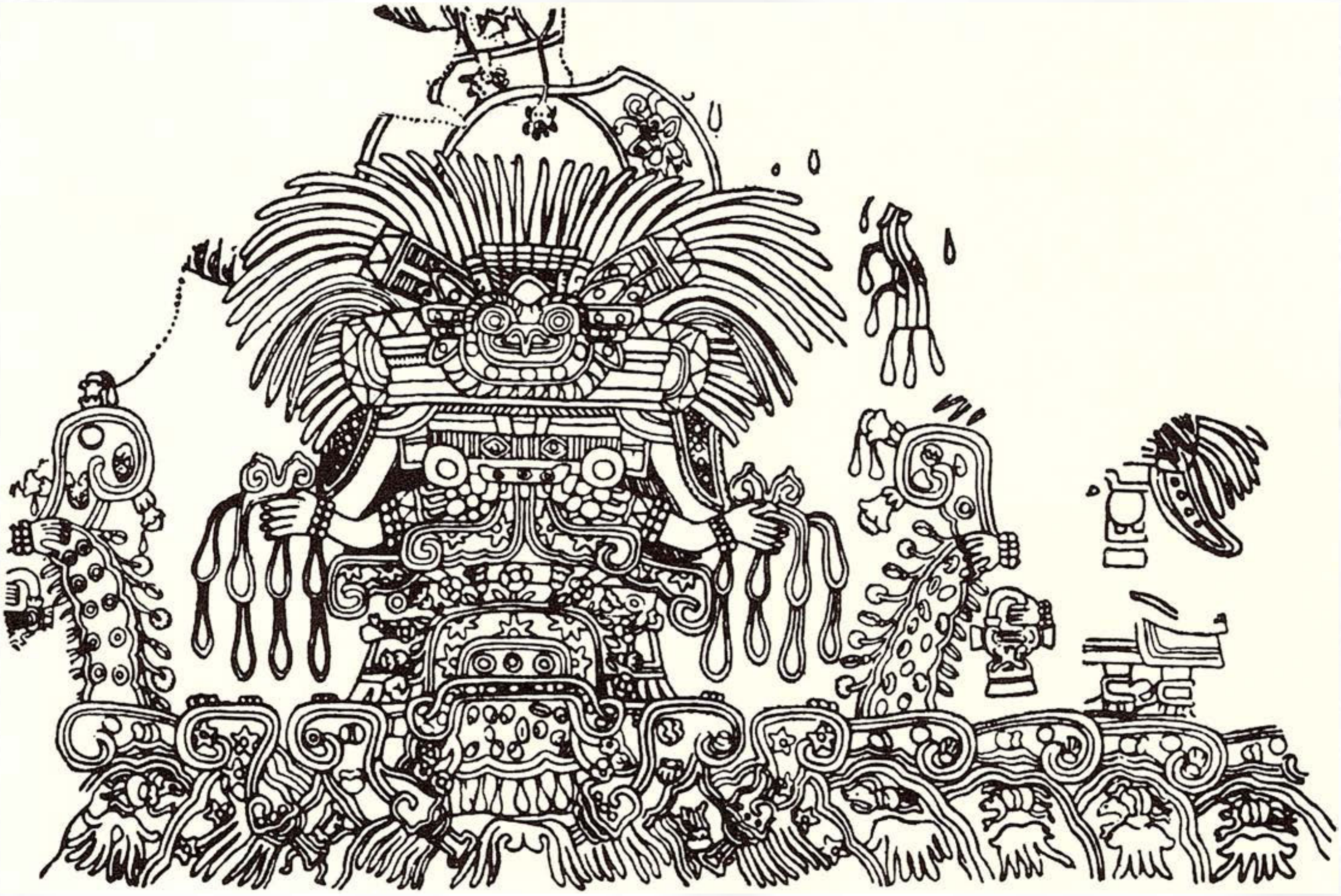
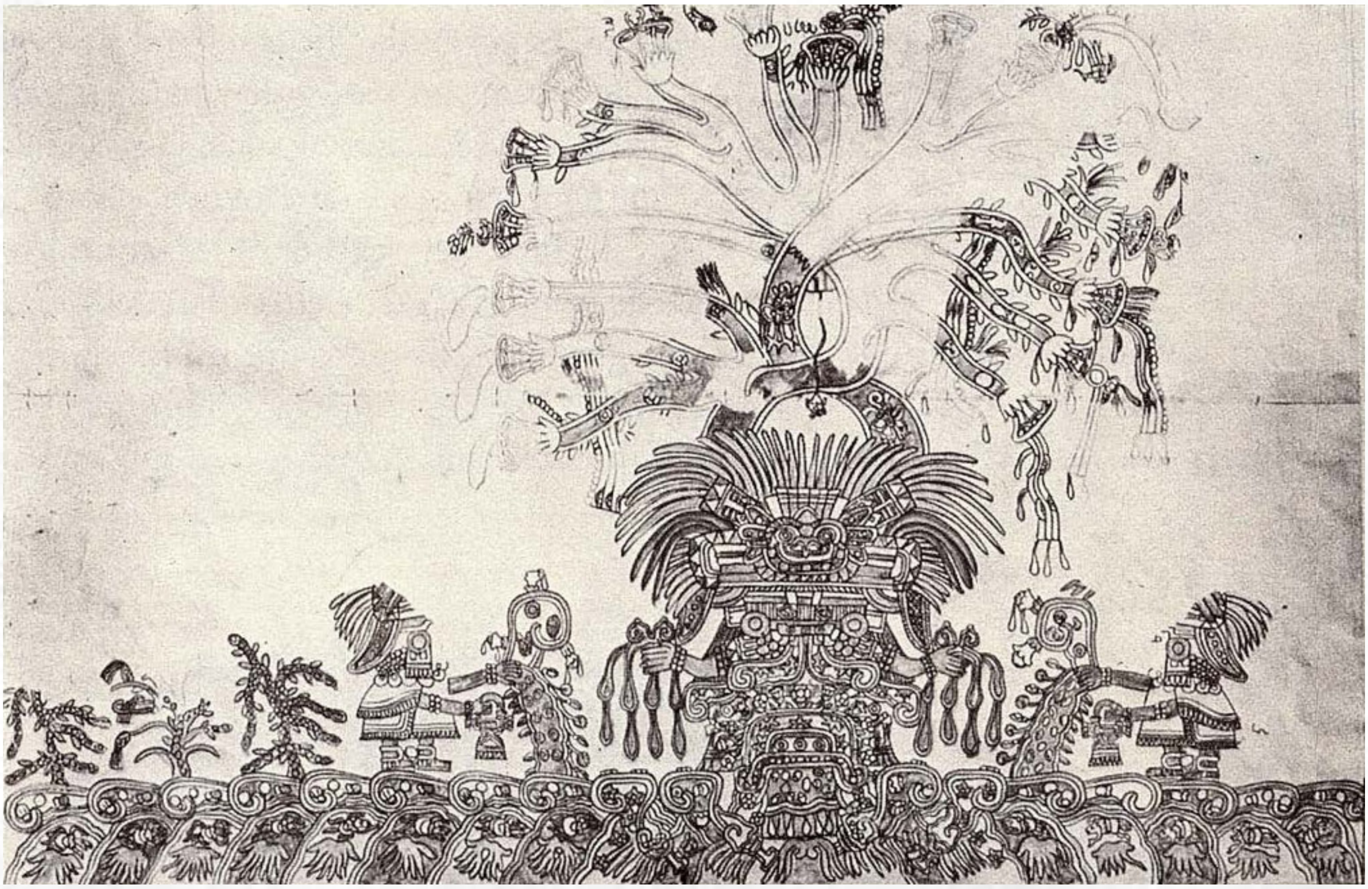


Fig 7 Female Divinity, Tepantitla

To the right of the divinity, a hand of a lost hierophant or deity protrudes and from it gushes a stream of falling water. (Fig 10) That this is indeed water is proved by the glyph to which we are now accustomed, alternating shells and mushrooms. The mushrooms are green. In the stream itself are seeds among which I recognize entheogenic seeds of Rhynchosia sp.



Figs 8-11 Villagra's intermediate paintings after a Tepantitla mural and details thereof

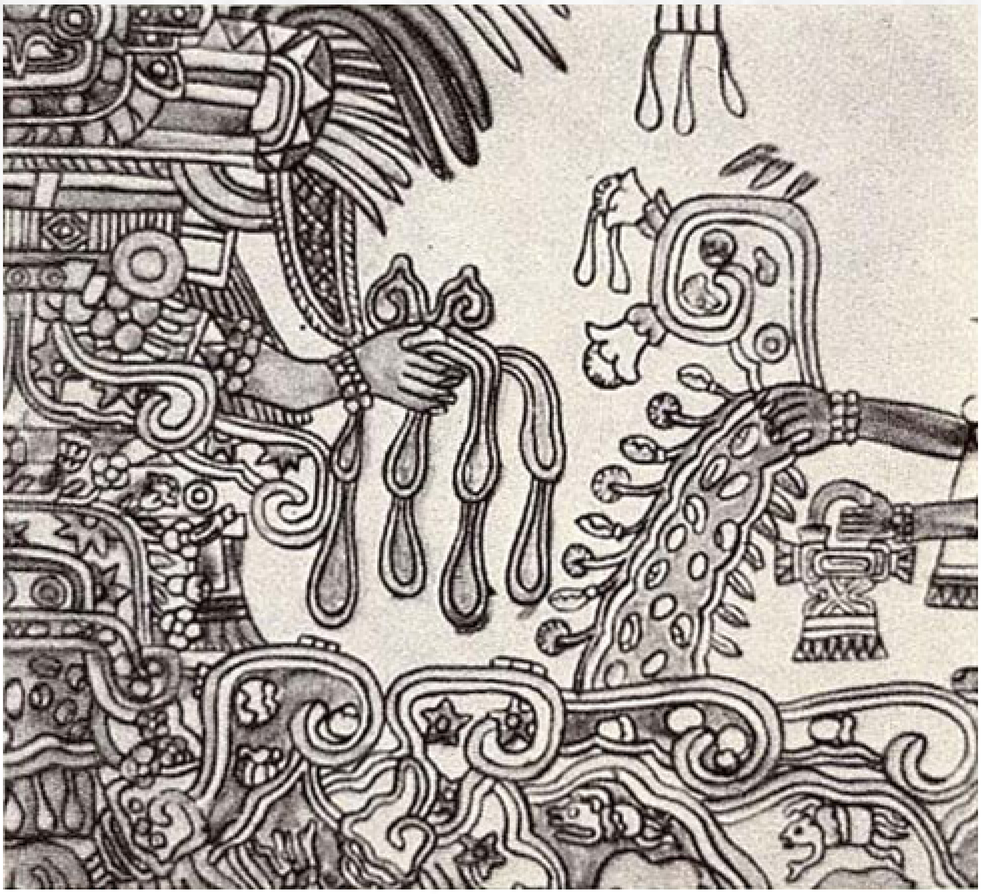


Fig 9

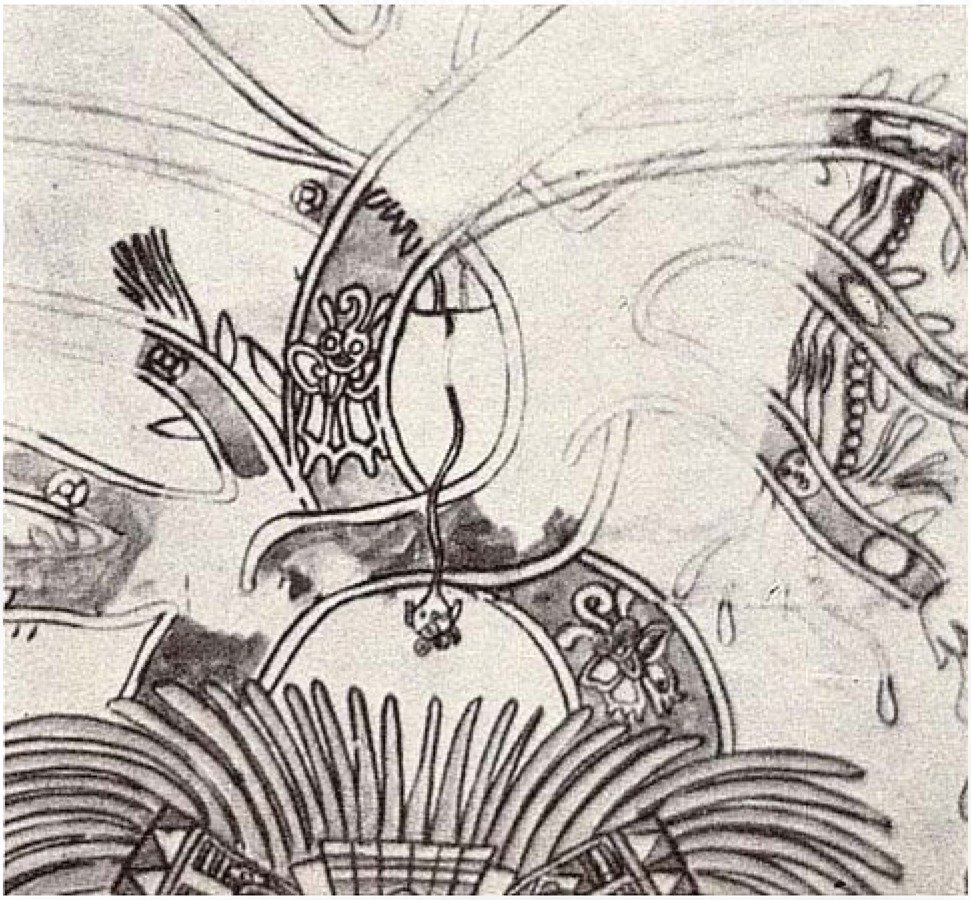


Fig 10

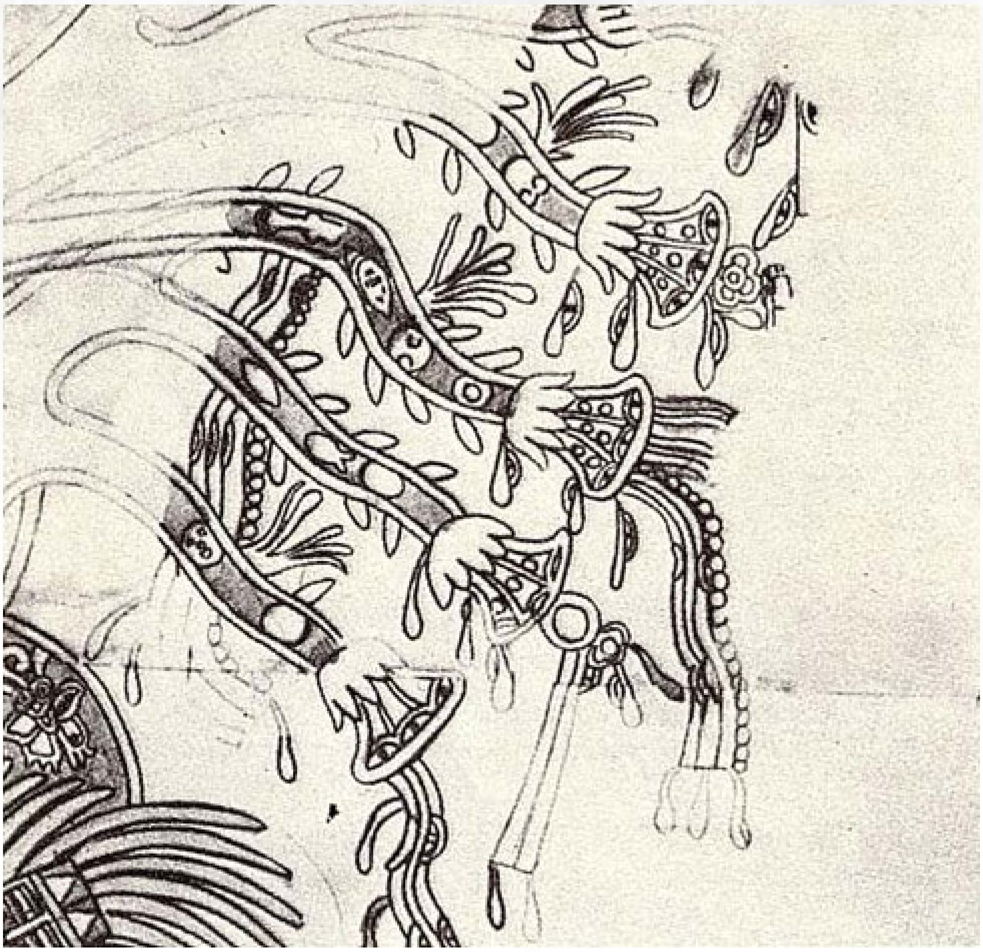


Fig 11

In the lower register of this mural we see the 'Playing Fields of Paradise' or Tlalocan as Caso has suggested. The lower right-hand corner of this mural shows a newcomer arriving in Tlalocan, waving a branch and shedding tears of nostalgia: so they interpret the picture. He sings an elaborate canticle, with five turnings in his speech scroll ornamented with *flowers*. Underneath this scene a stream emerges from the mouth of a frog. In the lake where he squats we see three times the symbol for water - shell and mushroom - and as the stream courses along 'disembodied eyes' mark its path. The whole scene is of the real world of the entheogenic vision of the Mesoamericans (Fig 12), unsuspected by Dr Caso or Sr Villagra.

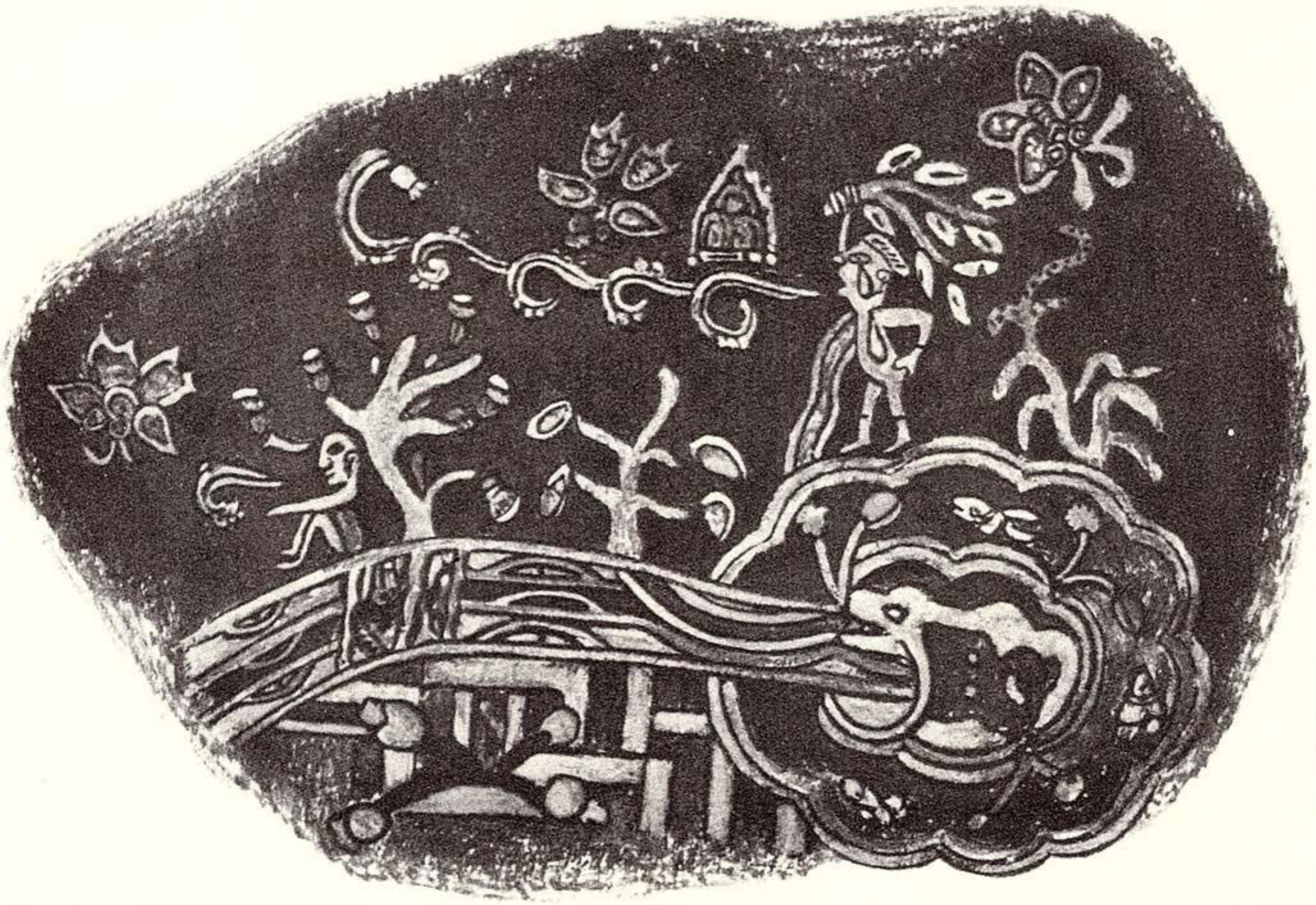
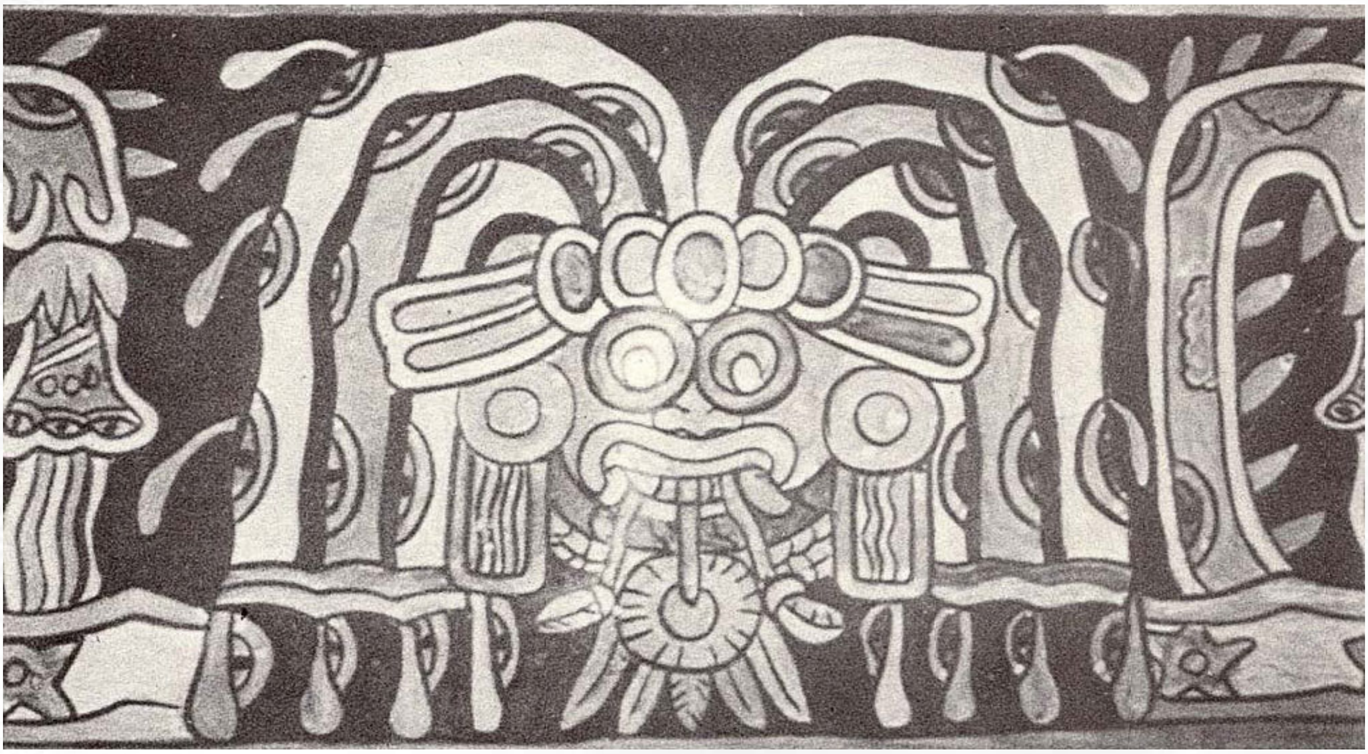


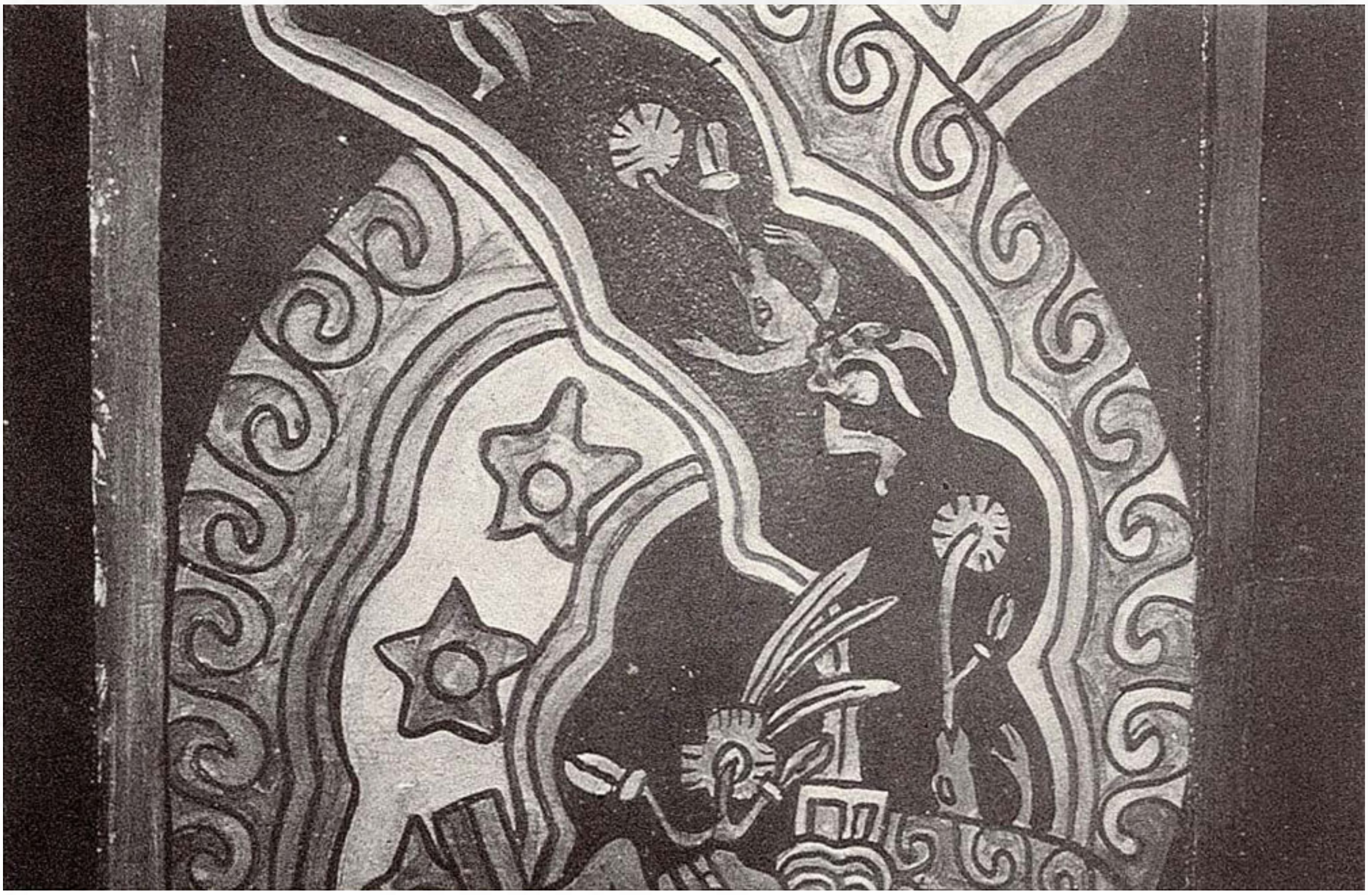
Fig 12 Tepantitla mural, detail: soul arriving on the Playing Fields of Paradise

Dr Henry B. Nicholson also photographed for me a few details in the borders, often serpentine, of the Tepantitla murals. We show these in Figures 13-15. From a jaguar's mouth hangs a mushroom, green for holiness, and from the top of his head bursts forth a fountain, dividing into two streams that fall on each side of his face. Drops of fluid, obviously entheogenic, emerge from the streams and a score or more of 'disembodied eyes' attend their fall. Nicholson gives us also another detail showing strange aquatic figures swimming with the familiar water glyph in their mouths - shell-and-mushroom. In a further detail there is the mushroom flanked on each side by a shell, the shells being of different species.

Margaret Seeler has supplied me with four black-and-white reproductions of the Teotihuacán murals that appear here as Figures 16-19. In two, *flowers* (perhaps highly stylized morning-glories) drip wondrous fluid, the flowers and the drops being accompanied by 'disembodied eyes'. In another, three creatures are proceeding upstream each with a mushroom in its mouth - a flying fish, a turtle(?), and a heron. Especially striking is the fourth: drops of fluid, obviously hallucinogenic, are giving birth to 'disembodied eyes' as they fall.



Figs 13 and 14 Tepantitla, details



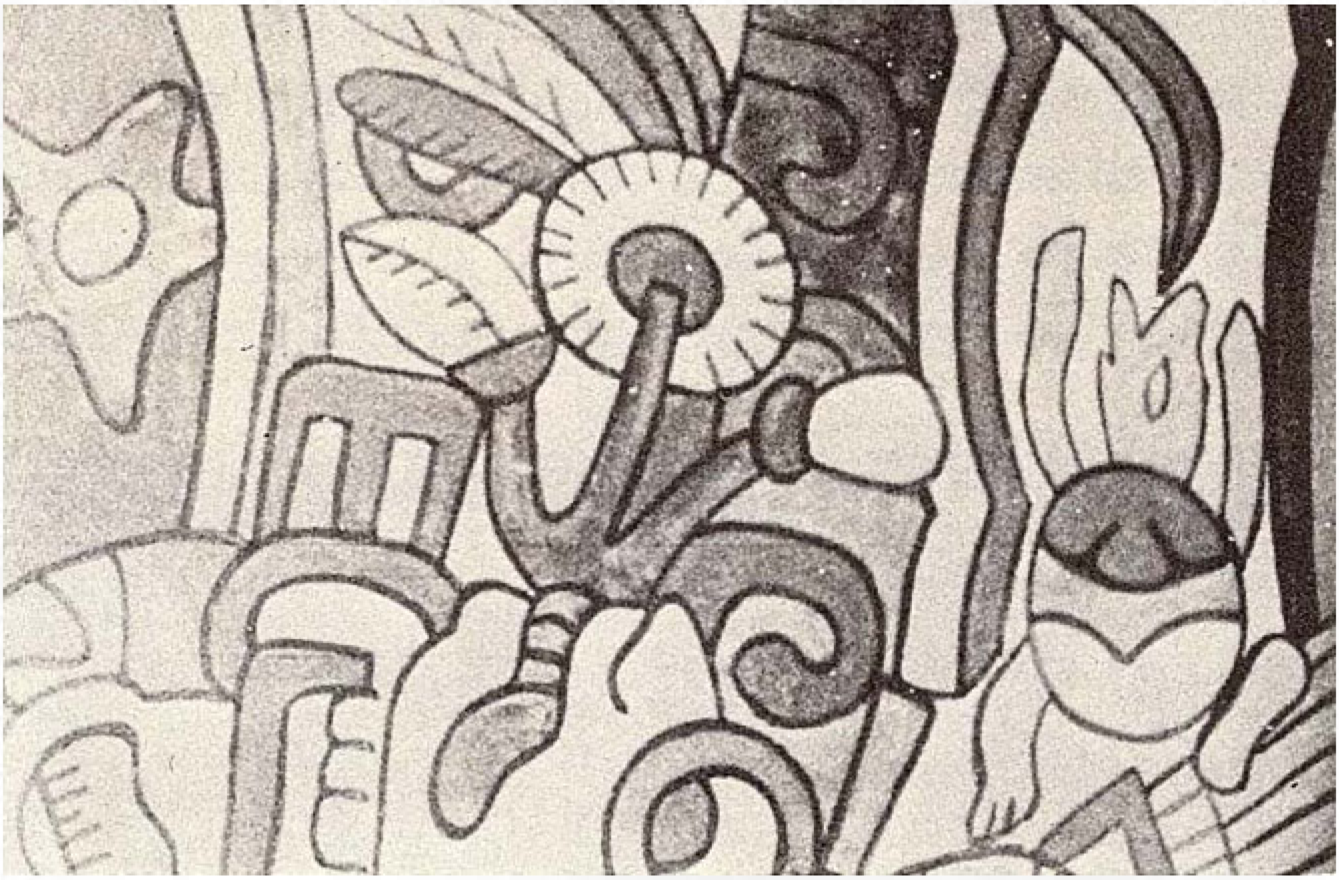
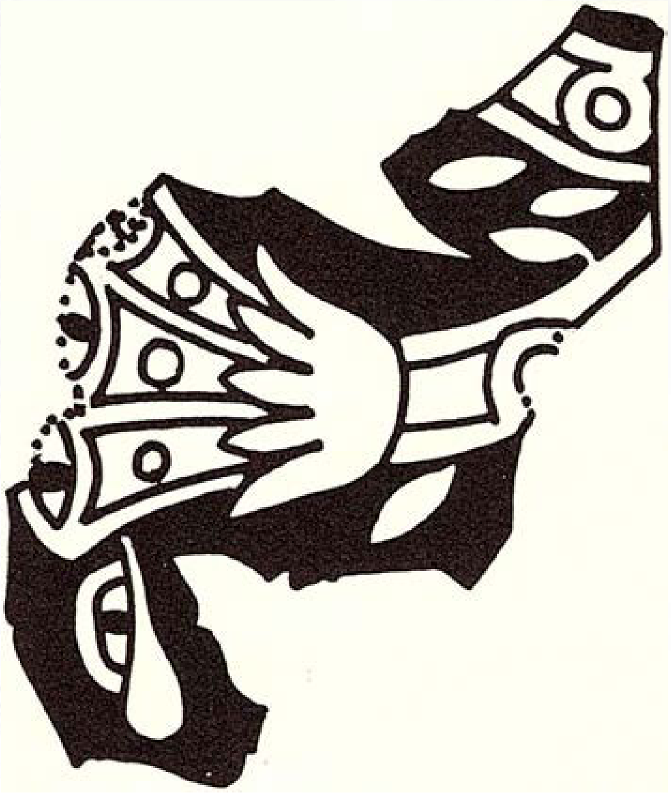
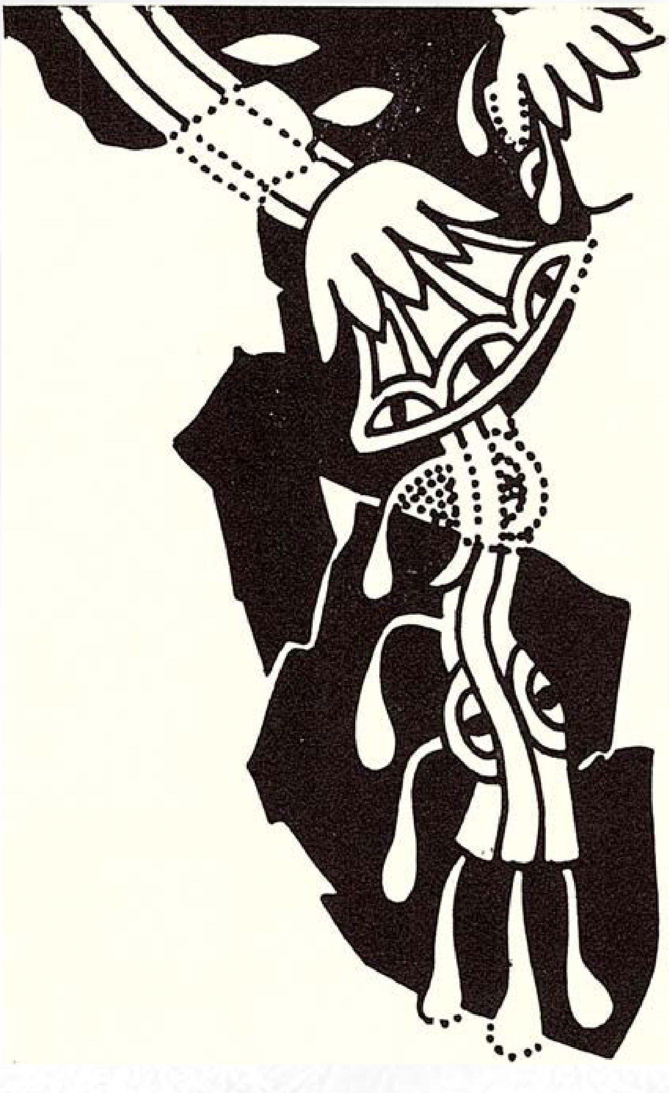


Fig 15 Tepantitla: further details





Figs 16 and 17 Tepanrirla: details

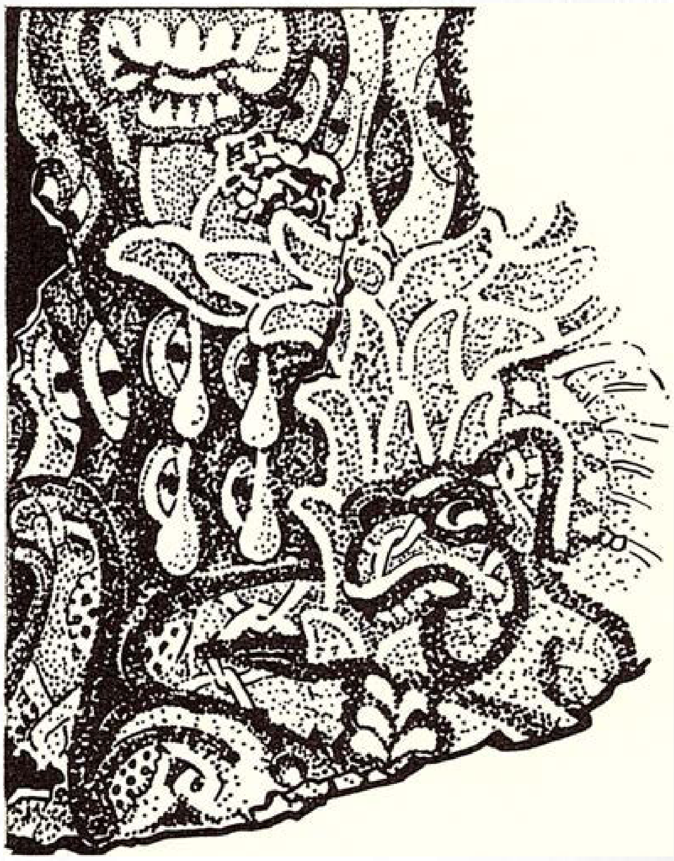


Fig 18

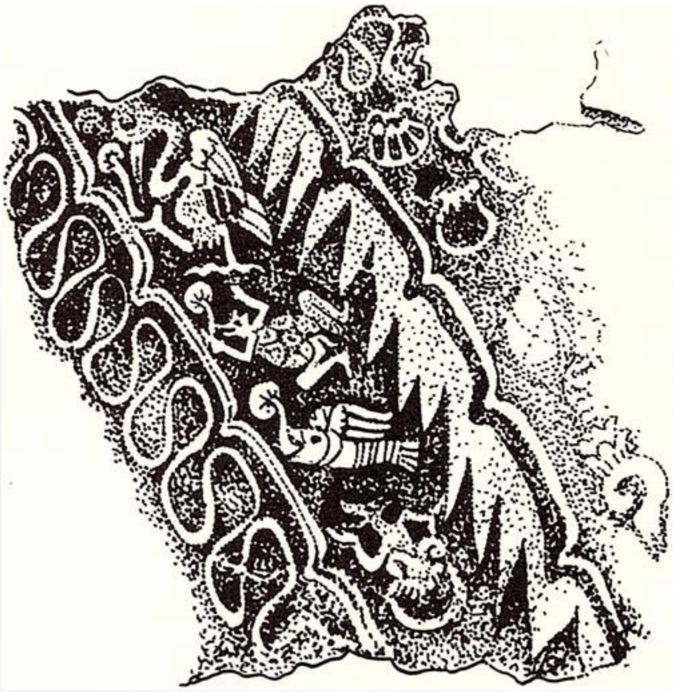


Fig 19

Zacuala

In all the glyphs for water that we have seen, mushrooms were the telling ingredient. But mushrooms figure also in isolation, away from water. Mme Laurette Séjourné and her archæological team discovered a mural on the front, perpendicular part of a step (it might be called a 'predella' in Western ecclesiastical architecture) in a structural complex known as Zacuala, which we reproduce in Figure 20. In the central cartouche of this mural there is a' radiant mouth', and from this cartouche four unmistakable greenish mushrooms emerge. Beyond the mushrooms on either side are three 'disembodied eyes'. Could there be more eloquent expression in paint of the Word, of Sacred Song, under the potent influence of the divine mushrooms? How could any single picture tell us more clearly what Teotihuacán was all about? Our painting was a reconstruction by Abel Mendoza based on the surviving fragments, which amply justified his restoration.

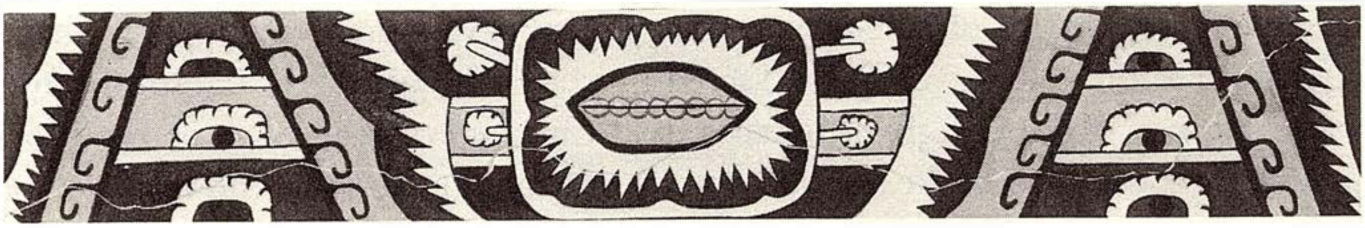


Fig 20 Zacuala: 'Predella'

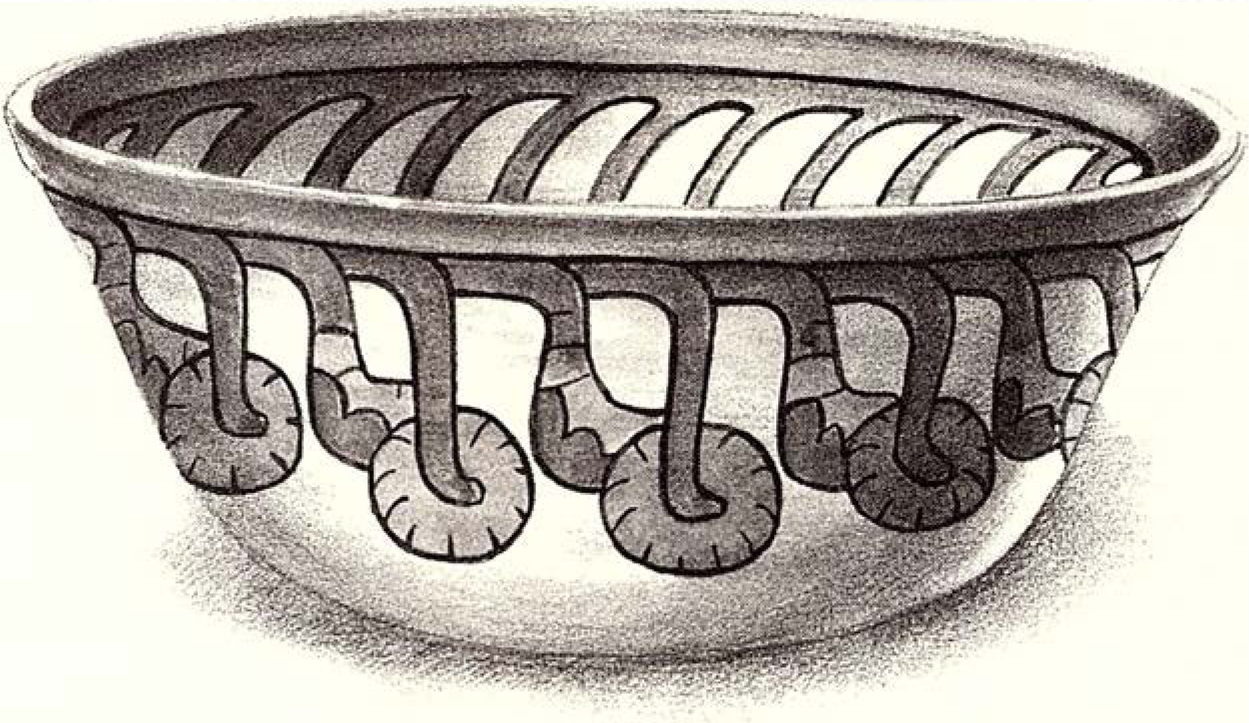
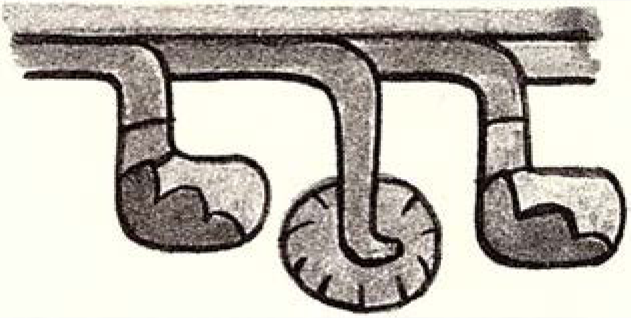


Fig 21 Zacuala: Painting of reconstructed bowl



Some sherds found in the débris of Zacuala permitted Mendoza to paint a terra cotta bowl decorated with a row of mushrooms encircling it and a second row, behind the mushrooms, of seashells. (Figure 21) I like to think this was a utility vessel to carry the mushrooms to the cenaculum where they were needed.

Chalchihuitl and Tonallo: a speculation

Small rings of jade played a prominent part in pre-Conquest Mesoamerican culture. Scholars seem to think this was because of the high value placed on the jade. Green, the color of jade, was always a symbol of enhancement, as we have often seen in the color given to the sacred mushrooms. But surely the mushroom comes first. It is colored green because its divinity merits the color of the most precious stone known to the Mesoamericans, though for the awesome mushrooms it was contrary to nature. The jde rings are precious, of course, because they are of jade but basically because they exemplified the sacred mushrooms. Agustín Villagra in his chapter on the 'Mural Painting of Teotihuacán' in the *Handbook of Middle American Indians* (1971, Vol 10, p 141) shows us the surviving elements in the facade that is peopled with *chalchihuites*, jade-green rings, which he has kindly reproduced for us. (Fig 22) He is right: they are the representations of jade-green rings. But surely they represent something infinitely more precious, the divine mushrooms. There is an intimate reciprocity between the jade rings, shaped to represent the glyph for mushroom and carved from the most precious stone, and the mushroom painted green like jade, the acme of holiness. A chalice designed by the finest goldsmith and jeweler, a Cellini-conceived cup, merely aspires to be worthy of the blood of Christ that it is destined to hold. The green *chalchihuites* to which Villagra calls our attention in the Road of the Dead are only a symbol of the jade rings that in turn speak for the wondrous mushrooms.

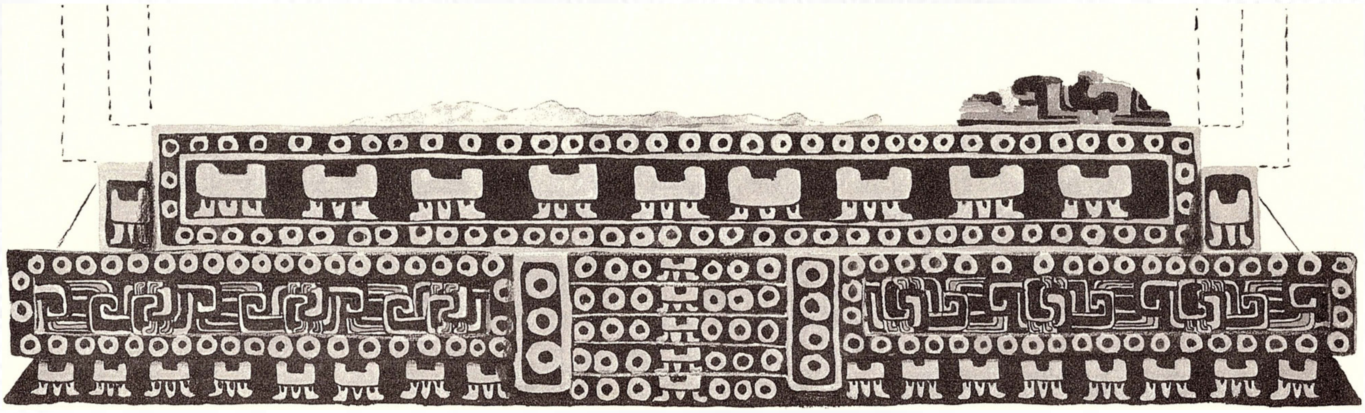
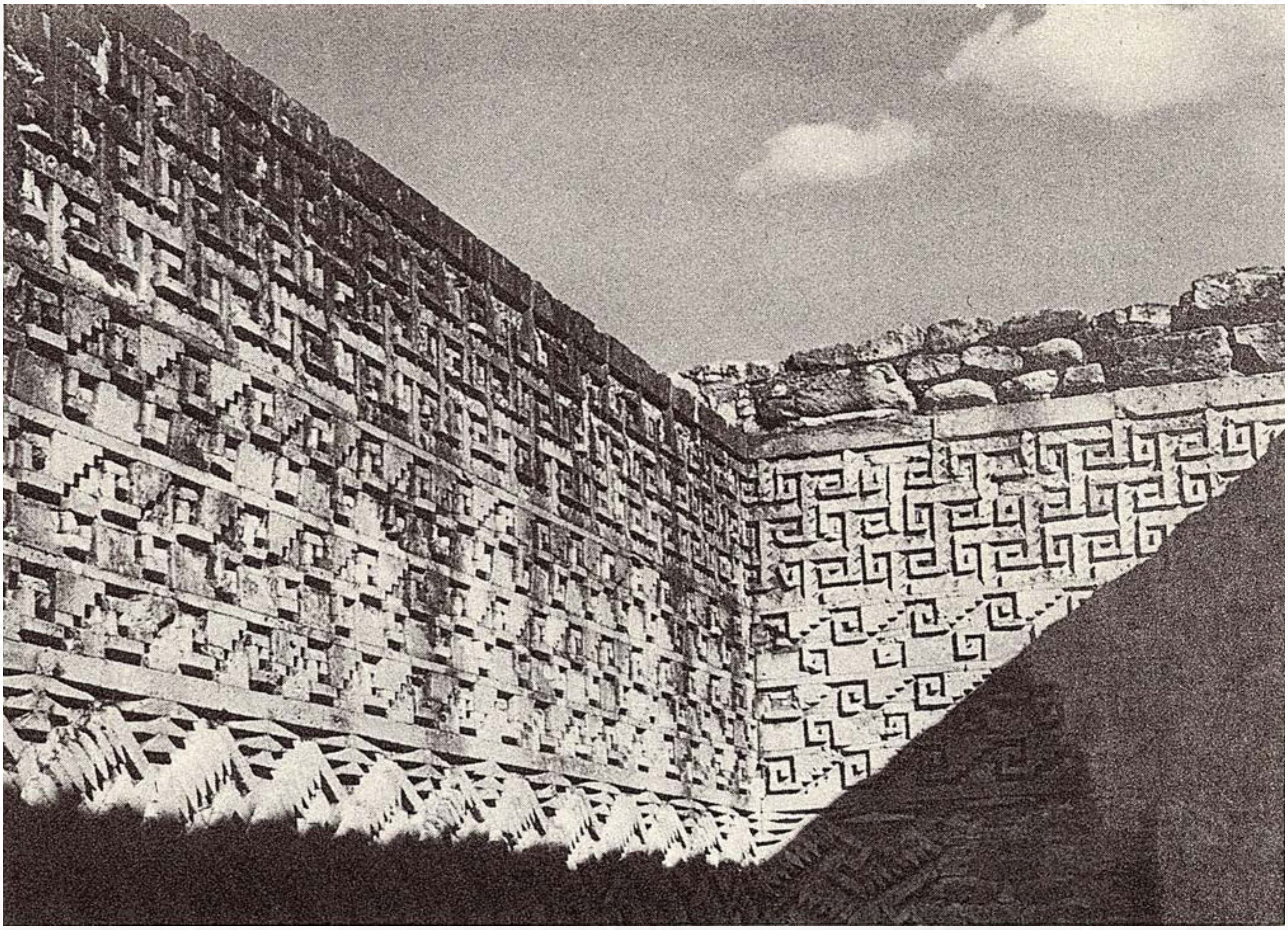


Fig 22 Teotihuacan: surviving elements of facade in the Road of the Dead, painted by Villagra Caleti

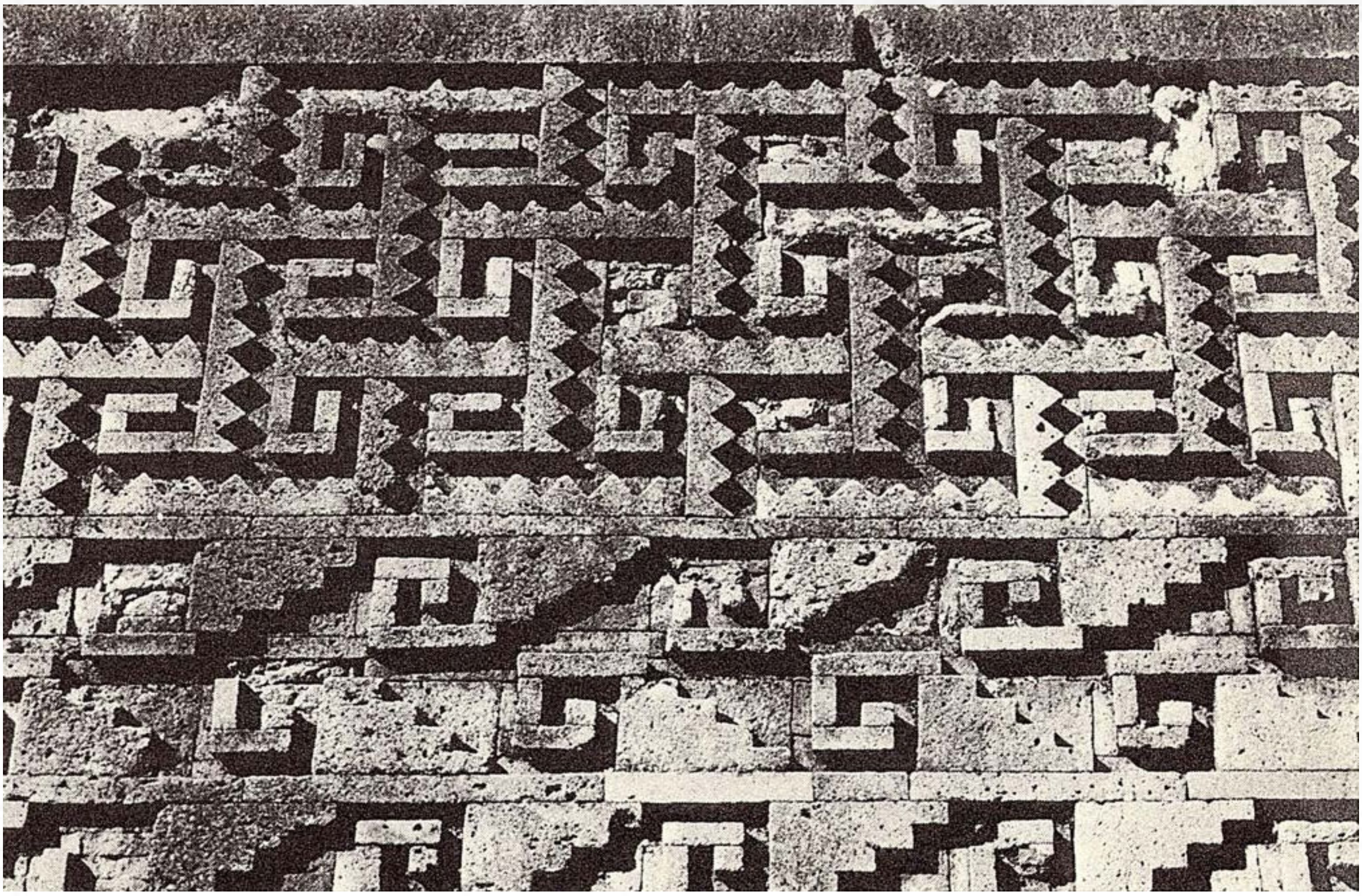
Again let us take the *tonallo* symbol. (p 64) What is the derivation of that symbol? What is it ultimately but four mushrooms, the sacred number four? And what of the series of concentric rings that we have seen encircling the *tablero* of our statue of Xochipilli? (p 64) Why are they not the glyph for mushrooms rather than solar symbols? The mushrooms signify of course all the other beneficent manifestations of a favorable Nature - solar warmth, gentle rains and life-giving showers, butterflies, hummingbirds, flowers waving in the breeze, music, laughter, singing and dancing, poetry. However alien it be for us of an alien culture, the sacred *flowers* breathed life, breathed reverence and joy, into all these other pleasant aspects of existence on this earth.

The superior entheogens of Mesoamerica - primarily the mushrooms and morning-glory seeds - all interrelated chemically, at the outset of the visions that they bring, more often than not start with abstract designs, for me mostly angular but for others often sinuous, curving, serpentine. They are breathtaking in their clarity, three-dimensional, in color, constantly shifting, changing, as it were dancing. We have already pointed out that these motifs recur in the finest of the Mesoamerican codices. I think this explains their haunting beauty that many have felt when contemplating them. We have suggested that this was why the codices were venerated beyond any reason that the Spaniards' mentality could grasp: the characters were inspired by the divinity that dwelt in the entheogen.

The architects of pre-Conquest Mexico let themselves go in complicated 'frets', borders usually with angular designs endlessly repeated, or else in rhythmically curving lines, and in Figures 23 and 24 we show photographs of these 'frets' from the ruins of Mitla. The same theme can be seen in Teotihuacán but the Mitla 'frets' serve to show how widely scattered they are in Mesoamerica. The 'frets' in Spanish are called *grecas* as they are also in Italian. *Greca* simply means 'Greek'. Is this not odd? Why 'Greek'? The *grecas* of Mitla could not have been inspired by Greece, nor did the Greeks learn to design their *grecas* from Mexico. Both, I suggest, were inspired by their respective entheogens, in Mesoamerica by the entheogens that by now we know well, in Greece by the sacred potion drunk at Eleusis and certainly elsewhere, coming from entheogenic mushrooms called Claviceps parasitic on barley or other grasses. There have been arguments about the swastika, which occurs in remote parts of the world to all appearances autochthonously. Or is diffusion the explanation? The answer surely lies rather in the natural diffusion of the plants producing entheogens instead of the diffusion of art motifs. To illustrate this we show in Figure 25 an amphora of the archaic period (ca BC 640) from Eleusis. Interspersed among the figures there are many ornamental 'fillers', as the art historian is apt to call them, which are simply our '*grecas*' broken down into isolated art motifs. The Greek art historian has generally said that this vase gives no clue to what took place once a year in the sacred precincts of the Temple to Demeter. But as he was not present on that night of revelations he of course does not know, and now that we are familiar once again with the abstract designs engendered by the entheogens, this new evidence tells us with certainty that the artist was drawing his inspiration from the potion of Eleusis. Such designs were the common property of initiates everywhere in the Age of Entheogens. Marija Gimbutas has revealed to us a wealth of such designs from artifacts running back to the fourth and fifth millennia B C, mostly from what she properly calls 'Old Europe' but what we know today as the Balkans. (The inhabitants of Old Europe, whoever they were, possessed cultivated barley and wheat and therefore ergot was available to them, in addition to several other entheogenic mushrooms.) She also reproduces the design (Fig 26) of a gold ring recovered near Knossos, ca BC 1500, showing a vision of five whirling females (Maenads?) with insect heads and 'hands', and a 'disembodied eye', which I suggest is the eye of the hallucinating observer.



Figs 23 and 24 Mitla: *grecas* in ruins of the pre-Conquest temple



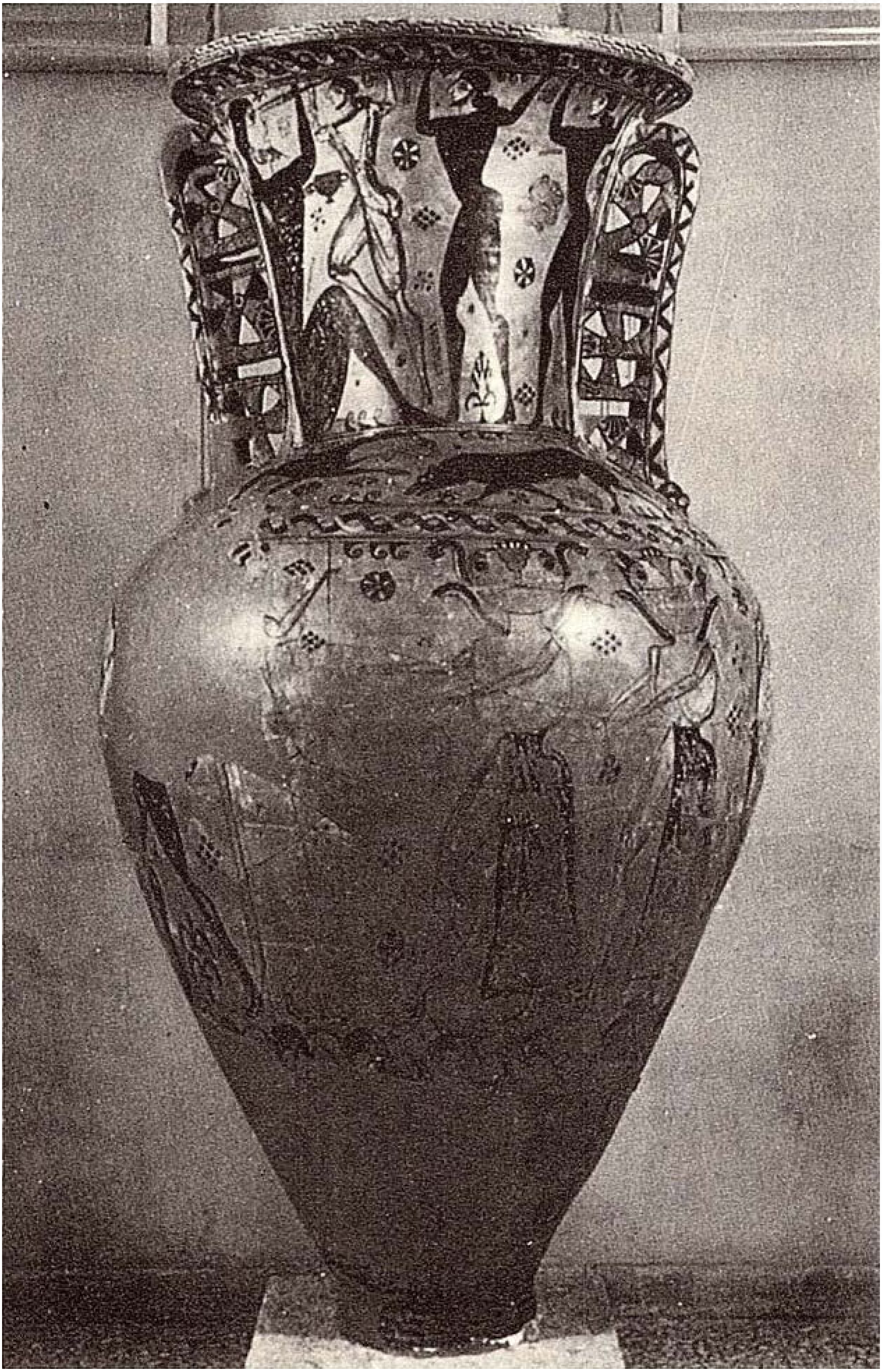


Fig 25 Archaic Greek amphora found in Eleusis

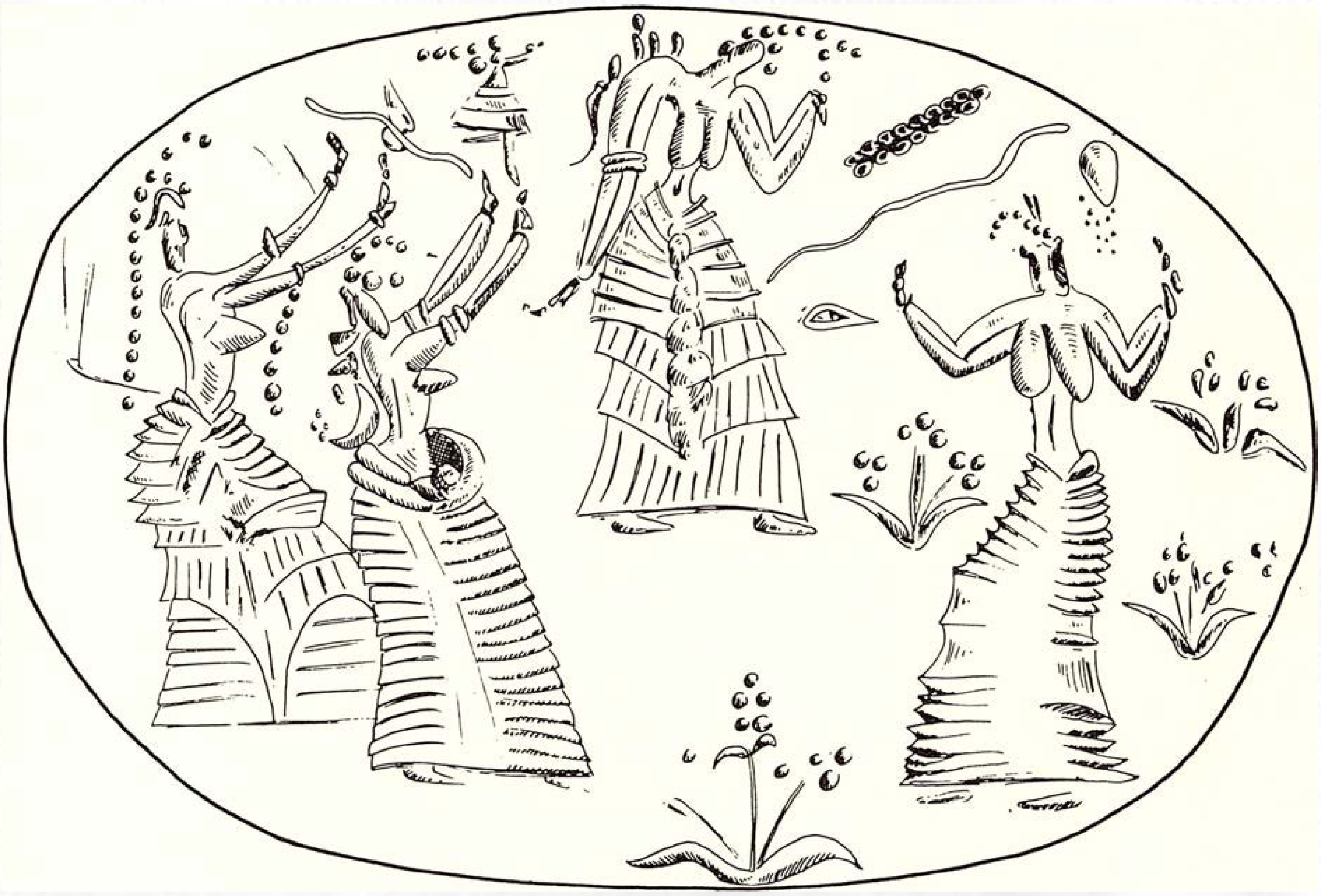


Fig 26 Gold Ring of Isopata near Knossos. Goddess on right and worshippers. Note disembodied eye. Much enlarged.

Teotihuacán belongs to prehistory. We cannot even be sure what language was spoken by the natives of that vast city-sanctuary. But its dimensions are so great that I suggest it was the religious capital of all Mesoamerica, and that for many centuries. Here is the explanation of the cultural amalgam that united so many peoples of diverse linguistic families, of diverse origins, living in widely different climates and ecosystems: that explanation lay in the entheogens and specifically in the Wondrous Mushrooms. For the native they were miraculous. Miller in his book on Teotihuacán even points out the plunging god that I think was Piltzintli, an aspect or manifestation of Xochipilli. The *veladas* that were sung in those chambers have their direct descendants in *veladas* being sung over wide areas of Mexico today, of which we possess full recordings in the chants of María Sabina. In 1960 I wrote:

> What you are seeing and what you are hearing appear as one: the music assumes harmonious shapes, giving visual form to its harmonies, and what you are seeing takes on the modalities of music - the music of the spheres. 'Where has there been greater rivalry between seeing and hearing?' How apposite to the Mexican experience was the ancient Greek's rhetorical question!

It is indeed surprising to discover in Mexico a common denominator with ancient Greece - in the *veladas* that were there sung the key to the Mysteries of Eleusis, in the 'ornamental fillers' that decorate the vase from archaic Attica and the frets of Mitla! There were two mushroom potions, in Greece derived from a Claviceps, in Mexico from a *Psilocybe*. The effect was the same and it was prodigious.

CHAPTER 9

The Mushroom Stones Of The Maya Highlands

Many now know about the mushroom stones of the Guatemalan highlands. They first emerged into the world's consciousness on 29 May 1898, when the famous German geographer Carl Sapper published a picture of one in *Globus*. (Figure 1) They had been discussed for some years in Guatemala in circles interested in the archæology of that country, and now finally they were breaking into print in journals of the outside world. Sapper pointed out that the mushroom stones were 'mushroom-shaped' but, strangely, failed to consider whether the sculptors might be carving mushrooms. He saw that these stones were religious. He dismissed a suggestion that they were phallic but in the end he left their purpose in the air. He was right in dismissing the erotic notion: the fungal world is filled with erotic symbolism, male and female, but when an artist sets out to present a phallus, he starts with a phallus in mind, not a mushroom, and the figurines are all mushroomic, not phallic. Sapper ends by urging that specialists in neighboring cultures be consulted to see whether they might shed light on these 'unique' figurines. But his appeal went unanswered until the Wassons linked the mushroom stones with the mushroom cult in Mexico in the early 1950's.

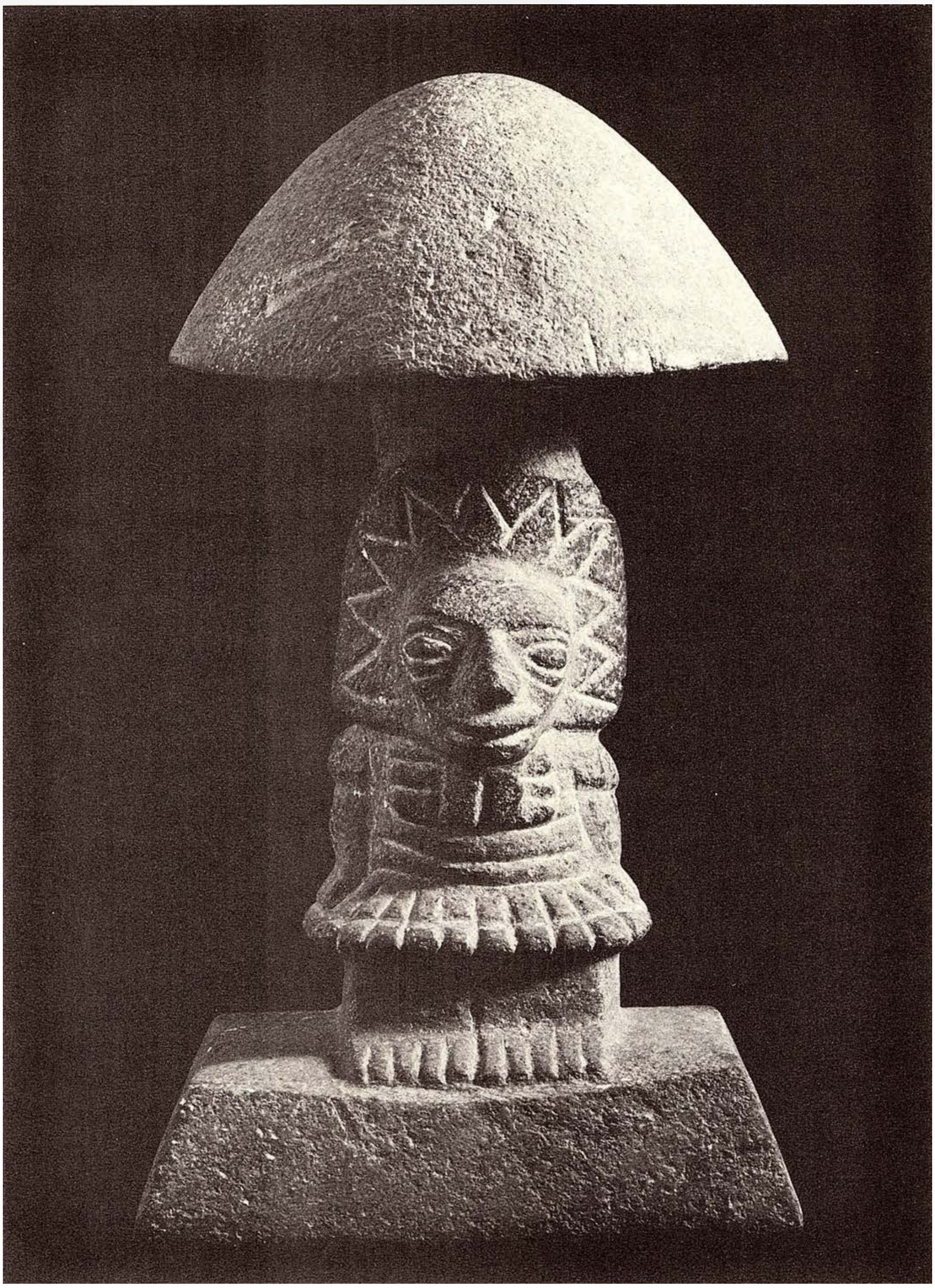


Fig 1 Earliest mushroom stone published. Now in Rietberg Museum, Zurich. Ht 32.5 cm

Two months after Sapper, on 29 July 1898, Daniel Brinton reverted to the mushroom stones in *Science*:

> I would offer a suggestion. They resemble in shape mushrooms or toadstools, and why should not that be their intention?
> [n. s., vol 8, no 187, p 127]

He then advanced a linguistic justification, discovering (as he thought) that the sounds in one of the Mayan languages for the words 'mushroom' and 'moon' were almost the same. Mayan scholars dismissed his idea, but let it be now noted that he was the first to tie mushroom stones with mushrooms. In this he was right but wrong in his follow-through. He had clearly never heard of the mushroom cult in Mesoamerica.

Archæologists in the Guatemalan highlands have been finding additional mushroom stones and many others have slid into the market from surreptitious sources, until today some three hundred are known to exist. They are in private collections and museums throughout the world. I have made a selection from the finest of them to illustrate this chapter.

When Valentina Pavlovna and I came on the Mesoamerican scene in 1952, we at once assumed that the mushroom cult reported by the friars in Mexico found full expression in the mushroom stones of the highland Maya. We propounded this thesis in *Mushrooms Russia & History* and other publications in the late 1950's, failing however to stress our surprise and puzzlement that it took us, outsiders, to see the obvious. True, we were specializing in the rôle of mushrooms in human cultures, but still we were astonished at the seeming blind spot of all scholars of European ancestry in failing to take into account what the sixteenth and seventeenth century friar-chroniclers had stressed, though inadequately. In *Mushrooms Russia & History* (pp 181-2) we drew attention to a reference to mushrooms in the pre-Conquest Mayan *Popol Vuh* in a religious context, and likewise to one in the *Annals of the Cakchiquels*, also Mayan, also religious. There are no other references to mushrooms in these pre-Conquest sources.

The late Stephan F. Borhegyi thought he discerned a tie linking the mushroom stones and the Mesoamerican ball game, for reasons that I will not enter into here. The ball game was a religious event alike in Guatemala and Mexico. (This may seem odd to some, but one need only attend a *sumo* match in Japan to see a survival of such a feeling in the ritual of those wrestling matches; and in ancient Greece the Olympic games breathed religion.) There is nothing incompatible between the mushroom stones and the ball game. Those who have mastered the mushrooms arrive at an extraordinary command of their faculties and muscular movements: their sense of timing is heightened. I have already suggested that the players had ingested the mushrooms before they entered upon the game. If the mushroom stones were related to the ball game, it remains to be discovered what rôle they played.

★

We were constantly on the lookout for evidence of the tie between the mushroom stones and mushrooms. The difficulty was that the last carvings, extremely crude, were made some centuries before the Conquest and it looked as though the stones were being abandoned at that time. We hardly dared hope to find a continuity with post-Conquest Mesoamerica.

Early in our pursuit we became acquainted with a mushroom stone in New York owned by Mr and Mrs Hans Namuth. He is a photographer and she had been born an Herrera of Guatemala. A striking piece, it came to be known as the Namuth artifact, and Mr Namuth graciously photographed it for us. (Figure 3) An elderly woman (as we thought her then) was bending over an inclined plane in front of her. The figurine was admirable but it meant nothing more to us than that.

Late in June 1960 Robert Ravicz and I made a field trip to the Mixteca together and in Juxtlahuaca we put up in the home of Robert's friends, Guadalupe González Vega and his family. On the night of 5-6 July we attended a *velada*, the aunt of our host serving us as *sabia*. The notable feature of this *velada* was the preparation of the entheogenic mushrooms: Juventina, the youngest daughter of the family, a child, a maiden (*doncella*), ground them on a *metate* over which she leaned. She ground them, as is customary, with a *mano*, a hand roller also made of stone. It was at once clear to me that the *doncella* was performing the religious office of the female figure in the Namuth artifact. There could be no doubt about it. The composition of the figurine was as close as the medium would permit the sculptor to go. (Figure 4)

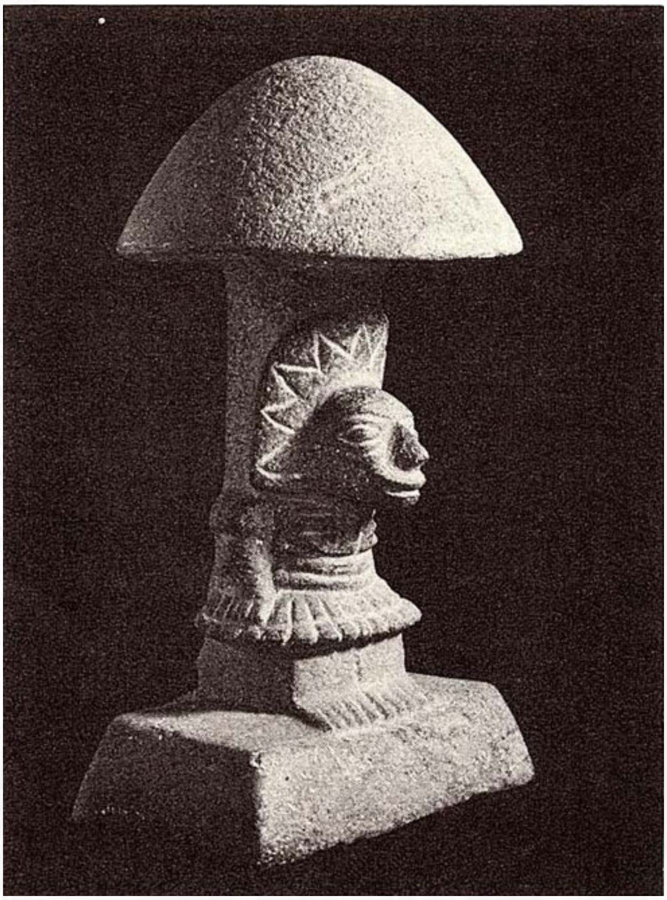


Fig 2 Second view of Rietberg mushroom stone

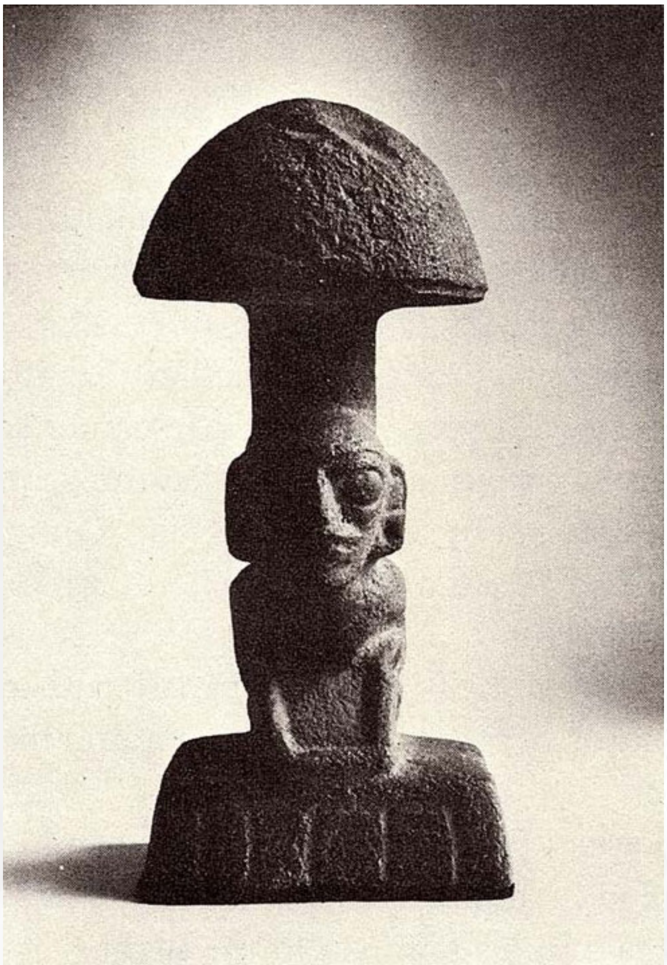


Fig 3 Hans Namuth artifact. Early photograph taken in middle 50's

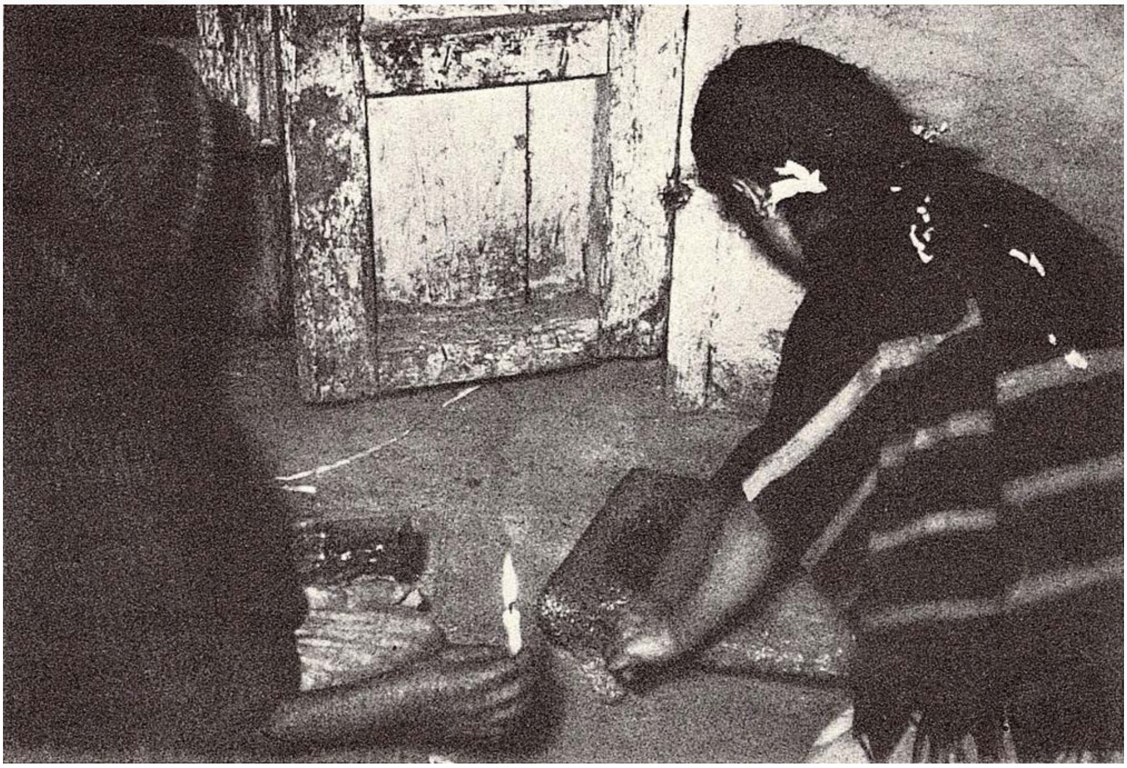


Fig 4 Young girl grinding sacred mushrooms in Juxtlahuaca, Oax., in the Mixteca

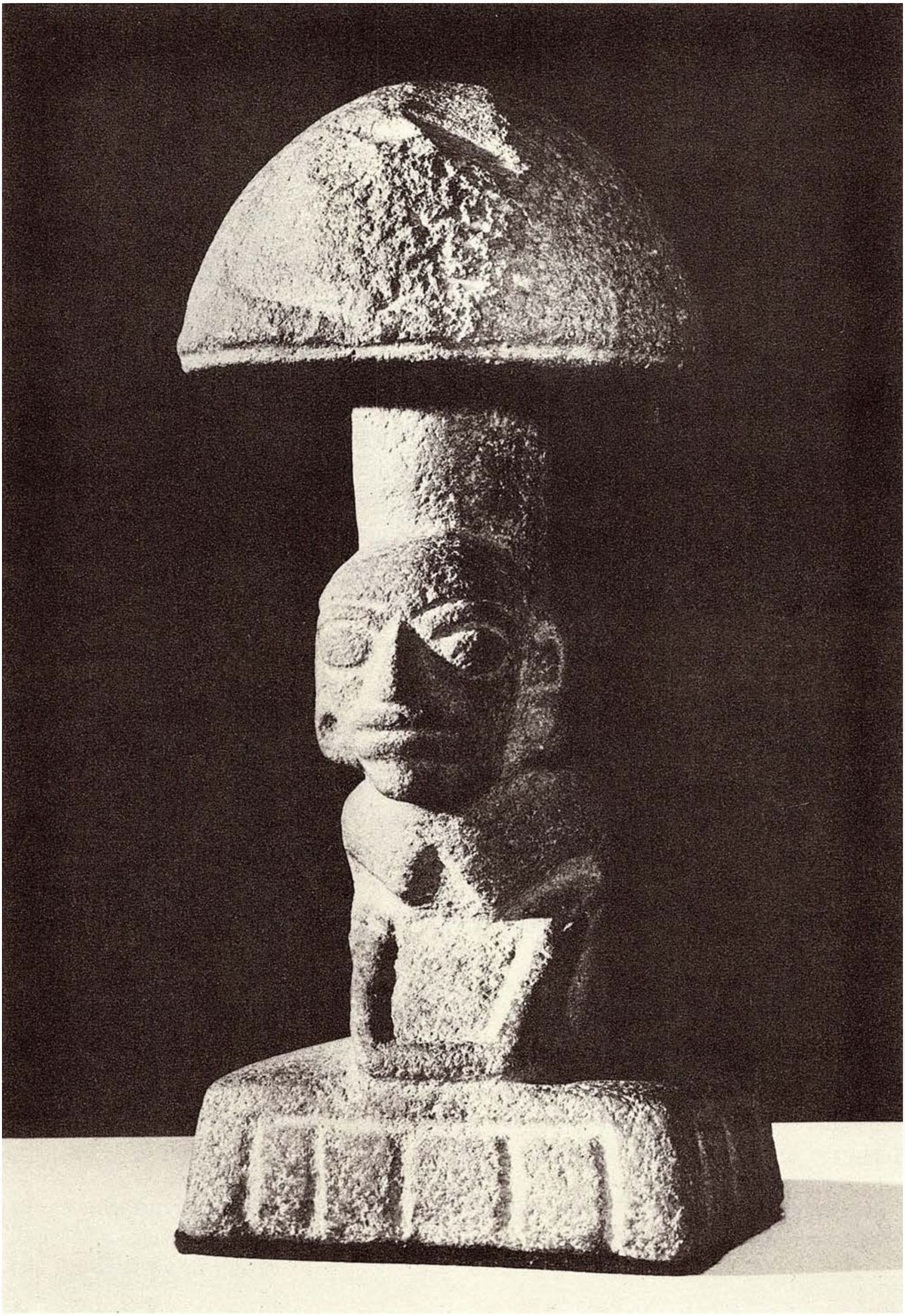


Fig 5 Second photo taken of Hans Namurh artifact in 1962

I returned to New York and on Steve Borhegyi's next visit we rushed around to the Namuth studio together: we perceived for the first time that the figure displayed the budding breasts of a virgin. We ordered new photographs that would highlight this feature. (Figure 5) In his letter dated 14 June 1962 to Mr Namuth, Borhegyi explained why we needed them:

> I am now completely positive that the figure on this mushroom stone represents a young female working on the metate.
> [Carbon copy in my Borhegyi file]

Later we learned that grinding the mushrooms on the *metate* and drinking the pulpy crushed mushrooms in water was far more widespread than we had known at the time: before the Conquest it may have been the general practice. I have given the evidence for this on pp 31-32.

Juventina in Juxtlahuaca was, all unknowing, the key to the highland Mayan *doncella* some 2000 years before.

A little later, reinforcing our Mixtec evidence, there emerged into the market place from the archæological site of Kaminaljuyu a remarkable find: nine miniature mushroom stones with nine miniature *metates* and *manos*. (Figure 6) The miniature mushroom stones were linked by physical association with the *metates* and *manos*. They supported the testimony of the Namuth artifact and of Juventina.

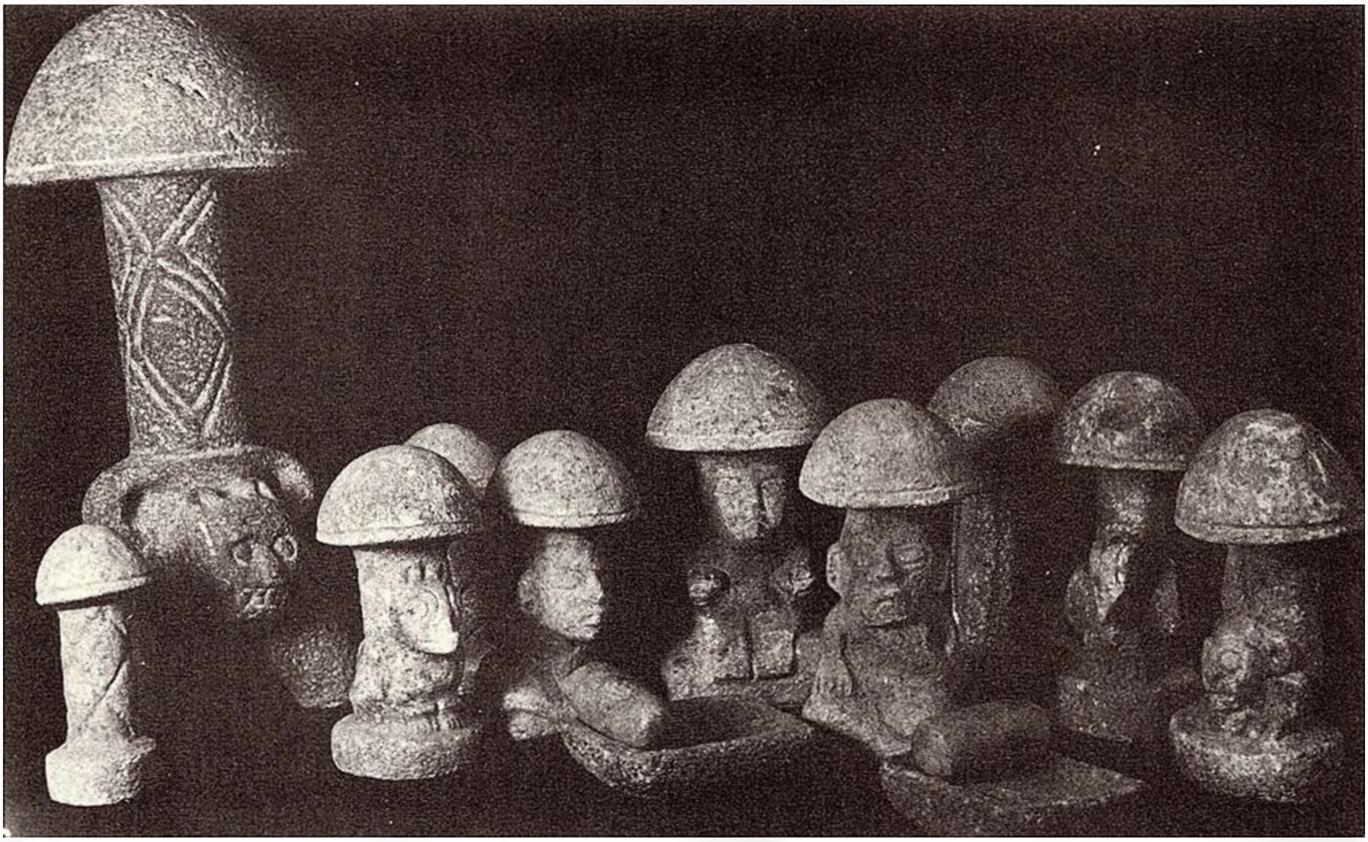


Fig 6 Miniature mushroom stones and metates, now in the Nottebohm Collection, pictured with a mushroom stone of normal size

For three weeks in 1953 Steve Borhegyi, his wife Susie, and we scoured the Guatemalan highlands seeking a contemporary use of entheogenic mushrooms. We did our best and we found none. The practice seems to have died out, but there is always a question: the Maya are more reserved than the Mexican Indians and we were less experienced then than later. We have always hoped for a breakthrough. There have been reports of the use of the sacred mushrooms among the Maya on both sides of the Guatemalan-Mexican border but the reports are not so far substantiated. Now the trails are muddied by the activities of trippers and hippies

Inexperienced observers have often remarked that no entheogenic mushrooms have been reported from Guatemala. They should realize that in Mexico Professor Heim and we had won the confidence of the Indians who brought the mushrooms to us and us to the mushrooms. To embark on a mycological survey of the highlands is an altogether different matter, much more arduous and prolonged. No reason exists to think the entheogenic species fail to grow there in abundance. Geologically the Guatemalan highlands are a continuation of the Sierra Madre in Mexico and we have always taken it for granted that the mycoflora would be the same. Bernard Lowy, Professor of Mycology at the State University of Louisiana in Baton Rouge, has been devoting a few weeks in each year to such a survey and he has lately found *Ps. mexicana* Heim in the heart of the Pokoman country. Pokoman is one of the Mayan-languages. (Fig 7) Professor Lowy is the first mycologist on record to make field trips in Guatemala.

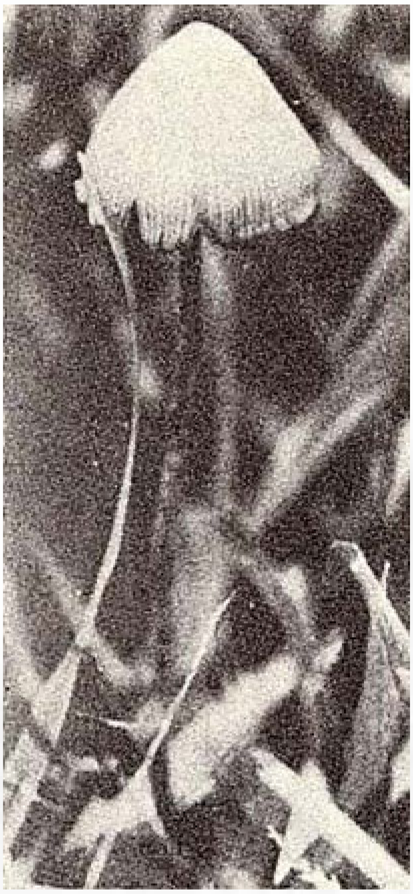


Fig 7

★

That the highland Maya knew the inebriating mushrooms is proven by a number of M ayan word lists for the Cakchiquel linguistic area around Guatemala City and Antigua. The lists that I have seen are mostly handwritten and experts date them from the end of the seventeenth century, though they bear no date. In the Tozzer Library at Harvard I discovered a photographed copy of a *Vocabulario Castellano-Cakchiquel* in which there are a number of entries for mushrooms. One reads: *hongo que emborracha*, 'mushroom that inebriates'. This word list was compiled, according to the library listing, by 'Calepino Franciscano',[31] and there is an almost identical copy in the Bibliothèque Nationale, Man. Americana, No 41, folio 106, linked with no name and written by a different and I think l ater hand. I am indebted to Karl-Herbert Mayer for discovering the Paris copy: he is assembling a notable collection of Mayan lexicons wherein the mushrooms figure. Then there is the *Vocabulario* compiled by the Franciscan friar Thomas Coto, to which Peter Furst drew my attention. It also lists *otros* [*hongos*] *que embriagan*, 'others that inebriate'. The Maya highlands and the highlands of what is now Mexico are essential areas of Mesoamerica, where there was an active give-and-take in warfare and trade throughout history and prehistory. Here is for me conclusive evidence that the use of entheogenic mushrooms existed in the highlands of what is now Guatemala. An anthropological trait as important as the use of entheogens would inevitably characterize the whole of the cultural entity known as Mesoamerica.

---

[31] In the Renaissance 'calepino' came to mean a Latin dictionary and then any bilingual dictionary, after a Latin lexicographer of that name. Calepino Franciscano = 'Franciscan Dictionary'.

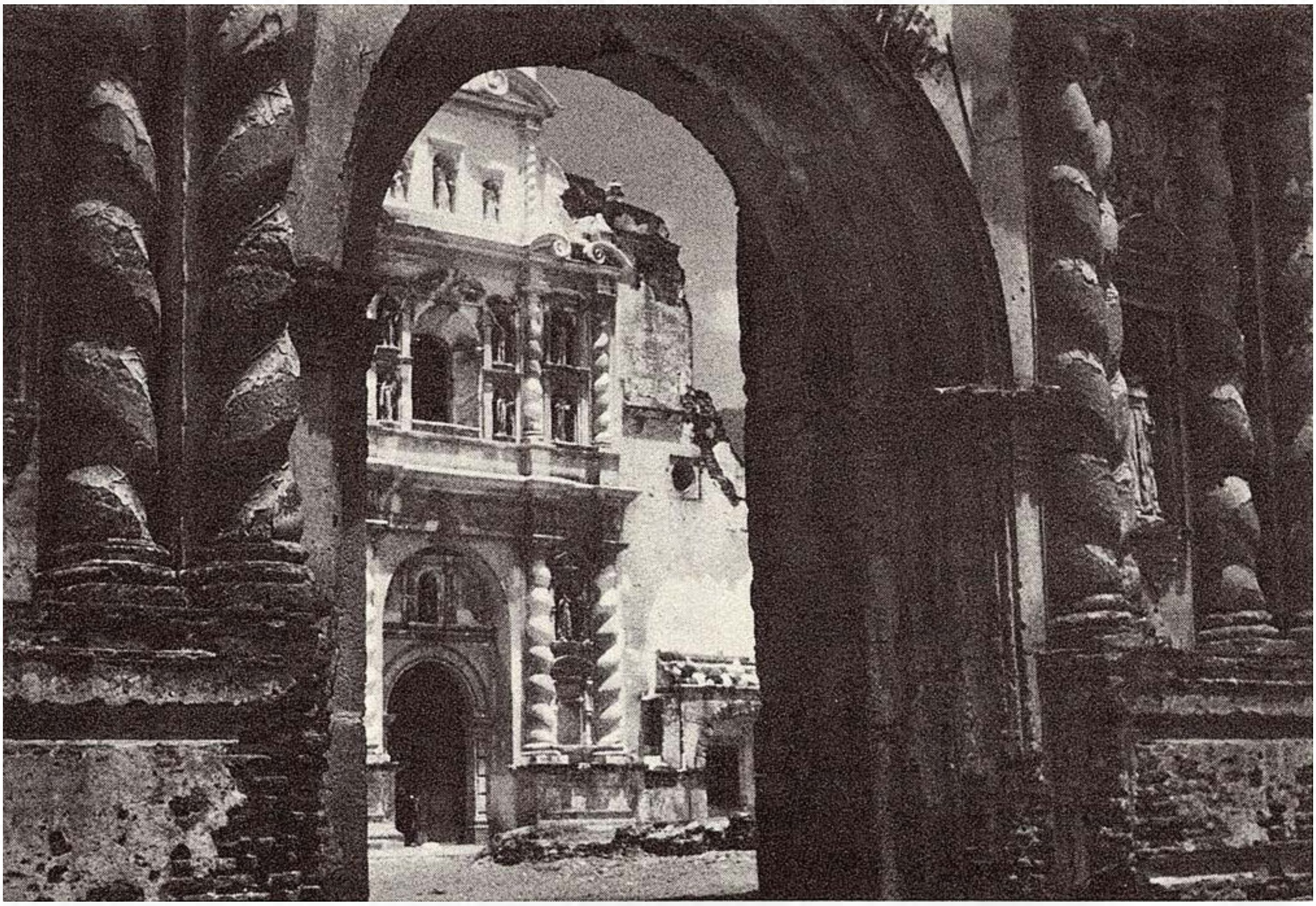


Fig 8 Church of San Francisco in Antigua seen through portal

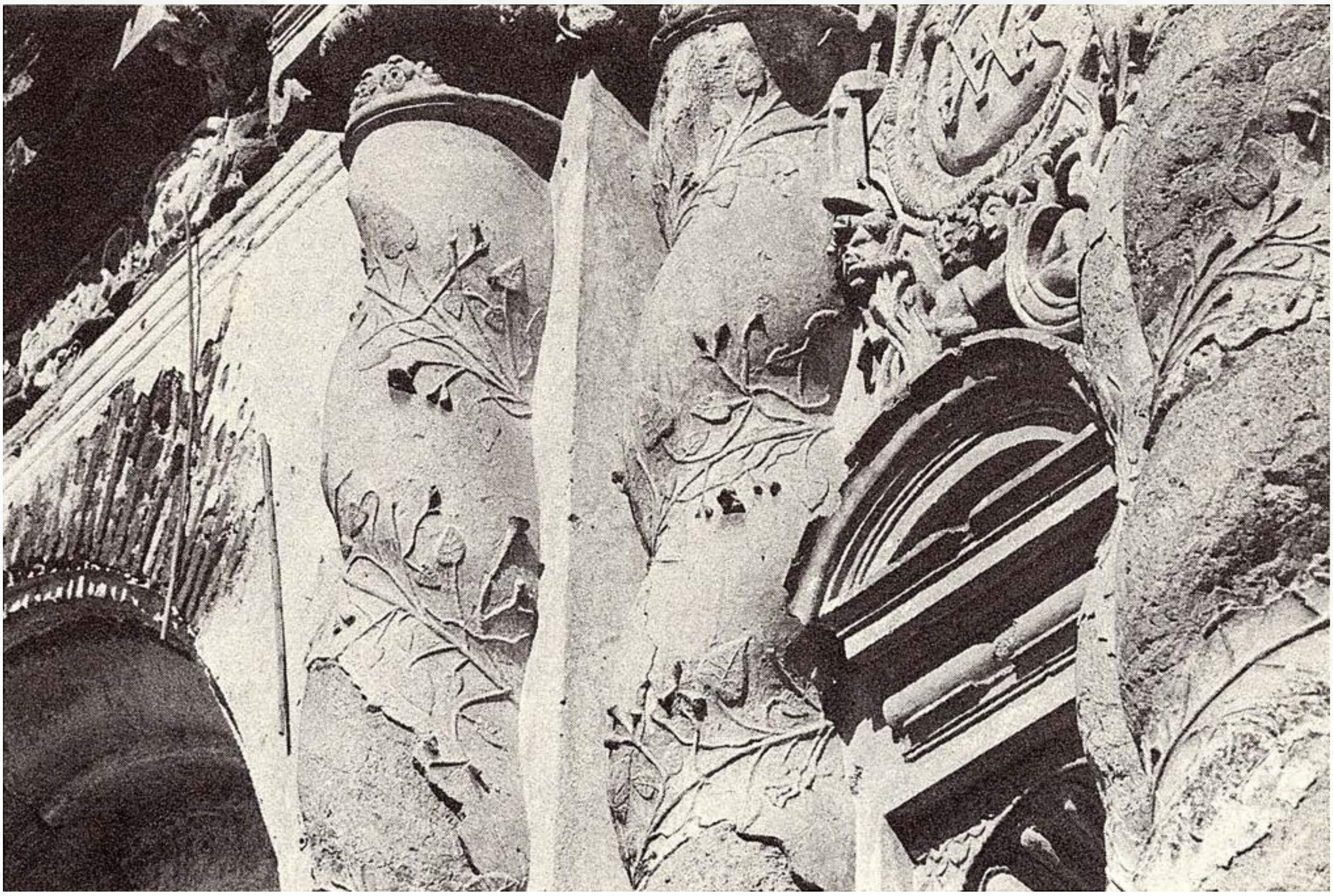
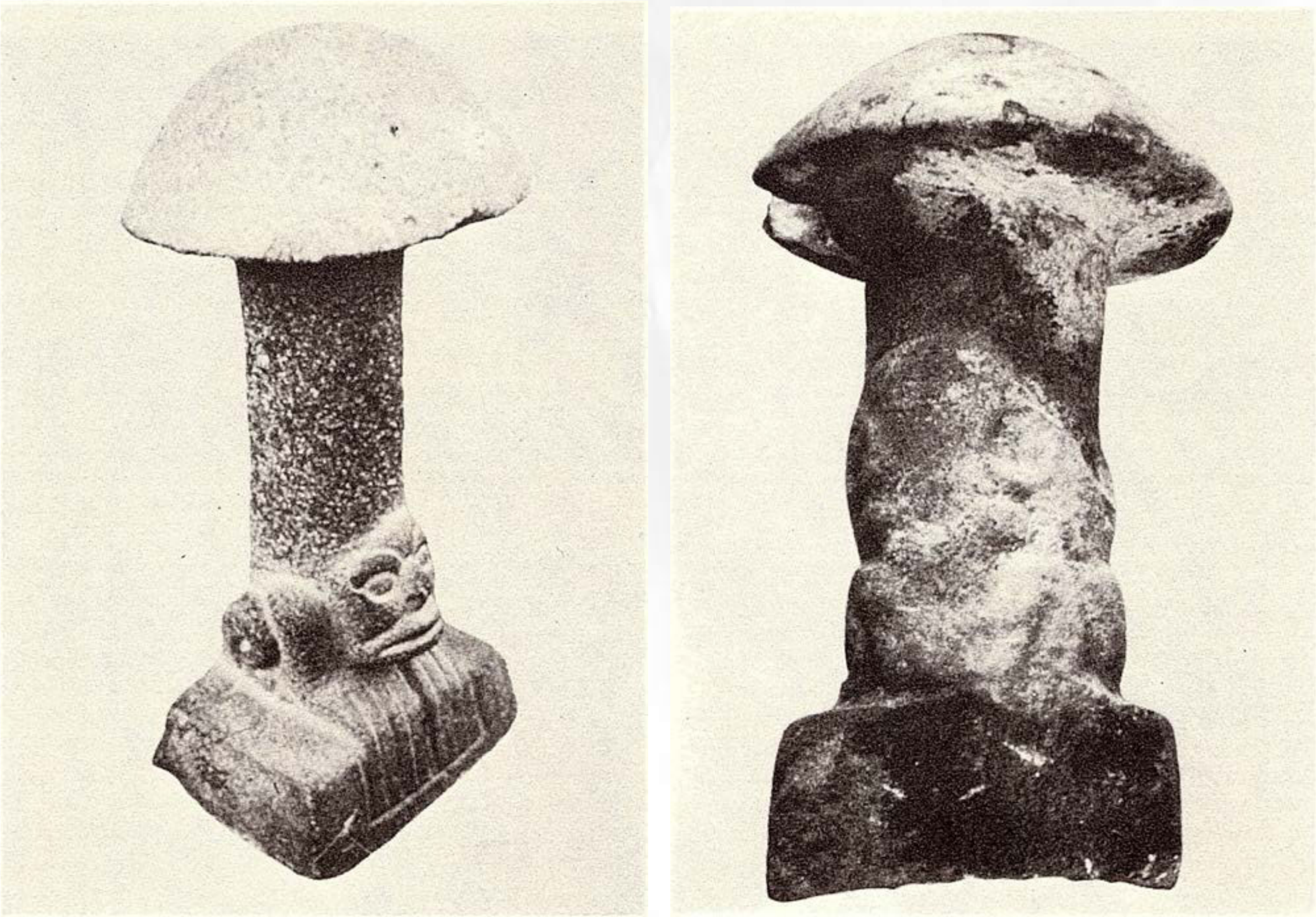


Fig 9 Detail of morning-glory carved on columns of portal

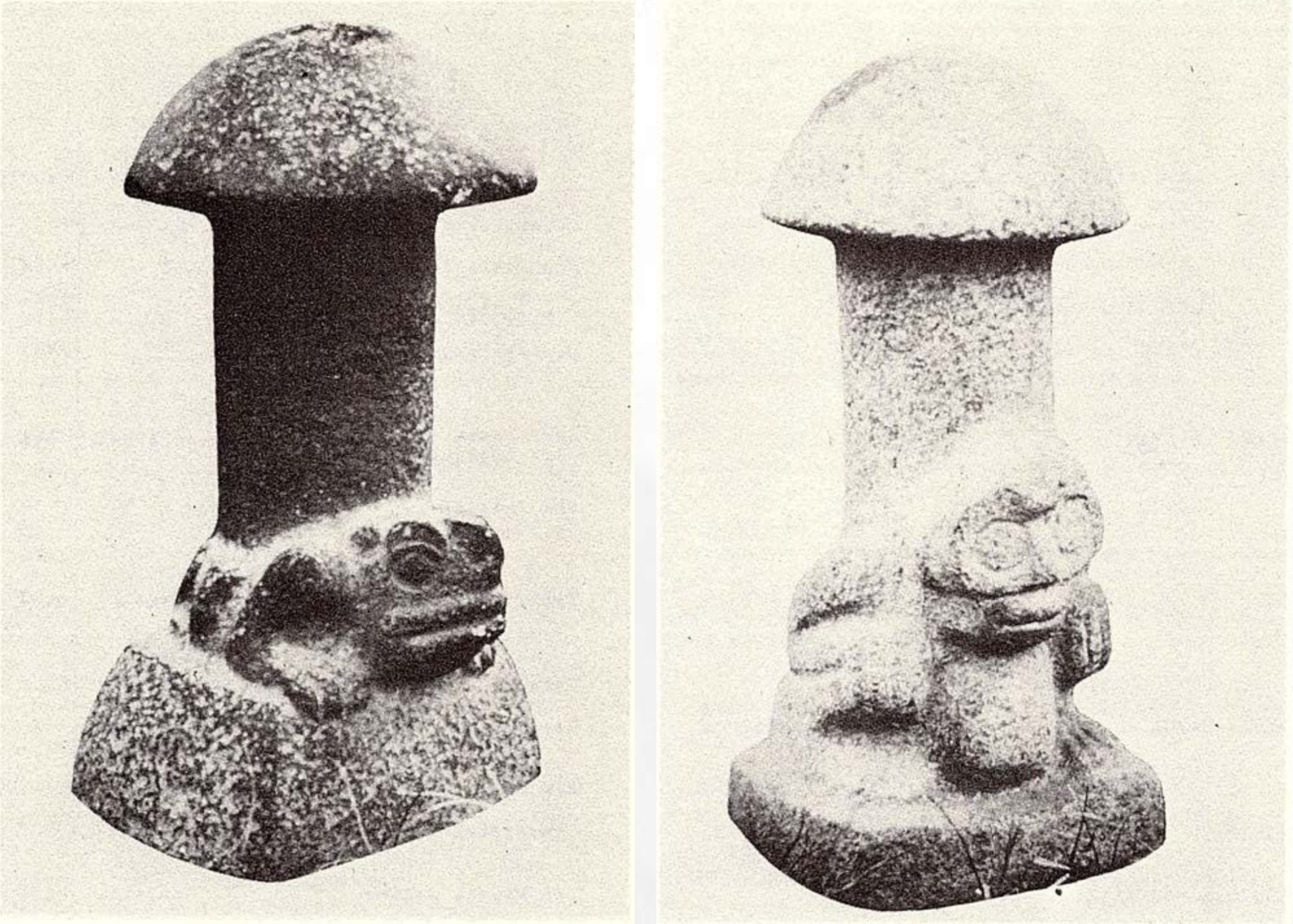
As though supporting this conclusion, Donald B. Lawrence, Professor emeritus of Botany at the University of Minnesota, has turned up ancill ary evidence in the portals to the patio of the Church of San Francisco in Antigua. This evidence is noteworthy in associating the complete pattern of entheogenic use in Mexico with such use in Guatemala. The columns of these portals were originally covered with stucco molded to represent a climber and that climber was a morning-glory. The colors are lost and only fragments remain of the climber. In Figures 8 and 9 we reproduce two views of this portal, one to place it in relation to the church, and the other, Joya Hairs' photograph of a detail. That the Indians were molding the entheogenic morning-glory seems to me evident. This was in the second half of the sixteenth or perhaps more probably in the seventeenth century. Did the Franciscan friars know what the Indians were doing? I should like to think so.

★

For readers who would pursue further the mushroom stones, I would draw their attention to Figures 10-13. In Figure 10 from the mouth of a giant toad a mushroom stone is emerging. In another, Figure 11, a mushroom rises from the back of a toad with an anthropomorphic face. In front the toad is indicated by the four toes on each of the front feet and the characteristic squat is seen from the side. We show two more mushrooms with the toad theme reiterated, Figs 12 and 13.



Figs 10 and 11 Two mushroom 'toadstools'

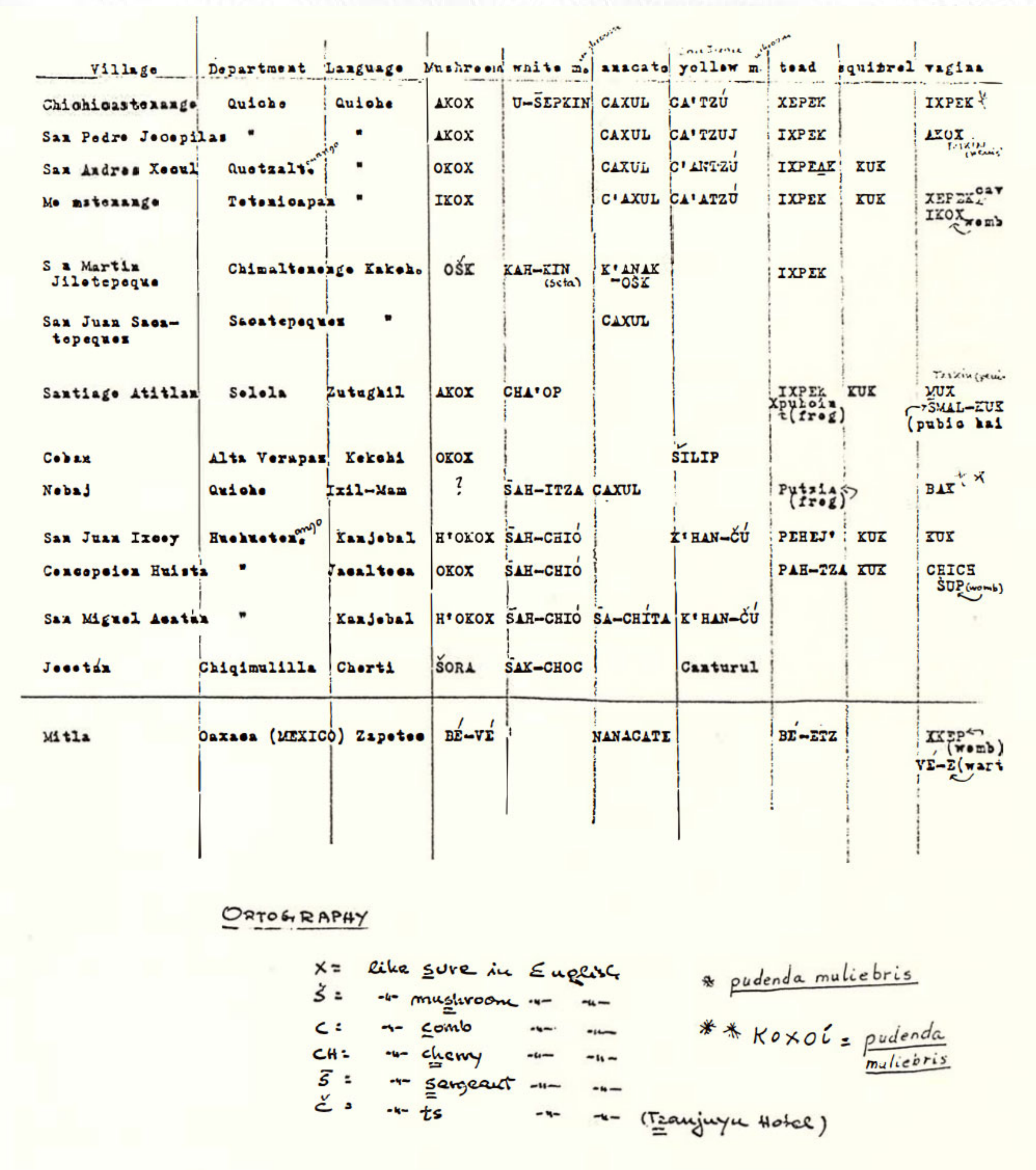


Figs 12 and 13 Two additional mushroom 'toadstools'

Strangely moving is the sporadic recurrence throughout the northern hemisphere of this chthonic deity, the toad, with the entheogenic mushroom. It survives to this day in the Basque language (*amoroto*, 'toad mushroom', *A. muscaria*), in rural France (*crapaudin*, *A. muscaria*), in Chinese (*hama chün*, 'toad mushroom', *A. muscaria*). In Old French le bot was a toad, the Devil, and a mushroom. (By 'mushroom' did the lexicographer mean any mushroom or a specific kind that he did not identify? A *crapaudin* perhaps?) The same association survives in far wider circles in those mycophobic lands where through taboo the handsomest of all our mushrooms has lost its name and what had been its name is become the designation ('toadstool') of every mushroom that the seeker distrusts, above all *A. muscaria*, which he *knows* he should distrust. How far back into the stone age must this association carry us! In Mesoamerica *A. muscaria* has been replaced by the superior Psilocybe species.

In our 1953 travels throughout the Maya highlands we discovered a convergence of three ideas in one Mayan word: 'toad', 'mushroom', and for the external genital organs of the woman. (*Mushrooms Russia & History*, p 280) Borhegyi sent us afterwards a chart in diverse Mayan languages and dialects giving us supporting evidence for this in Quiché and we reproduce that chart here. This linguistic pattern is not confined to Mayan languages. How widespread it may be, I do not know. Among the Kogi of Santa Marta, in the Sierra Nevada of Colombia, Gerardo ReichelDolmatoff writes:

> For a Kogi the toad symbolizes the feminine sexual organ in an aggressive and insatiable sense. Linguistically the words 'toad' and 'vagina' are identical (*maukuí*) and on occasions a man may refer to his wife as 'my toad'.* Mention of the word or the mere sight of a toad provokes hilarity and disgust. Young people laugh and the elderly become angry. It is a 'bad word'. The 'toad is ugly'. The toad is a woman, is the feminine sex. 'The toad eats worms', is a very common obscene phrase which being interpreted means the way that the feminine organ 'eats' the masculine.
> * In the dialect of the *Sancá* no word.exists to designate the feminine organ and a hybrid is used: *sapi* or the euphemism *soma* = 'flower'.
> [*Los Kogi*, vol 1, p 268; 1950, Bogotá. Translation mine: RGW]



Village	Department	Language	Mushroom	white m.	anacate	yellow m.	toad	squirrel	vagina
Chichicastenango	Quiche	Quiche	AKOX	U-ŠEPKIN	CAXUL	CA'TZÚ	XEPEK		IXPEK
San Pedro Jocopilas	"	"	AKOX		CAXUL	CA'TZUJ	IXPEK		AKOX
San Andres Xecul	Quetzalt.enango	"	OKOX		CAXUL	C'ANTZÚ	IXPEAK	KUK	
Mo mstenango	Totonicapan	"	IKOX		C'AXUL	CA'ATZÚ	IXPEK	KUK	XEPEK cav IKOX womb
San Martin Jilotepeque	Chimaltenango	Kakch.	OŠK	KAH-KIN (seta)	K'ANAK-OŠK		IXPEK		
San Juan Sacatepequez	Sacatepequez	"			CAXUL				
Santiago Atitlan	Solola	Zutughil	AKOX	CHA'OP			IXPEK Xpuhoiat (frog)	KUK	MUX ŠMAL-KUK (pubic hai
Coban	Alta Verapaz	Kekchi	OKOX			ŠILIP			
Nebaj	Quiche	Ixil-Mam	?	ŠAH-ITZA	CAXUL		Putzia (frog)		BAK
San Juan Ixcoy	Huehueten.ango	Kanjobal	H'OKOX	ŠAH-CHIÓ		K'HAN-ČÚ	PEHEJ'	KUK	KUK
Concepcion Huista	"	Jacalteca	OKOX	ŠAH-CHIÓ			PAH-TZA	KUK	CHICH ŠUP (womb)
San Miguel Acatán	"	Kanjobal	H'OKOX	ŠAH-CHIÓ	ŠA-CHÍTA	K'HAN-ČÚ			
Jocotán	Chiqimulilla	Chorti	ŠORA	ŠAK-CHOC		Canturul			
Mitla	Oaxaca (MEXICO)	Zapotec	BÉ-VÉ		NANACATE		BÉ-ETZ		XKEP (womb) VÉ-Z (wart

ORTOGRAPHY

X = like sure in English
Š : " mushroom " "
C : " comb " "
CH : " cherry " "
S̄ : " sergeant " "
Č : " ts " " (Tzanjuyu Hotel)

* pudenda muliebris

** KOXOÍ = pudenda muliebris

Fig 14 Chart of diverse Mayan languages and dialects, showing popular identification in Quiche of toad with female genitalia

How odd is this association of ideas throughout the northern Hemisphere! Perhaps the toad in Figure 10 is swallowing the mushroom, not giving it birth. We see our Mesoamerican toad in Hieronymus Bosch in his *Seven Deadly Sins* in the Prado (Figure 15) and we see it also in the mosaic of the ceiling in the Baptistery of Florence. (Figure 16)

In the association of these ideas we strike a vein that must go back to the remotest times in Eurasia, to the stone age: the link between the toad, the female sex organs, and the mushroom, exemplified here in the Mayan languages and the mushroom stones of the Maya highlands. Man must have brought this association across the Bering Strait (or the land-bridge that replaced it in the ice ages) as part of his intellectual luggage.

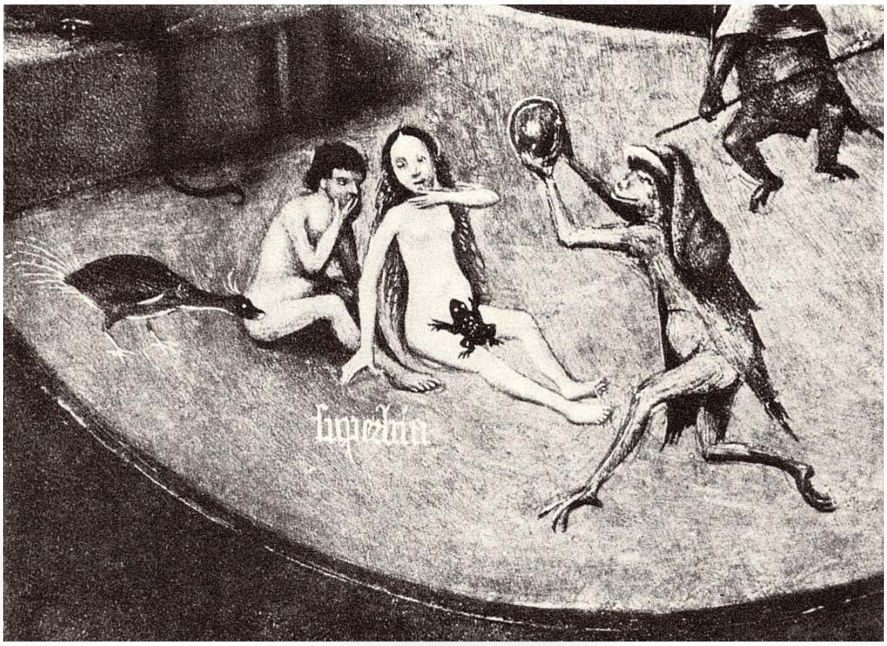


Fig 15 Hieronymus Bosch. *Seven Deadly Sins*. Detail: 'Superbia'. Madrid, Prado Museum

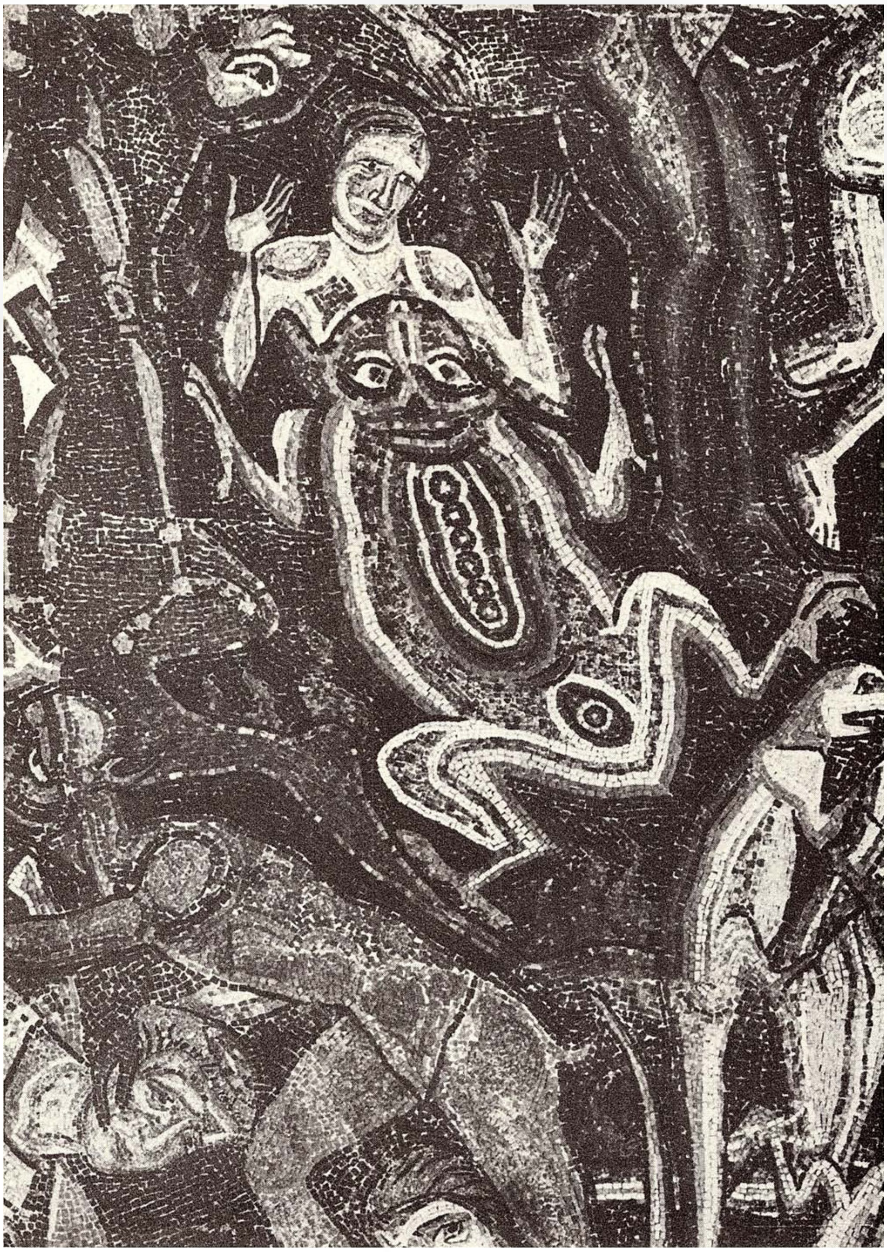


Fig 16 Toad. Detail from a mosaic. Florence, Battistero, in ceiling

★

When we look at the mushroom stones we must always remember that in pre-Conquest times most art, if not all, was religious, as it once was in Europe. And we must remember that the hold on the inner life of the Mesoamerican peoples of the entheogens, notably the entheogenic mushrooms, was all-powerful, as it is to this day in remote corners of highland Mexico. Those who have not explored the rôle of the entheogens in the cultural past of Mesoamerica easily overlook that rôle or assume that it was of minor importance, solely because for us it is of no importance.

To sum up our argument, then, and without suggesting the use to which the mushroom stones were put, I have shown, thanks to the Namuth artifact, that the sacred mushrooms were crushed on a *metate* by a maiden. It is certain that the entheogenic mushrooms flourished in the Maya highlands and that they and (thanks in this case to Donald Lawrence's keen eye) *ololiuhqui* were there used. The friars learned of the use and included the entheogenic mushrooms in their word lists of the Cakchiquel language. We have arrived at verbal associations of ideas - toad, *pudenda muliebria*, and mushroom - that link them, long long ago, with the same verbal associations in Eurasia.

There came to light in the late 1950's a terra cotta artifact representing an Indian woman, seated cross-legged on the floor, with her right hand on a plain hollow pottery mushroom and the left hand raised in air: she might be supplicating or giving voice to an oracular utterance. (Figure 24) This figurine is until now unique. The late Stephan F. Borhegyi said that it came from Tenenexpan in the State of Veracruz and it is, appropriately, in the style of a Remojadas piece, with the exposed sections of the woman's legs and arms covered with black asphalt paint (*chapopote*). The woman wears a turban-like headdress, a *quexquemitl*(a kind of shoulder cape), a beaded necklace, and a wrap-around skirt. In the middle of her back is a hole (Figure 25), which communicates with two round apertures in her upper lip under her nose, serving as nostrils, and one can blow smoke of tobacco or copal or aromatic plants through this hole in her back and out of her upper lip.

Our figurine fits well into the pattern of mycolatry that I have given in the pages of our book. It is a superb expression of the religious faith of a people who held the entheogenic mushrooms in awe, both for their ecstatic potency and their divinatory powers. It dates from the classic period, ca A D 300.

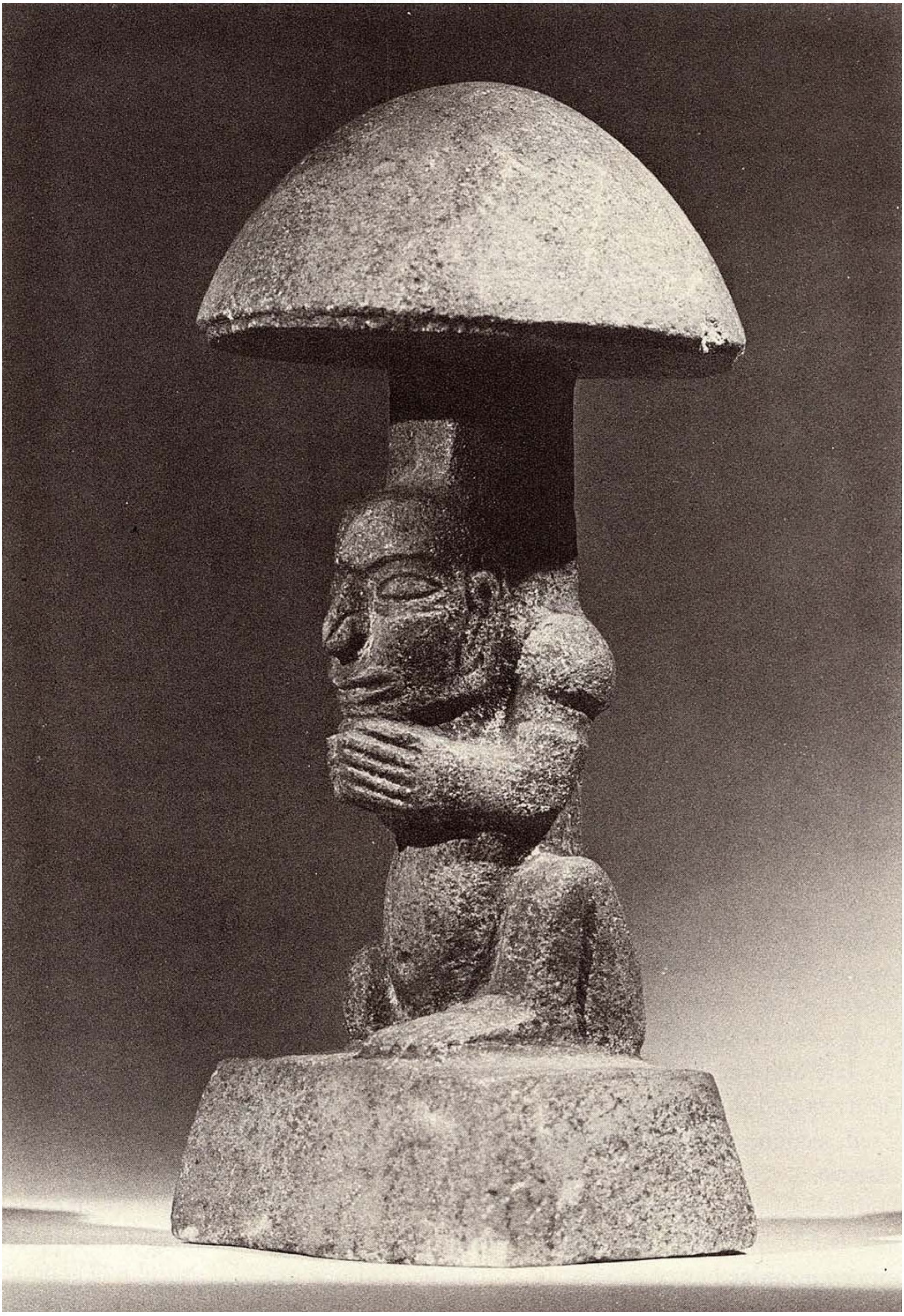


Fig 17 Mushroom stone in García Collection, Guaremala Ciry

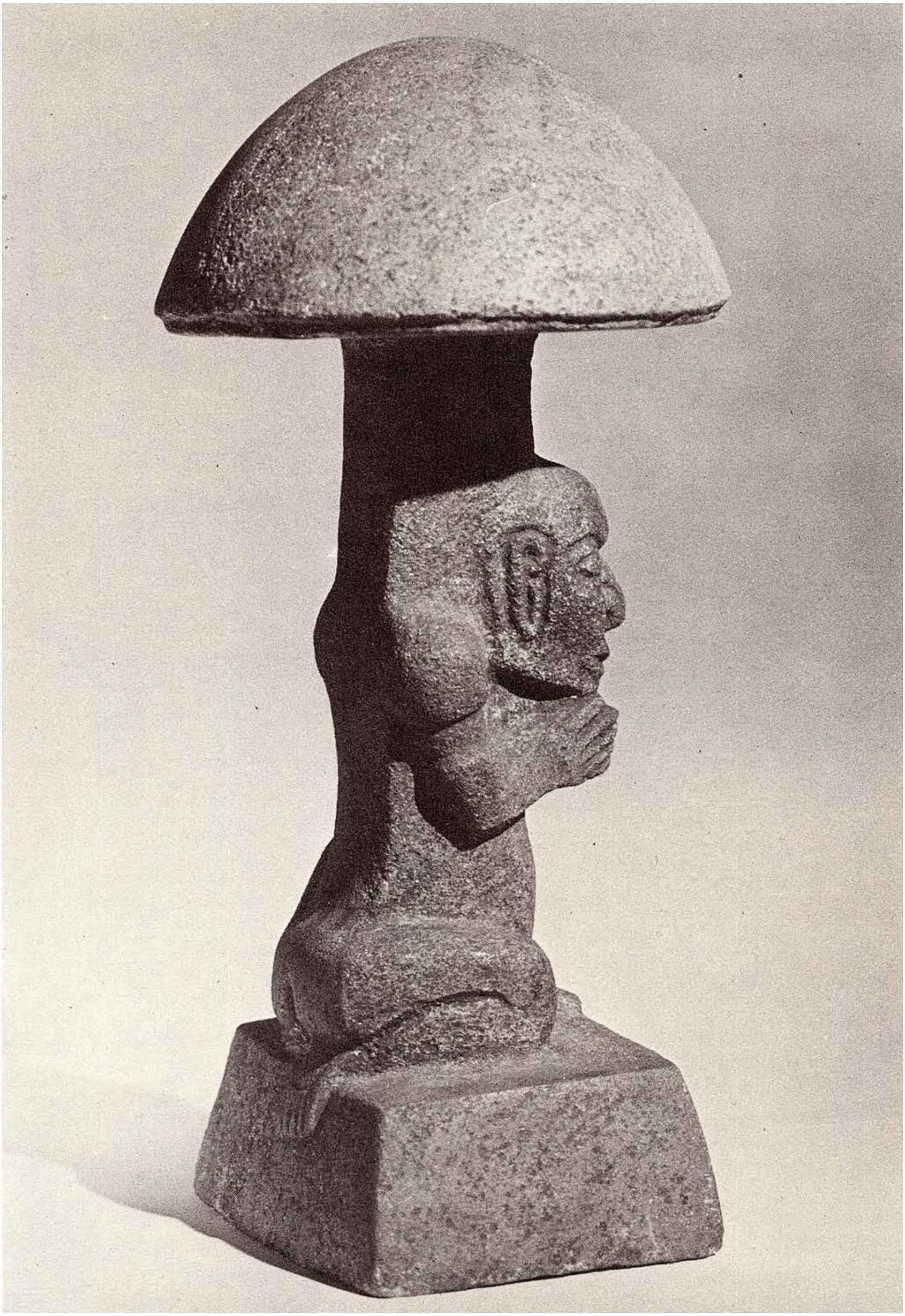
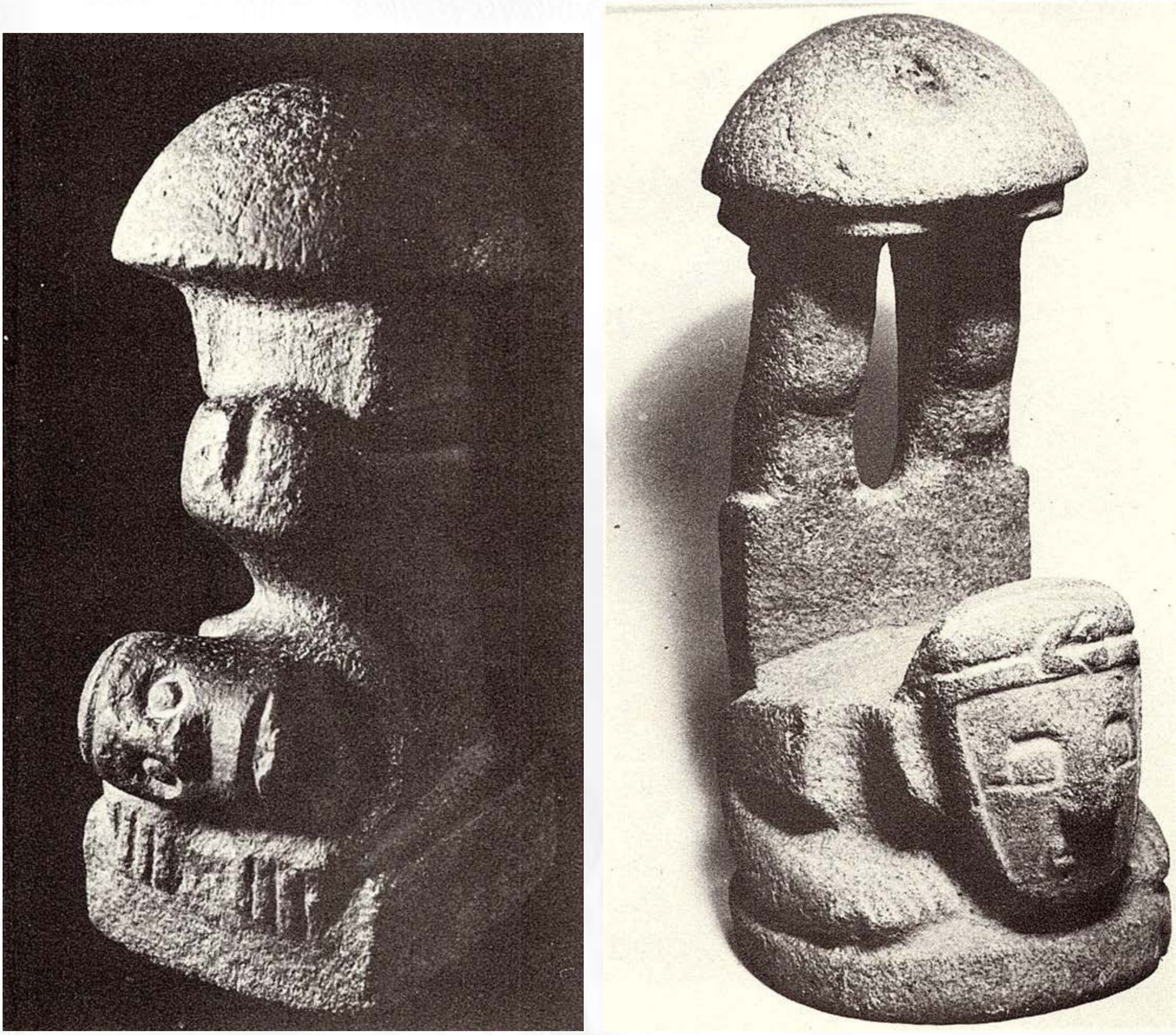
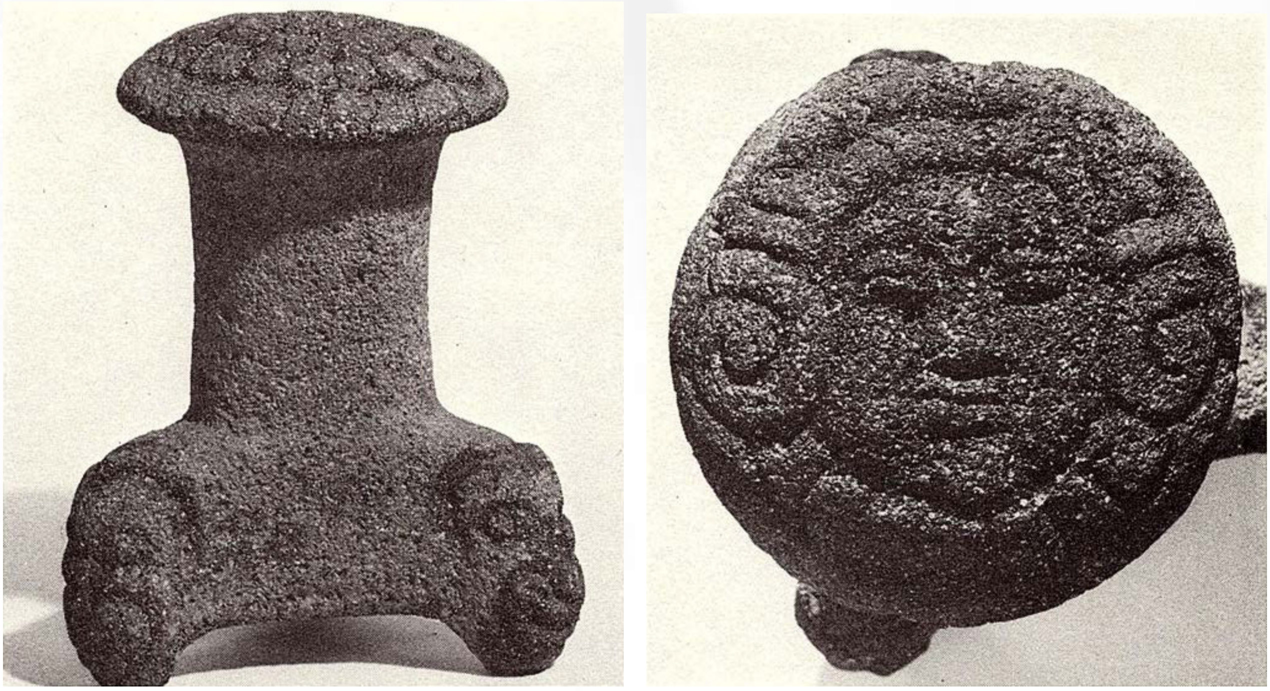


Fig 18 Second view of the same



Figs 19 and 20. Mushroom stones with Plunging Figure motif



Figs 21 and 22 Late Classic mushroom stone with carved head

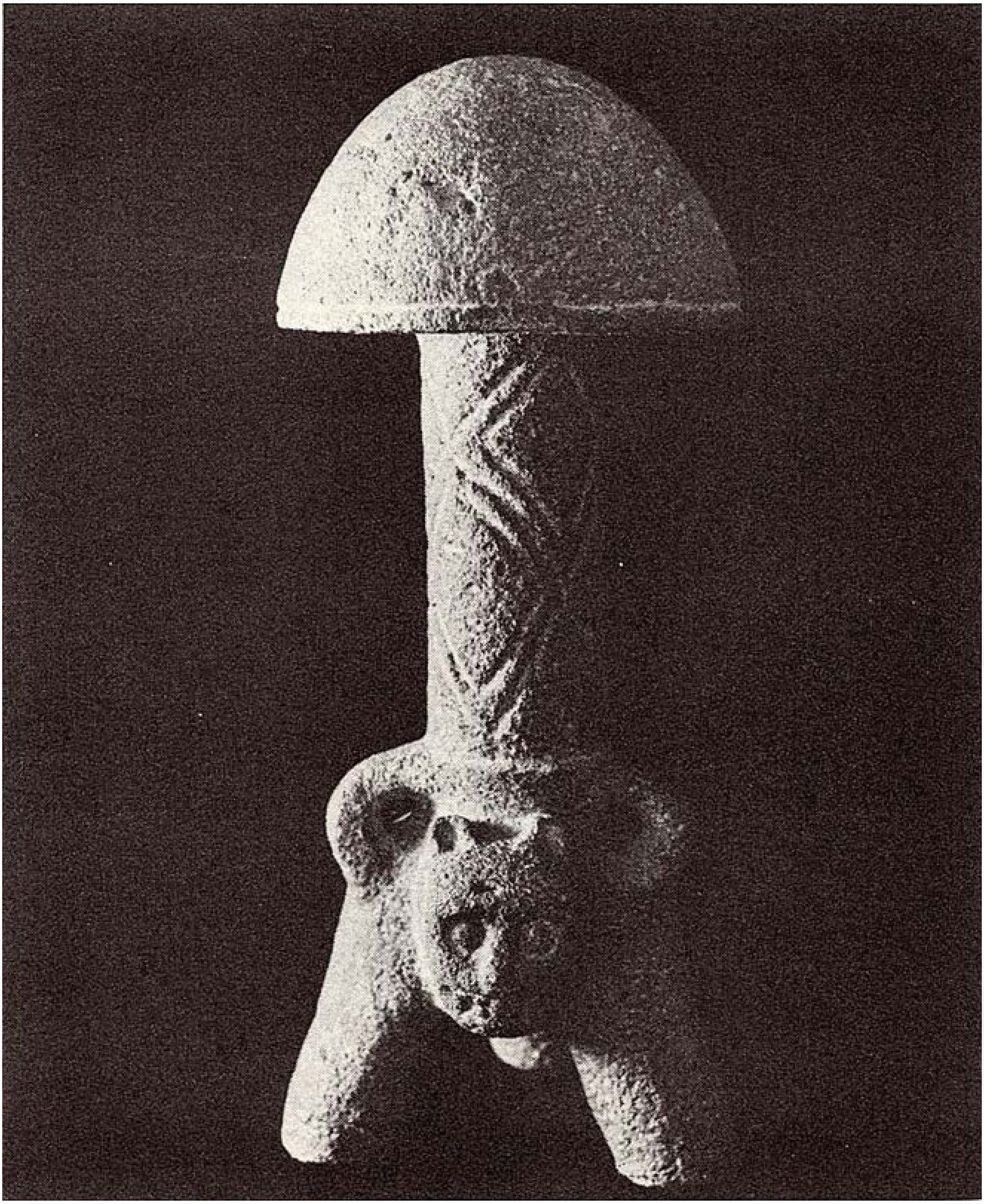
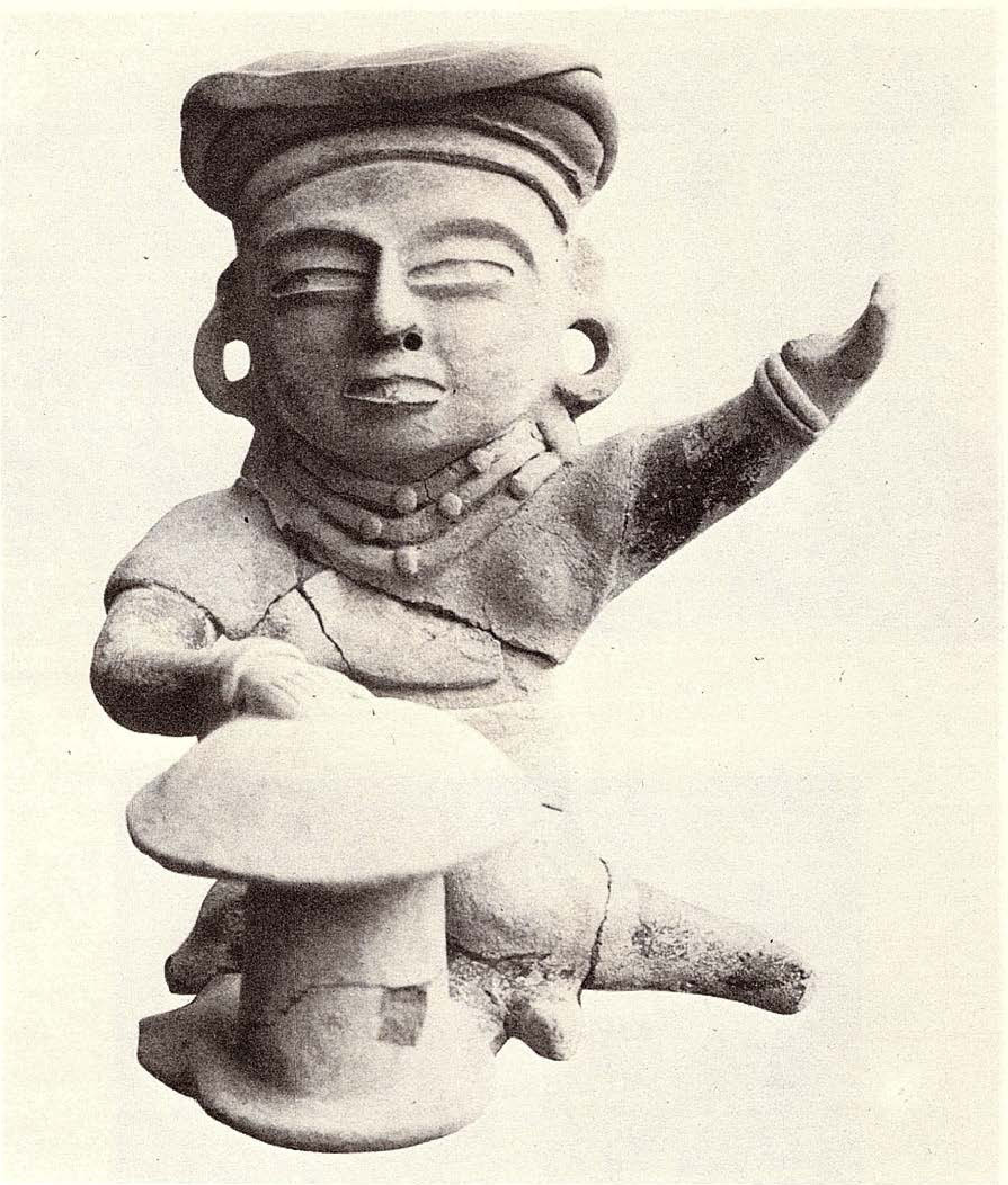


Fig 23 Mushroom stone with geometric design and jaguar head



Figs 24 and 25 Terra corra figurine, Remojadas style, found in Veracruz

★

29 July 1977

I had reached this point in writing my chapter when there reached me by post a copy of the doctoral thesis on the mushroom stones submitted by Dr Richard M. Rose to the Department of Anthropology of Harvard University in June 1977. In it he advances the novel thesis that the mushroom stones served a 'utilitarian' purpose in the making of the rubber balls used in the pre-Conquest ball game in the Maya highlands. He assembles evidence of the widest diversity to support his position and I think he makes good his case. I also hope he is right for he has supplied the missing copestone to support my mushroomic interpretation of the mushroom carvings of the Maya highlands. Somewhat strangely, Dr Rose does not see this, perhaps because his concentration on his voluminous and diverse evidence, all of it pertinent, has blinded him to the larger view. He has opened the door to a fresh discussion of Maya culture and the mushroom stones. What is 'utilitarian' is often also religious: designing and shaping a superb chalice is both a 'utilitarian' and a religious act. All art in pre-Conquest Mesoamerican society, or virtually all, is inspired by religious beliefs. At that time there was no 'art for art's sake', no *genre* art. The Maya ball game was, in essence, a religious observance.

From the beginning it has been known that the ball game of Mesoamerica was played over a much larger area than Mesoamerica: throughout the Caribbean islands and northern South America. Rose has explored the sources for this ball game over the whole area including the parts of Mexico that are north of the cultural entity known as Mesoamerica. He has come up with relevant data of fascinating kinds. The ball was of course of rubber. As the Maya did not know the vulcanizing process, a new ball presumably had to be made for every game. In making the ball, strips of latex were stretched on a round and roughened surface, the cap of our volcanic-stone mushrooms, and when the strips had hardened to the proper point they were removed and molded into the rubber ball. The pottery 'mushrooms' of El Salvador and Tabasco are smooth but *the cap is skillfully roughened* by pecking to the required degree, making the cap surface comparable to the mushroom stones. Rose enlists further evidence of a surprising kind: it has long been known that 'mushroom' caps have been found, not fragments of mushroom stones, but deliberately carved caps without pedestals. Until Rose no one could explain these beautifully carved caps and little attention had been paid to them. These caps date from the early phase of mushroom stone carvings. Rose thinks they were held in the hand and served the same purpose as the mushroom stones. Here then we find a use for these caps, until now unexplained.

Thus through more than a millennium and a half the mushroom stones apparently served the purpose of making rubber balls for the ball game, the artisan sitting on the ground, his legs encircling the mushroom stone, and applying by hand the latex in strips to the round mushroom cap.

We know something of the paraphernalia that the players in the ball game wore but of the rules and practices of the game we know little. The stakes were high, in the great games the very life of a player being the forfeit. We of modern European provenience naturally assume that the captain of the losing team was decapitated. In a society where the standards were utterly different, I am not so sure. The divinity to whom the game was dedicated deserved the sacrifice of the best, not the second best. The glory of winning the game and the plaudits of the attending throngs, plus his own transcendental beliefs, might well have led the captain of the winning team to off er himself to the sacrificer with the physical courage before certain death that was the crowning glory occasionally open to the Mesoamerican and North American natives. We see a parallel in the deaths of those Christian martyrs who presented themselves of their own volition to judges who would surely send them to the stake.

Henry Munn and I, independently of each other, have pointed out the extraordinary control, the precise timing, that the mushrooms generate in the shamanic ingester. It is the neophyte who staggers, who even steps off a cliff or out of a window into space. I now ask anew whether the ball player did not take the entheogenic mushrooms (or infusion of ground morning-glory seeds) before the game started and play under their influence. For the players as for the attendance the emotional tension of the game must have been awesome, each side fighting to win and the winning side (as I believe) having the honor of surrendering their captain to certain and quick death. Naturally in our pusillanimous, self-indulgent, permissive society such standards are inconceivable.

Those of us who have spoken for a conscious mushroomic use of the mushroom stones have never known what that use was. Twenty years ago we ventured the guess that they had served a ritual purpose in such *veladas* as María Sabina has sung throughout her life. No supporting evidence for this hypothesis has been discovered. Lately I have explored the activities of the Princes and Nobles of the Nahua with the divine mushrooms and have now recorded these doings in the preceding chapters. We can be certain that when they sang their poetry, when they entered upon the dance, they did not stammer, they did not stagger like drunken men. Their words glow with the wondrous religious passion that most - not all - of us in the West have lost. But the anthropologist, though he need not share in these beliefs, fails in his duty when he does not allow fully for them in studying Early Man, whether long ago or among his survivors in our own times.

When the child Juventina crushed the sacred mushrooms on the *metate* in Juxtlahuaca, she was performing a religious act as well as a utilitarian one. When the sculptor carved the beautiful Namuth artifact, he was depicting the same performance in stone as faithfully as the limitations of his medium permitted, and his carving expressed religious belief. The nine miniature mushroom stones with the nine miniature *metates* and *manos* speak for themselves in the same way. The toad effigy mushroom stones express a tripartite association of ideas that link in a common embrace Early Man throughout the Northern hemisphere. The craftsman who carved the stone shown in Figs 17, 18 *must* have been aware that he was carving a mushroom, as well as an artifact to serve in making the rubber ball. Dr Rose sets forth fairly the evidence offered us by the Namuth artifact but then fails to discuss it and draw conclusions. He fails to see the import of the miniature mushroom stones lying in a common cache with the miniature *metates* and *manos*. He ignores the toad symbolism in the toad effigies carved on four mushroom stones. He gives only a sentence to the terra cotta figurine, a woman with her right hand on a mushroom, her left hand raised in a speaking gesture, the Remojadas artifact found in Veracruz and dating from the time of Christ or shortly thereafter. (Figs 24-25)

If the mushroom stones of Guatemala were carved primarily for the making of rubber balls for the ball game - and Rose may well be right in thinking so - this in no way diminishes the relevance of the mushroom to the stone: Early Man was accustomed to see in superficial resemblances profound meanings. Similarities in the sound of distinct words are today dismissed as fun puns or as sources of confusion in the ambiguities that they provoke. But in preliterate times paronomasia, as such verbal identities are called, led to deeper misinterpretations, mistaken folk etymologies, as in the case of 'Soma'. And this was even truer in semiotics - communication through means other than words - as is to be seen in the (for us) absurd meanings placed on the forked root of the mandrake. From earliest times the stone cutter carving his volcanic rock to serve for making rubber balls must have associated this holy stone with the holy plant that it resembled, its sacral meaning being vastly enhanced by the overlapping of the two shapes. In fact, the mushroom may well have been, in this case, a prime motive in leading to the evolution of the cap into the tripartite mushroom stone.

Rose concedes, though grudgingly, that the hallucinogenic mushrooms were used in the Maya highlands. He fails to allow for the way the mushrooms permeated Mesoamerican life, for which the signs have been avail able to all though they have not been read. He fails to see the breathtaking beauty of his rubber ball - fashioned on a *mushroom* stone, thus redoubling the religious potency of his act. Probably the fashioning was attended by religious rites before, during, and after; and thereupon the ball was thrown into the game played by both teams with skilled fury for the highest of stakes.

CHAPTER 10
The historical record

In *Mushrooms Russia & History* (1957) Valentina Pavlovna and I gathered together and published a dozen extracts from early sources illustrating the use of inebriating mushrooms in Mesoamerica. We also cited early lexicons composed by friars for the Zapotec and Tarascan languages giving native words for these mushrooms, just as we have now done in the preceding chapter for Cakchiquel, an important highland Mayan language. In *Les Champignons hallucinogènes du Mexique* (1958) the quotations rose to above a score. Today, if I am right in my interpretations contained in this book, it is useless to count the pre-Conquest and later references to the divine mushrooms, so many are they, and more are sure to be discovered, especially in Nahuatl and Mayan texts not yet translated. The blind spot of the scholarly world for the entheogens manifests itself with peculiar force here in Mesoamerica precisely because their rôle was so important.

Chronologically the divinatory mushroom first appears in a tradition preserved for us in Fray Antonio Tello's chronicle when (according to this tradition) 'Teopiltzintli' led the Aztecs to their new 'Promised Land' back in the early centuries of our Christian era. (We have told this story in Chapter 7, p 140.) No one can say that this took place but the folk memory may well be right, for the function attributed to the divinatory mushroom was a normal one for it to perform.

Much later, one of the legendary 'founding fathers' of Tenochtitlan-Mexico was Nanacatzín, the 'mushroom' (*nanácatl*) with an affectionate and reverential suffix, *-tzín*. A number of lists of the founding fathers survive and Nanacatzín's name occurs in at least two, in Fray Juan de Torquemada's *Monarquía Indiana*, at the end of Chap 3, Book 2, and in the famous *Historia Antigua de México* published in Italian by the Jesuit Francisco Javier Clavijero in 1780-1. The list of the twenty legendary founders appears only in that first edition, as a footnote in the first volume of the Italian text at the beginning of Chapter 3.

For these two historical citations I am indebted to Gutierre Tibón of Cuernavaca, that questing scholar in the byways of Mesoamerican history. He is imbued with a sense of the poetry, the mystery, the drama of Mexico's past.

Diego Durán, O.P.

Among the friars the Dominican Diego Durán supplies us with unique evidence of the pre-Conquest use of mushrooms in his superb *Historia de las Indias de Nueva España*. (I shall use the two volume text edited by Father Garibay, 1967.) This work was written in the 16th century and survives in the author's own manuscript. Here is a remarkable account of the history of the Aztecs, an account that no Spaniard could have assembled on his own, an intimate inside story of the rulers of Mexico-Tenochtitlan, their entourage, their traditions and practices, their wars, religious beliefs, diversions, successes and failures. Durán cites constantly the '*Historia*' that he is using or sometimes certainly translating, and scholars seem agreed that when he wrote he had before him a narrative in Nahuatl but in Latin characters written or dictated by someone highly placed in the pre-Conquest regime who had enjoyed the confidence of the sovereign and who was steeped in the oral traditions of his people. This unidentified personage, intelligent and able, was clearly a partisan but as we do not possess comparable narratives by others, scholars can usually do no other than let his stand alone. As its author concerned himself solely with the doings of the kings and aristocrats, he tells us only by inference about the conditions of the farmers, the artisans, and the women folk. This '*Crónica X*' (as it is called) may still exist and its discovery would be a sensational event in Mesoamerican studies.

According to *Crónica X*, in the festivities following the coronation of the sovereign Tizoc in 1481, at the end of the great banquet, inebriating mushrooms were served to the guests. Durán does not say whether this had happened on the occasion of previous coronations but from his context it seems probable that it was habitual on all grand occasions. Here is what Diego Durán writes:

> 40. Y todos los señores y grandes de las provincias se levantaron y, para más solemnizar la fiesta, comieron todos de unos bongos monteses, que dicen que hacen perder el sentido, y así salieron todos muy aderezados al baile.

> [II Cap XL 40]
>
> And all the lords and grandees of the provinces rose and, to solemnize further the festivities, they all ate of some woodland mushrooms, which they say make you lose your senses, and thus they sallied forth all primed for the dance.

Tizoc's reign was a failure: he was pusillanimous and he died, probably poisoned (according to *Crónica X*), in 1486, whereupon his brother Ahuitzotl was elected his successor.

Not a word is said about mushrooms in the detailed and glowing account of Ahuitzotl's coronation feast, but in an important aside that Diego Durán makes on the text before him we gather by implication the general rôle played by the mushrooms on all such occasions. (This citation has been mentioned in Chap 5, p 95).

> 16. He notado una cosa en toda esta historia: que jamás hace memoria de que bebiesen vino de ningún género para embriagarse, sino sólo los hongos monteses, que los comían crudos, con los cuales, dice la historia, que se alegraban y regocijaban y salían algo de su sentido, y del vino nunca hace memoria, sino es para los sacrificios o mortuorios; sólo hace memoria de la abundancia de cacao que se bebía en estas solemnidades.
> [II Cap XLII 16]
>
> One thing I have noticed in all this *Historia* [= *Crónica X*]: that never is mention made that they drank wine [*ie* fermented drinks] of any kind to get drunk, but only the woodland mushrooms which they ate raw, with which, says the *Historia*, they would rejoice and grow merry and become somewhat tipsy; and mention is never made of wine save only for sacrifices or funerals; mention is made only of the abundance of chocolate that would be drunk on these exalted occasions.

In this pregnant aside Durán is telling us several things:

a. by strong implication the *Crónica X* speaks often of inebriating mushrooms but Durán as editor has chosen to omit all save four or five such citations and he is now summarizing all the references that lay before him;
b. he observes that fermented drinks were never taken with the mushrooms: fermented drinks were beneath the dignity of the Aztec aristocrats on occasions such as Durán is describing. (The Aztecs tried to confine the use of fermented drinks to the superannuated men and women whose active rôle in life had ended.) It seems to have been considered an offense to pollute the pure effect of the mushroom inebriation with alcoholic inebriation; and
c. an abundance of chocolate was however consumed in these great banquets: chocolate was a beverage served cold with maize, *poyomatli*, other flowers, and almost certainly spiked with the juice of entheogenic mushrooms or an infusion of ground morningglory seeds.

We come now to the coronation of Moctezuma II in 1502 when no one in the Aztec country had yet heard of the Spaniards. For four days there was feasting and celebration and then on the fourth day came the coronation followed by human sacrifices in numbers. Then follows this paragraph where the sacred mushrooms enter:

> 24. Acabado el sacrificio y quedando las gradas del templo y patio bañadas de sangre humana, de, allí iban todos a comer hongos crudos; con la cual comida salían todos de juicio y quedaban peores que si hubieran bebido mucho vino; tan embriagados y fuera de sentido, que muchos de ellos se mataban con su propia mano, y, con la fuerza de aquellos hongos, veían visiones y tenían revelaciones de lo porvenir, hablándoles el demonio en aquella embriaguez.
> [II Cap LIV 24]
>
> The sacrifice finished and the steps of the temple and patio bathed in human blood, they all went to eat raw mushrooms; on which food they all went out of their minds, worse than if they had drunk much wine [*ie* fermented drinks]; so drunk and senseless were they that many killed themselves by their own hand, and, with the force of those mushrooms, they would see visions and have revelations of the future, the Devil speaking to them in that drunken state.

Durán's tone here is so out of harmony with what he had previously said that, were we not dealing with the holographic manuscript in his own hand, I would ask whether we had to do with an interpolation of a priestly redactor. Such a violent statement - many men drunk and senseless killing themselves! - is repeated by white men unacquainted with the hallucinogenic mushrooms, or who have possibly been ill-prepared for the experience and been drunk from alcohol when they took them. In Father Garibay's three volumes of *Poesía Nahuatl* we see time and again the glowing ecstasy, the awe-struck and reverential attitude, of the Nahuatl aristocrats, speaking to us in person about the wondrous mushrooms.

The coronation of Moctezuma is the occasion for another passage strange for us, founded on *Crónica X* but with Durán's comments added, in which we learn that the princes and lords of the enemy states were invited to the festivities and that they accepted the invitation, where among other items on their social agenda, they witnessed from specially built blinds the sacrifice on one of the lofty pyramids of their own kin and compatriots captured in past 'wars'. Here we see to what extent those 'wars' were purely ceremonial, to capture prisoners for sacrifice. Afterwards Moctezuma sent the enemy delegations home laden with jewels and other presents, and he gave them powerful escorts back to their own borders so that they would not be waylaid as hated enemies by Aztecs or their allies. [See II LIV 23; also XLII 17 and elsewhere.]

Such passages in the chronicles of the Aztecs astonish us: the number of human sacrifices that are set forth in detail, the way in which they are keyed to the religious calendar, the variety of methods used in taking the lives of the victims many of them cruel taxing belief and, perhaps strangest of all, the presence at their deaths, on the invitation of the victorious Aztec king, of their kin and friends. All these elements leave us in a quandary. A well known mycologist has expressed the view that the victims, to prepare them for sacrifice, were fed massive doses of mushrooms:

> Il devient compréhensible maintenant comment les fêtes sacrificielles de l'ancien Mexique ont pu ne susciter aucune défense des milliers de victimes humaines choisies qu'on y sacrifiait de manière cruelle et sanglante: elles obtenaient la pleine coopération des victimes, selon toute apparence après des orgies massives de champignons.
> [*Bulletin Suisse de Mycologie*, June 1958]
>
> It now becomes comprehensible how the sacrificial feasts of ancient Mexico were unable to provoke any defense from the thousands of chosen human victims that were sacrificed in a cruel and bloody manner: they won the full cooperation of the victims, according to all appearances after massive orgies of mushrooms.

There is no support for this conclusion in either Durán's *Crónica X* nor in the testimony of Sahagún's Nahuatl informants nor anywhere else. This mycologist was giving circulation in a scientific journal to his own idle fancies. He did not know his sources, readily available though they were to him.

A point has now been reached in Mesoamerican research where we can begin, hesitatingly and with all reservations, to sum up this advanced culture of Early Man, evolved out of its own innards, with no sure trace of external influence, and define the outlines of its distinctive even though unexpressed objectives. Their intelligent and thoughtful leaders might not have formulated the objectives in my terms but I think these were at least subliminal in all that they did.

The highest goal of Mesoamerican Man, his greatest achievement, was to display physical and moral courage in the face of imminent death. Those mushrooms, had the victims eaten of them, would have deprived their behavior of merit: it would have been cheating. Imminent death may also have confronted the winner in the Maya ball game, when I think he would proudly rise to the occasion. The prospect of imminent death, always a possibility, lies like a shadow over the thinking of the poets that Father Garibay has given us. The presence of their kin and compatriots at their sacrifice must have imbued these victims with pride as they climbed the long, steep, shallow steps without balustrade of the pyramid to meet death when they reached the top. The enemy delegations, sad though they were, were a moral support for them and made their courageous behavior easier. We must not forget that slaves scheduled for sacrifice, from the moment when they were chosen and dedicated to the gods, received honored treatment, being given the best of clothing, the best of foods, and treated with utmost respect. Tlaxcala and that city's allies were habitual losers to the Aztecs at the moment of the Spanish conquest, but there is every reason to think that, if the tide had been reversed, they would have inflicted identical penalties on the Aztecs.

In accounts of the native North Americans I have read that prisoners destined to die would take pride in taunting their captors, insulting them ingeniously to infuriate them, even as their captors were torturing them and slowly putting them to death. May not this practice, where physical courage in face of certain death was exalted to the highest degree, have found its supreme, most sophisticated expression in the religious sacrifices of the Mesoamericans?

Moctezuma in his pride tried to carry yet further his ambivalent relations with those who were his enemies though his efforts were unsuccessful:

> 27. Desde este día, cuenta la historia, que tres veces en el año convidaba Motecuhzoma a los reyes y señores enemigos y les hacía gran fiesta. La una era en la fiesta que ellos llamaban de los señores, y la otra en la gran fiesta de las banderas, y la otra, cuando comían todos hongos, que la llamaban la fiesta de las revelaciones. Las cuales fiestas hallarán en la Segunda Parte de este libro [Vol 1 of this edition] escritas a la larga.
>
> 28. Este orden tomó Motecuhzoma de convidar a sus enemigos, el intento del cual no lo pone la historia; empero, concluiré con decir que Motecuhzoma convidaba a sus enemigos; lo cual no hicieron los demás reyes sus antepasados, sino sólo su abuelo el primer Motecuhzoma. La cual costumbre duró mientras reinó. Y lo mismo guardaron los tlaxcaltecas en convidarle a él a sus solemnidades y a las veces iba o enviaba sus grandes; iban sin ser sentidos de sus gentes, ni de los tlaxcaltecas, aunque, según la historia, muy pocas veces fue él en persona, ni se halló en estas fiestas ni solemnidades.
> [II Cap LIV 27, 28]
>
> From this day on, according to the *Historia*, three times a year Moctezuma would invite the enemy Kings and Lords and give them a big feast. One. was the feast that they called 'of the Lords', and the other was the great 'Feast of the Flags', and the other when they would all eat mushrooms, which they would call the 'Feast of the Revelations'. The which feasts will be found in the Second Part of this book written out at length.

Moctezuma took this decision to invite his enemies, but the History does not say what his intention was; however, I shall conclude by saying that Moctezuma invited his enemies, which was not done by the other kings his predecessors, save only by his grandfather the first Moctezuma. The which custom lasted as long as he reigned. And the same observed the Tlaxcaltecas inviting him to their solemnities, and sometimes he went or sent his grandees; they went without their people's noticing it, nor the Tlaxcaltecas, although, according to the History, very seldom did he go in person, nor did he attend the festivities nor the solemnities.

The Feast of the Lords and the Feast of the Flags are indeed described in what Durán calls the second part of his book. (In Father Garibay's edition he has reversed the two volumes, so that the relevant Chapters XI and XIII are now in his Vol 1.) But the Feast of the Revelations, 'when they would all eat mushrooms', is alas missing in its entirety. Was it perhaps suppressed by Durán's religious superiors? This lost section of *Crónica X* would certainly have proved an invaluable document for us.

There is one further reference to mushrooms in Durán:

> 26. [Moctezuma] después de estos oráculos y plegarias, hacía comer a los viejos y sacerdotes antiguos, hongos verdes y otros brebajes supersticiosos, que les hacía beber, para que supiesen en aquellas embriagueces que aquellas comidas y brebajes les causaban, de tener victoria o no. Y desdichados de los que le anunciaban mal suceso, porque luego eran mandados matar, sin ningún remedio.
> [II Cap LXV 26]

> [Moctezuma] after these oracles and supplications, made the old men and former priests eat *green* mushrooms and other superstitious potions that he made them drink, so that they would learn in those drunken states that were caused by those foods and potions whether he would win victory or not. And woe betide those who predicted a bad outcome, for forthwith he ordered them to be killed without help for it... [Italics mine]

'Green mushrooms': we already know what the green mushrooms are, the sacred ones, which in paintings are green to suggest the most valuable of jewels, the rings of jade.

Bernardino de Sahagún

The Dominican Diego Durán and the Franciscan Bernardino de Sahagún towered above the other friars in sixteenth century Mexico in their intellectual curiosity about the natives, their history and culture. According to Father Garibay, they almost surely sprang from Jewish families lately converted to Catholicism. If so, it must be no mere coincidence that these two able men devoted their lives to the study of the conquered and downtrodden race. Sahagún spent more than half a century taking down in Nahuatl the testimony of numbers of carefully selected informants - selected for their knowledge and connections - and in 'rendering' or paraphrasing (not translating) in a Spanish *versión* their depositions. The Sahagún corpus is immense, only now coming to be fully known. It lies in Madrid and in the Biblioteca Laurenziana in Florence. The *Florentine Codex*, as this latter manuscript is commonly called, is bilingual, the Nahuatl depositions with Sahagún's rendering, profusely illustrated. In the 1960's Dr Charles E. Dibble and Dr Arthur J. O. Anderson brought to term the immense task of translating the Nahuatl text into English and the University of Utah published it in thirteen large volumes, the Nahuatl text and their English translation in parallel columns.

In the light of its size, what is contained in the Sahagún corpus about the hallucinogens and the mushrooms in. particular is meager, and what there is seems written with studied detachment leaning on the pejorative side. Here is nothing of the free flowing enthusiasm of the Nahuatl poets rendered for us by Father Garibay, but we must also point out Sahagún does not indulge in vituperative condemnation of the sacred mushroom such as we see in the writings of Motolinía and De la Serna. The longest passage that Sahagún's informants ever give us of the formal use of mushrooms is in an account of a celebration of some prosperous merchants who are making a displ ay of their wealth in their neighborhood. We are grateful to Dr Dibble and Dr Anderson for having granted us permission to offer our readers their translation of this and other passages relating to the mushrooms, which are mostly new to the scholarly world. Here is the Nahuatl account of the merchants' mushroom celebration put into English:

> At the very first, mushrooms had been served. They ate them at the time when, they said, the shell trumpets were blown. They ate no more food; they only drank chocolate during the night. And they ate the mushrooms with honey. When the mushrooms took effect on them, then they danced, then they wept. But some, while still in command of their senses, entered [and] sat there by the house on their seats; they danced no more, but only sat there nodding.
>
> One saw in vision that already he would die, [and] there continued weeping. One saw in vision that he would die in battle; one saw in vision that he would be eaten by wild beasts; one saw in vision that he would take captives in war; one saw in vision that he would be rich, wealthy; one saw in vision that he would buy slaves - he would be a slave owner; one saw in vision that he would commit adultery - he would be struck by stones - he would be stoned; one saw in vision that he would steal - he would also be stoned; one saw in vision that his head would be crushed by stones - they would condemn him; one saw in vision that he would perish in the water; one saw in vision that he would live in peace, in tranquillity, until he died; one saw in vision that he would fall from a roof-top - he would fall to his death. However many things were to befall one, he then saw all in vision: even that he would be drowned.
>
> And when the effects of the mushrooms had left them, they consulted among themselves and told one another what they had seen in vision. And they saw in vision what would befall those who had eaten no mushrooms, and what they went about doing. Some were perhaps thieves, some perhaps committed adultery. Howsoever many things there were, all were told - that one would take

> captives, one would become a seasoned warrior, a leader of the youths, one would die in battle, become rich, buy slaves, provide banquets, ceremonially bathe slaves, commit adultery, be strangled, perish in the water, drown. Whatsoever was to befall one, they then saw all [in vision]. Perhaps he would go to his death in Anauac.
> [*Florentine Codex*, Dibble & Anderson, Bk 9 pp 38-39]

The Nahuatl original differs in one striking particular from Sahagún's Spanish rendering in the familiar Florentine text: the Codex says explicitly in Spanish that the mushrooms *aúm provocan a lujuria*, they 'even provoke lust'. This is an interpolation for which there is no justification in the Nahuatl source. Was Sahagún responsible for adding these words? Why were they inserted? To excite the sixteenth century readers seeking always the Fountain of Youth and new aphrodisiacs? Or to incite his pious readers against the mushrooms?

The well known passage where Sahagún in the *Florentine Codex* uses the word *teonanácatl* appears afresh in the Dibble & Anderson translation of the Nahuatl:

Nanacatl

> It is called *teonanácatl*. It grows on the plains, in the grass. The head is small and round, the stem long and slender. It is bitter and burns; it burns the throat. It makes one besotted; it deranges one, troubles one. It is a remedy for fever, for gout. Only two [or] three can be eaten. It saddens, depresses, troubles one; it makes one flee, frightens one, makes one hide.
> He who eats many of them sees many things which make him afraid, or make him laugh. He flees, hangs himself, hurls himself from a cliff, cries out, takes fright. One eats it in honey.
> I eat mushrooms; I take mushrooms.
> Of one who is haughty, presumptuous, vain, of him it is said: 'He bemushrooms himself'.
> [*Ibid* Bk 11 p 130]

Book 10 of Sahagún's *Historia General*

In Dibble & Anderson's translation of Book 10 we discover five references to the inebriating mushrooms where none is cited in the Spanish rendering. These five citations are parallel: indeed they resemble each other so closely that one asks oneself whether they were not dictated by the same informant. Much of this Book 10 is given over to a particular kind of exercise, primarily linguistic: scores of types of people are succinctly abstracted - people chosen by their occupation, worthy and unworthy, by kinship rôles as *eg* the 'grandmother', by social rank, *etc*: hundreds of such types are offered to us. Until Dibble & Anderson gave us their translation, this wealth of information about the Nahuatl vocabulary and the Nahuatl social organization was accessible to us only in the inadequate Spanish *versión* of the *Florentine Codex*. Here follows a mere sprinkling of the hundreds of individuals described:

The lazy mother
The goldcaster
The maguey syrup seller
The mason with plumb
The bad farmer
The good nephew
The sodomite
The seller of salt
The green stone seller
The seller of tamales
The bad nobleman
The buffoon
The lapidary
The harlot
The thief

The reader of these abstractions inevitably thinks back to that minor form of literature known to the literary historian as 'Characters', first delineated by Theophrastus in ancient Greece and developed most subtly in the seventeenth century by Jean de la Bruyère in France and Sir Thomas Over bury in England. These two men came after Sahagún and one may assume that he did not know Theophrastus. Sahagún was simply intent on finding ways to elicit systematically from his informants an immense range of vocabulary that would otherwise have escaped him, and a range of social circumstance that will prove an inexhaustible mine for scholars to pore over. Here then is one character:

Noblewoman

> The noblewoman [is] of nobility, belongs to the order of rulers, comes from rulership whether she

> is legitimate or a bastard child.
> The good noblewoman [is] one who is bashful, ashamed [of evil], who does things with timidity, who is embarrassed [by evil].
> She is embarrassed [by evil]; she works willingly, voluntarily.
> The bad noblewoman [is] infamous, very audacious, stern, proud, very stupid, brazen besotted, drunk. She goes about besotted; she goes about demented; she goes about eating mushrooms.
> [*Ibid* Bk 10 p 49]

The Harlot; the Carnal Woman is described at length. Put briefly, she is the whore of the itching buttocks. She lives like a bathed slave, acts like a sacrificial victim,[32] goes about with her head high - rude, drunk, shameless, eating mushrooms. [*Ibid* p 55] *The Lewd Youth* is a drunkard, foolish, dejected; a drunk, a sot. He goes about eating mushrooms. [*Ibid* p 37] *The One of Noble Lineage* when he is a bad nobleman is a flatterer - a drinker, besotted, drunk. He goes about becoming crazed on both kinds of Daturas; he goes about eating Daturas and mushrooms. He becomes vain, brazen. [Ibid p 20] *The Bad Youth* goes about becoming crazed on both kinds of Daturas and mushrooms; he is dissolute, mad; he goes about mocking, telling tales, being rude, repeating insults. [*Ibid* p 12)

From these citations we learn that the inebriating mushrooms had been abused under the old regime, as would be natural in any community freely using them. By accepted standards of the Nahua and other Mesoamericans, the mushrooms were imbued with sanctity and were to be ingested only where the glow of religious belief accompanied the act. In our five citations the repellent context was fortunate for Sahagún's informants: they could truthfully and gladly excoriate those who in former times had abused the mushrooms, and the friars would also approve such excoriation though they naturally were condemning all use of the mushrooms as a mortal sin, trafficking with the Devil. Even if friars as intelligent as Diego Durán and Sahagún were asking themselves searching questions about what the inebriating mushrooms really did, they could not afford to experiment with them, especially so if Father Garibay is right in thinking they were of Jewish origin: this racial origin must have been known to their conventual colleagues and extreme circumspection must have been the undeviating rule of their lives.

There remains one further citation of mushrooms in Book 10: in the description of *The Smoking Tube Seller*, the tobacco tube seller. (This would correspond to our tobacco pipe dealer but our tobacco pipe differs so much in appearance from the tobacco tube of the Nahua that Dibble & Anderson are well advised not to use our misleading term in their translation.) At the end of the description, which is rather lengthy, the informant gives a list of the ingredients that the seller offers with the tobacco for the 'tube'. [*Ibid* p 88] Amongst others there are mushrooms and *poyomatli*, the flowers of *Quararibea funebris*, with which we are already familiar. In my own experience in Mesoamerica I had not known that the sacred mushrooms were smoked and was sceptical when I read in Carlos Castaneda's *The Teachings of Don Juan* (entry for Sunday 10 Sept 1961) how Don Juan added los *honguitos* to his pipe mixture. Now there is the best of authority for Castaneda's text.

The holy office of the inquisition

In the notes at the end of Dr Aguirre Beltrán's *Medicina y Magia* there is a wealth of references to the court records of the Inquisition held in the Archivos Generales de la Nacion (= AGN) dealing with hallucinogens and in my files I hold copies of many of the cases that he cites. One arresting fact emerges from these files of the Inquisition: Spanish housewives of the lower classes seem to have consulted the hallucinogens often, not personally, but through their Indian servants and slaves who would know the *curandero* to consult, the hallucinogen to take. In my perusal of these files lasting for weeks I found no evidence that any Spaniard, male or female, had ingested the mushrooms but that many of them did not hesitate to enlist a surrogate from among the Indians. To this generalization there was one possible exception.

---

[32] Those selected for sacrifice were honored in the community, and went around well dressed, eating expensive food, carrying their heads high. See p 203 for further mention of this.

1

The earliest reference to the sacred mushrooms in the story of the Conquest came in 1537, when the first Bishop of Mexico, the Franciscan Juan de Zumárraga, presided over the trial in Mexico City of two Indians, brothers, called in Nahuatl Mixcoatl and Tlaloc and in Spanish Andrés and Juan. They were charged with organizing resistance to the Spaniards, arming their fellow Indians, and invoking their Indian divinities for help in the struggle. These activities were aggravated by the fact that they had been baptized and were apostates, backsliders. They seem to have enjoyed considerable success, and as the Spaniards had been on the scene at that time for only two decades, the rulers may well have been fearful of an uprising. The record is lengthy and the mushrooms are mentioned five times, each time briefly, as though the Spaniards were not altogether familiar with them, but the Spaniards knew well that the mushrooms were served by the Indians in what they considered a simulacrum of the Holy Eucharist. The brothers were convicted and sentenced: they were to be mounted on asses or other beasts of burden equipped with packsaddles, they were to be paraded through Mexico City, Tulantzingo, and other centers where they had carried on their agitation, and each was to receive one hundred l ashes in each community, with a crier going before proclaiming their offense. Their hair was to be shorn, they were to renounce their heresies, and they were to be remanded for a year to live in the monastery of Tulantzingo, listening to the Doctrine and doing penance for their misdeeds. Their property was to be sold for the benefit of the Exchequer of the Holy Office. All this having been done, the Guardian Father of Tulantzingo was empowered to absolve them and reconcile them to Holy Mother Church.

This trial must have caused a stir among the Indians at the time. The sacred mushrooms figure in it certainly but it would be a mistake to exaggerate their importance. The gravamen of the charge was that the accused were apostates stirring up the Indians with inflammatory talk, denouncing the Spaniards, mobilizing arms, encouraging rebellion, and professing the power of the gods of the old religion. But the Holy Office was fully aware of the parallel between the bread and wine of Holy Communion - the flesh and blood of Christ - and the mushrooms that, according to the Indians, gave them visions.

In the light of the terrifying cruelties inflicted commonly on prisoners in the sixteenth century, let it be noted that Andrés and his brother Juan came off lightly. [Archivo General de la Nación: Vol III *Procesos de Indíos, Idolatrias y Hechiceros* pp 53-78, Mexico City, 1912]

2

The files of the Inquisition disclose another episode, amusing as well as instructive, that took place in 1629 in Michoacán, some distance west of Mexico City. A young woman named Inés Martín had left her husband Gonzalo. In despair he sought her in the woods. There he met an Indian named Joseph who advised him to ingest certain mushrooms (*raíces* = roots) that would reveal her to him in a vision. He followed this advice with startling effect: they showed her to him in a vision half a league away, underneath a tree in a garden where a relative was delousing her. It is noteworthy that no one disputed the miraculous power of the mushrooms: the inquisitor himself tacitly accepted the story as told. The gravity of the case was not Gonzalo's credulity but that he had recourse to the Devil for a miracle. Gonzalo may have been entirely Spanish in origin, and if so, he is the first and only known instance where a non-Indian ingested the mushrooms until the Wassons came on the scene in 1955. Still today the mushrooms serve to find objects or animals or persons that one seeks, and here we have, in testimony before the Inquisition in 1630, a classic instance of this kind. The translation of some of the testimony of Gonzalo follows:

> In the town of Taximaroa, 11 May 1630, before Father friar Cristoval de Vaz, Commissary of the Holy Office of the Inquisition in this jurisdiction... at about 4 o'clock in the afternoon, there appeared without having been summoned and duly sworn to tell the truth a man who said that his name was Gonzalo Pérez and that he was married to Inés Martín, both domiciled in this town... who to clear his conscience accused and denounced himself in this wise: he says that about two years ago, his wife having fled from him, and as she was his first love he was profoundly touched by her absence, and going into the woods to look for her he found an Indian named Joseph, a servant of his father, who said to this witness that he would give him an herb that they call *nanacates* with which he would see where she was, and having given him two little roots he saw nothing and afterwards this witness said to this Joseph, 'Get away from me, for you are a witch for you have done nothing for me nor have I seen anything', to which said Indian said he should

> take five of those as it were roots and he would see her, and this witness without knowing what he was doing with the desire that he had to see his said wife took them at about the hour of vespers and ate them and within two hours having bedded down in the woods, he saw a snake that said to him, 'Turn your head and you will see your wife', and turning he saw her in the house of a first cousin of this witness named Petrona Gutiérrez who was delousing her, being half a league from that hacienda without being able to see said hacienda; and that this witness really saw her, and from where he was this witness went to the house of his parents and said to his mother he had seen his said wife and confessed that he had taken said herb because his mother already knew it, who threw a rosary around his neck, and said mother went in search of his said wife and she found her there where this witness had seen her and brought her to his house... He was asked whether he firmly believed that the herb had shown him his said wife and that it had been by the craft of the Devil, whereupon he said yes.
> [Audience of the Holy Office of the Inquisition, AGN, Mexico City, vol 340, fol 354-359, transcribed for us by the late Sra María de la Luz Viamonte]

3

Our third episode tells of a *curandero* who narrowly escaped the clutches of the Holy Office. A seventeenth century cleric, Jacinto de la Serna, composed a guide for priests ministering to the Indians. His work was entitled *Manual de Ministros de In dios para el Conocimiento de sus Idolatrías y Extirpación de Ellas*. He was a garrulous busybody, zealous in rooting out and extirpating all expressions of the Indians' old religion, and eager in his narrative to leave a record of his own zeal. Chapter IV of his work continues a recital of incidents that had happened to the author proving (as he says) that idolatry was still rampant among the Indians in his own time. In Section 3 of this chapter he is discussing native physicians and midwives, especially the rôle of 'witchcraft' in their practices, and certain goings on in his own household that had aroused his liveliest suspicions. A certain Indian, master of the native lore, had lately arrived in the village and had officiated at a religious rite in which the intoxicating mushrooms had been a central feature. The description of the religious ceremony reaches us through don Jacinto by hearsay only, as of course he was not present, but it carries a ring of authenticity.

> And what happened was that there had come to the village an Indian, a native of the village of Tenango, great master of superstitions, and his name was Juan Chichitón, which means 'little dog', and he had brought the red-colored mushrooms that are gathered in the uplands, and with them he had committed a great idolatry, and before I tell of it, I wish to describe the property of said mushrooms, which are called in the Mexican language *Quautlannamacatl*, and having consulted the Licentiate Don Pedro Ponce de León, the great Minister and Master of Masters as I said in Chapter II, he told me that these mushrooms were small and golden, and to gather them it was the custom for the priests and old men deputized as ministers for this kind of hum buggery to go up into the mountain, and they remained almost the whole night in prayer and superstitious entreaties, and at dawn, when there sprang up a certain breeze that they knew, then they gathered the mushrooms, attributing divinity to them, possessing as they did the same effect as *ololiuhqui* [*Turbina corymbosa* (L.) Raf.] or peyotl [*Lophophora Williamsii* (Lem.) Coulter], because whether eaten or drunk, it intoxicates them and deprives them of their senses, and makes them believe a thousand foolish things. And so this Juan Chichitón, having gathered the mushrooms on a certain night, in the house where everyone had gathered on the occasion of a saint's feast, the saint was on the altar, and the mushrooms with *pulque* and a fire beneath the altar, the *teoponastli* [a percussion instrument peculiar to Mesoamerica] and singing going on the whole night through, after most of the night had passed, said Juan Chichitón, who was the priest for that solemn rite, to all those present at the fiesta gave the mushrooms to eat, after the manner of Communion, and gave them *pulque* to drink, and finished off the festivities with an abundance of *pulque*, so that what with the mushrooms on the one hand and the *pulque* the other, they all went out of their heads, a shame it was to see.

De la Serna goes on to relate how he had made utmost efforts to ferret out and lay his hands on Chichitón. There was a hot chase, but by the skin of his teeth the 'Little Dog' eluded his pursuer's clutches.

The mycophobic syndrome: our supreme example

Our book has undertaken to show how the White Man at first tried to play down, then ignore, the entheogenic mushrooms of Mesoamerica, until, having fully accomplished this purpose, even the scholars specializing in the field, spokesmen as it were for our Western civilization, did not give them a thought. Here follows an enlightening illustration of this mental block from the very citadel of Mesoamerican studies.

In the late 1920's there was found lying in the library of the University of Texas, a manuscript entitled:

Coloquio de la nueua conbersion y bautismo
de los cuatro últimos reyes de Tlaxcala

'*Colloquy* of the new conversion and baptism
of the four last kings of Tlaxcala'

The 'Colloquy' is written in crude verse, a piece of religious propaganda devoid of literary merit. The participants in the 'Colloquy' are twelve: Hernán Cortés Marqués del Valle and his interpreter Marina, two 'Ambassadors', the cleric Juan Diaz, the four 'kings' (as they are called) of Tlaxcala, *Hongol demonio ydolo*, and two angels who raise their voices in triumphant singing as the four 'kings' are baptized with Christian names suggested by Cortés. The utterances of the four 'kings' are saturated with talk of *Hongol*: at first they are under *Hongol's* domination but they lend themselves readily to conversion and baptism. Though *Hongol* delivers three lengthy speeches, he of course loses out to the Christian appeals. The manuscript bears the date 1619 which gives us a *terminus ad quern*: it was composed in the early seventeenth century or the final years of the sixteenth.

Hongo is 'mushroom' in Spanish and it takes no perspicacity to see that *Hongol*, the Demon and Idol, is our *teonanácatl* or *xochinanácatl*.

Whether this 'Colloquy' was ever performed we do not know. But this 'Colloquy' does declare and ratify one lesson that our book brings out: the preoccupation of the friars for generations after the Conquest with the divine mushroom (as the Nahua called it), a powerful rival to the Holy Eucharist.

> Bastará decir que los cuatro reyes, como el autor los llama, hablan a la continua de un dios ONGOL, HONGOL, perfectamenta desconocido en Tlaxcala y en todo sitio en que se habla nahuatl, pues sabido es que esta lengua carece de G. [pp 157-159]
>
> Suffice it to say that the four kings, as the author calls them, speak continually of a god *ongol*, *hongol*, completely unknown in Tlaxcala and everywhere else where Nahuatl is spoken, since it is well known that this language lacks the letter G.

Father Garibay did not see that *hongol* was simply a translation of *teonanácatl* with the terminal *l* of Nahuatl added. The sacred mushrooms of the Nahua were absent from his mind. But how much did he differ from other Mesoamerican specialists?

In 1843 Prescott, in his *Conquest of Mexico*, omitted all mention of the sacred mushrooms. In 1898 Carl Sapper and also Daniel Brinton showed that they had never heard of the mushrooms in Mesoamerica. Walter Lehmann, when he edited the *Codex Vindobonensis* in 1929, remarked on the resemblance to mushrooms of the curious objects therein portrayed, but it did not occur to him that they might be what they looked like: he had failed to note the mushrooms in the writings of the friars. Father Garibay, reaching the height of his scholarly activities in the fifties, did not perceive the *teonanácatl* of the Nahua when editing his Sahagún (published in 1956), when he commented on the seventeenth century *Colloquy* featuring '*hongol*', nor ten years later when editing his *versión* of the Nahuatl poets in the 1960's. He did not know about the worries of his fellow clergy and their struggles against what they had considered the travesty of the Holy Eucharist that the Indians were accustomed to perpetrate with mushrooms. Indeed, did he not learn of the existence of the sacred mushrooms of the Nahua from the publicity that attended the discoveries of Heim and the Wassons?

Alfonso Caso, albeit with some reluctance, was the first and only Mesoamerican scholar to concede recognition to the potent entheogenic mushrooms in his paper on the *Codex Vindobonensis*. In it he declared at the outset that the paper owed its genesis to Heim and the Wassons. Even that paper of Dr Caso's, which appeared fifteen years ago, has had no reverberations in scholarly circles.

Safford's blunder in 1915 drew no protests from eminent scholars or scientists. Reko's persistent protests fell on deaf ears and he died a disappointed man in 1953. Weitlaner's efforts, and Jean Bassett Johnson's, and Schultes's passed unnoticed, perhaps because of the war. Until Valentina Pavlovna and I assembled and recapitulated their activities in an article that appeared in the *Journal* of the New York Botanical Garden, Jan-Feb 1958, few thought of them or of *teonanácatl*. Sahagún, Diego Durán, De la Serna, Motolinía, Hernández, *etc etc* - they might as well not have mentioned mushrooms. The sacred mushrooms of the Mesoamericans had fallen into oblivion. Safford was victorious, almost.

Strange, how most Mesoamerican scholars slough off as of no interest to them (or us!) an area of experience that for thousands of years irradiated the lives of the people they study. Our original and daring and eccentric hypothesis, my wife's and mine, that the peoples of Western Europe (except those speaking Catalán and the *langue d'oc*) were steeped from birth in darkest mycophobia to the point where their minds, all unawares, were invincibly closed to mushrooms, may well have been right! To my amazement, let it be said: was ever wild conjecture more stunningly ratified than ours by the extraordinary Mesoamerican evidence? But our strictures are not confined to Mesoamerica. The use of fungal entheogens was once circumpolar. The Claviceps at Eleusis, the fly-agaric linked with birch and conifer, and also (increasingly probable) with the famous Soma of the Aryans, along with the *teonanácatl* of Mesoamerica, seem to have evoked boundless awe and obeisance from our Eurasian ancestors and their New World descendants.

The range of mushroom use in mesoamerica

In Fig 1 we off er our readers a map of the areas over which I think it is fair to say that the cult of the divine mushroom probably prevailed at the moment of the Conquest. This is an approximation, perhaps on the conservative side. The map is built on linguistic areas as those areas probably stood in the fifteenth century. Trade was flowing constantly throughout Mesoamerica, the merchants travelling with their stocks of goods on their backs and, for mutual protection, in bands. There was also warfare in which slaves and goods were captured. It stands to reason that throughout this cultural area the mushrooms were known and used wherever they grew and perhaps slightly beyond. Their fame must have been wider than their use. There was no secrecy about the mushrooms. How could there be?

1. *The Nahua* in the Valley of Mexico have left us rich documentation on their use and abuse of inebriating mushrooms and the exalted status accorded to them by the aristocrats. Father Garibay in his rendering of the two anthologies in his *Poesía Nahuatl* 1-3 leaves us in no doubt about this and Diego Durán in brief but pungent references is in agreement. The Nahua were widely distributed over what is now central and southern Mexico and bands had emigrated to Guatemala on the Pacific Coast and into the Highlands where they were known as Pipil.

2,3,4. *The Otopamean* linguistic group: *Otomí*, *Matlatzinca*, *Mazahua*. In *Les Champignons hallucinogènes*... (1958) I traced back to 1543 the evidence for the use of the mushrooms in Otomí country and also cited an Otomí lexicon dated 1640 in the Biblioteca Nacional de México that cites Otomí words for the inebriating mushrooms. Karl-Herbert Mayer of Graz has lately discovered an Otomí lexicon in the Bibliothèque Nationale (Paris) dated 29 October 1605 giving similar words for the inebriating mushrooms in that language: these are both manuscripts, and the 1640 dictionary may have been copied from the original of the 1605 version. No one seems to have reported a present day use of the sacred mushrooms: perhaps no one has looked for it.

Similarly in the Matlatzinca country, in *Les Champignons hallucinogènes*, a manuscript lexicon of 1642 composed by Diego Basalenque lends support for the use there of the mushrooms. We called attention also to a document of 1579 that recorded the payment of tribute in kind in the old days to the Lord of Mexico, and among those deliveries were mushrooms. One anthropologist has drawn attention to the fact that in the records of tribute paid in kind under the kings of the Aztecs mushrooms are never mentioned. He had overlooked this passage, but it is true that so far as we now know it is unique. Is not the explanation simple? When we went down to Mexico in 1953 and began our exploration of the mushroom complex, we discovered that mushrooms did not figure in the market squares: they changed hands privately, they were carried out of sight through public thoroughfares, one did not speak of them. Was not this even truer in the old days before the Conquest?

The Matlatzinca language survives to this day in one town: San Francisco Oxtotilpan. Dr Gastón Guzmán and A. López-González, the former a mycologist and the latter an anthropologist of the Escuela Nacional de Antropología e Historia, succeeded in documenting the use of *Psilocybe Wassonii* among the inhabitants of that village. Leonardo Manrique, Chief of the Department of Linguistics of the Museo Nacional de Antropología, says that the name of these mushrooms in Matlatzinca today is *neto&ccaron;*^{h}*utata*, *ne-* being the plural, *-to-* a reverential diminutive, *-&ccaron;*^{h}*u-* the root for sacred, and *-tata* being lord; 'the most holy little Lords'.

For the Mazahua, we have no contemporary information. Robert Weitlaner and I visited them briefly but failed to arrive at any positive information. On the other hand in *Mushrooms Russia & History* we cited a manual prepared in Mexico and published in 1637 entitled *Doctrina y Enseñanza en la lengua Maçahua de Casas muy Utiles, y Provechosas para las Ministros de Doctrina* by the Licentiate Diego de Nágera (or Nájera) Yanguas, incumbent of Xocotitlan. This is a manual to guide the clergy serving the Mazahua population and specifically guiding them in asking questions of the faithful in the confessional. The Father confessor on folios 27-29 catechizes his penitent as to whether he has eaten mushrooms and got drunk on them and if so why, whether to find lost objects or for illness. The following extract shows the tenor of the questions, the column in English being added by us:

por que	yoqhenangueze	why
querias	daguiminemaha	didst thou want
comer	toguiça	to eat
essos hongos?	mayho yocho	those mushrooms?
por que	nanguezé	because
estaba enferrno	darirniçhoye	I was ill
queria comer	dariminemaha rogoza	I wanted to eat
hongos	yocho	mushrooms
para ver	maqheranuu	to see
lo que perdi	maqhe peqherobexi	what I had lost
quantas vezes?	hançhanixi?	how often?
no los comiste?	que higuiza?	didst thou not eat them?
no los comi	hiroza	I ate them not
solamente	anguechco	I only
queria	dariminemaha	wanted
comerlos	togoza	to eat them.

Mushrooms Russia & History p 221

5. *Tarascan*. A lexicon compiled by Maturino Gilberti and published in 1559 gives the word in Tarascan for the mushroom that inebriates. Furthermore, in the episode before the Inquisition that we told at length on pp 210-211, the scene took place in 1629 in Michoacan and Joseph the Indian was presumably a native Tarascan speaker.

6. *Huastecan*. This tongue descended from the Mayan stock is spoken along the Gulf Coast, the most northern of the languages that we are ternpted to place among those using the entheogenic mushrooms. Our only written evidence is a letter discovered by Guy Stresser-Péan to the clergy of Huasteca written by the Archbishop of Mexico in 1726 in which he deplores the pagan practice of taking mushrooms and possibly other substances to obtain visions. Three of the poems in *Poesía Nahuatl* (numbers 12, 13, and 14 in Vol 3), riotous drinking songs, were said by the anthologist in the sixteenth century to be Huastecan in inspiration. In our inquiries in the mid-twentieth century we have not found the use of mushrooms in low lying territory, and as the Huasteca is partly low lying, if the practice was native there, this might extend the range of their use.

7. *Totonac*. Some linguists suggest that this language is remotely related to Mayan. It is spoken by the people living on the Gulf of Mexico south of the Huasteca. Our terra cotta figurine showing a woman with her right arm on a mushroom and her left arm raised in what I interpret as a speaking gesture, is from what is now the Totonac country but dates from the beginning of our Christian era. We assume that the Totonacs knew the mushrooms that abound there.

8. *Mixe*. We visited this area twice and found abundant evidence that the entheogenic mushrooms were known to everybody, both in the eastern stretch of the Mixe country and the western. This Mixe region is a remote and conservative country and the usage must go back long before the Conquest.

9. *Zoque*. We have not visited this area and we have no information about it, either historical or contemporary. It is contiguous with the Mixe country to the West and with the Mayan peoples to the East and North. I do not see how they could avoid practicing the mushroom cult, but as I have no information I designate it with a question mark.

10. *Mazatec*. There seems to be no historical information but we have uncovered an abundance of contemporary tradition. María Sabina has been our ever flowing source of information, and the tradition is strong and obviously ancient.

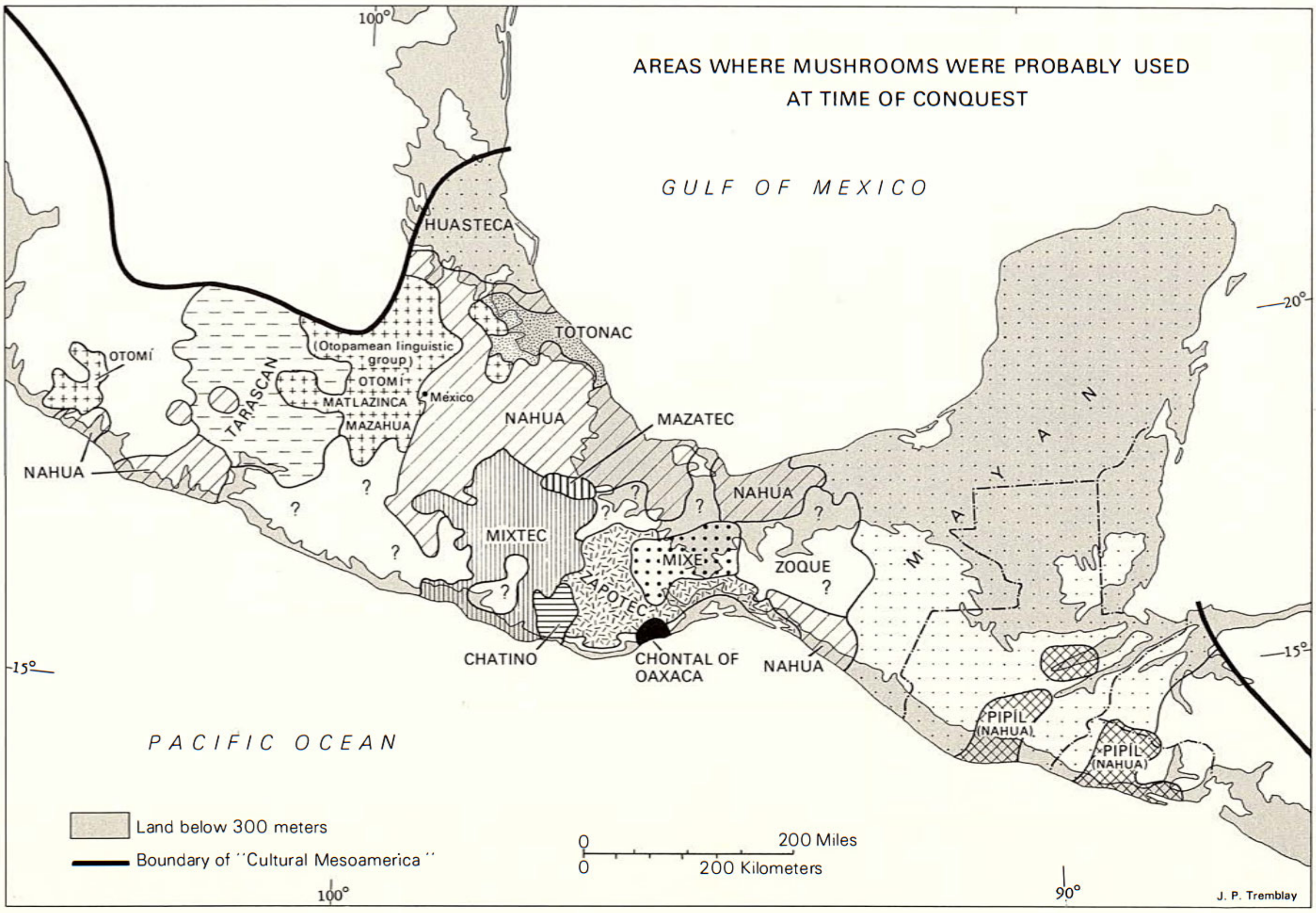
11. *Zapotec*. This major group of mutually unintelligible dialects is in an area where the inebriating mushrooms are common and where the people know them intimately. In a lexicon published in 1578 and compiled by Fray Juan de Córdoba there are words for 'mushrooms that they say give you visions'. There is additional testimony of considerable interest. It is to be found in *Paso y Troncoso: Papeles de Nueva España*, 2nd Serie, Geografía y Estadística, Vol IV: *Relaciones Geográficas de la Diócesis de Oaxaca*. The manuscript from which it was printed was dated 15 April 1580. The document begins on p 109 and deals with a Zapotec town called Teticpac, four leagues west of Antequera and 40 leagues from Tehuantepec. In the course of Paragraph XIV we read:

> Adoravan al demonio haziendo a su figura ydolos e caras de piedra muy feas a las quales sacrificavan perrillos e yndios esclauos y esta hera su adoracion e a quien tenian por dioses; e despues que hazian algun sacrifiçio tenian por costumbre bailar e ynbriagarse con vnos hongos en tal manera que vian muchas visiones e figuras espantables.
>
> They would worship the devil making in his likeness idols and faces of stone, very ugly to which they would sacrifice little dogs and Indian slaves and this was their worship and whom they took for gods; and after they had made some such sacrifice it was their custom to dance and get drunk on some mushrooms in such a manner that they would see many visions and fearful figures.

12. *Chatino*. This is a linguistic enclave in the Zapotec country. The language is called 'Zapotecan'. When Roger Heim and I went there in 1956, introduced by Bill Upson of the Instituto Lingüistico de Verano, we found many species of sacred mushrooms in use. As the Chatino country is entirely surrounded by Zapotec speakers, it is safe to assume that the practice is ancient.

13. *Mixteca*. The use of mushrooms in this important linguistic area is documented in the *Códice de Yanhuitlán* edited by Jiménez Moreno. On 15 October 1544 in proceedings before a Spanish scribe and notary, three Indians, notables, gave testimony concerning their ostentatious worship of the gods of the old religion. As they had been baptized, they were of course apostates. The principal Indian gave his testimony in Mixtec. It seems that he had taken inebriating mushrooms to invoke divine help in various circumstances. The pre-Conquest *Codex Vindobonensis* and the post-Conquest *Lienzo de Zacatepec* both include the same glyph for the sacred mushrooms. Both were Mixtec in origin. I visited the Mixteca twice, in 1960 and 1961, accompanied by Robert Ravicz and on the second occasion also by Roger Heim. Our mushroomic experiences have been published.

14. *Chinantla*. Robert J. Weitlaner and Thomas MacDougall learned of the use of inebriating mushrooms in Comaltepec and Yolox, Chinantec towns, in 1960, and in a letter to Weitlaner from Guadalupe M. Calderón, Chinantec Indian, dated 8 August 1963, he gave details about their use. Later Arthur J. Rubel and Jean Getterfinger-Krejci published a paper in *Economic Botany*, July-September 1976, submitted September 1974, giving an account of a *velada* that they had attended in Santiago Comal tepee. In that paper they also documented the use in the Chinantl a of inebriating mushrooms in the 18th century.


AREAS WHERE MUSHROOMS WERE PROBABLY USED AT TIME OF CONQUEST
GULF OF MEXICO
PACIFIC OCEAN
100°
100°
90°
20°
15°
15°
HUASTECA
TOTONAC
OTOMÍ
(Otopamean linguistic group)
OTOMÍ
MATLAZINCA
MAZAHUA
México
TARASCAN
NAHUA
NAHUA
MAZATEC
NAHUA
MIXTEC
MIXE
ZAPOTEC
ZOQUE
CHATINO
CHONTAL OF OAXACA
NAHUA
MAYAN
PIPIL (NAHUA)
PIPIL (NAHUA)
?
Land below 300 meters
Boundary of "Cultural Mesoamerica"
0
200 Miles
0
200 Kilometers
J. P. Tremblay

15. *Chantal de Oaxaca*. Evidence of a unique character seems to support the supposition that inebriating mushrooms were used in the small enclave, close by Tehuantepec, of speakers of this language classed as a Hokaltecan tongue. ('Chontal de Tabasco' is a Mayan language utterly unrelated.) Occasionally anthropologists working in remote villages in Mexico come across texts written on paper giving details, often liturgical, in the native language. They used to be most highly valued and handed down from generation to generation. When the paper was wearing out, it was recopied. No one can say how far back the text goes. Now that the hold of traditional values is breaking down, these papers are drifting into the hands of anthropologists and linguists and usually end up in the Department of Ethnology in the Museo Nacional. In the summer and fall of 1968 such a document was made available to Robert Weitlaner by Juan Ramírez, an informant who is wholly Chontal. In its text there occur the words '*mescal de hongo*': apparently the mushroom is thrown into boiling *mescal*. Later German Placencia of the Department of Ethnology found another manuscript where '*mescal de hongo*' is cited. In the light of the hold that the inebriating mushrooms have on the native peoples among whom these Chontal are living, I think we are justified in assuming that these documents refer to the use of inebriating mushrooms in the religious practices of the Chontal of Oaxaca.

16. *The Highland Mayan* languages. I have dealt with these in the preceding chapter.

CHAPTER 11

The shaman and the mushroom: new perspectives

The fascination of the Mesoamerican culture for the modern world lies in its strange (for us) traits, in the vast and ever expanding documentation permitting us to explore those traits always making discoveries, in the refinement of its thinking and its high artistic craftsmanship contrasting with human sacrifice and cannibalism on a scale unknown to us elsewhere, and in its chronological and geographical proximity to us. Here we possess an unrivalled opportunity to study Early Man in a pure culture, and also his head-on collision with sixteenth century European civilization.

How odd then is our failure until now to have grasped the hold on this culture of the entheogenic mushrooms. There was no secrecy about them before the Europeans arrived on the scene. How could there be? They grew almost everywhere in the highlands of southern Mexico. There would have been no secrecy after the White Man arrived on the scene, were it not that we, knowing nothing about them, seemed aggressively determined to learn nothing. Though living in the age of science, we regarded ourselves as inhibited from trespassing on this legitimate area of inquiry.

I have sometimes asked myself whether the unlettered ages, stretching back through æons of time, were not those belonging peculiarly to the entheogens, the Age of entheogens. The Mysteries of Eleusis began in the unlettered past of the amazing Greek people, then persisted for a few centuries under an hermetic seal of secrecy into an age of glorious letters, whereupon they finally and compl etely petered out. The Soma of the Vedic Hymns knew its heyday before the Aryans learned their letters but it disappeared with the coming of the alphabet, and it lingers on to this day among the Hindus (and some Sanskrit scholars!) only as an unsubstantial dream plant. Can these coincidences be dismissed as cases of *cum h&omacr;c ergo propter hoc*? Among the northern tier of peoples in Siberia the divine mushrooms flourished as a focus of devotion so long as they knew no alphabet, until the Russians and specifically the Soviets, precisely like the friars of Mesoamerica, tried to rub it out before studying it.

Has the advent of the alphabet with its slow progress among the languages of the world been studied in all its aspects? The coming of literacy and writing was the profound cultural event of our human civilization: this much we all know. Perhaps that event exerted a significantly different impact on different elements in the community. From my observations in Mexico, in the Algonkian country, in India, I think the unlettered herbalists possessed a body of knowledge, commanding an infinity of empirical subtleties, that has escaped our botanists and anthropologists. In the prehistory of all cultures including those still existing, the herbalists are a repository of knowledge acquired through centuries of intensive observation and experience which they pass on from generation to generation by word of mouth from master to apprentice. This was a self-contained system and largely secret. These practitioners were hardly the ones to quicken with excitement and curiosity when the talk of the alphabet was abroad in the land. On the other hand those who took to the new-fangled writing were the aggressive intellectual leaders and scribes, including sometimes priests for their own reasons and some of the aristocracy, all of them beings from a different world, and the hidden knowledge of the herbalists would hardly have come their way, their corpus of knowledge not lending itself easily to writing. Here is why Theophrastus and Dioscorides are disappointing for us: they were the heralds of the New Dawn in botany but were beginning virtually from scratch. They would have failed to win the trust of the herbalists in their midst. I am not dogmatic about these trends of long ago but am suggesting a plausible framework to explain what may have happened. The herbalists' knowledge was secret but of different degrees of secrecy. In Mesoamerica the entheogens were known to everyone, but in Greece secrecy was the rule.

In Mexico I have seen how quickly the coming of the alphabet (*ie* primary schools), the spread of literacy, changes the outlook of a village almost overnight. The old world of the *sabia*, the herbalist, the shaman, lingers on for a few more seasons in rapidly shrinking circles. Here is what María Sabina, the shaman in her eighties, said as translated from the Mazatec by Alvaro Estrada a little while ago:

> Es cierto que antes de Wasson nadie hablaba con tanta soltura acerca de los niños. Ningún Mazateco revelaba lo que sabía de ese asunto.... Los *niños* son la sangre de Cristo. Cuando los mazatecos hablamos de las *veladas* lo hacemos en voz baja y para no pronunciar el nombre que

> tienen en mazateco [*ˀnti^{1}xi^{3}tho^{3}*] los llamamos *cositas* o *santitos*. Así los llamaron nuestros antepasados.... Desde el momento en que llegaron los extranjeros... los niños santos perdieron su pureza. Perdieron su fuerza. Fueron profanados.... De ahora en adelante ya no servirán. No tiene remedio. Antes de Wasson, yo sentía que los *niños santos* me elevaban. Ya no lo siento así.
> [Alvaro Estrada: *La Vida de María Sabina*, pp 103, 119-20]
>
> Certainly before Wasson no one spoke with such freedom about the 'children'. No Mazatec would reveal what he knew on this subject.... The 'children' are the blood of Christ. When we Mazatecs speak of the *veladas*, we do so in a low voice and so as not to pronounce their name in Mazatec [*ˀnti^{1}xi^{3}tho^{3}*] we call them 'Little Things' or 'Little Saints'. Thus were they called by our forebears. From the moment when the strangers arrived the 'Holy Children' lost their purity. They lost their strength. They were profaned. From now on they will serve no purpose. There is no help for it. Before Wasson I felt that the Holy Children elevated me. I no longer feel so.

These words make me wince, but I was merely the precursor of the New Day. I arrived in the same decade with the highway, the airplane, the alphabet. The Old Order was in danger of passing with no one to record its passing. The Old Order does not mix with the New. The wisdom of the *Sabia*, genuine though it was, has nothing to give to the world of tomorrow. I think it was ever so with the arrival of the alphabet. Now the young generation is intent on the new learning, wants to forget the mushrooms that only yesterday evoked their awe, chooses the young doctor from the medical school in the city in preference to the wise-woman, and is not learning or is forgetting the language of his ancestors. Alvaro Estrada, Mazatec born in Huautla, writes me under date of 24 August 1977:

> Los jóvenes huautecos hoy día se avergüenzan de su origen indio y tratan de que sus hijos no hablen el mazateco.
>
> The young of Huautla are ashamed of their Indian origin and try to see to it that their children do not speak Mazatec.

Whether these trends are good or bad is not the question: they are inevitable.

We know that the shamanic practice of María Sabina is ancient. The evidence for this is diverse and I think overwhelming. The architectural arrangement of the immense building complexes of Teotihuacán and their murals, hitherto unexplained, make sense for the first time when interpreted by her practices. Ruiz de Alarcón's writings as illuminated by Alfredo López Austin's studies point to strikingly similar *veladas* in the Nahuatl-speaking country in the early seventeenth century, and we have listened to identical shamanic chants deep in the Zapotec country, though we did not tape them. The mushroom stones of Guatemala, the carvings of ecstatic figures of parallel age found in Mexico, the mythological genesis of the rôle for mushrooms elucidated for us in the *Codex Vindobonensis* - all speak with the same voice. We possess no starting point for this use of the divine mushrooms: the trail disappears from sight in the remotest past.

Shamanism is the term customarily used to describe one aspect of the religious life of communities, mostly preliterate, where individuals known to us as 'shamans' claim to possess, and are recognized by their neighbors as possessing, extraordinary powers for communicating with the unseen world, the world of departed spirits, which they enter through an ecstatic trance. The shamans are not organized in priesthoods: each is on his own, and the following he enlists is in proportion to the charisma that he enjoys. If, as is commonly believed, *Homo sapiens sapiens* began his domination of the world some 50,000 years ago, then it is possible, perhaps even a fair assumption that shamanism has been the highest vehicle for the expression of man's religious yearnings for more than nine-tenths of his domination of this earth, and it still survives with diminishing vigor in the world's outlying communities. If our Neanderthal (*Homo sapiens neanderthalensis*) and other predecessors were of comparable intellectual capacities, shamanism may well be far, far older.

In discussions of shamanism there has been much nonsense uttered about the rôle of inebriants. Distilled alcohol could never have been important. In the West distilled alcohol seems to have been a discovery of the School of Salemo about the year A D 1100, and it was kept a secret restricted to alchemical and monastic circles up to the Reformation four centuries later. In the East the Chinese were earlier, especially by the 'freezing-out' process, perhaps as early as the fourth century A D. But even so this is late in the long history of shamanism. I question whether fermented drinks - mead, wine, beers - were ever much used in shamanism: in most persons they cloud the brain and render muscular responses unreliable. Many are so primitive where the psyche is concerned that for them states of alcoholic inebriation are landmarks for judging mind-altering drugs. Alcohol and the entheogens are worlds apart. Their effects are different in kind. We must divorce alcohol from the entheogens: this is the first and great commandment. The entheogens, whose secrets the modem world is only now learning (chiefly from what I call 'Early Man' regardless of the chronological age) are a key to shamanism and the Mystery religions, a key that students have yet to evaluate at their full worth. In every case the use of these entheogens goes back as far as history, linguistics, and archæology carry us, and we must assume much further. Their use seems to be older than our oldest information. Not that the entheogens are needed to induce an ecstatic trance. Some people practicing shamanism do not know them. By dint of frenzied dancing, singing, shouting, and percussive music, chiefly drums, the shaman arrives at the desired state of ecstasy and finally falls down in a stupor, whereupon communication with the other world is established. The Hindus, perhaps inspired by a potent memory of their divine but inaccessible Soma, have evolved techniques - austerities, postures long maintained, physical exercises, mental concentration - that permit them to arrive at a state of 'contemplation' without the aid of plant hallucinogens. This state is of a different nature from the ecstasy we are discussing, and certainly its adepts rate its quality as superior, indeed as the ultimate in human achievement.

Botanists and anthropologists sometimes ask why we are discovering so many entheogens in use in the contemporary New World cultures, among Indian peoples of Mexico and southwards, as contrasted with their relative scarcity in Eurasia. Surely the answer lies in our being able to examine in the New World the many living cultures at the precise moment when they are entering the stage of their own proto-history from their prehistory. We catch these cultures when, so far as the entheogens go, they are still pure, thanks to the strange determination of our race through centuries not to trespass on this field - a boon certainly for us present day inquirers! In Eurasia we are dealing for the most part with cultures that emerged into history long ago, that have therefore left behind shamanism with its trappings, that have lost the secrets of their own herbalists of the remote past. Entheogens were always secret preparations in Greece and large parts of Eurasia, the secret spontaneously guarded by those privy to it. We must remember that the Indians of the New World have led our botanists by the hand to the entheogens. It would have been a lengthy, costly, perilous journey if we had had to rely on trial and error to arrive at those plants that, when properly handled, offer us psychotropic effects.

In his trance the shaman goes on a far journey - the place of the departed ancestors, or the nether world, or there where the gods dwell - and this wonderland is, I submit, precisely where the entheogens take us. They are a gateway to ecstasy. Ecstasy in itself is neither pleasant nor unpleasant. The bliss or panic into which it plunges you is incidental to ecstasy. When you are in a state of ecstasy, your very soul seems scooped out from your body and away it goes. Who controls its flight? Is it you, or your 'subconscious', or a 'higher power'? Perhaps it is pitch dark, yet you see and hear more clearly than you have ever seen or heard before. You are at l ast face to face with Ultimate Truth: this is the overwhelming impression (or illusion) that grips you. You may visit Hell, or the Elysian fields of Asphodel, or the Gobi desert, or Arctic wastes. You know awe, and bliss, and fear, even terror. Everyone experiences ecstasy in his own way, and never twice in the same way. Ecstasy is the very essence of shamanism. The neophyte from the great world associates the mushrooms primarily with visions, but for those who know the Indian language of the shaman the mushrooms 'speak' through the shaman. The mushroom is the Word: *es habla*, as Aurelio told me. The mushroom bestows on the *curandero* what the Greeks called *Logos*, the Aryans *Văc*, Vedic *kăvya*, 'poetic potency' as Louis Renou put it. The divine afflatus of poetry is the gift of the entheogen. The textual exegete skilled only in dissecting the cruces of the verses lying before him is of course indispensable and his shrewd observations should have our full attention, but unless gifted with *kăvya*, he does well to be cautious in discussing the higher reaches of Poetry. He dissects the verses but knows not ecstasy, which is the soul of the verses.

The shaman exercises his calling according to his lights. Every shaman puts on a different performance, and the extraordinary shaman is entitled to be called a virtuoso. His voice, his verses filled with traditional ('formulaic') phrases, his dancing, his percussive effects - these he works up in response to his little audience and in fulfillment of his genius, and there can be no doubt that sometimes the effect is telling. The reputation of a good shaman extends over a wide radius and some villages are famed for the shamans they produce, shamans with conviction, self-confidence, who *cantan recio*, 'sing stoutly', as they say. I believe villages exist in Mexico where there is such a strong tradition of shamanism that one may speak of a 'school' of shamanism associated with their names;[33] not of course an organized school but a tradition of shamanism permeating the village life and in which the villagers take quiet pride. While the shaman is not confined to any fixed liturgy, he is naturally a product of the cultural ambiance of his and the neighboring villages. He will be a prisoner of the conceptions of the universe and the beliefs that they possess, the practices that are habitual in the community. He may introduce personal variations into his performance, striking effects, but it is hardly possible for him to do violence to the framework of the world in which he has lived his life. He can only stretch that framework.

But what do we mean by 'stretching that framework'? In his ecstasy the shaman invokes in fervent verse and hymns the spirits that his neighbors know, gives utterance to the community's beliefs mythological and eschatological. When he is a man of intellectual power and moral prestige, will he not introduce grace notes into the common stock of those beliefs, variations and elaborations and deviations, within the confines that he senses are permissible and perhaps conforming to the inchoate notions already dimly felt by some in his gathering? Such deviations might take into account the heroic doings in war or hunting or when fishing on the high seas of the mighty men of his own generation, whom all have known, or natural catastrophes that have overtaken the village, or a migration to a new environment with strange and uncertain neighbors. These deviations will be accepted, and successive generations of shamans will bring innovations, which accounts for the fluidity of oral traditions among related peoples. For we speak of a world where there is no writing, where the corpus of cosmological and historical beliefs, the whole culture of the people and their vocabulary, lies in the minds and on the tongues of the living generation and nowhere else. Later, when the age of writing has arrived, an Herodotus comes along who puts down all the various recensions - 'some say this and some say that and yet others tell another story, but I think the truth is so-and-so'.[34] Surely the shaman preceded in time the itinerant bard, for the bard presupposes kings with their audience chambers and patronage and a degree of sophistication. The shaman knows only his neighbors among whom he has lived from the beginning. When possessed, he bears in his person the charisma of a village mediator with the spirits of the invisible world. How extraordinary that in this nuclear age so ancient a form of religious expression still survives, for a few more years, in the remote regions of the world!

Fly-agaric in the new world

In 1968 in my *Soma* I said that we should be thankful for the data we had assembled on the fly-agaric cult of Siberia but warned against exaggerating their importance. For a shamanic practice that had lasted we know not how many millennia our soundings reached back only three centuries, ripples on time's surface. Moreover those three centuries of cultural upheaval and chaos saw the end of the practice: it could be observed only when it was *in extremis*.

> Some of the observers [I wrote] were supercilious and none of them saw the implications of their observations. None of them seems to have been prepared in botany and none probed the questions that are compelling for us. The circumstances that brought them on the scene were at the same time bringing about the end of the beliefs and performances for which they were to be the sole witnesses. They were observing the fly-agaric cult only in its dying phase, when the

---

33. *Eg* San Lucas Zoquiapan, in the Sierra Mazateca.
34. This imprecision in all knowledge not tied to observations of nature (which by contrast are remarkably precise) is the dominant aspect of cultures in unlettered communities. Our earliest accounts - Homer, the Old Testament, the Rg Veda, the Kojiki, *etc* - bear witness to this. As for shamanism, in all the world's literatures there is surely no other shamanic performance that equals the mythic account in the Kojiki of Uzume's dance on an upturned rub before the cave where the sun-goddess has hidden herself. At the beginning of the eleventh century Lady Murasaki opens her *Tale of Gen ji* trailing the influences of the unlettered past of her people - 'some say this and some say that' - but she quickly hits her stride and thereafter she writes one of the most subtle and sophisticated of all novels of court life. Arthur Waley in the first and last of his footnotes, at the end of this opening chapter of the *Tale of Gen ji*, surprisingly fails to grasp the drama of this literary metamorphosis: he apologizes for his author and asks the reader to be indulgent! But she was only illustrating in her own gifted person how close is the unlettered mentality to the super-refined product of a cultivated society. In her person and her novel she was bridging the gap that separated the powerful pre-literate traditions of the Japanese and the sophisticated culture that they were drinking in from China.

> arean of its diffusion was being lopped away, when in some places the integrity of belief in it had bee undermined, and when the tribes themselves were mostly in a pitiful state of physical and psychological disarray. There is ample evidence that the ethnic movements, often gradual and more or less peaceful, in the inhospitable tundra and taiga of Siberia have been continuous, and we are far from unraveling them. In recent centuries the peoples practicing the fly-agaric cult have been living in areas to the north of where they were in their heyday, some of them on or close to the Arctic Ocean. They have been displaced from their former homes by Altaic tribes who do not, apparently, take the fly-agaric but who have absorbed into their shamanic practices the corpus of beliefs that go with the fly-agaric, beliefs that seem to accompany the ecology of the forest belt, especially the reverence for the birch. For the historian of human cultures it is a matter of regret that the impact of the modern world is inevitably brutal, bulldozer-like, in its disregard and contempt for the beliefs and ways of life of primitive peoples whom our industrial civilization wrenches from their traditions and tries, usually without success, to bring into step with our contemporary ideas. This holds true for the communist as well as the capitalist world.

When I wrote the foregoing paragraph about Siberian shamanism and the flyagaric, I did not anticipate the dénouement. True, almost twenty years ago Claude Lévi-Strauss had given me a lead in a Jesuit's letter to his brother written in the early seventeenth century, and in Lévi-Strauss's detailed review of *Soma* he expanded on other leads in the North American native cultures, but preoccupied as I was in a different direction and lacking the needed personal contact, those leads, though never forgotten, lay fallow. In 1975, through a combination of circumstances, I came to know, at first only by correspondence, a remarkable Ojibway herbalist and shaman, Keewaydinoquay,[35] living on a lovely island in Lake Michigan, the only resident on an island that had once belonged to her ancestors. There quickly unfolded before us an account of the fly-agaric cult that was breathtaking, not only for itself but for the fact that for centuries, millennia, the Ojibway, and in varying degrees the other peoples of the Algonkian nation, had looked to the fly-agaric for consultation about the most serious matters in their lives. The cultural trait that in Siberia we discerned dimly had been preserved for us, live and pure, as though in a time capsule, owing to the peculiar state of social relations between Whites and Algonkians during these last four hundred years.

And so, quite unexpectedly, we discover the cult of the fly-agaric in full panoply here in North America. No one knows when the Algonkians arrived here. The European settlers found them occupying a large part of North America, the Amerindian nation that is most widespread. Presumably they came across the Bering Strait, or else the land bridge that replaced the Strait during the successive Ice Ages. But if it should develop that they came from the north of Europe, in remote ages when the geography may have been different and stepping-stone islands permitted such transit, it would make no difference, for I think I have shown that the fly-agaric cult in former ages was circumpolar in extent, wherever the birch or appropriate conifers thrived.

As in Mexico, we owe the preservation of the cult into these modern times to the total lack of interest displayed by the White Man. It was an important and precious secret for the Ojibway, and they were not inclined to tell anyone about it who would sneer and scoff. How ironic it is that in Michigan and thereabouts, where the mycological faculties have considered themselves strong, the *miskwedo* (= *Amanita muscaria*) has played its age-old rôle among the Algonkians until now without so much as a nod from our mushroom men! (There need be no incompatibility between our mycologists and our ethnomycologists: witness Roger Heim.) Anthropologists and linguists have overlooked that rôle in spite of obvious clues in their standard sources and in spite of the widespread interest aroused by the anthology of Siberian source materials in my *SOMA: Divine Mushroom of Immortality*. Those in the Great Lakes area who take a professorial interest in the humane letters pass by on the other side when a poor Indian people not yet at home with the alphabet manifest their faith in a toadstool. Yet these same scholars will sit up straight at the mere mention of Eleusis or the Vedic Hymns, far removed though they are in time and space, or is it precisely because they are so removed?

Prof Bernard Lowy, mycologist of Louisiana State University, may well have uncovered exciting evidence in his ethnomycological investigations in Chiapas and the nearby Quiché-speaking area of Guatemala. There *Amanita muscaria* is common and well known but avoided. In Quiché, Dr Lowy tells us, it is called *kakuijá*, which carries the terrifying sense of *rayo* in Spanish, *foudre* in French, *parjanya* the thundergod in Sanskrit. Lightning in Spanish is commonly *relámpago* but this word is devoid of any aura of supernatural associations, free of mythological meaning. The Quiché speakers do not know why *A. muscaria* is the lightning-bolt and no longer think of the word's meaning when they use it. But *kakuijá* was the god of the lightning-bolt and this Quiché term is to be found in the *Popol Vuh*. How did this association of ideas, to which we are accustomed in Eurasia and among the Ojibway, arrive in the mountains of southern Mesoamerica? In Chichicastenango an alternative name for the *kakuljá* is *itzel ocox*, evil or diabolical mushroom. *A. muscaria* in Tuxtla Gutiérrez and San Cristóbal de las Casas is called *yuyo de rayo* when the native is speaking Spanish, again the mushroom of the lightning-bolt. For the Tzeltal-speakers in Zinacantan the fly-agaric is the *yuy chauk*, with the same meaning.

---

[35] Pronounced *Kee·way'dn·o'quay*

In folklore throughout Eurasia and Mesoamerica we are well acquainted with the tie that binds together the entheogenic mushroom and the lightning-bolt. Everywhere that tie is strong, but in Mesoamerica it generally belongs to the entheogenic Psilocybe and Stropharia genera: Dr Lowy has discovered one part of that area where the lightning-bolt impregnates the soft earth with the 'toad-mushroom'. Does this word *kakuljá* come from a time when the ancestors of the Quiché knew the secret of *A. muscaria* and used it? Did they abandon it because, long ago, they found the Psilocybe species preferable? Or because the friars in post-Conquest times drove it out?

New perspectives in ethnomycology are beckoning to us.

Consulted texts

1. Acosta, Joseph de, S.J.: *Historia Natural y Moral de las Indias*. Ed by Edmundo O' Gorman. Fondo de Cultura Económica, Mexico City, 1979.
2. Aguirre Beltrán, Gonzalo. [1] *Medicina y magia: el proceso de aculturación y el curanderismo en México*. Mimeographed México D F 1955.
3. Aguirre Beltrán, Gonzalo *Medicina y Magia: el proceso de aculturación en la estructura colonial*. INI Mexico D F 1963. On pp 188 and 264 Aguirre Beltrán mistakenly attributes the ventriloquism of the shaman to African influence; on p 146 he supplies dialectal variations of *peyotl* running all the way to *piule*; on pp 147-8 he quotes inquisitorial records to show the successive efforts of the Indians to discover in Christianity names of entities embodying Piltzintli in their old religion.
4. Anonymous. 'Coloquio de la Nueua Conberción y Bautismo de los Quatro Vltimos Reyes de Tlaxcala en la Nueua España.' *El Teatro de Nueva España en el Siglo XVI*, ed by José J. Rojas Garcidueñas. México D F 1935, pp 181-221
   In this religious play a principal character is *Hongol demonio ydolo*, a name obviously derived from the Sacred Mushroom. R.G.W.
5. Bancroft, Hubert Howe. *The Native Races*. Vol 2, 1874-1876. See p 360
6. Basalenque, Diego. Ms lexicon: *Vocabulario… Español-Matlatzinca y Matlatzinca-Español*. 1642. Biblioteca Nacional de' México. Also in John Carter Brown Library, Providence, R. I. See entries under *hongo que emborracha* and *chohui*
   This dictionary securely places the use of the Sacred Mushroom among the Matlatzinca to the west of Mexico City. R.G.W.
7. Benítez, Fernando. *Los Indios de México*. Biblioteca ERA México D F, Vols 1-4 In 'Los hongos alucinantes' Benítez presents an accurate picture of the sacred mushroom complex of the Mazatecs: Vol 3, 1970, pp 205-282. R.G.W.
8. Benzi, Marino. *Les derniers adorateurs du peyotl: Croyances, coutumes et mythes des Indiens Huichol*. Gallimard, Paris, 1972, p 337
9. Bourke, John Gregory. *Scatalogic [sic] Rites of all Nations*. 1891
10. Cairns, Huntington. 'A divine intoxicant.' *Atlantic Monthly* Vol 144, No 5 Nov 1929, pp 638-645 In this article the Safford thesis, denying the existence of all hallucinogenic mushrooms in Mexico, received its final expression. R.G.W.
11. Cárdenas, Juan de. *Problemas y Secretos Maravillosos de las Indias*. México, 1591
12. Caso, Alfonso. [1] 'El Paraíso Terrenal en Teotihuacán.' *Cuadernos Americanos*, Nov-Dec 1942, México D F, pp 127-136 -. [2] 'Representaciones de Hongos en los Códices.'*Estudios de Cultura Náhuatl*, Vol 4, pp 27 ff, UNAM, México D F 1963
13. Clavijero, Francisco Javier. *Historia Antigua de México*
    The first edition, appearing in Italian in Italy in 1780: *Storia Antica del Messico*, carried a footnote at the beginning of Vol 1 Chap 3 giving the name of the legendary founders of the City of Mexico and among these founders was Nanacatzin. I think no later edition has carried this footnote.
14. *Codex Borbonicus*. Facsimile reproduction. Akademische Druck- u. Verlagsanstalt, Graz, Austria, 1974
15. *Codex Borgia*. Facsimile reproduction. Akademische Druck- u. Verlagsanstalt, Graz, Austria, 1976
16. *Codex Magliabechiano*. Loubat edition, Rome, 1904. Also published by the University of California, Berkeley, 1903, and by Akademische Druck- u. Verlagsanstalt, Graz, Austria, 1970
    Illustration in picture writing of the Sacred Mushrooms coming down to us from the 16th century. R.G.W.
17. *Codex Vindobonensis Mexicanus 1*. Facsimile reproduction edited by Walter Lehmann and Ottokar Smital. Vienna, 1929
18. *Codex Vindobonensis Mexicanus 1*. Facsimile reproduction. Akademische Druck- u. Verlagsanstalt, Graz, Austria, 1974
19. *Códice de Yanhuitlan*. 1544 Edited by Wigberto Jiménez Moreno and Salvador Mateos Higuera. INAH México D F 1940
    This source places the Sacred Mushrooms in the Mixtec country. R.G.W.
20. *Códices Indigenas*. AGN, México D F 1933
    No 27 in this publication is relevant to our theme. R.G.W.
21. Córdova, Juan de. *Vocabulario en Lengua Çapoteca*. Mexico 1578 Facsimile reproduction by INAH,

Mexico D F 1942
This dictionary shows that the Sacred Mushrooms were known among the Zapotecs. See entries under *honguillo* and *xetas*. R.G.W.

22. Cortés, Hernán. *Cartas y Documentos*. Porrúa, México D F 1963
23. Covarrubias, Gaspar de. 'Relación de las Minas de Temazcaltepec.' 1579 *Papeles de Nueva España, Geografía y Estadística*, Madrid: Francisco del Paso y Troncoso, 1906. Ser 2, Vol 7, p 20 In the annual tribute paid by these Matlatzinca-speaking people to their overlord there is included a remittance of Sacred Mushrooms. R.G.W.
24. De la Maza, Francisco. 'El Tlalocan Pagano de Teotihuacán y el Tlalocan Cristiano de Tonantzintla.' *Homenaje al Doctor Alfonso Caso*. México D F 1951, pp 277-282
25. Díaz del Castillo, Bernal. *Historia Verdadera de la Conquista de la Nueva España*. Vols 1 and 2, Porrúa, México D F 1968
26. Durán, Fray Diego. *Historia de las Indias de Nueva España e Islas de la Tierra Firme*. Vols 1 and 2. Ed by Angel María Garibay K. Porrúa, México D F 1967
27. Epling, Carl and Carlos D. Játiva-M. 'A New Species of Salvia from Mexico.' Harvard *Botanical Museum Leaflet*, Cambridge, Mass., Vol 20:3, 1962, pp 75-76
28. Escalante, Roberto. [1] 'Datos Etnomicológicos de los Matlatzincas.' INAH, Sección de Lingtüística, México D F 1973
29. Escalante, Roberto. [2] and António Lopez. 'Hongos Sagrados de los Matlatzincas.' Museo Nacional de Antropología, Sección de Lingtüística, México D F December 1971
30. Estrada, Alvaro. *Vida de María Sabina: la Sabia de los Hongos*. Prologue by R. Gordon Wasson. Siglo XXI, México D F 1977
31. Fernández, Justino. 'Una Aproximación a Xochipilli.' *Estudios de Cultura Náhuatl*, UNAM, Vol 1, pp 31-41, México D F 1959
32. Flores, Francisco A. *Historia de la Medicina en México*. México: Secretaría de Fomento, 1886-1888, Vols 1-3. See Vol 1, pp 55, 258
33. Furst, Peter T., [1] Ed. 'Introduction' and 'To Find our Life: Peyote among the Huichol Indians of Mexico.' *The Flesh of the Gods*. Praeger, New York and Washington, 1972, pp vii-xvi, 136-184
34. Furst, Peter T., [2] 'Morning-glory and mother goddess at Tepantitla, Teotihuacán: iconography and analogy in pre-Columbian art.' *Mesoamerican Archaeology: New Approaches*. Ed by Norman Hammond. Duckworth, London, 1974, pp 187-215
35. Furst, Peter T., [3] *Hallucinogens and Culture*. Chandler & Sharp, San Francisco, 1976
36. Garibay K., Angel María. [1] *Historia de la Literatura Náhuatl*. Vols 1 and 2, Porrúa, México D F 1953
    Father Garibay in Vol 1, p 168, describes as the '*fiesta de Xochipilli*' the dance around an '*Arbol Florido*' ('Tree in Flower') that Diego Durán describes for us in Vol 1, p 193, of his text, edited by Father Garibay and listed below under Garibay [5]. In Vol. 2 'hongol' is discussed pp. 157-9.
37. Garibay K., Angel María. [2] 'Paralipómenos de Sahagún.' *Tlalocan*, Vol 2, No 3, pp 235-254, México D F 1947
38. Garibay K., Angel María. [3] Ed *Veinte Himnos Sacros de las Nahuas*. UNAM, México D F 1958
39. Garibay K., Angel María. [4] Ed *Poesía Náhuatl* in 3 Vols: Vol 1, 1964; Vol 2, 1965; Vol 3, 1968. UNAM, México D F Father Garibay denies that the sacred mushrooms figure in Nahuatl poetry, even when they are openly cited, saying that the reference is a poetic metaphor. See note in Vol 2, poem 28, p xcv. We mention in our text a lyric that Father Garibay conjectures was composed by a captive awaiting sacrifice: this is in Vol 2, p 122; note on p cxxviii to poem 30.
40. Garibay K., Angel María. [5] Ed *Historia de las Indias de la Nueva España* by Diego Durán. Vols 1, 2. Porrúa, México D F 1967
    Father Garibay in his Introductory Notes to Vol 1, p xv, says: 'Without straining the evidence in the least, I think that the implications lead us to view as probable, and even almost certain, a Jewish origin for Diego Durán. It is worthy of note that the most devoted investigators of the previous culture - Durán and Sahagún - are almost certainly of Jewish lineage.' [Translation mine: R.G.W.]
41. Garibay K., Angel María. [6] see Sahagún, Fray Bernardino de
42. Gelling, Peter and Hilda Ellis Davidson. *The Chariot of the Sun*. J. M. Dent & Sons Ltd, London 1969
43. Gilberti, Maturino. Tarascan lexicon. 1559. See entry under *hongo*.
    This lexicon places the sixteenth century use of the Sacred Mushroom in Tarascan country, in Michoacan. R.G.W.
44. Gimbutas, Marija. 1st ref herein p 43 is to *SOMA and the Fly-Agaric: Mr Wasson's Rejoinder to*

Professor Brough, Appendix III; published by Botanical Museum, Harv. Univ. Nov. 1972. 2nd ref herein p 143 is to *Gods and Goddesses of Old Europe*, Univ. of Cal. Press, 1974.

45. Guzmán, Gastón and A. López-González. 'Nuevo Habitat y Daros Etnomicológicos de *Psilocybe Muliercula*.' *Boletín de la Sociedad Mexicana de Micología*, No 4, Mexico D F, Diciembre 1970, pp 44-48
46. *Handbook of Middle American Indians*, 16 Vols. Robert Wauchope, General Editor. University of Texas Press, Austin, 1964-1976
47. Heim, Roger [1] and R. Gordon Wasson. *Les Champignons hallucinogènes du Mexique: Etudes ethnologiques, taxinomiques, biologiques, physiologiques et chimiques*. Avec la collaboration d'Albert Hofmann, Roger Cailleux, A. Cerletti, Arthur Brack, Hans Kobel, Jean Delay, Pierre Pichot, Th. Lemperière, and J. Nicolas-Charles. *Editions du Muséum National d'Histoire Naturelle*, 1958. Series 7, Vol 6, Paris 1958 (1959) 322 pp, 36 plates
48. Heim, Roger [2] Avec la collaboration de Roger Cailleux, R. G. Wasson, P. Thévenard. *Nouvelles Investigations sur les champignons hallucinogènes*. Editions du Muséum National d'Histoire Naturelle. Paris 1967
49. Heim, Roger [3] *Les Champignons toxiques et hallucinogènes*. N. Boubée & Cie, Paris, Jan 1963. New edition, 1978. Soc. Nouvelle des Editions Boubée, Paris
50. Heizer, Robert F. 'Mixtum Compositum: The use of narcotic mushrooms by primitive peoples.' *Ciba Symposia*, Vol 5:2, Feb 1944, pp 1713-1716
    This article, sent to us by Robert Graves in Sept 1952, first apprised us of the mushroom cult in Mexico and sparked our later investigations. At the same time Giovanni Mardersteig of Verona sent us a drawing of the mushroom stone on exhibit in the Rietberg Museum, Zurich. R.G.W.
51. Hernández, Francisco. *Historia Natural de Nueva España*. Vols 2 and 3 in *Obras Completas*, UNAM 1959
52. Hoogshagen, Searle. 'Notes on the sacred (narcotic) mushroom from Coatlan, Oaxaca, Mexico.' *Bulletin of the Oklahoma Anthropological Society*, Vol 7, 1959, pp 71-74
    An important contribution to contemporary anthropology for the light it sheds on the feelings toward the Sacred Mushrooms of the Mixe people. The author, an excellent linguist, has a sound grasp of the Mixe language. R.G.W.
53. *Inquisition, Holy Office of the*. 'Trial of Mixcoatl and Papalotl.' 1537 Ms Published in Publicaciones del AGN *Procesos de Indios, Idólatras, y Hechiceros*. Mexico D F 1912. Vol 3, pp 55 ff
    In this trial the analogy between the Christian Eucharist and the mushroom agapé is brought out, as in Motolinía and De la Serna. R.G.W.
54. *Inquisition, Holy Office of the*. 'In the case of Gonzalo Pérez.' 1629 Ms AGN Vol 340, pp 354-359
    An episode that takes place in Tarascan country involving the use of mushrooms. See also *Les Champignons halhtcinogènes du Mexique*, Heim, Roger, and R. G. Wasson: pp 41-43 . R.G.W.
55. Johnson, Jean Bassett. [1] 'Some notes on the Mazatec.' Lecture before Sociedad Mexicana de Antropología, México, 4 Aug 1938. Later published by Editorial Cultura, México D F 1939
    On the night of 16-17 July 1938 the young anthropologist Jean Bassett Johnson, with three companions (Bernard Bevan, Irmgard Weitlaner, and Louise Lacaud), witnessed a mushroom ceremony in Huautla de Jiménez. They were the first white persons known to have had this experience, and in the preceding entries Johnson gave his account of that event. Later he lost his life in the 1939-45 war, when the American forces landed in North Africa in Nov 1942. R.G.W.
56. Johnson, Jean Bassett. [2] 'The elements of Mazatec witchcraft.' Gothenburg Ethnographical Museum. *Ethnological Studies 9*, 1939, pp 119-149
57. *Kakchiquels, Annals of the*. Anonymous Kakchiquel Text. English version translated by Delia Goetz from Spanish version translated by Adrián Recinos. University of Oklahoma Press 1953. Also *Annals of the Cakchiquels*, Quiché and English text, edited by Daniel G. Brinton. Library of Aboriginal American Literature, No 6, Philadelphia, 1885, pp 114-115
    Mushrooms are mentioned in a context that, although obscure, is certainly religious. R.G.W.
58. Keen, Benjamin. *The Aztec Image*. Rutgers University Press. 1971
    The reference to 'magical mushrooms' is on p 504. R.G.W.
59. Keewaydinoquay. *Puhpohwee for the People: a Narrative Account of Some Uses of Fungi among the Ahnishinaubeg*. Botanical Museum of Harvard University, Cambridge, Mass. Feb., 1978. Ethnomycological Studies No 5
60. Kubler, George. *The Iconography of the Art of Teotihuacán*. Studies in Pre-Columbian Art and Archaeology, No 4, Dumbarton Oaks, Washington D C, 1967

61. Lanciego, José. Letter to the clergy of the Huasteca. (1926) Extract published in *La Parroquia de Tancanhuitz: Datos para su Historia*. Universidad Autónoma de San Luis Potosí, 1954, p 14. The letter is dated 8 June 1726
The bishop deplores the use of mushrooms among the people of the Huasteca. R.G.W.
62. León-Portilla, Miguel. [1] *La Filosofía Náhuatl*. UNAM, México D F 1959.
63. León-Portilla, Miguel. [2] *Los Antiguos Mexicanos, a través de sus crónicas y cantares*. Fondo de Cultura Económica. México D F 1961, and often reprinted.
64. Lewis, I. M. *Ecstatic Religion: An Anthropological Study of Spirit Possession and Shamanism*. Penguin Books 1971
65. López de Gómara, Francisco. *Historia de la Conquista de México*. Pedro Robredo, México D F 1943
66. López Austin, Alfredo. 'Términos del Nahualatolli.' *Historia Mexicana*, July-September 1967, Vol 17:1
67. Mayer, Karl-Herbert. *The Mushroom Stones of Mesoamerica*. Acoma Books, Ramona, California, 1977
68. Miller, Arthur G. *The Mural Painting of Teotihuacán*. Dumbarton Oaks, Washington D C, 1973
69. Miller, Walter S. *Cuentos Mixes*. INI, México D F, Biblioteca de Folklore Indígena, 1956, pp 37-47, 218-220
In recording stories gathered among the Mixe Indians Miller reports two involving the Sacred Mushrooms. R.G.W.
70. Mixe lexicon (? 1800), entries under *el honguillo con que se emborrachan*. Ms found by Walter Miller in San Lucas Camotlán and given to Museo Nacional de Antropología de México.
This gives us documentary evidence for the use in former times of the Sacred Mushrooms among the Mixe Indians. R.G.W.
71. Molina, Alonso de. Vocabulario en Lengua Castellana y Mexicana. 1571: entries under *hongo que emborracha and xochinanacatl*
This sixteenth century Nahuatl dictionary securely places the use of the Sacred Mushrooms among the Nahua of the valley of Mexico. R.G.W.
72. Motolinía, Fray Toribio de Benavente called. *Memoriales o Libro de las Cosas de la Nueva España y de los Naturales de Ella*. Edited by Edmundo O'Gorman. UNAM México D F 1971
73. Munn, Henry. 'The Mushrooms of Language.' *Hallucinogens and Shamanism*. Ed by Michael J. Harner. Oxford University Press, New York, 1973, pp 86 ff
74. Nagera (Nájera) Yanguas, Diego de. *Doctrina y Enseñança en la Lengua Maçahua de Cosas muy Utiles, y Provechosas para los Ministros de Doctrina*. México 1637. Folio 27-29
A manual for the clergy in which they are told how to ask, in the Mazahua language, when confessing their penitents, whether these persist in using the Sacred Mushrooms. R.G.W.
75. Nahuatl tapes, recorded in Amatlán de los Reyes, Veracruz, on the weekend of 4-6 June 1960, transcribed and translated into Spanish by Luis Reyes G.
The informants were various elderly women storytellers, relatives and friends of Sr Reyes. Irmgard Weitlaner Johnson and I were present. The Nahuatl texts and translations are in my files under Amatlan de los Reyes. R.G.W.
76. Ongaro, Alberto. Interview with María Sabina. *L'Europeo*, Milan, 29 Nov 1971
77. Orozco y Berra, Manuel. *Historia Antigua y de la Conquista de México*. México 1880. New edition 1960 Porrúa, México D F, with collaboration of Angel María Garibay K. and Miguel León-Portilla
Sacred Mushrooms are mentioned in Vol 1: 274 and Vol 3: 375. R.G.W.
78. Otomí lexicon. 1640 Ms, copied from sixteenth century ms now lost. Entries under *hongo que emborracha* and *hongos que enbelezan*. Biblioteca Nacional de México
This lexicon places the use of the Sacred Mushrooms among the Otomí Indians of the central zone around Tula. R.G.W.
79. Ott, Jonathan. [1] *Hallucinogenic Plants of North America*. Wingbow Press, Berkeley, 1976
80. Ott, Jonathan. - [2] and Jeremy Bigwood, Editors. *Teonanacatl: Hallucinogenic Mushrooms of North America*. Madrona Publishers, Seattle, Wash. 1978
81. Ott, Jonathan. - [3] *Mr. Jonathan Ott's Rejoinder to Dr. Alexander H. Smith*. Botanical Museum of Harvard University. Cambridge, Mass. Ethnomycological Studies No 6
82. Paso y Troncoso, F. del. *Papeles de la Nueva España*. Segunda Serie, Geografía y Estadística. Vol 4: 109-114 Relaciones Geográficas de la Diócesis de Oaxaca, 1579-1581. 'Relación de Teticpac,' written by Pedro Pérez de Zamora Abarca, dated 15 April 1580
83. Peñafiel, Antonio and Adela Breton. *Teotihuacán: estudio histórico y arquéologico*. México D F 1900
84. Pike, Eunice V. [1] *Not Alone*. Moody Press, Chicago, 1956, pp 109-110

85. Pike, Eunice V. [2] 'Mazatec sexual impurity and Bible reading.' *Practical Anthropology*, Tarrytown, New York Vol 7, No 2, March-April 1960, pp 49-53
86. Pike, Eunice V. [3] For letter to R. Gordon Wasson, see *MR & H*, pp 242-5
87. Pike, Eunice V. [4] and Florence Cowan. 'Mushroom ritual vs Christianity.' *Practical Anthropology*, Vol 6, No 4, July-Aug 1959, pp 145-150
    These valiant women, who have lived for years among the Mazatecs, have made an invaluable contribution to our knowledge of the rôle of the Sacred Mushrooms in the lives of the Indians. R.G.W.
88. *Popol Vuh*. Anonymous pre-Conquest Quiché Text, written down in Latin alphabet after the Conquest.
    In 1971 Munro S. Edmundson published an English translation direct from the Quiché: *The Book of Counsel: the Popol Vuh of the Quiché Maya of Guatemala*. Publication 35, Middle American Research Institute, Tulane University, New Orleans.
    Mushrooms are mentioned once, 1 6265. Though the context is enigmatic the passage is unmistakably religious. R.G.W.
89. Prescott, Wm. H.: *The Conquest of Mexico*, 1843
90. Ravicz, Robert. 'La Mixteca en el estudio comparativo del hongo alucinante.' *Anales de INAH*, México D F, Vol 13, 1960 (1961), pp 73-92
    An anthropological study of the rôle of the Sacred Mushrooms in one region of the Mixteca, based on observations made in 1960 in the company of R. Gordon Wasson. R.G.W.
91. Reko, Blas Pablo. [1] 'De los nombres botánicos Aztecos.' *El México Antigua*, México D F, Vol 1, No 5, Feb 1919, pp 113-157; *see* p 151
92. Reko, Blas Pablo. [2] Letter to J. N. Rose, U. S. National Museum. U. S. National Herbarium, Herbarium Sheet No 17457133, Washington D C, 1923
93. Reko, Blas Pablo. [3] 'Das Mexikanische Rauschgift Ololiuqui.' *El México Antiguo*, México D F, Vol 3/4, Dec. 1934, pp 1-7
94. Reko, Blas Pablo. [4] *Mitobotánica Zapoteca*. México D F 1945. See pp 14, 44, 53, 95
95. Reko, Blas Pablo. [5] 'Nombres botánicos Chinantecos.' *Boletín de la Sociedad Botánica de México*, No 8, Máxico D F 1949, pp 9-20, esp. p 12
    Reko was the modern precursor of all subsequent workers on the problem of the Sacred Mushrooms. An indefatigable field worker, his observations drew little attention at the time, but later they were fully recognized and his priority is now assured. R.G.W.
96. Reyes G., Luis. 'Una Relación sabre los Hongos Alucinantes.' *Tlalocan*, Vol 6: 2, Móxico D F 1970, pp 140-145
97. Rojas, Pedro. *Tonantzintla*. UNAM, México D F 1956
98. Rubel, Arthur J. and Jean Gettelfinger-Krejci. 'The Use of Hallucinogenic Mushrooms for Diagnostic Purposes among some Highland Chinantecs.' *Economic Botany*, Vol 30:3, July-Sept 1976, pp 235-248
99. Safford, W. E. [1] 'Narcotic Plants and Stimulants of the Ancient Americans.' *Annual Report of the Smithsonian Institution*, Washington D C, 1916, pp 387 f
100. Safford, W. E. [2] 'An Aztec narcotic'. *Journal of Heredity*, Vol 6, July 1915, pp 291-311
    This economic botanist, renowned in his day, in a full-dress study here advanced the thesis that the hallucinogenic mushrooms had never existed, and that early Spanish padres had confused peyote with fungi. R.G.W.
101. Safford, W. E. [3] 'Peyotl, the narcotic mescal button of the Indians.' *Journal of American Medical Association*, Vol 77:16, Oct 15, 1921, pp 1278-1279
    This article, published shortly before Safford's death, shows that he still persisted in his mistaken belief. R.G.W.
102. Sahagún, Fray Bernardino de. *Historia General de las Casas de Nueva España*
    1. Spanish text of the Florentine Codex. Edited in 4 Vols by Angel María Garibay K. Porrúa, México D F, 1956. Hallucinogenic mushrooms are cited in Sahagún's Spanish text and in the Flor Codex in the following places:
       (a) Bk IX, Chap viii; Flor Codex, fol 31r-31v
       (b) Bk X, Chap xxiv Par 16-17; Chap xxix, Par 34; Flor Codex, fol 122v
       (c) Bk XI, Chap vii, par 70, 74; Flor Codex, fol 129v-131r; illus No 516
    2. Nahuatl text of Flor Codex as translated into English by Arthur J. O. Anderson and Charles Dibble, University of New Mexico and of Utah, in 13 parts. Hallucinogenic mushrooms are cited in the following places:
       (a) Bk 9 pp 38-9

(b) Bk 10 pp 12, 20, 37, 49, 55, 88, 173
(c) Bk 11 pp 120 (under Teonacaztli), 129, 130; illus No 516

(The description of the Teonacaztli tree likens inebriation from its fruit to mushroom inebriation. In the Spanish texts on this tree - Bk 11 6:49 and 7:294 - the mushroom analogy is omitted.)

Sahagún is the monumental figure in Aztec historiography, an inexhaustible quarry for research. If I have proved my case for the metaphorical meaning of *flowers* in the language of the Princes and other leaders of Aztec society, we should comb the Sahagún material, in Nahuatl and Spanish, for the words *octli* and *xochitl*, 'flores' and 'rosas', to see where they signify the superior entheogens. For instance, in Bk 6 14-45 of the Spanish text the newly elected Prince is delivering the expected allocution to his people in which he exhorts them to lead virtuous lives and to emulate the past heroes who have died gloriously in war, heroes who (he says) are now living at ease in a world of delights, where they *chupan la suavidad de las flores del cielo*, 'sip the softness of the heavenly flowers'. Here indeed are our mushrooms or other superior hallucinogens. When we look at the Nahuatl text (Dibble & Anderson, Bk 6 p 74) we see that it says only 'who sip forever', '*flowers*' being understood. Dibble & Anderson in their translation from the Nahuatl interpolate them: 'who sip (the flower nectar) forever'. They must have looked to Sahagún's translation to arrive at the sense of 'sipping' the *flores del cielo*. In this key passage does not Sahagún give himself away? When his Nahuatl informant said 'sipping forever', Sahagún knew (or learned at that moment) the idiom for 'sipping [heavenly flowers] forever'. But certainly Sahagún with his powerful intellect and his empathy with the Indians, must have learned from his informants from early on the metaphorical meaning of '*flowers*'. Conforming to the practice of the other clergy, throughout his great work he played down drastically the rôle of the hallucinogens. R.G.W.

103. Santamaría, Francisco J. *Diccionario de Mejicanismos*. Porrúa, México D F 1959 See entry *piule* for application of this term to *ololiuhqui*
104. Sapper, Carl. 'Pilzförmige Götzenbilder aus Guatemala und San Salvador. '*Globus*, 28 May 1898
The first recorded picture and discussion of a mushroom stone. R.G.W.
105. Schultes, Richard Evans. [1] 'Peyote and plants used in the Peyote ceremony.' Harvard *Botanical Museum Leaflet*, Cambridge, Mass., Vol 4: 8, 12 April 1937, pp 136-137
106. Schultes, Richard Evans. [2] 'Peyote (*Lophophora Williamsii*) and Plants Confused with It.' Harvard *Botanical Museum Leaflet*, Cambridge, Mass., Vol 5:5, 19 Nov 1937, pp 69-73
107. Schultes, Richard Evans. [3] 'The identification of Teonanacatl, a Narcotic Basidiomycete of the Aztecs.' Harvard *Botanical Museum Leaflet*, Cambridge, Mass., Vol 7: 3, 21 Feb 1939, pp 37-54
This Leaflet drew considerable attention in scientific circles and laid the foundation for all subsequent serious work in the field. R.G.W.
108. Schultes, Richard Evans. [4] 'Teonanacatl, the narcotic mushroom of the Aztecs.' *American Anthropologist*, n. s., Vol 42, 1940, pp 429-443. Also J. B. Johnson's comments thereon, pp 449-450
109. Schultes, Richard Evans. [5] *A Contribution to Our Knowledge of Rivea Corymbosa: The Narcotic Ololiuqui of the Aztecs*. Botanical Museum, Harvard University, Cambridge, Mass., 1941
110. Schultes, Richard Evans. [6] 'Botany Attacks the Hallucinogens.' The Pharmaceutical Sciences: Pharmacognosy, Third Lecture Series, 1960 pp 169-185
111. Schultes, Richard Evans. [7] 'Tapping our heritage of ethnobotanical lore.' Paper presented on 22 May 1960 at the Annual Symposium of the Society for Economic Botany, 1 st Session. *Economic Botany*, Vol 14:4, Oct-Dec 1960 (Feb 1961), pp 257-262
112. Schultes, Richard Evans. [8] 'From witch doctor to modern medicine. Our knowledge of New World narcotic plants, with special reference to the mushrooms.' Report on lecture given on 21 March 1960 at the Boston Mycological Club, Waltham, Mass. *Bulletin of the Boston Mycological Chapter*, No 2, April 1960
113. Schultes, Richard Evans. [9] and Albert Hofmann. *The Botany and Chemistry of Hallucinogens*. Charles C. Thomas, Springfield, Illinois, 1973. Revised edition 1980
114. Serna, Jacinto de la. *Manual de Ministros de Indios para el Conocimiento de sus Idolatrías y Extirpación de Ellas*. México D F 1892. See Chap 4, Sec 3; also Chap 15, Sec 2, para 433. Also included in *Anales del Museo Nacional de México*, Vol 6, México D F, 1900
Like Motolinía, this author draws the analogy between the Christian Eucharist and the eating of the mushrooms; he suggests that the Indians regard the flesh of the mushrooms as divine, or as he considers it diabolic. R.G.W.
115. Siméon, Rémi. *Dictionnaire de la Langue nahuatl*. 1885.
Entries under *nanácatl* and *teonanácatl*

116. Sturdevant, William D. 'The World of Aztec Sculpture.' *Archeology*, Jan 1973, Vol 21:1, pp 10-15
117. Siegel, Ronald K. 'Hallucinations.' *Scientific American*, Oct 1977, Vol 237:4, pp 132 ff
118. Tello, Fray Antonio. *Libra segundo de la Crónica Miscelánea en que se trata de la conquista espiritual y temporal de la Santa Provincia de Xalisco en el Nuevo Reino de la Galicia y Nueva Vizcaya y descubrimiento del Nuevo México*. Guadalajara. 1891 p. 104
119. Tezozómoc, Fernando de Alvarado. *Crónica Mexicana*. México D F 1958 Chap 87
120. Thévet, André. *Histoyre du Mechique*. (before 1574) Ms (Rendered lost work by Andrés de Olmos, Antigüedades Mexicanas, *ca* 1543) Edited by Ed. de Jonghe. *Journal de la Société Américaine de Paris*, n. s., Vol 2, 1905, p 18
This historian recounts an episode dating from the middle of the fifteenth century, long before the Conquest, in which the Sacred Mushrooms were eaten in Otomí country in a religious context. R.G.W.
121. Tibón, Gutierre. *Historia del Nombre y de la Fundación de México*. Fondo de Cultura Económica. México D F 1975 p. 424
122. Toribio de Benavente, fray. See Motolinía
123. Torquemada, Fray Juan de. *Monarquía Indiana*, Vols 1-3, Porrúa, México D F 1969 Vol 1 Bk 2 Chap 3 p 83 col 1: in the list of legendary founders of the City of Mexico the second is 'Nanacatzin'
124. Wassén, Henry. [1] 'The Frog-Motive among the South American Indians.' *Antropos*, Vol 29, pp 319-370, Vienna, Austria, 1934
125. Wassén, Henry. [2] 'The Frog in Indian Mythology and Imaginative World.' *Anthropos*, Vol 29, pp 613-658, Vienna, Austria, 1934
126. Weitlaner, Roberto J. [1] *Summa Anthropologica en homenaje a Roberto J. Weitlaner*. INAH, México D F 1966
127. Weitlaner, Roberto J. [2] and Carlo Antonio Castro G. 'El Códice de Tlacoatzintepec.' *Papeles de la Chinantla*, Vol 1. INAH, México D F 1954, pp 188-199

Ethnomycological bibliography of R. G. and V. P. Wasson. July 1979

Books

1. Wasson, Valentina Pavlovna, and R. Gordon Wasson. *Mushrooms Russia and History*, 2 vol. With 85 plates, of which 26 are watercolors by Henri Fabre, reproduced by Daniel Jacomet, Paris, by the *pochoir* process. Pantheon Books, New York, 1957. Edition of 512 copies.
2. Wasson, R. Gordon. *SOMA: Divine Mushroom of Immortality*. New York: Harcourt, Brace & World, Inc. The Hague: Mouton, 1968 (1969). *De luxe* edition 680 copies; hardcover edition, paperback printings. Ethnomycological Studies No 1.
3. Wasson, R. Gordon, George and Florence Cowan, and Willard Rhodes. Photos by Allan Richardson. *María Sabina and Her Mazatec Mushroom Velada*. Harcourt Brace Jovanovich, New York and London, A Helen and Kurt Wolff Book, 1974. Complete text of *Velada* in Mazatec, translated into Spanish and English. Musical score by Willard Rhodes. Commentary by Wasson, the Cowans, and Rhodes. Ethnomycological Studies No 3.
4. Wasson, R. Gordon, Albert Hofmann, and Carl A. P. Ruck. *The Road to Eleusis: Unveiling the Secret of the Mysteries*, with a new translation of the *Homeric Hymn to Demeter* by Danny Staples. Harcourt Brace Jovanovich, New York and London. A Helen and Kurt Wolff Book. May 30, 1978. Ethnomycological Studies No 4.

(In collaboration with Roger Heim):

5. Heim, Roger, et R. Gordon Wasson. *Les Champignons hallucinogènes du Mexique*. With 37 full page plates of which 17 are in color, 83 illustrations in the text of which 14 are in color: and three maps. Edition du Musèum National d'Histoire Naturelle, Paris, Serie 7, Tome VI. 1958 (1959). Wasson is the author of the first three chapters, pp 15-122.
6. Heim, Roger, with the collaboration of Roger Cailleux, R. Gordon Wasson, and P. Thévenard. *Nouvelles Investigations sur les Champignons Hallucinogènes*. With 12 full page plates of which 5 are reproduced by *pochoir* process and one in four-color, 34 illustrations in the text of which 5 in color, and one map. Edition du Muséum National d'Histoire Naturelle, Paris, 1967.

Articles

1. Wasson, R. Gordon. 'Lightning-bolt and Mushrooms: An Essay in Early Cultural Exploration.' Festschrift: *For Roman Jakobson*, Mouton, The Hague, 1956, pp 605-612. Republished with illustrations in Dutch in *Antiquity and Survival* III: (1960) 1.
2. Wasson, R. Gordon. 'The Hallucinogenic Mushrooms of Mexico: An Adventure in Ethnomycological Exploration.' *Transactions* of The New York Academy of Sciences. Series II, Vol 21, No 4, pp 325-339. February 1957.
3. Wasson, R. Gordon. 'Seeking the Magic Mushroom.' With water colors by Roger Heim and photographs by Allan Richardson. *Life* magazine, N. Y., May 13, 1957. (International edition, June 10; 'En Busca de los Hongos Mágicos', *Life en Español*, June 3.)
4. Wasson, Valentina Pavlovna. 'I Ate the Sacred Mushroom.' *This Week* magazine, May 19, 1957.
5. Wasson, Valentina Pavlovna, and R. Gordon Wasson. 'The Hallucinogenic Mushrooms.' *The Garden journal*, The New York Botanical Garden, N. Y. Jan-Feb 1958, pp 1-6.
6. Wasson, R. Gordon. 'The Divine Mushroom: Primitive Religion and Hallucinatory Agents.' *Proceedings* of the American Philosophical Society, June 1958, 102 (3), pp 221-223.
7. Wasson, R. Gordon. 'Wild Mushrooms: A World of Wonder and Adventure.' *The Herbarist*, Boston, Mass., 1959, No 24, pp 13-28.
8. Wasson, R. Gordon. 'The Hallucinogenic Fungi of Mexico: An Inquiry into the Origins of the Religious Idea among Primitive Peoples.' (Annual Lecture of the Mycological Society of America, Stillwater, Oklahoma, August 30, 1960.) Harvard *Botanical Museum Leaflet*, Cambridge, Mass. Vol 19, No 7, 1961, pp 137-162.
9. Wasson, R. Gordon. 'A New Mexican Psychotropic Drug from the Mint Family.' Harvard *Botanical*

Museum Leaflets, Cambridge, Mass., Vol 20, No 3, December 28, 1962, pp 75-84.

10. Wasson, R. Gordon, and Sylvia Pau. 'The Hallucinogenic Mushrooms of Mexico and Psilocybin: A Bibliography.' Harvard *Botanical Museum Leaflets*, Cambridge, Mass. Vol 20, No 2a, March 10, 1963, pp 25-73c.
11. Wasson, R. Gordon. 'Ololiuhqui and Other Hallucinogens of Mexico', *Summa Anthropologica* en homenaje a Roberto J. Weitlaner. Instituto Nacional de Antropología e Historia, Secretaría de Educación Pública, México, 1966, pp 329-348. This paper was published under the title 'Notes on the Present Status of *Ololiuhqui* and the Other Hallucinogens of Mexico', Harvard *Botanical Museum Leaflets*, Cambridge, Mass., Vol 20, No 6, 1963, pp 161-193.
12. Wasson, R. Gordon. 'Fly-Agaric and Man.' *Ethnopharmacologic Search for Psychoactive Drugs*, Proceedings of a Symposium held in San Francisco, California, January 28-30, 1967. U. S. Department of Health, Education, and Welfare; Public Health Service, Pharmacology Section, Psychopharmacology Research Branch, National Institute of Mental Health, pp 405-414.
13. Wasson, R. Gordon. 'Soma of the Aryans: an ancient hallucinogen?' *Bulletin on Narcotics*, Vol XXII, No 3, July-September 1970. ('Le *Soma* des Aryens: un ancien hallucinogène?', *Bulletin des Stupéfiants*, vol XXII, no 3, juillet-septembre 1970.) Reprinted in journal of Psychedelic Drugs, Vol 3, No 2, Spring 1971.
14. Wasson, R. Gordon. Letters to the Editor, *Times Literary Supplement*, 1) August 21, 1970, 2) September 29, 1970.
15. Wasson, R. Gordon. 'Drugs: The Sacred Mushroom', *The New York Times*, September 26, 1970. The 'Op Ed' page.
16. Wasson, R. Gordon. 'SOMA: Comments Inspired by Professor Kuiper's Review.' *Indo-Iranian Journal*, Vol XII, No 4, 1970, pp 286-298. (Professor Kuiper's review immediately precedes the reply in the same issue.)
17. Wasson, R. Gordon. 'The Soma of the RigVeda: What Was It?' *Journal of the American Oriental Society*, Vol 91, No 2, April-June 1971, pp 169-187. Published along with Daniel H. H. Ingalls, Wales Professor of Sanskrit, Harvard University: 'Remarks on Mr. Wasson's *SOMA*' in the same issue of the *Journal*. (Both papers were reprinted by the American Oriental Society as No 7 in their Essay Series with an introduction by Ernest Bender, Editor of the *Journal*.) Translated into Spanish and published in *Plural*, Mexico City, in Jan-Feb issues, 1976.
18. Wasson, R. Gordon. 'The Death of Claudius or Mushrooms for Murderers', Harvard *Botanical Museum Leaflets*, Cambridge, Mass., Vol 23, No 3, April 7, 1972, pp 101-128.
19. Wasson, R. Gordon. *Flesh of the Gods*, Ed by Peter T. Furst, Chapter 6, 'The Divine Mushroom of Immortality', pp 185-200, and Chapter 7, 'What was the Soma of the Aryans?', pp 201-213. Praeger Publishers, New York, 1972.
20. Wasson, R. Gordon. *SOMA and the Fly-Agaric. Mr. Wasson's Rejoinder to Professor Brough*. Botanical Museum of Harvard University, Cambridge, Massachusetts, November 1972. Ethnomycological Studies No 2.
21. Wasson, R. Gordon. 'The Rôle of «Flowers» in Nahuatl Culture: A Suggested Interpretation', Harvard *Botanical Museum Leaflets*, Cambridge, Mass., Vol 23, No 8, 1973, pp 305-324.
22. Wasson, R. Gordon. 'Mushrooms and Japanese Culture', with three black-and-white plates. *The Transactions of the Asiatic Society of Japan*, Third Series, Vol 11, December 1973 (April 1975), pp 5-25.
23. Imazeki, Rokuya, and R. Gordon Wasson. '*Kinpu*, Mushroom Books of the Tokukawa Period', *The Transactions of the Asiatic Society of Japan* Third Series, Vol 11, December 1973 (April 1975), pp 81-92.
24. Sabina, María. *Mushroom Ceremony of the Mazatec Indians of Mexico*, recording by R. Gordon Wasson and with translation and commentary by Eunice V. Pike and Sarah C. Gudschinsky. Folkways Record and Service Corporation, 117 West 46th Street, New York, New York. The record bears the listing FR 8975.
25. Wasson, R. Gordon. Prologue to *La Vida de María Sabina: la Sabia de los Hongos*, by Alvaro Estrada. Published in Mexico City by Siglo XXI, 1977. The Prologue was written in English and translated by the publisher in Mexico City.
26. Wasson, R. Gordon. 'SOMA brought up-to-date.' *J of the American Oriental Society*, 99.1 1979. Also published as Harvard *Botanical Museum Leaflet* Vol 26, No 6, June 30, 1978 (1979), pp 211-223.

(In collaboration with Roger Heim):

27. Heim, Roger and Robert Gordon Wasson. 'Une Investigation sur les Champignons Sacrés des Mixtèques.' In the *Comptes rendus* of the Académie des Sciences, Paris, session of 29 January, 1961.
28. Heim, Roger and Robert Gordon Wasson. 'Note Préliminaire sur la Folie Fongique des Kuma.' In *Comptes rendus* of the Académie des Sciences, Paris, session of 3 February, 1964.
29. Heim, Roger and Robert Gordon Wasson. 'La Folie des Kuma.' *Cahier du Pacifique*, No 6, June 1964, pp 3-27. Edited by the Muséum National d'Histoire Naturelle. This article appeared in English under the title 'The "Mushroom Madness" of the Kuma', Harvard *Botanical Museum Leaflets*, Vol 21, No 1, June 11, 1965, pp 2-36.
30. Heim, Roger and Robert Gordon Wasson. 'Les Putka des Santals Champignons Doués d'une Ame.' *Cahiers du Pacifique*, No 14, September 1970.

Book Reviews

Wasson, R. Gordon: Four books by Carlos Castaneda:

1. *The Teachings of Don Juan. A Yaqui Way of Knowledge. Economic Botany*, Vol 23, No 2, April-June 1969, p 197.
2. *A Separate Reality. Further Conversations with Don Juan. Economic Botany*, Vol 26, No 1, January-March 1972, pp 98-99.
3. *Journey to Ixtlan: The Lessons of Don Juan. Economic Botany*, Vol 27, No 1, January-March 1973, pp 151-152.
4. *Tales of Power and Las Enseñanzas de Don Juan. Economic Botany*, Vol 28, No 3, July-September 1974, pp 245-246.

Credits for illustrations

Bibliotèque Nationale, Paris: Chap 6, Figs 10-11; Brunson, Howard: Chap 2, Fig 1; Clark, Joshua: Chap 3, Fig 24; Fratelli Alinari, Florence: Mosaic of toad in Battistero, Chap 9, Fig 16; Hairs, Joya: Chap 9, Figs 17-18; Johnson, Irmgard Weitlaner: Chap 7, Fig 1; Chap 8, Figs 23-24; Lowy, Bernard: Chap 9, Fig 7; Metropolitan Museum of Art, New York: Chap 3, Figs 30-31; Museo del Prado, Madrid: Chap 9, Fig 15; Museo Nacional de Antropología, Mexico: Chap 3, Figs 1, 26-29; Namuth, Hans: Chap 9, Figs 3, 5; Nicholson, Henry B.: Chap 3, Figs 3, 5-8, 12-13, 15; Nottebohm, Karl-Heinz: Chap 9, Fig 9; Richardson, Allan: Chap 1, Figs 1, 4, 6-7, 9-14; Chap 2, Fig 2; Rose, Richard M.: Chap 9, Figs 1, 2, 10-13, 19-23; Seeler, Margaret: Chap 3, Figs 2, 4, 9-11, 14, 16-21, 23, 25;; Chap 6, Figs 2, 7, 12; Chap 8, Figs 3, 16-19; Séjourné, Laurette, and Abel Mendoza: Chap 8, Figs 20-21; Tibón, Gutierre: Chap 7, Figs 18-24; Tremblay, J . P.: Prelude, Fig 1; Chap 1, Figs 1, 2; Chap 10, Fig 1; University of Texas Press, Austin: Prelude, Fig 1; Van Rouge, S. A., Ing Fernando Rojas: Chap 7, Figs 2-17; Villagra Caleti, Agustín, and Efrén del Pozo: Chap 8, Figs 1, 2, 8-11, 13-15, 22; Wasson, R. G.: Chap 1, Fig 8; Chap 9, Fig 4; Wiedel, Janine: Chap 9, Figs 24-25. Photos, maps, and charts in Chapters 1 and 2 of this book are reproduced by permission of Harcourt Brace Jovanovich, Inc . They were first published in *María Sabina and her Mazatec Mushroom Velada*, © 1974 by R. Gordon Wasson.

Index

Aguirre Beltrán, Gonzalo: 34, 38ftnt, 96, 143, 209
Ahuitzotl: 95, 200
Alarcón, Ruiz de: XXII, 10, 41, 136, 223
Amanita muscaria: 43, 53, 136, 185, 228, 229
Amatlán de Ios Reyes, Veracruz: 32, 38, 134
amoroto: 185
Amoxcalli: 103
amoxtli: 89, 103, 105, 109
anatopism: 108
anelhuayo: 91, 92
Archivo General de la Nación: XVIII, 34, 109-111
Arisreo Matías: XXIIftnt, 18, 41, 46, 47 and ftnt, 48, 96, 147, 148; Chap 2 Fig 1
Asociación del Sagrado Corazón de Jesús: XXII
Atocha, Nuestra Señora de: 141 and ftnt, 144; Chap 7 Fig 25
Atocha, Santo Niño de: 12, 137, 140ff; Chap 7 Figs 26-28
Aurelio Carreras: 13, 16, 25, 39, 118; Chap 2 Fig 2
Aztecs: who were they?: XVIIIftnt
Aztlan, Aztatlan: 140

Badianus manuscript: XVIII
ball game, Mesoamerican: 49, 178, 195, 196, 197, 203
Baptistery of Florence: 187
'bemushroom': 17, 52, 109, 152, 153, 155, 160, 207
Benitez, Fernando: 50, 51, 122
Benzi, Marino: 85
Biblioteca Laurenziana: 112, 205
Bihar: XXV, 42
Blake, William: 27, 28
'Book', *amoxtli*: 103
Borhegyi, Stephan F.: 178, 179, 181, 185, 189
Bosch, Hieronymous: 187
Botanical Society of Washington, D. C.: XIX
Brinton, Daniel: 175, 214
Britton & Brown, *Illustrated Flora*, edited by Henry A. Gleason: 66
brujería, brujo: 36, 108
Bulletin on Narcotics: 67
Byron's *Childe Harold*: 57

cacahuaxochitl: 67, 68ftnt, 69, 89, 97, 98, 99, 100
cacao tree: 97
Cakchiquel: 182, 189, 199
Calderán, Guadalupe M.: 218
Capilla del Rosario: 135
Cárdenas, Juan de: XVIII
Caso, Alfonso: 62, 105, 107, 108, 109, 111, 119, 120, 121, 122, 151, 158, 164, 214
Castaneda, Carlos: 209
Cayetano García Mendoza: 3, 5, 7, 8, 10, 11, 12, 13, 16, 17, 24, 25, 26, 27, 30, 154
Cellini: 170
Champollion, Jean-Jacques: 73
chapopote: 189
Charino: XXIV, 136, 218
Chiapas: 229
Chichitón, Juan: 212

Chinantec, Chinanrla: 32, 38, 115, 134, 136, 218
Cholula: 120, 138, 148
Chontal de Oaxaca: 218, 220
Chontal de Tabasco: 220
Chukchi: 52
chupador: 36, 37
Clavijero, Francisco Javier: 199
Codex Borbonicus: 160; Chap 8 Figs 4, 5
Codex Borgia: 148; Chap 7 Fig 29
Codex Magliabechiano: 112, 113; Chap 6 Fig 6
Codex Vindobonensis: 105, 109, 122, 151, 214, 218, 223; Chap 6 Fig 1
Códice de Yanhuitlán: 218
Códice Indigena: No 27: 109, 111, 116, 158, 160, 161; Chap 6 Figs 3, 4
Colima: 73
'commas of speech': 118
Conocybe: 60
copal: 12, 105, 153, 154, 189
Cordyceps capitata: 37, 38
Cortés, Hernán: 93, 1 09, 213
Coto, Thomas: 182
Covarrubias, Miguel: 152
Cowan, George and Florence: 21ftnt, 50, 62, 151ftnt
crapaudin: 185
Crónica X: 95, 200, 201, 202, 204
cueponi: 85, 92
curandero: 7, 13, 31, 32, 35-36, 38, 209, 211, 225

Dávalos G., Felipe: 151
Dibble, Charles E. and Arthur J. O. Anderson: 68ftnt, 98, 205, 206, 207, 209
Dioscorides: 222
disembodied eye: 17, 152, 153, 165-168
distilled alcohol: 34, 224
Dominican Friars, Order of: 141, 144, 146, 147, 200
doncella ('maiden'): 10, 31, 38, 135, 179, 181
double vision: 48
'dream *flowers*', temicxoch: 58, 160
Durán, Diego: 79, 80, 86, 95, 99, 161, 200ff, 208, 214, 215
Durango: 146

Early Man: XV, XVI, XXIII, 45, 81, 82, 92, 108, 148, 196, 197, 203, 221, 224
Easby, Dudley and Elizabeth: 76
ecstasy, ecstatic: 17, 47, 57 ff, 100, 137, 195, 202, 223, 224, 225, 226; Chap 3 Figs 27-31
Eleusis: 45, 87, 172, 173, 221
El México Antiguo: 96
Escalante, Roberto: 39
Estrada, Alvaro: 8ftnt, 13, 21ftnt, 37, 45, 50, 51, 122, 148, 151ftnt, 222, 223
Estudios de Cultura Náhuatl: 58, 105

Fabre, Henri: XXIV
Fernández, Justino: 58, 59, 72
Figueroa, Herminio and Manuel: 35
Florentine Codex: 68ftnt, 69, 98, 99, 112 and ftnt, 205-207; Chap 6 Fig 5
flower, flowers: XVII, 57, 59, 62, 65, 68, 71, 72, 78, 82-92, 94-98, 101, 103, 106, 158, 160, 164, 170
flowers and friendship: 87
flowers cause melodies to take shape and color, and shapes and colors to harmonize with melodies: 17, 88, 92, 152

Fresnillo: 146
'frets': 170, 174
Furst, Peter T.: 79, 103, 119ftnt, 151ftnt, 153, 162, 182

Gamio, Manuel: 59
Garibay K., Angel María: XVII, 82-86, 88, 89, 91-94, 96-98, 100-102, 120, 163, 202-205, 208, 213-215
Gilberti, Maturino: 217
Gilyak: 52
Gimbutas, Marija: 43, 173
Globus: 175
greca, grecas: 170, 172; Chap 8 Figs 23, 24
gribnoi dozhd': 97
Gudschinsky, Sarah C.: 21ftnt
Guzmán, Gastón: 44ftnt, 216

Hallucinogens, Age of: 173, 221
hama chün: 185
Heimia salicifolia: 66, 67
Heim, Roger: XXIV, XXV, 28, 38, 42, 50, 51, 60, 107, 121, 153, 181, 214, 218, 228
herbalists: XXIV, 36, 92, 222, 225, 228
Herlinda Martínez Cid: 35, 122
Hernández, Victor: 45, 112, 214
Herodotus: 226
Hofmann, Albert: 51
Holy Child of Atocha, see Atocha, Santo Niño de
hongos verdes, see mushrooms, green
Hoogshagen, Searle: 39, 151 ftnt
Huasteca, Huastecan: 94, 217
Huautla de Jiménez: XVI, XIX, 3, 31, 37, 48, 50, 120, 134, 137, 147, 148, 154, 223; Chap 1 Fig 1
Huichol: 85, 95, 144

Inquisition, Holy Office of the: XVII, XVIII, 39, 44, 45, 96, 143, 209-211, 217
Inquisition, Proceedings of the: 34, 145

Jakobson, Roman: 43ftnt
Jesús, Rufina de: 49
Jewish families: 205, 208
Jiménez Moreno, Wigberto: 114, 218
Johnson, Irmgard Weitlaner: 35, 44ftnt
Johnson, Jean Bassett: XX, 214
Journal of Heredity: XIX
Juxtlahuaca: 31, 178, 197

kakuljá: 229
Kaplan, Reid: 151ftnt,
kắvya: 225
Keen, Benjamin: XX
Keewaydinoquay: XVIIIftnt, 228
Kelly, Dr Isabel: 73
Ket: 52
Kogi of Santa Marta: 187
Kramrisch, Stella: 43
Kubler, George: 119ftnt, 162
Kumá: XXV

La Barre, Weston: 151ftnt

'landslide' mushroom: 7
Lawrence, Prof. Donald B.: 182, 189
le bot, see 'toad'
Lehmann, Walter: 107, 214
León-Portilla, Miguel: 78
Les Champignons hallucinogènes du Mexique: XXIV, 50, 60, 121, 199, 215
Lévi-Strauss, Claude: 227
Lewis, I. M.: XXftnt
Lienzo de Tlacoatzintepec: 115, 116; Chap 6 Figs 8, 9
Lienzo de Zacatepec No 1: 107, 218; Chap 6 Fig 1
Life: XVI, 152
lightning bolts: 53, 134, 229
'little girls': 136
Lockwood, Dr Tommie: 65
Logos: 39, 225
López Austin, Alfredo: 136, 223
Lophophora Williamsii: XIX, 95, 96, 146, 212
Los Antiguos Mexicanos: 78
Lowy, Bernard: 182, 229

MacDougall, Thomas: 38, 134, 218
maguey: 93
maize: 31, 71, 144, 201
Mardersteig, Giovanni: XX
María Apolonia: 10, 31, 49, 122
María Sabina: XVI, XXII, 3ff, 31-55, 83, 95, 103, 105, 109, 121, 122, 134-137, 140, 148, 149, 152, 154, 174, 196, 217, 222, 223; Chap 1 Figs 8-14
Martínez, Crescencio: 35
Martínez, Father Miguel: 146, 147
Matlatzinca: 34, 39, 136, 215, 216
Matrícula de Huexotzinco: 81, 114
Maya, highland: 51, 220
Mayer, Karl-Herbert: 114, 116, 182, 215
Mayrhofer, Manfred: 43
Maza, Francisco de la: 120, 122, 136
Mazahua: 215, 216
Mazatec: XVI, XX, XXIIftnt, XXIV, 3-30, 36, 39, 41, 45, 49-51, 53, 62, 83, 92, 105, 121, i22, 134, 135, 138, 147, 148, 217, 222, 223, 226ftnt; Chap 1 Figs 1, 2
Mazatlán de los Mixes: 102
Mendoza, Abel: 168
Mesoamerica, 'cultural', map of: Prelude Fig 1; Chap 10 Fig 1
metate: 32, 38, 98, 135, 179, 189, 197
metl: 93
Metropolitan Museum: 76
Mezcala figurine: 73, 76
Michaux, Henri: 109
Michoacán: 210, 217
Mictlantecuhtli: 114
Miller, Arthur G.: 149-174
Millon, R.: 151, 153
Mitla: 170, 174
Mixcoatl: 209
Mixe, Mixería: XXIV, 25ftnt, 37, 39, 49, 136, 217
Mixtec, Mixteca: 105, 106, 134-136, 146, 152, 178
Moctezuma: 101, 137, 201-205
Molina, Fray Alonso de: 80, 84, 85, 97, 121

Motolinía, see Toribio de Benavente
Mount Hagen: XXV
Munda: 43
Munn, Henry: 47, 50, 51, 122, 137, 151 ftnt, 152, 196
Museo de Cortés: 139
Museo Nacional de Antropología: 57, 71, 73, 79, 103, 161, 216, 220
Muséum National d'Histoire Naturelle: XXV
'mushroom', definition of: facing p XV
mushroom stones: XX, 49, 149, 175, 178, 179, 184, 189, 195-197, 223; Chap 9 Figs 1-3, 5, 6, 10-13, 17-23
mushroom stones, miniature: 181, 197
mushroom stones, toad associations: 184-189, 197
mushroom *velada* viewed as a simulacrum of the Holy Eucharist: XVIII, 44, 210
mushroom, wondrous: 53, 151, 152, 160, 170, 173, 202
mushrooms, allocation of sacred, in *velada*: 31
mushrooms, eating or drinking: 31, 179; Chap 9 Fig 4
mushrooms, *green*: 114, 158, 204, 205; Chap 6 Fig 6; Chap 8 Figs 2, 10, 13, 14, 20-22
mushrooms, pottery: 189, 195
mushrooms, the 'small fry' or 'little tykes': 37
Mushrooms Russia & History: XVI, XXIIftnt, XXIV, 31, 41, 50, 121, 151, 178, 185, 199, 216
'mycolatry', definition of: facing p XV, XV, 39, 189
mycologists: 50, 112, 182, 216, 228, 229
mycophiles: XV, 96
mycophobes: XV, XX, 42, 87, 185
Mystery religions: 224

Nágera (Nájera) Yanguas, Diego de: 216
Nahua: who were they?: XVIIIftnt
Nahua, inebriating drinks of the: 93ff
Nahua, paradise of the: 62
Nahuatlatos: 32, 79, 101, 136
Namuth, Hans: 178, 179, 189, 197
Nanacamilpa: 80
Nanacatepeque: 109
Nanacatlan: 81
nacatl: 42
nanácatl: 42, 93, 109, 199, 206
nanacates: 211
Nanacatzin: 199
nanacatzintzintli: 38
nanacaóctli: 82, 93, 94
New Guinea: XXV
Nicho de Hueyapan- 138-140; Chap 7 Figs 18-24
Nicholson, Henry B.: 57ftnt, 60, 166
Nicotiana rustica: 36, 160
Nicotiana tabacum: 66ftnt
niño dios: 148
Noguera, Eduardo: 158
^{2}nti^{1}xi^{3}tho^{3}: 5, 31, 38, 45, 92, 121, 222
Nundichi, Santo Niño de: 146, 147
Nymphæa: 158; Chap 8 Fig 3

Oaxaca, State of: XVI, XIX, 69, 88, 96, 98, 139, 146
octli: 93, 96, 97
odium theologicum: XVII, 29, 44
Ojibway: XVIIIftnt, 228, 229
Olmec: 76

ololiuhqui: 38 and ftnt, 66, 67, 98, 101, 103, 120, 146, 182-184, 189, 212
ololiuhqui, see *Turbina corymbosa*
'one-who-knows': 36
Ongaro, Alberto: 8, 48, 50, 51, 134
Otomí linguistic stock: 34, 39, 51, 136, 215
Otopamean linguistic group: 215

paradise of the Nahua: 62
Pennington, J D. 68
Pe:t Munt: 37
peyote, peyotl: XIX, 95, 144-146
peyotl, meaning of: 96
Pike, Eunice V.: XX, 21ftnt, 45, 151ftnt
pileus: 60, 158
Piltzintecuhtli: 106, 137
Piltzinteotl: 137
Piltzintli: 119, 137, 140, 141, 143, 144, 146, 148; Chap 7 Fig 29
pisiete: 36, 153, 160
piule: 96, 109
Plateros: 146, 147
'Playing Fields of Paradise': 164
Plowman, Dr Timothy: 65
plunging figure (a god?): 13, 136, 137, 148, 192
Popocatepetl: 57, 60, 96, 119
Popol Vuh: 178, 229
poyomatli: 32, 68ftnt, 88, 89, 91, 98-101, 153, 154, 201, 209
Pozo, Efrén del: 162
Prado: 187
pre-Conquest Nahuatl poetry: XVII, 32, Chap 4 pp 79ff
predella: 167
Prescott, Wm. H.: 213
Principe Niño: 137
Psilocybe, Psilocybin: 47, 53, 60, 108, 136, 174, 185, 229
Psilocybe aztecorum Heim: 60
Psilocybe Hoogshagenii Heim: 38
Psilocybe mexicana Heim: 182
Psilocybe Wassonii: 216
Puebla: XIX, 120, 139, 147
puliuhki: 93
putka: 42, 43
putika: 43

Quararibea funebris: 32, 67, 88-91, 98, 101, 209
Quetzalcoatl: 105, 106, 137
quexquemitl: 189
Quiché: 185, 229
Quinantzin, Mapa: 116-118; Chap 6 Figs 10-12

Ramírez, Juan: 220
Ravicz, Robert: 32, 135, 178, 218
Reichel-Dolmaroff, Gerardo: 187
Reko, Dr Blas Pablo: XIX, 96ftnt, 214
Remojadas: 189, 194, 195, 197
Reyes F., Felipe: 134
Reyes G., Luis: 134
Rhodes, Willard: 21ftnt, 50

Richardson, Allan: 3, 5, 10, 12, 15, 18, 24, 26, 27, 50
Richardson, Mary: 13
Rietberg Museum: XX
Rivea corymbosa, see *Turbina corymbosa*
Rojas, Pedro: 120, 122, 136, 137, 148
Rosas, Marina: 37, 134
Rose, Richard M.: 195-197
Rosetta stone: 73
Rubel, Arthur J.: 38, 134, 218
Ruck, Carl A. P.: 151ftnt

Safford, William E.: XIX, XX, 214
Sahagún, Bernardino de: XVIII, XXI, 10, 44ftnt, 68 and ftnt, 69, 99, 100, 112, 203, 205-208, 214, 237
San Agustín Loxicha: 96, 147
San Antonio Indoajico: 147
San Francisco Acatepec: 139
San Francisco, Antigua: Chap 9 Figs 8, 9
San Francisco Oxtotilpan: 39, 216
San Juan Amatitlán: 147
San Juan Mazatlán: 49
San Lucas Zoquiapan: 226ftnt
San Mateo Eloxochitlan: 147
San Pedro Nexapa: 37, 120
San Marcos, Church of: 147
Santal: 42, 43, 52
Santamaría, Francisco J.: 96
Santa María Tonantzintla: Chap 7 pp 119 ff
Santo Domingo, Church of: 135
Santo Niño: XXII, 136 ff
Sapper, Carl: 175, 214
Schultes, Richard Evans: XIX, XX, 65-67, 96 and ftnt, 101, 151ftnt, 187, 214
Seeler, Margaret: 57, 62, 66-68, 70, 167
Séjourné, Mme Laurette: 121, 167
Seler, Eduard Georg: 59
Señor don Pedro: 145
Sérignan: XXIV
Serna, Jacinto de la: 44, 211, 212, 214
Seven Flower: 106
shaman, designation of the: 36
shaman, shamanic: XVI, XVII, XIX, XXI, XXII, 28, 29, 31, 33-55, 102-105, 119, 134-136, 148, 196, Chap 11 pp 221 ff
Simlipal Hills: XXV
sinicuichi: 66, 67
Slavic languages, peculiar status of mushrooms in: 43
Smith, Elmer C.: 65
Smoking Tube Seller: 208
Soma: 43, 197, 221, 224, 227
St. John the Evangelist: 140
Stone Age: XVI, XIX, 28
Stresser-Péan, Guy: 44ftnt, 217
Stropharia: 60, 229
Sturdevant, William D.: 66ftnt
Sullivan, Thelma: 44 ftnt, 81, 92
sumo: 178
swastika: 172

tablero: 57ftnt, 61, 72, 170
Tamoanchan: 79, 92, 100, 101
Tarascan, Tarascans: 51, 199, 217
tecpillatolli: 96
Tello, Antonio: 140, 199
temicxoch: 58, 160
Tenango del Valle: 32, 34, 37, 134, 212
Tenenexpan: 189
Tenochtitlan: XVIIIftnt, 69, 103, 114, 200
Tenochtitlan-Mexico City, founding of: 161
Tenochtitlan-Mexico City, 'founding fathers' of: 199
teonanácatl: 44ftnt, 62, 80, 114, 120, 121, 206, 214
Teopancaxco: 121, 153, 155, 160; Chap 8 Figs 1, 2
Teopiltzintli: 137, 140, 199
Teotihuacán: 53, 62, 79, 103, 107, 111, 119ftnt,. 120-122, 149, Chap 8 pp 151 ff
Tepantitla: 62, 79, 103, 119, 121, 122, 153, 161, 166; Chap 8 Figs 7, 8-19
thain^{3}: 45
Theobroma cacao L.: 97, 98
Theophrastus: 207, 222
Tibón, Gutierre: 139, 140, 199
Times, The (London): 79
Tizoc: 200
Tlacotepec: 147
Tlaloc: 119ftnt, 134, 160, 209
Tlalocan: 59, 60, 62, 79, 83, 101, 119, 134, 164
tlamatini, tlamatinime: 78
Tlanixco: 37, 38, 134
Tlaola: 80
tlapapalli: 64
Tlaxcala: 80, 203, 213
Tlaxcaltecas: 204
Tlaxiaco: 146
toad: 112, 113, 184, 185, 187, 197
'toad mushroom': 185, 229
toadstool: 113, 175, 185
tonallo: 57ftnt, 64, 170
Tonantzintla: Chap 7 pp 119 ff; Chap 7 Figs 1-17
Toribio de Benavente, fray, called Motolinía: XVII, 44ftnt, 50, 214
Torquemada, Fray Juan de: 199
Totonacs: 51, 217
Tozzer Library: 182
Transubstantiation, Doctrine of: XVIII
Tree-in-*Flower*: 59, 79, 80, 88, 91, 92, 103, 137, 162, 163; Chap 4 Fig 1
Tulantzingo: 210
Turbina corymbosa (L.) Raf., formerly *Rivea corymbosa*: 38ftnt, 66, 67, 212
turkey eggs: 153

University of Texas: 213
Upson, Bill: 151ftnt, 218

Văc: 39, 225
Valentina Pavlovna: XV, XIX, XXIII, XXIV, XXV, 3, 29, 31, 121, 151, 175, 199, 214
Vedic Hymns: 43, 221, 229
velada, art of the mushroom: 46
velada essentials, darkness and isolation: 33
velada essentials, prohibitions: 34

velada essentials, the monitors: 33
veladas: XIX, XXV, Chap 1, 2 pp 3 ff, 73, 76, 78, 90, 92, 95, 102, 103, 106, 119, 121, 122, 135-137, 147, 148, 152, 155, 174, 178, 179, 196, 218, 222, 223
ventriloquism: 24ftnt, 34, 35, 154
Veracruz: XIX, 38, 49, 69, 81, 98, 197
Villagra Caleti, Agustín: 79, 80, 103, 155, 158, 161-163, 170
vino de hongos: 93, 94
vírgulas de habla: 118
voladores: 49

Wasson, Peter: 12, 21
water-lily: 158; Chap 8 Fig 3
Weitlaner, Robert J.: XIX, XXII, 13, 31, 50, 96, 112, 115, 214, 216, 218, 220
witchcraft: 108, 211
woman with mushroom, Remojadas figurine: 189, 194, 195, 197

Xochicuahuitl: 59, 79, 103
xochinanácatl: 80, 84, 85, 97, 114, 118, 121, 213
Xochinanácatl, Antonio: 81
Xochinanácatl, Luis and Diego: 114, Chap 6 Fig 7
Xochinanacatlán: 80
Xochipilli, 'Prince of *Flowers*': Chap 3 pp 57 ff, Chap 4 pp 79 ff, 97, 106, 137, 149, 174; Chap 3 Figs 1-26
xochitl: 37, 57, 64, 78, 80, 85, 86, 92, 94, 97, 101, 145, 148
Xolotla, Puebla: 44ftnt

Yukagir: 52

Zacatecas: 146
Zacuala: 121, 152, 153, 167, 168; Chap 8 Figs 20, 21
Zacualpán, Master of: 138-140
Zapotec: 18, 36ftnt, 38, 46, 51, 53, 96, 134, 136, 147, 148, 199, 217, 218, 223
Zempoaltepetl: 27ftnt
Zoque: 51, 217; Chap 10 Fig 1
Zumárraga, Juan de, first Bishop of Mexico: 209

For your special library on sacred drugs... two additional volumes of extraordinary interest!

PLANTS OF THE GODS Origins of Hallucinogenic Use

By Richard Evans Schultes and Albert Hofmann
With 380 illustrations (110 in full color)

Mushrooms . . . Hashish . . . Peyote . . . Ergot . . . LSD . . . Datura. Hallucinogens, yes. But what else do you know about them and some 80 others? A botanist and a chemist, both renowned authorities, bring you a fascinating study of psychoactive flora — where you find the plants, what's in them, how they're prepared and ingested, how they're used in religious rites, medical practice, meditation, and art and poetry. And what their effects are. A colorfully illustrated lexicon of 91 plants and their properties gives you facts you'd have to consult many medical journals to find, while the rest of this beautiful volume unfolds the story of the peoples who use sacred plants today as part of their cultural heritage. *192 pp., outsize format, hardcover.*

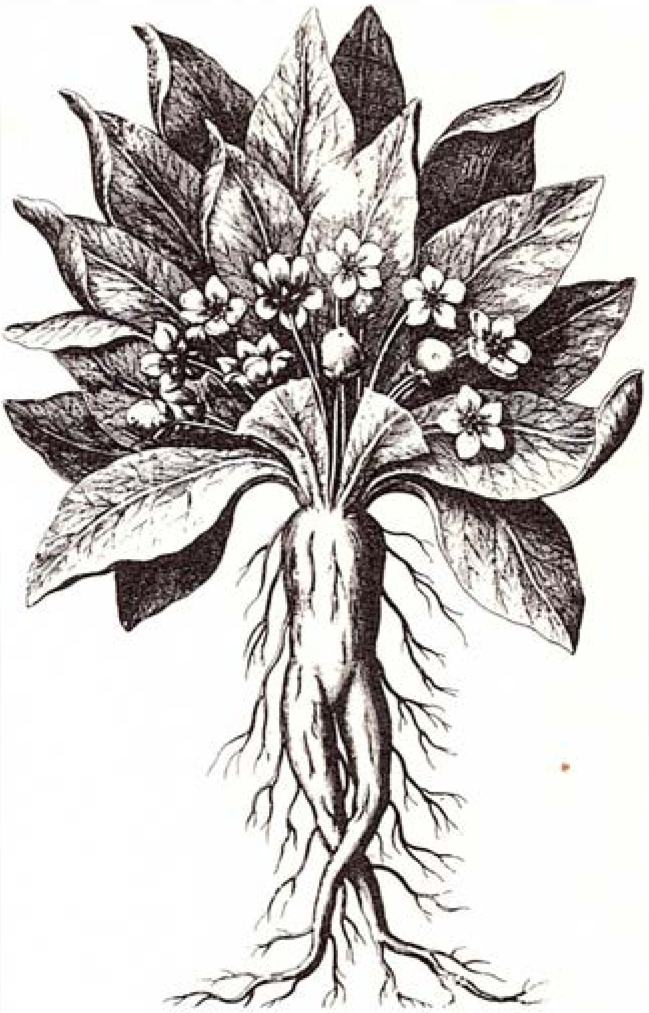
LSD: My Problem Child

By Albert Hofmann
192 pp., hardcover

The world-famous chemist and father of LSD recounts the intriguing inside story of how he came to synthesize LSD and how he now views the significance and implications of his important discovery. With complete candor he relates his encounters with such gurus as Huxley, Leary, and Wasson. He advances his own mystical philosophy in which he asserts that hallucinogens do indeed constitute cracks in the edifice of materialism. His book is, in a real sense, the story of the ''birth of the Psychedelic Age.''

McGraw-Hill Book Company

Mc
Graw
Hill



R. GORDON WASSON the preeminent authority on the use of psychoactive mushrooms in the history of such various culture areas as Siberia, India, Greece, and North and Central America, is Honorary Research Fellow with Harvard University's Botanical Museum and Honorary Research Associate with the New York Botanical Garden. The creator and pioneer of the science of ethnomycology, he has written numerous highly lauded books on hallucinogenic mushrooms, including *SOMA: Divine Mushroom of Immortality* and the recent *THE ROAD TO ELEUSIS*.

From the beginning, Wasson's interest in the entheogenic ("God-within-us") mushroom has lain solely in their role in Early Man's religious life. During decades of observation and study, Wasson—with his wife—surmised that mushroom worship prevailed among our remote ancestors in most of Eurasia and the Americas. Then they found proof that mycolatry ("The worship of a mushroom") had indeed also prevailed among peoples on the Arctic Ocean borders reaching all the way to the Bering Strait. And not only there but, as they discovered in the 1950s, among the peoples of Mesoamerica—an area that includes Nicaragua, Guatemala, Western Honduras, El Salvador, Belize, and Mexico east, west, and just north of Mexico City.

According to Dr. Wasson, the psychoactive mushrooms have been overlooked by scholars. He finds them in pre-Conquest mythology and poetry, in pre-Conquest sculpture and mural painting, even in some post-Conquest ecclesiastical art.

McGRAW-HILL BOOK COMPANY
Serving the Need for Knowledge
1221 Avenue of the Americas
New York, N.Y. 10020

". . . A CONSIDERABLE EVENT!"

For R. Gordon Wasson's many thousands of devoted readers and students both inside and outside today's community of specialists, this new book by "the acknowledged ranking ethnomycologist," is indeed, as Duke University's renowned Weston La Barre declares, *"a considerable event!"*

Your enthrallment begins with the book's opening description of the author's all-night vigil at a shamanic mushroom ceremony—the *velada*—in Huautla, Mexico. Against this awe-inspiring setting, you embark on a revolutionary investigation and analysis of the meaning and use of the divine hallucinogenic mushroom, *Psilocybe mexicana,* and its relevance to the cultures and peoples of Mesoamerica from pre-Columbian times to the present.

In its pages you will take part in the sacred ritual, become familiar with its rules and taboos, and witness, as if you were actually present, both the contemporary and historical impact of the sacred mushroom. You will actually *experience* its deep significance to users for healing, meditation, divination, and religious worship.

Astonishing photographs and drawings accompany Wasson's deep and sensitive penetration into the living and past cultures of Southern Mexico, and the role of the divine plant in the natives' religion, where the Indian happily weds it to Christianity.

A unique work, the book offers a vital key to our understanding not only of pre-Columbian art and literature before it was touched by European and Asian influences but also of the importance of the mushroom throughout the area today. It is the high culmination of Wasson's rich experiences, discoveries, and insights gleaned from a lifetime of voyages into the deepest territories of the hallucinogenic worlds, both past and present. In it he has distilled the sum total of all that he has learned and all he now believes to be the significance of the way people have used sacred drugs—as an element of life, of daily human activity, and as a source of constant and special spiritual strength.

THE WONDROUS MUSHROOM will stand as a supreme contribution to anthropological, pharmacological, and art research. Above all, it will remain a human experience not to be missed.

$12.95
0-07-068443-X

Mushroom Ritual versus Christianity

by

Eunice Pike and Florence Cowan

original source: http://www.mushroomjohn.org/pikeandcowan1.htm

Miss Eunice V. Pike and Mrs. Florence Cowan are members of the Wycliffe Bible Translators, working among the Mazateco Indian group of Oaxaca, Mexico. During their years of service in this field they have participated in the translation of the New Testament in Mazateco, which is currently in the process of publication.

How can one effectively present the message of divine revelation to a people who already have, according to their belief, a means whereby anyone who so desires may get messages directly from the supernatural world via a more spectacular and immediately satisfying way than Christianity has to offer? The Mazateco Indians equate the hallucinogenic mushroom with Jesus Christ himself, believing that when Jesus lived on earth he spat on the ground and his saliva sprang up as the mushroom. Through it as his mouthpiece, he speaks to them in the hallucinations which its chemical content induces. Christian hymns taught by the missionary are sometimes believed to be inspired by the mushroom and are probably sung to it by its devotes. Taboos applicable to mushroom eating are transferred to the Bible and result in fear of reading it. The partaking of the divine mushroom poses potential problems in relation to the Christian concept of the Lord's Supper. The use of the mushroom in southern Mexico in the quest of visions and supernatural revelations would appear to have many points in common with the use of peyote by the Indians of northern Mexico and the U.S.A., where there has been extensive syncretism of peyote ritual and Christian forms. PRACTICAL ANTHROPOLOGY would welcome further contributions on the problems of communicating the Christian message in this type of context. It is a subject that still needs much careful and prayerful study.

Some of the Indian groups of southern Mexico make ritual use of certain species of mushroom which have hallucinatory powers. The ceremonies are performed by a curandera or shaman but with the participation of other persons. Pagan and Catholic traits blend in the ritual, which is carried out in the presence of Catholic images. This use of the mushroom is centuries old, having been described by the early Spanish writers. The present article is based on the ritual as it is observed today among the Mazateco Indians of the State of Oaxaca. Our information for the most part comes from four sources: from the people who participate in the ceremonies, from shaman women who have become our friends, from overhearing the ceremony as it took place in a house next door to us, and from tape recordings of two all-night sessions which were made by R. G. Wasson and which he permitted us to hear[1].

[1] For specific details see V. P. and R. G. Wasson, *Mushrooms, Russia and History*. New York: Pantheon Books, 1957. A popular but valuable presentation of the mushroom ritual appears as a feature article by R. G. Wasson, "Seeking the Magic Mushroom," in *Life*, May 13, 1957, and *Life International*, June 10, 1957. See also Valentina P. Wasson, "I Ate the Sacred Mushroom," in *This Week Magazine*. May 19, 1957. For a later news report on the medicinal qualities of the hallucinogenic mushroom, see "Mushroom Madness," in Time. June 16, 1958.

Deceptive Mixtures

From all four of these sources we learn that the old tribal beliefs and Christian ideas and terminology have become mixed. One minute the shaman (a woman in both ceremonies which were recorded) would chant that she had the heart of Christ or the heart of the Virgin Mary; the next minute she was chanting that she was a snake woman, a moon woman, a bird woman. At both sessions she sang the Lord's prayer as it is sung in the Catholic church in the town of Huautla; but the next moment she was chanting about being a southern cross woman, or talking about a tiger eating someone's soul.

Many kinds of mushrooms grow in the Mazateco area, but only certain ones are used in the ceremony and only these will be discussed in this paper. Some informants say that the mushroom grows wherever a drop of Christ's saliva fell and that for that reason when the mushroom speaks it is Christ himself speaking. Other informants say that the mushroom grows wherever a drop of Christ's blood fell, and that for that reason the Huautla region has living land - land where the mushroom does not grow is dead.

The most common reason for eating the mushroom is in behalf of someone who is ill. One informant said, "Jesus Christ himself gave us the mushroom because we are poor people and have no doctors or medicine to help us." At other times the mushroom is used for divining such things as who stole a certain horse, who killed a certain man, whether or not a sick person will die, or the welfare of a person who is away from home. At the ceremony anyone present may eat the mushroom, but the shaman eats several times as many as the others. All see visions (beautiful colored moving pictures, they say), but the shaman chants and sings while the others lie quietly on straw mats. They may speak encouraging words to the shaman or make comments to one another. Somehow when the session is over, they have the impression that 'Jesus' has given them the answers. They know that the sick person will get better or die, that they must get the help of the doctor, call in the witch doctor, or look for certain herbs. They know that their relative int the faraway city is well or in trouble.

However, we have conflicting reports on how 'Jesus' goes about telling them these things. Our information differs sharply depending on its source. The patients, or people who hire the shaman, say, "Jesus said that my son would get better," or "Jesus told me to stop drinking liquor," or "The little mushroom said so." The patients never say, "The shaman said that Jesus said. ..." But one of our shaman friends insists that 'Jesus' doesn't 'tell' her anything. She insists that he never actually speaks to her. She 'sees' the sick boy well, or she 'sees' a tiger eating his soul. Her visions are like movies or television and she just talks about what she sees going on.

In the tape recording of the two ceremonies we were not able to pick any place where a supernatural being talked in first person giving a message. It was just the shaman singing about what a wonderful person she herself was. However, a mother told one of us that the mushroom had told her that her daughter would die and then added, "But don't be afraid, I'll take her soul to be with me." W have had hints that 'Jesus' talks directly to the sick person, or to the relatives by means of the mushrooms that they themselves have eaten. All our sources, however, agree that somehow those asking for guidance receive it, and that 'Jesus' is the one who gives it to them.

Attempts at Separation

We find that the deep-seated belief in the mushroom frequently causes the Mazatecos to misunderstand our witness for Christ. We must ever be alert to their way of thinking so that we may chose unambiguous words. Examples of some of the problems follow.

1. At least twice when describing heaven as a beautiful place, a place where there are no tears, etc., Eunice Pike has been asked, "Have you seen it?" She answered, "No," and at that time thought the question very queer - didn't the person know that only the dead have seen heave? Later she realized that a high percentage of Mazatecos claim to have seen heaven - the mushroom gives them moving pictures of it. Now she tells people, "The Book which tells us about God says that heaven. ..."

2. A shaman is respected and called a 'wise man' by the Mazatecos. One time a shaman stood listening to one of the authors witness about Christ. The expression on his face was one of sympathy and understanding. After a bit he spoke up, "I, too, am a wise man." The missionary didn't recover fast enough to tell him that she differed from him in that the things she taught were only those things which are in accord with God's written Word.

3. One time when one of the writers was objecting to the use of the mushroom she was told, "But what else could I do? I needed to know God's will and I don't know how to read."

4. One cloudy day the missionary was sitting at the local airstrip hoping that the plane would arrive. A number of Mazatecos were also waiting. To redeem the time she sang a hymn, planning to use it as a starting point for witnessing. The hymn she happened to choose was a new one that no Mazateco knew yet; in fact, she had translated it just the day before. As she sang she heard two of the women talking. "Isn't that beautiful! How

lovely! It's just like the mushroom." They had not been talking to her, but she couldn't keep out of that conversation. "No, it's not like the mushroom. This is different." The women would not listen. Emphatically they broke in to say, "We mean, wasn't it gracious of the mushroom to teach you that song!"

Many people have learned a number of the hymns in Mazateco, since at least five hundred phonograph records with hymns and a gospel message have been sold in the area. We now suspect that some of the hymns have been sung to the mushroom by the shaman. In fact, one Christian Mazateco warned one of the authors against teaching any hymns to her shaman friend. "She may sing them to the mushroom if you do!" All this poses many problems. Should we limit the sale of records to Christians only? But the wonderful thing about a record is that it can go where there are no Christians and no missionary. Should we teach hymns only to Christians? But singing a hymn is one of the easiest ways to start a conversation about Christ. We have gone on teaching the hymns, but now we are alert, ready to point out that a hymn is in accord with the Scriptures, whereas many of the shaman's chants are contrary to them.

5. There is one taboo that most people consider very necessary to observe when eating the mushroom. That is, they have to be ceremonially 'good' or 'clean'. Specifically, they must refrain from sexual intercourse for four or five days both before and after eating the mushroom. One of our shaman friends said that she had started eating the mushroom in behalf of others when she was twenty years old, but that she had stopped completely when she married. After her husband died she took up that work again. Then she married a second time, and again she stopped. Widowed the second time, she took up the work of shaman again.

This taboo which is imposed in connection with eating the mushroom has, it seems, been a direct source of difficulty in the distribution of the Scriptures. We tend to call the Scriptures "God's Word". The Mazatecos have considered the mushroom a means of getting a message from God, and hence the two things tend to get grouped in the same category. If such a taboo applies to the one, in the minds of at least some Mazatecos it applies to the other.

One young man of marrying age had been reading the Scriptures and enjoying them. Then one day he told us that he was thinking of getting married, and he wondered whether he could go on reading the Scriptures, or if he must stop once he was married. A leader in one village, a married man, seemed hungry for the gospel, listened eagerly when taught, asked pertinent questions, and seemed to accept the Lord and prayed for forgiveness of sin and for the Lord to bless his wife and children. But although well off financially he refused to buy the Scriptures and never read them for himself. When urged, he objected with, "People say that we will go crazy if we read God's Word." It was at least a year later that it dawned on us that the same reason is given for observing the taboos when eating the mushroom. One of our neighbors went crazy and we were told in a whisper that is was because he ate the mushroom when not 'clean'.

These and other incidents make us suspect that the taboo is so interpreted as to make people in general afraid to read the Scripture. Parents are afraid that their children will die. We are struggling with the problem and perhaps we are making progress. When selling Scripture in the market, we no longer use the term "God's Word"; rather we say, "This book teaches us about God."

Also we have made up a wedding song which gives advice to the Mazateco couple. (Old folks are supposed to give advice to a Mazateco couple.) The first verse tells of a couple getting married, and urges that they take the Jesus road. The husband is urged to love his wife. The wife is urged to respect her husband. Then in the second stanza they are urged to read the Scriptures. In the third stanza they are told to teach their children the Jesus way. That song is a good jumping off point to urge that the couple read and pray together.

6. It would appear that the eating of the mushroom has features in common with the Christian Eucharist, which are a potential source of confusion. During the mushroom ceremony the people all nibble on the mushroom at the same time. They make a kind of unit listening to the shaman sing and seeing visions together. In his description Wasson applied the word "agape" to the ceremony, and we have been asked (by outsiders) if the Mazatecos confuse it with the Lord's Supper. Does the eating of the divine mushroom have for the Mazateco a psychological value comparable to that which the Eucharist has for the Christian? What teaching must accompany the introduction of the Lord's Supper to the Mazatecos to prevent the Christians among them from seeking the same experience from the bread and wine that they have formerly gotten from the mushroom - and being disappointed? All this needs careful study and development in the local church context. We can see

possibilities of confusion. One Mazateco said that the mushroom must not be cooked because it is considered as a living person. However, since there is still no organized Mazateco church there has as yet been no celebration of the Lord's Supper, and therefore as of this date we know of no confusion. We have hopes that there will be none, for at least a handful of individuals have not stumbled when they received private instruction.

Supplying the Need now Filled by the Mushroom

Medicine has given at least some Christians the courage to reject the mushroom. When a non-Christian sister-in-law says, "You are killing your husband! Why don't you call the wise man?" (meaning that, if the wife does not call a shaman when her husband is sick, then she is the same as a murderer), the Christian can save face by answering, "I'm using medicine instead." That not only keeps the relatives from pressing so hard, but the medicine sometimes cures the patient.

The Mazatecos have occasions when they desire some special knowledge for which they usually turn to the mushroom. Sometimes this desire has been met by citing the admonition in James 1:5. We point out that God has promised to give us wisdom if we ask him. Once, when a Mazateco Christian asked, "How does a Jesus' follower go about finding a horse?, we prayed with him, asking for wisdom and guidance, and then suggested that he go out and hunt. He found the horse!

Perhaps part of the reason for using the mushroom is to have a party-like thing, or some special attention for the sick relative. If that be the case, then the need might be filled by public prayer for the sick one during the Christian service.

Surpassing the Mushroom

The shaman sings that the mushroom says she is clean, good, victorious. It calls her a humming bird, the moon, the morning star, the southern cross. She is an interpreter, a woman by whom others live, the law, medicine, justice. The mushroom says that she is the child god, a spirit, a saint, a creator, the heart of Christ, the heart of the Virgin Mary. She is light, speech, thought. But in spite of the pretty words the shaman is afraid. Even as she sings she fears her earthly enemies. She is afraid of the harm that may be done to her or her family by witchcraft (i.e. by a type of witchcraft that is completely apart from the mushroom). We had noticed in listening to the tapes that at times the shaman was weeping as she chanted. Upon being questioned, she explained to us that she was weeping because she was remembering that one of her sons had been murdered and she was concerned for the one that was left.

The mushroom often breeds fear. The visions may show the shaman that the patient is dying of 'fear sickness' with no suggestion of how to cure him. The relatives accept the diagnosis and prepare for the funeral while they wonder what it was that frightened him. In contrast, our Lord said (John 14:27), "Peace I leave with you, my peace I give unto you; not as the world giveth, give I unto you." In practice we have found this passage of Scripture to be true; many of the Mazateco Christians, with turmoil around them, have come to have hope and an inner peace - a peace that comes from knowing that they have a Savior, and Someone who loves them.

By contrast, in neither of the two mushroom tapes could we discover help for someone who knows that he is a sinner and needs salvation. The shaman sings of the greatness that she is said to have, but that greatness is of no real help to her; she is as bad off as any of the other 90,000 Mazatecos. Our Lord, however, can take a down-and-out repentant sinner and clean him up until he can bear the fruits of the Spirit.

The ethical values mentioned in the mushroom ceremony are in keeping with the values generally recognized in Indian cultures, but they fall far short of the ethics of Christianity. In the long list of virtues that the shaman claims for herself during the ceremony, there is no love, joy, peace, kindness, grace, or gentleness - none of the qualities that we recognize as fruits of the Spirit. These, however, are things that mark one who has become a Christian in the Mazateco society: love for family and for fellow Christians, joy in spite of hardships, peace in the midst of village wars. "By this shall all men know that ye are my disciples, if ye have love one to another" (John 13:35).

Conclusion

Some Mazateco believers, chiefly new Christians, have continued to use the mushroom for a while. Arguments against it have accomplished very little. The thing that has helped is study of the Scriptures - any and all parts of them - until the person concerned comes to understand God's idea of sin, his love and plan for the sinner, and something of God's greatness. That seldom happens after the study of a few brief passages; it seems to take a considerable amount before a person's eyes are opened.

The entheomycological origin of Egyptian crowns and the esoteric underpinnings of Egyptian religion

by

Stephen R. Berlant

Tel.: +1 610 353 1340.
E-mail address: berlant@comcast.net
P.O. Box 54, Broomall, PA 19008, USA

Received 17 January 2005; received in revised form 22 July 2005; accepted 27 July 2005 Available online 30 September 2005

original source: https://psilosybiini.info/paperit/The entheomycological origin of Egyptian crowns and the esoteric underpinnings of Egyptian religion (Berlant, 2005).pdf
backup source: http://www.psilosophy.info/resources/The entheomycological origin of Egyptian crowns and the esoteric underpinnings of Egyptian religion (Berlant, 2005).pdf

Table of Contents:

Abstract
1. Introduction
2. Materials and methods
3. Results
4. The mycological origin of Egyptian crowns as told in *Cheops and the Magicians*
5. Discussion and conclusions
References

Abstract

In this paper, I theorize that the Egyptian White and Triple Crowns were originally primordia of the entheogenic *Psilocybe* (*Stropharia*) *cubensis*, which an Egyptian tale known as *Cheops and the Magicians* allegorically explained grew on barley, and that Osiris was the God of spiritual rebirth because he personified this and other entheogenic mushrooms. I go on to theorize that the plant known commonly as the Eye of Horus, which the Egyptians included in cakes and ales designed to spiritually rebirth the living and the dead, was an entheogenic mushroom cap entirely analogous, if not identical, to Soma. Finally, I explain why so many scholars failed to discern these identities and relationships for so long.

Keywords: Egypt; Ethnobotany; Agaricales; *Amanita muscaria*; Psilocybine; History

1. Introduction

Ethnopharmacology was derived from the Greek words *ethnos* for people and pharmacology for the characteristics, properties, and effects of a drug. Accordingly, *ethnopharmacology* is, by definition, as much a social science as it is an experimental science, in that it is concerned with the way people used and continue to use drugs derived from plants.

Ethnopharmacologists must therefore often rely as much on the methods and materials historians, archaeologists, and various other specialists use to study a culture as they do on the more rigid methods and materials clinical and experimental pharmacologists use to study a culture's drugs. In fact, when the drugs in question are those of an ancient culture, ethnopharmacologists must often rely to a far greater extent, and in some cases solely, on that culture's literature and art, than on scientifically derived data.

This is particularly true if the drugs in question were used in an ancient culture's religious rituals, for such rituals were typically performed covertly, as the following passage of the Egyptian *Book of The Dead* (Budge, 1969a,b) makes clear:

> And you shall perform these ceremonies secretly in the Tuat-chamber of the tomb, for they are mysteries of the Tuat, and they are symbolic of the things which are done in Khert-Neter... Let no stranger anywhere have knowledge of it. Do not speak about it to any man. Do not repeat it. Let no [other] eye see it. Let no [other] ear hear it. Let no one see it except [thyself] and him who taught [it to thee]. Let not the multitude [know of it] except thyself and the beloved friend of thy heart.

Moreover, this is particularly true when the drugs in question were used in the ancient Near East, for paleobotanical evidence from this region is remarkably rare (Merlin, 2003).

Nevertheless, the literature and art of many ancient Near Eastern cultures have shed a great deal of light on the way members of these cultures used drugs recreationally, medicinally, and religiously. For example, La droga en el Antiguo Egipto noted pictures of the following psychoactive plants on the tomb walls of Egyptian Pharaohs and their bureaucrats: (1) the lotuses *Nymphaea alba* and *Nymphaea caerulea*, which contain the psychoactive alkoloid apomorphine; (2) *Lactuca verosa*, a substitute for opium with mild hypnotic effects; (3) the poppy *Papaver somniferum*, from which opium is, of course, extracted.

It is therefore not surprising that ancient Egyptian priests were designated by the Egyptian word *sem* for plants, or that these priests contemporaneously served as physicians - for the Egyptians, like all ancient peoples, believed that health and disease could be attributed to the actions of Gods. However, unlike the modern, Western medical practice of prescribing drugs for an afflicted person to take, an ancient Egyptian physician-priest would often himself take a drug that would presumably allow him to commune with the Gods on behalf of the afflicted person, and he would often administer drugs to spiritually rebirth, or even physically resurrect, the dead. Hence, Egyptian medicine and religion were inseparable.

In fact, since Egyptian physician-priests apparently had a considerable amount of expertise in the medico-religious use of botanicals, especially in the pursuit of immortality, it is not surprising that Medieval alchemists, whose occult religious pursuit of immortality ended up fathering pharmacology, were extremely interested in Egyptian religion, to the extent that our word *chemical* can ultimately be traced back through *alchemy* to the Greek word *Khemia* for Egypt. Heinrich (2002) presented a great deal of iconographic and textual evidence supporting his theory that the *alchemical* pursuit of immortality originally revolved particularly around the covert ingestion and investigation of the *Amanita muscaria*, and possibly the *Psilocybe cubensis*, just as Wasson (1968) presented a great deal of evidence that the ancient Hindu pursuit of immortality originally revolved around the covert ingestion of the *Amanita muscaria*, and later perhaps the *Psilocybe cubensis*, ostensibly as the deity Soma. Similarly, Graves (1960) and Ruck *et al*. (2001) presented a great deal of evidence supporting their theories that ancient Greek religion once revolved around the ingestion of the *Amanita muscaria* and, perhaps ergot, just as Wilson (2001) presented a great deal of evidence supporting his theory that Celts ingested the *Amanita muscaria* in their religious practices.

Indeed, Puharich (1959), a U.S. Army psychiatrist working at a chemical and biological warfare center in Maryland, claimed, on seemingly spurious grounds, that the ancient Egyptians used the *Amanita muscaria* to relieve pain and induce out-of-body experiences, and the U.S. government considered these claims important enough to spend many years investigating them.

It was subsequently learned that the ibotenic acid in the *Amanita muscaria* is an analogue of glutamic acid, which acts on nerve endings to effect analgesia, and that drying converts the ibotenic acid into muscimol, an analogue of GABA, which can indeed relieve pain. This paper examines the hypothesis that the ancient Egyptian practice of communing with their Gods, particularly in the pursuit of immortality, may have once revolved around the covert ingestion of the *Amanita muscaria* and *Psilocybe cubensis* in the hope that the positive results reported will be deemed interesting enough to prompt other studies of the subject.

2. Materials and methods

A variety of the ancient Egyptian texts and artworks are examined in view of the hypothesis that many Egyptian symbols were originally designed to represent entheogenic mushrooms, and Wasson's theory that a significant portion of the Rg Veda esoterically refers to *Amanita muscaria* and, perhaps, *Psilocybe cubensis* ingestion. As Merlin (2003) noted in his study of the ancient use of psychoactive plants, all such evidence is subject to interpretation and reconstruction, and disagreement may arise concerning the represented species. However, a lack or scarcity of evidence, in this case paleobotanical, does not necessarily mean that the depicted plants were absent.

3. Results

Fig. 1 shows the striking resemblance one typical and two anomalous Egyptian White Crowns, or *hedjeti* (Fig. 1B-D), bear to the pin-stage primordium of the *Psilocybe* (*Stropharia*) *cubensis* (Fig. 1A). This mushroom is considered an entheogen (Gk. *entheos* 'filled with God' + *gen* - 'to make') (Ruck, 1979), because the psychotropic chemicals, psilocybine and psilocin, it contains are known for leading people to believe, among other things, that they are divine and immortal.

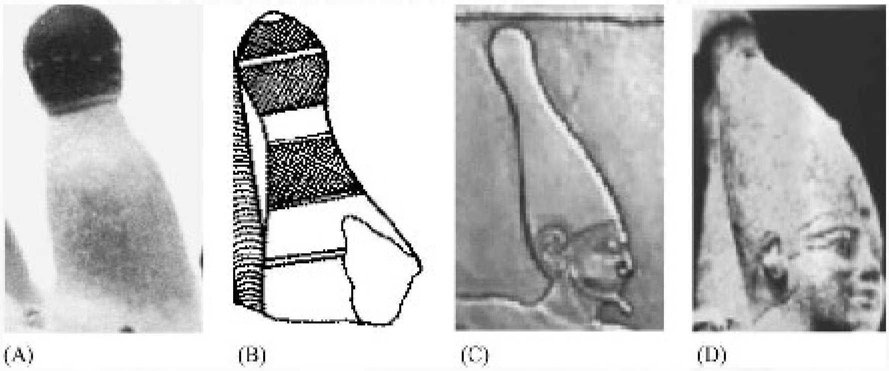
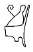
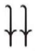


Fig. 1. (A) Pin-stage primordium of *Psilocybe cubensis* strikingly resembling (B) anomalous White Crown on an 11th Dynasty tomb wall at Deir-el-Bahari (Naville, 1910; Abubakr, 1937); (C) King Narmer's White Crown; (D) Pharaoh Sesostris I's anomalous White Crown (Evers, 1929).

Accordingly, there are grounds for believing that the Pharaohs - who also served as high *sem*, or herbal, priests - were essentially shamanic herbalists, whose well-documented belief in their own divinity and immortality was induced by *Psilocybe cubensis* ingestion, and that these monarchs then paid homage to the *Psilocybe cubensis*, first by wearing various stages of it on their heads and, later, by wearing representations of those stages as crowns.

This identification can also explain why, for instance, an Egyptian artist cross-hatched areas of the White Crown on an 11th Dynasty tomb wall at Deir-el-Bahari (Naville, 1910; Abubakr, 1937) (Fig. 1B) in a way that caused its top, or handle, to correspond precisely to the head and necklace of a *Psilocybe cubensis* primordium (Fig. 1A), while an Egyptian sculptor flattened the lower part of the bulb, or handle, of pharaoh Sesostris I's White Crown (Fig. 1D) in a way that caused it to strikingly resemble a *Psilocybe* cap emerging from its primordium. Hence, Abubakr (1937), in his extensive work on Egyptian crowns, was prompted to describe Sesostris I's crown as "pilzartige Form" (mushroom-shaped), though Abubakr did not realize just how appropriate his characterization of this crown was or the reason for the crown's heretofore enigmatic shape.

In addition, this identification can explain why the so-called Triple Crown (Fig. 2B), or *hemhem*, strongly suggests it was designed to represent a cluster of *Psilocybes* (Fig. 2A and B), while the hieroglyph for the Egyptian Double Crown,  known as the *shmty* or *pschent*, comprising the White and the Red Crowns, was determined by two plants, and , each obviously intended to represent one of these crowns.

It is generally believed that the Red Crown represented Lower Egypt, the White Crown Upper Egypt, and the Double Crown the unification of these regions under King Narmer. However, Wainwright (1923) presented evidence that the Red Crown may have actually originated in Upper Egypt.

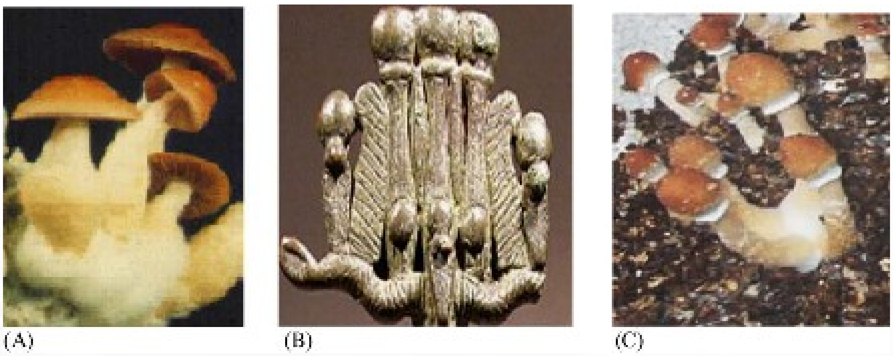


Fig. 2. Different stages of *Psilocybe cubensis* primordia (A and C) represented by the Triple Crown, or *hemhem* (B).

In any event, no theory has explained what either the Red or the White Crown was designed to represent, why both crowns were determined by plants, or why an enigmatic inscription in the tomb of the Fourth Dynasty Pharaoah Unas clearly states, "He has eaten the Red Crown, He has swallowed the Green One [and] delights to have their magic in his belly." (Faulkner, 1998, Utterance 274).

Lefebvre (1949) theorized that the Red and the Green Crowns, or *wadjet*, were the same crowns because the Egyptian word for green referred to things that were fresh, young, and prosperous, in agreement with the botanical nature of the Double Crown's determinant. However, considering the Egyptian practice of using green to signify plants (Wilkinson, 1994) in view of: (1) the evidence that the White Crown was originally designed to represent a *Psilocybe cubensis* and (2) the Egyptian practice of personifying the White Crown as Osiris who, as for reasons discussed below, was often painted green (Fig. 22), the Green Crown could have also, or alternatively, been another name for the White Crown.

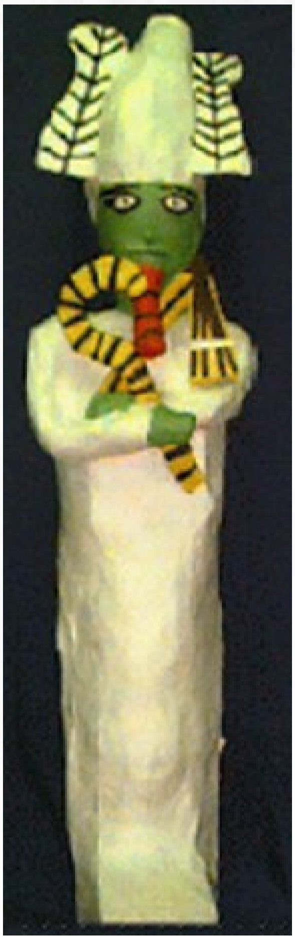


Fig. 22. Osiris as a green God.

In any case, Egyptologists have interpreted the above statement as a metaphorical reference to, for example, Upper Egypt swallowing Lower Egypt, whereas these statements can and should have been taken literally, particularly considering that the practice of wearing edible plants, especially psychotropic ones, as headdresses was widespread in antiquity. For example, Fig. 3 depicts: (1) the head of a Greek deity, often identified as Demeter, wearing a crown depicting the poppy capsules that yield opium; (2) two versions of the Egyptian Nile God Hapi, one wearing a papyrus crown and the other psychotropic lotus flowers (Emboden, 1978); (3) a Hawaiian helmet sporting mushrooms that Hoffman (2002) argued were entheogenic.

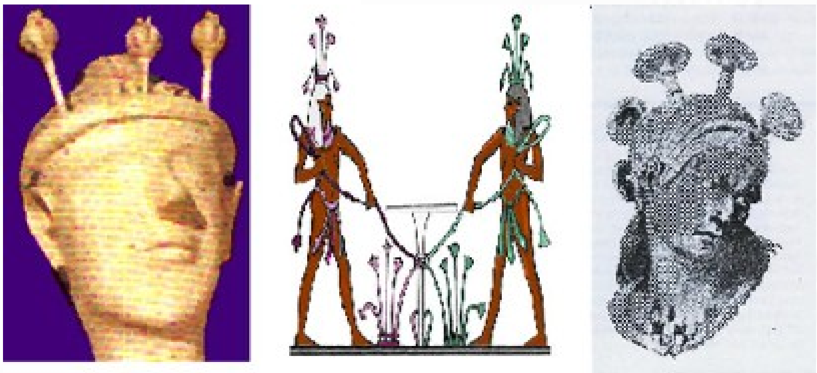


Fig. 3. (Left) Greek deity, often identified as Demeter, wearing a crown bearing the poppy capsules that yield opium. (Center) Two versions of the Egyptian Nile God Hapi, one wearing a papyrus crown and the other wearing entheogenic lotus flowers. (Right) Hawaiian helmet sporting mushrooms that Hoffman (2002) identified as entheogenic species.

Dikov (1971) found petroglyphs of humanoid figures wearing strikingly similar, mushroom-like headdresses high on a cliff in Chukchi Eskimo territory (Fig. 4, left), where the word for intoxication literally means "bemushroomed" (Wasson, 1968), and glyphs of similarly crowned figures carrying mushrooms were found in the Tassili-N-Ajjer region of the Sahara (Fig. 4, right) from which people may have migrated eastward to Egypt to escape the region's desertification. Although this region is currently arid, between 10,000 and 5500 BPE, during which this art was produced, the region had large lakes and forests, which included conifers and oaks. It can therefore be inferred that some of the mushrooms in this art were *Amanita muscariae*, which typically grow in mycorhizal relationship with these trees and birch.

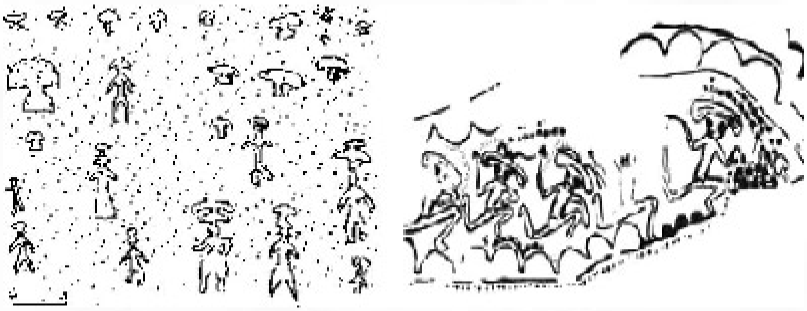


Fig. 4. (Left) Glyphs of mushroom-crowned humanoids on cliffs in Chukchi region of Russia. (Right) Pictures of similarly crowned beings carrying mushrooms on cave walls in the Tassili N-Ajjer region of the Sahara.

In fact, not too far from these Saharan glyph is one of a dancer whose head and neck seemingly comprise a primordial *Amanita muscaria* (Fig. 5B) (Samorini, 1992), and a glyph of a humanoid bee (Fig. 5A), who appears to be a shaman, covered with mushrooms (McKenna, 1992; Samorini, 1992), which Lhote (1973) interpreted as oars, and Mori (1975) as flowers. Of particular interest here is the pharaoh's use of the bee to symbolize that they were "bee-kings."

Still another Saharan glyph depicts a humanoid figure that appears to be defecating mushrooms that Samorini (1992) interpreted as *Psilocybes* based on this mushroom's coprophilia. However, this glyph may have been specifically designed to suggest that the depicted person was defecating the remains of previously ingested *Psilocybes* that would again grow into *Psilocybes*. In any case, Samorini (1992) concluded from these paintings that "there are at least two species [of mushrooms] one of which is small and topped with a 'papilla' (a characteristic it would share with most known hallucinogenic *Psilocybes*) and the other of which is larger (like

Boletus or *Amanita*)."

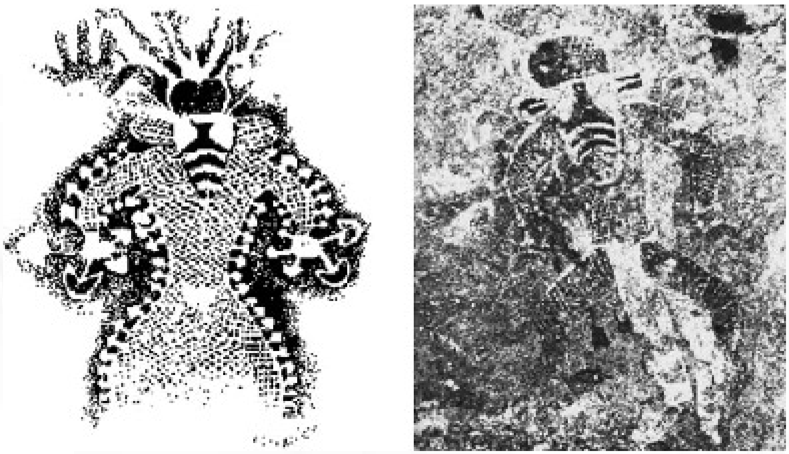


Fig. 5. (Left) Neolithic drawing of bee-headed humanoid from Tassili region of the Sahara. (Right) Mushroom-headed dancer from the same region.

Egypotologists have unanimously believed that the ancient Egyptians neither had nor ingested mushrooms, let alone entheogenic species. But the Egyptian climate, like the Sahara's, was far moister in prehistory than it is today, and Fig. 6 shows Egyptian glyphs depicting humanoid figures with mushrooms growing from their heads and ears that strikingly resemble pots from Mexico shaped like people with mushrooms growing from their ears (Schultes and Hoffman, 1992).

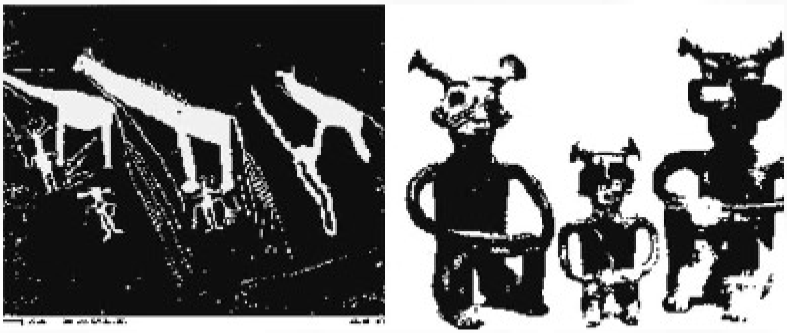


Fig. 6. (Left) Glyphs of beings with primordial mushrooms growing from the top of their heads and ears from El Hosh, Upper Egypt. (Right) Mexican pottery depicting people with mushrooms growing from their ears (Schultes and Hoffman, 1992).

These Egyptian glyphs, catalogued by Winkler (1938-1939), were found at El Hosh, in the Upper Egyptian region associated with the White Crown, not too far from which are other glyphs (Fig. 7) that can now be fairly reliably identified as phallic stage *Psilocybes* emerging from their primordia.

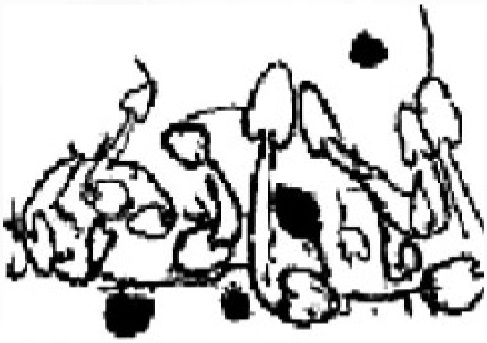


Fig. 7. Glyphs of phallic *Psilocybes* emerging from their primordia at El Hosh, Upper Egypt, the region the White Crown was associated with.

This identification can also more than adequately explain why the White and Triple Crowns were often worn on ram or cattle horns (Fig. 2B): *Psilocybes* tend to grow on the manure ruminants deposit in pastures, and the horns were evidently intended to suggest that these ruminants carried *Psilocybes* in their digestive systems. The Egyptians therefore sanctified the dung beetle, or scarab, for the apparent wisdom it showed rolling this manure into balls, from which *Psilocybes* would then often emerge.

The Egyptians then associated this beetle with the sun, apparently because *Psilocybe* ingestion typically causes people to see the world bathed in or emitting a bright, white or golden, mystico-religious light, while Egyptian artists often depicted the scarab pushing the sun across the sky, and *Psilocybe* caps as miniature suns.

A well-known principle of sympathetic magic held in antiquity, as it still does in some tribal societies, that the spirit of a food is ingested along with the food, and subsequently manifests itself in the eater: for example, members of many tribal societies believe that eating lion meat will make them strong like the lion, whereas eating rabbit meat will make them fast, or timid, like the rabbit. Accordingly, the ancient Egyptians who perceived this mystico-religious light after ingesting *Psilocybes* would have, and apparently did, attribute the phenomenon to the ingestion of the mushroom's indwelling light, hence solar, spirit, in full agreement with Spess's (2000) belief that entheogenic plants were anciently regarded as repositories of a divine light. By the same principle, these people would have also attributed that light to the manure from which the *Psilocybes* seemingly emerged, especially because the manure released light when burned.

Egyptian iconography is therefore loaded with many other structures that were clearly designed to depict mushrooms, though Egyptologists, for reasons explained below, have failed to identify these structures as mushrooms. Perhaps nowhere is this failure more evident than in the case of Egyptian ear studs, such as those depicted in Fig. 8. According to The Boston Museum of Fine Arts Catalogue (1982) depicting these studs, and Aldred's (1971) analysis of similar studs, they obviously resemble mushrooms. Yet, no explanation for this resemblance was given in these works, implying that it must be coincidental.

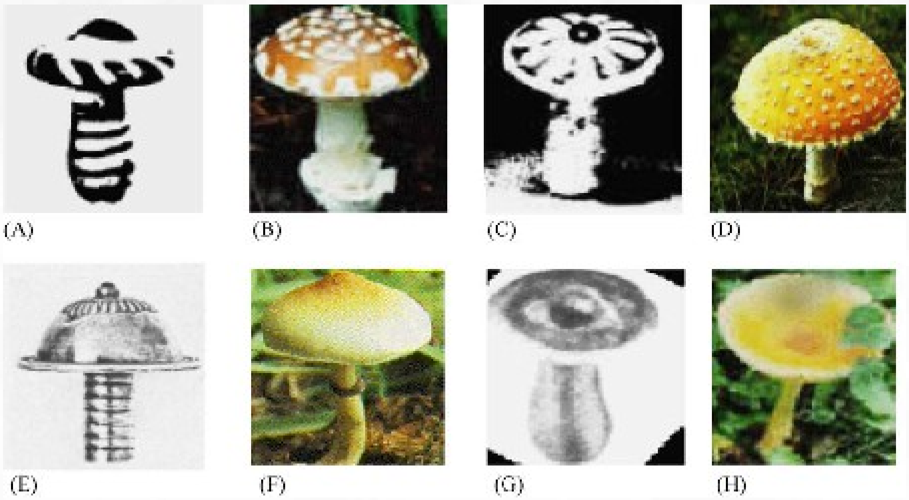


Fig. 8. 18th-19th Dynasty Egyptian ear studs (A, C, E, and G) were evidently designed to stylize the entheogenic *Amanita pantherina* (B), *Amanita muscaria* (D and H) and *Psilocybe* (*Stropharia*) *cubensis* (F) mushrooms.

On the contrary, the resemblance can be explained far more instructively by recognizing that studs A and E evoke the image of the entheogenic *Amanita pantherina* (Fig. 8B) and *Amanita muscaria* (Fig. 8D and H), typically found along the coast of North Africa (Festi and Bianchi, 1991), while stud E evokes the image of the coprophilic, gold-capped *Psilocybe* (*Stropharia*) *cubensis* (Fig. 8F). More specifically, the marginal whorl on the cap of stud A and the large rosette on the cap of stud C were evidently designed to suggest the patterns on the caps of *Amanita pantherinae* and *Amanita muscariae*, while the smaller rosette on the cap of stud E was evidently designed to suggest the dark circle on the caps of many *Psilocybes* (Fig. 8F) and some *Amanita muscariae* (Fig. 8H). The spirals on the stems of these studs were evidently designed to suggest the rings on the stems of the above-mentioned mushrooms; the central protrusions on the studs' caps were evidently designed to suggest the central protrusions on the caps of the so-called umbonate varieties of these mushrooms and, the caps of similar studs (Fig. 8G) have central depressions, which were evidently designed to suggest the depressions on the caps of so-called umbilicate varieties of these mushrooms (Fig. 8H). In particular, the incredible likeness between stud G and the umbilicate, gold, *Amanita muscaria* (Fig. 8H) cannot be easily ignored. Many studs were therefore made mainly or entirely from blue faience or lapis lazuli to evoke the blue color that distinguishes *Psilocybes* from similar looking mushrooms.

Other studs were made by combining blue with the reds, whites, and yellows of the *Amanitae* (Reisner, 1923; Aldred, 1971; Boston Museum of Fine Arts, 1982). And still other studs were made of gold to evoke the color of the gold-capped varieties of these mushrooms.

These mushrooms have traditionally been known for their ability to induce mystico-religious phenomena commonly known as ego death and spiritual rebirth which, as shown below, were apparently a central, though well-hidden, element in many Egyptian religious rituals long before relatively realistic representations of these mushrooms appeared as ear studs in the Middle Kingdom. The reasons this jewelry appeared relatively late in Egyptian history are unknown, but its appearance may have been caused by a relaxation in a long standing policy of secrecy stated in the previously cited passage of the Egyptian *Book of The Dead*, just as secrecy has traditionally surrounded the ingestion of entheogenic mushrooms elsewhere in the world (Allegro, 1969; Wasson, 1980).

Regardless of why these representations of mushrooms appeared full blown so late in Egyptian history, it can be inferred that these ear studs, many examples of which were found in tombs at Abydos, Kerma, and Amarna, were more than just meaningless pieces of jewelry that only coincidentally resemble mushrooms. These studs were almost certainly intended to represent entheogenic mushrooms, like those growing from the ears of the bemushroomed Egyptians depicted at El Hosh. Based on the anciently widespread belief that symbols, especially amulets, were imbued with the power of the things they represented, these ear studs were probably used funereally in attempts to spiritually rebirth, and perhaps even physically resurrect, dead Egyptians, based on the also anciently ubiquitous belief that such mushrooms were plants of immortality-hence, The Food of Gods (McKenna, 1992).

4. The mycological origin of Egyptian crowns as told in *Cheops and the Magicians*

The theory that the White and Triple Crowns were designed to represent *Psilocybe cubensis* primordia can be supported by noting that this mushroom is commonly cultivated today in essentially the same way an ancient Egyptian story, known as *Cheops and the Magicians*, allegorically describes how crowns were bestowed on the newborn rulers of Egypt's Fifth Dynasty in a document known as *The Westcar Papyrus*. That is, *Psilocybes* are commonly cultivated today by placing grain in containers, inoculating the grain with spores, and keeping the grain moist for approximately 14 days while the spores incubate. Similarly, in *Cheops and the Magicians*, crowns are bestowed on Egypt's rulers by deities who had hidden them in barley that they exposed to a storm and later incubated in a storeroom for 14 days (Lichtheim, 1975).

The manuscript fails without explaining what happened to the hidden crowns, which Lichtheim (1975) suggested were "magical tokens of kingship," rather than crowns, in an obviously strained effort to explain the peculiarity of crowns being hidden in barley. But considering: (1) the striking resemblance the typical, and particularly the atypical, White Crowns in Fig. 1 bear to *Psilocybe cubensis* primordia; (2) the anciently widespread practice of wearing psychotropic mushrooms and other plants as crowns; (3) the rupestrian and iconographic evidence that the ancient Egyptians had *Psilocybes*; and (4) the well-known practice of cultivating *Psilocybes* on grain, it can be inferred with a fair degree of assurance that *Cheops and the Magicians* was designed to allegorically explain that Egypt's crowns were originally *Psilocybes* that grew from barley.

It is apparently for this reason that the hieroglyph for the White Crown (Fig. 9) comprises what can now be identified as a *Psilocybe* primordium, ostensibly as the White Crown, over the Egyptian hieroglyph for a basket, evidently designed to represent the barley from which the crowns emerged in *Cheops and the Magicians*. Hence, in Fig. 10, the Egyptian solar deity Horus holds the White Crown up to his face in a bowl or basket to signify that the crown is edible (Fig. 10).

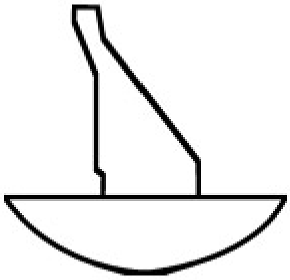


Fig. 9. White Crown hieroglyph.

The theory that the crowns in this story were *Psilocybes* can also explain why the story's author decided to create a storm out of the blue. Lichtheim (1975) attempted to explain this seemingly unnecessary peculiarity as a reason for the deities to return to the house. But the deities did not need an excuse, for they had already decided to return to the house to bestow crowns on the royal children before the storm even arose. In fact, it was apparently the deities themselves who created the storm, for the pertinent passage Lichtheim (1975) translated as, "Then they let a sky of storm and rain come up," can be translated even better as "Then they caused the storm and rain to come up."

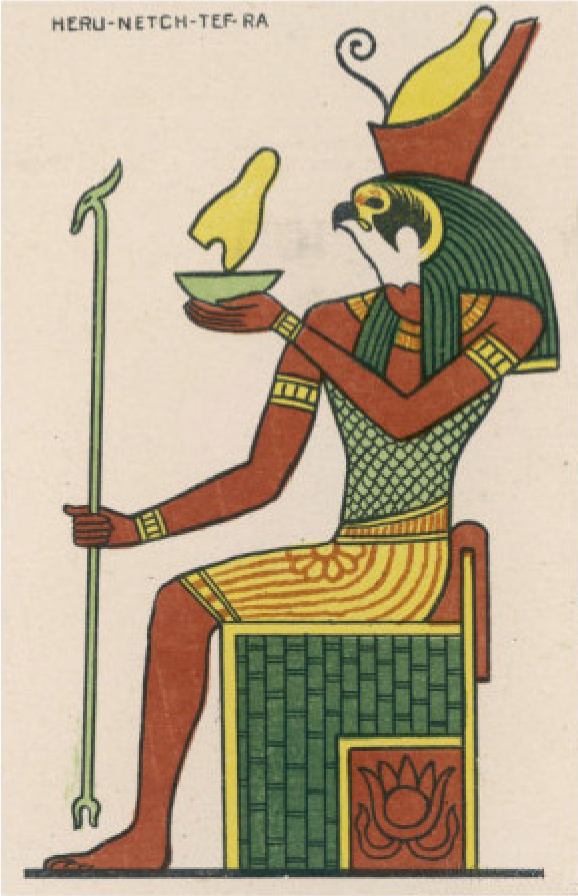


Fig. 10. Horus, wearing the Double Crown, holds the White Crown up to his face in a bowl or basket to signify that it is edible and, perhaps, that he is preparing to eat it.

The story's author evidently decided to have the deities create the storm because the emergence of mushrooms typically follows rain, thunder, and lighting in the world's fungal folklore, as (Wasson *et al.*, 1986) pointed out in the definitive work on that relationship. The author of *Cheops* therefore cleverly had the deities create the storm to moisten the barley, thereby presaging the appearance of the mushrooms it held.

The theory that the hidden crowns were *Psilocybes* finds still more support in its ability to explain why the maid hears music and dancing coming from the barley exactly 14 days after the barley had been exposed to the storm: the fruiting cycle of many *Psilocybes* is approximately 14 days (Stamets, 1996), and mushrooms, especially entheogenic species, were typically personified in antiquity, apparently based on the same tendency to personify plants that led modern commercial artists to personify, for instance, a banana as Chiquita Banana and a peanut as Mr. Peanut.

For example, Fig. 11A depicts: (1) the well-known Venus of Willendorf figurine, dated to approximately 25,000 BPE, and (2) a primordial *Amanita* (Fig. 11B). Comparing these structures, it becomes apparent that the figurine's strange coif was designed to personify the characteristically knotted cap of a primordial *Amanita*; the figurine's steatopygia was designed to personify the primordium's bulbous base; the figurine's strangely slender, segmented, and handless arms were designed to personify the dentate ring the *Amanita* ruptured veil leaves on the mushroom's stem; the red ochre the figurine was covered with was intended to color it the color *Amanita* caps often display (Berlant, 1999).

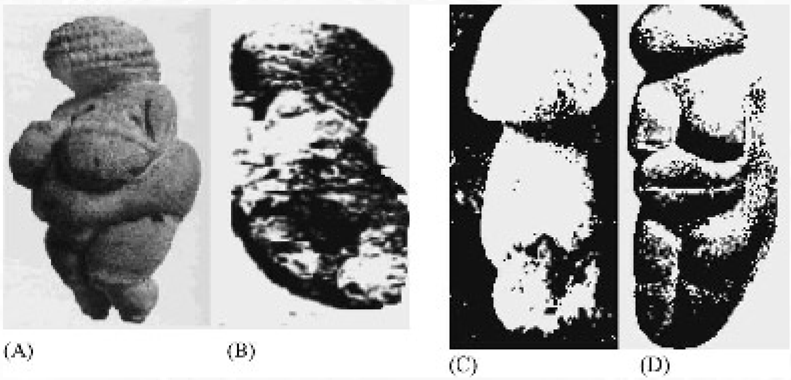


Fig. 11. (A) Venus of Willendorf; (B) primordial *Amanita muscaria*; (C) horse mushroom primordium; (D) anthropoid female figurine from Chiozza di Scandino, Italy (Berlant, 1999).

For the same reasons, the developing Horse Chestnut primordium (Fig. 11C) strikingly resembles the anthropoid figurine from Chiozza di Scandino, Italy (Fig. 11D) (Berlant, 1999).

That ancient Egyptian artists personified mushrooms, just as their European counterparts did, is readily apparent by observing that a Lawn Gallerina (Fig. 12A) was evidently personified in the Egyptian figurine with a conspicuous medial cleft (Fig. 12B); that a predynastic, Egyptian figurine (Fig. 12C) strikingly resembles the maturing *Amanita brunnescens*, or cleft foot, mushroom (Fig. 12D); that the three anthropoid, predynastic, Egyptian figurines beginning on the right in Fig. 13 strikingly resemble both the *Psilocybe cubensis* primordium on the far left and the White Crown on its immediate right (Berlant, 1999).

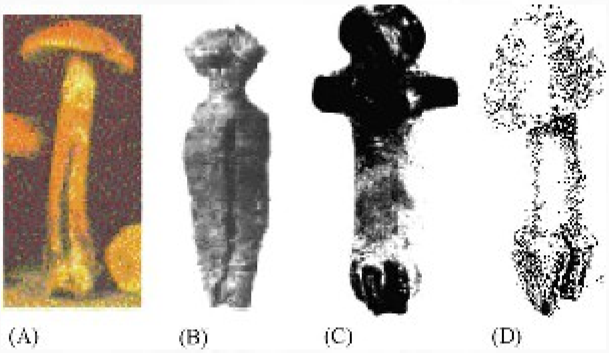


Fig. 12. Lawn Gallerina (A) personified in Egyptian figurine with conspicuous medial cleft (B), and maturing *Amanita brunnescens* (C) personified in anthropoid, predynastic, Egyptian figurine with conspicuous basal cleft (D).

For the same reasons, the anthropoid Canaanite figurines in Fig. 14B and C reveal that they were designed to represent a cluster of *Psilocybes*, just as the Triple Crown (Fig. 14D) apparently was. Since the Egyptians traded extensively with the Canaanites and other Levantine peoples, it is very possible that this trade included *Psilocybes* and *Amanita muscaria* that grew in mycorhizal relationship with the famous cedars of Lebanon, as they do with the less famous Moroccan cedars. Mabry (2000) quotes Dr. C. Bas of the Rikjksherbarium/Hortus Botanicus in Leiden, Netherlands, who studied the *Amanitae* for over 25 years, as having said:

> "It seems to me that it is; very probable that the *Amanita muscaria* grew (or still grows), in the Lebanon with *Cedrus* ... *Cedrus* is mentioned as a partner of *Amanita muscaria*. In Morocco grows *Cedrus atlanticus*, in Lebanon, *Cedrus libanotica*. But the differences between the two species is; very small. Moreover, the two Pinus species ... are widely cultivated around the Mediterranean." (Cited in Mabry, 2000)

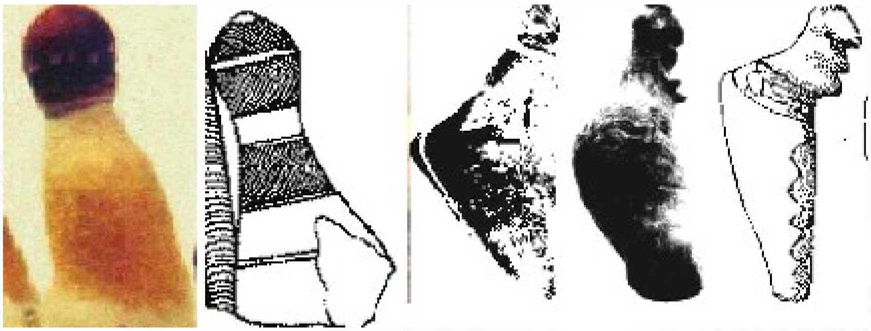
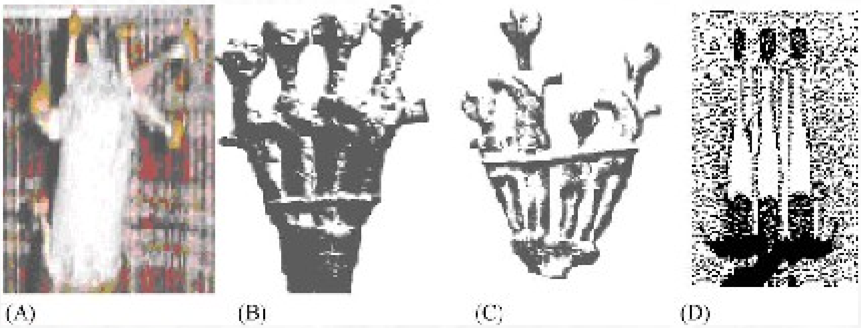


Fig. 13. *Psilocybe* primordium (left) symbolized by the White Crown (center) and personified by three, anthropoid, predynastic Egyptian figurines (right).



(A) (B) (C) (D)

Fig. 14. *Psilocybe* cluster, here on growth media (A) personified in Canaanite figurines (B and C) and symbolized by Egyptian Triple Crown (D).

Ancient artists who personified entheogenic mushrooms may have also done so for another reason, however: i.e., people who ingest such mushrooms often see mushroom-like beings singing, dancing, and gesturing in ways that are culturally dependent. In Siberia, for instance, these beings are regarded as helpers that usually lead "bemushroomed" individuals on journeys through realms that are regarded as spiritual, rather than illusory (Wasson, 1968), while in Central America these spirits are often referred to as "little children" or "clowns" (Munn, 1973; Wasson, 1980).

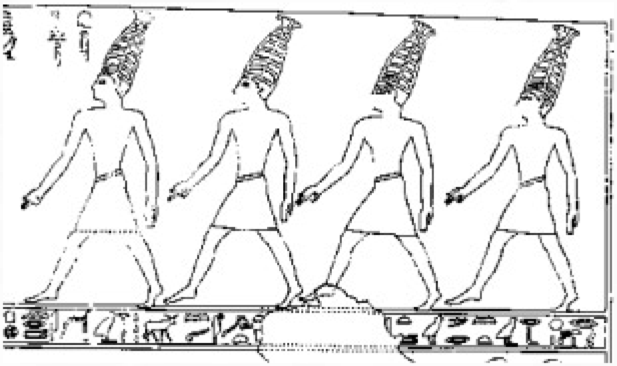


Fig. 15. Muu dancers wearing woven, basket-like, variations of the White Crown.

In view of this analysis, it is not coincidental that the Egyptian word *muu*, for the so-called *muu* dancers, (Fig. 15) who were responsible for bringing the souls of the dead to the afterworld, referred to jesters, buffoons, and dwarfs (Budge, 1978; Faulkner, 1986), for these dancers were evidently originally the Egyptian analogues of the dancing mushroom spirits people have typically seen after ingesting entheogenic mushrooms. This analysis is in full accord with: (1) the belief that the *muu* were originally dwarfs, just as the word for them implies (Moret, 1927); (2) the belief that the *muu* crown was a variation of the White Crown (Abubakr, 1937);

(3) the belief that the *muu* were personified crowns (Altenmuller, 1975), for the *muu* were indeed originally personifications of the *Psilocybes* their crowns were designed to represent.

The Egyptian shamans who personified the spirits that seemingly dwelled in the entheogenic mushrooms they ingested also deified these spirits as, for example: (1) the minor deity Nekhbet, the so-called Lady of El Kab, and (2) the major deity Osiris, the so-called "Lord of the White Crown [and he] ... whose White Crown is lofty." (Collier, 1996). Hence, the Papyrus of Ani explicitly calls Osiris "O thou [you] White Crown of the divine form!" (Budge, 1967).

Indeed, it is precisely because the Egyptians personified entheogenic mushrooms, on the one hand, as crowns, but on the other hand, as deities that the aforementioned inscription in the tomb of Pharaoh Unas also states "The Pharaoh is the bull of the sky ... who lives on the being of every god ... their big ones are for his morning meal, their middle sized ones are for his evening meal, their little ones are for his night meal" (Faulkner, 1998, Utterance 273-274), apparently in reference to the differently sized mushrooms, personified as Gods, that Pharaoh ingested.

Because Osiris was evidently originally the personification of a *Psilocybe*, the Papyrus of Ani says of him "Thy head is blue [like] lapis lazuli" (Budge, 1969a), obviously in reference to the tendency *Psilocybe* caps have of turning blue when touched, while the Egyptian Blue Crown, cap-crown, or *khepresh*, was designed to represent such a cap.

Because Osiris was originally a personified mushroom, the symbol Budge identified with him at the god's cult center at Abydos, where many entombed ear studs were found, was a plumed mushroom transected by a serpent (Fig. 16). Feathers were, for obvious reasons, used ubiquitously in antiquity as symbols of flight, especially that of the soul, and serpents were anciently known ubiquitously for their poisons and their ability to shed their skins, in an act that clearly would have evoked, and apparently did, the ego death and spiritual rebirth that entheogenic mushrooms often induce.

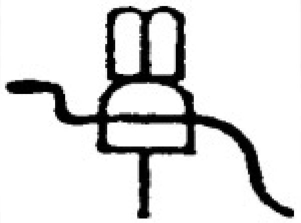


Fig. 16. Plumed mushroom and serpent symbol that Budge associated with Osiris at the god's cult center at Abydos.

Serpents were therefore intimately associated in antiquity with mushrooms, especially toxic and entheogenic species (Pliny the Elder, Naturalis Historiae XXII, line 95; Allegro, 1969; Nicander, 1953), and the Egyptians often surrounded the *Psilocybe cubensis* primordia on their crowns with both feathers and serpents to indicate that the mushrooms these crowns represented contained toxins that could confer immortality and divinity on people who ingested them. Hence, the aforementioned inscription in Unas's tomb also states, "It is the serpent-raised head who guards them for him," evidently referring to these serpents as guardians of the sacred mushrooms.

Because Osiris was originally a personification of a *Psilocybe*, which the White Crown symbolized, the picture of him rising up from a basket, enveloped in the wings of his consort Isis (Fig. 17), is entirely equivalent to the hieroglyph of the White Crown in a basket (Figs. 9 and 10).

Besides having been considered a personification of the White Crown, the Egyptians regarded Osiris as the personified spirit of barley; for example, the Coffin Texts quote Osiris as saying, "I am Osiris ... I am barley ..." (de Buck, 1947). Osiris therefore appears in Fig. 18 covered by and shedding the barley he personified with the Atef or Osiris crown, comprising the White Crown flanked by feathers, literally growing from his head, just as *Cheops and the Magicians* explains allegorically how the White Crown grew from the stored barley.

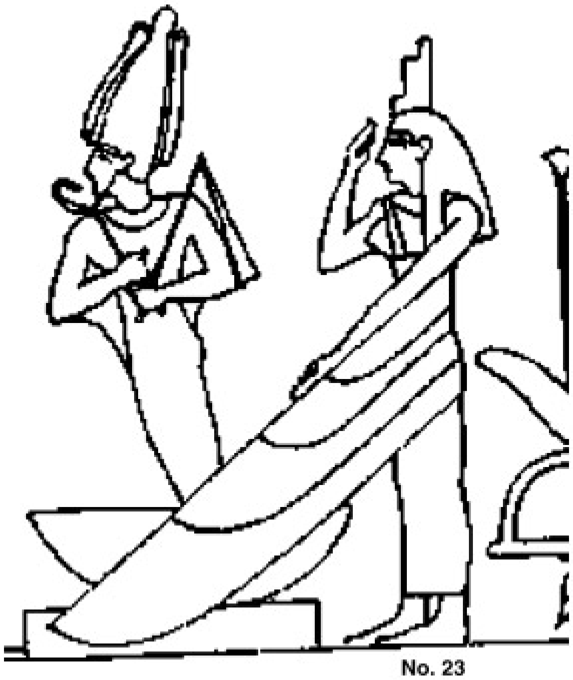


Fig. 17. Osiris rising up from a basket, enfolded in the wings of Isis is symbolically equivalent to the White Crown hieroglyph (Fig. 9).

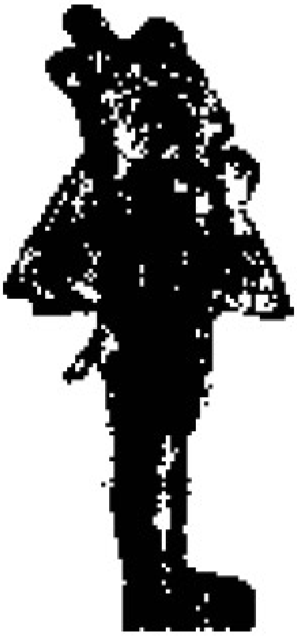


Fig. 18. Osiris shedding the barley he is personifying with a *Psilocybe* crown growing from his head, ostensibly as a crown.

Osiris was therefore typically depicted monopodially with arms akimbo (Fig. 19, left), obviously so he would look remarkably like a mushroom (Fig. 19, right), especially to anyone who was privileged to the esoteric information that Osiris's original nature was mycological. In fact, because the practice of personifying mushrooms as monopodial beings was widespread in antiquity, mummies were apparently fashioned with a single or fused legs and arms akimbo to look like mushrooms, as explained more below vis a vis the *tekenu*.

> This is a coffin-like vessel of granite which stands on supports in a greater basin. In it lies the golden image of the god. The vessel is filled with earth, which is intermixed with sacred material-incense, precious stones and so on. Seeds of differing kinds are embedded into this mixture, and their germination and growth signify the revival of the dead. (Otto, 1968, p. 58)

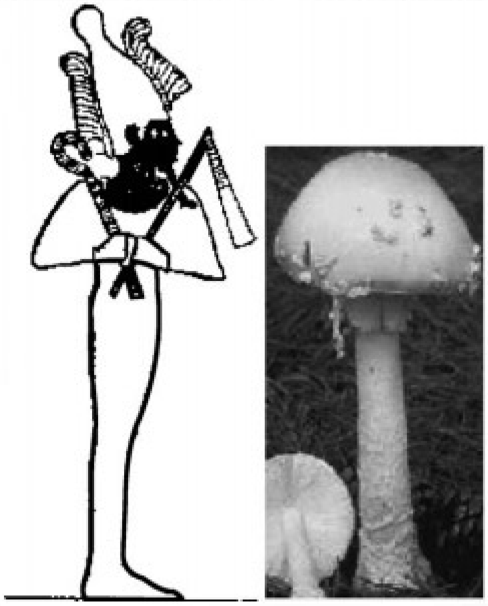


Fig. 19. (Left) Osiris in his typical mushroom-like pose. (Right) *Amanita muscaria*. Particularly noteworthy is the striking resemblance Osiris's hands bear to the annulus, just under the mushroom's cap.

Because Osiris was a personifed *Psilocybe*, the Egyptians also constructed beds of straw shaped like Osiris, to plant *Psilocybes*:

Plants subsequently grew from the straw and earthen image of Osiris, though the nature of these plants and the reason they were associated with Osiris's resurrection have never been adequately explained. It is generally believed that the plants were probably barley, but if so, there would have been no reason to construct a bed of precious stones and straw.

This practice can now be adequately explained as a ritualized personification either of the practice of growing *Psilocybes* from grain, as *Cheops and the Magicians* allegorically describes, or the practice of growing *Psilocybes* from straw and mycelia, known as spawn. In a modern version of the latter technique, used by people who typically grow *Psilocybes* for recreational use, a plastic cooler or tub is filled with vermiculite, just as the Egyptians filled Osiris's casket with earth and stones. A bed of sterilized straw is placed over the vermiculite, just as the Egyptians placed papyrus or straw over their stones, and *Psilocybe* mycelia, or spawn, is placed over the straw. Shortly thereafter, *Psilocybe* primordia begin sprouting, and about two weeks later the *Psilocybes* are mature and ready to eat.

It was apparently from ingesting these *Psilocybes* and experiencing the spiritual rebirth they could induce that Egyptian kings derived their knowledge of what they subsequently called the "Second Birth." This birth was then attributed to the spirit of the sun passing first into the straw, then into the *Psilocybes*, and finally back into the deceased Pharaoh, who was presumably then resurrected as the solar deity Osiris.

Mabry (2000) recognized that Osiris was a personified mushroom, though Mabry argued that Osiris personified the *Amanita muscaria*. Mabry's suspicion finds a great deal of support in its ability to explain why, for example, the Egyptians gave valiant warriors golden flies, like those in Fig. 20, upon their induction into the so-called Order of the Golden Fly. No comprehensive study has ever been done on the significance of this order or its symbol, though Egyptologists have speculated that the Egyptians must have regarded the fly as brave.

Indeed, the *Amanita muscaria* has traditionally been known in societies where it is still ingested for its ability to greatly increase a person's strength and bravery, and it has therefore been implicated as the drug Viking warriors, known as berserkers, took before going into battle (Wasson, 1968). Moreover, the *Amanita muscaria* is commonly called the Fly-Agaric, because it attracts and reputedly stuns or kills flies. Hence, the fly has often been used to symbolize this mushroom and would have indeed been an appropriate ancient Egyptian symbol of strength and bravery.

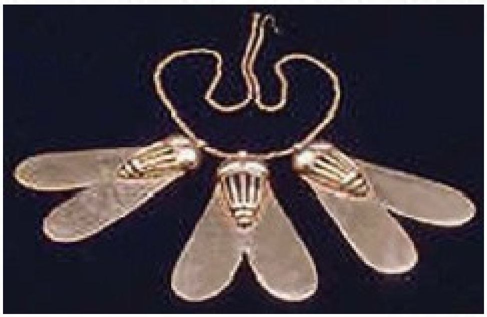


Fig. 20. A necklace of golden flies from the tomb of Queen Ahhotep, mother of Ahmose I.

Mabry's theory that Osiris personified the *Amanita muscaria* finds still more support in its ability to explain the enigmatic ritual of the *tekenu*, during which an Egyptian shamanic priest was pulled on a sled while lying in the fetal position wrapped completely in a bull's hide, emerging later in the same distinctly mushroom-like form that Osiris typically manifests (Fig. 21).

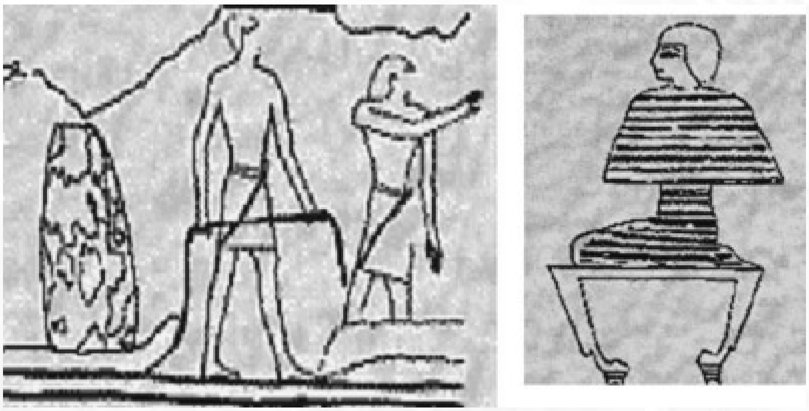


Fig. 21. Tekenu wrapped in a bull's hide representing an *Amanita muscaria* primordium. The priest eventually emerges in the same distinctly mushroom-like pose that Osiris typically manifests, in a position to administer the sacred mushroom cap he then personified.

The *Amanita muscaria*'s mottled red and white cap, combined with its ability to greatly increase strength, led ancient mytho-poets and artists to personify it as a bull (Wasson, 1968; Hoffman *et al.*, 2002; Ruck *et al.*, 2004). It can therefore be inferred that the *tekenu* ceremony was designed to recapitulate the birth of Osiris, whose spirit the Egyptians believed dwelled in barley and, consequently, in the parasitic, entheogenic mushrooms that absorbed the spirit of barley. Having been reborn as the mushroom deity, the priest was then in a position to administer the sacred mushroom cap he himself personified in the rebirthing ceremony appropriately known as "Opening of the Mouth."

The evidence presented above suggests further that the Egyptians were also ritualistically ingesting entheogenic *Amanita pantherina*, which can explain why Osirian priests typically wore panther skins.

In Fig. 23, Wepawet (*Upuaut*), the dog or jackal God, known as The Opener of The Ways, stares at Osiris's mushroom embodiment, perhaps because the predynastic Egyptians used dogs to search for the mushrooms Osiris personified, just as modern mushroom hunters often do. That this mushroom was probably a *Psilocybe* can be inferred by noting that standing on the right and left of it are non-steatopygous, ithyphallic, monopodial beings, evidently representing personified *Psilocybes*, rather than steatopygous *Amanita muscaria*, primordia. Their erect phalluses were apparently designed to resemble arms bearing the mushrooms these primordia yield, in accordance with the anciently ubiquitous practice of representing mushrooms as phalluses (Allegro, 1969).

These puppet-like creatures are evidently depictions of those used in processions honoring Osiris who, according to Herodotus (2.42), was the Egyptian analogue of Dionysus, the Greek God of intoxication. According to Egyptian legend, Osiris was dismembered by his brother Set and re-assembled by his consort Isis, except for his phallus, just as the Titans murdered Dionysus who was then represented by a disembodied phallus (Ruck, 2005). During this procession, led by a flautist and singers praising Osiris, the hinged, erect penises of these puppets, about 18 in. tall, were made to bob up and down by women who carried them through villages.

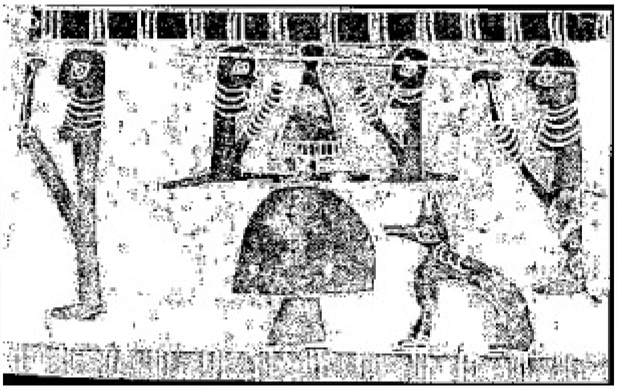


Fig. 23. The dog-God Wepwet (*Upuat*) pointing to Osiris's mushroom embodiment, surrounded by personified, ithyphallic, monopodial, *Psilocybe* primordia (from Mabry, 2000).

Herodotus claimed that the seer Melampus, who presumably introduced the worship of Dionysus to the Greeks, was well aware of this Egyptian procession, but did not quite understand it. Nevertheless, it was Melampus who reputedly transformed this procession into the Dionysian parade of the phallus (Ruck, 2005).

Because Osiris was originally an entheogenic mushroom, he also figures prominently in an Egyptian legend wherein he was resurrected after ingesting a structure the Egyptian called the *utchat*, now known commonly as the Eye of Horus.

The Eye of Horus (Fig. 24) has generally been regarded as a solar, lunar, and ornithological symbol because Horus was a solar and lunar deity with the head and, often, body of a hawk. But the Eye of Horus was heretofore unexplainably also a plant from which the Egyptians made an elixir and cakes they believed could confer immortality on people, about which E.W. Budge wrote:

> The gods nourished themselves with celestial food which was supplied to them by the Eye of Horus, that is to say, they supported their existence on the rays of light which fell from the sun which lit up heaven, and they became beings whose bodies were wholly of light. According to one myth the gods themselves lived upon a 'wood or plant of life,' which seems to have grown near the great lake in Sekhet-hetep, round which they were wont to sit .... In other places we read of 'bread of eternity' and 'beer of eternity.' (Budge, 1969a,b, vol. I, p. 164)

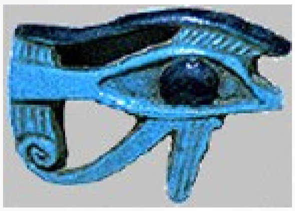


Fig. 24. An Egyptian *utchat*, representing the Eye of Horus, Re and Thoth, as well as a plant that could reputedly yield an elixir of immortality.

The Egyptians therefore included this plant of immortality in the ale and cakes they entombed with dead Egyptian kings, in accordance with the legend in which Osiris, whom every king aspired to become, was resurrected after he somehow ate the Eye of Horus (Griffiths, 1980). The entheomycological significance of this plant, and the reason Egyptian priests believed it could confer immortality on those who consumed foods made from it, can now be fully understood by noting that eyes are intuitively appropriate symbols of entheogenic mushroom caps, because such caps are ovoid like eyes and typically have a central protrusion or depression suggesting an eye's iris (Ott, 1969).

In addition, eyes, like suns, are very appropriate symbols of entheogenic mushroom caps, because ingesting such caps induces the luminous phenomena that solar and lunar symbols so aptly describe metaphorically.

Hence, such caps were reputed to give people the ability to see into other realms of reality. Thus, Odin, while hanging, like a personified rhizophyllic mushroom, from the sacred Yggdrasil tree, gained the gift of omniscience and prescience only after he drank from a well into which he had dropped his eye.

The theory that the Eye of Horus was an entheogenic mushroom cap can also be supported by noting that the Egyptians personified this eye in the very same way ancient Hindu priests personified Soma. More precisely,

1. The Egyptians personified Horus and Osiris as eyes, just as the Rg Veda describes the Soma plant and its elixir as an eye (Rg Veda I 875ab; IX 94; IX 10 ab).
2. The Egyptians personified Horus and Osiris as the sun, just as The Rg Veda personifies the spirit of the Soma plant, which also yielded a divine elixir, as a luminous, solar deity (Rg Veda I, 4610ab; IX, 26c; IX, 275ab).
3. The Egyptians described Horus and Osiris as luminous lunar deities, just as the Rg Veda describes the Soma plant and its elixir as a luminous lunar deity (Rg Veda 8.082.08; 10.052.02: 6.039.03).
4. The Egyptians claimed that the Eye of Horus could confer immortality on those who consumed it, or an elixir made from it, just as the Rg Veda describes the Soma plant and its elixir as having the ability to confer immortality on those who consumed it (Rg Veda, 8.048.03; 1.091.06; 1.091.18; 8.048.12; 8.048.11).
5. The Egyptians associated or personified Horus and Osiris as hawks, just as the Rg Veda as well as the Taittiriya Samhita and Aitareya Brahmana, associate Soma with a hawk, claiming more specifically that this hawk brought Soma to India (Rg Veda 1.080. 02; 1.093.06; 8.082.09) (Taittiriya Samhita 6.1) Aitareya Brahmana (3.25-27).
6. The Egyptians believed the Eye of Horus was submersed in and then taken from the primeval waters, just as the Rg Veda claims that Soma plant emerged from the primeval waters, and was an earthly, consumable part of those waters (Rg Veda, IV58.1) (Lidova, 1995).

From the above and many other Hindu textual passages too numerous to mention, it can be inferred that the Eye of Horus was almost certainly the Egyptian analogue of Soma. R.G. Wasson argued convincingly that Soma was originally the *Amanita muscaria* (Wasson, 1968), and perhaps later, a Pilocybe. The theory presented in this paper fully supports Wasson's theory.

5. Discussion and conclusions

This paper contains textual and graphic evidence strongly suggesting that the Egyptian White and Triple Crowns were originally primordia of the entheogenic *Psilocybe* (*Stropharia*) *cubensis*, which an Egyptian tale known as *Cheops and the Magicians* allegorically attributed to barley. In addition, the paper contains textual and graphic evidence strongly suggesting that Osiris was the God of spiritual rebirth, because he originally personified *Psilocybes*, the *Amanita muscaria* and, probably, the *Amanita pantherina*. Finally, the paper theorizes that the plant known as the Eye of Horus, which Egyptians included in cakes and ales they concocted to spiritually rebirth the living and the dead, was intimately associated with Osiris, because this eye symbolized an entheogenic mushroom cap that was the Egyptian analogue of Soma.

One might ask why Egyptologists who have studied the above material for so many years could have missed the identities and relationships I have just elucidated. The reason for this is, I believe, several-fold. First, as the eminent philosopher of science, Kuhn (1962) pointed out, professional education often leads students to view things in the same way their professors viewed them, often to the extent that getting either group to view those things differently is very difficult, if not impossible. It was for this reason, coupled with the failure to realize that authority is not tantamount to truth, that the Aristotelian notion of heavier objects falling faster than lighter ones managed to survive for over 1600 years, and current theories about the origins and underpinnings of Egyptian religion have existed virtually unchanged for decades. The theory presented in this paper is a radical departure from those theories, but rests on the same body of textual and graphic evidence.

Second, Egyptologists, as a general rule, know little or nothing, and implicitly care even less, about how drastically entheogenic plants can affect one's world view, or the extent to which such plants have traditionally been used ritualistically in other cultures, for example, to commune with ancestors who, in many cases, were deities. Osiris was the pharaonic patriarch, and communing with him apparently involved ingesting his botanical embodiments, entheogenic mushrooms. This, just as the Greeks ingested Dionysus's botanical embodiment, the grape - or as Graves (1960) suggested, entheogenic mushrooms in wine - after which his spirit seemingly rose up and possessed them. Herodutus's belief that Osiris was the Egyptian analogue, if not predecessor, of Dionysus was thus well founded.

Third, entheogenic mushrooms are regarded as illegal drugs used in this culture mainly by young adults for recreation, and the effects these mushrooms induce are regarded as hallucinations or illusions. In contrast, the ancients held psychotropic plants and the effects they induced in high regard, to the extent that the ingestion of these plants was typically reserved for priests and seers. The implicit tendency of Egyptologists to regard entheogenic mushrooms disdainfully is therefore a cultural bias that has evidently had a prejudicial effect on the wealth of evidence that the ingestion of such mushrooms underpinned ancient Egyptian religion.

Finally, Egyptologists and laymen alike have romanticized the Egyptians and their deities from the very advent of Egyptology. The theory that Egyptian religion and culture was built around the practice of ingesting entheogenic mushrooms, which we now condemn, can create a cognitive dissonance that some people may never be able to resolve.

References

1. Abubakr, A.M.J., 1937. Untersuchungen über die ägyptischen Kronen. Verlag J.J. Augustin, Gluckstadt.
2. Aldred, C., 1971. Jewels of The Pharaoh: Egyptian Jewelry of the Dynastic Period. Praeger Publishers, New York, PI. 68, p. 210.
3. Allegro, J., 1969. The Sacred Mushroom and The Cross. Doubleday, Garden City, NY.
4. Altenmüller, H., 1975. Zu Frage Der Mww in Studien Zur Altägyptischen Kultur 2 (Hamburg, 1975), 1-37. Cited in Reeder, G. Fall 1995. The Mysterious Muu and The Dance They Do, KMT 6:3, available on-line at http://www.egyptology.com/reeder/muu/.
5. Berlant, S., 1999. The prehistoric practice of personifying mushrooms. Journal of Prehistoric Religion 13, 22-29.
6. Boston Museum of Fine Arts, 1982. Egypt's Golden Age, the Art of Living in the New Kingdom, 1558-1085 B.C. Catalogue of the Exhibition. Museum of Fine Arts, Boston.
7. Budge, E.A.W., 1967. The Chapter of Driving Back The Slaughters Which Are Formed in Hensu. In: The Book of the Dead, the Papyrus of Ani in the British Museum. Dover Publications, New York, the Egyptian text with interlinear transliteration and translation, a running translation, introduction, available on-line at http://www.sas.upenn.edu/African Studies/ Books/Papyrus Ani.html.
8. Budge, E.A.W., 1969a. The papyrus of Ani, sheet 2. In: Budge, E.A.W. (Ed.), The Gods of the Egyptians or Studies in Egyptian Mythology, vol. 2. Dover Publications, New York, p. 153ff.
9. Budge, E.A.W., 1969b. The Gods of the Egyptians or Studies in Egyptian Mythology. Dover Publications, New York.
10. Budge, E.A.W., 1978. An Egyptian Hieroglyphic Dictionary: With an Index of English Words, King List, and Geographical List with Indexes, List of Hieroglyphic Characters, Coptic and Semitic alphabets, etc. Dover Publications, New York, p. 294.
11. Collier, S., 1996. The crowns of the Pharoah: their development and significance in ancient Egyptian kingship. Ph.D. Dissertation. U.C.L.A.
12. de Buck, A., 1947. Egyptian Coffin Texts III Texts of Spells 164-267. University of Chicago Press, Chicago, Spell 168.
13. Dikov, N.N., 1971. Naskalnuie Sagadki Drevniei Ciukotki (Pietroglifui Pegtimelia). Nauka, Moscow (cited in: Wasson, R.G., 1986. Persephone's Quest: Entheogens and the Origins of Religion. Yale University Press, New Haven, p. 69).
14. Emboden, W.A., 1978. The sacred narcotic lily of the Nile: Nymphaea Caerulea. Economic Botany 28, 304-310.
15. Evers, H.G., 1929. Staat aus dem stein: denkmäler, geschichte und bedeutung der agyptischen plastik während des mittleren reichs. F. Bruckmann, München, Tafel 35b.
16. Faulkner, R.O., 1986. A Concise Dictionary of Middle Egyptian Oxford. Griffith Institute, Ashmolean Museum.
17. Faulkner, R.O., 1998. The Ancient Egyptian Pyramid Texts. Sandpiper Books. Oxford University Press, New York.
18. Festi, F., Bianchi, A., 1991. Amanita muscaria: mycopharmacological outline and personal experiences. In: Lyttle, T. (Ed.), Psychedelic Monographs and Essays, vol. 5. P.M.&E. Publishing Group. Available on-line at http://leda.lycaeum.org/?ID=16317 (accessed on 18 September 2005).
19. Graves, R., 1960. Food for Centaurs: Stories, Talks, Critical Studies, Poems. Doubleday, Garden City, NY.
20. Griffiths, J.G., 1980. The Origins of Osiris and His Cult. Brill, Leiden, p. 27.
21. Gow, A.S.F., Scholfield, A.F. (Eds.), 1953. Nicander: The Poems and Poetical Fragments.
22. Heinrich, C., 2002. Magic Mushrooms in Religion and Alchemy. Park Street Press, Rochester, VT.
23. Hoffman, M., 2002. Mushroom myth and imagery in Hawai'i: evidence for an indigenous cult. Entheogen Review 11, 41-47.
24. Hoffman, M., *et al.*, 2002. The entheogenic eucharist of Mithras. Entheos 2, 13-50.
25. Kuhn, T.S., 1962. The Structure of Scientific Revolutions. University of Chicago Press, Chicago.
26. La droga en el Antiguo Egipto, available on-line at http://www. institutoestudiosantiguoegipto.com/begona drogas.htm.
27. Lefebvre, G., 1949. Rouge et Nuances Voisines. Journal of Egyptian Archaeology 35, 72-76.
28. Lhote, H., 1973. A la d'ecouverte des fresques du Tassili. Arthaud, Paris (cited in Samorini, 1992).
29. Lichtheim, M., 1975. Ancient Egyptian Literature: A Book of Readings. University of California Press, Berkeley.
30. Lidova, N.A., 1995. The Vedic Sources of Hindu Creation Myth. Prakrti, vol. 5.
31. Mabry, M., 2000. Osiris: Eine Reidentifikation. In: Bauer, W., Klapp, E., Rosenbohm, A. (Eds.), Der Fliegenpilz: Ein

Kulturhistorisches Museum. Verlag, Wienand.
32. McKenna, T., 1992. Food of the Gods: The Search for the Original Tree of Knowledge: A Radical History of Plants, Drugs and Human Evolution. Bantam Books, New York, NY, p. 71.
33. Merlin, M., 2003. Psychoactive plant use in the Old World. Economic Botany 57 (3), 295-323.
34. Moret, A., 1927. Mysteries Êgyptiene, p. 257ff.
35. Mori, F., 1975. Contributo al pensiero magico-religioso attraverso l'esame di alcune raffigurazioni rupestri preistoriche del Sahara. In: Valcamonica Symposium, vol. 72, pp. 344-366 (cited in Samorini, 1992).
36. Munn, H., 1973. The mushrooms of language. In: Harner, M.J. (Ed.), Hallucinogens and Shamanism. Oxford University Press, New York.
37. Naville, E., 1910. The XIth Dynasty Temple at Deir el-Bahari, published by order of the Committee, London.
38. Ott, J., 1969. Carved disembodied eyes of Teotihuacan. In: Wasson, R.G. (Ed.), Persephone's Quest, p. 141ff.
39. Otto, E., 1968. Egyptian Art and the Cults of Osiris and Amon. Thames & Hudson, London.
40. Pliny the Elder, 1969-1989. Natural History with an English translation by H. Rackham. Cambridge, Mass. Harvard University Press.
41. Puharich, A., 1959. The Sacred Mushroom: The Key to the Door to Eternity. Doubleday, Inc., Garden City, NY.
42. Reisner, G., 1923. Excavations at Kerma. Harvard African Studies. Parts IV-V, Peabody Museum. Harvard University, Cambridge, MA, pp. 256-257.
43. Ruck, C., 1979. Entheogens. Journal of Psychedelic Drugs 11, 45-46.
44. Ruck, C.A.P., 2005. Personal communication.
45. Ruck, C., Staples, B., Heinrich, C., 2001. The Apples of Apollo: Pagan and Christian Mysteries of the Eucharist. Carolina Academic Press, Durham, NC.
46. Ruck, C.A.P., *et al.*, 2004. The brotherhood of the warriors of Mithras. New England Classical Journal 31, 335-362.
47. Samorini, G., 1992. The Oldest Representations of Hallucinogenic Mushrooms in the World (Sahara Desert, 9000-7000 B.P.). Integration, vol. 2/3, pp. 69-78, available on-line at http://www.shroomery.org/index/par/25043.
48. Schultes, R.E., Hoffman, A., 1992. Plants of the Gods: Their Sacred Healing and Hallucinogenic Properties. Healing Arts Press, Rochester, Vermont.
49. Spess, D., 2000. Soma: The Divine Hallucinogen. Park Street Press, Rochester, VT.
50. Stamets, P., 1996. Psilocybin Mushrooms of the World: An Identification Guide. Ten Speed Press, Berkeley, CA.
51. Wainwright, G.A., 1923. The Red Crown in early prehistoric times. Journal of Egyptian Archaeology 9, 26-33.
52. Wasson, R.G., 1968. Soma, Divine Mushroom of Immortality. Harcourt, Brace & World, Inc., New York.
53. Wasson, R.G., 1980. The Wondrous Mushroom: Mycolatry in Mesoamerica. McGraw-Hill, New York.
54. Wasson, R.G., *et al.*, 1986. Lightningbolt and mushrooms. In: Persephone's Quest: Entheogens and the Origins of Religion. Yale University Press, New Haven, pp. 83-94.
55. Wilkinson, R.H., 1994. Symbol and Magic in Egyptian Art. Thames and Hudson, New York, NY.
56. Wilson, P.L., 2001. Ploughing the Clouds: The Search for Irish Soma. City Lights Books, San Francisco, CA.
57. Winkler, H., 1938-1939. Rock Drawings of Southern Upper Egypt. The Egypt Exploration Society, H. Milford, Oxford University Press, London.

Ancient Maya Mushroom Connections

A Transcendental Interaction Model

by

Thomas M. McGuire

Journal of Psychoactive Drugs,
Vol. 14(3) Jul-Sep, 1982

original report: http://docslide.us/documents/ancient-maya-mushroom-connection.html

Table of Contents:

Introduction
Mushrooms as magical and sacred plants
Mushrooms as exploitable plants
Mushrooms as local and nonlocal items of trade
Mushrooms as culturally integrative pharmacopoeia
Mushrooms as ethnobotanical reality
Acknowledgments
Notes
References

> *He who does not imagine in stronger and better lineaments, and in stronger and better light than his perishing eye can see, does not imagine at all.*
> - William Blake
>
> *Many wantons ... doe hunger after the earthie excrescences called Mushrums.*
> - John Gerard, 1597
> *The Herball, or Generall Histories of Plantes*

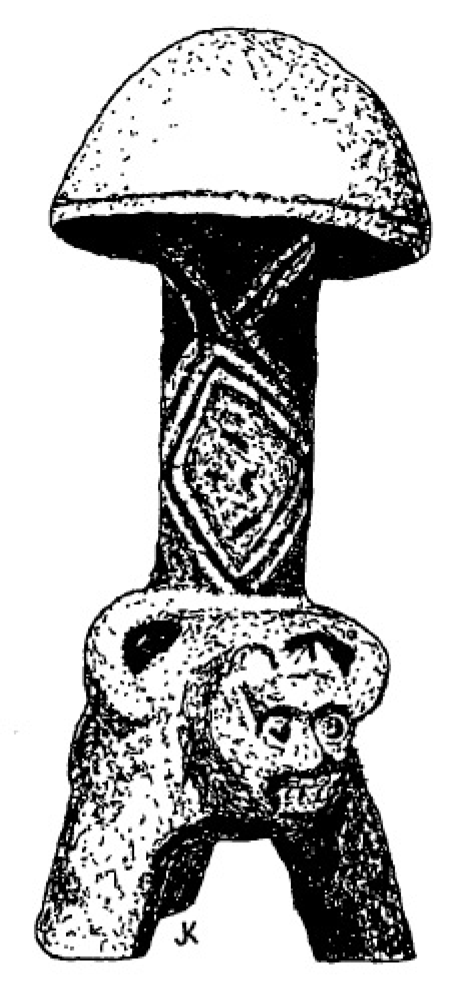
Introduction

Traders and trade in ancient Mayan society are subjects of intense discussion and debate in anthropological journals. Archaeologists such as Muriel Weaver (1952: 57) and William Rathje (1972) believe that without an integrated system of exchange, administrated by an astute managerial class, the Maya might never have achieved the lofty cultural peaks of the Classic Period. Trade and a trader class were essential if life was to carry on smoothly. The Maya traded most everything: salt, feathers, rubber, obsidian, flint, igneous stone, honey, cochineal, jade, wax, polychrome vessels and a panoply of other necessary and superfluous commodities of daily and ritual life. Ancient Mayas desired (and needed) these goods with a passion.

An item of trade and a group of traders are presented in this article in the framework of a hypothesis: a model which involves the ancient Maya of Mesoamerica and their propensity to utilize and trade a unique commodity, psychotropic mushrooms. The aim of this article is not to rehash specious information concerning the significance that ritual hallucinogenic mushrooms may have had for Mayan peoples centuries upon centuries ago, but rather, to reinterperet the role and status of these sacred plants in ancient Mayan society.

The "Transcendental Interaction Model" examines the phenomena of the proliferation of exploitable hallucinogenic mushrooms in Mesoamerica and the possible ways and means that prehistoric peoples utilized them; as well as discussing prehistoric mushroom effigy stones and other symbolic iconography. The model's fundamental components have been developed in response to Dobkin de Rios' inference (1974: 148) that "it is possible that psychotropic mushrooms were important trade items in the southern highlands, where active commerce with other parts of Mesoamerica existed." And also in response to Köhler's (1976: 145) skeptical comment that "none of the rather speculative hypotheses so far proposed offers a convincing explanation." Additionally, while Dobkin de Rios first mentioned the *existence* of a mushroom connection, she did not pursue the question of the *necessity* of that connection, given the sociocultural and political conditions of the time.

The mushroom mystique of the ancient Maya is made more comprehensible in the context of ordinary, business-as-usual mushroom trade. To be sure, the Transcendental Interaction Model is a speculative hypothesis of ritual mushroom use derived from "limited inferences" (Plog 1977: 138) that archaeologists are able to make about ancient Mayan religion, society and trade patterns. It is also without question a somewhat radical hypothesis. Emboden (1979: 91), in discussing advances of historical knowledge, observes: "The structure of Mayan civilization may require new interpretations.... The burgeoning reports [of hallucinogenic practices] in recent times suggest that much of the history of the peoples of ancient Middle America will have to be rewritten in light of [material] previously unknown in the psychohistory of these civilizations."



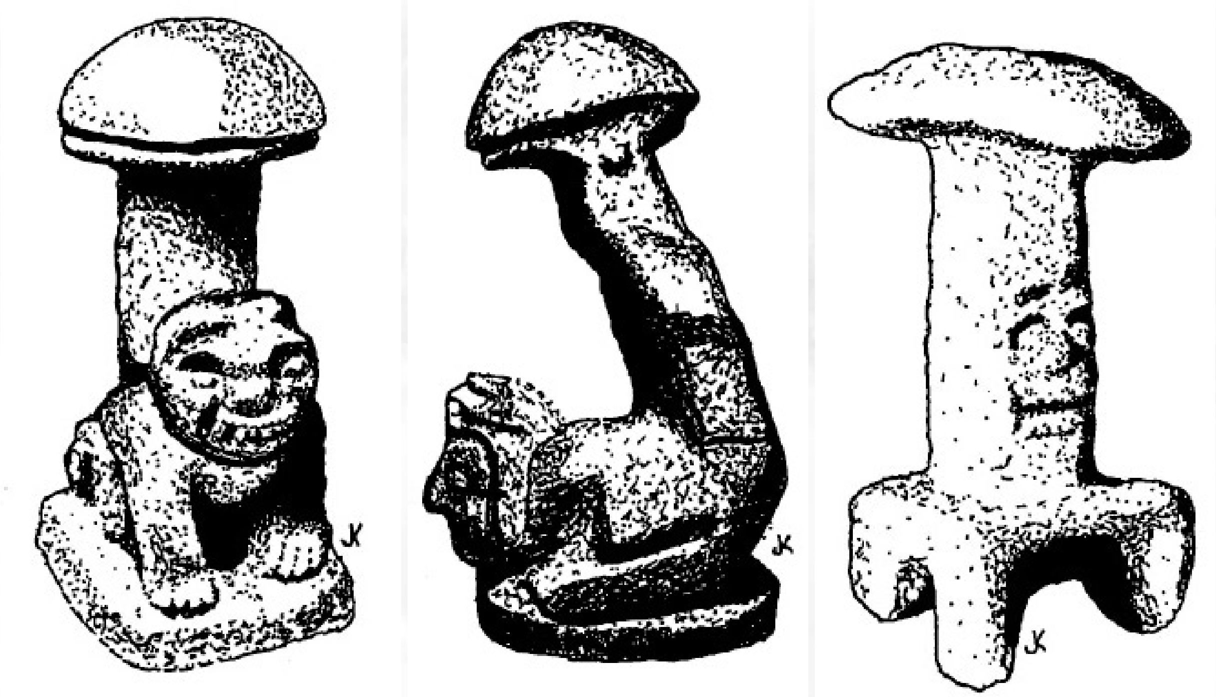
Several problematic variables are dealt with in this article which attest to the model's holistic and heuristic framework of understanding mushroom trade as cultural exchange. One variable is why a demand for different species of the genera *Psilocybe*, *Stropharia*, *Conocybe* and *Panaeolus* (and possibly, *Amanita muscaria*) would have been created by Mayan theologians. A second variable is how ritual and ceremony would have functioned at base organizational levels to manipulate and control sociopolitical and magi co-religious power. Another variable is how mushrooms, like any desired commodity in ancient Mayan society, would have formed the basis for part of (or would have been incorporated into) an already existing trade network connecting the great and small ceremonial centers of the day. A final variable is how well or satisfactorily the physical and ethnographic evidence for mushroom trade meets recent criteria for detecting or inferring its existence in prehistory. The physical criteria relate to Plog's (1977) crucial variables for documenting the existence of trade in the archaeologic record.[1] The ethnographic criteria are discussed in the following section.

The argument ascribes paramount importance to mushrooms in liturgical and curing/divining ceremonies. The viability of trading these sacred ritual artifacts is in documenting their *importance* as supreme power/prestige denominators. The approach of documenting the important place in culture of *magic* mushrooms is necessary.

Unlike concordant attitudes on jade, obsidian, salt and polychrome vessels (ceremonial and utilitarian items accepted by knowledgeable people as performing useful social and economic functions in Mayan culture), some archaeologists, particularly Köhler (1976), maintain that prehistoric Mayas and other peoples did not religiously and supernaturally worship the notorious fungi in ceremonials. Thus, to dispute and eschew Köhler's reasoning is in the model's best interest.

Mushrooms as magical and sacred plants

Millennia ago, a significant climatic change occurred and a postglacial wave of balmy temperatures regenerated new forms of animals and plants over the planet. The bountiful Americas offered human populations drifting down from Berengia (Late Pleistocene/Early Holocene land bridge linking Asia and North America) hundreds of plants to eat. The knowledge of which herbs were esculent and which were foul-tasting and poisonous probably was acquired during a trial-and-error period of indiscreet plant consumption. Questing for new and renewable food sources, nomadic gatherers foraged for plants that sometimes caused illness, sometimes nourished and sometimes killed (Emboden 1979: XIV). A few of the plants induced in users perceptual distortions so bizarre and bewildering (and probably pleasant) that they were at once exalted as "power" plants and as vehicles of transubstantiation. These strange plants - from barks and flower tops to fungi and cacti - assumed a socioreligious status (Furst 1976: 15) that escalated in importance as religious concepts and power hierarchies became increasingly complex.



After Schultes & Hofmann 1979: 148-149.

The archaeologic evidence for ritual mushroom use in Middle America is geographically distributed from El Salvador and Guatemala, westward to Mexico and up to the Gulf Coast. Temporally, they range from Preclassic (Formative) through Late Classic times (Mayer 1977: 19-30; Parsons 1974: 170). Furst (1976: 77) writes that "as long as 3,000 years ago at least the inhabitants of the highlands and the Pacific slope of Guatemala, as well as some of their neighbors, held certain mushrooms to be so sacred and powerful - perhaps even divine - that they represented them in great numbers in sculptured stone." When some of these odd sculptures were first discovered by Kidder, Jennings and Shook in a tomb at Kaminaljuyú, outside of modern Guatemala City, hardly anyone thought to associate the delicate Preclassic lapidary objects with the awareness-altering mushrooms which abound in Guatemala and Mexico.[2] "Due to ignorance of their actual employment and significance," the stones have been variously interpreted as "idols, fertility symbols, phalli, moon gods, cosmos symbols, maize pestles, clay models, field markers for ball games and farming, stone tools and representations of temples" (Mayer 1977: 5). Only the interpretation of their significance as field markers holds water. Their phallic symbolism is clearly flaccid because: (1) genitalia portrayal in other Mayan art forms is abnormal (Why the concentration of erotica at Kaminaljuyú and not elsewhere?); (2) they are one-sidedly male centered (Furst

1976: 80), which is contradictory to the general Mesoamerican trend of dualistic expression; and (3) they were found in association with *manos* and *metates*, for pulverization purposes, and not in association with sculptured vaginas or some other archetypical symbol of fecundity. No explanation sufficed for Kidder and his cohorts (1946) when the stones were brought to light as "peculiar and as yet unexplained objects." Eventually, the works of Wasson (1978, 1971, 1967) and de Borhegyi (1963, 1961) revised anthropological thought on this matter by unequivocally relating the stones in ceremonial symbolism to psychotropic mushrooms. Quite possibly, the carved objects were associated with the Mayan pantheon of night and underworld gods (de Borhegyi 1961).

Two scholars have critically questioned the cogency and reliability of Wasson's and de Borhegyi's work. Köhler (1976) rejoined: "On what do the foundations of their interpretations rest?" He propounds a theory of practicality rather than ceremonialism; linking the sculptured stones to potters' molds. Apparently heedless of their uncanny surface resemblance to psychodysleptic mushrooms, Köhler bases his conclusions primarily on the disparity of artistic styles in the stones (see figures). Why are some fancy and decorated, while the majority are plain and mundane? Because of a preponderance of *practical* stones rather than *ritual* ones, which are effigiated and decorated, Köhler (1976: 146) argues that "there are no indications whatsoever that the mushroom has become a god in its own right." In Köhler's view, mushrooms were probably frivolous and unimportant in Mayan society, and only a few maverick priests may have dared to try them. Richard M. Rose (cited in Mayer 1977: 1) shares Köhler's pragmatic views. In a preliminary report in 1977, Rose stated that the mushroom stones functioned as "effigies of ball players and/or deities of the ball game... as forms used in the manufacture of the rubber balls used in the game." Although these interpretations may aspire to validity, refusal to recognize the stones as mushroom idols "is likely to be a function of R.G. Wasson's ingenious division of people with those who loathe mushrooms and those who like them" (Furst 1976: 80). Schultes and Hofmann (1979: 151) affirm that "whatever the use of these 'mushroom stones,' they indicate the great antiquity of a sophisticated sacred use of hallucinogenic mushrooms."

Besides archaeologic evidence of carved mushroom stones, proto-Classic mushroom pottery and numerous stylizations of narcotic plants on bas-reliefs and monuments in association with deity figures (Emboden 1979: xiv), extant ethnographic parallels also refute the "negative evidence." Ethnographic parallels are useful tools of insight in understanding spiritual constructs of prehistoric peoples. Many groups remain documented case studies of unchanged cultural belief systems involving socially approved drug use to transcend daily life and to contact spiritual and supernatural worlds.[3] La Barre (1970: 120) attributes atavistic rites flourishing in remote parts of Mexico as being "probably the closest extant to the pre-Columbian Mexican rite." Furst (1976: 75-81), Emboden (1979: 90) and Schultes and Hofmann (1979: 153) allude to mushroom rituals among Choi and Lacandon Maya peoples - supposedly in seclusion in temples at Yaxchilan and probably other inaccessible ruins. They concede that formal ethnographic verifications would imply origins of preconquest ritual, not modern introductions or diffusions from elsewhere in historic times. Furst (1972: x) goes on to say that "the present day custom may well have its origins in Classic or Post-Classic Maya ritual," although in a later publication (1974: 59-60) he amended the restriction that one cannot maintain such a view with certainty.

The evidence for the ritual use of mushrooms in ancient times exists in archaeologic and ethnographic contexts. Although it may be subject to various interpretations, a deeper contention of the model acknowledges the cross-cultural and transtemporal importance of sacred alkaloid-rich plants. The Maya were not unique in their devotion and utilization of drugs as media of interpersonal and supernatural experience. In the following sections, sociopolitical and magico-religious parameters of pre-Columbian ritual mushroom use are defined and discussed in the context of trade.

Mushrooms as exploitable plants

Sanctioned drug use as a means of achieving extraordinary mind spaces and prestigious status in the culture might well explain some of the architectural, scientific, spiritual, epistemologic, artistic and political "aberrations" of the ancient Maya. Groping for answers, Furst (1972: x) wrote: "Perhaps, as Coe suggests, the artist-priests of Palenque itself found inspiration for their magnificent creations in mushroom-induced supernatural visions."

The *cult* of the mushrooms might have led to the development of interaction that better exploited the many rapidly perishable mushrooms in the mountains, forests and deer pastures of Mesoamerica.[4] Trafficking in psychotropic mushrooms, though, was an activity of little economic benefit to the Mayan people. As with trafficking quetzal bird (*Pharomachrus mocinno*) feathers and jade, for instance, only certain people *needed* the product. The importation-exportation syndrome of exotic and local products is the crux of the "Core Area - Buffer Zone Model" which Rathje developed in the 1970's to account for the emergence of tropical lowland Maya civilization. Rathje (1972: 386) proposes that Maya civilization evolved "in response to the need for consistent procurement and distribution of nonlocal basic resources useful to every household." Networks sprang up and interaction took place. The networks required regulation and maintenance. A breed of crafty managers and keen organizers arose to direct the trafficking and dispensing of vital salt, obsidian and igneous stone (mushroom effigies are made chiefly out of igneous stone). Rathje believes the procurement and distribution of essential requirements of life ignited Mayan cultural evolution in the jungles of southern Mexico, Guatemala, Belize and Honduras.

When applying Rathje's model to the procurement and distribution of psychotropic mushrooms, disparities emerge on two levels: (1) mushrooms were not the raison d'etre of Mayan culture (then again, neither were jade or brilliant trogon plumage); and (2) an underlying premise of the Transcendental Interaction Model (suggested by Dobkin de Rios [1976, 1974] and by Dobkin de Rios & Smith [1976]) is that "every household" did not have access to ceremonial plants. An ordinary Mayan family probably had about as much access to sacred mushrooms as an ordinary family today has to a Catholic priest's holy waters. In elemental form, Rathje states that economic interaction (trade) was vital to meet the ancient Maya's subsistence demands, and that this presumed interaction caused Classic civilization to flower.

The point is, mushrooms were not consumed for nourishment nor for anything so basic as physiologic survival and well-being. Wright (1974) makes it clear that other items exist and are traded as symbols of wealth or status and prestige. The procurement and distribution of mushrooms, then, was not motivated by "basic necessity" factors of the kind Rathje proposed, because mushrooms were never in the same category as igneous stone, salt and obsidian. Mushrooms, like other elitist ritual items, and unlike "basic resources useful to every household," were never prerequisites of cultural parturition. Other noneconomic motivations to trade must be discussed.

A subliminal noneconomic motivation to trade mushrooms and/or other psychoactive substances comes from a thought in Andrew Weil's book *The Natural Mind* that applies to Rathje's scheme. Weil's intriguing hypothesis is that psychoactive plants are ingested out of human subconscious urges to alter normal waking perceptions.[5] Weil (1972: 17) argues against economic and sociocultural motivations and conditioning to procure drugs: "The desire to alter consciousness periodically is an innate, normal drive analogous to hunger or the sexual drive." Furst (1976: 7) endorses this as a sound cross-cultural hypothesis, yet cautions that "for the present it must rest on circumstantial evidence."

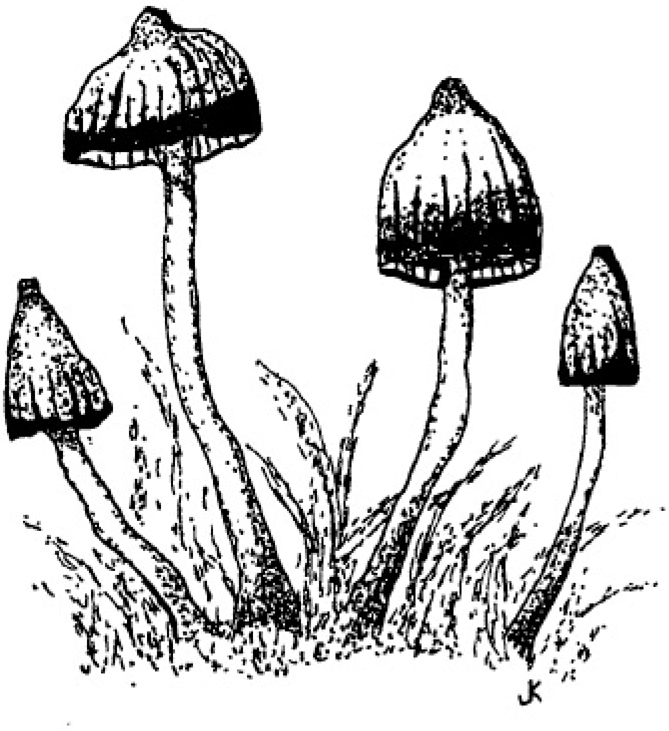
Examining Weil's hypothesis using Rathje's model, the pursuit of mushrooms with specific mind-altering tryptamines can be argued to be an inborn biological drive of the Mayan psyche to satiate certain *basic* psychological (primal) needs; just as the procurement of igneous stone, salt and obsidian was indispensable to the *basic* physical (elemental) needs of a civilization to develop. Although such an argument is highly abstract, Weil's ideas conveniently and logically relate the procurement and utilization of certain local and nonlocal mushrooms (Transcendental Interaction Model) to the procurement and utilization of certain basic resources (Core Area - Buffer Zone Model), in that the procurement and utilization of all four items (salt, stone, obsidian and mushrooms) conceivably can be viewed as an innate response/action to meet requirements of physical and neurophysiologies well-being.

Another noneconomic motivation for trading mushrooms was sheer necessity, born from religious fanaticism and from ritual infatuation which governed vast aspects of quotidian Mayan life. Mushrooms were integral to ceremonies that functioned to contact spirits and seek extramundane knowledge. The plentiful species, valued for different perceptual effects, "acquired a deep and controlling significance in almost every aspect of life" (Schultes 1976: 56). The priests' divinatory enactments, curing ceremonies and other rites geared toward impressing the populace by performing suprahuman feats were ineffectual without transgressing prosaic normal awareness. Potent mushrooms were as indispensable and irreplaceable in certain ceremonies as were choice quetzal bird feathers and priceless jade in others. No ersatz commodities were substituted. If priests could not gain access to suitable ritual mushrooms, other recourses existed for transcendence.

Schultes (1976: 65) comments how different species of mushrooms are utilized owing to "personal preferences" or to a specific "purpose of the use." Schultes and Hofmann (1979: 147-148) also assert that seasonal and regional availability influence choice of mushroom. True, these writers are not discussing trade and economics, but their ethnobotanical statements, per se, do support the possibilities of organized exchange to meet the supplies and demands of personal preferences, specific purposes, and seasonal and regional availability. What does personal preference relate to if not to the tremendous selection in Mesoamerica of psilocin- and psilocybin-containing mushrooms which produce quite different physical, emotional and psychopharmacologic responses.[6] In other words, in the field, one may not expect to find the same assortment of species employed at one time because different mushrooms grow in different places, and also because priests and shamans desired *variation*. Alternative states of perception appealed to priests and shamans who performed different symbolic roles in society; such as healing, predicting eclipses and divining weather for crops, looking into the past and future, and communicating with the gods and spirits.

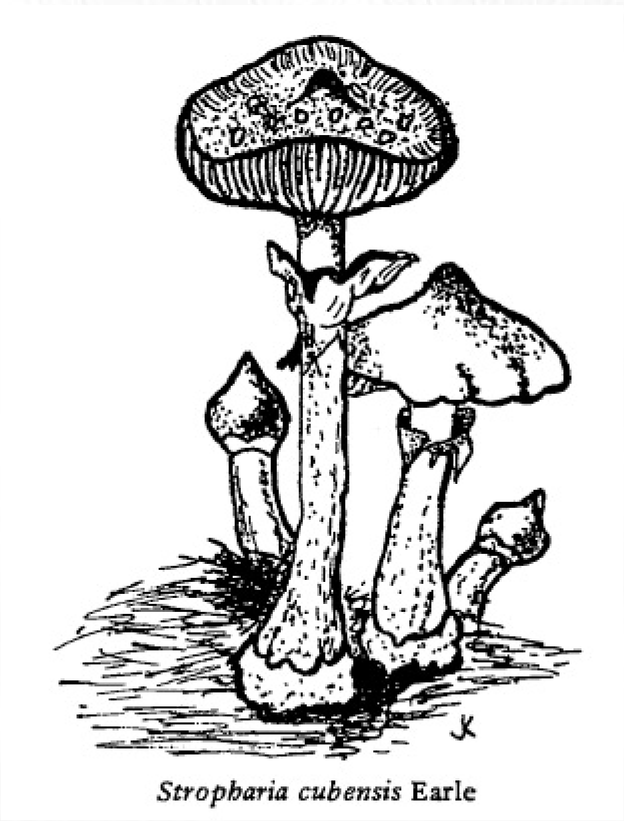
Another question is, how would the priests' choice of mushroom be decided; and why would one species be valued over another; and is it even true to assume that priests would have used diverse species? According to Schultes and Hofmann (1979: 52), modern-day shamans certainly enjoy variation: "Its use [*Panaeolus sphinctrinus*] by Oaxacan Indians along with so many other mushroom species demonstrates the tendency among shamans to use a surprisingly wide range of different mushrooms." An ethnobotanical look at the fungi is worthwhile.

Psilocybe mexicana and *Stropharia cubensis* are two of the most coveted mushrooms in Mexico. Presumably, their spores of popularity germinated in prehistoric eras. The effects of *S. cubensis* are stronger. Between four to eight mg of its juice incite phrenetic gesticulations and afford brilliant, phantasmagoric images quite in contrast to the gentle, subtle and lucid visual undulations of *Psilocybe mexicana* (e.g., Furst 1976: 87). *S. cubensis* possibly, was a likely candidate for the priest interested in utterly transcending mundane surroundings to achieve instantaneous, perhaps mindless godhead. *Psilocybe mexicana*, on the other hand, was possibly reserved for less demanding ceremonies and enactments, where intense overpowering hallucinations, poor motor control and jumbled thinking would have impeded a rational and discerning equilibrium.



Psilocybe mexicana

Psilocybe mexicana
After Schultes & Hofmann 1979: 144-145.

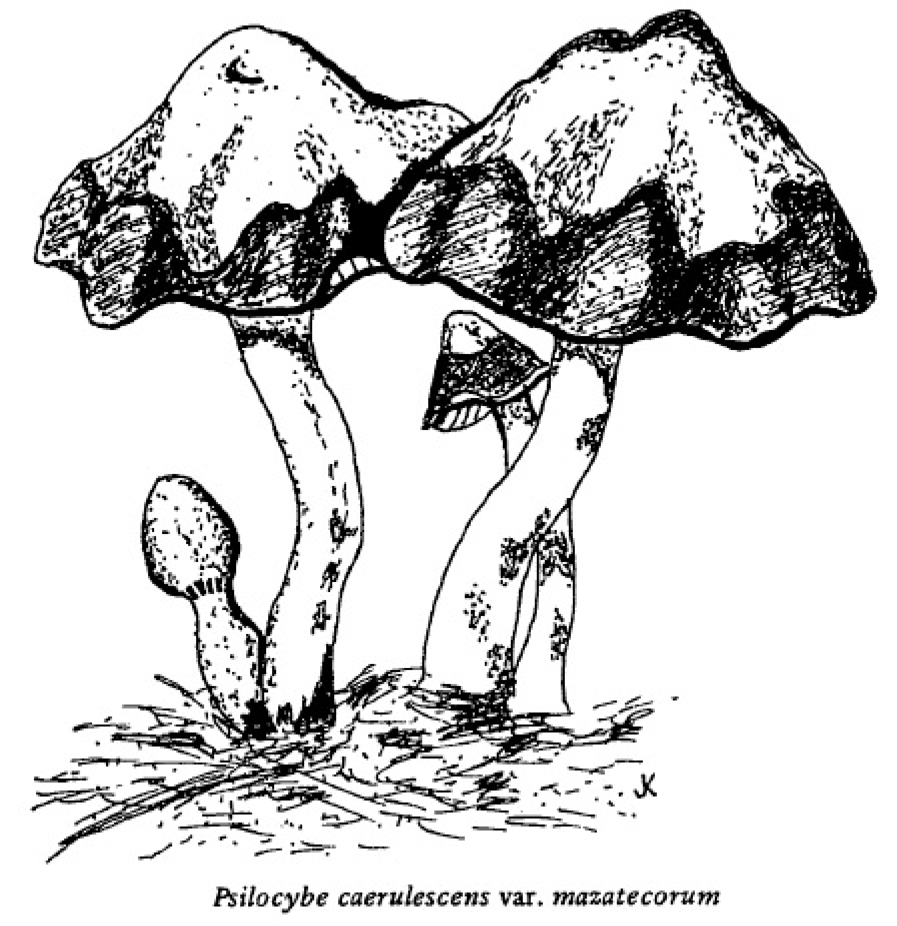


Stropharia cubensis Earle
After Schultes & Hofmann 1979: 144-145.

Stropharia cubensis and *Psilocybe mexicana* are but two of at least 24 botanically categorized and chemically studied hallucinogenic mushrooms exploited in Mexico alone (Schultes & Hofmann 1979: 27).[7] Native names are often indicative of apperceived inherent powers and qualities (Schultes 1976: 65). Etymologies may be traced to pre-Cortes times. *Psilocybe caerulenscens* var. *nigripes* has as a mythological epithet, "mushroom of superior reason." Could it be that this name came about as a result of this particular mushroom's reputation for imparting insightful, intellectual visions? Priests who predicted the future or studied metaphysical relationships between celestial bodies and human existence - arcane tasks demanding accuracy and convincing results - might logically have turned to *nigripes* for superior reason. Other examples of names suggesting idiosyncratic preferences include: *Psilocybe aztecorum*, "children of the waters"; *Psilocybe zapotecorum*, "crown of thorns" mushroom; and *Psilocybe semperviva* the "always alive" mushroom for the ever-active priest. Dated sixteenth and seventeenth century Quiche and Cakchiquel dictionaries also are a source of etymologic clues relating psychedelic fungi to prehistoric culture. The Quiche word *xibalbaj okox* means "mushroom of the underworld" - the nether kingdom where dwelt the Nine Lords as described in the sacred Popol Vuh of the Quiche Maya (Furst 1976: 79).

Was the ritual of mushroom ingestion widespread at a folk level? If so, the idea of everyone having access to unlimited quantities of mushrooms conflicts with and contradicts the idea of mushrooms as controlled commodities in limited access contexts. Perhaps incipiently, folk peoples utilized sacred fungi to facilitate and enhance supernatural contacts, but through time, as seen in Aztec imperial society, divine plants were usurped "for priests, nobility, and special guests of the empire" (Dobkin de Rios 1976: 41). With mushrooms abounding everywhere, a priestly litany of respect and fear kept the average person from picking them; so ultimately they could be used by specialists for "distinctive social goals" (Dobkin de Rios 1976: 41).

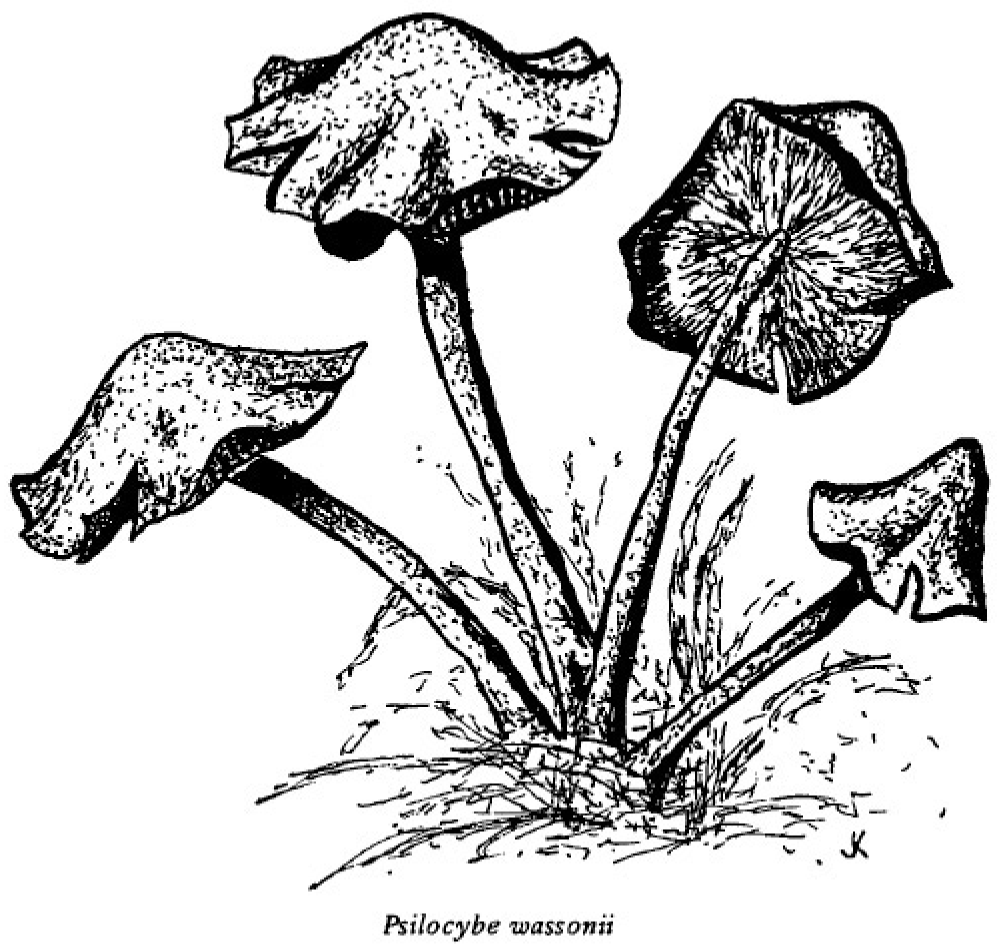
A final question is, what would be the purpose of organizing mushroom procurement and distribution into a regulated network with many sociopolitical and religious ramifications? An overriding motivation to trade mushrooms in a noneconomic context undoubtedly lies in limited access to various species of mushrooms. This implies an abundant product of nature, constantly in demand but not always available fresh, and controlled by elites for the purpose of maintaining them in power. Although Dobkin de Rios (1974: 162) admits she quite possibly overstated her case, in a tightly regulated and controlled trade network her insights into mushrooms being "usurped by hieratic functionaries" (1974: 151) to maintain "legitimate power" are intriguing and make logical, legitimate sense.



Psilocybe caerulescens var. *mazatecorum*
After Schultes & Hofmann 1979: 144-145.

The priest with sacred plant power at his disposal could leave the mundane world, communicate with gods and spirits, fight demons and malefactors, and report back to his people unharmed and tenfold wiser. Such a personage would command utmost awe and respect. He would be a demigod, an interloper between mortals and deities. The prestige and power awarded to mushroomeating hierophants in Mayan society were status indicators of their commitments to perpetuate cultural traditions, maintain social values and ideals, and to seek *beyond* to unravel existential secrets. Only someone in a position of representing the people, however (someone like a high priest who was near totalitarian in power and influence), could experience the visions and contact the deific forces residing in the plants. Dobkin de Rios and Smith (1976: 264-265) remark: "Psychotropic plants ... are denied to commoners ... access to the plants became part of a reward system ... the Maya restricted psychoactive flora ... restrictions of drug use helped maintain the elite in power." Furst (1974: 154), on the other hand, rebukes this notion: "There is no evidence for a 'usurpation' of any of the hallucinogens employed in Mesoamerica by a priestly elite." Furst is right: there is no evidence for it, but there is also no evidence against it, save for Furst's words. Certainly, there were pleasure-god seekers who ingested mushrooms clandestinely, against the Sacred Order of Mushroom Awareness, but the vast majority of peasants was not iconoclastic. They must have respected or feared the priests' dicta that mushrooms were sacred repositories of divine power to be left alone at the risk of insanity, poisonous illness, weird and uncontrollable flights of the soul, and even death.[8] It should be remembered how Catholics the world over once faithfully abided by the Pope's decree not to eat meat on Fridays. Like mushrooms in the hills after a rain, meat abounded in supermarkets on Fridays, but no self-respecting Catholic bought it or ate it. Most likely, sacred mushrooms "would be reserved for magico-religious rites and would not become the object of hedonistic bouts of abandon" (Emboden 1979: XIV) by either priests or peasants.

Technically, it might be impossible to *deny* access to what grows wild, but apparently, for a while the peasants did anything their theocratic masters told them to do: witness the corvée erection of temples and courtyards into staggering ceremonial centers; the clearing of the land; the irrigation projects; and the toiling in the fields. It is not far-fetched to imagine priests telling peasants to stay away from sacred mushrooms, and the latter obeying. Furst, though, claims that "not even the police power of the modern state has been able to stop widespread recourse to forbidden substances" (1974: 154). Is one to believe, therefore, that no matter what fiats the theocrats issued, the peasants ate mushrooms? Furst fails to see two main distinctions between police power of the modern state and the politicoreligious power of the Mayan "loose federation of autonomous city states" (Thompson 1966: 97). One distinction is that police power in the modern state is not remotely derived from the powers believed by aboriginal peoples to reside in certain sacred biodynamic plants, and is in no way contingent upon their usurpation or monopoly in order to retain or maintain power.[9] Secondly, Schultes and Hofmann (1979: 61) note a big difference between using "forbidden substances" today and in preindustrial societies where "plants are gifts of the gods, if not the gods themselves. It is obvious that our culture does not view hallucinogenic plants in this light." If our culture did, then perhaps tighter restrictions and controls would be placed on the use of such potentially power-laden artifacts.



Psilocybe wassonii
After Schultes & Hofmann 1979: 144-145.

The priest who ingested sacred plants became one with the spirit in them. Transforming into an entity dedicated to reifying culture, not escaping from it (Furst 1976: 16), priests had little problem bringing peasants under their tow of politico-spiritual persuasion. Priests were seen as honorable, benevolent people worthy of extreme obeisance. Peasants accepted the absolute prestige and ultimate power of their priest-gods.[10] Additionally, the mushroom eater in Mayan society could accrue prestige and wield inordinate power because of the magical endowments of mushrooms. Under the influence of *Psilocybe mexicana*, *Psilocybe hoogshagenii*, *Stropharia cubensis* or any number of potentially psychoactive fungi, priests could generate enormous power and respect in their roles. They could stage spectacular events for the peasantry, who could consequently only regard their theocratic leaders as suprahuman individuals on whom they bestowed rare apotheosis.

Psychoactive mushrooms were potent instruments of transubstantiation in Mayan religion and ritual. They were social mechanisms for gaining power and accruing prestige, and they also served as "holy mediators between man and his gods" (Schultes 1976: 7).

Mushrooms as local and nonlocal items of trade

Thus far, the desired magical and sacred qualities of species of four genera of psychoactive mushrooms have been discussed in social and politico-religious contexts. Also, some noneconomic, infrastructural functional motivations for trading these various species have been discussed. Furthermore, the psychopharmacologic significance of hallucinogenic mushrooms vis-à-vis certain social imports has been underscored to show how such imports (power, status, honorability and prestige) resulted from exclusive indulgence in the plants, as well as to show how a trade network perforce would have evolved to meet supplies and demands for *variable* altered states of consciousness desired by Mayan priests. The accruement of social imports in trade situations falls under the rubric of "emulation" and complements this author's idea of trade, in that it "brings exotic prestige artifacts which confer status on those individuals controlling the supply" (Renfrew 1975: 33).

The ritual use and importance of hallucinogenic mushrooms, a fundamental premise of the Transcendental Interaction Model, was more extensive and intensive in prehistory than in modern times. It should be remembered what the conquistadors did on learning of the "despised and feared form of plant life." In zealous campaigns of conversion and witch hunting, they forced shamans devoted to divine inebriants to conduct their pagan rites in the hinterlands. A few "refugee" peoples have managed to employ the sacramental plant up to the present day, but the ubiquity and fanaticism of the "mycophobic" Spaniards proved too overwhelming for most of the drug using, persecuted Indians. As Schultes and Hofmann, Mayer, and Furst have noted, at least from 24 to perhaps 57 different species are sought after in postconquest Mexico for important rituals. Was even more variation available before the cultural eradications of 1521 through the present?

Presuming the most ideal conditions of a world view structured on the visions of hallucinogenic mushrooms, one envisions, in ancient times, a desired commodity with variably acting psychoactive alkaloids existing in dispersed abundance. These countless species of mushrooms were in as much demand among priests as was new and shiny obsidian among toolmakers, and rare, bedazzling plumage among elitist artisans. There was no shortage of variation either: the mushrooms' individualized psychopharmacologic natures made them nonhomogenous products; ergo, *exotic* to priests in different regions. Different species do occur at different places; from dead tree trunks and wet pasturelands to marshlands and decaying plant material (Emboden 1979: 89). These various, sporadically appearing mushrooms with their variable powers of perceptual enhancement created demands by priests to partake of more than just their few locally occurring varieties, which were limited as ritual, transcendent paraphernalia. Perhaps dozens of psilocin- and psilocybin-containing mushrooms existed and were used by the Maya and other peoples. Perhaps they still exist and have yet to be discovered.[11] Schultes and Hofmann (1979: 148) are optimistic about this: "The probability that more species will be found in use is far from remote." The number of species in use before 1521 might have been phenomenal.

Is it foolhardy to think of priestly elites trading back and forth this revered "plant of the gods"? Local and long distance trade of revered artifacts is evident in early cultures of Mesoamerica. Thin orange pottery from Monte Albán and Teotihuacán is found at Kaminaljuyú; glazed plumbate wares with Mexican deities occur commonly at Maya components; salt was brought in from afar; and renowned eccentric flints, which perhaps originated in Guerrero or western Mexico. Dobkin de Rios (1974: 148) conjectures that "trade in psychotropic substances may have occurred" in contiguous areas.

Further convincing evidence for the trading of revered hallucinogenic artifacts is found in the appearance of an anthropormorphic gold "Darien pectoral" from Panama or Colombia at Chichén Itzá in Yucatán. Schultes and Bright (1979) arrive at the "inescapable conclusion" that these curious objects (over 150 exist in the Museo del Oro in Bogotá) represent the "religious use in prehispanic Colombia of intoxicating mushrooms." According to these two authors, and a number of other scholars, hallucinogenic mushrooms figured prominently in magico-religious rituals of aboriginal peoples all over the New World, including as far north as Canada and as far south as the Andes of Peru. Gold mushroom effigy pectorals, such as the one found at Chichén Itzá, along with mushroom stones, clay artifacts and stylizations on pottery were most probably items of long-distance exchange among members of prehistoric hallucinogenic-using cultures where artifacts were revered by shamans and priests as objects of deific, magico-religious devotion to mushroom spirits. The potential of real psychotropic fungi having made similar long-distance trips as items of exchange cannot be down-played. The genus *Psilocybe*, valued in Mesoamerica for species-variable psychoactive experiences, is also abundant in lower Central America and Colombia, with as many as 30 species reported (Schultes & Bright 1979: 121). Quite possibly dozens of species of *Psilocybe* mushrooms were traded back and forth throughout the ancient Americas.

If the question is still, "Why trade mushrooms?"; then, one ought to now presume the most inauspicious conditions and circumstances in ancient times *against* setting up a trade system to procure and distribute desired variations of hallucinogenic mushrooms. Could not Mayan priests simply pick the local fungi they wanted at the moment? And then, would not a handful of local varieties satisfy demands for different hallucinatory (spiritual) experiences? The quality of local fungi probably did not meet demands for *variable altered states*, since many different kinds of mushrooms were needed; depending on current states of mind, types and purposes of ceremonies, and seasonal and regional availabilities. Furthermore, Mayan priests probably were not likely to go mushroom foraging in the wilderness. Other people, minions and devotees of the priests, collected and traded mushrooms as psychoactive variations of a desired transcendent state. Mushrooms were traded locally and even as far away, perhaps, as central and western Mexico and southern Central America.

Long-distance exchange of hallucinogenic plants is entirely plausible, as demonstrated by the diffusion of peyote cacti (*Lophophora williamsii*) "far beyond the natural range of the plant into the United States and Canada, where Indians receive 'mescal buttons' by purchase from native Americans residing in Texas" (Schultes & Hofmann 1979: 134). Another contemporary line of evidence for ancient roots in the trade of psychoactive substances in Guatemala was supplied by mycologist B. Lowy (1977: 124), who reported that a local trade of psilocybin mushrooms was flourishing. Children were harvesting the fungi and were "offering them for sale to a clientele who traveled considerable distances to make their purchases."

Does the question, "Why trade mushrooms?" still exist? Why engage in formal exchange when so many species abounded? The following is a list of some of the known hallucinogenic mushrooms found in Mexico and Guatemala:

Psilocybe acutissima
Psilocybe aztecorum
Psilocybe caerulescens var. *mazatecorum, nigripes, albida, ombrophila*
Psilocybe cordispora
Psilocybe fagicola
Psilocybe hoogshagenii
Psilocybe mexicana
Psilocybe mixaeensis
Psilocybe semperviva
Psilocybe wassonii
Psilocybe muliercula
Psilocybe yungensis
Psilocybe zapotecorum var. *elongata*
Psilocybe candidipes
Psilocybe caerulipes var. *gastonii*
Psilocybe isauri
Conocybe siligineoides
Stropharia cubensis
Panaeolus sphinctrinus
Panaeolus fimicola
Amanita muscaria

Besides these, other nonhallucinogenic mushrooms existed and were ritually consumed for divinatory purposes owing to peculiar, suggestive shapes; among them, *Cordyceps capitata*, *Elapbomyces granulatus*, *Dietyophora phalloidea* and two others, *Clavaria truncata* and *Nevrophyllum floccosum* (always in association with *Psilocybe wassonii* [Wasson 1978: 82]). And what of the many poisonous varieties which are capable of altering awareness? Weil (1980: 47) asserts that one can select over a wide range of toxicity and derive pleasurable and satisfying visionary experiences. This opens up a virtually infinite supply of mushrooms and a demand for their variable alternative states.

The big question - the grand test of the viability of this reasoning - is whether or not all the mushrooms listed above occur locally and in equal distribution. If they do, then so much for local and nonlocal exchange of psychoactive mushrooms in the Transcendental Interaction Model. Schultes and Hofmann (1979: 147) point out, however, that it is just the opposite: "There may be years when one or more species are rare or absent - they vary in their distribution and are not ubiquitous." For example, there is definite limited access, intraregionally, to the species *Psilocybe aztecorum* and *Psilocybe mexicana*. The former grow only on the volcano, Mt. Popocatepetl; and the latter grow only above altitudes of 1,375 to 1,675 m (Schultes & Hofmann 1979: 151).[12] Limited access to these and other mushrooms, including local varieties, provided a rationalization to devise an exchange system managed by elitist priests and their cohorts involving the transfer and flow of the commodity among priests of all areas of Mesoamerica. Stone carvings indicate that some individuals, possibly traders, were at Kaminaljuyú. Who is to say what they might have brought with them and were taking back to Teotihuacán and elsewhere? Polanyi's (1975: 136) criteria of trade, which must involve personnel, goods, carrying and two-sidedness, are met sufficiently in the context of ancient Mayas and other contiguous culture groups reciprocally exchanging psychotropic mushrooms.

Mushroom exchange must be seen as intensive and intraregional. However, the idea of *local exchange* of mushrooms, which this author advocates along with distant exchange, conflicts with Rathje's idea of trade in a rainforest environment, in which he claims that all local exchange would be absent because of "ecological redundancy." This may hold true for most products exploited in a redundant milieu, where no need or exigency arises to trade them, but hallucinogenic mushrooms were exchanged locally and distantly because they were not a redundant product. Their individual protean visionary powers were avidly prized by priests.

If mushrooms were available locally, Polanyi's (1975: 136) definition of trade as a "method of acquiring goods that are not available on the spot" conflicts with a basic premise of the Transcendental Interaction Model. Mushrooms were available "on the spot" for the Maya, but mushrooms of one area may have afforded different visual experiences from those of a contiguous area; or some from a land beyond may have been desired because they affected motor movements and coordination; while others which might have occurred in a ubiquitous habitat may not have even been available owing to rainfall variations, perhaps, or to a decrease in the local deer population and the necessary excrement on which certain species grow. For these reasons, as well as the individual preferences of Mayan holy men, the supply in one area did not necessarily meet the demands of that area.

Renfrew's Law of Monotonic Decrement (1977: 85) states that some places "will receive less of a commodity than its neighbors nearer to the source." This is true in the context of the Transcendental Interaction Model, only in as much as it was a variation of a specific commodity and not the commodity itself which decreased in frequency the farther one got away from the source of a desired species of mushroom for a particular enactment. In other words, all priests had access to mushrooms (the commodity), but the desired variation of the commodity may sometimes have been absent or disproportionate because of distance, weather, idiosyncratic preferences and other related factors. Trading for goods that are not available on the spot (for example, different species of variably acting mushrooms) would evolve logically and inevitably into an activity of extensive/intensive transference of a commodity in demand because of desired variations in visionary experience. Dobkin de Rios (1976: 73), citing R. Blum, notes that the "more complex the society the more [one] can anticipate internal variety in drug use." Schultes and Hofmann (1979: 52) indicate the variation that shamans and priests desired.

According to Polanyi (1975: 144), the basis of procurement depends on the exigency of the products as functional and desired items in society; and also on the "difficulty of acquiring and transporting" the products. What sorts of problems, if any, might Mayan harvesters and traders have encountered in acquiring and transporting a rapidly perishable product like psilocybin mushrooms? Would they still be valued in a state of putrefaction? If serving rotten and foul-smelling mushrooms on the altar/platter of a ritual enactment was blasphemous, no priest would have settled for anything but fine mushrooms. But if mushrooms pop up and die as ephemeral creations of nature, how could supplies and demands possibly have been met?

Agaricaceae and Strophariaceae plants do not have to be immediately transported or consumed. They may instead be preserved; and ingestion of a dried form was common. The *manos* and *metates* found in conjunction with mushroom stones, together with certain mural depictions and wide-ranging ethnographic parallels, all suggest this. Artificial dessication, however, has a tendency to alter the taste and potency of the product.

Freshly picked mushrooms yield a psilocin and psilocybin content of about 0.03% of total weight, while dried specimens have a more concentrated 0.3% of the psychoactive principles (Schultes & Hofmann 1979: 23), since the weight of water and other organic matter evaporates. Although the alkaloids in mushrooms appear not to be water soluble, the amount of psilocin and psilocybin in fresh and dried mushrooms is not constant. Generally, the drier the specimen, the less potent it is. If many priests were using dried material, they would have needed regular and reliable access to more mushrooms than required when eaten fresh. If the percentages above *are* somewhat constant, dried mushrooms still might have been preferable since the bulk weight of ingestion would be reduced ten times. The alternate state of consciousness induced by dried specimens still was highly valued by priests looking for the "overall desirable qualities" mushrooms afforded. Also, by drying the product and preserving it for later dissemination, supplies could be met in areas where certain mushrooms were out of season, exceedingly rare or nonexistent.

The mushroom trade model conforms to Polanyi's view of trade: goods were available and obtainable locally and nonlocally; they were exploitable on the spot, in several hours or days later; and the only discernible defects in the product were altered taste and reduced potency. The reduced potency, however, implies a scarcity of a more powerful variable product, and therefore a staging ground for an ideal market in which large supplies of *ritual brand* dried mushrooms were exchanged.

Mushrooms as culturally integrative pharmacopoeia

The Transcendental Interaction Model derives cogency and unity from supporting research and comments by numerous scholars pursuing eclectic information.[13] The documentation by botanists, chemists, anthropologists, medical doctors, archaeologists and mycologists of the importance of hallucinogenic mushrooms in preliterate societies affords comfortable margins in extrapolating their pervasive role in prehistory.[3] A contingent argument of the model is that ritual/hallucinogenic/transcendent/curative and other ceremonies were much more pervasive and important in autochthonous cultural tradition before the arrival of Europeans in the early sixteenth century; and considering the zealous and phobic way the Spaniards set about denouncing and expunging hallucinogenic practices among Middle American cultures 450 years ago, it is astonishing that any practices at all involving transcendental ritual have survived the inquisitorial centuries.

Up to now, the model has been mainly concerned with noneconomic reasons for the reciprocality of exchanging variable fresh and preserved supplies of *necessary* hallucinogenic mushrooms. It is important now to consider plausible mechanisms and systems of the hypothetical mushroom exchange network. What was its structure? What groups or people traded and controlled mushrooms and toward what social, political and religious ends? How did mushroom trade figure in to an overall cultural matrix of events and relationships? The focus of the first part of this section is on reciprocity.

Many ritual artifacts were reciprocally traded by the ancient Maya, and the subliminal implications of this particular *style* of trade for the elites of society who made it work, enhance the idea of mushroom exchange. Wright's (1974) statement that "trade facilitates the exchange of ideas as well as of material commodities," synthesizes quite nicely the point that no matter how important sacred mushrooms were as material ritual items, they were equally important as sources of new ideas, insight and cultural input. Mushrooms may have been de facto items of exchange, but that aspect was only half the purpose - the overt half of what was being traded. Acquiring mushrooms and trading them locally and nonlocally created social bonds, or an interaction sphere wherein thoughts could be shared, information relayed and friendly relations stabilized.

Using Sahlins's (1972: 194) threefold classification scheme, a "balanced" system of reciprocal mushroom exchange wins out over "negative" and "generalized" systems (and over any other mode of substance exchange) because balanced reciprocity "refers to direct exchange." Additionally, Sahlins (1972: 195) believes that direct exchanges are socially and economically advantageous because they "stipulate returns of commensurate worth or utility."[14] Thus, Party A, dealing in mushrooms, might not have reciprocally received from Party B the equivalent in psychoactive material, even though Party A might have been in the market for a variation of that necessity. Direct exchanges, then, might have involved mushrooms for jade, quetzal bird feathers or aesthetic polychrome wares, since these and other commodities in ancient Mayan society represented exotic ritual returns of commensurate worth and utility. In one way or another, status, prestige and power were derived from or were affiliated with each item mentioned above.

Sahlins points out the relative unimportance of the actual trade item by stressing the importance of egalitarianism in trade. When trade takes place as an "equitable exchange of different necessities" (Sahlins 1972: 220), the result is social harmony and well-being. Hallucinogenic fungi as items of exchange in prehistoric Mayan society may have played a role in structuring relationships. If five sacks of *Psilocybe yungensis* were traded for two sacks of *Stropharia cubensis*, or if three lapidary objects of exquisite jadeite were traded for a beautiful *eccentric* flint, it would be egalitarian reciprocity. Now, what if Party A attempted to upset the harmonious balance of exchange by offering inferior mushrooms for superior ones, or fool's jade for the finest obsidian blades? Would not relations among groups of people become soured and disrupted by *inequitable* exchanges of different necessities? The procurement and distribution of essentials often leads to conflict in exploiting and trading them. Consider, for example, the possibility of a shortage of mushrooms, for whatever reason. If religious and political power went hand in hand, as they did in the defunct theocratic civilization, imagine the ramifications if priests in certain areas were deprived of locally occurring varieties of hallucinogenic mushrooms - the all-important artifacts of power and prestige. Or, better yet, imagine the ramifications if priests - certain disliked, recreant ones - were *purposely* deprived of locally *and* nonlocally occurring mushrooms by a power coalition of elitist priests. Is politico-religious dependence so far-fetched? Although no single Mayan site is believed to have been more powerful or influential than another, Culbert (1974: 74) demonstrates the existence toward Late Classic times of regional states. Bird Jaguar and Jeweled Skull were two powerful leaders who vied for politico-religious prominence. Can the satellite relationships between certain smaller and larger ceremonial centers, and between some Mayan centers and distant cultures like Teotihuacán or Monte Albán, be interpreted as politico-religious dependence? Or, at least, can it be politico-religious control owing to asymmetry of resource flow?

Trade as balanced reciprocity gave Mayan priests an inexhaustible supply of dried and fresh mushrooms from all over Mesoamerica.[15] In idealized form, balanced reciprocity always ensured a continual flow and influx of essential, desirable commodities. Concomitantly, and perhaps more importantly, ideas were exchanged and relations among the politically polarized but culturally knit Maya (Weaver 1972: 154) were affirmed and enhanced.

Mushrooms as ethnobotanical reality

The Transcendental Interaction Model is viable because it is in harmony with what knowledge is available on contemporary and extinct societies, early trade patterns and presumed politico-religious importance of hallucinogenic substances in ancient cultures. Verifying the existence of exchange systems in prehistory is, for the most part, like trying to verify or divine something in the future. In either respect, clues and data are often nonexistent. Although it is permissible to concoct situations and theories which logically and conveniently meet Plog's (1977) most demanding conditions for verifying trade, hard physical evidence is lacking for a more rigorous analysis and therefore a more scientific treatment of his criteria.

The commodity of trade discussed in this article is a perishable one. So were textiles in most early cultures, and definitely in Mayan culture. But who is to say if they were or were not traded? Ritual mushroom worship has survived the ages only in the form of happenstance discoveries of sculptured stones and pictographic representations on walls and codices. There are historical chronicles relating the use and importance of psychoactive plants in preconquest cultures, bequeathed to Western knowledge by Spanish friars and Jesuits who reviled their deific powers as paganism, idolatry and insanity. There are also elusive and ambiguous ethnographic descriptions of some Mayan peoples in Chiapas conducting rites with hallucinogenic mushrooms, but no one has concretely documented the veracity of these reports from the 1970's. Otherwise, nothing relevant to paleomycologic studies exists. The trade analyst working with jade, obsidian or pottery at least has a modicum of the actual item exchanged, and thereby can run chemical characterizations and study it in precise detail to determine exact origins and learn more fully its functions and ritual nature. This cannot be done with centuries-old commodities that have been ritually consumed and only infrequently memorialized in stone, painted murals and in latter-day vestiges of preliterate ceremonials.

Besides serving as agents promoting social worth, value and respect of tradition, hallucinogenic plants have always figured in mystico-religious quests for power and knowledge in human cultures around the world. For millennia, they have been exploited, utilized and worshipped for their amazing properties to alter reality and create access to worlds beyond: to the "wilderness of mind," where one is able to "celebrate or contact the realm of the supernatural, to heal an illness, diagnose its cause, divine the future or to promote social solidarity ..." (Dobkin de Rios 1976: 73).

The Transcendental Interaction Model's primary contribution to ethnobotanical knowledge has been to place exploitation, utilization and worship of psychoactive mushrooms in a specific context. This trade model does not impute any etiologic significance in the rise and fall of Classic Mayan civilization. Rathje's hypothesis of procurement and distribution of essential daily requirements and what might occur in cases of massive deprivation is insightful and could be a correct assessment of what caused Mayan civilization to flower, and conversely, what effected its downfall.

In a class with several other psychoactive florae employed ceremonially by ancient priests and shamans in Mesoamerica, mushrooms assumed an integral role in the infrastructural continuity of Mayan religion and ritual; and not in the macrostructural continuation of Mayan civilization. A culture absolutely dependent on psychopharmacologic substances for its well-being and survival is extremely anomalous. No drug has ever been so all-important as to actually create or destroy a culture. No culture in recorded human history has ever been dependent on drugs for basic survival, even though a huge pharmacopoeia pervades all levels of ritual and traditional life.

Dobkin de Rios (1974: 162) remarks: "I do not wish to suggest that we can reduce all of Maya culture to a series of drug-induced input." For certain, this is not the point of her work in the field; nor is it the point of the Transcendental Interaction Model. Hallucinogenic mushroom consumption was only an aspect of a vast mosaic of drug and nondrug ritual activities of the Maya. Of course, it is folly to think of these aboriginal people as perpetually intoxicated on narcotic plants, and to attribute all creations and innovations in art and technology to their recondite powers. Still, because of profound drug use and abuse in modern society, it is unwise to lose sight of the importance and respect that sacred plants assumed in ancient societies.

The intention of this article has been to highlight a specific context in which ritual hallucinogenic mushroom procurement, utilization and worship can be placed in ancient Mayan society. For some, it may come as a welcome attempt to structure the use of mushrooms into a contextual framework and to deal in depth with a subject in Mayan ethnology whose importance has been underplayed too long. For others, years may pass before the Transcendental Interaction Model is firmly rooted in the ethnobotanical reality espoused by growing ranks of serious mycophiles.

Acknowledgments

The author would like to thank Marie E. Ceccanese for her input of ideas and wealth of humanistic anthropological common sense, and especially for her patience, support and courage; Oscar Chamberlain for his editorial skills and heuristic sensibilities; Dr. Haree Deutchman for legitimizing and endorsing the initial research proposal at Indiana University in the spring of 1979; Professor Marlene Dobkin de Rios for her contributions and refinements; Jan Kearney for her beautiful pen and ink renditions of mushrooms and mushroom stones; and R.C. Rosenbalm for an unremitting interest in the project.

Notes

1. Plog's "particular characteristics" cannot be avoided in a discussion of trade in ancient times. Besides not varying with investigative problems, "it is unlikely an investigator can accurately model exchange networks without attention to the characteristics" (Plog 1977: 129-130). Since Plog's approach is a technical aspect of the trade model, which mainly interests archaeologists, a specialized discussion of his variables as related to psychoactive mushrooms is not in order here. In any event, in archaeologic trade records - be the item of trade pottery, stone or jade - Plog's (1977: 128) query about "What should one try to learn of the organization of this network?" is difficult, if not impossible, to answer. Unless all the variables are satisfactorily accounted for, the documentation of trade should be presented as only a logical and viable extrapolation of conceivable events in prehistory.
2. Mayer (1977) blatantly contradicts himself on pages 3 and 5 by first saying that mycologist Bernard Lowy (1977) found *Psilocybe mexicana* in Guatemala, and then claiming an "apparent absence" and also that "none of these exist in Guatemala." Köhler (1976) is another who seems to believe that

psychoactive mushrooms are not found in Guatemala. A consensus of experts cited in the references of this article indicates otherwise.

3. No matter how traditional in application ethnographic analogies may be, they never directly reflect bygone cultural activity. To reconstruct past civilizations accurately, all data are needed: not merely a sprinkling of artifacts and ecofacts; not primarily epigraphic attempts to decipher baffling stone inscriptions; not chiefly ruined ceremonial centers and ancient middens and sumptuary tombs, but every minute datum. All the data are never amassable in any field or project, but the few data that are available provide for logical inferences and viable extrapolations or constructions (also, divinations [Thomas 1974]). Construction of possible mushroom connections does not connote the specious accuracy of detail and truth that *reconstruction* does, which should be dismissed as an archaeologic misnomer.
4. Peter T. Furst (1976: 172-173) speculates that certain species of mushrooms which grow only in cow manure in modern Mexico, and therefore unavailable in prebovine America, might have flourished anyway in the dung of another ruminant, the deer, which figured prominently in Amerindian aboriginal peoples' symbolic and mythopoeic concepts of nature and *nagual* animism. Furst connects the sixteenth century prohibition by Mazatecs against the killing of deer (and the meaning of their name, "People of the Deer") to an "easily observable relationship between deer and their [Mazatec] preferred sacred psychoactive mushroom."
5. Dr. Weil hastens to add that while reality altering is a desired, worthy and socially approved means of exploring beyond mundane consciousness, it can be achieved with or without the aid of psychoactive plants and animals. If trade routes were severed and all hierophants were suddenly deprived of consistent supplies of hallucinogenic mushrooms for ritual enactments, an absence or paucity of the commodity probably would have had little social and economic repercussion; for numerous recourses to altered states of reality existed. A disrupted trade network might just signal the end of a mushroom connection. Yet, with other trade items (for example, Rathje's basic necessities of salt, igneous stone and obsidian) an absence or paucity of the commodity might well have resulted in a calamitous breakdown of systems.
6. Set and setting (individual moods, cultural contexts, societal expectations and milieu) certainly modify the pharmacologic effects of a given substance in a particular ambience (Weil 1980: 3), notwithstanding different chemical reactions in the brain and central nervous system. It would be highly speculative to talk about perceptual alterations on a chemical level, but having diligently experimented with several species in varying dosages, and in identical and removed environments with and without the same people (both Western and non-Western), this author feels that at a subjective level it is safe to conclude that the central excitation of his nervous system was qualitatively altered under the influence of different and identical species of hallucinogenic mushrooms. That is, each psychoactive experience was found to be, for example, more intense, or less colorful, or more stupefying, or less physically demanding, or more insightful than another. Marijuana serves as a phytochemical parallel, even though it is a nonalkaloid plant. The two main species, *Cannabis sativa* and *C. indica* definitely exert different energies on the mind and body, owing to their varying concentrations of tetrahydrocannabinol (THC). Similarly, hallucinogenic mushrooms have different potency levels which affect psychoactivity. The indolic alkaloid content responsible for changes in brain chemistry varies from species to species between 0.2% and 0.6%, and less in dried specimens (Schultes & Hofmann 1979: 79). The auditory, visual, physical and gustatory effects achieved when one species is substituted for another are quite different in intensity and potency. This is the variation hierophants desired. Moreover, the differences in intensity and potency are noticeable even within identical species. Emboden (1979: 162; italics added) supports this view: "The psychopharmacology of mind-altering plants is so complex that *a single plant may have multiphasic effects* due to its chemistry or according to dosage."
7. Mayer (1977: 34) states that 35 different species of hallucinogenic mushrooms are registered in Mexico, yet he offers no taxonomic verification of their existence or provenience. Furst (1976) refers to an astonishing 57 species utilized, but offers no listing, either.
8. If priestly propaganda had peasants believing that insanity and death were the prices to be exacted for the recreational use of hallucinogenic mushrooms, how did the "usurping hieratic functionaries" get away with their copious indulgences of the fungi? The answer lies in *ritual*: transcendent ceremonial enactments staged and orchestrated by powerful elitist Mayan theologians. In this standardized set and setting context, Weil (1980: 57) notes that "ritual and ceremony work to minimize the potential of drugs to cause negative experiences."

9. Although police power is not derived from sacred psychoactive plants, consider a form of usurpation, monopoly and control in modern society of certain legal medicinals, crops (e.g., the growing and sale of hops) and drugs (caffeine, nicotine, alcohol, barbiturates, amphetamines, etc.) by conglomerate tobacco and alcohol industries and pharmaceutical companies. The tight controls and restrictions by big business and government serve the pecuniary interests of these elite medical and pharmaceutical professions: their wealth perpetuates power, and ultimately, corruption.
10. Did the *downtrodden* and *oppressed* peasants - forever dimly spotlighted against the flashy backdrop of Classic Maya culture - ever finally tire of their situation and rebel? Possibly toward Late Classic times, a period of decadence, corruption and infighting, masses of hungry and angry peasants were mobilized into insurrection. Popular campaigns against established orders in the process of decay and disintegration hardly ever fail, as witnessed again and again in historical parallels. If peasant Mayan farmers and slaves could have united under a leader in a front against their perceived elite oppressors, their undermining and sabotaging tactics, along with other deleterious events, might have contributed to a full-scale toppling of Mayan civilization.
11. Spotting the fruiting bodies of camouflaged fungi in native habitats is a tricky enterprise (Weil 1980: 60,77). If the model of mushroom trade is correct, perhaps experienced and reverent individuals were called on who developed a knack for finding and collecting wild specimens. Perhaps a breed of special, ritual harvesters existed in Mayan social structure to disclose the whereabouts - the econiches - of exotic, potent species of mushrooms. Perhaps a group akin to the elite *Pochteca* trader class of Aztec society existed. It is probable that the *Pochteca* handled all transferences of the northern desert peyote cactus; for Dobkin de Rios (1976: 36) states that "it was dried and transported several hundred miles to the south," to Aztec territory. Could a Mayan *Pochteca* have collected and distributed mushrooms all over Mesoamerica?
12. Lowy (1977: 124) has botanically identified *Psilocybe mexicana* as occurring in Guatemala. Previously known only in Mexico, the discovery of this agaric in southern Mesoamerica raises some questions. Has *Psilocybe mexicana* always grown locally in Guatemala? If so, its appearance to Western eyes after all these years demonstrates the lacuna in ethnobotanical lore. Or, were spores of *Psilocybe mexicana* introduced into Guatemala ages ago by traders from Mexico?
13. It should be emphasized that none of these scholars had as a research proposal the documentation of mushroom exchange networks in ancient Mesoamerica. The notion probably never even entered their minds, but their comments about related matters - personal preferences, seasonal and regional availabilities, chemical compositions, residential deities with power-giving qualities and hieratic usurpation of controlled substances - indirectly supported certain claims and premises of the Transcendental Interaction Model. This author does not feel that he has misrepresented words or taken ideas out of context, but rather, has formed an interpretation based on sound inferences and logical extrapolations.
14. It is possible that many trade items were purchased using cacao beans (genus *Theobroma*) as currency. Sacred mushrooms, though, might have been in a league by themselves. Schultes and Hofmann (1979: 148) report that in present-day Oaxaca, mushrooms are not sold in marketplaces, although it is possible that they are reciprocally exchanged. Contradictory to this, Lowy (1977: 124) reports observing mushrooms for sale. Presumed reciprocal exchange among the ancient Maya might have taken place in a secluded temple or perhaps in the privacy of a special off-limits place. In any case, mushrooms were not necessarily traded expressly for mushrooms.
15. If obliged to present *negative* evidence against mushroom exchange in prehistoric Mesoamerica, a basic question arises: Why were the Maya never attracted to peyote (genus *Lophophora*) or morning glories (genera *Turbina* and *Ipomoea*) for ritual enhancements? Aztec wizards combined and alternated a multiplicity of mind-altering plants in ceremonies, including the revered *Teonanacatl*, the mushroom "flesh of the gods." To argue that the cacti were nonlocal, remote commodities (hence, not available for procurement and distribution) is fruitless if the Transcendental Interaction Model has presented a faithful context of long-distance exchange of psychoactive plants. The Maya most likely knew about peyote from lore coming out of western and central Mexico, but evidently they were content with mushrooms and the amazing variety they offered. Besides, it is not as though the Maya restricted themselves to one drug. They also utilized the probably psychoactive water lily (genus *Nymphaea*), which is seen repeatedly in art motifs; and there is evidence that bufotenine from the common toad contributed to the psychoactive pharmacopoeia employed by the ancient Maya in rites and sacraments (Dobkin de Rios 1976: 45).

References

1. Gilbert, T.P. 1974. The Lost Civilization: The Story of the Classic Maya. New York: Harper & Row.
2. de Borhegyi, S.F. 1963. Pre-Columbian pottery mushroom stones from Mesoamerica. American Antiquity Vol. 28: 328-338.
3. de Borhegyi, S.F. 1961. Miniature mushroom stones from Guatemala. American Antiquity Vol. 26: 498-504
4. Dobkin de Rios, M 1976. *The Wilderness of Mind: Sacred Plants in Cross-cultural Perspective*. Sage Research Papers in the Social Sciences. Beverly Hills, California: Sage.
5. Dobkin de Rios, M 1974. The influence of psychoactive flora and fauna on Maya religion. *Current Anthropology* Vol. 2(15): 147-164.
6. Dobkin de Rios, M & Smith, D.E. 1976. Using or abusing? An anthropological approach to the study of psychoactive drugs. *Journal of Psychedelic Drugs* Vol. 8(3): 263-266.
7. Emboden, W.A 1979. *Narcotic Plants*. New York: Macmillan.
8. Furst, P.T. 1976. *Hallucinogens and Culture*. San Francisco: Chandler & Sharp.
9. Furst, P.T. 1974. Hallucinogens in pre-Colombian art. In: King, M.E. & Traylor, I.R. (Eds.). *Art and Environment in Native America*. Lubbock, Texas: Texas Tech Press.
10. Furst, P.T. 1972. *Flesh of the Gods: The Ritual Use of Hallucinogens*. New York: Praeger.
11. Kidder, A.V.; Jennings, J.D. & Shook, E.M 1946. *Excavations at Kaminaljuyú, Guatemala*. Washington, D.C: Carnegie Institute.
12. Köhler, U. 1976. Mushrooms, drugs, and potters: A new approach to the function of pre-Columbian Mesoamerican mushroom stones. *American Antiquity* Vol. 41: 145-153.
13. La Barre, W. 1970. To Find Our Life: *The Peyote Hunt of the Huichols of Mexico*. Film review. *American Anthropologist* Vol. 72(5): 1201.
14. Lowy, B. 1977. Hallucinogenic mushrooms in Guatemala. *Journal of Psychedelic Drugs* Vol. 9(2): 123-125.
15. Mayer, K.H. 1977. *The Mushroom Stones of Mesoamerica*. Vienna: Friends of Ethnology Society.
16. Parsons, L 1974. *Pre-Columbian America: The Art and Archaeology of South, Central, and Middle America*. Milwaukee: Milwaukee Public Museum.
17. Polanyi, K. 1975. Traders and trade. In: Sabloff, J.A & Lamberg-Karlovsky, CC (Eds.). *Ancient Civilization and Trade*. Albuquerque: University of New Mexico Press.
18. Pollock, S.H. 1975. The psilocybin mushroom pandemic. *Journal of Psychedelic Drugs* Vol. 7(1): 73-84.
19. Plog, F. 1977. Modeling economic exchange. In: Earle, T.K. & Ericson, J.E. (Eds.). *Exchange Systems in Prehistory*. New York: Academic Press.
20. Rathje, W.L. 1972. Praise the gods and pass the metates: A hypothesis of the development of lowland and rainforest civilization in Mesoamerica. In: Leone, MP. (Ed). *Contemporary Archaeology*. Carbondale: Southern Illinois University Press.
21. Reichel-Dolmatoff, G. 1971. *Amazonian Cosmos: The Sexual and Religious Symbolism of the Tukano Indians*. Chicago: University of Chicago Press.
22. Renfrew, C 1977. Alternate models for exchange and spatial distribution. In: Earle, T.K & Ericson, J.E. (Eds.). *Exchange Systems in Prehistory*. New York: Academic Press.
23. Renfrew, C 1975. Trade as action at a distance: Questions of integration and communication. In: Sabloff, J.A. & Lamberg-Karlovsky, CC (Eds.). *Ancient Civilization and Trade*. Albuquerque: University of New Mexico Press.
24. Sahlins, M 1972. *Stone Age Economics*. Chicago: Aldine-Atherton.
25. Schultes, R.E. 1978. Evolution of the identification of the sacred hallucinogenic mushrooms of Mexico. In: Ott, J. & Bigwood, J. (Eds.). *Teonanacatl Hallucinogenic Mushrooms of North America*. Seattle: Madrona.
26. Schultes, R.E. 1976. *Hallucinogenic Plants*. New York: Western.
27. Schultes, R.E. & Bright, A 1979. Ancient gold pectorals from Colombia: Mushroom effigies? *Botanical Museum Leaflets*, Harvard University Vol. 27(5-6): 113-141.
28. Schultes, R.E. & Hofmann, A. 1979. *Plants of the Gods: Origins of Hallucinogenic Use*. New York: McGraw-Hill.
29. Thomas, D.H. 1974. *Predicting the Past*. New York: Holt, Rinehart & Winston.
30. Thompson, J.S. 1966. *The Rise and Fall of Maya Civilization*. Norman: University of Oklahoma Press.
31. Wasson, R.G. 1978. The hallucinogenic fungi of Mexico: An inquiry into the origins of the religious idea among primitive peoples. In: Ott, J. & Bigwood, J. (Eds.). *Teonanacatl: Hallucinogenic Mushrooms of North America*. Seattle: Madrona.
32. Wasson, R.G. 1971. Notes on the present status of ololiuqui and the other hallucinogens of Mexico. In: Weil, G.M; Metzner, R. & Leary, T. (Eds.). *The Psychedelic Reader*. New York: Citadel.
33. Wasson, R.G. 1968. *Soma: Divine Mushroom of Immortality*. New York: Harcourt, Brace & World.
34. Weaver, MP. 1972. *The Aztecs, Maya, and Their Predecessors: Archaeology of Mesoamerica*. New York: Seminar Press.
35. Weil, AT. 1980. *The Marriage of the Sun and Moon: A Quest for Unity in Consciousness*. Boston: Houghton Mifflin.
36. Weil, AT. 1972. *The Natural Mind: A New Way of Looking at Drugs and the Higher Consciousness*. Boston: Houghton Mifflin.
37. Wright, G. 1974. *Archaeology and Trade*. Reading, Massachusetts: Addison-Wesley

Teonanacatl - The Narcotic Mushroom of the Aztecs[1]

by

Richard Evans Schultes

American Antropologist, vol. 42, pp. 429-443, 1940

Harvard University
Cambridge, Mass.

original source: http://www.samorini.it/doc1/alt_aut/sz/schultes_teo.pdf
backup source: http://www.psilosophy.info/resources/schultes_teo.pdf

I

Because of the important roles which they played in ceremonial and in daily life, the narcotic plants of ancient Mexico are of especial interest to the anthropologist. Mexico possessed and still possesses many plant narcotics and intoxicants, of which a few are outstanding in their uses and are extremely interesting because of their great antiquity as well as because of the important bearing their use, distribution and history may have on questions of a theoretical nature. Of the most notable, are the *toleselo* or *coral-berry* (*Sophora secundiflora* (Ort.) Lag. ex DC.), *ololiuhqui* or *piule* (Rivea corymbosa (L.) Hall. f.), *peyote* (*Lophophora williamsii* (Lem.) Coult.), and *teonanácatl* (*Paneolus campanulatus* L. var. *sphinctrinus* (Fr.) Bresadola).

Long the center of confusion and ambiguity, *teonanácatl* was not known botanically until very recently. Therefore, a thorough discussion of the ethnobotanical history of this narcotic mushroom should be made available to anthropologists in order that the erroneous interpretations now rather widespread in anthropological literature concerning *teonanácatl* may be corrected.

II

In his *Historia de las cosas de Nueva España*, Sahagun[2] recorded the earliest description of *teonanácatl* and discussed its narcotic and medicinal uses among the Mexican Indians of the period of the Spanish conquest. One of these references in a general consideration of useful plants, states that they (the Chichimecas) possessed a great knowledge of plants and roots, and they were acquainted with properties and virtues of them; these same people were first to discover and use the root which they called *peiotl*, and those who are accustomed to eat and drink them used them in place of wine; and they did the same with those which they call *nanacatl*, which are harmful mushrooms which intoxicate in the same way as wine...[3]

A more detailed description of the plant and its uses occurs in a chapter which deals specifically with narcotic plants:

> There are some small mushrooms in that region which are called *teonanácatl*; these grow under the grass (hay) of the fields and pastures. They are round, have a rather high stipe, slender and terete. When eaten, they have a bad taste, hurting the throat, and they cause intoxication. They are medicinal for few fevers and for rheumatism. Only two or three need to be eaten. Those who eat them see visions and feel a faintness of the heart. And they provoke to lust those who eat a number, or even a few, of them.

From Sahagun's reports (as well as from other early reports which are quoted below), it is absolutely clear that the narcotic which the Aztecs called *teonanácatl* was a mushroom. *Teonanácatl* has been identified with the dried tops of the peyote-cactus, *Lophophora williamsii* (mescal buttons) and this misidentification has been widely accepted in botanical and anthropological literature. For this reason, it is necessary to examine closely and evaluate all of the early reports concerning *teonanácatl* and its uses. In the first of the excerpts quoted above, Sahagun clearly distinguished between "the root which they call *peiotl*" and "*nanacatl*, which are harmful mushrooms." Likewise, in the chapter on plant narcotics, from which the second excerpt is taken, Sahagun discusses, in one paragraph, the "small mushrooms ... which are called *teonanácatl*" and, in another paragraph *peiotl*, the "earth-cactus."

There is another herb like the earth-tunas which is called *peiotl*. It is white and grows in the north. Those who eat it see terrifying and amusing visions. The intoxication persists for two or three days and then stops...

Still further assurance that *teonanácatl* was a fungus is found in a third reference to the narcotic in Sahagun's *Historia*:

> The first thing which they ate at the gathering was small, black mushrooms which they called *nanacatl*. These are intoxicating and cause visions to be seen and even provoke sensuousness. They ate these (mushrooms) before dawn, and they also drank chocolate before daylight. They ate these little mushrooms with honey and when they began to be excited by them, they began to dance, some singing, others weeping, for they were already intoxicated by the mushrooms. Some did not want to sing but sat down in their quarters and remained there as if in a meditative mood. Some saw themselves dying in a vision and wept, others saw themselves being eaten by a wild beast; others imagined that they were capturing prisoners in battle, that they were rich; that they possessed many slaves, that they had committed adultery and were to have their heads crushed for the offense, that they were guilty of a theft for which they were to be killed, and many other visions which they saw. When the intoxication from the little mushrooms had passed, they talked over among themselves the visions which they had seen.

In a chapter on mushrooms (*De las setas*), Sahagun used the term *nanacatl* to refer to mushrooms:

> The cone-shaped mushrooms (*nanacatl*) *genus campos agrorum* in the mountains are good to eat. They are cooked for this purpose...

Sahagun not only described *teonanácatl* as a mushroom, but the plant is figured in (Plate CI; Fig. 453a) the *Paso y Troncoso* edition of Sahagun's writings as a small mushroom growing in a grassy field.

In addition to Sahagun's direct statements that *teonanácatl* was a mushroom it is obvious from linguistic evidence that the term *nanacatl* refers to mushroom. *Teonanácatl* probably was the specific word for the intoxicating mushrooms, for it appears that *nanacatl* referred to mushrooms in general. In Mexico at the present time, mushrooms are called *nanacates*.

In his *Dictionnaire de la langue Nahuatl ou Mexicaine* Siméon analyzed general words which include the root *nanacatl* and clearly indicated the meaning of the term:

> *Nanacatl*, Champignon: *quauhtla-nanacatl*, champignon des bois; au. fig. *nanacatl nicte-ittitinemi* (Olm.), rendre quelqu'un pervers, lui donner de mauvais conseils. En comp.: *nonanac* ou *nonanacauh* (Olm.) mon champignon, R. *nacatl*?
>
> *Nacatl*, Chair, viande; ... nonac, ma viande, la chair que je mange.
>
> *Teonanácatl*, Espèce de petit champignon qui a mauvais goût, enivre, et cause des hallucinations; il est médicinal contre les fièvres et la goutte (Sah.) RR. *teotl*, *nanacatl*.
>
> *Teyhuinti*, Qui enivre quelqu'un, enivrant; *teyhuinti nanacatl*, champignon enivrant.

Further evidence can be derived from a definition of *teonanácatl* offered by Jourdanet and Siméon in their translation of Sahagun's *Historia*:

> (*Teonanácatl*) c'est a dire: champignon dangéreux. La terme générique est *nanacatl*, qui se met en composition avec d'autres mots pour designer les diverses espèces de champignons.

As further corroboration, the compounds used by Hernandez may be cited. By adding adjectival prefixes to a modification of the term *nanacatl*, Hernandez[4] described several types of mushrooms under the heading "*De nanacatl seu Fungorum genere*": *iztacnanacame* (white mushroom), *tlapalnanacame* (reddish mushroom), and *chimalnanacame* (yellow-orbicular mushroom). He described *teonanácatl* as *teyhuinti* or "intoxicating."

In his *Catálogo*, Garcida[5] called eleven species of *Agaricus*, one of *Hypophillum*, and two species of *Boletus*, all Oaxacan *Fungi*, by the common name *nanacatl*. This is certainly convincing evidence that the word still refers to mushrooms in modern Mexico.

In the works of Serna,[6] a very complete description of the use of "coloured mushrooms," *quatlannamacatl* as a narcotic for divination is found:

> And it so happened that an Indian had come ... bringing some of the coloured mushrooms which are gathered in the hills and, with these, he had performed a great idolatry. But before explaining this (idolatry) I wish to explain the nature of the said mushrooms which, in the Mexican language, are called *quatlannamacatl* ... these mushrooms were small and yellowish and to collect them, the priests and all men, appointed as ministers for these impostures, went to the hills and remained almost the whole night in sermonizing and in superstitious praying. At dawn, when a certain little breeze which they know began to blow, they would gather them (the mushrooms), attributing to them deity. They have the same effect as ololiuqui and peyote, for when they are eaten or drunk, they intoxicate, depriving those who partake of them of their senses and making them believe a thousand absurdities.

A further description of the use of narcotic mushrooms, *teunamacatlth*, is given by Benvento in Kingsborough[7] and by Orozco y Berra:[8]

> They had another kind of intoxication... which was induced by small toad-stools or mushrooms... which are eaten raw. Because of the bitter taste of these mushrooms, they drink after them or eat with them a little honey after which they shortly see a thousand visions, especially snakes. They went raving mad, and they ran about the streets wildly ... In their language they called these mushrooms *teunamacatlth*, a word which means "bread of the gods"...

The meaning of the word *teonanácatl* has been questioned recently by LaBarre,[9] who states that Benvento's etymology ("bread of the gods") is wrong. The acceptance of this etymology or a similar one ("flesh of the gods") is wide. Safford[10] accepted "flesh of the gods" as a correct translation of *teonanácatl*. Bancroft,[11] furthermore, writing of Nahuatl intoxicants, said:

> Among the ingredients used to make their drinks more intoxicating the most powerful was the *teonanácatl*, "flesh of the gods," a kind of mushroom which excited the passions and caused the partaker to see snakes and divers other visions.

In an unpublished manuscript,[12] V. A. Reko applies the meaning of "divine food of a soft or fleshy nature" to *teonanácatl*. According to usage reported to Siméon,[13] *nanacatl* refers to mushrooms in general, but Siméon suggests, with reservations, that the root of *nanacatl* may be *nacatl*, the word for "meat" or "flesh." According to Siméon, therefore, *teonanácatl* may mean "flash of the gods."

In early Mexican literature, other references to the uses of mushrooms for intoxication are less detailed but nevertheless of interest and of importance.[14] Usually, they lack common names or descriptions which might make it possible to identify the actual plant which was used.

Kingsborough reports that "wild mushrooms" were given to visitors to Montezuma's coronation, and that the mushrooms intoxicated the visitors and caused them to dance.[15]

Motolinia[16] described a religious feast held by Montezuma at which intoxicating wild mushrooms were eaten; the visions which accompanied the intoxication were believed to constitute divine advice concerning the future.

Duran, quoted by Bourke,[17] states that, after the sacrifices of human beings at the coronation of Montezuma II, the multitude ate raw mushrooms which induced an intoxication which was much stronger than alcoholic intoxication; many committed suicide at the height of the intoxication, some received visions and were, in this way, enabled to prophesy the future. Although it is difficult to identify the plant which served as the narcotic these cases, the symptoms of the intoxications induced are the same as those induced by the *teonanácatl* of the ancient Aztecs and are the symptoms of the intoxication induced only (among the mushrooms) by membbers of the genus *Paneolus*, the genus with which *teonanácatl* has been identified.

Thompson[18] reports Saville as saying that Tizoc, an Aztec ruler, who was poisoned after a five year reign, may have been killed by the substitution of poisonous mushrooms for the intoxicating kinds which were normally eaten at ceremonies. The deadly *Amanita phalloides* (Fr.) Quél. may possibly have been the instrument of death, but this species never could have been secretly substituted, in a fresh condition especially, for the entirely different *Paneolus* spp., while slightly poisonous, they are not known to cause sudden death by poisoning.

III

The many references to the general use of narcotic mushrooms among Mexican Indians of four hundred years ago suggests to the ethnobotanists of the present time that these plants may still be used in parts of Mexico, in a similar way.

Curiously enough, the actual utilization of mushrooms as intoxicants in modern Mexico was unobserved until very recently. In 1923, Doctor Blas Pablo Reko wrote, in a letter to Doctor J. N. Rose of the United States National Herbarium,[19] that the *teonanácatl* is a "fungus ... which is still used under the same old name by the Indians of the Sierra Juárez in Oaxaca in their religious feasts."

In 1936, Mr. Robert J. Weitlaner of Mexico City visited the capital of the Mazatec region of Oaxaca, Huautla de Jiménez, and learned of the use of certain mushrooms in witchcraft and divination among these primitive peoples. He secured a few samples of the narcotic plants and sent them to Reko who forwarded several pieces to the Botanical Museum of Harvard University for identification.[20] These specimens were insufficiently preserved upon arrival to make possible a definite specific identification; they belonged to the genus *Paneolus*, and were possibly referable to a species which is closely allied to *Paneolus campanulatus* var. *sphinctrinus*.

While I was engaged in ethnobotanical investigations among the little known Mazatec Indians of the District of Teotitlán, Oaxaca, with Dr. B. P. Reko in the summer of 1938, samples of the narcotic mushrooms and information concerning their use were collected in Huautla de Jiménez.[21] These mushrooms are referable to *Paneolus campanulatus* L., var. *sphinctrinus* (Fries) Bresadola.[22] Though apparently used rather frequently, the plant does not appear to be common in the Mazatec country. It is valued highly. Growing in boggy pots in pastures and open fields it as easily available only during the rainy season from June to September. Those who search for, the plant gather and dry the specimens for use during the rest of the year. Because of the belief that the mushroom is semi-sacred, it is not offered for sale in the markets of the Mazatec towns, although the yashun paper (made from the bark of *Heliocarpus appendiculatus* Turcz.) and other articles for *brujería* (witchcraft) are important articles of sale in the markets of Huautla.

The native Mazatec names by which *Paneolus campanulatus* var. *sphinctrinus* is known in Huautla de Jiménez and San Antonio Eloxochitlán are *t-ha-na-sa* (meaning unknown), *sheto* ("pasture mushroom"), and *to-shka* ("intoxicating mushroom").

Among the Mazatec Indians there are professional divinators who earn a livelihood locating stolen property, discovering secrets, and giving advice through *Paneolus*-intoxication. It is impossible to state whether or not these divinators practice their art exclusively with *Paneolus*; it is probable that they are general *curanderos* (herb-doctors) as well. Due probably to the frequent ingestion of the slightly poisonous *Paneolus*, they are said to age rapidly, signs of approaching senility being apparent at the age of thirty-five.

The narcotic is taken to induce a semi-conscious state which is accompanied by a mild delirium. The incoherent utterances which are made during the intoxication are interpreted as prophetic or admonitory.[23] The doses which the Mazatec Indians prescribe vary with the size and the age of the individual. Usually fifteen mushrooms are considered sufficient to induce the desired effect, but larger doses are reported. Overdoses of fifty to sixty mushrooms result in severe poisonings, while continued use of excessive quantities is said to produce permanent insanity. While this might be an unexpected physiological result of the type of intoxication induced by species of *Paneolus*, it was not possible to verify this with actual cases in the field. According to a number of descriptions from the Indians, the intoxication lasts about three hours. Shortly after ingestion of the mushrooms, the subject experiences a general feeling of levity and well-being. This exhilaration is followed within an hour by hilarity, incoherent talking, uncontrolled emotional outbursts, and, in the later stages of intoxication by fantastic visions in brilliant colours, similar to the visions so often reported for the narcotic peyote (*Lophophora williamsii*).

Johnson,[24] engaged in ethnological work among the Mazatec Indians in 1938, was informed that *brujos* (witch-doctors) use several kinds of mushrooms. He reports the names of these as *steyi* and *tsami-ye*, *tsamikishu*, and *tsamikindi*. Unfortunately it was not possible to procure specimens, photographs, or descriptions, and botanical identification is thus precluded. It is not improbable, however, that one or more of these is a *Paneolus*. Although in my two visits to the Mazatec country narcotic mushrooms other than *Paneolus campanulatus* var. *sphinctrinus* were not found in use in divination, it is possible that poisonous mushrooms of the same or of other genera may be utilized. As emphasized below, the intoxication which has symptoms making it valuable to the Indians for divination is especially, but not exclusively, typical of the entire genus *Paneolus*.

Mr. Bernard Bevari of Mexico City, who has carried out ethnological studies among the Chinantec Indians and who has visited the Mazatec tribe, writes in a letter to me, that he was informed of the use of mushrooms for intoxication among the Mazatecs.

Extending my ethnobotanical investigations in northeastern Oaxaca in the spring and summer of 1939, I learned that *Paneolus campanulatus* var. *sphinctrinus* is used as a narcotic for divination among the Western Chinantec Indians. The consumption of the narcotic is not uncommon in the western Chinantla[25] where the fungus grows in the high mountain pastures during the torrential rains of July. In the *pueblitos* of Santa Cruz Tepetotutla and San Pedro Sochiapam in the District of Cuicatlán, aged men were seen gathering this mushroom in fields, and in San Juan Zautla, District of Cuicatlán, information as to the use of the plant was obtained from two sources. In Tepetotutla five mushrooms (Schultes 722) were obtained from one of the gatherers in exchange for several quinine pills. In these Chinantec villages, the *Paneolus* has the name *nañ-tau-ga* the information as to the utilization of the plant and descriptions concerning the intoxication were identical with those obtained from the neighboring Mazatec Indians. Furthermore, in Tepetotutla, I was informed that small doses of from five to eight of these mushrooms are prescribed for several consecutive days for severe attacks of rheumatism. No medical uses were reported in the Mazatec region but, according to Sahagun, *teonanácatl* in small doses of two or three was medicinal for fevers and for rheumatism among the Aztecs.

Further evidence of the use of narcotic mushrooms was obtained among the Chinantec and Zapotec Indians who together inhabit the small town of Latani, near Santiago Choapam, District of Choapam, in the south-easternmost corner of the Chinantec area. Since my visit to Latani was made before the advent of the late June and July rains, it was impossible to collect specimens of the fungus which, according to the inhabitants, is eaten as a narcotic for divination. Very detailed descriptions of the fungus and a full account of the type of intoxication which it induces indicate that the intoxicating mushroom of Latani is also a species of *Paneolus*. The possibility that it is *Paneolus campanulatus* var. *sphinctrinus* is not remote. The Chinantec name is *a-ni* ("medicinal mushroom") or *a-mo-kya* ("medicine for divination").

It is interesting to note here that *ololiuqui* or *piule* (the seeds of *Rivea corymbosa* (L.) hail. f., often mistakenly identified as a *Datura*), another divinatory-narcotic of ancient usage in Mexico, is found growing in dooryards in Latani and is used, in the same way as the mushrooms, as an aid to divination.[26]

There can be little doubt that *Paneolus campanulatus* var. *sphinctrinus* is used among other Indian groups in Oaxaca and possibly in other states as well. Johnson writes in a letter to me that the mushrooms are known to the Cuicatec Indians of the District of Cuicatlán, Oaxaca, but that these people do not use them. Reko has learned by correspondence that the Zapotecs of Santiago Yaveo, District of Choapam, Oaxaca, use this narcotic, but when Reko and I visited this pueblo in 1939, no specimens could be obtained. Search for this use among the Zapotec Indians of Santa Maria Tonaguia, San Ildefonso Villa Alta, Santa Maria Temascalapa, San Juan Yatsona and San Juan Yaée produced no results. Likewise, during a very short stay in the Mije country, I could not learn of its use among the inhabitants of Santa Maria Chisme, San Juan Metlaltepec, and Santiago Zacatepec (at the base of Cerro Zempoaltepetl). I think that it is highly probable that the narcotic properties of the *Paneolus* mushrooms are employed in divination among these peoples, however, and that when intensive investigation is carried out among the Mijes, the use of *Paneolus* will be discovered in this poorly studied tribe.

The names under which *Paneolus campanulatus* var. *sphinctrinus* is or has been known may be summarized as follows:

> Aztecs: *nanacatl* (mushroom); *teonanácatl* (sacred mushroom); *quauhtlananacatl* (wild mushroom); *teunamacatlth* (probably an erroneous rendition of *teonanácatl*).
> Chichimecas: name unknown.
> Chinantecs: *nuñ-tau-ga*; *a-ni*; *a-mo-kya*.
> Mazatecs: *t-ha-nu-sa* (meaning unknown); *she-to* (pasture mushroom); *to-shka* ("intoxicating mushroom"). Although the names for the narcotic mushrooms reported by Johnson cannot definitely be applied to this species, it is probable that the mushrooms are species of *Paneolus*: *steyi*; *tsami-ye*; *tsamikishu*; *tsamikindi*.

IV

Paneolus campanulatus L. var. *sphinctrinus* (Fr.) Bresadola is a small mushroom of boggy spots in meadows during the rainy seasons. This species and its closest relatives are found on all the major continents. The mushroom is about ten centimeters high, with a slender, terete, dark brown stipe from one to two millimeter in diameter. The dark colour of the stipe serves to separate this variety from its close relative, *Paneolus papilionaceus* Fries. The pileus, three centimeters in diameter and one half centimeter high, is either parabolical, conical, or nearly hemispherical, often slightly cuspidate or obtusely acuminate, smooth, light yellowish-brown. The gills are spotted and are dark brownish-black. The spores, varying from 12-18 x 7.5-12 µ, are black, sublimoniform. When dried, the entire mushroom assumes a brownish-black colour.

An excellent coloured illustration of *Paneolus campanulatus* var. *sphinctrinus* is to be found in Bresadola's *Iconographia Mycologica*.[27] Technical Latin diagnoses of the characters of the plant may be found in Bresadola's *Iconographia Mycologica* and in Fries' *Epicrisis*;[28] Bresadola's Latin diagnosis is republished in Schultes' *Plantae Mexicanae II*.

V

Species of the genus *Paneolus* have long been known to be poisonous,[29] but the use of *Paneolus campanulatus* var. *sphinctrinus* as an intoxicant in Mexico is the only instance in which its properties have been employed for narcotization, so far as I have been able to learn from the anthropological and botanical literature.

Ford[30] divides mushroom-poisoning into five categories, according to the physiological action of the poisonous constituents of the plants: 1) the choleriform type (caused by the deadly *Amanita phalloides* (Fr.) Qutl.); 2) the nerve-affecting type which is marked by convulsions, coma, and occasional deaths (caused by *Amanita muscaria* (L.) Pers., which is used in Kamchatka as a narcotic); 3) the gastrointestinal type; 4) the blood-dissolving type; 5) and the cerebral type. Paneolus-intoxication belongs to the fifth category of poisonings. The narcotic action is mainly cerebral and is characterized by exhilaration, a feeling of ease and well-being, muscular incoordination, drowsiness, a staggering gait or difficulty in walking, emotional excesses, laughter and hilarity, incoherent and delirious speech, mydriasis, and fantastically coloured visions.

Most of the full descriptions of the use of *teonanácatl* among the ancient Aztecs indicate, by the peculiar type of intoxication, that the mushroom was a species of *Paneolus*. It is indeed significant that these early descriptions and the notes obtained from the Mazatec, Chinantec, and Zapotec Indians agree completely with the description of a typical *Paneolus*-intoxication by Douglas[31] and Krieger.[32]

Knowing that *Paneolus* was a poisonous genus, the late Professor Santesson[33] carried out a series of pharmacological studies with specimens of *Paneolus campanulatus* var. *sphinctrinus* which were collected in the Mazatec country.[34] The results of experiments with frogs indicated that a principle was present which induced a kind of narcosis very similar to that which is induced by ololiuqui (*Rivea corymbosa* (L.) Hall. f.) another Mexican oracular narcotic. Santesson called this state "eine Art Halbnarkose." Chemical tests convinced Santesson that a glucoside, but no alkaloid, was present. This is rather unexpected, since in

Amanita muscaria (L.) Pers., the Kamchatkan narcotic mushroom, the active principle is an alkaloid-muscarine.

VI

The identity of *teonanácatl* was unknown for three centuries. During this time doubt has been expressed concerning the accuracy of all of the earlier writers in describing the narcotic as a "mushroom." As a result, considerable confusion and uncertainty arose and a serious error has been accepted and widely spread in the botanical and anthropological literature.

The first attempt to identify *teonanácatl* botanically was made in 1915, when Safford[35] published his conclusion that the so-called "mushroom" was, in reality, the dried tops of the cactus *Lophophora williamsii* (Lem.) Coulter and, notwithstanding all of the numerous early reports, was not a fungus. "Three centuries of investigation," wrote Safford, "have failed to reveal an endemic fungus used as an intoxicant in Mexico, nor is such a fungus mentioned either in works on mycology or pharmacography; yet the belief prevails even now that there is a narcotic Mexican fungus ..." On the basis of this argument, Safford concluded that the dried, brown, discoidal head ("mescal button") of the spineless peyote-cactus (*Lophophora williamsii*) resembled a "dried mushroom so remarkably that, at first glance, it will even deceive a mycologist." When this "remarkable" resemblance is analyzed with actual specimens, however, it is found not to exist. There is actually very little similarity in appearance between the dried pilei of *Basidiomycetes* and mescal buttons. The shrivelled crowns of the cactus have a heavy cushion of closely packed areolate tufts of silky hairs on the upper surface and a conspicuous fibrovascular region on the lower surface. It seems highly improbable that either the early writers or the Indians were likely to confuse dried peyote with dried mushrooms. But Safford concluded that those same people who gathered peyote and *teonanácatl* (one of which inhabits dry, calcareous deserts; the other, wet, soggy, mountain pastures) failed to recognize the hard wrinkled, brown mescal-buttons (which Safford stated were *teonanácatl*) as a part of the soft, succulent, green peyote-plant. The former he assumed the Aztecs called *teonanácatl*, the latter, *peiotl*.

Much of Safford's ethnobotanical investigation of Mexican plants was brilliant. It is not surprising, therefore, that his conclusions on this mysterious "narcotic mushroom," which was known only in the literature, were accepted and became firmly established in both botanical[36] and anthropological literature.[37] This identification was repeated several times by Safford and early gained a wide audience.[38] Some of the recent writers on the subject of narcotics, however, have not accepted Safford's conclusions.[39] Prior to 1915, when Safford made his identification of *teonanácatl*, a number of authors had occasion to mention the narcotic and accepted the statements which all of the early writers had made concerning the fact that *teonanácatl* was a mushroom.[40]

The first published objection to Safford's identification appeared in 1936 in a popular book by V. A. Reko[41]: "*Dem* (the Safford identification) *muss widersprochen werden. Die Nanacates sind Giftpilze, die mit Peyote nichts zu tun haben* ..." He suggested, but apparently without any basis, that *nanacatl* might be a species of *Amanita*.

From the first appearance of Safford's identification, however, Dr B. P. Reko has opposed the opinion that *teonanácatl* was a form of peyote. In 1923, he wrote to Dr J. N. Rose of the United States National Herbarium:[42]

> "... I see in your description of *Lophophora* that Dr Safford believes this plant to be the 'teonanácatl' of Sahagun which is surely wrong. It is actually as Sahagun states, a fungus which grows on dung-heaps and which is still used under the same old name by the Indians of the Sierra Juárez in Oaxaca in their religious feasts ..."

In 1919, he had stated[43] that *teonanácatl* was "*div. généros de hongos, especialmente un hongo negro que crece sobre estiercol y produce ejectos narcóticos*."

In 1939, specimens of *Paneolus campanulatus* L. var. *sphinctrinus* (Fr.) Bresadola which were collected in the Mazatec country of northeastern Oaxaca were identified as *teonanácatl*[44]. Later, the same plant was found to be used among the neighbouring Chinantecs and Zapotecs. There is, therefore, no longer any reason for the retention of Safford's misidentification of *teonanácatl* with *Lophophora williamsii*.

The entire genus *Paneolus* is known to be poisonous. Differences between species are often very slight and extremely technical. Different species, having the same intoxicating properties and being so similar in gross appearance, are without doubt utilized along with *Paneolus campanulatus* var. *sphinctrinus*. Although I have found no other mushroom used as *teonanácatl* in Oaxaca, numerous reports that there are several kinds of *teonanácatl* must be interpreted to mean that other species are actually used. Although the identification of "teonanacatl" was made on the basis of specimens of *Paneolus campanulatus* var. *sphinctrinus*, it is probable that this vernacular name refers to several or numerous species of *Paneolus* and that further ethnobotanical research will result in the discovery of other species which serve as divination-narcotics in southern Mexico.

VII

In summary, it may be stated that:

1. *Paneolus campanulatus* L. var. *sphinctrinus* (Fr.) Bresadola (and possibly other species of *Paneolus*) is used as a narcotic in witchcraft and divination among the Chinantecs, Mazatecs, and Zapotecs of southern Mexico.
2. The size, colour, form, growth habits, uses, and narcotic effects of *Paneolus campanulatus* var. *sphinctrinus* correspond so closely to the descriptions of the same aspects of the *teonanácatl* of the Chichimecas and early Aztecs that there can be no doubt that this species represents the intoxicating mushroom which was described by many of the early writers as one of the chief narcotics of Mexico at the time of the Spanish Conquest.
3. The discovery of the use of *Paneolus* in three Mexican Indian tribes and its identification with *teonanácatl* should dispel the confusion which has resulted in the literature from Safford's misidentification of *teonanácatl* with peyote.
4. Although it seems to have been and to be widely used in southern Mexico as a narcotic, *Paneolus* is not known to be utilized as an intoxicant by any other group of primitive peoples.

Notes

1. It is with pleasure that I express my appreciation of the constant interest which Professor Oakes Ames, Director of the Botanical Museum of Harvard University, has shown in the ethnobotanical work which has led among other things, to the rediscovery of *teonanácatl*. I wish also to thank the several workers whom I mention to this article for making available for me unpublished information in their possession.
2. B. de Sahagun, *Historie generale de choses de la Nouvelle Espagne*.
3. The translations which appear in this paper are free translations made by the writer from the original sources.
4. Francisco Hernandez (1790), p. 357.
5. Manuel Martinez Gardica (1391), p. 21.
6. Jacinto de la Serna (1892) pp. 61-63.
7. Lord, Kingsborough (1848), p. 17.
8. Manuel Orozco y Berra (1880) p. 437.
9. Weston LaBarre, *The peyote cult* (1938), pp. 128-130.
10. William Safford, *An Aztec Narcotic* (1915), p. 291.
11. Hubert Hugh Baseroft (1882), p. 360.
12. Victor A. Reko (undated).
13. Remi, Siméon (1885).
14. Kingsborough (1848), Fr. Motolinia (1858), p. 23; Orozco y Berra (1880).
15. Kingsborough, *Antiquities of Mexico* (cronica Mexicana), p. 153.
16. Motolinia (1858), p. 23.
17. John G. Bourke (1891).
18. J. Eric Thompson (1933), pp. 31, 74.
19. Letter preserved on herbarium sheet number 1745713, United States National Herbarium, Washington, D. C.
20. In an earlier article (32, p. 39), I stated that these mushrooms were collected among the Otomis of Puebla. This is an error which was caused by a misunderstanding in correspondence. In the article I gave no credit to Mr. Weitlaner for his work on *teonanácatl* in the Mazatec country, since this information has only recently been communicated to me by Mr. Jean B. Johnson.

21. Schultes and Reko 231, *Collections of Economic Botany* No. 5548 (Botanical Museum Harvard University, July 27 1938).
22. Schultes (February, 1939).
23. This, interestingly, parallels the use of ololiuqui or piule (*Rivea corymbosa*) which is also used as a narcotic for divination in parts of Oaxaca. Investigation revealed that this narcotic convolvulaceous plant, the seeds of which are used, is known in the Mazatec region but is no longer utilized. It is used, however, by the Chinantec and Zapotec Indians to the south (Schultes ined.).
24. Jean Bassett Johnson (1939).
25. The term *Chinantla* is extremely ambiguous, having been used in a number of different senses by historical anthropological and botanical writers. It is a term which, as Bevan points out (Instituto Panamericano de Geografia e Historia. Publ. N. 24, Mexico, 1938) should be used only in its widest sense: "a synonym for the region where any dialect or Chinantec is spoken". It is used here in this sense.
26. Richard Evans Schultes, *Plantae Mexicanae VI*.
27. J. Bresadola (1931), p. 894.
28. Elias Fries (1838), pp. 235-236.
29. Louis C. C. Krieger (1935).
30. W.W. Ford (1923), pp. 225-229.
31. B. Douglas (1917), pp. 209-221.
32. Kreiger (1935).
33. C.G. Santesson (1939), pp. 1-9.
34. Schultes and Reko, *op. cit*.
35. Safford, *An Aztec Narcotic* (1915).
36. N. L. Britton and J. N. Rose (1922) p. 84; William E. Safford, *Narcotic Plants and Stimulants of the Ancient Americans* (1917) pp. 398-405.
37. Herbert J. Spinden (1917), p. 36; Eric Stone (1932), p. 55; J. Eric Thompson (1932), p. 31, 74. See E.W. Enmart: *The Badianus Manuscript* (Baltimore, 1940), p 66.
38. William L. Stafford (1917).
39. Jean Bassett Johnson (1939); Weston LaBarre, *Native American Beers* (1938); *Ibid*., *The Peyote Cult* (1938); Bals Pablo Reko (1919); Victor A. Reko (undated); *Ibid*. (1936); Sahagun (1938); Schultes (April, 1937); *Ibid*. (November, 1937), Spinden (1917).
40. Bancroft (1882), p 360; Thomas A. Joyce (1914), p. 156; Siméon (1885); Manuel Urbina (1900), p. 25; *Ibid*., (1912), p. 131.
41. V.A. Reko (1936).
42. Letter preserved on herbarium sheet number 1745713, United States National Herbarium, Washington, D. C.
43. Blas Pablo Reko (1919).
44. Schultes (February, 1939).

BIBLIOGRAPHY

1. BANCROFT, HUBERT HUGH, *The native races*, vol. 2 (San Francisco, 1882).
2. BOURKE, JOHN G., *Scatological rites of all nations* (Washington, D. C., 1891).
3. BRESADOLA, J., *Iconographia Mycologia* (Milan, 1931).
4. BRITTON, N. I,. and J. N. ROSE, *The Cactaceae*, vol. 3 (Washington, D. C., 1922).
5. DOUGLAS, B., *Mushroom poisoning* (Torreya, vol. 17, pp. 171-175, 209-221. 1917).
6. FORD, W. W., *A new classification of mycetismus* (*mushroom poisoning*) (Transactions, Association of American Physicians, Vol. 38, pp. 225-229, 1923).
7. FRIES, ELIAS, *Epicrisis systematis mycologici seu synopsis Hymenomycetum* (Upsala 1836-1838).
8. GARCIDA, MANUEL MARTINEZ, *Catálogos de la flora y la fauna del estado de Oaxaca* (Oaxaca, 1891).
9. HERNANDEZ, FRANCISCO, *De historia plantarum Novae Hispaniae*, vol. 2 (Rome 1790).
10. JOHNSON, JEAN BASSETT, *Elements of Mazatec witchcraft* (Ethnological Studies No. 9, Gothenburg, pp. 128-150, 1939).
11. JOYCE, THOMAS A., *Mexican archaeology* (New York, 1914).
12. KINGSBOROUGH, Lord, *Antiquities of Mexico* (Ritos antiguos, vol. 9, London-New York 1848).
13. KINGSBOROUGH, Lord, *Antiquities of Mexico* (Cronica mexicana, vol. 9, London-New York 1848).
14. KRIEGER LOUIS C. C., *A popular guide to the higher fungi (mushrooms) of New York State* (New York State Museum Handbook, 11, Albany, 1935).
15. LA BARRE, WESTON, *Native American Beers* (*American Anthropologist*, vol. 40 no.2, pp. 224-234, April-June, 1938).
16. LA BARRE, WESTON, *The Peyote cult* (Yale University Publications in Anthropology no. 19, pp. 128-130, New Haven, 1938).
17. MOTOLINÍA, FR. TORIBIO DE, *Historia de los Indios de Nueva España* (in Coleccion de Documentos para la Historia de Mexico, vol. 1, Mexico, 1858).

18. OROZCO Y BERRA, MANUEL, *Historia antigua de la conquista de Mexico*, vol. 3 (Mexico, 1880).
19. REKO BLAS PABLO, De los nombres botánicos aztecos (El México Antiguo, vol. 1, no. 5, pp. 113-157, December, 1919).
20. REKO, VICTOR A., *Was bedeutet dos Wort Teonanacatl*? Unpublished manuscript undated.
21. REKO, VICTOR A., *Magische Gifte - Rausch- und Betäubungsmittel der Neuen Welt* (Stuttgart, 1936).
22. SAFFORD WILLIAM E., *Identification of teonanacatl of the Aztec with the narcotic cactus Lophophora williamsii and an account of its ceremonial use in ancient and modern times*, (Botanical Society, Washington, D. C., May, 1915).
23. SAFFORD WILLIAM E., *An Aztec Narcotic* (Journal of Heredity, vol. 6, pp. 291-311, 1915).
24. SAFFORD WILLIAM E., *Food Plants and textiles of ancient America* (Proceedings, 19th International Congress of Americanists, Washington, D.C.; 1917).
25. SAFFORD WILLIAM E., *Narcotic plants and stimulants of the ancient Americans* (Annual Report, Smithsonian Institution, Washington, pp. 398-405, 1917).
26. SAHAGUN, BERNARDINO DE, (Editor: Bustamante, Carlos Maria de) *Historia general de las cosas dc Nueva España*, vol. 3 (Mexico, 1829-1830).
27. SAHAGUN, BERNARDINO DE, (Translators: Jourdanet, D. and Remi Siméon) *Hostoire generale des choses de la Nouvelle Espagne*, vol. 3 (Paris, 1880).
28. SAHAGUN, BERNARDINO DE, *Historia general de las cosas dc Nueva España*, vol. 3 (Mexico, 1938).
29. SANTESSON, C. O. *Eeinige Mexikanische Rauschdrogen* (Archiv für Botanik, vol. 29a, no. 12, pp. 1-9, 1939).
30. SCHULTES, RICHARD EVANS, *Peyote and plants used in the peyote ceremony* (*Botanical Museum Leaflets*, Harvard University, vol. 4, no. 8, April 12, 1937).
31. SCHULTES, RICHARD EVANS, *Peyote (Lophophora williamsii) and plants confused with it* (*Botanical Museum Leaflets*, Harvard University vol. 5, No. 5, November 19,1937).
32. SCHULTES, RICHARD EVANS, *Plantae Mexicanae II. The Identification of teonanacatl, a narcotic Basidiomycete of the Aztecs* (*Botanical Museum Leaflets*, Harvard University vol. 7, no. 3, February 21, 1939).
33. SCHULTES, RICHARD EVANS, *Plantae Mexicanae VI. Rivea corymbosa, the narcotic oioliuqui of the Aztecs* (*Botanical Museum Leaflets* Harvard University, ined.).
34. SERNA, JACINTO DE LA, *Manual do ministros de Indios para el conocimiento de sus idolatrias y estirpacion de ellas* (in Coleccion de documentos ineditos para la historia de España, vol. 104, Madrid, 1892).
35. SIMEON, REMI, *Dictionnaire de la langue Nahautl or Mexicaine* (Paris, 1885).
36. SPINDEN HERBERT J., *Ancient civilizations of Mexico and Central America* (New York, 1917).
37. STONE, ERIC, *Medicine among the American Indians* (New York, 1932).
38. THOMPSON, J. ERIC, *Mexico before Cortez* (New York-London 1933).
39. TORO ALFONSO, *Las plantas sagradas de los Aztecos y su influencia sobre el arte précortesiano*, Proceedings 23rd International Congress of Americanistes, pp. 101-121, New York, 1930).
40. URBINA, MANUEL, *El peyote y el ololiuqui* (Anales Museo Nacional México, vol. 7, 1900).
41. URBINA, MANUEL, *El peyote y el ololiuqui* (La Naturaleza, vol. 1, no. 4, 1912).

The Identification of Teonanácatl, a Narcotic Basidiomycete of the Aztecs

by

Richard Evans Schultes

From **Botanical Museum Leaflets of Harvard University**
Plantae Mexicanae II
Cambridge, Massachusetts, February 21, 1939 Vol. 7, No. 3

original source: http://www.samorini.it/doc1/alt_aut/sz/schultes-identification-of-teonanacatl.pdf
backup source: http://www.psilosophy.info/resources/schultes-identification-of-teonanacatl.pdf

Table of Contents:

I. Introduction
II. The identification of teonanácatl
III. Historical background of teonanácatl
IV. Summary
BIBLIOGRAPHY

I. Introduction

Investigations dealing with the vegetable narcotics, intoxicants, and poisons used by primitive peoples comprise studies which involve some of the most fundamental culture-traits. The narcotic plants of the New World especially are attracting popular attention while stimulating scientific interest. In this connection, a large ethnobotanical and ethnopharmacological literature is being developed. A recent anthropological study (13) has briefly summarized some of the information concerning the primitive uses of a number of narcotics and has emphasized the importance to theoretical anthropology of correctly identified and thoroughly investigated ethnobotanical material. Indeed, this summary and other recent papers have clearly emphasized the need, as well as the desirability, of further botanical and ethnological investigations of plant narcotics, their uses, and their significance.

The plant narcotics of Mexico are of unique interest because careful records of their uses at the time of the Spanish Conquest are often available. It is possible, therefore, to compare their past uses with the uses made of them at the present time. Fundamental to any study of this kind, however, is a thorough botanical investigation of plant uses among modern Mexican Indians and a critical examination of the earlier ethnobotanical records.

Botanical and anthropological literature contains many references to a mushroom which has been employed as a narcotic by some of the Indians of Mexico. The Aztecs and the Chichimecas were the earliest recorded users of these mushrooms which they called *teonanácatl*. For several centuries, however, the identity of *teonanácatl* has remained obscure. Recurring references to it have mystified biological and anthropological investigators, inasmuch as careful search had failed to reveal any Mexican fungus possessing properties used to induce a narcosis. It has been suggested that the reports which associate *teonanácatl* with a mushroom are misleading or erroneous, although the sources from which they come are in other respects dependable and credible.

Both from a botanical and ethnological point of view a knowledge of the identity of *teonanácatl* should prove of value. Furthermore, the correct identification of this narcotic plant is rendered desirable and necessary because an obvious misidentification has gained wide acceptance among botanists and anthropologists.

II. The identification of teonanácatl

In the summer of 1938, I began ethnobotanical investigations among the Mazatec Indians of northeastern Oaxaca and learned that a mushroom, subsequently identified as *Paneolus campanulatus* L. var. *sphinctrinus* (Fr.) Bresadola[1], was being used as a narcotic.

In 1937, Dr. Bias Pablo Reko, my co-collector in Oaxaca, sent me several pieces of a mushroom which he found used as a narcotic by the Otomi Indians of Puebla and adjacent regions. Unfortunately, these specimens were poorly preserved, but they are referable to the genus *Paneolus* and belong to a related if not to the same species as those which were collected in Oaxaca.

Johnson (9) reports that three kinds of mushrooms are used by Mazatec *brujos* (witch-doctors); the names of these he reports as *steyí* and *tsami-yé*, *tsamikíshu*, and *tsamikindí*. Although botanical identifications were not made, it is probable that these are all species of *Paneolus*, possibly *P. campanulatus* var. *sphinctrinus* and its close allies *P. campanulatus* L. and *P. papilionaceus* Fr.

When identifiable specimens of the fungus had been secured and when ample information regarding its use was obtained, it became evident that *Paneolus campanulatus* var. *sphinctrinus* was the *teonanácatl* of the ancient Aztecs.

Paneolus campanulatus Linnaeus var. *sphinctrinus* (Fries) Bresadola Iconographia Mycologica (1931) t. 894.

Agaricus (Paneolus) sphinctrinus Fries Epicrisis systematis mycologici seu synopsis Hymenomycetum (1836-1838) 235-236.

Bresadola's description is:

> "Pileus carnosulus, parabolicus, obtuse acuminatus, opacus, levis, udus, glaber, fuligineo-nigricans, sicco olivaceo-lividus vel fuligineus, subsericeus, 1½-2½ cm. altus latusque, velo albo primitus dentato-appendiculatus; lamellae subconfertae, postice adnatae, cinereo-nigricantes, atro-maculatae, acie concolores; stipes fistulosus, cylindraceo-filiformis, aequalis, fuligineo-griseus, apice albopruinosus, deorsum rufescens, basi albo-floccosus, 5-8 cm. longus, l½-2½ mm. crassus; caro tenuis, dilute umbrina, inodora et insapora; sporae sublimoniformes, fusco-atrae, opacae, leves, 14-18 - 9-12µ; basidia clavato-capitata, 25-30 - 12 - 14µ; cellulae aciei lamellarum cylindraceae, 50-60 - 6-7µ."

MEXICO: in boggy spots in meadows during heavy rains, Huautla de Jiménez, Oaxaca, July 27, 1938, *Richard Evans Schultes & Blas Pablo Reko 231*, Harvard Botanical Museum Collections (Economic Botany) No. 5548.

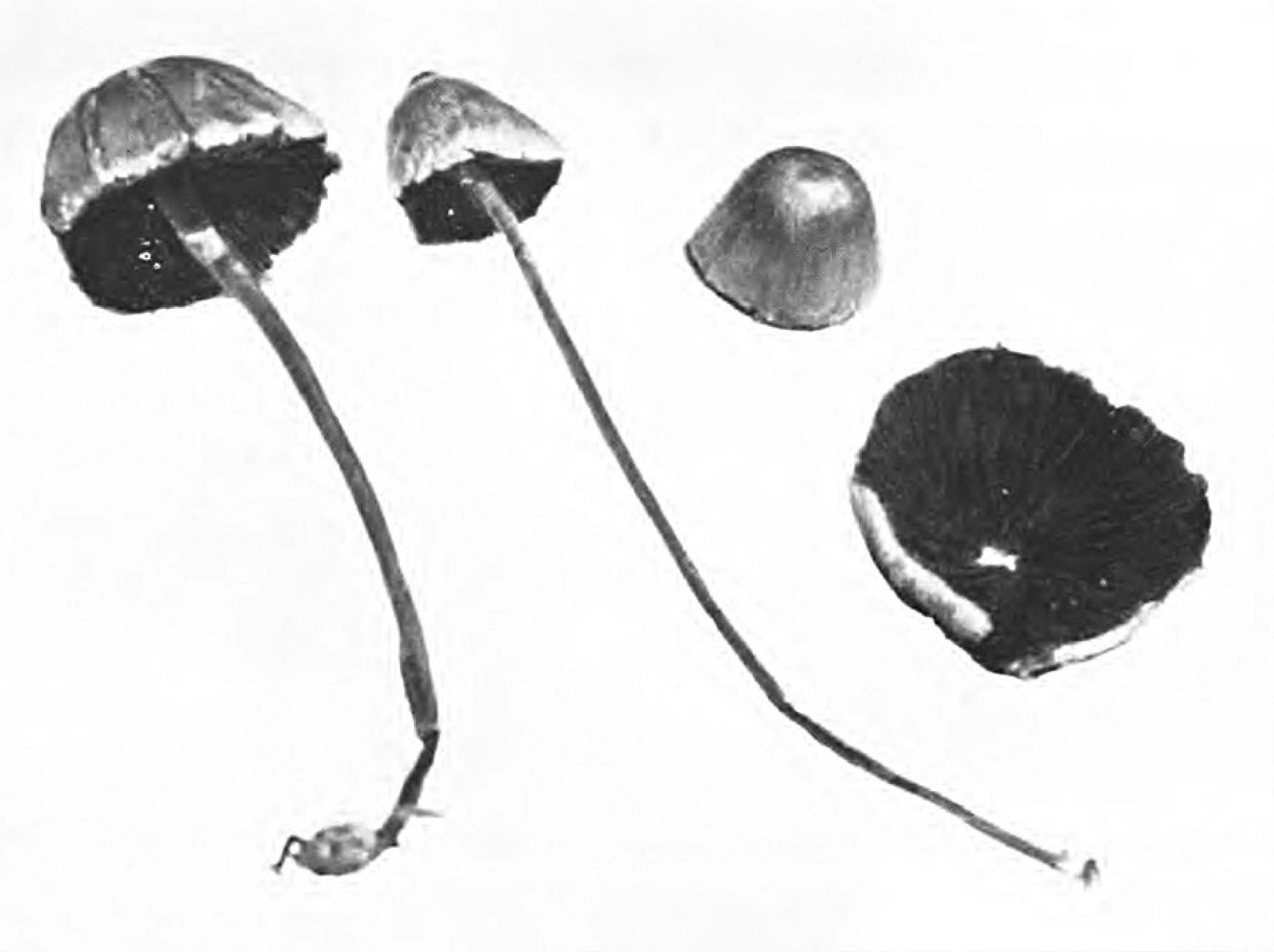
COMMON NAMES: Aztec - *nanacatl* ("mushroom") , *teonanácatl* ("sacred mushroom"), *quauhtlananacatl* ("wild mushroom"); Mazatec - *t-ha-na-sä* (meaning unknown), *she-to* ("pasture mushroom"), *to-shka* ("intoxicating mushroom"); Otomi - unknown.

The Oaxacan specimens, upon which this identification of *teonanácatl* is based, agree closely with the variety of *Paneolus campanulatus* L. which was made by the reduction of *Agaricus (Paneolus) sphinctrinus* Fr. to varietal rank. They lack, however, the pronounced appendiculate margin which is figured by Bresadola (8). The mushrooms are small, never more than ten centimeters in height. The dark brown stipe is terete and very slender and measures from one to two millimeters in diameter; the dark color of the stipe serves to separate this species from the closely related *Paneolus papilionaeeus* Fr. The pileus, three centimeters in diameter and one half centimeter in height, is usually somewhat conical (perfectly hemispherical in a few specimens), slightly cuspidate, and of a light yellowish-brown color. The gills are spotted and are dark brownish-black. The spores, varying from 12-15 x 7.5-8.3µ, are black. This mushroom and its close relatives *Paneolus campanulatus* L. and *P. papilionaceus* Fr. are exceedingly widespread, occurring on all the major continents.

---

[1] I wish to express my thanks to Dr. David Linder of the Farlow Herbarium, Harvard University, who corroborated field identifications and rendered further taxonomic assistance.

Among the Mazatec Indians, *Paneolus campanulatus* var. *sphinctrinus* is regularly used by some members of the tribe as a narcotic. The plant does not appear to be common in the Mazatec country. It grows in pastures and open fields during the rainy season from June to September. Those who use it search for it eagerly, gathering and drying it for future use. Because the mushroom is regarded as being semi-sacred, it is difficult to purchase specimens. They are usually presented as a gift.



Paneolus campanulatus L. var. *sphinctrinus* (Fr.) Bresadola

There are among the Mazatecs professional divinators who earn a livelihood by endeavoring through mushroom intoxication to locate stolen property, discover secrets, and give advice. The narcotic is taken to induce a semi-conscious state accompanied by a mild delirium. The incoherent utterances made during intoxication are interpreted as prophetic or admonitory. This, curiously enough, parallels the use of ololiuqui (the seeds of *Rivea corymbosa* (L.) Hall. f.), a convolvulaceous narcotic which is still used in parts of Oaxaca, and of various species of *Datura* which are very widely employed to induce a delirium that is thought to assist in divination and witchcraft.

The professional Mazatec divinators evidently store large numbers of these mushrooms for use throughout the year, for the doses said to be required for intoxication are large. It was impossible to learn whether these divinators practice their art exclusively with *Paneolus* or whether they are general *curanderos* (herb-doctors) as well. They are said to age rapidly, probably because of frequent ingestion of the slightly poisonous *Paneolus*: at the age of thirty-five, senility is apparent.

It was impossible to ascertain the extent of this profession, but the use of the narcotic is by no means confined to the divinators. Any individual may eat the mushrooms. That the consumption of the fungus is large is borne out by the fact that it was with difficulty that we were able to secure 4 two dozen specimens. Johnson (9) has learned that certain "narcotic mushrooms" are of importance in Mazatec witchcraft, and it is probable that these also are referable to the genus *Paneolus*.

The doses which the Indians employ vary with the size and age of the individual. Usually fifteen mushrooms are sufficient to induce the desired effect, but larger doses are reported. Overdoses of fifty or sixty mushrooms result in poisoning, while continued use of excessive quantities is said to produce permanent insanity. Whether or not this is true could not be ascertained.

According to Indian descriptions, the intoxication lasts about three hours. Shortly after ingestion of the mushrooms, a general feeling of exhilaration and well-being is experienced. This state of exhilaration is followed within an hour by hilarity, incoherent talking, and later, is accompanied by fantastic visions in brilliant colors, similar to the visions so characteristic of peyote-intoxication (*Lophophora williamsii* (Lem.) Coulter).

Paneolus is known to be slightly poisonous and narcotic. With the exception of Mexican Indians, I am aware of no primitive peoples who take advantage of the properties of this genus for intoxication. The effects of *Paneolus* have been studied (5, 6, 12) and the symptoms of the intoxication are similar to those of alcoholic-intoxication. Ford (6) has divided mushroom-poisoning into five categories: the choleriform type (*Amanita phalloides* (Fr.) Quel.); the nerve-affecting type in which occur convulsions and coma often resulting in death, (*Amanita muscaria* (L.) Pers. and other muscarine-containing forms); the gastro-intestinal type which is seldom fatal; the blood-dissolving type; and the cerebral type. Paneolus-intoxication belongs to the last category of poisonings. It is characterized by exhilaration, fantastic visual hallucinations, a feeling of ease and well-being, muscular incoordination, drowsiness, a staggering gait or difficulty in walking, emotional excesses, laughter, incoherent and uncontrolled speech, and mydriasis. The effects following ingestion are always of short duration.

It is of significance that the description of Paneolus-intoxication by Douglas (5) and Krieger (12) is practically identical with that given by the Mazatec Indians and with descriptions found in early Spanish accounts of the use of *teonanácatl* among the Aztecs.

III. Historical background of teonanácatl

The first attempt to identify *teonanácatl* botanically was made in 1915, when Safford (18, 19) published his conclusions that the so-called "mushroom" was, in reality, a part of the cactus *Lophophora williamsii* (Lem.) Coulter and, notwithstanding the numerous independent reports and descriptions in literature, was not a fungus.

After a careful study of herbarium specimens, Safford failed to find a Mexican mushroom with narcotic or intoxicating properties. Safford (19) states: "Three centuries of investigation have failed to reveal an endemic fungus used as an intoxicant in Mexico, nor is such a fungus mentioned either in works on mycology or pharmacography; yet the belief prevails even now that there is a narcotic Mexican fungus...". This induced him to search among other plants and plant products for something which the early writers or the Indians might have confused with a dried fungus. He believed that the dried, brown, discoidal head (mescal button) of the spineless peyote-cactus (*Lophophora williamsii*) resembled "a dried mushroom so remarkably that, at first glance, it will even deceive a mycologist" (19). Peyote was used by the Aztecs as a religious narcotic during this same period, and the symptoms of intoxication were described as somewhat similar, especially in the production of fantastic visual hallucinations. It should be emphasized, however, that there is actually little similarity in appearance between mescal buttons and the dried pilei of *Basidiomycetes*: the shrivelled crowns of *Lophophora williamsii* assume the drab color of a dried mushroom, it is true, but a heavy cushion of closely placed areolate tufts of silky hairs densely clothes the upper surface of the dried cactus-head, while the fibrovascular region is clearly visible on the lower surface. It seems improbable, therefore, that either the historians or the Indians were deceived by a superficial color-resemblance.

However, Safford (18, 19) based his conclusions: 1) on the apparent absence from Mexico of narcotic or intoxicating mushrooms and 2) on the supposed similarity between mescal buttons and dried mushrooms. He concluded that the Aztec Indians, who gathered for use both *peyote* and *teonanácatl* and whose botanical knowledge and powers of observation were keen, had failed to recognize the hard, wrinkled, brown mescal buttons as a part of the soft, succulent, green peyote-plant of the desert. The former, he assumed, they called *teonanácatl*, the latter *peiotl*.

Furthermore, Safford had at his command a number of the detailed descriptions of the early writers on Mexico. He failed to see in these, however, any overwhelming negation of his identification of *teonanácatl*. As La Barre (14) aptly states: "Safford identifies the two by a somewhat casual use of his evidence and mystifies himself with the consistent contradiction offered by all the early Spanish writers to his assumption. He composes the contradiction by assuming that the Aztecs did not recognize the dried, discoidal button as the same plant as the green cactus; despite overwhelming etymological evidence, he supposes they called the former '*teonanácatl*' and the latter 'peyotl'".

Much of the work done by Safford in the identification of important and interesting economic plants of ancient Mexico was brilliant. It is not surprising, therefore, that workers were inclined to accept his treatment of *teonanácatl*. Safford's erroneous identification unfortunately was generally accepted and has become rather firmly established in both botanical and anthropological literature.

Until recently, no published objections were raised against Safford 's identification. From the first, however, Doctor Bias P. Reko maintained that peyote and *teonanácatl* were not identical. Reko has carried out rather extensive botanical collecting and anthropological investigations of several kinds in Mexico for more than a quarter of a century. From his own experience and from a belief in the dependability of the early reports, he insisted on the presence of a narcotic mushroom among Mexican Indians. Thus, in 1919, he stated (15) that *nanacatl* was "div. géneros de hongos, especialmente un hongo negro que crece sobre estiércol y produce efectos narcóticos," and in 1923, he wrote as follows in a letter[2]:

> "… I see in your description of *Lophophora* that Dr. Safford believes this plant to be the '*teonanácatl*' of Sahagun which is surely wrong. It is actually, as Sahagun states, a fungus which grows on dung-heaps and which is still used under the same old name by the Indians of the Sierra Jaurez in Oaxaca in their religious feasts...".

The first published objection to Safford's identification appeared in 1937 (17): "Dem [the Safford identification] muss widersprochen werden. Die Nanacates sind Giftpilze, die mit Peyote nichts zu tun haben. Seit alten Zeiten ist es bekannt, dass ihr Genuss Rauschzustände, Extasen, und Geistesstörungen hervorruft, aber trotz ihrer Gefährlichkeit hat man sie überall, wo sie vorkommen, wegen ihrer berauschenden Eigenschaften bis auf den heutigen Tag geschätzt". V. A. Reko (17) suggests, but without corroboration or evidence, that *nanacatl* might be a species of *Amanita*. This refutation of Safford's identification, however, is important inasmuch as it once more centered attention on the problem. In 1937 and in 1938, I (23, 24) summarized the evidence against the identity of peyote and *teonanácatl*, and in 1938, La Barre (13) also indicated his doubts of Safford's identification.

Fray Bernardino de Sahagun (c. 1499-1590) was the first European to record the use of *teonanácatl* as a narcotic. There are several distinct references to this plant in his *Historia de las cosas de Nueva España* (20). One of these references, in a general consideration of useful plants, states that:

> … they [the Chichimecas] possessed a great knowledge of plants and roots, and they were acquainted with properties and virtues of them; these same people were the first to discover and use the root which they called *peiotl*, and those who are accustomed to eat and drink them used them in place of wine; and they did the same with those which they call *nanacatl*, which are harmful mushrooms which intoxicate in the same way as wine ...

A more detailed report of *nanacatl* is to be found in a chapter devoted to the consideration of narcotic and intoxicating plants:

> There are some small mushrooms in that region which are called *teonanácatl*; these grow under the grass (hay) of the fields and pastures. They are round, having a rather high stipe, slender and terete. When eaten, they have a bad taste, hurting the throat, and they cause intoxication. They are medicinal for fevers and for rheumatism. Only two or three need to be eaten. Those who eat

---

[2] Letter: B. P. Reko, Guadalajara, Mexico, to J.N.Rose, United States National Museum, Washington, D.C., July 18, 1923; herbarium sheet No. 1745713, United States National Herbarium, Washington, D.C.

> them see visions and feel a faintness of the heart. And they provoke to lust those who eat a number, or even a few, of them.

In the first of these excerpts, Sahagun clearly distinguished between "the root which they call peiotl" and "*nanacatl*, which are harmful mushrooms." Likewise in his chapter on narcotic plants from which the second excerpt is taken, Sahagun discussed the "small mushrooms ... which are called *teonanácatl*" and in another paragraph recognized *peiotl* as a distinct plant:

> There is another herb like the earth-tunas which is called *peiotl*. It is white and grows in the north. Those who eat it see terrifying and amusing visions. The intoxication persists for two or three days and then stops ...

In a third reference to the mushrooms, Sahagun explained the intoxication in great detail:

> The first thing which they ate at the gathering was small, black mushrooms which they called *nanacatl*. These are intoxicating and cause visions to be seen and even provoke sensuousness. They ate these [mushrooms] before dawn, and they also drank chocolate before daylight. They ate these little mushrooms with honey, and when they began to be excited by them, they began to dance, some singing, others weeping, for they were already intoxicated by the mushrooms. Some did not want to sing but sat down in their quarters and remained there as if in a meditative mood. Some saw themselves dying in a vision and wept; others saw themselves being eaten by a wild beast; others imagined that they were capturing prisoners in battle, that they were rich, that they possessed many slaves, that they had committed adultery and were to have their heads crushed for the offense, that they were guilty of a theft for which they were to be killed, and many other visions which they saw. When the intoxication from the little mushrooms had passed, they talked over among themselves the visions which they had seen.

From Sahagun's three references, it is obvious that the root-word *nanacatl* meant "mushroom." Teo*nanacatl* probably was the correct word for the narcotic species, and *nanacatl* served as a more general term. This more general use is found in still another one of Sahagun's botanical references to mushrooms:

> The cone-shaped mushrooms (*nanacatl*) *genus campos agrorum* in the mountains are good to eat. They are cooked for this purpose; if they are eaten raw or poorly cooked, they produce vomiting or diarrhea, and they may kill.

Further evidence of the meaning of *nanacatl* is found in the various combinations which were made by adding prefixes denoting the color, habitat, or attributes of the plant. Hernandez (8) describes the narcotic mushroom under the heading: "De *nanacatl* seu Fungorum genere." He considered *teonanácatl* as *teyhuinti* or "intoxicating", distinguishing from it several other types of mushrooms: *iztacnanacame* (white mushrooms), *tlapalnanacame* (reddish mushrooms), and *chimalnanacame* (yellow-orbicular mushrooms).

Jourdanet and Siméon (21) define *teonanácatl* as follows: "(*Teonanácatl*) c'est à dire: champignon dangéreux. La terme générique est *nanacatl*, qui se met en composition avec d'autres mots pour désigner les diverses espèces de champignons."

Siméon (26) analyzes several words with *nanacatl* as a root and clearly points out the meaning of the term:

"*Nanacatl* - Champignon; *quauhtla-nanacatl*, champignon des bois; au fig. *nanacatl nicte-ittitinemi* (Olm.), rendre quelqu'un pervers, lui donner de mauvais conseils. En comp.: *nonanac* ou *nonanacauh* (Olm.), mon champignon. R. *nacatl*?"

"*Nacatl* - Chair, viande; ... *nonac*, ma viande, la chair que je mange."

"*Teonanácatl* - Espèce de petit champignon qui a mauvais goût, enivre, et cause des hallucinations; il est medicinal contre les fièvres et la goutte (Sah.) RR. *teotl*, *nanacatl*."

"*Teyhuinti* - Qui enivre quelqu'un, enivrant; *teyhuinti nanacatl*, champignon enivrant."

An additional piece of evidence may be found in the use of the word *nanacatl* in modern Mexico. In provision markets of Mexico, mushrooms in general are called *nacatl* (17).

Serna (25) recorded a very complete description of *teonanácatl* and its use as a narcotic and clearly distinguished it from peyote:

> And it so happened that an Indian had come ... bringing some of the colored mushrooms which are gathered in the hills, and, with these, he had performed a great idolatry. But before explaining this [idolatry], I wish to explain the nature of the said mushrooms which, in the Mexican language, are called *quatlannamacatl* ... these mushrooms were small and yellowish, and to collect them the priests and old men, appointed as ministers for these impostures, went to the hills and remained almost the whole night in sermonizing and in superstitious praying. At dawn, when a certain little breeze which they know began to blow, they would gather them [the mushrooms], attributing to them deity. They have the same effects as ololiuqui and peyote, for when they are eaten or drunk, they intoxicate, depriving those who partake of them of their senses and making them believe a thousand absurdities.

Benvento in Kingsborough (10) reports the use of mushrooms for intoxication:

> They had another kind of intoxication...which was induced by small toadstools or mushrooms ... which are eaten raw. Because of the bitter taste of these mushrooms, they drink after them or eat with them a little honey after which they shortly see a thousand visions, especially snakes. They went raving mad, and they ran about the streets wildly ... In their language they called these mushrooms *teunamacatlth*, a word which means "bread of the gods...".

Basing his statement on the etymology proposed by Siméon (21,25), LaBarre (14) points out that Benvento's etymology is wrong. The belief that *teonanácatl* means "bread of the gods" or "flesh of the gods" is widespread. Thus, in an unpublished manuscript, V. A. Reko (16) applies the meaning of "divine food of a soft or fleshy nature" to *teonanácatl*. Safford (18, 19) consistently used the expression "flesh of the gods." Bancroft (l), in speaking of the intoxicants of the Nahuatls, wrote: "Among the ingredients used to make their drinks more intoxicating, the most powerful was the *teonanácatl*, 'flesh of the gods', a kind of mushroom which excited the passions and caused the partaker to see snakes and divers other visions."

There are numerous less explicit references to the use of mushrooms for intoxication in Mexico. These have no common names or descriptions which might serve to identify the plant, but it is probable that some of the references concern the same species of *Paneolus* which has been identified as *teonanácatl*. One of these references (11) relates that visitors who had come to the coronation of Montezuma were offered "wild mushrooms" to eat; these intoxicated them and made them dance. Duran, quoted by Bourke (2) states that after the sacrifice of human beings at the coronation of Montezuma II, the multitude ate raw mushrooms and that these induced an intoxication which was much stronger than alcoholic-intoxication; many committed suicide during the height of the intoxication; some received visions and were, in this way, permitted to foresee the future. It is probably safe to assume that the plants spoken of in these two instances were the *teonanácatl*, *Paneolus campanulatus* var. *sphinctrinus* or a related species. The great similarity in the intoxication to that which Ford (6) has described for *Paneolus* would seem to suggest that the intoxicant was a member of this genus.

Thompson (27) reports Saville as stating that Tizoc, an Aztec ruler who was poisoned after a five year reign, may have been killed by the substitution of poisonous mushrooms for the intoxicating kind which were normally eaten at ceremonies. It is probable that, if this were the case, the deadly *Amanita phalloides* (Fr.) Quél, was the instrument of death. Since this extremely poisonous mushroom could never be overlooked and mistaken for a species of *Paneolus*, it argues that the mushrooms must have been utilized dry, in which condition substitution would have been less difficult.

The discovery of the use of *Paneolus campanulatus* var. *sphinctrinus* as a narcotic among the Mazatecs of Oaxaca and its identification as the *teonanácatl* of ancient Mexico greatly enhances our knowledge of the useful Basidiomycetes. While the genus *Paneolus* has been known to have poisonous and narcotic properties, its use for intoxication has not been reported, so far as I have been able to learn, for any primitive peoples outside of Mexico. *Amanita muscaria* (L.) Pers., the fly-agaric, has been used somewhat ritually as a narcotic intoxicant by the natives of Kamchatka, and this has received rather intensive botanical, chemical, medical, and ethnological study for many years. *Amanita muscaria*, like *Paneolus campanulatus* var. *sphinctrinus*, is widely spread, but its use as a definite narcotic is confined to the relatively small Kamchatka area of northeastern Siberia, as the use of *Paneolus campanulatus* var. *sphinctrinus* as a narcotic is apparently known only from Mexico. Dorman in Bourke (2) reports that mushrooms were worshipped in the Antilles, in Virginia, and in California. Such a practice might be interpreted as indicating possibly a former use of the plant as a narcotic to produce oracular delirium. Possibly, however, the reverence accorded to the mushrooms is due to other entirely unrelated causes.

IV. Summary

1. *Paneolus campanulatus* L. var. *sphinctrinus* (Fr.) Bresadola is used as a narcotic in daily life and in divination and witchcraft among the Mazatec Indians of northeastern Oaxaca.
2. A species of *Paneolus* is employed as a narcotic by the Otomi Indians of Puebla and adjacent regions.
3. The size, color, form, growth habits, uses, and narcotic effects of *Paneolus campanulatus* var. *sphinctrinus* correspond so closely to the descriptions of the same aspects of the hitherto unknown *teonanácatl* of the early Mexican writers that there can be little doubt that this species represents the intoxicating mushroom which was in very wide use in daily life, in ceremonies, and in divination and witchcraft among the Aztecs and Chichimecas at the time of the Spanish Conquest.
4. The discovery of the use of *Paneolus campanulatus* var. *sphirictrinus* as a narcotic and the identification of this fungus with *teonanácatl* should dispel the confusion which has resulted in literature from Safford's misidentification of *teonanácatl* with peyote.
5. References in the early literature indicate that the Aztecs possessed an extensive knowledge of the useful and harmful Basidiomycetes.
6. Although species of *Paneolus* are found all over the world and are known to possess intoxicating or slightly poisonous properties, no reference to their use as narcotics is known for primitive peoples outside of Mexico.

BIBLIOGRAPHY

1. Bancroft, Hubert Hugh "The native races" vol. 2, p. 360, San Francisco, 1882.
2. Bourke, John G. "Scatological rites of all nations" Washington, 1891.
3. Bresadola, J. "Iconographia Mycologica" t. 894, Milan, 1931.
4. Britton, N.L. and Rose, J.N. "The Cactaceae" vol. 3, Washington, D.C., 1922.
5. Douglas, B. "Mushroom poisoning" Torreya, vol. 17, pp. 171- 175, 209-221, 1917.
6. Ford, W.W. "A new classification of mycetismus (mushroom poisoning)" Trans. Assoc. Am. Physic, vol. 38, pp. 225-229, 1923.
7. Fries, Elias "Epicrisis systematis mycologici seu synopsis Hymenomycetum" pp. 235-236, Upsala, 1836-38.
8. Hernandez, Francisco "De historia plantarum Novae Hispaniae" vol. 2, p. 357, Rome, 1790.
9. Johnson, Jean Bassett "Elements of Mazatec witchcraft" Am. Anthrop., ined.
10. Kings borough, Lord "Antiquities of Mexico" vol. 9, Ritos antiquos, p. 17, London-New York, 1848.
11. Kingsborough, Lord "Antiquities of Mexico" vol. 9, Cronica mexicana, p. 153, London-New York, 1848.
12. Krieger, Louis C.C. "A popular guide to the higher fungi (mushrooms) of New York State" N. Y. State Mus. Handb. 11, Albany, 1935.
13. La Barre, Weston "Native American beers" Am. Anthrop., vol. 40, no. 2, pp. 224-234, April-June, 1938.
14. La Barre, Weston "The peyote cult" Yale Univ. Publ. Anthrop., no. 19, pp. 128-130, 1938.
15. Reko, Bias Pablo "De los nombres botanicos aztecos" El. Mex. Ant., vol. 1, no. 5, pp. 113-157, December 1919.
16. Reko, Victor A. "Was bedeutet das Wort *Teonanácatl*?" Unpublished manuscript.

Mazatec sexual impurity and Bible reading

by

Eunice V. Pike

Eunice V. Pike is a missionary of the Wycliffe Bible Translators,
with many years of experience among the Mazatecs of southern Mexico.
She is one of the translators of the Mazatec New Testament.
Miss Pike was co-author of "Mushroom Ritual vs. Christianity,"
which appeared in the July-August (1959) issue of PRACTICAL ANTHROPOLOGY.

original text: http://www.mushroomjohn.org/pike1.htm

The point has repeatedly been made that the hearing of the gospel is filtered through presuppositions created by cultural ideas, experience, and world view. Sometimes this distortion in the reception of the message can result in complete misunderstanding. Occasionally the missionary has no idea of the interference involved. The following account is the story of a slowly awakening consciousness which came to Miss Pike in her work among the Mazatecs, an awareness of the set of assumptions which governed people's ideas about the Bible. It also discusses efforts to teach in such a way that the communication difficulty is overcome.

Spirits and Ceremonial Cleanliness

Over a period of years I have gradually become aware of the fact that Mazatecs consider sexual relations to be offensive to "God" and in fact to any spirit. If they have not had intercourse for a time, they are said to be "clean," otherwise they are "sinful." For fear of being punished by the spirits, the Mazatecs try to be ceremonially clean whenever they come in contact with them.

When contacting "Christ" by means of the sacred mushroom[1], they are supposed to refrain from intercourse about four days both before and after the mushroom ceremony. If they do not, it is said that the mushroom may make them crazy.

[1] See Eunice Pike and Florence Cowan, "Mushroom Ritual vs. Christianity," PRACTICAL ANTHROPOLOGY, Vol. 6, No. 4 (July-August 1959), pp. 145-150.

The same restriction is applied to witchcraft which they use to contact evil spirits, trying to pay them to harm another human being, or to stop harming some member of the family. If they are not "clean" when they use witchcraft, the spirits will punish them, perhaps by making them crazy, or perhaps by killing their children.

Parents must abstain for forty days whenever there has been a death in the family. If they do not, one of the children may die. During a whooping cough or measles epidemic, when one child dies, and then another, the neighbors gossip about the parents, saying, "They killed them by not remaining clean." To the Mazatec spirit world there is no difference between adultery and the sexual relations within marriage; they are equally "sinful."

To many Mazatecs the sun is God, and although he is a "good" god he also punishes for sexual relations. Specifically, if a man has prostate trouble, the people say it was because, sometime in his life, he had intercourse outdoors, that is, in the presence of the sun.

One Mazatec was reported to have studied a book called *The Prayers of James*. I was told that this book teaches a person how to steal. He can go through a door without opening it; he can walk into a room and steal without people seeing him. Later the man became "crazy." His relatives and people of his vicinity decided that he must not have been "clean" when he studied the book, and for that reason he had gone crazy.

Cleanliness and the Reading of the Scriptures

When I tried to interest Mazatecs in reading the Bible, I told them that it is the Word of God. When they did not respond, I thought they were not convinced. Now I suspect that sometimes they do not respond because they are convinced and have applied to the Scriptures the same restrictions that they apply to the mushroom, witchcraft, or a book of magic[2]. Specifically, they are afraid to read Scripture unless the are "clean."

[2] For similar ideas of "ritual purity" see Edward Norbeck, "pollution and Taboos in Contemporary Japan," *Southwestern Journal of Anthropology*, Vol. 8 (1952), pp. 269-285. He says that at the present time menstruation, childbirth, and death are the major sources causing ceremonial impurity. Avoidance of Shinto deities at such times is still practiced in some rural communities. In former times sexual intercourse was another cause of ceremonial impurity.

They say that the Scriptures are *xcon*^{1}, a difficult word to translate into English. When applied to a flood, or a strong wind, it seems to carry the meaning of 'dangerous' or 'awesome.' When applied to medicine, it means that caution must be used, and that if it is taken unwisely it might be harmful. I once thought of *xcon*^{1} as 'holy' when applied to a cross or a saint. Now, however, I would translate it with the more inclusive term of 'powerful' and point out that the power may be either good or bad.

It was the weight of a number of incidents that began to lead me to the conclusion that Mazatecs are afraid of the Bible. For example, a man who was a town leader was eager to hear the gospel. He came and asked us to teach him. He prayed, asking the Lord to forgive his sins and to bless his family, but although he was educated and capable of reading the Scriptures, he would never read them for himself. When I persisted, urging that he read at home, he objected with, "People say that we will go crazy if we read God's Word."

A young fellow who had been reading Scripture told me that he was considering marriage. He wanted to know if he could go on reading or if he must stop.

A widow, now a Christian, said, "I used to be a sinner, but gradually I'm becoming clean." When I questioned her, she explained that when her husband had been living she was sinful, but since his death she was gradually becoming clean.

I suspect that the statement, "We are all sinners," in some contexts would mean, "None of us are virgins." Or, looking at it from the other direction, one of the Mazatec terms for 'virgin' is *cho*^{4}*ta*^{4}*tsje*^{3} which translated literally means 'clean person'[3].

[3] Lorna Gibson, who has been working with the Pame Indians of San Luis Potosí, Mexico, says that they make no distinction between adultery and marriage relations. That is, both are regarded as sinful. She backed up her statements with these illustrations: (1) A young man wanting to do what was right, but also wanting to marry, asked with concern, "Is it a great sin for a man to take a wife?" (2) A Pame speaking of a recently married girl said of her, "She's a sinner now; she's married." (3) The Pame expression for "virgin" when translated literally means "woman-still-holy."
Mary Shaw, working with the Achi Indians of Guatemala, says that one man said to her, "I'd like to become a Christian, but if I did I'd have to stop living with my wife, wouldn't I?"
Esther Matteson, working with the Piro of Peru, tells of the time she and her translation helper first went over Heb. 13:4. He was amazed and thrilled, and he questioned her to be sure that he had understood the meaning of "Marriage is honourable in all, and the bed undefiled; but whoremongers and adulterers God will judge." Ten he got up from the translation table and literally rushed out to call the men of the village together and tell them the good news. His wife had a meeting with the women, and they were told. They had all known that adultery was wrong, but that marriage relations were not sinful was good news indeed.

In order to learn more fully whether or not Mazatecs believed that they must be "clean" in order to read Scripture, I asked a Christian widow, "Why are people afraid to read God's Word?" She answered, "Probably they are not clean. But I was never afraid - not even when my husband was living."

I asked a Christian mother with three young children the meaning of *cjoa*^{4}*fi*^{3}*tson*^{3}*ntjai*^{2} ;thing-destroy-behalf-of,' which is the word people use when several children in one family die. Her answer was vehement, "That's a bad word. Don't ever say it again!" I persisted - although I was careful not to tell her what I suspected about the word. I asked, "Is it really bad? I thought it had something to do with funerals." She was my friend and she wanted to help, so hesitatingly she told me, "It's what ... and ... [she named a husband and wife] did. That's why ... was born." Then again she was vehement. "It's a bad word. I don't believe it. People just say so. I've followed Jesus since I was a little girl, so I don't know what they are talking about."

But all the time she was talking, she kept putting in a little grammatical particle that indicates the speaker's doubt about what she was saying. She didn't really know that she was telling the truth and anybody who felt that strongly would probably like to *know*. So I said softly, "I don't believe it either." Then I made a bargain with her. "I'll tell you what God's Word says, if you'll tell me what the old people say." So I told her that there is a difference in God's sight between adultery and the marriage bed.

That was what her conscience had been telling her, but she had had no assurance. Then she kept her half of the bargain. She told me that the old folks say that if people use witchcraft while not "clean" some member of the family may die. Their term for that type of death was the word she had objected to. She was relieved to find out that the Bible does not consider the marriage bed sinful.

Her reaction gave me the courage to talk to another young married woman, who had been my informant about ten years ago. She had loved the Mazatec hymns. She had learned to read Mazatec Scripture fluently and she did so with interest. She had led in prayer, and I considered her to be genuinely Christian. There was a young fellow in the same town who was also interested in the gospel. He too sang hymns and read Scripture. They married and I was delighted. "The first Christian family!" I thought.

But they stopped reading Scripture. They stopped growing spiritually. I urged to no avail. They were still my friends, and as time passed they sent their children to me to be taught about the Lord. The wife still sang hymns; in fact she could sing about sixty of them in Mazatec and half that number in Spanish. Why had she stopped reading Scripture?

I began to suspect that I knew the answer. So one day I told her, "Some people say that it's *xcon*[1] to read God's Word when a man and wife are living together. That is not so." I told her about Adam and Eve, and that Noah was told to replenish the earth. "God doesn't object to you and your husband living together, and it pleases him when we study his Word." She listened very quietly. No comment.

Two days later her eight-year-old son came running down, "Mother wants to know when you are coming up to study." So I went up. Her face was shining with joy. She picked up the New Testament (she enjoys trying Spanish). She had found the Lord's Prayer and she was delighted. She had also been reading the Gospel of John in Mazatec. That was the first time in ten years that I had seen evidence of either her or her husband reading the Bible for themselves.

There was another young wife, mother of two children, who sent her children to study, and she herself wanted to be taught. One day she brought money with which to buy a hymn book, but before she bought it she asked with hesitation, "Is this book *xcon*[1]? Can I read it every day? Are there days when I should not read it?" By that time I knew the reason for her hesitation, so I answered, "This book will not hurt you. I am the youngest of eight children. My father read the Bible every day and yet none of us died in childhood. God likes to have us read his Word." She bought a hymn book and later came back to buy all the Scripture that is in print in Mazatec.

By that time I was ready to understand strangers when they delicately asked about "cleanliness" and "sin." One day as I entered a Mazatec market with books for sale, a man stopped me and asked, "Do you have a book that tells us how to get forgiveness for sin?" I started to pull out the First Epistle of John but he stopped me. "I can't read; just tell me." I thought that he was probably talking about the "sin" of uncleanliness - they are seldom concerned about any other sin - but I answered for sin in general. "We pray to the Lord" (I made sure that he knew what God I was talking about) "and tell him that we are sinners and ask him to forgive us."

The man suspected that I was talking about sin in general and he was not satisfied. He wanted to be sure that it applied to that one specific sin. So he explained, "I am a man and I have a wife. Can I be forgiven the sin of living with my wife?" Now I should have explained that living with one's wife is not sin, but I was embarrassed to talk about such things in the middle of a market, so I said simply, "Yes." But he wanted to be sure that he understood, so he said, "I can have lots of women, and all I have to do is say, 'I'm a sinner, please forgive me,' and he will." Middle of the market or not, I couldn't let that pass, so I differentiated between adultery and the marriage bed. I was surprised and grateful to notice that the people who gathered around were listening as though they wanted to know the answer, end not even one made a crude remark.

Conclusion

The task of getting such a message out to all Mazatecs seemed so great that I did not want to believe the evidence. I decided to check with some of the Christian men. At my request, my colleague Julian Lloret questioned the young man who had helped George Cowan in the translation of the New Testament and who is also the one who heads up the tiny group of Christians in the biggest Mazatec town. This young man confirmed the fact that Mazatecs consider the Scriptures to be "powerful" and that they are afraid to read them unless "clean." He was surprised, however, that we needed to ask because, according to him, people make that objection "all the time" when we are selling Scripture in the market. Lloret asked if the restriction applied to man and wife, or only to extra-marital relations. The reply was that it applied also to man and wife - "but we don't believe that, do we?" Even he wanted to be assured that God does not object to sexual relations in marriage.

We wanted to be very sure of our conclusions, so Lloret asked another young man who had left the tribe about ten years previously. He agreed with our data, and as a mature Christian he went on to give us some advice. "You must tell them that the Bible is different. They don't have to be clean to read the Bible. It's the Bible that cleans!"

That was a good suggestion and we have been looking for other answers in the Bible. There is Ruth 4:11 in which the people say of Ruth, "The Lord make the woman ... like Rachel and like Leah." In 1 Sam. 1:10, 11 Hannah prayed for a child and the Lord answered her prayer. In Joshua 1:8 the people are told to read the Bible every day. In 1 Cor. 7:5 a couple is told not to refuse each other unless it be my mutual consent. In 2 Sam. 11 and 12, by means of the example of David with Bathsheba, we are taught the difference in God's sight between adultery and marriage relations.

The Scripture is explicit in Heb. 13:4, but until our eyes were opened to the Mazatecs' confusion, we did not know enough to apply it. Now that we have a clearer understanding of the Mazatec fears and beliefs we hope that the distribution of Scripture and the growth of the church will go ahead faster.

Fly-Agaric Motifs in the Cú Chulaind Myth Cycle

by

Thomas J. Riedlinger

1999 Oct 29

presented at the Mycomedia Millennium Conference hosted by Fungi Perfecti at the Breitenbush Hot Springs Retreat and Conference Center in Detroit, Oregon

Citation: Riedlinger TJ. "Fly-Agaric Motifs in the Cú Chulaind Myth Cycle". Lecture given at the Mycomedia Millennium Conference as published on Erowid.org. Oct 29 1999, published by Erowid June 2005

original source: https://www.erowid.org/plants/amanitas/amanitas_writings5.shtml

Table of Contents:

Introduction
Cú Chulaind's Warp Spasms
Cú Chulaind's Wasting Sickness
Effects of Amanita muscaria
Shamanic Origins
Conclusion: The Soma Connection
References

Introduction

The ancient myths of Ireland include many fabulous tales regarding Cú Chulaind, a warrior of the Ulaid clan who lived in the province of Ulster. Some of these portray Cú Chulaind's legendary moodswings: at one extreme, a battle-fury so intense that it terrified even his family, friends and fellow warriors; at the other, a torpor with vivid, prophetic dreams in which he languished for a year. It strikes me that aspects of both of these states, as described in the tales, resemble the effects of ingesting *Amanita muscaria*, the psychoactive mushroom with a bright red cap and white "speckles" also known as the fly-agaric.

This connection is especially significant in light of recent theories which suggest that many ancient Irish myths contain thinly-veiled allusions to *Amanita muscaria*. Peter Lamborn Wilson was among the first to point this out in his 1995 article "Irish Soma."[2] According to him it is likely that the Celts who settled Ireland either used it there in rituals or remembered that it had been used by their ancestors prior to migrating westward from an "Indo-European heartland" near the southwestern edge of Siberia. Wilson calls it "Irish Soma" because *A. muscaria* also is considered a strong candidate for Soma, the unknown plant substance praised as a god in the Hindu *Rig Veda*. It is a curious but well-established fact that there are numerous strong similarities between the culture of the Irish Celts and that of the Aryan peoples who migrated southward to India from the same heartland, bringing with them an oral tradition of hymns that became the *Rig Veda*.[3] Some even think the name "Ireland" derives from a Celtic word, "Erin," which is based upon or shares a common root with the Sanskrit "Arya."[4] In Wilson's view, both cultures almost certainly first learned about the entheogenic effects of *A. muscaria* from Siberian shamans in the Indo-European heartland.

Support for Wilson's theory has been offered by Erynn Rowan Laurie and Timothy White in their *Shaman's Drum* article, "Speckled Snake, Brother of Birch: Amanita Muscaria Motifs in Celtic Legends," which contends that motifs of magical foods in Irish Celtic lore are best explained as "metaphoric references to *Amanita muscaria*, the highly valued psychotropic, redcapped mushroom that was once used shamanically throughout much of northern Europe." While agreeing that these references "could theoretically be faded memories of earlier pre-migration Indo-European practices, preserved in oral legends passed down from generation to generation," they think it more likely that Irish Celts actually used this mushroom in religious rituals. Their reason is that Celtic legends seem, in their opinion, to contain "certain innovative occult symbols for *A. muscaria* that are fairly unique to the insular Celts." They maintain that such symbols would not have been needed unless a sacred mushroom cult was still being practiced in Ireland by Celtic Druid priests "who wanted to communicate teachings about the sacrament's use to initiates, while maintaining a protective veil of secrecy around its identification."[5]

Considered together, these two articles and Wilson's recent book on Irish Soma[6] build a very strong case for the general theory that the myths of ancient Ireland reflect at least a lingering awareness of the psychoactive properties of *Amanita muscaria*. But none of them links *A. muscaria* directly to Cú Chulaind. For reasons discussed in the following pages, I think it plausible that he personifies this mushroom or at least its capricious effects. We will start by reviewing descriptions of Cú Chulaind's so-called "warp spasms" and "wasting sickness." Next we will look at reported effects of *A. muscaria* inebriation and compare them with these maladies. Finally, I will discuss the possibility that myths about Cú Chulaind may derive from a shamanic source in prehistoric times which also inspired the Soma cult of ancient India.

Cú Chulaind's Warp Spasms

The first of Cú Chulaind's two maladies is variously translated as "battle-fury,"[7] "battle frenzy," "battle ardor"[8] or - my personal favorite - "warp spasm."[9] It is always accompanied by a temporary physical distortion called a *ríastarthae*[10] or *riastradh*[11] which usually includes an aura-like glow around Cú Chulaind's head, described by various writers as the "hero's light"[12] or the "warrior's light."[13] He first exhibits this proclivity in childhood, when, as related in *Boyhood Deeds of Cú Chulaind* (*Macghnímhartha*), some other boys provoke him with a barrage of toy javelins, balls and "hurleys" - 150 of each. After knocking these missiles aside without much trouble, Cú Chulaind becomes a bit flustered:

> You would have thought that every hair was being driven into his head. You would have thought that a spark of fire was on every hair. He closed one eye until it was no wider than the eye of a needle; he opened the other until it was as big as a wooden bowl. He bared his teeth from jaw to ear, and he opened his mouth until the gullet was visible.[14]

At this point, understandably, the other boys decide that they have somewhere else to go. But Cú Chulaind, now out of control, begins striking them down. He thrashes fifty before he is stopped by his patron and maybe father, King Conchubur of Emuin Machae, who gently points out that he should have secured the protection of the other boys before he tried to play with them. In other words, he should not have presumed to barge into their games without asking permission. Cú Chulaind resolves instead that it is he who will protect the other boys, and all return to the playing field. After that he always wins no matter what they play, including a primitive version of golf, wrestling and "mutual stripping." (The rules of the latter are lost in obscurity, other than what is deducible from the report that Cú Chulaind "stripped them all so they were stark naked, while they could not take so much as the brooch from his mantle.")[15]

Another episode in *Boyhood Deeds* relates that when Cú Chulaind was seven years old he went for a ride in a chariot driven by King Conchubur's charioteer. Upon encountering three fierce warriors from another clan, Cú Chulaind kills them and cuts off their heads to keep as trophies. Next he leaps from the chariot onto an antlered deer and subdues it. Then he captures twenty swans by knocking them out of the sky with well-aimed stones. The deer is tethered to the chariot and trots along behind; the swans, likewise bound to the chariot, fly overhead; the heads presumably are swinging to and fro inside the chariot. So much excitement in one afternoon proves too much for Cú Chulaind, who finds himself having a warp spasm just as the chariot approaches home. According to the tale,

> When they arrived at Emuin, the watchman said "A man in a chariot is approaching, and he will shed the blood of every person here unless naked women are sent to meet him." Cú Chulaind ... said "I swear by the god the Ulaid swear by, unless a man is found to fight me, I will shed the blood of everyone in the fort." "Naked women to meet him!" shouted Conchubur. The women of Emuin went to meet Cú Chulaind gathered round Mugain, Conchubur's wife, and they bared their breasts before him. "These are the warriors who will meet you today!" said Mugain. Cú Chulaind hid his face, whereupon the warriors of Ulaid seized him and thrust him into a vat of cold water.

> This vat burst, but the second vat into which he was thrust boiled up with fist-sized bubbles, and the third he merely heated to a moderate warmth.[16]

It is related in another of the tales, *The Wasting Sickness of Cú Chulaind* (*Serglighe Con Culainn*), that all of the Ulaid women who loved him "blinded one eye in his likeness," because "it was Cú Chulaind's gift, when he was angry, that he could withdraw one eye so far into his head that a heron could not reach it, whereas the other eye he could protrude until it was as large as a cauldron for a yearling calf."[17] Also in this tale, which describes the hero's deeds as a young man, a third warp spasm comes upon him not long after he wakes from his year-long wasting sickness, described in the following section. This time he loses his cool (literally) during a furious battle in the land of Eithne Ingubai. Having just slaughtered thirty-four warriors, he finds it hard to stop even after the rest of the enemy army retreats. One of his own countrymen then says:

> "I fear that the man will turn his anger against us, for he has not yet had his fill of fighting. Have three vats of cold water brought, that his rage might be extinguished. The first vat that Cú Chulaind entered boiled over, and the second became so hot that no one could endure it, but the third grew only moderately warm."[18]

In the tale of *Briancu's Feast* (*Fledh Bhricrenn*), Cú Chulaind is challenged to "straighten" a house when, after lifting one side of it, he sets it down off-kilter. When he tries to comply but at first is unable to do so, the hero gets angry.

> Then his ríastarthae came over him: a drop of blood appeared at the tip of each hair, and he drew his hair into his head, so that, from above, his jet black locks appeared to have been cropped with scissors; he turned like a mill wheel and he stretched himself out until a warrior's foot could fit between each pair of ribs. His power and energy returned to him, and he lifted the house and reset it so that it was as straight as it had been before.[19]

Elsewhere in the Irish myths, Cú Chulaind's warp spasms are said to include: a booming heartbeat;[20] the ability to revolve within his own skin[21] and thus fight in multiple directions at the same time; the aforementioned "warrior's light" which rose from the crown of his head; the "warrior's moon," a projection "as thick as a whetstone" from his forehead; and a "stream of black blood [which] geysered from his skull as tall as a ship's mainmast."[22]

Cú Chulaind's Wasting Sickness

The title event of *The Wasting Sickness* is triggered when Cú Chulaind tries to capture a pair of enchanted birds flying over a lake. The song of these birds, who are joined by a red-gold chain, causes people to sleep. Though King Conchubur's wife warns him that "those birds possess some kind of power," Cú Chulaind twice casts stones at them - and misses! "Now I am doomed," he says, "for since the day I took up arms I have never missed my target."[23] He then throws his javelin at them and pierces a wing, but both birds manage to escape. After walking a while, the angry Cú Chulaind sits down with his back to a stone and there falls asleep. The story continues:

> While sleeping he saw two women approach: one wore a green cloak and the other a crimson cloak folded five times, and the one in green smiled at him and began to beat him with a horsewhip. The other woman then came and smiled and also struck him in the same fashion, and they beat him for such a long time that there was scarcely any life left in him. Then they left.[24]

When the Ulaid try in vain to rouse Cú Chulaind, Fergus, another hero, tells them: "No! Do not disturb him - it is a vision." At this point Cú Chulaind awakes, but cannot speak. For a year he remains in this state, confined to a sickbed, then slowly recovers. On hearing of his vision, King Conchubur counsels Cú Chulaind to return to the stone where he first fell asleep. There Cú Chulaind finds the green cloaked woman, who explains that she seeks his assistance as a warrior to fight on behalf of her people who dwell in the Sídh, a Celtic "other world." As noted by Mac Cana, the Sídh is a place of apparent contradictions whose people, though immortal, are not "permanently invulnerable nor exempt from violent death." The relativity of time and space is fluid there: "perspectives are reversed and brevity becomes length and length becomes brevity as one crosses the tenuous border between the natural and supernatural." Control of magic is the thing which most distinguishes lords of the Sídh from mortal kings and heroes,[25] as Cú Chulaind learns firsthand from his wasting sickness. When he tells the green-cloaked woman that he is "not fit to fight men," she replies: "That is soon remedied: you will be healed, and your full strength will be restored."[26] This comes to pass when an Ulaid woman later tells him: "Throw off sleep, the peace that follows drink, throw it off with great energy." Cú Chulaind then rises and, passing his hand over his face, at last conquers "all weariness and sluggishness."[27] It is during a subsequent battle which Cú Chulaind fights for the green-cloaked woman that he slaughters the thirty-four warriors while in warp spasm.

Effects of Amanita muscaria

Before proceeding it will be useful to review the main symptoms of Cú Chulaind's two maladies. Those exhibited during his warp spasm are: agitation (manic behavior, bristling hair); visual distortions (one eye protrudes, the other recedes); facial distortions (he grimaces and gapes, a thick "warrior's moon" projects from his forehead); tachycardia (booming heartbeat); blood rushes to his head (a drop of blood at the tip of each hair, a geyser of it spurts from his crown); light rushes to his head (a spark of fire appears at the tip of each hair, the "warrior's light" from his crown); he becomes very strong and very limber. He also becomes very hot, needing three successive dousings in vats of cold water before his temperature returns to normal. The symptoms of his wasting sickness are: sleepiness, vivid dreaming and prolonged lassitude.

Next let us review some eyewitness accounts of the effects of *Amanita muscaria* among Koryaks and other indigenous peoples of Siberia:

> [From an 1809 paper which describes the effects of fly-agaric mushroom eaten by Koryaks in Kamchatka:] The narcotic effect begins to manifest itself a half hour after eating, in a pulling and jerking of the muscles or a so-called tendon jump…The face becomes red, bloated, and full of blood, and…the head and neck muscles are also in a constantly convulsive state…According to their own statement, people who are slightly intoxicated feel extraordinarily light on their feet and are then exceedingly skillful in body movement and physical exercise. The nerves are highly stimulated, and in this state the slightest effort of will produces very powerful effects. Consequently, if one wishes to step over a small stick or straw, he steps and jumps as though the obstacles were tree trunks….[T]hese persons exert muscle efforts of which they would be completely incapable at other times; for example, they have carried heavy burdens with the greatest of ease, and eye-witnesses have confirmed to me the fact that a person in a state of fly-agaric ecstasy carried a 120-pound sack of flour a distance of 10 miles, although at any other time he would scarcely have been able to lift such a load easily.
>
> [From an 1893 book describing travels in Eastern Siberia from 1861-71:] When a Koryak consumes the fly-agaric…the mushroom seems to produce a peculiar effect on his optic nerves which makes him see everything on a greatly enlarged scale. For this reason it is a common joke among the people to induce such an intoxicated man to walk and then to place some small obstacle, such as a stick, in his way. He will stop, examine the little stick with a probing eye, and finally jump over it with a mighty bound. Another effect of the mushroom is said to be that the pupils become much enlarged and then contract to a very small size; this process is said to be repeated several times.
>
> [From a 1903 book based on two years of field research with Siberian tribes:] The effect…became evident by the time the men had swallowed the fourth mushroom. Their eyes took on a wild look…with a positively blinding gleam, and their hands began to tremble nervously….After a few minutes a deep lethargy overcame them, and they began quietly singing monotonous improvised songs…They suddenly sprang raving from their seats and began loudly and wildly calling for drums….And now began an indescribable dancing and singing, a deafening drumming and a wild running about…during which the men threw everything about recklessly, until they were completely exhausted. Suddenly they collapsed like dead men and promptly fell into deep sleep….It is this sleep that provides the greatest enjoyment; the drunken man has the most beautiful fantastic dreams.

> [From the diary of a Polish army officer, published in 1863, who was fed fly-agaric as medicine during a visit to Kamchatka in 1796 or 1797:] I ate half my medicine and at once stretched out, for a deep sleep overtook me. Dreams came one after the other. I found myself as though magnetized [mesmerized] by the most attractive gardens where ...a group of the most beautiful women dressed in white going to and fro seemed to be occupied with the hospitality of the earthly paradise....[Later, upon taking more of the mushroom,] I fell asleep anew and did not wake up for twenty-four hours. It is difficult, almost impossible, to describe the visions I had in such a long sleep...What I noticed in these visions and what I passed through are things that I felt I had seen or experienced some time before, and also things that I would never imagine even in my thoughts.

These are only a few of numerous such accounts collected by R. Gordon Wasson, the man who theorized that Vedic Soma was *Amanita muscaria*.[28] Many others have been published elsewhere,[29] including a recent report that copious perspiration can sometimes result from eating this mushroom, making it seem to objective observers as if the imbiber has "swallowed fire."[30] Similarities with aspects of Cú Chulaind's warp spasms and wasting sickness - as well as with his "salmon leap," the hero's fabled ability to jump across great distances or high into the air - would seem to be obvious.

The emphasis here is on aspects of Cú Chulaind's abnormal behavior corresponding to various symptoms of *Amanita muscaria* intoxication. The combined effect of these aspects in Cú Chulaind is exaggerated, making his deeds "more often seem superhuman than heroic," as one scholar noted.[31] There is nothing in the record to suggest that *A. muscaria* induces either lethal battle furies or year-long lassitude. Wasson, for example, was dismissive of the theory that the famous "berserk-raging" of the Vikings during battle was caused by ingesting this mushroom. Such "murderous ferocity," he noted, "is conspicuously absent from our eye-witness accounts of fly-agaric eating in Siberia."[32] However, it seems to me feasible that Cú Chulaind's warp spasms and wasting sickness represent exaggerated versions of the mushroom's true effects as perceived by observers and subjectively reported by its users, including ataxia (loss of muscle control), frenzied dancing in shamanic rites, amazing feats of strength, dramatic optical distortions, and disruption of sleep patterns lasting for several days with unusually vivid dreams.

Another interesting property of *Amanita muscaria* is that the urine of a person who ingests it becomes psychoactive. Apparently the chemical constituent that causes its psychoactivity metabolizes only rather slowly. Thus the Siberians have a long history, noted with astonishment by many Europeans, of drinking their own or another person's urine to prolong the mushroom's usefulness. A witness to this practice described it as follows in 1809:

> Among the Koryaks... it is quite common for a sober man to lie in wait for a man intoxicated with mushrooms and, when the latter urinates, to catch the urine secretly in a container and in this way to [*sic*] obtain a stimulating drink even though he has no mushrooms. Because of this curious effect, the Koryaks have the advantage of being able to prolong their ecstasy for several days with a small number of fly-agarics. Suppose, for example, that two mushrooms were needed on the first day for an ordinary intoxication; then the urine alone is enough to maintain the intoxication on the following day. On the third day the urine still has narcotic properties, and therefore one drinks some of this and at the same time swallows some fly-agaric, even if only half a mushroom; this enables him not only to maintain his intoxication but also to tap off a strong liquor on the fourth day.[33]

In other words, the psychoactive urine becomes less so with each successive urination unless supplemented by ingesting more *Amanita muscaria*. This diminishing effect, confirmed by scientific research,[34] recalls the procedure of dunking Cú Chulaind in three vats of water in order to progressively curtail his warp spasm and restore him to a state of normal consciousness. Another interesting parallel is found in the *Rig Veda*, where hymn 9.97.55 mentions three filters through which Soma must be passed to render it clarified.[35]

Also worth mentioning here is a striking description of Cú Chulaind's hair. According to one of the myths, it was "brown at the base" and "blood-red in the middle," with "a crown of golden yellow."[36] Dried caps of *Amanita muscaria* often exhibit the same three colors (see Figure 1).

Dried caps of Amanita muscaria
Photo by TJ Riedlinger, © 2005 Riedlinger

Shamanic Origins

The foregoing adds credence to theories that the ancient Irish Celts may have used *Amanita muscaria* as an intoxicant or in Druidic rituals. If so, this would seem to refute Wasson's claim that the Celts were one of the peoples "infected with a virulent mycophobia, coming down from prehistory"[37] and his report of finding "no mushrooms in the records that we possess of the shadowy Druids."[38] Perhaps what Wasson interpreted as Celtic mycophobia was actually a strong tabu against the casual mention of a psychoactive mushroom used exclusively in secret magic rituals. I do find it curious that Wasson does not comment on the mysterious "magic egg" (*anguinum*) which, according to Pliny the Elder, was "esteemed by the Druids and believed by them to 'ensure success in law-courts and a favourable reception by princes.'" Pliny described it as "round, and about the size of a smallish apple," with a "cartilaginous shell...pocked like the arms of a polypus [octopus]." The Druids told him that it was composed of secretions and spittle from snakes. Scholars have guessed that it may have been either a sea-urchin minus its spines or the agglomerated egg-case of a whelk.[39] To me it sounds possibly fungal in origin - perhaps a mushroom somewhat altered in appearance by Druidic art.

In any event, it is certain that the Irish bards, themselves most likely Druids, do not openly allude to any psychoactive mushrooms in the ancient myths. We have heard the opinion of Laurie and White that these myths refer to *Amanita muscaria* only symbolically in order to "communicate teachings about the sacrament's use to initiates, while maintaining a protective veil of secrecy around its identification." That may well have been the case. But they concede that Wilson's theory is another possibility; that Irish Celts may have "preserved *soma* motifs in their myths without actually continuing the use of soma - just as Christians still cherish many ancient pagan religious symbols, such as Yule logs and decorated trees at Christmas, and fertility bunnies and eggs at Easter, without understanding their original pagan content."[40] Wilson's viewpoint also seems to be supported by the fact that *A. muscaria* does not readily grow in Ireland. Laurie and White think it may have been more common there in ancient times, before the almost total deforestation of that country in the last thousand years. But if so, as they themselves admit, "there is no irrefutable archeological evidence...such as the discovery of an archaic medicine bag filled with psychoactive mushrooms" to prove that Irish Celts used *A. muscaria* or any other "psychotropic substances capable of inducing ecstatic, visionary experiences."[41]

I would add that the effects of *Amanita muscaria* are so unpredictable that the Celts had strong incentive to abandon its ritual use before settling in Ireland. The problem for them was not only that *A. muscaria*'s active ingredients vary "considerably" from mushroom to mushroom.[42] "Soil conditions and geographic and seasonal factors also affect its hallucinogenic properties."[43] Imagine the frustration of attempting to gauge the appropriate dose of local mushrooms for different people in varying regions and seasons and climates as the Celts migrated westward for thousands of miles from their point of origin! That alone would suffice to explain why the Celts may have abandoned using *A. muscaria* in favor of surrogate plants or mythic symbols such as magic food. However, my respect for the intelligence, resourcefulness and pluck of traditional shamans allows that it is possible that once they had settled in Ireland the Celts found some way to mitigate the mushroom's potentially dangerous effects. In that case what Cú Chulaind represented for the bards of ancient Ireland was not *A. muscaria*'s use in their contemporary culture but the difficulties that their Celtic ancestors experienced when using it before they came to Ireland. These difficulties may have been conflated with the memory of battles fought during the Celtic migration. For example, *The Cattle Raid of Cuailnge* (*Tàin Bó Cuailnge*), is believed to derive from a narrative version transcribed as early as the 7th century C.E. But the earliest surviving copy dates from the 11th century and appears to be "a conflation of two 9th-century texts with some extra material added by the compiler himself."[44] According to Dáithí Ó hÓgáin, who regards *The Cattle Raid of Cuailnge* as the "central, and structurally the basic, story in the [Ulster] cycle,"

> This narrative is taken to encapsulate many aspects of the culture of the ancient Ulaidh [*var.* Ulaid], portraying a warrior-aristocracy organised on the lines of a heroic society and providing an authentic picture of an Iron Age Celtic culture. The military-political situation described in the narrative was explained by a series of "pre-tales" which were put together at a quite early date in support of the *Tàin*. These "pre-tales" also preserve fragments of myth and ritual from ancient tradition, and thus the general corpus evidences several details which can be compared with what Greek and Latin writers on the Continent attribute to the Celts known to them.[45]

This reinforces the theory that Irish Celts retained in their traditions ancient memories of things that their ancestors did or saw done either during or before their migration from the Indo-European heartland. At about the same time that they started this westward migration around 2500 to 2300 B.C.E., their Aryan neighbors apparently left the same heartland and started moving southward into India. Reflecting on this process of migration and culturization, the distinguished archeologist Stuart Piggott has observed:

> More and more the archeological evidence begins to reflect the existence, over most of Europe, of a warrior aristocracy of a type familiar to us from the heroic and epic literature ranging from the Iliad to the Sagas; from the *Rig Veda* to the *Tàin Bó Cuailnge*. If we look for an early context for the structure of society already ancient in early Europe, the tripartite social grading in its various forms; the government by king, elders, and assembly; the importance of the warrior class - it fits readily within the framework of what we can infer from the early second millennium B.C. onwards.[46]

Piggott says that this earlier framework, comprising a "curious amalgam of traditions and techniques, of peoples and ideas," provided the general context from which Celtic culture emerged en route to Ireland.[47] Wasson, whose research exposed him to Piggott's ideas, sent Piggott a copy of his book *Soma* and received in return this endorsement of Wasson's fly-agaric theory in a previously unpublished letter dated 11 October 1970:

> I would say straight away that I am persuaded that you must be right. One can never arrive at mathematical certainty in such things, but I find the cumulative effect of your always level-headed and judicious arguments quite convincing. I had already thought that, whatever Soma may have been, its use in Vedic religion as an agent to induce ecstacy [sic] meant that we were, in that religion, partly in a world that was not characteristically Indo-European, but which was somehow

> linked with shamanism in its widest sense. I recently wrote a little book on the Druids, and in it had to consider whether there was a shamanistic element in Celtic religion: with Eliade, I had thought there was none, but his book set me thinking in wider terms. The probability of Finno-Ugrian elements in Sanskrit would of course give just the links needed between the two worlds.[48]

What Piggott actually says in his book *The Druids* is that the "Celtic tradition in Ireland conserved untouched archaisms in language, ideas and even prosody which have their counterparts in Sanskrit or Hittite, and we must be seeing fragments of a common heritage that goes back to the second millennium B.C."[49] His analysis of these archaisms led him to conclude that "the Irish vernacular sources, especially the hero-tales, are the product of a primitive, illiterate, heroic society with a warrior-aristocracy" which composed them in accordance with its values.[50] He also believes that certain Druidic practices of the Irish Celts suggest "a very archaic substrate of belief" reflecting, it may be, an even earlier and more "primitive" influence: Central Asian shamanism, possibly originating near the Altai Mountains which border Siberia.[51] Rutherford, too, calls attention to this region as a possible shamanic nexus for the Druids and Vedic Aryans.[52] In addition to observing that "the Brahmanic ritual drug soma...is plainly the descendant of those used by the shamans to assist in inducing the trances,"[53] he states in a footnote:

> Evidence as to whether the Druids used ritual drugs to aid trance is wholly circumstantial, coming in part from Pliny's description of the mistletoe-gathering ceremony, though the mistletoe-berry is not a hallucinogen, and partly from a folk-tradition that they extracted an opium-like substance from the poppy. It is also possible that the so-called "magic mushroom" was used for Druidic purposes.[54]

The term "magic mushroom" is usually used in reference to those of the *Conocybe*, *Psilocybe* or *Stropharia* genera, which have very different effects from *Amanita muscaria*.[55] However, Rutherford's guess is more compelling in regard to *A. muscaria*. For even if the Druids did not use the fly-agaric in their practices, the fact that it grows only in mycorrhizal relationship with conifer and birch trees makes it similar in one important respect to mistletoe: the latter is a parasitic plant which grows only on trees. According to Pliny, the Druids considered "nothing more sacred than mistletoe and the tree that it grows on, so long as it is an oak." Beneath such trees, he said, they held religious feasts and sacrificed "with prayers to the god to render [their] offering propitious."[56] It thus seems feasible to me that the Druids used mistletoe in these rituals as a symbolic surrogate for *A. muscaria*.

Conclusion: The Soma Connection

A similar process occurred, I believe, in the Vedic religion with Soma. However, this change would have happened more slowly because of different circumstances. Migrating westward from their Indo-European heartland, the Celts encountered a wider variety of indigenous cultures than the Aryans did heading southward into India. Each successive conquest of these cultures presumably altered the Celtic religion through a process of syncretic transformation, just as the religion of the Aryans was changed by local Indian religions. Since it took the Celts far longer to reach Ireland (apparently the first of them arrived there in the sixth or fifth century B.C.E.),[57] it is easy to see why the Irish myths differ so markedly from Vedic hymns to Soma while yet bearing what Mac Cana calls "the unambiguous marks of a common origin."[58]

One of these marks, I believe, is the Indic god Rudra who figures in some of the earliest Vedic hymns. Clark Heinrich has convincingly explored the possibility that Rudra was initially identified with Soma.[59] I would add that Rudra's attributes remind me of Cú Chulaind. This is clearest in *Rig Veda* 2.33, the "Hymn to Rudra," which acknowledges his power to bestow special favors on those who worship him properly and to injure or at least withhold his favors from those who do not.[60] The first of the favors solicited is "the vision of the sun" (2.33.1). Next come prayers for protection, progeny and health or healing. As with Cú Chulaind, Rudra's powers are potentially useful in battle. He is asked to ensure that "our warriors on horseback remain unscathed" (2.33.1) and to fend off "all assaults of injury" (2.33.3). But also like Cú Chulaind, Rudra sometimes shows a tendency to injure those he normally protects. Helplessly acknowledging that Rudra's "shattering power" and "vast strength" (2.33.10) make him "like unto a beast" that is "fearful and strong, all ready for the kill," his petitioners pray to be spared the effects of his "fearful wrath" (2.33.5) and "great ill-will" (2.33.14). Their exhortation, "lay another low - not us!" (2.33.11), sounds identical to what we would expect to hear Cú

Chulaind's fellow warriors tell him.

The Vedic priests apparently tried hard to accommodate Rudra's capricious behavior. I believe this accounts for the complex stipulations of their Soma ceremony. If the mushroom itself had an unpredictable potency which threatened unpleasant experiences, there was only one recourse: all other variables had to be strictly controlled. This is consistent with an observation made by Andrew Weil:

> One valuable influence of ritual is to minimize the disruptive potential of [psychoactive] drugs and maximize their useful effects. All drugs have this ambivalent potential: they can trigger positive, helpful reactions or unpleasant and unhelpful ones....Ritual in the use of drugs works to curb the development of panic reactions by standardizing expectation in a positive direction. It helps define reasons for taking psychoactive substances in the first place, and gives participants a framework of order through which to interpret their experience.[61]

In the Vedic Soma ritual, techniques were developed to standardize both the preparation of the sacrament and the constitutional receptivity of those who ingested it. The Soma plant was pressed to release its juice, a tawny liquid. Then this juice was mixed with milk or curds. Perhaps numerous *Amanita muscaria* mushrooms which had been harvested at different times in different locations were combined at this stage of the ritual, in order to average out their diverse potencies. The Soma drinkers prepared themselves to imbibe the concoction by fasting and chanting the relevant Vedic hymns for several days. This would have standardized the body biochemistry of different individuals as much as possible, while also adjusting their minds to provide an appropriate "framework of order" for enlightenment. Yet despite these precautions, they sometimes, unpredictably, encountered Rudra's devastating wrath and eventually tired of it. Then they, like their cousins the Celts did at least temporarily, gave up using *A. muscaria* in favor of non-psychoactive alternatives that were dependably transmissible from adepts to initiates - most notably the esoteric system of philosophy laid out in the Upanishads. At that point Rudra-Soma joined Cú Chulaind as a literary vestige of the Indo-European heartland.

References

1. A paper presented 29 October 1999 at the Mycomedia Millennium Conference, Breitenbush Hot Springs Retreat and Conference Center, Detroit, Oregon. © 1999 by Thomas J. Riedlinger.
2. Wilson, P. Lamborn. 1995. Irish Soma. *Psychedelic Illuminations* 1(8):42-48.
3. See, e.g., Olmstead, G.S. 1994. *The Gods of the Celts and the Indo-Europeans*. Budapest: Archeolingua.
4. Schulberg, L. 1968. *Historic India*. New York: Time-Life Books, p. 39.
5. Laurie, E.R. and White, T. 1997. Speckled snake, brother of birch: Amanita muscaria motifs in Celtic legends. *Shaman's Drum* 44:53-65.
6. Wilson, P.L. 1999. *Ploughing the Clouds: The Search for Irish Soma*. San Francisco: City Lights Books.
7. Rutherford, W. 1987. *Celtic Mythology: The Nature and Influence of Celtic Myth - from Druidism to Arthurian Legend*. London: Thorsons, p. 60.
8. Mac Cana, P. 1985. *Celtic Mythology*. New York: Peter Bedrick Books, p. 102.
9. Sharkey, J. 1975. *Celtic Mysteries: The Ancient Religion*. New York: Avon Books, p. 10.
10. Gantz, J. 1981. *Early Irish Myths and Sagas*. London: Penguin Books, p. 136.
11. Mac Cana, p. 102.
12. Cowan, T. 1993. *Fire in the Head: Shamanism and the Celtic Spirit*. San Francisco: Harper, p. 37.
13. Mac Cana, p. 102.
14. Gantz, p. 136.
15. *Ibid*., p. 139.
16. *Ibid*., p. 146.
17. *Ibid*., p. 156.
18. *Ibid*., p. 171.
19. *Ibid*., p. 230.
20. hÓgàin DO. 1991. *Myth, Legend and Romance: An Encyclopedia of the Irish Folk Tradition*. New York: Prentice Hall, p. 131.
21. Mac Cana, p. 102.
22. Cowan, pp. 37-38.
23. *Ibid*., p. 157.
24. *Ibid*.
25. Mac Cana, p. 64.
26. Gantz, p. 159.
27. *Ibid*., p. 165.
28. Wasson, R.G. 1968. *Soma: Divine Mushroom of Immortality*. New York: Harcourt Brace Jovanovich. The passages quoted appear on pp. 248-249, 254-255, 262 and 244-245, respectively.

29. One especially important recent article in *Shaman's Drum* magazine describes the use of *Amanita muscaria* by modern-day Koryaks. It corroborates all the essential details in most of the older stories quoted by Wasson. See: Salzman, E., Salzman, J., Salzman, J. and Lincoff, G. 1996. In search of *mukhomor*, the mushroom of immortality. *Shaman's Drum* 41:36-47.
30. Heinrich, C. *Strange Fruit: Alchemy, Religion and Magical Foods*. 1995. London: Bloomsbury, p. 26.
31. Gantz, p. 25.
32. Wasson, p. 157.
33. Quoted in Wasson, p. 249.
34. Ott, J. 1993. *Pharmacotheon*. Kennewick, Washington: Natural Products Co., p. 328.
35. Wasson, pp. 51-58.
36. Kinsella, T. 1969. Combat with Fergus and others. In *The Tain*. Translated by Thomas Kinsella from the Irish epic *Táin Bó Cuailnge* [subtitle]. London: Oxford University Press, p. 156
37. Wasson, p. 181.
38. *Ibid*., p. 176.
39. Piggott, S. 1975. *The Druids*. London: Thames and Hudson, p. 188.
40. Laurie and White.
41. *Ibid*.
42. Heinrich, p. 15.
43. McKenna, T. 1992. *Food of the Goods: The Search for the Original Tree of Knowledge*. New York: Bantam, p. 108.
44. hÓgáin, p. 414.
45. *Ibid*.
46. Piggott, S. 1965. *Ancient Europe: From the Beginnings of Agriculture to Classical Antiquity*. Chicago: Aldine Publishing, pp. 106-107.
47. *Ibid*.
48. Piggott, S. 11 October 1970. Personal letter to R. Gordon Wasson. On file in the Tina and Gordon Wasson Ethnomycological Collection in the Economic Botany Library of Oakes Ames, Harvard University.
49. Piggott, *Druids*, p. 88.
50. *Ibid*., p. 100.
51. *Ibid*., 188.
52. Rutherford, pp. 126, 128. See also Carl Ruck's comments on the Altai Mountains region as a possible source of *Amanita muscaria* in ancient times; in: Wasson, R.G., Kramrisch, S., Ott, J. and Ruck, C.A.P. 1986. *Persephone's Quest: Entheogens and the Origins of Religion*. New Haven, Connecticut: Yale University Press, p. 253.
53. *Ibid*., p. 104.
54. *Ibid*., p. 108.
55. Wasson, p. 162.
56. Pliny quoted in Eluère, C. *The Celts: Conquerors of Ancient Europe*. Translated by D Biggs. New York: Harry N. Abrams, p. 119.
57. Gantz, p. 6.
58. Mac Cana, p. 14.
59. Heinrich, pp. 37-43.
60. All quotes from the *Rig Veda* in this paper are taken from O'Flaherty, Wendy Doniger. (trans.) 1981. *The Rig Veda*. London: Penguin.
61. Weil, A. 1978. Reflections on psychedelic mycophagy. In Ott, J. and Bigwood, J. (eds.). *Teonanacatl: Hallucinogenic Mushrooms of North America*. Seattle: Madrona Publishers, pp. 152-153.

Dark Religion? Aztec Perspectives on Human Sacrifice

by

Ray Kerkhove

© Ray Kerkhove

original source: https://openjournals.library.sydney.edu.au/index.php/SSR/article/viewFile/208/187

Table of Contents:

Mesoamerica's 'Dark' Image
Explaining Mesoamerican/Aztec 'Darkness'
The Light of Darkness?
Dark Deeds or 'Great Deeds'?
Honour and Compliance in Aztec Human Sacrifice
Dark, Dead Gods
The Glory of Dying Well
Cutting Portals through the Impenetrable Wall
Heart-Extraction: Returning the Divine Fragment
Decapitation: Untangling the Soul?
Error and Atonement
Slavery and Capital Punishment
'The Road to Our Downfall': Humiliation-unto-Death
The Great Rebirth
Dying as God: Becoming by Enacting
The Eternal Sacrifice
Debt and Offerings

Mesoamerica's 'Dark' Image

No rite evokes so many stereotypes of 'pagan darkness' as human sacrifice. For seven thousand years[1] in every corner of Mesoamerica,[2] thousands of people were decapitated, stoned, drowned, burned, crushed to death or cut open to have their living hearts removed as part and parcel of religious festivals. This paper concentrates on the grandest manifestation of this tradition: Aztec human sacrifice. Necessarily, we will also ponder its broader Mesoamerican context.

Many Spanish estimates of the frequency of Aztec human sacrifice are now considered exaggerated.[3] Nevertheless, early sources (namely, Diaz, Duran, Sahagun, and Cortes) give almost identical figures: each Aztec temple-complex dispatched two to six victims every twenty days. Thus, each Aztec town, 'even the most wretched villages',[4] conducted forty to a hundred and twenty killings annually.[5] For cities and special events such as centenaries and royal funerals, the figure moved into the hundreds or thousands. The inauguration of the Templo Mayor consumed twenty thousand lives.[6]

Such slaughter amounts to the greatest ritual carnage in human history. Consequently, Mesoamerica is almost a resident alien in the world of human cultures. As Jacquetta Hawkes notes, Mesoamerican culture, and particularly its religion, appears unusually dark and is considered

> strange and remote... brutal and sinister... threatening and perverse... uninhibited in displaying... sadism... [and as] manifest[ing]... little of the counterbalancing virtues of humanity.[7]

So pervasive is this 'dark' image that Michael Hamer has called it an 'open wound' on the flank of scholarship.[8]

Explaining Mesoamerican/Aztec 'Darkness'

Attempts to explain this 'darkness' have, quite simply, failed. The most common explanation - that the Aztecs and their kin were savage, immoral or amoral[9] - is untenable in the face of the growing acknowledgement of the complexity of Aztec sciences, the delicate aesthetics of their literature, and the balanced nature of their ethico-legal codes. The Aztecs had strict laws against murder. Sacrificing priests had to be 'careful, helpful, never hurt anyone [and remain] compassionate towards others ...[and] loving'.[10]

Faced with such paradoxes, Laurette Sejourne, Irene Nicholson and Miguel León-Portilla have promoted the notion that Aztec spirituality was 'betrayed in its most sacred essence'[11] and was corrupted, in its 'darkest hour'[12] into human sacrifice for 'vicious totalitarian ends'.[13] Apart from the inherent racism of such a view (consigning much of Mesoamerican history to mere 'ignorance... decadence'),[14] this 'betrayal' theory is confounded by archaeological discoveries and improved readings of Mayan glyphics, which have established that mass sacrifice had always been a part of Mesoamerican society.

Other hypotheses suggest environmental or cultural deficiencies. Michael Harner and Marvin Harris, for example, view the rite as a means of procuring protein and 'essential amino acids' since victims' bodies were sometimes consumed.[15] J.M Ingham, Barbara Price, David Carrasco and others claim that the Aztec elite developed mass sacrifices in order to terrorize their populace and enemy states.[16] Peter Furst and Gordon Wasson assert that Mesoamerican religion is a remnant of Upper Paleolithic psychedelic shamanism; the implication of their argument being presumably that drug-induced confusion between hallucination and reality created sufficient hysteria for murder to be instituted as a sacred rite.[17]

All of these theories have serious flaws. Runn has found that the early Mexicans had plenty of protein sources[18] and only ate tiny slivers of human flesh in rare, restricted rites 'as a form of communion'.[19] Likewise, R. Hilton and Inga Clendinnen have debunked the 'oppression' argument, finding little evidence of Mesoamerican kingdoms being unusually totalitarian,[20] and that 'mere oppression' could not explain 'how the trick worked'.[21] Finally, it now seems Mesoamericans despised and tightly controlled the use of narcotics and in fact inflicted far harsher punishments than the modern West.[22]

The Light of Darkness?

Thus, the puzzle remains; the rite is 'still undeciphered'.[23] Perhaps the reason for this mystery is that there has been little effort made to reconstruct what sacrificial death may have actually meant to its practitioners. In this paper, I weave together filaments of what the Aztecs themselves said and thought about human sacrifice. Their 'voice' will be their art and literature, especially their rich stock of poetry and prose, which was collected soon after the Conquest by Bernardino de Sahagun, Diego Duran, Motolinia and others, as well as the Aztec responses recorded in Conquistadors' records and ethnographic studies. In assembling this reconstruction, I am guided by Frederick Streng's firm belief that every culture has 'problematic states' which it seeks to remedy by developing a path of 'ultimate transformation'; that is: a set of personal and collective/cultural practices.[24] Hence, the view we are taking here is that of human sacrifice as a path of 'ultimate transformation'.

Dark Deeds or 'Great Deeds'?

The first issue we need confront in order to establish a 'Strengian perspective' is whether the Aztecs considered their rite loathsome or honourable. It is often assumed that Aztec human sacrifice was the lot of poor or 'disposable' people such as commoners or foreigners. However, the earliest accounts concur that virtually all children slain in these rites were locals of noble lineage, *offered by their own parents*.[25] Likewise, adult victims rarely seem to have been foreigners. In 1454, the Aztec government forbade the slaying of captives from distant lands at their temples.[26] Duran's informants told him that sacrifices were '*nearly always*... friends of the [Royal] House'[27] (namely: warriors) and were often of considerable status, as well as coming from neighbouring city-states and allies who shared the same culture and creed.

Why this might be seems to have a lot to do with the nature of Mesoamerican warfare. Most people were captured rather than slain in war since the aim was 'not to slay, to do no harm to man or woman... but to feed the idol'.[28] *Xochiyaoyotl* ('flowery wars') - monthly ceremonial affrays between allies and neighbouring city-states - were the usual source of sacrificial victims who included priests and a high proportion of noblemen.[29] In other words, the 'victim-procuring wars' were prestigious affairs through which local priests and lords stood a good chance of becoming sacrificial victims; as the Aztec Emperor reminded his victims, 'today for you, tomorrow for me'.[30] Certainly, the sacrifice of neighbouring kings was common enough for Classic Mayan monarchs to actually take on the title of those they captured.[31]

These factors meant that there were many illustrious role-models for captives/soon-to-be-victims to emulate. The Tlaxcalcan captain Tlahuicoli, for example, who was captured and put in command of a major military expedition demanded to die in gladiatorial sacrifice *despite* being granted his freedom.[32] Likewise, the anonymous prince in the Mayan *Tale of Rabinal* escapes his captors to bid goodbye to his homeland, but nevertheless nobly returns to his enemy's temple to meet his ritual end.[33]

Thus, it seems sacrificial death was considered a glorious end. When Spaniards criticised the rite, Aztec informants made 'indifferent or sarcastic remarks'[34] and were equally quick to ridicule the 'weakness of the Christians'.[35] Duran notes that his informants applauded

> the sacrifice of human beings... [as] *the honoured oblation of great lords and noblemen. They remember these things and tell of them as if they had been great deeds*.[36]

Sacrifices, as the 'main act' of huge feasts and festivals, were indeed hailed as 'great deeds'. Victims usually died 'centre-stage' amidst the full splendour of dancing troupes, orchestras, elaborate costumes and decorations, carpets of flowers, crowds of thousands and all the assembled élite.

The captive/victim was the Aztec equivalent of a celebrity or rock star; they were 'sighed for' and 'longed for' by the audience.[37] Their deaths merited a public announcement and their names were immortalised in the local 'roll of honour'. Commemorated in songs, poems and epics, the deceased were further honoured by the *euillotl* (human effigies) their relatives had constructed from pine log torches and decorated with paper wings and jacket. These effigies were burnt in memory of the victim for two days, and they took pride of place in the heart of town. Indeed, sacrifices were made to a *euillotl*, as though to a god.[38]

Honour and Compliance in Aztec Human Sacrifice

The prestige of sacrificial and war-related death explains why the victims Cortes and Alvarado freed 'indignantly rejected [the] offer of release and *demanded to be sacrificed*.'[39] It may also explain why Diaz found that the Aztecs '...cared nothing for death in battle... [and] came at us like mad dogs'.[40] Hernan Cortez described an actual hunger for death, noting that the Aztecs 'seemed *determined to perish* more than any race of man known before.'[41] Purportedly, victims sang and danced to their deaths 'with great joy and gladness'.[42] Others walked up 'purely of their own will',[43] and the poets chanted *otiquittaco quinequi moyollo yehua itzmiquitla*: 'You came to see it... your heart desires it: it was death by the obsidian blade!'.[44]

But not every victim could have craved 'death by the obsidian blade'. Even Aztec accounts mention some who wept, 'faltered... weakened' or lost control of their bowels.[45] Amazingly though, these were such a minority that they were viewed as a bad omen[46] and a *tetlazolmictiliztli* ('insult to the gods').[47] A 'weak' victim was hurriedly taken aside and slain amidst the congregation's sarcastic jeers of 'he quite acquitted himself as a man'.[48]

What we can glean from all this is that the sacrificial role entailed a great deal of social expectation and acquiescence. Unwilling victims were sometimes passed over in favour of more willing ones.[49] Key roles were reserved for those 'without [moral] defects... of good understanding ... good mannered'.[50] For many rites, the victim had such a quantity of prescribed duties that the festival would have failed without his or her willing compliance. Victims were expected to bless children, greet and cheer passers-by, hear people's petitions to the gods, visit people in their homes, give discourses and lead sacred songs, processions and dances.[51] Clendinnen and Brundage felt only a few had this kind of role, but the *Florentine Codex* and Duran make no such distinctions, stating that

> those who had to die performed many *ceremonies*... [and] these [pre-sacrificial] rites were performed in the case of all the prisoners, each in turn.[52]

Dark, Dead Gods

When Spanish friars demanded that the Aztecs destroy their gods, the priests replied, enigmatically, 'our gods are *already dead*'.[53]

Mesoamerican divinities are indeed mostly 'dark' or 'dead'. According to Richard Haly, the Aztec High God was basically a 'bone god', existing as the 'marrow' or 'dead shadow' behind all the gods.[54] Certainly, most Mexican deities are skeletons, skull-headed or severed heads and dismembered corpses.

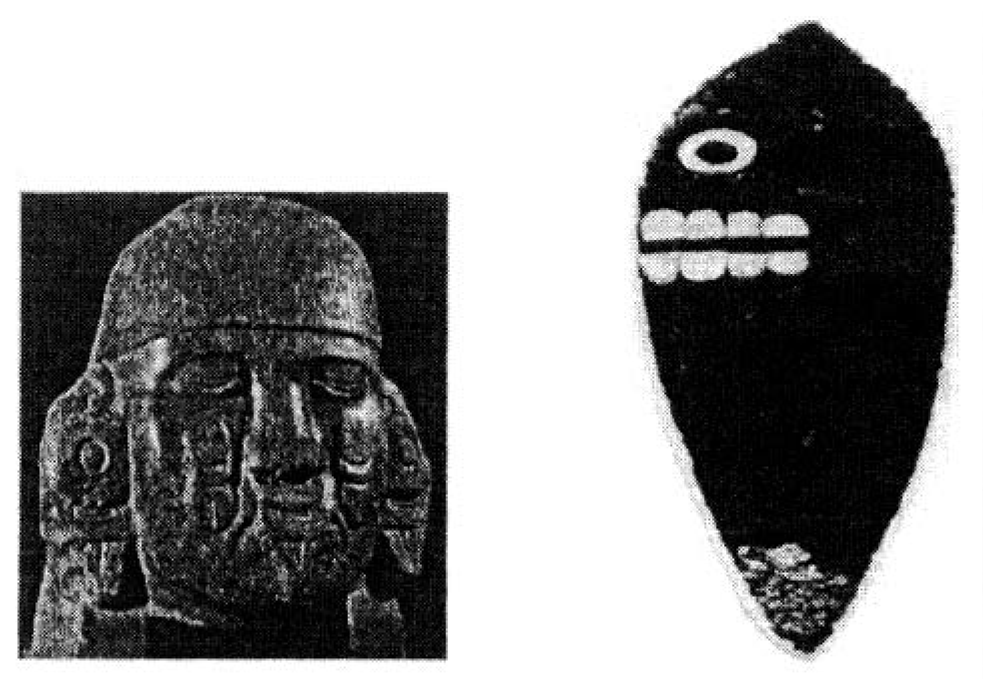


Figure 1: Dead, dark gods: God as a severed head (the moon goddess) and a hungry knife.

They are blackness and annihilation in one form or another, squatting in dimly lit or pitch black shrines.[55] These *tezcatl* (obsidian - black volcanic glass - mirrors) bear names such as 'Shadow', 'Black One', 'the Night' and 'Naught' (*Mahuq*'*utah*).[56] They are cosmic vortexes or vacuums; carnivores who devour warriors and maul their hearts; natural disasters; 'the Causer and Giver of aliments'; 'the Sacrificer', 'the Enemy', 'the Box of Death' (*Micapetlacalli*) and 'the Mother of the Inferno'[57] who 'kills... [whoever] wages war against us'.[58] As one poet sighed, 'He [the High God] too, came to cut off my life on earth'.[59]

Through these terrible gods, we, as individuals, 'disappear' into *Toanpopolihuiyan*: 'the Common House, where we lose ourselves' and 'become as one'.[60] Indeed, in this regard, this sinister pantheon is, in its extinguishing qualities, almost reminiscent of certain Buddhist concepts.[61] Sacrificial hymns collected by Bernardino de Sahagun have the victim singing that 'in a coffer of jade [the 'eagle vessel' that held human hearts] *I burn myself up*',[62] and that all 'will for ever end',[63] or, even more intriguingly, 'our death was *utterly ended*'.[64]

The Glory of Dying Well

Such imagery suggests that sacrificial death was believed to dissolve and purify in some absolute sense; certainly, it was claimed that death brought theosis wherein to die is to 'become God' (*teo-ti*).[65] Death contains all the highest joys, the highest truths and the highest states: 'peace and happiness are there' ; 'all is eternal there' ; there, 'the answer will be known (there)'.[66]

Regarding earthly life, by way of contrast, we hear it declared that:

> It is not true, no it is not true
> That we came to live on the earth
> We came here only to dream
> We came here only to sleep.[67]

Earth, we are told by a variety of Aztec poets, is not the place to accomplish things since 'our [real] home' lies in 'the Land of the Fleshless.'[68]

As might be expected with this kind of world-view, *how* one died was extremely important. The Aztecs meticulously organised death into types and levels. Passing away at home constituted the lowest end of the scale. 'A good death' was braver or more torturous. Those who died sacrificially, or in war or childbirth, procured the second-highest heaven (death in infancy formed the highest). Such fortunate souls are 'the God-dead' (*Teomicqui*) who

> go pure... live *hard by, nigh unto* the Sun... [who] always forever... rejoice... [since] the House of the Sun is... a place of joy.[69]

Miguel León-Portilla has shown that references to being 'joined to/at the side/nigh unto' this or that deity refers to 'Twinship' with a Deity which counts as the highest possible state.[70]

Cutting Portals through the Impenetrable Wall

Sacrificial death was also thought to provide 'an opening'[71] (what the Yaqui of northwest Mexico call 'the crack between the worlds') or portal into the highest Reality, which was hidden by an otherwise impenetrable wall. Native picture books such as *Codex Nuttall* show the heavens as a solid block above the world, occasionally punctured by a 'wound' through which deities could descend.

Mesoamericans required bloody 'openings' into the heavens because, as their religious songs complain, the gods are often 'stony'; that is: inexorable, silent.[72] Perforating the body, even to the point of death, was a way to 'perforate, penetrate' the 'mount' of God; indeed, this is the image used in some sacrificial hymns.[73] From infancy onwards, as Patricia Anawalt has shown, Aztecs performed ritual perforation known as *maceualiztli/tlaxoquixtiliztli*, 'good deeds', 'blood penance' which entailed piercing the ears, tongue, forearms and legs and drawing straws or ropes through the wounds. Such self-tortures were at times fatal, but were viewed as the best means of attaining spiritual boons and spiritual experiences ('vision serpents'). The practice was touted as our 'salvation'.[74]

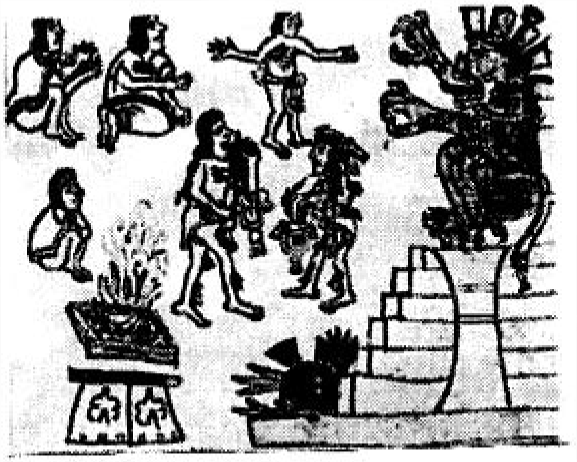


Figure 2: Tlaxoquixtiliztli (autosacrifice).[75]

Heart-Extraction: Returning the Divine Fragment

The chilling nature of Aztec heart-extraction may need to be read in the context of this culture that viewed excruciating (sometimes fatal) wounds as a path to the gods. The human offering was not enduring something he or she had no previous experience of. Nor did he or she suffer alone, since before and during human sacrifice, victims, priests and congregations habitually 'created openings' by perforating and bleeding themselves.[76]

The rite of ripping out victims' living hearts created the ultimate 'opening' through which to access the gods. The physical heart-soul (*tona*) was considered both the seat of the individual and a fragment of the Sun's heat (*istli*), and indeed the Sun itself was also considered a heart-soul, 'round, hot, pulsating'.[77] This divine fragment was seen as 'entombed' in our body and ruined by base desires.

> Where is your heart?
> You give your heart to each thing in turn.
> Carrying, you do not carry it...
> You destroy your heart on earth.[78]

Heart-extraction was evidently believed to liberate one's *istli* and reunite it with the Sun.

Aztec *Codex Magliabechiano*, Folio 70 depicts a victim's transformed heart flying Sunward on a trail of blood:

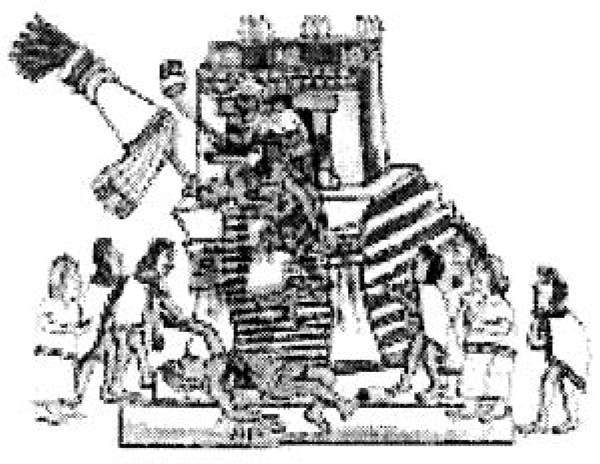


Figure 3: Emancipating the heart.[79]

The scene echoes a verse in *Codex Matritensis*:

> My heart rises;
> I fix my eyes upon You,
> next to You, beside You,
> O Giver of Life![80]

As noted earlier, 'next to You, beside You' refers to the highest possible spiritual attainment: the mystical state of Twinship with the deity. Likewise, 'rising' seems to be a metaphor for spiritual ascent. Images of heart-raising and heart-burning pervade Aztec poetry and Aztec heart-extraction. In sacrificial rites, the extracted heart was raised several times as its fumes (*istli*, 'heat') wafted upwards; additionally, it was often burnt to aid its ascent. Even today, Chamula Mayans refer to the 'best' (that is, most noble) heart as 'burning' or 'rising', while a heart on the point of death is described as 'very hot'.[81] The Aztec verb *tle'ca.uia* ('to burn', 'to set on fire') is, moreover, etymologically related to the verb *tle'cauia* ('to raise' or 'take up').[82] The end result was the notion of a *Yolleteotl*, a 'God-heart' which is apparently shown (wearing a little God-mask) in *Codex Laud*:

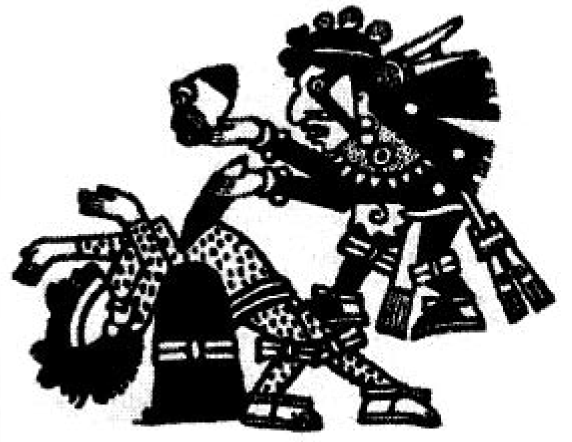
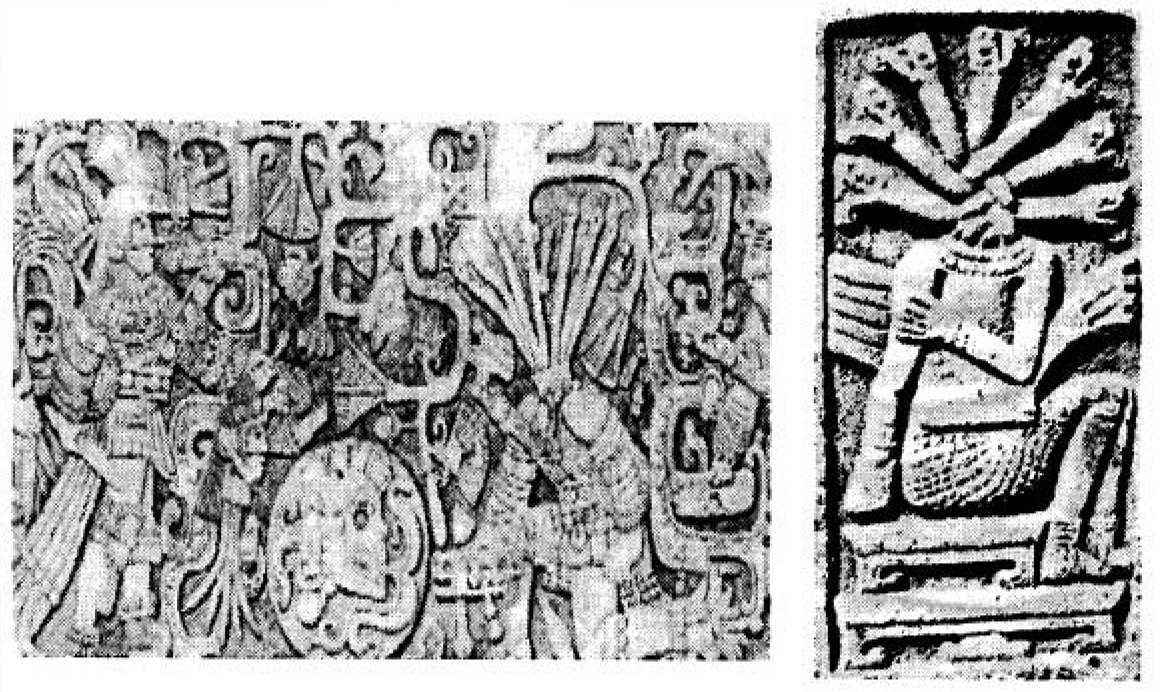


Figure 4: *Yolleteotl* (God-heart), wearing a Divine mask.[83]

Decapitation: Untangling the Soul?

Decapitation was undoubtedly another 'portal' of emancipation, being the second principal method of Aztec sacrifice. Native rationales for the act have been lost, but are certainly ancient. The centrepiece of the 9th and 10th century ball courts at both Tajin (on the Gulf Coast) and Chichen Itza is a series of reliefs depicting a key player being decapitated. From his neck, he sprouts *seven* serpents and vegetable vines which push back the amazed participants:



Figures 5 & 6: Decapitated ball players sprouting seven serpents and vines.[84]

Although we do not know precisely what this represents, Alan Sandstrom has found that contemporary Nahua (Aztecs) believe that each person has a seven-segmented *tonali* ('energy' or 'soul') which is viewed as a series of 'serpents' 'twisted' throughout the body.[85] Possibly the ball court reliefs depict the release and 'untwisting' of *tonali* through decapitation, perhaps even as a means of 'untangling' the knotted earth, as Ceclia Klein's study of the carvings suggests.[86]

Error and Atonement

Human sacrifice was also evidently a vehicle for atoning one's own, as well as, others' wrongs. According to the Mayan *Chilam Balam*, one woman, as she prepared herself for the sacrificial altar 'took upon herself the guilt of the locusts that have destroyed all that the people sowed'.[87] The Aztecs described victims who were 'sent [that is: killed] to plead for us,' or 'consecrated to annul all sin.'[88] In one Aztec poem, a warrior-victim announces that 'I embrace mankind ... I give myself to the community'.[89]

Death might seem a severe atonement, but in Aztec society, the slightest *tlatlacolli* ('sin' or 'insult') was a deadly serious matter. *Tlatlacolli* itself was viewed as an extremely dangerous force. Even a humble villager could, through an immoral act, unleash widespread natural disasters. Chamula Maya still blame plagues and droughts on the sins of individual villagers.[90] If an adulterer were to enter a house, Aztecs believed, all turkey chicks would perish from *tlazomiquiztli* ('filth-death').[91] For this reason, virtually every error incurred either the death sentence, life-threatening beatings, or permanent exile. If a ritual dancer made a wrong step; if a novice priest accidentally allowed a doughball offering to roll away, they were dragged off and executed.[92]

Although if such a person were not executed, they would probably have killed themselves anyway, for the Aztecs far outpaced their Catholic conquerors when it came to feeling burdened by guilt. Wrongdoers in the Aztec world would loudly proclaim that they were 'of mud, of earth'. They would physically and mentally torture themselves with *nonecoliloca* ('the hatred which I feel for myself') by slitting their tongues for vices of speech or their ears for vices of listening.[93] In classic Nahuatl (the Aztec language) the verbal form *ni-c-yecoa*, 'I sin', is closely related to *ni-c-ye.coa*, 'I finish it': error, quite literally, 'finishes' or 'ruins' everything.[94] There was a logical progression from the severity of sin through to the 'penance' of human sacrifice; indeed, the Nahuatl words for 'penance' and 'human sacrifice' were interchangeable.[95] Mere tears and blood washed away 'vile qualities' to some extent, but nevertheless even

> for a slight [sin they] hanged themselves, or threw themselves down precipices, or put an end to themselves by abstinence.[96]

Slavery and Capital Punishment

Such 'fatal atonement' was also visited upon slaves who were the only other main group from which human sacrifices were drawn,[97] and indeed it is no coincidence that Aztec 'sinners' actually described themselves as 'slaves' since enslavement was the punishment for all smaller misdeeds and debt. It was not a permanent class, and seems to have been composed largely of local people;[98] anyone could fall into (and out of) it.[99] However, if one continued to err, then slavery guaranteed a sacrificial end. Miscreant slaves were sold at market to whatever trade or craft guilds required someone to represent (and hence die as) their patron deity at the next festival.[100] So, sacrificial death sometimes blended capital punishment with personal atonement: 'fallen' persons atoned for (and were punished for) their crimes by dying for the gods. Some slave-deaths of this type were followed by an Aztec priest delivering a sermon about 'downfall' and what a real danger it was it was since those who 'esteemed... sweetness... ended in misery'.[101]

'The Road to Our Downfall': Humiliation-unto-Death

Such attitudes hint at an entire theology centred around 'the road to our downfall' as the Aztecs termed it, and this theology may well have provided the format and overall context for human sacrifice. Certainly one of the key myths of Mesoamerica is such a story. It concerns Quetzalcoatl Topiltzin, the epitome of an ascetic, celibate priest-king who, after decades of perfect conduct, agrees to imbibing a drink which he is told will make him 'compassionate' and help him to 'think of [or perhaps, in modern parlance, 'come to terms with'] death'.[102] Intoxicated, Quetzalcoatl commits incest with his sister, but then, overcome with remorse, he quits his throne. He buries and destroys his possessions and wanders about aimlessly, enduring hardships and humiliations. Finally (at least according to some versions of the tale), Quetzalcoatl immolates himself in a bonfire, thereby becoming the Morning Star. Significantly, Quetzalcoatl's 'humiliation onto death' is viewed as *necessary*; as the myth (*Leyenda de Los Soles*) itself explains,

> he [Quetzalcoatl] fell ... in order that he might strive, in order that the Dawn might come.[103]

Implied in this theme of 'necessary humiliation' is a warning against pride, and indeed pride was the chief topic of Mesoamerican homilies. Priests and Lords were constantly cautioned to 'humble' and 'humiliate' themselves through set 'Humiliations' (meaning self-sacrifices).[104] Thus, it is of little surprise that 'necessary humiliation' is a theme of Aztec human sacrifice. Most captives were kept for weeks - sometimes a year - before being slain. They initially lived a regal but religious existence chanting, fasting and holding vigils - rather similarly to Quetzalcoatl. Then, again much like Quetzalcoatl, they were feted: they were given 'pleasure girls' and intoxicants. After their 'downfall', they again emulated Quetzalcoatl by giving away and burying everything they owned. Finally, naked like infants (wearing only a paper loincloth), they met their deaths.

The Great Rebirth

This dressing like an infant suggests a connection with the Aztec emphasis on child-sacrifice. It was said that 'in the time of childhood, still in the time of purity, the good death is merited'.[105] As has already been noted, those who died in infancy occupied the highest heaven, suggesting to dress like a child was not simply a humiliation, but rather was also an allusion to seeking the highest heaven, to being 'reborn' through death. A large number of the 'sagely discourses' (which were a standard part of Aztec upbringing) bemoan the fact that our 'jade' (hearts or souls) were 'glowing' at birth and in infancy, but then grow 'cold,' 'enshrouded' and 'twisted' as we age.[106] Evidently human sacrifice was considered a vehicle for recapturing this lost (childhood) purity; certainly human sacrifice was sometimes referred to as 'birth'.[107] The captive is known as the 'child, son' of his captors, and inasmuch as he sings, throughout the sacrifice, 'my life shall revive... my heart will be refreshed', he hopes to recapture this lost childhood purity.[108] Indeed, in gladiatorial sacrifice, the victim is even tied by an umbilical-like 'sustenance rope'[109] which runs from his waist to a 'birth canal' (a hole in a stone).

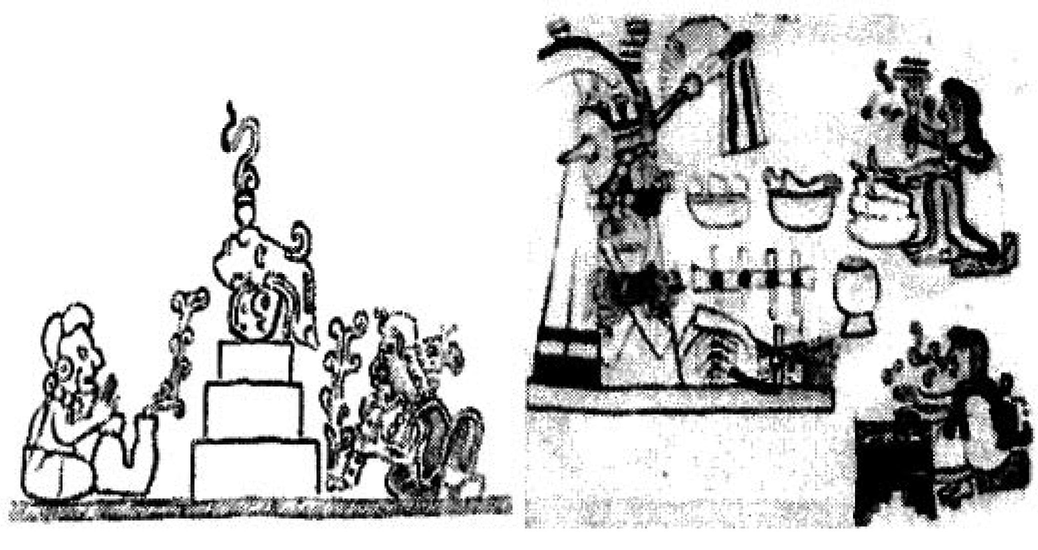
Dying as God: Becoming by Enacting

Aztec texts frequently refer to human sacrifice as *neteotoquiliztli*, 'the desire to be regarded as a god'.[110] Many rites consisted of victims taking on the paraphernalia, habits and attributes of the god or goddess whom they were dying as. This was known as being an *ixiptla*, becoming the god's representative or image. Interestingly, Aztec texts do not differentiate between human *ixiptla* and wooden or stone idols.[111] In fact, so elaborately costumed and painted were human *ixiptla* that even the congregation was unsure which were human and which were stone or wood.

To understand the significance of this, we need to digress a little into Mesoamerican concepts of divinity. Mesoamericans viewed deities as multiple yet One.[112] Rather like an actor (the Mayan term for god, *bacab*, actually meant 'clown, actor'),[113] gods usually wore masks, changing costumes and personas as the need arose, constantly transforming into each other and into a wide range of objects.[114] Their fluidity was such that the actual *appearance* or *face* of the God was a great mystery. Even the highest Mexican idols - those occupying the lofty pyramid-temples - were simply featureless lumps of dough over which clothes and precious masks were placed, and they were further hidden from view by bundled wrappings and veils.[115]

As a result, Aztec literature constantly speaks of a yearning to see the God's 'real' face and create a true 'face' for one's self.[116] In death, we are told that we will finally see God's face and achieve our own 'face'.[117] When a victim appeared in full regalia before the congregation, it was said that the divinity had been given 'human form': the god now had an *ixitli* (face),[118] since originally, as the sacrificial hymn of Cihuacoatl declares, 'Eagle feathers are no mask, for he rises *unmasked*'.[119]

All the native and Spanish sources on Aztec human sacrifice make it clear that victims were believed to attain full identity with the gods by dying as gods. Sahagun and Duran describe them being 'worshipped... as the deity'[120] or 'as though they had been gods'[121] (-the original Nahuatl term being *nicnoteoti'tzinca*, literally, 'I consider him a god').[122] Even whilst still alive, victims were honoured, hallowed and addressed (like gods) as 'Lord' and 'Lady'.[123] Posthumously, their remains were treated as actual relics of the gods which explains why victims' skulls, bones and skin were often painted, bleached, stored and displayed, or else used as ritual masks and oracles. Diego Duran's informants told him that whoever wore a victim's skin considered himself 'divine'.[124] The Mayan *Codex Dresden* and the Aztec *Codex Magliabechiano* depict victims' heads being worshipped and given food offerings.



Figures 7 & 8: Worshipping victims' severed heads.[125]

The Eternal Sacrifice

Some years after the Conquest, a body of Spanish Franciscans confronted the remaining Aztec priesthood and demanded - under threat of death - that they desist from their murderous practices. The Aztec priests conferred on the matter and boldly gave this defence:

> *Life* is because of the gods; with *their sacrifice* they gave us life... they produce our sustenance... [and] all which nourishes life.[126]

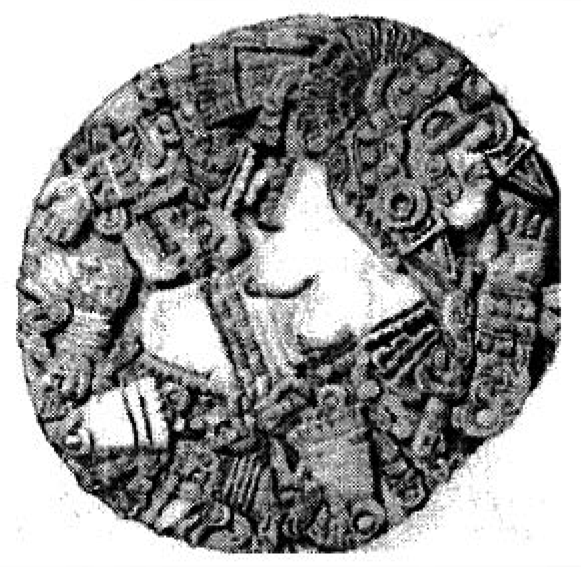


Figure 9: Large sculpture of the dismembered corpse of the Moon goddess, which stood in front of the Aztecs' Great Temple in today's Mexico City. Each severed limb is shown as Divine, wearing a God mask. Many Aztec sculptures and illustrations depicted the shattered or sacrificed bodies of the gods.

What the Aztec priests were referring to was a central Mesoamerican belief that a great on-going sacrifice sustains the universe. Everything is *tonacayotl*, the 'spiritual flesh-hood' or 'bodily (sacrificial) presence' of the gods on earth. Everything - the earth, crops, the moon, stars and people - springs from the severed or buried bodies, fingers, blood or heads of sacrificed gods.[127]

Dawn is the sun daily igniting itself for our sake; and then, crackling and screaming its way across the sky, the sun gives us sunset by smoldering in its own blood and embers.[128] It tears out its left eye (according to the Mayans) so that we will not be bothered by too much light at night; hence, the moon is the sun's hollow left eye socket.[129]

Our very existence, it was felt, was owed to this process: humanity is known as *macehuale*, 'the dead brought back to life through penance'.[130] The Earth Goddess *becomes* 'our food' so that we will not 'die of hunger'.[131] Daily, we till and eat the Earth Goddess's 'flesh' (soil and crops), build with her 'bones' (stones), and drink her 'blood' (water).[132] In several sacrificial rites, this was emphasized by eating grain images of the gods and declaring '*nicteocua*', 'I eat God'.[133]

Debt and Offerings

A strong sense of indebtedness arose from this worldview. Compared to the eternal sacrifice of the gods, human offerings were just a 'humble present',[134] a *nextlahualli* ('a debt', or 'tribute paid'), and indeed *nextlahualli* was a commonly used metaphor for human sacrifice.[135] Monaghan sees this encapsulated in the term *nchiso yu'uva* which was borrowed from the Aztecs' neighbours, the Nuyou Mixtec.[136] *Nchiso yu'uva* literally means a 'contract with the Earth' which involves giving life for life, on the basis of the understanding that one thing - and hence, everything - only lives by killing something else.

> We live here on the Earth [the dancer stomps the ground]
> We are all fruits of the Earth.
> The Earth sustains us...
> We eat of the earth
> *and the Earth eats us.*[137]

The modern Nahua shaman Aurelio puts it another way: 'everything in our lives is a *gift*';[138] nothing comes to us for free [edit. rem. - a bit of contradiction, since gift is exactly for free; in polish lang.: gift = *dar* and *dar*mo means for free and also *darmowy* (masc. sing.); where *dar mowy* means gift of speech]. Even under the threat of execution, Mesoamericans insisted that they *must* '*pay the debt* for [the gods'] bringing rain': if things are not paid for, a disastrous cosmic imbalance results.[139] Thus, rather than being an anomaly, human sacrifice was perceived as a natural obligation and so part of a mechanical tit-for-tat. The complex rites of kings and priests with its self-tortures and sacrifices were believed to 'set the people free' and 'protect the people',[140] whereas the victim simply 'gave her service'[141] and 'fulfil[led]' his 'duty'.[142]

Human sacrifice was, in this sense, the 'cherry' on top of a whole pile of offerings through which the Aztecs sought to repay their debt to the gods. They 'gladly parted'[143] with everything, happily burying, smashing, slaying and sinking vast quantities of quail, rabbits, dogs, feathers, flowers, insects, beans, grains, paper, rubber and treasures as sacrifices.[144] Even the 'stage' for human sacrifice, the massive temple-pyramids, were offering mounds crammed with treasures, grains, soil and human and animal sacrifices that were buried as gifts to the deities.[145] Adorned with the land's finest art, treasure and victims, temples themselves became offerings which were buried under new structures every eight or fifty-two years.

Despite two centuries of scholarship, many cultures continue to be dismissed as primitive and savage for having practised some form of human sacrifice. The worlds of the Celts, the Norse, the Asante, the early Peruvians and Hawaiians are mostly portrayed as dark and deluded, inhabited by ignorant, superstitious people, led by wicked priests. This is an insult to the sophistication of these cultures and their respective spiritualities. Highly urbane societies - indeed, much of the world - has practised human sacrifice at one time or another. The rite was part and parcel of the Kālī cult and Saivite Hinduism well into the 1830s (until British authorities stamped it out),[146] although modern Saivites now either deny or else completely ignore this heritage. As strange as sacrificial creeds might seem to us today, we need not look too far for modern parallels such as Kamikaze pilots or suicide bombers.

The beauty of Frederick's Streng's model is that it allows us to treat sacrificial creeds positively, as viable paths by which people sought to ultimately transform themselves and their community. Of course, in terms of the severity of its demands, Aztec/Mesoamerican religion was a 'dark' faith, yet this may, in the end, be the best explanation for the system's persistence over such a wide area for so many thousands of years. Its appeal evidently came from its willingness to publicly tackle the inevitability of death; for unlike many creeds, Aztec religion never paid lip service to the idea of dying for God or seeking an afterlife.

Footnotes

1. Even the earliest Mesoamerican quasi-farming cultures at Durron and Coxcalton show evidence of sacrificial practices. See R. S. MacNesh and M. L. Fowler *et al*, *The Prehistory of Tehuacan Valley* Vol.5, (Austin, 1972) p.84 and Robert D. Dienna, 'Religion and Social Organisation in Formative Times,' in Kurt V. Flannery (ed.) *The Mesoamerican Village*, (New York, 1976), p.351.
2. Significantly, an early observer, Duran, found that the rite was Coahuitl, meaning 'Feast which belongs to one and all' Fray Duran, trans. F. Horcasitas and D. Heyden, *Book of the Gods, and Rites of the Ancient Calendar* (Norman, 1971) p.77.
3. Patricia R. Anawalt, 'Understanding Aztec Human Sacrifice', *Archaeology*, (Jan.- Feb. 1980), p.42. See also B. C. Brundage, *The Jade Steps A Ritual Life of the Aztecs*, Univeristy of Utah (Salt Lake City, 1985) p.171, and the archaeological finds of E. M. Moctezuma, 'Archaeology and Symbolism in Ancient Mexico, The Temple Mayor of Tenochtitlan' *Journal of the American Academy of Religion* 53:3, (Dec. 1985), p.118.
4. Duran, *op. cit.*, p.77.
5. For a detailed analysis of the format and frequency of Aztec human sacrifice, see Raymond Constant Kerkhove, *Explaining Aztec Human Sacrifice*, MA Thesis, (St. Lucia, 1994), pp.34-5.
6. Anawalt, *op. cit.*, pp.39-40.
7. Jacquetta Hawkes, *The Atlas of Early Man* (London, 1976), pp.201-3
8. Michael Harner, 'The Ecological Basis for Aztec Sacrifice', *American Ethnologist* 4, (1977), p.133.
9. The Aztec amorality argument is still in favour with some; see for example, K. A. Read, 'Negotiating the Familiar and the Strange in Aztec Ethics', *Journal of Religious Ethics* 15: 1 (Spring 1987), pp.6-7.
10. Bernardino de Sahagun, *Florentine Codex General History of the Things of New Spain* trans. A. J. O. Andrews & Charles E. Dibble, (Santa Fe, 1981) Bk. 3: 9: 70.
11. Laurette Sejourne, *Burning Water: Thought and Religion in Ancient Mexico*, (London, 1956) pp.14-16.
12. Irene Nicholson, *Firefly in the Night: A Study of Ancient Nahuatl Poetry and Symbolism* (London, 1959), p.23.
13. *Ibid.*, p.19.
14. *Ibid.*, p.23.
15. These views were expressed by Michael Harner in articles such as 'The Enigma of Aztec Sacrifice,' in *Natural History* 86:4, (April 1971), p.133ff but gained greatest popularity through Marvin Harris' *Cannibals and Kings* (London, 1978).
16. See Barbara T. Price, 'Demystification, Enriddlement and Aztec Cannibalism: A Materialist Rejoinder to Harner' American Ethnologist 5:1, (February 1978), p.105 and J. M. Ingham, 'Human Sacrifice at Tenochtitlan' *Comparative Studies of Society and Religion* 26:3, (July 1984), p.347, 380. David Carrasco is the main champion of this line of argument. The best example of his views in this regard can be found in his combined work with J. Broda and A. A. Demarest, *The Great Temple of Tenochtitlan* (Berkeley, 1987), pp.65-6.
17. R. Gordon Wasson, *The Wondrous Mushroom: Mycolatry in Mesoamerica* (New York, 1980), pp.xvii, 57, 83, 95 and Peter J. Furst, *Flesh of the Gods: The Ritual Use of Hallucinogens*, (London, 1972), p.271f.
18. E. Hunn, 'Did the Aztecs Lack Animal Protein Domesticates?' *American Ethnologist* 9:3, (August 1982), pp.578-9.
19. Duran, *op. cit.*, p.191.
20. R. Hilton, 'Is Intellectual History Irrelevant? The Case of the Aztecs', *Journal of the History of Ideas* 33, (April 1972), p.340.
21. Inga Clendinnen, *Aztecs: An Interpretation* (Cambridge, 1991), p.4f.
22. de Sahagun, *op. cit.*, Bk. 2: 27: 106 Bk. 3: 5: 59.
23. David Carrasco, 'City as Symbol in Aztec Thought: Clues from the Codex Mendoza' *History of Religions* 20, (February 1980), p.201, note p.7.
24. Frederick J. Streng, *Understanding Religious Life* 3rd edition (Belmont, 1982), pp.2-8, 23-5, 43, 63, 84.
25. Compare Hernan Cortes, *Letters*, trans. A. R. Pagden (London, 1972), p.105 with T. de Motolinia, trans. F. B. Steck, *History of the Indians of New Spain*, (Washington DC, 1951), pp.118-19 and Duran, *op. cit.*, (1971), pp.223, 242.
26. Duran, trans. F. Horcasitas and D. Heyden, *The Aztecs: History of the Indies of New Spain*, (London, 1974) p.141.
27. *Ibid.*, my italics.
28. Duran, *op. cit.*, (1971), p.198.
29. Alfonso Caso, trans. L. Dunhan, *The Aztecs People of the Sun* (Norman, 1956), p.88.
30. *Tezozomoc* Vol. 2, in Jacques Soustelle, *Daily Life of the Aztecs* (London, 1955), p.100.
31. Linda Schele and Mary Ellen Miller, *The Blood of Kings: Dynasty and Ritual in Maya Art* (New York, 1986), p.210.
32. Peter G. Tsouras, *Warlords of the Ancient Americas: Central America* (London, 1996), p.147.
33. Rabinal Achi, 'Teutro Indigenes Prehispanico' in Miguel León-Portilla (ed), *Pre-Columbian Literatures of Mexico*, p.105.
34. Duran, *Book of the Gods and Rites* p.227.
35. *Chilam Balam de Chumayel* trans. Miguel Rivera (Madrid, 1986), pp.15 (29), 25 (51), 29 (58).
36. Duran, *Book of the Gods and Rites*, p.227, my italics.
37. de Sahagun, *op. cit.*, Bk. 2: 38: pp.168-71.

38. *Ibid*., Bk. 2: 4: 18: 69-70, Bk. 6: p.21.
39. Bernal Diaz, *The Conquest of New Spain*, (London, 1972), p.159. The incident with Alvardo is described by Nigel Davies in his *The Aztecs*: A History, (London, 1973), p.172.
40. Bemal Diaz, *op. cit*., pp.56, 142, 336.
41. Hernan Cortes, *Letters*, pp.297-8.
42. Duran, *Book of the Gods and the Rites of the Ancient Calendar*, pp.132, 232.
43. de Sahagun, *op. cit*., Bk. 2: 20: 49, Bk. 2: 24: 76, 33: 139-49, Bk. 9: 19, 88.
44. Irene Nicholson, *op. cit*., p.190.
45. de Sahagun, *op. cit*., Bk. 2: 51.
46. Duran, *Book of the Gods and the Rites of the Ancient Calendar*, p.132.
47. *loc. cit.*
48. de Sahagun, *op. cit*., Bk. 2: 21.
49. Sir John Eric Sidney Thompson, *Maya History and Religion* (Norman, 1970), p.181.
50. de Sahagun, *op. cit*., Bk. 2: 24: 68-71. Victims for special roles were also expected to be charming, quick and able to dance 'with feeling' to the sacred music.
51. *Ibid*., Bk. 3: 8, 2: 5: 9, 2: 24: 68-71.
52. *Ibid*., Bk. 2 : 5 : 9, my italics; see also Duran, *Book of the Gods and the Rites of the Ancient Calendar*, p.112.
53. Miguel León-Portilla, *Aztec Thought and Culture: A Study of the Ancient Nahuatl Mind* (Norman, 1963), p.64, my italics.
54. Richard Haly, 'Bare Bones: Rethinking Mesoamerican Divinity' *History of Religions* 31:3, (February 1992) pp.278, 286-9.
55. Duran, *op. cit*., (1971), p.211.
56. *Popul Vuh: The Book of Counsel*, trans. D. Tedlock, (New York, 1985), p.187.
57. Irene Nicholson, *op. cit*., p.88.
58. Duran, *op. cit*., (1974) p.149.
59. Laurette Sejourne, *op. cit*., p.7.
60. Miguel León-Portilla, *Native Mesoamerican Spirituality* (New York, 1980), p.44 and Irene Nicholson, *op. cit*., p.174.
61. This is perhaps most graphically evident in the resemblance to some of the equally fearsome depictions of Tibetan wrathful deities who, in tantric visualization practices, smash through the illusion of individuality and 'self-clinging' (*ātmagrāha / bdag 'dzin*) in a similar way to their Aztec counterparts, although with less of a communal or collective societal focus.
62. 'Song of Yiacatecuhtli' in de Sahagun, *op. cit*., Bk.2: 245, my italics.
63. de Sahagun, *op. cit*., Bk.2: 236-237.
64. Irene Nicholson, *op. cit*., p.94, my italics.
65. Joef Haekel, 'Hochgott und Gotter im alten Mexiko' *Kairos* 13 (1959), pp.132-3.
66. de Sahagun, *op. cit*., Bk. 6: 17: 203, and Irene Nicholson, *op. cit*., pp.50, 195.
67. *Collection of Mexican Songs* Folio 14r; Miguel León-Portilla, *Native Mesoamerican Spirituality*, p.184.
68. Irene Nicholson, *op. cit*., p.177.
69. de Sahagun, *op. cit*., Bk. 6: 21.
70. Miguel León-Portilla, *Native Mesoamerican Spirituality*, p.62f.
71. Irene Nicholson, *op. cit*., pp.42-4.
72. *Ibid*., p.199.
73. de Sahagun, *op. cit*., Bk. 2, App. 242.
74. *Popul Vuh*, p.190.
75. *Codex Magliabechiano* Folio 79r.
76. de Sahagun, *op. cit*., Bk. 2: 3: 8, 20: 49, 21: 47.
77. Alan Sandstrom, *Corn is Our Blood: Culture and Ethnic Identity in a Contemporary Aztec Village* (Norman, 1991) pp.239-40, 257; and Eva Hunt, *Transformation of the Hummingbird: Cultural Roots of a Zincantecan Mythical Poem* (Ithaca, 1977) p.89.
78. Irene Nicholson, *op. cit*., pp.156, 203.
79. *Codex Magliabechiano*, Folio 70.
80. *Codice Matritensis Folio* 195r, in Miguel León-Portilla, *Native Mesoamerican Spirituality* p.187.
81. G. H. Gossen, 'Animal Souls and Human Destiny in Chamula' *Man* 10:3 (September 1975), pp.449-50.
82. F. X. Clavigero, trans. J. O. Anderson, *Rules of the Aztec Language: Classical Nahuatl Grammar* (Salt Lake City, 1973), p.8.
83. *Codex Laud*.
84. *Aparico stela* (Tajin, Vera Cruz) and *The Great Ball Court* (Chichen Itza, Yucatan).
85. Sandstrom, *op. cit*., pp.239-40, 257-58.
86. Cecilia F. Klein, 'Woven Heaven, Tangled Earth: A Weaver's Paradigm of the Mesoamerican Cosmos' in Anthony F. Aveni and E. Urton (eds), *Ethnoastronomy and Archaeoastronomy in the American Tropics* (New York, 1982) p.11f.
87. *Chilam Balam de Chamayel*, p.42 (112).
88. Duran, *op. cit*., (1971), p.232.
89. MSS *Romance de Los*... Folio 27r, in Miguel León-Portilla, *Pre-Columbian Literatures of Mexico*, p.82.
90. Francisco Clavigero, *Historia antigua de Mexico* as cited in Frank J. Neumann, 'The Black Man in the Cave: An Aztec Variant of the Gatekeeper Motif' in F. E. Reynolds and E. H. Waugh (eds), *Religious Encounters with Death* (London, 1977) p.47.
91. de Sahagun, *op. cit*., Bk. 5: 29: 191-92.
92. *Ibid*., Bk. 2: 25: 80-86.
93. F. X. Clavigero, *op. cit*., p.78.
94. *Ibid*., p.7.
95. Burr Cartwright Brundage, *The Jade Steps*, pp.152, 187.
96. T. Motolinia, *History of the Indians of New Spain*, pp.106-7.
97. de Sahagun, *op. cit*., Bk. 2: 34: 148.
98. Duran, *op. cit*., (1971), p.260.

99. On the nature of Aztec slavery, see Soustelle, *op. cit.*, pp.73-7; and Davies, *op. cit.*, p.179.
100. Duran, *op. cit.*, (1971), p.131.
101. de Sahagun, *op. cit.*, Bk. 2: 24: 21. Interestingly, this same blend of punishment and atonement can be seen in Aztec attitudes toward state enemies. When Cortes denounced their sacrifice, Emperor Moctezuma countered that at least the Aztecs gave such foes, who were 'condemned to death', the 'honour' of dying for the gods, whereas the Spanish simply slew them on the battlefield; Clavigero, in C. S. Braden, *Religious Aspects of the Conquest of Mexico* (Durham, 1933) p.59.
102. de Sahagun, *op. cit.*, 3:4: 16-18.
103. Miguel León-Portilla, *Pre-Columbian Literatures of Mexico*, pp.92-9.
104. Motolinia, *op. cit.*, p.149, *Popul Vuh*, p.8.
105. de Sahagun, *op. cit.*, Bk.6:21.
106. *Ibid*., Bk.6: 18-21 and Codice Matritensis Folio 116r in Miguel León-Portilla, *Native Mesoamerican Spirituality*, p.210.
107. de Sahagun, *op. cit.*, Bk.2: 160, 235.
108. *Ibid*., Bk.2: 160.
109. *Ibid*., Bk.2: 21: 51.
110. Duran, *op. cit.*, (1971), p.177 (Note 4).
111. *Ibid*., p.102.
112. See Miguel León-PortiIIa, 'Aztec Gods: How Many?' in J. Akerenson (ed), *Citra 1492* (Washington DC, 1991).
113. J. Eric S. Thompson, *Maya History and Religion*, p.227.
114. Hunt, *op. cit.*, p.55. See also de Sahagun, *op. cit.*, Bk. 2:226, 238-239, and Duran, *op. cit.*, (1971), p.101.
115. Duran, *op. cit.*, (1971), pp.72-3.
116. Miguel León-Portilla, 'Pre-Hispanic Thought,' in M. de la Gueva (ed), *Major Trends in Mexican Philosophy* (Notre Dame, 1966) p.38.
117. Miguel León-Portilla, *Pre-Columbian Literatures* of Mexico, p.85.
118. Arvind Hvindfeldt, *Teotl and Ixiptlatli* (Copenhagen, 1958) pp.80-8.
119. de Sahagun, *op. cit.*, Bk. 2, Appendix 231.
120. Duran, *op. cit.*, (1971), pp.42, 109, 232.
121. de Sahagun, *op. cit.*, Bk. 2: 226, 238-9.
122. Clavigero, *op. cit.*, p.98.
123. Duran, *op. cit.*, (1971), p.189.
124. *Ibid*., p.176.
125. *Codex Dresden* and *Codex Magliabechiano* Folio 72r.
126. Miguel León-Portilla, 'Colligues and Christian Doctrines' in his *Aztec Thought and Culture: A Study of the Ancient Nahuatl Mind* (Norman, 1963) p.215, my italics. A similar defence of human sacrifice was given during the Conquest itself. See Bernal Diaz, *op. cit.*, p.240.
127. H. B. Nicholson, 'Religion in Pre-Hispanic Central Mexico' *Handbook of Middle American Indians 10*, (Austin, 1971) p.402.
128. Caso, *op. cit.*, pp.32-3.
129. Thompson, *op. cit.*, pp.203, 235.
130. Miguel León-Portilla, *Aztec Thought and Culture*, p.111.
131. de Sahagun, *op. cit.*, Bk. 2: 23: 64,.
132. Sandstrom, *op. cit.*, p.238.
133. Duran, *op. cit.*, (1971), p.215.
134. *Ibid*., p.188.
135. Burr Cartwright Brundage, *The Jade Steps*, p.157.
136. J. Monaghan, 'Sacrifice, Death and the Origin of Agriculture in the Codex Venus' *American Antiquity* 55:3 (1990), pp.561-7.
137. Sandstrom, *op. cit.*, p.263, my italics.
138. *Ibid*., p.368.
139. J. Marcus, 'Archaeology and Religion: A Comparison of Zapotec and Maya' *World Archaeology* 10:2 (October 1978), p.175.
140. *Chilam Balam* p.27 (54-57).
141. de Sahagun, *op. cit.*, Bk. 2: 36: 156.
142. *Ibid*., Bk. 3: 10: 29.
143. Motolinia, *op. cit.*, p.122.
144. Duran, *op. cit.*, (1971), pp.169, 188, 215. See also de Sahagun, *op. cit.*, Bk. 2: Appendix 176.
145. E. M. Moctezuma, 'Archaeology and Symbolism in Aztec Mexico: The Templo Mayor of Tenochtitlan' *Journal of the American Academy of Religion* 53:3 (December 1985), p.806.
146. Nigel Davies, *Human Sacrifice in History and Today*, (New York, 1981), pp.13f.

The Search for the Manchurian Candidate

The CIA and Mind Control

by

John Marks

© 1979 by John Marks

original text: http://www.wanttoknow.info/mk/search-manchurian-candidate.pdf
backup source: http://www.psilosophy.info/resources/search-manchurian-candidate.pdf

Table of Contents:

Author's Note
Part I - Origins of mind-control research
1. World War II
2. Cold War on the Mind
3. The Professor and the "A" Treatment
Part II - Intelligence or "Witches potions"
4. LSD
5. Concerning the Case of Dr. Frank Olsen
6. Them Unwitting: The Safehouses
7. Mushrooms to Counterculture
Part III - Spells - electrodes and hypnosis
8. Brainwashing
9. Human Ecology
10. The Gittinger Assessment System
11. Hypnosis
Part IV - Conclusions
12. The Search for the Truth

Author's Note

This book has grown out of the 16,000 pages of documents that the CIA released to me under the Freedom of Information Act. Without these documents, the best investigative reporting in the world could not have produced a book, and the secrets of CIA mind-control work would have remained buried forever, as the men who knew them had always intended. From the documentary base, I was able to expand my knowledge through interviews and readings in the behavioral sciences. Nevertheless, the final result is not the whole story of the CIA's attack on the mind. Only a few insiders could have written that, and they choose to remain silent. I have done the best I can to make the book as accurate as possible, but I have been hampered by the refusal of most of the principal characters to be interviewed and by the CIA's destruction in 1973 of many of the key documents.

I want to extend special thanks to the congressional sponsors of the Freedom of Information Act. I would like to think that they had my kind of research in mind when they passed into law the idea that information about the government belongs to the people, not to the bureaucrats. I am also grateful to the CIA officials who made what must have been a rather unpleasant decision to release the documents and to those in the Agency who worked on the actual mechanics of release. From my point of view, the system has worked extremely well.

I must acknowledge that the system worked almost not at all during the first six months of my three-year Freedom of Information struggle. Then in late 1975, Joseph Petrillo and Timothy Sullivan, two skilled and energetic lawyers with the firm of Fried, Frank, Shriver, Harris and Kampelman, entered the case. I had the distinct impression that the government attorneys took me much more seriously when my requests for documents started arriving on stationery with all those prominent partners at the top. An author should not need lawyers to write a book, but I would have had great difficulty without mine. I greatly appreciate their assistance.

What an author does need is editors, a publisher, researchers, consultants, and friends, and I have been particularly blessed with good ones. My very dear friend Taylor Branch edited the book, and I continue to be impressed with his great skill in making my ideas and language coherent. Taylor has also served as my agent, and in this capacity, too, he has done me great service.

I had a wonderful research team, without which I never could have sifted through the masses of material and run down leads in so many places. I thank them all, and I want to acknowledge their contributions. Diane St. Clair was the mainstay of the group. She put together a system for filing and cross-indexing that worked beyond all expectations. (Special thanks to Newsday's Bob Greene, whose suggestions for organizing a large investigation came to us through the auspices of Investigative Reporters and Editors, Inc.) Not until a week before the book was finally finished did I fail to find a document which I needed; naturally, it was something I had misfiled myself. Diane also contributed greatly to the Cold War chapter. Richard Sokolow made similar contributions to the Mushroom and Safehouse chapters. His work was solid, and his energy boundless. Jay Peterzell delved deeply into Dr. Cameron's "depatterning" work in Montreal and stayed with it when others might have quit. Jay also did first-rate studies of brainwashing and sensory deprivation. Jim Mintz and Ken Cummins provided excellent assistance in the early research stage.

The Center for National Security Studies, under my good friend Robert Borosage, provided physical support and research aid, and I would like to express my appreciation. My thanks also to Morton Halperin who continued the support when he became director of the Center. I also appreciated the help of Penny Bevis, Hannah Delaney, Florence Oliver, Aldora Whitman, Nick Fiore, and Monica Andres.

My sister, Dr. Patricia Greenfield, did excellent work on the CIA's interface with academia and on the Personality Assessment System. I want to acknowledge her contribution to the book and express my thanks and love.

There has been a whole galaxy of people who have provided specialized help, and I would like to thank them all: Jeff Kohan, Eddie Becker, Sam Zuckerman, Matthew Messelson, Julian Robinson, Milton Kline, Marty Lee, M. J. Conklin, Alan Scheflin, Bonnie Goldstein, Paul Avery, Bill Mills, John Lilly, Humphrey Osmond, Julie Haggerty, Patrick Oster, Norman Kempster, Bill Richards, Paul Magnusson, Andy Sommer, Mark Cheshire, Sidney Cohen, Paul Altmeyer, Fred and Elsa Kleiner, Dr. John Cavanagh, and Senator James Abourezk and his staff.

I sent drafts of the first ten chapters to many of the people I interviewed (and several who refused to be interviewed). My aim was to have them correct any inaccuracies or point out material taken out of context. The comments of those who responded aided me considerably in preparing the final book. My thanks for their assistance to Albert Hofmann, Telford Taylor, Leo Alexander, Walter Langer, John Stockwell, William Hood, Samuel Thompson, Sidney Cohen, Milton Greenblatt, Gordon Wasson, James Moore, Laurence Hinkle, Charles Osgood, John Gittinger (for Chapter 10 only), and all the others who asked not to be identified.

Finally, I would like to express my appreciation to my publisher, Times Books, and especially to my editor John J. Simon. John, Tom Lipscomb, Roger Jellinek, Gyorgyi Voros, and John Gallagher all believed in this book from the beginning and provided outstanding support. Thanks also go to Judith H. McQuown, who copyedited the manuscript, and Rosalyn T. Badalamenti, Times Books' Production Editor, who oversaw the whole production process.

John Marks
Washington, D.C. October 26, 1978

Part I - Origins of mind-control research

1. World War II

On the outskirts of Basel, Switzerland, overlooking the Rhine, lies the worldwide headquarters of the Sandoz drug and chemical empire. There, on the afternoon of April 16, 1943, Dr. Albert Hofmann made an extraordinary discovery - by accident.

At 37, with close-cropped hair and rimless glasses, Hofmann headed the company's research program to develop marketable drugs out of natural products. He was hard at work in his laboratory that warm April day when a wave of dizziness suddenly overcame him. The strange sensation was not unpleasant, and Hofmann felt almost as though he were drunk.

But he became quite restless. His nerves seemed to run off in different directions. The inebriation was unlike anything he had ever known before. Leaving work early, Hofmann managed a wobbly bicycle-ride home. He lay down and closed his eyes, still unable to shake the dizziness. Now the light of day was disagreeably bright. With the external world shut out, his mind raced along. He experienced what he would later describe as "an uninterrupted stream of fantastic images of extraordinary plasticity and vividness.... accompanied by an intense, kaleidoscope-like play of colors."

These visions subsided after a few hours, and Hofmann, ever the inquiring scientist, set out to find what caused them. He presumed he had somehow ingested one of the drugs with which he had been working that day, and his prime suspect was d-lysergic acid diethylamide, or LSD, a substance that he himself had first produced in the same lab five years earlier. As part of his search for a circulation stimulant, Hofmann had been examining derivatives of ergot, a fungus that attacks rye.

Ergot had a mysterious, contradictory reputation. In China and some Arab countries, it was thought to have medicinal powers, but in Europe it was associated with the horrible malady from the Middle Ages called St. Anthony's Fire, which struck periodically like the plague. The disease turned fingers and toes into blackened stumps and led to madness and death.

Hofmann guessed that he had absorbed some ergot derivative through his skin, perhaps while changing the filter paper in a suction bottle. To test his theory, he spent three days making up a fresh batch of LSD. Cautiously he swallowed 250 micrograms (less than 1/100,000 of an ounce). Hofmann planned to take more gradually through the day to obtain a result, since no known drug had any effect on the human body in such infinitesimal amounts. He had no way of knowing that because of LSD's potency, he had already taken several times what would later be termed an ordinary dose. Unexpectedly, this first speck of LSD took hold after about 40 minutes, and Hofmann was off on the first self-induced "trip" of modern times.[1]

Hofmann recalls he felt "horrific... I was afraid. I feared I was becoming crazy. I had the idea I was out of my body. I thought I had died. I did not know how it would finish. If you know you will come back from this very strange world, only then can you enjoy it." Of course, Hofmann had no way of knowing that he would return. While he had quickly recovered from his accidental trip three days earlier, he did not know how much LSD had caused it or whether the present dose was more than his body could detoxify. His mind kept veering off into an unknown dimension, but he was unable to appreciate much beyond his own terror.

Less than 200 miles from Hofmann's laboratory, doctors connected to the S.S. and Gestapo were doing experiments that led to the testing of mescaline (a drug which has many of the mind-changing qualities of LSD) on prisoners at Dachau. Germany's secret policemen had the notion, completely alien to Hofmann, that they could use drugs like mescaline to bring unwilling people under their control. According to research team member Walter Neff, the goal of the Dachau experiments was "to eliminate the will of the person examined."

At Dachau, Nazis took the search for scientific knowledge of military value to its most awful extreme. There, in a closely guarded, fenced-off part of the camp, S.S. doctors studied such questions as the amount of time a downed airman could survive in the North Atlantic in February. Information of this sort was considered important to German security, since skilled pilots were in relatively short supply. So, at Heinrich Himmler's personal order, the doctors at Dachau simply sat by huge tubs of ice water with stopwatches and timed how long it took immersed prisoners to die. In other experiments, under the cover of "aviation medicine," inmates were crushed to death in high-altitude pressure chambers (to learn how high pilots could safely fly), and prisoners were shot, so that special blood coagulants could be tested on their wounds.

The mescaline tests at Dachau run by Dr. Kurt Plotner were not nearly so lethal as the others in the "aviation" series, but the drug could still cause grave damage, particularly to anyone who already had some degree of mental instability. The danger was increased by the fact that the mescaline was administered covertly by S.S. men who spiked the prisoners' drinks. Unlike Dr. Hofmann, the subjects had no idea that a drug was causing their extreme disorientation. Many must have feared they had gone stark mad all on their own. Always, the subjects of these experiments were Jews, gypsies, Russians, and other groups on whose lives the Nazis placed little or no value. In no way were any of them true volunteers, although some may have come forward under the delusion that they would receive better treatment.

After the war, Neff told American investigators that the subjects showed a wide variety of reactions. Some became furious; others were melancholy or gay, as if they were drunk. Not surprisingly, "sentiments of hatred and revenge were exposed in every case." Neff' noted that the drug caused certain people to reveal their "most intimate secrets." Still, the Germans were not ready to accept mescaline as a substitute for their more physical methods of interrogation. They went on to try hypnosis in combination with the drug, but they apparently never felt confident that they had found a way to assume command of their victim's mind.

Even as the S.S. doctors were carrying on their experiments at Dachau, the Office of Strategic Services (OSS), America's wartime intelligence agency, set up a "truth drug" committee under Dr. Winfred Overholser, head of St. Elizabeth's Hospital in Washington. The committee quickly tried and rejected mescaline, several barbiturates, and scopolamine. Then, during the spring of 1943, the committee decided that *Cannabis indica* - or marijuana - showed the most promise, and it started a testing program in cooperation with the Manhattan Project, the TOP SECRET effort to build an atomic bomb. It is not clear why OSS turned to the bomb makers for help, except that, as one former Project official puts it, "Our secret was so great, I guess we were safer than anyone else." Apparently, top Project leaders, who went to incredible lengths to preserve security, saw no danger in trying out drugs on their personnel.

The Manhattan Project supplied the first dozen test subjects, who were asked to swallow a concentrated, liquid form of marijuana that an American pharmaceutical company furnished in small glass vials. A Project man who was present recalls: "It didn't work the way we wanted. Apparently the human system would not take it all at once orally. The subjects would lean over and vomit." What is more, they disclosed no secrets, and one subject wound up in the hospital.

Back to the drawing board went the OSS experts. They decided that the best way to administer the marijuana was inhalation of its fumes. Attempts were made to pour the solution on burning charcoal, and an OSS officer named George White (who had already succeeded in knocking himself out with an overdose of the relatively potent substance) tried out the vapor, without sufficient effect, at St. Elizabeth's. Finally, the OSS group discovered a delivery system which had been known for years to jazz musicians and other users: the cigarette. OSS documents reported that smoking a mix of tobacco and the marijuana essence brought on a "state of irresponsibility, causing the subject to be loquacious and free in his impartation of information."

The first field test of these marijuana-laced cigarettes took place on May 27, 1943. The subject was one August Del Gracio, who was described in OSS documents as a "notorious New York gangster."[2] George White, an Army captain who had come to OSS from the Federal Bureau of Narcotics, administered the drug by inviting Del Gracio up to his apartment for a smoke and a chat. White had been talking to Del Gracio earlier about securing the Mafia's cooperation to keep Axis agents out of the New York waterfront and to prepare the way for the invasion of Sicily.[3]

Del Gracio had already made it clear to White that he personally had taken part in killing informers who had squealed to the Feds. The gangster was as tough as they came, and if he could be induced to talk under the influence of a truth drug, certainly German prisoners could - or so the reasoning went. White plied him with cigarettes until "subject became high and extremely garrulous." Over the next two hours, Del Gracio told the Federal agent about the ins and outs of the drug trade (revealing information so sensitive that the CIA deleted it from the OSS documents it released 34 years later). At one point in the conversation, after Del Gracio had begun to talk, the gangster told White, "Whatever you do, don't ever use any of the stuff I'm telling you." In a subsequent session, White packed the cigarettes with so much marijuana that Del Gracio became unconscious for about an hour. Yet, on the whole the experiment was considered a success in "loosening the subject's tongue."

While members of the truth-drug committee never believed that the concentrated marijuana could compel a person to confess his deepest secrets, they authorized White to push ahead with the testing. On the next stage, he and a Manhattan Project counterintelligence man borrowed 15 to 18 thick dossiers from the FBI and went off to try the marijuana on suspected Communist soldiers stationed in military camps outside Atlanta, Memphis, and New Orleans. According to White's Manhattan Project sidekick, a Harvard Law graduate and future judge, they worked out a standard interrogation technique:

Before we went in, George and I would buy cigarettes, remove them from the bottom of the pack, use a hypodermic needle to put in the fluid, and leave the cigarettes in a shot glass to dry. Then, we resealed the pack.... We sat down with a particular soldier and tried to win his confidence. We would say something like "This is better than being overseas and getting shot at," and we would try to break them. We started asking questions from their [FBI] folder, and we would let them see that we had the folder on them... We had a pitcher of ice water on the table, and we knew the drug had taken effect when they reached for a glass. The stuff actually worked.... Everyone but one - and he didn't smoke - gave us more information than we had before.

The Manhattan Project lawyer remembers this swing through the South with George White as a "good time." The two men ate in the best restaurants and took in all the sights. "George was quite a guy," he says. "At the Roosevelt Hotel in New Orleans after we had interviewed our men, we were lying on the beds when George took out his pistol and shot his initials into the molding that ran along the ceiling. He used his 22 automatic, equipped with a silencer, and he emptied several clips." Asked if he tried out the truth drug himself, the lawyer says, "Yes. The cigarettes gave you a feeling of walking a couple of feet off the floor. I had a pleasant sensation of well-being. ... The fellows from my office wouldn't take a cigarette from me for the rest of the war."

Since World War II, the United States government, led by the Central Intelligence Agency, has searched secretly for ways to control human behavior. This book is about that search, which had its origins in World War II. The CIA programs were not only an extension of the OSS quest for a truth drug, but they also echoed such events as the Nazi experiments at Dachau and Albert Hofmann's discovery of LSD.

By probing the inner reaches of consciousness, Hofmann's research took him to the very frontiers of knowledge. As never before in history, the warring powers sought ideas from scientists capable of reaching those frontiers - ideas that could make the difference between victory and defeat. While Hofmann himself remained aloof, in the Swiss tradition, other scientists, like Albert Einstein, helped turned the abstractions of the laboratory into incredibly destructive weapons. Jules Verne's notions of spaceships touching the moon stopped being absurd when Wernher von Braun's rockets started pounding London. With their creations, the scientists reached beyond the speculations of science fiction. Never before had their discoveries been so breathtaking and so frightening. Albert Hofmann's work touched upon the fantasies of the mind - accessible, in ancient legends, to witches and wizards who used spells and potions to bring people under their sway. In the early scientific age, the dream of controlling the brain took on a modern form in Mary Shelley's creation, Dr. Frankenstein's monster. The dream would be updated again during the Cold War era to become the Manchurian Candidate, the assassin whose mind was controlled by a hostile government.[4] Who could say for certain that such a fantasy would not be turned into a reality like Verne's rocket stories or Einstein's calculations? And who should be surprised to learn that government agencies - specifically the CIA - would swoop down on Albert Hofmann's lab in an effort to harness the power over the mind that LSD seemed to hold?

From the Dachau experiments came the cruelty that man was capable of heaping upon his fellows in the name of advancing science and helping his country gain advantage in war. To say that the Dachau experiments are object lessons of how far people can stretch ends to justify means is to belittle by cliché what occurred in the concentration camps. Nothing the CIA ever did in its postwar search for mind-control technology came close to the callous killing of the Nazi "aviation research." Nevertheless, in their attempts to find ways to manipulate people, Agency officials and their agents crossed many of the same ethical barriers. They experimented with dangerous and unknown techniques on people who had no idea what was happening. They systematically violated the free will and mental dignity of their subjects, and, like the Germans, they chose to victimize special groups of people whose existence they considered, out of prejudice and convenience, less worthy than their own. Wherever their extreme experiments went, the CIA sponsors picked for subjects their own equivalents of the Nazis' Jews and gypsies: mental patients, prostitutes, foreigners, drug addicts, and prisoners, often from minority ethnic groups.

In the postwar era, American officials straddled the ethical and the cutthroat approaches to scientific research. After an Allied tribunal had convicted the first echelon of surviving Nazi war criminals - the Görings and Speers - American prosecutors charged the Dachau doctors with "crimes against humanity" at a second Nuremberg trial. None of the German scientists expressed remorse. Most claimed that someone else had carried out the vilest experiments. All said that issues of moral and personal responsibility are moot in state-sponsored research. What is critical, testified Dr. Karl Brandt, Hitler's personal physician, is "whether the experiment is important or unimportant." Asked his attitude toward killing human beings in the course of medical research, Brandt replied, "Do you think that one can obtain any worthwhile fundamental results without a definite toll of lives?" The judges at Nuremberg rejected such defenses and put forth what came to be known as the Nuremberg Code on scientific research.[5] Its main points were simple: Researchers must obtain full voluntary consent from all subjects; experiments should yield fruitful results for the good of society that can be obtained in no other way; researchers should not conduct tests where death or serious injury might occur, "except, perhaps" when the supervising doctors also serve as subjects. The judges - all Americans - sentenced seven of the Germans, including Dr. Brandt, to death by hanging. Nine others received long prison sentences. Thus, the U.S. government put its full moral force behind the idea that there were limits on what scientists could do to human subjects, even when a country's security was thought to hang in the balance.

The Nuremberg Code has remained official American policy ever since 1946, but, even before the verdicts were in, special U.S. investigating teams were sifting through the experimental records at Dachau for information of military value. The report of one such team found that while part of the data was "inaccurate," some of the conclusions, if confirmed, would be "an important complement to existing knowledge." Military authorities sent the records, including a description of the mescaline and hypnosis experiments, back to the United States. None of the German mind-control research was ever made public.

Immediately after the war, large political currents began to shift in the world, as they always do. Allies became enemies and enemies became allies. Other changes were fresh and yet old. In the United States, the new Cold War against communism carried with it a piercing sense of fear and a sweeping sense of mission - at least as far as American leaders were concerned. Out of these feelings and out of that overriding American faith in advancing technology came the CIA's attempts to tame hostile minds and make spy fantasies real. Experiments went forward and the CIA's scientists - bitten, sometimes obsessed - kept going back to their laboratories for one last adjustment. Some theories were crushed, while others emerged in unexpected ways that would have a greater impact outside the CIA than in the world of covert operations. Only one aspect remained constant during the quarter-century of active research: The CIA's interest in controlling the human mind had to remain absolutely secret.

World War II provided more than the grand themes of the CIA's behavioral programs. It also became the formative life experience of the principal CIA officials, and, indeed, of the CIA itself as an institution. The secret derring-do of the OSS was new to the United States, and the ways of the OSS would grow into the ways of the CIA. OSS leaders would have their counterparts later in the Agency. CIA officials tended to have known the OSS men, to think like them, to copy their methods, and even, in some cases, to be the same people. When Agency officials wanted to launch their massive effort for mind control, for instance, they got out the old OSS documents and went about their goal in many of the same ways the OSS had. OSS leaders enlisted outside scientists; Agency officials also went to the most prestigious ones in academia and industry, soliciting aid for the good of the country. They even approached the same George White who had shot his initials in the hotel ceiling while on OSS assignment.

Years later, White's escapades with OSS and CIA would carry with them a humor clearly unintended at the time. To those directly involved, influencing human behavior was a deadly serious business, but qualities like bumbling and pure craziness shine through in hindsight. In the CIA's campaign, some of America's most distinguished behavioral scientists would stick all kinds of drugs and wires into their experimental subjects - often dismissing the obviously harmful effects with theories reminiscent of the learned nineteenth-century physicians who bled their patients with leeches and belittled the ignorance of anyone who questioned the technique. If the schemes of these scientists to control the mind had met with more success, they would be much less amusing. But so far, at least, the human spirit has apparently kept winning. That - if anything - is the saving grace of the mind-control campaign.

World War II signaled the end of American isolation and innocence, and the United States found it had a huge gap to close, with its enemies and allies alike, in applying underhanded tactics to war. Unlike Britain, which for hundreds of years had used covert operations to hold her empire together, the United States had no tradition of using subversion as a secret instrument of government policy. The Germans, the French, the Russians, and nearly everyone else had long been involved in this game, although no one seemed as good at it as the British.

Clandestine lobbying by British agents in the United States led directly to President Franklin Roosevelt's creation of the organization that became OSS in 1942. This was the first American agency set up to wage secret, unlimited war. Roosevelt placed it under the command of a Wall Street lawyer and World War I military hero, General William "Wild Bill" Donovan. A burly, vigorous Republican millionaire with great intellectual curiosity, Donovan started as White House intelligence adviser even before Pearl Harbor, and he had direct access to the President.

Learning at the feet of the British who made available their expertise, if not all their secrets, Donovan put together an organization where nothing had existed before. A Columbia College and Columbia Law graduate himself, he tended to turn to the gentlemanly preserves of the Eastern establishment for recruits. (The initials OSS were said to stand for "Oh So Social.") Friends - or friends of friends - could be trusted. "Old boys" were the stalwarts of the British secret service, and, as with most other aspects of OSS, the Americans followed suit.

One of Donovan's new recruits was Richard Helms, a young newspaper executive then best known for having gained an interview with Adolf Hitler in 1936 while working for United Press. Having gone to Le Rosey, the same Swiss prep school as the Shah of Iran, and then on to clubby Williams College Helms moved easily among the young OSS men. He was already more taciturn than the jovial Donovan, but he was equally ambitious and skilled as a judge of character. For Helms, OSS spywork began a lifelong career. He would become the most important sponsor of mind-control research within the CIA, nurturing and promoting it throughout his steady climb to the top position in the Agency.

Like every major wartime official from President Roosevelt down, General Donovan believed that World War II was in large measure a battle of science and organization. The idea was to mobilize science for defense, and the Roosevelt administration set up a costly, intertwining network of research programs to deal with everything from splitting the atom to preventing mental breakdowns in combat. Donovan named Boston industrialist Stanley Lovell to head OSS Research and Development and to be the secret agency's liaison with the government scientific community.

A Cornell graduate and a self-described "saucepan chemist," Lovell was a confident energetic man with a particular knack for coming up with offbeat ideas and selling them to others Like most of his generation, he was an outspoken patriot. He wrote in his diary shortly after Pearl Harbor: "As James Hilton said, 'Once at war, to reason is treason.' My job is clear - to do all that is in me to help America."

General Donovan minced no words in laying out what he expected of Lovell: "I need every subtle device and every underhanded trick to use against the Germans and Japanese - by our own people - but especially by the underground resistance programs in all the occupied countries. You'll have to invent them all, Lovell, because you're going to be my man." Thus Lovell recalled his marching orders from Donovan, which he instantly received on being introduced to the blustery, hyperactive OSS chief. Lovell had never met anyone with Donovan's personal magnetism.

Lovell quickly turned to some of the leading lights in the academic and private sectors. A special group - called Division 19 - within James Conant's National Defense Research Committee was set up to produce "miscellaneous weapons" for OSS and British intelligence. Lovell's strategy, he later wrote, was "to stimulate the Peck's Bad Boy beneath the surface of every American scientist and to say to him, 'Throw all your normal law-abiding concepts out the window. Here's a chance to raise merry hell.'"

Dr. George Kistiakowsky, the Harvard chemist who worked on explosives research during the war (and who became science adviser to Presidents Eisenhower and Kennedy) remembers Stanley Lovell well: "Stan came to us and asked us to develop ways for camouflaging explosives which could be smuggled into enemy countries." Kistiakowsky and an associate came up with a substance which was dubbed "Aunt Jemima" because it looked and tasted like pancake mix. Says Kistiakowsky: "You could bake bread or other things out of it. I personally took it to a high-level meeting at the War Department and ate cookies in front of all those characters to show them what a wonderful invention it was. All you had to do was attach a powerful detonator, and it exploded with the force of dynamite." Thus disguised, "Aunt Jemima" could be slipped into occupied lands. It was credited with blowing up at least one major bridge in China.

Lovell encouraged OSS behavioral scientists to find something that would offend Japanese cultural sensibilities. His staff anthropologists reported back that nothing was so shameful to the Japanese soldier as his bowel movements. Lovell then had the chemists work up a skatole compound which duplicated the odor of diarrhea. It was loaded into collapsible tubes, flown to China, and distributed to children in enemy-occupied cities. When a Japanese officer appeared on a crowded street, the kids were encouraged to slip up behind him and squirt the liquid on the seat of his pants. Lovell named the product "Who? Me?" and he credited it with costing the Japanese "face."

Unlike most weapons, "Who? Me?" was not designed to kill or maim. It was a "harassment substance" designed to lower the morale of individual Japanese. The inspiration came from academicians who tried to make a science of human behavior. During World War II, the behavioral sciences were still very much in their infancy, but OSS - well before most of the outside world - recognized their potential in warfare. Psychology and psychiatry, sociology, and anthropology all seemed to offer insights that could be exploited to manipulate the enemy.

General Donovan himself believed that the techniques of psychoanalysis might be turned on Adolf Hitler to get a better idea of "the things that made him tick," as Donovan put it. Donovan gave the job of being the Fuhrer's analyst to Walter Langer, a Cambridge, Massachusetts psychoanalyst whose older brother William had taken leave from a chair of history at Harvard to head OSS Research and Analysis.[6] Langer protested that a study of Hitler based on available data would be highly uncertain and that conventional psychiatric and psychoanalytic methods could not be used without direct access to the patient. Donovan was not the sort to be deterred by such details. He told Langer to go ahead anyway.

With the help of a small research staff, Langer looked through everything he could find on Hitler and interviewed a number of people who had know the German leader. Aware of the severe limitations on his information, but left no choice by General Donovan, Langer plowed ahead and wrote up a final study. It pegged Hitler as a "neurotic psychopath" and proceeded to pick apart the Führer's psyche. Langer, since retired to Florida, believes he came "pretty close" to describing the real Adolf Hitler. He is particularly proud of his predictions that the Nazi leader would become increasingly disturbed as Germany suffered more and more defeats and that he would commit suicide rather than face capture.

One reason for psychoanalyzing Hitler was to uncover vulnerabilities that could be covertly exploited. Stanley Lovell seized upon one of Langer's ideas - that Hitler might have feminine tendencies - and got permission from the OSS hierarchy to see if he could push the Führer over the gender line.[7] "The hope was that his moustache would fall off and his voice become soprano," Lovell wrote. Lovell used OSS's agent network to try to slip female sex hormones into Hitler's food, but nothing apparently came of it. Nor was there ever any payoff to other Lovell schemes to blind Hitler permanently with mustard gas or to use a drug to exacerbate his suspected epilepsy. The main problem in these operations - all of which were tried - was to get Hitler to take the medicine. Failure of the delivery schemes also kept Hitler alive - OSS was simultaneously trying to poison him.[8]

Without question, murdering a man was a decisive way to influence his behavior, and OSS scientists developed an arsenal of chemical and biological poisons that included the incredibly potent botulinus toxin, whose delivery system was a gelatin capsule smaller than the head of a pin. Lovell and his associates also realized there were less drastic ways to manipulate an enemy's behavior, and they came up with a line of products to cause sickness, itching, baldness, diarrhea, and/or the odor thereof. They had less success finding a drug to compel truthtelling, but it was not for lack of trying.

Chemical and biological substances had been used in wartime long before OSS came on the scene. Both sides had used poison gas in World War I; during the early part of World War II, the Japanese had dropped deadly germs on China and caused epidemics; and throughout the war, the Allies and Axis powers alike had built up chemical and biological warfare (CBW) stockpiles, whose main function turned out, in the end, to be deterring the other side. Military men tended to look on CBW as a way of destroying whole armies and even populations. Like the world's other secret services, OSS individualized CBW and made it into a way of selectively but secretly embarrassing, disorienting, incapacitating, injuring, or killing an enemy.

As diversified as were Lovell's scientific duties for OSS, they were narrow in comparison with those of his main counterpart in the CIA's postwar mind-control program, Dr. Sidney Gottlieb. Gottlieb would preside over investigations that ranged from advanced research in amnesia by electroshock to dragnet searches through the jungles of Latin America for toxic leaves and barks. Fully in the tradition of making Hitler moustacheless, Gottlieb's office would devise a scheme to make Fidel Castro's beard fall out; like Lovell, Gottlieb would personally provide operators with deadly poisons to assassinate foreign leaders like the Congo's Patrice Lumumba, and he would be equally at ease discussing possible applications of new research in neurology. On a much greater scale than Lovell's, Gottlieb would track down every conceivable gimmick that might give one person leverage over another's mind. Gottlieb would preside over arcane fields from handwriting analysis to stress creation, and he would rise through the Agency along with his bureaucratic patron, Richard Helms.

Early in the war, General Donovan got another idea from the British, whose psychologists and psychiatrists had devised a testing program to predict the performance of military officers. Donovan thought such a program might help OSS sort through the masses of recruits who were being rushed through training. To create an assessment system for Americans, Donovan called in Harvard psychology professor Henry "Harry" Murray. In 1938 Murray had written Explorations of Personality, a notable book which laid out a whole battery of tests that could be used to size up the personalities of individuals. "Spying is attractive to loonies," states Murray. "Psychopaths, who are people who spend their lives making up stories, revel in the field." The program's prime objective, according to Murray, was keeping out the crazies, as well as the "sloths, irritants, bad actors, and free talkers."

Always in a hurry, Donovan gave Murray and a distinguished group of colleagues only 15 days until the first candidates arrived to be assessed. In the interim, they took over a spacious estate outside Washington as their headquarters. In a series of hurried meetings, they put together an assessment system that combined German and British methods with Murray's earlier research. It tested a recruit's ability to stand up under pressure, to be a leader, to hold liquor, to lie skillfully, and to read a person's character by the nature of his clothing.

More than 30 years after the war, Murray remains modest in his claims for the assessment system, saying that it was only an aid in weeding out the "horrors" among OSS candidates. Nevertheless, the secret agency's leaders believed in its results, and Murray's system became a fixture in OSS, testing Americans and foreign agents alike. Some of Murray's young behavioral scientists, like John Gardner,[9] would go on to become prominent in public affairs, and, more importantly, the OSS assessment program would be recognized as a milestone in American psychology. It was the first systematic effort to evaluate an individual's personality in order to predict his future behavior. After the war, personality assessment would become a new field in itself, and some of Murray's assistants would go on to establish OSS-like systems at large corporations, starting with AT&T. They also would set up study programs at universities, beginning with the University of California at Berkeley.[10] As would happen repeatedly with the CIA's mind-control research, OSS was years ahead of public developments in behavioral theory and application.

In the postwar years, Murray would be superseded by a young Oklahoma psychologist John Gittinger, who would rise in the CIA on the strength of his ideas about how to make a hard science out of personality assessment and how to use it to manipulate people. Gittinger would build an office within CIA that refined both Murray's assessment function and Walter Langer's indirect analysis of foreign leaders. Gittinger's methods would become an integral part of everyday Agency operations, and he would become Sid Gottlieb's protégé.

Stanley Lovell reasoned that a good way to kill Hitler - and the OSS man was always looking for ideas - would be to hypnotically control a German prisoner to hate the Gestapo and the Nazi regime and then to give the subject a hypnotic suggestion to assassinate the Führer. The OSS candidate would be let loose in Germany where he would take the desired action, "being under a compulsion that might not be denied," as Lovell wrote.

Lovell sought advice on whether this scheme would work from New York psychiatrist Lawrence Kubie and from the famed Menninger brothers, Karl and William. The Menningers reported that the weight of the evidence showed hypnotism to be incapable of making people do anything that they would not otherwise do. Equally negative, Dr. Kubie added that if a German prisoner had a logical reason to kill Hitler or anyone else, he would not need hypnotism to motivate him.

Lovell and his coworkers apparently accepted this skeptical view of hypnosis, as did the overwhelming majority of psychologists and psychiatrists in the country. At the time, hypnosis was considered a fringe activity, and there was little recognition of either its validity or its usefulness for any purpose - l*et al*one covert operations. Yet there were a handful of serious experimenters in the field who believed in its military potential. The most vocal partisan of this view was the head of the Psychology Department at Colgate University, George "Esty" Estabrooks. Since the early 1930s, Estabrooks had periodically ventured out from his sleepy upstate campus to advise the military on applications of hypnotism.

Estabrooks acknowledged that hypnosis did not work on everyone and that only one person in five made a good enough subject to be placed in a deep trance, or state of somnambulism. He believed that only these subjects could be induced to such things against their apparent will as reveal secrets or commit crimes. He had watched respected members of the community make fools of themselves in the hands of stage hypnotists, and he had compelled his own students to reveal fraternity secrets and the details of private love affairs - all of which the subjects presumably did not want to do.

Still his experience was limited. Estabrooks realized that the only certain way to know whether a person would commit a crime like murder under hypnosis was to have the person kill someone. Unwilling to settle the issue on his own by trying the experiment, he felt that government sanction of the process would relieve the hypnotist of personal responsibility. "Any 'accidents' that might occur during the experiments will simply be charged to profit and loss," he wrote, "a very trifling portion of that enormous wastage in human life which is part and parcel of war."

After Pearl Harbor, Estabrooks offered his ideas to OSS, but they were not accepted by anyone in government willing to carry them to their logical conclusion. He was reduced to writing books about the potential use of hypnotism in warfare. Cassandra-like, he tried to warn America of the perils posed by hypnotic control. His 1945 novel, Death in the Mind, concerned a series of seemingly treasonable acts committed by Allied personnel: an American submarine captain torpedoes one of our own battleships, and the beautiful heroine starts acting in an irrational way which serves the enemy. After a perilous investigation, secret agent Johnny Evans learns that the Germans have been hypnotizing Allied personnel and conditioning them to obey Nazi commands. Evans and his cohorts, shaken by the many ways hypnotism can be used against them, set up elaborate countermeasures and then cannot resist going on the offensive. Objections are heard from the heroine, who by this time has been brutally and rather graphically tortured. She complains that "doing things to people's minds" is "a loathsome way to fight." Her qualms are brushed aside by Johnny Evans, her lover and boss. He sets off after the Germans - "to tamper with their minds; Make them traitors; Make them work for us."

In the aftermath of the war, as the U.S. national security apparatus was being constructed, the leaders of the Central Intelligence Agency would adopt Johnny Evans' mission - almost in those very words. Richard Helms, Sid Gottlieb, John Gittinger, George White, and many others would undertake a far-flung and complicated assault on the human mind. In hypnosis and many other fields, scientists even more eager than George Estabrooks would seek CIA approval for the kinds of experiments they would not dare perform on their own. Sometimes the Agency men concurred; on other occasions, they reserved such experiments for themselves. They would tamper with many minds and inevitably cause some to be damaged. In the end, they would minimize and hide their deeds, and they would live to see doubts raised about the health of their own minds.

Notes 1

The information on Albert Hofmann's first LSD trip and background on LSD came from an interview by the author with Hofmann, a paper by Hofmann called "The Discovery of LSD and Subsequent Investigations on Naturally Occurring Hallucinogens," another interview with Hofmann by Michael Horowitz printed in the June 1976 High Times magazine, and from a CIA document on LSD produced by the Office of Scientific Intelligence, August 30, 1955, titled "The Strategic Medical Significance of LSD-25."

Information on the German mescaline and hypnosis experiments at Dachau came from "Technical Report no. 331-45, German Aviation Research at the Dachau Concentration Camp," October, 1945, US Naval Technical Mission in Europe, found in the papers of Dr. Henry Beecher. Additional information came from Trials of War Criminals Before the Nuremberg Tribunal, the book Doctors of Infamy by Alexander Mitscherlich and Fred Mielke (New York: H. Schuman, 1949), interviews with prosecution team members Telford Taylor, Leo Alexander, and James McHaney, and an article by Dr. Leo Alexander, "Sociopsychologic Structure of the SS," Archives of Neurology and Psychiatry, May, 1948, Vol. 59, pp. 622-34.

The OSS experience in testing marijuana was described in interviews with several former Manhattan Project counterintelligence men, an OSS document dated June 21, 1943, Subject: Development of "truth drug," given the CIA identification number A/B, I, 12/1; from document A/B, I, 64/34, undated, Subject: Memorandum Relative to the use of truth drug in interrogation; document dated June 2, 1943, Subject: Memorandum on T. D. A "confidential memorandum," dated April 4, 1954, found in the papers of George White, also was helpful. The quote on US prisoners passing through Manchuria came from document 19, 18 June 1953, Subject: ARTICHOKE Conference.

The information on Stanley Lovell came from his book, Of Spies and Strategems (Englewood Cliffs, N.J.: Prentice-Hall, 1963), from interviews with his son Richard, a perusal of his remaining papers, interviews with George Kistiakowsky and several OSS veterans, and from "Science in World War II, the Office of Scientific Research and Development" in Chemistry: A History of the Chemistry Components of the National Defense Research Committee, edited by W. A. Noyes, Jr. (Boston: Little, Brown & Company, 1948).

Dr. Walter Langer provided information about his psychoanalytic portrait of Hitler, as did his book, The Mind of Adolf Hitler (New York: Basic Books, 1972). Dr. Henry Murray also gave an interview, as did several OSS men who had been through his assessment course. Murray's work is described at length in a book published after the war by the OSS Assessment staff, Assessment of Men (New York: Rinehart & Company, 1948).

Material on George Estabrooks came from his books, Hypnotism (New York: E. P. Dutton and Co., 1945) and Death in the Mind, co-authored with Richard Lockridge (New York: E. P. Dutton, 1945), and interviews with his daughter, Doreen Estabrooks Michl, former colleagues, and Dr. Milton Kline.

Footnotes 1

1. While Hofmann specifically used the word "trip" in a 1977 interview to describe his consciousness-altering experience, the word obviously had no such meaning in 1943 and is used here anachronistically.
2. Del Gracio's name was deleted by the CIA from the OSS document that described the incident, but his identity was learned from the papers of George White, whose widow donated them to Foothills College in Los Altos, California. CIA officials cut virtually all the names from the roughly 16,000 pages of its own papers and the few score pages from OSS that it released to me under the Freedom of Information Act. However, as in this case, many of the names could be found through collateral sources.
3. Naval intelligence officers eventually made a deal in which mob leaders promised to cooperate, and as a direct result, New York Governor Thomas Dewey ordered Del Gracio's chief, boss of bosses, Charles "Lucky" Luciano freed from jail in 1946.
4. The term "Manchurian *Candida*te" came into the language in 1959 when author Richard Condon made it the title of his best-selling novel that later became a popular movie starring Laurence Harvey and Frank Sinatra. The story was about a joint Soviet-Chinese plot to take an American soldier captured in Korea, condition him at a special brainwashing center located in Manchuria, and create a remote-controlled assassin who was supposed to kill the President of the United States. Condon consulted with a wide variety of experts while researching the book, and some inside sources may well have filled him in on the gist of a discussion that took place at a 1953 meeting at the CIA on behavior control. Said one participant, "... individuals who had come out of North Korea across the Soviet Union to freedom recently apparently had a blank period of disorientation while passing through a special zone in Manchuria." The CIA and military men at this session promised to seek more information, but the matter never came up again in either the documents released by the Agency or in the interviews done for

this book.

5. The Code was suggested in essentially its final form by prosecution team consultant, Dr. Leo Alexander, a Boston psychiatrist.
6. Four months before Pearl Harbor, Donovan had enlisted Walter Langer to put together a nationwide network of analysts to study the morale of the country's young men, who, it was widely feared, were not enthusiastic about fighting a foreign war. Pearl Harbor seemed to solve this morale problem, but Langer stayed with Donovan as a part-time psychoanalytic consultant.
7. Langer wrote that Hitler was "masochistic in the extreme inasmuch as he derives sexual pleasure from punishment inflicted on his own body. There is every reason to suppose that during his early years, instead of identifying himself with his father as most boys do, he identified with his mother. This was perhaps easier for him than for most boys since, as we have seen, there is a large feminine component in his physical makeup.... His extreme sentimentality, his emotionality, his occasional softness, and his weeping, even after he became Chancellor, may be regarded as manifestations of a fundamental pattern that undoubtedly had its origin in his relationship to his mother."
8. Although historians have long known that OSS men had been in touch with the German officers who tried to assassinate Hitler in 1944, the fact that OSS independently was trying to murder him has eluded scholars of the period. Stanley Lovell gave away the secret in his 1963 book, Of Spies and Strategems, but he used such casual and obscure words that the researchers apparently did not notice. Lovell wrote: "I supplied now and then a carbamate or other quietus medication, all to be injected into der Führer's carrots, beets, or whatever." A "quietus medicine" is a generic term for a lethal poison, of which carbamates are one type.
9. Gardner, a psychologist teaching at Mount Holyoke College, helped Murray set up the original program and went on to open the West Coast OSS assessment site at a converted beach club in San Juan Capistrano. After the war, he would become Secretary of HEW in the Johnson administration and founder of Common Cause.
10. Murray is not at all enthusiastic with the spinoffs. "Some of the things done with it turn your stomach," he declares.

2. Cold War on the Mind

CIA officials started preliminary work on drugs and hypnosis shortly after the Agency's creation in 1947, but the behavior-control program did not really get going until the Hungarian government put Josef Cardinal Mindszenty on trial in 1949. With a glazed look in his eyes, Mindszenty confessed to crimes of treason he apparently did not commit. His performance recalled the Moscow purge trials of 1937 and 1938 at which tough and dedicated party apparatchiks had meekly pleaded guilty to long series of improbable offenses. These and a string of postwar trials in other Eastern European countries seemed staged, eerie, and unreal. CIA men felt they had to know how the Communists had rendered the defendants zombielike. In the Mindszenty case, a CIA Security Memorandum declared that "some unknown force" had controlled the Cardinal, and the memo speculated that the communist authorities had used hypnosis on him.

In the summer of 1949, the Agency's head of Scientific Intelligence made a special trip to Western Europe to find out more about what the Soviets were doing and "to apply special methods of interrogation for the purpose of evaluation of Russian practices." In other words, fearful that the communists might have used drugs and hypnosis on prisoners, a senior CIA official used exactly the same techniques on refugees and returned prisoners from Eastern Europe. On returning to the United States, this official recommended two courses of action: first, that the Agency consider setting up an escape operation to free Mindszenty; and second, that the CIA train and send to Europe a team skilled in "special" interrogation methods of the type he had tried out in Europe.

By the spring of 1950, several other CIA branches were contemplating the operational use of hypnosis. The Office of Security, whose main job was to protect Agency personnel and facilities from enemy penetration, moved to centralize all activity in this and other behavioral fields. The Security chief, Sheffield Edwards, a former Army colonel who a decade later would personally handle joint CIA-Mafia operations, took the initiative by calling a meeting of all interested Agency parties and proposing that interrogation teams be formed under Security's command. Security would use the teams to check out agents and defectors for the whole CIA. Each team would consist of a psychiatrist, a polygraph (lie detector) expert trained in hypnosis, and a technician. Edwards agreed not to use the teams operationally without the permission of a high-level committee. He called the project BLUEBIRD, a code name which, like all Agency names, had no significance except perhaps to the person who chose it. Edwards classified the program TOP SECRET and stressed the extraordinary need for secrecy. On April 20, 1950, CIA Director Roscoe Hillenkoetter approved BLUEBIRD and authorized the use of unvouchered funds to pay for its most sensitive areas. The CIA's behavior-control program now had a bureaucratic structure.

The chief of Scientific Intelligence attended the original BLUEBIRD meeting in Sheffield Edwards' office and assured those present that his office would keep trying to gather all possible data on foreign - particularly Russian - efforts in the behavioral field. Not long afterward, his representative arranged to inspect the Nuremberg Tribunal records to see if they contained anything useful to BLUEBIRD. According to a CIA psychologist who looked over the German research, the Agency did not find much of specific help. "It was a real horror story, but we learned what human beings were capable of," he recalls. "There were some experiments on pain, but they were so mixed up with sadism as not to be useful.... How the victim coped was very interesting."

At the beginning, at least, there was cooperation between the scientists and the interrogators in the CIA. Researchers from Security (who had no special expertise but who were experienced in police work) and researchers from Scientific Intelligence (who lacked operational background but who had academic training) pored jointly over all the open literature and secret reports. They quickly realized that the only way to build an effective defense against mind control was to understand its offensive possibilities. The line between offense and defense - if it ever existed - soon became so blurred as to be meaningless. Nearly every Agency document stressed goals like "controlling an individual to the point where he will do our bidding against his will and even against such fundamental laws of nature as self-preservation." On reading one such memo, an Agency officer wrote to his boss: "If this is supposed to be covered up as a defensive feasibility study, it's pretty damn transparent."

Three months after the Director approved BLUEBIRD, the first team traveled to Japan to try out behavioral techniques on human subjects - probably suspected double agents. The three men arrived in Tokyo in July 1950, about a month after the start of the Korean War. No one needed to impress upon them the importance of their mission. The Security Office ordered them to conceal their true purpose from even the U.S. military authorities with whom they worked in Japan, using the cover that they would be performing "intensive polygraph" work. In stifling, debilitating heat and humidity, they tried out combinations of the depressant sodium amytal with the stimulant benzedrine on each of four subjects, the last two of whom also received a second stimulant, picrotoxin. They also tried to induce amnesia. The team considered the tests successful, but the CIA documents available on the trip give only the sketchiest outline of what happened.[1] Then around October 1950, the BLUEBIRD team used "advanced" techniques on 25 subjects, apparently North Korean prisoners of war.

By the end of that year, a Security operator, Morse Allen, had become the head of the BLUEBIRD program. Forty years old at the time, Allen had spent most of his earlier career rooting out the domestic communist threat, starting in the late 1930s when he had joined the Civil Service Commision and set up its first security files on communists. ("He knows their methods," wrote a CIA colleague.) During World War II, Allen had served with Naval intelligence, first pursuing leftists in New York and then landing with the Marines on Okinawa. After the war, he went to the State Department, only to leave in the late 1940s because he felt the Department was whitewashing certain communist cases. He soon joined the CIA's Office of Security. A suspicious man by inclination and training, Allen took nothing at face value. Like all counterintelligence or security operators, his job was to show why things are not what they seem to be. He was always thinking ahead and behind, punching holes in surface realities. Allen had no academic training for behavioral research (although he did take a short course in hypnotism, a subject that fascinated him). He saw the BLUEBIRD job as one that called for studying every last method the communists might use against the United States and figuring out ways to counter them.

The CIA had schooled Morse Allen in one field which in the CIA's early days became an important part of covert operations: the use of the polygraph. Probably more than any intelligence service in the world, the Agency developed the habit of strapping its foreign agents - and eventually, its own employees - into the "box." The polygraph measures physiological changes that might show lying - heartbeat, blood pressure, perspiration, and the like. It has never been foolproof. In 1949 the Office of Security estimated that it worked successfully on seven out of eight cases, a very high fraction but not one high enough for those in search of certainty. A psychopathic liar, a hypnotized person, or a specially trained professional can "beat" the machine. Moreover, the skill of the person running the polygraph and asking the questions determines how well the device will work. "A good operator can make brilliant use of the polygraph without plugging it in," claims one veteran CIA case officer. Others maintain only somewhat less extravagantly that its chief value is to deter agents tempted to switch loyalties or reveal secrets. The power of the machine - real and imagined - to detect infidelity and dishonesty can be an intimidating factor.[2] Nevertheless, the polygraph cannot compel truth. Like Pinocchio's nose, it only indicates lying. In addition, the machine requires enough physical control over the subject to strap him in. For years, the CIA tried to overcome this limitation by developing a "super" polygraph that could be aimed from afar or concealed in a chair. In this field, as in many others, no behavior control scheme was too farfetched to investigate, and Agency scientists did make some progress.

In December 1950, Morse Allen told his boss, Paul Gaynor, a retired brigadier general with a long background in counterintelligence and interrogation, that he had heard of experiments with an "electro-sleep" machine in a Richmond, Virginia hospital. Such an invention appealed to Allen because it supposedly put people to sleep without shock or convulsions. The BLUEBIRD team had been using drugs to bring on a state similar to a hypnotic trance, and Allen hoped this machine would allow an operator to put people into deep sleep without having to resort to chemicals. In theory, all an operator had to do was to attach the electrode-tipped wires to the subject's head and let the machine do the rest. It cost about $250 and was about twice the size of a table-model dictating machine. "Although it would not be feasible to use it on any of our own people because there is at least a theoretical danger of temporary brain damage," Morse Allen wrote, "it would possibly be of value in certain areas in connection with POW interrogation or on individuals of interest to this Agency." The machine never worked well enough to get into the testing stage for the CIA.

At the end of 1951, Allen talked to a famed psychiatrist (whose name, like most of the others, the CIA has deleted from the documents released) about a gruesome but more practical technique. This psychiatrist, a cleared Agency consultant, reported that electroshock treatments could produce amnesia for varying lengths of time and that he had been able to obtain information from patients as they came out of the stupor that followed shock treatments. He also reported that a lower setting of the Reiter electroshock machine produced an "excruciating pain" that, while nontherapeutic, could be effective as "a third degree method" to make someone talk. Morse Allen asked if the psychiatrist had ever taken advantage of the "groggy" period that followed normal electroshock to gain hypnotic control of his patients. No, replied the psychiatrist, but he would try it in the near future and report back to the Agency. The psychiatrist also mentioned that continued electroshock treatments could gradually reduce a subject to the "vegetable level," and that these treatments could not be detected unless the subject was given EEG tests within two weeks. At the end of a memo laying out this information, Allen noted that portable, battery-driven electroshock machines had come on the market.

Shortly after this Morse Allen report, the Office of Scientific Intelligence recommended that this same psychiatrist be given $100,000 in research funds "to develop electric shock and hypnotic techniques." While Allen thought this subject worth pursuing, he had some qualms about the ultimate application of the shock treatments: "The objections would, of course, apply to the use of electroshock if the end result was creation of a 'vegetable.' [I] believe that these techniques should not be considered except in gravest emergencies, and neutralization by confinement and/or removal from the area would be far more appropriate and certainly safer."

In 1952 the Office of Scientific Intelligence proposed giving another private doctor $100,000 to develop BLUEBIRD-related "neurosurgical techniques" - presumably lobotomy-connected.[3] Similarly, the Security office planned to use outside consultants to find out about such techniques as ultrasonics, vibrations, concussions, high and low pressure, the uses of various gases in airtight chambers, diet variations, caffeine, fatigue, radiation, heat and cold, and changing light. Agency officials looked into all these areas and many others. Some they studied intensively; others they merely discussed with consultants.

The BLUEBIRD mind-control program began when Stalin was still alive, when the memory of Hitler was fresh, and the terrifying prospect of global nuclear war was just sinking into popular consciousness. The Soviet Union had subjugated most of Eastern Europe, and a Communist party had taken control over the world's most populous nation, China. War had broken out in Korea, and Senator Joseph McCarthy's anti-Communist crusade was on the rise in the United States. In both foreign and domestic politics, the prevailing mood was one of fear even paranoia.

American officials have pointed to the Cold War atmosphere ever since as an excuse for crimes and excesses committed then and afterward. One recurring litany in national security investigations has been the testimony of the exposed official citing Cold War hysteria to justify an act that he or she would not otherwise defend. The apprehensions of the Cold War do not provide a moral or legal shield for such acts, but they do help explain them. Even when the apprehensions were not well founded, they were no less real to the people involved.

It was also a time when the United States had achieved a new preeminence in the world. After World War II, American officials wielded the kind of power that diplomats frequently dream of. They established new alliances, new rulers, and even new nations to suit their purposes. They dispensed guns, favors, and aid to scores of nations. Consequently, American officials were noticed, respected, and pampered wherever they went - as never before. Their new sense of importance and their Cold War fears often made a dangerous combination - it is a fact of human nature that anyone who is both puffed up and afraid is someone to watch out for.

In 1947 the National Security Act created not only the CIA but also the National Security Council - in sum, the command structure for the Cold War. Wartime OSS leaders like William Donovan and Allen Dulles lobbied feverishly for the Act. Officials within the new command structure soon put their fear and their grandiose notions to work. Reacting to the perceived threat, they adopted a ruthless and warlike posture toward anyone they considered an enemy - most especially the Soviet Union. They took it upon themselves to fight communism and things that might lead to communism everywhere in the world. Few citizens disagreed with them; they appeared to express the sentiments of most Americans in that era, but national security officials still preferred to act in secrecy. A secret study commission under former President Hoover captured the spirit of their call to clandestine warfare:

> It is now clear we are facing an implacable enemy whose avowed objective is world domination by whatever means and at whatever cost. There are no rules in such a game. Hitherto acceptable long-standing American concepts of "fair play" must be reconsidered. We must develop effective espionage and counterespionage services and must learn to subvert, sabotage, and destroy our enemies by more clever, more sophisticated, and more effective methods than those used against us.

The men in the new CIA took this job quite seriously. "We felt we were the first line of defense in the anti-Communist crusade," recalls Harry Rositzke, an early head of the Agency's Soviet Division. "There was a clear and heady sense of mission - a sense of what a huge job this was." Michael Burke, who was chief of CIA covert operations in Germany before going on to head the New York Yankees and Madison Square Garden, agrees: "It was riveting.... One was totally absorbed in something that has become misunderstood now, but the Cold War in those days was a very real thing with hundreds of thousands of Soviet troops, tanks, and planes poised on the East German border, capable of moving to the English Channel in forty-eight hours." Hugh Cunningham, an Agency official who stayed on for many years, remembers that survival itself was at stake, "What you were made to feel was that the country was in desperate peril and we had to do whatever it took to save it."

BLUEBIRD and the CIA's later mind-control programs sprang from such alarm. As a matter of course, the CIA was also required to learn the methods and intentions of all possible foes. "If the CIA had not tried to find out what the Russians were doing with mind-altering drugs in the early 1950s, I think the then-Director should have been fired," says Ray Cline, a former Deputy Director of the Agency.

High Agency officials felt they had to know what the Russians were up to. Nevertheless, a careful reading of the contemporaneous CIA documents almost three decades later indicates that if the Russians were scoring breakthroughs in the behavior-control field - whose author they almost certainly were not - the CIA lacked intelligence to prove that. For example, a 1952 Security document, which admittedly had an ax to grind with the Office of Scientific Intelligence, called the data gathered on the Soviet programs "extremely poor." The author noted that the Agency's information was based on "second- or third-hand rumors, unsupported statements and non-factual data."[4] Apparently, the fears and fantasies aroused by the Mindszenty trial and the subsequent Korean War "brainwashing" furor outstripped the facts on hand. The prevalent CIA notion of a "mind-control gap" was as much of a myth as the later bomber and missile "gaps." In any case, beyond the defensive curiosity, mind control took on a momentum of its own.

As unique and frightening as the Cold War was, it did not cause people working for the government to react much differently to each other or power than at other times in American history. Bureaucratic squabbling went on right through the most chilling years of the behavior-control program. No matter how alarmed CIA officials became over the Russian peril, they still managed to quarrel with their internal rivals over control of Agency funds and manpower. Between 1950 and 1952, responsibility for mind control went from the Office of Security to the Scientific Intelligence unit back to Security again. In the process, BLUEBIRD was rechristened ARTICHOKE. The bureaucratic wars were drawn-out affairs, baffling to outsiders; yet many of the crucial turns in behavioral research came out of essentially bureaucratic considerations on the part of the contending officials. In general, the Office of Security was full of pragmatists who were anxious to weed out communists (and homosexuals) everywhere. They believed the intellectuals from Scientific Intelligence had failed to produce "one new, usable paper, suggestion, drug, instrument, name of an individual, etc., etc.," as one document puts it. The learned gentlemen from Scientific Intelligence felt that the former cops, military men, and investigators in Security lacked the technical background to handle so awesome a task as controlling the human mind.

"Jurisdictional conflict was constant in this area," a Senate committee would state in 1976. A 1952 report to the chief of the CIA's Medical Staff (itself a participant in the infighting) drew a harsher conclusion: "There exists a glaring lack of cooperation among the various intra-Agency groups fostered by petty jealousies and personality differences that result in the retardation of the enhancing and advancing of the Agency as a body." When Security took ARTICHOKE back from Scientific Intelligence in 1952, the victory lasted only two and one-half years before most of the behavioral work went to yet another CIA outfit, full of Ph.D.s with operational experience - the Technical Services Staff (TSS).[5]

There was bureaucratic warfare outside the CIA as well, although there were early gestures toward interagency cooperation. In April 1951 the CIA Director approved liaison with Army, Navy, and Air Force intelligence to avoid duplication of effort. The Army and Navy were both looking for truth drugs, while the prime concern of the Air Force was interrogation techniques used on downed pilots. Representatives of each service attended regular meetings to discuss ARTICHOKE matters. The Agency also invited the FBI, but J. Edgar Hoover's men stayed away.

During their brief period of cooperation, the military and the CIA also exchanged information with the British and Canadian governments. At the first session in June 1951, the British representative announced at the outset that there had been nothing new in the interrogation business since the days of the Inquisition and that there was little hope of achieving valuable results through research. He wanted to concentrate on propaganda and political warfare as they applied to such threats as communist penetration of trade unions. The CIA's minutes of the session record that this skeptical Englishman finally agreed to the importance of behavioral research, but one doubts the sincerity of this conversion. The minutes also record a consensus of "no conclusive evidence" that either Western countries or the Soviets had made any "revolutionary progress" in the field, and describe Soviet methods as "remarkably similar ... to the age-old methods." Nonetheless, the representatives of the three countries agreed to continue investigating behavior-control methods because of their importance to "cold war operations." To what extent the British and Canadians continued cannot be told. The CIA did not stop until the 1970s.

Bureaucratic conflict was not the only aspect of ordinary government life that persisted through the Cold War. Officials also maintained their normal awareness of the ethical and legal consequences of their decisions. Often they went through contorted rationalizations and took steps to protect themselves, but at least they recognized and paused over the various ethical lines before crossing them. It would be unfair to say that all moral awareness evaporated. Officials agonized over the consequences of their acts, and much of the bureaucratic record of behavior control is the history of officials dealing with moral conflicts as they arose.

The Security office barely managed to recruit the team psychiatrist in time for the first mission to Japan, and for years, Agency officials had trouble attracting qualified medical men to the project. Speculating why, one Agency memo listed such reasons as the CIA's comparatively low salaries for doctors and ARTICHOKE's narrow professional scope, adding that a candidate's "ethics might be such that he might not care to cooperate in certain more revolutionary phases of our project." This consideration became explicit in Agency recruiting. During the talent search, another CIA memo stated why another doctor seemed suitable: "His ethics are such that he would be completely cooperative in any phase of our program, regardless of how revolutionary it may be."

The matter was even more troublesome in the task of obtaining guinea pigs for mind-control experiments. "Our biggest current problem," noted one CIA memo, "is to find suitable subjects." The men from ARTICHOKE found their most convenient source among the flotsam and jetsam of the international spy trade: "individuals of dubious loyalty, suspected agents or plants, subjects having known reason for deception, etc." as one Agency document described them. ARTICHOKE officials looked on these people as "unique research material," from whom meaningful secrets might be extracted while the experiments went on.

It is fair to say that the CIA operators tended to put less value on the lives of these subjects than they did on those of American college students, upon whom preliminary, more benign testing was done. They tailored the subjects to suit the ethical sensitivity of the experiment. A psychiatrist who worked on an ARTICHOKE team stresses that no one from the Agency wanted subjects to be hurt. Yet he and his colleagues were willing to treat dubious defectors and agents in a way which not only would be professionally unethical in the United States but also an indictable crime. In short, these subjects were, if not expendable, at least not particularly prized as human beings. As a CIA psychologist who worked for a decade in the behavior-control program, puts it, "One did not put a high premium on the civil rights of a person who was treasonable to his own country or who was operating effectively to destroy us." Another ex-Agency psychologist observes that CIA operators did not have "a universal concept of mankind" and thus were willing to do things to foreigners that they would have been reluctant to try on Americans. "It was strictly a patriotic vision," he says.

ARTICHOKE officials never seemed to be able to find enough subjects. The professional operators - particularly the traditionalists - were reluctant to turn over agents to the Security men with their unproved methods. The field men did not particularly want outsiders, such as the ARTICHOKE crew, getting mixed up in their operations. In the spy business, agents are very valuable property indeed, and operators tend to be very protective of them. Thus the ARTICHOKE teams were given mostly the dregs of the clandestine underworld to work on.

Inexorably, the ARTICHOKE men crossed the clear ethical lines. Morse Allen believed it proved little or nothing to experiment on volunteers who gave their informed consent. For all their efforts to act naturally, volunteers still knew they were playing in a make-believe game. Consciously or intuitively, they understood that no one would allow them to be harmed. Allen felt that only by testing subjects "for whom much is at stake (perhaps life and death)," as he wrote, could he get reliable results relevant to operations. In documents and conversation, Allen and his coworkers called such realistic tests "terminal experiments" - terminal in the sense that the experiment would be carried through to completion. It would not end when the subject felt like going home or when he or his best interest was about to be harmed. Indeed, the subject usually had no idea that he had ever been part of an experiment.

In every field of behavior control, academic researchers took the work only so far. From Morse Allen's perspective, somebody then had to do the terminal experiment to find out how well the technique worked in the real world: how drugs affected unwitting subjects, how massive electroshock influenced memory, how prolonged sensory deprivation disturbed the mind. By definition, terminal experiments went beyond conventional ethical and legal limits. The ultimate terminal experiments caused death, but ARTICHOKE sources state that those were forbidden.

For career CIA officials, exceeding these limits in the name of national security became part of the job, although individual operators usually had personal lines they would not cross. Most academics wanted no part of the game at this stage - nor did Agency men always like having these outsiders around. If academic and medical consultants were brought along for the terminal phase, they usually did the work overseas, in secret. As Cornell Medical School's famed neurologist Harold Wolff explained in a research proposal he made to the CIA, when any of the tests involved doing harm to the subjects, "We expect the Agency to make available suitable subjects and a proper place for the performance of the necessary experiments." Any professional caught trying the kinds of things the Agency came to sponsor - holding subjects prisoner, shooting them full of unwanted drugs - probably would have been arrested for kidnapping or aggravated assault. Certainly such a researcher would have been disgraced among his peers. Yet, by performing the same experiment under the CIA's banner, he had no worry from the law. His colleagues could not censure him because they had no idea what he was doing. And he could take pride in helping his country.

Without having been there in person, no one can know exactly what it felt like to take part in a terminal experiment. In any case, the subjects probably do not have fond memories of the experience. While the researchers sometimes resembled Alphonse and Gastone, they took themselves and their work very seriously. Now they are either dead, or, for their own reasons, they do not want to talk about the tests. Only in the following case have I been able to piece together anything approaching a firsthand account of a terminal experiment, and this one is quite mild compared to the others the ARTICHOKE men planned.

Notes 2

The origins of the CIA's ARTICHOKE program and accounts of the early testing came from the following Agency Documents # 192, 15 January 1953; #3,17 May 1949; A/B, I,8/1,24 February 1949; February 10, 1951 memo on Special Interrogations (no document #); A/B, II, 30/2, 28 September 1949; #5, 15 August 1949; #8, 27 September 1949; #6, 23 August 1949; #13, 5 April 1950; #18, 9 May 1950; #142 (transmittal slip), 19 May 1952; #124, 25 January 1952; A/B, IV, 23/32, 3 March 1952; #23, 21 June 1950; #10, 27 February 1950; #37, 27 October 1950; A/B, I, 39/1, 12 December 1950; A/B, II, 2/2, 5 March 1952; A/B, II, 2/1, 15 February 1952; A/B, V, 134/3, 3 December 1951; A/B, I, 38/5, 1 June 1951; and #400, undated, "Specific Cases of Overseas Testing and Applications of Behavioral Drugs."

The documents were supplemented by interviews with Ray Cline, Harry Rositzke, Michael Burke, Hugh Cunningham, and several other ex-CIA men who asked to remain anonymous. The Final Report of the Select Committee to Study Governmental Operations with Respect to Intelligence (henceforth called the Church Committee Report) provided useful background.

Documents giving background on terminal experiments include #A/B, II, 10/57; #A/B, II, 10/58, 31 August, 1954; #A/B, II, 10/ 17, 27 September 1954; and #A/B, I, 76/4, 21 March 1955.

Footnotes 2

1. For a better-documented case of narcotherapy and narcohypnosis, see Chapter 3.
2. While the regular polygraphing of CIA career employees apparently never has turned up a penetration agent in the ranks, it almost certainly has a deterrent effect on those considering coming out of the homosexual closet or on those considering dipping into the large sums of cash dispensed from proverbial black bags.
3. Whether the Agency ultimately funded this or the electric-shock proposal cited above cannot be determined from the documents.
4. The CIA refused to supply either a briefing or additional material when I asked for more background on Soviet behavior-control programs.
5. This Agency component, responsible for providing the supporting gadgets disguises, forgeries, secret writing, and weapons, has been called during its history the Technical Services Division and the Office of Technical Services as well as TSS, the name which will be used throughout this book.

3. The Professor and the "A" Treatment

The three men were all part of the same Navy team, traveling together to Germany. Their trip was so sensitive that they had been ordered to ignore each other, even as they waited in the terminal at Andrews Air Force Base outside Washington on a sweltering August morning in 1952. Just the month before, Gary Cooper had opened in High Noon, and the notion of showdown - whether with outlaws or communists - was in the air. With war still raging in Korea, security consciousness was high. Even so, the secrecy surrounding this Navy mission went well beyond ordinary TOP SECRET restrictions, for the team was slated to link up in Frankfurt with a contingent from the most hush-hush agency of all, the CIA. Then the combined group was going to perform dangerous experiments on human subjects. Both Navy and CIA officials believed that any disclosure about these tests would cause grave harm to the American national interest.

The Navy team sweated out a two-hour delay at Andrews before the four-engine military transport finally took off. Not until the plane touched down at the American field in the Azores did one of the group, a representative of Naval intelligence, flash a prearranged signal indicating that they were not being watched and they could talk. "It was all this cloak-and-dagger crap," recalls another participant, Dr. Samuel Thompson, a psychiatrist, physiologist, and pharmacologist who was also a Navy commander.

The third man in the party was G. Richard Wendt, chairman of the Psychology Department at the University of Rochester and a part-time Navy contractor. A small 46-yearold man with graying blond hair and a fair-sized paunch, Wendt had been the only one with companionship during the hours of decreed silence. He had brought along his attractive young assistant, ostensibly to help him with the experiments. She was not well received by the Navy men, nor would she be appreciated by the CIA operators in Frankfurt. The behavior-control field was very much a man's world, except when women subjects were used. The professor's relationship with this particular lady was destined to become a source of friction with his fellow experimenters, and, eventually, a topic of official CIA reporting.

In theory, Professor Wendt worked under Dr. Thompson's supervision in a highly classified Navy program called Project CHATTER, but the strong-minded psychologist did not take anyone's orders easily. Very much an independent spirit, Wendt ironically, had accepted CHATTER's goal of weakening, if not eliminating, free will in others. The Navy program, which had started in 1947, was aimed at developing a truth drug that would force people to reveal their innermost secrets.

Thompson, who inherited Wendt and CHATTER in 1951 when he became head of psychiatric research at the Naval Medical Research Institute, remembers Naval intelligence telling him of the need for a truth drug in case "someone planted an Abomb in one of our cities and we had twelve hours to find out from a person where it was. What could we do to make him talk?" Thompson concedes he was always "negative" about the possibility that such a drug could ever exist, but he cites the fear that the Russians might develop their own miracle potion as reason enough to justify the program. Also, Thompson and the other U.S. officials could not resist looking for a pill or panacea that would somehow make their side all-knowing or all-powerful.

Professor Wendt had experimented with drugs for the Navy before he became involved in the search for a truth serum. His earlier work had been on the use of Dramamine and other methods to prevent motion sickness, and now that he was doing more sensitive research, the Navy hid it under the cover of continuing his "motion sickness" study. At the end of 1950, the Navy gave Wendt a $300,000 contract to study such substances as barbiturates, amphetamines, alcohol, and heroin. To preserve secrecy, which often reached fetish proportions in mind-control research, the money flowed to him not through Navy channels but out of the Secretary of Defense's contingency fund. For those drugs that were not available from pharmaceutical companies, Navy officials went to the Federal Bureau of Narcotics. The Commissioner of Narcotics personally signed the papers, and special couriers carried pouches of illegal drugs through Washington streets and then up to the professor at Rochester. Receipts show that the Bureau sent the Navy 30 grams of pure heroin and 11 pounds of "Mexican grown" marijuana, among other drugs.

Like most serious drug researchers, Wendt sampled everything first before testing on assistants and students. The drug that took up the most space in his first progress report was heroin. He had became his own prime subject. At weekly intervals, he told the Navy, the psychologist gave himself heroin injections and then wrote down his reactions as he moved through the "full range" of his life: driving, shopping, recreation, manual work, family relations, and sexual activity. He noted in himself "slight euphoria ... heightened aesthetic appreciation ... absentminded behavior ... lack of desire to operate at full speed ... lack of desire for alcohol ... possibly reduced sex interest ... feeling of physical well-being." He concluded in his report that heroin could have "some, but slight value for interrogation" if used on someone "worked on for a long period of time."[1]

Wendt never had any trouble getting student volunteers. He simply posted a notice on a campus bulletin board, and he wound up with a long waiting list. He chose only men subjects over 21, and he paid everyone accepted after a long interview $1.00 an hour. With so much government money to spend, he hired over 20 staff assistants, and he built a whole new testing facility in the attic of the school library. Wendt was cautious with his students, and he apparently did not share the hard drugs with them. He usually tested subjects in small groups - four to eight at a time. He and his associates watched through a two-way mirror and wrote down the subjects' reactions. He always used both placebos (inert substances) and drugs; the students never knew what - if anything - they were taking. According to Dr. Thompson, to have alerted them in advance and thus given themselves a chance to steel themselves up "would have spoiled the experiment."

Nonetheless, Wendt's procedure was a far cry from true unwitting testing. Any drug that was powerful enough to break through an enemy's resistance could have a traumatic effect on the person taking it - particularly if the subject was totally unaware of what was happening. The Navy research plan was to do preliminary studies on subjects like Wendt's students, and then, as soon as the drug showed promise, to try it under field conditions. Under normal scientific research, the operational tests would not have been run before the basic work was finished. But the Navy could not wait. The drugs were to be tested on involuntary subjects. Thompson readily admits that this procedure was "unethical," but he says, "We felt we had to do it for the good of country."

During the summer of 1952, Professor Wendt announced that he had found a concoction "so special" that it would be "the answer" to the truth-drug problem, as Thompson recalls it. "I thought it would be a good idea to call the Agency," says Thompson. "I thought they might have someone with something to spill." Wendt was adamant on one point: He would not tell anyone in the Navy or the CIA what his potion contained. He would only demonstrate. Neither the CHATTER nor ARTICHOKE teams could resist the bait. The Navy had no source of subjects for terminal experiments, but the CIA men agreed to furnish the human beings - in Germany - even though they had no idea what Wendt had in store for his guinea pigs. The CIA named the operation CASTIGATE.

After settling into a Frankfurt hotel, Wendt, Thompson, and the Naval Intelligence man set out to meet the ARTICHOKE crew at the local CIA headquarters. It was located in the huge, elongated building that had housed the I. G. Farben industrial complex until the end of the war. The frantic bustle of a U.S. military installation provided ideal cover for this CIA base, and the arrival of a few new Americans attracted no special attention. The Navy group passed quickly through the lobby and rode up the elevator. At the CIA outer office, the team members had to show identification, and Thompson says they were frisked. The Naval Intelligence man had to check his revolver.

A secretary ushered the Navy group in to meet the ARTICHOKE contingent, which had arrived earlier from Washington. The party included team leader Morse Allen, his boss in the Office of Security, Paul Gaynor, and a prominent Washington psychiatrist who regularly left his private practice to fly off on special missions for the Agency. Also present were case officers from the CIA's Frankfurt base who had taken care of the support arrangements - the most important of which was supplying the subjects.

Everyone at the meeting wanted to know what drugs Wendt was going to use on the five selected subjects, who included one known double agent, one suspected double, and the three defectors. The professor still was not talking. Dr. Thompson asked what would happen if something went wrong and the subject died. He recalls one of the Frankfurt CIA men replying, "Disposal of the body would be no problem."

After the session ended, Thompson took Wendt aside and pointed out that since the professor, unlike Thompson, was neither a psychiatrist nor a pharmacologist, he was acting irresponsibly in not having a qualified physician standing by with antidotes in case of trouble. Wendt finally relented and confided in Thompson that he was going to slip the subjects a combination of the depressant Seconal, the stimulant Dexedrine, and tetrahydrocannabinol, the active ingredient in marijuana. Thompson was dumbfounded. He remembers wanting to shoot Wendt on the spot. These were all well-known drugs that had been thoroughly tested. Indeed, even the idea of mixing Seconal and Dexedrine was not original: The combined drug already had its own brand name - Dexamyl (and it would eventually have a street name, "the goofball"). Thompson quickly passed on to the CIA men what Wendt had in mind.[2] They, too, were more than a little disappointed.

Nevertheless, there was never any thought of stopping the experiments. The ARTICHOKE team had its own methods to try, even if Wendt's proved a failure, and the whole affair had developed its own momentum. Since this was one of the early ARTICHOKE trips into the field, the team was still working to perfect the logistics of testing. It had reserved two CIA "safehouses" in the countryside not far from Frankfurt, and Americans had been assigned to guard the experimental sites. Agency managers had already completed the paperwork for the installation of hidden microphones and two-way mirrors, so all the team members could monitor the interrogations.

The first safehouse proved to be a solid old farmhouse set picturesquely in the middle of green fields, far from the nearest dwelling. The ARTICHOKE and CHATTER groups drove up just as the CIA's carpenters were cleaning up the mess they had made in ripping a hole through the building's thick walls. The house had existed for several hundred years without an observation glass peering in on the sitting room, and it had put up some structural resistance to the workmen.

Subject #1 arrived in the early afternoon, delivered in a CIA sedan by armed operators, who had handcuffed him, shackled his feet, and made him lie down on the floor of the back seat. Agency officials described him as a suspected Russian agent, about 40 years old, who had a "Don Juan complex." One can only imagine how the subject must have reacted to these rather inconsistent Americans who only a few hours earlier had literally grabbed him out of confinement, harshly bound him, and sat more or less on top of him as they wandered through idyllic German farm country, and who now were telling him to relax as they engaged him in friendly conversation and offered him a beer. He had no way of knowing that it would be the last unspiked drink he would have for quite some time.

On the following morning, the testing started in earnest. Wendt put 20 mg. of Seconal in the subject's breakfast and then followed up with 50 mg. of Dexedrine in each of his two morning cups of coffee. Wendt gave him a second dose of Seconal in his luncheon beer. The subject was obviously not his normal self - whatever that was. What was clear was that Wendt was in way over his head, and even the little professor seemed to realize it. "I don't know how to deal with these people," he told the CIA psychiatric consultant. Wendt flatly refused to examine the subject, leaving the interrogation to the consultant. For his part, the consultant had little success in extracting information not already known to the CIA.

The third day was more of the same: Seconal with breakfast, Dexedrine and marijuana in a glass of water afterwards. The only break from the previous day's routine came at 10:10 A.M. when the subject was allowed to play a short poker game. Then he was given more of Wendt's drugs in two red capsules that were, he was told, "a prescription for his nerves." By 2:40 P.M., Wendt declared that this subject was not the right personality type for his treatment. He explained to his disgusted colleagues that if someone is determined to lie, these drugs will only make him a better liar. He said that the marijuana extract produced a feeling of not wanting to hold anything back and that it worked best on people who wanted to tell the truth but were afraid to. OSS had discovered the same thing almost a decade earlier.

Wendt retired temporarily from the scene, and the others concluded it would be a shame to waste a good subject. They decided to give him the "A" (for ARTICHOKE) treatment. This, too, was not very original. It had been used during the war to interrogate prisoners and treat shell-shocked soldiers. As practiced on the suspected Russian agent, it consisted of injecting enough sodium pentothal into the vein of his arm to knock him out and then, twenty minutes later, stimulating him back to semiconsciousness with a shot of Benzedrine. In this case, the benzedrine did not revive the subject enough to suit the psychiatric consultant and he told Dr. Thompson to give the subject another 10 mg. ten minutes later. This put the subject into a state somewhere between waking and sleeping - almost comatose and yet bug-eyed. In hypnotic tones that had to be translated into Russian by an interpreter, the consultant used the technique of "regression" to convince the subject he was talking to his wife Eva at some earlier time in his life. This was no easy trick, since a male interpreter was playing Eva. Nevertheless, the consultant states he could "create any fantasy" with 60 to 70 percent of his patients, using narcotherapy (as in this case) or hypnosis. For roughly an hour, the subject seemed to have no idea he was not speaking with his wife but with CIA operatives trying to find out about his relationship with Soviet intelligence. When the subject started to doze, the consultant had Thompson give him a doubled jolt of Benzedrine. A half hour later, the subject began to weep violently. The consultant decided to end the session, and in his most soothing voice, he urged the subject to fall asleep. As the subject calmed down, the consultant suggested, with friendly and soothing words, that the subject would remember nothing of the experience when he woke up.

Inducing amnesia was an important Agency goal. "From the ARTICHOKE point of view," states a 1952 document, "the greater the amnesia produced, the more effective the results." Obviously if a victim remembered the "A" treatment, it would stop being a closely guarded ARTICHOKE secret. Presumably, some subject who really did work for the Russians would tell them how the Americans had worked him over. This reality made "disposal" of ARTICHOKE subjects a particular problem. Killing them seems to have been ruled out, but Agency officials made sure that some stayed in foreign prisons for long periods of time. While in numerous specific cases, ARTICHOKE team members claimed success in making their subjects forget, their outside consultants had told them "that short of cutting a subject's throat, a true amnesia cannot be guaranteed." As early as 1950, the Agency had put out a contract to a private researcher to find a memory-destroying drug, but to no apparent avail.[3] In any case, it would be unreasonable to assume that over the years at least one ARTICHOKE subject did not shake off the amnesic commands and tell the Russians what happened to him. As was so often the case with CIA operations, the enemy probably had a much better idea of the Agency's activities than the folks back home.

Back at the safehouse, Wendt was far from through. Four more subjects would be brought to him. The next one was an alleged double agent whom the CIA had codenamed EXPLOSIVE. Agency documents describe him as a Russian "professional agent type" and "a hard-boiled individual who apparently has the ability to lie consistently but not very effectively." He was no stranger to ARTICHOKE team members who, a few months before, had plied him with a mixture of drugs and hypnosis under the cover of a "psychiatric-medical" exam. At that time, a professional hypnotist had accompanied the team, and he had given his commands through an elaborate intercom system to an interpreter who, in turn, was apparently able to put EXPLOSIVE under.[4] Afterward, the team reported to the CIA's Director that EXPLOSIVE had revealed "extremely valuable" information and that he had been made to forget his interrogation through a hypnotically induced amnesia. Since that time EXPLOSIVE had been kept in custody. Now he was being brought out to give Professor Wendt a crack at him with the Seconal-Dexedrine-marijuana combination.

This time, Wendt gave the subject all three drugs together in one beer, delivered at the cocktail hour. Next came Seconal in a dinner beer and then all three once more in a postprandial beer. There were little, if any, positive results. Wendt ended the session after midnight and commented, "At least we learned one thing from this experiment. The people you have to deal with here are different from American college students."

During the next week, the CIA men brought Wendt three more subjects, with little success. The general attitude toward Wendt became, in Thompson's words, "hostile as all hell." Both the Agency and the Navy groups questioned his competence. With one subject, the professor declared he had given too strong a dose; with the next, too weak. While he had advertised his drugs as tasteless, the subjects realized they had swallowed something. As one subject in the next room was being interrogated in Russian that no one was bothering to translate, Wendt took to playing the same pattern on the piano over and over for a half hour. While the final subject was being questioned, Wendt and his female assistant got a little tipsy on beer. Wendt became so distracted during this experiment that he finally admitted, "My thoughts are elsewhere." His assistant began to giggle. Her presence had become like an open sore - which was made more painful when Mrs. Wendt showed up in Frankfurt and the professor threatened to jump off a church tower, Thompson recalls.

Wendt is not alive to give his version of what happened, but both CIA and Navy sources are consistent in their description of him. ARTICHOKE team leader Morse Allen felt he had been the victim of "a fraud or at least a gross misinterpretation," and he described the trip as "a waste of time and money." A man who usually hid his feelings, Allen became livid when Wendt's assistant measured drugs out with a penknife. He recommended in his final report that those who develop drugs not be allowed to participate in future field testing. "This, of course, does not mean that experimental work is condemned by the ARTICHOKE team," he wrote, "but a common sense approach in this direction will preclude arguments, alibis, and complaints as in the recent situation." In keeping with this "common sense approach," he also recommended that as "an absolute rule," no women be allowed on ARTICHOKE missions - because of the possible danger and because "personal convenience, toilet facilities, etc., are complicated by the presence of women."

Morse Allen and his ARTICHOKE mates returned to the States still convinced that they could find ways to control human behavior, but the Navy men were shaken. Their primary contractor had turned out to be a tremendous embarrassment. Dr. Thompson stated he could never work with Wendt again. Navy officials soon summoned Wendt to Bethesda and told him they were canceling their support for his research. Adding insult to injury, they told him they expected refund of all unspent money. While the Navy managers made some effort to continue CHATTER at other institutions, the program never recovered from the Wendt fiasco. By the end of the next year, 1953, the Korean War had ended and the Navy abandoned CHATTER altogether.

Over the next two decades, the Navy would still sponsor large amounts of specialized behavioral research, and the Army would invest huge sums in schemes to incapacitate whole armies with powerful drugs. But the CIA clearly pulled far into the lead in mind control. In those areas in which military research continued, the Agency stayed way ahead. The CIA consistently was out on what was called the "cutting edge" of the research, sponsoring the lion's share of the most harrowing experiments. ARTICHOKE and its successor CIA programs became an enormous effort that harnessed the energies of hundreds of scientists.

The experience of the CIA psychiatric consultant provides a small personal glimpse of how it felt to be a soldier in the mind-control campaign. This psychiatrist, who insists on anonymity, estimates that he made between 125 and 150 trips overseas on Agency operations from 1952 through his retirement in 1966. "To be a psychiatrist chasing off to Europe instead of just seeing the same patients year after year, that was extraordinary," he reminisces. "I wish I was back in those days. I never got tired of it." He says his assignments called for "practicing psychiatry in an ideal way, which meant you didn't become involved with your patients. You weren't supposed to." Asked how he felt about using drugs on unwitting foreigners, he snaps, "Depends which side you were on. I never hurt anyone... . We were at war."

For the most part, the psychiatrist stopped giving the "A" treatment after the mid- 1950s but he continued to use his professional skills to assess and manipulate agents and defectors. His job was to help find out if a subject was under another country's control and to recommend how the person could be switched to the CIA's. In this work, he was contributing to the mainstream of CIA activity that permeates its institutional existence from its operations to its internal politics to its social life: the notion of controlling people. Finding reliable ways to do that is a primary CIA goal, and the business is often a brutal one. As former CIA Director Richard Helms stated in Senate testimony, "The clandestine operator ... is trained to believe you can't count on the honesty of your agent to do exactly what you want or to report accurately unless you own him body and soul."

Like all the world's secret services, the CIA sought to find the best methods of owning people and making sure they stayed owned. How could an operator be sure of an agent's loyalties? Refugees and defectors were flooding Western Europe, and the CIA wanted to exploit them. Which ones were telling the truth? Who was a deception agent or a provocateur. The Anglo-American secret invasion of Albania had failed miserably. Had they been betrayed?[5] Whom could the CIA trust?

One way to try to answer these questions is to use physical duress - or torture. Aside from its ethical drawbacks, however, physical brutality simply does not work very well. As a senior counterintelligence official explains, "If you have a blowtorch up someone's ass, he'll give you tactical information." Yet he will not be willing or able to play the modern espionage game on the level desired by the CIA. One Agency document excludes the use of torture "because such inhuman treatment is not only out of keeping with the traditions of this country, but of dubious effectiveness as compared with various supplemental psychoanalytical techniques."

The second and most popular method to get answers is traditional spy tradecraft. Given enough time, a good interrogator can very often find out a person's secrets. He applies persuasion and mental seduction, mixed with psychological pressures of every description - emotional carrots and sticks. A successful covert operator uses the same sorts of techniques in recruiting agents and making sure they stay in line. While the rest of the population may dabble in this sort of manipulation, the professional operator does it for a living, and he operates mostly outside the system of restraints that normally govern personal relationships. "I never gave a thought to legality or morality," states a retired and quite cynical Agency case officer with over 20 years' experience. "Frankly, I did what worked."

The operator pursues people he can turn into "controlled sources" - agents willing to do his bidding either in supplying intelligence or taking covert action. He seeks people in a position to do something useful for the Agency - or who someday might be in such a position, perhaps with CIA aid. Once he picks his target, he usually looks for a weakness or vulnerability he can play on. Like a good fisherman, the clever operator knows that the way to hook his prey is to choose an appropriate bait, which the target will think he is seizing because he wants to. The hook has to be firmly implanted; the agent sometimes tries to escape once he understands the implications of betraying his country. While the case officer might try to convince him he is acting for the good of his homeland, the agent must still face up to being branded a traitor.

Does every man have his price? Not exactly, states the senior counterintelligence man, but he believes a shrewd operator can usually find a way to reach anyone, particularly through his family. In developing countries, the Agency has caused family members to be arrested and mistreated by the local police, given or withheld medical care for a sick child, and, more prosaically, provided scholarships for a relative to study abroad. This kind of tactic does not work as well on a Russian or Western European, who does not live in a society where the CIA can exert pressure so easily.

Like a doctor's bedside manner or a lawyer's courtroom style, spy tradecraft is highly personalized. Different case officers swear by different approaches, and successful methods are carefully observed and copied. Most CIA operators seem to prefer using an ideological lure if they can. John Stockwell, who left the Agency in 1977 to write a book about CIA operations in Angola, believes his best agents were "people convinced they were doing the right thing ... who disliked communists and felt the CIA was the right organization." Stockwell recalls his Agency instructors "hammering away at the positive aspect of recruitment. This was where they established the myth of CIA case officers being good guys. They said we didn't use negative control, and we always made the relationship so that both parties were better off for having worked together." More cynical operators, like the one quoted above, take a different view: "You can't create real motivation in a person by waving the flag or by saying this is for the future good of democracy. You've got to have a firmer hold than that.... His opinions can change." This ex-operator favors approaches based either on revenge or helping the agent advance his career:

> Those are good motives because they can be created with the individual.... Maybe you start with a Communist party cell member and you help him become a district committee member by eliminating his competition, or you help him get a position where he can get even with someone. At the same time, he's giving you more and more information as he moves forward, and if you ever surface his reports, he's out of business. You've really got him wrapped up. You don't even have to tell him. He realizes it himself.

No matter what the approach to the prospective agent, the case officer tries to make money a factor in the relationship. Sometimes the whole recruiting pitch revolves around enrichment. In other instances, the case officer allows the target the illusion that he has sold out for higher motives. Always, however, the operator tries to use money to make the agent dependent. The situation can become sticky with money-minded agents when the case officer insists that part or all of the payments be placed in escrow, to prevent attracting undue attention. But even cash does not create control in the spy business. As the cynical case officer puts it, "Money is tenuous because somebody can always offer more."

Surprisingly, each of the CIA operators sampled agrees that overt blackmail is a highly overrated form of control. The senior counterintelligence man notes that while the Russians frequently use some variety of entrapment - sexual or otherwise - the CIA rarely did. "Very few [Agency] case officers were tough enough" to pull it off and sustain it, he says. "Anytime an agent has been forced to cooperate, you can take it for granted that he has two things on his mind: he is looking for a way out and for revenge. Given the slightest opportunity, he will hit you right between the eyes." Blackmail could backfire in unexpected ways. John Stockwell remembers an agent in Southeast Asia who wanted to quit: "The case officer leaned on the guy and said, 'Look, friend, we still need your intelligence, and we have receipts you signed which we can turn over to the local police.' The agent blew his brains out, leaving a suicide note regretting his cooperation with the CIA and telling how the Agency had tried to blackmail him. It caused some problems with the local government."

The case officer always tries to weave an ever-tightening web of control around his agent. His methods of doing so are so personal and so basic that they often reveal more about the case officer himself than the agent, reflecting his outlook and his personal philosophy. The cynical operator describes his usual technique, which turns out to be a form of false idealism: "You've got to treat a man as an equal and convince him you're partners in this thing. Even if he's a communist party member, you can't deal with him like a crumb. You sit down with him and ask how are the kids, and you remember that he told you last time that his son was having trouble in school. You build personal rapport. If you treat him like dirt or an object of use, eventually he'll turn on you or drop off the bandwagon."

John Stockwell's approach relies on the power of imagination in a humdrum world: "I always felt the real key was that you were offering something special - a real secret life - something that he and you only knew made him different from all the pedestrian paper shufflers in a government office or a boring party cell meeting. Everybody has a little of Walter Mitty in him - what a relief to know you really do work for the CIA in your spare time."

Sometimes a case officer wants to get the agent to do something he does not think he wants to do. One former CIA operator uses a highly charged metaphor to describe how he did it: "Sometimes one partner in a relationship wants to get into deviations from standard sex. If you have some control, you might be able to force your partner to try different things, but it's much better to lead her down the road a step at a time, to discuss it and fantasize until eventually she's saying, 'Let's try this thing.' If her inhibitions and moral reservations are eroded and she is turned on, it's much more fun and there's less chance of blowback [exposure, in spy talk].... It's the same with an agent."

All case officers - and particularly counterintelligence men - harbor recurring fears that their agents will betray them. The suspicious professional looks for telltale signs like lateness, nervousness, or inconsistency. He relies on his intuition. "The more you've been around agents, the more likely you are to sense that something isn't what it should be," comments the senior counterintelligence man. "It's like with children."

No matter how skillfully practiced, traditional spycraft provides only incomplete answers to the nagging question of how much the Agency can really trust an agent. All the sixth sense, digging, and deductive reasoning in the world do not produce certainty in a field that is based on deception and lies. Whereas the British, who invented the game, have historically understood the need for patience and a stiff upper lip, Americans tend to look for quick answers, often by using the latest technology. "We were very gimmick-prone," says the senior counterintelligence official. Gimmicks - machines, drugs, technical tricks - comprise the third method of behavior control, after torture and tradecraft. Like safecrackers who swear by the skill in their fingertips, most of the Agency's mainstream operators disparage newfangled gadgets. Many now claim that drugs, hypnosis, and other exotic methods actually detract from good tradecraft because they make operators careless and lazy.

Nevertheless, the operators and their high-level sponsors, like Allen Dulles and Richard Helms, consistently pushed for the magic technique - the deus ex machina - that would solve their problems. Caught in the muck and frustration of ordinary spywork, operators hoped for a miracle tool. Faced with liars and deceivers, they longed for a truth drug. Surrounded by people who knew too much, they sought a way to create amnesia. They dreamed of finding means to make unwilling people carry out specific tasks, such as stealing documents, provoking a fight, killing someone, or otherwise committing an antisocial act. Secret agents recruited by more traditional appeals to idealism, greed, ambition, or fear had always done such deeds, but they usually gave their spymasters headaches in the process. Sometimes they balked. Moreover, first they had to agree to serve the CIA. The best tradecraft in the world seldom works against a well-motivated target. (The cynical operator recalls offering the head of Cuban intelligence $1,000,00~in 1966 at a Madrid hotel - only to receive a flat rejection.) Plagued by the unsureness, Agency officials hoped to take the randomness - indeed, the free will - out of agent handling. As one psychologist who worked on behavior control describes it, "The problem of every intelligence operation is how do you remove the human element? The operators would come to us and ask for the human element to be removed." Thus the impetus toward mind-control research came not only from the lure of science and the fantasies of science fiction, it also came from the heart of the spy business.

Notes 3

The primary sources for the material on Professor Wendt's trip to Frankfurt were Dr. Samuel V. Thompson then of the Navy, the CIA psychiatric consultant, several of Wendt's former associates, as well as three CIA documents that described the testing: Document # 168, 19 September 1952, Subject: "Project LGQ"; Document # 168, 18 September 1952, Subject: Field Trip of ARTICHOKE team,20 August-September 1952; and #A/B, II, 33/21, undated, Subject: Special Comments.

Information on the Navy's Project CHATTER came from the Church Committee Report, Book I, pp. 337-38. Declassified Navy Documents N-23, February 13, 1951, Subject: Procurement of Certain Drugs; N-27, undated, Subject: Project CHATTER; N-29, undated, Subject: Status Report: Studies of Motion Sickness, Vestibular Function, and Effects of Drugs; N-35, October 27, 1951, Interim Report; N-38, 30 September, 1952, Memorandum for File; and N-39, 28 October, 1952, Memorandum for File.

The information on the heroin found in Wendt's safe comes from the Rochester Democrat and Chronicle, October 2, 1977 and considerable background on Wendt's Rochester testing program was found in the Rochester Times-Union, January 28, 1955. The CIA quote on heroin came from May 15,1952 OSI Memorandum to the Deputy Director, CIA, Subject: Special Interrogation.

Information on the Agency's interest in amnesia came from 14 January 1952 memo, Subject: BLUEBIRD/ARTICHOKE, Proposed Research; 7 March 1951, Subject: Informal Discussion with Chief [deleted] Regarding "Disposal"; 1 May 1951, Subject: Recommendation for Disposal of Maximum Custody Defectors; and #A/B, I, 75/13, undated, Subject: Amnesia.

The quote from Homer on nepenthe was found in Sidney Cohen's The Beyond Within: The LSD Story (New York: Atheneum, 1972).

The section on control came from interviews with John Stockwell and several other former CIA men.

Footnotes 3

1. What Wendt appears to have been getting at - namely, that repeated shots of heroin might have an effect on interrogation - was stated explicitly in a 1952 CIA document which declared the drug "can be useful in reverse because of the stresses produced when ... withdrawn from those addicted." Wendt's interest in heroin seems to have lasted to his death in 1977, long after his experiments had stopped. The woman who cleaned out his safe at that time told the Rochester Democrat and Chronicle she found a quantity of the white powder, along with syringes and a good many other drugs.
2. Being good undercover operators, the CIA men never let on to Wendt that they knew his secret, and Wendt was not about to give it away. Toward the end of the trip, he told the consultant he would feel "unpatriotic" if he were to share his secret because the ARTICHOKE team was "not competent" to use the drugs.
3. Homer reported the ancient Greeks had such a substance - nepenthe - "a drug to lull all pain and anger, and bring forgetfulness of every sorrow."
4. Neither Morse Allen nor anyone else on the ARTICHOKE teams spoke any foreign languages. Allen believed that the difficulty in communicating with the guinea pigs hampered ARTICHOKE research.
5. The answer was yes, in the sense that Soviet agent Harold "Kim" Philby, working as British intelligence's liaison with the CIA apparently informed his spymasters of specific plans to set up anticommunist resistance movements in Albania and all over Eastern Europe. The Russians almost certainly learned about CIA plans to overthrow communist rule in Eastern Europe and in the Soviet Union itself. Knowing of such operations presumably increased Soviet hostility.

Part II - Intelligence or "Witches potions"

4. LSD

Albert Hofmann's discovery of LSD in 1943 may have begun a new age in the exploration of the human mind, but it took six years for word to reach America. Even after Hofmann and his coworkers in Switzerland published their work in a 1947 article, no one in the United States seemed to notice. Then in 1949, a famous Viennese doctor named Otto Kauders traveled to the United States in search of research funds. He gave a conference at Boston Psychopathic Hospital,[1] a pioneering mental-health institution affiliated with Harvard Medical School, and he spoke about a new experimental drug called d-lysergic acid diethylamide. Milton Greenblatt, the hospital's research director, vividly recalls Kauders' description of how an infinitesimally small dose had rendered Dr. Hofmann temporarily "crazy." "We were very interested in anything that could make someone schizophrenic," says Greenblatt. If the drug really did induce psychosis for a short time, the Boston doctors reasoned, an antidote - which they hoped to find - might cure schizophrenia. It would take many years of research to show that LSD did not, in fact, produce a "model psychosis," but to the Boston doctors in 1949, the drug showed incredible promise. Max Rinkel, a neuropsychiatrist and refugee from Hitler's Germany, was so intrigued by Kauders' presentation that he quickly contacted Sandoz, the huge Swiss pharmaceutical firm where Albert Hofmann worked. Sandoz officials arranged to ship some LSD across the Atlantic.

The first American trip followed. The subject was Robert Hyde, a Vermont-born psychiatrist who was Boston Psychopathic's number-two man. A bold, innovative sort, Hyde took it for granted that there would be no testing program until he tried the drug. With Rinkel and the hospital's senior physician, H. Jackson DeShon looking on, Hyde drank a glass of water with 100 micrograms of LSD in it - less than half Hofmann's dose, but still a hefty jolt. DeShon describes Hyde's reaction as "nothing very startling." The perpetually active Hyde insisted on making his normal hospital rounds while his colleagues tagged along. Rinkel later told a scientific conference that Hyde became "quite paranoiac, saying that we had not given him anything. He also berated us and said the company had cheated us, given us plain water. That was not Dr. Hyde's normal behavior; he is a very pleasant man." Hyde's first experience was hardly as dramatic as Albert Hofmann's, but then the Boston psychiatrist had not, like Hofmann, set off on a voyage into the complete unknown. For better or worse, LSD had come to America in 1949 and had embarked on a strange trip of its own. Academic researchers would study it in search of knowledge that would benefit all mankind. Intelligence agencies, particularly the CIA, would subsidize and shape the form of much of this work to learn how the drug could be used to break the will of enemy agents, unlock secrets in the minds of trained spies, and otherwise manipulate human behavior. These two strains - of helping people and of controlling them - would coexist rather comfortably through the 1950s. Then, in the 1960s, LSD would escape from the closed world of scholar and spy, and it would play a major role in causing a cultural upheaval that would have an impact both on global politics and on intimate personal beliefs. The trip would wind up - to borrow some hyperbole from the musical Hair - with "the youth of America on LSD."

The counterculture generation was not yet out of the nursery, however, when Bob Hyde went tripping: Hyde himself would not become a secret CIA consultant for several years. The CIA and the military intelligence agencies were just setting out on their quest for drugs and other exotic methods to take possession of people's minds. The ancient desire to control enemies through magical spells and potions had come alive again, and several offices within the CIA competed to become the head controllers. Men from the Office of Security's ARTICHOKE program were struggling - as had OSS before them - to find a truth drug or hypnotic method that would aid in interrogation. Concurrently, the Technical Services Staff (TSS) was investigating in much greater depth the whole area of applying chemical and biological warfare (CBW) to covert operations. TSS was the lineal descendent of Stanley Lovell's Research and Development unit in OSS, and its officials kept alive much of the excitement and urgency of the World War II days when Lovell had tried to bring out the Peck's Bad Boy in American scientists. Specialists from TSS furnished backup equipment for secret operations: false papers, bugs, taps, suicide pills, explosive seashells, transmitters hidden in false teeth, cameras in tobacco pouches, invisible inks, and the like. In later years, these gadget wizards from TSS would become known for supplying some of history's more ludicrous landmarks, such as Howard Hunt's ill-fitting red wig; but in the early days of the CIA, they gave promise of transforming the spy world.

Within TSS, there existed a Chemical Division with functions that few others - even in TSS - knew about. These had to do with using chemicals (and germs) against specific people. From 1951 to 1956, the years when the CIA's interest in LSD peaked, Sidney Gottlieb, a native of the Bronx with a Ph.D. in chemistry from Cal Tech, headed this division. (And for most of the years until 1973, he would oversee TSS's behavioral programs from one job or another.) Only 33 years old when he took over the Chemical Division, Gottlieb had managed to overcome a pronounced stammer and a clubfoot to rise through Agency ranks. Described by several acquaintances as a "compensator," Gottlieb prided himself on his ability, despite his obvious handicaps, to pursue his cherished hobby, folk dancing. On returning from secret missions overseas, he invariably brought back a new step that he would dance with surprising grace. He could call out instructions for the most complicated dances without a break in his voice, infecting others with enthusiasm. A man of unorthodox tastes, Gottlieb lived in a former slave cabin that he had remodeled himself - with his wife, the daughter of Presbyterian missionaries in India, and his four children. Each morning, he rose at 5:30 to milk the goats he kept on his 15 acres outside Washington. The Gottliebs drank only goat's milk, and they made their own cheese. They also raised Christmas trees which they sold to the outside world. Greatly respected by his former colleagues, Gottlieb, who refused to be interviewed for this book, is described as a humanist, a man of intellectual humility and strength, willing to carry out, as one ex-associate puts it, "the tough things that had to be done." This associate fondly recalls, "When you watched him, you gained more and more respect because he was willing to work so hard to get an idea across. He left himself totally exposed. It was more important for us to get the idea than for him not to stutter." One idea he got across was that the Agency should investigate the potential use of the obscure new drug, LSD, as a spy weapon.

At the top ranks of the Clandestine Services (officially called the Directorate of Operations but popularly known as the "dirty tricks department"), Sid Gottlieb had a champion who appreciated his qualities, Richard Helms. For two decades, Gottlieb would move into progressively higher positions in the wake of Helms' climb to the highest position in the Agency. Helms, the tall, smooth "preppie," apparently liked the way the Jewish chemist, who had started out at Manhattan's City College, could thread his way through complicated technical problems and make them understandable to nonscientists. Gottlieb was loyal and he followed orders. Although many people lay in the chain of command between the two men, Helms preferred to avoid bureaucratic niceties by dealing directly with Gottlieb.

On April 3, 1953, Helms proposed to Director Allen Dulles that the CIA set up a program under Gottlieb for "covert use of biological and chemical materials." Helms made clear that the Agency could use these methods in "present and future clandestine operations" and then added, "Aside from the offensive potential, the development of a comprehensive capability in this field ... gives us a thorough knowledge of the enemy's theoretical potential, thus enabling us to defend ourselves against a foe who might not be as restrained in the use of these techniques as we are." Once again, as it would throughout the history of the behavioral programs, defense justified offense. Ray Cline, often a bureaucratic rival of Helms, notes the spirit in which the future Director pushed this program: "Helms fancied himself a pretty tough cookie. It was fashionable among that group to fancy they were rather impersonal about dangers, risks, and human life. Helms would think it sentimental and foolish to be against something like this."

On April 13, 1953 - the same day that the Pentagon announced that any U.S. prisoner refusing repatriation in Korea would be listed as a deserter and shot if caught - Allen Dulles approved the program, essentially as put forth by Helms. Dulles took note of the "ultra-sensitive work" involved and agreed that the project would be called MKULTRA.[2] He approved an initial budget of $300,000, exempted the program from normal CIA financial controls, and allowed TSS to start up research projects "without the signing of the usual contracts or other written agreements." Dulles ordered the Agency's bookkeepers to pay the costs blindly on the signatures of Sid Gottlieb and Willis Gibbons, a former U.S. Rubber executive who headed TSS.

As is so often the case in government, the activity that Allen Dulles approved with MKULTRA was already under way, even before he gave it a bureaucratic structure. Under the code name MKDELTA, the Clandestine Services had set up procedures the year before to govern the use of CBW products. (MKDELTA now became the operational side of MKULTRA.) Also in 1952, TSS had made an agreement with the Special Operations Division (SOD) of the Army's biological research center at Fort Detrick, Maryland whereby SOD would produce germ weapons for the CIA's use (with the program called MKNAOMI). Sid Gottlieb later testified that the purpose of these programs was "to investigate whether and how it was possible to modify an individual's behavior by covert means. The context in which this investigation was started was that of the height of the

Cold War with the Korean War just winding down; with the CIA organizing its resources to liberate Eastern Europe by paramilitary means; and with the threat of Soviet aggression very real and tangible, as exemplified by the recent Berlin airlift" (which occurred in 1948).

In the early days of MKULTRA, the roughly six TSS professionals who worked on the program spent a good deal of their time considering the possibilities of LSD.[3] "The most fascinating thing about it," says one of them, "was that such minute quantities had such a terrific effect." Albert Hofmann had gone off into another world after swallowing less than 1/100,000 of an ounce. Scientists had known about the mind-altering qualities of drugs like mescaline since the late nineteenth century, but LSD was several thousand times more potent. Hashish had been around for millennia, but LSD was roughly a million times stronger (by weight). A two-suiter suitcase could hold enough LSD to turn on every man, woman, and child in the United States. "We thought about the possibility of putting some in a city water supply and having the citizens wander around in a more or less happy state, not terribly interested in defending themselves," recalls the TSS man. But incapacitating such large numbers of people fell to the Army Chemical Corps, which also tested LSD and even stronger hallucinogens. The CIA was concentrating on individuals. TSS officials understood that LSD distorted a person's sense of reality, and they felt compelled to learn whether it could alter someone's basic loyalties. Could the CIA make spies out of tripping Russians - or vice versa? In the early 1950s, when the Agency developed an almost desperate need to know more about LSD, almost no outside information existed on the subject. Sandoz had done some clinical studies, as had a few other places, including Boston Psychopathic, but the work generally had not moved much beyond the horse-and-buggy stage. The MKULTRA team had literally hundreds of questions about LSD's physiological, psychological, chemical, and social effects. Did it have any antidotes? What happened if it were combined with other drugs? Did it affect everyone the same way? What was the effect of doubling the dose? And so on.

TSS first sought answers from academic researchers, who, on the whole, gladly cooperated and let the Agency pick their brains. But CIA officials realized that no one would undertake a quick and systematic study of the drug unless the Agency itself paid the bill. Almost no government or private money was then available for what had been dubbed "experimental psychiatry." Sandoz wanted the drug tested, for its own commercial reasons, but beyond supplying it free to researchers, it would not assume the costs. The National Institutes of Mental Health had an interest in LSD's relationship to mental illness, but CIA officials wanted to know how the drug affected normal people, not sick ones. Only the military services, essentially for the same reasons as the CIA, were willing to sink much money into LSD, and the Agency men were not about to defer to them. They chose instead to take the lead - in effect to create a whole new field of research.

Suddenly there was a huge new market for grants in academia, as Sid Gottlieb and his aides began to fund LSD projects at prestigious institutions. The Agency's LSD pathfinders can be identified: Bob Hyde's group at Boston Psychopathic, Harold Abramson at Mt. Sinai Hospital and Columbia University in New York, Carl Pfeiffer at the University of Illinois Medical School, Harris Isbell of the NIMH-sponsored Addiction Research Center in Lexington, Kentucky, Louis Jolyon West at the University of Oklahoma, and Harold Hodge's group at the University of Rochester. The Agency disguised its involvement by passing the money through two conduits: the Josiah Macy, Jr. Foundation, a rich establishment institution which served as a cutout (intermediary) only for a year or two, and the Geschickter Fund for Medical Research, a Washington, D.C. family foundation, whose head, Dr. Charles Geschickter, provided the Agency with a variety of services for more than a decade. Reflexively, TSS officials felt they had to keep the CIA connection secret. They could only "assume," according to a 1955 study, that Soviet scientists understood the drug's "strategic importance" and were capable of making it themselves. They did not want to spur the Russians into starting their own LSD program or into devising countermeasures.

The CIA's secrecy was also clearly aimed at the folks back home. As a 1963 Inspector General's report stated, "Research in the manipulation of human behavior is considered by many authorities in medicine and related fields to be professionally unethical"; therefore, openness would put "in jeopardy" the reputations of the outside researchers. Moreover, the CIA Inspector General declared that disclosure of certain MKULTRA activities could result in "serious adverse reaction" among the American public.

At Boston Psychopathic, there were various levels of concealment. Only Bob Hyde and his boss, the hospital superintendent, knew officially that the CIA was funding the hospital's LSD program from 1952 on, to the tune of about $40,000 a year. Yet, according to another member of the Hyde group, Dr. DeShon, all senior staff understood where the money really came from. "We agreed not to discuss it," says DeShon. "I don't see any objection to this. We never gave it to anyone without his consent and without explaining it in detail." Hospital officials told the volunteer subjects something about the nature of the experiments but nothing about their origins or purpose. None of the subjects had any idea that the CIA was paying for the probing of their minds and would use the results for its own purposes; most of the staff was similarly ignorant.

Like Hyde, almost all the researchers tried LSD on themselves. Indeed, many believed they gained real insight into what it felt like to be mentally ill, useful knowledge for health professionals who spent their lives treating people supposedly sick in the head. Hyde set up a multidisciplinary program - virtually unheard of at the time - that brought together psychiatrists, psychologists, and physiologists. As subjects, they used each other, hospital patients, and volunteers - mostly students - from the Boston area. They worked through a long sequence of experiments that served to isolate variable after variable. Palming themselves off as foundation officials, the men from MKULTRA frequently visited to observe and suggest areas of future research. One Agency man, who himself tripped several times under Hyde's general supervision, remembers that he and his colleagues would pass on a nugget that another contractor like Harold Abramson had gleaned and ask Hyde to perform a follow-up test that might answer a question of interest to the Agency. Despite these tangents, the main body of research proceeded in a planned and orderly fashion. The researchers learned that while some subjects seemed to become schizophrenic, many others did not. Surprisingly, true schizophrenics showed little reaction at all to LSD, unless given massive doses. The Hyde group found out that the quality of a person's reaction was determined mainly by the person's basic personality structure (set) and the environment (setting) in which he or she took the drug. The subject's expectation of what would happen also played a major part. More than anything else, LSD tended to intensify the subject's existing characteristics - often to extremes. A little suspicion could grow into major paranoia, particularly in the company of people perceived as threatening.

Unbeknownst to his fellow researchers, the energetic Dr. Hyde also advised the CIA on using LSD in covert operations. A CIA officer who worked with him recalls: "The idea would be to give him the details of what had happened [with a case], and he would speculate. As a sharp M.D. in the old-school sense, he would look at things in ways that a lot of recent bright lights couldn't get.... He had a good sense of makedo." The Agency paid Hyde for his time as a consultant, and TSS officials eventually set aside a special MKULTRA subproject as Hyde's private funding mechanism. Hyde received funds from yet another MKULTRA subproject that TSS men created for him in 1954, so he could serve as a cutout for Agency purchases of rare chemicals. His first buy was to be $32,000 worth of corynanthine, a possible antidote to LSD, that would not be traced to the CIA.

Bob Hyde died in 1976 at the age of 66, widely hailed as a pacesetter in mental health. His medical and intelligence colleagues speak highly of him both personally and professionally. Like most of his generation, he apparently considered helping the CIA a patriotic duty. An Agency officer states that Hyde never raised doubts about his covert work. "He wouldn't moralize. He had a lot of trust in the people he was dealing with [from the CIA]. He had pretty well reached the conclusion that if they decided to do something [operationally], they had tried whatever else there was and were willing to risk it."

Most of the CIA's academic researchers published articles on their work in professional journals, but those long, scholarly reports often gave an incomplete picture of the research. In effect, the scientists would write openly about how LSD affects a patient's pulse rate, but they would tell only the CIA how the drug could be used to ruin that patient's marriage or memory. Those researchers who were aware of the Agency's sponsorship seldom published anything remotely connected to the instrumental and rather unpleasant questions the MKULTRA men posed for investigation. That was true of Hyde and of Harold Abramson, the New York allergist who became one of the first Johnny Appleseeds of LSD by giving it to a number of his distinguished colleagues. Abramson documented all sorts of experiments on topics like the effects of LSD on Siamese fighting fish and snails,[4] but he never wrote a word about one of his early LSD assignments from the Agency. In a 1953 document, Sid Gottlieb listed subjects he expected Abramson to investigate with the $85,000 the Agency was furnishing him. Gottlieb wanted "operationally pertinent materials along the following lines: a. Disturbance of Memory; b. Discrediting by Aberrant Behavior; c. Alteration of Sex Patterns; d. Eliciting of Information; e. Suggestibility; f. Creation of Dependence."

Dr. Harris Isbell, whose work the CIA funded through Navy cover with the approval of the Director of the National Institutes of Health, published his principal findings, but he did not mention how he obtained his subjects. As Director of the Addiction Research Center at the huge Federal drug hospital in Lexington, Kentucky, he had access to a literally captive population. Inmates heard on the grapevine that if they volunteered for Isbell's program, they would be rewarded either in the drug of their choice or in time off from their sentences. Most of the addicts chose drugs - usually heroin or morphine of a purity seldom seen on the street. The subjects signed an approval form, but they were not told the names of the experimental drugs or the probable effects. This mattered little, since the "volunteers" probably would have granted their informed consent to virtually anything to get hard drugs.

Given Isbell's almost unlimited supply of subjects, TSS officials used the Lexington facility as a place to make quick tests of promising but untried drugs and to perform specialized experiments they could not easily duplicate elsewhere. For instance, Isbell did one study for which it would have been impossible to attract student volunteers. He kept seven men on LSD for 77 straight days.[5] Such an experiment is as chilling as it is astonishing - both to lovers and haters of LSD. Nearly 20 years after Dr. Isbell's early work, counterculture journalist Hunter S. Thompson delighted and frightened his readers with accounts of drug binges lasting a few days, during which Thompson felt his brain boiling away in the sun, his nerves wrapping around enormous barbed wire forts, and his remaining faculties reduced to their reptilian antecedents. Even Thompson would shudder at the thought of 77 days straight on LSD, and it is doubtful he would joke about the idea. To Dr. Isbell, it was just another experiment. "I have had seven patients who have now been taking the drug for more than 42 days," he wrote in the middle of the test, which he called "the most amazing demonstration of drug tolerance I have ever seen." Isbell tried to "break through this tolerance" by giving triple and quadruple doses of LSD to the inmates.

Filled with intense curiosity, Isbell tried out a wide variety of unproven drugs on his subjects. Just as soon as a new batch of scopolamine, rivea seeds, or bufotenine arrived from the CIA or NIMH, he would start testing. His relish for the task occasionally shone through the dull scientific reports. "I will write you a letter as soon as I can get the stuff into a man or two," he informed his Agency contact.

No corresponding feeling shone through for the inmates, however. In his few recorded personal comments, he complained that his subjects tended to be afraid of the doctors and were not as open in describing their experiences as the experimenters would have wished. Although Isbell made an effort to "break through the barriers" with the subjects, who were nearly all black drug addicts, Isbell finally decided "in all probability, this type of behavior is to be expected with patients of this type." The subjects have long since scattered, and no one apparently has measured the aftereffects of the more extreme experiments on them.

One subject who could be found spent only a brief time with Dr. Isbell. Eddie Flowers was 19 years old and had been in Lexington for about a year when he signed up for Isbell's program. He lied about his age to get in, claiming he was 21. All he cared about was getting some drugs. He moved into the experimental wing of the hospital where the food was better and he could listen to music. He loved his heroin but knew nothing about drugs like LSD. One day he took something in a graham cracker. No one ever told him the name, but his description sounds like it made him trip - badly, to be sure. "It was the worst shit I ever had," he says. He hallucinated and suffered for 16 or 17 hours. "I was frightened. I wouldn't take it again." Still, Flowers earned enough "points" in the experiment to qualify for his "payoff in heroin. All he had to do was knock on a little window down the hall. This was the drug bank. The man in charge kept a list of the amount of the hard drug each inmate had in his account. Flowers just had to say how much he wanted to withdraw and note the method of payment. "If you wanted it in the vein, you got it there," recalls Flowers who now works in a Washington, D.C. drug rehabilitation center.

Dr. Isbell refuses all request for interviews. He did tell a Senate subcommittee in 1975 that he inherited the drug payoff system when he came to Lexington and that "it was the custom in those days.... The ethical codes were not so highly developed, and there was a great need to know in order to protect the public in assessing the potential use of narcotics.... I personally think we did a very excellent job."

For every Isbell, Hyde, or Abramson who did TSS contract work, there were dozens of others who simply served as casual CIA informants, some witting and some not. Each TSS project officer had a skull session with dozens of recognized experts several times a year. "That was the only way a tiny staff like Sid Gottlieb's could possibly keep on top of the burgeoning behavioral sciences," says an ex-CIA official. "There would be no way you could do it by library research or the Ph.D. dissertation approach." The TSS men always asked their contacts for the names of others they could talk to, and the contacts would pass them on to other interesting scientists.

In LSD research, TSS officers benefited from the energetic intelligence gathering of their contractors, particularly Harold Abramson. Abramson talked regularly to virtually everyone interested in the drug, including the few early researchers not funded by the Agency or the military, and he reported his findings to TSS. In addition, he served as reporting secretary of two conference series sponsored by the Agency's sometime conduit, the Macy Foundation. These series each lasted over five year periods in the 1950s; one dealt with "Problems of Consciousness" and the other with "Neuropharmacology." Held once a year in the genteel surroundings of the Princeton Inn, the Macy Foundation conferences brought together TSS's (and the military's) leading contractors, as part of a group of roughly 25 with the multidisciplinary background that TSS officials so loved. The participants came from all over the social sciences and included such luminaries as Margaret Mead and Jean Piaget. The topics discussed usually mirrored TSS's interests at the time, and the conferences served as a spawning ground for ideas that allowed researchers to engage in some healthy cross-fertilization.

Beyond the academic world, TSS looked to the pharmaceutical companies as another source on drugs - and for a continuing supply of new products to test. TSS's Ray Treichler handled the liaison function, and this secretive little man built up close relationships with many of the industry's key executives. He had a particular knack for convincing them he would not reveal their trade secrets. Sometimes claiming to be from the Army Chemical Corps and sometimes admitting his CIA connection, Treichler would ask for samples of drugs that were either highly poisonous, or, in the words of the onetime director of research of a large company, "caused hypertension, increased blood pressure, or led to other odd physiological activity."

Dealing with American drug companies posed no particular problems for TSS. Most cooperated in any way they could. But relations with Sandoz were more complicated. The giant Swiss firm had a monopoly on the Western world's production of LSD until 1953. Agency officials feared that Sandoz would somehow allow large quantities to reach the Russians. Since information on LSD's chemical structure and effects was publicly available from 1947 on, the Russians could have produced it any time they felt it worthwhile. Thus, the Agency's phobia about Sandoz seems rather irrational, but it unquestionably did exist.

On two occasions early in the Cold War, the entire CIA hierarchy went into a dither over reports that Sandoz might allow large amounts of LSD to reach Communist countries. In 1951 reports came in through military channels that the Russians had obtained some 50 million doses from Sandoz. Horrendous visions of what the Russians might do with such a stockpile circulated in the CIA, where officials did not find out the intelligence was false for several years. There was an even greater uproar in 1953 when more reports came in, again through military intelligence, that Sandoz wanted to sell the astounding quantity of 10 kilos (22 pounds) of LSD enough for about 100 million doses - on the open market.

A top-level coordinating committee which included CIA and Pentagon representatives unanimously recommended that the Agency put up $240,000 to buy it all. Allen Dulles gave his approval, and off went two CIA representatives to Switzerland, presumably with a black bag full of cash. They met with the president of Sandoz and other top executives. The Sandoz men stated that the company had never made anything approaching 10 kilos of LSD and that, in fact, since the discovery of the drug 10 years before, its total production had been only 40 grams (about 11/2 ounces).[6] The manufacturing process moved quite slowly at that time because Sandoz used real ergot, which could not be grown in large quantities. Nevertheless, Sandoz executives, being good Swiss businessmen, offered to supply the U.S. Government with 100 grams weekly for an indefinite period, if the Americans would pay a fair price. Twice the Sandoz president thanked the CIA men for being willing to take the nonexistent 10 kilos off the market. While he said the company now regretted it had ever discovered LSD in the first place, he promised that Sandoz would not let the drug fall into communist hands. The Sandoz president mentioned that various Americans had in the past made "covert and sideways" approaches to Sandoz to find out about LSD, and he agreed to keep the U.S. Government informed of all future production and shipping of the drug. He also agreed to pass on any intelligence about Eastern European interest in LSD. The Sandoz executives asked only that their arrangement with the CIA be kept "in the very strictest confidence."

All around the world, the CIA tried to stay on top of the LSD supply. Back home in Indianapolis, Eli Lilly & Company was even then working on a process to synthesize LSD. Agency officials felt uncomfortable having to rely on a foreign company for their supply, and in 1953 they asked Lilly executives to make them up a batch, which the company subsequently donated to the government. Then, in 1954, Lilly scored a major breakthrough when its researchers worked out a complicated 12- to 15-step process to manufacture first lysergic acid (the basic building block) and then LSD itself from chemicals available on the open market. Given a relatively sophisticated lab, a competent chemist could now make LSD without a supply of the hard-to-grow ergot fungus. Lilly officers confidentially informed the government of their triumph. They also held an unprecedented press conference to trumpet their synthesis of lysergic acid, but they did not publish for another five years their success with the closely related LSD.

TSS officials soon sent a memo to Allen Dulles, explaining that the Lilly discovery was important because the government henceforth could buy LSD in "tonnage quantities," which made it a potential chemical-warfare agent. The memo writer pointed out, however, that from the MKULTRA point of view, the discovery made no difference since TSS was working on ways to use the drug only in small-scale covert operations, and the Agency had no trouble getting the limited amounts it needed. But now the Army Chemical Corps and the Air Force could get their collective hands on enough LSD to turn on the world.

Sharing the drug with the Army here, setting up research programs there, keeping track of it everywhere, the CIA generally presided over the LSD scene during the 1950s. To be sure, the military services played a part and funded their own research programs.[7] So did the National Institutes of Health, to a lesser extent. Yet both the military services and the NIH allowed themselves to be co-opted by the CIA - as funding conduits and intelligence sources. The Food and Drug Administration also supplied the Agency with confidential information on drug testing. Of the Western world's two LSD manufacturers, one - Eli Lilly - gave its entire (small) supply to the CIA and the military. The other - Sandoz - informed Agency representatives every time it shipped the drug. If somehow the CIA missed anything with all these sources, the Agency still had its own network of scholar-spies, the most active of whom was Harold Abramson who kept it informed of all new developments in the LSD field. While the CIA may not have totally cornered the LSD market in the 1950s, it certainly had a good measure of control - the very power it sought over human behavior.

Sid Gottlieb and his colleagues at MKULTRA soaked up pools of information about LSD and other drugs from all outside sources, but they saved for themselves the research they really cared about: operational testing. Trained in both science and espionage, they believed they could bridge the huge gap between experimenting in the laboratory and using drugs to outsmart the enemy. Therefore the leaders of MKULTRA initiated their own series of drug experiments that paralleled and drew information from the external research. As practical men of action, unlimited by restrictive academic standards, they did not feel the need to keep their tests in strict scientific sequence. They wanted results now - not next year. If a drug showed promise, they felt no qualms about trying it out operationally before all the test results came in. As early as 1953, for instance, Sid Gottlieb went overseas with a supply of a hallucinogenic drug - almost certainly LSD. With unknown results, he arranged for it to be slipped to a speaker at a political rally, presumably to see if it would make a fool of him.

These were freewheeling days within the CIA - then a young agency whose bureaucratic arteries had not started to harden. The leaders of MKULTRA had high hopes for LSD. It appeared to be an awesome substance, whose advent, like the ancient discovery of fire, would bring out primitive responses of fear and worship in people. Only a speck of LSD could take a strongwilled man and turn his most basic perceptions into willowy shadows. Time, space, right, wrong, order, and the notion of what was possible all took on new faces. LSD was a frightening weapon, and it took a swashbuckling boldness for the leaders of MKULTRA to prepare for operational testing the way they first did: by taking it themselves. They tripped at the office. They tripped at safehouses, and sometimes they traveled to Boston to trip under Bob Hyde's penetrating gaze. Always they observed, questioned, and analyzed each other. LSD seemed to remove inhibitions, and they thought they could use it to find out what went on in the mind underneath all the outside acts and pretensions. If they could get at the inner self, they reasoned, they could better manipulate a person - or keep him from being manipulated.

The men from MKULTRA were trying LSD in the early 1950s - when Stalin lived and Joe McCarthy raged. It was a foreboding time, even for those not professionally responsible for doomsday poisons. Not surprisingly, Sid Gottlieb and colleagues who tried LSD did not think of the drug as something that might enhance creativity or cause transcendental experiences. Those notions would not come along for years. By and large, there was thought to be only one prevailing and hardheaded version of reality, which was "normal," and everything else was "crazy." An LSD trip made people temporarily crazy, which meant potentially vulnerable to the CIA men (and mentally ill, to the doctors). The CIA experimenters did not trip for the experience itself, or to get high, or to sample new realities. They were testing a weapon; for their purposes, they might as well have been in a ballistics lab.

Despite this prevailing attitude in the Agency, at least one MKULTRA pioneer recalls that his first trip expanded his conception of reality: "I was shaky at first, but then I just experienced it and had a high. I felt that everything was working right. I was like a locomotive going at top efficiency. Sure there was stress, but not in a debilitating way. It was like the stress of an engine pulling the longest train it's ever pulled." This CIA veteran describes seeing all the colors of the rainbow growing out of cracks in the sidewalk. He had always disliked cracks as signs of imperfection, but suddenly the cracks became natural stress lines that measured the vibrations of the universe. He saw people with blemished faces, which he had previously found slightly repulsive. "I had a change of values about faces," he says. "Hooked noses or crooked teeth would become beautiful for that person. Something had turned loose in me, and all I had done was shift my attitude. Reality hadn't changed, but I had. That was all the difference in the world between seeing something ugly and seeing truth and beauty."

At the end of this day of his first trip, the CIA man and his colleagues had an alcohol party to help come down. "I had a lump in my throat," he recalls wistfully. Although he had never done such a thing before, he wept in front of his coworkers. "I didn't want to leave it. I felt I would be going back to a place where I wouldn't be able to hold on to this kind of beauty. I felt very unhappy. The people who wrote the report on me said I had experienced depression, but they didn't understand why I felt so bad. They thought I had had a bad trip."

This CIA man says that others with his general personality tended to enjoy themselves on LSD, but that the stereotypical CIA operator (particularly the extreme counterintelligence type who mistrusts everyone and everything) usually had negative reactions. The drug simply exaggerated his paranoia. For these operators, the official notes, "dark evil things would begin to lurk around," and they would decide the experimenters were plotting against them.

The TSS team understood it would be next to impossible to allay the fears of this ever-vigilant, suspicious sort, although they might use LSD to disorient or generally confuse such a person. However, they toyed with the idea that LSD could be applied to better advantage on more trusting types. Could a clever foe "re-educate" such a person with a skillful application of LSD? Speculating on this question, the CIA official states that while under the influence of the drug, "you tend to have a more global view of things. I found it awfully hard when stoned to maintain the notion: I am a U.S. citizen - my country right or wrong.... You tend to have these good higher feelings. You are more open to the brotherhood-of-man idea and more susceptible to the seamy sides of your own society.... I think this is exactly what happened during the 1960s, but it didn't make people more communist. It just made them less inclined to identify with the U.S. They took a plague-on-both-your-houses position."

As to whether his former colleagues in TSS had the same perception of the LSD experience, the man replies, "I think everybody understood that if you had a good trip, you had a kind of above-it-all look into reality. What we subsequently found was that when you came down, you remembered the experience, but you didn't switch identities. You really didn't have that kind of feeling. You weren't as suspicious of people. You listened to them, but you also saw through them more easily and clearly. We decided that this wasn't the kind of thing that was going to make a guy into a turncoat to his own country. The more we worked with it, the less we became convinced this was what the communists were using for brainwashing."

The early LSD tests - both outside and inside the Agency - had gone well enough that the MKULTRA scientists moved forward to the next stage on the road to "field" use: They tried the drug out on people by surprise. This, after all, would be the way an operator would give - or get - the drug. First they decided to spring it on each other without warning. They agreed among themselves that a coworker might slip it to them at any time. (In what may be an apocryphal story, a TSS staff man says that one of his former colleagues always brought his own bottle of wine to office parties and carried it with him at all times.) Unwitting doses became an occupational hazard.

MKULTRA men usually took these unplanned trips in stride, but occasionally they turned nasty. Two TSS veterans tell the story of a coworker who drank some LSDlaced coffee during his morning break. Within an hour, states one veteran, "he sort of knew he had it, but he couldn't pull himself together. Sometimes you take it, and you start the process of maintaining your composure. But this grabbed him before he was aware, and it got away from him." Filled with fear, the CIA man fled the building that then housed TSS, located on the edge of the Mall near Washington's great monuments. Having lost sight of him, his colleagues searched frantically, but he managed to escape. The hallucinating Agency man worked his way across one of the Potomac bridges and apparently cut his last links with rationality. "He reported afterwards that every automobile that came by was a terrible monster with fantastic eyes, out to get him personally," says the veteran. "Each time a car passed, he would huddle down against the parapet, terribly frightened. It was a real horror trip for him. I mean, it was hours of agony. It was like a dream that never stops - with someone chasing you."

After about an hour and a half, the victim's coworkers found him on the Virginia side of the Potomac, crouched under a fountain, trembling. "It was awfully hard to persuade him that his friends were his friends at that point," recalls the colleague. "He was alone in the world, and everyone was hostile. He'd become a full-blown paranoid. If it had lasted for two weeks, we'd have plunked him in a mental hospital." Fortunately for him, the CIA man came down by the end of the day. This was not the first, last, or most tragic bad trip in the Agency's testing program.[8]

By late 1953, only six months after Allen Dulles had formally created MKULTRA, TSS officials were already well into the last stage of their research: systematic use of LSD on "outsiders" who had no idea they had received the drug. These victims simply felt their moorings slip away in the midst of an ordinary day, for no apparent reason, and no one really knew how they would react.

Sid Gottlieb was ready for the operational experiments. He considered LSD to be such a secret substance that he gave it a private code name ("serunim") by which he and his colleagues often referred to the drug, even behind the CIA's heavily guarded doors. In retrospect, it seems more than bizarre that CIA officials - men responsible for the nation's intelligence and alertness when the hot and cold wars against the communists were at their peak - would be sneaking LSD into each other's coffee cups and thereby subjecting themselves to the unknown frontiers of experimental drugs. But these side trips did not seem to change the sense of reality of Gottlieb or of high CIA officials, who took LSD on several occasions. The drug did not transform Gottlieb out of the mind set of a master scientist-spy, a protégé of Richard Helms in the CIA's inner circle. He never stopped milking his goats at 5:30 every morning.

The CIA leaders' early achievements with LSD were impressive. They had not invented the drug, but they had gotten in on the American ground floor and done nearly everything else. They were years ahead of the scientific literature - l*et al*one the public - and spies win by being ahead. They had monopolized the supply of LSD and dominated the research by creating much of it themselves. They had used money and other blandishments to build a network of scientists and doctors whose work they could direct and turn to their own use. All that remained between them and major espionage successes was the performance of the drug in the field.

That, however, turned out to be a considerable stumbling block. LSD had an incredibly powerful effect on people, but not in ways the CIA could predict or control.

Notes 4

The description of Robert Hyde's first trip came from interviews with Dr. Milton Greenblatt, Dr. J. Herbert DeShon, and a talk by Max Rinkel at the 2nd Macy Conference on Neuropharmacology, pp. 235-36, edited by Harold A. Abramson, 1955: Madison Printing Company.

The descriptions of TSS and Sidney Gottlieb came from interviews with Ray Cline, John Stockwell, about 10 other ex-CIA officers, and other friends of Gottlieb.

Memos quoted on the early MKULTRA program include Memorandum from ADDP Helms to DCI Dulles, 4/3/53, Tab A, pp. 1-2 (quoted in Church Committee Report, Book I); APF A-1, April 13, 1953, Memorandum for Deputy Director (Administration, Subject: Project MKULTRA - Extremely Sensitive Research and Development Program; #A/B,I,64/6, 6 February 1952, Memorandum for the Record, Subject: Contract with [deleted]

#A/B,I,64/29, undated, Memorandum for Technical Services Staff, Subject: Alcohol Antagonists and Accelerators, Research and Development Project. The Gottlieb quote is from Hearing before the Subcommittee on Health and Scientific Research of the Senate Committee on Human Resources, September 21, 1977, p. 206.

The background data on LSD came particularly from The Beyond Within: The LSD Story by Sidney Cohen (New York: Atheneum,1972). Other sources included Origins of Psychopharmacology: From CPZ to LSD by Anne E. Caldwell (Springfield, III.: Charles C. Thomas, 1970) and Document 352, "An OSI Study of the Strategic Medical Importance of LSD-25," 30 August 1955.

TSS's use of outside researchers came from interviews with four former TSSers. MKULTRA Subprojects 8, 10, 63, and 66 described Robert Hyde's work. Subprojects 7, 27, and 40 concerned Harold Abramson. Hodge's work was in subprojects 17 and 46. Carl Pfeiffer's Agency connection, along with Hyde's, Abramson's, and Isbell's, was laid out by Lyman B. Kirkpatrick, Memorandum for the Record, 1 December 1953, Subject: Conversation with Dr. Willis Gibbons of TSS re Olson Case (found at p. 1030, Kennedy Subcommittee 1975 Biomedical and Behavioral Research Hearings). Isbell's testing program was also described at those hearings, as it was in Document # 14, 24 July, 1953, Memo For: Liaison & Security Officer/TSS, Subject #71 An Account of the Chemical Division's Contacts in the National Institute of Health; Document #37, 14 July 1954, subject [deleted]; and Document # 41,31 August,1956, subject; trip to Lexington, Ky.,21-23 August 1956. Isbell's program was further described in a "Report on ADAMHA Involvement in LSD Research," found at p. 993 of 1975 Kennedy subcommittee hearings. The firsthand account of the actual testing came from an interview with Edward M. Flowers, Washington, D.C.

The section on TSS's noncontract informants came from interviews with TSS sources, reading the proceedings of the Macy Conferences on "Problems of Consciousness" and "Neuropharmacology," and interviews with several participants including Sidney Cohen, Humphrey Osmond, and Hudson Hoagland.

The material on CIA's relations with Sandoz and Eli Lilly came from Document #24, 16 November, 1953, Subject: ARTICHOKE Conference; Document #268, 23 October, 1953, Subject: Meeting in Director's Office at 1100 hours on 23 October with Mr. Wisner and [deleted]; Document # 316,6 January,1954, Subject: Lysergic Acid Diethylamide (LSD-25); and Document #338, 26 October 1954, Subject: Potential Large Scale Availability of LSD through newly discovered synthesis by [deleted]; interviews with Sandoz and Lilly former executives; interviews with TSS sources; and Sidney Gottlieb's testimony before Kennedy subcommittee, 1977, p. 203.

Henry Beecher's US government connections were detailed in his private papers, in a report on the Swiss-LSD death to the CIA at p. 396, Church Committee Report, Book I, and in interviews with two of his former associates.

The description of TSS's internal testing progression comes from interviews with former staff members. The short reference to Sid Gottlieb's arranging for LSD to be given a speaker at a political rally comes from Document #A/B, II, 26/8, 9 June 1954, Subject: MKULTRA. Henry Beecher's report to the CIA on the Swiss suicide is found at p. 396, Church Committee Report, Book I.

Footnotes 4

1. During the 1950s, Boston Psychopathic changed its name to Massachusetts Mental Health Center, the name it bears today.
2. Pronounced M-K-ULTRA. The MK digraph simply identified it as a TSS project. As for the ULTRA part, it may have had its etymological roots in the most closely guarded Anglo-American World War II intelligence secret, the ULTRA program, which handled the cracking of German military codes. While good espionage tradecraft called for cryptonyms to have no special meaning, wartime experiences were still very much on the minds of men like Allen Dulles.
3. By no means did TSS neglect other drugs. It looked at hundreds of others from cocaine to nicotine, with special emphasis on special-purpose substances. One 1952 memo talked about the urgent operational need for a chemical "producing general listlessness and lethargy." Another mentioned finding - as TSS later did - a potion to accelerate the effects of liquor, called an "alcohol extender."
4. As happened to Albert Hofmann the first time, Abramson once unknowingly ingested some LSD, probably by swallowing water from his spiked snail tank. He started to feel bad, but with his wife's help, he finally pinpointed the cause. According to brain and dolphin expert John Lilly, who heard the story from Mrs. Abramson, Harold was greatly relieved that his discomfort was not grave. "Oh, it's nothing serious," he said. "It's just an LSD psychosis. I'll just go to bed and sleep it off."
5. Army researchers, as usual running about five years behind the CIA, became interested in the sustained use of LSD as an interrogation device during 1961 field tests (called Operation THIRD CHANCE). The Army men tested the drug in Europe on

nine foreigners and one American, a black soldier named James Thornwell, accused of stealing classified documents. While Thornwell was reacting to the drug under extremely stressful conditions, his captors threatened "to extend the state indefinitely, even to a permanent condition of insanity," according to an Army document. Thornwell is now suing the U.S. government for $30 million.

In one of those twists that Washington insiders take for granted and outsiders do not quite believe, Terry Lenzner, a partner of the same law firm seeking this huge sum for Thornwell, is the lawyer for Sid Gottlieb, the man who oversaw the 77-day trips at Lexington and even more dangerous LSD testing.

6. A 1975 CIA document clears up the mystery of how the Agency's military sources could have made such a huge error in estimating Sandoz's LSD supply (and probably also explains the earlier inaccurate report that the Russians had bought 50,000,000 doses). What happened, according to the document, was that the U.S. military attaché in Switzerland did not know the difference between a milligram (1/1,000 of a gram) and a kilogram (1,000 grams). This mix-up threw all his calculations off by a factor of 1,000,000.
7. Military security agencies supported the LSD work of such well-known researchers as Amedeo Marrazzi of the University of Minnesota and Missouri Institute of Psychiatry, Henry Beecher of Harvard and Massachusetts General Hospital, Charles Savage while he was at the Naval Medical Research Institute, James Dille of the University of Washington, Gerald Klee of the University of Maryland Medical School, Neil Burch of Baylor University (who performed later experiments for the CIA), and Paul Hoch and James Cattell of the New York State Psychiatric Institute, whose forced injections of a mescaline derivative led to the 1953 death of New York tennis professional Harold Blauer. (Dr. Cattell later told Army investigators, "We didn't know whether it was dog piss or what it was we were giving him.")
8. TSS officials had long known that LSD could be quite dangerous. In 1952, Harvard Medical School's Henry Beecher who regularly gave the Agency information on his talks with European colleagues, reported that a Swiss doctor had suffered severe depression after taking the drug and had killed herself three weeks later.

5. Concerning the Case of Dr. Frank Olsen

In November 1953, Sid Gottlieb decided to test LSD on a group of scientists from the Army Chemical Corps' Special Operations Division (SOD) at Fort Detrick in Frederick, Maryland. Although the Clandestine Services hierarchy had twice put TSS under strict notice not to use LSD without permission from above, Gottlieb must have felt that trying the drug on SOD men was not so different from giving it to his colleagues at the office. After all, officials at TSS and SOD worked intimately together, and they shared one of the darkest secrets of the Cold War: that the U.S. government maintained the capability - which it would use at times - to kill or incapacitate selected people with biological weapons. Only a handful of the highest CIA officials knew that TSS was paying SOD about $200,000 a year in return for operational systems to infect foes with disease.

Gottlieb planned to drop the LSD on the SOD men in the splendid isolation of a three-day working retreat. Twice a year, the SOD and TSS men who collaborated on MKNAOMI, their joint program, held a planning session at a remote site where they could brainstorm without interruption. On November 18, 1953, they gathered at Deep Creek Lodge, a log building in the woods of Western Maryland. It had been built as a Boy Scout camp 25 years earlier. Surrounded by the water of a mountain lake on three sides, with the peaks of the Appalachian chain looking down over the thick forest, the lodge was isolated enough for even the most security conscious spy. Only an occasional hunter was likely to wander through after the summer months.

Dr. John Schwab, who had founded SOD in 1950, Lt. Colonel Vincent Ruwet, its current chief, and Dr. Frank Olson, its temporary head earlier that year, led the Detrick group. These germ warriors came under the cover of being wildlife writers and lecturers off on a busman's holiday. They carefully removed the Fort Detrick parking stickers from their cars before setting out. Sid Gottlieb brought three coworkers from the Agency, including his deputy Robert Lashbrook.

They met in the living room of the lodge, in front of a roaring blaze in the huge walk-in fireplace. Then they split off into smaller groups for specialized meetings. The survivors among those who attended these sessions remain as tight-lipped as ever, willing to share a few details of the general atmosphere but none of the substance. However, from other sources at Fort Detrick and from government documents, the MKNAOMI research can be pieced together. It was this program that was discussed during the fateful retreat.

Under MKNAOMI, the SOD men developed a whole arsenal of toxic substances for CIA use. If Agency operators needed to kill someone in a few seconds with, say, a suicide pill, SOD provided super-deadly shellfish toxin.[1] On his ill-fated U-2 flight over the Soviet Union in 1960, Francis Gary Powers carried - and chose not to use - a drill bit coated with this poison concealed in a silver dollar. While perfect for someone anxious to die - or kill - instantly, shellfish toxin offered no time to escape and could be traced easily. More useful for assassination, CIA and SOD men decided, was botulinum. With an incubation period of 8 to 12 hours, it allowed the killer time to separate himself from the deed. Agency operators would later supply pills laced with this lethal food poison to its Mafia allies for inclusion in Fidel Castro's milkshake. If CIA officials wanted an assassination to look like a death from natural causes, they could choose from a long list of deadly diseases that normally occurred in particular countries. Thus in 1960, Clandestine Services chief Richard Bissell asked Sid Gottlieb to pick out an appropriate malady to kill the Congo's Patrice Lumumba. Gottlieb told the Senate investigators that he selected one that "was supposed to produce a disease that was ... indigenous to that area [of West Africa] and that could be fatal." Gottlieb personally carried the bacteria to the Congo, but this murderous operation was scrubbed before Lumumba could be infected. (The Congolese leader was killed shortly thereafter under circumstances that still are not clear.)

When CIA operators merely wanted to be rid of somebody temporarily, SOD stockpiled for them about a dozen diseases and toxins of varying strengths. At the relatively benign end of the SOD list stood Staph. enterotoxin, a mild form of food poisoning - mild compared to botulinum. This Staph. infection almost never killed and simply incapacitated its victim for 3 to 6 hours. Under the skilled guidance of Sid Gottlieb's wartime predecessor, Stanley Lovell, OSS had used this very substance to prevent Nazi official Hjalmar Schacht from attending an economic conference during the war. More virulent in the SOD arsenal was Venezuelan equine encephalomyelitis virus. It usually immobilized a person for 2 to 5 days and kept him in a weakened state for several more weeks. If the Agency wanted to incapacitate someone for a period of months, SOD had two different kinds of brucellosis.[2]

A former senior official at Fort Detrick was kind enough to run me through all the germs and toxins SOD kept for the CIA, listing their advantages and disadvantages. Before doing so, he emphasized that SOD was also trying to work out ways to protect U.S. citizens and installations from attack with similar substances. "You can't have a serious defense," he says, "unless someone has thought about offense." He stated that Japan made repeated biological attacks against China during World War II - which was one reason for starting the American program.[3] He knows of no use since by the Soviet Union or any other power.

According to the Detrick official, anyone contemplating use of a biological product had to consider many other factors besides toxicity and incubation period.

Can the germ be detected easily and countered with a vaccine? He notes that anthrax, a fatal disease (when inhaled) that SOD stored for CIA, has the advantage of symptoms that resemble pneumonia; similarly, Venezuelan equine encephalomyelitis can be mistaken for the grippe. While vaccines do exist for many of the stockpiled diseases, SOD was forever developing more virulent strains. "I don't know of any organism susceptible to a drug that can't be made more resistant," states the Detrick man.

Did the disease have a high degree of secondary spread? SOD preferred it not to, because these germ warfare men did not want to start epidemics - that was the job of others at Fort Detrick.

Was the organism stable? How did humidity affect it? SOD considered these and many other factors.

To the CIA, perhaps the most important question was whether it could covertly deliver the germ to infect the right person. One branch of SOD specialized in building delivery systems, the most famous of which now is the dart gun fashioned out of a .45 pistol that ex-CIA Director William Colby displayed to the world at a 1975 Senate hearing. The Agency had long been after SOD to develop a "non-discernible microbioinoculator" which could give people deadly shots that, according to a CIA document, could not be "easily detected upon a detailed autopsy." SOD also rigged up aerosol sprays that could be fired by remote control, including a fluorescent starter that was activated by turning on the light, a cigarette lighter that sprayed when lit, and an engine head bolt that shot off as the engine heated. "If you're going to infect people, the most likely way is respiratory," notes the high Detrick official. "Everybody breathes, but you might not get them to eat."

Frank Olson specialized in the airborne delivery of disease. He had been working in the field ever since 1943, when he came to Fort Detrick as one of the original military officers in the U. S. biological warfare program. Before the end of the war, he developed a painful ulcer condition that led him to seek a medical discharge from the uniformed military, but he had stayed on as a civilian. He joined SOD when it started in 1950. Obviously good at what he did, Olson served for several months as acting chief of SOD in 1952-53 but asked to be relieved when the added stress caused his ulcer to flare up. He happily returned to his lesser post as a branch chief, where he had fewer administrative duties and could spend more time in the laboratory. A lover of practical jokes, Olson was very popular among his many friends. He was an outgoing man, but, like most of his generation, he kept his inner feelings to himself. His great passion was his family, and he spent most of his spare time playing with his three kids and helping around the house. He had met his wife while they both studied at the University of Wisconsin.

Olson attended all the sessions and apparently did everything expected of him during the first two days at the lodge. After dinner on Thursday, November 19, 1953 - the same day that a Washington Post editorial decried the use of dogs in chemical experiments - Olson shared a drink of Cointreau with all but two of the men present. (One had a heart condition; the other, a reformed alcoholic, did not drink.) Unbeknownst to the SOD men, Sid Gottlieb had decided to spike the liqueur with LSD.[4]

> "To me, everyone was pretty normal," says SOD's Benjamin Wilson. "No one was aware anything had happened until Gottlieb mentioned it. [20 minutes after the drink] Gottlieb asked if we had noticed anything wrong. Everyone was aware, once it was brought to their attention." They tried to continue their discussion, but once the drug took hold, the meeting deteriorated into laughter and boisterous conversation. Two of the SOD men apparently got into an all-night philosophical conversation that had nothing to do with biological warfare. Ruwet remembers it as "the most frightening experience I ever had or hope to have." Ben Wilson recalls that "Olson was psychotic. He couldn't understand what happened. He thought someone was playing tricks on him.... One of

his favorite expressions was 'You guys are a bunch of thespians.'"

Olson and most of the others became increasingly uncomfortable and could not sleep.[5] When the group gathered in the morning, Olson was still agitated, obviously disturbed, as were several of his colleagues. The meeting had turned sour, and no one really wanted to do more business. They all straggled home during the day.

Alice Olson remembers her husband coming in before dinner that evening: "He said nothing. He just sat there. Ordinarily when he came back from a trip, he'd tell me about the things he could - what they had to eat, that sort of thing. During dinner, I said, 'It's a damned shame the adults in this family don't communicate anymore.' He said, 'Wait until the kids get to bed and I'll talk to you." Later that night, Frank Olson told his wife he had made "a terrible mistake," that his colleagues had laughed at him and humiliated him. Mrs. Olson assured him that the others were his friends, that they would not make fun of him. Still, Olson would not tell her any more. He kept his fears bottled up inside, and he shared nothing of his growing feeling that someone was out to get him. Alice Olson was accustomed to his keeping secrets. Although she realized he worked on biological warfare, they never talked about it. She had had only little glimpses of his profession. He complained about the painful shots he was always taking.[6] He almost never took a bath at home because he showered upon entering and leaving his office every day. When a Detrick employee died of anthrax (one of three fatalities in the base's 27-year history), Frank Olson told his wife the man had died of pneumonia.

Alice Olson had never even seen the building where her husband worked. Fort Detrick was built on the principle of concentric circles, with secrets concealed inside secrets. To enter the inner regions where SOD operated, one needed not only the highest security clearance but a "need to know" authorization. Her husband was not about to break out of a career of government-imposed secrecy to tell her about the TOP SECRET experiment that Sid Gottlieb had performed on him.

The Olsons spent an uncommunicative weekend together. On Sunday they sat on the davenport in their living room, holding hands - something they had not done for a long time. "It was a rotten November day," recalls Mrs. Olson. "The fog outside was so thick you could hardly see out the front door. Frank's depression was dreadful." Finally, she recalls, they packed up the three young children, and went off to the local theater. The film turned out to be Luther. "It was a very serious movie," remembers Mrs. Olson, "not a good one to see when you're depressed."

The following day, Olson appeared at 7:30 A.M. in the office of his boss, Lieutenant Colonel Ruwet, To Ruwet, Olson seemed "agitated." He told Ruwet he wanted either to quit or be fired. Taken aback, Ruwet reassured Olson that his conduct at the lodge had been "beyond reproach." Seemingly satisfied and relieved, Olson agreed to stay on and spent the rest of the day on routine SOD business. That evening, the Olsons spent their most lighthearted evening since before the retreat to Deep Creek Lodge, and they planned a farewell party for a colleague the following Saturday night.

Tuesday morning, Ruwet again arrived at his office to find a disturbed Frank Olson waiting for him. Olson said he felt "all mixed up" and questioned his own competence. He said that he should not have left the Army during the war because of his ulcer and that he lacked the ability to do his present work. After an hour, Ruwet decided Olson needed "psychiatric attention." Ruwet apparently felt that the CIA had caused Olson's problem in the first place, and instead of sending him to the base hospital, he called Gottlieb's deputy Robert Lashbrook to arrange for Olson to see a psychiatrist.

After a hurried conference, Lashbrook and Gottlieb decided to send Olson to Dr. Harold Abramson in New York. Abramson had no formal training in psychiatry and did not hold himself out to be a psychiatrist. He was an allergist and immunologist interested in treating the problems of the mind. Gottlieb chose him because he had a TOP SECRET CIA security clearance and because he had been working with LSD - under Agency contract - for several years. Gottlieb was obviously protecting his own bureaucratic position by not letting anyone outside TSS know what he had done. Having failed to observe the order to seek higher approval for LSD use, Gottlieb proceeded to violate another CIA regulation. It states, in effect, that whenever a potential flap arises that might embarrass the CIA or lead to a break in secrecy, those involved should immediately call the Office of Security. For health problems like Olson's, Security and the CIA medical office keep a long list of doctors (and psychiatrists) with TOP SECRET clearance who can provide treatment.

Gottlieb had other plans for Frank Olson, and off to New York went the disturbed SOD biochemist in the company of Ruwet and Lashbrook. Olson alternately improved and sank deeper and deeper into his feelings of depression, inadequacy, guilt, and paranoia. He began to think that the CIA was putting a stimulant like Benzedrine in his coffee to keep him awake and that it was the Agency that was out to get him. That first day in New York, Abramson saw Olson at his office. Then at 10:30 in the evening, the allergist visited Olson in his hotel room, armed with a bottle of bourbon and a bottle of the sedative Nembutal - an unusual combination for a doctor to give to someone with symptoms like Olson's.

Before Olson's appointment with Dr. Abramson the following day, he and Ruwet accompanied Lashbrook on a visit to a famous New York magician named John Mulholland, whom TSS had put under contract to prepare a manual that would apply "the magician's art to covert activities." An expert at pulling rabbits out of hats could easily find new and better ways to slip drugs into drinks, and Gottlieb signed up Mulholland to work on, among other things, "the delivery of various materials to unwitting subjects." Lashbrook thought that the magician might amuse Olson, but Olson became "highly suspicious." The group tactfully cut their visit short, and Lashbrook dropped Olson off at Abramson's office. After an hour's consultation with Abramson that afternoon the allergist gave Olson permission to return to Frederick the following day, Thanksgiving, to be with his family.

Olson, Ruwet, and Lashbrook had plane reservations for Thursday morning, so that night, in a preholiday attempt to lift spirits, they all went to see the Rodgers and Hammerstein hit musical, Me and Juliet. Olson became upset during the first act and told Ruwet that he knew people were waiting outside the theater to arrest him. Olson and Ruwet left the show at intermission, and the two old friends walked back to the Statler Hotel, near Penn Station. Later, while Ruwet slept in the next bed, Olson crept out of the hotel and wandered the streets. Gripped by the delusion that he was following Ruwet's orders, he tore up all his paper money and threw his wallet down a chute. At 5:30 A.M., Ruwet and Lashbrook found him sitting in the Statler lobby with his hat and coat on.

They checked out of the hotel and caught the plane back to Washington. An SOD driver picked Olson and Ruwet up at National Airport and started to drive them back to Frederick. As they drove up Wisconsin Avenue, Olson had the driver pull into a Howard Johnson's parking lot. He told Ruwet that he was "ashamed" to see his family in his present state and that he feared he might become violent with his children. Ruwet suggested he go back to see Abramson in New York, and Olson agreed. Ruwet and Olson drove back to Lashbrook's apartment on New Hampshire Avenue off Dupont Circle, and Lashbrook summoned Sid Gottlieb from Thanksgiving dinner in Virginia. All agreed that Lashbrook would take Olson back to New York while Ruwet would go back to Frederick to explain the situation to Mrs. Olson and to see his own family. (Ruwet was Olson's friend, whereas Lashbrook was no more than a professional acquaintance. Olson's son Eric believes that his father's mental state suffered when Ruwet left him in the hands of the CIA's Lashbrook, especially since Olson felt the CIA was "out to get him.") Olson and Lashbrook flew to LaGuardia airport and went to see Abramson at his Long Island office. Then the two men ate a joyless Thanksgiving dinner at a local restaurant. Friday morning Abramson drove them into Manhattan. Abramson, an allergist, finally realized that he had more on his hands with Olson than he could handle, and he recommended hospitalization. He wrote afterward that Olson "was in a psychotic state ... with delusions of persecution."

Olson agreed to enter Chestnut Lodge, a Rockville, Maryland sanitarium that had CIA-cleared psychiatrists on the staff. They could not get plane reservations until the next morning, so Olson and Lashbrook decided to spend one last night at the Statler. They took a room on the tenth floor. With his spirits revived, Olson dared to call his wife for the first time since he had left originally for New York. They had a pleasant talk, which left her feeling better.

In the early hours of the morning, Lashbrook woke up just in time to see Frank Olson crash through the drawn blinds and closed window on a dead run.

Within seconds, as a crowd gathered around Olson's shattered body on the street below, the cover-up started. Lashbrook called Gottlieb to tell him what had happened before he notified the police. Next, Lashbrook called Abramson, who, according to Lashbrook, "wanted to be kept out of the thing completely." Abramson soon called back and offered to assist. When the police arrived, Lashbrook told them he worked for the Defense Department. He said he had no idea why Olson killed himself, but he did know that the dead man had "suffered from ulcers." The detectives assigned to the case later reported that getting information out of Lashbrook was "like pulling teeth." They speculated to each other that the case could be a homicide with homosexual overtones, but they soon dropped their inquiries when Ruwet and Abramson verified Lashbrook's sketchy account and invoked high government connections.

Back in Washington, Sid Gottlieb finally felt compelled to tell the Office of Security about the Olson case. Director Allen Dulles personally ordered Inspector General Lyman Kirkpatrick to make a full investigation, but first, Agency officials tried to make sure that no outsider would tie Olson's death either to the CIA or LSD. Teams of Security officers were soon scurrying around New York and Washington, making sure the Agency had covered its tracks. One interviewed Lashbrook and then accompanied him to a meeting with Abramson. When Lashbrook and Abramson asked the security officer to leave them alone, he complied and then, in the best traditions of his office, listened in on the conversation covertly. From his report on their talk, it can safely be said that Lashbrook and Abramson conspired to make sure they told identical stories. Lashbrook dictated to Abramson, who made a recording of the symptoms that Olson was supposed to be suffering from and the problems that were bothering him. Lashbrook even stated that Mrs. Olson had suggested her husband see a psychiatrist months before the LSD incident.[7] Lashbrook's comments appeared in three reports Abramson submitted to the CIA, but these reports were internally inconsistent. In one memo, Abramson wrote that Olson's "psychotic state ... seemed to have been crystallized by [the LSD] experiment." In a later report, Abramson called the LSD dose "therapeutic" and said he believed "this dosage could hardly have had any significant role in the course of events that followed.[8]

The CIA officially - but secretly - took the position that the LSD had "triggered" Olson's suicide. Agency officials worked industriously behind the scenes to make sure that Mrs. Olson received an adequate government pension - two-thirds of her husband's base pay. Ruwet, who had threatened to expose the whole affair if Mrs. Olson did not get the pension, submitted a form saying Olson had died of a "classified illness." Gottlieb and Lashbrook kept trying to have it both ways in regard to giving Olson LSD, according to the CIA's General Counsel. They acknowledged LSD's triggering function in his death, but they also claimed it was "practically impossible" for the drug to have harmful aftereffects. The General Counsel called these two positions "completely inconsistent," and he wrote he was "not happy with what seems to me a very casual attitude on the part of TSS representatives to the way this experiment was conducted and to their remarks that this is just one of the risks running with scientific investigation."

As part of his investigation, Inspector General Kirkpatrick sequestered Gottlieb's LSD files, which Kirkpatrick remembers did not make Gottlieb at all happy. "I brought out his stutter," says Kirkpatrick with a wry smile. "He was quite concerned about his future." Kirkpatrick eventually recommended that some form of reprimand be given to Gottlieb, TSS chief Willis Gibbons, and TSS deputy chief James "Trapper" Drum, who had waited 20 days after Olson's death to admit that Gottlieb had cleared the experiment with him. Others opposed Kirkpatrick's recommendation. Admiral Luis deFlorez, the Agency's Research Chairman, sent a personal memo to Allen Dulles saying reprimands would be an "injustice" and would hinder "the spirit of initiative and enthusiasm so necessary in our work." The Director's office went along, and Kirkpatrick began the tortuous process of preparing letters for Dulles' signature that would say Gottlieb, Gibbons, and Drum had done something wrong, but nothing too wrong. Kirkpatrick went through six drafts of the Gottlieb letter alone before he came up with acceptable wording. He started out by saying TSS officials had exercised "exceedingly bad judgment." That was too harsh for high Agency officials, so Kirkpatrick tried "very poor judgment." Still too hard. He settled for "poor judgment." The TSS officials were told that they should not consider the letters to be reprimands and that no record of the letters would be put in their personnel files where they could conceivably harm future careers.

The Olson family up in Frederick did not get off so easily. Ruwet told them Olson had jumped or fallen out of the window in New York, but he mentioned not a word about the LSD, whose effects Ruwet himself believed had led to Olson's death. Ever the good soldier, Ruwet could not bring himself to talk about the classified experiment - even to ease Alice Olson's sorrow. Mrs. Olson did not want to accept the idea that her husband had willfully committed suicide. "It was very important to me - almost the core of my life - that my children not feel their father had walked out on them," recalls Mrs. Olson.

For the next 22 years, Alice Olson had no harder evidence than her own belief that her husband did not desert her and the family. Then in June 1975, the Rockefeller Commission studying illegal CIA domestic operations reported that a man fitting Frank Olson's description had leaped from a New York hotel window after the CIA had given him LSD without his knowledge. The Olson family read about the incident in the Washington Post. Daughter Lisa Olson Hayward and her husband went to see Ruwet, who had retired from the Army and settled in Frederick. In an emotional meeting, Ruwet confirmed that Olson was the man and said he could not tell the family earlier because he did not have permission. Ruwet tried to discourage them from going public or seeking compensation from the government, but the Olson family did both. [9] On national television, Alice Olson and each of her grown children took turns reading from a prepared family statement:

> We feel our family has been violated by the CIA in two ways," it said. "First, Frank Olson was experimented upon illegally and negligently. Second, the true nature of his death was concealed for twenty-two years.... In telling our story, we are concerned that neither the personal pain this family has experienced nor the moral and political outrage we feel be slighted. Only in this way can Frank Olson's death become part of American memory and serve the purpose of political and ethical reform so urgently needed in our society.

The statement went on to compare the Olsons with families in the Third World "whose hopes for a better life were destroyed by CIA intervention." Although Eric Olson read those words in behalf of the whole family, they reflected more the politics of the children than the feelings of their mother, Alice Olson. An incredibly strong woman who seems to have made her peace with the world, Mrs. Olson went back to college after her husband's death, got a degree, and held the family together while she taught school. She has no malice in her heart toward Vin Ruwet, her friend who withheld that vital piece of information from her all those years. He comforted her and gave support during the most difficult of times, and she deeply appreciates that. Mrs. Olson defends Ruwet by saying he was in "a bad position," but then she stops in mid-sentence and says, "If I had only been given some indication that it was the pressure of work.... If only I had had something I could have told the kids. I don't know how [Ruwet] could have done it either. It was a terrible thing for a man who loved him."

"I'm not vindicative toward Vin [Ruwet]," reflects Mrs. Olson. "Gottlieb is a different question. He was despicable." She tells how Gottlieb and Lashbrook both attended Olson's funeral in Frederick and contributed to a memorial fund. A week or two later, the two men asked to visit her. She knew they did not work at Detrick, but she did not really understood where they came from or their role. "I didn't want to see them," she notes. "Vin told me it would make them feel better. I didn't want an ounce of flesh from them. I didn't think it was necessary, but, okay, I agreed. In retrospect, it was so bizarre, it makes me sick ... I was a sucker for them."

Gottlieb and Lashbrook apparently never returned to the biological warfare offices at SOD. Little else changed, however. Ray Treichler and Henry Bortner took over CIA's liaison with SOD. SOD continued to manufacture and stockpile bacteriological agents for the CIA until 1969, when President Richard Nixon renounced the use of biological warfare tactics.

And presumably, someone replaced Frank Olson.

Notes 5

The description of the CIA's relationship with SOD at Fort Detrick comes from interviews with several ex-Fort Detrick employees; Church Committee hearings on "Unauthorized Storage of Toxic Agents, Volume 1; Church Committee "Summary Report on CIA Investigation of MKNAOMI" found in Report, Book I, pp. 360-63; and/ Kennedy subcommittee hearings on Biological Testing Involving Human Subjects by the Department of Defense, 1977. The details of Sid Gottlieb's involvement in the plot to kill Patrice Lumumba are found in the Church Committee's Interim Report on "Alleged Assassination Plots Involving Foreign Leaders," pp. 20-21. The Church committee allowed Gottlieb to be listed under the pseudonym Victor Scheider, but several sources confirm Gottlieb's true identity, as does the biographic data on him submitted to the Kennedy subcommittee by the CIA, which puts him in the same job attributed to "Scheider" at the same time. The plot to give botulinum to Fidel Castro is outlined in the Assassination report, pp. 79-83. The incident with the Iraqi colonel is on p. 181 of the same report.

The several inches of CIA documents on the Olson case were released by the Olson family in 1976 and can be found in the printed volume of the 1975 Kennedy subcommittee hearings on Biomedical and Behavioral

Research, pp.1005-1132. They form the base of much of the narrative, along with interviews with Alice Olson, Eric Olson, Benjamin Wilson, and several other ex-SOD men (who added next to nothing). Information also was gleaned from Vincent Ruwet's testimony before the Kennedy subcommittee in 1975, pp. 138-45 and the Church committee's summary of the affair, Book I, pp. 394-403. The quote on Harold Abramson's intention to give his patients unwitting doses of LSD is found in MKULTRA subproject 7, June 8, 1953, letter to Dr. [deleted]. Magician John Mulholland's work for the Agency is described in MKULTRA subprojects 19 and 34.

Footnotes 5

1. Toxins are chemical substances, not living organisms, derived from biological agents. While they can make people sick or dead, they cannot reproduce themselves like bacteria. Because of their biological origin, toxins came under the responsibility of Fort Detrick rather than Edgewood Arsenal, the facility which handled the chemical side of America's chemical and biological warfare (CBW) programs.
2. Brucellosis may well have been the disease that Gottlieb selected in the spring of 1960 when the Clandestine Services' Health Alteration Committee approved an operation to disable an Iraqi colonel, said to be "promoting Soviet-bloc political interests" for at least three months. Gottlieb told the Church committee that he had a monogrammed handkerchief treated with the incapacitating agency, and then mailed it to the colonel. CIA officials told the committee that the colonel was shot by a firing squad - which the Agency had nothing to do with - before the handkerchief arrived.
3. For some reason, the U.S. government has made it a point not to release information about Japanese use of biological warfare. The senior Detrick source says, "We knew they sprayed Manchuria. We had the results of how they produced and disseminated [the biological agents, including anthrax].... I read the autopsy reports myself. We had people who went over to Japan after the war."
4. Gottlieb stated just after Olson's death, at a time when he was trying to minimize his own culpability, that he had talked to the SOD men about LSD and that they had agreed in general terms to the desirability of unwitting testing. Two of the SOD group in interviews and a third in congressional testimony flatly deny the Gottlieb version. Gottlieb and the SOD men all agree Gottlieb gave no advance warning that he was giving them a drug in their liqueur.
5. For the very reason that most trips last about eight hours no matter what time a subject takes the drug, virtually all experimenters, including TSS's own contractors, give LSD in the morning to avoid the discomfort of sleepless nights.
6. To enter the SOD building, in addition to needing an incredibly hard-to-get security clearance, one had to have an up-to-date shot card with anywhere from 10 to 20 immunizations listed. The process was so painful and time consuming that at one point in the 1960s the general who headed the whole Army Chemical Corps decided against inspecting SOD and getting an on-the-spot briefing. When asked about this incident, an SOD veteran who had earlier resigned said, "That's the way we kept them out. Those [military] types didn't need to know. Most of the security violations came from the top level.... He could have gone in without shots if he had insisted. The safety director would have protested, but he could have."
7. Mrs. Olson says that this is an outright lie.
8. Nonpsychiatrist Abramson who allowed chemist Lashbrook to tell him about his patient's complexes clearly had a strange idea what was "therapeutic" - or psychotherapeutic, for that matter. In Abramson's 1953 proposal to the CIA for $85,000 to study LSD, he wrote that over the next year he "hoped" to give hospital patients "who are essentially normal from a psychiatric point of view ... unwitting doses of the drug for psychotherapeutic purposes." His treatment brings to mind the William Burroughs character in Naked Lunch who states; "Now, boys, you won't see this operation performed very often, and there's a reason for that ... you see, it has absolutely no medical value."
9. President Gerald Ford later personally apologized to the Olson family, and Congress passed a bill in 1976 to pay $750,000 in compensation to Mrs. Olson and her three children. The family voluntarily abandoned the suit.

6. Them Unwitting: The Safehouses

Frank Olson's death could have been a major setback for the Agency's LSD testing, but the program, like Sid Gottlieb's career, emerged essentially unscathed. High CIA officials did call a temporary halt to all experiments while they investigated the Olson case and re-examined the general policy. They cabled the two field stations that had supplies of the drug (Manila and Atsugi, Japan) not to use it for the time being, and they even took away Sid Gottlieb's own private supply and had it locked up in his boss' safe, to which no one else had the combination. In the end, however, Allen Dulles accepted the view Richard Helms put forth that the only "operationally realistic" way to test drugs was to try them on unwitting people. Helms noted that experiments which gave advance warning would be "pro forma at best and result in a false sense of accomplishment and readiness." For Allen Dulles and his top aides, the possible importance of LSD clearly outweighed the risks and ethical problem of slipping the drug to involuntary subjects. They gave Gottlieb back his LSD.

Once the CIA's top echelon had made its decision to continue unwitting testing, there remained, in Richard Helms' words, "only then the question of how best to do it." The Agency's role in the Olson affair had come too perilously close to leaking out for the comfort of the security-minded, so TSS officials simply had to work out a testing system with better cover. That meant finding subjects who could not be so easily traced back to the Agency.

Well before Olson's death, Gottlieb and the MKULTRA crew had started pondering how best to do unwitting testing. They considered using an American police force to test drugs on prisoners, informants, and suspects, but they knew that some local politicians would inevitably find out. In the Agency view, such people could not be trusted to keep sensitive secrets. TSS officials thought about trying Federal prisons or hospitals, but, when sounded out, the Bureau of Prisons refused to go along with true unwitting testing (as opposed to the voluntary, if coercive, form practiced on drug addicts in Kentucky). They contemplated moving the program overseas, where they and the ARTICHOKE teams were already performing operational experiments, but they decided if they tested on the scale they thought was necessary, so many foreigners would have to know that it would pose an unacceptable security risk.

Sid Gottlieb is remembered as the brainstorming genius of the MKULTRA group - and the one with a real talent for showing others, without hurting their feelings, why their schemes would not work. States an ex-colleague who admires him greatly, "In the final analysis, Sid was like a good soldier - if the job had to be done, he did it. Once the decision was made, he found the most effective way."

In this case, Gottlieb came up with the solution after reading through old OSS files on Stanley Lovell's search for a truth drug. Gottlieb noted that Lovell had used George White, a prewar employee of the Federal Bureau of Narcotics, to test concentrated marijuana. Besides trying the drug out on Manhattan Project volunteers and unknowing suspected Communists, White had slipped some to August Del Gracio, the Lucky Luciano lieutenant. White had called the experiment a great success. If it had not been - if Del Gracio had somehow caught on to the drugging - Gottlieb realized that the gangster would never have gone to the police or the press. His survival as a criminal required he remain quiet about even the worst indignities heaped upon him by government agents.

To Gottlieb, underworld types looked like ideal test subjects. Nevertheless, according to one TSS source, "We were not about to fool around with the Mafia." Instead, this source says they chose "the borderline underworld" - prostitutes, drug addicts, and other small-timers who would be powerless to seek any sort of revenge if they ever found out what the CIA had done to them. In addition to their being unlikely whistle-blowers, such people lived in a world where an unwitting dose of some drug - usually knockout drops - was an occupational hazard anyway. They would therefore be better equipped to deal with - and recover from - a surprise LSD trip than the population as a whole. Or so TSS officials rationalized. "They could at least say to themselves, 'Here I go again. I've been slipped a mickey,"' says a TSS veteran. Furthermore, this veteran remembers, his former colleagues reasoned that if they had to violate the civil rights of anyone, they might as well choose a group of marginal people.

George White himself had left OSS after the war and returned to the Narcotics Bureau. In 1952 he was working in the New York office. As a high-ranking narcotics agent, White had a perfect excuse to be around drugs and people who used them. He had proved during the war that he had a talent for clandestine work, and he certainly had no qualms when it came to unwitting testing. With his job, he had access to all the possible subjects the Agency would need, and if he could use LSD or any other drug to find out more about drug trafficking, so much the better. From a security viewpoint, CIA officials could easily deny any connection to anything White did, and he clearly was not the crybaby type. For Sid Gottlieb, George White was clearly the one. The MKULTRA chief decided to contact White directly to see if he might be interested in picking up with the CIA where he had left off with OSS.

Always careful to observe bureaucratic protocol, Gottlieb first approached Harry Anslinger, the longtime head of the Federal Bureau of Narcotics, and got permission to use White on a part-time basis. Then Gottlieb traveled to New York and made his pitch to the narcotics agent, who stood 5'7", weighed over 200 pounds, shaved his head, and looked something like an extremely menacing bowling ball. After an early-morning meeting, White scrawled in his sweat-stained, leather-bound diary for that day, June 9, 1952: "Gottlieb proposed I be a CIA consultant - I agree." By writing down such a thing and using Gottlieb's true name,[1] White had broken CIA security regulations even before he started work. But then, White was never known as a man who followed rules.

Despite the high priority that TSS put on drug testing, White's security approval did not come through until almost a year later. "It was only last month that I got cleared," the outspoken narcotics agent wrote to a friend in 1953. "I then learned that a couple of crew-cut, pipe-smoking punks had either known me - or heard of me - during OSS days and had decided I was 'too rough' for their league and promptly blackballed me. It was only when my sponsors discovered the root of the trouble they were able to bypass the blockade. After all, fellas, I didn't go to Princeton."

People either loved or hated George White, and he had made some powerful enemies, including New York Governor Thomas Dewey and J. Edgar Hoover. Dewey would later help block White from becoming the head of the Narcotics Bureau in New York City, a job White sorely wanted. For some forgotten reason, Hoover had managed to stop White from being hired by the CIA in the Agency's early days, at a time when he would have preferred to leave narcotics work altogether. These were two of the biggest disappointments of his life. White's previous exclusion from the CIA may explain why he jumped so eagerly at Gottlieb's offer and why at the same time he privately heaped contempt on those who worked for the Agency. A remarkably heavy drinker, who would sometimes finish off a bottle of gin in one sitting, White often mocked the CIA crowd over cocktails. "He thought they were a joke," recalls one longtime crony. "They were too complicated, and they had other people do their heavy stuff."

Unlike his CIA counterparts, White loved the glare of publicity. A man who gloried in talking about himself and cultivating a hard-nosed image, White knew how to milk a drug bust for all it was worth - a skill that grew out of early years spent as a newspaper reporter in San Francisco and Los Angeles. In search of a more financially secure profession, he had joined the Narcotics Bureau in 1934, but he continued to pal around with journalists, particularly those who wrote favorably about him. Not only did he come across in the press as a cop hero, but he helped to shape the picture of future Kojaks by serving as a consultant to one of the early-television detective series. To start a raid, he would dramatically tip his hat to signal his agents - and to let the photographers know that the time had come to snap his picture. "He was sort of vainglorious," says another good friend, "the kind of guy who if he did something, didn't mind having the world know about it."[2]

The scientists from TSS, with their Ph.D.s and lack of street experience, could not help admiring White for his swashbuckling image. Unlike the men from MKULTRA, who, for all their pretensions, had never worked as real-live spies, White had put his life on the line for OSS overseas and had supposedly killed a Japanese agent with his bare hands. The face of one ex-TSS man lit up, like a little boy's on Christmas morning, as he told of racing around New York in George White's car and parking illegally with no fear of the law. "We were Ivy League, white, middle-class," notes another former TSSer. "We were naive, totally naive about this, and he felt pretty expert. He knew the whores, the pimps, the people who brought in the drugs. He'd purportedly been in a number of shootouts where he'd captured millions of dollars worth of heroin.... He was a pretty wild man. I know I was afraid of him. You couldn't control this guy ... I had a little trouble telling who was controlling who in those days."

White lived with extreme personal contradictions. As could be expected of a narcotics agent, he violently opposed drugs. Yet he died largely because his beloved alcohol had destroyed his liver. He had tried everything else, from marijuana to LSD, and wrote an acquaintance, "I did feel at times I was having a 'mind-expanding' experience but this vanished like a dream immediately after the session." He was a law-enforcement official who regularly violated the law. Indeed, the CIA turned to him because of his willingness to use the power of his office to ride roughshod over the rights of others - in the name of "national security," when he tested LSD for the Agency, in the name of stamping out drug abuse, for the Narcotics Bureau. As yet another close associate summed up White's attitude toward his job, "He really believed the ends justified the means."

George White's "pragmatic" approach meshed perfectly with Sid Gottlieb's needs for drug testing. In May 1953 the two men, who wound up going folk dancing together several times, formally joined forces. In CIA jargon, White became MKULTRA subproject #3. Under this arrangement, White rented two adjacent Greenwich Village apartments, posing as the sometime artist and seaman "Morgan Hall." White agreed to lure guinea pigs to the "safehouse" - as the Agency men called the apartments - slip them drugs, and report the results to Gottlieb and the others in TSS. For its part, the CIA let the Narcotics Bureau use the place for undercover activities (and often for personal pleasure) whenever no Agency work was scheduled, and the CIA paid all the bills, including the cost of keeping a well-stocked liquor cabinet - a substantial bonus for White. Gottlieb personally handed over the first $4,000 in cash, to cover the initial costs of furnishing the safehouse in the lavish style that White felt befitted him.

Gottlieb did not limit his interest to drugs. He and other TSS officials wanted to try out surveillance equipment. CIA technicians quickly installed see-through mirrors and microphones through which eavesdroppers could film, photograph, and record the action. "Things go wrong with listening devices and two-way mirrors, so you build these things to find out what works and what doesn't," says a TSS source. "If you are going to entrap, you've got to give the guy pictures [flagrante delicto] and voice recordings. Once you learn how to do it so that the whole thing looks comfortable, cozy, and safe, then you can transport the technology overseas and use it." This TSS man notes that the Agency put to work in the bedrooms of Europe some of the techniques developed in the George White safehouse operation.

In the safehouse's first months, White tested LSD, several kinds of knockout drops, and that old OSS standby, essence of marijuana. He served up the drugs in food, drink, and cigarettes and then tried to worm information - usually on narcotics matters - from his "guests." Sometimes MKULTRA men came up from Washington to watch the action. A September 1953 entry in White's diary noted: "Lashbrook at 81 Bedford Street - Owen Winkle and LSD surprise - can wash." Sid Gottlieb's deputy, Robert Lashbrook, served as "project monitor" for the New York safehouse.[3]

White had only been running the safehouse six months when Olson died (in Lashbrook's company), and Agency officials suspended the operation for reevaluation. They soon allowed him to restart it, and then Gottlieb had to order White to slow down again. A New York State commissioner had summoned the narcotics agent to explain his role in the deal that wound up with Governor Dewey pardoning Lucky Luciano after the war. The commissioner was asking questions that touched on White's use of marijuana on Del Gracio, and Gottlieb feared that word of the CIA's current testing might somehow leak out. This storm also soon passed, but then, in early 1955, the Narcotics Bureau transferred White to San Francisco to become chief agent there. Happy with White's performance, Gottlieb decided to let him take the entire safehouse operation with him to the Coast. White closed up the Greenwich Village apartments, leaving behind unreceipted "tips" for the landlord "to clear up any difficulties about the alterations and damages," as a CIA document put it.[4]

White soon rented a suitable "pad" (as he always called it) on Telegraph Hill, with a stunning view of San Francisco Bay, the Golden Gate Bridge, and Alcatraz. To supplement the furniture he brought from the New York safehouse, he went out and bought items that gave the place the air of the brothel it was to become: Toulouse-Lautrec posters, a picture of a French cancan dancer, and photos of manacled women in black stockings. "It was supposed to look rich," recalls a narcotics agent who regularly visited, "but it was furnished like crap."

White hired a friend's company to install bugging equipment, and William Hawkins, a 25-year-old electronics whiz then studying at Berkley put in four DD-4 microphones disguised as electrical wall outlets and hooked them up to two F-301 tape recorders, which agents monitored in an adjacent "listening post." Hawkins remembers that White "kept a pitcher of martinis in the refrigerator, and he'd watch me for a while as I installed a microphone and then slip off." For his own personal "observation post," White had a portable toilet set up behind a two-way mirror, where he could watch the proceedings, usually with drink in hand.

The San Francisco safehouse specialized in prostitutes. "But this was before The Hite Report and before any hooker had written a book," recalls a TSS man, "so first we had to go out and learn about their world. In the beginning, we didn't know what a john was or what a pimp did." Sid Gottlieb decided to send his top staff psychologist, John Gittinger, to San Francisco to probe the demimonde.

George White supplied the prostitutes for the study, although White, in turn, delegated much of the pimping function to one of his assistants, Ira "Ike" Feldman. A muscular but very short man, whom even the 5'7" White towered over, Feldman tried even harder than his boss to act tough. Dressed in suede shoes, a suit with flared trousers, a hat with a turned-up brim, and a huge zircon ring that was supposed to look like a diamond, Feldman first came to San Francisco on an undercover assignment posing as an East Coast mobster looking to make a big heroin buy. Using a drug-addicted prostitute name Janet Jones, whose common-law husband states that Feldman paid her off with heroin, the undercover man lured a number of suspected drug dealers to the "pad" and helped White make arrests.

As the chief Federal narcotics agent in San Francisco, White was in a position to reward or punish a prostitute. He set up a system whereby he and Feldman provided Gittinger with all the hookers the psychologist wanted. White paid off the women with a fixed number of "chits." For each chit, White owed one favor. "So the next time the girl was arrested with a john," says an MKULTRA veteran, "she would give the cop George White's phone number. The police all knew White and cooperated with him without asking questions. They would release the girl if he said so. White would keep good records of how many chits each person had and how many she used. No money was exchanged, but five chits were worth $500 to $1,000." Prostitutes were not the only beneficiaries of White's largess. The narcotics agent worked out a similar system to forgive the transgressions of small time drug pushers when the MKULTRA men wanted to talk to them about "the rules of their game," according to the source.

TSS officials wanted to find out everything they could about how to apply sex to spying, and the prostitute project became a general learning and then training ground for CIA carnal operations. After all, states one TSS official, "We did quite a study of prostitutes and their behavior.... At first nobody really knew how to use them. How do you train them? How do you work them? How do you take a woman who is willing to use her body to get money out of a guy to get things which are much more important, like state secrets. I don't care how beautiful she is - educating the ordinary prostitute up to that level is not a simple task."

The TSS men continually tried to refine their knowledge. They realized that prostitutes often wheedled extra money out of a customer by suggesting some additional service as male orgasm neared. They wondered if this might not also be a good time to seek sensitive information. "But no," says the source, "we found the guy was focused solely on hormonal needs. He was not thinking of his career or anything else at that point." The TSS experts discovered that the postsexual, light-up-acigarette period was much better suited to their ulterior motives. Says the source:

> Most men who go to prostitutes are prepared for the fact that [after the act] she's beginning to work to get herself out of there, so she can get back on the street to make some more money... . To find a prostitute who is willing to stay is a hell of a shock to anyone used to prostitutes. It has a tremendous effect on the guy. It's a boost to his ego if she's telling him he was really neat, and she wants to stay for a few more hours.... Most of the time, he gets pretty vulnerable. What the hell's he going to talk about? Not the sex, so he starts talking about his business. It's at this time she can lead him gently. But you have to train prostitutes to do that. Their natural inclination is to do exactly the opposite.

The men from MKULTRA learned a great deal about varying sexual preferences. One of them says:

> We didn't know in those days about hidden sadism and all that sort of stuff. We learned a lot about human nature in the bedroom. We began to understand that when people wanted sex, it wasn't just what we had thought of - you know, the missionary position.... We started to pick up

> knowledge that could be used in operations, but with a lot of it we never figured out any way to use it operationally. We just learned.... All these ideas did not come to us at once. But evolving over three or four years in which these studies were going on, things emerged which we tried. Our knowledge of prostitutes' behavior became pretty damn good... . This comes across now that somehow we were just playing around and we just found all these exotic ways to waste the taxpayers' money on satisfying our hidden urges. I'm not saying that watching prostitutes was not exciting or something like that. But what I am saying was there was a purpose to the whole business.[5]

In the best tradition of Mata Hari, the CIA did use sex as a clandestine weapon, although apparently not so frequently as the Russians. While many in the Agency believed that it simply did not work very well, others like CIA operators in Berlin during the mid-1960s felt prostitutes could be a prime source of intelligence. Agency men in that city used a network of hookers to good advantage - or so they told visitors from headquarters. Yet, with its high proportion of Catholics and Mormons - not to mention the Protestant ethic of many of its top leaders - the Agency definitely had limits beyond which prudery took over. For instance, a TSS veteran says that a good number of case officers wanted no part of homosexual entrapment operations. And to go a step further, he recalls one senior KGB man who told too many sexual jokes about young boys. "It didn't take too long to recognize that he was more than a little fascinated by youths," says the source. "I took the trouble to point out he was probably too good, too well-trained, to be either entrapped or to give away secrets. But he would have been tempted toward a compromising position by a preteen. I mentioned this, and they said, 'As a psychological observer, you're probably quite right. But what the hell are we going to do about it? Where are we going to get a twelve-year-old boy?' " The source believes that if the Russian had had a taste for older men, U.S. intelligence might have mounted an operation, "but the idea of a twelve-year-old boy was just more than anybody could stomach."

As the TSS men learned more about the San Francisco hustlers, they ventured outside the safehouse to try out various clandestine-delivery gimmicks in public places like restaurants, bars, and beaches. They practiced ways to slip LSD to citizens of the demimonde while buying them a drink or lighting up a cigarette, and they then tried to observe the effects when the drug took hold. Because the MKULTRA scientists did not move smoothly among the very kinds of people they were testing, they occasionally lost an unwitting victim in a crowd - thereby sending a stranger off alone with a head full of LSD.

In a larger sense, all the test victims would become lost. As a matter of policy, Sid Gottlieb ordered that virtually no records be kept of the testing. In 1973, when Gottlieb retired from the Agency, he and Richard Helms agreed to destroy what they thought were the few existing documents on the program. Neither Gottlieb nor any other MKULTRA man has owned up to having given LSD to an unknowing subject, or even to observing such an experiment - except of course in the case of Frank Olson. Olson's death left behind a paper trail outside of Gottlieb's control and that hence could not be denied. Otherwise, Gottlieb and his colleagues have put all the blame for actual testing on George White, who is not alive to defend himself. One reason the MKULTRA veterans have gone to such lengths to conceal their role is obvious: fear of lawsuits from victims claiming damaged health.

At the time of the experiments, the subjects' health did not cause undue concern. At the safehouse, where most of the testing took place, doctors were seldom present. Dr. James Hamilton, a Stanford Medical School psychiatrist and White's OSS colleague, visited the place from time to time, apparently for studies connected to unwitting drug experiments and deviant sexual practices. Yet neither Hamilton nor any other doctor provided much medical supervision. From his perch atop the toilet seat, George White could do no more than make surface observations of his drugged victims. Even an experienced doctor would have had difficulty handling White's role. In addition to LSD, which they knew could cause serious, if not fatal problems, TSS officials gave White even more exotic experimental drugs to test, drugs that other Agency contractors may or may not have already used on human subjects. "If we were scared enough of a drug not to try it out on ourselves, we sent it to San Francisco," recalls a TSS source. According to a 1963 report by CIA Inspector General John Earman, "In a number of instances, however, the test subject has become ill for hours or days, including hospitalization in at least one case, and [White] could only follow up by guarded inquiry after the test subject's return to normal life. Possible sickness and attendant economic loss are inherent contingent effects of the testing."

The Inspector General noted that the whole program could be compromised if an outside doctor made a "correct diagnosis of an illness." Thus, the MKULTRA team not only made some people sick but had a vested interest in keeping doctors from finding out what was really wrong. If that bothered the Inspector General, he did not report his qualms, but he did say he feared "serious damage to the Agency" in the event of public exposure. The Inspector General was only somewhat reassured by the fact that George White "maintain[ed] close working relations with local police authorities which could be utilized to protect the activity in critical situations."

If TSS officials had been willing to stick with their original target group of marginal underworld types, they would have had little to fear from the police. After all, George White was the police. But increasingly they used the safehouse to test drugs, in the Inspector General's words, "on individuals of all social levels, high and low, native American and foreign." After all, they were looking for an operational payoff, and they knew people reacted differently to LSD according to everything from health and mood to personality structure. If TSS officials wanted to slip LSD to foreign leaders, as they contemplated doing to Fidel Castro, they would try to spring an unwitting dose on somebody as similar as possible. They used the safehouse for "dry runs" in the intermediate stage between the laboratory and actual operations.

For these dress rehearsals, George White and his staff procurer, Ike Feldman, enticed men to the apartment with prostitutes. An unsuspecting john would think he had bought a night of pleasure, go back to a strange apartment, and wind up zonked. A CIA document that survived Sid Gottlieb's shredding recorded this process. Its author, Gottlieb himself, could not break a lifelong habit of using nondescriptive language. For the MKULTRA chief, the whores were "certain individuals who covertly administer this material to other people in accordance with [White's] instructions." White normally paid the women $100 in Agency funds for their night's work, and Gottlieb's prose reached new bureaucratic heights as he explained why the prostitutes did not sign for the money: "Due to the highly unorthodox nature of these activities and the considerable risk incurred by these individuals, it is impossible to require that they provide a receipt for these payments or that they indicate the precise manner in which the funds were spent." The CIA's auditors had to settle for canceled checks which White cashed himself and marked either "Stormy" or, just as appropriately, "Undercover Agent." The program was also referred to as "Operation Midnight Climax."

TSS officials found the San Francisco safehouse so successful that they opened a branch office, also under George White's auspices, across the Golden Gate on the beach in Marin County.[6] Unlike the downtown apartment, where an MKULTRA man says "you could bring people in for quickies after lunch," the suburban Marin County outlet proved useful for experiments that required relative isolation. There, TSS scientists tested such MKULTRA specialties as stink bombs, itching and sneezing powders, and diarrhea inducers. TSS's Ray Treichler, the Stanford chemist, sent these "harassment substances" out to California for testing by White, along with such delivery systems as a mechanical launcher that could throw a foul-smelling object 100 yards, glass ampules that could be stepped on in a crowd to release any of Treichler's powders, a fine hypodermic needle to inject drugs through the cork in a wine bottle, and a drug-coated swizzle stick.

TSS men also planned to use the Marin County safehouse for an ill-fated experiment that began when staff psychologists David Rhodes and Walter Pasternak spent a week circulating in bars, inviting strangers to a party. They wanted to spray LSD from an aerosol can on their guests, but according to Rhodes' Senate testimony, "the weather defeated us." In the heat of the summer, they could not close the doors and windows long enough for the LSD to hang in the air and be inhaled. Sensing a botched operation, their MKULTRA colleague, John Gittinger (who brought the drug out from Washington) shut himself in the bathroom and let go with the spray. Still, Rhodes testified, Gittinger did not get high, and the CIA men apparently scrubbed the party.[7]

The MKULTRA crew continued unwitting testing until the summer of 1963 when the Agency's Inspector General stumbled across the safehouses during a regular inspection of TSS activities. This happened not long after Director John McCone had appointed John Earman to the Inspector General position.[8] Much to the displeasure of Sid Gottlieb and Richard Helms, Earman questioned the propriety of the safehouses, and he insisted that Director McCone be given a full briefing. Although President Kennedy had put McCone in charge of the Agency the year before, Helms - the professional's professional - had not bothered to tell his outsider boss about some of the CIA's most sensitive activities, including the safehouses and the CIA-Mafia assassination plots.[9] Faced with Earman's demands, Helms - surely one of history's most clever bureaucrats -

volunteered to tell McCone himself about the safehouses (rather than have Earman present a negative view of the program). Sure enough, Helms told Earman afterward, McCone raised no objections to unwitting testing (as Helms described it). A determined man and a rather brave one, Earman countered with a full written report to McCone recommending that the safehouses be closed. The Inspector General cited the risks of exposure and pointed out that many people both inside and outside the Agency found "the concepts involved in manipulating human behavior ... to be distasteful and unethical." McCone reacted by putting off a final decision but suspending unwitting testing in the meantime. Over the next year, Helms, who then headed the Clandestine Services, wrote at least three memos urging resumption. He cited "indications ... of an apparent Soviet aggressiveness in the field of covertly administered chemicals which are, to say the least, inexplicable and disturbing," and he claimed the CIA's "positive operational capacity to use drugs is diminishing owing to a lack of realistic testing."[10] To Richard Helms, the importance of the program exceeded the risks and the ethical questions, although he did admit, "We have no answer to the moral issue." McCone simply did nothing for two years. The director's indecision had the effect of killing the program, nevertheless. TSS officials closed the San Francisco safehouse in 1965 and the New York one in 1966.

Years later in a personal letter to Sid Gottlieb, George White wrote an epitaph for his role with the CIA: "I was a very minor missionary, actually a heretic, but I toiled wholeheartedly in the vineyards because it was fun, fun, fun. Where else could a red-blooded American boy lie, kill, cheat, steak rape, and pillage with the sanction and blessing of the All-Highest?"

After 10 years of unwitting testing, the men from MKULTRA apparently scored no major breakthroughs with LSD or other drugs. They found no effective truth drug, recruitment pill, or aphrodisiac. LSD had not opened up the mind to CIA control. "We had thought at first that this was the secret that was going to unlock the universe," says a TSS veteran. "We found that human beings had resources far greater than imagined."

Yet despite the lack of precision and uncertainty, the CIA still made field use of LSD and other drugs that had worked their way through the MKULTRA testing progression. A 1957 report showed that TSS had already moved 6 drugs out of the experimental stage and into active use. Up to that time, CIA operators had utilized LSD and other psychochemicals against 33 targets in 6 different operations. Agency officials hoped in these cases either to discredit the subject by making him seem insane or to "create within the individual a mental and emotional situation which will release him from the restraint of self-control and induce him to reveal information willingly under adroit manipulation." The Agency has consistently refused to release details of these operations, and TSS sources who talk rather freely about other matters seem to develop amnesia when the subject of field use comes up. Nevertheless, it can be said that the CIA did establish a relationship with an unnamed foreign secret service to interrogate prisoners with LSD-like drugs. CIA operators participated directly in these interrogations, which continued at least until 1966. Often the Agency showed more concern for the safety of its operational targets abroad than it did for its unwitting victims in San Francisco, since some of the foreign subjects were given medical examinations before being slipped the drug.[11]

In these operations, CIA men sometimes brought in local doctors for reasons that had nothing to do with the welfare of the patient. Instead, the doctor's role was to certify the apparent insanity of a victim who had been unwittingly dosed with LSD or an even more durable psychochemical like BZ (which causes trips lasting a week or more and which tends to induce violent behavior). If a doctor were to prescribe hospitalization or other severe treatment, the effect on the subject could be devastating. He would suffer not only the experience itself, including possible confinement in a mental institution, but also social stigma. In most countries, even the suggestion of mental problems severely damages an individual's professional and personal standing (as Thomas Eagleton, the recipient of some shock therapy, can testify). "It's an old technique," says an MKULTRA veteran. "You neutralize someone by having their constituency doubt them." The Church committee confirms that the Agency used this technique at least several times to assassinate a target's character.[12]

Still, the Clandestine Services did not frequently call on TSS for LSD or other drugs. Many operators had practical and ethical objections. In part to overcome such objections and also to find better ways to use chemical and biological substances in covert operations, Sid Gottlieb moved up in 1959 to become Assistant for Scientific Matters to the Clandestine Services chief. Gottlieb found that TSS had kept the MKULTRA programs so secret that many field people did not even know what techniques were available. He wrote that tight controls over field use in MKDELTA operations "may have generated a general defeatism among case officers," who feared they would not receive permission or that the procedure was not worth the effort.

Gottlieb tried to correct these shortcomings by providing more information on the drug arsenal to senior operators and by streamlining the approval process. He had less luck in overcoming views that drugs do not work or are not reliable, and that their operational use leads to laziness and poor tradecraft.

If the MKULTRA program had ever found that LSD or any other drug really did turn a man into a puppet, Sid Gottlieb would have had no trouble surmounting all those biases. Instead, Gottlieb and his fellow searchers came frustratingly close but always fell short of finding a reliable control mechanism. LSD certainly penetrated to the innermost regions of the mind. It could spring loose a whole gamut of feelings, from terror to insight. But in the end, the human psyche proved so complex that even the most skilled manipulator could not anticipate all the variables. He could use LSD and other drugs to chip away at free will. He could score temporary victories, and he could alter moods, perception - sometimes even beliefs. He had the power to cause great harm, but ultimately he could not conquer the human spirit.

Notes 6

The CIA's reaction to Frank Olson's death is described in numerous memos released by the Agency to the Olson family, which can be found at pp.1005-1132 of the Kennedy Subcommittee 1975 hearings on Biomedical and Behavioral Research. See particularly at p. 1077, 18 December 1953, Subject: The Suicide of Frank Olson and at p. 1027, 1 December 1953, Subject: Use of LSD.

Richard Helms' views on unwitting testing are found in Document #448, 17 December 1963, Subject: Testing of Psychochemicals and Related Materials and in a memorandum to the CIA Director, June 9, 1964, quoted from on page 402 of the Church Committee Report, Book I.

George White's diary and letters were donated by his widow to Foothills Junior College, Los Altos, California and are the source of a treasure chest of material on him, including his letter to a friend explaining his almost being "blackballed" from the CIA, the various diary entries cited, including references to folk-dancing with Gottlieb, the interview with Hal Lipset where he explains his philosophy on chasing criminals, and his letter to Sid Gottlieb dated November 21, (probably) 1972.

The New York and San Francisco safehouses run by George White are the subjects of MKULTRA subprojects 3,14,16,42, and 149. White's tips to the landlord are described in 42-156, his liquor bills in 42-157, "dry-runs" in 42-91. The New York safehouse run by Charles Siragusa is subproject 132. The "intermediate" tests are described in document 132-59.

Paul Avery, a San Francisco freelance writer associated with the Center for Investigative Reporting in Oakland, California interviewed William Hawkins and provided assistance on the details of the San Francisco safehouse and George White's background. Additional information on White came from interviews with his widow, several former colleagues in the Narcotics Bureau, and other knowledgeable sources in various San Francisco law-enforcement agencies. An ex-Narcotics Bureau official told of Dr. James Hamilton's study of unusual sexual practices and the description of his unwitting drug testing comes from MKULTRA subproject 2, which is his subproject.

Ray Treichler discussed some of his work with harassment substances in testimony before the Kennedy subcommittee on September 20, 1977, pp. 105-8. He delivered his testimony under the pseudonym "Philip Goldman."

"The Gang that Couldn't Spray Straight" article appeared in the September 20, 1977 Washington Post.

Richard Helms' decision not to tell John McCone about the CIA's connection to the Mafia in assassination attempts against Castro is described in the Church Committee's Assassination report, pp. 102-3.

The 1957 Inspector General's Report on TSS, Document #417 and the 1963 inspection of MKULTRA, 14 August 1963, Document #59 provided considerable detail throughout the entire chapter. The Church Committee Report on MKULTRA in Book I, pp. 385-422 also provided considerable information.

Sid Gottlieb's job as Assistant to the Clandestine Services chief for Scientific Matters is described in Document

#74 (operational series) 20 October 1959, Subject: Application of Imaginative Research on the Behavioral and Physical Sciences to [deleted] Problems" and in the 1963 Inspector General's report.

Interviews with ex-CIA Inspector General Lyman Kirkpatrick, another former Inspector General's staff employee, and several ex-TSS staffers contributed significantly to this chapter.

Helms' letter to the Warren Commission on "Soviet Brainwashing Techniques," dated 19 June 1964, was obtained from the National Archives.

The material on the CIA's operational use of LSD came from the Church Committee Report, Book I, pp. 399-403 and from an affidavit filed in the Federal Court case of John D. Marks v. Central Intelligence Agency, et. al., Civil Action No. 76-2073 by Eloise R. Page, Chief, Policy and Coordination Staff of the CIA's Directorate of Operations. In listing all the reasons why the Agency should not provide the operational documents, Ms. Page gave some information on what was in the documents. The passages on TSS's and the Medical Office's positions on the use of LSD came from a memo written by James Angleton, Chief, Counterintelligence Staff on December 12, 1957 quoted in part at p. 401 of the Church Committee Report, Book I.

Footnotes 6

1. CIA operators and agents all had cover names by which they were supposed to be called - even in classified documents. Gottlieb was "Sherman R. Grifford." George White became "Morgan Hall."
2. One case which put White in every newspaper in the country was his 1949 arrest of blues singer Billie Holliday on an opium charge. To prove she had been set up and was not then using drugs, the singer checked into a California sanitarium that had been recommended by a friend of a friend, Dr. James Hamilton. The jury then acquitted her. Hamilton's involvement is bizarre because he had worked with George White testing truth drugs for OSS, and the two men were good friends. White may have put his own role in perspective when he told a 1970 interviewer he "enjoyed" chasing criminals. "It was a game for me," he said. "I felt quite a bit of compassion for a number of the people that I found it necessary to put in jail, particularly when you'd see the things that would happen to their families. I'd give them a chance to stay out of jail and take care of their families by giving me information, perhaps, and they would stubbornly refuse to do so. They wouldn't be a rat, as they would put it."
3. Despite this indication from White's diary that Lashbrook came to the New York safehouse for an "LSD surprise" and despite his signature on papers authorizing the subproject, Lashbrook flatly denied all firsthand knowledge of George White's testing in 1977 Senate testimony. Subcommittee chairman Edward Kennedy did not press Lashbrook, nor did he refer the matter to the Justice Department for possible perjury charges.
4. This was just one of many expenditures that would drive CIA auditors wild while going over George White's accounts. Others included $44.04 for a telescope, liquor bills over $1,000 "with no record as to the necessity of its use," and $31.75 to make an on-the-spot payment to a neighborhood lady whose car he hit. The reason stated for using government funds for the last expense: "It was important to maintain security and forestall an insurance investigation."
5. In 1984, George Orwell wrote about government-encouraged prostitution: "Mere debauchery did not matter very much, so long as it was furtive and joyless, and only involved the women of a submerged and despised class."
6. In 1961 MKULTRA officials started a third safehouse in New York, also under the Narcotics Bureau's supervision. This one was handled by Charles Siragusa who, like White, was a senior agent and OSS veteran.
7. Rhodes' testimony about this incident, which had been set up in advance with Senator Edward Kennedy's staff, brought on the inevitable "Gang That Couldn't Spray Straight" headline in the Washington Post. This approach turned the public perception of a deadly serious program into a kind of practical joke carried out badly by a bunch of bumblers.
8. Lyman Kirkpatrick, the longtime Inspector General who had then recently left the job to take a higher Agency post, had personally known of the safehouse operation since right after Olson's death and had never raised any noticeable objection. He now states he was "shocked" by the unwitting testing, but that he "didn't have the authority to follow up ... I was trying to determine what the tolerable limits were of what I could do and still keep my job."
9. Trying to explain why he had specifically decided not to inform the CIA Director about the Agency's relationship with the mob, Helms stated to the Church committee, "Mr. McCone was relatively new to this organization, and I guess I must have thought to myself, well this is going to look peculiar to him ... This was, you know not a very savory effort." Presumably, Helms had similar reasons for not telling McCone about the unwitting drug-testing in the safehouses.
10. Helms was a master of telling different people different stories to suit his purposes. At the precise time he was raising the Soviet menace to push McCone into letting the unwitting testing continue, he wrote the Warren Commission that not only did Soviet behavioral research lag five years behind the West's but that "there is no present evidence that the Soviets have any singular, new potent, drugs ... to force a course of action on an individual."
11. TSS officials led by Sid Gottlieb, who were responsible for the operational use of LSD abroad, took the position that there was "no danger medically" in unwitting doses and that neither giving a medical exam or having a doctor present was necessary. The Agency's Medical Office disagreed, saying the drug was "medically dangerous." In 1957 Inspector General Lyman Kirkpatrick noted it would be "unrealistic" to give the Medical Office what amounted to veto power over covert operations by letting Agency doctors rule on the health hazard to subjects in the field.
12. While I was doing the research for this book, many people approached me claiming to be victims of CIA drugging plots. Although I listened carefully to all and realized that some might be authentic victims, I had no way of distinguishing between someone acting strangely and someone made to act strangely. Perhaps the most insidious aspect of this whole technique is

that anyone blaming his aberrant behavior on a drug or on the CIA gets labeled a hopeless paranoid and his case is thrown into the crank file. There is no better cover than operating on the edge of madness.

One leftist professor in a Latin American university who had opposed the CIA says that he was working alone in his office one day in 1974 when a strange woman entered and jabbed his wrist with a pin stuck in a small round object. Almost immediately, he become irrational, broke glasses, and threw water in colleagues' faces. He says his students spotted an ambulance waiting for him out front. They spirited him out the back door and took him home, where he tripped (or had psychotic episodes) for more than a week. He calls the experience a mix of "heaven and hell," and he shudders at the thought that he might have spent the time in a hospital "with nurses and straitjackets." Although he eventually returned to his post at the university, he states that it took him several years to recover the credibility he lost the day he "went crazy at the office." If the CIA was involved, it had neutralized a foe.

7. Mushrooms to Counterculture

The MKULTRA scientists reaped little but disaster, mischief, and disappointment from their efforts to use LSD as a miracle weapon against the minds of their opponents. Nevertheless, their insatiable need to try every possibility led them to test hundreds of other substances, including all the drugs that would later be called psychedelic. These drugs were known to have great potency. They were derived from natural botanical products, and the men from MKULTRA believed from the beginning that rare organic materials might somehow have the greatest effect on the human mind. The most amazing of the psychedelics came from odd corners of the natural world. A1bert Hofmann created LSD largely out of ergot, a fungus that grows on rye; mescaline is nothing more than the synthetic essence of peyote cactus. Psilocybin, the drug that Timothy Leary preferred to LSD for his Harvard experiments, was synthesized from exotic Mexican mushrooms that occupy a special place in CIA history.

When the MKULTRA team first embarked on its mind-control explorations, the "magic mushroom" was only a rumor or fable in the linear history of the Western world. On nothing more than the possibility that the legend was based on fact, the Agency's scientists tracked the mushroom to the most remote parts of Mexico and then spent lavishly to test and develop its mind-altering properties. The results, like the LSD legacy, were as startling as they were unintended.

Among the botanicals that mankind has always turned to for intoxicants and poisons, mushrooms stand out. There is something enchantingly odd about the damp little buttons that can thrill a gourmet or kill one, depending on the subtle differences among the countless varieties. These fungi have a long record in unorthodox warfare. Two thousand years before the CIA looked to unleash powerful mushrooms in covert operations, the Roman Empress Agrippina eliminated her husband Claudius with a dish of poisonous mushrooms. According to Roman history, Agrippina wanted the emperor dead so that her son Nero could take the throne. She planned to take advantage of Claudius' love for the delicious *Amanita caesarea* mushroom, but she had to choose carefully among its deadly look-alikes. The poison could not be "sudden and instantaneous in its operation, lest the desperate achievement should be discovered," wrote Gordon and Valentina Wasson in their monumental and definitive work, Mushrooms, Russia and History. The Empress settled on the lethal *Amanita phalloides*, a fungus the Wassons considered well suited to the crime: "The victim would not give away the game by abnormal indispositions at the meal, but when the seizure came he would be so severely stricken that thereafter he would no longer be in command of his own affairs." Agrippina knew her mushrooms, and Nero became Emperor.

CIA mind-control specialists sought to emulate and surpass that kind of sophistication, as it might apply to any conceivable drug. Their fixation on the "magic mushroom" grew indirectly out of a meeting between drug experts and Morse Allen, head of the Agency's ARTICHOKE program, in October 1952. One expert told Allen about a shrub called piule, whose seeds had long been used as an intoxicant by Mexican Indians at religious ceremonies. Allen, who wanted to know about anything that distorted reality, immediately arranged for a young CIA scientist to take a Mexican field trip and gather samples of piule as well as other plants of "high narcotic and toxic value of interest to ARTICHOKE."

That young scientist arrived in Mexico City early in 1953. He could not advertise the true purpose of his trip because of ARTICHOKE's extreme secrecy, so he assumed cover as a researcher interested in finding native plants which were anesthetics. Fluent in Spanish and familiar with Mexico, he had no trouble moving around the country, meeting with leading experts on botanicals. Then he was off into the mountains south of the capital with his own field-testing equipment, gathering specimens and testing them crudely on the spot. By February, he had collected sacks full of material, including 10 pounds of piule. Before leaving Mexico to look for more samples around the Caribbean, the young scientist heard amazing tales about special mushrooms that grew only in the hot and rainy summer months. Such stories had circulated among Europeans in Mexico since Cortez had conquered the country early in the sixteenth century. Spanish friars had reported that the Aztecs used strange mushrooms in their religious ceremonies, which these converters of the heathens described as "demonic holy communions." Aztec priests called the special mushrooms *teonanacatl*, "God's flesh." But Cortez's plunderers soon lost track of the rite, as did the traders and anthropologists who followed in their wake. Only the legend survived.

Back in Washington, the young scientist's samples went straight to the labs, and Agency officials scoured the historical record for accounts of the strange mushrooms. Morse Allen himself, though responsible in ARTICHOKE research for everything from the polygraph to hypnosis, took the trouble to go through the Indian lore. "Very early accounts of the ceremonies of some tribes of Mexican Indians show that mushrooms are used to produce hallucinations and to create intoxication in connection with religious festivals," he wrote. "In addition, this literature shows that witch doctors or 'divinators' used some types of mushrooms to produce confessions or to locate stolen objects or to predict the future." Here was a possible truth drug, Morse Allen reasoned. "Since it had been determined that no area of human knowledge is to be left unexplored in connection with the ARTICHOKE program, it was therefore regarded as essential that the peculiar qualities of the mushroom be explored...." Allen declared. "Full consideration," he concluded, should be given to sending an Agency man back to Mexico during the summer. The CIA had begun its quest for "God's flesh."

Characteristically, Morse Allen was planning ahead in case the CIA's searchers came up with a mushroom worth having in large quantities. He knew that the supply from the tropics varied by season, and, anyway, it would be impractical to go to Mexico for fungi each time an operational need popped up. So Allen decided to see if it were possible to grow the mushrooms at home, either outdoors or in hothouses. On June 24, 1953, he and an associate drove from Washington to Toughkenamon, Pennsylvania, in the heart of "the largest mushroom-growing area in the world." At a three-hour session with the captains of the mushroom industry, Allen explained the government's interest in poisonous and narcotic fungi. Allen reported that the meeting "was primarily designed to obtain a 'foothold' in the center of the mushroom-growing industry where, if requirements for mushroom growing were demanded, it would be done by professionals in the trade." The mushroom executives were quite reluctant to grow toxic products because they knew that any accidental publicity would scare their customers. In the end, however, their patriotism won out, and they agreed to grow any kind of fungus the government desired. Allen considered the trip a great success.

As useful as this commitment might be, an element of chance remained as long as the CIA had to depend on the natural process. But if the Agency could find synthetic equivalents for the active ingredients, it could manufacture rather than grow its own supply. Toward this goal of bypassing nature, Morse Allen had little choice but to turn for help to the man who the following year would wrest most of the ARTICHOKE functions from his grasp: Sid Gottlieb. Gottlieb, himself a Ph.D. in chemistry, had scientists working for him who knew what to do on the level of test tubes and beakers. Allen ran ARTICHOKE out of the Office of Security, which was not equipped for work on the frontiers of science.

Gottlieb and his colleagues moved quickly into the mysteries of the Mexican hallucinogens. They went to work on the chemical structures of the piule and other plants that Morse Allen's emissary brought back from his field trip, but they neglected to report their findings to the bureaucratically outflanked Allen. Gottlieb and the MKULTRA crew soon got caught up in the search for the magic mushroom. While TSS had its own limited laboratory facilities, it depended on secret contractors for most research and development. Working with an associate, a cadaverously thin chemistry Ph.D. named Henry Bortner, Gottlieb passed the tropical plants to a string of corporate and academic researchers. One of them, Dr. James Moore, a 29-yearold chemist at Parke, Davis & Company in Detroit, was destined to be the first man in the CIA camp to taste the magic mushroom. Moore's career was typical of the specialists in the CIA's vast network of private contractors. His path to the mushroom led through several jobs and offbeat assignments, always with Agency funds and direction behind him. A precise, meticulous man of scientific habits, Moore was hardly the sort one would expect to find chasing psychedelic drugs. Such pursuits began for him in March 1953, when he had returned to his lab at Parke, Davis after a year of postdoctoral research at the University of Basel. His supervisor had called him in with an intriguing proposal: How would he like to work inside the company on a CIA contract? "Those were not particularly prosperous times, and the company was glad to get someone else to pay my salary [$8,000 a year]," notes Moore 25 years later. "If I had thought I was participating in a scheme run by a small band of mad individuals, I would have demurred."

He accepted the job.

The Agency contracted with Parke, Davis, as it did with numerous other drug companies, universities, and government agencies to develop behavioral products and poisons from botanicals. CIA-funded chemists extracted deadly substances like the arrow-poison curare from natural products, while others worked on ways to deliver these poisons most effectively, like the "nondiscernible microbioinoculator" (or dart gun) that the

Army Chemical Corps invented. CIA-connected botanists collected - and then chemists analyzed - botanicals from all over the tropics: a leaf that killed cattle, several plants deadly to fish, another leaf that caused hair to fall out, sap that caused temporary blindness, and a host of other natural products that could alter moods, dull or stimulate nerves, or generally disorient people. Among the plants Moore investigated was Jamaica dogwood, a plant used by Caribbean natives to stun fish so they could be easily captured for food. This work resulted in the isolation of several new substances, one of which Moore named "lisetin," in honor of his daughter.

Moore had no trouble adjusting to the secrecy demanded by his CIA sponsors, having worked on the Manhattan Project as a graduate student. He dealt only with his own case officer, Henry Bortner, and two or three other CIA men in TSS. Once Moore completed his chemical work on a particular substance, he turned the results over to Bortner and apparently never learned of the follow-up. Moore worked in his own little isolated compartment, and he soon recognized that the Agency preferred contractors who did not ask questions about what was going on in the next box.

In 1955 Moore left private industry for academia, moving from Detroit to the relatively placid setting of the University of Delaware in Newark. The school made him an assistant professor, and he moved into a lab in the Georgian red-brick building that housed the chemistry department. Along with his family, Moore brought his CIA contract - then worth $16,000 a year, of which he received $650 per month, with the rest going to pay research assistants and overhead. Although the Agency allowed a few top university officials to be briefed on his secret connection, Moore appeared to his colleagues and students to be a normal professor who had a healthy research grant from the Geschickter Fund for Medical Research in Washington.

In the world of natural products - particularly mushrooms - the CIA soon made Moore a full-service agent. With some help from his CIA friends, he made contact with the leading lights in mycology (the study of mushrooms), attended professional meetings, and arranged for others to send him samples. From the CIA's point of view, he could not have had better cover. As Sid Gottlieb wrote, Moore "maintains the fiction that the botanical specimens he collects are for his own use since his field interest is natural-product chemistry." Under this pretext, Moore had a perfect excuse to make and purchase for the CIA chemicals that the Agency did not want traced. Over the years, Moore billed the Agency for hundreds of purchases, including 50 cents for an unidentified pamphlet, $433.13 for a particular shipment of mescaline, $1147.60 for a large quantity of mushrooms, and $12,000 for a quarter-ton of fluothane, an inhalation anesthetic. He shipped his purchases on as Bortner directed.

Moore eventually became a kind of short-order cook for what CIA documents call "offensive CW, BW" weapons at "very low cost and in a few days' time ..." If there were an operational need, Bortner had only to call in the order, and Moore would whip up a batch of a "reputed depilatory" or hallucinogens like DMT or the incredibly potent BZ. On one occasion in 1963, Moore prepared a small dose of a very lethal carbamate poison - the same substance that OSS used two decades earlier to try to kill Adolf Hitler. Moore charged the Agency his regular consulting fee, $100, for this service.

"Did I ever consider what would have happened if this stuff were given to unwitting people?" Moore asks, reflecting on his CIA days. "No. Particularly no. Had I been given that information, I think I would have been prepared to accept that. If I had been knee-jerk about testing on unwitting subjects, I wouldn't have been the type of person they would have used. There was nothing that I did that struck me as being so sinister and deadly.... It was all investigative."

James Moore was only one of many CIA specialists on the lookout for the magic mushroom. For three years after Morse Allen's man returned from Mexico with his tales of wonder, Moore and the others in the Agency's network pushed their lines of inquiry among contacts and travelers into Mexican villages so remote that Spanish had barely penetrated. Yet they found no magic mushrooms. Given their efforts, it was ironic that the man who beat them to "God's flesh" was neither a spy nor a scientist, but a banker. It was R. Gordon Wasson, vice-president of J. P. Morgan & Company, amateur mycologist, and co-author with his wife Valentina of Mushrooms, Russia and History. Nearly 30 years earlier, Wasson and his Russian-born wife had become fascinated by the different ways that societies deal with the mushroom, and they followed their lifelong obsession with these fungi, in all their glory, all over the globe.[1] They found whole nationalities, such as the Russians and the Catalans, were mycophiles, while others like the Spaniards and the Anglo-Saxons were not.

They learned that in ancient Greece and Rome there was a belief that certain kinds of mushrooms were brought into being by lightning bolts. They discovered that widely scattered peoples, including desert Arabs, Siberians, Chinese, and Maoris of New Zealand, have shared the idea that mushrooms have supernatural connections. Their book appeared in limited edition, selling new in 1957 for $125. It contains facts and legends, lovingly told, as well as beautiful photographs of nearly every known species of mushroom.

Inevitably, the Wassons heard tell of "God's flesh," and in 1953 they started spending their vacations pursuing it. They took their first unsuccessful trek to Mexico about the time James Moore got connected to the CIA and Morse Allen met with the Pennsylvania mushroom executives. They had no luck until their third expedition, when Gordon Wasson and his traveling companion, Allan Richardson, found their holy grail high in the mountains above Oaxaca. On June 29, 1955, they entered the town hall in a village called Huautla de Jiménez. There, they found a young Indian about 35, sitting by a large table in an upstairs room. Unlike most people in the village, he spoke Spanish. "He had a friendly manner," Wasson later wrote, "and I took a chance. Leaning over the table, I asked him earnestly and in a low voice if I could speak to him in confidence. Instantly curious, he encouraged me. 'Will you,' I went on, 'help me learn the secrets of the divine mushroom?' and I used the Indian name *nti sheeto*, correctly pronouncing it with glottal stop and tonal differentiation of the syllables. When [he] recovered from his surprise he said warmly that nothing could be easier."

Shortly thereafter, the Indian led Wasson and Richardson down into a deep ravine where mushrooms were growing in abundance. The white men snapped picture after picture of the fungi and picked a cardboard boxfull. Then, in the heavy humid heat of the afternoon, the Indian led them up the mountain to a woman who performed the ancient mushroom rite. Her name was María Sabina. She was not only a curandera, or shaman, of "the highest quality," wrote Wasson, but a "señora sin mancha, a woman without stain." Wasson described her as middle-aged and short, "with a spirituality in her expression that struck us at once. She had a presence. We showed our mushrooms to the woman and her daughter. They cried out in rapture over the firmness, the fresh beauty and abundance of our young specimens. Through the interpreter we asked if they would serve us that night. They said yes."

That night, Wasson, Richardson, and about 20 Indians gathered in one of the village's adobe houses. The natives wore their best clothes and were friendly to the white strangers. The host provided chocolate drinks, which evoked for Wasson accounts of similar beverages being served early Spanish writers. María Sabina sat on a mat before a simple altar table that was adorned with the images of the Child Jesus and the Baptism in Jordan. After cleaning the mushrooms, she handed them out to all the adults present, keeping 26 for herself and giving Wasson and Richardson 12 each.

María Sabina put out the last candle about midnight, and she chanted haunting, tightly measured melodies. The Indian celebrants responded with deep feeling. Both Wasson and Richardson began to experience intense hallucinations that did not diminish until about 4:00 A.M. "We were never more wide awake, and the visions came whether our eyes were open or closed," Wasson wrote:

> They emerged from the center of the field of our vision, opening up as they came, now rushing, now slowly at the pace that our will chose. They were vivid in color, always harmonious. They began with art motifs, such as might decorate carpets or textiles or wallpaper or the drawing board of an architect. Then they evolved into palaces with courts, arcades, gardens - resplendent palaces with semiprecious stones.... Could the miraculous mobility that I was now enjoying be the explanation for the flying witches that played some important part in the folklore and fairy tales of northern Europe? These reflections passed through my mind at the very time that I was seeing the vision, for the effect of the mushrooms is to bring about a fission of the spirit, a split in the person, a kind of schizophrenia, with the rational side continuing to reason and to observe the sensations that the other side is enjoying. The mind is attached by an elastic cord to the vagrant senses.

Thus Gordon Wasson described the first known mushroom trip by "outsiders" in recorded history. The CIA's men missed the event, but they quickly learned of it, even though Wasson's visit was a private noninstitutional one to a place where material civilization had not reached. Such swiftness was assured by the breadth of the Agency's informant network, which included formal liaison arrangements with agencies like the Agriculture Department and the FDA and informal contacts all over the world. A botanist in Mexico City sent the report that reached both CIA headquarters and then James Moore. In the best bureaucratic form, the CIA description of Wasson's visions stated sparsely that the New York banker thought he saw "a multitude of architectural forms." Still, "God's flesh" had been located, and the MKULTRA leaders snatched up information that Wasson planned to return the following summer and bring back some mushrooms.

During the intervening winter, James Moore wrote Wasson - "out of the blue," as Wasson recalls - and expressed a desire to look into the chemical properties of Mexican fungi. Moore eventually suggested that he would like to accompany Wasson's party, and, to sweeten the proposition, he mentioned that he knew a foundation that might be willing to help underwrite the expedition. Sure enough, the CIA's conduit, the Geschickter Fund, made a $2,000 grant. Inside the MKULTRA program, the quest for the divine mushroom became Subproject 58.

Joining Moore and Wasson on the 1956 trip were the world-renowned French mycologist Roger Heim and a colleague from the Sorbonne. The party made the final leg of the trip, one at a time, in a tiny Cessna, but when it was Moore's turn, the load proved too much for the plane. The pilot suddenly took a dramatic right angle turn through a narrow canyon and made an unscheduled stop on the side of a hill. Immediately on landing, an Indian girl ran out and slid blocks under the wheels, so the plane would not roll back into a ravine. The pilot decided to lighten the load by leaving Moore among the local Indians, who spoke neither English nor Spanish. Later in the day, the plane returned and picked up the shaken Moore.

Finally in Huautla, sleeping on a dirt floor and eating local food, everyone reveled in the primitiveness of the adventure except Moore, who suffered. In addition to diarrhea, he recalls, "I had a terribly bad cold, we damned near starved to death, and I itched all over." Beyond his physical woes, Moore became more and more alienated from the others, who got on famously. Moore was a "complainer," according to Wasson. "He had no empathy for what was going on," recalls Wasson. "He was like a landlubber at sea. He got sick to his stomach and hated it all." Moore states, "Our relationship deteriorated during the course of the trip."

Wasson returned to the same María Sabina who had led him to the high ground the year before. Again the ritual started well after dark and, for everyone but Moore, it was an enchanted evening. Sings Wasson: "I had the most superb feeling - a feeling of ecstasy. You're raised to a height where you have not been in everyday life - not ever." Moore, on the other hand, never left the lowlands. His description: "There was all this chanting in the dialect. Then they passed the mushrooms around, and we chewed them up. I did feel the hallucinogenic effect, although 'disoriented' would be a better word to describe my reaction."

Soon thereafter, Moore returned to Delaware with a bag of mushrooms - just in time to take his pregnant wife to the hospital for delivery. After dropping her off with the obstetrician, he continued down the hall to another doctor about his digestion. Already a thin man, Moore had lost 15 pounds. Over the next week, he slowly nursed himself back to health. He reported in to Bortner and started preliminary work in his lab to isolate the active ingredient in the mushrooms. Bortner urged him on; the men from MKULTRA were excited at the prospect that they might be able to create "a completely new chemical agent." They wanted their own private supply of "God's flesh." Sid Gottlieb wrote that if Moore succeeded, it was "quite possible" that the new drugs could "remain an Agency secret."

Gottlieb's dream of a CIA monopoly on the divine mushroom vanished quickly under the influence of unwanted competitors, and indeed, the Agency soon faced a control problem of burgeoning proportions. While Moore toiled in his lab, Roger Heim in Paris unexpectedly pulled off the remarkable feat of growing the mushrooms in artificial culture from spore prints he had made in Mexico. Heim then sent samples to none other than Albert Hofmann, the discoverer of LSD, who quickly isolated and chemically reproduced the active chemical ingredient. He named it psilocybin.

The dignified Swiss chemist had beaten out the CIA,[2] and the men from MKULTRA found themselves trying to obtain formulas and supplies from overseas. Instead of locking up the world's supply of the drug in a safe somewhere, they had to keep track of disbursements from Sandoz, as they were doing with LSD. Defeated by the old master, Moore laid his own work aside and sent away to Sandoz for a supply of psilocybin.

This lapse in control still did not quash the hopes of Agency officials that the mushroom might become a powerful weapon in covert operations. Agency scientists rushed it into the experimental stage. Within three summers of the first trip with James Moore, the CIA's queasy professor from America, the mushroom had journeyed through laboratories on two continents, and its chemical essence had worked its way back to Agency conduits and a contractor who would test it. In Kentucky, Dr. Harris Isbell ordered psilocybin injected into nine black inmates at the narcotics prison. His staff laid the subjects out on beds as the drug took hold and measured physical symptoms every hour: blood pressure, knee-jerk reflexes, rectal temperature, precise diameter of eye pupils, and so on. In addition, they recorded the inmates' various subjective feelings:

> After 30 minutes, anxiety became quite definite and was expressed as consisting of fear that something evil was going to happen, fear of insanity, or of death.... At times patients had the sensation that they could see the blood and bones in their own body or in that of another person. They reported many fantasies or dreamlike states in which they seemed to be elsewhere. Fantastic experiences, such as trips to the moon or living in gorgeous castles were occasionally reported.... Two of the 9 patients ... felt their experiences were caused by the experimenters controlling their minds...

Experimental data piled up, with operational testing to follow.

But the magic mushroom never became a good spy weapon. It made people behave strangely but no one could predict where their trips would take them. Agency officials craved certainty.

On the other hand, Gordon Wasson found revelation. After a lifetime of exploring and adoring mushrooms, he had discovered the greatest wonder of all in that remote Indian village. His experience inspired him to write an account of his journey for the "Great Adventures" series in Life magazine. The story, spread across 17 pages of text and color photographs, was called "Seeking the Magic Mushroom: A New York banker goes to Mexico's mountains to participate in the age-old rituals of Indians who chew strange growths that produce visions." In 1957, before the Russian sputnik shook America later that year, Life introduced its millions of readers to the mysteries of hallucinogens, with a tone of glowing but dignified respect. Wasson wrote movingly of his long search for mushroom lore, and he became positively rhapsodic in reflecting on his Mexican "trip":

> In man's evolutionary past, as he groped his way out from his lowly past, there must have come a moment in time when he discovered the secret of the hallucinatory mushrooms. Their effect on him, as I see it, could only have been profound, a detonator to new ideas. For the mushrooms revealed to him worlds beyond the horizons known to him, in space and time, even worlds on a different plane of being, a heaven and perhaps a hell. For the credulous, primitive mind, the mushrooms must have reinforced mightily the idea of the miraculous. Many emotions are shared by men with the animal kingdom, but awe and reverence and the fear of God are peculiar to men. When we bear in mind the beatific sense of awe and ecstasy and caritas engendered by the divine mushrooms, one is emboldened to the point of asking whether they may not have planted in primitive man the very idea of God.

The article caused a sensation in the United States, where people had already been awakened to ideas like these by Aldous Huxley's The Doors of Perception. It lured waves of respectable adults - precursors of later hippie travelers - to Mexico in search of their own curanderas. (Wasson came to have mixed feelings about the response to his story, after several tiny Mexican villages were all but trampled by American tourists on the prowl for divinity.) One person whose curiosity was stimulated by the article was a young psychology professor named Timothy Leary. In 1959, in Mexico on vacation, he ate his first mushrooms. He recalls he "had no idea it was going to change my life." Leary had just been promised tenure at Harvard, but his life of conventional prestige lost appeal for him within five hours of swallowing the mushroom: "The revelation had come. The veil had been pulled back.... The prophetic call. The works. God had spoken."

Having responded to a Life article about an expedition that was partially funded by the CIA, Leary returned to a Harvard campus where students and professors had for years served as subjects for CIA- and military-funded LSD experiments. His career as a drug prophet lay before him. Soon he would be quoting in his own Kamasutra from the CIA's contractor Harold Abramson and others, brought together for scholarly drug conferences by the sometime Agency conduit, the Macy Foundation.

With LSD, as with mushrooms, the men from MKULTRA remained oblivious, for the most part, to the rebellious effect of the drug culture in the United States. "I don't think we were paying any attention to it," recalls a TSS official. The CIA's scientists looked at drugs from a different perspective and went on trying to fashion their spy arsenal. Through the entire 1960s and into the 1970s, the Agency would scour Latin America for poisonous and narcotic plants.[3] Earlier, TSS officials and contractors actually kept spreading the magic touch of drugs by forever pressing new university researchers into the field. Boston Psychopathic's Max Rinkel stirred up the interest of Rochester's Harold Hodge and told him how to get a grant from the Agency conduit, the Geschickter Fund. Hodge's group found a way to put a radioactive marker into LSD, and the MKULTRA crew made sure that the specially treated substance found its way to still more scientists. When a contractor like Harold Abramson spoke highly of the drug at a new conference or seminar, tens or hundreds of scientists, health professionals, and subjects - usually students - would wind up trying LSD.

One day in 1954, Ralph Blum, a senior at Harvard on his way to a career as a successful author, heard from a friend that doctors at Boston Psychopathic would pay $25 to anyone willing to spend a day as a happy schizophrenic. Blum could not resist. He applied, passed the screening process, took a whole battery of Wechsler psychological tests, and was told to report back on a given morning. That day, he was shown into a room with five other Harvard students. Project director Bob Hyde joined them and struck Blum as a reassuring father figure. Someone brought in a tray with six little glasses full of water and LSD. The students drank up. For Blum, the drug did not take hold for about an hour and a half - somewhat longer than the average. While Hyde was in the process of interviewing him, Blum felt his mind shift gears. "I looked at the clock on the wall and thought how well behaved it was. It didn't pay attention to itself. It just stayed on the wall and told time." Blum felt that he was looking at everything around him from a new perspective. "It was a very subtle thing," he says. "My ego filter had been pretty much removed. I turned into a very accessible state - accessible to myself. I knew when someone was lying to me, and the richness of the experience was such that I didn't want to suffer fools gladly." Twenty-four years later, Blum concludes: "It was undeniably a very important experience for me. It made a difference in my life. It began to move the log jam of my old consciousness. You can't do it with just one blast. It was the beginning of realizing it was safe to love again. Although I wouldn't use them until much later, it gave me a new set of optics. It let me know there was something downstream."[4]

Many student subjects like Blum thought LSD transformed the quality of their lives. Others had no positive feelings, and some would later use the negative memories of their trips to invalidate the whole drug culture and stoned thinking process of the 1960s. In a university city like Boston where both the CIA and the Army were carrying on large testing programs at hospitals connected to Harvard, volunteering for an LSD trip became quite popular in academic circles. Similar reactions, although probably not as pronounced, occurred in other intellectual centers. The intelligence agencies turned to America's finest universities and hospitals to try LSD, which meant that the cream of the country's students and graduate assistants became the test subjects.

In 1969 the Bureau of Narcotics and Dangerous Drugs published a fascinating little study designed to curb illegal LSD use. The authors wrote that the drug's "early use was among small groups of intellectuals at large Eastern and West Coast universities. It spread to undergraduate students, then to other campuses. Most often, users have been introduced to the drug by persons of higher status. Teachers have influenced students; upperclassmen have influenced lower-classmen." Calling this a "trickle-down phenomenon," the authors seem to have correctly analyzed how LSD got around the country. They left out only one vital element, which they had no way of knowing: That somebody had to influence the teachers and that up there at the top of the LSD distribution system could be found the men of MKULTRA.

Harold Abramson apparently got a great kick out of getting his learned friends high on LSD. He first turned on Frank Fremont-Smith, head of the Macy Foundation which passed CIA money to Abramson. In this cozy little world where everyone knew everybody, Fremont-Smith organized the conferences that spread the word about LSD to the academic hinterlands. Abramson also gave Gregory Bateson, Margaret Mead's former husband, his first LSD. In 1959 Bateson, in turn, helped arrange for a beat poet friend of his named Allen Ginsberg to take the drug at a research program located of f the Stanford campus. No stranger to the hallucinogenic effects of peyote, Ginsberg reacted badly to what he describes as "the closed little doctor's room full of instruments," where he took the drug. Although he was allowed to listen to records of his choice (he chose a Gertrude Stein reading, a Tibetan mandala, and Wagner), Ginsberg felt he "was being connected to Big Brother's brain." He says that the experience resulted in "a slight paranoia that hung on all my acid experiences through the mid-1960s until I learned from meditation how to disperse that."

Anthropologist and philosopher Gregory Bateson then worked at the Veterans Administration Hospital in Palo Alto. From 1959 on, Dr. Leo Hollister was testing LSD at that same hospital. Hollister says he entered the hallucinogenic field reluctantly because of the "unscientific" work of the early LSD researchers. He refers specifically to most of the people who attended Macy conferences. Thus, hoping to improve on CIA and military-funded work, Hollister tried drugs out on student volunteers, including a certain Ken Kesey, in 1960. Kesey said he was a jock who had only been drunk once before, but on three successive Tuesdays, he tried different psychedelics. "Six weeks later I'd bought my first ounce of grass," Kesey later wrote, adding, "Six months later I had a job at that hospital as a psychiatric aide." Out of that experience, using drugs while he wrote, Kesey turned out One Flew Over the Cuckoo's Nest. He went on to become the counterculture's second most famous LSD visionary, spreading the creed throughout the land, as Tom Wolfe would chronicle in The Electric Kool-Aid Acid Test.

CIA officials never meant that the likes of Leary, Kesey, and Ginsberg should be turned on. Yet these men were, and they, along with many of the lesser-known experimental subjects, like Harvard's Ralph Blum, created the climate whereby LSD escaped the government's control and became available by the early sixties on the black market. No one at the Agency apparently foresaw that young Americans would voluntarily take the drug - whether for consciousness expansion or recreational purposes. The MKULTRA experts were mainly on a control trip, and they proved incapable of gaining insight from their own LSD experiences of how others less fixated on making people do their bidding would react to the drug.

It would be an exaggeration to put all the blame on - or give all the credit to - the CIA for the spread of LSD. One cannot forget the nature of the times, the Vietnam War, the breakdown in authority, and the wide availability of other drugs, especially marijuana. But the fact remains that LSD was one of the catalysts of the traumatic upheavals of the 1960s. No one could enter the world of psychedelics without first passing, unawares, through doors opened by the Agency. It would become a supreme irony that the CIA's enormous search for weapons among drugs - fueled by the hope that spies could, like Dr. Frankenstein, control life with genius and machines - would wind up helping to create the wandering, uncontrollable minds of the counterculture.

Notes 7

R. Gordon and Valentina Wasson's mammoth work, Mushrooms, Russia and History, (New York: Pantheon, 1957), was the source for the account of the Empress Agrippina's murderous use of mushrooms. Wasson told the story of his various journeys to Mexico in a series of interviews and in a May 27, 1957 Life magazine article, "Seeking the Magic Mushroom."

Morse Allen learned of piule in a sequence described in document #A/B,I,33/7, 14 November 1952, Subject: Piule. The sending of the young CIA scientist to Mexico was outlined in #A/B, I,33/3,5 December 1952. Morse Allen commented on mushroom history and covert possibilities in #A/B, I, 34/4, 26 June 1953, Subject: Mushrooms - Narcotic and Poisonous Varieties. His trip to the American mushroom-growing capital was described in Document Number illegible], 25 June 1953, Subject: Trip to Toughkenamon, Pennsylvania. The failure of TSS to tell Morse Allen about the results of the botanical lab work is outlined in #A/B, I, 39/5, 10 August 1954 Subject: Reports; Request for from TSS [deleted].

James Moore told much about himself in a long interview and in an exchange of correspondence. MKULTRA Subproject 51 dealt with Moore's consulting relationship with the Agency and Subproject 52 with his ties as a procurer of chemicals. See especially Document 51-46, 8 April 1963, Subject: MKULTRA Subproject 51; 51-24, 27 August 1956, Subject: MKULTRA Subproject 51-B; 52-94, 20 February 1963, Subject: (BB) Chemical and Physical Manipulants; 52-19, 20 December 1962; 52-17, 1 March 1963; 52-23, 6 December 1962; 52-64, 24 August 1959.

The CIA's arrangements with the Department of Agriculture are detailed in #A/B, I, 34/4, 26 June, 1953, Subject: Mushrooms - Narcotic and Poisonous varieties and Document [number illegible], 13 April 1953, Subject: Interview with Cleared Contacts.

Dr. Harris Isbell's work with psilocybin is detailed in Isbell document # 155, "Comparison of the Reaction Induced by Psilocybin and LSD-25 in Man."

Information on the counterculture and its interface with CIA drug-testing came from interviews with Timothy Leary, Allen Ginsburg, Humphrey Osmond, John Lilly, Sidney Cohen, Ralph Blum, Herbert Kelman, Leo Hollister, Herbert DeShon, and numerous others. Ken Kesey described his first trip in Garage Sale (New York: Viking Press, 1973). Timothy Leary's Kamasutra was actually a book hand-produced in four copies and called Psychedelic Theory: Working Papers from the Harvard IFlF Psychedelic Research Project, 1960-1963. Susan Berns Wolf Rothchild kindly made her copy available. The material about Harold Abramson's turning on Frank Fremont-Smith and Gregory Bateson came from the proceedings of a conference on LSD sponsored by the Josiah Macy, Jr. Foundation on April 22, 23, and 24, 1959, pp. 8-22.

Footnotes 7

1. On their honeymoon, in the summer of 1927, the Wassons were strolling along a mountain path when suddenly Valentina abandoned Gordon's side. "She had spied wild mushrooms in the forest," wrote Wasson, "and racing over the carpet of dried leaves in the woods, she knelt in poses of adoration before one cluster and then another of these growths. In ecstasy she called each kind by an endearing Russian name. Like all good Anglo-Saxons, I knew nothing about the fungal world and felt the less I knew about these putrid, treacherous excrescences the better. For her they were things of grace infinitely inviting to the perceptive mind." In spite of his protests, Valentina gathered up the mushrooms and brought them back to the lodge were she cooked them for dinner. She ate them all - alone. Wasson wanted no part of the fungi. While she mocked his horror, he predicted in the face of her laughter he would wake up a widower the next morning. When Valentina survived, the couple decided to find an explanation for "the strange cultural cleavage" that had caused them to react so differently to mushrooms. From then on, they were hooked, and the world became the richer.
2. Within two years, Albert Hofmann would scoop the CIA once again, with some help from Gordon Wasson. In 1960 Hofmann broke down and chemically recreated the active ingredient in hallucinatory ololiuqui seeds sent him by Wasson before the Agency's contractor, William Boyd Cook of Montana State University, could do the job. Hofmann's and Wasson's professional relationship soon grew into friendship, and in 1962 they traveled together on horseback to Huautla de Jiménez to visit María Sabina. Hofmann presented the curandera with some genuine Sandoz psilocybin. Wasson recalls: "Of course, Albert Hofmann is so conservative he always gives too little a dose, and it didn't have any effect." The crestfallen Hofmann believed he had duplicated "God's flesh," and he doubled the dose. Then María Sabina had her customary visions, and she reported, according to Wasson, the drug was the "same" as the mushroom. States Wasson, whose prejudice for real mushrooms over chemicals is unmistakable, "I don't think she said it with very much enthusiasm."
3. See Chapter 12.
4. Lincoln Clark, a psychiatrist who tested LSD for the Army at Massachusetts General Hospital, reflects a fairly common view among LSD researchers when he belittles drug-induced thinking of the sort described by Blum. "Everybody who takes LSD has an incredible experience that you can look at as having positive characteristics. I view it as pseudo-insight. This is part of the usual response of intellectually pretentious people." On the other hand, psychiatrist Sidney Cohen, who has written an important book on LSD, noted that to experience a visionary trip, "the devotee must have faith in, or at least be open to the possibility of the 'other state.' ... He must 'let go,' not offer too much resistance to losing his personal identity. The ability to surrender oneself is probably the most important operation of all."

Part III - Spells - electrodes and hypnosis

8. Brainwashing

In September 1950, the Miami News published an article by Edward Hunter titled " 'Brain-Washing' Tactics Force Chinese into Ranks of Communist Party." It was the first printed use in any language of the term "brainwashing," which quickly became a stock phrase in Cold War headlines. Hunter, a CIA propaganda operator who worked under cover as a journalist, turned out a steady stream of books and articles on the subject. He made up his coined word from the Chinese hsi-nao - "to cleanse the mind" - which had no political meaning in Chinese.

American public opinion reacted strongly to Hunter's ideas, no doubt because of the hostility that prevailed toward communist foes, whose ways were perceived as mysterious and alien. Most Americans knew something about the famous trial of the Hungarian Josef Cardinal Mindszenty, at which the Cardinal appeared zombie-like, as though drugged or hypnotized. Other defendants at Soviet "show trials" had displayed similar symptoms as they recited unbelievable confessions in dull, cliché- ridden monotones. Americans were familiar with the idea that the communists had ways to control hapless people, and Hunter's new word helped pull together the unsettling evidence into one sharp fear. The brainwashing controversy intensified during the heavy 1952 fighting in Korea, when the Chinese government launched a propaganda offensive that featured recorded statements by captured U.S. pilots, who "confessed" to a variety of war crimes including the use of germ warfare.

The official American position on prisoner confessions was that they were false and forced. As expressed in an Air Force Headquarters document, "Confessions can be of truthful details.... For purposes of this section, 'confessions' are considered as being the forced admission to a lie." But if the military had understandable reasons to gloss over the truth or falsity of the confessions, this still did not address the fact that confessions had been made at all. Nor did it lay to rest the fears of those like Edward Hunter who saw the confessions as proof that the communists now had techniques "to put a man's mind into a fog so that he will mistake what is true for what is untrue, what is right for what is wrong, and come to believe what did not happen actually had happened, until he ultimately becomes a robot for the Communist manipulator."

By the end of the Korean War, 70 percent of the 7,190 U.S. prisoners held in China had either made confessions or signed petitions calling for an end to the American war effort in Asia. Fifteen percent collaborated fully with the Chinese, and only 5 percent steadfastly resisted. The American performance contrasted poorly with that of the British, Australian, Turkish, and other United Nations prisoners - among whom collaboration was rare, even though studies showed they were treated about as badly as the Americans. Worse, an alarming number of the prisoners stuck by their confessions after returning to the United States. They did not, as expected, recant as soon as they stepped on U.S. soil. Puzzled and dismayed by this wholesale collapse of morale among the POWs, American opinion leaders settled in on Edward Hunter's explanation: The Chinese had somehow brainwashed our boys.

But how? At the height of the brainwashing furor, conservative spokesmen often seized upon the very mystery of it all to give a religious cast to the political debate. All communists have been, by definition, brainwashed through satanic forces, they argued - thereby making the enemy seem like robots completely devoid of ordinary human feelings and motivation. Liberals favored a more scientific view of the problem. Given the incontrovertible evidence that the Russians and the Chinese could, in a very short time and often under difficult circumstances, alter the basic belief and behavior patterns of both domestic and foreign captives, liberals argued that there must be a technique involved that would yield its secrets under objective investigation.

CIA Director Allen Dulles favored the scientific approach, although he naturally encouraged his propaganda experts to exploit the more emotional interpretations of brainwashing. Dulles and the heads of the other American security agencies became almost frantic in their efforts to find out more about the Soviet and Chinese successes in mind control. Under pressure for answers, Dulles turned to Dr. Harold Wolff, a world-famous neurologist with whom he had developed an intensely personal relationship. Wolff was then treating Dulles' own son for brain damage suffered from a Korean War head wound. Together they shared the trauma of the younger Dulles' fits and mental lapses. Wolff, a skinny little doctor with an overpowering personality, became fast friends with the tall, patrician CIA Director. Dulles may have seen brainwashing as an induced form of brain damage or mental illness. In any case, in late 1953, he asked Wolff to conduct an official study of communist brainwashing techniques for the CIA. Wolff, who had become fascinated by the Director's tales of the clandestine world, eagerly accepted.

Harold Wolff was known primarily as an expert on migraine headaches and pain, but he had served on enough military and intelligence advisory panels that he knew how to pick up Dulles' mandate and expand on it. He formed a working partnership with Lawrence Hinkle, his colleague at Cornell University Medical College in New York City. Hinkle handled the administrative part of the study and shared in the substance. Before going ahead, the two doctors made sure they had the approval of Cornell's president, Deane W. Malott and other high university officials who checked with their contacts in Washington to make sure the project did indeed have the great importance that Allen Dulles stated. Hinkle recalls a key White House aide urging Cornell to cooperate. The university administration agreed, and soon Wolff and Hinkle were poring over the Agency's classified files on brainwashing. CIA officials also helped arrange interviews with former communist interrogators and prisoners alike. "It was done with great secrecy," recalls Hinkle. "We went through a great deal of hoop-de-do and signed secrecy agreements, which everyone took very seriously."

The team of Wolff and Hinkle became the chief brainwashing studiers for the U.S. government, although the Air Force and Army ran parallel programs.[1] Their secret report to Allen Dulles, later published in a declassified version, was considered the definitive U.S. Government work on the subject. In fact, if allowances are made for the Cold War rhetoric of the fifties, the Wolff-Hinkle report still remains one of the better accounts of the massive political re-education programs in China and the Soviet Union. It stated flatly that neither the Soviets nor the Chinese had any magical weapons - no drugs, exotic mental ray-guns, or other fanciful machines. Instead, the report pictured communist interrogation methods resting on skillful, if brutal, application of police methods. Its portrait of the Soviet system anticipates, in dry and scholarly form, the work of novelist Alexander Solzhenitzyn in The Gulag Archipelago. Hinkle and Wolff showed that the Soviet technique rested on the cumulative weight of intense psychological pressure and human weakness, and this thesis alone earned the two Cornell doctors the enmity of the more right-wing CIA officials such as Edward Hunter. Several of his former acquaintances remember that Hunter was fond of saying that the Soviets brainwashed people the way Pavlov had conditioned dogs.

In spite of some dissenters like Hunter, the Wolff-Hinkle model became, with later refinements, the best available description of extreme forms of political indoctrination. According to the general consensus, the Soviets started a new prisoner off by putting him in solitary confinement. A rotating corps of guards watched him constantly, humiliating and demeaning him at every opportunity and making it clear he was totally cut off from all outside support. The guards ordered him to stand for long periods, let him sit, told him exactly the position he could take to lie down, and woke him if he moved in the slightest while sleeping. They banned all outside stimuli - books, conversation, or news of the world.

After four to six weeks of this mind-deadening routine, the prisoner usually found the stress unbearable and broke down. "He weeps, he mutters, and prays aloud in his cell," wrote Hinkle and Wolff. When the prisoner reached this stage, the interrogation began. Night after night, the guards brought him into a special room to face the interrogator. Far from confronting his captive with specific misdeeds, the interrogator told him that he knew his own crimes - all too well. In the most harrowing Kafkaesque way, the prisoner tried to prove his innocence to he knew not what. Together the interrogator and prisoner reviewed the prisoner's life in detail. The interrogator seized on any inconsistency - no matter how minute - as further evidence of guilt, and he laughed at the prisoner's efforts to justify himself. But at least the prisoner was getting a response of some sort. The long weeks of isolation and uncertainty had made him grateful for human contact even grateful that his case was moving toward resolution. True, it moved only as fast as he was willing to incriminate himself, but ... Gradually, he came to see that he and his interrogator were working toward the same goal of wrapping up his case. In tandem, they ransacked his soul. The interrogator would periodically let up the pressure. He offered a cigarette, had a friendly chat, explained he had a job to do - making it all the more disappointing the next time he had to tell the prisoner that his confession was unsatisfactory.

As the charges against him began to take shape, the prisoner realized that he could end his ordeal only with a full confession. Otherwise the grueling sessions would go on forever. "The regimen of pressure has created an overall discomfort which is well nigh intolerable," wrote Hinkle and Wolff. "The prisoner invariably feels that 'something must be done to end this.' He must find a way out." A former KGB officer, one of many former interrogators and prisoners interviewed for the CIA study, said that more than 99 percent of all prisoners signed a confession at this stage.

In the Soviet system under Stalin, these confessions were the final step of the interrogation process, and the prisoners usually were shot or sent to a labor camp after sentencing. Today, Russian leaders seem much less insistent on exacting confessions before jailing their foes, but they still use the penal (and mental health) system to remove from the population classes of people hostile to their rule.

The Chinese took on the more ambitious task of re-educating their prisoners. For them, confession was only the beginning. Next, the Chinese authorities moved the prisoner into a group cell where his indoctrination began. From morning to night, he and his fellow prisoners studied Marx and Mao, listened to lectures, and engaged in self-criticism. Since the progress of each member depended on that of his cellmates, the group pounced on the slightest misconduct as an indication of backsliding. Prisoners demonstrated the zeal of their commitment by ferociously attacking deviations. Constant intimacy with people who reviled him pushed the resistant prisoner to the limits of his emotional endurance. Hinkle and Wolff found that "The prisoner must conform to the demands of the group sooner or later." As the prisoner developed genuine changes of attitude, pressure on him relaxed. His cellmates rewarded him with increasing acceptance and esteem. Their acceptance, in turn, reinforced his commitment to the Party, for he learned that only this commitment allowed him to live successfully in the cell. In many cases, this process produced an exultant sense of mission in the prisoner - a feeling of having finally straightened out his life and come to the truth. To be sure, this experience, which was not so different from religious conversion, did not occur in all cases or always last after the prisoner returned to a social group that did not reinforce it.

From the first preliminary studies of Wolff and Hinkle, the U.S. intelligence community moved toward the conclusion that neither the Chinese nor the Russians made appreciable use of drugs or hypnosis, and they certainly did not possess the brainwashing equivalent of the atomic bomb (as many feared). Most of their techniques were rooted in age-old methods, and CIA brainwashing researchers like psychologist John Gittinger found themselves poring over ancient documents on the Spanish Inquisition. Furthermore, the communists used no psychiatrists or other behavioral scientists to devise their interrogation system. The differences between the Soviet and Chinese systems seemed to grow out of their respective national cultures. The Soviet brainwashing system resembled a heavy-handed cop whose job was to isolate, break, and then subdue all the troublemakers in the neighborhood. The Chinese system was more like thousands of skilled acupuncturists, working on each other and relying on group pressure, ideology, and repetition. To understand further the Soviet or Chinese control systems, one had to plunge into the subtle mysteries of national and individual character.

While CIA researchers looked into those questions, the main thrust of the Agency's brainwashing studies veered off in a different direction. The logic behind the switch was familiar in the intelligence business. Just because the Soviets and the Chinese had not invented a brainwashing machine, officials reasoned, there was no reason to assume that the task was impossible. If such a machine were even remotely feasible, one had to assume the communists might discover it. And in that case, national security required that the United States invent the machine first. Therefore, the CIA built up its own elaborate brainwashing program, which, like the Soviet and Chinese versions, took its own special twist from our national character. It was a tiny replica of the Manhattan Project, grounded in the conviction that the keys to brainwashing lay in technology. Agency officials hoped to use old-fashioned American know-how to produce shortcuts and scientific breakthroughs. Instead of turning to tough cops, whose methods repelled American sensibilities, or the gurus of mass motivation, whose ideology Americans lacked, the Agency's brainwashing experts gravitated to people more in the mold of the brilliant - and sometimes mad - scientist, obsessed by the wonders of the brain.

In 1953 CIA Director Allen Dulles made a rare public statement on communist brainwashing: "We in the West are somewhat handicapped in getting all the details," Dulles declared. "There are few survivors, and we have no human guinea pigs to try these extraordinary techniques." Even as Dulles spoke, however, CIA officials acting under his orders had begun to find the scientists and the guinea pigs. Some of their experiments would wander so far across the ethical borders of experimental psychiatry (which are hazy in their own right) that Agency officials thought it prudent to have much of the work done outside the United States.

Call her Lauren G. For 19 years, her mind has been blank about her experience. She remembers her husband's driving her up to the old gray stone mansion that housed the hospital, Allan Memorial Institute, and putting her in the care of its director, Dr. D. Ewen Cameron. The next thing she recalls happened three weeks later:

> They gave me a dressing gown. It was way too big, and I was tripping all over it. I was mad. I asked why did I have to go round in this sloppy thing. I could hardly move because I was pretty weak. I remember trying to walk along the hall, and the walls were all slanted. It was then that I said, "Holy Smokes, what a ghastly thing." I remember running out the door and going up the mountain in my long dressing gown.

The mountain, named Mont Royal, loomed high above Montreal. She stumbled and staggered as she tried to climb higher and higher. Hospital staff members had no trouble catching her and dragging her back to the Institute. In short order, they shot her full of sedatives, attached electrodes to her temples, and gave her a dose of electroshock. Soon she slept like a baby.

Gradually, over the next few weeks, Lauren G. began to function like a normal person again. She took basket-weaving therapy and played bridge with her fellow patients. The hospital released her, and she returned to her husband in another Canadian city.

Before her mental collapse in 1959, Lauren G. seemed to have everything going for her. A refined, glamorous horsewoman of 30, whom people often said looked like Elizabeth Taylor, she had auditioned for the lead in National Velvet at 13 and married the rich boy next door at 20. But she had never loved her husband and had let her domineering mother push her into his arms. He drank heavily. "I was really unhappy," she recalls. "I had a horrible marriage, and finally I had a nervous breakdown. It was a combination of my trying to lose weight, sleep loss, and my nerves."

The family doctor recommended that her husband send her to Dr. Cameron, which seemed like a logical thing to do, considering his wide fame as a psychiatrist. He had headed Allan Memorial since 1943, when the Rockefeller Foundation had donated funds to set up a psychiatric facility at McGill University. With continuing help from the Rockefellers, McGill had built a hospital known far beyond Canada's borders as innovative and exciting. Cameron was elected president of the American Psychiatric Association in 1953, and he became the first president of the World Psychiatric Association. His friends joked that they had run out of honors to give him.

Cameron's passion lay in the more "objective" forms of therapy, with which he could more easily and swiftly bring about improvements in patients than with the notoriously slow Freudian methods. An impatient man, he dreamed of finding a cure for schizophrenia. No one could tell him he was not on the right track. Cameron's supporter at the Rockefeller Foundation, Robert Morrison, recorded in his private papers that he found the psychiatrist tense and ill-at-ease, and Morrison ventured that this may account for "his lack of interest and effectiveness in psychotherapy and failure to establish warm personal relations with faculty members, both of which were mentioned repeatedly when I visited Montreal." Another Rockefeller observer noted that Cameron "appears to suffer from deep insecurity and has a need for power which he nourishes by maintaining an extraordinary aloofness from his associates."

When Lauren G.'s husband delivered her to Cameron, the psychiatrist told him she would receive some electroshock, a standard treatment at the time. Besides that, states her husband, "Cameron was not very communicative, but I didn't think she was getting anything out of the ordinary." The husband had no way of knowing that Cameron would use an unproved experimental technique on his wife - much less that the psychiatrist intended to "depattern" her. Nor did he realize that the CIA was supporting this work with about $19,000 a year in secret funds.[2]

Cameron defined "depatterning" as breaking up existing patterns of behavior, both the normal and the schizophrenic, by means of particularly intensive electroshocks, usually combined with prolonged, drug-induced sleep. Here was a psychiatrist willing - indeed, eager - to wipe the human mind totally clean. Back in 1951, ARTICHOKE's Morse Allen had likened the process to "creation of a vegetable." Cameron justified this tabula rasa approach because he had a theory of "differential amnesia," for which he provided no statistical evidence when he published it. He postulated that after he produced "complete amnesia" in a subject, the person would eventually recover memory of his normal but not his schizophrenic behavior. Thus, Cameron claimed he could generate "differential amnesia." Creating such a state in which a man who knew too much could be made to forget had long been a prime objective of the ARTICHOKE and MKULTRA programs.

Needless to say, Lauren G. does not recall a thing today about those weeks when Cameron depatterned her. Afterward, unlike over half of the psychiatrist's depatterning patients, Lauren G. gradually recovered full recall of her life before the treatment, but then, she remembered her mental problems, too.[3] Her husband says she came out of the hospital much improved. She declares the treatment had no effect one way or another on her mental condition, which she believes resulted directly from her miserable marriage. She stopped seeing Cameron after about a month of outpatient electroshock treatments, which she despised. Her relationship with her husband further deteriorated, and two years later she walked out on him. "I just got up on my own hind legs," she states. "I said the hell with it. I'm going to do what I want and take charge of my own life. I left and started over." Now divorced and remarried, she feels she has been happy ever since.

Cameron's depatterning, of which Lauren G. had a comparatively mild version, normally started with 15 to 30 days of "sleep therapy." As the name implies, the patient slept almost the whole day and night. According to a doctor at the hospital who used to administer what he calls the "sleep cocktail," a staff member woke up the patient three times a day for medication that consisted of a combination of 100 mg. Thorazine, 100 mg. Nembutal, 100 mg. Seconal, 150 mg. Veronal, and 10 mg. Phenergan. Another staff doctor would also awaken the patient two or sometimes three times daily for electroshock treatments.[4] This doctor and his assistant wheeled a portable machine into the "sleep room" and gave the subject a local anesthetic and muscle relaxant, so as not to cause damage with the convulsions that were to come. After attaching electrodes soaked in saline solution, the attendant held the patient down and the doctor turned on the current. In standard, professional electroshock, doctors gave the subject a single dose of 110 volts, lasting a fraction of a second, once a day or every other day. By contrast, Cameron used a form 20 to 40 times more intense, two or three times daily, with the power turned up to 150 volts. Named the "Page-Russell" method after its British originators, this technique featured an initial one-second shock, which caused a major convulsion, and then five to nine additional shocks in the middle of the primary and follow-on convulsions. Even Drs. Page and Russell limited their treatment to once a day, and they always stopped as soon as their patient showed "pronounced confusion" and became "faulty in habits." Cameron, however, welcomed this kind of impairment as a sign the treatment was taking effect and plowed ahead through his routine.

The frequent screams of patients that echoed through the hospital did not deter Cameron or most of his associates in their attempts to "depattern" their subjects completely. Other hospital patients report being Petrified by the "sleep rooms," where the treatment took place, and they would usually creep down the opposite side of the hall.

Cameron described this combined sleep-electroshock treatment as lasting between 15 to 30 days, with some subjects staying in up to 65 days (in which case, he reported, he awakened them for three days in the middle). Sometimes, as in the case of Lauren G., patients would try to escape when the sedatives wore thin, and the staff would have to chase after them. "It was a tremendous nursing job just to keep these people going during the treatment," recalls a doctor intimately familiar with Cameron's operation. This doctor paints a picture of dazed patients, incapable of taking care of themselves, often groping their way around the hospital and urinating on the floor.

Cameron wrote that his typical depatterning patient - usually a woman - moved through three distinct stages. In the first, the subject lost much of her memory. Yet she still knew where she was, why she was there, and who the people were who treated her. In the second phase, she lost her "space-time image," but still wanted to remember. In fact, not being able to answer questions like, "Where am I?" and "How did I get here?" caused her considerable anxiety. In the third stage, all that anxiety disappeared. Cameron described the state as "an extremely interesting constriction of the range of recollections which one ordinarily brings in to modify and enrich one's statements. Hence, what the patient talks about are only his sensations of the moment, and he talks about them almost exclusively in highly concrete terms. His remarks are entirely uninfluenced by previous recollections - nor are they governed in any way by his forward anticipations. He lives in the immediate present. All schizophrenic symptoms have disappeared. There is complete amnesia for all events in his life."

Lauren G. and 52 other subjects at Allan Memorial received this level of depatterning in 1958 and 1959. Cameron had already developed the technique when the CIA funding started. The Agency sent the psychiatrist research money to take the treatment beyond this point. Agency officials wanted to know if, once Cameron had produced the blank mind, he could then program in new patterns of behavior, as he claimed he could. As early as 1953 - the year he headed the American Psychiatric Association - Cameron conceived a technique he called "psychic driving," by which he would bombard the subject with repeated verbal messages. From tape recordings based on interviews with the patient, he selected emotionally loaded "cue statements" - first negative ones to get rid of unwanted behavior and then positive to condition in desired personality traits. On the negative side, for example, the patient would hear this message as she lay in a stupor:

> Madeleine, you let your mother and father treat you as a child all through your single life. You let your mother check you up sexually after every date you had with a boy. You hadn't enough determination to tell her to stop it. You never stood up for yourself against your mother or father but would run away from trouble.... They used to call you "crying Madeleine." Now that you have two children, you don't seem to be able to manage them and keep a good relationship with your husband. You are drifting apart. You don't go out together. You have not been able to keep him interested sexually.

Leonard Rubenstein, Cameron's principal assistant, whose entire salary was paid from CIA-front funds, put the message on a continuous tape loop and played it for 16 hours every day for several weeks. An electronics technician, with no medical or psychological background, Rubenstein, an electrical whiz, designed a giant tape recorder that could play 8 loops for 8 patients at the same time. Cameron had the speakers installed literally under the pillows in the "sleep rooms." "We made sure they heard it," says a doctor who worked with Cameron. With some patients, Cameron intensified the negative effect by running wires to their legs and shocking them at the end of the message.

When Cameron thought the negative "psychic driving" had gone far enough, he switched the patient over to 2 to 5 weeks of positive tapes:

> You mean to get well. To do this you must let your feelings come out. It is all right to express your anger.... You want to stop your mother bossing you around. Begin to assert yourself first in little things and soon you will be able to meet her on an equal basis. You will then be free to be a wife and mother just like other women.

Cameron wrote that psychic driving provided a way to make "direct, controlled changes in personality," without having to resolve the subject's conflicts or make her relive past experiences. As far as is known, no present-day psychologist or psychiatrist accepts this view. Dr. Donald Hebb, who headed McGill's psychology department at the time Cameron was in charge of psychiatry, minces no words when asked specifically about psychic driving: "That was an awful set of ideas Cameron was working with. It called for no intellectual respect. If you actually look at what he was doing and what he wrote, it would make you laugh. If I had a graduate student who talked like that, I'd throw him out." Warming to his subject, Hebb continues: "Look, Cameron was no good as a researcher.... He was eminent because of politics." Nobody said such things at the time, however. Cameron was a very powerful man.

The Scottish-born psychiatrist, who never lost the burr in his voice, kept searching for ways to perfect depatterning and psychic driving. He held out to the CIA front - the Society for the Investigation of Human Ecology - that he could find more rapid and less damaging ways to break down behavior. He sent the Society a proposal that combined his two techniques with sensory deprivation and strong drugs. His smorgasbord approach brought together virtually all possible techniques of mind control, which he tested individually and together. When his Agency grant came through in 1957, Cameron began work on sensory deprivation.

For several years, Agency officials had been interested in the interrogation possibilities of this technique that Hebb himself had pioneered at McGill with Canadian defense and Rockefeller money. It consisted of putting a subject in a sealed environment - a small room or even a large box - and depriving him of all sensory input: eyes covered with goggles, ears either covered with muffs or exposed to a constant, monotonous sound, padding to prevent touching, no smells - with this empty regime interrupted only by meal and bathroom breaks. In 1955 Morse Allen of ARTICHOKE made contact at the National Institutes of Health with Dr.

Maitland Baldwin who had done a rather gruesome experiment in which an Army volunteer had stayed in the "box" for 40 hours until he kicked his way out after, in Baldwin's words, "an hour of crying loudly and sobbing in a most heartrending fashion." The experiment convinced Baldwin that the isolation technique could break any man, no matter how intelligent or strong-willed. Hebb, who unlike Baldwin released his subjects when they wanted, had never left anyone in "the box" for more than six days. Baldwin told Morse Allen that beyond that sensory deprivation would almost certainly cause irreparable damage. Nevertheless, Baldwin agreed that if the Agency could provide the cover and the subjects, he would do, according to Allen's report, "terminal type" experiments. After numerous meetings inside the CIA on how and where to fund Baldwin, an Agency medical officer finally shot down the project as being "immoral and inhuman," suggesting that those pushing the experiments might want to "volunteer their heads for use in Dr. Baldwin's 'noble' project."

With Cameron, Agency officials not only had a doctor willing to perform terminal experiments in sensory deprivation, but one with his own source of subjects. As part of his CIA-funded research, he had a "box" built in the converted stables behind the hospital that housed Leonard Rubenstein and his behavioral laboratory. Undaunted by the limits set in Hebb's work, Cameron left one woman in for 35 days, although he had so scrambled her mind with his other techniques that one cannot say, as Baldwin predicted to the Agency, if the prolonged deprivation did specific damage. This subject's name was Mary C., and, try as he might, Cameron could not get through to her. As the aloof psychiatrist wrote in his notes: "Although the patient was prepared by both prolonged sensory isolation (35 days) and by repeated depatterning, and although she received 101 days of positive driving, no favorable results were obtained."[5] Before prescribing this treatment, Cameron had diagnosed the 52-year-old Mary C.: "Conversion reaction in a woman of the involutional age with mental anxiety; hypochondriatic." In other words, Mary C. was going through menopause.

In his proposal to the CIA front, Cameron also said he would test curare, the South American arrow poison which, when liberally applied, kills by paralyzing internal body functions. In nonlethal doses, curare causes a limited paralysis which blocks but does not stop these functions. According to his papers, some of which wound up in the archives of the American Psychiatric Association, Cameron injected subjects with curare in conjunction with sensory deprivation, presumably to immobilize them further.

Cameron also tested LSD in combination with psychic driving and other techniques. In late 1956 and early 1957, one of his subjects was Val Orlikow, whose husband David has become a member of the Canadian parliament. Suffering from what she calls a "character neurosis that started with postpartum depression," she entered Allan Memorial as one of Cameron's personal patients. He soon put her under his version of LSD therapy. One to four times a week, he or another doctor would come into her room and give her a shot of LSD, mixed with either a stimulant or a depressant and then leave her alone with a tape recorder that played excerpts from her last session with him. As far as is known, no other LSD researcher ever subjected his patients to unsupervised trips - certainly not over the course of two months when her hospital records show she was given LSD 14 times. "It was terrifying," Mrs. Orlikow recalls. "You're afraid you've gone off somewhere and can't come back." She was supposed to write down on a pad whatever came into her head while listening to the tapes, but often she became so frightened that she could not write at all. "You become very small," she says, as her voice quickens and starts to reflect some of her horror. "You're going to fall off the step, and God, you're going down into hell because it's so far, and you are so little. Like Alice, where is the pill that makes you big, and you're a squirrel, and you can't get out of the cage, and somebody's going to kill you." Then, suddenly, Mrs. Orlikow pulls out of it and lucidly states, "Some very weird things happened."

Mrs. Orlikow hated the LSD treatment. Several times she told Cameron she would take no more, and the psychiatrist would put his arm around her and ask, "Lassie," which he called all his women patients, "don't you want to get well, so you can go home and see your husband?" She remembers feeling guilty about not following the doctor's orders, and the thought of disappointing Cameron, whom she idolized, crushed her. Finally, after Cameron talked her out of quitting the treatment several times, she had to end it. She left the hospital but stayed under his private care. In 1963 he put her back in the hospital for more intensive psychic driving. "I thought he was God," she states. "I don't know how I could have been so stupid.... A lot of us were naive. We thought psychiatrists had the answers. Here was the greatest in the world, with all these titles."

In defense of Cameron, a former associate says the man truly cared about the welfare of his patients. He wanted to make them well. As his former staff psychologist wrote:

> He abhorred the waste of human potential, seen most dramatically in the young people whose minds were distorted by what was then considered to be schizophrenia. He felt equally strongly about the loss of wisdom in the aged through memory malfunction. For him, the end justified the means, and when one is dealing with the waste of human potential, it is easy to adopt this stance.

Cameron retired abruptly in 1964, for unexplained reasons. His successor, Dr. Robert Cleghorn, made a virtually unprecedented move in the academic world of mutual back-scratching and praise. He commissioned a psychiatrist and a psychologist, unconnected to Cameron, to study his electroshock work. They found that 60 percent of Cameron's depatterned patients complained they still had amnesia for the period 6 months to 10 years before the therapy.[6] They could find no clinical proof that showed the treatment to be any more or less effective than other approaches. They concluded that "the incidence of physical complications and the anxiety generated in the patient because of real or imagined memory difficulty argue against" future use of the technique.

The study-team members couched their report in densely academic jargon, but one of them speaks more clearly now. He talks bitterly of one of Cameron's former patients who needs to keep a list of her simplest household chores to remember how to do them. Then he repeats several times how powerful a man Cameron was, how he was "the godfather of Canadian psychiatry." He continues, "I probably shouldn't talk about this, but Cameron - for him to do what he did - he was a very schizophrenic guy, who totally detached himself from the human implications of his work ... God, we talk about concentration camps. I don't want to make this comparison, but God, you talk about 'we didn't know it was happening,' and it was - right in our back yard."

Cameron died in 1967, at age 66, while climbing a mountain. The American Journal of Psychiatry published a long and glowing obituary with a full-page picture of his not-unpleasant face.

D. Ewen Cameron did not need the CIA to corrupt him. He clearly had his mind set on doing unorthodox research long before the Agency front started to fund him. With his own hospital and source of subjects, he could have found elsewhere encouragement and money to replace the CIA's contribution which never exceeded $20,000 a year. However, Agency officials knew exactly what they were paying for. They traveled periodically to Montreal to observe his work, and his proposal was chillingly explicit. In Cameron, they had a doctor, conveniently outside the United States, willing to do terminal experiments in electroshock, sensory deprivation, drug testing, and all of the above combined. By literally wiping the minds of his subjects clean by depatterning and then trying to program in new behavior, Cameron carried the process known as "brainwashing" to its logical extreme.

It cannot be said how many - if any - other Agency brainwashing projects reached the extremes of Cameron's work. Details are scarce, since many of the principal witnesses have died, will not talk about what went on, or lie about it. In what ways the CIA applied work like Cameron's is not known. What is known, however, is that the intelligence community, including the CIA, changed the face of the scientific community during the 1950s and early 1960s by its interest in such experiments. Nearly every scientist on the frontiers of brain research found men from the secret agencies looking over his shoulders, impinging on the research. The experience of Dr. John Lilly illustrates how this intrusion came about.

In 1953 Lilly worked at the National Institutes of Health, outside Washington, doing experimental studies in an effort to "map" the body functions controlled from various locations in the brain. He devised a method of pounding up to 600 tiny sections of hypodermic tubing into the skulls of monkeys, through which he could insert electrodes "into the brain to any desired distance and at any desired location from the cortex down to the bottom of the skull," he later wrote. Using electric stimulation, Lilly discovered precise centers of the monkeys' brains that caused pain, fear, anxiety, and anger. He also discovered precise, separate parts of the brain that controlled erection, ejaculation, and orgasm in male monkeys. Lilly found that a monkey, given access to a switch operating a correctly planted electrode, would reward himself with nearly continuous orgasms - at least once every 3 minutes - for up to 16 hours a day.

As Lilly refined his brain "maps," officials of the CIA and other agencies descended upon him with a request for a briefing. Having a phobia against secrecy, Lilly agreed to the briefing only under the condition that it and his work remain unclassified, completely open to outsiders. The intelligence officials submitted to the conditions most reluctantly, since they knew that Lilly's openness would not only ruin the spy value of anything they learned but could also reveal the identities and the interests of the intelligence officials to enemy agents. They considered Lilly annoying, uncooperative - possibly even suspicious.

Soon Lilly began to have trouble going to meetings and conferences with his colleagues. As part of the cooperation with the intelligence agencies, most of them had agreed to have their projects officially classified as SECRET, which meant that access to the information required a security clearance.[7] Lilly's security clearance was withdrawn for review, then tangled up and misplaced - all of which he took as pressure to cooperate with the CIA. Lilly, whose imagination needed no stimulation to conjure up pictures of CIA agents on deadly missions with remote-controlled electrodes strategically implanted in their brains, decided to withdraw from that field of research. He says he had decided that the physical intrusion of the electrodes did too much brain damage for him to tolerate.

In 1954 Lilly began trying to isolate the operations of the brain, free of outside stimulation, through sensory deprivation. He worked in an office next to Dr. Maitland Baldwin, who the following year agreed to perform terminal sensory deprivation experiments for ARTICHOKE's Morse Allen but who never told Lilly he was working in the field. While Baldwin experimented with his sensory-deprivation "box," Lilly invented a special "tank." Subjects floated in a tank of body-temperature water wearing a face mask that provided air but cut off sight and sound. Inevitably, intelligence officials swooped down on Lilly again, interested in the use of his tank as an interrogation tool. Could involuntary subjects be placed in the tank and broken down to the point where their belief systems or personalities could be altered?

It was central to Lilly's ethic that he himself be the first subject of any experiment, and, in the case of the consciousness-exploring tank work, he and one colleague were the only ones. Lilly realized that the intelligence agencies were not interested in sensory deprivation because of its positive benefits, and he finally concluded that it was impossible for him to work at the National Institutes of Health without compromising his principles. He quit in 1958.

Contrary to most people's intuitive expectations, Lilly found sensory deprivation to be a profoundly integrating experience for himself personally. He considered himself to be a scientist who subjectively explored the far wanderings of the brain. In a series of private experiments, he pushed himself into the complete unknown by injecting pure Sandoz LSD into his thigh before climbing into the sensory-deprivation tank.[8] When the counterculture sprang up, Lilly became something of a cult figure, with his unique approach to scientific inquiry - though he was considered more of an outcast by many in the professional research community.

For most of the outside world, Lilly became famous with the release of the popular film, The Day of the Dolphin, which the filmmakers acknowledged was based on Lilly's work with dolphins after he left NIH. Actor George C. Scott portrayed a scientist, who, like Lilly, loved dolphins, did pioneering experiments on their intelligence, and tried to find ways to communicate with them. In the movie, Scott became dismayed when the government pounced on his breakthrough in talking to dolphins and turned it immediately to the service of war. In real life, Lilly was similarly dismayed when Navy and CIA scientists trained dolphins for special warfare in the waters off Vietnam.[9]

A few scientists like Lilly made up their minds not to cross certain ethical lines in their experimental work, while others were prepared to go further even than their sponsors from ARTICHOKE and MKULTRA. Within the Agency itself, there was only one final question: Will a technique work? CIA officials zealously tracked every lead, sparing no expense to check each angle many times over.

By the time the MKULTRA program ended in 1963, Agency researchers had found no foolproof way to brainwash another person.[10] "All experiments beyond a certain point always failed," says the MKULTRA veteran, "because the subject jerked himself back for some reason or the subject got amnesiac or catatonic." Agency officials found through work like Cameron's that they could create "vegetables," but such people served no operational use. People could be tortured into saying anything, but no science could guarantee that they would tell the truth.

The impotency of brainwashing techniques left the Agency in a difficult spot when Yuri Nosenko defected to the United States in February 1964. A ranking official of the Soviet KGB, Nosenko brought with him stunning information. He said the Russians had bugged the American embassy in Moscow, which turned out to be true.

He named some Russian agents in the West. And he said that he had personally inspected the KGB file of Lee Harvey Oswald, who only a few months earlier had been murdered before he could be brought to trial for the assassination of President Kennedy. Nosenko said he learned that the KGB had had no interest in Oswald.

Was Nosenko telling the truth, or was he a KGB "plant" sent to throw the United States off track about Oswald? Was his information about penetration correct, or was Nosenko himself the penetration? Was he acting in good faith? Were the men within the CIA who believed he was acting in good faith themselves acting in good faith? These and a thousand other questions made up the classical trick deck for spies - each card having "true" on one side and "false" on the other.

Top CIA officials felt a desperate need to resolve the issue of Nosenko's legitimacy. With numerous Agency counterintelligence operations hanging in the balance, Richard Helms, first as Deputy Director and then as Director, allowed CIA operators to work Nosenko over with the interrogation method in which Helms apparently had the most faith. It turned out to be not any truth serum or electroshock depatterning program or anything else from the Agency's brainwashing search. Helms had Nosenko put through the tried-and-true Soviet method: isolate the prisoner, deaden his senses, break him. For more than three years - 1,277 days, to be exact - Agency officers kept Nosenko in solitary confinement. As if they were using the Hinkle-Wolff study as their instruction manual and the Cardinal Mindszenty case as their success story, the CIA men had guards watch over Nosenko day and night, giving him not a moment of privacy. A light bulb burned continuously in his cell. He was allowed nothing to read - not even the labels on toothpaste boxes. When he tried to distract himself by making a chess set from pieces of lint in his cell, the guards discovered his game and swept the area clean. Nosenko had no window, and he was eventually put in a specially built 12' X 12' steel bank vault.

Nosenko broke down. He hallucinated. He talked his head off to his interrogators, who questioned him for 292 days, often while they had him strapped into a lie detector. If he told the truth, they did not believe him. While the Soviets and Chinese had shown that they could make a man admit anything, the CIA interrogators apparently lacked a clear idea of exactly what they wanted Nosenko to confess. When it was all over and Richard Helms ordered Nosenko freed after three and a half years of illegal detention, some key Agency officers still believed he was a KGB plant. Others thought he was on the level. Thus the big questions remained unresolved, and to this day, CIA men - past and present - are bitterly split over who Nosenko really is.

With the Nosenko case, the CIA's brainwashing programs had come full circle. Spurred by the widespread alarm over communist tactics, Agency officials had investigated the field, started their own projects, and looked to the latest technology to make improvements. After 10 years of research, with some rather gruesome results, CIA officials had come up with no techniques on which they felt they could rely. Thus, when the operational crunch came, they fell back on the basic brutality of the Soviet system.

Notes 8

Edward Hunter's article " 'Brain-Washing' Tactics Force Chinese into Ranks of Communist Party" appeared in the Miami News on September 24, 1950. His book was Brainwashing in Red China (New York: Vanguard Press, 1951). Other material came from several interviews with Hunter just before he died in June 1978.

The Air Force document cited on brainwashing was called "Air Force Headquarters Panel Convened to Record Air Force Position Regarding Conduct of Personnel in Event of Capture," December 14, 1953. Researcher Sam Zuckerman found it and showed it to me.

The figures on American prisoners in Korea and the quote from Edward Hunter came from hearings before the Senate Permanent Subcommittee on Investigations,84th Congress, June 19,20,26, and 27, 1956.

The material on the setting up of the Cornell-Hinkle-Wolff study came from interviews with Hinkle, Helen Goodell, and several CIA sources. Hinkle's and Wolff's study on brainwashing appeared in classified form on 2 April 1956 as a Technical Services Division publication called Communist Control Techniques and in substantially the same form but unclassified as "Communist Interrogation and Indoctrination of 'Enemies of the State' - An Analysis of Methods Used by the Communist State Police." AMA Archives of Neurology and Psychiatry, August, 1956, Vol. 76.

Allen Dulles spoke on "Brain Warfare" before the Alumni Conference of Princeton University, Hot Springs, Virginia on April 10, 1953, and the quote on guinea pigs came from that speech.

The comments of Rockefeller Foundation officials about D. Ewen Cameron and the record of Rockefeller funding were found in Robert S. Morrison's diary, located in the Rockefeller Foundation Archives, Pocantico Hills, New York.

The key articles on Cameron's work on depatterning and psychic driving were "Production of Differential Amnesia as a Factor in the Treatment of Schizophrenia," Comprehensive Psychiatry, 1960, 1, p. 26 and "Effects of Repetition of Verbal Signals upon the Behavior of Chronic Psychoneurotic Patients" by Cameron, Leonard Levy, and Leonard Rubenstein, Journal of Mental Science, 1960, 106, 742. The background on Page-Russell electroshocks came from "Intensified Electrical Convulsive Therapy in the Treatment of Mental Disorders" by L. G. M. Page and R. J. Russell, Lancet, Volume 254, Jan. - June, 1948. Dr. John Cavanagh of Washington, D.C. provided background on the use of electroshock and sedatives in psychiatry.

Cameron's MKULTRA subproject was #68. See especially document 68-37, "Application for Grant to Study the Effects upon Human Behavior of the Repetition of Verbal Signals," January 21, 1957.

Part of Cameron's papers are in the archives of the American Psychiatric Association in Washington, and they provided considerable information on the treatment of Mary C., as well as a general look at his work. Interviews with at least a dozen of his former colleagues also provided considerable information.

Interviews Yvith John Lilly and Donald Hebb provided background on sensory deprivation. Maitland Baldwin's work in the field was discussed in a whole series of ARTICHOKE documents including #A/B, I,76/4, 21 March 1955, Subject: Total Isolation; #A/B,1, 76/12, 19 May 1955, Subject: Total Isolation - Additional Comments; and #A/B, I, 76/17,27 April 1955, Subject: Total Isolation, Supplemental Report #2. The quote from Aldous Huxley on sensory deprivation is taken from the book of his writings, Moksha: Writings on Psychedelics and the Visionary Experience (1931-1963), edited by Michael Horowitz and Cynthia Palmer (New York: Stonehill, 1978).

The material on Val Orlikow's experiences with Dr. Cameron came from interviews with her and her husband David and from portions of her hospital records, which she furnished.

Cameron's staff psychologist Barbara Winrib's comments on him were found in a letter to the Montreal Star, August 11, 1977.

The study of Cameron's electroshock work ordered by Dr. Cleghorn was published as "Intensive Electroconvulsive Therapy: A Follow-up Study," by A. E. Schwartzman and P. E. Termansen, Canadian Psychiatric Association, Volume 12, 1967.

In addition to several interviews, much material on John Lilly came from his autobiography, The Scientist (Philadelphia: J. B. Lippincott Company, 1978).

The CIA's handling of Yuri Nosenko was discussed at length in hearings before the House Assassinations Committee on September 15, 1978. The best press account of this testimony was written by Jeremiah O'Leary of the Washington Star on September 16, 1978: "How CIA Tried to Break Defector in Oswald Case."

Footnotes 8

1. Among the Air Force and Army project leaders were Dr. Fred Williams of the Air Force Psychological Warfare Division, Robert Jay Lifton, Edgar Schein, Albert Biderman, and Lieutenant Colonel James Monroe (an Air Force officer who would later go to work full time in CIA behavioral programs).
2. Cameron himself may not have known that the Agency was the ultimate source of these funds which came through a conduit, the Society for the Investigation of Human Ecology. A CIA document stated he was unwitting when the grants started in 1957, and it cannot be said whether he ever found out.
3. Cameron wrote that when a patient remembered his schizophrenic symptoms, the schizophrenic behavior usually returned. If the amnesia held for these symptoms, as Cameron claimed it often did, the subject usually did not have a relapse. Even in his "cured" patients, Cameron found that Rorschach tests continued to show schizophrenic thinking despite the improvement in overt behavior. To a layman, this would seem to indicate that Cameron's approach got only at the symptoms, not the causes of

mental problems. Not deterred, however, Cameron dismissed this inconsistency as a "persistent enigma."

4. Cameron wrote in a professional journal that he gave only two electroshocks a day, but a doctor who actually administered the treatment for him says that three were common at the beginning of the therapy.
5. In his proposal to the Human Ecology group, Cameron wrote that his subjects would be spending only 16 hours a day in sensory deprivation, while they listened to psychic driving tapes (thus providing some outside stimuli). Nevertheless, one of Cameron's colleagues states that some patients, including Mary C. were in continuously. Always looking for a better way, Cameron almost certainly tried both variations.
6. Cleghorn's team found little loss of memory on objective tests, like the Wechsler Memory Scale but speculated that these tests measured a different memory function - short-term recall - than that the subjects claimed to be missing.
7. Lilly and other veterans of government-supported research note that there is a practical advantage for the scientist who allows his work to be classified: it gives him an added claim on government funds. He is then in a position to argue that if his work is important enough to be SECRET, it deserves money.
8. As was the case with LSD work, sensory deprivation research had both a mind control and a transcendental side. Aldous Huxley wrote thusly about the two pioneers in the field: "What men like Hebb and Lilly are doing in the laboratory was done by the Christian hermits in the Thebaid and elsewhere, and by Hindu and Tibetan hermits in the remote fastness of the Himalayas. My own belief is that these experiences really tell us something about the nature of the universe, that they are valuable in themselves and, above all, valuable when incorporated into our world-picture and acted upon [in] normal life."
9. In a program called "swimmer nullification," government scientists trained dolphins to attack enemy frogmen with huge needles attached to their snouts. The dolphins carried tanks of compressed air, which when jabbed into a deepdiver caused him to pop dead to the surface. A scientist who worked in this CIA-Navy program states that some of the dolphins sent to Vietnam during the late 1960s got out of their pens and disappeared - unheard of behavior for trained dolphins. John Lilly confirms that a group of the marine mammals stationed at Cam Ranh Bay did go AWOL, and he adds that he heard that some eventually returned with their bodies and fins covered with attack marks made by other dolphins.
10. After 1963 the Agency's Science and Technology Directorate continued brain research with unknown results. See Chapter 12.

9. Human Ecology

Well before Harold Wolff and Lawrence Hinkle finished their brainwashing study for Allen Dulles in 1956, Wolff was trying to expand his role in CIA research and operations. He offered Agency officials the cooperation of his colleagues at Cornell University, where he taught neurology and psychiatry in the Medical College. In proposal after proposal, Wolff pressed upon the CIA his idea that to understand human behavior - and how governments might manipulate it - one had to study man in relationship to his total environment. Calling this field "human ecology," Wolff drew into it the disciplines of psychology, medicine, sociology, and anthropology. In the academic world of the early 1950s, this cross-disciplinary approach was somewhat new, as was the word "ecology," but it made sense to CIA officials. Like Wolff, they were far in advance of the trends in the behavioral sciences.

Wolff carved out vast tracts of human knowledge, some only freshly discovered, and proposed a partnership with the Agency for the task of mastering that knowledge for operational use. It was a time when knowledge itself seemed bountiful and promising, and Wolff was expansive about how the CIA could harness it. Once he figured out how the human mind really worked, he wrote, he would tell the Agency "how a man can be made to think, 'feel,' and behave according to the wishes of other men, and, conversely, how a man can avoid being influenced in this manner."

Such notions, which may now appear naive or perverse, did not seem so unlikely at the height of the Cold War. And Wolff's professional stature added weight to his ideas. Like D. Ewen Cameron, he was no obscure academic. He had been President of the New York Neurological Association and would become, in 1960, President of the American Neurological Association. He served for several years as editor-in-chief of the American Medical Association's Archives of Neurology and Psychiatry. Both by credentials and force of personality, Wolff was an impressive figure. CIA officials listened respectfully to his grand vision of how spies and doctors could work symbiotically to help - if not save - the world. Also, the Agency men never forgot that Wolff had become close to Director Allen Dulles while treating Dulles' son for brain damage.

Wolff's specialized neurological practice led him to believe that brain maladies, like migraine headaches, occurred because of disharmony between man and his environment. In this case, he wrote to the Agency, "The problem faced by the physician is quite similar to that faced by the Communist interrogator." Both would be trying to put their subject back in harmony with his environment whether the problem was headache or ideological dissent. Wolff believed that the beneficial effects of any new interrogation technique would naturally spill over into the treatment of his patients, and vice versa. Following the Soviet model, he felt he could help his patients by putting them into an isolated, disoriented state - from which it would be easier to create new behavior patterns. Although Russian-style isolation cells were impractical at Cornell, Wolff hoped to get the same effect more quickly through sensory deprivation. He told the Agency that sensory-deprivation chambers had "valid medical reason" as part of a treatment that relieved migraine symptoms and made the patient "more receptive to the suggestions of the psychotherapist." He proposed keeping his patients in sensory deprivation until they "show an increased desire to talk and to escape from the procedure." Then, he said, doctors could "utilize material from their own past experience in order to create psychological reactions within them." This procedure drew heavily on the Stalinist method. It cannot be said what success, if any, Wolff had with it to the benefit of his patients at Cornell.

Wolff offered to devise ways to use the broadest cultural and social processes in human ecology for covert operations. He understood that every country had unique customs for child rearing, military training, and nearly every other form of human intercourse. From the CIA's point of view, he noted, this kind of sociological information could be applied mainly to indoctrinating and motivating people. He distinguished these motivating techniques from the "special methods" that he felt were 'more relevant to subversion, seduction, and interrogation." He offered to study those methods, too, and asked the Agency to give him access to everything in its files on "threats, coercion, imprisonment, isolation, deprivation, humiliation, torture, 'brainwashing, "black psychiatry,' hypnosis, and combinations of these with or without chemical agents." Beyond mere study, Wolff volunteered the unwitting use of Cornell patients for brainwashing experiments, so long as no one got hurt. He added, however, that he would advise the CIA on experiments that harmed their subjects if they were performed elsewhere. He obviously felt that only the grandest sweep of knowledge, flowing freely between scholar and spy, could bring the best available techniques to bear on their respective subjects.

In 1955 Wolff incorporated his CIA-funded study group as the Society for the Investigation of Human Ecology, with himself as president.[1] Through the Society, Wolff extended his efforts for the Agency, and his organization turned into a CIA-controlled funding mechanism for studies and experiments in the behavioral sciences.

In the early days of the Society, Agency officials trusted Wolff and his untried ideas with a sensitive espionage assignment. In effect, the new specialty of human ecology was going to telescope the stages of research and application into one continuing process. Speeding up the traditional academic method was required because the CIA men faced an urgent problem. "What was bothering them," Lawrence Hinkle explains, "was that the Chinese had cleaned up their agents in China.... What they really wanted to do was come up with some Chinese [in America], steer them to us, and make them into agents." Wolff accepted the challenge and suggested that the Cornell group hide its real purpose behind the cover of investigating "the ecological aspects of disease" among Chinese refugees. The Agency gave the project a budget of $84,175 (about 30 percent of the money it put into Cornell in 1955) and supplied the study group with 100 Chinese refugees to work with. Nearly all these subjects had been studying in the United States when the communists took over the mainland in 1949, so they tended to be dislocated people in their thirties.

On the Agency side, the main concern, as expressed by one ARTICHOKE man, was the "security hazard" of bringing together so many potential agents in one place. Nevertheless, CIA officials decided to go ahead. Wolff promised to tell them about the inner reaches of the Chinese character, and they recognized the operational advantage that insight into Chinese behavior patterns could provide. Moreover, Wolff said he would pick out the most useful possible agents. The Human Ecology Society would then offer these candidates "fellowships" and subject them to more intensive interviews and "stress producing" situations. The idea was to find out about their personalities, past conditioning, and present motivations, in order to figure out how they might perform in future predicaments - such as finding themselves back in Mainland China as American agents. In the process, Wolff hoped to mold these Chinese into people willing to work for the CIA. Mindful of leaving some cover for Cornell, he was adamant that Agency operators not connected with the project make the actual recruitment pitch to those Chinese whom the Agency men wanted as agents.

As a final twist, Wolff planned to provide each agent with techniques to withstand the precise forms of hostile interrogation they could expect upon returning to China. CIA officials wanted to "precondition" the agents in order to create long lasting motivation "impervious to lapse of time and direct psychological attacks by the enemy." In other words, Agency men planned to brainwash their agents in order to protect them against Chinese brainwashing.

Everything was covered - in theory, at least. Wolff was going to take a crew of 100 refugees and turn as many of them as possible into detection-proof, live agents inside China, and he planned to do the job quickly through human ecology. It was a heady chore for the Cornell professor to take on after classes.

Wolff hired a full complement of psychologists, psychiatrists, and anthropologists to work on the project. He bulldozed his way through his colleagues' qualms and government red tape alike. Having hired an anthropologist before learning that the CIA security office would not give her a clearance, Wolff simply lied to her about where the money came from. "It was a function of Wolff's imperious nature," says his partner Hinkle. "If a dog came in and threw up on the rug during a lecture, he would continue." Even the CIA men soon found that Harold Wolff was not to be trifled with. "From the Agency side, I don't know anyone who wasn't scared of him," recalls a longtime CIA associate. "He was an autocratic man. I never knew him to chew anyone out. He didn't have to. We were damned respectful. He moved in high places. He was just a skinny little man but talk about mind control! He was one of the controllers."

In the name of the Human Ecology Society, the CIA paid $1,200 a month to rent a fancy town house on Manhattan's East 78th Street to house the Cornell group and its research projects Agency technicians traveled to New York in December 1954 to install eavesdropping microphones around the building. These and other more obvious security devices - safes, guards, and the like - made the town house look different from the academic center it was supposed to be. CIA liaison personnel held meetings with Wolff and the staff in the secure confines of the town house, and they all carefully watched the 100 Chinese a few blocks away at the Cornell hospital. The Society paid each subject $25 a day so the researchers could test them, probe them, and generally learn all they could about Chinese people - or at least about middle-class, displaced, anti-Communist ones.

It is doubtful that any of Wolff's Chinese ever returned to their homeland as CIA agents, or that all of Wolff's proposals were put into effect. In any case, the project was interrupted in midstream by a major shake-up in the CIA's entire mind-control effort. Early in 1955, Sid Gottlieb and his Ph.D. crew from TSS took over most of the ARTICHOKE functions, including the Society, from Morse Allen and the Pinkerton types in the Office of Security. The MKULTRA men moved quickly to turn the Society into an entity that looked and acted like a legitimate foundation. First they smoothed over the ragged covert edges. Out came the bugs and safes so dear to Morse Allen and company. The new crew even made some effort (largely unsuccessful) to attract non-CIA funds. The biggest change, however, was the Cornell professors now had to deal with Agency representatives who were scientists and who had strong ideas of their own on research questions. Up to this point, the Cornellians had been able to keep the CIA's involvement within bounds acceptable to them. While Harold Wolff never ceased wanting to explore the furthest reaches of behavior control, his colleagues were wary of going on to the outer limits - at least under Cornell cover.

No one would ever confuse MKULTRA projects with ivory-tower research, but Gottlieb's people did take a more academic - and sophisticated - approach to behavioral research than their predecessors. The MKULTRA men understood that not every project would have an immediate operational benefit, and they believed less and less in the existence of that one just-over-the-horizon technique that would turn men into puppets. They favored increasing their knowledge of human behavior in relatively small steps, and they concentrated on the reduced goal of influencing and manipulating their subjects. "You're ahead of the game if you can get people to do something ten percent more often than they would otherwise," says an MKULTRA veteran.

Accordingly, in 1956, Sid Gottlieb approved a $74,000 project to have the Human Ecology Society study the factors that caused men to defect from their countries and cooperate with foreign governments. MKULTRA officials reasoned that if they could understand what made old turncoats tick, it might help them entice new ones. While good case officers instinctively seemed to know how to handle a potential agent - or thought they did - the MKULTRA men hoped to come up with systematic, even scientific improvements. Overtly, Harold Wolff designed the program to look like a follow-up study to the Society's earlier programs, noting to the Agency that it was "feasible to study foreign nationals under the cover of a medical-sociological study." (He told his CIA founders that "while some information of general value to science should be produced, this in itself will not be a sufficient justification for carrying out a study of this nature.") Covertly, he declared the purpose of the research was to assess defectors' social and cultural background, their life experience, and their personality structure, in order to understand their motivations, value systems, and probable future reactions.

The 1956 Hungarian revolt occurred as the defector study was getting underway, and the Human Ecology group, with CIA headquarters approval, decided to turn the defector work into an investigation of 70 Hungarian refugees from that upheaval. By then, most of Harold Wolff's team had been together through the brainwashing and Chinese studies. While not all of them knew of the CIA's specific interests, they had streamlined their procedures for answering the questions that Agency officials found interesting. They ran the Hungarians through the battery of tests and observations in six months, compared to a year and a half for the Chinese project.

The Human Ecology Society reported that most of their Hungarian subjects had fought against the Russians during the Revolution and that they had lived through extraordinarily difficult circumstances, including arrest, mistreatment, and indoctrination. The psychologists and psychiatrists found that, often, those who had survived with the fewest problems had been those with markedly aberrant personalities. "This observation has added to the evidence that healthy people are not necessarily 'normal,' but are people particularly adapted to their special life situations," the group declared.

While CIA officials liked the idea that their Hungarian subjects had not knuckled under communist influence, they recognized that they were working with a skewed sample. American visa restrictions kept most of the refugee left-wingers and former communist officials out of the United States; so, as a later MKULTRA document would state, the Society wound up studying "western-tied rightist elements who had never been accepted completely" in postwar Hungary. Agency researchers realized that these people would "contribute little" toward increasing the CIA's knowledge of the processes that made a communist official change his loyalties.

In order to broaden their data base, MKULTRA officials decided in March 1957 to bring in some unwitting help. They gave a contract to Rutgers University sociologists Richard Stephenson and Jay Schulman "to throw as much light as possible on the sociology of the communist system in the throes of revolution." The Rutgers professors started out by interviewing the 70 Hungarians at Cornell in New York, and Schulman went on to Europe to talk to disillusioned Communists who had also fled their country. From an operational point of view, these were the people the Agency really cared about; but, as socialists, most of them probably would have resisted sharing their experiences with the CIA - if they had known.[2]

Jay Schulman would have resisted, too. After discovering almost 20 years later that the Agency had paid his way and seen his confidential interviews, he feels misused. "In 1957 I was myself a quasi-Marxist and if I had known that this study was sponsored by the CIA, there is really, obviously, no way that I would have been associated with it," says Schulman. "My view is that social scientists have a deep personal responsibility for questioning the sources of funding; and the fact that I didn't do it at the time was simply, in my judgment, indication of my own naiveté and political innocence, in spite of my ideological bent."

Deceiving Schulman and his Hungarian subjects did not bother the men from MKULTRA in the slightest. According to a Gottlieb aide, one of the strong arguments inside the CIA for the whole Human Ecology program was that it gave the Agency a means of approaching and using political mavericks who could not otherwise get security clearances. "Sometimes," he chuckles, "these left-wing social scientists were damned good." This MKULTRA veteran scoffs at the displeasure Schulman expresses: "If we'd gone to a guy and said, 'We're CIA,' he never would have done it. They were glad to get the money in a world where damned few people were willing to support them.... They can't complain about how they were treated or that they were asked to do something they wouldn't have normally done."

The Human Ecology Society soon became a conduit for CIA money flowing to projects, like the Rutgers one, outside Cornell. For these grants, the Society provided only cover and administrative support behind the gold-plated names of Cornell and Harold Wolff. From 1955 to 1958, Agency officials passed funds through the Society for work on criminal sexual psychopaths at Ionia State Hospital,[3] a mental institution located on the banks of the Grand River in the rolling farm country 120 miles northwest of Detroit. This project had an interesting hypothesis: That child molesters and rapists had ugly secrets buried deep within them and that their stake in not admitting their perversions approached that of spies not wanting to confess. The MKULTRA men reasoned that any technique that would work on a sexual psychopath would surely have a similar effect on a foreign agent. Using psychologists and psychiatrists connected to the Michigan mental health and the Detroit court systems, they set up a program to test LSD and marijuana, wittingly and unwittingly, alone and in combination with hypnosis. Because of administrative delays, the Michigan doctors managed to experiment only on 26 inmates in three years - all sexual offenders committed by judges without a trial under a Michigan law, since declared unconstitutional. The search for a truth drug went on, under the auspices of the Human Ecology Society, as well as in other MKULTRA channels.

The Ionia project was the kind of expansionist activity that made Cornell administrators, if not Harold Wolff, uneasy. By 1957, the Cornellians had had enough. At the same time, the Agency sponsors decided that the Society had outgrown its dependence on Cornell for academic credentials - that in fact the close ties to Cornell might inhibit the Society's future growth among academics notoriously sensitive to institutional conflicts. One CIA official wrote that the Society "must be given more established stature in the research community to be effective as a cover organization." Once the Society was cut loose in the foundation world, Agency men felt they would be freer to go anywhere in academia to buy research that might assist covert operations. So the CIA severed the Society's formal connection to Cornell.

The Human Ecology group moved out of its East 78th Street town house, which had always seem a little too plush for a university program, and opened up a new headquarters in Forest Hills, Queens, which was an inappropriate neighborhood for a well-connected foundation.[4] Agency officials hired a staff of four led by Lieutenant Colonel James Monroe, who had worked closely with the CIA as head of the Air Force's study of Korean War prisoners. Sid Gottlieb and the TSS hierarchy in Washington still made the major decisions, but Monroe and the Society staff, whose salaries the Agency paid, took over the Society's dealings with the outside world and the monitoring of several hundred thousand dollars a year in research projects. Monroe personally supervised dozens of grants, including Dr. Ewen Cameron's brainwashing work in Montreal. Soon the Society was flourishing as an innovative foundation, attracting research proposals from a wide variety of behavioral scientists, at a time when these people - particularly the unorthodox ones - were still the stepchildren of the fund-granting world.

After the Society's exit from Cornell, Wolff and Hinkle stayed on as president and vice-president, respectively, of the Society's board of directors. Dr. Joseph Hinsey, head of the New York Hospital-Cornell Medical Center also remained on the board. Allen Dulles continued his personal interest in the Society's work and came to one of the first meetings of the new board, which, as was customary with CIA fronts, included some big outside names. These luminaries added worthiness to the enterprise while playing essentially figurehead roles. In 1957 the other board members were John Whitehorn, chairman of the psychiatry department at Johns Hopkins University, Carl Rogers, professor of psychology and psychiatry at the University of Wisconsin, and Adolf A. Berle, onetime Assistant Secretary of State and chairman of the New York Liberal Party.[5] Berle had originally put his close friend Harold Wolff in touch with the CIA, and at Wolff's request, he came on the Society board despite some reservations. "I am frightened about this one," Berle wrote in his diary. "If the scientists do what they have laid out for themselves, men will become manageable ants. But I don't think it will happen."

There was a lot of old-fashioned backscratching among the CIA people and the academics as they settled into the work of accommodating each other. Even Harold Wolff, the first and the most enthusiastic of the scholar-spies, had made it clear from the beginning that he expected some practical rewards for his service. According to colleague Hinkle, who appreciated Wolff as one the great grantsman of his time, Wolff expected that the Agency "would support our research and we would be their consultants." Wolff bluntly informed the CIA that some of his work would have no direct use "except that it vastly enhances our value ... as consultants and advisers." In other words, Wolff felt that his worth to the CIA increased in proportion to his professional accomplishments and importance - which in turn depended partly on the resources he commanded. The Agency men understood, and over the last half of the 1950s, they were happy to contribute almost $300,000 to Wolff's own research on the brain and central nervous system. In turn, Wolff and his reputation helped them gain access to other leading lights in the academic world.

Another person who benefited from Human Ecology funds was Carl Rogers, whom Wolff had also asked to serve on the board. Rogers, who later would become famous for his nondirective, nonauthoritarian approach to psychotherapy, respected Wolff's work, and he had no objection to helping the CIA. Although he says he would have nothing to do with secret Agency activities today, he asks for understanding in light of the climate of the 1950s. "We really did regard Russia as the enemy," declares Rogers, "and we were trying to do various things to make sure the Russians did not get the upper hand." Rogers received an important professional reward for joining the Society board. Executive Director James Monroe had let him know that, once he agreed to serve, he could expect to receive a Society grant. "That appealed to me because I was having trouble getting funded," says Rogers. "Having gotten that grant [about $30,000 over three years], it made it possible to get other grants from Rockefeller and NIMH." Rogers still feels grateful to the Society for helping him establish a funding "track record," but he emphasizes that the Agency never had any effect on his research.

Although MKULTRA psychologist John Gittinger suspected that Rogers' work on psychotherapy might provide insight into interrogation methods, the Society did not give Rogers money because of the content of his work. The grant ensured his services as a consultant, if desired, and, according to a CIA document, "free access" to his project. But above all, the grant allowed the Agency to use Rogers' name. His standing in the academic community contributed to the layer of cover around the Society that Agency officials felt was crucial to mask their involvement.

Professor Charles Osgood's status in psychology also improved the Society's cover, but his research was more directly useful to the Agency, and the MKULTRA men paid much more to get it. In 1959 Osgood, who four years later became president of the American Psychological Association, wanted to push forward his work on how people in different societies express the same feelings, even when using different words and concepts. Osgood wrote in "an abstract conceptual framework," but Agency officials saw his research as "directly relevant" to covert activities. They believed they could transfer Osgood's knowledge of "hidden values and cues" in the way people communicate into more effective overseas propaganda. Osgood's work gave them a tool - called the "semantic differential" - to choose the right words in a foreign language to convey a particular meaning.

Like Carl Rogers, Osgood got his first outside funding for what became the most important work of his career from the Human Ecology Society. Osgood had written directly to the CIA for support, and the Society soon contacted him and furnished $192,975 for research over five years. The money allowed him to travel widely and to expand his work into 30 different cultures. Also like Rogers, Osgood eventually received NIMH money to finish his research, but he acknowledges that the Human Ecology grants played an important part in the progress of his work. He stresses that "there was none of the feeling then about the CIA that there is now, in terms of subversive activities," and he states that the Society had no influence on anything he produced. Yet Society men could and did talk to him about his findings. They asked questions that reflected their own covert interests, not his academic pursuits, and they drew him out, according to one of them, "at great length." Osgood had started studying cross-cultural meaning well before he received the Human Ecology money, but the Society's support ensured that he would continue his work on a scale that suited the Agency's purposes, as well as his own.

A whole category of Society funding, called "cover grants," served no other purpose than to build the Society's false front. These included a sociological study of Levittown, Long Island (about $4,500), an analysis of the Central Mongoloid skull ($700), and a look at the foreign-policy attitudes of people who owned fallout shelters, as opposed to people who did not ($2,500). A $500 Human Ecology grant went to Istanbul University for a study of the effects of circumcision on Turkish boys. The researcher found that young Turks, usually circumcised between the ages of five and seven, felt "severe emotional impact with attending symptoms of withdrawal." The children saw the painful operations as "an act of aggression" that brought out previously hidden fears - or so the Human Ecology Society reported.

In other instances, the Society put money into projects whose covert application was so unlikely that only an expert could see the possibilities. Nonetheless, in 1958 the Society gave $5,570 to social psychologists Muzafer and Carolyn Wood Sherif of the University of Oklahoma for work on the behavior of teen-age boys in gangs. The Sherifs, both ignorant of the CIA connection,[6] studied the group structures and attitudes in the gangs and tried to devise ways to channel antisocial behavior into more constructive paths. Their results were filtered through clandestine minds at the Agency. "With gang warfare," says an MKULTRA source, "you tried to get some defectors-in-place who would like to modify some of the group behavior and cool it. Now, getting a juvenile delinquent defector was motivationally not all that much different from getting a Soviet one."

MKULTRA officials were clearly interested in using their grants to build contacts and associations with prestigious academics. The Society put $1,500 a year into the Research in Mental Health Newsletter published jointly at McGill University by the sociology and psychiatric departments. Anthropologist Margaret Mead, an international culture heroine, sat on the newsletter's advisory board (with, among others, D. Ewen Cameron), and the Society used her name in its biennial report. Similarly, the Society gave grants of $26,000 to the well-known University of London psychologist, H. J. Eysenck, for his work on motivation. An MKULTRA document acknowledged that this research would have "no immediate relevance for Agency needs," but that it would "lend prestige" to the Society. The grants to Eysenck also allowed the Society to take funding credit for no less than nine of his publications in its 1963 report. The following year, the Society managed to purchase a piece of the work of the most famous behaviorist of all, Harvard's B. F. Skinner. Skinner, who had tried to train pigeons to guide bombs for the military during World War II, received a $5,000 Human Ecology grant to pay the costs of a secretary and supplies for the research that led to his book, Freedom and Dignity. Skinner has no memory of the grant or its origins but says, "I don't like secret involvement of any kind. I can't see why it couldn't have been open and aboveboard."

A TSS source explains that grants like these "bought legitimacy" for the Society and made the recipients "grateful." He says that the money gave Agency employees at Human Ecology a reason to phone Skinner - or any of the other recipients - to pick his brain about a particular problem. In a similar vein, another MKULTRA man, psychologist John Gittinger mentions the Society's relationship with Erwin Goffman of the University of Pennsylvania, whom many consider today's leading sociological theorist. The Society gave him a small grant to help finish a book that would have been published anyway. As a result, Gittinger was able to spend hours talking with him about, among other things, an article he had written earlier on confidence men. These hucksters were experts at manipulating behavior, according to Gittinger, and Goffman unwittingly "gave us a better understanding of the techniques people use to establish phony relationships" - a subject of interest to the CIA.

To keep track of new developments in the behavioral sciences, Society representatives regularly visited grant recipients and found out what they and their colleagues were doing. Some of the knowing professors became conscious spies. Most simply relayed the latest professional gossip to their visitors and sent along unpublished papers. The prestige of the Human Ecology grantees also helped give the Agency access to behavioral scientists who had no connection to the Society. "You could walk into someone's office and say you were just talking to Skinner," says an MKULTRA veteran. "We didn't hesitate to do this. It was a way to name-drop."

The Society did not limit its intelligence gathering to the United States. As one Agency source puts it, "The Society gave us a legitimate basis to approach anyone in the academic community anywhere in the world." CIA officials regularly used it as cover when they traveled abroad to study the behavior of foreigners of interest to the Agency, including such leaders as Nikita Khrushchev. The Society funded foreign researchers and also gave money to American professors to collect information abroad. In 1960, for instance, the Society sponsored a survey of Soviet psychology through the simple device of putting up $15,000 through the official auspices of the American Psychological Association to send ten prominent psychologists on a tour of the Soviet Union. Nine of the ten had no idea of the Agency involvement, but CIA officials were apparently able to debrief everyone when the group returned. Then the Society sponsored a conference and book for which each psychologist contributed a chapter. The book added another $5,000 to the CIA's cost, but $20,000 all told seemed like a small price to pay for the information gathered. The psychologists - except perhaps the knowledgeable one - did nothing they would not ordinarily have done during their trip, and the scholarly community benefited from increased knowledge on an important subject. The only thing violated was the openness and trust normally associated with academic pursuits. By turning scholars into spies - even unknowing ones - CIA officials risked the reputation of American research work and contributed potential ammunition toward the belief in many countries that the U.S. notion of academic freedom and independence from the state is self-serving and hypocritical.

Secrecy allowed the Agency a measure of freedom from normal academic restrictions and red tape, and the men from MKULTRA used that freedom to make their projects more attractive. The Society demanded "no stupid progress reports," recalls psychologist and psychiatrist Martin Orne, who received a grant to support his Harvard research on hypnotism. As a further sign of generosity and trust, the Society gave Orne a follow-on $30,000 grant with no specified purpose.[7] Orne could use it as he wished. He believes the money was "a contingency investment" in his work, and MKULTRA officials agree. "We could go to Orne anytime," says one of them, "and say, 'Okay, here is a situation and here is a kind of guy. What would you expect we might be able to achieve if we could hypnotize him?' Through his massive knowledge, he could speculate and advise." A handful of other Society grantees also served in similar roles as covert Agency consultants in the field of their expertise.

In general, the Human Ecology Society served as the CIA's window on the world of behavioral research. No phenomenon was too arcane to escape a careful look from the Society, whether extrasensory perception or African witch doctors. "There were some unbelievable schemes," recalls an MKULTRA veteran, "but you also knew Einstein was considered crazy. You couldn't be so biased that you wouldn't leave open the possibility that some crazy idea might work." MKULTRA men realized, according to the veteran, that "ninety percent of what we were doing would fail" to be of any use to the Agency. Yet, with a spirit of inquiry much freer than that usually found in the academic world, the Society took early stabs at cracking the genetic code with computers and finding out whether animals could be controlled through electrodes placed in their brains.

The Society's unrestrained, scattershot approach to behavioral research went against the prevailing wisdom in American universities - both as to methods and to subjects of interest. During the 1950s one school of thought - so-called "behaviorism," - was accepted on campus, virtually to the exclusion of all others. The "behaviorists," led by Harvard's B. F. Skinner, looked at psychology as the study of learned observable responses to outside stimulation. To oversimplify, they championed the approach in which psychologists gave rewards to rats scurrying through mazes, and they tended to dismiss matters of great interest to the Agency: e.g., the effect of drugs on the psyche, subjective phenomena like hypnosis, the inner workings of the mind, and personality theories that took genetic differences into account.

By investing up to $400,000 a year into the early, innovative work of men like Carl Rogers, Charles Osgood, and Martin Orne, the CIA's Human Ecology Society helped liberate the behavioral sciences from the world of rats and cheese. With a push from the Agency as well as other forces, the field opened up. Former iconoclasts became eminent, and, for better or worse, the Skinnerian near-monopoly gave way to a multiplication of contending schools. Eventually, a reputable behavioral scientist could be doing almost anything: holding hands with his students in sensitivity sessions, collecting survey data on spanking habits, or subjectively exploring new modes of consciousness. The CIA's money undoubtedly changed the academic world to some degree, though no one can say how much.

As usual, the CIA men were ahead of their time and had started to move on before the new approaches became established. In 1963, having sampled everything from palm reading to subliminal perception, Sid Gottlieb and his colleagues satisfied themselves that they had overlooked no area of knowledge - however esoteric - that might be promising for CIA operations. The Society had served its purpose; now the money could be better spent elsewhere. Agency officials transferred the still-useful projects to other covert channels and allowed the rest to die quietly. By the end of 1965, when the remaining research was completed, the Society for the Investigation of Human Ecology was gone.

Notes 9

MKULTRA subprojects 48 and 60 provided the basic documents on the Society for the Investigation of Human Ecology. These were supplemented by the three biennial reports of the Society that could be found: 1957, 1961, and 1961-1963. Wolff's own research work is MKULTRA subproject 61. Wolfs proposals to the Agency are in #A/B, II, 10/68, undated "Proposed Plan for Implementing [deleted]" in two documents included in 48-29, March 5, 1956, "General Principles Upon Which these Proposals Are Based." The Agency's plans for the Chinese Project are described in #A/B, II, 10/48, undated, Subject: Cryptonym [deleted] A/B, II 10/72,9 December,1954, Subject: Letter of Instructions, and #A/B, II, 10/110, undated, untitled.

Details of the logistics of renting the Human Ecology headquarters and bugging it are in #A/B, II, 10/23, 30 August, 1954, Subject: Meeting of Working Committee of [deleted], No. 5 and #A/B, II, 10/92, 8 December, 1954, Subject: Technical Installation.

The Hungarian project, as well as being described in the 1957 biennial report, was dealt with in MKULTRA subprojects 65 and 82, especially 65-12, 28 June 1956, Subject: MKULTRA subproject 65; 65-11, undated, Subject: Dr. [deleted]'s Project - Plans for the Coming Year, July,1957-June,1958; and 82-15,11 April 1958, Subject: Project MKULTRA, Subproject 82.

The Ionia State sexual psychopath research was MKULTRA Subproject 39, especially 39-4, 9 April 1958, Subject: Trip Report, Visit to [deleted], 7 April 1958. Paul Magnusson of the Detroit Free Press and David Pearl of the Detroit ACLU office both furnished information.

Carl Rogers' MKULTRA subproject was # 97. He also received funds under Subproject 74. See especially 74-256, 7 October 1958, Supplement to Individual Grant under MKULTRA, Subproject No. 74 and 97-21, 6 August 1959, Subject: MKULTRA Subproject 97.

H. J. Eysenck's MKULTRA subproject was #111. See especially 111-3, 3 April 1961, Subject: Continuation of MKULTRA Subproject 111. The American Psychological Association-sponsored trip to the Soviet Union was described in Subproject 107. The book that came out of the trip was called Some Views on Soviet Psychology, Raymond Bauer (editor), (Washington: American Psychological Association; 1962).

The Sherifs' research on teenage gangs was described in Subproject # 102 and the 1961 Human Ecology biennial report. Dr. Carolyn Sherif also wrote a letter to the American Psychological Association Monitor, February 1978. Dr. Sherif talked about her work when she and I appeared on an August 1978 panel at the American Psychological Association's convention in Toronto.

Martin Orne's work for the Agency was described in Subproject 84. He contributed a chapter to the Society-funded book, The Manipulation of Human Behavior, edited by Albert Biderman and Herbert Zimmer-(New York: John Wiley & Sons; 1961), pp. 169-215. Financial data on Orne's Institute for Experimental Psychiatry came from a filing with the Commonwealth of Massachusetts, Attachment to Form 1023.

The quote from John Gittinger came from an interview with him conducted by Dr. Patricia Greenfield. Dr. Greenfield also interviewed Jay Schulman, Carl Rogers, and Charles Osgood for an article in the December 1977 issue of the American Psychological Association Monitor, from which my quotes of Schulman's comments are taken. She discussed Erving Goffman's role in a presentation to a panel of the American Psychological Association convention in Toronto in August 1978. The talk was titled "CIA Support of Basic Research in Psychology: Policy Implications."

Footnotes 9

1. In 1961 the Society changed its name to the Human Ecology Fund, but for convenience sake it will be called the Society throughout the book.
2. Also to gain access to this same group of leftist Hungarian refugees in Europe, the Human Ecology Society put $15,000 in 1958 into an unwitting study by Dr. A. H. M. Struik of the University of Nijmegen in the Netherlands. An Agency document extolled this arrangement not only as a useful way of studying Hungarians but because it provided "entree" into a leading European university and psychological research center, adding "such a connection has manifold cover and testing possibilities as well as providing a base from which to take advantage of developments in that area of the world."
3. Professor Laurence Hinkle states that it was never his or Cornell's intention that the Society would be used as a CIA funding conduit. When told that he himself had written letters on the Ionia project, he replied that the Society's CIA-supplied bookkeeper was always putting papers in front of him and that he must have signed without realizing the implications.
4. By 1961 the CIA staff had tired of Queens and moved the Society back into Manhattan to 201 East 57th Street. In 1965 as the Agency was closing down the front, it switched its headquarters to 1831 Connecticut Avenue N.W. in Washington, the same building owned by Dr. Charles Geschickter that housed another MKULTRA conduit, the Geschickter Fund for Medical Research.
5. Other establishment figures who would grace the Human Ecology board over the years included Leonard Carmichael, head of the Smithsonian Institution, Barnaby Keeney, president of Brown University, and George A. Kelly, psychology professor and Society fund recipient at Ohio State University.
6. According to Dr. Carolyn Sherif, who says she and her husband did not share the Cold War consensus and would never have knowingly taken CIA funds Human Ecology executive director James Monroe lied directly about the source of the Society's money, claiming it came from rich New York doctors and Texas millionaires who gave it for tax purposes. Monroe used this standard cover story with other grantees.
7. A 1962 report of Orne's laboratory, the Institute for Experimental Psychiatry, showed that it received two sizable grants before the end of that year: $30,000 from Human Ecology and $30,000 from Scientific Engineering Institute, another CIA front organization. Orne says he was not aware of the latter group's Agency connection at the time, but learned of it later. He used its grant to study new ways of using the polygraph.

10. The Gittinger Assessment System

With one exception, the CIA's behavioral research - whether on LSD or on electroshock - seems to have had more impact on the outside world than on Agency operations. That exception grew out of the work of the MKULTRA program's resident genius, psychologist John Gittinger. While on the CIA payroll, toiling to find ways to manipulate people, Gittinger created a unique system for assessing personality and predicting future behavior. He called his method - appropriately - the Personality Assessment System (PAS). Top Agency officials have been so impressed that they have given the Gittinger system a place in most agent-connected activities. To be sure, most CIA operators would not go nearly so far as a former Gittinger aide who says, "The PAS was the key to the whole clandestine business." Still, after most of the touted mind controllers had given up or been sent back home, it was Gittinger, the staff psychologist, who sold his PAS system to cynical, anti-gimmick case officers in the Agency's Clandestine Services. And during the Cuban missile crisis, it was Gittinger who was summoned to the White House to give his advice on how Khrushchev would react to American pressure.

A heavy-set, goateed native of Oklahoma who in his later years came to resemble actor Walter Slezak, Gittinger looked much more like someone's kindly grandfather than a calculating theoretician. He had an almost insatiable curiosity about personality, and he spent most of his waking hours tinkering with and trying to perfect his system. So obsessed did he become that he always had the feeling even after other researchers had verified large chunks of the PAS and after the CIA had put it into operational use - that the whole thing was "a kind of paranoid delusion."

Gittinger started working on his system even before he joined the CIA in 1950. Prior to that, he had been director of psychological services at the state hospital in Norman, Oklahoma. His high-sounding title did not reflect the fact that he was the only psychologist on the staff. A former high school guidance counselor and Naval lieutenant commander during World War II, he was starting out at age 30 with a master's degree. Every day he saw several hundred patients whose mental problems included virtually everything in the clinical textbooks.

Numerous tramps and other itinerants, heading West in search of the good life in California, got stuck in Oklahoma during the cold winter months and managed to get themselves admitted to Gittinger's hospital. In warmer seasons of the year, quite a few of them worked, when they had to, as cooks or dishwashers in the short-order hamburger stands that dotted the highways in the days before fast food. They functioned perfectly well in these jobs until freezing nights drove them from their outdoor beds. The hospital staff usually called them "seasonal schizophrenics" and gave them shelter until spring. Gittinger included them in the psychological tests he was so fond of running on his patients.

As he measured the itinerants on the Wechsler intelligence scale, a standard IQ test with 11 parts,[1] Gittinger made a chance observation that became, he says, the "bedrock" of his whole system. He noticed that the short-order cooks tended to do well on the digit-span subtest which rated their ability to remember numbers. The dishwashers, in contrast, had a poor memory for digits. Since the cooks had to keep track of many complex orders - with countless variations of medium rare, onions, and hold-the-mayo - their retentive quality served them well.

Gittinger also noticed that the cooks had different personality traits than the dishwashers. The cooks seemed able to maintain a high degree of efficiency in a distracting environment while customers were constantly barking new orders at them. They kept their composure by falling back on their internal resources and generally shutting themselves off from the commotion around them. Gittinger dubbed this personality type, which was basically inner-directed, an "Internalizer" (abbreviated "I"). The dishwashers, on the other hand, did not have the ability to separate themselves from the external world. In order to perform their jobs, they had to be placed off in some far corner of the kitchen with their dirty pots and pans, or else all the tumult of the place diverted them from their duty. Gittinger called the dishwasher type an "Externalizer" (E). He found that if he measured a high digit span in any person - not just a short-order cook - he could make a basic judgment about personality.

From observation, Gittinger concluded that babies were born with distinct personalities which then were modified by environmental factors. The Internalized - or I - baby was caught up in himself and tended to be seen as a passive child; hence, the world usually called him a "good baby." The E tot was more interested in outside stimuli and attention, and thus was more likely to cause his parents problems by making demands. Gittinger believed that the way parents and other authority figures reacted to the child helped to shape his personality. Adults often pressured or directed the I child to become more outgoing and the E one to become more self-sufficient. Gittinger found he could measure the compensations, or adjustments, the child made on another Wechsler subtest, the one that rated arithmetic ability. He noticed that in later life, when the person was subject to stress, these compensations tended to disappear, and the person reverted to his original personality type. Gittinger wrote that his system "makes possible the assessment of fundamental discrepancies between the surface personality and the underlying personality structure - discrepancies that produce tension, conflict, and anxiety."

Besides the E-I dimensions, Gittinger identified two other fundamental sets of personality characteristics that he could measure with still other Wechsler subtests. Depending on how a subject did on the block design subtest, Gittinger could tell if he were Regulated (R) or Flexible (F). The Regulated person had no trouble learning by rote but usually did not understand what he learned. The Flexible individual, on the other hand, had to understand something before he learned it. Gittinger noted that R children could learn to play the piano moderately well with comparatively little effort. The F child most often hated the drudgery of piano lessons, but Gittinger observed that the great concert pianists tended to be Fs who had persevered and mastered the instrument.

Other psychologists had thought up personality dimensions similar to Gittinger's E and I, R and F. even if they defined them somewhat differently. Gittinger's most original contribution came in a third personality dimension, which revealed how well people were able to adapt their social behavior to the demands of the culture they lived in. Gittinger found he could measure this dimension with the picture arrangement Wechsler subtest, and he called it the Role Adaptive (A) or Role Uniform (U). It corresponded to "charisma," since other people were naturally attracted to the A person while they tended to ignore the U.

All this became immensely more complicated as Gittinger measured compensations and modifications with other Wechsler subtests. This complexity alone worked against the acceptance of his system by the outside world, as did the fact that he based much of it on ideas that ran contrary to accepted psychological doctrine - such as his heretical notion that genetic differences existed. It did not help, either, that Gittinger was a non-Ph.D. whose theory sprang from the kitchen habits of vagrants in Oklahoma.

Any one of these drawbacks might have stifled Gittinger in the academic world, but to the pragmatists in the CIA, they were irrelevant. Gittinger's strange ideas seemed to work. With uncanny accuracy, he could look at nothing more than a subject's Wechsler numbers, pinpoint his weaknesses, and show how to turn him into an Agency spy. Once Gittinger's boss, Sid Gottlieb, and other high CIA officials realized how Gittinger's PAS could be used to help case officers handle agents, they gave the psychologist both the time and money to improve his system under the auspices of the Human Ecology Society.

Although he was a full-time CIA employee, Gittinger worked under Human Ecology cover through the 1950s. Agency officials considered the PAS to be one of the Society's greatest triumphs, definitely worth continuing after the Society was phased out. In 1962 Gittinger and his co-workers moved their base of operations from the Human Ecology headquarters in New York to a CIA proprietary company, set up especially for them in Washington and called Psychological Assessment Associates. Gittinger served as president of the company, whose cover was to provide psychological services to American firms overseas. He personally opened a branch office in Tokyo (later moved to Hong Kong) to service CIA stations in the Far East. The Washington staff, which grew to about 15 professionals during the 1960s, handled the rest of the world by sending assessment specialists off for temporary visits.

Hundreds of thousands of dollars in Human Ecology grants and then even more money in Psychological Assessment contracts - all CIA funds - flowed out to verify and expand the PAS. For example, the Society gave about $140,000 to David Saunders of the Educational Testing Service, the company that prepares the College Board exams. Saunders, who knew about the Agency's involvement, found a correlation between brain (EEG) patterns and results on the digit-span test, and he helped Gittinger apply the system to other countries. In this regard, Gittinger and his colleagues understood that the Wechsler battery of subtests had a cultural bias and that a Japanese E had a very different personality from, say, a Russian E. To compensate, they worked out localized versions of the PAS for various nations around the world.

While at the Human Ecology group, Gittinger supervised much of the Society's other research in the behavioral sciences, and he always tried to interest Society grantees in his system. He looked for ways to mesh their research with his theories - and vice versa. Some, like Carl Rogers and Charles Osgood, listened politely and did not follow up. Yet Gittinger would always learn something from their work that he could apply to the PAS. A charming man and a skillful raconteur, Gittinger convinced quite a few of the other grantees of the validity of his theories and the importance of his ideas. Careful not to threaten the egos of his fellow professionals, he never projected an air of superiority. Often he would leave people even the skeptical - openmouthed in awe as he painted unnervingly accurate personality portraits of people he had never met. Indeed, people frequently accused him of somehow having cheated by knowing the subject in advance or peeking at his file.

Gittinger patiently and carefully taught his system to his colleagues, who all seem to have views of him that range from great respect to pure idolatry. For all his willingness to share the PAS, Gittinger was never able to show anyone how to use the system as skillfully as he did. Not that he did not try; he simply was a more talented natural assessor than any of the others. Moreover, his system was full of interrelations and variables that he instinctively understood but had not bothered to articulate. As a result, he could look at Wechsler scores and pick out behavior patterns which would be valid and which no one else had seen. Even after Agency officials spent a small fortune trying to computerize the PAS, they found, as one psychologist puts it, the machine "couldn't tie down all the variables" that Gittinger was carrying around in his head.

Some Human Ecology grantees, like psychiatrist Robert Hyde, were so impressed with Gittinger's system that they made the PAS a major part of their own research. Hyde routinely gave Wechslers to his subjects before plying them with liquor, as part of the Agency's efforts to find out how people react to alcohol. In 1957 Hyde moved his research team from Boston Psychopathic Hospital, where he had been America's first LSD tripper, to Butler Health Center in Providence. There, with Agency funds, Hyde built an experimental party room in the hospital, complete with pinball machine, dartboard, and bamboo bar stools. From behind a two-way mirror, psychologists watched the subjects get tipsy and made careful notes on their reaction to alcohol. Not surprisingly, the observers found that pure Internalizers became more withdrawn after several drinks, and that uncompensated Es were more likely to become garrulous - in essence, sloppy drunks. Thus Gittinger was able to make generalizations about the different ways an I or an E responded to alcohol.[2] Simply by knowing how people scored on the Wechsler digit-span test, he could predict how they would react to liquor. Hyde and Harold Abramson at Mount Sinai Hospital made the same kind of observations for LSD finding, among other things, that an E was more likely than an I to have a bad trip. (Apparently, an I is more accustomed than an E to "being into his own head" and losing touch with external reality.)

At Gittinger's urging, other Human Ecology grantees gave the Wechsler battery to their experimental subjects and sent him the scores. He was building a unique data base on all phases of human behavior, and he needed samples of as many distinct groups as possible. By getting the scores of actors, he could make generalizations about what sort of people made good role-players. Martin Orne at Harvard sent in scores of hypnosis subjects, so Gittinger could separate the personality patterns of those who easily went into a trance from those who could not be hypnotized. Gittinger collected Wechslers of businessmen, students, high-priced fashion models, doctors, and just about any other discrete group he could find a way to have tested. In huge numbers, the Wechslers came flowing in - 29,000 sets in all by the early 1970s - each one accompanied by biographic data. With the 10 subtests he used and at least 10 possible scores on each of those, no two Wechsler results in the whole sample ever looked exactly the same. Gittinger kept a computer printout of all 29,000 on his desk, and he would fiddle with them almost every day - looking constantly for new truths that could be drawn out of them.

John Gittinger was interested in all facets of personality, but because he worked for the CIA, he emphasized deviant forms. He particularly sought out Wechslers of people who had rejected the values of their society or who had some vice - hidden or otherwise - that caused others to reject them. By studying the scores of the defectors who had come over to the West, Gittinger hoped to identify common characteristics of men who had become traitors to their governments. If there were identifiable traits, Agency operators could look for them in prospective spies. Harris Isbell, who ran the MKULTRA drug-testing program at the Lexington, Kentucky detention hospital, sent in the scores of heroin addicts. Gittinger wanted to know what to look for in people susceptible to drugs. The Human Ecology project at Ionia State Hospital in Michigan furnished Wechslers of sexual psychopaths. These scores showed that people with uncontrollable urges have different personality patterns than so-called normals. Gittinger himself journeyed to the West Coast to test homosexuals, lesbians, and the prostitutes he interviewed under George White's auspices in the San Francisco safehouse. With each group, he separated out the telltale signs that might be a future indicator of their sexual preference in others. Gittinger understood that simply by looking at the Wechsler scores of someone newly tested, he could pick out patterns that corresponded to behavior of people in the data base.

The Gittinger system worked best when the TSS staff had a subject's Wechsler scores to analyze, but Agency officials could not very well ask a Russian diplomat or any other foreign target to sit down and take the tests. During World War II, OSS chief William Donovan had faced a similar problem in trying to find out about Adolf Hitler's personality, and Donovan had commissioned psychoanalyst Walter Langer to make a long-distance psychiatric profile of the German leader. Langer had sifted through all the available data on the Führer, and that was exactly what Gittinger's TSS assessments staff did when they lacked direct contact (and when they had it, too). They pored over all the intelligence gathered by operators, agents, bugs, and taps and looked at samples of a man's handwriting.[3] The CIA men took the process of "indirect assessment" one step further than Langer had, however. They observed the target's behavior and looked for revealing patterns that corresponded with traits already recorded among the subjects of the 29,000 Wechsler samples.

Along this line, Gittinger and his staff had a good idea how various personality types acted after consuming a few drinks. Thus, they reasoned, if they watched a guest at a cocktail party and he started to behave in a recognizable way - by withdrawing, for instance - they could make an educated guess about his personality type - in this case, that he was an I. In contrast, the drunken Russian diplomat who became louder and began pinching every woman who passed by probably was an E. Instead of using the test scores to predict how a person would behave, the assessments staff was, in effect, looking at behavior and working backward to predict how the person would have scored if he had taken the test. The Gittinger staff developed a whole checklist of 30 to 40 patterns that the skilled observer could look for. Each of these traits reflected one of the Wechsler subtests, and it corresponded to some insight picked up from the 29,000 scores in the data base.

Was the target sloppy or neat? Did he relate to women stiffly or easily? How did he hold a cigarette and put it into his mouth? When he went through a receiving line, did he immediately repeat the name of each person introduced to him? Taken as a whole, all these observations allowed Gittinger to make a reasoned estimate about a subject's personality, with emphasis on his vulnerabilities. As Gittinger describes the system, "If you could get a sample of several kinds of situations, you could begin to get some pretty good information." Nevertheless, Gittinger had his doubts about indirect assessment. "I never thought we were good at this," he says.

The TSS assessment staff, along with the Agency's medical office use the PAS indirectly to keep up the OSS tradition of making psychological portraits of world leaders like Hitler. Combining analytical techniques with gossipy intelligence, the assessors tried to give high-level U.S. officials a better idea of what moved the principal international political figures.[4] One such study of an American citizen spilled over into the legally forbidden domestic area when in 1971 the medical office prepared a profile of Daniel Ellsberg at the request of the White House. To get raw data for the Agency assessors, John Ehrlichman authorized a break-in at Ellsberg's psychiatrist's office in California. John Gittinger vehemently denies that his staff played any role in preparing this profile, which the White House plumbers intended to use as a kind of psychological road map to compromise Ellsberg - just as CIA operators regularly worked from such assessments to exploit the weaknesses of foreigners.

Whether used directly or indirectly, the PAS gave Agency case officers a tool to get a better reading of the people with whom they dealt. CIA field stations overseas routinely sent all their findings on a target, along with indirect assessment checklists, back to Washington, so headquarters personnel could decide whether or not to try recruitment. The TSS assessment staff contributed to this process by attempting to predict what ploys would work best on the man in the case officers' sights. "Our job was to recommend what strategy to try," says a onetime Gittinger colleague. This source states he had direct knowledge of cases where TSS recommendations led to sexual entrapment operations, both hetero- and homosexual. "We had women ready - called them a stable," he says, and they found willing men when they had to.

One CIA psychologist stresses that the PAS only provided "clues" on how to compromise people. "If somebody's assessment came in like the sexual psychopaths', it would raise red flags," he notes. But TSS staff assessors could only conclude that the target had a potentially serious sex problem. They could by no means guarantee that the target's defenses could be broken. Nevertheless, the PAS helped dictate the best weapons for the attack. "I've heard John [Gittinger] say there's always something that someone wants," says another former Agency psychologist. "And with the PAS you can find out what it is. It's not necessarily sex or booze. Sometimes it's status or recognition or security." Yet another Gittinger colleague describes this process as "looking for soft spots." He states that after years of working with the system, he still bridled at a few of the more fiendish ways "to get at people" that his colleagues dreamed up He stayed on until retirement, however, and he adds, "None of this was personal. It was for national security reasons."

A few years ago, ex-CIA psychologist James Keehner told reporter Maureen Orth that he personally went to New York in 1969 to give Wechsler tests to an American nurse who had volunteered her body for her country. "We wanted her to sleep with this Russian," explained Keehner. "Either the Russian would fall in love with her and defect, or we'd blackmail him. I had to see if she could sleep with him over a period of time and not get involved emotionally. Boy, was she tough!" Keehner noted that he became disgusted with entrapment techniques, especially after watching a film of an agent in bed with a "recruitment target." He pointed out that Agency case officers, many of whom "got their jollies" from such work, used a hidden camera to get their shots. The sexual technology developed in the MKULTRA safehouses in New York and San Francisco had been put to work. The operation worked no better in the 1960s, however, than TSS officials predicted such activities would a decade earlier. "You don't really recruit agents with sexual blackmail," Keehner concluded. "That's why I couldn't even take reading the files after a while. I was sickened at seeing people take pleasure in other people's inadequacies. First of all, I thought it was just dumb. For all the money going out, nothing ever came back."

Keehner became disgusted by the picking-at-scabs aspect of TSS assessment work. Once the PAS had identified a target as having potential mental instabilities, staff members sometimes suggested ways to break him down, reasoning that by using a ratchet-like approach to put him under increased pressure, they might be able to break the lines that tied him to his country, if not to his sanity. Keehner stated, "I was sent to deal with the most negative aspects of the human condition. It was planned destructiveness. First, you'd check to see if you could destroy a man's marriage. If you could, then that would be enough to put a lot of stress on the individual, to break him down. Then you might start a minor rumor campaign against him. Harass him constantly. Bump his car in traffic. A lot of it is ridiculous, but it may have a cumulative effect." Agency case officers might also use this same sort of stress-producing campaign against a particularly effective enemy intelligence officer whom they knew they could never recruit but whom they hoped to neutralize.

Most operations - including most recruitments - did not rely on such nasty methods. The case officer still benefited from the TSS staffs assessment, but he usually wanted to minimize stress rather than accentuate it. CIA operators tended to agree that the best way to recruit an agent was to make the relationship as productive and satisfying as possible for him, operating from the old adage about catching more flies with honey than vinegar. "You pick the thing most fearful to him - the things which would cause him the most doubt," says the source. "If his greatest fear is that he can't trust you to protect him and his family, you overload your pitch with your ability to do it. Other people need structure, so you tell them exactly what they will need to do. If you leave it open-ended, they'll be scared you'll ask them to do things they're incapable of."[5]

Soon after the successful recruitment of a foreigner to spy for the CIA, either a CIA staff member or a specially trained case officer normally sat down with the new agent and gave him the full battery of Wechsler subtests - a process that took several hours. The tester never mentioned that the exercise had anything to do with personality but called it an "aptitude" test - which it also is. The assessments office in Washington then analyzed the results. As with the polygraph, the PAS helped tell if the agent were lying. It could often delve deeper than surface concepts of true and false. The PAS might show that the agent's motivations were not in line with his behavior. In that case, if the gap were too great, the case officer could expect to run up against considerable deception - resulting either from espionage motives or psychotic tendencies.

The TSS staff assessors sent a report back to the field on the best way to deal with the new agent and the most effective means to exploit him. They would recommend whether his case officer should treat him sternly or permissively. If the agent were an Externalizer who needed considerable companionship, the assessors might suggest that the case officer try to spend as much time with him as possible.[6] They would probably recommend against sending this E agent on a long mission into a hostile country, where he could not have the friendly company he craved.

Without any help from John Gittinger or his system, covert operators had long been deciding matters like these, which were, after all, rooted in common sense. Most case officers prided themselves on their ability to play their agents like a musical instrument, at just the right tempo, and the Gittinger system did not shake their belief that nothing could beat their own intuition. Former CIA Deputy Director Ray Cline expresses a common view when he says the PAS "was part of the system - kind of a check-and-balance - a supposedly scientific tool that was not weighed very heavily. I never put as much weight on the psychological assessment reports as on a case officer's view.... In the end, people went with their own opinion." Former Director William Colby found the assessment reports particularly useful in smoothing over that "traumatic" period when a case officer had to pass on his agent to a replacement. Understandably, the agent often saw the switch as a danger or a hardship. "The new guy has to show some understanding and sympathy," says Colby, who had 30 years of operational experience himself, "but it doesn't work if these feelings are not real."

For those Agency officers who yearned to remove as much of the human element as possible from agent operations, Gittinger's system was a natural. It reduced behavior to a workable formula of shorthand letters that, while not insightful in all respects, gave a reasonably accurate description of a person. Like Social Security numbers, such formulas fitted well with a computerized approach. While not wanting to overemphasize the Agency's reliance on the PAS, former Director Colby states that the system made dealing with agents "more systematized, more professional."

In 1963 the CIA's Inspector General gave the TSS assessment staff high marks and described how it fit into operations:

> The [Clandestine Services] case officer is first and foremost, perhaps, a practitioner of the art of assessing and exploiting human personality and motivations for ulterior purposes. The ingredients of advanced skill in this art are highly individualistic in nature, including such qualities as perceptiveness and imagination. [The PAS] seeks to enhance the case officer's skill by bringing the methods and disciplines of psychology to bear.... The prime objectives are control, exploitation, or neutralization. These objectives are innately anti-ethical rather than therapeutic in their intent.

In other words, the PAS is directed toward the relationship between the American case officer and his foreign agent, that lies at the heart of espionage. In that sense, it amounts to its own academic discipline - the psychology of spying - complete with axioms and reams of empirical data. The business of the PAS, like that of the CIA, is control.

One former CIA psychologist, who still feels guilty about his participation in certain Agency operations, believes that the CIA's fixation on control and manipulation mirrors, in a more virulent form, the way Americans deal with each other generally. "I don't think the CIA is too far removed from the culture," he says. "It's just a matter of degree. If you put a lot of money out there, there are many people who are lacking the ethics even of the CIA. At least the Agency had an ideological basis." This psychologist believes that the United States has become an extremely control-oriented society - from the classroom to politics to television advertising. Spying and the PAS techniques are unique only in that they are more systematic and secret.

Another TSS scientist believes that the Agency's behavioral research was a logical extension of the efforts of American psychologists, psychiatrists, and sociologists to change behavior - which he calls their "sole motivation." Such people manipulate their subjects in trying to make mentally disturbed people well, in turning criminals into law-abiding citizens, in improving the work of students, and in pushing poor people to get off welfare. The source cites all of these as examples of "behavior modification" for socially acceptable reasons, which, like public attitudes toward spying, change from time to time. "Don't get the idea that all these behavioral scientists were nice and pure, that they didn't want to change anything, and that they were detached in their science," he warns. "They were up to their necks in changing people. It just happened that the things they were interested in were not always the same as what we were." Perhaps the saving grace of the behavioral scientists is summed up by longtime MKULTRA consultant Martin Orne: "We are sufficiently ineffective so that our findings can be published." With the PAS, CIA officials had a handy tool for social engineering. The Gittinger staff found one use for it in the sensitive area of selecting members of foreign police and intelligence agencies. All over the globe, Agency operators have frequently maintained intimate working relations with security services that have consistently mistreated their own citizens. The assessments staff played a key role in choosing members of the secret police in at least two countries whose human-rights records are among the world's worst.

In 1961, according to TSS psychologist John Winne, the CIA and the Korean government worked together to establish the newly created Korean Central Intelligence Agency (KCIA). The American CIA station in Seoul asked headquarters to send out an assessor to "select the initial cadre" of the KCIA. Off went Winne on temporary duty. "I set up an office with two translators," he recalls, "and used a Korean version of the Wechsler." The Agency psychologist gave the tests to 25 to 30 police and military officers and wrote up a half-page report on each, listing their strengths and weaknesses. Winne wanted to know about each candidate's "ability to follow orders, creativity, lack of personality disorders, motivation - why he wanted out of his current job. It was mostly for the money, especially with the civilians." The test results went to the Korean authorities, whom Winne believes made the personnel decisions "in conjunction with our operational people."

"We would do a job like this and never get feedback, so we were never sure we'd done a good job," Winne complains. Sixteen years after the end of his mission to Seoul and after news of KCIA repression at home and bribes to American congressmen abroad, Winne feels that his best efforts had "boomeranged." He states that Tongsun Park was not one of the KCIA men he tested.

In 1966 CIA staffers, including Gittinger himself, took part in selecting members of an equally controversial police unit in Uruguay - the anti-terrorist section that fought the Tupamaro urban guerrillas. According to John Cassidy, the CIA's deputy station chief there at the time, Agency operators worked to set up this special force together with the Agency for International Development's Public Safety Mission (whose members included Dan Mitrione, later kidnapped and killed by the Tupamaros). The CIA-assisted police claimed they were in a life-and-death struggle against the guerrillas, and they used incredibly brutal methods, including torture, to stamp out most of the Uruguayan left along with the guerrillas.

While the special police were being organized, "John [Gittinger] came down for three days to get the program underway," recalls Cassidy. Then Hans Greiner, a Gittinger associate, ran Wechslers on 20 Uruguayan candidates. One question on the information subtest was "How many weeks in the year?" Eighteen of the 20 said it was 48, and only one man got the answer right. (Later he was asked about his answer, and he said he had made a mistake; he meant 48.) But when Greiner asked this same group of police candidates, "Who wrote Faust?" 18 of the 20 knew it was Goethe. "This tells you something about the culture," notes Cassidy, who served the Agency all over Latin America. It also points up the difficulty Gittinger had in making the PAS work across cultural lines.

In any case, CIA man Cassidy found the assessment process most useful for showing how to train the anti-terrorist section. "According to the results, these men were shown to have very dependent psychologies and they needs d strong direction," recalls the now-retired operator. Cassidy was quite pleased with the contribution Gittinger and Greiner made. "For years I had been dealing with Latin Americans," says Cassidy, "and here, largely by psychological tests, one of [Gittinger's] men was able to analyze people he had no experience with and give me some insight into them.... Ordinarily, we would have just selected the men and gone to work on them."

In helping countries like South Korea and Uruguay pick their secret police, TSS staff members often inserted a devilish twist with the PAS. They could not only choose candidates who would make good investigators, interrogators, or whatever, but they could also spot those who were most likely to succumb to future CIA blandishments. "Certain types were more recruitable," states a former assessor. "I looked for them when I wrote my reports.... Anytime the Company [the CIA] spent money for training a foreigner, the object was that he would ultimately serve our control purposes." Thus, CIA officials were not content simply to work closely with these foreign intelligence agencies; they insisted on penetrating them, and the PAS provided a useful aid.

In 1973 John Gittinger and his longtime associate John Winne, who picked KCIA men, published a basic description of the PAS in a professional journal. Although others had written publicly about the system, this article apparently disturbed some of the Agency's powers, who were then cutting back on the number of CIA employees at the order of short-time Director James Schlesinger.

Shortly thereafter, Gittinger, then 56, stopped being president of Psychological Assessment Associates but stayed on as a consultant. In 1974 I wrote about Gittinger's work, albeit incompletely, in Rolling Stone magazine. Gittinger was disturbed that disclosure of his CIA connection would hurt his professional reputation. "Are we tarred by a brush because we worked for the CIA?" he asked during one of several rather emotional exchanges. "I'm proud of it." He saw no ethical problems in "looking for people's weaknesses" if it helped the CIA obtain information, and he declared that for many years most Americans thought this was a useful process. At first, he offered to give me the Wechsler tests and prepare a personality assessment to explain the system, but Agency officials prohibited his doing so. "I was given no explanation," said the obviously disappointed Gittinger. "I'm very proud of my professional work, and I had looked forward to being able to explain it."

In August 1977 Gittinger publicly testified in Senate hearings. While he obviously would have preferred talking about his psychological research, his most persistent questioner, Senator Edward Kennedy, was much more interested in bringing out sensational details about prostitutes and drug testing. A proud man, Gittinger felt "humiliated" by the experience, which ended with him looking foolish on national television. The next month, the testimony of his former associate, David Rhodes, further bruised Gittinger. Rhodes told the Kennedy subcommittee about Gittinger's role in leading the "Gang that Couldn't Spray Straight" in an abortive attempt to test LSD in aerosol cans on unwitting subjects. Gittinger does not want his place in history to be determined by this kind of activity. He would like to see his Personality Assessment System accepted as an important contribution to science.

Tired of the controversy and worn down by trying to explain the PAS, Gittinger has moved back to his native Oklahoma. He took a copy of the 29,000 Wechsler results with him, but he has lost his ardor for working with them. A handful of psychologists around the country still swear by the system and try to pass it on to others. One, who uses it in private practice, says that in therapy it saves six months in understanding the patient. This psychologist takes a full reading of his patient's personality with the PAS, and then he varies his treatment to fit the person's problems. He believes that most American psychologists and psychiatrists treat their patients the same whereas the PAS is designed to identify the differences between people. Gittinger very much hopes that others will accept this view and move his system into the mainstream. "It means nothing unless I can get someone else to work on it," he declares. Given the preconceptions of the psychological community, the inevitable taint arising from the CIA's role in developing the system, and Gittinger's lack of academic credentials and energy, his wish will probably not be fulfilled.

Notes 10

The material on the Gittinger Personality Assessment System (PAS) comes from "An Introduction to the Personality Assessment System" by John Winne and John Gittinger, Monograph Supplement No. 38, Clinical Psychology Publishing Co., Inc. 1973; an interview with John Winne; interviews with three other former CIA psychologists; 1974 interviews with John Gittinger by the author; and an extended interview with Gittinger by Dr. Patricia Greenfield, Associate Professor of Psychology at UCLA. Some of the material was used first in a Rolling Stone article, July 18, 1974, "The CIA Won't Quite Go Public." Robert Hyde's alcohol research at Butler Health Center was MKULTRA Subproject 66. See especially 66-17, 27 August, 1958. Subject: Proposed Alcohol Study - 1958-1959 and 66-5. undated, Subject: Equipment - Ecology Laboratory.

The 1963 Inspector General's report on TSS, as first released under the Freedom of Information Act, did not include the section on personality assessment quoted from in the chapter. An undated, untitled document, which was obviously this section, was made available in one of the CIA's last releases.

MKULTRA subproject 83 dealt with graphology research, as did part of Subproject 60, which covered the whole Human Ecology Society. See especially 83-7, December 11, 1959, Subject: [deleted] Graphological Review and 60-28, undated, Subject [deleted] Activities Report, May, 1959-April, 1960.

Information on the psychological profile of Ferdinand Marcos came from a U.S. Government source who had read it. Information on the profile of the Shah of Iran came from a column by Jack Anderson and Les Whitten "CIA Study Finds Shah Insecure," Washington Post, July 11, 1975.

The quotes from James Keehner came from an article in New Times by Maureen Orth, "Memoirs of a CIA

Psychologist," June 25, 1975.

For related reports on the CIA's role in training foreign police and its activities in Uruguay, see an article by Taylor Branch and John Marks, "Tracking the CIA," Harper's Weekly, January 25, 1975 and Philip Agee's book, Inside the Company: CIA Diary (London: Penguin; 1975).

The quote from Martin Orne was taken from Patricia Greenfield's APA Monitor article cited in the last chapter's notes.

Gittinger's testimony before the Senate Select Committee on Intelligence and the Kennedy subcommittee on August 3, 1977 appeared on pages 50-63. David Rhodes' testimony on Gittinger's role in the abortive San Francisco LSD spraying appeared in hearings before the Kennedy subcommittee, September 20, 1977, pp. 100-110.

Footnotes 10

1. Developed by psychologist David Wechsler, this testing system is called, in different versions, the Wechsler-Bellevue and the Wechsler Adult Intelligence Scale. As Gittinger worked with it over the years, he made modifications that he incorporated in what he named the Wechsler-Bellevue-G. For simplicity's sake, it is simply referred to as the Wechsler system throughout the book.
2. As with most of the descriptions of the PAS made in the book, this is an oversimplification of a more complicated process. The system, as Gittinger used it, yielded millions of distinct personality types. His observations on alcohol were based on much more than a straight I and E comparison. For the most complete description of the PAS in the open literature, see the article by Gittinger and Winne cited in the chapter notes.
3. Graphology (handwriting analysis) appealed to CIA officials as a way of supplementing PAS assessments or making judgments when only a written letter was available. Graphology was one of the seemingly arcane fields which the Human Ecology Society had investigated and found operational uses for. The Society wound up funding handwriting research and a publication in West Germany where the subject was taken much more seriously than in the United States, and it sponsored a study to compare handwriting analyses with Wechsler scores of actors (including some homosexuals), patients in psychotherapy, criminal psychopaths, and fashion models. Gittinger went on to hire a resident graphologist who could do the same sort of amazing things with handwriting as the Oklahoma psychologist could do with Wechsler scores. One former colleague recalls her spotting - accurately - a stomach ailment in a foreign leader simply by reading one letter. Asked in an interview about how the Agency used her work, she replied, "If they think they can manipulate a person, that's none of my business. I don't know what they do with it. My analysis was not done with that intention.... Something I learned very early in government was not to ask questions."
4. A profile of Ferdinand Marcos found the Filipino president's massive personal enrichment while in office to be a natural outgrowth of his country's tradition of putting loyalty to one's family and friends ahead of all other considerations. Agency assessors found the Shah of Iran to be a brilliant but dangerous megalomaniac whose problems resulted from an overbearing father, the humiliation of having served as a puppet ruler, and his inability for many years to produce a male heir.
5. This source reports that case officers usually used this sort of nonthreatening approach and switched to the rougher stuff if the target decided he did not want to spy for the CIA. In that case, says the ex-CIA man, "you don't want the person to say no and run off and tattle. You lose an asset that way - not in the sense of the case officer being shot, but by being nullified." The spurned operator might then offer not to reveal that the target was cheating on his wife or had had a homosexual affair, in return for the target not disclosing the recruitment attempt to his own intelligence service.
6. While Agency officials might also have used the PAS to select the right case officer to deal with the E agent - one who would be able to sustain the agent's need for a close relationship over a long period of time - they almost never used the system with this degree of precision. An Agency office outside TSS did keep Wechslers and other test scores on file for most case officers, but the Clandestine Services management was not willing to turn over the selection of American personnel to the psychologists.

11. Hypnosis

No mind-control technique has more captured popular imagination - and kindled fears - than hypnosis. Men have long dreamed they could use overwhelming hypnotic powers to compel others to do their bidding. And when CIA officials institutionalized that dream in the early Cold War Days, they tried, like modern-day Svengalis, to use hypnosis to force their favors on unwitting victims.

One group of professional experts, as well as popular novelists, argued that hypnosis would lead to major breakthroughs in spying. Another body of experts believed the opposite. The Agency men, who did not fully trust the academics anyway, listened to both points of view and kept looking for applications which fit their own special needs. To them, hypnosis offered too much promise not to be pursued, but finding the answers was such an elusive and dangerous process that 10 years after the program started CIA officials were still searching for practical uses.

The CIA's first behavioral research czar, Morse Allen of ARTICHOKE, was intrigued by hypnosis. He read everything he could get his hands on, and in 1951 he went to New York for a four-day course from a well-known stage hypnotist. This hypnotist had taken the Svengali legend to heart, and he bombarded Allen with tales of how he used hypnosis to seduce young women. He told the ARTICHOKE chief that he had convinced one mesmerized lady that he was her husband and that she desperately wanted him. That kind of deception has a place in covert operations, and Morse Allen was sufficiently impressed to report back to his bosses the hypnotist's claim that "he spent approximately five nights a week away from home engaging in sexual intercourse."

Apart from the bragging, the stage hypnotist did give Morse Allen a short education in how to capture a subject's attention and induce a trance. Allen returned to Washington more convinced than ever of the benefits of working hypnosis into the ARTICHOKE repertory and of the need to build a defense against it. With permission from above, he decided to take his hypnosis studies further, right in his own office. He asked young CIA secretaries to stay after work and ran them through the hypnotic paces - proving to his own satisfaction that he could make them do whatever he wanted. He had secretaries steal SECRET files and pass them on to total strangers, thus violating the most basic CIA security rules. He got them to steal from each other and to start fires. He made one of them report to the bedroom of a strange man and then go into a deep sleep. "This activity clearly indicates that individuals under hypnosis might be compromised and blackmailed," Allen wrote.

On February 19, 1954, Morse Allen simulated the ultimate experiment in hypnosis: the creation of a "Manchurian *Candida*te," or programmed assassin. Allen's "victim" was a secretary whom he put into a deep trance and told to keep sleeping until he ordered otherwise. He then hypnotized a second secretary and told her that if she could not wake up her friend, "her rage would be so great that she would not hesitate to 'kill.' " Allen left a pistol nearby, which the secretary had no way of knowing was unloaded. Even though she had earlier expressed a fear of firearms of any kind, she picked up the gun and "shot" her sleeping friend. After Allen brought the "killer" out of her trance, she had apparent amnesia for the event, denying she would ever shoot anyone.

With this experiment, Morse Allen took the testing as far as he could on a make-believe basis, but he was neither satisfied nor convinced that hypnosis would produce such spectacular results in an operational setting. All he felt he had proved was that an impressionable young volunteer would accept a command from a legitimate authority figure to take an action she may have sensed would not end in tragedy. She presumably trusted the CIA enough as an institution and Morse Allen as an individual to believe he would not let her do anything wrong. The experimental setting, in effect, legitimated her behavior and prevented it from being truly antisocial.

Early in 1954, Allen almost got his chance to try the crucial test. According to a CIA document, the subject was to be a 35-year-old, well-educated foreigner who had once worked for a friendly secret service, probably the CIA itself. He had now shifted his loyalty to another government, and the CIA was quite upset with him. The Agency plan was to hypnotize him and program him into making an assassination attempt. He would then be arrested at the least for attempted murder and "thereby disposed of." The scenario had several holes in it, as the operators presented it to the ARTICHOKE team. First, the subject was to be involuntary and unwitting, and as yet no one had come up with a consistently effective way of hypnotizing such people. Second, the

ARTICHOKE team would have only limited custody of the subject, who was to be snatched from a social event. Allen understood that it would probably take months of painstaking work to prepare the man for a sophisticated covert operation. The subject was highly unlikely to perform after just one command. Yet, so anxious were the ARTICHOKE men to try the experiment that they were willing to go ahead even under these unfavorable conditions: "The final answer was that in view of the fact that successful completion of this proposed act of attempted assassination was insignificant to the overall project; to wit, whether it was even carried out or not, that under 'crash conditions' and appropriate authority from Headquarters, the ARTICHOKE team would undertake the problem in spite of the operational limitations."

This operation never took place. Eager to be unleashed, Morse Allen kept requesting prolonged access to operational subjects, such as the double agents and defectors on whom he was allowed to work a day or two. Not every double agent would do. The candidate had to be among the one person in five who made a good hypnotic subject, and he needed to have a dissociative tendency to separate part of his personality from the main body of his consciousness. The hope was to take an existing ego state - such as an imaginary childhood playmate - and build it into a separate personality, unknown to the first. The hypnotist would communicate directly with this schizophrenic offshoot and command it to carry out specific deeds about which the main personality would know nothing. There would be inevitable leakage between the two personalities, particularly in dreams; but if the hypnotists were clever enough, he could build in cover stories and safety valves which would prevent the subject from acting inconsistently.

All during the spring and summer of 1954, Morse Allen lobbied for permission to try what he called "terminal experiments" in hypnosis, including one along the following scenario:

> CIA officials would recruit an agent in a friendly foreign country where the Agency could count on the cooperation of the local police force. CIA case officers would train the agent to pose as a leftist and report on the local communist party. During training, a skilled hypnotist would hypnotize him under the guise of giving him medical treatment (the favorite ARTICHOKE cover for hypnosis). The hypnotist would then provide the agent with information and tell him to forget it all when he snapped out of the trance. Once the agent had been properly conditioned and prepared, he would be sent into action as a CIA spy. Then Agency officials would tip off the local police that the man was a dangerous communist agent, and he would be arrested. Through their liaison arrangement with the police, Agency case officers would be able to watch and even guide the course of the interrogation. In this way, they could answer many of their questions about hypnosis on a live guinea pig who believed his life was in danger. Specifically, the men from ARTICHOKE wanted to know how well hypnotic amnesia held up against torture. Could the amnesia be broken with drugs? One document noted that the Agency could even send in a new hypnotist to try his hand at cracking through the commands of the first one. Perhaps the most cynical part of the whole scheme came at the end of the proposal: "In the event that the agent should break down and admit his connection with US intelligence, we a) deny this absolutely and advise the agent's disposal, or b) indicate that the agent may have been dispatched by some other organ of US intelligence and that we should thereafter run the agent jointly with [the local intelligence service]."

An ARTICHOKE team was scheduled to carry out field tests along these lines in the summer of 1954. The planning got to an advanced stage, with the ARTICHOKE command center in Washington cabling overseas for the "time, place, and bodies available for terminal experiments." Then another cable complained of the "diminishing numbers" of subjects available for these tests. At this point, the available record becomes very fuzzy. The minutes of an ARTICHOKE working group meeting indicate that a key Agency official - probably the station chief in the country where the experiments were going to take place - had second thoughts. One participant at the meeting, obviously rankled by the obstructionism, said if this naysayer did not change his attitude, ARTICHOKE officials would have the Director himself order the official to go along.

Although short-term interrogations of unwitting subjects with drugs and hypnosis (the "A" treatment) continued, the more complicated tests apparently never did get going under the ARTICHOKE banner. By the end of the year, 1954, Allen Dulles took the behavioral-research function away from Morse Allen and gave it to Sid Gottlieb and the men from MKULTRA. Allen had directly pursued the goal of creating a Manchurian *Candida*te, which he clearly believed was possible. MKULTRA officials were just as interested in finding ways to assert control over people, but they had much less faith in the frontal-assault approach pushed by Allen. For them, finding the Manchurian *Candida*te became a figurative exercise. They did not give up the dream. They simply pursued it in smaller steps, always hoping to increase the percentages in their favor. John Gittinger, the MKULTRA case officer on hypnosis, states, "Predictable absolute control is not possible on a particular individual. Any psychologist, psychiatrist, or preacher can get control over certain kinds of individuals, but that's not a predictable, definite thing." Gittinger adds that despite his belief to this effect, he felt he had to give "a fair shake" to people who wanted to try out ideas to the contrary.

Gottlieb and his colleagues had already been doing hypnosis research for two years. They did a few basic experiments in the office, as Morse Allen did, but they farmed out most of the work to a young Ph.*D. candida*te at the University of Minnesota, Alden Sears. Sears, who later moved his CIA study project to the University of Denver, worked with student subjects to define the nature of hypnosis. Among many other things, he looked into several of the areas that would be building blocks in the creation of a Manchurian *Candida*te. Could a hypnotist induce a totally separate personality? Could a subject be sent on missions he would not remember unless cued by the hypnotist? Sears, who has since become a Methodist minister, refused to talk about methods he experimented with to build second identities.[1] By 1957, he wrote that the experiments that needed to be done "could not be handled in the University situation." Unlike Morse Allen, he did not want to perform the terminal experiments.

Milton Kline, a New York psychologist who says he also did not want to cross the ethical line but is sure the intelligence agencies have, served as an unpaid consultant to Sears and other CIA hypnosis research. Nothing Sears or others found disabused him of the idea that the Manchurian *Candida*te is possible. "It cannot be done by everyone," says Kline, "It cannot be done consistently, but it can be done."

A onetime president of the American Society for Clinical and Experimental Hypnosis, Kline was one of many outside experts to whom Gittinger and his colleagues talked. Other consultants, with equally impressive credentials, rejected Kline's views. In no other area of the behavioral sciences was there so little accord on basic questions. "You could find an expert who would agree with everything," says Gittinger. "Therefore, we tried to get everybody."

The MKULTRA men state that they got too many unsolicited suggestions on how to use hypnosis in covert operations. "The operators would ask us for easy solutions," recalls a veteran. "We therefore kept a laundry list of why they couldn't have what they wanted. We spent a lot of time telling some young kid whose idea we had heard a hundred times why it wouldn't work. We would wind up explaining why you couldn't have a free lunch." This veteran mentions an example: CIA operators put a great deal of time and money into servicing "dead drops" (covert mail pickup points, such as a hollow tree) in the Soviet Union. If a collector was captured, he was likely to give away the locations. Therefore Agency men suggested that TSS find a way to hypnotize these secret mailmen, so they could withstand interrogation and even torture if arrested.

Morse Allen had wanted to perform the "terminal experiment" to see if a hypnotically induced amnesia would stand up to torture. Gittinger says that as far as he knows, this experiment was never carried out. "I still like to think we were human beings enough that this was not something we played with," says Gittinger. Such an experiment could have been performed, as Allen suggested, by friendly police in a country like Taiwan or Paraguay. CIA men did at least discuss joint work in hypnosis with a foreign secret service in 1962.[2] Whether they went further simply cannot be said.

Assuming the amnesia would hold, the MKULTRA veteran says the problem was how to trigger it. Perhaps the Russian phrase meaning "You're under arrest" could be used as a preprogrammed cue, but what if the police did not use these words as they captured the collector? Perhaps the physical sensation of handcuffs being snapped on could do it, but a metal watchband could have the same effect. According to the veteran, in the abstract, the scheme sounded fine, but in practicality, a foolproof way of triggering the amnesia could not be found. "You had to accept that when someone is caught, they're going to tell some things," he says.

MKULTRA officials, including Gittinger, did recommend the use of hypnosis in operational experiments on at least one occasion. In 1959 an important double agent, operating outside his homeland, told his Agency case officer that he was afraid to go home again because he did not think he could withstand the tough interrogation that his government used on returning overseas agents. In Washington, the operators approached the TSS men about using hypnosis, backed up with drugs, to change the agent's attitude. They hoped they could instill in him the "ability or the necessary will" to hold up under questioning.

An MKULTRA official - almost certainly Gittinger - held a series of meetings over a two-week period with the operators and wrote that the agent was "a better than average" hypnotic subject, but that his goal was to get out of intelligence work: The agent "probably can be motivated to make at least one return visit to his homeland by application of any one of a number of techniques, including hypnosis, but he may redefect in the process." The MKULTRA official continued that hypnosis probably could not produce an "operationally useful" degree of amnesia for the events of the recent past or for the hypnotic treatment itself that the agent "probably has the native ability to withstand ordinary interrogation ... provided it is to his advantage to do so."

The MKULTRA office recommended that despite the relatively negative outlook for the hypnosis, the Agency should proceed anyway. The operation had the advantage of having a "fail-safe" mechanism because the level of hypnosis could be tested out before the agent actually had to return. Moreover, the MKULTRA men felt "that a considerable amount of useful experience can be gained from this operation which could be used to improve Agency capability in future applications." In effect, they would be using hypnosis not as the linchpin of the operation, but as an adjunct to help motivate the agent.

Since the proposed operation involved the use of hypnosis and drugs, final approval could only be given by the high-level Clandestine Services committee set up for this purpose and chaired by Richard Helms. Permission was not forthcoming.

In June 1960 TSS officials launched an expanded program of operational experiments in hypnosis in cooperation with the Agency's Counterintelligence Staff. The legendary James Angleton - the prototype for the title character Saxonton in Aaron Latham's Orchids for Mother and for Wellington in Victor Marchetti's The Rope Dancer - headed Counterintelligence, which took on some of the CIA's most sensitive missions (including the illegal Agency spying against domestic dissidents). Counterintelligence officials wrote that the hypnosis program could provide a "potential breakthrough in clandestine technology." Their arrangement with TSS was that the MKULTRA men would develop the technique in the laboratory, while they took care of "field experimentation."

The Counterintelligence program had three goals: (1) to induce hypnosis very rapidly in unwitting subjects; (2) to create durable amnesia; and (3) to implant durable and operationally useful posthypnotic suggestion. The Agency released no information on any "field experimentation" of the latter two goals, which of course are the building blocks of the Manchurian *Candida*te. Agency officials provided only one heavily censored document on the first goal, rapid induction.

In October 1960 the MKULTRA program invested $9,000 in an outside consultant to develop a way of quickly hypnotizing an unwitting subject. John Gittinger says the process consisted of surprising "somebody sitting in a chair, putting your hands on his forehead, and telling the guy to go to sleep." The method worked "fantastically" on certain people, including some on whom no other technique was effective, and not on others. "It wasn't that predictable," notes Gittinger, who states he knows nothing about the field testing.

The test, noted in that one released document, did not take place until July 1963 - a full three years after the Counterintelligence experimental program began, during which interval the Agency is claiming that no other field experiments took place. According to a CIA man who participated in this test, the Counterintelligence Staff in Washington asked the CIA station in Mexico City to find a suitable candidate for a rapid induction experiment. The station proposed a low-level agent, whom the Soviets had apparently doubled. A Counterintelligence man flew in from Washington and a hypnotic consultant arrived from California. Our source and a fellow case officer brought the agent to a motel room on a pretext. "I puffed him up with his importance," says the Agency man. "I said the bosses wanted to see him and of course give him more money." Waiting in an adjoining room was the hypnotic consultant. At a prearranged time, the two case officers gently grabbed hold of the agent and tipped his chair over until the back was touching the floor. The consultant was supposed to rush in at that precise moment and apply the technique. Nothing happened. The consultant froze, unable to do the deed. "You can imagine what we had to do to cover-up," says the official, who was literally left holding the agent. "We explained we had heard a noise, got excited, and tipped him down to protect him. He was so grubby for money he would have believed any excuse."

There certainly is a huge difference between the limited aim of this bungled operation and one aimed at building a Manchurian *Candida*te. The MKULTRA veteran maintains that he and his colleagues were not interested in a programmed assassin because they knew in general it would not work and, specifically, that they could not exert total control. "If you have one hundred percent control, you have one hundred percent dependency," he says. "If something happens and you haven't programmed it in, you've got a problem. If you try to put flexibility in, you lose control. To the extent you let the agent choose, you don't have control." He admits that he and his colleagues spent hours running the arguments on the Manchurian *Candida*te back and forth. "Castro was naturally our discussion point," he declares. "Could you get somebody gung-ho enough that they would go in and get him?" In the end, he states, they decided there were more reliable ways to kill people. "You can get exactly the same thing from people who are hypnotizable by many other ways, and you can't get anything out of people who are not hypnotizable, so it has no use," says Gittinger.

The only real gain in employing a hypnotized killer would be, in theory, that he would not remember who ordered him to pull the trigger. Yet, at least in the Castro case, the Cuban leader already knew who was after him. Moreover, there were plenty of people around willing to take on the Castro contract. "A well-trained person could do it without all this mumbo-jumbo," says the MKULTRA veteran. By going to the Mafia for hitmen, CIA officials in any case found killers who had a built-in amnesia mechanism that had nothing to do with hypnosis.[3]

The MKULTRA veteran gives many reasons why he believes the CIA never actually tried a Manchurian *Candida*te operation, but he acknowledges that he does not know.[4] If the ultimate experiments were performed, they would have been handled with incredible secrecy. It would seem, however, that the same kind of reasoning that impelled Sid Gottlieb to recommend testing powerful drugs on unwitting subjects would have led to experimentation along such lines, if not to create the Manchurian *Candida*te itself, on some of the building blocks, or lesser antisocial acts. Even if the MKULTRA men did not think hypnosis would work operationally, they had not let that consideration prevent them from trying out numerous other techniques. The MKULTRA chief could even have used a defensive rationale: He had to find out if the Russians could plant a "sleeper" killer in our midst, just as Richard Condon's novel discussed.

If the assassin scenario seemed exaggerated, Gottlieb still would have wanted to know what other uses the Russians might try. Certainly, he could have found relatively "expendable" subjects, as he and Morse Allen had for other behavior control experiments. And even if the MKULTRA men really did restrain themselves, it is unlikely that James Angleton and his counterintelligence crew would have acted in such a limited fashion when they felt they were on the verge of a "breakthrough in clandestine technology."

Notes 11

Morse Allen's training in hypnosis was described in Document #A/B, V,28/1, 9 July 1951, Subject [Deleted]. His hypnosis experiments in the office are described in a long series of memos. See especially #A/B, III, 2/18, 10 February 1954, Hypnotic Experimentation and Research and #A/B, II, 10/71, 19 August 1954, Subject: Operational/Security [deleted] and unnumbered document, 5 May 1955, Subject: Hypnotism and Covert Operations.

The quote on U.S. prisoners passing through Manchuria came from document #19, 18 June 1953, ARTICHOKE Conference.

Alden Sears' hypnosis work was the subject of MKULTRA subprojects 5, 25, 29, and 49. See especially 49-28, undated, Proposal for Research in Hypnosis at the [deleted], June 1, 1956 to May 31, 1957, 49-34, undated, Proposals for Research in Hypnosis at the [deleted], June 1, 1956 to May 31, 1957; 5-11, 28 May 1953, Project MKULTRA, Subproject 5 and 5-13,20 April 1954, Subject: [deleted]. See also Patrick Oster's article in the Chicago Sun-Times, September 4, 1977, "How CIA 'Hid' Hypnosis Research."

General background on hypnosis came from interviews with Alden Sears, Martin Orne, Milton Kline, Ernest Hilgard, Herbert Spiegel, William Kroger, Jack Tracktir, John Watkins, and Harold Crasilneck. See Orne's chapter on hypnosis in The Manipulation of Human Behavior, edited by Albert Biderman and Herbert Zimmer (New York: John Wiley & Sons; 1961), pp. 169-215.

The contemplated use of hypnosis in an operation involving a foreign intelligence service is referred to in the Affidavit by Eloise R. Page, in the case John D. Marks v. Central Intelligence Agency *et al*., Civil Action no. 76-2073.

The 1959 proposed use of hypnosis that was approved by TSS is described in documents #433, 21 August 1959, Possible Use of Drugs and Hypnosis in [deleted] Operational Case; #434, 27 August 1959, Comments on [deleted]; and #435, 15 September 1959, Possible Use of Drugs and Hypnosis in [deleted] Operational Case.

MKULTRA Subproject 128 dealt with the rapid induction technique. See especially 128-1, undated, Subject: To test a method of rapid hypnotic induction in simulated and real operational settings (MKULTRA 128).

A long interview with John Gittinger added considerably to this chapter. Mr. Gittinger had refused earlier to be interviewed directly by me for this book. Our conversation was limited solely to hypnosis.

Footnotes 11

1. Sears still maintains the fiction that he thought he was dealing only with a private foundation, the Geschickter Fund, and that he knew nothing of the CIA involvement in funding his work. Yet a CIA document in his MKULTRA subproject says he was "aware of the real purpose" of the project." Moreover, Sid Gottlieb brought him to Washington in 1954 to demonstrate hypnosis to a select group of Agency officials.
2. Under my Freedom of Information suit, the CIA specifically denied access to the documents concerning the testing of hypnosis and psychedelic drugs in cooperation with foreign intelligence agencies. The justification given was that releasing such documents would reveal intelligence sources and methods, which are exempted by law. The hypnosis experiment was never carried out, according to the generic description of the document which the Agency had to provide in explaining why it had to be withheld.
3. Referring to this CIA-mob relationship, author Robert Sam Anson has written, "It was inevitable: Gentlemen wishing to be killers gravitated to killers wishing to be gentlemen."
4. The veteran admits that none of the arguments he uses against a conditioned assassin would apply to a programmed "patsy" whom a hypnotist could walk through a series of seemingly unrelated events - a visit to a store, a conversation with a mailman, picking a fight at a political rally. The subject would remember everything that happened to him and be amnesic only for the fact the hypnotist ordered him to do these things. There would be no gaping inconsistency in his life of the sort that can ruin an attempt by a hypnotist to create a second personality. The purpose of this exercise is to leave a circumstantial trail that will make the authorities think the patsy committed a particular crime. The weakness might well be that the amnesia would not hold up under police interrogation, but that would not matter if the police did not believe his preposterous story about being hypnotized or if he were shot resisting arrest. Hypnosis expert Milton Kline says he could create a patsy in three months- an assassin would take him six.

Part IV - Conclusions

12. The Search for the Truth

I'm a professional and I just don't talk about these things. Lots of things are not fit for the public. This has nothing to do with democracy. It has to do with common sense.
- GRATION H. YASETEVITCH, 1978
(explaining why he did not want to be interviewed for this book)

To hope that the power that is being made available by the behavioral sciences will be exercised by the scientists, or by a benevolent group, seems to me to be a hope little supported by either recent or distant history. It seems far more likely that behavioral scientists, holding their present attitudes, will be in the position of the German rocket scientists specializing in guided missiles. First they worked devotedly for Hitler to destroy the USSR and the United States. Now, depending on who captured them they work devotedly for the USSR in the interest of destroying the United States, or devotedly for the United States in the interest of destroying the USSR. If behavioral scientists are concerned solely with advancing their science it seems most probable that they will serve the purpose of whatever group has the power.
- CARL ROGERS, 1961

Sid Gottlieb was one of many CIA officials who tried to find a way to assassinate Fidel Castro. Castro survived, of course, and his victory over the Agency in April 1961 at the Bay of Pigs put the Agency in the headlines for the first time, in a very unfavorable light. Among the fiasco's many consequences was Gottlieb's loss of the research part of the CIA's behavior-control programs. Still, he and the others kept trying to kill Castro.

In the aftermath of the Bay of Pigs, President Kennedy reportedly vowed to splinter the CIA into a thousand pieces. In the end, he settled for firing Allen Dulles and his top deputies. To head the Agency, which lost none of its power, Kennedy brought in John McCone, a defense contractor and former head of the Atomic Energy Commission. With no operational background, McCone had a different notion than Dulles of how to manage the CIA, particularly in the scientific area. "McCone never felt akin to the covert way of doing things," recalls Ray Cline, whom the new Director made his Deputy for Intelligence. McCone apparently believed that science should be in the hands of the scientists, not the clandestine operators, and he brought in a fellow Californian, an aerospace "whiz kid" named Albert "Bud" Wheelon to head a new Agency Directorate for Science and Technology.

Before then, the Technical Services Staff (TSS), although located in the Clandestine Services, had been the Agency's largest scientific component. McCone decided to strip TSS of its main research functions - including the behavioral one - and let it concentrate solely on providing operational support. In 1962 he approved a reorganization of TSS that brought in Seymour Russell, a tough covert operator, as the new chief. "The idea was to get a close interface with operations," recalls an ex-CIA man. Experienced TSS technicians remained as deputies to the incoming field men, and the highest deputyship in all TSS went to Sid Gottlieb, who became number-two man under Russell. For Gottlieb, this was another significant promotion helped along by his old friend Richard Helms, whom McCone had elevated to be head of the Clandestine Services.

In his new job, Gottlieb kept control of MKULTRA. Yet, in order to comply with McCone's command on research programs, Gottlieb had to preside over the partial dismantling of his own program. The loss was not as difficult as it might have been, because, after 10 years of exploring the frontiers of the mind, Gottlieb had a clear idea of what worked and what did not in the behavioral field. Those areas that still were in the research stage tended to be extremely esoteric and technical, and Gottlieb must have known that if the Science Directorate scored any breakthroughs, he would be brought back into the picture immediately to apply the advances to covert operations.

"Sid was not the kind of bureaucrat who wanted to hold on to everything at all costs," recalls an admiring colleague. Gottlieb carefully pruned the MKULTRA lists, turning over to the Science Directorate the exotic subjects that showed no short-term operational promise and keeping for himself those psychological, chemical, and biological programs that had already passed the research stage. As previously stated, he moved John Gittinger and the personality-assessment staff out of the Human Ecology Society and kept them under TSS control in their own proprietary company.

While Gottlieb was effecting these changes, his programs were coming under attack from another quarter. In 1963 the CIA Inspector General did the study that led to the suspension of unwitting drug testing in the San Francisco and New York safehouses. This was a blow to Gottlieb, who clearly intended to hold on to this kind of research. At the same time, the Inspector General also recommended that Agency officials draft a new charter for the whole MKULTRA program, which still was exempt from most internal CIA controls. He found that many of the MKULTRA subprojects were of "insufficient sensitivity" to justify bypassing the Agency's normal procedures for approving and storing records of highly classified programs. Richard Helms, still the protector of unfettered behavioral research, responded by agreeing that there should be a new charter - on the condition that it be almost the same as the old one. "The basic reasons for requesting waiver of standardized administrative controls over these sensitive activities are as valid today as they were in April, 1953," Helms wrote. Helms agreed to such changes as having the CIA Director briefed on the programs twice a year, but he kept the approval process within his control and made sure that all the files would be retained inside TSS. And as government officials so often do when they do not wish to alter anything of substance, he proposed a new name for the activity. In June 1964 MKULTRA became MKSEARCH.[1]

Gottlieb acknowledged that security did not require transferring all the surviving MKULTRA subprojects over to MKSEARCH. He moved 18 subprojects back into regular Agency funding channels, including ones dealing with the sneezing powders, stink bombs, and other "harassment substances." TSS officials had encouraged the development of these as a way to make a target physically uncomfortable and hence to cause short-range changes in his behavior.

Other MKULTRA subprojects dealt with ways to maximize stress on whole societies. Just as Gittinger's Personality Assessment System provided a psychological road map for exploiting an individual's weaknesses, CIA "destabilization" plans provided guidelines for destroying the internal integrity of target countries like Castro's Cuba or Allende's Chile. Control - whether of individuals or nations - has been the Agency's main business, and TSS officials supplied tools for the "macro" as well as the "micro" attacks.

For example, under MKULTRA Subproject #143, the Agency gave Dr. Edward Bennett of the University of Houston about $20,000 a year to develop bacteria to sabotage petroleum products. Bennett found a substance that, when added to oil, fouled or destroyed any engine into which it was poured. CIA operators used exactly this kind of product in 1967 when they sent a sabotage team made up of Cuban exiles into France to pollute a shipment of lubricants bound for Cuba. The idea was that the tainted oil would "grind out motors and cause breakdowns," says an Agency man directly involved. This operation, which succeeded, was part of a worldwide CIA effort that lasted through the 1960s into the 1970s to destroy the Cuban economy.[2] Agency officials reasoned, at least in the first years, that it would be easier to overthrow Castro if Cubans could be made unhappy with their standard of living. "We wanted to keep bread out of the stores so people were hungry," says the CIA man who was assigned to anti-Castro operations. "We wanted to keep rationing in effect and keep leather out, so people got only one pair of shoes every 18 months."

Leaving this broader sort of program out of the new structure, Gottlieb regrouped the most sensitive behavioral activities under the MKSEARCH umbrella. He chose to continue seven projects, and the ones he picked give a good indication of those parts of MKULTRA that Gottlieb considered important enough to save. These included none of the sociological studies, nor the search for a truth drug. Gottlieb put the emphasis on chemical and biological substances - not because he thought these could be used to turn men into robots, but because he valued them for their predictable ability to disorient, discredit, injure, or kill people. He kept active two private labs to produce such substances, funded consultants who had secure ways to test them and ready access to subjects, and maintained a funding conduit to pass money on to these other contractors. Here are the seven surviving MKSEARCH subprojects:

> First on the TSS list was the safehouse program for drug testing run by George White and others in the Federal Bureau of Narcotics. Even in 1964, Gottlieb and Helms had not given up hope that unwitting experiments could be resumed, and the Agency paid out $30,000 that year to keep the safehouses open. In the meantime, something was going on at the "pad" - or at least George White kept on sending the CIA vouchers for unorthodox expenses - $1,100 worth in February 1965 alone under the old euphemism for prostitutes, "undercover agents for operations." What

> White was doing with or to these agents cannot be said, but he kept the San Francisco operation active right up until the time it finally closed in June. Gottlieb did not give up on the New York safehouse until the following year.[3]

MKSEARCH Subproject #2 involved continuing a $150,000a-year contract with a Baltimore biological laboratory This lab, run by at least one former CIA germ expert, gave TSS "a quick-delivery capability to meet anticipated future operational needs," according to an Agency document. Among other things, it provided a private place for "large-scale production of microorganisms." The Agency was paying the Army Biological Laboratory at Fort Detrick about $100,000 a year for the same services. With its more complete facilities, Fort Detrick could be used to create and package more esoteric bacteria, but Gottlieb seems to have kept the Baltimore facility going in order to have a way of producing biological weapons without the Army's germ warriors knowing about it. This secrecy-within-secrecy was not unusual when TSS men were dealing with subjects as sensitive as infecting targets with diseases. Except on the most general level, no written records were kept on the subject. Whenever an operational unit in the Agency asked TSS about obtaining a biological weapon, Gottlieb or his aides automatically turned down the request unless the head of the Clandestine Services had given his prior approval. Gottlieb handled these operational needs personally, and during the early 1960s (when CIA assassination attempts probably were at their peak) even Gottlieb's boss, the TSS chief, was not told what was happening.

With his biological arsenal assured, Gottlieb also secured his chemical flank in MKSEARCH. Another subproject continued a relationship set up in 1959 with a prominent industrialist who headed a complex of companies, including one that custom-manufactured rare chemicals for pharmaceutical producers. This man, whom on several occasions CIA officials gave $100 bills to pay for his products, was able to perform specific lab jobs for the Agency without consulting with his board of directors. In 1960 he supplied the Agency with 3 kilos (6.6 pounds) of a deadly carbamate - the same poison OSS's Stanley Lovell tried to use against Hitler.[4] This company president also was useful to the Agency because he was a ready source of information on what was going on in the chemical world. The chemical services he offered, coupled with his biological counterpart, gave the CIA the means to wage "instant" chemical and biological attacks - a capability that was frequently used, judging by the large numbers of receipts and invoices that the CIA released under the Freedom of Information Act.

With new chemicals and drugs constantly coming to their attention through their continuing relations with the major pharmaceutical companies, TSS officials needed places to test them, particularly after the safehouses closed. Dr. James Hamilton, the San Francisco psychiatrist who worked with George White in the original OSS marijuana days, provided a way. He became MKSEARCH Subproject #3.

Hamilton had joined MKULTRA in its earliest days and had been used as a West Coast supervisor for Gottlieb and company. Hamilton was one of the renaissance men of the program, working on everything from psychochemicals to kinky sex to carbon-dioxide inhalation. By the early 1960s, he had arranged to get access to prisoners at the California Medical Facility at Vacaville.[5] Hamilton worked through a nonprofit research institute connected to the Facility to carry out, as a document puts it, "clinical testing of behavioral control materials" on inmates. Hamilton's job was to provide "answers to specific questions and solutions to specific problems of direct interest to the Agency." In a six-month span in 1967 and 1968, the psychiatrist spent over $10,000 in CIA funds simply to pay volunteers - which at normal rates meant he experimented on between 400 to 1,000 inmates in that time period alone.

Another MKSEARCH subproject provided $20,000 to $25,000 a year to Dr. Carl Pfeiffer. Pfeiflfer's Agency connection went back to 1951, when he headed the Pharmacology Department at the University of Illinois Medical School. He then moved to Emory University and tested LSD and other drugs on inmates of the Federal penitentiary in Atlanta. From there, he moved to New Jersey, where he continued drug experiments on the prisoners at the Bordentown reformatory. An internationally known pharmacologist, Pfeiffer provided the MKSEARCH program with data on the preparation, use, and effect of drugs. He was readily available if Gottlieb or a colleague wanted a study made of the properties of a particular substance, and like most of TSS's contractors, he also was an intelligence source. Pfeiffer was useful in this last capacity during the latter part of the 1960s because he sat on the Food and Drug Administration committee that allocated LSD for scientific research in the United States. By this time, LSD was so widely available on the black market that the Federal Government had replaced the CIA's informal controls of the 1950s with laws and procedures forbidding all but the most strictly regulated research. With Pfeiffer on the governing committee, the CIA could keep up its traditional role of monitoring above-ground LSD experimentation around the United States.

To cover some of the more exotic behavioral fields, another MKSEARCH program continued TSS's relationship with Dr. Maitland Baldwin, the brain surgeon at the National Institutes of Health who had been so willing in 1955 to perform "terminal experiments" in sensory deprivation for Morse Allen and the ARTICHOKE program. After Allen was pushed aside by the men from MKULTRA, the new TSS team hired Baldwin as a consultant According to one of them, he was full of bright ideas on how to control behavior, but they were wary of him because he was such an "eager beaver" with an obvious streak of "craziness." Under TSS auspices, Baldwin performed lobotomies on apes and then put these simian subjects into sensory deprivation - presumably in the same "box" he had built himself at NIH and then had to repair after a desperate soldier kicked his way out. There is no information available on whether Baldwin extended this work to humans, although he did discuss with an outside consultant how lobotomized patients reacted to prolonged isolation. Like Hamilton, Baldwin was a jack-of-all trades who in one experiment beamed radio frequency energy directly at the brain of a chimpanzee and in another cut off one monkey's head and tried to transplant it to the decapitated body of another monkey. Baldwin used $250 in Agency money to buy his own electroshock machine, and he did some kind of unspecified work at a TSS safehouse that caused the CIA to shell out $1450 to renovate and repair the place.

The last MKSEARCH subproject covered the work of Dr. Charles Geschickter, who served TSS both as researcher and funding conduit. CIA documents show that Geschickter tested powerful drugs on mental defectives and terminal cancer patients, apparently at the Georgetown University Hospital in Washington. In all, the Agency put $655,000 into Geschickter's research on knockout drugs, stress-producing chemicals, and mind-altering substances. Nevertheless, the doctor's principal service to TSS officials seems to have been putting his family foundation at the disposal of the CIA - both to channel funds and to serve as a source of cover to Agency operators. About $2.1 million flowed through this tightly controlled foundation to other researchers.[6] Under MKSEARCH, Geschickter continued to provide TSS with a means to assess drugs rapidly, and he branched out into trying to knock out monkeys with radar waves to the head (a technique which worked but risked frying vital parts of the brain). The Geschickter Fund for Medical Research remained available as a conduit until 1967.[7]

As part of the effort to keep finding new substances to test within MKSEARCH, Agency officials continued their search for magic mushrooms, leaves, roots, and barks. In 1966, with considerable CIA backing, J. C. King, the former head of the Agency's Western Hemisphere Division who was eased out after the Bay of Pigs, formed an ostensibly private firm called Amazon Natural Drug Company. King, who loved to float down jungle rivers on the deck of his houseboat with a glass of scotch in hand, searched the backwaters of South America for plants of interest to the Agency and/or medical science. To do the work, he hired Amazon men and women, plus at least two CIA paramilitary operators who worked out of Amazon offices in Iquitos, Peru. They shipped back to the United States finds that included Chondodendron toxicoferum, a paralytic agent which is "absolutely lethal in high doses," according to Dr. Timothy Plowman, a Harvard botanist who like most of the staff was unwitting of the CIA involvement. Another plant that was collected and grown by Amazon employees was the hallucinogen known as yage, which author William Burroughs has described as "the final fix."

MKSEARCH went on through the 1960s and into the early 1970s, but with a steadily decreasing budget. In 1964 it cost the Agency about $250,000. In 1972 it was down to four subprojects and $110,000. Gottlieb was a very busy man by then, having taken over all TSS in 1967 when his patron, Richard Helms finally made it to the top of the Agency. In June 1972 Gottlieb decided to end MKSEARCH, thus bringing down the curtain on the quest he himself had started two decades before. He wrote this epitaph for the program:

> As a final commentary, I would like to point out that, by means of Project MKSEARCH, the Clandestine Service has been able to maintain contact with the leading edge of developments in the field of biological and chemical control of human behavior. It has become increasingly obvious over the last several years that this general area had less and less relevance to current clandestine operations. The reasons for this are many and complex, but two of them are perhaps worth mentioning briefly. On the scientific side, it has become very clear that these materials and techniques are too unpredictable in their effect on individual human beings, under specific circumstances, to be operationally useful. Our operations officers, particularly the emerging

> group of new senior operations officers, have shown a discerning and perhaps commendable distaste for utilizing these materials and techniques. They seem to realize that, in addition to moral and ethical considerations, the extreme sensitivity and security constraints of such operations effectively rule them out.

About the time Gottlieb wrote these words, the Watergate break-in occurred, setting in train forces that would alter his life and that of Richard Helms. A few months later, Richard Nixon was reselected. Soon after the election, Nixon, for reasons that have never been explained, decided to purge Helms. Before leaving to become Ambassador to Iran, Helms presided over a wholesale destruction of documents and tapes - presumably to minimize information that might later be used against him. Sid Gottlieb decided to follow Helms into retirement, and the two men mutually agreed to get rid of all the documentary traces of MKULTRA. They had never kept files on the safehouse testing or similarly sensitive operations in the first place, but they were determined to erase the existing records of their search to control human behavior. Gottlieb later told a Senate committee that he wanted to get rid of the material because of a "burgeoning paper problem" within the Agency, because the files were of "no constructive use" and might be "misunderstood," and because he wanted to protect the reputations of the researchers with whom he had collaborated on the assurance of secrecy. Gottlieb got in touch with the men who had physical custody of the records, the Agency's archivists, who proceeded to destroy what he and Helms thought were the only traces of the program. They made a mistake, however - or the archivists did. Seven boxes of substantive records and reports were incinerated, but seven more containing invoices and financial records survived - apparently due to misfiling.

Nixon named James Schlesinger to be the new head of the Agency, a post in which he stayed only a few months before the increasingly beleaguered President moved him over to be Secretary of Defense at the height of Watergate. During his short stop at CIA, Schlesinger sent an order to all Agency employees asking them to let his office know about any instances where Agency officials might have carried out any improper or illegal actions. Somebody mentioned Frank Olson's suicide, and it was duly included in the many hundreds of pages of misdeeds reported which became known within the CIA as the "family jewels."

Schlesinger, an outsider to the career CIA operators, had opened a Pandora's box that the professionals never managed to shut again. Samples of the "family jewels" were slipped out to New York Times reporter Seymour Hersh, who created a national furor in December 1974 when he wrote about the CIA's illegal spying on domestic dissidents during the Johnson and Nixon years. President Gerald Ford appointed a commission headed by Vice-President Nelson Rockefeller to investigate the past CIA abuses - and to limit the damage. Included in the final Rockefeller report was a section on how an unnamed Department of the Army employee had jumped out of a New York hotel window after Agency men had slipped him LSD. That revelation made headlines around the country. The press seized upon the sensational details and virtually ignored two even more revealing sentences buried in the Rockefeller text: "The drug program was part of a much larger CIA program to study possible means for controlling human behavior. Other studies explored the effects of radiation, electric-shock, psychology, psychiatry, sociology, and harassment substances."

At this point, I entered the story. I was intrigued by those two sentences, and I filed a Freedom of Information request with the CIA to obtain all the documents the Agency had furnished the Rockefeller Commission on behavior control. Although the law requires a government agency to respond within 10 days, it took the Agency more than a year to send me the first 50 documents on the subject, which turned out to be heavily censored.

In the meantime, the committee headed by Senator Frank Church was looking into the CIA, and it called in Sid Gottlieb, who was then spending his retirement working as a volunteer in a hospital in India. Gottlieb secretly testified about CIA assassination programs. (In describing his role in its final report, the Church Committee used a false name, "Victor Scheider.") Asked about the behavioral-control programs, Gottlieb apparently could not - or would not - remember most of the details. The committee had almost no documents to work with, since the main records had been destroyed in 1973 and the financial files had not yet been found.

The issue lay dormant until 1977, when, about June 1, CIA officials notified my lawyers that they had found the 7 boxes of MKULTRA financial records and that they would send me the releasable portions over the following months. As I waited, CIA Director Stansfield Turner notified President Carter and then the Senate Select Committee on Intelligence that an Agency official had located the 7 boxes. Admiral Turner publicly described

MKULTRA as only a program of drug experimentation and not one aimed at behavior control. On July 20 I held a press conference at which I criticized Admiral Turner for his several distortions in describing the MKULTRA program. To prove my various points, I released to the reporters a score of the CIA documents that had already come to me and that gave the flavor of the behavioral efforts. Perhaps it was a slow news day, or perhaps people simply were interested in government attempts to tamper with the mind. In any event, the documents set off a media bandwagon that had the story reported on all three network television news shows and practically everywhere else.

The Senate Select Committee on Intelligence and Senator Edward Kennedy's Subcommittee on Health and Scientific Research soon announced they would hold public hearings on the subject. Both panels had looked into the secret research in 1975 but had been hampered by the lack of documents and forthcoming witnesses. At first the two committees agreed to work together, and they held one joint hearing. Then, Senator Barry Goldwater brought behind-the-scenes pressure to get the Intelligence panel, of which he was vice-chairman, to drop out of the proceedings. He claimed, among other things, that the committee was just rehashing old programs and that the time had come to stop dumping on the CIA. Senator Kennedy plowed ahead anyway. He was limited, however, by the small size of the staff he assigned to the investigation, and his people were literally buried in paper by CIA officials, who released 8,000 pages of documents in the weeks before the hearings. As the hearings started, the staff still not had read everything - let alone put it all in context.

As Kennedy's staff prepared for the public sessions, the former men from MKULTRA also got ready. According to one of them, they agreed among themselves to "keep the inquiry within bounds that would satisfy the committee." Specifically, he says that meant volunteering no more information than the Kennedy panel already had. Charles Siragusa, the narcotics agent who ran the New York safehouse, reports he got a telephone call during this period from Ray Treichler, the Stanford Ph.D. who specialized in chemical warfare for the MKULTRA program. "He wanted me to deny knowing about the safehouse," says Siragusa. "He didn't want me to admit that he was the guy.... I said there was no way I could do that." Whether any other ex-TSS men also suborned perjury cannot be said, but several of them appear to have committed perjury at the hearings.[8] As previously noted, Robert Lashbrook denied firsthand knowledge of the safehouse operation when, in fact, he had supervised one of the "pads" and been present, according to George White's diary, at the time of an "LSD surprise" experiment. Dr. Charles Geschickter testified he had not tested stress-producing drugs on human subjects while both his own 1960 proposal to the Agency and the CIA's documents indicate the opposite.

Despite the presence of a key aide who constantly cued him during the hearings, Senator Kennedy was not prepared to deal with these and other inconsistencies. He took no action to follow up obviously perjured testimony, and he seemed content to win headlines with reports of "The Gang That Couldn't Spray Straight." Although that particular testimony had been set up in advance by a Kennedy staffer, the Senator still managed to act surprised when ex-MKULTRA official David Rhodes told of the ill-fated LSD experiment at the Marin County safehouse.

The Kennedy hearings added little to the general state of knowledge on the CIA's behavior-control programs. CIA officials, both past and present, took the position that basically nothing of substance was learned during the 25-odd years of research, the bulk of which had ended in 1963, and they were not challenged. That proposition is, on its face, ridiculous, but neither Senator Kennedy nor any other investigator has yet put any real pressure on the Agency to reveal the content of the research - what was actually learned - as opposed to the experimental means of carrying it out. In this book, I have tried to get at some of the substantive questions, but I have had access to neither the scientific records, which Gottlieb and Helms destroyed, nor the principal people involved. Gottlieb, for instance, who moved from India to Santa Cruz, California and then to parts unknown, turned down repeated requests to be interviewed. "I am interested in very different matters than the subject of your book these days," he wrote, "and do not have either the time or the inclination to reprocess matters that happened a long time ago."

Faced with these obstacles, I have tried to weave together a representative sample of what went on, but having dealt with a group of people who regularly incorporated lying into their daily work, I cannot be sure. I cannot be positive that they never found a technique to control people, despite my definite bias in favor of the idea that the human spirit defeated the manipulators. Only a congressional committee could compel truthful testimony from people who have so far refused to be forthcoming, and even Congress' record has not been good so far. A determined investigative committee at least could make sure that the people being probed do not determine the "bounds" of the inquiry.

A new investigation would probably not be worth the effort just to take another stab at MKULTRA and ARTICHOKE. Despite my belief that there are some skeletons hidden - literally - the public probably now knows the basic parameters of these programs. The fact is, however, that CIA officials actively experimented with behavior-control methods for another decade after Sid Gottlieb and company lost the research action. The Directorate of Science and Technology - specifically its Office of Research and Development (ORD) did not remain idle after Director McCone transferred the behavioral research function in 1962.

In ORD, Dr. Stephen Aldrich, a graduate of Amherst and Northwestern Medical School, took over the role that Morse Allen and then Sid Gottlieb had played before him. Aldrich had been the medical director of the Office of Scientific Intelligence back in the days when that office was jockeying with Morse Allen for control of ARTICHOKE, so he was no stranger to the programs. Under his leadership, ORD officials kept probing for ways to control human behavior, and they were doing so with space-age technology that made the days of MKULTRA look like the horse-and-buggy era. If man could get to the moon by the end of the 1960s, certainly the well-financed scientists of ORD could make a good shot at conquering inner space.

They brought their technology to bear on subjects like the electric stimulation of the brain. John Lilly had done extensive work in this field a decade earlier, before concluding that to maintain his integrity he must find another field. CIA men had no such qualms, however. They actively experimented with placing electrodes in the brain of animals and - probably - men. Then they used electric and radio signals to move their subjects around. The field went far beyond giving monkeys orgasms, as Lilly had done. In the CIA itself, Sid Gottlieb and the MKULTRA crew had made some preliminary studies of it. They started in 1960 by having a contractor search all the available literature, and then they had mapped out the parts of animals' brains that produced reactions when stimulated. By April 1961 the head of TSS was able to report "we now have a 'production capability' " in brain stimulation and "we are close to having debugged a prototype system whereby dogs can be guided along specific courses." Six months later, a CIA document noted, "The feasibility of remote control of activities in several species of animals has been demonstrated.... Special investigations and evaluations will be conducted toward the application of selected elements of these techniques to man." Another six months later, TSS officials had found a use for electric stimulation: this time putting electrodes in the brains of coldblooded animals - presumably reptiles. While much of the experimentation with dogs and cats was to find a way of wiring the animal and then directing it by remote control into, say, the office of the Soviet ambassador, this cold-blooded project was designed instead for the delivery of chemical and biological agents or for "executive action-type operations," according to a document. "Executive action" was the CIA's euphemism for assassination.

With the brain electrode technology at this level, Steve Aldrich and ORD took over the research function from TSS. What the ORD men found cannot be said, but the open literature would indicate that the field progressed considerably during the 1960s. Can the human brain be wired and controlled by a big enough computer? Aldrich certainly tried to find out.

Creating amnesia remained a "big goal" for the ORD researcher, states an ex-CIA man. Advances in brain surgery, such as the development of three-dimensional, "stereotaxic" techniques, made psychosurgery a much simpler matter and created the possibility that a precisely placed electrode probe could be used to cut the link between past memory and present recall. As for subjects to be used in behavioral experiments of this sort, the ex-CIA man states that ORD had access to prisoners in at least one American penal institution. A former Army doctor stationed at the Edgewood chemical laboratory states that the lab worked with CIA men to develop a drug that could be used to help program in new memories into the mind of an amnesic subject. How far did the Agency take this research? I don't know.

The men from ORD tried to create their own latter-day version of the Society for the Investigation of Human Ecology. Located outside Boston, it was called the Scientific Engineering Institute, and Agency officials had set it up originally in 1956 as a proprietary company to do research on radar and other technical matters that had nothing to do with human behavior. Its president, who says he was a "figurehead," was Dr. Edwin Land, the founder of Polaroid. In the early 1960s, ORD officials decided to bring it into the behavioral field and built a new wing to the Institute's modernistic building for the "life sciences." They hired a group of behavioral and medical scientists who were allowed to carry on their own independent research as long as it met Institute standards. These scientists were available to consult with frequent visitors from Washington, and they were encouraged to take long lunches in the Institute's dining room where they mixed with the physical scientists and brainstormed about virtually everything. One veteran recalls a colleague joking, "If you could find the natural radio frequency of a person's sphincter, you could make him run out of the room real fast." Turning serious, the veteran states the technique was "plausible," and he notes that many of the crazy ideas bandied about at lunch developed into concrete projects.

Some of these projects may have been worked on at the Institute's own several hundred-acre farm located in the Massachusetts countryside. But of the several dozen people contacted in an effort to find out what the Institute did, the most anyone would say about experiments at the farm was that one involved stimulating the pleasure centers of crows' brains in order to control their behavior. Presumably, ORD men did other things at their isolated rural lab.

Just as the MKULTRA program had been years ahead of the scientific community, ORD activities were similarly advanced. "We looked at the manipulation of genes," states one of the researchers. "We were interested in gene splintering. The rest of the world didn't ask until 1976 the type of questions we were facing in 1965.... Everybody was afraid of building the supersoldier who would take orders without questioning, like the kamikaze pilot. Creating a subservient society was not out of sight." Another Institute man describes the work of a colleague who bombarded bacteria with ultraviolet radiation in order to create deviant strains. ORD also sponsored work in parapsychology. Along with the military services, Agency officials wanted to know whether psychics could read minds or control them from afar (telepathy), if they could gain information about distant places or people (clairvoyance or remote viewing), if they could predict the future (precognition), or influence the movement of physical objects or even the human mind (photokinesis). The last could have incredibly destructive applications, if it worked. For instance, switches setting off nuclear bombs would have to be moved only a few inches to launch a holocaust. Or, enemy psychics, with minds honed to laser-beam sharpness, could launch attacks to burn out the brains of American nuclear scientists. Any or all of these techniques have numerous applications to the spy trade.

While ORD officials apparently left much of the drug work to Gottlieb, they could not keep their hands totally out of this field. In 1968 they set up a joint program, called Project OFTEN, with the Army Chemical Corps at Edgewood, Maryland to study the effects of various drugs on animals and humans. The Army helped the Agency put together a computerized data base for drug testing and supplied military volunteers for some of the experiments. In one case, with a particularly effective incapacitating agent, the Army arranged for inmate volunteers at the Holmesburg State Prison in Philadelphia. Project OFTEN had both offensive and defensive sides, according to an ORD man who described it in a memorandum. He cited as an example of what he and his coworkers hoped to find "a compound that could simulate a heart attack or a stroke in the targeted individual." In January 1973, just as Richard Helms was leaving the Agency and James Schlesinger was coming in, Project OFTEN was abruptly canceled.

What - if any - success the ORD men had in creating heart attacks or in any of their other behavioral experiments simply cannot be said. Like Sid Gottlieb, Steve Aldrich is not saying, and his colleagues seem even more closemouthed than Gottlieb's. In December 1977, having gotten wind of the ORD programs, I filed a Freedom of Information request for access to ORD files "on behavioral research, including but not limited to any research or operational activities related to bioelectrics, electric or radio stimulation of the brain, electronic destruction of memory, stereotaxic surgery, psychosurgery, hypnotism, parapsychology, radiation, microwaves, and ultrasonics." I also asked for documentation on behavioral testing in U.S. penal institutions, and I later added a request for all available files on amnesia. The Agency wrote back six months later that ORD had "identified 130 boxes (approximately 130 cubic feet) of material that are reasonably expected to contain behavioral research documents."

Considering that Admiral Turner and other CIA officials had tried to leave the impression with Congress and the public that behavioral research had almost all ended in 1963 with the phaseout of MKULTRA, this was an amazing admission. The sheer volume of material was staggering. This book is based on the 7 boxes of heavily censored MKULTRA financial records plus another 3 or so of ARTICHOKE documents, supplemented by interviews. It has taken me over a year, with significant research help, to digest this much smaller bulk. Clearly, greater resources than an individual writer can bring to bear will be needed to get to the bottom of the ORD programs.

A free society's best defense against unethical behavior modification is public disclosure and awareness. The more people understand consciousness-altering technology, the more likely they are to recognize its application, and the less likely it will be used. When behavioral research is carried out in secret, it can be turned against the government's enemies, both foreign and domestic. No matter how pure or defense-oriented the motives of the researchers, once the technology exists, the decision to use it is out of their hands. Who can doubt that if the Nixon administration or J. Edgar Hoover had had some foolproof way to control people, they would not have used the technique against their political foes, just as the CIA for years tried to use similar tactics overseas?

As with the Agency's secrets, it is now too late to put behavioral technology back in the box. Researchers are bound to keep making advances. The technology has already spread to our schools, prisons, and mental hospitals, not to mention the advertising community, and it has also been picked up by police forces around the world. Placing hoods over the heads of political prisoners - a modified form of sensory deprivation - has become a standard tactic around the world, from Northern Ireland to Chile. The Soviet Union has consistently used psychiatric treatment as an instrument of repression. Such methods violate basic human rights just as much as physical abuse, even if they leave no marks on the body.

Totalitarian regimes will probably continue, as they have in the past, to search secretly for ways to manipulate the mind, no matter what the United States does. The prospect of being able to control people seems too enticing for most tyrants to give up. Yet, we as a country can defend ourselves without sending our own scientists - mad or otherwise - into a hidden war that violates our basic ethical and constitutional principles. After all, we created the Nuremberg Code to show there were limits on scientific research and its application. Admittedly, American intelligence officials have violated our own standard, but the U.S. Government has now officially declared violations will no longer be permitted. The time has come for the United States to lead by example in voluntarily renouncing secret government behavioral research. Other countries might even follow suit, particularly if we were to propose an international agreement which provides them with a framework to do so.

Tampering with the mind is much too dangerous to be left to the spies. Nor should it be the exclusive province of the behavioral scientists, who have given us cause for suspicion. Take this statement by their most famous member, B. F. Skinner: "My image in some places is of a monster of some kind who wants to pull a string and manipulate people. Nothing could be further from the truth. People are manipulated; I just want them to be manipulated more effectively." Such notions are much more acceptable in prestigious circles than people tend to think: D. Ewen Cameron read papers about "depatterning" with electroshock before meetings of his fellow psychiatrists, and they elected him their president. Human behavior is so important that it must concern us all. The more vigilant we and our representatives are, the less chance we will be unwitting victims.

Notes 12

The reorganization of TSS was described in document #59, 26 July 1963, Report of the Inspection of MKULTRA and in interviews with Ray Cline, Herbert Scoville, and several other former CIA officials.

Richard Helms' recommendations for a new MKULTRA charter were described in document #450, 9 June, 1964, Sensitive Research Programs (MKULTRA).

Admiral Stansfield Turner's statement on the MKULTRA program was made before a joint session of the Kennedy subcommittee and the Senate Select Committee on Intelligence, August 3, 1977, pp. 4-8.

MKSEARCH programs and their origins in MKULTRA are described in documents #449, 8 April 1964, Revision of Project MKULTRA and #S-1-7, untitled, undated.

Dr. Edward Bennett's work is the subject of MKULTRA subprojects 104 and 143. See especially 143-23, 11 December 1962, Subject: MKULTRA Subproject 143. Other information on the CIA's economic sabotage program against Cuba came from interviews with Major General Edward Lansdale, Ray Cline, William Colby, Lincoln Gordon, Covey Oliver, Charles Meyer, Richard Goodwin, Roger Morris, several former CIA and State Department officials, and Cuban government officials.

The continued safehouse operation is MKSEARCH subproject 4. See especially S-12-1, bank statements and receipts of safehouse. The CIA's dealings with the Treasury Department over the Long committee's investigations of wiretaps are detailed in documents #451, 30 January 1967, A Report on a Series of Meetings with Department of the Treasury officials and #452, undated, Meeting with Department of Treasury Official.

The biological laboratory is the subject of MKULTRA subprojects 78 and 110 and MKSEARCH 2. See especially Documents 78-28, September 28, 1962, Subject: PM Support and Biological [deleted] and S-5-6, 8 September 1965, Subject: Hiring by Chief TSD/BB of [deleted], Former Staff Employee in a Consultant Capacity on an Agency Contract. The costs of the Fort Detrick operations came from p. 18 and p. 204 of the Church committee hearings on Unauthorized Storage of Toxic Agents September 16,17, and 18,1975. The description of TSS's procedures for dealing with biological weapons came from Document 78-28 (cited above) and document #509, undated (but clearly June 1975), Subject: Discussions of MKNAOMI with [deleted].

The chemical company subproiect is MKULTRA subproject 116 and MKSEARCH 5. See especially 116-57,30 January 1961, Subject: MKULTRA, Subproject 116; 116-62, October 28, 1960, shipping invoice- and 116-61,4 November 1960, Subject: MKULTRA Subproject 116. Also see James Moore's subproject, MKULTRA 52; especially 52-53, invoice # 3, 1125-009-1902, April 27, 1960.

James Hamilton's work is the subject of MKULTRA subprojects 124 and 140 and MKSEARCH Subproject 3. See especially 140-57, 6 May 1965, Subject: Behavioral Control and 140-83, 29 May 1963, Subject: MKULTRA Subproject 140.

Carl Pfeiffer's subprojects are MKULTRA 9, 26, 28, and 47 and MKSEARCH 7. See especially S-7-4, undated, Subject: Approval of Project [deleted].

Maitland Baldwin's Subprojects are MKULTRA 62 and MKSEARCH 1. See especially 62-2, undated [deleted] Special Budget and 62-3, undated, 1956, Subject: Re: Trip to [deleted], October 10-14, 1956.

Charles Geschickter's subprojects are MKULTRA 23, 35, and 45 and MKSEARCH 6. See especially 35-10, May 16, 1955, Subject- To provide for Agency-Sponsored Research Involving Covert Biological and Chemical Warfare; 45-78, undated, Research Proposal: 1960, 45-104 undated, Subject: Research Proposal: 1958-1959; 45-95, 26 January 1959, Continuation of MKULTRA, Subproject No.45; 45-104,21 January 1958, Continuation of MKULTRA, Subproject No.45; 45-52,8 February 1962, Continuation of MKULTRA, Subproject No. 45; S-13-7,13 August Subject, Approval of [deleted]; and S-13-9, 13 September 1967, Subject: Approval of [deleted]. See also Geschickter's testimony before the Kennedy subcommittee, September 20, 1977, pp. 44-49.

The lack of congressional or executive branch knowledge of CIA behavioral activities was mentioned on p. 386, Church Committee Report, Book I.

Amazon Natural Drug's CIA connection was described by an ex-ClA official and confirmed by the mother of another former Agency man. Several former employees described its activities in interviews.

Gottlieb's termination of MKSEARCH came from Document S-14-3 10 July 1972, Termination of MKSEARCH.

The destruction of MKULTRA documents was described in Document #419, 3 October, 1975, Subject: Destruction of Drug and Toxin Related Files and 460, 31 January, 1973, Subject: Project Files: (19511967).

The MKULTRA subprojects on electric stimulation of the brain are 106 and 142. See especially 106-1, undated, Subject: Proposal; 142-14, 22 May 1962, Subject: Project MKULTRA, Subproject No. 142; and document #76 (MKDELTA release), 21 April 1961, Subject: "Guided Animal" Studies.

The list of parapsychology goals was taken from an excellent article by John Wilhelm in the August 2, 1977 Washington Post: "Psychic Spying?"

Project OFTEN information was taken from document #455,6 May 1974, Subject: Project OFTEN and Memorandum for the Secretary of Defense from Deanne P. Siemer, September 20, 1977, Subject: Experimentation Programs Conducted by the Department of Defense That Had CIA Sponsorship or Participation and That Involved the Administration to Human Subjects of Drugs Intended for Mind-control or

Behavior-modification Purposes.

The quote from B. F. Skinner was taken from Peter Schrag's book, Mind Control (New York: Pantheon, 1978) p. 10.

Footnotes 12

1. At 1977 Senate hearings, CIA Director Stansfield Turner summed up some of MKULTRA's accomplishments over its 11-year existence: The program contracted out work to 80 institutions, which included 44 colleges or universities, 15 research facilities or private companies, 12 hospitals or clinics, and 3 penal institutions. I estimate that MKULTRA cost the taxpayers somewhere in the neighborhood of $10 million.
2. This economic sabotage program started in 1961, and the chain of command "ran up to the President," according to Kennedy adviser Richard Goodwin. On the CIA side, Agency Director John McCone "was very strong on it," says his former deputy Ray Cline. Cline notes that McCone had the standing orders to all CIA stations abroad rewritten to include "a sentence or two" authorizing a continuing program to disrupt the Cuban economy. Cuba's trade thus became a standing target for Agency operators, and with the authority on the books, CIA officials apparently never went back to the White House for renewed approval after Kennedy died, in Cline's opinion. Three former Assistant Secretaries of State in the Johnson and Nixon administrations say the sabotage, which included everything from driving down the price of Cuban sugar to tampering with cane-cutting equipment, was not brought to their attention. Former CIA Director William Colby states that the Agency finally stopped the economic sabotage program in the early 1970s. Cuban government officials counter that CIA agents were still working to create epidemics among Cuban cattle in 1973 and that as of spring 1978, Agency men were committing acts of sabotage against cargo destined for Cuba.
3. In 1967 a Senate committee chaired by Senator Edward Long was inquiring into wiretapping by government agencies, including the Narcotics Bureau. The Commissioner of Narcotics, then Harry Giordano told a senior TSS man - almost certainly Gottlieb - that if CIA officials were "concerned" about its dealings with the Bureau involving the safehouses coming out during the hearings, the most "helpful thing" they could do would be to "turn the Long committee off." How the CIA men reacted to this not very subtle blackmail attempt is unclear from the documents, but what does come out is that the TSS man and another top-level CIA officer misled and lied to the top echelon of the Treasury Department (the Narcotics Bureau's parent organization) about the safehouses and how they were used.
4. James Moore of the University of Delaware, who also produced carbamates when he was not seeking the magic mushroom, served at times as an intermediary between the industrialist and the CIA.
5. During the late 1960s and early 1970s, it seemed that every radical on the West Coast was saying that the CIA was up to strange things in behavior modification at Vacaville. Like many of yesterday's conspiracy theories, this one turned out to be true.
6. Geschickter was an extremely important TSS asset with connections in high places. In 1955 he convinced Agency officials to contribute $375,000 in secret funds toward the construction of a new research building at Georgetown University Hospital. (Since this money seemed to be coming from private sources, unwitting Federal bureaucrats doubled it under the matching grant program for hospital construction.) The Agency men had a clear understanding with Geschickter that in return for their contribution, he would make sure they received use of one-sixth of the beds and total space in the facility for their own "hospital safehouse." They then would have a ready source of "human patients and volunteers for experimental use," according to a CIA document, and the research program in the building would provide cover for up to three TSS staff members. Allen Dulles personally approved the contribution and then, to make sure, he took it to President Eisenhower's special committee to review covert operations. The committee also gave its assent, with the understanding that Geschickter could provide "a reasonable expectation" that the Agency would indeed have use of the space he promised. He obviously did, because the CIA money was forthcoming. (This, incidentally, was the only time in a whole quarter-century of Agency behavior-control activities when the documents show that CIA officials went to the White House for approval of anything. The Church committee found no evidence that either the executive branch or Congress was informed of the programs.)
7. In 1967, after Ramparts magazine exposed secret CIA funding of the National Student Association and numerous nonprofit organizations, President Johnson forbade CIA support of foundations or educational institutions. Inside the Agency there was no notion that this order meant ending relationships, such as the one with Geschickter. In his case, the agile CIA men simply transferred the funding from the foundation to a private company, of which his son was the secretary-treasurer.
8. Lying to Congress followed the pattern of lying to the press that some MKULTRA veterans adopted after the first revelations came out. For example, former Human Ecology Society director James Monroe told The New York Times on August 2, 1977 that "only about 25 to 30 percent" of the Society's budget came from the CIA - a statement he knew to be false since the actual figure was well over 90 percent. His untruth allowed some other grantees to claim that their particular project was funded out of the non-Agency part of the Society.

Entheogenic Mysticism: A Jamesian Assessment

by

G.William Barnard

original text: http://www.neip.info/upd_blob/0000/446.pdf
backup source: http://www.psilosophy.info/resources/446.pdf

In my anthropology of religion course "Magic, Myth, and Religion," I devote a substantial amount of time to a discussion of the centrality of non-ordinary states of consciousness in the religious life of many cultures. During this section of the course, I focus on how individuals in numerous cultures use fasting, dancing, drumming, chanting, breathing exercises, and so on, as ways to facilitate contact with various spiritual realities. In this section of the course, I also discuss the ways in which sacred (i.e., consciousness altering) plants are ritually ingested by individuals in several cultures, especially in the Americas, in an attempt to open themselves to spiritual dimensions of existence. My students are typically quite fascinated, for instance, to learn about the Huichol people's annual peyote pilgrimage, or the role that ayahuasca plays within the context of the Santo Daime tradition (a Brazilian syncretistic new religious movement), or the centrality of the San Pedro cactus in coastal Peruvian curanderismo. However, after my students have been exposed to numerous detailed accounts of the visionary/mystical experiences that practitioners in these traditions have had after ingesting these sacred substances, almost inevitably some student will ask a question that goes something like the following: "Aren't all of these so called visionary/mystical experiences merely hallucinations caused by taking drugs?"

As a professor, I think that it is crucial to address this question. After all, at least on the face of it, it is understandable why students would raise such questions. Given the taken-for-granted "scientific" (i.e., materialistic and positivistic) perspective that most of my students have internalized, it is easy to see how they would interpret the dramatic epiphanies produced by ingesting different species of sacred plants as simply delusory hallucinations, as nothing more than the result of the malfunctioning neuro-chemical activity within the brains of those who have taken these psychoactive substances. Given this set of presuppositions, it can be very difficult for my students to comprehend why we should take seriously the claims made by those within these religious traditions who advocate the ritual use of entheogens (i.e., substances that "generate god or spirit within").

Having internalized the message that all drugs are psychologically and physiologically harmful, socially destructive, and addictive (with the significant exception of socially approved versions of drugs, such as alcohol, Prozac, nicotine, and caffeine) it can be tough for my students to swallow (so to speak) that within many cultures in the Americas, mind-altering substances, such as peyote, psilocybin mushrooms, and ayahuasca, are seen as gifts from the gods, are valued as powerful medicines for the body and the mind, are taken in order to nurture harmonious relationships with others, and are deeply revered as the source of not only their music and art, but also their most fundamental religious beliefs and practices. It can be hard for my students to imagine that people within these cultures would claim, repeatedly, fervently, that rejection of this visionary knowledge is, quite simply, a form of insanity. It can take quite a lot of persuasive evidence on my part for them to begin to accept even the possibility that entheogenic substances are non-addictive, that there is no evidence that they are psychologically or physiologically harmful if used within structured ritual contexts, and that they have been safely consumed by human beings for possibly tens of thousands of years.

My guess is that many of you in this audience might well sympathize with my students' reluctance to take entheogenic mystical and visionary experiences as seriously as those that are catalyzed by non-entheogenic "spiritual technologies," such as meditation, drumming, dancing, fasting, prayer, and so on. It is just so easy to think that the alterations of consciousness that are associated with the ingestion of peyote, psilocybin, and ayahuasca are merely hallucinations.

As I often point out to my students, however, this negative assessment of the experiences of those who take entheogens within a religious context is rooted in a taken-for-granted understanding of the relationship between the brain and consciousness. As the American philosopher and psychologist William James points out in an essay published in 1898 ("Human Immortality: Two Supposed Objections to the Doctrine"), the standard materialistic understanding of the relationship between the brain and consciousness assumes that the brain itself produces the "stuff" of consciousness in much the same way that steam is produced by a kettle, or light is produced by an electric circuit. From this perspective, which James calls the "productive" theory of consciousness, consciousness is created by the various complex chemical interactions that take place inside the brain.[1]

If we assume that the neurochemical activity of the brain *produces* our states of consciousness, then it makes sense to also assume that if a people eat psilocybin mushrooms or peyote buttons, or drink ayahuasca, that the so-called mystical experiences or religious visions that they describe are nothing more than the hallucinatory byproducts of cerebral malfunctions caused by the chemical activity of these substances. However, what many of us may not realize is that, from the perspective of the productive theory of consciousness, *every* mystical or religious experience is hallucinatory, they too are nothing more than mental aberrations caused by the misfirings of neurons in the brain. From the perspective of the productive theory of consciousness, the only real world is the world that is perceived through the senses. By definition, therefore, if you are having extra-sensory perceptions, then there is simply something wrong with your cerebral circuitry. From the perspective of the productive theory of consciousness, the exalted mystical experiences of Teresa of Avila, for instance, have exactly the same status as the peyote visions of the headman in a Native American Church: *both* are hallucinations generated by pathological activity of the brain.

In James' essay, however, he points out that there is an alternative way to understand the relationship between the brain and consciousness (and therefore, an alternative way to understand the genesis of mystical and religious experiences). It is also possible, James writes, that consciousness pre-exists the brain, and that the role of the brain is to mold that pre-existent consciousness into various forms. Seen from this perspective, the brain's task would be to receive and transmit limited forms of this consciousness in much the same way as, to use an anachronistic example, a radio receives portions of pre-existing radio waves and then transmits them through the air as sound waves. James refers to this relationship between the brain and a pre-existing larger consciousness as the "transmissive function," and points out that this transmissive function is operative "in the case of a colored glass, a prism, or a refracting lens," when "the energy of light, no matter how produced, is by the glass shifted and limited in color, and by the lens or prism determined to a certain path and shape."[2]

James insists that it is just as logical and scientific to postulate that the brain receives, limits, directs, and shapes pre-existent states of awareness as it is to postulate that the brain produces different states of consciousness. *Both* theories take for granted that there is a relationship between the brain and consciousness. According to both theories, an alteration in the neurochemical interactions of the brain corresponds to an alteration in consciousness. What is not so self evident, however, is that the neurochemical interactions of the brain *cause* the corresponding alterations of consciousness. What is just as likely, at least from a philosophical perspective, is that alterations in the brain chemistry "open the door" to levels of consciousness that were previously inaccessible. (Another option is that alterations within the pre-existing field of consciousness are what cause the shifts in the neurochemical activity of the brain. This way of understanding the relationship between consciousness and the brain is how many cultures would, at least tacitly, explain states of mediumship where culturally endorsed spiritual beings are said to speak and act in-and-through the willing body of a religious practitioner. This option is also, more prosaically, what many of us tacitly assume takes place when we believe that our intentions, thoughts and feelings, i.e., our states of consciousness, direct the activity of our physical body.)

James emphasizes that "the theory of production is ... not a jot more simple or credible in itself than any other conceivable theory. It is only a little more popular."[3] Indeed, James claims that, in some ways, the transmissive function has certain theoretical advantages over its more popular competitor. If the transmissive theory of consciousness is accepted, then consciousness "does not have to be generated *de novo* in a vast number of places. It exists already, behind the scenes," intimately connected with this world.[4]

James points out another apparent advantage of the transmissive theory of consciousness over the productive theory: the transmissive theory is able to account coherently for a wide variety of phenomena that the productive theory has difficulty explaining. Such phenomena as "religious conversions, providential leadings in answer to prayer, instantaneous healings, premonitions, apparitions at time of death, clairvoyant visions or impressions, and the whole range of mediumistic capacities" are all more easily understood with the transmissive theory of consciousness.[5] This is so, as James notes, because the productive theory of consciousness is intimately linked with sense perceptions, but in the case of many of these less orthodox phenomena, "it is often hard to see where the sense-organs can come in."[6] For instance, as James mentions, a medium might have knowledge of the personal life of his or her client that would be impossible to obtain from the senses, or a person might see a vision of someone who, hundreds of miles away, was at that very moment dying. James points out that it is difficult to see how the productive theory of consciousness can explain how these types of knowledge were produced within a single brain. But if the transmissive theory is accepted, the answer is apparent: "they don't have to be 'produced,' - they exist ready-made in the transcendental world," so that in "cases of conversion, providential leadings, sudden mental healings, etc. it seems to the subjects themselves ... as if a power from without, quite different from the ordinary action of the senses or of the sense-led mind, came into their life, as if [their life] suddenly opened into that greater life in which it has its source."[7]

James believes that psychologists and philosophers choose between the transmissive theory and the productive theory of consciousness based on what type of world they are willing or able to accept (i.e., based on their metaphysical assumptions). If these thinkers are limited to a purely materialistic or naturalistic perspective, then the productive function of the brain will be all that they will acknowledge as valid. If, however, these thinkers assume that "the whole universe of material things ... [is] a surface-veil of phenomena, hiding and keeping back the world of genuine realities," if they believe that life is similar to Percy Shelly's words in his poem "Adonais," in which "Life, like a dome of many-colored glass, Stains the white radiance of eternity," then they will acknowledge that the transmissive function of the brain is a legitimate possibility.[8] Utilizing Shelly's metaphor, James theorizes that our brains might indeed be places in this "dome" where the "beams" of consciousness could most easily enter into our realm of experience. In that case, as the "white radiance" of that larger pre-existing consciousness enters our brains, then a type of refracting and "staining and distortion" would naturally occur, shaping that greater consciousness into the personal, imperfect, and unique forms that consciousness takes inside "our finite individualities here below."[9]

Drawing upon the work of the French philosopher Henri Bergson, Aldous Huxley offers a strikingly similar explanation of the relationship between consciousness and the brain in his 1954 book *The Doors of Perception*. Huxley points out that according to Bergson, each of us is, under the surface of our normal everyday awareness, connected to, and potentially aware of, the entire universe. We are normally, however, cut off from this "Mind at Large" because our brain screens or filters out the vast majority of what we are potentially able to perceive in order to protect us from being overwhelmed and confused by this almost infinite amount of information. Our brains, therefore, act in essence as biological reducing valves. Seen from this perspective, the primary function of our brain is not so much to *produce* consciousness as it is to limit the torrential flow of information that is pouring into us, moment by moment, to the bare minimum we need to survive.

Drawing upon his own experiences taking mescaline (the active chemical component of peyote and San Pedro), Huxley postulates that perhaps the ingestion of sacred substances (or conversely, various spiritual disciplines) "impair the efficiency of the cerebral reducing valve," resulting in an influx of extrasensory knowledge as well as perceptions of a world of visionary beauty.[10] He theorizes that perhaps entheogens (as well as, at least implicitly, "spiritual technologies," such as chanting, fasting, meditation, contemplation, ecstatic dance, and so on) allow us to tap into "previously untapped levels of our own mind ... and previously unrecognized dimensions or levels of reality"; seen in this way, these sacred substances do not "distort reality," but rather, "disclose dimensions or levels of existence that are otherwise screened by the rational ego."[11]

While many, if not most, academics and scientists might scoff at the alternative understanding of the relationship between the brain and consciousness that is proposed by James, Bergson, and Huxley, there have been a handful of current theorists who have taken this non-mainstream perspective quite seriously. For instance, George Wald, a Nobel Prize winning physiologist from Harvard points out:

> There is no way of knowing whether the brain contains consciousness in the sense that it is producing it or whether it is simply a reception and transmission mechanism which, as Bergson has argued, has the function of selection and realization of conscious images and not the production of such

> images. As a neuroscientist, one can only intervene in the brain and record whether the intervention in particular parts of the brain results in the evocation or abolishment of conscious experience.[12]

As Wald notes, simply because there is a correspondence between brain activity and states of consciousness does not indicate that those states were produced by the brain, or somehow localized within it. Suppose, for example, that we compare the brain to a television set. There is, apparently, a one-to-one relationship between the electrical and mechanical activity of the television set and the programs that are appearing on the screen. But no one ever claims that the program that is appearing on the screen has been *produced* by the television. Instead, a television set receives, limits, directs, and shapes pre-existing electro-magnetic signals of various frequencies into the programs that we watch on the screen. Similarly, as Wald notes, if we "pull a transistor out of [our] T.V. set and it no longer works," we would not (or at least should not) "conclude that the transistor is the source of the program," anymore than we are forced to conclude that the brain is what produces consciousness simply because when a person's brain has been damaged by a severe organic illness or trauma, her or his cognitive abilities are severely impaired.[13]

Seen from this perspective, we can theorize that entheogens are simply a way to "change the channel" of the "television" of the brain so that it can receive information from other (and in this case, "spiritual") dimensions of reality. If we are willing to accept this alternate way of understanding the relationship between the activity of the brain and changes in our states of consciousness (at least as a philosophical possibility), then the mystical experiences that take place after ingesting various entheogens can be understood as potentially valid visionary/mystical experiences, and not necessarily as delusive psychopathological hallucinations.

In *The Varieties of Religious Experience*, James cautions that it is crucial that we question our frequent tendency to assume that any insight that arises in conjunction with a powerful alteration of our physiology is invalid. As he points out, we would never dismiss the validity of a scientific insight simply because it arose during a fever. Similarly, we should not dismiss the insights of a mystic or visionary simply because their body's chemistry has shifted in certain respects. In much the same way, therefore, given the assumption that the visions or insights that arise in conjunction with drinking ayahuasca, or eating peyote are said to arise from superconscious dimensions of reality, it is quite possible that they may in actuality be *more* truthful and beneficial to our well being than the perceptions and beliefs that emerge from our normal waking state of consciousness. They should not be prematurely dismissed simply because of a bias in favor of the state of consciousness that our culture assumes to be normative.

Similarly, as scholars of religion, we might need to question the assumption that the mystical experiences that take place within more well-known mystical traditions such as, Christian, Jewish, Islamic, Hindu, Buddhist, and Taoist forms of mysticism, are inherently superior to the mystical insights that are obtained via the ingestion of entheogens. But why should we make this assumption? What are the criteria by which we assess whether mystical experiences (whether entheogenically-inspired or not) are valid and/or valuable? Once again, James's perspective offers us a way to begin to answer some of these important questions.

In the *Varieties*, James offers the three-fold proto-pragmatic criteria of "immediate luminosity," "philosophical reasonableness," and "moral helpfulness" to assess the validity and value of religious/mystical experiences. "Immediate luminosity" is the criterion that encourages us to take seriously the experiential component of a religious state of mind - its immediate force, its raw voltage, its direct, tangible feeling. "Philosophical reasonableness" is the criterion that we can use to assess whether a religious state of mind can be shown to be reasonable and logical by virtue of its place within an articulate and defensible philosophical system of beliefs. Finally, "moral helpfulness" is demonstrated when and if a religious state of mind can be shown to initiate, on the whole and over the long run, positive consequences for the individual and/or the community. These criteria are not mutually exclusive, but rather interact with, and depend upon, each other. Furthermore, this evaluative procedure is not a matter of precisely weighing the percentage of each criterion's importance, but instead, is a holistic, cumulative process. As James emphasizes, the final test for assessing a state of mind is not the individual "score" of each of these criteria, but rather it is their cumulative weight, the way they work as a whole and on the whole.[14]

What I would like to do during the remainder of the time that we have together is to apply these three criteria to a specific test case to see whether they might help us to begin the difficult, yet important, task of determining whether the mystical experiences found in an entheogenic tradition are as inspiring, trustworthy, and transformative as those found in other, more well known, mystical traditions.

For the purposes of our discussion, I have chosen to focus on the Santo Daime tradition. After giving a brief overview of the history and major beliefs and practices of this Brazilian entheogenically-based religious movement, I will examine several mystical narratives arising from within the tradition to illustrate the extent to which these entheogenically-inspired experiences match up with the power, immediacy, and luminosity of mystical experiences found in other non-entheogenic traditions (i.e., I will attempt to assess their immediate luminosity, James' first criterion). I will then briefly describe some of the central (albeit often implicit) philosophical understandings that undergird the religious teachings of the Santo Daime tradition, in order to explore whether their depth, complexity, and coherence equals that of other mystical traditions (i.e., I will attempt to assess their philosophical reasonableness, James' second criterion). And finally, I will offer various accounts of the personal and social transformative effects of taking ayahuasca within the ritual context of the Santo Daime tradition, as a way to investigate the extent to which this entheogenic tradition can be at least as personally and socially transformative as other more well known mystical traditions (i.e., I will attempt to assess their moral helpfulness, James' third criterion).

The Santo Daime religious movement began late in the second decade of the twentieth century. Raimundo Irineu Serra, a seven foot tall black man working as a border guard deep in the Amazonian rainforest at the border between Brazil and Peru became interested in the use of ayahuasca in the tribal ceremonies of the people of the area. Ayahuasca is a tea created from boiling together in water a vine (*Banisteriopsis caapi*) and the leaves from a bush (*Psychotria viridis*). Neither the vine nor the leaf, separately, is psychoactive. It is only when they are combined (especially in a ritualistic context) that an entheogen is produced.

Irineu Serra, after drinking ayahausca, had a powerful experience in which he claimed that the Spirit of the Moon revealed herself to him as the Rainha da Floresta, the Queen of the Forest. Later identified as the Virgin Mary, this sacred Being told Irineu that he had a special mission on earth: to establish a new religious movement called the Santo (Holy) Daime. (It can be said, therefore, that the entire tradition of the Santo Daime itself arose from an entheogenically inspired experience.)

Within this new context the sacramental tea was also given a new name, i.e., the "Daime," a word that comes from the Portuguese verb "dar": to give. It is linked to invocations that are frequently present during Santo Daime rituals: *dai-me amor, dai-me luz, dai-me forca* ("give me love, give me light, give me strength"). Within the Santo Daime tradition, the Daime is understood to be a sacrament that embodies the consciousness of a vastly intelligent and compassionate divine Being, a Being that, for Santo Daime practitioners, is equated with both Christ and the Holy Spirit, a Being who, in the words of one of the leaders of the movement, "incarnates in order to provide teaching, comfort, healing, and spiritual evolution to those" who take it within themselves as a liquid form of communion, a Being who opens a "gateway to other dimensions where other Beings reside."[15]

Mestre Irineu ("Master Irineu") as he was eventually called by his followers, gradually became well known as a powerful healer, visionary and spiritual teacher. In 1940, he established the first Santo Daime center in the town of Rio Branco, Brazil. Over time, complex and highly structured rituals developed that centered on taking the Daime as a sacrament and thus the shape of the Santo Daime tradition as we know it today began to emerge - a religion that although rooted in Christianity, also incorporates within itself elements of native South American spirituality, as well as aspects of African religiosity and Spiritism.

With the death of Mestre Irineu in 1971, the group split into several different branches. The most well known "line" of the Santo Daime tradition is that which centered around the charismatic leadership of Sebastiao Mota de Melo, later known as Padrinho Sebastiao.

Sebastiao Mota de Melo was born in 1920 and grew up in the middle of the Amazon rainforest. He made his living as a rubber tapper and builder of dugout canoes, but spiritually, he became known from a relatively early age as a powerful visionary and mediumistic healer of the impoverished people of that area. At the age of 38, following the guidance of one of the beings that he frequently incorporated in his mediumistic sessions, Padrinho Sebastiao traveled with his family in 1958 to Rio Branco. He had been suffering for several years from a fatal liver disease, and in hopes of a cure, he approached Mestre Irineu.

After taking the Daime, Padrinho Sebastiao had a series of powerful visionary experiences. In one of these experiences, he watched, from outside his body, as two resplendently beautiful beings took out his skeleton and abdominal organs from his body, without any pain, all the while vibrating his body, rocking it from side by side. These beings then used a hook that "opened, separated, and extracted" from his abdominal organs "three nailsized insects" which the beings of light claimed were responsible for Padrinho Sebastiao's illness.[16] In Sebastiao's account of this experience, he reports the following: "[the being] who had been seated next to my prostrate body, which was still stretched out on the floor, came very close to me and said, 'Here it is! What was killing you were these three insects, but now you will not die from them any more.' Then they closed my body. ... I healed, like a child."[17]

Padrinho Sebastiao was completely cured after this experience and, not surprisingly, he decided to become one of Mestre Irineu's followers. They quickly became very close, and with permission from Mestre Irineu, Padrinho Sebastiao set up a Santo Daime center of his own outside of Rio Branco. After Mestre Irineu's death, the community that had grown around Padrinho Sebastiao continued to flourish. But in the late 1970's he began to receive inner guidance to leave this location. Therefore, in 1980, Padrinho Sebastiao, his family, and about 100 followers left the Rio Branco area, with almost no material resources, and relocated deep in the rainforest at a site called Rio do Ouro. After three years of hard work, building houses, clearing and cultivating land, enduring sickness and hardship, a private landowner turned up, claiming his right to the land. Not wanting any trouble and trusting his inner guidance, the Santo Daime members left Rio do Ouro, and during the years of 1983-84, about 300 members settled in what came to be known as Céu do Mapiá (Heaven of Mapiá), located even deeper within the rainforest, on the banks of the Mapia river.

Soon afterwards, affiliated Santo Daime centers were set up in major Brazilian cities. These centers attracted many new members, but they also drew attention to the movement. A commission of army officials, university teachers, psychiatrists, psychologists, doctors and others was appointed to study the use of the Daime and visited Céu do Mapia in 1984. A similar commission had already visited the Rio do Ouro community in 1982. Both of these commissions wrote a report to the authorities that concluded that no negative psychological or social effects were linked to the ritual use of ayahuasca. Nonetheless, the Brazilian government decided to ban the use of ayahuasca in 1985. Due to the uproar that this decision created, another commission was put together in 1986. Eventually, after a careful investigation, the commission once again made a positive assessment of the Santo Daime tradition (as well as other traditions that used ayahuasca in ritual contexts), and the ban against ayahuasca was legally removed in Brazil in 1986.

After the death of Padrinho Sebastiao in 1990, one of his sons, Alfredo Mota de Melo, now called Padrinho Alfredo, took over the leadership of the movement. With his blessings, Santo Daime centers were started all around the world, particularly in Europe, Japan, and the United States.

What participants in all of these centers share is the desire to meet regularly in order to drink Daime collectively as a sacrament. During all of the rituals (or "works," as they are called) of the Santo Daime, participants gather together (men on one side, women on the other) around a central altar table and then sing (often for hours, with great reverence and devotion) collections of simple, yet hauntingly beautiful hymns that were originally "given" from the spiritual world to the more advanced members of the movement. According to the Santo Daime practitioners, praying and praising God together musically, with great purity and focus, accompanied by the rhythmic shaking of maracás, generates a powerful current of transformative spiritual energy and creates an uplifting, harmonious environment that is conducive to profound inner communion with the spiritual world and with the numerous beings that are said to exist there.

The powerful visionary/mystical experiences that individuals have during the Santo Daime works are called "miracaos." Like classical mystical experiences, these miracaos are said to be exceedingly difficult to describe, at least with any degree of adequacy, but many of the experiences that *are* shared manage to be quite evocative. For instance, one Santo Daime practitioner describes his experiences in the following way:

> "During my years of taking the Holy Daime, perhaps what stands out the most is feeling this incredibly powerful divine force working within me, with so much compassion and wisdom, clearing my body, mind, and energy field of anything that stands in the way of how this Light and

Love wants to express itself in and through me."

He goes on to note: "Another way in which I frequently experience the Daime working within me is that I will feel that I have been lifted, almost bodily, into another dimension of reality, one that is always present but that is normally hidden from my sight. From within this higher vibratory level of existence, I'll frequently see wave after wave of divine beauty with my eyes closed, visions that effortlessly flower within me as radiant, living, blossoming, geometric patterns of color, as profoundly significant manifestations of God's abundant, joyous, and exuberant creativity. And if my eyes are open, I'll look around me, and while I'm not physically seeing anything different, nonetheless somehow everything is brighter, absolutely perfect, transfigured, just shimmering with God's presence and Light."

Continuing, this practitioner adds: "I also remember one time, at the height of one of these moments, when we were all singing hymns together in the salao [the room where the works take place] and I was filled with so much ecstasy. I knew then, with this awestruck certainty, that all of us in that room were Christ, fully Christ, manifesting himself within us, as us. I could see that we were absolutely filled with divine glory, and that it was pouring through us. We were all singing together with such love, as this golden, radiantly beautiful Light shone within us and around us, Light that was offered as a gift to the entire world. One of my Daime brothers looked at me, just at that moment, and his eyes were really bright. I knew, somehow, that he was sharing this experience with me. He reached over, gave me this wonderful hug and said: 'Remember this, don't forget this.' And I never have."[18]

Another Santo Daime practitioner shared what she experienced the first time that she took the Daime: "I have to begin by saying what did *not* happen - since so many of my feared expectations, even about how I would *physically* be able to handle the Santo Daime, did not manifest. I was prepared perhaps to regurgitate it right back up - to vomit the murky brown, intensely bitter, distinctive-tasting drink. I was prepared perhaps to undergo one continuous state of nausea and/or emotional turmoil throughout my whole time under the influence of Daime and to end up flat on my back throughout the whole experience - or perhaps to be so completely freaked out that I'd simply want to flee the scene altogether. What I was *not* prepared for, right after taking my initial, partial shot glass of Santo Daime, was the sweetness of the experience - the way in which I so easily surrendered to the slow, thick, woozy feeling of the Daime's takeover of my physical being - the way that I so easily yielded to the pull of the Daime, the way that I was taken down the rabbit hole of an inner world that seemed both foreign and familiar to me, both intricately detailed and vast, both intensely personal and universal."

Continuing her account of her first experience with the Santo Daime, this woman goes on to say: "One of my defining and ongoing experiences of Santo Daime during that first encounter was the way in which I became essentially pinned in my seat, held bolt upright and extremely still - again as though not of my own volition, but due to the force of the current that was flowing within me. I was able to sit for hours at a time, literally held in place, serenely cross-legged in the blissful posture of a yogini in samadhi. As this seeming physical paralysis would take over, I was also made to understand (in the subtle ways that the Daime was always guiding and instructing me) that this bodily stillness was essential for my inner learning and deepening - that this was how the Daime needed to do her work within me. I would be sitting so deeply indrawn and completely at peace, while simultaneously I would be aware of the lively, even at times riotous, momentum of the singing and rattling that was filling the room. At times there would be a cacophony of other things also happening. For instance, I would be wrenchingly aware of this or that person (or several people) loudly weeping, undergoing some deeply personal, emotional clearing. Or I would be aware of this or that person physically purging into one of the buckets that were set just outside of the open door."

She added: "Although I have experienced in meditation before the sensation of being glued upright and still in my seat, as though it would take a great force of personal will to move even so much as a finger (even if I had wanted to!), I have never experienced such a sustained and internally directed period of time with such deep inner rapture and peace. It was as though I was the center around which everything was spiraling - the spiritual core at the heart of the world of matter, the prism of Light in and through which the unfolding, divine play of Consciousness itself was arising and subsiding, manifesting and dissolving the world of form and illusion. Time after time, any fear or question about what was happening to me that would momentarily surface was profoundly met and resolved. I came to understand at a level beyond mere mental comprehension that only what is *not* real can ever die, that only what is illusion - the egoic structure, defended being, belief in limitation, suffering based on ignorance and darkness, and so on - can ever die. Amazing insights about the unified nature of Consciousness and matter as well as specific directives about my personal life mission spontaneously arose: everything was happening in such harmony and perfection."[19]

These two accounts seem to match up well with many, if not most, of the classical narratives of mystical experiences that can be found within more well-known mystical traditions. I would therefore suggest that in terms of James's three criteria, these experiences clearly manifest the deeply felt, undeniably powerful impact of the criterion of "immediate luminosity."

What is not perhaps quite as clear, at least at this moment, is whether these experiences live up to the other two criteria. However, if we look carefully at the Santo Daime tradition, it is possible to see the "philosophical reasonableness" of this religious movement manifesting itself in and through its rich and multifaceted, albeit primarily implicit, set of religious teachings. Within the Santo Daime tradition, some of the most profound teachings are said to arise directly within each individual in-and-through the miracaos. Teachings within the Santo Daime tradition also take more public and concrete form within the revealed hymns that serve as the musical heart of the movement, as well as via spontaneous talks given by advanced practitioners during the context of the ritual works.

It is, of course, impossible within the very limited time that we have available today for me to give anything more than a brief glimpse of the range and depth of these teachings, but perhaps this task can be made easier by drawing upon some terse, yet eloquent, reflections on the central tenets of the tradition that have been written by a handful of the more experienced and articulate members within the movement. For instance, in the preface to *Forest of Visions*, one of the two books written about the Santo Daime tradition in the English language, Jonathan Goldman, an Oregon-based long time practitioner of the movement, shares some of his insights into the metaphysical assumptions that undergird the Santo Daime religious tradition.

According to Goldman, it is understood within the Santo Daime community that Jesus Christ "implanted a conscious seed in this world by his life and death. This was his mission: to initiate the vast change in human consciousness that is now beginning to come to fruition."[20] With Jesus' death, this "living matrix of consciousness," this "organizing principle of humanity's awakening" realized the distortions that would inevitably come to the teachings of the Christ and therefore chose to enter the rain forest, embodying itself in the jagube vine and the rainha leaf. However, as Goldman goes on to say, this superconscious being "through the Holy Daime ... is [currently] calling to Itself, one by one, the many souls who are ready to rapidly awaken the seed that Jesus planted, the Christ Consciousness in themselves."[21]

According to Goldman, this "direct experience of God" is the "birthright of all humans."[22] He goes on to suggest: "The Daime Path is laid out for each of us who is drawn to it, to walk and evolve as we go, at an accelerated, but distinctly individual, pace."[23] Goldman argues that the Daime is a type of spiritual "'short cut,' a very intense, demanding path to which people whose souls are ready to take a huge evolutionary leap are drawn, people who require a very deep cleansing and healing to take this leap, and who have the motivation to find the courage to follow their soul's urging."[24] Goldman claims:

> The Holy Daime Path is an authentic mystery school. There are levels of knowledge, stages of initiation that one passes through in one's program of rapid evolution... . The job of the initiate is to show up, drink Daime, work on the earth to live the teachings ... love God, love the earth, love all beings in God's creation, including yourself, love and respect your brothers and sisters, accept the truth of your own divinity and of your own faults, learn to embody forgiveness and mercy, and gain the hard won humility that comes from meeting a Divine force head on.[XXV]

Padrinho Alex Polari, another elder within the Santo Daime tradition, writes in *Forest of Visions*: "The Holy Daime is not for everyone. The rituals of the Daime are not meant to be an 'experience,' but rather to provide a chance to interact intimately with a Divine Being of unimaginable intelligence, compassion, clarity, and spiritual power."[26] He goes on to say: "The drink per se is the vehicle, the sacrament. Its ingestion reorganizes our organic, neurochemical, and energetic foundation, adjusting us to spiritual reality and its multiple meanings."[27] According to Polari: "Those who learn to work and receive this light consciousness synchronize themselves to higher plains of pure cosmic effervescence that penetrates the astral plane of our planet. As we drink from [this] spring of immortality, we operate through the patterned matrix made by all the ... beings of the universe."[28]

I think that while this exceedingly terse depiction of some of the central philosophical understandings of the Santo Daime tradition may leave some of you wanting to know more (and perhaps others of you glad that you do not), it is perhaps safe to say that this religious tradition possesses an intriguing, multi-layered, complex, and coherent set of beliefs and that, therefore, we can also ascertain that it fulfills "philosophical reasonableness," the second of James's criteria.

As for the third and final of James's criteria, i.e., "moral helpfulness," I would like to suggest that one of the most important reasons why individuals become members of the Santo Daime tradition and continue to engage in this difficult and demanding path of inner purification is not primarily due to the depth of the religious understandings within this path, or even because of the profound mystical and visionary experiences that frequently occur, but perhaps primarily, and crucially, because of the physical, moral, emotional, mental, and spiritual transformations that they perceive within themselves and within others as a result of drinking the Daime.

The Daime is understood to be much more than a drink that opens up the spiritual world. It is also seen as an all purpose healing elixir. Most people report feeling physically and psychically recharged after drinking the Daime, and the purging of parasites and toxins is an integral part of the healing process that it catalyzes. Similarly, contrary to the fear that the Daime is itself an addictive substance, there are countless accounts of the Daime's ability to overcome an individual's addiction to drugs and alcoholism. In *Morality as Practice*, the doctoral dissertation of Titti Kristina Schmidt, a Swedish anthropologist who spent fifteen months in Céu do Mapiá, there is an account of a man named Ernesto who was a drug addict before becoming a Santo Daime practitioner. In *Morality as Practice*, Ernesto describes the following difficult transition that he went through as he combated his drug addiction with the help of the Daime: "When I drank the Daime for the first time it was like hell. I went through a very tough period and didn't have any good experiences at all. The only thing I got was high fever, boils and wounds all over my body."[29] According to Ernesto, his limpeza, or cleaning, took several months. As he points out:

> I was so intoxicated by the drugs so the Daime had to work hard... . Eventually I started to feel better. I thought that I had recovered. So I stopped drinking the Daime and went back to drugs again. But this time it was really hell! Other drugs, which had earlier been a relief to me, did not work any more. After a couple [of] weeks I felt myself more or less forced back to the Daime. Then I started the whole procedure of 'cleansing' all over again. After some time my health improved and in due course I understood the power and the beauty of the Daime. Since then I have never touched any drugs.[30]

Practitioners of the Santo Daime tradition believe that the Daime can heal a wide range of severe illnesses. As Schmidt points out: "Céu do Mapiá has today a national reputation as a healing community. The villagers claim that they can treat a whole range of well-known diseases, for example, skin problems, respiratory diseases, contagious infections, hepatitis, diabetes, leprosy, malaria, worms, dysentery, digestive problems, anaemia, fevers, influenza, mental disorders" and so on.[31] According to Schmidt, "the community has also gained recognition outside Brazil, attracting people who hope to be cured from terminal diseases such as cancer and HIV/AIDS."[32]

People who come to the Santo Daime hoping to be cured of their illnesses often tell dramatic stories of their healing encounter with the Daime. Schmidt shares one such story in her account of Barbara, a woman diagnosed with an inoperable brain tumor:

> When Barbara started to drink the Daime she had what many members call a 'spiritual surgery' ... Under the influence of the Daime brew, she witnessed her own operation done by a group of doctors in spiritual form. After the operation, the spirits told her to rest and eat only certain prescribed food. Later when Barbara recovered, she returned to the hospital in Sao Paulo and asked them to [t]ake a new x-ray. To the surprise of the doctors, the tumor was gone. What amazed them even more was that Barbara (who has no Western medical training) could explain the whole operation, which corresponded to an ordinary brain surgery. She could even describe the instruments used by the spiritual doctors, instruments that, according to Barbara, the doctors in Sao Paulo confirmed were similar to the ones used during ordinary brain surgeries.[33]

Dramatic physical cures are not the only transformative effects that can be attributed to the Santo Daime. There are also numerous positive social and ecological changes that have been catalyzed by practitioners of the Santo Daime movement. For instance, Céu do Mapiá is regularly visited by many Brazilian authorities who see it as a model community to be emulated by other villages in the Amazon rainforest. Individuals within Céu do Mapiá have consciously attempted to create an eco-village where there is a strong focus not only on protecting the ecosystem in the two National Forests that surround Céu do Mapiá (National Forests that were created in large part due to the concerted initiative of leading members of the Santo Daime movement in the late 1980's), but also on learning how to be self-sufficient by developing sustainable, ecologically aware interactions with forest resources. Schmidt points out that in 2002, "there were more than 40 ongoing projects within the village, aiming at, among other things, forest preservation, environmental education, and the production of alternative forest medicine and food."[34] Céu do Mapiá has also become a place for those living in the region to go for medical help and/or to find work. The village offers free medical care to the local population, and runs two hospitals: one that offers Western oriented medicine, and another that is based on alternative healing modalities.

Once again, even within the limitations of this extremely cursory investigation of the transformative effects of Santo Daime religious tradition, it seems valid to say that James's third criteria, "moral helpfulness," can be rapidly crossed off of our list as well. There is abundant evidence that the Santo Daime not only has the capacity to promote physical and psychological well being, but also fosters harmonious social interactions and promotes a love and respect for the natural world that is manifest in numerous concrete and ongoing environmental initiatives.

Taking all of this information into consideration, I would like to suggest that, based on James's three criteria for assessing the value and validity of mystico-religious experiences, we can, and perhaps should, conclude that this entheogenic mystical tradition is at least as worthy of our respect as any of the other more well known mystical traditions. Perhaps these entheogenic substances truly are what they are said to be: profound, sacred, God-given gifts that can powerfully assist us in our quest to know the true nature of ourselves, as well as the all-too-often hidden beauty of the world around us.

1. James, William. *Essays in Religion and Morality*. (Cambridge, MA: Harvard University Press, 1982), p. 84.
2. Ibid. , p. 86.
3. Ibid, p. 89.
4. Ibid.
5. Ibid, p. 92.
6. Ibid, p. 93.
7. Ibid.
8. Ibid, p. 86.
9. Ibid, p. 87.
10. Fuller, Robert C. *Stairways to Heaven: Drugs in American Religious History*. (Boulder, CO: Westview Press, 2000), p. 73.
11. Ibid.
12. Papanicolaou, Andrew and Pete A. Y. Gunter, eds. *Bergson and Modern Thought: Towards a Unified Science*. (New York: Harwood Academic Publishers, 1987), p. 349-50.
13. Ibid, p. 350. Wald's television metaphor echoes a way of understanding the relationship between the brain and states of

consciousness that was extensively discussed and developed in the Europe and America in the late 19th century, not only by William James and Henri Bergson, but also by such thinkers as, F. C. S. Schiller and F. W. H. Myers. Edward and Emily Kelly call this perspective the "filter" or "transmission" theory. For a thorough and insightful discussion of this perspective, see Kelly, Edward F. and Emily William Kelly, *Irreducible Mind* (Lanham, Maryland: Rowman and Littlefield, 2007), pp. 28-9, and 606-638. In Barnard, G. William. *Exploring Unseen Worlds* (Albany, NY: State University of New York Press, 1997), pp. 163-170, I discuss James's elaboration of this theoretical outlook.

14. William James, *The Varieties of Religious Experience* (Cambridge: Harvard University Press, 1985), p. 24.
15. Polari de Alverga, Alex. *Forest of Visions: Ayahuasca, Amazonian Spirituality, and the Santo Daime Tradition*. (Rochester,Vermont: Park Street Press, 1999), p. xxii -xxiii.
16. Ibid, p. 75.
17. Ibid.
18. Written communication, 2008. Many Santo Daime practitioners claim that it is possible at times to have a joint "revelation" or visionary spiritual experience during a Daime work. Schmidt shares one of her own experiences that she believes possibly illustrates this phenomenon: "During a ritual when I was lying in the healing room feeling awful after having drunk the Daime I was overwhelmed by questions about the Daime and the spiritual world. Suddenly I spotted an old ... medium standing in the doorway. She looked straight at me. I looked back and, being under the effect of Daime, I started to question her and she answered all my questions patiently, none of us uttering a single word." Schmidt wondered about this incident for several days, not sure if the answers that she received from the woman (which she remembered clearly afterwards) were only part of her imagination. A week later she went to the old woman's house for a birthday party. She wasn't sure whether to ask the medium about the experience, so she just sat in the woman's kitchen, watching her wash dishes. Schmidt adds: "After a while I decided to ask her the same questions as I remembered them fairly well. Suddenly she stopped working, looked at me and said: 'Kristina why are you asking all these questions again. I have already answered them. Do you remember when I stood there in the doorway, looking at you, during the ritual?' 'Yes,' I said. 'Well, then you know already,' she said and continued with what she was doing." Schmidt, Titti Kristina. *Morality as Practice: The Santo Daime, an Eco-Religious Movement in the Amazonian Rainforest*. (Uppsala, Sweden: Dissertation, Uppsala University. *Uppsala Studies in Cultural Anthropology* 41. 2007), p.170.
19. Written communication, 2008.
20. *Forest of Visions*, p. xxiv.
21. Ibid.
22. Ibid.
23. Ibid.
24. Ibid, p. xxvi.
25. Ibid, p. xxx
26. Ibid, p. xxxi.
27. Ibid, p. 58.
28. Ibid, p. 59.
29. *Morality as Practice*, p. 127.
30. Ibid.
31. Ibid, p. 65.
32. Ibid.
33. Ibid, p. 128.
34. Ibid, p. 63.

Evidence for Ritual Use of Entheogens in Ancient Mesoamerica and the Implications for the Approach to Religion and Worldview

by

Marc Blainey

original source: http://www.wayeb.org/download/theses/blainey_2005.pdf
backup source: http://www.psilosophy.info/resources/blainey_2005.pdf

Table of Contents:

Introduction
Ancient Mesoamerican Religion
Archaeological Evidence for Entheogens in relation to their Psychoactive Properties
 Mushrooms
 Peyote Cactus
 Toads
 Ayahuasca
 The Morning Glory and other Entheogenic Flowers
From Proof to Practice: Lessons from Entheology
Observing Entheophilic Ideologies from an Entheophobic Perspective
Entheophobic Bias as the Continuation of the "Noble Savage" Falsehood
Correcting the Oversights: A Revised View of Ancient Mesoamerican Religion
Summary
Bibliography

> "Undoubtedly one of the major reasons that anthropologists for so long underestimated the importance of hallucinogenic substances in shamanism and religious experience was that very few had partaken themselves of the native psychotropic materials (other than peyote) or had undergone the resulting subjective experiences so critical, perhaps paradoxically, to an empirical understanding of their meaning to the peoples they studied."
> -Michael J. Harner

Introduction

Humans have long understood that the ingestion of psychoactive chemicals via local flora and fauna produces powerful alterations in consciousness. However, this has been interpreted in a variety of ways depending upon the cultural context in which these substances are used. For example, the fungal parasite *ergot*, containing lysergic acid amide, occasionally appears on the rye crops of Europe, but "the purposeful hallucinogenic use of the fungus seems to have been restricted to ancient Greece" (Schultes & Hofmann 1979: 102).

In most ethnopharmacological studies, these substances are termed *hallucinogens* or *psychedelics*, in an attempt to classify the type of psychological experience that is produced. However, the term *entheogen*, meaning "plants or chemical substances which awaken or generate mystical experiences," (Forte 1997: 1) will be used in the present paper as an alternative to the more popular terms because the term one uses to label these substances is informative. The more popular terms, which emphasize primarily the sensory effects that are produced, fail to convey the great meaning and sacredness ascribed to these substances by ancient cultures. *Hallucinogen* implies that the resultant experiences are nothing more than fanciful delusions that lack significance in the real world. *Psychedelic* is a loaded term closely affiliated with the "drug culture" of the 1960's and 1970's so its use in the description of ancient cultures is confounded with recent historical associations that have nothing to do with ancient Pre-Columbian religion (for example, see Clark 1969).

It is not that previous treatments of Pre-Columbian religions have completely ignored the use and depiction of entheogenic substances in Mesoamerica (see Carrasco 1990). When discussions do mention entheogens in Mesoamerican religious practices, it is usually only brief lip-service paid to a topic that our modern prohibitionist values would rather not discuss (Martin and Grube 2000: 15). Notable exceptions to this rule are the work of Peter T. Furst (1972; 1974) and Haviland and Haviland (1995). I intend to pick up where Marlene Dobkin de Rios left off in her unheeded call from a 1974 issue of *Current Anthropology* for Mesoamerican specialists to "shed further light on the role of psychotropic flora and fauna in Maya religion" (Dobkin de Rios 1974: 152).

Dobkin de Rios was an anthropologist but not a regional specialist in the cultures of Mesoamerica so she appealed for assistance from Mesoamericanists, receiving many replies about her theories regarding entheogen use. However, most of the replies were very unwelcoming to her suggestions that ancient Mesoamericans used drugs and many esteemed scholars vehemently denounced her claims. Decades have passed with only negligible research conducted on the subject of entheogens in this region (with the exception of a chapter comprised entirely of secondary sources in Rudgley 1993) and scholars of ancient Mesoamerican religion appear to have utterly disregarded Dobkin de Rios. This paper will seek to end this trend by taking a close look at entheogens, their use in religious ritual and the depiction of their use in iconographic remains. In addition, an assessment of the ethnocentricism that hides the evidence of past entheogen use will ensue, referring to an *entheophobic* bias that permeates the methodologies of modern research priorities. The following discussion will attempt to revitalize entheogen studies as they pertain to ancient Mesoamerican religion and worldview.

Ancient Mesoamerican Religion

All the religions of the Pre-Columbian Americas share characteristics that distinguish them from the rest of the world. Their common metaphysical philosophy revolves around a belief in the interconnectedness of the natural, social and spiritual worlds where ancestors and deities are directly accessible through the proper ritual (Stover 1986: 516-517). However, within North and South America, indigenous cultures differ drastically when compared to each other and the two continents' native groups are separated into many diverse cultural regions of which Mesoamerica is one of the most archaeologically rich.

The religious traditions of the Mesoamerican region are diverse relative to each other but are grouped together because they exhibit many mutual qualities that have diffused throughout the region from Northern Mexico to El Salvador after thousands of years of war and trade (Joyce 2004). Native American understanding of the cosmos revolved around a belief in three separate levels of the universe: a divine realm in the sky, a gruesome underworld and the human middle realm. They recorded their religious performances, aimed at pleasing the pantheon of deities above and below them, on public works of text and iconography depicting "burning of incense, dances, games, and other dramatic performances, and also human sacrifice, often paired with militaristic symbolism" (Joyce 2004: 7). Not surprisingly, the most important aspects of Mesoamerican life were also the foremost spiritual concerns, such as the connection of maize (corn), the main part of their diet, with the rain god (Dobkin de Rios 1974: 151). This common religious ideology of the region was organized around a unique conception of cyclical time where a sophisticated knowledge of mathematics was employed to track the movements of the stars relative to a precise calendar (Joyce 2004).

So it is established that the content of Mesoamerican religious texts and monumental iconography were exclusively reserved for the most significant aspects of their culture. So why is there so much artistic and textual reference to the use of entheogens? The obvious answer would be that these sacred substances were very important to ancient Mesoamerican religious rights and that their use was perceived to be a holy act. However, the archaeological and ethnohistorical literature has essentially ignored the influence of these substances and the few references that do occur are made in passing as if the author acknowledges their modern status as objectionable. A good example of how customary Western values have corrupted our view of ancient religion is found in a recent National Geographic article entitled "Descent into the Maya Underworld." In this article, which claims to be a portrayal of modern and ancient Mayan religious beliefs, there is only one mention of a shaman drinking "*balché*, a mildly intoxicating beverage, almost non-stop" (Roberts 2004: 43). Balché is a fermented alcohol derived from the bark of a local tree that has not been criminalized (Konzevik Cabib 1998: 663), unlike the many entheogens. Noticeably absent are the notorious *xibalbaj okox*, "underworld mushroom," also known as the *k'aizalah okox*, "lost-judgement mushroom," mentioned in ethnohistoric accounts (Sharer 1994: 542).

As the following discussion will demonstrate, the omission of entheogens in the study of Mesoamerican religions is a serious oversight. It is difficult to deduce whether the above religious traits were inspired by the use of entheogens or whether predetermined worldviews embodied an ideological environment into which entheogens were naturally integrated. The chicken-or-egg origins squabble is irrelevant to the present discussion which will focus on filling in the gaps of past accounts of ancient Mesoamerican religion that were incomplete because of their disregard for the obvious ritual importance of entheogens.

Archaeological Evidence for Entheogens in relation to their Psychoactive Properties

This section will seek to build on the efforts of Dobkin de Rios (1974) to whom much credit is warranted even though she concedes that her treatment of the topic was woefully inadequate. At the end of her article, "The Influence of Psychotropic Flora and Fauna on Maya Religion," appears a series of responses from various scholars. As expected, there are those for and against her opinion, but perhaps the most significant responses are those from two of the most prodigious luminaries in the history of Maya archaeology; Tatiana Proskouriakoff and J. Eric S. Thompson. Proskouriakoff states that:

> "Direct flights of fancy such as [Dobkin de Rios] offers here should have no place in a scholarly journal, and I think that the referees have been guilty of a serious error of judgement." (Proskouriakoff's reply in Dobkin de Rios 1974: 159)

Although J. Eric S. Thompson had previously acknowledged that the Maya probably utilized entheogens in a religious context (Thompson 1970: 185) he is pessimistic:

> "It is surely rash to substitute for such strong mythological associations the theory that we are faced with representational evidence that the Maya used toad and water lily in hallucinatory rites. Apparently, the properties of the two have become known to science only in recent years; that they were known to the Maya finds no support from any observations by outsiders from the conquest to the present or from Maya colonial writings." (Thompson's reply in Dobkin de Rios 1974: 160)

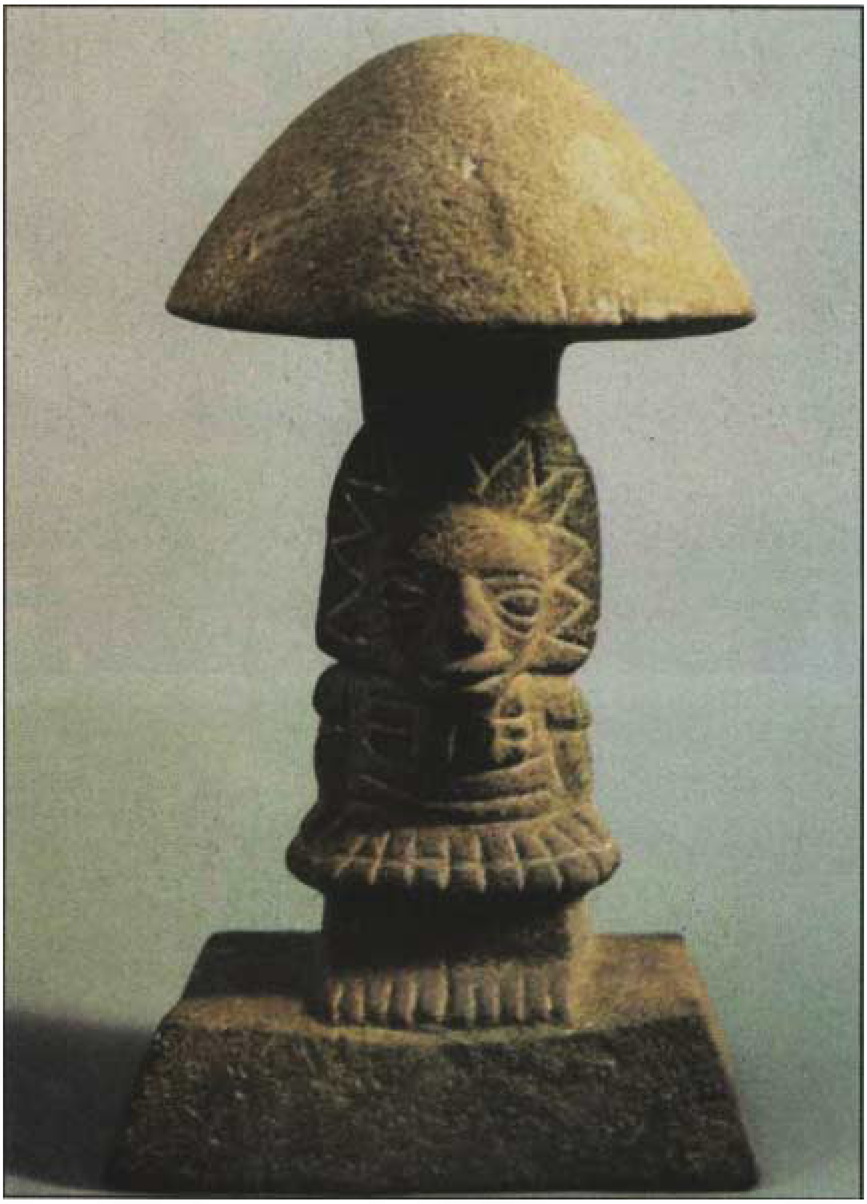
However, as Dobkin de Rios points out, statistical surveys have shown that researchers tend to overlook the importance of entheogens within a culture until they experiment with the chemical themselves (Dobkin de Rios 1974: 161).

Proskouriakoff and Thompson's pessimist attitudes, as shown above, act as a stumbling block for impartial research that is attempting to further the discipline in the face of "the conservatism of Maya scholarship" (Dobkin de Rios 1974: 162). Unfortunately, since Dobkin de Rios' pleas for scholarly rigour went unheeded, we must proceed according to the fact that a knowledge and understanding of the effects of these substances has yet to be effectively linked with the already substantial corpus on Mesoamerican religion. It is hoped that the mind-altering substances explained below will be incorporated into contemporary models of Mesoamerican religion to produce a much more inclusive and complete understanding of Pre-Columbian spiritual beliefs.

Dobkin de Rios refers to the work of Arnold Ludwig (1969: 13-16) who devised ten general distinguishing characteristics of altered states of consciousness that can be applied to entheogen-induced religious experiences: (1) altered thinking/concentration, (2) modified sense of time, (3) loss of control (depending on cultural worldview this can be a positive or negative encounter), (4) eccentric emotional expression making intoxication obvious, (5) altered sense of one's own body and atypical sense of self, (6) sensory distortions including synaesthesia, (7) unconventional meaning/significance given to one's surroundings and events compared to sober state, (8) belief in the acquiring of ineffable knowledge, (9) mental and physical sensations of invigoration and, (10) hypersuggestibility and the loss of conceptual and behavioural inhibitions. Ludwig's description stands in stark contrast to the "objective" portrayals of the mushroom experience found in pharmacological volumes where they are said to cause "*disturbances* in thinking, *illusions*...and *impaired* ego functioning" (Julien 2005: 612 emphasis added).

Mushrooms

Several genera of mushrooms contain the entheogenic chemical, psilocybin (4-phosphoryl-DMT) or psilocin (4-hydroxy-DMT), including *Psilocybe*, Stropharia, *Panaeolus*, *Copelandia*, and *Conocybe*. It does not matter which of the two chemicals the mushroom contains because psilocybin is transformed into psilocin during digestion (Julien 2005: 610).



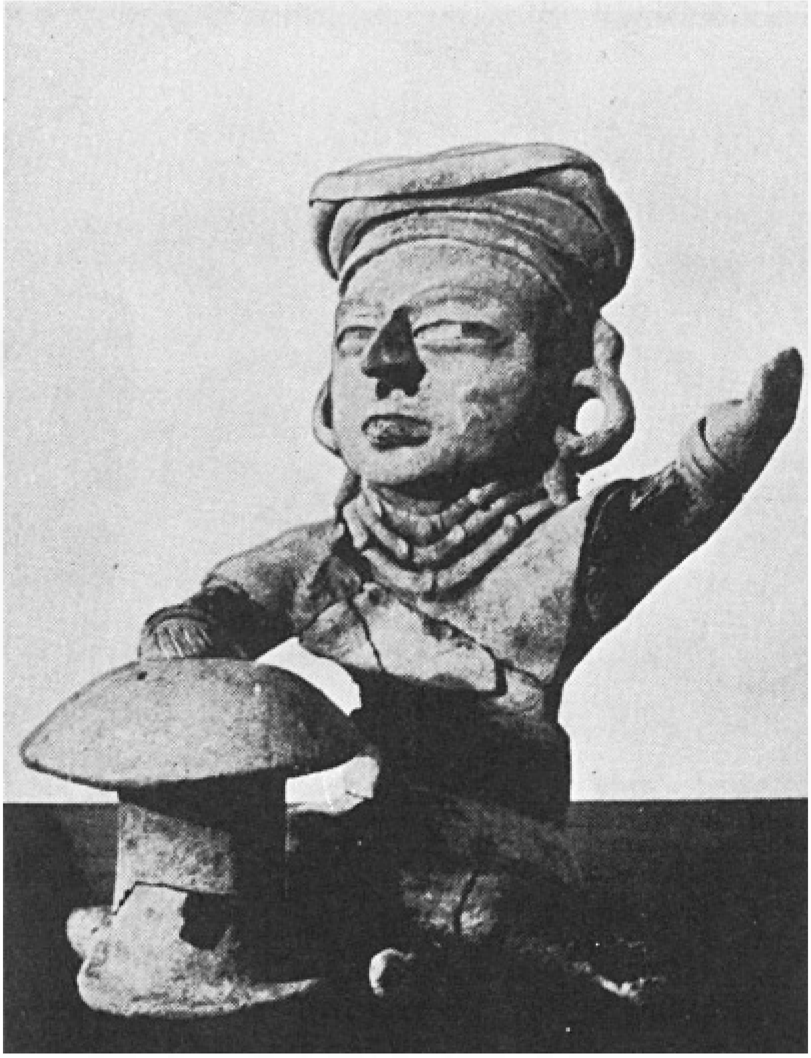
Mushroom stone with human effigy, from Wasson 1980: 176.

Mushrooms are arguably the most frequently depicted entheogen in the archaeological record of Mesoamerica and probably the most widely utilized because they are one of the only substances that requires no preparation to achieve the desired effects. Chemists and psychologists have said the effects of psilocybin are comparable to those of LSD but they have also been equated to psychosis. The Pre-Columbian use of entheogenic mushrooms was seen in a totally different sense where the effects were attributed to contact with divinities and fantastic mental journeys. Known to the Aztecs as *teonanacatl* ("flesh of the gods"), psilocybe mushrooms were promptly demonized by Christian missionaries soon after European contact in the 17th century. The religious persecution of the use of these mushrooms resulted in their use being hidden from foreigners until knowledge of them was rediscovered in the 1950's by R. Gordon Wasson, a banker from New York City (Beyerstein & Kalchik 2003: 17; Julien 2005: 612). Wasson ventured deep into the Oaxacan highlands of

Mexico in search of the fabled mushroom shaman, María Sabina. He was the first foreigner to participate in the sacred *Velada* ceremony, which he described in numerous writings upon his return to the United States:

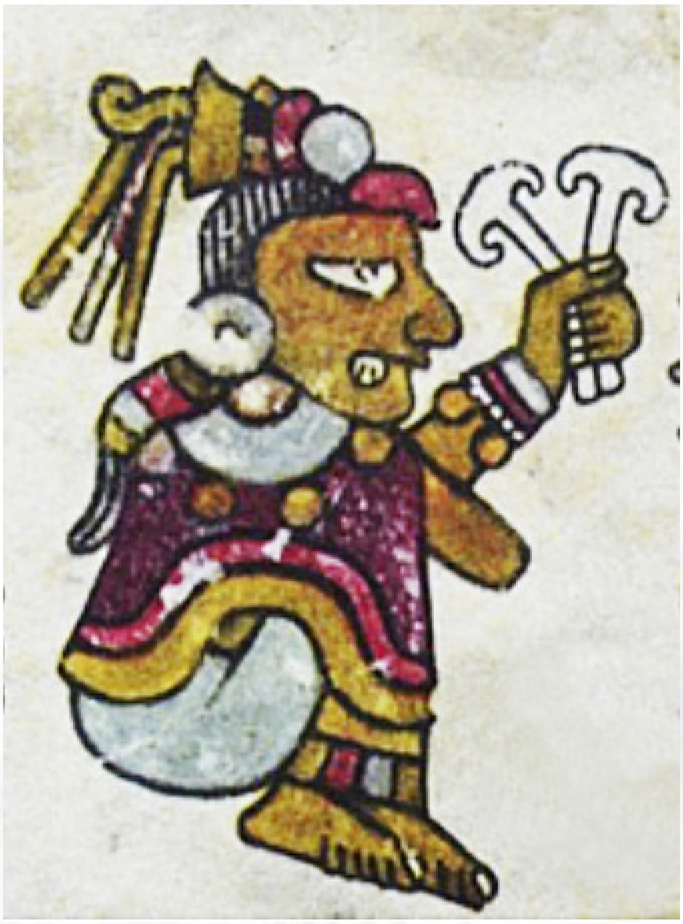
> "the mushrooms gave me no choice. They took full and sweeping possession of me. There is no better way to describe the sensation than to say that it was as though my very soul had been scooped out of my body and translated to a point floating in space...we saw geometric patterns, angular not circular, in richest colors...the patterns grew into architectural structures, with colonnades and architraves, patios of regal splendor, the stone-work all in brilliant colors, gold and onyx and ebony, all most harmoniously and ingeniously contrived, in richest magnificence extending beyond the reach of sight." (Wasson 1980: 15)

Wasson's qualitative description of the experience is essential because it adds an empathetic quality that more detached scientific descriptions lack. The purpose of focussing on these empirical descriptions is to open a previously closed window of understanding when paired with the ancient Mesoamerican cultural context. The importance of the sciences in aiding the research of social scientists is not devalued in this approach. Nevertheless, for studies regarding religious transcendence I believe it to be much more vital to appreciate the full scope of the altering of consciousness instead of relegating these mental journeys to materialistic quantifications.



Priestess and mushroom stone, from de Borhegyi 1963: 332.

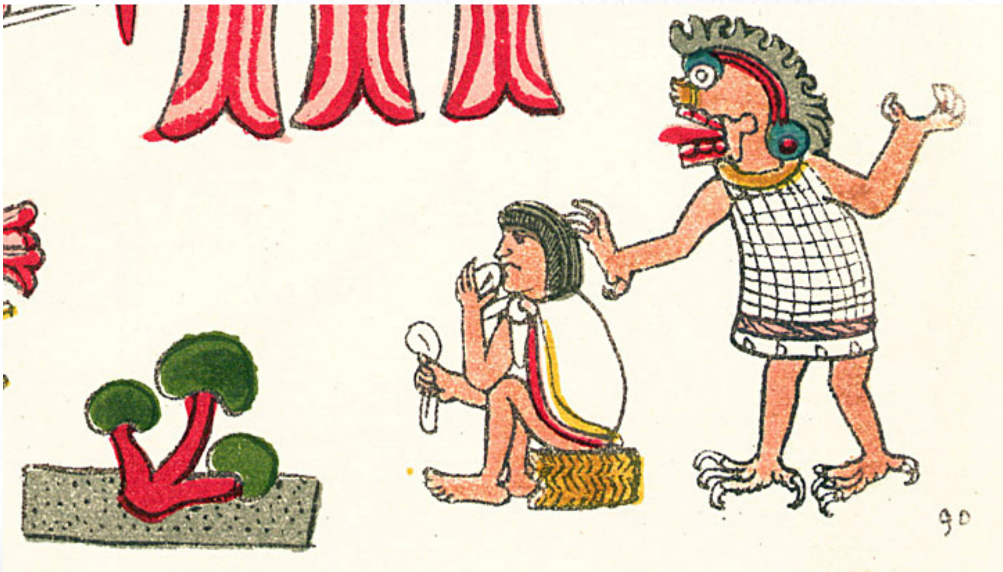
Archaeological evidence for the use of these mushrooms is found in the iconographic representations of mushrooms being ingested and the numerous mushroom shaped *altars* that are found throughout Mesoamerica. An ethnocentric bias on the part of the scholars studying ancient Mesoamerican religion attests for the oversight regarding the connection between these altars and the ritual use of entheogenic mushrooms. Mushroom altars were made of both stone and ceramic, often accompanied with ideologically significant effigies build into the base (de Borhegyi 1963; Kohler 1976). One Pre-Columbian pottery figurine from Veracruz, Mexico represents a woman whose "left hand rests on a plain, hollow pottery mushroom, while her right arm is extended upward as if in prayer" (de Borhegyi 1963: 332). It appears as if this figure is a depiction of the ceremonies in which the mushroom altars were employed for spiritual purposes, possibly as effigy altars of the sacred "flesh of the gods" that were simultaneously consumed.



Vindobonensis codex, from Schultes & Hofmann 1979: 146

There are also scriptural references to the use of entheogenic mushrooms. In the *Vindobonensis* codex, "nine deities receive instructions from Quetzalcoatl on the origin and use" (Schultes & Hofmann 1979: 146) of the mushrooms. The depiction of deities alongside someone consuming mushrooms in the Aztec *Magliabechiano* codex serves to further the notion that these mushrooms were eaten in a ritual context (Wasson 1980: 113). When one considers the portrayals of mushrooms in scriptural codices and the mushroom effigy altars, it becomes difficult to argue against the idea that mushroom ceremonies were being performed in ancient times much like they were when Wasson participated in the Oaxacan Velada in 1955.

There are over 20 different species of entheogenic mushrooms found in Mexico so it is reasonable to make the connection between the known transcendental properties of psilocybin mushrooms and the use of mushroom altars in ritual consumption ceremonies (Dobkin de Rios 1974: 148). If one looks at Wasson's description of the experience, it becomes clear that if indeed these mushrooms were being used in religious ceremonies, the cultural impact would be considerable. This is especially true in the case of Amerindian traditions. In the context of their holistic worldview, these experiences would not be considered illusions; rather, the visions caused by these mushrooms would be interpreted as genuine voyages to otherworldly realms.



Magliabechiano codex, from Wasson 1980: 113

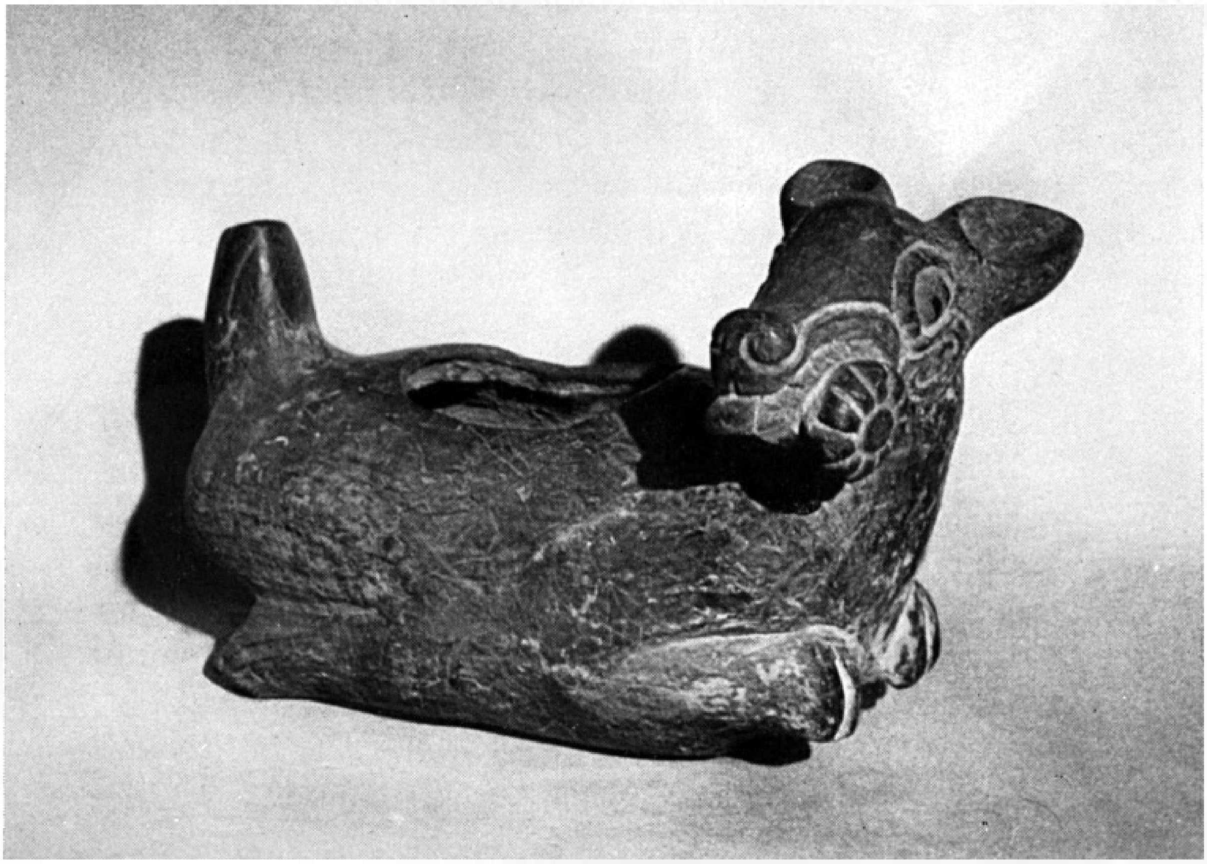
Peyote Cactus

Lophophora williamsii, or peyote, is a common cactus species found in western Mexico and the South-western United States, which contains the entheogenic chemical mescaline in the "button," a small blossom at the end of the cactus branches (Julien 2005: 594). Evidence for Pre-Columbian use of peyote is scantier than that of other entheogens, and it was most broadly documented in the years following European contact (Furst 1972: 136-137). One exception is an archaeological investigation conducted at a three thousand year old cave site in Texas that yielded peyote buttons "found in a context suggesting ceremonial use" (Schultes & Hofmann 1979: 132). The entheogenic properties of mescaline are comparable to LSD and psilocybin in that they produce dazzling visual effects that are best described by the great novelist/poet Aldous Huxley, who wrote a book about his experiences with mescaline:

> "I continued to look at the flowers, and in their living light I seemed to detect the qualitative equivalent of breathing - but a breathing without returns to a starting point, with no recurrent ebbs but only a repeated flow from beauty to heightened beauty, from deeper to ever deeper meaning. Words like "grace" and "transfiguration" came to my mind, and this, of course, was what, among other things, they stood for. My eyes traveled from the rose to the carnation, and from that feathery incandescence to the smooth scrolls of sentient amethyst which were the iris. The Beatific Vision, Sat Chit Ananda, Being-Awareness-Bliss - for the first time I understood, not on the verbal level, not by inchoate hints or at a distance, but precisely and completely what those prodigious syllables referred to." (Huxley 1954: 18)

It is curious that a plant that produces such an awe-inspiring experience would fail to gain the iconographic prominence of the other entheogens. However, this may have to do with the conflating of peyote's identity with other psychoactive plants of the region.

J.S. Slotkin (1955) conducted a survey of the missionaries' written records and found that the interchangeable terms *peyote* and *peyotl* were generally used by colonizers to refer to the myriad of strange substances consumed by the natives. He points out a glaring problem in the ethnobotanical literature where scholars have assumed the straightforwardness of historical references to peyote, even when there is no solid evidence that the use of this term, and the many other native terms, refers directly to the mescaline cactus (Slotkin 1955). This obscurity may be attributed to the fact that native groups did not categorize peyote buttons separately, or perhaps the motif of peyote in Mesoamerican art is still unknown to iconographers. One exception is a "snuffing" effigy pipe dating to 500 B.C. from the Oaxacan site of Monte Albán "in the form of a deer with a Peyote in its mouth" (Schultes & Hofmann 1979: 133). There is also the suggestion that the bright, vibrant colours preferred by many Mesoamerican cultures for use in decorations and blanket/clothing patterns were inspired by the visions induced by peyote (Beyerstein & Kalchik 2003: 21).



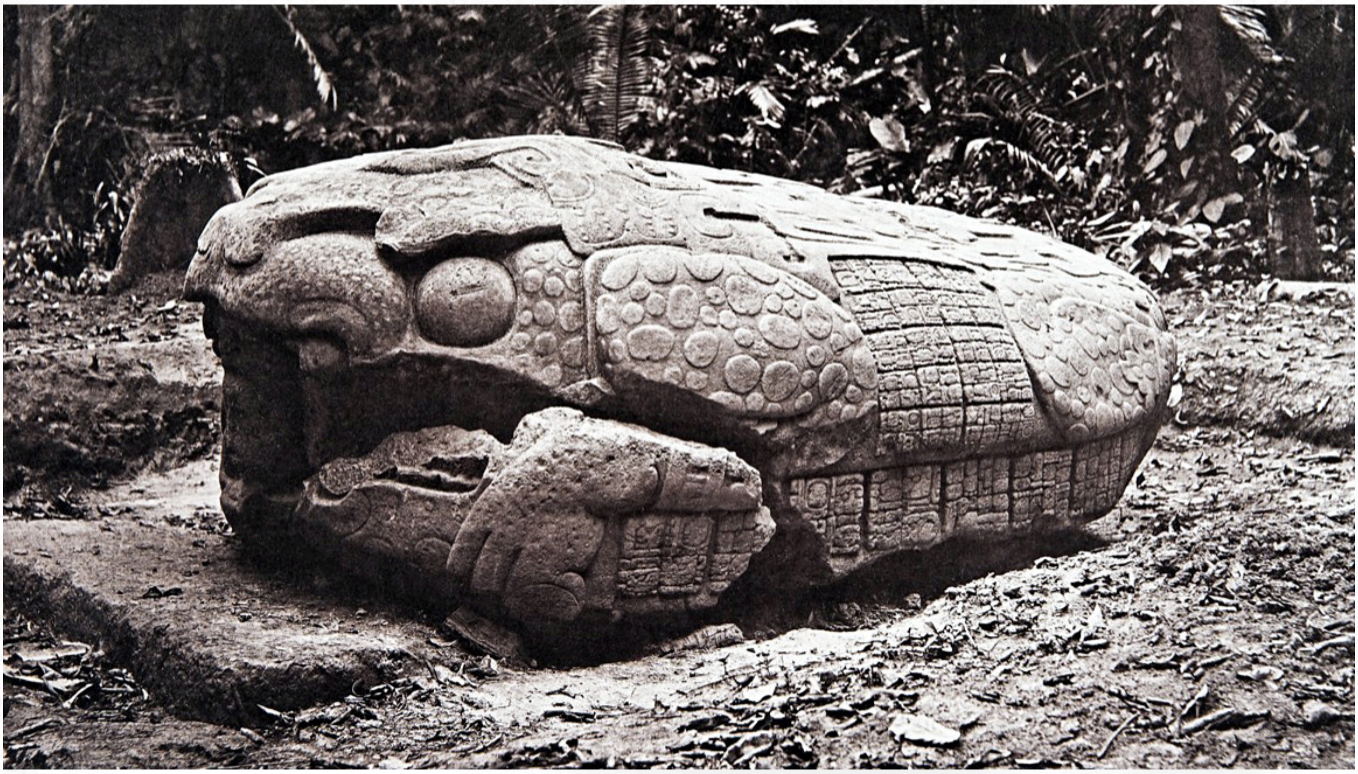
"a deer with a Peyote in its Mouth" (Schultes & Hofmann 1979: 133)

It is clear that there was widespread use of peyote buttons at the time of European contact and these practices were aggressively condemned by Christian missionary powers. In fact, peyote represented perhaps the most severe offence to Christian authorities because native groups who were being converted began to associate the divine properties of peyote with images of the infant Jesus (Wasson 1980: 144). This infuriated missionaries who were trying to convert the natives and convince them of the Christian path to God. Instead, they found the natives resorting to traditional paths to the divine via the ingestion of entheogenic flora and fauna.

Toads

The possible use of toad toxins for entheogenic purposes has long been debated and continues to be an uncertain theory. What is certain is that the toad was recurrently depicted in Mesoamerican art (see Kennedy 1982), possibly more than the mushroom and at times with the toad image forming the base of mushroom stones (see Wasson 1980: 184-185). Many species of the toad genus *Bufo* have paratoid glands that excrete the entheogenic chemical 5-hydroxy-DMT, also called bufotenine. Bufotenine, which resembles psilocin in structure, is only entheogenically active when administered by smoking or snorting and when combined with some type of MAO (monoamine oxidase) inhibitor (Beyerstein & Kalchik 2003: 26). As you will see below with the discussion of Ayahuasca, MAO inhibitors are needed for certain chemicals to protect the entheogenic molecule from being broken down before its effects are felt.

Much of the literature concerning the use of toad venom as an entheogen has died out since the 1992 publication of an antagonistic paper by ethnobotanists Wade Davis and Andrew Weil. In their article, they point out the many discrepancies that have confounded past attempts to link the abundant iconographic representations of *Bufo marinus* toads to their use as entheogens. Naturally, Davis and Weil attack the lack of ethnohistorical evidence, but I would reply that perhaps after the zealous missionaries targeted their other entheogens, such as mushrooms and peyote, the Mesoamericans tried to protect their remaining entheogens by not allowing the colonizers to know about their existence. Davis and Weil also point out the fact that *Bufo marinus* toxin, besides containing bufotenine, also contains bufogenin and bufotoxin, which are both powerful poisons that were used in Europe as murder weapons (Davis and Weil 1992: 51-52).



"Monolithic Animal G", from the site of Quirigua, in Kennedy 1982: 278.

I am not yet prepared to declare dead the possible connection between iconographic representations of the toad on pottery and stone, and its use as an entheogen. After all, there are copious depictions of *Bufo marinus* that distinguish it from other Mesoamerican toad species by its unique cranial crest, paratoid and tibial glands, and its middorsal vertebral stripe. The majority of representations of *Bufo marinus* are unmistakable because of the consistently identical representation of the paratoid glands (the source of the toxin) as liver-shaped disks above the shoulders with numerous punctated marks to signify the venom-secreting pores. Perhaps the best of all representations of these *Bufo marinus* characteristics is the unmistakable "Monolithic Animal G" from the Guatemalan site of Quirigua (Kennedy 1982: 277-278). With these unambiguous depictions of *Bufo marinus* appearing so frequently across Mesoamerica, is it possible that they figured out a way to circumvent the poison problem? Kennedy (1982) describes a possible method whereby the toxic toads could have been fed to ducks, which are known to have livers that are uniquely capable as detoxifiers and would then allow the hallucinogens to be exploited through the ingestion of the ducks' livers. Interestingly, ducks are a common theme in the art of the Olmec, a pre-Mayan people of the Gulf of Mexico coast. It is at the Olmec site of San Lorenzo where one of the biggest collections of *Bufo marinus* bone dumps was found in association with an unexplainable U-shaped "water control system." This structure has puzzled archaeologists and could only be described by researchers as pertaining to "ritual use." Kennedy cannot help but propose that perhaps this cistern, which is too small for human bathing, might have been used as a place for ducks to swim while they were fed *Bufo marinus* (Kennedy 1982: 286). These collections of toad bones have been found all over Central America but they present a dietary anomaly because of the presumed toxicity of the toads (Davis and Weil 1992: 53).

Davis and Weil (1992) are correct in their assessment of *Bufo marinus* toxin as being too poisonous to be ingested in an unmodified form and that bufotenine might not be entheogenic after all, but they do point to an interesting *Bufo* species found in the American mid-west called *Bufo alvarius*. This particular species also secretes bufotenine but it has entheogenic properties only because it also contains O-methyl transferase, which converts the small proportion of bufotenine into the very strong entheogen, 5-MeO-DMT, increasing this chemical's proportion in the toxin from zero to a whopping 15% (Davis and Weil 1992: 55). Therefore, it could be argued that ancient Mesoamericans could have combed their amazingly diverse forests (fourth most plant species among regions of the world[1]) for O-methyl transferase, which they could have found in trees of the genus *Pinus*[2]. Wade Davis describes his experience after smoking 5-MeO-DMT from *Bufo alvarius*:

> "Shortly after inhalation I experienced warm flushing sensations, a sense of wonder and well-being, strong auditory hallucinations, which included an insect-cicada sound that ran across my

> mind and seemed to link my body to the earth. Though I was indoors, there was a sense of the feel of the earth, the dry desert soil passing through my fingers, the stars at midday, the scent of cactus and sage, the feel of dry leaves through hands. Strong visual hallucinations in orblike brilliance, diamond patterns that undulated across my visual field. The experience was in every sense pleasant, with no disturbing physical symptoms, no nausea, perhaps a slight sense of increased heart rate." (Davis and Weil 1992: 56).

If we accept the ingenuity of the Mesoamerican peoples, it is possible that they were able to test different *Bufo-Pinus* concoctions on prisoners that had been acquired from war victories (Sharer 1994: 144), much like the Nazi medical experiments, until a safe and effective mixture of 5-MeO-DMT was developed from *Bufo marinus* toxin.

Ayahuasca

Ayahuasca is a tea beverage that is still popular among Amazonian native groups and was the subject of the most comprehensive phenomenological survey ever conducted on an entheogen. Benny Shanon, an Israeli cognitive psychologist, published *The Antipodes of the Mind: Charting the Phenomenology of the Ayahuasca Experience* (2002), which now stands as the standard review of the experiences induced by an entheogen. Shanon is a reputable cognitive psychologist whose writings on the Ayahuasca experience present a fair and unbiased account of substances that are currently banned and considered scandalous in modern Western societies. In comparison, Wasson's work on mushrooms is helpful, but he was not a professionally trained scholar, let alone his lack of training in the culture of Mesoamerica. Benny Shanon, on the other hand, has provided an invaluable academic text, which would be idyllic to have for every entheogen discussed here. Like a cartographer who maps a geographical region of the earth, Shanon describes every facet of the Ayahuasca intoxication in intricate detail, combining the contents of visions with corresponding philosophical and psychological concepts.

The active entheogenic chemicals in Ayahuasca are DMT (N, N-dimethyltryptamine), usually derived from the *Psychotria viridis* bush and MAO inhibitors, such as harmaline/harmine that normally come from the *Banisteriopsis caapi* vine, which act as entheogens and prolong the experience by slowing the breakdown of DMT (Shanon 2002: 15-16). DMT is the main entheogenic constituent to the tea and even when administered by itself, it is one of the most potent and fast-acting entheogenic chemicals. It has been synthesized and made into snortable or smokeable crystals in modern times, but for the most part, DMT was administered to people in ancient times as a tea, such as Ayahuasca (Julien 2005: 609). An initial problem is that there is no evidence for the use of Ayahuasca in the archaeological record, but this does not rule out its use because as one can see from the above discussion of obvious entheogen use, the ancient entheogenic rituals are only evident when the researcher is willing to open their eyes to the evidence.

It can be safely argued that the seeking out of methods with which to gain transcendence was an important aspect of ancient Mesoamerican religion. We can see this in the insatiable trial-and-error with which they discovered the entheogenic properties of many plants and the possibility of their experimentation with the extraction of bufotenine. Even though neither *Psychotria viridis* nor *Banisteriopsis caapi* are found in Mesoamerica, there are plants native to Mesoamerica that contain DMT and MAO inhibitors. *Mucuna pruriens*, otherwise known as Cowhage, is a DMT-containing climbing plant native to many parts of the world, including Mexico and Guatemala.[3] Also, *Ceiba pentandra*, a religiously significant tree to the Maya (Sharer 1994: 33), contains the MAO inhibitors kaempferol and tannin,[4] neither of which is toxic.[5,6] Therefore, we can cautiously suggest that Mesoamerican cultures exploited the plants in their territory in the same manner as their Amazonian counterparts managed to perfect their Ayahuasca beverage after millennia of trial-and-error "research."

Out of the millions of species of plants in the rainforest, to find one of the ingredients to Ayahuasca is amazing, but to find the correct pairing is an astounding feat (Shanon 2002: 16). Shanon sums up his competent familiarity with Ayahuasca by stating:

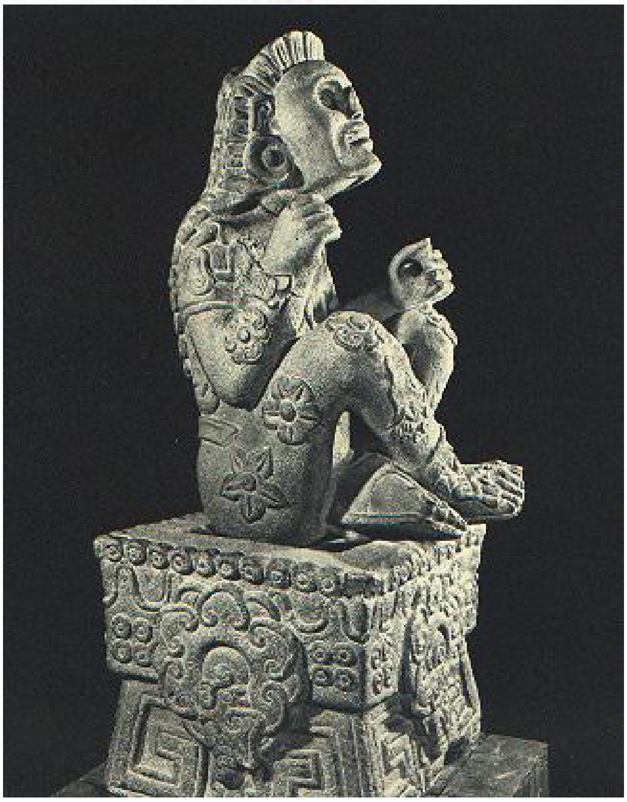
> "Personally, if I were to pick one single effect of Ayahuasca that had the most important impact on my life...I would say that before my encounter with the brew I was an atheist...and when I

> returned back home after my long journey in South America, I no longer was one. Likewise, a significant number of informants I have interviewed indicated that the main lesson they received from Ayahuasca was religious or spiritual. 'Ayahuasca showed me that God exists,' 'I have come to appreciate the place of the sacred in human life,' 'I have encountered the Divine,' are all statements I have heard more than one person say. There are many individuals who, in direct consequence of their experience with Ayahuasca, underwent a radical religious or spiritual conversion." (Shanon 2002: 260)

Such profound consequences of the Ayahuasca experience demand attention from Mesoamerican scholars. They should be emulating the cultures they are interested in by developing a propensity to seek out transcendence through meticulous investigation of, and experimentation with Mesoamerican flora and fauna. Of course, it could be argued that modern researchers can never fully recreate the experience in the same way as it was perceived by ancient Mesoamericans. Yet this is true of every archaeological investigation; for example, if we restore the Mayan pyramids to their original splendour, the awe that they inspire in modern viewers is not the same as it was in 700 A.D. The purpose of archaeology is to theoretically recreate ancient ideologies so that we can gain a better understanding of how the world appeared to the ancients. Entheogens offer us the same degree of insight into the minds of ancients as material objects extracted from the ground or the monumental architecture that dots the Mesoamerican landscape.

The Morning Glory and other Entheogenic Flowers

There were multiple flower species known to ancient Mesoamericans that contain entheogenic chemicals. Most notable is the use of the seeds of the Morning Glory flower (*Turbina corymbosa*), called *ololiuhqui* by the Aztecs, which contains lysergic acid amide (the same chemical that is found in the ergot fungus discussed earlier). The LSA molecule is almost identical in structure to the much more potent lysergic acid diethylamide (LSD), which was the central inspiration for the drug culture of the 1960's and 70's (Beyerstein & Kalchik 2003: 19; Clark 1969). Even though LSA is not as potent as LSD, when hundreds of seeds were ground into a powder, they would be blended into a cacao beverage and sometimes psilocybin mushrooms were added to the mixture (Wasson 1980: 98). Indeed, even though the Morning Glory is found throughout Central America and the Caribbean, it appears that they were only purposely used as entheogens within Mexico (Schultes & Hofmann 1979: 159).

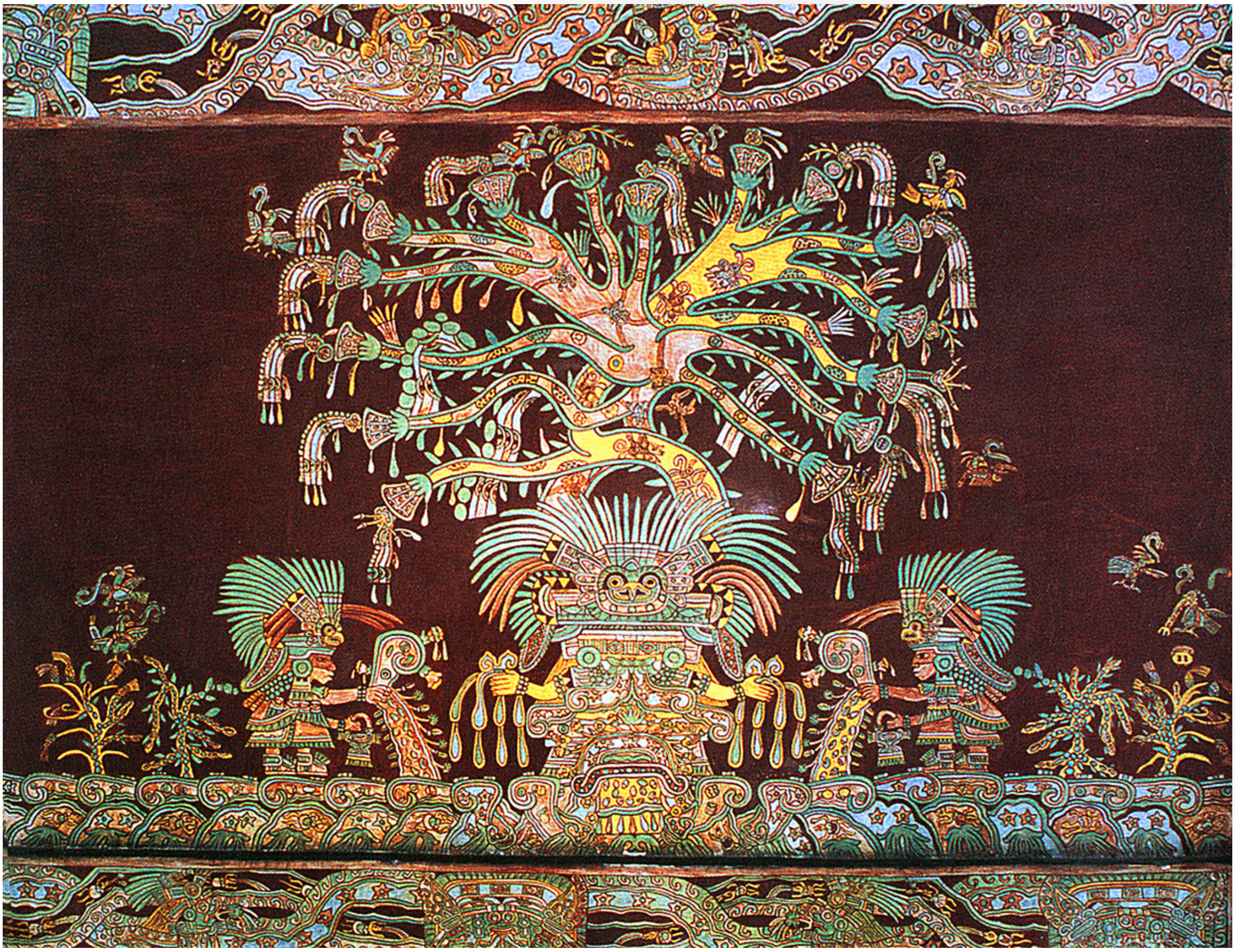


Xochipilli statue, in Wasson 1980: 61

Morning Glory seeds were an important device of the Aztec shaman, who used peyote while also drinking a concoction made of *ololiuhqui*, spiders, scorpions, salamanders and vipers. This beverage was called *Petun* and was esteemed by the Aztec shamans while the Spanish friars detested it because of the presumed devilish nature of the intoxication it produced (Dobkin de Rios 1984: 146). It is easy to appreciate the difficulty with understanding ideologies that are totally different than the modern Western worldview when one looks at translations of Aztec religious prayers to the ololiuhqui-specific deity:

> "Come now, come hither, Green Woman: behold the green heat (fever) and the brown heat: remove thou the flaming or scarlet heat, the yellow heat or by this token, I send thee to the seven caves. And I do command thee, put it not off till tomorrow or another day, for sooner or later thou wilt be compelled to do it. Who is the God - the so powerful and superior one - who can destroy the work of thy hands. It is I who command it, I the prince of enchantment." (cited in Dobkin de Rios 1984: 146)

Since this is a translation from the original Nahuatl into Spanish and now English, the obscurity of the prayer highlights the fact that certain concepts and symbolism only make sense in the context of the worldview in which they originate, and we are still a long way off from truly understanding the religious context in which this prayer would have made sense. It is also interesting that there is so much referral to colours and different types of heat. These colour and temperature references are understandable when one considers the content of the quotations in earlier discussions of entheogenic experiences.



Aztec Mother Goddess alongside *Ololiuhqui* vines with entheogenic "nectar" flowing out of the Morning Glory blossoms, in Schultes & Hofmann 1979: 160-161

There is a notable Aztec sculpture depicting their flower deity, Xochipilli, in a prayerful position with images of different flower species on his limbs and body. Besides the morning glory, there are illustrations of a tobacco leaf (*Nicotiana tabacum/rustica*[7]), mushroom caps, a sinicuichi flower (*Heimia salicifolia*[8]), a flower (poyomatli) from the cacahuaxochitl plant (*Quararibea funebris*[9]) and a still unidentified four-petaled flower. All of these flowers are known to have been categorized by the Aztec as aristocratic entheogens that were used mainly by the upper echelons of society (Wasson 1980: 64-71). Ololiuhqui was also praised by the Aztec's ancestors from the city of Teotihuacán who portrayed the experience of Morning Glory seeds artistically in a beautiful mural from 500 AD (Beyerstein & Kalchik 2003: 18-19). These are but a few of the many iconographic examples of entheogenic flowers but it is enough to suggest that Mesoamerican religion also held these types of entheogens to be of religious value. Like the other entheogens, *ololiuhqui* was also outlawed as an instrument of the devil (Furst 1974: 206).

From Proof to Practice: Lessons from Entheology

The iconographic and ethnohistorical evidence overwhelmingly illustrates that the ancient Mesoamericans revered the extraordinary properties of these entheogens enough to recreate them artistically. Therefore, it only makes sense that modern reconstructions of their religion should incorporate an appreciation for this reverence and an understanding of the states of consciousness that they induce in order not to overlook an important aspect of ancient Mesoamerican religious worldview.

The above discussion represents a rare conflation of the emerging field of entheology with the already established disciplines of art history and archaeology. It is hoped that further study will finally demand a response to Dobkin de Rios' 1974 plea for cultural scholars to familiarize themselves with entheogens. These substances and their influence on ancient Mesoamerican religion can no longer be ignored as they have been in the past. Future studies of Mesoamerican religion and worldview must now take into account the facts described above. Since it has been established that researchers tend to ignore entheogenic substances until they experience them themselves, it is advisable that scholars who intend to study the ideology of the peoples of Mesoamerica should pursue a comprehension of entheogenic experience in order to gain an appreciation for the cultural ramifications. Some may argue that there is still not enough evidence for the significance of these substances but if this is true, it is only because the iconographic remains have been assessed with an eye that is not looking for them. I will predict that when more researchers begin to acknowledge the metaphysical impact of entheogens and begin to look for representations of entheogenic flora and fauna that there will be an upsurge in the amount of iconographic evidence. It is also advisable that scholars begin to lessen their reliance on the ethnohistorical writings of the conquistadors and missionaries because these texts are prejudiced against the native uses of entheogens. The writings of the colonizers do not properly represent the sacredness imbued in these substances by indigenous Mesoamericans:

> "I believe that, incited by the cursed devil, these wretched Indians remain confused and are neither fish nor foul in matters of the faith." (Friar Durán, cited in Torrance 1994: 199)

Future studies of the religions of this region must begin to comprehend them from the point of view of the native, not that of those who oppressed and persecuted them. This requires a turn to iconography and a desire to understand how ancient Mesoamericans made sense of existence and the human condition. After all, that is the purpose of the pursuit of anthropology: to study the behaviours and customs of other cultures and compare them to ours in an attempt to better recognize what it really means to be human. Anthropology is hindered when the views of the modern West are projected onto the vastly different worldviews of non-western societies. The rest of this current study will strive to excavate the oversights of the past and suggest a more authentic reading of ancient Mesoamerican religion that includes an appreciation for the ritual use of entheogens.

Observing Entheophilic Ideologies from an Entheophobic Perspective

There are seemingly endless possibilities to the structure and scope of human ideologies. However, each ideological system is regarded by its followers as the one true explanation of reality while all competing versions are held to be irrational and false. When one really delves into the subject of basal metaphysics, it becomes clear that all of them are groundless descriptions of an existence that is intrinsically beyond human understanding. Earnest Becker declares that "this is what society is and always has been: a symbolic action system, a structure of statuses and roles, customs and rules of behaviour, designed to serve as a vehicle for earthly heroism" (Becker 1973: 4). By heroism, he is referring to the seeking out of a feeling of purpose and specialness within a metaphysical reality that is fundamentally devoid of knowable purpose. For Mesoamericans, "ritual coercion is one response to the uncertainties of a world never fully conformable to human need" combined with the "incorporation of more flexible means of transcendence through personal communication with the divine" (Torrance 1994: 197). In short, it is the curse of the human condition that no one can know what the true meaning of life is, so we fabricate a system that reinforces itself as the ultimate depiction of what reality *is*. I believe this process of demoting other cultural worldviews in defence of our own secretly arbitrary pursuit of heroism has resulted in an ethnocentrically skewed conception of ancient Mesoamerican religion. The above synopsis serves to demonstrate that past scholars have certainly overlooked the importance of entheogens in ancient Mesoamerican spirituality, but why did this omission occur across the discipline?

I propose that the oversight is related to a worldview classification scheme established by R. Gordon Wasson. Wasson was mainly focussed on the use of mushrooms in different societies and he noticed that the perception of mushrooms crossculturally was separated into those worldviews that liked mushrooms (*mycophiles*) and those that had a fear of them (*mycophobes*) (Wasson 1980: xv). I want to expand his classification for the purposes of this paper to a broader ideological breakdown of all cultures as either *entheophilic* or *entheophobic*. This new typology will serve to reassess the misguided outlook that has been assumed by modern scholars as they approach ancient religious ideologies. As seen in our legal codes, the modern Western worldview holds that all intoxication, other than that brought on by alcohol, is objectionable and immoral. Conversely, Pre-Columbian peoples were ignorant of the practice of alcohol distillation and could only produce a few fermented alcohols from cacti, maize, honey, or pineapple, all of which were strictly regulated:

> "Among the ancient Aztecs, getting drunk without incurring the wrath of society was a privilege of old age; drunkards could receive severe punishments, ranging from public disgrace to death by stoning or beating" (de Smet 1985: 20).

When one considers this outlawing of alcoholism with the overwhelming evidence for the use of entheogens by ancient Mesoamericans, it appears that their social rules regarding intoxication represent the antithesis to the laws of the modern West. It can be safely concluded that all studies of ancient Mesoamerican religion and worldview that have excluded entheogens exhibit entheophobic bias that precludes the importance of these substances for entheophilic ideologies. I will illustrate this point through a critique of Davíd Carrasco's Religions of Mesoamerica (1990).

Entheophobic Bias as the Continuation of the "Noble Savage" Falsehood

Davíd Carrasco is currently Rudenstine Professor of the Study of Latin America at the Harvard Divinity School, and one of the leading authorities on Mesoamerican religion[10]. In his overview of past and present Mesoamerican religion (Carrasco 1990), there is only one reference to the use of entheogens in Mesoamerican religious practices; a remiss narrative on the use of peyote by the Huichol groups of Western Mexico as "one outstanding example" (Carrasco 1990: 138).

Considering the mass of evidence described above, it is not justifiable to exclude the ritual use of entheogens in an overview of Mesoamerican religion. Nevertheless, Carrasco (1990) deems it necessary to dedicate an entire chapter to the Christianization of Mesoamerican society and devotes only three pages to discussing the sanctity of vegetation. Under the heading "Plants and the Sacred Dead," the author describes the religious significance of agricultural crops without a single mention of the employing of entheogenic plants in religious rights (Carrasco 1990: 27). This massive oversight is doubtlessly the result of a hidden ethnocentric bias rooted in the training of today's scholars of religion and culture. Regrettably, it is virtually impossible to separate oneself from one's acculturation into the modern worldview, let alone an instinctive reverence for the assumedly objective truths of one's own moral standards.

The moral structure of today's modern world is primarily founded on Judeo-Christian principles. These principles, however, are not universally applicable and are merely a type of ideology known as *Religions of*

Difference; a metaphysic that grounds "the source of all goodness and truth in the transcendent, maintaining that humans are saved by a God outside rather than a God within" (Woodhead & Heelas 2000: 27). This ideological stance conflicts with the Mesoamerican view of the human being as fundamentally divine in nature and as a vehicle of direct consultation with sacred forces:

> "Mesoamerican peoples saw the human body as the nucleus and unifying body of the cosmos, which was permeated…with specific supernatural powers and entities. The human body was progressively filled - at conception, birth, the first exposure to fire and sunlight, and at points of special achievements in life - with powers originating in the celestial spheres above and in sacred events that took place in mythical time." (Carrasco 1990: 53)

Carrasco only acknowledges distinctions between ancient Mesoamerican religion and that of Religions of Difference when the attributes of the former correspond to the modern view of Native American spirituality as inferior. He concedes that images of indigenous peoples as "the wild man and the noble savage, were already deeply embedded in the European mind before Mesoamerica was discovered" (Carrasco 1990: 7).

Western researchers who ignore the significance of entheogens do so because they consider the experiences incited by these substances to be nothing but delusions. This is an illegitimate value judgement against the views of the people they are studying and displays the preformed assumptions that scholars have, prior to their delving into the subject matter. This is a clear demonstration of the very same Eurocentric bias that Carrasco denounces above, in his rebuke of the Spanish colonizers. It may seem like harsh criticism, but it is inexcusable in light of the blatancy of ritual entheogen use that has been featured in the above discussion. Adding to this image of the savage nature of ancient Mesoamerican peoples is the focus on human sacrifice and bloodletting. Of course, these ghastly ceremonies were certainly popular amongst Mesoamerican groups, but so were entheogen rituals, which are all but ignored in modern analyses. The choice as to which aspects of ancient Mesoamerican religion are discussed and which ones are ignored is entirely that of the researcher. Thus, it is suspect when an author chooses to focus on the violent features of a religion, especially when the description of such practices could be substituted for a description of entheogenic ritual:

> "Though it may seem strange to modern readers, bloodletting was not strange or unusual in Maya culture. It was described in the mythology of various communities, part of the public rituals of everyday life, and central to the ritual actions of the upper classes." (Carrasco 1990: 110)

One could replace the word "bloodletting" with "use of entheogens" in the above passage and it would remain true. If Carrasco is determined to enlighten his modern readers regarding the "strange" rituals of ancient Mesoamericans, it is remarkable that he would not mention the "strange" alterations of consciousness that they sought through the ingestion of entheogens.

The inclusion of bloodletting ceremonies alongside an omission of the entheophilic tendencies of ancient Mesoamericans reveals the prejudice that exists when modern scholars assess ancient ideologies. If those ideologies inspire the performing of rituals that are palpably abhorrent to modern readers, such as human sacrifice and bloodletting, they are included for shock value. On the other hand, when the ritual behaviours in question correspond to a more ambiguous moral issue being faced by modern society, such as the legal conflict between entheophobes and entheophiles, the matter is ignored altogether. The trouble is that the present legal status of entheogens holds them to be illicit, and any mention of them as safely enjoyable within a genuine religious context would imply that modern laws are unsubstantiated. To state that entheogens are an acceptable form of spiritual transcendence violates the established standards of modern Western morality. Therefore, it seems that evaluations of ancient Mesoamerican religion are expected to ignore the importance of these sacred substances in favour of a more acceptable image of the ancient Mesoamerican as a "noble savage:" their religious beliefs represent "a world that fascinates us, as it did the conquistadores and friars, by being so grotesque a reflection of our own" (Torrance 1994: 199). Ancient Mesoamericans are revered for the human qualities that we share with them, while at the same time, it is assumed that the modern citizen cannot learn anything from their barbaric religious practices organized around a warped sense of the divine.

Correcting the Oversights: A Revised View of Ancient Mesoamerican Religion

The above allegations are merely an account of how modern society's entheophobic bias obstructs the pursuit of an impartial portrayal of ancient Mesoamerican religion. Dobkin de Rios (1974) cites ethnographic data collected from the Human Relations Area Files at Yale by Richard Blum (Dobkin de Rios 1974: 161). Blum documents Western researcher's tendency to fail to notice the use of drugs that they themselves have not experimented with, which makes the oversights of archaeologists understandable:

> "It is apparent that observers from the outside (nonnatives) have been quicker to report their own reactions to drug use than to report the judgements of people within a society. Thus, we have observer assessments more often set forth than indigenous ones for all the drugs...Our conclusion from Tables 8 and 9 is that observers have been more sensitive to their own than to indigenous views of drug use within cultures." (Blum 1969: 147)

Blum is discussing ethnographic studies of contemporary cultures, and it appears that archaeologists are committing the same errors with ancient societies. When this entheophobic prejudice is exposed, it is imperative that the discipline amend its approach to the subject of study in order to incorporate the important facts that have been excluded.

This necessary reformation of archaeological approaches to ancient religion has still yet to be accomplished because "few large-scale archaeological studies have tried to explore the role of ideology in culture change" (Demarest 1992: 7). If the study of ideology and worldview is still treated as trivial in most archaeological surveys, this must now be rejected in light of the emerging truth that ideological structures dictate a culture's entire conception of the nature of reality. The problem of ignoring ideology stems from the inability of modern scholars to recognize that they have a worldview themselves; one that clouds their judgement when considering the vastly different worldviews of ancient cultures. For example, the concept of the duality of existence "in Mesoamerican thought...was not a duality of confrontation or opposition, such as is stressed in Western civilization from the 5th century B.C. onward, but a duality of complementary, interdependent, interrelating forces, each playing its respective role in the cosmic drama" (Labbé 1982: 35).

The Western concept of duality as "confrontation or opposition" speaks volumes about the modern failures to accept ancient behaviours that defy modern legal and moral presumptions. In the modern Western worldview, there is only the binary of "good" and "bad," and if it has been decided that entheogenic intoxication is "bad," then there is no need to discuss the ways entheogens have been conceived of as "good" in other cultural contexts because these cultures were obviously mistaken. It is acceptable to discuss human sacrifice and bloodletting because these practices have no place in modern religious life, but entheogen use is much more ambiguous. The uncertainty of moral codes against entheogens makes any discussion of them a challenge to existing laws. Apparently, the disinterest of religious scholars is stronger than their desire to fully understand the worldview of the subjects they are researching. It is hoped that the present paper has been successful in challenging this status quo of indifference and that it has opened new avenues of inquiry into the cognitive realms of entheogens, both in ancient and modern contexts. Future studies of Mesoamerican religion and worldview would be wise to incorporate the ritual importance of entheogens (for example mushrooms as *teonanacatl* "flesh of the gods"); for to ignore these substances is tantamount to neglecting to discuss the significance of bread and wine in Catholic mass.

Summary

The evidence for ritual use of entheogens exists in the archaeological record; but it is up to Mesoamericanists to permit the evidence to be taken into consideration. Iconographic remains reveal a large repertoire of bizarre visionary illustrations to which compelling interpretations were attached, usually of a divine nature. Ancient Mesoamericans possessed an ideological structure that greatly differed from the manner in which we view human existence today; a worldview into which entheogenic transcendence was readily integrated.

In this way, it becomes apparent that a major aspect of modern archaeological study is the examination of ourselves as modern civilization, relative to the values and moralities of foreign cultures. When we are confronted with the strange religious practices of prehistoric New World civilizations, it is threatening to discover that the standard moral system to which we adhere is merely an arbitrary ideological scheme that possesses no universal applicability.

Continued research into the ritual use of these substances by ancient Mesoamericans may reveal that their journeys into transcendent states of consciousness offered much more than delusional visions. Perhaps the phenomena that are encountered under the entheogenic intoxication offer repeatable, empirical experiences that can be analyzed as existentially-oriented science, ala Ernest Becker's Science of Man? (Becker 1968: 247, 1971: 158). Only through rigorous experimentation with the entheogens and the subsequent journeying into the otherworldly realms conjured by the ingestion of psychoactive chemicals can these methodological lapses be rectified.

1. http://www.biodiversityhotspots.org/xp/Hotspots/mesoamerica?showpage=Biodiversity
2. http://www.tarweed.com/pgr/PGR99-026.html
3. www.erowid.org/plants/mucuna_pruriens/mucuna_pruriens.shtml
4. http://www.ars-grin.gov:8080/npgspub/xsql/duke/pl_act.xsql?taxon=1204
5. Stedman's Medical Dictionary, 27th ed. 2000: pp. 1785
6. http://www-cie.iarc.fr/htdocs/monographs/vol31/kaempferol.html
7. http://www.erowid.org/plants/tobacco/tobacco.shtml
8. http://www.erowid.org/plants/sinicuichi/
9. http://www.erowid.org/plants/cacahuaxochitl/cacahuaxochitl.shtml
10. http://www.hds.harvard.edu/faculty/carrasco.html

Bibliography

1. Becker, Ernest 1968 *The Structure of Evil: an essay on the unification of the science of man*. New York: G. Braziller.
2. Becker, Ernest 1971 *The Birth and Death of Meaning: an interdisciplinary perspective on the problem of man*. New York: Free Press.
3. Becker, Ernest 1973 *The Denial of Death*. New York: Free Press.
4. Beyerstein, Barry & Kalchik, Mark 2003 History of the Psychedelic Experience. In *Hallucinogens: A Forensic Drug Handbook*. Richard Laing (editor). Pp. 1-36. New York: Academic Press.
5. Blum, Richard H. 1969 A Cross-Cultural Study. In *Society and Drugs*. William Henry and Nevitt Sanford (editors). Pp. 134-186. San Francisco: Jossey-Bass.
6. Carrasco, Davíd 1990 *Religions of Mesoamerica*. San Francisco: Harper & Row.
7. Clark, Walter Houston 1969 *Chemical Ecstasy: Psychedelic Drugs and Religion*. New York: Sheed and Ward.
8. Davis, Wade & Weil, Andrew 1992 Identity of a New World Psychoactive Toad. *Ancient Mesoamerica*. 3: 51-59.
9. de Borhegyi, Stephen F. 1963 Pre-Columbian Pottery Mushrooms from Mesoamerica. *American Antiquity*. 28: 328-338.
10. Demarest, Arthur A. 1992 Archaeology, Ideology, and Pre-Columbian Cultural Evolution: The Search for and Approach. In *Ideology and Pre-Columbian Civilizations*. Arthur Demarest and Geoffrey Conrad (editors). Pp. 1-13. Santa Fe, NM: School of American Research Press.
11. de Smet, Peter A.G.M. 1985 *Ritual enemas and Snuffs in the Americas*. Amsterdam: Centre for Latin American Research and Documentation.
12. Dobkin de Rios, Marlene 1974 *The Influence of Psychotropic Flora and Fauna on Maya religion*. Current Anthropology. 15: 147-64.
13. Dobkin, de Rios, Marlene 1984 *Hallucinogens: Cross-Cultural Perspectives*. Albuquerque, NM: University of New Mexico Press.
14. Forte, Robert 2000 Introduction. In *Entheogens and the Future of Religion*. Robert Forte (editor). Pp. 1-5. San Francisco: Council on Spiritual Practices.
15. Furst, Peter T. 1972 To Find Our Life: Peyote Among the Huichol Indians of Mexico. In *Flesh of the Gods: The Ritual Use of Hallucinogens*. Peter T. Furst (editor). Pp. 136-184. New York: Praeger, Inc.
16. Furst, Peter T. 1974 Morning Glory and Mother Goddess at Tepantitla, Teotihuacán: Iconography and Analogy in Pre-Columbian Art. In *Mesoamerican Archaeology: New Approaches*. N. Hammond (editor), Pp. 187-215. London: Duckworth.
17. Haviland, William A. and Haviland, Anita de Laguna 1995 Glimpses of the Supernatural: Altered States of Consciousness and the Graffiti of Tikal, Guatemala. *Latin American Antiquity* 6(4): 295-309.
18. Harner, Michael J. 1973 Preface. In *Hallucinogens and Shamanism*. Michael J. Harner (editor), Pp. vii-viii. Oxford: Oxford University Press.
19. Huxley, Aldous 1954 *The Doors of Perception*. New York: Harper and Brothers.
20. Joyce, Rosemary 2004 Mesoamerica: A Working Model. In *Mesoamerican Archaeology*. Julia Hendon and Rosemary Joyce (editors). Pp. 1-42. Malden, MA: Blackwell Publishing.
21. Julien, Robert M. 2005 *A Primer of Drug Action: A Concise, Nontechnical Guide to the Actions, Uses, and Side Effects of Psychoactive Drugs*. 10th ed. New York: Henry Holt.
22. Kennedy, Alison Bailey 1982 Ecce Bufo: The Toad in Nature and in Olmec Iconography. *Current Anthropology*. 23: 273-290.
23. Koehler, Ulrich 1976 Mushrooms, Drugs, and Potters: a new approach to the Function of Pre-Columbian Mesoamerican mushroom stones. *American Antiquity*. 41: 145-53.
24. Konzevik Cabib, Adriana *et al*. 1998 Glossary. In *Maya*. Peter Schmidt, Mercedes de la Garza & Enrique Nalda (editors). Pp. 662-670. New York: Rizzoli International Publications.
25. Labbé, Armand, J. 1982 *Religion, Art, and Iconography: Man and Cosmos in Prehispanic Mesoamerica*. Santa Ana, CA: Bowers Museum Foundation.
26. Ludwig, Arnold 1969 Altered States of Consciousness. In *Altered States of Consciousness*. Charles Tart (editor). Pp. 9-22. Toronto: John Wiley & Sons.
27. Roberts, David 2004 Descent into the Maya Underworld. In *National Geographic, November*, 2004. Bill Allen (editor). Pp. 36-53. Washington: National Geographic Society.
28. Robertson, Merle Greene 1998 Sculpture and Murals of the Usumacinta Region." In *Maya*. Peter Schmidt, Mercedes de la Garza & Enrique Nalda (editors). Pp. 297-307. New York: Rizzoli International Publications.
29. Rudgley, Richard 1993 *The Alchemy of Culture*. London: British Museum Press.
30. Schultes, Richard Evans and Hofmann, Albert 1979 *Plants of the Gods: Origins of Hallucinogenic Use*. New York: McGraw-Hill.
31. Shanon, Benny 2002 *The Antipodes of the Mind: Charting the Phenomenology of the Ayahuasca Experience*. Oxford: Oxford University Press.
32. Sharer, Robert 1994 *The Ancient Maya*. Stanford, CA: Stanford University Press.
33. Slotkin, J. S. 1955 Peyotism, 1521-1891. *American Anthropologist*. 57: 202-230.
34. Stover, S. 1986 Amerindian Spirituality. In *The Study of Spirituality*. Cheslyn Jones *et al*. (editors). Pp. 513-518. New York: Oxford University Press.
35. Thompson, J. Eric S. 1970 Maya History and Religion. Norman, OK: University of Oklahoma Press.
36. Torrance, Robert M. 1994 *The Spiritual Quest: Transcendence in Myth, Religion, and Science*. Berkeley, CA: University of California Press.
37. Wasson, R. Gordon 1980 *The Wondrous Mushroom: Mycolatry in Mesoamerica*. New York: McGraw Hill.
38. Woodhead, Linda and Heelas, Paul 2000 *Religion in Modern Times*. Malden, MA: Blackwell.

Mushroom Sacraments in the Cults of Early Europe

by

Carl Anton Paul Ruck

NeuroQuantology, March 2016, Volume 14, Issue 1, Page 68-93

DOI: 10.14704/nq.2016.14.1.897

original report: http://www.neuroquantology.com/index.php/journal/article/viewFile/897/749

Corresponding author: Carl Ruck, Professor
Address: Department of Classical Studies, School of Theology, 754 Commonwealth Ave, Boston, Massachusetts 02215, USA
e-mail: bacchus@bu.edu, blaise131@verizon.net
Phone: 1-617-353-4435 (office), 1-781-925-0182 (home)

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 8 December 2015; **Accepted**: 29 January 2016

Table of Contents:

Abstract
Marital Crisis
Psychedelic Revolution
Soma
Mushroom Surrogates
Eleusinian Mystery
Ergot Mushrooms
Primitive Grasses
The First Plowman
Reception
Wine and Mushrooms
The Wine Mix
Maronian Wine
Ionian Enlightenment
Lycanthropy
Phrygian Cap
Eggshells
Dumbbell
Phallic Grotesqueries
Penates
Tages
Cosmic Liver
Indigenous Foreigner
Fairy Tables
Mithraism
Raven's Bread
Soldiers of Christ
Old Europe
Issenheim Altarpiece
  Bacchanal of the Andrians
Ghent Altarpiece
The Garden of Eden
References

Abstract

In 1957, R. Gordon Wasson, a professional banker and amateur mycologist, inadvertently launched a profound cultural change that has come to be called the Psychedelic Revolution, by publishing an account of his experience with a Mazatec shaman in Hautla de Jiménez in the mountains of central Mexico. The article appeared in Life magazine and was intended as publicity for his forthcoming Russia, Mushrooms, and History, in which he and his Russian-born wife Valentina Pavlovna pursued their lifelong fascination with their dichotomous attitudes toward fungi, which had led them to suspect a cultural taboo upon a sacred object. In 1968 he traced this taboo back to the Vedic Soma, which he identified as a psychoactive mushroom. The identification, if correct, implied that there should be evidence for a similar sacred role for the mushroom in other regions in antiquity where the migrating Indo-European people settled. In 1978, he proposed such a role for the visionary potion that was central to the mystical experience of the Greek Eleusinian Mystery, that was celebrated annually for two millennia at a sanctuary near Athens. The possibility that the ancient Greeks indulged in chemically altered consciousness is antithetical to Europe's idealization of Classical antiquity and the proposal was largely ignored. Mushrooms, however, were fundamental to social norms and religious observances in the celebration of Dionysus, and figured in other Mystery cults and in the foundational traditions of many cities, including Mycenae and Rome. The Soma sacrament as the Persian haoma was proselytized to the West by the Zoroastrian priests of Mithras and became a major cohesive indoctrination for the Emperors, army, and bureaucrats who administered the Roman Empire. It survived the Conversion to Christianity in the knighthoods of late antiquity and the medieval world, and was assimilated to the Eucharist of certain of the ecclesiastical elite.

Key Words: mushroom, ergot, Dionysus, Apollo, Mithraism, Renaissance art, prehistoric rock art.

Marital Crisis

In *Mushrooms, Russia and History* (Wasson and Wasson, 1957), R. Gordon Wasson and his Russian-born wife Valentina Pavlovna pursued their fascination with fungi, dating back to 1927, when upon their delayed honeymoon they first became aware of their dichotomous attitudes to something so simple and fundamental as mushrooms. The subject had never arisen in their five years of courtship. In a walk through the forested Catskills before supper at a friend's loaned mountain chalet, she discovered that the path was strewn with lovely mushrooms that he considered all loathsome toadstools. As a marital avocation while they each engaged in their separate careers, hers in medicine and his as an investment banker, they began collecting occurrences of mushrooms in European folklore, literature and art, which culminated in the deluxe two-volume compilation published just shortly before her death.

They had come to suspect that the difference, which they termed mycophobia and mycophilia, betrayed some religious taboo upon a sacred substance, traceable back to the earliest prehistory and somewhat mysteriously still surviving into modern times, perhaps as some kind of archetypal folk memory. The mushroom's sanctity is reflected in the absence of a name for something too sacred to name (Ruck, 2010). The natural growth, which can be classified as neither plant nor animal, is designated by metaphors or distanced as foreign words imported into the language. Among the mycophilic Slavs, there are more than forty designations, while the mycophobic Anglo-Saxons have only four, the foreign imports, fungus from Latin as metaphorically a 'sponge' and champignon from the French as a product of the 'field.' Mushroom is similarly an import from Late Latin through the intermediary of French *mousseron*. It, too, is ultimately a metaphor, derived from the verb *mussare*, which is onomatopoetic for making the sound of mooing or bellowing cattle, and hence a bovine zoomorphism of the mushroom (Ruck, 2015a). The only truly Anglo-Saxon name is the toadstool, describing it as a folkloric chair upon which is seated a loathsome toad, secreting the psychoactive toxin bufotenine, which it shares with certain fungi.

The intermediary status of the mushroom's classification, moreover, is reflected in its abundant occurrences in folkloric tradition, where it functions as the ultimate mediator between oppositional forces and concepts (Toporov, 1985). This dichotomy inevitably suggests the divide between the realms of life and death, and the mushroom lends itself readily to zoomorphism and anthropomorphic materializations as guides or modes of transport across the intervening frontier.

Psychedelic Revolution

This suspicion of the mushroom's primordial sanctity had led the Wassons in 1953 to the south-eastern Mexican village of Huatla de Jiménez in the mountains of Oaxaca, where they were introduced to the diviner Aurelio Carreras and his mother-in-law María Sabina. Gordon and Valentina participated as outsiders in a mushroom ceremony, an evening rite or *velada*, that had been kept as a carefully guarded secret of the indigenous people. The Wassons included an account of the events in *Mushrooms, Russia, and History*, but intentionally buried in the text, where it generally escaped notice and elicited little attention. Gordon innately abhorred sensationalizing his discoveries. In 1956, he read a short carefully worded paper before an association of Classical scholars in Philadelphia describing his experiences in Mexico, but in the ensuing discussion he intimated that the mushroom cult might shed light upon the Greek Mystery religion of Eleusis and the name of the city of Mycenae. One of the metaphors for the mushroom in Greek is *mykes*, as slimy and 'mucous.' Shortly later he received a letter from a friend of some thirty-five years advising him to keep his focus on Mexico and avoid implicating Classical antiquity. Nevertheless, there is a mythical account that a Greek hero Perseus plucked a mushroom at the site of the ancient city, and the monster Gorgon Medusa, whose head he similarly harvested as a golden apple with a pruning hook, was recognized in antiquity, in hermetic funerary contexts, as a mushroom (Ruck, 1978).

The pursuit of this same intriguing suspicion of a mushroom cult in Europe had already brought Wasson and his wife in 1952 to the Plaincouralt chapel in central France, where a Romanesque fresco of the Temptation episode in the biblical Garden of Eden had been suggested as early as 1911 as depicting the Tree of Knowledge in the guise of a psychoactive mushroom (Marchand *et al.*, 1911). They were advised, however, by a noted art historian that the resemblance was purely fortuitous and that medieval artists customarily painted trees in the stylized likeness of mushrooms. If they had looked across the Chapel at the opposing wall by the entrance, however, they would have noticed a mysterious scene that is not without relevance to the interpretation of the Tree of Knowledge. Another mushroom hovers in the air, in the guise of a red blacksmith's hammer, labeled by an inscription in dialectal Old French as the key of heaven. The fresco depicts the miracle of Eligius, the Chapel's namesake and patron saint. The mushroom is identified as the miraculous steed that has brought the Lord to the blacksmith's smithy to shoe His horse's single foot. Eligius is named as the patron of the 'Elect,' those privileged to see the Lord (Ruck *et al.*, 2007). The horse as the miraculous entheogenic transport occurs also in the birth of the flying Pegasus from the severed neck of the plucked Medusa's head. Wherever Pegasus touched down, a magical spring of inspiring waters burst forth, for which reason he is named as the 'Fountain Horse.'

Partly as publicity for the forthcoming publication of *Mushrooms, Russia, and History*, Wasson made public an account in the now legendary 13 May 1957 issue of *Life* magazine of his mushroom-induced visionary experience in 1955 with the Mazatec shamanic healer María Sabina, whose identity he attempted to mask under the pseudonym of Eva Mendez, thereby divulging and greatly popularizing the secret and inadvertently launching a flood of tourism to the remote mountain village and the ensuing cultural phenomenon that has come to be termed the Psychedelic Revolution. Albert Hofmann had discovered LSD in 1943, but it went without public notice until Wasson's magazine article, and within ten years *Life* published another article about LSD as a therapeutic drug that had gotten out of control. The patrician Wasson was a most unlikely person to play such a role and he distanced himself from the notoriety of the several leaders who rose to prominence in the resulting turmoil of recreational drug abuse, countercultural politics, and religious innovation.

Soma

Gordon retired from banking in 1963 and in the afternoon of his last day at work, he boarded a friend's merchant ship that sailed to the Far East, pursuant to the same theory of the mushroom's sanctity in the Old World that he and his wife had found among the indigenous peoples of Mexico. Two years later, he returned from the Orient and settled in Danbury, Connecticut, to work on the evidence he had gathered, resulting in the publication in 1968 of *Soma: Divine Mushroom of Immortality*, written with the aid of the young Indologist and Vedic scholar Wendy Doniger O'Flaherty, who now holds the Mircea Eliade professorial chair at the University of Chicago (Wasson, 1968). Wasson had heard of the reportedly intoxicating Soma as a teenager from his father, an Episcopalian clergyman, who wrote a book on God and alcohol and brewed spirits in his basement during the era of Prohibition.

Soma is an unidentified deified but not personified plant in the Vedic Sanskrit texts, carefully preserved as an oral tradition dating back as early as the mid second millennium BCE and committed to writing only after the rise of Buddhism, the earliest in the first century BCE, but mostly toward the end of the first millennium CE. The same sacred plant was known to the ancient Persians as *haoma* (sometimes deified), a dialectal version of the same name, described in the sacred texts of Zoroastrianism called the *Avesta*, which is so titled since they are the sole surviving examples of the Avestan language, a liturgical Old Iranian tongue closely resembling Vedic Sanskrit. The surviving texts where similarly transmitted by oral tradition dating back probably to the mid second millennium BCE, but finally committed to writing in the third century CE in the Sassanian era, which replaced the Parthian Empire and continued as the ruling dynasty until its overthrow by the Muslims in the mid seventh century.

Since Zoroaster is not so much a personal name as a profession meaning 'astrologer,' it is difficult to date the first occurrence of the priest who held the title, and some would place him a millennium later. The first Zoroaster (Zarathustra) is probably a figure of mythologized history. He revised the Hindu polytheism, elevating the solar deity Ahura Mazda ('Illumination Wisdom') to sole monotheistic primacy, with the heroic Mithras as mediator with the human realm. Many elements of the Mithras story coincide with the Greek hero Perseus of Mycenae (Ruck *et al*., 2011). Since the Zoroastrian priests or Magi proselytized their faith, their concept of monotheism may be the original source of the ensuing monotheistic religions, including the mid second millennium heresy of the Egyptian pharaoh Akhenaten.

Wasson proposed that the primordial botanical identity of this Soma/*haoma* plant was a mushroom, in particular the psychoactive *Amanita muscaria*, commonly called the fly agaric for its apparent ability to attract and kill flies. The physical characteristics of the divine plant as transmitted in the formulaic oral tradition are difficult to interpret since some may be metaphoric and others are open to a variety of linguistic interpretations, but remarkable for a plant, there seem to be no indications of a flower, leaves, or roots, attributes unique to a mushroom. The Soma ceremony was specifically intended to induce a state of intoxicated ecstasy that produced spiritual health, renewal, and immortality through mystical communion with deity (Spess, 2000), and was an entheogen. The theory had a controversial reception, with some proposing other candidates, most commonly cannabis, opium, and ephedra (Syrian rue) (Flattery *et al*., 1989). Residues of all three have been detected in archaeological remains of temples were the *haoma* ceremony was performed in sites as early as the mid second millennium BCE, as well as indications that the rite may have involved animal masks in the ritual, implying initiatory experiences of zoomorphic transmogrification (Bennett, 2007; Sarianidi, 2007). The cannabis was apparently used to fumigate the chambers. It is probably ephedra that is depicted in ancient portrayals of the Magi priests carrying the barsom bundle of twigs, and it still is used along with pomegranate in living Zoroastrian practice among the Parsis today, where the ancient *haoma* is called *hom*. There is also a tradition in contemporary practice that the ritual is purely symbolic, with only commemorative token sub-threshold amounts of the entheogen administered. It appears to be a customary tendency for religions to revise their history in denying the ecstatic nature of the original rites (Ruck *et al*., 2013), which in all probability have continued unabated, restricted for certain groups of the elite, or survive among marginalized and isolated adherents of the religion.

Syrian rue (*Peganum harmala*) is a bright green, dense, twiggy herbaceous succulent with conspicuous white flowers that grows in arid desert conditions. It has established itself as an invasive foreign import in the American Southwest. Its acts as a monoamine oxidase inhibitor (MAOI) and hence can function in the preparation of brews like *ayahuasca* to prevent digestive destruction, but evidence of its psychoactive properties in isolation is sparse and debatable. It is the source of the dye called Turkish red, employed in carpet weavings.

Wasson argued that although a variety of surrogate substitutes were employed as the tribal migrations moved into new areas that did not present a suitable habitat, the fungus best matched the characteristics as fossilized in the transmitted oral tradition, including its transfer and persistence into the excreted urine in a more potent potentiated form. This latter characteristic can be interpreted as culturally pejorative, but it is documented in Siberian shamanism which employs the *Amanita muscaria*. There is also a tradition of therapeutic urine drinking in Ayurvedic medicine. Wasson would later discover the use of the fly agaric and its urinous metabolite among certain indigenous people of the New World, as disclosed to him by Keewaydinoquay, a shaman of the Anishinaabeg (Ojibwe) of the region around the Great Lakes (Keewaydinoquay, 1984).

Mushroom Surrogates

In 1975, the art historian Stella Kramrisch, a specialist in Indian art and Hinduism, who held the professorship of South Asian Art at the University of Pennsylvania and was a curator at the Pennsylvanian Museum of Art, demonstrated that one of the first surrogates for Soma was a mushroom, not a psychoactive variety, but chosen for its symbolism as a mediator between death and spiritual transcendence (Kramrisch, 1975). Its corpse-like putrid stench was transmuted into fragrance in the firing of a ritual clay vessel, which represented the decapitated head of the deity Makha, analogous to the fungal materialization of the Greek Gorgon. One of the earliest depictions of the Gorgons occurs on a colossal seventh-century *píthos* urn that once served as a grave monument along the sacred road to the Mystery sanctuary of Eleusis. It depicts them with pots for heads, suggesting that the pot-headed females were anthropomorphisms of the potion that was the original content of the vessel.

In 1982, Wasson similarly discussed a non-psychoactive mushroom that appears to have been a surrogate for the original Soma. Gautama, the first Buddha (sixth to fourth century BCE), did not die, but by his own volition, it was claimed, since he had achieved such complete control over his physical body, he simply ceased living, the Great Demise, as it is called (Wasson *et al.*, 1982). As he was traveling with his entourage of monks to the place that he had chosen for this termination, he was offered hospitality by a blacksmith, who served them a meal of mushrooms. The role of a blacksmith as culinary host is an unlikely detail, except as mythologized history, and probably implicates the motif of the alchemical smithy (Ruck, 2015a). Brahmans can eat no mushrooms since they grow from unclean matter, but since all plants have a similar manner of growth, the prohibition betrays a probable taboo upon a sacred substance. Gautama decided, at this critical moment of his life, that he alone could break the prohibition and accepted this last meal, that he denied his entourage.

Eleusinian Mystery

After the publication of *Soma: Divine Mushroom of Immorality*, and before the appearance of such confirmatory evidence, it was argued that if the Soma/*haoma* sacrament was indeed fungal, there should be indications of a similar sanctity of the mushroom in other regions that the IndoEuropeans occupied in their migrations, beginning at the start of the second millennium BCE, away from the central Asiatic highlands that was considered their ancestral homeland, mythologized in Greek tradition as the Hyperborean country of the people who lived in a Apollonian paradise beyond the North Wind. Wasson returned to his intimation about the Greek Eleusinian Mystery and enlisted a team that included the Swiss chemist Albert Hofmann. In 1978, they published *The Road to Eleusis: Unveiling the Secret of the Mysteries* (Wasson *et al.*, 1978). It has been republished three times in commemorative successive decades. Mystery religions in antiquity involved something that the initiates were bound to keep secret. Plato describes the experience as a face-to-face visionary encounter with deity. The Judaic NeoPlatonist Saint Paul of Tarsus employed the same metaphor in describing what he called the Christian Mystery (Ruck, 2014). At Eleusis, this happened annually, predictably on schedule simultaneously for groups of several thousand candidates on a single night after the drinking of a special potion, whose ingredients were well known: kernels of barley and a common insecticide called fleabane, 'stirred' or mixed in an aqueous solution, for which reason it was termed the *kykeón* ('stirred with a circular motion,' cognate with 'cycle'). The simultaneous access to face-to-face mystical vision for thousands on a single night annually for over a millennium would be difficult to interpret as anything but an experience of shamanic communion with divinity induced by a psychoactive agent, and in this case the precise formula is an element in the recorded tradition.

The fleabane would seem the most obvious candidate for a toxic substance, and it had been proposed already as early as the nineteenth century. It, however, is not visionary, nor is its toxicity accessible in the miniscule concentration in the *kykeón*. Its role is symbolic, representing a wild plant, in contrast to the hulled barley groats, which are the products of cultivation. The fleabane, moreover, was personified as the water nymph Minthe, fragrant with the scent of mint (for which she is named), in which persona she was the perfumed whore of the netherworld lord Hades, abducted without the sanctity of marriage and hence the enemy of the matrimonial rite and civilized patriarchal culture. In Greek cultural tradition, the transition from matriarchal dominance to patriarchal revisionism marked the transition to Classical antiquity and the reign of the twelve Olympian deities, headed by the father god Zeus. Emblematic of that transition was the imposition of monogamous matrimonial control of the husband over his wife. The goddess Demeter vented her anger on this minty whore by grinding her with a mortar and pestle into a residue of despicable fragrance. In botanical nomenclature, fleabane is *Mentha pulegium*, where the specific name is an adjectival form of *pulex*, the Latin for 'flea.' In English it is commonly called 'pennyroyal,' where 'penny' is a corruption of *pulegium*. The honorific description of it as 'royal' (from the Old French *pouliol royale*) probably derives from its association with the Mystery.

In the year 415 BCE, it was discovered that numerous prominent citizens of Athens had been profaning the Eleusinian rite in their private homes by using the *kykeón* as a recreational drug with friends at their drinking parties. As parodied on the comic stage at the time, it was precisely evidence of the profane drinking of the potion that implicated the culprits. The accused were brought to trial and executed or else fled into exile, with the resultant confiscation of their properties for sale at public auction. The death penalty seems to have pertained only to divulging the secret of the Eleusinian Mystery, and specifically for profane use of the *kykeón*. The ancient Greeks had access to many intoxicating herbs and substances to flavor and fortify their wines, as was customary, and fleabane certainly was not worth the formidable hazards of breaking the prohibition against the sacred drink. Socrates was parodied on the comic stage at the time in Aristophanes' *Birds*, as profaning the Mystery in a rite of necromancy, in which he summons a troupe of fantastic anthropomorphisms that are easily identifiable as mushrooms. The most obvious is the tribe of Shade-foot creatures, who have but a single foot, with which they hop vigorously about until they tire, whereupon they fall upon their backs and slumber under the shade cast by the broad uplifted single foot that resembles a parasol (Ruck, 1981). Another of these anthropomorphisms was the Tongue-in-bellies, with a bulbous head that comprised their entire body, supported on their conjoined legs like a single support. They, too, not only are easily recognizable as fugal creatures, but in this configuration they blasphemously resemble the hermaphroditic dwarf who first served the specified *kykeón* potion as the etiology for its role in the Mystery initiation.

Ergot Mushrooms

The Wasson team demonstrated that the psychoactive agent in the *kykeón* was derived from the complex of numerous toxins present in ergot (*Claviceps purpurea*), a fungus that is parasitic on grain. Hofmann proposed that the active chemical was ergonovine, which is the only one that is water soluble and thus easily separable from the other toxins, some of which are potentially lethal and responsible for ergotism, causing gangrenous dermal lesions, hallucinations, and convulsive muscular twitching. Ergonovine, however, is only slightly visionary, if at all. Nevertheless, ergot often figured in medieval potions and the common nucleus of the ergot alkaloids is lysergic acid. In 2000, Peter Webster and Daniel Perrine revised the theory, identifying the active agent as ergotamine, a vascular dilator commonly prescribed in sub-threshold amounts combined with caffeine for the treatment of migraine (Webster, Perrine, and Ruck, 2000. Ruck, 2006). Ergotamine by partial hydrolysis (i.e., combining with water, but not a dissolution) in an alkaline aqueous solution yields ergine (LSA, lysergic acid amide), which is the same substance known as the visionary *ololiuhqui*, extracted from the seeds of certain morning glories in the shamanism of the Maya and Aztecs of ancient Mexico. LSD does not occur in nature, but LSA resembles it and is a natural substance.

The mycelia (root-like growth) of the ergot invade the parasitized grain kernels, causing enlarged purplish red sclerotia (hard bodies), protruding from the sheaf like cock's spurs, for which it is named (from the French *argot*). All mushrooms have a similar mode of growth, with the mycelia permeating large areas of ground, sometimes, as is the case with the *Amanita*s, living in mycorrhizal symbiosis with the roots of certain trees. The mycelium of the sclerotium, when the ergot falls to the ground and absorbs moisture, enters its fruiting stage, yielding tiny mushrooms visible to the naked eye, thereby identifying the ergot-infested kernel as apparently the seed of the otherwise seedless mushroom. Mushrooms propagate by microscopic spores, which were not detected in antiquity. Hence ergot mediates between the totally wild mushroom and the cultivated grain.

Primitive Grasses

The alkaline aqueous solution would have been produced by the addition of wood or bone ash to the water. This, also, represents a mediation, since the ashes constitute the residue from burnt offerings, the remains of sacrifice. The intrusion of the phallic plowshare into the symbolic vulva that is the furrow of the plowed field, converting it from the natural wilderness to cultivated arable land, is a sexual affront upon the sanctity of Earth, which must be appeased by a compensatory offering. In mythical tradition, the first plowman was sacrificed in the field he plowed, and the rite was repeated symbolically at each annual first insertion of the plowshare in a special field allocated for the inaugural plowing (Ruck, 2015a).

The sheaves of cultivated barley represent the cultivated antithesis of wild inedible grasses. Such edible grains were hybridized from more primitive grains. The most primitive is spelt (*Triticum spelta*), so named because it fruits with spikelets consisting of only two 'split' red grain kernels. These spikes obviously resemble the ergots of *Claviceps purpurea*. Hybridizing, moreover, is an ongoing process. Without continual human intervention, the hybridized grain would regress to its more primitive grassy manifestations. This is clear, for example, in the hybridizing of Indian corn by the indigenous peoples of the New World. If the cob falls to the ground, the next shoots that sprout from the entire ear will crowd each other out, so that their stalks grow progressively weaker and shorter, reverting to primitivism.

Weeds similarly infringe upon the healthy growth of the cultivated grains. A common weed in fields of grain is darnel or tares (*Lolium temulentum*). Its botanic nomenclature defines its species as 'drunken,' although it contains in itself no intoxicating chemical. Its reputation in antiquity as an intoxicant that induces altered eyesight derives solely from its common tendency to host the parasitic ergot, to which it is particularly susceptible. Darnel produced a cheap bread of proverbially poor quality, responsible for hallucinations. It threatened the cultivated crop, not only by competing for space, but also by contamination from its parasitic fungus. The ergot was called rust (Greek *erysibe*, Latin *robiga*) in antiquity, by which metaphor it not only designated its red color, but also likened it to the metallic oxidizing corruption that causes the iron tool to revert to the natural ore. It is hence emblematic of cultural recidivism.

The grain goddess Demeter/Ceres bore the epithet of *Erysibe* and wore slippers of reddish purple. In folkloric tradition, the ergot is metaphorically a pack of grain wolves, led by the grain Mother, rustling through the sheaves of fruiting grain, leaving the protruding infested kernels as 'wolf teeth,' that are also the iron teats of the goddess, who seduces children to come and nurse, rendering them maddened. A red dog was the annual victim of choice in Roman times to ward off the threatened infestation of ergot. The redness of the dog not only matched the color of the rust, but also associated it with the fox, which was interchangeable as a canine with the wolf, and hence the red dog represented also the primitive ancestors of the domesticated canine. There is also a mythical tradition that the rust scraped from a sacrificial knife was the antidote for the sexual impotency of a boy who had feared that he was the designated human victim.

The First Plowman

The potion of the Mystery initiation thus combined the wild and toxic fleabane, with its connotations of primitive sexuality, and the grain of the cultivated field. The connotations of the latter represent the grain goddess Demeter, who in the etiological myth for the Mystery is reconciled to the marriage of her daughter Persephone to her former abductor, Hades, the lord of the netherworld. The seed of grain must similarly be entrusted to the earth, in order to be risen. The mother relinquishes her daughter to the household of her husband, and the lord of the realm of death becomes related as an in-law to the celestial realm of the mother and her fellow Olympians. At the moment of the vision in the Mystery, the candidates, who had journeyed in the spirit to the netherworld, resurfaced in the initiation chamber at the moment that Persephone ratified her marital union to the otherworld by giving birth to the Mystery child, who was ultimately the first plowman. In mythical tradition, the celestial daughter had taken a seed of pomegranate into her body as she exited the netherworld, thereby contaminating her ethereal nature with physical matter, rendering her a creature that belonged to both realms. The pomegranate was named for its seedy bloody red matrix as the fruit of the menstrual 'flux.' Ergot figured in the pharmaceutics of ancient midwifery both to stimulate uterine contraction and to control postpartum bleeding.

The ergot as the cultivated fungus was the multifaceted mediating agent in the potion. The efficacy of fleabane as an insecticide probably commemorates the similar toxicity of the fly agaric or 'kill-fly' (fly-bane, French *tue-mouche*). All noxious insects, moreover, lend themselves to identification with malevolent spirits. There were two stages to the Mystery, however, for which reason the rite is usually designated by the plural. The Mystery, like all the Panhellenic sanctuaries, underwent a patriarchal revision in the seventh century, reinterpreting rites of the Bronze Age, dating back to the mid second millennium, and probably even earlier. The Lesser Mystery commemorated not this patriarchal revision and the consummation of the marriage in the birth of the child, but the unsanctioned abduction, which in the mythical tradition was occasioned by the picking of a wild plant called the *nárkissos*, so named for the narcosis that it induced. This rite was enacted six months earlier and involved not the mediating ergot fungus, but its primordial identification as the wild mushroom. The sole participant for the Lesser Mystery was the noble woman who bore the titular role of Queen of Athens, attended by her female sisterhood of assistants, who prepared her in a secret ceremony for her sexual engagement with the deity in the guise of the bellowing mushroom in a sacred chamber called the bull stall, opened just once a year for this ceremony. The role for the so-called Queen dates back to the traditions that predate the patriarchal revision of Greek culture occasioned by the advent of the deities in their restructured personae as members of the twelve Olympians.

Reception

The reception of *The Road to Eleusis* was generally unenthusiastic, with one eminent scholar entertaining the theory, probably merely as a curtesy to the Swiss Hofmann, but misunderstanding it and concluding that by all reports ergot poisoning was an unpleasant experience (Burkert, 1987). A recent book on the Bronze Age archaeology of the Eleusinian sanctuary (2015), in the obligatory initial overview of the religion, employs the word entheogen (which implies the acceptance of the concept that a psychoactive substance is animate with deity), but considers the argument speculative and concludes that the best explanation of the *kykeón* is that it offered a fortifying refreshment to end the daylong preliminary fast of the candidates, who had walked the exhausting twelve miles across a mountain pass along the Sacred Road from Athens (Cosmopoulos, 2015). A couple of groats of uncooked barley stirred in an aqueous medium with an insecticide is an unlikely nutritional boost. As recently as 2013, an article on ritual vision at Eleusis that promises a summary of 'learned reconstructions' of what it calls 'scopic regimes' includes no mention of entheogens or *The Road to Eleusis* (Petridou, 2013). A new textbook of Classical Mythology, makes no mention of the *kykeón* in its summary list of the different possibilities proposed for the Eleusinian Mystery over the centuries, and although it claims to place the ancient myths in the context of cross-cultural traditions and contemporary debate, it censors the subject of drugs and dismisses Mithras in half a sentence as something popular in the second and third centuries CE (Maurizio, 2016). Classical scholarship is resistant to the notion that drugs played a role in ancient society. Similarly, an exposé of drug expertise in Classical culture has caused its author to be shunned in the profession (Hillman, 2008).

Wine and Mushrooms

The mushroom, however, is not confined to the Eleusinian rite in Classical antiquity. It is fundamental to the symbolism and rituals of the god Dionysus, the deity of wine, drama, and the ecstatic communion with divinity. The ritual emblem for the mountain revels was the thyrsus, the hollow stalk or peduncle of a giant reed, stuffed with ivy leaves. Magical plants must be gathered with rituals that address their indwelling potencies as entheogens (Geniusz, 2009). This often involves fantasies of sexual engagement and birthing. The thyrsus is the receptacle for the gathered plants. Thus it was interchangeable with the narthex as a term. This latter lends it name to the giant fennel (*Ferula communis*) or narthex. The Latin botanical nomenclature classifies it as a 'rod,' and the Greek narthex has the obvious etymology as the 'narcotic container.' Several ancient compendia of medicinal herbs were titled *Narthex*. When Perseus plucked the Gorgon head at Mycenae, he placed it in a *kibisis*. This container has a similar significance. In ancient depictions, it is seen as a wide open-mouthed sack slung upon the arm. It is the bag, as still used today, for harvesting apples and other fruits, allowing the harvester to catch the fruits picked or pruned from the tree with the other hand (Ruck, 2015b). Because of its mycorrhizal symbiosis with the subterranean roots of its host tree, the *Amanita* mushroom was seen as a fruit of its tree, equally with the magical golden apples fruiting on its uplifted branches.

As with the wild growths that yielded to cultivation in the planting of barley and other grains, the grapevine had primitive antecedents. Most emblematic of these was the ivy, whose leaves and diminutive berries were intoxicating in their natural state, whereas the leaves and fruits of the grapevine are edible. Upon the crushed grapes, however, can be grown wine as a civilized intoxicant. The ivy leaves stuffed into the thyrsus represent the natural toxins that predate the evolution of viticulture. The other plants cited for the mountain revels had a similar symbolism. Among these are smilax (bindweed or wild morning glory) and bryony (wild cucumber). Like ivy, both physically resemble the grapevine and its clustered fruits, but they are toxic in their natural state. European folkloric tradition (Grimm, *Muttergottesgläschen*) identifies the morning glory as intoxicating, perhaps analogous to the *ololiuhqui* of the New World (Ruck, 2014). Sometimes the ivy atop the thyrsus/narthex is replaced with a pinecone. In this configuration, the rod symbolizes the ecstatic experience accessed by the gathered magical plants or entheogens. The pineal gland is so named for its resemblance to the pinecone and was identified in antiquity as the gateway of the soul for transcendence.

The grapevine, moreover, is obviously a cultivated vine since it requires annual pruning to fruit. In this regard, it is analogous to the olive, which is the plant most emblematic of civilization as evolved from chaotic primitivism. Hence, the olive branch is symbolic of peace, and a wreath of olive and an amphora of its oil were awarded to victorious athletes. Mythical tradition identified the olive tree as the transmutation of a mushroom transported from the Hyperborean homeland in central Asia, and it was commemorated as such in the annual secret botanical offering supposedly sent from there to the sanctuary of Apollo on the island of Delos (Ruck, 1983).

The fermentation process was correctly recognized as a fungal growth. Mushrooms themselves were called a 'fermentation of the earth.' Significantly in ordinary culinary nomenclature persisting as late as the fourth century CE, the stipe of the mushroom was called its thyrsus, with the cap representing the psychoactive plants stuffed into its stalk. In the case of the *Amanita* mushrooms, the toxins are largely present in the cap. Prominent in the metaphoric accounts of the mountain revels is the encounter with the mooing and bellowing bovine zoomorphic manifestations of the mushroom. A fragment of a fifth-century tragedy about the hero Perseus describes the ground bellowing with fruiting mushrooms. Whatever the revelers did on the mountainside, the drinking of wine was never an element. The rite symbolized the ecstatic rapture encountered through the wild plants that predated the evolution of the grapevine. The mooing bovines in myth, moreover, are always in heat, stung by the bite of the cow fly (*Tabinus bovinis*), who was personified as the spirit of their herdsman prodding them with the sexual lusting of the estrus, sending them into wild dancing (Ruck, 2015a). The tradition survived into medieval Europe, spreading northwards from the Greek settlements in Southern Italy, where it was known as the tarantella, the mad dancing fever precipitated by the bite of the spider. The ecstatic cows surrounded by the flies is a motif suggestive of the *tue-mouche*.

The grape bunches hanging from the grapevine were typically depicted as an analogue resembling the shape of a mushroom. Apart from the numerous poetic descriptions of the experience, there are irrefutably reliable historic accounts of extreme states of mental derangement as late as the Roman period. In graphic and literary depictions, the revel is permeated with hybrid creatures that are obviously visionary materializations from a non-ordinary reality. Among these are the ithyphallic goat-men or satyrs who engage sexually with the revelers and represent the attendants of the deity in his persona before the advent of viticulture. The grazing habit of the goat made it a threat to the vineyard, and hence an archetypal enemy of viticulture. Goats often figure as discoverers of the toxicity of plants as they tend to graze on all manner of wild plants, and the goat-herder, who lived in intimate close proximity of his animals, would have noticed the intoxication induced in his herd by certain wild psychoactive plants. Additionally, toxic plants impart the same psychoactive toxicity to the flesh of the animals that ingest them (Piper, 2013). The quail in particular were deemed drunken in antiquity because of their staggering gait and were noted as dangerous to eat since they often fed on plants that were lethal to humans (Ruck, 2015a). Appropriately the hybrid goat-men attendants of the old version of the god were suitable victims offered to his evolving persona as patron of viticulture and the civilized arts of the theater. Tragedy is so named as the honorific song sung for the slaughtered goat that is the archetypal enemy of the grapevine. In the ritual picking of the grapes for the vendange, the harvesters are depicted miming satyrs.

In Vedic and Avestan traditions, wine, although the most obvious intoxicating candidate, was never a surrogate for the entheogen, probably since it represents the antithesis of the wild mushroom. From the latest antiquity in the fourth or fifth century CE, Nonnus of Egyptian Panopolis in his *Dionysiaca* describes the fight between Dionysus, returning with his revel entourage from their conquest of the Indians of the Indus Valley, and the supporters of the Greek Perseus, a battle that epitomizes the antithetical contest between the wine triumphant and the aboriginal mushroom of Mycenae and the Hindu Soma (Ruck, 2014). The contest of Perseus versus Dionysus ends without victor since Hermes intervenes to reconcile the two brothers, both sons of Zeus. In this ultimate conflict, Dionysus employs the diamond as his weapon. It was reputed to have the power to repel all venoms, deflecting even the toxicity of the mushroom that was the Gorgon head. As an opponent of Dionysus, Perseus is fulfilling the same role as Pentheus of Thebes and Lycurgus of Thrace, who both opposed the advent of the civilizing gift of wine. Lycurgus, as the 'Wolfworker,' has a name that associates him with traditions of lycanthropy, and Pentheus, as the 'Suffering' complement to the Joy of Dionysus, was decapitated by the revelers, who placed his head atop the thyrsus as the analogue of the ivy and the other wild plants gathered on the mountainside amid the mooing of mushrooms.

The Wine Mix

Like the mediating potion of the *kykeón*, wine was a mixture that honored the toxins that predated viticulture by adding them to the vinous medium. Thus wine was customarily drunk diluted with three or four parts water, but even diluted it was extraordinarily potent. As little as a pint of diluted 4% alcoholic content drunk over a period of several hours in a succession of rounds could induce extreme intoxication. Only four rounds could result in mental derangement, and further drinking ended in a brawl. Alcohol itself was unknown as the intoxicant in antiquity. Distillation of liquids was not discovered until the fourteenth century CE, when the distillate was named alcohol by analogy to the process for metallic distillates and equated to the *quinta essentia* (quintessence, the 'fifth' quality) that Aristotle had postulated as the element of the celestial bodies that permeated matter as the spiritual soul (Ruck *et al*., 2012). This clearly derives from the ancient tradition that the wine served a sacral function. Since the alcohol produced by natural fermentation is limited to around 13%, after which concentration the aqueous environment becomes too inhospitable for continued growth of the fermenting yeasts, the toxicity of the wine was due to these fortifying herbal additives. These included even deadly poisons like hemlock in sub-lethal dosages and venom milked from serpents. This tradition survives in the modern Greek folk wine of *retsina* and in the demotic naming of the drink not 'wine' (*[w]oínos*), but the 'mix' (*krasi*). A recent archaeological discovery of an intact wine cellar from the mid second millennium BCE confirms the presence of psychoactive additives to the wine (Ritter, 2013). The tradition survives in certain rural wines of Europe today fortified with substances such as the dermal secretions of salamanders and toads.

The additives represent the toxins that predated viticulture. One of these additives appears to have been actually a mushroom. A Greek fifth-century red-figure *hydria* found in a cemetery of ancient Ainos (modern Enez, Turkey) depicts what is obviously a cultic scene, probably relative to the funerary rites performed for the burial of the deceased. A mushroom is highlighted as a special ingredient to be added along with other plants (perhaps bryony or smilax) to the mixing of a *píthos* urn of wine (Ruck, 2014).

Maronian Wine

The Thracian provenance of the *hydria* vase suggests that this particular wine was the legendary wine of Maron, a priest of Apollo and a descendant of Dionysus. In the Homeric *Odyssey*, Odysseus uses this wine to intoxicate the Cyclops Polyphemus. It was so potent that it would have required twenty parts of water for dilution. In the Roman period, a vineyard was still marketing a version of this heroic wine. On the testimony of the Roman governor of the region, it still required eights parts of water to be drunk safely. The blinding of the drunken Cyclops is depicted on the neck of the Eleusinian *píthos*, above the scene with the jug-headed Gorgons. The two scenes are probably complementary. A single tear in the shape of a mushroom drips from the eye of the blinded Cyclops. Both scenes are decorated with graphic designs termed *grecas*, which are interpreted as representations of entopic vision, the onset of chemically altered sight, where the eye begins to see the coursing of the blood flow across the retina (Wasson, 1986). Such whirling graphics are documented from prehistoric rock art. This mushroom-infused wine is particularly associated with Thrace, where archaeological evidence indicates that a mushroom cult existed dateable back at least to the generation before the Trojan War and the mythical tradition of Orpheus and the sailing of Jason with the troupe of Argonauts (Markov, 2008, 2014; Kiotsekoglou, 2014; Samorini, 2012).

In addition to the numerous megalithic natural rock formations that resemble mushrooms, a cave at Thracian Ismara/Maroneia that served as a sanctuary presents a fungal likeness in the configuration of its entrance, two adjacent openings like eyes with an overhanging rock configuration giving the impression of a stipe as nose supporting a mushroom cap as forehead, imparting a fungal face of the goddess to the mountain (Kiotsekoglou, 2014). The design resembles the fifth-fourth-century BCE marble bas-relief votive plaque of Eukrates found in the excavation of the Eleusinian sanctuary, the ex voto of a blind man who saw the vision; it depicts his eyes, with the goddess rising above against a hemispherical red cap as a sunrise. The same configuration of visionary eyes and fungal nose bridge occurs on silver and gold tablets found in the seventh-century Thracian sanctuary of Demeter at Mesimvria Zone. Persephone as a head rising from the ground was the essential vision at the Eleusinian Mystery sanctuary, and she is so depicted, attended by satyrs, on Greek vases. The fourth-century coinage of Thracian Maroneia employs the motif of the bunch of clustered grapes in the configuration of a mushroom. The fungal head of Persephone bears comparison to the prophetic head of Orpheus, of which there were several in caves throughout Thrace, from which could be read oracular responses, interpreted from the enigmatic magical markings on its surface (Ruck, 2014). Like Pentheus, Orpheus was decapitated in a Dionysian revel. Orpheus was cited as the founder of the Eleusinian rite, and although he belonged to the generation before the Trojan War in the mid second millennium BCE, he was also involved in the seventh-century patriarchal reorganizing of the rite, indicating that Orpheus is obviously a figure of mythologized history. There are two sources for the Mystery that combine and are reconciled in the patriarchal revision, one is from Minoan Crete of the goddess with the opium poppy, and the other is the Thracian Orphic origin, which involves the reciprocal complementary opposition of Apollo and Dionysus. Athens was a mythical relative of Thrace through the abduction of their princess Oreithyia by the north wind Boreas as she was gathering magical plants with a group of maidens called the Pharmacists.

The pre-patriarchal revision of the Eleusinian rite involves the wild plant cited as the *nárkissos* in the etiological myth of Persephone's abduction. The actual plant is probably the sea daffodil, *Pancratium maritimum*, which is illustrated in Minoan frescoes and a gold signet ring, depicting women with bee-heads gathering flowers in a visionary context, and on Mycenaean sacral swords. As its Latin nomenclature as 'allpowerful' (as in the athletic contest of the pancratium) suggests, the daffodil is psychoactive. It is not difficult to see that the flower resembles the vulva surrounding the reproductive stamens and pistil. By the Roman period, this daffodil had become identified as an ingredient compounded with olive oil in an unguent used by the Magoi Zoroastrian priests of Mithras to confer grace and power. This inevitably involves it in the tradition of the *haoma* sacrament, for which reason it was also identified as an orange-red flower. The opium of the Minoan goddess was similarly commemorated in the transition to the patriarchal revision as the pomegranate that inseminated Persephone to engender the Mystery child, since the red fruit of the pomegranate resembles the capsules of the opium poppy, similarly filled with its profusion of seeds.

Common to all the Thracian megalithic sites is their proximity to a water source, a river or a fountain spring, often haunted by a nymph, whose male mate is the river. A similar motif occurs at the Eleusinian sanctuary with the Sacred Well that lies beside the great portal to the sanctuary. The water from this well was spilled from two urns in the ritual of the 'full-pouring' (*Plemochóë*) as the inauguration of the Mystery, accompanied by the words written on the wall beside the double-gated entrance, 'Rain! Conceive!' Thus the goddess was invoked to birth the Mystery child that would culminate the ceremony.

The megalithic Thracian monuments often served as markers for organized necropolises or cemeteries. Many Greek and Anatolian phallic tombstones from all periods survive in the shape more correctly recognized as a mushroom. The asymmetry of the glans is never shown, nor the urinal duct nor the testicles, and the knob is often flat or spherical. Both the duct as an 'eye' and the testicles, in contrast, were elements commonly included in the sculptural and painted representations of the phallus and its metaphoric deployment on the comic stage. As the scholarly authorities on Greek burial customs concluded, none of these tombstones bear the slightest resemblance to the organ which the Greek artists knew so well and the only group of objects which they all can be said to resemble is toadstools (Kurtz *et al*., 1971). In fact, 'mushroom' appears to have been a metaphor for both the erect penis and for the burial coffin or the tomb.

A tombstone from Dascylion in ancient Bithynia on the shore of the Black Sea presents a particularly fine example of these ancient mushroom tombstones. The deceased Lysandra is depicted seated between two butterfly Psyche souls, like Celtic fairies, in a niche carved into the cap of the mushroom. Hermes as the escort of souls is carved into the stipe as a herm-pillar with penis, flanked by dogs or wolves.

Ionian Enlightenment

The Greeks obviously came into contact with the Achaemenid Persians in the sixth century through the expansion of their empire, which ushered in the period known as the Ionian Enlightenment and would culminate in the two wars at the beginning of the fifth century with the invasions of Darius and his son Xerxes ten years later. The sixth-century philosopher Pythagoras of Samos was initiated into the *haoma* rites while a prisoner in Persian-controlled Egypt. Ovid described what Pythagoras experienced as a journey in the spirit to the deities far-off in space to drink down with his eyes what Nature denies to human vision. In addition, disgraced aristocratic Greek politicians commonly sought asylum with Persian satraps and participated in their secret initiatory ritual (Ruck *et al.*, 2011). Their *haoma* sacrament, however, was known much earlier at least by the mid second millennium as *[h]ómomi*, which is the original for the moly (*mólu*) of the Homeric tradition, the plant that Hermes gave to Odysseus as an antidote for the drugs of the sorceress Circe.

On the comic stage of Athens of the Classical period, this Persian sacrament was well known and associated with Thracians. In Aristophanes' *Wasps* (422 BCE), it was visionary, inducing clairvoyance, and described metaphorically as a herded bull, and a lethal potion of its blood in a scene enacted by two Thracian slaves in an obscene routine of mutual fellatio, with the mushroom identified by its common metaphor as an erect penis whose ejaculate induced a Persian nodding sleep. It bellowed when strenuously erect with a snotty discharge, punning upon the mooing *mykes* and mucus (Ruck, 2012).

Among the Thracians, the mushroom cult was still empowering their kings as late as the first century BCE, as it did Darius, as witnessed by a Greek doctor assigned to the Persian court, in an intoxicated celebration of Mithras reserved solely for him. The cult also appears to have been the basis of lycanthropic rites binding their elite into a brotherhood of warriors. One of the Scythian contingents in the Persian forces was named the *Saka Haomavarga*, which means the '*Haoma* wolves' (Gershenson, 1991) The lycanthropic transmogrification was known to the Homeric tradition, as narrated in Odysseus' encounter with the Thracian horseman *Rhesus* in the *Iliad*. The event was also the subject of the Rhesus tragedy attributed to Euripides, when the dead horseman is cited as involved in Thracian Mystery rites (Ruck, 2014). Rhesus is probably a version of the Thracian god Sabazios or Zalmoxis. Darius' troops also knew of the mushroom's metabolite in urine. These are instances of a widespread cult better known among the Nordic berserkers of the medieval period, who materialized on the battlefield as wolves or bears, but which can be traced back to antiquity. The Emperor Trajan confronted it in his encounter with the Thracian Dacians, named for the 'wolf' and who bore into battle the ensign of their wolf-serpent Draco, bellowing in the wind. The Emperor was met by a Dacian shaman who read a warning to him off the markings on a mushroom cap.

Lycanthropy

The particular mushroom that fits the parameters of all these indications is the *Amanita muscaria*. It alone of the fungi is documented as inducing heightened physical strength and heroic fury in battle, and the scabby white remnants on its expanded cap allow a written message to be interpreted from its surface, and it alone is noted for its superior potentiated metabolite in urine. Many other Indo-European tribes were similarly named or associated with the wolf, and the common ritual indoctrination of the adolescent males into packs of wolves is documented among the ancient Spartans. The deity presiding over these packs as the assembly of his herd was the god Apollo, and he is the deity in Greek tradition involved in the motif of lycanthropy. As herdsman, he was invoked to protect the flock from the depredation of the wolves, but as the wolf god he also culled his flock as recipient of human victims.

In the evolution of Greek culture, Apollo was distanced from his darker persona and his lupine manifestations as the 'wolf' (*lykos*) were given a false etymology derived from the 'light' of the sun and its solar illumination. *Lykios* was fancifully associated with Latin *lux* for 'light' and Greek *leukós* for 'white,' and Apollo's epithet was explained as derived from the 'sun shining and making everything white.' The god's tenuous claim to the light of day, however, is reflected in the word for the dangerous marginal time of the dawn and the twilight as the 'wolf-light' (*lykóphos*). Similarly, the liminal threatening time when werewolves were abroad, the 'wolf-walk' (*lykábas*) was forced to mean the 'path of the sun' and glossed as a period of time, perhaps a year. The fulfilment of a period of time, however, implies termination or the temporal end, when the ultimate victim would be required. In the traditional antithesis between Apollonian and Dionysian modes of cognition, Dionysus assumes the burden of Apollo's lycanthropic involvement, freeing his brother to preside over the transmutation of toxicity into the entranced enthrallment of music and the metamorphosis of the deadly twanging of the thong of the bow and its poisoned arrows into the harmonized strings of the lyre. The words for 'arrow' and 'poison' are homonymous (*iós*) in Greek.

At Delphi, the original mid second millennium sanctuary was the Wolf Cave on Mount Parnassos, one of the largest subterranean cave complexes in Greece, with a succession of forty chambers leading deep within the sacred mountain. A rock formation within its entrance presents the likeness of a wolf. As the deity transitioned to his revised patriarchal Apollonian persona, the sanctuary was moved to its present location ever since the seventh century lower down the mountain, and the Cave above was entrusted to Dionysus or Hermes. The ecstatic revels there were still celebrated as winter rites of plant gathering well into Roman times, during which period Apollo would absent himself from the sanctuary. As a commemoration of his more ancient manifestations, he was forever linked, however, to the Wolf Cave since the oracular priestess would prepare herself for her ecstatic possession by the god in the below-ground chamber at the back of the Temple by bathing in the Castalian Spring that flowed from the subterranean lake within the Cave to surface at the base of the twin cliffs that loom above the present Temple sanctuary and she was named the Pythoness, after the former hermaphroditic serpent deity who once resided within the Wolf Cave as an oracle of Earth, instead of the Olympian Zeus as father of Apollo.

When it is not the brothers Dionysus or Hermes who assume the burden of Apollo's displaced darker person and his involvement with deadly or mind altering wild and primordial toxins, it is a beloved son like Asklepios, patron of druggist/doctors (*iatroí*), or Ion of Athens, eponymous ancestor of the Ionian tribal group, or Iamos, the founder of the brotherhood of shamans at the sanctuary of Olympia. The mythical tradition of them all involves them in the botanical lore of entheogens, with both Ion and Iamos providing opportunity for poetic elaboration on the etymology of their names and the motif of the *iós* arrow toxins derived from sacred plants (Ruck, 1976). This is true also of Apollo's homoerotic chosen victims, like Hyacinthus, Daphnis, and Cyparissus, who all metamorphosed into psychoactive or funereal plants (Ruck, 2015a). The homoeroticism was ritualized in the indoctrination of adolescents into the military packs of wolves. There was a tradition that even the Castalian Spring was named for the maiden who was the first of the many victims tossed into its waters from the twin cliffs high above.

Orpheus of Thrace was another of these beloved victims (Ruck, 2014). Despite his devotion to the solar manifestation of Apollo, he is named as the 'Orphan' from the light of his deity and was harvested as a primordial psychoactive anthropomorphism in the Dionysian revel. In the case of Kyknos (Cygnus), named as the 'Swan,' his grieving sisters metamorphosed into trees whose tears fell as lumps of amber. Such resinous discharge of trees was the commonly supposed origin of mushrooms, and all of these figures have a similar involvement ultimately with the fungus (Ruck, 2015a). Kyknos himself metamorphosed into the swan, which as Apollo's special bird, sings the swansong, the first and last utterance it ever makes, superlative, beyond all imagining, being the description of the paradise beyond this life to which the deity sends his victims.

Phrygian Cap

The lycanthropic motif is the origin of the Thracian/Phrygian cap. It provides the botanical name for the mushroom's cap as the *pileus*, implying an anthropomorphized creature beneath it wearing it as its hat. It had a long continuance through medieval and Renaissance tradition until modern times as a marker for initiates into the secrets of the ancient Mysteries (Ruck *et al*., 2011). The Phrygian cap was originally a fox pelt, complete with snout and ears, sometimes the entire animal (Ruck, 2014). The Thracian reveling plant gatherers of the pre-viticulture Dionysus were named for this pelted cap. The fox is a canine analogue of the wolf, and its pointed snout and red color were stylized in the drooping felt versions known as the liberty cap, awarded to liberated slaves, although the original liberation freed the initiate from the restrictions imposed by the human condition.

The red cap is as ubiquitous as the little creatures that materialize in the lore of Europe, most notably in the tale of 'Little Red Cap' (*Rotkäppchen*), known in English as 'Little Red Riding Hood,' and the episode of lycanthropy and with a similar ultimately ethnobotanical referent (Ruck *et al*., 2007). The English title predates the Grimm brothers' collection, and the 'riding hood' as a term for the Phrygian cap indicates that the heroine of the tale is on a journey that will culminate in sexual awakening with her aged grandmother as initiator and a lupine transmogrification in the belly of the devouring wolf. Digestion is a metaphor with alchemical implications of transcendence. Nineteen-century illustrations of Little Red's encounter with the wolf often include the fly agaric growing in the woodland scene, which would seem to indicate that the illustrator was privy to the secret.

Eggshells

The etiology of the red cap was explained as the remnants of the egg from which the twin Dioskouroi (Dioscuri) were hatched, each wearing a half shell. As such they were cited as patrons of the Mystery of the Great Gods (*Mégaloi Theoí*) of Samothrace, which was second only to the great Eleusinian rite in antiquity in reputation and importance. The twins were inseparably bound to each other. Although only one of them was immortal, the son of Zeus, while the other was mortal, the son of their mother Leda's husband Tyndareus, they vowed to share their dual fate, dying together on alternate days, and returning the next. They obviously imply a similar aspiration for the initiates as they sailed the perilous voyage through life, and hence the twins were cited commonly as patrons of seafaring, although their true significance refers to a metaphysical journey. They could be represented as two adjacent *amphorae* vessels of the Mystery's Thracian wine of Maron, especially potent from its fungal additive, whose toxicity is indicated by the serpents entwining the vessels. Numerous drinking cups that were the property of the priesthood survive in the ruins of the Samothracian sanctuary, leading the archaeologist who excavated the site to conclude that excessive drinking to the point of intoxication was clearly an element in the Mystery (Lehmann, 1954). Similar rites involving the same complex of deities occurred elsewhere, and drinking from special sacred vessels was always an element, with the cups then shattered to exclude them from later profane usage.

The Dioskouroi could also be depicted as two posts, representing the half eggshells of the curved red caps, joined by a crossbeam, as if they were Siamese twins, before their separation. In this configuration, they resembled their cousins, the Moliones, who were similarly hatched from a single egg, but joined at the waist as Siamese twins (Ruck, 2015a; Ruck *et al*., 2001). They are the mythical prototype of the spherical primordial humans that were sliced in half like an egg in Aristophanes' tale of the Hermaphrodite in Plato's *Symposium*. This tradition of the Siamese twins encodes another attribute of the *Amanita muscaria* that identifies it as the magical plant that sprouted from the liver of the tormented Titan Prometheus that served as food for eagles (Ruck, 2015a). Eagles' fare is a version of raven's bread, a metaphor for the mushroom, because of the birds' fondness for the *Amanita* (Klapp, 2013). As food for the thunderbird, it occurs also in indigenous North American tradition. Medea plucked the Promethean mushroom to compound the dermal unguent that she entrusted to Jason (Iason) to fortify him with the superior strength that allowed him to yoke the fire-breathing bulls, with which he plowed the field to sow the primordial toxic crop that sprouted from the fangs of a monster serpent. He is named Iason, like Ion and Iamos, for his involvement with this *iós* toxin.

Dumbbell

Medea cut the root of this Promethean plant amid the sound of bellowing and mooing from the earth, and it is described as growing with a double stem (*kaúlos didúmos*), not a branching stem. It is, more exactly, a 'twin' stem. The epithet of the Dioskouroi was the 'Twins, '*Didúmoi*, and they became the constellation Gemini. This encodes a riddle since no plant grows from the earth with a twinned stem, side by side, except the *Amanita*s. As the subterranean nodule or egg that develops from the mycelium into the fruiting mushroom expands, the stem or stipe/trunk extends in both directions, pushing the base apart from the cap, shattering the eggshell, producing a shape like a dumbbell, easily recognizable when plucked from the ground. It is also the traditional shape of the sacred thunderbolt that inseminated the mushroom at its conception from the heavens, meshing celestial fire in the wet matrix of matter. The thunderbolt of Zeus in this dumbbell shape, often with conventional lighting flashes attached and sometimes with wings, is the Greek version of the *vajra* thunderbolt of Indra, and in Buddhism it is symbolic of the thunderbolt experience of *Bodhi* or 'awakening.'

The Mystery child could be depicted also as emerging from the cosmic egg, pushing the two hemispherical eggshells apart, marked with the signs of the Zodiac as indication of the transcendent return to the celestial realm (Ruck *et al*., 2011). This double-stemmed herb of Prometheus, moreover, was the same color as the plant involved in the rituals of the Wolf Cave at Delphi and in the birth of Ion of Athens in the cave beneath the Acropolis. In this version, the plant goes by the name of Krokos (crocus), chosen for the phallic appearance of the blossom as it emerges from the earth. In mythical elaborations, Krokos was anthropomorphized as another adolescent who fell victim to the deity, and he was linked with another lover called Smilax or 'bindweed,' and they both represent the primordial plants that predate the evolution of viticulture. The crocus is analogous to the *nárkissos* and Minoan frescoes depict both monkeys and maidens gathering it. The monkey was emblematic of little primordial humanoids, and they were mythologized in the figure of the Kerkopes, whose name designates them as having the appearance of a 'tail,' indicative of their fundamental phallic identity. They survived in European folklore as the German *Kobald*, the French *gobelin*, and the puck of England, ecstatic mischievous little creatures, like fairies, in the entourage of the Dionysian plant-gathering revel.

Phallic Grotesqueries

Although the Dioskouroi were depicted as idealized youths, there were analogues of them in the Mystery of Samothrace that made them dwarfish and ithyphallic, since the cult of the Great Gods encodes the secret that the divinities were actually great in power, but the opposite in stature. The Dioskouroi were warriors and a fanciful version of them occurs as the *Kaulomykétes*, little men comprised of the 'stem' (*kaúlos*) uplifting the mushroom caps as a shield above their heads. These creatures must obviously be no bigger than mushrooms themselves. This stem, moreover, was a common metaphor for the erect penis, which reduces the entire anthropomorphism to its phallic function as the 'mushroom' penis. As *Kaulomykétes*, the little warriors have an asparagus stem as their sword, a vegetable of choice for its phallic thrust and its noticeable effect on the scent of the urine (Ruck, 2015a).

In this configuration with uplifted shield, the Dioskouroi mushroom warriors are analogous to another of their anthropomorphisms in the Mystery of the Great Gods as the Corybants ('helmeted-dancers') and the Curetes ('boys'). Although they, too, are idealized youths, they sprung from the fingers of Rheia, the mother of Zeus, as she grasped the ground in labor. The Cretan Caves on Mount Dicte and Ida, where Zeus was born, were equated with the sacred Zerynthian Caves on Samothrace and throughout Macedonia and Thrace as sites for the Mystery. The Corybants danced ecstatically, clashing their shields to drown out the sound of the baby's birthing and are typically depicted with shields uplifted and standing on a single foot. The pose is symbolic and it appears also in depictions of Mithras, where it encodes the same fungal identity of the *haoma* sacrament (Ruck *et al*., 2011). Mithras himself is traditionally attended by two male torchbearers, who always stand with their legs crossed, making them essentially one-footed and also symbolizing the entrapment of the celestial fire in matter, emblematic of the sacred mushroom. The Dioskouroi often are depicted with these same crossed legs. The torchbearers always depicted with one holding his torch thrust downward, the other upward, on either side of the Cosmic Bull, signifying the entrapment and liberation of the celestial fire through the sacrifice of the bull.

As finger creatures from the digits of Rheia, plucking plants in ritual mimesis of birthing, the Corybants are analogues of the tiny creatures named for the 'fingers' as dactyls. They often occur as a brotherhood of five, African pygmies, a fistful of them, from Latin *pugnus*, cognate with pugilist for 'boxer,' which is probably responsible for the portrayal of the Dioskouroi as boxers, although the Greek *pygmé* is the measure of a forearm or cubit, making them approximately a foot tall. The actual five-foot Pygmies of Africa were named after their mythological etiology and were considered sacred and much in demand as holy magical curiosities by the Egyptian pharaohs. This tradition continued through the Renaissance in Europe with the dwarves in the entourages of the royal families and in folkloric heroes like Tom Thumb, only so big as a thumb, and swollen like the penile member that is his essential identity (Ruck *et al*., 2007).

Another version of them in the Mystery was the black-skinned *Kábeiroi*, misshapen dwarves, the males with prominent erections. The sorceress Circe was depicted as such on surviving vessels from the Mystery as she compounds her potion for a *Kabeiric* ithyphallic Odysseus, sailing on a drunken amphora of the special wine of the rite (Ruck, 2015a). On the stage in Athens, the tragedian Aeschylus depicted the *Kábeiroi* in an orgy drunk on the wine of Maron in his satyr play. In Aristophanes' *Lysistrata* (411 BCE), the divided chorus of combatting males and females was staged as dual troupes of *Kabeiric* grotesqueries in a parody of the Mystery as practiced on the island of Lemnos. The *Kábeiroi* were also imagined as crabs, wielding their pincer claws as henchmen of Hephaestus in the metallurgical volcanic crucible of alchemical transmutation, forging a cure for ordinary blindness. The metallurgist's pincers were called 'crabs' and Aristophanes staged them in the *Wasps* (422 BCE) as pubic lice impersonated by children, obscenely dancing around the erect phallic personification of the Persian *haoma* sacrament, with which the comedy had begun (Ruck, 2012). As the mythical figure of the Crab, the creature was involved in the motif of the toxins that anointed the poisoned arrows of the hero Heracles, and it was ultimately transported to the stars as the constellation of Cancer (Ruck, 2015b).

Penates

These Mystery figures were associated with the Etruscans, who were thought in antiquity, perhaps correctly, to have been Trojans who passed though Samothrace on route to Italy. *Kábeiroi* may be an Etruscan word, and inscriptions in an Etruscan-like language are preserved on Lemnos. On Samothrace, portions of the liturgy were recited in a no-longer comprehensible pre-Greek or Pelasgian tongue (Cooper, 2000). These creatures of the Mystery were known to the Romans as the Penates, idealized adolescent males in historical times, although the original Penates that Aeneas carried out of Troy to the banks of the Tiber were probably *Kabeiric*. They were preserved there in historical times, probably as pious forgeries. It is significant, however, that the Penates as displayed in private houses were always statuettes or figurines, little people. The twin posts of the *Dioskouroi* joined by the crossbeam could be interpreted as an iconic glyph of a shrine or of the household placed under their guardianship, in which form the Spartans carried the emblem into battle as a standard in front of their army. The glyph was called the *dókana*, derived from the Greek verb *déxasthai*, meaning 'to receive' (Waites, 1919). As a shrine, it represented the opened tombs in Sparta that hospitably received and released the twin brothers on alternate days, and it symbolized the brotherly love, mortal and immortal, that spans this world and the grave, open to receive and release its guests, binding the household to the other realm, under the sacrosanct obligation of reciprocal 'hospitality,' *philoxenía* or *theoxenía*. The Dioskouroi were summoned and expected to materialize as guests at the table of their host (Klöckner, 2010). A similar linkage of guestfriendship (*xenía*), the reciprocal role of host to guest, was the ultimate benefit promised to the initiates at Eleusis.

The Roman Penates were guardians of the household's store of provisions in the innermost recesses of the home, the *penus*. A small portion of the meal was thrown on the fire as a token offering at every dinner as a sacrifice to remove the taint of primordial toxicity, after which the attendant slave would announce that the food was now safe to eat. The etymological derivation from the 'innermost' was more significantly connected in antiquity with their phallic identity and the motif of 'penetration' into the secret shrine of the household's goddess of the central hearth and into the inner core of life, with connotations of sexuality and mystical vision (Bonnefoy, 199). The toxicity of the creatures that sprouted from the primordial intrusion of the plowshare into the vulva of Earth was mythologized in the tales of the Sown Men, the autochthons who sprouted from the serpent fangs. They were tricked into internecine strife, a battle that blamed them for their own fraternal sacrifice, leaving only a few remaining, whom the plowman took into his own family as in-laws.

Tages

The Etruscans had their own version of the autochthonous creature. This was the tiny male named Tages, who popped up out of the ground in the path of the plowman and founded their religion. People gathered around this miraculous apparition and in the presence of the entire populace of Etruria, what it said was written down from dictation as the holy book that was the foundation of the Etruscan science of divination. His father was Genius, the *creator spiritus* or 'creative spirit,' sometimes winged fairylike, that personified an individual's manifestation of divine nature, resident in all aspects of creation, including the observances of communal life, the norms of civilization and its ritual procedures, linking them to the realm of nature and the cosmos (Grummond, 2006). Sometimes Tages is depicted as just a talking head emerging from the ground, obviously not yet capable of walking. All the autochthons display a similar ambulatory difficulty, indicative of their botanical identity, and if they walk at all, they tend to be lame or have but a single foot (Lévi-Strauss, 1955). As a talking head, Tages resembles the prophetic heads of the harvested Orpheus, and it is likely that what they said by dictation was read off the markings on their heads, like the message encoded on the mushroom of the Dacian shaman, presented to the Emperor Trajan. Tages usually wears the conical red Phrygian cap, and his basic identity is phallic, wearing a pouch as a locket around his neck containing phallic objects as a protective amulet, such as was customary for Roman male children until puberty, and then stored as a memento and brought out again for display on special adult honorary occasions.

Tages is the Latinized version of his name, which in Etruscan would have been Tarchies, probably a variant of Tarchunus, the Etruscan version of the Latin Tarchon, the legendary founder of the Etruscan city of Tarquinia, north of Rome. Tarchon was the name of the plowman, which makes him identical with Tages, and they were customarily portrayed together, the little talking head and the plowman recording the dictation. The ancient Etruscan cemetery at Tarquinia dating from the eighth century BCE contains a number of stone urns containing the cremated remains of the deceased, covered with hemispherical covers, presenting the likeness of mushrooms. It is the pattern copied in the more elaborate Etruscan multi-chambered tombs, which are cylindrical and topped with a grassy mound, like the Mausoleum of Augustus, which are probably mushrooms with expanded stipes. As philhellenes, the Etruscans often placed Greek vases as funerary offerings with the deceased in these mausoleums. The placement in the tombs allowed them to survive until modern times. The vase depicting Perseus with the decapitated head of the Gorgon Medusa is one such vase. Mushroom shapes are prominent in many of these. One of them is a large fourth-century BCE platter, over two feet in diameter, depicting the abduction of Persephone, with the rim decorated in raised knob-shaped mushrooms, which are not intended as handles (Ruck, 2014).

The special knowledge that Tages entrusted to the Etruscans was divination through the inspection of the liver of a sacrificed animal, haruspicy (hepatoscopy). It is an art of the greatest antiquity that can be traced back to Mesopotamia and even earlier, with references both in the Bible and in Homer. The priest inspecting the liver is traditionally depicted with wings, indicative of his shamanic rapture, and standing with one foot raised and resting on a rock, mediating between earth and the celestial realm, and Etruscan mirrors portraying the ritual often have the winged Genius on the base handle.

Cosmic Liver

Since the liver is essential for life, the largest and weightiest of the entrails and containing the greatest amount of the life force in the form of blood, it was considered the center of personal existence. The markings of the universe could supposedly be read off its surface, and thus it was a microcosm of the vitality of the celestial realm. The haruspex, by manipulating the liver, could also influence events in the cosmos that it mirrored. Such power was seen as a threat to the established order, and astrologers were on occasion either banned or executed by a succession of Roman Emperors. The liver as food for the eagle was the organ that was the site of the daily torment of the chained Titan Prometheus as punishment for his creation of man and the theft of fire. He is the mythical prototype of the clairvoyant seer, named for his 'Fore-thought' or prognostication. The liver was considered the primordial organ of the body, the part that developed first in the fetus, around which the rest of the person grew in the womb. It is the organ that functions in hemolysis, the cleansing of the blood from toxins, and thus it is a motif in botanical agencies for shamanic rapture. Although it is unlikely that the ancients knew of the filtering function of the liver, it was thought to be the organ through which the digested food from the stomach entered the bloodstream. The liver would have the highest concentration of psychoactive toxins, reabsorbing what the kidneys did not eliminate into the urine. The theft of fire, hidden in the narthex, involves the motif of root-cutters and herb-gatherers. The bitter brownish or greenish-yellow secretion of the liver called bile or gall (Latin *bilis*, Greek *cholé*, both derived from the Indo-European root *ghel*- for 'shine,' yellow like 'gold,' with which it is cognate) is another element in this motif. It is listed as two of the basic humors of the body (melancholic, choleric) and was associated in Roman thought with rancor and madness. 'Gall' was further implicated in the motif of psychoactive toxins by its association with the venom of serpents, which it was thought contaminate plants by contagion. Eating your enemy's liver was equivalent to mastering his soul.

Indigenous Foreigner

The shared identity of the Tages and Tarchon, the autochthon and the plowman, makes the founder consubstantial with the foundation. This is often expressed by the motif of the founder as supposed foreign immigrant encountering himself in the personae of the indigenous autochthons, like Cadmus at Thebes, who slew the serpent to plow the field with its fangs and subsequently metamorphosed himself with his bride into serpents. In the exemplar of Prometheus, the creator of man is consubstantial with the primordial organ of the prognostic liver that serves as food for eagles, which implies that he is a fungal personification. In Corinth, there was a tradition that in former times men had indeed first sprouted from the ground as mushrooms swollen after a rainfall. On the comic stage of Athens, Aristophanes costumed Prometheus in the *Birds* (415 BCE) with his phallus unfurled as a parasol, in imitation of the Shade-foot fungal anthropomorphism (Ruck, 1981). There could not be a more blatant revelation of the mushroom's central role in Greek tradition as the origin of all human intelligence and science, as catalogued by the Titan himself in the *Prometheus* tragedy ascribed to Aeschylus.

The mythical tradition of these little fungal creatures mediates the opposition between the realms of life and death in terms of the relationship between the primordial toxicity of the wilderness and the inaugural plowing of the agrarian field to plant the crops of civilized culture. Hence, it is fundamental to the founding of cities, an accord and covenant with the forces of primitivism. In narrating the arrival of the Trojan Penates to Italy, Virgil in the *Aeneid* was required to include a bizarre and enigmatic event recorded in the supposedly historical accounts. This involved the fungal identity of the plant most emblematic of the wilderness and as the *haoma* sacrament, most indicative of the transcendence toward culture (Ruck *et al.*, 2013; Ruck, 2015a).

Fairy Tables

It was predicted that Aeneas and his men would be cursed to endure such extreme hunger before they founded the new settlement in Italy that they would be forced to eat their own tables. The curse was an item of arcane tradition, a brief riddling mention of a weird mythical event apparently recorded in some now-lost work preserved in the Alexandrine library, probably elaborating some ethnographic anthropological motif, which was a particular interest of the scholar-writers who presided over the library and its vast collection of texts. Virgil discussed it with historians among his friends, who were puzzled by its meaning. He, however, was required to include it, and he figured it out and transformed it into an innocuous surrogate, as suited the rational sobriety promulgated by his patron Augustus as a national agendum or at least as the virtue he claimed as destined Emperor.

The mythical precedent was the repulsive tables of food defiled by the excrement of the Harpies like a swarm of monstrous flies, which was all that the starving Thracian prophet Phineus had for food, but which also was responsible for his gift of clairvoyance, which to say, that the food was psychoactive or an entheogen. The Harpies were imagined to materialize as a whirlwind and to snatch people away, hence their name a 'Snatchers,' sometimes demonized as ornithological human hybrids, but also portrayed as beautiful women with wings. Like the fairies of Celtic lore, they were accused of stealing people away to their netherworld realm on a blast of wind, called an elfin eddy. A person was apt suddenly to disappear from sight in this world, in a fit of rapture, possessed in the clutches of these ravishing Harpy virgins. Hence, a visitation by the Harpies had orgasmic connotations of shamanic ecstasy, which is the common metaphor in Greek for mystical vision. The edible tables are the folkloric motif of the fairy tables, a loathsome slimy red tabletop, supported on a pedestal and spread with the dainty morsels of the scabby white remnants of the *Amanita*'s shattered universal veil, and swarming with the flies attracted to the contaminated feast. The fairies also scatter round breads about the ground, but the food is cursed and should never be eaten, except in the times of severest hunger. Conversely, a piece of bread thrown on the ground was the surest amulet to ward off a blast of the dangerous kidnapping wind.

Virgil saves his hero by a ruse of paternal piety from partaking in the ecstatic feasting required for the primordial encounter with the new land that he as founder must settle. Without knowing what he is doing, he follows the precise directions of his putative divine grandfather Jupiter/Zeus (the father of his mother Venus) as delivered from the oracle at Dodona, spreading rounds of primitive spelt bread upon the ground and heaping them with wild fruits, and after they have eaten them, the curse becomes merely a joke, as his son Iulus (the supposed ancestor of Julius Caesar) notes that they have eaten their tables. The only way to thwart a true prophecy is to enact it in some other way, and this Aeneas, pious as ever, has blindly done. There was no shortage of proper tables for use as equipment aboard his ships and thus the novel banqueting protocol was merely his uncomprehending adherence to the directive from Dodona.

Mithraism

The *haoma* sacrament was directly introduced into Rome in 69 BCE, just the year after the probable date of Virgil's birth, when the general Pompey took the Cilician pirates captive to the city of Rome. As a young man, Virgil probably knew of Mithraism, and a hundred years later, by the time of Nero, there were already well-established Mithraic lodges in the city for him to be the first of the almost continuous succession of emperors to be initiated in what was called 'magical dinners' (Ruck *et al*., 2011). Earlier versions of the initiation lodges were already prevalent in Anatolia, traceable back to well before the sixth century. The lodges were small subterranean chambers, preferably with a natural source of water, imitating a cave in which the hero Mithras slaughtered the Cosmic Bull, and the initiates, like Pythagoras, experienced a transcendent journey of the spirit to the rim of the universe. The lodges spread throughout the Empire in Europe, Britain, North Africa, and the Near East, although rare in Greece since they already had similar rites associated with Perseus. It indoctrinated most of the emperors, and the army and male bureaucrats who administered the Empire, until the conversion of Constantine, who was himself probably an initiate. The seven sacraments of the Christian Church are modeled on the seven stages of the Mithraic rite. The sixth stage elevated the candidate to the persona of the Apollonian Solar Charioteer as the adoptive son of the Father, which was the seventh and highest grade. As adoptive son, he was pure from the Gnostic contamination of physical conception, correlating with the Platonic ideal of spiritual paternity, a role that Christ also played in the heresy of Adoptionism. Hence, women were excluded from membership in the lodges. It was the Charioteer's role to be offered as symbolic victim to usher in the final apocalyptic Conflagration, after which the cosmos would be renewed as the new age. This is obviously similar to Christ as sacrificial mediator of his Father with humankind, and the Second Coming, which was originally expected within the lifespan of the first disciples.

In Mithraism, the Solar Charioteer and the Father ratified their relationship by a banquet upon the meat of the Cosmic Bull in the form a loaf of bread, marked with a chiastic cross, representing the solar ellipse, which is segmented by the astrological glyphs of the zodiac, intersecting with the celestial equatorial belt, indicating that the bread was meant to symbolize the cosmic sphere, as something heaved up by the fungal leavening to form the heavens. The loaf of sacramental bread thus has the same symbolic relationship to the cosmos as the prognostic liver. The chiastic design was copied in the bread of the early Communion rite of Christianity. Virgil's 'fatal crusts' of round bread in the episode of the edible tables were similarly marked into quadrants, suggesting that the poet may have been a Mithraic initiate. The cross comes to signify the zodiacal marker for the sign that will preside over the new age occasioned by the precession of the equinoxes caused by the wobble in the Earth's axis, ushering in a new age about every 26,000 years. The cross thus also marks the time for the cosmic sacrifice, as time moved from the constellation of the zodiacal Bull Taurus to the Age of the Lamb Aries, and thus it also had implications for the cross of the Crucifixion. Aries as the Lamb also added new spiritual implications to the interpretation of the mythological tradition of Jason and the quest for the Golden Fleece of the sacrificed ram (Ruck, 2015a).

Raven's Bread

The Mithraic bread was served to the two banqueters by the Raven, which was the lowest and first grade in the initiation, representing the sinful entrapment of spirit in matter, which would be released in the final stages of initiation. At the second stage, the initiate became the bride of the Father. The bread was Raven's bread, the common metaphor for the *Amanita muscaria* (Klapp, 2013), and called a bread by analogy to the spongy expansion of the fungus, the microcosmic version of the universe, to which it offered transcendent return. The symbol of the Raven was the chalice, which suggests that the Raven's bread was the fortifying agent in the sacramental potion, as in the wine of Maron, and the drink was metaphorically a cup of bull's blood. Sometimes the Raven is shown handing the drink to the two banqueters in a bullhorn *rhyton* vessel, reinforcing the metaphor. It also was supposedly skewered bits of the bull's roasted meat, although depictions show the Raven pecking at the meat, with the skewer held vertically above the clasped hands of the Father and his adoptive son, above the burning fire in the brazier, which would be quite unlikely in reality. However, the skewered meat presents a credible likeness to the mushroom for which it is the metaphor. Significantly, the sixth grade in the initiatory sequence was Perses, the Persian, who was the 'keeper of the fruits,' and his name suggests Perseus, who was the father of Perses, the etiological founder of the Persian people. The Mithraeum lodges were not banqueting clubs, nor are the tiny confined subterranean chambers appropriate venues for slaughtering a bull, disposing of the copious flood of its ensuing blood, roasting its butchered flesh, and serving an ordinary dinner. Other aspects of the ritual activity involved miming with animal masks, sexual humiliation, physical intimidation, and rowdy hazing, as is a common feature in initiatory admission to secret societies.

The tauroctony or 'bull slaughter' in Mithraism was a mythical event, often mistakenly equated to the *Taurobolium*, in which an actual bull was slaughtered on a grating above the initiate who was bathed in its blood. This was a rite in the religion of Cybele as imported into Rome in the third century BCE as the Great Phrygian Mother, in which the initiates represented Attis and practiced self-castration in their frenzied ecstasy. Attis was traditionally represented wearing the Phrygian cap and the frenzy of the rite may well have involved a similar fungal intoxicant. The remains of an ancient *Taurobolium* lie beneath the Vatican, but it was not the tauroctony of Zoroastrian Mithraism. Churches, however, were often also built above Mithraea, as in the Church of San Clemente, near the Roman Coliseum.

Soldiers of Christ

The Mithraea resemble drug dens, rather than banqueting chambers, sometimes with other rooms for rituals and indoctrination. Various psychoactive substances were probably involved in the successive grades of initiation, and the chamber was probably fumigated with incenses like cannabis, as seems to have the more ancient custom with the *haoma* cult indicated at archaeological sites, but the role of the *Amanita muscaria* as the bread served by the Raven in the religion explains to a large measure how the mushroom cult was promulgated throughout Europe as the supposed cohesive civilizing force until its official suppression by the Conversion. The third grade of Mithraism, however, was the Soldier, enlisted for the cosmic battle, and it seems likely that the concept of a brotherhood of warriors and its ritual indoctrination, like other aspects of Mithraism, was expropriated by Christianity, as was clearly the case with the sacrament of Confirmation, which made a Christian a soldier of Christ, instead of Mithras.

The *haoma* sacrament probably was transferred to groups like the Knights Templar and medieval knighthood. The ancient wolf sacrament continued, moreover, among the Nordic peoples and persisted in their berserker rites even after their conversion. It also continued in the Eastern Church among Gnostic sects like Manichaeism, whose Persian prophet Mani arouse in third-century Mesopotamia, incorporating dualistic Gnostic elements of Zoroastrian religion with Christianity, and which spread to southern Europe in the tenth century and persisted in China until the nineteenth, where they were noted for their ecstatic rituals and their fondness for red mushrooms. Where Mithraism in the Middle East persisted in fringe peoples only marginally assimilated into Islam, Mithras was still celebrated as late as the twentieth century with a sacrament of the *Amanita muscaria* (Ruck *et al.*, 2011). There were also numerous sects of early Christianity with a similar Gnostic dualism and a fungal sacrament which were suppressed as heresies even before the Conversion. In the mid first century, Paul reproached his congregation in Corinth for practicing the Eucharist in a manner that had caused the sickness and death of quite a few of their members (Ruck *et al.*, 2013; Ruck, 2015a). A fourth-century Christian sanctuary uncovered beneath the eleventh-century Basilica of Aquileia north of Venice preserves a mosaic floor ornamented with baskets of *Amanita*s and snails. The chamber was an early Christian meeting hall or agape and the floor decoration is plausibly interpreted as a depiction of the Eucharist (Fabbro, 1996). As recent as the end of the sixteenth century, an epistle of a monk on the Holy Mount of Athos details a miracle: that the Eucharist altar grew into the shape of 'a holy mushroom with its cap in the shape of forty apples which ascended over the holy table and overshadowed the entire sanctuary.' Those found infirm in the cloister who tasted of the holy mushroom were healed (Goldblatt, 1994).

The twelfth-century Basilica of San Vicente in Ávila replaced a nearby Mithraeum. It blatantly displays the mushroom as the food of the celestial banquet on the tympanum of its portal, with the portal itself, as always, indicating a distinctly fungal design, with the opening, either with or without a dividing mullein, suggesting the stipe supporting the hemisphere of the tympanum as its cap (Ruck, 2006). The tympanum itself is half of the almond-shape or *mandorla* that traditionally represents the vulva of the Goddess, assimilated into Christianity as the gateway to Paradise. Only the elite, who reserved for themselves the direct contact with deity, would recognize this fungal design as they passed through the portal to sacred space, but it surely was intentional, an indication of a heretical version of the Eucharist that perpetuated a sacred plant involved in the pagan cults that the Church Dominant had suppressed.

Old Europe

It was, moreover, only the urban centers under direct control of the bureaucracies and the Church that converted. The old religions continued in the countryside and villages (*pagus*), where the country folk or 'peasants' (*pagani*) preserved many aspects of pre-Christian tradition, called Paganism after them. The mushroom cult, in various forms, was one of these, not only as remnants of Mithraism, but also apparently because there were indigenous sources as well, predating the Roman Empire and dating back even to before the Indo-European migrations of the mid second millennium BCE. Shamanism involving mushrooms survived into the twentieth century in places like Lithuania and Iceland, the latter converting to Christianity only in the tenth century and then mainly to improve economic integration with the European mainland (Nichols, 2000). Rock art from the Neolithic (sixth millennium BCE) in Catalonian Spain at Selva Pasquale depicts mushrooms, probably *Psilocybe hispanica*, as dancing anthropomorphisms, with a fresco of a bull delineating in greater detail a natural likeness suggested by the stone surface (Akers *et al.*, 2011). It forms an element in a total rock configuration aligned and oriented as a solstitial marker and the site was clearly involved in sacral rites. Similar rock paintings in northern Africa, perhaps as old as the eighth millennium BCE depict shamans consubstantial with a fungal identity, as well zoomorphic transmogrification into an antlered deer and bees. Some depictions suggest consubstantial anthropomorphisms of *Amanita muscaria*. Rock art of the San people of South Africa, and elsewhere, also indicates probable psychoactive agents for accessing shamanic rapture. The similarity of metaphors with traditions from Classical antiquity and with those documented in the New World suggests that the spirit supposedly resident in the entheogen communicates with the shaman, as is commonly claimed.

Issenheim Altarpiece

Certain works of European art from the Renaissance suggest that a mushroom cult continued in elite societies of Christians. The most defining characteristic of the *Amanita muscaria* is the persistence of its potentiated toxin as a metabolite in urine, perhaps reflected in the ancient tradition of the second birth of Dionysus from the groin of his father. Between 1512 and 1516, Matthias Grünewald painted an altarpiece for the monastic hospital at Issenheim, in Alsace, now displayed in the Unterlinden Museum at Colmar (Ruck *et al.*, 2007). The monastery claimed Saint Anthony of Egypt as patron and it tended patients suffering from the affliction of ergotism named Saint Anthony's fire after the saint. Prominent in its complex of images presented in three layers of unfolding panels is the depiction of the divine Infant's *vase de nuit* or chamber pot, above which is a transparent crystal vessel of ornate Persian design like a monstrance containing the amber fluid of the Baby's urine, above which, the Virgin, in heaven amid a consort of angelic and demonic musicians appears, wearing a crown of flames surrounded by an orange nimbus, as she blesses the sacrament. The risen Christ is depicted in the adjacent panel to the right rising from the tomb, surrounded by the same nimbus, his white legs trailing the white burial shroud and presenting a credible anthropomorphism of the *Amanita muscaria*. At the innermost third level of presentation, which was visible only on the saint's day and for special rituals, two scenes with Saint Anthony, patron of mushrooms-seekers, flank a shrine with wood carvings. On the right, demons torment the saint. A poor deformed man, afflicted with the pustules of the disease, clutches a bible beside a tree trunk that is host for fungi. On the left, the saint is depicted entertaining a visit from the Hermit Paul of Thebes. For their meagre banquet, a Raven descends delivering two bits of Raven's bread, whereas ordinarily the saint was sustained by a single daily piece of the bread from the Raven. Beneath the Raven, a deer approaches, about to graze on some of the mushrooms for which the *Cervidae* are notably fond, including the *Amanita*'s metabolite in urine. Another deer rests between Anthony and Paul, engaged in conversation, probably on the subject of their miraculous nourishment in the desert. The motif of the deer hunt in medieval and Renaissance art probably always had the gathering of the mushroom as its referent. Both Saints Hubertus and Eustatius experienced a vision of the Christ suspended between the antlers of a stag while out on the hunt.

Bacchanal of the Andrians

Between the years 1523 and 1526, while in residence with the Duke, Titian painted *The Bacchanal of the Andrians* for Alfonso I d'Este to decorate the antechamber to the bedroom he shared with his second wife, Lucrezia Borgia, daughter of Pope Alexander VI (Heinrich, 1995; Ruck *et al*., 2007; Ruck *et al*., 2012). The theme of the antechamber's art was depictions of ancient orgies or revels. The painting is now in the Museum of the Prado in Madrid. There are two levels of reality in the depicted scene, the islanders of the Greek isle of Andros, who held an annual revel to celebrate the arrival of the god Dionysus, at which time the rivers of the island flowed with wine. The other level of reality is the materialization of the god's nude male attendants, scooping up the wine from the river, drinking it, and carting it away. Shockingly nude in the corner of the right foreground reclines a voluptuous female, who is Ariadne, the bride of the god, exposing her genital area. Lucretia may has served as model for Ariadne. Beside her is the god, Dionysus-Bacchus, but incongruously as a child, lifting his shirt to urinate in the river's stream, his penis and her vulva adjacent. The two levels of reality appear unaware of the other's presence, except for two figures. One from the mythical entourage is pouring the liquid from a pitcher into the uplifted saucer held by a woman, unaware of him behind her, as she reclines on the bank of the stream, totally engrossed in conversation with her neighbor. Beside her another from the mythical entourage is looking at a crystal pitcher held aloft by an islander in a group of Andrians dancing about a tree, in whose branches sits a large peacock, emblematic of the changes of color effected through alchemical transmutation, thus identifying the urine from the river's stream as the golden elixir of immortality. The two crystal pitchers mark the nexus where one reality impinges on the other, suggesting that the liquid content is visionary or hallucinatory.

In front of the women in conversation by the riverbank is a piece of musical notation; the music is a perpetual canon or round whose text reads, "He who drinks but once and doesn't drink it again knows not true drinking." The reference is clearly to the child's pee, round and round, which is being poured into her cup and which appears again in the monstrance of the crystal pitcher. Another of the males from the mythical entourage behind the two conversing women is looking directly at the peeing child and knows full well that it is divine urine that he is scooping from the stream. The source of the river appears personified as a river god in the distant right above the reclining Ariadne. He is a white-bearded man, apparently passed out, the river's fountain issuing from between the legs of his nude body, ostensibly from his genitals as urine. Equally unconscious and in the same pose is the nude Ariadne, he and she probably adding to the urine flowing in the stream. Beside the peeing god is an overturned large stemmed golden chalice, of probably ecclesiastical design, suggesting that the alchemical elixir of transmuted pee is the Eucharist.

The peeing homunculus or little man was a motif in alchemical depictions, releasing his urine within the alembic containing the potion of transcendence, and the alchemists riddled that the so-called stone that conferred the knowledge of philosophers was actually something despicable, common and everyday, tossed out as offal into the streets. Since both Grünewald and Titian were in residence for an extended period as they accomplished their patrons' commission, it is difficult to imagine that the artists had not partaken of the sacrament encoded in their paintings.

Ghent Altarpiece

In 1432, Jan van Eyck completed the Ghent Altarpiece (titled the *Adoration of the Mystic Lamb*) that his brother Hubert had begun but left unfinished upon his death in 1426 as a commission from Duke Philip the Good of Burgundy, to coincide with the birth of the Duke's son from his third wife Isabella of Portugal and the inauguration of the warrior brotherhood of knights called the Order of the Golden Fleece (Ruck and Hoffman, 2012). The Duke was a great enthusiast of alchemy. Here in the outer level of the polyptych altarpiece, the urine appears in a transparent flask catching the light of the sun on a window ledge of the bedchamber where the Virgin, already pregnant, is receiving the news of the Annunciation. The dove of the Annunciation descending above her head was the traditional Flemish design for the ciborium containing the bread of the Eucharist, and the central panel of this outer level of presentation depicts the sacristy chamber where the priest prepared to administer the Communion.

The flask of urine is proof that the Virgin is indeed pregnant. Ancient and medieval doctors studied the effluents of the body as a clue to the inner workings of the patient's physical condition, and the urine as the most copious was of particular significance. Some doctors, called 'piss prophets,' claimed that they could determine pregnancy from the color of the urine, and there are published color charts that they employed as a guide. The flask of urine was also a metaphor elaborated by Saint Bernard and others to explain how the Virgin could conceive and yet remain *virgo intacta*, with unbroken hymen. It was like a beam of sunlight penetrating the glass of a flask, imparting its color to the liquid, but leaving the vessel intact.

The Altarpiece originally was fitted with a mechanism of clockwork that daily opened the panels of the outer presentation, accompanied with mechanical music, to reveal the inner presentation for the Eucharist. Here the same model who served for the pregnant Virgin is portrayed on the right upper panel as the shockingly nude Eve, already pregnant, and also in the central panel as the Virgin now elevated to her role as the *Regina Coeli*, Queen of Heaven. She is enthroned beside Jesus, now her consort as the Almighty. He is an astonishingly handsome young man, and he is also the same model who served for the portrayal in the upper left panel opposite Eve for the portrait of the equally shockingly nude Adam, about to walk out of his niche to assume his future role as mate of Eve's redemption in the persona of the *Regina Coeli*.

The divine couple sit enthroned beside the Baptist, the original patron of the Church, to witness in the scene below them the marriage feast of the Mystic Lamb. The scene is the Apocalyptic Revelation of John of the stream flowing through the New Jerusalem, when he rescinds the prohibition of the Garden of Eden and invites all to eat freely now of the forbidden fruit of the knowledge of good and evil that will make man like onto God and his angels. The Lamb stands upon an altar in a flowering meadow, surrounded by the *Arma Christi*, the instruments of the Crucifixion. The Lamb's Blood spurts from His body, as the source for an elaborate fountain that is the source of the river. The basin of the fountain contains gemstones and coral. Water passing over magical stones was thought to absorb their potency. The coral was supposedly derived from the blood that dripped from the decapitated Gorgon Medusa, from which sprouted spongy mushrooms that only turned Petrified as coral when immersed in water. In scientific nomenclature coral belongs to the family of the *Gorgonacea* and its name as 'coral' derives from ancient Greek, where it is the diminutive for the *kore* or pubescent girl, probably linking the blood to the menses. The esteem for coral is of the greatest antiquity, traceable back to the Zoroastrian Magi and the Vedic Brahman priests, who endowed it with sacred properties, probably since it was metaphoric for the *haoma* and Soma sacrament. As Petrified, it was the original for the alchemical *lapis philosophorum* or 'stone of the philosophers.' In medieval symbolism, it was known as the *lapis Christi*, the Petrified Blood of Christ.

To the left of the central panel of the Mystic Lamb, the Duke is portrayed amid a troupe of knights as the Soldiers of Christ, approaching the sacred meadow of the fountain river, about to lay claim to sovereignty over the New Jerusalem. Their path is strewn with gemstones and corals. The matching panel opposite on the left depicts Saint Anthony and the Hermit Paul, probably still discussing the miracle of the Raven's bread, as they, too, approach the Mystic Lamb. Anthony carries a rosary of coral beads, and several gemstones lie in his path at the base of the tau-cross he carries as a walking stick, prodding the ground as a mushroom-seeker looking for truffles, which folkloric tradition ever since antiquity considered the Petrified urine of a stag. Anthony was also the patron of pigs, which were employed for scenting out the presence of the underground mushrooms. The sows are drawn to them by the noticeable scent of male urine, androstenol, which the truffles produce. Customarily they are hunted *avec la mouche*, 'with the fly,' as is the phrase, because like the *Amanita muscaria* they attract swarms of flies. Islamic tradition, allegedly going back to Muhammad, claimed that the truffle had an effect on the eyes, which implies alteration of vision.

On the outer presentation, the Baptist is depicted in grisaille as a statue holding the cup of poison to which he was immune, its toxicity indicated by the serpent lifting its head from the vessel. In the inner presentation, the spigot on the fountain is a grotesquerie that is the face of the serpent in the cup of poison. An inscription on the rim of the fountain identifies its water as *Aqua Vitae*, the 'water of life,' which by this date had been already for about a hundred years been labeled as the alchemical distillate.

The Altarpiece identifies the blood of the Lamb pouring over the corals and gemstones as the blood that flowed from the side of Christ, when pierced with the lance of the Roman centurion Longinus, which is depicted among the instruments of the Crucifixion. The Duke actually had a phial of the Petrified Holy Blood, enclosed and sealed within a crystal tube, that was given to his ancestor Sybilla of Anjou on Christmas of 1148 in Jerusalem, a holy relic allegedly discovered by the Knights Templar, and when she touched it she had a vision of the New Jerusalem, which was going to be the city of Bruges in Flanders. It is preserved in Bourg Square in the city of Bruges, and every Friday up until 1325, and then intermittently thereafter, many witnesses claimed that the dried blood liquefied, sometimes dripping as newly shed blood from the reliquary. By this tradition, the story of the Altarpiece reaches back to Philip's twelfth-century ancestor, Philip of Alsace, the Count of Flanders, and the tale of the Grail commissioned from the poet Chrétien de Troyes.

The Garden of Eden

Wasson continued to suspect that confirmation of his identification of Soma would be found in Christianity. When it came in the form of John Allegro's *Sacred Mushroom and the Cross* (1970), he didn't recognize it, much to Allegro's disappointment. As an amateur scholar, Wasson customarily deferred to the opinion of professional authorities. Allegro, the linguist and scholar of the Dead Sea Scrolls, an academic with impeccable credentials in ancient Classical and Near and Middle Eastern languages, had already published several books; he had read Wasson's writings and appropriately acknowledged them, knew of his Mexican discoveries, and accepted his identification of Soma as the fly-agaric. Wasson, like all Allegro's critics, would have found the linguistic documentation beyond his expertise. He asked a rabbi and a Catholic Monseigneur in his acquaintance their opinion and they assured him that there wasn't a word of truth in it.

The Wondrous Mushroom: Mycolatry in Mesoamerica was the last book that Wasson saw through to publication (Wasson, 1980). By this time, he had become quite convinced that the experience that had occurred with María Sabina was religious in essence. His later work with the Anishinaabeg (Ojibwe) shaman Keewaydinoquay (Peschel) demonstrated how widespread or universal was the role of sacred visionary substances in the origin and practice of religion (Keewaydinoquay, 1984), requiring a new designation devoid of the cultural environment of the psychedelic era. For this, he endorsed entheogen: "'God within us,' those plant substances that, when ingested, give one a divine experience. The new word notably captures the rich cultural resonances evoked by the substances, many of them fungal, over vast areas of the world in proto- and prehistory."

In *Persephone*'s *Quest*, Wasson's final book, published just after his death in 1986, he proclaimed by its subtitle that he had concluded that entheogens were the origin of religion (Wasson *et al.*, 1986). The first chapter was Wasson's final summation. "As I am nearing the end of my days," he began, "I will draw up an account of our mushroom quest." Here he came back to the question of a mushroom cult in Christianity. "I once said that there was no mushroom in the Bible," he wrote. "I was wrong.... I hold that the fruit of the Tree of Knowledge of Good and Evil was Soma, was the *kakuljá*, was *Amanita muscaria*, was the Nameless Mushroom of the English-speaking people."

References

1. Akers BP, Ruiz JF, Piper A and Ruck CAP. A prehistoric mural in Spain depicting neurotropic *Psilocybe* mushrooms? Economic Botany 2011; 65(2): 121-128.
2. Bennett C. Cannabis and the soma solution, Trine Day, Waterville., 2007.
3. Bonnefoy Y. Greek and Egyptian mythology, University of Chicago Press, Chicago. 1991.Translated under the direction of Wendy Doniger from the French, Dictionnaire de mythologies et des religions des sociétés traditionnelles et du monde antique, 1981, Flammarion, Paris. 1991.
4. Burkert W. Ancient mystery cults. Harvard University Press, Cambridge., 1987.
5. Cooper JH. Etruscan and Lemnian appear to be twigs of the Pelasgian branch of the Indo-European language. Mankind quarterly 2000; 40(4): 421-434.
6. Cosmopoulos M. Bronze age Eleusis and the origins of the Eleusinian mysteries, Cambridge University Press, Cambridge., 2015.
7. Fabbro F. Did early Christians use hallucinogenic mushroom? Archaeological evidence. 1996.
8. http://distelrath.tripod.com/fabbro.htm Accessed date: 4 December 2015.
9. Flattery DS and Schwartz M. The botanical identity of the Indo-Iranian sacred hallucinogen 'Soma" and its legacy in religion, language and Middle Eastern folklore, The University of California Press, Berkeley., 1989
10. Geniusz WM. Our knowledge is not primitive: decolonizing botanical Anishinaabe teachings (Iroquois and their neighbors, Syracuse University Press, Syracuse., 2009.
11. Gershenson DE. Apollo the wolf god, Journal of Indo-European monograph series, no. 8, University of Michigan, Institute for the Study of man, Ann Arbor., 1991.
12. Goldblatt H. Notes on the text of Ivan Vysens'kyj's "Epistle to the renegade bishops. Harvard Ukrainian Studies 1994; 18 (1-2): 47-75.

13. Grummond N, Thomson de. Etruscan myth, and legend, University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia., 2006.
14. Heinrich C. Strange fruit: alchemy, religion, and magical foods, a speculative history. Bloomsbury, London., 1995.
15. Hillman D. The chemical muse: drug use and the roots of Western civilization, St. Martins / Thomas Dunne Books, New York., 2008.
16. Keewaydinoquay (Peschal), with an introduction by Wasson, R.G. The miswedo in Anishinaabeg Life, Stamperia Valdonega, Verona. From the hand-corrected master proof of the unpublished printing, of which only five copies exist, sequestered from access in the Wasson Archives, Harvard Library., 1984.
17. Kiotsekoglou S. Stone mushrooms of Thracian megalithic sanctuaries. Ruck, C.A.P., ed., Dionysus in Thrace: ancient entheogenic themes in the mythology and archaeology of Northern Greece, Bulgaria, and Turkey, Regent Press, Berkeley, 2014; pp. 241-256.
18. Klapp E. Raven's bread and other manifestations of fly agaric in Classical and biblical literature. Rush, J.A., ed., Etheogens and the development of culture: the anthropology and neurobiology of ecstatic experience, Atlantic Books, Berkeley, 2013; pp. 333-342.
19. Klöckner A. Getting in contact: concepts of human - divine encounter in Classical Greek art. Bremmer J.N., and Erskine, A., eds., The gods of ancient Greece: identities and transformations, Edinburgh University Press, Edinburgh, 2010; pp. 106-125.
20. Kramrisch S. The mahavira vessel and the plant putika.' Journal of the American Oriental Society 1975; 95 (2): 222-235.
21. Kurtz D and Boardman J. Greek burial customs, Thames and Hudson, London., 1971.
22. Lehmann K. Samothrace: a guide to the excavations and the Museum. Thessaloniki: Institute of Fine Arts, New York University, Thessaloniki., 1954.
23. Levi-Strauss C. Tristes tropiques, Librairie Plon, Paris.,1955.
24. Marchand M and Boudier M. 'La fresque de Plaincourault (Indre). Bulletin Société Mycologique Française 1911; 27: 31-33.
25. Markov V. The ancient Thracian megalithic sanctuary 'Markov Kamak' at Tsarev Peak in Rila Mountain: semantic and functional analysis. Geoarchaeology and archaeomineralogy. Publishing House 'St. Ivan Rilski,' 2008; pp. 177-179.
26. Markov V., Archaic mushroom monuments and Bulgarian folkloric motifs. Ruck, C.A.P., ed., Dionysus in Thrace: ancient entheogenic themes in the mythology and archaeology of Northern Greece, Bulgaria, and Turkey, Regent Press, Berkeley, 2014; pp. 183-198.
27. Maurizio L. Classical mythology in context, Oxford University Press, Oxford., 2016.
28. Nichols BM. The fly-agaric and early Scandinavian religion. Eleusis: Journal of Psychoactive Plants and Compounds, new series 2000; 4: 87-118.
29. Petridou G., Blessed is he who has seen': the power of ritual viewing and ritual framing in Eleusis,' Helios 2013; 40(1- 2): 309-341.
30. Piper A. The milk of the goat Heidrun: an investigation into the sacramental use of psychoactive milk and meat. Rush, J.A., ed., Etheogens and the development of culture: the anthropology and neurobiology of ecstatic experience, Atlantic Books, Berkeley, 2013; pp. 211-278.
31. Ritter M. Ancient wine cellar unearthed in Israel shows Canaanites enjoyed a sophisticated drink,' New York: AP..2013.http://www.huffingtonpost.com/2013/11/22/ ancient-wine-cellar-israel_n_4323848.html [3 December 2015].
32. Ruck CAP. On the sacred names of Iamos and Ion: ethnobotanical referents in the hero's parentage. Classical Journal 1976; 71(3): 235-252.
33. Ruck CAP., Documentation. Wasson, R.G., Hofmann, A., and Ruck, C.A.P., The road to Eleusis: unveiling the secret of the mysteries, Harcourt Brace Jovanovich, New York.1978. Reprint, Hermes Press, Los Angels, 1998. Reprint, Atlantic Books, Berkeley, 1978; pp. 85-136.
34. Ruck CAP., Mushrooms and philosophers. Journal of Ethnopharmacology 1981; 4: 179-205.
35. Ruck CAP. Sacred mushrooms of the goddess: secrets of Eleusis, Berkeley: Ronin Publishing, Berkeley., 2006.
36. Ruck CAP. Fungus redivivus: new light on the mushroom controversy. Allegro, J. Sacred mushroom and the cross: a study of the nature and origins of Christianity within the fertility cults of the ancient Near East, Hodder and Stoughton, London, 1970. Reprint, Gnostic Media Research and Publishing, Los Angeles, 2010; pp. 351-381.
37. Ruck CAP. The great god Sabazios and the crab dance in Athens. The stone mushrooms of Thrace, EKATAIOS, Alexandroupoli, 2012; pp. 193-220.
38. Ruck CAP. The great gods of Samothrace and the cult of the little people. Regent Press, Berkeley. 2015a
39. Ruck CAP. The son conceived in Drunkenness: magical plants in the world of the Greek hero. Nemi / Pen and Anvil Press, Boston., 2015b.
40. Ruck CAP and Hoffman A. Entheogens, myth, and human consciousness, Ronin Publishing, Berkeley., 2013.
41. Ruck CAP and Hoffman MA. The effluents of deity: alchemy and psychoactive sacraments in medieval and renaissance art, Carolina Academic Press, Durham., 2012.
42. Ruck CAP and Larner R. Virgil's edible tables. Rush, J.A., ed., Etheogens and the development of culture: the anthropology and neurobiology of ecstatic experience, Atlantic Books, Berkeley, 2013; pp. 387-450.
43. Ruck CAP., ed., Dionysus in Thrace: ancient entheogenic themes in the mythology and archaeology of Northern Greece, Bulgaria, and Turkey. Regent Press, Berkeley., 2014.
44. Ruck CAP, Hoffman MA and González Celdrán JA. Mushrooms, myth, and Mithras: the drug cult that civilized Europe. City Lights Books San Francisco., 2014.
45. Ruck CAP, Staples BD, González Celdán J and Hoffman MA. The hidden world: survival of pagan shamanic themes in European fairytales. Carolina Academic Press, Durham., 2007.
46. Ruck CAP, Staples D and Heinrich C. The apples of Apollo: pagan and Christian Mysteries of the Eucharist. Carolina Academic Press, Durham., 2001.
47. Ruck CAP. The offering from the Hyperboreans. Journal of Ethnopharmacology 1983; 8: 177-207.
48. Samorini G. Mushroom effigies in world archaeology: from rock art to mushroom-stones. The stone mushrooms of Thrace, EKATAIOS, Alexandroupoli, 2012; pp. 16-44.

49. Sarianidi V. Necropolis of Gonur. Kapon Editions, Athens., 2007.
50. Spess DL. Soma: the divine hallucinogen. Inner Traditions / Bear and Co, Rochester., 2000.
51. Toporov VN. On the seminotics of mythological conceptions about mushrooms. Semiotica 1985; 53(4): 295-357.
52. Waites M. The meaning of the 'dokana'. American Journal of Archaeology 1995; 23(1): 1-18.
53. Wasson RG. Soma: divine mushroom of immortality. Harcourt Brace Jovanovich, New York., 1968.
54. Wasson RG. The wondrous mushroom: mycolatry in Mesoamerica. McGraw-Hill Company, New York., 1980.
55. Wasson RG. Persephone's quest,' Wasson, R. G., Kramrisch, S., Ott, J., and Ruck, C.A.P., Persephone's quest: entheogens and the origins of religion, Yale University Press, New Haven, 1986; pp. 17-81.
56. Wasson RG and Doniger (O'Flaherty) W. The last meal of the Buddha. Journal of the American Oriental Society 1982; 102(4): 591-603.
57. Wasson RG, Hofmann A and Ruck CAP. The road to Eleusis: unveiling the secret of the mysteries. Harcourt Brace Jovanovich, New York. Reprint, Hermes Press, Los Angeles, 1998. Reprint, Atlantic Books, Berkeley, 2008.
58. Wasson VP and Wasson RG. Mushrooms, Russia, and history, Pantheon Books, New York., 1957.
59. Webster P, Perrine D and Ruck CAP. 'Mixing the kykeon'. Eleusis: Journal of Psychoactive Plants and Compounds, new series 2000; 4: 55-86.

Traditional knowledge about mushrooms in a Nahua community in the state of Tlaxcala, México

by

A. Montoya[1], O. Hernández-Totomoch, A. Estrada-Torres, A. Kong, J. Caballero

Mycologia, 95(5), 2003, pp. 793-806.

Accepted for publication February 24, 2003.

© 2003 by The Mycological Society of America

original text:
https://www.researchgate.net/profile/Adriana_Montoya2/publication/49674837_Traditional_Knowledge_about_Mushrooms_in_a_Nahua_Community_in_the_State_of_Tlaxcala_Mexico/links/55f03b1708ae0af8ee1c884c/Traditional-Knowledge-about-Mushrooms-in-a-Nahua-Community-in-the-State-of-Tlaxcala-Mexico.pdf
backup source:
http://www.psilosophy.info/resources/Traditional-Knowledge-about-Mushrooms-in-a-Nahua-Community-in-the-State-of-Tlaxcala-Mexico.pdf

A. Montoya[1]
O. Hernández-Totomoch
A. Estrada-Torres
A. Kong
Centro de Investigaciones en Ciencias Biológicas,
Universidad Autónoma de Tlaxcala Km 10.5
Autopista San Martín Texmelucan-Tlaxcala,
Ixtacuixtla, Tlaxcala, C.P. 90120, México

J. Caballero
Jardín Botánico, Instituto de Biología, Universidad
Nacional Autónoma de México Apartado Postal
70-614, México, D.F. 04510, México

[1] Corresponding author. E-mail: ametnomicol@hotmail.com

Table of Contents:

- **Abstract**
- **Introduction**
- **Materials and methods**
  - Field of study
- **Results**
  - Collection of mushrooms
  - Morphology
  - Categories of mushroom use
  - Food
  - Commerce
  - Insecticide
  - Medicine
  - Classification criteria
  - Hot-cold classification
  - Classification by use
  - The growing season
  - Data on where mushrooms grow
  - Frequency of mention
- **Discussion**
- **Acknowledgments**
- **Literature cited**

Abstract

This paper describes the traditional mycological knowledge of the Nahua of San Isidro Buensuceso, on the slopes of La Malinche Volcano National Park, in the state of Tlaxcala, México. The results described in this paper were obtained through interviews with villagers selected at random; a freelisting technique was used to determine the cultural significance of the mushrooms of the region. A total of 48 species, which had 65 Náhuatl names and 40 in Spanish, were identified. Although San Isidro villagers consider mushrooms to be a natural resource mainly used for food, they also use them for medicine, insecticides and trade. This paper presents traditional information on the morphology, ecology, fenology and consistency of the mushrooms found around San Isidro. It proposes that, from a cultural perspective, *Gomphus flocossus*, *Ramaria* spp. and *Boletus* spp. are the most important species of the region.

Keywords: Ethnomycology, La Malinche National Park, Nahua, traditional uses of fungi, wild mushrooms

Introduction

The Nahua are the most numerous and widely distributed ethnic group in central México. Nevertheless, few academic studies have focused on describing the group's traditional knowledge of mushrooms. Nahua used fungi during rituals, according to historic record. Nahua prehispanic poetry describes fungi consumption in religious ceremonies. The fungi used in those ceremonies commonly were known as "xochinancatl" or "*teonanácatl*" (Wasson 1983). *Psilocybe aztecorum* Heim, known as "niños," "niñitos" or, in Náhuatl, "apipiltzin," currently is used in religious rites in San Pedro Nexapa, on Volcan Popocátepetl. *Psilocybe muliercula* Sing. & Smith is a hallucinogenic mushroom used by the Nahua in Tenango del Valle, in the state of México (Guzmán 1983).

Although it is not known whether Nahua ceremonial use has endured elsewhere, other uses and aspects of the traditional knowledge have been studied. Dubovoy (1968) analyzed various indigenous codices and presented evidence that, in the past, the Nahua used mushrooms for food. Martín del Campo (1968) translated Náhuatl mushroom names registered by Herrera and Guzmán (1961), explained their meaning and offered synonyms and ecological information. Guzmán *et al*. (1975) studied a specimen of *Ganoderma lobatum* (Schw.) Atk., which is displayed in a place of honor in a church in Chignahuapan, Puebla. Local people revere this particular mushroom, which was found in a local forest, believing that it has miraculous properties because of designs on its surface that suggest the face of Christ, the sun, the moon and the number 80. De Ávila *et al*. (1980) analyzed the traditional Náhuatl nomenclature that residents of Hueyapan, Morelos, used for mushrooms, documenting how the mushrooms were used and how they were prepared for consumption. González (1982) carried out a study in Santa Catarina del Monte, Texcoco, obtaining information on the Náhuatl nomenclature of the local mushrooms, where they grew and how they were used. Martínez-Alfaro *et al*. (1983) investigated the importance of mushrooms and the differences in the traditional knowledge of some communities in Puebla, gathering information on the origin of the mushrooms, their Náhuatl names, uses and importance. That paper concluded that the perception of mushrooms varies according to the viewer's age, sex, economic position and degree of cultural integration into the community. Gispert *et al*. (1984) interviewed people of all ages in two Nahua communities in the state of México. They asked their subjects nine questions dealing with mushroom nomenclature, classification, morphology, ecology and use. They also collected 24 mushroom species. They concluded that, in the village of Parres, mushroom trade is an important activity while, in the village of El Capulín, mushrooms are used only for home consumption.

In Tlaxcala, there is no documentaton on the current use of mushrooms by the Nahua, although there is some evidence that the ancient Nahua knew of their hallucinogenic and edible properties (Wasson 1983). The oldest reference is found in a paragraph in the book *Relación de Tlaxcala* (*Tlaxcala Connection*), written by Muñoz-Camargo (1586). This paragraph describes the use of a mushroom called "nanacatl", which the local aristocracy ate to predict the future. When these seers ate the mushroom, they were said to become drowsy, faint and have visions. Rojas-Garcidueñas (1935 in Wasson 1983) published an anthology of plays written toward the end of the 16th century, called *El Teatro de la Nueva España* (*The Theater of New Spain*). One of the plays (it is not known whether it ever was performed in public) included in this work shows the opposition of the church to the use of hallucinogens. The play describes a baptism ceremony in which royalty ate such mushrooms. Wasson (1983) interpreted the words "hongol," "demon" and "idol" in this play to mean "teonaanacatl" or "xochinanacatl" because of the way the word "mushroom" is translated into Spanish.

No one has determined the taxonomic identity of the mushrooms used for religious purposes by the ancient Tlaxcaltecan. However, such a register might include *Psilocybe aztecorum* or *Copelandia cyanescens*, two species with hallucinogenic properties that have been found in Tlaxcala (Guzmán 1983, Santiago-Martínez *et al*. 1990). Additional historical references to these mushrooms can be found in ancient writings. One example is the name Antonio Xochinanácatl ("xochinanácatl = hongo flor = mushroom flower"), which appeared in a judicial proceeding in Tlaxcala long ago. The word "Nanacamilpa" means "milpa de hongos" ("nanacatl = hongo y milpa = mushroom and cornfield") and is the name of a Tlaxcaltecan municipality founded in 1858. It is not known why this municipality was thus named (Wasson 1983). Residents of some communities on the slopes of Volcan La Malinche, Tlaxcala, still speak Náhuatl, with the village of San Isidro Buensuceso having the greatest number of inhabitants who speak it (79% of the population; INEGI 2000).

No studies have been conducted to measure the cultural significance of fungi, other than investigations into the roles fungi have played in the lives of Mesoamericans since pre-Hispanic days. For this reason this study was launched to describe the traditional mushroom knowledge of the people of San Isidro Buensuceso, including information on mushroom nomenclature, morphology, use and when and where mushrooms grow. The number of times mushroom names were mentioned in a free listing was used as an indicator of the cultural significance of those mushrooms to San Isidro residents. We do not know which factors they rely on when assessing the cultural importance of mushrooms; natural availability (abundance in the forest) and income derived sales could be two such factors. To test whether this is so, data from an ecological study were used to determine the relationship of the abundance of various mushrooms species in the forest and the cultural significance of such mushrooms to the community. Cultural significance also was compared to the price of each species.

Materials and methods

Field of study

The village of San Isidro Buensuceso, which lies on the southern slope of Volcan La Malinche, at 2600 m (FIG. 1), belongs to the municipality of San Pablo del Monte, in the southeastern part of the state of Tlaxcala. The community was founded near the end of the 19th century and has 6253 inhabitants (INEGI 2000). It has a temperate, subtropical climate, with plenty of summer rain and with average winter rain of less than 5 mm a month. The annual temperature varies between 12 C and 18 C. March, June, July and August are the warmest months, with temperatures between 14 C and 15 C, while the coldest months are December, January and February, with temperatures between 11 C and 12 C (Garcia 1986).

The residents of San Isidro Buensuceso collect mushrooms in local forests, as well as in areas surrounding the town and in cultivated fields. The vegetation of the forests includes: *Abies religiosa* (HBK.) Chamb. & Schl., *Pinus hartwegii* Lindl. and *Pinus montezumae* Lamb. Some forest patches with steep slopes, and a few areas near the crater Hueytlaocan have a mixture of *Alnus jorullensis* H.B. & K., *Salix* spp., *Cupressus* sp., *Quercus* spp. and *Abies religiosa*. The main types of shrubbery include secondary elements such as *Baccharis conferta* HBK. and *Senecio* spp. Grasslands have filled in the open areas; they consist of *Muhlenbergia macroura* (H.B.K.) Hitch., *Stipa ichu* (Ruiz & Pavón) Kunth. and *Eragostris bartieri* Dar.

Fieldwork involved 26 visits to San Isidro Buensuceso, in which 226 semistructured interviews were conducted. For these interviews, participants of both sexes and of different ages (5-90 yr) were selected randomly following Bernard (1988). The random selection was done as follows: 100 numbered dots were placed around the edge of a local map. Pairs of numbers were chosen randomly from a plastic bag, and lines were drawn between those numbers on the map. After 50 lines were drawn, the sampling was begun. The uneven areas created by the lines were numbered, and some of those plots were chosen randomly until 22 had been selected. Ten or 11 households in the designated area were visited, again at random.

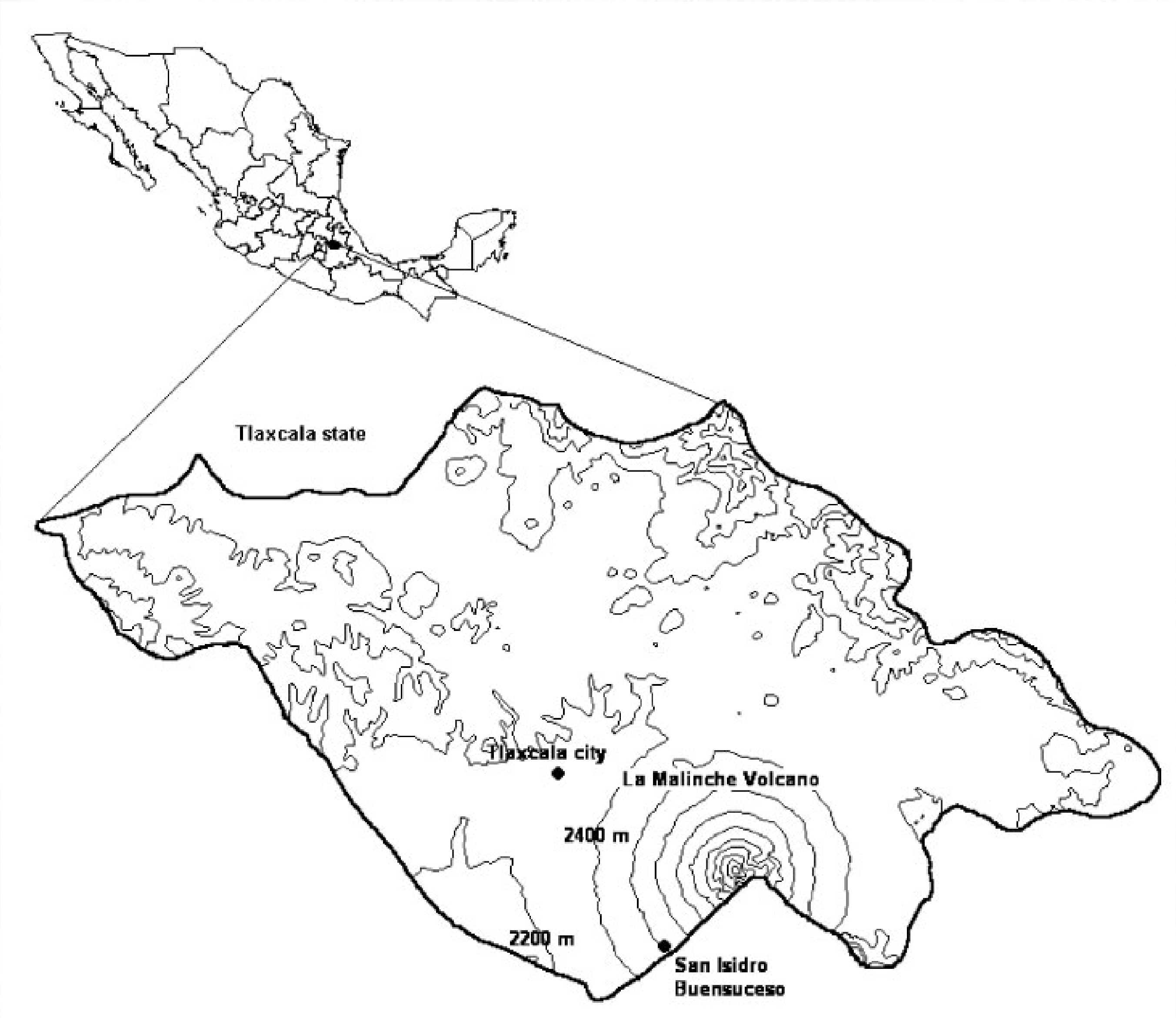


Fig. 1. Location of San Isidro Buensuceso and Malinche National Park.

In each interview, direct questions were used and, on several occasions, fresh or dry mushrooms and field guides were shown as stimuli. The interviews covered these aspects: common names of mushrooms, ideas about the origin of mushrooms, elements required for their development, classification according to the "cold-hot" system (described later), words used to name the different parts of the mushrooms, mushroom uses, methods of cooking, criteria used to distinguish edible from poisonous mushrooms, the months mushrooms are found, the locations where they are found and the prices at which they are sold in the community.

During the rainy seasons of 1998-2000, fieldtrips were undertaken with key informants from the village, with the intention of collecting the mushrooms known and used by the locals and to corroborate the information obtained about times and places of growth. All mushroom species were collected in La Malinche National Park. The collections were taken to the Centro de Investigaciones en Ciencias Biologicas of the Universidad Autonoma de Tlaxcala (UAT) (Research Center of Biological Sciences) with the aim of identifying and drying them, as suggested by Cifuentes *et al*. (1986). Different taxonomic keys were used to identify mushrooms, depending on the genus involved; those keys were supplied mainly by Abott and Currah (1988), Bon (1987), Jenkins (1986), Moser (1983), Romagnesi (1967) and Singer (1975). The specimens then were deposited in TLXM (Holmgren and Holmgren 1995). The initials used for collectors are: AK (Alejandro Kong), E-T (A. Estrada-Torres), OHT (O. Hernández-Totomoch) and AM (A. Montoya). The classification used was based on that proposed by Hawksworth *et al*. (1995). Náhuatl names were written as pronounced by the San Isidro villagers and later translated into Spanish, using the Simeon (1977) and Sullivan (1992) dictionaries. The names then were compared with the information published by De Ávila *et al*. (1980).

To determine the cultural significance of the mushrooms studied, structured interviews were conducted with 46 participants (24 females and 22 males, most of them married couples). One of the households of each area previously selected in the semistructured interviews was chosen for this purpose. Structured interviews made use of free listings, in which respondents were asked to name 20 mushrooms that they were familiar with (the question in Náhuatl was: ("rnechunili tlanitoca nanacatl" = "Tell me the names of 20 mushrooms you know") (Weller and Romney 1988, Bernard 1988). Each interview was carried out independently of the others. The surveys were conducted during the dry season (January-April), ensuring that all mushroom species had the same probability of being mentioned.

TABLE I. Mushroom species and traditional names used in San Isidro Buensuceso

Scientific name and voucher specimens	Náhuatl name	Spanish name
1. *Agaricus campestris* L. *AM 1644*	*ayotzin*, *ayutzin* (*ayotl* or *ayutl* = turtle; ayohtli = pumpkin; *tzin* = diminutive reverential; little turtle or little pumpkin)	Champiñón
2. *Amanita caesarea* (Scop.) Pers. *AM 1598*	*ayoxóchitl* (*ayotl* = zucchini; *xochitl* = blossoms; zucchini blossom mushroom) *cuazitlal* = ? *aquiyoxóchitl* (*quiyotl* or *quiotl* = vástago o retoño; *xochitl* = flower).	flor de calabaza = zucchini blossoms amarillos = yellow mushrooms
3. *Amanita tuza* Guzmán *AM 1747*	*cuatlamanil, cuatlal* (*quaitl* = head; *tlamanil* = ?) *iztacnanácatl* (*iztac* = white; *nanacatl* = mushroom; white mushroom)	-
4. *Armillaria mellea* (Vahl) P. Kumm. *AM 1742*	*tetecuitl* (*tecuitlatl* = slime or *cuitla*, excrement; probably means stone excrement) *xotlalist* = ? *xocuitlas* = ?	-
5. *Boletus atkinsonii* Peck *AM 1595*	*xotoma, xotomame, xotomate, xotomatzi* (icxi = paw, *tomahuac* = fat, fat paw mushroom; or *xitomatl* = red tomato, mushroom like tomato) *tlapalxotoma* (*tlapalli* = color), *tlatlauxotoma* = ? *tlacuaxotoma* = ? *pantenanácatl* (pan = bread; mushroom like bread) *tlaxcaxotoma* (tlaxcalli = tortilla; tortilla mushroom) *zacaxotoma* (*zacatl* = grass) *ocoxaltoma* (*ocoxal* = pine cone litter) *oyamelxotoma* (*oyametl* = fir)	panza grande = big belly pante = ? cemita = meat sandwich pata gorda = fat paw
6. *Boletus pinophilus* Pilát & Dermek *OHT 05,22*	*xotoma, xotomame, xotomate, xotomatz xitomatl* = looks like red tomato, mushroom like tomato; *tlapalxotoma, tlatlauxotoma, tlacuaxotoma, pantenanácatl, tlaxcaxotoma, zacaxotoma, ocoxaltoma, oyamelxotoma* See *B. atkinsonii*	panza grande = big belly pante = ? cemita = meat sandwich pata gorda = fat paw
7. *Cantharellus cibarius* Fr. *OHT 25*	tecosa, tecusa, tecutzal (*cuztic* = yellow; there is a yellow wild flower called *teguza*)	amarillitos = little yellow mushrooms
8. *Chroogomphus jamaicensis* (Murrill) O.K. Mill. *OHT 21*	*tlapaltecosa tlapaltecosauitl* (*tlapalli* = color or painting; it refers to a purple *tecosa*) *xilpatzutl* = ?	hongo morado = purple mushroom
9. *Clitocybe giba* (Pers.) P. Kumm. *OHT 44*	*izquilo* (*izquitl* = perfumed flower; the name refers to the mushroom's sweet smell) *totomoch* (*totomachtle* = the corn husk; its color resembles the color of cornhusks)	hongo de campana = bell mushroom campanilla = little bell
10. *Clitocybe* cf. *squamulosa* (Pers.) Fr. *OHT 24*	*izquilo, totomoch* See *C. gibba*	hongo de campana = bell mushroom campanilla = little bell

11. *Gomphus floccosus* (Schwein.) Singer *AM 1609*	*tlapitzal* (*tlapitzalli* = trumpet; mushroom with the trumpet shape) *oyamelnanácatl* (*oyametl* = fir; *nanacatl* = mushroom; fir mushroom)	corneta = trumpet cornetilla = little trumpet
12. *Hebeloma* cf. *mesophaeum* Fr. *AM 1713*	*ocoxalnanácatl* (*ocoxalli* = pine cone litter, it refers to pine needles; mushroom which grow in pine needles) *rastrojonanácatl* (rastrojo in Spanish means stubble; it refers to a mushroom growing in pine cone litter which looks like stubble)	hongo de ocote = pine cone mushroom
13. *Helvella crispa* (Scop.) Fr. *OHT 19*; *AM 1602*	*pantalonanácatl* (pantalón in Spanish means trousers, *nanácatl* = mushroom) *huihuixocatzi* (*uiuixqui* = weak; *xocatzi;* = ?, weak mushroom ?) *gachupitzetze* = ? *soldadosnanácatl* (*soldados* in Spanish means soldiers, the soldiers mushroom) *huevisnanácatl* (huevo in Spanish means egg; egg mushroom)	*gachupi* blanco (blanco = white, *gachupi* = colloquial Mexican Spanish for Spaniards) orejas = ears güerito = little blond mushroom orejas de ratón = mouse ears
14. *Helvella lacunosa* Afzel. *OHT 20, 38*	*charronanácatl* (charro in Spanish means horseman; horseman mushroom) *cuatlil* (*quaitl* = head; *tlilli* = black; black head)	tamborcito = little drum negrito = little black mushroom *gachupi negro* = black gachupi
15. *Hygrophorus chrysodon* (Bastch.) Fr. *AK 2831*	*xilonananácatl* (*xilotl* = corncob; *nanacatl* = mushroom) *xilonaltzitzi* (*tzitzi* = ?) *xixilonanácatl*	señoritas = young ladies blanquitos = little white mushrooms
16. *Lactarius indigo* (Schwein.) Fr. *OHT 32*	*cacaxnanácatl* (*cacaxtli* = it refers a kind of bird and its blue color)	hongo azul = blue mushroom
17. *Lactarius salmonicolor* R. Heim *et* Leclair *OHT 30*	*chilnanácatl* (*chilli* = chilipepper; *nanácatl* = mushroom; referring to its bright red color or to the peppery flavor some informants claimed it has) *chilabuelita* (abuelita in Spanish means grandma), *chimelnanácatl, chilnanatzi, chichilnácatl, oyamelchilnanácatl*	cajetitos rojos = red cajetitos (something shaped like a dish), trompa de cochino = pig
18. *Laccaria bicolor* (Maire) Orton *OHT 18*	*xocoyoli, xuxocoyoli, xoxocoyoli, xoxocoyolnanácatl, xocoyolnanácatl* (*xogoyolli* = the last child in the family, *xogoyolti* is the plural form, *xocoyoles* the Spanishized plural. The name is given because it is one of the smallest edible mushrooms)	clavito = little nail
19. *Lycoperdon perlatum* Pers. *AM 1615*, *OHT 14*	*xiteburo, xitenanácatl, xitetl* (*xiuitl* = red herb; *tetl* = egg; *buro* = simplification of the Spanish word, *burro* = donkey; donkey egg mushroom) *cefamil* = ?	huevitos = little eggs
20. *Lycoperdon* sp. *AM 1605*	*xiteburo, xitenanácatl, xitetl cefamil* See *L. perlatum*	huevitos = little eggs
21. *Lyophyllum decastes* (Fr.) Singer *AM 1741*	*xoletl, xuletl (xoletl* = It must be very delicate, *xolectle* is one easily hurt, *xoleme* is the plural) *tlacualxoletl*, (*tlacuahuac* = oak) *ocolxoletl* (*ocotl* = conepines) *cuaxuaxoletl* = ?	clavitos = little nails hongo de mata = tuft mushroom
22. *Morchella elata* Fr. *OHT 31*	*olonanácatl* (*olotl* = corncob, they are like corncobs. The name applies to various species of *Morchella*)	olotes = corncobs
23. *Morchella esculenta* (L.) Pers. *AM 857*	*olonanácatl* See *M. elata.*	olotes = corncobs
24. *Pleurotus opuntiae* (Durieu & Lév.) Sacc. *AM 974*	*menanácatl* (*metl* = maguey, *nanácatl* = mushroom) *mesonanácatl* (megotl = dry maguey, mushroom of dry maguey) *huexonanácatl* (*huexotl* = willow, willow mushroom)	hongo de maguey = maguey mushroom
25. *Ramaria bonii* Estrada *AM 1599*	*xelhuas* (*xelguaztle* = brush or broom, mushroom broom)	escobeta = broom
26. *Ramaria cystidiophora* (Kauffman) Corner *AM 1715D*	*xelhuas* (See *R. bonii*)	escobeta = broom

27. *Ramaria rubripermanens* Marr & D.E. Stuntz *AM 1715C, 1747A*	*xelhuas* (See *R. bonii*) *cuamanox* = ? *xelhuastzitzi* (tzitzi = ?)	escobeta morada = purple broom
28. *Ramaria sanguinea* (Pers.) Quél. *AM 1747B*	*xelhuas* (See *R. bonii*)	escobeta = broom
29. *Ramaria versatilis* Quél. *AM 1766*	*xelhuas* (See *R. bonii*)	escobeta = broom
30. *Russula delica* Fr. *OHT 15*	*cuatecax* (*cuatlil* = head, *tecaxitl* = stone dish; mushroom with a cap like a stone dish, because it has the shape of the stone dish, or metate used to mash vegetables to make sauces) *cualtzitzi* (*cuatlil* = head, *tzitzi* = ?) *iztacnanácatl* (*iztac* = white, *nanácatl* = mushroom)	charritos = little horsemen tecajete = Spanicized word from *tecaxitl*
31. *Suillus pseudobrevipes* A.H. Smith et Thiers *AM 1596*	*poposo, pupuso* (*poposonallot* = foam; foam mushroom. Referring to the hymenium appearance)	panza = belly pancita chica = little belly
32. *Ustilago maydis* (DC.) Corda *AM 973*	*cuitlacoche* (*cuitla* = excrement; *cochi* = the pig; pig's excrement)	hongo de maíz = corn mushroom cochinito = little pig

Free-listing compilations leads to several conclusions. First, some items on the list are better known, more important or more familiar to respondents than other items. Such items usually are placed high on an individual list. Second, there is usually a wide range in terms of where residents will place each item in their lists. The free-listing technique, therefore, lets us find the most important items with minimal effort. The list will not be definitive. However, as the number of respondents increases, the list will becomes more stable and the order of items will tend not to change even when a few new items are added by new respondents (Weller and Romney 1988). This approach suggests that the names of the mushrooms referred to most often by respondents are those that have the greatest cultural importance in the community studied.

The hypothesis of this paper is that the importance of a mushroom species bears a relationship to its abundance in the forest and/or to its price. To prove this, a three-year ecological study was undertaken in an area of 1600 m2 in a nearby forest. Fruiting bodies of edible fungi were collected from four *Abies religiosa-Pinus* and four *Pinus-Alnus* transect lines along an altitude gradient in La Malinche National Park. In this area, it was possible to determine how many mushrooms grew in each of four sectors located at the same altitude as the village collection zones. Mushroom abundance was calculated by counting the fruit bodies of each species found in the area under study. The details of the methodology and the results of that ecological study will be published in a subsequent paper. A Spearman index was calculated with a statistics program (StatSoft Inc. 1995) to determine the correlation between frequency of mention and mushroom abundance or frequency of mention and prices.

Results

In total, 48 species were identified, which had 105 common names (65 Náhuatl and 40 Spanish) (TABLES I and II). The mushrooms identified were classified as Ascomycetes or Basidiomycetes. Among the first group, there were three main families: Helvellaceae, with two species; Hypocreaceae, with one species; and Morchellaceae, with two species. The second group contained: Russulaceae and Ramariaceae, with nine species; Boletaceae, with six; Tricholomataceae, with five; Amanitaceae, with four; Lycoperdaceae, with two; and Agaricaceae, Chantharellaceae, Cortinariaceae, Gomphaceae, Gomphidiaceae, Hygrophoraceae, Pleurotaceae, Strobylomycetaceae, Ustilaginaceae and Xerocomaceae with one species each.

Collection of mushrooms

Those who spend their time gathering and selling mushrooms are known as "hongeros", i.e., "mushroomers" or "those who gather mushrooms." Gatherers walk 10 km or more, spending 8-10 h in the process. Usually, at least two people, often of the same family or close neighbors, work together. Both men and women gather mushrooms, with the only difference being that men go farther afield. For example, the men search distant canyons to find bigger and better mushrooms. On occasion, they investigate almost inaccessible locations to find more mushrooms. The men return and give the mushrooms to the women, who have been collecting in the more accessible places. Women then take charge of all mushrooms and carry them back to the village.

TABLE II. Species and traditional names used to describe poisonous fungi

Scientific name and voucher specimens	Náhuatl name	Spanish name
1. *Amanita muscaria* (L.) Hook. *OHT 13*	*pizutnanácatl* (*pitzotl* = pig, *nanácatl* = mushroom; mushroom of the pig, referring to the bad mushroom) *zitlalnanácatl* (*zitlalli* or *citlalin* = star; mushroom of the star, referring to the scales, because they looks like stars)	hongo malo o venenoso
2. *Amanita* cf. *smithiana* Bas *AM 1594*	*pizutnanácatl* (See *A. muscaria*)	hongo malo
3. *Boletus miniatopallescens* A. H. Sm. & Hesler *AM 1607*	*xotomarabia* (*xitomatl* = looks like red tomato, mushroom like tomato; *rabia* = rabies, means that the mushroom is poisonous)	hongo malo
4. *Chalciporus piperatus* (Bull.) Bataille *OHT 04*	*poposorabia, poposo, pupuso* (*poposonallot* = foam, poisonous foam mushroom, referring to the hymenium appearance)	hongo malo
5. *Lactarius chelidoniun* var. *quelidonioides* (A. H. Sm.) Hesler & A. H. Sm. *OHT 11*	*pizutnanácatl* (See *A. muscaria*)	hongo malo
6. *Lactarius luculentus* Burl. *OHT 09*	*pizutnanácatl* (See *A. muscaria*)	hongo malo
7. *Lactarius mexicanus* Kong & Estrada *OHT 07*	*pizutnanácatl* (See *A. muscaria*) *cuatecax* de veneno (*cuatlil* = head; *tecaxitl* = dish stone; poisonous mushroom with a head like a stone dish)	hongo malo
8. *Lactarius* cf. *villosus* Clem. *OHT 10*	*pizutnanácatl* (See *A. muscaria*)	hongo malo
9. *Ramaria abietina* (Pers.) Quél. *AM 1600*	*Xelhuas* del veneno (*xelhuas* = broom, a poisonous broom)	hongo malo
10. *Leccinum aurantiacum* (Bull.) Gray *AM 1606*	*tepexotoma* (*tepetomatl* = madroño tree. Is a *xotoma* growing around madroños (*Arbutus* spp.)	hongo malo
11. *Ramaria abietina* (Pers.) Quél. *AM 1600*	*xelhuas* del veneno (*xelhuas* = broom, a poisonous broom)	hongo malo
12. *Ramaria apiculata* (Fr.) Donk *E-T 2304*	*xelhuas* del veneno (See *R. abietina*)	hongo malo
13. *Ramaria concolor* (Corner) R. H. Petersen *AM 1601*	*xelhuas* del veneno (See *R. abietina*)	hongo malo
14. *Russula* cf. *fragilis* Vittad. *AK 2924*	*pizutnanácatl* (See *A. muscaria*	hongo malo
15. *Russula grisceacens* (Bon & Gaugué) Marti *AK 2939*	*pizutnanácatl* (See *A. muscaria*	hongo malo
16. *Russula murrilli* Burl. *AM 1613*	*pizutnanácatl* (See *A. muscaria*	hongo malo
17. Xerocomus truncatus (Singer, Snell & E. A. Dick) *OHT 03*	*xotomarabia* (It is a poisonous *xotoma*)	hongo malo

While gatherers are on forays, they exchange information about their finds. For example, they talk about the difficult access in certain locations, the form and color of different mushrooms, and the size and presence and absence of certain structures. FIGURE 2 shows gatherers from San Isidro with mushrooms collected in the forest of La Malinche.

FIG. 2. Nahua from San Isidro collecting wild edible mushrooms in to the forest.

Morphology

San Isidro residents can name most parts of a mushroom: the cap, the veil, the cap context, the gills, the scales, the ring and the sac. FIGURE 3 shows the Náhuatl names that the San Isidro villagers have given to each part.

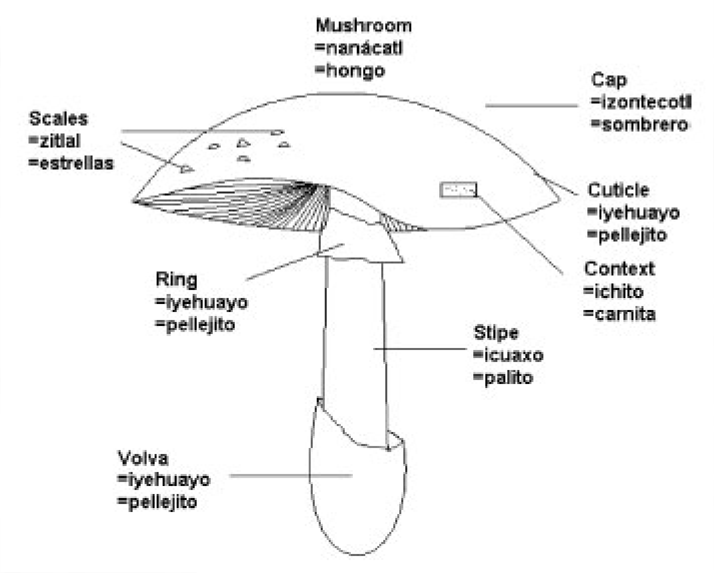

Mushroom
=nanácatl
=hongo
Cap
=izontecotl
=sombrero
Scales
=zitlal
=estrellas
Cuticle
=iyehuayo
=pellejito
Context
=ichito
=carnita
Ring
=iyehuayo
=pellejito
Stipe
=icuaxo
=palito
Volva
=iyehuayo
=pellejito

FIG. 3. Náhuatl terms for mushroom structures.

Categories of mushroom use

There are four main categories of mushroom use in San Isidro: food, trade, insecticide and medicine.

Food

Edible mushrooms are called "cualinanácatl," which means "good mushroom." San Isidro villagers know approximately 58 mushroom names in Náhuatl and 39 in Spanish, which correspond to 31 edible species. The mushrooms preferred because of their taste are *Gomphus floccossus* ("tlapitzal"), *Ramaria* spp. ("xelhuasnanácatl") and *Boletus* spp. ("xotoma"). Each family has its own special way of preparing and eating mushrooms. Mushrooms might be stewed, put in quesadillas, scrambled with eggs, served in a mole or cooked with chile.

Commerce

Of the 220 interviewed, 21% sell the mushrooms they find. Wild mushrooms are sold "for the ranch" and "for the market". "For the ranch" is the most common sale and involves going to nearby villages and peddling door to door. Vendors have certain customers who buy their mushrooms every year; vendors tend to go directly to those houses first.

"For the market" sales take place at a local market, where mushrooms are put in small piles in vendors' stalls. This activity takes place mainly in San Pablo del Monte's municipal marketplace. The mushrooms are sold by the kilo, by a portion halved by hand or by the piece, depending on the species. Only large mushrooms, such as *Amanita caesarea* ("ayocóchitl"), *Boletus atkinsonii*, *B. pinophilus* ("*xotoma*") and *Gomphus floccosus* ("tlapitzal"), are sold individually.

Insecticide

The only species used as an insecticide is *Amanita muscaria*. The flesh of the mushroom cap is mixed with sugar and put in dish in a high place in the room. The mixture is supposed to attract and kill flies. This use was mentioned by 1.4% of the respondents.

Medicine

Only *Ustilago maydis* serves a medicinal purpose for 37% of those interviewed. One use is to spread the spores of the dried mushroom on a wound. It also can be used to moisturize dry lips, heal wounds, dry the navels of newborns, to heal baby rashes (in powder form), to stop hemorrhages and to help heal animal bites. The mushroom also is prepared as a tea to alleviate dehydration caused by the consumption of too much alcohol.

Classification criteria

Texture and consistency are important selection criterions for mushrooms merchants. Mushrooms are classified either as "plain" or "of higher quality". "Plain" mushrooms are brittle, fragile, small and easily damaged during transport. Because they need care, they are placed in the upper part of the collection basket or in a separate container. Examples of such mushrooms are *Clitocybe gibba* and *C. squamulosa* ("izquilo"), *Ramaria* spp. ("xelhuas"), *Hebeloma* cf. *mesophaeum* ("ocoshal"), *Amanita tuza* ("cuatlamanil"), *Laccaria bicolor* ("xocoyule") and *Hygrophorus chrysodon* ("xilonananácatl").

Mushrooms considered to be of the best quality are those that have a firmer and more enduring texture, are large and are not affected by transportation. Examples include *Gomphus floccosus* ("tlapitzal"), *Amanita caesarea* ("xochilnanácatl"), *Boletus pinophilus* ("xotoma"), *B. atkinsonii* ("tlacuahuacxotoma") and *Lyophyllum* spp. ("xuletl"). San Isidro villagers like to collect solid mushrooms because these are generally of good quality and only a few are discarded. Nevertheless, they collect all the mushrooms they can find so that they will have more to sell and eat. Mushrooms are carried in baskets, boxes and plastic bags.

Hot-cold classification

Classification of food and other elements of the universe as "cold" or "hot" is an important element of the

Latin-American cultures (for a detailed explanation see Foster 1979 and Montoya *et al*. 2002). According to this classification, mushrooms in several parts of México are considered to be cold. In San Isidro, they are considered "cold" by 69% of those interviewed and hot by 3%. The first criterion (cold) is associated with a minor stomach ache that some experience after eating a lot of mushrooms. Respondents think that mushrooms are cold because they grow in the forest where it tends to be cold. Some (3.1%) answered that mushrooms are "hot" because they need the heat of the sun to fruit or because they upset the stomach.

Classification by use

San Isidro residents put mushrooms into two categories: good mushrooms ("cualinanatl" = hongo bueno = good mushroom) and inedible mushrooms ("pitzunanácatl"). The most important are the edible mushrooms. This is evidenced by the many names they have been given, the knowledge of where and when they grow, the time spent looking for them, price and the fact that they choose to eat these species more than any others.

Seventeen poisonous species, which had seven Ná- huatl names (TABLE II), were collected. In Spanish, they are called "hongos malos" or "hongos venenosos" while, in Náhuatl, the terms are "pitzunanácatl" (= hongo de puerco = mushroom of the pig) and "zitlalnanácatl" (= estrella-hongo = star mushroom). The latter refers to the white scales on the cap of *Amanita muscaria*, a fungus widely known in the San Isidro area and considered poisonous by most respondents.

Some add the word "rabies" to fungi considered poisonous, such as *Xerocomus truncatus*, which is named "xotomarabia". Poisonous fungi have no use whatsoever and are considered harmful, with the exception of *Amanita muscaria*, used as an insecticide. Many San Isdidro residents believe that all edible mushrooms have a poisonous double. For example, the double for *Amanita caesarea*, known as "ayoxó- chitl," is *Amanita muscaria* ("citlalnanácatl" or "ayoxóchitl de veneno").

TABLE III lists the criteria the villagers use to identify edible and poisonous mushrooms. To be certain that they have collected an edible species, gatherers always pay particular attention to the morphological structures of each mushroom gathered.

TABLE III. Criteria used to distinguish between a poisonous and an edible mushroom

Poisonous fungi	Edible fungi
* When you cut the mushroom it turns either green or purple	* When you cut the mushroom it does not stain green or purple
* When you taste a piece of the mushroom, it burns/stings the tongue	* When you taste a piece of the mushroom, it does not burn/sting the tongue
* Bad odor	* Pleasant odor
* Tastes bitter	* Sweet taste
* There is no presence of worms	* Presence of worms
* Presence of scales on the cap	* Without scales on the cap

The growing season

In the case of San Isidro Buensuceso, mushroom season begins in March and ends in September, with June, July and August producing the most mushrooms. Mushrooms can be divided into several categories according to when they fruit. The first group includes those that need only a little humidity. These appear from March to June and include *Agaricus campestris*, *Amanita tuza*, *Hebeloma* cf. *mesophaeum*, *Lyophyllum decastes* and *Russula delica*. Some San Isidro residents believe that "xoletl" (*Lyophyllum decastes)* is edible only if it is collected before June 24; they believe it is poisonous after that date.

The second group includes mushrooms that need a lot of moisture to fruit. These appear from July until September and include: *Amanita caesarea*, *Armillaria mellea*, *Boletus atkinsonii*, *Laccaria bicolor* and *Suillus* *pseudobrevipes*. Species that emerge at the end of rainy season (the third group) include: *Cantharellus cibarius*, *Clitocybe gibba*, *Gomphus floccosus*, *Helvella crispa*, *Helvella lacunosa*, *Hygrophorus chrysodon*, *Lactarius salmonicolor*, *Morchella* spp. and *Ramaria* spp.

Data on where mushrooms grow

San Isidro gatherers know exactly where to look for each type of mushroom. TABLE IV presents this information.

TABLE IV. Places where mushrooms grow

Outside of the forest	
Plains and meadows	*Agaricus campestris* (ayutzi)
	Lycoperdon perlatum (xiteburo)
On *Agave* spp. (maguey)	*Pleurotus opuntiae* (mesonanácatl)
Around agricultural fields (*Zea mays*) on oak trunks (*Quercus* sp.)	*Armillaria mellea* ("tehtecui")
Road sides	*Amanita tuza* ("cuatlamanil")
In the forest	
In fir forest (*Abies religiosa*) ("oyametl")	*Clitocybe gibba* ("izquilo") *Gomphus floccossus* ("tlapitzal") *Helvella crispa* ("gachupi") *Helvella lacunosa* ("charronanácatl") *Hygrophorus chrysodon* ("xilona") *Lactarius salmonicolor* ("chilnanácatl") *Morchella esculenta, M. elata* ("olonanácatl") *Ramaria* spp. ("xelhuas")
In pine forest (*Pinus* spp.) ("ocotl")	Associated to grass (*Agrostis* sp. and *Mulhenbergia* sp.) *Boletus pinophilus, B. atkinsonii* ("xotoma") *Suillus granulatus, S. pseudobrevipes* ("poposo") *Amanita caesarea* ("ayoxóxitl") *Cantharellus cibarius* ("tecosa") *Chroogompus jamaiscensis* ("tlapaltecosa") *Hebeloma* cf. *mesophaeum* ("ocoxal") *Laccaria bicolor* ("xoxocoyule") *Lyophyllum decastes* ("xuletl")
In oak forest (*Quercus* spp.) ("tlacuauatl")	*Armilaria mellea* ("tehtecui") *Lactarius indigo* ("cacaxnanácatl") *Hypomyces lactifluorum* ("chilnanácatl de ocotl") *Boletus* sp. ("xotoma")

Frequency of mention

The free-listing technique, described earlier, yielded a total of 52 traditional and common names for 29 mushroom species. TABLE V shows how often each species was mentioned.

According to the study findings, more than 90% of those interviewed mentioned these mushrooms: *Gomphus floccosus*, *Ramaria* spp., and *Boletus pinophilus*. Other mushrooms also appreciated and mentioned by more than 50% of the participants were: *Amanita caesarea*, *Cantharellus cibarius*, *Clitocybe* spp., *Laccaria bicolor*, *Lyophyllum decastes*, *Morchella* spp. and *Russula delica*. The mushrooms mentioned by more than 20% of the interviewees but fewer than 50% were: *Hebeloma* cf. *mesopheum*, *Armillaria mellea*, *Hygrophorus chrysodon*, *Suillus pseudobrevipes*, *Chroogomphus jamaiscensis*, *Helvella crispa*, *Lactarius indigo*, *Agraricus campestris* and "*totoltenanácatl*" (a species not gathered by San Isidro villagers).

TABLE V. Frequency of mushroom mention using free listing

Scientific name	Traditional name	Women	Men	Total
Gomphus flocossus	*tlapitzal*, cornetas	22	21	42
Ramaria spp.	*xelhuasnanácatl*	19	23	42
Boletus pinophilus	*xotoma*	21	20	41
Cantharellus cibarius	*tecosananácatl*	19	16	35
Russula delica	*cuatecax* (*nanácatl*), *iztacnanácatl*	18	16	34
Amanita caesarea	*ayoxochitl*	13	7	30
Laccaria bicolor	*xoxocoyuli*	16	19	30
Lyophyllum decastes	*xuletl, xuletlnanácatl*	16	16	28
Clitocybe gibba, C. squamulosa	*izquilo, izquilonaná catl, izquilon, totomoch*	15	11	26
Morchella elata, M. conica	*olonanácatl* olotitos, suéter	14	10	24
Hebeloma cf. *mesophaeum*	ocoxalnanácatl (sh), *ocoxoletl, xuletl* de *ocoxal*	12	9	21
Armillaria mellea	*tehtecui*	12	7	19
Hygrphorus chrysodon	*xilonananácatl*	8	9	17
Suillus pseudobrevipes	*poposo*	8	7	15
Chrogoomphus jamaiscencis	*tecosa cafecita, t.* de toro, *tlapaltecusa, tecosan morado*	9	5	14
Helvella lacunosa	*gachupinanácatl, gachupi, g. blanco*	6	6	12
Lactarius indigo	*cacaxnanácatl, cuatecax azul*, h. azul	7	5	12
Lycoperdon perlatum	*xiteburo, xitetl*	2	1	3
Agaricus campestris	*ayutzi*	8	2	10
	totoltenanácatl	3	7	10
	cefamile	4	4	8
Lactarius salmonicolor	*chilnanácatl*	3	5	8
Amanita tuza	*cuatlamanil*	3	5	8
Pleurotus opuntiae	*menanácatl*, hongo de maguey	4	3	7
Amanita muscaria	*citlalnanácatl*	2	4	6
Lyophyllum sp.	*tlacuahuacxuletl*	4	1	5
Lactarius salmonicolor	*chilnanácatl de oyametl, oyamechilnanácatl*	3	1	4
Helvella lacunosa	*gachupin* negro, charro	1	2	3
	cuatlillzi	1	2	3
	solnanácatl	2	1	3
Boletus atkinsonii	*tlapalxotoma*	0	2	2

TABLE VI lists how many of each of 17 species were found in the local forest. These figures are compared with data on the frequency of mention and prices. Mushroom names were ranked from most significant to least significant, according to the number of people who named them. The table presents abundance information only for the species mentioned in the free listing and for which prices were available. The Spearman correlation index between frequency of mention and abundance had a value of 20.51, while that between frequency of mention and price had a value of 0.39. The most abundant species in the study area were *Laccaria bicolor*, *Morchella* spp., *Clitocybe* spp., and *Helvella lacunosa*. *Amanita caesarea*, *Gomphus floccosus*, *Ramaria* spp., *Boletus pinophilus*, *Laccaria bicolor* and *Helvella crispa* fetched the highest prices.

TABLE VI. Comparison between frequency of mention, abundance values and selling prices of 17 species of wild mushrooms

Scientific name	Mention frequency (Number of persons who mention each species)	Abundance values (Number of fruit bodies in 1600 m^2)	Selling prices (2000)	
			Pesos per kilogram	US Dollars per kilogram
Gomphus floccosus	42	9	$30.00	3.19
Ramaria spp.	42	0	$30.00	3.19
Boletus pinophilus	41	2	$30.00	3.19
Cantharellus cibarius	35	2	$8.00-10.00	0.85-1.06
Russula delica	34	10	$25.00	2.66
Lyophyllum decastes	33	12	$15.00	1.6
Amanita caesarea	30	0	$70.00	7.45
Laccaria bicolor	30	225	$30.00	3.19
Clitocybe giba	26	152	$8.00-10.00	0.85-1.06
Morchella spp.	24	161	$8.00-10.00	0.85-1.06
Hebeloma cf. *mesopheum*	21	36	-	-
Hygrophorus chrysodon	17	50	$8.00-10.00	0.85-1.06
Chroogomphus jamaisensis	14	2	$8.00-10.00	0.85-1.06
Helvella crispa	12	80	$30.00	3.19
Lactarius salmonicolor	4	13	$25.00	2.66
Helvella lacunosa	3	122	$25.00	2.66
Lycoperdon perlatum	3	18	$8.00-10.00	0.85-1.06

Discussion

San Isidro Buensuceso is an important community, from a cultural point of view, given that its residents retain many of their indigenous traditions, maintain a set of typical social and family values, still use forest products for their subsistence and communicate in their indigenous (Náhuatl) language.

This study obtained detailed information about several aspects of traditional mushroom knowledge. According to the information gleaned from the older residents, we hypothesize that mushrooms have played a role in the daily lives of this community for a very long time. Unfortunately, no previous studies confirm this information.

Based on the number of mushroom species (33) used by the people of San Isidro, the number of names in use (115) and the information about when and where each species grows each season, one can say that the traditional mushroom knowledge in San Isidro Buensuceso is similar to that of other Nahua communities, such as Hueyapan, Morelos (De Ávila *et al*. 1980), Santa Catarina del Monte, in the Valley of México (González 1982), Parres, D.F. and El Capulín (Gispert *et al*. 1984). A comparison of the few ethnomycological Nahua studies to date shows that each has had its own focus, but there is a commonality as well; they all addressed traditional nomenclature, where and when mushrooms grow, how mushrooms are rated according to the "hot-cold" system and how certain species are cooked.

Descriptions of Nahua knowledge show that, until today, in different places in México, this indigenous group uses mushrooms both for food and for commercial purposes. Of course, we do not really know how important mushroom commerce is. For example, it appears to be very important in some places, such as Santa Catarina del Monte, and not so important for San Isidro residents. On the other hand, the knowledge of this resource is detailed, probably because mushroom collection and commerce began deep in the past (Martín del Campo

1968).

From the total known species in San Isidro, the villagers eat 67% of them and various recipes are used to prepare and cook each one. Mushrooms help provide a nutritional complement to an otherwise monotonous diet (Montoya *et al*. 2000). For example, mushrooms provide protein in a diet that normally consists of beans, tortillas and sauce. To that end, it is important that species are selected that can be cooked together in one dish, with consideration for taste and texture.

The activity of collecting is equally important, because it permits Nahua to preserve their traditional mushroom knowledge, which is passed onto their children during forays or when mushrooms are sorted for sale or when they are prepared for meals at home. Similarly, they pass on information concerning how to distinguish edible mushrooms from those considered poisonous. This has helped reduce incidences of mushroom poisonings.

A primary means of identifying mushrooms is the morphology of the fruit bodies. San Isidro villagers recognize and can name all the parts of mushrooms in the *Agaricales* order (gilled mushrooms). Estrada- Torres (1989) concluded that this knowledge might be determined by the influence of a species, or group of species, that had a major cultural value in a region. The results of the current study indicate that this does not appear to be the case in San Isidro, where the most important mushrooms are not Agarics.

In addition to their use as food at home, edible mushrooms are sold in neighboring communities. Although this activity does not seem that important in this region (considering how few people - 21% - are engaged in it), it does produce additional income. Only a few use mushrooms as medicine or insecticide (37% and 1.4%, respectively). Nevertheless, Nahua have some knowledge of such uses, which increases their potential pharmaceutical resources. There has been no evidence that San Isidro Buensuceso residents use hallucinogenic mushrooms for ceremonial or medicinal purposes, despite what historical records of Tlaxcala say about their use by the ancient Nahua.

Based on the study's findings, it seems that San Isidro villagers take a utilitarian approach when classifying their mushrooms, because they always refer first to the edible ones, which they use in great numbers. They put "citlalnanácatl" (*Amanita muscaria*) or "pitzunanácatl", the poisonous ones, in second place and use only a few of them.

San Isidro villagers gather the most and most diverse number of edible mushrooms in the area they call "the mountain". Based on the number of species found, forests with *Pinus* and *Abies* provide the type of vegetation that promotes the greatest diversity of mushrooms and produces the species that are most valued from a commercial point of view. Forests of *Abies* are especially important because that is where *Gomphus floccosus*, the most sought after mushroom in the area, thrives. Several hunters rely on *Sarcodon* sp. to indicate the presence of that species. They believe that, if *Sarcodon* sp. is present, they are certain to find several fruit bodies of *Gomphus*. This is odd because *Sarcodon* is dark and difficult to see, whereas *Gomphus* is bright orange. Perhaps because both species grow at the end of the rainy season, gatherers make the connection.

Away from the mountain, oak forests are important because of the species that grow there. Nevertheless, San Isidro residents believe that mountain mushrooms are superior and have a much better flavor because they grow where there are many trees. Our findings on where and when mushrooms grow agree with those published by González (1982) and Gispert *et al*. (1984).

The results on the cultural importance of the mushrooms used by the San Isidro villagers, as indicated by the free listing, suggest that *Gomphus floccosus*, *Ramaria* spp. and *Boletus pinophilus* are the most important mushrooms to this community. The efforts spent on their collection and the fact that only few are found are the determinants of price. They are the ones most sought after, although they fruit in remote places. Those most valued in this community are not the gilled mushrooms, as was suggested by Estrada-Torres (1989) for other communities in the country.

The mushrooms mentioned earlier are the ones most valued, and almost everyone in San Isidro is familiar with them. At the very least, they cook *Gomphus floccosus* in various ways. The sale of these mushrooms produces a higher income than the sale of the more fragile and smaller species, which also require more energy to collect.

Although Lincoff (1977) concluded that *Gomphus floccosus* can upset the stomach, this does not seem to be the case in México. Moreover, it is surprising to see how popular this mushroom has become in San Isidro. Nevertheless, because it is bitter, a knowledge of the mushroom is needed to cook it properly. The cleaning process involves removing the scales on the cap and the veins of the hymenophore. San Isidro residents, in addition, recommend boiling the mushroom before cooking it with other ingredients; this mushroom generally is eaten in a mole or in tamales.

The Spearman correlation indices for frequency of mention in the free listing and number of mushrooms found and for frequency of mention and selling prices were low (20.51 and 0.39, respectively). The reason for this is that a high frequency of mention does not always correspond with abundance or price. It was a surprise to discover that the correlation between abundance and frequency of mention was not positive, indicating that, most of the time, a mushroom found only rarely is mentioned frequently. This means that the most abundant resources are not always the most appreciated, and because a great deal of time and effort are spent looking for the rarer but particularly popular species, prices are higher. Thus, the abundance of mushrooms and prices are factors that contribute to the attribution of cultural significance of at least some species. But, because other factors also could affect how important each species is considered to be, our findings only partially support the hypothesis posed earlier. In the following paragraphs, we show some of the instances where at least one of the predictions of this study (correlation between frequency of mention and abundance or price) is satisfied.

Gomphus floccosus, *Ramaria* spp., *Boletus pinophilus*, *Russula delica* and *Lyophyllum decastes* were mentioned most frequently and brought in the highest prices, but their numbers in the forest were among the lowest. Although *Cantharellus cibarius* are scarce and culturally important, neither fact is reflected in its price.

Amanita caesarea fetches the highest price ($7.44/kg) of all the mushrooms that are sold by San Isidro villagers and is found rarely in the areas studied, but these facts are not reflected in this mushroom's cultural value, which was lower than those mentioned above. The scarcity of this species must be due the fact that it develops in very specific micro-environments, which were not included in our sample areas. *Laccaria bicolor* is the most abundant species and fetches a relatively good price, even though it is generally mixed with other marketed species. Even though it is not the most popular species, one can conclude that, for 68% of those interviewed, it has a relatively high cultural value.

On the other hand, *Clitocybe gibba* and *Morchella* spp. were mentioned by more than half of those interviewed and are among the most abundant species, yet their prices are among the lowest. *Helvella crispa* and *Helvella lacunosa* both are abundant and expensive, yet they received the least mention in the free listings. *Chroogomphus jamaicensis*, *Hygrophorus chrysodon* and *Lycoperdon perlatum* were mentioned by less than half of those interviewed, and their abundance, as well as their prices, were low.

Although the frequency with which a species was mentioned is a good indicator of its cultural significance, it is necessary to confirm this conclusion with other studies that consider additional variables, such as abundance, selling prices, knowledge of where mushrooms grow, the fruiting season, information on morphology, recipes used, eating preferences and consistency of fruiting bodies. These variables should be factors in determining more precisely the cultural value of mushrooms in this and other Mexican communities.

Acknowledgments

We greatly appreciate the helpful comments by Dr. Alejandro Casas Fernández of the Instituto de Ecología, Campus Morelia, Michoacan. We also thank Florencia García for the first English translation and Gundi Jeffrey for her help with editing and revising that translation. Translation of Náhuatl names was supported by María Rosario Xochitiotzin, a specialist in lingustics. We also are grateful to Lorenza Pérez Flores, Don Pánfilo and all the residents of San Isidro, who made this paper possible. We also wish to thank Coordinación General de Ecología of Tlaxcala for its support for this research in Malinche National Park. This study was supported by a grant of CONACYT, with additional financing from PROMEP/UATLAX-29.

Literature cited

1. Abbot SP, Currah RS. 1988. The genus *Helvella* in Alberta. Mycotaxon 33:229-250.
2. Bernard HR. 1988. Research methods in cultural Anthropology. Newbury Park: SAGE Publications Inc. 520 p.
3. Bon M. 1987. The mushroom and toadstools of Britain and North Western Europe. Nueva Jersey: Domino Books. 352 p.
4. Cifuentes J, Villegas M, Pérez-Ramírez L. 1986. Hongos. Pages 55-64 in A. Lot and F. Chiang comps. Manual de Herbario. D.F.: Consejo Nacional de la Flora de México. 142 p.
5. De Á vila A, Welden AL, Guzmán G. 1980. Notes on the ethnomycology of Hueyapan, Morelos, México. Journal of Ethnopharmacol 2:311-321.
6. Dubovoy C. 1968. Conocimiento de los hongos en el México antiguo. Boletín Informativo de la Sociedad Mexicana de Micología 2:16-24.
7. Estrada-Torres A. 1989. La etnomicología: Avances, problemas y perspectivas. Examen predoctoral. México D.F. Escuela Nacional de Ciencias Biológicas Instituto Politécnico Nacional.
8. Foster George M. 1979. El Legado Hipocrático Latinoamericano: "Caliente y Frío" en la Medicina Popular. Medicina tradicional 2(6):5-24.
9. García ME. 1986. Apuntes de climatología. 5th ed. México D. F. García M. Editora. 155 p.
10. Gispert M, Nava O, Cifuentes J. 1984. Estudio comparativo del saber popular de los hongos en dos comunidades de la Sierra del Ajusco. Boletín de la Sociedad Mexicana de Micología 19:253-264.
11. González J. 1982. Notas sobre la etnomicología náhuatl. Boletín de la Sociedad Mexicana de Micología 17:181-186.
12. Guzmán G. 1983. The Genus *Psilocybe*. A systematic revision of the known species including the history, distribution and chemistry of the Allucinogenic species. Nova Hedwigia 74. Cramer, Vaduz.
13. ———, Wasson RG, Herrera T. 1975. Una iglesia dedicada al culto de un hongo, "Nuestro Señor del Honguito", en Chignahuapan, Puebla. Bol Soc Mex Mic 9:137-147.
14. Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Dictionary of the fungi. 8th ed. Wallingford
15. Herrera T, Guzmán G. 1961. Taxonomía y ecología de los principales hongos comestibles de diversos lugares de México. An Ins Biol Univ Nac Aut Mex 32:33-135.
16. Holmgren PK, Holmgren NH. 1995. Additions to Index Herbariorum (Herbaria). 8th ed. 4th series. Taxon 44: 251-266.
17. INEGI. 2000. XII Censo General de población y vivienda. Datos por localidad, Tlaxcala.
18. Jenkins TD. 1986. *Amanita* of North America. Eureka: Mad. River Press. 197 p.
19. Lincof G, Mitchel DH. 1977. Toxic and hallucinogenic mushroom poisoning. A handbook for physicians and mushroom hunters. New York: Litton Educational Publishing Inc. 267 p.
20. Martín del Campo R. 1968. Contribución al conocimiento de la nomenclatura micológica náhuatl. Bol Inf Soc Mex Mic 2:25-35.
21. Martínez-Alfaro MA, Perez-Silva E, Aguirre-Acosta E. 1983. Etnomicología y exploraciones micológicas a la Sierra Norte de Puebla. Boletín de la Sociedad Mexicana de Micología 18:51-64.
22. Montoya A, Hernández-Totomoch O, Estrada-Torres A, Kong A. 2000. Recetas tradicionales para cocinar hongos silvestres. Fundación Produce Tlaxcala A.C. Folleto técnico No. 20. 18 p.
23. Moser M. 1983. Keys to Agarics and Boleti (Polyporales, Boletales, *Agaricales*, *Russula*les). London: Roger Phillips. 535 p.
24. Muñoz-Camargo D. 1586. Descripción de la Ciudad y Provincia de Tlaxcala (Facsímil Edition of the unpublish work of 1586) in Acuña R. 1984. Relaciones geográficas del siglo XVI Tlaxcala. Vol. 1. México D.F.: UNAM. p 191.
25. Romagnesi H. 1967. Les *Russules* d'Europe et d'Africa du Nord. París: Bordas. 998 p.
26. Santiago-Martínez G, Kong A, Montoya A, Estrada-Torres A. 1990. Micobiota del estado de Tlaxcala. Revista Mexicana de Micología 6:227-243.
27. Simeon R. 1977. Diccionario de la lengua Náhuatl o Mexicana. México D.F.: Siglo XXI.
28. Sheffler L. 1999. Los indígenas mexicanos. México, D.F.: Panorama. 250 p.
29. Singer R. 1975. The *Agaricales* in modern taxonomy. Vaduz: Cramer. 912 p.
30. StatSoft, Inc. (1995). STATISTICA for Windows [Computer program manual]. Tulsa, OK.
31. Sullivan T. 1992. Compendio de gramática Náhuatl. México D.F.
32. Wasson G. 1983. El hongo maravilloso teonanácatl. México D.F.: Fondo de Cultura Económica. 307 p.
33. Weller SC, Romney AK. 1988. Systematic data collection. Newbury Park: SAGE Publications Inc. 96 p.

The Hallucinogenic mushrooms of Mexico: An adventure in ethnomycological exploration

by

R. Gordon Wasson

This paper, illustrated with slides, was presented at a meeting of the Division on January 23,1959.

New York, N. Y

original text: https://bibliography.maps.org/resources/download/15622

Our inquiries into the hallucinogenic mushrooms, after six years and more of research, are now at the end of their first phase.

In Paris, a book on our mushrooms has just been published by the *Muséum National d'Histoire Naturelle*. Handsomely illustrated, it deals with every aspect of this strange mushroom complex - anthropological, linguistic, historical, archeological, mycological, chemical, psychological, and religious - and even the initial steps in the therapeutic use of the active agent in the mushrooms. Roger Heim, director of the museum, is the author, and he has done me the signal honor of joining my name to his on the title page. On January 29, 1959, an exhibition illustrating our mushrooms and our experiences with them opened in the American Museum of Natural History, New York, N.Y., to which the Paris Muséum has generously lent its collaboration. Thus publication of this paper offers a timely and welcome opportunity to report on our remarkable adventure in ethnomycology*.

> * "Ethnomycology" was a word coined by us, after the analogy of ethnobotany, to signify the role played by mushrooms in the history of human cultures. It first appeared in print in 1954 in an invitation sent out by the American Geographical Society, New York, N.Y., to a lecture that we were to give before that body.

It was in September 1952 that my late wife and I first learned of the existence of a mushroom cult among the Indian tribes of southern Mexico. Immediately we undertook, in our spare time, to learn all that had been published about it. There were only three modern papers on this cult that contributed helpful information. However, in the old writings about Mexico, dating mostly from the Sixteenth and Seventeenth Centuries, we found a number of references to it, all of them of absorbing interest to us. We undertook to make an anthology of these quotations, upwards of a score of them, some of their existing only in manuscripts of the time. We were helped in this search for the sources by kind friends, notably by those eminent authorities on ancient Mexico, Robert J. Weitlaner and his daughter, Irmgard Weitlaner-Johnson. We analyzed these quotations, pinpointing on the map of Mexico the places to which they referred, collating the descriptions of the fungi, and scrutinizing what was said about the use of the mushrooms. We undertook to peruse the archeological record in Meso-America: and what an extrordinarily complex, rich, and enigmatic record it is! We believe that we have discovered, for the first time, our sacred mushrooms in that record. In our forthcoming book we publish the text of all our quotations, and we submit the archeological evidence for the mushroom cult to the judgment of those qualified in this thorny field of recondite learning.

Here a number of questions will occur to the mycologist. What mushroom or mushrooms are worshipped? Many of the old writers speak of the visions that these fungi cause. Do they really produce visions? If so, what is the active agent in them that provokes such a response? What is its molecular structure? Could it be used in therapeutics?

Then there is the anthropological problem. What were the geographical limits of the cult in the old days and where does it survive now, if at all? What role does the mushroom play in the lives of the Indians? The cult lingers in the areas where it existed earlier, in the uplands of southern Mexico, roughly from the latitude of Mexico City to the Isthmus of Tehuantepec. It survives feebly if at all in the cities and surrounding country, but in full vigor off the highways, in Indian villages where the native languages are still in current use. In these remote places the sacred mushroom holds the entire population in its grip. The anthropologists have overlooked it simply because they have not asked about it and the Indians do not volunteer to talk about it.

Not all anthropologists are temperamentally suited for studying such a phenomenon as the mushroom rite among the primitive Indians of Mexico. The anthropological discipline schools its neophytes in a respect for hard, down-to-earth facts. These students are prepared to arrive at the systems of kinship and marriage among the peoples they study, the rules of land tenure and exploitation, the methods of manufacture of textiles and other artifacts, the customs governing the exchange of goods, the calendar systems, and the native cosmologic and eschatological ideas. By the nature of the archeological discipline, there is a natural selection of persons who are not poets, not mystics, not skilled in assessing subjective emotions. Yet in primitive man the poetic element, the religious feeling, exists, and it richly deserves the attention of the modern world. The difference I speak of is the difference between the beauty of a bird in flight and the taxonomist's description of that same bird's flight muscles; between the breathless beauty of a rainbow and the physicist's spectrum analysis of that same rainbow. The divine mushroom that causes the eater to see visions plays perforce a vital role in the inner life of the Indian, that aspect of his life which he is reluctant to discuss with strangers of another race and language, and doubly so if those strangers would not enter into the experience sympathetically. The anthropologist who explores these subjects should possess the soul of a poet and the tact of a father confessor, yet he must not let his own imagination run away with him. He must observe, with the eye of a poet, the role of the mushroom in a primitive culture far removed from his own, and confine himself to that function. His task resembles the problem of a translator of poetry, who must possess poetic feeling and yet harness his own Pegasus to another man's imagination. How seldom do we meet with a good translation of poetry! So it is, I feel, with the anthropologist's study of the subjective religious life of the Mexican Indian. Trained from the beginning to an austere respect for nuggets of fact, most anthropologists - not all - are ill-prepared to enter into the poetic world of the subjective life of the people they are studying, for exploring the world revealed by the sacred mushroom. We at least are alive to the problem. In our writings about the mushroom cult we have tried to escape the Scylla of dry factualism and also the Charybdis of unbridled imagination.

Each year since 1953 we have made expeditions to southern Mexico, to the remote mountain fastnesses where the mushroom cult survives, traveling intentionally in the rainy season, by mule over mountain trails, often in the rain, to live in the Indian villages where the Spanish language is known only to a few head men. Our first and essential task was to win the confidence of the Indians. Their initial reaction to our presence was always reserved, occasionally hostile: the Indians have had contact with white men for centuries, and we are not viewed with the favor one should like. Our attitude was that of humble suppliants coming to learn the secrets of the sacred mushroom for the benefit of our own people. After an interval the Indians met us more than halfway.

From the beginning we had three objectives: (1) to obtain some of the sacred mushrooms; (2) to attend the ceremony in which they are eaten; and (3) to share in the eating. We were intent on learning everything about the cult: how and when the mushrooms are gathered; how they change hands and reach the ultimate consumer, the Indian (and Spanish, if any) names for the mushrooms; the meaning of those names; the manner of performing the ceremony in the different tribes and villages; the purpose of the ceremony; whether the mushrooms are really psychotropic; what one experiences on eating them; and the dosage. We were eager to get photographs and tape recordings of the ceremony, to study the words linguistically and religiously, to identify the mushrooms, to isolate the active agent (if any), to describe this agent's molecular structure, to define its properties, and, finally, to place our mushroom cult in the context of what is known of primitive religious behavior. A little more than six years have passed since we began to devote our spare time to this avocation, and we have now attained all these objectives in some degree.

The identification of our mushrooms proved much more complicated and exciting than we had imagined. The old writers had given inadequate descriptions of these fungi, but what they said indicated that there were several species. (After all, who can blame those authors for their inadequacies, since the science of mycology had not yet been born?) Although we expected to find several species, our discoveries went far beyond this. Each region that we visited makes use of species peculiar to itself, only a few species turning up in more than one region. The sacred mushrooms of Mexico belong, for the most part, to the genus *Psilocybe* and, except for one or two species, they are new to science. Genuinely psychotropic and hallucinogenic, they are the following, arranged according to the regions in which they were found:

Sierra Mazateca: (1) *Psilocybe mexicana* Heim; (2) *Psilocybe semperviva* Heim and Cailleux; (3) *Psilocybe caerulescens* Murrill var. *Mazatecorum* Heim: (4) *Psilocybe yungensis* Singer & Smith;* (5) *Psilocybe acutissima* Heim; (6) *Stropharia*** *cubensis* Earle (synonym: *Psilocybe cubensis* (Earle) Singer); and (7) *Conocybe siligineoides* Heim.

* This species poses a problem. Ingested by Thomas Davis and RGW in the field, it proved to be psychotropic and (in RGW's case) hallucinogenic. Subsequently in the laboratory the tests for psilocybin were negative.
** The psychotropic activity of this species was recognized by the Indians but, owing to paucity of material, has not been proved in the "laboratory or by experiment on ourselves".

Slopes of Popocatepetl, Valley of Mexico: (8) *Psilocybe aztecorum* Heim. Tenango del Valle: (9) *Psilocybe wassonii* Heim (synonym: *Psilocybe muliercula* Singer & Smith).

San Agustín Loxicha, in the Sierra Costera; (10) *Psilocybe zapotecorum* Heim (also No.1, and two other species of unknown identity).

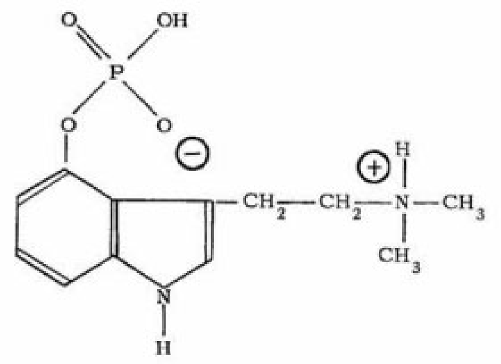
Mixería, region of San Juan Mazatlán: (11) *Psilocybe hoogshageni* Heim; (12) *Psilocybe cordispora* Heim; and (13) *Psilocybe mixaeensis* Heim (also No.1).

Yaitépec, in the Chatino country, Sierra Costera: (14) *Psilocybe caerulescens* Murrill var. *nigripes* Heim (also Nos. 1 and 10).

Sochi apam in the Chinantla, No. 1?

On the periphery of the area where mushrooms are used for divination, two species serve for that purpose that we believe riot to be psychotropic. Their phallic suggestiveness obviously explains their role. In Tenango del Valle the Indians consume *Cordyceps capitata* in association with hallucinogenic *Psilocybe* sp. In one corner of the Chinantla the *curandera* crushes and eats *Dictyophora phalloides* to heighten her divinatory powers.

Roger Heim of Paris, our mentor in all matters mycological, has devoted himself to the classification and study of our mushrooms and, in 1956, he joined us in the field. He identified them as Basidiomycetes and, with the aid of his young assistant Roger Cailleux, he succeeded in cultivating almost all of the fourteen species of Mexican hallucinogenic agarics in the *Laboratoire de Cryptogamie* in Paris, at first in sterile, artificial media, later in compost in hothouses, thus freeing us of our dependence on Mexico for our supply of raw material. In the Sandoz laboratories of Basel, Switzerland, with material supplied from Paris, a research team headed by Albert Hofmann and including Heim, A. Brack, and H. Kobel succeeded in large-scale culture of *Psilocybe mexicana*, in sterile conditions on artificial media, isolating two distinctive substances. They called one of them psilocybin and the other psilocin, and they reduced psilocybin to a pure white crystalline powder, arrived at its molecular structure, and synthesized this compound in full (0-phosphoryl-4-hydroxy-N-dimethyl-tryptamine). The active agent is not an alkaloid nor a polypeptide but an indole structure. It contains an atom of phosphorus and, as such, is a substance new to chemical science. Psilocin, which is present in much smaller amounts, is a dephosphorization of psilocybin.



Physical and chemical data: empirical formula, $C_{12}H_{17}O_4N_2P \cdot CH_3OH$; molecular weight, 284.3•32; melting point, 200 to 210°C. with decomposition; solubility, in 120 parts of water at 20°C.; and pH, 5.3. Keller color reaction: 0.1 mg. of psilocybin dissolved in 1 cc. 0.01 per cent ferric chloride containing acetic acid and stratified with 1 cc. concentrated sulfuric acid. After mixing, a violet color is obtained.

For our part, my wife and I concentrated our attention on the anthropological side of the mushroom cult. In the remote Indian villages the Indians regard the psychotropic mushrooms as holy. They fear and adore them. Although the mushrooms are nowhere any longer called by the Aztec term *teo-nanácatl*, "God's flesh," the Indians regard them as the key to communication with the Deity. The mushrooms today are eaten behind closed doors, in the silence and darkness of the night. They do not change hands in the market place for money, but are delivered privately, carefully wrapped up, perhaps in a banana leaf. The Indians do not discuss the sacred mushrooms in gatherings: you learn about them talking in a whisper with a friend who trusts you, preferably at night. *Es muy delicado*, it is very perilous, the Indians say, not to be taken lightly, and only as a sacrament. There is nothing in common, absolutely nothing, between these sacred mushrooms and our use of alcohol. The vulgar jocularity with which fully civilized peoples sometimes talk of a "binge" or a "jag" is alien to the Indian with his mushrooms. The effects are wholly different. With the mushrooms there is no hang-over, no obfuscation of the memory, and it seems that one does not become addicted to the mushrooms as one sometimes does to alcohol and certain other drugs. The dosage remains the same throughout life. The mushrooms are taken when a grave problem needs to be resolved and, I believe, only then. Perhaps there is illness in the family and the mushroom is consulted to learn whether the patient will live or die. If the verdict is for death, the family does not wait but immediately prepares for the funeral, and the sick person loses the will to live and shortly afterward gives up the ghost. If the verdict is for life, the mushroom will tell what must be done if the patient is to recover. Or, again, if a donkey has been lost or if some money has been stolen, the mushroom is consulted and gives the answers. Among these unlettered folk, speaking languages that are not written, there is often no news of an absent member of the family, perhaps one who has gone as a "wetback" to the United States. Here the mushroom, as a postal service, brings tidings of the absent one, whether he is alive and well, or sick or in jail, or prosperous or poor, or whether he is married and has children.

The method of taking the mushrooms varies. In the Mixe country the mushrooms are consumed privately by the suppliant, with only one friend present, to attend to what might happen and be a witness. In other regions a *curandero* or healer, who takes the mushrooms and who may serve them to others present, is called in. We know of two quite different rites that the *curandero* may use. In one of them the mushrooms are superimposed on the ceremony of divination that is common to all Meso-America, a much larger area than the mushroom country. In this ceremony the *curandero* casts kernels of maize, and according to the way they fall reads the answers to the questions that are put to him. Of course, there is much more to the ceremony than that: all the accessories to the rite play their part - hen's eggs, turkey eggs, *guacamaya* (macaw) feathers, copal (a resin), cacao beans, tapers of pure beeswax, and *amate*, or wrappings of bark. These accessories play their role with a precision, a nicety, that are equal to the reverence and care with which a priest handles the holy utensils of the Mass. In the mushroom country the *curandero* simply adds mushrooms to this customary ceremony to strengthen the divine power within him.

In the alternative ceremony the *curandero*, having partaken of the divine mushrooms, waits for them to seize hold of him and then chants his supplications to the Almighty to come down and answer the prayers and problems of those present. In this ceremony the *curandero* is esteemed according to the skill he displays in formulating the appeals to God. Today, and I dare say throughout the past, there have been *curanderos* who were frauds, *embusteros* as they are called, but it has been our privilege to know two who were not, and one of them, María Sabina, is a woman of presence, integrity, and intelligence. The *curanderos* are called of God. That is, one becomes a *curandero* because, having taken the mushrooms, they tell one to follow that vocation. The *curanderos* are not organized in a hierarchy: each one practices his calling on his own, like the shamans of Siberia, although they may exchange ideas on occasion with each other. As a class, they are shy, usually living apart on the outskirts of town. It would be well worthwhile, before the tradition is lost, to explore all the villages where the sacred mushroom is consulted, to seek out the most proficient *curanderos*, win their confidence, and explore the recesses of their minds. These agents are the surviving repositories of the Old Religion. I am certain that they would surprise you by the content of their minds and their virtuosity in the discharge of their office.

The sacred mushrooms of Mexico seize hold of you with irresistible power. They lead to a temporary schizophrenia, or pseudoschizophrenia, in which your body lies, heavy as lead, on the *petate*, or mat, and you take notes and compare experiences with your neighbor, while your soul flies off to the ends of the world and, indeed, to other planes of existence. The mushrooms take effect differently with different persons. For example, some seem to experience only a divine euphoria, which may translate itself into uncontrollable laughter. In my case I experienced hallucinations. What I was seeing was more clearly seen than anything I had seen before. At last I was seeing with the eye of the soul, not through the coarse lenses of my natural eyes. Moreover, what I was seeing was impregnated with weighty meaning: I was awe-struck. My visions, which never repeated themselves, were of nothing seen in this world; no motor cars, no cities with skyscrapers, no jet engines. All my visions possessed a pristine quality: when I saw choir stalls in a Renaissance cathedral, they were not black with age and incense, but as though they had just come, fresh carved, from the hand of the Master. The palaces, gardens, seascapes, and mountains that I saw had that aspect of newness, of fresh beauty, that occasionally comes to all of us in a flash. I saw few persons, and then usually at a great distance, but once I saw a human figure near at hand, a woman larger than normal, staring out over a twilight sea from her cabin on the shore. It is a curious sensation: with the speed of thought you are translated wherever you desire to be, and you are there, a disembodied eye, poised in space, seeing, not seen, invisible, incorporeal.

I have placed stress on the visual hallucinations, but all the senses are equally affected, and the human organism as a whole is lifted to a plane of intense experience. A drink of water, a puff of the cigarette, is transformed, leaving you breathless with wonder and delight. The emotions and intellect are similarly stepped up. Your whole being is aquiver with life.

Our friends of Sandoz are offering this active agent for experimentation on the inmates of our hospitals for the emotionally disturbed in Paris and in Lexington, Ky. Will no one try it out on the exceptionally gifted? There is the possibility - I say no more than the possibility - that their powers will be sharpened and they will command insights not given to them in their normal existence.

While we were seeing our visions in the blackness of a tropical night, with the rain pouring outside, the *curandera* was giving voice to her canticles, invoking the deity to come down among us. She and her daughter took turns at singing. At times she would rise and engage in a complicated clapping, slapping, whacking of different parts of her body, with different resonance depending upon the part of her body that she would strike, with a complicated timing of the whacks, the blows being nicely modulated, sometimes struck lightly, sometimes with full power; and she would rotate to the cardinal points of the compass as she performed. There we were, in a humble Indian hut, with our visions and the authoritative voice of the daughter's singing in our ears, and the percussive blows of the mother displaying a ventriloquistic virtue, now here, now there, near at hand, far away, as though we were afloat in space, stroked by breezes, listening to the voice raised in song, and surrounded by the calls of eerie creatures darting around us.

The performance of the *curandera* reaches a climax every twenty or thirty minutes. Then suddenly the singing stops and the mushroom speaks. She whips out the words of the oracle, loud, sharp, with compelling authority, the syllables cutting the night air and the darkness and the silence like a knife. Afterward everyone relaxes, cigarettes are lighted, and there is general conversation in which the *curandera* participates.

After four or five hours of this experience we would all fall into a deep slumber, from which we would awaken some two hours later, refreshed and ready for work - ready, that is, except that the clear recollection or our adventure made work seem unimportant, and the important thing to do was to compare notes with our companions and record in our diary every detail of the nights events.

I have now told you what we have accomplished, in the field and the laboratory, in the past six years. We have rediscovered the sacred mushrooms of Mexico, identified them, isolated the active agent, and proceeded to the determination of its properties. What is there for us to do now? Our field of research broadens as we progress. Let me outline, what seems to me, in the anthropological field, the course to persue. Remember that all I shall say is speculative, awaiting confirmation.

We are dealing here with an authentic form of the religion of primitive men. Let me repeat what I said before: that it would be an error to bracket the hallucinogenic mushrooms with alcohol, as just another drug that serves as an escape for man. The mushroom, despite its potency, is a dying agent. In the primitive world its survival is spotty, although there is evidence that its use was widespread long ago. It survives only in peripheral cultures, among the most isolated and neglected peoples, in Siberia, in Borneo, in New Guinea, until recently in Peru, and in Mexico. At an early stage in the evolution of a culture, it serves as the great mediator with God for peoples who are just beginning to be familiar with the idea of God.

The animal kingdom does not know God; it has no conception of the religious idea. The animal cannot imagine horizons beyond the horizon it has actually seen, a past earlier than it has experienced, a future beyond the immediate future, planes of existence other than this one in which we find ourselves. There must have come a time when man, emerging from his bestial past, first grasped these possibilities, vaguely, hesitantly; when he first knew the awe that goes with the idea of God. Perhaps these ideas came to him unaided, by the light of his dawning intelligence. I suggest to you that, as our most primitive ancestors foraged for their food, they must have come upon our psychotropic mushrooms, or perhaps other plants possessing the same property, and eaten them, and known the miracle of awe in the presence of God. This discovery must have been made on many occasions, far apart in time and space. It must have been a mighty springboard for primitive man's imagination. The secret of the miraculous discovery would be closely guarded, and it would leave little trace, other than by ricochet in folklore, in legend, and in the etymology of relevant words. From the beginning of history there have been seers, mystics, prophets, and poets who have seemed to possess the secret vision of eternal values. They achieved this by fasting and other ascetic practices or, perhaps, as in the case of Blake and Keats, by their abnormal sensitivity. Blake's description of the poetic gift is singularly apt for the experience of the mushroom agape: "He who does not imagine in a stronger and better light than his perishing mortal eye can see, does not imagine at all." The divine mushroom would open up the world of visions to far greater numbers, and the kingdom of God would be within reach of everyone who possessed the sacred secret. The Kingdom of God would be within you.

The ceremony we attended in southern Mexico was a true agape, a love-feast, a Holy Supper, in which we all felt the presence of God, in which the Element carried its own conviction in the miracles it performed within us. The faithful were not obliged to accept the dogma of Transubstantiation in order to know that they had partaken of the body of Christ. (How startling it is that the ancient Aztecs called this Element by the same name that we use for the Bread and Wine of the Eucharist - God's Flesh!) May not the sacred mushroom, or some other natural hallucinogen, have been the original element in all the Holy Suppers of the world, being gradually replaced by harmless Elements in a watering down of the original fearful sacrament? May this not be the explanation of the Archetypes, the Ideas, of Plato? The ancient Greeks never revealed the secret of the Eleusinian mysteries, yet many must have known it and whispered to each other about it. We know only that the initiates drank a potion and later in the night knew a great vision. The Greeks, who were the fathers of pure reason, reserved a portion of their minds for the mystical element, the mysteries of Eleusis, the oracle at Delphi, the daemon of Socrates. No one knows for sure what beverage the ancient Hindus meant by the *soma*, nor what was the origin of the *ling chih* of the Chinese, the divine mushroom of immortality. Here is a missing element in our knowledge of these cultures, one that possibly can now be identified by the methods that we have used in our quest of the sacred mushroom.

There remains one question that some may be asking themselves, and that I gladly answer. How is it that I, a banker, and my wife, a pediatrician, have gone into these remote territories, and how does it come about that I write about these subjects? Our mushrooms impinge on a multitude of disciplines: in science, on mycology, chemistry, psychology, and medicine, in the humanities, on folklore and mythology, philology, anthropology, archeology, history, and religion. How does it come about that laymen without academic qualifications in any of these disciplines are so bold as to address a scientific body on these subjects?

My wife and I began to gather our material long ago, in 1927, on an August afternoon in the Catskills, as we strolled along a mountain path on the edge of a forest. She was of Russian birth and I am of Anglo-Saxon ancestry. I knew nothing of mushrooms and cared less. They were for me rather repellent and, like as not, deadly poisonous. In the years that we had known each other, I had never discussed mushrooms with my wife. Suddenly she darted away from my side: she had seen a forest floor carpeted with mushrooms of many kinds. She knelt before them, called them by endearing Russian names, and over my protests insisted on gathering them in her dress and taking them back to our lodge, where she went so far as to cook them and eat them - alone. My wife adored mushrooms, though she had never studied them or possessed a book about them. What she knew about them she had picked up at her mother's knee. The Great Russians experience a love for mushrooms that passes belief, that borders on the abnormal, just as we Anglo-Saxons are abnormally afraid of them.

This episode made so deep an impression on us that from then on, as circumstances permitted, we gathered all the information that we could about the attitude of various peoples toward mushrooms - what kinds they know, their names for them, the etymology of those names, the folklore and legends in which mushrooms figure, references to them in proverbs and literature and mythology. We were interested in what untutored folk knew about mushrooms, those who had never seen a book on the subject, but knew only what had come down by oral tradition from their ancestors. Like stout Cortez, awed by the spectacle of the Pacific from his peak in Darien, we found we were privileged to tread a virgin field ripe for exploration. Slowly it dawned on us that the peoples of Europe were divided ethnomycologically into two groups, those who adored mushrooms and those who had an exaggerated fear of them and loathed them - the "mycophiles" and the "mycophobes," words that we coined. The objective evidence supporting this hypothesis was reenforced by myriad clues to be found in philology and folklore. A bold surmise gradually gripped us: perhaps our remote ancestors had worshipped the mushroom. This would explain our evidence, for that which is worshipped is both adored and feared, both holy and unclean. We traveled far and wide, to Lapland, to the Basque country, to Friesland, until we had assembled what seemed to us an impressive body of clues. Like the long slow swell that rocks the ocean days after the mighty hurricane has passed, so our cold, fossilized evidence, for all its scholarly inertness, seemed to us to betoken, when assembled for the first time and properly read, the terror and adoration that had once gripped our primitive ancestors long ago, perhaps before history began. We postulated the cult of a divine mushroom, as astronomers postulate the presence of an astral body without having seen it, deducing its presence from the behavior of other bodies. The question remained: if mushrooms were worshipped, which mushrooms and why?

We now cast our net further afield and, in our inquiries, embraced all of the Eurasian land mass. What was our surprise and delight to discover that there are peoples in Siberia who have worshipped a certain kind of mushroom horn antiquity to our own time. They are the most primitive tribes in that primitive country, the Paleo-Siberian communities. We found that the use of mushrooms for ritualistic purposes was known in New Guinea, in Borneo. Then we went to Mexico, on our very doorstep. I have told you about our work there.

Perhaps we were helped, rather then hindered, by our lack of training in any of the disciplines that we needed. An academic scholar or scientist would have hesitated to tread where we wandered freely. In the course of our journeyings, both intellectual and geographical, we drew on the specialized knowledge of hundreds of informants, ranging from untutored country folk to academicians. In a sense my wife and I felt that we were merely the lens through which the light of their information was focused on the screen of our design. If the theories that we advance have any validity, the credit goes primarily to our informants. We wish we could cite all of them here. We wish we could cite at least all of the principal ones, men such as Robert Graves of Majorca, Spain; Adriaan Barnouw of New York, N. Y., Richard Schultes of Harvard University, Cambridge, Mass., and Gordon Ekholm of the American Museum of Natural History, New York, N.Y. There are, however, two men we shall cite to whom we owe a debt that we can never repay, without whose help we would never have brought our book to term.

First, there is that prodigious scholar and teacher, Roman Jakobson, of Harvard University and the Massachusetts Institute of Technology Cambridge, Mass, From the day we met him during World War II, he has encouraged us, he has pursued us relentlessly, plied us with rich material, with ideas, with questions, never letting us slow up, driving us on to get out our book. Preeminent as a Slavicist, as a philologist, as a linguist, as a folklorist, as a cultural historian, as a pioneer in the new science of communications, himself fertile in all these fields, electrifying as a teacher, he is truly one of the great intellects of our time, and withal abounding in those human qualities that endear him to his students and disciples. It has been our pride that we gained his friendship and captured his interest in our researches.

Then there is Roger Heim. We met him for the first time in 1949 in Paris, when we intruded into his presence in his laboratory, wholly unknown to him, without academic qualifications, without introduction except for a telephone call from a colleague who himself did not know us. From the beginning he has been our ever-loyal, ever-patient guide in all matters mycological. I need not say how difficult a scientific discipline his is. His dedication to it is entire, his knowledge of it encyclopedic. Beyond the horizons of mycology, he commands in an astonishing way the realms of general science and the humanities. In fact, for him all science is only an extension of the humanities, a frontier that men are now exploring and that they are incorporating into the ever-accumulating body of human knowledge and human culture. Editor of the *Revue de Mycologie*, Director of the *Laboratoire de Cryptogemie*, author of *Les Chempignons d'Europe*, a mushroom manual of new conception that surpasses anything we have in the English language, Director of the *Muséum National d'Histoire Naturelle*, *Membre de l'Institut*, occupying the very chair and the very room that Buffon occupied, an accomplished stylist in the French language, he exemplifies the finest traditions of French science and French culture. Without his ever-ready hand to help us over the hard places, without his authoritative voice to support us in our field work, we should never have dared to persevere. I am honored to have the privilege of paying this tribute to a great Frenchman, a great scientist, an eminent exponent of the best in the Western tradition of humane and scientific letters.

References

Early Papers

1. SCHULTES, RICHARD E. Feb. 21, 1939. The identification of *teonanácatl*, a narcotic basidiomycete of the Aztecs. Botanical Museum Leaflet, Harvard Univ.7(3).
2. SCHULTES, RICHARD E. 1940. Teonanacatl, the narcotic mushroom of the Aztecs. Am. Anthropologist, n.s. 42: 429-443, 549-550.
3. JOHNSON, JEAN B. 1939. The elements of Mazatec Witchcraft. Ethnological Studies No.9. Gothenburg Ethnographical Museum, Sweden.

Publications Associated with the Name of Roger Heim

4. HEIM, ROGER & R. G. WASSON. (With the collaboration of Albert Hofmann, Roger Cail1eux, A. Cerletti, Arthur Brack, Hans Kobel, Jean Delay, Pierre Pichot, Thérèse Lempérière, Pierre Nicholas-Charles.) Les Champignons Hallucinogènes du Mexique; Archives du Muséum National d'Histoire Naturelle, Paris. 7th series. VI. 1958 (1959).

The following appeared in the Comptes Rendus of the Académie des Sciences, Paris.

5. HEIM, ROGER. Feb. 20, 1956. Les champignons divinatoires utilisès dans les rites des Indiens Mazatéques, recueillis au cours de leur premier voyage au Mexique, en 1953, par Mme Valentina Pavlovna Wasson et M. R. Gordon Wasson. 242: 965-968. (Reprinted in Revue de Mycologie, May 15, 1957, Vol. XXII, fasc. 1: 58-62; also in Notes préliminaires sur les Agarics hallucinogènes du Mexique, 1957: 1-5.)
6. HEIM, ROGER. March 12, 1956. Les champignons divinatoires recueillis par Mme Valentina Pavlovna Wasson et Mr. R. Gordon Wasson au cours de leurs missions de 1954 et 1955 dans les pays mije, mazatèque, zapotèque et nahua du Mexique méridional et central. 242: 1389-1395, (Reprinted in Revue de Mycologie, May 15, 1957, Vol. XXII, fasc. 1: 62-70; also in Notes préliminaires...: 5-13.)
7. HEIM, ROGER. Feb. 4, 1957. Les Agarics hallucinogènes du genre *Psilocybe* e recueillis au cours de notre recénte mission dans le Mexique méridional et central en compagnie de M. R. Gordon Wasson. 244: 695-700. (Reprinted in Revue de Mycologie, May 15, 1957, Vol. XXII, fasc. 1: 70-76; also in Notes prélimtnaires...: 13-19.)
8. HEIM, ROGER & ROGER CAILLEUX. June 24, 1957. Culture pure et obtention semi-industrielle des Agarics hallu cinogènes du Mexique. 224: 3109-3114. (Reprinted in Revue de Mycologie, Sept. 15, 1957, Vol. XXII, fasc. 2: 183-189; also in Notes préliminaires...: 22-28.)
9. HEIM, ROGER. Aug. 5, 1957. Analyse de quelques expériences personelles produites par l'ingestion des Agarics hallucinogènes du Mexique. 245: 597-603. (Reprinted in Revue de Mycologie, Sept. 15, 1957, Vol. XXII, fasc. 2: 189-197; also in Notes préliminaires...: 28-36.)
10. HEIM, ROGER. Nov. 18, 1957. Sur les *Psilocybes* hallucinatoires des Aztèques et sur le microendémisme des Agarics utilisés par les Indiens du Mexique à des fins divinatoires. 245: l761-1765. (Reprinted in Revue de Mycologie, Dec. 31, 1957, Vol. XXII, fasc. 3: 300-305; also in Nouvelles observations sur les Agarics hallucinogènes du Mexique: 3-8.)
11. HEIM, ROGER, ARTHUR BRACK, HANS KOBEL, ALBERT HOFMANN & ROGER CAILLEUX. March 3, 1958. Déterminisme de la formation des carpophores et des sclérotes dans la culture du *Psilocybe mexicana* Heim, Agaric hallucinogène du Mexique, et mise en évidence de 1a psilocybine et de la psilocine. 246: 1346-1351. (Reprinted in Revue de Mycologie, April 15, 1958, Vol. XXIII, fasc. 1: 106-113; also in Nouvelles observations...: 9-16.)
12. HEIM, ROGER & ALBERT HOFMANN. Aug. 4, 1958. Isolement de la psilocybine à partir du *Stropharia cubensis* Earle et d'autres espèces de champignons hallucinogenes mexicains appartenant au genre *Psilocybe*. 247: 557-561. (Reprinted in Revue de Myco1ogie, Oct. 15, 1958, Vol. XXIII, Fasc. 3: 347-351.)
13. *Presented by* HEIM, ROGER. Note of Jean Delay, Pierre Pichot, Mlle Thérèse Lempérière and Pierre Nicolas-Charles. Oct. 20, 1958. Effets psycho-physiologiques de la psilocybine, 247: 1235-1238.

***

14. HEIM, RQGER. Chronique scientifique of the Figaro Littéraire. April 21, 1956. "On vénère au Mexique des champignons qui suscitent l'hallucination ou la folie..." (Reprinted in Notes préliminaires...: 37-41.)
15. HEIM, ROGER. Chronique scientifique of the Figaro Littéraire. Sept. 28, 1957. (Reprinted in Notes préliminaires...: 42-46.)
16. HEIM, ROGER. Breves latinae diagnoseis hallucinogenarum mexicanarum Psilocybarum ad fera specimina pertinentium, Revue de Myco1ogie, May 15, 1957. XXII, fasc. 1: 77-79. (Reprinted in Notes préliminaires...: 20-22.)
17. HEIM, ROGER. Diagnosis latina *Conocybe siligineoides* Heim. Revue de Mycologie , Sept. 15, 1957. XXII, fasc. 2: 197-198. (Reprinted in Notes préliminaires...: 36-37.)
18. HEIM, ROGER. Diagnose latine du *Psilocybe wassonii* Heim, espèce hallucinogène des Aztèques. Revue de Mycologie, April 15, 1958. XXIII, fasc. 1: 119-120. (Reprinted in Nouvelles observations...: 22-23.)
19. HEIM, ROGER. Le *teonanácatl* ou chair de dieu. Science et Nature, Sept.-Oct. 1957, No. 23: 3-6.
20. HEIM, ROGER. Les critères d'ordre chimique dans l'étude des affinités chez les champignons. The Linnaeus Commemoration of Upsala University, Symposium on Systematics of Today, Upsala, May 29, 1957 (1958): 48-58.

21. HEIM, ROGER. Le syndrome narcotien chez les champignons à action cérébrale. Histoire de la Médecine, Sept. 1958, No. VIII: 1-16.
22. HEIM, ROGER. Les actions nerveuses provoquées par les champignons. Science et Nature, Sept.-Oct. 1958, No. 29: 1-8.
23. HOFMANN, ALBERT, ROGER HEIM, ARTHUR BRACK & HANS KOBEL. Psilocybin, ein psychotroper Wirkstoff aus mexikanischen Rauschpilz *Psilocybe mexicana* Heim. Experientia, March 1958, XIV, fasc. 3: 107-112.
24. HEIM, ROGER & ROGER CAILLEUX. Latina diagnosis *Psilocybes sempervivae* Heim et Cailleux, speciei mutantis hallucinogenae mexicanae per culturam obtentae. Revue de Mycologie, Oct. 15, 1958. XXIII, fasc. 3: 352-353.
25. HOFMANN, ALBERT. Chemical aspects of psylocybin, the psychotropic principle from the Mexican fungus, *Psilocybe mexicana* Heim. Paper presented at the First International Meeting of Neuro-Psycho-Pharmacology, Rome, Sept. 8-13, 1958.
26. DELAY, JEAN. Comparaison des troubles du comportement induits par les substances psychotropes avec les psychoses humaines, Paper presented at the same Meeting.
27. HOFMANN, ALBERT, A. FREY, H. OTT, T. PETRZILKA & F. TROXLER. Konstitutionsaufklärung und Synthese von Psilocybin. Experientia, Nov. 1958, XIV: 397-401.
28. HOFMANN, ALBERT & F. TROXLER. Identifizierung von Psilocin. Experientia, March 1959, XV. In press.
29. HEIM, ROGER. Chronique scientifique of the Figaro Littéraire. Jan. 31, 1959. "Au pays de la découverte. Le savant n'entre pas toujours le premier."

Publications Associated with the Name of the Wassons

30. WASSON, VALENTINA PAVLOVNA & R. GORDON WASSON. Mushrooms Russia and History. 2 vol. Pantheon Books, N. Y., 1957.
31. WASSON, R. GORDON. Seeking the magic mushroom. With water colors by Roger Heim. Life magazine, N. Y., May 13, 1957. (International edition, June 10; Culto de los hongos sagrados, Life en Español, June 3.)
32. WASSON, VALENTINA P. I ate the sacred mushroom. This Week magazine, May 19, 1957.
33. WASSON, R. GORDON. Lightning-bolt and mushrooms; an essay in early cultural exploration. Festschrift for Roman Jakobson, Mouton, The Hague, 1956.
34. WASSON, VALENTINA P. & R. GORDON WASSON. The hallucinogenic mushrooms. The Garden Journal, The New York Botanical Garden, N. Y., Jan.-Feb. 1958.
35. WASSON, R. GORDON. The divine mushroom: primitive religion and hallucinatory agents. Proceedings of the Amer. Philosophical Society, June 1958, 102(3):221-223.
36. WASSON R. GORDON. Wild Mushrooms: A world of wonder and adventure. The Herbarist, Boston, Mass., 1959, No. 24. In press. See also No.4 above.
37. SABINA, MARIA. Mushroom Ceremony of the Mazatec Indians of Mexico, recorded by R. Gordon Wasson and with translation and commentary by Eunice V. Pike and Sarah C. Gudschinsky. Folkways Record and Service Corporation. 117 W. 46th St., N. Y. 36, N. Y. The record bears the listing FR9875.

Publications Associated with the Names of Rolf Singer and Alexander H. Smith.

38. SINGER, ROLF. The *Agaricales* (Mushrooms) in Modern Taxonomy. Lilloa. Univ. of Tucumán, Argentina, 1949 (1951): 472, 506.
39. SINGER, ROLF. Sacred mushrooms inspire medical research. Chicago Natural History Museum Bulletin, Dec. 1957.
40. SINGER, ROLF & ALEXANDER H. SMITH. New Species of *Psilocybe*. Mycologia, Jan.-Feb. 1958, L (1): 141-2.
41. SINGER, ROLF. Mycological investigations on teonanácatl, the Mexican hallucinogenic mushroom. Part I. With Alexander H. Smith, Part II. Mycologia, March-April 1958, L (2): 239-303.
42. SINGER, ROLF. Pilze, die zerebralmyzetismen Verursachen. Schweizerische Zeitschrift für Pilzkunde, June 1958: 81-89.
43. SINGER, ROLF, ALEXANDER H. SMITH & G. GUZMAN HUERTA. A new species of Psathyrella. Lloydia, March 1958, 21(1): 26-28.
44. SINGER, ROLF WITH S. I. STEIN, RALPH W. AMES & ALEXANDER H. SMITH. Observations on agarics causing cerebral mycetisms. Mycopathologia et Mycologia applicata, Nov. 29, 1958, Vol. IX, fasc. 4: 262-284.

Archeology

45. BORHEGYI, STEPHAN. The enigmatic mushroom stones of Meso-America. Middle American Research Records, Vol. III, published by the Middle American Research Institute, Tulane University, Louisiana, 1959. In press.

An Aztec Narcotic

(Lophophora williamsii)

by

W. E. SAFFORD

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D.

original text: https://www.samorini.it/doc1/alt_aut/sz/safford-an-aztec-narcotic.pdf
backup source: http://www.psilosophy.info/resources/safford-an-aztec-narcotic.pdf

Table of Contents:

Methods of exorcism
Early history of Teonanacatl
Determination of the drug
Identity with the narcotic peyotl
Raiz diabolica, or devil's root
Cacalia also called peyotl
The genus lophophora
Lophophora williamsii
Geographical distribution
Chemical history of the drug
Physiological action
Ceremonial use by the Indians
Among the Tarahumaris
Use by the Huicholes of Jalisco
Present use in the United States
The peyote society
Among the Omaha Indians
Use in ancient Mexico
Summary

> **So-called "Sacred Mushroom," or Teonanacatl, Still in Use by the Indians of Mexico and the United States, Producing Hallucinations of a Remarkable Nature, Is Identified with the Peyotl Zacatecensis, or Devil's Root of Ancient Mexico, and the "Mescal Button" of Texas.**[1]

Accounts of many early travellers in America and missionaries to the Indians call attention to the veneration of the aborigines for various plants, showing that they attributed to all plants a spirit somewhat like that of animals or even of man himself. To certain plants special honors were paid; others were avoided with dread; while others, with no pronounced virtues or evil properties, were little noticed. An example is given by a Mexican writer of the homage paid to a certain tree cut down in order to form a bridge over a stream in Michoacan. The people of the village were called together by the governor and a religious service was held about a cross erected for the special ceremony, with candles burning before it and choristers assisting. A procession was formed which climbed the mountain, where the tree was growing. When it fell there came an aged Indian woman who, taking a few of its branches, laid them on the trunk where it had been cut, and consoling it with loving words begged that it might not feel humiliated or angry; for they had chosen it on account of its magnificent stature and great strength, and it was destined to span a mighty river, so that all the people of the land of Michoacan might cross over upon it. And before dragging it away they placed upon the place where it had fallen a piece of lighted candle, which had been left over from Holy Thursday; and they repeated in its honor a very solemn litany, sprinkling it with holy water and much pulque.[2] On the next day, having propitiated the spirit of the tree, they bore away the hewn beam to the bridge with much shouting and jubilation.[3]

The same author speaks of the veneration paid by the Mexicans to certain medicinal plants and to the narcotics *Ololiuhqui*, the sacred *Nanacatl*, the *Peyotl*, and the *Picietl* (tobacco), "to which they ascribe deity and with which they practice superstitions."

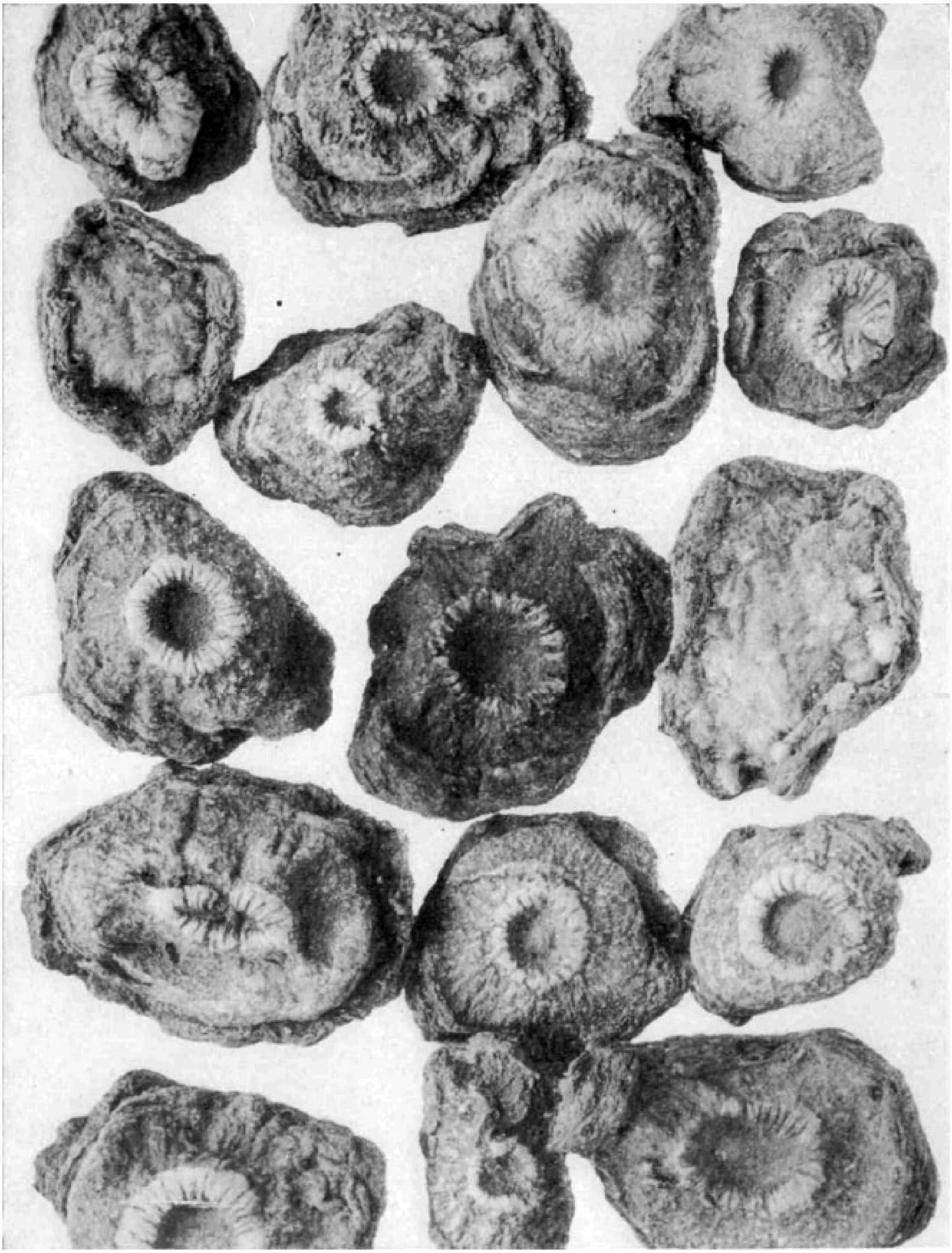


Fig. 1 - THE AZTEC NARCOTIC CACTUS, TEONANACATL
"God's Flesh," or "Sacred Mushroom" of the Aztecs - discs cut from the crown of the cactus *Lophophora williamsii* and dried. Photograph of specimens received by the Bureau of Chemistry, U. S. Department of Agriculture from the Indian Office in 1914. Now widely used as a narcotic by Indians on United States Reservations. - Natural size.

Methods of exorcism

The following example is among those given to show the method of exorcism employed by the Aztec *titzitls*, or herb doctors. In this case the spirit of the Ololiuhqui, is addressed. "Come now, come hither, *Green Woman*, behold the green heat and the brown heat; remove thou the flaming or scarlet heat, the yellow heat, or by this token I send thee to the seven caves. And, I command thee, put it not off till tomorrow or another day; for sooner or later thou wilt be compelled to do it. Who is the god - the so powerful and superior one - who can destroy the work of thy hands? I command it, I, the prince of enchantment." Others using the Hueinacaztli ("great-ear"), Mecaxochitl ("cord-flower"), and Coanenepilli ("serpent's tongue"), repeat the following: "Come hither, thou, the yellow and ardent red one; come and expel the green pain, the brown pain, which now wishes to take away the life of the son of the gods!" And with the herb Atlinan ("water-weed"), "I invoke thee, my mother, thou of the precious waters! Who is the god or who the so powerful one that wishes to destroy and burn my enchantment? Ea! Come thou, sister of the Green Woman, whom I am about to go and leave in the seven caves, where the green pain, the brown pain, will hide itself. Go and rub with thy hands the entrails of the bewitched one, so that thou mayst prove thy power and fall not into disgrace!"

Early history of Teonanacatl

Bancroft, in referring to the narcotics used by the ancient Mexicans, mentions one, which was believed by the early Spaniards to be a fungus. In writing of their ceremonial feasts he says: "Among the ingredients used to make their drinks more intoxicating the most powerful was the *teonanacatl*, 'flesh of God,' a kind of mushroom which excited the passions and caused the partaker to see snakes and divers other visions."[4] This information was undoubtedly derived from accounts of the Spanish padres, one of whom, Bernardino Sahagun, writing before the year 1569, states that it was the Chichimeca Indians of the north who first discovered the properties and made use of these "evil mushrooms which intoxicate like wine.[5]

They were gathered in the territory now northern Mexico and southern Texas, preserved by drying, and carried southward. The inhabitants of the Valley of Mexico knew them only in their dry state. It is also very probable that the early writers who recorded their use had seen them only when dry and never knew then: as living plants. Francisco Hernandez, the physician sent by Philip II in 1570 to study the resources of Mexico, or New Spain, describes them under the heading "*De nanacatl seu Fungorum genere*." From the harmless white mushrooms (*iztacnanacame*), red-mushrooms (*tlapalnanacame*), and yellow orbicular-mushrooms (*chimalnanacame*), used for food, he distinguished them as *teyhuinti*, which signifies "intoxicating."[6] In this connection it is interesting to note that this Nahuatl word, *teyhuinti*, or *teyuinti*, (from yuinti, to be drunk) survives, in the form of *tejuino* or *tehuino* in the State of Jalisco, Mexico, and *tesuino* or *tizwin* in the south-western United States, as the name of certain intoxicating drinks, the principal of which is a kind of beer brewed from malted maize.

Determination of the drug

Three centuries of investigation have failed to reveal an endemic fungus used as an intoxicant in Mexico, nor is such a fungus mentioned either in works on mycology or pharmacography; yet the belief prevails even now that there is a narcotic Mexican fungus, and it is supported by Simeon in his monumental dictionary of the Nahuatl language, in which the following definitions occur:

> "*Teonanacatl*, espèce de petit champignon qui a mauvais gout, enivre et cause des hallucinations; il est médicinal contre les fièvres et la goutte."[7]
>
> "*Teyuinti*, qui enivre quelqu'un, enivrant; *teyuinti nanacatl*, champignon enivrant."[8]

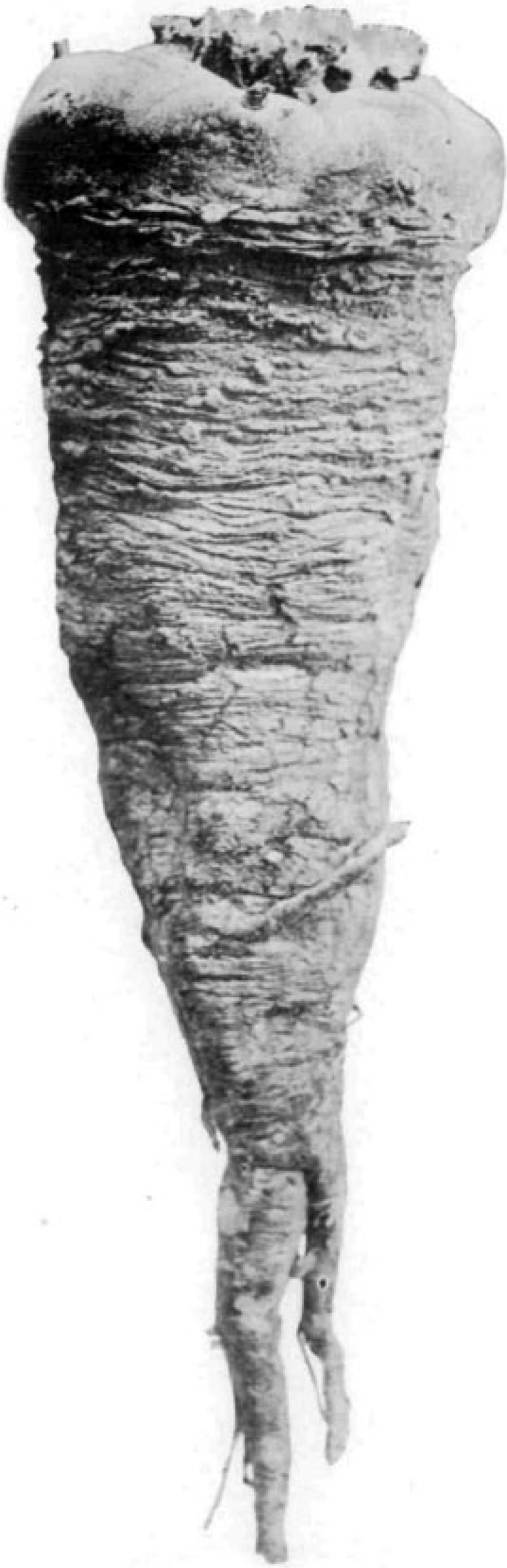


Fig. 2 - THE "DEVIL'S ROOT"
Peyotl Zacatecensis (*Lophophora williamsii*). "The root is of nearly medium size, sending forth no branches nor leaves above ground, but with a certain wooliness adhering to it. [On account of its magic properties] this root scarcely issues forth, but conceals itself in the ground, as though unwilling to harm those who may discover it and eat it." - Francisco Hernandez, 1576. Photograph natural size.

In connection with his study of the economic plants of the Mexicans and the Indians of the south-western United States the writer has sought diligently for a fungus having the properties attributed to the *teonanacatl*. As this narcotic was used by various tribes of *Chichimecas*, and the Chichimecas inhabited the territory situated in what is now northern Mexico and the southwestern United States, it was natural to look for the plant in this region. No such fungus, however, was discovered, but in its place a narcotic plant having properties exactly like those attributed to the *teonanacatl* was encountered; moreover, one form of this plant, when prepared as a drug, resembles a dried mushroom so remarkably that at first glance it will even deceive a trained mycologist. It is discoid in form and apparently peltate when seen from below; but the upper surface bears tufts of silky hairs, and a close inspection reveals the fact that it is the crown of a small fleshy spineless cactus which has been cut off and dried. The cactus in question, *Lophophora williamsii*, when entire, resembles a carrot or radish rather than a mushroom, and when cut into longitudinal slices or irregular pieces, would never be mistaken for a fungus. For this reason the drug prepared in the latter form was not recognized in southern Mexico as the same as the discoid form, and it was called *peyotl* by the Aztecs, while the name *nanacatl* was applied to the latter.

Identity with the narcotic peyotl

Sahagun, who described the drugs of the ancient Mexicans from specimens brought to him by Indian herb doctors, failed to recognize the identity of the *teonanacatl* and *peyotl* of the Chichimecas, although he attributes similar narcotic properties to each. The latter he describes as follows:

> "There is another herb, like tunas[9] of the earth; it is called *peiotl*; it is white; it is produced in the north country; those who eat or drink it see visions either frightful or laughable; this intoxication lasts two or three days and then ceases; it is a common food of the Chichimecas, for it sustains them and gives them courage to fight and not feel fear nor hunger nor thirst; and they say that it protects them from all danger."[10]

The plant itself was described by Hernandez as follows, under the heading *De Peyotl Zacatecensi, seu radice molli et lanuginosa*.

> "The root is of nearly medium size, sending forth no branches nor leaves above ground, but with a certain woolliness adhering to it on account of which it could not be aptly figured by me. Both men and women are said to be harmed by it. It appears to be of a sweetish taste and moderately hot. Ground up and applied to painful joints it is said to give relief. Wonderful properties are attributed to this root (if any faith can be given to what is commonly said among them on this point). It causes those devouring it to be able to foresee and to predict things; such, for instance, as whether on the following day the enemy will make an attack upon them; or whether the weather will continue favorable; or to discern who has stolen from them some utensil or anything else; and other things of like nature which the Chichimecas really believe they have found out. On which account this root scarcely issues forth, but conceals itself in the ground, as if it did not wish to harm those who discover it and eat it."[11]

From the above description, which applies perfectly to the plant from Zacatecas shown in fig, 2, it follows that the *Peyotl zacatecensis* of Hernandez is identical with *Lophophora williamsii*. Specimens of the drug collected at Zacatecas by the late Dr. Edward Palmer are shown in Fig. 3. They bear little resemblance to the mushroom-like buttons shown in Fig. 1, and it is not surprising that they should have been supposed to be distinct from the *teonanacatl* by the early Spanish writers.

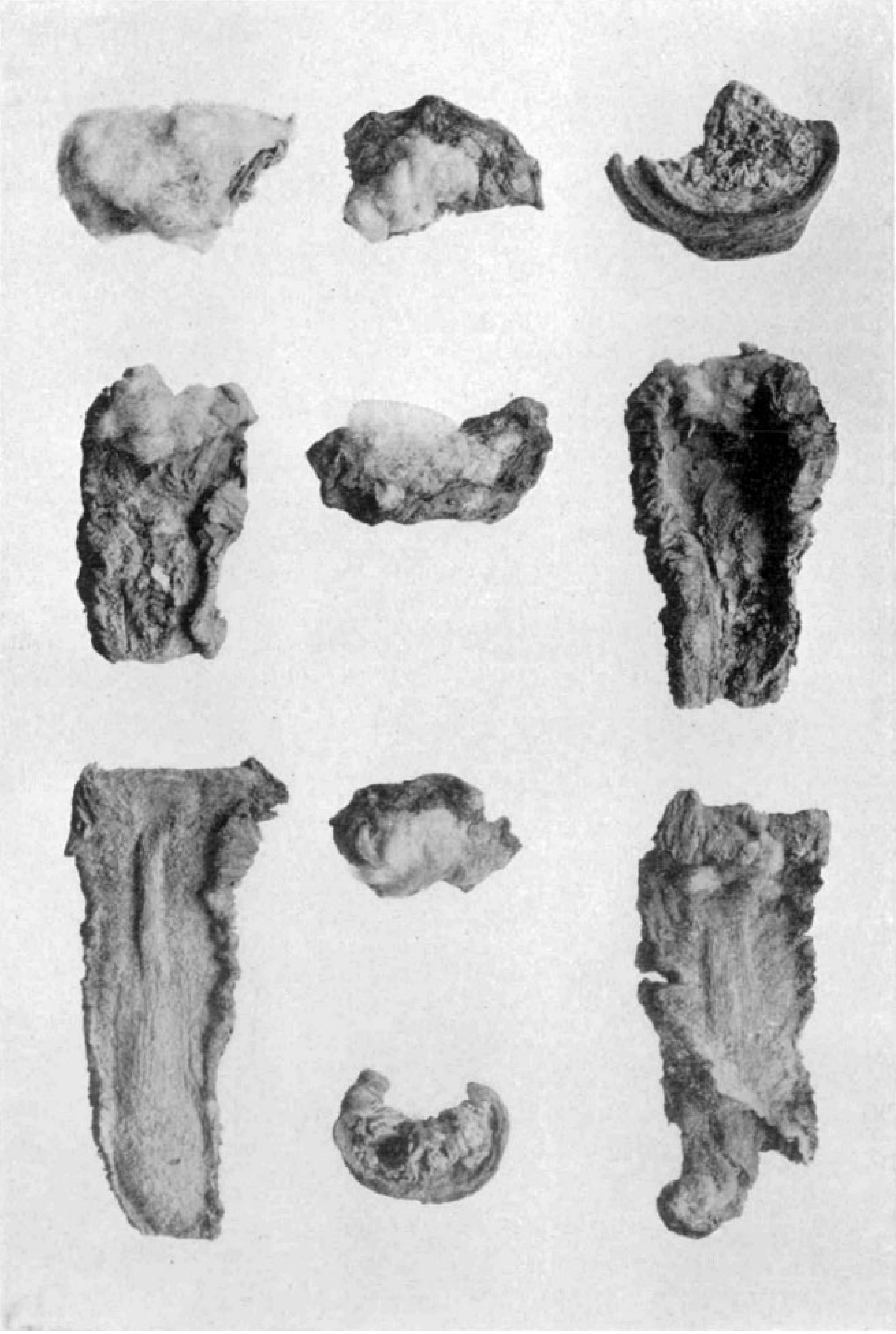


Fig. 3 - PEYOTE OF ZACATECAS, *Lophophora willamsii*
This form of the narcotic drug was called by the early Spanish missionaries "Raiz diabolica," or Devil's Root. Photograph of material in the Economic Collection, U. S. Department of Agriculture, collected at Zacatecas, Mexico, by the late Edward Palmer.

Raiz diabolica, or devil's root

By this name it was designated by Padre Jose Ortega, who tells of its use by the Cora Indians in his Historia del Nayarit, published anonymously at Barcelona in 1754, and republished under his own name in 1887. In describing their nocturnal dances he writes as follows:

> Close to the musician was seated the leader of the singing whose business it was to mark the time. Each of these had his assistants to take his place when he should become fatigued. Nearby was placed a tray filled with peyote which is a diabolical root (*raiz diabolica*) that is ground up and drunk by them so that they may not become weakened by the exhausting effects of so long a function, which they began by forming as large a circle of men and women as could occupy the space of ground that had been swept off for this purpose. One after the other went dancing in a ring or marking time with their feet, keeping in the middle the musician and the choir-master whom they invited, and singing in the same unmusical tune (*el mismo descompasado tono*) that he set them. They would dance all night, from 5 o'clock in the evening to 7 o'clock in the morning, without stopping nor leaving the circle. When the dance was ended all stood who could hold themselves on their feet; for the majority from the *peyote* and the wine which they drank were unable to utilize their legs to hold themselves upright."[12]

The early missionaries were opposed to the drug not so much on account of its physiological effects upon the Indians but because of its connection with certain superstitious rites connected with their primitive religion. Eating the *teonanacatl*, or *peyotl*, was declared by the padres to be almost as grave a sin as eating human flesh. In a little religious manual published by Fray Bartholomé Garcia in 1760, for the use of the missionaries to the Indians of San Antonio, Texas, the following questions, to be used in the confessional, are printed:

> "Has comido carne de gente?" (Hast thou eaten flesh of man?)
>
> "Has comido el peyote?" (Hast eaten the peyote?)[13]

The name *teonanacatl* is now obsolete. The drug is called by various names among the Indians using it: *xicori* by the Huicholes of Jalisco; *hikori*, or *hikuli*, by the Tarahumaris of Chihuahua; *huatari* by the Cora Indians of the Tepic mountains; *kamaba* by the Tepehuanes of Durango; *ho* by the Mescalero Apaches of New Mexico, who formerly ranged as far south as Coahuila; *seni* by the Kiowas; and *wokowi* by the Comanches, some of whom formerly lived in the state of Chihuahua. The name *peyote* has survived as a general commercial term; and the mushroom-like discs from the Rio Grande region are now widely spread among the northern Indians of the United States under the misleading names of "mescal buttons" or "mescal beans," as well as under the Nahuatl name *peyote*.

This name is of Aztec origin, derived from *peyotl*, the Nahuatl word for "cocoon." That its application to Lophophora was not general in early times is shown by the fact that Dr. Leonardo Oliva, professor of Pharmacology at the University of Guadalajara, declared it a singular thing that the *peyote* was regarded by the Mexicans as a plant having the virtue of giving unusual endurance to those using it, and the power of walking great distances without tiring. The only plant known to him by this name was a yellow-flowered Composite, with velvety tuberous roots, which from their form and indument might easily be likened to the cocoon of a moth.[14] As a matter of fact this name is still commonly applied to several species of Cacalia, the principal one of which, *Cacalia cordifolia*, is common in the vicinity of Guadalajara, Jalisco, in the drug markets of which the root is offered for sale under the name *peyote*.

Cacalia also called peyotl

The genus Cacalia belongs to the section Senecioneae, which includes Arnica, Tussilago, and other medicinal plants. To this genus should be referred the *Peyotl xochimilcensis* and the *Nanacace* of Hernandez, both of which are composites endemic in the neighborhood of Xochimilco, in the valley of Mexico, having a single stem growing from the middle of a cluster of nut-like tubers, with a terminal cluster of yellow-flowered rayless heads subtended by a scarious involucre. They should not be confused with the narcotic cactus called peyotl or peyote.

The peyote of Guadalajara, *Cacalia cordifolia*, was first described botanically by Kunth from specimens collected by Humboldt and Bonpland at Santa Rosa, Mexico. Its tubers, about the size of walnuts or hickory nuts, are covered with soft woolly hairs. From the center one of the cluster rises a single smooth terete stem bearing alternate, thickish, conspicuously net-veined leaves. The lower leaves are long-petioled, the upper ones, near the terminal inflorescence, are short-stemmed and much, smaller. The blades are roundish or broadly ovate, cordate at the base and angled on the margin. The flower heads are arranged in the form of a corymb, with many tubular 5-toothed flowers crowded on a naked flat receptacle, subtended by an involucre cupshaped in form, composed of many narrow acute teeth. There are no marginal ray-flowers. The disc-flowers have both stamens and pistils, the latter with an exserted forked stigma. The pappus is pilose, somewhat resembling thistledown when mature.

Fig. 4 shows the woolly tubers, reticulate leaves, and mature inflorescense of *Cacalia cordifolia*, photographed from material in the United States National Herbarium, collected by the writer in February, 1907, in the vicinity of Guadalajara, state of Jalisco, Mexico.

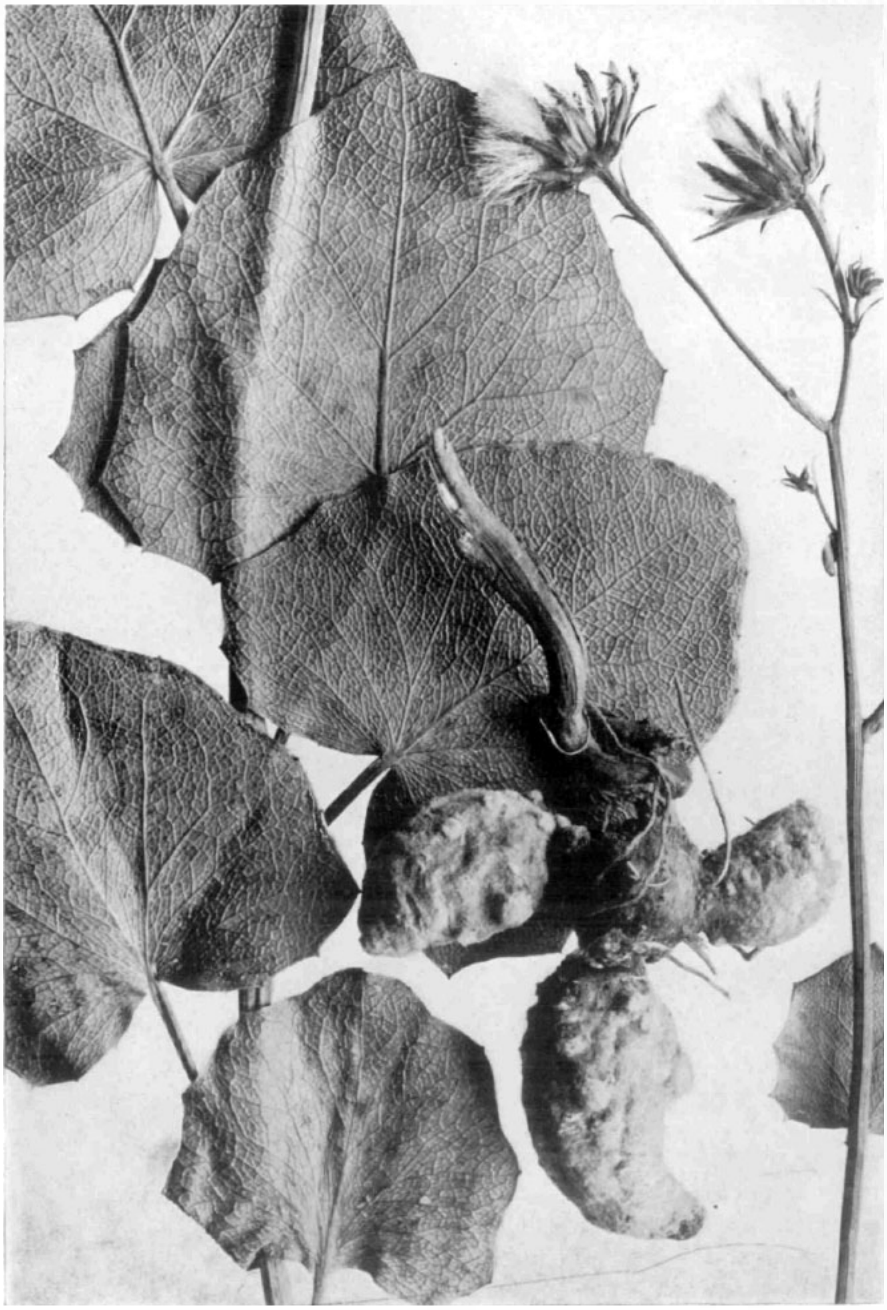


Fig. 4 - PEYOTE OF JALISCO, *Cacalia cordifolia*, **H. B. K.**
A member of the Composite, or daisy family, bearing velvety tubers; closely allied to the *Peyotl Xochimilcensis* of Hernandez. The tubers, called peyotl ("cocoons"), have medicinal properties, but they are not narcotic. Photograph of specimen in the U. S. National Herbarium collected near Guadalajara in 1907 by W. E. Safford. Photograph natural size.

Other specimens in the herbarium are from the Pedregal, or lavabeds, near Tlalpan, in the Federal District of Mexico, corresponding very closely with the descriptions of *Peyotl xochimilcensis*: of Hernandez; and from Alvarez, state of San Luis Potosi, where the tubers, locally known as *cachan*; are offered for sale in the drug-markets as an aphrodisiac and a remedy for sterility.

The genus lophophora

The genus Lophophora was based by Coulter upon a small plant described in 1845 by Lemaire, in the Allgemeine Garten-Zeitung, under the name *Echinocactus williamsii*. This plant, though suggesting certain echinocacti by its form differs essentially from all species of that genus in its fruit, which is devoid of scales, and resembles the smooth club-shaped "chilitos" of the Mamillarias. The plant is also devoid of spine-bearing areoles. In 1886 it was referred to the genus Anhalonium, which it resembles in its flowers and fruits,, but from the type of which it differs in several important features.

The genus Anhalonium, defined by Lemaire in 1839, proved to be identical with the genus. Ariocarpus previously established by Scheidweiler, the type of which, *Ariocarpus retusus*, described in 1838, is specifically identical with, the plant described the following year by Lemaire as *Anhalonium prismaticum*.[15] This fact was recognized in 1845, by Salm-Dyck, who, however, adopted the generic name *Anhalonium*.[16] On account of the laws of priority the generic name Ariocarpus must be retained and its synonym Anhalonium be dropped.

In the genus Ariocarpus (Anhalonium) the tubercles are very prominent, usually more or' less triangular or pyramidal in shape, and imbricating somewhat like the scales of an artichoke. The lower and upper parts are very different, the former comparatively thin and flat, while the upper exposed triangular part is very thick and hard. The lower surface of the tubercles is smooth and keeled, the upper surface is plane, as in *Ariocarpus retusus*; or convex and irregularly mamillate, with the acuminate apex bearing a woolly pulvillus, as in *Ariocarpus furfuraceus*; or more or less fissured and presenting a warty appearance, as in *Ariocarpus fissuratus*. One of these species is figured by Lumholtz under the name of *hikorisunami*,[17] and it is said by him to be more powerful than the common *hikori sunami* (*Ariocarpus williamsii*), but he offers no evidence that it has narcotic properties. The Indians declare that if you wear this plant as an amulet the bears cannot harm you nor the deer run away from you. The latter superstition is also held in connection with the closely related *Ariocarpus kotschubeyanus*, commonly called" pezuña de venado," (Fig. 5) probably on account of the close resemblance of its tubercles to the hoof of a deer.

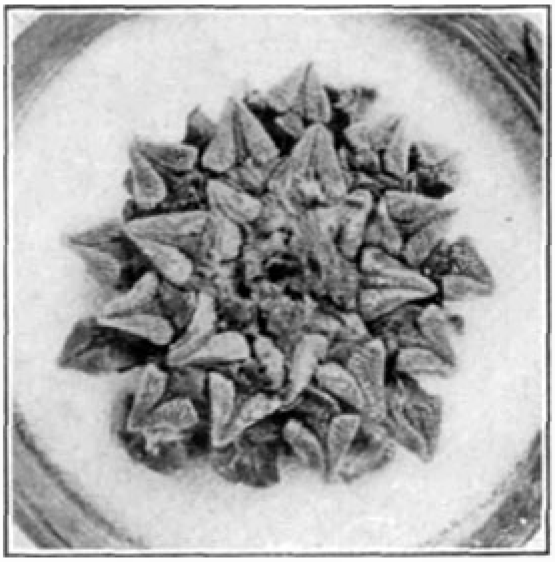


Fig. 5 - DEER-HOOF CACTUS
Ariocarpus kotschubeyanus, a plant with supposed magic properties, highly prized by Indians of northern Mexico, who declare that if the hunter wears this cactus (here shown natural size), the deer can not run away from him. It probably owes this prestige to the resemblance of its tubercles to the hoofs of a deer.

In the genus Lophophora the tubercles are quite unlike those of Ariocarpus (Anhalonium), being devoid of a differentiated upper part and having the lower part broad and rounded. Instead of being developed into pyramidal or triangular projections the tubercles often coalesce into broad continuous vertical or somewhat spiral ribs (Fig. 7), and in young specimens the plant appears almost smooth, with the tubercles separated by shallow impressed lines (Fig. 9).

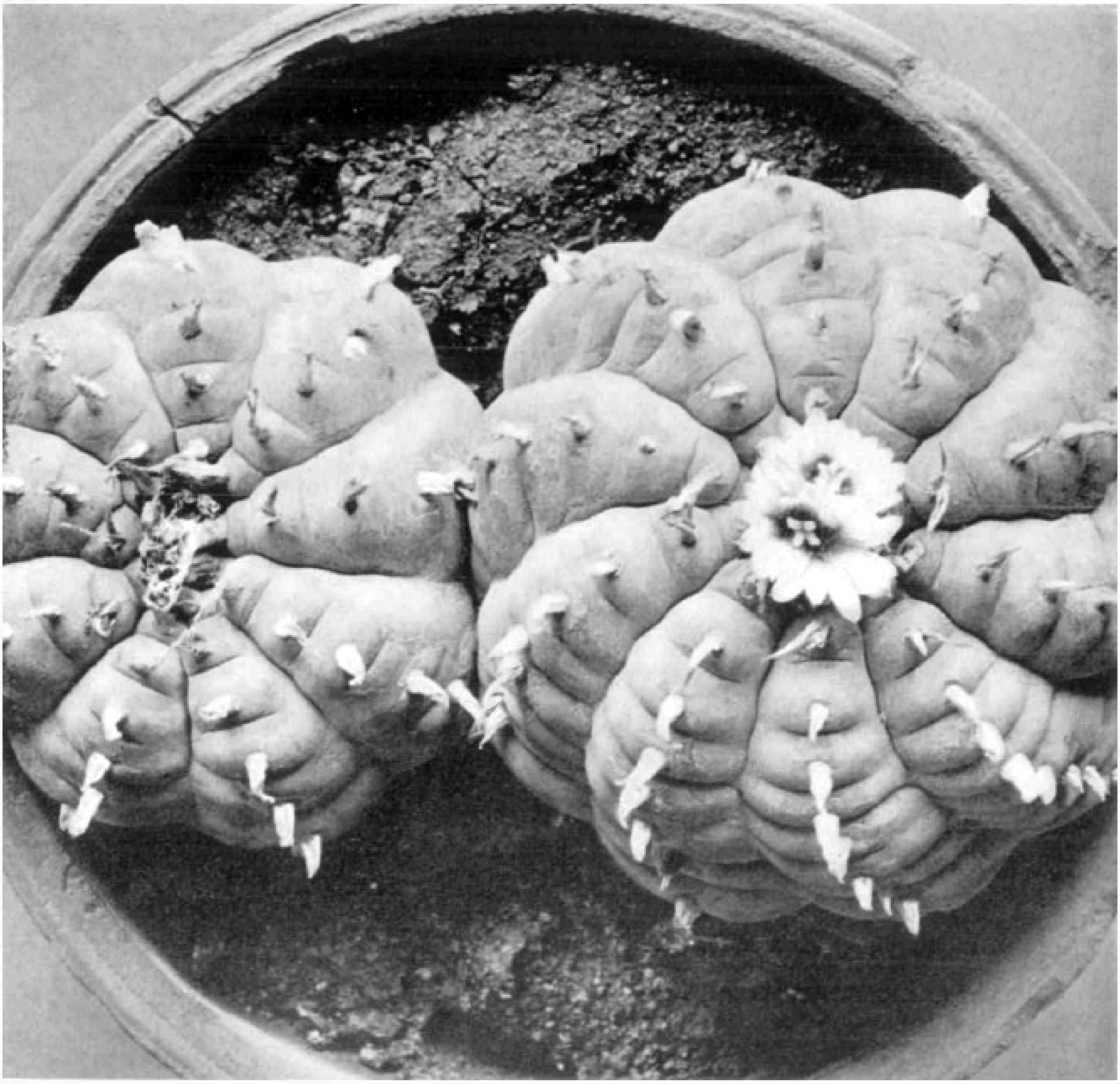


Fig. 7 - LOPHOPHORA WILLIAMSII
Typical form with defined ribs. Photograph of specimen in the Cactus House of the U. S. Department of Agriculture, collected in 1910, on the Hacienda de Cedros, near Mazapil, state of Zacatecas, Mexico, by Dr. Elswood Chaffey. Photograph natural size.

Lophophora williamsii

Lophophora williamsii (*Anhalonium williamsii* Lemaire) is a succulent spineless cactus, usually shaped like a turnip or carrot with a depressed-globose or hemispherical head bearing low inconspicuous tubercles and a tapering tap root. The tubercles occur normally in longitudinal ribs, but in some forms of the plant they are arranged spirally or irregularly. In the center of each tubercle there is a flower-bearing areole with a dense tuft of erect hairs, from the midst of which the flower issues. When mature the tuft of hairs persists as a pulvillus in the form of a pencil or brush of hairs. Unlike the plants of the genera Echinocactus and Mamillaria there is no spine-bearing areole. The flower (Fig. 6) is very much like that of an Ariocarpus, without a well-defined calyx, but with the outer floral leaves sepal-like and the inner ones petal-like and rose-tinted, with a darker median line on the back of each, giving to it a feather-like appearance. The stamens are numerous, with white filaments and bright yellow anthers: and the style bears four pale yellow stigmas projecting above the mass of stamens. The ovary is devoid of scales, in which respect it differs from that of the genus Echinocactus, and the smooth crimson or rose-colored club-shaped fruit resembles that of a Mamillaria. The plants grow either solitary, or, more frequently, in clusters of several from a common base.

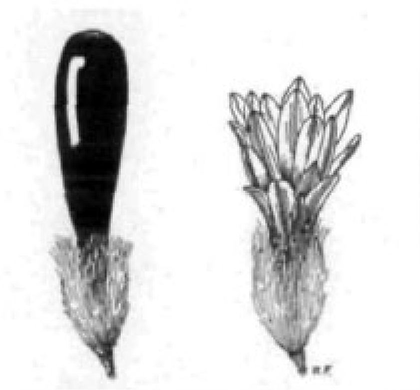


Fig. 6 - FRUIT AND FLOWER
Flower of *Lophophora williamsii* (at the right) with rose-tinted petals, issuing from a tuft of hairs, while the fruit (shown at the left) is pink or crimson. Drawing natural size.

Lophophora williamsii is quite variable, sometimes its ribs instead of being vertical are more or less diagonal or spiral, and instead of being separated by straight grooves the latter are sinuous; or the tubercles may be irregularly arranged. One form was described by Hennings as a distinct species under the name *Anhalonium lewinii*;[18] but the type plant described and figured by him was a boiled up "mescal-button" obtained from Parke, Davis & Co., of Detroit, Michigan, in all probability gathered in the vicinity of Laredo, Texas. In this form the ribs are usually thirteen in number separated by strongly sinuous grooves (Fig. 9). Sometimes there are twelve ribs or even as few as nine; while in the typical *L. williamsii* there are usually eight ribs separated by straight or almost straight lines, or sometimes as many as 10. It has been wrongly asserted that the petals of *L. lewinii* are yellow: typical plants of this form now blooming in the cactus house of the United States Department of Agriculture (May, 1915) have rose-tinted flowers in no way distinguishable in form or color from those of *L. williamsii*. Indeed, in specimens collected by Lloyd in Zacatecas typical plants of *L. williamsii* and *L. lewinii* are to be found in the same cluster growing from a common base. Another form (Fig. 10) departs from the typical *L. williamsii* even more than the plant figured by Hennings. It has the tubercles more or less irregularly arranged and separated into angular areas by intersecting lines. In young plants the surface is smooth, but in older plants (Fig. 8) the tubercles are often prominent. At first the writer was inclined to separate this form from both *L. williamsii* and *L. lewinii*, but after carefully comparing a number of specimens the three types seem to be connected by intermediate forms, and they cannot, therefore, be specifically distinct. Indeed as they sometimes grow from the same base it would be improper even to designate them as varieties.

Geographical distribution

The general range of the genus Lophophora is from southern Texas along the valley of the Rio Grande, from the mouth of the Pecos River south-eastward, to southern Querétaro, Mexico. Definite localities in which plants have been collected are the following:

Texas. - Mouth of the Pecos River, *William Lloyd*; vicinity of Laredo, *Mrs. Anna B. Nickels* (specimens now growing in the cactus house of the U. S. Department of Agriculture); near Ojuelos, *C. Ochoa* (dried specimens in the form of "mescal buttons" in the economic collection of the U.S. Department of Agriculture); near Aguilares (specimens sent by parcel post to the Menominee Indians, now in possession of the Bureau of Chemistry).

Tamaulipas. - In the vicinity of Nuevo Laredo, *Mrs. Anna B. Nickels*; near Camargo, south shore of the Rio Grande at the mouth of the Rio San Juan, *E. A. Goldman*, of the U. S. Biological Survey.

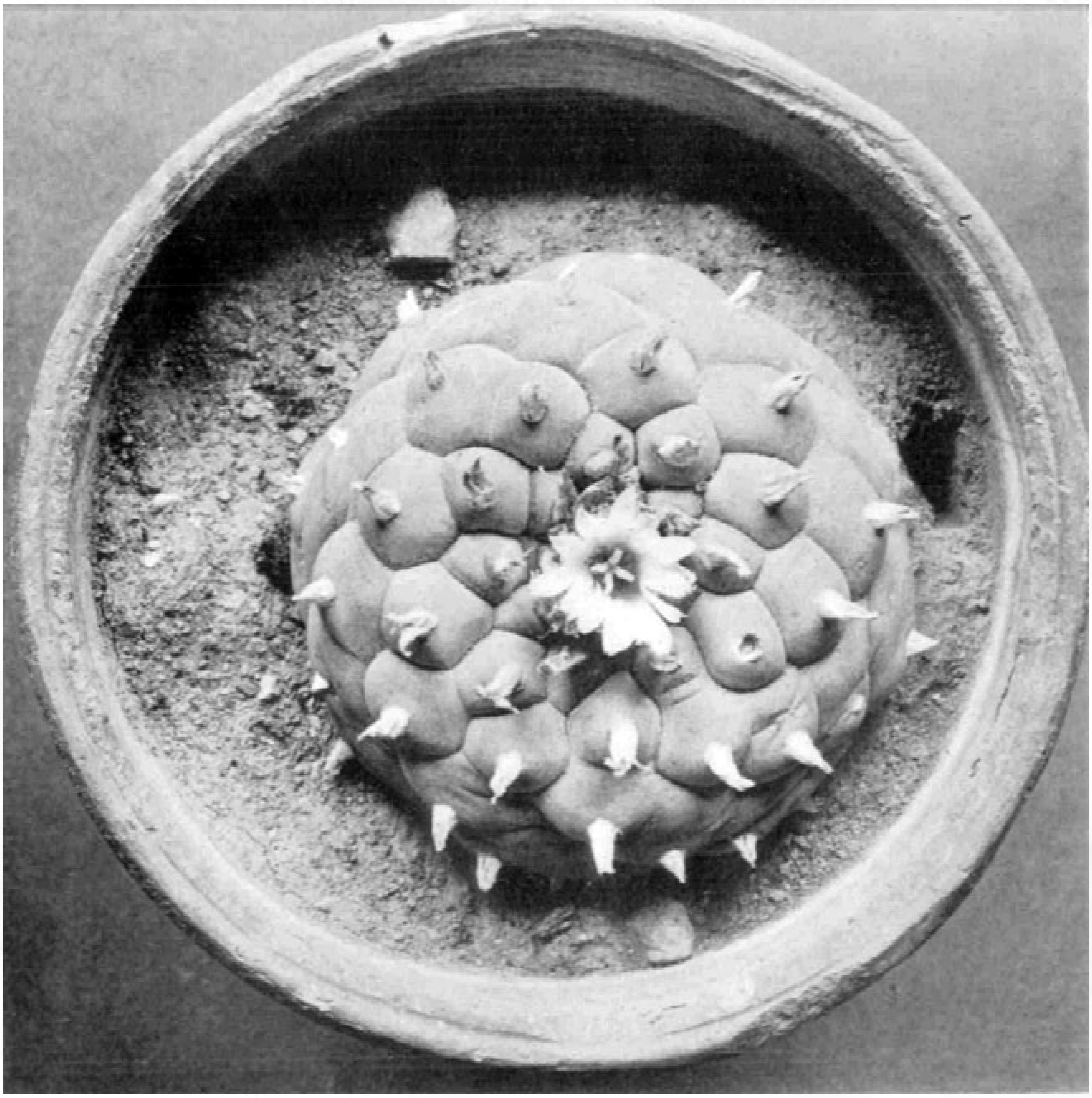


Fig. 8 - ANOTHER TYPE OF LOPHOPHORA
Form described by Hennings as a distinct species, *Anhalonium lewinii*, but often occurring in the same cluster with the typical form, growing from the same root. Photograph of specimen in the Cactus House of the U. S. Department of Agriculture, collected in the state of Zacatecas, Mexico, in 1908, by F. E. Lloyd. Photograph natural size.

Nuevo Leon. - Vicinity of Monterrey, *Professor Emilio Rodriguez*, (specimens growing in the cactus garden of the Colegio Civil, at Monterrey).[19]

Coahuila. - Cerro del Pueblo, near Saltillo, *Dr. Edward Palmer* (living plants in cactus house, U. S. Department of Agriculture; dried plants in economic collection).

Chihuahua. - Near Jimenez, in the Sierra de Amole (locality in which the Tarahumari Indians collect their supply for ceremonial purposes); near Santa Rosalía de Camargo, in the Sierra de Amargosa (also visited by the collecting expeditions of the Tarahumari Indians, as stated by Lumholtz).

San Luis Potosi. - Vicinity of Real de Catorce as cited by *Diguet* (locality whence the Huichol Indians obtain their supply).

Zacatecas. - Vicinity of Cedros, near Mazapil, near northern boundary, *Professor F. E. Lloyd* and *Dr. E. Chaffey* (living plants in the cactus house of the U. S. Department of Agriculture; also dried specimens from the market of the city of Zacatecas in the economic collection).

Querétaro. - Near Higuerillos, not far from the city of Querétaro, *Dr. J. N. Rose* (specimen in cactus house of the Department of Agriculture).

Chemical history of the drug

Attention was called to the use of this plant as an intoxicant by the Indians by Mrs. Anna B. Nickels of Laredo, Texas, who collected material for Parke, Davis and Co., of Detroit, Michigan, and for other wholesale dealers in drugs. Mrs. Nickels suggested that a chemical and therapeutic study of the plant be made, and stated that the plant was also used for "breaking fevers," and that the tops cut off and dried were locally known as " mescal buttons." The accompanying photograph of this veteran cactus-lover and assiduous collector, in her cactus garden at Laredo, was taken by David Griffiths of the U.S. Department of Agriculture.

A serious study of its properties was first begun in 1888, by Dr. L. Lewin of Berlin, who used for the purpose specimens obtained from Parke, Davis, and Company. It was afterwards studied by Dr. Arthur Heffter of the Pharmacological Institute of the University of Leipsic; and, in the United States, by a group of persons at Washington, centering in the Bureau of American Ethnology, and including as associates the Division of Chemistry of the Department of Agriculture for chemical analysis; Drs. D. W. Prentiss and Francis P. Morgan of the department of Materia Medica and Therapeutics of the Columbian University, for the study of its physiological properties; and the Botanical Division of the Department of Agriculture for the settlement of botanical questions. The material for the studies carried on in this country was supplied by James Mooney of the Bureau of American Ethnology. The chemical analysis was made by Ervin E. Ewell, who announced his results in a paper entitled "The Chemistry of the Cactaceae," read before the Washington Section of the American Chemical Society, April 9, 1896.[20]

Dr. Lewin obtained from the drug an alkaloidal substance which he called anhalonin. This substance was a brown, syrup-like liquid, having an intense alkaline reaction. From it Heffter obtained three alkaloids; the first, which he called anhalonin, was in the form of brilliant, colorless, needle-shaped crystals; the second was in the form of non-lustrous, white rhombic tables; the third was an amorphous and very poisonous alkaloid left behind by the mother liquor.

Mr. Ewell found, in addition to the alkaloids, at least two resinous bodies, and a wax-like substance insoluble in cold alcohol but soluble in hot alcohol, petroleum ether, and chloroform. The resinous bodies, of a dark brown color and thick consistency, have the characteristic taste and odor of the moistened drug itself. It was suggested that the drug's activity might be due to these resinous bodies rather than to the alkaloids. One marked peculiarity of the plant is that about one-half its ash proved to be potassium chloride - a proportion greater than that hitherto found in any other plant.[21]

Physiological action

Further investigations are about to be made in the Bureau of Chemistry by Dr. Lyman F. Kebler, chief of the division of drugs, and Dr. Francis P. Morgan, whose work in this drug has already been referred to.

The various accounts of the effects of Lophophora differ considerably; but nearly all of those who have experimented with it, including Dr. S. Weir Mitchell, agree in the statement that it produces beautiful color visions. The pupil becomes dilated and remains in this condition for some time, often for twenty-four hours, and at the same time there is a slight loss of the power of accommodation and consequent disturbance of vision. Depression of the muscular system has been observed as one of its effects, either well marked or indicated only by inactivity and lazy contentment; and sometimes this was followed by partial anesthesia of the skin after the effects of the drug began to disappear. Sometimes the patient was seized with nausea and vomiting, caused perhaps by the bitter and unpleasant taste of the drug when first put into the mouth. In some cases there was a marked loss of the sense of time. The effects of the drug have been compared with those of Indian hemp (*Cannabis indica*), which has found its way from the Eastern Hemisphere to Mexico and the southwest United States, where it is known as *marihuana*; but instead of the exciting effect of the latter, Lophophora produces rather a state of ideal content, with no tendency to commit acts of violence.

A detailed account of the experiments of Drs. Prentiss and Morgan was published in the Therapeutic Gazette of September 16, 1895, pp. 580-585.[22]

Ceremonial use by the Indians

The first to bring to public notice the ceremonial use of this narcotic by existing tribes of Indians was James Mooney of the Bureau of American Ethnology, in a paper read before the Anthropological Society of Washington on November 3, 1891. His attention had been directed to it while making investigations among the Kiowas, who are descendants of one of the tribes known to the Aztecs by the name of "Chichimecas." Mr. Mooney found that these Indians attribute divine powers to the drug and the ceremony attending its use is of the nature of a religious rite in which all the tribes of the southern plains take part.

The Kiowas and other Indians of Oklahoma receive the greater part of their supply of the drug from traders who bring it from the vicinity of Laredo, Texas, in the form of "mescal buttons," which are identical with the *teonanacatl* of the ancient Mexicans. Like the ancient Mexican feasts referred to above, their meetings are nocturnal, usually beginning Saturday night. A summary of Mr. Mooney's account was published in the Therapeutic Gazette of September 16, 1895. A more detailed description was published by Mr. Mooney the following January, in the same journal, from which the following extracts are taken.

"The ceremony occupies from twelve to fourteen hours, beginning about 9 or 10 o'clock and lasting until nearly noon the next day. Saturday night is now the time usually selected, in deference to the white man's idea of Sunday as a sacred day and a day of rest. The worshipers sit in a circle around the inside of the sacred tipi, with a fire blazing in the center. The exercises open with a prayer by the leader, who then hands each man four mescals, which he takes and eats in quick succession, first plucking out the small tuft of down from the center. In eating, the dry mescal is first chewed in the mouth, then rolled into a large pellet between the hands, and swallowed, the man rubbing his breast and the back of his neck at the same time to aid the descent. After this first round the leader takes the rattle, while his assistant takes the drum, and together they sing the first song four times, with full voices, at the same time beating the drum and shaking the rattle with all the strength of their arms. The drum and rattle are then handed to the next couple, and so the song goes on round and round the circle - with only a break for the baptismal ceremony at midnight, and another for the daylight ceremony - until perhaps 9 o'clock the next morning. Then the instruments are passed out of the tipi, the sacred foods are eaten, and the ceremony is at an end ... The dinner, which is given an hour or two after the ceremony, is always as elaborate a feast as the host can provide. The rest of the day is spent in gossiping, smoking, and singing the new songs, until it is time to return home."[23]

Among the Tarahumaris

Lumholtz, in his account of the plant-worship of the Tarahumari Indians of the southwestern Chihuahua, mentions several kinds of cacti which they regard with superstitious veneration; but there is no evidence that any of these have narcotic properties except the "hikori huanami," which is the typical *Lophophora williamsii*. A species of Ariocarpus (probably *A. fissuratus*) was sold to him under the name of "hikori sunami," and was declared by the vendor to have certain magical powers; but he did not see it used as an intoxicant. Much that Lumholtz relates in connection with the ceremonial use of the narcotic hikori appears extravagant and fanciful; but it is undoubtedly true that the Tarahumari Indians, like their more southerly neighbors the Coras and Huicholes, have been led by the wonderful visions induced by the plant to attribute to it supernatural powers. Even the Christians among them salute it and make the sign of the cross when approaching it, and it is often carried by them as a charm or amulet. They declare that Hikori sits next to God and is called "uncle," because it is God's brother.

It will be shown later that a similar superstition is common among some of the Indian tribes of the United States who pay to the plant divine homage. In some of their religious societies there is a ceremony of baptism in which the candidate is sprinkled with an extract of the plant, and also a kind of communion in which the plant is eaten as an incarnation of the Deity, or the flesh of God.

Lumholtz gives an account of the expeditions of the Tarahumaris in quest of hikori, describing their consecration with copal incense before starting out, their ten-days' journey to the land of the Hikori, the erection of a cross on their arrival, the superstitious observances attending the gathering of the plant, which recall the stories of the early European herbalists regarding the mandrake and other magic plants, and the ceremonies attending their return.

The Indians of the village go out with music to welcome the travellers, bearing their precious burden; and at night there is a festival of teswin-drinking and dancing in honor of the plant. The hikori is piled in a heap at the foot of a cross, and is sprinkled with teswin, which is grateful to it; and the next day a sheep or even an ox or two goats are sacrificed in its honor. The wild heathen Indians living in caves or under overhanging cliffs in the barrancas, when they hear of the return of the expedition, come to buy supplies of the hikori for their own use. "One plant," says Lumholtz, "costs a sheep, and the buyer holds a feast in honor of his purchase, and repeats the feast at the same time every year."[24]

Use by the Huicholes of Jalisco

The ceremonies attending the acquisition and use of the drug by the Indians of the Nayarit mountains of Jalisco and Tepic were described by Leon Diguet in 1899. These Indians belong to the tribes known as Huicholes, Coras, Tepehuanes, and Tepecanos. The Coras, whose use of the *raiz diabolica*, as described by Padre Ortega, has already been noted, now obtain their supply from the Huicholes. The latter send expeditions across the state of Zacatecas to Catorce in San Luis Potosi, where the plant is endemic. The specimens from Zacatecas in the Economic Collection of the Bureau of Plant Industry are not at all mushroom-like, but resemble dry pieces of radishes or carrots sliced longitudinally, or small, terminal fragments covered with silky wool, such as those . described by early writers as "*peyote de Zacatecas*." (See Fig. 3.) By the Huicholes the drug is known neither as peyote nor *teonanacatl*, but as *xicoli*, or *hicuri*, which is identical with the name *hikori* applied to it by the Tarahumari Indians.

According to Diguet the Huicholes collect the plant in October. The expedition lasts about one month, and its return is an occasion for celebration. "Those who take part decorate their hats and their hair with feathers and paint on their faces the distinctive attributes of their caste and of their gods. After having made an offering of peyote upon their altars they distribute pieces of it to all those they meet; a supply of peyote is kept for the feasts which will take place during the course of the year; the rest is sold to those who did not take part in the expedition.

"In eating the peyote the Indians chew the pulp of the plant, which has been cut up into small pieces, and at first spit out the saliva which at the beginning dissolves a bitter principle having a very disagreeable taste, then they absorb the active principle which dissolves little by little in the saliva."[25] According to Diguet the Indians regard the drug as food for the soul, and revere it on account of its miraculous properties. The manifestation of the hallucinations which it produces a little after the absorption of its active principle is held to be a supernatural grace by which men are permitted to communicate with the gods; and, moreover, "in using the drug with moderation the partaker is endowed with energy which permits him to overcome great fatigue and to endure hunger and thirst for five days."[26]

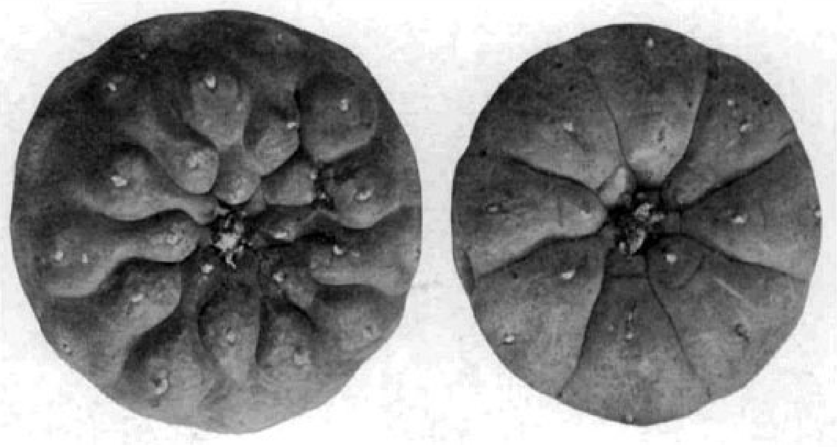


Fig. 9 - TEXAS TYPE
Specimens of Lophophora from the vicinity of Laredo, Texas; the upper one a typical *L. williamsii*, with eight ribs separated by straight grooves; the lower one identical with "*L. lewinii*," with 13 ribs seprated by sinuous grooves. Photographes from plants growing in Cactus House of U. S. Department of Agriculture; natural size.

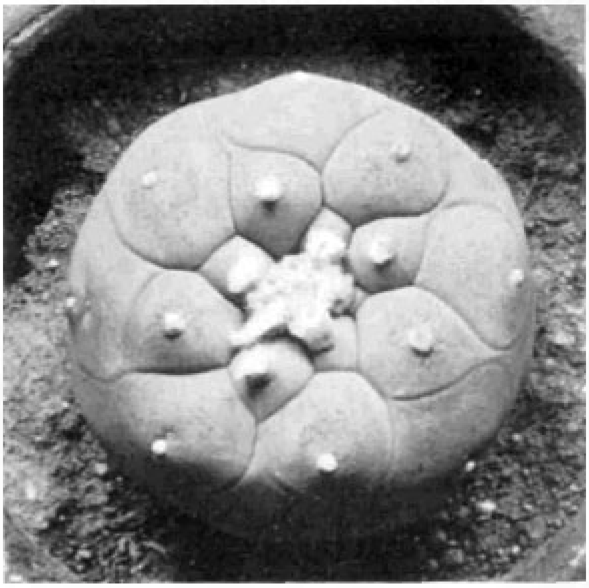


Fig. 10 - THE SOUTHERN TYPE
Young plant of Lophophora from Higuerillos, state of Queretaro, Mexico, the southern limit of the genus. Collected in 1905 by Dr. J. X. Rose. Photograph natural size.

Present use in the United States

Efforts have been made to prevent the spread of the drug among the Indians of the United States, and action has been taken in the courts to prosecute those who have been instrumental in procuring it and furnishing it. One of the most recent cases is that of the United States versus an Indian named Nah-qua-tah-tuck, alias Mitchell Neck, of the Menominee Indian Reservation. Wisconsin, accused of furnishing intoxicants to certain Indians, in violation of the law. Dr. Francis P. Morgan, of the Bureau of Chemistry, was summoned as a Government expert. The trial developed the following facts:

On March 15, 1914, the accused brought a supply of the drug in a dress suit case to the house of an Indian family named Ncconish, situated a short distance north of the village of Phlox, Wisconsin, near the western boundary of the Menominee Reservation, at which place there was a meeting of a religious nature. The drug had been received by parcel post from Aguilares, Texas. The participants first made a line about the house to keep out the evil spirits, and then invoked God, begging him to make all of them good and to keep them from evil. The peyote was next distributed, and when it was eaten caused the partakers to see the evil things they had done and showed them the good things they ought to do.

The ceremony began about 9 o'clock in the evening. One witness testified that shortly after having eaten four buttons he could see pictures of various kinds when his eyes were shut. First he saw God, with a bleeding wound in his side. This vision vanished when he opened his eyes, but reappeared when he closed them again. Then he saw the devil with horns and tail, of the color of a negro. Then he saw bad things which he had done before, bottles of whiskey which he had drunk, a watermelon which he had stolen, and so many other things that it would take all day to tell of them. Then he saw a cross with all kinds of colors about it, white, red, green and blue. He was not made helpless. He stated that he could have walked had he wished to do so, but that he preferred to sit still and look at the pictures.

Another witness testified that he ate the peyote so that his soul might go up to God. The witnesses who testified at this trial declared that the peyote helped them to lead better lives and to forsake alcoholic drinks. The defendent was acquitted on the ground that the meeting was one of a religious nature.

The peyote society

Thomas Prescott of Wittenberg, Wisconsin, testified that there is a regularly-organized association among the Indians called the Peyote Society, also known as the Union Church Society, of which he had been a priest for seven years. In the weekly ceremonies of this society the peyote is either eaten or taken in the form of tea. In his opinion the effect of the peyote is to make better men of the Indians. Many of them were formerly common vagabonds, liable to commit all sorts of crimes when under the influence of alcohol. After becoming members of the peyote society, however, they gave up drink, established themselves in regular homes, and lived sober and industrious lives. In relating his personal experience he made the following statements:

> "We boys, before we got this peyote, was regular drunkards; so when I was drunk I was lying on the road somewhere sometimes, and I got no home nor nothing. Before I got this I did wrong and everything else. Now, since I got this peyote, it stopped me from drinking, and now, since I used this peyote, I have been sober, and today I am sober yet ... I see a good and a bad when I eat that peyote. When I eat that peyote then it teaches me my heart; I know anything that is right and what is wrong. That is the way peyote works for good and works for God, and that is how we worship. ... When I took this peyote I could see myself when I used to be drunk; I could see the bottles which used to have my whiskey and alcohol in; I could see myself lying drunk in the road. That is the way it shows us the bad and teaches us the good. ... We could have our meetings without this peyote; but we see some more coming - a new person - he wants to use it - when he takes this peyote then he believes God. That is why we use it for. Without this, why, they would not believe anybody."[27]

Dr. Morgan gave to the court an account of his experiments bearing upon the physiological action of the drug administered in his presence to several young men who had volunteered for the purpose. The chief effect noticed was the production of visions of various kinds: of moving objects, constantly changing designs and figures of landscapes, friezes, balls of beautiful colors in constant motion. Suggestions of definite objects also brought up visions of that object. These visions were seen only when the eyes were closed. The pupil of the eye was made larger, and this enlargement lasted till the following day; the pulse became slower at first but increased when a greater quantity of the drug was taken; there was evidence of muscular depression with a disinclination to exertion of any kind; and there was a loss of conception of. space and time and, in some cases, symptoms of dual personality, not unlike that caused by hashish (*Cannabis indica*). The after effects, however, were insomnia, while hashish eating is usually followed by sleep. In this respect it also differs from opium and somewhat resembles the active principles of coffee and coca (*Erythroxylon coca*). Dr. Morgan further testified that as far as he knew no therapeutic or remedial value of the drug had been established.

At a meeting of the Lake Mohonk Conference in October, 1914, several papers relating to the effects of this drug upon the Indians were read and affidavits from two Omaha Indians were quoted. From one of the latter, I take the following extracts:

Among the Omaha Indians

At the meetings of the Society "before they sing they pass the peyote around. They begin taking this medicine along about dark, and when they pass it, ask you how many you want, and they often try to persuade you to take more than you want. The medicine does not work right away, but after it begins to take effect along toward midnight they begin to cry and sing and pray and stand and shake all over, and some of them just sit and stare. I used to sit in their range right along, and ate some of their medicine, but after I ate it the first time I was kind of afraid of it. It made me feel kind of dizzy and my heart was kind of thumping and I felt like crying. Some of-them told me that this was because of my sins. It makes me nervous, and when I shut my eyes I kind of see something like an image or visions, and when my eyes are open I can't see it so plain. One of these fellows took twelve beans, or twelve peyote, sitting with some girls ... After I have taken twelve peyote I saw a mountain with roads leading to the top and people dressed in white going up these roads. I got very dizzy and I began to see all kinds of colors, and arrows began to fly all around me. I began to perspire very freely. I asked to be taken out of doors. At that time it was 20° below zero. I felt better when I got out of doors. When I went in again I began to hear voices just like they came from all over the ceiling and I looked around in the other room and thought I heard women singing in there, but the women were not allowed to sing in the meetings usually, and so this was kind of strange. ... After eating thirty-six of these peyote I got just like drunk, only more so, and I felt kind of good, but more good than when I drink whiskey, and then after that I began to see a big bunch of snakes crawling all around in front of me, and it was a feeling like as if I was cold came over me. The treasurer of the Sacred Peyote Society ... was sitting near me, and I asked him if he heard young kittens. It sounded as if they were right close to me; and then I sat still for a long time and I saw a big black cat coming toward me, and I felt him just like a tiger walking up on my legs toward me, and when I felt his claws I jumped back and kind of made a sound as if I was afraid, and he asked me to tell him what was the matter, so I told him after a while. I did not care to tell at first; but I made up my mind then, after what I saw, that I would not take another one of these peyotes if they gave me a ten dollar bill. ... In this Sacred Peyote Society they have a form of baptism and they baptize with the tea made from stewing the peyote, and they baptize 'in the name of the Father, and the Son, and the Holy Ghost,' the Holy Ghost being the peyote. Then you drink some of the tea and they make signs on your forehead with the tea and then take an eagle's wing and fan you with it. I heard an educated Indian and he said in a meeting on Sunday morning, ' My friends, I am glad I can be here and worship this medicine with you; and we must organize a new church and have it run like the Mormon Church.'"[28]

Use in ancient Mexico

From the preceding description of a meeting of the Sacred Peyote Society held by the Winnebagos and Omahas in 1914 I turn back to the first account we have of the *Teonanacatl* feasts of the Aztecs, written by Padre Bernardino Sahagun in the sixteenth century - before Sir Francis Drake set out upon his voyage round the world - before tobacco which, under the name of *picietl*, the Mexicans also worshipped, was first brought to England

"The first thing eaten at the party was certain black mushrooms which they call *nanacatl*, which intoxicate and cause visions to be seen, and even provoke sensuousness. These they ate before the break of day, and they also drank cacao (chocolate) before dawn. The mushrooms they ate with syrup (of Maguey sap), and when they began to feel the effect they began to dance; some sang; others wept because they were already intoxicated by the mushrooms; and some did not wish to sing, but seated themselves in their rooms and remained there as though meditating. Some had visions that they were dying and shed tears; others imagined that some wild beast was devouring them; others that they were capturing prisoners in warfare; others that they were rich; others that they had many slaves; others that they had committed adultery and were to have their heads broken as a penalty; others that they had been guilty of a theft, for which they were to be executed; and many other visions were seen by them. After the intoxication of the mushrooms had passed off they conversed with one another about the visions which they had seen."[29]

The following description of a religious meeting in July, 1626, at which sacred mushrooms were administered in the form of communion, is related by Padre Jacinto de la Serna, at that time beneficiary of Tenantzingo.

"To this meeting had come an Indian, native of the pueblo of Tenango (about 25 kilometers from Toluca) and grand master of superstitions, named Juan Chichiton (or "John Little-dog"), who had brought some of the mushrooms that are gathered in the *monte*, and with these he had performed a great idolatry. But before proceeding with my story I wish to explain the nature of the said mushrooms, which in the Mexican language are called *Quauhtlananacatl* ("wild mushrooms"). When I asked the *licenciado* Don Pedro Ponce de Leon what they were like, he said that these mushrooms were small and yellow, and that they were collected by priests and old men, appointed as ministers for these impostures, who would proceed to the place where they grow and remain almost the whole night in prayer and in superstitious conjuring; and at dawn, when a certain little breeze known to them would begin to blow, then they would gather the narcotic, attributing to it deity, with the same properties as *ololiuhqui* or *peyote*, since when eaten or drunk, they intoxicate those who partake of them, depriving them of their senses, and making them believe a thousand absurdities."[30]

"This man, Juan Chichi ton, brought these mushrooms one night to a house where there was a gathering for the celebration of a saint's feast. The saint stood on the altar and below the altar were the mushrooms, with some pulque, and fire. All night long the *teponaztli* (wooden drum made from a hollowed log) kept time to the singing, and after the greater part of the night had passed, the said Juan Chichi ton, who was the priest of that solemnity, administered to all those congregated at the feast mushrooms and pulque after the manner of communion, winding up the celebration with an abundant quantity of pulque; so that the mushrooms on their part and the pulque on its, took away their reason, which was a pity. The said Juan Chichiton fled soon afterward, nor could I obtain information about the others who took part, in order to chastise them, with the exception of Leonor Maria, whom I kept as a prisoner in my house for having joined in the idolatry which they performed with the mushrooms."

Fig. 11 - MRS. ANNA B. NICKELS IN HER CACTUS GARDEN
This veteran cactus lover, a resident of Laredo, Texas, called attention to the narcotic properties of Lophophora, and supplied to Parke, Davis & Co. material with which to investigate the drug. Photograph by David Griffiths, U. S. Department of Agriculture.

"I asked the said *licenciado* Don Pedro Ponce de Leon in what manner these creatures perform their acts of witchcraft in working harm to others; and he told me that in making their threats and menaces they strike themselves on the breast as at the Sanctus with the tips of their fingers and then, opening their hand, they make a gesture as if hurling something in the direction of the person whom they are menacing or wish to bewitch, saying: 'You shall pay me for that, as you will see!' But concerning other words and things which they say and do by order of the devil in these *embustes*, never or scarcely ever could anything be ascertained; though it stands to reason that they must have them as a pact with the devil; and he, who is the author of all, closes their mouths, so that there may be no means of remedying the evil."[31]

Summary

After comparing the preceding accounts of the use of narcotics by the ancient Mexicans and by the Indians of the present day, separated in time by three centuries and in space by thousands of miles, there can remain no doubt that the mushroom-like peyote used by our own Indians in the United States, which we know to be identical with, the sacred *hikuli*, or *hicori*, of the Sierra Madre Indians, is the same drug which was called *teonanacatl*, or "sacred mushroom," by the Aztecs. According to the earliest writers, it was endemic in the land of the Chichimecas, the early home of our Apaches, Comanches, and Kiowas, which is also the source of the modern supply. The ancient Mexicans, like the Huicholes and Tarahumaris of the present day, obtained their supply of the drug through the medium of messengers, consecrated for the purpose, who observed certain religious rites in collecting it, and who were received with ceremonial honors on their return. Although the Indians on our northern reservations now receive it through the medium of the parcel post; yet they attribute to it the same divine properties as the ancient Mexicans and like them combine its worship with the religion they have received from Christian missionaries. It is only natural that those who arc engaged in the work of Christianizing and uplifting our Indians should try, like the early Spanish missionaries, to stamp out its use. On the other hand many of the Indians who use the narcotic declare that they take it as a kind of sacrament or communion, and that it helps them to turn from wickedness and lead good lives.

A knowledge of botany has been attributed to the Aztecs which they were far from possessing. Their plant names show that their classification of plants was not based upon real affinities, and it is very probable that they had not the slightest notion of the difference between a flowering plant and a fungus. Certainly they applied the names *nanacatl* and *nanacace* to both fungi and flowering plants and the name *peyotl* to both the narcotic cactus, Lophophora, and to the tuber-bearing composite, Cacalia. The botanical knowledge of the early Spanish writers, Sahagun, Hernandez, Ortega, and Jacinto de la Serna, was perhaps not much more extensive: their descriptions were so inadequate that even to the present day the chief narcotic of the Aztecs, *Ololiuhqui*, which they all mention, remains unidentified.[32] They knew these narcotic drugs only in their dry state; and the general appearance of the *peyotl* brought from the vicinity of Zacatecas (Fig. 3) was so very different from the *teonanacatl* from the more northerly region inhabited by the Chichimecas (Fig. 1) that the two forms might easily have been regarded as coming from distinct plants.

As far as the author knows, this is the first time that the identity of the "sacred mushroom" of the Aztecs with the narcotic cactus known botanically as *Lophophora williamsii* has been pointed out. That it should have been mistaken by the early Spaniards for a mushroom is not surprising when one notices the remarkable resemblance of the dried buttons to peltate fungi, and also bears in mind that the common potato (*Solanum tuberosum*) on its introduction into Europe was popularly regarded as a kind of truffle, a fact which is recorded by its German name, *Kartoffel*, or *Tartuffel*.

Footnotes

1. Based upon a paper entitled "Identification of the Teonanacatl, or 'Sacred Mushroom' of the Aztecs with the narcotic cactus, Lophophora, and an account of its ceremonial use in ancient and modern times," read by the author May 4, 1915, at a meeting of the Botanical Society of Washington. Published by authority of the Secretary of Agriculture.
2. Fermented sap of the Century Plant (*Agave americana*), which also yields the strong distilled spirit called mescal.
3. Jacinto de la Serna, "Manual de Ministros par el conocimiento de idolatrias y extirpacion de ellas." In Documentos inéditos para la Historia de España, vol. 104, p. 159-160.
4. Bancroft, H. H., Native Races, 2: 360. 1875.
5. Sahagun, Bernardino (1499-1590). Hist. Nueva España (ed. Bustamente), vol. 3, p. 118.
6. "Quoniam inebrare solent, Teyhuinti nomine nuncupati sunt, et e fulvo in fuscum vergant colorem, risum inopportunum concitent, imaginemque citra risum inebriantium possint exhibere." Hernandez, Francisco (1514-1578). Hist. Pl. Nov. Hisp. (ed. Rom.) 2:357. 1790.
7. Siméon, Rémi, Dict, de la langue Nahuatl, p. 436, 1885.
8. Op. cit. p. 412.
9. *Tuna*, the Spanish name for the fruit of the Opuntia, or prickly pear.
10. Sahagun (1499-1590). Hist, general de las cosas de Nueva España (ed. Bustamente) 3:241, 1830.
11. Hernandez (1514-1578). De Hist. Plant. Nov. Hisp. 3:70, 1790.
12. Ortega, Padre José (d. 1700). Hist, del Nayarit, pp. 22-23 (new ed.) 1887.
13. García, Fr. Bartholomé. Manual para administrar los Santos Sacramentos etc. p. 15, 1760.
14. "Es singular que los mexicanos miraban el *Peyote* (el que conozco es delas Compuestas ...) como un medicamento propio para dar aptitud á andar sin cansarse ..." Oliva, Lecc. de Farmacologia 2:392. 1854.
15. See Scheidweiler, Bull. Acad. Royale des Sciences de Bruxelles 5:492, 1 pl. 1838. Lemaire, Cact. 1, 1839.
16. See *Anhalonium retusum* Salm-Dyck, Cact. Hort. Dyck. 15. 1845.
17. Scribners Magazine 16:451. 1894.
18. See Hennings, Gartenflora 37:410, Figs. 1-4. 1888.
19. See Safford, W. E., "Cactaceae of Northeastern and Central Mexico," in Smithsonian Report for 1908, p. 528 pl. 3, Fig. 5. 1909.

20. See Ewell, Erwin E., "The Chemistry of the Cactaceae," in Journ. Amer. Chem. Soc. 18:624-643, 1896.
21. Prentiss, D. W. and Morgan, Francis P., in Therap. Gazette 19, Sept. 16, 1895, p. 579.
22. See also Prentiss and Morgan. "Therapeutic uses of Mescal Buttons." Therap. Gazette 20:4. 1896.
23. Mooney, James. "The Mescal Plant and Ceremony." Therap. Gazette 20: 7. 1896.
24. See "Tarahumari Dances and Plant-worship." Carl Lumholtz, in Scribner's Magazine, October, 1894. Vol. 16, pp. 438-456.
25. Diguet, Léon. "La Sierra du Nayarit et ses Indigènes." Nouvelles Arch. Missions Scientifiques 9: 622-24. 1899.
26. Diguet, Léon. loc. cit. p. 621.
27. From ms. report of the case of the "United States versus Nah-qua-tah-tuck, alias Mitchell Neck, in the archives of the Bureau of Chemistry. 1914.
28. Daiker, F. H., "Liquor and Peyote a Menace to the Indian," in Report of the Thirty-second Annual Lake Mohonk Conference, October, 1914, pp. 66, 67.
29. Sahagun, Bernardino. Hist. Nueva España (ed. Bustamente) 2:366. 1829.
30. Lumholtz gives a somewhat similar account of the expeditions of the Huichol hikuli-seekers: their prayers before starting forth on their journey, their priestly character, their worship of the God of Fire, the importance attached to their dreams while on the road, the ceremonial shooting of arrows on their arrival in the hikuli country, their votive offerings, their prayers to the five winds, and their petition to the hikuli not to make them crazy, the gathering of the sacred plants and of the discharged arrows covered with dew, and the return home with its attending ceremonies. Lumholtz, Carl - Unknown Mexico 2: 126-136. 1902.
31. Jacintode la Serna, "Manual de los Ministros para el conocimiento de sus idolatrías y extirpacion de ellas," in Documentos inéditos para la Historia de España, vol. 104, p. 61. Madrid, 1892.
32. Sahagun describes two plants bearing the name *Ololiuhqui*: one, which is not narcotic, with a fleshy turnip-like root, leaves like those of a Physalis, and yellow flowers; the other, also called *Coaxoxouhqui*, or "green snake," with highly narcotic seeds. (Op. cit. vol. 3, pp. 264, 241.) Hernandez describes the latter as round like those of Coriander, and says that they are produced by a twining plant called *Coaxihuitl*, or "snake-weed," which has fibrous roots and longish white flowers (Hern. ed. Recchi, p. 145); while Serna does not describe the plant, which he probably never saw, but compares the form of the seeds to that of lentils: "semilla a modo de lantejas que llaman Ololiuhqui." (Op., cit. p. 163.) Hernandez thought the plant might be the same as the *Solanum maniacum* of Dioscoroides. Dr. Manuel Urbina, of the National Museum of Mexico, declared it to be *Ipomoea sidaefolia* of Choissy; but this identification, while agreeing with Hernandez's illustration, lacks confirmation through investigation of the chemical properties and physiological action of the seeds of this species; and it is not known that any of the Convolvulaceae are narcotic, though many of the Solanaceae, which have somewhat similar flowers, are highly so. It is very strange that Mexican botanists living in the country of the Ololiuhqui have not solved the mystery of its identity.

Celestial Botany: Entheogenic Traces in Islamic Mysticism

by

Frederick R. Dannaway

© Frederick R. Dannaway

original text: https://documents.pub/download/celestial-botany-entheogenic-traces-in-islamic-mysticism

Table of Contents:

- **Abstract**
- **An Entheogenic Heritage**
- **Muhammad the Prophet Shaman**
- **Spiritual Flight and The Cult of the Severed-Head**
- **Shia and Sufi: and the Mantle of Gnostic Islam**
- **Friends of God**
- **Conclusion**
- **Footnotes**
- **References**

Abstract

This paper will highlight some of primary evidence for entheogenic plant use in Islamic cults that partake of a vastly older legacy of ritual plant use. The accumulated research on entheogens and religions demands that certain traditions be reevaluated in light a continuing and coherent symbolism that enshrines holy plants as high mysteries in diverse faiths. Following the *soma/haoma* complex through Asia and Chinese Shamanism and into Persian and Islamic cults the use of entheogens meets with traditions in the ancient Middle East that shared doctrines of magic plants and cup rituals of visionary wine. The Greek, Semitic and Hermetic traditions merge with the shamanic techniques that persist in the esoteric symbolism of the Shia Muslims and Sufi as demonstrated in their holy books, art and poetry. The alchemical tradition thus emerges has having a definite entheogenic context that was cherished and protected by initiates from the profane. This speculative hypothesis rests on the collective evidence of religious traditions surrounding Islam that possessed similar rituals and reverence for plants that becomes a hidden aspect of mystical Islam.

Keywords: Shia, Sufi, Soma, Hoama, entheogen, *Amanita muscaria*.

An Entheogenic Heritage

The world's oldest religions clearly have a heritage of entheogens at their ritual core. While the debates and speculations will no doubt continue as to precise species or preparation, the role of these plants and their extracts becomes more and more self-evident. The pioneering research of various scholars have made very persuasive arguments for sacramental plant use in various cultures from Vedic Brahmins (Wasson 1968; Houben 1999) to Greek mystery religions (Ruck 1992) and Christian mystics and Manicheans (Allegro 1970; Ruck, Heinrich and Staples 2000; Hoffman and Ruck 2007). Researchers have further focused their attentions on various myths, folklore and art to articulate the central and ancient role of "magical plants" from an Irish Soma (Wilson 1999) to Tantric Buddhist sects (Hajicek-Dobberstein 1995, Crowley 2005, Strickmann 1966). This extends to the heirs of these ancient religions in such traditions as Islam (Dannaway, Piper, and Webster 2006; Piper 2002) alchemy and Grail mythology (Heinrich 2002, Shelly 1995) and Freemasonry (Hoffman and Ruck 2002).

This paper will offer some additional evidence that would support a similar complex of plant use into various Islamic cults. The utterly ancient Epic of Gilgamesh must be cited as a precedent for such ideas, as it is a quest for a "plant of immortality" that spreads and inspires doctrine of similarly described soma/haoma plants found throughout the ancient world. Likewise, the Egyptians seem to have had various entheogenic wines or beers and plants at their disposal with some suggestions of various mushroom species (Berlant 2005). The works of Joseph Needham (1975), an early collaborator with Wasson, on China and its sciences becomes most revealing in the field of alchemy which will prove a link for these cultures across space and time. Here the older influences and precursors to the elaborate and increasingly esoteric world of elixir alchemy unite and disperse into the Persian and Islamic world ending in Europe, which may well have retained the entheogenic legacy (Ruck 2007). For it is in China that Vedic, Daoist, Buddhist, Tantric, and indigenous shamanism combine into a dynamic and yet esoteric doctrine that makes sense of the Prophet Muhammad's hadith to "seek knowledge, even unto China." This often took the form of metallurgical symbolism effused with mystical teachings that evolved into alchemy (Needham 1954, 1975; Giradot 1983; Kalyanaraman 2004). The word *Sufi* may itself be Chinese and intimately connected with Chinese Shamanism which preserved the ancient associations of magic plants (Needham 1954; Mahdihassan 1959, 1990).

Needham's insightful research distills some essentials about this complex of plants and metals that combine in the alchemical arts, which he associates with the *Amanita muscaria* mushroom and other entheogenic preparations. The earliest Chinese texts use the language of "searching for" (chhiu) the herb or plant of immortality (often described as a fungus) while later it came to be "effecting a chemical transformation" or "preparing by heating" which is startling to contemplate though the implications go far beyond the scope of this discussion.

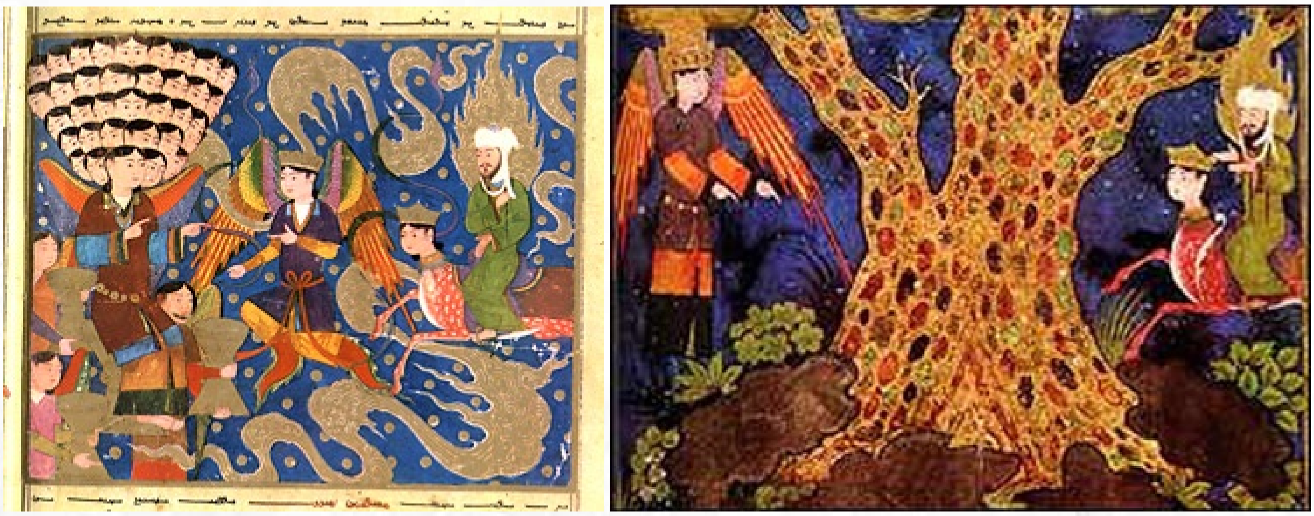
What is essential is that there was a fundamental shift in finding the singular entheogen in whatever cultural context to basically producing it my more and more sophisticated means as the alchemical literature amply illustrates. While this may delve into the issues of the loss of the soma identity and the related attempts to define it with a single plant identification on one level, what is more important for our purposes here is that alchemical tradition as essentially "entheogenic" in nature and there was a transition from a search to manipulation and production (Needham 1974). Yet a further dimension that combines the inner (*nei dan*) and outer alchemy (*wei dan*) could be the adept as alchemical vessel where his own body transmutes the active principles of the mushroom (ibotenic acid decarboxylated to muscimol) excreted in the urine which accords with the Vedic descriptions. This is not to reduce alchemy to the search for or manipulations of alkaloids but to express that entheogens represent an aspect of elixir alchemy.

While much of the theology, philosophy and medicines of the Islamic mystics no doubt comes from the Greeks (Tibb-e-Unani), there is sparse evidence of a Hellenistic elixir alchemy proper (though there is a rich entheogenic tradition such as the *kykeon*, *pharmakon athanasius*, etc.) and likewise, except for some apocryphal works, in the Jewish-Alexandrian tradition (Needham 1974). We must again rely on Needham to establish three provisional categories of alchemy: "gold-faking, gold-making, and the preparation of the drug of deathlessness" to which we may add that the terminologies of the various branches overlap and are interchangeable. Needham discusses the quintessential alchemical term "elixir" as having a possible Chinese origin and further links with the familiar "philosopher's stone and powders of projection" familiar in the Middle Ages. Madhihassan (1951) in discussing the etymology of elixir was dissatisfied with Arabic or Greek roots favored an origin from the complex of Chinese phrases such as *yao chi* "medicinal dose" and *yao chih* "medicinal mushroom" though he would offer other suggestions and the matter is hardly settled. Madhihassan's (2002) etymological treatment of elixir alchemy combines metallurgical and botanical associations with *kimiya* as a root for alchemy meaning "gold-making juice."

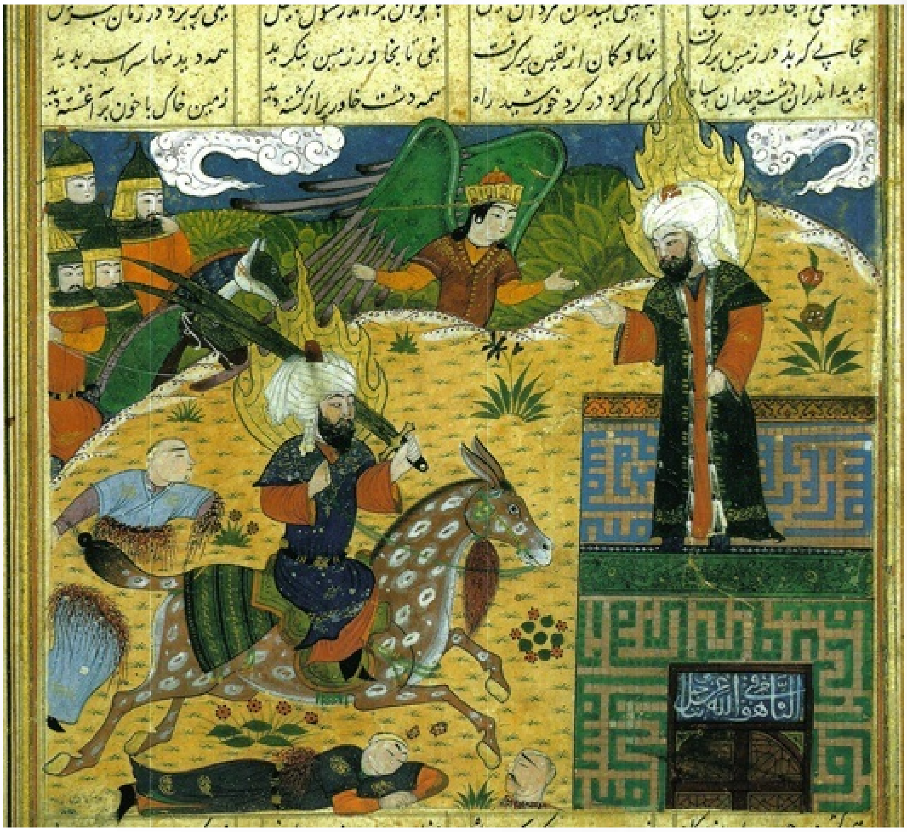
There are hidden realms in esoteric Islam that hint of a continued use of entheogens in the forebears of the Prophet, the Prophet Muhammad, and his extended house the Shia, and the cults that coalesced around various charismatic messianic figures. These cults preserve core doctrines and cosmologies as well as a tendency to radical autonomy and militant fervor to protect themselves and their religion.

Muhammad the Prophet Shaman

The prophet Muhammad spoke to the angelic messenger of God and underwent visionary initiatory voyages to the heavenly and infernal regions (1). He mounted the mysterious shamanic beast, *al-buraaq*, which means "lightning" in Arabic and which begins to draw associations with mushrooms, as they have ancient folklore links with lightning and thunder perhaps due to their sudden appearances after rains. Wasson notes that *Banat*'*u*'*rrad*, "Daughters of Thunder" are used as an expression for fungus, but an unnamed species, in the dictionary of classical Arabic in his discussion of "Lightingbolt and Mushrooms" (Wasson 1986). Though described in Islamic literature as being white and something like a donkey or a mule, the fabulous creature is curiously depicted in some examples of Islamic art as being red and white in a design consistent with *Amanita muscaria* mushroom, the entheogen suspected to be a major candidate for the soama/haoma and the symbolic colors of alchemy.



Note the angel is pointing down towards the tree where a mushroom is found and Buraq is red/white as in *Amanita muscaria*.



(2)

In the above images, Muhammad is seen riding the red and white creature, again the colors of the *Amanita* mushroom, in his shamanic night journey *isra*' and ascension to heaven *mi'raj* reminiscent of the ascent of Arda Viraf who takes a narcotic and takes a visionary flight through heaven and hell (Seguy 1977). This representation of *Buraq* may indicate that regional cults viewed the Islamic revelation through their own shamanic traditions or that Islam retained the ritual heritages of the ancient world. These traditions would be enshrouded in the mysteries of Shia gnosis, alchemy and Sufism that spread into Europe. The other image depicts Imam Ali on a similar creature with the red and white colors and in a scene entitled "Gabriel Shows Ali's Valor to the Prophet" from the 15th century Persian epic of Ali, the *Khavaran Nameh*, which shows his steed in these colors particularly in scenes of battle where it is grey in other scenes though more research is needed to fully develop these curious depictions of the changing mounts (Birjandi 2004). Another uncle of the Prophet Muhammad is Amir Hamza, whose folktales date back to the time of the Prophet and whose exploits unite Chinese, Indian, Persian, Greek and Arabian cultures, also rides a similarly described winged-demon steed *Ashqar* Devzad (Lakhnavi and Bilgrami 2007). This series of tales involves treasures under trees and occult lore of the Prophet Khizir and Imam Ali (even before he was born) in aiding in battles and traveling to the land of the *jinns* for temporal and spiritual *jihad* for the True Faith anticipating the coming of the Prophet Muhammad.

The mixture of *Peganum harmala*/*Amanita muscaria* (or a coded reference to the *haoma* type plant/mushroom) may have been used by early Muslims for entheogenic and military purposes as the etymology of *Peganum* has been linked with the flying-horse *Pegasus*. Flattery (1989) reports of another epithet of *haoma* that links "swiftness" and horses, like the flying horse Buraq which is as "quick" as lightening. There is the precedent for courage giving herbs in *hadith* such as is found in the collection of the theologian Muhammad Baqir Majlisi, whose collections are widely considered authentic in the Shia world. Amongst other more magical/medicinal uses of *harmal* in connection with the 6th Imam Jafar, there is related an incident wherein the Prophet complains to Allah the fighters are cowardly. Muhammad receives a revelation from God that the people should ingest *isfand* "by means of it they might become brave" (Flattery 1989). Other less reliable, yet still widespread hadith (controversial today in modern Egypt) record strange incidents of urine drinking (usually and obviously this would be *haram*) one of which is:

> "the Prophet SAW used to have a wooden bowl in which he used to urinate and place under His bed. One night, He searched for it but did not find it and asked for it saying, where is the bowl? The members of the house replied 'Umm Salamah's slave girl Barrah drank it' who came from Habashah with her. The Prophet replied, 'surely she has protected herself from the fire with a great wall'."

This is a most extraordinary hadith as are others that concern people going "beserk" after the Prophet told them to drink the urine of a certain camel, suggestive of ancient shamanic practices of drinking reindeer urine. Mixing bull urine with *harmel* is mentioned in Old Iranian rituals (Flattery 1989) and the incidents of "urine-drinking" incidents in Islamic lore, which are more than expected given the obsession with hygiene especially in toiletry, align with some of the key points of the identifications of *soma* and shamanic plants as suggested by Wasson (1978). The epithets of *haoma* of having a "hundred waters" are suggestive of a diuretic effects as well as the profuse perspiration experienced when ingesting *Amanita muscaria*/*Peganum harmala*.

There is an argument to be made for the initiation of Muhammad at a very young age into a desert brotherhood that definitely was Eucharistic in character. This complex included a "Shiite grail liturgy" (Corbin 1998) that accords with the research of Eisenmann (1997) in linking exoteric and esoteric doctrines of the Shia Gnostics with the early Christian mystics. Muhammad declares his son-in-law and cousin (though again in the literature this relationship is sometimes conflated to nephew/uncle) Imam Ali: "Thou art the Knight of this community" and performs a "ritual of the Cup" that might point to pre-Islamic rituals of which will be discussed below. But considering the decidedly Gnostic and increasingly mystical revelations of each Shia Imam, especially the 6th Imam Ja'far, the Shia tradition through Imam Ali can be seen to represent rituals and contexts more in sympathy with ancient mystery schools than Sunni Islam (Corbin 1994). Muhammad's uncle, Abu Talib, is controversial in Islam with the Sunni slander that he was never a Muslim which contrasts the Shia veneration that dismisses the Sunni version as a plot against the family of the Prophet in collusion with the Umayyad, the rival clan of the Hashimites of the Prophet Muhammad (Shirazi 2001). (3)

These symbolic rituals of cups and military brotherhoods partakes of an entheogenic legacy extending back into the earliest Indo-Iranian cults discussed at length by Eliade and Dumézil. The groups become literally berserk with intoxication, and their lycanthropic ritual consisted of "those who change themselves into wolves (*varka*) in the ecstasy brought on by soma (*hauma*) (Eliade 2006). The mushroom *Amanita muscaria* is at once ritual sacrament and entheogen, medicine, and combat stimulant and its powers may well have been a factor in the military success of the early Muslim fighters who had their own warrior brotherhoods waging *jihad*. The Indian verses of soma connect to furious battle with such verses as "Indra, the man god who drinks soma, becomes stimulated for battle after drinking soma" (Rig Veda 9.44.3; 9:97.37; 5.44.13). Converging on these syncretic Islamic traditions from multiple angles of influence is the knightly mysteries of Mithras. The military nature of these fraternal devotees also contained an initiatory ritual for the soldiers that were connected with a sacred cup and visionary Eucharist (Hoffman, Ruck and Staples 2002;Ruck *et al*. 2004). Mithras is also associated with caves, cups and ecstatic mystery rites and it must be remembered that Muhammad received many of his revelations in a cave The Cave of Thor (Ghar Thour).

Franz Cumont (1956) mentions there are many similarities in cosmologies with the Gnostic Mazdeans that retained much of the fleeing teachings attributed to what Eisenman called the "Opposition Alliance." This military alliance reveals the strange mix of herbalists and healers with military mystics. As Cumont (1956) again states, "the Mithraists' most profound religious beliefs were associated with the miraculous creation of "beneficent plants" and further that their symbolism is often grouped with a "krater" or cup that was used in "divine feast and probably drank of the wine which conferred immortality." It was the clear connections of Eucharistic meal, of communion of "bread" and "blood" and immortality that prompted Justin Marty to presume the entire affair was a blasphemous parody of the Christian Euchasrist. Dr. Moghdam (1975) writes of the Iranian origin of "the divine meal, the Lord's Supper, apparently the Cup used for the 'nushabe' (water of immortality, in Islam becomes the *Maul-hayat*) became the holiest object in the service. That cup figures very prominently in Persian literature and especially in the mystical poems. The cup has seven lines or measures corresponding to the seven degrees in Mithraism. The full cup is for the Pir or the Father, who is known as the Pir of the seven lines. In the West it gave rise to the 'Graded cup', Latin 'gradalis' or grail. The lore of the Holy Grail and Arthurian legends are discussed in terms of entheogens by Heinrich (2002) and related folklore by Ruck (2007) demonstrating the persistence of these associations. Moghdam (1975) further states "As to remnants of Mithraism in Iran, at its best it survives in Iranian mysticism represented by the Divan-e Shams, the Golshan-e Raz, and above all, in the poems of Hafez, and of course in the strong influence it exerted on Islamic Sufism, which is quite distinct from Iranian mysticism." He adds "In sects, there is a survival of Mithraism in the Ahl-e Haq and the Yazidis, and other small sects scattered in closed communities" which I have already discussed in terms of entheogens (Dannaway et. al. 2008). The "red-heads" or Qizilbash, extremist devotees of the Imam Ali, are a mystical calvary, "convinced of the invincibility" and throw themselves into battle with no armor after wild orgiastic parties, and they are even accused of lycanthropic cannibalism (Rudi 2005). This group might suggest a continued use of entheogens in extremist, militant sects that would exploit the herbal uses for war purposes as discussed above in the context of Shia hadith.

The radically Gnostic and syncretic traditions of the earliest Shia, such as the first Imam Ali who speaks of alchemy in the highest praise, presents a problem that is solved when Shia Islam is viewed as the fruition of a coherent doctrine of visionary plants and alchemical elixirs. Either the Shia are immediately arch-heretics to Islam, as the Sunni maintain, foregoing and betraying their Prophet, Uncle/Father/Grandfather the moment he is buried or they, and they alone, retain the true doctrines of Islam as taught by the Prophet. This would require the belief that the Imams themselves spontaneously adopted extremely complex esoteric doctrines over the assumption that these practices represented a core occult doctrine of Islam taught to the chosen few. The previously discussed currents that find exact and clear examples in the Shia gnosis can be linked with the Syrian and Sabian traditions in such a way as to make Muhammad's protection to them make perfect sense. Muhammad's recognition of "People of the Book" (*Ahl al- Kitab*) raises him to the level of a reformer of the religion of Abraham that had degenerated into corrupt idolatry. The Prophet was initially accused of being a Sabian ("washed ones") by his adversaries and they had nearly identical practices of ablution and obsession with purity that still characterizes the Shia today (Green 1992). The living, breathing and actively appropriating force that could be described roughly as Hermeticism is the thread that binds these traditions. The Syrian city of Harran possessed the old astrotheological lore that was certainly one essential component to these mystery cults Green (1992). The city's location and Syria's in general, makes it a fertile area for cross-influence from the well known entheogenic mysteries of Greece and Rome from one direction and the *soma*/*haoma* astronomy cults coming from the other.

The Semitic material, via fleeing Gnostics and converts, met with a region familiar with the passing fancy of exoteric doctrines of what amounted to the same "mystery." This mystery is undoubtedly that of spiritual immortality and the reverence for the plants that produces the visionary experience that imparts the feeling of death and rebirth in the context of the Logos made flesh either in the Prophet or Imam. The Krater as the vessel for this pressed (*haoma*/*soma*: Indo-Iranian root *sav- "to press") substance that bestows immortality always appears with similar descriptions. From the "Lady with the Mead Cup" Indo-European cup rituals to the indigenous "grail" myths of Ireland its associations always retain the same striking characteristics (Enright 1996).

The Hermetic material, which was preserved in Harran, was given prophetic status as a revealed book in Islam and garnered the fascination of mystics in every tradition with which it made contact. The Hermetic *Krater* combines the baptismal, or bathing purity cult, and the "symbolic drinking of knowledge" together with mystic piety and "initiatory brotherhood." The Hermetic material also provides the common terminology that characterized much of these ancient mystery schools of the "universal man/perfect man/Logos/standing-one/Imam" that is evident from the Mithraic and Christian cults to the Shia gnostic and Sufi. The Logos-Nous is described in its liquid form as a holy beverage, or as one Hermetic treatise states, "And I sowed in the words of wisdom and they were nourished with the ambrosian water." A variant is, "Those who are able to imbibe somewhat more than others of that vision attain to full fruition of that most lovely sight." The astrotheological connection with the constellation Krater is discussed in the Hermetic material as being the "drink of oblivion" (lethe) that souls drink from on their descent into the earth. It is therefore an act of cyclical "rebirth" to drink of the earthly cup of knowledge, the Krater, and to imbibe the divine fluid that wakes one from the sleep of forgetfulness that overtakes the soul. The symbolic drinking of knowledge or "drinking the Word" gives the vision of God and grants immortality echoing the praises of the *soma*/*haoma* of the Vedic and Iranian Gaokerena of which it is said, "those who drink of the life-giving juice of this plant will obtain perfect welfare, including deathlessness" (Corbin 1989).

The alchemist Zosimus, an immensely significant figure combining Greek and Egyptian traditions in Islamic alchemical literature, has writings which discuss:

> "the uncommunicated mystery which none of the prophets dared to divulge in words but revealed only to the initiated. In their symbolical scriptures they called it the stone which is not a stone, the thing unknown yet known to everyone, the despised thing of great price, the thing given by God and yet not given. For my part I shall praise it under the name of the thing given by God and yet not given, for in all our works it is the only thing which dominates matter. Such is the drug of power, the mithriac mystery" (Needham 1980).

Likewise, the *Kitab al-Zibaq al-Gharbi* (Book of the Western Medicine) discusses this stone that is not a stone, with "Know that this 'water' has been named Divine because it brings the qualities out among the qualities and revivifies the dead; therefore it has been called the 'Water of the Living Things,' just as the stone has been called the 'Animate Stone'. It is the Water of Life and he that has drunk of it can never die..." (Needham 1980).

The celestial Krater is linked in Vedic star lore with the *soma* cult of immortality, and of course the constellation that retains that name. The Krater as "cup of immortality" acquires a sophisticated level of technology in the Hermetic material. Some scholars maintain that "the topos of the Krater as a vessel filled with divine substance is a gnostic continuation of the Jewish Sophiaspekulation" and "it is closely related, within the frame of pneumatic doctrine of grace, to the other gnostic topos of the potion of gnosis, where the receiving of knowledge is compared to a drink. The entheogenic aspect is quite clear with the observation that "the expression 'to drink gnosis' has basically reached the status of a technical term." It is this same "technical" language which prompted John Allegro to make his radical case about the true nature of the Jewish religion and connection with the manna, or mushroom of immortality, which Robert Graves also suggested as discussed below.

Littleton and Malcor (2000) take a bold step following Dumezil and then going him one better to make a solid argument for a "Scythian" influence that converges in the pre-Christian grail myths. The obvious guess is that all traditions proceed from some yet unknown proto-IndoEuropean like race that even in a remote time possessed some complex "ecstatic wisdom." The Grail myths themselves yield evidence for nearly all possible origins, from the Iranian and Scythian/Alanic sword in the stone to the discussed cup/military correspondences. The circumstances that surround the Grail do seem to nearly always retain a Middle Eastern characteristic, no doubt from Crusade influences, but they are many and persistent enough to lend credence to both Kahane and Littleton/Malcor's conclusions as to a pre-Christian tradition which was subsequently Christianized. There are abounding textual references to Saracen comrades and Moorish persons appearing at the strangest times and places in Wolfram von Eschenbach's Parzival (Eschenbach 2006). Various instances such as the heathen "kyot" who was skilled in stars and herbs is deciphered my scholars as having to be either of Jewish or Muslim origins.

This Guyot (kyot) is the source for Eschenbach's version which Wolfram is clear to distinguish as the "true version." Parzifal is at various times described as either being "Moorish" or related to a Moor, or involved with a Moorish Princess. Eschenbach claims his source is a Moorish document claiming the secrets of the Holy Grail and the brotherhood that guards it from the profane. Corbin (1998) describes the appropriate context of the Shia Grail liturgy with the word *futuwwat* of which an approximate translation may be "knightly chivalry." He describes it as "deeply rooted in Shiism, and more generally in Islamic esotericism." Corbin notes the similarity with rituals appears in the "flowering of the European trade-guilds, such as the 'Compagnon du Devoir' in France" as well noting the affinity with the "signs of recognition" associated with the Druze and Scottish Rite Freemasons (Corbin 1989). Mohammad instituted the "ritual of the cup" and also symbolically passed the Mantle (*al-kisa*') of Prophecy to Imam Ali which in turn spread throughout the Islamic world in both Sunni and Shia groups. The lore of Imam Ali and his famous sword 'zulfikar' bear a strong association with the Excalibur of Arthurian tradition. Another of many links to grail lore parallels with King Arthur who was said to be the only one to pull the sword out of the stone there is a very popular Shia legend that none but Ali could pull Zulfikar from its sheath and various cults in the region worship a sword stuck in the earth. Corbin notes the Prophetic tradition that records that in Mohammad's youth there "existed a chivalric order (*futuwwat-dari*) whose ritual involved a cup of wine," though this could well be a common term for any intoxicating liquor. This tradition does involve Muhammad's same uncle (he was a *widow's son* like the Grail heroes) that took him to Syria, Abu Jahl, who completed the ritual "with four hundred comrades." (4)

This would go further in supporting the Syrian initiation claim of Muhammad with his uncle. Syria mystery traditions had special rites for foreign children in a "secret house" (bayt sirr) and "dark temple" (haykal muzlim) (Green 1992). Corbin's research also highlights the all important distinction that there were two "cup rituals" within the Muslim community. The Shiite version was for the "servants of light," again recalling the Qumran terminology, and was a cup with the "Wine of Malakut" which is a liquefied substance that, whatever it was, induced powerful visionary results into the realms of light. The ritual of the "drink (wine)" is as Corbin again states, "named for the Malakut (the spiritual word which includes the *mundus imaginalis* '*alm al-mithal*' or world governed by Angels) ...(which) shows that were are dealing with a sacred ritual, and that its action occurs in the visionary world." The situation then becomes of an initiatory ritual of a liquid substance that launches one into the visionary world that was instituted by the Prophet Muhammad and sustained in the Shia community. The secretive Nusayri/Alawi are already discussed by Eisenman as retaining exact terminology and symbolism of the earliest "gnostic" Christian that persisted and mixed with the other discussed traditions in Syria. These Nusayri have their hymns and liturgy drinking their wines of "servant of light" ('*abd al-nur*) which isn't likely alcoholic in the Islamic tradition Sunni or Shia (Bar Asher et. a. 2002). Then the hadith presents stories of Muhammad learning a cup ritual from his uncle with whom he journeyed to Syria. This ecstatic tradition is characterized in visionary experience and angelology that mixes Mithraic and Persian terminology freely with esoteric Shia doctrine and is quite distinct from the Sunni version. The Shia versions for the knightly "servants of light" has all the characteristics of the European grail as in various traditions of immortality, "always full" of the "source of life" ('*ayn alhayat*).(4) One devoted extremist Shia sect, the *Kizilbash*, or the "red heads" seem a likely group to continue these traditions as they were militant supporters of the Shia Imami tradition.

Henry Corbin's (1994, 1998) work on Mazdean and Shi'ite traditions in Iran reveals several dimensions to an "esoteric Islam" that include some aspects directly related to ancient entheogenic traditions. Corbin discusses integration of the rituals of the old Mazdean divinities into the angelic hosts of the Gnostic Shia Muslims including a *haoma*, Gaokarena, "of which it is said, 'He who partakes of it becomes immortal" and it is an Elixir of immortality (Corbin 1989). These symbolic associations transfer with the revelation of Islam to a host of angels, where each has a botanical association with a flower or plant in a very eloquent "sacred botany." The folklore of various plants in the region associated with *haoma*, such as the *harmal* or *isphand* plant *Peganum harmala* are well discussed (Flattery 1989) and recently in an article of Moses and the burning bush, though this theory has been suggested before (Shannon 2008). The *harmal* of *isphand* (*Pegaganum harmala*) ingested alone is entheogenic, and intimately linked with the Shia Imams, could be active by a subcutaneous ingestion by way of dyeing the elaborate geometrical carpets famous throughout the Islamic world, a principle use of the plant to obtain the brilliant red hue, and the use in the dyeing of the fez may well "color" the sweating spinning dervishes of certain Sufi orders. Bioassay of entheogenic doses of *Peganum harmala* have reported the feeling of "contact" with an invisible being which might recall the initiatory prophet Khidir, in whose steps flowers grow. Modern Mazdean Gnostics employ the stimulant herb *Ephedera* which was an early substitute for the haoma but there is some interesting research on the interaction of *Ephedera* and *Peganum harmala* (Flattery 2004).

In the same context of the recent theory published on the use of DMT producing plants and Biblical prophets (Shannon 2008), the pre-Islamic cult of the goddess Al-Uzza yields similar plant species. It is said the goddess would reveal herself in a grove of three acacia trees in Mecca, which contain the powerful entheogenic DMT in *ayahuasca*, and whose symbol was the crescent moon and the morning star. In ancient times she was considered enshrined in the Ka'aba where she was served by an order of priestesses. The black stone to this day is cared for by the Beni Shaybah, "the sons of the old woman." AlUzza becomes a source of serious contention, famous in the "Satanic Verses" as one of the daughters of Allah and though her sanctuary was destroyed some scholars note she is still called upon in times of sickness of certain of the faithful. Alexander Shulgin (1996) in his classic *Tihkal* cites ancient beliefs from the Near East and Egypt of "a balsam or oil peddled to the priests of yore by Bedouins, which claim it to have come from the "original" Tree of Knowledge" which existed at the lowest point on earth near the Dead Sea and Sinai Desert." Of course this oil is from the acacia. The goddess revealed in an acacia grove is suggestive of an entheogenic experience and at least places two plants that combine to form an ayahuasca like potion in the same region and in cults that formed the syncretic faith of Islam. I have argued for the Islamic use of ergot and other psychoactive plants elsewhere (Dannaway, Piper, and Webster 2006) and speculate that either specific plants represented different cults or sects, with the predominance of the specified ritual plant evolving with the various religious expressions pre-Islamic and Islamic, or else there was no single ritual plant and many psychoactive plants were used in various ritual and initiatory capacities. Perhaps Muhammad's cult of the mushroom supplanted the pagan DMT cult, or perhaps it was appropriated into the Shia rites as discussed below. Perhaps Muhammad reformed traditions that were originally monotheistic and which had lapsed into a degraded and corrupt religious hierarchy that would continue to assault his house.

Interestingly, the much maligned and increasingly vindicated linguist John Allegro (1970) writes of various "rue" species, which could be *Peganum harmala* or *Syrian Rue*, in connection with *Amanita* mushrooms perhaps to potentiate the effects in some species and to alleviate overdose in others. Allegro sees an esoteric word play "between the Aramaic *mestebit ha*' "submissive" and the mushroom name MASh-TAB-BA-RI-TI and its possible source for Muhammad's teachings", as his followers are called Muslims "the submissive ones." Allegro also suggests entheogenic fungi at the heart of the Ismaili of the Old Man and the Mountain and his famous Assassins, popularly but not necessarily linked with the use of *Cannabis sativa*, though the term hashish can mean any dried herb. The very interesting speculation of the Day of the Zulu involving the consumption of *Amanita muscaria* as a war drug to give superhuman strength and fearlessness (Knight 2006) is an attractive hypothesis to the military success of the Muslims against some insurmountable odds. The Koran speaks of the Battle of Badr:

> Allah had helped you at Badr, when ye were a contemptible little force; then fear Allah; thus May ye show your gratitude. Remember thou saidst to the Faithful: "Is it not enough for you that Allah should help you with three thousand angels (Specially) sent down? "Yea, - if ye remain firm, and act aright, even if the enemy should rush here on you in hot haste, your Lord would help you with five thousand angels Making a terrific onslaught. Qur'an: Sura 3:123-125

This could allude to mushrooms as "angels" taken by the faithful before raging into battle. Ruck (2007) has reexamined the role of *Amanita muscaria* in the war-fury of the Berserkers and if this "technology" was known throughout the ancient world then perhaps the Muslim armies made use of the mushrooms to their ultimate success. The PBS documentary also featured to martial artists equally matched in the past in an experiment in which one is given a placebo and the other *Amanita muscaria* with the results of the bemushroomed fighter abandoning his technique and just dominating his opponent in every way in a combative fury (Knight 2006).

Yet another source of entheogenic traditions could derive from the Zoroastrian Magi Salman al-Farsi who went on a mystic quest that brought him to Syria and finally, after being sold into slavery, into company with the Prophet Muhammad where he is highly honored as a mystical patriarch. In the mystical Alawi tradition that splintered after the 6th Imam Jafar, the Imam Ali, Muhammad, and Salman al-Farsi are the "Idea, the Name, and the Door (to God)" respectively in a trinity which is a doctrine that both unites and divides various Christian churches. The Nusayri-Alawi venerate Imam Ali as the *amir al-nahi* as the "prince of bees" which also has entheogenic connotations with bee's and honey in a vast array of folklore and alchemical literature (Ruck 2007).

Spiritual Flight and The Cult of the Severed-Head

Yet another curious recurrent theme amongst these various groups is the oracular or prophetic "talking heads" that partake of associations with *soma* from ancient times (Kramrisch in Wasson 1986). The "Secret of the Cut-Off Heads" is one of entheogenic mushrooms, particularly the sacrifice of the mushroom's "head" perhaps with the intent of keeping the mycorrhiza intact. Kramrisch decodes myths of those "losing their heads" with mushroom intoxication and magical horses that reveal "the sweet secret" of the *Soma*. There is a tradition of "Headless Magicians" with Soma links and the "act of truth" in an initiatory complex that extends this ritual symbolism into the fringes of the occult in the ancient world (Coomaraswamy 1944). Heinrich (2002) links the beheading with mushrooms and the initiatory circumcision as well as the prophetic head of John the Baptizer. He quotes the *Apocryphon of James*, of the Nag Hammadi texts, linking John's severed head with prophecy and a riddle by Jesus that begins with, "When you come to know what "head" means, and that prophecy issues from the head, then understand the meaning of "Its head was removed." Heinrich also links the severed head motif in alchemical manuscripts, such as in the *Splendor Solis*, with the Vedic legends, such as the six headed god Skanda that indicate the mushrooms were cultivated by careful harvest and other techniques to ensure the supply.

One finds many legendary beheadings in pre-Islamic and Islamic legends but some definitely conform to these established connections of magic heads and mushrooms. One of the previously mentioned uncles of Muhammad, Amir Hamza, beheads many foes but in a garden of jinns and might *ifrit* he beheads a youth and proceeds into a series of magical chambers that ultimately leads him to his magic steed. The head of the third Imam Hussain was said to speak after the massacre at Karbala and a legend maintained by the Kizilbash (red head, as in the mushroom) Kurds describes an Armenian priest who, recognizing the head as supernatural, wanted to retain the head then on its way to the Umayyad Caliph Yazid (Moosa 1988). The priest's eldest son offers his own head as a substitute to fool the Sunni and the priest instantly deprives his son of his head. He cuts off six heads out of seven sons to convince the murderers, which must remind one of the six-headed Skanda mushroom-god who is similarly beheaded. The ruse does not convince the Sunni murderer's until the seventh son is decapitated which apparently somehow convinced their foes. The priest thus retains the head in secret and adorns it with precious metals where it eventually impregnates the sole daughter of the priest having transformed into a bowl of honey, and the legend explains this as the origins of the birth of the 5th Shia Imam al-Baqir.

The implications of a complex of oracular-heads and entheogens must wait for a future paper, but some revealing clues are scattered around in popular myths such as is found in the Knights Templars and their strange talking-head Baphomet which has been discussed as a possible corruption of Mahomet. The somewhat controversial Sufi Idris Shah (2002), working with Robert Graves, speculates an Arabic origin meaning "Father of Understanding" and links with the Sufi *ras el-fahmat* (head of knowledge) that has an oracular function. The Sufi master and Persian poet Farid al-Din 'Attar (the druggist) has many poems that describe the Seeker as wandering, "iterant and headless" though his poetry on wine and drugs are treated metaphorically such as the scholarly discussion of his "spiritual flight" which contains a chapter *On Losing One's Head*... though in the context of spiritual boasting and authority (Lewisohn and Shackle 2006). 'Attar's poems offer complex symbolism, such as this verse which is consistent with heads and entheogenic wines and the Sufi mystic Hallaj who was executed because he declared "I am the Truth" (*Ana'l Haq*) in religious ecstasy.

"They saw Hallaj in a dream one night, his head cut off, but with cup in hand. They asked, " How is it your head is cut off? Tell-how long you have chosen this cup? He said, 'The king of blessed name gave this cup to the headless one. Those who forget their own heads can drink from this spiritual cup." Clearly there is some relationship between these headless mystics, the "Grail-head" and the various oracular heads as well as perhaps the *caput mortem* (dead head) of alchemy and "cult of the severed head" in Ireland. Scholars debate these associations but not attempt to place the overwhelmingly similar and shared themes that inform the myths of the Templars and the Grail legends (Nicholoson 2001), though Ruck (2007) and his fellow scholars have unearthed many details of "heads" in European fairytales. Sufi seekers such as in the Nimatullahi Order bring a whole nutmeg (*juz*), symbolic of the head, as representing their head sacrificed to the Master (Netton 2000). This might reflect a substitution from the mushroom for the potential initiate for the symbolic nutmeg as Sufism became more institutionalized.

The theory of Syrian initiations is bolstered by the research of Green (1992) that links these cults of the head with alchemical and astrotheological lore of the Hermetic center of learning that was Harran. This research discusses a secret metallurgical guild of alchemical initiates who have a cult of a prophetic head (*al-r'as*) and Harranians were accused of being "Adherents of the Head" (*Ashab al-r'as*) which is described as resembling the god Mercury ('*Utarid*). The head is pulled off in chemical operation at certain times when the planet Mercury is exalted and "it spoke" is similar to other "prophetic heads" found in Arabian magical texts and in the Jabirian corpus, which gives instructions for using prophetic severed heads. These traditions are discussed in the context of Indian astrology and alchemy and Sabian magical texts that discuss oracular heads. The Syrian mystery cults that are linked with the esoteric Shia sects retain the curious lore of the "heads" that may well be the source for the reemergence of the cult in Europe and the charges against the Templar Knights in worshipping the idol head Baphomet as well as "Grail-head" myths from Irish folklore.

Shia and Sufi: and the Mantle of Gnostic Islam

> "Alchemy is the Sister of prophecy"
> *Imam Ali ibn Abi Talib*

The religion of Islam is too often studied, even by scholars, through the eyes of the Sunni and much of the information on the Shia (the party of Imam Ali, the Prophet Muhammad's grandson and son-in-law) is fragmentary, misunderstood or from polemical sources. I have a perhaps radical theory of the Shia, in that I view them as in many senses a much more "legitimate" representation of Islamic theology and cosmology. An example would be the Shia insistence that the Prophet could not only read but was well read and highly educated, a fact which Sunni and many scholars deny, and I suspect because this makes the Koran appear more of a miracle if from an illiterate camel driver, even though it contains some very pagan elements obviously incorporated into the text to link with and either replace or fulfill prior traditions (Stetkevych 1996).

Flattery (1989) collects several Hadith and poems that illustrate nearly identical phrasing in praise of the Syrian rue or *harmal* plant and quotes the 6th Imam Ja'far and his teaching that *harmal* seeds ward off evil influence which resonates with its continued use in Turkey and Iran as a method to avert the evil eye. But Imam Ja'far, perhaps the most "esoteric" of all the Shia Imams, which traditions holds as the revered master of the alchemist Abu Musa Jabir ibn Hayyan, known and translated into Europe under the Latinized moniker Geber (though this is debated as to what extant). The word gibberish is said to have originated from Jabir and his near hopelessly obscure alchemical writings but his work is laced with metaphors of red lions and special mention of the "elixir of the prophets." Jabir (likely a complex of initiates writing under one name) called Imam Ja'far his master and he wrote an interesting alchemical treatise called the "Book of Venus" that deals with matters of a "special red sulphur." There is an anecdote about a sick concubine and our alchemist has "a certain elixir with me, and gave her a draught...with vinegar and honey," effecting a cure much to the relief of the Caliph (Holymard 1957) *harmal* is still used for heat exhaustion and "magical" illnesses. It is interesting to note the possible role of *harmal* both as medicine and entheogen, and we might note that vinegar or acetic acid removes the "lion's share" of alkaloids, and yet-tobe translated botanical Hadith of the early Imams prescribe such concoctions with honey for a variety of illness. Scholars, such as Syed Nomanul Haq (1994), trying to make sense of Jabir's immense body, of work suggest that the intermittent scholarship that is interrupted by nonsense and irrelevant interjections does not indicate a lack of substance but rather indicates that Jabir was following a specific tradition to obscure his language for the uninitiated.

The "Principle of the Dispersion of Knowledge" (Tabdid al-ilm) is like modern artistic deconstruction in which the work is completed, cut up and placed at random throughout the entire work. The final product thus hides behind scattered references like a puzzle in which the dedicated must have the entire corpus in order to make sense of the "secret." In the Works of Geber there is constant reference to the "red stone" and the meaning is clear that these are not the common materials known by the names such as mercury and cinnabar, but rather "hypothetical" substances that induce a spiritual transmutation. The language of an alchemical entheogenic cinnabar is familiar, with similar references in the diverse alchemical traditions. The Mao Shan tradition of Taoism is known to employ just such precise language of a red cinnabar and practiced rituals that were made fragrant by "hemp-laced incense" (Saso 1990) and Needham repeatedly suggests "hallucinogens" at the very heart of the Taoist cannon and Chinese alchemy (Needham 1975). Al-Hakim, another alchemist, also the Mad Caliph of certain infamy, is said to have written a document of a "Red elixir of Moses and the rest of the Prophets" (Holmyard 1990).

This preserves a tradition passed down from antiquity to the 6th Imam Ja'far whose legacy is draped in occult insinuations. Imam Ja'far was the last Imam held in common between the different Shia sects of the Twelver, who continue the line through Ja'far's younger son, and the Sevener who believe the position of Imam went to the senior brother Ismail of which the Ismaili trace their ascent to the present day through the Aga Kahn. The alchemist Dubais ibn Malik records this tradition in his writings of a fine jeweled amulet of which he comes into possession. He relates that on the inside there were two manuscripts of two recipes written in the shaky handwriting of Al-Hakim of which he was certainly familiar given Malik's somewhat privileged position in Hakim's court. Al-Hakim was accorded divine status by some followers, the Druze, who persist to this day in Israel, Syria and Lebanon despite incessant warfare and persecution. Many, perhaps credulous, writers assume Masonic connections with the Druze in terms of symbolism and structure. Further investigations might include their noted use of a botanical as means of identification amongst themselves. Al-Hakim was also castigated as a lunatic by others but his links with Hermetic documents and connections with the Brethren of Purity (*Rasa'il-e Ikhwan us Safa*) and the *al-batiniyyah* (the esotericists), suggest more than just a simple case of a deranged monarch.

Alchemical historian E.J. Holmyard (1923) translates an alchemical treatise by Al-'Iraqi, Knowledge Acquired Concerning the Cultivation of Gold, which discusses the necessary elixirs (al-iksir). This partakes of the language of the Indian and Chinese "potable gold" that finds its way through Islamic alchemists into Europe (Needham 1975). The emphasis is that one should be hot and red, the second cold and white, which is the constant theme of the work, and sometimes uses the designations of silver for the white and the gold for the red in keeping with the metallurgical code. 'Iraqi informs his readers these secrets are guarded by the sages and "all were very jealous of it even with their sons, and more so with the rest of men." His discussion on the "first matter" of the operation proceeds to the language of an alchemically prepared food or salt which is the seed of a "metallic-plant."

This prima materia is further described as a tree that grows "in the lands of the West" with blossoms of red and the second is a blossom between red and black, divulging the recurrent themes of these specific colors of the *haoma* and *soma*. 'Iraqi says of this tree that whoever eats of it 'man and jinn will obey' and also notes "this is the tree of which Adam was forbidden to eat." These alchemists describe their potion or elixir or stone in various terms of which many identify the familiar red sulphur, or the Ruby or Red lion known throughout the universal works of alchemy. This is the Philosopher's stone or "Red stone" that is the goal of alchemy. Needham (1954) curiously mentions a "laughing mad stone" which was called "*al-bahit*" which drove people mad when they saw it, laughing them selves to death. There are scattered mythological references to such a stone, such as in the "Alexander-Romance," but most interesting is that it garners an entire section in the alchemist writings of Jabir, the *Kitab al-Bahit* or Book of the Surprising. It shows up again in the Kitab al-Sumum or Book of Poisons of Ibn al-Wahshiya and even in the Latin Picatrix which was of an Arabic source as well as being mentioned by the Sufi saint Ibn Arabi (Elmore 1999). Needham writes, that "it may well be something very solid beyond these mythological ghosts and shadows. For was indeed in China a hallucinogenic mushroom which leads to uncontrollable laughter and may well kill in excessive doses." Whatever the implications of this, there seems to be a connection to mushrooms and Needham is perhaps the first author to directly discuss alchemy in the context of psychoactive plants and entheogens.

Friends of God

The Gnostic Shia have multiple sects, including the Fiver (Zaydi), Sevener (Ismaili), and Twelver (*Ithnā'ashariyya*) and if one counts with the latter eleven of the 12 were martyred. The Shia Gnostics seemed to have publicly split with the Sufi at the time of the 8th Imam al-Rida perhaps in another act of dissimulation ("al-Taqiyya") discussing their wisdom as the gnosis (irfan) as the Shia suffered ironically from being called "people of innovation" (Ahlul Bida'ah). What is critical to this discussion is to establish what would seem to be a line of transmission that is pre-Islamic in origin that came to fruition in Shia Islam with the divergent currents of the Twelver and the Sevener or Ismaili Muslims and in some Sufi sects. That the former transmission spread to Turkey is not open to debate, though how much of the original Iranian influence filtered through the predominately Sunni country of Turkey is still an issue in academic circles. The Shia influence merged with an existing Asiatic current is well established as in "the golden chain of Sufism in Shi'ite Islam," or *Tuhfah yi-Abbasi* (Khursani 2008) and the various chivalrous orders of Islam (Shah-Kazemi and Lewison 2007).

The Bektashi order of dervishes displays a wealth of indigenous shamanic influence from incantations and ritual dance to the ritual sacrifice of sheep or ram to the miracles and shape-shifting of saints so there would be a ready understanding of new initiations involving entheogens, they would likely even be expected. Their veneration for nature and sacred groves further suggest Asiatic influence and as Prof. McElwain (1983) of Stockholm notes in his article "Ritual Change in a Turkish Village," there is a plethora of evidence to "indicate a possibility of a Jewish or occult strand in a tradition already swollen with syncretic origins." Later in the same article Dr. McElwain describes the difficulties of translating these mystic poems and for our purposes we might note his comment that certain episodes present particular challenges of which some consist of, "drug-induced trips in some cases or pantheistic flights of ecstasy "which becomes extremely pertinent to this discussion.

The poem he translates under the name of Ali Hayder seems to originate in the 16th century and the author is noted to be Muhammet Amet. The verse is a lamentation of a ritual nature dealing with, as the title suggests, sacrifice, a concept emotionally and spiritually linked with the plight of the party of Ali, the Shia, who have faced unbelievable horrors and persecution. Here the act is in honor of the Twelve Imams and the brutal history of the house of the Prophet that was heir to the "green mantle" of authority through the offspring of the Prophet's daughter Fatima and Imam Ali, the prophet's cousin and son-in-law. This poem has a particular focus on the first three Imams Ali, Hasan and Huseyin. The language reflects possible ancient connections between man and the welfare of the land and people and is even suggestive of prehistorical human sacrifice, an idea which might still impact the now metaphysical self-sacrifice to the glory, honor and service of the Twelve Imams.

A sixth pillar in Shia Islam is social justice and it is interesting to note that these Shia dervish orders represented a struggle against the corruption of the Ottoman Sultans, a further connection with this theme of sacrifice. In the third portion of the work the poem conjures a tension that is consistent with themes of an ordeal and subsequent initiation. There is the imagery of knives and lances and a naked candidate. There is an inner light in a sip of wine, while the Pir, shakyh or master, whispers into the ear of the aspirant and an oath is taken binding the initiates into a ceremony designed to occupy all the senses to facilitate the sacrifice and rebirth, recalling not only the wise words of Christ but also the rituals of Freemasons. The wording in the poem suggest that some impending theophany is to occur, the sacrifice of the ego into the unity of Allah, and this direct interface with reality as in "Lets hand in hand on the Truth take hold" while the innocent is in a "pit of misery on one dark night" of the soul we might assume and "to be satiated with the drink came I" again recalls the Iranian motif of the haoma. The next verse is so crucial to this line of discussion that it must be quoted in full:

> "The juice of the pounded peony was giving Made drunk whom for love of Truth gave up living,
> Shouted Shah Huseyin then to tears were driven, To taste the ecstasy of that drink came I."

Here we have linguistic evidence of entheogenic ritual in Bektashi Lineage of dervishes. The line in the original Turkish has possible cognates with a mix of Hebrew and Arabic of which the literal meaning might suggest a "heavenly sherbert." The first striking bit of evidence is the act of pounding a plant to produce ecstasy in a ritual context which is consistent with the *soma/haoma* lore which is discussed at length in Wasson, *et al.*, the very word having suggested etymological links meaning, "to pound." The haoma rituals and the mortal and pestle theme seem to be always present on some level of the ceremony from China to Turkey.

While the peony is not psychoactive it is reasonable to suggest that given the rather extensive research of a number of scholars who have described the confounding of this species with a host of other plants, all "active," this could very well indicate either a code word to hide the true nature of the rite from the profane or to further signify a gradual substitution that eventually left the ritual 'watered-down.' The peony seems to be the subject of entheogenic allusions with connections to mandrake or the "aglaophotis" mention by Aelian and Dioscorides which links both together as "dog-dragged" suggesting a further connection with the mandrake with possible celestial implications of the harvest and the Dog Star, Sirius. John Allegro (1970) finds evidence of such connections in Pliny and sundry botanical folk lore, identifying it with the *Amanita muscaria* mushroom through Greek appellations of the sun god and Sumerian linguistic implications of a "capsule of fecundity or a womb." Certainly many of the ancient descriptions of "their" peony are not consistent with the flowery herbaceous plant known today by Pliny's description of capsules full of seeds that are red and black which also makes Syrian rue or harmal another possible candidate that was a likely choice to these opportunistic sects in the situation where the mushroom was scarce or not in season.

Allegro further elaborates at length throughout his controversial book of the further identification ,or in his words, "code" that consists of a language of plants of which the primary species are the peony, mandrake, mushroom *Amanita*, and the added *harmal* (*isfand* of the Prophets) or Syrian rue (Peganum Harmala). The idea of sacrifice and death-like effects of the mandrake along with its human-like root, complement the themes of "redness" that suggest blood. I suggest that the ritual was the subject of a gradual substitution with a keen eye towards appropriate symbolism from human sacrifice to animal sacrifice and entheogens to the eventual substitution of alcohol, the red raki of Turkey. Dr. McElwain also notes that the raki he saw in the Turkish village was of a white color (its usually red), possibly recalling the white haoma discussed by Corbin, and he notes the other name for this raki is "arslan sutu" or lion's milk again increasing the many linguistic connections between the alchemical terminology to the filtering and pounding of the haoma as strained through milk as in the Iranian material. The lion was also the symbol of Ali as the roaring warrior-scholar that was the model Sufi and Shia. The half naked Abdals of Rum have also been described as using botanicals in religious functions such as "certain youth called cuccegler, who carry in certain hand-trays a pulverized herb called *asseral*, which, when eaten, makes one just as merry as if one drunk wine" (Karamustafa 1994).

Allegro's discussion on the mandrake/peony/mushroom centers on evidence that is rather clear from his overall conclusions. The continued support he gives of cognates and allusions across alphabets and cultures with the main focus on the Sumerian, Hebrew and Arabic gives further credence with his scrutiny of Koranic language and the legends of the Assassins.. But this is a precedent for this paper to trace briefly the diverse entheogenic culture that is hidden in different Shia factions, and their use of plants in a ritual context. To trace this theme towards its logical conclusion is beyond the scope of this work, but brief mention of further evidence brought to light by Robert Eisenman (1998) suggests a common language of religious terminology that is so specific that it can be traced in the earliest Hebrew scriptures, especially the apocryphal offerings that are primarily concerned with the elusive sect of the Nasserites. These specific phrasings and epithets can be found as early as Genesis in the descriptions of Noah through the Psalms and into the Gospels. The current research tends to suggest that giving the ensuing inquisitional efforts to formalize Roman doctrine the Gnostic heresies were pushed out into the desserts of Arabia only to come to fruition again in Islam, and through the Shia resistance to the pretended representatives or Caliphs of the Sunni. The pivotal mélange of entheogens, political activism and mystical aspiration conspire against the root of fundamentalism. The ritual described in the poem uses a lyrical recitation in a ceremonial atmosphere in which the candidate's senses are enraptured and seduced by the romance and mystery of a true sacramental cult. His initiation into a larger spiritual context based on spiritual and social justice express the original foundations of Islam as a mission against oppression.

Conclusion

> *The Apple of Khidr*
> At that time I was ignorant of the sciences of realities. And I saw...Khidr..., and he gave me an apple, and I ate a piece of it. Then he said, "Eat all of it, for that is how much of it I ate." And I saw as it were an ocean from the throne to the earth, and I Saw nothing but this; it was like the radiance of the sun. My mouth opened involuntarily, and all of it entered into my mouth. I drank until not a single drop of it remained.
> Sufi Master Ruzbihan Baqli from his *Unveiling of Secrets*

This admittedly speculative hypothesis perhaps begins to define the growing evidence for entheogens in the various related religions of the ancient world. There are numerous gaps in the growing field of ethnobotany and ethnomycology especially with respect to Islamic culture. Certainly any cultures that have a ritual that speaks of some plant/wine/cup that confers immortality offers a clue that entheogens may well have a place in their theology. Alchemical lore is another link as metallurgical guilds were intimately linked with the shamanic arts from the beginning of recorded history and the Islamic material is saturated with the alchemical search for an elixir to such an extant that the fervor passed into Europe. The use of "magical" plants/elixirs/potions/mushrooms in these various cultures suggests that these various mystics either accessed some intact initiatory tradition that conveyed the "ecstatic technology" of entheogens across time or they rediscovered them in the course of consistent and widespread ancient legends.

I end this essay with the words of a female Sufi mystic who seems to speak of the various bright colors of the *A. muscaria* var. *formosa* found at the base of a tree, as they are known to take on caps of bright yellow sometimes. She writes of these other worldly fruits in the walled garden that is paradise and, I would ask, what other fruits grow at the base of a tree than the fruiting mushroom?

> ...I saw, then, in a dream a tree of incomparable
> verdant freshness, beauty and magnitude;
> on this tree three kinds of fruit were growing
> that bore no resemblance to the fruits of this world
> and were plump like a virgin's breast:
> a white fruit, a red fruit and a yellow fruit, shining like
> stars on the green base of the tree...
> Rabia Al Adawiya (c. 714 - 801 A.D.)

Footnotes

1. I have heard in two separate university religious classes suggesting the prophet Muhammad was epileptic though the professors quoted Christopher Hitchens as their source. There is also, of course, a similar prejudice that is subtle in attributing theophany to entheogens, as is the case with the recent article by Shannon (2008) where Moses is mocked as a hippy drug user in the mainstream press.
2. These images can be seen in color in the exquisite book of Seguy (1977) or online http://www.zombietime.com/mohammed_image_archive/islamic_mo_full/ My past co-author Alan Piper and I arrived at the conclusion this image of Buraq as *Amanita muscaria* independently and simultaneously following sometimes identical lines of research. He must be cited as a pioneer in the study Islamic entheogens as well as credited with this contribution.
3. We take the perhaps radical step in taking the Shia as the true representation of Muhammad's Islam, and it seems scholar Henry Corbin agreed. There is even a Shia tradition of how those that supported the Caliphate, i.e. the Meccan hierarchy now nominally Muslim, refused a copy of Imam Ali's Koran in favor for their own "version." There is little love between many Shia and Sunni as recent troubles in Iraq illustrate, and Shia celebrate the demise of Sunni, such as the abhorred Caliph Omar. It must be remembered that the massacre of the Prophet's family at Karbala influenced Shia activities for years to come as most Shia Imams were martyred. I believe this situation reached such proportions that the 6th Imam split the lineage on purpose, even at the risk of sectarian strife to preserve the Hidden Imam,

whose existence is necessary for the existence of the world as the Spiritual Pole, essentially confusing which was the real Imam into such sects as the Alawi/Nusayri and Ismaili who are both prime candidates for the passing of the Grail mythos into Western Culture during the crusades. One must not the sudden appearance of Grail, alchemical cults with severed heads and "widow's son" doctrines in Europe and perhaps the Wasteland motif represents the Arabian Desert. The cup rituals might contain any number of entheogenic substances, such as the dried mushroom that is rehydrated and "pressed" and the liquid "wine" is drunk by the "drinkers of fire" (nusadir). In the course of researching this theory, I must note the Imam Ali is often described as the nephew of the prophet in the literature, even in peer-reviewed Islamic journals, so clearly there are indications that this described the relationship between Muhammad and his cousin/son-in-law, and this is a common theme in much of the Iranian Shia literature.

4. Graves remarks in Food for Centaurs as to Amanita muscaria's "fox-like" color in Palestine. p.273 Nan-e-saghta; peculiarly enough, the Egyptian-Arabic word for mushroom ('aysh-al-ghorab) also translates to "raven's bread". [In the Afdari (Semnani) language of Iran, the name kalagh-nun (crow's bread) is given to an unidentified species of mushroom. (Georg Morgenstierne, "'Mushroom' and 'toadstool' in Indo-Iranian", Bulletin of the School of Oriental and African Studies, University of London 20:451- 457 (1957), pg. 453.) - PGW] The Parzifal Grail myth retain that heavenly bread motiff: Today is Good Friday, and they await there a dove,winging down from Heaven. It always brings a small white water, and leaves it on the stone." Parzifal 827.9 "..the true tale was sent to us..." as oppossed to the false Troyes version Wolfram's stress on the fact the kyot was baptized, as well as multilingual, could mean he was either a Muslim or Jew. Graves (1962) also writes: I learned only last week from an Arabic scholar, that the root-word F.T.R. means, in Arabic, first "toadstool," then "divine rapture," then "sacred pellets of bread." This points to a pre-Islamic hallucinogenic practice of immense age. This wine is described in part of the liturgy as taught by their sects Master, Al-Khasibi who was an intimate with the 6th Imam, with "Oh God, this is your servant 'abd al-nur, a substance you have grace, extolled, and absolutely permitted to your devotees who know you,...less by it with security and protection, and [sound] health and against sickness, and remove us worry and sorrow" and that it is a "substance of fire which God made his His greatest sacrifice and most noble substance" (Bar-Asher et. al. 2002). The Ismaili apparently had a amrita like substance, *ami* associated with a nectar of immortality, that was mixed with the soil of Karbala, where the Prophet's family was massacred (Khan in White 2000).
5. There are many interesting speculations on Templar and Islamic contacts with the Ismaili and perhaps the Alawi as well. The wasteland of the Grail myths are the hot deserts. The "widow's son" symbolism is often associated with military brotherhoods in the knightly romances of Perceval and showing up in Finnish folklore and persisting to at least the Civil War as De Santillana notices in his audacious *Hamlet's Mill*. He relates the curious incident of Gen. Armistead who fell at Picket's Charge in Gettysburg yelling repeatedly to his captors "I am a Son of the Widow" which De Santillana notes "is obviously the password of a secret military brotherhood that his captors did not understand, nor the historian either" and Littleton and Malcor do not attach any importance the recurrence of the phrase. The metallurgical connections with the "Widow's son" may well relate to the master-builder and caster of the Brazen Sea for the Temple, Hiram Abiff who is a "son of a widow" (1 Kings 7:14). I suspect a cult of immortality associated of the "widow's son" being raised from the dead as by Elisha (2 Kings 4:32-37) and Elijah (1 Kings 17:22-24) as well as Jesus (Luke 7:11). Alchemical enigmas can be found that describe the process in terms of mystery of the widow, stone of the widow, or orphans stone. The *Codex Marcianus*, a collection of early Greek/Egyptian alchemical fragments contains a line that links the widow cult with a drug of deathlessness with Isis talking to her son Horus, a widow's son himself, "Now realize the mystery, my son, the drug, the elixir of the widow."

References

1. Allegro, J.M., 1970. The Sacred Mushroom and the Cross: A Study of the Nature and Origins of Christianity within the Fertility Cults of the Ancient Near East. Garden City, NY: Doubleday.
2. Bar-Asher, Meir M.; Kofsky, Arieh, 2002. The Nusayri-Alawi Religion: An Enquiry into Its Theology and Liturgy. NYC: Brill Academic Publishers.
3. Berlant, Stephen R., 2005. The entheomycological origin of Egyptian crowns and the esoteric underpinnings of Egyptian religion. Journal of Ethnopharmacology Volume 102, Issue 2, 14 275-288
4. Birjandi, Ibn Hisam Khusifi, 2004. Khavaran-nameh. Tehran: Vezarate Ershad.
5. Coomaraswamy, Ananda K., 1944. Headless Magicians; And an Act of Truth. Journal of the American Oriental Society, Vol. 64, No. 4 (Oct. - Dec.), pp. 215-217.
6. Corbin, Henry, 1994. The Man of Light in Iranian Sufism. New Lebanon: Omega Publications.
7. Corbin, Henry, 1989. Spiritual Body and Celestial Earth. Princeton: Princeton University Press.
8. Corbin, Henry, 1998. The Voyage and the Messenger. Berkeley: North Atlantic Books.
9. Crowley, Mike, 2005. "When Gods Drank Urine: the riddle of Soma." Presented at Entheogenesis conference, updated now on www.earthrites.org.
10. Cumont, Franz, 1956. The Mysteries of Mithra, 2d rev. ed., trans. by Thomas J. McCormack; Hinnells, J. R., ed., Mithraic Studies, 2 vols.
11. Dannaway, F.R., Piper, A., and Webster, P., 2006. "Bread of Heaven or Wines of Light: Enthogenic Legacies and Esoteric Cosmologies." Journal of Psychoactive Drugs 38: 493-503. 40
12. Eisenman, Robert, 1998. James the Brother of Jesus. New York: Penguin Books.
13. Eliade, Mircea, 1986. Zalmoxis: The Vanishing God : Comparative Studies in the Religions and Folklore of Dacia and Eastern Europe. Chicago: Univ of Chicago Press.
14. Eliade, Mircea, 1962. The Forge and the Crucible. New York: Harper and Brothers.
15. Elmore,Gerald T. ed.,1999. Islamic Sainthood in the Fullness of Time: Ibn Al-Arabi's Book of the Fabulous Gryphon. Boston: Brill Academic Publishers.
16. Enright, Michael, 1996. Lady with a Mead Cup: Ritual Prophesy and Lordship in the European Warband from La Tene to the Viking Age. Dublin: Four Courts Press.
17. Eschenbach, Wolfram von, 2006. Parzival and Titurel. Trans. Cyril Edwards. Oxford: Oxford University Press.
18. Flattery, D. and Schwartz, M., 1989. Haoma and Harmaline: The Botanical Identity of the Indo-Iranian Sacred Hallucinogen "Soma" and its Legacy in Religion, Language, and Middle Eastern Folklore [Near Eastern Studies (Vol. 21)]. Berkeley, CA: University of California Press.
19. Geldner, K. F., 1951. Der Rig-Veda III. Harvard Oriental Series, vol. 35. Cambridge MA: Harvard UP.
20. Graves, Robert, 1960. Food for Centaurs. Garden City, NY: Doubleday.
21. Graves, Robert, 1962. Oxford Addresess on Poetry. NY: Doubleday & Co.
22. Green, Tamara M., 1992.The City of the Moon God : Religious Traditions of Harran. Religions in the Graeco-Roman world, 0927-7633; v. 114. New York : E.J. Brill, 1992.
23. Hajicek-Dobberstein, Scott, 1995. "Soma siddhas and alchemical enlightenment: psychedelic mushrooms in Buddhist tradition" Journal of Ethnopharmacology. Oct; 48 (2), pp. 99-118
24. Haq, Syed Nomanul, 1994. Names, Natures, and Things: The Alchemist Jabir ibn Hayyan and His Kitab al-ahjar. Boston : Kluwer Academic Publishers.
25. Heinrich, Clark, 2002. Magic Mushrooms in Religion and Alchemy. Rochester: Park Street Press.
26. Hoffman, M. A., C. A. P. Ruck, and B. Staples, 2002. "The Entheogenic Eucharist of Mithras". Entheos 2.1:13-46. 41
27. Hoffman, Michael and Carl A.P. Ruck, 2002. Freemasonry and the Survival of the Eucharistic Brotherhoods. Entheos: The Journal of Psychedelic Spirituality. Taos: Entheomedia.
28. Holymard, E.J., 1957. Alchemy. New York: Penguin. Holymard, E.J., Abu'l Qasim al-Iraqui, The Book of Knowledge Aquired Concerning the Cultivation of Gold. Paris.
29. Houben, Jan E.M., 1999. The Soma-Haoma problem: Introductory overview and observations on the discussion. Electronic Journal of Vedic Studies Vol. 9 Issue 1a (May 4) Retrieved January 18, 2008 from http://www.ejvs.laurasianacademy.com/ejvs0901/ejvs0901a.txt
30. Khan,Dominique-Sila, 2000. Conversation between Guru Hasan Kabiruddin and Jogi Kanipha : Tantra revisited by the Isma 'ili preachers. White,
31. David Gordon (ed) Tantra: In Practice. Princeton: Princeton University Press.
32. Kalyanaraman, S. 2004., Indian Alchemy: Soma in the Veda. New Dheli: Munshiram Manoharial Publishers Pvt. Ltd.
33. Karamustafa, Ahmet, 1994. God's Unruly Friends. Salt Lake City: University of Utah Press.
34. Khursani, Shaykh Muhammad 'Ali Mu'adhdin Sabzawari, 2008. Tuhfah yi-Abbasi, The Golden Chain of Sufism In Shi'ite Islam. New York: University Press of America.
35. Knight, Ian, 2006. PBS Secrets of the Dead. Day of the Zulu (pbs.org). http://www.pbs.org/wnet/secrets/case_zulu/clues.html. Retrieved February 9, 2008.
36. Lakhnavi, Ghalib and Abdullah Bilgrami, 2007. The Adventures of Amir Hamza. New York: Modern Library Edition.
37. Littleton, C. Scott & Linda Malcor, 2000. From Scythia to Camelot. New York: Garland Publishing, Inc.
38. Mahdihassan, S., 1951. "The Chinese Origin of Three Cognate Words: Cheistry, Elixir, and Genii." Bombay: Journal of the University of Bombay, n.s., 20.2: 107-131. Madhihassan, S., 2002.
39. Indian Alchemy or Rasayana. Delhi: C. Motilal Banarsidass Publishers. Mahdihass, S., 1990. "The Sufi, his headdress and its significance." American Journal of Chinese Medicine. 18(3-4):185-96.
40. McElwain, Thomas, 1983. Ritual and Sacrifice in a Turkish Village. 42 Stockholm: Out of Print manuscript with a title in Turkish.

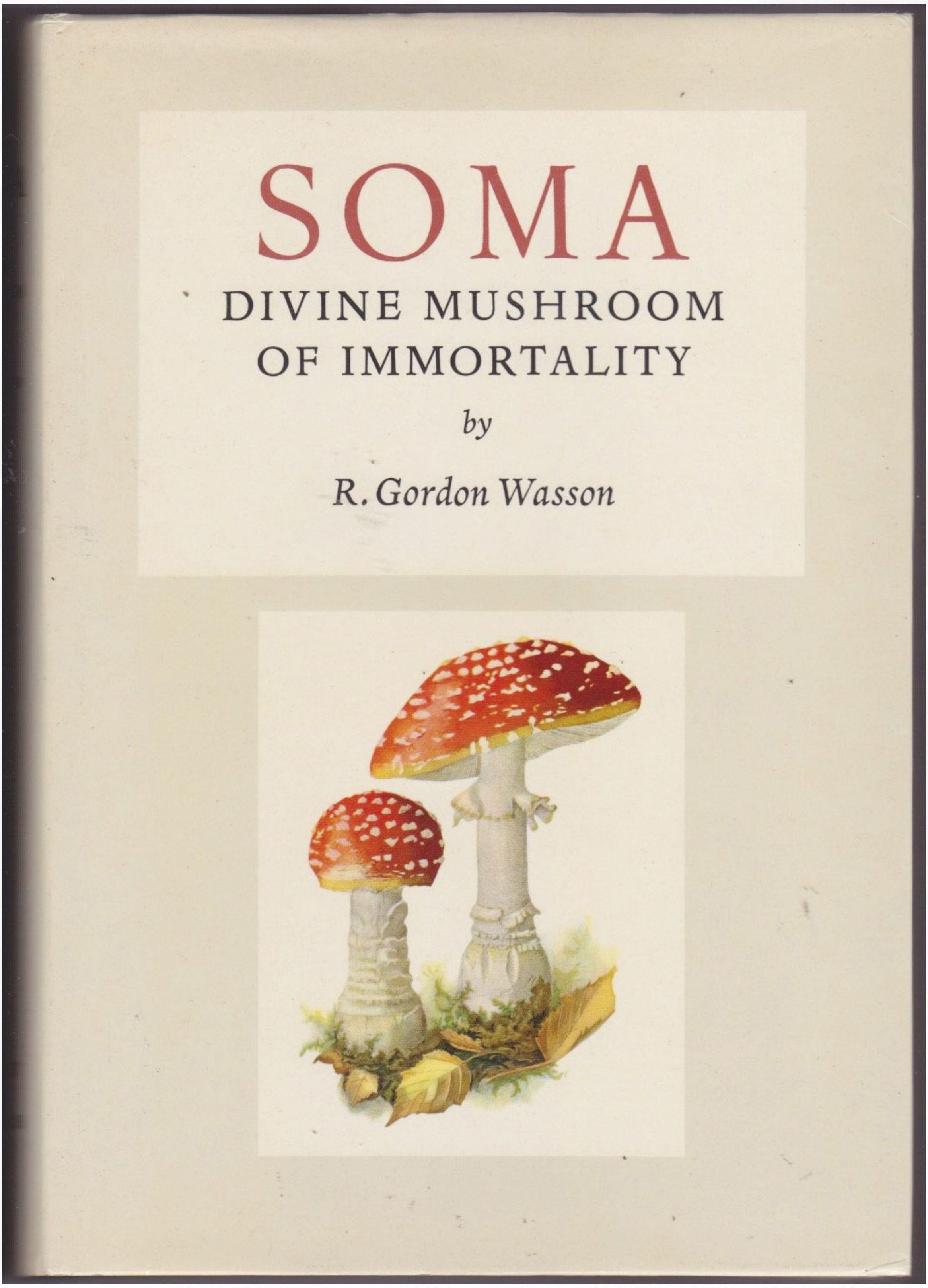
41. McElwain, Thomas, 1983. Hymns of Sacrifice. Finnland: Ibid. circa 1983. (via personal correspondence)
42. Moghdam, M., 1975. Address to the Second International Congress of Mithraic Studies in Tehran.
43. Needham, Joseph, 1954. Science and Civilization in China, vol. 5.Pt.1 Cambridge: Cambridge University Press.
44. Needham, Joseph, 1974. Science and Civilization in China, vol. 5.Pt.2 Cambridge: Cambridge University Press.
45. Needham, Joseph, 1980. Science and Civilization in China, vol. 5.Pt.4 Cambridge: Cambridge University Press.
46. Netton, Ian Richard, 2000. Sufi Ritual:The Parallel Universe. New York: RoutledgeCurzon.
47. Nicholson, Helen, 2001. Love, War and the Grail: Templars, Hospitallers and Teutonic Knights in Medieval Epic and Romance, 1150-1500. Boston: E. J. Brill.
48. Piper, A. 2002. The Lote Tree of the Furthest Boundary: Psychoactive sacraments in Islamic Gnosis. Entheos: The Journal of Psychedelic Spirituality 2 (1).
49. Ruck, Carl A. P., Blaise Daniel Staples, Clark Heinrich, 2001. The Apples of Apollo, Pagan and Christian Mysteries of the Eucharist, Carolina Academic Press.
50. Ruck, Carl A. P., 2007. The Hidden World: Survival of Pagan Shamanic Themes in European Fairytales. Durham: Carolina Academic Press.
51. Ruck, Carl A.P.; Hoffman, Mark Alwis; Staples, Blaise Daniel, 2004. The Brotherhood of the Warriors of Mithras. New England Classical Journal 31, 335-362.
52. Rudi, Mathee, 2005. The Pursuit of Pleasure. Princeton: Princeton University Press.
53. Saso, Michael J., 1990. Blue Dragon -White Tiger: Taoist Rites of Passage. Washington D.C.: University of Hawaii Press.
54. Shah, Idris, 2002. The Sufis. New York: Anchor Books.
55. Shah-Kazemi, Reza and Leonard Lewisohn, 2007. The Sacred Foundations of Justice in Islam: The Teachings of 'Ali ibn Abi Talib. Bloomington: World Wisdom, Inc..
56. Shanon, Benny, 2008. Biblical Entheogens: a Speculative Hypothesis. Time and Mind: 43 The Journal of Archaeology Consciousness and Culture Volume I - Issue I March 2008 pp. 51-74
57. Shirazi, Sultanul Wa Izin, 2001. Peshawar Nights. World Islamic Network. Seguy, Marie-Rose, 1977. The Miraculous Journey of Mahomet. New York: George Braziller.
58. Shelly, William Scott, 1995. The Elixir:An Alchemical Study of the Ergoy Mushrooms. Indiana: Cross Cultural Publications, Inc.
59. Shulgin, Alexander and A. Shulgin, 1996. Tihkal. Berkeley: Transform Press. Strickmann, Michel, 1966. Notes on Mushroom Cults in Ancient China. Unpublished manuscript, Rijksuniversiteit Gent.
60. Stetkevych, Jaroslav, 1996. Muhammad and the Golden Bough: Reconstructing Arab Myth. Indiana: Indiana University Press.
61. Wasson, R.G., 1968. Soma: Divine Mushroom of Immortality. New York, NY: Harcourt, Brace & World.
62. Wasson, R. Gordon and Kramrisch, Ott and Ruck. 1986. Persephone's Quest. New Haven:Yale University Press.
63. Wasson, R.G., Hofmann, A., and Ruck, C.A.P., 1978. The Road to Eleusis: Unveiling the Secret of the Mysteries. New York, NY: Harcourt, Brace, Jovanovich.
64. Wilson, Peter Lamborn, 1999. Ploughing the Clouds: The Search for Irish Soma. San Francisco: City Light Books.

Soma: Divine mushroom of immortality

by

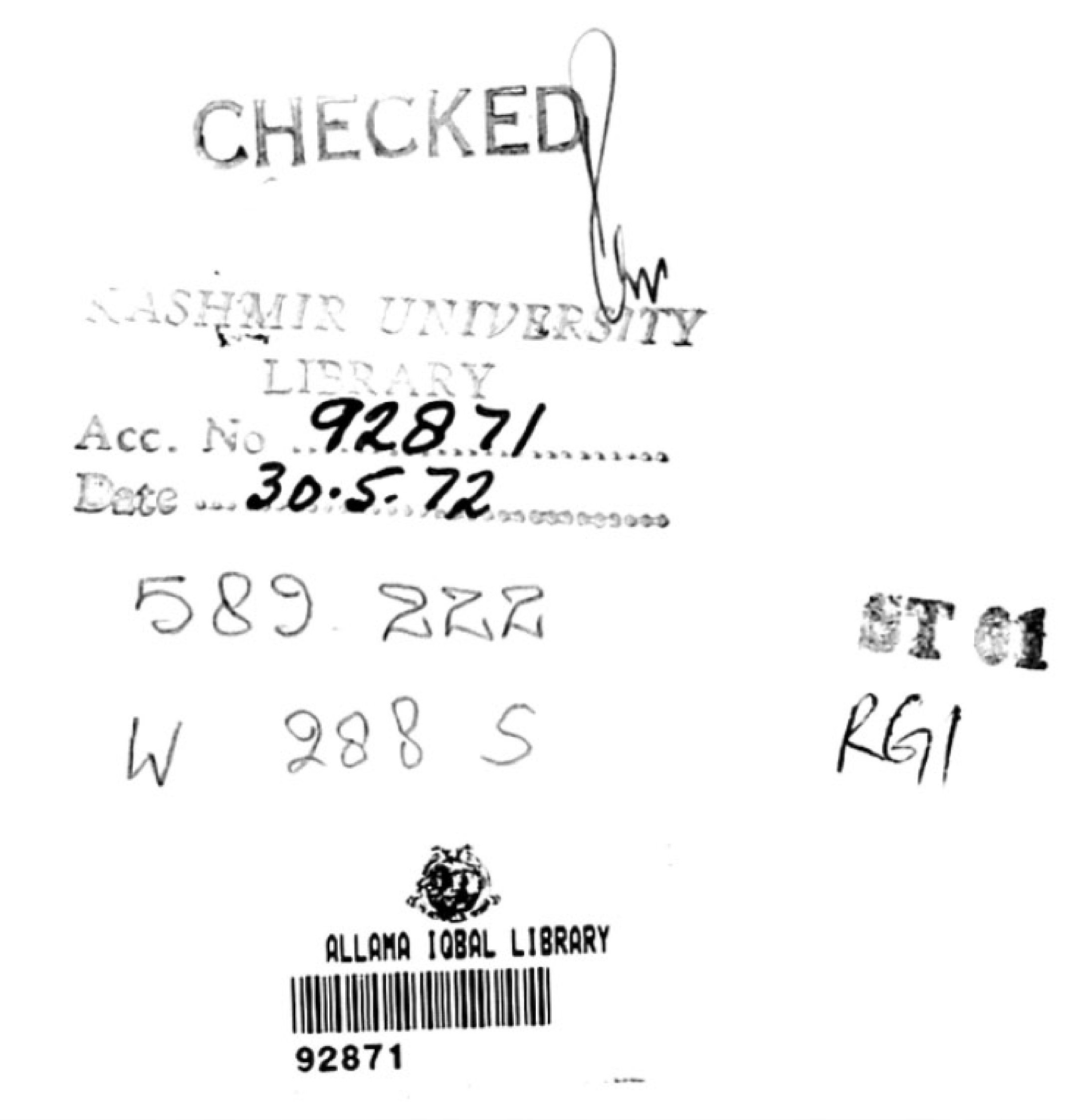
Roger Gordon Wasson

original text: https://archive.org/download/in.ernet.dli.2015.449342/2015.449342.Soma-Divine.pdf
backup source: https://www.psilosophy.info/resources/2015.449342.Soma-Divine.pdf


SOMA
DIVINE MUSHROOM
OF IMMORTALITY
by
R. Gordon Wasson

Ethno-mycological Studies

No. 1



CHECKED
KASHMIR UNIVERSITY
LIBRARY
Acc. No 92871
Date 30.5.72
589.222
W 288 S
ST 01
RG1
ALLAMA IQBAL LIBRARY
92871

Note to this edition:

1. Samhita Devanagari Accent has been included to Samhita Roman Accent for verses of ṚgVeda according to https://theveda.org.in
2. Latin transcription has been added to Greek words, e.g. ἀμβροσία [*ámvrosía*].
3. Chinese hand calligraphy writings are presented in a form of semistylised computer font.
4. Footnotes numbering changed to continuous form, with each footnote has its individual number.
5. Page references in this version relate to the pages of original edition.

Table of Contents:

PART ONE - SOMA: DIVINE MUSHROOM OF IMMORTALITY
- I. The problem
- II. The Fly-agaric of Eurasia
- III. The Ground Rules of the Search
- IV. Soma Was Not Alcoholic
- V. The Roots, Leaves, Bloosoms, Seed of Soma: Where Are They?
- VI. Soma Grew in the Mountains
- VII. The Two Forms of Soma
- VIII. Epithets and Tropes for Soma in the ṚgVeda
  - A. Introductory
  - B. "Hári" and red
  - C. The bull and soma
  - D. The udder and soma
  - E. The stalk and soma
  - F. Soma's "head"
  - G. Four poetic conceits
    - 1. The single eye
    - 2. Mainstay of the sky
    - 3. The navel
    - 4. The filtres
      - The First Filtre
      - The Third Filtre
  - H. "Tongue of the way"
- IX. Soma and the Fly
- X. Words Used for Soma in the ṚgVeda
- XI. Miscellanea
- XII. Mani, Mushroom, Urine
- XIII. The Marvelous Herb

PART TWO - THE POST-VEDIC HISTORY OF THE SOMA PLANT
- I. The Brāhmaṇas and the &sacute;rauta-sūtras
- II. Later Sanskrit Works
- III. Early European References
- IV. Mid-Nineteenth Century
- V. File Number 118
- VI. The Turn of the Century
- VII. Mukherjee and the *Bhang* Theory
- VIII. Later Researches in the 20th Century

PART THREE - NORTHERN EURASIA AND THE FLY-AGARIC
- I. The Fly-agaric in Siberia: the Testimony of Explorers, Travelers, and Anthropologists
- II. A Far-Reaching Siberian Word-Cluster
  - *1. The Antiquity of Fly-Agaric Inebration*
  - *2. The Distribution of Fly-Agaric Inebration*
  - *3. The 'poŋ' Cluster Among The Indo-Europeans*
- III. Europe and the Fly-Agaric

Epilogue: The Tree of Life and the Marvelous Herb
Acknowledgements

Exhibits
- 1. The fly-agaric in Siberia
  - *Preliminary Note*
  - *A. Explorers, Travelers, Anthropologists*
    - [1] Kamieński
    - [2] 'Denbei', a Japanese castaway

- [3] von Strahlenberg
- [4] Krasheninnikov
- [5] Steller
- [6] Georgi
- [7] de Lesseps
- [8] Sarychev
- [9] Kopeć
- [10] von Langsdorf
- [11] Erman
- [12] von Maydell
- [13] von Dittmar
- [14] Kennan
- [15] Lansdell
- [16] Jadrintsev
- [17] Patkanov
- [18] Sljunin
- [19] Enderli
- [20] Vanderlip
- [21] Jochelson
- [22] Bogoraz
- [23] Itkonen
- [24] Lehtisalo
- [25] Dunin-Gorkavich
- [26] Karjalainen
- [27] Bergman
- [28] Donner
- [29] Worth and Jochelson: Koryak and Kamchadal Tales
  - Kamchadal Tales: A - Czelkutqu and the Amanita Girls
  - B - Ememqut and his Wife Yeltalnen
  - C - Kutq, Miti, and the Little Louse
  - D - The Codfish, the Rams, and the Amanita
  - Koryak Tales: A - Little-bird-man and Raven-man
  - B - Ememqut and Sun-man's Daughter
  - C - Ememqut and White-Whale-Woman
  - D - Raven and Wolf
- [30] Shamanic Hymn translated from the Vogul

B. The Linguistic Aspect

- Preliminary Note
- [31] Boas
- [32] Munkácsi
- [33] Kannisto
- [28a] Donner
- [24a] Lehtisalo
- [34] Uotila
- [35] Bouda
- [36] Steinitz
- [37] Hajdú
- [38] Balázs
- [39] Pedersen

C. Secondary Sources

- [40] Hartwich
- [41] Eliade
- [42] Brekhman and Sem

2. THE FLY-AGARIC IN SCANDINAVIAN WRITINGS

Preliminary Note

[43] Ödman

[44] Schübeler
[45] Mörner and Hildebrandsson
[46] Nordhagen
[47] Kuylanstierna-Andrassy
CITATIONS FROM THE ṚGVEDA
INDEX

PART ONE

SOMA

DIVINE MUSHROOM OF IMMORTALITY

I. The problem

In the second millennium before our Christian era a people who called themselves 'Aryans' swept down from the Northwest into what is now Afghanistan and the Valley of the Indus. They were a warrior people, fighting with horse-drawn chariots; a grain-growing people; a people for whom animal breeding, especially cattle, was of primary importance; finally, a people whose language was Indo-European, the Vedic tongue, the parent of classical Sanskrit, a collateral ancestor of our European languages. They were also heirs to a tribal religion, with an hereditary priesthood, elaborate and sometimes bizarre rituals and sacrifices, a pantheon with a full complement of gods and other supernatural spirits, and a mythology rich with the doings of these deities. Indra, mighty with his thunderbolt, was their chief god, and Agni, the god of fire, also evoked conspicuous homage. There were other gods too numerous to mention here.

Unique among these other gods was Soma. Soma was at the same time a god, a plant, and the juice of that plant. So far as we know now, Soma is the only plant that man has ever deified. (The Mexican Indians seem to regard the hallucinogenic plants, whether mushrooms, *peyotl*, or morning glories, as mediators with god, not as a god. The Nahua - Aztecs and other groups speaking the same tongue - called the mushrooms *teonanáacatl*, 'god's flesh', but the mushrooms do not figure in their pantheon.) In the course of the Soma sacrifice the juice was pounded out with stones on resounding planks and was drunk by the officiating priests. Soma - the three Somas - inspired hymns vibrant with ecstasy, composed over centuries by priests who lived in centers remote from each other. In the end, at an early period in the first millennium before Christ, these hymns were gathered together, and the canon of that text has come down to us intact. Compared with ours, the Vedic civilization was simple, but their verses - the figures of speech with which they embellished their thoughts and feelings, their play with the meanings and sounds of words, the rules of their prosody - were sometimes subtle and sophisticated. Some of the hymns are of so exalted, even delirious, a tenor that the modern reader is led to exclaim: 'This surely was composed under the influence of a divine inebriant'. It takes little perception to sense the difference in tone between the awe-inspired hymns to Soma and the rowdy drinking songs of the West prompted by alcohol.

In the hierarchy of Vedic gods certain others took precedence over Soma, but since Soma was a tangible, visible thing, its inebriating juice to be ingested by the human organism in the course of the ritual, a god come down and manifesting himself to the Aryans, Soma played a singular rôle in the Vedic pantheon. The poets never tire of stressing Soma's sensuous appeal. In appearance it was brilliant, reminding them of the Sun, of Fire, of the rays of the Sun, of the round bowl of the heavenly firmament, 'the back of the sky'. The dried plants were first freshened with water. They were then macerated with stone pestles, and the tawny yellow juice as it came coursing through the conduits of the press was compared, in the hyperbole of the day, with thunder.[1] The priests, after imbibing the juice, seem to have known, for the nonce, the ecstasy of existence in the World of the Immortals. The Divine Element was not just a symbol of a spiritual truth as in the Christian communion: Soma was a miraculous drink that spoke for itself.

A book of 1028 hymns is our sole contemporary source of information about the period it deals with. There is agreement on the text, but many words are of doubtful meaning and doubly so in their allusions that often escape us. They have been preserved for us, both words and melodies, by oral tradition; by achievements of the human memory that have no parallel in other cultures, preserved better than our ancient learning in the

---

1. Parjanya, the god of thunder, was the father of Soma, according to one tradition, ṚgVeda IX 82[3]; Abel Bergaigne, *La Religion Védique*, Vol. I, pp. 172-3.

manuscripts with which our Western scholars are familiar. When a Brahman schooled in the ancient tradition sings us a hymn from the ṚgVeda, with intonation precisely right, there is reason to think that it is as though we were listening to a tape recording 3,000 years old. These hymns, still eliciting the utmost reverence among countless Hindus, constitute the earliest monument in their religious and literary heritage, as well as one of the earliest cultural legacies of our own Indo-European world. As the eminent French Vedist Louis Renou has said, the whole of this immense collection, known as the ṚgVeda, is present *in nuce* in the themes that Soma presents to us.[2]

But what manner of plant was this Soma? No one knows. For twenty-five centuries and more its identity has been lost. The Hindus, probably for the reasons that will emerge as my argument progresses, allowed this authentic Soma to fall into disuse and early on began to resort to sundry substitutes, substitutes that were frankly recognized as such and that to this day are met with in India in their peculiar religious rôle. The West discovered the Sanskrit and Vedic cultures almost two centuries ago. For two centuries we have been absorbing the lessons that India has to teach us, in linguistics, in mythology and philosophy and religion, in literature, art, history, anthropology, archaeology. This difficult assimilation is still going on, though possibly at a slower, more sober pace than in the enthusiasm of the initial discoveries.

But the identity of Soma is as obscure today as two centuries ago, and what is more, this mystery is compounded by what I will call the mystery of the mystery of Soma. When I first embarked on the problem in 1963, I could hardly believe what I found to be the situation. Here is a clear-cut botanical question - a psychotropic plant that calls for identification. The clues should be in the Vedic hymns. True, the poems contain no botanical description such as a scientist would ask for. Those remote singers were no modern botanists. The poet-priests of the ṚgVeda were composing for contemporaries, certainly not for posterity 3,000 years away, and their imagery and terms often elude our understanding, just as our hymns would make hard going for our collateral descendants 3,000 years hence. But the hymns are all shot through with Soma, and 120 of them are entirely devoted to the plant-god. The hymns are not make-believe about a fictitious plant: if ever there was genuine poetry about a genuine plant, here it is. Was it possible that so much could have been written by lyric poets about a plant, over centuries, in many centers of priestly activity, and its identity not be revealed? It was no secret for the poet-priests. How extraordinary it would have been if all of them, numbering scores, perhaps a hundred, had withheld from their verses the revealing descriptive terms, the tell-tale metaphors, that the trained reader today needs to spot the plant! But this did not happen. All that has happened is that no ethno-botanist with an interest in psychotropic plants has applied himself to the examination of the hymns.

The Vedic culture has been primarily a subject for Vedic scholars and secondarily for those scholars who interest themselves in comparative mythology and religion. The specialists in Vedic learning have included a handful of brilliant men, of extraordinary perception, who are assured of a lasting reputation by the works they have left behind. They have been tilling a field, a rich field it is true, in a remote frontier province of the humanities, and they must often have felt that they were leading an isolated existence. The early translations of the ṚgVeda were execrable. Only now, in the annotated translations of the late K. F. Geldner and the late Louis Renou, does a student with no Vedic possess a rendering that permits him to sense some of the nuances of the original.[3] (Certain it is that I, for one, could have done nothing without Renou's translation and commentary.[4]) Throughout the dawn and early morning of Vedic studies, in the 19th century, many cultivated people in the West, not merely Vedic scholars but educated laymen, knew at least what the Soma problem was. More recently, whenever the subject has been broached, scholars and editors have sighed and wearily turned away: the Soma question has dropped into oblivion simply because it has seemed to defy solution. One would have thought that students of religion would have focussed on it, but our contemporary religious thinkers (with notable exceptions) have no sympathy with drugs as a way to religious experience, though accepting a rôle for other external aids such as music, architecture, and liturgy; and (unconsciously of course) many of them are nothing loath to gloss over and ignore the historical rôle of Soma in the higher reaches of our own religious history. Yet it cannot be gainsaid that Vedic culture with Soma unidentified is the play of Hamlet with Hamlet left out. The identification of Soma remains one of the chief desiderata of Vedic studies. That the question continues to be slighted constitutes, as I have said, the mystery of the Soma enigma.

---

[2] *Etudes Védiques et Pāṇinéenes*, E. de Boccard, Editeur, Paris, tome IX, 1961, p. 8.

[3] In *The Soma-Hymns of the ṚgVeda* S. S. Bhawe has begun an excellent translation into English, with a lengthy commentary. Oriental Institute, Baroda, 1957, 1960, 1962. He has published 70 of the hymns to Soma, out of 114 in Maṇḍala IX.

[4] His translation, so far as it had gone before his untimely death in August 1966, had been completed before I had an opportunity to lay before him my thesis, in three long talks that I had with him in Paris and his country house in the Eure, in the spring of that year. He found my thesis *séduisante* and encouraged me to prepare as quickly as possible a full-dress presentation, but naturally he did not commit himself.

There is no sure evidence that in Vedic times Soma was drunk by others than the priests. By a deliberate decision the priests must finally have decided to discontinue the use of the Sacred Plant. That familiarity with the genuine Soma seems to have been confined to the priesthood would make the enforcement of such a decision effective, and the very memory of the plant itself was finally lost. For more than two millennia the hymns to Soma have been sung and revered in the absence of Soma. The record of these intervening centuries is strangely, significantly, silent about the holy herb. In India discussions of such matters were confined to the priestly circles: others were uninformed and uninterested. The priestly compositions that have come down to us show acute concern over the relative merits of various substitutes, but no concern over the plant itself. Moreover, the Hindus traditionally have not been interested in the facts of history, considering them irrelevant when weighed in the balance against the future incarnation of the individual's soul. Brahmans among my friends in India have assured me that the many substitutes for Soma used over the large expanse of the subcontinent and through the ages were always known by the inner circles of the priestly caste to be substitutes. This cannot be proved but must have been a fact. The contrast between the ecstasy of Soma inebriation as sung in the hymns and the effects, often vile, of any of the many substitutes was always too glaring to be ignored.

To the Europeans knowledge about Soma came late. It was not until 1784 that the word itself, spelled *Sōm*, made its début on the European scene, in Charles Wilkins's English translation of the *Bhagavad Gītā*. (The earliest citation for Soma that the Oxford Dictionary gave was 1827.) In the 1830's European scholars finally awoke to the mystery of Soma's identity, but their efforts to solve the problem from that day to this have been singularly futile. They have merely worked over the Brahmanic discussions of the substitutes, apparently under the misapprehension that the original Soma must have closely resembled the substitutes, if it was not in fact one of them. Or they volunteered suggestions pulled out of the air, flouting the ṚgVedic text and Brahmanic practice. In *Part Two* of this book Wendy Doniger O'Flaherty gives the revealing story of this search.

And so in the fullness of time it has fallen on me, a retired banker, to be greatly daring and to submit to the intellectual world a new theory of Soma's identity. As I entered into the extraordinary world of the ṚgVeda, a suspicion gradually came over me, a suspicion that grew into a conviction: I recognized the plant that had enraptured the poets. For this purpose the text of the hymns, the epithets and tropes pertaining to the plant, are abundantly clear. As I went on to the end, as I immersed myself ever deeper in the world of Vedic mythology, further evidence seeming to support my idea kept accumulating. By Jove, I said, this is familiar territory!

At the same time there hovered constantly in my mind's eye the admonitory finger of Tristram Shandy as he warned against the occupational hazard of those who advance hypotheses:

> It is in the nature of a hypothesis when once a man has conceived it, that it assimilates everything to itself, as proper nourishment, and from the first moment of your begetting it, it generally grows stronger by everything you see, hear or understand.

And so, while well aware of the perils that attend my enterprise, I present my case. If I am wrong, how quickly will my proposal be forgotten! If I am right, I claim the privilege of adding a new and exciting chapter to the world's knowledge of the remote past, the proto-history of our own Indo-European culture.

In a word, my belief is that Soma is the Divine Mushroom of Immortality, and that in the early days of our culture, before we made use of reading and writing, when the ṚgVeda was being composed, the prestige of this miraculous mushroom ran by word of mouth far and wide throughout Eurasia, well beyond the regions where it grew and was worshipped.

II. The Fly-agaric of Eurasia

My candidate for the identity of Soma is *Amanita muscaria* (Fr. ex L.) Quél., in English the fly-agaric, the *Fliegenpilz* of the Germans, the *mukhomor* of the Russians, the *fausse oronge* or *tue-mouche* or *crapaudin* of the French, the brilliant red mushroom with white spots familiar in forests and folklore throughout northern Eurasia.

This is the first time that a mushroom has been proposed in the Soma quest.

The fly-agaric is an inebriant but not alcoholic. As far back as our records go, it has been the Sacred Element in the shamanic rites of many tribes of northern Siberia, tribes that are concentrated in the valleys of the Ob and the Yenisei, and then, after an interruption, other tribes in the extreme northeast of Siberia. Apparently some of these tribesmen scarcely knew alcohol until the Russians introduced it in the 16th and 17th centuries, but the fly-agaric had been their precious possession long before then. The available records about its religious rôle are adequate to reveal its main properties but fall short of what we would have them be in the light of the proposal made in this paper. Our earliest eye-witness account of its use is by a Pole, Adam Kamieński, in 1658, among the Ostyak of the Irtysh River (tributary of the Ob), an Ugrian people of the Finno-Ugrian family.[5] Today we know its use is common to the Ostyak and their kin the Vogul, the Ket of the Yenisei Valley, the Samoyed peoples (who together with the Finno-Ugrians make up the Uralic group), and three sister tribes, unrelated linguistically to the others, on the north Pacific Coast, the Chukchi, the Koryak, and the Kamchadal. Responsible observers have reported that the Yukagir, who survive in Siberia in tiny communities near the Arctic Ocean, and the Inari Lapps in Finland, preserve oral traditions of having consumed the fly-agaric in times past, though they no longer do so.

The Russians began their conquest of Siberia at the end of the 16th century and our knowledge of these Siberian tribes virtually starts then. The use of the fly-agaric has been in retreat ever since the arrival of the White Man. It has ceded ground to the vodka of the Russians and, until the Russian Revolution, the fire-water of the western whalers. A more powerful influence has been the aggressive cultural thrust of the Russians, who frown on some of the practices peculiar to the natives. (In a conflict of cultures the stronger one always assumes right away, without examination, that all its ways, its vices as well as its virtues, are incomparably superior.) To the Russian conquest of Siberia, therefore, we owe our knowledge of the use of the fly-agaric and also the approaching end of that use. In the Exhibits we publish *in extenso* the accounts of travellers, linguists, and anthropologists that deal with the fly-agaric in Siberia. There is linguistic and folkloric evidence to indicate that formerly, in proto-history, it was used by some of the Indo-European peoples, as well as the Hungarians.

III. The Ground Rules of the Search

My primary source, the basis of my identification of Soma, is the ṚgVeda, as made accessible to me in the recent annotated translations, to wit, those of Renou, Geldner, and Bhawe.[6] It is certain that the poets of the ṚgVeda knew the original Soma at first hand, and they never strayed from it for long. I invoke later texts and the Avesta only where they help us to know what the ṚgVeda means.

Any suggestion for the identity of Soma must meet the following criteria: 1) Is it in conflict with the ṚgVeda? 2) Does it fit comfortably into such descriptive terms as the ṚgVeda poets apply to Soma, and into the indications as to the source of supply, methods of handling, *etc.*? 3) Does the proposal happily resolve some of the many *cruces* in the ṚgVeda? On all three counts I am hopeful that my suggestion meets the requirements.

---

5. *Vide* Exhibit **[**1**]**, p. 233. Throughout this book the numbers between heavy brackets refer to the Exhibits.
6. I exclude from consideration the latest hymns to have been written, the last to be included in the canon before it was closed. These hymns differ from the others considerably in tone and language, and there is reason to believe that substitutes, which I think had always been occasionally used, had now almost completely replaced Soma in the sacrifice. These hymns are mostly in Maṇḍala X from 85 through 191.

It was only after I had finished my examination of the ṚgVeda text, and after Dr. O'Flaherty had laid before me her paper written at my request on the history of Soma since Vedic times (here published as *Part Two*), that I realized how unorthodox I had been in my approach. It turns out that I was unique. Everyone else, literally everyone, had relied on later sources, sources composed at a time when the original Soma had been superseded by substitutes, and on plants called in various modern vernaculars by names derived from 'Soma'. Or they had had recourse to guesses, without supporting evidence; guesses such as rhubarb, or hashish, or wild grape wine, in disregard of their incompatibility with the ṚgVeda. At a later stage I shall have more to say on this. But here the question of substitutes calls for some discussion.

The Aryans came from the north but no one knows from where. Thomas Burrow made headway on this question when in *The Sanskrit Language*[7] he marshalled the latest linguistic evidence about the prehistory of the Indo-European peoples. The Indo-Iranian branch of the race, before migrating to the areas that they were to conquer, had occupied the marches of the Indo-European domains and had lived in long and intimate contact with a race that spoke proto-Finno-Ugric, with whom they exchanged lexical elements.[8] The words that they borrowed from their Finno-Ugric neighbors do not appear in other Indo-European languages.

If as I believe the Aryans brought down with them from their homeland a cult of the sacred fly-agaric, it must needs follow that their priests had from the start wrestled with the problem of substitutes. The fly-agaric is not always available. Like most species of mushrooms, it does not lend itself to cultivation. The supply is therefore limited and varies with the season and the year. It can be dried and thus preserved: the ṚgVeda speaks on several occasions of water being added to the (presumably dry) Soma, so that it would swell up again.[9] The fly-agaric is a mycorrhizal mushroom: in Eurasia it grows only in an underground relationship with the pines, the firs, and above all the birches. Where these trees are not, neither does the fly-agaric grow. It can be transported, but channels of trade must be set up and maintained. A well organized priesthood would not allow the cult to falter for want of the Sacred Element, and in the Indus Valley settlements, far but not too far from birch and conifer, the use of substitutes, while always regrettable, must have been so common as to arouse no comment. This would make the final abandonment of the fly-agaric easier than if no substitutes had ever been used. Wendy O'Flaherty in her paper on the history of the Soma question has pointed out the consistent association, in early times, of the color red with the substitutes for Soma that were preferred - a significant pointer when the fly-agaric, flaming red, as the original Soma is under consideration. Friends in the Vaidika Saṁ&sacute;odhana Maṇḍala in Poona, where such questions as this are studied, have told me that three criteria governed the choice of substitutes: the plant should be small, it should be leafless, and it should possess fleshy stalks. If these are ancient criteria, it is easy to see how they were suggested by the fly-agaric - small, leafless, with juicy stalk. That the criteria seem arbitrary and permitted the choice of plant substitutes bearing no outward resemblance to the fly-agaric is not incompatible with the sacerdotal habit of mind. The substitute had to be constantly available, and what plant that met this condition could resemble the fly-agaric? In the hot arid regions of northwest India, Afghanistan, and Iran the available species of three botanical genera, Ephedra, Sarcostemma, and Periploca, seemed to meet these requirements with fair success and they came to be widely used in the post-Vedic Soma sacrifice.

There has been an impression in India and elsewhere that Soma was a creeper, *vallī* in Sanskrit. No ṚgVedic authority exists for this term, in fact none in the whole corpus of Vedic literature. But the three genera that I have cited could be construed as *vallī* and therefore I refrain from contending that *vallī* was not used in ṚgVedic times. Indeed in the second half of the Maṇḍala X, in the last batch of hymns to be added before the canon was closed, there is a verse that may refer to such substitutes:

> X 85[3]
> One thinks one drinks Soma because a plant is crushed.
> The Soma that the Brahmans know - that no one drinks.

सोमं॑ मन्यते पपि॒वान्यत्सं॑पिं॒षंत्योष॑धिं	*sómaṃ manyate papivā̆n yát saṃpiṃṣánty óṣadhim*
सोमं॒ यं ब्र॒ह्माणो॑ वि॒दुर्न तस्यां॑श्नाति॒ कश्च॒न	*sómaṃ yám brahmā̆ṇo vidúr ná tásyā&sacute;nāti ká&sacute; caná*

---

7. Faber & Faber, London, 1955, Chap. 1.
8. *Ibid.*, pp. 23-27
9. *Vide, e.g.*, IX 74[2].

(For the convenience of scholars we shall always add the Vedic text of the verses that we quote.) This verse, and the late hymn of which it forms a part, may have been composed at the very moment when the original Soma had already fallen into disuse, when only priests still remembered what it was, and when substitutes were currently accepted as the genuine article.

IV. Soma Was Not Alcoholic

In the West it has been repeatedly suggested that Soma was an alcoholic drink. (The culture of the modern world has long been obsessed with alcohol as the sole inebriant.) This can be denied with assurance. The difference in tone between the bibulous verse of the West and the holy rapture of the Soma hymns will suffice for those of any literary discrimination or psychological insight. But there are criteria other than the literary and the subjective. The stalks were pressed as a liturgical act and before the liturgy was finished the juice was drunk. Three sacramental offerings could be made in one day. Even if we allow for the heat of the summer in the Indus Valley, fermentation could not have advanced far in a religious rite repeated thrice in a day. Moreover, those who know the fermenting process must find it hard, indeed impossible, to imagine anyone, no matter how far removed from our culture, waxing lyrical, even ecstatic, over a drink in active fermentation. It is not as though the Indo-Aryans were unfamiliar with fermented drinks. They had their *súrā*, mentioned several times in the ṚgVeda but without reverential pæans; quite the contrary:

> VII 86[6ab]
> Malice has not been of my own free will, O Varuṇa; it was *súrā*, anger, dice, a muddled head.
>
> न स स्वो दक्षो॑ वरुण॒ ध्रुति॒ः सा सुरा॑ म॒न्युर्वि॒भीद॑को॒ अचि॑त्तिः
>
> *ná sá svó dákṣo varuṇa dhrútiḥ sā́ súrā manyúr vibhī̆dako ácittiḥ*

A mere difference between fermented drinks would not cause the gulf that separates *súrā* from the Soma that inspired the great hymns.

Yet it has been suggested, as will be seen in *Part Two*, that recollections of the mead of their ancestors might have clothed this particular beverage for the Aryans with rich associations entitling it to a superior footing than other fermented drinks. But no one knows whether the ancestors of the Aryans had been drinking mead: many peoples knowing honey do not ferment it. In any case bees with their honey exist in the Indus Valley, and there would have been no reason to give up mead, if indeed it had been Soma, and even less to exchange it for the vile tasting substitutes that took its place. Honey, *mádhu*, is mentioned frequently in the ṚgVeda but mead never. Honey is cited for its sweetness and also is often applied as a metaphor of enhancement to Soma. There is reason to think it was used on occasions to mix with Soma, but the two were never confused. Honey offers no stalks to pound in the course of the liturgy, nor does it ferment in a twinkling.

The most astonishing of candidates for Soma was espoused by Sir Aurel Stein, the explorer-scholar, *viz.*, rhubarb. He had observed it growing wild in the mountains. According to Stein himself, no Indian in recorded history has made a fermented drink of rhubarb, though of course with the addition of sugar or honey the juice lends itself to fermentation. There is no reason to think any Indian ever did so. True, there are stalks to press, but the juice would not ferment and become alcoholic at once. All the rich Soma adjectives and metaphors of the ṚgVeda make odd reading when linked to rhubarb: resplendent, Born of Thunder, Mainstay of the Earth, Navel of the Way, Immortal Principle. Stein must have forgotten either his ṚgVeda or his sense of humour.

In 1921 an Indian advanced the notion that Soma, after all, was nothing but *bhang*, the Indian name for marijuana, *Cannabis sativa*, hemp, hashish. He conveniently ignored the fact that the ṚgVeda placed Soma only on the high mountains, whereas hemp grows everywhere; and that the virtue of Soma lay in the stalks, whereas it is the resin of the unripened pistillate buds of hashish that transport one into the beyond; or, much weaker, the leaves, which are never mentioned in the ṚgVeda. The stalks of hemp are woody.

The Indo-Iranians did not know the distillation process and therefore Soma could not have been a strong drink, *i.e.*, brandy or the distillate of grains. It should be unnecessary to argue this point, but scholars - Indian and Western alike - use the terms loosely, terms properly applicable only to distilled liquor. In IX 107[12] the poet compares Soma with the 'intoxicating one'; Geldner supplies *Branntwein* (brandy) as an example of what he might have meant, and Renou follows his lead with *alcool* (any distilled beverage). I doubt whether they would have made these suggestions had they been alert to the anachronism. V. S. Agrawala in his *India as Known to Pāṇini* seems to mean decanting when he mistakenly says distilling.[10] Dr. O'Flaherty in her account of the Soma search finds it necessary to record many such confusions and ambiguities.

The Orientalist Berthold Laufer wrote, 'Certain it is that distillation was a western invention, and was unknown to the ancient Chinese.'[11] The Dutch scholar R. J. Forbes in his *Short History of the Art of Distillation*[12] concludes that there is no evidence for distilled beverages before the distillation process was discovered and practiced around A. D. 1100 in Italy, probably at Salerno. ('Alcohol' is of Arabic origin but in Arabic it meant something other than what we mean by it.) The making of *aquavitæ* (as it was called for a long time, and still is, in parts of Europe) remained a secret of the alchemists and some monastic establishments for centuries, until the Reformation, when in the course of a decade, in the second quarter of the 16th century, thanks to the dissolution of the monasteries by the Protestants, the 'secret' became common property, and the product, after having changed hands for a king's ransom, sold suddenly dirt cheap. There was no contemporary comment on the social implications of this unanticipated fruit of religious reform.

V. The Roots, Leaves, Bloosoms, Seed of Soma: Where Are They?

In the ṚgVeda (excluding the latter half of Maṇḍala X, last to be admitted to the canon) there is no reference to the root of the Soma plant, nor to its leaves, nor to its blossoms, nor to its seed. In a lengthy anthology of lyric poetry written over centuries in the far flung Valley of the Indus and its tributaries, how odd it is that no poet ever speaks of these conspicuous parts of almost all chlorophyll-bearing plants, not even casually or incidentally. There must have been a conspiracy of silence, laid down perhaps by the dictates of their very religion, but why?

Alternatively, they were speaking of a plant that had neither seed nor blossom nor leaf nor root; *viz*., a mushroom. As for seed, there is positive evidence that Soma was thought to lack seed: Soma was procreated from on high, the Somic germ having been placed by the gods. Soma was divinely engendered:

> IX 83[3d]
> The [gods, those] fathers with a commanding glance, laid the [Somic] germ.
>
> नृचक्ष॑सः पि॒तरो॒ गर्भ॒मा द॑धुः *nṛcákṣasaḥ pitáro gárbhamā́ dadhuḥ*

In a world where farming was already well developed one would expect Soma to be cultivated. A plant with properties so extraordinary would elicit the utmost attention, though owing to its sacred character we would rather expect its growth to be confined to the gardens of the higher priesthood. But the fact is that there is never a mention of its cultivation. Perhaps it did not lend itself to man's efforts to make it grow. To this day the fly-agaric (like almost all other species of mushrooms) refuses to be cultivated. Even in the laboratory it will not sprout.

Note. While our argument in favour of the fly-agaric is founded squarely on the ṚgVeda, there is one verse in the Avesta that seems to speak of the 'trunks' and 'branches' of the sacred plant, and discussion of that verse is in order if only to forestall objections.

The Avesta is the Bible of the religion of Zoroaster (= 'Zarathustra'), a religion that lingers on to this day in the Parsi community centered in Bombay. Tradition has it that most of the Avesta was lost when Alexander the Great overran Iran, but the surviving fragments are still substantial. There is no consensus among scholars on the dates of Zoroaster. Some assign him to about the 10th century B.C., this early date being based on reasonable arguments derived from linguistics and comparative cultural studies. Others prefer to accept the tradition according to which he was living around B. C. 600, the proposed dates being 630-553, or 628-551, or

---

[10] 2nd edition, Varanasi, 1963, p. 121.
[11] *Chinese Contributions to the History of Civilization in Ancient Iran*, Field Museum, Chicago, 1919, p. 238.
[12] E. J. Brill, Leiden, 1948, pp. 32, 88-89.

618-541. The *ipsissima verba* of the great Prophet are enshrined in the Avesta, but most of the text is of later date and some of its traditions stem back long before his time. Religiously and linguistically the Avesta and ṚgVeda are siblings. The text of the ṚgVeda is, however, much purer owing to its marvelous preservation through the ages by the disciplined human memory. The Avesta like the ṚgVeda knew an inebriating plant that was the object of worship, and the Avestan 'Haoma' and the Vedic Soma were certainly identical, at least at the start. Three chapters, Yasna 9, 10, and 11, consist of numinous phrases of adoration addressed to Haoma; collectively they are known as the Hōm Yašt. James Darmesteter, who gave us our standard translation of the Avesta, felt sure that the Hōm Yašt had been interpolated late into the text, between B.C. 140 and A. D. 50. One might expect its authority to be impugned by reason of this late date, but an interpolated text may incorporate ancient words and traditions, and precisely this is the situation here, the Hōm Yašt preserving for us in its words and matter some of the truly archaic elements in the Avesta, perhaps antedating Zoroaster himself. Thus it becomes necessary to examine Yasna 10.5, which I give below in the original Iranian dialect peculiar to the Avesta, in Darmesteter's French translation, and in my English rendering of Darmesteter. The speaker is addressing Haoma:

varəδayaŋuha mana vaca	Grandis par ma parole	Grow by my word
vīspə̄sča paiti varəšaǰiš	dans tous tes troncs, dans toutes tes	in all thy trunks, in all thy branches,
vīspə̄sča paiti frasparəγə̄	branches, dans toutes tes tiges	in all thy stems
vīspə̄sča paiti fravāxšə̄	dans tous tes troncs, dans toutes tes	in all thy trunks, in all thy branches,
	branches, dans toutes tes tiges.	in all thy stems.
(In the original text the last three lines are repeated.)	*Darmesteter's rendering.*	*English translation of Darmesteter.*

I have underlined in the Avestan text the three words that Darmesteter renders by 'trunks', 'branches', and 'stems'. The question is how certain are these meanings. (We reproduce on p. 122 [see original ed.] the picture of Haoma that Darmesteter gives us, in what he says is its natural size. It is a leafless plant without 'trunk' or 'branches'.) I shall take up these three words in the inverse order of their appearance in the verse.

3. *fravāxši-*. This word had three meanings or uses: (a) stem, (b) the *membrum virile*, and (c) antler. The prefix *fra-* conveys the idea of forward movement, of growth, thrust, erection. This is lacking in our lifeless 'stem', but how felicitous for our fast-growing mushroom tribe! In many of the world's cultures there is a semantic overlap between 'mushroom' and the *membrum virile*, for obvious reasons; *e.g.*, Greek μύχης [*mýchis*], Japanese *matsutake*. In mycology we use 'stipe' rather than 'stem', but perhaps 'sprout' would convey better the thrust of the original.

2. *frasparəγa-*. According to the lexicons this word meant 'shoot', 'sprout', 'sucker', and again the prefix *fra-* conveys the feel of forward thrust. There seems no warrant for Darmesteter's 'branches', except for the later Pahlavi and Sanskrit translations of the word, which may have been influenced by the current Haoma-substitutes. Darmesteter was presupposing that Haoma was a tree or shrub and translating the word to conform to his presupposition. The meaning and feel of the word closely resembles *fravāxši-*.

1. *varəšaǰi-*. This word presents the Avestan student with difficulties. It occurs only three times, in Yasna 10.5, Yasna 71.9, and Yašt 8.42. The contexts are similar and do not help. The word is compound, noun + verb, *varəša*, 'tree', and *gay*, 'to live'. The grammatical relationship between these two elements is not clear. The suggestion has been made that the word's meaning was 'that which gives life to the tree', whence 'root' seems a viable guess. Bartholomæ suggested this meaning in his famous Old-Iranian Dictionary, but he was not sure as he added a question-mark to the explanation. Darmesteter was following Middle-Iranian traditions when he translated the word as 'trunk', and this meaning was confirmed by H. W. Bailey who at the same time rejected the rendering 'root'. (*Journal of the Royal Asiatic Society of Great Britain and Ireland*, 1934, pp. 507-8.) Bailey's conclusion was based on the Pahlavi translation of the word *varəšaǰi-* by *bun* = 'stalk' or 'trunk', and *advan* = 'stalk', the latter originally meaning 'the upper part of a tree', which rules out 'root'.

The Pahlavi tradition is not a completely reliable guide to the meaning of uncertain terms in the Avesta, but so long as no serious contradiction arises, it may help to make the rendering more probable. If Haoma was a mushroom, the translation must accommodate itself to that fact, and we are relying on the ṚgVeda to establish this. Now if Bailey's 'stalk' be accepted as a possible meaning of *varəšaǰi-*, this is again close to the other two words that we examined before. Here then we have perfect harmony of style. Yasna 10.5 was written in an elevated rhythmic prose by a bard who was addicted to poetic parallelism. We have seen that most of the verse was repeated word for word. We have seen that in the verse that concerns us the second and third substantives virtually duplicate each other. Does it not therefore become a poetic necessity that the first of the triad should be a close synonym? On this assumption and on the assumption that Haoma was a mushroom, I suggest the following translation:

> Swell, (then,) by my word!
> in all thy stalks, and in all thy shoots, and in all thy sprouts.
> in all thy stalks, and in all thy shoots, and in all thy sprouts.

★

For help in dissecting Yasna 10.5 I am indebted and grateful to Dr. Heinrich von Stietencron, of Heidelberg.

VI. Soma Grew in the Mountains

Time and again the ṚgVeda speaks of Soma as hailing from the mountains, from the tops of the mountains, which in the case of the Indo-Aryans meant either the Hindu Kush or the Himalayas:

V 43[4c]
… plant from the mountain, …

मध्वो॒ रसं॑ सु॒गभ॑स्तिर्गि॑रि॒ष्ठां॑	*mádhvo rásaṃ sugábhastir giriṣṭhā́ṃ*

V 85[2d]
… he has placed the Soma on the mountain top.

दि॒वि सूर्यं॑मदधा॒त्सोम॒मद्रौ॑	*diví sū́ryam adadhāt sómam ádrau*

IX 18[1a]
… the Soma seated on the mountain top …

परि॑ सुवा॒नो गि॑रि॒ष्ठाः प॒वित्रे॒ सोमो॑ अक्षाः	*pári suvānó giriṣṭhā́ḥ pavítre sómo akṣāḥ*

IX 46[1b]
… these Somas grown on the mountain top.

क्षरं॑तः पर्व॑ता॒वृधः॑	*kṣárantaḥ parvatāvŕ̥dhaḥ*

IX 62[4a]
… the Soma stalk … seated on the mountain top;

असा॑व्यं॒शुर्मदा॑या॒प्सु दक्षो॑ गिरि॒ष्ठाः	*ásāvy aṃ&sacute;úr mádāyāpsú dákṣo giriṣṭhā́ḥ*

IX 62[15a]
… Born on the mountain top, … the Soma juice is placed for Indra

गि॒रा जा॒त इ॒ह स्तु॒त इंदु॒रिंद्रा॑य धीयते	*girā́ jātá ihá stutá índur índrāya dhīyate*

IX 71[4a]
… [This Soma] … that grows in the mountain …

परि॑ द्यु॒क्षं॑ सह॑सः पर्वता॒वृधं॒	*pári dyukṣáṃ sáhasaḥ parvatāvŕ̥dhaṃ*

IX 82[3b]
… at the navel of the Earth, in the mountains, [Soma] has placed his residence …

नाभा॑ पृथि॒व्या गि॒रिषु॒ क्षयं॑ दधे	*nā́bhā pr̥thivyā́ giríṣu kṣáyaṃ dadhe*

IX 85[10ab]
… In the firmament of heaven the Seers milk … the bull-Soma seated on the mountain top;

दि॒वो नाके॒ मधु॑जिह्वा अस॒श्चतो॑ वे॒ना दु॑हंत्यु॒क्षणं॑ गिरि॒ष्ठां॑	*divó nā́ke mádhujihvā asa&sacute;cáto venā́ duhanty ukṣáṇaṃ giriṣṭhā́m*

IX 87[8a]
... Here is the flow of Soma that is come from within the most distant mountain ...

ए॒षा यंयौ पर॒मादं॒तरद्रेः॒ *eṣā́ yayau paramā́d antár ádreḥ*

IX 95[4b]
... This [Soma], ... [this] stalk, [this] bull seated on the mountain top ...

शुं दुंहंत्यु॒क्षणं गिरि॒ष्ठां *aṃ&sacute;úṃ duhanty ukṣáṇaṃ giriṣṭhā́m*

IX 98[9c]
... This Soma juice, god [himself], sitting on the mountain ...

दे॒वो दैंवी गिरि॒ष्ठा *devó devī giriṣṭhā́*

The poets say that Soma grows high in the mountains. They make a point of this. They never speak of it as growing elsewhere. They must mean what they say. What a useless business it is for us to go chasing in the valleys after rhubarb, honey, hashish, wild Afghan grapes; in hot arid wastes after species of Ephedra, Sarcostemma, Periploca! For the Vedic poet this lofty birthplace was additional testimony to its divine origin, bringing it closer to the celestial sphere, to Indra, to Parjanya. It is unlikely that the poets of the ṚgVeda should have conspired together to attribute a fictitious habitat to Soma.

In Northern Eurasia the birch and conifer grow at sea level. South of the Oxus and in India they are found only at a great height in the mountains, around 8,000 to 16,000 feet. As I have mentioned already, the fly-agaric grows in mycorrhizal relationship with the birch and the conifer. (Centuries later, when the art of writing began to play a rôle in Indian culture, the bark of the Himalayan birch quickly gained renown in Northern India for writing purposes.)

The Indo-Aryans, having conquered only the valleys, did not control the source of their Soma supply. The mountains were still held by their enemies, probably the Dasyus, the hated and despised dark skinned Dasyus. Under the circumstances there could be no ceremony attending the gathering of the sacred Soma, such as had perhaps attended it in the homeland, and such as we know attended the gathering of the hallucinogenic mushrooms of Mexico. All that had been left behind, and now, in Vedic times, a ceremony attended the buying of the holy plant from the natives who came down from the heights where the birch and the conifer grow. In the *&sacute;atapatha Brāhmaṇa* (as well as elsewhere) there is an account, absurd by our standards, of the ceremonial purchase, complete to speckled cane to beat the seller with, wherein a cow of a particular hue of skin and eye is exchanged for the Sacred Element.[13] This barter price for Soma reminds us, curiously, of the high price paid for the fly-agaric by the native tribesmen of the Maritime Provinces of Siberia: they are said to give as much as a reindeer for one fly-agaric, or even two or three reindeer.[14]

VII. The *Two Forms* of Soma

I now come to a crucial argument in my case.

The fly-agaric is unique among the psychotropic plants in one of its properties: it is an inebriant in *Two Forms*.

> *First Form*:
> Taken directly, and by 'directly' I mean by eating the raw mushroom, or by drinking its juice squeezed out and taken neat, or mixed with water, or with water and milk or curds, and perhaps barley in some form, and honey; also mixed with herbs such as *Epilobium* sp.
>
> *Second Form*:
> Taken in the urine of the person who has ingested the fly-agaric in the *First Form*.

---

13. Eggeling translation, Part II, pp. 66 ff.
14. *Vide infra*, **[**11**]**, p. 252.

The *Second Form*, as urine, was first called to the attention of the Western World by a Swedish army officer, Filip Johann von Strahlenberg, after having served 13 years as a captive of the Russians in Siberia. His book, first published in German in Stockholm, appeared in 1730;[15] and an English translation in London in 1736 and again in 1738 under a lengthy title beginning *An Historico-Geographical Description of the North and Eastern Parts of Europe and Asia*. Since then many other travellers and anthropologists have set forth the facts, usually going to extremes in characterizing the practice as revolting, disgusting, filthy, and the like. So far as our records go, none of them has tried the urine, not even the anthropologists, among whom there are usually some who pride themselves on participating to the full in native ways and who consider it their professional duty to do so. In 1798, a Pole, Joseph Kope&cacute;, a literary figure of some standing, tried the mushrooms (but not the urine) and published his remarkable impressions of the experience.[16] That he was ill at the time and running a fever detracts from the value of his testimony.

In the ṚgVeda Soma also has *Two Forms*, expressly so described in IX 66[2,3,5]:

> IX 66[1-2]
> Cleanse thyself, O [thou] to whom all peoples belong, for all wondrous deeds,
> the praiseworthy god, the friend for the friends.
> With those two Forms [*dual, not plural*] which stand facing us,
> O Soma, thou reignest over all things, O Pávamāna!

पव॑स्व विश्वचर्षणे॒ऽभि विश्वा॑नि॒ काव्या॑	*pávasva vi&sacute;vacarṣaṇeʹbhí ví&sacute;vāni kā́viyā*
सखा॒ सखि॑भ्य॒ ईड्य॑ः	*sákhā sákhibhya ī́ḍyaḥ*
ताभ्यां॒ विश्व॑स्य राजसि॒ ये प॑वमान॒ धाम॑नी	*tā́bhyāṃ ví&sacute;vasya rājasi yé pavamāna dhā́manī*
प्र॒ती॒ची सो॑म त॒स्थतु॑ः	*pratīcī́ soma tasthátuḥ*

> IX 66[3]
> The Forms [plural, not dual] that are thine, thou pervadest them,
> O Soma, through and through, O Pávamāna, at the appointed hours,
> O Wonder-worker!

परि॒ धामा॑नि॒ यानि॑ ते॒ त्वं सो॑मासि वि॒श्वत॑ः	*pári dhā́māni yā́ni te tváṃ somāsi vi&sacute;vátaḥ*
पव॑मान ऋ॒तुभि॑ः कवे	*pávamāna ṛtúbhiḥ kave*

> IX 66[5]
> Thy shining rays spread a filtre on the back of heaven, O Soma,
> with [thy] Forms [plural, not dual].[17]

तव॑ शु॒क्रासो॑ अ॒र्चयो॑ दि॒वस्पृ॒ष्ठे वि त॑न्वते	*táva &sacute;ukrā́so arcáyo divás pṛṣṭhé ví tanvate*
प॒वित्र॑ं सोम॒ धाम॑भिः	*pavítraṃ soma dhā́mabhiḥ*

In the Soma sacrifice the *First Form* is drunk by Indra and his charioteer, Vāyu, who are impersonated by high functionaries in the rite. The Vedic commentators, knowing nothing of the fly-agaric, have reached a consensus that the *First Form* is the simple juice of the Soma plant, and the *Second Form* is the juice after it has been mixed with water and with milk or curds. The commentators are agreed on this, the Vedic mythologies are so written, the matter is considered settled.[18]

While in default of any other explanation it is easy to see how this was arrived at, it is unsatisfactory because it flies in the face of the ṚgVeda text. Indra and Vāyu are repeatedly drinking the juice of Soma mixed with milk or curds, and, saving error on my part, they are never in the ṚgVeda drinking juice expressly described as not mixed with anything.

---

15. Philip Johan von Strahlenberg, *Das Nord- und Östliche Theil von Europa und Asia, in so weit solcher das gantze Russische Reich mit Siberien und der grossen Tartary in sich begreiffet*. ... Stockholm, 1730. *Vide* **[**3**]**, p. 234.
16. *Vide* **[**9**]**, pp. 243 ff.
17. Sanskrit and Vedic possess three numbers, singular, dual, and plural. In IX 66[2] the dual number is used speaking of the *Two Forms*. This is natural as the poet faces two vessels containing, one the juice of Soma presumably mixed with milk, *etc.*, the other Soma urine. In verses 3 and 5 he speaks of all Soma's forms, the celestial, the plant, the juice, the Soma urine, and therefore uses the plural.
18. *Vide*, *e.g.*, A. A. Macdonell, *The Vedic Mythology*, London, 1897, pp. 82, 106.

I will cite four instances where Indra and Vāyu drink Soma mixed with milk or curds. The first instance, V 51[4-7], is crucial because there is no mention of curds and the reader might think the poet was speaking of the unmixed juice, exactly as the commentators contend, until suddenly in verse 7, just before the end, it seems that all along the poet took for granted the curds! In the many instances where the poet does not mention the milk or curds, the omission seems accidental. The fly-agaric was often, perhaps usually, dried up when it was used in the sacrifice, and initially it had to be soaked in water, reinflated so to speak. Here are verses V 51[4-7]:

1

V 51[4-7ab]
... Here is the Soma [that] pressed in the vat is poured all around inside the cup, he dear to Indra, to Vāyu.
... O Vāyu, arrive hither for the invitation, accepting it, to share in the oblation! Drink [of the juice] of the pressed stalk, up to [thy full] satisfaction!
... Indra and thou, Vāyu, ye have a right to drink of these pressed [stalks]. Accept them, immaculate ones, for [your full] satisfaction!
... Pressed for Indra, for Vāyu, have been the Soma plants requiring a mixture of curds.

अ॒यं सोम॑श्च॒मू सु॒तोऽम॑त्रे॒ परि॑ षिच्यते	*ayáṃ sóma&sacute; camū́ sutó'matre pári ṣicyate*
प्रि॒य इंद्रा॑य वा॒यवे॑	*priyá índrāya vāyáve*
वाय॒वा या॑हि वी॒तये॑ जुषा॒णो ह॒व्यदा॑तये	*vā́yavā́ yāhi vītáye juṣāṇó havyádātaye*
पिबा॑ सु॒तस्यांध॑सो अ॒भि प्रय॑ः	*píbā sutásyā́ndhaso abhí práyaḥ*
इंद्र॑श्च वायवेषां सु॒ताना॑ं पी॒तिम॑र्हथः	*índra&sacute; ca vāyav eṣāṃ sutā́nāṃ pītím arhathaḥ*
तांजु॑षेथामरे॒पसा॑व॒भि प्रय॑ः	*tā́ñ juṣethām arepásāv abhí práyaḥ*
सु॒ता इंद्रा॑य वा॒यवे॒ सोमा॑सो॒ दध्या॑शिरः	*sutā́ índrāya vāyáve sómāso dádhyā&sacute;iraḥ*

The following three quotations say expressly that Indra and Vāyu drink Soma mixed with milk or curds:

2

IX 11[2]
The Atharvans have mixed milk with thy sweetness, longing for the god, the god [Soma] for the god [Indra].

अ॒भि ते॒ मधु॑ना॒ पयोऽथ॑र्वाणो अशिश्रयुः	*abhí te mádhunā páyó 'tharvāṇo*
दे॒वं दे॒वाय॑ देव॒यु	*a&sacute;i&sacute;rayuḥ devám devā́ya devayú*

IX 11[5-6]
Cleanse the Soma, pressed out by the hand-worked stones; dilute the sweet one in the sweetness [milk or water].
Approach with reverence; mix him with curds, put the Soma juice into Indra.

हस्त॑च्युतेभि॒रद्रि॑भिः सु॒तं सोम॑ं पुनीतन	*hástacyutebhir ádribhiḥ sutáṃ sómaṃ punītana*
मधा॒वा धा॑वता॒ मधु॑	*mádhāv ā́ dhāvatā mádhu*
नम॒सेदुप॑ सीदत द॒ध्नेद॒भि श्री॑णीतन	*námaséd úpa sīdata dadhnéd abhí &sacute;rīṇītana*
इंदु॒मिंद्रे॑ दधातन	*índum índre dadhātana*

3

IX 62[5-6]
The beautiful plant beloved of the gods, [the Soma] washed in the waters, pressed by the masters, the cows season [it] with milk.
Then like drivers [urging] on a horse, they have beautified [the Soma], the juice of liquor for drinking in common, for the Immortal One [Indra].

शु॒भ्रमंधो॑ दे॒ववा॑तम॒प्सु धू॒तो नृभि॑ः सु॒तः	*&sacute;ubhrám ándho devávātam apsú dhūtó nṛ́bhiḥ sutáḥ*
स्वदं॑ति॒ गाव॒ः पयो॑भिः	*svádanti gā́vaḥ páyobhiḥ*
आदी॒मश्वं॒ न हेता॒रोऽशूं॑शुभन्न॒मृता॑य	*ā́d īm á&sacute;vaṃ ná hétāró '&sacute;ū&sacute;ubhann amṛ́tāya*
मध्वो॒ रसं॑ सध॒मादे॑	*mádhvo rásaṃ sadhamā́de*

4

IX 109[15]
All the gods drink this Soma when it has been mixed with milk of cows and pressed by the Officiants.

> IX 109[17-18]
> The prize-winning Soma has flowed, in a thousand drops cleansed by the waters, mixed with the milk of cows.
> O Soma, march ahead toward Indra's bellies, having been held in hand by the Officiants, pressed by the stones!
>
> पिबं॑त्यस्य॒ विश्वे॑ दे॒वासो॒ गोभि॑ः श्री॒तस्य॒ नृभि॑ः सु॒तस्यं॑
> स वा॒ज्यं॑क्षाः स॒हस्रं॑रेता अ॒द्भिर्मृं॑जा॒नो गोभि॑ः श्रीणा॒नः
> प्र सों॑म या॒हींद्रं॑स्य कु॒क्षा नृभि॑र्येमा॒नो अद्रिं॑भिः सु॒तः
>
> *píbanty asya ví&sacute;ve devā̆so góbhiḥ &sacute;rītásya nŕ̥bhiḥ sutásya*
> *sá vājy ákṣāḥ sahásraretā adbhír mr̥jānó góbhiḥ &sacute;rīṇānáḥ*
> *prá soma yāhī̆ndrasya kukṣā̆ nŕ̥bhir yemānó ádribhiḥ sutáḥ*

If then the traditional view of the first and second 'Form' of Soma is to be replaced, what evidence do I adduce in favor of my interpretation?

Only the words of the ṚgVeda. In the hymns to Soma there comes a time when the religious emotion reaches a climax, an intensity of exaltation, that is overwhelming, and that after 3,000 years, in a world of utterly different orientation, even in translation, cannot but move any perceptive reader. These hymns are in Maṇḍala IX, from say 62 through perhaps 97, the mood then tending to ease off. The 74th hymn, in particular, consists of an enumeration of phrases that we have learned by now to recognize when they occur singly, clearly numinous phrases for the contemporary believers, tense phrases piled one on the other, Pelion on Ossa, in portentous sequence, until we suddenly read, at the end of verse 4, a phrase not met with before and not to be met again:

> IX 74[4]
> Soma, storm cloud imbued with life, is milked of ghee, milk. Navel of the Way, Immortal Principle, he sprang into life in the far distance. Acting in concert, those charged with the Office, richly gifted, do full honor to Soma. The swollen men piss the flowing [Soma].
>
> आ॒त्म॒न्वन्नभो॑ दुह्यते घृ॒तं पयं॑ ऋ॒तस्य॒ नाभिं॑र॒मृतं॒ वि जां॑यते
> स॒मी॒ची॒नाः सु॒दानं॑वः प्रीणंति॒ तं नरों॑ हि॒तमवं॑ मेहंति॒ पेरं॑वः
>
> *ātmanván nábho duhyate ghr̥tám páya r̥tásya nā̆bhir amŕ̥taṃ ví jāyate*
> *samīcīnā̆ḥ sudā̆navaḥ prīṇanti táṃ náro hitám áva mehanti péravaḥ*

If the final clause of this verse bears the meaning that I suggest for it, then it alone suffices to prove my case.

Renou renders the final phrase of this verse 4 as follows:

> Les [Maruts] seigneurs à la vessie pleine compissent [le Soma] mis-en-branle.
>
> The [Maruts] lords with full bladders piss [Soma] quick with movement.

Renou had lived with the ṚgVeda text for a lifetime and knew everything that had ever been said by scholars about it. He discerned that the 'swollen' men had full bladders and that they were urinating Soma. But to give meaning to the sentence he introduced the gods of rain, the Maruts. Certainly there are precedents for the clouds' 'urinating' rain. But in this verse and at this point in the hymns the Maruts are out of place. From IX 68 to 109 there are 24 other citations of *nŕ̥* in the plural (men) and in every instance they are the officiants at the sacrifice.'[19] So are they in 74[4]. It is noteworthy that Grassmann translates *nŕ̥* in this verse by 'men serving...' *etc.*, in conformity with his third definition of *nŕ̥*, 'men serving the gods, such as singers and sacrificers'. He does not translate it by his 6th definition, which would include gods. The priests appointed to impersonate Indra and Vāyu, having imbibed the Soma mixed with milk or curds, are now urinating Soma. They in their persons convert Soma into the *Second Form*. When Renou translated this verse, he had never heard of the Siberian use of the fly-agaric. Roger Heim and I apprised him of the facts when we dined with the Renous in the middle of April 1966.

Let us pause for a moment and dwell on a rather odd figure of speech. The blessings of the fertilizing rain are likened to a shower of urine. The storm-clouds fecundate the earth with their urine. Vedic scholars have lived so long with their recalcitrant text, and so close to it, that they remark no longer on an analogy that calls for explanation. Urine is normally something to cast away and turn from, second in this respect only to excrement.

---

19. *Vide* IX 68[4,7]; 72[2,4,5]; 75[3,5]; 78[2]; 80[4(2)]; 86[20,22,34]; 87[1]; 91[2]; 95[1]; 97[5]; 99[8]; 101[3]; 107[16]; 108[15]; 109[8,15,18].

In the Vedic poets the values are reversed and urine is an ennobling metaphor to describe the rain. The values are reversed, I suggest, because the poets in Vedic India were thinking of urine as the carrier of the Divine Inebriant, the bearer of *amṛta*. This would explain the rôle that urine - human and bovine - has played through the centuries as the medico-religious disinfectant of the Indo-Iranian world, the Holy Water of the East.

The words of this hymn IX 74 are redolent with a most holy mystery, the handling of the miraculous Soma planted on the mountain tops by the gods. Those charged with the Office are the Guardians-of-the-Meaning, the Guardians-of-the-Melodies, the Guardians-of-the-Mystery. The Pressing Stones, the woolen Filtre, the mingling of the Soma juice first with water, then with milk or curds in the vessels - all this is set forth clearly. Then the details of the Mystery are hidden from us. This is not in my opinion deliberate. Every party to the proceedings knew every detail. But when an event takes place that stirs people to their depths, a hush naturally falls, a feeling of awe and terror and adoration mingle. They speak in a whisper, as the rubric directs the clergy to do at the climax of the Mass. The details of the Mystery are certainly not to be put into Hymns. Thus we do not know what the dose of the juice was, nor how much water was added, nor how much milk or curds, nor what the effect was. We do not know whether the effect of the *First Form* and the *Second Form* was identical. Chemists say it could well be different, the juice being one thing and the metabolite another. Or it might be the same, the juice developing its marvelous properties only after it has been converted into the metabolite. There is a further possibility. In modern experience the fly-agaric causes nausea. If the agent that provokes vomiting is not the same as the one that leads to ecstasy, the former might be eliminated in the digestive track and the urine be thus freed from this inconvenience. We do not know how the metabolite was taken, whether neat or with water or milk or curds or honey. In the ṚgVeda we are not told who shared in the divine beverage. Afterwards only the priests, or some of them, were privileged to imbibe, but must there not have been a primitive age when others who participated in the rites shared in the drink? We know that centuries later the &sacute;ūdras, the outcastes, were not permitted even to hear the words of the ṚgVeda hymns, so holy were these.

Bhawe calls attention to three passages in the ṚgVeda that seem to him to stress the skill needed in the mixing of the Soma juice.[20] This might refer only to complicated ritualistic gestures and postures that had to be executed with precision. But in his judgement it is more likely that the blending of the ingredients had to be just right. Perhaps there was a secret recipe, the fruit of esoteric experience passed on from one generation of priests to the next. This recipe might be able to reduce or eliminate the initial nausea provoked by the Soma juice.

Let us pause for a moment and consider the probabilities. Some 3,250 years ago the Indo-Aryans living in the Indus Valley were worshipping a plant whose juice, pressed out and drunk immediately, seems to have had astonishing psychic effects, effects comparable to those of our Mexican hallucinogenic mushrooms, comparable but far different. The identity of that plant is not known. Hundreds of poets living over centuries in different centers speak of it in hallowed syllables but without mentioning leaves, roots, blossoms, or seed. Its stalk ('stipe' in mycologists' language) was obviously fleshy. How well these fit a wild mushroom! Nowhere in the thousand hymns is a dimension given of the 'stalk' that is incompatible with the stipe of a mushroom. It grew only high in the mountains. How well this fits the fly-agaric in the latitude of the Indus Valley! The poet says that the priests who have drunk the juice of this mysterious plant urinate the divine drink. In the traditions of Eurasia there is only one plant that supplies a psychotropic metabolite - the fly-agaric. Could any key unlock this combination save the fly-agaric?

If mine is indeed the interpretation to place on the *Second Form* of Soma in the ṚgVeda text, this should not be the only reference to the potable metabolite in Indo-Iranian literature and Parsi traditional practice. In the Avesta there is a verse in a famous Yasna, 48:10, supposed to preserve the very words of the Teacher himself, which has never been satisfactorily explained:

> When wilt thou do away with this urine of drunkenness with which the priests evilly delude [the people] as do the wicked rulers of the provinces in [full] consciousness [of what they do]?
> [*Translation by R. C. Zaehner*. - The text below corresponds to the underlined part of the translation only.]

---

[20] S. S. Bhawe: *The Soma-Hymns of the ṚgVeda*, Part III, p. 176, comment on 70^{8d}; also 47^{1a} and 99^{7a}.

> *Kadā aǰə mūΘrəm ahyā madahyā*...?

The learned commentators, not knowing of the *Second Form* of the Soma of the Iranians (called Haoma), have arbitrarily changed 'urine' to 'excrement' and have puzzled over the meaning. Surely Zoroaster meant what he said: he was excoriating the consumption of urine in the Soma sacrifice. If my interpretation be accepted, there is opened up a promising line of inquiry in Zoroastrian scholarship.

In the vast reaches of the *Mahābhārata*, the classical Indian epic, there occurs one episode - an isolated episode of unknown lineage - that bears with startling clarity on our *Second Form*. It was introduced into the text perhaps a thousand years after the fly-agaric had ceased to be used in the Soma sacrifice, and perhaps the editor did not know its meaning, which only today we are recovering. Here it is, as translated by Wendy O'Flaherty.

> *Mahābhārata*, A&sacute;vamedha Parvan, 14.54.12-35
> *Kṛṣṇa* had offered *Uttañka* a boon, and *Uttañka* said, "I wish to have water whenever I want it." *Kṛṣṇa* said, "When you want anything, think on me," and he went away. Then one day *Uttañka* was thirsty, and he thought on *Kṛṣṇa*, and thereupon he saw a naked, filthy *mātañga* [= *caṇḍāla*, an outcaste hunter], surrounded by a pack of dogs, terrifying, bearing a bow and arrows. And *Uttañka* saw copious streams of water flowing from his lower parts. The *mātañga* smiled and said to *Uttañka*, "Come, *Uttañka*, and accept this water from me. I feel great pity for you, seeing you so overcome by thirst." The sage did not rejoice in that water, and he reviled *Kṛṣṇa* with harsh words. The *mātañga* kept repeating, "Drink!", but the sage was angry and did not drink. Then the hunter vanished with his dogs, and *Uttañka's* mind was troubled; he considered that he had been deceived by *Kṛṣṇa*. Then *Kṛṣṇa* came, bearing his disc and conch, and *Uttañka* said to him, "It was not proper for you to give me such a thing, water in the form of the stream from a *mātañga*." Then *Kṛṣṇa* spoke to *Uttañka* with honeyed words, to console him, saying, 'I gave it to you in such form as was proper, but you did not recognize it. For your sake I said to Indra, "Give the *amṛta* to *Uttañka* in the form of water." Indra said to me, "A mortal should not become immortal; give some other boon to him." He kept repeating this, but I insisted, "Give the *amṛta*." Then he said to me, "If I must give it, I will become a *mātañga* and give the *amṛta* to the noble descendant of *Bhṛgu* [i.e., *Uttañka*]. If he accepts the *amṛta* thus, I will go and give it to him today." As he continued to say, "I will not give it [otherwise]," I agreed to this, and he approached you and offered the *amṛta*. But he took the form of a *caṇḍāla*. But your worth is great, and I will give you what you wished: on whatever days you have a desire for water, the clouds will be full of water then, and they will give water to you, and they will be called *Uttañka*-clouds.' Then the sage was pleased.

Plate I - The Soma of the ṚgVeda

Plate II - The Immortal Hári RV IX 69[5]: With unfading vesture, brilliant, newly clothed, the immortal *hári* wraps himself all around.

We found the first reference to Soma-urine in the ṚgVeda at a point in the liturgy where the proceedings and the religious emotion called for frankness in utterance. This reference did not stand alone in the literatures of Iran and India. There should be yet others in the ṚgVeda itself, perhaps more veiled as befits a holy mystery. I believe there are many such, but for the orderly progress of my argument I will defer their discussion until I reach the third of the three 'filtres'.

VIII. Epithets and Tropes for Soma in the ṚgVeda

Until this very day no poet in the English language has ever sung the supernal beauties of the fly-agaric; nor I believe has any novelist or essayist paid obeisance to this remarkable fruit. The same can be said probably for all the Germanic and Celtic languages. The original 'toadstool' was the fly-agaric, if we judge by the French and Basque languages. In the conservative provinces of France the dialectal name of the fly-agaric is *crapaudin*, 'the toad,' and in the Biscay and Guipuzcoa country the Basques call it by the precise Basque equivalent of the French provincial name, - *amoroto*. In *Mushrooms Russia and History* (Pantheon Books, New York, 1957) my wife V. P. Wasson and I explored the folkloric and linguistic background of the fly-agaric throughout Europe, and showed the deep hold that it exerted at one time on the imagination of the north European peoples. It seemed that a shadow hung over the fly-agaric, an ancestral curse; yes, a tabu. In many West European languages there are childhood ditties dealing with it, but beyond the nursery no one dwells on it except to repudiate it whenever occasion demands. At present I leave to the reader to find his own explanation for this tabu.

In the fall of the year, hard by a birch or pine, one is apt to find the fly-agaric. The season in the temperate zone lasts two or at most three weeks, with the climax coming in the middle week. The fly-agaric emerges as a little white ball, like cotton wool. It swells rapidly and bursts its white garment, the fragments of the envelope remaining as patches on the brilliant red skin underneath. At first the patches almost cover the skin, but as the cap expands they are reduced in relative size and finally are nothing more than islands on the surface. In fact, under certain conditions, especially as a result of rain, they are washed off altogether and the fly-agaric then shines without blemish as a resplendent scarlet mushroom. When the plant is gathered it soon loses its lustre and takes on a rather dull chestnut hue. Such is the dominant fly-agaric in Eurasia and in Washington, Oregon, and British Columbia. There is another variety found commonly in the rest of the United States, a variety that is a brilliant yellow, sometimes with a reddish tinge in the center of the cap. These two varieties are not mutually exclusive: occasionally specimens of each are found in the other's territory, and attention is then drawn to the oddity in mycological journals, perhaps in the miscellaneous notes for amateurs. No one knows what causes these two varieties in different sectors of the temperate zone, nor does anyone know whether the difference extends beyond the coloration and certain morphological features to the chemistry of the plant.[21]

When the fly-agaric is crushed and the juice milked out, the liquor comes forth a tawny yellow. As we shall see, in the ṚgVeda it is sometimes hard to say whether the poet, when he is speaking of Soma, has in mind the plant or the juice. The glowing adjectives of enhancement that he employs could describe either.

Now let us see how the poets of the ṚgVeda describe Soma.

A. Introductory

There are no words in the ṚgVeda that describe Soma as black, or gray, or green, or dark, or blue. All the great Vedic scholars from Burnouf to Renou seem to be in agreement on this.[22]

B. "Hári" and red

Hári is the most common of the colour epithets for Soma in the ṚgVeda. Numerically it far exceeds all the other colour words put together and rivals the epithet 'bull' that the poets never tire of applying to Soma. The word *hári* is cognate with *híraṇya* (golden) in Sanskrit and with χόλος [*chólos*] (gall) and χλωρός [*chlorós*] (yellow) in Greek, and ultimately with the English 'gall' and 'yellow'.

---

21. My division of *A. muscaria* into two varieties will not satisfy the mycologists. Those interested in pursuing this matter should consult Roger Heim: *Un problème à éclaircir: celui de la tue-mouche*, in the *Revue de Mycologie*, Vol. XXX, fasc. 4. 1965, pp. 296 ff.
22. Occasionally in later times *hári* came to include 'green' among its meanings, but this usage seems not to be ṚgVedic, except possibly in the late hymns that we exclude from consideration.

Hári is the precise adjective that one would wish to employ in Vedic to describe the fly-agaric. *Hári* is not only a colour word: the intensity of the colour is also expressed by it. It is dazzling, brilliant, lustrous, resplendent, flaming. In colour it seems to have run from red to light yellow. The mythological horses of the sun-god were *hári*: in this context the word is usually rendered by 'bay' or 'chestnut', but one doubts whether any mundane colour such as bay would describe the steeds of the sun. They are flaming and full of brio. *Hári* is of course a term of enhancement, and by being linked together, Soma and the sun-god's horses are mutually enhanced. How well the breathtaking fly-agaric fits into this picture.

Plate III - Tawny yellow Pávamāna.

Some other colour adjectives are used from time to time for Soma. Thus on one of the many occasions when Soma is called a bull, the bull is 'red,' *vṛ́ṣā &sacute;óṇo* (IX 97[13a]). Others are:

> *aruṇá*: This according to Grassmann means reddish, bright brown, golden-yellow, red, the red of morning.
> *aruṣá*: Again Grassmann: red, fire-colour, applied especially to fire, the sun, lightning, dawn, Soma, *etc*.
> *babhrú*: reddish brown, brown. Monier Williams gives 'tawny'.

The juice of the fly-agaric is tawny yellow. As we have said already, often we do not know whether the plant or the juice is being described. The dried fly-agaric is dull by comparison with the fresh specimen, *babhrú* rather than *hári*.

The poets of the ṚgVeda not only use the same adjective for Soma and the sun-god's horses. They compare Soma directly with the sun. The sun is a shining disc and thus a compelling metaphor for the fly-agaric, as compelling as it is inappropriate for any chlorophyll-bearing plant. Here is a selection of such figures:

I 46[10ab]
Light has come to the plant, a sun equal to gold ...

अभू॑दु भा उ॑ अं॒शवे॒ हिर॑ण्यं॒ प्रति॒ सूर्यः॑
ábhūd u bhā́ u aṃ&sacute;áve híraṇyaṃ práti sū́ryaḥ

I 135[3b]
This [Soma is] thy precise share, accompanied by the rays that are his in common with the sun

तवा॒यं भा॒ग ऋ॒त्वियः॒ सर॑श्मिः॒ सूर्ये॒ सचा॑
távāyáṃ bhāgá ṛtvíyaḥ sára&sacute;miḥ sū́rye sácā

IX 2^{6c}
He [Soma] shines together with the Sun ...

सं सूर्ये॑ण रोचते	*sáṃ sū́ryeṇa rocate*

IX 27^{5ab}
Here he is, racing with the sun, Pávamāna in the sky ...

ए॒ष सूर्ये॑ण हासते॒ पव॑मानो॒ अधि॒ द्यवि॑	*eṣá sū́ryeṇa hāsate pávamāno ádhi dyávi*

IX 28^{5ab}
He [Soma] has made the sun to shine.

ए॒ष सूर्य॑मरोचय॒त्पव॑मानो॒ विच॑र्षणिः	*eṣá sū́ryam arocayat pávamāno vícarṣaṇiḥ*

IX 37^{4bc}
He has made the sun to shine.

पव॑मानो अरोचयत् जा॒मिभिः॒ सूर्यं॑ स॒ह	*pávamāno arocayat jāmíbhiḥ sū́ryaṃ sahá*

IX 61^{8c}
He [Soma] joins forces with the sun's rays.

सं सूर्य॑स्य र॒श्मिभिः॑	*sáṃ sū́ryasya ra&sacute;míbhiḥ*

IX 63^{7ab}
Purify thyself with this stream by which thou [Soma] madest the sun to shine

अ॒या प॑वस्व॒ धार॑या॒ यया॒ सूर्य॒मरो॑चयः	*ayā́ pavasva dhā́rayā yáyā sū́ryam árocayaḥ*

IX 63^{8ab}
Pávamāna has hitched Eta&sacute;a [the sun's steed] to the Sun ...

अयु॑क्त॒ सूर॒ एत॑शं॒ पव॑मानो म॒नावधि॑	*áyukta sū́ra éta&sacute;aṃ pávamāno manā́v ádhi*

IX 64^{7}
[the Soma's flowing liquor] like the rays of the sun.

पव॑मानस्य विश्ववि॒त्प्र ते॒ सर्गा॑ असृक्षत सूर्य॑स्येव॒ न र॒श्मयः॑	*pávamānasya vi&sacute;vavit prá te sárgā asṛkṣata* *sū́ryasyeva ná ra&sacute;máyaḥ*

IX 64^{9c}
thou hast whinneyed like the sun-god.

अक्रां॑दे॒वो न सूर्यः॑	*ákrān devó ná sū́ryaḥ*

IX 71^{9b}
he has clothed himself with the fire-bursts of the sun.

दधि॒ त्विषी॑रधित॒ सूर्य॑स्य	*ádhi tvíṣīr adhita sū́ryasya*

IX 76^{4c}
he who has been cleansed by the sun's ray.

यः सूर्य॒स्यासि॑रेण मृ॒ज्यते॑	*yáḥ sū́ryasyā́sireṇa mṛjyáte*

IX 86^{22d}
thou hast made the sun to mount the sky.

न्नृभि॑र्य॒तः सूर्य॒मारो॑हयो दि॒वि	*nṛ́bhir yatáḥ sū́ryam ā́rohayo diví*

IX 86^{29d}
Thine, O Pávamāna, are the lights, the sun.

तव॒ ज्योतीं॑षि पवमान॒ सूर्यः॑	*táva jyótīṃṣi pavamāna sū́ryaḥ*

IX 86^{32a}
He [Soma] wraps himself all around with the rays of the sun.

स सूर्य॑स्य र॒श्मिभिः॒ परि॑ व्यत॒	*sá sū́ryasya ra&sacute;míbhiḥ pári vyata*

IX 97[31d]
[once] born, thou [Soma] didst fill the sun with rays.

जज्ञा॒नः सूर्यं॑मपिन्वो अ॒र्कैः	*jajñānáḥ sū́ryam apinvo arkáiḥ*

IX 97[33d]
O Soma juice, ... go bellowing to the sun's ray.

क्रंदं॑न्निहि॒ सूर्य॒स्योपं॑ र॒श्मिं	*krándann ihi sū́ryasyópa ra&sacute;mím*

IX 97[41d]
the juice has engendered light for the sun.

जंन॑य॒त्सूर्यें॒ ज्योति॒रिंदुः॑	*'janayat sū́rye jyótir índuḥ*

IX 111[3b]
[The Soma] races against the rays [of the Sun], vehicle beautiful to see, celestial vehicle beautiful to see.

त्सं र॒श्मिभिं॑र्यतते दर्श॒तो रथो॒ दैव्यों॑ दर्श॒तो रथः॑	*sáṃ ra&sacute;míbhir yatate dar&sacute;ató rátho dáivyo dar&sacute;ató ráthaḥ*

For the past century students of the ṚgVeda have been aware of a link that ties Soma to Agni, the god of fire. This tie is intimate and all pervasive, to the point where Bergaigne even went so far as to advance the hypothesis that the two had been interchangeable. Hymns addressed to Soma sometimes call him 'Agni'. (IX 66[19-21]; 67[23-24]) Soma is the child of the thunder-storm. The plant shares its liquid nature with the rain, its brilliance with the lightning (IX 22[2]), and the fire that lightning causes. Its inebriating potency is thought to rival the subtlety of flames. 'Make me to burn like fire started by friction', says the poet, addressing Soma. (VIII 48[6]) Some years ago I gathered together evidence indicating that a peculiar relationship existed in primitive man's mentality between the mushroom world and thunder-storms,[23] extending far beyond the Indo-European tribes but also including them. This relationship exists between Soma and the thunder-storm, and in fact it reaches an intensity no where else found. The flame-like plant, child of the thunder-bolt, possesses inebriating qualities that harmonize with its celestial appearance.

These observations on the colour of Soma may have failed to convey the full impression of radiance that marks Soma throughout the ṚgVeda, radiance without a specific colour linked to it. Take for example this verse:

IX 69[5]
With unfading vesture, brilliant, newly clothed, the immortal *hári* wraps himself all around. By authority he has taken the back [*i.e.*, the vault] of heaven to clothe himself in, a spread-cloth like to a cloud...

अमृं॑क्तेन॒ रुशं॑ता॒ वासं॑सा॒ हरि॒रमं॑त्यों निर्णिजा॒नः परिं॑ व्यत दि॒वस्पृ॒ष्ठं ब॒र्हणां॑ नि॒र्णिजैं॑ कृतोप॒स्तरं॑णं च॒म्वोंर्न॑भ॒स्मयं॑	*ámṛktena rú&sacute;atā vā́sasā hárir ámartyo* *nirṇijānáḥ pári vyata* *divás pṛṣṭhám̐ barháṇā nirṇíje kṛtopastáraṇaṃ* *camvórn abhasmáyam*

In the following verse the poet telescopes the life history of the fly-agaric, and how delicately he does it! For the first time in millennia the verse takes on meaning:

IX 71[2]
Aggressive as a killer of peoples he advances, bellowing with power. He sloughs off the Asurian colour that is his. He abandons his envelope, goes to the rendez-vous with the Father. With what floats he makes continually his vesture-of-grand-occasion.

प्र कृं॑ष्टि॒हेवं॑ शू॒ष एं॑ति॒ रोरुं॑वदसु॒र्यं॑१◌॒॑ वर्णं॒ नि रिं॑णीते अस्य॒ तं जहां॑ति व॒व्रिं पि॒तुरैं॑ति निष्कृ॒तमुं॑प॒प्रुतं॑ कृणुते नि॒र्णिजं॒ तनां॑	*prá kṛṣṭihéva &sacute;ūṣá eti róruvad asuryáṃ várṇaṃ* *ní riṇīte asya tám* *jáhāti vavríṃ pitúr eti niṣkṛtám upaprútaṃ kṛṇute* *nirṇíjaṃ tánā*

---

23. *Vide* R. Gordon Wasson. 'Lightning-bolt and Mushrooms: an essay in early cultural exploration.' Festschrift *For Roman Jakobson*, Mouton, The Hague, 1956, pp. 605-612.

Plate IV - SŪRYA: Sun.
RV IX 37[4bc]: He has made the sun to shine.

In the first line the poet reminds us of the extraordinary strength displayed by a simple mushroom in forcing its way to the surface against obstacles. 'Asurian' is not a colour: it is the radiance associated with Asuras, which at this period in Indo-Aryan history meant the divinities. The fly-agaric sloughs off the radiant envelope that is his to start with the 'universal veil', and prepares to meet with the Sky (= Father). He dons of course his gorgeous apparel, his *nirṇíj*, his 'vesture-of-grand-occasion', what Renou calls his *robe d'apparat*. Nine times[24] in Maṇḍala IX the poets speak of the *nirṇíj* of Soma: this is his dazzling vesture-of-grand-occasion. Often his costume is linked with the milk of cows: this is the fly-agaric while still studded with plaques of snow, with tufts of snowy wool. There is one occasion on which the poet stoops to a banal simile:

> IX 86[44c]
> Like a serpent he creeps out of his old skin.
>
> अहि॒र्न जू॒र्णा॑मति॑ सर्पति॒ त्वच॒म
> *áhir ná jūrṇā́m áti sarpati tvácam*

At least some of the poets knew their fly-agaric *in situ*, high in the mountains: could the last phrase in this verse have been written by anyone who did not know it?

> IX 70[7]
> He [Soma] bellows, terrifying bull, with might, sharpening his shining [*hári*] horns, gazing afar. The Soma rests in his well-appointed birthplace. The hide is of bull, the dress of sheep.
>
> रु॒वति॑ भी॒मो वृ॑ष॒भस्त॑वि॒ष्यया॒ शृं॑गे॒ शिशा॑नो॒ हरि॑णी विचक्ष॒णः
> आ योनिं॒ सोम॒ः सुकृ॑तं॒ नि षी॑दति ग॒व्ययी॒ त्वग्भ॑वति नि॒र्णिग॒व्ययी॑
> *ruváti bhīmó vṛṣabhás taviṣyáyā &sacute;ṛ́ṅge &sacute;í&sacute;āno háriṇī vicakṣaṇáḥ*
> *ā́ yóniṃ sómaḥ súkṛtaṃ ní ṣīdati gavyáyī tvág bhavati nirṇíg avyáyī*

'The hide is of bull, the dress of sheep.' The red bull of IX 97[13] supplies him with his skin; his dress is of fluffy tufts of white sheep's wool.

Often have I penetrated into a forest in the fall of the year as night gathered and seen the whiteness of the white mushrooms, as they seemed to take to themselves the last rays of the setting sun, and hold them fast as all else faded into the darkness. When fragments of the white veil of the fly-agaric still cling to the cap, though night has taken over all else, from afar you may still see Soma, silver white, resting in his well-appointed birth-place close by some birch or pine tree. Here is how three thousand years ago a priest-poet of the Indo-Aryans gave voice to this impression:

> IX 97[9d]
> By day he appears *hári* [colour of fire], by night, silvery white.
>
> दि॒वा ह॒रि॒र्द॒दृ॑शे॒ नक्त॑मृ॒ज्रः
> *dívā hárir dádṛ&sacute;e náktam ṛjráḥ*

Soma's scarlet coat dominates by day; by night the redness sinks out of sight, and the white patches, silvery by moon and starlight, take over.

C. The bull and soma

The bull was the mightiest beast familiar to the Indo-Aryans. It was the symbol of strength in the ṚgVeda and it was the commonest metaphor for Soma. It exchanged attributes with Soma: both were seated high in the mountains, both were gazing afar off, both bellowed, both sharpened shining horns. Sometimes the image was taken from Soma, sometimes from the bull, thus:

> IX 70[7ab]
> He [Soma] bellows, terrifying bull, with might, sharpening his shining horns, gazing afar…
>
> रु॒वति॑ भी॒मो वृ॑ष॒भस्त॑वि॒ष्यया॒ शृं॑गे॒ शिशा॑नो॒ हरि॑णी विचक्ष॒णः
> *ruváti bhīmó vṛṣabhás taviṣyáyā &sacute;ṛ́ṅge &sacute;í&sacute;āno háriṇī vicakṣaṇáḥ*

The hallucinogenic mushrooms of Mexico act passively: the subject seems to an outsider to be withdrawn in meditation. Soma, in addition to translating one to Elysium, seems to have possessed a kinetic potency, filling

---

24. IX 68[1], 71[2], 82[2], 86[26,46], 95[1], 99[1], 107[26], and 108[12].

one with the joy of extraordinary physical and vocal activity. This is reported alike in the ṚgVeda and in Siberia, where, as we shall see, phenomenal displays of physical prowess sometimes attend inebriation by the fly-agaric.

It is important that the modern reader fix his attention on the sense of power that Soma gave to the poets of the ṚgVeda. They ring all the changes on this metaphor of a bull. (Sometimes Soma is a buffalo.) For the poets the bull is a creature that constantly sharpens his horns: there are many such references. We have just seen Soma compared to a bull 'sharpening his shining horns'. Once the poet resorts to synecdoche:

> IX 97[9c]
> Soma with sharpened horns [*i.e.*, Soma the bull] attains his [full] reach.
>
> प॒री॒ण॒सं कृ॑णुते ति॒ग्मशृं॑गो॒ *parīṇasáṃ kṛṇute tigmá&sacute;ṛṅgo*

Some have deduced from this verse that Soma must have been a plant with thorns! But of course the 'sharpened horns' are nothing more than the familiar cliche for a bull, and the bull is Soma.

Plate V - AGNI: Fire.

D. The udder and soma

The swollen hemisphere of the fly-agaric's cap naturally suggests an udder to the poet:

III 48[3ab]
Approaching his mother, he [Indra] cries for food; he looks toward the sharp Soma as toward the udder.

उ॒प॒स्थाय॑ मा॒त॒र॒मन्न॑मैट्ट ति॒ग्मम॑पश्यद॒भि सोम॒मूधः॑

upasthā́ya mātáram ánnam aiṭṭa tigmám
apa&sacute;yad abhí sómam ū́dhaḥ

IV 23[1ab]
What priest's sacrifice has [Indra] enjoyed, [approaching] the Soma as it were an udder?

क॒था म॒हाम॑वृध॒त्कस्य॒ होतु॑र्य॒ज्ञं जु॑षा॒णो अ॒भि सोम॒मूधः॑

kathā́ mahā́m avṛdhat kásya hótur yajñā́ṃ juṣāṇó abhí
sómam ū́dhaḥ

VII 101[1ab]
Raise the three voices that are preceded by light and that milk the udder, which is milked of sweetness... [... Soma]

ति॒स्रो वाच॒ः प्र व॑द॒ ज्योति॑रग्रा॒ या ए॒तद्दु॒ह्रे म॑धुदो॒घमूधः॑

tisró vā́caḥ prá vada jyótiragrā yā́ etád duhré
madhudoghám ū́dhaḥ

VIII 9[19a]
When the swollen stalks were milked like cows with [full] udders...

यदापी॑तासो अं॒शवो॒ गावो॒ न दु॒ह्र ऊध॑भिः

yád ā́pītāso aṃ&sacute;ávo gā́vo ná duhrá ū́dhabhiḥ

IX 68[1]
The sweet juices have hurried to the god like milch cows [to a calf]. Resting upon the barhis, noisy, with full udders, they have made the red ones their flowing garment. [This is before the Soma plants are pressed. They are resting in an open space, on the ground, waiting to be pressed.]

प्र दे॒वमच्छा॒ मधु॑मंत॒ इंद॒वोऽसि॑ष्यदंत॒ गाव॒ आ न धे॒नवः॑
ब॒र्हि॒षदो॑ वच॒नाव॑ंत॒ ऊध॑भिः परि॒स्रुत॑मु॒स्रिया॑ नि॒र्णिज॑ं धिरे

prá devám ácchā mádhumanta índavó
&sacute;iṣyadanta gā́va ā́ ná dhenávaḥ
barhiṣádo vacanā́vanta ū́dhabhiḥ parisrútam usríyā
nirṇíjam dhire

IX 69[1ab]
The thought is placed like an arrow upon a bow; like a calf to the udder of his mother he hastens. [The figure may not refer to Soma but the context suggests that it does.]

इषु॒र्न धन्व॒न्प्रति॑ धीयते म॒तिर्व॒त्सो न मा॒तुरुप॑ स॒र्ज्यूध॑नि

íṣur ná dhánvan práti dhīyate matír vatsó ná mātúr úpa
sarjy ū́dhani

IX 107[5ab]
Milking the dear sweetness from the divine udder, he has sat in his accustomed place.

दु॒हा॒न ऊध॑र्दि॒व्यं मधु॑ प्रि॒यं प्र॒त्नं स॒धस्थ॒मास॑दत्

duhāná ū́dhar divyáṃ mádhu priyáṃ pratnáṃ
sadhástham ā́sadat

E. The stalk and soma

Not only is the Soma plant likened to an udder; the stalk or *aṃ&sacute;ú* (literally a 'shoot', a perfect word for the stipe of a mushroom) is likened to a teat:

I 137[3ab]
The priests milk this *aṃ&sacute;ú* for you both [Varuṇa and Mitra, two gods], like the auroral milch cow, with the aid of stones they milk the Soma, with the aid of stones.

तां वां॑ धे॒नुं न वा॑स॒रीम॒ंशुं दु॑ह॒ंत्यद्रि॑भिः॒ सोमं॑ दुह॒ंत्यद्रि॑भिः

tā́m vām dhenúm ná vāsarī́m aṃ&saucte;úṃ duhanty
ádribhiḥ sómaṃ duhanty ádribhiḥ

II 13[1cd]
The first milk of the *aṃ&sacute;ú* is the best.

तदां॒हना अं॑भवत्पि॒प्युषी॒ पयो॒ऽ◌ंशोः पी॒यूषं॑ प्रथ॒मं तदु॒क्थ्यं॑

tád āhanā́ abhavat pipyúṣī páyo 'ṃ&sacute;óḥ pīyū́ṣaṃ prathamáṃ tád ukthyám

III 36^{6cd}
Indra is farther than this seat when the milked *aṃ&sacute;ú*, the Soma, fills him.

अत॑श्चि॒दिंद्रः॒ सद॑सो॒ वरी॑या॒न्यदीं॒ सोमः॑ पृ॒णति॑ दु॒ग्धो अं॒शुः

áta&sacute; cid índraḥ sádaso várīyān yád īṃ sómaḥ pṛṇáti dugdhó aṃ&sacute;úḥ

IV 1^{19cd}
He has tapped so to speak the pure udder of the cows, rendering the milk clear as is the juice yielded by the *aṃ&sacute;ú*.

शुच्यूधो॑ अतृ॒णन्न गवा॒मंधो॒ न पू॒तं परि॑षिक्तमं॒शोः

&sacute;úcy ū́dho atṛṇan ná gávām ándho ná pūtáṃ páriṣiktam aṃ&sacute;óḥ

V 43^{4}
The ten fingers, the two arms, harness the pressing stone; they are the preparers of the Soma, with active hands. The one with good hands [the priest] has milked the mountain-grown sap of the sweet honey [Soma]; the *aṃ&sacute;ú* has yielded the dazzling [sap].

दश॒ क्षिपो॑ युंजते बा॒हू अद्रिं॒ सोम॑स्य॒ या श॑मि॒तारा॑ सु॒हस्ता॑
मध्वो॒ रसं॑ सु॒गभ॑स्तिर्गिरि॒ष्ठां चनि॑श्चदद्दुदुहे शु॒क्रमं॒शुः

dá&sacute;a kṣípo yuñjate bāhū́ ádriṃ sómasya yā́ &sacute;amitārā suhástā mádhvo
rásaṃ sugábhastir giriṣṭhā́ṃ cáni&sacute;cadad duduhe &sacute;ukrám aṃ&sacute;úḥ

VIII 9^{19ab}
When the swollen *aṃ&sacute;ú* were milked like cows with [full] udders...

यदापी॑तासो अं॒शवो॒ गावो॒ न दु॒ह्र ऊध॑भिः

yád ā́pītāso aṃ&sacute;ávo gā́vo ná duhrá ū́dhabhiḥ

IX 72^{6a}
They milk the thundering[25] *aṃ&sacute;ú*...

अं॒शुं दु॑हंति स्त॒नयं॑त॒मक्षि॑तं क॒विं क॒वयो॒ऽपसो॑ मनी॒षिणः॑

aṃ&sacute;úṃ duhanti stanáyantam ákṣitaṃ kavíṃ kaváyo 'páso manīṣíṇaḥ

Plate VI - RV IX 71^{1bc}: He sloughs off the Asurian colour that is his.
He abandons his envelope.

---

[25] The word for 'thundering' here, *stanáyantam*, from the verb *stan*, 'to roar' or 'to thunder', is probably related to the Vedic and

classical Sanskrit word for breast, *stana*, thought also to be derived from *stan*, perhaps *via* the image of the cloud.

IX 95[4ab]
They milk the *aṃ&sacute;ú*, this bull at home on the mountain.

तं म॑र्मृजा॒नं म॑हि॒षं न सानां॑वं॒शुं दु॑हंत्यु॒क्षणं॑ गिरि॒ष्ठां	*tám marmṛjānáṃ mahiṣáṃ ná sā̆nāv aṃ&sacute;úṃ duhanty ukṣáṇaṃ giriṣṭhā̆m*

IX 107[12cd]
With the milk of thy *aṃ&sacute;ú*...

अं॒शोः पयं॑सा मदि॒रो न जागृं॑वि॒रच्छा॒ कोशं॑ मधु॒श्चुतं॑	*aṃ&sacute;óḥ páyasā madiró ná jā̆gṛvir ácchā kó&sacute;aṃ madhu&sacute;cútam*

In the light of my fly-agaric hypothesis, the milking imagery that pervades the Soma passages in the ṚgVeda acquires new meaning. A chlorophyll-bearing plant, whether leafy or leafless, does not suggest the udder and milking. The dominance of the word *aṃ&sacute;ú* - stalk, stem, stipe - calls for comment. Over much of Eurasia certain important species of wild mushrooms are dried and strung together on strings by the stipes, hanging caps down. (The caps shrink more than the stipes and are more friable.) This may have been the practice in Vedic times and would explain, if explanation be needed, the emphasis on the stipe in the vocabulary.[26] Bogoraz, writing about the turn of the century, says expressly that in the Chukotka the fly-agarics were usually *strung up* in three's, this being it seems the trading unit. (*Vide* **[**22**]** p. 273)

F. Soma's "head"

In English we speak of the 'cap' of the mushroom, but in many other languages including the Vedic 'head' is used instead:

IX 27[3]
This bull, heaven's head [*mūrdhán*], Soma, when pressed, is escorted by masterly men into the vessels, he the all-knowing.

ए॒ष नृभि॒र्वि नीं॑यते दि॒वो मू॒र्धा वृषा॑ सु॒तः सोमो॒ वनें॑षु विश्व॒वित्	*eṣá nṛ́bhir ví nīyate divó mūrdhā̆ vṛ́ṣā sutáḥ sómo váneṣu vi&sacute;vavít*

IX 68[4cd]
While Soma enters into contact with the fingers of the officiants, he protects his head [*&sacute;íras*].

अं॒शुर्यवें॑न पिपिशे य॒तो नृभिः॒ सं जा॒मिभि॒र्नसं॑ते॒ रक्षं॑ते॒ शिरः॑	*aṃ&sacute;úr yávena pipi&sacute;e yató nṛ́bhiḥ sáṃ jāmíbhir násate rákṣate &sacute;íraḥ*

IX 69[8cd]
For you are, O Soma juices, ... the heads [*mūrdhán*] of heaven, carried erect, creators of vital force.

यू॒यं हि सों॑म पि॒तरो॒ मम॒ स्थनं॑ दि॒वो मू॒र्धानः॒ प्रस्थिं॑ता वय॒स्कृतः॑	*yūyáṃ hí soma pitáro máma sthána divó mūrdhā̆naḥ prásthitā vayaskṛ́taḥ*

IX 71[4cd]
On Soma's head [*mūrdhán*] the cows with a full udder mix their best milk in streams, [*i.e.*, milk is mingled with Soma juice.]

आ यस्मि॒न्गावः॑ सुहु॒ताद ऊधं॑नि मू॒र्धंछ्री॒णंत्यं॑ग्रि॒यं वरीं॑मभिः	*ā̆ yásmin gā̆vaḥ suhutā̆da ū̆dhani mūrdhā́ñ chrīṇánty agriyáṃ várīmabhiḥ*

IX 93[3abc]
The udder of the cow is swollen; the wise juice is imbued with its streams. In the vessels the cows mix with their milk the *mūrdhán*.

---

[26] When I was a boy in Chesterfield County, Virginia, the farmers would call the leaves of the tobacco plant 'stems'. When the time came for gathering the leaves, they would string them together by the principal rib or 'stem', perhaps a score of them together, and take them to the tobacco barn to be dried by smoking, hanging each batch over rungs that stretched from beam to beam in the barn. Fires were then built in troughs on the ground. This is another example where handling practices led to a curious use of the word 'stem'.

उ॒त प्र पिं॑प्य॒ ऊध॒रघ्न्यां॑या॒ इंदु॒र्धारां॑भिः सचते सुमे॒धाः मू॒र्धानं॒ गावः॒ पयं॑सा च॒मूष्व॒भि श्री॑णंति॒ वसुं॑भि॒र्न नि॒क्तैः	*utá prá pipya ū́dhar ághnyāyā índur dhā́rābhiḥ sacate sumedhā́ḥ* *mūrdhā́naṃ gā́vaḥ páyasā camū́ṣv abhí &sacute;rīṇanti vásubhir ná niktáiḥ*

G. Four poetic conceits

In speaking of Soma the poets of the ṚgVeda have recourse repeatedly to four conceits. They have never been adequately explained. They are not descriptive in any immediate sense: they express what the poets considered transcendental truths. Let us see how the fly-agaric fares with them.

1. The single eye[27]

I 87^{5ab}
We speak because of our descent from the ancient father; the tongue moves with *the eye of Soma*.

पि॒तुः प्र॒त्नस्य॒ जन्मं॑ना वदामसि॒ सोमं॑स्य जि॒ह्वा प्र जिं॑गाति॒ चक्षं॑सा	*pitúḥ pratnásya jánmanā vadāmasi sómasya jihvā́ prá jigāti cákṣasā*

IX 9^{4}
Quickened by the seven minds, he [Soma] has encouraged the rivers free of grief, which have strengthened *his single eye*.

स स॒प्त धी॒तिभिं॑र्हि॒तो न॒द्यो॑ अजिन्वद॒द्रुहः॑ या एक॒मक्षिं॑ वावृ॒धुः	*sá saptá dhītíbhir hitó nadyó ajinvad adrúhaḥ* *yā́ ékam ákṣi vāvṛdhúḥ*

IX 10^{8ab}
I have drunk the navel [*i.e.*, Soma] into the navel [*i.e.*, stomach] for our sake. Indeed, *the eye* is altogether with the sun. [*Bhawe rendering*]

नाभा॒ नाभिं॑ न॒ आ दं॑दे॒ चक्षुं॑श्चि॒त्सूर्ये॒ सचां॑ क॒वेरपं॑त्य॒मा दुं॑हे	*nā́bhā nā́bhiṃ na ā́ dade cákṣu&sacute; cit sū́rye sácā* *kavér ápatyam ā́ duhe*

IX 10^{9}
The sun [*i.e.*, Soma] looks *with the eye* towards the dear places and the highest place of heaven, ... [*Bhawe rendering*]

अ॒भि प्रि॒या दि॒वस्प॒दमं॑ध्व॒र्युभि॒र्गुहां॑ हि॒तं सूरः॑ पश्यति॒ चक्षं॑सा	*abhí priyā́ divás padám adhvaryúbhir gúhā hitám sū́raḥ* *pa&sacute;yati cákṣasā*

IX 97^{46c}
[Soma] who has *for eye* the sun

स्वं॑र्चक्षा रथि॒रः स॒त्यशुं॑ष्मः॒	*svárcakṣā rathiráḥ satyá&sacute;uṣmaḥ*

The one element in these verses, some of them difficult, that concerns us here is 'the single eye'. Does not the photograph, reproduced in Plate X, explain the image that the poet had in mind? How perverse this metaphor is if we have to do with a creeper, *vallī*. How meaningless if we deal with rhubarb.

---

[27] In the Atharvaveda, XIII 1^{45}, there is another allusion to the single eye that is relevant here. In Wm. D. Whitney's translation, p. 717.

2. Mainstay of the sky

IX 2[5]
The ocean [of Soma] has been cleansed in the waters; *mainstay of the sky*, the Soma in the filtre, he who is favourable to us.

स॒मु॒द्रो अ॒प्सु मा॑मृजे विष्टं॒भो ध॒रुणो॑ दि॒वः सोमः॑ प॒वित्रे॑ अस्म॒युः	*samudró apsú māmṛje viṣṭambhó dharúṇo diváḥ sómaḥ pavítre asmayúḥ*

IX 72[7ab]
In the navel of the earth [is situated the Soma], which is also the *mainstay of the sky* ...

नाभा॑ पृथि॒व्या ध॒रुणो॑ म॒हो दि॒वो॒३॒॑ऽपामू॒र्मौ सिंधु॑ष्वं॒तरु॑क्षि॒तः	*nā́bhā pṛthivyā́ dharúṇo mahó divó 'pā́m ūrmáu síndhuṣv antár ukṣitā́ḥ*

IX 74[2ab]
Mainstay of the sky, well laid, the full *aṃ&sacute;ú* runs throughout everything ...

दि॒वो यः स्कं॒भो ध॒रुणः॒ स्वा॑तत॒ आपू॑र्णो अं॒शुः प॒र्येति॑ वि॒श्वतः॑	*divó yáḥ skambhó dharúṇaḥ svā́tata ā́pūrṇo aṃ&sacute;úḥ paryéti vi&sacute;vátaḥ*

IX 86[35cd]
... thou sittest in the vessels, having been pressed for Indra, inebriating drink, which inebriates, supreme *mainstay of heaven*, [Soma] who gazes in the far distance.

इंद्रा॑य॒ मद्वा॒ मद्यो॒ मदः॑ सु॒तो दि॒वो वि॑ष्टं॒भ उ॑प॒मो वि॑चक्ष॒णः	*índrāya mádvā mádyo mádaḥ sutó divó viṣṭambhá upamó vicakṣaṇáḥ*

IX 86[46ab]
He has spilled forth, *mainstay of the sky*, the offered drink; he flows throughout the world ...

अस॑र्जि स्कं॒भो दि॒व उद्य॑तो॒ मदः॒ परि॑ त्रि॒धातु॒र्भुव॑नान्यर्षति	*ásarji skambhó divá údyato mádaḥ pári tridhā́tur bhúvanāny arṣati*

IX 87[2cd]
... father of the gods, progenitor of the moving force, *mainstay of the sky*, foundation of the earth.

पि॒ता दे॒वानां॑ जनि॒ता सु॒दक्षो॑ विष्टं॒भो दि॒वो ध॒रुणः॑ पृथि॒व्याः	*pitā́ devā́nāṃ janitā́ sudákṣo viṣṭambhó divó dharúṇaḥ pṛthivyā́ḥ*

IX 89[6ab]
Mainstay of the sky, foundation of the earth, all establishments are in the hand of this [Soma] ...

वि॒ष्टं॒भो दि॒वो ध॒रुणः॑ पृथि॒व्या विश्वा॑ उ॒त क्षि॒तयो॒ हस्ते॑ अस्य	*viṣṭambhó divó dharúṇaḥ pṛthivyā́ ví&sacute;vā utá kṣitáyo háste asya*

IX 108[16]
Enter into the heart of Indra, receptacle for Soma, like rivers into the ocean, thou [O Soma] who pleasest Mitra, Varuṇa, Vāyu, supreme *mainstay of heaven*!

इंद्र॑स्य॒ हार्दि॑ सोम॒धान॒मा वि॑श समु॒द्रमि॑व॒ सिंध॑वः जुष्टो॑ मि॒त्राय॒ वरु॑णाय वा॒यवे॑ दि॒वो वि॑ष्टं॒भ उ॑त्त॒मः	*índrasya hā́rdi somadhā́nam ā́ vi&sacute;a samudrám iva síndhavaḥ júṣṭo mitrā́ya váruṇāya vāyáve divó viṣṭambhá uttamáḥ*

We have given only a selection of the passages where Soma is a mainstay of the sky. Others have translated this by 'pillar' and 'fulcrum' of the sky.

What poet could conceive of a creeper, a climber, any vine - some species of Sarcostemma or Ephedra - as 'mainstay of the sky', 'foundation of the earth'? But the sturdy stanchion with its resplendent capital that is the fly-agaric lends itself well to this poetic conceit.

3. The navel

'Navel', *nābhi*, is one of the most important words in the ṚgVeda. In its primary meaning as the umbilicus it occurs only once, in a late hymn, X 90[14]. As the 'hub' of a wheel it recurs three times; this use need not detain us. What we call 'blood kin' for the Vedic poets was 'umbilical kin'; in this sense we find it nine times. By far the most interesting citations of the word are the ones where it is used transcendentally, to express a mythological idea, in a reverential and sacred context. Soma is the Navel of the Way (= *Ṛtá*), says the poet. By *Ṛtá* he means the divine order of things, a word that seems to convey somewhat the same idea as the *Tao* of Lao Tze.

Plate VII - RV IX 71[2d]: He makes of milk his vesture-of-grand-occasion.

Plate X - RV IX 9[4c]: The single eye.

This figurative use of the navel for Soma in Vedic times arrested my attention. In the fungal vocabularies of various unrelated Eurasian peoples I had come across the navel, and here it was playing a rôle in the India of the Aryans! Was this accidental convergence, or was it because Soma was a mushroom - the fly-agaric?[28] True, all words relating to childbirth play a bigger rôle in the vocabularies of primitive peoples than among others. Thus in ancient Greece the ὄμφαλος [*ómfalos*], a stone carving fixed in Delphi and now in the Delphi museum, was famed for centuries as the center of the world.

But it is a fact that peoples who know their mushrooms and live with them in their daily lives are apt to see parallels between mushrooms and the umbilicus. The lexicographer Dal reports that in Russia *pup* means 'navel' and the derivative *pupyri* is applied in the familiar language to fungal growths. In contemporary Cambodian the word *psət* means both navel and mushroom. This word's primary meaning is navel and it is clearly borrowed from the Malayo-Polynesian family of languages, where the hypothetical proto-Malayo-Polynesian word was **pusəg*, 'navel', a word with far flung progeny in languages spoken off the east coast of Asia, including *heso* in Japanese, whose medieval form was *feso*, stemming back to **pëso* in proto-Japanese. In standard contemporary Korean the word recurs in the form *p°sət*. There it means only 'mushroom', but in two southwestern dialects spoken only on the island of Tšedju, in the province of Cholla Namdo, words that may stem back to the same root mean the navel. In these dialects the navel takes the forms *pötoŋ* and *pötoŋ-ro*.[29]

In April 1966 Georges Dumézil introduced to me a young Turkish national, Orhan Alparslan, a student of architecture at the University of Paris. He came from a village, Zennun, situated off the highway running from Ankara to Samsun, at about the half-way point. He was a Circassian and his village was largely Circassian. He had been a shepherd boy in his childhood, and he possessed a remarkably clear memory. He described for me the various kinds of mushrooms that he had learned to know and gave me the names for them. He drew the shaggy mane - *Coprinus comatus* -, explained that it quickly turned into black ink but the black was tinged with violet, and gave its local name as *göbek mantari*, Turkish words meaning 'navel mushroom'.

Even in the scientific vocabulary of mycologists the navel has crept in. Many species of mushrooms are either 'umbilicate' or 'umbonate', depending on whether the 'navel' is a pocket in the middle of the cap or a protrusion. There is a genus, the Omphalia, whose name comes from the Greek ὄμφαλος [*ómfalos*], navel. True, these are neo-classical words devised in the last two centuries by scientists, but scientific names, especially those devised in the youth of the science (such as is here the case), often reflect facts lying deep in the consciousness of the race. The *muscaria*, for example, in *Amanita muscaria*, expresses the folk traditions of the Germanic race.

It is not my contention that these far flung analogies in vocabulary have influenced each other; quite the contrary. I believe a mushroom is apt to suggest the navel to the primitive observer, wherever he be, and that the Vedic people, obsessed as they were with the fly-agaric, applied to it the navel analogy, and imbued it with a multitude of transcendental meanings. Already we have seen a number of these figures of speech. We learned in IX 74[4] that Soma was the Navel of the Way. Here are others:

> IX 79[4ab]
> Your highest navel is attached in heaven; your fingers grow on the back of the earth.
>
> दि॒वि ते॒ नाभा॑ पर॒मो य आ॑द॒दे पृ॑थि॒व्यास्ते॑ रुरुहुः॒ सान॑वि॒ क्षिपः॑
>
> *diví te nā́bhā paramó yá ādadé pṛthivyā́s te ruruhuḥ sā́navi kṣípaḥ*

We recall how the single eye of Soma was tied to the eye of the sun in IX 10[8]; in that same verse the navel now figures intelligibly:

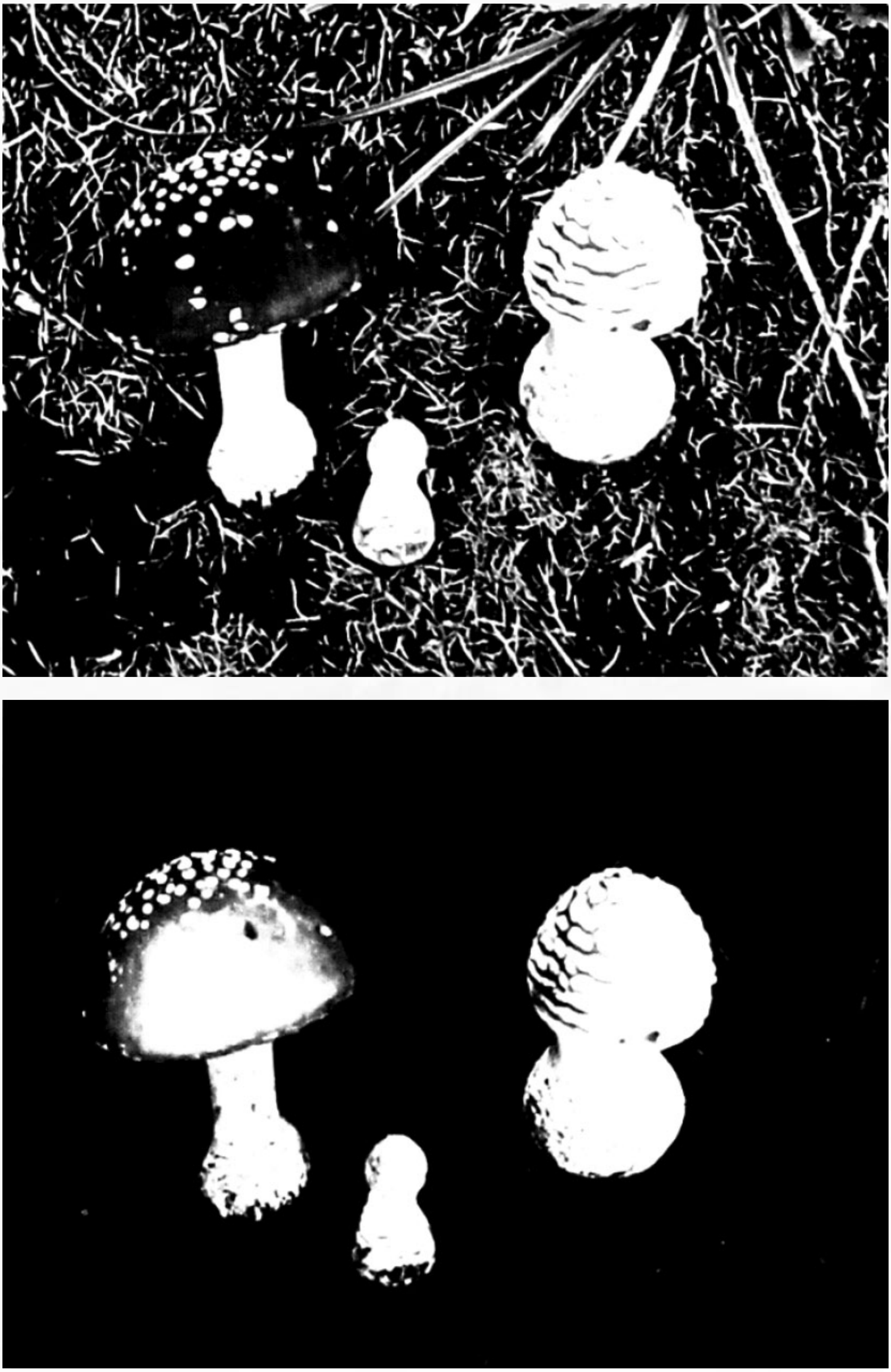
---

[28] One of our valuable sources about the fly-agaric in Siberia is G. H. von Langsdorf. He found it in use as an inebriant among the Kamchadal. In discussing its fungal identification he writes: '... the Kamchadal mushroom has a cap with a *navel-like* protuberance in the middle,...'! *Vide* **[**10**]**, p. 247. The word in the German text is *nabelförmig*.

[29] I am indebted to Dr. Johannes Rahder of Yale University for this information about the Korean dialects. He relied on the two volume work on Korean dialects compiled by the late Professor Shinpei Ogura, *Chōsen-go Hōgen no Kenkyū* (Studies of Korean Dialects): publishers, Iwanami, Tokyo 1944, pp. 97-98 of Vol. 1.

IX 10[8]
I have drunk the navel [*i.e.*, Soma] into the navel [*i.e.*, stomach] for our sake. Indeed, the eye is altogether with the sun. I have milked the child of the wise. [*Bhawe rendering*]

नाभा॒ नाभिं॑ न॒ आ द॑दे॒ चक्षु॑श्चि॒त्सूर्ये॒ सचा॑ क॒वेरप॑त्य॒मा दु॑हे	*nā̆bhā nā̆bhiṃ na ā̆ dade cákṣu&sacute; cit sū̆rye sácā* *kavér ápatyam ā̆ duhe*



Plates VIIIa & VIIIb - RV IX 97[9d]: By day he appears *hári*. By night, silvery white.

Again two hymns later Soma is called the all-seeing navel of the wise:

> IX 12[4]
> The sharp seer, in heaven's navel, is magnified in the woolen filtre, Soma the wise, possessed of good intelligence.
>
> दि॒वो नाभा॑ विचक्ष॒णोऽव्यो॒ वारे॑ महीयते
> सोमो॒ यः सु॒क्रतु॑ः क॒विः
>
> *divó nā́bhā vicakṣaṇó 'vyo vā́re mahīyate sómo yáḥ sukrátuḥ kavíḥ*

In the following verse Soma's navel is associated with the 'head' (= cap) of the mushroom:

> I 43[9abc]
> Thy descendants, O Immortal One, according to the supreme institution of the Way, receive them on thy navel, O Soma, thou who art the head [of heaven];
>
> यास्ते॑ प्र॒जा अ॒मृत॑स्य॒ पर॑स्मि॒न्धाम॑न्नृतस्य॑
> मू॒र्धा नाभा॑ सोम वेन
>
> *yā́s te prajā́ amŕ̥tasya párasmin dhā́mann ṛtásya mūrdhā́ nā́bhā soma vena*

Soma is repeatedly said to be in the navel of the earth, in the navel of heaven. It was a practice of the ṚgVeda poets to use epithets proper to one god when speaking of another. Agni and Soma, fire and the 'fire-agaric' (as I am tempted to call the fly-agaric) thus exchange epithets, and 'navel' is often applied to Agni. But I think it will not be disputed that the navel figure belongs to Soma; the frequency of its use with Soma and the elaboration of the uses make it peculiarly Soma's. As we have seen, pp. 39 ff [org. edit.], 'Agni' for the poet is a way of saying 'Soma'.

4. The filtres

In the ṚgVeda filtres figure prominently. One of them, a filtre of lamb's wool, presents no problem. After the Soma had been pounded with stones and mixed with water, it was forced through a filtre or strainer, which caught the pulp and fibrous elements and allowed the tawny yellow liquor to pass through and run down to the vats.

But the ṚgVeda speaks of two other filtres that have always baffled the scholars. If Soma is the fly-agaric they present no problem. The woolen filtre is in fact the second or middle filtre.

The First Filtre

In the order of their function, the verses speak first of a celestial filtre, the filtre that I offer to the reader in Plate XII, where the sun's rays, escorting Soma down from the sky, are caught and held on the fiery back of heaven (= the pileus of the fly-agaric).

In the first verse that I shall quote the poet says expressly that King Soma has the filtre for his chariot, and immediately thereafter cites the studs, *bhṛṣṭí*, that carry him to fame; *i.e.*, the white patches on his cap.

> IX 86[40cd]
> King, having the filtre for chariot, he has attained the victory prize; a thousand studs, he conquers puissant renown.
>
> राजा॑ प॒वित्र॑रथो॒ वाज॒मारु॑हत्स॒हस्र॑भृष्टिर्जयति॒ श्रवो॑ बृ॒हत्
>
> *rā́jā pavítraratho vā́jam ā́ruhat sahásrabhṛṣṭir jayati &sacute;rávo bṛhát*

> IX 10[5]
> (This verse has puns difficult to translate. Its meaning is clear. The Soma plants are called 'suns', *sū́rā*, a natural metaphor in the light of our various plates. The heavenly Somas spread the strainer of their (= the sun's) rays for *themselves* to come down).
>
> आ॒पा॒नासो॑ वि॒वस्व॑तो॒ जनं॑त उ॒षसो॒ भगं॑
> सू॒रा॒ अण्वं॒ वि तं॑न्वते
>
> *āpānā́so vivásvato jánanta uṣáso bhágam sū́rā áṇvaṃ ví tanvate*

How clear this would have been for Geldner and Bhawe if they had possessed the key. Bhawe, commenting on this verse in his Part I, p. 53, refers to the 'mysterious sieve through which the sun's rays pass'. Geldner before him had sensed that the Somas and the Suns are the same, and in his commentary had divined that the filtre straining the sun's rays is referred to elsewhere, notably in IX 66[5], 76[4], and 86[32].[30]

> IX 66[5abc]
> Thy clear rays spread over the back of heaven, the filtre, O Soma,...
>
> तव॑ शु॒क्रासो॑ अ॒र्चयो॑ दि॒वस्पृ॒ष्ठे वि त॑न्वते
> प॒वित्रं॑ सोम॒ धाम॑भिः
>
> *táva &sacute;ukrā́so arcáyo divás pṛṣṭhé ví tanvate*
> *pavítraṃ soma dhā́mabhiḥ*

Plate IX - RV IX 70[7d]: The hide is of bull, the dress of sheep.

As a poetic figure for the fly-agaric, there seems nothing to explain here. In this same hymn, verses 19-21, Soma is addressed as Agni, *i.e.*, the fly-agaric as fire. (We have already called attention to this on p. 39.) The fly-agaric is both fire and sun, it catches the sun's rays on its back and holds them there, where they filtre the Soma juice into the plant. The same theme recurs in

> IX 67[22-25]
> This Soma, which today circulates in the distance, which is a cleanser, may it cleanse us in the filtre!
> The filtre that has been spread in thy flame, O Agni, with it, cleanse our song.
> Thy filtre, O Agni, equipped with flames, may it cleanse us, cleanse us with the fruits of sacred songs!
> With these both, the filtre and the fruits [of song], O God Savitṛ, cleanse me through and through!

---

[30] Harvard Oriental Series, 35, p. 17, ftn. to 5c.

पव॑मानः॒ सो अ॒द्य नः॑ प॒वित्रे॑ण॒ विच॑र्षणिः
यः पो॒ता स पु॑नातु नः
यत्ते॑ प॒वित्र॑म॒र्चिष्यग्ने॒ वित॑तम॒न्तरा
ब्रह्म॒ तेन॑ पुनीहि नः
यत्ते॑ प॒वित्र॑मर्चि॒वदग्ने॒ तेन॑ पुनीहि नः
ब्र॒ह्म॒स॒वैः पु॑नीहि नः
उ॒भाभ्यां॑ देव सवितः प॒वित्रे॑ण स॒वेन॑ च
मां पु॑नीहि वि॒श्वतः॑

pávamānaḥ só adyá naḥ pavítreṇa vícarṣaṇiḥ
yáḥ potā́ sá punātu naḥ
yát te pavítram arcíṣy ágne vítatam antár ā́
bráhma téna punīhi naḥ
yát te pavítram arcivád ágne téna punīhi naḥ
brahmasaváiḥ punīhi naḥ
ubhā́bhyāṃ deva savitaḥ pavítreṇa savéna ca
mā́ṃ punīhi vi&sacute;vátaḥ

Here Soma is addressed under the name of Agni. Metaphorically the miraculous plant seems to share every attribute of Agni, - flame-coloured, subtle, it purifies with its filtre as fire does with its flames.

In the following verse the strainer is not mentioned by name. Soma, Lord of the Universe, cleanses himself in the Sun's rays, the celestial filtre:

IX 76[4]
Monarch of everything that sees the sun-light, Soma cleanses himself. Triumphing over the Prophets, he made the Word of the Way to resound, he who is cleansed by the Sun's ray, he the father of poems, Master-Poet never yet equalled!

विश्व॑स्य॒ राजा॑ पवते स्व॒र्दृशं॑ ऋ॒तस्यं॑ धी॒तिमृं॑षि॒षाळं॑वीवशत्
यः सूर्यं॒स्यासिं॑रेण मृ॒ज्यते॑ पि॒ता मं॑ती॒नामसं॑मष्टकाव्यः

ví&sacute;vasya rā́jā pavate svardṛ́&sacute;a ṛtásya
dhītím ṛṣiṣā́ḷ avīva&sacute;at
yáḥ sū́ryasyā́sireṇa mṛjyáte pitā́ matīnā́m
ásamaṣṭakāvyaḥ

IX 83[1ab]
Thy filtre has been spread, O Bráhmaṇaspáti [Soma]...

प॒वित्रं॑ ते॒ वित॑तं ब्रह्मणस्पते प्र॒भुर्गात्रा॑णि॒ पर्ये॑षि वि॒श्वतः॑

pavítraṃ te vítataṃ brahmaṇas pate prabhúr gā́trāṇi
páry eṣi vi&sacute;vátaḥ

IX 83[2abd]
The filtre of the burning [Soma] has been spread in heaven's home. Its dazzling mesh was spread afar... They climb the back of heaven in thought.

तपो॑ष्प॒वित्र॒ं वित॑तं दि॒वस्प॒दे शोचं॑तो अस्य॒ तंत॑वो॒ व्यं॑स्थिरन्
अवं॑त्यस्य पवी॒तारं॑मा॒शवो॑ दि॒वस्पृ॒ष्ठमधिं॑ तिष्ठंति॒ चेतं॑सा

tápoṣ pavítraṃ vítataṃ divás padé &sacute;ócanto asya
tántavo vy ásthiran
ávanty asya pavītā́ram ā&sacute;ávo divás pṛṣṭhám
ádhi tiṣṭhanti cétasā

In this verse the 'filtre' that we see in Plate XII is translated to heaven in the flame of the sacrifice. How easy it is for the poet to move from the earthly to the transcendental plane. How compact is the cosmology. Soma, fire, sun, sun's rays, the navel of the earth, the single eye, mainstay of the sky, celestial strainer, thunder-storm, aurora - they are all interlocked, meeting in our resplendent fly-agaric.

Here are further verses in the same tenor:

IX 86[30ab]
As for thee, O Soma-juice, thou art clarified in the filtre so as to establish thyself [in] space for the gods.

त्वं प॒वित्रे॒ रजं॑सो॒ विधं॑र्मणि दे॒वेभ्यः॑ सोम पवमान पूयसे

tváṃ pavítre rájaso vídharmaṇi devébhyaḥ soma
pavamāna pūyase

IX 86[32ab]
The Soma envelops himself all around with rays of the sun,...

स सूर्यं॑स्य र॒श्मिभिः॒ परिं॑ व्यत॒ तंतुं॑ तन्वा॒नस्त्रि॒वृतं॒ यथां॑ वि॒दे

sá sū́ryasya ra&sacute;míbhiḥ pári vyata tántum
tanvānástrivṛ́tam yáthā vidé

IX 91[3cd]
... By a thousand paths free of dust, Soma, armed with verses, knowing the Word, the Sun passes the filtre.

स॒ह॒स्र॒मृक्वां॑ प॒थिभिं॑र्वचो॒विदं॑ध्व॒स्मभिः॒ सूरो॒ अण्वं॒ वि यां॑ति

sahásram ṛ́kvā pathíbhir vacovíd adhvasmábhiḥ sū́ro
áṇvaṃ ví yāti

It seems that in this verse the Sun is a metaphor, standing for Soma.

The Third Filtre

A third filtre is mentioned in two verses of the ṚgVeda, and this brings us back to the discussion of the *Two Forms* of Soma on pp. 25 ff [org. edit.], which we promised to resume at a later point in the argument.

> IX 73[8ab]
> The Guardian of the *Ṛtá* [Soma] cannot be deceived, he of the good inspiring force; he carries three filtres inside his heart.
>
> ऋ॒तस्य॑ गो॒पा न दभा॑य सु॒क्रतु॒स्त्री ष प॒वित्रा॑ हृ॒द्यं१◌॒॑तरा द॑धे
>
> *ṛtásya gopā́ ná dábhāya sukrátus trī́ ṣá pavítrā hṛdy ántár ā́ dadhe*
>
> IX 97[55]
> Thou runnest through the three filtres stretched out; thou flowest the length, clarified. Thou art Fortune, thou art the Giver of the Gift, liberal for the liberal, O Soma-juice.
>
> सं त्री प॒वित्रा॒ वित॑तान्ये॒ष्यन्वेकं॑ धावसि पू॒यमा॑नः
> असि॒ भगो॒ असि॑ दा॒त्रस्य॑ दा॒तासि॑ म॒घवा॑ म॒घव॑द्भ्य इंदो
>
> *sáṃ trī́ pavítrā vítatāny eṣy ánv ékaṃ dhāvasi pūyámānaḥ*
> *ási bhágo ási dātrásya dātā́ 'si maghávā maghávadbhya indo*

Let us assume the fly-agaric surmise is well founded. Then the third filtre becomes clear: the Soma juice that is drunk by 'Indra' and 'Vāyu' in the course of the liturgy is filtered in their organisms and issues forth as sparkling yellow urine, retaining its inebriating virtue but having been purged of its nauseating properties.

That the priceless ambrosia was filtered down from the celestial sphere on the sun's rays into the plant is clear. That the Soma juice was filtered through the lamb's wool into the vessels at the place of sacrifice is also clear. What happened next? 'Indra' and 'Vāyu' consumed the liquor mixed with milk or curds and it would appear that their condition was a matter of considerable anxiety. How else are we to explain the poets' preoccupation with the Soma as it passed through their organisms? The poets do not stress the inebriation of the priests. Instead they take us with Soma into Indra's heart, into his belly or bellies, into his entrails. If these verses do not mean that in the Vedic ritual the priests were impersonating the gods, what do they mean?

> IX 70[10bcd]
> Purify thyself in Indra's stomach, O juice! As a river with a vessel, enable us to pass to the other side, thou who knowest; thou who battlest as a hero, save us from disgrace!
>
> वाजं॑म॒र्षेंद्रं॑स्येंदो ज॒ठर॒मा पं॑वस्व
> ना॒वा न सिंधु॒मति॑ पर्षि वि॒द्वांछूरो॒ न यु॒ध्य॒न्नवं॑ नो नि॒दः स्पः॑
>
> *vā́jam arṣéndrasyendo jaṭháram ā́ pavasva*
> *nāvā́ ná síndhum áti parṣi vidvā́ñ chū́ro ná yúdhyann*
> *áva no nidáḥ spaḥ*

Or the preceding verse:

> IX 70[9]
> Clarify thou thyself, O Soma, for the invitation to the gods. Thou who art a bull enter into the heart of Indra, receptacle for Soma! Enable us to traverse the evil passages saving us from oppression! For he who knows the country gives the directions to him who informs himself.
>
> पवं॑स्व सोम दे॒ववीं॑तये॒ वृषेंद्रं॑स्य॒ हार्दि॑ सोम॒धान॒मा विं॑श
> पु॒रा नों॑ बा॒धाद्दुं॑रि॒ताति॑ पारय क्षेत्र॒विद्धि दिश॒ आहा॑ विपृच्छ॒ते
>
> *pávasva soma devávītaye vṛ́ṣéndrasya hā́rdi somadhā́nam ā́ vi&sacute;a*
> *purā́ no bādhā́d duritā́ti pāraya kṣetravíd dhí dí&sacute;a ā́hā vipṛcchaté*

Obviously there was doubt about the outcome of the perilous passage. 'Indra' and his colleagues had to know their business, had to be experienced pilots. It looks as though Bhawe was justified in saying that skill was needed in mixing the Soma juice with milk or curds in the right way.

Is not the following verse imbued with new meaning, in the light of my interpretation, - the *human waters* being put into movement?

IX 63[7]
Clarify thou thyself by that stream by which thou madest the sun to shine, putting into movement the human waters!

अ॒या प॑वस्व॒ धार॑या॒ यया॒ सूर्य॒मरो॑चयः	*ayā́ pavasva dhā́rayā yáyā sū́ryam árocayaḥ*
हि॒न्वा॒नो मानु॑षीर॒पः	*hinvānó mā́nuṣīr apáḥ*

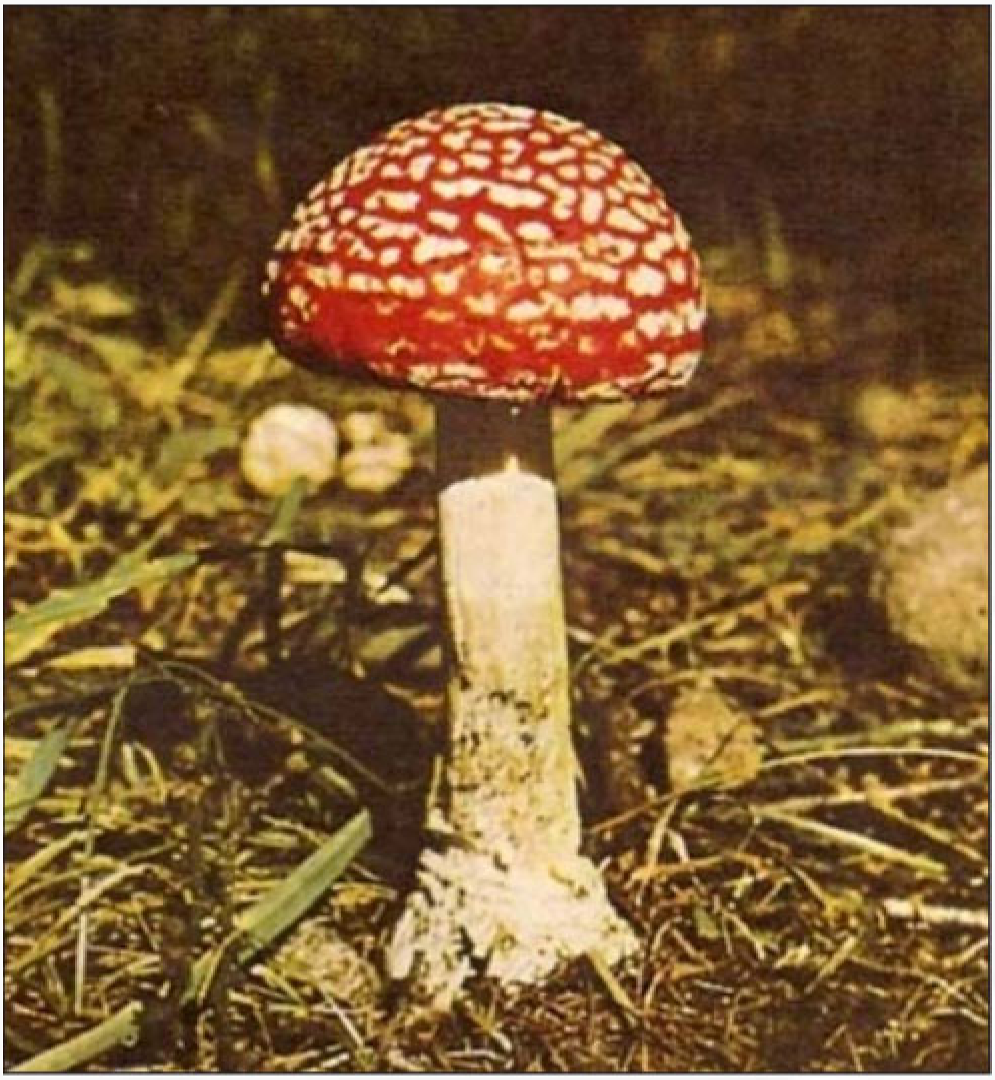


Plate XI - RV IX 109[6a]: Thou art the mainstay of the sky.

Here are other references to Soma in the belly of Indra:

IX 72[2ab]
… the [Officiants] … draw the Soma by milking into the belly of Indra.

सा॒कं व॑दंति ब॒हवो॑ मनी॒षिण॒ इंद्र॑स्य॒ सोम॑ ज॒ठरे॒ यदा॑दु॒हुः	*sākám̐ vadanti bahávo manīṣíṇa índrasya sómaṃ jaṭháre yád āduhúḥ*

IX 72[5ab]
Spurred on by the two arms of the Officiant, in jets, the pressed Soma is clarified according to its nature, suitable for thee, O Indra!

नृबा॒हुभ्यां॑ चोदि॒तो धार॑या सु॒तो॑ऽनुष्व॒धं॑ प॑वते॒ सोम॑ इंद्र ते	*nṛ́bāhúbhyāṃ coditó dhā́rayā sutó 'nuṣvadhám̐ pavate sóma indra te*

IX 76[3a]
O Soma Pávamāna, … penetrate into the entrails of Indra!

इंद्र॑स्य सोम॒ पव॑मान ऊ॒र्मिणा॑ तवि॒ष्यमा॑णो ज॒ठरे॒ष्वा वि॑श	*índrasya soma pávamāna ūrmíṇā taviṣyámāṇo jaṭháreṣv ā́ vi&sacute;a*

IX 80[2d]
O Soma, thou clarifiest thyself for Indra; ...

इंद्रा॑य सोम पवसे॒ वृषा॒ मद॑ः	*índrāya soma pavase vŕ̥ṣā mádaḥ*

IX 80[3]
In the belly of Indra the inebriating Soma clarifies itself.

एंद्रं॑स्य कु॒क्षा पं॑वते म॒दिंत॑म॒	*éndrasya kukṣā̆ pavate madíntama*

Here is a clear statement. As in the other two filtres, Soma is clarifying itself in the belly of Indra, in preparation for a further step.

IX 81[1ab]
The waves of Soma Pávamāna advance into the belly of Indra.

प्र सोमं॑स्य॒ पवं॑मानस्यो॒र्मय॒ इंद्रं॑स्य यंति ज॒ठरं॑ सु॒पेशं॑सः	*prá sómasya pávamānasyormáya índrasya yanti jaṭháraṃ supé&sacute;asaḥ*

IX 85[5cd]
Cleansed like a winning race horse, thou hast spilled thyself in the belly of Indra, O Soma!

म॒र्मृ॒ज्यमा॑नो॒ अत्यो॒ न सा॑न॒सिरिंद्रं॑स्य सोम ज॒ठरे॒ समं॑क्षरः	*marmr̥jyámāno átyo ná sānasír índrasya soma jaṭháre sám akṣaraḥ*

The 86th hymn is climactic for Indra as Soma's filtre:

IX 86[2]
Thy inebriating drinks, swift, are released ahead, like teams running in divers directions, like the milch cow with her milk towards her calf, so the Soma juices, waves rich in honey, go to Indra, thunder-bolt carrier.

प्र ते॒ मदा॑सो मदि॒रासं॑ आ॒शवोऽसृं॑क्षत॒ रथ्या॑सो॒ यथा॒ पृथं॑क् धे॒नुर्न व॒त्सं पयं॑सा॒भि व॒ज्रिण॒मिंद्र॒मिंदं॑वो॒ मधुं॑मंत ऊ॒र्मय॑ः	*prá te mádāso madirā̆sa ā&sacute;ávó 'sr̥kṣata ráthyāso yáthā pŕ̥thak* *dhenúr ná vatsáṃ páyasābhí vajríṇam índram índavo mádhumanta ūrmáyaḥ*

IX 86[3]
Like a race horse launched in movement for the victory prize, flow, O Soma, thou who procurest the light-of-the-sun for heaven's vat, whose mother is the pressing stone; thou, Bull, seated in the filtre above the calf's wool, clarifying thyself, thou Soma, that Indra may have his pleasure!

अत्यो॒ न हिंया॒नो अ॒भि वाजं॑मर्ष स्व॒र्वित्कोशं॑ दि॒वो अद्रिं॑मातरं वृषा॑ प॒वित्रे॒ अधि॒ सानो॑ अ॒व्यये॒ सोम॑ः पुना॒न इं॑द्रि॒याय॒ धायं॑से	*átyo ná hiyānó abhí vā̆jam arṣa svarvít kó&sacute;aṁ divó ádrimātaram* *vŕ̥ṣā pavítre ádhi sā̆no avyáye sómaḥ punāná indriyā̆ya dhā̆yase*

IX 86[16cd]
He advances to the rendez-vous with Indra, the Soma juice ...

प्रो अं॑यासी॒दिंदु॒रिंद्रं॑स्य निष्कृ॒तं	*pró ayāsīd índur índrasya niṣkr̥táṁ*

IX 86[19cd]
By the action of the streams he has made the utensils resound while penetrating into the heart of Indra.

क्रा॒णा सिंधू॑नां क॒लशाँ॑ अवीवश॒दिंद्रं॑स्य॒ हार्द्या॑वि॒शन्मं॑नी॒षिभि॑ः	*krāṇā̆ síndhūnāṁ kalá&sacute;āṁ̐ avīva&sacute;ad índrasya hā̆rdy āvi&sacute;án manīṣíbhiḥ*

IX 86[22]
Clarify thyself, O Soma, in the celestial structures of thine essence, thou who hast been released roaring into the vessel, in the filtre. Lodged in the belly of Indra, roaring with vigour, held in hand by the Officiants, thou hast made the sun to mount the sky.

पवं॑स्व सोम दि॒व्येषु॒ धामं॑सु सृजा॒न इं॑दो क॒लशे॑ प॒वित्र॒ आ सीद॒न्निंद्रं॑स्य ज॒ठरे॒ कनिं॑क्रद॒न्नृभि॒र्यं॑त॒ः सूर्य॒मारो॑हयो दि॒वि	*pávasva soma divyéṣu dhā̆masu sr̥jāná indo kalá&sacute;e pavítra ā̆* *sī̆dann índrasya jaṭháre kánikradan nŕ̥bhir yatáḥ sū̆ryam ā̆rohayo diví*

IX 86[23ab]
Pressed by the pressing-stones, thou clarifiest thyself in the filtre, O Soma-juice, when penetrating into the entrails of Indra!

अद्रि॑भिः सु॒तः प॑वसे प॒वित्र॒ आँ इंद॒विंद्र॑स्य ज॒ठरे॑ष्वावि॒शन्

ádribhiḥ sutáḥ pavase pavítra ā́m̐ índavíndrasya
jaṭháreṣv āvi&sacute;án

★

IX 108[15]
For Indra, that he may drink, clarify thou thyself, O Soma, held in hand by the Lords, well armed, inebriating ...

इंद्रा॑य सोम॒ पात॑वे॒ नृभि॑र्य॒तः स्वा॑यु॒धो म॒दिंत॑मः
पव॑स्व॒ मधु॑मत्तमः

índrāya soma pā́tave nṛ́bhir yatáḥ svāyudhó
madíntamaḥ
pávasva mádhumattamaḥ

IX 108[16]
Enter into the heart of Indra, Soma's receptacle, like the rivers into the ocean, thou, [O Soma,] who pleasest Mitra, Varuṇa, Vāyu, O thou supreme Mainstay of the Sky!

इंद्र॑स्य॒ हार्दि॑ सोम॒धान॒मा वि॑श समु॒द्रमि॑व॒ सिंध॑वः
जुष्टो॑ मि॒त्राय॒ वरु॑णाय वा॒यवे॑ दि॒वो वि॑ष्टं॒भ उ॑त्त॒मः

índrasya hā́rdi somadhā́namā vi&sacute;a samudrám
iva síndhavaḥ
júṣṭo mitrā́ya váruṇāya vāyáve divó viṣṭambhá uttamáḥ

IX 109[18]
O Soma, advance into the belly of Indra, having been held in hand by the Officiants, pressed by the stones!

प्र सो॑म या॒हींद्र॑स्य कु॒क्षा नृभि॑र्येमा॒नो अद्रि॑भिः सु॒तः

prá soma yāhī́ndrasya kukṣā́ nṛ́bhir yemānó ádribhiḥ
sutáḥ

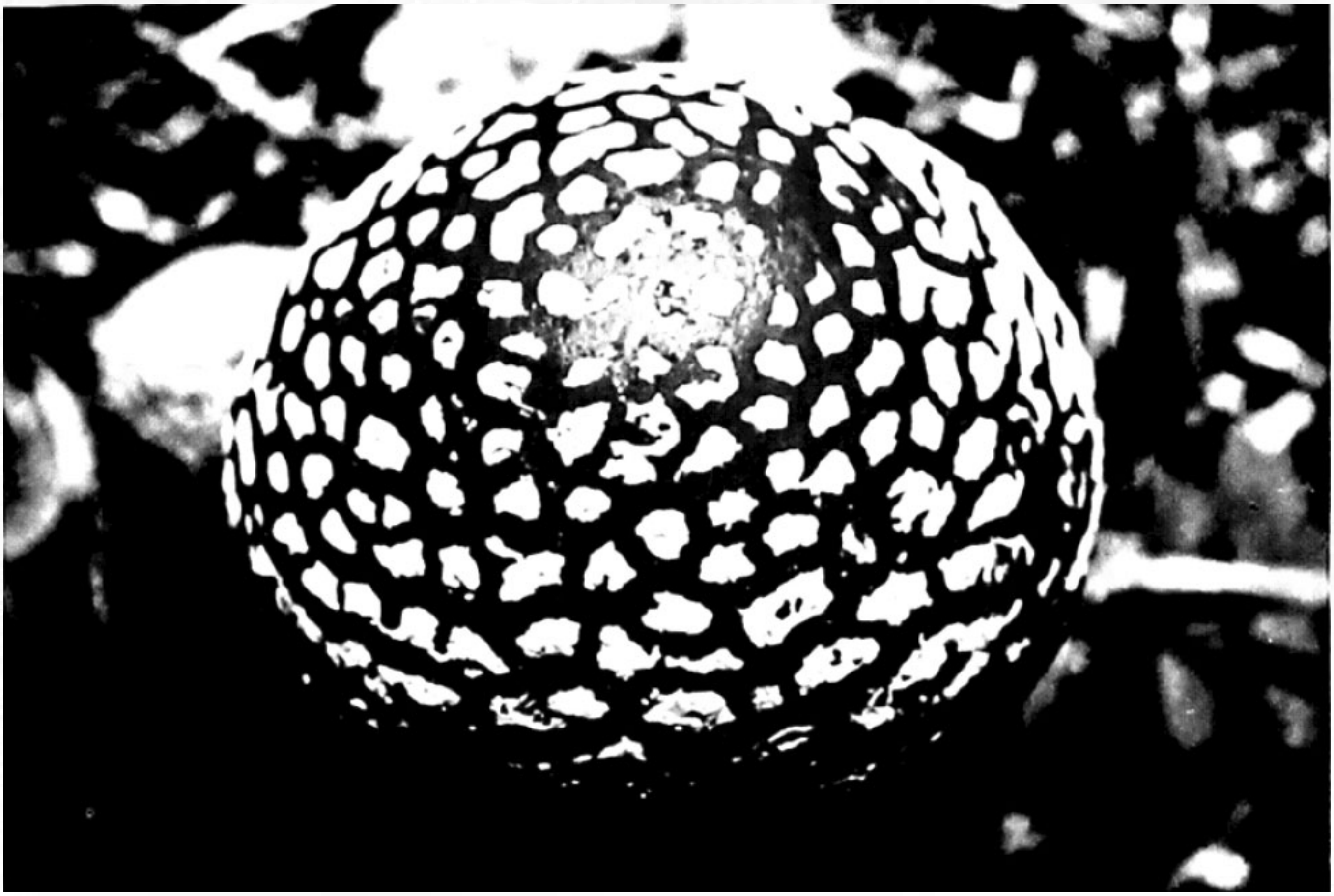


Plate XII - RV IX 86[40d]: With his thousand knobs he conquers mighty renown.

H. "Tongue of the way"

The second verse of IX 75 begins with 'Tongue of the Way' (*ṛtásya jihvā̆*), and the poet continues to apostrophize Soma as the source of eloquence. 'The Way' is *Ṛtá*, the divine order of things. Abel Bergaigne[31] remarked that the expression, 'Tongue of the Way', was picturesque and said it meant prayer. Caland and Henry,[32] on the other hand, were baffled. 'Tongue of the Way' could not be translated in any other way, but how could Soma be a tongue? These scrupulous scholars did not visualize the fly-agaric: its cap, the full blown red tongue, held the clue to the little mystery.

Plate XIII - RV IX 75[2a]: Tongue of the Way.

I. The 'Knots' or 'Knobs' or 'Studs' or 'Spikes' on the Fly-Agaric.

Already we have seen how well the spots on the fly-agaric serve as the first of the three 'fibres' for Soma. In a more mundane sense these spots are called in Vedic *bhṛṣṭí*, a word that is used for the knobs or studs on a cudgel, as on the cudgel of Indra. With his thousand knobs or studs Soma conquers potent fame: so say the hymns in two places, IX 83[5d] and 86[40d].

There is yet another passage pertinent to this theme, and it illustrates well the kind of problem that working in a language as remote as Vedic leads one into. Early in my inquiries I came upon a verse, IX 15[6], that seemed to present an obstacle to my fly-agaric thesis. According to the poet of this hymn, when the Soma plant is pressed and then run through the woolen filtre, it leaves behind in the filtre its 'knots' or 'nodules'. (The Vedic word, in the plural, is *páruṣā*.) There has been some difficulty with the sense of the sentence, but agreement on this particular word. Now mushrooms have no knots or nodules, which are characteristic of shrubs and trees. Here was a hurdle to cross or I was in trouble.

The latest translation of this hymn is S. S. Bhawe's (1957), and I found that he had devoted two pages of concentrated commentary to all the words that attend these 'knots'.[33] Suddenly, without his knowing the full import of what he was saying, he cleared up my difficulties. The 'knots', it seemed, had been 'sticking to' (*pibdanā̆*) Soma's body, and they were shining (*vásūni*) also! His verbal analysis is original and seemingly sound. Without knowing of our fly-agaric thesis, he comes out with a sense that fits the fly-agaric perfectly.

---

31. Abel Bergaigne, *La Religion Védique*, Vol. III, p. 241.
32. W. Caland and V. Henry, *L'Agniṣṭoma*, Paris, 1906, Para. 221, p. 338, ftn. 7.
33. Part 1, pp. 71-3; *vide* p. 6, ftn. I.

The shining 'rays' (as the Vedic poets are always referring to them), the scales or white patches or knobs or warts sticking to the cap (as we say) of the fly-agaric, are left behind in the strainer. Whether the Vedic word *párus* covers a semantic area broad enough to embrace not only the knots in wood but also the 'knobs' on the fly-agaric's cap, or whether the poet was resorting to a metaphor as we do in English, I leave to Vedic scholars to determine. For the Indo-Aryans the white spots of the fly-agaric were shining (*vásūni*) knobs or studs (*páruṣā*) sticking (*pibdanā̆*) to the cap. This example illustrates the delicacy of the task of the translator, the rare prescience of gifted students who are oft-times groping in the dark, and finally the help it will be to the scholar when at last he knows the identity of Soma and can familiarize himself with all its characteristics and properties.

As an instance of this help I will cite the word *sahásrapājas*, an epithet for Soma that occurs twice in the ṚgVeda in almost identical passages. (ṚgVeda IX 13[3] and 42[3]). The first part of this word offers no difficulty: *sahásra*- means 'thousand'. But what is the meaning of a thousand -*pājas*? On this there has been much comment but no agreement. Some have thought the word meant 'forms', others have suggested 'colours', and yet a third commentator sees in it 'rays'. But in the light of our Plate XII and our discussion of the First Filtre are we not simply viewing the thousand 'studs' from a different metaphoric angle? This is consonant with the imagery of the First Filtre, the rays escorting Soma down from their heavenly abode and then filtering the divine inebriant with midwifely solicitude into the plant. We do not yet know the precise meaning of -*pājas*, nor the anatomy of its poetic associations, but we do localize it and, for lack of a better, 'rays' will do. The Vedic poets see the white spots on the fly-agaric either as 'studs' or as sparkles of the divine light. (We in the English-speaking world see them as warts disfiguring a repulsive toadstool.) If I am right in identifying Soma with the fly-agaric, then in re-studying the whole of the ṚgVeda we must at all times be alive to the numinous glow of this awesome plant, a plant with miraculous inebriating virtue fully matched by its vesture-of-grand-occasion. When still in the dark as to its identity, great scholars like Renou have felt that Soma was the heart and soul of the ṚgVeda. If we know now what Soma was, like the holy *óṣadhi* itself the ṚgVeda with its thousand hymns - **sahásrarc* - is certainly destined to glow again with a rebirth of radiance from its thousand facets.

IX. Soma and the Fly

Does the fly-agaric help us in understanding this verse, which has troubled the translators? It reads, in part, as follows:

> I 119[9ab]
> To you, O A&sacute;vins, that fly betrayed the Soma.
>
> उ॒त स्या वां॒ मधु॑म॒न्मक्षि॑कारप॒न्मदे॒ सोम॑स्यौशि॒जो हु॑वन्यति
>
> *utá syā̆ vāṃ mádhuman mákṣikārapan máde*
> *sómasyau&sacute;ijó huvanyati*

The word for 'fly', *mákṣika*, might mean bee. The word for Soma is *mádhu*, 'honey', a frequent metaphor for Soma. The verse might well be interpreted as meaning that the bees have betrayed their honey to the A&sacute;vins. This is grammatically and semantically unexceptionable, but it is banal to the point of inanity. On the other hand, if a fly betrayed Soma to the A&sacute;vins, we are plunging to the depths of Indo-European folklore. Throughout northern Europe, wherever the fly-agaric is well known, there is a folk belief that the fly-agaric is linked to flies. Here we find the statement that the fly betrayed Soma to the A&sacute;vins. Did the fly lead the A&sacute;vins to the fly-agaric?

I have conducted experiments with the fresh Eurasian fly-agaric, splitting the stipe (stem, *aṃ&sacute;ú*) lengthwise and letting it bleed. Where flies have access to such stipes, the flies are drawn to them, suck the juice, and collapse helpless into a stupor. They do not die from the juice. On the contrary they recover completely in a matter of hours or one or two days. While in the stupefied state they may of course be killed by their enemies or be blown away to their deaths in non-viable surroundings.[34]

---

[34] *Vide* also *Nature*, Vol. 206, No. 4991, pp. 1359-1360, June 26, 1965: 'Constituents of *Amanita Muscaria*', K. Bowden, A. C. Drysdale, G. A. Mogey.

X. Words Used for Soma in the ṚgVeda

The name Soma is derived from the root *su*, meaning 'to press'. Soma is the pressed one. Another word for Soma is *ándhas*. Both Soma and *ándhas* are used in the ṚgVeda to designate the plant and its juice, *ándhas* being probably cognate with ανθος [*anthos*], the Greek word for 'flower'. (It is as though the Aryans called Soma *the* flower.) In the ṚgVeda 'Soma' and *ándhas* are used exclusively for the sacred plant and its juice, but the plant must have carried a name before it was elevated to its high station as a god and before it could have been called by a name derived from the liturgical act of pressing; this early name is lost. The Vedic lexicographer Grassmann translated *ándhas* by the word *Kraut*, 'herb', such as 'food for cattle'. In classical Sanskrit one of the common words for 'herb' is *tṛ́ṇa*, and, surprisingly, in the earliest Sanskrit dictionary, the *Amarako&sacute;a* (*ca*. A. D. 450), it is defined not only as 'herb' but as 'mushroom'. In the ṚgVeda *tṛ́ṇa* occurs from time to time but no translator had ever found a passage where he said it meant 'mushroom'. But there is a hymn directed to the Ṛbhus that says:

> I 161[11ab]
> In the uplands you have created *tṛ́ṇaṃ* for this people, in the lowlands ingenious waters.
>
> उ॒द्वत्स्व॑स्मा अकृणोतना॒ तृणं॑ नि॒वत्स्व॒पः स्व॑प॒स्यया॑ नरः
>
> *udvátsv asmā akṛṇotanā tṛ́ṇaṃ nivátsv apáḥ*
> *svapasyáyā naraḥ*

Because Soma is repeatedly associated in the hymns with the heights, if I am right that Soma is the fly-agaric, this sentence should be reviewed to consider whether *tṛ́ṇa* does not mean here the divine plant, the fly-agaric. Another word often used for Soma in the ṚgVeda is *óṣadhi*, and the lexicographers tell us that it also meant herb. But in the Vedic mind the plant categories did not correspond precisely to our own, and the three terms for 'herb' seem to have embraced all small fleshy plants. Similarly, as we shall see, the Chinese term *chih* 芝 originally meant a fleshy plant, but as time passed its meaning came to be confined to a particular mushroom.

Many other names are applied to Soma in the ṚgVeda, all of them metaphors stressing one or another of its aspects. In passages where the drink receives the highest homage it is sometimes called *amṛta*, cognate with 'ambrosia', the liquor of immortality. That which is pressed is *aṃ&sacute;ú*, 'stalk'. Sometimes Soma is called simply *vīrúdh*, 'the plant'. The juice is *pávamāna*, from the root *pu*, 'clear flowing', or *indu*, the 'bright drop', or sometimes *drapsá*, the 'drop', or *rása*, the 'fluid', or *pitú*, the 'beverage', or *máda*, 'inebriation', or *mádhu*, 'honey'.

The rich Soma vocabulary reflects the importance of the plant and its sacred rôle. The ordinary word for a common or garden mushroom occurs only once in the ṚgVeda, in a hymn addressed to Indra, where the poet says:

> I 84[8ab]
> When will he trample upon the godless mortal as upon a *kṣúmpa*?
>
> क॒दा मर्तं॑मरा॒धसं॑ प॒दा क्षुंपं॑मिव स्फुरत्
>
> *kadă mártam arādhásaṁ padă kṣúmpam iva sphurat*

Yāska, the earliest of the commentators on the ṚgVeda, who lived not later than the 5th century B.C., said *ksúmpa* meant a mushroom, *ahichatrikā*, and Geldner accepts this identification. The word survives in contemporary Hindi as *khumbi* and in the market place of Old Delhi one buys under that name a wild mushroom belonging to the genus Phellorina, close to or identical with *Phellorina delestrei* Dur.

It is not surprising, on the contrary it is to be expected, that the sacred mushroom should be in a category by itself, segregated from the rest of the mushroom world. This is what happens among the Mazatec Indians of Mexico, in whose language there are two words, one that embraces mushrooms belonging to sacred species, and the other that includes the rest of the fungi. Among the Mazatecs the two words neatly divide the fungal world between them.

'Mushroom' in classical Sanskrit is *chattra*. In the sense of 'mushroom' this word may not have existed in Vedic times; certainly the Aryans did not bring it down from the North. The word itself comes from the root *chad*, 'to cover', and its primary meaning is 'parasol'. For southern peoples the parasol, furnishing protection from the sun, is of importance, and from Cambodia to Ethiopia it is a symbol of authority, in India the mark of the Kṣatriya caste, the rulers, the rajputs. Until recently the northern peoples have not known the parasol or the umbrella. When the Aryans invaded Iran and India, they gave to this newly discovered utensil an Aryan name, *chattra*, and later extended the meaning of that name to embrace the fleshy capped fungi.

In India today mushrooms do not play an important role. Only in the Northwest, in Kashmir and the Punjab, are they much relished, as well as among Muslims and Sikhs in the Punjab and Delhi. *Agaricus hortensis* (our cultivated mushroom, the *champignon de Paris*) is almost unknown, as well of course as *Agaricus campestris*. The mushroom that enjoys some popularity for the table is *Pleurotus eryngii* in various of its subspecies. In Delhi large quantities of *P. eryngii* s. sp. *nebrodensis* are imported from Afghanistan for sale in the market, where they are called *dhingri*. In Kashmir there is a smaller variety, *P. eryngii* Fr. ex D. C. forma *tesselatus*, that goes by the name of *hĕḍar*, *hĕnḍa*. The aristocrats of the mushroom world in Kashmir are the morels, called *kana-g*^{ü}*ch*, the 'ear-morel'; recently they have become too expensive for the people of Kashmir to eat, and today they are gathered only for export to the Punjab, New Delhi, and Paris. But they still figure in the folklore of Kashmir and must be served at wedding feasts, if there are means to buy them. For mushrooms considered inedible, *kukur-nmt(t)ā*, 'dog's urine', and endless variations of the same expression, are the dominant word throughout India. In the languages derived from Sanskrit of modern India I have found no trace of a sacred mushroom.

The Laws of Manu, Chap. V 5, place a tabu on mushrooms for the three upper castes of Hindus (= 'twice-born men'): 'Garlic, leeks and onions, mushrooms [*kavaka*] and all plants springing from impure substances are unfit to be eaten by twice-born men.' It is impossible to say whether this prohibition is related to a sacred use of the fly-agaric in Vedic times; probably not. The hermit or ascetic lies under a similar inhibition, Chap. VI 14: 'Let him avoid honey, flesh, and mushrooms growing on the ground [*bhūmi kavaka*], *bhūstṛṇa*,...' Elsewhere *bhūstṛṇa* is said to mean, among other plants, mushrooms that grow on the ground, the same as *bhūmi kavaka*. Clearly the Hindus are mycophobes. In the Punjab, Kashmir, and the Northwest, where the population has been Muslim and Sikh for centuries - in the Indus Valley, south of the Hindu Kush - there is a deep-seated mycophilia running counter to the general Hindu attitude. This is the area where the ṚgVeda was composed.

There is one episode conspicuous in the religious annals of India in which mushrooms played, or may have played, a decisive rôle: the death of Buddha at the age of 80 in the middle of the sixth century B. C. He was making his way with his followers, talking and preaching as he went, through the kingdom of Magadha, the present state of Bihar, and had paused for the night at a place called Pāvā. One Chunda, a metal worker, asked him for dinner and he accepted. Among other dishes Chunda served *sūkara-maddava*, called in one recension *sūkara-mansa*. (These words are from the Buddhist scriptures written in the Pali language, a tongue spoken a century or more later than the events we are describing and farther to the west. The Buddha himself must have spoken Magadhi Prakrit, also closely related to Sanskrit.) The two terms mean the same thing, but what is that meaning? The first word means 'swine', 'boar', cognate with the Latin *sus*, English 'swine'. The second element means soft flesh. 'Soft flesh of swine?' 'Swine's soft flesh?' *i.e.*. the soft flesh of which pigs are fond? A subjective genitive or an objective genitive? Buddhism has never made much of this, but the two great schools, Mahayana and Theravāda, have disagreed on it. The Mahayana school has held that the Buddha ate pork, it proved to be bad, and he died of the effects, after dysentery. The Theravāda school believes, on the other hand, that he died from mushrooms, a food of which pigs are fond. A Chinese translation of the *Dīgha Nikāya*, including the Book of the Great Decease, made in the beginning of the fifth century A. D., rendered *sūkara-maddava* by *mu erh*, tree mushroom.[35] I record the extraordinary circumstances of Buddha's death because they bring in mushrooms, but I am not prepared at this time to advance an explanation for the myth that would link it with Soma: the sources - Chinese, Sanskrit, and Pali - need to be re-examined with minute care. Nor, so far as I now know, are the ṚgVeda and Soma to be associated with the triple-tiered *chattra* ('parasol' and 'mushroom') that surmounts the great stupa at Sanchi, one of the earliest and most awe-inspiring Buddhist structures that survive; nor with the megalithic 'mushroom-stones' found in great numbers in Kerala, and less often in Nepal.

---

[35] *Vide* (I) '*Sūkara-Maddava* and the Buddha's Death', by Fa Chow, Silver Jubilee Vol. of *Annals* of Bhandarkar Oriental Research Institute, Poona, 1942, pp. 127-133; and (2) 'Nourriture du Dernier Repas du Buddha', by André Bareau *Mélanges d'Indianisme*, Editions E. de Boccard, Paris, 1968, pp. 61-71.

XI. Miscellanea

George Watt, the botanist who devoted his life to the study ot the flora of India,[36] is said to have declared that 'no plant is known at present [1884] which would fulfil all the requirements [of Soma], and he lays particular stress on the fact that the vague and poetical descriptions given of the Soma make any scientific identification almost impossible.'[37] Watt did not read Sanskrit, much less Vedic. He did not allow for the deficiencies in the translations of the ṚgVeda on which he depended: he may have been unaware of them. The early renderings of the ṚgVeda made the ancient poets sound like upper class Europeans of the 19th century, frock-coated, with their inhibitions and pruderies, their etiolated religious outlook. Even today one hears it said that the ṚgVeda is vague and contradictory about Soma. This recalls the blind men who were defining the elephant by feeling each one a different part of the huge beast. Their reports were contradictory indeed. Who is to say that the ṚgVeda is contradictory without first knowing what Soma is?

The hymns of the ṚgVeda fit the fly-agaric like a glove. True, one must possess some awareness of the psychotropic plants of the world and their rôle in primitive religion. Given that familiarity, a reading of Geldner, Renou, and Bhawe leads straight to the fly-agaric.

Indians and Westerners who reverence the ṚgVeda for its religious feeling will perhaps be revolted by the dual forms of Soma and will even experience a visceral resistance to this solution of the enigma. Furthermore, a few Vedic scholars may know a momentary pang of regret. For almost a century and a half Soma has been the great unknown of Vedic studies, until this unknown had come to be considered a permanent built-in feature of this remote area of learning. Playing the Vedic game with aces wild has had its charms: it allowed individual leeway in reading difficult passages. It permitted even the great Bergaigne, in an unguarded moment, to suppose that Soma was merely some plant or other expressly selected by Aryan priests who went looking high in the mountains for this purpose (an 'Ecclesiastical Commission', we would call it), that the myth of Soma's mountain origin might be fulfilled;[38] as though the myth came first and the plant was an afterthought! This was possible only because Soma remained a blank. If Bergaigne was right, the poets of the ṚgVeda, and especially of Maṇḍala IX, must have been engaging in make-believe. His remark flouted all that the poets had to say in praise of the marvelous properties of the plant and the divine inebriation that resulted from drinking its juice. Their religion was founded on a hoax.

On the other hand the identification of Soma will give impetus to Vedic studies. The religion of the ṚgVeda now assumes body, fresh colour, a sharp bite. If I be right, the whole corpus of hymns, and the Avesta as well, must be re-read in the light of the discovery that a divine mushroom was at the center of these religions, was the focus of these poets. How astonishing that we can still draw parallels with the fly-agaric cult in Siberia, where as we shall see in *Part Three* it lingers on, in the last stages of degeneration among the peripheral tribes of the extreme north.

In Siberia the fly-agaric is utilized by the shamans. In the Indus Valley we associate it with an organized priesthood. This priesthood may have characterized Indo-European society in their homeland, but are we safe in assuming so? May not a shamanistic religion have acquired an hieratic structure under the pressures of a tough war of conquest lasting centuries? In a world of enemies the shamans may have found it in their own interest and the interest of the community to close their ranks, to band together and organize a tribal priesthood, as a weapon of political power. The assembling of the hymn book, about which Vedic scholars know something from internal evidence, may have kept step with the organizing of the priesthood.

Why was Soma so soon abandoned in India, perhaps even before the forms were closed on the canon of the ṚgVeda? For one thing, questions of supply, which must always have been awkward, became impossible when the Indo-Aryans spread out over all of India. The mushroom crop in the Hindu Kush and the Himalayas was each year a fixed quantity. Of course for a time the priests could make do with insufficient fly-agarics (as they had had to do many times in seasons of short supply), stretching out the Holy Element by utilizing the *Second form*, and by mixing the precious fluid with ever more water and milk until only a symbol of the Real Presence remained. Possibly the *Second form* fell from favour and came under the condemnation of the priesthood, as it seems to have done in some quarters in Iran. The silence among later Indian writers about the true Soma would indicate that the decision to abandon it was deliberate and universal, and extended even to the discussion of it. But the memory of Soma must have stayed alive in the inner circles of Brahmans, perhaps for centuries. India is a land where the incredible sometimes comes true, and I should be delighted, but not altogether surprised, to discover that there are still circles privy to the knowledge of the true Soma.

---

[36] Watt's monumental work, *Dictionary of the Economic Products of India*, 1889-1896, edited and partly written by him, in many volumes, is a major legacy of the British rule in India, of lasting value.

[37] Quoted from Max Müller, *Collected Works*, London, Vol. X, 1888, p. 223. The observations attributed by Müller to Watt do not appear in Watt's published statements.

[38] Abel Bergaigne, *La Religion Védique*, Vol. I, p. 183. The French text reads: 'Enfin le choix que les Aryas védiques faisaient d'une plante croissant sur les montagnes pour en tirer le breuvage du sacrifice, ne leur avait-il pas été suggéré par le mythe du Soma, venu de la montagne suprême, IX 87^8, c'est-à-dire du ciel et particulièrement des nuages du ciel, I 187^7?'

As the substance of the Sacrifice became diluted and finally vanished, as the Divine Inebriant was reduced to a fading sacerdotal memory, inevitably more and more emphasis was placed by the priests on the efficacy of pure liturgy, and sacerdotalism proliferated to a point that the world has never seen equalled. The Brahmans of those days, profoundly moved by the legacy they had received from their ancestors and not yet possessed of an alphabet, set up, and copper-riveted in place, a method of preserving by sheer memory the words and melody of the original hymns that would withstand the vicissitudes of time. Would it be too much to say that the psychotropic mushrooms stirred them to make this supreme effort? With the passing of the generations Soma, the Divine Plant, no longer a part of Hindu experience, became sublimated in later Hindu mythology and took its place in the heavenly firmament as the Moon God. Dr. Stietencron has asked whether the Soma-Moon equivalence may not have been suggested by several of the attributes of the fly-agaric - its successive phases as it passes from the egg stage through to its ultimate end, all in a period comparable with the monthly cycles of the moon, though quicker; its pock-marked face; its white flesh; its white rotundity before it breaks through the white veil; the crescent that appears when the cap is bisected at a certain stage of its growth. A people richly endowed with poetic imagination would need only these features to see in the moon a transcendental fly-agaric.

The sublime adventure of religious contemplation, the mystical experience, which the priestly caste (and perhaps others) of the Indo-Aryans had known through the mediation of the fly-agaric, could now only be achieved through regulated austerity and mortification of the flesh, and the Hindus, who had known to the full the bliss that contemplation can give, made themselves the masters of these techniques: the price being counted as nothing compared with the prize.

XII. Mani, Mushroom, Urine

Possibly we can adduce evidence that will show vestiges of the cult of the sacred mushroom surviving in esoteric circles under Iranian influence down to the 11th century of the Christian era. The evidence is tenuous but in the light of my fly-agaric thesis it is tantalizingly suggestive. For the first time our trail leads us to China.

Of the sacred texts of Iran only a part survives, and much of what survives is corrupt and confusing. A succession of religions marked the history of ancient Iran - the primitive religion that Zoroaster undertook to reform, Zoroastrianism, Mithraism, Manichæism, some others, each of them preserving features of its predecessors and changing the emphasis, but all of them laying stress on the dualism of this world, the conflict between light and dark, between good and bad.

For some years before his conversion to the Christian faith in A. D. 386, St. Augustine was a follower of Mani, though he never visited Iran. Immediately thereafter he wrote his attack on the Manichæans, in which there is a passage, seldom noticed, condemning them for eating mushrooms, as well as other delicacies.[39] The Latin text reads as follows:

---

39. St. Augustine, *De Moribus Manichæorum* ('About the Ways of the Manichæans'), Chap. 13, Para. 30. In imperial Rome *boletus* was the name applied to what we call the genus Amanita, including both the edible and the toxic amanitas. *Vide: Mushrooms Russia and History*, Wasson & Wasson, New York, 1957, Chap. IV, Mushrooms for Murderers. So great was St. Augustine's influence on later churchmen that I think his mycophobic utterance may have had a part in shaping the virulent diatribes against mushroom-eaters of St. François de Sales and Jeremy Taylor. *Vide* our *MR&H*, pp. 21-2, 353.

> Quid porro insanius dici aut cogitari potest, hominem boletos, orizam, tubera, placentas, caroenum, piper, laser, distento ventre cum gratulatione ructantem, et quotidie talia requirentem, non inveniri quemadmodum a tribus signaculis, id est a regula sanctitatis excidisse videatur.

Writing to confound the Manichæans, St. Augustine speaks of those who stuff themselves every day, to gratify their appetites, with *boletos* (a class of mushroom), rice (in Rome at that time an expensive luxury), truffles (or perhaps underground mushrooms of the genus known today as Terfezia, common in North Africa), flat cakes, sweet wine boiled until thick, pepper, and silphium (a spice, highly esteemed, from a plant now allegedly extinct), and he asks whether anyone can suppose that such people do not lose their standing in holiness.

Only an ethno-mycologist might remark, on coming across this sentence in the great Doctor of the Church, that of the seven cates bringing down his censure, two belong to the fungal tribe, that the first of the seven is the Amanitas to which the fly-agaric belongs, and that he is writing against the Manichæans, an Iranian religion founded by Mani about a century earlier. Even an ethno-mycologist could hardly do more than make a mental note of this; which note, however, would spring to life on reading about the Manichæans in China.

The Iranians introduced the religion of Mani into China in A. D. 694 and 719, and during the rest of the T'ang dynasty and down through the Sung this Iranian sect of Manichæans played something of a rôle in the religious life of the Chinese, especially in their impact on the Taoists.[40] They won a victory when in A. D. 763 they gained as a convert the Khan of the Uighurs, a powerful Mongolian people. Much later an unfriendly Chinese official, Lu Yu 陸游 (A. D. 1125-1209), wrote two reports on the activities and practices of the devotees of Manichæism in Fukien province. Among their evil ways he lists their practice of eating certain mushrooms:

What they eat is always the *red mushrooms, hung hsün* (紅蕈)

The two distinguished French sinologues who edited this text, Messrs. Chavannes and Pelliot, could not be expected to know that it is precisely in Fukien province that there grows an abundance of an edible red mushroom, which is gathered there and widely eaten not only in Fukien province but throughout China. Chinese mycologists call it *Russula rubra* (Kromb.) Bres., and anyone conversant with the province would assume that this is the mushroom of which Lu Yu speaks. How astonishing was this charge of mycophagia, which Lu Yu hurled against the little sect of Mani disciples. The Chinese know their mushrooms and consume wild species in quantities. It is not as though a mycophobic Englishman had leveled the heinous accusation against, say, a band of Gypsies. To be guilty of this offense the Manichæans must have been gluttons for mushrooms, and the local red mushrooms to boot, and clearly, since he was speaking about their religion, the practice was a part of their religion. Were not these mushrooms another substitute for Soma, a substitute more appropriate, in that it was *red mushrooms*, than any known to have been used in India?

The second report of Lu Yu, probably submitted in A.D. 1166, is just as interesting.

以溺為法水, 用以沐浴

They [the Manichæans] consider urine as a ritual water and use it for their ablutions.

MM. Chavannes and Pelliot observe in a footnote that 'the use of cow's urine is known in Brahmanism and, on certain occasions, in Mazdaism [Zoroastrianism]; but the context here hardly permits one to think of anything

---

40. The information about the activities of the disciples of Mani in China comes from *Un Traité manichéen Retrouvé en Chine, traduit et annoté par Ed. Chavannes et P. Pelliot*, Paris, 1912, pp. 292-340, especially 302-5 and 310-314, including the footnotes. This study was first published in the *Journal Asiatique*, November-December 1911. On p. 304 the French scholars, translating the passage from St. Augustine, render *boletos* by *cèpes*, thereby falling into error. In Antiquity, as we have said, the *boletus* was an amanita and the *cèpe* was the *suillus*, the Italian *porcino*. Linnæus created the confusion: when he was naming the genera and species he resorted to the ancient Greek and Latin words but paid not the slightest heed to their ancient meanings.

except human urine, and analogies are more rare on this point'. Lu Yu goes on to complain that as the Manichæans eat so many Russula mushrooms, the price of mushrooms of the Russula kind goes up. For 'mushrooms', he here uses the two characters *hsün* 蕈, *chün* 菌. The first Chinese character is the same as he used before. The second one is the other standard Chinese character for mushroom. In the second half of the sentence he repeats the two characters but in reverse order:

食蕈菌, 則菌蕈為之貴

As they eat fungi mushrooms, therefore mushrooms fungi grow dear.

Mani was born in Iran perhaps a millennium or more after Zoroaster and at least 1,500 years after the period when the ṚgVeda was being composed in the Indus Valley. If anyone takes the attitude that, because of the lapse of time, the practices of the Manichæans are irrelevant to my Soma-Haoma-fly-agaric thesis, I will not argue with him. In a part of the world and in a period where religious practices and beliefs showed a marked underlying stability and persistence, it seems to me that the use in this Iranian cult of urine, apparently human urine, and of mushrooms, *red* mushrooms, is more than chance. In esoteric religious circles the ancient practices may have lived on with modifications for many centuries.

The religion of Zoroaster still survives in the community of Parsis, largely centered in Bombay. It is pertinent to my argument that they still drink urine in their religious rites, though only in token amounts and only the urine of a bull.[41] As I have already mentioned, throughout the area that stretches from Iran to India cow's urine is used as a disinfectant, a religious or ceremonial disinfectant, paralleling somewhat our historical use in the West of Holy Water.

So much emphasis is laid on cows in the ṚgVeda and on the urine of bulls in the religion of the Parsis that the question naturally presents itself whether cows consume the fly-agaric and whether they are affected by it, along with their urine and milk. I cannot answer this. In early October 1966 with three Japanese friends, all mycologists,[42] I visited Sugadaira, in Nagano prefecture, five hours west of Tokyo by fast train. There were many birch trees scattered over the mountains, and an abundance of fly-agarics growing at their feet. A herd of heifers was grazing in the lush highland pasture, and we took advantage of the opportunity to offer them some of the fly-agarics that we had in our baskets. Two of the animals ate them from our hands avidly; two or three turned away with indifference. We did not carry our experiment further, as the animals were of fine Frisian breed and the owner was unaware of our scientific activities. We did not have an opportunity to catch the urine of the heifers that had eaten the fly-agarics; besides, they would have eaten many, many more, had we supplied them.

In 1965 and again in 1966 we tried out the fly-agarics repeatedly on ourselves. The results were disappointing. We ate them raw, on empty stomachs. We drank the juice, on empty stomachs. We mixed the juice with milk, and drank the mixture, always on empty stomachs. We felt nauseated and some of us threw up. We felt disposed to sleep, and fell into a deep slumber from which shouts could not rouse us, lying like logs, not snoring, dead to the outside world. When in this state I once had vivid dreams, but nothing like what happened when I took the Psilocybe mushrooms in Mexico, where I did not sleep at all. In our experiments at Sugadaira there was one occasion that differed from the others, one that could be called successful. Rokuya Imazeki took his mushrooms with *mizo shiru*, the delectable soup that the Japanese usually serve with breakfast, and he toasted his mushroom caps on a fork before an open fire. When he rose from the sleep that came from the mushrooms, he was in full elation. For three hours he could not help but speak; he was a compulsive speaker. The purport of his remarks was that this was nothing like the alcoholic state; it was infinitely better, beyond all comparison. We did not know at the time why, on this single occasion, our friend Imazeki was affected in this way.

---

[41] Jivanji Jamshedji Modi: *The Religious Ceremonies and Customs of the Parsees*, 1923, 2nd ed. 1937; Bombay. *Vide* p. 93 (in the 2nd edition) and other references indexed under 'Gaomez', 'Nirang', and 'Nirangdin'.

[42] These friends were Yoshio Kobayashi, Rokuya Imazeki, and Masami Soneda, all well known mycologists. We were guests of Shigeyoshi Iwasa at the lodge of the Meguro High School, Tokyo; unfortunately Professor Iwasa could not join us. We were most hospitably cared for by the hosts at the lodge, Mr. and Mrs. Mikiyoshi Motai.

In the cultural history of Eurasia has the reindeer played a part in the attitude toward mushrooms and also toward urine, owing to certain traits peculiar to the reindeer? The northern forest and tundra folk live in an intimacy with the reindeer that is hard for us to imagine, an intimacy that amounts almost to a symbiotic relationship. Reindeer manifest two addictions, two passions, one to urine especially human urine, and the other to mushrooms including the fly-agaric. When human urine or mushrooms are in the vicinity, the half-domesticated beasts become unmanageable. All reindeer folk know of these two addictions (how could they not know about them?), though not all know that the mushroom addiction embraces the fly-agaric since the fly-agaric does not always grow over the areas where reindeer abound. Reindeer, like men, suffer (or enjoy) profound mental disturbances after eating the fly-agaric. In *Part Three* and the Exhibits we shall give the testimony of travelers on these points. I now call attention, for the first time in this context, to the odd traits of the reindeer because of their possible bearing on the fly-agaric complex in the religious life of the Siberian peoples. In the give and take of the human species and the reindeer may not the human race have learned from the reindeer to esteem urine and the inebriating qualities of the fly-agaric also, and finally the combination of the two? It has been said that in Vedic times - *ca*. B. C. 1500-1000 - reindeer had not been domesticated. How conclusive is the evidence for this in northern Siberia? It is thought that the ancestors of the Aryans did not live in the reindeer latitudes. There is linguistic evidence that may show the Indo-Europeans discovered the virtues of the fly-agaric before the Siberian tribes, and we are beginning to perceive the extent of the trade relations that always existed across those vast land expanses of Siberia. In that heyday of the fly-agaric cult may the Indo-Europeans have mastered techniques that encouraged cows to eat the resplendent heavenly mushroom? All these questions are speculative and at present unanswerable.

XIII. The Marvelous Herb

1

In the Shahnameh of Firdousi there is an episode that bears on our quest for the genuine Soma. The Shahnameh ('Book ot Kings') is the great Persian epic of 60,000 rimed couplets, a repository of all Iranian history and all national legends known to the poet. Firdousi completed his prodigious work just after A. D. 1000, and the episode that interests us is attributed to the 6th century, at the court of the outstanding Sassanid king Khosru I, called Anushirvan ('the Blessed'), who reigned from A. D. 531 to 579. Whether the episode as recounted by Firdousi took place as told or whether he merely passes on an embroidered version of what had become a legend is immaterial: its terms are what interest us,[43] whether true or false. Here is my summary of the passage pertinent to our inquiry. It will be apparent later why I have put a sentence in italic.

> At the court of King Khosru there was an outstanding physician, one Bursōē, an elderly man who loved to talk and who was reputed to be versed in every branch of knowledge. One day he presented himself before the King at the hour of audience and said: 'O King, friend of learning, you who explore science and who keep it in memory, today I have perused in a serene spirit an Indian book. It is said therein that on a mountain in India there grows a plant brilliant as Byzantine satin. If a skillful man gathers it and mixes it cannily, and *if then he spreads it on a dead man, the dead man recovers the power of speech without fail and forthwith*. If the King permits, I am going to undertake this difficult quest. I shall make use of all that I know to guide me and I hope to accomplish this marvel. It would be only just that the dead return to life, since the world has for king the Blessed One.' Whereupon the King replied: 'It is not likely that this will be, but perhaps we must try.'
>
> The King added that as Bursōē would probably need a guide, he should go amply supplied with gifts for the Indian Rajah. [Later in the story the Rajah is identified as having his capital at Kanauj, the meager ruins of which still exist in Uttar Pradesh, fifty miles from Kanpur, on the Ganges far south of the Himalayas.]
>
> Bursōē set out on his journey and arrived in the presence of the Rajah, who welcomed him and

---

[43] Firdousi: *Shahnameh*, verses 3431-3568; I have relied on the French translation of Jules Mohl.

> read the letter delivered to him. He assured Bursōē that all the Brahmans living in the mountains would help him. Bursōē went everywhere in the mountains on foot, and he chose herbs dry and fresh, faded and others in their full glory. After crushing them he spread them over corpses, 'but those herbs did not bring back a single one to life.'

The rest of the tale, which recounts how Bursōē extricated himself as well as he could from his embarrassing predicament, does not concern us.

It is noteworthy (1) that the book that Bursōē had read was Indian; (2) that according to the Indian book the herb shimmered like satin of Byzantium; (3) that in India Bursōē had recourse to the mountains; and (4) that he was promised Brahmans living in the mountains for his guides. The herb grew in the mountains of India - no other place is mentioned. Bursōē had been reading an Indian book - we are not told what one nor when it was written. In the episode do we not hear a clear though fading echo of the Soma of the ṚgVeda, of the marvelous herb that grew high in the mountains and for which the Brahmans alone held the key?

2

In Indian literature the Purāṇas contain legends and tales of the olden days, all of them religious and in verse. The different Purāṇas took their present shape at different times, running from perhaps the 4th to the 16th centuries.

A story is told in several of the Purāṇas that may bear on the Bursōē episode in the Shahnameh. The version that I shall give is from the *Padma Purāṇa*, Part 2, Book 6, Chapter 8, verses 40-63. Scholars tell us that it assumed its present form between A. D. 800 to 1000. A certain Mount Droṇa figures in it: '*dróṇa*' (from *dru*, Sanskrit, 'made of wood') is the word commonly used in the ṚgVeda for the wooden vessels that contain Soma. Here the word has been transferred to that other receptacle for Soma, the mountain out of which the marvelous herb grew.

> Jalandhara was the king of the demons and he was waging war against the gods. The spiritual preceptor of the demons, their guru, was named &sacute;ukra; he had a magic incantation that he had received from &sacute;iva by means of which he revived all the demons as they fell in battle. Viṣṇu, who was leading the army of the gods, said to Bṛhaspati, who was the guru of the gods, '&sacute;ukra has revived all the demons. Why do you not revive the gods?' Bṛhaspati said, 'I will revive the gods with herbs.' Then Bṛhaspati went to the great Droṇa Mountain beside the ocean of milk, and he took the herbs that grew there and by means of yoga he revived the gods. Seeing this, Jalandhara said to &sacute;ukra, 'How can the gods be revived without your magic?' &sacute;ukra said, '*There is a mountain named Droṇa beside the ocean of milk, and herbs grow there that revive the dead. The guru of the gods went there and took the herbs and revived the gods who had fallen in battle*.' Hearing this, Jalandhara went to the ocean of milk and he went to the mountain Droṇa and beat it with his fists until Droṇa said, 'I am your slave; protect me.' Jalandhara then commanded the mountain to go down to the nether world below the earth, and Droṇa went there; as he went, all the herbs cried out. Then Jalandhara returned to the battlefield and fought with Viṣṇu and conquered him. - *Translated by Wendy Doniger O'Flaherty.*

In the Sanskrit text the word for herb is *óṣadhi*, one of the terms often used for Soma in the ṚgVeda. In Sanskrit there was a poetic convention that precious herbs (*óṣadhi*) grew on the Himalayas. They were brilliant and shone like lamps at night. There are hundreds of such references, of which perhaps the most famous is Kālidāsa's *Kumārasambhava* I 10:

> Where the magic herbs (*óṣadhi*) cast their glow into the caves of mountaineers who lie there with their mistresses, lamps of the love-chamber that need no oil.[44]

---

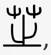
44. I am indebted to Professor Daniel H. H. Ingalls for this reference. He also supplied me with a Sanskrit proverb, which may go back to a Prakrit original: 'On the snowy mountains grows the magic herb, but the snake is on your head.' (Snowy mountains = Himalayas) *Vide* translation by D. H. H. Ingalls: *An Anthology of Sanskrit Court Poetry*, Harvard Oriental Series 44, verse 791; also *idem* p. 522 for further references to the proverb.

All Chinese know the *ling chih* 靈芝, a conception that goes back in Chinese cultural history for thousands of years; just how far back is the question at issue here.

The *ling chih* is a symbol of happy augury, bespeaking good fortune, good health, longevity, even life with the immortals. Conventionally the phrase is translated by 'the divine fungus - or mushroom - of immortality'. The 'marvelous herb' would be a simpler rendering, or again the 'herb of spiritual potency'. It is one of that large family of Chinese expressions drawn from nature - animals, plants, mountains, clouds, *etc.* - which seem to have constituted in a sense the furniture of every Chinese mind. The Chinese would distill from the chosen objects a conventional meaning, and thereafter the objects were used in literature and art to convey this meaning, like pictographs. At an early date the Taoists captured the concept of a divine mushroom of immortality, and they exploited it fantastically in their writings in the first millennium of our era and even later, until the original idea was lost in a welter of imaginary divagations. Beginning with the Yüan Dynasty (A. D. 1280-1368) the *ling chih* has been endlessly represented in art - in paintings, carvings in jade and deer's antlers, furniture and carpet designs, balustrades, jewelry, lady's combs, perfume bottles, in short wherever the artistic urge found an outlet. It has become a cliché in newspapers, novels, conversation. For two thousand years the idea of the *ling chih* has passed through various phases in the cultural history of China, and I hope someday to publish my notes on these, looking to the time when enough will be known for someone to write the biography of the miraculous fungal idea.

Up to now students of Chinese culture have always regarded the *ling chih* as indigenous to China.[45] I shall suggest that it came from India and was a 'literary' reflection of Soma, the miraculous mushroom of the ṚgVeda. Certainly the fungal idea, once it reached China, found there fertile soil: an 'elixir of immortality' has bemused many peoples, such as the West Europeans in the 16th century, but the Chinese seem to have been singularly susceptible to this will-o'-the-wisp, always hoping to come upon a plant or mineral or juice that would prolong virility and longevity. The novelty of the *ling chih* is precisely that it was a mushroom, and this is India's contribution to our story.

Alfred Salmony in his *Antler and Tongue*[46] has called attention to the accumulating evidence of the influence of India on the China of the Late Eastern Chou, from the 7th to the 3rd centuries B.C. He has pointed out that the influence could be solely 'literary', *i.e.*, whereby the Chinese 'heard tell' of practices elsewhere and under the stimulus of such reports sought to duplicate them. This is what Joseph Needham calls 'stimulus diffusion',[47] what I would call 'idea diffusion'. Salmony cites a number of examples and supplies the bibliographical references. To this list I now propose to add the *ling chih*.

First a word as to the vocabulary for the divine, the miraculous, mushroom. This assumed such importance in Chinese culture that alternative expressions evolved. It is often called the 'miraculous *chih*', 神芝, or 'auspicious herb', 瑞草. With Chinese culture the idea spread to Korea and Japan, where however it has tended to be confined to the literate and intellectual classes. *Ling chih* in Japan, written with the same Chinese characters, becomes *reishi*, the *l* yielding to *r* in the customary way. But more widely used than *reishi* today is *mannentake* 萬年茸 'ten-thousand-year mushroom'. Scholars say that in the archaic stage of Chinese culture the character for *chih* 芝 was written , a pictograph of 'herb', a small plant that was not woody. In Japanese this meaning is still current: where *chih* 芝 appears in contexts other than *ling chih*, it is pronounced *shiba* and means 'lawn'. Presumably it meant this in spoken Chinese in the early T'ang Dynasty (A. D. 618-906), when the Japanese probably borrowed the word. But in the specific sense of 'mushroom' it had already had a long history in China. In the *Li Chi*, one of the 'Thirteen Classics' of China, *chih* 芝 is listed as

---

45. *Vide, e. g.* Michael Sullivan: *The Birth of Landscape Painting in China*, University of California Press, San Francisco and Los Angeles, 1962, p. 52. Sullivan's discussion of the *ling chih* (*vide* references in his index) is the best that has appeared in recent times. Also, Marcel Granet: *La Pensée Chinoise*, Paris, 1934, 'L'art de la longue vie', pp. 507 ff.
46. Alfred Salmony: 'Antler and Tongue, an essay on ancient Chinese symbolism and its implications'. *Artibus Asiæ*, Ascona, Switzerland, 1954, pp. 51-52.
47. Joseph Needham: *Science and Civilization in China*, Cambridge University Press, Vol. I, 1961, pp. 244-248.

a ritual food of the emperor, thus figuring in the religious ceremonies that were an important part of his functions.[48] The early commentators gloss this as meaning an edible mushroom growing on trees, probably what is known in recent centuries as the tree-ear, *mu erh* 木耳 familiar throughout the temperate zone to those versed in mushroom lore as the wood ear, *Auricularia auricula-judae* (Bull.) Quél. The *Li Chi* comes down to us in a recension dating from the early Han (the two centuries before Christ), but the contents are supposed to have been assembled in the late Chou period, from the 7th to the 3rd centuries B.C.

Though *chih* in the sense of 'mushroom' seems already to have been familiar, the idea of *ling chih*, a supernatural mushroom with miraculous powers, appears first in the Ch'in Dynasty (B. C. 221-207) under the great Emperor Shih-huang, who assumed the title of the 'First Emperor', by which he has always been known, for it was he who unified all China for the first time and who built the Chinese Wall to keep the barbarians out. Until his reign we find not a single word about the marvelous plant: no mention in the Classics, in the inscriptions on the bronze vessels, on the oracle bones. There are no carvings in jade or deer's antlers, no representations in pottery or jewelry, on halberds or belt buckles. If the conception had existed, we must assume an implausible conspiracy of silence in this singularly articulate people concerning an idea that prompts thousands of tongues to wag.

Then, suddenly, there is a burst of talk about the wonder fungus, but only talk. People busy themselves looking for it, especially in the mountains, but no one finds it. The great historian Ssu-ma Ch'ien (B. C. 145-87?) is the source of most of our reliable information on this. There are many passages in his account of Shih-huang's reign telling of talks between the Emperor and his necromancers: a magical herb ('*chih*') existed, but where was it? Everyone was searching but it was nowhere to be found. Matters reached a point where the Emperor was advised to go into the mountains alone, and in disguise, obscurely, on tip-toe, and perhaps he might surprise it! We your humble servants are trying to find *chih*. It is one of the miraculous medicines that even the gods cannot come upon easily. 'This is the manner in which the Emperor is addressed by Lu-shêng, one of the sages who was giving advice.[49] The Emperor has been told of a marvelous plant and, asking his necromancers to find it, gets only evasive answers. They believe (or pretend to believe) the reports of its properties, but have no idea what to look for. Addressing the 'master of humanity', who clearly believed the reports, they do not dare confess their ignorance by telling the truth.

Or again we read that Shih-huang sends vessels into the Eastern Sea to seek the mysterious fungus on islands off the coast and far away.[50] One sage (or necromancer, or shaman), Hsü Fu, seems to have rallied hundreds of youths of both sexes to embark with him and to have sailed away to the Southeast. The reports of this voyage are numerous. According to one account, they never returned, but Ssu-ma Ch'ien tells us that Hsü Fu came back and reported falsely about as follows: 'Your humble servants sailed east and southward and reached P'êng-lai [allegedly one of the three godly islands in the Seas]. There your humble servants saw palaces made of *chih*. There were servants, copper in colour and dragon in appearance. The palaces were so bright that they lit up the heavens.'[51]

I take it that the reports of Soma had reached the Emperor by the sea route: hence the voyages to establish contact with the source of information. I take it that the reports placed Soma high in the mountains: hence the futile excursions into the mountains to find the plant. The first reports about Soma probably reached China in the reign of Shih-huang-ti, but possibly they came a few decades earlier, Shih Huang being the first to pursue the matter. In any case in China the conception of the miraculous *chih* probably does not antedate the 3rd century B. C.

---

[48] *Li Chi*, Chap. 12. 禮記内則.

[49] From Ssu-ma Ch'ien: *Shih chi* 史記, biography of Shih-huang.

[50] The proponents of early deliberate trans-Pacific contacts with America must face these texts in considering the stage of development in navigation that the Orientals had reached as late as the Ch'in Dynasty. Contacts by sea between India and China involved only plane sailing, but the difficulties were staggering for the people of those times. The Japanese had hardly established contacts with China *via* Korea, much less the islands of the Pacific. As late as the middle of the first millennium A. D. voyages from Kyushu to Shantung were formidable adventures, exceedingly perilous.

[51] *Op.cit.*, Vol. 118, 'The Biographies of Princes Huai-nan and Hêng-shan' 淮南衡山列傳; quotation from the biography of Prince Huai-nan, a grandson of the first Han emperor.

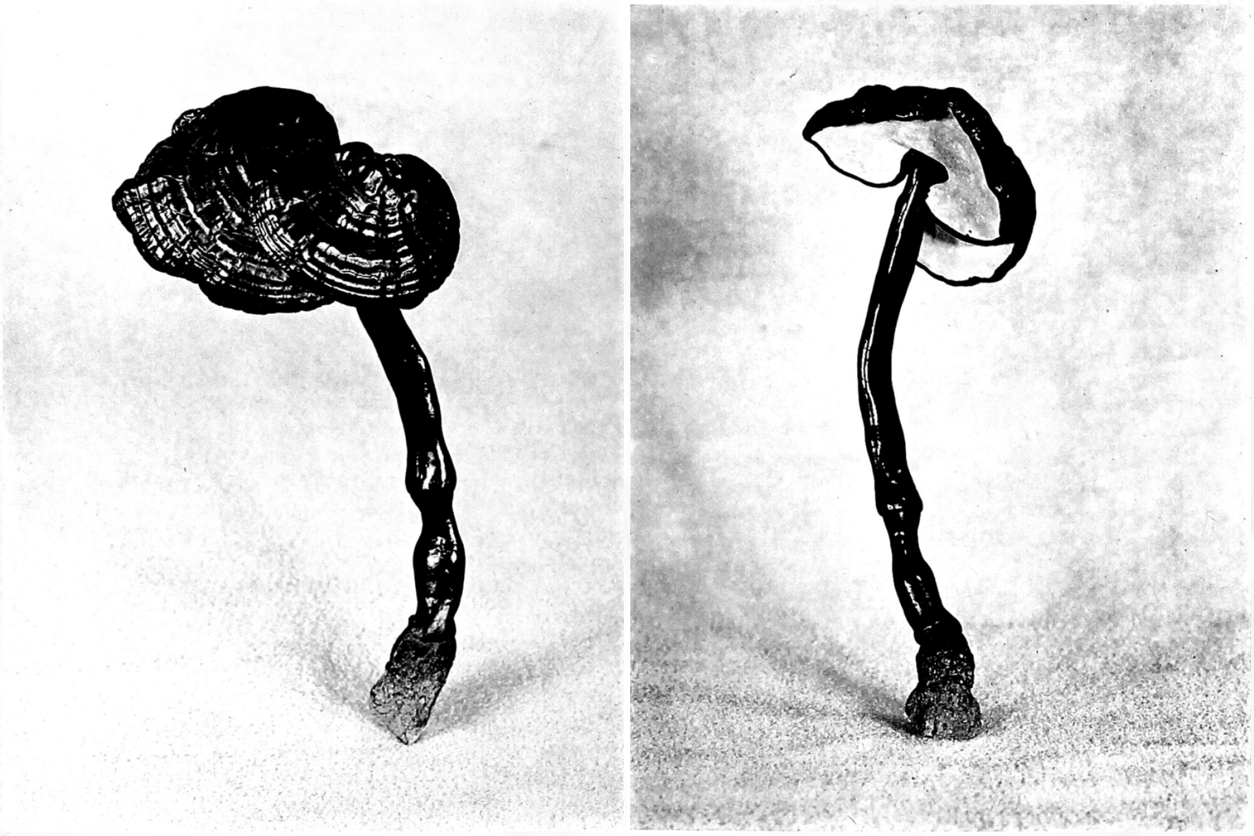


Plate XIV and Plate XV - Twin-leafed LING CHIH from above and from below.
(*Collection R. G. Wasson*)

Ssu-ma Ch'ien, the father of Chinese history, lived in the reign of the early Han Emperor Wu (B.C. 157-87), about a century after Shih-huang. Contemporary with Ssu-ma Ch'ien there was a famous gentleman-in-waiting at court by name Tung-fang Shuo 東方朔, a man renowned for his ready wit. In the Taoist canon there survives a work attributed to him, the *Shih chou chi* 十洲記, 'Notes on Ten Continents', that gives another account of the voyage of Hsü Fu. Scholars say that the attribution to Tung-fang Shuo is certainly spurious, and that the *Shih chou chi* could not have been written before the 4th or 5th centuries and probably several centuries later. In short it is a product of the second half of the first millennium, therefore contemporaneous *sensu lato* with Bursōē's journey and with the *Padma Purāṇa* from which we have already quoted. In the following excerpt taken from the *Shih chou chi*[52] we have underlined phrases that will strike a familiar chord:

> The isle of Tsu is situated close by, in the Eastern Sea. There grows a never-dying plant, shaped like water-grass, with blades three to four *ch'ih* [feet] in length. *A man who has been dead three days revives immediately when this plant is laid on him*. When it is eaten it prolongs life. In the time of Shih-huang-ti of the Ch'in dynasty, when murdered people lay broadcast in the 'great preserve' and across the roads, *birds resembling crows or ravens appeared with this plant in their bills, and placed it on the faces of those corpses, with the effect that they sat up immediately, and revived*. The officers reported this to the Emperor. On this Shih-huang-ti sent out an envoy with a sample of this plant [草 *ts'ao*]; and he interrogated the doctor of the Spectre Valley, who lived near the north wall. 'This herb [*ts'ao*]', thus spoke the sage, 'is the herb of immortality of the Tsu island in the Eastern Ocean, where it grows in a red marble field. Some call it *chih* 芝 which feeds the *shên* 神 [spirit]. Its leaves grow luxuriantly, and one stalk suffices to give life to a man.' On these words Shih-huang-ti with enthusiasm spoke: 'Can it be fetched from there?' And he sent

---

[52] The Chinese text of this episode is given by J. J. M. de Groot: *The Religious System of China*, Brill, Leiden, Vol. IV, pp. 307-8. I have followed de Groot's translation except in a few particulars where on the advice of my Chinese friends I have emended it.

> an envoy to the island, one Hsü Fu, with five hundred young people of both sexes, in command of a ship with decks. They put to sea to seek the island but they never came back.

Here then we have three tales that intermesh in an odd manner. The Iranian version conveys a clear echo of the Soma of the ṚgVeda. There has been added to the marvelous herb one fabulous property: it revives the dead. In the Indian tale an herb with the identical miraculous virtue grows on Mount Droṇa, the name of this mountain echoing the word in the ṚgVeda that designates the receptacle for the juice of Soma. In the late Chinese revision of the Hsü Fu tale the same fabulous virtue is attributed to an herb: it makes the dead to rise. This tale is a variant of one told by Ssu-ma Ch'ien perhaps six or seven hundred years earlier about the First Emperor, Shih-huang, and a *fungus or mushroom with miraculous properties*. Here is an example of idea diffusion, and the idea, I believe, had its source in the Soma of the ṚgVeda. The marvelous fungus of the Chinese, first appearing in the reign of Shih Huang-ti, must today be viewed in the light of Sino-Indian contacts and the evidence that Soma was a mushroom.

The next chapter in the history of the *ling chih* takes place in B. C. 109, a century after the time of the Emperor Shih-huang. The Han Dynasty (B.C. 206 - A. D. 220) now rules China and Wu-ti occupies the throne. The sources for our information about the episode that I am going to relate are the same Ssu-ma Ch'ien whom we have already quoted and who was contemporary with the later event, and Pan Ku (A. D. 32-92), the chronicler of the Han Dynasty and also a reliable historian. In the imperial Kan-ch'üan palace building operations had been under way in the first half of the year. Then, in late summer (probably August), in an inner pavilion of the palace, there appeared a fungal plant, a marvelous growth with nine paired 'leaves'. The Emperor Wu made the most of the event. He identified the plant with the famous *chih* that Shih-huang and his necromancers could not locate. He issued an edict and exclaimed that even the inner chambers of the palace were not discriminated against. He proclaimed an amnesty of prisoners, served beef and wine to a hundred families, and composed an ode for the occasion, the earliest poem about a mushroom (but far from the last and far from the best) that comes down to us in Chinese history. Pan Ku has preserved it for us:

齊房產草	My secluded dwelling produces an herb,
九莖連葉	Nine stems with twin leaves!
宮童效異	The palace pages busy themselves with this miracle;
披圖案諜	They lay out pictures and consult records!
玄氣之精	The essence of the Mysterious Breath,
回复此都	There it is, returned again to this residence,
蔓蔓日茂	Day after day this superb growth,
芝成靈華	This *chih*, which unfolds its beauties most marvelously!

Under the Emperor Wu taxes were levied harshly to meet his needs and grumbling was widespread. He was hardly popular and perhaps he seized on the unusual appearance of a fungal growth inside the palace chambers as a public relations ploy, bestowing on this plant the name *chih* to turn in his favor its good name and prestige. The episode is known to this day by everyone familiar with Chinese history, somewhat like the vase of Clovis in French history and King Alfred and the pancakes in English history. The ode is No. 13 in the nineteen ritual odes that were sung to music on the seasonal occasions of the Chinese year.

At last the unidentified *chih* of Shih-huang-ti had found an identity, an identity that it has retained to this day. Naturally this fungus had nothing to do with its Indian precursor, which Shih-huang had never succeeded in locating in the mountains of China. I think it is safe to assume that the plant found growing in the imperial palace in B. C. 109 was *Ganoderma lucidum* (Leyss.) Karst., the same species that has been represented in Oriental art - Chinese, Japanese, Korean - time without number in recent centuries. The definitive scientific identification of the fungus pictured in Chinese paintings since the Yüan Dynasty was made by two Japanese mycologists, by Iwao Hino in May 1937 and by Rokuya Imazeki in 1934 and 1939.[53]

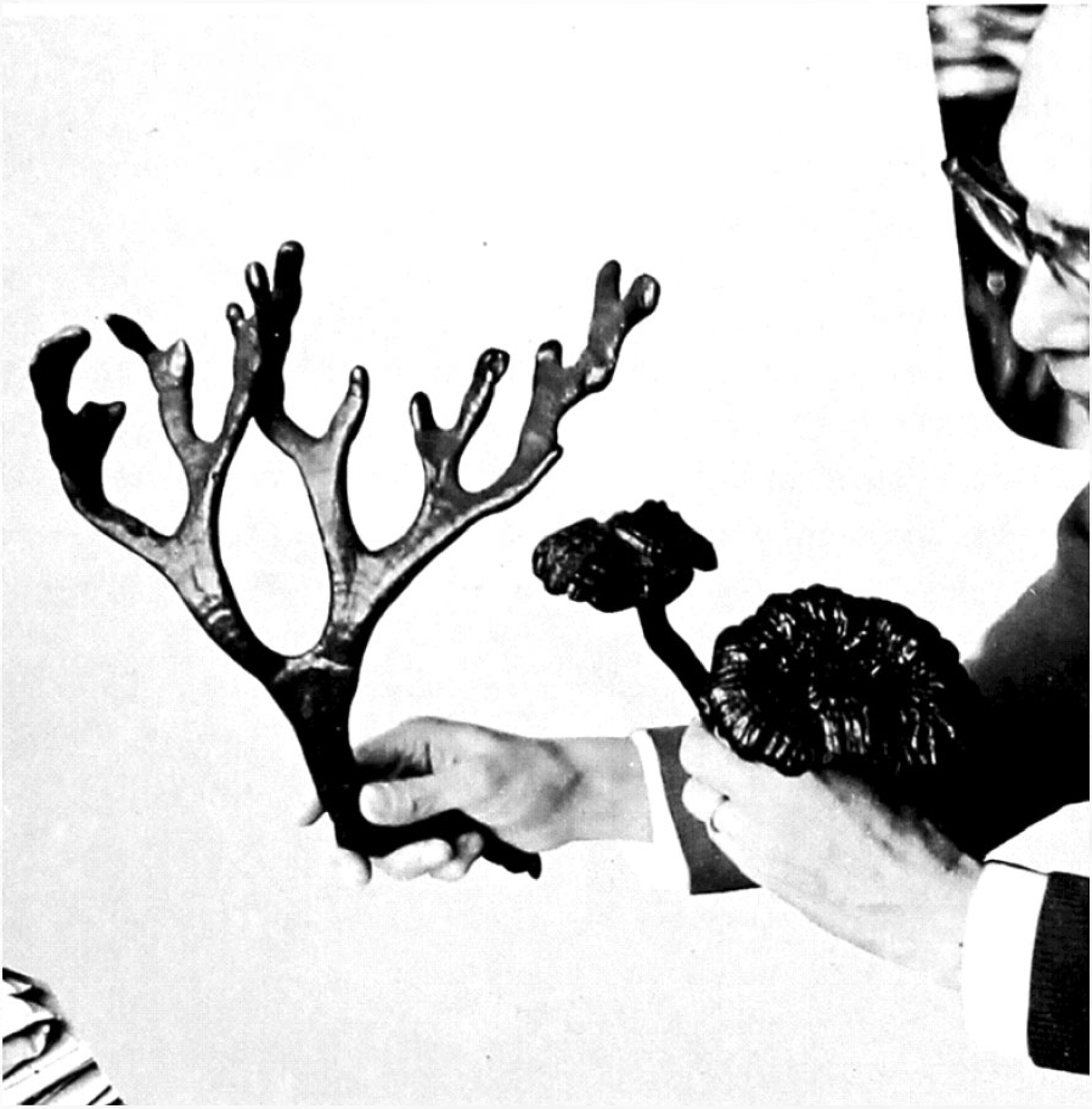


Fig. 1. *Ganoderma lucidum*. Normal and abnormal shapes.

Ganoderma lucidum is a woody fungus, therefore inedible, that grows widely in the temperate zone. We see it in Europe and America, but we have never made anything of it. In appearance it can be of stunning beauty, with its rich lacquer-like finish, the concentric lines of its strange pileus, its odd stem. Those unversed in these matters often refuse to believe that the high polish of this mushroom has not been artificially applied. But its peculiar virtue is that it is protean. There is the normal form, and there is the endless variety of other shapes and consistencies that it assumes when it grows under abnormal conditions, as for example in the dark. The cap (or 'pileus') is always attached to the stem (or 'stipe') eccentrically, and it can give rise to the 'paired leaves' of Wu-ti, as we show in Plates XIV and XV. (*Vide supra*, poem by Wu-ti. In classic Chinese the pileus of a mushroom was a 'leaf' and in Japanese this use of 'leaf' has survived down to our own day. The Chinese character is 葉, in Chinese reading *yeh*, Japanese *ha*.) We know that there had been building operations going forward in the Imperial Palace earlier in the year. This is precisely the condition that might produce an abnormal *chih* inside the new structure: the wood was not seasoned and the growth made its appearance in the obscurity of the secluded chambers. The nine 'double-leaves' would be a rare curiosity, but it is certainly not at all unbelievable.

---

[53] Rokuya Imazeki: *Natural Science and Museums*, 1934, No. 61, pp. 11-15, 'Good Omen Plant, *Mannentake*'; also *Bulletin of the Tokyo Science Museum*, March 1939, No. 1, 'Studies on Ganoderma of Nippon'. I wao Hino (Miyazaki): *Botany and Zoology*, May 1937, Vol. 5, No. 5, '*Reishi* and *Ganoderma lucidum* that grow in Europe and America: their Differences'. (All are in Japanese, with English summary.)

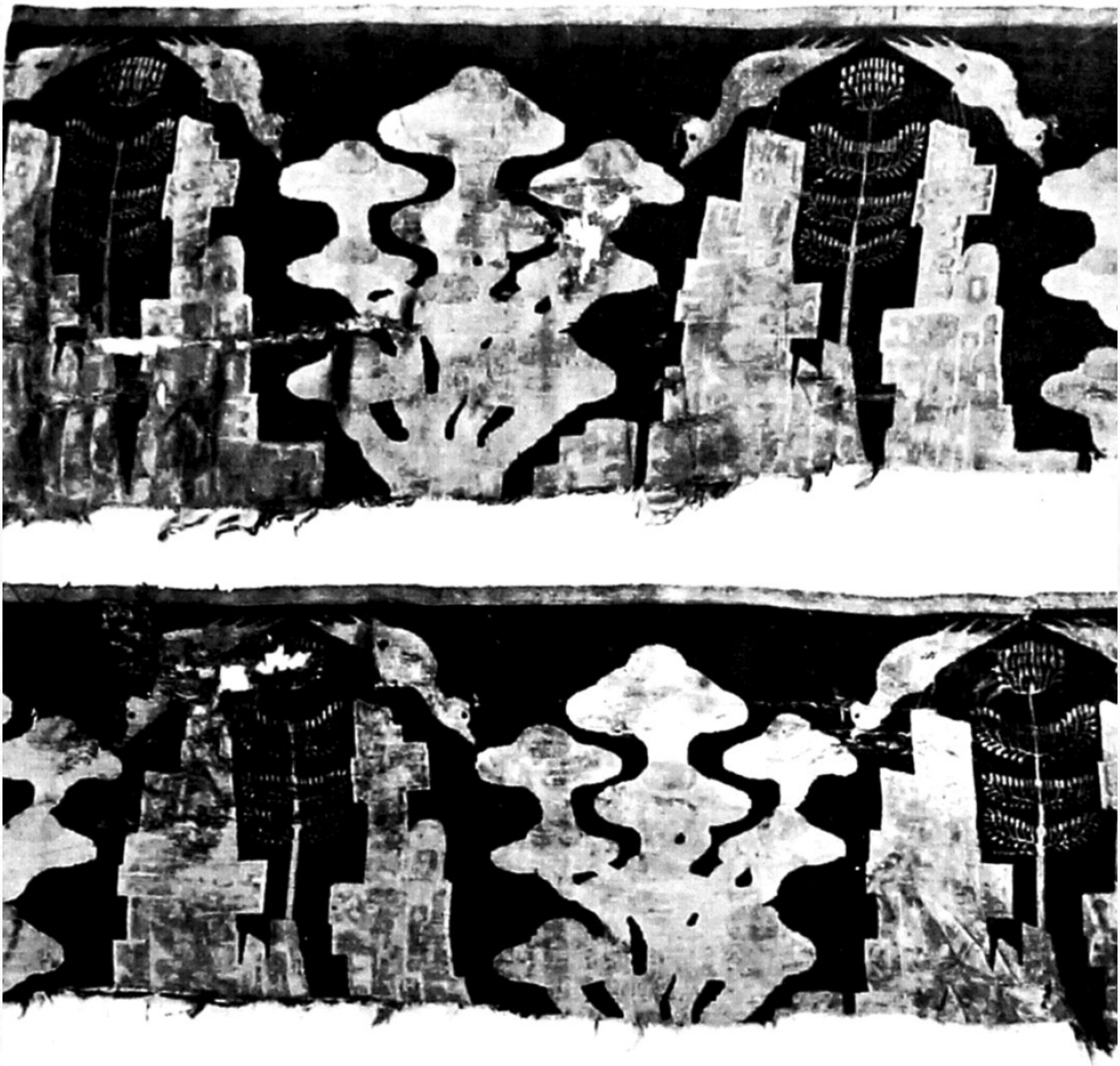


Plate XVI - NOIN ULA TEXTILE (*here shown divided in two parts*), 1st century A. D. From Mongolian tomb. Contemporary connoisseurs of Chinese art suggest that the enigmatic plant toward which the birds are leaning is LING CHIH, the fabulous Fungus of Immortality. (*Courtesy of the Hermitage Museum, Leningrad*).

Pan Ku, the chronicler of the Han Emperors, composed a second ode to the *ling chih*, more than a century after the Emperor Wu's. The attentive reader will have noted that until now we have never quoted an ancient source for the name *ling chih*. Everyone has used either *chih* alone, or *ts'ao chih*, 草芝, 'plant chih', or *chih ts'ao* 芝草 'chih plant'. In the last line of the Emperor Wu's poem, the first character is *chih* 芝, the next to the last is *ling* 靈. *Ling* has a long and complicated history in Chinese. To start with, it is made up by the combination of three characters - 雨, 'rain'; 口口口 (three mouths) 'praying for'; and 巫, 'shaman'. Combined in a single character, they mean spiritual potency, a stirring of the soul. Pan Ku in his ode joined *ling* and *chih*, the two concepts that the Emperor Wu had associated together in the same verse, thus minting the phrase that ever since has been in common currency. Here is Pan Ku's ode:

因露寢兮產靈芝	*Ling chih* grows with the settling dew,
象三德兮瑞應圖	The sign of the three virtues, happy omen's picture fulfilled.
延壽命兮光此都	It prolongs lives and glorifies the capital.
配上帝兮象太微	It accompanies the Emperor on high, Image of the Sky!
參日月兮揚光輝	Image of the sun and the moon, it throws out bursts of light!

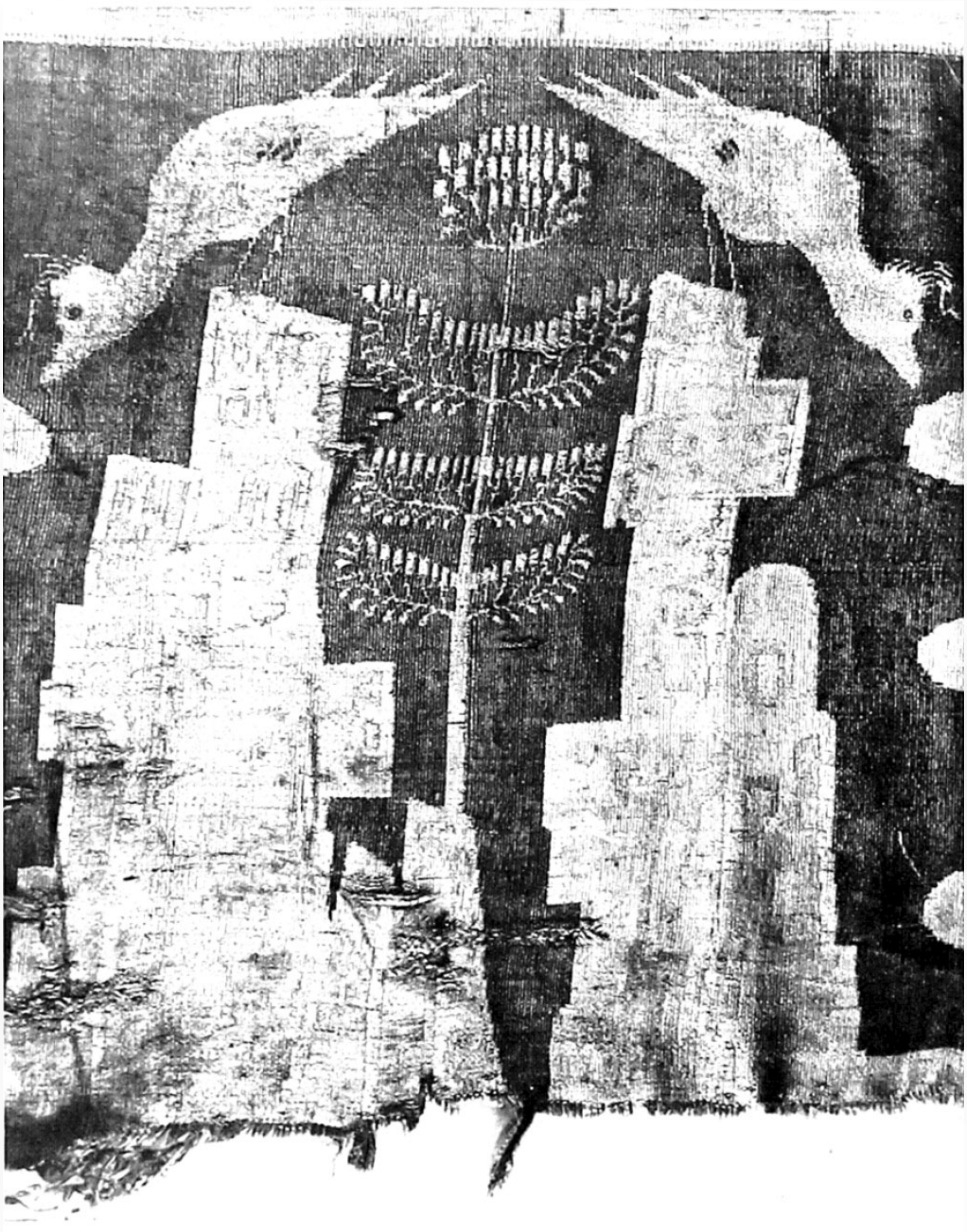


Plate XVII - NOIN ULA TEXTILE (detail).

The three Virtues of the Universe are the Heavens, the Earth, and Man. The pictures of happy omens were mythical documents from heaven depicting auspicious marvels such as the unicorn, the phoenix, the dragon, and the *ling chih*. Was not Pan Ku's ode intended to be used as an alternative to Wu-ti's in the liturgical year?

Lately the art historians have provided us with an unexpected development in the history of *ling chih*. A Russian archæological expedition in 1924-5 unearthed some remarkable artefacts in tombs at Noin Ula in what is now Mongolia. They date from the first century A. D., perhaps the early part of the century. Among the finds was a silk textile, reproduced in our Plates XVI and XVII.[54] A single motif is repeated several times. It consists of two rocky crags, a bird perched on each of the crags leaning down and outward, a graceful tree between the crags, and outside the crags, a plant with nine stalks terminating in what Michael Sullivan calls a 'poached-egg' design. The birds are so placed that they are about to reach the 'poached eggs'. Perceval Yetts in his description of this textile refers to the plant as a 'clumsy fungoid form'. Sullivan has identified it with *ling chih*. Sullivan sees no parallel for the treatment of the rocky crags in either Han China or the Near East, and he suggests a derivation from India, the wall painting in Cave X at Ajanta dating from the first century B.C. showing a similar silhouette. Here is independent support for my thesis of an Indian origin for the *ling chih* notion.

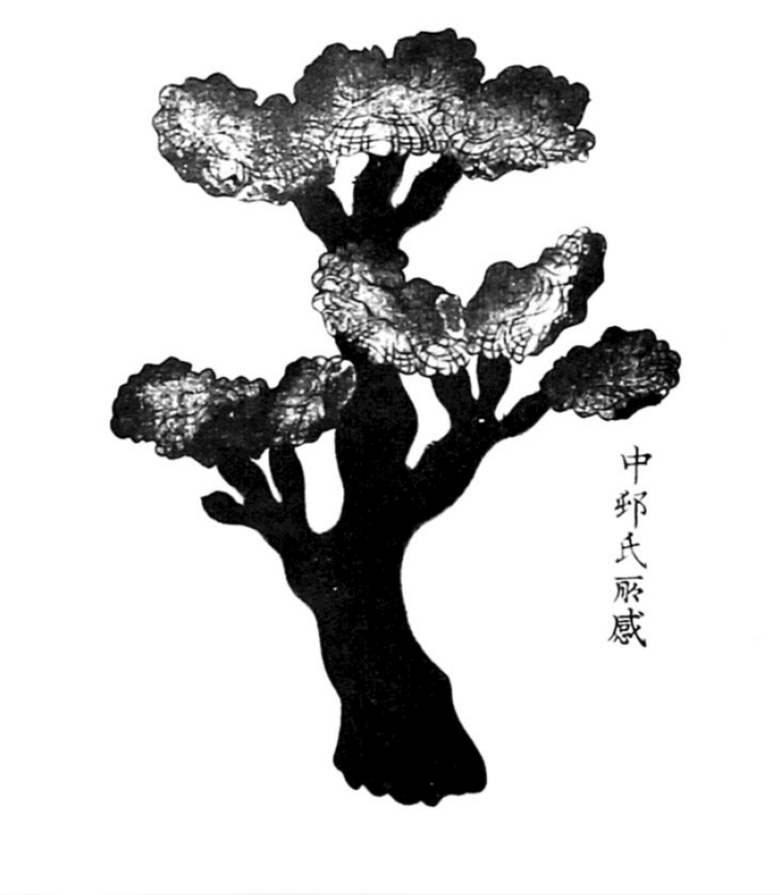


Fig. 2. From *Sakikusa-kō* ('An Inquiry into the Happy Herb'), by Suigetsu Kan-ō. An essay published in 1850 in Japan. The inspiration for this representation of *Ganoderma lucidum* stems back almost 2,000 years to the specimen that the Emperor Wu of China discovered growing in the inner pavilion of his palace.

---

[54] The first and best description in English of the Noin Ula finds as a whole was that of W. Perceval Yetts: 'Discoveries of the Kozlov Expedition', *Burlington Magazine*, April 1926, pp. 168-176. The textile that interests us was discussed at some length by Michael Sullivan: *The Birth of Landscape Painting in China*, pp. 52-53 and Pl. 35; other references to *ling chih* in his index, with numerous reproductions of *bas reliefs* representing the fungus. William Willetts: *Chinese Art*, London and New York, 1958, also accepts the identification, pp. 290-292. The Noin Ula textile hangs in the Hermitage Museum, Leningrad, where the Museum authorities graciously photographed it for me.

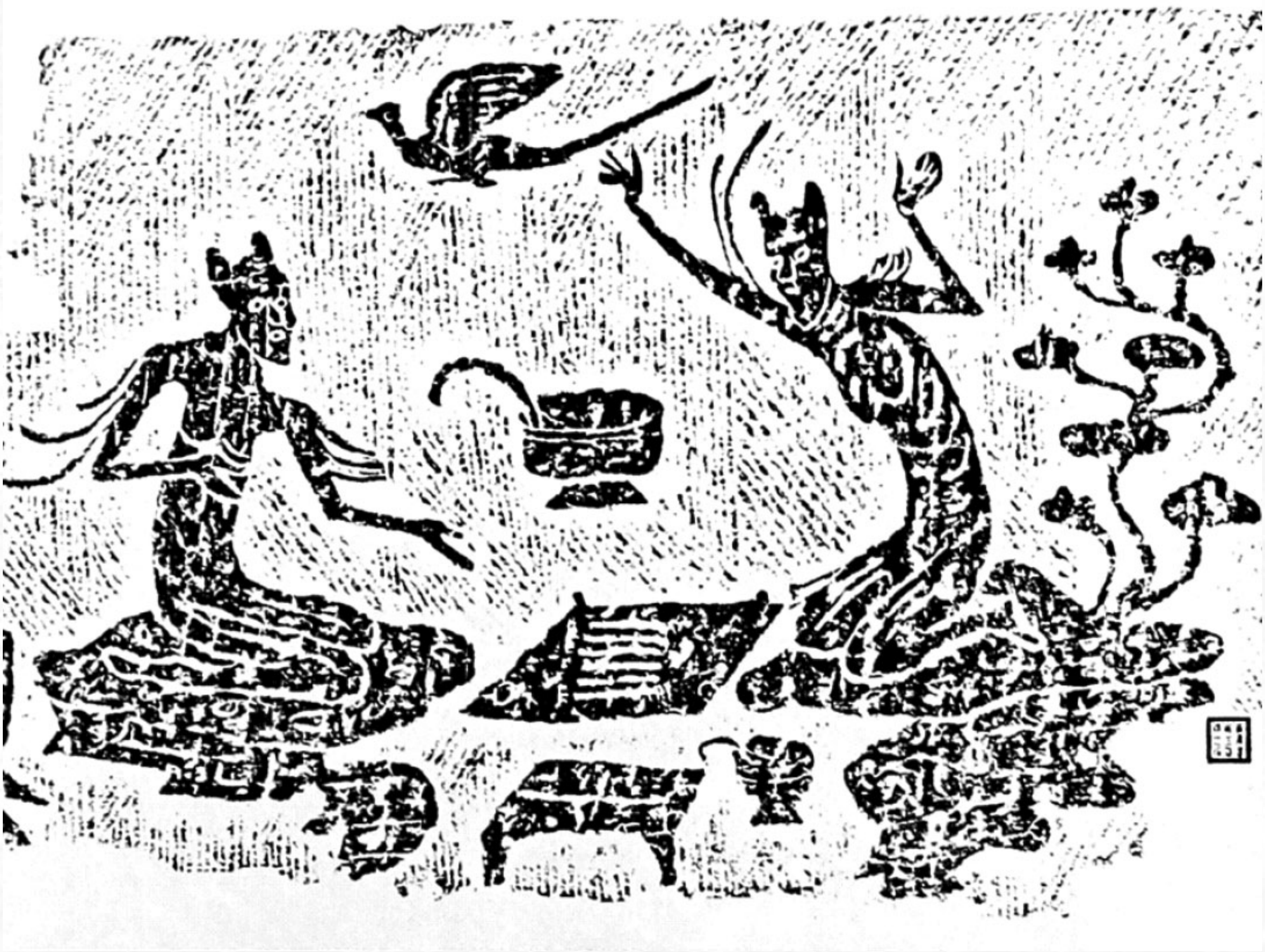


Plate XVIII - Rubbing of a Han Dynasty Stone Carving. Found in Szechwan Province. The two hags with pendulous breasts, having wings on their arms, are assumed to be Immortals. They are playing the board game, popular at that time, known as *liu-po*. Behind the figure on the right there is what Chinese art critics today interpret as a Han Dynasty conception of the LING CHIH, the fabled 'Marvelous Herb' or 'Divine Fungus of Immortality'.
(*Courtesy of Rolf Stein, Esq.*)

I suggest that the fungal form was the artist's effort to embody the Emperor Wu's *chih* with nine twin-leaves, his knowledge of it being only literary. (The textile, dating from the later Han, came more than a century after the event in Wu-ti's reign.) And if India inspired the crags, perhaps the birds reaching down to the fungoid forms re-enact the familiar Indian legend of the rape of Soma by a falcon from a celestial mountain top.[55] Since the Noin Ula finds art historians have assembled a number of *bas reliefs* representing the same conventionalized motif, the 'poached eggs', and the stalks or stems that support them. In Plate XVIII we show one of these, also having nine 'stems' or stipes.

If I am right, we see the genesis of the *ling chih* in the reign of Shih Huang-ti, when on the strength of verbal reports from India about a miraculous mushroom he sent his necromancers looking for it here there and everywhere in the mountains. We see Wu-ti fixing the identity of this elusive mushroom on *Ganoderma lucidum* thanks to its fortuitous appearance in an inner chamber of his palace - a changeling that he was successful in foisting on the Chinese people. We see artists in the later Han, obviously unfamiliar with the fungus itself, depicting from verbal reports a fungus every whit as fabulous as the phoenix, the dragon, and the unicorn.

---

[55] The birds in the textile are probably the demoiselle crane, whose distribution extends from China to Spain. This was the guess of Roger Tory Peterson when we visited him in his home in Old Lyme, Conn., at Christmastide 1966. The legs are those of a wader. The black wing feathers and crest complete the identification. But of course the artist may not have considered the species of bird important, so long as it was big and spectacular.

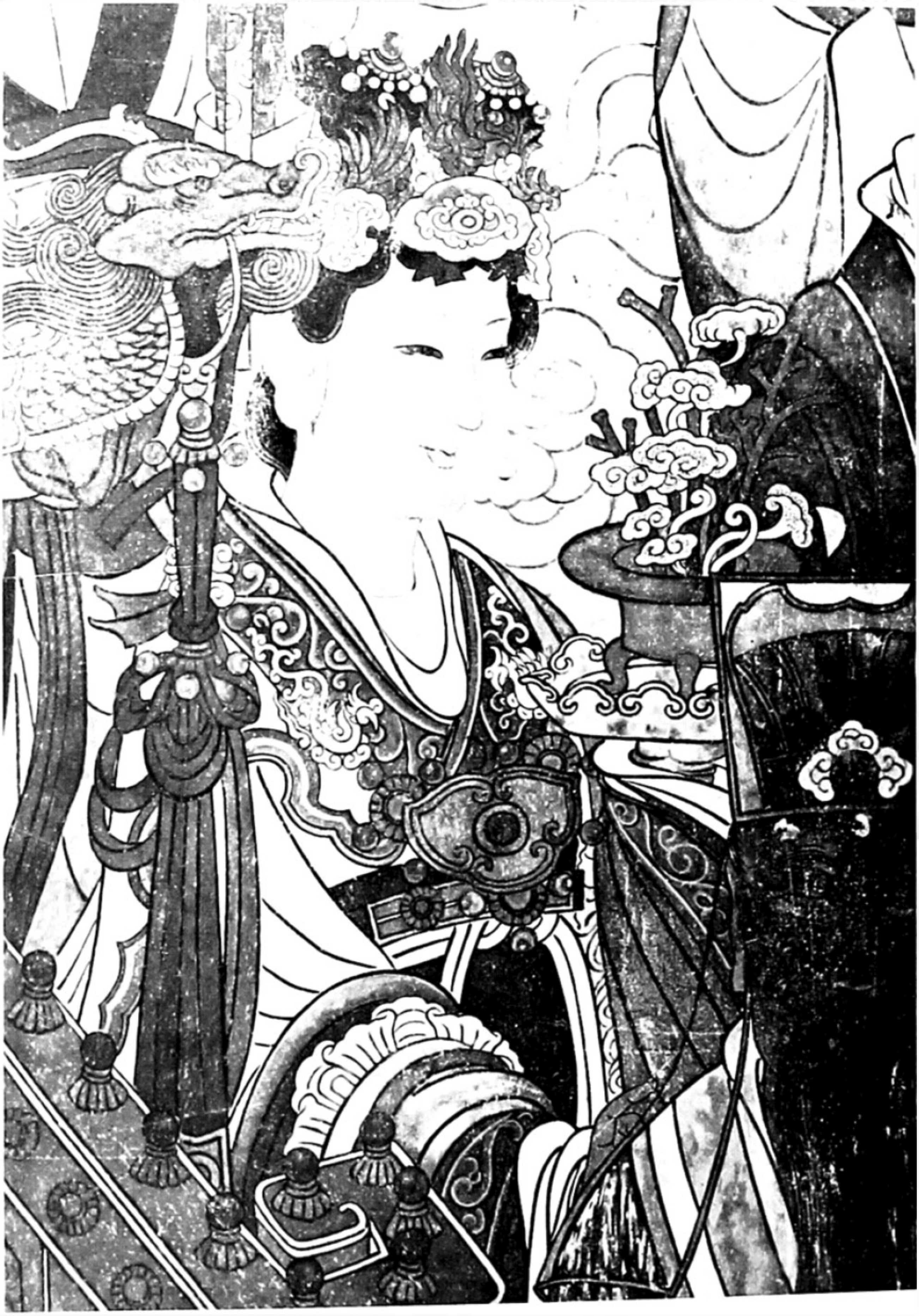


Plate XIX - Maid of Honour 女侍, attending the Heavenly Emperor. In her left hand she carries a vase with LING CHIH in two of its shapes, the normal one and the one that suggests deer's antlers or coral branches. Painted c. A. D. 1300.

If I failed to make good my case for the fly-agaric as Soma, the argument in this chapter has no base. If Soma was the fly-agaric, then I submit the probabilities favour Soma as the inspiration for the Chinese idea of a divine mushroom of immortality. That the idea lived on in Iran and India well into the first millennium of our era is certain: Firdousi, the *Mahābhārata*, the Purāṇas, Kālidāsa and the other poets - all testify to that. In these centuries the Chinese picked up the idea but only by hearsay. It will not have escaped the perceptive reader that when Wu-ti joined in a single verse the *ling* and the *chih*, and thus took a vital step in fathering on a certain fungus the vibrant name of the Marvelous Herb, he chose one that, in addition to other remarkable properties, was deep *red* in colour and that *shimmered like a satin of Byzance*. The strange convolutions of its pileus suggested to the Chinese mind the cumulus where the Immortals dwell, and thus in the course of time there came about an artistic convention by which, in the Yüan Dynasty and later, the painters made the clouds of the Celestial plane and the Herb of Immortality resemble each other to a point where, in extreme cases, it is hard to tell them apart.

We have advanced one step toward a United Field throughout Eurasia for a religious origin underlying the supernatural folklore that centres on an hallucinogenic mushroom. In *Part Three* we will carry this argument into northern Eurasia. But meanwhile we invite our readers to divert their attention to Dr. O'Flaherty's account of the post-Vedic history of the Soma question. The lesson that one must draw from her narrative about the futility of much scholarship is humbling.

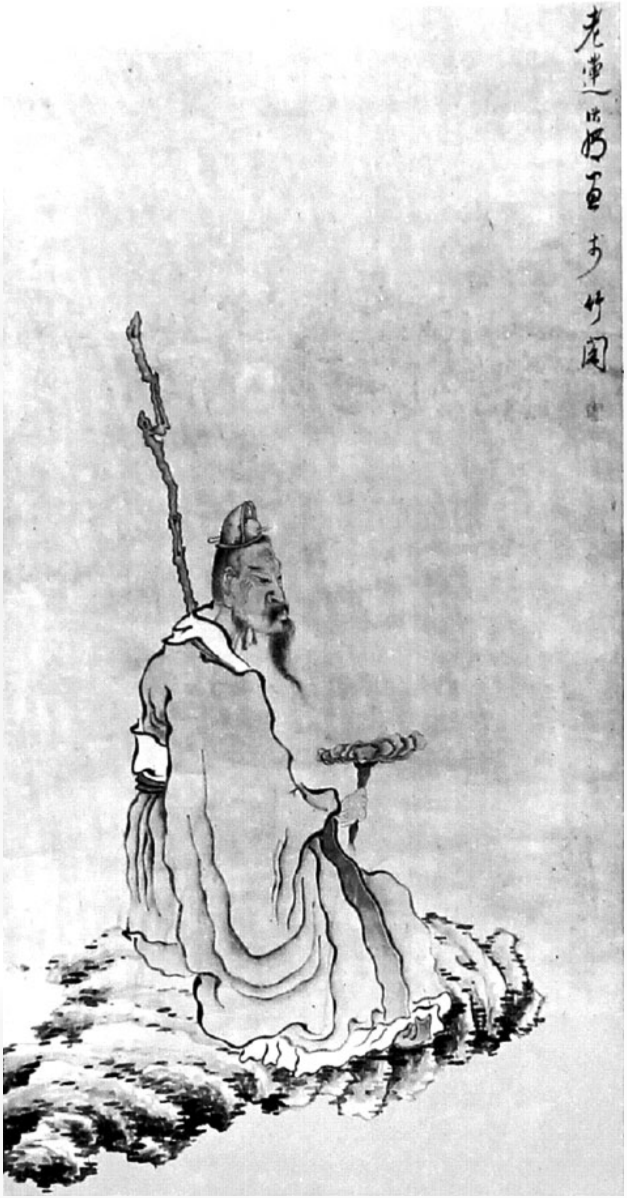


Plate XX - Chinese Sage Contemplating LING CHIH.
Painted by Chên Hung-shou (1559-1652).
(*Courtesy of Wango Wêng, Esq.*)

PART TWO

THE POST-VEDIC HISTORY OF THE SOMA PLANT

by Wendy Doniger O'Flaherty

The history of the search for Soma is, properly, the history of Vedic studies in general, as the Soma sacrifice was the focal point of the Vedic religion. Indeed, if one accepts the point of view that the whole of Indian mystical practice from the *Upaniṣads* through the more mechanical methods of yoga is merely an attempt to recapture the vision granted by the Soma plant, then the nature of that vision - and of that plant - underlies the whole of Indian religion, and everything of a mystical nature within that religion is pertinent to the identity of the plant.

In place of such an all-inclusive study, the present essay attempts to summarize what has been written since Vedic times about the physical nature of the Soma plant and the substitutes for Soma. I have worked in the Bodleian Library and the Indian Institute at Oxford, the India Office in London, and the British Museum, and of necessity I have omitted the contributions of Indian scholars whose works are not available in those collections. Furthermore, I have dealt summarily with the Haoma of the Avesta, since the work done on the botanical identification of Haoma has been subsumed for the most part under the study of Soma.

I. The Brāhmaṇas and the &sacute;rauta-sūtras

After the era of the Vedas there came a period when the centre of intellectual activity moved from the valley of the Indus to the upper Ganges and the Yamunā. A spate of works, the direct outgrowth of the Vedas and preserving ancient traditions, many of them lengthy, arose as a kind of corpus of ritual textbooks. These are the *Brāhmaṇas*, prose works dating from about 800 B.C.

Súrā is generally believed to have been an alcoholic drink of some sort - wine or rice wine or fermented liquor or beer or even distilled spirits[56] - or else to refer to alcoholic drinks in general. The *Brāhmaṇas* say clearly that Soma was not *súrā*. The *&sacute;atapatha Brāhmaṇa* declares: 'Soma is truth, prosperity, light; and *súrā* untruth, misery, darkness.'[57]

The *Taittirīya Brāhmaṇa* says, 'Soma is male and *súrā* is female; the two make a pair.'[58] The sharp distinction made by the text seems to rule out the possibility that Soma was simply another kind of alcoholic drink, and it would seem probable that *súrā* embraced all the fermented drinks that rated mention in the ṚgVeda.

The *Brāhmaṇas* are much preoccupied with the question of substitutes for Soma. They are books of ritual composed for the sacerdotal caste, and in places they seem to be deliberately obscure. If the priests knew what Soma was, they never stated it clearly, and their references to the Soma plant are ultimately of little help in establishing its botanical identity. It may be assumed that Soma was none of the plants expressly suggested as substitutes for it, though of course it may have resembled any of them in some particular and probably did so. But it is difficult to draw any sure conception from these negative hints, for the substitutes often bear little resemblance to each other, including as they do grasses, flowers, creepers, and even trees.

The *&sacute;atapatha Brāhmaṇa* sets forth an order in which substitutes should be used. First comes the reddish-brown (*aruṇá*) *phālguna* plant, which may be used because it is similar to Soma (*sómasya nyañga*), but the bright red (*lóhita*) *phālguna* plant must not be used. If *phālguna* is unavailable, then the *&sacute;yenahṛta* plant may serve, for there is a tradition that Soma was once carried away by a falcon, and a stalk (*aṃ&sacute;ú*) fell from the sky and became the *&sacute;yenahṛta* plant. The third choice is the *ādāra* plant, which sprang from the liquor that flowed from the sacrificial animal when it was decapitated. Fourth comes the brown *dū́rvā* grass, which is similar to Soma, and last choice is yellow *kú&sacute;a* grass. This being least satisfactory, a cow must be given in atonement.[59]

---

[56] Monier-Williams' dictionary gives 'distilled liquor' as a primary meaning of *súrā*, but evidence is strong that the distilling process was not known in India until a much later era.

[57] *&sacute;atapatha Brāhmaṇa*, Chowkhamba edition, 5.1.2.10.

[58] *Taittirīya Brāhmaṇa*, Ānandā&sacute;rama edition, 1.3.3.2.

The *Tāṇḍya Brāhmaṇa* says that the *putīka* is the plant which grew from a leaf (or feather, *parṇa*) that fell when Soma was carried through the air, and that it is therefore a suitable substitute.[60] In his commentary on this work, Sāyaṇa says, 'If they cannot obtain the Soma whose characteristics are described in the sacred text, then they may use the species of creeper (*latā*) which is known as *putīka*; if they cannot find *putīka*, then they may use the dark grass (*&sacute;yāmalāni tṛṇāṇi*) known as *arjunāni*.'[61] Yet another ætiological myth is used to explain the substitution of the fruit of the *nyagrodha* (sacred fig or banyan tree): the gods once tilted over their Soma cups, and the *nyagrodha* tree grew from the spilt drops.[62] Elsewhere it is said that even when Soma is available, one should use the juice of the *nyagrodha* fruit for non-Brahmans to drink.[63] It is probable that this fruit, like the *dū́rvā* and *kú&sacute;a* grasses, was accepted as a substitute for Soma more by virtue of its own sacred nature than for any resemblance to the Soma plant.

Various other substitutes for Soma appear in the *Brāhmaṇas*: *syāmaka* (cultivated millet, said by the *&sacute;atapatha Brāhmaṇa* to be most like Soma of all the plants),[64] *muñja* grass (sacred in itself), *kattṛṇa* (a fragrant grass),[65] and *parṇa* (a sacred tree).[66] The European lexicographers - Wilson, Roth, Monier-Williams - struggle to identify all these plants in modern botanical terms but often arrive at conflicting conclusions, as do the *Brāhmaṇas* themselves. Certain pertinent facts emerge, however, from the Brāhmaṇic literature:

1. The colour red is consistently associated with the Soma substitute. Red is the colour of the *nyagrodha* flower; the colour of the *phālguna* plant;[67] the colour of the acceptable *dū́rvā* grass;[68] and even the colour of the cow used in the purchase of Soma.[69]
2. There is a clear distinction between the identity of Soma and the identity of the substitutes. For Soma one must look to the ṚgVeda; for the substitutes, the *Brāhmaṇas* are the earliest sources of importance, but they contain no passages about the authentic Soma of sure evidential value. They are concerned with the ritual and symbolic nature of the Soma plant, not with its botanical identity.

II. Later Sanskrit Works

The writers of the post-Brāhmaṇic period, Sanskrit lexicographers and Vedic commentators, continued to dwell upon a multiplicity of plants that served as Soma, but most of them agreed upon only one thing: that Soma was a creeper (*vallī* or *latā*). Yet nowhere in the ṚgVeda do these terms appear, Soma being there considered an herb (*óṣadhi*) or plant (*vīrúdh*). Amara Siṃha, the earliest of the Indian lexicographers (ca. A. D. 450) gives many synonyms for what he calls *somavallī*, all of which Monier-Williams has the courage to define as *Cocculus cordifolius*. Amara also describes a plant that he calls *somarājī*, which Monier-Williams says is *Vernonia anthelmintica*.[70] These are distinguished from *súrā*.[71] The later lexicographers generally imitate

---

59. *&sacute;atapatha Brāhmaṇa*, 4.5.10.2-6.
60. *Tāṇḍya Brāhmaṇa*, Bibliotheca Indica edition, 9.5.1.
61. *Tāṇḍya Brāhmaṇa*, 9.5.3.
62. *Aitareya Brāhmaṇa*, Haug edition, 7.5.30.
63. *Kātyāyana &sacute;rautasūtra*, Albrecht Weber, ed., Berlin, 1859, verse 7.8.13.
64. *&sacute;atapatha Brāhmaṇa*, 5.3.3.4.
65. *Cf.* Hemacandra, *Abhidhānacintāmaṇi*, ed. Böhtlingk and Roth, St. Petersburg, 1849, 1191-1192.
66. *Cf. Kauṣītaki Brāhmaṇa*, Ānandā&sacute;rama edition, 2.2. and *&sacute;atapatha Brāhmaṇa*, 6.6.3.7.
67. H. H. Wilson: *Sanskrit Dictionary*, 1832, defines *phālguna* as 'a red plant, *Arjunana pentaptera*.'
68. Rudolph von Roth, in his 1881 article in the *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, 'Über den Soma', identified the red *dū́rvā* grass with the *Cynodon dactylon* which the Indians used, according to Roxburgh, to make a drink, 'a very cheap kind of Soma' (*eine sehr billige Soma*), as Roth remarked.
69. *Taittirīya Saṃhitā*, Keith edition, 6.1.6; *&sacute;atapatha Brāhmaṇa*, 3.3.1.15.
70. *Amarako&sacute;a*, Kielhorn edition, Bombay, 2.4.82-3 and 2.4.95.
71. *Ibid.*, 2.10.39. Amara gives as synonyms for *súrā* the terms *varuṇātmayā*, *halipriyā*, and *pari&sacute;rut*; the latter may refer to an intoxicating liquor made from herbs or to the Soma of the Vedas (ṚgVeda IX I^{6}, and *&sacute;atapatha Brāhmaṇa*

12.7.1.7).

Amara in their discussions of Soma: Medinī refers to an herb, the Soma creeper,[72] which Yāska had mentioned as an herb that caused exhilaration when pressed and mixed with water,[73] while Sāyaṇa, the most famous of the Vedic commentators, refers to it as the Soma creeper.[74] &Sacute;abarasvāmi, another great commentator, also refers to Soma as a creeper, but one that yields milky juice;[75] this was to be retained as an acceptable attribute of Soma from then on through the European discussions, and the belief in the milky sap appears in the Hindu medical works as well.[76]

One might expect the early medical treatises to be less fanciful than the *Brāhmaṇas*, but this is not the case. The *Dhanvantarīyanighaṇṭu*, a medical work of *ca*. A. D. 1400, says that the Soma creeper yields the Soma milk and is dear to Brahmans.[77] The *Rājanighaṇṭu* describes the properties of Soma: the *somavallī* has great clusters and is a bow-like creeper, yielding the Soma milk; the *somavallī* is acrid, pungent, cool, black, sweet, and it serves to dispel biliousness, to quench thirst, to cause wounds to dry up, and to purify.[78] A more detailed, but hardly more scientific, description appears in the *Su&sacute;rutasaṃhitā*, a medical text in verse, dating from perhaps the fourth century A.D., which reduces to its ultimate absurdity the passion for symmetry and classification that permeates these writings. It tells us that although there was originally created one kind of *somavallī*, it was then divided into twenty-four varieties: *aṃ&sacute;uman* Soma smells like ghee; *muñjara* Soma has leaves like those of garlic; *garuḍahṛta* (= *&sacute;yenahṛta*) and *&sacute;vetākṣa* ('white-eyes') are pale, look like cast-off snake-skins, and are found pendant from the boughs of trees; *etc*.[79] Unfortunately, the enumeration of these varieties proves of limited value for botanical identification: one reads that all of them have the same qualities, all are creepers with milky juice, all are used in the same way, and all have fifteen black leaves, which appear one per day during the waxing moon and drop off one per day during the waning moon.[80]

Folk medicine and medical science in India are known collectively as *Āyurveda* ('The Sacred Knowledge of Long Life'). There is a widely quoted Āyurvedic verse, found both in Dhūrtasvāmi's commentary on Āpastamba's *&sacute;rautasūtra* of the black Yajur Veda and in the *Bhāvaprakā&sacute;a*, that Max Müller cited in 1855 as the earliest 'scientific' description of Soma that he knew. It describes the plant as a black creeper, sour, leafless, yielding milk, having fleshy skin, causing or preventing phlegm, causing vomiting, and eaten by goats.[81] In spite of the admittedly late origin of this description, and in spite of the many equally authoritative descriptions in earlier Sanskrit works which contradict it, it served European scholars as a peg on which to hang their favourite theories. Its sharp detail and 'scientific' tone contrasted favourably with such descriptions as that of the *Su&sacute;ruta*, and it seemed to agree with the descriptions of Soma given to Westerners by Indians of that day.

---

72. *Medinīko&sacute;a*, Nathalal Laxmichand edition, 36.
73. Yāska's *Nighaṇṭu* and *Nirukta*, Laksman Sarup, ed., University of the Punjab, 1927; 11.2.2. and 5.17. *prīṇāti nacamanena* is given as the etymology for *nicumpana*.
74. Commentary on ṚgVeda III 48^{2}. Max Müller edition.
75. &sacute;abarasvāmi, commentary on the *Pūrva Mimāṃsa Sūtra*, Gaekwad edition, 2.2.17. Soma is called *latā kṣīriṇī*.
76. This ascription to Soma of a 'milky' quality was probably based upon the Vedic statements that Soma was mixed with milk, or that Soma itself became white when mixed with milk, or that the juice of Soma was 'milk' in the metaphorical sense of the supreme liquid, or the liquid pressed out of a swollen container; for it must be noted that nowhere in the Vedas is the raw Soma juice itself described as white or milky, but always as yellow or brown or red or golden.
77. *Dhanvantarīyanighaṇṭu*, Ānandā&sacute;rama Series No. 33, Poona, 1896; verse 4.4.
78. *Rājanighaṇṭu*, Ānandā&sacute;rama Series No. 33; verses 3.29-30. The pertinent terms are: *mahāgulm&#257 dhanurvallī*; *katu&sacute; &sacute;itā madhurā*; *pittadāhakṛt* (or alternate reading: *pittadāhanut*); *tṛsnāvi&sacute;oṣa&sacute;amanī* (alternate reading: *kṛṣṇā vi&sacute;oṣa&sacute;amanī*); and *pāvanī* (or *pācani*).
79. *Su&sacute;rutasaṃhitā*, Education Press, Calcutta, 1834, chapter 29. I have been unable to find the quotation in other editions of this work, but it is quoted in full in the *&sacute;abdakalpadruma* (Vol. V, p. 417), Calcutta, 1814, which attributes it to the *Su&sacute;ruta*. It will be noted that several of the *Su&sacute;ruta*'s 'varieties' of Soma refer to substitutes mentioned in the *Brāhmaṇas*.
80. This lunar connection is an extrapolation of the mythological association of Soma with the moon in the Vedas, and it accounts for the name 'moon-plant' given to Soma by the Bengalis of the last century. Yet Edward Balfour, in his *Cyclopædia of India*, published in London in 1885, maintained that the Soma plant itself derived its name from the Sanskrit word for moon, *soma*, because 'it was gathered by moonlight.'
81. Cited by F. Max Müller in 'Die Todtenbestattung bei den Brahmanen,' *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, No. 39, 1855, pp. XLII ff. The text reads:

&sacute;yāmalā 'mlā ca niṣpatrā kṣīriṇī tvaci māṃsalā
&sacute;leṣmalā vamanī vallī somākhyā chāgabhojanam

III. Early European References

The earliest non-Indian notices of Soma are in the Avesta, where the plant appears as Haoma, but these references are more obscure than those of the ṚgVeda; the question of the 'authenticity' of the Soma cult of the Avesta will be discussed below as it arises in the course of European discussions. The earlier parts of the Avesta - the *Yašts* - refer to Haoma as being strained for the sacrifice,[82] as the only drink which is attended with piety rather than with anger,[83] as a tall, golden plant[84] with golden eyes.[85] The *Yasna* devotes three full hymns to Haoma (9-11), which it describes as growing in the mountains,[86] pressed twice a day,[87] odoriferous,[88] possessing many trunks, stems, and branches,[89] and yielding a yellow juice which is to be mixed with milk;[90] Haoma is golden and has a flexible stem.[91] The *Yasna* seems to distinguish between Haoma and other intoxicating beverages, of which it disapproves, but it has been suggested that Zoroaster hated the Haoma drinkers as well as drinkers in general.[92] Beyond this general description, and the evidence that the Soma cult was at least Indo-Iranian rather than simply Indian in its origin, the Avesta sheds little light on the Soma problem.

Megasthenes said of the Indians, 'They never drink wine except at sacrifices,' distinguishing this sacrificial wine from their ordinary liquor - probably *súrā* - which he describes as 'composed of rice instead of barley.'[93] McCrindle suggests that this 'wine was probably Soma juice,' and as the passage is certainly pre-Tantric it must in fact refer to Soma. Thus Megasthenes - misled no doubt by the similar rites among his own people - must be held responsible for the origination of a misconception that continues to plague Vedic studies to the present day. Plutarch speaks of a plant that the Iranians dedicated to a religious use:

> For pounding in a mortar an herb called ὅμωμι [*ómomi*] they invoke Hades and darkness; then having mingled it with the blood of a slaughtered wolf, they bear it forth into a sunless place and cast it away.[94]

Bernadakis conjectured that this ὅμωμι [*ómomi*] was the same as the μῶλυ [*móly*] of the *Odyssey* X 305, a fabulous herb probably cognate with the Sanskrit *mūla* (root); Orientalists of note, including Paul Anton de Lagarde,[95] have suggested that ὅμωμι [*ómomi*] was none other than the Haoma of the Iranians, the Soma of the Indians. In 1929 Emile Benveniste dismissed this notion:

> We must beware of correcting the text on this point, as the majority of editors have done following P. de Lagarde. The substitution of the plant μῶλυ [*móly*] for the enigmatic ὅμωμι [*ómomi*] is the device of harassed interpreters and is no better than the explanation of ὅμωμι [*ómomi*] by *hauma*; the first is arbitrary, and the second absurd ... ὅμωμι [*ómomi*] is another name of *amomum* which is used in the cult of Ahriman as *hauma* is sacred to the cult of Ohrmazd.[96]

---

[82] *Yašt* fragment 21.9. This and the following are from the edition of James Darmesteter and L. H. Mills, *Sacred Books of the East*, Volumes 4, 23, and 31.
[83] *Ashi Yašt*, 2.5, and *Yasna*, 10.8.
[84] *Sirozah*, 2.30.
[85] *Ashi Yašt*, 6.37, *Gos Yašt*, 4.17, and *Mihir Yašt*, 23.88.
[86] *Yasna*, 10.3.
[87] *Yasna*, 10.2.
[88] *Yasna*, 10.4.
[89] *Yasna*, 10.5; *vide supra*, pp. 19-21.
[90] *Yasna*, 10.13.
[91] *Yasna*, 9.16.
[92] Henrik Samnel Nyberg: *Die Religionen des Alten Irans*, Leipzig, 1938, pp. 188, 244, and 288.
[93] Megasthenes, *Indika*, translated by J. W. McCrindle, Calcutta, 1887 (Schwanbeck edition, Bonn, 1846), fragment 27, page 69. Quoted by Strabo, 15.1.53-56.
[94] Plutarch: *De Iside et Osire*, Squire edition, 1744, p. 117; μζ [*mz*].
[95] *Vide infra*, p. 108.

[96] Emile Benveniste: *The Persian Religion: According to the Chief Greek Texts*, 1929, p. 74. The *amomum* is thought to be the Indian spice plant, *Nepaul cardamom*. It is mentioned in Aristophanes' *The Frogs*, 110, and in Theophrastes' *Historia Plantarum*, 9.7.2, where it is said to come from India as cardamom comes from Persia.

In 1771 A. H. Anquetil-Duperron brought out the first translation of the Avesta, after having spent some years in India in association with the Parsis. For the Haoma plant, he observed, the Parsis used a tree (*arbre*) which, they said, grew in Persia but not in India and resembled a vine but never bore any fruit. Anquetil-Duperron thought the plant resembled a kind of heather (*bruyère*), with knots very close together and leaves like those of jasmine. 'All these details lead me to believe that the *Hom* is the ἄμωμος [*ámomos*] of the Greeks and the *amomum* of the Romans.'[97] As the Indo-Iranian connection was not yet established, nor the Soma cult itself discovered, this suggestion was not pursued.

Then in 1784 the first translation of a Sanskrit work into English appeared, Charles Wilkins's rendering of the *Bhagavad Gītā*. In it he included a note: '*Sōm* is the name of a creeper, the juice of which is commanded to be drunk at the conclusion of a sacrifice.[98] This is the earliest published citation of Soma in a European language that I have found. In his 1794 translation of the laws of Manu, Sir William Jones describes Soma as 'the moon plant (a species of mountain-rue).'[99] H. T. Colebrooke then published his translation of the *Amarako&sacute;a*, saying that the *somrāj* was *Vernonia anthelmintica* (= *Conyza anthelmintica*),[100] but cautioning his readers that commentators seldom describe the plants they mention and that 'a source of error remains in the inaccuracy of the Commentators themselves ... the correspondence of Sanscrit names with the generick and specifick names in Natural History is in many instances doubtful.'[101]

In 1814, William Carey published his *Hortus Bengalensis*, which was a summary of the manuscript that William Roxburgh was to publish in 1832. Carey identified *Sarcostemma brevistigma* (= *Asclepias acida*, *Sarcostemma acidum*, *Sarcostemma viminale*, *Cynanchium viminale*) as the plant known in Bengali and Sanskrit as *somalutā*, and also remarked that *Ruta graveolens*, a rue, bore the same Sanskrit name.[102] He did not link them with the Vedas, but he did take occasion to observe that Himalayan plants do not grow in Bengal,[103] an observation that was ignored by the Vedic scholars who later used Roxburgh's work to identify Soma.

In his 1819 *Sanskrit Dictionary*, Horace Hayman Wilson identified *soma* as 'the moon plant (*Asclepias acidum*) [= *Sarcostemma brevistigma*],' *somavallī* as 'a twining plant (*Menispermum glabrum*) [= *Tinospora cordifolia*],' or 'a medicinal plant (*Serratula anthelmintica*) [= *Vernonia anthelmintica*]'; in the 1832 edition of the dictionary, he added *somarājin*, which he defined as *Serratula anthelmintica*, though he still gave this as an alternative for *somavallī* as well.[104]

Sir Graves Chamney Haughton, in his 1825 edition of Jones's *Ordinances of Manu*, had corrected Jones's 'mountain rue' to 'swallow-wort (*Asclepias acidum*) [= *Sarcostemma brevistigma*],' probably following Carey. Finally, in 1832 William Roxburgh published his *Flora Indica*; he identified *Sarcostemma brevistigma* with *somalutā* in Sanskrit and Bengali, a plant (as he said) of much milky juice of a mild nature and acid taste. He added that 'native travellers often suck the tender shoots to allay their thirst.'[105] This is hardly the description of a plant that induces religious ecstasy, but Roxburgh identifies it with *sōm* mentioned by Wilkins as the sacrificial plant. He distinguishes it from *somrāj* (as Colebrooke had done in 1808), which is *Vernonia anthelmintica*, a plant with an acid taste,[106] and he further distinguishes *Calotropis gigantea* (= *Asclepias* appears in juxtaposition with *somavallī* in the *Amarako&sacute;a*.

---

[97] A. H. Anquetil-Duperron: *Zend-Avesta, traduit par Anquetil du Perron*, Paris, 1771, Vol. II, p. 535.

[98] Charles Wilkins: *The Bhāgvāt Geeta*. Serampore, 1784, p. 80, note 42.

[99] Sir William Jones: *Institutes of Hindu Law, or, the Ordinances of Manu*, Calcutta, 1794, verse 3.158.

[100] H. T. Colebrooke: *Cosha or Dictionary of the Sanscrit Language, by Amara Sinha, with an English Interpretation and Annotations by H. T. Colebrooke, Esq.*, Serampore, 1808, p. 102, note on verse 4.3.14. It should be added that Amara distinguished this plant from the *somavallī*, for which Colebrooke gives no botanical name.

[101] Colebrooke, *op. cit.*, p. 10.

[102] William Carey: *Hortus Bengalensis, A Catalogue of the Plants Described by Dr. Roxburgh in his Manuscript Flora Indica*, Calcutta, 1814, pp. 20 and 32.

[103] *Ibid.*, p. xi.

[104] Horace Hayman Wilson: *Sanskrit Dictionary*, Calcutta, 1819 and 1832. In identifying *somavallī* with *Menispermum glabrum*, Wilson was misled by Colebrooke, whose Amara Siṃha he cites for this reference; Colebrooke, though giving no definition of *somavallī*, had given *Menispermum glabrum* (= *Tinospora cordifolia*) for the plant *guḍucī* (*guricha* in Colebrooke's note) which

[105] William Roxburgh: *Flora Indica*, Serampore, 1832, Vol. II, p. 33.

[106] *Ibid*., Vol. III, p. 406.

gigantea) as the plant used by the natives for medical purposes.

From these beginnings down to our own time Soma has been identified with various species of Sarcostemma (= Asclepiads, related to the American milkweeds), of Ephedra, of Periploca, all of them leafless climbers superficially resembling each other, yet belonging to genera botanically far apart. Botanists in India would gather specimens, identify them with scientific names, and add the vernacular names that local helpers would give them, such as *somalutā*. Linguists and serious travellers would occasionally bring back plant names picked up in the various languages spoken from India to Iran that seemed to stem back to Soma or Haoma - *e.g.*, *hum*, *huma*, *yehma*; *um*, *uma*; *um*, *umbur*[107] - and, linking them to the plant to which they belonged, present to the world another candidate for Soma. Most of these plants were or had been at some time used as substitutes for Soma or Haoma: to be eligible, plants had to meet certain requirements, which may have changed from area to area and from century to century. R. G Wasson's Brahman informants said to him that the substitute 'Somas' had to be small, leafless, and with fleshy stems, attributes that are common in varying degrees to the three genera listed above and to the traditional descriptions in the *Brāhmaṇas* and medical texts.

IV. Mid-Nineteenth Century

For the next fifty years, Sanskritists and botanists alike merely elaborated upon Roxburgh's identification. Henry Piddington gives '*Sarcostemma viminale*' for the Bengali *soom* and *Asclepias acidum*' for *somalutā*,[108] but these two names are now considered to represent the same species: *Sarcostemma brevistigma*. John Stevenson, in his translation of the *Sāma Veda*, says that Soma is '*Sarcostemma viminale*,' 'the moon-plant' and describes in some detail the method of its use, observing that according to the commentator it is pressed and mixed with barley and allowed to stand for nine days, 'but how many days precede [the ceremony] and how many follow, I do not know ... the Soma, when properly prepared, is a powerful spirit...'[109]

Vedic studies had now begun to assume considerable importance in Europe. In 1844, Eugène Burnouf published the first of a series of articles on Haoma, wherein he said that the Haoma juice, obtained by trituration, was the same as the Soma of the Vedic sacrifice, but he did not venture a botanical identification.[110] In 1845, J. O. Voigt published his *Hortus Suburbanus Calcuttensis*, a catalogue of the plants in the H. E. I. C. Botanical garden. Once again *soma-rāj* is *Vernonia anthelmintica* and *shom-luta* is *Sarcostemma brevistigma*; Voigt also mentions that farmers use the *Sarcostemma brevistigma* to rid their fields of white ants.[111] He draws attention to the use of the Asclepiads in general as emetics and to their acrid and bitter milk, and points out that in the West Indies they are a popular remedy for worms in children, given in doses of a teaspoon to a tablespoon.[112]

Friedrich Windischmann thought that the Soma plant might be *Sarcostemma brevistigma*, but he doubted that the Indian Soma was the same as the Haoma of the Persians, as the plant might have changed with the change in location. Yet he considered that the Avesta preserved the tradition of Soma and the sacrifice better than the ṚgVeda did, and he called attention to the Persian belief (remarked long ago by Anquetil-Duperron) that Soma did not grow in India.[113] Christian Lassen added his assent that Soma was *Sarcostemma brevistigma*,[114] and William Dwight Whitney wrote that Soma was:

---

[107] George Watt: *Dictionary of the Economic Products of India*, Calcutta, 1890, cites these examples in his article on 'Ephedra.' *Vide infra*, p. 121.

[108] Henry Piddington: *An English Index to the Plants of India*, Calcutta, 1832, p. 79 and p. 9.

[109] John Stevenson: *Sanhitā of the Sāma Veda*, London, 1842, p. iv.

[110] Eugène Burnouf: 'Etudes sur la langue et sur les textes zends. IV: Le Dieu Homa, 'in *Journal Asiatique*, 8th Series, No. 4, December, 1844, p. 468.

[111] J. O. Voigt: *Hortus Suburbanus Calcuttensis, A Catalogue of the Plants in the Honourable East India Company Botanical Garden*, Calcutta, 1845, pp. 405 and 542.

[112] *Ibid*., p. 539.

113. Friedrich Windischmann: 'Über den Somakultus der Arier,' *Abhandlungen der Königlichen Baierischen Akadamie der Wissenschaften*, Munich, 1846, pp. 127-142.
114. Christian Lassen: *Indische Altertumskunde*, Bonn, 1847, Volume I, p. 281.

> a certain herb, the *Asclepias acida* [= *Sarcostemma brevistigma*], which grows abundantly upon the mountains of India and Persia ... which, when fermented, possesses intoxicating qualities. In this circumstance, it is believed, lies the explanation of the whole matter. The simple-minded Arian [*sic*] people ... had no sooner perceived that this liquid had power to ... produce a temporary frenzy ... than they found in it something divine ...[115]

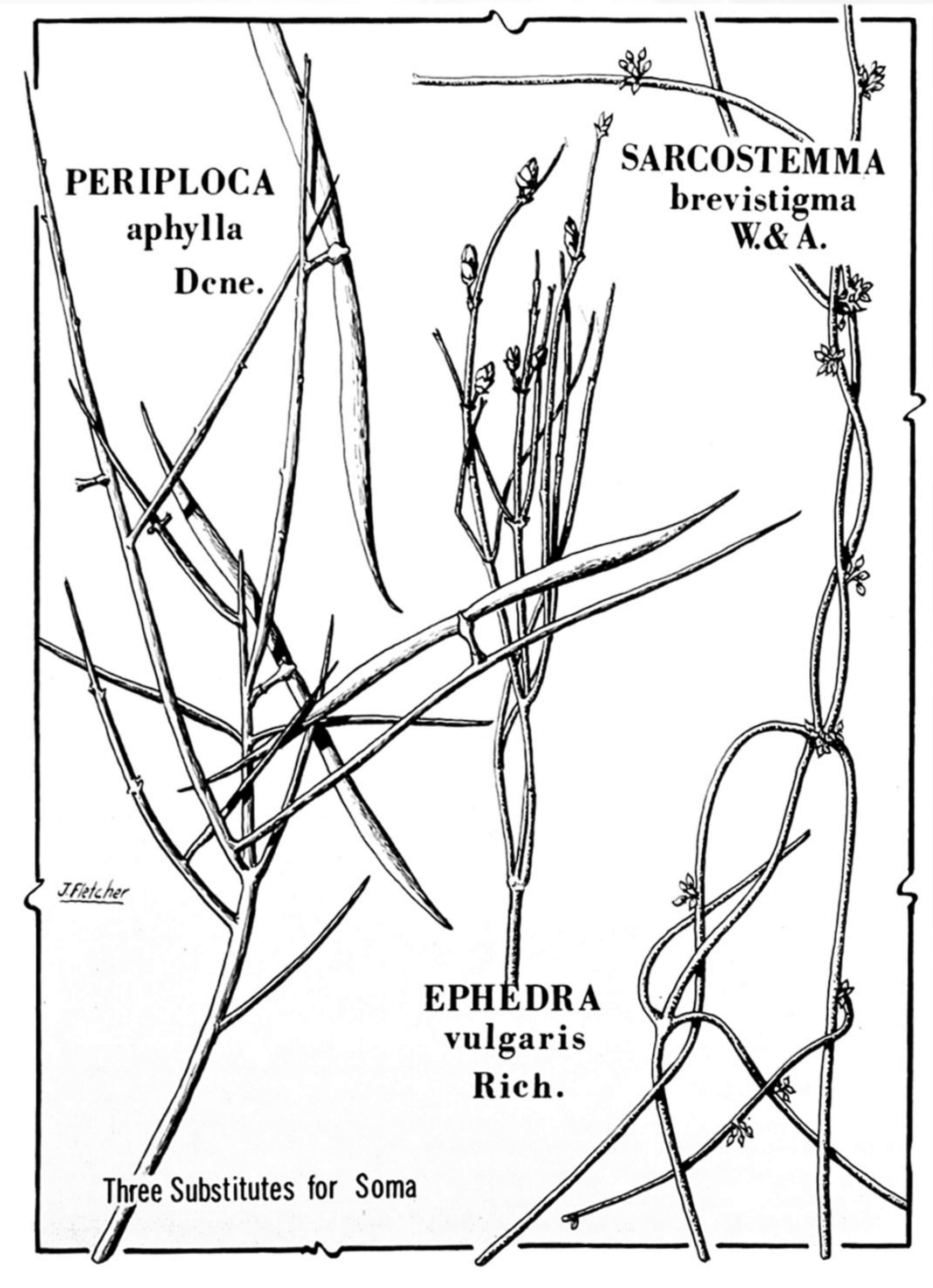

PERIPLOCA
aphylla
Dcne.
SARCOSTEMMA
brevistigma
W.& A.
J.Fletcher
EPHEDRA
vulgaris
Rich.
Three Substitutes for Soma

Fig. 3. Three substitutes for Soma.

---

115. William Dwight Whitney: 'On the main results of Vedic researches in Germany, '*Journal of the American Oriental Society*, No. 3, 1853, p. 299.

Otto Böhtlingk and Rudolph von Roth accepted only tentatively *Sarcostemma brevistigma* as Soma, and perspicaciously added that it seemed to grow farther south than the Vedas indicate.[116]

Friedrich Max Müller in 1855 published an important article in which he quoted Dhūrtasvāmi's description of Soma[117] and said that this seemed to agree most strikingly with the accepted botanical descriptions of various Sarcostemmas. But he doubted whether the Vedic Soma would be found growing in Bombay (where the Sarcostemmas are found) rather than in the mountains of the North. Moreover, he asked, why would the Indians of the era of the *Brāhmaṇas* use *putīka* as a substitute for Soma if they could find 'Soma' itself- *i.e.*, Sarcostemma spp. - right in Bombay?[118]

For thirty years no notice was taken of this Āyurvedic source, nor of Max Müller's doubts. Major Heber Drury accepted *Sarcostemma brevistigma* as *shom-luta*,[119] and Walter Elliot referred *somalatā* to the same species.[120] Martin Haug believed that the Persians had probably replaced the original Haoma with something else, retaining the name, and he thought that the present-day Soma of the Indians was in fact a substitute, but that the substitute retained in a measure the qualities of the true Vedic plant, with no leaves and a bitter white sap: 'It is a very nasty drink, but has some intoxicating effect,' he wrote, having tasted it several times but being unable to take more than a few teaspoonfuls.[121]

Sir George Christopher Birdwood, in his *Catalogue of the Vegetable Productions of the Presidency of Bombay, including a list of the drugs sold in the bazaars of Western India*, included *Sarcostemma brevistigma* under 'drugs', identifying it as the *somalutā* of the Vedas, a 'fermented liquor ... mixed with barley and ghee ... This wine was drunk at all their religious ceremonies and was used as an intoxicant by the rishis... Water passed through a bundle of *somalutā* and a bag of salt will extirpate white ants from a field watered with it.'[122] Birdwood identified *Sarcostemma brevistigma* with *S. acida* and expressed the view that 'the Som of the Vedas and the Hom of the Zend Avesta' were perhaps 'the real plant ... present to the mind of the writer ... of the first chapters of Genesis,'[123] - an original contribution to the debate, and one of the few that is not echoed by anyone. In this year, Eugène Burnouf published his Sanskrit dictionary, wherein he described Soma as the juice of *Sarcostemma brevistigma*; the following year, J. Forbes Watson described the Soma plant as *Sarcostemma brevistigma*; the *somalatā* (Telegu) as the same species; and the *somalutā* (Sanskrit) as *Ruta graveolens*.[124]

Paul Anton de Lagarde (Paul Anton Boetticher) maintained that ὅμωμι [*ómomi*] was another word for μῶλυ [*móly*] or πήγανον [*píganon*], the mountain rue, and that it was a substitute used by the Greeks when they no longer had the *hōm* itself, the original sacred plant.[125] Drawing attention to the *Odyssey* verse describing the μῶλυ [*móly*] as a plant with a black root and a flower white as milk,[126] and to the mythological significance of rue,[127] Lagarde maintained that the description of the *harmal* (= *haoma* = ὅμωμι [*ómomi*] = μῶλυ [*móly*]) given by Arabian botanists described the plant precisely: a shrub with leaves like those of a willow and flowers like those of jasmine, with an intoxicating and soporific effect.[128] He added that Soma and Haoma were not the same plant, though they had the same name and use, and he linked the Soma of the ṚgVeda to rue by means of

---

116. Otto Böhtlingk and Rudolph von Roth: *Sanskritwörterbuch nebst allen Nachträgen*, St. Petersburg, 1855-75.
117. *Vide supra*, p. 100.
118. F. Max Müller: 'Die Todtenbestattung bei den Brahmanen,' *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, No. 39, 1855, p. xlii ff.
119. Major Heber Drury: *Useful Plants of India*, Madras, 1858, p. 385.
120. Walter Elliot: *Flora Andhrica, A Vernacular and Botanical List of Plants Commonly Met with in the Telegu District*, Madras, 1859, p. 169.
121. Martin Haug: *Essays on the Religion of the Parsees*, 1861, pp. 219-222, and *Aitareya Brāhmaṇa*, Bombay, 1863, Vol. II, p.489.
122. Sir George Christopher Birdwood: *Catalogue of the Vegetable Productions of the Presidency of Bombay*, Bombay, 1865, p. 53.
123. *Ibid.*, p. 209.
124. J. Forbes Watson: *Index to Native and Scientific Names of Indian and Other Economic Plants and Products*, London, 1866, p. 530.
125. Paul Anton de Lagarde: *Gesammelte Abhandlungen*, Leipzig, 1866, p. 174.

126. *Odyssey*, X, 304-5.
127. Jacob Ludwig Grimm: *Deutsche Mythologie* (Göttingen, 1835), p. 962, had mentioned that rue was used in sacrifices to the devil.
128. Lagarde. *op. cit.*, p. 175.

the Vedic epithet *sahásrapājas*, 'possessing a thousand *pājas*,' which he related to the Greek term for rue, πήγανον [*píganon*].[129]

But no matter how many botanists and scholars accepted the Sarcostemma thesis, there were always reservations held in some quarters. In 1871 John Garrett declared flatly that 'the Soma of the Vedas is no longer known in India'.[130] Nevertheless J. D. Hooker elaborated upon his earlier identification of Soma with *Sarcostemma brunonianum* by observing that this plant abounded in an acid milky juice and was 'hence eaten by the natives as salad, and sucked by travellers to allay thirst, thus forming a remarkable exception to the usually poisonous nature of the Asclepiadeous juices.'[131] Still there was room for new theories: Drury suggested that the 'moon creeper' might be *Calonyction muricatum* (*Ipomoea muricata*), a plant whose swollen pedicels are cooked as vegetables and whose seeds are used as purgatives.[132] Nevertheless, Hermann Grassmann, whose Vedic dictionary is the standard work to this day, accepted the general view that Soma was a Sarcostemma.[133]

In 1873 Rajendra Lala Mitra revived the case for Soma as an alcoholic beverage. The original Indo-Aryans drank 'soma-beer and strong spirits,' which, when they moved to the hot climate of India, tended to make them ill. 'The later Vedas, accordingly, proposed a compromise, and leaving the rites intact, prohibited the use of spirits for the gratification of the senses.'[134] Soma was 'made with the expressed juice of a creeper (*Asclepias acida* or *Sarcostemma viminale*) [both = *Sarcostemma brevistigma*] diluted with water, mixed with barley meal, clarified butter [ghee], and the meal of wild paddy [*nīvāra*], and fermented in a jar for nine days. ... The juice of the creeper is said to be of an acid taste, but I have not heard that it has any narcotic property.' Mitra was of the opinion that the starch of the two meals - barley and wild paddy - produced 'vinous fermentation' and that the Soma juice promoted fermentation and flavoured the brew while checking the acetous decomposition, in the manner of hops.[135] In this way Mitra seemed to cover every likelihood - except for the possibility that Soma was not alcoholic at all, but a plant containing a psychotropic drug. It should also be pointed out that Mitra speaks of 'soma-beer and *strong spirits*.' Presumably he used this latter term in its customary sense, meaning distilled alcohol. This is an anachronism.

In 1874 Arthur Coke Burnell called attention to the fact that there were different 'Somas' in different parts of India, the Hindus of the Coromandel coast using *Sarcostemma brevistigma* in their rites, and those of the Malabar coast using *Ceropegia decaisneana* or *C. elegans*.[136] In the following year, Martin Haug elaborated on his previous descriptions by describing the Soma plant as a small twining creeper with a row of leafless shoots containing sour, milky sap; he identified the plant as *Sarcostemma intermedium*, mentioning *S. brevistigma* and *S. brunonianum* as related varieties, and he expressed his opinion that the plants denoted at the present time by the terms *somalatā* and *somavallī* were later substitutes.[137]

In 1878 Friedrich Spiegel reported that the Indian Parsis sent their priests to Kerman to obtain Haoma.[138] This was the year that saw the publication of Abel Bergaigne's *La Religion Védique*; Bergaigne thought that Soma was a fermented drink and that milk was added to it to help the fermentation process. He calls it a spirituous liquor, the word spirituous (*une liqueur spiritueuse*) being applicable in a broad sense to any volatile inebriating drink.[139]

In 1879, Heinrich Zimmer acknowledged that present-day Hindus used a kind of Sarcostemma, citing Haug and adding that the nausea Haug had experienced was consistent with the *Brāhmaṇa* descriptions of Soma;

---

129. The term *sahásrapājas*, occurring only twice in the ṚgVeda (IX 13[3] and IX 42[3]), is generally translated as 'possessing a thousand forms,' or 'colours', or 'rays'.
130. John Garrett: *Classical Dictionary of India*, Madras, 1871, p. 594.
131. Joseph Dalton Hooker: *Curtis's Botanical Magazine*, London, 1872, Tab. 6002.
132. Major Heber Drury: *Useful Plants of India* (2nd edition), London, 1873.
133. Hermann Grassmann: *Wörterbuch zum Rig Veda*, Leipzig, 1873.
134. Rajendra Lala Mitra: 'Spirituous Drinks in Ancient India,' *Journal of the Royal Asiatic Society of Bengal*, 1873, p. 2.

[135] *Ibid*., p. 21.
[136] Arthur Coke Burnell: *Elements of South Indian Palæography*, Mangalore, 1874, p. I.
[137] Martin Haug: in a review of Grassmann's *Wörterbuch; Göttingische Gelehrte Anzeigen*, 1875, pp. 584-595.
[138] Friedrich Spiegel: *Eranische Alterthumskunde*, Leipzig, 1878, Vol. III, p. 572.
[139] Abel Bergaigne: *La Religion Védique*, Paris, 1878, Vol. 1, pp. ix and 148.

but he expressed doubts whether this plant, found in Bombay and all over India, could have grown in the high site of Vedic civilization. He quoted various *Brāhmaṇa* references to substitutes to support his thesis that Sarcostemma was in fact just such a substitute, which had appeared in the course of time.[140]

In 1881 Mitra reiterated his beer theory,[141] and Kenneth Somerled Macdonald wrote, 'Soma is now admitted, we believe, by the best Sanskrit scholars to have been intoxicating. The numerous references in the ṚgVeda are consistent only with such an interpretation.'[142] He proceeded to repeat Mitra's theory in great detail, though he failed to give Mitra credit for it.

The early 1880's saw the most enthusiastic and intense period of the Soma debate. Scholarly tempers flared, new and important names began to appear, and ingenious theses were advanced. Rudolph von Roth began it with an article in which he reviewed all the recent theories about Soma as well as some of the *Brāhmaṇa* information; he concluded that although *Sarcostemma brevistigma* seemed to be well established as the present-day Soma plant, there was no assurance that this plant - which grew in the plains - was the Vedic plant, which must still grow in the mountains.[143] Though he believed that the Soma of the *Brāhmaṇas* was a substitute made necessarv when the Vedic people moved away from their original home, he felt that the true Soma was probably some species of Sarcostemma or at least an Asclepiad, and he felt that any information about the present-day Soma might shed light on the Vedic plant.

In the following year, Edward William West expressed the opinion that the plants used for Soma in India and Persia at the present time were substitutes for the original Haoma-Soma plant, and he observed that the most common substitute in South and West India was the *Sarcostemma brevistigma*, 'a leafless bush of green succulent branches, growing upwards, with flowers like those of an onion,' and resembling *Euphorbia tirucalli* or thornless milk-bush when not in flower.[144] In that same year Angelo de Gubernatis, quoting Roth, expressed doubt whether the Soma plant could be identified at that time; he suggested that perhaps the Soma cult had shifted to wine in Persia, Asia Minor, and Greece, and that in India in later times its place was taken by a beverage offered to the gods and deliberately made unpalatable so that no mortal would be tempted to drink it.[145]

In 1883 Monier-Williams brought out his *Religious Thought and Life in India*. He defined Soma as *Sarcostemma brevistigma*, 'a kind of creeper with succulent, leafless stem,' but he added, 'And yet it is remarkable that this sacred plant [the original, true Soma] has fallen into complete neglect in modern times. When I asked the Brahmans of North India to procure specimens of the true Soma for me, I was told that, in consequence of the present sinful condition of the world, the holy plant had ceased to grow on terrestrial soil, and was only to be found in heaven.' Nevertheless a creeper 'said to be the true Soma' had been pointed out to him by Burnell in South India, where it was being used by orthodox Brahmans.[146]

In 1884 D. N. Ovsianiko-Kulikovskij published a book of some 240 pages devoted entirely to Soma and containing a great deal of learned and imaginative material; unfortunately, since it was published in Russian and never translated, it was not noted by subsequent scholars writing in other European languages, though Ovsianiko-Kulikovskij was familiar with all of the significant literature in German, French, and English.[147] He maintained, on grounds of sound linguistic reasoning, that the word 'soma' applied first to the plant and later to the juice[148] and went on to discuss this plant:

---

[140] Heinrich Zimmer: *Altindisches Leben*, Berlin, 1879, p. 275.
[141] Rajendra Lala Mitra: *Indo-Aryans*, London, 1881, pp. 390-419.
[142] Kenneth Somerled Macdonald: *The Vedic Religion*, London, 1881, p. 66.
[143] Rudolph von Roth: 'Über den Soma,' *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, No. 35, 1881, pp. 680-692.
[144] Edward William West: *Pahlavi Texts, Sacred Books of the East*, Volume 18, 1882, p. 164.
[145] Angelo de Gubernatis: *La Mythologie des Plantes*, Paris, 1882, Vol. II, pp. 350-369.

146. Sir Monier Monier-Williams: *Religious Thought and Life in India*, London, 1883, pp. 12-13.
147. D. N. Ovsianiko-Kulikovskij: *Zapiski Imperatorskogo Novorosiiskogo Universiteta*, Volume 39, Odessa, 1884. Chast' I: *Kul't bozhestwa Soma v Drevnei Indii v epokhu Ved*. [Part 1: The Cult of the Deity 'Soma' in Ancient India in the Vedic Epoch] I am indebted to D. M. O'Flaherty for the translation.
148. *Ibid*., p. 7.

> At the same time, the terms Soma and Haoma did not cease to signify also the divinity, whose gift or attribute the intoxicating beverage was considered to be. As concerns this last, it is presently obtained in India from a plant of the family *Asclepias acida*. Whether it was obtained from the same plant in antiquity, or from another, or if from another, from which particular one - all of these are questions that of necessity must remain for the time being without an answer. The description of the flower and the liquid of Soma in the ṚgVeda is not applicable to *Asclepias acida* and the beverage obtained from it.[149]

Ovsianiko-Kulikovskij described the sacrament of collecting Soma as taking place at night, 'in the light of the moon,' observing: 'Perhaps this feature has some link with the later identification of Soma with the moon.'[150] He continued:

> It was mixed with water, sour milk, and barley corn. Then it underwent fermentation, after which a strong, intoxicating beverage was obtained. The description of this procedure is met in a number of places in the ninth Maṇḍala of the ṚgVeda, but always in a fragmentary and often obscure form.[151]

This was the more or less conventional view of Soma, but then Ovsianiko-Kulikovskij went on to express his doubts that Soma had been a product of fermentation at all, and to suggest - in cautious but clear terms - that Soma might have been some sort of narcotic. This is by far the earliest reference to such a possibility, and it is significant that it appears in the writings of a Russian, who may have known of the Siberian cults:

> It is possible that the narcotic power of Soma was greater than the similar power of other drinks used in the time of the Veda; possibly it was of an essentially different nature. The action of Soma is always depicted in the most many-hued colours, as something fascinating, elevating, illuminating; on the other hand the action of common drink (*súrā*) is painted in far from such attractive colours ... It is also quite possible that the superiority of Soma was entirely imaginary and rested solely on that religious sanction which fell to the portion of Soma (that is, not *Asclepias acida* or any other sort of Indian plant, but - Soma, as a religious and cultural psychological conception) as early as the most remote Indo-Iranian antiquity.[152]

Roth then brought out another paper, in which he emphasized his feeling that Soma must still exist.[153] But he acknowledged that Albert Regel, the botanist employed by the Russian government, who had searched for Soma at Roth's request in the Syr Darya and Amu Darya watersheds, had reported finding no trace of a plant meeting Soma's description. Regel had expressed his opinion that the closest thing to Soma that he had found had been rhubarb, though he admitted that rhubarb was not used by the natives to make any intoxicating drink. Roth had supplied him with Vedic descriptions of Soma, and from them it was clear that none of the Asclepiads, Euphorbias, Ferulas, yellow Compositæ, or *Cannabis sativa* (hemp) conformed to the formula. Wilkens, a zoologist specializing in South Turkestan, had reported to Roth that in his opinion Soma might be *Peganum harmala*,[154] belonging to the Rutaceæ, though it lacked the sweetness and juiciness that the true Soma was thought to have had. Nothing daunted, Roth ended up with a flourish: 'Usbekistani today may drink their kumiss in cups in which Soma once gave them cheer. ... To find the Soma one need not be a botanist: the plant will have to be recognized in all its juiciness [*Saftfūlle*] by every eye.'

---

149. *Ibid*., p. 8.
150. *Idem*. This peculiar notion appears only one year later in the *Cyclopædia* of Edward Balfour (*vide supra*, p. 99), but it is most unlikely that he knew Ovsianiko-Kulikovskii's work.

151. *Ibid*., p. 9.
152. Ovsianiko-Kulikovskij, *op. cit.*, p. 12.
153. Rudolph von Roth: 'Wo wächst der Soma?', *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, No. 38, 1884, pp. 134-139.
154. The πήγανον [*píganon*] and *harmal* to which Lagarde had referred.

V. File Number 118

Charles James Lyall, Secretary to the Chief Commissioner of Assam, translated Roth's papers and forwarded them, with his own remarks, to the Afghan Frontier Delimitation Commission. They in turn handed them over to the botanist George Watt, who published them with *his* added remarks, under the heading, 'A note upon Dr. Roth's suggestion regarding the Soma Plant', in a document issued as File No. 118 of the Government of India, Revenue and Agricultural Department, Simla, August 20, 1884.

Watt felt that Roth had produced no evidence that Soma was a species of Sarcostemma or any other Asclepiad; he considered it 'a great pity that Dr. Roth, instead of propounding his own theory at such length and in attempting to confute arguments against it, did not rather publish briefly the leading passages from Sanskrit literature descriptive of the plant ... placing in the hands of the naturalist to the Commission a brief abstract from the Sanskrit authors, and thus leave his mind unbiased by any theories.' Watt was of the opinion that Soma was not necessarily a succulent, juicy plant, but that it might be rather a dry branch used in a decoction, 'either by simple maceration or boiling.' He went on: 'Can any one who has examined the bitter milky sap of the Asclepiadæ ... suppose that such a liquid could ever be used for more than a medicinal purpose, and still less become the Soma of the Vedas? It is much more likely that the oblong fruits of the Afghan grape..., imported into the plains, as they are at the present day, afforded the sweet and refreshing cup of which our Aryan ancestors became drunk while wrapt in the oblivion of religious enthusiasm.'[155] He did not pursue this suggestion, however, and considered the Compositæ or Umbelliferæ more likely than the Asclepiads as candidates for Soma.

In reply to this, Max Müller wrote to the *Academy* journal on October 20, 1884, misquoting Haug ('it was extremely nasty and not at all exhilarating', where Haug had described the Soma he tasted as 'a very nasty drink, but [it] has some intoxicating effect'), referring to the *Brāhmaṇa* substitutes and the tradition that Soma 'was brought by barbarians from the North,' and finally getting to the point - that he, Friedrich Max Müller, had published thirty years earlier the 'oldest scientific description of the Soma plant' that he knew of or had hope of finding, the Dhūrtasvāmi description of the dark creeper eaten by goats.[156]

On November 9, Roth replied in the same journal to 'the learned scholar': 'I did not, indeed, remember the passage referred to; but if it had been in my mind I should scarcely have mentioned it...' He said it was impossible to date the '*Āyurveda*', that Max Müller's passage sounded like descriptions of 'the later, even the latest date, especially in the so-called *Nighaṇṭus*,' taking exception to the adjective *vamanī* by insisting that 'it is not to be supposed that the Soma, or its principal substitute in later times, should have caused vomiting,' and, as a parting blow, correcting Max Müller's translation of *&sacute;leṣmalā* from 'destroying phlegm' to 'producing phlegm.' He concluded that the plant described was merely the 'Soma of later times which we know (that is, the *Sarcostemma acida* [*brevistigma*]), correctly described as bearing no leaves.' He still believed that the 'genuine original Soma' would bear great resemblance to its later substitute, and answered Watt's 'decoction' theory thus: 'I am sorry not to be able to conform my views to those of the distinguished botanist. The Aryans no more drank a decoction of the Soma plant than they drank tea or coffee. It would be, indeed, a disgrace to the interpreters of the Veda and Avesta if Dr. Watt were right.' He ended with the arch hope that the botanists of the Commission 'will not bring us home, as Soma, the Asafœtida, which there obtrudes itself upon one's notice, or any other Ferula.'

Max Müller replied on November 17 in another letter to the *Academy*, defending his Āyurvedic passage as the oldest *scientific* description of the Soma, standing up for his translation of *&sacute;leṣmalā* as dissolving rather than producing phlegm, and keeping his original reading for *vamanī* rather than the *pāvanī* (purifying) suggested by Roth. He admitted that 'this oldest scientific description of the Soma plant' might refer to a later substitute, and concluded: 'As to the Soma which the Brahmans knew (ṚgVeda X 85^{3}), I shall welcome it whenever it is discovered, whether in the valley of the Oxus or in that of the Neckar.'

---

155. That the Aryans knew of such a fruit and of an alcoholic drink made from it is established by Pāṇini's reference to the sweet grape juice of Kāpi&sacute;ī, north of Kabul (Pāṇini 4-2-99).
156. *Vide supra*, pp. 100 and 107.

At this point the botanists entered the forum. J. G. Baker of the Kew Herbarium wrote to the *Academy* on November 15, noting that Dr. Aitchison had been selected as the botanist to attend the Afghan Delimitation Commission and supporting Max Müller's faith in the Sarcostemma, which, he pointed out, is eaten by men and animals throughout Sindh, Arabia, and Persia. He said that the flowers of the *Periploca aphylla* are eaten by the natives of Baluchistan 'and taste like raisins.' W. T. Thiselton-Dyer of the Royal Kew Gardens then supported Watt's suggestion of the Afghan grapes: 'That the primitive Soma was something not less detestable than anything that could be extracted from a Sarcostemma I find it hard to believe. When, however, the original Soma was unprocurable, and the use became purely ceremonial, the unpalatableness of the Soma substitute was immaterial.'[157] The Sarcostemma, according to Thiselton-Dyer, was chosen when the Soma plant was forgotten (or unavailable in the hot plains) because 'there is a faint resemblance in texture and appearance, though not in form, between the joint of a Sarcostemma and an unripe green grape,' the Vedic Indians having had no word to distinguish a fruit from the stem of a plant, Thiselton-Dyer maintained.[158]

Max Müller answered this, on December 8, with a reference to the Vedic tradition that Soma juice was mixed with barley milk, a process that, he suggested, was incompatible with the grape hypothesis but not with a kind of hops; he added that 'a venturesome etymologist might not shrink even from maintaining that hops and Soma are the same word,' deriving *hops* from Hungarian *komló*, mediæval Latin *humolo*, mediæval Greek χουμέλη [*chouméli*], and ultimately Sanskrit *soma*, 'which, for a foreign word, brought from Persia into Europe, is tolerably near ... Now hops mixed with barley would give some kind of beer. Whether milk would improve the mixture I am not brewer enough to know.'

Charles G. Leland then wrote to the *Academy* to support the hops hypothesis with information about the *soma* or *sumer* ('the pronunciation is not fixed') of the Romany tongue, apologizing that 'any confirmation of this, drawn from such a very disreputable source as gypsy, is, indeed, not worth much,' but pointing out that there was much Sanskrit in gypsy words and that *soma* in Romany meant 'scent or flavour ... thus the hop gives the *suma* or *soma* to the beer, as the lemon to punch.' He added that the fact that hops do not grow in the present dwelling place of the Hindus confirms rather than disproves Max Müller's theory, since if it were still available there the Indians would be using it instead of the present substitute. At this point (December 20), A. Houtum-Schindler wrote from Teheran with a tale of a Sarcostemma that he had been shown by the Parsis in Kerman, a plant with a greenish white juice and a sweetish taste that caused vomiting when taken in amounts of more than a dozen drops, and that corresponded closely with Max Müller's Āyurvedic description - *if* it was viewed only 'several days after it had been collected,' by which time the stalk would have turned dark, the juice turned sour, and the leaves fallen off. To this ingenious postulate he added several descriptions of the *Hum* plant from various Persian dictionaries, including one of a deadly poison the fruit of which is much liked by partridges and which resembles a tamarisk tree - 'the latter qualities evidently refer to another plant.' W. T. Thiselton-Dyer then identified still another plant used by the Parsis in their rites - the *Ephedra vulgaris* which, he said, bore sweet red berries and somewhat resembled *Tamarix articulata*, like the plant mentioned by Houtum-Schindler: 'But he [Houtum-Schindler] also says it is "a deadly poison" (though apparently not to partridges). This does not agree with Ephedra, which is browsed by goats.'

On this note the *Academy* correspondence ended, but the argument continued. On January 25, 1885, Watt published his 'Second Note on the Soma Plant,' in which he said that a Dr. Dymock of Bombay had sent him a Haoma plant which was *Periploca aphylla* and had told him he thought that the plant was not used to obtain liquor but that a small portion of it was added to a liquor obtained from grain; he added that, according to the Parsis, the Haoma never decayed. This strengthened Watt's opinion that Soma was not a succulent plant, certainly not a Sarcostemma, an opinion which was further encouraged by a letter he had received from Rajendra Lala Mitra, who had suggested that Soma might have been used like hops as an ingredient in the preparation of a kind of beer, and that the Vedic phrase 'Soma juice' was merely a figure of speech. 'The word "sweet,"' Mitra wrote, 'which has so much puzzled the learned Professor von Roth, may be safely, nay appropriately, used in a poem in praise of bitter beer.' Watt was therefore convinced that the Haoma plant was the Soma after all, that 'the dry and bitter twigs' had been used to flavour some other beverages, 'much in the

---

157. Here he refers to de Gubernatis II, 352; *vide supra*, p. 112.
158. This is not true. *Phala*, 'fruit,' recurs in the ṚgVeda, referring to the fruit of a plant (not Soma) rather than to the stem. Cf. ṚgVeda III 45[4], IV 57[6], X 71[5]. X 97[15] and X 146[5].

same way as Acacia bark is used throughout India.' In passing, Watt rejected a suggestion he had received from Benjamin Lewis Rice that Soma might have been 'sugarcane or some species of sorghum'; he concluded that *Periploca aphylla* - the Haoma of Dr. Dymock - was after all the most likely Soma plant, and he quoted Baker's description of *Periploca aphylla* as having 'flowers fragrant, eaten by natives, taste like raisins.'

Surgeon General Edward Balfour, in the third edition of his *Cyclopædia of India*, maintained that the Soma of Vedic times was a 'distilled alcoholic fluid' made from the *Sarcostemma brevistigma* which flowers during the rains in the Deccan. In the same article he referred to the Soma juice as 'a fermented liquor' and 'this beer or wine'; he believed that this liquid was used at all religious festivals and by the rishis at their meals; and he attributed to Windischmann the suggestion that the Soma plant may have been the gogard tree.[159]

In 1885 Julius Eggeling published the second volume of his translation of the *&sacute;atapatha Brāhmaṇa*, wherein he observed that the exact identity of the Soma plant was 'still somewhat doubtful,' but that every probability seemed to favour the *Sarcostemma brevistigma* or some other plant of the same genus. In answer to Watt's suggestion that the opinions of all the 'Sanskrit authors' be assembled for the botanists to use, Eggeling wrote: 'One might as well ask a Hebrew scholar to give accurate descriptions of the "lily of the valley" to enable the botanist to identify and classify the lovely flower which delighted the heart of King Solomon. It is exactly the want of an accurate knowledge of the nature of the Soma plant which prevents Vedic scholars from being able to understand some of the few material allusions to it.'[160] Undaunted, Aitchison wrote a letter to the Daily News (13 March 1885) expressing his opinion that Soma was wine after all. He modified this, however, when he returned from Afghanistan and published *The Botany of the Afghan Delimitation Commission*, wherein he informed his readers that the natives of North Baluchistan call *Periploca aphylla*, *Ephedra pachyclada*, and another *Ephedra* '*Hum*, *Huma*, and *Yehma*.' He said that the natives eat the small red fruit of these plants, but he hesitated to identify any of them with the original Soma.[161] Finally, in 1888, Max Müller republished the *Academy* correspondence in his *Biographies of Words and the Home of the Aryans*[162] with additional notes by Thiselton-Dyer, who supported Max Müller by saying that Soma 'was certainly in later times a fermented drink made from grain, to which the Soma plant itself was only added as an ingredient.' Observing that, according to Roxburgh, the Sarcostemma was 'not necessarily nauseous,' he nevertheless rejected it as a possibility for the Primitive Soma, rejecting as well Houtum-Schindler's *Hum* (which he identified as *Periploca aphylla*) and his tamarisk-like plant (which he identified as *Periploca hydaspidis*, indistinguishable he said, from *Ephedra foliata* except when in flower). He concluded with a belief that the Sarcostemma was used, like hops, to flavour the 'more effective ingredients' of fermented grain, and that it was used *not* 'as a ceremonial reminiscence of the grape' but in the absence of the original Soma plant - the hop. George Watt concluded this episode with his article on Ephedra in the *Dictionary of the Economic Products of India*, where he rejected, among other hypotheses, his own former suggestion of the Afghan grape, though he could not resist noting that wild grapes are called '*Um*, *Umbur*' in Kashmir.[163] He mentioned that *Ephedra vulgaris* grew in the Himalayas, that *Ephedra pachyclada* and *E. foliata* were found in Garhal and Afghanistan, that *Periploca aphylla* was used sometimes in Bombay, but that the Parsis *huma* was usually an Ephedra. He said that *putīkas* (Basella spp.), when stripped of their leaves, would resemble Sarcostemmas; that *Vernonia anthelmintica* and *Pæderia fœtida* are known as *somaraj* in Hindustan; that Asclepiads are emetics and are eaten by goats; and that Sarcostemma is rare but Periploca plentiful in Central Asia. He rejected the Periploca, however, on the grounds that the Aryans would have recognized it in India and not have used the Sarcostemma in its place. And from all this he concluded that Soma refers to 'an early discovery of the art of fermentation' rather than to any plant in particular. All the sound and fury had proven nothing, after all.

---

159. Surgeon General Edward Balfour: *The Cyclopædia of India and of Eastern and Southern Asia, Commercial, Industrial, and Scientific; Products of the Mineral, Vegetable, and Animal Kingdoms, Useful Arts and Manufactures* (3rd edition), London, 1885, Vol. III, p. 703.

160. Julius Eggeling: *&sacute;atapatha Brāhmaṇa, Sacred Books of the East*, Volume II (1885), pp. xxiv ff.
161. I. E. Aitchison: *The Botany of the Afghan Delimitation Commission*, Transactions of the Linnæan Society, London, 1887, p. 112.
162. Max Müller: *Collected Works*, London, 1888, Vol. X, pp. 222-242.
163. George Watt: *Dictionary of the Economic Products of India*, Calcutta, 1890, 'Ephedra'.

VI. The Turn of the Century

Still the battle raged, if more quietly, over the same ground. Adalbert Kuhn said that Haoma and Soma were separate plants resembling each other in name and external appearance, the Soma of present-day India being *Sarcostemma brevistigma* (an identification that he chose to attribute to Roth), which was not however the original or at least the only plant from which Soma was taken.[164] John Firminger Duthie then added an odd piece of information that went unnoticed: The Marwara people call the spiked grass known as *Setaria glauca* Soma.[165] Darmesteter in his translation of the *Avesta* referred to Haoma as a yellow plant with very close-set knots[166] 'like the Indian Soma'.[167] Monier-Williams' Dictionary (1891) simply gave *Sarcostemma brevistigma* for Soma, and J. Börnmuller mentioned that he had met with a Parsi priest in Yezd carrying *huma*.[168] At once he recognized it as *Ephedra distachya*, and thus he had solved at last the problem mentioned to him first by Max Müller in Oxford. He added that the plant grew all over Central Asia and that large quantities of it were dried and sent from Persia to Bombay every year.

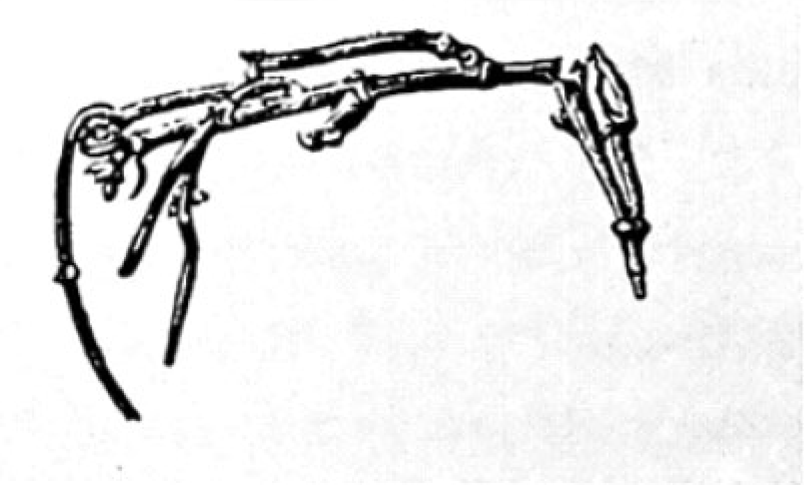


Fig. 4. 'Haoma' of the Persians. As pictured in James Darmesteter's translation of the Avesta, 1890-1892. Said to be life-size.

Alfred Hillebrandt then produced his extensive summary of the recent Soma theories and introduced his own famous theory that Soma was the moon throughout the ṚgVeda. He explained that contemporary Soma plants were probably not the same as the original, that substitutes had been used as soon as the Aryans left their homeland in the Sindh, and that the Vedas themselves were self-contradictory, since they had been compiled in various times and places.[169] He pointed out that Soma was not a blossoming plant and therefore could not be hops as Max Müller had suggested; that Soma had a red stalk and reddish brown sap; and that the epithet 'with hanging branches' (*naicā&sacute;ākhá*)[170] probably referred to the *nyagrodha* (*Ficus religiosa*) which was an important substitute. In fact, he concluded, even at the time of the ṚgVeda itself, various plants were already in use, and he cited Burnell's evidence that different Somas were used simultaneously in different parts of India.

Hermann Oldenberg devised a new theory, suggesting that the original Soma was itself a substitute, not for wine but for the Indo-European honey drink, mead or hydromel.[171] Of course it had long been recognized that

---

164. Adalbert Kuhn: *Mythologische Studien*, Gütersloh, 1886, Volume I, p. 106.
165. John Firminger Duthie: *The Fodder Grasses of North India*, Roorkee, 1888, p. 14.
166. *Vide supra*, pp. 59-60.
167. James Darmesteter: *Avesta*, translation into French, Paris, 1890-1892; introduction, p. lxv. He gives a picture of the plant as

well (*vide* fig. 4).

168. J. Börnmuller: 'Reisebriefe aus Persien,' in *Mitteilungen des Thüringischen Botanischen Verlags*, 1893, p. 42.
169. Alfred Hillebrandt: *Vedische Mythologie*, Breslau, 1891, Vol. I, pp. 1-18.
170. This word, however, occurs only once in the ṚgVeda (III 53^{14}) and its meaning is uncertain; Grassmann thinks that it may refer to the name of a sage.
171. Hermann Oldenberg: *Die Religion des Veda*, Berlin, 1894, pp. 366 ff.

the Sanskrit *mádhu*, the Greek μεθυ [*methy*], and English *mead* were cognate, and that *mádhu* was applied to Soma in the ṚgVeda (whence all the trouble over the bitterness of Sarcostemma), but *mádhu* was a general term applied to milk and rain as well as to Soma, and the simple identification of Soma with *mádhu* had still left open the botanical identification of Soma as a plant whose sap was known as honey. Oldenberg, however, avoided this difficulty by postulating mead as a forerunner and Soma as a later substitute: this distracted attention from the Soma plant itself (since it was no longer to be regarded as the *original*, the *Ur*-plant, that everyone sought) but it did not, of course, add anything at all to what was known about the Indian Soma.

This theory was to become well known and widely accepted, but it had little immediate impact. Edmund Hardy maintained that Soma was neither any form of honey nor *súrā* but most probably *Sarcostemma brevistigma* after all.[172] Vedic scholars generally clung to the Asclepiad hypothesis[173] or they hazarded even less: P. Regnaud called Soma 'une liqueur enivrante,' and cautioned against taking the Vedic texts literally when they spoke metaphorically.[174] Rustomjee Naserwanyil Khory covered some *very* old ground by considering a *Brāhmaṇa* substitute to be the original Soma;[175] he identified Soma (*somavallī* in Sanskrit, *amṛtavallī* in Bengali) as a climbing shrub called *Tinospora cordifolia*, the extract of which (called *gurjo*, *gilo*, etc.) is used as an aphrodisiac, a cure for gonorrhea, and a treatment for urinary diseases. Christian Bartholomæ in his famous *Altiranisches Wörterbuch* (1904) described Haoma as a plant used in medicine, for magic, and as an alcoholic drink, but he refrained from identifying the plant. W.W. Wilson thought Soma was the σιλφιον [*silfion*] (Latin *laserpitium*) mentioned in a fragment of Alcman as a plant that has wonderful properties, grows on mountains, is golden, and is plucked by birds.[176] He supported this argument with complex Indo-European linguistics but was cautious enough to note: 'It is not improbable that even at the time of the Vedas, use was made of more than one kind of plant. W. Caland and Victor Henry considered the question of the identification of Soma insoluble.[177] Henry maintained that the Indo-Aryans had imported Soma ever since they entered the area of Northwest India, and that the present-day Soma of India did not correspond to the Vedic descriptions of its taste or characteristics.[178] Still the old definitions persisted: K. L. Bhishagratna in his 1907 edition of the *Su&sacute;ruta* defined *somalatā* as *Sarcostemma brevistigma* and *somarājī* as *Vernonia anthelmintica*. Maurice Bloomfield referred to Soma merely as 'an intoxicating drink ... regarded as the tipple of the gods,'[179] and A. A. Macdonell and A. B. Keith concluded that the ṚgVeda descriptions were 'inadequate to identify the plant... It is very probable that the plant cannot now be identified.'[180] Then Hermann Brunnhofer came forward to defend Lagarde's 'mountain rue' (originally Sir William Jones's theory, though Lagarde did not say so and probably did not know of Jones's opinion). Brunnhofer maintained that Lagarde had already solved the Soma question forty years previously, 'though the Vedists still ignore him.'[181] He elaborated upon Lagarde's theory by mentioning Pliny's description of a plant known as ἀμβροσία [*ámvrosía*] possessing characteristics that suggested a kind of rue to Brunnhofer.[182] He then called attention to the ṚgVedic verse (IV 3^{9c}), perhaps an oblique reference to Soma, that speaks of a black cow giving white milk; Brunnhofer considered this a perfect description of the μῶλυ [*móly*], a dark plant with white milk.

In 1911 Carl Hartwich published *Die menschlichen Genussmittel*, in which he discussed various forms of tobacco, alcohol, and drugs.[183] He included 'Soma - Haoma' in his study, but was uneasy about its status as a drug or stimulant ('*Genussmittel*'); having described various accepted botanical 'Somas' (*Sarcostemma*

---

172. Edmund Hardy: *Die Vedische-Brahmanische Periode*, Münster, 1893, pp. 152-153.
173. Zenaïde A. Ragozin: *Vedic India*, London, 1895, p. 171; W. Caland: *Altindische Zauberritual*, Amsterdam, 1900, p. 188.
174. P. Regnaud: 'Remarques sur le IXème Maṇḍala du ṚgVeda,' *Revue de l'Histoire Religieuse*, XLIII, 1902, pp. 308-313.
175. Rustomjee Naserwanyil Khory: *Materia Medica of India and their Therapeutics*, Bombay, 1903.
176. W. W. Wilson: 'The Soma offering in a fragment of Alkman,' *American Journal of Philology*, No. 30, 1906, pp. 188-195. Roth in his 1884 essay had suggested that Soma in India had occupied a sacred position similar to that held by the now extinct σιλφιον [*silfion*] plant of Ancient Greece, but he had not considered the two plants identical.
177. W. Caland and Victor Henry: *L'Agniṣṭoma*, Paris, 1906-7, p. 471.
178. Victor Henry: *Soma et Haoma*, Paris, 1907, p. 52.
179. Maurice Bloomfield: *The Religion of the Veda*, New York, 1908, p. 145.

brevistigma, *Periploca aphylla*, *Basella cordifolia*, *etc*.), he went on to say: 'Although all of these have been tested - though not altogether thoroughly - none of them is known to have stimulating or sedative or other characteristics which could mark it as a drug or stimulant.' He therefore considered it possible that they might have been used as supplements, perhaps as spices, to the other known ingredients of the Soma drink (meal, milk, and whey) in which alcohol might have been produced.[184] The possibility that Soma might have been some other plant which *did* have 'stimulating or sedative characteristics' does not seem to have occurred to him, though he granted that the Persians used for their Haoma a different plant (*Ephedra vulgaris*) containing a drug (ephedrine) which caused dilation of the pupil.[185] One of the plants that Hartwich gave as an alleged Soma was *Vitex negundo*, whose bitter leaves and root were used against fever. Since the plant was originally native to tropical America, Hartwich dismissed it as a possible Soma, but observed in conclusion that in India it was known as *Indrahasta* and *Indrasurā* ('the hand of Indra' and 'the wine of Indra').[186] It may be that this association with Indra - together with Indra's fondness for Soma (to which Hartwich refers) - recommended the *Vitex negundo* to Hartwich, for he gives no Sanskrit names for any of the other plants he mentions. Yet in this context it is surprising that he did not mention *Indrā&sacute;ana* ('the food of Indra')[187] which was a common name for hemp, *Cannabis sativa*, the leaves of which were dried and chewed, supplying just the *Genussmittel* that Hartwich seemed to seek.

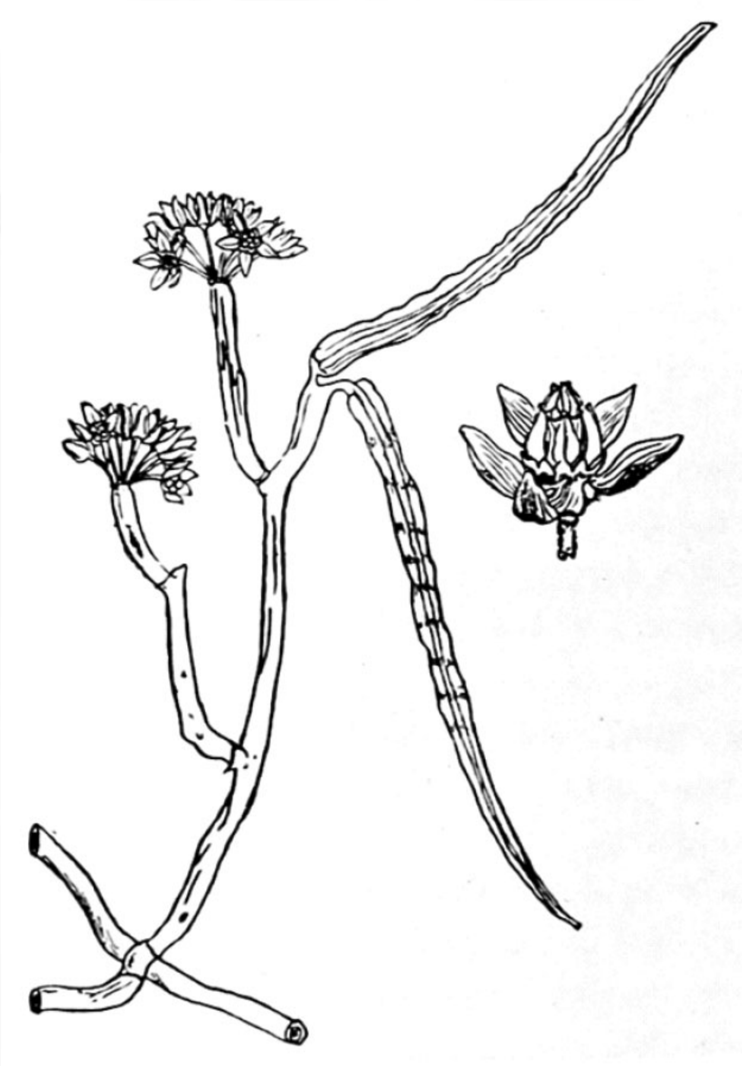


Fig. 5. 'Soma'. As pictured in Zenaīde A. Ragozin: *Vedic India*, New York, 1895.

---

180. Arthur Anthony Macdonell and Arthur Berriedale Keith: *Vedic Index*, London, 1912, Vol. II, p. 475.
181. Hermann Brunnhofer: *Arische Urzeit*, Bern, 1910, p. 297.
182. *Ibid*., p. 300. The quotation from Pliny (*Historia Naturalis* 27.28.11) merely says that of several plants bearing the name of αμβροσία [*amvrosía*], one has leaves around the bottom of the stem resembling those of rue (*foliis rutae circa imum caulem*). Elsewhere (*Historia Naturalis* 14.40), Pliny speaks of αμβροσία [*amvrosía*] as a kind of grape.
183. C. Hartwich: *Die menschlichen Genussmittel*, Leipzig, 1911, p. 806 ff.

[184] Hartwich, *op. cit.*, p. 809
[185] *Ibid.*, p. 808.
[186] *Indrasurā* (also known as *Indrasurasa* and *Indrasurisa*) is mentioned in the *Amarako&sacute;a*, the *Su&sacute;ruta Saṃhitā*, and the *&sacute;abdakalpadruma*, but is nowhere associated with Soma.
[187] *lndrā&sacute;ana* as a name for hemp (perhaps by confusion with *Indra-&sacute;aṇa*, which woud mean the hemp of Indra) is mentioned in the *&sacute;abdamālā* (quoted in the *&sacute;abdakalpadruma*) and appears in its prākrit form - *Indrāsana* - in *Dhūrtasamāgama* 90.8.

Keith reassembled the old evidence but still considered the Soma problem insoluble,[188] and L. H. Mills produced an odd throwback in which he insisted that Haoma and Soma grew independently from the same original, and that 'nothing humorous, let us remember, attached to the idea of [alcoholic] stimulus at first in those early days'.[189] The *Oxford History of India*[190] merely observed that the Parsis say that Soma is Asclepias, and E. W. Hopkins concurred but questioned whether this was the plant referred to in the Vedas, the Avesta, and Plutarch, suggesting that the names might have been retained when substitutes for the plant were used.[191] Chapman Cohen stated without reference or explanation his belief that the Soma drink 'is prepared from the flower of the lotus,' an idea that was bound to occur to someone sooner or later, in view of the *Odyssey* tradition of the lotus-eaters and the sanctity of the lotus in India, but which seems to have attracted no supporters after this.[192] E. B. Havell then suggested that Soma was *Eleusine coracana* or *rāgi*, the common millet, an idea that he supported on the basis of Vedic characteristics (shaped like udders, tawny, growing in the mountains) and the *&sacute;atapatha Brāhmaṇa* reference to *dŭrvā* and *ku&sacute;a* as substitutes, both of which resemble *rāgi*, 'the common millet still used in the Eastern Himalayas for making the intoxicating drink called *Marua*.'[193] He mentioned that the Brahmans, while preparing Soma, 'sang a song which reminds one of a good old Aryan sailors' chantey, with a refrain, "Flow, Indu, flow for Indra".'[194] Havell admitted that, 'whether fermentation took place before or after it was so used is a point which is not very clear,' but he was clear on its history: *rāgi* had been the Aryans' principal food and drink until they moved to the Ganges Valley and switched to rice, 'and, perhaps under the influence of Buddhism, gradually gave up intoxicating liquors, or "went dry".' Then they used substitutes for the *rāgi-Soma*, forgot its name and retained contact with it only as the food of the lowest caste, the &sacute;ūdras. Havell said that *Marua* when kept too long is nauseating and evil-smelling, in keeping with certain descriptions of Soma, but when fresh 'it is an exhilarating drink that easily intoxicates the uninitiated.' He then administered the coup-de-grâce: the Indo-European myth of the bringing of Soma from heaven by an eagle is explained by the simple fact that birds lined their nests with *rāgi*. One would hardly think that this argument merited rebuttal, but it did in fact stimulate an answer that was to become the last significant theory of Soma: Mukherjee's theory that Soma was hemp, *Cannabis sativa* (= *Cannabis indica*), known to the initiate as *bhang* (the Hindi term derived from Sanskrit *bhañgá*, m., or *bhañgā*, f.), ganja, hashish, marijuana, or pot.

VII. Mukherjee and the *Bhang* Theory

Braja Lai Mukherjee[195] picked unlikely grounds on which to challenge Havell's flimsy theory, which he said was based upon considerations 'which may be supplemented by others of a more important character,' *e.g.*, that there was no reference to cows' udders in the ṚgVeda.[196] He then supplied an elaborate 25-point argument to show that Soma was in fact not *Eleusine coracana* but *bhang*: *&sacute;atapatha Brāhmaṇa* 5.1.1.12 says that Soma is *u&sacute;ānā*;[197] Soma was 'originally amongst the Kirāṭas,' a mountain tribe; amongst the Kirāṭas, *u* and *a* were articular prefixes; therefore *u&sacute;ānā* = *&sacute;aṇa*; *&sacute;aṇa* is hemp; the Tanguts call hemp by the name *dschoma*; hemp = Greek *kanna* [sic] = Sanskrit *&sacute;aṇa*; the Tibetan word for hemp is *somaratsa*; the preparation of Soma is similar to that of *bhang*; the deity Mahādeva (&sacute;iva) is a lover of *bhang*; *bhang* is used by the modern representatives of the Vedic people in the celebration of worship of the goddess Durgā, which is a Soma sacrifice.[198] The final link in the argument is this: '*Bhang* is sacred to Hindus by tradition.' In sum, 'May we not conclude that the weight of evidence is in favour of the identification of Soma with *Cannabis* (*bhang*)?' This strange argument, combining linguistic reasoning with the purest twaddle, was further developed by Mukherjee in his book, *The*

---

[188] A. B. Keith: The *Taittirīya Saṃhitā*, Harvard Oriental Series, Volumes 18 and 19, 1914, introduction and p. 119.
[189] L. H. Mills: 'The Avestic H(a)oma and the Vedic Soma,' *Asiatic Review*, No. 8, 1916, p. 315.
[190] Vincent Smith: *Oxford History of India*, 1919, p. 23.
[191] E. W. Hopkins: 'Soma,' in Hastings' *Encyclopaedia of Religion and Ethics*, Vol. 11, Edinburgh, 1920, p. 685.
[192] Chapman Cohen: *Religion and Sex*, Edinburgh, 1919, p. 57.

193. E. B. Havell: 'What is Soma?', in the *Journal of the Royal Asiatic Society*, 1920, pp. 349 ff.
194. ṚgVeda IX 113.
195. Braja Lal Mukherjee: 'The Soma Plant.' *Journal of the Royal Asiatic Society*, 1921, p. 241.
196. This is untrue. *Vide supra*, p. 43.
197. This verse does not refer to Soma at all, but verses 3.4.3.13 and 4.2.5.15 of the Mādhyandina recension of the *&sacute;atapatha Brāhmaṇa* speak of a plant called *u&sacute;ānā*, from which Soma is made.
198. The Durgā celebration, the use of *bhang*, and the tradition that &sacute;iva uses *bhang*, are all late characteristics of Bengal &sacute;aivism.

Soma Plant,[199] which was reviewed in a brief paragraph by L. D. Barnett, who said blandly that Mukherjee made out a good but not always convincing case for hemp as Soma.[200]

Sir Charles Eliot expressed 'considerable doubt that Soma could be identified. He said it was a plant with 'yellow juice of a strong smell, fiery taste, and intoxicating properties,' and that the Parsis of Yezd and Kerman used Asclepiads.[201] N. B. Pavgee rebutted Havell without proposing any alternative, using the argument merely as a foil for his own hypothesis - that Soma was indigenous to the Saptasindhu region (*i.e.*, India proper) and was not 'brought in' by 'Aryans.' The Indo-Aryans were autochthonous in India, he wrote, and 'had not immigrated'; the Iranian Soma is, of course, spurious, but kept the old name. Soma could not be any kind of liquor, for liquor is an evil, while Soma - the true Soma - was 'exhilarating yet slightly intoxicating' and 'gave moral elevation'. Pavgee does not explain how this was done, nor does he identify the Soma plant.[202]

In 1922 Jakob Wilhelm Hauer published a work that lent a kind of peripheral support to the *bhang* theory, for he referred to the Soma cult as the most highly developed form of the use of narcotics to induce ecstasy, calling particular attention to the late Vedic hymn (X 136) that describes a long-haired sage who drinks poison with Rudra.[203] Hauer believed that Soma was the most important toxic means of inducing ecstasy, but not the only such means, and he suggested that the Vedic references might be traces of a primitive ecstatic practice of hallucination caused by certain plants.[204] Whether these 'plants' were Sarcostemmas, Afghan grapes, or hemp, Hauer neglects to say, but his final remark is more suggestive of a hallucinogenic plant than of anything else: opium is no longer used in a religious context, but every time we light up a good cigar we experience a faint reflection of the splendour of the rapture of the primeval ecstatic.[205] Though this ancient Yogic cult is clearly non-Vedic, presumably pre-Vedic, Hauer does not say whether he believes the Soma plant to have been the same as the drug of the 'primeval ecstatic', or perhaps a substitute for it. Yet his remarks are provocative in the context of the search for a hallucinogenic Soma plant.

VIII. Later Researches in the 20th Century

In 1924, Gilbert Slater advanced a novel hypothesis: that *amṛta* (Soma) was Egyptian beer, a fermentation of date juice or palmyra palm or coconut palm, brought to India from Mesopotamia.[206] This theory was noted but not accepted. Georges Dumézil maintained that Soma was native to India, and that it was the Indian substitute for the Indo-European 'sacred barley beer' rather than for the Indo-European mead that Oldenberg had postulated.[207] The beer was replaced by wine in Greece and by Soma in India, and the one word for this beer, or for a beverage with a cereal base which must have preceded it, was the sacred ritual name: ambrosia, the Greek ἀμβροσία [*ámvrosía*] and the Sanskrit *amṛta*, the elixir of immortality. Barley itself must have been Indo-European, as the linguistic evidence indicates: Greek χριθή [*chrithí*], Latin *hordeum*, Armenian *gari*, and various Celtic words for beer, *e.g.*, *cervesia* (Gallic) and *cuirm* (Irish). As for the sacred position of barley in India, Dumézil referred to the tradition that barley (*yava*) had stayed with the gods when all the other plants had left them, thus enabling the gods to conquer their enemies.[208] The *Mahābhārata* relates that the gods once churned the ocean in order to obtain the *amṛta*, but a terrible poison emerged and would have destroyed them all had &sacute;iva not swallowed it and saved them; in the light of Dumézil's theory that the *amṛta* is barley beer, this myth is an expression of excessive fermentation that must be arrested.[209]

---

199. Braja Lal Mukherjee: *The Soma Plant*, Calcutta, 1922.
200. L. D. Barnett: Review in *Journal of the Royal Asiatic Society*, 1923, p. 437.
201. Sir Charles Eliot: *Hinduism and Buddhism*, London, 1921, Vol. I, p. 69.
202. N. B. Pavgee: *The indigenous far-famed Soma and the Aryan Authochthones in India*, Poona, 1921, and 'Soma juice is not

liquor,' Third Oriental Conference, 1924, pp. 70-79.
203. Jakob Wilhelm Hauer: *Die anfänge der Yogapraxis im Alten Indien*, Berlin, 1922, p. 137.
204. *Ibid.*, pp. 57, 59, 61.
205. Hauer, *op. cit.*, p. 62.
206. Gilbert Slater: *The Dravidian Element in Indian Culture*, London, 1924, p. 78.
207. Georges Dumézil: 'Le Festin d'lmmortalité', *Annales du Musée Guimet*, No. 34, 1924, p. 279.
208. *&sacute;atapatha Brāhmaṇa*, 3.6.1.8-9.
209. Dumézil, *op. cit.*, p. 285.

Louis Lewin's *Phantastica: Narcotic and Stimulating Drugs* included Soma in the chapter on alcohol rather than narcotics, mentioning *Periploca aphylla*, *Sarcostemma brevistigma*, *Setaria glauca*, and *Ephedra vulgaris* as plants that had been identified with Soma, but he added: 'None of these plants is able to give rise to such effects as have been attributed to Soma. ... I regard Soma as a very strong alcoholic beverage obtained by fermentation of a plant.'[210] Elsewhere he suggested that the yogis might have used some sort of narcotic such as Indian hemp or scopolamine, but he did not identify this practice with the cult of Soma.[211]

The Sarcostemma theory returned yet again, this time in a paper by L. L. Uhl, who maintained that Sarcostemma, and not Ephedra, was the original Soma, saying that he had found *Sarcostemma brevistigma* frequently at latitude 15° in South India, where it is called Soma and is used in sacrifices.[212] Arthur Berriedale Keith expressed the view that the Soma problem, though insoluble, had led to 'interesting investigations, but to no sure result, and the only thing certain is that the plant, which has been used in modern India as the Soma plant, is one which would not be considered by modern tastes as at all pleasant in the form of pressed juice mixed with water.'[213] Then, somewhat echoing de Gubernatis' reasoning, Keith went on to say that although one can't be sure what was pleasant to a Vedic Indian, nevertheless it is likely that 'the drink was originally a pleasant one; in the course of time the long distance from which the shoots had to be brought may easily have made it less attractive, as it certainly encouraged the use of various substitutes described in the ritual text books.' Keith agreed with Hauer's suggestion that ṚgVeda X 136 might be a reference to the use 'of some poison to produce exhilaration or hypnosis,'[214]relating this to a verse about hemp (*&sacute;aṇa*) in the *Atharvaveda*,[215] but not to Soma. Elsewhere he observed that the Avesta does not call Haoma mead, and suggested that mead was the Indo-European drink and that Soma was identified with it when Soma was discovered, in India, and found to produce 'a juice pleasant to drink or at least intoxicating.'[216]

In 1926 G. Jouveau-Dubreuil wrote an article suggesting that Soma was none other than a species of Asclepias after all.[217] He had discovered that the Nambudri Brahmans (on the Malabar coast, in Kerala) of Taliparamba, who practiced 'pure Vedic ceremonies,' sent to a Raja in Kollangod at the foot of the high mountains to obtain their Soma plant, a leafless, milky, green creeper that was an Asclepiad. *Plus ça change* ... Yet neither the Sarcostemma theory nor the theory that Sarcostemma was merely a substitute was incompatible with the beer theory of Max Müller and Mitra (for the beer could be made with the Sarcostemma or the plant for which it was a substitute), nor were these or the wine theory incompatible with Oldenberg's mead theory (for the mead could have been replaced by any of the above in India), and so the theories continued to live side by side. Otto Schrader and A. Nehring maintained that the Indo-European honey was replaced by the Soma plant - still called *mádhu* - in Aryan times, while wine and beer were later substituted for it throughout Europe.[218] P. V. Kane was unconvinced by any of the theories, but mentioned that in the Deccan a plant called *rānsera* was used as a substitute for Soma.[219]

In 1931 Sir Aurel Stein published a paper entitled, 'On the Ephedra, the Hum Plant, and the Soma,'[220] describing a cemetery in Central Asia filled with packets of Ephedra twigs. Recalling the evidence for Ephedra as Haoma and Soma and quoting Wellcome's *Excerpta Therapeutica* for evidence that the Chinese use an Ephedra called *Ma-huang* to get an alkaloid drug (ephedrine), he then followed this with the assertion that Ephedra could *not* have been the original Soma, for it was bitter and Soma sweet, and Ephedra was not

---

210. Louis Lewin: *Phantastica: die betäubenden und erregenden Genussmittel*, Leipzig, 1924; published in London, 1931, as *Phantastica: Narcotic and Stimulating Drugs*, from which I cite the above information, p. 161, note.
211. *Ibid.*, p. 117.
212. L. L. Uhl: 'A contribution towards the identification of the Soma plant of Vedic times,' in *Journal of the American Oriental Society*, No. 45, 1925, p. 351.
213. A. B. Keith: *Religion and Philosophy of the Vedas and Upanishads*, Harvard Oriental Series, Volumes 31-2, 1925, pp. 172,

mountainous. He then concluded: 'The only result of these inquiries has been to direct my attention more closely to ... the wild rhubarb,' which grows in the mountains, has a fleshy stalk, and can be made into rhubarb wine, though Stein admits that the Indians do not do so.[221] Granting that the Vedic descriptions of the Soma plant could apply to Asclepias or rhubarb - or to anything else, for that matter - Stein nevertheless maintained that the descriptions of the Soma *juice* best applied to rhubarb. He added that the juice might be mixed with milk to facilitate fermentation, 'which alone could endow a juice like that obtained from the rhubarb with the exhilarating and exciting effect so clearly indicated in the Vedic hymns.'[222]

Perhaps the strangest episode in the history of Soma research came in 1933, with a truly Twentieth Century theory of Soma. Dr. Paul Lindner of Berlin published an article entitled, 'The Secret of Soma'.[223] He referred to a statement by E. Hubers that Soma was merely a decoction of barley or millet, into which the juice of the Soma plant had been added as a catalyst for fermentation (*Gärungserreger*), though it was unclear what kind of fermentation took place.[224] Lindner's own studies of the micro-organisms of the Agave in Mexico, particularly of *Thermobacterium mobile*, had brought him to the conclusion that yeast played only a secondary role in the fermentation, after the fermentation-bacteria had prepared the field. He went on to say that *Thermobacterium mobile* can produce alcohol in grapes and in cane sugar, and concluded that since the 'purity of fermentation' took precedence over the material fermented, even *Sarcostemma brevistigma*, *Calotropis gigantea*, or *Ephedra distachya*, which had been considered as 'the holy Soma plant,' might have yielded the juice 'which was enjoyed by young and old.' Lindner was convinced that *Thermobacterium mobile* was the most important fermenting agent of the tropics, and that the songs of praise to Soma really must have been 'dedicated to this *Bacterium*.' He suggested that the tropical explorers try '*TM*' in the juice of the Indian butter tree, *Bassia latifolia*, or the Ceylonese cowtree, *Gymnema lactiferum*, which have milky saps, the former sweet, the latter bitter. When Lindner himself had tried a spoonful of *TM* it had resulted in 'undiminished feeling of well-being and almost odourless excrement.'[225] Dr. Leo Kaps had treated patients in the Wilheminenspital in Vienna with *TM* beer and obtained extraordinary results, and a Swedish firm and a Viennese brewery were about to produce a *TM* beer with small alcoholic content. I have found no evidence that Soma-TM-beer was in fact manufactured nor any further reference to the Lindner theory after this initial publication.

An original and, in retrospect, provocative contribution to the argument was made in 1936 by Philippe de Félice.[226] He was unable to identify Soma but he described the plant in terms that seem remarkably up-to-date: he would probably have called Soma an 'hallucinogen', had the word existed. He deduced from the record that *Sarcostemma brevistigma* and similar plants had served to replace Soma toward the end of the Vedic period, when the Indo-Iranians in emigration were forced to use new drugs in place of Soma. Alcoholic drinks such as *súrā*, he thought, might also have come to be used. Then he continues:

> Instead of indulging in suppositions that no document supports, ought we not rather to ask ourselves whether, to arrive at the drink that plunged them into ecstasy, the ancient Indo-Iranians did not have recourse, like so many other primitive peoples, to some plant whose toxic properties they had discovered? This is what the examination of the texts seems to make clear. The liquor about which they speak is always drawn from a plant. This plant grows on the mountains which, as time passes, seem to become more and more distant, more and more inaccessible.[227] What serves to produce the mystical potion is neither the leaves nor the fruit, but always the stems. The juice is either red or clear yellow. It must be filtered or decanted, to eliminate certain elements that are disturbing or that perhaps risk rendering it too toxic.

283-4, 482.

[214] *Ibid*., p. 402.

[215] *Atharvaveda*, ed. Roth and Whitney, Berlin, 1855, IV.5.

[216] Keith, *op. cit*., p. 172.

[217] G. Jouveau-Dubreuil: 'Soma', translated by Sir R. Temple in the *Indian Antiquary*, No. 55, 1926, p. 176.

[218] Otto Schrader and A. Nehring: *Reallexikon der Indogermanischen Altertumskunde*, Berlin, 1929, Vol. II, p. 139.

[219] P. V. Kane: *History of Dharma&sacute;āstra*, 1930-62, Vol. II, part 2, chap. 33, pp. 1202-3.

[220] Sir Aurel Stein: 'On the Ephedra, the Hum Plant, and the Soma,' *Bulletin of the London School of Oriental Studies*, 6/2, 1931, pp. 501 ff.

221. Sir Aurel noted that Albert Regel had suggested rhubarb in 1884. *Vide supra*, p. 114.
222. Stein, *op. cit.*, p. 513.
223. Paul Lindner: 'Das Geheimnis um Soma,' *Forschungen und Fortschritte*, No. 5, 1933, p. 65.
224. E. Hubers: 'Schilderungen der Bierbereitung im fernen Osten,' in *Mitteilungen der Gesellschaft für Bibliographie und Geschichte des Brauwesens*. Lindner also cited J. Arnolds' *Origin and History of Beer and Brewing*.
225. '*unvermindertes Wohlbefinden und fast geruchlose Exkremente*.'
226. Philippe de Félice: *Poisons Sacrés, Ivresses Divines: Essai sur quelques formes inférieures de la mystique*, Paris, 1936, pp. 265-266.
227. The Indo-Aryans, spreading out east and south from the Indus Valley, were finding themselves increasingly remote from the Hindu Kush and the Himalayas. W.D.O'F.

> Sometimes it has a bad taste or even smacks of carrion; thus it is certainly not for pleasure that one drinks it. The inebriation that it provokes can present grave dangers: the spirit wanders, the drink can lead even to madness. It happens sometimes that the inebriation is accompanied by organic disturbances, which are in reality symptoms of an acute intoxication.
>
> Men know and fear the baleful effects of the drug, and, though he was a god, Indra himself did not escape them, since one day the Soma came forth from every opening in his body. This emeto-cathartic effect is confirmed in an old book of Hindu medicine. ...
>
> One may conclude from all this, it seems to us, that from the most remote antiquity the Indo-Iranians, when they were still dwelling together in their original home, possessed a special beverage reserved exclusively for the ceremonies of their religion and drawn from a toxic plant. The information that we possess about this plant unfortunately does not permit us to determine the species; but it is enough for us to classify it as among the toxic plants the use of which is widespread, for reasons of a mystical nature, in all parts of the world.

De Félice's reference to the emeto-cathartic effect of Soma is to the epithet *vamanī* in the Āyurvedic description and to the *Brāhmaṇa* story in which Soma injured Indra and flowed from his mouth and 'all the openings of his vital airs, and from his urinary tract'.[228]

Meanwhile the more conventional line of Vedic studies continued. L. van Itallie published an article in Dutch investigating the *Sarcostemma acidum* stalks in the light of the Soma plant; he described acids and alkaloids, carbohydrates and phytosterins, tannic acids and glycosides, but drew no new conclusions.[229] Johannes Hertel pointed out that there were many different kinds of Soma which scientific botany was unable to distinguish.[230] Henrik Nyberg referred to Soma-Haoma as an intoxicating drink made from a plant no longer identifiable, but he contributed obliquely to the *bhang* theory with his suggestion that Zoroaster was a shaman who drugged himself with hemp.[231] Nyberg himself, however, distinguished clearly between Haoma and hemp as plants, explaining Zoroaster's aversion to Haoma in the light of the belief that Haoma-drinking induced a state of intoxication (*Rausch*) rather than ecstasy.[232] Joges Candra Roy then developed Mukherjee's *bhang* hypothesis, adding to the original argument the facts that Soma is actually called *bhang* in the ṚgVeda;[233] that Soma is called a creeper nowhere in the ṚgVeda, but rather an herb (*óṣadhi*), a term which could apply to *bhang*; and finally that the Soma sacrifice 'was a feast and the drink added hilarity; *bhang* has been in use on similar occasions.'[234] Delli Roman Regni repeated the argument that Soma was not a fermented liquor but rather a

---

228. *&sacute;atapatha Brāhmaṇa* 1.6.3.1-7.
229. L. van Itallie, '*Soma-Haoma*, de heilige plant der Indiërs en der Perzen,' *Natuurwetenschappelijk tijdschrift* No. 19 (1937), pp. 1 and 9-11.
230. Johannes Hertel: 'Das Indogermanische Neujahrsopfer im Veda,' in *Mitteilungen der Sächsischen Akademie der Wissenschaften*, Vol. 90, 1938, p. 83.
231. Henrik Samnel Nyberg: *Die Religionen des Alten Irans*, Leipzig, 1938, pp. 177, 190, 290 and 341. He cites several Avestan references to hemp, among them *Yašt* 13.124, *Vendidad* 15.14. *Vendidad* 19.20, *Yasna* 44.20, and *Vendidad* 19.41. W. B. Henning rebutted this argument in his *Zoroaster: Politician or Witch-Doctor?*, Oxford, 1951; he considered Nyberg's theory one to be rejected 'without further consideration ... if one reflects on the effects of hemp, the physical, mental and moral deterioration it brings,' and he maintained that the Avestan citations, 'if correctly interpreted, can at the most serve to show that they cultivated hemp, possibly for the purpose for which hemp is cultivated all the world over - *i.e.*, to obtain its fibre.'
232. Nyberg, *op. cit.*, p. 288.
233. ṚgVeda IX 61[13]. *Bhañgá* here seems to be an epithet meaning 'intoxicating' (from *Bhañj*, to break, *i.e.*, to disrupt the senses), but the reading occurs only once and is uncertain. Macdonell suggests that the word *bhañgá* first applied to Soma, meaning

'intoxicating,' and then 'came to designate hemp' (*Vedic Index*, Volume II, p. 93). Otto Schrader suggests that *bhang* 'was originally prized for the intoxicating effects of its decoctions' (*Prehistoric Antiquities of the Aryan Peoples*, translated from the German and published in London, 1890, p. 299), but after the one questionable Vedic occurrence, *bhañga* appears in classical Sanskrit several times only to designate the plant, with no reference to any narcotic effects. The 8th century A. D. *&sacute;ārñgadhara Saṃhitā* (Bombay 1888; 1.4.19) is the first extant source that considers *bhañgā* a drug; it likens it to'the saliva of a snake,' *i.e.*, opium (*phenaṃ cāhisamudbhavam*) and the commentator adds that the effect is like that of inebriating liquor (*madyaviṣayavat*). The *Bhāvaprakā&sacute;a* (Chowkhamba edition, 1.1) refers to *bhañgā* (*mātulāni*) as intoxicating and causing hallucination (*moha*) and slow speech (*mandavāk*); and the *Dhanvantarīya-nighaṇṭu* describes *bhañgā* as intoxicating, bitter, stimulating talk, inducing sleep, and producing hallucinations.

[234] Joges Candra Roy: 'The Soma Plant,' *Indian Historical Quarterly*, No. 15, June 1939, pp. 197-207.

non-alcoholic 'syrup-like thing,'[235] and C. Kunham Raja maintained that, according to both the Vedas and the Avesta, Soma produced happiness (*máda*) while *súrā* produced evil intoxication (*durmáda*) and that Soma was a creeper with leaves, no longer available. Soma, he reasoned, had not time to ferment and if it had been an alcoholic drink the Indians would have substituted for it another alcoholic drink when it became unavailable, instead of the known non-alcoholic substitutes that they in fact used.[236] Yet the wine hypothesis - dead and killed again so often - reappeared in Ernst Herzfeld's *Zoroaster and his World*,[237] where he remarked that in 1931 he had received a letter from a New York gentleman who believed that a plant growing only in Persepolis - the *Salvia persepolitana* - was the Haoma, but that nothing had ever come of this communication. Herzfeld maintained that Soma must be a fermentation from grapes; that *aṃ&sacute;ú* means 'shoot, tendril, or bunch of grapes; that the god Homa is the Aryan Dionysos; and that 'to thus define *homa* means to explain how wine [cultivated all over Iran before the advent of the Aryans and after] could remain unknown to the Avesta, and how the cultivation of *homa* [common in the Avesta] could disappear in Iran long before the Arab conquest. The solution is evident: *homa* is vine, wine.'[238] He adds that Haoma could not possibly be *bhang* because 'the use of hashish in Zoroaster's time is an imagination. The mysterious *homa* is wine, a reality ... Nothing is known of the use of hemp as a narcotic prior to the Arsacid period.'[239]

Still R. N. Chopra held to the Sarcostemma theory,[240] mentioning also the possibility of *Periploca aphylla*;[241] earlier, Chopra had also done extensive work with the Ephedras.[242] Karl Geldner in his translation of the ṚgVeda maintained that Soma could only be a species of Ephedra, probably *Ephedra intermedia* or *E. pachyclada*, the fruit of which is red and eaten by children and the stem of which is dried and taken in water as a treatment for fever.[243] Though he himself admitted that the juice was described as red, he nevertheless reiterated the old tradition that the 'milk' of the plant must be white, citing as support for this the verses that he had translated as Soma juice *mixed* with milk (IX 91$^{2\text{-}3}$ - '*nicht ganz klar*') or Soma delighting us with the 'milk' (*i.e.*, the expressed fluid) of the stem (IX 107^{12}).

Chinnaswami Sastri published, in 1953, an article demonstrating that Soma was not wine, reviewing the *Brāhmaṇa* substitutes, and concluding that the Soma juice was neither an intoxicant nor a stimulant.[244] The

---

[235] Delli Roman Regni: 'The control of liquor in Ancient India,' *New Review*, Calcutta, November 1940, p. 382.
[236] C. Kunham Raja: 'Was Soma an intoxicating drink of the People?', *Adyar Library Bulletin*, No. 10, 1946, pp. 90-105.
[237] Ernst Herzfeld: *Zoroaster and his World*, Princeton, 1947, Volume II, pp. 543 ff.
[238] Bracketed material appears elsewhere in Herzfeld.
[239] The first certain European reference to the use of hemp as a drug in India is in García d'Orta's record of a conversation with the Sultan Badar in Goa in 1563. The Sultan confessed that whenever in the night he had a desire to visit Portugal and Turkey and Arabia, 'all he had to do was to eat a little *bangue*...' In 1676 Henrich van Rheede (van Draakenstein), the governor of Malabar, published his *Hortus Indicus Malabaricus* in Amsterdam (written in Latin and Dutch), in which he called attention to a plant named *bangi* that was smoked like tobacco and caused inebriation (Vol. 10, p. 67). George Everhard Rumph in 1755 described at length, in Latin, the effect of the *Cannabis sativa* (also known as *ginji*) upon the natives, likening the plant to the Homeric νηπενθές [*nipenthés*]... For the inhabitants of these regions, not content with the natural virtue of wine, which, however, they do not possess in great quantity, or with the other types of wine tree of that place, on the ground that in their opinion it elates one for a short time only, have devised from this plant such things as are able at a moment to remove anxieties of the heart, grief, or fear of dangers; yet this cannot be, except by a violent commotion of the senses and clouding of the intellect, which they themselves call drunkenness but we call inanity, which is usually followed by mania or a stupid condition.' (Rumphius, *Herbarium Amboinense*, Amsterdam, 1755; volume 5, p. 208). By 1868 *bhang* was so well known that Lord Neaves honored it with this bit of doggerel:

The hemp - with which we used to hang
Our prison pets, yon felon gang -
In Eastern climes produces Bang,

Esteemed a drug divine.

240. R. N. Chopra, S. C. Nayar, I. C. Chopra: *Glossary of Indian Medicinal Plants*, 1956.
241. R. N. Chopra *et al.*: *Poisonous Plants of India*, 1949, Vol. I, p. 683.
242. R. N. Chopra, S. Krishna, and T. P. Ghose, 'Indian Ephedras, their Chemistry and Pharmacology,' *Indian Journal of Medical Research*, No. 19, 1931-2, pp. 177-219; and *cf.* S. Krishna and T. P. Ghose, 'Indian Ephedras and their Extraction,' *Journal of the Indian Society of Chemistry*, No. 48 T, 1929, p. 67.
243. Karl Geldner: *Der Rig-Veda*, published in Harvard Oriental Series, Volumes 33-35, 1951, Vol. III, p. 2. Part I of an earlier version of Geldner's translation had been published in Leipzig in 1923, but Geldner died before the completion of Part III (which included the Soma hymns).
244. Chinnaswami Sastri: 'Soma-svarūpavimar&sacute;a,' in *Our Heritage*, No. I, Calcutta, 1953, 80-86.

orthodoxy of Sri Chinnaswami's position may be indicated by the fact that his article is written in Sanskrit. Reinhold F. G. Müller pointed out the references to Soma in the Hindu medical books and concluded that fermented drinks, *súrā*, and brandy could have been used as substitutes, but he remarked that evidence of the process of distillation in India before Islam had not been proven.[245] Mircea Eliade expresses the view that ritual intoxication by means of hemp, opium, and other plant drugs is characteristic of a decadent period of shamanism, and that such means were only reluctantly admitted into the sphere of classical Yoga. He remarks, however, upon Patañjali's reference to herbs as a source of meditative powers and on the ṚgVedic description of the sage drinking poison.[246] He points to the use of opium and hashish in ecstatic and orgiastic sects in India, but he does not comment on Soma's possible status as such a drug, nor indeed upon the nature of the ecstasy induced by Soma, though he treats of the Vedas - and of ecstasy - at great length.[247]

A. L. Basham says that Soma is not what the Parsis now call Haoma (for the latter has no inebriating qualities), nor is it alcoholic (for it was consumed on the same day that it was pressed), and he goes on: 'The effects of Soma, with "vivid hallucinations" and the sense of expanding to enormous dimensions, are rather like those attributed to such drugs as hashish. Soma may well have been hemp... from which modern Indians produce a narcotic drink called *bhang*.'[248] Several Indian works were then published which investigated certain previously ignored plants as possible Soma plants: Nadkarni and Nadkarni identified the 'moon-creeper' with *Pæderia fœtida* , a plant used for the treatment of rheumatism;[249] P. V. Sharma called *Crimun latifolium*, a plant whose leaves and roots are emetic and purgative, the *som-vel*.[250]

V. G. Rahurkar arose to combat the alcohol theory, insisting that the Vedic references to *ṛjīṣá* and *tiróahnya*[251] show that Soma did not have time to ferment; he supported Oldenberg's mead hypothesis and concluded: 'Soma juice, thus, seems to be an orgiastic ... non-alcoholic syrup-like ... enervating drink. It was not even a fermented liquor.'[252] B. H. Kapadia says that Soma's 'fruit' is red and fleshy and liked by children;[253] that it seems to have been a creeper (he cites *atasá* and *vána*);[254] and that it is an inflexible bush with dense, upright, leafless stalks. Still, Pentii Aalto states that Soma fermented for one to nine days; 'the alcohol percentage cannot have been high. Perhaps the juice of the plant contained narcotic ingredients.'[255]

The possible nature of these 'narcotic ingredients' was the subject of an article by Karl Hummel, who gave Vedic citations to establish that the Soma plant must be mountainous, yielding copious sap, and golden red in color.[256] Noting the opinions of Regel and Sir Aurel Stein, Hummel maintained that rhubarb best satisfied the requirements, for rhubarb is known to grow in the mountains of inner Asia, to yield a copious green-gold sap which turns reddish brown after standing for a while, and, of course, to be bright red, or, in some species, golden. Moreover, rhubarb is known to contain the drug Emodin; the problem of the supposed sweetness of the Soma juice, a quality absent from rhubarb juice, is easily solved by the assumption that the Indo-Aryans mixed Soma with honey, as well as with barley and milk. And as for intoxicating properties, also absent from the rhubarb juice, Hummel maintained that these were sufficiently supplied by the mere *sight* of the glorious

---

245. Reinhold F. G. Müller: 'Soma in der Altindischen Heilkunde,' *Asiatica, Festschrift f&uumlr Friedrich Weller*, Leipzig, 1954, p. 428-441.
246. Patañjali (*Yogasūtram*, Kā&sacute;ī Sanskrit Series No. 85, Benares, 1931; verse 4.1) states that *auṣadhi* (herbs) and *samādhi* (meditation) are methods of obtaining *siddhi* (perfection through yoga).
247. Mircea Eliade: *Le Yoga, Immortalité et Liberté*, Paris, 1954; republished by Bollingen, 1958, in English translation as *Yoga: Immortality and Freedom*, p. 338.
248. A. L. Basham: *The Wonder That Was India*, London, 1954, pp. 235-6.
249. K. M. Nadkarni and A. K. Nadkarni, *Indian Materia Medica*, Bombay, 1954.
250. P. V. Sharma, *Dravya Gun Vigyan*, Benares, 1956.

red stalks in the eyes of 'the naive people.' A more conventional source of intoxication - *i.e.*, fermentation - was cited by N. A. Qazilbash to support his choice for Soma - *Ephedra pachyclada*.[257] Qazilbash maintained that the absence of latex in the Ephedra did not disqualify' it, for only the later Sanskrit writers, and never the ṚgVeda, attributed the presence of latex to the Soma plant. *Ephedra pachyclada* grows abundantly all along the Hindu Kush and Suleman ranges and yields a number of alkaloids, including L-ephedrine, Ephedra, and Pseudo-ephedrine, which act similarly to the hormone adrenalin and are used (in the form of crushed green twigs of *Ephedra pachyclada*) in Khyber and parts of Afghanistan as aphrodisiacs; it was Qazilbash's belief that at the time of the ṚgVeda the Ephedra plant was allowed to ferment, yielding a liquor that contained alcohol and ephedra alkaloids; 'the liquor, therefore, was intoxicating and possessed invigorating and stimulating effects ... [and] ... aphrodisiacal effects.'[258]

G. M. Patil remarks upon Soma's unparalleled intoxicating and invigorating nature. 'This intoxicant made [the Vedic people] talkative and inspired them to fight. It made them forget their mental and physical agonies, and therefore, it was a wonderful herb...'[259] Jan Gonda reiterated the hydromel theory,[260] and Alain Daniélou at first supported the theory of Soma as the creeper *Sarcostemma brevistigma*,[261] but later he seems to have amended his views in favor of Indian hemp ('*le chanvre Indien*') as the plant from which the ancient Soma drink was made.[262] Yet the growing dissatisfaction with conventional theories of Soma and increasing familiarity with drug-induced religious experiences have led many modern scholars to venture onto new territory; Leopold Fischer suggests that the state of mind evinced by the Soma texts 'comes much closer to alkaloid drug experiences than to alcoholic intoxication.'[263]

It is ironic that one of the earliest Vedic beliefs about Soma - that it was brought by a bird[264] - appears as a scientific criterion in two of the most recent studies of the Soma plant. Varro E. Tyler discards *Periploca aphylla* as a possibility because it 'occurs only at low altitudes in the mountains, contains a gummy latex not utilizable as a beverage, and lacks fleshy fruits attractive to birds ... [Soma's] fruits are eaten by birds which disperse the seeds in the mountains, thereby propagating the plant.'[265] He also discards the Ephedra theory because 'it is very difficult to express much juice from these xeromorphic plants,' though he adds that *Ephedra pachyclada* when boiled in milk is used as an aphrodisiac and that 'the ash of the plant is mixed with tobacco to produce an intoxicating mixture which is applied to the gums.' Bringing similar objections against the rhubarb plant, he concludes: 'Either the ancient hymns of the *Rigveda* and the *Avesta* are gross exaggerations of fact or there grows in the vast mountain ranges of north-west India a plant whose CNS-stimulating properties, so well-known to the old inhabitants, still remain hidden from modern man.'[266]

A far more thorough article was published in the same year by J. G. Srivastava, but he too held fast to the importance of the agency of the bird, and to another long-disputed criterion: the ṚgVedic verse that some have misinterpreted as attributing to the Soma plant a thousand boughs.[267] He supports the latter implication with a verse from the *Rājanighaṇṭu* which according to him describes the climber as having 'several stems from the root-stock',[268] and with a verse from the *Su&sacute;ruta Saṃhitā* which gives the Soma plant 'a tuberous root'.[269]

---

[251] *ṛjīṣá* (which occurs only once, ṚgVeda I 32[6]) is thought by some to refer to the part of the Soma stalk left over after the juice has been expressed; Grassmann takes it to mean 'rushing forward freely', and, as it applies to Indra rather than Soma, this is more likely, *tiróahnya*, 'having lasted through yesterday', is an adjective applied to Soma.
[252] V. G. Rahurkar: 'Was Soma a spirituous liquor?', *Oriental Thought*, No. 2, 1955, pp. 131-149.
[253] B. H. Kapadia: *A Critical Interpretation and Investigation of Epithets of Soma*, Mahavidyalaya, Vallabha, 1959, pp. 4 and 35.
[254] *atasá* means 'bush, undergrowth, or shrub'; *vána* means 'tree'. Their relationship with Soma in the ṚgVeda is inconclusive.
[255] Pentii Aalto: 'Madyam apeyam,' in *Johannes Nobel Commemoration Volume*, Jñānamuktāvalī International Academy of Indian Culture, New Delhi, 1959, pp. 17-37.
[256] Dr. Karl Hummel, Tübingen: 'Aus welcher Pflanze stellten die arischen Inder den Somatrank her?', *Mitteilungen der Deutschen Pharmazeutischen Gesellschaft und der Pharmazeutischen der DDR*, April 1959, pp. 57-61.

[257] N. A. Qazilbash: 'Ephedra of the Rigveda,' *The Pharmaceutical Journal*, London, November 1960, pp. 497-501.
[258] R. Hegnauer, in his *Chemotaxonomie der Pflanzen* (Basel, 1962, Vol. I, pp. 451-460), discusses in detail the toxic effects of various Ephedras, identifying several of them with the Soma plant on the basis of Qazilbash's work.
[259] G. M. Patil: 'Soma the Vedic Deity,' *Oriental Thought*, No. 4, 1960, pp. 69-79.
[260] Jan Gonda: *Die Religionen Indiens*, Stuttgart, 1960, Vol. I, p. 64.
[261] Alain Daniélou: *Le Polythéisme Hindou*, Paris, 1960, p. 111.
[262] Alain Daniélou: *L'Erotisme Divinisé*, Paris, 1962, p. 53.
[263] Agehananda Bharati (Leopold Fischer): *The Tantric Tradition*, London, 1965, p. 287.

264. *Vide supra*, p. 96. The belief that the Soma was brought from heaven by a falcon appears frequently throughout the ṚgVeda and other Indo-European sources. *cf.* A. Kuhn, *Mythologische Studien, I: Die Herabkunft des Feuers und des Göttertranks*, Gütersloh, 1886. Also *cf.* ṚgVeda I 80^{2}, III 43^{7}, IV 18^{13}, IV 26^{6}, V 45^{9}, IX 68^{6}, IX 77^{2}, IX 86^{24}, X 11^{4}, X 99^{8}, X 144^{4}, *etc.*
265. Varro E. Tyler. Jr.: 'The Physiological Properties and Chemical Constituents of Some Habit-Forming Plants: Soma-Homa, Divine Plant of the Ancient Aryans', *Lloydia*, Vol. 29, No. 4, December 1966, p. 284.
266. *Ibid*., p. 285.
267. ṚgVeda IX 5^{10}. *Sahásraval&sacute;am*, the adjective in question, modifies *vánaspátim*, which refers to the tree of sacrifice, not to the Soma plant.
268. J. G. Srivastava, 'The Soma Plant,' *Quarterly Journal of Crude Drug Research*, No. 6 (1966), I, p. 811. This seems to be a translation of the phrase cited above and translated as 'having great clusters' (*vide supra*, p. 99).
269. Srivastava does not give the Sanskrit for this particular phrase but it may be a translation of *aṃ&sacute;uman* (*vide supra*, p. 99).

Granting however that the ṚgVeda itself never attributes to the plant the qualities of a climber or milky latex, Srivastava goes on to mention several other plants with which the Soma has been identified, including the *Centella asiatica*, *Cocculus hirsutus* (used as a laxative and a cure for venereal diseases), *Fraxinus floribundus*, *Psoralea corylifolia* (used to cure leprosy), *Cæsalpinia crista*, and *Thespesia lampas* - most of these cited by the *Āyurvedic Kosh*. He disqualifies the genus Sarcostemma and the *Periploca aphylla* because birds do not disperse their fruits; he disqualifies *Vitis vinifera* because it does not have the 'twigs and stalks' that 'the *Rig-veda* clearly states' to have been used; and finally he settles back upon the Ephedra, whose 'seeds are covered by red, succulent, edible bracts, and are dispersed by birds,' and whose medical properties - which he describes at length - are commensurate with the fame of the Soma plant.[270]

Most recently an article by J. P. Kooger appeared to summarize briefly the major Soma theories, including Wasson's *Amanita muscaria* thesis, based on the note presented by Wasson in 1966 at the Peabody Museum of Natural History at Yale University. Referring to Wasson's theory as 'sensational' (*opzienbarende*) and likely to deal a great blow to extant theories, he nevertheless concluded that the mystery surrounding the identity of the Soma plant was by no means solved.[271]

Some years ago, R. C. Zaehner revived the rhubarb suggestion by referring to Haoma in these rather qualified terms: 'The Haoma plant (from its description as yellow and glowing probably something very like our rhubarb, which is found in the Iranian mountains to this day)...'[272] More recently, he mentioned to me the possibility that Haoma might be the wild chicory, which grows in the mountains of Persia, though he considers this suggestion merely a shot in the dark. But in actual fact, what else have all the other theories been but just that? Some ingenious, some thoughtful, some obviously silly, some plausible, some vague, some stubbornly wrong-headed, some Procrustean, some groping toward the truth - but all shots in the dark.

Not knowing what plant the poets of the ṚgVeda had in mind, modern scholars have often jumped to the conclusion that the hymns are vague and obscure in speaking of Soma. The *Brāhmaṇas*, dealing as they do with involved chains of substitutes, add to the confusion in almost geometric progression; the few Avestan parallels are rendered more or less useless by the overlay of purely Iranian elements; and by the time the Europeans enter the scene, with their fixed ideas and various axes to grind, the situation approaches bedlam. Handicapped by a rudimentary knowledge of the vernacular and ancient languages of India and by inadequate communication in the academic world, scholars covered the same ground over and over again. Time and time again the same ideas appear, are disproved, and reappear as if they were proven theories; scholars draw upon the work of their colleagues and occasionally upon newly discovered primary materials, but there is remarkably little attention to the ṚgVeda itself. (Hillebrandt, Roth, and Geldner are notable exceptions.) Even within these limits, there seems to have been little contact between botanists and Vedists, Indian scholars and Europeans.

Fairly convincing evidence that Soma was not an alcoholic beverage was established quite early, yet Europeans continued to identify it with various forms of alcohol, and Indians continued to put pen to paper in order to assure the world that wine - which is of course anathema to an orthodox Hindu - was not Soma. The word for intoxication is ambiguous both in Sanskrit (*máda*) and in European languages; it denotes drunkenness or inebriation resulting from alcohol, but it may also apply to a mental state *similar* to that produced by alcohol. Thus the statement that Soma was 'intoxicating' as it appears in various discussions and in the ṚgVeda itself does not really exclude *any* plant capable of producing a state of exhilaration, including narcotic or psychotropic plants. The further vagueness of such terms as 'liquor' and 'strong spirits' blurred the distinction between fermentation and distillation, as does the uncertain connotation of the term *súrā*. All of this served to mask the inappropriateness of the identification of Soma with alcohol.

Often scholars tended to confuse the question of the identity of the plant with the nature of the process by which the drink was made from it, overlooking the fact that the beer theory, the mead theory, and the Sarcostemma theory are complementary rather than opposed, while only such theories as those postulating wine or *bhang* exclude all others. And, on the other hand, this failure to distinguish substance from method led several scholars to attempt a combination of various theories that are in fact incompatible.

It was difficult to resist the temptation to identify the Vedic plant with the plant actually used by the descendants of the authors of the Vedas, no matter how many facts argued against this identification; and in fact one is inclined to believe that there must be *some* relationship between the original and the substitutes, some quality in the substitute which resembled a quality of Soma enough for it to have been chosen in the absence of Soma, but the question remains as to which quality - taste or colour or effect or shape - this might conceivably be.

B. H. Kapadia remarked, 'Many Latin names are given for this plant like Ephedra, *etc*., but we do not know exactly about it,' and this could surely stand as the epitaph for the greater part of the research done in those halcyon days of science - the nineteenth century, particularly the nineteenth century in Germany - when one still felt that by giving a categorizing Latin name to an unknown quantity one had somehow settled something. To argue whether Soma was *Sarcostemma brevistigma*, or *Ephedra pachyclada*, or *Periploca aphylla* was to assure oneself that the Soma plant had been found and that there only remained a few messy details to be cleared up; this led to smugness and a general disinclination to delve further that might not have existed had one been forced to call the plant 'milkweed' or 'some sort of rue'. It is at first striking that *bhang* was not considered as a possibility until 1921, but it is more understandable when one takes into consideration the greater attention that the psycho-physiological effects of drug-taking have received in recent times, especially in contrast with the universal disapprobation with which they were formerly associated.[273] Only in the last few generations have the anthropologists, botanists, and pharmacologists of the West entered fully into the problems presented by psychotropic plants and their role in the history of human cultures. The use of hashish in the Middle East has, of course, long been known, but until twenty years ago only as a curiosity. The discovery of mescaline by the modern world is almost a century old, and for some years has provoked widespread attention.

Aldous Huxley, one of the leading writers on this subject in recent times, gave the name 'Soma' to an unspecified marvellous drug in his novel *Brave New World*, in 1932. In his last novel, *Island* (1962), he depicted a Utopia that is clearly Indian throughout - Sanskrit is the language of the cult, &sacute;iva is worshipped, and Yoga is essential to the philosophy of the islanders. And the drug upon which the cult of the Island is based is an hallucinogenic mushroom. That the mushroom is yellow and traditionally collected high in the mountains might suggest that Huxley had *Amanita muscaria* in mind - even that he was thinking of the Soma of the ṚgVeda, although he says expressly that the 'moksha-medicine' (as it is called) is *not* one of 'those lovely red toadstools that gnomes used to sit on.'[274] Later in 'Culture and the Individual'[275] Huxley, discussing the genesis of *Island*, says that he had been thinking of 'a substance akin to psilocybin', the active agent in the divine mushrooms of Mexico. The Wassons played a major part in the re-discovery of the Mexican psilocybin cult and Wasson himself had discussed his Mexican mushrooms and the Soma problem with Huxley in the late 1950's.

Certainly as soon as one rids oneself of the assumption that anything 'intoxicating' must be alcoholic, an hallucinogen of some kind seems the likely candidate for Soma, far more likely than millet or Afghan grapes or rhubarb or any other of the many plants that have been suggested. Few Vedic scholars knew any botany and some of them may not have realized that they were dealing with a problem primarily botanical. The botanists on the other hand could not read the ṚgVeda, by far the most important source about Soma, and so they

---

270. Srivastava, *op. cit.*, p. 816.
271. J. P. Kooger, 'Het Raadsel van de Heilige Soma-Plant der Indo-Iraniers, '*Pharmaceutisch Tijdschrift voor België*, 44th year, No. 7, 1967, pp. 137-143.
272. R. C. Zaehner: *The Dawn and Twilight of Zoroastrianism*, London, 1961, p. 88.

permitted themselves to enter upon speculations that often seem ludicrous in the light of the Vedic hymns. But on behalf of both Vedists and botanists it is only fair to recall that for the most part the Soma question had for them merely a peripheral interest. Though the identification of Soma remained a desideratum of Indian studies, no outstanding figure applied himself directly and fully to the solution of this enigma. The historians of religion seem likewise to have given it only glancing attention.

---

273. In this context, it is interesting to note that by 1884 Regel had rejected *bhang* (*Cannabis indica*) as a possibility for the Soma plant. *Vide supra*, p. 114.
274. Aldous Huxley: *Island*, Penguin ed., 1964, p. 140.
275. An essay published in *The Book of Grass*, an anthology edited by George Andrews and Simon Vinkenoog, Grove Press Inc., New York, 1967, pp. 192-201. The passage cited is on p. 200.

PART THREE

NORTHERN EURASIA AND THE FLY-AGARIC

I. The Fly-agaric in Siberia: the Testimony of Explorers, Travelers, and Anthropologists

In the Exhibits we have assembled all the basic sources that we could find on the use of the fly-agaric for inebriating purposes in Siberia. They include a miscellany of travelers (a few of them Innocents Abroad), explorers and scientists on governmental mission, and anthropologists; also some linguists who discuss a fascinating word cluster that relates to our theme. We have added three secondary sources for particular reasons.

The earliest of our authors **[**1**]** is a poor Polish lad, not endowed with much education, who kept a diary of his stay in Siberia as a prisoner of the Tsar. An entry in that diary records the fact that in 1658 he saw the Ob-Ugrian Ostyaks getting drunk on the fly-agaric. Our latest paper is by two Soviet scientists **[**42**]** living in Vladivostok who in the fall of 1966 contributed an epitaph to the ancient practice:

> The minor nationalities of Siberia and the Far East now do not use any psychoactive drugs. ... After the October Socialist Revolution and the establishment of Soviet Power these not numerous peoples have embarked on a new way of historical development. Formerly backward nationalities on a borderland of Russia, with the help of the Russian people and Soviet Power, they soon reached the socialist phase of social development.

The Soviet Union has never allowed foreigners to visit these 'minor nationalities'.

The testimony of our writers is of course worth only as much as the writers are worth. A few of them - notably the English-speaking contingent **[**14, 15, 20**]** and the one Frenchman **[**7**]** - lack understanding. They are superficial and disdainful, and most of their information seems to come from local Russian informants of dubious reliability, or from earlier writers whom we have also quoted, or else read and discarded as worthless. (*Vide*, *e.g.*, Kennan **[**14**]** citing Oliver Goldsmith, who in turn paraphrased von Strahlenberg **[**3**]**.) The ignorance about mushrooms of these writers in English and French seems to have been complete. We reprint what they had to say because they are often quoted as sources but they are worthless.

When Erman **[**11**]** informs us that Toyon's wife transplanted a number of baby fly-agarics from the forest to her garden where he saw them some days later flourishing in their big scarlet caps, the mycologist raises his eyebrows. When he says that a native pays a reindeer for one fly-agaric in the off-season, we accept this, as other witnesses testify to the high value placed on the marvelous plant by those who used it.

Some of the Siberian tribesmen live in filth and indulge in practices that shock and revolt those Europeans whose sense of scientific detachment is not phenomenally developed. If in addition the observer is a mycophobe, taught from childhood to turn away with a shudder from a 'toadstool', his impulses will surely overpower his objectivity. Europeans have long held the fly-agaric to be lethal. The testimony of our writers on this will certainly be found surprising. Many of them and among the most trustworthy expressly acquit the fly-agaric of causing death; in fact, they testify that, properly dried, it has no bad effects. When a few of the writers mention deaths from the fly-agaric each of those deaths should be weighed carefully. Is there a single witness (some of whom spent not months but years and even a decade among the natives) who saw a man die from fly-agaric eating, or who was present in a settlement at the time of such a death? I think not. Does the reported death come from a native informant or from a fellow European, probably a mycophobe? If the latter, is it only hearsay in the foreign community, perhaps the very same death that was reported by Krasheninnikov **[**4**]** in his book published in the middle of the 18th century, a death that he himself reported as hearsay? If the source is native, is it of the kind - highly significant - that is accepted as veridical, according to Kai Donner **[**28**]**, in the upper Yenisei among the Ket and the Selkup; *viz.*, that only shamans and those who are to become shamans can eat the fly-agaric with impunity; all others will surely die. (Lehtisalo [24] records similar shamanic beliefs.) Donner is not discussing vital statistics: he translates us to a different realm. We are in the presence of fossil survivals of remote beliefs, a sanction for violating a tabu, and it is precisely the sanction (at the time a projection of a surmise) that led my wife and me decades ago to suspect that our own remote ancestors had worshipped a mushroom and that a heavy tabu, surviving to this very day, had been laid on eating it. Death will come if the layman presumes to eat the forbidden fruit, the Fruit of Knowledge, the Divine Mushroom of Immortality that the Taoists talk about and that the poets of the ṚgVeda celebrated. The fear of this 'death' has lived on as an emotional residue, long after the shaman and his religion have faded from memory, and here is the explanation lor the mycophobia that has prevailed throughout northern Europe, in the Germanic and Celtic worlds, in particular for the macropsia with which the north Europeans - and not least the mycologists and toxicologists - have viewed the poisonous properties of the fly-agaric.

There is a consensus among our writers that the natives of Siberia consumed the fly-agaric only after drying it. Von Strahlenberg [3] says that water is poured on it, then the water and mushrooms are boiled and the liquor is drunk. He does not mention dried mushrooms, but as he is speaking of winter they must have been dried. He and von Langsdorf [10] are the only ones who mention cooking the fly-agaric. Krasheninnikov [4] says that the dried mushrooms are steeped in the must of an Epilobium, which later writers have identified as the Russian *kiprei*, *Epilobium angustifolium*. (The 'must' is *not* fermented.) Krasheninnikov is the only source to mention Epilobium, but there seems no reason to doubt his word. It is natural, given the scattered population in Siberia and the poor communications, that customs vary from settlement to settlement, and even within the same settlement, from shaman to shaman. Steller [5] says that 'the fly-agarics are dried, then eaten in large pieces without chewing, being washed down with cold water.' Georgi [6], on the other hand, is responsible for the statement that in the Narym region the natives either eat one fresh mushroom or drink a decoction of three; but he is suspect as a witness. According to von Langsdorf [10], the Kamchadal prefer to leave the mushrooms to dry in the ground, exposed to the natural air and the sun. Small ones with many warts, he says, are the best and the most powerful. They are swallowed whole, being swallowed with the juice of bilberries (*Vaccinium uliginosum*), either one large mushroom or two small. Erman [11] and von Maydell [12] mention that they are taken dry, von Maydell adding that they are smoked and shrivelled up. Enderli's [19] description is classical on this point:

> At the man's order, the woman dug into an old leather sack, in which all sorts of things were heaped one on top of another, and brought out a small package wrapped in dirty leather, from which she took a few old and dry fly-agarics. She then sat down next to the two men and began chewing the mushrooms thoroughly. After chewing, she took the mushroom out of her mouth and rolled it between her hands to the shape of a little sausage. The reason for this is that the mushroom has a highly unpleasant and nauseating taste, so that even a man who intends to eat it always gives it to someone else to chew and then swallows the little sausage whole, like a pill. When the mushroom sausage was ready, one of the men immediately swallowed it greedily by shoving it deep into his throat with his indescribably filthy fingers (for the Koryaks never wash in all their lives).

The Koryak told Sljunin [18] that the fresh fly-agarics are highly poisonous and hence they do not eat them. They are dried, either in the sun or over the fire, and then consumed with fresh water to wash them down. Karjalainen [26], speaking of the shaman's ways among the Irtysh Ostyak, says that they swallow whole either three or seven mushroom caps, which may be fresh or dried: the Irtysh usage runs counter to the trend among our witnesses in that the shaman may take fresh mushrooms. Kannisto [33] speaking of the Vogul cultures reports that the mushrooms are dry when they are used. Lehtisalo [24], discussing the Yurak shamans (northern Samoyeds), tells us that the mushrooms must be fully grown and dry. Jochelson [21] also confirms that they are taken dry. There is no aspect of the fly-agaric on which there is more testimony than this, and the witnesses are almost unanimous. Particularly impressive is the quotation that we give in [30] from an heroic hymn of the Vogul people, where the hero, the 'two-belted one', addressing his wife, says, 'Woman, bring me in my three sun-dried fly-agarics!'

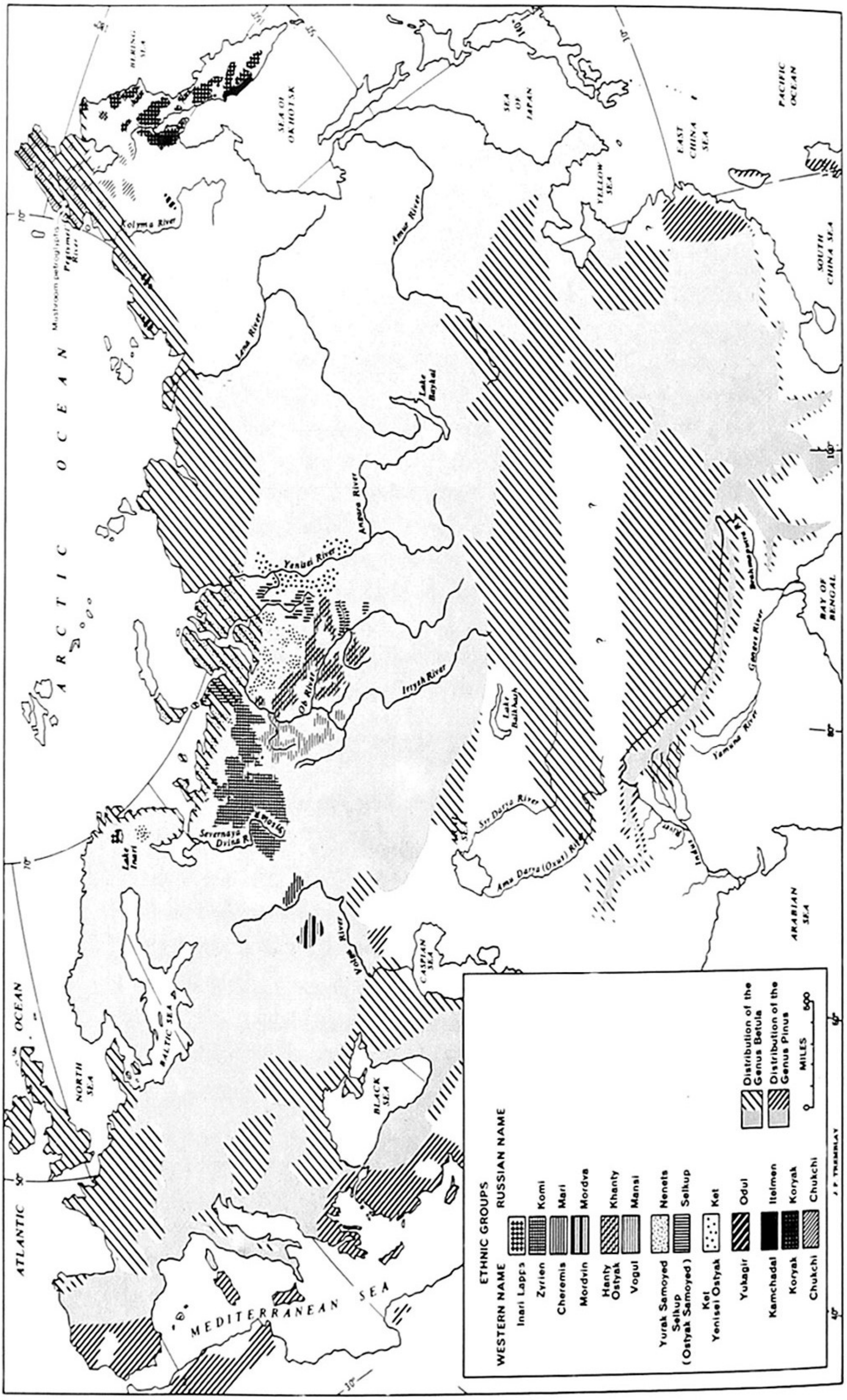
THREE MAPS

The data for our maps are drawn from the following sources:

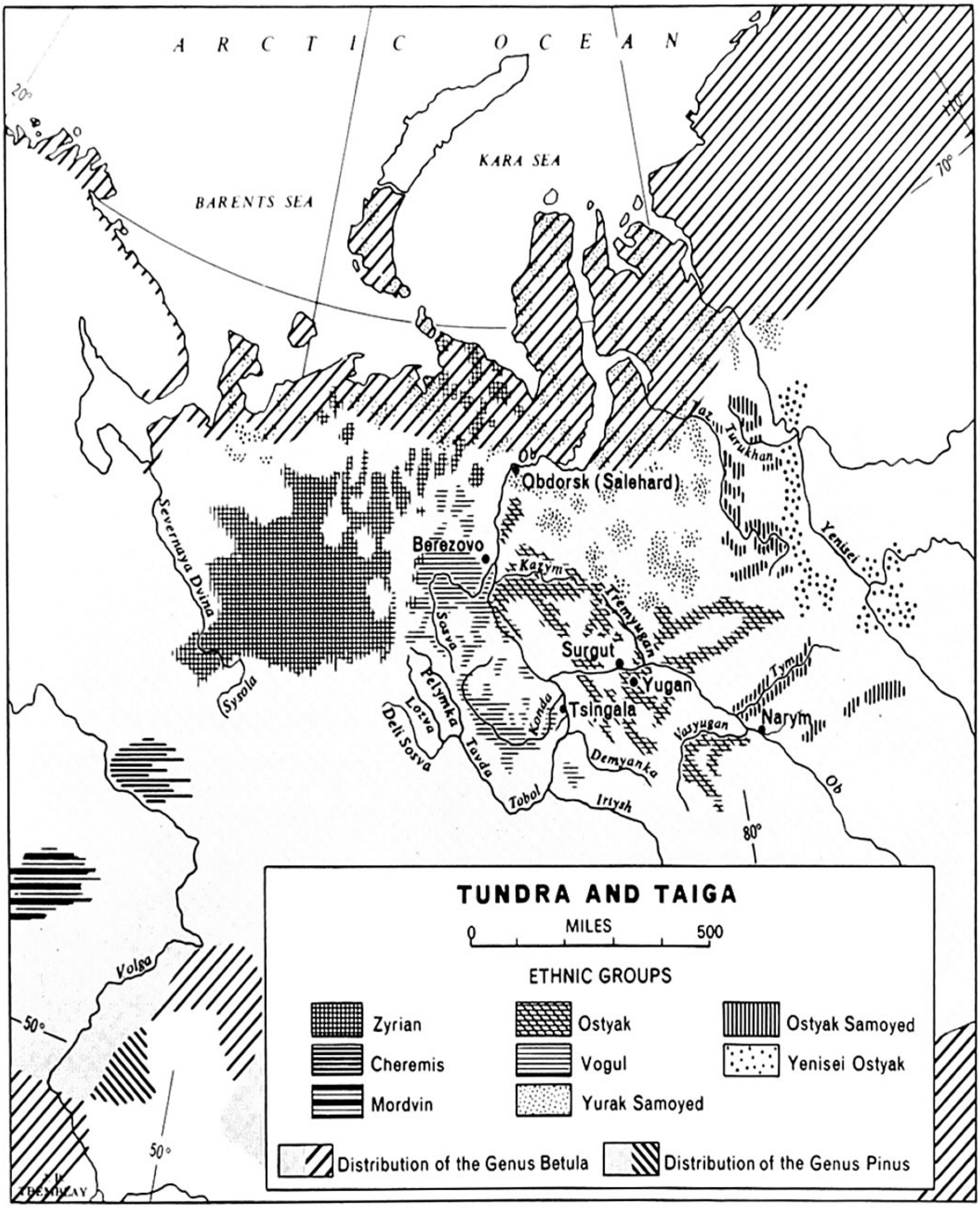
A. the ethnic distribution from the map accompanying *The Peoples of Siberia*, M. G. Levin and L. P. Potapov, Editors, originally published in Moscow and Leningrad in 1956 under the title *Narody Sibiri*; translated into English under the editorship of Stephen Dunn and published by the University of Chicago Press, 1964;

B. for the distribution of the genus Betula we have relied chiefly on *Trees & Shrubs of the USSR*, S. Ja. Sokolov, ed., Ac. of Sciences, USSR, Moscow and Leningrad, 1951, vol. II, text fig. 72, p. 267: supplementing this source by data from the Gray Herbarium;

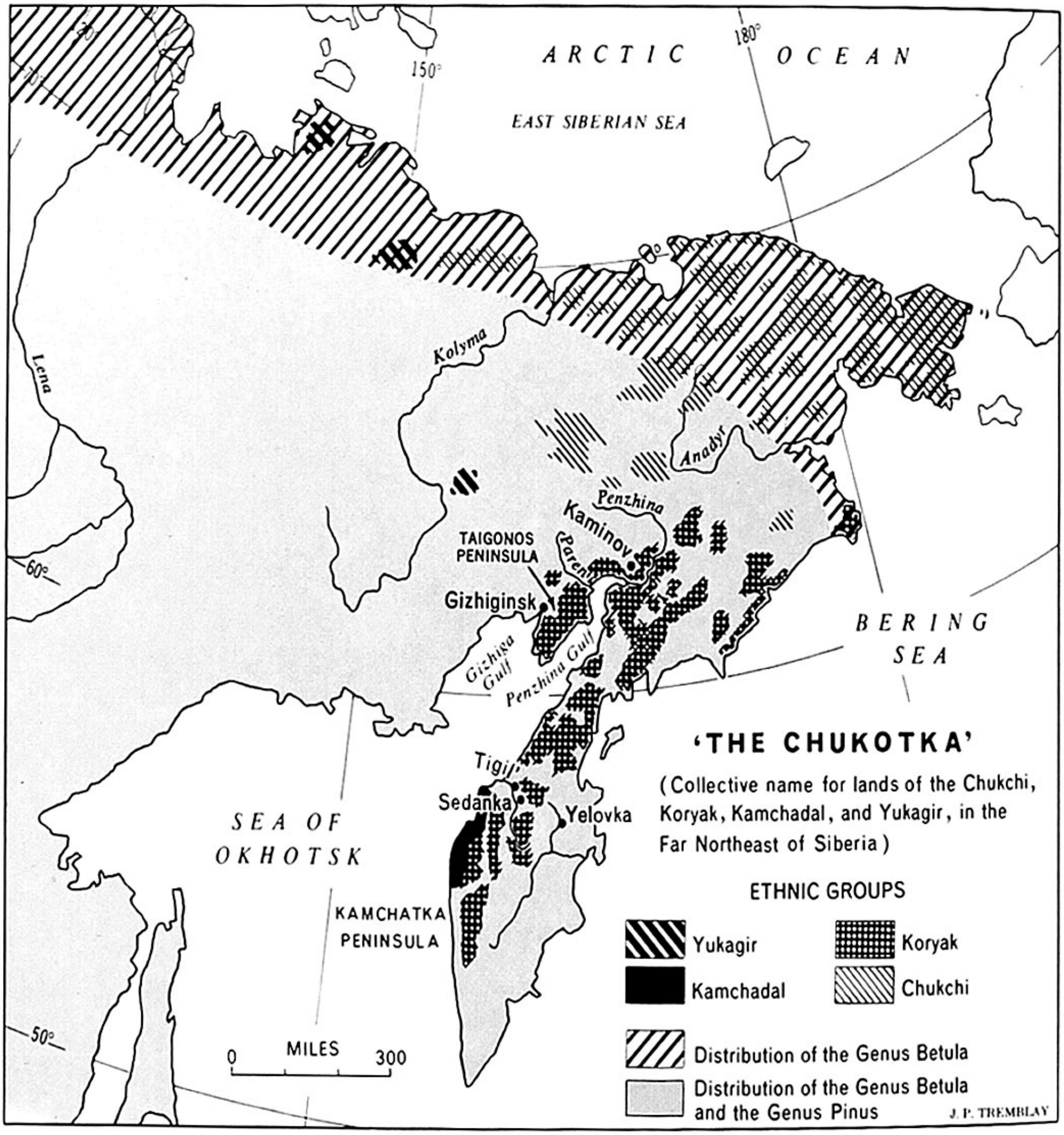
C. for the distribution of the genus Pinus we rely on *Geographic Distribution of the Pines of the World*, by Wm. B. Crichfield and Elbert L. Little, Jr., Forest Service of the U.S. Department of Agriculture, Washington, D.C., February 1966. The distribution of firs and other conifers is generally within the confines set by the pines.


ARCTIC OCEAN
ATLANTIC OCEAN
PACIFIC OCEAN
BERING SEA
SEA OF OKHOTSK
SEA OF JAPAN
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
BAY OF BENGAL
ARABIAN SEA
CASPIAN SEA
BLACK SEA
MEDITERRANEAN SEA
NORTH SEA
BALTIC SEA
Kolyma River
Lena River
Amur River
Lake Baykal
Angara River
Yenisei River
Ob River
Irtysh River
Lake Balkhash
Syr Darya River
Amu Darya (Oxus) R.
Severnaya Dvina R.
Volga River
Lake Inari
Indus River
Ganges River
Yamuna River
Brahmaputra R.
Mushroom petroglyphs
Pegtymel River
ETHNIC GROUPS
WESTERN NAME
RUSSIAN NAME
Inari Lapps
Zyrien
Komi
Cheremis
Mari
Mordvin
Mordva
Hanty Ostyak
Khanty
Vogul
Mansi
Yurak Samoyed
Nenets
Selkup (Ostyak Samoyed)
Selkup
Ket Yenisei Ostyak
Ket
Yukagir
Odul
Kamchadal
Itelmen
Koryak
Koryak
Chukchi
Chukchi
Distribution of the Genus Betula
Distribution of the Genus Pinus
MILES
0
500
J. P. TREMBLAY
10°
30°
40°
60°
70°
80°
100°

A


ARCTIC OCEAN
BARENTS SEA
KARA SEA
20°
70°
110°
80°
50°
50°
Obdorsk (Salehard)
Ob
Berezovo
Kazym
Tremyugan
Surgut
Yugan
Tsingala
Narym
Tym
Vasyugan
Demyanka
Irtysh
Tobol
Tavda
Konda
Sosva
Pelymka
Lozva
Deli Sosva
Sysola
Severnaya Dvina
Volga
Yenisei
Turukhan
Taz
Ob
TUNDRA AND TAIGA
0 MILES 500
ETHNIC GROUPS
Zyrian
Cheremis
Mordvin
Ostyak
Vogul
Yurak Samoyed
Ostyak Samoyed
Yenisei Ostyak
Distribution of the Genus Betula
Distribution of the Genus Pinus
THEMMLAY

B


ARCTIC OCEAN
180°
150°
70°
EAST SIBERIAN SEA
Kolyma
Lena
60°
50°
Anadyr
Penzhina
Kaminov
Paren'
TAIGONOS PENINSULA
Gizhiginsk
Gizhiga Gulf
Penzhina Gulf
BERING SEA
'THE CHUKOTKA'
(Collective name for lands of the Chukchi, Koryak, Kamchadal, and Yukagir, in the Far Northeast of Siberia)
Tigil
Sedanka
Yelovka
SEA OF OKHOTSK
KAMCHATKA PENINSULA
ETHNIC GROUPS
Yukagir
Koryak
Kamchadal
Chukchi
Distribution of the Genus Betula
Distribution of the Genus Betula and the Genus Pinus
0 MILES 300
J. P. TREMBLAY

C

Thus it seems that drying is of the essence. The natives think that the fresh ones are dangerous, or at least not satisfactorily inebriating. Some say that eating many fresh mushrooms will kill you, but how do we know? I did not realise this when I went to Japan in the fall of 1965 and 1966, and with Japanese friends tried the fresh fly-agarics. The ṚgVeda had not prepared me for the drying. I had known of course that the Soma plants were mixed with water before being pounded with the pressing stones, but I had supposed that this was to freshen up the plants so that they would be capable of yielding juice when pressed. The desiccation, I thought, was an inevitable consequence of bringing the mushrooms from afar and keeping them on hand. There was nothing to tell me that desiccation was a *sine qua non* of the Soma rite. The reader may think that I should have familiarized myself with the Siberian practice before going to Japan. I agree. Imazeki, who by chance toasted his caps on one occasion before eating them, alone had satisfactory results, insistently declaring that this was nothing like alcohol, that this was far superior, in fact in a different world. Alone among us all, he has known *amṛta*, the ambrosia of the Immortals.

As for the harm that the fly-agarics might be expected to provoke, our witnesses give revealing testimony.

Georgi **[**6**]** says that the natives

> feel much less head after this method of intoxication than is produced by spirituous liquors; nor is the use of it followed by any dangerous consequences.

Kopeć's experiences **[**9**]** with the mushrooms, for what they are worth, were benign and pleasant; he was not moved to violence. Von Langsdorf **[**10**]** says that although he made great efforts to find out something about the harmful or possibly deadly effects of the fly-agaric, he could obtain no satisfactory information on the subject.

> The Koryaks [he goes on] greatly prefer fly-agarics to the Russians' vodka and maintain that after eating fly-agarics a man never suffers from headaches or other ill effects. It is true that in extremely rare cases (of which no one could recall any specific example) persons who consumed an extraordinarily large quantity of the mushrooms are said to have died in convulsions, senseless and speechless, after six or eight days. However, it is not reported that moderate consumption ever produced any harmful after-effects. If, contrary to expectations, immoderate consumption of fly-agarics should nevertheless be followed by pressure on the stomach or some other disturbance, two or three spoonfuls of fat, blubber, butter, or oil are reputed to be an infallible remedy.

(Sljunin **[**18**]** gives an alternative antidote: '... a glass of vodka or diluted alcohol. A quarter of an hour after swallowing the vodka, the Koryak who is totally oblivious of his environment under the effect of the mushroom, completely regains consciousness.') Erman **[**11**]** quotes a native informant as saying that

> mushroom intoxication had a quite different effect from alcoholic drunkenness, since the former put the Kamchatka natives into a peaceful and gentle (*skromno* in Russian) mood, and they had seen how differently the Russians were affected by spirits.

Von Maydell **[**12**]**, who passed the decade from 1861 to 1871 in Siberia, confirms the impression conveyed by his predecessors:

> ... the mushroom produces only a feeling of great comfort, together with outward signs of happiness, satisfaction, and well-being. Thus far the use of the fly-agaric has not been found to lead to any harmful results, such as impaired health or reduced mental powers.

In a footnote he adds that he had been told of one fatal case, a Russian who died after eating rather large quantities of fresh mushrooms. He 'had been told': again we are in the realm of hearsay.

Von Dittmar **[**13**]** says substantially the same:

> Mukhomor eaters describe the narcosis as most beautiful and splendid. The most wonderful images, such as they never see in their lives otherwise, pass before their eyes and lull them into a state of the most intense enjoyment. Among the numerous persons whom I myself have seen intoxicated in this way, I cannot remember a single one who was raving or wild. Outwardly the effect was always thoroughly calming - I might almost say, comforting. For the most part the people sit smiling and friendly, mumbling quietly to themselves, and all their movements are slow and cautious.

According to Sljunin **[**18**]**, the Koryak maintain that the continued consumption of the mushroom has no ill effect on the person's health. Enderli **[**19**]** reports that after a period of lethargy and monotonous singing, the mushroom eater is suddenly seized with a frenzy, raving and calling for drums, and then begins a deafening spell of singing, drumming, and running around within the confines of the yurt. He concludes with this sentence: '... immoderate consumption involves the danger of madness or death, but such cases occur rarely.' If he had seen or heard of an actual death, he is such an excellent reporter that he would certainly have told us about it. Jochelson and Bogoraz **[**21, 22**]** report no murderous outbreaks by fly-agaric eaters, and Jochelson says that to his question as to which they preferred, brandy or fly-agaric, many Koryak answered, 'Fly-agaric.' Jochelson added: 'Intoxication from the latter is considered more pleasurable, and the reaction less painful, than that following brandy.'

In these comments of various observers there is nothing that suggests the berserk-raging of the Vikings. Murderous ferocity marked the Viking seizures almost always, whereas murderous ferocity is conspicuously absent from our eye-witness accounts of fly-agaric eating in Siberia. In most of the reports the effect is soothing, *skromno*; sometimes there is a noisy inebriation. Both are familiar to us as expressions of alcoholic inebriation and both are harmless. The ardent advocate of a link between the fly-agaric and berserk-raging must content himself as best he can with the testimony of Krasheninnikov [4]: 'The Kamtschadales and the Koreki eat of it when they resolve to murder anybody.' This generalisation is hearsay: had he known of a particular episode, he would have reported it. Thus he tells us about four Russians who ate the fly-agaric, three of them in his entourage and one by hearsay. They were a menace only to themselves. This is the consensus of all the witnesses, and even here the threat to themselves is often hearsay, perhaps a reflex of the conventional attitude of Europeans when speaking of inebriation. Reguly and, after a lapse of some forty years, Munkácsi took down from native Vogul singers an Heroic Song concerning the Creation of the World. This song [30], drawn from the depths of the Vogul culture, is alone enough to demolish the berserk-raging notion of the Scandinavians. Our Hero had eaten three sun-dried fly-agarics and lay in a stupor when there bursts in upon him a messenger with news of the enemy's imminent invasion. The messenger urges the 'bemushroomed' Hero to throw off his inebriation and to come and lead the fight. The Hero replies that he has no strength and sends the messenger to rally his younger brothers. It is only on the second call that the Hero pulls himself out of the fly-agaric stupor and calls for his arms.

So far as we know, only two of our witnesses ate the mushroom: Kopeć [9], whose colourful narrative we publish for the first time in English, and Donner [28], who unfortunately and rather primly gives us no details other than that it is a powerful intoxicant. None drank of the urine. But a number of the Russians who settled in Siberia took to the fly-agaric, at least for a time. Many of our witnesses speak of this, and there is a startling sentence in Erman [11, p. 253] reading as follows:

> … the Russians of Klynchevsk, who according to the man from Yelovka pick whole packhorse loads of this valuable plant, prepare an extract by decocting it in water, and try to take away its extremely disgusting taste by mixing the extract with various berry juices.

What is surprising in this passage is the formula that the Russians hit on: extracting the juice with the help of water and adding various vehicles to make the drink palatable. In ancient times Soma was mixed with water and pounded with stones, then mixed with milk or curds or barley-water or honey; in Klynchevsk they mixed the extract with the juice of berries.

A fairly consistent picture of the fly-agaric syndrome emerges from reading the accounts of our witnesses. Krasheninnikov [4] says that in moderation it raises the spirits and makes one brisk, courageous, and cheerful, but if indulged in to excess, it leads to trembling, a merry or melancholic mood according to one's disposition, and macropsia: 'a small hole appearing to them as a great pit, and a spoonful of water as a lake.' Von Langsdorf [10] confirms the macropsia: 'If one wishes to step over a small stick or straw, one steps or jumps as though the obstacles were tree trunks.' So do von Maydell, Sljunin, Bogoraz, and Jochelson [12, 18, 22, 21]. There is often vomiting and at some stage sleep supervenes, during and after which one sees marvelous visions, *not* erotic according to von Maydell [12]; 'highly sensuous' according to Enderli [19]. Kopeć [9] seems to confirm Enderli. (We wonder how von Maydell knew the fly-agaric did not give erotic pleasure.) A number of our witnesses testify to the increase in strength that can be expected: von Langsdorf [10] met eye-witnesses who said that a man inebriated with the mushroom had been able to carry a 120-lb. sack of flour 10 miles, and Bogoraz [22] describes one under the influence of the fly-agaric:

> His agility increases, and he displays more physical strength than normally. Reindeer-hunters of the Middle Anadyr told me that before starting in canoes in pursuit of animals, they would chew agaric because that made them more nimble on the hunt. A native fellow-traveler of mine, after taking agaric, would lay aside his snowshoes and walk through the deep snow hour after hour by the side of his dogs for the mere pleasure of exercise, and without any feeling of fatigue.

Von Langsdorf [10] declares that according to the statements of the natives, those who have taken the fly-agaric in moderation feel 'extraordinarily light on their feet and are then exceedingly skillful in bodily movement and physical exercise.' Erman [11] confirms this:

> There is no doubt ... about a 'marvelous increase in physical strength', which the man praised as still another effect of the mushroom intoxication. 'In harvesting hay', he said, 'I can do the work of three men from morning to nightfall without any trouble, if I have eaten a mushroom.'

The Chukotka tribesmen personify the mushroom as little men or women. Krasheninnikov [4] was the first to call attention to this. 'It is observed, whenever they have eaten of this plant, they maintain that, whatever foolish things they did, they only obeyed the commands of the mushroom.' (We quote from the 18th century rendering by James Grieve.) Jochelson and Bogoraz [21, 22] ratify this. The former writes: 'The idea of the Koryak is that a person drugged with agaric fungi does what the spirits residing in them (*wapaq*) tell him to do;' and the latter: 'The spirits of the fly-agaric have an outward appearance similar to that of the actual mushrooms, and the agaric-eater feels impelled to imitate them.' The Koryak and Kamchadal tales that we reprint are shot through with this personification of the mushroom. Among the Ob-Ugrians Lehtisalo [24] observes the same phenomenon. The mushroom eater enters the realm of the little people, talks with them, learns from them what he wishes to know - the future, the outlook for a sick person, *etc*. Among the Ob-Ugrians the divine mushroom seems to have retained more of its sacred character. It plays a role in the myths of creation and, as we have seen, there are vestiges of stern tabus on its use by unqualified persons.

Of all the properties of the fly-agaric as it is used in Siberia, the one that has drawn the most attention is its effect on the urine of the person who eats it. The inebriating virtue of the mushroom passes into the urine, whence the custom in the Chukotka of drinking the urine. This is amply confirmed by all our best sources and there can be no doubt about its truth. No one knows to this day the chemical composition of the inebriant. No one can say whether the drug in the mushroom is identical to the drug in the urine. Perhaps alien elements in the mushroom, such as sometimes cause nausea, are filtered out in the urine. To von Langsdorf [10] alone goes the credit of having asked some of these questions:

> I was not able to ascertain whether the consumption of fly-agaric is followed by constipation or diarrhœa or by an increase or decrease in the urine.
>
> I was also unable to obtain any satisfactory answer when I asked whether the taste or smell of the urine had been changed; everyone was probably ashamed to admit that he had drunk his own or someone else's. Nevertheless it strikes me as not improbable that fly-agarics, like turpentine, asparagus, and other things, impart a special, possibly quite pleasant, smell and taste to the urine. By analogy it would be worth investigating whether other narcotic substances, such as opium, *Digitalis purpurea*, cantharides, *etc*., also retain their properties in the urine.

Many of the best names on our list of sources discuss this practice of urine drinking: von Strahlenberg [3], Krasheninnikov [4], Steller [5], von Langsdorf [10], Erman [11], von Maydell [12], von Dittmar [13], Sljunin [18], Enderli [19], Jochelson [21], and Bogoraz [22]. But those who describe the Uralic and Ket practices are silent about the urine. It is to be assumed that these tribes do not know its virtue, or that knowing it, they do not indulge in it. They are closest to Russia and perhaps have been under the Russian influence more strongly than the peoples of the far Northeast. Perhaps fly-agarics are so common in their forests that they have no need to resort to their own urine to supplement the supply. We can only regret that none of the writers about these peoples seem to have put the question to them. If we have interpreted ṚgVeda IX 74[4] correctly, the Indo-Aryans were drinking urine impregnated with the fly-agarics 3,500 years ago, and before then the Indo-Aryans had come south from a region adjacent to an Uralic people, with whom it is to be assumed that they shared their fly-agaric eating propensities, inluding perhaps the urine-drinking.

By assembling as many of the sources as I could find and laying them before the reader, his attention is called as it has never been before to the peculiar and perhaps significant role of the reindeer in the fly-agaric complex of Siberia. Reindeer have a passion for mushrooms and especially for the fly-agaric, on which they inebriate themselves. Reindeer have a passion for urine and especially human urine. When the human urine is impregnated with fly-agaric, what a regal cate is there, to be served to a favoured reindeer! Steller [5], who stayed behind in Siberia when Krasheninnikov [4] returned to Russia, was the first to call attention to this. Von Langsdorf [10] saw the importance of this and quotes Steller *in extenso* on it. Erman [11] bears independent witness to the fact in an astonishing paragraph. Bogoraz [22] stresses the passion of the reindeer for human urine, which is likely to make it dangerous to relive oneself in the open when there are reindeer around. The curious account of the death of two reindeer given by Sarychev [8], slightly garbled though it must be, seems to relate to the same phenomenon. Before I had read Steller **[**5**]** and Erman **[**11**]**, I made my suggestion on pp. 75-76 that living as some of these tribesmen do in intimacy with the reindeer, almost in a symbiotic relationship with them, they may have found it easy to indulge in the drinking of the urine in imitation of the beasts. Here then would be the genesis of the urine-drinking that has astonished the West.

What is the relationship between the hallucinogenic mushrooms of Middle America and the fly-agaric complex of Siberia?

The mushrooms are utterly different. The fly-agaric is an Amanita. The sacred mushrooms in Mexico are far removed, belonging to the Psilocybe, Stropharia, and Conocybe genera, these genera being closely interrelated. The drugs in the Mexican mushrooms are psilocybin and psilocin. We do not know what the drug is in the fly-agaric, or perhaps the drugs. The Mexican mushrooms keep one awake for about four or five hours, and then one falls into a deep, dreamless slumber for a couple of hours; there is no hangover. Though one remains awake and experiences hallucinations, one has little or no desire to move about. There is no macropsia. At the very moment one can talk about the marvels that one sees, and exchange comments with one's neighbors, but there is no kinetic agent in the mushrooms. By contrast, in Siberia some tribesmen feel an urge to talk loudly or shout and sing, to dance, to run about, to perform feats of physical activity. In Siberia stress is laid on the visions one has during a profound sleep that, according to most of our sources, comes at the end of ten or twelve hours, and also during the waking hours that follow.

There is one point of similarity. In each case nausea and vomiting occasionally occur in some persons. When the mushrooms act as an emetic immediately or a few minutes after they are ingested, it is a remarkable fact that in both cases the vomiting has no effect on the later inebriation. I have experienced this myself in Mexico. Von Langsdorf **[**10**]** is our witness for Siberia:

> ... people who have eaten a large quantity of mushrooms often suffer an attack of vomiting. The rolled-up mushrooms previously swallowed whole are then vomited out in a swollen, large, and gelatinous form, but even though not a single mushroom remains in the stomach, the drunkenness and stupor nevertheless continue, and all the symptoms of fly-agaric eating are, in fact, intensified.

There is a striking similarity in the imaginative world of the Mexican Indians and the tribesmen of Siberia: both have created a community of dwarfs who take over. In Mexico the mushrooms command. They speak through the *curandero* or shaman. He is as though not present. The mushrooms answer the questions put to them about the sick patient, about the future, about the stolen money or the missing donkey. The mushrooms take the form of *duendes*, to use the Spanish term; dwarfs in English. Similarly the eater of fly-agarics comes under the command of the mushrooms, and they are personified as amanita girls or amanita men, the size of the fly amanita.

If I am asked whether there is any genetic relationship between the two areas in the light of the similar mushroom practices, I should say that to harbor such a thought would be hazardous. The Indians of the New World have shown themselves supreme in the arts of the herbalist, discovering properties in the plant kingdom from which we Europeans have learned much. The Indians were certain to discover the divine mushrooms (as they think them to be) and it was natural, given their cultural background, that they should personify them as *duendes* and think they were speaking through the shaman's words. The same thing was true with the Siberian tribesmen. Both cults are, in my opinion, thousands of years old and autonomous in origin.

II. A Far-Reaching Siberian Word-Cluster

A remarkable pattern of linguistic evidence marks the fungal vocabulary of many Siberian tribes and the European peoples. Specialists in the Uralic family of languages have greatly contributed to the Uralic aspect of this problem, but no first class scholar has dealt with the linguistic and cultural aspects of the entire pattern of fungal words that are scattered throughout northern Eurasia from the Iberian peninsula to Bering Strait. I can do no more than assemble some of the evidence and pose the questions that call for answers.

1. The Antiquity of Fly-Agaric Inebration

In the Vogul language all words relating to drunkenness are derived from the word for fly-agaric, *paŋχ*, and its innumerable variants according to the dialect. This means that Vogul speakers, when they talk of getting drunk, say that the man is 'bemushroomed'. But it is important to note that the Vogul speaker is not aware of the etymology of the word: he uses it without thinking of the fly-agaric, whether the man was 'bemushroomed' on alcohol or fly-agaric. This is similar to our use of the word 'drunk'. If we say the shaman is getting 'drunk' on fly-agaric, it would not occur to us that he does not 'drink' the fly-agaric. If the Vogul speaker says that that foreigner was 'bemushroomed' yesterday on vodka, it never occurs to him that one drinks alcohol, instead of eating a mushroom. Just as our basic word in English is a secondary meaning derived from a beverage that one drinks, so in Vogul the basic word is derived from the fly-agaric. The fly-agaric was the original inebriant and probably the only one.

Vogul is an Ugrian language. In Zyrian (= Komi), a Finnic language, there are a number of words, *pagal-*, *pagav-*, *etc.*, meaning to lose consciousness as from alcohol. Uotila [34, 38] tells us that they are derived from ⋆*pag-*, and are cognate with the Vogul *paŋχ*. The Zyrians do not use the fly-agaric today, but these words would indicate that their ancestors did so.

It seems certain that these words go back to a time when fermented drinks (not to speak of their distillate, alcohol) were either not known at all or were unimportant, to a time when the fly-agaric was *the* inebriant. It seems that they go back to a time before the Ugrian and Finnic languages became differentiated, centuries before Christ.

But our story does not end there. Castrén [24a] in the last century reported the word *faŋkáˀam*, 'to be drunk', in the Tavgi language, belonging to the northern Samoyed group. It this attestation is sound, and Uralic scholars treat it seriously, then the beginnings go back far indeed. For between the Finno-Ugrian languages and the Samoyed languages there exists precisely the same p~t shift that we find distinguishing the Latin and Germanic languages; *e.g.*, Latin *pater*~ English 'father'. The Tavgi word, manifesting this basic shift, cannot therefore be a borrowing from Vogul or Zyrian. It goes back to a common ancestor, before the Uralic peoples divided into the Samoyed and the proto-Finno-Ugrian, certainly thousands of years before Christ. We cannot say when the fly-agaric was first used in the northern reaches of Eurasia. We can say, if Castrén is to be relied on, that it was being used when the ancestral tongue of the Uralic peoples split up. In any case we feel safe in saying, on the evidence supplied by the Uralic languages, that the fly-agaric was being invoked as a divine inebriant before the Aryans left their ancestral home and long before the ṚgVeda was composed.

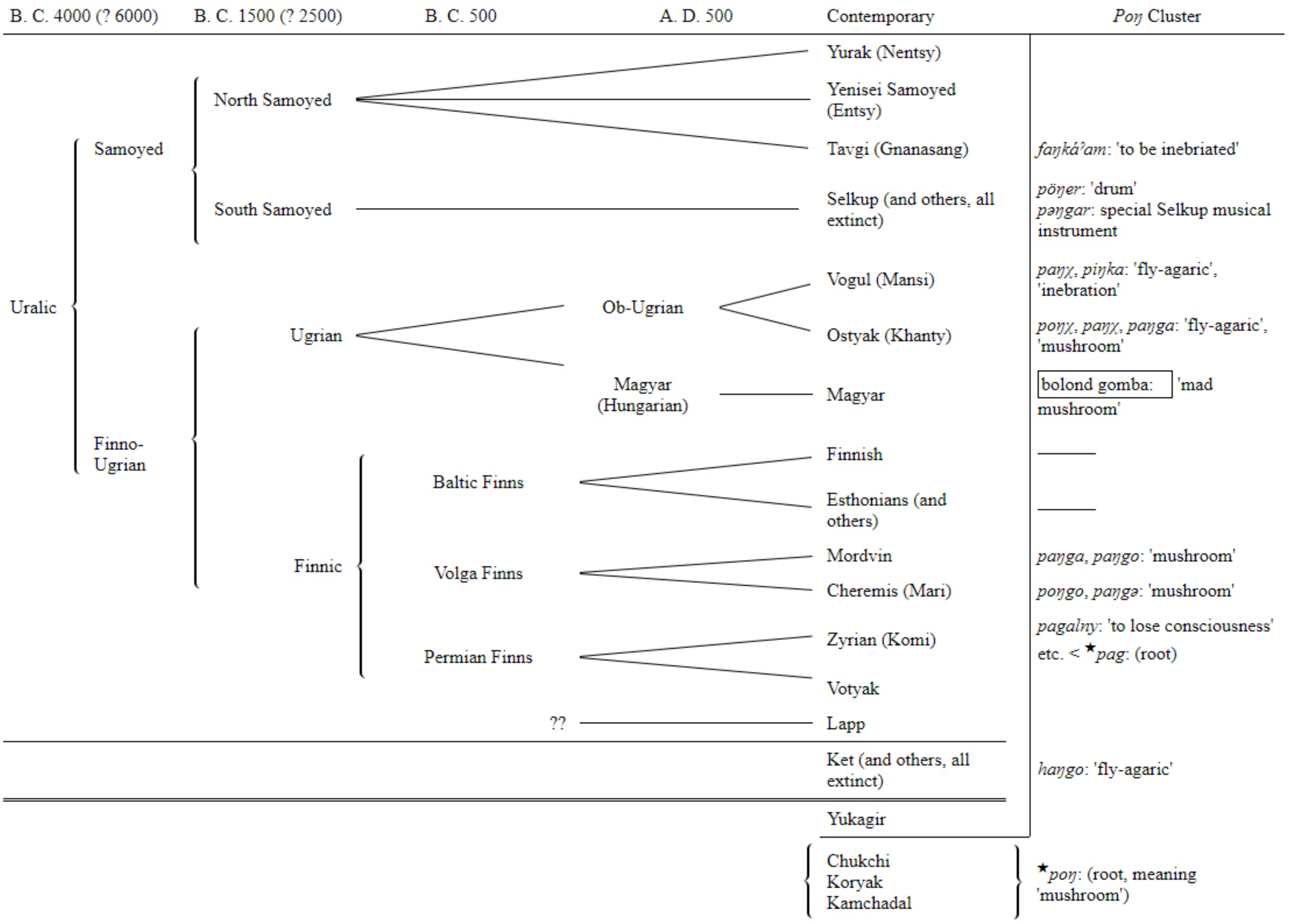
2. The Distribution of Fly-Agaric Inebration

So far as I know, Franz Boas initiated the accumulation of evidence on this subject when he pointed out [31] that the three languages of the Chukchi group, in the far Northeast of Siberia, used for 'mushroom' words whose common root was *poŋ*. He made no mention of such a root in the Ob Valley, and he was probably not aware of it. His book appeared in 1922 but the materials for it had been accumulated from the turn of the century.

The Finnish linguist Artturi Kannisto [33] was gathering data among the Vogul in the first decade of this century. He recorded the names *pa:ŋχ* and *pə:ŋχ* for the 'fly-agaric' used by shamans to achieve ecstasy. His papers were published only in 1958, long after his death. Munkácsi, the Magyar scholar, working in part with collections made in the second quarter of the last century by Antal Reguly, drew attention [32] to the Ob-Ugrian and Volga Finnic cluster of fungal words having identical origin, though in Ob-Ugrian they meant a specific mushroom, the fly-agaric, whereas in Mordvin and Cheremis they were generic, 'mushroom'. He suggested an Iranian word, *banha*, as cognate with or the etymon of the Uralic words. At least one of his colleagues, Lehtisalo [24a], expressed doubt about this, and now that we know more concerning the Iranian word, Munkácsi's suggestion seems to be ruled out. Apparently Lehtisalo in 1928 [24a] was the first to bring in the Samoyed languages: it was he who drew attention to Castrén's discovery that in the Tavgi tongue (in the North Samoyed group) *faŋkáˀam* means 'to be inebriated' and that it must be cognate with the other words. Uotila in 1930 [34] then added the Southern Samoyed language, Selkup, seeing in *pöŋer* and *pəŋgar*, the 'drum' and another musical instrument used by shamans, derivatives of the root *poŋ*. He detects a connection between our cluster and the Zyrian *pagal-*, *etc.*, 'to lose consciousness'. Bouda [35] in 1941 confirmed Boas's findings for the Chukchi group and he for the first time linked the word for 'mushroom' in the far Northeast with the Uralic words that we have been discussing. Steinitz in 1944 [36] thought that the link with the Zyrian *pagal-*, *pagyr*, meaning 'to lose consciousness', *etc.*, was unclear. In a notable paper Balázs [38] in 1963 summed up the Uralic evidence. He is inclined to accept Uotila's judgment on the Zyrian words, rather than Steinitz's hesitant position. He is sceptical about Munkácsi's view concerning an Iranian origin for this cluster, leaving however the last word to Iranian scholars. Apparently he was unaware of Walter B. Henning's pronouncement, published in 1951, on the Iranian word *bang*. (*Vide* Eliade [41])

We show the distribution of these tribes in the recent past in our maps A, B, and C. They have changed their location slowly over the past centuries, and are now disappearing. The Yukagir, for example, were once an important people; now they are confined to three shrinking areas. The Finno-Ugrian peoples, on the strength of linguistic evidence as interpreted by ethno-botanists and zoologists, seem to have had their original home in the bend of the Volga River, where the Mordvin and Cheremis tribes now are. The Ob-Ugrians and the linguistic ancestors of the Magyars presumably migrated to the east, the Magyars furthest to the East. Later the Magyars under Turco-Khasar domination migrated West to the Pannonian plain where they now are. They succeeded in surviving the Turkish domination and their own language emerged as dominant.

CHART OF URALIC LANGUAGES AND OTHERS


B. C. 4000 (? 6000)
B. C. 1500 (? 2500)
B. C. 500
A. D. 500
Contemporary
Poŋ Cluster
Uralic
Samoyed
Finno-Ugrian
North Samoyed
South Samoyed
Ugrian
Finnic
Ob-Ugrian
Magyar (Hungarian)
Baltic Finns
Volga Finns
Permian Finns
??
Yurak (Nentsy)
Yenisei Samoyed (Entsy)
Tavgi (Gnanasang)
Selkup (and others, all extinct)
Vogul (Mansi)
Ostyak (Khanty)
Magyar
Finnish
Esthonians (and others)
Mordvin
Cheremis (Mari)
Zyrian (Komi)
Votyak
Lapp
Ket (and others, all extinct)
Yukagir
Chukchi
Koryak
Kamchadal
faŋkáˀam: 'to be inebriated'
pöŋer: 'drum'
pəŋgar: special Selkup musical instrument
paŋχ, *piŋka*: 'fly-agaric', 'inebration'
poŋχ, *paŋχ*, *paŋga*: 'fly-agaric', 'mushroom'
bolond gomba: 'mad mushroom'
paŋga, *paŋgo*: 'mushroom'
poŋgo, *paŋgə*: 'mushroom'
pagalny: 'to lose consciousness' etc. < ★*pag*: (root)
haŋgo: 'fly-agaric'
★*poŋ*: (root, meaning 'mushroom')

In the chart facing this page we show the linguistic families and the distribution of the *poŋ* cluster. We have even added a time scale but hasten to add that it is speculative, intended to give some idea of the linguistic history that we are dealing with.

A number of conclusions seem to emerge from our evidence. The rôle of the fly-agaric has been shrinking for centuries. Until a few generations ago it was deeply rooted in the Ob-Ugrian and Samoyed cultures, the words related to *poŋ* having given to these peoples many derivatives for 'inebriation', the musical instruments of the shaman, *etc*. In the tradition reported by Itkonen [23] among the Inari Lapps that they were once familiar with the fly-agaric as an inebriant, we get some idea of the wider range that this practice enjoyed. It is to be inferred from the distribution of the *poŋ* root in the Chukotka that these peoples were once adjacent to the Ob-Ugrians, far to the west, and that they were pushed into their present location by the infiltration of Tungus and Yakut from somewhere to the south. We must not think of this movement as resulting from wars of conquest to which precise dates might be given. It is much more likely to have been a relatively peaceful occupation of inhospitable wastes punctuated by occasional clashes with the sparse inhabitants. The Tungus (with the Lamut) and the Yakut have been where they are now for as far back as we have records. Perhaps a score of centuries have passed since the peoples of the Chukotka were living adjacent to the Ob-Ugrians.

The fly-agaric was accessible to man in the forest belt ages before he knew the art of distillation. For the gathering it was available to him probably before he possessed facilities for storing berries and the juice thereof, and before he had mastered the technique of fermenting liquors. It is hard to see why the shaman should not have been resorting to the fly-agaric for inebriation and ecstasy since the receding ice-cap of the last ice-age permitted him and the birch to exist together in the northern reaches of Eurasia.

3. The 'poŋ' Cluster Among The Indo-Europeans

Now we shift the scene to the Indo-European world and Europe. In 1901 Holger Pedersen, then a young man and destined to become one of the leading figures in the comparative study of the Indo-European languages, published a lengthy paper in Polish ⟦39⟧ in which he found that the Proto-slavic ★*goHba*, the Old Church Slavonic *gǫba*, the Old High German *swamb*, the two Greek variants *sphóngos* and *sphóngê*, and the Latin *fungus* were cognates. The late V. Machek, distinguished Slavic philologist, accepted this correlation in his *Etymologický Slovník* (Prague, 1957) of the Czech language. So does Jan Otrębski, the Polish philologist, in a paper that he published in 1939 in Vilno entitled *Indogermanische Forschungen*, where he gives scores of examples of the identical metathesis. Among Slavists the weight of evidence is in favor of this interpretation; only Berneker held that, though Pedersen's case was tempting, it was 'unclear'. He did not elaborate. Boisacq, following Berneker, deduced that the Pedersen thesis should be discarded.

Professor Roman Jakobson, solicited for his opinion on this matter, said:

> The etymology of Holger Pedersen, the great Danish specialist in the comparative study of Indo-European languages, seems to me and to many other linguists, *e.g.*, the distinguished Czech etymologist V. Machek, as the only convincing attempt to interpret the fungal name of the European languages. Not one single serious argument has been brought against Pedersen's 'attractive' explanation, as Berneker defines it, and not one single defensible hypothesis has been brought to replace this one.[276]

Was not the *poŋ* cluster of the Uralic peoples borrowed, perhaps as far back as Uralic times, from the neighboring Indo-Europeans? If the thesis of this book is right, the Aryans were using the fly-agaric in their religious rites before they left their homeland. The Indo-Iranians do not possess a word of the *poŋ* cluster, because under tabu influences they had replaced it by Soma or Haoma, and the original word was lost.[277]

But even if this supposition is right, there remains the further question as to what the original meaning of *poŋ* was, and whether it designated the fly-agaric when it was borrowed. We may take it for granted that specific meanings precede generic definitions: *i.e.*, names for individuals or species precede the names for classes of things. But this is not much help, for mushroom names easily change their meaning from specific to general, and from the name of one species to another, and meanings often shift when words go wandering from one people to another.

---

276. *Vide Botanical Museum Leaflet*, Harvard University, Vol. 19, No. 7 (1961), p. 150, ftn.
277. R. L. Turner in his *Comp. Dict. of the Indo-Aryan Languages*, Entry 7643, assembles a group of cognate words in contemporary Indian vernaculars derived from Sanskrit that stem back to the hypothetical Sanskrit ★*paggala-*, 'mad', 'madness'. He suggests the possibility of a link to Sanskrit *paṅgú*, 'lame', 'crippled in the legs', of which the variant forms suggest to Turner a non-Aryan origin. May these be remote descendants of our *paŋχ* cluster?

For the cultural evolution of man, the shamanic use of the fly-agaric may have been vital, greatly broadening the range of his experience, making known to him horizons beyond any that he knew in real life, in short sparking his imagination. But there was another spark, even more vital for his very survival. We all know the two ways by which most men generated fire in early times - by percussion, or by rubbing two wooden members together. But not enough stress has been laid on the primary tinder to catch the spark, a tinder so inflammable that it bursts into flames at once. The best tinder for this purpose in northern Eurasia has always been the dried *Fomes fomentarius*. This is a shelf fungus most commonly found on birch. At Maglemose, in diggings that date from soon after the last ice age, *Fomes fomentarius* has been found close by the hearth stones. At Star Carr in Yorkshire, in diggings of the same culture but perhaps somewhat earlier, *Fomes fomentarius*, sometimes still attached to the birch host, have been found next to iron pyrites and the hearth stones. These archaælogical diggings date back almost to the last ice age, which began to recede *ca*. 12,000 B. C. As the ice cap receded and man pushed his way north, the control of fire defined his range of diffusion, and this touchwood or 'punk' (which in the style of this book we should spell *pəŋk*), this *amadou* or *yesca* or *Zunderschwamm* or *trut* or *zhagra* or *tapló* was what assured him of warmth and a cooked meal. Perhaps the men of Maglemose or Star Carr, whoever they were, as they busied themselves about those ancient hearths, were already calling their tinder 'punk'. The discovery of *Fomes fomentarius* and the simple methods of preparing punk for use had marked a long step forward in man's material progress and the comforts of human existence.

★

NOTE 1. Is *mo-ku*, written either 蘑菇 or 蘑菰 a member of the *poŋ* cluster? It is the ordinary market-place word for edible mushrooms throughout China. The word is not found in classical Chinese. The earliest citation that I can find is in the *Rules of Cooking* 飲膳正要, written in 1330 and published in 1456. These were compiled by Hu Ssu Hui 忽思慧, the senior chef of the Mongol Emperor and himself also a Mongol. (The Dynasty in 1330 was Mongol.) In Mongolian the same word in various dialectal forms is also used for mushroom. Philologists have not been sure which culture borrowed the word from the other. It seems to me that the circumstances indicate a Chinese borrowing from Mongolian. The Chinese characters possess different meanings, but in sound they lent themselves to express the Mongolian word. In Pekin *mo-ku* means specifically *Tricholoma mongolicum*, a delicious mushroom highly prized all over China, which was and still is imported in large quantities from Mongolia. It is also known as *k'ou mo* 口蘑, which means for the Chinese 'brought through the Kalgan gate'; in other words, through the Great Wall from Mongolia. With the passing of time the sense of *mo-ku* has become general, especially outside of Pekin.

If then the word is Mongolian, will the Mongolian experts tell us whether *mo-ku* could come from *poŋ*? *(s)pongos* > ⋆*bongos* > ⋆*mongo(s)* > *mogu*.

NOTE 2. In 1963 I was visiting New Zealand and on August 6 was in Rotorua, in the center of the northern island, a Maori community. I was chatting with an elder of the Maori people, Keta Ehau, 74 years old at the time. Naturally the subject came around to mushrooms and he volunteered a story that seemed to him remarkable, and to me even more so. He had been in Siberia with two Canadians and a South African during the first world war, in the Government service, and he found that the natives there were still using touchwood, as the Maoris do in New Zealand. The natives where he was called it *paŋke* or *paŋkə*. This had made an impression on him because in Rotorua the fungus that serves as touchwood is called *paŋe*, without the *k*. But of course vacillation between *ŋ* and *ŋg* or *ŋk* is frequent. This fungus grows on the *rātā* tree, *Metrosideros robusta*, a member of the myrtle family. At Ruatoria, on the coast to the east of Rotorua, touchwood is made from a fungus growing on the *tawai* tree, Nothofagus spp. There the fungus so used is called *pú:tawa*, and *paŋe* is unknown.

How strange to find a word that might be a member of the *poŋ* family among the Maori of Rotorua! I looked the word up in Williams's A *Dictionary of the Maori Language*, of which many editions have appeared since the first in 1844. *Pú:tawa* was in them all. In the fifth edition, 1917, I found '*Pangē*, *pangī*: tinder, touchwood, made from spongy fungus.' In a copy of the fourth edition, 1892, that lies in the Trumbull Library, Wellington, there are the editor's notes made in anticipation of the fifth edition, and among them is this entry written by hand, probably around 1914.

III. Europe and the Fly-Agaric

1

If I have established my case that Soma was the fly-agaric - that the *amṛta* of the Aryans was until only yesterday the divine inebriant still currently consumed by the shamans over vast reaches of Siberia, then at once the initial steps by which my wife Valentina Pavlovna and I started out on our inquiries more than forty years ago take on relevance and a cutting edge. For we did not begin by looking for Soma. Decades were to pass before Soma drew my attention. We started out by accumulating purely European ethno-mycological data, chiefly philological and folkloric, and those European data led us twenty years later to make a bold, many would say a wild, surmise: the striking pattern of our evidence would be understandable if we postulated a period when a mushroom had played a rôle in the religious life of our own remote ancestors, perhaps some 6,000 years ago, millennia before they could read and write, when the last ice-age was still yielding the frozen wastes to the pioneer food gatherers. We did not know which mushroom nor why, but it must have been hedged about with all the sanctions that attend sacred things in primitive societies. Judging by what we considered vestigial survivals in our own folkways, it must have been instinct with *mana*, an object of awe, of terror, of adoration.

Our later discoveries in Siberia and mine more recently among the Indo-Iranians were an immediate sequel to those early hesitant stumbling steps that we were taking in the 1930's, and they lend credence to our 'wild surmise' about our own European ancestors, for it is unlikely that a foolish misinterpretation of evidence would lead us to these rich finds. It is therefore in order to re-examine our early evidence, constituting as it does an exploration into the pre- and proto-history of our own European stock.

My wife and I embarked on this our intellectual foray late in August 1927. A little episode started us on our way. Valentina Pavlovna was Russian, a Muscovite by birth. I was of Anglo-Saxon ancestry. We had been married less than a year and we were now off on our first holiday, at Big Indian in the Catskills. On that first day, as the sun was declining in the West, we set out for a stroll, the forest on our left, a clearing on our right. Though we had known each other for years, it happened that we had never discussed mushrooms together. All of a sudden she darted from my side. With cries of ecstasy she flew to the forest glade, where she had discovered mushrooms of various kinds carpeting the ground. Since Russia she had seen nothing like it. Left planted on the mountain trail, I called to her to take care, to come back. They were toadstools she was gathering, poisonous, putrid, disgusting. She only laughed the more: I can hear her now. She knelt in poses of adoration. She spoke to them with endearing Russian diminutives. She gathered the toadstools in a kind of pinafore that she was wearing, and brought them to our lodge. Some she strung on threads to hang up and dry for winter use. Others she served that night, either with the soup or the meat, according to their kind. I refused to touch them. ... This episode, a small thing in itself affecting only a peripheral aspect of our busy lives, led us to make inquiries, and we found that the northern Slavs know their mushrooms, having learned them at their mother's knee; theirs is no book knowledge. They love these fungal growths with a passion that, viewed with detachment, seemed to me a little exaggerated. But we Anglo-Saxons reject them viscerally, with revulsion, without deigning to make their acquaintance, and our attitude is even more exaggerated than the Slavs'. Little by little my wife and I built up extensive files concerning this modest corner of human behaviour, not only about the Slavs and Anglo-Saxons but about all the peoples of Europe, even to the Basques, the Frisians, the Lapps, and the Albanians.

Years passed. We had reached the 1940's before we pronounced our 'wild surmise', and we then gave utterance to it only to each other, since we were afraid of appearing ridiculous to our friends, perhaps even a trifle touched. Our evidence was airy and insubstantial, but it possessed a poetic consistency that carried conviction with us. We resolved to cast our net further afield and to explore the tribal cultures of Siberia. What was our amazement when we found, right on the doorstep of Europe, a mushroom - the fly-agaric - occupying the center of the stage in the shamanism of many northern tribes. We were hitting pay dirt and for long we thought we had reached the end of our road.

In 1952 our attention was diverted to Mexico, where we learned that there was a mushroom cult to be explored and studied *in situ*, both historically through the centuries or even the millennia, and also as a living anthropological practice in many Amerindian cultures of Oaxaca, Puebla, and Vera Cruz. The mushrooms used in Mexico were not the fly-agaric of Siberia and we could not discover any umbilical cord linking the Mexican and Siberian cults, but we enjoyed ample opportunity to dissect the modalities of a divine mushroom inebriant. The ten rainy seasons - 1953 to 1962 - spent in the remote mountains of Mexico[278] were a rewarding experience but they were only a diversion from our Eurasian preoccupations. In the course of these years Valentina Pavlovna's fatal illness manifested itself: she died on the last day of 1958, in the evening. Meanwhile we had rushed our *Mushrooms Russia & History* into print in May 1957. In it we expressed our 'wild surmise' hesitantly, by implication rather than directly, and not a single reviewer caught it. We were still unwilling to sponsor openly the notion of a divine mushroom among our own ancestors. Only one critic, a first-class mycologist, hinted at the point when he said that we had not succeeded in establishing our theory as to the origin of 'fly-agaric'.[279] The scientific mind is prone to measure evidence by austere scientific standards, by calibrating quantitative phenomena. But the myths and verbal origins of pre-literate communities are sheer poetry, to be understood only by poets and those with a gift for the play of imagery. There are values in those societies that do not lend themselves to quantitative calibration. This is where our critic went wrong. We were certain that the 'fly' of divine possession was the fly of the fly-agaric, and this fly has now led me to Soma.

I do not recall when the Soma possibility first drew my attention: it was certainly after our first book went to press. My wife had never heard of the Soma mystery. My brother Tom and I, we had been told about Soma by our father in the first decade of this century, but in my case the question had lain dormant in the depths of sleeping memory until the '50's. From 1955 on I was in intermittent correspondence with Aldous Huxley, and often when he visited New York he would come down to Wall Street and have lunch with me. Perhaps it was he who revived my interest in this strange historical enigma. One day he and I were discussing the hallucinogens,[280] and I remember tossing out the fanciful suggestion that Soma might prove to be the fly-agaric, and describing to him the red and yellow phases of this remarkable mushroom, and its rôle in Siberia, with which I think he was already acquainted. I knew nothing about Soma at that time, and to aspire to the Soma secret was to be reaching for the moon. When *The Island* appeared some years later, I was surprised to discover that Huxley had set his story in an Indian setting, with &sacute;iva being worshipped and yoga being practiced, and the drug that is the focus of the cult in the story is a yellow mushroom, surely the yellow fly-agaric: Huxley says expressly that it is the yellow mushroom rather than the red one on which gnomes sit! In his story he was coming close to the truth: he possessed the poet's intuition. Later, in 'Culture and the Individual' Huxley explained[281] that he had had in mind the mushrooms that yield psilocybin, the Mexican mushrooms that my wife and I had played a part in rediscovering and making known to the world. ... I remember that in these same years, in the late '50's, I also discussed the Soma problem with Mr. John P. C. Train, of New York.

After my conversations with Huxley and about the time when *The Island* appeared, in 1962, but before I had read it, in July, I engaged Wendy Doniger to write a *précis* of the Soma question, and she submitted her report on February 16, 1963. It was 33 pages of single-spaced typescript. In it she called my special attention to ṚgVeda IX 74*[4]*, where the priests urinate Soma. This had astonished her and left her nonplussed: little did she suspect what it would mean for me, with my Siberian background. Her report lay dormant for months until I finally retired from my bank at the end of June of that year and translated myself to the Orient for a stay of some years.

---

[278] These expeditions remain to be written up and I plan to do this in the coming years.

[279] R. W. G. Dennis: *Kew Bulletin*, No. 3, 1957 (1958); pp. 392-395.

[280] At this particular Huxley luncheon Stephan F. de Borhegyi was also present. ... 'Hallucinogen' and 'hallucinogenic' were words coined by a group of physicians preoccupied with these mysterious drugs - Abram Hoffer, Humphrey Osmond, and John Smythies in America, and Donald Johnson in England. To Johnson goes priority. In 1953 he brought out a pamphlet. *The Hallucinogenic Drugs*, published by Christopher Johnson in London. But he says he picked up the word from the others, who however did not get into print until January 1954, in an article on 'Schizophrenia: A New Approach', in *The Journal of Mental Health*, London, Vol. C. The word quickly took hold and now trips off everyone's tongue as though it had been used for generations. The uninitiated layman is apt to think of the hallucinogens as merely a new kind of alcohol but by devising a fresh name the radical difference is established from the start. For those who know their effects, 'hallucinogens' may seem inadequate but it fits so long as one remembers that the hallucinations affect all the senses and also the emotions.

[281] *Vide supra*, p. 146.

I shall begin by saying where in Europe's past I have *not* found the cult of a sacred mushroom.

1. Mushrooms do not figure in the various witchcraft epidemics that raged in Europe in the late mediæval and renaissance times. The evidence here is voluminous and circumstantial, extending from Spain to Hungary and from France to Scotland and Sweden. That a rôle for mushrooms is never mentioned seems to me conclusive.

2. I have found no mushrooms in the records that we possess of the shadowy Druids. Our sources are meager. If we knew more, mushrooms might figure, but the evidence now is negative.

3. In Viking times, from the 8th to the 10th centuries, there was a special category of the Viking warriors known as the Berserks. Big powerful men, they fought in the forefront of the battle with a wild fury. They would 'go berserk' and this berserk-raging made them famous and feared. Today the belief prevails in certain Scandinavian circles that this berserk-raging was provoked by the fly-agaric. In Sweden and Norway even text-books and encyclopædias assert this as a fact. Samuel Ödman, a Swede, first propounded **[**43**]** the idea in 1784, deriving the notion from the accounts of travellers in Siberia earlier in the century. He cites Georgi **[**6**]** and Steller **[**5**]**, and there is every reason to assume that he knew von Strahlenberg **[**3**]** and Krasheninnikov **[**4**]** also. A century later, in 1886. Fredrik Christian Schübeler, a Norwegian, expressed the same view. In Exhibits **[**43**]** throug **[**46**]** we give in translation the principal statements in favor of the fly-agaric, for the reader to pass on their merit. The opposition has not been without able advocates, notably Fredrik Grøn, a specialist in the medical history of Norway, and Magnus Olsen, the authority on Norse traditions and literature.

Certain it is, in my opinion, that the fly-agaric was *not* used by the Berserks, and no time should be lost in expunging this yarn from the reference books. My reasons are two-fold.

First. The fly-agaric is never mentioned in the Sagas or Eddas. Of the fungal world only punk or touchwood (*knösk* and dialectal variants thereof) appears in them. No mysterious or unidentified plant plays a part in the berserk-raging. The early historians Saxo Grammaticus and Olaus Magnus made no mention of any such agent. There is no record of an oral tradition antedating the 19th century of such a practice. Ödman said expressly that he was basing his view on Georgi's **[**6**]** and Steller's **[**5**]** account of the Siberian shamanic usage.

The advocates of the fly-agaric as the cause of berserk-raging are constrained to place excessive weight on a shadowy episode alleged to have taken place in 1814. The story goes that in a brief war between Norway and Sweden the Swedish soldiers of the Värmland regiment were seen by their officer to be seized by a raging madness, foaming at the mouth. On inquiry the officer is said to have learned that the soldiers had eaten of the fly-agaric, to whip up their courage to a fighting pitch. But this episode has not been substantiated. On November 1, 1918, a Swedish physiologist named Carl Th. Mörner read a paper on the higher fungi before a learned society in Upsala. In the oral discussion that followed the paper a meteorologist, H. Hildebrandsson, disclosed for the first time the story of the Värmland regiment. Later, when Mörner published his paper, he cited what Hildebrandsson had said, and this is our only evidence for what had happened. But Mörner did not seize the opportunity, at that time possibly available, to ascertain Hildebrandsson's source and to confirm his story with additional details. No one has ever heard of the episode other than from Hildebrandsson's account told offhand, in the discussion that followed a lecture, more than a century after the event and half a century ago. Bo Holmstedt, Professor of Toxicology at the Karolinska Institute of Stockholm, has lately made rigorous efforts to verify it in Värmland or elsewhere, without success. We must remember that Professor Hildebrandsson was speaking outside the field of his special competence and was merely contributing to an oral discussion.

Second. The symptoms of fly-agaric inebriation are the opposite of berserk-raging, and the Norwegians and Swedes who imagine that they are the same would do well to read Exhibits **[**1**]** through **[**38**]**. The effect of the fly-agaric is soothing, comforting, quieting, tranquillizing. At one stage there is a feeling of physical exhilaration, but in our case-histories there is not a single report of wild bellicosity. In an heroic hymn **[**30**]** of the Vogul a myth is told: the Hero has consumed three sun-dried fly-agarics and is lying in a stupor. A messenger rushes in, announces the imminent approach from the North of the fearful Mocking-bird Host with the red rump, and calls on the Two-Belted One to go forth and fight. But though the enemy is at the very gate, our Hero says he cannot stir because of his inebriation, and sends off the messenger to seek out his two younger brothers. The peril grows desperate and the messenger, returning, implores the Hero to fight. This time he *throws off* his inebriation, sallies forth, and slays the enemy right and left. The testimony of the myth only confirms what the travelers tell us over and over again. Not one of them describes a syndrome corresponding in the remotest degree to berserk-raging.

At the session of the Société Mycologique de France held on October 6, 1910, there was presented to the attendance a photograph of a Romanesque fresco from a disaffected chapel that had belonged to the Abbaye de Plaincourault in the center of France. It was later the subject of a note published on pp. 31-33, Vol. XXVII, of the *Bulletin* of the Société. The fresco, crude and faded, is of the familiar temptation scene in the Garden of Eden. The gentlemen who presented the fresco to the Société Mycologique made the sensational statement that, instead of the customary Tree, the artist had given us the fly-agaric. A serpent was entwined around a gigantic fly-agaric and was engaged in a colloquy with Eve.

The interpretation put on the fresco by the mycologists has made an impression on their colleagues, particularly in England. Thus John Ramsbottom endorses the fungal message in *Mushrooms & Toadstools*[282] and in *A Handbook of the Larger British Fungi*;[283] also R. T. and F. W. Rolfe, in *The Romance of the Fungus World*;[284] *The Illustrated London News*, Nov. 21, 1953; finally, Frank H. Brightman more recently in *The Oxford Book of Flowerless Plants*, in 1966.[285] My wife and I visited the Plaincourault chapel on August 2, 1952. It is in the Berry, between Ingrandes and Mérigny, facing the Val de l'Anglais, hard by the Château of Plaincourault. The Chapel bears the date 1291 and the fresco must come down from that time or thereabouts. On April 2, 1959, Mme Michelle Bory, of the Muséum National d'Histoire Naturelle, visited the chapel at my request, and made the copy of the fresco that we offer our readers in Plate XXI.

The mycologists would have done well to consult art historians. Here is an extract from a letter that Erwin Panofsky wrote me in 1952:

> ... the plant in this fresco has nothing whatever to do with mushrooms ... and the similarity with *Amanita muscaria* is purely fortuitous. The Plaincourault fresco is only one example - and, since the style is provincial, a particularly deceptive one - of a conventionalized tree type, prevalent in Romanesque and early Gothic art, which art historians actually refer to as a 'mushroom tree' or in German, *Pilzbaum*. It comes about by the gradual schematization of the impressionistically rendered Italian pine tree in Roman and Early Christian painting, and there are hundreds of instances exemplifying this development - unknown of course to mycologists. ... What the mycologists have overlooked is that the mediæval artists hardly ever worked from nature but from classical prototypes which in the course of repeated copying became quite unrecognizable.

Professor Panofsky gave expression to what I have found is the unanimous view of those competent in Romanesque art. For more than half a century the mycologists have refrained from consulting the art world on a matter relating to art. Art historians of course do not read books about mushrooms. Here is a good example of the failure of communications between disciplines.

The misinterpretation both of the Plaincourault fresco and of berserk-raging must be traced to the recent dissemination in Europe of reports of the Siberian use of the fly-agaric. I think the commentators have made an error in timing: the span of the past is longer than they have allowed for, and the events that they seek to confirm took place before recorded history began.

---

[282] Collins, London, 1953, pl. 1b, p. 34; p. 46.
[283] Brithish Museum, London, 1949, p. 26.
[284] Chapman & Hall, London, 1925, p. 291.
[285] p. 112.

Traditionally the European peoples vary like night and day in their attitude toward wild mushrooms. There are two areas that are on excellent terms with them. The northern Slavs and Lithuanians, and the Mediterranean littoral from Majorca and Catalonia to Provence and including apparently the whole of the *langue d'oc* area of France: these are the areas where wild mushrooms are considered friends, where children gather them for fun before they can read and write, where no adult feels the need of a mushroom-manual, where immense quantities of mushrooms are prepared for the table in innumerable ways, and where accidents are unknown. The gentle art of mushroom-knowing is a universal accomplishment. Mushrooms are a conversation piece among men and women. Novelists introduce them into their narratives, poets into their verses; and they recur in proverbs and ditties. Moreover - and here is the telling thing - all the references are friendly, favorable, wholesome.

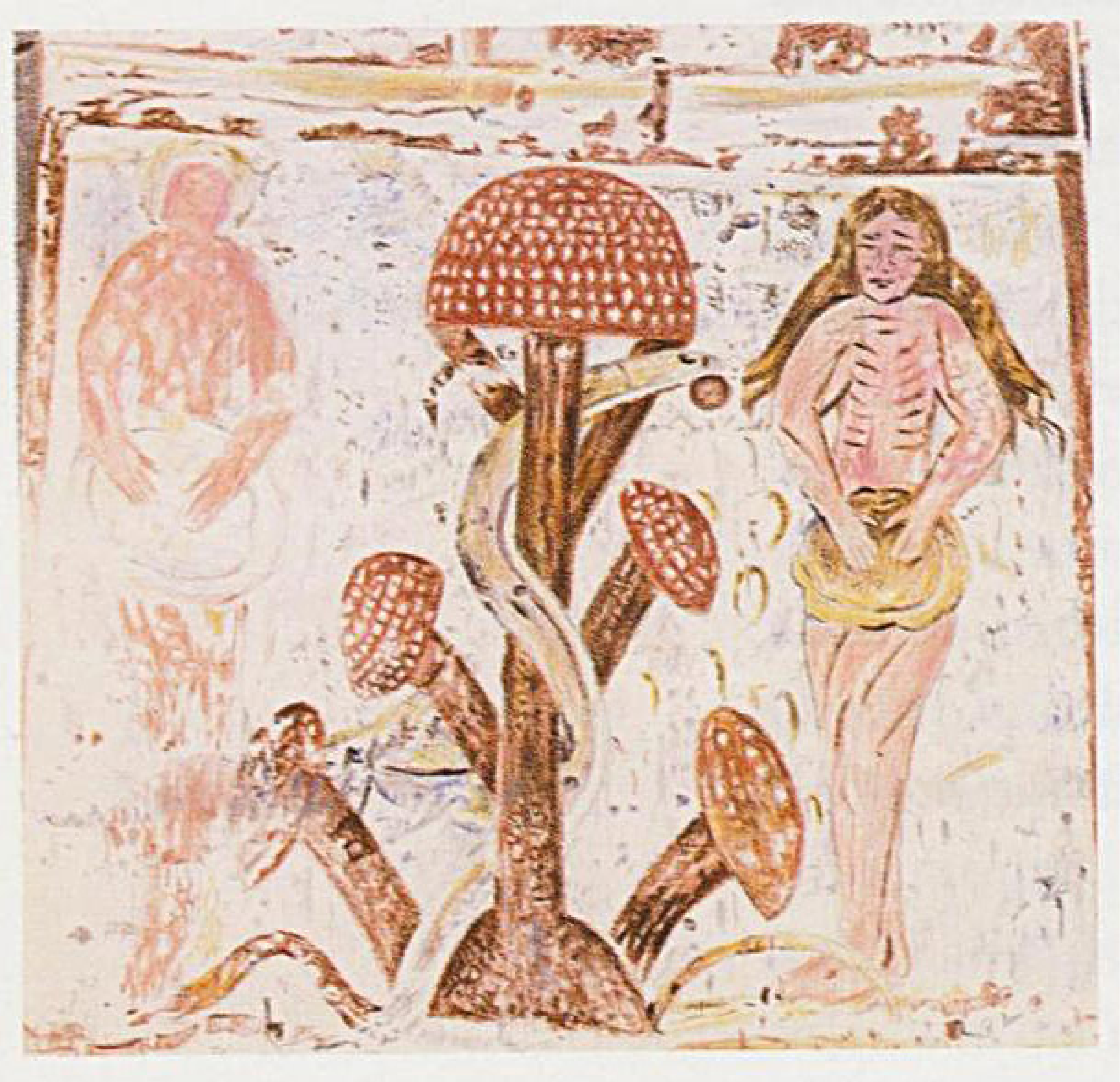


Plate XXI - Fresco of Plaincourault. Abbaye de Plaincourault. Mérigny, Indre, facing the Val de l'Anglais, in the Berry. (Copied April 2, 1959, by Mme Michelle Bory, staff member of the Laboratoire de Cryptogamic, Muséum National d'Histoire Naturelle, Paris)

On the other hand the Germanic and Celtic peoples are infected with a virulent mycophobia, coming down from pre-history. In recent generations there has been some improvement as the traveled and educated classes have begun to spread a different gospel, and as groups of zealous mushroom amateurs have begun to leaven the mass of the population. The criterion by which to judge this aspect of a people's culture is the pronouncements of the older writers and of the untutored country folk. The educated element does not offer a pure strain of the native ways. In *Mushrooms Russia & History* we presented an anthology of many such expressions and I have assembled other quotations since that book appeared. Here I shall cite only a few.

The English people to begin with had no name for a mushroom that would permit them to eat it: 'toadstool' was our chief word and one does not eat a toadstool. The Court under French influence in the 15th century introduced *mousseron*, which became 'mushroom', and from then on the English, or at least a few of the more enlightened ones, could consume one or two species. But even the French were unenthusiastic. The *Grete Herball* of 1526, a translation from the French, voices the hostility of both peoples:

> ... Fungi ben mussherons ... There be two maners of them; one maner is deedly and sleeth them that eateth of them and be called tode stooles, and the other dooth not. They that be not deedly haue a grosse gleymy [slimy] moysture that is dysobedyent to nature and dygestyon, and be peryllous and dredfull to eate & therefore it is good to eschew them.

So mushrooms are of two classes, those that are deadly and those that had best be eschewed. In Diderot's *Encyclopédie* the Enlightenment had not yet spread to mycophagy:

> But whatever dressing one gives to [mushrooms], to whatever sauce our Apiciuses put them, they are really good but to be sent back to the dung heap where they are born.[286]

For Keats, in *Endymion* a 'fungous brood' sends up, 'sickly and pale, Chill mushrooms coloured like a corpse's cheek.' Tennyson makes one of his heroines, Lynette, turn away from Gareth as though she smelled 'a foul-flesh'd agaric', deeming it 'carrion of some woodland thing'. Spenser in *The Shepheardes Calendar* identified the 'grieslie Todestool' with winter, and so does Shelley, thus also doing violence to nature, in *The Sensitive Plant*:

And agarics and fungi, with mildew and mould,
Started like mist from the wet ground cold;
Pale, fleshy, as if the decaying dead
With a spirit of growth had been animated!

Their moss rotted off them, flake by flake,
Till the thick stalk stuck like a murderer's stake,
Where rags of loose flesh yet tremble on high,
Inspecting the winds that wander by.

Montaigne, that giant of the Renaissance, pouring forth the rich contents of his mind and feelings in his Essays, ignores the fungal world. Here is a son of Périgord who never mentions truffles. Rabelais presents to his readers an obnoxious character called Lent-observer who has a *potiron*, mushroom, for a chin, and whose excrement consists of morels and toadstools. There is never a kind word for mushrooms in Rabelais, this native of Chinon in the heart of France. So far as I know, neither Chaucer nor Milton mentioned them, and Shakespere barely.

For the modern poets mushrooms are unchanged. Emily Dickinson repeats the old refrain:

Had nature any outcast face,
Could she a son contemn,
Had nature an Iscariot,
That mushroom - it is him.

Or D. H. Lawrence in *How Beastly the Bourgeois Is*:

---

[286] Article on *Champignons* by Louis Jacourt, 1753: Mais quelqu'apprêt qu'on leur donne, à quelque sauce que nos Apicius les puissent mettre, ils ne sont bons réelement qu'à être renvoyés sur le fumier où ils naissent.

How beastly the bourgeois is
especially the male of the species -
Nicely groomed, like a mushroom
standing there so sleek and erect and eyeable -
and like a fungus, living on the remains of bygone life,
sucking his life out of the dead leaves of greater life than his own.

And even so, he's stale, he's been there too long,
Touch him, and you'll find he's all gone inside
just like an old mushroom, all wormy inside, and hollow
under a smooth skin and an upright appearance.

Full of seething, wormy, hollow feelings
rather nasty -
How beastly the bourgeois is!

Standing in their thousands, these appearances, in damp England
what a pity they can't all be kicked over
like sickening toadstools, and left to melt back, swiftly
into the soil of England.

The poets invoke mushrooms only when they seek a loathsome figure of speech. Of course mushrooms decay, but why pick on mushrooms? Everything that lives will rot. The poets never see the infinitely subtle, fresh colouration, quivering with life, of the mushroom world, varying from species to species and from individual to individual; the delicate softness of their texture, their shapes, graceful, grotesque; the aroma of each species different from all others, conveying by its scent its own proper signature.

Wild fungi are an emotional trip-hammer for mycophile and mycophobe alike, and in the poets with their heightened sensibilities the contrast in the response to fungi is sharpest. Professor Roman Jakobson was spending the summer of 1919 in Pushkino, near Moscow, with the poet Vladimir Majakovskij, who would go out almost daily into the forest to look for mushrooms. He would usually return with a large basket-full of them. He knew them all and where to look for every kind. He told his companion that mushroom gathering offered the ideal accompaniment for the composition of poetry, and in the course of that summer he composed the best parts of his epic, *150 Million*, while engaged in this pastime. During the previous season, in 1918, he had conceived his play *Mystery Bouffe* in the woods among the mushrooms.

In the beginning the Germanic world was steeped in darkest mycophobia. Certainly nowhere in European literature is there a more perfect expression of loathing for mushrooms - all the more eloquent because taken for granted - than in the writings of Saxo Grammaticus, the Danish historian who flourished about A. D. 1200. He was telling of a military campaign waged in Sweden by Hadding the Dane in the 10th century, and how the Danes ran out of provisions, and were driven to the last extremities of hunger. Here in Book 1: VII: 7 of his *Saxonis Gesta Danorum* we discover the low opinion in which the Danes of olden times held wild mushrooms:

> ... After the spring thaw, Hadding returned to Sweden and there spent five years in warfare. By reason of this lengthy campaign, his soldiers, having consumed all their provisions, were reduced virtually to starvation, and resorted to forest mushrooms to satisfy their hunger. Finally under pressure of extreme necessity they ate their horses, and in the end they satisfied themselves with the carcasses of dogs. Even worse, they did not scruple to eat human limbs.

Now that the passing centuries have dimmed for us the personal sufferings of Hadding's host, we may permit ourselves to be amused by the graduated stages of their desperation as reflected in their diet, and our thoughts turn to what soldiers of other origins would have done in a like pass. Had they been Celts, they would surely have eaten horses, dogs, and each other before turning to the foul fungi of the forest. If they had been Slavs of the North, they would have been feasting on those noble mushrooms from the outset of their long campaign, and, fortified by the delectable fare, would have engaged the enemy like lions, and most certainly turned the tide of war. Until General Bernadotte, a son of Pau in the Pyrenees who became King of Sweden, spoke well of ceps, neither Lapps nor Swedes ate mushrooms. We know this because Linnæus tells us so. In the section on the fungi in his *Flora Lapponica*, he observes that in Sweden only foreigners consider mushrooms fit for eating, nor does he except himself from the general rule. What a pity that the great Linnæus was a mycophobe! It is said that when he was naming the famous *Lactarius deliciosus*, he thought he was naming a Lactarius of the Mediterranean that had been described to him as excellent eating: he thought the specimen before him was the same *because it smelled as though it ought to taste good*.

4

Members of a community observing a tabu are far from sensing that it is a tabu. Their obedience to the tabu is in the natural order of things. It lies along the grain of the wood. As I am writing for the English-speaking world, I fear my readers will put aside my book, saving: 'The poor idiot just doesn't know you may get poisoned from mushrooms. Come, what'll it be, a highball or a Martini?' The breathtaking aspect of it is the unanimity of the witnesses. Those from mycophilic peoples are invariably mycophile; those from mycophobic races are invariably mycophobe. The only exceptions are those who have traveled and read widely, and because they have traveled, at least intellectually, they are not really exceptions. In the 1920's and 1930's this subject was a frequent conversation piece in gatherings frequented by White Russians, but it was only table-talk. My wife and I thought it deserved better than that. Today everyone is aware that deep-seated emotional attitudes acquired in early life are of profound importance. It seems to me that when such traits betoken the attitudes of whole tribes or peoples, and when those traits have remained unaltered throughout recorded history, and expecially when they differ sharply from one people to a neighboring people, then you are face to face with a phenomenon of profound cultural importance, whose primal cause is to be discovered only in the well-springs of cultural history. In this instance we are exploring from the inside (not through cave paintings or mute archæological artifacts) one aspect of the religious life of our ancestors in protohistory.

'Toadstool' is an astonishing folk-word. For centuries it has incapsulated the inspissated loathing and fear of the English-speaking people for wild mushrooms. For the Englishman, as commonly used it means any mushroom he does not know and therefore distrusts, which means all or almost all wild mushrooms. One of the two most important words in the fungal vocabulary of Europe, it has nevertheless lost almost everywhere its application to a particular species. For the sinister mark of the toad is not confined to the English fungal vocabulary. You will find it in Norwegian and Danish, though not in Swedish; in Low German, Dutch, and Frisian; in Breton, Welsh, and Irish. It cannot be translated into standard French, and the other Romance languages know it not. Nor does it survive in standard High German, though it lingers on in High German dialects. Thus the citadel of the 'toadstool' is in the ring of peoples who dwell around the shores of the North and Irish Seas, a gigantic and evil fairy-ring, as it were, embracing the surviving Celts, many of the Germanic peoples, provincial France (where the 'toad' figure may have come down from the Gauls), and the Spanish Basque country of Guipuzcoa and Biscay. The Bretons, let it be remembered, emigrated from Britain to their present home across the Channel in the fifth and sixth centuries after Christ, and are thus remote heirs, folkwise, of old Britain.

Not all of these peoples use the figure of the toad's stool. The Norwegians and Danes speak of the toad's hat; the Low Germans, of the frog's stool; the Dutch say toad's stool; and the Frisians refer to an old fungus as a toad's hide. The Irish term is the frog's pouch; the Welsh, toad's cheese; the Bretons, toad's cap, but by the addition of a single initial sibilant, their term becomes toad's stool, and this is a recognized variant in their language. Here are the words in these tongues: in Norwegian and Danish, *paddehat*; in Low German, *poggenstohl*; in Dutch, *paddestoel*; in Frisian, *poddehûd*; in Irish, *bolg losgainn*, with *bolg* meaning pouch; in Welsh, *caws llyffant*, with *caws* meaning cheese; in Breton, *kabell tousec*, and also *skabell tousec*. The Pennsylvania Dutch speak a dialect of High German that comes down from the language of the Palatinate in the 18th century, and in Pennsylvania Dutch we find both toad's stool and toad's foot: *grottestuhl* and *grottefuss*. We know that toad's bread, *pain de crapault*, was used for wild fungi in 16th century France, and this same expression has been reported in modern times in the Calvados region of Normandy. All these names hinging on the toad seem indefinite in their application, and all of them are pejorative. But there are two contiguous or almost contiguous areas that give the term specific meaning. The fly-agaric is called *crapaudin* in many parts of France and in the form *grapaoudin* this word has been reported as far south as the Hérault, on the Mediterranean. In the Basque of Guipuzcoa and Biscay the fly-agaric is the *amoroto*, the precise equivalent of *crapaudin*, 'the toad-like thing'. Often the peripheral cultures of the world preserve archaic traits and meanings better than the throughways of trade and communication, and when we find that the toad is linked to the fly-agaric in Basque and in French provincial usage, our attention is alerted.

All these words, in varying degrees, exhale a bad odor. They designate wild fungi that the speaker considers, rightly or wrongly, inedible and dangerous. The English toadstool, freighted with evil, is typical of the class. In the dialects of England there are numerous variants, and these are interesting because they echo the figures of speech that are current in our list of foreign words. Thus we find toadcheese or taddecheese, toad's bread, toad's cap or toadskep, and toad's meat. For the toad itself there is an ancient variant, pad or paddock, which gives us paddock-stool and puddock-stool. This 'pad' is the same word for toad that the Dutch and Frisians, the Norwegians and Danes, use. This is the witches' word in the opening scene of *Macbeth*:

Padock calls anon: faire is foule, and foule is faire,
Hover through the fogge and filthie ayre.

Here in our argument we interrupt its course for a necessary diversion.

Today civilized men have a kindly feeling for the toad. Lewis Carroll and Kenneth Grahame have planted the seeds of their benign influence in the minds of successive generations of well brought up English-speaking children. The Victorians were inclined to foster sympathy for the whole animal world. (Was this because the industrial revolution released increasing numbers of men from slavery to the soil, from intimate conflict with cantankerous nature?) As for the toad, there has been an additional influence: men of science have undertaken to show that it is the farmer's friend.

Far different was the repute of the toad in times past. There was no other member of the animal kingdom that inspired such revulsion and fear. Chaucer spoke of the 'foule tode', and Spenser of the loathly and venomous toad. 'A pad in the straw' was what our ancestors said when they meant 'a nigger in the woodpile'. (Now that this last phrase is banned in polite society and perhaps vanishing, why not revive the earlier expression?) Shakespere reveled in the toad as a potent term of abuse. In *Richard III* the toad is a recurring theme, as is fitting for a play about a king described as:

That bottel'd Spider, that foule bunch back'd Toad.

Among all of Shakespere's many references to the toad, there is not one that is neutral, much less friendly. Edgar in *King Lear* denounces Edmund as 'a most toad-spotted traitor'; and the witches in *Macbeth*, when they concoct their hellish brew, give to the toad pride of place in the cauldron:

Toad, that under cold stone
Days and nights hast thirty-one
Swelter'd venom sleeping got,
Boil thou first i' the charmed pot.

Not only were toads venomous; to the mediæval mind they were also a symbol of lechery, as were warts and moles, with which toads were supposed to be covered.

The evil repute of the toad is not yet dead. There are English circles where 'Toad!' flung in anger would be a fighting insult now. The derivative 'toady' brings to mind the sycophantic and hypocritical squat of the creature, with its upturned watchful eyes. The bad name of the toad survives among untutored countryfolk in England and the United States, where farmers cling to the belief that the spittle of toads is poisonous, and that warts will grow on the skin where a toad has touched. French peasants down to recent times, and perhaps even now, put toads to death by methods shocking for their cruelty, methods that reveal an ingenuity in torture ordinarily reserved by man for his fellow-man.[287]

The unpleasant abuse heaped on the toad, as well as the serpent, seems to have been a fruit of Christianity. In Old French *le bot* was a name for Satan, resorted to as an evasive term, a word derived from a Germanic root, meaning the club-footed one, or the splay-footed, or the limping one. (Among Satan's traditional attributes was a bad foot causing him to limp.) That same word *bot* was a designation also for the toad and the toadstool, constituting thus a sinister trinity linked together in verbal identity. In the Carpathians and the Ukraine the

---

287. *Vide Le Folklore de France*, by Paul Sébillot, vol. III. *La Faune et la Flore*, Paris, 1906; pp. 280 ff.

toad theme recurs in the mushroom vocabulary in conjunction with the 'mad-mushroom', which as we shall see can be traced to the fly-agaric, *poŋχ*, *paŋχ*, of the Ostyak. Surprisingly, in China the common name for the fly-agaric is 蛤蟆菌, *ha-ma chün*, 'toad-mushroom';[288] in that country suffering from deforestation the fly-agaric today is found chiefly in Manchuria, along the Amur River. But the foul reputation of the toad in Western Europe is absent, significantly, in Russia and China.

One asks oneself why the early Churchmen in the West convicted the toad of heinous crimes. Was it because the toad occupied an honoured place in the Pagan pantheon? So it seems. In a remarkable paper[289] Marija Gimbutas has shown how paganism lingered on in Lithuania long after it had disappeared elsewhere, until the last century, and one can study the surviving practices there. The Lithuanian peasants in the conservative areas continued to regard toads and snakes gently, encouraging them to live in their homes and considering their welcome presence a happy augury. Only a hundred years ago these peasants were still making wooden grave markers carved in the shape of stylized birds and of toad's hind legs (Fig. 6). Professor Gimbutas shows her readers prehistoric pottery from central Europe with the toad motif incised on the clay (Fig. 7). The toad seems to have been a beneficent deity, a chthonic spirit compact with earth force and sexuality; the snake likewise. But Christianity changed all that, and not for the better.

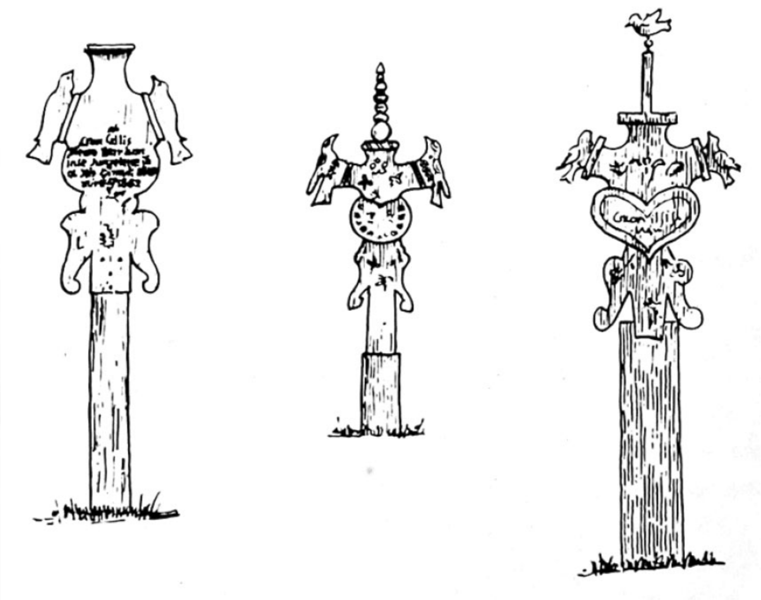


Fig. 6. Wooden grave markers carved in bird and toad's leg motifs from the 19th century cemeteries in Lithuania Minor. (After Marija Gimbutas: *Ancient Symbolism in Lithuanian Folk Art*, p. 32, Mem. of Amer. Folklore Society, Philadelphia, Vol. 49, 1958).

How strange it is that the most spectacular, the most potent, mushroom lacks a name in the English language. A people priding ourselves on our love of nature has not bestowed a name on this regal plant bedecking our woods in the fall of the year. (For 'fly-agaric' of course is not a name. I use it in this book as a term of convenience. It has no circulation among the genuine country-folk of the English-speaking world. A post-Linnæan invention, 'fly-agaric' has led its exsanguinated existence mostly between the pages of pallid mushroom manuals.) On the other hand, the most important fungal word in English, 'toadstool', has no specific meaning; though on the Continent, in those regions where it retains a specific association, the link with the fly-agaric is unmistakable. Our earliest citations for the word are of course after the Christian fathers had introduced writing into northern Europe, and already it had lost its moorings. I suggest that the 'toadstool' was originally the fly-agaric in the Celtic world; that the 'toadstool' in its shamanic rôle had aroused such awe and fear and adoration that it came under a powerful tabu, perhaps like the Vogul tabu where the shamans and their apprentices alone could eat of it[290] and others did so only under pain of death; that people hesitated to

---

288. 刘波 Liu Po: 蘑菇及其栽培 Mo-ku chí ch'i tsai-p'ei [Mushrooms and Their Cultivation], 科学出版社 K'o-hsüeh Ch'u-pan Shê [Scientific Publication Association], Peking, 1964; pp. 21, 88.
289. *Ancient Symbolism in Lithuanian Folk Art*, Memoirs of the American Folklore Society, Vol. 49, 1958.
290. *Vide supra*, pp. 152-153; also Kai Donner [28] p. 286, and Lehtisalo [24] p. 280.

pronounce the very name of this mushroom, so that in time it became nameless and the name it formerly carried hovered thereafter ambiguously over the whole fungal tribe so that all the mushroom world fell under the same floating tabu. This tabu was a pagan injunction belonging to the Celtic world. The shamanic use of the fly-agaric disappeared in time, perhaps long before the Christian dispensation. But in any case the fly-agaric could expect no quarter from the missionaries, for whom toad and toadstool were alike the Enemy. (We remind the reader of St. Augustine's censure of mushroom-eating by the Manichæans supported much later by the excoriations of St. François de Sales and of Jeremy Taylor, p. 71.) Today we are dealing with a deep-seated emotional attitude born in a tabu long forgotten, a tabu on a Sacred Element, the fly-agaric, a tabu overlaid by and mixed up with the venom of the Christian Church's anathema.

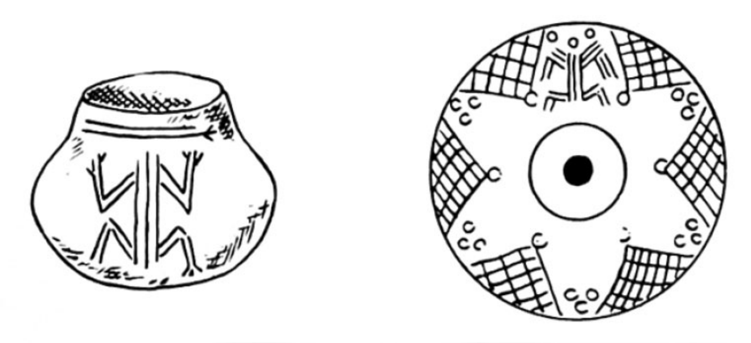


Fig. 7. Toad motif on prehistoric pottery. Left: Neolithic pot with incised toad form. Second half of 3rd millennium B. C. Danubian I culture in Czechoslovakia. Right: Figure of toad on bottom of Early Iron Age pot from Central Germany. (After Marija Gimbutas: *Ancient Symbolism in Lithuanian Folk Art*, p. 35, Mem. of Amer. Folklore Society, Philadelphia, Vol. 49, 1958).

The truly lethal mushrooms - *Amanita phalloides*, *A. verna*, *A. virosa* - have played virtually no role in Eurasian history. They are of importance only to the rare individual who eats one of them and dies from it, and to his kin. (They have occasionally served the assassin's purpose.) In many of the languages of Europe the peasants have no name for them: they pass them by and ignore them. But everyone knows the notorious reputation of the fly-agaric and shudders at the thought of eating it. Thus in our own day a sanction having its origin in a purely religious tabu thousands of years old is better known and more effective than the lethal properties of the deadly species.

5

In the spring and again in the summer of 1967 I visited Dr. János Gulya, in Budapest, to consult with him in the field where he is the master, the Finno-Ugrian languages, and especially the Ugrian cluster - Magyar, Ostyak, and Vogul. Out of his knowledge of these, to us, remote languages he drew to my attention a usage in Ostyak that may have relevance for our inquiry into the fly-agaric. The word *tul-paŋχ*[291] occurs in two Heroic Songs, in one as part of the hero's name, and in the second, repeatedly in the course of the narrative. In both cases the word signifies the fly-agaric, '*tul*-' meaning 'fool' and 'foolish'; *paŋχ* means of course 'fly-agaric'. This serves to nail down the meaning of expressions that have circulated in past centuries in many parts of Europe, but whose specific sense has long been up in the air.

In Magyar there is a phrase, a conversational cliché, *bolond gomba*, 'fool-mushroom', circulating especially in rural areas, as when one asks of a person behaving foolishly, 'Have you eaten of the fool's mushroom?', or when one rejects a proposition by saying, 'Do you think I have eaten a fool-mushroom, that I should do such a thing?' Or again, 'He is laughing as though he had eaten fool's mushrooms.' In Hungary the 'wise-woman', *javas asszony*, is said to use this same mushroom in love philtres, and the angry lover sends the philtre on to the object of his passion. At our request considerable effort has been made in Hungary to find out whether peasants in any region of that country identify the *bolond gomba* with a particular species, but with no success. This is why Dr. Gulya's discovery of a linguistic link with the Ob-Ugrian peoples is gratifying. The link bridges the centuries and securely fixes a knowledge in former times of the properties of the fly-agaric in the Pannonian Plain among the Hungarian people.

---

[291] The citations are in *Osztják Hösénekek* [Ostyak Heroic Songs], Reguly A. és Pápay J. hagyatéka [*The Legacy of Anton Reguly and J.Pápay*]. I. kötet. [Vol. I.] Reguly Könyvtár I. [Reguly Library I.] Edited by Miklós Zsirai, Budapest, 1944. The first citation is from the first heroic song, pp. 2-165, on pp. 2-3. The second citation is from the second song, pp. 392, 398, 400. The first song was from Obdorsk, now Salehard. The second was from the northern Sosva river basin.

The fly-agaric's peculiar virtue was widely known. In Yugoslavia one still says, *Najeo se ljutih gljiva*, 'He has eaten enough of the fool-mushroom'. In Vienna one may hear, *Er hat verrückte Schwammerl gegessen*, 'He has eaten the mad mushrooms,' and all Germans recognize the meaning of *Narrenschwamm*, 'fool-mushroom'. John Parkinson in his *Theatricum Botanicum* (1640) speaks of the 'foolish mushroom', but he is leaning on his Continental sources. The 17th century Polish poet Wacław Potocki warns his readers in *The Unweeded Garden* against a kind of mushroom called *szmer*, lest it render the reader foolish (*szaleć*), 'as from opium'. He was clearly passing on hearsay, since no mushroom could be confused with opium. A Slovak informant from near the Tatra Mountains tells us that rejected mushrooms are variously called by his people *žabací huby*, toad-mushrooms, *hadáci huby* and *hadúnke huby*, both meaning viper-mushrooms and *šalené huby*, mad-mushrooms. The toad and serpent, prehistoric deities chased away by Christianity, are thus associated with the inebriating mushrooms. To the east of Slovakia, in the Ukraine, the natives today call any wild mushroom that they reject *zhabjachyj hryb* - the toad-like mushroom.

The Hungarians invaded Europe and settled in the Pannonian plain late in history, at the end of the 9th century. Their 'mad mushroom', *bolond gomba*, establishes a link with the fly-agaric of the Ob-Ugrians, but not with European pre-history. Whether the verbal traces of the 'mad-mushroom' that we have found are all derived from Ugrian sources, *via* the Magyar peoples, we cannot say. It seems probable that a knowledge of the properties of this extraordinary fungus survived independently. How otherwise are we to explain the name of the fly-agaric in Catalan - *oriol foll*, the 'mad-oriole', the 'oriole' being *Amanita cæsarea* and the fly-agaric thus being the 'fool's *A. cæsarea*'; or the *mujolo folo* around Toulouse, or the *coucourlo fouolo* in the Aveyron, or the *ovolo matto* in the Trentino, all meaning 'mad mushroom'? In the dialect of Fribourg, Switzerland, the fly-agaric is the 'devil's hat', *tsapi de diåblhou*. Eugène Rolland reports *bò* as a designation for any gilled fungus in the Haute Saône and *botet* in the Loire, both presumably meaning originally the Satanic mushroom, by way of *bot*, 'toad' and Satan in Old French. In the Aude two words designate the fly-agaric, *mijoulo folho*, the 'mad-mushroom', and *tuo-mouscos*, the 'fly-killer'; they are synonyms.

6

This discussion of the fungal vocabulary of Europe has finally brought us to the second of the two important mushroomic words of the European languages - *Fliegenpilz* (or *Fliegenschwamm* in the older tongue), the 'fly mushroom' of the Germans and corresponding words in all the other Germanic languages, except English in which I find no trace of the 'fly' figure. The word in the Germanic languages is simply 'fly-mushroom'. In Russian and French the mushroom is popularly called the 'fly-killer'. In Russian *mukhomor* is the only name for this conspicuous and decorative mushroom. In French, as we have seen, *tue-mouche* competes with the more important *fausse oronge*, the 'false Caesar's amanita', and also with the *crapaudin* of the provinces.

In *Mushrooms Russia & History* we gave what for our time was a new explanation of the German 'fly-mushroom': the fly, in our opinion, was certainly the fly of madness, of divine possession. The association of madness with insect activity, and particularly with the fly, *sensu lato*, is exceedingly old and can be documented throughout Eurasia. In the course of our Siberian readings we found Jochelson ⁅21, p. 267⁆ reporting in the Chukotka that if the eater of the fly-agaric vomits, the people believe that the spirits of the demonic mushroom can be found in the vomit as 'worms', which then quickly vanish into the earth. He was speaking of the Koryak. Bogoraz in turn says of the Chukchi ⁅22, p. 277⁆ that the shamans think psychic disturbances are caused by insects, and they use insects in their treatment of mental disorders. The shaman catches an insect from off his drum, swallows it, spits it up, and applies it to the head of the victim. He then sucks the sick man's head. Sometimes the insect is imaginary, sometimes real. This widespread notion that insects cause madness was based, as I will venture to suggest, on a natural phenomenon: the herdsmen saw their reindeer and sheep driven into a frenzy when insects lodged in their nostrils and procreated there, and the animals did not recover until the new generation emerged from the nose.

Bugs, flies, moths, all kinds of larvæ - in short, the insect world - constituted for our ancestors until recent times an order of nature instinct with supernatural powers, mostly malevolent and always awesome. Their strange shapes and stranger behaviour, their incredible numbers and countless kinds, perhaps most of all their undeniable faculty of metamorphosis, may be at the root of this rôle that they played in the thinking of untutored mankind. The fly was divinely possessed and so was the *Fliegenpilz*. Already in the Old Testament the neighbors of the Israelites worshipped Beelzebub, whose name meant the Lord of Flies. In the Greek New Testament, where that heathen god does not appear, the same name was used as a synonym for the Prince of Demons. The Biblical term crops out in modern literature, as in line 1334 of Goethe's *Faust: Wenn man euch Fliegengott, Verderber, Lügner heißt*... 'When one calls you Fly-god, Destroyer, Liar...' In Nordic mythology the god Loki assumes the appearance of a 'fly' to enter the tightly closed apartment of the sleeping goddess Freya. He pricks her, and when she starts, deftly detaches her necklace and steals it. Whatever that 'fly' was, no one thought of it as a housefly, for the housefly does not bite.

In the Middle Ages and the Renaissance it was the convention to represent demons in the shape of flies. Hieronymus Bosch, the greatest of Europe's painters of the demonic world, presents us with a superb illustration of flies in their demonic rôle. We find it in the left hand panel of the Hay Wain, where the momentous events that took place in the Garden of Eden leading up to Man's First Fall are portrayed with moving beauty. We reproduce the upper portion of that panel in Plate XXII, wherein the observer sees that the angels expelled and tumbling down from Heaven assume the form of 'flies' - a diverse lot of winged demons, Beelzebub's host. In recent times the poet echoes this theme skeptically when, a few years ago, he uttered in *The Times Literary Supplement* the following sprightly lines:

> Has Freud not hit the Devil on the snout?
> Is not Beelzebub destroyed by Flit?
> Are we important? Do we really sprout
> Immortal souls that priests may manumit?
> *H. S. Mackintosh, issue of Oct. 2, 1953*.

Sometimes accidents of sound led to confusions in names. In English 'flea' and 'fly' are words of different origins, but the phonetic similarity caused them sometimes to be used one for the other. When in *Henry V* Falstaff lay dying, he saw a 'flea' stick upon the toper Bardolph's flaming nose, whereupon he said it was a 'blacke Soule burning in Hell'. What he saw was of course a fly, and the black soul in hell was, according to the beliefs of that day, its incorporeal counterpart, the Demon domiciled in every fly. Though in English the fly is not linked with the fly-agaric, the supernatural associations of the word survive. The Oxford Dictionary reports that 'fly' has always been a designation for a 'familiar spirit', and one still hears occasionally 'fly' as an adjective meaning nimble, dextrous, sharp, with the suggestion of an uncanny faculty in those directions.

One of the most interesting examples of the Satanic fly in European literature is to be found in that classic of the Danish stage, Ludvig Holberg's *Jeppe of the Hill*, first produced in 1722. Two physicians are conversing. One of them speaks of his Lordship, who has had a strange, ugly dream, which so excited him that he imagines himself a peasant. Whereupon the other physician recalls a remarkable case ten years back: '... a man who thought his head was full of flies. He could not rid himself of the delusion, until a most clever doctor cured him in the following manner. He covered his patient's whole head with a plaster in which he had embedded masses of dead flies. [Query: were they the Spanish flies of the Pharmacopæia?] After a while he removed the plaster and showed the flies to the patient, who naturally believed that they had been drawn from his own head and therefore concluded that he was cured.' Here is a beautiful instance of the way a dramatist (or physician) puts to use an outworn belief that lingers on in the penumbra of man's consciousness: an outworn belief, but one that has survived until only yesterday, as we have just seen, in the Chukchi country.

In the Middle Ages delirium, drunkenness, and insanity were attributed to insects that were loose inside the head of the victim. This belief, strange for the modern mind, survives in many familiar locutions. A man has a bee in his bonnet, a fly (or bug) in his ear, or demonic bats (= 'bots') in his belfry. The Norwegians get flies into their heads or put flies into others' heads. To 'put a bee on someone' means to fix him willy nilly for a given purpose: in this locution the demonic intent is scarcely fossilized. It used to be said in French, when a man was becoming angry, that *la mouche lui monte à la tête*, a fly is climbing up into his head. Down to recent times *avaler les mouches* was a phrase for saying that someone had summoned up his courage, and the flies thus swallowed were of course demonic. Rabelais at the very end of Book IV makes the coward Panurge protest that, far from being afraid, he is braver than if he had eaten all the flies cooked in the pastries of Paris betwixt St. John's Day and All Saints'. There is a colloquial expression that circulates around Lyons and perhaps elsewhere: *Ne prends pas la mouche*: don't catch a fly, don't get excited.

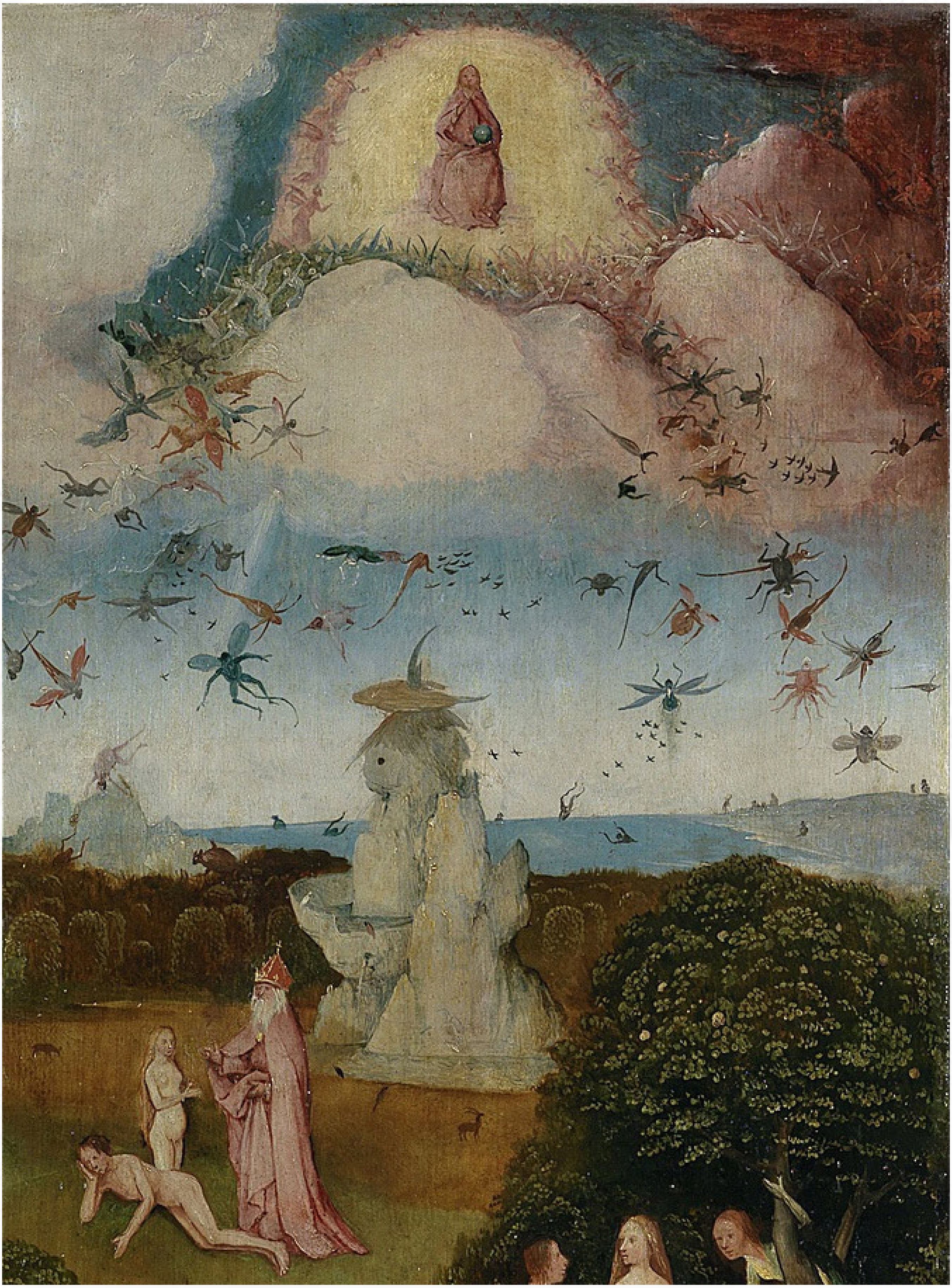


Plate XXII - Hieronymus Bosch: the Hay-wain.
Upper part of left panel of triptych.
(*Courtesy of Prado Museum, Madrid*)

Of a man who is unbalanced one says, *Il a I'araignée dans le plafond*, he has a spider in his ceiling, *i.e.*, in his upper story. The Czechs use an identical phrase: *míti mouchu* (or *pavouka*) *na mozku*, to have a fly (or spider) on the brain. The Italian is apt to say, *Gli è saltata la mosca al naso*, the fly jumped to his nose, that is to say, he became upset. When the Dutch say, *Hij ziet ze vliegen*, he sees them flying, he has bats in the belfry, does not the turn of phrase refer to the 'flies' that he sees? In Russian they say of a man who is tipsy: *on c mukhoj*, so-and-so is 'with fly'. There is a gesture peculiar to the Russians that we feel sure stems from this association of psychic possession with flying insects. The Russian when he suggests having an alcoholic drink is like as not to perform a fillip against his neck below the ear: this is so habitual that it is become a Pavlov reflex. Does not that familiar fillip invoke the demonic 'fly' entering the mind? According to the Icelandic-English lexicon of Cleasby-Vigfusson, under *fluga*, in Icelandic belief sorcerers would bewitch flies and send them to kill their enemies. This explains the modern Icelandic phrases, 'to swallow the fly' or 'to carry the fly', meaning 'to be the tool of another man in a wicked business'. In Basque folklore, sorcerers and other malevolent beings would work their will through demons that assumed the shape of flies, and sorcerers would carry the demonic creatures in a sheath such as anglers use for their flies today.

7

Everyone who knows the first thing about wild mushrooms knows why the fly-agaric is so called: it kills the flies that feed on it and until modern times it was used as a household insecticide on the Continent. This is what all the books say. What is more, there is a large part of Europe where the untutored rustics, the people who read no books, also accept the story as part of their legacy of folk knowledge. It belongs to that curious fund of 'facts' that people keep repeating to each other and believing, without verification or analysis, like the saying that all Russians are good linguists. The area of Europe where our folk belief prevails is extensive but not all-inclusive. It embraces the Slavic world, the Germanic world except the British Isles, the Vosges, where Franco-German bilingualism prevails, and one or two enclaves elsewhere in France. The ancient authors, though they have much to say about the fungi, never refer to a fly-killer, and in modern Italy among the country folk we believe the association with the fly is unknown, but our inquiry has not been exhaustive. It is unknown among the Basques, and apparently to all the rural population of the Iberian peninsula. If we judge by Eugène Rolland's evidence in his *Flore Populaire*, in France the name *tue-mouche*, 'kill-fly', is indigenous only in Alsace and the Aude, though thanks to the mushroom manuals it is now familiar to a sprinkling of educated Frenchmen elsewhere. (Rolland reports that at Val-d'Ajol in the Vosges the natives hang the fly-agaric from the ceiling, where, he says, it draws flies to their death.) By contrast the German *Fliegenpilz* or 'fly-fungus' has its variants in all the German dialects, and also in Dutch and the Germanic languages of Scandinavia, but not in English.

Albertus Magnus, the Universal Doctor of the Church, supplies us with our earliest citations[292] attributing insecticidal properties to the fly-agaric; his writings date from the 13th century. Other learned clerks follow suit down the centuries. They differ in details disconcertingly. The distinguished Carolus Clusius, for example, whom some consider the father of mycology, describes the fly-killing fungi as a genus having five or six species, of which one is the fly-agaric.[293] Clusius was a widely travelled man and he places the use of the fly-agaric for fly-killing only in Frankfort-on-the-Main. The great Linnæus in *Flora Svecica* repeated the statement about killing flies, but instead of Frankfort he said it was a custom in Smolandia, a Swedish province where he had spent his childhood. This is not the only reference to the insecticidal agaric in Linnæus. In his famous *Skånske Resa* ('Journey through Scania') published in 1751, on page 430, he tells how a certain Swede in Upsala got rid of bedbugs from two of his rooms by the use of *Amanita muscaria*. He describes the remedy and then concludes with what we consider a most significant statement:

> One takes in the autumn fresh specimens of the fly amanita, pounds them with a pestle quite small in a jar, lets them stand well closed until they become slimy or like gruel. Then one takes a feather or brush and smears all the cracks and corners where they (the bedbugs) keep themselves, and this procedure is repeated several times at monthly intervals. The room stinks for two or three days, but then the smell disappears. These nasty creatures die of it as if the

---

[292] *De Vegetabilibus*, Book II, Chap. 6:87; Book VI, Chap. 7:345.
[293] *Rariorum Plantarum Historia*, 1601, Genus XII of the Pernicious Mushrooms.

> plague had come amidst them, and whole bug-families perish as if from the Black Death. Although this remedy is simple, it is surer than anything else hitherto invented, and with its aid several houses in Upsala have now become free of bugs.

In a note on the next page Linnæus adds that he has learned of this method for the first time from a Mr. Bern, Cashier of Interests in Upsala. The text is in Swedish.

For us the striking thing about this description is that it is a report on a novelty. Certain families of Upsala were putting the popular reputation of the fly-agaric to a test, and their first impression was enthusiastic. Why had they not been using it for centuries? What were their final conclusions, say five years later? The answers to these questions are not vouchsafed to us. Was not Europe in these last centuries finally reaching a standard of living that made people more impatient with insect pests, and as the older and original meaning of *Fliegenpilz* was being forgotten, were they not now misinterpreting the name, and experimenting here and there to try out the mushroom's insecticidal virtues, only to discover that they were of no practical value?

After Linnæus the references to the fly killing potency of the fly-agaric in mushroomic writings are innumerable. All the mycologists believe in it - with one dissenting voice. None puts it to a test - with one exception. The French mycologist Jean Baptiste Bulliard, in his *Histoire des Plantes Vénéneuses et Suspectes de la France*, which he finished in 1779, dares to strike a sceptical note. Speaking of the fly-agaric, he says:

> I have never noticed that it kills flies, as several authors assert. I have had specimens, raw and cooked, for long periods in my apartment. Flies light on them, and seem even to eat them, without bad effects. But I intend to repeat this experiment with certain new precautions.

We know not the results of the promised experiments, but we know that when Bulliard died in 1793, he held the view that a new scientific name should be bestowed on *Amanita muscaria*, and he suggested '*Agaricus pseudo-aurantiacus*', presumably because he considered the old name false. The mycological world has not deferred to his wishes, nor until the last few years even tested his premises. In the last fifteen years steps have been taken to remedy this. As long ago as 1953, on our suggestion, the mycologist F. E. Eckblad of the Botanical Museum of Oslo, working under Professor Rolf Nordhagen, performed experiments leading him to the tentative conclusion that there was no evidence of insecticidal virtue in the fly-agaric. More recently Professor Roger Heim has supervised experiments by some of his assistants seeking the answer to the problems that we have raised,[294] and work has been in progress also in Switzerland, Japan, and England. It seems that the complex chemical make-up of the fly-agaric varies, perhaps materially so far as the fly-killing and the inebriating constituents are concerned, according to place and season of growth.

Albertus Magnus was relying on hearsay, and so indeed was Linnæus when he quoted a Mr. Bern about bedbugs. Most writers have placed the fly-killing at a distance from themselves in time or place, Clusius in

---

[294] The Eckblad results are in a letter that he wrote me dated Sept. 8, 1953, and that we summarized in *Mushrooms Russia & History*, p. 213.

More recently, the *Revue de Mycologie*, Roger Heim editor, has carried the following articles under the general heading of '*Un Problème à éclaircir: celui de la Tue-mouche*':

Tome XXX (1965), Fasc. 1-2, July 15, 1965:
- L'Amanite tue-mouche, bien ou mal nommée? by Gabrielle Bazanté, pp. 116-121.
- Etude de l'action de l'*Amanita muscaria* sur les mouches, by Monique Locquin, pp. 122-123.

Tome XXX (1965), Fasc. 4, I966:
- L'Amanite tue-mouche nord-américaine n'est pas la *Muscaria*, by Roger Heim, pp. 294-298. This is a *mise au point* of the various forms of *A. muscaria* that have been reported in the journals.

Tome XXXI, Fasc. 3, Nov. 30, 1966:
- Continuation of Gabrielle Bazanté's paper, pp. 261-268.
- Continuation of Monique Locquin-Linard's paper, pp. 269-276.

Tome XXXII (1967), Fasc. 5, July 1968:
- Continuation of Monique Locquin-Linard's paper, pp. 428-437.

For the papers of the Eugster-Waser team in Zürich, the Bowden team in England, and the Takemoto team in Japan, *vide* bibliographies that accompany the papers by Conrad H. Eugster and Peter G. Waser published in *Ethnopharmacologic Search for Psychoactive Drugs*, a volume edited by Daniel H. Efron, Bo Holmstedt, and Nathan S. Kline, 1967, Public Health Service Publication No. 1645; being the 'Proceedings of a Symposium held in San Francisco, Calif., January 28-30, 1967.'

Frankfort, Linnæus in Smolandia, John Ramsbottom in Poland, Bohemia, and Rumania. Mr. Ramsbottom[295] also says that the fly-agaric was 'formerly' used in England and Sweden for killing bedbugs, as though it had been an habitual practice in those places, thus justifying the occasional use of the name 'bug agaric'. But Linnæus was reporting a novelty in Sweden, and 'bug agaric' in English cannot be old, since Linnæus by his great authority imposed the name 'agaric' on the gilled fungi and 'bug' for 'bedbug' is a modernism in the English language. Only Bulliard put the fly-agaric to the test, and his findings were negative. But in support of Bulliard's scepticism we can add a story told to us by a Russian friend, Ekaterina Apollinarievna Bouteneff. Her nurse in childhood was an unlettered peasant woman from the region of Riazan. Our friend remembers having seen this good woman time and again put out a saucer with a crushed cap of the fly-agaric in it, a lump of sugar on top of the fungal mess. This was going to kill the flies, she would always say. But our friend always observed that the flies did not die. When she would ask her nurse why they did not die, the reply was always the same: 'They are sure to die later.'

In the past ten years much work has been done on the chemistry and pharmacology of the fly-agaric by Drs. Conrad H. Eugster and Peter G. Waser of the University of Zürich, Switzerland, and by Dr. T. Takemoto and his colleagues at Sendai University in Japan. An acid has been isolated from *Amanita muscaria* which the Japanese named 'ibotenic', and it possesses slight insecticidal properties. Under favorable conditions flies, imbibing the juice of the freshly cut specimens, fall into a stupor. In the stupor they are apt to succumb to their enemies, but if not, they recover after some hours or even days.

8

Twenty-five years ago we had gathered, Valentina Pavlovna and I, much of the information that has been offered to the reader in this chapter. 'Toadstool' and *Fliegenpilz* were folk-words coming down to us from our remotest ancestors, for whom they were freighted with supernatural meaning. To amplify our information concerning them we set out to explore the primitive cultures of Siberia, with the results that now lie before the reader. This in turn led me to work up and here present an interpretation of certain aspects of the ṚgVeda, and of the Soma that lies at the core of the ṚgVeda. Out of the depths of Asia we gain the vast perspective of an ancient cult, now finally disappearing, and what it must have meant for man's imagination and emotional life in the pre-literate phases of his past. How strange and stirring that the Soma of the Aryans should be linked to the 'toadstool' of our day in subtle ways that no one has suspected until now!

The primordial inebriant of northern Eurasia was the fly-agaric. This was the divine inebriant that inspired the astonishing lyrics of Maṇḍala IX of the ṚgVeda, and the Heroic Hymns of the Vogul in our own time. Through a different set of circumstances the same inebriant was responsible for laying a blight on the mushroom world throughout the English-speaking world. I suppose that the 'toad' figure of the 'toadstool' was peculiarly the property of the Celts, and the tabu must have been enforced by singularly effective religious sanctions. The high reverence that must have accompanied the tabu changed to intense revulsion when the divine inebriant became under the Christian dispensation demonic possession. These are only speculative guesses, of course, but the strength of the tabu even today is impressive. In the English-speaking world there are victims of allergy who are peculiarly sensitive to mushrooms. It is even said that among mycologists there are those who, poor souls, must retrain from eating the objects of their study, for fear of reactions. My wife, who was a physician specializing in allergies and with a large Russian practice, had never heard of a Slav who complained of sensitivity to mushrooms. There have been many distinguished mycologists in the English-speaking world, but would not incomparably more talent have flowed into this field if 'toadstools' had not been of its theme?

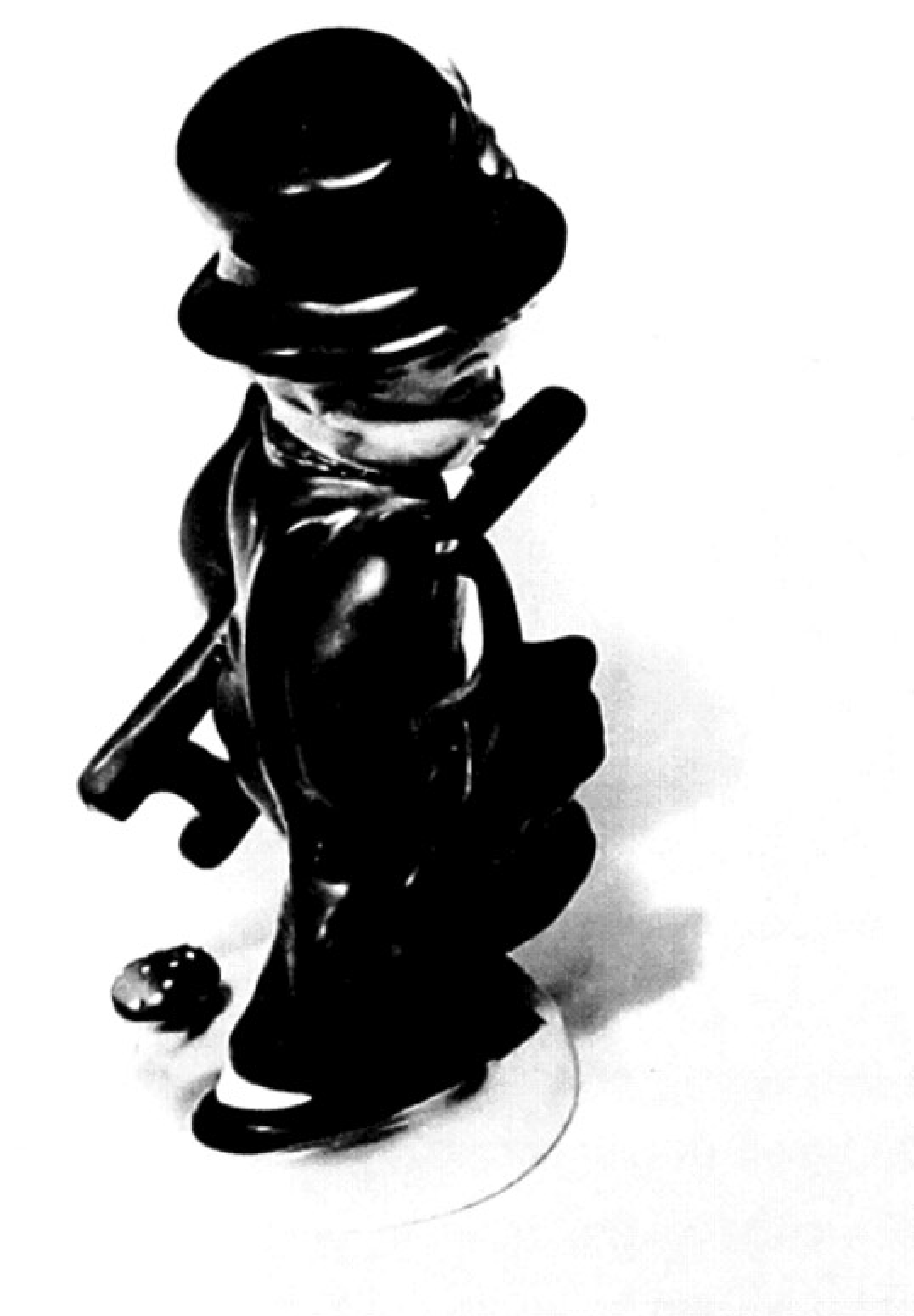
The attitude of the Germanic world has been somewhat different from the English. Whether Albertus Magnus believed the story of the fly-killing mushroom we cannot say. As time has gone on and the world has become increasingly fly-conscious it has become easier to believe that the fly-agaric is so named because it kills flies. Perhaps this alternative explanation served the Church's purpose, diverting attention from the awesome truth. Certainly in recent generations, when with increasing education the fly has come to be considered a pest, this watered-down meaning of the name has completely won the day for mothers, governesses, nursery maids (now called baby-sitters), and children.

---

[295] *Vide* his *Poisonous Fungi*, Penguin Books Ltd., 1945, p. 21.

There is a further distinction to be drawn between the *Fliegenpilz* and the 'toadstool'. No one eats the fly-agaric in Germany, of course, but the attitude toward it is not unfriendly. The red mushroom with white spots appears frequently on greeting cards to convey good wishes and a seasonal message of happy augury, precisely as the *ling chih* is used in China and throughout the Chinese orbit.

A noteworthy thing: this attribute of happy augury belonging to the *Fliegenpilz* is regarded by chimney-sweeps as peculiarly theirs. The chimney-sweep pursues an ancient craft that still lingers on in Central Europe. One occasionally sees its devotees hurrying through the streets of the ancient cities, dressed in their formal black garb, the leader wearing his top-hat, with ladders and brushes, the utensils of their trade. The fire of the hearth is their traditional preoccupation. Has the chimney-sweep made the fly-agaric his own for the same reason that the Vedic poet identified Soma with Agni?



Epilogue: The Tree of Life and the Marvelous Herb

In *Part Three* and the Siberian Exhibits I have laid before the reader evidence for the part played by the fly-agaric as a divine inebriant in the proto- and pre-history of Eurasia. A recapitulation of this evidence will bring out aspects that the more detailed account tended to obscure and will chart the course for further inquiries.

Our surprising discovery in Siberia is linguistic. Just as we of Indo-European stock say today that so-and-so is 'drunk', a word derived from the fermented beverage that we 'drink', and just as we say of the Siberian shaman that he gets 'drunk' on fly-agaric without giving thought to the semantic contradiction, so the corresponding word in the Ob-Ugrian and one (at least) of the Samoyed languages can be translated as 'bemushroomed', and where that word survives it is used for alcoholic inebriation with no awareness of philological anomaly. Moreover we can assert that that word goes back far into the past. The Finno-Ugrian languages and the Samoyed group together make up the Uralic family. There is a characteristic consonant shift between Samoyed and the other languages of the family: an 'f' in Samoyed turns up as 'p' in the others. As the reader will perceive when he reads **[**34**]**, the Ob-Ugrian root *paŋχ* appears as *faŋkáˀam* in Tavgi, a north Samoyed language, both of them connoting inebriation. (This happens to be precisely the same shift that occurs between the Latin and Germanic families, - *e.g.*, the 'p' in *pater* and the 'f' in 'father'.) The cluster of words that interests us shows this characteristic shift, and therefore it was not borrowed at some later time but must go back to common Uralic. According to the weight of scholarly opinion, Uralic ceased to be spoken *ca*. 6000 B. C., or according to some authorities as recently as 4000 B. C. At that remote period there was not yet writing in the world: the Sumerians seem to have been the first to devise a method for making speech visible, and this they did shortly before 3000 B. C.

The use of the fly-agaric as an inebriant therefore dates back to the period when common Uralic was last spoken, but this is the minimum age. There is no reason to suppose that the peculiar virtue of this miraculous herb went for long undiscovered after it became common in the birch and pine forests as these spread over the Siberian plains in pursuit of the retreating ice cap of the last glacial age, *ca*. 10,000 B.C. After all, the first inhabitants probing the northlands were food gatherers, and how could they fail to see this spectacular plant with its solar disk growing around the base of the noble birch? And given their mental equipment and physical appetites, how could they fail to discover and then to take advantage of its inebriating qualities? None of our writers, not even the able anthropologists Bogoraz and Jochelson (who as Russians were surely mycophiles), seem to have discerned the rôle that it must have played in the past of the north-Eurasian peoples. Perhaps the Soviet authorities, now that they are under less pressure from urgent problems, will be disposed to allow able, sympathetic observers to go among the tribesmen and learn what they still know about their former practices with the fly-agaric, the normal inebriant over that vast expanse of the earth's surface for thousands of years.

We must be thankful for the anthropological testimony that we possess but we must not exaggerate its importance. For a shamanic practice that has lasted six, or eight, or ten millennia our soundings reach back only three centuries, ripples on time's surface. Some of the observers were supercilious and none of them saw the implications of their observations. None of them seems to have been prepared in botany and none probed the questions that are compelling for us. The circumstances that brought them on the scene were at the same time bringing about the end of the beliefs and performances for which they were to be the sole witnesses. They were observing the fly-agaric cult only in its dying phase, when the area of its diffusion was being lopped away, when in some places the integrity of belief in it had been undermined, and when the tribes themselves were mostly in a pitiful state of physical and psychological disarray. There is ample evidence that the ethnic movements, often gradual and more or less peaceful, in the inhospitable tundra and taiga of Siberia have been continuous, and we are far from unraveling them. In recent centuries the peoples practicing the fly-agaric cult have been living in areas to the north of where they were in their heyday, some of them on or close to the Arctic Ocean. They have been displaced from their former homes by Altaïc tribes who do not, apparently, take the fly-agaric[296] but who have absorbed into their shamanic practices the corpus of beliefs that go with the

---

296. For this conclusion we rely chiefly on negative evidence. Anthropologists like S. M. Shirokogorov, who specialized in the Tungus and Yakut cultures, make no mention of the fly-agaric. Ivan A. Lopatin, also with extensive personal experience, has assured me in a personal communication that the Tungus shamans know nothing of the practice. *Vide* also Brekhman and Sem **[**42**]** p. 334.

fly-agaric, beliefs that seem to accompany the ecology of the forest belt, especially the reverence for the birch. For the historian of human cultures it is a matter of regret that the impact of the modern world is inevitably brutal, bulldozer-like, in its disregard and contempt for the beliefs and ways of life of primitive peoples whom our industrial civilization wrenches from their traditions and tries, usually without success, to bring into step with our contemporary ideas. This holds true for the communist as well as the capitalist world: witness the authors that we quote in [42].

In northern Europe there is circumstantial evidence that in former times, long before the advent of literacy, the fly-agaric held sway over our own ancestors. This evidence, suggestive but falling short of proof, was enough to launch us on our inquiry, and the collateral confirmation that we found in Siberia buttresses our initial supposition as to our own ancestors. The picture that begins to emerge of a united field in Eurasia where the fly-agaric evoked religious adoration is mightily reenforced by my discovery that the Aryans, hailing from northern Eurasia and settling in the second millennium before Christ on the Iranian plateau and in the Indus Valley, brought down with them as one of their gods the fly-agaric, incorporating it into their elaborate religion of basic Indo-European pattern. The fly-agaric appears to have given those who ate it (or drank its juice) a feeling of elation, of ecstasy, so powerful that they felt they were sharing, for the nonce, the life of the immortals. As we shall see, we think that the renown of this divine inebriant spread far beyond northern Eurasia and the Aryan world. We have already suggested that under the First Emperor of China, Shih-huang, toward the end of the third century before Christ, rumours about the marvelous herb erupted in the Imperial Court and led to the conception of the *ling chih*, the 'Divine Mushroom of Immortality', which the Taoists made peculiarly their own and which survives to this day throughout the orbit of Chinese culture.

There is I think an inference that we may draw: a plant with properties that could be plausibly named the Herb of Immortality responded to one of man's deepest desires in the early stages of his intellectual development. The superb fly-agaric gave him a glimpse of horizons beyond any that he knew in his harsh struggle for survival, of planes of existence far removed and above his daily round of besetting cares. It contributed to the shaping of his mythological world and his religious life.

Now that the hallucinogens are again becoming familiar to us all, perhaps vicariously we are vouchsafed a glimpse into the subjective life of peoples known to us heretofore only by the mute artifacts uncovered by the archæologists. To weigh the effects of those hallucinogens is a formidable task, today rendered doubly difficult (perhaps even impossible) by the emotions they inspire in our own community, not least among the students of religion. Some of these seem loath to admit even the possibility that the hallucinogens encouraged the birth of religion, and may have led to the genesis of the Holy Mysteries. For them the hallucinogens are the abomination of abominations. Moreover, the fixation of our Western world on alcohol, often a stultifying intoxicant and seldom an invigorating one, closes our minds to other inebriants, older perhaps for the race than our fermented drinks and in their effects utterly different.

In the face of the Siberian testimony and the Vedic hymns, I am at a loss to explain what I write down as the partial failure of my own experiments with the fly-agaric. True, these experiments have confirmed that its reputation as a lethal mushroom is only a superstition, a tabu handed down to us from our remote forebears. (I use 'tabu' not as a figure of speech but in its strictest anthropological sense.) But why did we not feel the elation that the writers and poets describe, comparable with what my companions and I experienced after eating the hallucinogenic mushrooms of Mexico? Is there a difference between the fly-agaric of continental Asia and the Japanese and European specimens? This is possible; we must remember that von Langsdorf [10, p. 240] thought the Siberian fly-agaric displayed a 'navel' lacking in the European ones, in short, to use the mycologists' word, that it was 'umbonate'. But it seems unlikely. There was the divergent experience that Rokuya Imazeki once enjoyed, on October 1, 1965, in Sugadaira. (*Vide* p. 75) All the fly-agarics that we have eaten were gathered in October. We find evidence[297] that at the end of the season their potency falls off. We must either greatly increase the dose or try specimens gathered in summer. The affirmative testimony about the fly-agaric in Siberia is compelling, not to speak of the astonishing lyrics addressed to Soma in the ṚgVeda.

---

297. *Vide* Brekhman and Sem [42] p. 335; also [10] p. 247. Dr. Conrad Eugster informs me that chemical analysis shows more ibotenic acid in the fly-agarics gathered in mid-summer.

In her recent little book[298] Miss Barnard has driven home brilliantly the need to seek the genesis of myths in natural phenomena. Let us see how this fits the case of the Tree of Life and the Wondrous Herb of Immortality.

In the Siberian and Altaïc cultures, wherever the birch grows it plays an exalted rôle, sometimes also the pine, more rarely the fir. The tall Siberian birch with its delicate dancing foliage and its dazzling white bark is a thing of ethereal beauty, and this alone is enough to give it a favored place in the affections of the Russians. But beyond the Urals it enlisted more than the affections of the tribesmen: it is the nodal point for their shamanism, for their beliefs about the supernatural. All or almost all of the serious writers about these cultures speak of the conspicuous place of the birch in their practices and thoughts.[299] Yet not one of them links that special place with the fly-agaric. Not one of them perceives why the birch is the Tree of Life.

The fly-agaric lives in mycorrhizal intimacy with the birch, especially the birch; sometimes with the pine, occasionally with the fir. Moreover, while *Fomes fomentarius* grows on several kinds of trees, it is popularly associated with the birch because the birch is the most common of its hosts. *Fomes fomentarius* is the shelf fungus, often reaching huge size, that has always supplied the north Eurasian tribesmen with punk or touchwood, the primary tinder that catches the spark from the fire-drill and bursts into flames. This also has a mystic rôle to play: among many primitive peoples the procreation of fire is analogous to the sexual act. In French 'punk' is *amadou*, a word that goes back to Latin *amare*, and in English a 'punk' until only a few centuries ago was the harlot who sparked her lover into flame. The parallel 'spunk' has to this day the scabrous meaning of 'semen', and 'spark', a different grade of the same word, carries various erotic meanings. We shall see that in Siberia the same associations hold good. In the northern latitudes it was only a ready fire that made life livable and punk (cognate as I have suggested with Ob-Ugrian *paŋχ*, *poŋχ*; with Chukchi *poŋ*) seems to have captured men's emotions. The birch, parent to both fly-agaric and punk, naturally held pride of place as the Tree of Life, providing in punk the key to fire for the body[300] and in the fly-agaric fire for the soul.

What must have been conspicuous facts of nature for the Siberian food-gatherers are almost completely ignored by the Europeans who have visited them. This is not surprising. Europe's intellectuals are largely recruited from the urban culture and are or soon become strangers to the countryside. Of all the writers about the fly-agaric in Siberia that we assemble in the Exhibits, only three mention its connection with the birch. Von Maydell in 1893 wrote of the fly-agaric that 'it is said to occur only among birch trees', and almost a century earlier, in 1809, von Langsdorf observed that 'isolated fly-agarics grow in Kamchatka, in birch forests and on dry plains'. (Probably the 'dry plains' of von Langsdorf were the habitat of the dwarf birch of the Arctic regions, *Betula nana*; for the fly-agaric will grow with any species of birch.) But even von Maydell did not perceive the implications of the accurate observation that he reported as having been made to him by others. Von Dittmar also associated the fly-agaric with birch forests but vaguely.[301] Even the Russians and Poles failed to point out the connection between the fly-agaric[302] and the place of the birch in Siberian folklore. Since 1885 mycologists have recognized the mycorrhizal relationships between certain species of mushrooms and certain species of trees, but this important advance in their science did nothing to broaden and deepen the knowledge of anthropologists because mycologists are prone to keep to themselves, and they often look down their noses

---

[298] Mary Barnard: *The Mythmakers*, Ohio University Press, 1966.

[299] Here are three secondary works that will introduce the reader to the vast bibliography of primary sources about the place held by the birch among the Siberian peoples:
a. *The Mythology of All Races*, John Arnott MacCulloch, Editor; Vol. IV, *Finno-Ugrian, Siberian*, by Uno Holmberg, Chap. V, 'The Tree of Life'. Archæological Institute of America, Boston, 1927.
b. Jean-Paul Roux: *Faune et Flore Sacrées dans les Sociétés Altaïques*. Adrien-Maisonneuve, Paris, 1966. *Vide* pp. 52-62, 81, 89, 186, 359-361.
c. Mircea Eliade: *Shamanism: Archaic Techniques of Ecstasy*, Bollingen Series LXXVI, Pantheon Books, New York, 1964; pp. XIV, 70, 116-120, 244-246, 403. Translated from the French, *Le Chamanisme: Les Techniques Archaïques de l'Extase*, Payot, Paris, 1951; pp. 9, 78, 116-120, 245-246, 362.

[300] *Vide* **[**4**]**, the Editor's note on *zhagra*, a Russian word for 'punk', p. 238; also Jochelson **[**21**]**, p. 269.

[301] *Vide* **[**12**]**, p. 254; **[**10**]**, p. 247, and **[**13**]**, p. 256.

[302] There is a traditional saying, exceedingly old, in Russian:

Po veleniju shchuch'emu,	On the pike's bidding,
Po prikazu mukhomorovu.	On the fly-agaric's orders.

The pike plays a potent rôle in Russian folklore. Here it is yoked with the fly-agaric. Is this couplet borrowed from a Finnic or Ob-Ugrian people? Do we hear in the fly-agaric's 'orders' a distant echo of the orders of the fly-agaric that are reported in Jochelson and Bogoraz? *Vide* **[**21**]**, pp. 268 ff.; also **[**22**]**, pp. 274 ff.

on 'folklore' about mushrooms as a childish and irrelevant diversion from the grave questions of taxonomy and scientific nomenclature that preoccupy them; and most anthropologists, strangely, seldom study botany and never mycology. I say 'strangely' because plants fill a large part of the universe of the peoples we commonly call primitive.[303]

The birch is preeminently the tree of Siberian shamanism. This is so widely recognized that I need not argue the case and will only summarize it. We read, for example, that among the Buriat northwest of Lake Baïkal the inhabitants bow morning and evening to two birches that they have planted in front of their huts. We read that the birch with seven or eight or nine branches is favoured, these symbolizing the successive gradations in ascending to the ultimate heaven; and it is held that the trees' roots penetrate to the very depths of the earth. As though to symbolize the reach upwards and the reach downwards, an eagle (or a mythological bird that we conventionally call an eagle) surmounts the tree and a serpent dwells at its roots. Again we read that the shaman selects a stout birch, fells it, and places it in the center of the yurt that he is going to build for his performance. He cuts seven or eight or nine notches in it, representing the seven or eight or nine heavens through which he will ascend. Later in the course of his ecstatic performance he climbs this tree making use of the steps, and passes through the hole in the roof through which the smoke from the fire finds its way, going on his symbolic journey to the other world.[304]

Uno Holmberg in the *Mythology of All Races* summarizes the Siberian myths about the birch in his chapter on the Tree of Life. The spirit of the birch is a middle-aged woman who sometimes appears from the roots or the trunk of the tree in response to the prayers of her devotees. She emerges to the waist, her eyes are grave, she has flowing locks, her bosom is bare, and her breasts are swelling. She offers milk to the Youth who approaches her. He drinks and his strength grows a hundred-fold. This myth, which is repeated in myriad variations, clearly refers to the fly-agaric. But none of Holmberg's sources have called this to his attention. What are the 'breasts' but the 'udders' of the ṚgVeda, the swelling pileus of the full-grown fly-agaric? In another tale the tree yields a 'heavenly yellowish liquid.' What is this but the tawny yellow *pávamāna* of the ṚgVeda? Repeatedly we hear of the Food of Life, the Water of Life, the Lake of Milk that lies, ready to be tapped, near the roots of the Tree of Life. There where the Tree grows is the Navel of the Earth, the Axis of the World, the Cosmic Tree, the Pillar of the World. The imagery is rich in synonyms and doublets.

Mircea Eliade believes that this cosmological scheme probably has an oriental origin, or that its mythical features go back to a 'palæoriental' prototype (a toponymic designation that I have difficulty in assigning to a specific location; apparently it lies somewhere between the eastern Mediterranean and China), or (after Uno Harva) that the ensemble of initiation rites among the Siberian tribes comes down from a Mithraïc source.[305] It is the consensus of all who have written on the matter that the Siberians could not have fathered the myths and practices that they have made their own. Or, to put the thought more accurately, the very idea of such a possibility seems not to have been entertained by them.

On the contrary I now suggest that the source and focus of diffusion of all these myths and tales and figures of speech - all this poetic imagery - were the birch forests of Eurasia. The peoples who emigrated from the forest belt to the southern latitudes took with them vivid memories of the herb and the imagery. The renown of the Herb of Immortality and the Tree of Life spread also by word of mouth far and wide, and in the South where the birch and the fly-agaric were little more than cherished tales generations and a thousand miles removed from the source of inspiration, the concepts were still stirring the imaginations of poets, story-tellers, and sages. In these alien lands, far from the birch forests of Siberia, botanical substitutions were made for Herb and Tree. Here is where absurdities were introduced into the legends, where fabulous variations proliferated, where peoples who had never known the North such as the Semites were influenced by the ideas and in one way or another incorporated them into their religious traditions. The end-products of these extravaganzas have caused scholars much (and I think needless) trouble as they subjected them to sober exegesis and tried to reconcile them.

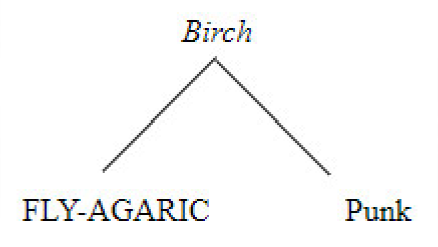
---

[303] There are of course notable exceptions to this criticism of anthropologists; *e.g.*, the studies in ethno-botany carried out by Harold C. Conklin among the Ifugao on the island of Luzón, in the Philippines. *Vide* (1) *Studies in Philippine Anthropology; in honor of H. Otley Beyer*, edited by Mario D. Zamora, pp. 204-262; and (2) 'Ifugao Ethnobotany 1905-1965: the 1911 Beyer-Merrill Report in Perspective', *Economic Botany*, Vol. 21, No. 3, July-September 1967, pp. 243-272.

[304] J.-P. Roux, *Faune et Flore Sacrées dans Sociétés Altaïques*, Paris, 1966, pp. 54, 59. M. Eliade, *op. cit.*, pp. 9, 116-122; French edition, pp. XIV, 116-120.

[305] Mircea Eliade, *op. cit.*, pp. XIV, 245-6, 60-70, 120. French edition, pp. 9, 247, 79, 121.

In the north to this day we find a notable consistency in the myths and poems of the Siberian people, having regard to the facts of nature. Their imagination never takes them more than one or two removes away from the life history of the fly-agaric, the birch (or pine or fir), and punk. The contradictions and wild embellishments begin only when the corpus of myths is translated to the exotic world of the Near East, Mesopotamia, Iran and India, and China; in short when the umbilical cord with the natural phenomena is broken. Here then is nature's triangle:



The fly-agaric holds the place of honour in this Trinity: without it there would be nothing. Its beauty matches its magic powers. The birch is also indispensable. Some will find it astonishing that the Siberian peoples observed and understood, according to their lights, the mycorrhizal relationship, only rediscovered by mycologists in 1885. For the tribesmen the roots of the birch tapped the lake of the Waters of Life and filled to overflowing with tawny yellow milk the breasts of the fly-agaric. The noble stance of the superb birch befitted its rôle as host and divine guardian. The punk is the least of the Trinity, vital in the North but meaningless in the South where other methods for making fire were used. But we must not disregard it. Here for example is a legend about punk that survives in many recensions from Central Asia.

Speaking of the Uighur, a Mongolian tribe, Marco Polo tells us that

> They say of their Khan who first ruled over them that he was not of human origin, but was born of one of those excrescences on the bark of trees, and that we call *esca*. From him descended all the other Khans.[306]

In another version of the same myth we learn that two trees played a part in procreating the royal family of the Uighurs, a birch and an evergreen resembling a pine.[307] *Esca* is the Italian word for 'punk', in Siberia *Fomes fomentarius*.

J.-P. Roux, the latest writer on the rôle of the flora among the Altaïc peoples, raises the inevitable question. Speaking of the place that the birch holds in the shamanic *séances* and at the animal sacrifices, he observes:

> Nothing permits us to think that the tree is chosen because of its capabilities or its appearance or because it acquires by reason of the ceremony the nature of a venerated tree. The only point that merits our attention is perhaps without value, the effect of a simple coincidence: the shamanic tree is most often a birch, that is to say, as everyone knows, a tree whose bark is whitish. With people who accord so great an importance to the colour white, is not the choice of the birch motivated by its flashing bark?[308]

No one had pointed out to M. Roux that the birch is host to the fly-agaric and touchwood. True, the quality of whiteness has an almost magical meaning for the northern Eurasians. But the question presents itself whether this is not secondary, and whether whiteness enjoys its exalted status partly because it characterizes the host to the fly-agaric and punk. Or, to put it differently, the fly-agaric and punk are primary in the hold of the birch on the souls of the natives and it must follow as night the day that the whiteness of the birch is in most fitting and wonderful harmony with its supernal attributes.

---

[306] The Italian text reads:

> Raccontano che il re che li resse per primo non era di origine umana, ma era nato da una di quelle escrescenze che la linfa produce sulla corteccia degli alberi, escrescenze che noi designiamo col nome di esca. - *Il Libro di Messer Marco Polo*, edited by L. F. Benedetto, Treves-Treccani, Milan and Rome, 1932, p. 73.

[307] J.-P. Roux, *op. cit.*, p. 359.

[308] J.-P. Roux, *op. cit.*, p. 186.

The Siberian legends and myths as we possess them were recorded in recent generations. They never cite the link that ties the fly-agaric to the birch. Perhaps this is because for the Siberian tribesmen the connection was self-evident: any cretin would know as much. Students of the Siberian cultures, unaware of the thesis that I am developing, have only by chance, occasionally, asked a few of their Siberian informants a few of the relevant questions, and they have not followed through. The inquirer who goes among primitive people must know the questions to pose, must see the implications of the answers he receives, must probe slowly with utmost patience and tact, especially where religious beliefs and practices are concerned. (The anthropologist has a thankless calling: no matter how thorough he is, his successors are certain to reproach him for not having put all the questions that later seem imperative.) Even so we could hardly ask for better than Holmberg's essay on the Tree of Life in Siberia, as it is presented in the *Mythology of All Races*. The fly-agaric and the Soma hymns of the ṚgVeda supply the key that unlocks the myths of his tribesmen.

The word for 'birch' in Sanskrit is *bhūrja*. Scholars have sometimes expressed mild surprise that the Aryans remembered, after their long migration, this Indo-European name, with cognates in almost all Indo-European tongues; in fact, the birch is, significantly, one of the few trees of which this can be said. The migration of the Aryans must have lasted for generations, even centuries. Yet when they first caught sight of the birch in the Hindu Kush or the Himalayas, we must assume that right away they exclaimed, 'What, the *bhūrja*!' Of course communications with the homeland may have been better in pre-literate Asia than we imagine: we may be victims of the bias of the literate world against periods in man's past about which we know almost nothing. But even if there was complete isolation, *bhūrja* as the Tree of Life held a place in their subjective life that they would not quickly forget. On the other hand *bhūrja* is not mentioned in the ṚgVeda, and Abel Bergaigne a century ago pointed out how trifling was the rôle of the Tree of Life in the Vedic hymns.[309] This should also not surprise us. In the mythological pattern that we are discussing the fly-agaric held the central position and the Tree of Life was secondary. The Indo-Aryans possessed the Marvelous Herb, which they bought from aborigines high in the mountains. With the fly-agaric in hand, what need had they of the birch? What was out of sight was for the moment out of mind. But elsewhere in the Near and Middle East the poets and sages had neither and from the renown of both their imaginations could embroider endless patterns.

On pp. 77-84 we gave three recensions - Indian, Iranian, Chinese - of the same tale going back to the Soma~fly-agaric of the Aryans. These versions came down from the second half of the first millennium after Christ. Thus they were late, and we may ask ourselves how many at that time in the Southern latitudes had knowledge of the fly-agaric. In each of these versions a novel element was introduced: the notion that the leaves of the Herb of Immortality, it placed on corpses, would restore them to life. This absurd accretion was however of ancient provenience: we can trace it back a thousand years before the Vedic hymns were composed, to the Sumerian fragments of the Epic of Gilgamesh.[310] The Soma hymns are unique and precious for their textual integrity, but tales of the Herb of Immortality (that is, of the fly-agaric) long antedate the ṚgVeda.

When man first devised a method of inscribing words on clay, *ca*. 3000 B. C., he poured forth on his tablets, among other items, the ideas that seemed to him deserving of perpetuation, but ideas not necessarily indigenous, derived from sources not necessarily known to the learned men who were shaping the characters. There is a scholarly bias, as understandable as it is mistaken, to trace the origin of ideas according to the literacy of peoples, and sometimes to give to the Near Eastern and Mesopotamian cultures credit for conceptions that they were merely the first to record. This is, I suggest, the case with the Herb of Immortality and the Tree of Life, whose archetypes were brought down from the forests of Siberia in the fourth millennium before Christ or earlier. The Hittites and the Mitanni rulers were Indo-European invaders from the north who preceded the Aryans, and the Sumerians long preceded them, and there were doubtless others even earlier of whom we have no historical knowledge. We must avoid the temptation of supposing that the tribesmen of Siberia could not have possessed a rich world of the imagination simply because, not having mastered the art of writing, they are for us inarticulate. When the Sumerians wrote down the Epic of Gilgamesh, we should not think of it as a fresh creation. It already belonged to the world of mythology and he is a rash scholar who today would say with assurance that that corpus of myths first saw the light of day in the Near East or Mesopotamia.

---

[309] Abel Bergaigne: *La Religion Védique*, Vol. I, p. 199.

[310] Geo Widengren: *The King and the Tree of Life in Ancient Near Eastern Religion* (King and Saviour IV), Uppsala Universitets Årsskrift 1951:4. Acta Universitatis Upsaliensis; p. 21. In the Near and Middle East graves of prehistoric cultures running back to *ca*. 6500 B. C. have been found in which the corpses were painted with ochre or cinnabar. It has been suggested to me that this practice may have had its origin in the crimson fly-agaric, the Herb of Immortality, and in the notion that the 'leaves' of the sacred *oṣadhi* if placed on a corpse would in some way assure it of Eternal Life.

Was Uno Harva mistaken and did the Mithraïc beliefs and rites come down from the forests of what we now call Siberia? Let us look again at what is known of the Orphic mysteries, and reconsider the archetype of our own Holy Agapé. On what element did the original devotees commune, long before the Christian era? Certainly the overt vocabulary relating to the birch and the fly-agaric carried great prestige over millennia throughout the south and east of Asia: the Tree of Life, the Pillar of the World, the Cosmic Tree, the Axis of the World, the Tree of the Knowledge of Good and Evil - all these were variations stemming back to the birch and the fly-agaric of the northern forests. The Herb (or Plant) of Life, the Herb of Immortality, the fruit of the Tree of Life, the Divine Mushroom of Immortality - these are alternatives ultimately representing the fly-agaric, no matter how far removed the poet or sage or king might be from the real thing. In remote China we have seen the devotees of the Manichæan sect as late as the 12th century eating 'red mushrooms' in such quantity as to arouse the indignation of a pillar of the Chinese Establishment: is not this an echo of Siberian shamanism, not having passed direct from Siberia to China, but tortuously, through successive Middle Eastern religions, until we reach the last of Mani's followers, far from his Iranian home? The Water (or Milk) of Life and the Food of Life are doublets, the former being the *pávamāna* expressed from the latter, the resplendent Soma. If I am right, here is striking confirmation of the ideas advanced by Miss Barnard. When we seek the source of myths, we should *chercher*, not *la femme*, but *un phénomène de la nature*.

In the opening chapters of Genesis we are faced with the conflation, clumsily executed, of two recensions of the fable of the Garden of Eden. The Tree of Life and the Tree of the Knowledge of Good and Evil are both planted in the center of Paradise. They figure as two trees but they stem back to the same archetype. They are two names of one tree. The Fruit of the Tree is the fly-agaric harboured by the birch. The Serpent is the very same creature that we saw in Siberia dwelling in the roots of the Tree.

Of arresting interest is the attitude of the redactors of Genesis toward the Fruit of the Tree. Yahweh deliberately leads Adam and Eve into temptation by placing in front of them, in the very middle of the Garden, the Tree with its Fruit. But Yahweh was not satisfied: he takes special pains to explain to his creatures that theirs will be the gift of knowledge if, against his express wishes, they eat of it. The penalty for eating it (and for thereby commanding wisdom or education) is 'surely death'. He knew the beings he had created, with their questing intelligence. There could be no doubt about the issue. Yahweh must have been secretly proud of his children for having the courage to choose the path of high tragedy for themselves and their seed, rather than serve out their lifetimes as docile dunces. This is evidenced by his prompt remission of the death penalty. ... It is clear that among community leaders the hallucinogens were already arousing passionate feelings: when the story was composed the authentic fly-agaric (or an alternative hallucinogen) must have been present, for the fable would not possess the sharp edge, the virulence, that it does if surrogates and placebos were already come into general use. The presence of the serpent is a happy necessity, for throughout Eurasia the serpent is intimately associated with the fungal nomenclature of the mushroom world, or with particular species of mushrooms, though in nature as it happens they have nothing to do with each other. Only in regions where snakes are unimportant, as in the British Isles, is the serpent replaced by the toad. The toad is then made heir to the curse visited on the serpent, and in turn the toad infects and infests the toadstool. The snake, the toad, and the toadstool are alike chthonic spirits.

If these perceptions are right, then the mycologists were right also, in a transcendental sense of which neither they nor the artist had an inkling, when they saw a serpent offering a mushroom to Eve in the Fresco of Plaincourault. And Ponce de León early in the 16th century was still seeking in Florida the pool of living water that he might have discovered in the Siberian taiga, the pool where Gilgamesh finally found his Herb of Immortality thousands of years earlier, only to lose it again to the Serpent who was more subtle than any beast of the field, the very same Serpent who engaged Eve in pleasant conversation, whose habitation is in the roots of the towering Siberian birch.

Acknowledgements

As everyone who knows me will realize, my dependence on others with specialized knowledge in different fields has been complete. In Sanskrit and Vedic I have enlisted the cooperation of Dr. Wendy Doniger O'Flaherty, and I have consulted Professor Daniel H. H. Ingalls of Harvard University, the late Professor Louis Renou of the Sorbonne, and Professor Georges Dumézil of the Collège de France. For my first steps in this field I am under obligations to Professor Bart van Nooten, now on the faculty of the University of California. In matters of general Indo-European linguistics my friend and revered mentor has been Professor Georg Morgenstierne of Oslo, who has guided my footsteps in the Indo-Iranian field, the Kafir and Dardic languages, and the older tongues of Scandinavia and the Northern Seas. Mrs. Inger Anne Lysebraate, mycologist of Oslo, has volunteered to help me in pointing up the possible references to mushrooms in the early literatures of Iceland and Scandinavia.

For my Chinese inquiries I am indebted to Wango Wêng 翁萬戈, of New York, to Chou C'hi-k'uên 周啟昆, formerly of the faculty of Hong Kong University, better known to his English-speaking friends as Steve Chou, now of Leeds University, to Professor Kao Yao-lin 高耀琳, formerly of Nanking University, now living in Hong Kong, and particularly to Kristofer M. Schipper, élève de l'Ecole Française d'Extrême Orient, who on the occasions of my repeated visits was living in Tainan, Taiwan. Mr. Wêng has written all of the Chinese characters that appear in my book. For guidance in Japanese fungal matters I have had the valuable assistance of Professor Yoshio Kobayaski of Ueno Museum, and of Rokuya Imazeki, co-author with Tsuguo Hongo of the standard manual in two volumes on Japanese mushrooms, an excellent field guide that the English-speaking world has yet to equal.

Dr. János Gulya of Budapest has generously given me days of his time reviewing with me many problems pertinent to my theme in the Uralic (especially the Ob-Ugrian) languages; and Tamás Radványi also, who has served us as a gifted and gracious interpreter. The Publishing Office of the Magyar Academy of Sciences has kindly consented to let me re-publish in English extracts from their *Glaubenswelt und Folklore der Sibirischen Völker*, edited by V. Diószegi and originally published in 1963. I wish also to record here my appreciation of the help given me in former years by the late Dr. Sándor Gönyey, formerly of the Ethnographical Museum of Budapest, and by Dr. Gabriel Bohus, of the Botanical Department of the Museum of Natural History, also of Budapest. Professor Robert Austerlitz managed to find time from the crushing pressure of administrative and teaching duties at Columbia University to guide my steps in matters of Siberian linguistics.

In the area of library research for efficient and intelligent service I thank Marcelle Lecomte Drakert of New York. Miss Mary Mahoney and Mrs. Evelyn Waters of Ridgefield, Connecticut, have laboured long and hard in the preparation of the manuscript for the printer.

The Human Relations Files of New Haven, Conn., were helpful to me in canvassing sources about the remote peoples of Asia, especially of Siberia. I am grateful to them for introducing me to Philip Lozinski; it was he who put me on the trail of St. Augustine and the Chinese Manichæans, and he has shown a continuing interest in my mushroom inquiries.

For a financial grant that aided my travels in the Far East I am beholden to the Bollingen Foundation of New York; and for my appointment as an Honorary Curator of Botany, to the Milwaukee Public Museum and its Director, Dr. Stephan F. de Borhegyi.

The Botanical Museum of Harvard University has graciously appointed me to its faculty as Research Fellow, and the New York Botanical Garden has made me Honorary Research Associate. These dignities have served to open doors for me in the Far East where I had been unknown. It has also been a privilege to enjoy the facilities of these two institutions and to have had access at all times to the guidance and counsel of Professor Paul C. Mangelsdorf, until lately director of the Museum, and of Dr. Richard Evans Schultes, its Curator of Economic Botany and now also the Executive Director of the Museum.

It is always a pleasure for me to express my continuing gratitude to Professor Roger Heim, Membre de l'Institut, for his help in furthering my inquiries. He and his excellent staff at the Laboratoire de Cryptogamie, of the Muséum National d'Histoire Naturelle, seem always delighted to work on my questions, little and big, and the reception that they accord me on my frequent visits to Paris moves me deeply. From the beginning Professor Heim has shown a particular interest in every aspect of my researches into the strange problem of the fly-agaric: he has initiated his own programme of experimental studies, which are being reported from time to time in the *Revue de Mycologie*. In pursuit of our mutual interests he and I have traveled together to the farthest reaches of the inhabited world.

Among those to whom I am beholden for collaboration I cannot refrain from citing Dr. Giovanni Mardersteig of Verona. Eminent typographer, scholar, and artist, he has not only shown endless patience in the printing of my manuscripts: on numerous occasions out of the store of his learning he has contributed to my argument, and he and his family by their kindnesses make my visits to Verona memorable events in my life. What a pleasure it is, when probing the unknown in the cultural history of our race, to be brought into touch with men like Professor Heim and Dr. Mardersteig.

I had hoped that this treatise on the Herb of Longevity would appear in 1966, on the occasion of the 70th birthday of Roman Jakobson, to whom I have dedicated it. But in 1968 it is by two years that much more appropriate. May the Tree of Knowledge, possessed as it is of a private line to the Herb, continue for many years to bestow abundant blessings on a favoured son!

R. Gordon Wasson
Danbury, Connecticut
June 1968

Exhibits

1. The fly-agaric in Siberia

Preliminary Note

We have assembled here the writings of those who have described the practice of eating the fly-agaric in Siberia. In Section A we include explorers, travelers, and anthropologists, as well as a few native folk tales and a Vogul hymn gathered and translated by the anthropologists and linguists. In Section B we have grouped together linguists - mostly Finnish and Hungarian - who give us evidence of a fly-agaric word pattern that presents us with a fascinating aspect of social history. Of the many writers about the peculiar mushroomic habits of the Siberian tribesmen who have passed on the information at second or third hand, we have chosen three for particular reasons to include in our Section C. One is Carl Hartwich, whose *Die menschlichen Genussmittel* set a landmark in the history of pharmacology; it was published in 1911. Another is Professor Mircea Eliade, who enjoys wide renown as a student of the history of religions and religious practices throughout the world. The third is a paper by two Soviet scientists.

Undoubtedly there are primary sources that have eluded us, perhaps important ones. We have searched diligently, but the sea of writings about Siberia is so vast, the sources so widely scattered, that some could easily have escaped our net.

We have arranged the selections roughly in their chronological order.

A. Explorers, Travelers, Anthropologists

[1] Kamieński

> KAMIEńSKI-Dłużyk, Adam. Dyarusz więzienia moskiewskiego, miast i miejsc. (A Diary of Muscovite Captivity, Towns and Settlements) In *Warta*. A collection of articles. Edited by the Rev. A. Maryański. Poznań, Poland. Published in 1874. pp. 378-388; the passage relating to mushrooms is on p. 382.

[This is the earliest report that we have found of fly-agaric eating among the tribesmen of Siberia. It is an entry in the journal of a Polish prisoner of war made in 1658. He is describing the habits of the Ob-Ugrian Ostyak of the Irtysh region in Western Siberia, tributary to the River Ob. - RGW]

... They neither sow nor plow; they live only on fish and fowl of which there is a great wealth there, namely swans, geese, ducks such as we don't have. These very Ostyaki go about in fish skins and they have footwear from the same and parkas from geese and swans. They dwell in camps on islands. They smoke various fish for the winter and tear off the fat from the fish into a birchbark vessel, two vessels full; and they drink it warm by the quart, to our great astonishment. And they make nets from nettles and some have shirts from nettles. They eat certain fungi in the shape of fly-agarics, and thus they get drunk worse than on vodka, and for them that's the very best banquet.

[2] 'Denbei', a Japanese castaway

> OGLOBLIN, N. 'The First Japanese in Russia in 1701-1705.' *Russkaya Starina*. October 1891, pp. 19-24.

[This article in the Russian review contains as Section V the story of 'Denbei', the first Japanese to arrive in Russia. He came from Osaka; and his vessel after leaving Yedo (Tokyo) in the last years of the 18th century was thrown off course by storms. The crew finally sighted Kamchatka and took refuge in the estuary of a small river. The natives, who are called in the text Kuril Islanders, took three of the Japanese prisoners, of whom two later died, Denbei being left. The Russian explorer Atlasov, passing that way, heard tell of the prisoner, and the latter was led to him. After further vicissitudes Atlasov took him to Moscow where he was presented to Peter the Great, who insisted that he learn Russian and that he teach his own language - Japanese - to a few Russians. He gave an account of what had happened to him. Though he learned some Russian and could make himself understood in the language of Kamchatka, his account is filled with discrepancies attributable to errors in communication. 'Denbei' is the name of this Japanese merchant in the Russian transcription: his Japanese name is unknown to us. His testimony is almost, but not quite, worthless. We have included it for the sake of completeness and because it establishes the earliest date on record when the Russian Imperial Court was apprised of the Siberian practice of eating the fly-agaric. In telling of his misfortunes among the inhabitants of Kamchatka, he had this to say, according to the Russian text. - RGW]

They [the natives of Kamchatka] place their fish in pits, covering them on top with twigs and grass, and when the fish turn all mouldy, they put them into wooden troughs, add water, and heat this concoction with hot stones, also mixing in some fly-agarics. They drink this brew, and treat their guests with it, and get drunk on it. However he [Denbei] and his companions could not drink this concoction but ate roots and fish which were not yet too mouldy.

[3] von Strahlenberg

> STRAHLENBERG, Filip Johann von. An Historico-Geographical Description of the North and Eastern Parts of Europe and Asia; But more particularly of Russia, Siberia, and Great Tartary; etc. ... London. 1736. Second printing, 1738. Originally published in Stockholm in 1730. Translated also into French. p. 397 of the English edition.

[Von Strahlenberg was a Swedish Colonel who passed twelve years in Siberia as a prisoner of war. He was chiefly in Tobolsk where he assembled much accurate and valuable information about the peoples of Siberia. He is describing the practices of the Koryak tribe in the extreme northeast of Siberia. - RGW]

The Russians who trade with them [Koryak], carry thither a Kind of Mushrooms, called, in the Russian Tongue, Muchumor, which they exchange for Squirils, Fox, Hermin, Sable, and other Furs: Those who are rich among them, lay up large Provisions of these Mushrooms, for the Winter. When they make a Feast, they Pour Water upon some of these Mushrooms, and boil them. They then drink the Liquor, which intoxicates them; The poorer Sort, who cannot afford to lay in a Store of these Mushrooms, post themselves, on these Occasions, round the Huts of the Rich, and watch the Opportunity of the Guests coming down to make Water; And then hold a Wooden Bowl to receive the Urine, which they drink off greedily, as having still some Virtue of the Mushroom in it, and by this Way they also get Drunk. In Spring and Summer they catch a large Quantity of Fish, and digging Holes in the Ground, which they line with the Bark of Birch, they fill them with it, and cover the Holes over with Earth. As soon as they think the Fish is rotten and tender, they take out some of it, pour Water upon it, and boil it with red-hot Pebbles (as the Finnlandians do their Beer) and feed upon it, as the greatest Delicacy in the World. This Mess stinks so abominably, that the Russians who deal with them, and who are none of the most squeamish, are themselves not able to endure it. Of this Liquor they likewise drink so immoderately, that they will be quite intoxicated, or drunk with it.

[4] Krasheninnikov

> KRASHENINNIKOV, Stepan. Opisaniye Zyemli Kamchatki. (Description of Kamchatka Land) St. Petersburg. 1755.

[Translations into English, French, and German appeared in the 18th century. We have had made a fresh translation from the Russian, finding that the 18th century translations corrupted the meaning and shortened the text. The edition that we used was edited under the auspices of the Soviet Academy of Sciences, with notes, and published in Moscow and Leningrad in 1949. - RGW]

Chapter 14
CONCERNING THE FEASTS AND GAMES OF KAMCHATKA

They hold feasts whenever the people of an *ostrog* [stockade] wish to entertain their neighbors, especially whenever there is a wedding or some successful trapping venture, and these are spent, for the most part, in overeating, dancing, and singing. On such occasions the guests are treated by their hosts to large goblets of *opanga* so generously that they have to vomit more than once.

Sometimes for their enjoyment they also use the *mukhomor*, the well-known mushroom that we ordinarily use for poisoning flies. [*Mukhomor* - fly-agaric] It is first soaked in must of *kiprei* [*Epilobium angustifolium*], which they drink, or else the dried mushrooms are rolled and swallowed whole, which method is very popular.

The first and usual sign by which one can recognize a man under the influence of the *mukhomor* is the shaking of the extremities, which will follow after an hour or less, after which the persons thus intoxicated have hallucinations, as if in a fever; they are subject to various visions, terrifying or felicitous, depending on differences in temperament; owing to which some jump, some dance, others cry and suffer great terrors, while some might deem a small crack to be as wide as a door, and a tub of water as deep as the sea. But this applies only to those who overindulge, while those who use a small quantity experience a feeling of extraordinary lightness, joy, courage, and a sense of energetic well-being, such as the Turks are said to experience when they have partaken of opium.

It is worth noting that all those who have eaten the *mukhomor* unanimously affirm that all their extravagant actions at the time are carried out on orders of the *mukhomor*, which secretly commands them. But all their actions are so harmful to them that, if there were no one to look out for them, not many of them would remain alive. Concerning excesses of the Kamchadals, which happen among them, I will make no mention, since I have not witnessed any personally and the Kamchadals do not like to talk about this; but then it could be, too, that it does not come to such extremes among them, either because they have become accustomed to the *mukhomor*, or because they do not use it to excess. However, in respect to the Cossacks who have eaten the above mushroom, I shall report some wild behavior, some of which I personally have witnessed, and some of which I heard from the perpetrators of those actions, or from other trustworthy persons.

An orderly of Lieutenant-Colonel Merlin who was with the investigation in Kamchatka was commanded by the *mukhomor* to strangle himself under a delusion that this would cause other people to admire him. This, in fact, might have come to pass, had not his friend restrained him.

Another of the local residents [Cossacks] had a vision of Hell and a terrifying fiery chasm into which he was to be cast; for which reason, following the orders of the *mukhomor*, he was forced to get down on his knees and confess all the sins that he could remember committing. His friends, of whom there were many in the common room where the intoxicated man was confessing, heard this with great amusement, while he seemed to believe that he was confessing his sins in the privacy of the sacrament to God alone. Because of this he was made the butt of much deliberate ridicule, since, among other things, he related some things which should have best remained unknown to others.

A certain soldier, they say, used to eat the *mukhomor* in moderate quantities whenever he had to go on a long journey, and thus was able to cover great distances without any fatigue; but, ultimately, having indulged to the point of delirium, he crushed his own testicles and died.

The son of a Cossack from Bolsheretsk, who was in my employ as an interpreter, had been made drunk on *mukhomor* without his knowledge, and attempted to cut his own abdomen on the *mukhomor*'s orders, from which he was barely saved in the last minute, for his hand was restrained in the very act.

Kamchadals and settled Koryaks also eat *mukhomor* while planning to kill somebody. Incidentally, among the settled Koryaks the *mukhomor* is held in such high esteem that those who are intoxicated are not allowed to urinate on the ground but are furnished by others with a dish for this purpose, which urine they drink and also do wild things like those who have eaten the mushroom; for they get the *mukhomor* from Kamchadals, as it does not grow in their own country. Four mushrooms, or less, constitute a moderate use, but for a high degree of intoxication up to ten mushrooms are usually consumed.

Members of the female sex neither indulge in eating to excess nor partake in *mukhomor* consumption, owing to which all their amusements consist of talking, dancing, and singing ...

[In the above account Krasheninnikov tells of four Europeans who ate the mushroom. Three were certainly exhibitionists, such as make a show of themselves in the West with alcohol. The third, who is said to have died, was reported as hearsay. Krasheninnikov was a careful author, and he concedes that such extravagant behaviour may not occur among the natives. He adds that the Kamchadal and the settled Koryak eat the fly-agaric 'while planning to kill somebody'. He gives no examples and as no subsequent writer, not even his own colleague Steller, repeats the statement, much less documents it, we may disbelieve this. Krasheninnikov wrote early and is of historical importance but we possess later informants immeasurably better equipped to tell us about the tribesmen. This single sentence, familiar to Ödman [*vide infra*, **[**43**]**) may be responsible for the belief that berserk-raging came out of Siberia. But Krasheninnikov nowhere makes mention of wild ferocious behaviour suggestive of berserk-raging. - RGW]

[In 1949 a definitive edition of Krasheninnikov was published by the Soviet Academy of Sciences, edited by Lev Semenovich Berg. In this edition Berg shows himself aware of the cultural significance of the fungi in the Kamchadal society in a note, p. 236, on a passage in Krasheninnikov where the latter speaks of the Kamchadal as 'omnivorous creatures, for they pass by neither *zhagra* nor *mukhomor*, though the former has no taste and does not satisfy hunger, and the latter is obviously harmful'. Berg's footnote on this passage follows: - RGW]

The Kamchadal... will pass by neither *zhagra* nor *mukhomor*. *Zhagra*, according to the Dictionary of Dal', is another name for punk, touchwood, tree fungus, Polyporaceæ. Referred to here is the white agaric (family Polyporaceæ), which grows on trees. The body of the fungus Fomes sp. was formerly used as tinder; some of them have medicinal application. Certain species of the genus Polyporus are edible. Concerning the use of the variety of fungi Polyporus that grows on birch trees (*der weisse Baum-Schwamm* in German) for alimentary purposes, Steller has this to report (p. 92): the Kamchadal knock them off birches with sticks, break them up with axes, and eat them frozen. S. Yu. Lipshitz and Yu. A. Liverovskiy (1937, p. 197) report that ashes of the fungus Polyporus (Polyporus sp.) are used in Kamchatka as snuff. Concerning the use which the Kamchadal make of the 'birch tinder' as a pain killer, Krasheninnikov reports on p. 443. Concerning fungi Polyporus of Kamchatka see: A. S. Bondartsev: *Fungi of the Family Polyporaceæ, Telephoreæ, and Hydneæ, Collected in Kamchatka by V. P. Savich*. (From the Expedition to Kamchatka of F. P. Ryabushinskiy. Botanical Series, Part 2, Moscow, 1914. pp. 525-534.) The most wide-spread fungus in Kamchatka is *Fomes igniarius* (L.), harmful to rock birch, white birch, alder, and aspen. *Fomes fomentarius* (L.) is found on both varieties of birch. There are many other species of this genus and also other genera. Of the genus Polyporus in Kamchatka, *Polyporus sulfureus* (Bull.) is found on the larch and *P. varius* Fries on the poplar.

Steller also reports (pp. 92-93) on the use of the *mukhomor* (fly-agaric) as an intoxicant by Kamchadal, Koryak, and Yukagir. See also L. S. Berg, *Discovery of Kamchatka* ..., Third Edition, 1946, pp. 163-164.

[*Zhagra* in Russian is a synonym of *trut*, the former being derived from a root 'to burn' and the latter from 'to rub'. Both mean primarily *Fomes fomentarius*, the shelf fungus that grows on many trees but that is primarily linked with the birch because the birch is its commonest host in the forest belt of Eurasia. Many species of fungus have been used as the primary tinder in the making of fire, but for 'touchwood' or 'punk' *Fomes fomentarius* has enjoyed primacy from the beginning. At Star Carr in Yorkshire quantities of *Fomes fomentarius* were found in the site of a settlement dating from 9,000 to 10,000 years ago, some still attached to birch logs, along with flint. The touchwood was adjacent to the hearthstones. (*Vide* J. G. D. Clark and others: *Excavations at Star Carr*, Cambridge University Press, 1954, pp. 17-18; also E. J. H. Corner: 'Report on the Fungus-Brackets from Star Carr, Seamer,' in the 'Preliminary Report on the Excavations at Star Carr, Seamer, Scarborough, Yorkshire', *The Prehistoric Society*, XVI, 1950, pp. 123-4.) The British Isles were still attached to the Continent by land, and the site was early Mesolithic, apparently a temporary camp of hunters, not long after the last ice age. The culture was the same as had been previously described at Maglemose (the 'Great Bog'), Denmark, where also *Fomes fomentarius* was found adjacent to the hearth stones. (*Vide* N. Fabritius Buchwald and Sigurd Hansen: 'Om Fund af Tøndersvamp fra Postglacialtiden i Danmark', *Danmarks geologiske Undersøgelse*, IV Række, Bd. 2, Nr. 11, 1934.)

[The fungus that the Kamchadal knock off birches and then eat frozen is certainly different, probably *Polyporus betulinus*, a soft, white, rather spongy or rubbery growth on the birch, without much taste, which is sometimes eaten raw or cooked by mycophiles in Europe and the United States. - RGW]

[5] Steller

> STELLER, Georg Wilhelm. Beschreibung von dem Lande Kamtschatka, dessen Einwohnern, deren Sitten, Nahmen, Lebensart und verschiedenen Gewohnheiten. (Description of Kamchatka, its Inhabitants, their Customs, Names, Way of Life, and Different Habits) Leipzig. 1774. pp. 92-93.

[Steller, a member of the Krasheninnikov expedition, stayed on and later published a valuable account of his life in Kamchatka. - RGW]

Among the mushrooms the poisonous fly-agaric (in Russian *muchamoor*, in Italmen [Kamchadal] *ghugakop*) is highly valued. In the Russian settlements this habit has been lost for a long time. However, around the Tigil and towards the Koryak border it is very much alive. The fly-agarics are dried, then eaten in large pieces without chewing them, washing them down with cold water. After about half an hour the person becomes completely intoxicated and experiences extraordinary visions. The Koryak and Yukagir are even fonder of this mushroom. So eager are they to get it that they buy it from the Russians wherever and whenever possible. Those who cannot afford the fairly high price drink the urine of those who have eaten it, whereupon they become as intoxicated, if not more so. The urine seems to be more powerful than the mushroom, and its effect may last through the fourth or the fifth man. Despite the fact that I have personally made these observations in 1739, some people have contradicted my experiences. I have therefore taken great pain to establish the truthfulness of what has been recorded here. Reports from persons whose authority cannot be attacked have confirmed my findings. Thus a man from the lower gentry named Kutukov, having to guard the reindeer herd, has noticed that these animals have frequently eaten that mushroom, which they like very much. Whereupon they have behaved like drunken animals, and then have fallen into a deep slumber. When the Koryak encounter an intoxicated reindeer, they tie his legs until the mushroom has lost its strength and effect. Then they kill the reindeer. If they kill the animal while it is drunk or asleep and eat of its flesh, then everybody who has tasted it becomes intoxicated as if he had eaten the actual fly-agaric.

[6] Georgi

> GEORGI, Johann Gottlieb. Russia: or, A Compleat Historical Account of all the Nations which Compose that Empire. London. 1780. First published in German in St. Petersburg, 1776-1780. pp. 189-190.

Their drink [of the Ostyak] is water, broth, and fish-soups, a great deal of milk, and brandy whenever they are rich enough to buy any. The Ostyaks are very fond of getting drunk; and, as they have but seldom the means of procuring strong liquors for that purpose, they get intoxicated by smoking a great quantity of strong tobacco, and by chewing a kind of mushroom called the fly mushroom. ... Numbers of the Siberians have a way of intoxicating themselves by the use of mushrooms, especially the Ostyaks who dwell about Narym. To that end they either eat one of these mushrooms quite fresh, or perhaps drink the decoction of three of them. The effect shews itself immediately by sallies of wit and humour, which by slow degrees arises to such an extravagant height of gaiety, that they begin to sing, dance, jump about, and vociferate: they compose amorous sonnets, heroic verses, and hunting songs. This drunkenness has the peculiar quality of making them uncommonly strong; but no sooner is it over than they remember nothing that has passed. After twelve or sixteen hours of this enjoyment they fall asleep, and, on waking, find themselves very low-spirited from the extraordinary tension of the nerves: however, they feel much less head-ache after this method of intoxication than is produced by spirituous liquors; nor is the use of it followed by any dangerous consequences.

★

From the author's chapter on the 'The Yakoutes' , Vol. 2, p. 394:

They never wash their hands or any part of their person. Their skin-sacks that hold the milk stink abominably, and communicate a horrid taste to their contents. In the summer season they drink so much koumiss, and smoke tobacco so constantly, that they are frequently drunk. When they intend to get fuddled in a decent manner, they endeavour to procure the Russian brandy; but, as they are but seldom able to obtain it, they supply this want by mushrooms of an inebriating quality, as the Ostyaks, and several other people of Siberia do.

[So far as I know, this is the only passage in the Siberian texts that attributes the eating of the fly-agaric to the Yakut, whose language belongs to the Altaïc family. Perhaps fringe settlements of Yakut had taken to the habit from their neighbors, *e.g.*, the Yukagir, who apparently in the 18th century were still eating the *mukhomor*. (Sten Bergman's statement **[**27**]** about the Lamut addiction to the fly-agaric falls into the same category of isolated testimony.) Or in Georgi's case he may simply be mistaken. His book with its wealth of detail about the peoples of Siberia holds the reader's attention but it is exasperating in that it is inadequately documented: the reader usually does not know what the author observed personally and what he took from others, nor who the others were nor whether they were reliable. The diaries of his travels in Siberia would be most interesting, but we do not know whether they survive. - RGW]

[7] de Lesseps

> LESSEPS, Jean Baptiste Barthélemy, Baron de. Journal historique du voyage de M. de Lesseps. ... Paris. 1790. Translated into German and English. The English edition appeared in 1790 in two volumes in London, entitled 'Travels in Kamchatka, during the Years 1787-1788'. The following is from the English edition, Vol. 2, pp. 90-91 and 104-5.

[How supercilious and superficial are this French aristocrat's remarks about the fly-agaric, which he seems not to have recognized as a mushroom common in his own country. - RGW]

Their passion for strong liquors, increased by the dearness of brandy, and the difficulty of procuring it on account of their extreme distance, has led them to invent a drink, equally potent, which they extract from a red mushroom, known in Russia as a strong poison by the name of *moukhamorr*.[311] They put it in a vessel with certain fruits, and it has scarcely time to clarify when their friends are invited to partake of it. A noble emulation inflames the guests, and there is a contest of who is best able to disburden the master of the house of his nectar. The entertainment lasts for one, two, or three days, till the beverage is exhausted. Frequently, that they may not fail of being tipsy, they eat the raw mushroom at the same time. It is astonishing that there are not more examples of the fatal effects of this intemperance. I have seen however some amateurs made seriously ill, and recovered with difficulty; but experience does not correct them, and upon the first occasion that offers, they return to their brutish practice. It is not from absolute sensuality, it is not from the pleasure of drinking a liquor, that by its flavour creates an irresistible craving for more; they seek merely in these orgies a state of oblivion, of stupefaction, of total brutishness, a cessation of existence, if I may so call it, which constitutes their only enjoyment, and supreme felicity.

★

... On the eve of their magic ceremonies, they pretend indeed to fast all the day, but they make up for this abstinence at night by a profusion of the *moukamorr*, the intoxicating poison I have described, which they eat and drink to satiety. This preparatory intoxication they consider as a duty. It is probable that they feel its effects the next day, and that they derive from it an elevation of spirits that contributes to derange their minds, and give them the necessary strength to go through their extravagant transports.

---

[311] It is used in the Russian houses to destroy insects.

[8] Sarychev

> SARYCHEV, Gavriil Andreevich. Achtjährige Reise im Nordostteil Sibiriens das Eismeer und den Östlichen Ozean (1785-1793). (An Eight-Year Voyage in Northeastern Siberia, on the Arctic Ocean and the Northeast Pacific) Leipzig. 1905-15. Translated from the Russian original published in 1802 in St. Petersburg. pp. 274-5.

[There is no direct reference to the fly-agaric, but on pp. 274-5 of the reprint published in 1954 we find a curious report of the death of two reindeer in the Chukchi country. Their death is attributed to an excessive intake of human urine. It sounds as though the urine in question was impregnated with the metabolite of the fly-agaric. - RGW]

In the last few days the Chukchi have had two dead reindeer and take the cause to be that they had given them too much human urine to drink. They give them some from time to time in order to make them strong and improve their staying-power. The fluid has the same effect on the reindeer as intoxicating drink has on people who have fallen victim to the drinking habit. The reindeer become just as drunk and have just as great a thirst. At night they are noisy and keep running around the tents in the expectation of being given the longed-for fluid. And when some is spilled out into the snow, they start quarreling, tearing away from each other the clumps of snow moistened with it. Every Chukchi saves his urine in a sealskin container which is especially made for the purpose and from which he gives his reindeer to drink. Whenever he wants to round up his animals, he only has to set this container on the ground and slowly call out 'Girach, Girach!', and they promptly come running toward him from afar.

[9] Kopeć

> KOPEć, Joseph. Dziennik ... (Diary of a Journey Along the Whole Length of Asia...; in Polish) Wrocław. 1837. An amplified text was published in Berlin, in 1863, from which this translation from Polish, done by Prof. Wiktor Weintraub, was made. pp. 198-202.

[Joseph Kopeć, a Brigadier in the Polish army, was a man of letters. According to Professor Wiktor Weintraub of Harvard University, he was mentally unbalanced and prone to exaggeration but in spite of his weaknesses his good faith can be relied upon. He was not a liar and he ate the mushrooms. The year is 1797 or perhaps 1796. Kopeć is in Kamchatka. He is ill and running a fever. He arrives with his companions at a native settlement covered with snow-drifts and enters the yurt, as is customary, through the opening at the top of the roof from which the smoke of the fire emerges. He then describes what happens. - RGW]

Hardly a few moments had passed when a sudden change of air brought about a great change in my sick body. The air of this closed *yurta*, always stinking, mixed with the acrid scent of whale-fat used as lamp oil, made me so weak that I thought the hour of my death would strike. Thus abandoning the fire and tea I called for my evangelist in the hope of getting some help from this man, a bit more educated, as I understood, than other people in the art of healing. After having learned about my mishap, the evangelist comes a little later, he approaches the fire, and ordering me to sit up he tells me first to drink my tea. While I am doing this, the Kamchadals bring from the middle of the tent a large number of ermine hides and deer skins. Feeling a bit revived, I ask what is the meaning of this. To which the evangelist, complying with my curiosity, says to me:

'Before I give you the medicine, I must tell you something important. You have lived for two years in Lower Kamchatka but you have known nothing of the treasures of this land. Here,' opening some birch bark in which a few mushrooms were wrapped, 'are mushrooms that are, I can say, miraculous. They grow only on a single high mountain close to the volcano and they are the most precious creations of nature.'

'Take into account, Sir,' the evangelist goes on, 'that the hides brought by local people I receive as gifts in exchange for these mushrooms. They would even give all their possessions, had I many of them and if only I sought to take advantage of the situation. These mushrooms have a special and as though supernatural quality. Not only do they help the man who uses them but he sees his own future as well. Since you are weak you should eat one mushroom. It will give you the sleep you are lacking.'

Hearing so many strange things about the merits of that mushroom, I was in doubt for a long time whether I should make use of it. However, the wish to recover my health and above all to sleep overcame my fears, and so I ate half my medicine and at once stretched out, for a deep sleep overtook me. Dreams came one after the other. I found myself as though magnetized[312] by the most attractive gardens where only pleasure and beauty seemed to rule. Flowers of different colours and shapes and odours appeared before my eyes; a group of most beautiful women dressed in white going to and fro seemed to be occupied with the hospitality of this earthly paradise. As if pleased with my coming, they offered me different fruits, berries, and flowers. This delight lasted during my whole sleep, which was a couple of hours longer than my usual rest. After having awakened from such a sweet dream, I discovered that this delight was an illusion. I was distressed that it had disappeared, as if it had been true happiness. These impressions made pleasant for me the few hours that remained until the end of the day. Having receive such bewitching support from the miraculous mushroom and even having been fortified by sleep such as I had not had for a long time, I started to have confidence in its supernatural qualities (as my evangelist had taught me to do), and with the approach of night I asked my physician for a second helping. He was pleased with my courage and at once bearing the offering of his friendly benevolence, he gave me a similar whole mushroom. Having eaten this stronger dose, I fell soundly asleep in a few minutes. For several hours new visions carried me to another world, and it seemed to me that I was ordered to return to earth so that a priest could take my confession. This impression, although in sleep, was so strong that I awoke and asked for my evangelist. It was precisely at the hour of midnight and the priest, ever eager to render spiritual services, at once took his stole and heard my confession with a joy that he did not hide from me. About an hour after the confession I fell asleep anew and I did not wake up for twenty-four hours. It is difficult, almost impossible, to describe the visions I had in such a long sleep; and besides there are other reasons that make me reluctant to do so. What I noticed in these visions and what I passed through are things that I felt I had seen or experienced some time before, and also things that I would never imagine even in my thoughts. I can only mention that from the period when I was first aware of the notions of life, all that I had seen in front of me from my fifth or sixth year, all objects and people that I knew as time went on, and with whom I had some relations, all my games, occupations, actions, one following the other, day after day, year after year, in one word the picture of my whole past became present in my sight. Concerning the future, different pictures followed each other which will not occupy a special place here since they are dreams. I should add only that as if inspired by magnetism I came across some blunders of my evangelist and I warned him to improve in those matters, and I noticed that he took these warnings almost as the voice of Revelation.

It is not for me to argue about the usefulness and the influence on human health of this miraculous mushroom. But I can state that its medical usefulness, had it been known among more educated peoples, should have earned it a place among so many known remedies of nature in the matter of fighting human maladies. Can anyone deny that in spite of our vast knowledge (relative to our forces) of natural phenomena, there still exist almost countless phenomena about which we can only guess? Can one put a limit to nature at a point that delimits the possibilities of inquiries and discoveries of human research? Innumerable effects of recently discovered magnetic forces, effects that cannot be detected by physical means nor pinpointed with any degree of precision to some specification on the human body, seem to reconcile in some measure the controversy concerning this mushroom. It is then possible that in the sleep brought by the influence of this mushroom, a man is able to see at least some of his real past and if not the future at least his present relations. If someone can prove that both the effect and the influence of the mushroom are non-existent and erroneous, then I shall stop being defender of the miraculous mushroom of Kamchatka.

Whatever may be the nature and qualities of the above-mentioned mushroom, I must confess that the taking of it had a powerful effect on my mind, as well as a strong impression [on my senses], so that I grew disquieted to a certain degree, from which passing into anxiety I became finally gloomy. This credulity having even the power of faith was based first of all on the conviction of the evangelist that my truthful visions were a true warning of heaven, and, secondly, on a conviction coming from within me, when later I perceived, being awake, the confirmation of what the dreams had predicted. This led me to have confidence in the dependability of my dreams about the future. However, as time passed, during my travels, this faith started to slacken and when its influence on my mind ended, a peace of soul returned to me together with better health.

---

312. When Kopeć wrote, 'magnetism' had recently caught the attention of scientists and intellectuals in Europe: this explains his usage of the word. - RGW.

[10] von Langsdorf

> LANGSDORF, Georg Heinrich von. Einige Bemerkungen, die Eigenschaften des Kamtschadalischen Fliegenschwammes betreffend. (Some Remarks Concerning the Properties of the Kamchadal Fly-Agaric) Wetterauischen Gesellschaft für die gesammte Naturkunde. Annalen, Vol. I, No. 2, Frankfurt M. 1809. pp. 249-256. Paper submitted by the author in French to the Russian Imperial Academy of Sciences in St. Petersburg.

The plant kingdom is of immeasurable influence and usefulness for mankind, since it supplies most of our clothing, food, drink, and shelter. The medical science of primitive peoples consists entirely in their knowledge of the more or less efficacious plants, and everyday experience confirms the fact that even a number of plants native to our own regions are known to many uneducated nations almost more thoroughly than they are to us.

To demonstrate this assertion, I should like to say at this point something about the nature and effects of the fly-agaric, which we regard as extremely poisonous but which is used by various inhabitants of northeastern Asia as an intoxicant just as wine, brandy, arrack, opium, kava, and the like are used by other nations. During my stay in Kamchatka I had the opportunity to gather detailed information on the effects of this mushroom, and today I shall try to tell you the most important points as briefly as possible.

Ordinarily it would be necessary first to make a closer examination of the nature of the mushroom, in so far as possible, and thereby show whether, and to what extent, the mushrooms found in those areas differ from our own.

However, since time is too short at this moment, I shall not give any detailed description of the ordinary fly-agaric and shall confine myself to pointing out that, at least on the basis of four dried specimens which I brought with me from Kamchatka and of a drawing made there by Privy Councillor Tilesius, it does appear that some difference exists between Kamchadal mushrooms and those of our own country: the Kamchadal mushroom has a cap with a navel-like protuberance in the middle, its stalk seems to grow thicker towards the base, and, in particular, the lamellæ may be yellowish rather than white. However, since this cannot be stated with any certainty until the living mushroom has again been observed in Kamchatka, we shall regard it for the time being as a special variety:

Amanita muscaria var. *Camtschatica*.

Isolated fly-agarics grow almost everywhere in Kamchatka, in birch forests and on dry plains. They are found most abundantly in the central part of the peninsula, especially around Vishna Kamchatka and Milkova Derevna. In some years they are seen in great numbers, but in others they are extremely scarce.

The Kamchadals gather them usually during the hottest months of July and August; they maintain that those that dry by themselves in the earth, on the stalk, and that are somewhat furry and velvety to the touch on the under side of the cap have a far stronger narcotic effect than those picked fresh and strung up to dry in the air.

The size is variable, with diameters ranging from 1-1½ to 5-6 inches.

The smaller mushrooms, which are bright red and covered with many white warty protuberances, are said to be far stronger in narcotic power than the larger ones, which are pale red and have few white spots.

Since the establishment of closer contacts with the Russians, the Kamchadals have taken particularly to drinking vodka and have left the consumption of fly-agarics to their wandering neighbors, the Koryaks, for whom they gather the fly-agarics and trade them very profitably for reindeer.

The usual way to consume fly-agarics is to dry them and then to swallow them at one gulp, rolled up into a ball, without chewing them; chewing fly-agarics is considered harmful, since it is said to cause digestive disturbances.

Sometimes these mushrooms are cooked fresh and eaten in soups or sauces, since they then taste more like the usual edible mushrooms and have a weaker effect, so that when the mushrooms are prepared in this way, a larger amount can be eaten without harmful results. Occasionally, too, fly-agarics are soaked in berry juice, which one may thereafter drink at his pleasure as a genuine intoxicating wine. Juice squeezed from bilberries (*Vaccinium uliginosum*) is said to be most suitable for this purpose because it heightens the intoxicating effect, so that one may expect to achieve a more potent result with a smaller quantity.

The body's predisposition or susceptibility to the intoxicating effect of fly-agarics apparently is not the same at all times, since the same person may sometimes be very strongly affected by a single mushroom and at other times remain completely unaffected after eating twelve to twenty of them. Ordinarily, however, one large fly-agaric or two small ones are enough to make an enjoyable day.

The narcotic effect is also said to be heightened by the drinking of large quantities of cold water afterwards.

The narcotic effect begins to manifest itself about a half hour after eating, in a pulling and jerking of the muscles or a so-called tendon jump (although sometimes these effects appear only after an hour or two); this is gradually followed by a sense of things swimming before the eyes, dizziness, and sleep. During this time, people who have eaten a large quantity of mushrooms often suffer an attack of vomiting. The rolled-up mushrooms previously swallowed whole are then vomited out in a swollen, large, and gelatinous form, but even though not a single mushroom remains in the stomach, the drunkenness and stupor nevertheless continue, and all the symptoms of fly-agaric eating are, in fact, intensified. Many other persons never vomit, even after eating copiously of the mushrooms.

The nature of the ecstasy or drunkenness caused by the fly-agaric resembles the effects of wine and vodka to the extent that it renders unconscious the persons intoxicated with it and arouses in them feelings that are mostly joyful, less often gloomy. The face becomes red, bloated, and full of blood, and the intoxicated person begins to do and say many things involuntarily.

In the milder stages, as I have said, there are tendon jerks, but in the more advanced stages there are jerky movements of the limbs, and then the intoxicated persons often appear to be dancing and making the most outlandish pantomime movements with their hands. Similarly, the head and neck muscles are also in a constantly convulsive state; if a person has eaten musrooms to excess, he goes into genuine convulsions.

According to their own statement, persons who are slightly intoxicated feel extraordinarily light on their feet and are then exceedingly skillful in bodily movement and physical exercise.

The nerves are highly stimulated, and in this state the slightest effort of will produces very powerful effects. Consequently, if one wishes to step over a small stick or a straw, he steps and jumps as though the obstacles were tree trunks. If a man is ordinarily talkative, his speech nerves are now in constant activity, and he involuntarily blurts out secrets, fully conscious of his actions and aware of his secret but unable to hold his nerves in check. In this condition a man who is fond of dancing dances and a music-lover sings incessantly. Others run or walk quite involuntarily, without any intention of moving, to places where they do not wish to go at all.

The muscles are controlled by an uncoordinated activity of the nerves themselves, uninfluenced by and unconnected with the higher will-power of the brain, and thus it has occasionally happened that persons in this stage of intoxication found themselves driven irresistibly into ditches, streams, ponds, and the like, seeing the impending danger before their eyes but unable to avoid certain death except by the assistance of friends who rushed to their aid. In this intense and stimulated state of the nervous system, these persons exert muscular efforts of which they would be completely incapable at other times; for example, they have carried heavy burdens with the greatest of ease, and eye-witnesses have confirmed to me the fact that a person in a state of fly-agaric ecstasy carried a 120-pound sack of flour a distance of 10 miles, although at any other time he would scarcely have been able to lift such a load easily.

But the strangest and most remarkable feature of the fly-agaric is its effect on the urine. The Koryaks have known since time immemorial that the urine of a person who has consumed fly-agarics has a stronger narcotic and intoxicating power than the fly-agaric itself and that this effect persists for a long time after consumption. For example, a man may be moderately drunk on fly-agarics today and by tomorrow may have completely slept off this moderate intoxication and be completely sober; but if he now drinks a cup of his own urine, he will become far more intoxicated than he was from the mushrooms the day before. It is not at all uncommon, therefore, that drunkards who have consumed this poisonous mushroom will preserve their urine as if it were a precious *liqueur* and will drink it as the occasion offers.

The intoxicating effect on the urine is found not only in the persons who have eaten the fly-agaric itself but also in every person who drinks the urine. Among the Koryaks, therefore, it is quite common for a sober man to lie in wait for a man intoxicated with mushrooms and, when the latter urinates, to catch the urine secretly in a container and in this way to obtain a stimulating drink even though he has no mushrooms.

Because of this peculiar effect, the Koryaks have the advantage of being able to prolong their ecstasy for several days with a small number of flyagarics. Suppose, for example, that two mushrooms were needed on the first day for an ordinary intoxication; then the urine alone is enough to maintain the intoxication on the following day. On the third day the urine still has narcotic properties, and therefore one drinks some of this and at the same time swallows some fly-agaric, even if only half a mushroom; this enables him not only to maintain his intoxication but also to tap off a strong liquor on the fourth day. By continuing this method it is possible, as can easily be seen, to maintain the intoxication for a week or longer with five or six fly-agarics.

Equally remarkable and strange is the extremely subtle and elusive narcotic substance contained in the fly-agarics, which retains it effectiveness permanently and can be transmitted to other persons: the effect of the urine from the eating of one and the same mushroom can be transmitted to a second person, the urine of this second person affects a third, and similarly, unchanged by the organs of this animal secretion, the effect appears in a fourth and a fifth person.

For still another remarkable observation concerning the nature of the fly-agaric I am indebted to Steller, who, in his description of the Kamchatka region [p. 240] states the following: 'It was related to me by reliable people, among both the Russian and the Koryak nation - indeed, by a man from the lower gentry named Kutukov, who has charge of the Cassa reindeer herd - that reindeer often eat this mushroom, among others (for they have a great appetite for mushrooms), after which they fall down and thrash about for a while as if they were drunk and then fall into a deep sleep. When the Koryaks find a wild reindeer, therefore, they tie its feet until it has slept off the effects and the mushroom has lost its potency, and only then do they kill the reindeer; for if they killed such an animal while it was sleeping or still raving, everyone who ate its flesh would go into a similar frenzy, as if he had actually eaten the fly-agaric himself.'

Although I made great efforts to find out something about the harmful or possibly deadly effects of the fly-agaric, I could not obtain any satisfactory information on the subject.

The Koryaks greatly prefer fly-agarics to the Russians' vodka and maintain that after eating fly-agarics a man never suffers from headaches or other ill effects.

It is true that in extremely rare cases (of which no one could recall any specific example) persons who consumed an extraordinarily large quantity of the mushrooms are said to have died in convulsions, senseless and speechless, after six or eight days. However, it is not reported that moderate consumption ever produced any harmful after-effects.

If, contrary to expectations, immoderate consumption of fly-agarics should nevertheless be followed by pressure on the stomach or some other disturbance, two to three spoonfuls of fat, blubber, butter, or oil are reputed to be an infallible remedy that can relieve any ill effects.

There are some people in Kamchatka who drink a glass of bilberry [*Vaccinium uliginosum*] juice in which fly-agarics have been soaked whenever they have a stomach-ache, colic, or other ailment and who regard it as a universal remedy; however, I was not able to ascertain whether the consumption of fly-agaric is followed by constipation or diarrhœa or by an increase or decrease in the urine.

I was also unable to obtain any satisfactory answer when I asked whether the taste or smell of the urine had been changed - everyone was probably ashamed to admit that he had drunk his own urine or somebody else's. Nevertheless, it strikes me as not improbable that fly-agarics, like turpentine, asparagus, and other things, impart a special, possibly quite pleasant, smell and taste to the urine; by analogy, it would be worth investigating whether other narcotic substances, such as opium, *Digitalis purpurea*, cantharides, *etc*. also retain their properties in the urine.

The nature of the fly-agaric, therefore, offers the scientist, physician, and naturalist a great deal of food for thought: our *materia medica* might perhaps be enriched with one of the most efficacious remedies, and judicious physicians might find in the fly-agaric the most potent remedy to apply to the body in cases of paralysis and other diseases of the extremities.

[11] Erman

> ERMAN, Adolph. Reise um die Erde durch Nord-Asien und die beiden Oceane in den Jahren 1828, 1829 und 1830 ausgeführt. (A Journey around the World through Northern Asia and both Oceans in 1828, 1829 and 1830) Berlin. 1833-48. p. 223.

[The author speaks of the fly-agaric among the Kamchadal and Koryak peoples. - RGW]

My companions had eagerly been gathering fly-agaric (*Amanita muscaria* Esenb.; in Russian, *mukhomor*, *i.e.*, fly pest) both in the woods through which we had ridden in the morning and now at the foot of the Northern Baidar mountains. Because of its brilliant red color they caught sight of every one of them from afar and this always caused a sudden halt in our caravan which at first surprised me. They now confirmed what had already been told me in Tigilsk about the intoxicating properties of this mushroom and said that it was not eaten in Sedanka but only gathered for the Koryaks, who in wintertime often paid a reindeer for a single dried piece. *Mukhomor*, they said, was much rarer in northern Kamchatka and the Koryaks had only learned about its properties because the meat of reindeer which had eaten it had an effect that was as intoxicating as the mushroom itself. It was this experience that had caused them to use it most sparingly and with maximum advantage and here was why they even collected the urine of persons who had managed to come by a *mukhomor*, and mixed it with their drink as an intoxicant that was still very effective.

★

P. 259. On the same day I tasted for the first time a plant eaten by all Kamchadals, learning in the days that followed to appreciate it - in addition to other fine qualities - for the ease with which it could be carried because of its unusual lightness, and with which it could be used since it required no preparation. I am referring to a felt-like substance made from the stalks of the so-called *kiprei* (*Epilobium angustifolium*). Several of the stalks are laid on top of one another and squeezed and beaten in layers two to three inches wide so that the sweet sap inside penetrates the green bast and the pieces of woody cortex; thereafter this turns into firm dark-green pleasant-smelling strips made up into lengths of four to six feet and the width already mentioned. These are eaten raw but always smeared with butter or seal fat, and, with this addition, I too now found them palatable, easily digestible and nourishing.

The example of the Russians [from the southern tip of Kamchatka] had caused the Yelovka natives to try an agricultural experiment during this same year, for they had planted some potatoes on a plot between their houses. The plants seemed, however, in a very sad state, owing no doubt to incorrect cultivation, and on part of the plot they had already been replaced by much more carefully tended mushrooms. These belonged to Toyon's wife, who had picked them in the woods in the Spring and transplanted them when they were tiny, and now she pointed out to me with special pride the big size of their scarlet caps and their many white spots, which are considered to presage a powerful effect. She spoke with the most unrestrained enthusiasm of her love for this intoxicant, and I noticed she had a glassy look in her eyes and copper-red cheeks, which no doubt came from excessive indulgence although I did not see the same symptoms in many other mushroom-eaters I met later.

★

Pp. 304-306. Thereafter in one of those open places in the woods we gathered twenty mushrooms, to the immense joy of the older of my companions who, as an enthusiastic devotee of this intoxicant, again praised its powers and its benefits. He affirmed, from his own experience, the most varied effects of this mushroom on herbivorous animals: wild reindeer that have eaten some of them are often found so stupefied that they can be tied with ropes and taken away alive; their meat then intoxicates everyone who eats it, but only if the reindeer is killed soon after being caught; and from this it appears that the communicability of the narcotic substance lasts about as long as it would have affected the animals' own nerves. He also said that this mushroom intoxication had a quite different effect from alcoholic drunkenness, since the former put the Kamchatka natives into a peaceful and gentle (*skromno*) mood, and they had seen how differently the Russians were affected by spirits.[313]

... There is no doubt, however, about a 'marvellous increase in physical strength,' which the man from Yelovka praised as still another effect of mushroom intoxication. 'In harvesting hay,' he said, 'I can do the work of three men from morning to nightfall without any trouble, if I have eaten a mushroom.' Of the various ways of using *mukhomor* he said that the best was the simplest way, *viz*., drying it, swallowing it raw, and washing it down with water. On the other hand, the Russians of Klynchevsk, who according to him pick whole packhorse loads of this valuable plant, prepare an extract by decocting it in water, and try to take away its extremely disgusting taste by mixing the extract with various berry juices.

★

P. 312. Sept. 5. Although all we could boast of were a few exertions, but no unusual adventures, our old hunter nevertheless felt himself entitled to be rewarded with the pleasures of intoxication. Immediately after our arrival he exchanged some of the mushrooms we had gathered for dry ones, of which he at once swallowed three small pieces (one and one-half mushrooms) and washed them down with water. When it is fresh, the *mukhomor* is so sticky and of such loose consistency that it is hard to swallow without chewing. This, however, makes the unpleasant taste of the *mukhomor* so disgusting that it is considered impossible to cope with any real quantity of them in this condition.

The strong will that is here displayed in order to obtain pleasant excitation is even more striking when one observes that this sets in only long after the narcotic is used and certainly not without troublesome transition. Thus, a good hour after he had eaten the mushrooms they had shown no effect on his mood, and he told me then that he would have to lie down quietly and sleep till the next morning in order to see the most pleasant things, some of them in dreams while asleep and others after waking next day.

[12] von Maydell

> MAYDELL, Baron Gerhard von. Reisen und Forschungen im Jakutskischen Gebiet Ostsibiriens in den Jahren 1861-1871. (Journeys and Investigations in the Jakutskaia Oblast' of Eastern Siberia in 1861-1871) Published as Vol. 1-2 in Series IV of Beiträge zur Kenntniss des Russischen Reiches und der angrenzenden Länder Asiens, St. Petersburg. 1893. Vol. 1, pp. 298-300.

At the Paren' I also obtained some dried fly-agaric (*Amanita muscaria*), which is very highly prized among the Koryaks for its intoxicating effect. It is not eaten in the fresh state, in which it is believed to be poisonous, but always hung up to be smoked until it is shriveled and quite dry so that it will keep well. It is said to occur only among birch trees and hence is confined to a few localities, among which I heard Penzhinskoye and Markovo mentioned in particular. When a Koryak consumes the fly-agaric, he chews the dried mushroom and then drinks it down with water. After a while he becomes greatly stimulated, converses with people whom he sees although they are not there at all, tells them with much satisfaction about his great wealth, and so on. He can also be asked questions by the people present, and he will sometimes answer them quite sensibly but always with reference to the things which he imagines and which, in his intoxication, seem real to him. During the intoxication he is quite capable of walking from place to place without staggering, but the mushroom seems to produce a peculiar effect on his optic nerves which makes him see everything on a greatly enlarged scale. For this reason it is a common joke among the people to induce such an intoxicated man to walk and then to place some small obstacle, such as a stick, in his way. He will stop, examine the little stick with a probing eye, and finally jump over it with a mighty bound. Another effect of the mushroom is said to be that the pupils become much enlarged and then contract to a very small size; this process is said to be repeated several times. When the drunken man has sobered up, he feels no bodily discomfort at all but only regrets that his beautiful visions have given way to harsh reality; in reply to questions he will say that he has been in pleasant company, that he was the owner of fine herds, and the like. However, the effect of the mushroom seems to differ from that of opium: the visions are not of an erotic nature; instead the mushroom produces only a feeling of great comfort, together with outward signs of happiness, satisfaction, and well-being. Thus far the use of the fly-agaric has not been found to produce any harmful results, such as impaired health or reduced mental powers; this is probably due to the fact that, in general, the Koryaks are seldom able to indulge their passion for the mushroom, since it is found only in a few places, and even there only in small quantities.[314]

---

[313] ... As to the effects of *mukhomor* on the Russians who always ate too many of them (up to ten mushrooms, whereas I never saw a Kamchadal use more than two), Krasheninnikov tells of some cases in which the most intense excitement ended in the fury of the intoxicated man directed against himself. According to him, a young Cossack from Bolsheretsk, after eating many mushrooms, was restrained with difficulty from putting a knife into his abdomen, while another actually killed himself by self-castration. [*Vide* **[**4**]** - RGW]

The Chukchis - at least those I have encountered - were completely unacquainted with this intoxicant; however, it was said in Markovo that when the people of the town happened to be unable to get brandy, they would sometimes resort to eating fly-agarics.

[13] von Dittmar

> DITTMAR, Carl von. (Karl von Ditmar) Reisen und Aufenthalt in Kamtschatka in den Jahren 1851-1855. (Journey and Sojourn in Kamchatka in 1851-1855) Published as Vol. 8 in Series 3 of Beiträge zur Kenntniss des Russischen Reiches und der angrenzenden Länder Asiens. St. Petersburg. 1900. Part II, Section 1, pp. 98-100.

Finally, I should mention one other plant of this region of meadows and birch forests which plays a role in the life of the peoples living here. This is the fly-agaric, *Amanita muscaria*, which the local inhabitants often call *mukhomor*. These mushrooms are fiery red with many large white spots; they are not rare and can be recognized from far away in the rich green of somewhat shady and damp places. The Kamchadals themselves have little use for the mushrooms, but they like to gather them in order to sell them in a dried state to the Koryaks and Chukchis, who buy them eagerly. Although this mushroom is a great favourite in the North, it appears not to occur there at all, or at least to be a great rarity; however, the intoxicating and nerve-stimulating effect of the *mukhomor* is known far and wide among the Northern peoples, and they are very fond of it. Both Koryaks and Chukchis like to carry with them a small box made of *Betula nana* in which they carry small bits of chopped-up dried fly-agaric, so that they may have their favorite intoxicant always ready to hand. Another such box contains tobacco, which they enjoy in three different ways - smoking it, chewing it, and taking it as snuff. On the other hand, the *mukhomor* is only chewed, and the juice is then swallowed. The mushroom plays an important role at every celebration, especially among the shamans, but it is also very frequently enjoyed at other times by anyone who has become addicted to this pleasure and can no longer get along without it, just as the alcoholic cannot get along without his alcohol or the opium-addict without his opium. Anyone who indulges freely in this pleasure soon becomes a slave to it and is willing to give anything to enjoy the intoxication again.

Mukhomor-eaters describe the narcosis as most beautiful and splendid. The most wonderful images, such as they never see in their lives otherwise, pass before their eyes and lull them into a state of the most intense enjoyment. Among the numerous persons whom I myself have seen intoxicated in this way, I cannot remember a single one who was raving or wild. Outwardly the effect was always thoroughly calming - I might almost say, comforting. For the most part the people sit smiling and friendly, mumbling quietly to themselves, and all their movements are slow and cautious. Walking seems to be uncomfortable to them, although they are quite capable of it. They have a glassy, almost imbecilic look in their eyes, as if they scarcely noticed their surroundings, and their facial features are somewhat distorted. People generally claim that the effect of the mushroom poison becomes more intense and more beautiful when it has already passed through another organism. Thus an intoxicated man will often be followed by someone else who wants to collect his urine, which is supposed to possess this effect to a particularly high degree. Similarly, the meat of reindeer that have accidentally eaten of the mushroom is said to possess the intoxicating effect in a very pleasant form. The use of the *mukhomor* seems to be a very old practice, since all the early authors, such as Pallas and Krasheninnikov, tell the same and similar stories.

---

[314] I was told of only one fatal case that resulted from eating fly-agaric but it was explained as having been due to the fact that the man in question - a Russian - had taken fresh instead of dried mushrooms in rather large quantities.
The mushroom has a surprising effect on urine; *i.e.*, it seems as if the intoxicating effect of the narcotic contained in the mushroom passes principally into the urine. It is a well-known fact that as soon as a Koryak feels that his state of intoxication is beginning to ebb, he drinks his own urine if he has no more mushrooms, and the effect is restored. This cannot be repeated, however, for the urine has no effect a second time. I was told about a man who, while riding with a Koryak, stopped at a yurt near which a man, another Koryak, was sitting. He was thoroughly intoxicated and therefore in a very happy mood. The Koryak who had been riding naturally asked him for a piece of mushroom, which the latter deeply regretted he could not give because he had none left. However, he went and urinated, and then gave the product to his guest, who drank it all and now became intoxicated also. After a little while the host became sober while the guest's intoxication continued, and when the former complained about not being able to return to his pleasant state, the guest now gave him some of his urine, which however no longer had any effect.

[Ten years earlier, in 1890, von Dittmar had published his *Historischer Bericht*, 'Historical Report', according to the diary of his travels in Kamchatka, through the same publishing channels, in St. Petersburg. On pp. 524 and 590 there are two entries pertinent to our inquiry into the fly-agaric in Siberia. - RGW]

... I learned that shamans are very eager to take in a certain quantity of *Amanita muscaria* in order to get themselves into a stupor resembling complete insanity. The Koryak were complaining about the fact that this drug was not available at the time and that, as a rule, it was difficult to obtain in Taigonos. The mushroom does not grow on the peninsula and has to be brought from Kamchatka, where there is much of it and it is very effective. From Kamchatka this precious merchandise has to make its way all around the Penzhinsk Gulf, from peddler to peddler, and since everybody is wild about it, not much of it gets here.

... As I approached her [a drum-beating widow who hopes to resuscitate her dead husband by shaman's exercises - Translator], I immediately noticed that she was drunk with fly-agaric, a fact that was corroborated by the others. As a matter of fact, it is quite common here among the Koryak, and especially among the Chukchi, to produce small, round boxes made of birch bark containing small dried pieces of fly-agaric. People sniffing tobacco take out their little boxes, so these people take out theirs containing the mushroom. They chew the pieces, keeping them in their mouths for a long time without swallowing. They assert that this practice puts them into a state of bliss during which they see the most beautiful visions. They sit peacefully, without ranting and raving, their eyes wide open and staring, as if they no longer belonged to this world ...

[14] Kennan

> KENNAN, George. Tent Life in Siberia and Adventures among the Koraks and other Tribes in Kamtschatka and Northern Asia. New York and London. 1871, pp. 202-204. The journey was made in 1865-1870.

[To one versed in the literature this account by an American a century ago of his experience among the Koryak sounds disturbingly superficial and wrong-headed. Why was he astonished by the practice of eating the fly-agaric, when every prepared traveler in the region had known of it for generations? Why does he think that the 'natives' speak Russian? 'Muk-a-moor', as he writes the word, is Russian, not Koryak. Note his prudish reticence about the urine-drinking. - RGW]

... We... were surprised, as we came out into the open air, to see three or four Koraks shouting and reeling about in an advanced stage of intoxication - celebrating, I suppose, the happy event which had just transpired. [A wedding] I knew that there was not a drop of alcoholic liquor in all Northern Kamtchatka, nor, so far as I knew, anything from which it could be made, and it was a mystery to me how they had succeeded in becoming so suddenly, thoroughly, hopelessly, undeniably drunk. Even Ross Browne's beloved Washoe, with its 'howling wilderness' saloons, could not have turned out more creditable specimens of intoxicated humanity than those before us. The exciting agent, whatever it might be, was certainly as quick in its operation, and as effective in its results, as any 'tangle-foot' or 'bottled-lightning' known to modern civilization. Upon inquiry we learned to our astonishment that they had been eating a species of the plant vulgarly known as toadstool. There is a peculiar fungus of this class in Siberia, known to the natives as 'muk-a-moor', and as it possesses active intoxicating properties, it is used as a stimulant by nearly all the Siberian tribes. Taken in large quantities it is a violent narcotic poison; but in small doses it produces all the effects of alcoholic liquor. Its habitual use, however, completely shatters the nervous system, and its sale by Russian traders to the natives has consequently been made a penal offence by Russian law. In spite of all prohibitions, the trade is still secretly carried on, and I have seen twenty dollars worth of furs bought with a single fungus. The Koraks would gather it for themselves, but it requires the shelter of timber for its growth, and is not to be found on the barren steppes over which they wander; so that they are obliged for the most part to buy it, at enormous prices, from the Russian traders. It may sound strangely to American ears, but the invitation which a convivial Korak extends to his passing friend is not, 'Come in and have a drink', but, 'Won't you come in and take toadstool?' Not a very alluring proposal perhaps to a civilized toper, but one which has a magical effect upon a dissipated Korak. As the supply of these toadstools is by no means equal to the demand, Korak ingenuity has been greatly exercised in the endeavor to economize the precious stimulant, and make it go as far as possible. Sometimes, in the course of human events, it becomes imperatively necessary that a whole band shall get drunk together, and they have only one toadstool to do it with. For a description of the manner in which this band gets drunk collectively and individually upon one fungus, and keeps drunk for a week, the curious reader is referred to Goldsmith's *Citizen of the World*, Letter 32. It is but just to say, however, that this horrible practice is almost entirely confined to the settled Koraks of Penzhinsk Gulf - the lowest, most degraded portion of the whole tribe. It may prevail to a limited extent among the wandering natives, but I never heard of more than one such instance outside of the Penzhinsk Gulf settlements.

[14] Lansdell

> LANSDELL, Henry. Through Siberia. London. 1882. Vol. II, pp. 644-5.

[Note the English author's unfamiliarity with the common fly-agaric; also his prudery. - RGW]

Among the flora, however, of North-Eastern Siberia is a peculiar mushroom spotted like a leopard, and surmounted with a small hood - the fly-agaric, which here has the top scarlet, flecked with white points. In other parts of Russia it is poisonous. Among the Koriaks it is intoxicating, and a mushroom of this kind sells for three or four reindeer. So powerful is the fungus that the native who eats it remains drunk for several days, and by a process too disgusting to be described, half-a-dozen individuals may be successively intoxicated by the effects of a single mushroom, each in a less degree than his predecessor.

[16] Jadrintsev

> JADRINTSEV, Nikolai Mikhailovich. Sibirien: geographische, ethnographische und historische Studien. (Siberia: Geographical, Ethnographic, and Historical Studies) Jena. 1886. p. 337.

[The only reference that the author makes is the following: - RGW]

... Furthermore, the natives are passionately addicted to the fly-agaric (*i.e.*, to a decoction of *Amanita muscaria*), which replaces liquor and is also sold to merchants.

[17] Patkanov

> PATKANOV, Serafim Keropovich. Die Irtysch-Ostjaken und ihre Volkspoesie. (The Irtysh Ostyak and their Folk-Poetry) St. Petersburg. 1897. p. 121.

[The only reference to mushrooms is in a discussion of shamanism. - RGW]

The shaman must get himself into an exalted state to be able to talk to the gods. To achieve this he consumes several (either seven or fourteen or twenty-one) fly-agarics, which are capable of producing hallucinations.

[18] Sljunin

> SLJUNIN, Nikolai Vasil'evich. Okhotsko-Kamchatskii krai. Estestven-noistoricheskoe opisanie. (The Okhotsko-Kamchatskii Kraj. An Essay in Natural History) St. Petersburg. 1900. In two volumes. Vol. I, pp. 654-655.

The population dislikes mushrooms and therefore does not gather them. An exception is the fly-agaric (*Amanita muscaria*), widely used by the Koryaks because it produces a peculiar inebriation. They are so fond of this mushroom that they will pay considerable sums of money (in local terms, hides of foxes and sables) to obtain it. Exploiting this weakness, some people have set up a highly profitable commerce. Thus a certain Tykaniev, a Koryak of the Olyutorskoye settlement, made a fortune (a herd of reindeer) selling these mushrooms. Although the law forbids the trade in fly-agarics and other poisonous herbs and plants, it is almost impossible to enforce this law under the local conditions of life and the distances involved. The orders of the district commander (including the explanation of the noxious effect of the fly-agaric on the human organism) are completely ignored.

The effect of the fly-agaric is quite peculiar and reminds us of the scenes of inebriation, delirium, and hallucinations which we have frequently witnessed in Chinese opium dens. An excellent antidote is a glass of strong vodka or diluted alcohol. A quarter of an hour after swallowing the vodka, the Koryak who is totally oblivious of his environment under the effect of the mushroom, completely regains consciousness. He laments the disappearance of his world of dreams, because when inebriated he loses the concept of time and all objects appear to him greatly magnified (an effect similar to the one produced by hashish), which is the source of many jokes.

The Koryaks maintain that fresh fly-agarics are highly poisonous and hence do not eat them. They are first dried for a long time in the sun and over the fire in the tent. Only then is the mushroom consumed, together with fresh water to wash it down. The Koryaks claim that continuous consumption of the mushroom has no ill effect on the person's health. We have seen addicts, however, whose emaciated aspect, yellowish colour of the skin, and uncertain gait can only be attributed to protracted consumption of the fungus. Its inebriating effect is of short duration since the poison (an alkaloid) is rapidly eliminated by the urine which, if drunk, produces an effect similar to that of the mushroom itself.

[19] Enderli

> ENDERLI, J. 'Zwei Jahre bei den Tschuktschen und Korjaken.' (Two years among the Chukchi and Koryak) Petermanns Geographische Mitteilungen. Gotha. 1903. pp. 183-184.

[This is one of the most valuable accounts that we have. - RGW]

Very little alcohol is brought up to the North, at least around Gizhiga, but the Koryak know how to make intoxicating drinks from various kind of berries. In addition, however, they have another substance with which they can produce a narcotic intoxication, *viz.*, the fly-agaric. This mushroom is seldom found in those areas. It is collected by the women in the autumn, dried, and eaten on ceremonial occasions in the winter.

At the man's order, the woman dug into an old leather sack, in which all sorts of things were heaped one on top of another, and brought out a small package wrapped in dirty leather, from which she took a few old and dry fly-agarics. She then sat down next to the two men and began chewing the mushrooms thoroughly. After chewing, she took the mushroom out of her mouth and rolled it between her hands to the shape of a little sausage. The reason for this is that the mushroom has a highly unpleasant and nauseating taste, so that even a man who intends to eat it always gives it to someone else to chew and then swallows the little sausage whole, like a pill. When the mushroom sausage was ready, one of the men immediately swallowed it greedily by shoving it deep into his throat with his indescribably filthy fingers, for the Koryaks never wash in all their lives.

The effects of the poison became evident by the time the men had swallowed the fourth mushroom.[315] Their eyes took on a wild look (not a glassy look, as may be seen in drunken men), with a positively blinding gleam, and their hands began to tremble nervously. Their movements became awkward and abrupt, as if the intoxicated men had lost control of their limbs. Both of them were still fully conscious. After a few minutes a deep lethargy overcame them, and they began quietly singing monotonous improvised songs whose content was approximately 'My name is Kuvar, and I am drunk, I am merry, I will always eat mushrooms,' and so on.

---

[315] Different values have also been mentioned for this dose.

The song grew more and more lively and loud, sometimes interrupted by words shouted out at lightning speed; the animal-like wild look in the eyes grew stronger, the trembling of the limbs grew more intense, and the upper body began to move more and more violently. This condition lasted about ten minutes. All at once the men-first the Reindeer-Koryak and a little later the other man - were seized with a fit of frenzy. They suddenly sprang raving from their seats and began loudly and wildly calling for drums. (Every family owns disk-shaped drums of reindeer hide, which are used for religious purposes.) The women immediately brought two drums and handed them to the intoxicated men. And now there began an indescribable dancing and singing, a deafening drumming and a wild running about in the yurt, during which the men threw everything about recklessly, until they were completely exhausted. Suddenly they collapsed like dead men and promptly fell into a deep sleep; while they slept, saliva flowed from their mouths and their pulse rate became noticeably slower.

It is this sleep that provides the greatest enjoyment; the drunken man has the most beautiful fantastic dreams. These dreams are highly sensuous, and the sleeping man sees whatever he wants to.

After a half hour the two men awakened at almost the same time. The effects of the poison had subsided and both men were in possession of their senses, but their walk was uncertain and convulsive. Soon, however, the effects of the poison became apparent again; the drunken men were seized with a new but weaker fit of frenzy. Then they fell asleep again; they awakened for a short period to full consciousness, which was again succeeded by another fit. The attacks continued in this way a few more times, growing less violent each time. They probably would have stopped entirely after a few hours if these intoxicated men had not used another method which renewed the intensity of the intoxication.

It appears that the poison of the fly-agaric is excreted in the urine, and this, when a man drinks it, produces the same effects as the fly-agaric itself. Since fly-agarics are relatively rare in those regions, they are highly prized by the Koryaks, and they therefore consider it too expensive to waste their urine, whose effects are entirely similar to those of the mushroom.

I noticed now that a woman brought the awakened man a small sheet-metal container, into which the man voided his urine in the presence of everybody. The container is used exclusively for this purpose, and Koryaks carry it with them even when they travel. The drunken man (or, more properly, the poisoned man) put the container down next to him; the urine was still warm and the steam was rising densely in the cold yurt when the second mushroom-eater, who was just awakening, saw the urine container near him, seized it without a word, and drank a few large gulps. Soon after this the first man, the actual 'owner of the urine,' followed the other's example. After a few moments the urine they had drunk began to do its work, and the symptoms of the intoxication grew more violent, as they had before. Sleep alternated with attacks of frenzy and moments of complete calm. The intoxication was intensified each time by drinking urine. The frenzied dances and the drinking-bouts continued in this way all through the night, and it was almost evening of the next day before the Koryaks recovered from their stupor. The remaining urine was carefully preserved for a short time, to be used again on the next occasion. Even while traveling, when the Koryak leaves his settlement in a half-drunken condition, he never squanders his urine; he continues to collect it in the container which he carries with him for the purpose.

This is the greatest enjoyment, the merriest entertainment, that the Koryak knows, and he waits for it impatiently all year long. It is true that he likes alcoholic drinks better because of their milder form (this refers only to 95% pure alcohol [sic!], which many people drink without any admixture of water), for the effects of fly-agaric poisoning, in the form of heart palpitations and nausea, often last one or two days, and immoderate consumption of the mushroom involves the danger of madness or death. Such cases, however, occur very rarely.

But the natives believe that the fly-agaric, unlike alcohol, has the power to reveal the future to the man who consumes it; if, before eating the mushroom, the man recites over it certain definite formulas stating his wish to see the future, the wish will come true in his dream.

[20] Vanderlip

VANDERLIP, Washington B. In Search of a Siberian Klondike. New York. 1903. pp. 214-215.

[The author places the following episode in the Koryak village of 'Kaminaw', presumably Kaminov. - RGW]

A peculiar custom sometimes to be noted among these people [Koryaks] is that of drinking a kind of liquor made from a large species of mushroom. The effect is, in some respects, similar to that produced by hashish. At first the imbiber shakes as with the ague; and presently he begins to rave as if in delirium. Some jump and dance and sing, while others cry out in agony. A small hole looks to them like a bottomless pit, and a pool of water as broad as the sea. These effects are produced only when the beverage is used to excess; a small quantity has much the same effect as a moderate amount of liquor. Curiously enough, after recovering from one of these debauches, they claim that all the antics performed were by command of the mushroom. The use of it is not unattended by danger, for unless a man is well looked after he is likely to destroy himself. The Koryaks sometimes take this drug in order to work themselves to the point of murdering an enemy. Three or four of the mushrooms is a moderate dose, but when one wants to get the full effect one takes ten or twelve.

[Vanderlip offered his book to the public as an account of the author's experiences in Siberia, but the excerpt that we have quoted ought by rights to be relegated to the secondary sources, since the statements in it can be traced without exception to others, notably Krasheninnikov **[4]**, with only minimal changes in wording. Vanderlip could have compiled his paragraph in the Reading Room of the New York Public Library. - RGW]

[21] Jochelson

JOCHELSON, Waldemar. (Iokhel'son, Vladimir Il'ich)
1. The Koryak: Memoir of the American Museum of Natural History, New York. A publication of the Jesup North Pacific Expedition. Vol. VI, Part I Religion and Myth, New York, 1905. Part II. Material Culture and Social Organization of the Koryak, 1908. pp. 582-584.

[Vladimir Bogoraz and Vladimir Jochelson were two distinguished Russian anthropologists. On the invitation of the American Museum of Natural History, the Imperial Academy of Science designated them to collaborate with the Jesup North Pacific Expedition, they to contribute the studies of the tribes of the Maritime Provinces of Siberia and the extreme tip of Siberia opposite Alaska. They wrote more extensively about the fly-agaric practices of these tribes than anyone else has done, and with keener discernment. They were in the field at the turn of the century. We reprint in full what they had to say about the fly-agaric habit and we bring to the reader's attention a number of folk tales in which the fly-agaric figures. We have simplified their phonetic transcription of native names and words. - RGW]

The Koryak are most passionate consumers of the poisonous crimson fly-agaric, even more so than the related Kamchadal and Chukchee, probably because the fungus is most common in their territory. Some travellers, as Krasheninnikov and Dittmar, were of the opinion that the fly-agaric was bought by the Koryak from Kamchatka. Thus, Dittmar says that there is no fly-agaric on the Taigonos Peninsula,[316] and that it is brought there from Kamchatka; while Krasheninnikov[317] asserts that in general the Koryak have no fly-agaric, and that they get it from the Kamchadal. My own observations, however, have convinced me that not only is fly-agaric abundant all over the Koryak territory, but that the Koryak supply the Chukchee with it. In the middle of the month of August I saw in the valley of the Varkhalam River, not far from its mouth, an extensive field dotted with the characteristic crimson caps of the fly-agaric, with their white spots. In the villages of the Maritime Koryak, along the whole western coast of Penshina Bay, I knew individuals who were engaged in gathering and drying fly-agaric, and who carried on a very profitable trade in it. One Koryak from Alutorsk, who dealt in fly-agaric, is mentioned by Sljunin.[318]

---

[316] Dittmar, p. 451. [Our ref. **[13]** p. 256 - RGW]
[317] Krasheninnikov, II, p. 150. [Our ref. **[4]** p. 237 - RGW]
[318] Sljunin, I, p. 654. [Our ref. **[18]** p. 260 - RGW]

The Koryak do not eat the fly-agaric fresh. The poison is then more effective, and kills more speedily. The Koryak say that three fresh fungi suffice to kill a person. Accordingly, fly-agaric is dried in the sun or over the hearth after it has been gathered. It is eaten by men only; at least, I never saw a woman drugged by it.[319] The method of using it varies. As far as I could see, in the villages of Penshina Bay, the men, before eating it, first let the women chew it, and then swallow it. Bogoraz[320] says that the Chukchee tear the fungus into pieces, chew it, and then drink water. Sljunin describes in the same way[321] the Koryak method of using fly-agaric. In describing the use of fly-agaric by the Chukchee and Koryak, Dittmar[322] says that they chew it, and keep the quid in their mouths for a long time without swallowing it. Krasheninnikov[323] says that the Kamchadal roll the dried fungus up in the form of tube, and swallow it unchewed, or soak it in a decoction of willow-herb and drink the tincture.

Like certain other vegetable poisons, as opium and hashish, the alkaloid of fly-agaric produces intoxication, hallucinations, and delirium. Light forms of intoxication are accompanied by a certain degree of animation and some spontaneity of movements. Many shamans, previous to their seances, eat fly-agaric in order to get into ecstatic states. Once I asked a Reindeer Koryak, who was reputed to be an excellent singer, to sing into the phonograph. Several times he attempted, but without success. He evidently grew timid before the invisible recorder; but after eating two fungi, he began to sing in a loud voice, gesticulating with his hands. I had to support him, lest he fall on the machine; and when the cylinder came to an end, I had to tear him away from the horn, where he remained bending over it for a long time, keeping up his songs.

Under strong intoxication, the senses become deranged; surrounding objects appear either very large or very small, hallucinations set in, spontaneous movements, and convulsions. So far as I could observe, attacks of great animation alternate with moments of deep depression. The person intoxicated by fly-agaric sits quietly rocking from side to side, even taking part in the conversation with his family. Suddenly his eyes dilate, he begins to gesticulate convulsively, converses with persons whom he imagines he sees, sings, and dances. Then an interval of rest sets in again.

However, to keep up the intoxication, additional doses of fungi are necessary Finally a deep slumber results, which is followed by headache, sensations of nausea, and an impulse to repeat the intoxication. If there is a further supply of fungi, they are eaten. At the beginning of winter, when the supply is still large, old men begin their carousals. In Kuel there are two elders of the Paren' clans, and during my sojourn in that village I was sometimes unable to hold conversation with either of them for days at a time. They were either intoxicated by the fungi or in a bad mood from the after-effects. At the same season the Reindeer Koryak resort to the coast settlements to purchase and eat fly-agaric. To regale a guest with fly-agaric is a sign of special regard. Dr. Sljunin says a small glass of brandy or diluted alcohol serves as a splendid antidote in cases of fly-agaric poisoning.[324]

There is reason to think that the effect of fly-agaric would be stronger were not its alkaloid quickly taken out of the organism with the urine. The Koryak know this by experience, and the urine of persons intoxicated with fly-agaric is not wasted. The drunkard himself drinks it to prolong his hallucinations, or he offers it to others as a treat. According to the Koryak, the urine of one intoxicated by fly-agaric has an intoxicating effect like the fungus, though not to so great a degree. I remember how, in the village of Paren', a company of fly-agaric eaters used a can in which California fruit had been put up, as a beaker, into which the urine was passed, to be drunk afterwards. I was told of two old men who also drank their own urine when intoxicated by brandy, and that the intoxication was thus kept up.

From three to ten dried fungi can be eaten without deadly effect. Some individuals are intoxicated after consuming three. Cases of death rarely occur. I was told of a case in which a Koryak swallowed ten

---

319. Krasheninnikov (II, p. 150) says that the Kamchadal women do not eat fly-agaric, but Dittmar (p. 106) cites the case of a Koryak woman (a shaman) who was intoxicated by it. [Our ref. **[4]** p. 237; **[13]** p. 257- RGW]
320. Bogoraz, The Chukchee, Vol. VII of this series, p. 205. [Our ref. **[22]** p. 273 - RGW]
321. Sljunin, I, p. 655. [Our ref. **[18]** p. 261 - RGW]
322. Dittmar, p. 506. [Our ref. **[13]** p. 256 - RGW]
323. Krasheninnikov, II, p. 147. [Our ref. **[4]** pp. 235-236 - RGW]
324. Sljunin, I, p. 654. [Our ref. **[18]** p. 261 - RGW]

mushrooms without feeling their effect. When he swallowed one more, vomiting set in, and he died. In the opinion of the Koryak, the spirits of the fly-agaric had choked him. They related that these spirits had come out with the matter vomited, in the shape of worms, and that they vanished underground.

The Koryak were made acquainted with brandy by the Russians and by American whalers. Despite the prohibition issued by the Russian Government against the importation of brandy, it often finds its way in winter into the Koryak villages and camps, being taken there on trading-trips by Russian merchants. Whalers take it to the coast settlements in summer. Like all other primitive tribes, the Koryak are passionate consumers of brandy, and dealers often obtain an arctic or red fox in exchange for one wineglassful of brandy. To my question as to which they preferred, brandy or fly-agaric, many Koryak answered, 'Fly-agaric.' Intoxication from the latter is considered more pleasurable, and the reaction is less painful, than that following brandy. Like fly-agaric, brandy is drunk chiefly by elderly men. Old people do not give it to the young, that they themselves may not be deprived of the pleasure; and if young people or women happen to obtain brandy, they frequently give it up to the older members of the family. Two herd-owners whom I met on the Palpal were entirely unacquainted with this drink. Some Koryak in the coast villages have learned from the Russian Cossacks how to make brandy of blueberries. They subject the berries to fermentation, and by means of a pipe distil the liquid from one iron kettle into another, the latter serving as a refrigerator. The result is a rather strong liquor of such disgusting taste and odor that the mere attempt to taste it nauseated me. Krasheninnikov[325] says that the Cossacks in Kamchatka and, following their example, the Kamchadal, distilled brandy from 'sweet grass' (*Heracleum sphandilium*).

Pp. 120-121. Among the objects believed by the Koryak to be endowed with particular power is fly-agaric (wa'paq, *Agaricus muscarius*). The method of gathering and the use made of this poisonous fungus will be described later on. It may suffice here to point out the mythologic concept of the Koryak regarding fly-agaric. Once, so the Koryak relate, Big-Raven had caught a whale, and could not send it to its home in the sea. He was unable to lift the grass bag containing travelling-provisions for the whale. Big-Raven applied to Existence to help him. The deity said to him, 'Go to a level place near the sea: there thou wilt find white soft stalks with spotted hats. These are the spirits wa'paq. Eat some of them, and they will help thee.' Big-Raven went. Then the Supreme Being spat upon the earth, and out of his saliva the agaric appeared. Big-Raven found the fungus, ate of it, and began to feel gay. He started to dance. The Fly-Agaric said to him, 'How is it that thou, being such a strong man, canst not lift the bag?' - 'That is right,' said Big-Raven. 'I am a strong man. I shall go and lift the travelling-bag.' He went, lifted the bag at once, and sent the whale home. Then the Agaric showed him how the whale was going out to sea, and how he would return to his comrades. Then Big-Raven said, 'Let the Agaric remain on earth, and let my children see what it will show them.'

The idea of the Koryak, is, that a person drugged with agaric fungi does what the spirits residing in them (wa'paq) tell him to do. 'Here I am, lying here and feeling so sad,' said old Euwinpet from Paren' to me; 'but, should I eat some agaric, I should get up and commence to talk and dance. There is an old man with white hair. If he should eat some agaric, and if he were then told by it, "You have just been born," the old man would at once begin to cry like a new-born baby. Or, if the Agaric should say to a man, "You will melt away soon," then the man would see his legs, arms, and body melt away, and he would say, "Oh! why have I eaten of the agaric? Now I am gone!" Or, should the Agaric say, "Go to The-One-on-High," the man would go to The-One-on-High. The latter would put him on the palm of his hand, and twist him like a thread, so that his bones would crack, and the entire world would twirl around. "Oh, I am dead!" that man would say. "Why have I eaten the agaric?" But when he came to, he would eat it again, because sometimes it is pleasant and cheerful. Besides, the Agaric would tell every man, even if he were not a shaman, what ailed him when he was sick, or explain a dream to him, or show him the upper world or the underground world, or foretell what would happen to him.'

P. 483. When the reindeer feed exclusively on lichens, they acquire a special longing for the urine of human beings. This longing attracts them to human habitations. Fig. 9 represents a vessel (the name in Koryak signifies 'the reindeer's night-chamber') made of seal-skin, which every herdsman carries suspended from his belt, and of which, he makes use whenever he desires to urinate, that he may keep the urine as a means of attraction in capturing refractory reindeer. Quite frequently the reindeer come running to camp from a far-off

---

325. Krasheninnikov, II, p. 406.

pasture to taste of snow saturated with urine, a delicacy to them. The reindeer have a keen sense of hearing and of smell, but their sight is rather poor. A man stopping to urinate in the open attracts reindeer from afar, which, following the sense of smell, will run to the urine, hardly discerning the man, and paying no attention to him. The position of a man standing up in the open while urinating is rather critical when he becomes the object of attention from reindeer coming down on him from all sides at full speed.

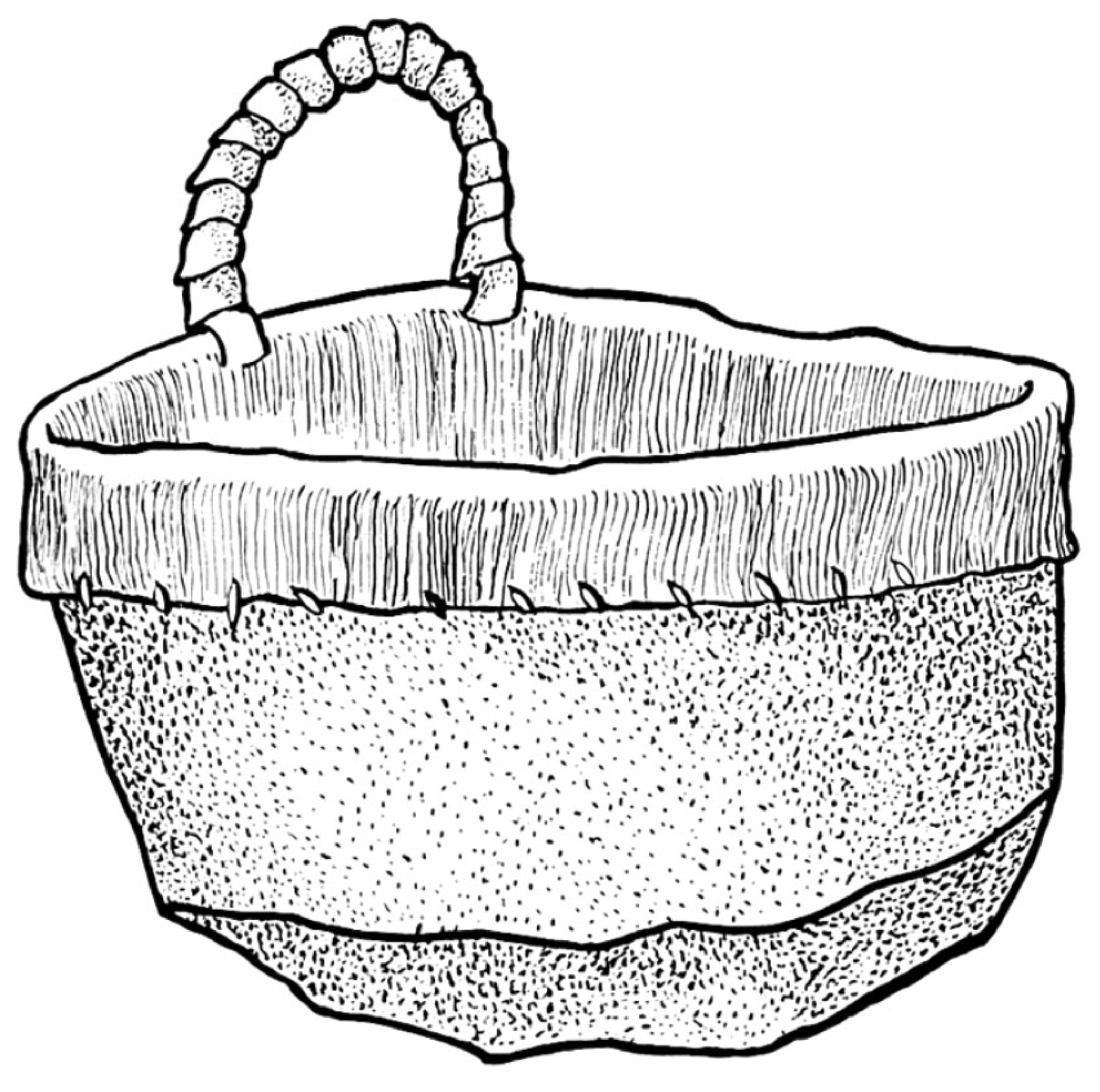


Fig. 9. Seal-skin vessel for gathering urine impregnated with inebriating virtue derived from fly-agaric, in use among the Koryak. (After Waldemar Jochelson, *The Koryak*, p. 483; Mem., Amer. Museum of Natural History, 1908)

P. 565. At the present time the use of sulphur or Swedish matches is quite widespread. Even when obtaining the sacred fire, some Koryak turn the drill for a short time as a formality only, and the fire is really kindled with a match; but they cannot always obtain matches, so that the most common means of obtaining fire is the strike-a-light. Although not much used, the strike-a-light seems to have been known to the Koryak prior to their encounter with the Russians, having been introduced by the Tungus, who had received it from the Amur tribes. Even now, merchants often import from Vladivostok steel and flint of Chinese origin. Tinder is prepared from a fungus which grows on the stumps of birch-trees. [*Fomes fomentarius* - RGW] The fungus is stripped of its hard outer layer, and the inner spongy mass is boiled in water. Then it is dried; and a light, brittle, and highly inflammable punk is thus obtained.

Fire-making tools are more often needed by the nomadic Reindeer Koryak than by the sedentary Maritime people. A new fire need rarely be made in the underground houses of the Maritime Koryak. The women are very skilful in keeping up the fire of the hearth. They cover the embers with ashes; and when reviving the fire, they rake it up, put small chips of wood on the glowing embers, and fan them until they burst into flame. The Maritime Koryak need fire-tools only on journeys. However, when in possession of matches, they are very fond of striking them to light their lamps or pipes, even when the fire is burning on the hearth. On the other hand, if the fire goes out entirely, and neither match nor tinder is on hand, the ancient method of obtaining fire by means of the drill-bow is resorted to. This, however, happens very rarely.

[In the Koryak village where Jochelson was staying, the ceremonies attending the 'home journey of the white whale' were being celebrated. - RGW]

P. 74. The old men ate fly-agaric, and, when the intoxication had passed, they told whither the 'Fly-Agaric Men' (Wapa'qala'nu) had taken them, and what they had seen. The women and the young people sang and beat the drum.

[There had been a pestilence and the community were arranging for the cremation of a child. All kinds of gifts were being sent to be placed on or near the pyre, some for the dead child and others for the child to take to relatives who had died in the pestilence. - RGW]

P. 112. Two agaric fungi were sent to one old man who had been very fond of agaric intoxication.

[In the following extract about the 'water of life' we are reminded of the fly-agaric in one of its manifestations, as a liquid, either derived directly from the mushroom, or the urine of the reindeer that has imbibed the mushroom, or human urine. Should we not consider the possibility that this conception, so widespread in Eurasian and American folklore, had its origin in the fly-agaric? Here is what Jochelson says: - RGW]

P. 351. We find in American tales some elements that occur in the myths of the Old World, but they are absent in the Koryak tales recorded here. For instance, 'the water of life,' which a hero procures to restore dead bodies to life, or to revive bones, figures frequently in Indian myths on both sides of the Rocky Mountains, and is also one of the favorite episodes of the myths of the Old World.[326] Another case in point is the cosmogonic tale about the raven, or some other bird or other animal which dives into the water to obtain some mud, out of which the earth is created. This tale is popular in many parts of North America, and is found as well among the Chukchee and Yukagir.

[Speaking of the lack of cleanliness among the Koryak, the author says: - RGW]

P. 416. The kettles in which the food is cooked are full of reindeer and dog hair, which fall from the clothes and fill the air of the Koryak house. The Koryak kill lice, which are regarded by them as properly belonging to a healthy man, with their teeth. There is a prevailing belief among them, as well as among the Yukaghir, that when a man is deserted by lice he will soon die. They eat also the large larvæ which develop from the eggs deposited by the reindeer-flies in the hair of the reindeer. No matter how putrid food may be, the Koryak have no aversion to it, and they will even drink the urine of persons intoxicated with fly-agaric.

Pp. 417-8. People addicted to the use of fly-agaric can be detected by their appearance. Even when they are in a normal condition, a twitching of the face is observable, and they have a haggard look and an uneven gait.

P. 115. In the beginning of things, at the mythological time of the Big Raven, the transformation of animals and inanimate objects into men was a natural occurrence. 'At that time, man also possessed the power of transforming himself. By putting on the skin of an animal, or by taking on the outward form of an object, he could assume its form. Big Raven and Eme'mqut turned into ravens by putting on raven coats. Kĭlu´, the niece of Big Raven, put on a bear-skin and turned into a bear. Eme'mqut put a dog's skin on his sister, and she became a dog. Eme'mqut and his wives put on wide-brimmed spotted hats resembling the fly-agaric, and turned into those poisonous fungi.[327] The belief in the transformation of men into women after putting on a woman's clothes, and *vice versa*, is closely related to this group of ideas.'

---

[326] It seems that in the Koryak tales the blood of the reindeer takes the place of 'the water of life'. It must be noted here that in one Chukchee tale we find 'bladder with living water' (Bogoraz: Chukchee Materials, p. XXIV); and in one Yakut tale (Khudyakov, p. 127) 'three bottles with living water' are mentioned. As to the Chukchee, Mr. Bogoraz considers the passage as borrowed from the Russian.

> 2. The Yukaghir and the Yukaghirized Tungus. Vol. IX of the Jesup North Pacific Expedition, p. 419.

They [the Yukagir. - RGW] do not eat mushrooms regarding them as unclean food growing from dogs' urine. However, according to traditions, they used to intoxicate themselves with the poisonous fly-agaric, which is still eaten by the Koryak and Chukchee. The Yukaghir call mushrooms *can-pai*, *i.e.*, tree girl.

[22] Bogoraz

> BOGORAZ, Vladimir Germanovich. (Bogoras, Waldemar) The Chukchee. Memoir of the American Museum of Natural History. Jesup North Pacific Expedition. Parts 1, 2, and 3. New York. 1904-1909. pp. 205-207.

INTOXICANTS. - Fly-agaric is the only means of intoxication discovered by the natives of northeastern Asia. Its use is more common in the Koryak tribe, as agaric does not grow outside of the forest border. For the same reason only the Southern Pacific Chukchee - *e.g.*, those around the Anadyr, Big River, and Opuka River - are supplied with the intoxicating mushroom. They do not compare with the Koryak, however, in their passion for agaric.

The Russianized natives of the Anadyr until recently shared in the consumption of this intoxicant, but now they have almost wholly given up its use. The reason of this change is that they consider the strong intoxication produced by this stimulant as shameful for a Christian. They also realize that the consumption of fly-agaric involves some danger. With a person unaccustomed to its use it may even cause death. The abstinence from agaric is also noticed among the northern Kamchadal, and to some degree among the Maritime Koryak of northern Kamchatka, though all of these people gather it assiduously in order to trade it to their less civilized reindeer-breeding neighbors.

Fortunately for the tribes consuming the fly-agaric, it grows only in certain places, and the supply is often limited. The mushrooms are usually dried up and strung together in threes, that number being an average dose. Some of the natives of course require much more to produce any effect. The intoxication may be followed by sickness, or the after-effect may be very slight. When eaten, the mushrooms are torn to small shreds, and these are chewed piece by piece, and swallowed with a little water. Among the Koryak the woman chews the mushroom, and offers the ready quid to her husband to swallow.

I witnessed a few times the progress of intoxication by means of agaric. The symptoms are analogous to those produced by opium or hashish. The intoxication comes on rather suddenly, in about a quarter of an hour after the consumption of the mushrooms. Usually the person remains awake; but the natives say that if a person falls asleep immediately after eating mushrooms, they will work more effectively, and in a short time he will awaken more thoroughly under their influence. The intoxication has three stages. In the first the person feels pleasantly excited. His agility increases, and he displays more physical strength than normally. Reindeer-hunters of the Middle Anadyr told me that before starting in canoes in pursuit of animals, they would chew agaric because that made them more nimble on the hunt. A native fellow-traveller of mine, after taking agaric, would lay aside his snow-shoes and walk through the deep snow hour after hour by the side of his dogs for the mere pleasure of exercise, and without any feeling of fatigue. During this period the agaric-eater sings and dances. He frequently bursts into loud peals of laughter without any apparent reason. It is a state altogether of noisy joviality. His face acquires a darker hue and twitches nervously; his eyes are now contracted, and again almost bursting from their sockets; his mouth puckers and grins or spreads into a broad smile.

---

[327] Tale 12.

Flashes of the second stage often appear early, shortly after the first traces of intoxication become visible; indeed, all three stages are frequently intermingled. This is noticeable especially among elderly inveterate agaric-eaters. During the second stage the intoxicated person hears strange voices bidding him perform more or less incongruous actions; he sees the spirits of fly-agaric and talks to them. He still recognizes surrounding objects, however, and when talked to is able to answer. All things appear to him increased in size. For instance, when entering a room and stepping over the door-sill, he will raise his feet exceedingly high. The handle of a knife seems to him so big that he wants to grasp it with both hands.

The spirits of fly-agaric have an outward appearance similar to that of the actual mushrooms, and the agaric-eater feels impelled to imitate them. For example, I saw one man suddenly snatch a small narrow bag and pull it with all his might over his head, trying to break through the bottom. He was evidently imitating the mushroom bursting forth from the ground. Another walked around with his neck drawn in, and assured every one that he had no head. He would bend his knees and move very quickly, swinging his arms violently about. This was in imitation of the spirits of fly-agaric, who are supposed to have no necks or legs, but stout cylindrical bodies which move about swiftly.

The spirits of fly-agaric are fond of playing practical jokes on men under their influence. They begin with asking for homage either for themselves or for surrounding objects, - the hills, the river, the moon, *etc*. Then they show some of the objects under a delusive aspect. When asked why this strange change has occurred, the spirits answer that it portends danger to the man's life unless he makes obeisance in a particular way. To illustrate. An intoxicated man, while talking to me reasonably enough, suddenly leaped aside, and, dropping on his knees, exclaimed, 'Hills, how do you do? Be greeted!' Then he stood up, and, looking at the full moon, asked, 'O Moon! why are you waning so fast?' He told me that the spirits answered, 'Even so will your life wane, unless you show the moon your bare buttocks.' This he did, and then, suddenly recovering his senses, began to laugh at his foolish actions.

In the third stage the man is unconscious of his surroundings, but he is still active, walking or tumbling about on the ground, sometimes raving, and breaking whatever happens to come into his hands. During this period the agaric spirits take him through various worlds and show him strange sights and peoples. Then a heavy slumber ensues, lasting for several hours, during which it is impossible, to rouse the sleeper. How persistent are the spirits' commands is shown by the following instance of a man, who, when about to retire, was ordered to lie down in the midst of his dog-team. Although he was attacked by the dogs, we could not keep him away from them. He finally succeeded in staying with the dogs all night.

On awakening, a general weakness and heavy headache ensue, accompanied by nausea, often violent vomiting. The drunken state can be renewed by a single mushroom. In this manner inveterate agaric-eaters keep up their intoxication day after day.

Drinking the urine of one who has recently eaten fly-agaric produces the same effect as eating the mushroom. The passion for intoxication becomes so strong that the people will often resort to this source when agaric is not available. Apparently without aversion they will even pass this liquor around in their ordinary tea-cups. The effect is said to be less than from the mushrooms themselves.

I have already spoken about the amount of trade in strong liquors carried on in northeastern Siberia. The Chukchee, as well as all other inhabitants of the country, are eager for a chance to drink spirits. In all my journeys through these countries I met people in only two places who knew nothing about strong liquors. In one case they were some Maritime Koryak in small villages on the northern border of the Kamchatka district. These people were far from the Kamchatka towns and from Gishiginsk trading-settlements. At the same time, they were so poor that nobody sought to bring liquors to them. The other case was that of the Kerek of the southern shore of Anadyr Bay.

P. 282. Thus, for instance, the intoxicating mushrooms of the species fly-agaric are a 'separate tribe' (*ya*'*nřa-va*'*rat*). They are very strong, and when growing up they lift upon their soft heads the heavy trunks of trees, and split them in two. A mushroom of this species grows through the heart of a stone and breaks it into minute fragments. Mushrooms appear to intoxicated men in strange forms somewhat related to their real shapes. One, for example, will be a man with one hand and one foot; another will have a shapeless body. These are not spirits, but the mushrooms themselves. The number of them seen depends on the number of mushrooms consumed. If a man has eaten one mushroom, he will see one mushroom-man; if he has eaten two or three, he will see a corresponding number of mushroom-men. They will grasp him under his arms, and lead him through the entire world, showing him some real things, and deluding him with many unreal apparitions. The paths they follow are very intricate. They delight in visiting the places where the dead live. These ideas are illustrated in a sketch (Fig. 10) drawn by a Chukchee.

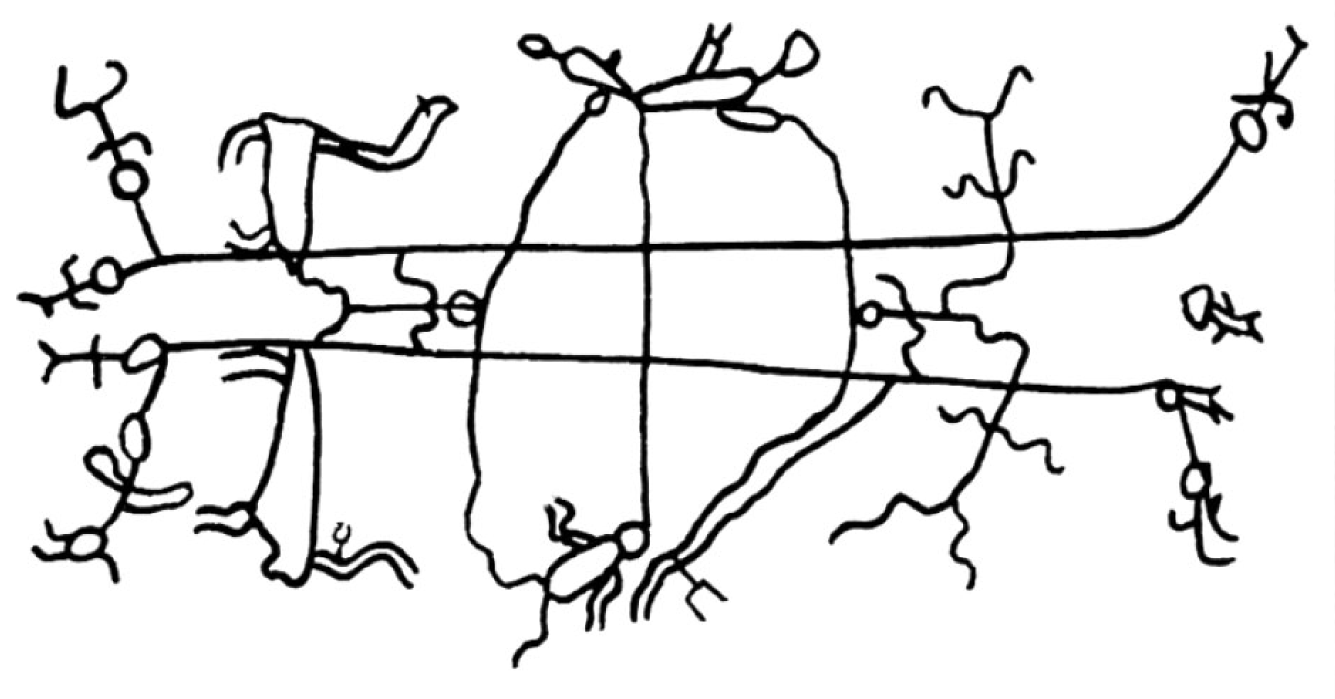


Fig. 10. Drawing made by a Chukchee of the wanderings of 'fly-agaric men'. (After Waldemar Bogoraz, *The Chukchee*, p. 282; Mem., Amer. Museum of Natural History, Vol. VII, Part 2).

Pp. 322-323. Thunder is said to be produced by the passing of the thunder-bird. Others attribute it to the rattling noise made by girls playing on a spread sealskin. Rain is the urine of one of the girls. In one tale the lightning is described as a one-sided man who drags his one-sided sister along by her foot. She is intoxicated with fly-agaric. The noise caused by her back as it strikes the floor of heaven is thunder, her urine is rain. Obsidian is said to be the stone of the thunder, which falls from the sky in round balls, or even in roughly chipped arrow-heads and lances. Perhaps the idea of stone arrow-heads falling from the sky, so common in the Old World, is borrowed from the Tungus or from the Russianized natives.

Intoxicating mushrooms form a 'separate tribe' (*ya'n řa-va'rat*). We have already noted that they are very strong, and that, when coming out of the earth, they can lift a large tree-trunk on their head, or shatter a rock into pieces. They appear to intoxicated men in strange shapes.

On one sketch (Fig. 10) there are represented the tracks of a man who is led around by mushrooms. He thinks that he is a reindeer, then he is 'submerged,' and after a while he comes out laboring under the same idea. The path of his tracks connects all men and all beasts seen during the trance.

P. 414. I saw a shaman trying to recall to her senses a sick woman who had fallen into a heavy swoon. To do this he began to beat the drum with the utmost force. Then he pretended to catch something from the drum and to swallow it hurriedly. Immediately afterward he appeared to spit it out into the hollow of his hand, and then in the quickest possible way pretended to empty his palm over the head of the patient. After that, he began to mumble and gibber over the crown of the patient's head. In order to prevent the soul from leaving, he breathed into the hollow of his hand, and then applied his palm to the breast of the patient. At intervals he pretended to suck out the source of the suffering from the crown of her head. For this he made sucking motions with his mouth at some distance from her head. From time to time he made grimaces, and pretended to be choking, evidently for the purpose of showing that something bad had entered his mouth. At last he spat violently, and then began again the whole process.

From my own observation I know that a real insect is sometimes used in treatments of such a kind. This is brought near to the breast or to the head of the patient, and then vanishes, deftly abstracted by the shaman, who pretends that it has entered the body.

[Bogoraz in the following passage gives a classic description of the whalebone device used by the tribesmen of the north, in both Eurasia and America, for killing wolves. The Chukchee call it *wapaq*, which is also their name for the fly-agaric, presumably because the wolf after swallowing the *wapaq* jumps wildly around and then quiets down, exhausted. Bogoraz assumes that the primary meaning of the name is fly-agaric but does not discuss this. In the absence of further information it seems possible that the name of the device was transferred as a figure of speech to the mushroom. The mushroom with its religious associations is likely to attract to itself under tabu influence various names and *wapaq* would have been the current one in the time of Bogoraz. Here is how he describes the *wapaq*. - RGW]

P. 141. Till recent times the well-known spit of whalebone,[328] identical with that of the American Eskimo, was used to catch wolves. It consisted of a slender rod of whalebone, with sharp-pointed ends, folded together several times, and bound with a thin thread of sinew well saturated with oil. Afterward it was several times soaked in water and allowed to freeze. The whole object was then well covered with blubber, tallow, meat, or such like. These folded spring-spits were often joined in strings of five or six, and hung on a bush on the wolf's trail, but so high as to be out of reach of foxes; or they were laid in a hole in the ice and water was poured over them, so that it would freeze to a transparent protecting cover strong enough to resist the attacks of smaller animals. The wolf would break through the ice and swallow all the spits, which would unfold in the stomach, and, breaking through its walls, cause the speedy death of the animal. But with only one or two spits it was able to walk away for a considerable distance, even so far that it would never be found by the hunter.

[Bogoraz mentions in the foregoing footnote that mice store up the fly-agaric in their winter holes. He has more to say about this on p. 198: - RGW]

The roots of *Claytonia acutifolia* Willd, *Hedisarum obscurum*, *Polygonum viviparum*. *Polygonum polymorphum*, *Pedicularis sudetica*, *Potentilla fragiformis*, *Oxytropis*, various species of *Carex*, and several others, are used by the Chukchee. They are the only vegetable food that is really relished. During the summer women often go digging roots. They use a digging-pick, which in former times consisted of a handle with bone point or simply of a sharp-pointed piece of antler, while at present it has an iron point tied to a wooden handle. Nests of mice are also robbed. It is considered dangerous, however, to take all the roots from the nests, because the owner might retaliate by means of magic. Moreover, the Chukchee believe that some of the roots and herbs found in the storehouses of mice are poisonous, and are gathered by the mice partly for the purpose of poisoning the robbers, partly as an intoxicant, like fly-agaric (*Agaricus muscarius*), which is used by man.

[On p. 148 Bogoraz quotes in Chukchee a riddle: - RGW] 'I have a headache. I am bleeding from my nose. Stop my nose bleeding! … What is it?' Answer: 'Fly-agaric.' He explains this riddle with the following note: 'The eating of the fly-agaric causes, after the intoxication has passed, a violent headache, which may be assuaged by a new dose of the same drug.'

[Bogoraz devotes considerable space to recording the life of the reindeer herdsmen and their tribulations. He says that one of their hardships comes with the mushroom season in the fall, when presumably the herds become unruly. Another is the insects, two species of which lay their eggs under the skin of the animals and another in the nostrils. Here is what he says about the nostril infestation: - RGW]

Another fly, of smaller size and darker color (*Ædemagena tarandi* Slunin), lays its eggs in the reindeer's nostrils. The larvæ go up to the throat, and penetrate the cartilage. The next year, when the maggots are full-grown, they cause a constant cough, which continues until the last one drops to the ground. The Yukaghir and the Tungus, following the example of Yakut cattle-breeders, try to protect their reindeer from obnoxious insects by a smudge of smouldering dung, or of a fire covered with green leaves. But with the wild and large herds of the Chukchee such fires are of little value, and not without danger. Thus, some five years ago, Tungus herdsmen who were tending the herd of a rich Chukchee on the Alaseya River tried to surround it with fires, and finally burned the whole pasture, and injured half of the animals.

---

[328] Its name in Chukchee is wa'pak, which means literally 'fly-agaric' (an intoxicating mushroom). The Chukchee and the Koryak are very fond of this mushroom; and when they find it in the woods, they pick it off just as eagerly as the wolves snatch after the greased whalebone spits. The Chukchee believe, moreover, that mice, when gathering roots for the winter, bring in some unknown intoxicating herbs which they use in their ceremonials. These herbs also serve to protect their stores from intruders, because they are said to act as poison on most other animals, including man. These herbs are called by a name derived from that of the intoxicating mushroom, - elhi-wapak ('white agaric'), - and a similar name is given to the whalebone spit on account of its power of killing the animal that swallowed it.

[23] Itkonen

> ITKONEN, T. I. Heidnische Religion und späterer Aberglaube bei den Finnischen Lappen. (Heathen Religion and Late Superstitions of the Finnish Lapps) Mémoires de la Société Finno-Ougrienne LXXXVII. Helsinki. 1946. p. 149.

[The author is a well known and reliable Finnish scholar. - RGW]

... When speaking of sorcerers, reference must be made to the custom of Siberian shamans of eating fly-agarics to get into an ecstatic stupor; the Ob-Ugrian sorcerers, for instance, consumed each time three or seven mushrooms. It is interesting to note that according to a tradition among the reindeer Lapps of Inari, Lapp sorcerers used to eat fly-agarics with seven dots.

[24] Lehtisalo

> LEHTISALO, T. Entwurf einer Mythologie der Jurak-Samojeden. (Outline of Yurak Samoyed Mythology) Mémoires de la Société Finno-ougrienne. Vol. LIII. Helsinki. 1924.

The forest Yurak magicians also knew the custom of eating fly-agarics. These were eaten when they were dry and fully grown; the small capless mushrooms were too potent, and it is said that a female magician died from eating them. Only someone who is familiar with the origin of the fly-agaric can eat it 'with fortunate results,' but if in his intoxication he does not see the mushroom spirits properly, they may kill him, or he may go astray in the dark. The number of mushrooms eaten is usually two and a half, *i.e.*, only half of the last mushroom is eaten. The magician sees man-like creatures appearing before him, as in a dream; they number as many as the mushrooms he has eaten, and the half-mushroom is represented by a half-man. They run away quickly, along the path which the sun, after it has set in the evening, travels in order that it may rise again in the morning, and the magician follows them. He is able to stay close on their heels only because the half-spirit runs slowly and keeps looking back as if it were waiting for its other half. It is dark there, and the magician cannot see anything. Along the way the spirits of the fly-agaric tell him what he wants to know, *e.g.*, the possibilities for curing a sick person. When they come out into the light again, on the spot where God created the fly-agarics, there is a pole with seven holes and cords. After the magician ties up the spirits, the intoxication leaves him and he awakens. Now he sits down, takes in his hand the symbol of the Pillar of the World, the four-sided staff with seven slanting crosses cut into each side at its upper end, and he sings of what he has seen and heard.

[25] Dunin-Gorkavich

> DUNIN-GORKAVICH, A. A. Tobol'skij Sever. (The Northern Region along the Tobol) St. Petersburg. 1904. p. 95.

[The author is discussing the Ob-Ugrians. - RGW]

The shaman first eats some *panga* (dried mukhomor [fly-agaric]) and becomes drunk on it. After this he works his magic, that is to say, he utters peculiar cries and plays on the tambourine.

[26] Karjalainen

KARJALAINEN, K. F. Die Religion der Jugra-Völker. (Religion of Ugrian Folk) Helsinki. 1927. pp. 278-280.

The use of the fly-agaric, *paŋχ*, as an intoxicant is a wide-spread custom among the Ugrians and is most firmly established in the southern regions. The custom was mentioned even in the Berezov area, but with the additional comment that it was rare; in the Obdorsk area, on the other hand, it is unknown. The significance of the *paŋχ* is also confirmed to a certain extent by the fact that in the songs of the North Voguls the spirits are described as consuming it as a delicacy. When the Man who Observes the World is called, he may be in a state of 'intoxication caused by the one-footed notched-edged sevenfold *paŋχ*.' However, this is not said to his shame; on the contrary, it is supposed to indicate his power and wealth. This intoxicant has been used by magicians[329] for their own special purposes; they use it along the Tremyugan, and even more along the Vasyugan; it is an ordinary stimulant along the Irtysh, and it is also used for the same purpose in some places in the Vogul region. The only edible part of the *paŋχ* is the upper part of the cap, stripped of the stalk and covering; it may be eaten raw, direct from the forest, but in most cases - and along the Tremyugan almost exclusively - it is eaten after it has been dried in the sun or in an oven; winter supplies, of course, are always dried. Even when it is eaten in the ordinary manner, various precautionary rules must be followed; these rules arose from the relatively high toxicity of the mushroom, but in later times they took on a religious character. If the magician eats of the mushroom, this always has a *cultic significance*, which is only natural, since by eating he creates helpers for himself, or, as the people of Tsingala put it, '*paŋχ* enters into him' through the eating. Along the Irtysh fly-agarics are usually eaten in the evening. The number of mushrooms or bites eaten is three or seven, and according to Patkanov, even fourteen, twenty-one, or more; these numbers should be taken *cum grano salis*, since the effect of such a large number of whole mushrooms can seldom be tolerated even by a person accustomed to eating them. Sometimes the mushrooms are spread with butter or fat before eating, but usually they are eaten simply with bread, and water is drunk to make them easier to swallow. According to the Vasyugan people, the power of the mushroom derives from the fact that it was created from the spittle of the God of Heaven, and the mushroom is so potent that the Devil was unconscious for seven days and nights after eating it. For this reason, men also must not eat much of it. If anyone consumes too much of it, his teeth become clamped together, foam comes out of his mouth, his eyes bulge, and he can be saved only by the forcible administration of milk or salt, for '*paŋχ* wants nothing to do with' these substances. The most potent is the 'king fly-agaric,' which is small in stature, with a high stalk and only one single white spot in the center of the cap; ordinary, smaller specimens grow in a circle all around it. These ideas of the Vasyugan people are legendary, but we see from their ceremonies that they maintain a careful reserve with regard to the *paŋχ*. When the Vasyugan magician eats the mushroom, he always leaves the second half of the last mushroom and hides it, for then the *paŋχ* cannot use its full power to harm him. Eating the mushroom results in intoxication, and in the case of the *paŋχ* this includes a compulsion to sing which only a few can resist. The effect lasts 'from morning to sundown,' according to one informant. The Tremyugan magician eats *paŋχ* at any time of the day and does not hide the other half; instead, he cuts out a piece of the middle of each mushroom, 'the crown of the *paŋχ*'s head,' and throws it into the fire or onto a clean spot in the yard. The man who is intoxicated from eating fly-agarics sees the *paŋχ* 'dancing' before his eyes, invisible to others; that is to say, they move in the direction of the sun and sing a song, which the intoxicated Ostyak repeats after them word for word, so that the *paŋχ* act as 'singing-leaders' for the prophesying magician. At the same time the *paŋχ* tell the magician what he wants to know.[330]

Drum, zither, and *paŋχ* are the 'great' material means by which the Ugrian magician attempts to communicate with the spirits and obtain the information he needs. There are also many other means, both material and mental, used for uncovering mysteries. One such means which is found everywhere and is certainly very ancient is the *dream-vision*, possibly the natural forerunner of artificially stimulated ecstasy; another is soothsaying based on dreams, and this is what soothsaying with the aid of the *paŋχ* essentially amounts to.

---

[329] Shamans. - RGW.

[330] Concerning a stimulant of his own, the Swedish officer in 1714 (?) reports: 'We gave them *šaar* (tobacco); they smoked it and inhaled the smoke and thereupon fell to the ground quite unconscious, as if they were dead; afterwards they said that Shaitan had tormented them.' However, to judge by the name used for tobacco, this description most probably refers to the Ostyak Samoyeds [= Selkup].

Pp. 306-8. The ceremonies of the Irtysh Ostyaks are very different from the foregoing in certain respects. When *t'ərtəŋ-χoi* is brought into the house where he is needed (so it was said along the Demyanka), he takes resinous tree bark and fills the hut with smoke, waving everywhere in the hut the cloth which has been hung up as a sacrifice to Säŋkə. At his direction home-made beer is brewed and in the evening the bath is heated for him. After the bath the magician eats three or seven fly-agaric caps on an empty stomach - for he has fasted all day long - swallowing them either fresh or, in most cases, after they have been dried in the sun or sometimes in an oven, and then he lies down. When he has slept for a while, he springs up and begins to shout and walk to and fro, his whole body trembling with excitement. As he shouts, he reports what the spirit has revealed to him through his emissaries,[331] which spirit should be offered a sacrifice, what is to be sacrificed, which man has spoiled the luck of the hunt, how the luck can be regained, and so on. After the 'emissaries' have told everything, they depart and the magician sinks into a deep sleep, from which he does not awaken until morning. In the morning the appropriate spirit is entertained with home-made beer, porridge, and bread at the rear window, *i.e.*, in the icon corner, and is given the promise that the desired sacrifice will be made as soon as the animal designated has been procured.

The procedure is essentially the same in Tsingala; *t'ərtəŋ-χajat* eats three dried *paŋχ* with bread, half a mushroom at a time, and then goes to sleep; after he awakens, he shouts out what has been revealed to him. Before this proceeding, 'three seven kopeks'[332] (= three copper two-kopek pieces) are placed on the table, 'in the way of the *paŋχ*,' as a sacrifice for Säŋkə, and while the magician begins to tell his story, both he and the money are smoked with *pikhta* [spruce bark]. This questioning does not take place until evening, when night is falling. In the same village Schultz personally witnessed a questioning of the following nature: The magician was an old woman who, before beginning her magic, placed candles in front of the icons and a loaf of bread on the table; she made seven indentations in the loaf, naming Astanai and other Ostyak epic folk heroes. An old man who served as the sacrificer or priest in the village smoked the old woman, the bread, and all those present, using spruce bark smoke. The old woman ate three dried fly-agarics, a bite at a time, taking a swallow of water after each bite. After three or four minutes she began to hiccup; the hiccuping was following by shouting, and this in turn by a kind of singing. This went on for about half an hour. The hiccuping and singing gradually died away, and the whole proceeding ended when the old woman drank water and bowed before the icons. The others followed her example. The subject of the old woman's song was not she herself but 'the spirit of the fly-agaric.'- In the Zavodniya yurt there exist today women who undertake such investigations; they too eat *paŋχ* and then tell their revelations in song after a short sleep, during which they visit Säŋkə.

Pp. 315-316. The procedure followed by the Vasyugan fly-agaric soothsayer is quite simple, simpler than it is, for example, in the Irtysh region. Such a man was asked to give information about the mental disturbance suffered by a woman. Towards evening, he ate two and a half *paŋχ* and slept for a little while; after awakening, he sat down in the corner of his birch-bark yurt and began to sing, keeping his eyes closed and shaking his body to and fro. The intoxication did not seem to be very strong, since after he stopped singing, he was able to speak clearly with the spectators and take snuff into his nose. He continued singing in this way until morning, narrating the events of his journey, telling how far the *paŋχ* had brought him, through many districts and different countries, how it had led him into a church, and so on. - In spite of all his efforts, however, this time he did not reach the goal of his journey, *viz.*, the place where the information was available. The reason for this unfortunate conclusion was that ill-behaved people had shown the hidden half-*paŋχ* to me, and this had angered those *paŋχ* that had been eaten.

As can be seen from the foregoing, the manipulations of the Ugrian shamans may be quite different in the various regions, and special features in customs and ideas are found particularly in the southern Ostyak regions. Customs that may doubtless be regarded as late additions from the Irtysh region are *bathing in the bath-room, the deposition of sacrifice gifts, smoke-curing, and the entertaining of the Säŋkə*, although the latter, *e.g.*, in Tsingala, is not asked directly for information at all. The entire questioning of the *paŋχ*, for example, is also something that came into use in later times; the Voguls and Ostyaks know this to some extent

---

331. 'Little spirits' appear in person, while 'great spirits' only send their messengers, about whom nothing more specific is known.
332. 'drei sieben Kopeken.' - RGW.

from the Surguts, it has spread to some extent along the Tremyugan, and it has become predominant among the Irtysh Ostyaks.

It is not impossible that this custom is a coalescence of the dream-vision and the earlier intoxication; this is suggested by the fact that after consuming the *paŋχ* the magician always sleeps for a while; to my mind, this is needed not for evoking and intensifying the effects of the fly-agaric, but for evoking dream-visions in order to give information and make prophecies. The representation of the magician's assistants that has become established along the Vasyugan, a representation which is late in its present form, was also apt to influence the prevailing ideas concerning the magician's method, contribute a new nuance to them, and give rise to additional features, even though a great deal that is native may essentially be found in the ceremonies, as a comparison with North Ostyak customs shows.

A method that was already used by magicians in early times but was not their only method was magic *in the dark*, which is still practiced today in many regions, both among the Voguls[333] and among the Ostyaks. I am inclined to believe that the Tsingala custom of questioning the *paŋχ* in the evening, when night is coming on, is also a remnant of this. In such cases, the magician is often tied up with ropes, a custom for which Novitskij and Müller cite examples from the West and which is still prevalent along the Vasyugan.

[27] Bergman

> BERGMAN, Sten. Vulkane, Bären und Nomaden. (Volcanoes, Bears, and Nomads) Stuttgart. 1926. pp. 159-160.

On the day after the celebration a Koryak visited the Lamut camp. He came with his dog and apparently had no other purpose than to sit and chat for a while. When the loud barking of the dogs announced his arrival, we went out of the yurt to welcome him. It was a Koryak named Akei, who owned a large herd of reindeer and a yurt in the vicinity. He was small and sinewy, his face was leather-colored, and his features were not unlike those of an American Indian. His movements were slow and awkward. He walked to the yurt with a gently rolling gait.

'Priyatel′, have you any fly-agarics for me?' was the first thing he asked after exchanging greetings. Priyatel′ is the form of address used by the Koryaks and Lamuts to everyone and means simply 'friend.' He apparently took me for a trader, for when these men travel to the mountains, they usually carry fly-agarics with them; the Koryaks and Lamuts[334] are passionately fond of using these as an intoxicant.

[28] Donner

> DONNER, Kai.
> 1. Ethnological Notes about the Yenisei-Ostyak (in the Turukhansk Region) [Yenisei-Ostyak = Ket] Mémoires de la Société Finno-ougrienne. Vol. LXVI. Helsinki. 1933. pp. 81-2.

Haŋgo is a mushroom, the flybane [= fly-agaric], eaten by the shamans. Seven such mushrooms are eaten, whereupon human beings become 'mad'. Those who are not, or are not going to be, shamans die from eating these mushrooms. The shamans, specially those of the Ostyak-Samoyed (= Selkup) in the Narym district, were known for consuming flybanes as a means of intoxication before starting the shamanizing. At present (1912-1914) it is not so much practised.

[In the preceding extract, note the telltale marks of a folk belief: those who are shamans or who are going to be shamans eat the mushrooms with impunity, but others die from them. Donner mentions the same belief as being present in the Selkup culture, a Samoyed group that are neighbors to the Ket. We quote the passage in the third of our extracts from Donner; *vide infra*. It seems to have lingered on among the Samoyed and Ket of the upper Yenisei. - RGW]

---

[333] Munkácsi mentions that in the case of sacrifices the magic is practiced during the day in front of the spirits' food-storehouse or at some other place that is sacred to a spirit, while in other cases it is usually practiced at night in a dark yurt, where the fire on the open fireplace is extinguished while the magic is going on.

[334] Bergman alone among our sources includes the Lamut among those who use the fly-agaric. The Lamut are closely related linguistically and culturally to the Tungus. - RGW.

> 2. Bei den Samojeden in Sibirien. (Among the Samoyed in Siberia) Stuttgart. (Our copy is dated 1926. First published in Swedish in 1918). p. 110.

The performance always takes place in the evening, when darkness is falling, and may last all night long. When the performance is about to start, the shaman calls his assistants, who bring out the drum and slowly warm it at the fire in order to stretch the skin as tight as possible. Along the Ket the shaman makes no preparations of any kind, but in other places he often eats several fly-agarics in order to go into a trance more easily. These mushrooms contain a very strong poison, and I can say from personal experience that it is highly intoxicating. The natives often use it to get drunk on when they have no alcohol.

> 3. La Sibérie: La Vie en Siberie: les Temps anciens. Translated from the Finnish by Léon Froman. Paris, Gallimard, Nouvelle Revue Française. 1946. p. 225.

Even one who otherwise would find it easy to enter into rapport with the world of spirits would not enter into ecstasy in a state of trance indispensable for this purpose without having acquired the habit. Nor must it be so easy to absorb a sufficient dose of fresh fly-agarics, or preferably dried specimens, to enter into the necessary state of drunkenness or stupor. Among the Samoyed-Ostyak of the Yenisei [Selkup], the mushrooms should number from two to seven, but one says that he who is not a shaman and who eats them falls sick and dies, which is probably true for the poison of the mushrooms is violent and one could not absorb a strong dose without being used to it. The absorption of fly-agarics - as of all direct stupefying agents - must have been especially current among the Samoyed of the region of Narym. Nevertheless there are many shamans who feel that they have no need of inebriating substances or other similar products to provoke a change of state permitting them to pass into the other world, where they will meet later with all the spirits that influence the condition and life of mankind.

[29] Worth and Jochelson: Koryak and Kamchadal Tales

> Koryak and Kamchadal Tales, taken down by Waldemar Jochelson in the original languages.

[Among Jochelson's mss. found after his death there were a number of tales in the Kamchadal language. Professor Dean S. Worth took them in hand and has published them in a beautiful edition in 1961, produced by Mouton in The Hague. Professor Worth has edited them in the Kamchadal language with literal interlinear translation in English, followed by a smooth translation. Jochelson also took down many Koryak tales. His mss. in the original language do not survive, but he turned many of them into English and published them in his work on the Koryak. The fly-agaric figures in eight of these tales, four of them among those in the Kamchadal language and four translated into English from the Koryak, and with the permission of Mouton & Co. we reproduce them here.

The only alteration that we have made in the text of these tales is a simplification of the spelling of native words, or in some cases the suppression of the native name where it is irrelevant to the theme of our book. - RGW]

KAMCHADAL TALES
A - Czelkutqu and the Amanita Girls

There lived Czelkutq. He wooed Kutq's daughter Sinanewt and worked for her. He brought in much wood. Czelkutq married Sinanewt. They began to live. They amused themselves well. Sinanewt gave birth; a son was born. Czelkutq set off into the woods, where he met the beautiful Amanita girls. Czelkutq stayed with the girls and forgot his wife. Sinanewt thought of her husband and waited for him. She thought: 'Where is he, long ago he was killed!'

With them there lived an old aunt of hers, Kutq's sister, who said: 'Well, Sinanewt, stop waiting for your husband; long ago he stayed with the Amanita; send your son to his father.'

The little boy set off to his father. He began to sing: 'My father is Czelkutq, my mother is Sinanewt, father has forgotten us.'

Czelkutq heard his son singing and said to the girls: 'Go and burn him with burning brands, and tell him that I am no father to him.'

The girls took the burning brands and burned the boy all over, they burned his little hands all over. 'It is hot! Mother, they burn me!' he cried, and back he went to his mother. She asked: 'Well, what did your father say?'

'He said: "I am no father to you;" he ordered the Amanita girls to burn me with hot brands; he burned my hands all over; it is hot and hurts me. I will not go to my father again, or they will burn me with hot firebrands.'

The next day his grandmother sent him to his father again, saying: 'Go once more, sing again, say "Father, tomorrow all of us will leave, you will stay in the forest here with the Amanita; afterwards you will surely starve"'.

The little boy set off to his father and began to sing: 'Father, tomorrow all of us will leave together. You will remain in the forest with the Amanita; afterwards you will surely starve.'

Czelkutq, hearing his son singing, became angry and said: 'Go, girls, and beat him thoroughly with a leather strap and burn him with fire; tell him to stop coming here.'

Thus the girls took firebrands and a leather strap and began to beat him and burn him; thus they drove him away. The boy cried, and started back to his mother. He was burned all over when he arrived, but his grandmother blew at him and made him well. The old woman said: 'Well, Sinanewt, let us get ready to go, we shall go into the woods.'

They began to get ready; they tied up all the animals and took them all, leaving nothing. They started into the woods. When they arrived, they picked out a high mountain, climbed up to the top, and poured water all over the mountain, making a sheet of ice.

Czelkutq began to go into the woods. He did not kill any animals at all; all the traces had gotten lost. He and the girls began to starve. What could they eat? Then Czelkutq remembered his wife and son and went home. He came to his house, but did not find his wife and son. He began to weep: 'Where did all my people get lost? I am starving, Sinanewt, I am hungry. Where did you and our son go away?'

He followed his wife by their traces, and reached that high mountain. 'How to get up? The ice is very slippery.' From below he called up: 'Sinanewt, pull me up!'

Sinanewt threw down a leather cord and called out: 'Well, Czelkutq, catch the cord!'

He caught the cord. She began to pull him up to the top of the mountain, but when he was ready to step onto the top, she cut the cord with a knife. Czelkutq flew downwards, he fell, he died, he revived, and again he called out: 'Sinanewt, pull me up, I am starving!'

'Why don't you live with the Amanita? Why don't you live with the Amanita? Why do you come to us? You tortured your son, and now you are being paid back; it's you yourself who began that sort of life.'

'Sinanewt, stop being angry, pull me up, I am hungry!'

She threw down the cord again, saying: 'Well, catch, I shall pull you up now.'

Czelkutq caught the cord and she pulled him up. When he got near the top, she again cut the cord with a knife; he flew down, he fell, he died, he lay there, he came to life again, and cried out: 'Sinanewt, stop being angry!'

'If I pull you up, will you go on living like that afterwards?'

'No, I won't, Sinanewt, I shall stop living like that.'

She threw down the cord, he was pulled up, dried out, and became happy; he ate, he became satiated. Again they began to live as before, amusing themselves. The Amanita dried up and died.

B - Ememqut and his Wife Yeltalnen

Kutq lived with his wife Miti. They had a girl-child, Yeltalnen. There was also an old woman, Kutq's mother, who lived with them. Many suitors came, but the old woman ate them all up, letting nobody pass by. The old woman was a cannibal. Ememqut heard of the very pretty girl Yeltalnen. He made ready to go there, and caught a wild reindeer. When he went, he took the reindeer with him. When he came near, he drove the reindeer on ahead of him. The old woman ate up the reindeer, but Ememqut passed by without her noticing him. He came to Kutq and asked: 'Kutq, where is your girl?'

Kutq said: 'We have no girl.'

Yeltalnen was in another house. Ememqut began to live with Kutq. He certainly wanted to get to Yeltalnen, but she did not accept him. Ememqut thought this over, turned himself into an old woman, and made a violent snowstorm. He came to Yeltalnen again and began to plead, 'Let me in, Yeltalnen, I am suffering from the cold.'

She let him in. Yeltalnen did not recognize Ememqut, but thought he was really an old woman and said: 'Old woman, sit down there by the door.'

Ememqut lulled Yeltalnen to sleep. She fell fast asleep and felt nothing. Ememqut did what was needed and then left. Thus Yeltalnen became pregnant. Yeltalnen realized she was pregnant and made baby clothes. Miti came in and said: 'Well, Yeltalnen, what are you doing? What are you thinking about?'

Yeltalnen answered: 'Yes, Mother, I am pregnant. I certainly slept with nobody. I only let a little old woman in here once during a violent snowstorm.'

Miti said: 'That must have been Ememqut.'

Yeltalnen gave birth to a very pretty child. She said to her mother and father: 'Well, tell my suitor that Yeltalnen says, "All right, I accept."'

Kutq and Miti answered: 'Marry Ememqut if you wish.'

Ememqut married her. He began to live well. Ememqut said: 'Well, let us start home.' They began to get ready. Ememqut went out into the yard and whistled; three pair of reindeer arrived, and they started home. Yeltalnen's friends told her: 'You are happy now, but later your snot will dangle on your whip.'

They came home. Many ravens had soiled Ememqut's house with excrement. Ememqut fixed up the house. He began to arrange a feast and invited everybody. The cossacks came. Cickimcican came, acting as if he had eaten Amanita. He said: 'Yeltalnen, urinate into a scoop of horn, and I shall drink your urine, since we used to sleep under the same covers.'

Yeltalnen said: 'Cickimcican, you are lying.'

Ememqut became angry with his wife and abandoned the feast; all the guests went back home without having feasted. Ememqut lay down all the time, he stopped getting up altogether; he was angry because of Cickimcican's remarks. He stopped looking at his wife and was angry all the time. Yeltalnen said: 'Ememqut, you are angry with me all the time; I shall go home to my father.'

Ememqut said: 'Well, go ahead.'

Yeltalnen began to cry and went out into the yard. She whistled, and two pair of reindeer arrived. She went back into the house and said: 'Well, good-by, Ememqut, I am going.'

Ememqut tried to grab his wife by the skirt, but he couldn't hold her. Then Yeltalnen drove off with the reindeer and disappeared. She began to weep; a snot was dangling on her whip. She said: 'My girl-friends were really telling the truth.'

She came to her father and mother, and began again to live in the other house.

It grew warm. In the yard the sun was warm. Sinanewt said: 'Ememqut, it is warm in the yard; I shall carry you out there.' Ememqut didn't want to go out, but Sinanewt carried him out anyway, together with his bedding. Ememqut's whole side had been fouled by lying down. He began to sit there in the yard, and said: 'Sinanewt, get my arrows. I shall count them and see whether any got lost.'

Sinanewt brought him the arrows and Ememqut began to count them. A piece of grass was dangling on the arrows; he could not untie it, so he cut it off with a knife and threw it behind him. Then somebody began to cry behind him, saying: 'I take pity on you, Ememqut; you have cut me loose with a knife.'

Ememqut looked back and saw a little old spider-woman. The spider-woman got up and went around Ememqut three times. Then he improved and got well. He remembered his wife, and started off to see her. He arrived there, but was not let in. He began to live there. He worked for Kutq three years, but his wife was not given back to him. Ememqut dug a passage under the earth to his wife. He went through the passage secretly and slept there with his wife. Three years went by, and Ememqut's wife was given back to him. They started home. They came home, and began to live well again. Again he arranged a feast, and invited all the people. Many guests came. The bad man Cickimcican came again. Ememqut grabbed him and threw him somewhere far away. He began to feed the guests. When they stopped eating, they began to wrestle. Nobody could compete with Ememqut; they all fell. They stopped wrestling and began to toss each other on a skin. Again nobody could compete with Ememqut; they all fell down. They stopped playing this game. They all began to urinate. Ememqut urinated very far: nobody could compete with him, and he beat them all. Ememqut began to live and to rejoice.

C - Kutq, Miti, and the Little Louse

Kutq lived with his wife Miti. Their children were Ememqut and Sinanewt. Ememqut used to go hunting in the woods. He started out to spend the autumn in the woods. At home, Kutq used to carry in wood. He grew tired, and once he said: 'Miti, you give birth to a small louse.'

'Eh, stop talking nonsense, Kutq!'

Kutq went to get wood, and Miti gave birth to a small louse. She looked and saw that it was very bright, like the sun. Then Miti began to sneeze. She swaddled the louse and hid it. Kutq came home and said: 'Ah, I am tired; take the load of wood, Miti.'

Miti said: 'Put it up yourself, Kutq: I already gave birth to a louse.'

'Yes, you gave birth; well, I shall have a look at the child.'

'It is very ugly.'

'Well, Miti, I shall see.'

Miti unwrapped the louse. Kutq looked, and fell on his back. He said: 'Hide the child, Miti, it is too bright.'

Then Miti hid the louse. Kutq said: 'I shall make another dwelling for the louse.'

'Well, make it.'

Kutq began to work and made the dwelling. The louse began to live there secretly.

Emenqut came home. Nobody told him anything, and he did not know about the louse. Miti used to bring food to the louse. Ememqut watched where his mother went with the food. Once Ememqut ate and then went out to the yard and hid among the piled-up logs. Miti took food to the louse and opened the door of the dwelling. A light shone out; then Miti covered up the entrance and went back into her house. Ememqut found the dwelling, opened the door, and saw his sister, who shone like the sun. Then Ememqut fell down and died. Kutq and Miti said: 'Where did Ememqut go off to?'

Miti got up early and looked for Ememqut. She found him, but he had already died. Miti began to weep, and Kutq also wept; they grieved for Ememqut. Kutq said: 'Miti, let us go and look for pleasure.'

They got ready to go. Ememqut was carried into the house and covered over. Outside they blocked up the whole door with wood. They set out. When they looked back at the house, they again began to weep. They met the people called Raven's Berries, who invited them to stay there to live with them. Kutq did not want to do this. They went on, and met the storks, who also asked them to live there with them. Kutq said: 'The heart does not want to live here.'

They went farther on, crossed mountain ridges, and met the Amanita. There they found pleasure. They stayed there: they were well met. Kutq began to live there with his family. They were rejoicing. However, when they remembered Ememqut, then they wept. The sun and the moon said: 'Where did Ememqut get lost? He is not to be seen. Maybe he has died somewhere.'

The sun said: 'Moon, let us go look for Ememqut.'

The moon said: 'Well, let us go.'

They began to get ready, and set out. They went around the whole universe, but Ememqut was nowhere to be found. The sun said: 'Well then, let us go to Kutq's house.'

They set off to Kutq's house, but when they got there they found the house all blocked up with wood. They threw down the wood and went into the house. They saw that Ememqut was dead. The sun said: 'Moon, let us revive Ememqut. You go around him beating the drum.'

The moon said: 'I am not strong: I appear, wax, and wane, without warming anybody,' and added: 'You warm everyone better, sun.'

The sun said: 'You try first.'

Then the moon began to go around Ememqut, beating his drum and kicking him, but he could not revive him. Again he went around him, beating the drum and kicking him, but again he did not revive him. A third time he went around him beating the drum and kicking him, but Ememqut only moved his little finger. The moon became tired. Then the sun began to go around Ememqut beating the drum and kicking him; Ememqut opened his eyes. The sun went around a second time, beating the drum and kicking him; Ememqut sat up. The sun went around a third time beating the drum and kicking Ememqut; Ememqut then got up and said: 'Yes, I have been asleep for a long time.'

The sun and the moon said: 'If we hadn't come you would have slept forever.'

The three of them began to make a summer-hut. They made it on three portable posts. All kinds of animals came and sat down: migratory geese, swans, cuckoos, and grebes, all came and sat down to sing songs. The only animals they did not seat were the bears. They set out to Kutq; they sat down to amuse themselves. The bears stretched up against the house; they too wanted to sit down. The cuckoo began to laugh at the bears. The sun said: 'Cuckoo, stop laughing, or we will throw you out.'

Wherever they passed by the people heard them and came out to see. Old men and women were carried out in their bedding; for the first time they heard of such pleasure. They came to Kutq. Kutq and Miti saw that everyone was having a good time, and began to weep, saying: 'If only Ememqut were alive he too would be sitting here enjoying himself!'

Kutq wept again; they all began to climb down from the summer-hut. There they saw Ememqut. Kutq and Miti began to be very happy. Then the sun married the louse and the moon married Sinanewt. Ememqut married the Amanita. All the people began to rejoice and started back to Kutq's house. They all became Amanita. They all began to live there and to rejoice.

D - The Codfish, the Rams, and the Amanita

Codfish lived with her son Ilaqamtalxan. The Amanita girls lived there too, and gathered berries. The rams courted the girls, but the girls did not wish to marry. Codfish slept all the time. When it rained the Amanita set out to gather berries. They got soaking wet. When they came back they went into the codfish's ear and built a fire to dry themselves. The codfish woke up and said: 'Ow, it's hot, there's a fire in my ear.'

His mother said: 'Come here; I shall see what's the matter.'

She looked, but nothing was burning. 'You are lying,' she said.

Again the codfish fell asleep. The girls went out and ran farther away. Codfish woke up and saw the girls, saying: 'So, it was you who built a fire in my ear.'

'Well, we were only drying ourselves out.'

Codfish said: 'Come here and eat.'

The girls said: 'We don't want to eat.'

The girls went home. Again the rams came, and then the girls married them. They invited the codfish to the wedding. It ate up everything and became satiated; then it went home and fell asleep. The rams began to live well and to rejoice.

KORYAK TALES

A - Little-bird-man and Raven-man

Raven-Man said once to Little-Bird-Man, 'Let us go to Creator's to serve for his daughters.' Little-Bird-Man consented, and they started off to go to Creator. 'What have you come for?' he asked them. 'We have come to serve here,' they answered. 'Well, serve,' he said. Then he said to Miti, 'Let Little-Bird-Man serve at our house, and Raven-Man at sister's.' - 'No,' replied Miti, 'let Raven-Man serve here, and Little-Bird-Man there.' Raven-Man and, Little-Bird-Man began to serve. A violent snowstorm broke out, which lasted several days. Finally Creator said to the suitors, 'Look here, you, who always keep outside, stop the storm.' Raven-Man said, 'Help me get ready for the journey.' They cooked all sorts of food for him. He took his bag, went outside, stole into the dogkennel, and ate all his travelling-provisions. When he had finished eating, he returned to the house, and said, 'I have been unable to stop the snowstorm.' Creator said to Little-Bird-Man, 'Now it is your turn to go and try to put a stop to the storm. The women shall cook supplies for your journey too.' Little-Bird-Man replied, 'I don't need anything. I will go just as I am.' He flew away to his sisters. They asked him, 'What did you come for?' He answered, 'I am serving at Creator's for his niece, and he has sent me to stop the snowstorm.' Then his older sister knocked him over the head and stunned him. Little-Bird-Man broke in two, and the real Little-Bird-Man came out from within. His sisters brought him a kettle of lard and some shovels, and went with him to the land of the sunrise. There they covered up all the openings with snow, caulked the cracks with fat, and it stopped blowing. It cleared up. Little-Bird-Man went home with his sisters, caught some reindeer, and drove to Creator's. On his way he ate some fly-agaric which his sisters had gathered, and became intoxicated. He arrived at Creator's, and noticed that his entire house was covered with snow. He shovelled off the snow, and shouted to his bride, 'Kĭlu′, come out! untie my fur cap.' The people came out of the house to meet him, and saw that it had cleared up.

Soon after that, Raven-Man and Little-Bird-Man married, and on that occasion ate some fly-agaric. Raven-Man said, 'Give me more. I am strong, I can eat more.' He ate much agaric, became intoxicated, and fell down on the ground. At the same time, Creator said, 'Let us leave our underground house, and move away from here. The reindeer have eaten all the moss around here.'

They called Raven-Man, but were unable to wake him. They struck his head against a stone, and it split, so that his brain fell out. Creator left him in that condition, saying to a post in the house, 'When he recovers his senses, and calls his wife, you answer in her place.' Thereupon Creator wandered off.

When Raven-Man came to, he cried, 'Yiñe'a-ñe'ut!' The Post replied, 'Here I am.' - 'Have I become intoxicated with fly-agaric?' - 'Yes, with fly-agaric,' the Post replied. Then he noticed his brain, and asked, 'Have you made a pudding for me?' - 'Yes, I have,' the Post replied again. Raven-Man took his brain and ate it. Then he came to his senses. He felt of his head, and discovered that his skull was split, and that there was no brain in it. 'Whither shall I fly now?' he thought. He flew up to a mound and sat down. 'My sister Mound,' he said, 'I have come to you. Give me something to eat.' She replied, 'I have nothing. All the birds sit here upon me, and they have eaten all the berries.' - 'You are always stingy!' said Raven-Man. 'I will fly to a place from which the snow has thawed off.' He arrived at another place, and said, 'Sister, give me some berries to eat.' - 'I have nothing,' that place replied. 'Every bird sits here, and they have eaten everything.' - 'You, too, are stingy,' said Raven-Man. 'I will go to the beach.' He flew down there, and said, 'Sister, give me something to eat.' - 'Eat as much as you please,' said the Beach. 'I have plenty of seaweed.'

And Raven-Man remained on the seashore. That's all.

Told by Kučã̆'ñin, a Reindeer Koryak woman,
in camp on Chaibuga River, April, 1901.

B - Ememqut and Sun-man's Daughter

It was at the time when Creator lived. There was no village and no camp near him. One evening his son Ememqut was returning home. It was getting dark. Suddenly he noticed sparks coming out of a marmot's hole. He went into the hole, and saw Marmot-Woman sitting there. He married her, and took her home. On the following day he again went hunting, met Sphagnum-Woman, took her for his wife, and also conducted her home.

Ememqut's cousin Illa′ envied his success in having found pretty wives for himself, and conceived a plan to kill him in order to take away his wives. Illa′ said to his sister Kĭlu′, 'Go and call Ememqut. Tell him that I have found a tall larch-tree with gum. Let him go with me to take out the gum; and while there, I will throw the tree upon him and kill him.' She went and called Ememqut, and he and Illa′ started off to the woods. They began to pick out the gum. Suddenly Illa′ threw the tree down upon Ememqut and killed him.

Illa′ ran home, singing and repeating to himself, 'Now Marmot-Woman is mine, and Sphagnum-Woman is also mine.' He came running home, and said to Kĭlu′, 'Go into Creator's house and tell Ememqut's wives, your future sisters-in-law, to come to me.'

Kĭlu′ came into Creator's underground house, and saw Ememqut lying in bed with his wives, and all of them chewing larch-gum. She returned to her brother, and said, 'Ememqut is at home alive, and lying with his wives.' - 'Well; said Illa′, 'now I will kill him in another way.'

On the next day Illa′ sent his sister to Ememqut to tell him that he had found a bear's den. Illa′ added. 'He shall go with me to kill the bear.' Kĭlu′ delivered the message to Ememqut. Ememqut came, and went to the woods with Illa′. As soon as they reached the den, the bear jumped out, rushed upon Ememqut, and tore him into small pieces.

Illa′ ran home again, singing and repeating, 'Now Marmot-Woman is mine, and Sphagnum-Woman is also mine.' He came running home, and said to his sister. 'Go and call your sisters-in-law.' She went into Creator's house, and saw Ememqut sitting at the hearth, and his wives cooking bear-meat. Kĭlu′ came home, and said to her brother, 'Why, Ememqut is alive at home, and his wives are cooking bear-meat.'

'Well,' said Illa′, 'now I will put an end to him.' He dug a hole in his underground house, and made an opening which led to the lower world, and put a reindeer-skin on top of the hole. 'Go and call Ememqut to play cards with me.' Thus said Illa′ to his sister. Ememqut replied, 'I am coming.' When Kĭlu′ was gone, Ememqut said to his wives, 'He is likely to kill me this time, for he has made a hole for me which leads to the lower world. I shall go now. If I do not come back for a long time, go out and look at my lance which is standing there. If it should be shedding tears, then I am no longer among the living. Then tie some whalebone around your bodies, which will wound him when he lies down to sleep with you.'

Ememqut went away. When he entered Illa′'s house, Kĭlu′ said to him, 'There is a skin spread for you: sit down on it.' As soon as Ememqut stepped on the skin, he fell down into the lower world.

Soon his wives went out, and, seeing that tears were running from his lance, they said, 'Our husband is dead now.' Then they tied some whalebone around their bodies. After a while, Kĭlu′ came and said to them, 'Come, Illa′ is calling you.' They went. Illa′ said to his sister, 'Make a bed for us: we will lie down to sleep.' Kĭlu′ made the bed, and Illa′ lay down with Ememqut's wives. They tried to lie close to Illa′, and pricked and wounded him all over. After a while, when they went outside, both stepped accidentally upon the skin, and fell down into the lower world.

Having fallen into the lower world, Ememqut found himself in a vast open country. He walked about, and came upon a dilapidated empty underground house. This was the abode of Sun-Man's daughter. Her name was Mould-Woman. Sun-Man covered her with a coating of mould, and let her down into the lower world, that the people on earth might not be tempted by her dazzling beauty. Ememqut stopped near the house, and began to cry. Suddenly he heard Mould-Woman's voice behind him, saying, 'You are such a nice-looking young man, why do you cry?' Ememqut answered, 'I thought that I was all alone here. Now, since I have seen you, I feel better. Let us live together. I will take you for my wife.' Ememqut married her, and they settled down to live together.

When Ememqut's wives fell down into the lower world, they also found themselves in a vast open country. They wandered about, and soon fell in with Mould-Woman. They said to her, 'We are Ememqut's wives.' She replied, 'So am I.' - 'Well, then don't tell your husband that we are here. You are bad-looking; and when he finds out that we are here, he will desert you and come to look for us.' Mould-Woman returned home. After she had met the two women, she used to go out to visit them; and Ememqut noticed her frequent absence. He asked her, 'Is there some one near our house?' - 'No, there is no one there,' she replied.

Once when she went out, Ememqut followed her stealthily. She sang as she went, 'My husband is a valiant man: he kills all the whales; he kills all the reindeer!' and Ememqut walked behind her, and laughed. She heard his laughter, turned around, but there was no one to be seen, for Ememqut had suddenly turned into a reindeer-hair. Then she said to her buttocks, 'Buttocks, why do you laugh?' She went on singing. Ememqut again laughed behind her. She looked back again, but Ememqut had turned into a little bush.

Thus she reached the place where Ememqut's former wives were. Ememqut suddenly jumped out in front of her. She was so much frightened that she fell down dead. Then the coating that covered her cracked, broke in two, and the real handsome and brilliant daughter of Sun-Man appeared from it. Ememqut took all his three wives and settled down.

Once Ememqut said to his wives, 'The Fly-Agaric-Men (Wapa'qala'nu) are getting ready to wander off from here into our country: let us move with them.' His wives prepared for the journey, and made themselves pretty round hats with broad brims and red and white spots on them, in order to make themselves look like agaric fungi. Then they started, and the Fly-Agaric people led them out into their country, not far from Creator's underground house.

Illa′ and Kĭlu′ went to gather agaric fungi. Suddenly Ememqut and his wives jumped out from among the fungi. Then they took Illa′ and Kĭlu′ home. Ememqut put them upon the Apa'pel,[335] on which they stuck fast. Ememqut said to his wives, 'Boil some meat in the large kettle, and scald Illa′ and Kĭlu′ with the hot soup. In the morning pour out over their heads the contents of the chamber-vessels. Put hot stone-pine-wood ashes from the hearth also on their heads.'

They did as they had been told. Finally Ememqut's aunt Hanna said to him, 'You have punished them enough; now let them off.' Ememqut let them off, and they lived in peace again.

---

[335] Apa'pel (from A'pa, 'grandfather' or 'father' [Kamenskoye]) is the name given to sacred rocks or hills.

Ememqut took his wife to Sun-Man's house, then he came back with Sun-Man's son, who married Yiñe'a-ñe'ut. Thus they lived. That's all.

Told by Kučã'ñin, a Reindeer Koryak woman,
in camp on Chaibuga River, April, 1901.

C - Ememqut and White-Whale-Woman

It was at the time when Big-Raven lived. A small spider was his sister, and her name was Amıʹḷḷu. Pičvuʹčin wished to marry her. At that time Big-Raven became very ill, and was unable to leave his bed. 'Pičvuʹčin,' he said, 'you are my brother-in-law-to-be. Do something for me, go in search of my illness.' Pičvuʹčin beat his drum, found the illness, and said to Big-Raven, 'Take your team tomorrow and go to the seashore.' In the morning Big-Raven started with his team of dogs. After a while he was able to sit erect upon the sledge; then he tried to stand up; and soon he was able to run along, and direct his dogs. At the mouth of the river he saw a water-hole, and in that hole he found a White-Whale woman, Miti by name, whom he took for his wife. He carried her home. In due time she gave birth to Ememqut, who soon grew to be a man, and also took a White-Whale woman for his wife. Then Ememqut went for a walk, and found there Withered-Grass-Woman whom he also took for his wife. After that he brought home Fire-Woman, and then Kınčesaʹtı-ñaʹwut.

These four women lived together without quarrelling, until finally Ememqut found Dawn-Woman. She began to quarrel with all the others. The White-Whale woman said, 'I am his first wife. I am the oldest woman. I will go away.' Big-Raven's people sat up for several nights watching, to prevent her leaving the house. At last Big-Raven's lids dropped, and he said, 'I want to sleep.'

Then she ran away. She reached a lake, and there her heart was swallowed by a seal. She transformed herself into a man, and married a woman of the Fly-Agaric people. Ememqut went in search of her. While on his way, he found a brook from which he wanted to take a drink of water. He smelled smoke coming up from beneath. He looked down, and saw a house on the bottom. His aunt Amıʹḷḷu, and her servant Kıhıʹḷḷu, were sitting side by side in the house. While he was drinking from the brook, his tears fell into the water, and dropped right through into his aunt's house, moistening the people below.

'Oh!' they said, 'it is raining.' They looked upward, and saw the man drinking. 'Oh!' they said, 'there is a guest.' Then Kıhıʹḷḷu said, 'Shut your eyes, and come down.' He closed his eyes, and immediately found a ladder by which he could descend. 'Give him food,' said Amıʹḷḷu. The servant picked up a tiny minnow from the floor, in the corner, all split and dried. She brought also the shell of a nut of the stone pine and a minnow's bladder not larger than a finger-nail. Out of the latter she poured some oil into the nutshell, and put it before Ememqut with the dried fish. 'Shut your eyes, and fall to.' He thought, 'This is not enough for a meal;' but he obeyed, and with the first movement dipped his hand into the fish-oil, arm and all, up to the elbow. He opened his eyes, and a big dried king-salmon lay before him, by the side of the oil-bowl. He ate of the fish, seasoning it with oil. Then his aunt said 'Thy wife is on the lake, and her heart has been swallowed by a seal. She has turned into a man and wants to marry a woman of the Fly-Agaric people.' He went to the lake and killed the seal. Then he took out his wife's heart, and entered the house of the Fly-Agaric people. An old woman lived in the house. He put the heart on the table, and hid himself in the house. His wife, who had assumed the form of a man, lived in that house; and in a short time she came in from the woods, and said, 'I am hungry.' - 'There is a seal's heart on the table,' said the old woman. 'Have it for your meal.' She ate the heart, and immediately she remembered her husband. He came out of his hiding-place. They went home, and lived there. That's all.

Told in the village of Pallaʹn.

D - Raven and Wolf

Raven said to his wife, 'I want to go coasting. Give me a sled!' She gave him a salveline. He refused to take it, and said, 'It is too soft: it will break into pieces.' Then she gave him a seal. He rejected it also, saying, 'It is too round: it will roll away.' Then she gave him an old dog-skin. On this he coasted down hill. A Wolf passed by, and said, 'Let me, too, coast down hill.' - 'How can you? You have no sled: you will fall into the water.' - 'Oh. no! My legs are long: I will brace them against the stones.' Wolf coasted down the hill, fell into the water, and cried. 'Help me out of this! I will give you a herd of water-bugs!' - 'I do not want it!' - 'Help me out, and I will give you a herd of mice!' - 'I do not want it!' - 'Help me out, and I will give you my sister, the one with resplendent (metal) ear-rings!' Then Raven helped him out. Wolf said, 'Fare thee well! I am an inlander. I will go inland, far into the country. Where are you going?' - 'I belong to the coast. I will stay here, close to the seashore.' Wolf went his way. Raven transformed himself into a reindeer-carcass, and lay down across Wolf's path. Wolf ate of it. Then Raven revived within his belly, and cried. 'Qu!' Wolf started to run. Raven tore out his heart, and dashed it against the ground. Wolf died. Raven dragged the body to his house, and said to Miti, 'I have killed a wolf! Dance before the carcass!' Miti began to dance, and to sing, 'Haˊke, haˊke, ka haˊke! Huk, huk! My husband killed one with a long tail!' Wolf's brothers followed the trail; but Raven dropped on the trail a couple of whalebone mushrooms.[336] They swallowed them, and were killed. Raven's people dragged them into the sleeping-room of Raven's daughters. Yiñˊîa-ñeˊwhut and Čannaˊy-ñaˊwut, pretending that these were the girls' bridegrooms. The oldest of Wolfs brothers, whose name was Long-Distance-between-Ears (literally 'large-[between-the]-ears-interval'), followed Raven's trail. Again Raven dropped a couple of whalebone mushrooms. Wolf, however, did not swallow them, but took them to Raven's house. 'What are these?' he asked Raven. 'These are my children's toys.' - 'And where are my brothers? Their trail seems to lead here.' - 'No, they did not come here.' Wolf and his hosts went to sleep. In the night-time Wolf stole into the girls' sleeping-room, wakened his dead brothers, and they led the girls away.

Told in the village of Opuˊka.

[30] Shamanic Hymn translated from the Vogul

> VOGUL Hymns and Heroic Songs. Antal Reguly and Bernát Munkácsi. Vogul Népköltési Gyűjtemény. (An Anthology of Vogul Folklore) Vol. 1. Regék és Énekek a Vilag Teremtéséről. (Sagas and Songs about the Creation of the World) Published in fascicles from 1892 to 1902. Vol. II. Istenek Hősi Énekei, Regéi és Idéző Igéi. (Heroic Songs, Sagas, and In vocative Spells of Gods) 1892. Budapest.

[There survives a substantial corpus of texts in Vogul and Ostyak taken down by Antal Reguly and Bernát Munkácsi from native singers. Reguly, a man of remarkable character, was working among the Vogul in 1843-1846, and he died prematurely in that decade without having published the Vogul texts that he had recorded. In 1888-1889 Munkácsi, with Reguly's notes, visited the Vogul country and, seeking out the same singers or their successors, had them repeat the same songs. With the lapse of time there were naturally variations. In the two volumes before us Munkácsi published Reguly's texts, his own texts, and translations of his own texts into Magyar. He also brought out volumes of textual exegesis. Hungarian scholars merit our gratitude for having preserved these texts for posterity and annotated them, publishing a large part of them.

In these native texts there is a category that scholars call in German *Fliegenpilzlieder*, 'fly-agaric-songs', songs composed under the influence of the fly-agaric. I have unfortunately not had an opportunity to explore these songs, which lie hidden behind linguistic barriers for the English-speaking world. Apart from their general interest for the world of scholarship, they may well contain important treasures for the ethno-mycologist; and if the thesis of this book turns out to be right, it will become imperative that the West gain access to this store-house of fly-agaric poems. After all, of the Siberian peoples who knew the fly-agaric, the cult among the Vogul in recent centuries was the strongest: it pervaded their religious life, their vocabulary, their songs. The sanctions for the abuse of the fly-agaric still held the people in thrall into this century: anyone not a shaman who ate the fly-agaric did so at peril of death.

In May 1967 I spent three days in Budapest with Dr. János Gulya, of the Linguistic Institute of the Hungarian Academy of Sciences, the outstanding Vogul scholar. With the help of Tamás Radványi, university instructor in English, we concentrated our attention on passages from one of the three Heroic Songs that Munkácsi had discussed in his paper on mushroom inebriation. (*Vide* **[**32**]**) This song is of particular interest for the light it sheds on the question of the bellicosity of the man under fly-agaric inebriation. Our Hero, the Two-Belted One, has eaten three sun-dried fly-agarics. News comes that the Mocking-bird Army from the north is invading the country and our Hero is desperately needed to lead the fight against the invaders. But he is in a fly-agaric stupor and sends the messengers to his younger brothers. Later they return and implore him *to throw off his stupor* and come and fight. This he does: he sallies forth and slays the enemy right and left. The Song exists in two recensions, Reguly's and Munkácsi's: the meaning of both is the same. Here is the English translation in prose of Munkácsi's recension of the Song (Vol. I, pp. 113, 115, 117) as we worked it out in Budapest. - RGW]

---

[336] A well-known contrivance, made of a slender spit of whalebone bent around, tied with sinew, and then covered with hard, frozen tallow. When swallowed by a wolf, the tallow melts, the sinew string gets loosened, and the sharp ends of the spit break through the walls of the stomach.

> The men keep going on. Whether for a long time or a short time, they keep going on. To their fortress Jäkh-tumen they returned, they got home. Their mother, a woman of the Kami [river], sets up a kettle [for brewing beer] so big that it could not be used up by the whole town. For three nights and three days people keep drinking. The ecstasy of the ecstatic would not come to the eldest man, the inebriation of the inebriated one would not come. The Sovereign of the Lake to his daughter, to his wife, goes home, comes up to them, says, 'The inebriation of the inebriated man has not come to me; listen, woman, go out, fetch me in my three sun-dried fly-agarics!' She answers, 'Perhaps in your folly you wish to drink the blood of your paternal line, perhaps in your folly you wish to drink the blood of your maternal line!' He says, 'Why have you vexed me, the Two-Belted One, so long as I was calm? Do I ask you whether I wish to drink the blood of my paternal line? I do not ask you. Woman, now fetch me in my three sun-dried fly-agarics!' She throws them before him. He, putting them into his mouth with the ten bear-teeth, chews them, and the ecstasy of the ecstatic man comes upon him.

★

> The big larch-wood door is kicked open. 'Oh, Uncle, don't carouse with the drunkenness of the drunken man! From northern regions the mocking-bird army with the red rump has flown here and they have all occupied your seven silver-headed posts that you yourself set up in the age of your increasing manhood [childhood]'. 'I have not strength enough, because of my inebriation [heat] of the inebriated [heated] man. Carry the news to the two younger sons of my father!'.

★

> The big larch door is again opened, 'Oh, Uncle, don't carouse with the drunkenness of the drunken man! From northern regions the mocking-bird army with red rump has flown here and they have all occupied, surrounded, your seven silver-headed posts! 'The man says, 'Bring me my armour...'

[The Hero then goes forth and wreaks havoc on the enemy.... The reader will have noticed that the Hero has asked for his three *sun-dried* fly-agarics. When he is urged to leave off his 'carousing with the drunkeness of the drunken man', in the Vogul original the three operative words are all derivatives from *paŋχ*, 'fly-agaric'. Dr. Gulya informs me that the Vogul no longer think of the fly-agaric when they use these words: the root gives them their everyday word for inebriation and its source is not present in their minds. One can become 'bemushroomed' on alcohol. - RGW]

B. The Linguistic Aspect

Preliminary Note

In this section we do not translate our authors. We paraphrase them, eliminating passages where they quote their predecessors, simplifying (sometimes radically) their phonetic representation of the original words, and standardising their various systems. We have reduced the number of dialectal differences or eliminated them. So far as we know, we have included every philologist who has dealt with the *poŋ* cluster. Linguists who interest themselves in the problems that the cluster raises will wish to consult the original sources.

The special characters that we use are:

ə : 'shwa', pronounced like the vowel in 'but'.
ɔ : an open *o*, pronounced like the vowel in 'awl'.
ŋ : a nasal; thus we write 'siŋer' for 'singer' but 'fiŋger' = 'finger'.
ł : a 'dark' *l* as in American English, rather than the French *l*.
χ : the Greek chi is pronounced as the *ch* in Loch Lomond.
ñ : as in Spanish; *cf*. *ny* in 'canyon'.
ˀ : glottal stop; as the word 'bottle' is pronounced by Scots. - *botˀl*.
ä : the sound of the vowel in 'let'.

A vowel long in quantity is indicated by the colon that follows it.

One of our linguistic contributors, Artturi Kannisto, contributes important, even sensational, ethno-mycological data. His information is dependable, and he dug out the fact that the Voguls of the Sosva and the upper Lozva use mushrooms other than the fly-agaric for shamanistic ends. In the valley of the Pelymka it is not clear whether the sexual distinction between male and female corresponds to different species of mushrooms or to some conventional distinction in the specimens of *A. muscaria*. Kannisto gathered his information in the first decade of this century, though it saw the light of day only in 1958. Even now it may not be too late for Russian mycologists to learn the precise species that the Vogul shamans were utilizing in Kannisto's day. It is to be hoped that they will not let these clues go unexplored.

Independently of Kannisto, I have received confirmation from Ivan A. Lopatin, the authority on Siberian cultures, that mushroom species other than the fly-agaric are used for their psychic effects. His personal communications to me were dated January 28, 1963, and July 19, 1966.

In these pages 'the Chukotka' will occasionally be found as a convenient geographical term. It is used in the Soviet Union to embrace all lands of the Chukchi, Koryak, Kamchadal, and Yukagir, in the Far Northeast of Siberia.

[31] Boas

> BOAS, Franz. Handbook of American Indian Languages. Part 2. Washington, Government Printing Office. 1922.

On p. 693 Boas arrives at the stem *poŋ* as meaning 'mushroom' in the Chukchi, Koryak, and Kamchadal languages. There is a duplication of the syllable in those languages, *poŋpoŋ* and *poŋpo*, *etc*., and this is discussed on p. 688, where however the meaning of the word receives a specific sense: the fly-agaric. Boas gathered his data at the turn of the century.

[32] Munkácsi

> MUNKÁCSI, Bernát. 'Pilz' und 'Rausch'. ('Mushroom' and 'Intoxication') Keleti szemle. (Oriental Review) Vol. VIII. Budapest. 1907. pp. 343-344.

[This paper by Munkácsi was the first of a number that discuss the *paŋχ* cluster of words in some of the Altaic languages. We call attention to a sentence in it that we print in italic. This sentence seems to give justification for the Scandinavian belief that the fly-agaric can incite furious behaviour - berserk-raging - in the eater, and as we were dealing with a traditional Heroic Song issuing from the very entrails of the Vogul culture, rather than with the questionable observations of foreign travelers, it was vital to determine the facts. This led me to Budapest in the spring of 1967, where I worked out a translation from Vogul into English with the help of Dr. János Gulya, which we give in **[**30**]**. As the reader will perceive, the sense of the poem is utterly different from Munkácsi's one-sentence synopsis of it: in a stupor from three sun-dried agarics, our Hero is unable to respond to the call to arms. But time passes and the urgency grows, and when the messengers press their appeal to throw off his stupor he finally calls for his arms. The distinguished Magyar scholar had certainly never heard of the debate in Scandinavia and wrote out his summary without regard to it: even today it seems to be unknown to Altaic specialists in Hungary. The poem exists in two recensions, Reguly's and Munkácsi's, but the sense of both is identical. - RGW]

In Vogul the fly-agaric (*Amanita muscaria*) is called in the northwest dialect *pa:ŋχ*, and in the Middle Lozva West dialect *pə:ŋk*. This word is probably identical with the North Ostyak *poŋχ*, 'mushroom, fly-agaric', the Irtys Ostyak *pa:ŋχ, paŋχ*, 'fly-agaric'; the Yugan Ostyak *paŋga*, 'fly-agaric'; the Mordvinian *paŋga, paŋgo*, 'mushroom'; the Cheremis *poŋgo, poŋgə*, 'mushroom'. In North Vogul the word *paŋχ* also means 'intoxication', 'drunkenness'; whence *pa:ŋχeŋ χum*, 'drunken man'. In the Lozva *pa:ŋχli, pa:ŋχeta:li*, and in the Pelymka *pə:ŋkˀli* mean 'he is drunk, intoxicated (*jolpa:ŋχles*, 'he has gotten drunk'; *pa:ŋχlim χɔtpä*, Lozva, *pə:ŋkˀlemkˀɔr*, a drunken man).

The connection between these similarly pronounced words can be explained by the fact that among the Voguls and Ostyaks in earlier times the fly-agaric played the same role as brandy plays today. As Patkanov reports ('A type of Ostyak Epic Hero,' pp. 5, 39: Irtysh Ostyaks 1: 121), it is said that singer of heroic songs or a shaman would, in order to bring himself to a state of exaltation, consume 7, 14, or even 21 fly-agarics, which had been dried for this purpose and either soaked in water or spread with butter or fat before consumption. After consuming this narcotic, a person becomes almost crazy, undergoes severe hallucinations, and sings in a loud voice all night long until, completely exhausted, he finally falls helpless on the ground and lies unconscious for a long time. Gods also find pleasure in this narcotic. Thus a hymn addressed to the 'Man-Who-Observes-the-World' (*mir susne-χum*) contains the following lines:

> While you, in the corner of your seven-sided holy house that came from your father *Numi-Tɔrem* [Upper Heavens], your seven partitioned golden house, on your seven golden-footed tables, on your seven golden-lidded chests, run about in ecstasy caused by seven one-footed glasses, as you are running about in ecstasy caused by seven one-footed notch-edged fly-agarics (akw laˀylep lar'siŋ χu:rpä sa:t pa:ŋχ se:ŋwen χajtnen χalt), may your holy little ear, which is as big as a lake, as big as the Ob, nevertheless hearken here. May your golden eyes, which reflect the Ob, sparkle in this direction!
> (Vogul Népköltési Gyűjtemény, 11:314)

This thought is expressed in another hymn to the same deity as follows:

> While you run about in the ecstasy of your intoxication caused by seven fly-agarics with spotted heads (kumliŋ puŋkep sa:t pa:ŋχ kus'män, se:ŋχwen χajtne χalt), may your mind, demanding blood sacrifice, may your mind, demanding food sacrifice, like the swelling water of the Ob, like the swelling water of the Lake, direct itself here. (*Ibid*., 11:362)

In the song about the creation of the heavens and the earth, recorded by Reguly, we are told of the Kami woman's oldest son, who later turned into a bear, that when after a three-day beer feast he had not yet achieved the intoxication he had been longing for, *he asked his wife to bring him three fly-agarics that had been dried in the sun* (χɔ:tel tɔ:sem χu:rem pa:ŋχ), *and that after he consumed these, he few into such a rage* *that he mercilessly slaughtered a great crowd of people*. (*Ibid*., 1:114)

In the name *paŋχ* of this narcotic we recognize the Old Persian word *baŋha-*, whose meaning, according to Bartholomæ (Altiranisches Wörterbuch, 925), is the following: '1. Name of a plant (and its juice) which was also used for producing abortions; 2. Name of a narcotic made from that plant and also a designation of the state of narcosis produced thereby.' Other instances of this word are: Sanskrit: *bhaṅga-*, *bhaṅgā-*, meaning 'hemp; a narcotic prepared from hemp seeds'; modern Persian: *bang*, 'henbane' [*Hyoscyamus niger*] (*bangī*, 'senseless'); Armenian: *bang*, 'hyoscyamus'; Afghan: *bang*, 'hemp' (Horn, Modern Persian Etymology, 53; Uhlenbeck, Etymological Dictionary of the Old Indian language, 194). According to Wilhelm Geiger (East Iranian Culture in Ancient Times, p. 152), hemp is used in Persia for making 'the notorius hashish, the use of which deranges the human organism in the most frightful manner'. From all this we conclude that the Vogul word *paŋχ*, Ostyak *poŋχ*, 'mushroom, fly-agaric', as well as the Mordvinian word *paŋga*, and the Cheremis *poŋgo*, 'mushroom', according to their original etymon, have properly the meaning 'intoxicating', 'narcotic', and that the knowledge of this culture product among the Finnish peoples comes from the Aryans, just as this may be assumed to be true with regard to 'beer' (Vogul, Zyrian, Votyak *sur*, Vogul *sor*, Ostyak *sɔr*, Hungarian *ser*, *sör*, Sanskrit *súrā*, Avestan *hura*, 'a spirituous drink, chiefly brandy' or 'beer'.)

[33] Kannisto

> KANNISTO, Artturi. E. A. Virtanen and Matti Liimola, editors. 'Materialien zur Mythologie der Wogulen gesammelt von Artturi Kannisto.' (Materials on the Mythology of the Vogul Gathered by Artturi Kannisto) Mémoires de la Société Finno-ougrienne. Vol. 113, pp. 419-420.

In order to become intoxicated, the Vogul shaman employs or used to employ, above all things, the fly-agaric (*paŋχ*, *pə:ŋk*,[337] *etc*.); after having eaten them, he becomes intoxicated. He must be in this state when he begins to exercise his functions [as shaman]. From the area around the river Sosva we have the report that fly-agarics grow out of a single 'foot,' six or seven of them together; when they are dry, they are yellowish brown. Around the Upper Lozva, the term *pa:ŋχ* refers to a small mushroom (not the beautiful many-colored fly-agaric) that grows at the base of a tree stump and the like in clusters, as if out from a single root; the *ña:it-χum*, 'shamans', dry and eat them. In the area around the Lower Konda the *pa:ŋχ* are collected after St. Peter's Day and dried in the hut. The shaman *ñoait-χar* or *käiləŋ-χar* eats seven of them when he begins his séance. Before they are eaten they are soaked in water; if there is butter on hand, they are eaten with butter; otherwise without. Once the fly-agaric has begun to affect the shaman, one says: *pa:ŋχŋə joχtwəs*, 'the fly-agaric has come into him'. After the shaman has eaten the fly-agaric he walks around the room, sings, and continues the séance. Around the river Pelymka, the fly-agaric is called *saittoal pə:ŋχ*, the fly-agaric that causes loss of sense'. There are male and female fly-agarics (respectively *kum-pə:ŋk* and *ne:-pə:ŋk*); the former are eaten by male shamans and the latter by female shamans. One must eat either three or seven of them. Nowadays fly-agarics are no longer used around the Pelymka. When the shaman 'makes the room dark' and eats fly-agaric before his séance, he must don *wa:rim u:lamt*, 'sacrificial clothes' (Upper Lozva).

P. 286. Around the area of the Lower Konda he [*käiləŋ* 'the shaman'] says which sacrifice is to be made after he has eaten fly-agaric, and he sleeps after having eaten them.

Pp. 429-430. Around the area of the Lower Konda there are shamans who are married, unmarried, or who have been married in the past, as well as male and female shamans. The *käiləŋ* (shaman) also performs the following: he eats seven fly-agarics on the preceding evening, walks about the room, leaves the room a number of times, looks at the sky, yells something, enters, lies down, and remains in that position until morning. Then he tells what he knows and gives advice.

---

[337] *pa:ŋχ* and *pə:ŋk* are the same term in two dialects.

[28a] Donner

> DONNER, Kai. 'Ethnological Notes about the Yenisey-Ostyak (in the Turukhansk Region)' Mémoires de la Société Finno-ougrienne LXVI. Helsinki. 1933, pp. 81-82.

Donner here says that *haŋgo* means 'fly-agaric' in the dialect of Ket spoken in the Turukhansk region. We have already given the quotation under **[**28**]**.

[24a] Lehtisalo

> LEHTISALO, T.
> 1. Juhlakirja Yrjö Wichmannin kuusikymmenvuoti-späiväksi. (Publication in honor of Yrjö Wichmann's 60th birthday) Mémoires de la Société Finno-ougrienne. Vol. LVIII. Helsinki. 1928, p. 122.

On this page there is a note on a word reported by Castrén in the Tavgi tongue, one of the Samoyed languages, called in the Soviet Union today the language of the Nganasan people. That word is: *faŋkáˀam*, 'to be drunk'. He sees parallels with this word in various Finno-Ugrian languages:

Mordvinian:	paŋgo, 'mushroom, lichen'
Cheremis:	poŋgə, 'mushroom'
Vogul:	paŋχ, piŋka, 'fly-agaric'
Ostyak:	pa:ŋχ, pɔ:ŋk, paŋχtəm, puŋkłəm, depending on the dialect; the meaning is 'fly-agaric'

From the wide dissemination of this word the author concludes that intoxication from eating the fly-agaric goes back probably to pre-Uralic times.

The similarity of this word to the Latin *fungus*, Greek σπόγγος [*spóngos*] may be merely accidental. Munkácsi's assumption that the Finno-ugrians borrowed the word from Indo-Iranian is not likely, the author holds, giving as the example in Sanskrit *bhaṇga-s*, 'hemp and the narcotic substance made from it'.

> 2. 'Sampa, sammas'. Virittäjä. Helsinki. 1929. pp. 130-132. Translated from the Finnish.

Our language has many words phonetically reminiscent of the term *sampo* in the Kalevala. They may all belong to the same word family. Of these only one has been compared with an equivalent in the more distant related languages, *viz*., the word *sammakko*, *sammakka* ('frog', 'toad') [and other related words - RGW], which has been linked to Lapp *cuobo*, gen. *cubbu*, 'frog', 'toad'. (*Vide* E. N. Setälä, 'Zur Etymologie von *Sampo*, FUF II, pp. 146 ff.) In this paper I will present a form from Samoyed that corresponds to another word in this Finnish family. Since the word I am writing about must be kept distinct phonetically from *sammakko*, *etc*., we must reckon with two word families of the type *sampa*.

Let us look at the following Samoyedic forms. Yurak Samoyed: *sa:mpa:*, 'to carry the ghost-soul of the deceased to the hereafter to the accompaniment of the shaman's drum', ... [and other dialectal forms] meaning 'to sing an incantation to the accompaniment of the shaman's drum', 'he who sings an incantation to the accompaniment of the shaman's drum', 'shaman', *etc*. - On the Finno-Ugric side, we are immediately reminded of the Ostyak word (Konda dialect) *paŋχtəm*, 'to sing and shamanize after having eaten fly-agaric; to cure with incantations'. This word is of course related to Ostyak *paŋχ*, 'fly-agaric'. (*Vide* NSFOu Dol. 58, p. 122.) Bearing this in mind, the next step is to look for a word meaning 'fungus' or 'mushroom' that might be phonetically linked with the Samoyed words mentioned above. Thus we come upon the Finnish words *maansampa*, 'puffball', and *puunsampa*, 'a white pinhead-sized efflorescence on birches, alders, and willows', in which we propose that the element *sampa* originally meant 'fungus' or 'mushroom'. The Samoyed words go back to the initial palatalized sibilant ★*s*-, which distinguishes them, on the evidence of Lapp, from the word *sammakko*, which goes back to ★*č*-.

Closely related to the meaning 'fungus', 'mushroom', 'efflorescence', are the disease names *sampa*, *sammas*, *sampaat*, 'childhood disease affecting the mucus membrane of the mouth; swollen glands in the jaw' (Mikkeli area); 'glands in the jaw' (Häme, Savo); 'a disease of horses' (Viitasaari). From this we proceed further to the word *sammasvesi*, 'water from a certain spring used to cure *sammas*' (Sääksmäki); 'water from a hole in a rock used to wash out the mouth of a child suffering from *sammas*' (Luopioinen). According to Gottlund, the word *sammaslahde* is used to designate medicinal springs where a specified amount is paid when water is taken from them.

It might be mentioned also in passing that it would be tempting to link *tatti*, 'fungus', 'mushroom', with the following Samoyed word: Yurak Samoyed ... [The author supplies various words from Samoyed dialects meaning 'shaman'. But he concludes that this is rendered somewhat uncertain as *tatti* might be related to a different Yurak Samoyed word, though in turn there are counter-arguments that the author gives. - RGW]

We may furthermore bear in mind that I have linked the Tavgi Samoyed *faŋkáˀam*, 'to be inebriated', with the words in the Finno-Ugric family of languages meaning 'mushroom' and 'fly-agaric'; *cf.*, *e.g.*, Mordvin *paŋgo*, 'mushroom', Ostyak *pa:ŋχ*, 'fly-agaric' (*vide* NSFOu LVIII, p. 122). [The writer now quotes Donner and others whom we have translated. - RGW] We may regard it as certain that in the dim antiquity of the Proto-Uralic period the Finnic shaman ate intoxicating fly-agaric during his sorcery sessions. We now understand how it was that later, when the shaman had stopped eating the fly-agaric and was beating his drum, he relapsed in the course of his sorcery session into a state resembling madness and finally fell unconscious to the ground ('falling into a trance').

[34] Uotila

UOTILA, T. E. 'Etymologioita.' ('Etymologies') Virittäjä. Helsinki. 1930, pp. 176-7.

Some Asian and notably Finno-Ugric peoples use the fly-agaric for inebriating purposes. Here are the members of this word family:

Mordvinian (Mokša)	- paŋga, 'mushroom'	
(Erza)	- paŋgo, 'mushroom, lichen'	
Cheremis	- poŋgo, paŋgə, 'fungus'	
Ostyak (North)	- poŋχ, 'mushroom, fly-agaric'	
(Irtysh)	- paŋχ, 'fly-agaric'	
Other Dialects	- paŋχ, 'fly-agaric'	
	- pɔŋk, 'fly-agaric'	
	- paŋχtəm	'to shamanize while singing after having eaten the fly-agaric:
	- puŋkłəm	to cure by shamanizing'
Vogul (North)	- paŋχ, piŋka, 'fly-agaric'	
Tavgi	- faŋkáˀam, 'to be drunk'	
Selkup	- pöŋer, 'drum'	
	- pəŋgar, 'a special Selkup musical instrument'	

These words belong to the Uralic family ★*p8nk8* (the '8' - back vowel). To it belong the following Zyrian forms:

(Sysola dialect)	- pagalny, 'to lose one's consciousness'
	- pagavny, 'to poison oneself, to kill oneself'
(Luza)	- pagyr, 'bitter taste in beer', 'sour, sharp, penetrating'

After giving some more derivatives, the author says that they reflect the effect of the fly-agaric on those who have eaten it. From the Uralic root ★*p8nk8* Uotila derives the ★*pag* form meaning the fly-agaric; and *pagyr*, bitter, from 'having the taste of fly-agaric', and *pagal*, 'the power to inebriate'.

[35] Bouda

BOUDA, Karl. *Das Tschuktschische*. (The Chukchi) Published as Part 4 in Beiträge zur Kaukasischen und Sibirischen Sprachwissenschaft, by Deutsche Morgenländische Gesellschaft. Leipzig. 1941.

In this philological study Bouda on p. 35 under entry 20 discusses Chukchi *poŋpoŋ*, *pompoŋ*, meaning mushroom. By comparing it with Koryak *pˀoiunv*, mushroom, and *a-pˀonake*, 'without mushrooms', he arrives at the Chukchi root *poŋ*. He compares these words with

Cheremis:	*poŋgo*, 'mushroom'
Mordvinian:	*paŋgo*, 'mushroom'
Ostyak:	*poŋχ*, *paŋχ*, 'fly-agaric'
Vogul:	*pɔŋk*, *pa:ŋχ* 'fly-agaric'

In a footnote he calls attention to the use of the fly-agaric by the Ob-Ugrian shamans so that, having been entranced by its poison, they may communicate with gods and spirits.

[36] Steinitz

STEINITZ, Wolfgang. Geschichte des Finnisch-ugrischen Vokalisnuis. (History of Finno-Ugrian Vowel Structure) Stockholm. 1944. p. 37.

The author includes in his list of words the Vogul *paŋk*, fly-agaric, which in Mordvinian is *paŋgo*.[338] In the Ostyak of Surgut he supposes that there has been an alternation of the vowel from ★*a* to ★*u* to ★*i*, leading to these three forms: *pɔŋkełłem*, *puŋkłəm*; *pyŋkła*. Only ★*y* in Vogul, with *pə:ŋk*- in one dialect. Changing vowel in Cheremis: *poŋgə*. It is unclear whether Zyrian *pagal*-, *pagyr* comes from this source.

[37] Hajdú

HAJDÚ, P. Von der Klassifikation der samojedischen Schamanen. (On the classification of Samoyed Shamans) Glaubenswelt und Folklore der sibirischen Völker. (Religion and Folklore of the Siberian Peoples) Edited by V. Diószegi. Akadémiai Kiadó, Budapest. 1963. pp. 161-190.

P. 170. T. Lehtisalo is of the opinion that the family of the Nenets (Samoyed) word *sa:mpa:* may be related to the Finnish word *sampa*, fungus, sea-foam.[339] This Finnish word occurs in the names of diseases, as, for example, *sampa*, *sammas*, *sampaat*, a disease of the mucous membrane of the mouth in children; swelling of the submaxillary glands; a disease of horses. The word is also found in compounds such as *maansampa*, puffball; *puunsampa*, white mushroom the size of a pinhead on birches, willows, and alders. According to Lehtisalo, the meaning 'to work magic' originally referred to magic that was performed in the state of ecstasy brought on by fly-agarics. For a semantic confirmation of this, he cites the Khanti verb *paŋχtem*, to work magic while singing after consuming fly-agarics, to heal by magic (<: *paŋχ*, fly-agaric) On phonetic grounds, Lehtisalo distinguishes the Finnish *sampa*-Nenets *sa:mpa:* from the Finnish *sampo* and its derivatives. This is certainly an imaginative explanation, but there are many reasons which compel us to disagree with it. In the first place, this comparison seems doubtful to us because the agreement between the words is found only in the two most widely separated members of the Uralic language family. Another argument against it is that the meaning 'mushroom' has not been found in Samoyed and the meaning 'to work magic in the state of ecstasy brought on by fly-agaric' is unknown in these languages. One could suppose, of course, that the verb 'to work magic' was expressed by a derivative of a word meaning 'mushroom'; however, in Samoyed the form *sa:mpa:* is without a suffix, in so far as we can consider it to be the form corresponding to the Finnish *sampa*.

---

[338] The Mordvinian and Cheremis word means 'mushroom'.

[339] Lehtisalo, T. '*Sampa, sammas*'. *Virittäjä*, Vol. XXXIII, pp. 130-132. [Our ref. **[**24a**]** pp. 310-312 - RGW]

Because of these many problems, I have attempted to find a different explanation for the Samoyed *sa:mpa:*.

[The author then refers the reader to an article that he wrote, 'Etimológiai megjegyzések' ('Etymologische Bemerkungen') ['Etymological Notes'], in *Nyelvtudományi Közlemények*, Vol. LVI, pp. 53-56.]

[38] Balázs

> BALÁZS, J. 'Über die Ekstase des ungarischen Schamenen.' (On the Ecstasy of the Hungarian Shamans) Glaubenswelt und Folklore der Sibirischen Völker. (Religion and Folklore of the Siberian Peoples) Edited by V. Diószegi. pp. 57-83. Akadémiai Kiadó, Budapest. 1963.

[Sections 1 and 2 (pp. 57-59) discuss the Hungarian word *rejt*, 'hide,' the Old Hungarian word variously spelled *rüt*, *rőt*, *röjt*, *réüt*, *rit*, *riüt*, entrance, enrapture,' and the problems whether these two words are related in meaning and whether one or both may be traced back to the shamanism of the Ugric period. - RGW]

Pp. 59-67.
3. We may come closer to a solution of this problem it we investigate the methods by which the shamans worked themselves into a state of ecstasy; in this process we shall make use of the latest linguistic, ethnographic, and archæological results, as well as a critical analysis of earlier data. The semantic explanation of the Hungarian verb *rejt*, 'ecstasize,' is based, to this day, chiefly on Hunfalvy's arguments and on Munkácsi's commentaries on the Russian academician P. S. Pallas's description of his travels.

Concerning the ecstasy of the shamans among the Mansi and the 'northern' shamans in general, Munkácsi writes: 'The visible reality in the magical performances of the northern shaman is that he transports himself into a state of unconsciousness resembling a trance, *i.e.*, into a state of ecstasy. Even when he begins the magical performance, he is in a befogged condition owing to the fly-agaric or brandy he has previously taken. His drunkenness and his agitated nervous state are intensified by the foot-stamping, the loud, excited singing, the wild howling, and the noise of clashing kettles and pots, as well as by the illusion of being in communication, or even in combat, with the spirit.' Here we see that the shaman eats the poisonous fly-agaric or becomes drunk with brandy and in this way achieves a state of trance. In connection with the shamanism of the Ugric peoples, Karjalainen mentions that the shamans of the Irtysh-Khanty often used the fly-agaric as a narcotic. Many travelers describe how the Siberian shamans eat fly-agarics and thus fall into a state of ecstasy.

A systematic compilation of such data has been made by A. Ohlmarks. He states that the fly-agaric (*Amanita muscaria* L. Pers.) is the stupefacient most commonly used by shamans among the Koryak, Kamchadal, Nentsy (Yurak Samoyed), and Selkup (Ostyak Samoyed), and among the Khanty along the Yenisei and the Irtysh. Ohlmarks devotes a separate chapter to alcohol, which is used as a stupefacient by the shamans of many Siberian tribes. He states that the shamans of the Irtysh-Khanty, the Tungus, the Lapps, the Buryats, and other peoples often drink alcoholic beverages until they lose consciousness. Nevertheless alcohol cannot compare with the fly-agaric as an effective narcotic. The designations for the fly-agaric form a very widespread family of words in the Ob-Ugric languages and in a number of Finno-Ugric languages. The corresponding derivations are extraordinarily revealing from a semantic point of view because they indicate the method (quite likely a very old and very widespread method) by which the Finno-Ugrian shamans achieved a state of ecstasy.

Here is a list of the etymologically related words for the fly-agaric in the various Finno-Ugric languages:

Mansi: *paŋχ*, *piŋka*, 'fly-agaric'; Northern dialect: *pa:ŋχ*; Middle Lozva dialect: *peŋk*, 'fly-agaric, *agaricus muscarius*'; Khanti Northern dialect: *poŋχ*, 'mushroom, fly-agaric'; Irtysh dialect: *pa:ŋχ*, *paŋχ*, 'fly-agaric'; Yugan dialect: *paŋga*, *pa:ŋχ*, 'fly-agaric'; Irtysh dialect: *poŋk* (*puŋkəm*), 'the fly-agaric'; Lower-Demyanka dialect: *paŋχ*; Verkh, Kalymsk, Vartokovsk dialect: *paŋk*; Tremyugan dialect: *pəŋk*; Nizyam-Berezovo dialect: *poŋχ*, Kazum dialect: *ponk*, 'fly-agaric'; Mordvinian: *paŋga*, *paŋgo*, 'mushroom'; Cheremis: *paŋgə*, *poŋgo*, *poŋγə*, 'mushroom'.

The importance of the poisonous fly-agaric in the ecstasy of the Mansi shamans is proved by the fact that in the Northern Mansi dialect the word *pa:ŋχ* means 'drunkenness'.

The following words are derivatives by which the concepts of 'drunkenness, ecstasy' are expressed in Mansi: *pa:ŋχli*, *pa:ŋχeta:li*; Lozva Pelym dialect: *pəŋkli*, 'he is drunk, intoxicated.' Likewise, *paŋχtem* in the Northern Khanti dialect and *puŋkłəm* in the Irtysh dialect mean 'to work magic while singing after eating fly-agarics, to heal by enchantment'; in the Upper Demyanka dialect *panɣətta* means 'to shout and make noise after eating fly-agarics'; in the Tremyugan dialect *pɔŋkəłta:ɣə* means 'to become intoxicated with fly-agaric, to sing through the effects of fly-agaric.' The singing of the shaman who is transported into ecstasy by eating fly-agarics is expressed in Khanti by the following words: Tremyugan dialect: *pɔŋk a:rəχ*, *pɔŋkəłsauɣə*, 'fly-agaric song, a song which the shaman sings after eating fly-agarics', Vasyugan dialect: *panləmnəŋ*, 'song which is sung after eating fly-agarics.'

According to T.E. Uotila, the following also belong to this word family: in Komi (Wichm.), Sysola dialect: *pagal-*, to lose consciousness (*i.e.*, through drinking alcohol); (Wied.): *pagal-* (*pagav-*), to lose consciousness, to be overwhelmed (?) [or: to be deluded (?)]; (Sachow [or: Zakhov]): *pagav-*, to poison oneself, to kill oneself; Udorka-Vashka dialect: to be unsteady, to stagger, Sysola dialect. According to Uotila the primary noun root of these words is ★pag-, which we can relate to the above words denoting the fly-agaric. He believes that this word must also have existed in Komi and cites as evidence the following Komi adjectives: (Wichm.) Luza dialect: *pagyr*, sour, sharp (like the taste of beer); (Wied.): *pagyr*, sour, sharp, penetrating; (Wichm.): *pagyra*, penetrating (beer), *pagyra*, sharp-tasting. Uotila assumes that these adjectives are derived from the noun ★*pag*, 'fly-agaric,' by adding the suffix -r and that their original meaning is 'tasting like fly-agaric.' He believes that a special significance must have been attached to the fly-agaric in the Komi language also. Steinitz, on the other hand, doubts that the reference to these Komi words is justified in this connection. They may have acquired their meaning of 'falling into ecstasy, into a trance' through the same semantic development as the above-mentioned Mansi and Khanti verbs with similar meanings.

According to Lehtisalo the following words also belong to this category: Nganasan (Castr.) *faŋkáˀam*, to be drunk, and even Selkup (Castr.), Kamas, Kheya, Kha, Upper-Ob dialect *pöŋer*, drum, Tym dialect *pəŋgər*, a special Samoyed musical instrument, the Russian *domra*; Narym, Lower Vasyugan, Middle-Ket dialect *pəŋgər*, Upper-Ket dialect *py:ŋga:r*, Khaya dialect *p&#601ggər*, the same.

Lehtisalo compares the Nenets verb *sa:mpa:*, to sing the shade of a dead person down into the underworld to the accompaniment of the magic drum, *etc.*, with the Finnish noun *sampa: maansampa*, puff ball, *puunsampa*, a whitish mushroom the size of a pinhead, found on birches, alders, and willows. If the root of this Samoyed verb is a noun meaning 'mushroom', then we have here a semantic relationship similar to that between the following nouns and verbs: Khanti *pa:ŋχ paŋχtəm*, Nenets, Obdorsk dialect *ja:pˀe:*, to be drunk, Nenets (Reg.) *javebš*, fly-agaric, Lyamin dialect *wi:ppi:*, Nyalina dialect *wˀi:ppi:*. Pur dialect *wi:pi:*, fly-agaric, Enets, Khantaika dialect *jeviˀe:rro*, Bayikha dialect *jebiˀedo*, to be drunk.

On this basis, Lehtisalo assumes that the Finnish shamans also used the fly-agaric as a stupefying agent in earlier times and that people probably 'became intoxicated by eating fly-agarics as early as proto-Uralic times.'

In every case the above-mentioned Finno-Ugric words meaning 'ecstasy, intoxication, drunkenness' are similarly traceable to a noun which means 'fungus, fly-agaric' and was used figuratively to denote the intoxicated, ecstatic, or drunken state itself (as in Mansi), whereas the verbal derivatives of this same noun in many Finno-Ugric languages have the meaning 'to fall into a trance.' From the semantic viewpoint this requires no further explanation, since it is obvious that the root-word of derivatives which mean 'to come into a condition' is the same word which is used to denote the substance producing the condition. There is a causal relationship between such root-words and their derivatives. The verbs formed from these nouns mean 'to provide somebody with something' or 'to be provided with something.' Thus we find not only from descriptions given by travelers but also from definite linguistic facts (derivatives of Finno-Ugric words which mean 'fungus' or 'fly-agaric') that the Finno-Ugrian shamans used the fly-agaric as a stupefying agent in ancient times.

4. It might be asked, however, whether all verbs meaning 'to fall into ecstasy' in the Finno-Ugric languages are derived from a noun meaning 'fungus' or 'fly-agaric,' and whether these Finno-Ugric words are not loan-words.

Munkácsi believes that these Finno-Ugric words are of Old Iranian origin. He bases his opinion on the fact that the semantic development of the Old Iranian word *baŋha* is remarkably similar to that of the above-mentioned Mansi word for the fly-agaric. According to Bartholomæ this Old Iranian word has several different meanings: '1. Name of a plant (and its juice) which was also used for producing abortions: 2. Name of a narcotic made from that plant and also a designation of the state of narcosis produced thereby.' Other references in connection with this word are: Old Indian *bhaṇga-*, *bhaṇgā-*, 'hemp; a narcotic prepared from hemp seeds': modern Persian *bang*, 'henbane,' (*bangī*, 'senseless'); Armenian loan-word *bang*, '*Hyoscyamus niger*'; Afghan *bang*, 'hemp.' In Persia, according to W. Geiger, hashish is made from hemp.

Whether Munkácsi is right in making this correlation is a matter for experts in Iranian to decide. As far as the semantic development is concerned, it is rather difficult to imagine that a word which originally meant 'hemp' would be used by the Finno-Ugric peoples to describe the fly-agaric, since these two plants do not resemble each other in the slightest, except for their narcotic effect. (Lehtisalo considers the borrowing of these words unlikely.) Nevertheless, it must be borne in mind that hemp seeds might have played, and perhaps still play, a role in the ecstasy of the shamans. We shall return to this point later.

[39] Pedersen

> PEDERSEN, Holger. 'Przyczynki do gramatyki porównawczej języków słowiańskich'. (Contributions to the comparative grammar of Slavic languages) Materiały i Prace Komisyi Językowej Akademii Umiejętno&sacute;ci w Krakowie. Vol. I, No. 1, pp. 167-176. Kraków. 1901.

There follows an abstract of the original paper in Polish, an abstract prepared by Roman Jakobson as a working paper.

I

Old Bulgarian gąba 'spongia', Polish gąbka. The Old Bulgarian gąba is usually compared with the Lithuanian gum̃bas, 'illness of the uterus, excrescence on a tree', (Mieżinis), 'an excrescence on an organic body or on a stone, colic, cramps of the stomach' (Kurschat), Latvian gumba 'tumor', gumpis, 'colic'. This etymology is improbable.

II

It presents difficulties when one compares the accent of the Lithuanian gum̃bas with the Serbian gȕba, Slovenian góba: the Serbian short falling accent̏ corresponds to the Lithuanian ´, and the Slovenian ' corresponds to the Lithuanian '.

III

Lorentz' law, surmising the change of um̃ to the Slavic ą is erroneous.

IV

To the Slavic gąba there corresponds etymologically the Old High German swamb. Kluge compares swamb with the Greek somphós, 'porous', but it is not plausible. Swamb could represent the Indo-European ★sg̏ hombho-s. The Indo-European g̏ ho gave in Germanic wa, as in the Gothic warms: Latin formus. In Baltic and Slavic languages the consonant s in the initial cluster sg had to disappear; compare Old Bulgarian gasiti and Lithuanian gesýti with Greek sbénnȳmi.

V

Also the German swamb could be easily explained from the original ★sg˘hombho- as well as from ★sg˘hōmbho-. But if the Lithuanian gum̃bas does belong here, one must accept ★sg˘hombho- as the original form and the Lithuanian gumbas represents the reduction ★sg˘hṃbho-. The same reduction occurs in the German sumpf, but English swamp.

VI

Also ★sgwombho- could be admitted as the original form. Then the Slavic gąba either lost the semivowel w during the Baltic-Slavic stage, or it represents an Indo-European variant without w.

VII

In this case it is possible to combine gąba: swamb with Greek sfóngos, Latin fungus. The Greek and Latin expressions spring from the original forms beginning with ★sph-. Here also belong Armenian sunk, sung, 'sponge, pumice', but Armenian s can represent only the Indo-European ★sp and not ★sph. However it is possible to suppose ★sphwongo-. From ★sphwongo there could arise ★sgwompho- and also ★sgwombho-; the alternation ph~bh is not unusual after the nasal consonants.

C. Secondary Sources

[40] Hartwich

> HARTWICH, Carl. Die menschlichen Genussmittel: ihre Herkunft, Verbreitung, Geschichte, Anwendung, Bestandteile und Wirkung. (Human Stimulants: Their Origin, Distribution, History, Use, Components, and Effects) Leipzig. 1911. pp. 255-260.

[Hartwich was a distinguished toxicologist and pharmacologist of his day. He had read widely, he was intelligent, and he expressed himself well and forcibly. What he wrote about the fly-agaric in *Die menschlichen Genussmittel* reflected the best opinion of his day and in pharmacology it exerted wide influence; but on the fly-agaric in major features it was wrong or misleading. As late as 1911 he gave expression to the ancient European superstition that the fly-agaric is dangerously toxic: 'four mushrooms can kill a man'. On the contrary, it is difficult to find case histories of healthy adults who have died from it, which is in striking contrast to the deadly amanitas! He perpetuates the notion that the Tungus and Yakut tribesmen - both speaking Altaic tongues - use the fly-agaric. He quotes 'a Zürich man's letter dated 1799' reporting that the Russian troops occupying Zürich in that year had gathered fly-agarics on the Zürichberg and eaten them, allowing his reader to suppose that it was for their intoxicating effect. In historic times no Russian - whether Great Russian or Little Russian or White Russian - has taken the fly-agaric for its inebriating effect. This statement will not be successfully gainsaid. The Russians have produced numbers of excellent specialists in Slavic folklore and folk practices, and today when the Russian world stands revealed to us, thanks to numbers of persons in the West who have learned the language, it would be impossible for a pharmacologist of standing to say that the Russians eat the *mukhomor*, as they call the fly-agaric, for the inebriation that follows. True, there have been reports that some of the Russian civil servants and Cossacks stationed among the Palæosiberian tribes have taken the habit from the natives, but it is not in this sense that ignorant people lay the charge of fly-agaric eating. A West, where only yesterday there were elements in the educated classes that regarded the Russians as *Untermensch* and not worthy of study, was prepared to believe anything that, according to Western prejudices, was degrading about their neighbors in Eastern Europe. It is not that consuming the fly-agaric would have been disgraceful, any more than consuming alcohol or tobacco. But there were Westerners who believed the Russians ate the fly-agaric, as Hartwich seems to have done. It was not so. Diverse cultures should not be confused: each stands on its own bottom, and to associate the Slavic culture with that of the Koryak is like asking an American tourist whether Iroquois is his native tongue.

[Hartwich of course gives some measure of credence to the belief, common in Scandinavia, that berserk-raging was produced by the fly-agaric. On the use of the fly-agaric in Siberia Hartwich quotes Enderli, who is excellent, and Kennan, who is childish. He ignores Strahlenberg, Maydell, Langsdorf, Georgi, Erman, and Dittmar, who wrote in German; Krasheninnikov who was translated into German; and Bogoraz and Jochelson, whose works had already been published in English in Leiden. Had he done his homework properly, he would have found some answers to the questions that baffled him, such as a possible explanation for the urine drinking of the reindeer folk. He also draws on Ernst von Bibra, a pioneer pharmacologist whose *Die narkotischen Genussmittel und der Mensch* appeared in Nüremberg in 1855, though he was only a secondary source relying on writers whom Hartwich should have read. He quotes Kennan to the effect that the continued use of the fly-agaric has harmful results, adding that Kennan no doubt was right. Kennan had been in the Koryak country, but the man on the spot can be a bad observer and Kennan's text gives no ground for reliance on his word. The fly-agaric may be harmful if its use is continued, but it is the function of a man of science to reduce the area of guessing and not himself reach conclusions that are only guesses. The excessive use of alcohol is harmful, but not the continued moderate use. May this not be true of the fly-agaric? - RGW]

The fly-agaric is one of the most remarkable stimulants. Except for one otherwise unknown poisonous mushroom which was consumed as a delicacy[340] by the ancient Mexicans, it is the only stimulant in the broad subkingdom of cryptogamic plants, and no other stimulant ranges so far north. Only some unusual forms of alcohol production from milk are found in the region of Siberia bordering on the area where fly-agaric is used, and in the extraordinary method of its use it is unparalleled by any other stimulant on earth.

The fly-agaric (*Amanita muscaria* L. Pers.) grows in forests and its distribution is circumpolar in the northern hemisphere; it is found in Europe, Northern Asia, and North America, but it also occurs in South Africa.[341]

It is highly poisonous, and the splendid red colour of its cap, with its sharply contrasting white warts, sometimes entices the inexperienced to eat it. A great many deaths traceable to this cause have been reported. Four mushrooms can kill a man; sheep, on the other hand, appear to be immune to it. The symptoms observed after such poisoning are nausea, vomiting, thirst, colic pains, mucous and bloody stools, flow of saliva, and fainting spells; sometimes there are also intoxication-like states and lethargy, dilation of the pupils with disturbed vision and even temporary blindness, delirium, hallucinations, raving, cyanosis (blue colouration of the skin), difficulty in breathing, loss of consciousness, and cramps. Death has occurred after ten hours, or sometimes after eight. A victim may recover after 5-24 hours.[342] It derives its name from the fact that an extract of this mushroom was used for killing flies, particularly in earlier times, before fly-paper saturated with arsenic, quassia, and the like became widely known. Its use in medicine has always been insignificant. According to Kosteletzky,[343] it has been recommended for use against nervous attacks, swollen glands, ulcers, and - in Kosteletzky's time - for use as a powder or tincture against consumption.

At present it is used as a stimulant only in Siberia, and its range is very extensive. It begins with the Ostyaks, whose territory extends from the Ob to the Yenisei. From here it continues uninterrupted to the easternmost part of Asia. After the Ostyaks come the Samoyeds and Tunguzes, then the Yakuts, the Yukagirs, the Chukchis, the Koryaks, and the Kamchadals. The area of fly-agaric use probably does not extend far south of 6o° north latitude at any point.

According to some reports, the use of the mushroom extended farther west in earlier days and was perhaps forced back by the spread of alcohol. A Zürich man's letter dated 1799,[344] the year in which a Russian army under Korsakoff was in Zürich, mentions with amazement the fact that the Russians gathered fly-agarics on the Zürichberg and ate them. These Russians, of course, must have become acquainted with the mushrooms in their own homeland.

At Polotsk on the Dvina (presumably in 1812) French soldiers ate fly-agarics, and four of them died within a short time.[345] No doubt they had seen the local inhabitants eating the mushrooms. While the Russians in these last two cases were probably not Mongols, as in Siberia, but Slavs, there are conjectures that go even further, and according to some, it may be assumed that even Germanic peoples used the fly-agaric in earlier times. For example, it is sometimes reported[346] that the berserkers - those Germanic warriors who attacked the enemy in a wild frenzy, naked and without adequate defensive weapons, and who in some ways resembled Malays who run amuck - worked themselves into such a state of senseless fury by drinking fly-agaric mixed with an alcoholic drink. These are merely conjectures; nevertheless, the possibility must be considered that the use of fly-agaric was more widespread in earlier times than it is today.

---

[340] Today we know that there are more than a dozen species of these mushrooms, and we have given each of them names. I would take exception to Hartwich's use of the word 'poisonous' unless we are ready to apply it also to alcohol and tobacco. 'Delicacy' is hardly the word to describe the attitude of the Indians toward their holy eucharist. - RGW.

[341] Engler-Prantl, *Pflanzenfamilien* (Plant Families) I, I, 275.

[342] Lewin, *Lehrbuch der Toxikologie* (Textbook of Toxicology), second edition, 1897, p. 410.

[343] Kosteletzky, *Med. Pharm. Flora*, Vol. I, 1831, p. 13.

[344] In recent years we have made strenuous efforts to locate this letter but without success. The fly-agaric can be prepared properly for the table. Whether the Russians in some parts of that vast country may have known how, we cannot say. - RGW.

[345] Vadrot, 1824. After Orfila, *Allgemeine Toxikologie* (General Toxicology), translated into German by Hermbstädt, 1818, Vol. 4, p. 40.

[346] *e.g.*, in E. Krause, *Tuisko-Land* (Tuisko Land), 1891, p. 379. Lewin, *l.c.*

The mushroom is used in a good many different ways in Siberia, but it is certainly not true that it is fermented into a beverage; assertions to this effect are obviously due to a confusion with the production of alcohol through fermentation. According to von Bibra, it is eaten fresh in soups or sauces, but it is reputed to be less effective when used in this way than in the dried state; this is readily understandable in view of the high water content of the fresh mushroom. It is called by the names *muchumor*, *mukamor*, and *mucho-more*.[347] It seems to be a fairly common custom to eat the mushroom in the juice of berries of *Vaccinium uliginosum* L. or in an extract made from the leaves of the narrow-leafed willow herb (*Epilobium angustifolium* L.). (I should point out that these berries are believed by some to have an intoxicating effect, as is suggested by the German names *Rauschbeere* and *Trunkelbeere*.) Even though there are a few reports of cases in which an effect of this kind has been observed, there are many others of cases in which the berries were eaten without any such effect. Ascherson believes that the reports of intoxication are due to a confusion of the berries with those of *Empetrum nigrum* L. (crowberries), which are also called *Rauschbeere* in German. But the fact seems to be that these also can be eaten without ill effects. I remember that in describing his crossing of Greenland, F. Nansen writes that he and his companions ate tremendous amounts of this fruit. (See also Schübeler, *Pflanzenwelt Norwegens* [Flora of Norway], pp. 276 and 324 ...)

The most common practice, however, is simply eating the mushroom in a dried state. It has been observed that the active component passes unchange into the urine, and this remarkable fact has been utilized to obtain a long series of successive effects with a relatively small quantity of mushrooms.

[Hartwich then quotes J. Enderli in full; *vide* our text, [191 - RGW]

The most striking thing in this detailed account is that the active principle of the mushroom evidently is excreted unchanged in the urine, so that the latter retains the effectiveness of the mushroom. There is no doubt whatever that the urine is drunk for purposes of intoxication, and this has also been reported by other observers. According to Kennan,[348] however, it is only the settled and more primitive Koryaks who know this custom. Von Bibra reports that the efficacy is not lost even after repeated consumption, so that four or five people in succession may be intoxicated by the same quantity of mushrooms, first directly and then indirectly.

Apart from the fact that this custom strikes us as highly unappetizing, it seems strange at first glance that the Koryaks could ever have hit upon the idea of drinking urine. Of course, the intoxicating effect of the urine might have been noticed by accident when a man intoxicated with fly-agaric mistakenly drank the urine which he had collected in a container in the close quarters of the yurt. It must also be remembered, however, that urine was not always and everywhere regarded as something repugnant. Among the Chinese it is still used as a medicine, both in its original state and in the form of the residue left after evaporation. Not only among the Chinese, however, but even in our own part of the world, it occasionally has a rôle in folk use, although the rôle is that of a sympathetic agent rather than a recognized medicament. (*Vide*, for example, Kristian Frantz Paulini, *Neu-Vermehrte Heylsame Dreck-Apotheke*, 'On how almost every kind of ... illness, and harm done by sorcery ... is successfully cured by means of excrement and urine - Franckfort am Mayn, 1734.' A new edition of this book was printed about the middle of the last century. I also have before me a new edition of another *Dreck-Apotheke*, which turns out to be an extract of Paulini's book.) If we go back several centuries, we find that science regarded urine not as merely a substance excreted by the body but as something with a special mystery about it. It was ideas of this kind that led Brand in Hamburg in 1670 to seek the philosopher's stone in urine and to discover that it contained phosphorus.

It is also noteworthy that the mushroom-eater discovers the future in his intoxication if he follows certain prescribed formulas. Thus we see that there is a religious factor involved. In this same connection, von Bibra reports that the shamans, the Siberian sorcerer-priests, use the mushroom to transport themselves into a state of ecstasy.[349] (This is not explicitly stated on page 136 of von Bibra's book, but it is unmistakably clear from the context.) His description of the effects differs in some ways from Enderli's: the symptoms described by von Bibra are, in general, not so severe, and the people in his account act in a more lively manner - those with musical talent sing without interruption, while others converse, laugh, and tell their secrets to all the world. They lose their sense of space and leap into the air in order to get over a straw or other small object. Frequently, however, muscular strength is also remarkably increased: one man intoxicated with fly-agaric carried a 120-pound weight for about 10 miles.

---

[347] Why did not Hartwich look up *mukhomor* in a Russian lexicon? - RGW.

[348] George Kennan, *Tent Life in Siberia*, p. 156 of D. Halk's German translation, *Zeltleben in Sibirien*, Leipzig, Reclamsche Bibliothek.

According to Kennan (p. 156 of the German translation) - who says, no doubt quite rightly, that continued use of the fly-agaric has very harmful results - the practice has been prohibited by the Russians in Siberia; as we have seen, this prohibition has had as little effect as the prohibition of other stimulants. An indication of the Koryaks' craving for the mushroom may be found in the high prices they pay for it. Since the mushroom does not grow on the Koryaks' own steppes, it is brought to them by Russian dealers, and Kennan reports that he saw furs worth 25 rubles paid for a single mushroom.

[41] Eliade

> ELIADE, Mircea.
> 1. Yoga: Immortality and Freedom. Pantheon Books. New York. 1958. A translation from: Le Yoga: Immortalité et Liberté. Paris. 1954. pp. 338-9 (French text: p. 335)

[In the following excerpts from this writer's books we have printed in italic certain passages on which we will comment. - RGW]

In the sphere of shamanism, strictly speaking, intoxication by drugs (hemp, mushrooms, tobacco, *etc.*) seems not to have formed part of the original practice. For, on the one hand, shamanic myths and folklore record a decadence among the shamans of the present day, who have become unable to obtain ecstasy in the fashion of the 'great shamans of long ago'; on the other, it has been observed that where shamanism is in decomposition and the trance is simulated, there is also overindulgence in intoxicants and drugs. In the sphere of shamanism itself, however, we must distinguish between *this* (*probably recent*) *phenomenon of intoxication for the purpose of* '*forcing*' *trance*, and the ritual consumption of 'burning' substances for the purpose of increasing 'inner heat'...

> Shamanism: Archaic Techniques of Ecstasy. Pantheon Books. New York. 1964. A translation from: Le Chamanisme et les Techniques archaïques de l'Extase. Paris. 1951.

P. 477. (French text: p. 415) ... But closer study of the problem gives the impression that the use of narcotics is, rather, indicative of the decadence of a technique of ecstasy or of its extension to 'lower' peoples or social groups. In any case, *we have observed that the use of narcotics* (*tobacco*, *etc.*) *is relatively recent* in the shamanism of the far Northeast.

Pp. 400-1. (French text: 360-1). The importance of the intoxication sought from hemp is further confirmed by the extremely wide dissemination of the Iranian term through Central Asia. In a number of Ugrian languages the Iranian word for hemp, *bangha*, has come to designate both the preeminently shamanic mushroom *Agaricus muscarius* (which is used as a means of intoxication before or during the séance) and intoxication;[350] compare, for example, the Vogul *pânkh*, 'mushroom' (*Agaricus muscarius*), Mordvinian *panga*, *pango*, and Cheremis *pongo*, 'mushroom.' In northern Vogul, *pânkh* also means 'intoxication, drunkenness.' The hymns to the divinities refer to ecstasy induced by intoxication by mushrooms.[351] These facts prove that the magico-religious value of intoxication for achieving ecstasy is of Iranian origin. Added to the other Iranian influences on Central Asia, to which we shall return, *bangha* illustrates the high degree of religious prestige attained by Iran. It is possible that, among the Ugrians, the technique of shamanic intoxication is of Iranian origin. But what does this prove concerning the original shamanic experience? Narcotics are only a vulgar substitute for 'pure' trance. *We have already had occasion to note this fact among several Siberian peoples; the use of intoxicants* (*alcohol, tobacco, etc.*) *is a recent innovation* and points to a decadence in shamanic technique. Narcotic intoxication is called on to provide an imitation of a state that the shaman is no longer capable of attaining otherwise. Decadence or (must we add?) vulgarization of a mystical technique - in ancient and modern India, and indeed all through the East, we constantly find this strange mixture of 'difficult ways' and 'easy ways' of realizing mystical ecstasy or some other decisive experience.

---

[349] O. Stoll, *Suggestion und Hypnotismus in der Völkerpsychologie* [Suggestion and Hypnotism in Folk Psychology], second edition, 1904. He discusses the Siberian shamans and their tricks in detail but does not say that they use the fly-agaric in order to achieve a state of ecstasy; instaed, he attributes this state to loud noises, dance movements, and auto-suggestion developed by practice.

[350] Bernhardt Munkási, "'Pilz' und 'Rausch'"; *Keleti szemle*, Budapest, VIII, 1907, pp. 343-344. I owe this reference to the kindness of Stig Wikander. [*Vide* Exhibit 【32】 - RGW]

[351] *Ibid.*, p. 344.

P. 223. (French text: 202-4) Intoxication by mushrooms also produces contact with the spirits, but in a passive and crude way. But, *as we have already said, this shamanic technique appears to be late and derivative*. Intoxication is a mechanical and corrupt method of reproducing 'ecstasy', being 'carried out of oneself'; it tries to imitate a model that is earlier and that belongs to another plane of reference.

Pp. 220-1. (French text: 201-2) Summoned to a house, the shaman [among the Ostyak of the Irtysh - RGW] performs fumigations and dedicates a piece of cloth to Sänke, the celestial Supreme Being.[352] After fasting all day, at nightfall he takes a bath, eats three or seven mushrooms, and goes to sleep. Some hours later he suddenly wakes and, trembling all over, communicates what the spirits, through their 'messenger', have revealed to him: the spirit to which sacrifice must be made, the man who made the hunt fail, and so on. The shaman then relapses into deep sleep and on the following day the specified sacrifices are offered.[353]

Ecstasy through intoxication by mushrooms is known throughout Siberia. In other parts of the world it has its counterpart in ecstasy induced by narcotics or tobacco, and *we shall return to the problem of the mystical powers of toxins*. Meanwhile, we may note anomalies in the rite just described. A piece of cloth is offered to the Supreme Being, but communication is with the spirits and it is to them that sacrifices are offered; shamanic ecstasy proper is obtained by intoxication with mushrooms - a method, by the way, which allows shamanesses, too, to fall into similar trances, with the difference that they address the celestial god Sänke directly. These contradictions show that there is a certain hybridism in the ideology underlying these techniques of ecstasy. *As Karjalainen already observed*,[354] *this type of Ugrian shamanism appears to be comparatively recent and derivative*.

Today Professor Eliade enjoys renown and his word carries weight in certain circles interested in the origin and history of religions, and since he seems to hold the view that the use of divine inebriants is probably a 'recent phenomenon' among shamans, or at least among Siberian shamans, a few words of comment on his treatment of this vital aspect of his subject seems called for. As we have seen on pp. 165 ff, there is valid linguistic evidence that the use of inebriating mushrooms in Siberia goes back to the Uralic period, at a time when the Ob-Ugrian and the Samoyed languages had not yet evolved out of their mother Uralic tongue, more than 6000 years ago. Professor Eliade does not tell us what he means by the term 'recent phenomenon', but presumably he would not carry shamanic inebriation back more than, say, five centuries. The linguistic evidence seems to contradict his conclusions, and there is no evidence supporting them.

1. We have presented the quotations from Professor Eliade's books in their inverse order, the last one first, with deliberate intent, to reveal a trait of his thinking.

The extract that we have quoted from his book on Yoga gives no source or authority for his statements, not even himself. He speaks *ex cathedra*. The reader is not told where one may consult the 'shamanic myths and folklore', nor is it clear how 'myths and folklore' would document a decadence in shamanism, nor do we know whom he quotes when he cites the '"great shamans of long ago"'. We do not know why divine inebriation is a '(probably recent) phenomenon'. That there is decadence in shamanism among the minor nationalities of the world is clear and self-explanatory, as their feeble cultures founder in the mælstrom of the modern world. It is also true that in their disarray these peoples have taken to hard liquor. But this proves nothing as to the antiquity of divine inebriation, and in particular divine inebriation from the indigenous mushrooms of Siberia.

---

[352] The original meaning of *sänke* was 'luminous, shining, light'. (K.F. Karjalainen: *Die Religion der Jugra-Völker*, II, p. 260)

[353] *Ibid*., III, 306. A similar custom is attested among the Tsingala (Ostyak). Sacrifices are offered to Sänke, the shaman eats three mushrooms and falls into a trance. Shamanesses employ similar methods; achieving ecstasy by mushroom intoxication, they visit Sänke and then sing songs in which they reveal what they have learned from the Supreme Being himself (*ibid*., p. 307). Cf. also Jochelson, *The Koryak*, II, 582-583.

[354] *Ibid*., III, 315 ff. [*Vide* Exhibit **[**26**]** - RGW]

On p. 477 of Professor Eliade's book on shamanism he repeats the same thought: the use of 'narcotics (tobacco, etc.) is relatively recent in the shamanism of the far Northeast'. He says 'we have observed' this, by which he probably does not mean that he has observed this in the far Northeast. He probably means that he has discussed the matter and arrived at a conclusion earlier in the volume. He gives no page reference. But, contrary to what he says, in this volume there is no discussion of inebriation in far Northeastern shamanism. There is discussion of Ob-Ugrian shamanism, in the far West of Siberia.

On p. 401 Professor Eliade says: 'We have already had occasion to note this fact among several Siberian peoples; the use of intoxicants (alcohol, tobacco, etc.) is a recent innovation'. We turn back, and on p. 223 he says, '... as we have already said this shamanic technique appears to be late and derivative', referring to intoxication by mushrooms. Again we look back and on p. 220 we find the subject mentioned once more: 'As Karjalainen already observed, this type of Ugrian shamanism appears to be comparatively recent and derivative'. In the same passage he includes this surprising phrase, '... we shall return to the mystical powers of toxins'! And so the reader has found himself shunted back, and back, and back, and again back, only now to be shuttled forward. His statements that the shamanic use of mushrooms is a recent innovation stand unsupported. His reference to Karjalainen gives him no comfort, as the reader will see from **[**26**]** where we quote in full the relevant passage. Karjalainen is discussing the fine points of shamanic technique. It seems that the Ostyak shamans of the Irtysh regions have recently influenced the other comunities in certain particulars. Karjalainen has nothing to say about the span of time during which the shamans have used the fly-agaric to achieve ecstasy.

2. In the excerpt that we have quoted from page 400 of his work on shamanism, Professor Eliade makes a number of flat assertions about the etymon of the word used among certain Finno-Ugric peoples, especially the Ob-Ugrians, for 'mushroom' and 'fly-agaric'. He says that this word is derived from *bangha* meaning 'hemp' (= hashish, marijuana) in Iranian. He quotes as his authority for this derivation the Hungarian philologist Munkácsi, but Munkácsi turns out to have been more cautious than Professor Eliade. Munkácsi said in 1907 that he sees in *bangha* and in *pango* (I cite only one of the Finno-Ugric variants) the same word, and he advances the hypothesis that the Uralic peoples took their words for inebriation from the Aryans. (We quote Munkácsi in full in **[**32**]**.) Munkácsi leaves the question open when the borrowing took place and his wording even permits the reader to ask whether the borrowing may not have taken place before the Aryans emigrated to what has since been called Iran. Other philologists specializing in the Finno-Ugric languages have been inclined to disagree with Munkácsi, but Professor Eliade does not quote them. (*Vide* Lehtisalo **[**24a**]** and Balázs **[**38**]**.) Professor Eliade says, 'These facts prove that the magico-religious value of intoxication for achieving ecstasy is of Iranian origin.' But he has given us no facts, he has asserted as facts what is his own philological speculation, and from these speculative remarks he has gone on to draw religious conclusions that are non-sequiturs.

Apparently the Iranian sources offer no support to Professor Eliade's case. His *Shamanism* appeared in French in 1951. In the same year the Oxford University Press brought out Professor Walter B. Henning's Ratanbai Katrak Lectures delivered in 1949 under the title *Zoroaster: Politician or Witch Doctor?* At the end of his second lecture this eminent Iranian scholar found that the inebriating derivatives of hemp were unknown in Iran before the 11th century at the earliest, that the Persian word *bang* in the sense of 'Indian hemp' is a borrowing from India, that in Iran this Indian word collided with a homonym *bang*, a word used in Iran since Avestan times for a number of Hyoscyamus species (the English 'henbane'), most or all of which are lethal. Persian *bang* in the sense of 'hemp' appears for the first time in medical writings of the 13th century. It is surprising that the English edition of *Shamanism* appeared in 1964 without taking into account the discoveries made since the first edition.

Even without the evidence that Professor Henning adduces, an Ob-Ugrian borrowing of the name for the fly-agaric from Iran in the recent past, as Professor Eliade alleges, is on its face unlikely. Are we to suppose, contrary to all probability, that the tribesmen discovered only late in the day the peculiar inebriating virtue of the familiar fly-agaric, and that having discovered it they crossed rivers and mountains to reach the distant Iranian plateau where it does not grow, and there borrowed the name of another plant that outwardly does not resemble it in the slightest, and brought the name home, and that thereafter everyone called the spectacular mushroom by a new, foreign name?

Professor Eliade suggests that the Ob-Ugrian shamanic practices may have been borrowed from Iran along with the word. But the use of the mushroom is certainly indigenous. A rôle for inebriants in shamanism, including hallucinogenic mushrooms, has sprung up spontaneously in many unrelated parts of the New and the Old Worlds. There is every reason to think that the inebriating mushroom in its religious rôle is millennia old, long outdating the emigration of the Aryans to the Iranian plateau.

Professor Eliade then gives expression to his feelings about the shamanic use of inebriants:

> Narcotics are only a vulgar substitute for 'pure' trance. We have already had occasion to note this fact among several Siberian peoples; the use of intoxicants (alcohol, tobacco, *etc*.) is a recent innovation and points to a decadence in shamanic technique. Narcotic intoxication is called on to provide an *imitation* of a state that the shaman is no longer capable of attaining otherwise.

His preference on moral grounds for other techniques to attain ecstasy has affected his critical faculty when he discusses what is purely an historical question: how old is mushroom inebriation?

3. Professor Eliade lumps all inebriants together. Here is his habitual way of referring to them, as quoted from his books:

> ... intoxication by drugs (hemp, mushrooms, tobacco, *etc*.)
> - (from *Yoga: Immortality and Freedom*)
> ... the use of narcotics (tobacco, *etc*.)
> - (from *Shamanism*, p. 477)
> ... the use of intoxicants (alcohol, tobacco, *etc*.)
> - (from *Shamanism*, p. 401)

For the modern toxicologist this lumping together of diverse psychotropic drugs, obliterating the enormous differences among them, is crude. Let the reader note the catch-all expression, 'etc.'. Professor Eliade does not even take the first step, which is to distinguish between fermented drinks and distilled alcohol. Apparently his translator ignores the difference between the French *alcool*, which is limited to the distillate, and the English 'alcohol', which also embraces fermented beverages such as beer and wine. The discovery of the distillation technique was a sensational development in the social history of the world, never adequately documented and commented on. The technique of distilling potable alcohol seems to have been devised only once, by the school of Salerno, in about A. D. 1100.[355] ('Alcohol' is an Arabic word but in Arabic it meant 'mascara'.) After leading an obscure existence for some centuries in alchemical laboratories and monastic establishments, it leapt into prominence and importance in the 16th century. Schübeler **[**42**]** says that brandy (*i.e.*, 'burnt wine') first became known in Norway in 1531. In England it seems not to have been widely known as late as A. D. 1530 but by 1550 it was cheap. It was everywhere called *aqua vitae*, the water of life. In Russia the sources say that the art of distilling penetrated to Moscow through the Black Sea route, perhaps brought from Italy by Italian merchants, in the early 16th century. Sigismund von Herberstein on a diplomatic mission to Muscovy describing a banquet in the Kremlin[356] in 1526 says:

> ... At length, the servers going out for food ... first brought in *aqua vitae*,
> which they always drink at the commencement of dinner.

---

[355] *Vide* R. J. Forbes: *Short History of the Art of Distillation*. Brill, Leiden. 1948. pp. 32, 88-89.

[356] In the Latin text, *Rerum Moscoviticarum Commentarii*, Bâle, 1551, p. 134, *aqua vitae* appears; and in the Italian translation, *Commentarii della Moscovia* ... Venice, 1550, folio 77 verso, *acqua de vita*. Apparently from Herberstein's words the pre-prandial vodka was already in 1526 established as a custom. We do not know when it came to be called *vodka*, from *voda* an affectionate diminutive of 'water'. (The English and Russian words are cognate.) Already we find *vodka* in Kamieński **[**1**]** in 1658.

Yermak's invasion of Siberia in 1580 marked the beginning of the conquest of that land, and it is probable that hard liquor became known to the tribesmen through the Russians. Has hard liquor ever played a rôle in the religious life of any people? The outlying races of the world may have tried it out in recent centuries sporadically and spasmodically, but Professor Eliade is right in saying that its use in shamanism marks the dying phase in the indigenous religious life of the Siberians.

Tobacco was a gift of the New World to the Old. In the American Indian cultures it was (and still is) a holy plant used in the religious life of the Indians and on other solemn occasions. Among Europeans and their descendants elsewhere it became a habit and an addiction but played no rôle in religion. But after tobacco reached Siberia, probably also in the latter part of the 16th century or at the latest in the 17th century, it is astonishing how quickly the tribesmen adapted it to shamanism, thus recapturing for it the religious meaning that it has always had for the American Indians. This religious connotation was seized upon and quickly integrated into the ways of communities that were in a stage of their cultural evolution similar to the American Indians' when these were first seen by Europeans. Let it be noted that tobacco became adapted to Siberian Shamanism without the influence of the American Indian cultures. Here lies a wholesome object lesson for those who would lightly draw inferences of trans-Pacific contacts merely on the strength of parallel usages.

When Professor Eliade lumps the fly-agaric with hard liquor and tobacco, he is committing an anachronism. He forgets that the fly-agaric is indigenous to the forests of Siberia and that, for the eater, the effects are utterly different from hard liquor. He says that 'narcotics are only a vulgar substitute for "pure" trance.' Would he have said this in 1951 about the Soma that inspired the hymns of the ṚgVeda? We know incomparably more about the world of psychotropic drugs than was known even as late as 1951, when Professor Eliade's work on shamanism was first published. The abuses of these drugs by unbalanced or childish people that are reported in the press do not speak for their use. The West is on the threshold of penetrating their secrets. There is an unexplored world before us, and we should not prejudge it.

All over the world, wherever anthropologists have been making their way, they have been finding the native peoples utilizing as shamanic inebriants natural plant products. With astonishing resourcefulness untutored folk, or rather their herbalists, in ages past discovered these 'drugs', as we call them, and how best to prepare them for medico-religious ends. The plants themselves and the methods of treating them are often secrets of the shaman, not to be had for the asking. Sometimes the inquirer is initiated into the mystery, only to suspect that he has not been told the full story. In this book we present the testimony of many witnesses on the use of the fly-agaric in Siberian shamanism. But Kannisto ⁅33⁆ tells us expressly that mushrooms in addition to the fly-agaric serve the same purpose in the Vogul area, a remarkable fact confirmed for the Chukotka by Ivan Lopatin. In the Vogul case the deficiency in our knowledge is attributable rather to the lack of zeal in the searchers than to concealment by the natives. To this day no one in the Western world can tell us what those other mushrooms are. The inebriants used in food-gathering communities seem to be myriad, their use going back to pre-history. Each presents a problem to our biochemists and pharmacologists, whose abilities are taxed to isolate the active agents, to describe their molecular structure, to synthesize them, and to explore their potentialities.

The thinking of the West is obsessed with alcohol as the sole inebriant: we down-grade and ignore the natural intoxicants that primitive man discovered long ago by himself: we are loath, we seem to be afraid, to discover their possibilities. The distillate of alcohol - what the French call *l'alcool* - is a late comer on the stage of history, but in the perspective of the past of *homo sapiens* even fermented drinks are relatively recent. It is hard to see how the peoples of Siberia could have mastered the art of fermentation before they acquired the technique of making pottery or wineskins. Even today in the tropics there are primitive peoples (such as the Kumá of New Guinea) who did not know fermented drinks until the white man brought them in. It is significant that the Uralic word for 'inebriation' is taken from the name for the fly-agaric: in the sequence of history the food-gatherers must have discovered the natural inebriants long before they learned the art, tricky for those who performed it first, of fermentation.

[42] Brekhman and Sem

BREKHMAN, I. I., and SEM, Y. A. 'Ethno-pharmacological Investigation of some Drugs of Siberian and Far-Eastern Minor Nationalities.' Paper submitted to the Symposium on the Ethnopharmacologic Search for Psycho-active Drugs held at the University of California, San Francisco Medical Center, on January 28-30, 1967.

[This paper by two Soviet scientists based in Vladivostok is of interest for the information that it contains and also because it is, I think, the first utterance out of the U.S.S.R. on the use of the fly-agaric among the Siberian tribesmen. The attitude of the Soviet Union toward this practice finds expression in the concluding paragraphs of the paper. It will be observed that they do not write from personal experience: they rely almost entirely on what Krasheninnikov **[4]** wrote more than two centuries ago - a source superseded by many others today. - RGW]

Various narcotics and stimulants had been used as intoxicating liquors or in popular medicine by the minor nationalities of Siberia and the Far East. Appertaining to them is the use of fly-agaric, tobacco, and its substitutes, alcoholic drinks, root of ginseng, young antlers of the maral, etc.

Fly-agaric (*Amanita muscaria*) had been used mostly by the palæoasiatic peoples of Kamchatka and Chukotka (Itelmen, Koryak, Chukchi, Yukagir). The use of fly-agaric on a vast scale was unknown to all the Tungus world. To it belong Evenki, Eveni, Udegay, Neguidaltsi, Nanai, Ulchi, Oroch, Solon, Manchu, Oroki; and of the palæoasiatic peoples, the Nivkhi [Gilyak] of Amur and Sakhalin.

Fly-agaric had been used with aims of: 1) merry-making, 2) overcoming certain difficulties, 3) instilling one's nerve in the time of inter-tribal clashes and wars, and 4) during a performance of rituals. Stepan Krasheninnikov, one of the first explorers of Kamchatka and its population, thus described the use of fly-agaric by the Itelmen (Kamchadal) and Koryak: 'For good cheer they at times use fly-agaric, too, that is familiar among us; herewith we exterminate flies'. At some other place he remarks that 'Kamchadal and sedentary Koryak eat fly-agaric when they design to kill some one'.[3]

There were known two ways of the use of fly-agaric, in its natural state and in the way of infusion. Fly-agaric was picked in spring, in summer, not often in autumn. For the use of fly-agaric in its natural state the gathered fungi were kept in a dry cool place and were slightly desiccated. 'As need be', wrote S. Krasheninnikov, 'dry mushrooms when rolled are swallowed whole, the which way is in great usage'. For making an infusion the caps of the fungi were soaked in water. After 5-6 days the infusion could be used.[3] More drastic was an infusion of fly-agaric in willow-weed wash. They prepared the latter from willow-weed (*Epilobium angustifolium* L) having boiled it down to a sweet and thick wash. In days of old fly-agaric had been used in Siberia and Kamchatka for a homebrew or added to underproof vodka, which led to intense excitement frequently ending in murder or suicide and now and again in death as a result of poisoning.[1,5]

A twofold use of fly-agaric and its infusion was known to the minor nationalities of North-East of Asia - the so-called 'moderate' and 'immoderate'. The Itelmen [Kamchadal] themselves considered the use of the fungus up to four mushrooms at a time as moderate, which contributed to an increase of organism resistance to fatigue, took off weariness, acted tonically. After such an application, wrote S. P. Krasheninnikov, 'they feel within themselves extraordinary ease, mirth, valour and nerve'.

After an immoderate use, from 5 to 10 fungi at a time, would come a second stage of fly-agaric effect which was accompanied by intoxication and hallucinations. S. P. Krasheninnikov,[3] who observed in person the effect of fly-agaric on Itelmen and Kamchadal, wrote: 'The first and usual sign whereupon ye can apprize of a person being wrought up with the mushroom is a twitch of limbs which would come in an hour or less, thereafter the drunk rave as in a fever; and they dream apparitions, ugly or cheery, as their temper be: from this cause some go a-hopping and some a-dancing, all being in great horror. To some, a slit taketh a view of a big door and a spoon of water of a sea ... But this needs must be thought of those that use it beyond measure'. The use of more than 10 fungi at a time led to a fatal end.

The second stage of intoxication was, probably, accompanied by a temporary partial paralysis and exuberant hallucinations, by involuntary actions. 'All their actions are so harmful that of persons left heedless scarcely any would escape with life.' During S. P. Krasheninnikov's stay in Kamchatka the Cossacks and Russian servants of government also acquired from the Itelmen the habit of fly-agaric use with the aim of intoxication. It served them as a substitute for alcohol. Its effect was known among the inhabitants of Kamchatka as extravagancies', 'visions of infernal regions and fire-spitting abyss', and an inclination to confess one's sins; attempts at suicide, etc.

Everybody addicted to fly-agaric accounted for his actions as if they had been in obedience to the order of Omnipotent Mushroom. In the opinion of the Chukchi 'inebriant mushrooms are a special tribe (*anra-varat*). They are strong and when growing they break through thick roots of trees and dissect them into halves with their sturdy heads. They shoot through stones and crush them to bits. Fly-agaric appears to drunken men in a shape strange and man-like. Thus a certain mushroom appeared in the shape of a single-armed and single-legged man, and another was like a stump. They are not ghosts, they are mushrooms themselves. Their number seen by a man corresponds to the number of fungi eaten by a man. If a man ate one mushroom, he would see one man-mushroom; if he ate two or three, then he would see their respective number. The mushrooms take a man by the hand and lead him to the other world, they show him all that is there, make him do all kinds of unbelievable things. The ways of mushrooms are tortuous. They visit the land where the dead live.'[2]

The effect of the fly-agaric continued until the products were evacuated from the system of a man. Even the urine of this man would have an inebriating effect. 'With sedentary Koryaks the fungus is in so high esteem', wrote S. P. Krasheninnikov, 'that a drunken man is not allowed to pass water on the floor, but they put a vessel before him, and his urine they drink and run mad like those that had eaten the mushroom'.

By the customary law of the minor nationalities of Chukotka and Kamchatka the use of fly-agaric was permitted only to men. Its use by women was prohibited.

Interesting are observations of fly-agaric action on deer, they after eating fungi and the following violent excitement fall into a deep sleep, the meat of such deer, the Koryak vouched, acted on a man inebriatingly.[4]

The northern group of nationalities, especially the Itelmen of Kamchatka, had had another stimulant - wine from 'sweet herb'. The secret of its production passed from them to Russian Cossacks and sedentary Koryaks in the 16th and 17th centuries. For making wine Itelmens used the 'sweet herb' (*Heracleum dulce* Fisch. sem. *Umbelliferæ*). For making grass sugar and wine were used young spring stems, which were usually gathered by women. To avoid the influence of the poisonous juice of the plant they put on gloves. The stored bunches of stems were put in grass bags and kept there until sugar was educed on the stems. Grass sugar was used for making various kinds of Itelmen dainties, beverage, etc.

Sometimes the 'sweet herb' was eaten, like betel, in its fresh natural state. The effect of its chewing was similar to that of alcoholic intoxication. The 'sweet herb' was mostly used for making wine. First was made wine dough. For this aim the 'sweet herb' was put in warm water and leavened with honeysuckle or bog bilberry. The mixture prepared thus was kept in warmth, which contributed to fermentation. As soon as fermentation ceased the wine dough was considered to be ready. Usually, this required about a day. For making wine the 'sweet herb' now in a large quantity was soaked in warm water and leavened with dough, and in a day they began distillation. At first, as S. P. Krasheninnikov notes, comes wine of proof similar to that of vodka, then comes a softer wine. The strength of vodka is such that it is possible to mordant even iron. Itelmens attest that this wine 'presses on the heart very much' and 'decreases sex appeal'.

G. V. Steller, another explorer of Kamchatka, thus described the effect of 'herbal wine': '... whosoever partaketh of it but a few goblets he is harassed by queer phantasies all night and the next day he feels melancholy just as if he had committed some crime'.[3] So the effect of the wine from the 'sweet herb' was similar to that of fly-agaric in some measure.

During a shamanic rite the Nanai, Udegay, Ulchi, and Orochi used to employ some plants that made a specific influence on the psychic state of a person, which, probably, promoted to an arrival of mass hypnosis so needed during a rite. Usually it was the leaves of Ledum, which passed under the name of 'senkura' with the Nanai, 'sengkuro' with the Ulchi, 'sengkia' with the Udegay, 'synkiu' with the Orochi, etc. They used to employ *Ledum palustre* L and *Ledum hypoleucum* Kom. The desiccated leaves stored beforehand were put on the hearth or on a frying pan. A strong active smell in a small dwelling would stupefy those present at the rite. Probably, in some measure it calmed the sick as it was employed at ritual exercises over the sick.

Undoubtedly, the psychoactive drugs employed by the minor nationalities of Siberia and the Far East are not studied yet completely and require further investigations by ethnographers and pharmacologists.

The minor nationalities of Siberia and the Far East now do not use any psychoactive drugs, which have been relinquished because of radical changes in economy, culture, mode of life, and ideology of the population of this part of the Soviet Union. After the October Socialist Revolution and the establish ment of the Soviet Power these not numerous nationalities have embarked on a new way of historical development. Formerly backward nationalities of one of borderlands of Russia, with the help of the Russian people and Soviet Power, passing through intermediate stages, they have soon reached the socialist phase of social development.

LITERATURE USED

1. Balov, J. Poisonous fungi. Medicine Gazette No 40, 1428, 1912.
2. Bogoraz, V. G. The Chukchi. Part 2. Religion. Authorized translation from English. Glavsevmorput Publishing Co., Leningrad, 1939.
3. Krasheninnikov, S. P. Description of the land of Kamchatka, Vol. 2. St. Petersburg, 1775.
4. Orlov, N. I. Edible and poisonous mushrooms. Medguiz Publishing Co., 1953.
5. Tikhomirov, V. A. Edible and poisonous mushrooms. Moscow, 1879.

2. THE FLY-AGARIC IN SCANDINAVIAN WRITINGS

Preliminary Note

No one who discusses the fly-agaric in Europe can ignore the debate that has been carried on for almost two centuries in Scandinavia on this issue. First Samuel Ödman in 1784 and then Fredrik Christian Schübeler in 1886 propounded the thesis that those Viking warriors known as 'berserks' ate the fly-agaric before they 'went berserk'; in short, that 'berserk-raging' was deliberately caused by the ingestion of our spotted amanita. Apparently the argument went to Ödman and Schübeler by default, because today we find their thesis incorporated in the Scandinavian encyclopædias and the school history books. In fairness to them I here present in full what they said in presenting their views, as well as the utterances of a number of their followers, eminent professors all of them. I wish I could agree with them.

I add also a part of the account of a tragic episode that happened in Hungary at the end of the second World War, in 1945, written by a Swedish woman who was there at the time. There is in it a curious statement about a fungal decoction said to have been used by the Russian troops that occupied briefly the town of Fehérvár.

[43] Ödman

> ÖDMAN, Samuel. 'Försök at utur Naturens Historia förklara de nordiska gamla Kämpars Berserka-gång.' (An attempt to Explain the Berserk-raging of Ancient Nordic Warriors through Natural History) Nya Handlingar, published by the Kungliga Vetenskaps Akademien, Vol. 5. Stockholm. 1784. pp. 240-247.

In the oldest chronicles of our country we not infrequently come across incidents which, for want of a knowledge of natural history, are either explained quite erroneously or risk being relegated, through the injustice of the scholar, to the myths of the dark ages. I am sure that I am not mistaken if I include in this category the accounts, preserved in the old Norse Sagas, concerning the *Berserks* of ancient times, and the celebrated frenzies which, under the name of *Berserka-gång* (Going Berserk), are described in such curious wise.

It is not for me, nor is this the place, to discuss these prodigies of History at length. A brief outline will suffice to pave the way for the present enquiry.

These warriors, according to the military thinking of their times necessary adjuncts for the aims of their warlords, but also often feared by the Prince in whose service they were employed, are depicted more as wild beasts than human beings. As soon as the Berserk-fury came over them, they were seen to rage like ravening wolves, recoiling from neither fire nor iron, braving the direst perils, rushing at the most redoubtable enemy, biting their own shields, *etc.*, or, if no enemy were at hand, venting their fury on inanimate objects, uprooting trees, overturning rocks, and in their exalted state scarcely distinguishing friend from foe. King Halfdan's Berserks are portrayed in Hrolf's Saga in the following interesting manner: 'On these warriors', the account reads, 'there at times fell such a fury that they could not control themselves but slaughtered man and beast, and all that stood in their way and minded not what they did. While this fury lasted they stopped at nothing; but when it left them they were so powerless that they did not have half of their normal strength, and were as weak as if they had just recovered from some sickness, and this fury lasted about one day.' An illuminating example of this is also given in Hervarar Saga, at the battle that took place at Sámsey.

The respect shown towards these heroes was always mingled with a sort of secret hatred, even in heathen times, for which their arrogance no doubt gave good cause. With the peaceful principles that the first Christian preachers tried to instil in the Barbarians of the north, the Berserks soon lost all their prestige, as an alleged connection with the devil caused their skill and their trade to be viewed with even greater horror. To be sure, fighting did not cease altogether, but the difference in attitude made it no longer permissible to use such sinister aids for the purpose. So the science died out with its practitioners; for a long time no further clue to the mystery was sought other than ascribing it to the assistance and co-operation of unclean spirits, so that not only did Prof. Verelius call it a *diabolical art*,[357] but even in this century two dissertations published at Uppsala propounded the same theory,[358] probably because the no doubt exaggerated accounts of these fighters which have been handed down to us, have been taken all too literally.

I am not of the opinion that these transports should be viewed solely as the effect of some special quality of temperament whereby such extraordinary motions can be induced by a mind in a state of violent ferment for, although we are not entirely without examples which could support such an assumption, the persons who suffer from such afflictions, between paroxysms, are not able to maintain the defiant arrogance which made the Berserks so hated even in times of peace. On the other hand, since the Plant-kingdom affords several means of creating such disorder in the mind and inducing the most frenzied attacks of folly, I am inclined to believe that the Berserks knew of some such intoxicating substance which they used when occasion demanded and which they kept as a secret among themselves so that their prestige with the public would not be diminished on account of the simplicity of the means employed.

That *Opium* could produce exactly the same effects is a matter of common knowledge. What we are told on this subject about the inhabitants of the island of Celebes and their opium-induced frenzies when they go to battle matches in every detail the accounts of the Norse Berserks of old. Kempfer's reports of the frenzies which were common practice in his day, in Java, and went by the name of *Hamuk*,[359] so strongly support the possibility that opium could turn people into Berserks, that the testimony of Alpinus can very well be omitted.[360] But since as yet no voyage to the Levant could have taught our ancestors this means; since as yet no Allen or Dillenius had discovered how to prepare opium from the poppy-buds of Europe, and there is still less reason to conclude that such attempts could have been thought of at that time in Sweden, although they subsequently succeeded in the case of Lindestolpe, one cannot reasonably trace Berserk frenzies to this intoxicating resin.

If *Atropa Bella Donna* were indigenous to our northern climes, the example[361] given by Mr. Gmelin the younger would throw considerable light on the question of Berserks. The same applies to several intoxicating substances found in India.[362]

A suitable preparation could also be made from the *Hemp* leaf, which would be sufficient to bring on this periodic bout of frenzy.[363] But since it is not yet certain whether the hemp of our climate corresponds to the southern variety which gives the Persians, Indians and Egyptians their *Bangve*, whose intoxicating properties have already been noted by Galeno, and of which the Turks still use a mixture to strengthen their tobacco, according to Dr. Russel's observations,[364] like the ancient Scythians who, according to Herodotus, were made giddy in the head from the smoke of its seeds, thrown on hot stones, and as it is also certain that this East Indian plant was not known in the North at such an early period, there is no likelihood that it could have been used for this purpose.

Of those native plants of ours which might be considered in this connection, several are known to have some intoxicating properties, although not in sufficient degree to warrant attention, such as *Crambe maritima*, *Lolium tremulentum* and others of which either a large dose is required to obtain such a powerful effect or whose influence is more likely to have rendered the Berserks incapable of committing the excesses ascribed to them in as much as, having a more soporific effect, they bring on drowsiness and apathy. *Datura stramonium* should also merit special consideration as its properties, which are not unknown to our Physicians, have been the subject of new studies by the same Mr. Gmelin.[365]

---

[357] Epist. Dedicatoria Hist, præfixa.

[358] One by Mr. Hamnell in 1709. De *Magia Hyperboreorum* who, on page 42, suggest that *Berserk frenzies were probably brought on by the devil*; the other by Mr. Ramelius, 1725, de *Furore Bersekio*, who, on page 24, regrets that *much as he would have liked to acquit the Berserks of the charge of dealing with the devil, he dare not take up their defence in the matter*.

[359] Am. Exot. Fasc. 3. p. 649. s. Opii deglutiunt bolum, quo intentionis idea exasperatur, turbatur ratio, et infrænus redditur animus, adeo ut stricto pugione, instar tigridum rabidarum in publicum excurrant, obvios quosvis, sive amicos, sive inimicos trucidaturi.

[360] de Med. Aeg. page 121.

[361] Russian Journey. Vol. 3, p. 361. 15 grains in wine made a Persian soldier light-headed.

[362] Diss. Linn. Inebriantia. S. 3.

[363] Alpin. *l.c.* p. 121. Kemph. *l.c.* p. 645.

[364] Nat. Hist. of Aleppo. page 83.

Of all Swedish plants, however, I consider the Fly-Agaric, *Agaricus muscarius*, to be the one which really solves the mystery of the Berserks. Its use is so widespread in Northern Asia that there are hardly any nomadic tribes there that do not use it in order to deprive themselves of their feelings and senses that they may enjoy the animal pleasure of escaping the salutary bonds of reason. The Ostyaks, the Samoyed, the Yukagir and others use it daily, and the *Chukchi* whose rigorous icy climate does not produce this mushroom, obtain it by bartering their reindeer, which are their most valuable possession. The dose of this poisonous substance is from 1 to 4 mushrooms, according to size. The Ostyaks can only tolerate one, or use a decoction of 3.[366] The Kamchadal drink it with a decoction of *Epilobium*.[367] Those who use this mushroom first become merry, so that they sing, shout, *etc.*, then it attacks the functions of the brain and they have the sensation of becoming very big and strong; the frenzy increases and is accompanied by unusual energy and convulsive movements. *The sober persons in their company often have to watch them to see that they do no violence to themselves or others*. The raving lasts 12 hours, more or less. Then lassitude sets in, culminating in complete exhaustion and sleep. Steller[368] reports the curious fact that the urine of persons under the influence of this mushroom possesses the same intoxicating properties. And that the Tungus Shamans, in the ceremonial use of their so-called magic drum, are accustomed to swallow a goodly draught of this urine so as to be able to fall into the epilepsy or ecstatic trance proper to this ceremony has been attested by Mr. Georgi,[366] with several pertinent comments, in his description of the peoples under the Russian Imperial Government. T. II, pages 329, 336.

What seems to me to point particularly to the Fly-Agaric in this case is the fact that its use is a custom from the part of Asia whence Odin, with his Aesir, made his celebrated migration to our North. For although the distiller's art subsequently devised a short cut to this ignominious abuse, and the use of the mushroom accordingly ceased in the region of the Danube, it none the less spread from that point with the northward-migrating Hordes, which still used it. And that the history of the Berserks in our North begins with the arrival of Odin, I find not only accepted by those who have produced all possible evidence from the dark annals of antiquity, but also consistent with the designs of a warlord who with a dozen raving men could make himself so feared and secure among alien tribes. The honour other warriors won for themselves by slaying a Berserk, whom they looked upon as a malefactor, seems to prove that the custom was not a native one. And as this mushroom, like similar substances, prematurely emaciates the human body and makes it insensitive and clumsy, it may have had the effect of inculcating Odin's principle of going to Valhalla in good time, through a voluntary death, over the precipice, so that the honour of the proven hero might not be dimmed, especially as statecraft demanded that a Berserk, as the foremost militia-man, should be regarded as invincible.

[In Ödman's account I have printed in italic the crucial sentence, the source of much misunderstanding. (Mörner **[**45**]** relies on it, quoting it in full.) Here it is:

> The sober persons in their company [*i.e.*, those who have taken the fly-agaric - RGW] often have to watch them to see that they do no injury to themselves or others.

This statement is unjustified. A careful reading of our many Exhibits fails to disclose a single case where a Siberian tribesman under the influence of the fly-agaric threatened either himself or others with injury. On the contrary, the effect is to calm the subject, to put him into a benign mood. Nor is there any reason to believe that this is a question of dosage. Members of the lower orders of the *Russian* community, discovering in the 18th century a surprising new inebriant and jumping to the conclusion that it must be similar to vodka but even more extraordinary, threaten themselves with injury when under its influence (*Vide* **[**4**]**, p. 236; **[**10**]**, p. 249), but the attentive reader will note with a weary smile that, like the tiresome exhibitionists whom we have all known, in every case the inebriated man always takes care to have a friend at hand to arrest his hand. The

---

365. Gmelin. *l.c.* Tom. I. p. 43. A man who gathered the seeds of Datura at Voronezh was asked what he used them for, and replied that one put them in beer to make the intoxication greater.
366. *Vide* Georgi **[**6**]** - RGW.
367. *Vide* Krasheninnikov **[**4**]** - RGW.
368. *Vide* Steller **[**5**]** - RGW.

one case in the *Russian* community of a suicide **[**4**]** is only hearsay, as Krasheninnikov takes pains to make clear. We may all suspect what that means in the context of the people Krasheninnikov was dealing with. He says the natives take the fly-agaric before going out to kill someone but he gives no support for his statement. He did not know the native language and he relied largely on Russian informants. His own colleague Steller does not repeat this, and the many later observers who knew the country from long experience, some of them professional linguists speaking the local languages, fail to confirm it. Krasheninnikov was an astute observer trying to arrive at the facts through a screen of questionable informants. He should be admired as a worthy period piece, certainly not quoted as an authority on the fly-agaric in 1968. After all, we no longer consult Benjamin Franklin or Lomonosov on physics, great and revered figures though they be. ... As for Ödman, why should anyone cite him today?]

[44] Schübeler

SCHÜHUBELER, Fredrik Christian. Viridarium Norvegicum I. Norway. 1886. pp. 224-226.

[After identifying *Amanita muscaria* by the various vernacular names current in the chief countries of western Europe, our author, the Norwegian botanist, continues: - RGW]

In old Norwegian historical writings there are many references to the fact that in olden times there was a particular type of warrior known as Berserkers, *i.e.*, men who at times were seized by a wild fury which temporarily doubled their strength and made them oblivious to bodily pain, but at the same time numbed all humanity and reason and made them resemble wild beasts. This rage, which was called Berserksgang, occurred not only in the heat of battle but also in the course of strenuous work, so that those who were possessed by it accomplished things that otherwise would appear beyond human strength.[369] This condition is said to have begun with trembling, chattering of the teeth and a sensation of cold, after which the face swelled up and changed colour. Along with this went a fierce passion, growing into a positive fury, during which they howled like wild beasts, bit the edges of their shields, and hewed down everything that came in their way without distinction of friend and foe. When the attack had passed it was followed by an intense apathy and lack of energy, which might last for a day or more.[370]

Even while I was a medical student, and later as a practising doctor, I had a special predilection for toxicology, and particularly the poisons that come from the vegetable world. I have a lively recollection that all that long time ago by comparing all the symptoms that appeared during the so-called Berserksgang, I came to the conclusion that this paroxysm could scarcely be anything else than a kind of intoxication, the symptoms of which closely resembled the effects of *Amanita muscaria*. When one compares with this the descriptions by Krascheninnikov, Steller, and Erman of the symptom seen in the state of intoxication reached by the Kamchadals and other peoples of north-east Asia after partaking of fly amanita, then the correspondence is so unmistakable that my previous hypothesis has all the appearance of fact. Some time after I had reached this stage, I discovered by serendipity that the Swedish Professor Samuel Ödman expressed the same opinion a hundred years ago, though without offering any special evidence for the rightness of the theory.[371]

The reports given by the above-mentioned Russian authors may be summarised thus:[372] since the Kamchadals came into closer contact with the Russians they have begun to drink brandy, and to leave the use of fly amanita to their nomadic neighbours the Koryaks, for whom they now collect the fungi, which can profitably be exchanged for reindeer. - The first symptoms to appear in one who has drunk a 'liqueur' made from fly amanita and the juice of *Epilobium angustifolium* are: a characteristic trembling in every limb; half an hour later he begins to rage, and according to his temperament he then becomes either merry or morose. - The drunkenness has, in fact, a certain resemblance to that caused by wine or brandy, in that the drunken person,

---

369. Eyrbyggja Saga 28. Landnamabók III. 20. P. A. Munch. The History of the Norwegian People. Christiania, 1852-63. Part 1, Vol. 2, pp. 172-3.
370. R. Keyser. Collected Works. Christiania, 1868, p. 355 ff.
371. Kongl. Vetenskaps Academines nya Handlingar (Royal Scientific Academy's Recent Proceedings). Vol. 5, 1874, p. 240 ff.
372. Cf. Emile Boudier. *Die Pilze in ækonomischer, chemischer und toxikologischer Hinsicht*. Uebertragen und mit Anmerkungen versehen von (The economic, chemical and toxicological aspects of fungi. Translated and annotated by) Dr. Th. Husemann. Berlin 1867, p. 118 ff.

being more or less unconscious, almost invariably grows jolly and only rarely morose. The face becomes red and swollen, as if from extravasated blood, and the drunken men now begin to say and do many involuntary things. - Those who are only mildly affected feel themselves very light of foot and appear inclined to all kinds of bodily activity. The slightest irritation has an unduly strong effect on nerves rendered abnormally sensitive. Some display a muscular strength which in normal conditions would be impossible. Eye-witnesses have reported that a person who ordinarily would have great difficulty in even lifting such a load, has carried a sack of flour weighing 120 pounds a distance of 15 versts (10 miles). - 'The Kamchadals also confirmed what I had already been told in Tigilisk (Ust Tigil) about the intoxicating property of fly amanita, and assured me further that it is not eaten in Sedanka, but only collected for the Koryaks, who in winter will often give a reindeer for a single specimen.'[373] - 'The fly amanita (Muchamor) is very rare in the northern part of Kamchatka, and the Koryaks first learned its properties from the fact that the flesh of a reindeer that had eaten this fungus had just as intoxicating an effect as the plant itself. From the experience thus gained, instinct gradually taught them to enjoy the delights of this precious ware in the most economical way, by keeping the urine of a person intoxicated with fly amanita and later using it as a very effective intoxicant.' - 'As an example of the striking increase in muscular power, a man related that when he had swallowed a portion of fly amanita in the morning he could work without difficulty during the hay-making season from morning to night, and accomplish as much as would otherwise require three men.'

Our celebrated historian P. A. Munch is of the opinion that the Berserksgang was nothing but 'a periodically returning madness'.[374] I cannot share his view, but insist that the berserksgang was induced by some stimulant or other, and specifically by the fly amanita. The probability that this is so is greatly strengthened by the fact that the symptoms described above, both of Berserksgang in Norway and of the effects of fly amanita in Kamchatka, are presented with an accuracy as congruent as if they were written by a keenwitted doctor familiar with all kinds of sickness. Moreover the most peculiar symptoms that accompanied Berserksgang were always repeated in the same form, and the whole thing ceased some time after the introduction of Christianity (about A. D. 1000) had brought a purer ethical standard. It is true that Berserksgang was regarded, both by those who suffered from it and by onlookers, at times at least, as so great an infliction that even the Icelander Thorstein Ingemundsøn made a vow to the Gods in order to free his brother Thorer from this misfortune (Utími).[375] This may, however, also be explained by saying that Thorer in his better moments may have recognised his deplorable condition, but that he found it just as difficult to break free from it as those who now drug themselves with opium or hashish, or even those who have succumbed to an excessive consumption of spirits.

Here may be mentioned also what is related (in the Droplaugar sona-saga p. 3) of the Icelander Thrymketil;[376] but according to what Professor Konrad Maurer of Munich has told me personally, this account is nothing but an addition which an Icelander in the latter half of the last century wove into the Saga.

And if, as appears to me to be established beyond doubt, use was made of some stimulant or other, this cannot have been either beer, mead, wine or brandy, as the effect of all these is very different from what is described here. Moreover, brandy was not known in Norway before 1531, when it was called 'Aqua vitaæ'.[377] And, of course, there can be no question of opium or hashish in this country so long ago. A motive for the constant use of fly amanita as an intoxicant can also be found in the fact that it produces the same phantasms and visions as hashish or opium.[378]

---

[373] George Kennan says that in spite of the fact that the Russian Government has forbidden the sale of fly amanita to the Koryaks, this trade still flourishes. He has, in fact, himself witnessed that a single specimen has been exchanged for furs to a value of 20 dollars. (George Kennan. *Tent Life in Siberia*. London, 1871, p. 139).

[374] P. A. Munch. *The History of the Norwegian People*. Part 1, Vol. I, p. 790.

[375] Vatnsdöla Saga. Ch. 30. 37. - P. A. Munch, *The History of the Norwegian People*. Part 1, Vol. I, pp. 790-1.

[376] R. Keyser. *Collected Works*. Christiania, 1868, p. 356.

[377] Collected Examples for the Language and History of the Norwegian People, 2, pp. 48-49. The English name 'whisky' is a corruption of the Celtic word 'usquebaugh', *i.e.*, 'water of life'. (F. W. Pavy. A Treatise on Food and Dietetics. 2nd Ed. London, 1875, p. 240)

[378] Emile Boudier *l.c.*, p. 124 (Husemann's annotation).

Although the old historical records do not say so, it seems reasonable to suppose that the means that was used to induce the state in question must have been kept a secret. The Berserkers were feared by all, and could, in a sense, enforce whatever they wished; it is therefore in the nature of things that they did all they could to retain this extraordinary respect from the common people. So the knowledge of the stimulant was probably passed on as a secret from man to man. Even in our own time, even in our own capital, it is well known that there are certain 'secret' recipes that are bequeathed from parents to children.

The less enlightened part of the population naturally saw the Berserksgang as a supernatural phenomenon, to be ranked with enchantment and suchlike wonders; it may even have been believed that the Berserkers were possessed by demons; but this cannot have been the case with well-informed people. That even as early as the beginning of the 11th century Berserksgang was regarded as a condition for which the sufferers were themselves responsible is clearly indicated by the following: before Erik Jarl left Norway, he called together in 1015 the noblemen and the most powerful peasants to consult them about the laws and government of the kingdom. At this meeting single combat was abolished, and Berserkers and robbers were outlawed.[379] In Thorlak's and Ketil's Icelandic Church Law[380] which was adopted in 1123 as the law of Iceland, there appears the following passage: 'If any man goes Berserk, he is to be punished with three years' banishment (Fjörbaugsgar), and the same applies to those men who are present if they do not bind him, but if they bind him no one shall be punished. Each repetition of the offence will he be punished.' Any comment on this would appear to be superfluous.

[45] Mörner and Hildebrandsson

> MÖRNER, Carl Th. Några erfarenhetsrön om de högre svamparna: Kritisk öfversikt. (Some observations on the higher fungi) Published in Upsala Läkareförenings Förhandlingar, Vol. XXIV, 1-2. Upsala. 1919.

[On November 1, 1918, Carl Mörner read a paper on the higher fungi before the Royal Scientific Society in Upsala. Mörner was a well known professor of physiology and an excellent amateur mycologist. In the discussion that followed the reading of his paper Professor H. Hildebrandsson, who held a chair in meteorology, told of an episode that had happened in 1814 when Sweden and Norway were engaged in a short war with each other. When Mörner published his book on mushrooms in 1919 he inserted a paragraph giving the substance of what Hildebrandsson had said. This is in the second of the two paragraphs that we quote from Mörner's book: - RGW]

Described in popular terms, a mild or medium-severe attack of poisoning resembles a state of alcoholic intoxication in a person who cannot hold his liquor. 'The Kamchadales,'[381] to quote E. Fries, 'make an intoxicating drink [from the fly-agaric], and it has been suggested that the fly-agaric was used in our country in olden times to bring on the so-called berserk furies'. This last-mentioned piece of information is obviously based on S. Ödman's 'Attempt to Explain the Berserk Frenzies of the Old Norse Warriors on the Basis of Natural History' (1784), an interesting work of which a brief outline may be given at this point. After dismissing opium, belladonna, hemp and the like as out of the question for the North, particularly at that time, Ödman expresses the following opinion: 'Of all Swedish plants, however, I consider the Fly-agaric, *Agaricus muscarius*, to be the one which really solves the mystery of the Berserks'. Explaining his reasons for this belief, he gives the following classic description of the notorious amanita intoxication: 'Its use is so widespread in Northern Asia that there are hardly any nomadic tribes there that do not use it in order to deprive themselves of their feelings and senses that they may enjoy the animal pleasure of escaping the salutary bonds of reason. ... The dose of this poisonous substance is from 1 to 4 mushrooms, according to size. ... Those who use this mushroom first become merry, so that they sing, shout, *etc.*, then it attacks the functions of the brain and they have the sensation of becoming very big and strong; the frenzy increases and is accompanied by unusual energy and convulsive movements. *The sober persons in their company often have to watch them to see that they do no violence to themselves or others*. The raving lasts 12 hours, more or less. Then lassitude sets in, culminating in complete exhaustion and sleep'.

---

[379] Grettis Saga. Ch. 19.
[380] Grágás, Finsen's Edition. Ch. 7, pp. 22-23.
[381] Other authors also mention the Koryaks, Ostiaks, Samoyedes, and Chukchi as using fly-agaric for purposes of intoxication.

According to the observations of an officer of the Värmland regiment, fly-agaric was also used at a much later date in order to induce a good fighting spirit. In the course of an advance during the 1814 war, he noticed that some of the men were seized with frenzy and foaming at the mouth. This was traced, on investigation, to the cause just mentioned.[382]

[It is unfortunate that Mörner did not get from Hildebrandsson the source of his account; it would have been easy at the time to do this. Recent efforts by Bo Holmstedt, Professor of Toxicology at the Karolinska Institutet, Stockholm, to find confirmation for the episode have been unavailing: he can discover no local tradition in Värmland relating to it, and he is an extraordinarily resourceful man. Hildebrandsson's reputation as a meteorologist was high; his scholarship above reproach. But in this case he was not in his own field and he was volunteering a remark in a discussion following a lecture. Should not a careful person ask himself how much weight to give to such an utterance, even from a man of Hildebrandsson's standing? - RGW]

[46] Nordhagen

> NORDHAGEN, Rolf. Fluesopp of Berserkergang. (Amanita and Berserk Frenzies) Published in the Norwegian newspaper *Aftenposten*, Jan. 11, 1930.

[Professor Nordhagen held the chair in botany at Oslo University. - RGW]

In an article, Dr. F. Grøn has launched an attack on the late Professor Schübeler's theory that Amanita were the cause of berserk frenzies. Since my own name is also mentioned in the article, on account of a popular piece I wrote for *A-Magasinet*, in which I took a sympathetic view of the theory, I should now like to be allowed to make a few remarks on the subject. For Doctor Grøn's article suffers from one grave defect - several very important elements are passed over in silence, although they are of crucial significance for anyone wishing to adopt a stand on the theory.

It would never have occurred to me to resurrect Professor Schübeler's theory had I not come across a thoroughly modern work on mushroom-poisoning which strongly supports the theory. I am thinking of the book by the eminent Swedish scholar, Professor Carl T. Mörner, entitled: 'On the Higher Mushrooms' (Uppsala, 1919). Since Mörner is a physician and professor of physiological chemistry, considerable importance must be attached to his statements.

In the chapter on Amanita, Mörner deals first with the two varieties which can be considered relevant in this context, that is, *Amanita muscaria* and *Amanita pantherina*. He quotes at length the Swedish professor S. Ödman, who in 1784, that is, long before Schübeler's time, published a famous dissertation entitled 'Attempt to Explain the Berserk Frenzies of the Old Scandinavian Warriors, on the Basis of Natural History', in which he maintains that the berserks know how to use Amanita in order to put themselves in a suitably martial mood. In this connection Mörner produces some extraordinarily interesting information which militates strongly in favour of the theory.

In the first place he mentions a detail which Professor H. Hildebrandsson reported in 1918 after a lecture given by Mörner at the Royal Scientific Society in Stockholm. During the advance of the Värmland regiment in 1814, a Swedish officer noticed that some of the men were 'raving' and foaming at the mouth. *An investigation revealed that these soldiers had eaten Amanita in order to be in proper fighting fettle!*

This piece of information strikes me as being extremely important and I am surprised that Dr. Grøn does not say a single word about either Mörner's book or this particular episode. The soldiers of the Värmland regiment cannot possibly have hit on the notion of eating Amanita by themselves. There must undoubtedly be a popular tradition behind the whole story which may very well have survived from Viking times. In his important articles on Norwegian folk medicine, Reichborn-Kjennerud has demonstrated the antiquity of many of the household remedies which are sometimes applied to both humans and animals even today in our rural areas.

---

[382] This was reported by Professor H. Hildebrandsson in connexion with a lecture given by the author to the Royal Scientific Society on 1 Nov. 1918.

Secondly, Mörner reports a very important case of mushroom-poisoning (no doubt from *Amanita pantherina*) which occurred at Malmö in 1908. A German workman had consumed a plateful of poisonous fungi. After a bare one and a half hours he became light-headed and had to be taken to hospital. Violent fits of mania soon ensued; the patient sang, shouted, laughed and ground his teeth as he jumped about on the bed and hit out with his arms. On account of this he had to be transferred to the psychiatric department and, in the course of this, he put up a furious resistance, manhandling the attendants. The spectacle continued until 4 a. m., when he fell asleep, and the next morning he was 'perfectly fit' again.

Speaking of this case, Mörner says that it may be described as a 'complete berserk frenzy'.

It would take far too long to discuss all the theories put forward on the subject during the past hundred years. But as Mörner is a specialist in toxicology (in his book he mentions no less than 170 different works that are basically toxicological in content!), it will not do to contend, as Dr. Grøn does, that modern toxicological research knocks the bottom out of the Ödman-Schübeler theory.

I also think that he passes rather lightly over all the accounts which exist of the use by primitive Siberian peoples of Amanita as an intoxicant. We cannot escape the fact that the old explorers' descriptions of the course taken by the 'intoxication' tallies very closely with the berserk symptoms. That the intoxication very often takes a far quieter form is established beyond all doubt. But this by no means disproves the theory. Here as in the case of other poisons it depends on the size of the dose. It may be noted that Amanita, like tobacco, are highly prized by Northern Siberian tribes, and that they therefore undoubtedly economize with the precious substance. My colleague Professor H. U. Sverdrup has told me a hair-raising tale about the exorbitant price demanded for a single specimen of Amanita in the region of the Bering Strait. But that is another story, as Kipling says. Experience has obviously taught these people to arrive at the most appropriate dose. Besides, in the last few generations Amanita has steadily been supplanted by hard liquor all over Siberia, so conditions are now not nearly so favourable as they were for the study of Amanita intoxication.

Bergen, January 1930.

[47] Kuylanstierna-Andrassy

KUYLENSTIERNA-ANDRASSY, Stella. Pustan Brinner. Stockholm. 1948. pp. 92-93.

[The author is a Swedish lady married to an Hungarian nobleman, Count Imre Andrassy. The book is autobiographical. The title means, 'Burning Plain'. The chapter from which we quote is entitled, 'Svarta mässan i Fehérvár', or The Black Mass in Fehérvár. It tells of an experience that the author went through at the end of the second World War, in 1945, when the Russian forces occupied the town of Fehérvár momentarily. Her account follows: - RGW]

All private cars are to be instantly present at Apponyitér, the radio announced one day in November.

Imre [her husband] came and collected me in our car and then we drove to the market place where the cars were to assemble. A doctor with dressings was placed in our car. The marching column was formed and the caravan, numbering about 150 cars, snaked its way out of town.

As usual, we drove with secret orders. Only the chief of the column knew where we were headed. We drove southwards. It had been said in the news that the town of Fehérvár had been liberated from the Russians the same day. We guessed that we were on our way there to bring help to the liberated people.

Our guesses came true. The goal was the old Hungarian coronation town, a beautiful country town famous for its cathedral in baroque style. We arrived there in the afternoon. The town was small where before the war there lived only 40,000 people. But the town had great strategic value. Through it runs the auto route down to the Balkans and the main road to Vienna. Through it passed the big oil line from Lispe. The Germans had determined to hold it at any price, but one day when the Panzers became stuck in the bottomless clay the Russians had taken it by surprise. Now it had been recaptured by a counterattack. A Hungarian officer whom we met at the market place in front of the cathedral related to us how this had happened.

'The Russians came stealthily in the November mist immediately before dawn. They came through the maize fields which rustled where the harvest had not been brought in because of lack of people. They succeeded in passing over the Danube without being seen at the big marshes near Baja, where one thought it would be impossible for human beings to advance. The spearhead consisted of 'convict battalions', recruited from among the worst criminals and loose people in the Red Army. In their nostrils they had pieces of cotton soaked with a curious mushroom poison that transforms human beings into beasts. Some of them were captured by us. When the effects of the poison started to wear off, they shouted and cried as though obsessed. They raged and bit like dogs mad with rabies and thereafter fell to the ground in a deep sleep.'

[Under the tensions that must have existed at that horrible moment in Fehérvár, it was not to be expected that the details needed to satisfy scientists in peace-time would be forthcoming. Cotton wads soaked with 'mushroom poison' were in the Russian nostrils. How did they breathe? The inquirer naturally would like to know what kind of mushroom it was. There is no hint, in the Russian writings about war through the ages, of such a practice. The minor nationalities of Siberia, where the fly-agaric is used, certainly did not make up the contingent of Russian troops, since they are far too few in number and the Russian authorities frown on their consumption of the fly-agaric. The reports concerning the Altaïc peoples of Siberia indicate that mushrooms (except for *Fomes fomentarius*, used as tinder for making fire) play almost no rôle in their lives. - RGW]

CITATIONS FROM THE ṚGVEDA

The following verses from the ṚgVeda are cited in our text. Where the page numbers arc printed in italic, the text of the verse is quoted in whole or in part.

Maṇḍala I	Page
32^{6}	139 ftn. 6
43^{9}	*51*
46^{10}	*37*
80^{2}	141 ftn. 7
84^{8}	*63*
87^{5}	*46*
119^{9}	*61*
135^{3}	*37*
137^{3}	*44*
161^{11}	*62*
187^{7}	68 ftn.
Maṇḍala II	
13^{1}	*44*
Maṇḍala III	
36^{6}	*44*
43^{7}	141 ftn. 7
45^{4}	117 ftn. 2
48^{2}	98 ftn. 5
48^{3}	*43*
53^{14}	122 ftn. 5
Maṇḍala IV	
1^{19}	*44*
3^{9}	125
18^{13}	141 ftn. 7
23^{1}	*43*
26^{6}	141 ftn. 7
57^{6}	117 ftn. 2
Maṇḍala V	
43^{4}	*22, 44*
45^{9}	141 ftn. 7
51^{4-7}	*27*
85^{2}	*22*
Maṇḍala VII	
86^{6}	*15*
101^{1}	*43*
Maṇḍala VIII	
9^{19}	*43, 44*

48^{6}	39
Maṇḍala IX	
1^{6}	98 ftn. 2
2^{5}	*47*
2^{6}	*38*
5^{10}	142 ftn. 3
9^{4}	*46*; Pl. X, fac. p. 48
10^{5}	*52*
10^{8}	*46, 50*
10^{9}	*47*
11^{2}	*28*
11^{5-6}	*28*
12^{4}	*51*
13^{3}	60, 109 ftn. 4
15^{6}	59
18^{1}	*22*
22^{2}	39
27^{3}	*45*
27^{5}	*38*
28^{5}	*38*
37^{4}	*38*
42^{3}	60, 109 ftn. 4
46^{1}	*22*
47^{1}	31 ftn.
61^{8}	*38*
61^{13}	136 ftn. 4
62^{4}	*22*
62^{5-6}	*28*
62^{15}	*22*
63^{7}	*38, 56*
63^{8}	*38*
64^{7}	*38*
64^{9}	*38*
66^{1-3}	*26*
66^{5}	*26, 52*
66^{19-21}	39
67^{23-24}	39
67^{22-25}	*53*
68^{1}	41 ftn., *43*
$68^{4, 7}$	30 ftn.
68^{4}	*45*
68^{6}	141 ftn. 7
69^{1}	*43*

69^{5}	*40*; Pl. VII, fac. p. 48
69^{8}	*46*
70^{7}	*41*, *42*; Pl. IX, fac. p. 52
70^{8}	31 ftn.
70^{9}	*55*
70^{10}	*55*
71^{2}	*40*, 41 ftn.; Pl. V, fac. p. 42; Pl. VI, fac. p. 44
71^{4}	*22*, *46*
71^{9}	*38*
72^{2}	*56*
$72^{2, 4, 5}$	30 ftn.
72^{5}	*56*
72^{6}	*44*
72^{7}	*47*
73^{8}	*54*
74^{2}	13 ftn. 3, 47
74^{4}	*29*, *30*, *50*
75^{2}	*58*; Pl. XIII, fac. p. 58
$75^{3, 5}$	30 ftn.
76^{3}	*56*
76^{4}	*38*, 52, *53*
77^{2}	141 ftn. 7
78^{2}	30 ftn.
79^{4}	*50*
80^{2}	*56*
80^{3}	*56*
80^{4}	30 ftn.
81^{1}	*57*
82^{2}	41 ftn.
82^{3}	4 ftn., *22*
83^{1}	*53*
83^{2}	*54*
83^{3}	*18*
83^{5}	59
85^{5}	*57*
85^{10}	*22*
86^{2}	*57*
86^{3}	*57*
86^{16}	*57*
86^{19}	*57*
$86^{20, 22, 34}$	30 ftn.
86^{22}	*39*, *57*
86^{23}	*58*

86^{24}	141 ftn. 7
86^{26}	41 ftn.
86^{29}	*39*
86^{30}	*54*
86^{32}	*39*, 52, *54*
86^{35}	*47*
86^{40}	*52*, 59; Pl. XII, fac. p. 58
86^{44}	*41*
86^{46}	41 ftn., *47*
87^{1}	30 ftn.
87^{2}	*48*
87^{8}	*23*, 68 ftn.
89^{6}	*48*
91^{2}	30 ftn.
$91^{2\text{-}3}$	138
91^{3}	*54*
93^{3}	*46*
95^{1}	30 ftn., 41 ftn.
95^{4}	*23*, *45*
97^{5}	30 ftn.
97^{9}	*41*, *42*; Pl. VIII, fac. p. 50
97^{13}	*37*, 41
97^{31}	*39*
97^{33}	*39*
97^{41}	*39*
97^{46}	*47*
97^{55}	*55*
98^{9}	*23*
99^{1}	41 ftn.
99^{7}	31 ftn.
99^{8}	30 ftn.
101^{3}	30 ftn.
107^{5}	*43*
107^{12}	16, *45*, 138
107^{16}	30 ftn.
107^{26}	41 ftn.
108^{12}	41 ftn.
108^{15}	30 ftn., *58*
108^{16}	*48*, *58*
109^{6}	*48*; Pl. XI, fac. p. 56
109^{8}	30 ftn.
109^{15}	*28*,30 ftn.
$109^{17\text{-}18}$	*28*

109[18]	30 ftn., *58*
111[3]	*39*
113	127 ftn. 6
Maṇḍala X	
11[4]	141 ftn. 7
71[5]	117 ftn. 2
85[3]	*14*
90[14]	48
97[15]	117 ftn. 2
99[8]	141 ftn. 7
136	129, 131
144	141 ftn. 7
146[5]	117 ftn. 2

Index

Numbers in heavy brackets **[ ]** refer to the Exhibits.

Aalto, Pentii: 140
Academy (journal): 116-120
Adam and Eve, legend of: 178-180, 220-222
ādāra: 96
Afghan Frontier Delimitation Commission: 115-117, 120
Afghan grape: *vide* Soma, theories about identity of
Afghanistan: 3, 14, 141
Agaricus campestris: 64
Agaricus hortensis: 64
Agaricus muscarius: 268, 278, 345, 352
Agaricus pseudo-aurantiacus: 200
Agni: 3, 39. 51-53, 204; Pl. V, fac. p. 42
Agrawala, V. S.: 17
ahichatrikā: 63
Ahriman: 102
Aitchison, I. E.: 117, 120
Ajanta: 90
Akadémiai Kiadó: 224, **[**38**]** 315
Albanians: 173
alcoholic beverage: *vide* Soma, theories about identity of
alcool: 17, 331
Alfred, King, and pancakes: 86
Alparslan, Orhan: 49
Altaīc: 209, 211, 217, 241, 356
amadou (French for 'touchwood'): 170
Amanita (= fly-agaric) girls: 288 ff.
Amanita cæsarea: 194
Amanita muscaria (Fr. ex L.) Quél.: 10, 50, 61 ftn., 143, 146, 179, 199, 200, 201 ftn. 1, 202, 251, 254, 257, 260, 305, 315, 322, 334, 348, 353
Amanita muscaria var. *Camtschatica*: 247
Amanita pantherina: 353-354
Amanita phalloides: 192
Amanita verna: 192
Amanita virosa: 192

Amanitas: 71 ftn., 72
Amarako&sacute;a (*Amara Siṃha*): 62, 98 ftn. 1, 102 ftn. 5, 103 ftn. 4, 126 ftn. 3
ἄμωμος, *amomum*: 102
ἀμβροσία: 125, 130
amoroto (Basque for 'toadstool'): 187
amṛta: 30, 33-34, 63, 130, 155, 172
amṛtavallī: 123
aṃ&sacute;ú: 44, 45, 47, 61, 63, 96, 137
Amu Darya River (Oxus): 114; Map A, fac. p. 154
Amur River: Map A, fac. p. 154
Anadyr River: 159, 273, 274, 275; Map C, fac. p. 154
ándhas: 62
ἄνθος: 62
Andrews, George: 146 ftn. 2
Anglo-Saxons: 173
Anquetil-Duperron, A. H.: 102, 106
Āpastamba: 100
aquavitæ: 17, 332
Arian: *vide* Aryan
Aristophanes: 102 ftn. 1
arjunāni: 97
aruṇá: 37, 96
aruṣá: 37
Aryan: 3, 4, 12, 13, 15, 49, 64, 68, 76, 107, 115-116, 120-122, 127, 129, 132, 136 ftn. 4, 137, 142 ftn. 1, 165, 169, 172, 203, 209, 210, 218
Asafætida: 116
Asclepias sp.: *vide* Soma, theories about identity of
A&sacute;vins: 61
atasá: 140
Atharvans: 28
Atharvaveda: 46 ftn. 1, 132
Atlasov: **[2]** 233
Austerlitz, Robert: 224
Avesta: 12, 19-21, 32, 68, 95, 100-102, 106, 108, 116, 121-122, 127, 132,137, 144
Avesta, *Hōm Yašt*: 19-21, 100
Avesta, *Yasna*: 9-11, 32, 100, 101
Axis of the World: 214, 220
Āyurveda, *-ic*: 100, 107, 116, 118, 13
Aztecs: 3

Babhrú: 37
Bailey, H. W.: 21
Baker, J. G.: 117
Balázs, J.: 166, 330; - and *paŋχ* cluster, **[38]** 315-318
Balfour, Edward: 99 ftn. 4, 113 ftn. 4, 119
Balkhash, Lake: Map A, fac. p. 154
Balov, J.: 338
banha: 166
banyan tree (*Fica religiosa*): 97
barley: 106, 110, 118, 130
Barnard, Mary: 211, 220
Barnett, L. D.: 129
Bartholomæ: 21
Basella sp.: *vide* Soma, theories about identity of
Basham, A. L.: 139
Basques: 173, 198

Bassia sp.: *vide* Soma, theories about identity of
Baykal, Lake: Map A, fac. p. 154
Bazanté, Gabrielle: 201 ftn. 1
Beelzebub: 195, 196
beer: *vide* Soma, theories about identity of - fermented drink
'bemushroomed': 164, 207-208, 304
Benveniste, Emile: 101, 102 ftn. 1
Berezovo: 281; Map A, fac. pag. 154
Berg, Lev Semenovich: 237, 238
Bergaigne, Abel: 4 ftn., 39, 58, 68, 111, 218
Bergman, Sten: 241, **[27]** 285
Bernadakis: 101
Bernadotte, J.-B.: 184
Berneker, Erich: 168
berserk-raging: *vide* fly-agaric and berserk-raging
Betula nana: 213, 256
Bhagavad Gītā: 8, 102
bhang (*bhañgá*, *bhañgā*): *vide* Soma, theories about identity of, - *Cannabis sativa*
Bhāvaprakā&sacute;a: 100
Bhawe, S. S.: 6 ftn. 1, 12, 31, 46, 47, 52, 56, 59, 67
Bhishagratna, K. L.: 125
Bhṛgu: 34
bhṛṣṭí: 59
bhūmi kavaka: 64, 65
bhūrja: 218
bhūstṛṇa: 64
Bibra, Ernst von: 322, 324-326
Big Indian: 173
bilberry (*Vaccinium uliginosum*): 154, 248, 251, 324
birch: 13, 23-24, 35, 41, 218; exalted rôle of, among Siberian tribesmen 211-222; *vide* also fly-agaric and birch
Birdwood, George Christopher: 108
Bloomfield, Maurice: 125
Boas, Franz: 165, 166, **[31]** 306 - and *poŋ* cluster, 306
Bodleian Library: 95
Boetticher, Paul Anton: *vide* Lagarde, Paul Anton de
Bogoraz, Vladimir: 45, 157, 159, l6l, 195, 208, 213 ftn. 2, 265, 266, 271 ftn., **[22]** 273-279, 276 fig., 322, 338
Bohus, Gabriel: 224
Boisacq, Emile: 168
boletos: 71, 72 ftn.
Bollingen Foundation: 224
Bondartsev, A. S.: 238
Borhegyi, Stephan F. de: 175 ftn. 1, 224
Börnmuller, J.: 122
Bory, Michelle: 179
Bosch, Hieronymus: 195: Pl. XXII fac. p. 196
Böhtlingk, Otto: 107
Bouda, Karl: 166; - and *paŋχ* cluster, **[35]** 313
Bouteneff, Ekaterina Apollinarievna: 202
Bowden, K.: 61 ftn.
Brahmans: 4, 7, 8, 14, 69, 78, 99, 104, 112, 117, 127
Brāhmaṇas: 95 ff., 107, 111, 116, 123, 135, 138, 143
Brāhmaṇas - Aitareya Brāhmaṇa: 97 ftn. 2
Brāhmaṇas - Kauṣītaki Brāhmaṇa: 97 ftn. 6
Brāhmaṇas - &sacute;atapatha Brāhmaṇa: 24, 95 ftn., 120, 127, 128, 135 ftn. 2

Brāhmaṇas - Taittirīya Brāhmaṇa: 96, 97 ftn. 9
Brāhmaṇas - Tāṇḍya Brāhmaṇa: 96, 97 ftn. 1
Brāhmaṇaspáti: 53
brandy: 138; *vide* also *aquavitæ*, *vodka*, *Branntwein*
Branntwein: 16
Brekhman, I.I., and Sem, Y. A.: 151, 209 ftn., 211 ftn. 1, **[**42**]** 334-338
Brightman, Frank H.: 179
British Museum: 95
Brunnhofer, Hermann: 125
Buchwald, N. Fabritius: 239
Buddaya&sacute;as of Kabul: 65 ftn.
Buddha, death of: 65
buffalo: 42
bull: 36, 37, 41, 42
bull - sharpened shining horns of: 42
Bulliard, Jean Baptiste: 200, 202
Burnell, Arthur Coke: 110, 112, 123
Burnouf, Eugène: 36, 106, 108
Burrow, Thomas: 13
Bursōē: 77-78, 84

Cæsalpinia sp.; *vide* Soma, theories about identity of
Caland, W.: 58, 124, 125 ftn. 1
Calonyction sp.: *vide* Soma, theories about identity of
Calotropis sp.: *vide* Soma, theories about identity of
Cambodia: 63
caṇḍāla: 33-34
Cannabis sativa (= *C. indica*): *vide* Soma, theories about identity of
'cap' of mushroom: *vide* Soma 'head'
Carey, William: 103
Carroll, Lewis: 187
Castrén, Matthias Alexander: 165, 166, 310
Catalonia: 180
Catskills: 173
Centella sp.: *vide* Soma, theories about identity of
cèpes: 72 ftn.
Ceropegia sp.: *vide* Soma, theories about identity of
champignon de Paris: 64
chattra: 63, 64
Chaucer, Geoffrey: 182, 188
Chavannes, Ed.: 72, 73
Cheremis: 166, 167; Map A, fac. p. 154; Map B, fac. p. 154
chimney-sweep and fly-agaric: 204 fig.
Chopra, I. C.: 138 ftn. 1
Chopra, R. N.: 138
Chou Ch'i-k'uên: 223
Chukchi. 10, 165, 166, 195, 197, 243, 255 ff., 265, 271, 273 ff., 305, 334, 336, 346; Map A, fac. p. 154; Map C, fac. p. 154
Chukotka: 159, 160, 167, 194, 305, 333, 334, 336; Map C, fac. p. 154
Chunda: 65
cinnabar: 219 ftn.
Clark, J. G. D.: 239
Clovis, vase of King: 86
Clusius, Carolus: 199, 201
Cocculus sp.: *vide* Soma, theories about identity of
coconut palm: *vide* Soma, theories about identity of, - fermented drink

Cohen, Chapman: 127
Colebrooke, H. T.: 102, 103 ftn. 4, 104
Compositæ: *vide* Soma, theories about identity of
conifer: 13, 23-24, 41
Conklin, Harold C.: 213 ftn. 3
Conyza sp.: *vide* Soma, theories about identity of
Corner, E. J. H.: 239
Coromandel coast: 110
Cosmic Tree: 215, 220
crane, demoiselle: 91 ftn.
crapaudin: 10, 35, 187, 194
creeper: 14, 47, 96, 97, 98, 136, 140, 141; *vide* also *Soma-vallī*, *-latā*, *-lutā*, *shom-luta*
Crinum sp.: *vide* Soma, theories about identity of
crowberries (*Empetrum nigrum*): 324
Cynanchium sp.: *vide* Soma, theories about identity of

Daniélou, Alain: 141
Darmesteter, James: 19-21, 121, 122
Dasyus: 23
date juice: *vide* Soma, theories about identity of, - fermented drink
decarnated skeletons painted red: 219 ftn.
Deccan: 119, 132
Deli Sosva River: Map B, fac. p. 154
Delphi: 49
Demyanka River: Map B, fac. p. 154
Denbei: 233-235
Dennis, R. W. G.: 174 ftn. 2
Dhanvantarīyanighaṇṭu: 99
dhingri: 64
Dhūrtasvāmi's description of Soma: 100, 107, 116
Dickinson, Emily: 182
Diderot's *Encyclopédie*: 181
Diószegi, V.: 224
Dittmar, Carl von: 156, 161, 213, ⁅13⁆ 256-258, 265, 266, 322
Divine Mushroom (or Fungus) of Immortality: 9, 80, 153, 210, 220; *vide* also *Ling Chih* 'dog's urine': 64
Donner, Kai: 152, 158, ⁅28⁆ 286-287, [28a] 309-310
Drakert, Marcelle Lecomte: 224
drapsá: 63
Droṇa, Mount: 78-79, 85
Druids: 176
Drury, Heber: 107, 109
Dumézil, Georges: 49, 130, 223
Dunin-Gorkavich, A. A.: ⁅25⁆ 280
Durgā, goddess: 128
durmáda (intoxication): 137
dū́rvā: 96, 97, 127
Duthie, John Firminger: 121
Dymock, Dr., of Bombay: 119

Eckblad, F. E.: 200, 201 ftn. 1
Efron, Daniel H.: 201 ftn. 1
Eggeling, Julius: 24 ftn. 1, 120
Egyptian beer: 130
Eleusine coracana: *vide* Soma, theories about identity of
Eliade, Mircea: 138, 139 ftn. 2, 166, 214 ftn., 215, 231; - and shamanic inebriation, ⁅41⁆ 326-334
Eliot, Charles: 129

Elliot, Walter: 107
Empetrum nigrum: *vide* crowberries
Enderli, J.: 154, 157, 159, 161, [19] 261-264, 322, 324, 326
Ephedra sp.: *vide* Soma, theories about identity of
Ephedra vulgaris: 105 fig.
Epic of Gilgamesh: 219, 220
Epilobium angustifolium: *vide kiprei*
Erman, Adolph: 152, 154, 156, 158, 159, 161, 162, [11] 251-254, 322, 348
esca: 216
Eta&sacute;a: 38
Ethiopia: 63
Eugster, Conrad H.: 201 ftn. 1, 202, 211 ftn. 1
Euphorbia sp.: *vide* Soma, theories about identity of

Fa Chow: 65 ftn.
faŋkáˀam: 165, 166, 207, 310
fausse oronge: 10, 194
Félice, Philippe de: 134, 135, 147
Ferula sp.: *vide* Soma, theories about identity of
Fica religiosa: 97
filtres, three: 31, 34, 51-58: *vide* also Soma and filtres
Finno-Ugrian linguistic family: 10, 13; linguistic chart, fac. p. 166
Finno-Ugrians: 10, 13, 165,167, 192, 207; lingustic chart, fac. p. 166
Finns: 165, 166, 213 ftn. 2; linguistic chart, fac. p. 166
fir: 13
Firdousi: 77-78, 91
Fischer, Leopold: 141
Fliegenpilz: 10, 194 ff., 199, 200, 202; as symbol of happy augury, 204
Fliegenpilzlieder: 302
Fliegenschwamm: 194
flies and madness: 195-198
flies, eggs of, laid in reindeer nostrils: 279
fly-agaric and berserk-raging: 157-158, 176-178, [4] 237, [32] 306, [40] 322, 324, 341 ff.
fly-agaric and birch: 13, 23-24, 35, 41, 74, 211, 212-222, [4] 238-239, [10] 247, [12] 254, [13] 256, [21] 269
fly-agaric and cattle: 74-75
fly-agaric and chimney-sweep: 204 fig.
fly-agaric and conifers: 13, 23-24, 41
fly-agaric and firs: 13
fly-agaric and flies: 61, 198 ff.
fly-agaric and Lamut: [6] 241, [27] 285
fly-agaric and navel: 48-51
ly-agaric and Ob-Ugrians: 160 ff.
fly-agaric and punk (touchwood): 216-222, [4] 237-239
fly-agaric and reindeer: 24, 75-76, 161-162, [5] 240, [10] 250, [11] 252, 253
fly-agaric and 'single eye': 46-47
fly-agaric and udder: 43, 45, 46, 214
fly-agaric and urine: 25 ff., 54-58, 158, 160-161, [4] 237, [5] 239-240, [10] 249-250, 251, [12] 255 ftn., [13] 257, [14] 259, [19] 263, [21] 267, 270 illus., [22] 275, [40] 324, [43] 346, [44] 349
fly-agaric and Yakut: [6] 241
fly-agaric as fire: 52-54
fly-agaric as inebriant of northern Eurasia: 164 ff., 172 ff., 207 ff.
fly-agaric as sacred herb: 62
fly-agaric bought for reindeer: 24, 152, [10] 247, [11] 252, [14] 259, [43] 346, [44] 349
fly-agaric cannot be cultivated: 18
fly-agaric dried before eating: 153-155, [3] 234, [4] 236, [5] 239, [6] 240, [10] 247, [11] 253, [12] 254,

[13**]** 256, **[**18**]** 261, **[**21**]** 266, **[**24**]** 280, **[**26**]** 281, 283, **[**30**]** 303, **[**32**]** 307
fly-agaric eaten by Cossacks: **[**4**]** 236
fly-agaric foretells the future: **[**19**]** 264
fly-agaric gathered in July and August: **[**10**]** 247
fly-agaric induces feats of strength: 42, 159 **[**6**]** 240, **[**10**]** 249, **[**22**]** 273-274
fly-agaric inebriation, absence of hangover from: 155, **[**6**]** 240, **[**10**]** 250
fly-agaric inebriation, euphoria caused by: 155-156, **[**4**]** 236, **[**6**]** 240, **[**9**]** 244-245, **[**11**]** 253, **[**13**]** 256, **[**22**]** 274
fly-agaric inebriation, syndrome of: 75, 158-160, 179, 210-211, **[**4**]** 236-237, **[**5**]** 239-240, **[**6**]** 240, **[**9**]** 244-246, **[**10**]** 248-250, **[**12**]** 254-256, **[**13**]** 256-257, **[**18**]** 261, **[**19**]** 262, **[**21**]** 266-267, **[**22**]** 273-274, **[**26**]** 282
fly-agaric juice, colour of: 37
fly-agaric marketed in strings of three: 45, **[**22**]** 273
fly-agaric not sole mushroom in shamanic use in Siberia: 305, **[**33**]** 308-309
fly-agaric riddle: **[**22**]** 278
fly-agaric, alleged toxicity of: 152-153, 155-156, **[**6**]** 240, **[**10**]** 250-251, **[**12**]** 255, **[**18**]** 261
fly-agaric, comparison of, with Middle American hallucinogenic mushrooms: 162-164, 174
fly-agaric, consequences of identification of, with Soma: 67-70
fly-agaric, cultic meaning of, among Ob-Ugrians: **[**26**]** 281-285
fly-agaric, decoction made from, by Russians: 160, **[**11**]** 253
fly-agaric, description of: 13, 35-36, 41
fly-agaric, dreams caused by: **[**9**]** 244-245, **[**19**]** 262
fly-agaric, European folkloric and linguistic background of: 36, 172 ff.
fly-agaric, 'knobs' or 'studs' of: 59-60
fly-agaric, Koryak mythology concerning: **[**21**]** 268-270, 272
fly-agaric, life history of: 40
fly-agaric, macropsia caused by: 158, 162, **[**4**]** 236, **[**10**]** 249, **[**12**]** 255, **[**18**]** 261, **[**21**]** 266, **[**22**]** 274
fly-agaric, personification of, by Siberian tribesmen: 159-160, 163, **[**4**]** 236, **[**21**]** 267, 268, 271, **[**22**]** 274-275, 276, **[**24**]** 280, **[**29**]** 287-301
fly-agaric, preference for, as compared with alcohol: 155, 156, 157, **[**10**]** 250, **[**11**]** 253, **[**21**]** 267-268
fly-agaric, reputation of, as fly killer: 61, 198-202
fly-agaric, shrinkage in use of, in Siberia: 11, 208-209, **[**42**]** 334
fly-agaric, tabus on eating of: 152, 153, 160, **[**24**]** 280, **[**28**]** 286
fly-agaric, *two forms* of: 25 ff.
fly-agaric, use of, by women: **[**4**]** 237, **[**31**]** 257, **[**21**]** 266
fly-agaric, varieties of: 35-36
fly-agaric, Yurak (Samoyed) mythology concerning: **[**24**]** 280
'fly-agaric', origin of term: 190
Fomes fomentarius: 169, 170, 217, 238, 239, 269, 356
Fomes igniarius: 238
Food of Life: 214, 220
fool-mushroom: 192-193
Forbes, R. J.: 17, 332 ftn. 1
Frankfort-on-the-Main: 199
Fraxinus sp.: *vide* Soma, theories about identity of
Fries, E.: 352
Frisians: 173
Fukien province: 72, 73

Ganges: 95, 127
ganja: *vide* Soma, theories about identity of, - *Cannabis sativa*
Ganoderma lucidum (leyss.) Karst.: 87 illus., 88, 90 illus., 91
García d'Orta: 137 ftn. 4
Garden of Eden: 178-180, 220-222
Garrett, John: 109
garuḍahṛta: 99

Geldner, Karl F.: 6, 12, 16, 52, 63, 67, 138, 144
Genus Betula, Distribution of: Map A, fac. p. 154; Map B, fac. p. 1 54; Map C, fac. p. 154
Genus Pinus, Distribution of: Map A, fac. p. 154; Map B, fac. p. 154; Map C. fac. p. 154
Georgi, Johann Gottlieb: 153, 155, 177, ⁅6⁆ 240-241, 322, 346
Ghose, T. P.: 138 ftn. 3
ghugakop ('fly-agaric' in Kamchadal): 239
Gimbutas, Marija: 189, 190-191 figs.
Gizhiginsk: 275; Map C, fac. p. 154
Gizhiga Gulf: 261; Map C, fac. p. 154
göbek mantari: 50
Goethe, Wolfgang: 195
Goldsmith, Oliver: 151, 259
Gonda, Jan: 141
Gönyey, Sandor: 224
Grahame, Kenneth: 187
Granet, Marcel: 80 ftn.
Grassmann, Hermann: 30, 37, 62, 109, 110 ftn. 4, 122 ftn. 5, 139 ftn. 6
Grieve, James: 159
Grimm brothers: 109
Grøn, Fredrik: 177, 353, 354
Groot, J. J. M. de: 84 ftn.
Gubernatis, Angelo de: 112, 117 ftn. 1, 131
Gulya, János: 192, 193, 223, 302-304, 306
Gymnema sp.: *vide* Soma, theories about identity of
gypsies (Romany language): 118

Hadding the Dane: 184
Hajdú, P., and *paŋχ* cluster: ⁅37⁆ 314
'hallucinogen', origin of the word: 175 ftn. 1
hallucinogenic mushrooms ol Mexico: 23, 32, 42, 75, 146, 162-163, 174-175, 211, 322
hallucinogens: 113 ('narcotic'), 129-130, 134, 146, 210, 221
ha-ma chün ('toad-mushroom'): 189
Han Dynasty: 82, 83 ftn., 85, 90, 91
haŋgo: 286, 309
Hansen, Sigurd: 239
Haoma: 19-21, 33, 95, 100, 101, 102, 104, 106, 107, 109, 110, 112, 121, 122 fig., 126, 132, 135-137, 139
Hardy, Edmund: 123
hári: 36-42; Pl. 11, fac. p. 34
harmal: 109, 114
Hartwich, Carl: 125, 126, 231
Hartwich, Carl and fly-agaric: ⁅40⁆ 321-326
Harva, Uno: 215, 220
hashish: *vide* Soma, theories about identity of, - *Cannabis sativa*
Hauer, Jakob Wilhelm: 129, 130, 131
Haug, Martin: 107, 108 ftn. 1, 110, 111, 116
Haughton, Graves Chamney: 103
hauma: 102
Havell, E. B.: 127, 128, 129
Hegnauer, R.: 141 ftn. 1
Heim, Roger: 30, 36 ftn. 1, 201, 225
hemp: *vide* Soma, theories about identity of, - *Cannabis sativa*
Henning, W. B.: 136 ftn. 2, 166, 330
Henry, Victor: 58, 125
Herb of Immortality: 211, 215, 219, 220, 222
Herb (or Plant) of Life: 220
Hermitage Museum: 89 ftn.

Hertel, Johannes: 135, 136 ftn. 1
Herzfeld, Ernst: 137
heso (Japanese): 49
Hildebrandsson, H.: 177, 178, 352, 353, 354
Hillebrandt, Alfred: 122, 144
Himalayas: 22, 23, 69, 218
Hindu Kush: 22, 65, 69, 141, 218
Hino, Iwao: 87
Hittites: 219
Hoffer, Abram: 175 ftn. 1
Holberg, Ludvig: 196
Holmberg, Uno: 214, 218
Holmsted, Bo: 178, 201 ftn. 1, 353
Holy Agapé: 220
Holy Water of the East: 30, 74
hōm: 102, 108
homa: 119, 132, 137
Hōm Yašt: *vide* Avesta
honey: *vide* Soma, theories about identity of
Hongo, Tsuguo: 223
Hooker, Joseph Dalton: 109, 119
Hopkins, E. W.: 127
hops, derivation of: 117,118; also *vide* Soma, theories about identity of
Houtum-Schindler, A.: 118, 120
Hsü Fu: 83, 84, 85
Hubers, E.: 133
hum, *huma*: 104, 118, 120, 122, 132
Human Relations Files: 224
Hummel, Karl: 140
Hungarian Academy of Sciences, publishing office of, (Akadémiai Kiadó): 224
Hungarians: 11
Hu Ssu Hui: 170
Huxley, Aldous: 146, 147, 175, 176
hydromel: 123, 141: *vide* also Soma, theories about identity of, honey

Idea diffusion: 81
Imazeki, Rokuya: 74 ftn. 2, 75, 87, 155, 211, 223
Indian Institute (Oxford): 95
Indian Office: 95
Indians, Mexican: 3, 163
Indra: 3, 23, 26, 27, 28, 30, 33, 43, 44, 55, 56, 63; heart or belly or entrails of, 54 ff.
Indrahasta: 126
Indrā&sacute;ana: 126
Indrasurā: 126
índu: 63
Indus (River and Valley): 3, 13, 15, 16, 32, 65, 68, 73-74, 95, 209; Map A, fac. p. 154
Ingalls, Daniel H. H.: 79, 223
insect as cause of illness: 277
Ipomœa sp.: *vide* Soma, theories about identity of
Iran: 14, 19, 34, 71, 74
Irtysh Ostyak: *vide* Ostyak, Irtysh
Irtysh River: 10, 154; Map A, fac. p. 154; Map B, fac. p. 154
Itallie, L. van: 135
Itelmen: *vide* Kamchadal
Itkonen, T. I.: 167, 【23】 279
Iwasa, Shigeyoshi: 74 ftn. 2

Jacourt, Louis de: 181 ftn. 1
Jadrintsev, Nikolai Mickhailovich: 260
Jakobson, Roman: 40 ftn., 168, 183, 225, 319
jewel herb: 81
Jochelson, Vladimir: 154, 157, 159, 161, 194, 208, 213 ftn. 2, **[21]** 265-273, 270 fig., 287, 322, 328 ftn. 2
Johnson, Donald: 175 ftn. 1
Jones, William: 102, 125
Jouveau-Dubreuil, G.: 132

Kabul: 115 ftn.
Kālidāsa: 79, 91
Kamchadal: 10, 49 ftn. 1, 153, 236, 237, 238, 239, 243 ff., 265, 273, 287 ff., 305, 315, 334-337, 346, 349 ff.; Map A, fac. p. 154; Map C, fac. p. 154
Kamchadal tales: 160, 288-294
Kamchatka: 233 ff., 238, 241, 243 ff., 273, 334-337, 349 ff.; Map C, fac. p. 154
Kamieński Dłużyk, Adam: 10, 151, **[1]** 233, 332 ftn.
Kaminov: Map C, fac. p. 154
kana-g^{ü}ch: 64
Kan-ch'uan palace: 85
Kane, P. V.: 132
Kannisto, Artturi: 154, 165, 305, 333; - and *paŋχ* cluster, **[33]**
Kan-ō, Suigetsu: 90
Kao Yao-ling: 223
Kapadia, B. H.: 140, 145
Kāpi&sacute;ī: 115 ftn.
Kaps, Leo: 134
Karjalainen, K. F.: 154, **[26]** 281-285, 315, 328-329
Karolinska Institute: 178, 353
kattṛṇa: 97
Kātyāyana &sacute;rautasūtra: 97
kavaka: 64
Kazym River: Map B, fac. p. 154
Keith, Arthur Berriedale: 125, 126, 131
Keats, John: 182
Kennan, George: 151, **[14]** 258-259, 322, 325, 326, 349 ftn. 3.
Kerala: 66, 132
Kerman (Iran): 110, 118, 129
Ket: 10, 152, 161, 286, 309; Map A, fac. p. 154
Keta Ehau: 171
Kew Herbarium: 117
Khanty: Map A, fac. p. 154: *vide* Ostyak, linguistic chart, fac. p. 166.
Khory, Rustomjee Naserwanyil: 123
khumbi: 63
Khyber Pass: 141
kiprei (*Epilobium angustifolium*): 153, 235, 252, 324, 335, 349
Kirāṭas: 128
Kline, Nathan S.: 201 ftn. 1
Klynchevsk: 158, 253
'knobs' of Soma: 59-60: Pl. XII, fac. p. 58
knösk: 177
'knots' of Soma: 59-60: Pl. XII, fac. p. 58
Kobayashi, Yoshio: 74 ftn. 2, 223
Kollangod: 132
Kolyma River: Map A, fac. p. 154; Map C, fac. p. 154
Kooger, J. P.: 143
Kopeć, Joseph: 25, 155, 158, 159, **[9]** 243-246

Koryak: 10, 154, 155, 156, 157, 160, 195, 234, 237 ff., 247, 249 ff., 285 ff., 305, 315, 322, 325, 326, 334-337, 340; Map A, fac. p. 154; Map C, fac. p. 154
Koryak tales: 160, 268-269, 272, 294-301
k'ou mo: 170
Krasheninnikov, Stepan: 152, 153, 157, 158, 159, 161, 177, [4] 235-239, 253 ftn., 257, 264, 265, 266, 268, 322, 334-338, 346 ftn. 2, 347, 348
Krause, E.: 324 ftn. 1
Krishna, S.: 138 ftn. 3
Kṛṣṇa: 33
Kṣatriya: 64
kṣúmpa: 63
Kuhn, Adalbert: 121, 141
kukur-mut(t)ā: 64
Kumārasambhava: 79
kumiss: 114
ku&sacute;a (grass): 96, 97, 127
Kuylenstierna-Andrassy, Stella: [47] 355-356

Lagarde, Paul Anton de: 101, 102, 108, 109 ftn. 3, 114 ftn. 3. 125
Lamut: 241, 285
Langsdorf, G. H. von: 49 ftn. 1, 153, 155, 158-162, 211, 213, [10] 246-251, 322
langue d'oc: 180
Lansdell, Henry: [14] 259
Lao Tze: 49
Lapps: 173
Lapps, Inari: 10, 167, 279; Map A, fac. p. 154
Lassen, Christian: 106, 107 ftn. 1
Laufer, Berthold: 17
Lawrence, D. H.: 182
Lehtisalo, T.: 152, 154, 160, 166, [24] 280, 330; - and *paŋχ* cluster, [24a] 310-312, 314, 317-318
Leland, Charles G.: 118
Lena River: Map A, fac. p. 154
León, Ponce de: 221
Lesseps, Jean Baptiste Barthélemy de: [7] 241-242
Lewin, Louis: 131, 323 ftn. 1
Lindner, Paul: 133, 134
Ling Chih: 62, 80 ff., 88 ff., 87 & 90 figs., 204, 210; Plates XIV and XV, fac. p. 82; Pl. XVIII, fac. p. 90: Pl. XIX, fac. p. 91; Pl. XX, fac. p. 92
Linnæus, Carolus: 72, 184, 199, 200, 201
Lipshitz, S. Yu.: 238
Lithuanians: 180, 189
Liverovskiy, Yu. A.: 238
Locquin, Monique: 201 ftn. 1
Lopatin, Ivan A.: 209 ftn., 305, 333
Lozinski, Philip: 224
Lozva: 305 ff.; Map B, fac. p. 154
Lu Yu: 72-73
Lyall, Charles James: 115
Lysebraate, Inger Anne: 223

Macdonald, Kenneth Somerled: 111
Macdonell, A. A.: 26, 125, 136 ftn. 4
Machek, V.: 168
macropsia: 153, 158, 162, 236, 249, 255, 261, 266, 274
máda (happiness): 63, 137, 144
Madana: 97

mádhu: 16, 61, 63, 123, 132
Maghada: 65
Maglemose: 169, 170, 239
Magnus, Albertus: 199, 201, 203
Magnus, Olaus: 177
Magyar: 166, 167, 192, 193, 302
Mahābhārata: 33, 91, 130
Mahoney, Mary: 224
Mainstay: *vide* Soma, mainstay of the sky
Majakovskij, Vladimir: 183
Majorca: 180
mákṣika: 61
Malabar coast: 110, 132
Mangelsdorf, Paul C.: 224
Mani: 71-74, 220
Manichæism: 71, 72, 191, 224
Mansi: Map A, fac. p. 154; Map B, fac. p. 154; linguistic chart, fac. p. 166
Manu, Laws of: 64, 102, 103
Maori: 171
Mardersteig, Giovanni: 225
marijuana; *vide* Soma, theories about identity of, - *Cannabis sativa*
Markovo: 254-255
marua: 127
Maruts: 29, 30
'Marvelous Herb': *vide Ling Chih*
mātañga: 33
Maydell, Gerhard von: 154, 156, 159, 161, 213, **[**12**]** 254-256, 322
Mazatec Indians of Mexico: 63
Mazdaism: 73
mead (hydromel): *vide* Soma, theories about identity of, - fermented drink
Medinīko&sacute;a: 98
μεθυ: 123
Megasthenes: 101
Menispermum sp.; *vide* Soma, theories about identity of
metabolite, potable: 32
metabolite, potable psychotropic: 32
metabolite, potable *vide* fly-agaric, metabolite of
millet: 97, 146
Mills, L. H.: 126, 127 ftn. 1
Milton, John: 182
Milwaukee Public Museum: 224
miraculous *chih*: 81
Mitanni: 219
Mithraism: 71, 215
Mitra: 44, 48, 58
Mitra, Rajendra Lala: 109,111, 119, 132
μῶλυ: 101, 102, 108, 109, 125
Modi, Jivanji Jamshedji: 74 ftn. 1
Mohl, Jules: 77 ftn.
mo-ku: 170, 171, 189 ftn. 2
Mongolian language: 170
Monier-Williams, Monier: 37, 97, 98, 112
Monier-Williams' dictionary: 94, 98, 122
Montaigne, Michel Eyquem de: 182
moon: *vide* Soma, theories about identity of
Mordvin: 166, 167; Map A, fac. p. 154; Map B, fac. p. 154

morels: 64
Morgenstierne, Georg: 223
Mörner, Carl Th.: 177, 178, 347, **[45]** 351-353, 354
Motai, Mr. and Mrs. Mikiyoshi: 74 ftn. 2
muchumor: *vide mukhomor*
mu erh: 65, 82
Mukherjee, Braja Lal: 128, 129, 136
mukhomor: 10, 156, 194, 235, 236, 238 ff., 251 ff., 280, 321, 324, 349
mūla: 101
Müller, Friedrich Max: 67 ftn. 2, 98 ftn. 5, 100, 107, 116 ff., 120, 122, 132, 285
Müller, Reinhold F. G.: 138
Munch, P. A.: 350
muñja, muñjara: 97, 99
Munkácsi, Bernát: 157, 166, 285 ftn. 1, **[30]** 302-304, 327 ftn. 1, 330: - and *paŋχ* cluster, **[32]** 306-308, 310, 315 ff.
mūrdhán: 45-46
mushrooms, Satanic link in Old French: 189
mushroom stones in Kerala, Nepal: 66
mūΘrəm: 32
mycophilia: 180, 185, 208
mycophobia: 181, 184, 185
mycorrhiza: 13, 23, 213, 216

Năbhi: 48
Nadkarni, K. M. and A. K.: 139
Nahua: 3
naicā&sacute;ākhá: 122
Nambudri Brahmans: 132
Narym: 153, 240, 287; Map B, fac. p. 154
nausea: 31, 32, 55, 75
navel: 16, 29, 48-51, 214: *vide* also Soma and navel
Nayar, S. C.: 138 ftn. 1
Needham, Joseph: 81
Nehring, A.: 132
New Zealand: 171
Nighaṇṭu and *Nirukta*: 98, 116
nirṇíj: 41
nīvāra: 110
'nodules' of Soma: 59-60
Noin Ula: 89, 91; Pl. XVI, fac. p. 88; Pl. XVII, fac. p. 89
Nooten, Bart van: 223
Nordhagen, Rolf: 201, **[46]** 353-355
Novitskij, Gr.: 285
nyagrodha (*Fica religiosa*): 97, 122
Nyberg, Henrik Samuel: 101 ftn. 6, 136

Obdorsk: 192 ftn. 1, 281-285; Map B. fac. p. 154
Ob (river and valley): 10, 165; Map A, fac. p. 154; Map B, fac. p. 154
Ob-Ugrians: 151, 160, 166, 167, 193, 207, 213 ftn. 2, 280, 281; linguistic chart fac. p. 166
ochre: 219 ftn.
Odin: 346
Ödman, Samuel: 176, 177, 237, 341, **[43]** 343-347, 352
Odyssey: 101, 108, 109 ftn. 1, 127
O'Flaherty, Wendy Doniger: 8, 12, 17, 33, 79, 92, 176, 223
Ogloblin, N.: **[2]** 233-234
Ohlmarks, A.: 315

Ohrmazd: 102
Okhotsk, Sea of: Map A, fac. p. 154; Map C, fac. p. 154
Oldenberg, Hermann: 123, 130, 132, 139
Olsen, Magnus: 177
ομφαλος: 49
Omphalia: 50
ὄμωμι: 101, 102, 108, 109
opium: 129, 136 ftn. 4, 138, 139, 193
Orlov, N. I.: 338
Orphic: 220
óṣadhi (herb): 62, 79, 98, 136, 219 ftn.
Osmond, Humphrey: 175 ftn. 1
Ostyak: 10, 189, 192, 240, 241, 302, 306 ff., 346; Map B, fac. p. 154
Ostyak Irtysh: 154, 233, 260, 281-285, 306 ff., 327
Ostyak Samoyed: Map A, fac. p. 154; Map B, fac. p. 154
Ostyak Ugrian: 315
Otrebski, Jan: 168
Ovsianiko-Kulikovskij, D.N.: 112-113
Oxus: 23; Map A, fac. p. 154

Paddy, wild: 110
Padma Pūraṇa: 78, 84
Pæderia sp.: *vide* Soma, theories about identity of
pagal-: 164, 166
pagav-: 164
**paggala-*: 169 ftn.
pagyr: 166
Pahlavi: 20, 21
Pallas, P. S.: 257, 315
palmyra palm: *vide* Soma, theories about identity of, - fermented drink
paŋe (Maori): 171
paṇgú: 169 ftn.
Pāṇini: 17, 115 ftn.
Pan Ku: 85, 86, 88, 89
Pannonian plain: 167, 193
Panofsky, Erwin: 179-180
paŋχ: 164 ff, 169 ftn., 189, 192, 207, 281-285, 304, 306-313
paŋχ and inebriation: 164, 207-208
Papay, J.: 192 ftn.
parasol: 63
Paren': 254, 267; Map C, fac. p. 154
Parjanya: 4 ftn., 23, 39, 40
Parkinson, John: 193
parṇa: 96, 97
Parsis: 19, 32, 74, 102, 110, 118, 119, 122, 127, 129, 139
páruṣā: 59
Patañjali: 139
Patil, G. M.: 141
Patkanov, Serafim: ⁅17⁆ 260, 281, 307
Paulini, Kristian Frantz: 325
pávamāna: 38, 56, 63, 214, 220; Pl. III, fac. p. 36
pāvanī: 99 ftn. 2, 117
Pavgee, N. B.: 129
Peabody Museum of Natural History, Yale University: 143
Pedersen, Holger: 168, ⁅39⁆ 319-320
Peganum harmala: *vide* Soma, theories about identity of

Pelliot, P.: 72, 73
Pelymka: 305 ff.; Map B, fac. p. 154
Penzhinsk Gulf: 254, 257, 259, 265, 266; Map C, fac. p. 154
Periploca aphylla: 105 fig.
Periploca sp.: *vide* Soma, theories about identity of
*_pëso_ (proto-Japanese): 49
Peterson, Roger Tory: 91 ftn.
Peter the Great: 233-234
phala: 117
phālguna: 96, 97
Phellorina Delestrei Dur: 63
pibdaná: 59
Piddington, Henry: 104, 106
pillar of the sky: *vide* Soma, mainstay of the sky
Pillar of the World: 215, 220, 280
Pilzbaum: 179
pine: 13, 35, 41
pitú: 63
πηγανον: 108, 109, 114
Plaincourault fresco: 178-180: Pl. XXI, fac. p. 180, 221
Pleurotus Eryngii: 64
Pleurotus Eryngii s.sp. *nebrodensis*: 64
Pleurotus ostreatus: 82
Pliny: 125
Plutarch: 101 ftn. 8, 127
Polo, Marco: 216
Polyporus betulinus: 239
poŋ: 165-171
pot: *vide* Soma, theories about identity of, - *Cannabis sativa*
Potocki, Wacław: 193
Pressing Stones: 31
Provence: 180
psət (Cambodian): 49
p°sət (Korean): 49
psilocybin: 75, 146, 162, 175
Psoralea sp.; *vide* Soma, theories about identity of
pu: 63
punk: 170, 177, 212 ftn. 2, 216, 217, 238
pup, pupyri (Russian): 49
Purāṇas: 78, 91
Pūrva Mimāṃsa Sūtra: 98
*_pusəg_: 49
Pushkino: 183
pú:tawa (Maori): 171
putīka: 96, 97, 107, 121

Qazilbash, N. A.: 140, 141

Rabelais, François: 182, 197
Radványi, Tamás: 223, 302-304
rāgi (millet): 127-128
rāgi-Soma: 127
Ragozin, Zenaīde A.: 123 ftn. 3; 124 fig.
Rahder, Johannes: 49 ftn. 2
Rahurkar, V. G.: 139, 140 ftn. 1
Raja, C. Kunham: 137

Rājanighaṇṭu: 99, 142
Ramsbottom, John: 179, 201
rānsera: 132
rása: 63
red mushrooms: 72, 73, 74, 220
Regel, Albert: 114, 140, 145 ftn.
Regnaud, P.: 123
Regni, Delli Roman: 136
Reguly, Antal: 157, 166, 192 ftn., **[30]** 302-304, 306, 307
reindeer and fly-agarics: *vide* fly-agaric and reindeer
reindeer and fly-agarics and urine: 75-76, 161, 243, 269
reindeer, driven mad by insects: 195
Renou, Louis: 5, 6, 12, 17, 29, 30, 36, 41, 67, 223
Rheede, Henrik van: 137 ftn. 4
rhubarb: *vide* Soma, theories about identity of, - fermented drink
Rice, Benjamin Lewis: 119
robe d'apparat: 41
Rolfe, R. T. and F. W.: 179
Rolland, Eugène: 194, 198, 199
Romany language, *soma*, *sumer*: 118
Roth, Rudolph von: 97, 107, 111, 112, 114-117, 119, 121, 144
Rotorua (New Zealand): 171
Roux, J.-P.: 214 ftn., 217
Roxburgh, William: 97 ftn. 8, 103, 104, 120
Roy, Joges Candras: 136
Ṛtá: 48, 54, 58
ṛtásya jihvā̆: 58
Ruatoria (New Zealand): 171
Rumph, George Everhard: 137 ftn. 4
Russula rubra (Kromb.) Bres.: 73
Ruta sp.: *vide* Soma, theories about identity of
Rutaceæ: 114
Ryabushinskij, F. P.: 238

&sacute;abarasvāmi: 98
sacerdotalism: 68, 69
sacred fig (*Fica religiosa*): 97
sahásrapājas: 109
Sakikusa: 90 illus.
Salmony, Alfred: 81
Salvia sp.: *vide* Soma, theories about identity of
Sāma Veda: 106
Samoyed: 10, 154, 165, 166, 167, 207, 280, 286, 287, 310, 346; linguistic chart, fac. p. 166
Sanchi stupa: 66
Sarcostemma brevistigma: 105 fig.
Sarcostemma sp.: *vide* Soma, theories about identity of
Sarychev, Gavriil Andreevich: 161, **[8]** 242-243
Sastri, Chinnaswami: 138
Saxo Grammaticus: 177, 184
Sāyaṇa: 96, 98
Schipper, Kristofer M.: 223
Schrader, Otto: 132, 136
Schübeler, Fredrik Christian: 177, 324, 332, 341, **[44]** 348-351, 353
Schultes, Richard Evans: 224
Sébillot, Paul: 189 ftn. 1
Sedanka: 252; Map C, fac. p. 154

Selkup Samoyed: 152, 166, 282 ftn., 286-287, 315, 317; Map A, fac. p. 154
Sem, Y. A.: *vide* Brekhman & Sem
serpent: 41, 179, 214, 221
Serratula sp.: *vide* Soma, theories about identity of
Setaria sp.: *vide* Soma, theories about identity of
Severnaya Dvina River: Map A, fac. p. 154; Map B, fac. p. 154
Shahnameh: 77-78
Shakespere, William: 182, 188
shamanism, Siberian: 10, 68, 153, 163, 174, 208, 213, 220, 326 ff.
Sharma, P. V.: 139
Shelley, Percy Bysshe: 182
Shih-huang, Shih-huang-ti: 82-86, 91, 210
Shirokogorov, S. M.: 209 ftn.
shom-luta: 106, 107: *vide* also Soma-creeper
Sindh: 122
&sacute;íras: 45
Slater, Gilbert: 130
Slavs: 173, 180
&sacute;leṣmalā: 116, 117
Sljunin, Nikolai: 154, 156, 157, 159, 161, [18] 260-261, 265, 266, 267
Slovakia: 193
Smith, Vincent: 127 ftn. 2
Smythies, John: 175 ftn. 1
Société Mycologique de France: 178-179
Sōm: 8, 102, 104, 108
Soma and Agni: 39, 51, 204
Soma and curds: 26-28
Soma and filtres: 26, 31, 34, 5I_58; Pl. XII, fac. p. 58
Soma and fly: 61
Soma and mystical contemplation: 68-70, 95
Soma and navel: 16, 29, 48-51, 214
Soma and Romany: 118
Soma and 'single eye': 46-47; Pl. X, fac. p. 48
Soma and stalk: 44
Soma and sun (*Sūrya*): 37-39, 52, 54
Soma and *súrā*: 15, 95, 96, 98, 114, 123, 134, 137, 138, 144
Soma and thunder: 4, 44
Soma and thunderstorm: 39, 40, 54
Soma and 'toadstool': 203
Soma and udder: 43, 44, 46, 214
Soma bought for a cow: 24
Soma-creeper (-*vallī*, -*latā*, -*lutā*, *shom-luta*): 14, 97, 98 ff., 102-104, 106-108, 110, 123, 125, 137, 140-141
Soma focal point of Vedic religion: 5, 95
Soma growing in mountains: 16, 22-24, 32
Soma 'head' (= cap): 45-46
Soma mainstay of sky: 16, 47-48, 54, 58; Pl. XI, fac. p. 56
Soma milk: 98-99; Pl. VII, fac. p. 48
Soma, colour of: 13, 36-42
Soma, definition of: 3
Soma, Dhūrtasvāmi's description of: 100, 107, 116
Soma, etymology of: 62
Soma, fig. of: 124; PI. 1, fac. p. 34
Soma, legends about origin of: 4, 39, 141-142
Soma, priests urinating: 25 ff., 176
Soma, reasons for abandonment of: 13, 69 ff.

Soma, roots, leaves, blossoms, seed of: 18, 32
Soma, substitutes for: 12, 13, 112; in *Brāhmaṇas*, 95 ff, 111, 122;
Soma, substitutes for should be red, 97; should be small, leafless, fleshy, 14, 104
Soma, substitutes for sacred barley beer, 130
Soma, substitutes for mead (hydromel), 123
Soma, synonyms for: 62, 63
Soma, theories about identity of deliberately unpalatable: 112
Soma, theories about identity of distilled spirits: 16-17, 119, 138
Soma, theories about identity of fermented drink:
alcoholic beverage: 15, 17, 109, 110, 112, 131, 132, 134
Afghan grapes: 23, 115, 117, 121, 129, 146
beer: 111, 117-120, 130, 132
coconut palm: 130
date juice: 130
honey: 15-16, 23
mead: 15-16, 123, 141
palmyra palm: 130
rhubarb: 12, 16, 23, 47, 114, 140, 142-143, 146
súrā: *vide* Soma and *súrā*
wild grape wine: 12, 23
wine: 108, 115, 117, 120, 137
Soma, theories about identity of hops: 110, 117-119, 122
Soma, theories about identity of moon: 69-70, 99, 102, 106, 109, 122, 139
Soma, theories about identity of *Thermobacterium mobile*: 133, 134
Soma, theories about identity of Asclepias sp.: 103, 104, 107, 109-110, 112-115, 121, 123, 127, 129, 132
Soma, theories about identity of Basella sp.: 121, 126
Soma, theories about identity of Bassia sp.: 133, 134
Soma, theories about identity of Cæsalpinia sp.: 143
Soma, theories about identity of Calonyction sp.: 109
Soma, theories about identity of Calotropis sp.: 104, 133
Soma, theories about identity of *Cannabis sativa* (= *C. indica*), *bhang*, *ganja*, hashish, hemp, marijuana, pot: 12, 16, 114, 126,128-129, 132, 135-139, 141, 144, 145
Soma, theories about identity of Centella sp.: 142
Soma, theories about identity of Ceropegia sp.: 110
Soma, theories about identity of Cocculus sp.: 98, 142
Soma, theories about identity of Compositæ: 114-115
Soma, theories about identity of Conyza sp.: 102
Soma, theories about identity of Crinum sp.: 139
Soma, theories about identity of Cynanchium sp.: 103
Soma, theories about identity of *Eleusine coracana* (millet): 127, 128
Soma, theories about identity of Ephedra sp.: 14, 23, 104, 118, 120-122, 126, 131-133, 138, 140-143; 105 fig.
Soma, theories about identity of Euphorbia sp.: 112, 114
Soma, theories about identity of Ferula sp.: 114, 116
Soma, theories about identity of Fraxinus sp.: 143
Soma, theories about identity of Gymnema sp.: 133, 134
Soma, theories about identity of Ipomœa sp.: 109
Soma, theories about identity of Menispermum sp.: 103
Soma, theories about identity of Pæderia sp.: 121, 139
Soma, theories about identity of *Peganum harmala*: 114
Soma, theories about identity of Periploca sp.: 14, 23, 104, 117, 119-121, 126, 131, 138, 142-143, 145; 105 fig.
Soma, theories about identity of Psoralea sp.: 143
Soma, theories about identity of Ruta sp. (mountain-rue): 102, 108, 125
Soma, theories about identity of Salvia sp.: 137
Soma, theories about identity of Sarcostemma sp.: 14, 23, 103-104, 106-112, 115-117, 119-123, 126,

131, 132, 133, 135, 138, 143-145; 105 fig.
Soma, theories about identity of Serratula sp.: 103
Soma, theories about identity of Setaria sp.: 121, 131
Soma, theories about identity of Tamarix sp.: 118
Soma, theories about identity of Thespesia sp.: 143
Soma, theories about identity of Tinospora sp.: 103, 123
Soma, theories about identity of Umbelliferæ: 115
Soma, theories about identity of Vernonia sp.: 98, 102, 104, 106, 121, 125
Soma, theories about identity of Vitex sp.: 126
Soma, theories about identity of Vitis sp.: 143
Soma, *two forms* of: 25, 26, 54
soma-rāj, *somrāj*, *somarājī*, *somarājin*: 98, 102-104, 106, 121, 125
somalatā, *somalutā*, *soma-lutā* (creeper): 97, 98, 103 ff., 106-108, 110, 123, 125: *vide* also Soma-creeper
somavallī (creeper): 14, 98, 99, 102 ftn. 5,103, 110, 123; *vide* also Soma-creeper
som-vel: 139
Soneda, Masami: 74 ftn. 2
&sacute;óṇo: 37
Sosva River: Map B, fac. p. 154
Spenser, Edmund: 182, 188
Spiegel, Friedrich: 110
&sacute;rautasūtra: 97, 100
Srivastava, J. G.: 142, 143 ftn. 1
Ssu-ma Ch'ien: 82-85
Star Carr: 169, 170, 238
St. Augustine: 71, 72, 191, 224
St. François de Sales: 71, 191
Stein, Aurel: 132, 140
Stein, Aurel and rhubarb: 16, 133
Steinitz, Wolfgang: 166; - and *paŋχ* cluster, **[**36**]** 313, 317
Steller, Georg Wilhelm: 153, 161,162, 177, 237, 238, **[**5**]** 239-240, 250, 337, 346, 347, 348
Stevenson, John: 106
Stietencron, Heinrich von: 21, 69
Stoll, O.: 325 ftn. 2
Strahlenberg, Filip Johann von: 25, 151, 153, 161, 177, **[**3**]** 234-235, 322
strainers: *vide* fibres
'studs' of Soma: 59-60
&sacute;udra: 31
Suigetsu Kan-ō: 90
suillus: 72
sūkara-maddava, *sūkara-mansa*: 65
Suleman Mountains: 141
Sullivan, Michael: 80 ftn., 89 ftn., 90
Sumerians: 207, 219
sun: *vide* Soma and sun
Sung Dynasty: 72
súrā: *vide* Soma and *súrā*
sūrya: Pl. IV, fac. p. 40; *vide* Soma and sun
Su&sacute;ruta, *Su&sacute;ruta Saṃhitā*: 99, 100, 125, 126 ftn. 3, 142
Sverdrup, H. U.: 355
&sacute;vetākṣa: 99
swallow-wort: 103
syāmaka: 97
&sacute;yenahṛta: 96, 99
Syr Darya: 114; Map A, fac. p. 154
Sysola River: Map A, fac. p. 154; Map B, fac. p. 154

Taiga: Map B, fac. p. 154
Taigonos: 257; Map C, fac. p. 154
Takemoto, T.: 201 ftn. 1, 202
Tamarix sp.: *vide* Soma, theories about identity of
T'ang Dynasty: 72, 81
Tao: 49
Taoists: 72, 80, 153, 210
tapló (Magyar for touchwood): 170
Tatra Mountains: 193
Tavda River: Map B, fac. p. 154
Tavgi: 165, 166, 207, 310
Taylor, Jeremy: 71, 191
Taz River: Map B, fac. p. 154
Tennyson, Alfred: 182
teo-nanácatl (god's flesh): 3
Terfezia sp.: 72
Theophrastes: 102 ftn. 1
Thermobacterium mobile: *vide* Soma, theories about identity of
Thespesia sp.: *vide* Soma, theories about identity of
Thiselton-Dyer, W. T.: 117, 118, 120
thunder: *vide* Soma and thunder
thunderstorm: *vide* Soma and thunderstorm
Tigil: 239, 252, 349; Map C, fac. p. 154
Tikhomirov, V. A.: 338
tinder: 169-170, 171, 238
Tinospora sp.: *vide* Soma, theories about identity of
toad, in Lithuanian culture: 189-190
'toad', linked with fly-agaric in Chinese: 189
'toad', linked with fungi in various European languages: 186
toad linked to Satan in Old French: 189
toad, sinister associations of, in Germanic and Celtic folklore: 187 ff., 203
toadstool: 35, 152, 173, 181, 183, 185-189, 202, 203, 221
Tobol' River: Map B, fac. p. 154
Tongue of the Way: 58; Pl. XIII, fac. p. 58
touchwood: 169, 170, 171, 177, 217, 238, 239
Train, John P. C.: 176
Transpacific contacts, discussion of: 83, 162-163, 332-333
Tree of Life: 214, 215, 218, 219, 220
Tree of the Knowledge of Good and Evil: 220
Tremyugan: 281-285
Tricholoma mongolicum: 170
Tristram Shandy: 8
tṛ́ṇa: 62
truffles: 72
trut: 170, 238
Tsingala: 281-285, 328 ftn. 2; Map B, fac. p. 154
tue-mouche: 10, 36 ftn. 1, 194, 198
tul-paŋχ: 192
tundra: Map. B, fac. p. 154
Tung-fang Shuo: 84
Tungus: 269, 276, 279, 321, 334
Turner, R. L.: 169 ftn.
Turukhan River: Map B, fac. p. 154
Tyler, Varro E.: 142
Tym River: Map B, fac. p. 154

Udder: *vide* fly-agaric and udder
Ugrians: 10, 164, 165, 192, 281; linguistic chart fac. p. 166
Uhl, L. L.: 131
Uighur: 216
um, uma, umbur: 104, 121
Umbelliferæ: *vide* Soma, theories about identity of
Uotila, T. E.: 161, 166; - and *paŋχ* cluster, [34] 312, 316-317
Upaniṣads: 95, 131 ftn. 4
Upsala: 177, 199-200, 351
Uralic: 10, 161, 164, 165, 166, 169, 207, 208
urine: 25-34, 52-58, 73-76, 158, 160-162, 235, 237, 239-240, 243, 249-250, 252, 255 ftn., 257, 259, 261, 263, 267, 269, 275, 276
urine and fly-agaric: *vide* fly-agaric and urine
urine and rain: 30, 276
urine and reindeer: *vide* reindeer and urine
urine and Soma: 25 ff.
urine as medico-religious disinfectant: 30, 74
'urine of drunkenness': 32
u&sacute;ānā: 128
Usbekistani: 114
Uttaṅka: 33

Vaccinium uliginosum: *vide* bilberry
Vaidika Saṁ&sacute;odhana Maṇḍala: 13
vamanī: 116, 117, 135
vána: 140
Vanderlip, Washington B.: [20] 264
Värmland: 177, 178, 353-354
Varuṇa: 15, 44, 48, 58
Vasyugan: 281-285; Map. B, fac. p. 154
Vāyu: 26, 27, 28, 30, 48, 55, 59
Vernonia sp.: *vide* Soma, theories about identity of
'vesture-of-grand-occasion': 41
Vinkenoog, Simon: 146 ftn. 2
vīrúdh ('plant' = Soma): 63, 98
Vitex sp.: *vide* Soma, theories about identity of
Vitis sp.: *vide* Soma, theories about identity of
Vladivostok: 269, 334
vodka: 11, 332 ftn.
Vogul: 10, 154, 157, 164, 165,178,191, 192, 193, 231, 281, 285, 305 ff., 333; Map A, fac. p. 154; Map B, fac. p. 154
Vogul Hymns: 302-304: 306-308
Voigt, J. O.: 106
Volga Finns: *vide* Finns; also linguistic chart, fac. p. 166
Volga River: Map A, fac. p. 154; Map B, fac. p. 154
vṛ́ṣā: 37

Wapaq: 160, 268, 277-278
Waser, Peter G.: 201 ftn. 1, 202
Wasson, R. G., and Aldous Huxley: 146, 147, 175-176
Wasson, R. G., his *A. muscaria* theory, comment on: 143
Wasson, R. G., quoting Brahman informants: 104
Wasson, Valentina Pavlovna: 172, 174, 202
Wasson, V. P. and R. G.: 35, 40 ftn., 71 ftn., 146
Water (or Milk) of Life: 214, 216, 220, 271
Waters, Evelyn: 224

Watson, J. Forbes: 108
Watt, George: 67, 104 ftn. 3, 115-117, 119-121
Weintraub, Wiktor: 243
Wêng, Wango: 223
West, Edward William: 112
Whitney, William Dwight: 46 ftn. 1, 107
Widengren, Geo: 219 ftn.
wild grape wine: *vide* Soma, theories about identity of
Wilkens: 114
Wilkins, Charles: 8, 102, 104
Willetts, William: 89 ftn. 1
Wilson, Horace Hayman: 97, 103
Windischmann, Friedrich: 106, 119
witchcraft, European: 176
Worth, Dean S.: 287
Wu, Wu-ti: 84-86, 88-91

Yajur Veda, black: 100
Yakut: 241, 271 ftn., 279, 321
Yamunā: 95
Yāska: 63, 98
Yasna, *vide* Avesta
yehma: 104, 120
Yelovka: 158, 252 ff.; Map C, fac. p. 154
Yenisei (river and valley): 10, 286-287; Map A, fac. p. 154; Map B, fac. p. 154
Yenisei Ostyak: Map A, fac. p. 154; Map B, fac. p. 154
yesca: 170
Yetts, Perceval: 89 ftn., 90
Yüan Dynasty: 80, 87, 92
Yugan: Map B, fac. p. 154
Yukagir: 10, 166, 238, 239, 241, 271, 272, 279, 305, 334, 346; Map A, fac. p. 154; Map C, fac. p. 154
Yurak Samoyed: 154, 280, 315; Map A, fac. p. 154; Map B, fac. p. 154

Zaehner, R. C.: 32, 143
Zarathustra: 19
Zend Avesta: *vide* Avesta
zhagra: 170, 212 ftn. 2, 238
Zimmer, Heinrich: 111
Zoroaster: 19, 33, 71, 73-74, 101, 136, 137, 330
Zoroastrianism: 71, 73
Zunderschwamm: 170
Zyrian: 164-166; Map A, fac. p. 154; Map B, fac. p. 154

KASHMIR UNIVERSITY
LIBRARY
Acc. No. 92871
Date 30-5-72

ALLAMA IQBAL LIBRARY
92871

The Use of Hallucinogenic Mushrooms for Diagnostic Purposes among some Highland Chinantecs

by

Arthur J. Rubel and Jean Gettelfinger-Krejci[1]

Economic Botany 30: 235-248. July-September, 1976. pp. 235-248

Submitted for publication September 22, 1974; accepted for publication November 22, 1974.

original report: https://www.jstor.org/stable/4253740

[1] Department of Anthropology, Michigan State University, East Lansing, Michigan; and University of Notre Dame, Notre Dame, Indiana.

> This article describes the ingestion of hallucinogenic mushrooms - *Psilocybe Hoogshagenii* Heim - as a means to diagnose illness among contemporary Chinantec-speaking Indians of the Sierra de Ixtlán, Oaxaca, Mexico. It is possible that several varieties of hallucinogenic mushrooms are used amongst these highland Chinantecs, the specific variety utilized depending upon "seasonal availability and the precise purpose for which the narcotic is to be taken" (Schultes, 1972: 10). However, the following describes only the observed use of *Psilocybe Hoogshagenii*, and it should not be generalized to the use of other mushrooms which may prove equally available to diagnosticians in the Sierra.

As Wasson, Sclhultes, and Heim have already made abundantly clear, the contemporary usage of narcotic mushrooms in Mexico boasts a long and venerable past. It is now clear that at least some of the hallucinogenic mushrooms utilized in contemporary Mexico were represented by the *teonanacatl* of the pre-hispanic and colonial last. It is unfortunate that, for the most part, those descriptions of *teonanacatl* usage which do come down to us from the early chroniclers, describe its use amongst Nahuatl speakers of the central highlands, leaving only speculation as to the extent to which those descriptions might be applied to non-Nahuatl speakers, located in the more southern regions of México.

However that may be, it is a reasonable assumption that the Spanish missionaries forcefully inveighed against and fearsomely sanctioned continuance of the use of hallucinogenic mushrooms or such other mood modifiers as morning glory seeds or fermented liquors. The confessional used by Padre Nicolás de León (La Barre, 1959) is a case in point, as is the *Doctrina Christiana en Lengua Chinanteca* used by Padre Nicolas de la Barreda. Padre de Leon's concerns are illustratedI in the following translation into English (La Barre: 23):

> Art thou a sooth-sayer? Dost thou foretell events by reading omens, interpreting dreams, or by tracing circles and figures on water? Dost thou suck the blood of others? Dost thou wander about at night, calling upon dreams to help thee? Hast thou drunk peyotl, or given it to others to drink, in order to discover secrets, or to discover where stolen or lost articles were?

Of more immediate interest are the concerns of F. de la Barreda during the early 18th Century, inasmuch as de la Barreda's parish included Santiago Comaltepec, the *municipio* from which this current information derives. Comaltepec, San Juan Yólox, and, probably, San Juan Quiotepec are three localities which were joined together by a civil *congregación* in 1603 to form a single parish served by a priest who resided in the town of Yolox. Incidentally, these three *municipios* are the exclusive components of the sub-group of Chinantecs known as Dza-Hmi (Weitlaner and Cline: 1; Cline's introduction to de la Barreda: 19). Father de la Barreda's major concern for his parishioners is reflected in some questions from his confessional of 1730, which refer to the First Commandment:

> Have you adored, given cult to the devil, or to poles (palos), or to the Sun, as your ancestors did? Have you become a witch or sorcerer? Do you have herbs or other instruments in the house with which you are able to communicate with the devil? Do you have herbs or other instruments in the

> mountains with which you can communicate with the devil? [39, 41]

It is curious that he makes no specific mention of either hallucinogenic mushrooms or *Rivea corymbosa*, although it is a reasonable possibility that implicit reference was made to these substances when questions were asked of the confessor with respect to divination, the use of special plants, herbs, "or other measures for the exercise of witchcraft and sorcery" (Cline: 61 Weitlaner and Cline: 551). As Cline noted with respect to de la Barreda's 18th Century confessional, "In spite of the brevity of the questions and the absence of many details, it is clear enough that in 1730 as well as today, a great part of the ancient rituals and beliefs persisted in Yólox. The plain, unadorned suggestions found in de la Barreda serve only to excite the researcher's appetite without satisfying it."

The paucity of ethnographic references and inferences to be drawn from de la Barreda, and the rarity of materials left us by other chroniclers of the Sierra de Ixtlain prior to the Twentieth Century (Weitlaner & Cline: 530; Gwaltney: 198-205) make it difficult to ascertain the importance of *pulque*, *Rivea corymbosa*, or *Psilocybe Hoogshagenii* during the centuries preceding our own. Today, however, it is very clear that residents of Santiago Comaltepec regularly ferment and drink both *pulque* and *tepache* during the seasons when they are available (and without any indication of public, uncontrolled inebriation about which Father de la Barreda expressed so much concern), but neither the mushrooms or *Rivea corymbosa* are used extensively today except by a very few people. We have record of only a handful of men and women in the entire municipio of more than 1,100 residents who have ingested mushrooms. When they have done so it is only to diagnose, or divine the whereabouts of a lost object or animal, or to establish communication with deceased loved ones. To our knowledge, there is no one in Comaltepec regularly using *Rivea corymbosa*, although residents are aware that it is available in the neighboring municipios of San Juan Quiotepec and San Miguel Maninaltepec in which localities there are persons who take it in the form of a tea to divine on request (cf. Mac Dougall). It should also be noted that although the senior author is well acquainted with several very reputable healers in Comaltepec, none of them to my knowledge make use of either *Rivea corymbosa* or *Psilocybe Hoogshagenii* for purposes of diagnosis, healing or divination. The only person of our acquaintance to regularly use *Psilocybe Hoogshagenii* in Comaltepec is Don Antonio from whom most of the following ethnographic information derives.[2] Don Antonio ingests mushrooms only on the request of patients seeking diagnosis or the whereabouts of lost articles or animals. Compared to other healers, Don Antonio does not boast of high stature in this community.

Don Antonio is a Chinantec-speaking male of approximately 36-40 years of age. He was born in the municipio and attended several grades of elementary school, but is functionally unable to communicate in Spanish. Like other healers of the municipio, Don Antonio learned his techniques during an apprenticeship with another, elder practitioner whom he paid for the training received (cf., Munn: 103, 105, 119).

Several meetings with Don Antonio permitted the collection of information about beliefs related to the collection and use of the hallucinogenic mushrooms preliminary to observations of a night-long session during which he ingested ten of the plants.

These transcriptions of conversations and, later, observation of a session indicate how very much interwoven are the moralistic norms which help govern this peasant society and a deferential involvement with those supernatural beings - "the children" - who so readily reinforce those moralistic norms. Despite the infusion of moralistic admonitions in the talk of "the children", and despite the deference with which they are treated, one is hard-put to describe the observed ingestion of mushrooms as either a ritual or a religious mystery in this municipio. This, of course, is in remarkable contrast to the ritualism and sense of mystery associated with the collection, preparation, and ingestion of hallucinogenic mushrooms among the nearby Mazatec of Huautla de Jiménez as described by Wasson (1972: 195) and Munn, or among other Mexican groups described in the literature. However, this relative paucity of ritual or mystery in Comaltepec is quite consonant with the more general observation that such symbolic elaboration is quite scarce throughout the cultural life of this municipio.

Among the more important beliefs governing the use of hallucinogenic mushrooms in Comaltepec, are the following. For best effect, the mushrooms should be eaten only on the favorable or propitious days of Wednesday, Saturday, and Sunday. The plants may be picked by anyone, male or female, married or unmarried, child or adult. They may be collected at any time of the day, but may be eaten only at night and in a secluded spot isolated from the sounds of other humans. The mushrooms are not processed in any way after picking. They are not ground, nor are they to be soaked or boiled in water. Neither should they be cut with a knife. Because the mushrooms are of a "cold" quality the medium needs sip on *mezcal* liquor throughout the session. (For concepts of "cold" and "hot" in this region, see Adams and Rubel). There is no need to practice sexual continence prior to eating the mushrooms, but one must abstain from the eating of a heavy meal immediately before a session. On the other hand, it is quite alright to eat lightly of soft boiled eggs, coffee, chocolate, bread, although tortillas are considered too heavy. As a matter of fact, the distilled liquor *mezcal* and "holy water" - *agua bendita* - are prescribed accompaniments of eating the hallucinogenic mushrooms in this community, and coffee is considered a necessity. The *mezcal* and coffee provide the medium the strength necessary for the rigors of the experience, and *mezcal* counteracts the "very cold" quality inherent in the mushrooms.

On the other hand, the holy water is kept alongside the medium before and after he eats the hallucinogens in order to protect him from undesirable effects. "The people are also accustomed to drink holy water when they have a bad trip with the mushrooms. You can die, or you can find your mouth tight, so much so that you cannot talk. That is why you require holy water at hand." The most common cause of a bad trip, according to Don Antonio, is the lack of good faith on the part of the client. That is, if the person asking Don Antonio for assistance is either trying to ridicule the latter's diagnostic procedures or really does not believe in the worthiness of "children" (*Los Niños* or *Los Chamaquitos*). Characteristic of a bad trip is that, instead of pretty little children arriving to the sounds of lovely music, such ugly animals as snakes, octopus, tigers, and coyotes march before one's eyes, encircle his face and head, often-times kissing him on the lips and eyes. Don Antonio reports that sipping holy water before lying down, but after eating the mushrooms, serves to prevent such horrendous experiences.

From the reports of Don Antonio, complemented by those of a few others who have accompanied mediums as they partook of the mushrooms, a good trip is a most pleasant and rich experience. If one has eaten only "female" mushrooms there will appear to him only female children, if one has eaten only "boys," then only boys will appear. There is some controversy over the relative value of "boy" and "girl" mushrooms (*machos* and *hembras*) because Don Antonio, on the one hand, avers that "the boys are more powerful and talk more," whereas a woman who has eaten the mushrooms reports that this is not so. Nevertheless, there seems agreement that it is best to take boys and girls together so that boys and girls together will appear to the diagnostician. It should be emphasized that Comaltepec informants universally denied the requirement of eating mushrooms in pairs: a boy and a girl, a boy and a girl, together.

Informants also agree that the boys and girls are approximately one inch in stature or approximately the height of a full-grown *Psilocybe Hoogshagenii*. According to Don Antonio: "The *chamaquitos* look and dress the way that people look here. They wear cotton trousers (*calzones de manta*), they are little boys and girls. (It should be noted that the *calzones de manta* are the traditional indigeneous costume for highland males, but only three or four men in the entire *municipio* were observed to dress so conservatively, and no children were observed in *calzones de manta* during Rubel's year in the commtinity.)

"They are just a very little taller than the mushrooms, and they look like the mushrooms. They seem to be very handsome. They wear stocking-hats (a woolen hat very much affected by the male residents of the highland, cold regions). On the other hand, they are barefoot and wear neither sandals or shoes. Some of them are dark-skinned, others light, just as are the mushrooms, themselves, of different colors. Sometimes they speak Spanish, sometimes they speak in Chinantec. Even when they speak amongst themselves, they speak both languages mixed together. They appear to be poor people as I am for, after all, it is I who am eating the mushrooms."

As has been mentioned earlier, Don Antonio's reports of his involvement with the respected children are very much enfolded within moralistic reinforcement to the norms of behavior in the community. The children speak in support of cooperative and friendly interpersonal relations. They enjoin against fractious and hostile ties. In support of such an orientation, they oppose the fractiousness generated by witchcraft accusations, enjoin against the breaking of promises, or the ridiculing of others. When a client requests assistance in good faith and treats the medium with respect, and the diagnostician has not eaten a large meal immediately prior to eating the mushrooms, then the boys and girls enter in a good humor. "They enter by twos and threes, boys and girls together. They enter dancing, and leaping, and playing. When they come in a good humor, there is very pretty music, it is very pretty. But only when they are in a good mood.

"There are those in our community who want to know the truth. They ask me to find out which person is doing them harm. They want the names of those people, that is the custom of our people. But, I have not been able to tell them the names of their enemies because the mushrooms, themselves, do not permit it. The boys and girls who appear before me say 'No'. They will not seek out the names, they won't give me the names! They will only say that the patient should ask God-*Dios* - for help, or that the patient should make a vow to God. That is all that they permit. They *do* tell me that someone is doing harm to the patient, but they refuse to identify who it is. If they were to do so, it would cause me difficulty, and cause my patient difficulties. That is why they do not wish to identify the person causing my patient's illness.

"The mushrooms advise me that the reason why they will not tell me the identity of the witches (*dañadores*) is to protect me, that is what they advise me. At times, the people would become drunk and they would strike me because I have identified them, and then I would suffer.

"There are many kinds of sickness, but many times the people don't carry out the cures that I advise. They only desire to ask me their questions in order to ridicule me, as shown by the fact that they do not comply with my recommendations. That is why I do not like to agree to eat the mushrooms for the people because I lose time and, besides, I suffer (from a consequent bad trip). There are those who ask me what they should do and I find out for them, I make recommendations to them, but they do not follow my instructions. Instead, they blame a witch (*braujo*) for the persistence of their condition. I get tired of those who do not obey what I recommend to them. It is tiresome. For example, there is the case of a woman who once came to ask me questions. I told her what she must do, I told her that she was suffering from *susto* [for description of the *susto* illness, see Rubel, 1964]. I gave her the cure which the mushrooms had given to me for her. She never complied [with my advice]. Then she returned to ask me to eat the mushrooms a second time for her. I took them again, but this time the mushrooms scolded me [*me regañaron*]. They said to me: 'Why do you do whatever the people ask you to? If the people don't do what you tell them to, if they only make fun of you, then you should not comply with their whimsies'. The mushrooms recommend that the people make a vow, or request a mass for the dead, or they recommend remedies which the patient should take, and they counsel that the patients have faith in God. That is what the mushrooms say!"

In this vein, the mushrooms also admonish Don Antonio to look out for his own welfare as well as that of his clients. "The mushrooms tell me: 'You comply with what we have advised, and if the others do not, the fault is not yours. You collect [your fee] from the people', that is what they tell me to do!" "There was a woman who came to see me and to request my assistance. I ate the mushrooms and advised her that she was to dig a hole to cure her *susto*. She was to dig the hole at the place where her *susto* occurred. Then she was to bring the earth she had excavated from that place back to her house where it was to be used to blow [*soplar*] upon her. She never did it! She returned to insist that I take the mushrooms another time which I did because of her need and her insistence. The second time the mushrooms scolded me. They asked me: 'Why do you comply with their wishes if they do not follow your advice? Why should you suffer from eating little [abstaining from the large meal of the day] when they do not pay you attention? Don't pay any attention to the capricious requests of the people!', that is what the mushrooms counseled me."

There now follows a description of observations made during a session in which Don Antonio ingested *Psilocybe Hoogshageni* Heim. The reader will readily note the infusion of moralistic injunctions incorporated in the communication of messages between "the children", the medium, and the client. In this instance, the client was the senior author who requested a diagnosis and prognosis for his own mother who was critically ill in New York City.

Despite our having been informed previously by Don Antonio that Thursday was not a propitious day for diagnosis, other pressing matters related to our research on the *susto* phenomenon prevented our joining Don Antonio on a Wednesday, Saturday, or Sunday, and it was considered better to take a chance on an unpropitious Thursday than risk the later disappearance of the mushrooms, as the season waned in late August. Don Antonio accepted the logic of this argument and agreed to a session on an unfavorable day. However, the reader will note several references in the forthcoming text in which Don Antonio comments on the unpropitiousness of the day.

Our arrangement was to pick up the diagnostician at a place alongside the highway, drive in the jeep to another location, and proceed on foot to an isolated, depopulated hamlet, four hours walk from the highway. Unfortunately, a flat tire, and delays caused by highway construction caused Rubel and his interpreter to arrive several hours late.[3] The delays made it impossible to walk to the hamlet before sunset, and neither Don Antonio or the interpreter relished walking the mountain paths in the cloud forest after dark. Consequently, it was decided to go to another, populated, hamlet alongside the highway. This alternative proved less propitious than the original plan because youngsters peered through the windows of the schoolhouse in which we prepared for the event. Moreover, instead of permitting the medium to collect the mushrooms in the security and privacy of the cloud forest surrounding the abandoned hamlet, he was subjected to the ridicule of the children who accompanied him as he picked the plants in our alternative site.

On arrival in the hamlet, Don Antonio immediately set about to locate the mushrooms which grew in profusion in the immediate neighborhood of the homes. He and the children quickly collected enough to meet his needs. It is worthwhile observing that he was aided by both boys and girls, and that as far as could be observed, neither he nor they made any special preparations for the task. No one washed their hands or other parts of their bodies, changed clothes, said prayers, crossed themselves, or in any other way prepared themselves for the collection of the plants. When the mushrooms were in hand, there seemed no special way of handling them while carrying them to the schoollhouse. However, Don Antonio showed care not to discard, or allow to be discarded, any of the mushrooms which were picked.

When Don Antonio decided that he had enough mushrooms, we retired with him to the empty schoolhouse where he awaited the dark of the night and the quiet that came with it. During our wait, the medium piled the ten mushrooms one on top of another, reminding me of a game of "pick up stix." When asked the significance of the number ten, he responded that he had picked only six mushrooms, but that the mischievous children had picked the other four. He commented that *he* had taken the other four from the children so that they - the four mushrooms in excess - would not feel mistreated.

Although, clearly, the act of collecting the mushrooms and the respect which surrounds the act of eating them in this hamlet show this occasion to be different from other, more mundane events, they could not be described as mysterious, a usage implying a religious experience.

The use of the term 'mystery' very aptly (Wasson, in Furst: 195) describes the preparation and ingestion of mushrooms among the neighboring Mazatec of Huatla de Jiménez (*Ibid*.; fig. 1 in Weitlaner & Cline; Weitlaner & Hoppe). There are several other differences in the collection, preparation, and use of mushrooms in Comaltepec compared with their treatment elsewhere in Mexico. Those differences will be discussed in concluding sections. However, it should be well noted that the problem of comparing the cultural usage of hallucinogenic mushrooms in Chinantec-speaking Comaltepec with that characteristic of linguistically different peoples in Mexico is compounded by the fact that only one person regularly practices the eating of mushrooms in Comaltepec, making it difficult to distinguish between what may prove to be cultural behavior and that which possibly represents idiosyncratic behavior.

After dark, Don Antonio began to eat the mushrooms one by one without any perceived preparation other than an "Our Father" and a "Hail Mary" in Spanish which preceded the actual eating of the mushrooms by between 40 minutes to an hour. Rubel was startled by the matter-of-factness with which he set about eating the ten mushrooms, one by one, button end first, followed by the entire stem. Nothing was left, nothing set to one side. I say that I was startled because of reports which describe somber preparatory rites among contemporary Mazatec (Wasson, 1972), Mixtec (Ravicz: 80), Zapotec (Ravicz: 84), and Lacandon (Robertson, 1973).

Unlike all other reports of contemporary use of hallucinogenic mushrooms in Oaxaca (see Schultes, in Furst), these observations in Comaltepec are notable for the absence or rarity of ritual, magical connotations, or religious "mystery", but this is quite consonant with a general paucity of ritual in this municipio.

After ingesting the mushrooms, Don Antonio sipped at the *mezcal*, following which he became more friendly to me and inquired of me whether my body was *contento* (comfortable). I advise him that it was and inquired whether his body was also *contento*? He responded that it was. He requested Us not to provide him with large amounts of *mezcal* when he requests a drink because he was not supposed to drink large quantities but, rather, to sip the *mezcal* from the shot-glass provided.

Because, during the collecting of the mushrooms, he had distinguished males (*machos*) from females (*hembras*) based on his understanding that the larger mushrooms were male, I enquired of him whether those he had eaten represented both male and female plants. He answered that he had eaten only males. I suggested that there had been some small mushrooms among them and asked were they not *hembras*? He responded again by affirming that they had been all males.

He then asked me to describe my mother's condition to him. I described her as very ill, very weak, and so sad that, at times, she begins to cry. Her abdominal area has become quite enlarged although she does not eat much. He responded by asking whether her condition is not very frail? I answered that it was, but that at the present time she is not in the hospital, although she goes in and out of the hospital as her condition changes. I also informed him that she had been very ill for approximately three years. Don Antonio responded: "I do not know what to do, and neither do you. Let's see what these people [*gente* that is, the mushrooms] will say. Because that is what he wishes to know."

Then Don Antonio began to pray in Chinantec: "I do not attempt to mistreat you. I do this only in response to the problems which people have at home. I obliged myself to help this man, and he made an agreement with me, and here he is. I came to fulfill my part of the agreement. It is not that I wish to eat, you know. You are aware of what is happening. You know that others laugh and make fun of what I do, but also you can tell whether what they say about me is true. Well, that is the way it is! Yes, they try to ridicule us. They cannot! Well, let us see how many of the mushrooms I am able to eat?"

Then he informed us that the six mushrooms were equivalent to "six pesos. If it was someone other than him who came with me, they would be worth six pesos. I collected ten of them, but I feel able [*aguanto*] to eat only six. Only six will I eat, because these are fresh. Those that are left over I will keep, in order that they do not complain about me. If one were to throw them away they would complain. One digs them up because they are useful. One cannot simply throw them away. You dug them up for a reason, to meet a necessity, and cannot throw them away. However, if he wishes to take them away with him, he may do so for it is as if he had bought them now. I am going to keep them because I dug them up, and to throw them away would mean that they would suffer, and then they complain". He then requested the interpreter to extend the straw mat (*petate*) on the floor because he was now ready to lie down.

Before he lay down, Don Antonio advised the interpreter that he had spoken to the mushrooms to advise them as to the reason for digging them up. He advised them that the reason was to answer my question about the health of my mother. I asked whether piling the mushrooms on top of one another before eating them had any significance. He answered that it had simply been to gather them together, but had no other significance. We then asked Don Antonio whether it was not true that one was supposed to take both males and females together [*revueltas*]? He answered in an interesting fashion: "It is not essential. They can be eaten - all males - when they are found like this [that is, when only males have been discovered]. In fact, the words of the males are of greater value. The men have greater value because they talk more and they appear in a more pretty form [porque platican más y se ven más bonitos]. If you eat them mixed together - men and women - then they arrive together [revueltas vienen]."

The interpreter then requested Don Antonio to advise us when he was hungry because we had brought much food for him to eat. The diagnostician answered: "That's what I like. People attend me well when they have a problem [Así me gusta. La gente sí atiende bien cuando hay necesidad!]." He then said that he would not eat until after the children [*los niños*] have bade him farewell, until after the matter was closed.

Don Antonio then asked us to request some hot coffee from the storekeeper. The interpreter suggested the possibility that hot coffee at this time might not be good for him. He responded: "I will drink it immediately while I am still hot because the mushrooms are cold, are they not?" When the interpreter responded that he, himself, had no idea whether they were cold or not, Don Antonio advised us that: "These mushrooms are cool [*frescos*] and will soon have an effect. If they had been dry, it would be more difficult". Don Antonio then sighed audibly, which led me to ask whether he was feeling sad. He said: "This act is difficult because when one commits himself to it, he must comply. It is difficult; I always worry when I commit myself to taking the mushrooms. I always worry because when I take the mushrooms, they always have an effect, and one is always frightened. That is because one always sees frightening, ugly things. It startles one. When you have taken many times, as I have, then you know that you will be frightened, and so I worry because the moment is arriving in which I will be frightened. It is always like this when the effects begin. One becomes sad. He is not content because he is unable to sleep well."

He then asked whether I had advised my mother that I was going to make an inquiry about her condition? I told him that I had not because she is far away in New York City. He then asked whether I have visited my mother, and I told him that I had paid her a visit in June and during last Christmas. Don Antonio then asked whether the tape recorder would make a record of the fact that he was not eating the mushrooms out of sheer whimsy but, rather, to the contrary, he does so to respond to my need to be informed about my mother's health. He repeated his anxious comments: "No es por mi gusto que tomo, pero por cierto necesidad!" He began to yawn very deeply and often, again expressing his fears of the effects to come: "Está difícil, éste!" The interpreter asked whether there was still time for him to go out for the purchase of hot coffee before the diagnostician was affected by the mushrooms. The latter reassured him about the time and stated that he would not go to sleep without hot coffee. As a matter of fact, he adds that he would like some hot coffee and that, at the present time, he is going to request a piece of the bread we have brought for him, "... so that I can eat it when the coffee arrives. In this way I will be strong [be courageous?] when the effects begin". [Amongst these Chinantec it is generally customary to drink hot coffee before retiring at night.]

We then left for coffee and on our return found him yawning deeply and sighing. He advised that he was now ready to retire. At our request he repeated a prayer he says he pronounced during our absence. It proved to be an "Our Father" followed by a "Hail Mary," both in Spanish.

In response to several repetitions of a question by the interpreter as to whether that was the complete prayer, or whether there might be more. he continued with a Hail Mary.

He then began to eat the mushrooms. In the midst of eating them, he requested a bit more of the mescal. Then: "We will wait awhile until the smell [*olor*] of the mushrooms passes. Mientras tanto, se ponga silencio!" [In the meantime, be quiet!] He began to eat the mushrooms again after a brief respite during which he asked for a little more mescal. He announced: "I am going to eat all ten of the mushrooms in order that none be left over. Once and for all, I will eat them all, in order that none of them be lost! I usually eat only six, but I will eat all ten, then it would be like throwing the remainder away. They - mushrooms - could say to me: 'Why did you throw away our *compañeros*? It is as if they were *we* and you had thrown us away! ' "

Don Antonio then asked of the interpreter whether there was mescal in the other bottle we had brought him. When told that it contained mescal, he answered: "Well, you are well prepared. Tomorrow you can give me the meat, if he has brought meat? Don't say anything to my brother. If he so wishes, he can leave the meat with my mother telling her it is for Antonio to eat." He then asked whether I have, indeed, brought him meat. I answered that I have eggs, and tortillas, and bread for him. He began to laugh when the interpreter advised that Antonio had already eaten the meat we had brought him in sandwiches while we drove along the highway.

He continued to talk, but became more and more disconnected and rambling. He suggested I give him some payment now so that when we go to the store on the highway tomorrow, we need not speak of payment in front of onlookers. In answer to his request for more mescal, the interpreter advised him not to get drunk, but he responded that he wanted more mescal because lie felt like vomiting from the food he had just eaten. His conversation became more and more rambling as he became more and more loquacious in both Chinantec and Spanish.

He then asked: Is your mother's illness the only thing that you wish to find out? Perhaps there is no cure for her, for you say that she has been ill for three years." Following this, he either began to speak to himself or was whispering so low that we are unable to recover what he said from the tape. Then, again, he became more audible, speaking to the anthropologist. "I am pleased with the help that you have given to the *municipio*. I am very grateful! There are people here who have threatened me because I do not assist with the communal labor, something I am unable to do. There are those who have mistreated me because I have been unable to help. Perhaps sometime when you and I are together and these people mistreat me, you will tell them to desist because I am your friend. I feel very content because you are helping us. That is why I am making the effort to help you, if only a bit. Even though the people say to me that I have soiled myself for telling you what one is able to do [to speak with "the children" by means of hallucinogenic mushrooms]. I don't know what to do because this man already knows well what it is that I do! This man does favors for the people, too. By not charging for a ride in his automobile, lie saves one a lot of money that it would cost for the fare. The people say that I am soiling the community because I tell you that I take the mushrooms. But you are someone who helps the people and assists the community and so I do what I am able to help you. I believe that we are now going to lie down. Let's see what lie [Rubel] has to say about it. But first I will smoke a cigarette."

He lay down on his mat in a dark corner of the room, I tried to sleep in my hammock, an(h the interpreter tried to sleep on one of the benches. Several hours later, but long before (lawn, Don Antonio was heard to be restless and began to speak, apparently to himself. I asked him whether "the children" had appeared to him. He answered in the affirmative. He then continued: "They said to me that although it is not yet the proper time, it doesn't matter because you made an agreement with him [anthropologist] and he arrived here fulfilling his part of the agreement. You, too, complied with your word. That is the only proper way to do things.

"Los niños said: 'You have fulfilled your agreement with him.'" "I have met my obligation to him on that matter", said Don Antonio to me. "With reference to your mother, it is certain that she will not recover. But she will live a while longer. She is not going to die very soon, but neither is she going to recover to the condition she was in prior to becoming ill, because she is now elderly. That is the way it is!"

In response to a question from the interpreter as to whether there was not some other message in addition to that which he passed on to me, the response was: "One part ended with that. Then they said that he had best be careful wherever he went. Take care on the highway. Taking account of the condition of the roads where he goes, they are not very safe. Inasmuch as he relates well with the people, nothing will happen to him, because he is a nice person. Well, that is what 'the children' said! I only wish that you two could speak with them. If only you could hear their words. He [anthropologist] appreciates the people, so nothing will happen to him on the road."

I then inquired whether "the children" had told him what I was to do. He answered: "You must request a mass. For example, during this fiesta of ours which is approaching. That is, if you are present at that fiesta? If he really desires that this should come to pass then it will be necessary for him to request a mass. He should request a mass before the Virgen de los Remedios, that is, if he really wants with all his heart that which he is asking."

"They told me that 'We will meet this man afterwards', that is all that they said. They said to me, When a person wishes to speak with you, you also must be prepared to ask questions. That is why we are desirous of speaking, because this man wanted to come this far with you'. They said to me, 'If this man arrived willingly with you because of his need to ask you a question, you should be willing, also'."

The interpreter asked whether that was all, to which Don Antonio responded that there was nothing else. He then added: "They told me more. They said: 'It is not important that we meet only once in a while, we and you remain the same towards one another'." Then, addressing himself to the interpreter, he began to importune: "They said that it is good that you are working with him. For example, when I am in need of help and that man is not here, then you will do me the favor of seeking help for me from him. In case he is not present, you will serve in his stead. You will favor me with something, according to my need. That is good that you have a friendship with this man and that the mushrooms are not opposed to you. Let us work together, you and I, with this man."

The interpreter asked whether there was more to the message? "Yes. They said that if he takes the trouble to ask for the mass, perhaps his mother will recover. Perhaps she will recover half of her former health. Because when the Virgin of the Remedios arrived, there was the flower known as 'flor de los remedios'. Because she blessed the whole world in order for that flower to exist."

Don Antonio then asked me whether his performance was good or bad. He asked whether I felt happy. I told him that I did not feel happy because he had not provided a remedy for my mother. "But that is why you are to request the mass. Your mother will recover because if you request the mass up there, the blessing will arrive in your country where your mother is. She sends her blessing with much ease. As your mother is of a very advanced age, it has been a long time that she has had this sickness. But she will recover by half." Then, to the interpreter: "Tell him, in order that he (hoes not feel sad!" "Tell him that if he requests the mass he is not to tell people that he does so on Antonio's advice. He can tell them that he does so of his own free will. That is what he can do. That is all that I can tell you. Let us see if he does this?"

In response, then, to a question from me as to whether the children had presented themselves to him in good humor or in bad humor, he answered that they had been in a good humor because: "They told me that this man is of good will, he really wishes to find out the answer to his question. 'It does not matter,' they said to me, 'that it is not the appropriate day. It is essential to comply with your arrangement when a person arrives truly desiring to know the answer to a question. When a person acts in good faith, even though it is not one of the proper days, one must respond to the inquiry. Whatever else, as he has met his agreements with the people and inasmuch as he has fulfilled his part of the bargain, you, also, have met your obligation. In that way, everything resulted well. It did not result badly! For, if you had not met your word, it would be bad'."

Inasmuch as Don Antonio had advised in an earlier conversation that he sometimes saw animals, sometimes children (*los niños*) after eating the hallucinogenic mushrooms, the interpreter asked Don Antonio whether animals presented themselves this time. "Yes, the snake presented himself. The snake always appears. He always appears together with the octopus. These animals presented themselves after the children had appeared. The children say that these animals are for those people who do not marry, who do not become formally married, for those who only live together, but do not marry. Moreover, these animals are for those who do marry, but later become divorced. Like Martin, it is not good!

"They said to me that when persons call upon you, you must attend them. When you are in need, and it is critical, and you have nothing for your expenses, you should request aid of those who have. Ask them to help you when you are in need. Remember that time when this man called upon me to assist him? That is why I went, to be of assistance to him. It is not good when one has been offered a gift and immediately afterwards returns to that same person to request of him another gift. That is not right! Isn't that right, isn't it? It is not good to wander about, shamefully asking aid of people. The people remember to whom they have previously provided assistance. It isn't correct to return again and again to the same,people for aid. Do you recall that time when I arrived at this man's house and he gave me some money to help) me? He helped me plenty that time. I am very grateful for it.

"I have still not slept; I am now going to sleep for a while. I have not lied. I now am going to sleep peacefully. I have not slept a wink. I have done a favor for him, and he did a favor for me. That is the way that I like it! I like it when we help one another in the face of need!"

Some comparisons

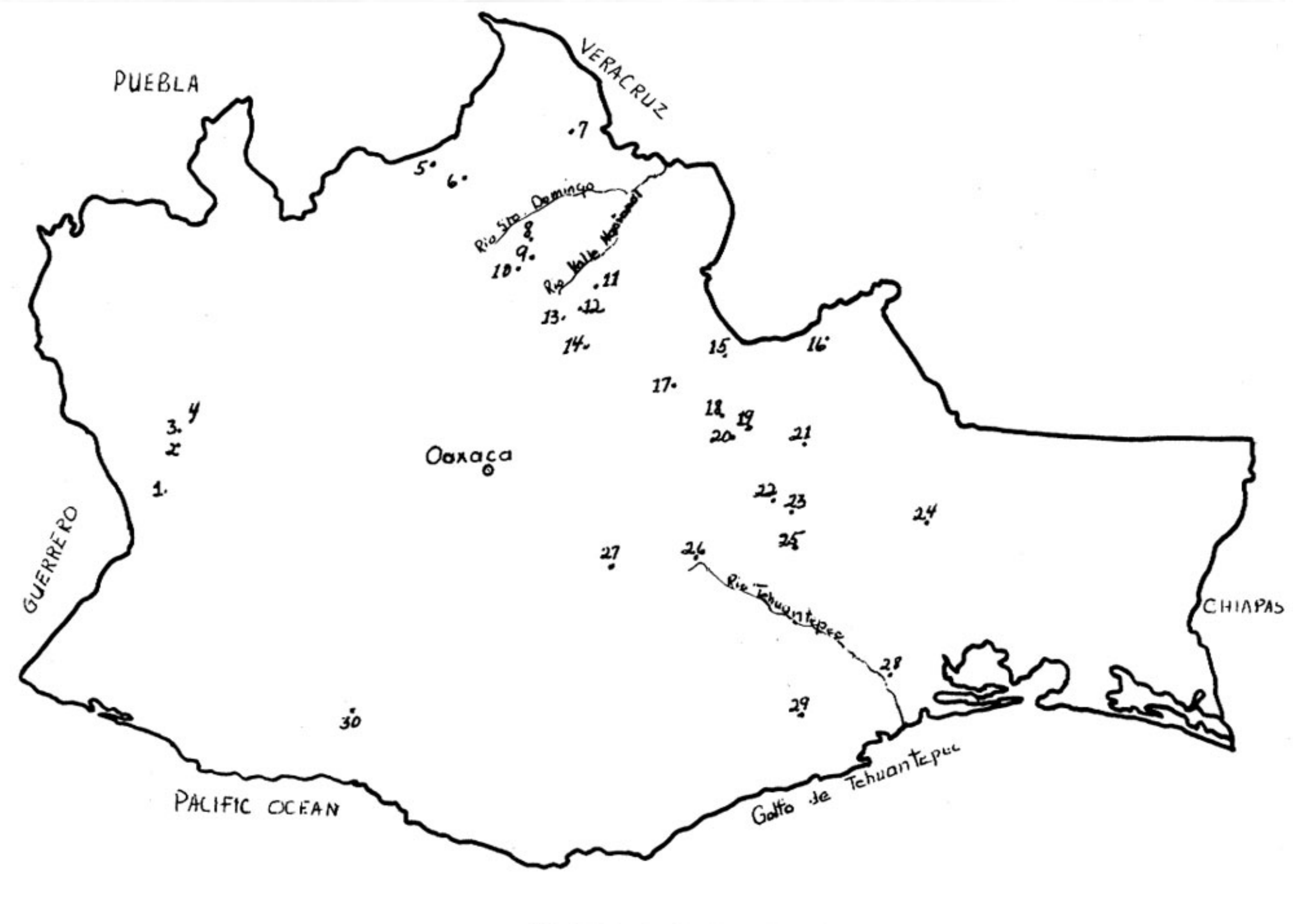
Although the preceding interviews and observations related to the ingestion of *Psilocybe Hoogshagenii* among highland Chinantec of Santiago Comaltepec suggest some degree of variance from what seems more general practice among other groups of Mexico, we shall dwell on the similarities demonstrated. The way in which Don Antonio and others of Comaltepec relate to the narcotic mushrooms is far more secular and matter-of-fact than is reported from other groups, and particularly from the Mazatec of Huautla de Jiménez from where there are good ethnographic reports (Heim and Wasson, Chapt. II: Munn). On reflection, the difference appears one of degree, rather than of kind. Indeed, as earlier suggested, the matter-of-factness with which the mushrooms are treated in Comaltepec is quite compatible with the general absence of rich symbolism in this *municipio*.

Data obtained in Comaltepec by means of participant observation and interviews indicate that there are many features which these mountain people share with others who are linguistically and geographically distant from them (Merrifield). But, as Miller (1966: 326) has properly emphasized, comparative ethnographic data is so thin and scattered with respect to the contemporary use of narcotic mushrooms that one attempts generalizations only with great caution. Miller warned that rather than suggest the existence of a single cult devoted to the use of hallucinogenic mushrooms all over Middle America, it should be borne in min(d that even among villages of the relatively isolated Mixe, "... rites related to the use of mushrooms vary from one locale to another" (*Ibid*; cf., Ravicz: 90). Thus, keeping in mind the need for caution, we will emphasize only those traits from Comaltepec which appear to be of greatest significance and which are generally shared with other groups from which the use of these hallucinogens has been reported.

First, and perhaps of over-riding significance, mushrooms with narcotic properties are distinguished from others which do not have such an effect. The narcotic mushrooms are gathered only in order to respond to an individual's need to know the answer to questions of critical personal import: "What is the cause of my illness?" "What must I do to recover good health?" As is true elsewhere, but not universally, the mushrooms are collected in Comaltepec by *either* the diagnostician or the client for whom he will query the "little people" - *los niños*. However, in Comaltepec only the diagnostician eats the hallucinogens, and *only* he hears how "*los niños*" respond to his questions.

As is universally true in this region of the Sierra, in Comaltepec the mushrooms are ascribed special religious characteristics and treated with reverence. Unlike other localities, such as Mixe-speaking Camotlán in which the mushrooms are referred to as "Our Lords, the Earth's mushrooms" (Miller, 1966: 319), or as among the Nahuatl of San Pedro Nexapa who call the narcotic plants "The Noble Princes of the waters" (Wasson, 1963: 184), in Comaltepec, the personified mushrooms receive deference but not *such* great awe.

It is generally true in this area that the same techniques of prayer are used to solicit aid of the mushrooms as of other supernatural beings. Moreover, people do not arbitrarily discriminate between those supernatural figures which are post-conquest, and those which probably derive from pre-Christian periods. Although all reports indicate that narcotic mushrooms are revered in and of themselves, the ex tent to which they are independent of the will or control of other, perhaps more powerful, deities seems to vary. Don Antonio appealed directly to the mushrooms for counsel, whereas, in other communities mediating supernatural figures are invoked to ensure that the mushrooms will present themselves. (Wasson and Heim: 88; Ravicz: 80, 82; Munn: 90, 91). Mrs. Merle Robertson reports that among some Lacandon, the practitioners bypass Christian deities in order to go directly to pre-conquest deities: "They (*Psilocybe cubensis* and *Panaeolus venenosus*) are placed in the ritual bowls on small stone altars in ancient Maya *oratorios* (places of worship). The purpose of their use, according to the Lacandons, is to contact their gods." (Personal communication.)



THE STATE OF OAXACA, MEXICO

Fig. 1. Sites in which use of narcotic mushrooms is reported in the state of Oaxaca, Mexico.

1. Santa Maria Zacatepec
2. Chayuco
3. Agua Fría } distrito de Juxtlahueca
4. Santa María
5. Eloxochitlán
6. Huautla
7. Soyaltepec
8. San Juan Zautla
9. San Juan Quetzalapa
10. San Pedro Sochiapán
11. Santa Cruz Tepetotutla
12. San Francisco Llagas
13. San Juan Quiotepec
14. Santiago Comaltepec
15. "Latani" - San Juan Latana
16. Santiago Yaveo
17. Teocalcingo
18. Santiago Zacatepec
19. San Juan Cotzocón
20. Santa Maria Alotpec
21. San Juan Mazatlán
22. San Lucas Camotlán
23. Santa Margarita Huitepec
24. San Juan Guichicovi
25. Santa Maria Coatlán
26. Juquila Mixes
27. Mitla
28. San Jose Paraíso
29. Tenango
30. Yaitepec

Surely one of the more interesting results of comparative research which Wasson, Heim and Weitlaner have done so much to inspire, is the discovery that hallucinogenic mushrooms have such similar effects across linguistic and cultural boundaries within Mexico. With remarkably little variation, that which is revealed to the taker of the mushrooms assumes the form of graphic, colored, and auditory experiences. The human forms which appear are approximately the stature of grown mushrooms, and these revealed "little people" speak in both the indigenous tongue of the medium, and in Spanish. To the contrary, in reports by European researchers - Heim, Cailleux, Hofman, and Brack - in which they describe the effects on themselves of relatively "controlled" dosages of the mushrooms, or of psilocybin extract, not a single researcher reports significant encounters with persons or animals, much less bilingual boys and girls or elderly people of small stature (Wasson and Heim: 273-4, 280, 282, 283, 284) (luring experimentation. Doubtless, what one experiences during such an occasion is a function of chemical *and* cultural influences in interaction as Miller (1966: 326, 327) and Munn (114, 122) appear to suggest. One also ventures to suggest, that individual personalities must play some part in the variations in response to the narcotic properties of the mushrooms, a premise which makes all the more interesting the similarity of responses reported from so many Indian individuals, living in so many different cultural milieux.

In Chinantec-speaking Comaltepec, and in at least four other Chinantec-speaking communities (Heim and Wasson: 99), the major function of the mushrooms rites is to diagnose and prognose illness. The important role of the mushrooms in healing have also been attested to among the Mazatec (Heim and Wasson: Chapter II; Munn), among some of the Mixteca (Ravicz: 77-8), Mixe (Miller, 1956, 1966; Hoogshagen: 313-4), Chatino (Wasson, 1966: 343, fn.), and Nahuatl (op. cit., 346). The second most often reported function of the narcotic mushrooms in this region is for purposes of divining the whereabouts of an object or animal which has been lost or, perhaps, stolen. Utilization of the mushrooms to communicate with the dead seems restricted to Comaltepec (cf. Miller's commentary on séances, p. 326).

Finally, as Wasson has emphasized (1966: 166-70), despite widespread use, narcotic mushrooms are nowhere in the region taken whimsically or without serious consideration, preparation, and reverence. Its most general use is to acquire counsel from divine beings for diagnosis an(I prognosis of illness. However, by no means do *all* diagnosticians have recourse to, or even know how to exploit, the powers of the mushrooms. Whether or not those practitioners whose diagnoses depend upon the hallucinogenic mushrooms differ from other healers of the same community, along dimensions of personality, social status, or the manner in which they have been recruited to their healing responsibilities remain tantalizing questions to be answered only by empirical field research. Because of the rapid changes affecting the communities where these traditional practices of diagnosis and divination still survive, the time which remains for such badly needed research is distressingly brief.

---

2. The name Don Antonio is a pseudonym to provide the medium some protection from outsiders.
3. Further references in the text to "the author," "the anthropologist," or "this man" refer to Rubel.

Acknowledgments

The authors wish to express gratitude to the National Institute of Mental Health for its financial support and encouragement of the investigation of Etiological Factors in the Epidemiology of Susto (MH 18561) of which this is a product.

We are grateful to Mr. Gordon Wasson and Roger Heim for identification of these mushrooms. We also wish to acknowledge the selfless assistance of Professors Francisco and Rejane Moreno with translations from French sources.

Literature Cited

1. Adams, Richard N. and Rubel, Arthur J. "*Sickness and Social Relations*," Handbook of Middle American Indians, Vol. 6, Ed. Manning Nash (Austin: University of Texas Press, 1967), 333-356.
2. de la Barreda, Nicolás. "Doctrina Christiana en Lengua Chinanteca," *Papeles de la Chinantla 1730*, Serie Científica #6, (Mexico City: Museo Nacional de Antropología, 1960).
3. Furst, Peter T. *Flesh of the Gods* (New York: Praeger Publishers, 1972).
4. Gwaltney, John L. *The Thrice Shy* (New York: Columbia University Press, 1970).
5. Harner, Michael J., Ed. Hallucinogens and Shamanism (New York: Oxford University Press, 1973).
6. Heim, Roger and Wasson, R. Gordon. *Les Champignons Hallucinogenes du Mexique*, (Paris: Archives du Muséum Nationale d'Histoire Naturelle, Series 7, Vol. 6, 1958).
7. Hoogshagen, Searle, "A Sketch of the Earth's Supernatural Functions in Coatlán Mixe." *Summa Anthropologica en Homenaje a Roberto J. Weitlaner* (Instituto Nacional de Antropología e Historia, Mexico City, 1966), 313-316
8. La Barre, Weston. *The Peyote Cult* (Hamden, Conn.: Slhoe String Press, 1959).
9. MacDougall, Thomas. "Ipomoea Tricolor: a Hallucinogenic Plant of the Zapotecs", *Boletín del Centro de Investigaciones Antropológicas de México*, Vol. 6 (March 1, 1960) 61-65.
10. Merrifield, William R. "Linguistic Clues for the Reconstruction of Chinantec Prehistory," *Summa Anthropologica en Homenaje a Roberto J. Weitlaner* (Instituto Nacional de Antropología e Historia, México City, 1966), 579-595.
11. Miller, Walter S. "El Tonalamatl Mixe y los Hongos Sagrados", *Summa Anthropologica en Homenaje a Roberto J. Weitlaner* (Instituto Nacional de Antropología e Historia, México City, 1966), 317-328.
12. Munn, Henry, "The Mushrooms of Language", *In Harner*, 86-122.
13. Ravicz, Robert. "La Mixteca en el Estudio Comparativo del Hongo Alucinante", *Anales del Instituto Nacional de Antropologia e Historia*, 13, 1960 (1961), 73-92.
14. Robertson, Merle Greene. *Personal Communication*, April 6, 1973.
15. Rubel, Arthur J., "The Epidemiology of a Folk Illness: Susto in Hispanic America", *Ethnology 3*, 268-283.
16. Schultes, Richard Evans. "An Overview of Hallucinogens in The Western Hemisphere", *In Furst*, 3-54.
17. *Summa Anthropologica en Homenaje a Roberto J. Weitlaner* (Mexico: Instituto Nacionial de Antropología e Historia, 1966).
18. Wasson, R. Gordon. "Notes on the Present Status of Ololiuhqui and the Other Hallucinogens Of Mexico", *Botanical Museum Leaflets*, Vol. 20 (6, Nov.) 1963, 161-193.
19. Wasson, R. Gordon. "Ololiuhqui and the Other Hallucinogens of Mexico", *Summa Anthropologica en Hornenaje a Roberto J. Weitlaner* (Instituto Nacional de Antropología e Historia, Mexico City, 1966), 329-348.
20. Weitlaner, Roberto J. and Cline, Howard F. "The Chinantec," Vol. 7, Part 1, *Handbook of Middle American Indians*, Ed. Evon Z. Vogt (Austin: University of Texas Press, 1969), 523-552.
21. Weitlaner, Roberto J. and Hoppe, Walter A. "The Mazatec," *Handbook of Middle American Indians*, Vol. 7, Part 1 (Austin: University of Texas Press, 1969), 516-522.

Religious use of hallucinogenic fungi: A comparison between Siberian and Mesoamerican cultures

by

Harri Nyberg

Karstenia 32:71 - 80. 1992

Department of Plant Biology, University of Helsinki, Viikki, SF-00710 Helsinki, Finland

original report: https://www.funga.fi/Karstenia/Karstenia%2032-2%201992-4.pdf
backup source: http://www.psilosophy.info/resources/Karstenia%2032-2%201992-4.pdf

Table of Contents:

- Introduction
- Pharmacological properties of the Red Fly Agaric, Amanita muscaria
- Pharmacological properties of Psilocybe mushrooms
- Use of the Fly Agaric in Eurasian shamanism
- The Fly Agaric in North and Central America
- Religious use of Psilocybe fungi in Mesoamerica
- Mushroom rituals of the Mazatecs in Huautla de Jiménez
- Conclusions
- References

The religious uses of hallucinogenic mushrooms in northern Eurasian and Mesoamerican cultures are compared. In northern Eurasia, some shamanistic cultures have used the Fly Agaric (*Amanita muscaria* (L.) Pers.); Mesoamericans, mainly mushrooms of the genus *Psilocybe* (Fr.) Kummer. The hallucinogenic potency of the former is due to isoxazole compounds and of the latter, psilocybine-type compounds. Despite similarities between ihe uses in these two cultural areas, there are also marked differences: the Fly Agaric did not seem to have been an object of religious, ritual veneration in northern Eurasia, whereas this was true for the *Psilocybe* mushrooms in Mesoamerica. This is suggested to be a result of the difference between these two mushroom groups in their pharmacological and clinical effects on man and also a result of vast cultural differences between the areas in question. The cultural and religious differences between northern Eurasian and Mesoamerican use of hallucinogenic fungi and the significance of these differences are discussed.

Keywords: *Amanita muscaria*, hallucinogenic fungi, Mesoamerican cultures, *Psilocybe*, shamanism, Siberian cultures

Introduction

Religious use of hallucinogenic fungi has been repeatedly documented among shamanistic cultures in different parts of the world. In this paper, the use of these fungi by Siberian shamanistic cultures and by certain Mesoamerican Indian cultures are compared. There is an extensive documentation of the use of the Red Fly Agaric (*Amanita muscaria* (L.) Pers.) in Siberia, although the ethnologists have obviously been more interested in the shamanistic rites and their aims and performances, as well as in the mythology of the peoples studied. The use of the Fly Agaric by shamans or ordinary people in Siberia and its consequences have often been overlooked and usually described more or less briefly (e.g. Bogoras 1904-1909, Jochelson 1908, Lehtisalo 1924, Karjalainen 1927, Ohlmarks 1939, Siikala 1978). Studies on the Siberian use of the Fly Agaric have diminished during the recent years, with the notable exception of Saar (1991), who also presents some new data on the subject. However, the possible religious veneration of the Fly Agaric by the Siberian peoples is a question which is largely neglected.

For some Mesoamerican ethnic groups, the use of hallucinogenic fungi was an essential part of the culture during the Spanish conquest, when it was for the first time observed by Europeans. It is obvious that this use of fungi had a long history behind it already at that time Fray Bernardino de Sahagún (1499-1590) mentioned the Aztec use of hallucinogenic fungi (Aztec *teonanácatl*) in his famous work "Historia General de las Cosas de Nueva España", also known as *The Florentine Codex* (de Sahagún, English transl. 1950-1963; hallucinogenic mushrooms are cited in Book 9: pp. 38-39; Book 10: pp. 12, 20, 37, 49, 55, 88, 173; Book 11: pp. 120, 129, 130, Fig. 516). The Florentine Codex is bilingual (Spanish and Aztec) and is regarded also as the most important document on Classical Nahuatl (Aztec) language. As regards cultural anthropology, de Sahagún's research methods were far ahead of his time and even today his work is much more reliable than other Mexican documents from the same period (Ortiz de Montellano 1990).

This use of hallucinogenic fungi, especially species of the genus *Psilocybe*, was still practiced, but already about to vanish in the 1950s, when it received the attention of the scientific world, mainly as a result of the field studies of R.G. Wasson and R. Heim in Mexico (see, for instance, Wasson 1957, Heim and Wasson 1958, Guzmán 1959, Wasson 1959, 1961). These discoveries, along with the growing interest in psychoactive drugs, led to a veritable stream of books and articles in which plants containing psychoactive or hallucinogenic compounds were described again and again. It is certainly no coincidence that all this happened when the 'hippie' movement was emerging; it created a supply and demand of many pseudo-scientific writings. Some scientists also pondered the value of hallucinogenic substances as tools for research of religious experiences (for example, Staal 1975), or even encouraged their use. However, this trend, along with the recreational use of mushrooms, declined in the 1980s and, after all, recreational use has little to do with religion and thus falls outside the scope of this paper. However, the recreational use of psychoactive substances offers an interesting field for psychological and sociological studies.

Mushroom cult in Mesoamerica is evident from numerous so-called 'mushroom stones' dating from the Middle Preclassic Mayan period (1000-400 B.C.) to the Classic Mayan period (500-1000 A.D.) in southern Mexico and in Guatemala (de Borhegyi 1961, 1963, Lowy 1971, 1972, Morley *et al*. 1983). Also pottery mushrooms have been found in the Maya area (Mexico, Guatemala, El Salvador) dating from approximately the above-mentioned periods (de Borhegyi 1961, 1963). A well-known early (Mayan Preclassic) 'collection' of mushroom stones has been found from the Kaminaljuyú tombs near Guatemala City (de Borhegyi 1961, Morley *et al*. 1983). Stone engravings and frescoes representing or symbolizing mushrooms (according to the interpretation of Wasson 1980) occur also in the murals of Teotihuacán and other Aztec temples; however, engravings and paintings representing flowers of hallucinogenic plants seem to be much more common in the temples. Several XVI century Mexican codices have illustrations representing mushrooms (Heim & Wasson 1958, Wasson 1980).

In this paper, I imply that although the religious use of mushrooms was found in both the Old and the New World, the ways of their uses and the rites, myths and ways of thought associated with them were essentially different. In comparing Siberian and Mesoamerican cultures I omit discussion of the well-known theory that the Indian and Iranian *soma/haoma* was identical with the Fly Agaric (Wasson 1968); this very controversial question deserves a treatment of its own (Nyberg 1991a). The possible use of the Fly Agaric by ancient Norsemen (to explain the berserk rage) I have treated elsewhere (Nyberg 1991b). In comparative religion, the subject of the use of hallucinogenic fungi falls in the area of phenomenology, psychology and mysticism.

The effects of hallucinogenic fungi are caused by their chemical constituents whose occurrence, structure and toxicology can be studied by means of chemical and physiological methods. This is an interesting field of ethnopharmacology, other relevant fields being mycology (both the taxonomy and physiology of fungi), clinical toxicology and plant chemistry. The material for this study was provided by the extensive literature on the subject and the author's experience in plant chemistry.

Pharmacological properties of the Red Fly Agaric, Amanita muscaria

The Red Fly Agaric (*Amanita muscaria*) is a mushroom with wide distribution in the northern hemisphere. It is mycorrhizal with birch, pine and occasionally other coniferous and deciduous trees, of boreal and temperate climate, and is found in more southern latitudes only in montane forests. The genus comprises c. 100 species, of which at least the death-angel (*Amanita phalloides* (Fr.) Link.) and its white relatives (*A. virosa* (Fr.) Bert., *A. verna* (Bull.: Fr.) Roques) are deadly poisonous to man. The Fly Agaric is not fatal, because its poisons are isoxazole compounds, not related to the cyclopeptides of the deadly *Amanita* species. The Fly Agaric is an easily recognized, red-capped (some forms yellow-capped), large species, usually with white patches on the cap. Formerly it was used as a fly poison, a practice which is reflected in its vernacular name in many languages. The first toxic compound isolated from it, muscarine, was long held to be the main source of its poisonous properties, until the mushroom was found to contain far too small amounts of muscarine (0.0003%) for it to be pharmacologically active (Bresinsky & Besl 1985). Later other isoxazoles were found in larger amounts: ibotenic acid, muscazone and muscimol. Some strains contain c. 0.1% of ibotenic acid, but in other strains this is mostly replaced by muscazone (Wagner 1985).

Although *Amanita muscaria* is a well-known species indigenous to both Eurasia and America, it comprises numerous subspecies or geographical races, which differ in their isoxazole composition; moreover, variation occurs down to different clones of the mushroom. This explains the very varied responses in man observed in modern studies towards Fly Agaric consumption. The chemical, clinical and pharmacological properties of the Fly Agaric have been described by Singer (1978) and Bresinsky & Besl (1985). Although the taxonomy of *A. muscaria* is still not fully known, a satisfactory review can be found in Singer (1978). The poisonous compounds are water-soluble, but not very rapidly extractable from the mushrooms, e.g. by boiling. In contrast, when the mushrooms are eaten or a broth made of them, the poisons dissolve and are absorbed rapidly from the stomach and the intestines into blood, and their effects are manifested after 30 minutes to 3 hours. The isoxazoles, especially muscimol (Schultes & Hofmann 1980), pass through the human renal system almost intact, and thus it is possible to ingest them by drinking urine, human or reindeer, which also seem to eat the fungus (Furst 1976): this custom has been reported several times from northern Siberia (Bogoras 1904-1909, Jochelson 1908, Ohlmarks 1939, Saar 1991). Urine-drinking has probably been practiced because of the rarity of the Fly Agaric: this mycorrhizal mushroom is not likely to occur in treeless northern Siberia. It has thus also had certain commercial value in these parts.

Largest amounts of poisons occur in the mushroom cap, especially in the yellowish layer under the red pileipellis. Only small amounts can be found in the stipe. The main symptoms of *Amanita muscaria* poisoning (the *Amanita pantherina*-syndrome: Bresinsky & Besl1985) are lack of muscular coordination, moods fluctuating from bliss to rage, a sense of unreality, and emotional and also visual hallucinations (Singer 1978, Bresinsky & Besl 1985). The symptoms often begin with a short period of sleep (Wasson 1968, Siikala 1978). A capacity to exceed one's normal physical powers has also been reported, for example, people are able to walk long distances in deep snow without getting tired, but when the mushroom effects end, exhaustion follows (Bogoras 1904-1909). In some users the Fly Agaric apparently causes a hang-over, and abstinence symptoms after long usage (Bogoras 1904-1909, Jochelson 1909), but this seems to depend on the individual. The nature of the hallucinations caused by the mushroom also seems to depend on the culture, and on psychological and physical characteristics of the user. In northern Siberia, the mushroom seems to have been used mainly by males. I will return later to the role of the Fly Agaric in shamanism.

Pharmacological properties of Psilocybe mushrooms

Most of the hallucinogenic mushrooms used in Mesoamerican cultures belong to the genus *Psilocybe*. This is a cosmopolitan genus with 144 species, of which 81 have been reported to contain hallucinogenic compounds (Bresinsky & Besl1985). Their taxonomy has been well monographed by Guzmán (1983). The seem to have been in use already in pre-Columbian (mainly in Mayan and Aztec) cultures in what are now Mexico, Guatemala and El Salvador. As early as in the 16th century de Sahagún (1950-1963) mentioned the use of *teonanácatl*, which Nahuatl word is often translated as 'divine flesh', 'flesh of the gods', (e.g. by Furst 1976), but a better translation is 'divine mushroom', 'dangerous mushroom' (Cooke 1977, Wasson 1980). This, however, was often confused by earlier scientists with the peyote cactus (Nahuatl *peyotl*, *Lophophora williamsii* (Lem.) Coulter; Ott 1978, Schultes & Hofmann 1980). In the 1950s, thanks to the work of several eminent investigators (Schultes 1939, Reko 1949, Heim & Wasson 1958, Ott 1978, Singer 1978, Schultes & Hofmann 1980) it finally turned out that *teonanácatl* meant hallucinogenic mushrooms. The attitude of the Catholic church was from the beginning very unfavourable toward the use of the mushrooms, seen as a diabolic mimicry of the Holy Communion, and the church succeeded to suppress the use so that it survived only in remote mountainous areas. The traditional religious practice has been documented in the divinatory and magic rites of the Mazatec, Chinantec, Chatino, Zapotec, Mixe and Mixtec of Oaxaca, the Nahua of Mexico, and possibly the Otomí of Puebla and the Tarascana of Michoacán (Schultes & Hofmann 1980). Possible modern use has also been reported among the Chol and Lacandón Maya (Furst 1976). Linguistic evidence reveals much wider use in the whole area of ancient Aztec and Mayan cultures.

The most important species of *Psilocybe* in religious use have been *P. aztecorum* Heim, *P. caerulescens* Murr., *P. hoogshagenii* Heim, *P. mexicana* Heim, *P. yungensis* Singer & Smith, *P. zapotecorum* Heim and *P. (Stropharia) cubensis* (Earle) Singer (Schultes & Hofmann 1980). Complete lists were published by Schultes & Hofmann (1980) and Guzmán (1983).

These mushrooms seem to prefer sites with high nitrogen content, and some of them are growing on cattle and deer dung. They are very variable in size, but usually small with a stipe of at most 10-15 cm and a more or less cone-shaped cap (hence the name 'liberty cap'). *P. cubensis* differs in habit from most other species; it is tall, robust and flat-topped. Their hallucinogenic compounds are psilocybine (the most important), psilocine and baeocystine. Some other related compounds are also found, but usually in small amounts (Schultes & Hofmann 1980; Bresinsky & Besl 1985). The psilocybine compounds are water-soluble indole derivatives, and have close relationships with tryptophane metabolism and auxin-type plant hormones. As tryptamines they bear a resemblance to the active compounds of several hallucinogenic plants, for instance, ayahuasca (*Banisteriopsis caapi* (Spruce ex Griseb.) Morton), Syrian rue (*Peganum harmala* L.) and peyote (*Lophophora williamsii*). Close chemical relatives are also the ergot alkaloids of the ergot fungus (*Claviceps purpurea* (Fr.) Tulasne) and the synthetic, not naturally occurring LSD (lysergic acid diethylamide).

The symptoms caused by these fungi (mainly by psilocybine) have been called 'the *Psilocybe* syndrome' (Bresinsky & Besl 1985). Psilocybine is a powerful compound causing hallucinations in man with doses as low as 4-8 mg or about two grams of dried fungi (Schultes & Hofmann 1980). The effects are psychologically dramatic but do not affect man physiologically very greatly: symptoms pass in 6-10 hours without apparent aftereffects. The psychical symptoms vary according to the mental disposition and balance of the individual: feelings of euphoria or panic and consciousness of time, space and self change in a way which is very difficult afterwards to put into words; colours, sounds, smells and touch reach unusual intensities. Erotic feelings are often strong, and the person may experience imaginative traveling to distant places or times of the past or future. Luminous visual hallucinations are vivid especially in the dark: they may have geometric, organic or ornamental pattern shapes. It has been suggested that the human sacrificial victims of the Aztecs were willing to die because they were drugged with psilocybine (Bresinsky & Besl 1985). However, the Aztecs thought that the continued existence of the world was guaranteed by sacrifice of human blood and hearts to the sun, and the souls of the sacrifice victims fared better in the afterlife than those of ordinary people (Ortiz de Montellano 1990). Thus it seems that no drugging was necessary, especially as the Aztec philosophical ideas were thoroughly permeated with the importance of fulfilling one's duty.

The *curanderos* who have consumed these mushrooms for decades have showed no abstinence symptoms between the seasons of use, and usually belonged to the oldestliving and mentally best-balanced individuals of their societies. No evidence exists of addiction or permanent psychic changes from psilocybine. In this, psilocybine resembles mescaline, as both seem to be lacking any element causing permanent damage to man.

Use of the Fly Agaric in Eurasian shamanism

Many documents on the use of *Amanita muscaria* in northern Siberia date back to the 17th century (Furst 1976). Use seems to have been both religious and recreational, and *A. muscaria* seems also to have been the only inebriant in the area before the availability of alcohol (Bogoras 1904-1909). When using *A. muscaria*, the psychological aim of the shaman is to reach an altered state of consciousness (ASC). Siikala (1978) defined several of these states and classified them; the religious use of *A. muscaria* is mainly connected with 'sacral institutional ASC'. However, the attaining of the ASC in Siberian shamanistic practices do not seem to depend on the use of the mushroom. The necessary prerequisites for a shaman to enter the ASC are a careful preparation of the séance (fasting, abstaining from sexual relations for a time, solitude, ritual donning of the shaman dress, and singing of hymns). The trance (ASC) is then usually attained with the help of rhythmic beating of the shaman's drum with increasing intensity. Mainly the rhythmic flow of impulses seems to influence the central nervous system of the shaman (Eliade 1964, Siikala 1978). But what is the attitude of shamans and their peoples towards *A. muscaria* and the reasons for its use?

Saar (1991) separates two regions of customary *A. muscaria* use. The first is West Siberia and the Taimyr Peninsula, where mushroom use has been reported among the K.hanty (Ostyaks), Selkup (Southern Samoyeds), Nganasan (Taimyr Samoyeds) and Ket ('Yenisey Ostyaks'), with episodic use even now. The second area is the easternmost Siberia, including the Chukchi and Kamtchatka Peninsulas. The use of mushrooms has been reported among all peoples of the region: the Chukchi, Koryak, Itelmen ('Kamchadal'), Inuit, Yukagir, Even (Tungus) and even the Russian descendants of the earliest settlers in the area. Here the custom of *A. muscaria* consumption is still alive (Saar 1991). In some cultures, e.g. the Khanty, also women could be shamans and use the mushroom (Karjalainen 1927).

Bogoras (1904-1909) describes how *A. muscaria* leads to the appearance of the spirits of the Fly Agaric. The spirits bear the shape of actual mushrooms, and the user feels impelled to imitate them. The spirits are mischievous and play practical jokes on the user. They also ask for obeisance, which must be given, otherwise the person's life would be in danger. The spirits can take him to various worlds and show him visions. The Koryak call these spirits *wapaq*, a name used also to denote the mushroom itself (Furst 1976). Saar (1991) states that the mushroom spirits of the Khanty are half as tall as men and usually ask why the person has eaten the mushroom: this question must be answered. The person explains and then tells his desires and the spirits give the answer, in the form of a song or a narrative. The Forest Nenets believed that only those who were acquainted with the 'inner nature' of *A. muscaria*, could eat them "with luck", otherwise the spirits are not clearly visible, and they lead the shaman into darkness (Lehtisalo 1924). The Nenets shaman had to eat, in addition to the 'suitable' amount of mushroom caps, one halved mushroom cap, as this produced a spirit less powerful than the others and he will be able to follow them as they run swiftly in the same direction as the sun. The 'half-spirit' falls behind the others and makes it easier to follow the spirits.

Saar (1991) lists the reasons for the consumption of *A. muscaria* in Northern Eurasia as follows: 1) for communication with the souls of the dead or with spirits; 2) for treatment of diseases; 3) for naming a new-born child; 4) for making clear the cause of a dangerous situation and finding ways to overcome it; 5) for interpretation of dreams, prediction and fortunetelling, and seeing past events; 6) for visiting different worlds and flight over the earth (shamanistic journeys); 7) for creation of assistant spirits using *A. muscaria* as a mediator; 8) for increasing the shaman's courage; 9) for inspiration to recite songs or epics; 10) to increase bodily resistance to physical strain and 11) to call forth spirits of high status. According to the shamans, it is necessary to take into account the phase of development of the fruit body and the personality of the person consuming it. Also the dose and the form in which *A. muscaria* is consumed are important, but must be adjusted according to the user's purpose and to the 'nature' of the individual. Recreational use of *A. muscaria* has also at all times existed in Northern Eurasia (Bogoras 1904-1909, Jochelson 1909, Saar 1991). In the 19. century some ethnic groups preferred the use of the Red Fly Agaric as an inebriant instead of alcohol (Wasson 1968).

These descriptions suggest that the Fly Agaric itself was not an object of religious veneration, and no real mushroom cult existed in Siberia. The mushroom spirits are merely considered potentially dangerous helpers in the shaman's journey, with no evidence of any mushroom cult similar to that of the Mesoamerican cultures. Saar (1991) states that some Siberian peoples held the mushrooms to be supernatural beings, but it would perhaps be more correct to regard them as secondary tools. In fact, those shamans who did not need to utilize the mushroom as an ally were considered more powerful (Saar 1991). The eating of mushrooms does not seem to involve any specific rituals, and Eliade (1964) and Siikala (1978) share the view that only a weak shaman, i.e. a person whose psychical disposition to shamanism is not very suitable, had to use a chemical 'tool' to attain the necessary ASC. Eliade (1964) sees the use of mushrooms as a late development and even a 'degeneration' of shamanism; the high status of the shaman in society has caused many "less gifted" individuals to resort to mushrooms, which have the capacity to produce the necessary ASC, but in a crude and passive way (Eliade 1964).

The Fly Agaric in North and Central America

Amanita muscaria occurs through the vast area of North and Central America in all suitable habitats, though in the south only in mountainous areas. In the United States it fruits from early spring through late autumn, in Mexico from summer to autumn in the pine-oak forest belt (Ott 1976). In Mesoamerica the Fly Agaric is usually regarded as a poisonous and dangerous species (Lowy 1974). However, as the taxonomy of *A. muscaria* is incompletely known, it is not certain whether all clones belong to the same species in this area. Very little is known of its possible religious use outside the Old World: Wasson (1986a) reports its religious role among the Ojibwa Indians and its use by the Maya for divinatory purposes. Among the Quiché, Cakchiquel and Tzeltal Maya it seems to be associated with thunder and lightningbolts (Lowy 1974, Wasson 1986b). It seems that the association of certain mushrooms with thunder is widespread in different parts of the world, but little evidence is available to indicate that the Mesoamerican cultures were ever aware of the hallucinogenic properties of *A. muscaria*. However, certain mushroom stones of ancient Mesoamerica bear closer resemblance to *A. muscaria* than to *Psilocybe*: one striking example has been found in Patzcuaro (Michoacán, Mexico: Guzmán 1990). Also a ceramic bottle representing a human head with a patched mushroom emerging from the side of the forehead has been found; the mushroom bears a close resemblance to *Amanita muscaria* and the bottle is typical for the Mochica culture in Peru dating back to 200-500 A.D. (Niemela 1984). Mushroom figures with patches on the cap occur also in Maya codices (Lowy 1972). It has been suggested that *A. muscaria*, which occurs throughout Guatemalan and Mexican pine forests, was once used by several tribes in Mesoamerica for religious purposes (Guzmán 1990).

Religious use of Psilocybe fungi in Mesoamerica

In contrast to the Eurasian cultures, a genuine mushroom cult in Mesoamerican cultures seems to have existed, and its beginnings can be traced to remote antiquity. The remarkable 'mushroom stones' (of stone or pottery) of the ancient Mayas and mural frescoes found in central Mexico are striking archeological evidence, the earliest 'mushroom stones' dating from the period 1000-300 B.C. (Mayan Early and Middle Preclassic: de Borhegyi 1961, 1963, Lowy 1971, Schultes 1972). Mushroom stones are found in all parts of Highland Guatemala and in the Petén province in northern Guatemala. They occur also in the Mexican states of Oaxaca, Tabasco, Veracruz and Chi a pas, and in El Salvador (de Borhegyi 1961, 1963). They represent many different types, but the "stipe" is usually decorated with human or animal figures; their description and analysis are outside the scope of this article, but they seem to imply the existence of important mushroom cults among the ancient Maya.

Scripts from the early Conquest period (late 16th century) contain several descriptions of the importance of hallucinogenic mushrooms to Mexican religion and life. By far the most important contribution to the early knowledge of Mesoamerican mushroom cults is the huge work of de Sahagún (manuscript (*The Florentine Codex*) from 1578-80, English tr. by Anderson & Dibble 1950-1963). Three types of hallucinogenic fungi are mentioned also by the famous Spanish physician, F. Hernández, sent to Mexico by the King of Spain (Hernández 1942-1946, orig. 1577: mushrooms mentioned in book 2/fX, Ch. 95). However, few later references to the use of hallucinogenic mushrooms in Mexico are to be found, until modern scientific interest 'discovered' the phenomenon anew, first in the 1930s, largely through the work of R.J. Weitlaner, B.P. Reko, J.B. Johnson and R.E. Schultes (Johnson 1939, Schultes 1939, 1940, 1978, V.A. Reko 1949, Heim & Wasson 1958). In the 1950s the task was taken up by R.G. Wasson, R. Heim, R. Singer and G. Guzmán; their results and the discovery of an extant mushroom cult in Mexico have been published many times, for instance by Wasson (1957), Heim & Wasson (1958), Singer (1958), Schultes (1972) and Wasson (1980). The earliest Mexican and

Spanish sources are well presented by Heim & Wasson (1958).

It is evident that specialists in the mushroom cult existed from the earliest times, and the use of hallucinogenic mushrooms in Mesoamerica was strictly ritualistic and under the control of 'professionals'. These people were in modern times called, in Spanish, *curandero*s (masc.) or *curanderas* (fern.), which reveals their main function: curing of illnesses. They had, however, other tasks also, such as finding lost or stolen property and predicting the future. Another name for the curers is *sabio* (masc.) or *sabia* (fern.), 'wise man, wise woman'. Quite often they were women. These are in literature also called 'shamans', but to me it seems that the latter name leads one astray, as the Mesoamerican 'wise person' does not in every respect resemble the Eurasian shaman. The Mazatec Indians, who have been most completely studied in this matter, divided the curers into three further categories (Estrada 1981): 1) on the lowest level is the sorcerer (Sp. *brujo*, Mazatec *tji ʔe*) who can be evil and turn himself into an animal (*nagual*, Nahuatl *nahualli*) at night; 2) on the intermediate level is the curer (Mazatec *cho ta xi vʔe'nta*), who uses massage, potions and a sacred language of his own; 3) in Huautla de Jiménez (Oaxaca, Mexico), the third and superior category was the 'Wise One and Doctor' (Mazatec *cho ta chji ne*), who does not use potions and does no evil. His power is in his ability to ingest and communicate with the mushrooms, euphemistically called 'saint children' (Mazatec *ʔnti xti santo*), 'little one who springs forth' (Mazatec *ʔnti xi tjo*), 'little saints' (Mazatec *ʔnti*' *sa nto*) and 'little things' (Mazatec *ʔnti*'*tso jmi*). Other edible or poisonous mushrooms are never called by these names (Estrada 1981).

The most comprehensively documented mushroom cult was found in the 1950s in the state of Oaxaca, southern Mexico. The Indian inhabitants of some mountain villages, especially the Zapotecs of San Agustín Loxicha, the Mixe of SanJuan Mazatlán and the Mazatecs of Huautla de Jiménez, still actively practised the nocturnal mushroom séances (Sp. *velada*); the *curandera* of Huautla, María Sabina (born 1894), has especially attained worldwide fame (Heim & Wasson 1958, Wasson 1958, Furst 1976). First she was introduced by Wasson (1957) under a pseudonym to protect the person and village against public interest. Her life and sacred chants have been published by Estrada (1981), himself a native Mazatec; and H. Munn, an American who married a Mazatec woman from Huautla, has contributed to our knowledge of María Sabina both by translating Estrada (1981) into English and studying the sacred language used in the mushroom cult (Munn 1973). The *velada* of María Sabina has also been recorded and the words and tunes published (Wasson *et al*. 1974).

The Mixe Indians in the eastern part of the state of Oaxaca, Mexico, have also used hallucinogenic *Psilocybe* mushrooms for divinatory and medicinal purposes up to the present time (Lipp 1990). In Mixe, these mushrooms are called *na.shwiñ. mush* and are further recognized under the following names: 1) *pi.'tpa* 'spindle whorl' or '*ene.ti.ic* 'thunder's teeth' (*Psilocybe mexicana*, *P. cordispora* Heim), 2) *atka:t* 'judge' (*P. hoogshagenii*) and *ko:ng* 'lord, governor' (*P. caerulescens*). The Mixe consider these mushrooms to be all-knowing soothsayers, equated with the blood of Christ. According to the Mixe, illnesses originate in man's bones, and the mushrooms are the only 'medicine' able to penetrate the bones. They are said to grow only in sacred soil. According to the description of Lipp (1990), when they are found, they are first revered with kneeling and the lighting of candles, then plucked very carefully and taken to a house for treatment with copal (from *Bursera bipinnata* (DC) Engl. or some other woody plant yielding resins; author's comment) incense or to a church, and then they are used after three days. The partakers must abstain from sexual intercourse, from fowl or pig meat, mescal, eggs or vegetables during this period. After the mushrooms are eaten, on the next day chili peppers are eaten, but meat and alcohol are proscribed for one month. The mushrooms are always consumed in pairs, and the dosage varies according to the age and sex of the person. They are eaten in a lonely hut to prevent anyone from overhearing the conversation with the mushrooms; the mushrooms are also held to be sensitive to noise, and they stop 'speaking' when it occurs. Other hallucinogenic fungi found in divinatory use in this area are reported to be some species of the family *Lycoperdaceae*, and *Scleroderma verrucosum* Pers. (Ott *et al*. 1975). It is also interesting to note that in Chignahuapán (State of Puebla, Mexico), a church has been discovered to have been dedicated to a mushroom; this mushroom, carefully preserved in the church, was identified as *Ganoderma lobatum* (Schw.) Atk. (Guzmán *et al*. 1975, Guzmán 1990). This polypore has no hallucinogenic properties, but it is closely related to *Ganoderma lucidum* (Curt.: Fr.) Karst. which is considered especially in China and Japan to have medicinal properties (Stamets 1990). However, it is probable that the Indians of Chignahuapán had, at least formerly, practised a cult of sacred mushrooms (Guzmán 1990).

Mushroom rituals of the Mazatecs in Huautla de Jiménez

Munn (1973) describes the Mazatec mushroom *velada* as follows:

> *The Mazatec Indians eat the mushrooms only at night at absolute darkness. It is their belief that if you eat them in the daylight you will go mad… Usually several members of a family eat the mushrooms together: it is not uncommon for a father, mother, children, uncles and aunts to all participate in these transformations of the mind that elevate consciousness onto a higher plane. The mushrooms themselves are eaten in pairs, a couple representing man and woman that symbolizes the dual principle of procreation and creation. Then they sit together in their inner light, dream and realize and converse with each other, presences seated there together, their bodies immaterialized by the blackness, voices from without their communality… For everyone present the purpose of the session is a therapeutic catharsis… The psychedelic experience of the Mazatecs is inseparably connected with the curing of an illness; not only physical illness but spiritual and ethical problems. The mushrooms are eaten when something is wrong.*

Both María Sabina herself (Estrada 1981) and Munn (1973) stress the importance of language in the mushroom cult. María Sabina describes the beginning phases of her call as follows (Estrada 1981):

> *I remember that I had a vision: some people appeared who inspired me with respect. I knew they were the Principal Ones of whom my ancestors spoke. They were seated behind a table on which there were many written papers. I knew that they were important papers. There were a number of Principal Ones, six or eight of them… Right away I heard a voice. A voice that was sweet but authoritarian at the same time. Like the voice of a father who loves his children but raises them strictly. A wise voice that said: "These are the Principal Ones". I understood that the mushrooms were speaking to me. I felt an infinite happiness. On the Principal Ones' table a book appeared, an open book that went on growing until it was the size of a person. In its pages there were letters. It was a white book, so white it was resplendent.*
>
> *One of the Principal Ones spoke to me and said: "María Sabina, this is the Book of Wisdom. It is the Book of Language. Everything that is written in it is for you. The Book is yours, take it so you can work". I exclaimed with emotion: "That is for me. I receive it"… I limited myself to contemplating it and, at that moment, I began to speak. Then I realized that I was reading the Sacred Book of Language. My Book. The Book of the Principal Ones.*
>
> *I had attained perfection. I was no longer a simple apprentice. For that, as a prize, as a nomination, the Book had been granted me. When one takes the saint children, one can see the Principal Ones. Otherwise not. And it's because the mushrooms are saints: they give wisdom. Wisdom is Language. Language is in the Book. The Book is granted by the Principal Ones. The Principal Ones appear through the great power of the children. I learned the wisdom of the Book. Afterwards, in my later visions, the Book no longer appeared because I already had its contents in my memory.*

The curing ceremony that María Sabina used to cure her sister is described as follows:

> *The vigil… I conducted as the ancient Mazatecs did. I used candles of pure wax; flowers, white lilies and gladiolas (all kinds of flowers can be used as long as they have scent and color); copal and San Pedro (ground-up tobacco (Nicotiana rustica L.) mixed with lime and sometime also with garlic; author's comment) as well.*
>
> *In a brazier I burned the copal and with the smoke incensed the saint children that I held in my hands. Before eating them, I spoke to them. I asked them for favor. That they bless us, that they teach us the way, the truth, the cure. That they give the power to follow the tracks of evil in order to be done with it. I said to the mushrooms: "I will take your blood. I will take your heart. Because my conscience is pure, it is clean like yours. Give me truth. May Saint Peter and Saint Paul be with me". When I felt dizzy, I blew out the candles. The darkness serves as a background for what is seen.*

The person who gathers or uses *Psilocybe* mushrooms in the way decribed above must abstain from sexual relations and avoid any connection with corpses, dead animals or any decomposing matter.

The *language* (the sacred chants) of María Sabina is interestingly full of symbolism which is not easily understood. Moreover, the *language* is not the same in all cases (Estrada 1981). An example of the chants runs as follows (the original Mazatec translated into English by Estrada 1981):

> *I am a woman who shouts, says*
> *I am a woman who whistles, says*
> *I am a woman who thunders, says*
> *I am a woman who plays music, says*
> *I am a spirit woman, says*
> *I am a woman who shouts, says*
> *Ah, our Jesus Christ, says*
> *Ah, our Jesus, says*
> *Our Saint Peter woman, says*
> *Our Saint Peter woman, says*
> *Our Ustandi woman, says*
> *Our shooting star woman, says*
> *Our shooting star woman, says*
> *Our whirling woman of colors, says*

The Mazatec used in the chants is much richer in vocabulary than the usual conversational language, and much of it is incomprehensible to ordinary people; this, of course, is a common trait to shamanistic sacred languages everywhere (Eliade 1964). The word 'says' repeated after each strophe refers to the mushrooms; it is the sacred mushroom who 'says' everything. In the chants, Christian holy persons and native Mazatec characters (for instance, the Lord of the Mountains, Mazatec *Chicon Ninto*) appear together. The syncretistic features of the cult are manifest, although the Indian concepts are the prevailing ones, being woven together with Christianity only in comparatively modern times.

Conclusions

It seems that, to our present knowledge, religious use of hallucinogenic fungi has occurred in two large areas in the world: northern Eurasia and Mesoamerica. Outside these areas, the evidence is inconclusive, although Wasson (1968, 1986a), especially, sought to prove fungi's former use also among the early Indo-Aryans and Greeks. I also disagree with the theory enthusiastically put forward by Wasson (Wasson 1961, 1986a), and favoured by some other scholars, such as La Barre (1972, 1990), that hallucinogens were once indeed the source of all religion and of the evolution of human culture in general. One should take seriously the warnings ofWeil (1978), concerning psychedelic mycophagy, and Naranjo (1990), who comments on Wasson's ideas on the origins of religion. However, it is true that the shamanistic world-view seems to be a very old way for man to arrange his relationship both to the visible and the supernatural world (Furst 1976). On the other hand, it is significant that Furst himself does not openly commit himself to 'the Wasson theory' even in his published reminiscences of Wasson (Furst 1990).

It is evident that the use of hallucinogenic or if we prefer to use the word coined by Ruck and Wasson (Wasson 1978, Wasson 1986a), *entheogenic*- mushrooms has many common characteristics both in northern Eurasia and Mesoamerica: both cultural areas have used them for similar purposes. But there are also profound differences: in northern Eurasia the mushrooms themselves have not been objects of veneration, while in Mesoamerican cultures this has been the rule. In my opinion, this contrast is mainly a result of the difference in the mind-altering properties between *Amanita muscaria* and the *Psilocybe* mushrooms, which, in turn, derives from the fact that these two groups contain totally different hallucinogenic compounds.

We also have to take into account the profound cultural differences between Mesoamerican and Siberian cultures. In Mesoamerica, the religious use of hallucinogenic fungi evolved among culturally advanced agriculturalist peoples with a centralized government, which emphasized the role of the rulers, gods, shrines and a priestly class. The use of hallucinogenic fungi in modern times can be considered a remnant of an official religious system, which disintegrated after the Spanish conquest. In contrast, the Siberian cultures were culturally at a lower level with more diffuse and variable religious ideas and with a subsistence economy based on hunting, fishing and reindeer-breeding. This formed the basis of the development of shamanism in its 'genuine' form (i.e. in the sense described by Eliade 1964). Moreover, the Siberian peoples were mostly nomadic or seminomadic, and this explains the wide distribution of the use of *Amanita muscaria* in northern Eurasia and the cultural similarities of the peoples concerned, from the Lapps in the west to the Chukchi and Koryak in the east. The use of *Psilocybe* fungi in Mesoamerica seems, in contrast, to have been confined to relatively small areas. However, the difference in the active hallucinogenic compounds of *Amanita muscaria* and *Psilocybe* must also have been an important factor in explaining the differences between the religious use of fungi in Mesoamerica and Siberia.

Table 1. Comparison between the religious use of hallucinogenic fungi in Siberia and Mesoamerica

mushrooms: mainly *Psilocybe*, also others	mushrooms: *Amanita muscaria* only
use strictly ritual and obligatory	use not ritual or obligatory
use limited to professional shamans	use not limited to professionals
no recreational use	recreational use common
mushrooms regarded as divine or a manifestation of divinity	mushrooms regarded as a tool or as as an ally
mushrooms sacred	mushrooms not sacred
mushrooms not subject to trade	mushrooms have commercial value
use not revealed to outsiders	no special secrecy in use
the mushrooms themselves speak to the shaman	the mushroom calls forth spirits; the shaman speaks with the spirits

Acknowledgements. I am grateful to Dr. Tuomo Niemelä (Department of Botany, University of Helsinki) for critical reading of the manuscript and many useful comments and suggestions. I also wish to thank Ms. Sirkka Sällinen and to Ms. Marjatta Rautiala (Botanical Library, Department of Botany, University of Helsinki) for their patience in helping me to find the often not so easily available sources for my work.

References

1. Bogoras, W. 1904-1909: The Chukchee. The Jesup North Pacific Expedition. - Mem. Amer. Mus. Nat. Hist. 7:1-733. EJ. Brill, Leiden - G.E. Stechert, New York.
2. de Borbegyi, S.F. 1961: Miniature mushroom stones from Guatemala - Amer. Antiquity 26:498-504.
3. de Borhegyi, S.F. 1963: Precolumbian pottery mushrooms from Mesoamerica - Amer. Antiquity 28:328-338.
4. Bresinsky, A. & Besl, H. 1985: Giftpilze. Ein Handbuch für Apotheker, Ärtzte und Biologen. - 295 pp. Wissenschaftliche Verlagsgesellschaft, Stuttgart.
5. Cooke, R.C. 1977: Fungi, man and his environment. - 144 pp. Longman, London.
6. Eliade, M. 1964: Shamanism: Archaic techniques of ecstacy. - 610 pp. Pantheon Books, New York.
7. Estrada, A. 1981: Mar&iaacute;a Sabina: Her life and chants. - 239 pp. Ross-Erikson, Santa Barbara, CA.
8. Furst, P.T.1976: Hallucinogens and culture. - 194 pp. Chandler & Sharp, Novato, CA.
9. Furst, P.T. 1990: 'Vistas beyond the horizon of this life': Encounters with R. Gordon Wasson. In: Riedlinger, T.J. (ed.), The sacred mushroom seeker: 67-81. - Dioscorides Press, Portland, OR.
10. Guzmán, G. 1959: Sinopsis de los conocimientes sobre los hongos alucinógenos mexicanos. - Bol. Soc. Bot. de Mexico 24:14-34.
11. Guzmán, G. 1983: The genus *Psilocybe*: A systematic revision of the known species including the history, distribution and chemistry of the hallucinogenic species. - Beih. Nova Hedw. 74:1-439.
12. Guzmán, G. 1990: Wasson and the development of mycology in Mexico. In: Riedlinger, T.J. (ed.), The sacred mushroom seeker: 83-110. - Dioscorides Press, Portland, OR.
13. Guzmán, G., Wasson, R.G. & Herrera, T. 1975: Una iglesia dedicada al culto de un hongo "Nuestro Señor del Honguito", en Chignahuapán, Puebla. - Bol. Soc. Mexicano Mic. 9:137-147.
14. Heim, R. & Wasson, R.G. 1958: Les champignons hallucinogènes du Mexique. Études ethnologiques, taxonomiques, biologiques, physiologiques et chimiques. Arch. Mus. Nat. d'Hist. Nat., 7e Sr. 6:1-322 + 36 plates. Paris.
15. Hernández, F. 1942-1946: Historia de las plantas de Nueva España, Vols 1-3. Imprenta Universitaria, México. (Orig. 1577, in Latin; quoted after Heim & Wasson (1958) and Ortiz de Montellano (1990).
16. Jochelson, W. 1908: The Koryak. The Jesup North Pacific Expedition. - Mem. Amer. Mus. Nat. Hist. 6:1-842. E.J. Brill, Leiden - G.E. Stechert, New York.
17. Johnson, J.B. 1939: The elements of Mazatec witchcraft. - Ethnol. Studies (Gothenburg) 9 (1939):128-150.
18. Karjalainen, K.F. 1927: Die Religion der Jugra-Völker III. - Folklore Fellows Commun. 63:1-352.
19. La Barre, W. 1972: Hallucinogens and the origin of religion. In: Furst, P.T. (ed.), Flesh of the gods: The ritual use of

hallucinogens: 261-278. - George Allen & Unwin, London.

20. La Barre, W. 1990: My friend Gordon. In: Riedlinger, T J. (ed.), The sacred mushroom seeker: 147-149. - Dioscorides Press, Portland, OR.
21. Lehtisalo, T. 1924: Entwurf einer Mythologie der Jurak-Samojeden. - Mem. Soc. Finno-Ougr. 53:1-171.
22. Lipp, FJ. 1990: Mixe concepts and uses of entheogenic mushrooms. In: Riedlinger, T.J. (ed.), The sacred mushroom seeker: pp. 151-159. - Dioscorides Press, Portland, OR.
23. Lowy, B. 1971: New records of mushroom stones from Guatemala. - Mycologia 63:983-993.
24. Lowy, B. 1972: Mushroom symbolism in Maya codices. Mycologia 64:816-821.
25. Lowy, B. 1974: *Amanita muscaria* and the thunderbolt legend in Guatemala and Mexico. - Mycologia 66:188-191.
26. Morley, S.G., Brainerd, G.W. & Sharer, RJ. 1983: The ancient Maya, 4th Ed. - 708 pp. Stanford University Press, Stanford, CA.
27. Munn, H. 1973: The mushrooms of language. In: Harner, MJ. (ed.), Hallucinogens and shamanism: 86-122. - Oxford University Press, London.
28. Naranjo, C. 1990: A posthumous 'encounter' with R. Gordon Wasson. In: Riedlinger, T.J. (ed.), The sacred mushroom seeker: pp. 177-181. - Dioscorides Press, Portland, OR.
29. Niemelä, T.1984: Tapoja, taikojaja uskomuksia In: Härkönen, M. (main ed.), Sienestäjän tietokirja: 15-18. - Valitut Palat-Reader's Digest, Helsinki.
30. Nyberg, H. 1991a: The problem of the Aryans and the Soma: Botanical evidence. - Paper read at the Conference on Archeological and linguistic Approaches to Ethnicity in Ancient South Asia,Toronto 4-6 Oct. 1991.
31. Nyberg, H.1991b: Röd flugsvamp-orsaken till bärsärkaraseriet? - Jordstjärnan 12:7-10.
32. Ohlmarks, Å. 1939: Studien zum Problem des Schamanismus. - 395 pp. C.W.K. Gleerup, Lund, Ejnar Munksgaard, Kopenhagen.
33. Ortiz de Montellano, B.R. 1990: Aztec medicine, health and nutrition. - 308 pp. Rutgers University Press, New Brunswick, NJ.
34. Ott, J. 1976: Hallucinogenic plants of North America. 161 pp. Wingbow Press, Berkeley, CA.
35. Ott, J., Guzmán, G., Romano, J. & Díaz, J.L. 1975: Nuevas datos sabre los supuestos licoperdaceos psicotrópicos y dos casas de intoxicación provocados por hongos del genera Scleroderma en Mexico. Bol. Soc. Mexicano Mic. 9:67-76.
36. Reko, V.A. 1949: Magische Gifte. Rausch- und Betäubungsmittel der neuen Welt, 3. Aufl. - 175 pp. Ferdinand Enke Verlag, Stuttgart. (First edition 1936).
37. Saar, M. 1991: Ethnomycological data from Siberia and northeast Asia on the effect of *Amanita muscaria* - J. Ethnopharmacol. 31:157-173.
38. de Sahagún, Fray B. 1950-1963: The Florentine Codex. General history of the things in New Spain. 14 vols. English tr. by AJ.0. Anderson & C.E. Dibble. The School of American Research and the University of Utah, Santa Fe, NM. - Cited parts: Book 9 (= Vol. 10) - The merchants. 1959, 97 pp.; Book 10 (=Vol. 11) - The people. 1961, 197 pp.; Book 11(= Vol. 12) - Earthly things. 1963, 297 pp.
39. Schultes, R.E. 1939: Plantae Mexicanae II. The identification of teonanacatl, a narcotic basidiomycete of the Aztecs. - Bot. Mus. Leafl. Harvard Univ. 7:37-54.
40. Schultes, R.E. 1940: Teonanacatl, the narcotic mushroom of the Aztecs. - Amer. Anthropologist 40:698-715.
41. Schultes, R.E. 1972: An overview of hallucinogens in the Western Hemisphere. In: Furst, P.T. (ed.), Flesh of the gods: The ritual use of hallucinogens: 3-54. - George Allen & Unwin, London.
42. Schultes, R.E. 1978: Evolution of the identification of the sacred hallucinogenic mushrooms of Mexico. In: Ott, J. & Bigwood, J. (eds.), Teonanacatl: Hallucinogenic mushrooms of North America: 25-41. - Madrona Publishers, Seattle, WA.
43. Schultes, R.E. & Hofmann, A.1980: The botany and chemistry of hallucinogens, 2nd ed. - 437 pp. Charles C. Thomas, Springfield, Ill.
44. Siikala, A.-L. 1978: The rite technique of the Siberian shaman. - Folklore Fellows Commun. 220:1-385.
45. Singer, R. 1958: Mycological investigations on teonanácatl, the Mexican hallucinogenic mushroom I: The history of teonanacatl, field work and culture work. - Mycologia 50:239-261.
46. Singer, R.1978: Hallucinogenic mushrooms. In: Rumack, B.H. & Salzman, E. (eds.), Mushroom poisoning: Diagnosis and treatment 201-214. - CRC Press, West Palm Beach, Fla.
47. Staal, F.1975: Exploring mysticism. - 224 pp. Penguin Books, Harmondsworth.
48. Stamets, P. 1990: A discussion on the cultivation of Ganoderma lucidum (Curtis: Fr.) Karst., the reishi or ling zhi mushroom of immortality. - Mcllvainea 9(2):40-50.
49. Wagner, H. 1985: Pharmazeutische Biologie 2: Drogen und ihre inhaltsstoffe, 3. Aufl. - 496 pp. Gustav Fischer Verlag, Stuttgart.
50. Wasson, R.G. Great adventures. Seeking the magic mushroom. - Life International 22(2) (June 10,1957): 44-60.
51. Wasson, R.G.1959: The hallucinogenic mushrooms of Mexico: An adventure in ethnomycological investigation. - Transact. NY Acad. Sci. 21:325-339.
52. Wasson, R.G. 1961: The hallucinogenic fungi of Mexico: An inquiry into the origins of the religious idea among primitive peoples. - Bot. Mus. Leafl. Harvard Univ. 19:137-162.
53. Wasson, R.G. 1968: Soma: Divine mushroom of immortality. - 381 pp. Harcourt Brace Jovanovich, New York.
54. Wasson, R.G. 1980: The wondrous mushroom: Mycolatry in Mesoamerica - 248 pp. McGraw-Hill, New York.
55. Wasson, R.G., Cowan, G., Cowan, F. & Rhodes, W. 1974: María Sabina and her Mazatec mushroom *velada*. Text, tunes and recordings. - Harcourt Brace Jovanovich, New York.
56. Wasson, R.G. 1986a: Persephone's quest. In: Wasson, R.G., Kramrisch, S., Ott, J. & Ruck, C.A.P. (eds.), Persephone's quest: Entheogens and the origins of religion: 17-81. - Yale University Press, New Haven, CT.
57. Wasson, R.G. 1986b: Lightningbolt and mushroom. In: Wasson, R.G., Krarnrisch, S., Ott, J. & Ruck, C.A.P. (eds.), Persephone's quest Entheogens and the origins of religion: 83-94. - Yale University Press, New Haven, CT.
58. Weil, A. 1978: Reflections on psychedelic mycophagy. In: Ott, J. & Bigwood, J. (eds.), Teonanacatl: Hallucinogenic mushrooms of North America; pp. 149-155. - Madrona Publishers, Seattle, WA.

Introduction: Evidence for entheogen use in prehistory and world religions

by

Michael Winkelman[*]

Journal of Psychedelic Studies 3(2), pp. 43-62 (2019)

(Received: July 7, 2019; accepted: August 11, 2019, First published online: September 13, 2019)
DOI: 10.1556/2054.2019.024

© 2019 The Author(s)

original report:
https://www.researchgate.net/publication/335799340_Introduction_Evidence_for_entheogen_use_in_prehistory_and_world_religions/fulltext/5d7c4bd1299bf1d5a97d6e56/Introduction-Evidence-for-entheogen-use-in-prehistory-and-world-religions.pdf
backup source: http://www.psilosophy.info/resources/Introduction-Evidence-for-entheogen-use-in-prehistory-and-world-religions.pdf

[*] Retired, School of Human Evolution and Social Change, Arizona State University, Tempe, AZ, USA
Corresponding address: Michael Winkelman; Caixa Postal 62, Pirenopolis, Go. 72980-000, Brazil; Phone: +1 623 239 1662; E-mail: michaeljwinkelman[@]gmail.com

Table of Contents:

- **Introduction: Psychedelic Use In Human Antiquity**
  - Worldwide psilocybin mushroom species
  - Psychedelic influences in hominin evolution
  - Entheogens in shamanic origins
  - The antiquity of *Homo sapiens*' relationships with psychoactive plants
- **Mushroom And Entheogenic Cults Of The Past**
  - Asia
    - *Prehistoric evidence*
    - *The Soma controversy*
    - *Entheogenic mushroom use in complex Asian societies*
    - *Soma as ayahuasca analogue*
  - Africa and the Middle East
    - *Old Testament evidence for entheogens*
    - *Islamic entheogenic roots*
  - Europe
    - *Fungiform representations of ancient Europe*
    - *Greek entheogenic roots*
    - *Women's roles in entheogenic traditions*
    - *Religious use of A. muscaria in Christianity*
    - *Psychedelic mushrooms in Catholic art and architecture*
    - *The psychedelic gospels: The secret history of hallucinogens in Christianity*
    - *The witches' flying ointments*
  - Sacred mushrooms in the Americas
    - *North America*
    - *Mesoamerica and Central America*
    - *María Sabina: An ethnographic analogy for ancient Mesoamerican mycolatry*
    - *Costa Rica's entheogenic prehistory*
    - *South America*
- **Conclusions: The Modern Loss And Eternal Return Of Entheogenic Spirituality**
  - A modern entheogenic-origin religion: Mormonism
  - Entheogens as a universal religious heritage
- **References**

This introduction to the special issue reviews research that supports the hypothesis that psychedelics, particularly psilocybin, were central features in the development of religion. The greater response of the human serotonergic system to psychedelics than is the case for chimpanzees' serotonergic receptors indicates that these substances were environmental factors that affected hominin evolution. These substances also contributed to the evolution of ritual capacities, shamanism, and the associated alterations of consciousness. The role of psilocybin mushrooms in the ancient evolution of human religions is attested to fungiform petroglyphs, rock artifacts, and mythologies from all major regions of the world. This prehistoric mycolatry persisted into the historic era in the major religious traditions of the world, which often left evidence of these practices in sculpture, art, and scriptures. This continuation of entheogenic practices in the historical world is addressed in the articles here. But even through new entheogenic combinations were introduced, complex societies generally removed entheogens from widespread consumption, restricted them in private and exclusive spiritual practices of the leaders, and often carried out repressive punishment of those who engaged in entheogenic practices.

Keywords: mushrooms, religion, shamanism, origins of religion, psychedelics, entheogens

Introduction: Psychedelic Use In Human Antiquity

When human ancestors first intentionally ingested psychedelics will forever remain unknown, but what is certain is that millions of years ago hominins encountered psilocybin-containing mushroom species across the temperate regions of the world and undoubtedly consumed them. Just when our ancestors began to deliberately use these conscious-altering substances in rituals will never be known with certainty. However, we can be reasonably certain that more than a million years ago, our *Homo habilis* and *Homo erectus* ancestors and their mimetic capacity expressed in group song and dancing expanded beyond the nighttime displays characteristic of hominids (Donald, 1991; Dunbar, 2014; Winkelman, 2009, 2010a, 2010c, 2015) as they were extended by the effects of psychedelic mushrooms. This expanded visionary ritual capacity set the foundations for the emergence of shamanism and the deliberate use of psychoactive plants to enhance ritual activities and visionary experiences.

The evidence for the ancient ritual consumption of psychedelic plants and their influence on human evolution is partially substantiated by the converging evidence reviewed here:

1. Psilocybin-containing species are found virtually in all regions of the world and stretching back millions of years, as evidenced in psilocybin-containing species unique to each of the major regions of the world;
2. the enhanced binding of the human serotonin receptors with psychedelics;
3. shamanic traditions of ritual use of sacred mushrooms and other psychedelic substances that have great antiquity, as attested to language, art, petroglyphs, and stone sculptures of fungiform figures that often closely resemble the observable features of local psilocybin-containing mushroom species; and
4. ancient psychedelic mushroom use attested to in artifacts from religious traditions in all of the major regions of the world.

Worldwide psilocybin mushroom species

The human engagement with psychedelics was inevitable in the form of psilocybin-containing mushrooms. The widespread presence of species containing psilocybin across most ecozones (Guzmán, 2005, 2009; Guzmán, Allen, & Gartz, 1998; Stamets, 1996) indicates that they were widely present as environmental influences affecting hominin adaptations across the major inhabitable regions of the earth for millions of years. There is a worldwide distribution of psychedelic fungi, especially the psilocybin-containing species, as well as other fungi that are used as entheogens. Psychoactive fungi are found across most ecozones. In the Americas, they have been noted as far north as Alaska and as far south as Chile; other Southern Hemisphere extremities include Australia and New Zealand. The presence of psilocybin-containing species across the tropics and extending far into northern latitudes assured that our various ancestor species commonly encountered and ingested psilocybin-containing mushrooms.

The premodern worldwide distribution of psychedelic mushrooms is illustrated by regionally specific species. In addition to species unique to Thailand (*Psilocybe samuiensis*), New Zealand (*Psilocybe aucklandii*), Australia (*Psilocybe australiana* and *Psilocybe subaeruginosa*), Japan (*Psilocybe argentipes* and *Psilocybe subcaerulipes*), and Africa (*Panaeolus africanus* and *Psilocybe natalensis*), there are psychoactive fungi that are distributed across major regions of the earth such as the Northern Hemisphere, Eurasia, tropical and subtropical zones, and the Arctic and Alpine areas (Guzmán *et al.*, 1998). This distribution, especially the numerous region-specific species that attest to their ancient presence, shows the inevitability of worldwide premodern exposure of hominins to psychedelic species.

Psychedelic influences in hominin evolution

The evidence for psychedelic influences in hominin antiquity is indirect, but undeniable with the weight of diverse forms of evidence. Humans have a long-term evolutionary relationship with psychotropic plant substances, a relationship that resulted from their selective effects on human evolution (Sullivan & Hagen, 2002). There were a variety of ancient exposures to plant substances that effected human evolution, with our ancestors acquiring fitness benefits as a consequence of the use of psychoactive substances (Sullivan, Hagen, & Hammerstein, 2008).

The use of psychedelics exemplifies these enhancements of neurotransmitter functions as a consequence of their ingestion in plant sources. Evidence for the influences of psychedelics on human evolution is found in the greater sensitivity of the binding of psychedelics with the human serotonergic system than is the case for chimpanzees (Pregenzer, Alberts, Bock, Slightom, & Im, 1997). These differences reflect the survival advantages that resulted from their use and the consequent selection for those ancestors with an enhanced capacity to utilize these exogenous analogues of the serotonergic neurotransmitters, influencing a major neuromodulatory system. The human-chimpanzees differences in the sensitivity of response of the serotonergic system establish that there were ancient hominin adaptations involving selection for those ancestors in the hominin line that had a capacity for enhanced binding with psychedelics.

Hominin adaptations to the secondary metabolites of fungi, particularly distinguishing among toxic species, food sources, and consciousness-altering psychedelic species, were significant for human survival. Consequently, human ancestors underwent a multimillion year process of acquiring biological and eventually cultural adaptations to distinguish among mushroom species and their appropriate use. These experiences could have functioned as selective factors in the evolution of specific characteristics of the human brain, our neurotransmitter systems, and our innate psychology that could best exploit these serotonin- and dopamine-enhancing effects.

These psychoactive effects were inevitably incorporated into the central dynamics of shamanic rituals, attested to in the diverse species used as sacraments or entheogens in cultures around the world (see Rätsch, 2005; Schultes, Hofmann, & Rätsch, 1992). Shamanism was central to premodern ritual practices, attested to in the worldwide presence of shamanism in foraging societies (Winkelman, 1992). This ritual activity was central to many aspects of human adaptation and evolution, including subsistence, social organization, healing, cosmology, and symbolic cognition (Winkelman, 2010a).

Entheogens in shamanic origins

Shamanism was central to premodern ritual practices worldwide, attested to the presence of remarkably similar shamanistic practices and beliefs in foraging societies cross-culturally (Winkelman, 1992, 2010a, 2010b). The entheogenic contributions to the origins and evolution of shamanic practices are indicated by the substantial parallels between the basic principles of shamanism and the experiences induced by psilocybin mushrooms and other psychedelics. Ethnographic accounts reveal repetitive features associated with the ritual use of psychedelics in cultures around the world (Dobkin de Rios, 1984; Winkelman, 2007). These include the belief that they are:

- entheogenic, inducing an internal sense of spiritual presence;
- provide access to a spiritual world, the supernatural, bringing the world of mythic beliefs into experience;

- produce an experience of one's soul or spirit and its separation from the body and travel to the supernatural world;
- cause experiences of the activation of powers within and outside of the person;
- induce experiences of relationships with animals and at times the sense of transformation into an animal;
- provoke experiences of ego death followed by transformation or rebirth;
- provide information through visions;
- engage healing, especially through the dramatic ritual evocation of emotional experiences; and
- provide processes for group integration and enhanced social cohesion.

Guerra-Doce (2006, 2015) similarly notes that the predominant model of entheogenic consumption in foraging societies is associated with shamanic practices, where the shaman consumes the sacrament to enhance the healer's spiritual force and divinatory capacity for purposes of healing. These entheogenic practices generally occur in a communal ritual context with the attendance of the entire local group, who are often subjected to the conditions of ritual-fasting, as well as the experiences from drumming, singing, and clapping and overnight vigil. These ritual practices enhance the effects of the entheogen in producing experiences of communication with divinities for a range of objectives. These include: diagnoses of disease and guiding treatment; establishing contact with the ancestors to obtain advice; seeking advice from the spirits regarding plans for the future; acquiring information regarding hunting and about missing family members; and seeking to influence spiritual forces to enhance well-being.

The institutionalization of the effects of psilocybin within communal ritual practices was inevitable foundational influences in the evolution of human religiosity, as well as significant aspects of our evolved psychology (Winkelman, 2010a, 2013). Psychoactive substances were inevitably incorporated into the central dynamics of shamanic and religious rituals, attested to in the diverse species used as sacraments or entheogens in cultures around the world (see Dobkin de Rios, 1984; Rätsch, 2005; Schultes *et al*., 1992). Shamanism provided the cosmological and ritual context within which the experiences induced by psychedelics were incorporated into human culture, and through their selective effects, into humans' innate psychology (Winkelman, 2010a, 2013, 2014a, 2014b). These influences also contributed to the development of ritual healing practices, exploiting principles that were part of the formation of our evolved sociality and psychology (Winkelman, 2015). These shamanic activities played a key role in the evolution of hominins (Winkelman, 2010c) and the evolution of modern human cultural during the Middle/Upper Paleolithic some 50,000 years ago (Winkelman, 2002).

Rossano (2007, 2009, 2011) points out that the interaction of shamanic ritual context with the evolution of the human brain contributed to selection for susceptibility to hypnotic and placebo effects. The well-known "suggestibility" and contextual effects (set and setting) produced by psychedelics indicate that their use would have also contributed to these tendencies to be influenced by the expectations of others. This selection occurred because of the health benefits provided by the mental states that enhanced susceptibility to ritual healing and the ability to use alternate identities, supernatural beliefs, and internalization of the expectations of others to produce beneficial internal states. This ritual context also selected for greater propensities for a variety of personal, interpersonal, and cognitive responses that enhanced ritual healing processes.

Psychedelics enhanced the survival and reproduction of those who could best exploit and benefit from their effects; consequently, psychedelics operated as environmental factors that selected for those who had greater degrees of those innate qualities that were elicited by the neurobehavioral effects of psychedelic and exploited by ritual processes. The selective effects of psychedelics exercised their influences in the context of enhanced capacities for participation in ritual and healing activities. These involved the enhanced cognitive states that were produced by the effects of psychedelics (enhanced serotonin and its effects of brain function; see Winkelman, 2014b, 2017b).

Humans have sought out not only psychedelic mushrooms for their consciousness altering properties, but a wide variety of plant substances as well. While a principal conceptualization of psychedelics is that they involve the ethnobotanical (and chemical) substances with action on the serotonin 5HT2 receptors (such as psilocybin, ergots, ayahuasca, and bufotenine), the visionary and entheogenic substances are not limited to this class of action. Visionary and entheogenic experiences are produced by diverse classes of plants and their respective neurochemicals and their effects on diverse neurotransmitter systems, not only serotonin, but also dopamine, endocannabinoids, GABA, muscarine, and others (see Winkelman, 2017a, 2017b for review). The human potential for entheogenic experiences and visionary encounters appears to reflect innate properties of our nervous system, a potential elicited by many different drug and non-drug mechanisms (also see Winkelman, 2011). This human search for drug-induced spiritual encounters has an intimate relationship with our evolved psychology (Winkelman, 2013, 2014a, 2014b) and has led humans to discover many different plant substances for altering consciousness.

The antiquity of *Homo sapiens*' relationships with psychoactive plants

In his paper here on "*The oldest archaeological data evidencing the relationship of Homo sapiens with psychoactive plants*," Giorgio Samorini provides a worldwide overview of what we know about the prehistory of entheogenic practices. As modern instruments become increasingly sophisticated and sensitive, they are capable of detecting the presence of miniscule quantities of psychoactive plant sources in various archeological materials. These varied approaches (also see Fitzpatrick, 2018) are providing hard evidence of the antiquity of humanity's use of botanical agents known for their ability to induce alterations of consciousness. Samorini's review of the archeological literature on the presence of psychoactive plant sources shows evidence of *H. sapiens*' relationship with psychoactive plant sources going back nearly 10,000 years. This synthesis regarding the earliest knowledge of the main psychoactive plant sources of the world indicates the antiquity of use of diverse plants sources, but not always providing certain knowledge regarding their mode of use (i.e., intoxicant, food, or material).

A more pressing question for Samorini's findings is whether the use of these plant substances was for entheogenic purposes or for other reasons. In some sense, these questions might always remain ambiguous, but from the perspective of the entheogenic paradigm, the meaning of the facts is less ambiguous. If our distant ancestors deliberately left psychoactive substances in graves and other deposits, is there a fundamental ambiguity regarding what the message is here? The limited grave goods attest to the substantial significance that people placed in these objects, and more so, their implications for concepts of the spiritual and afterlife. Burials are intrinsically entheogenic in their intentions, an unequivocal statement that people perceived these substances as central to relationships with the spiritual and the afterlife. The presence of mushroom representations is particularly powerful evidence in this regard, attesting to a central concern with entheogenic experiences. There is no reason to presume that the fungiform representations were depictions of culinary activities or incidental environmental features. The inclusion of mushroom effigies in burial goods and ritual artifacts attests directly to their significance in the production of entheogenic experiences. Proposals of non-entheogenic purposes to ancient mushroom representations face the burden of proof and ought to be backed by evidence, not just offered as speculations.

The diversity of psychoactive plant substances used in the past as indicated in Samorini's review here makes an important point. The widespread use of diverse plant substances and psychoactive ingredients to evoke common themes of entheogenic experience and shamanism reveals that what is important about these agents is not many different and specific forms of psychophysiological action, but rather the common shift in consciousness that is produced by many different psychoactive agents and mechanisms (Winkelman, 2011, 2017a). It is the general principle of the alteration of consciousness, which is relevant to understanding entheogenic experiences. While the specific substances used may not conform to the "classic psychedelic" - those acting at the 5HT-2 serotonin receptors - the real issue is their visionary and entheogenic capacities, induced through a variety of pathways or mechanisms, but resulting in a common physiological condition of organismic operation (an integrative mode of consciousness; Winkelman, 2011).

As Fitzpatrick and Merlin (2018) point out, while humans' use of psychoactive substances falls into many different pharmaceutical categories (i.e., inebriants, stimulants, opiates, narcotics, hallucinogens, etc.), ethnographic analogies suggest that their use in the past generally shares a common entheogenic function of divine communication, even if the substances involved are not generally considered to be hallucinogenic or psychedelic (acting at 5HT2 serotonin receptors). The classification of the use of these diverse psychoactive substances as entheogenic in purpose is appropriate, given the typical perspectives of most cultures toward the use of varied classes of psychoactive substances that are employed to enhance experiences of contact with deities and supernatural forces. An entheogenic perspective may be valid even in the cases of substances with recognized alcohol content because of the widespread practice of mixing other psychoactive substances in the fermentation process to enhance the effects.

The integrative mode of consciousness emerges with the elevation of ancient brain functions by diverse process that promotes psychodynamic growth and cognitive, social, and psychological integration. Diverse ritual activities induce this integrative mode of consciousness, stimulating the autonomic nervous system through extensive ergotropic (sympathetic) activation until collapse into a trophotropic (parasympathetic) dominant state with a slowing of the brain waves into a more synchronized and coherent pattern (see Winkelman, 2011 for review). This extreme parasympathetic state is a recuperative state of the body, a state of extreme relaxation culminating in sleep and unconsciousness that restores homeostatic balance and evokes endogenous healing responses, especially through reduction of stress responses. This shift to parasympathetic dominance is also accompanied by a shift from left-hemisphere- to right-hemisphere-dominated brain processes and from frontal brain activity to predominant brain wave patterns emanating from lower brain structures. Winkelman (2017a, 2018) has reviewed evidence indicating that these diverse entheogenic substances result in the stimulation of innate modular structures and intelligences that provide the central features of spirit encounters.

The human search for chemically enhanced consciousness as a better conduit to experience divinity is a virtual universal of human cultures. And as will be illustrated in a number of articles below, this development likely began with the most easily available sources - psychedelic mushrooms - which were later supplanted by more complex combinations of plants. This primordial use of mushrooms as entheogens is illustrated by findings of fungiform artifacts from all of the major areas of the world, as seen in the following section of this introduction. While far from exhaustive, it establishes that there existed ancient spiritual practices in all of the major regions of the world that were entheomycological, finding entheogenic inspiration in locally available psychedelic fungi.

Mushroom And Entheogenic Cults Of The Past

By their nature, mushrooms are hard to detect in the archeological record, as their fleshy substance largely composed of water quickly deteriorates and leaves little if any physical trace. Consequently, the evidence regarding the roles of psychedelic mushrooms in cultural activities of the past involves fungiform representations in petroglyphs, rock art, sculptures, and metal artifacts found in cultures around the world. Samorini (2012) reviewed a wide range of mushroom forms found in cultures around the world, showing that mycolatry is a widespread ancient practice. Psychedelic mushrooms were encountered in most of the habitable regions of the world and displayed in ways that indicate that they were central features of early ritual systems. Their significance led their practitioners to capture the source of their experiences and their significance by producing images on stone.

Asia

A deep prehistory of mycolatry in Asia is well attested to in the presence of practices and mythology regarding *Amanita muscaria* and *Psilocybe* species (Figures 1 and 2) among diverse cultures of the region. Furthermore, there is reason to expect that encounters with *A. muscaria* stretch back as long as hominins occupied the temperate forest regions of the Northern Hemisphere where these mushrooms grow in symbiosis with *Betula* spp. (birch) and *Pinus* spp. (pine trees).

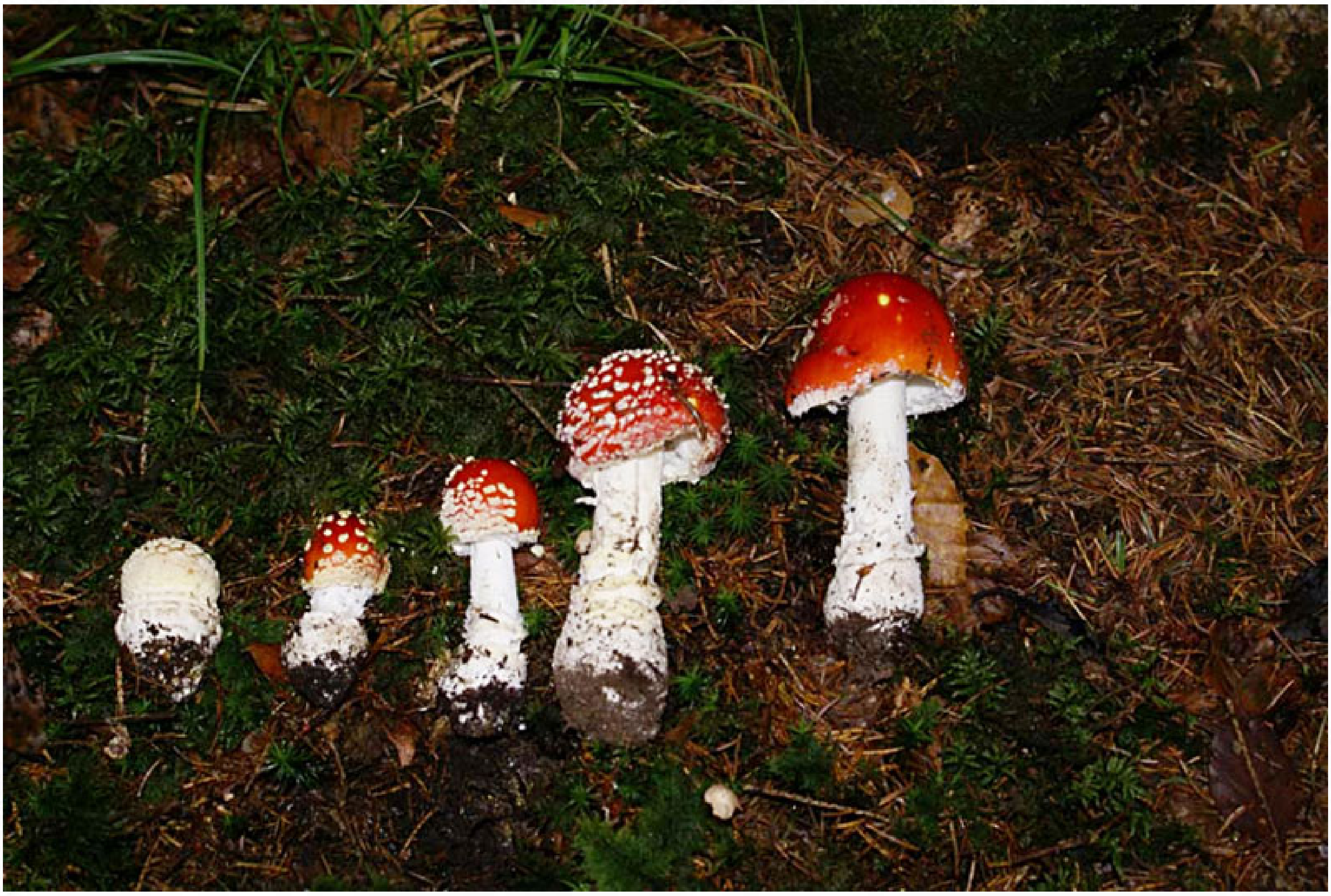


Figure 1. Amanita muscaria (photo credit: Meena Maillart; used with permission)

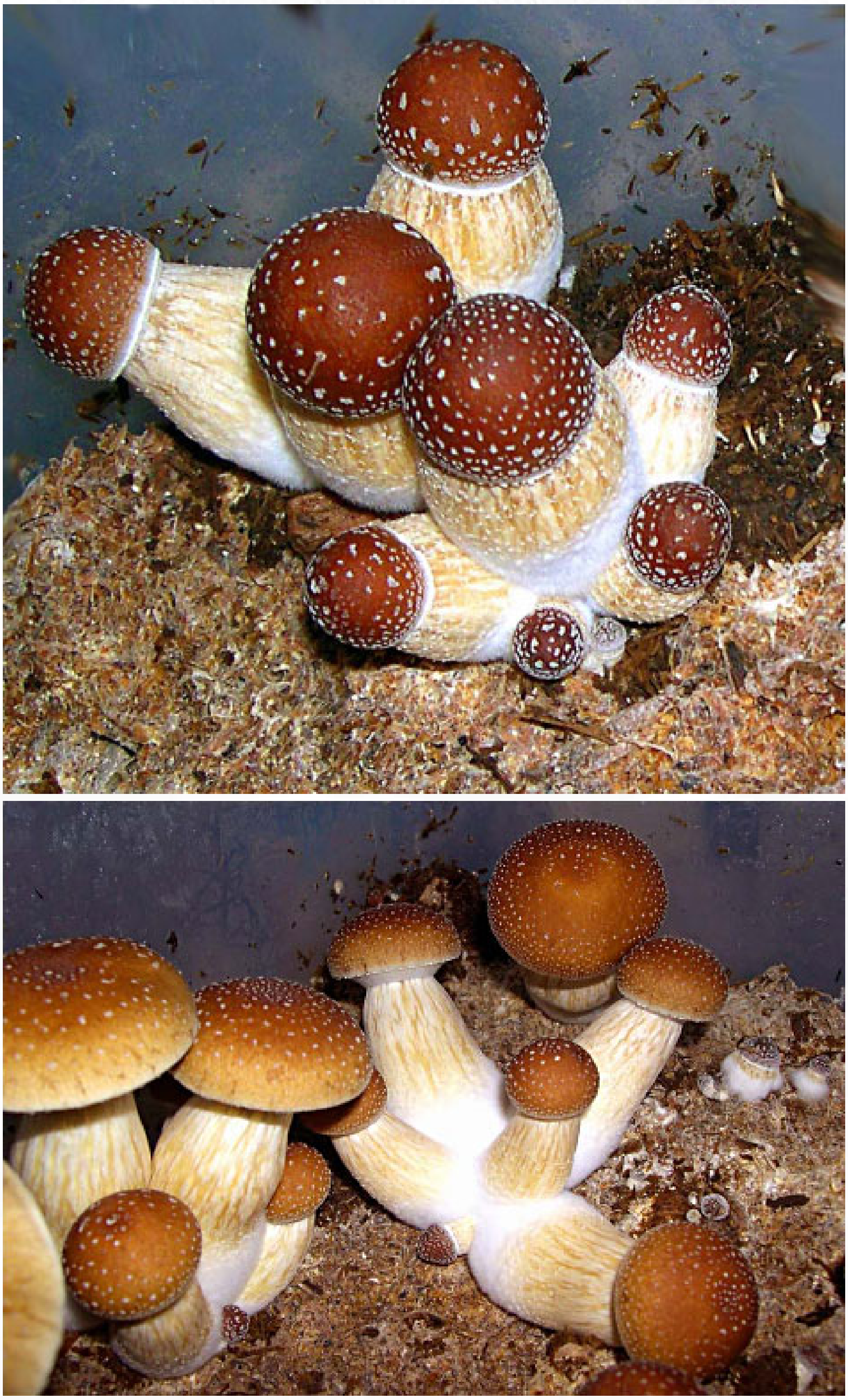


Figure 2. (a, b) *Psilocybe cubensis* grown from spores obtained in India (photo credit: John Allen; used with permission)

Prehistoric evidence

The direct evidence for prehistoric mycolatry is found in a variety of mushroom and mushroom-human depictions found in the northern regions of Eurasia (see Hoppál, 2013; Rozwadowski & Kosko, 2002). Panels in the Pegtymel River region of Siberia are exhibited on large rock formations. Figure 3 presents sketches of rock art images in the Sayan Canyon of the Yenisei from Devlet and Devlet (2002); they proposed that these portray human figures with mushroom-like heads and are reflections of ancient cults involving *A. muscaria*. The identification of *A. muscaria*, as opposed to other psychedelic mushroom species, is based on features exhibited on the headgear of the anthropomorphic being. Some of these mushroomshaped caps have shallow areas that appear to represent the white spots that are found on the caps of *A. muscaria*.

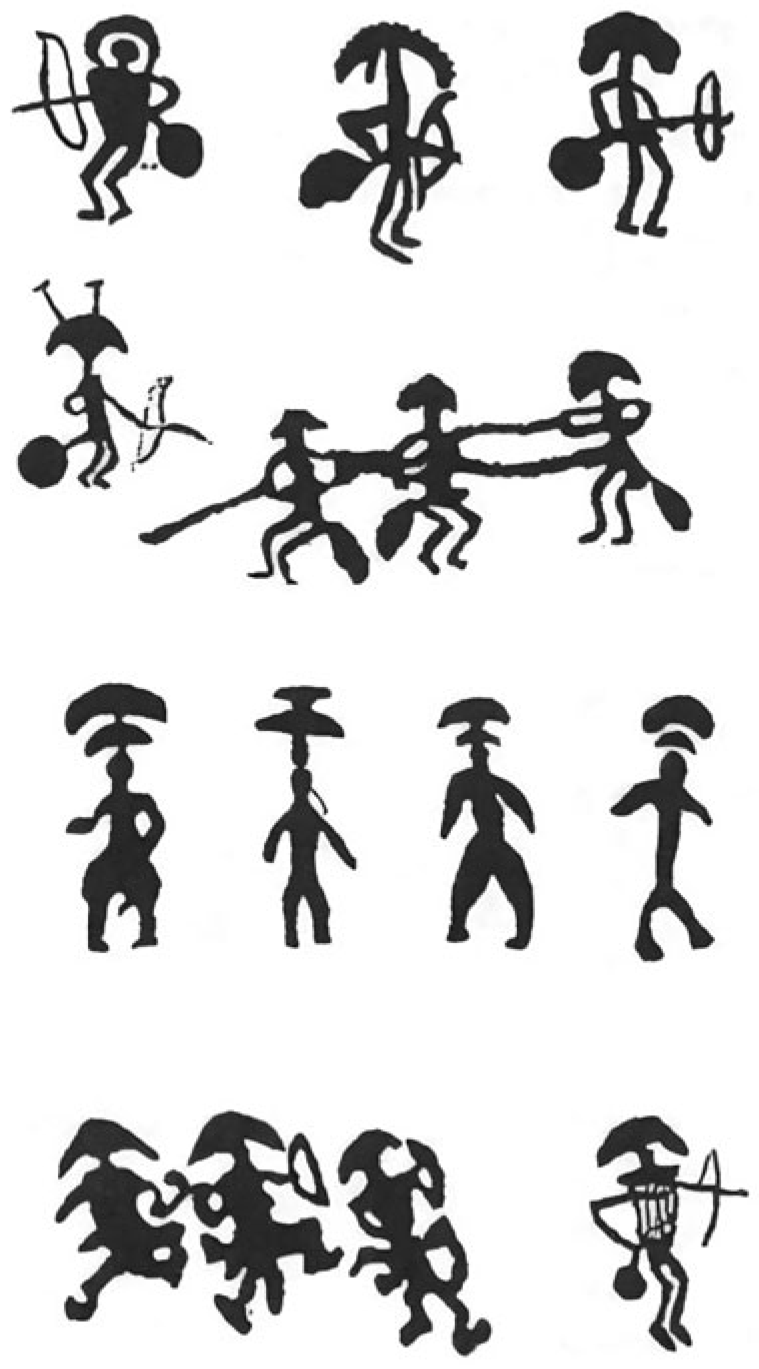


Figure 3. Representations of petroglyphs that Devlet and Devlet (2002) call "fly-agaric creatures" (in reference to *A. muscaria*) and discuss as shamanistic figures. Images found in Upper Yensi Basin, Khara-Chulun Mongolia, and the Pegtymel rock art site. Images used with permission of Andrzej Rozwadowski from Rozwadowski and Kosko (2002)

Guzmán (2016) has noted that some of these depictions may more closely represent *Boletus* species, which are used for their psychedelic effects in Papúa New Guinea (Reay, 1960) and China (Stijve, 1997). These petroglyph images of humans covered with giant mushroom shapes were likely made by the ancestors of the local cultures because the Chukchi mythology refers to human-like mushrooms and had practices of using *A. muscaria* that continued until the current era (Saar, 1991; Schurr, 1995).

Ethnohistorical studies show that the ingestion of A. muscaria was involved in shamanic practices, although there are more modern cases of non-ritual individual use. Bogoraz (1909) reported that the shamans among such diverse groups as the Yukagir, Kamchadal, Inuit, and Koryak and Chukchi ate the mushrooms and even *drank* the urine of reindeer intoxicated on the fungi, receiving an even more potent dose of the psychoactive ingredients once the more toxic substances were processed by the body (see Feeney, 2010; Schurr, 1995). This shamanic context of *A. muscaria* use was part of other ritual practices to produce alterations of consciousness experienced as a travel to and entry within the spirit world. The widespread association of the *A. muscaria* with reindeer reflects the animals' practice of consuming the mushrooms, as well as drinking the enhanced psychoactive substances in the drugged deer's urine. These behaviors may reflect the origins of human knowledge regarding the mushroom's intoxicating properties still present in the urine.

The Soma controversy

In their article "*The 'Kamasutra' Temples of India - a Case for the Encoding of Psychedelically-induced Spirituality*," Meena Maillart-Garg and Michael Winkelman address one of the most famous entheogenic controversies, the identity of Soma of Hindu traditions, proposed to be the mushroom *A. muscaria* by Wasson (1972). The presence of mushroom representations in the sculptures of sanctuaries of the Khajuraho Temples provides evidence that entheogenic mushrooms are the identity of soma. They analyze the features of these fungiforms and Vedic traditions to propose that these are designed to depict both the *A. muscaria*, as well as *Psilocybe cubensis* species (see Figures 1 and 2a,b). They further propose that some of the so-called "broken" sculptures of Khajuraho are not actually damaged, but rather deliberately constructed to appear vandalized to encode information related to entheogens in the "figure 8" form of the early stage of *A. muscaria*. The central placement of mushroom pedestals as necessary steps into the sanctum of the temples attests to a profound entheogenic message. This physical and symbolic data has considerable implications for a reevaluation of the ancient roots of Hinduism, indicating that entheogenic mushrooms were the most important sacraments of early Hinduism and persisted for millennia.

Entheogenic mushroom use in complex Asian societies

Wasson's (1972) proposal of the existence of a widespread entheogenic *A. muscaria* mushroom tradition across Eurasia has various forms of support from findings reported for complex societies as well. The continuation of mushroom cults in complex societies of Asia was illustrated by Crowley (2015), Dannaway (2009) and Hajicek-Dobberstein (1995), who review evidence of religious mushroom cults. Psychedelic mushroom use is reported for Taoist cult practices documented in Tibet and China by Crowley (2015) and Hajicek-Dobberstein (1995), as well as across the ancient Indo-Aryan world from India to Greece (Ruck, Staples, & Heinrich, 2001). Chinese traditions recorded the use of hallucinogenic plants, including mushrooms, in herbal manuscripts almost 2,000 years ago. Dannaway (2009) points to evidence the use of botanicals substances as tools for obtaining siddhis or mystical powers in: the yogic tradition of Patanjali; ancient Buddhists texts, especially in the Buddhist Tantric traditions; and Taoist literature, the later making references to what is translated as "magic mushrooms" and "divine mushrooms."

Hajicek-Dobberstein (1995) reviews biographical accounts of some legendary Buddhist adepts from the first millennium (200-900 AD) that provides clues to a psychedelic practice represented in symbols that suggest that they consumed *A. muscaria* as a tool for achieving enlightenment. The identity as *A. muscaria* is revealed in common symbols representing Soma in the Rg Veda, Buddhist traditions, and ancient shamanic practices found across Northern Eurasia. Hajicek-Dobberstein (1995) presents evidence that "*The congruity of the set of symbols in the legend of Arydeva and the sets of symbols in the mythology of A. muscaria from Siberian and Vedic traditions is too strong to be a coincidence*" (p. 109). For instance, the Sanskrit term "madhu," meaning "honey, sweetness, delicious," is a common description of Soma in the Rg Veda; such descriptions parallel the characterizations of the Buddhist Amrta as a "nectar of the gods," a delicious food and drink. The exalted and sacred status attributed to the birch tree in Siberian and Altaic cosmology and its central roles in shamanic rites reflects the trees' role as the habitat *A. muscaria*, constituting the preferred mycorrhizal symbiont of the species. Hajicek-Dobberstein (1995) proposes this is the reason for the significance of the birch as a "great drug" in India pharmacopeia in spite of its rather innocuous medicinal properties, a reflection of its status derived from its role as the symbiont of *A. muscaria*. Paralleling the Siberian mythologies of one-eyed demons, Vedic texts describe beings with a single eye associated with Soma that Wasson interpreted as derived from the characteristics of the early stage of development *A. muscaria* when it appears similar to a bloody human eye-ball.

Hajicek-Dobberstein (1995) reviews materials from *The Stories of the Eighty-Four Siddhas*, representing later codifications of oral biographical legends that described experiences of notable Buddhist adepts using psychedelic mushrooms. These stories indirectly convey such experiences in words and symbols that embed a deeper level of meaning in sandhabhasa, an "enigmatic language" that simultaneously reveals a secret message to the initiates while openly obscuring the true facts for the uninitiated. But as is the case in other traditions, the Buddhists texts provide the identity of *A. muscaria* for this elixir of enlightenment in its features as a magically potent urine, the one-eyed and one-legged beings, and the references to its symbiont birch tree.

Crowley (2015) explores further psychedelic associations with a class of Buddhist deities with the name Uṣṇ&imacr;ṣa, referring to the crown of the head, specifically a "crownbump" (umbo) or cranial protrusion that characterized them, as well as the depictions of many Buddhas. Crowley presents evidence that these crown bumps represented a tantric Buddhist sacrament derived from earlier traditions of psychedelic mushroom use. Based on analysis of liturgical data in the Sadhanamala and the traditions associated with the sacramental amrita, Crowley contends that these bumps are representations of *Psilocybe* species.

Crowley notes that the lack of an explicit Sanskrit term for mushroom led to the use of terms such as "umbrella" and "parasol" (along with other terms such as silindhraka, meaning "maggoty thing") to refer to mushrooms. Silindhraka also has the meaning of "growing on cow dung," a reference to the proclivity of *P. cubensis* and other psilocybin-containing species to grow up through bovine dung. Various references to the blue neck and staff of the parasol reflect the dark ring hanging on the mushroom's stem that is characteristic of *P. cubensis*; and the tendency of the flesh to bruise blue that is characteristic of psilocincontaining species. Crowley extends his analyses to Japanese Buddhist traditions where representations of various deities include depictions of mushrooms that resemble various entheogenic species of the *Psilocybe* genus characteristic of the region (*P. liniformans* and *P. argentipes*). Further analyses of the meanings of the names of the various Uṣṇ&imacr;ṣas provide confirmation of his interpretation of entheogenic mushrooms in features that reflect the physical features of the mushrooms (sprouting, specific colors, wheel-like, etc.), their growing seasons (rainy), and effects (quick acting and vomiting).

Soma as ayahuasca analogue

In the article on "*Soma* and *Haoma*: Ayahuasca analogues from the Late Bronze Age," Matthew Clark continues the examination of the various identities of the entheogenic soma, noting the common elements in the myths and religious practices of both Indian and the Zoroastrianism practices of Persia. Clark notes that the sacred texts have references to several different kinds of *soma/haoma* and examines the consistency in the evidence for various botanical candidates proposed for Soma. He proposes that this "nectar of immortality" was eventually derived from complex plant formulas that included more than a dozen plants. These included DMT sources and monoamine oxidase inhibitors, as well as other psychedelic substances that provided a synergistic formula similar to the famous ayahuasca from South America. He proposes that knowledge of psychoactive properties of the constituent plants was widely diffused from their origins in Central Asia to India and then Persia.

Many plant identities proposed for soma suggest that there were likely more than a single soma. The widespread Eurasian shamanistic use of *A. muscaria* indicates that it must be considered as a primordial entheogen of the region. During cultural development, a variety of factors made *A. muscaria* less available (i.e., deforestation of the symbiotic trees) and the entheogen was replaced by other substances then more readily available (coprophilous or fimicolous *Psilocybe* species), and eventually more complex botanical and chemical combinations that served the same purpose in altering consciousness.

Africa and the Middle East

There is limited ethnomycological data for the ancient use of psychedelic mushrooms of Africa. There are, however, widespread contemporary traditions of hallucinogen use (see De Smet, 1996; Sobiecki, 2017). Some of the most significant entheomycological data is the evidence from the well-known petroglyphs in the Tassili caves in the south of Algeria (Lajoux, 1964; Lhote, 1968; Mori, 1974, cited in Samorini, 1992). Mycological traditions are also suggested for Ancient Egypt, where fungiform representations in Egyptian crowns provide iconic symbols of entheogenic traditions (Berlant, 2005).

Samorini (1989, 1990, 1992) characterized the Tassili petroglyphs and rock paintings as possibly the most ancient of the physical evidence for ethno-mycological practices, hypothesized to date 7000-9000 years BP. Echoing previous analyses, he proposed that these works of art reflect the states of consciousness produced by psychedelic mushrooms and the associated ritual dances that are clearly reflected in the postures of some of the figures. Based on their features, Guzmán (2012) proposed these mushroom figures represent *Psilocybe mairei*, but they also resemble other African psychedelic species, including *P. cubensis* and other species known in the region (*Psilocybe aquamarina* and *P. natalensis*; Guzmán, 2016).

The shamanic nature of the associated ceremonies was noted by the discoverer of this Tassili art, Henri Lhote (1968, 1973), who pointed out that these remote painted cave walls served as secret sanctuaries, consistent with specialized ritual activities. In one panel there are several figures shown in active postures implying dancing, with each holding a mushroom-shaped object (see Figure 4). Samorini (1992, p. 6) notes: "*two parallel lines come out of this object to reach the central part of the head of the dancer, the area of the roots of the two horns. This double line could signify an indirect association or nonmaterial fluid passing from the object held in the right hand and the mind. This interpretation would coincide with the mushroom interpretation if we bear in mind the universal mental value induced by hallucinogenic mushrooms - the lines an ideogram which represents something non-material in ancient art - represent the effect that the mushroom has on the human mind.*" Shamanic figures with mushroom features are repeated in other petroglyphs of the region; see Figures 5 and 6), with a typical gait of a dancing figure with legs bent inward and with the depiction of mushroom figures in the hand as well as on the forearms and thighs and distributed in the area around the body.

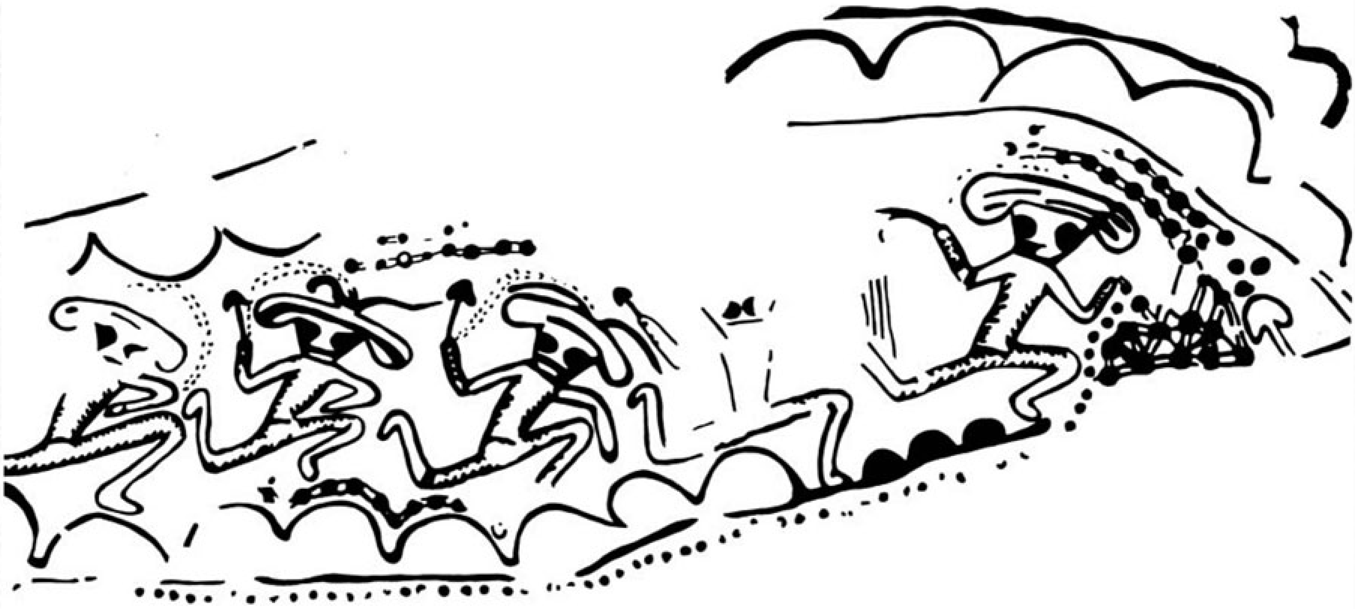


Figure 4. Relief of a painting in a rockshelter of Tin Tazarift, Tassili, Algeria that Samorini interprets as dancing figures with a mushroom as a head and a mushroom-like object in the right hand with lines coming out of this object and extending to the head of the dancer, representing some energy passing from the object to the mind (photo credit: Giorgio Samorini; used with permission)

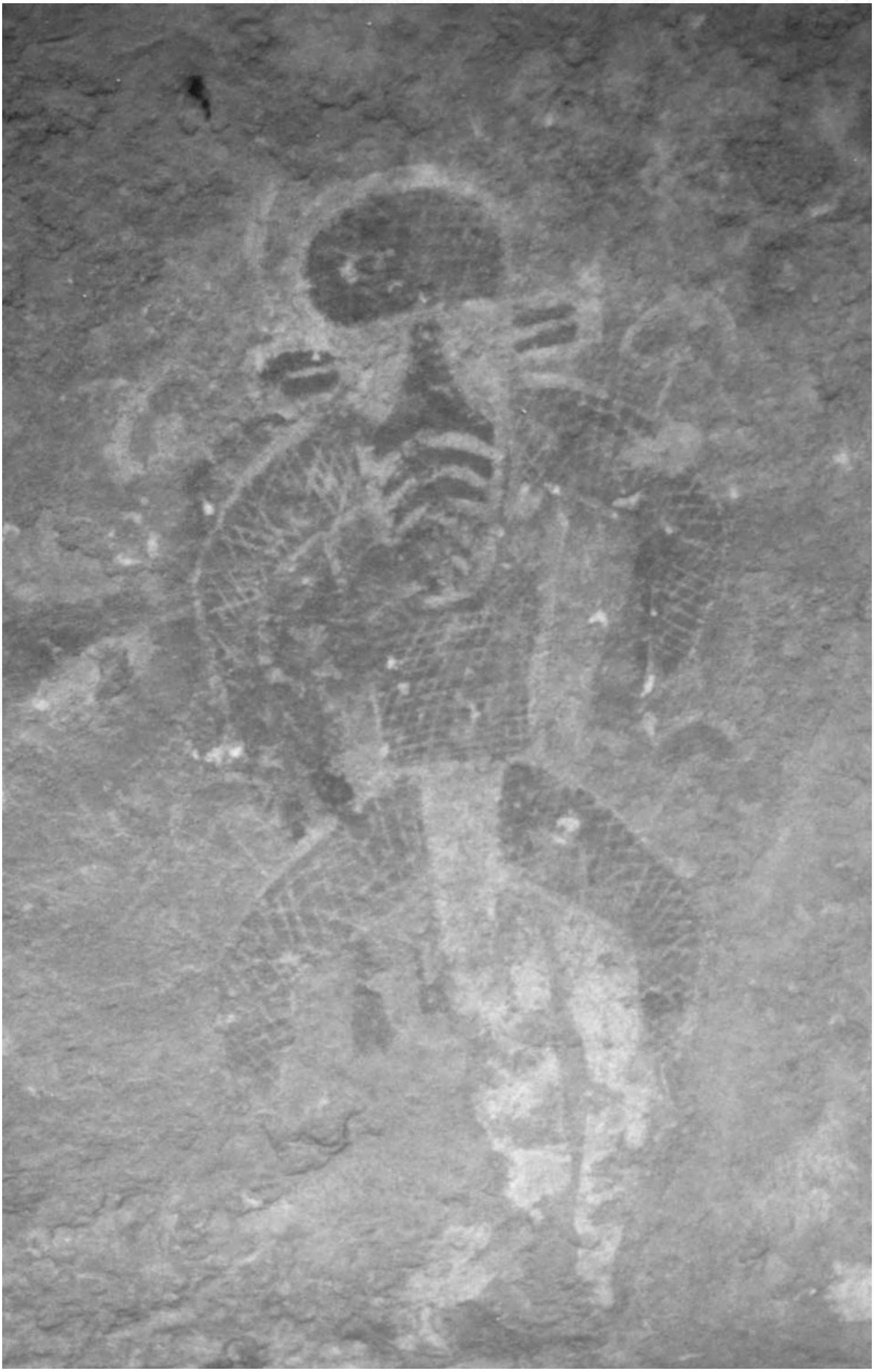


Figure 5. Photograph of a petroglyph that Samorini calls a "Mushroom Divinity" located at In-Aouanrhat, Tassili (Algeria) (photo credit: Giorgio Samorini; used with permission)

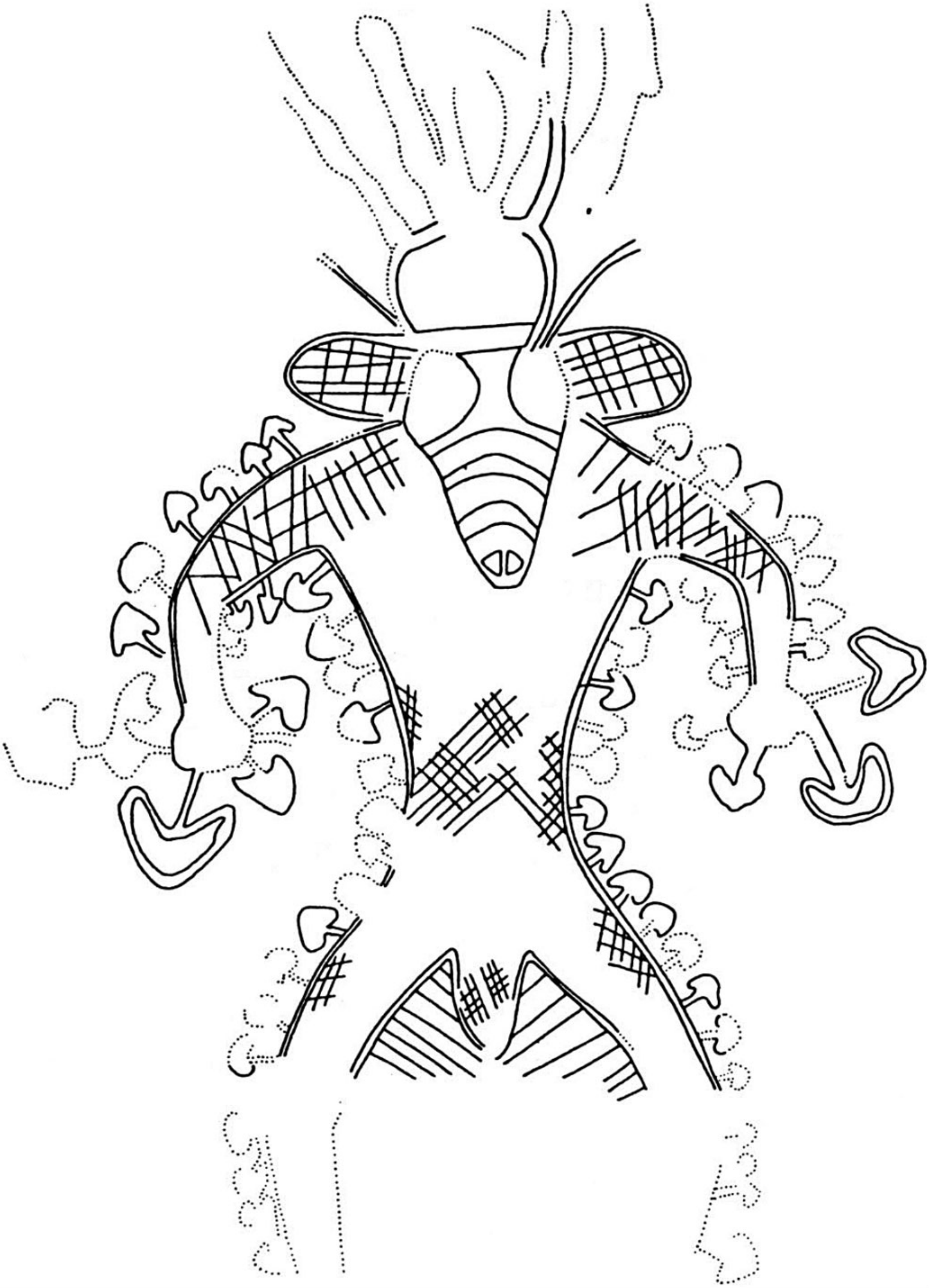


Figure 6. A sketch of the petroglyph at Ti-n-Tarin, Tassili (Algeria) that Samorini calls a "Mushroom Divinity" (photo credit: Giorgio Samorini; used with permission)

These are not the only mushroom depictions in African cultures. Mushroom-head figures adorn the front cover of the 1993 *South Africa Archaeological Bulletin* (vol. 68 #57; also see Hollmann, 1993), depicting scenes from the Bella Vista site in Ladybrand District of the Orange Free State. These images portray a group of men dancing in the style of the shamanic medicine dance of the San people. These figures are mostly characterized by various mushroom shapes on their heads, and in a few cases, with inverted mushroom caps with birds (a classic symbol of shamanic flight), which are shown within the mushroom cup on top of the body (in place of a head). The association of the mushrooms with the medicine dance reinforces the shamanic interpretation and functions of the mushroom caps, a primordial iconic symbol of the locus of effects of the entheogens.

Old Testament evidence for entheogens

The article "*Getting High with the Most High: Entheogens in the Old Testament*" by Danny Nemu presents evidence of the use of entheogenic substances in ancient Judaic traditions. Nemu compiles evidence from scripture, historical sources, and archeology to identify the plants likely found in the Old Testament Manna, Showbread, the Holy Ointment, and the Tabernacle Incense. The psychoactive significance of the ointment and the incense is in their proclaimed role enabling the priestly caste to have a direct experience of their God. The sacramental way they are consumed and the taboos around them are highly suggestive of their use as psychoactive agents. Furthermore, the psychoactive components found in these preparations include GABA receptor agonists and modulators and opioid receptor agonists, as well as enzyme inhibitors that permit them to be orally active. The combinations in these preparations show that the ancient Israelites understood the plant synergisms involved in producing entheogenic experiences and deliberately employed them.

Ruck *et al*. (2001) provide further evidence for *A. muscaria* practices in Judaic traditions, characterizing Moses as an entheogenic shaman, especially in his encounters with the "burning bush" on the "Mountain of God." This bush, with a flaming center that did not burn or consume the bush, also spoke to Moses, giving him instructions. Ruck *et al*. (2001, p. 164) point to the features of *A. muscaria* in burning coal and white ash appearance of the tree, as well as in the signs given by Yahweh to Moses to convince the followers - his hand showing "leprous patches white as snow" (resembling the *A. muscaria* veil remnants on the cap) and the ability to take his hand from his cloak and "to draw water and have it turn red" - (the liquid pressed out of the mushroom). Other circumstantial evidence they present includes the coincidence of the season for obtaining these mushrooms and grazing sheep in the mountains - after the rains. Signs of *A. muscaria* effects are also found in Moses' symptoms of violent illness and his subsequent "superhuman courage and confidence."

Islamic entheogenic roots

In his article "Bur&amacr;q depicted as *A. muscaria* in a Fifteenth Century Timurid Illuminated Manuscript?," Alan Piper present evidence of enthogenic roots within Islamic traditions derived from Turkey and Afghanistan. These influences are expressed in the Herat manuscript, which provides descriptions of the formative experiences of the Prophet Mohammed. These include the *mi'raj* - the miraculous ascent of the Prophet Mohammed through the seven heavens to receive God's instructions - and the proceeding *isra* - the "Night Journey" - during which Mohammed traveled overnight from Mecca to Jerusalem by means of a fabulous beast called *Bur&amacr;q*. Piper analyzes the illustrations of this manuscript, reflecting Islamic traditions formed in an admixture of Turco-Mongolian shamanism, which records Mohammed's *mi'raj*. Piper shows that descriptions in the Herat manuscript that depict the fabulous creature through which Mohammed makes this ascent share distinctive features of the *A. muscaria*, depicting the *Bur&amacr;q* with the distinctive red and white spotted skin of the mushroom. Piper makes an argument for shamanic and entheogenic interpretations based on several elements, including the similarity between the *mi'raj* and shamanic journeying. *Mi'raj* refers to a "ladder" that reaches from earth to heaven for the ascent and descent of the Angels of God, corresponding to the notched tent pole that Siberian shamans use as the axis mundi for their celestial ascents to the spirit powers. Features of Siberian shamanic spirit journeys and *A. muscaria* experiences are found in key elements of the *mi'raj* story. Piper uses ethnographic analogy for interpretation of this depiction of the *Bur&amacr;q* through an interdisciplinary approach that shows how these representations of the Bur&amacr;q depicted in the Herat manuscript are related to Islamic traditions influenced by Buddhism, Hinduism, and other regional cultures. An Islamic spiritual leader called Baraq Baba who is involved in a situation of consumption of vomit has analogies in the consumption of *A. muscaria* in Siberian cultures, a connection that may explain other parallels between the *Bur&amacr;q* and *A. muscaria*.

Europe

Shamanistic practices using *A. muscaria* existed across ancient Europe (Rätsch, 2005), but these entheogenic rituals were generally lost, repressed, or hidden in esoteric cults long before the emergence of Christianity and the formation of modern Europe, making the evidence of their importance easy to overlook. Nonetheless, evidence for ritual practices using mushrooms are attested to numerous artifacts, especially in folklore, mythology, and early mystery religions of the region. These involved both *Amanita* and *Psilocybe* species, as well as other plant combinations.

Fungiform representations of ancient Europe

The oldest reported mushroom petroglyphs of Europe yet discovered are those found in the Selva Pascuala mural of rock art at Villar del Humo, a post-Paleolithic rock art site in Cuenca, Spain. Akers, Ruiz, Piper, and Ruck (2011) present evidence that these figures reflect the ritual use of *Psilocybe* in Europe as long as 8000 BP. The representations present fungiform figures that depict both the key features of *Psilocybe hispanica* - specific aspects of variation within the species, such as the straight to sinuous stalks, and convex to bluntly subconical caps that characterize the typical morphological variation observed in this species.

The shamanic interpretation of these fungal representations is substantiated by several additional facts. One is their depiction on a panel with a bull, a highly significant association given the proclivity for many *Psilocybe* species to grow in the dung of bovines. The shamanic interpretation of these depictions at Selva Pascuala is also supported by the austere location of this rock art, which was not a habitation site, but because of its isolation, suggests that it served a special ritual purpose.

Although these *Psilocybe* traditions, like those of *A. muscaria*, were largely lost in European antiquity, they are attested to the artifacts, mythology, and folklore of the cultures of region. The fungiform heads on petroglyphs in the western regions of Europe (Molodin & Cheremisin, 1999) indicate such activities were still carried out during the Bronze Age, when such practices were apparently still widespread. Kaplan (1975) analyzed Bronze Age metallurgy and petroglyphs of Scandinavia to argue that the fungiform metal works are in fact representation of mushrooms used for ritual purposes. These mushrooms constituted symbols of a religious tradition of ancient ritual consumption of psychedelic mushrooms. However, many of these representations are highly stylized and leave unanswered questions regarding the ritual context of their use.

Greek entheogenic roots

There was a continuation of many earlier cults of *A. muscaria* within Greek culture, including Dionysus (Ruck, 2014). Their origins lie further in the past, derived from ancient Egyptian religions that were conveyed throughout Western Eurasia and northern Africa by a Hellenic inspired diffusion of the mysteries of Isis and Osiris throughout the Roman European empire (Ruck *et al*., 2001). Wasson, Hoffman, and Ruck (1978) identified *A. muscaria* as the sacramental offering to Apollo, an ancient entheogen of Greek culture that was later substituted with other psychoactive substances. Although *A. muscaria* was also associated with the Goddesses Demeter and Persephone of the Eleusinian mysteries, the identity of this ancient sacrament of the Greek mystery schools proposed by Wasson *et al*. (1978) in *The Road to Eleusis* was the LSD-like fungus ergot that grows on rye. The use of *A. muscaria* within the rituals of Dionysius and Apollo was secret and they were publicly portrayed as dangerous or ancient pagan practices to facilitate their cover-up. Even the manifestations in the ancient Greek-Roman world were subjected to official condemnation, imprisonment, and even death to those who practiced these entheogenic rites (Ruck, 2014).

A Classical Greek marble fragment (5th century BC; see Figure 7) is called "The Exaltation of the Flower," based on a mis-identification of the fungiform that is the central element between the heads of two females identified as the Demeter and Kore, also known as Persephone (Ruck, 2006; Samorini, 1998). The stella was found beneath the ruins of a Catholic monastery in Thessaly, Greece, which had been built on top of the shrine to Demeter. While various identities (i.e., opium poppy and flower) have been proposed for the fungiforms on the stella, the mushroom is the most direct resemblance, and certainly the obvious candidate given the nature of the location - a sacred site.

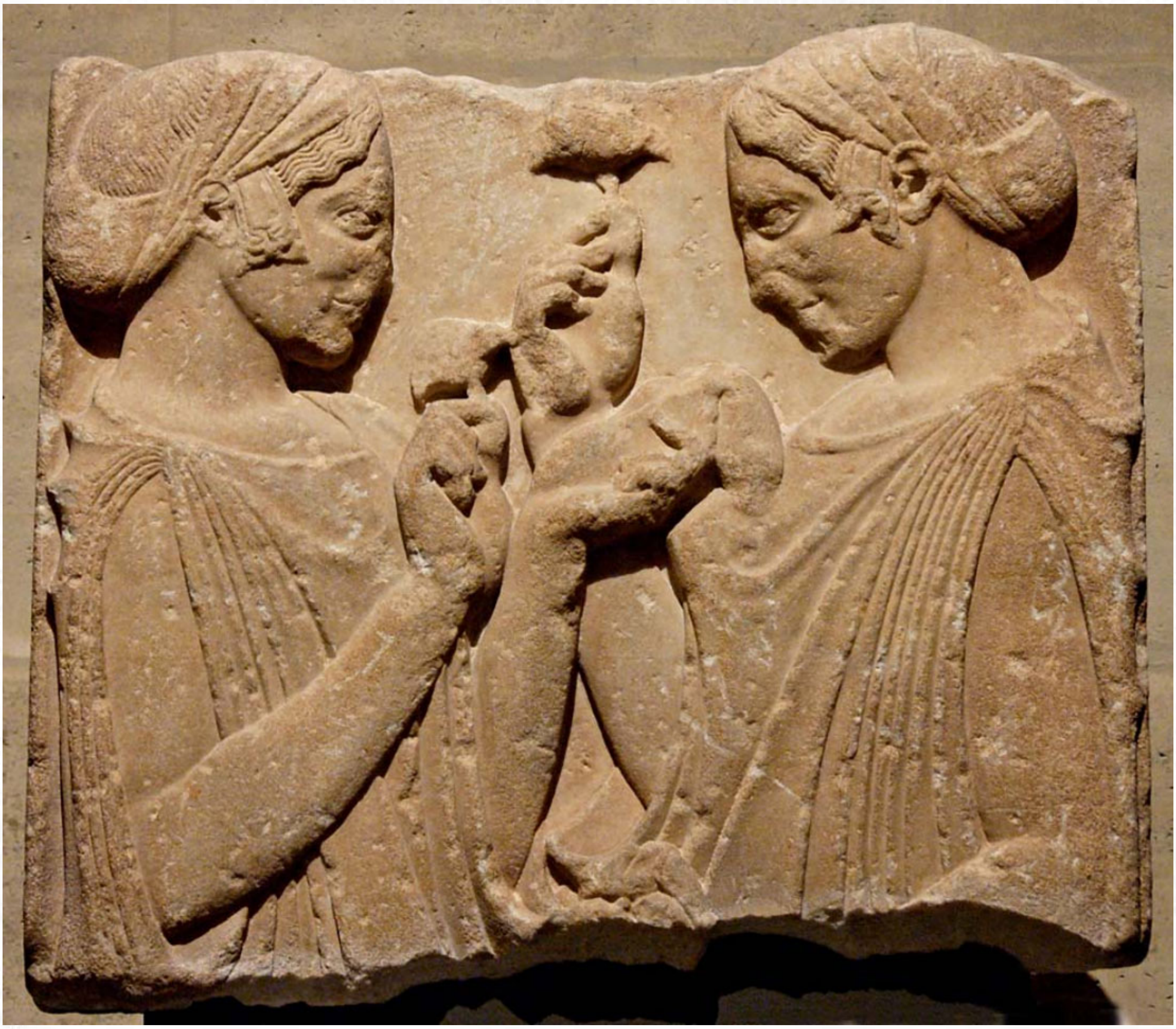


Figure 7. Exaltation of the flower (photo by Lan Nguyen placed in the public domain)

Ruck *et al*. (2001) illustrate the Greek entheogenic past as revealed in the many entheogenic features of the Greek hero Perseus, known as the "mushroom picker," as well as associated mythological figures who have central features that provide symbolic representations of the physical features of *A. muscaria*. Physical characteristics and ecological and mythological aspects of *A. muscaria* use are suggested by the characterizations of deities and sacraments that have central features of the fungi, including: the reddish-orange and white color patterns; the associations with thunderbolts, rain, and bulls; the trees with which the mushroom grows in symbiosis; and the golden-red liquid extracted; as well as the subsequent use of the urine as the sacrament, among others.

Perseus is linked to another figure of Greek mythology, Jason, known for his exploits of acquiring the Golden Fleece and the Golden Apples, which have features directly associated with the characteristics of *Amanita* species. These include Jason's shamanic training, his identity as single-footed, and the meaning of his name (Iason), which (Ruck *et al*., 2001) propose as "drug man." The association of the origins of Perseus (also known as Iamos) with a period of transition from matrilineal Greek culture to the patrilineal Olympian traditions speaks to a key social transition involving the use - and eventual abandonment - of the psychedelic mushrooms, which were seen as a challenge to the Olympian order.

Women's roles in entheogenic traditions

There are deep roots to European female entheogenic traditions, tied to the ancient regime of matriarchy and Aphrodite (Ruck, 2014; Ruck *et al*., 2001). These traditions of priestess and sorceresses involved knowledge of plant use that was also found among the traditions of the European midwives and female herbalists, who used a variety of methods to alter consciousness and heal. The activities of Greco-Roman priestesses of the various mystery religions provide ample evidence of the use of sophisticated pharmacological combinations that permitted the induction of a variety of ecstatic alterations of consciousness (Hillman, 2014; Ruck, 2014). The association of aphrodisiacs with these entheogenic combinations attest to a period in which women themselves, rather than a male hierarchy, controlled their bodies and sexuality. These traditions were the context of the healing practices of Jesus, who famously exorcised the seven demons of Mary Magdalene, whose knowledge of herbal practices identifies her as a priestess of these ancient mystery cults.

These female-based entheogenic practices contributed to the formation of European and Christian practices through the traditions of Mithraism from the Zoroastrian practices of Persia (Hoffman, Ruck, & Staples, 2002). They propose that the Mithraic practices involved the further evolution of these earlier mushroom cults from an ancient Indo-European culture that preceded the separate Hindu and Iranian developments, and constituting the original pan-Eurasian religion. The few descriptions of the Mithraic sacrament allude not only to its mushroom-like qualities (thrusting out of the earth, single-footed), as well as specific *A. muscaria* features (red caps, white jewels, associations with mountains, and the symbiotic tree species).

Ruck *et al*. (2001; Ruck, Hoffman, & González-Celdrán, 2014) propose the Mithraic links as evidence of *A. muscaria* as the Christian Eucharist, arguing for a foundational role of *A. muscaria* in Christians' sacramental body and blood of Christ that are to be eaten and drunk, constituting a real rather than merely symbolic representation of that sacramental flesh and blood. The *A. muscaria* is a "flesh that contains blood" - a reference to the red liquid squeezed from the mushroom flesh when rehydrated. The stem is also a flesh, which with drying, turns a color similar to bread. Other parallels with the Eucharist include its production of a sense of vitality to life and a sense of unity with deity. Ruck *et al*. (2001) extend this analysis to the chalice of the Holy Grail, pointing out that the fully form *A. muscaria* presents as a chalice with its upturned edges forming a cup around the blood red cap.

The incorporation of the entheogenic practices of Mithras into the foundations of Christianity was facilitated by the widespread diffusion of the practices through the Roman Empire, where Mithraic rites were important mechanisms for the foundation of bonds of brotherhood among the soldiers of the Roman army and its political apparatus (Hoffman *et al*., 2002). While the later ascendant Catholic Church viciously persecuted the Mithraic religion, their entheogenic rituals persisted in pagan practices, as well as sects functioning secretly within the Church.

The entheogenic traditions of Europe retreated from public life and the male dominated priesthoods, which had antipathy for the shamanic alterations of consciousness. The last thing that the bishop wants to hear is that there is a new saint in the parish. This patriarchal rejection of the entheogenic traditions left them in the hands of women and their spiritual healing traditions. These ancient mushroom practices also persisted in the popular culture as attested to the survival of this information in diverse areas, such as its widespread association with toads and elves (Morgan, 1995). *A. muscaria* survivals include its highly probable role in historical and contemporary Christmas designs. Parallels with Siberian practices and beliefs suggest that symbolic remnants of these ancient *A. muscaria* traditions are still present in contemporary culture, reflected in representations of the red and white of Santa Claus, his flying reindeer, the associated birch and pine trees, and their hanging colorful gifts derived from practices of hanging the mushrooms to dry on these symbiont trees.

Religious use of A. muscaria in Christianity

There is a growing body of literary material recently reinterpreted in light of the entheogenic perspectives that present evidence for widespread entheogenic mushrooms cults across Europe, and even in the formation of Christianity. Evidence for the continuation of shamanistic *A. muscaria* practices in ancient Europe is found in a wide range of mythological and religious phenomena and artifacts (Rätsch, 2005).

The possibility of a broader European role of *A. muscaria* practices beyond its shamanic roots was boldly proposed by Allegro (1970), who in his book, *The Sacred Mushroom and the Cross*, attributed the origins of Christianity to an *A. muscaria* cult. The sacramental body of Christ is the mushroom, with the extracted red juice the blood that is also the sacrament. Allegro presented linguistic evidence that suggested not only Christianity, but also Judaism and Islam had ancient roots involving ritual worship of *A. muscaria*.

Although Allegro had fame as an expert on the Dead Sea Scrolls, his hypothesis received little serious attention, but rather was summarily dismissed in what has been alleged to have been a deceitful and repressive cover-up by Gordon Wasson (see Irvin, 2008; also see Brown & Brown, 2016 and their article below). Wasson's rejection of *The Sacred Mushroom & the Cross* was not on the basis of an objective evaluation of the evidence. Rather than engaging Allegro's information and arguments on the origins of Christianity in mushroom cults, Wasson summarily dismissed Allegro's ideas and subjected Allegro's work to ridicule through intellectually questionable behavior (Irvin, 2008). By reference to private correspondence, Irvin reveals that Wasson's dismissal of Allegro's work was not because he read it - Wasson apparently confided to others that he did not even read Allegro's book. Instead Wasson took the opinions of a rabbi and a priest and dissuaded further research in this area.

But as we will see below, there is strong evidence for entheogenic cults using psychedelic mushrooms within Christianity. Evidence supporting Allegro's hypothesis of the ancient entheogenic roots of Christianity is found in the repeated appearance of mushroom representations in later Christian art, some with the typical characteristics of *A. muscaria*, and other depictions resembling local psychedelic species of the *Psilocybe* and *Stropharia* genera (see Brown & Brown, 2016; Hoffman *et al*., 2002; Ruck, 2017, 2011; Ruck *et al*., 2001). Allegro (2008) received post-humus support in a rerelease of his book with additional evidence provided by Carl Ruck (also see Brown and Brown's article here).

Psychedelic mushrooms in Catholic art and architecture

Although many aspects of entheogenic knowledge disappeared from European cultures, this ritual knowledge and messages regarding entheogenic mushrooms remained blatantly displayed - for the initiate - in Christian artifacts, from architectural features such as fungiform door frames to elaborate commissioned art works with mushrooms conspicuously displayed in key areas - such as above the hand of saints. Evidence that such practices persisted through direct transmission is found in the Anthonite healing order and esoteric Christian groups such as the Albigensians and Cathars, and many paintings of Saint Hildegard of Bingen (see Keizer, 2012).

The involvement of *A. muscaria* in the secret rituals of Catholics is indicated by it being well-represented in works of Hildegard of Bingen (1098-1179), a Catholic saint who was also a German Benedictine abbess and an accomplished philosopher, writer, and mystic (Keizer, 2012). The Isenhein altarpiece produced by Matthias Grünewald contains representations of mushrooms, one significantly in the background of outstretched hands of Saint Anthony. The location of the painting within the Abbott of the Anthonites, the followers of St. Anthony (patron of mushroom hunters) who founded a Christian healing order, reflects their secret knowledge and use of *A. muscaria*. Ruck *et al*. (2001) note the repetitive allusions to the *A. muscaria* in many significant aspects of the artistic composition. Mushroom caps and stipes subtly surround angels and an *A. muscaria* mushroom is depicted in the background as if floating in St. Anthony's outstretched hand and pointed finger. Depictions of a raven with the "raven's bread" (*A. muscaria*) and the stag (the urine of which provides an enhanced psychoactive preparation) present a scene rich with symbolic references to these ancient entheogenic traditions of Eurasia, as well as the hidden traditions of Christianity.

The psychedelic gospels: The secret history of hallucinogens in Christianity

In the article "*Entheogens in Christian Art: Wasson, Allegro and the Psychedelic Gospels*," Jerry Brown and Julie Brown provide an in-depth analysis of the presence of entheogenic mushroom images in early and medieval Christian art. They begin with a review of the controversy between avocational ethnomycologist R. Gordon Wasson and philologist John Marco Allegro regarding the presence of psychoactive mushrooms in Christianity particularly the identification of a figure in the 12th century Chapel of Plaincourault in France as a representation of an *A. muscaria* mushroom. This seminal debate about the role of entheogens in Christianity was then decided in Wasson's favor, who discounted the Amanita interpretation by reference to an opinion of an art historian, who characterized it as a stylized pine tree in private correspondence with Wasson. However, Browns show that in other correspondence, which Wasson did not share, the same authority questioned such identification.

The Browns present a summary of central findings of their book "*The psychedelic gospels: The secret history of hallucinogens in Christianity*," which presents widespread evidence of entheogens in Christian art found in abbeys, churches, chapels, and cathedrals across Europe and the Middle East. This includes a detailed examination of the evidence for the identification of the Chapel of Plaincourault figure as an *A. muscaria* mushroom, as well as other features of the fresco that identify entheogenic themes. Their fieldwork across Europe and the Middle East provides abundant iconographic evidence of other entheogenic species represented in Christian art, in particular *Psilocybe* species. They show that time and again, the representations of biblical events have clear depictions of mushrooms that resemble psilocybin-containing species, and that the oversized and central placement of these objects indicate that they are central to the messages of these representations. Their paper provides a review and critique of the various positions taken in the debate regarding the presence of entheogenic mushrooms in Christian art, and asks why Wasson, arguably the leading world figure of the epoch advocating for entheogenic interpretations of the religious past, rejected, until the end of his life, such interpretations of Christian artifacts. The silence of the Catholic Church and art authorities remains a puzzle, unless one endorses a theory of a conspiracy of silence to suppress the entheogenic past of Christianity. Browns call for the establishment of an Interdisciplinary Committee on the Psychedelic Gospels, housed by an academic institution, to examine the evidence for entheogenic mushrooms in Christian art and provide a more satisfactory resolution to what may be the most important knowledge about the origins of this religion.

Brown and Brown's assessment of The Plaincouralt Fresco and its undeniable representation of *A. muscaria* places it as a representation of the Tree of Good and Evil of the Garden of Eden. This situates the *A. muscaria* sacrament as complex phenomena, simultaneously the forbidden fruit, as well as the means by which humans acquired morality in the knowledge of the difference between good and evil. An entheogen that provides forbidden knowledge also gave the consciousness necessary for morality, as well as Adam and Eve's self-consciousness of their own nakedness.

Whether or not the secret sacrament of early Christianity was originally *A. muscaria*, ergot wheat drinks, or other entheogenic admixtures, the certainty is that *A. muscaria* practices persisted among esoteric cults, mystery schools, and the Gnostic sects hidden within members of the Catholic Church. *A. muscaria* traditions also persisted within esoteric societies such as Freemasonry, which incorporated earlier influences of the Knights Templar and other groups (Hoffman *et al.*, 2002). The presence of *A. muscaria* practices was obscured by the official Church's efforts to stamp them out and by many cult's efforts to hide evidence of use to protect the secrecy of the continuing ritual practices. This leaves questions regarding whether Wasson's opposition to Allegro's ideas was a continuation of the historical repression of entheogenic traditions within Christianity.

The witches' flying ointments

The survivals of these actual entheogenic-inspired ritual practices also continued well into the second millennium in Europe, occasionally revealed in the practices of those accused of witchcraft, pagan rituals, and various secret societies. Their associations with females are well-noted in the history of the European witchcraft trials, where these female traditions are alleged to use a wide range of powerful psychoactive substances.

In an article "*Those Goddamn Ointments: Four Histories*," Tom Hatsis documents and analyzes these aspects of entheogenic history of Western Europe that survived into the Renaissance and early modern eras in beliefs regarding "flying ointments." In contrast to the postmodern academic skepticism regarding the actual reality of such ointments, which may attribute such beliefs to the fabrications of fearful religious minds, Hatsis shows us that there is more probably a factual basis for them, albeit in dramatically altered form. While it is true that both theologians' misconstruals and popular fears have fueled many beliefs, such as murdered children and cannibalistic spirit familiars, these constitute an early modern radical reconceptualization of what were prior practices and beliefs. Hatsis similarly contends that the 1970s popularization of the concept of "flying ointments" by anthropologist Michael Harner (1973) is also a fabrication of that era. Nonetheless, these mistaken construals and fabrications have a likely historical basis in the medieval beliefs regarding what he calls transvection ointments, referring to their alleged ability to make the person fly in some form, or to travel in spirit. Hatsis reviews the evidence that something like this historically documented ointment derived from medieval folk traditions was the basis from which a variety of otherwise inaccurate modern and post-modern beliefs derived. Although the exact composition of such ointments will likely forever remain a mystery, Hatsis concludes "there is every reason to believe that the ointments contained psychoactives," including the various mandrake species of the genus *Mandragora*, which share the hallucinogen and hypnotic properties derived from their tropane alkaloids. Hatsis proposes that other hallucinogens likely included in these transvection ointments are henbane (*Hyoscyamus niger*) and belladonna (*Atropa belladonna*), both with worldwide fame as magical potions. The inclusion of such powerful consciousness-altering agents in these classic ointments speaks to a shamanic past of these practices, where powerful botanically induced alterations of consciousness were part of ritual healing practices.

Although the exact composition of the witches' brews may remain forever unknown, Rätsch (2005) proposes that there is good evidence that a variety of psychotropic plants were used, including *Valeriana officinalis*, *Mandragora officinarum*, *Hyoscyamus niger*, *Papaver* spp., *Atropa belladonna*, *Datura* spp., and many others. The use of these powerful psychoactive plants to induce stupor, paralysis, and death-like states was the basis of the extraordinary experiences reported of flying and strange worlds found in many traditions of Europe.

Sacred mushrooms in the Americas

Ironically, as the Renaissance and Enlightenment finished off the last vestiges of entheogenic spirituality in Europe, it began to bring the same perspectives back into European society through colonial encounters with the foreign other that brought knowledge of shamanism, *A. muscaria* use, and entheogenic practices into Europe from Siberia and the Americas. The *A. muscaria* traditions of Eurasia were likely already part of the shamanic cultures of the populations that migrated to the Americas 15,000 years ago or more. Although reports of *A. muscaria* traditions are rare in Native American traditions recorded from early contact and ethnographic periods in North America, there is clear evidence of mycolatry in the ethnographic record and mythology. There are also clear representations in the archeological record of Mesoamerica and South America of artifacts representing *A. muscaria*. Representations of various *Psilocybe* species are also found widely across Mesoamerica and South America. Borhegyi (2010) shows numerous examples of mushrooms in art and artifacts from across central Mexico and Peru, establishing both the antiquity and widespread distribution of an ancient pre-Columbian mushroom cult.

North America

Evidence for indigenous North American use of *A. muscaria* is reported by several sources (Navet, 1988; Peschel, 1978; Wasson, 1979). Wasson sought and found evidence of contemporary North American *A. muscaria* ritual among the Ojibway in the writings of Peschel Keewaydinoquay, a woman who was a custodian of her culture's indigenous spiritual traditions. Navet (1988) provides a summary of ethnohistorical sources of information regarding the use of *A. muscaria* and its role in the origin myth of the Ojibway, where a red and white mushroom buzzes with strange sounds and songs. When Little Brother consumes the biggest of the mushrooms, he is transformed into a mushroom himself. The Big Brother uses drumming, tobacco, and eagle feathers in a ritual that the shamans had recommended. This enabled Big Brother to escape with the little Brother mushroom and transform him back into a human. But something had changed: "*Little Brother woke up smiling every morning, the heart happy and a song on his lips*" (Navet, 1988, p. 169). Curiously, he cures and resolves misfortunes with the waters that flowed out of his penis, a clear parallel to the Siberian practices of consuming the even more potent urine from one who consumes *A. muscaria*. Little Brother begins to perform healing rituals based on the powers acquired from the supernatural experience in the land of the mushrooms, providing a mythological verification of a general entheogenic hypothesis of the origin of shamanic-healing practices in the experiences produced by psychedelic mushrooms.

Mesoamerica and Central America

The prominent mushroom depictions in stone sculptures and ceramics provides clear evidence that psychedelic rituals were central features of ancient Pre-Hispanic American cultures from Mesoamerica down into South America (Torres, 1996, 2006; Torres & Repke, 2006; Velandia, Galindo, & Mateus, 2008). The most ancient evidence of sacred mushroom rituals in the Americas may be the representations of *A. muscaria* among the Mayas and Náhuatl in México, represented in ceramics from Mesoamerica and Peru and in stone objects found in Nayarit, Mexico. The Aztec's entheogenic mushroom ceremonies involving the consumption of the sacrament teonanácatl or "God's flesh" were documented by the Spanish chroniclers. *Psilocybe* species are the predominant candidates and likely involved several species. Guzmán (2008, 2016) reviews archeological and botanical evidence that various species of these psilocybin-containing mushrooms were used in sacred rituals in prehistoric México, Mesoamérica, and South America. Borhegyi and Borhegyi-Forrest (2015) analyzed the visual data in Justin Kerr's compilation photographs of ancient Mesoamerican art that illustrate realistic, conventional, and abstract depictions of *A. muscaria*, as well as species with characteristics representative of several *Psilocybe* species (and possibly *Panaeolus* species).

The ritual use of entheogenic mushrooms was especially widespread in Mesoamerica and continued into the modern era with more than two dozen psilocybin-containing species used for religious ceremonies in Mexico (Guzmán, 2016; Wasson, 1980). Among the most well-known archeological evidence of fungiforms are the "mushroom stones" discovered during archeological excavations in sites in Guatemala, which Borhegyi examined in the collections of the Guatemalan National Museum. Borhegyi (1961, 1962) proposed that these stones were evidence of an ancient cult of mycolatry. The stone effigies carved in the shape of mushrooms that were found in Guatemala establish a high level of organized religious mycolatry in Mesoamerica as early as 600 BCE. But while both Borhegyi and Wasson proposed that the identity of the mushroom stones was *A. muscaria*, Guzmán (2012) proposed the identity of these "mushroom stones" as *Psilocybe zapotecorum*, based on their robust form and the common appearance of the species in the region.

María Sabina: An ethnographic analogy for ancient Mesoamerican mycolatry

The Western encounters with the indigenous use of psilocybin mushrooms by Mesoamerican cultures was reported from the cultural distance of the Spanish invaders, whose accounts related by Catholic priests were severely distorted by their ideological views of these practices as involving witchcraft. The violent oppression of these practices led to their virtual extinction in most of Mexico. The surviving practices came to the attention of Western scholars in the early 20th century when anthropologists and ethnobotanists reported their ritual use in Oaxaca Mexico. These investigations among the Mazatec and subsequent publications by Gordon Wasson (Wasson, 1980; Wasson, Cowan, & Rhodes, 1974) brought international attention to María Sabina, a Mazatec *sabia*, meaning wise woman. This Mazatec healer and her ritual use of psychedelic mushrooms (*Psilocybe caerulescens* Murrill and *Psilocybe mexicana* Heim) and others provides an ethnographic analogy for understanding these ancient traditions (see Estrada, 1977; Munn, 1973). In addition to the mushrooms, María Sabina and other Mazatec healers use other psychoactive plants including *Salvia divinorum* and local tobacco (*Nicotiana rustica* L., *Solanaceae*). These practices (summarized from Schultes & Winkelman, 1995) provide an ethnographic analogy for understanding the nature of the prehistoric practices.

While María Sabina's practices had obvious Christian influences in her invocations of Jesus, Mary, and Christian saints, her healing activities manifest indigenous traits that are a window to the ancient pre-Columbian Mesoamerican use of psychedelic mushrooms in healing rites. María Sabina's training and healing practices reflect the classic features of shamanism found cross-culturally (Winkelman, 1990, 1992). Features of her life and practices involving shamanistic elements are the processes of selection for the vocation, the interactions with mushroom beings or spirits, the experiences of training, the ritual therapeutic activities, and the cosmologies regarding the causes of illness.

María Sabina's grandparents were also "wise ones," her paternal and maternal grandparents practicing as healers. María Sabina began her formation as a shaman at an early age of 6 years, when she ingested mushrooms out of hunger while with her sister attending the cows in the mountains. The experiences that followed gave María Sabina her calling to use mushrooms for healing. These sacraments that she called "saintly children" nourished her during periods of hunger in the forest and gave both sustenance and spiritual inspiration. As expressed in traditions around the world, she experienced the mushrooms speaking to her, manifesting in visions and voices that encouraged her, offered her advice on how to address problems, and eventually gave her the gifts to heal.

This entheogenic origin of her powers, personal development, and healing practices, experienced as direct interaction with the spirit within the mushrooms, is a feature of shamanic experiences that is reported worldwide. The ingestion of the mushrooms provides the spiritual contact and experiences of the training for use of the sacred mushrooms, engaging them as agents that provide wisdom and healing powers. This animistic quality of the experience is exemplified in her personifications of the mushrooms as "saintly children," "little women," "little nuns," "children that sprout," and Christian personages, especially the Virgin Mary and Jesus Christ (Allen, 1997; Estrada, 1977; Wasson *et al*., 1974).

María Sabina felt that she was born to be a healer, a preordained potential that unfolded as the mushrooms gave her the wisdom necessary for performing the rituals to heal and other powers. These plants were experienced as sentient beings that communicated with her internally in extensive engagements experienced as "language of the mushrooms." These communications from the mushrooms taught the traditions of the wise ones, guiding her professional practice and providing the information needed to diagnose illness and heal. The techniques for using the mushroom are not something the healers learn beforehand, but rather acquire this knowledge directly from the mushrooms when their force acts through the healer's body. The mushrooms speak directly to and through the person, stating the origins of illness and the ritual processes necessary for healing. The healing process is advised by the healer's and patients' visions that reveal the origin of the problem.

The formation of a mushroom healer engages process of self-initiation as the neophyte directly experiences the spirits of the mushrooms in visionary experiences as higher sources of spiritual authority. These entities provided María Sabina access to a Book of Wisdom, spiritual texts that were used to heal with the power derived from the "language of the mushrooms." This power is expressed in the healer's songs that emerge when the mushrooms are consumed and then act through the body of the shaman during the ritual, chanting, singing, speaking, and the directing the healing processes.

The ritual healing is an overnight vigil held in the darkness, generally far from others in a remote house. The ill person is accompanied by their family and other members of the community, and generally remain together overnight. The participants must comply with a number of restrictions, avoiding sexual behavior and alcohol consumption for 4 days before and after the ceremony and fasting from breakfast on the day of the ritual.

The use of mushrooms is necessary for the healer, and may also be ingested by the patients if the healer decides it is necessary. The mushrooms are normally eaten raw, often accompanied by a cup of cacao. The power of the healing ceremony is also produced by the healer's singing and chanting, combined with whistling, humming, and ventriloquistic effects. The healer dances and chants during much of the night, often breaking into words that convey the healing powers of the mushrooms. Munn (1973) characterized the sacred language of the mushrooms as a "poetic art" of words and sounds that are used as tools to elicit emotions and catharsis. María Sabina's diverse use of sounds, not only in singing and chanting, but other monotone rhythmic utterances, also functions as procedures for altering consciousness. The healing done with the mushrooms involves such traditional shamanistic practices as addressing the loss of the soul or spirit of the person, resolving spirit afflictions, providing exorcisms, and removing hexes by sorcerers and witches. The *veladas* were also used for a physical illness and to resolve disputes. The healer may address the actions of evil spirits, block hexes, or the consequence being enchanted by evil spirits or sorcerers. The healing *veladas* are normally held to seek a remedy to a persistent health problem, but may be used for acquiring solutions to other problems. The *velada* is typically focused on the cure illness or to determine the possibility of recovery from some disease and the treatments necessary. The mushrooms are also used in divination to locate lost animals and discover the situation of distant family members.

Costa Rica's entheogenic prehistory

In their article "*Ritual consumption of psychedelic fungi and plants in ancestral Costa Rica*," José Manuel Rodríguez Arce and Marco Antonio Arce Cerdas examine artifacts that document the use of psychedelics in pre-Columbian societies that inhabited the current Costa Rican territory. They examine the cultural and social significance of this activity through integration of historical, ethnographic, archeological, and paleobotanical findings. Psychoactive plants of the region included tobacco (*Nicotiana* spp.), cacao (*Theobroma cacao*), morning glory (*Turbina corymbosa*, *Ipomoea tricolor*, and *I. carnata*), fly agaric (*A. muscaria*), cohoba (*Anadenanthera peregrina*), and various psilocybin mushroom species (e.g., *Psilocybe aztecorum* and *P. caerulescens*). The 46 artifacts from the Museums of the Central Bank of Costa Rica and the National Museum of Costa Rica reveal the centrality of supernatural ritual practice linked to psychedelics. These aspects of the archeological record together with other data permit a nuanced examination of their use of psychoactive substances. Ethnographic analogies suggest these substances were instruments to attain esoteric knowledge that was central to healing practices and a source of social power. Archeological evidence that psychedelic drug use was most frequent in the record during the period from 300 BCE to 300 CE suggest that psychedelics and their effects were instrumental in the emergence of sociopolitical formations in ancient Costa Rica. This significance is attested to by the placement of a mushroom-shaped ceramic statue in an elite burial along with sumptuary symbolic objects (carved jade effigies), along with snuff inhalers (rather than pipes). These inhalers appear to have been employed as insignia of political and ceremonial rank, as attested by the presence of worn down orifices for suspending them as pendants. Access to entheogenic ritual knowledge was part of the source of power of high-ranking leaders and may have played a role decision-making and coordination of tasks during a period of sociopolitical complexification.

South America

Evidence of ancient sacred mushroom practices in Peru is found in iconographic depictions that document the ritual use of sacred mushrooms on stones, ceramic vessels, and in metal work. Trutmann (2012) presents photographs from diverse sources that show these mushrooms representations in Moche ceramic artifacts (dated between 100 BCE and 800 AD) that have realistic representations of *Psilocybe* species and *A. muscaria*. Trutmann (2012) reviews archeological evidence of sacred mushroom use in prehistoric Peru in the Cupisnique, Paracas, Moche, Chimú and Pukará cultures, as well as the mushroom stones of Chucuito (see Figures 8 and 9 for photographs). Trutmann presents these various stone mushrooms as evidence of their ancient ritual use among a number of areas in coastal and highland Peru dating from as early as 1200 BCE. These mycolatry practices continued until the European conquest, as evidenced in documents from the end of the 17th century. Schultes (1966) summarized evidence that the Yurimagua culture of the Peruvian Amazon employed an inebriating beverage based on a tree fungus that was likely *Psilocybe yungensis*, which was also used ritually in Bolivia and southern Mexico.

These mushroom representations provide evidence of not only the use of various *Psilocybe* species, but also the famous *A. muscaria* mushroom, easily recognized because of its red and white coloration. This later species, represented in ancient ceramics but not documented in contemporary ethnobotany of Peru, suggests that long distance trade in these sacred items and the ancient Peruvian practice of borrowing of sacred plants from other cultural traditions. Analyses of artistic representations by Velandia *et al*. (2008) illustrate some of the frequent motifs of South America iconography in relationship to fungiforms and conventional representations of mushrooms, making the argument that abstract mushroom representations are far more widespread than apparent.

In his article "*The Use of Psychoactive Plants and Fungi by Ancient Indigenous Populations of the North Andes*," Manuel Torres presents evidence of the widespread ceremonial use of entheogenic plants in the ancient cultures of South America. He reviews evidence that the use of entheogenic plants permeated these cultures as a core feature of shamanic religious practices. The importance of these entheogenic substances was expressed in a complex iconographic systems revealed in a variety of media, most of which survived in stone sculptures and gold work. These include the San Pedro cactus.

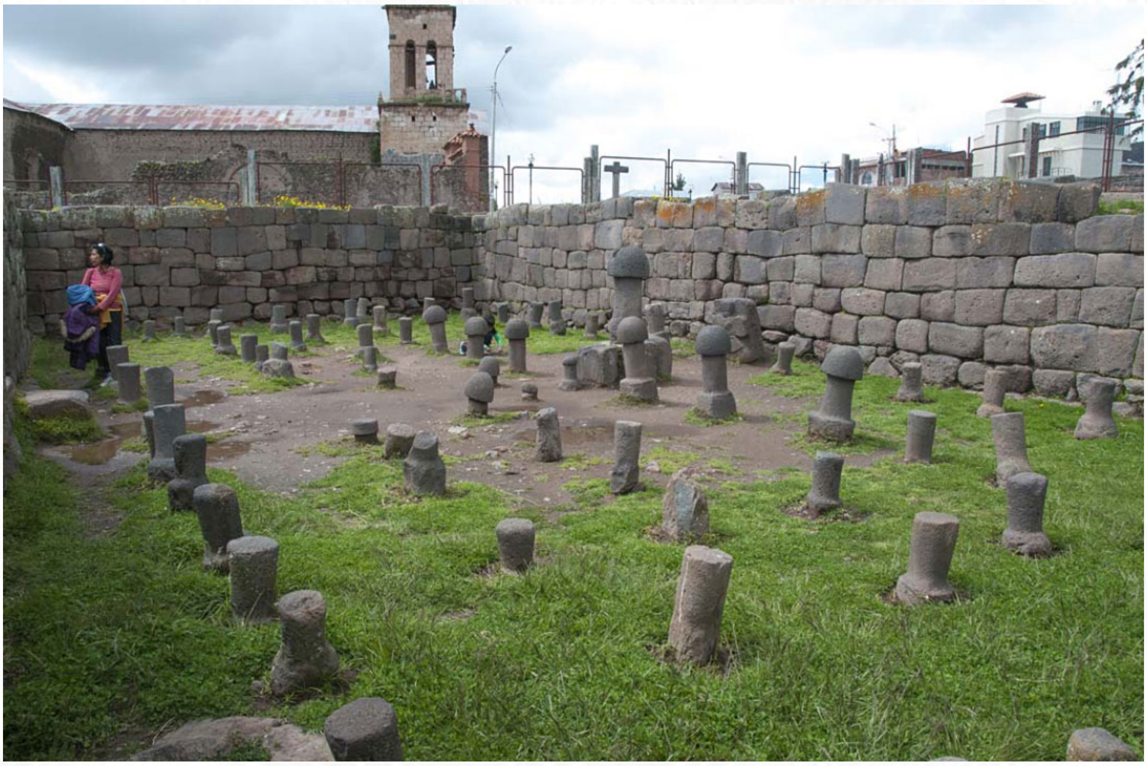


Figure 8. An image from Inka Uyo, showing a collection of ordinary roof bearing stones together with mushroom-shaped stones collected from around Chucuito Peru (photo credit: Peter Trutmann; used with permission)

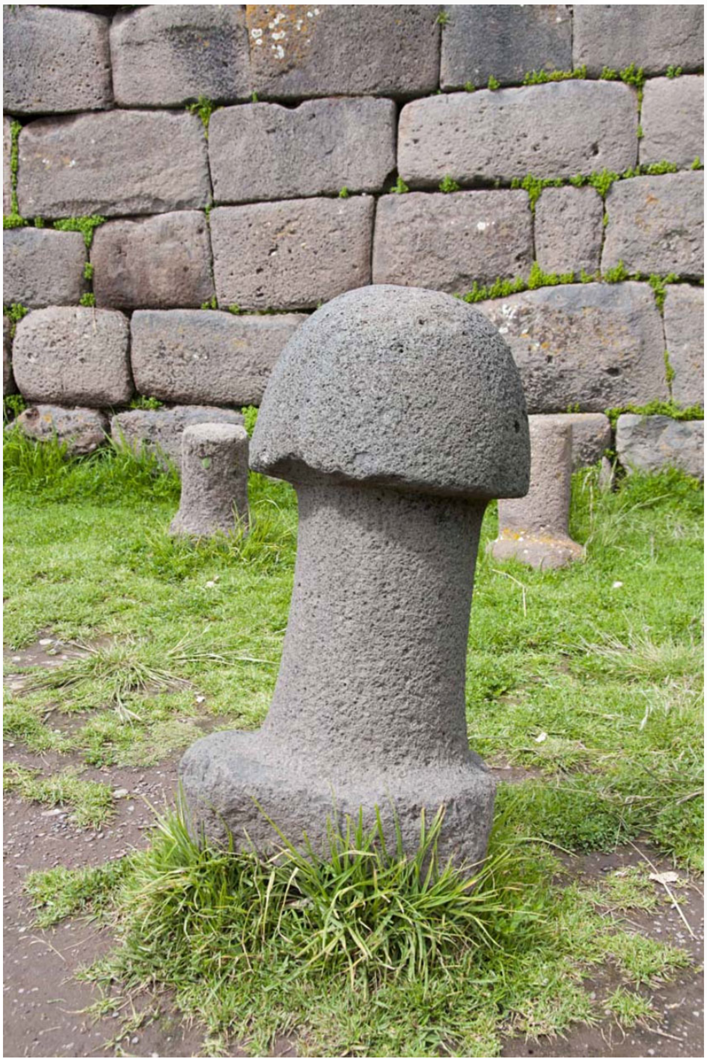


Figure 9. A mushroom-shaped stone from Chucuito, Peru (photo credit: Peter Trutmann; used with permission)

Echinopsis sp. (synonym: *Trichocereus* sp.) and psychoactive snuffs from *Anadenanthera colubrinai* practices are still attested to in South American cultures today. The fungiform representations in the Darién pendants have been identified as psychedelic mushrooms by several authorities, consistent with the entheogenic themes found in burial artifacts. Torres provides iconographic analyses of ceremonial paraphernalia to show how they reveal the central role of entheogens in the religious practices of the ancient cultures of this region.

However, with rare exceptions outside of Mesoamerica, these entheogenic mushroom rituals were not reported in the historical or near-contemporary ethnographic documents produced by the Western world. The exact nature of these ancient entheogenic practices was lost due a variety of factors, perhaps the most important of these being the extremely destructive influences of the prohibition of consumption and teaching about these substances issued by Catholic Inquisition. This repression upon threat of punishment with death by torture that persisted well into the colonial period in the Americas assured the loss of the knowledge regarding these practices during the subsequent formation of mestizo cultures through acculturation. Furthermore, this repression contributed to the production of mycophobic attitudes in the mestizo cultures, further contributing to extinction of knowledge regarding entheogenic ritual practices. Even today "Christian" people of indigenous cultures may set out to kill their more "primitive" neighbors who harbor and engage in these ancient shamanic practices.

Conclusions: The Modern Loss And Eternal Return Of Entheogenic Spirituality

Interdisciplinary evidence regarding the entheogenic use of mushrooms provides perspectives for interpreting findings from investigations by archeologists and ethnobotanists. What this entheomycological research has revealed is that religious activities focused on the entheogenic use of psychedelic mushrooms were present in all of the major geographical regions of the world. These widespread practices indicate that use of entheogenic mushrooms is a universal religious heritage of humanity. This simple fact should lead to unequivocal support for an entheogenic paradigm, specifically mycolatry, when iconographic evidence of fungiforms is found in the archeological record. Arguments for culinary or other ethnobotanical representations should be required to provide extraordinarily robust evidence to counter what is arguably a virtual universal of human cultures - evidence of beliefs and practices related to the entheogenic use of psychoactive mushrooms.

The continuity of these entheogenic mushroom traditions from prehistoric shamanic traditions into historical cultures is attested to the articles in this special issue. The entheogenic encounters that inspired the evolution of shamanism continued in the practices of historical and contemporary religions - Hinduism, Buddhism, Jainism, Judaism, Islam, Christianity, and others. While the coverage provided in this introduction and the following articles is not a comprehensive review of this evidence, it points to the widespread evidence of psychedelic mushrooms and other entheogens in the early formation of the major world religions. The shamanic impulse that gave rise to worldwide entheogenic practices was, however, more hidden in these traditions of complex societies, where the knowledge regarding use of these substances was now an exclusive practice of a priestly class. This hiding of secret knowledge regarding entheogenic use contributed to the general loss of knowledge about mushroom-induced transformations of consciousness that give rise to religious traditions.

Entheogens, especially mushrooms of the *Amanita* and *Psilocybe* genera, have inspired countless spiritual encounters and traditions in the past. But are entheogenic-inspired religions just a phenomena of the remote past, a relic of a previous era and human mentality when humans were more susceptible to the chemically inspired entheogenic encounters? Or are these entheogenic potentials still part of the modern ecopsychology of humanity. Our final article here gives an emphatic "Yes!"

A modern entheogenic-origin religion: Mormonism

In the article "*The Entheogenic Origins of Mormonism*," Robert Beckstead and his co-authors Bryce Blankenagel, Cody Noconi, and Michael Winkelman present evidence regarding the entheogenic origins of the Church of Latter Day Saints, known as Mormonism. This modern worldwide religion has its roots in the early 19th century American Midwest with Joseph Smith Jr., the founder who rapidly gathered thousands of recruits to Mormonism with the compelling power of visionary experiences. The authors argue that this was due to the convincing power of entheogenic-induced experiences. The family of Smith shows evidence of a history of entheogenic knowledge that produced his revelatory experiences and that entheogens were incorporated into the early Mormon Church in sacraments, anointing, and temple rituals. The 19th century historical data related to the rise of Mormonism and events in Joseph Smith's life and the experiences of early Mormon converts suggest the ritual use of entheogenic material was explored, systematized, and modified by Joseph Smith Jr. in the founding period of Mormonism. The unusual features of visionary and spiritual experiences reported during early periods of Mormonism mimic the anti-cholinergic syndrome produced by *Datura stramonium*. The neurophysiological and phenomenological effects of various entheogenic plants explain the unusual symptomatology reported in newspapers of the time, as well as ego dissolution, visionary experiences, and mood-enhancing sequelae experienced by Mormons. Mormonism is a very important example of entheogen-inspired religions, showing that they are not just a thing of our ancient past, but also part of recent history. Mormonism shows the power of a few early entheogenic experiences to inspire the formation of a religious organization that can persist long after its founders and their entheogenic stimuli have faded from the scene.

Entheogens as a universal religious heritage

Our various contributions here on the entheogenic elements of religions of the past - and their descendants in the present - provide ample data for assertions about a common worldwide basis of religious experiences in psychedelics and their influences in the formation of humanity's religions. The roots of entheogenic religions in shamanistic practices are not just a relic of the past, but also a part of the present, as exemplified in the many contemporary ayahuasca practices and churches. Perhaps, entheogenic religion is here to stay. It is after all part of our evolution and nature. One can hope that this nascent stage of reemergence will move beyond this into an entheogenic revival, a global movement of spiritual acceptance across traditions that is worthy of the sacred mushrooms' long history.

Shortly before his death, Wasson recanted on his rejection of the Allegro's hypothesis regarding the entheogenic origins of Christianity, proclaiming in his final book, *Persephone*'s *Quest* (Wasson, Kramrisch, Ott, & Ruck, 1986): "*I once said there was no mushroom in the Bible. I was wrong. It plays a hidden role (that is, hidden from us until now) and a major one, in what is the best-known episode of the Old Testament, the Garden of Eden story and what happened to Adam and Eve.... I hold that the fruit of the Tree of Knowledge of Good and Evil was Soma... was the Amanita muscaria.*"

As proclaimed in the subtitle of the book - *Entheogens and the Origins of Religion* - the primordial origins of religious thought and experience are found in the neurophenomenology of psychedelic mushrooms and other entheogenic plants. Unfortunately, Wasson did not support Allegro's hypothesis in that crucial time when he could have changed the course of entheogenic and Christian studies.

"*Jesus said to them: Amen, amen I say unto you: Except you eat the flesh of the Son of man, and drink his blood, you shall not have life in you.*"

If this refers to *A. muscaria* and psilocybin-containing mushroom species, the real Christian Pentecost may still await humanity. Spiritual experiences of many religious traditions apparently originated in the effects of *A. muscaria* and *Psilocybe* species. Our religions - Judaism, Buddhism, Hinduism, Christianity, Islam, and others, including Mormonism - have ancient roots in entheogenic experiences produced by these fungi, as well as numerous sacred plants. Humanity can recover their true spiritual roots through the ritual engagement with these sacraments. And if we do so we will become better people from the experiences. That is another paper, but the evidence is there that these substances make us more egoless, other-oriented, altruistic, compassionate, open, tolerant, friendly, and less fearful, anxious, depressed, etc. - effects that undoubtedly benefited us in the past and can do so in the future.

Acknowledgements: The author received no support for this work and is responsible for all aspects of this article.

Conflict of interest: The author has no conflicts of interest nor any financial incentive for the ideas expressed here.

References

1. Akers, B., Ruiz, J., Piper, A., & Ruck, C. (2011). A prehistoric mural in Spain depicting neurotropic psilocybe mushrooms? *Economic Botany*, 65(2), 121-128. doi:10.1007/s12231-011-9152-5
2. Allegro, J. (1970). *The sacred mushroom and the cross*. New York, NY: Doubleday.
3. Allegro, J. (2008). *The sacred mushroom and the cross*. Grand Terrace, CA: Gnostic Media.
4. Allen, J. W. (1997, October). *Teonanácatl: Ancient and contemporary shamanic mushroom names of Mesoamerica and other regions of the World*. Ethnomycological journals: Sacred mushroom studies (Vol. III, pp. 1-47). Seattle, Washington: Psilly Publications and Raver Books.
5. Berlant, S. (2005). The entheomycological origin of Egyptian crowns and the esoteric underpinnings of Egyptian religion. *Journal of Ethnopharmacology, 102*(2), 275-288. doi:10.1016/j.jep.2005.07.028
6. Bogoraz, V. (1909). The Chukchee. Social organization. *The Jesup North Pacific Expedition 7, Social organization* (Vol. 11, pp. 537-733). New York: American Museum of Natural History.
7. Borhegyi, S. (1961). Miniature mushroom stones from Guatemala. *American Antiquity, 26*(4), 498-504. doi:10.2307/278737
8. Borhegyi, S. (1962). *The enigmatic mushroom stones of meso-America*. New Orleans, LA: Middle American research Institute, Tulane University.
9. Borhegyi, C. (2010). *Mushroom symbolism in pre-Columbian art*. Retrieved from http://www.mushroomstone.com
10. Borhegyi, C., & Borhegyi-Forrest, S. (2015). Mushroom intoxication in meso-America. In P. Wexler (Ed.), *History of toxicology and environmental health*. Amsterdam, The Netherlands: Academic Press.
11. Brown, J., & Brown, J. (2016). *The psychedelic gospels: The secret history of hallucinogens in Christianity*. Rochester, VT: Park Street Press.
12. Crowley, M. (2015). Umbrellas, wheels, and bumps on the head: A proposed solution to the Uṣṇ&imacr;ṣa mystery. *Time and Mind, 8*(2), 191-218. doi:10.1080/1751696X.2015.1026028
13. Dannaway, F. (2009). Thunder among the pines: Defining a pan-Asian soma. *Journal of Psychoactive Drugs, 41*(1), 67-84. doi:10.1080/02791072.2009.10400676
14. De Smet, P. (1996). Some ethnopharmacological notes on African hallucinogens. *Journal of Ethnopharmacology, 50*(3), 141-146. doi:10.1016/0378-8741(95)01337-7
15. Devlet, E., & Devlet, M. (2002). Siberian shamanistic rock art. In A. Rozwadowski & M. Kosko (Eds.), *Spirits and stones shamanism and rock art in Central Asia and Siberia* (pp. 120-136). Pozna&nacute;, Poland: Instytut Wschodni Uam.
16. Dobkin de Rios, M. (1984). *Hallucinogens: Cross cultural perspectives*. Albuquerque, NM: University of New Mexico.
17. Donald, M. (1991). *Origins of the modern mind*. Cambridge, MA: Harvard University Press.
18. Dunbar, R. (2014). *Human evolution: A pelican introduction* [Kindle iOS version]. Retrieved from Amazon.com
19. Estrada, A. (1977). *Vida de María Sabina, la sabia de los hongos* [The life of Maria Sabina, Wise woman of the mushrooms]. México: Siglo XXI.
20. Feeney, K. (2010). Revisiting Wasson's soma: Exploring the effects of preparation on the chemistry of *Amanita muscaria*. *Journal of Psychoactive Drugs, 42*(4), 499-506, doi:10.1080/02791072.2010.10400712
21. Fitzpatrick, S. (Ed.). (2018). *Ancient psychoactive substances*. Gainesville, FL: University Press of Florida.
22. Fitzpatrick, S., & Merlin, M. (2018). Introduction. Drugs from a deep time perspective. In S. Fitzpatrick (Ed.), *Ancient psychoactive substances* (pp. 1-19). Gainesville, FL: University Press of Florida.
23. Guerra-Doce, E. (2006). *Las drogas en la prehistoria: Evidencias arqueológicas del consume de sustancias psicoactivas en Europa* [Drugs in prehistory: Archaeological evidence for consumption of psychoactive substances in Europe]. Barcelona, Spain: Bellaterra.
24. Guerra-Doce, E. (2015). Psychoactive substances in prehistoric times: Examining the archaeological evidence. *Time & Mind, 8*(1), 91-112. doi:10.1080/1751696X.2014.993244
25. Guzmán, G. (2005). Species diversity of the genus *psilocybe* (Basidiomycotina, Agaricales, Strophariaceae) in the world mycobiota, with special attention to hallucinogenic properties. *International Journal of Medicinal Mushrooms, 7*(1), 305-332. doi:10.1615/IntJMedMushr.v7.i12.280
26. Guzmán, G. (2008). Hallucinogenic mushrooms in Mexico: An overview. *Economic Botany, 62*(3), 404-412. doi:10.1007/s12231-008-9033-8
27. Guzmán, G. (2009). The hallucinogenic mushrooms: Diversity, traditions, use and abuse with special reference to the genus psilocybe. In J. K. Misra & S. K. Deshmukh (Eds.), *Fungi from different environments* (pp. 256-277). Enfield, UK/Jersey, NJ/Plymouth, UK: Science Publishers.
28. Guzmán, G. (2012). New taxonomical and ethnomycological observations on psilocybe s. s. (fungi, basidiomycota, agaricomycetidae, agaricales, strophariaceae) from Mexico, Africa and Spain. *Acta Botánica Mexicana, 100*(100), 79-106. doi:10.21829/abm100.2012.32
29. Guzmán, G. (2016). Las relaciones de los hongos sagrados con el hombre a través del tiempo [The relations across time of sacred mushrooms with humans]. *Anales de Antropología, 50*(1), 134-147. doi:10.1016/j.antro.2015.10.005
30. Guzmán, G., Allen, J., & Gartz, J. (1998). A world wide geographical distribution of the neurotropic fungi, an analysis and

discussion. *Annali dei Museo civico, Rovereto, 14,* 189-280.

31. Hajicek-Dobberstein, S. (1995). Soma, siddhas and alchemical enlightenment: Psychedelic mushrooms in Buddhist tradition. *Journal of Ethnopharmacology, 48*(2), 99-118. doi:10.1016/ 0378-8741(95)01292-L
32. Harner, M. (1973). The role of hallucinogenic plants in European witchcraft. In M. Harner (Ed.), *Hallucinogens and Shamanism* (pp. 125-150). New York, NY: Oxford University Press.
33. Hillman, D. (2014). Sex, snake venom, and cult: The use of compound psychotropics by Greco-Roman priestesses. In J. Rush (Ed.), *Entheogens and the development of culture* (pp. 113-127). Berkeley, CA: North Atlantic Books.
34. Hoffman, M., Ruck, C., & Staples, B. (2002). The entheogenic Eucharist of Mithras. *Entheos, 2*(1), 13-46.
35. Hollmann, J. (1993). Preliminary report on the Koebee rock paintings of Western Cape Province, South Africa. *South Africa Archaeological Bulletin, 48*(157), 16-25. doi:10.2307/3888872
36. Hoppál, M. (2013). *Shamans and symbols prehistory of semiotics in rock art*. Budapest, Hungary: International Society for Shamanistic Research.
37. Irvin, J. (2008). *The holy mushroom: Evidence of mushrooms in Judea-Christianity. A critical re-evaluation of the schism between John M. Allegro and R. Gordon Wasson over the theory on the entheogenic origins of Christianity presented in The Sacred Mushroom and the Cross*. Grand Terrace, CA: Gnostic Media.
38. Kaplan, R. W. (1975). The sacred mushroom in Scandinavia. *Man, 10*(1), 72-79. doi:10.2307/2801183
39. Keizer, G. (2012). Hildegard of Bingen: Unveiling the secrets of a medieval high priestess and visionary. In J. A. Rush (Ed.), *Entheogens and the development of culture* (pp. 85-210). Berkeley, CA: North Atlantic Books.
40. Lajoux, J. (1964). *Le meraviglie del Tassili* [The wonders of Tassili]. Bergamo, Italy: Instituta Arti Grafiche.
41. Lhote, H. (1968). Données récentes sur les gravures et les peintures rupestres du Sahara [Recent data on the engravings and rock paintings of the Sahara]. In E. Ripall Perellá (Ed.), *Simposio de Arte Rupestre*. Barcelona, Spain.
42. Lhote, H. (1973). *A la découverte des fresques du Tassili* [The discovery of the frescoes of Tassili]. Paris, France: Arthaud.
43. Molodin, V., & Cheremisin, V. (1999). Petroglyphes de l'Age du bronze du plateau d'Ukok: A propos des representations de personages avec une coiffure fongiform [Bronze Age petroglyphs of the Ukok Plateau: About representations of personages with a fungiform hairstyle]. *Arts Asiatiques, 54*(1), 148-152. doi:10.3406/arasi.1999.1440
44. Morgan, A. (1995). *Toads and toadstools: The natural history, mythology, and cultural oddities of this strange association*. Berkeley, CA: Celestial Arts.
45. Mori, F. (1974). The earliest Saharian rock-engravings. *Antiquity, 48*(190), 87-92. doi:10.1017/S0003598X00054314
46. Munn, H. (1973). The mushrooms of language. In M. Harner (Ed.), *Hallucinogens and shamanism* (pp. 86-122). New York, NY: Oxford.
47. Navet, É. (1988). Les ojibway et l'amanite tue-mouche (amanita muscaria). Pour une ethnomycologie des Indiens d'Amérique du nord [The Ojibway and the fly agaric (*Amanita muscaria*). For an ethnomycology of North American Indians]. *Journal de la Société des Américanistes, 74,* 163-180. doi:10.3406/ jsa.1988.1334
48. Peschel, K. (1978). *Puhpohwee for the people: A narrative account of some uses of fungi among the Ahnishinaabeg*. Cambridge, MA: Botanical Museum of Harvard University.
49. Pregenzer, J., Alberts, G., Bock, J., Slightom, J., & Im, W. (1997). Characterization of ligand binding properties of the 5-HT1D receptors cloned from chimpanzee, gorilla and rhesus monkey in comparison with those from the human and guinea pig receptors. *Neuroscience Letters, 235*(3), 117-120. doi:10.1016/S0304-3940(97)00728-3
50. Rätsch, C. (2005). *The encyclopedia of psychoactive plants: Ethnopharmacology and its applications*. Rochester, NY: Park Street Press.
51. Reay, M. (1960). Mushroom madness in the New Guinea highlands. *Oceania, 31*(2), 137-1399. doi:10.1002/j.1834-4461.1960.tb00746.x
52. Rossano, M. (2007). Did meditating make us human? *Cambridge Archaeological Journal, 17*(1), 47-58. doi:10.1017/S0959774307000054
53. Rossano, M. (2009). Ritual behavior and the origins of modern cognition. *Cambridge Archaeological Journal, 19*(2), 243-256. doi:10.1017/s0959774309000298
54. Rossano, M. (2011). Setting our own terms: How we used ritual to become human. In H. Walach, S. Schmidt, & W. Jonas (Eds.), *Neuroscience, consciousness and spirituality* (pp. 39-55). Berlin, Germany: Springer.
55. Rozwadowski, A., & Kosko, M. (2002). *Spirits and stones shamanism and rock art in central Asia and Siberia*. Pozna&nacute;, Poland: Instytut Wschodni Uam.
56. Ruck, C. (2006). *Sacred mushrooms: Secrets of Eleusis*. Berkely, CA: Ronin Publishing.
57. Ruck, C. (2014). Shamanic induction of altered states for spiritual inspiration. In J. Harold Ellens (Ed.), *Seeking the sacred with psychoactive substances: Chemical paths to spirituality and to God* (Vol. 2, pp. 45-54). Santa Barbara, CA: Praeger/ABC-CLIO.
58. Ruck, C. (Ed.). (2017). *Dionysus in thrace: Ancient entheogenic themes in the mythology and archaeology of Northern Greece, Bulgaria, and Turkey*. Berkeley, CA: Regent Press.
59. Ruck, C., Hoffman, M., & González-Celdrán, J. (2014). *Mushrooms, myth, and Mithras: The drug cult that civilized Europe*. San Francisco, CA: City Lights Books.
60. Ruck, C., Staples, B., & Heinrich, C. (Eds.). (2001). *The apples of Apollo: Pagan and Christian mysteries of the Eucharist*. Durham, NC: Carolina Academic Press.
61. Rush, J. (2011). *The mushroom in Christian art: The identity of Jesus in the development of Christianity*. Berkeley, CA: North Atlantic Books.
62. Saar, M. (1991). Ethnomycological data from Siberia and northeast Asia on the effect of *Amanita* muscaria. *Journal of Ethnopharmacology, 31*(2), 157-1733. doi:10.1016/0378-8741(91)90002-U
63. Samorini, G. (1989). Etnomicologia dell'arte rupestre sahariana (Periodo delle Teste Rotonde) [Ethnomycology of Saharan rock art (Round Head Period)]. *Bollettino Camuno Notizie, 6*(2), 18-22.
64. Samorini, G. (1990). Sciamanisma, funghi psicotropi e stati alterati di coscienza: Un rapporto da chiarire [Shamanism, psychotropic fungi and altered states of consciousness: A report to be clarified]. *Bollettino Camuno Studi Preistorici, 25/26,*

147-150.

65. Samorini, G. (1992). The oldest representations of hallucinogenic mushrooms in the world (Sahara desert, 9000-7000 BP). *Integration, 2*(3), 69-78.
66. Samorini, G. (1998). The pharsalus bas-relief and the Eleusinian mysteries. *The Entheogen Review, 7*(2), 60-63.
67. Samorini, G., (2012). Mushroom effigies in world archaeology: From rock art to mushroom-stones. In D. Spasova (Ed.), *Proceedings of the Conference "The Stone Mushrooms of Thrace"* (pp. 16-42). Alexandroupoli, Greece: Greek Open University.
68. Schultes, R. (1966). The search for new natural hallucinogens. *Lloydia, 29,* 297.
69. Schultes, R., Hofmann, A., & Rätsch, C. (1992). *Plants of the gods: Their sacred, healing and hallucinogenic powers*. Rochester, VT: Healing Arts Press.
70. Schultes, R., & Winkelman, M. J. (1995). The principal American Hallucinogenic plants and their bioactive and therapeutic properties. In M. J. Winkelman & W. Andritzky (Eds.), *Sacred plants, consciousness and healing: Cross-cultural and interdisciplinary perspectives*. Yearbook of cross-cultural medicine and psychotherapy (Vol. 5, pp. 205-240). Berlin, Germany: Verlag.
71. Schurr, T. (1995). Aboriginal Siberian use of amanita muscaria in shamanistic practices: Neuropharmacological effects of fungal alkaloids ingested during trance induction, and the cultural patterning of visionary experience. *Curare, 18*(1), 31-65.
72. Sobiecki, J. (2017). Psychoactive initiation plant medicines: Their role in the healing and learning process of South African and Upper Amazonian traditional healers. In D. McKenna (Ed.), *Ethnopharmacological search for psychoactive drugs* (pp. 175-180). London, UK: Synergetic Press, Ltd.
73. Stamets, P. (1996). *Psilocybin mushrooms of the world*. Berkeley, CA: Ten Speed Press.
74. Stijve, T. (1997). Hallucinogenic bolets in China? *Eleusis, 7,* 33.
75. Sullivan, R., & Hagen, E. (2002). Psychotrophic substance-seeking: Evolutionary pathology or adaptation? *Addiction, 97*(4), 389-400. doi:10.1046/j.1360-0443.2002.00024.x
76. Sullivan, R., Hagen, E., & Hammerstein, P. (2008). Revealing the paradox of drug reward in human evolution. *Proceedings of the Royal Society B, 275*(1640), 1231-1241. doi:10.1098/rspb.2007.1673
77. Torres, C. (1996). Archaeological evidence for the antiquity of psychoactive plant use in the Central Andes. *Annali dei Museo civico, Rovereto, 11,* 291-326.
78. Torres, C. (2006). Los colgantes Darien. Evidencia para el uso de hongos visionarios en los Andes Septentrionales? [The Darien pendants. Evidence for the use of visionary mushrooms in the Northern Andes] *Revista Cultura y Droga, 11,* 47-62.
79. Torres, C., & Repke, D. (2006). *Anadenanthera. Visionary plant of ancient South America*. New York, NY: Haworth Press.
80. Trutmann, P. (2012). *The forgotten mushrooms of ancient Peru. Global Mountain Action*. Fungi and Mountains Publication Series: No 1. Retrieved from https://www.researchgate.net/ publication/233853675_THE_FORGOTTEN_MUSHROOMS_OF_ANCIENT_PERU
81. Velandia, C., Galindo, L., & Mateus, K. (2008). Micolatría en la iconografía prehispánica de América del Sur [Mycolatry in the pre-Hispanic iconography of South America]. *International Journal of South American Archaeology, 3,* 1-23.
82. Wasson, G. (1972*). Soma the divine mushroom of immortality*. New York, NY: Harcourt Brace Jovanovich.
83. Wasson, G. (1979). Traditional use in North America of *Amanita muscaria* for divinatory purposes. *Journal of Psychedelic Drugs, 11*(1-2), 25-28. doi:10.1080/02791072.1979.10472088
84. Wasson, G. (1980). *The wonderous mushroom: Mycolatry in Mesoamerica*. New York, NY: McGraw Hill.
85. Wasson, G., Cowan, G., & Rhodes, F. W. (1974). *Maria Sabina and her mushroom velada*. New York, NY: Harcourt Brace Jovanovich.
86. Wasson, G., Hoffman, A., & Ruck, C. (1978). *The road to Eleusis: Unveiling the secret of the mysteries*. New York, NY: Harcourt Brace Jovanovich.
87. Wasson, G., Kramrisch, S., Ott, J., & Ruck, C. (1986). *Persephone's quest entheogens and the origins of religion*. New Haven, CT: Yale University Press.
88. Winkelman, M. (1990). Shaman and other "magico-religious" healers: A cross-cultural study of their origins, nature and social transformations. *Ethos, 18*(3), 308-352. doi:10.1525/ eth.1990.18.3.02a00040
89. Winkelman, M. (1992). *Shamans, priests, and witches. A cross-cultural study of magico-religious practitioners* (Anthropological Research Papers #44). Tempe, AZ: Arizona State University.
90. Winkelman, M. (2002). Shamanism and cognitive evolution. *Cambridge Archaeological Journal, 12*(1), 71-101. doi:10.1017/ S0959774302000045
91. Winkelman, M. J. (2007). Shamanic guidelines for psychedelic medicines. In M. J. Winkelman & T. Roberts (Eds.), *Psychedelic medicine: New evidence for hallucinogenic substances as treatments* (Vol. 2, pp. 143-167). Westport, CT: Praeger/Greenwood Publishers.
92. Winkelman, M. J. (2009). Shamanism and the origins of spirituality and ritual healing. *Journal for the Study of Religion, Nature and Culture, 3*(4), 458-489. doi:10.1558/jsrnc.v3i4.458
93. Winkelman, M. J. (2010a). *Shamanism: A biopsychosocial paradigm of consciousness and healing* (2nd ed.). Santa Barbara, CA: ABC-CLIO.
94. Winkelman, M. J. (2010b). The shamanic paradigm: Evidence from ethnology, neuropsychology and ethology. *Time and Mind: The Journal of Archaeology, Consciousness and Culture, 3*(2), 159-181. doi:10.2752/175169610X12632240392758
95. Winkelman, M. J. (2010c). Evolutionary origins of ritual. In A. Michaels (Ed.), *Body, performance, agency, and experience* (pp. 331-349). Wiesbaden, Germany: Harrassowitz Verlag.
96. Winkelman, M. J. (2011). A paradigm for understanding altered consciousness: The integrative mode of consciousness. In E. Cardeña & M. J. Winkelman (Eds.), *Altering consciousness multidisciplinary perspectives: Volume 1. History, culture and the humanities* (pp. 23-44). Santa Barbara, CA: Preager ABC-CLIO.
97. Winkelman, M. J. (2013). Shamanism and psychedelics: A biogenetic structuralist paradigm of ecopsychology. *European Journal of Ecopsychology, 4,* 90-115.
98. Winkelman, M. J. (2014a). Shamanic consciousness and human evolution. In J. H. Ellens (Ed.), *Seeking the sacred with psychoactive substances: Chemical paths to spirituality and god* (Vol. 1, pp. 129-155). Santa Barbara, CA: Praeger/ ABC-CLIO.

99. Winkelman, M. J. (2014b). Evolutionary views of entheogenic consciousness. In J. H. Ellens (Ed.), *Seeking the sacred with psychoactive substances: Chemical paths to spirituality and god* (Vol. 1, pp. 341-364). Santa Barbara, CA: Praeger/ABC-CLIO.
100. Winkelman, M. J. (2015). Shamanism as a biogenetic structural paradigm for humans' evolved social psychology. *Psychology of Religion and Spirituality, 7*(4), 267-277. doi:10.1037/rel0000034
101. Winkelman, M. J. (2017a). Mechanisms of psychedelic visionary experiences: Hypotheses from evolutionary psychology. *Frontiers in Neuroscience, 11,* article 539. doi:10.3389/fnins.2017.00539
102. Winkelman, M. J. (2017b). Shamanism and the brain. In N. K. Clements (Ed.), *Religion: Mental religion*. MacMillan Interdisciplinary handbooks (pp. 355-372). Farmington Hills, MI: MacMillan Publishers.
103. Winkelman, M. J. (2018). An ontology of psychedelic entity experiences in evolutionary psychology and neurophenomenology. *Journal of Psychedelic Studies, 2*(1), 5-23. doi:10.1556/2054.2018.002

Mushroom-Trees in Christian Art

by

Giorgio Samorini

Eleusis, n.s., 1:87-108, 1998

© 1998, Giorgio Samorini

original source: https://www.samorini.it/doc1/sam/sam-alberifungo-1998.pdf
backup source: http://www.psilosophy.info/resources/sam-alberifungo-1998.pdf

Summary: In this article, various examples of the so-called "mushroom-trees" to be found in early and medieval Christian art works from a number oj churches in Tunisia, central France and other regions of Europe are presented and discussed. The author makes it clear that the works of art presented here are considered from the point of view of the possible esoteric intention of the artists in their inclusion of the mushroom motif This paper, based on the most recent research, reaches two main conclusions. Firstly, the typological differentiation among the "mushroom-trees" of these works would appear due to a natural variation among psychoactive mushrooms. Secondly, on the basis of analysis of the works in question, a call is made for a serious and unprejudiced ethnomycological study of early Christian culture.

In an article published in the previous issue of this magazine, I presented a discussion of the mushroom-tree in the famous frescos of the Romanesque chapel of Plaincourault in the province of Indre in central France (SAMORINI 1997).

During a visit in May 1997, I was able to examine the frescos of the chapel (and also note their state of deterioration). Here, we find the scene of the Temptation with its mushroom-tree - painted by the Knights of the Order of Malta on their return from the Crusades.

By way of summary of my earlier article, I observed that the Plaincourault mushroom-tree is to be found in the scene of the Temptation from the book of Genesis. It appears between Adam and Eve, with a serpent coiled around it - in its mouth the fruit it offers to Eve.

According to the historian of Christian art, Erwin Panofsky (cf. WASSON 1969: 179-180) this type of tree - which resembles a mushroom and which, for this reason, is termed *Pilzbaum* ("mushroom-tree") in German - is widespread (above all, in Romanesque and early Gothic) Christian art. It has been considered the schematic representation of a conifer (the "umbrella pine") and there are hundreds of examples illustrating the gradual transformation from the naturalistic forms of the pine to the more schematic "umbrella-tree", hence to the various forms of mushroom-tree.

Toward the beginning of this century, a French mycologist put forward the hypothesis that the Plaincourault mushroom-tree was a representation of *Amanita muscaria*, the well-known psychoactive mushroom with its white-spotted red cap. If this is the case, the esoteric content of the Temptation would appear evident - i.e. identification between the Tree of Knowledge of Good and Evil and a mushroom capable of producing visionary states and "illumination".

After a hurried visit to the chapel in Plaincourault and, above all, after consulting the art historian Panofsky, R. G. Wasson categorically denied the validity of the interpretation offered by the French mycologist and supported and propagated by his followers. In his essay on Soma (1968: 179-180), Wasson, the father of modern ethnomycology, after citing Panofsky's comment, stated " it would have been better if the mycologists had consulted the art historians".

Closer examination of the facts reveals that, in a footnote in his *Mushrooms, Russia and History*, Wasson had already stated even more forcefully that "The Plaincourault fresco does not represent a mushroom and has no place in a discussion of ethno-mycology. It is a typical stylized Palestinian tree, of the type familiar to students of Byzantine and Romanesque art" (WASSON & WASSON 1957, 1:87).

As I have already noted on a previous occasion (SAMORINI 1997) and as the evidence I present here would suggest, Wasson's conclusion may be considered premature. However, it must be remembered that, according to J. OTT (1997), Wasson was unable to advance research into the Plaincourault "case" on account of his fundamental research and discoveries in Mexico and concerning the Vedic *soma*. Nevertheless, I feel this hardly justifies his hasty dismissal of this idea.

I might add that Wasson's probable "oversight" does not in any way diminish the credibility or stature of the father of modern etnomycology. I stress this point because the direction I have taken in my studies has as its starting point the trail blazed for mycologists by Wasson's critical works.

With the premise that the problem of interpretation of the evidence consists in establishing the intention of these artists to represent the mushroom symbol as part of the esoteric content of their work, we may now consider a detailed description of the evidence.

In the Plaincourault mushroom-tree form (fig. 1), we may note the following details: 1) the semispherical foliage or fronds is similar to the cap of a mushroom and is studded with spots (in this case, whitish on an ochre background); 2) two of lateral ramifications join the frond-cap from below and symmetrically in relation to the main trunk of the tree. These two ramifications may be intended as a means of representing the three dimensions of the tree with a serpent coiled around its trunk. From the mycological angle, however, these ramifications might represent the membranes enveloping mushrooms of the family of the Amanitaceae at the early stages of development. This membrane then breaks when the cap broadens out and separates from the stalk; 3) the roundish fruit of the tree is, here, held in the mouth of the serpent as it offers it to Eve; 4) along and around the base of the main trunk we have ramifications which are also very similar to mushrooms in form surmounted by "caps" upon which once more we may note whitish spots. I have also studied a number of other mushroom-trees characterized by the same four iconographic features found at Plaincourault.

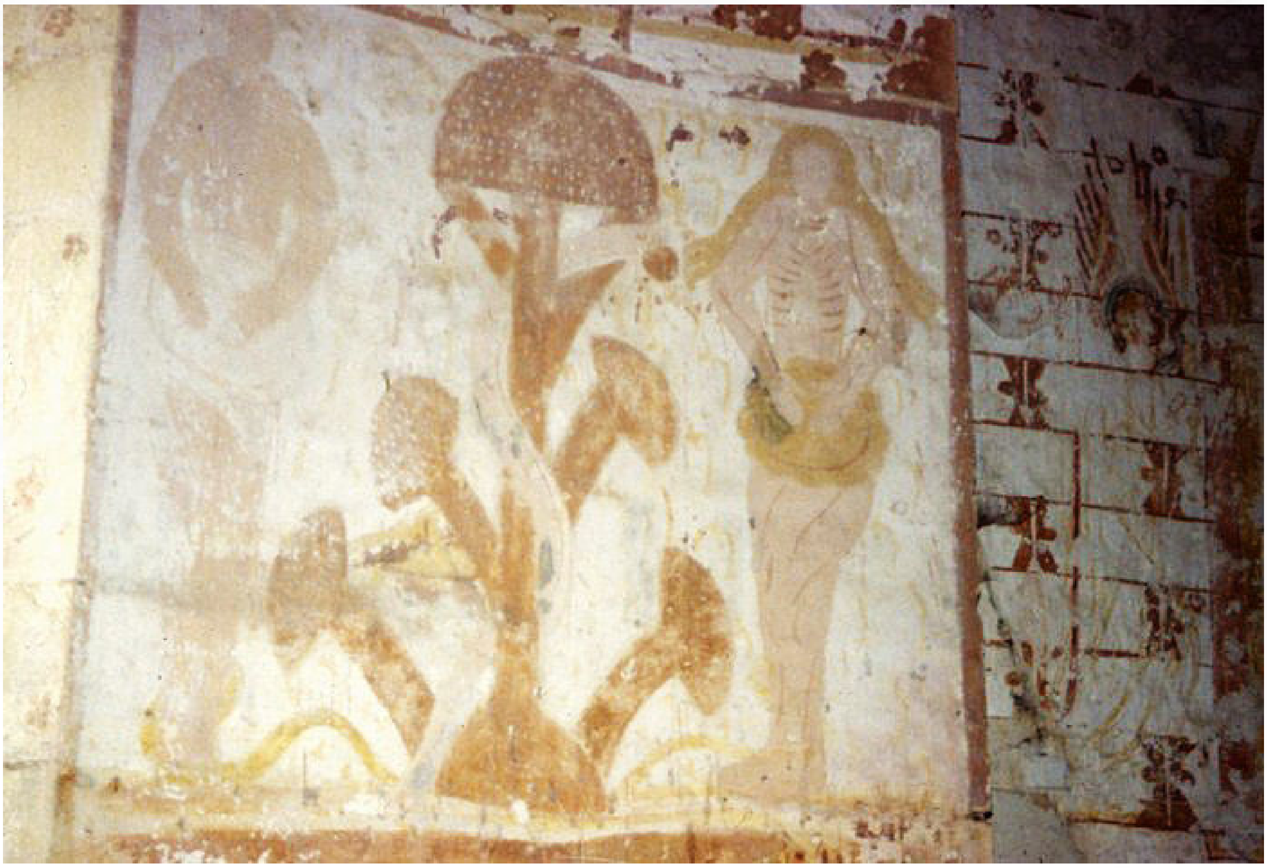


Fig. 1 - Plaincourault Chapel, Indre, central France. Fresco of the Temptation. End of the 12th century AD.

Two examples are to be found in 4th and 5th century B.C. Tunisian mosaics. In Tunisia during the centuries of Roman domination (I st-4th centuries B.C.) there was a flourishing tradition of well-crafted mosaic work of considerable artistic value. This tradition was continued in the mosaic floors of the first Christian churches (FANTAR 1995).

The mosaic in fig. 2 decorates the baptistry of the *henchir* Messaouda in the Tunisian region of Sfax. lt probably dates back to the 5th century a.c., and here we have an iconographic scheme which was fairly widespread and of very ancient origin: two animals symmetrically placed beside the Tree of Life.

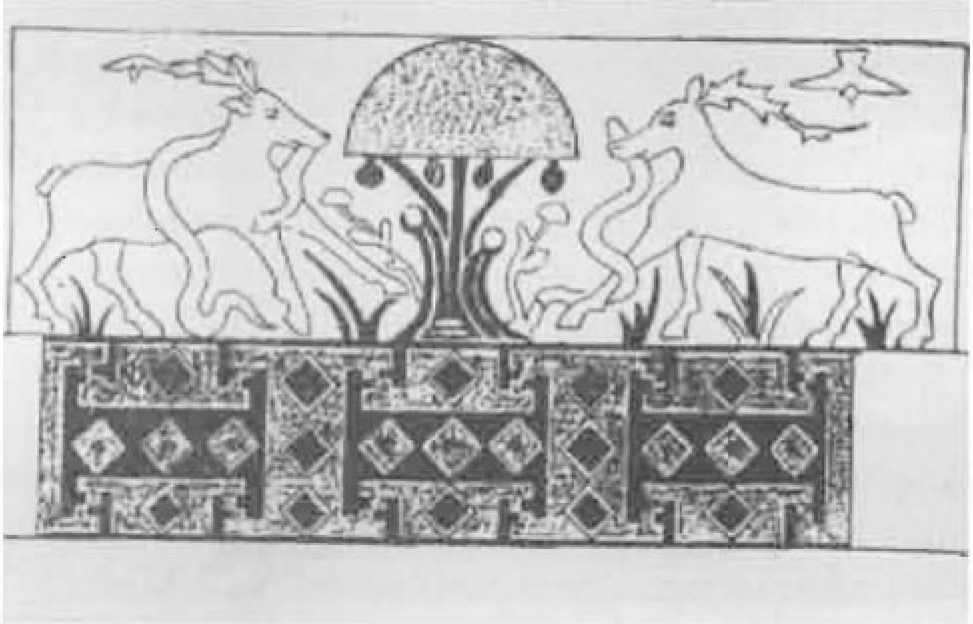


Fig. 2 - *Henchir* Messaouda, Sfax, Tunisia. Baptistry mosaico V century a.C (From PUECH 1949)

The first representations of this arrangement date back to Sumerian art of the 3rd millenium B.C. The two animals are generally of the same species; they are horned wild animals or quadrupeds (above all, Cervidae) or birds. The object placed between them is the Tree of Life. A typical example is the two wild animals beside the sacred tree Horn (Haoma) of Persian art. Simi/ar representations exist, such as a Plant of Life, a recipient containing the Water of Life, a Tree of Life from the foot of which rivers of the Water of Life spring forth (usually, four rivers are represented), or even a column (as in the famous "Door of Lions" at Mycene surmounted by two lions rampant upon a column). Sometimes the two animals feed on the Tree of Life or drink from the Chalice or the springs of the Water of Life. This variant is probably c1osest to the original iconographic scheme. This artistic scheme originates in the Middle East and spread to much of the Old World including North Africa as it underwent local stylistic modifications. According to FANTAR (1995: 107), the Phoenicians brought it to Africa, where it passed into the hands of the Romans.

The Tree of Life is the element most subject to stylistic variation, from the most realistic to the most imaginative. The palm-tree is one of the most widespread types. It may be more or less realistic, or represented by a single palm leaf the size of a tree. A further common type in the Mediterranean basin is the conifer-tree, sometimes represented quite simply by a pine cone. The mushroom-tree, which appears to derive from the conifer tree, seems to be less widespread than the other two types mentioned here.

Christianity was one of the last and most important means by which the artistic scheme of the two animals and the Tree of Life spread. The two most frequently adopted animals were two lambs or two fishes. The *Cantharos* (chalice) of the Water of Life or the Cross gradually took the place of Tree of Life. The esoteric meaning of the scene also changed, as CHARBONNEAU-LASSAY (1997: 54) has pointed out: "When, in the iconography of the first centuries of Christianity, two fish or animals surround an emblem, this always directly represents Jesus Christ; and the animals which accompany Christ are the symbolic representation of the Christian faithful". With the transformation of the Tree of Life into a Cross we therefore have an identification between the Tree and Christ. The Water of Life, placed in the *Cantharos*, and which flows from the Tree of Life becomes more and more closely identified with Christ's blood.

On further examination of the Messaouda mosaic, we may note that the two animals are deer, both of which are savaging a serpent. The deer savaging a serpent is also an iconographic scheme of pre-Christian origin. This motif is associated with the belief, record ed by writers in antiquity, that deer were fierce foes and persecutors of serpents (cf. CHARBONNEAU-LASSAY 1994; see "Deer", l:XXX; PUECH 1944). The tree placed between the two animals is a mushroom-tree of the same kind as that found at Plaincourault and it is endowed with the same four characteristics mentioned above, namely, 1) the cap-shaped fronds, with many spots; 2) the two lateral ramifications of the main trunk joining the frond; 3) the round fruits (here, hanging from the frond) and; 4) the fungoid protruberances at the foot of the tree. In the upper right corner of this scene we may note a dove, a widespread feature of Christian art with a great variety of meanings.

The same artistic scheme is featured in another 4th century A.D. Tunisian mosaic (fig. 3; cf. FANTAR 1955: 107) from Carthage, now in the *Bardo Museum* in Tunis. This mosaic was discovered in a Roman house and not in a Christian church. Not only do we find the main pair of animals, two lions, but also other pairs, hares and birds (probably doves) in the upper half of the scene, these two symmetrically arranged around the tree. The tree is rendered fairly realistically and, indeed, it might be considered a conifer-tree, despite the presence of the four characteristics of the Plaincourault and Messaouda mushroom-trees which ascribe it to this type of representation. The Carthaginian mosaic tree would appear to be midway between conifer-tree and Pl a incourault-type mushroom-tree. If this is the case, it might be considered a (pre-Christian) prototype of this mushroom-tree.

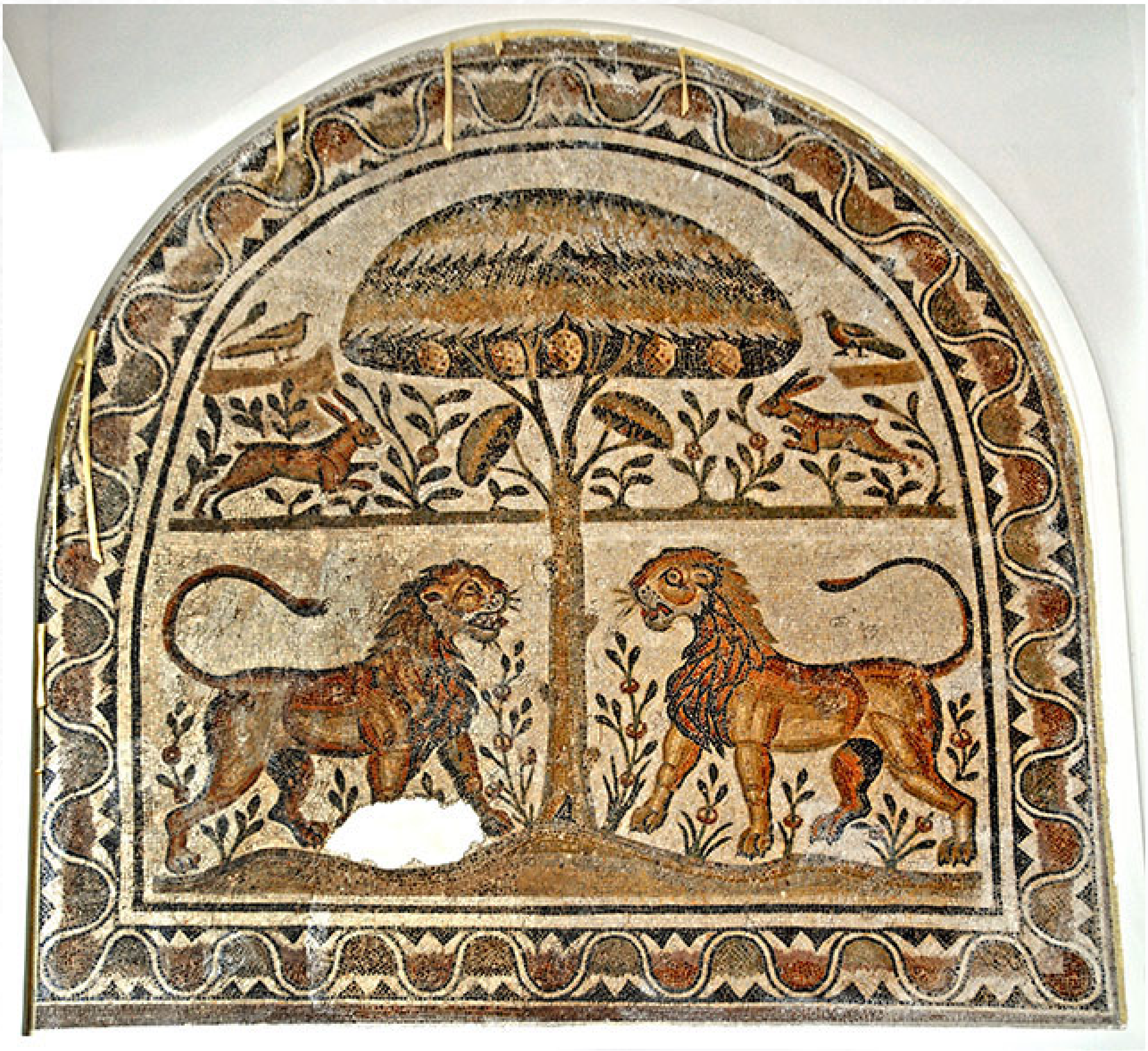


Fig. 3 - Mosaic from a Roman house. Carthage, Tunisia. 4th C AD

The fruits of the Carthage mosaic tree are represented with the characteristics of a cone, and this is the main detail which provides the identity of conifer. Art historians, including Panofsky (cf. WASSON 1968: 179), believe this conifer-tree form corresponds to *Pinus pinea*, the "umbrella pine", a common Mediterranean pine (cf. fig. 4). This conclusion is probably correct for the Carthaginian mosaic and any number of other examples of conifer-tree, but less appropriate for the Plaincourault and Messaouda mushroom-trees and others which I shall mention shortly. We should also bear it in mind that the mycological interpretation does not rule out the dendrological (pine) interpretation, or vice versa, given the ecological association between conifers and certain species of mushrooms, notably *Amanita muscaria*.

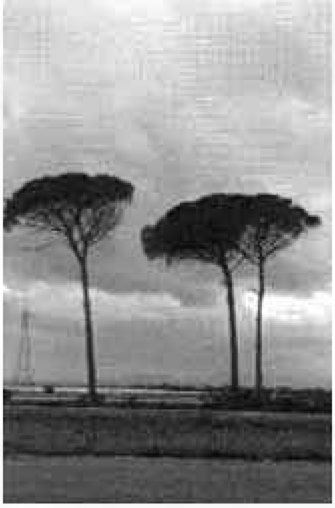


Fig. 4 - "Umbrella pine" (*Pinus pinea*)

We also find another kind of mu shroom-tree in Tunisia. This is from the *henchir* Ounaïssia (6th-7th century), at the moment housed in the Museum of Sbeitla (fig. 5, cf. FANTAR 1995:229). We might consider this scene a transition stage in an iconographic scheme which is only slightly different from that of the two animals symmetrically placed beside the Tree of Life; it might be considered a variant of a scheme which also originates in the Middle East and dates back to remotest antiquity. Here we have the two animals and *three* Trees or Plants of Life which are usually the same as each other, one between the two animals and the other two behind them. A fine example comes from the Mycenean gold ring in fig. 6, in which three trees or plants are combined with two quadrupeds, apparently steinboks. During the last stage of absorption of this artistic scheme in Christian art (i.e. its full transformation into a "truly" Christian symbol) we may note the recurring image of the two animals combined with one or more crosses. As we have already indicated, the Trees of Life become the symbol of the Cross, once Christianized, and the three parts constituting many examples of a certain type of Tree of Life (e.g. in the Mycenean ring) become the three upper components of the Cross, the various stages of the "crucifixion" of the Tree of Life become evident in paleo-Christian art.

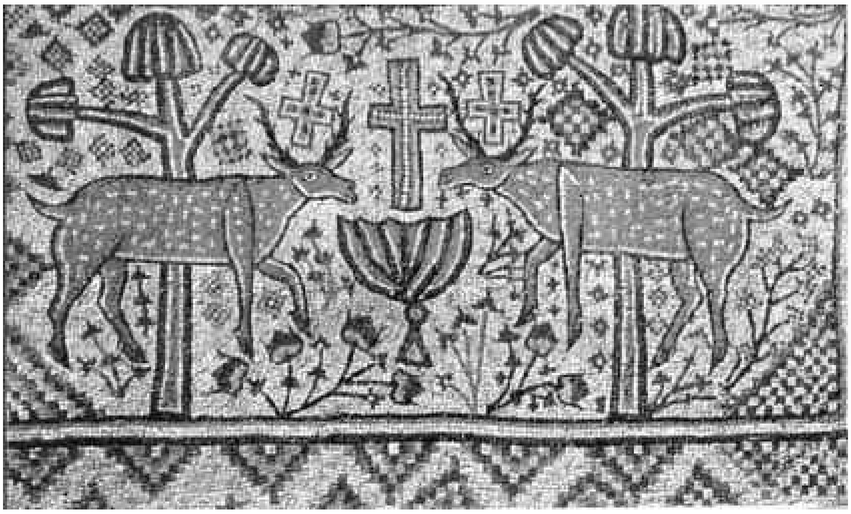


Fig. 5 - Mosaic from the henchir Ounaïssia. Tunisia. 6th-7th C AD

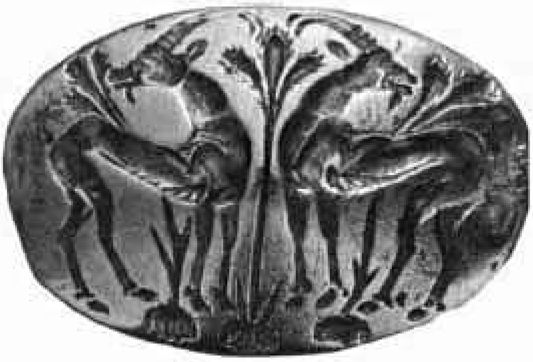


Fig. 6 - Mycenean gold ring

The Ounaïssia mosaic represents a stage in the transition of this iconographic scheme: the two animals are symmetrical1y placed and are once more two (ochre-coloured and white-spotted) Cervidae; the tree placed between the animals has already completed its transformation into a "cross", and, below it, there is a *Cantharos* containing the Water of Life (at this stage, perhaps already considered the blood of Christ). We may also note that the other two Trees of Life, placed behind the animals, have not yet been fully 'crucified'. These two trees are mushroom-trees of a different kind than the Plaincourault one. Both feature the three cap-like fronds and, upon these, vertical lines have been traced which we may consider "striations".

In another 5th-6th century mosaic from the Béja region in Tunisia, housed in the *Bardo Museum* in Tunis (fig. 7, cf. FANTAR 1995:92-3), we find a mushroom-tree similar to the Ounaïssia example. This mosaic represents a Greek mythological scene in which Achilles receives instruction from Chiron, the wisest of the Centaurs, on deer-hunting. A Chimera is presented in the lower left corner. Achilles and Chiron are surrounded by four plants of the same shape, and on careful observation we may consider them mushroom-trees. Probably for reasons of space, three of these are composed of two mushrooms but the fourth has three. Each of the frond-caps presents lines in various colours which remind us of the "striations" encountered in the Ounaïssia mushroom-trees. Some of these lines overlap the lower edge of the frond-cap. This kind of mushroom-tree has been called "tree with medusa-shaped frond" (RIOU 1992). Mycologically speaking, these overlapping lines recall the filaments which adorn the edges of the caps of various species of psychoactive and non-psychoactive *Panaeolus*-type mushrooms.

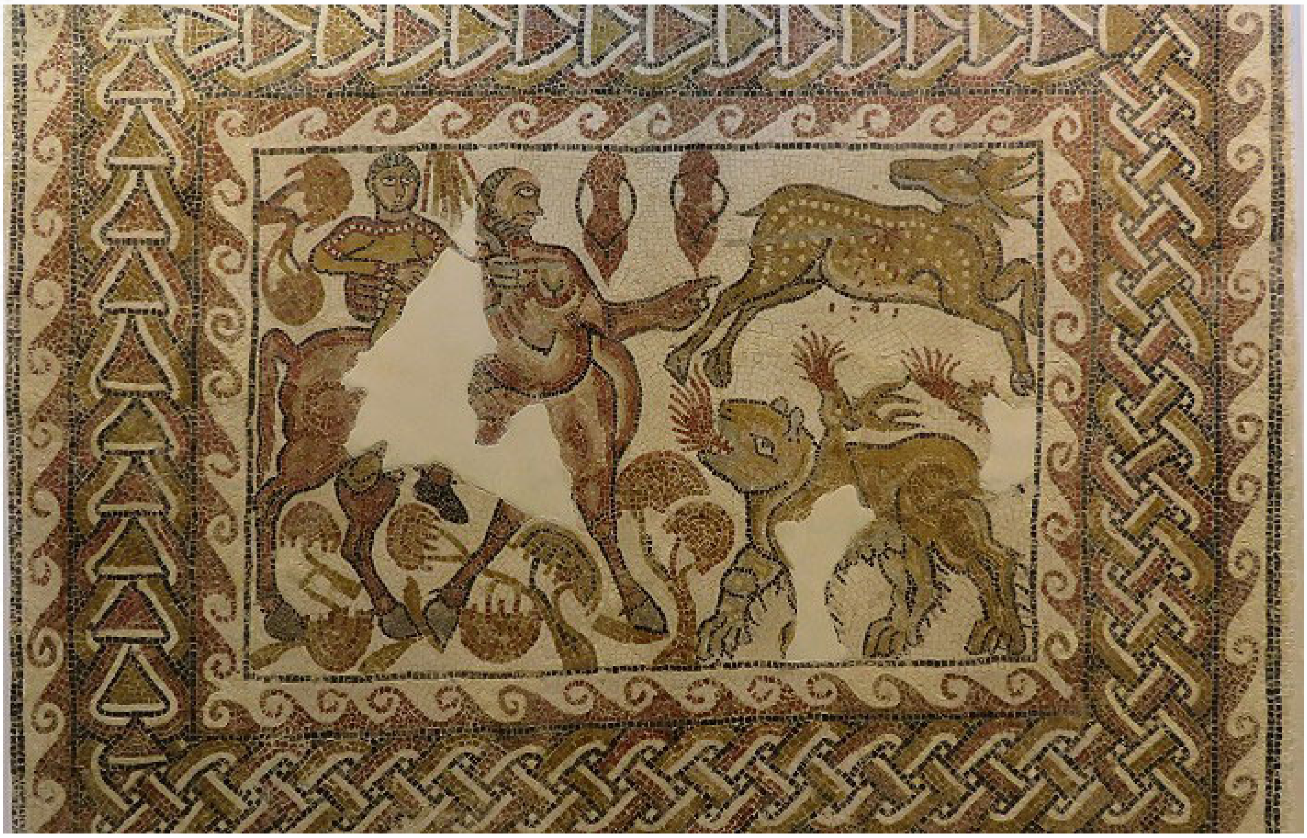


Fig. 7 - Roman mosaic, Béja, Tunisia. 5th-6th C AD

In fact, ROBERT GRAVES associated the mythological figure of the Centaur with psychoactive mushrooms in his essay *Food for Centaurs* (1960, cf. 1994). However, the arguments he used were unthorough and perhaps a bit fanciful. FANTAR (1995: 92) comments on the Béja mosaic, the work of Christian artists who revived pagan symbols and mythologies, and stresses the point that it dates back to a period of heresy and fratricide due to struggles among various groups of Christians.

We find mushroom-trees which are similar to the Ounaïssia examples in a fresco dating back more or less to the same period as the Plaincourault mushroom trees, and from the same area (central France). This fresco is in the Abbey of Saint-Savin-sur-Gartempe (fig. 8) in the province of Vienne, about 40 kilometers from Poitiers and only 9 kilometers from Plaincourault. The Abbey's frescos are among the most highly admired works of French Romanesque art. They are dated *circa* 1100, about 80 years before the Plaincourault frescos and, like these, are of the Haute-Poitou Romanesque Style (OURSEL, 1994).

Fig. 8 - Abbey of Saint-Savin-sur-Gartempe, Vienne, central France

On the ceiling above the central nave of the church at a height of about 16 metres, there are some scenes from the Old Testament. Figure 9 presents the scene of the fourth day of Creation with God placing the Sun in the firmament in the presence of two trees which could hardly be considered mere ornament. One of these is a mushroom-tree. The moon and sun are anthropomorphically depicted, each featuring a head within a medallion.

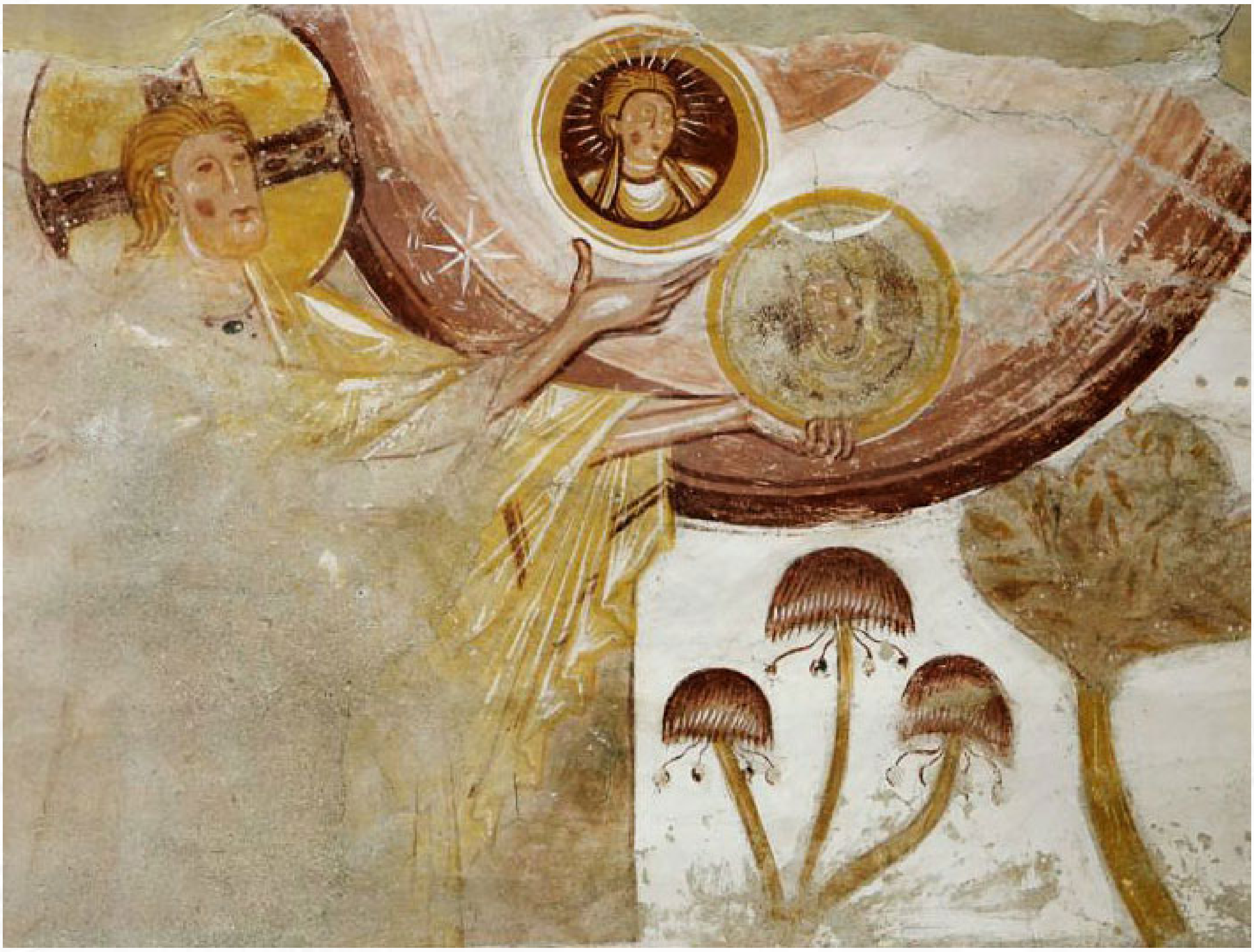


Fig. 9 - Fresco from Saint-Savin-sur-Gartempe, *circa* 1100 AD

In the same fig. 9 we see part of the preceding scene (which has somewhat deteriorated) depicting the third day of Creation - the day of the creation of vegetation. Here, we see two trees of two types (one, a mushroom tree) which are also like the ones on the right. A third tree of the same kind is depicted elsewhere among the nave frescos next to the scene of Moses in the presence of the Pharaoh (RIOU 1992:35). We should also bear in mind that the Saint-Savin-sur-Gartempe frescos include many other trees which also have a fairly tall trunk which is often above a sort of ring. The trunk spreads out to form a number of branches, generally three, and some branches terminate with a compact trilobate frond. A number of these trees spring from a small conical base or mound which might represent a mountain (RIOU 1992). H has been suggested that the pictorial cycle of Saint-Savin-sur-Gartempe contains stylistic influences of the Byzantine art of northern Italy (cf. LABANDE-MAILFERT 1974). The mushroom-trees are all the same. They have a large trunk encroaching downwards upon the lower scenes of the same wall, as we may note in the detail provided (fig. 10). These trees are also similar to the Ounaïssia mushroom-trees. Here too, they present three mushrooms with striated "caps".

Scholars have termed this kind of vegetation "mushroom-tree", or even " tree with medusa-shaped frond" (RIOU 1992). Alternatively, it has been defined "mushroom-shaped flowers" (THOUMIEU 1997: 134). ELEMIRE ZOLLA (1979) seems to have no hesistation at alias to the inspiration of the Saint-Savin-sur-Gartempe mushroom-trees: they are hallucinogenic mushrooms, "symbols of the divine, and of exceptional powers".

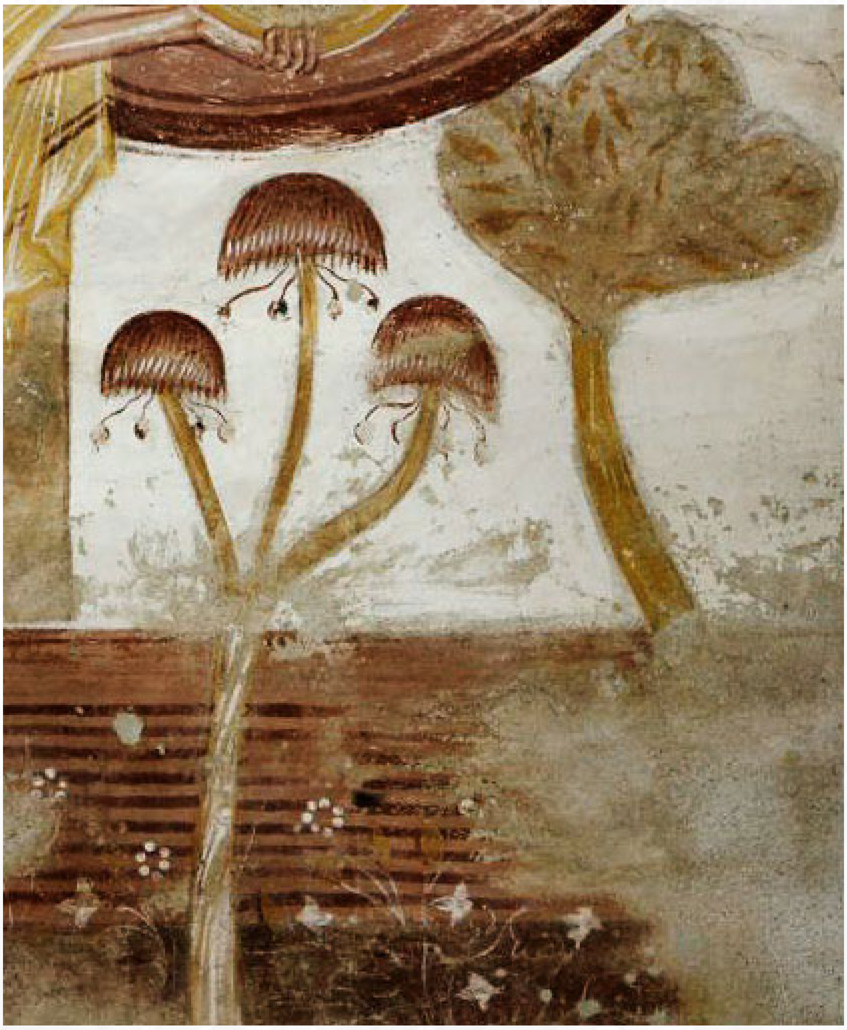


Fig. 10 - Fresco from Saint-Savin-sur-Gartempe (detail)

As stated above, in reference to the mushroom-tree from the Béja mosaic (fig. 7), the striations hanging over the "frond" are very similar to the fringes on the caps of various species of *Panaeolus*. These striations are more a feature of mushrooms than trees; very many mushrooms present these striations, some of which are psychoactive. In fact, the mushroom striations are caused by the juncture between the gills and the cap (see fig. 11). The four cirrous adornments under each cap terminate with a small round object which might symbolize the fruit of the mushroom-tree.

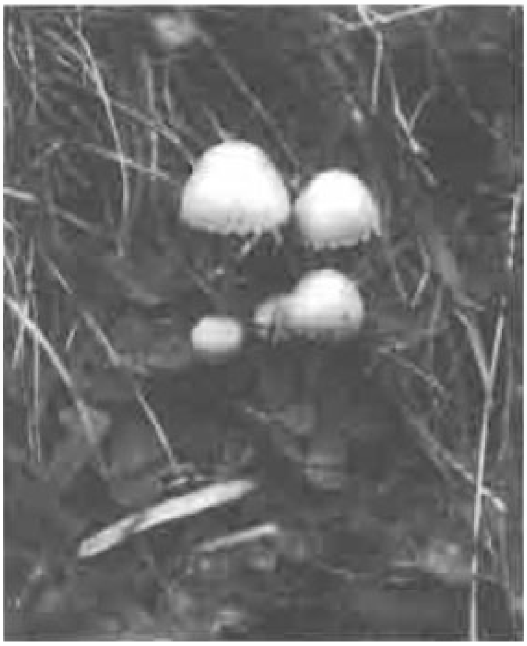


Fig. 11 - *Panaeolus* sp.

In fig. 12, we see the frontispiece of a German edition of the *Carmina Burana*. This edition is dated to the early 12th century and is housed in the Munich *Staatsbibliolek*. Various types of tree are depicted; they are quite bizarre, although they do have a common source: the large group of artistic forms which developed in the Mediterranean from the Greek period on (GRABAR & NORDENFALK 1958). One of these trees, which is very small, in the middle of the top half and upon which a bird perches, is a mushroom-tree of the Saint-Savin type, made up of three mushrooms with striated caps.

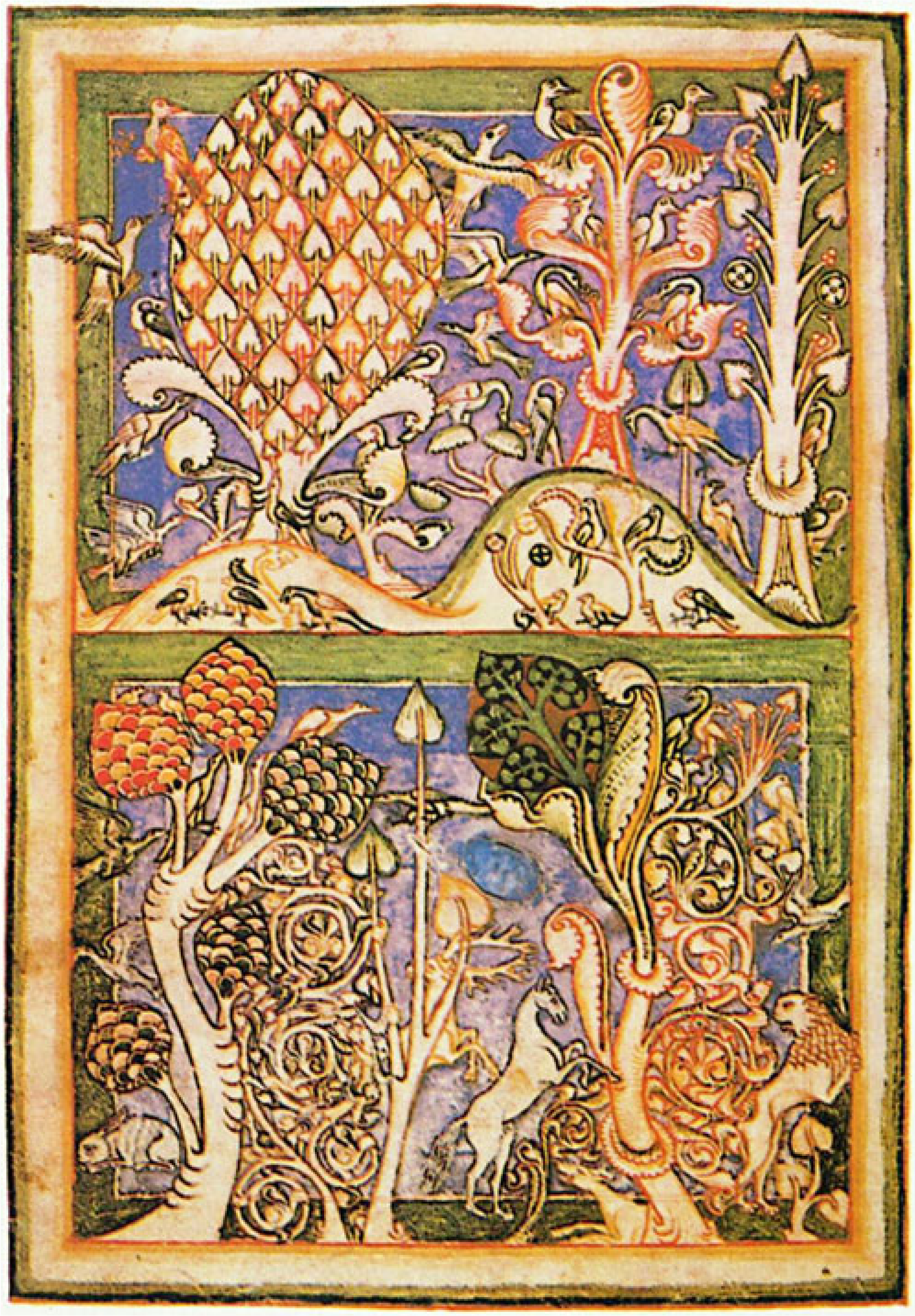


Fig. 12 - Frontespiece of a German edition of the *Carmina Burana*. 13th C AD (from GRABAR & NORDENFALK 1958)

As Panofsky notes (in WASSON 1968: 179), there are many mushroom-trees in Romanesque art (more than I present here). Apart from the types described above, there are others the styles of which are derived from local variants and individual imagination. One example is the mushroom-tree in the magnificent frescos in the small church in Vic (fi g. 13), once more in central France in the Berry region some 80 kilometers from Plaincourault (fig. 13). These 12th century frescos are the work of an anonymous artist, as are most of the works I present here. They therefore follow the Saint-Savin works, which are themselves only slightly earlier than the Plaincourault frescos. Although these frescos do not represent the Haut-Poitou Romanesque Style they are nevertheless considered part of the same artistic tradition (GRABAR & NORDENFALK 1958).

Fig. 13 - Church of Vic, Berry, central France.

As Manuel and Dona Torres pointed out to me, the scene of Jesus entering Jerusalem is presented in the upper part of the right wall of the choir (fig. 14). Christ is riding a donkey. Some people welcome Christ by laying their cloaks on the ground while others pluck flowers and leaves from the trees and offer them to him. The trees are stylized as palms in the manner of a familiar and fairly widespread typology. However, the upper part of one of the trees is quite unusual (see detail, fig. 15). It terminates with five umbrellas and may be defined a mushroom-tree. The mushroom-like appearance is further confirmed by the concave "caps", as depicted. Here, we might say, we have a "mushroom-palm".

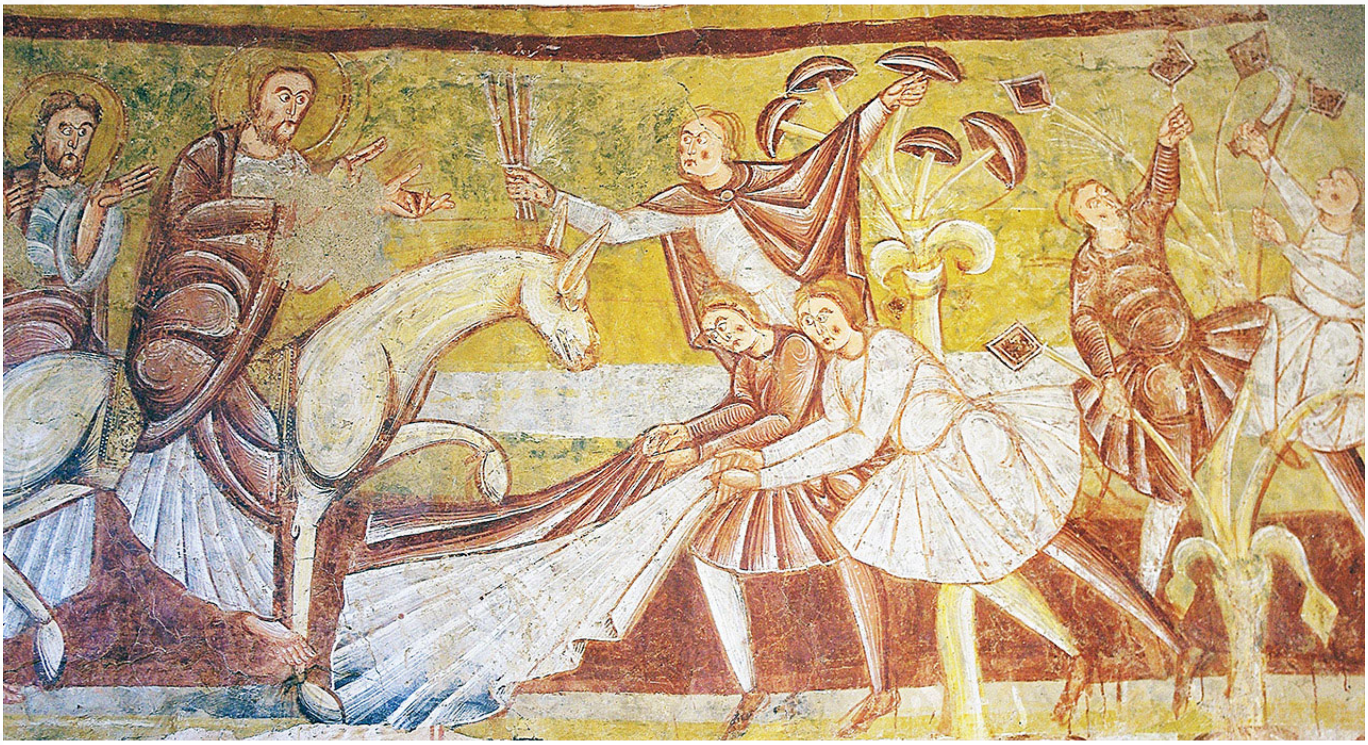


Fig. 14 - Fresco from the church of Vic. 12th C AD

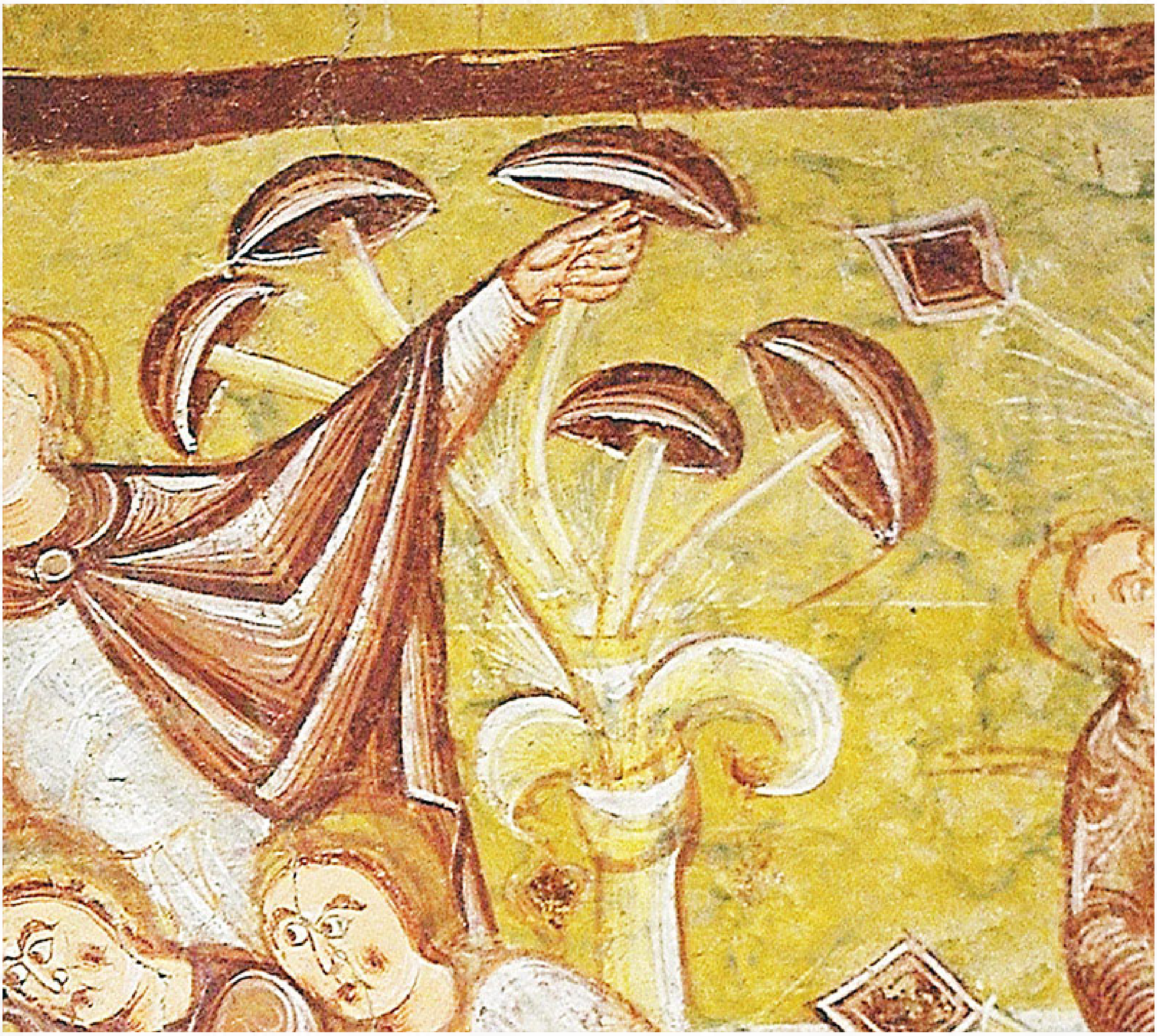


Fig. 15 - Fresco from the church of Vic (detail)

Mushroom-trees can also be found in twentieth century folk religious art which - iconographically speaking are the outcome of developments taking place in the Middle Ages or in even remoter epochs.

See, for example the Rumenian painting reproduced in fig. 16, which my Bolognese colleague Dr Guido Baldelli kindly brought to my attention. Many folk crucifixions are to be found in the houses of Rumenian farmers. During the various periods of the Middle Ages the mythological image of the Tree of Life rising out of the Cross of the Passion of Christ and extending its branches was commonly encountered, as was the belief that the Cross itself had been made out of the wood of the Tree of Life (cf., for example, COOK 1987). We note the presence of the mushroom-tree, or rather of groups of mushroom-trees springing up all over the Cross in Rumenian paintings of the kind presented here in fig. 16. The "caps" are red with white spots, like the fly-agaric. Another interesting detail is the inclusion of smaller striated caps. It would appear that this kind of painting, after centuries of reproduction, combines two different kinds of mushroom-trees which, despite all, may each be identified separately even today.

Rather than transmitting esoteric messages indicating some knowledge of psychoactive mushrooms, it is more likely that the folk artists of today are quite simply reproducing stereotyped images in pictures such as these, and are quite unaware of any mycological interpretation of their work.

However, if it is recognized that during the Middle Ages knowledge of the psychoactive properties of mushrooms stili existed, it is more likely that this was the intention in older representations. Here, the indications are few and far between, and it must also be noted that research of this kind has been very scarce indeed.

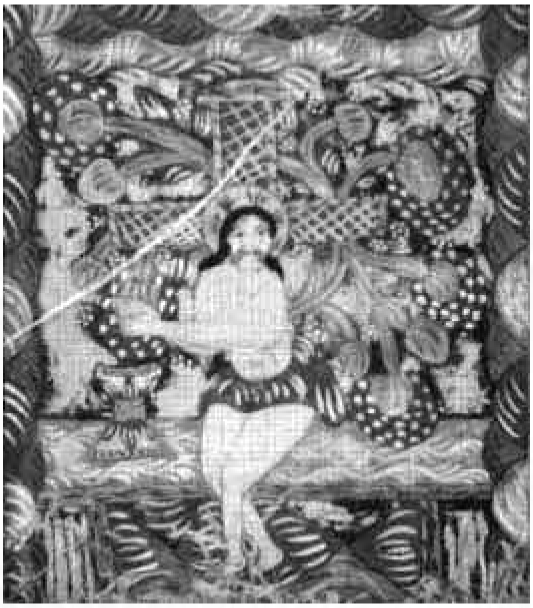


Fig. 16 - Rumenian painting. 20th C AD (photo Dr. GUIDO BALDELLI)

There are quite a few psychoactive mushrooms in Europe. Not only do we have the two species, *Amanita muscaria* and *A. pantherina* - which require conifer or birch woods in their habitat (forests which were much more common and extensive than they are today) -, we also find a few dozen species of psilocybian mushrooms including the genera *Psilocybe*, *Inocybe*, *Pluteus* and *Panaelous* (to be found both in fields and forests, on the plains and in mountainous regions) (FESTI 1985; GARTZ 1996; GUZMÁN 1983; STAMETS 1996).

While there are few ethnomycological *data* concerning the relations between these mushrooms and European peoples, the most interesting findings concern the Iberian peninsula.

JOSEP FERICGLA (1993) found traces of the use of fly-agaric in the 20th century on the southern side of the Pyrenees in Catalonia. His research shows that until the first decades of this century, *A. muscaria* was consumed (by shepherds, charcoal burners, and isolated peasants) in the remoter rural areas - and today there are those who consume it "just to get high" and no longer for reasons concerning religious life or magic.

In any case, there is a colloquial Catalán expression, *estar tocat de bolet* ("to be touched by the mushroom") referred to one acting or saying completely crazy things. This would appear to reflect once widespread knowledge of the inebriating power of certain mushrooms, above all the *oriol fol* (*falsa oronja*) or *matamosca* (*A. muscaria*) (FERICGLA 1994: 177-184). Nowadays, the Catalán expression is used without thinking about whence it came or how it derived, just as mushroom gatherers in northern Italy refer to inedible mushrooms as *funghi matti* ("crazy mushrooms"), unaware of the fact that this expression has broadened its meaning over time and once referred to certain mushrooms which "drive you mad" or which are, rather, inebriating.

Psilocybe semilanceata may be found close by in the Basque country. Although it is a mushroom with which people are familar, they are apparently unaware of its psychoactive properties; its vernacular name is *sorgin zorrotz* (BECKER 1989:243), a term which refers to the figure of the witch. 1. M. FERICGLA (1998) translates this Basque term with the Castilian term *bruja picuda*, as in *bruja que tiene pico*, literally "witch with a point", that is: witch carrying a pointed object. This brings to mind the traditional image of the witch with her pointed hat. This piece of etymological information might confirm the hypothesis that the witch's pointed hat was a representation of a psychoactive mushroom such as witches may well have consumed. Likewise, the hypothesis put forward by a number of researchers (cf., for example, CALVETTI 1986) that Little Red Riding Hood's headgear originally represented the cap of the fly agaric, as might the hoods of other woodland folk from European folk and fairy tales. In any case, the Basque term, *sorgin zorrotz* is one of the few instances recorded up to the present in which psilocybian mushrooms have perhaps not been forgotten but are stili referred to by traditional names (names of some consistency, given the allusions to which they might have).

In Aragón, bordering Catalonia, 19th century bronze medallions have been discovered, showing the devil beside what might be "hallucinogenic" mushrooms (GARI 1996).

It may be appropriate at this stage to bring up Robert Grave's recollections of a visit to Portugal: "Some years ago, I learned that a number of Portuguese witches made magic use of some varieties of mushroom and I arranged that the most famous mycologist in Europe, my friend Dr. Roger Heim, receive a sample [of these mushrooms]. If I remember correctly, they were *Panaeolus papilionaceus*. The document is in Wasson's possession" (GRAVES 1984: 132-3; cf., also, *id*. 1992: 52). Although Graves is not considered entirely trustworthy since, as we noted above, some of his interpretations are perhaps a bit fanciful, this episode bears investigation.

In Italy I recently discovered a 1880 use of *A. muscaria* apparently for pleasure in the province of Milan, in an area in which, according to folk tradition, this kind of mushroom *fa cantare* ("makes you sing") (GRASSI 1880; cf. SAMORINI 1996).

In 1990, in the journal *Nature*, Daniele Piomelli advanced the unlikely hypothesis that St. Catherine of Genoa entered a state of ecstasy after (perhaps unwittingly) consuming *A. muscaria*. PIOMELLI's evidence (1991) is a passage from the biography of this saint - who lived between the years 1447 and 1510 - in which reference is made to "Aloe epatico" (hepatic aloe) and "agarico pestato" (pounded or crushed agaric) which the biographer understands to be unpleasant-tasting preparations used as condiments by the saint in order to deny herself any pleasure in alimentation. However, as Tjakko Stijve points out, "there is no reason to believe this 'agaric' was *A. muscaria*. Fly agaric is not bitter tasting and the term 'agaric' in the 15th century was widely used to indicate *Agaricum officinale* (Vill. ex Fr.) Donk which, in its dry form, was a commodity considered beneficial. Furthermore, *A. officinale* is very bitter, but it does not act on the central nervous system" (STIJVE 1994). By way of confirmation of Stijve's conclusion, it is worth noting that even as far back as Dioscorides and Pliny, the term *agaricum* was associated with this polyporaceous mushroom (LAZZARI 1973).

JONATHAN OTT (1998: 131-2, n. 70) refers to an illustration appearing in a work on Gnosticism by RANDOLPH KURT (1987) in which, in a fragment of a Manichaean miniature, probably of French origin, the "Feast of Bema" is depicted with Mani beside the " table of God" on which there is a basket containing bread and red "sacred fruits " with white spots, like the cap of fly-agaric. WASSON also (1968: 71-6) had already stated that there may be a link between this mushroom and Manichaeism.

Turning to central and eastern Europe, we may consider Jochen Gartz's observations: "Clusius (1525-1609), the great physician and botanist, discovered the *bolond gomba* in Hungary. This mushroom was known under the German name *Narrenschwamm* ("fool's mushrooms"). It was used in rural areas, where it was processed into love potions by wise men or *javas asszony*. At about the same time, this " fool's mushroom" was documented in Slovakja as well. In addition, the mushroom found its way into the verses of Polish poet Vaclav Potocki (1625--1699), who refers to its potential for "causing foolishness much like opium does". Similarly, in England, John Parkinson's *Theatricum Botanicum* (1640) includes details about a "foolish mushroom". The Austrian colloquial expression "he ate those madness-inducing mushrooms" (*er hat verrückte Schwammerln gegessen*) refers to states of mental confusion. Historic source materials such as these are scarce and widely-scattered. Undoubtedly, they refer to psychotropic mushrooms" (GARTZ 1996:11-12).

I remember the old Croatian myth preserved in folk tales, according to which the fly-agaric springs up on Christmas night (H. Kleijn 1962; *cit. in* MORGAN 1995: 116--7).

With regard once more to mushroom-tree re presentations, we cannot be sure that the artists wished to represent psychoactive mushrooms; indeed, it is unlikely that this was the case. However, in the two examples I present below we have good reason to suspect that the artists wished to supplement the depicted scenes with an esoteric message associated with psychoactive mushrooms.

CHRIS BENNETT and LYNN and JUOY OSBURN (1995) wrote an essay on the history of Cannabis, one page of which is dedicated to *A. muscaria*. Here they present the surprising image (fig. 17) taken fro m a 14th century manuscript on alchemy from the Bodleian Library in Oxford (England). Bennet and Osburn comment as follows: "... the alchemical painting show a man intoxicated on *Amanita muscaria* mushrooms. He clutches one mushroom in his [left] hand as he dances about holding his other hand to his forehead as if the reve1ation is too intense. Behind him a tree grows with a spotted mushroom for a top" (BENNET *et al.*, 1995: 240).

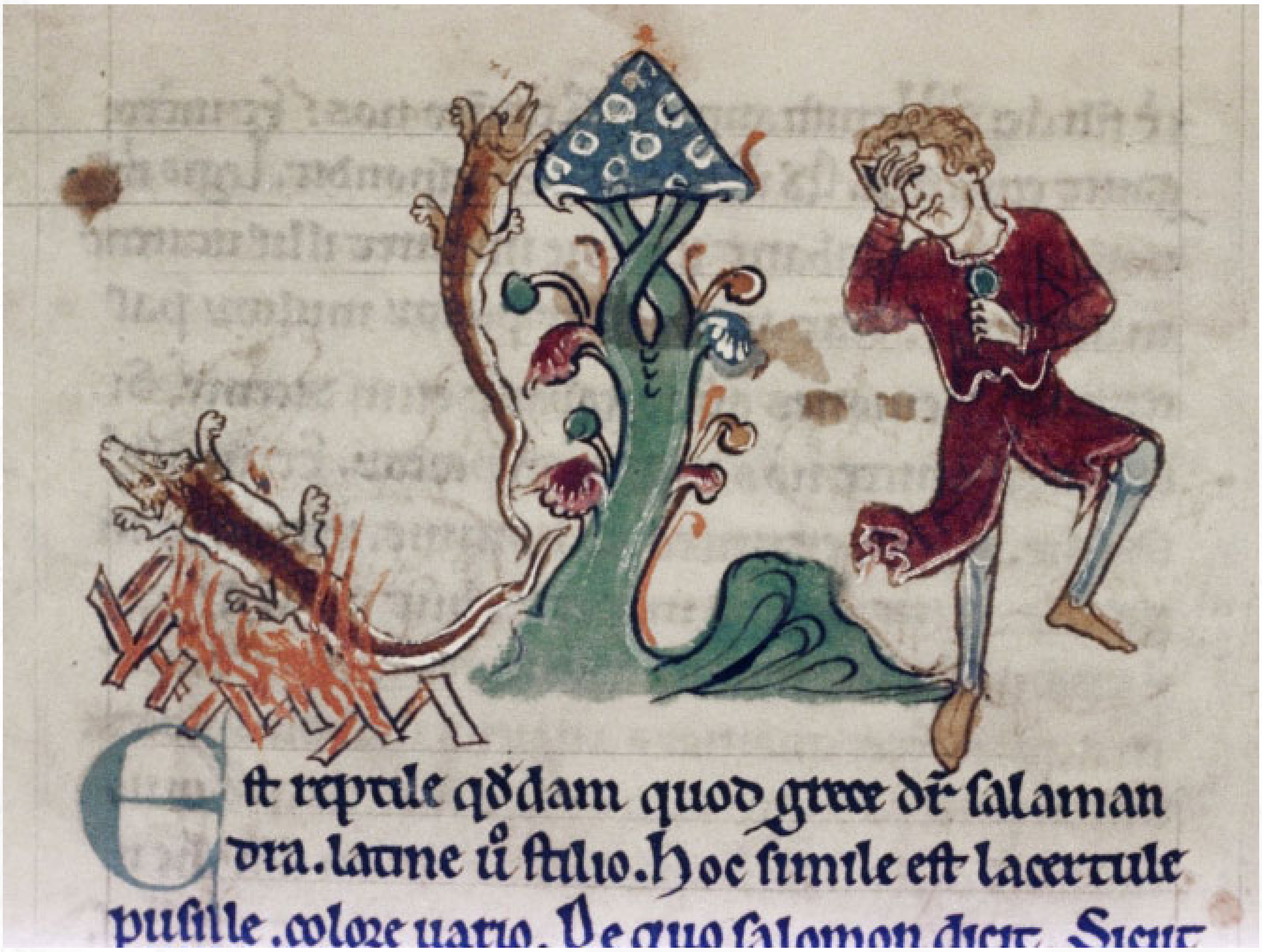


Fig. 17 - Painting from a 14th C AD alchemical manuscript (from BENNETT *et al.*, 1995:241)

The tree in question is a mushroom-tree of the Plaincourault variety. It presents the four particularities described above. The impression is that the man may be dancing; however, he may be swaying as a result of the overpowering effect of the mushroom. This latter impression is confirmed by the fact that his hand is on his forehead in the typical manner of a person in a state of mental confusion, inebriation or dizziness. These signs are characteristic of the onset of the effects of fly-agaric. If we follow this line of interpretation, and accept Bennett's and the Osburns' hypothesis that the object in the man's left hand is also a mushroom, we are justified in thinking that the author of this manuscript intended to draw the tree with the semblance of a mushroom, and not just any mushroom; it is *A. muscaria*. This very picture, which we might consider an alchemical puzzle, parts of which we are trying to uncover, includes other interesting symbols. Beside the Amanita-tree we see one salamander, and another one above a fire. Here we find the first confirmation of something I personally have suspected for some time now, and that is that the salamander in certain circles engaged in alchemical studies during the Middle Ages may have been a secret symbol for fly-agaric (due perhaps partly to the fact that the cap of the mushroom and the skin of the salamander are both maculate). The alchemical salamander, which Pliny called *animal stellatum*, is the *Salamandra salamandra* L., and is popularly known in Italy as the *salamandra pezzata* (pied salamander). According to Duccio Canestrini, "in all likelihood, on seeing salamanders coming out of damp tree trunks - their favoured habitat - to escape fire, the legend came about that these animals were incombustible" (CANESTRINI 1985:27). In ancient times it was believed that salamanders could survive in the midst of fire and would not be consumed by flames, and as time went by they became gradually more closely associated with fire.

If the hypothesis be correct that in certain alchemical circles the salamander symbolizes fly-agaric (and fig. 17 would seem. to corroborate this), the familiar symbol of the salamander above a fire might, in these circles, represent the drying of the cap of the fly-agaric. It is well known that fly-agaric must be dried before it is consumed to obtain the full effects (cf. FESTI 1990: 171).

In the mediaeval alchemical and heraldic repertory, the iconographic scheme of the salamander in the midst of flames is generally unaccompanied by other elements. However, the scene presented in fig. 18 (taken from the *Musaeum Hermeticum* of 1678) is more complex. The man appears to be moving the salamander toward the fire with his trident as though he wished to toast it. This is not the widespread allegory of the salamander which can brave the flames without getting burnt; this is instead an operation of the *Opra* depicted in the manner of an alchemical allegory (the salamander is immersed in flames due to the action of man; man is cooking it, or drying it, as one does with fly-agaric before consuming it for its inebriating effects).

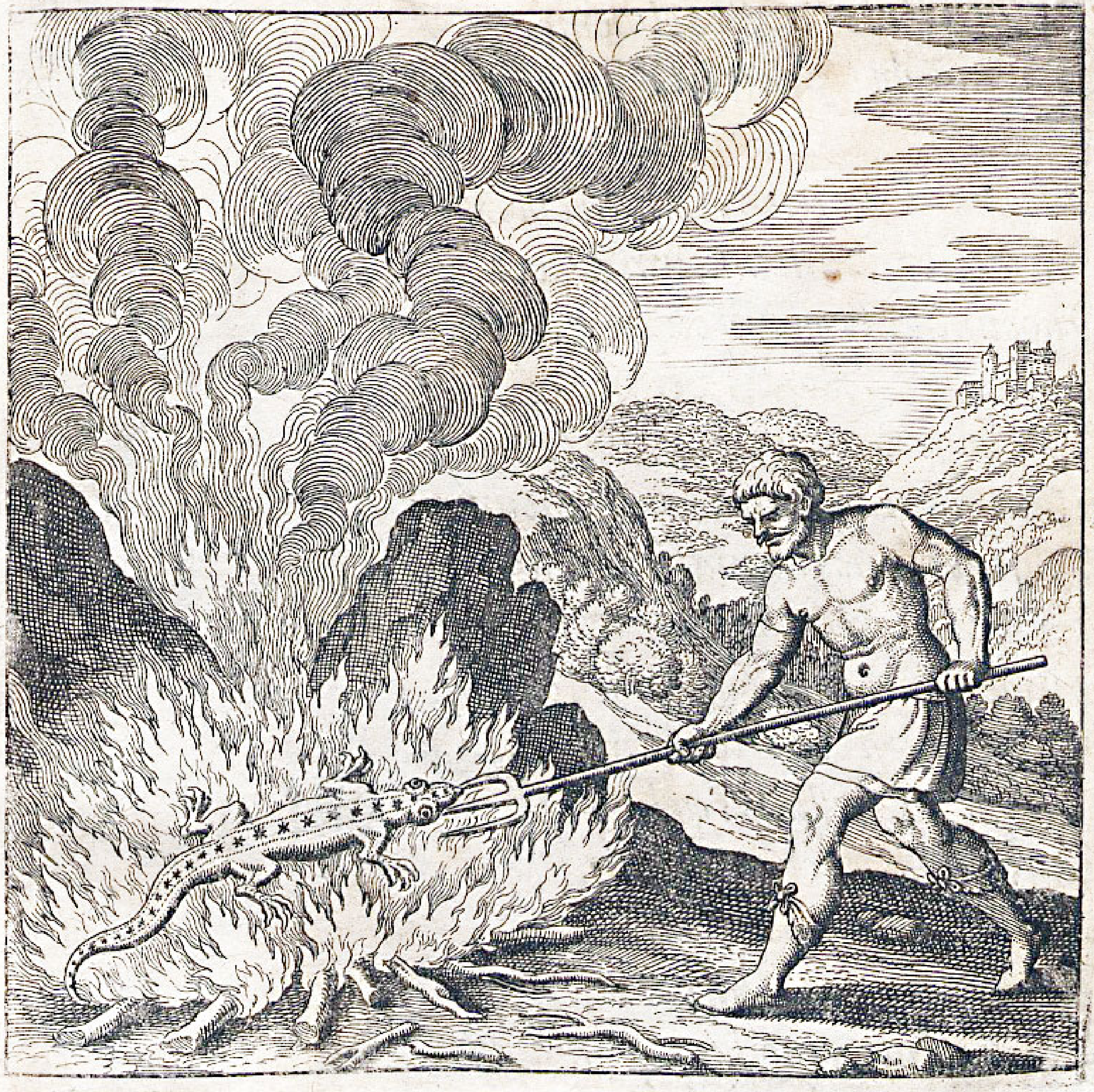


Fig. 18 - Illustration from the *Musaeum hermeticum*. 1678 AD

Actually, I well remember the extraordinary page from the well-known alchemical treatise by Salomon Trismosin, *Splendor solis* (first edition 1582), presented and discussed by CLARK HEINRICH (1994: 167-9 and table 41). In it, the winged Divine Hermaphrodite with its two heads is represented as if it were standing on only one leg. It holds two objects in its hands. These objects, given their form and color, fairly closely resemble the lower part of the cap and the ovule from which the fly-agaric grows. Furthermore, the hermaphrodite is placed in a birch forest (this is one of the few species of tree with which the fly-agaric can enter into a symbiotic relationship). According to interpretations of alchemical symbolism, certain correspondences seem to emerge surprising clearly: the relationship between the sun and moon represented by the two heads and the two different coloured wings (red and white), which the mushroom precisely represents.

The next item we shall consider was located by the German chemist JOCHEN GARTZ (1996). It is a bas-relief from the bronze doors of the cathedral in Hildesheim close to Hannover (northern Germany) by an artist named Bernward, dating back to *circa* 1020 (fig. 19).

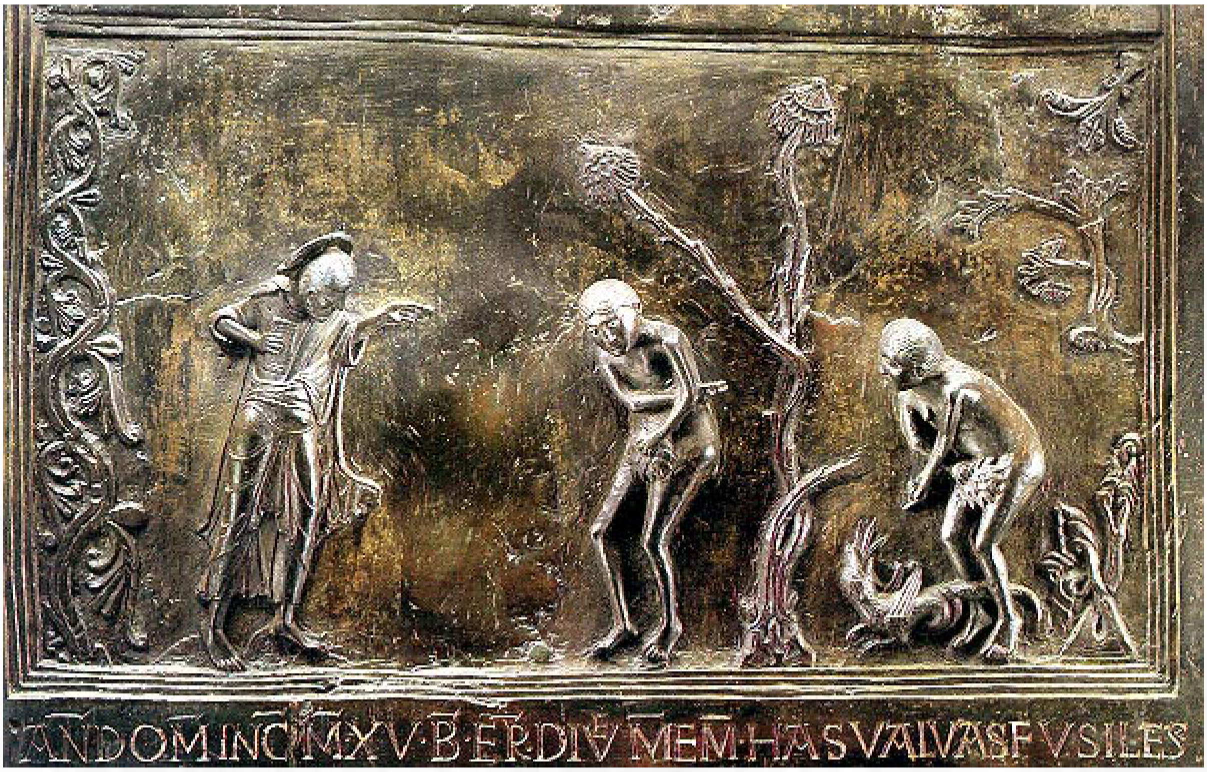

AN DOM INC MXV B ERDIV MEM HAS VALVAS FVSILES

Fig. 19 - Bas-relief of the bronze doors of the cathedral in Hildesheim, northern Germany.
Circa 1020 AD (with kind permission of JOCHEN GARTZ)

The scene following the Temptation, fairly realistically rendered, shows Adam and Eve who have already eaten the forbidden fruit. They discover their nudity, and, covering their sex with an object, perhaps leaves, they speak with God. God is asking Adam who ate the fruit, and appears to be pointing at him with His right hand. Adam covers his sex with his right hand and with the left points to Eve. She covers her sex with her right hand and with the left points at the horrendous creature writhing on the ground at her feet, the incarnation of the Tempter. There is a mushroom-tree between Adam and Eve upon which we may note two mushrooms with pointed striated caps. T'his is the "Saint-Savin" type of mushroom (three striated mushrooms). Here, the third mushroom has been consumed by Adam and Eve, as revealed by the broken branch springing from the lower part of the tree trunk. The esoteric meaning would appear to be quite clear. T'he mushroom-tree is realistically rendered with a precision not far short of anatomic accuracy and can be identified as one of the most common Germanic and European psilocybian mushroom, *P. semilanceata* (Fr.) Quél. This mushroom is endowed with a characteristic "papilla" or "papillate umbon" surmounting the cap; this seems to indicate quite clearly that the artist intended to represent precise ly this species of mushroom in his basrelief.

By way of summary, we may note that with the alchemical illustration (fig. 17) we have at least one example of the "Plaincourault" type mushroom-tree with its four characteristics as defined and, here, we are justified in our strong suspicion that the artist wished to represent a psychoactive mushroom, the mushroom in question being *A. muscaria* (or the mushroom of the same genus, *A. pantherina*). With the German bas-relief of fig. 19 we have also found at least one "Saint-Savin" type mushroom, with its three typically striated caps, and here too we are justified in strongly suspecting that the artist intended to represent a psychoactive mushroom (the mushroom in question is a psilocybian). Thus, we have discovered a precise typological differentiation among mushroom-trees in Christian art which corresponds with the variation in naturally occurring psychoactive mushrooms (cf. fig. 20).

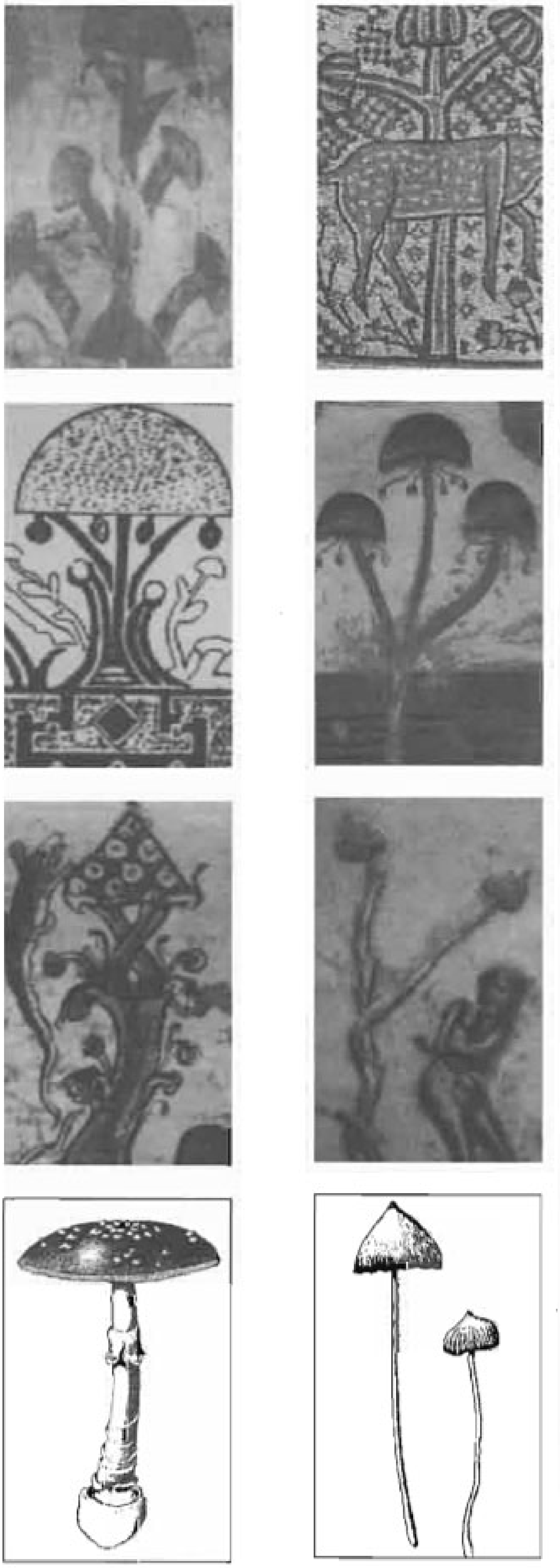
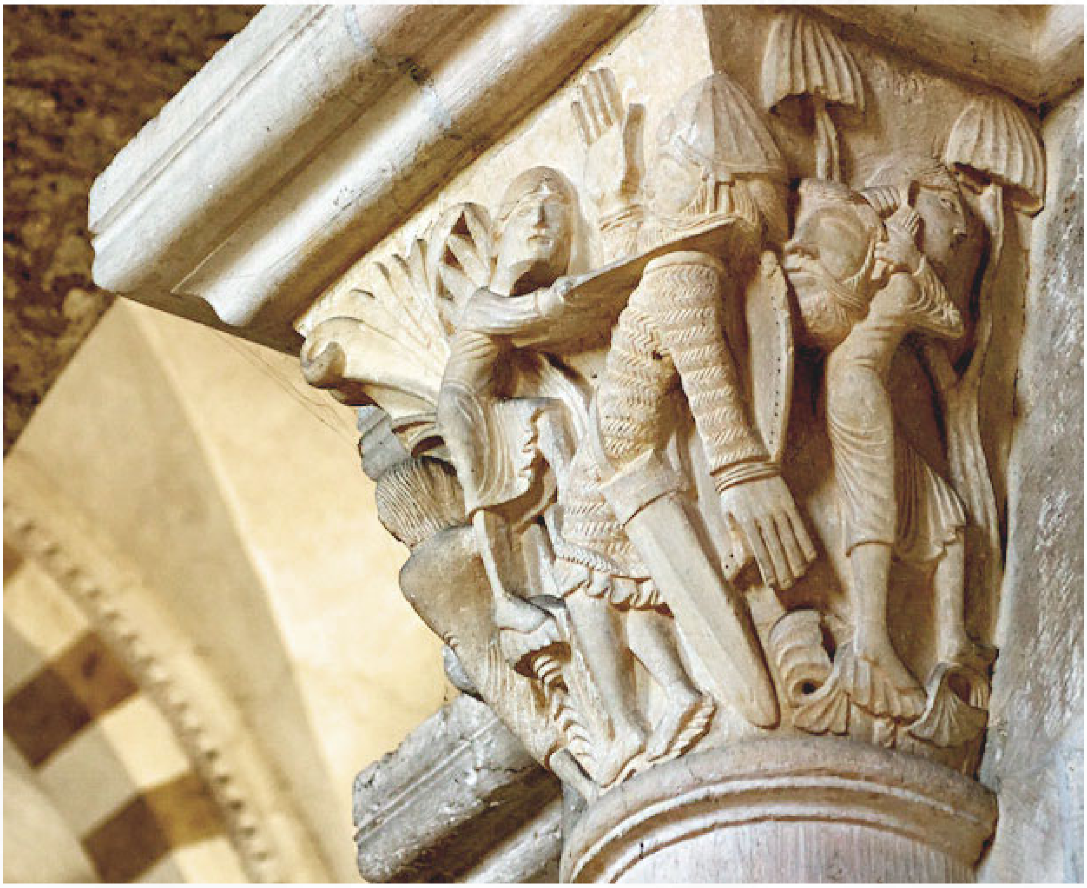


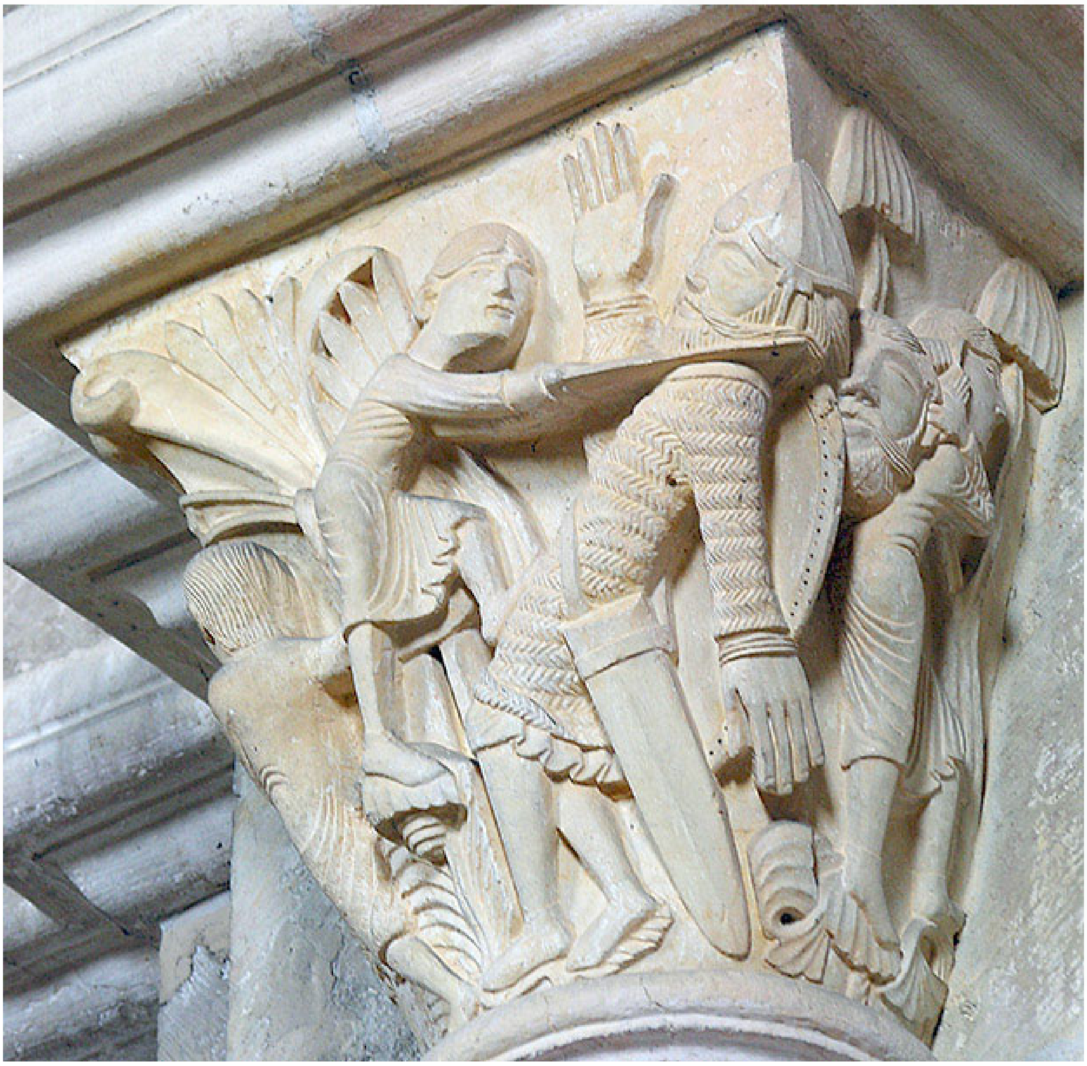
Fig. 20

I have recently identified another mushroom-tree on a capital in the famous Romanesque basilica at Vézélay (fig. 21), this too in central France. This basilica's hundred capitals dating back to *circa* 1135 are well-known and are probably the work of one sculptor.

Fig. 21 - Basilica of Vézélay, central France

In figs 22 and 23, we see capital no. 50 with scenes from the biblical account of the struggle between David and Goliath (*I Samuel*, 17). The anterior face shows David decapitating the Philistine giant with his sword; on the right side, instead, we have the next scene in which David carries the head of the giant on his shoulders as a trophy he will display to King Saul in Jerusalem. The artist sculpted a mushroom-tree by David's side in this scene and, if we look carefully, we may note that David, carrying Goliath's head, is walking on some leaves, one of which. belongs to the mushroom-tree. This mushroom-tree might be considered of the "Saint-Savin" type, given the evident striations on the caps of the mushrooms, but here we have only two. If we go back to the Hildesheim mushroom-tree (fig. 19), we will remember that, although there were two mushrooms there too, we have an explanation for the absence of a third one (which in any case existed). Here too, we are tempted to search for the third mushroom. Consider Goliath's helmet in the preceding scene. The shape and striations (grooves, or fluting) of the helmet are quite similar to those of the two mushroom caps of the mushroom-trees. If we examine one side of the capital (fig. 23) and bear in mind that it is located well above the viewer, the "illusion" created if we may cali it that - is of a mushroom-tree with three caps. Far reasons of space, artists often had to eliminate details from scenes and would not hesitate to superimpose motifs and sequences otherwise represented in chronological order and therefore separately. In the Tunisian mosaic at Béja (fig. 7), far example, we have Achilles and the centaur, Chiron. Here, three of the four mushroom-trees are without the third mushroom, probably due to lack of space.





Figg. 22 & 23 - Capital n. 50 from the basilica of Vézélay. *Circa* 1135 AD

Considering this Vézélay capital, one might also be tempted to interpret the object which can only just be seen under David's foot on the anterior face as the "third mushroom". THOUNIEU (1997:149) comments: "David is so small compared to the giant that he has to climb up a sort of plant in order to decapitate him". This plant might be taken for one of the many decorative leaf motifs which are a feature of the Vézélay stonework. But it has a stalk and can hardly be thought of as a branch or petiole, and therefore might be a mushroom. If this is the case, the esoteric message is unfolded before our eyes: to gain enough strength to decapitate Goliath (allegory of the struggle between good and evil), David must "ascend" by means of something which will "imbue" him with courage and strength. Mushrooms, the form of which is the same as that of the mushroom-tree in capital no. 50, appear in the foliage of other capitals in the same basilica. See, for example, the anterior face of capital 26 (fig. 24) representing the 4th century Bishop of Tours, St. Martin, as he preaches (he is known for his incessant efforts to convert pagans). In the middle of this scene, we find a palm tree which VIVIANE HUYS-CLAVEL (1996: 123) interprets as the "tree of the pagans" which St. Martin hurls insults at, the veneration of which St: Martin openly condemns. On the top of the palm tree we see a mushroom. Is it mere chance that a tree believed to be "pagan" should also feature a mushroom? There is something odd about this tree. Stylistically speaking, the mushroom poking out of the palm frond makes little sense; indeed, quite the opposite: it is an anomaly which seems to have been included to set this tree apart from the others and provide it with a separate meaning, as though the mushroom itself was an indication of the tree's "pagan" nature. The Vézélay master was meticulous at his job and the impression is that nothing was left to chance in these capitals. The wealth of allegorical and esoteric material in each scene is evident and, indeed, has been fully acknowledged by all scholars active in this field.

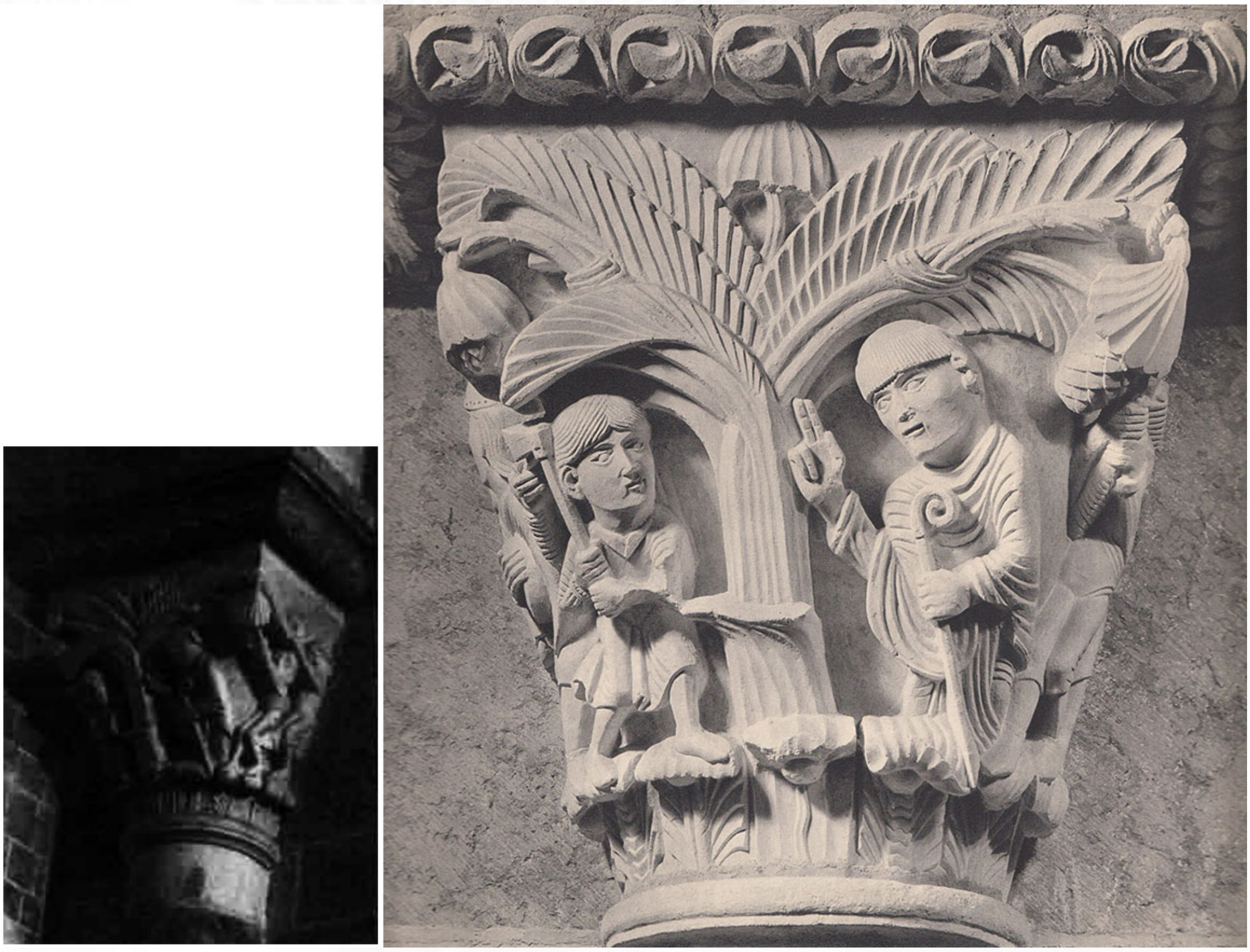


Fig. 24 - Capital n. 26 from the basilica of Vézélay. *Circa* 1135 AD

Lastly, I wish to refer to the observations made by FRANCO FABBRO (1996) on one of the mosaics of the paleo-Christian basilica of Aquileia (Fig. 25) in northern Italy (the Friuli-Venezia Guilia region). The mosaic forms part of the oldest paleo-Christian part of the basilica, known as the "*Cripta degli Scavi*", dated 314 A.D. (cf. MARINI 1994). Among the various subjects - animals, crosses, geometrie symbols - we may note a basket containing mushrooms (Fig. 26). Here, we have no mushroom-tree but mushrooms themselves, represented as such by the artist. Perhaps this is the only existing example known to us to date of the evident representation of mushrooms in an early Christian church.

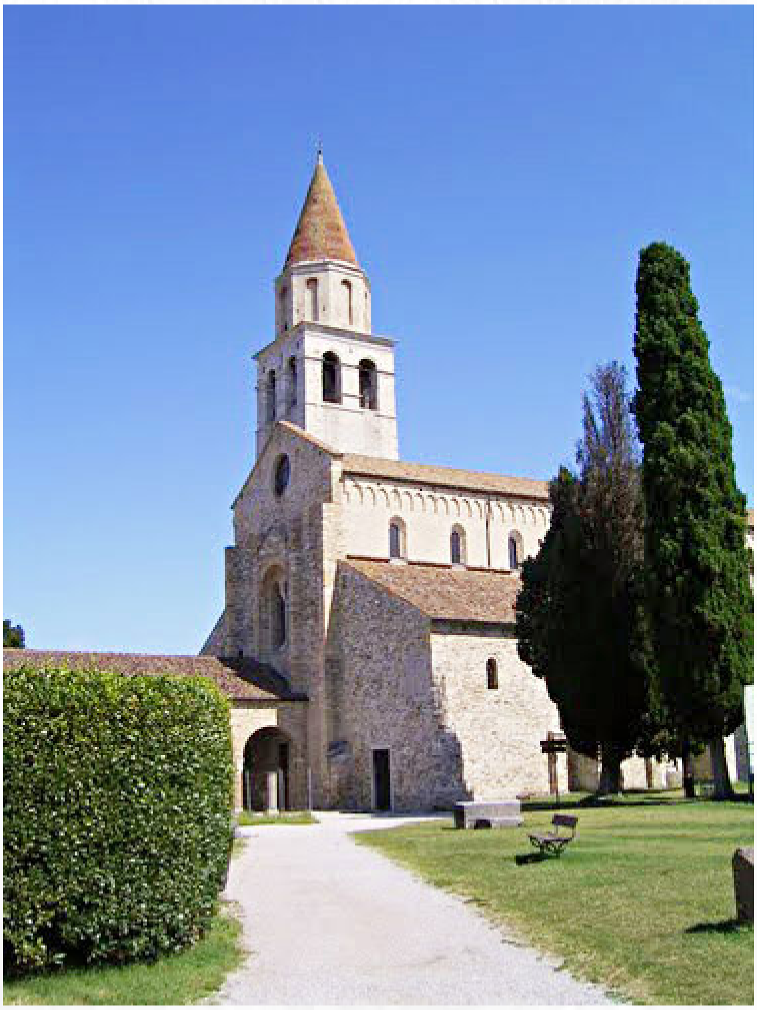


Fig. 25 - Basilica of Aquileia, Friuli-Venezia Giulia, northern Italy

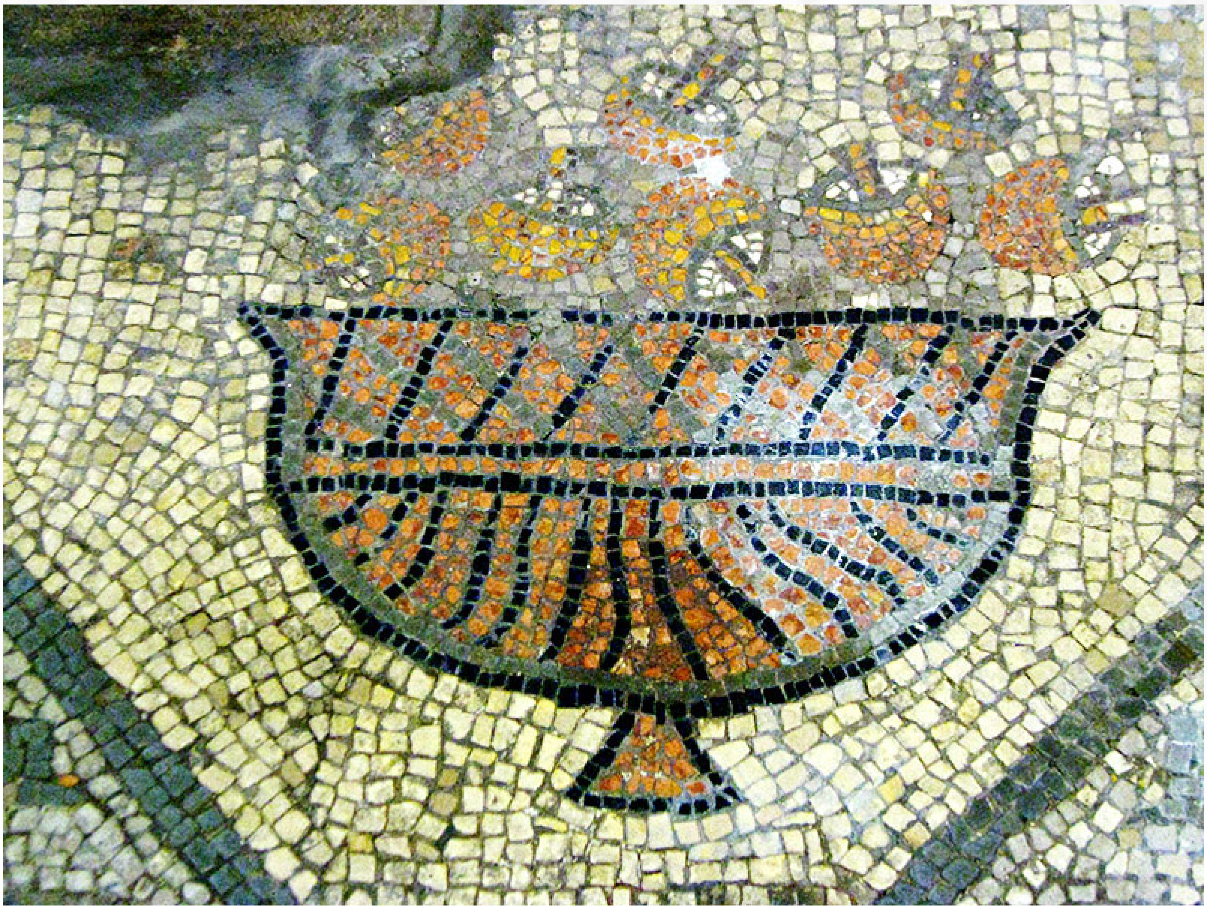


Fig. 26 - Mosaic of the "Cripta degli Scavi" from the Basilica of Aquileia (detail), 314 AD

Fabbro appears to have no doubts as to the species of mushroom presented: fly-agaric. Indeed, he is perhaps too self-assured and hasty in his conclusion that this Aquileia "find" provides corroborative evidence that the early Christians used fly-agaric. As Francesco Festi of the *Museo Civico* in Rovereto and I concluded (FESTI & SAMORINI 1997), the mushrooms represented in the Aquileia mosaic were probably *Amanita caesarea*, also known as "*ovulo buono*" (royal-agaric), an edible mushroom considered a delicacy by the ancient Romans and often included in the figurative works of the Roman imperial period. We based our view on the fact that the mushroom stalks are yellow and not white, this being one of the distinguishing marks between these two species. However, after paying a visit to the basilica I did note that the part of the mosaic corresponding to the inside of the caps, the gills, is white, as are the gills of the fly-agaric, and not yellow (as in the royal-agaric). Furthermore, while the gills of the royal-agaric are always yellow, in some cases the gills and stalk of fly-agaric present gradations of yellow (ARIETII & TOMASI 1975: 106). It was also noted that the artist had circumscribed the various areas of the mosaic to be filled in with different colours with dark-coloured fragments, which means that the wrong colour of fragment would not be able to make its way into another circumscribed zone of another colour. Therefore we may conclude that the artist wished to portray these mushrooms specifically with white gills, and that there is good reason to doubt that these mushrooms are in fact *A. caesarea*. Another feature of this mosaic is that two of the eight mushrooms have stalks which are not entirely yellow but also white.

The Aquileia mushrooms would therefore appear not to be explicitly represented as belonging either to the fly or the royal agaric species. Representation of the royal agaric would not call for subterfuge, but fly agaric would. However, this may be yet another species of mushroom or quite simply a generic "mushroom". It has been hypothesized that the mosaic represents the food (including mushrooms) the faithful consumed during agapes (mysterious ritual feasts held by early Christians) (Brusin & Zovatto 1957, *cit. in* FABBRO 1996).

I fully appreciate just how complex an investigation of this kind is, how many pitfalls await the researcher, and how easily he may be "led up the garden path". I therefore prefer not to offer my own interpretations of the various works of art presented here.

In any case, we may confidently conclude from what has emerged that justifications do exist for serious and unprejuduced ethnomycological study of early Christian culture, and it is our hope that such studies will take place.

Acknowledgements
I wish to thank the following for the aid and suggestions regarding the material presented in this arlicle: prof. Elemire Zolla (Montepulciano, SI, Italy); Francesco Festi (Museo Civico di Rovereto, TN, Italy); Dona & Manuel Torres (Florida International University, Miami, FL, USA); Dr. Guido Baldelli (Monzuno, BO, Italy); Jonathan Ott (Natural Products, Xalapa, Vér., Mexico); Josep M. Fericgla (Institut de Prospectiva Antropologica, Barcelona, Spain); Tjakko Stijve (Nestlé Research Centre, Lausanne, Switzerland); Jochen Gartz (University of Leipzig, Germany).

References

1. ARIETTI NINO & RENATO TOMASI, 1975, *I funghi velenosi*, Edagricole, Bologna.
2. BECKER G., 1989, *Setas*, Susaeta, Madrid.
3. BENNETT CHRIS, LYNN OSBURN & JUDY OSBURN, 1995, *Green Gold the Tree of Life. Marijuana in Magic and Religion*, Access Unlimited, Frazier Park, CA.
4. CALVETTI ANSELMO, 1986, Fungo Agarico muscario e cappuccio rosso, *Lares*, 52:555-565.
5. CANESTRINI DUCCIO, 1985, *La salamandra*, Rizzoli, Milano.
6. CHARBONNEAU-LASSAY LOUIS, 1994 (19.), *Il Bestiario del Cristo*, 2 voll., Arkeios, Roma.
7. CHARBONNEAU-LASSAY LOUIS, 1997, *Le Pietre Misteriose del Cristo*, Arkeios, Roma.
8. COOK ROGER, 1987, *L'Albero della Vita*, RED, Como.
9. FABBRO FRANCO, 1996, Did Early Christian used Hallucinogenic Mushrooms? Archaeological evidence, on web: www.etnoteam.it/maiocchi.
10. FANTAR H. M'HAMED (Ed.), 1995, *I mosaici romanici di Tunisia*, Jaca Book, Milano.
11. FERICGLA M. JOSEP, 1993, Las supervivencias culturales y el consumo actual de *Amanita muscaria* en Cataluña, *Ann.Mus. Civ.Rovereto*, Suppl. vol. 8:245-256.
12. FERICGLA M. JOSEP, 1994, *El Hongo y la génesis de Las culturas*, Los Libros de la Liebre de Marzo, Barcelona (originally [*missing*]
13. FESTI FRANCESCO, 1985, *Funghi allucinogeni. Aspetti psicofisiologici e storici*, LXXXVI Pubblicazione dei Musei Civici di

Rovereto, Rovereto (TN).
14. FESTI FRANCESCO & ANTONIO BIANCHI, 1991, *Amanita muscaria*: mycopharmacological outline and personal experiences, *Psyched.Monogr.& Essays*, 5:209-250.
15. FESTI FRANCESCO & GIORGIO SAMORINI, 1997, Pers.comm.
16. GARI LACRUZ ÁNGEL, 1996, La brujería y los estados alterados de consciencia, in: J.M. FericgIa (Ed.), *Actas del Il Congreso Internacional para el Estudio de los Estados Modificados de la Consciencia*, Lèrida, Octubre 1994, Institut de Prospectiva Antropologica, Barcelona,: 14-21.
17. GARTZ JOCHEN, 1996, *Magic Mushroom Around the World*, LIS, Los Angeles, CA.
18. GRABAR A. & C. NORDENFALK, 1958, *Romanesque Painting. XI-XIII Centuries*, Skira, Lausanne, Switzerland.
19. GRASSI BATISTA, 1880, Il nostro Agarico Muscario sperimentato come alimento nervoso, *Gazz.Ospit.Milano*, 1:961-972.
20. GRAVES ROBERT, 1984, *Los dos nacimientos de Dionisio*, Seix Bareal, Barcelona.
21. GRAVES ROBERT, 1992, *La Dea Bianca*, Adelphi, Milano.
22. GRAVES ROBERT, 1994, *La comida de los centauros y otros ensayos*, Madrid, Alianza.
23. GUZMÁN GASTÓN, 1983, *The genus Psilocybe*, Nova Edwigia vol. 74, Cramer, Vaduz.
24. GUZMÁN GASTÓN, 1997, Pers.comm.
25. HUYS-CLAVEL VIVIANE, 1996, *La Madeleine de Vézélay. Cohérence du décor sculpté de la nef*, Comp' Act, Chambéry.
26. KURT R., 1987, *Gnosis: the Nature and History of Gnosticism*, Harper San Francisco, New York, N. Y.
27. LABANDE-MAILFERT YVONNE, 1974, Le cycle de l'Ancient Testament à Saint-Savin, *Rev.Hist.Spir.*, 50:369-396.
28. LAZZARI GIACOMO, 1973, *Storia della micologia italiana*, Saturnia, Trento.
29. MARINI GRAZIANO (cur.), 1994, *La basilica patriarcale di Aquileia*, SO.Co.B.A., Aquileia.
30. MORGAN ADRIAN, 1995, *Toads and Toadstools*, Celestial Arts, Berkeley, CA.
31. OTT JONATHAN, 1997, *Pharmacophilia or The Natural Paradises*, Kennewick, WA, natural Products.
32. OURSEL RAYMOND, 1984, *Haut-Poitou Roman*, Zodiaque, Ab. St. Marie de la Pierre-qui-Vire.
33. PIOMELLI DANIELE, 1991, One route to religious ecstasy, *Nature*, 349:362.
34. PUECH HENRI-CHARLES, 1949, Le cerf et le serpent, *Cah.Archéol.*, 4: 17-60.
35. RIOU YVES-JEAN, 1992, *L'abbaye de Saint-Savin-sur-Gartempe*, L'Inventaire, Ministère de l'Education et Culture.
36. SAMORINI GIORGIO, 1996, Un singolare documento storico inerente l'agarico muscario / A peculiar historical document about Fly Agaric, *Eleusis*, 4:3-16.
37. SAMORINI GIORGIO, 1997, L'albero-fungo di Plaincourault/The mushroom-tree of Plaincourault, *Eleusis*, 8:29-37.
38. STAMETS PAUL, 1996, *Psilocybin Mushrooms of the World*, Ten Speed, Berkeley, CA.
39. STIJVE TJAKKO, 1994, Pers.comm.
40. THOUMIEU MARC, 1997, *Dizionario d'iconografia romanica*, Jaca Book, Milano.
41. WASSON G. ROBERT, 1968, *Soma. Divine Mushroom of Immortality*, HBJ, New York.
42. WASSON P. VALENTINA & ROBERT G. WASSON, 1957, *Mushrooms, Russia and History*, Pantheon, New York.
43. ZOLLA ELEMIRE, 1979, I funghi-bambini di Maria Sabina, *Giornale di Brescia*, Venerdì 7 Settembre.

New Data from the Ethnomycology of Psychoactive Mushrooms

by

Giorgio Samorini

Museo Civico di Rovereto, Largo S. Caterina 43, 38068 Rovereto (TN), Italy

International Journal of Medicinal Mushrooms, Vol. 3, p. 257-278 (2001)

© 2001, Giorgio Samorini

original report: https://www.samorini.it/doc1/sam/samorini-new-data-from-ethnomycology.pdf
backup source: http://www.psilosophy.info/resources/samorini-new-data-from-ethnomycology.pdf

Table of Contents:

- Abstract
- African ethnomycology
- The 'Umbrella Stones' from Kerala
- The Mount Bego rock-engraving
- The Pharsalus Bas Relief
- The 'mushroom trees' in christian art
- References

Abstract

The author presents his research on ethnology of psychoactive mushrooms developed during the last 20 years. in the core of the Sahara Desert, on a group of rock paintings, dating back to 9000-7000 B.C., mushroom effigies are represented repeated ly. The polychromic scenes of harvest. adoration, and the offering of mushrooms lead to suppose we are dealing with an ancient hallucinogenic mushroom cult. Another significant documentation refers to an old mushroom religious cult located in the Kerala State, India. It belongs to a megalithic, pre-Indoeuropean culture dating back to the 1st millennium B.C. The so-called *kuda-kallu* ("umbrella stone") may resemble a large mushroom. In Europe, an effigy of a mushroom, very likely fly agaric, inserted in a scene with shamanistic connotations, is calved on a rock engraving of Mount Bego, France, dating back to 1800 B.C. Further important archaeo-ethnomycological documentation is to be found in the Greek culture. in particular, in a 5th century B.C. bas relief from Pharsalus, the two goddesses of the Eleusinian Mysteries, Demeter and Persephone, are represented, showing each other objects, two of which have a mushroom like shape. This bas relief takes us to the very heart of the controversial issue of the Eleusinian ethnobotany. Finally, various examples of the so-called "mushroom trees" to be found in early and medieval Christian artwork from a number of churches are discussed. These works of art are considered from the point of view of the possible esoteric intention of the artists in their inclusion off the mushroom motif. The typological differentiation among the "mushroom trees" would appear due to a natura l variation among psychoactive mushrooms.

Key Words: Ethnomycology, archaeology, psychoactive or hallucinogenic mushrooms.

My contribution is focused on the research carried out on psychoactive mushrooms over the past 20 years following the pioneering work of Robert Gordon Wasson, who is considered the father of modern ethnomycology (Wasson and Wasson, 1957; Wasson 1968, 1980). The new information can be found in the Old World, Africa and Europe in particular, because these geographic areas have been looked into in any depth only since the 1980s.

The information presented in this article refers primarily to the use of psychoactive mushrooms in the past, that is, information from research carried out in the field of archaeo-ethnomycology.

The most up-to-date maps of the distribution of psychoactive mushrooms show the presence of these mycetes - psilocybians in particular - roughly throughout the world, and numbering more than 200 species.

African ethnomycology

The African continent, where the use of psychoactive mushrooms was previously unknown, reveals now what appears to be the oldest proof of the knowledge and use of this kind of vegetable; the findings are located primarily in the Sahara desert, an area where mushrooms are currently extremely rare.

Before turning into a desert, the Sahara region was cut across by rivers and lakes and was covered by a lush plant life and populated by human tribes. These peoples left behind a rich variety of rock paintings that have been preserved by the desertification and consequential dehydration of the area.

The ethnomycological documentation I have identified, also following two research trips during the 1980s, belongs to the characteristic "Round Head" period (Samorini, 1989, 1992). The absolute chronology of this pictorial epoch is still uncertain, although it is generally estimated to have been between 9000 and 8000 and 7500 and 6500 years ago. The highest concentration of rock paintings is found in Tassili (Algeria); these skillful findings can also be found in Tadrart Acacus (Libya), Ennedi (Chad), and more sporadically in Djebel Ouenat (Egypt) (Sansoni, 1994).

One of the most significant and comprehensive scenes is in a shelter in Tin Tazarift (South Tassili); it portrays a series of masked individuals lined up and in hieratic/dancing position, encircled by long and waving geometrical design festoons of various kinds, which quite likely have a very specific meaning now lost to us (Fig. 1). Each dancer is holding a mushroom-shaped object in his right hand: surprisingly, two dotted parallel lines are depicted stal1ing from the point of contact between the hand and the mushroom-like object that reach the central point above the head. Two horns then originate from this point. The double line could denote an indirect connection or an immaterial fluid passing between the object held in the hand (or the act of holding it in one's hand) and the human mind. This association fits in well with a mycological interpretation if one keeps in mind the universal mental value (often mystical-spiritual in nature) of experiences involving psychotropic mushrooms.

In a shelter in Tin-Abouteka, again in Tassili, a pattern appears at least twice connecting mushrooms with fish, a unique symbolic association among the ethnomycological type cults (Fig. 2). Two mushrooms are portrayed across from each other, and perpendicular to the fish drawings, at about the height of the caudal region. Further up, other fish can be seen, with similar features and size as the others, but without the two mushrooms at the sides.

This ethnomycological-type cult shows a certain richness in the repetition of the figures so as to suggest a definite associated conceptual structure. Two southern Tassili characters (from the Aouanrhat and Matalem-Amazar areas; Figs. 3 and 4 are such examples, both about 80 cm in height with the mask and stance typical of the period (bent legs and arms folded downwards). Another common characteristic that largely helps la identify them consists of the presence of lance-type objects that come out of the forearms and thighs, while others are grasped in the hands. In the Matalem-Amazar figure, these objects are dotted all around the outline of the body.

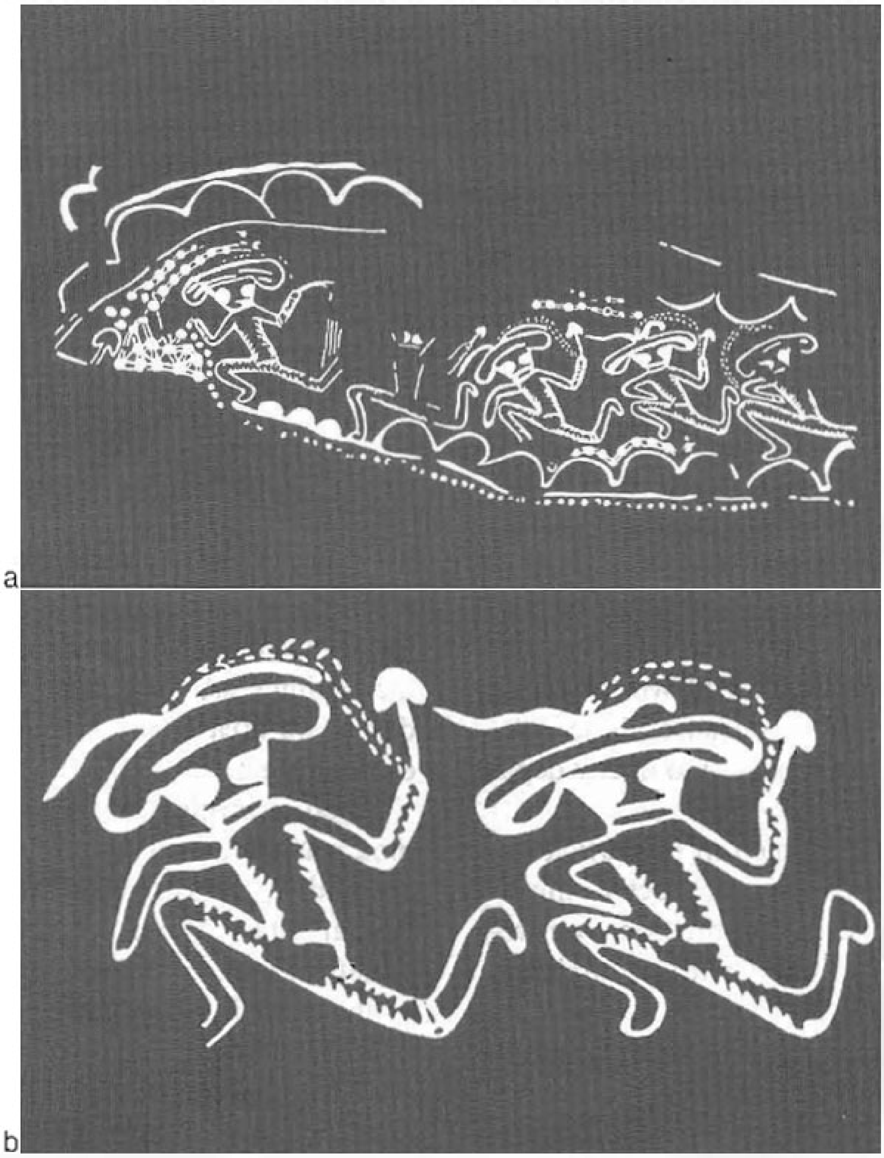


Figure 1. (**a**) Design from a prehistoric rock painting, Tin Tazarift, Tassili, Algeria; (**b**) delail.

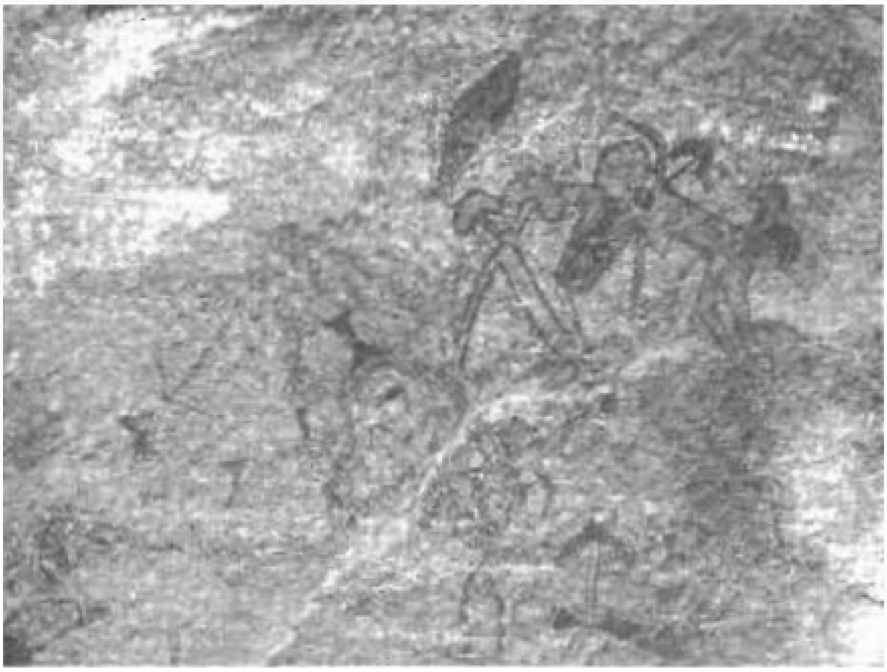


Figure 2. Rock painting from Tin Abouteka, Tassili, Algeria.

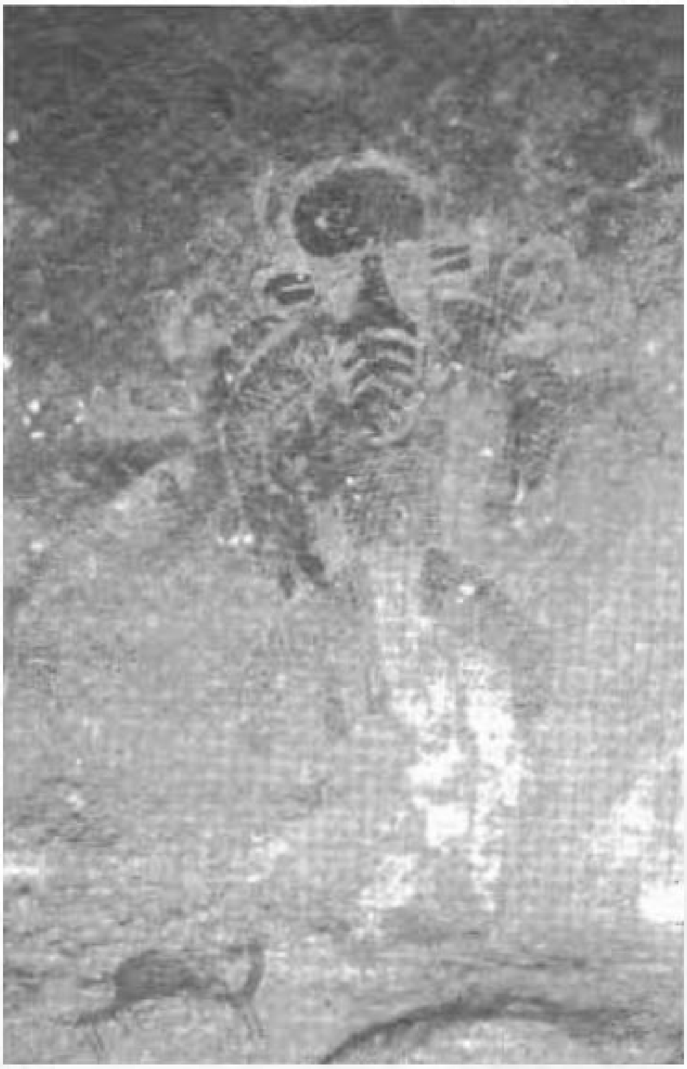


Figure 3. Rock painting from Aouanrhat, Tassili, Algeria.

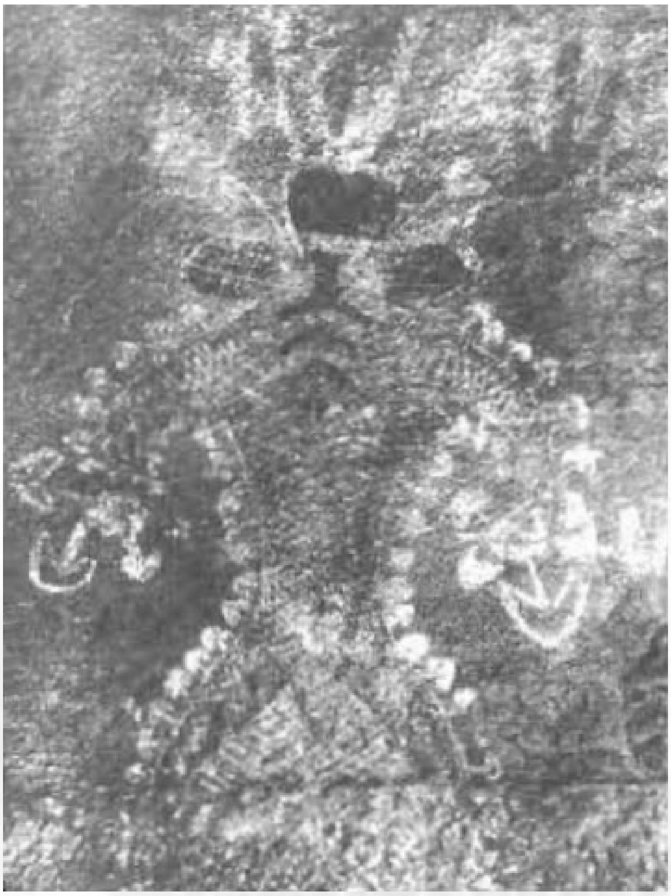


Figure 4. Rock painting from Matalem-Amazar, Tassili, Algeria.

In these cases, too, the lance-like elements represent the same symbol as was found in various scenes from the Round Head period, and are interpreted here as mushrooms. Said elements have been read by many authors as the tips of arrows, rowing boats (Mori, 1975), vegetables, even flowers (Lhote, 1973, pp. 210 and 251), or as unidentifiable enigmatic symbols. The shape that more closely matches that of the cult object in question is the mushroom, mare than likely of the psychotropic kind, whose socio-sacred use is marked in the scenes showing its harvest and offering, as well as in the expressive dance rituals, in the phosphene geometric work and also in the visionary productions from Tassili.

The fungiform symbolism seems to be represented in two different ways: as a realistic object held in the hands of the figures (usually masked or with special headdresses), or as an element "coming out" of the body. There are even cases where the figure's head is in the shape of a large mushroom.

The Round Head artwork is strewn with figures, of various degrees of anthropomorphism, with a fungiform head. Some have a pointed "cap head" or with a papilla, others hold a leaf or branch in their hand. In many cases, archaeologists themselves labeled the figures as having "fungiform heads" (*tête-champignon*), without actually attaching any ethnomycological symbolic value to it, that is, without making a direct reference to mushrooms. This is the case, for example, of the paintings found in the Algerian region of Immidir, north of the Hoggar mountain range. These paintings may very well belong to the Round Head period (Muzzolini *et al.*, 1991).

Several data suggest the existence of an ancient psychoactive cult, with a complex variety of botanical species, accompanied by associated mythological representations. It is not easy to devise a hypothesis about the mushroom species that are portrayed - their biochemical characteristics are partly at the root of the kind of mental experience they provide - as they belong to a flora that is no longer present in today's barren Sahara basin. The paintings let one infer the presence of at least two species, one of small size, often with papilla on the very top and with similar characteristics to most of the currently known *Psilocybe* hallucinogens, while the other is of larger size (such as *Boletus* or *Amanita*).

The polinimetric analyses carried out on Tassili highlighted the kind of mountain vegetation that would have been found there during the Round Head period, consisting of various conifers and oak (AA.VV., 1986: 97); it can be assumed that the depicted mushrooms were part of this belt of forest and that, at least the larger sized ones, relied heavily on some of these tree species (symbiotic mushrooms).

In the less than specific debate on this Saharian documentation mentioned in popular psychedelic literature, these paintings are wrongly considered to belong to a Neolithic civilization, that is, a civilization of breeders. They belong in fact to a Palaeolithic, or epi-Palaeolithic civilization, existing toward the end of the Stone Age. Herein lies the most important consequence of this Saharan age: for the first time we come across evidence of the use of psychoactive mushrooms in the Stone Age. Thus the hypothesis by Wasson *et al*. (1986) that the knowledge of sacred mushrooms originated in the Stone Age appears to have been confirmed.

In equatorial Africa, other ethnomycological details are being uncovered. One of the most interesting findings refers to an ethnic group from the Ivory Coast.

The following narration is taken from a recent French book, written by herbal therapist Yves Soubrillard (1992). The author met Souleymane, a traditional healer belonging to the Mao ethnic group from the Ivory Coast, at an African congress. Souleymane sold the herbal therapist, at a very high price, some of his secrets about magic plants. He invited the therapist to spend some time in his village and there he revealed to him his knowledge concerning various mind-altering plants, among which were two psychoactive mushrooms. Soubrillard had a chance to tryout the effects of both mushrooms.

The first of these is called *tamu*, which means "knowledge mushroom;" it was identified by the herbal therapist as belonging to a *Conocybe* species (fam. Bolbitiaceae). The second is called "action mushroom," and is identified with a *Stropharia* species (fam. Strophariaceae).

It is more than likely that there was some truth behind the account (which may have been rendered intentionally confused and contradictory) made by Soubrillard of his experience, and it does deserve more serious and competent investigation.

By observing other cases of intentional use of psychoactive mushrooms in Africa, I remember that Frantz Thille (1990), who spent some time with the Babinga Pigmies from the Central African Republic, learned that this nomadic tribe is aware of the hallucinogenic nature of certain forest mushrooms; the fungi, however, were reserved only for use by the witch doctors (the *n'gagna*) for their trances. Robert Graves (1994 [1957]: 91) also reported about psychoactive mushrooms based on information provided to him by a Dr. Sinclair Loutit. Dr. Loutit lived for many years in western Africa and, according to him, the Ibo people of Nigeria also reserved mushrooms exclusively for the witch doctors' rituals, in which human flesh was also eaten. In Madagascar there are mushrooms that bring about a kind of merry intoxication; among them is the Tanala's *tsigegy*, which grows on the rotting trunks of fallen trees. It is not, however, known what species it belongs to (Heim, 1978: 37).

In 1983, Adrian Morgan (1995: 169) told the story of a friend who went to Zimbabwe to teach English in the Harare region. One day two students offered to take him to the forest to look for, and eat, mushrooms and roots that would lead to him becoming intoxicated. The professor didn't accept the offer.

If all these African ethnographic details were confirmed (for a full review cf. Samorini, 2001), we would find ourselves facing the most extensive and differentiated "complex" concerning the use of psychoactive mushrooms in the world. This would portray Africa as the continent where the uses, beliefs, and mythologies about hallucinogenic mushrooms, probably from very ancient times, are best preserved.

The 'Umbrella Stones' from Kerala

Let us move on to Asia now, and notably to south India and to the state of Kerala. A rather mysterious megalithic prehistoric culture characterizes this land, particularly regarding its origins. This civilization from the south Indian Iron Age shows dolmen, menhir, and other stone monuments, remarkably similar to the megalithic monuments from northern Europe, although very distant both geographically and chronologically.

Typical megalithic monuments from Kerala are the *kuda-kallu* (Fig. 5), which means "umbrella stones" in the Malayalam language; archaeologists have classified them as dating from between 1000 B.C. and 100 A.D. The most important concentration of these monuments is found in the interior of the Trichur and Palghat regions north of Cochin, in central Kerala (Krishna, 1967).

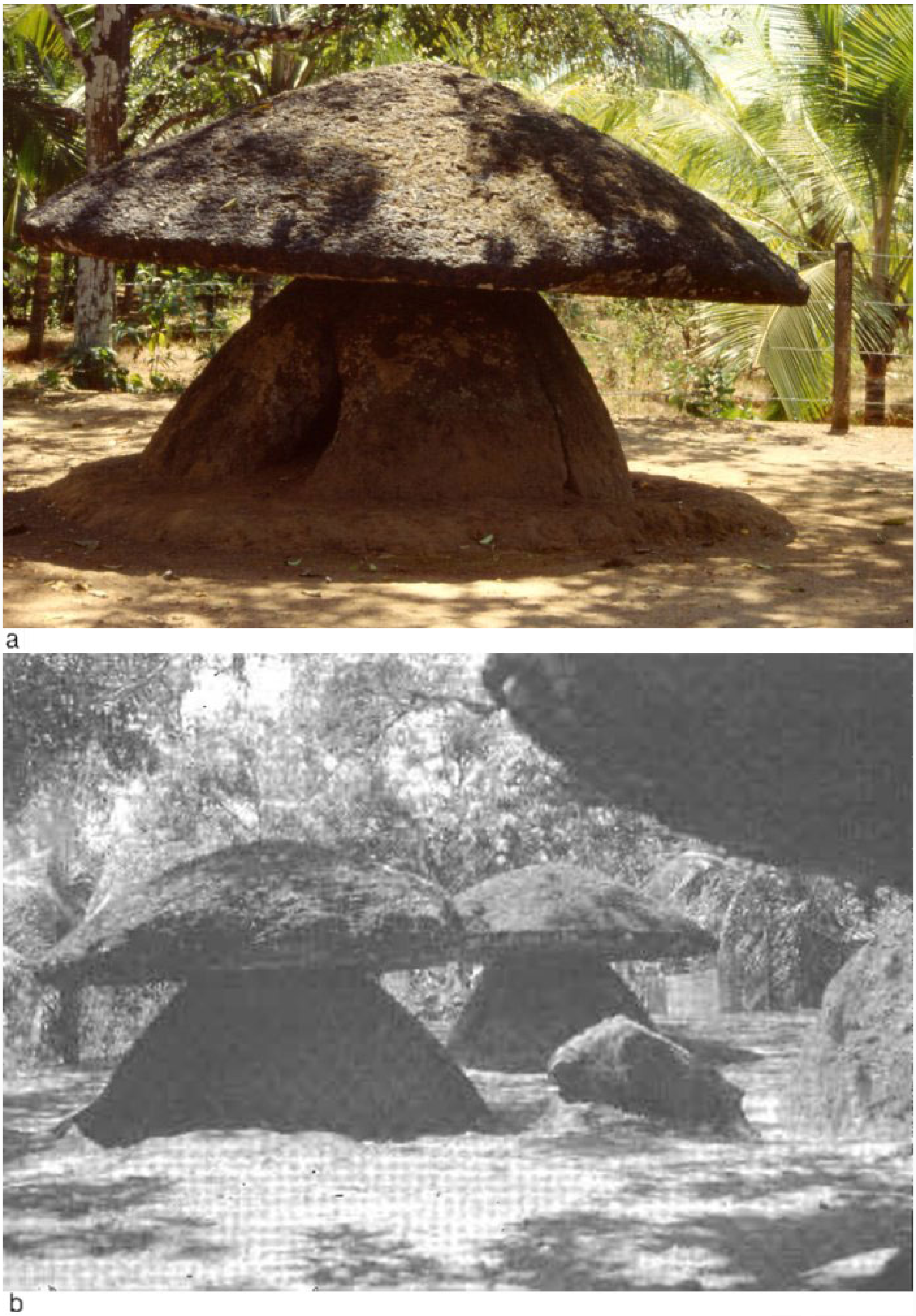


Figure 5. (**a,b**) Megalithic "umbrella stones" (*kuda-kallu*) from Arryannor, Kerala, Southern India (1 st millennium B.C.).

On average, the *kuda-kallu* measure 1.5-2 m in height and 1.5-2 m in width. They are made up of four stones cut into half segments, joining at the bottom and holding up a fifth stone that is flat on the side on which it is resting and convex and even in shape on the other side. The entire complex would seem to resemble an umbrella, or, even better, a huge mushroom. These monuments are not graves. It was suggested that they were archaic prototypes of the Buddhist stupa (Longhurst, 1979). Culturally, the *kuda-kallu* is strongly associated with the umbrella, an archaic symbol of power and authority and sacredness that was widespread in ancient Egypt among the Assyrian and the eastern civilizations.

Although the connection between these stone monuments and the umbrella is plausible, I have put forward the hypothesis whereby they were supposed to portray mushrooms, as they are very similar in shape (Samorini, 1995b).

The name *kuda-kallu* was clearly given at a later time, no doubt after the time when the monument was erected. There is no re liable evidence that it has the same meaning as the name given to it by those who built it. Besides, as Longhurst confirms, it is more than likely that during the Asoka period, some centuries after the erection of the *kuda-kallu*, the royal umbrella was associated with the stupa, for which the *kuda-kallu* are seen as the forerunners, both from an architectural and a symbolic point of view.

In his book *Soma*, Wasson (1968: 66) makes a brief reference to the Kerala "mushroom stone," although he did not actually see them. I believe that if he had had the opportunity to go to the Arryannor sites and had found himself before the seven *kuda-kallu*, he would have been very impressed.

Near the *kuda-kallu* are other megalithic monuments: menhir, dolmen, stone circles, and "hood stones." These "hood stones" are very interesting because of something I noticed On some of them. They are made up of a single stone that covers over an underground grave. I saw numerous round cavities on some of them, dispersed over the entire upper surface of the stone (Fig. 6). The point of these cavities is incontestable: they served a clear decorative purpose and also highlighted a distinctive characteristic of the object that the "hood stones" were meant to represent (Fig. 7). One must take into consideration that the most practical way of representing the fly agaric or the panther-cap's white spots on stone was by scooping out round boles in the surface. At this point, the hypothesis that the " hood stones" and the *kuda-kallu* were meant to specifically represent either one or both of these mushroom species becomes much more convincing.

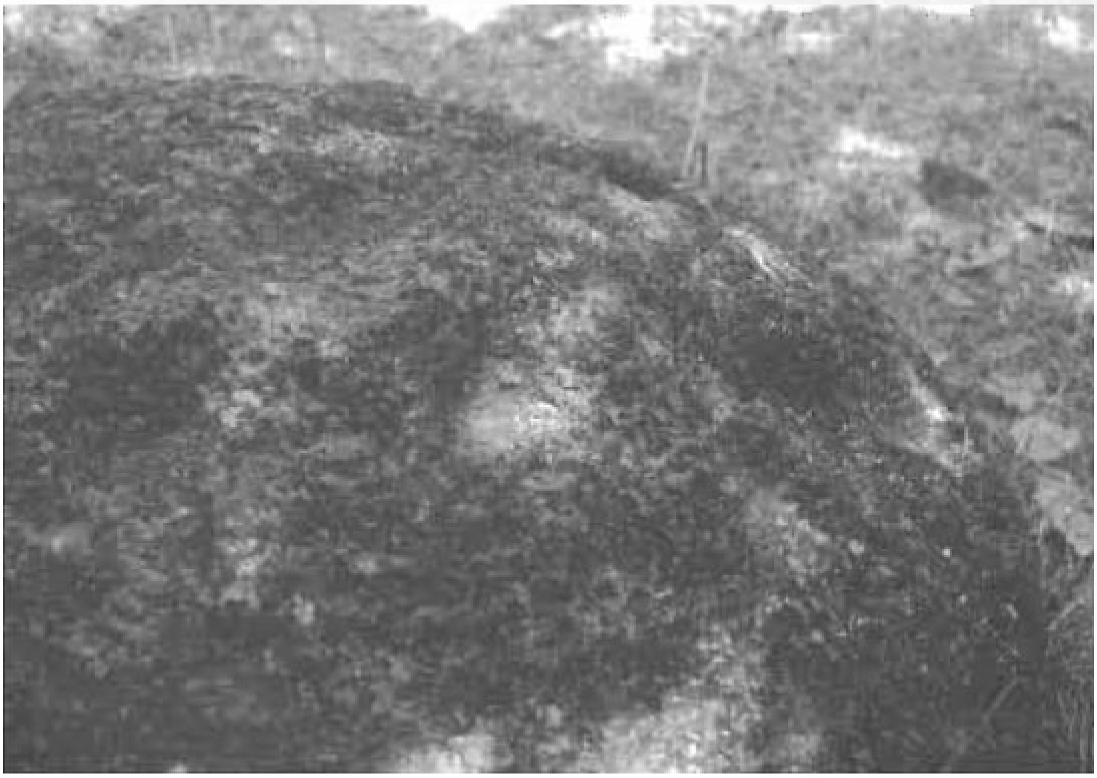


Figure 6. "Hood stone" (*topikal*) from the megalithic site of Cheramangad, Kerala, Southern India.

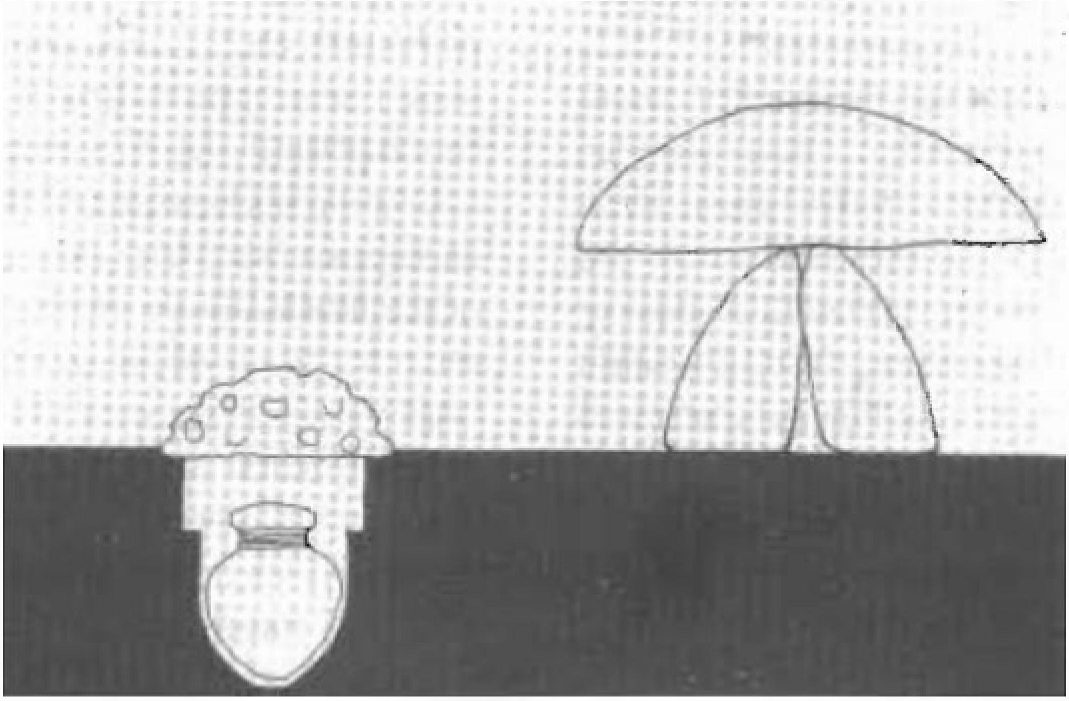


Figure 7. Design of a *topikal* and a *kuda-kallu*.

Amanita muscaria and *A. pantherina* are present in south India, in the coniferous forests of the Kodaikanal region (in Tamil Nadu), about 80 km from the megalithic sites. In this same region, different species of psilocybian mushrooms Can be found: *Psilocybe cubensis*, *P. zapotecorum* var. *aztecorum* and var. *bonetii*, *Copelandia cyanescens*, and so forth (Natarjan and Raman, 1983). The Kodaikanal region is a place noted for the so-called "psychedelic tourism," in which the psilocybian mushrooms are particularly involved today.

If the *kuda-kallu* really represented mushrooms, they therefore represented psycho active mushrooms, that is, mushrooms that allowed visions of the "other side," of life after death; as such, they were far more suitable than others (than edible mushrooms, for instance) to being associated with funeral cults.

The hypothesis by Wasson (1968) that identified the sacred drink and the divinity *soma* in the *ṚgVeda* - the most ancient Indian holy text with the fly agaric is well known. If the *kuda-kallu* were trying to portray psycho active mushrooms, then this poses the question already raised by Wasson: what relationship is there between the megalithic *kuda-kallu* cult and the *soma Veda* cult? There doesn't seem to be any direct connection, in the sense that the *kuda-kallu* is not a symbol of the cult originating or influenced by the *soma* cult. These monuments were erected by pre-Indo-European Dravidian populations. The cult associated with the *kuda-kallu* developed in a period preceding the Ari's contact with south India: the Ari had already left behind the knowledge of the original *soma* and instead worshipped using substitutes.

The megalithic cultures of south India and Europe share a number of common features, even though there is a chronological difference between them of at least a thousand years: a distance that appears to be a serious obstacle to those theories that would have the former civilization originating directly from the latter. Nevertheless, the similarities in Some of the characteristics of the two cultures are surprising and involve the shape of the *kuda-kallu* itself. The shape of some British and northern French dolmens brings the *kuda-kallu* dolmen to mind. Also, the whole range of European megalithic works should be subject by accurate ethnomycological research.

To corroborate this, one only has to take a look at the rock engravings on two of the monoliths in the most famous north European megalithic ceremonial site of Stonehenge (monoliths which have been classified by archaeologists with the numbers 4 and 53). The engraved images (Fig. 8) are part of the same figurative motif, interpreted by archaeologists as the symbol representing a sacrificial axe - an object that has actually been found in megalithic burial sites. Nevertheless, the variations in the shapes of the engraved axes seem to be unusuall with respect to axes shown on other monuments from the same megalithic culture. The unique characteristics of the Stonehenge axes are peculiar to this archaeological site and are such as so justify an ethnomycological hypothesis (Samorini, 1995b). As I recently maintained in my ethnomycological analysis of

Greek culture, "All too often researchers base their arguments on largely accepted opinions when interpreting unknown and repeated symbols found in archaeological documents. Maybe this is to avoid hurting the feelings of the author who - sometimes over a hundred years before - first gave his interpretation, or maybe it is simply due to interpretative indolence" (Samorini *et al.*, 1995: 321).

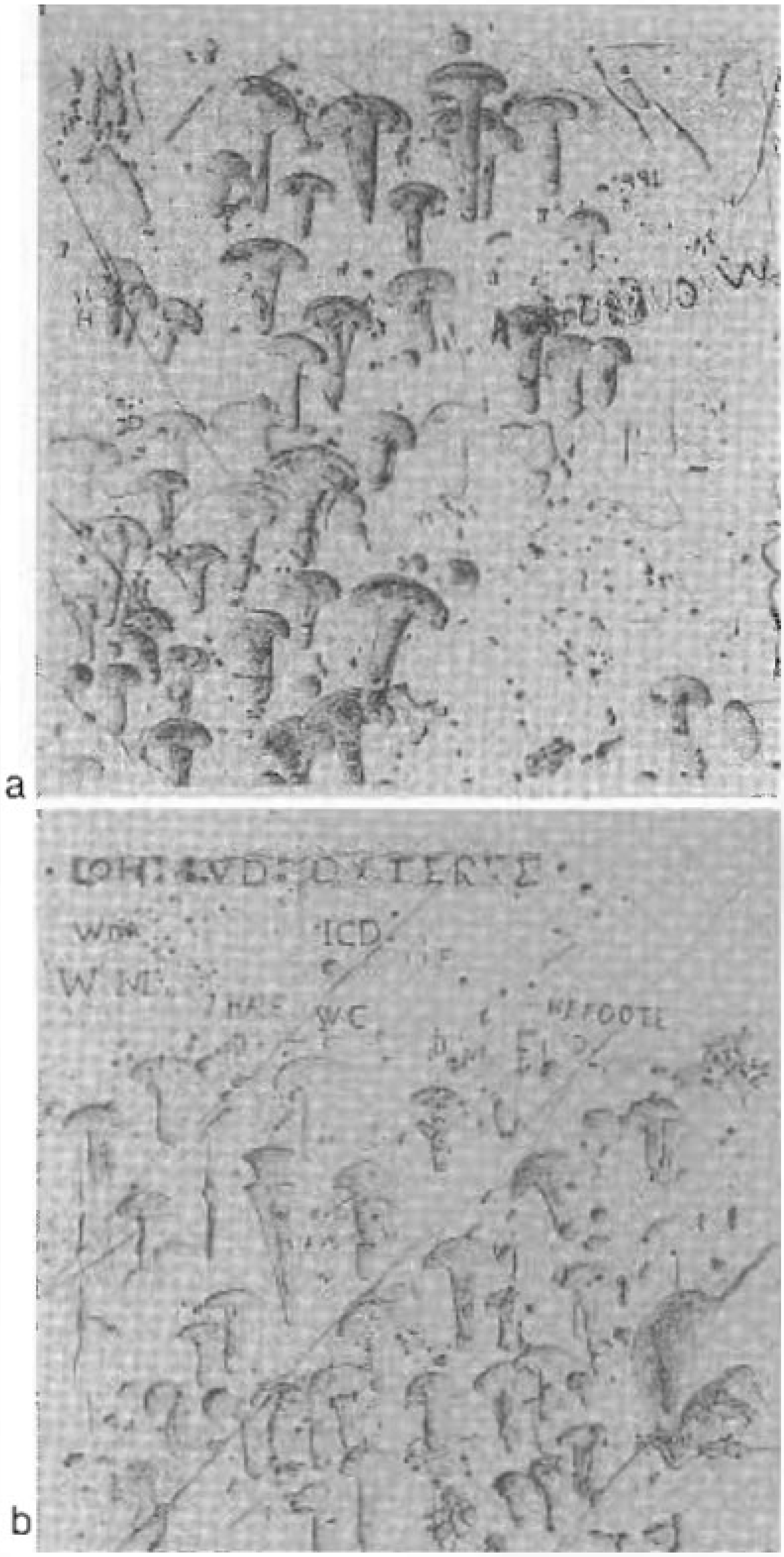


Figure 8. Design of rock art engraved on monoliths no. 4 (**a**) and no. 53 (**b**) from the megalithic site of Stonhenge (England).

The same evaluation holds both for the Stonehenge engravings and for the Kerala *kuda-kallu*. The *mushroom stones* of Guatemala were interpreted in the same way - for a long time they were stubbornly read as phallic symbols or pestles for mortars (Lowy, 1981).

The documentation about Stonehenge and Kerala suggests that the knowledge of the fly agaric was not unique to Indo-European civilizations; it will not surprise me therefore if, one day, the discovery that an archaic cult which made use of this mushroom will be made known, perhaps in southern Africa, that is, totally cut off from any Indo-European influence.

The Mount Bego rock-engraving

An interesting representation of mushrooms is seen in the rock art of the Maritime Alps of southern France. This document, noted by myself in the mid-1980s, was recently brought to the fore by a Frenchman named Patrick Duvivier and myself (Duvivier, 1998; Samorini, 1998b).

A mountain called Mt. Bego, located in the highest area of the Maritime Alps, has always been considered to be sacred since ancient times. On this mountain, and in the nearby Valley of Marvels, are thousands of rock engravings. Different stages and styles can be identified which span a period beginning in 2500 B.C. and running until the first decades of our own age.

In the highest part of the Valley of Marvels is an engraved boulder that is considered to be one of the most significant finds in the entire region's rock art; the boulder is commonly known as the "Altar Rock," and on its face is a scene of the so-called 'Tribal Chief." The rock itself is red-crimson in color and rises above a smooth, wide, rocky surface covered by hundreds of engravings. The rock stands like an altar on a history-seeped surface, in a position that dominates the valley, and so appears to be the central element of the cult associated with rock art (Fig. 9). It has been dated back to the first part of the Bronze Age, around 1800 B.C. (Lum1ey *et al*., 1990: 45).

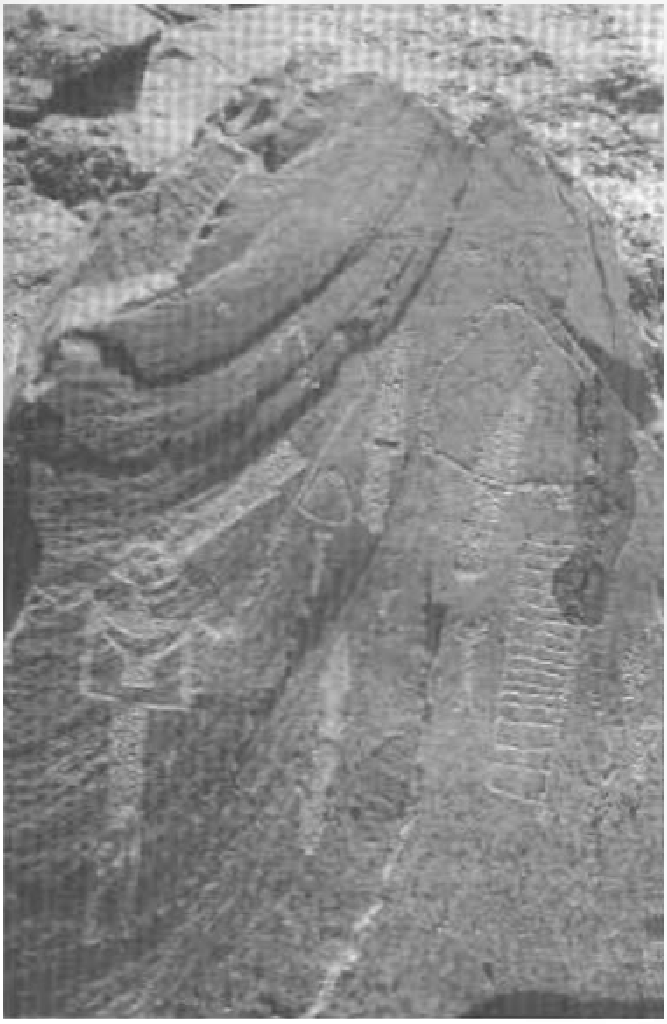


Figure 9. The "Altar Rock" prehistoric engraving from Valley of Marvels (Mount Bego), Southern France (1800 B.C.).

On the rocky "altar" surfaces some daggers, a stairlike design, a little figure in a praying position, and a larger anthropomorphic figure that was wrongly named the "Tribal Chief" - it is most probably a shaman - are engraved. Let us now consider the fungiform image in the scene (Fig. 10): it is on the right of the large anthropomorphic figure, next to the "dagger" or "bolt of lightning" hitting him on the head. This object has been interpreted in turn as an abstract design, a stylized bovine skull, and more frequently as a dagger or other ritual weapon. It is nevertheless difficult to see any kind of weapon in them. There are two details that may escape the attention of an archaeologist, although not the careful eye of a mycologist, which lead rather firmly to the interpretation of the object as a mushroom of the *A. muscaria* species. The first element regards the thickening seen in the upper part of the "stem," which would seem to portray the ring that runs around *Amanita* mushroom stems. The second detail concerns a collection of pointed engravings found on the top part of the "cap."

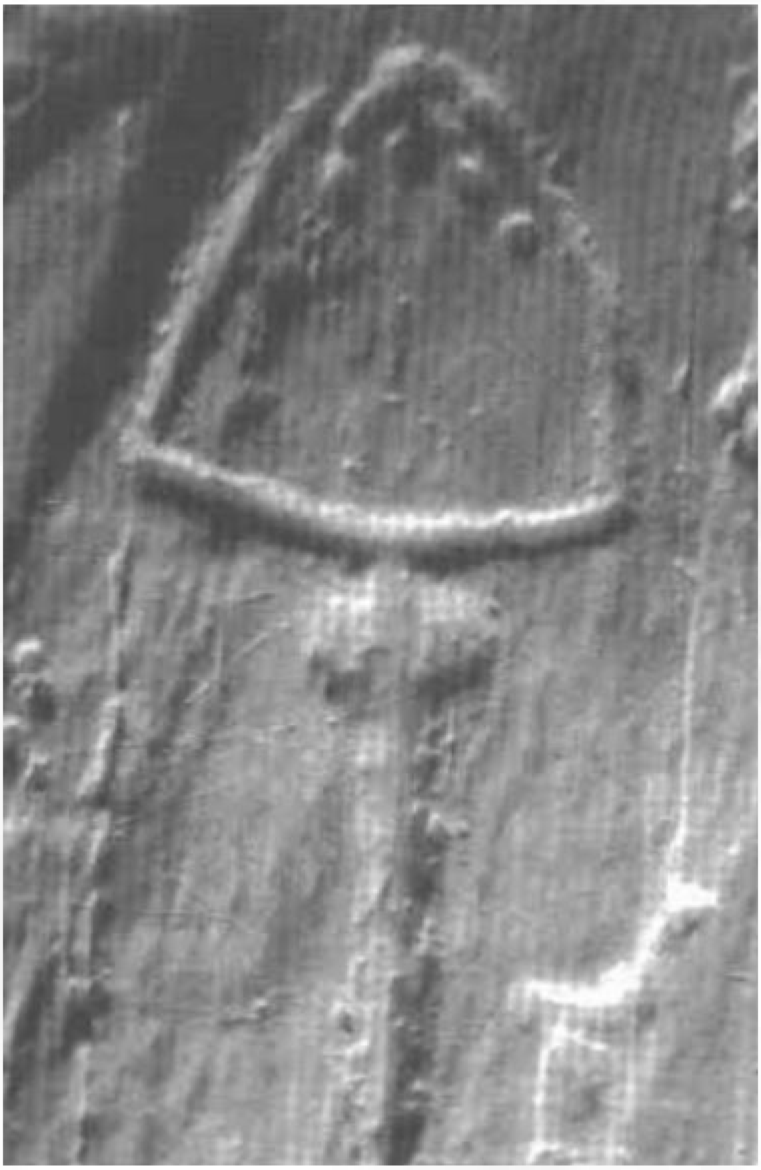


Figure 10. Detail of the mushroom effige in the "Altar Rock."

Let me remind you that the presence of "little dots" - either painted or engraved - on the image of the surface of a mushroom cap in a religious scene denotes almost without fail the *A. muscaria*, Or the related and equally psychoactive *A. pantherina*. Finding mushrooms in a religious context leads one to identify it as a hallucinogenic-type mushroom, that is, as a kind of vegetable whose ingestion induces mental experiences generally interpreted in terms of enlightenment and mystic-religious visions. Hallucinogenic mushrooms with "little dots" on the cap are typically either *A. muscaria* or *A. pantherina*. Going back to the "Altar Rock" scene at Mount Bego, the entire setting would seem to have shamanic connotations owing to the images of mushroom and stairlike drawings (perhaps a real stairway) - key elements of basic shamanism.

The Pharsalus Bas Relief

Let us move on now to Greek culture. In this section, I will confine my description to the so-called "Pharsalus Bas Relief" (Fig. 11). Dating from the second half of the 5th century B.C., it is currently preserved in the Louvre Museum in Paris (no. 701, titled "The Exaltation of the Flower" in the museum catalog). Various scholars have wanted to see represented in this exhibit the two goddesses of the Eleusinian Mysteries Demeter and Persephone - in the act of showing or exchanging certain objects, interpreted more or less as flowers (Baumann, 1993).

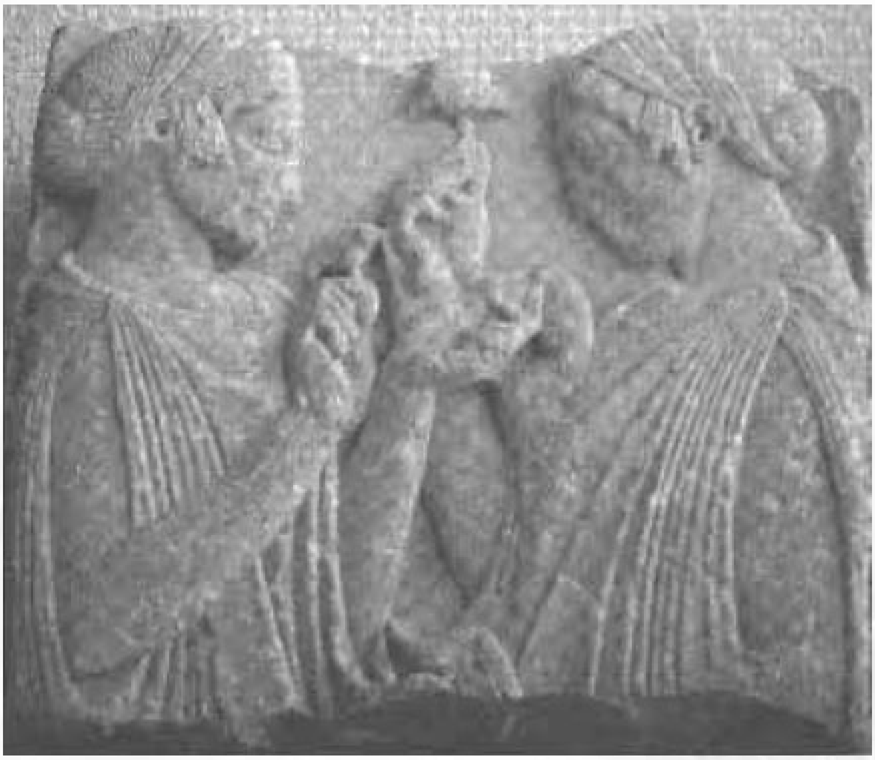


Figure 11. Pharsalus bas relief, from Thessaly, Greece (5th century B.C.) (Louvre Museum).

In actual fact, the object held in the hand of the figure on the right-hand side of the scene (likely, a younger looking Persephone) evokes more easily the shape of a mushroom rather than of a flower. Also the way in which the object is held in the hand, squeezing the inferior part of its "stalk" between the two fingers, is reminiscent of the way one holds a mushroom in ones fingers to show it. Robert Graves first proposed a mycological interpretation for this work of art in his book *Food for Centaurs* of 1956, in which he did not include a picture (according to the Spanish version of 1994). From his observation of the exhibit he concluded that the "fly-agaric is at the origin of the prophetic inspiration of the Eleusinian Mysteries" (Graves, 1994 [1956]: 92). A curious fact is that he brought it to R. G. Wasson's attention already in the distant 1956, which is tantamount to saying that Was son was familiar with this document some 20 years before he and his colleagues proposed the ergot as the Eleusinian entheogen (Wasson *et al*., 1978). But he did not discuss it in his writings.

In a preliminary way I have presented and discussed this document in other places (Samorini *et al*., 1995; Samorini, 1998a). In the bas relief three hands are distinguishable, each holding an object. The first object, the highest one in the bas relief, held by Persephone, is mushroom-shaped, like a *Psilocybe* or, even better, a *Panaeolus*. The second object, held by Demeter, is the same object, the same mushroom, but it is held at a slant and is broken. Therefore, it is possible to hypothesize that Demeter and Persephone are both holding a mushroom, attributable as a psilocybinic type.

But the true enigma of this scene is the third object held by Demeter in her left hand. Previously (Samorini, 1998a) I had observed that, if the first two objects represented psychoactive mushrooms, or rather they had psychopharmacological connotations, it is possible to imagine that also the third object had psychopharmacological connotations, immediately recognizable by the initiates as much as the first two objects. Therefore, we would be before two psychopharmacological keys: a fact that becomes evident when one observes the structure and the evolution of the Eleusinian Mysteries.

As far as the enigmatic third object held by Demeter, to this day I have not found a satisfactory answer. Beyond the rose or a more generic "flower," certain scholars have forward various possibilities: a phallus, a bag of seeds, or even a sheep's astragalus. A phallus is unlikely; Greek artists have never depicted the phallus in this way (Greek artists were masters of the representation of the phallus). Robert Graves has interpreted this object as a leather bag, "like the ones that were used to keep prophetic die" (Graves, 1994[1956]: 92), but the use of prophetic die or other divine practices is unknown in the Eleusinian Mysteries. Ruck and Staples (1999) see it as the symbol of the "old religion," previous to the reforms that the Eleusinian cult was certainly subject to. More recently, they hypothesized that we are dealing with a leather saddle bag (*pera* in ancient Greek) similar in type to the one that Perseus used to hide Medusa's head (who should be none other than a fungal mythological metaphor, cf. Heimich *et al*., 1999). Therefore in the bas relief the two goddesses would have brought the two mushrooms out of the saddle bag. But Ruck does not even abandon the hypothesis held in their period by Graves and Wasson that from that *pera* saw a snake coming out (ibid.). I am convinced, after my first-hand observation of the exhibit, that there is no representation of a snake and that it is not possible to come to any interpretative hypothesis on the Pharsalus bas relief through studying only photographs of the exhibit. In my opinion, that third object represents an important element for the identification of the original Eleusinian psychoactive brew.

To further complicate the matter, a new piece of data has been added. With a first-hand observation of the bas relief I have been able to confirm that originally Persephone's forearm and left hand were also represented, along the lower part of the bas relief, that here seems splintered. This hand held another object - the fourth of the whole scene - of which only the upper part is visible. Following a careful observation, I would say that we are looking at a flower from above, with a little circular center surrounded by large petals. The presence of a fourth object, probably floreal, complicates further the ethnobotanical interpretation of the scene, which is open to various solutions.

The 'mushroom trees' in christian art

The research that follows was described as "surprising" and "enigmatic" by many of those to which I have presented it. I must confess that the results and conclusions of this research are still uncertain, even to myself. Since the mid-1990s I have been following a "trail" within Christianity with the intention of following serious ethnomycological tracks and trails wherever they may take me (Samorini, 1998c).

This may bring John Allegro's hypothesis to the reader's mind - which saw both the Old and New Testaments as sprinkled with metaphors alluding to a cult based on the fly agaric - and one may even think that I too might plan to go over the same ground and validate the said hypothesis. Not at all. I believe that my research goes where the documentation takes it, while in Allegro's work the documentation was used to take the author where he wanted to go, a hypothesis that I consider strained and methodologically flawed.

My research is based on the study of a particular iconographic outline popular in ancient Christian art - the so-called "mushroom trees."

According to the historian of Christian art, Erwin Panofsky (cf. Wasson, 1968: 179-180) this type of tree - which resembles a mushroom and which, for this reason, is tenned *Pilzbaum* ("mushroom tree") in German - is widespread above all, in Romanesque and early Gothic Christian art. It has been considered the schematic representation of a conifer (the "umbrella pine") and there are hundreds of examples illustrating the gradual transformation from the naturalistic forms of the pine to the more schematic "umbrella tree," hence to the various forms of the mushroom tree.

The first of these mushroom trees that I would like to bring to the reader's attention - and which was previously discussed by other authors - is in the famous frescos of the Romanesque chapel of Plaincourault in the province of Indre in central France (Samorini, 1997). During a visit in May 1997, I was able to examine the frescos of the chapel (Fig. 12). Here, we find the scene of the Temptation with its mushroom tree-painted by the Knights of the Order of Malta on their return from the Crusades. Toward the beginning of the 20th century, a French mycologist put forward the hypothesis that the Plaincourault mushroom tree was a representation of *Amanita muscaria*, the well-known psychoactive mushroom with its white-spotted red cap. If this is the case, the esoteric content of the Temptation would appear evident, that is, identification between the Tree of Knowledge of Good and Evil and a mushroom capable of producing visionary states and "illumination."

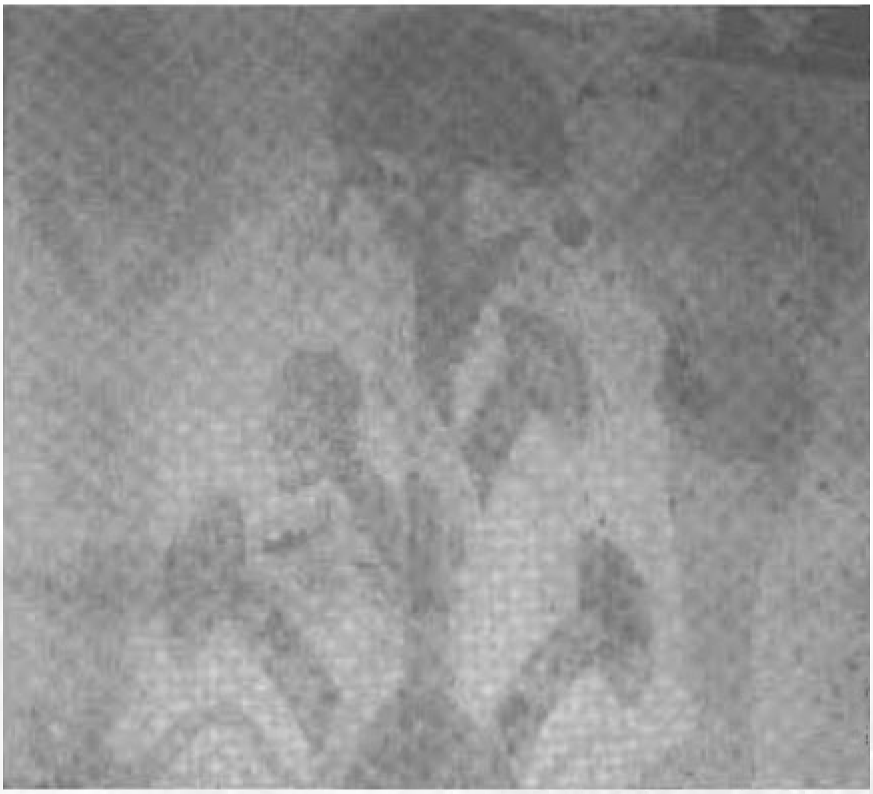


Figure 12. Romanesque fresco from the Plaincourault chapel, Central France (12th century).

After a hurried visit to the chapel in Plaincourault and, above all, after consulting the art historian Panofsky, R. G. Wasson categorically denied the validity of the interpretation offered by the French mycologist and supported and propagated by his followers. And yet, Wasson had already been confronted with at least one case of monodisciplinary blindness and interpretative slothfulness of professional researchers - that of the mushroom stones in Central America, interpreted for decades as phallic emblems by archaeologists. It is therefore quite strange that the father of ethnomycology stopped before the lapidary appraisal of an art historian and did oat, instead, follow the tracks of the other "mushroom tree" representations in Roman and Christian art as he should have done. The fact is that his conclusion appears rather superficial: "Mycologists should have consulted art historians" (Wasson and Wasson, 1958: (79). In fact Wasson, besides considering Panofsky's complete lack of knowledge of the history of psychoactive use, should have looked around him during his visit at Plaincourault, and tried to understand in which territory he was. If he could have the opportunity of seeing what can be found at just 9 km from Paincourault, at the famous Saint-Savin-sur-Gartempe Abbey, he would not surely have been cowed by the statements of an art historian.

With the premise that the problem of interpretation of the evidence consists in establishing the intention of these artists to represent the mushroom symbol as part of the esoteric content of their work, we may now consider a detailed description of the evidence.

In the Plaincourault mushroom tree form, we may note the following details: (1) The semispherical foliage or fronds is similar to the cap of a mushroom and is studded with spots (in this case, whitish on an ochre background); (2) two of lateral ramifications join the frond cap from below and symmetrically in relation to the main trunk of the tree. These two ramifications may be intended as a means of representing the three. dimensions of the tree with a serpent coiled around its trunk. From the mycological angle, however, these ramifications might represent the membrane enveloping mushrooms of the family of the Amanitaceae at the early stages of development. This membrane then breaks when the cap broadens out and separates from the stalk; (3) the roundish fruit of the tree is, here, held in the mouth of the serpent as it offers it to Eve; and (4) along and around the base of the main trunk we have ramifications that are also very similar to mushrooms in form surmounted by "caps" upon which once more we may note whitish spots.

I have also studied a number of other mushroom trees characterized by the same four iconographic features found at Plaincourault. Two examples are to be found in 4th and 5th century A.C. Tunisian mosaics. In Tunisia during the centuries of Roman domination (1st-4th centuries A. C.) there was a flourishing tradition of well-crafted mosaic work of considerable artistic value. This tradition was continued in the mosaic floors of the first Christian churches (Fantar, 1995).

The mosaic in Fig. 13 decorates the baptistry of the *henchir* Messaouda in the Tunisian region of Sfax. It probably dates back to the 5th century A.C., and here we have an iconographic scheme that was fairly widespread and of very ancient origin: two animals symmetrically placed beside the Tree of Life.

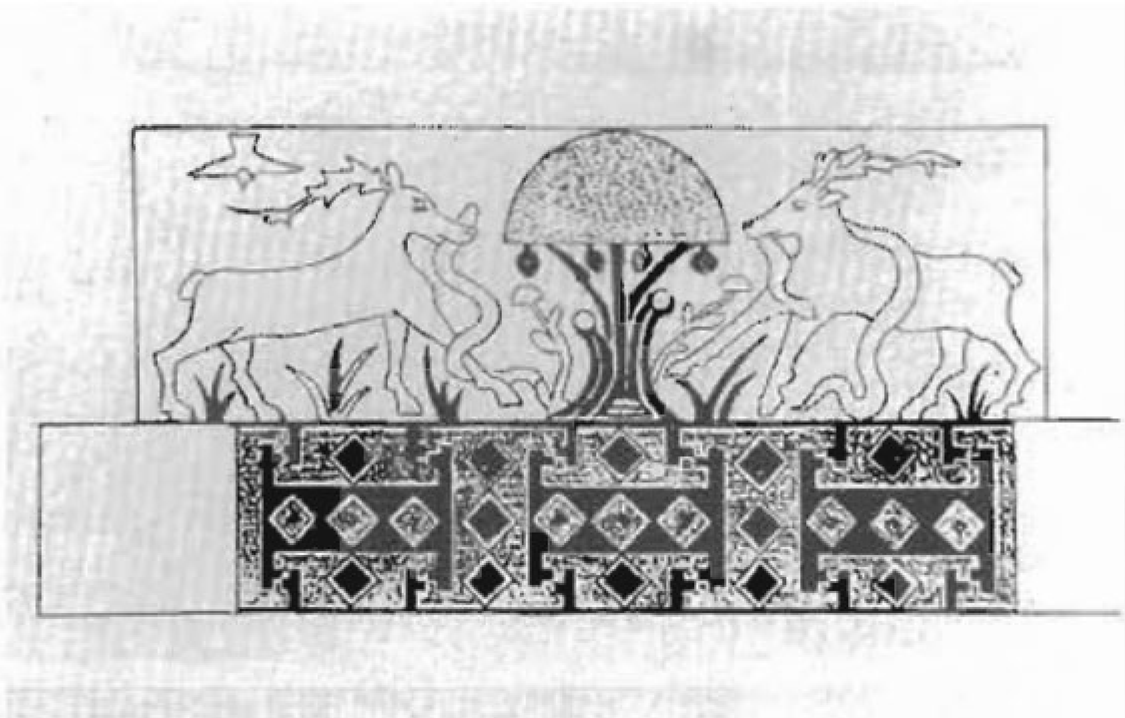


Figure 12. Design by a paleo-Christian mosaic from Messaouda, Tunisia (5th century).

The first representations of this arrangement date back to Sumerian art of the 3rd millenium B.C. The two animals are generally of the same species; they are horned wild animals or quadrupeds (above all, Cervidae) or birds. The object placed between them is the Tree of Life. A typical example is the two wild animals beside the sacred tree Horn (Haoma) of Persian art. Similar representations exist, such as a Plant of Life, a recipient containing the Water of Life, a Tree of Life from the foot of which rivers of the Water of Life spring forth (usually, four rivers are represented), or even a column (as in the famous "Door of Lions" at Mycene surmounted by two lions rampant upon a column). Sometimes the two animals feed on the Tree of Life or drink fro m the Chalice or the springs of the Water of Life. This variant is probably closest to the original iconographic scheme. This artistic scheme originates in the Middle East and spread to much of the Old World including North Africa as it underwent local stylistic modifications. According to Fantar (1995: 107), the Phoenicians brought it to Africa, where it passed into the hands of the Romans.

The Tree of Life is the element most subject to stylistic variation, from the most realistic to the most imaginative. The palm tree is one of the most widespread types. It may be more or less realistic, or represented by a single palm leaf the size of a tree. A further common type in the Mediterranean basin is the conifer tree, sometimes represented quite sim ply by a pine cone. The mushroom tree, which appears to derive from the conifer tree, seems to be less widespread than the other two types mentioned here. Christianity was one of the last and most important means by which the artistic scheme of the two animals and the Tree of Life spread. The two most frequently adopted animals were two lambs or two fishes. The *cantharos* (chalice) of the Water of Life or the Cross gradually took the place of Tree of Life. The esoteric meaning of the scene also changed, as Charbonneau-Lassay (1997: 54) has pointed out: "When, in the iconography of the first centuries of Christianity, two fish or animals surround an emblem, this always directly represents Jesus Christ; and the animals which accompany Christ are the symbolic representation of the Christian faithful." With the transformation of the Tree of Life into a Cross we therefore have an identification between the Tree and Christ. The Water of Life, placed in the *cantharos*, and which flows fro m the Tree of Life, becomes more and more closely identified with Christ's blood.

On further examination of the Messaouda mosaic, we may note that the two animals are deer, both of which are savaging a serpent. The deer savaging a serpent is also an iconographic scheme of pre-Christian origin. This motif is associated with the belief, recorded by writers in antiquity, that deer were fierce foes and persecutors of serpents (cf. Charbooneau-Lassay, 1994; see "Deer," 1:XXX; Puech, 1949). The tree placed between the two animals is a mushroom tree of the same kind as that found at Plaincourault and it is endowed with the same four characteristics mentioned previously: (I) the cap-shaped fronds, with many spots; (2) the two lateral ramifications of the main trunk joining the frond; (3) the round fruits (here, hanging from the frond); and (4) the fungoid protruberances at the foot of the tree. In the upper right corner of this scene we may note a dove, a widespread feature of Christian art with a great variety of meanings.

We also find another kind of mushroom tree in Tunisia. This is from the *henchir* Ounaïssia (6th-7th century), at the moment housed in the Museum of Sbeitla (Fig. 14, cf. Fantar, 1995:229). We might consider this scene a transition stage in an iconographic scheme that is only slightly different from that of the two animals symmetrically placed beside the Tree of Life; it might be considered a variant of a scheme that also originates in the Middle East and dates back to remotest antiquity. Here we have the two animals and *three* Trees or Plants of Life that are usually the same as each other, one between the two animals and the other two behind them.

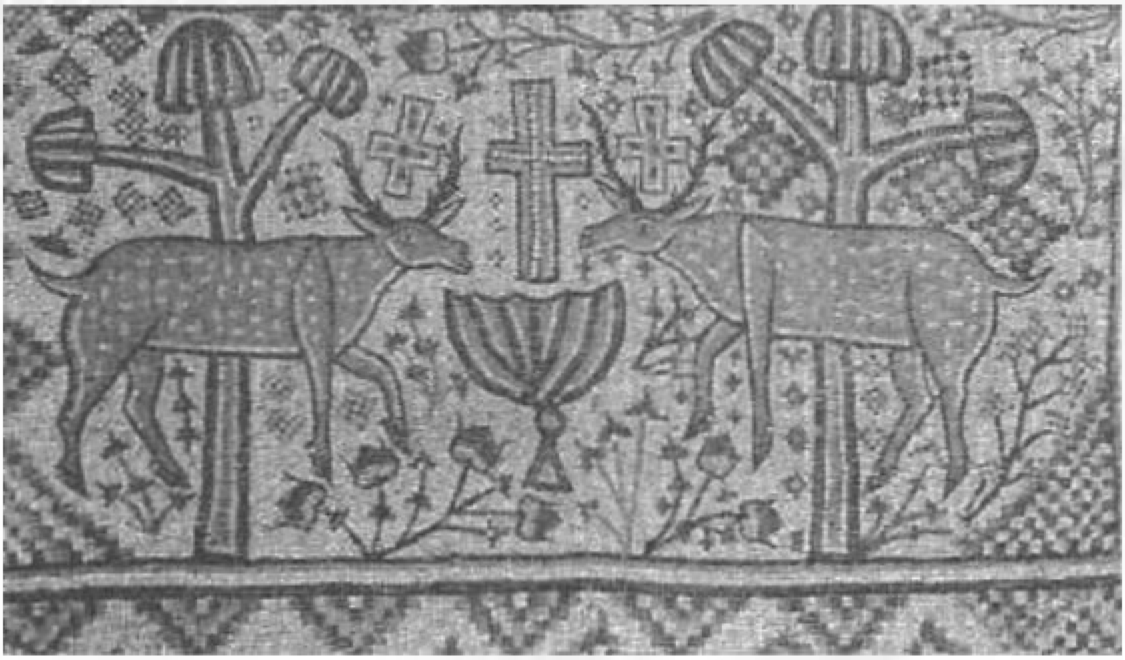


Figure 14. Paleo·Christian mosaic from Ounaïssia, Tunisia (6th-7th century).

During the last stage of absorption of this artistic scheme in Christian art (i.e., its full transformation into a "truly" Christian symbol) we may note the recurring image of the two animals combined with one Or more crosses. As we have already indicated, the Trees of Life become the symbol of the Cross; once Christianized, and the three parts constituting many examples of a certain type of Tree of Life become the three upper components of the Cross, and the various stages of the "crucifixion" of the Tree of Life become evident in paleo-Christian art. The Ounaïssia mosaic represents a stage in the transition of this iconographic scheme: the two animals are symmetrically placed and are once more two (ochre-colored and white-spotted) Cervidae; the tree placed between the animals has already completed its transformation into a "cross," and, below it, there is a *Cantharos* containing the Water of Life (at this stage, perhaps already considered the blood of Christ). We may also note that the other two Trees of Life, placed behind the animals, have not yet been fully "crucified." These two trees are mushroom trees of a different kind than the Plaincourault one. Both feature the three caplike fronds and, upon these, vertical lines have been traced that we may consider "striatures."

We find mushroom trees that are similar to the Ounaïssia examples in a fresco dating back more or less to the same period as the Plaincourault mushroom trees, and from the same area (central France). This fresco is in the Abbey of Saint-Savin-sur-Gartempe in the province of Vienne, about 40 km from Poitiers and only 9 km from Plaincourault. The Abbey's frescos are among the most highly admired works of French Romanesque art. They are dated ca. 1100, about 80 years before the Plaincourault frescos and, like these, they belong to the Haute-Poitou Romanesque Style (Oursel, 1994).

On the ceiling above the central nave of the church at a height of about 16 m, there are some scenes from the Old Testament. Figure 15a presents the scene of the fourth day of Creation with God placing the Sun in the firmament in the presence of two trees that could hardly be considered mere ornament. One of these is a mushroom tree. In the same figure we see part of the preceding scene (which has somewhat deteriorated) depicting the third day of Creation - the day of the Creation of vegetation. Here, we see two trees of two types (one, a mushroom tree) that are also like the ones on the right. A third tree of the same kind is depicted elsewhere among the nave frescos next to the scene of Moses in the presence of the Pharaoh (Riou, 1992: 35). The mushroom trees are all the same. They have a large trunk encroaching downwards on the lower scenes of the same wall, as we may note in the detail provided (Fig. 15b). These trees are also similar to the Ounaïssia mushroom trees. Here too, they present three mushrooms with striated "caps." Scholars have termed this kind of vegetation "mushroom tree," or even "tree with medusa-shaped frond" (Riou, 1992). Alternatively, it has been defined "mushroom-shaped flowers" (Thoumieu, 1997: 134).

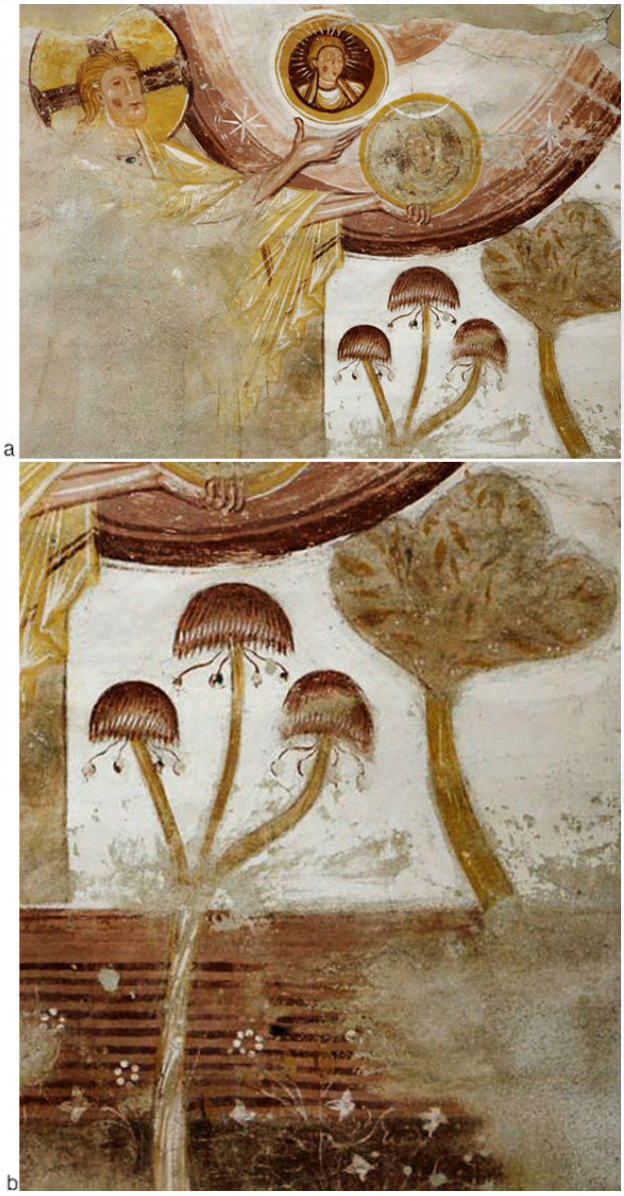


Figure 15. (**a**) Romanesque fresco from Saint-Savin-sur-Gartempe's abbey, Central France (12th century); (**b**) detail of the "mushroom tree."

The striatures hanging over the "frond" are very similar to the fringes on the caps of various species of *Panaeolus*. These striatures are more a feature of mushrooms than of trees; very many mushrooms, some of which are psychoactive, present these striatures. In fact, the mushroom striatures are caused by the juncture between the gills and the cap. The four cirrous adornments under each cap terminate with a small round object that might symbolize the fruit of the mushroom tree.

As Panofsky notes (in Wasson, 1968: 179), there are many mushroom trees in Romanesque art (more than I present here). Apart from the types described previously, there are others the styles of which are derived from local variants and individual imagination.

One example is the mushroom tree in the magnificent frescos in the small church in Vie, once more in central France, in the Berry region, some 80 km from Plaincourault. These 12th century frescos are the work of an anonymous artist, as are most of the works I present here. They therefore follow the Saint-Savin works, which are themselves only slightly earlier than the Plaincourault frescos. Although these frescos do not represent the Haut-Poitou Romanesque Style they are nevertheless considered part of the same artistic tradition (Grabar and Nordenfalk, 1958).

As Manuel and Dona Torres pointed out to me, the scene of Jesus entering Jerusalem is presented in the upper part of the right wall of the choir (Fig. 16). Christ is riding a donkey. Some people welcome Christ by laying their cloaks on the ground while others pluck flowers and leaves from the trees and offer them to him. The trees are stylized as palms in the manner of a familiar and fairly widespread typology. However, the upper part of one of the trees is quite unusual. It terminates with five umbrellas and may be defined a mushroom tree. The mushroom like appearance is further con filmed by the concave "caps," as depicted. Here, we might say, we have a "mushroom palm."

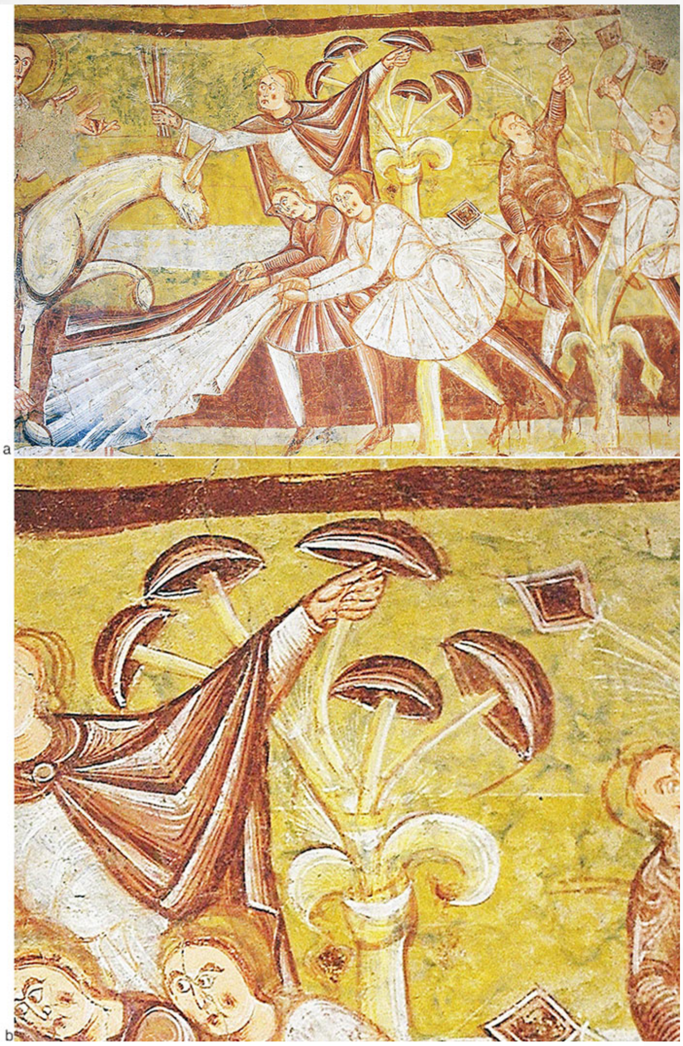


Figure 16. (**a**) Romanesque fresco from the Vic church, Central France (12th century); (**b**) detail of the "mushroom tree."

In the course of 3 second visit to the little church in Vic with Mr. and Mrs. Tones, in May 2000, they pointed out to me the existence of a second mushroom tree. The scene at the entrance of Christ coming into Jerusalem continues over the other part of the choir with the representation of Jerusalem's fortification. Despite the picture having been damaged along its length, one can still see a mushroom tree inside the city walls (altogether similar to the previous one); a couple of men are seen climbing the tree and are caught in the act of cutting off the mushrooms with knives (Fig. 17). We see only the hands of the second man; in one hand he is holding the knife. Thus, the point of the mushroom-esoteric message becomes even more believable.

Another mushroom, similar to the one at Vic and identified by J. M. Alarem from Barcelona, can be found in the 11th century fresco from Sant Sadurni d'Osormort, a Catalan church; now kept at the Episcopal Museum in the Catalan city of Vic (not to be confused with the little church in the central French town of Vic mentioned earlier). In this case, too, we see the theme of temptation. The Tree of Knowledge of Good and Evil, with the snake coiled around it, is shown with a normal treelike shape and is seen in the scene to the left of Eve (Fig. 18). A second tree-presumably the Tree of Life - is painted between Eve and Adam and is actually a mushroom tree, with six ochre-colored mushroom caps on the tips; highlighted in white on it are one to four lines that bring the streaking effect of mushrooms to mind. From a stylistic point of view this fresco, belonging to the "Osormort Maestro" series, was linked with the frescos from the Saint-Savin crypt, even though there is a chronological hiatus of at least a century between them (Ainaud de Lasarte, 1989: 50-1).

Bennett *et al*. presented the surprising image (Fig. 19) taken from a 14th century alchemical manuscript from the *Bodleian Library* in Oxford (England). They comment as follows: "The alchemical painting show a man intoxicated on *Amanita muscaria* mushrooms. He clutches one mushroom in his [left] hand as he dances about holding his other hand to his forehead as if the revelation is too intense. Behind him a tree grows with a spotted mushroom for a top" (Bennett *et al*., 1995: 240).

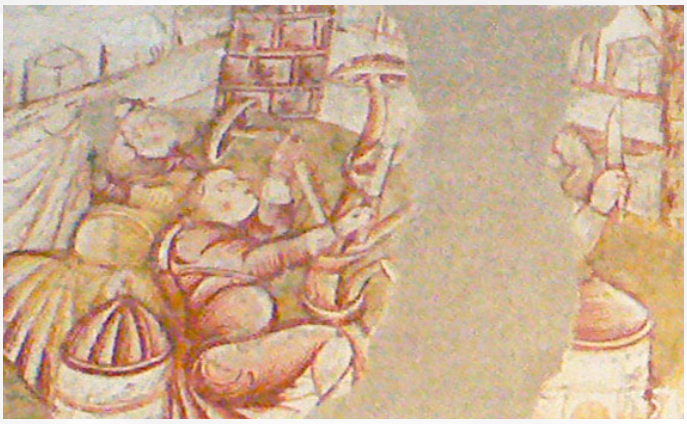


Figure 17. Fresco from the Vic church, with detail of the second "mushroom tree."

The tree in question is a mushroom tree of the Plaincourault variety. It presents the four particularities described in the preceding. The impression is that the man may be dancing; however, he may be swaying as a result of the overpowering effect of the mushroom. This latter impression is confirmed by the fact that his hand is on his forehead in the typical manner of a person in a state of mental confusion, inebriation, or dizziness. These signs are characteristic of the onset of the effects of fly agaric. If we follow this line of interpretation, and accept Benneu's hypothesis that the object in the man's left hand is also a mushroom, we are justified in thinking that the author of this manuscript intended to draw the tree with the semblance of a mushroom, and not just any mushroom; it is *A. muscaria*. This very picture, which we might consider an alchemical puzzle, parts of which we are trying to uncover, includes other interesting symbols. Beside the Amanita-tree we see one salamander, and another one above a fire. Here we find the first confirmation of something I personally have suspected for some time now, and that is that the salamander in certain circles engaged in alchemical studies during the Middle Ages may have been a secret symbol for fly agaric (due perhaps partly to the fact that the cap of the mushroom and the skin of the salamander are both maculate).

I have recently identified another mushroom tree on a capital in the famous Romanesque basilica at Vézelay, this too in central France. This basilica 's hundred capitals dating back to ca. 1135 are well known and are probably the work of one sculptor.

In Fig. 20 we see capital no. 50 with scenes from the biblical account of the struggle between David and Goliath (*I Samuel*, 17). The anterior face shows David decapitating the Philistine giant with his sword; on the right side, instead, we have the next scene in which David carries the head of the giant on his shoulders as a trophy he will display to King Saul in Jerusalem. The artist sculpted a mushroom tree by David's side in this scene and, if we look carefully, we may note that David, carrying Goliath's head, is walking on some leaves, one of which belongs to the mushroom tree.

This mushroom tree might be considered of the "Saint-Savin" type, given the evident striatures on the caps of the mushrooms, but here we have only two, and we are tempted to search for the third mushroom. Consider Goliath's helmet in the preceding scene. The shape and striatures (grooves, or fluting) of the helmet are quite similar to those of the two mushroom caps of the mushroom trees. If we examine one side of the capital and bear in mind that it is located well above the viewer, the "illusion" created - if we may call it that - is of a mushroom tree with three caps. For reasons of space, artists often had to eliminate details from scenes and would not hesitate to superimpose motifs and sequences otherwise represented in chronological order and therefore separately.

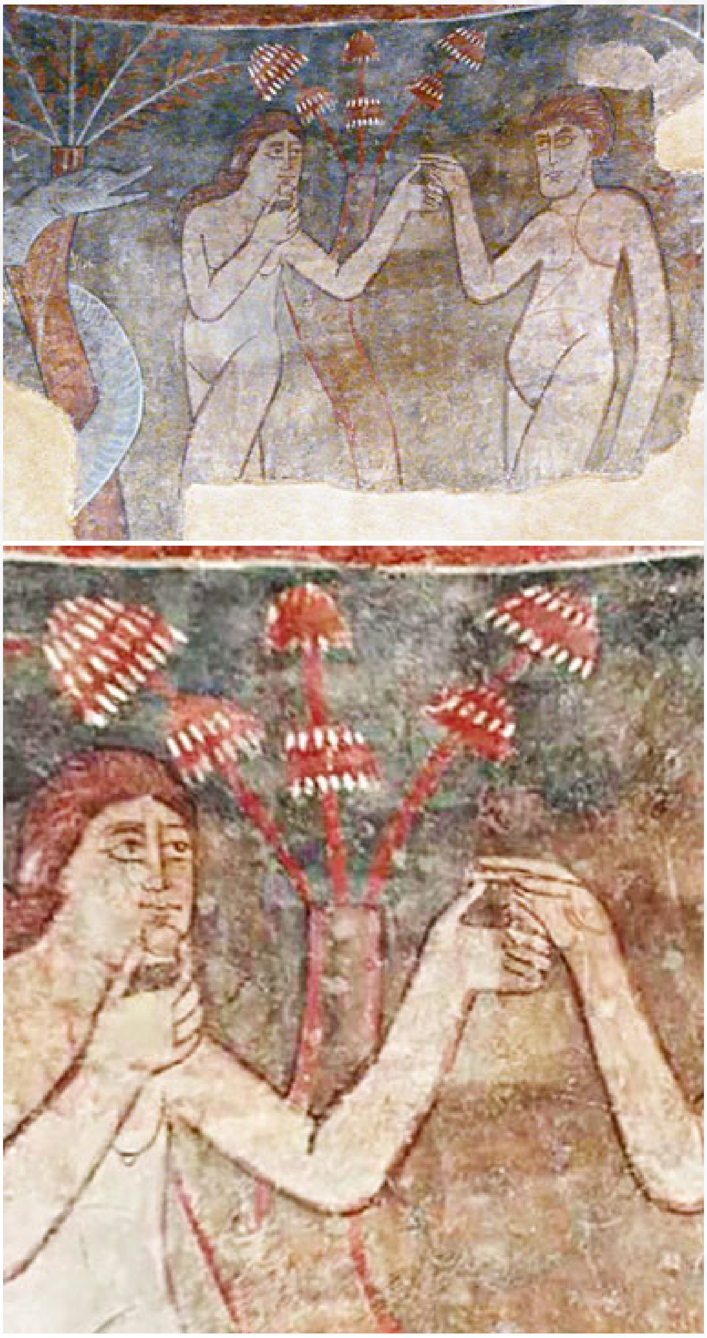


Figure 18. Romanesque fresco from the Catalan Sant Sadurni d'Osormort's church, Spain (12th century).

Considering this Vézelay capital, one might also be tempted to interpret the object that can only just be seen under David's foot on the anterior face as the "third mushroom." Thoumieu (1997: 149) comments: "David is so small compared to the giant that he has to climb up a sort of plant in order to decapitate him." This plant might be taken for one of the many decorative leaf motifs that are a feature of the Vézelay stonework. But it has a stalk and can hardly be thought of as a branch or petiole, and therefore might be a mushroom. If this is the case, the esoteric message is unfolded before our eyes: to gain enough strength to decapitate Goliath (allegory of the struggle between good and evil), David must "ascend" by means of something that will "imbue" him with courage and strength.

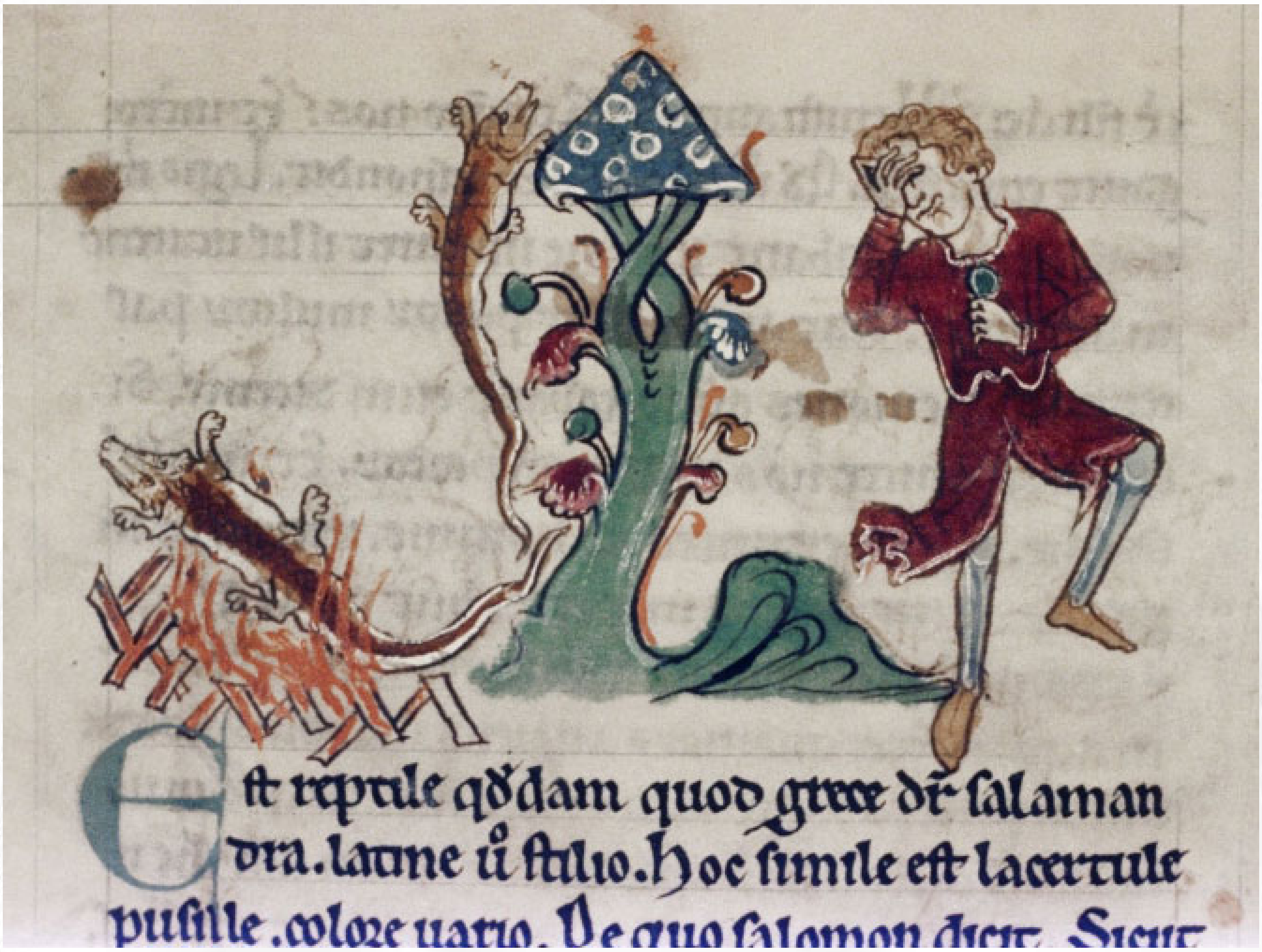

Est reptile qđdam quod grece dr salaman
dra. latine ū stilio. Hoc simile est lacertule
pusille. colore uario. De quo salomon dicit. Sicut

Figure 19. Painting from a 14th century alchemical manuscript (Bodleian Library, Oxford).

Mushrooms, the form of which is the same as that of the mushroom tree in capital no. 50, appear in the foliage of other capitals in the same basilica. The wealth of allegorical and esoteric material in each scene is evident and, indeed, has been fully acknowledged by all scholars active in this field.

In some cases we find ourselves before images of veritable mushrooms, rather than mushroom trees, as is the case with some of the above mentioned Vézelay capitals, or in the paleo-Christian mosaics in Aquileia.

I wish to refer to the observations made by Franco Fabbro (1999) on one of the mosaics of the paleo-Christian basilica of Aquileia in northern Italy (the Friuli-Venezia Guilia region). The mosaic forms part of the oldest paleo-Christian part of the basilica, known as the "*Cripta degli Seavi*,"dating to 314 A.D. (Marini, 1994). Among the various subjects - animals, crosses, geometric symbols - we may note a basket containing mushrooms (Fig. 21). Here, we have no mushroom tree but mushrooms themselves, represented as such by the artist.

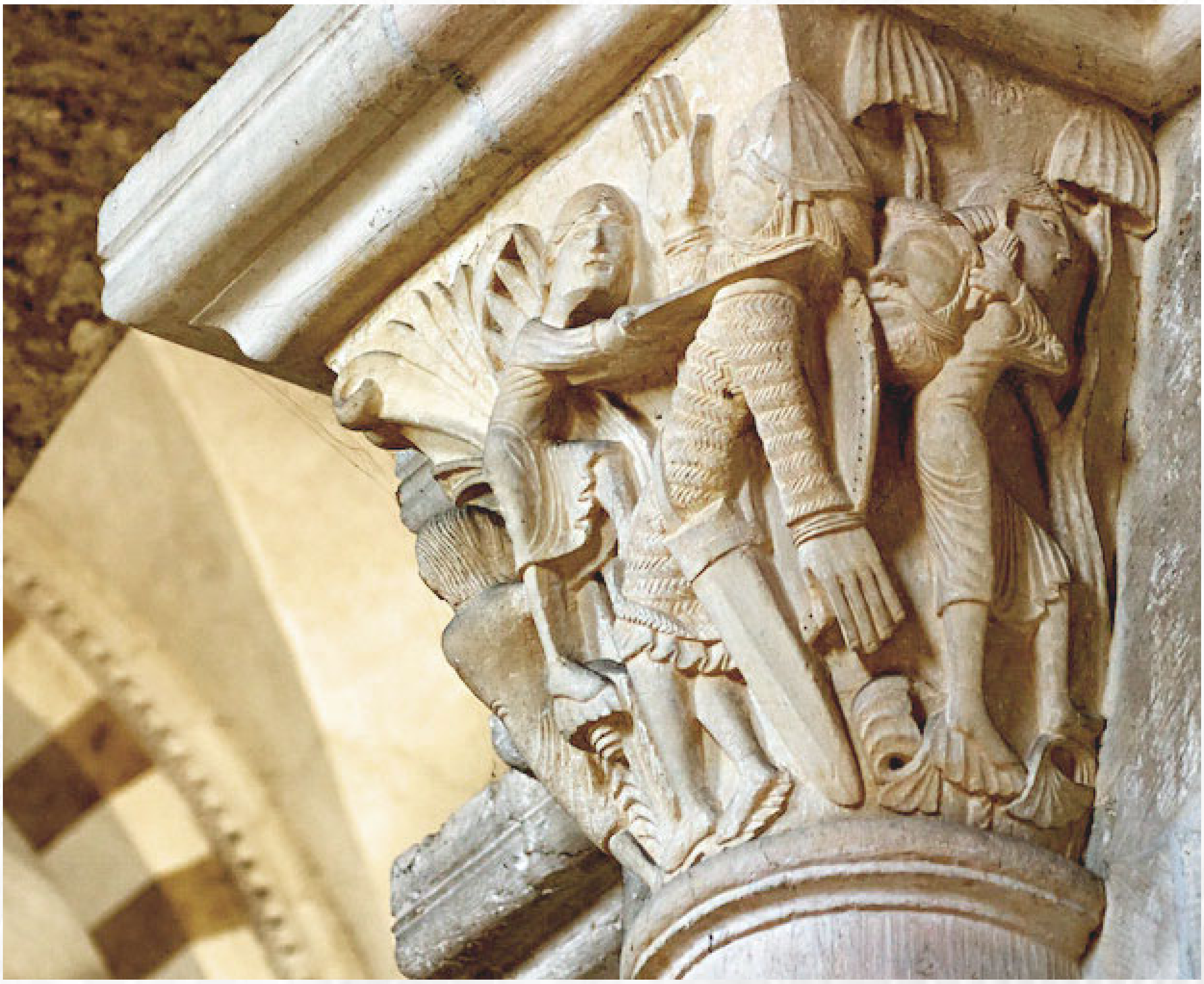


Figure 20. Romanesque capital from the basilica of Vézelay, Central France (12th century).

Fabbro appears to have no doubts as to the species of mushroom presented: fly agaric. Indeed, he is perhaps too self-assured and hasty in his conclusion that this Aquileia "find" provides corroborative evidence that the early Christians used fly agaric.

As Francesco Festi of the *Museo Civico* in Rovereto and I concluded (cit. in Samorini, 1998c), the mushrooms represented in the Aquileia mosaic were probably *Amanita caesarea*, also known as *ovulo buono* (royal agaric), an edible mushroom considered a delicacy by the ancient Romans and often included in the figurative works of the Roman imperial period. We based our view on the fact that the mushroom stalks are yellow and not white, this being one of the distinguishing marks between these two species. However, after paying a visit to the basilica J did note that the part of the mosaic corresponding to the inside of the caps, the gills, is white, as are the gills of the fly agaric, and not yellow (as in the royal agaric). Furthermore, while the gills of the royal agaric are always yellow, in some cases the gills and stalk of fly agaric present gradations of yellow (Arietti and Tomasi, 1975: 106). It was also noted that the artist had circumscribed the various areas of the mosaic to be filled in with different colors with dark-colored fragments, which means that the wrong color of fragment would not be able to make its way into another circumscribed zone of another color. Therefore we may conclude that the artist wished to portray these mushrooms specifically with white gills, and that there is good reason to doubt that these mushrooms are in fact *A. caesarea*. Another feature of this mosaic is that two of the eight mushrooms have stalks that are not entirely yellow but also white.

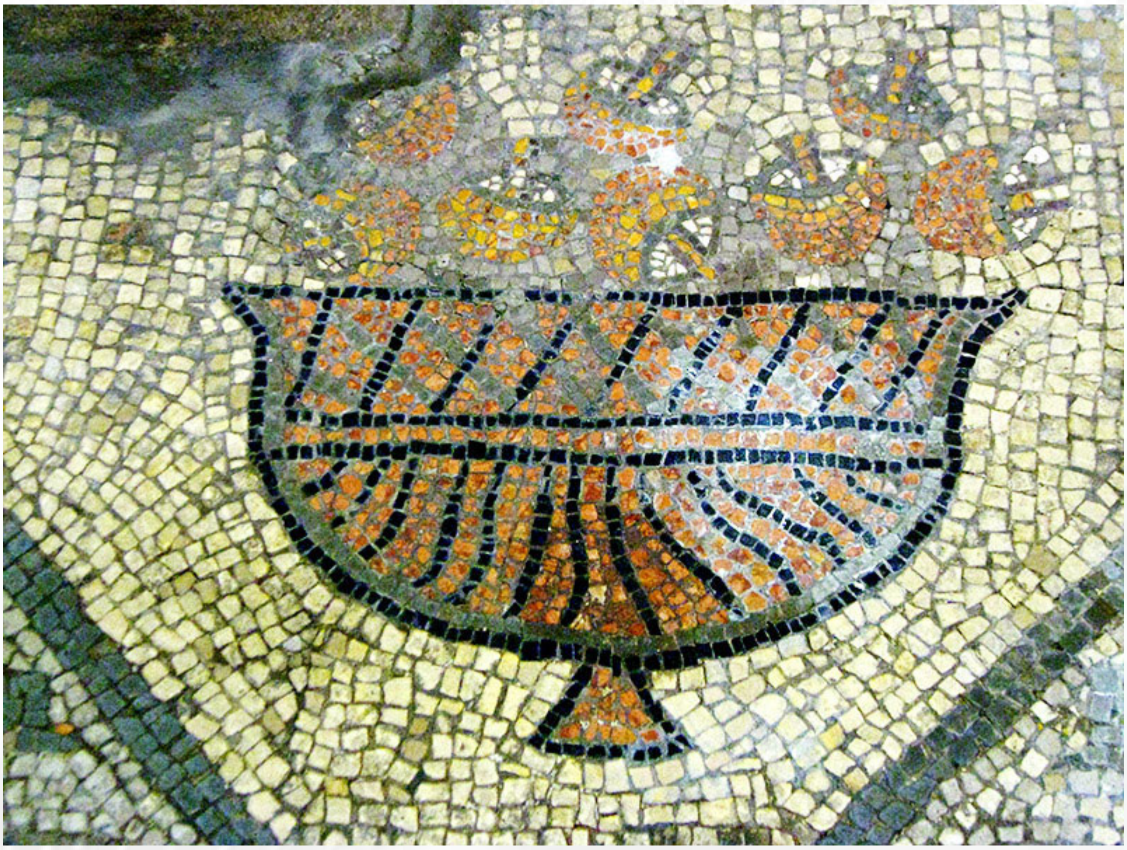


Figure 21. Mosaic from the paleo-Christian church of Aquileia. Northern Italy (4th century).

The Aquileia mushrooms would therefore appear not to be explicitly represented as belonging either to the fly or the royal agaric species. Representation of the royal agaric would not call for subterfuge, but fly agaric would. However, this may be yet another species of mushroom or quite simply a generic "mushroom." It has been hypothesized that the mosaic represents the food (including mushrooms) the faithful consumed during agapés (mysterious ritual feasts held by early Christians) (Brusin and Zovatto, 1957, cit. in Fabbro, 1999).

It is hard to reach a definite conclusion regarding the enigmatic presence of such mushroom symbols - in some cases clearly hallucinogens - in Christian art.

Although I try to be open to further potential interpretations, I have the tendency to consider these documents in a far broader context that foes beyond Christian culture. I see a religious, philosophical, and esoteric "mycological tradition" that holds in itself the knowledge and use of hallucinogenic mushrooms, with different cultural pathways and mushroom species. This knowledge originated in the most ancient times and was carried on throughout the centuries. In one century it will have been brought forward by Mitra disciples, in another we would see it in certain Gnostic sects; in yet another it would have been the Celtic druids or the Etruscan priests, or even the Dyonisos followers or followers of some Jewish alchemist scholar. In some cases, disciples of the mycological tradition will have been persecuted and forced to worship in secret, like certain European medieval sorcerers or some Christian sects considered to be heretical by the central ecclesiastical powers. Before Christ and after, both within and without Christianity, the tradition has been preserved, taking more than one direction in the tangle of Eurasian cultures, a tradition that was tenacious and unwilling to die out. The Mexican case is a perfect example: in it, the enteogenic mushroom cult, which was believed to have disappeared centuries before, wiped out by the colonial Inquisition, actually survived and made it to modem times.

It is in such a context that one can try to explain the references to the knowledge of psychoactive mushrooms within the vast Christian culture. The latter should not be seen as an inviolable cultural monolith, but rather as a "cultural pattern" that was repeatedly merged, both locally and marginally, with traditional cults or arts such as alchemy, in which Christians encountered the sacrament of "mycological tradition," expressing it in esoteric form in church frescos or alchemic books.

By following a transcultural path, the tradition has been perpetuated over centuries and millennias; the required faith has been continually revived by the direct experience of revelation and enlightenment provided by the sacrament. Many cults, religions, beliefs, and rituals of all ages, but one sacrament: the holy mushrooms.

References

1. **AA. VV. 1986.** *Arte Preistorica del Sahara.* De Luca and Mondadori, Roma and Milana.
2. **Ainaud De Lasarte J. 1989.** *La Pintura Catalana.* La Fascinació del Romanie, Carroggio, Barcelona.
3. **Arietti N., and Tomasi R. 1975.** *I Funghi Velenosi.* Edagricole, Bologna.
4. **Baumann H. 1993.** *Greek Wild Flowers and Plant Lore in Ancient Greece.* Herbert, London.
5. **Bennett C., Osburn L., and Osburn J.** 1995. *Green Gold the Tree of Life. Marijuana in Magic and Religion.* Frazier Park, CA, Access Unlimited.
6. **Charbonneau-Lassay L. 1994.** *Il Bestiario del Cristo.* 2 vol. Arkeios, Roma.
7. **Charbonneau-Lassay L. 1997.** *Le Pietre Misteriose del Cristo.* Arkeios, Roma.
8. **Duvivier P. 1998.** *Amanita muscaria* ancient history. *Entheogen. Rev.*, 7, 34-35.
9. **Fabbro F. 1999.** Funghi e chioeciole nei rituali religiosi dei primi Cristiani di Aquileia. *Eleusis,* n.s., **3,** 69-81.
10. **Fantar M. H. (ed.) 1995.** *I Mosaici Romani di Tunisia.* Milano, Jaca Book.
11. **Festi F. 1985.** *Funghi Allucinogeni. Aspetti Psicofisiologici e Storici.* Rovereto, Musei Civici.
12. **Gartz J. 1996.** *Magic Mushrooms Around the World.* Los Angeles, CA, LIS.
13. **Grabar A., and Nordenfalk C. 1958.** *Romanesque Painting. XI-XIII Centuries.* Lausanue (Suiza), Skira.
14. **Graves R. 1994 (1957).** *La Comida de los Centauros y Otros Ensayos.* Madrid, Alianza.
15. **Guzmán G., Allen J. W., and Gartz J. 2000.** A worldwide geographical distribution of the neurotropic fungi. An analysis and discussion. *Ann Mus Civ Rovereto,* **14,** 189-280.
16. **Heim R. 1978.** *Les Champignons Toxiques et Hallucinogènes.* Boubée, Paris.
17. **Heinrich C., Ruck C. P., and Staples B. D. 1999.** Perseus, the mushroom picker. *Eleusis,* **2,** 25-56.
18. **Huys-Clavel V. 1996.** *La Madeleine de Vézelay.* Coherénce du décor sculpté de la nef, Comp'Act, Chambéry.
19. **Krishna I. L. A. 1967.** *Kerala Megalithic and Their Builders.* Madras, University of Madras.
20. **Lhote H. 1988.** *A la Découverte des Fresques du Tassili.* Arthaud, Paris.
21. **Longhurst A. H. 1979.** *The Story of the Stupa.* New Delhi, Asian Educational Services.
22. **Lowy B. 1981.** Were mushroom stones potter's molds? *Rev Interamer,* **11,** 231-237.
23. **Lumley H. de et al. 1990**. La stèle gravé dite du "Chef de Tribu," dans la région du Mont Bego, Vallées des Merveilles, Alpes Maritimes. *L'Anthropologie,* **94,** 3-62.
24. **Marini G. (cur.) 1994.** *La Basilica Patriarcale di Aquileia.* SO.Co.BA., Aquileia.
25. **Morgan A. 1995.** *Toads and Toadstools.* Celestial Arts, Berkeley, CA.
26. **Mori F. 1975.** Contributo al pensiero magico-religioso attraverso l'esame di alcune raffigurazioni rupestri preistoriche del Sahara. *Valcamonica Symp, '72,* 344-366.
27. **Muzzolini A. et al. 1991.** Essai de classification de peintures de l'Immidir (Algérie). *Sahara,* **4,** 135-140.
28. **Natarajan K., and Raman N. 1983.** *South Indian Agaricales,* Vaduz, Cramer.
29. **Oursel R. 1984.** *Haut-Poitou Roman.* Ab. S.Marie de la Pierre-qui-Vire, Zodiaque.
30. **Puech H.-C. 1949.** Le cerf et le serpent. *Cah Archéol,* **4,** 17-60.
31. **Riou Y.-J. 1992.** *L'abbaye de Saint-Savin-sur-Gartempe.* L'Inventaire, Ministère de l'Education et Culture.
32. **Ruck C. P., and Staples D. 1999.** Vischio, Centauri e Datura. *Eleusis,* n.s., **2,** 3-23.
33. **Samorini G. 1989.** Etnomicologia nell'arte rupestre Sahariana (Periodo delle "Teste Rotonde"). *Boll Camuno Notiz,* **6,** 18-22.
34. **Samorini G. 1992.** The oldest representations of hallucinogenic mushrooms in the world (Sahara Desert, 9000-7000 B.P.). *Integration,* **2-3,** 69-78.
35. **Samorini G. 1995a.** *Gli Allucinogeni nel Mito.* Raceonti sulle origini delle piante psicoattive, Torino, Nautilus.
36. **Samorini G. 1995b.** Umbrella-stones or mushroom-stones? (Kerala, southern India). *Integration,* **6**, 33-40.
37. **Sarnorini G. 1995c.** Traditional use of psychoactive mushrooms in Ivory Coast?, *Eleusis.* 1, 22-27.
38. **Samorini G. 1997.** The mushroom tree of Plaincourault. *Eleusis,* **8,** 29-37.
39. **Samorini G. 1998a.** The Pharsalus bas-relief and the Eleusinian Mysteries. *Entheogen. Rev.*, 7, 60-63.
40. **Samorini G. 1998b.** Further considerations on the mushroom effigy of Mount Bego. *Entheogen Rev* 7, 35-36.
41. **Samorini G. 1998c.** The mushroom trees in Christian art. *Eleusis,* n.s., 1, 87-108.
42. **Samorini G. 2001.** *Funghi Allucinogeni. Studi Etnomicologici.* Telesterion, Vicenza.
43. **Samorini G. *et al.* 1995.** Rappresentazioni fungine nell'arte greca. *Ann Mus Civ Rovereto,* 10, 307-326.
44. **Sansoni U. 1994.** *Le più Antiche Pitture del Sahara. L'Arte delle Teste Rotonde.* Jaea Book, Milano.
45. **Soubrillard Y. 1992.** *Souleymane le Guérisseur ou le Pouvoir des Plantes.* Paris. L'Harmattan.
46. **Thille F. 1990.** *Au Coeur de la Forêt Vierge.* Albin Michel, Paris.
47. **Thoumieu M. 1997.** *Dizionario d'Iconografia Romanica .* Jaca Book, Milano.
48. **Wasson R. G. 1968.** *Soma. Divine Mushroom of Immortality.* New York. HBJ.
49. **Wasson R. G. 1980.** *The Wondrous Mushroom. Mycolatry in Mesoamerica,* New York, McGraw-Hill.
50. **Wasson V. P., and Wasson R. G. 1957.** *Mushroom, Russia and History,* 2 vols. New York, Pantheon.
51. **Wasson R. G., Hofmann A., and Ruck C. P. 1978.** *The Road to Eleusis. Unveiling the Secret of the Mysteries.* New York, HBJ.
52. **Wasson R. G. et al. 1986.** *Persephone's Quest. Entheogens and the Origins of Religion.* New Haven & London, Yale University.

Entheogens in Christian art: Wasson, Allegro, and the Psychedelic Gospels

by

Jerry B. Brown[1*] and Julie M. Brown[2]

Received: April 26, 2019; accepted: June 11, 2019; First published online: September 9, 2019

Journal of Psychedelic Studies 3(2), pp. 142-163 (2019) DOI: 10.1556/2054.2019.019

© 2019 The Author(s)

original report: https://philpapers.org/archive/BROEIC-5.pdf
backup source: https://www.psilosophy.info/resources/BROEIC-5.pdf

[1] Retired, Department of Global & Sociocultural Studies, Florida International University, North Miami, FL, USA
[2] Independent Author and Researcher

Corresponding author: Jerry B. Brown, PhD; Retired, Department of Global & Sociocultural Studies, Florida International University, 12555 Biscayne Blvd., Suite 952, North Miami, FL 33181, USA; Phone: +1 305 321 5612; E-mail: jbbrown@gate.net

Table of Contents:

- **Abstract**
- **Introduction**
- **Wasson-Allegro controversy**
  - End of the road for Allegro
- **Chapel of Plaincourault, Central France**
  - Mushroom tree in Eden, Plaincourault
- **Samorini's mushroom tree typology**
- **Entheogens in christian art**
  - Saint Martin de Vicq, Central France
  - Purification of Isaiah's lips
- **Psychedelic gospels theory**
  - Chartres Cathedral, France
  - Canterbury Cathedral, England
  - Saint Michael's Church, Germany
- **Entheogens and early Christianity**
- **Critiques of the psychedelic gospels theory**
  - Ignorance by art historians
  - Overenthusiasm by ardent advocates
  - Oversimplification by medieval historians
  - Overture by conservative Christians
- **Interdisciplinary committee on psychedelic gospels**
  - Wasson's paradox
  - Call for an interdisciplinary committee
- **Conclusions**
- **References**

Abstract

In light of new historical evidence regarding ethnomycologist R. Gordon Wasson's correspondence with art historian Erwin Panofsky, this article provides an in-depth analysis of the presence of entheogenic mushroom images in Christian art within the context of the controversy between Wasson and philologist John Marco Allegro over the identification of a Garden of Eden fresco in the 12th century Chapel of Plaincourault in France. It reveals a compelling financial motive for Wasson's refusal to acknowledge that this fresco represents *Amanita muscaria*, as well as for Wasson's reluctance to pursue his hypothesis regarding the entheogenic origins of religion into Christian art and artifacts. While Wasson's view - that the presence of psychoactive mushrooms in the Near and Middle East ended around 1000 BCE - prevailed and stymied research on entheogens in Christianity for decades, a new generation of 21st century researchers has documented growing evidence of *A. muscaria* and psilocybin-containing mushrooms in Christian art, consistent with ethnobotanist Giorgio Samorini's typology of mushroom trees. This article presents original photographs, taken during fieldwork at churches and cathedrals throughout Europe and the Middle East, that confirm the presence of entheogenic mushrooms in Christian art: in frescoes, illuminated manuscripts, mosaics, sculptures, and stained glass windows. Based on this iconic evidence, the article proposes a psychedelic gospels theory and addresses critiques of this theory by art historians, ardent advocates, medieval historians, and conservative Catholics. It calls for the establishment of an Interdisciplinary Committee on the Psychedelic Gospels to independently evaluate the growing body of evidence of entheogenic mushrooms in Christian art in order to resolve a controversial question regarding the possible role of entheogens in the history and origins of Christianity.

Keywords: Allegro, Christian art, Christianity, entheogens, psychedelics, Wasson

Introduction

The articles in this Special Issue on "*Psychedelics in History and World Religions*" offer compelling documentation of entheogen use in prehistorical and historical societies. Winkelman's review of the literature and summary of articles in this issue (see "*Introduction: Evidence for Entheogen Use in Pre-History and World Religions*") demonstrates that:

1. The entheogenic encounters that inspired the evolution of shamanism continued in the practices of historical and contemporary religions - Hinduism, Buddhism, Jainism, Judaism, Islam, and Christianity - providing widespread confirmation of entheogens in the formation of the major world religions, which often left evidence of these practices in art.
2. There is growing visibility in the past two decades of additional representations of psychedelic mushrooms in Christian art (see Brown & Brown, 2016; Hoffman, Ruck, & Staples, 2002; Irvin, 2008; Rush, 2011; Ruck, Staples, & Heinrich, 2001).

In this context, the major goals of this article are to provide an in-depth analysis of the "psychedelic gospels theory" regarding the presence of entheogenic mushroom images in early and medieval Christian art by:

1. Revisiting the Wasson-Allegro controversy in the light of new evidence, especially as it relates to the questions of psychoactive mushrooms in Christianity and the identification of an *Amanita muscaria* mushroom in the medieval Chapel of Plaincourault in France;
2. Presenting evidence of entheogens in Christian art and proposing the theory of the psychedelic gospels based on the authors' field research at abbeys, churches, chapels, and cathedrals in Europe and the Middle East;
3. Replying to critiques of the psychedelic gospels theory by art historians, ardent advocates, medieval historians, and conservative Christians.
4. Resolving "Wasson's paradox" and calling for the establishment of an Interdisciplinary Committee on the Psychedelic Gospels.

Wasson-Allegro controversy

The controversy between ethnomycologist R. Gordon Wasson (1898-1986) and philologist John Marco Allegro (1923-1988) over psychoactive mushrooms in Christianity in general, and over the identification of an *A. muscaria* mushroom (commonly known as "fly agaric") in the 12th century Chapel of Plaincourault in Central France in specific, has cast a lasting shadow over the study of entheogens in Christian art - a shadow that has shaped "*the academic response to Allegro's book and the opinions of subsequent generations of scholars*" (Winkelman, 2010, p. 106).

The significance of the identification of the mushroom tree in Plaincourault as a psychoactive mushroom is a landmark in psychedelic studies because it was the catalyst for the seminal debate between Wasson and Allegro about the role of entheogens in Christianity. If Wasson were right, then entheogens, especially sacred mushrooms, were only found at the very early stages of Judeo-Christianity ending around the time of Genesis, about 1000 BCE. However, if Allegro were right, then entheogens were integral to the origins of Judeo-Christianity with their usage persisting at least into medieval times, as evidenced by the Plaincourault fresco that was painted after 1000 CE. This positive identification of entheogens in Christian art would open the door to a line of inquiry that could ultimately require a reconsideration of the history of Christianity.

In his masterwork, *Soma: Divine Mushroom of Immortality* (1968), Wasson identifies the elusive Soma plantgod-juice of the Hindu *Rigveda* as the psychoactive *A. muscaria* mushroom. While concluding that mushrooms played a role in the religious life of our remote ancestors, Wasson (1970b, September 25) proclaims that "*My book brings the role of the fly agaric in the Near and Middle East down to 1000 B.C.*"

To defend this conclusion, Wasson had to come to terms with "a fly-agaric in the ointment": the controversial image of a large mushroom tree placed in the center of a medieval fresco depicting Adam and Eve in the Garden of Eden. Wasson first saw this late 13th century wall painting during his visit to the Chapel of Plaincourault on August 2, 1952. He later presented a drawing of this fresco as a color plate in *Soma* (Wasson, 1968, p. 180). Figure 1 is an unaltered photograph of the same fresco that we took during our visit to this chapel on July 19, 2012.

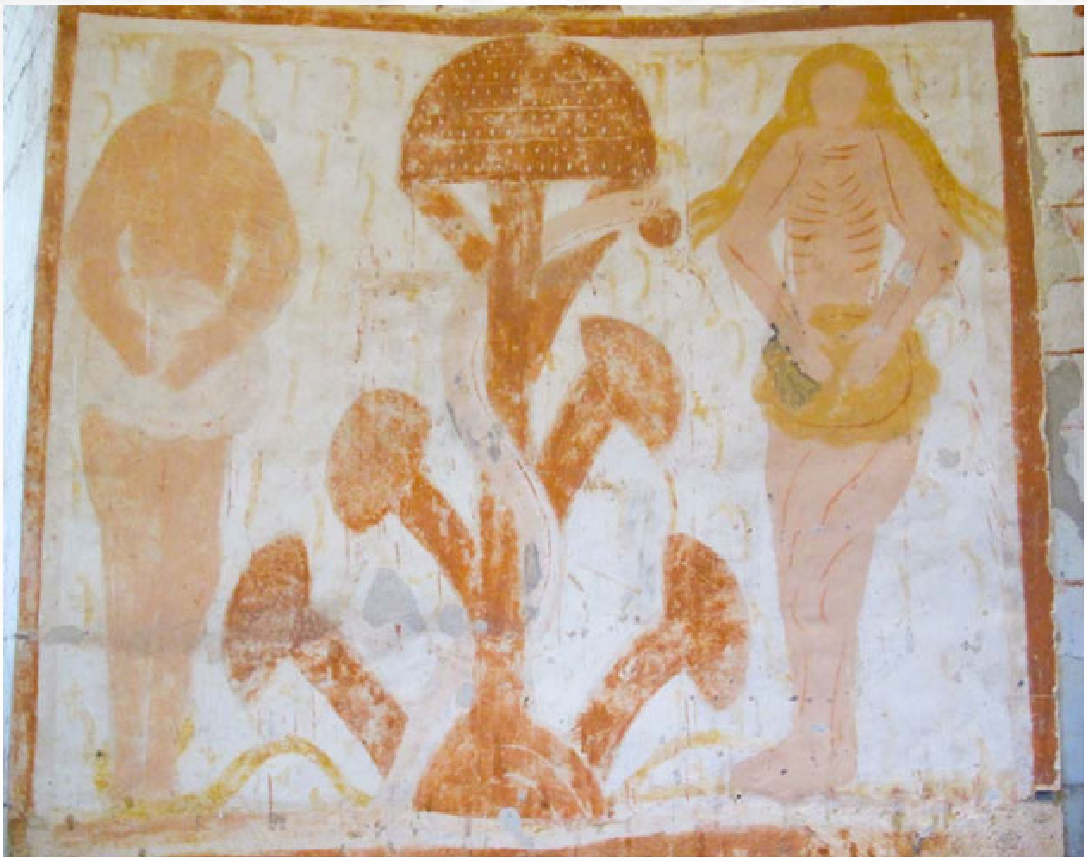


Figure 1. Temptation in the Garden of Eden, Chapel of Plaincourault, Indre, Central France, *ca.* 1291 (photo by Julie M. Brown)

Previous French observers had interpreted this image as a mushroom or mushroom tree. Writing around 1900, Abbot Rignoux describes this fresco as a "mushroom-tree with several heads." Soon afterward, a photograph of this fresco was shown at a meeting of the Société Mycologique de France on October 6, 1910. The gentleman who presented the fresco made what was then the sensational observation that "*instead of the customary Tree, the artist had given us the fly-agaric*" (Wasson, 1968, p. 179). More recently, the official guide book "Mérigny-Indre, Chapelle de Plaincourault" makes note of the "*tree of original sin depicted as an enormous mushroom*" (2009, p. 7).

Sacred mushroom seeker R. Gordon Wasson disagreed with these conclusions. Arguing that "The mycologists would have done well to consult art historians," Wasson (1968) cites a May 2, 1952 letter received from Erwin Panofsky, who has been lauded as "*the most influential art historian of the twentieth century*" (Smith, 2005, p. XXVII):

> *... the plant in this fresco has nothing whatever to do with mushrooms ... and the similarity with Amanita muscaria is purely fortuitous. The Plaincourault fresco is only one example - and, since the style is very provincial, a particularly deceptive one - of a conventionalized tree type, prevalent in Romanesque and early Gothic art, which art historians actually refer to as a "mushroom-tree" or in German*, Pilzbaum (Wasson, 1968, pp. 179-180).

In affirming that "*Professor Panofsky gave expression to what I have found is the unanimous view of those competent in Romanesque art*," Wasson (1970a, August 21) defers to the authority of art historians to close the door on the matter. In short, Plaincourault is categorically not a mushroom.

In opposition to Wasson, John Marco Allegro, a renowned Dead Sea Scrolls scholar, contended that this was clearly an *A. muscaria* mushroom. Writing in *The Sacred Mushroom and the Cross* (*The Sacred Mushroom*) 2 years after the publication of Wasson's *Soma*, Allegro (1970) states:

> *The prime example of the relation between the serpent and the mushroom is, of course, in the Garden of Eden story of the Old Testament. The cunning reptile prevails upon Eve and her husband to eat of the tree, whose fruit "made them as gods, knowing good and evil" (Gen 3:4). The whole Eden story is mushroom-based mythology, not least in the identity of the "tree" as the sacred fungus, as we shall see. Even as late as the thirteenth-century some recollection of the old tradition was known among Christians, to judge from a fresco painted on the wall of a ruined church in Plaincourault in France (pl. 2). There the Amanita muscaria is gloriously portrayed, entwined with a serpent, whilst Eve stands by holding her belly.* (p. 80)

Therefore, there began the furious "battle of the mushroom-trees." In a 1970 letter to the *Times Literary Supplement*, Wasson (1970a, August 21) publicly attacked Allegro's interpretation of the Plaincourault mushroom tree as an *A. muscaria*: "*Presumably he [Allegro] had read the footnote in which I dismissed the fresco on page 87 of Mushrooms, Russia and History and, more specifically, Panofsky's letter reproduced on page 179 of SOMA. He chooses to ignore the interpretation put on this fresco by the most eminent art historians.*"

Nevertheless, we find a certain disingenuousness in Wasson's position. While he famously cites this first Panofsky letter of May 2, 1952 - a letter that has often been quoted in academic discussions of Wasson and Allegro - to the best of our knowledge, Wasson never refers to or quotes the second Panofsky letter written shortly after on May 12, 1952. We obtained copies of both letters from the Tina and R. Gordon Wasson Ethnomycological Collection Archives (Wasson Archives) and believed this is the first time they have both been displayed together in print (see Figures 2 and 3).

Of great and until now overlooked historical significance for the Wasson-Allegro controversy is the fact that in this second letter Panofsky takes a step back and on reflection qualifies his initial categorical rejection of the Plaincourault fresco as *A. muscaria*. In the May 12 letter (Figure 3), Panofsky (1952) states:

> *The only possibility I should be prepared to admit is that, once the transformation [the development from pine tree to 'Pilzbaum'] had taken place and was generally accepted in art, some especially ignorant craftsman may have misunderstood the finished project, viz., the "Pilzbaum," as a real mushroom. But even that is not very probable because even the most*

> *mushroom-like specimens show some traces of ramification; if the artists had labored under the delusion that the model before him was meant to be a mushroom rather than a schematized tree he would have omitted the branches altogether.*

In the second sentence of this quote, Panofsky commits the logical fallacy of assuming the conclusion because *A. muscaria* mushrooms are often found growing in clusters. Given the lack of perspective in Romanesque art, this could be a two-dimensional representation by the artist of a mature *A. muscaria* surrounded not by "branches" but by four recently emerged smaller mushrooms.

This omission looms large in the context of Wasson's campaign not only to refute Allegro's claims but to unfairly discredit him. For example, in this same letter that appeared in the *Times Literary Supplement* Wasson (1970a, August 21) states, "*Mr. Allegro is not a mycologist but, if anything, a cultural historian.*"

As Irvin (2008) notes in his in-depth analysis of the Wasson-Allegro schism,

> *Wasson doesn't just say Allegro is not a mycologist, the likes of which he's just put down, but includes the caveat "if anything," purely as an insult to Allegro. Wasson himself was a banker and not a professional mycologist or art historian. Allegro, contrary to the image that Wasson wants to portray of him, was an eminent cultural historian, theologian, and philologist.* (p. 11)

End of the road for Allegro

After the publication of *Soma* (1968), Wasson's second career as an ethnomycologist flourished. He subsequently coauthored seminal studies of entheogens in ancient and contemporary religion, including *María Sabina and Her Mazatec Mushroom Velada* (1974), *The Road to Eleusis: Unveiling the Secret of the Mysteries* (1978), and shortly before his death *Persephone's Quest: Entheogens and the Origins of Religion* (1986). As accolade followed accolade, Wasson was acclaimed as "*the father of modern ethnomycology" and, like it or not, as a 'founder' of the 1960s psychedelic movement*" (Riedlinger, 1997a, p. 10).

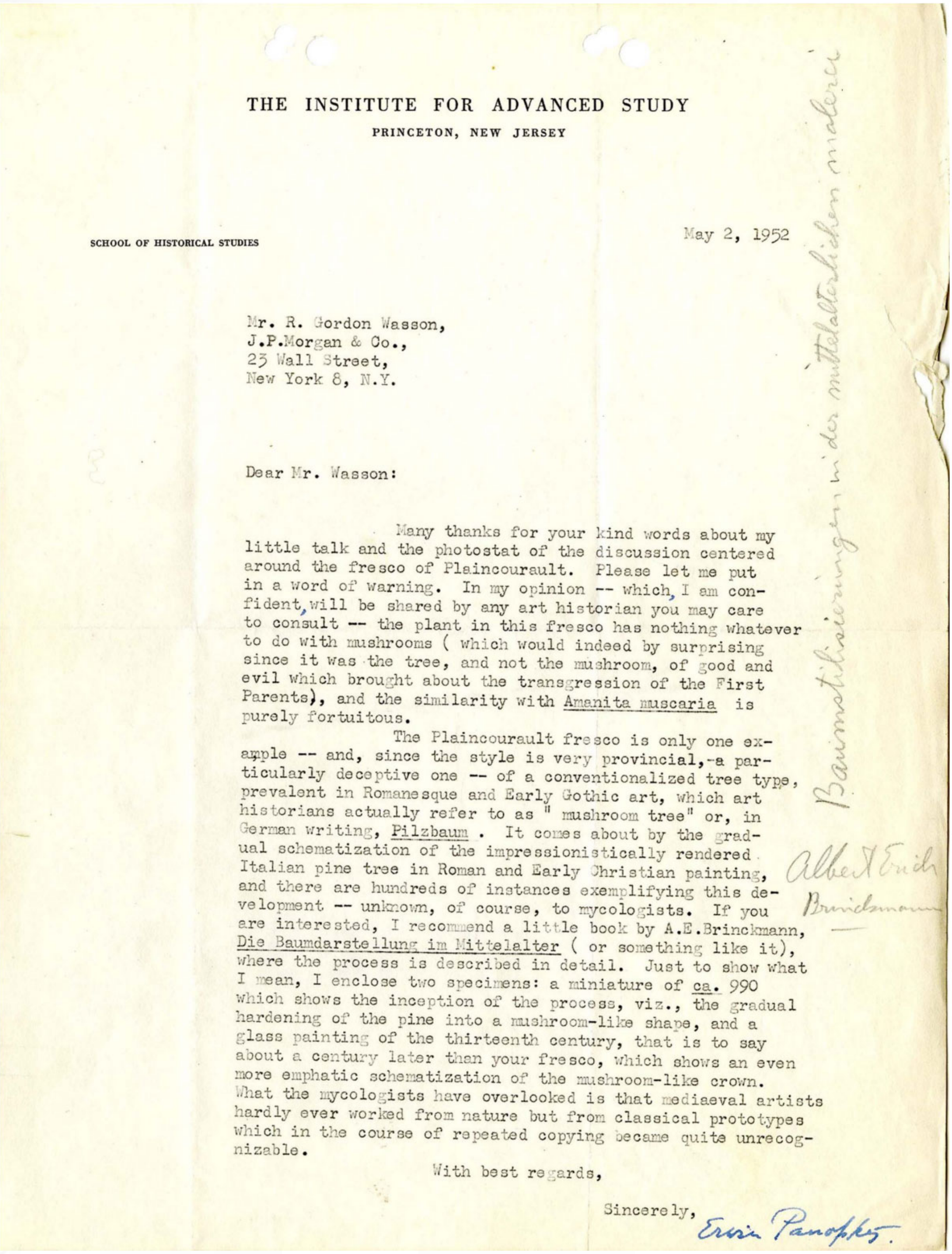
However, of all the praise bestowed on Wasson none was more illustrious than being compared to one of the most brilliant minds in the history of science. The ethnobotanist Ott (1997) praised Wasson as "*a twentieth century Darwin*" (p. 190) noting that, just as Darwin developed a naturalistic theory of evolution to explain the origin and descent of man, so Wasson developed a naturalistic theory of entheogens to explain the origins and diffusion of religion.

Conversely, the publication in 1970 of *The Sacred Mushroom* destroyed Allegro's academic credibility. Until that time, he was well-known as a distinguished philologist and the most controversial member of the scholarly team studying the Dead Sea Scrolls, most of which were written in Hebrew and Aramaic as early as 300 BCE.

The Sacred Mushroom turned Allegro's fleeting fame into infamy and in some circles even into demonization as a radical who was out to destroy the Christian faith. The subtitle said it all: *A Study of the Nature and Origins of Christianity within the Fertility Cults of the Middle East*. As if suggesting that Jesus did not exist ("ahistoricity of Jesus") were not enough, Allegro argued that early Christianity was a fertility cult based on the ingestion of hallucinogenic mushrooms and that Jesus was merely a metaphor for the sacred mushroom. Consequently, he postulated that the entire bible was a "hoax," based on an elaborate secret code woven throughout the story by cryptographers to disguise the mushroom cult.

Certainly, earlier scholars had recognized the significance of entheogens in ancient religious cults that used sacred plants to achieve a sense of continuity with the ancestors and the gods. Yet, Allegro was the first to have the temerity to relate these themes to Judaism and Christianity, tracing their roots linguistically back to the earliest written Sumerian and Semitic language groups.

As Allegro's biographer (and daughter), Judith Anne Brown (2005), points out there were significant difficulties with *The Sacred Mushroom*. First, many of the archaic word derivations were highly speculative and needed further verification, leading to scathing critiques by linguistic experts in biblical languages. Second, the idea that much of the Old and New Testament was a secret code for a mushroom cult was simply too convoluted and improbable. Brown (2005) notes that "*However vast the amount of philological evidence, Christians could* *not accept that the New Testament was little more than a cover-story for the drug-crazed followers of a fungus cult*" (p. 207). "A sensationalist lunatic theory" wrote *The Times* in 1971, reflecting the prevailing public opinion in England (Brown, 2005, p. 213).



THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY

SCHOOL OF HISTORICAL STUDIES

May 2, 1952

Mr. R. Gordon Wasson,
J.P.Morgan & Co.,
23 Wall Street,
New York 8, N.Y.

Dear Mr. Wasson:

Many thanks for your kind words about my little talk and the photostat of the discussion centered around the fresco of Plaincourault. Please let me put in a word of warning. In my opinion -- which, I am confident, will be shared by any art historian you may care to consult -- the plant in this fresco has nothing whatever to do with mushrooms (which would indeed by surprising since it was the tree, and not the mushroom, of good and evil which brought about the transgression of the First Parents), and the similarity with Amanita muscaria is purely fortuitous.

The Plaincourault fresco is only one example -- and, since the style is very provincial, a particularly deceptive one -- of a conventionalized tree type, prevalent in Romanesque and Early Gothic art, which art historians actually refer to as " mushroom tree" or, in German writing, Pilzbaum . It comes about by the gradual schematization of the impressionistically rendered Italian pine tree in Roman and Early Christian painting, and there are hundreds of instances exemplifying this development -- unknown, of course, to mycologists. If you are interested, I recommend a little book by A.E.Brinckmann, Die Baumdarstellung im Mittelalter (or something like it), where the process is described in detail. Just to show what I mean, I enclose two specimens: a miniature of ca. 990 which shows the inception of the process, viz., the gradual hardening of the pine into a mushroom-like shape, and a glass painting of the thirteenth century, that is to say about a century later than your fresco, which shows an even more emphatic schematization of the mushroom-like crown. What the mycologists have overlooked is that mediaeval artists hardly ever worked from nature but from classical prototypes which in the course of repeated copying became quite unrecognizable.

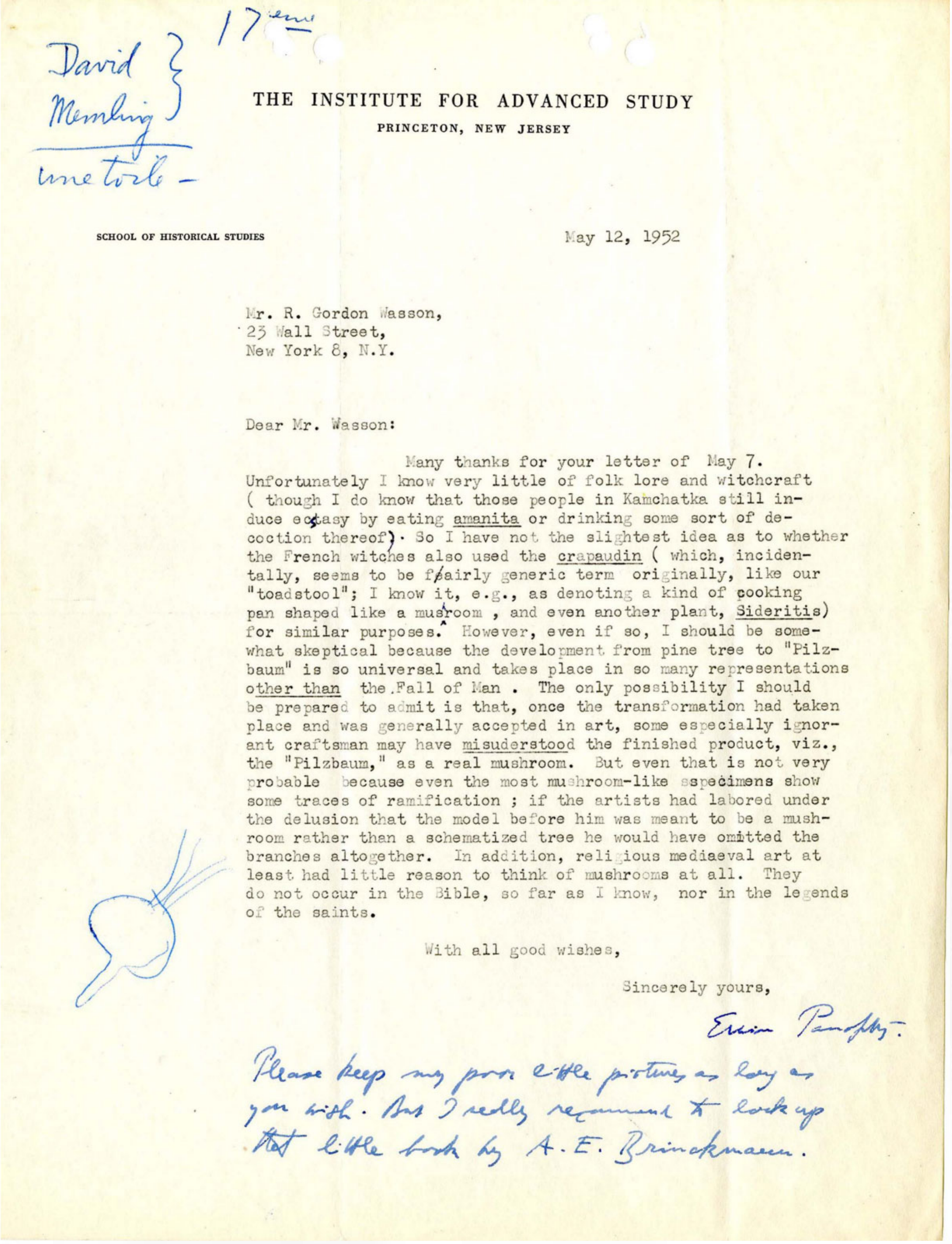
With best regards,

Sincerely,
Erwin Panofsky.

Baumstilisierungen in der mittelalterlichen malerei

Albert Erich
Brinckmann

Figure 2. Letter of Erwin Panofsky to R. Gordon Wasson, May 2, 1952. Wasson Archives, Harvard University Herbarium, Cambridge, Mass



17ème

David }
Memling }
une toile –

THE INSTITUTE FOR ADVANCED STUDY
PRINCETON, NEW JERSEY

SCHOOL OF HISTORICAL STUDIES

May 12, 1952

Mr. R. Gordon Wasson,
23 Wall Street,
New York 8, N.Y.

Dear Mr. Wasson:

Many thanks for your letter of May 7. Unfortunately I know very little of folk lore and witchcraft (though I do know that those people in Kamchatka still induce ecstasy by eating amanita or drinking some sort of decoction thereof). So I have not the slightest idea as to whether the French witches also used the crapaudin (which, incidentally, seems to be fairly generic term originally, like our "toadstool"; I know it, e.g., as denoting a kind of cooking pan shaped like a mushroom , and even another plant, Sideritis) for similar purposes. However, even if so, I should be somewhat skeptical because the development from pine tree to "Pilzbaum" is so universal and takes place in so many representations other than the Fall of Man . The only possibility I should be prepared to admit is that, once the transformation had taken place and was generally accepted in art, some especially ignorant craftsman may have misuderstood the finished product, viz., the "Pilzbaum," as a real mushroom. But even that is not very probable because even the most mushroom-like specimens show some traces of ramification ; if the artists had labored under the delusion that the model before him was meant to be a mushroom rather than a schematized tree he would have omitted the branches altogether. In addition, religious mediaeval art at least had little reason to think of mushrooms at all. They do not occur in the Bible, so far as I know, nor in the legends of the saints.

With all good wishes,

Sincerely yours,

Erwin Panofsky.

Please keep my poor little pictures as long as you wish. But I really recommend to look up that little book by A. E. Brinckmann.

Figure 3. Letter of Erwin Panofsky to R. Gordon Wasson, May 12, 1952. Wasson Archives, Harvard University Herbarium, Cambridge, Mass

However, while the theory of the "bible as a secret code for a fertility cult" was soon forgotten, the search for evidence of mushrooms in Christianity persisted. In fact, later evidence showed that they occurred in Christian art much more widely than Allegro realized at the time of the 1970 publication of *The Sacred Mushroom*, prompting Judith Anne Brown to observe in her Foreword to the 40th anniversary edition of Allegro's (2009) book that "*Evidence from the art world might have gone a long way to convince his critics that his ideas were reasonable*" (p. xi). However, the sole image that Allegro presented was the Plaincourault fresco, which was printed on the book jacket of the original edition of *The Sacred Mushroom*. This image, along with Allegro's conclusion "There the *Amanita muscaria* is gloriously portrayed," directly challenged Wasson's interpretation of the Plaincourault fresco. But none of this survived the vehement rejection of *The Sacred Mushroom*. As Judith Anne Brown (2005) confesses, "*Instead, the book ruined his reputation. After it came out, very little he had said in the past or would say in the future was given any attention*" (pp. xv-xvi).

Chapel of Plaincourault, Central France

Wasson and his wife Tina visited Plaincourault in 1952. We entered the chapel in 2012, that is 60 years later. The chapel is situated close by the Plaincourault castle. Both were built in the second half of the 12th century by the Knights of the Order of Malta upon their return from the Crusades. The small chapel is 60-ft long and 20-ft wide. It is architecturally simple with a single nave (the main body of the church), which ends in a semi-circular apse (the end of the chapel). Originally, the walls of the chapel were completely decorated with scenes from the Old and New Testament interspersed with geometric and floral paintings.

In addition to the Temptation scene, the three other frescoes still recognizable today on the apse wall are the Virgin and Infant, the Scourging of Jesus, and the Crucifixion. In the vault of the apse is a painting of Christ Pantocrator (omnipotent ruler of the Universe) framed by a tetramorph. On the left wall of the nave (looking inward from the entrance) is a well-preserved scene of the legend of St. Eligio, the patron saint of blacksmiths, under a faint inscription in Latin that was interpreted as "We do not have the key."

The frescoes belong to the family group of "Romanesque wall paintings of Central France," which have been extensively catalogued and studied by art historians (Kupfer, 1993). These paintings use the Romanesque color palette including yellow, red, gray, ochre, white, and blue. The chapel was built in the 12th century and the Temptation fresco was painted in the late 13th century, *ca*. 1291.

The most well-preserved fresco is the Temptation scene depicting Adam and Eve and the Tree of the Knowledge of Good and Evil, around which is coiled a snake offering Eve the fruit of the Tree. The Tree is dramatically drawn in the shape of an enormous man-sized mushroom, with four smaller mushrooms protruding from the long stem of the central "mushroom tree."

Mushroom tree in Eden, Plaincourault

Close onsite observation reveals several intriguing aspects of this Temptation scene. As background for these observations, we present an enhanced version of the photo of this fresco taken during our 2012 visit to Plaincourault. This enhancement brings out the colors and contrast of the image but does not alter it in any other way.

First, the curved cap of the mushroom nearly touches the top border of the fresco, making it slightly taller than Adam and Eve. As an artistic technique, size matters in Romanesque art. It is therefore noteworthy that the mushroom tree is taller than Adam and Eve. Since mushrooms in nature would be diminutive compared to humans, the artist is obviously communicating the central significance of this mushroom tree in the Genesis story of the Garden of Eden.

Second, now Adam and Eve are aware of their nakedness covering themselves with round objects that regardless of what they depict are not drawn in the irregular shape of natural fig leaves. Furthermore, the size of these objects is larger than would be needed to simply provide cover.

Does Plaincourault represent A. muscaria?

Famed American ethnobotanist Richard Evans Schultes and Swiss pharmacologist Albert Hofmann, the first person to synthesize LSD, observe that "*The Tree of Knowledge, entwined by a serpent, bears an uncanny resemblance to the Amanita muscaria mushroom*" (Schultes & Hofmann, 1992, p. 83). The Italian ethnobotanist Giorgio Samorini (1998) analyzed multiple representations of mushroom trees, all of which have umbrella-shaped foliage and none of which resembles the uplifted branches of the Italian pine. Samorini (1998) contends that "*Wasson's conclusion may be considered premature*" (p. 88) and identifies Plaincourault as the prototypical *A. muscaria* mushroom tree.

In time, even the most vocal historical opponents of this identification either hedged their bet (Panofsky) or partially recanted (Wasson). As we have shown, in his second letter to Wasson, Panofsky (1952, May 12) confesses that he is "prepared to admit" that there is a possibility that the artist of Plaincourault drew "a real mushroom" (see Figure 3). Writing in *Persephone's Quest* shortly before he died, Wasson (Wasson, Kramrisch, Ott, & Ruck, 1986) admits:

> *I once said there was no mushroom in the Bible. I was wrong. It plays a hidden role (this is, hidden from us until now) and a major one, in what is the best-know episode of the Old Testament, the Garden of Eden story, and what happened to Adam and Eve. ... I hold that the fruit of the Tree of Knowledge of Good and Evil was Soma ... was Amanita muscaria, was the Nameless Mushroom of the English-speaking people.* (pp. 74-75)

While Wasson did not explicitly acknowledge that the fresco at Plaincourault attests to *A. muscaria*, his remarkable late-in-life admission makes this the logical next step. But before taking this next step, let us first consider three alternative explanations:

1. *It is not a mushroom tree; it is a stylized Italian pine tree*. We have already discussed and dispatched this Wasson-Panofsky interpretation.
2. *It is not a mushroom tree; it is an apple tree*. This is textually inaccurate for there is no identification of the "fruit" of the Tree to be found anywhere in the Bible: not in Genesis nor in any of the books of the Old or New Testament. In fact, the first reference to the fruit as an apple does not appear until the 16th century. Aside from this lack of scriptural references, the idea that the image at Plaincourault is an artistic representation of an apple would be far-fetched. No painter in the history of religious art has ever drawn half of an apple, systematically covered with identical spots, on top of the trunk of a tree planted in the center of Eden.
3. *It is not about the fruit; it is about the fall*. Writing succinctly, the apostle Paul declares "*For as in Adam all die, so also in Christ all will be made alive*" (1 Cor. 12:21-22). Citing Paul, other apostles, and a host of church fathers, historian Hatsis (2017a) argues that "*The fruit wasn't an actual, material thing that could be eaten (like an orange), but rather symbolic of strict adherence to divine law and the consequences for obstinacy*" (p. 19). For Hatsis, the fruit is a metaphor for obedience: for following God's commands and the consequences of defiance.

While this view is prevalent, it represents the imposition of a New Testament Christian metaphor onto an Old Testament Hebrew myth. The renowned mythologist Joseph Campbell (2018) observes "*Every myth, whether or not by intention, is psychologically symbolic. Its narratives and images are to be read, therefore, not literally, but as metaphors*" (p. 28). Therefore, it is important to let the myth speak for itself, metaphorically in its own words - especially a foundational myth that attempts to reconcile two opposites: why does evil appear so early in God's perfect creation?

In the words of Genesis from the King James Bible Online (2019): "*And the LORD God commanded the man, saying, Of every tree of the garden thou mayest freely eat: But of the tree of the knowledge of good and evil, thou shalt not eat of it: for in the day that thou eatest thereof thou shalt surely die*" (Genesis, 2:16-17). Next, the serpent appears saying: "*And the serpent said unto the woman, Ye shall not surely die: For God doth know that in the day ye eat thereof, then your eyes shall be opened, and ye shall be as gods, knowing good and evil*" (Genesis, 3:4-5). Finally, after both Adam and Eve have eaten the fruit, they do not die but are expelled from Eden, at which point God in a remarkable passage ponders what will happen next (speaking to whom? we can only wonder), "*And the LORD God said, Behold, the man is become as one of us, to know good and evil: and now, lest he put forth his hand, and take also of the tree of life, and eat, and live for ever, Therefore the LORD God sent him forth from the garden of Eden*" (Genesis: 22-23).

Aside from the enigmatic question of what this monotheistic Hebrew God means by becoming "one of us," let us focus on two intriguing aspects of the Plaincourault fresco from the perspective of Genesis. The first is the depiction of separate historical biblical events (also called "moments") in the same fresco. In this Temptation fresco, we see the serpent offering the forbidden fruit to Eve before she has eaten thereof, while at the same time Adam and Eve are covering themselves, which in Genesis takes place after they have consumed the fruit and become aware of their nakedness. From a Christian perspective, this scene represents both the Temptation and the Original Sin.

Second, we call attention to an aspect of the fresco that to the best of our knowledge has not been commented upon by prominent observers, neither by Allegro nor Wasson nor most recently Samorini. Looking at the enhanced photograph, we see that Eve has no breasts. In fact, her chest and arms are "skeletonized" (see Figure 4).

Anthropologist Furst (1976) points out that one of the most enduring aspects of shamanism is the idea that life is resident in the bones, which are the most durable part of the body lasting up to 50,000 years after death. Mircea Eliade (1974), one of the world's preeminent authorities on shamanism, writes that "*Bone represents the very source of life, both in humans and animals. To reduce oneself to the skeleton condition is equivalent to re-entering the womb of this primordial life, that is, to a complete renewal, mystical rebirth*" (p. 63). Medieval churches frequently preserved the bones of saints as sacred relics. In this context, the skeletonization of Eve suggests that she has crossed the threshold of an entheogen-inspired journey of death and rebirth, a central theme in shamanism.

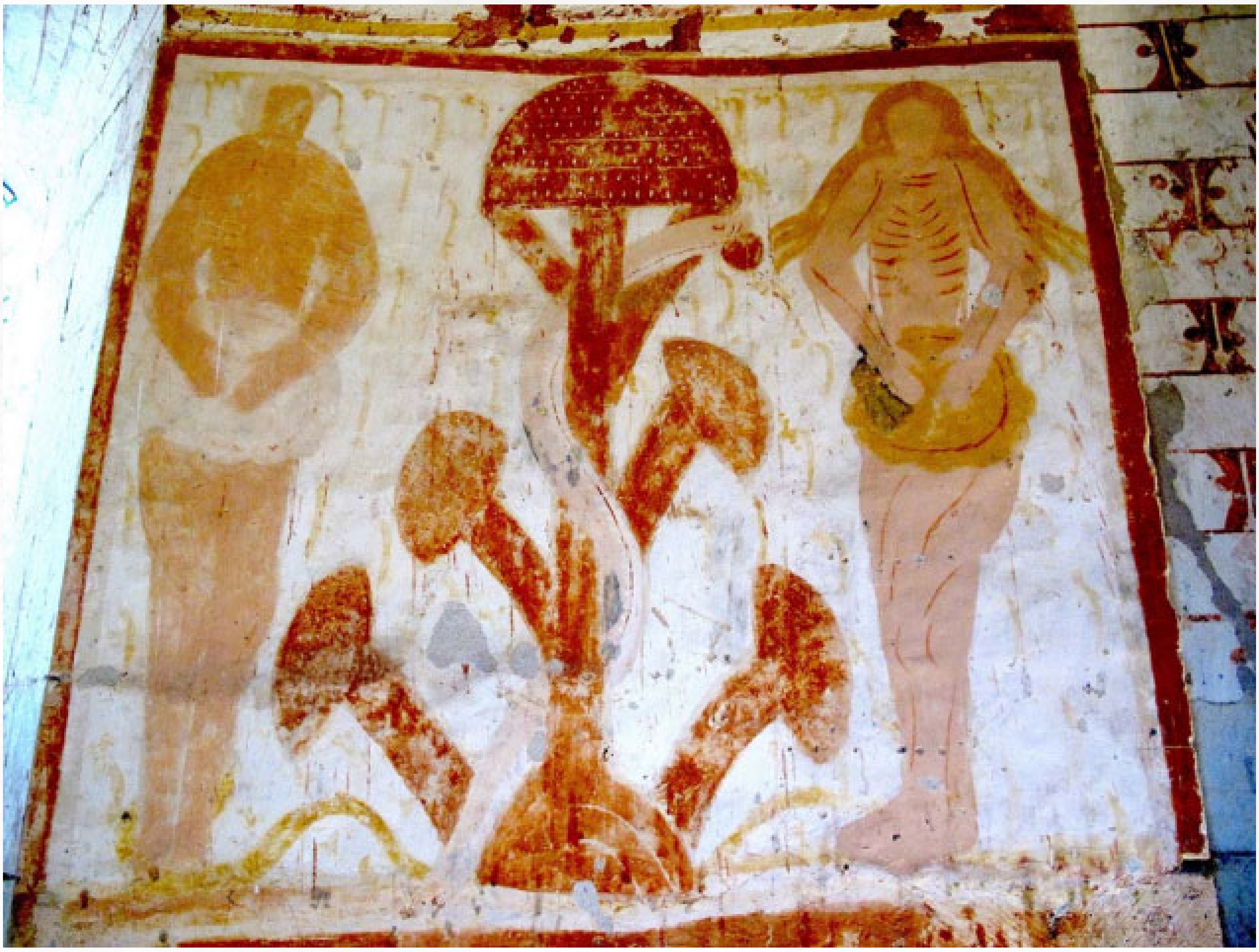


Figure 4. Temptation in the Garden of Eden. Chapel of Plaincourault, Indre District, Central France, *ca*. 1291 (color- and contrast-enhanced photo by Julie M. Brown)

Based on this analysis of the Plaincourault fresco, we agree with Wasson's (1968) entheogenic interpretation on Genesis as articulated in *Soma*:

> *Yahweh deliberately leads Adam and Eve into temptation by placing in front of them, in the very middle of the Garden, the Tree with its Fruit. But Yahweh was not satisfied: he takes special pains to explain to his creatures that theirs will be the gift of knowledge if, against his express wishes, they eat of it. The penalty for eating it (and for thereby commanding wisdom or education) is surely death. He knew the beings he had created, with their questing intelligence. There could be*

> *no doubt about the issue. Yahweh must have been secretly proud of his children for having the courage to choose the path of high tragedy for themselves and their seed, rather than serve out their lifetimes as docile dunces. This is evidenced by his prompt remission of the death penalty.* (p. 221)

Following Wasson's train of thought, we now propose a fourth possible explanation of the Plaincourault fresco:

4. It is about the Tree; it is an entheogen that offers higher consciousness. By placing a large *Amanita muscaria* mushroom tree in the center of Eden; by depicting two historical moments, before and after eating the fruit of the Tree, in the same scene; and by skeletonizing Eve, the painter or his priestly patrons captured the true meaning of Genesis.

To push this explanation to its apotheosis, the essence of Genesis is not about the fall; it is about transcendence. The serpent does not bring evil into God's perfect world; it brings wisdom. In addition, Eve is not a weak-willed woman who is responsible for the original sin and humanity's downfall; she is a courageous spiritual guide who leads humanity to exercise-free will and achieve higher consciousness. Invoking Occam's razor, we suggest that this interpretation of Genesis and Plaincourault parsimoniously resolves two biblical puzzles: the identification of the Tree and the presence of evil in the Garden of Eden - the latter posing a dilemma that has confounded Christian and Jewish theologians alike for centuries.

Despite Wasson's firm acknowledgment that the Tree of Genesis was a powerful psychedelic, one that could inspire knowledge and wisdom, he never took the final logical leap of concluding - as we do - that the Temptation fresco in the Chapel of Plaincourault represents an *A. muscaria* mushroom.

Samorini's mushroom tree typology

In an article on "'Mushroom-Trees' in Christian Art," Samorini (1998) analyzes multiple examples of "mushroom trees" found in early and medieval Christian art from churches in Tunisia, Central France, and other areas of Europe. He finds that "*the typological differentiation among the 'mushroom-trees' of these works would appear due to the natural variation among psychoactive mushrooms*" (p. 87). Based on these natural variations, Samorini develops a twofold typology: the "Plaincourault" mushroom tree (*A. muscaria*) and the "Saint Savin" mushroom tree (*Panaeolus*, *Psilocybe*, and other psilocybin-containing mushrooms).

Paraphrasing Samorini (1998, pp. 88-89), the major characteristics of the Plaincourault mushroom tree (see Figure 4), which is based on the Plaincourault fresco, are:

1. Semispherical foliage similar to a broad mushroom cap and dotted with whitish spots;
2. Two lateral ramifications (branches) that join the cap to the main trunk-stem of the mushroom tree, possibly representing the three dimensions of the tree or the remaining membranes from the early stages of the fungus' development;
3. The roundish fruit of the tree held in the mouth of the serpent which is offering the fruit to Eve; and
4. Around the base of the main trunk-stem, additional ramifications with caps also dotted with whitish spots.

In comparison, the Saint Savin mushroom tree is based on a ceiling fresco found in the Abbey of Saint-Savinsur-Gartempe (Saint Savin) located in the department of Vienne 6 miles east of Plaincourault (Figure 5). The Abbey's frescoes are prized examples of the Haute-Poitou Romanesque Style and are dated *ca*. 1100, nearly 200 years before the Plaincourault fresco.

We explored Saint Savin the day after our visit to the Chapel of Plaincourault. Painted 50 ft above the floor on a long-vaulted ceiling, which runs the length of the nave, is an elaborate series of 61 colorful frescoes that tell the story of the Old Testament. This biblical chronology begins in Scene 1 with Genesis and ends with Exodus.

In Scene 3, The Creation of the Stars, God wearing a cruciform halo places the sun and the moon into the sky. The moon and sun are each anthropomorphically represented by a head within a medallion and are placed in a heavenly realm separated from earth by a wide, multilayered barrier. Directly below the sun and the moon are two distinct types of plants: one, an umbrella-shaped mushroom with a down swept cap, resembling the psilocybin-containing species; and the other, an Italian pine with upswept branches (Figure 5).

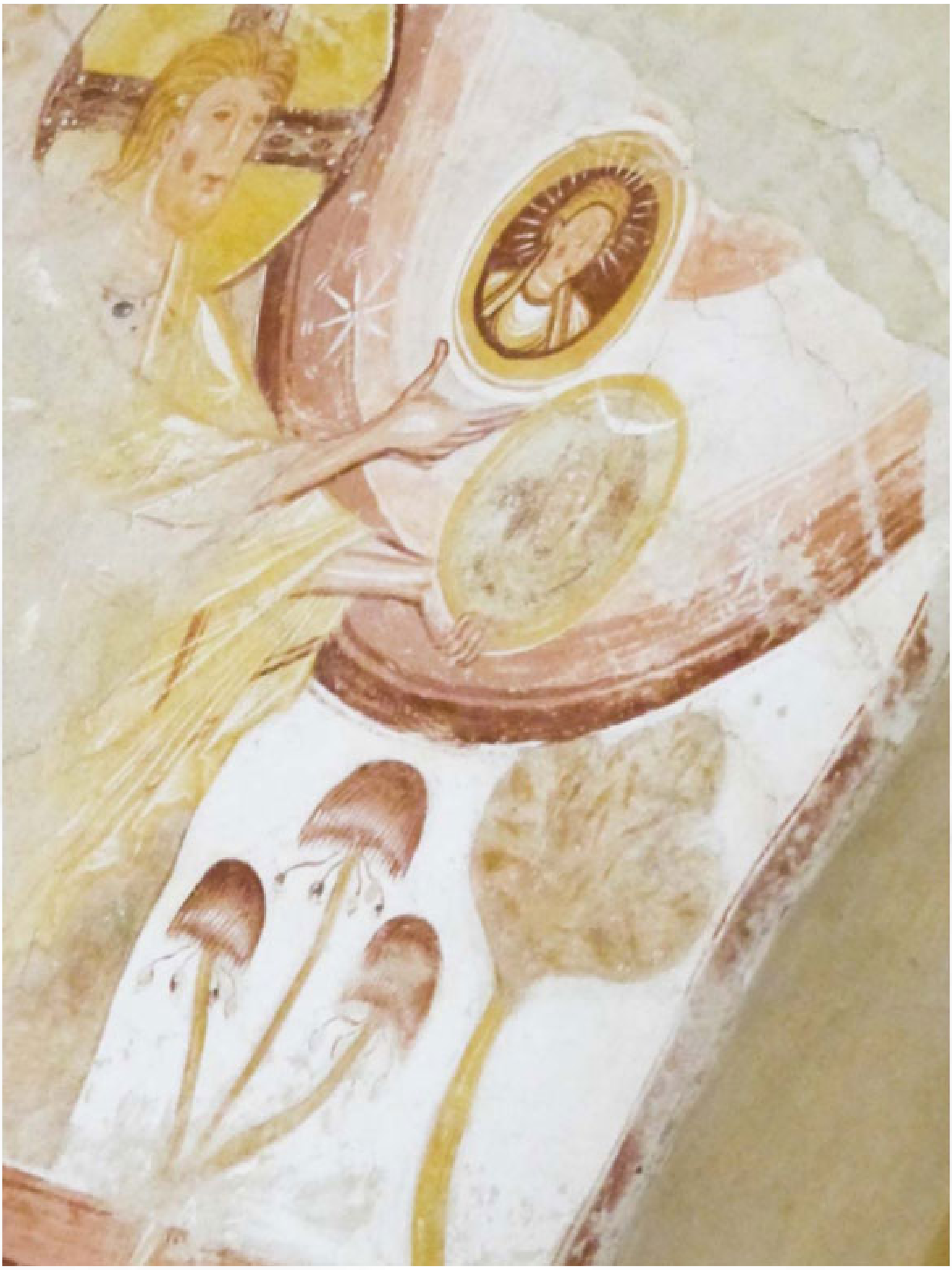


Figure 5. Genesis. The Creation of the Stars. Abbey of Saint-Savin-sur-Gartempe, 11th-12th century (photo by Julie M. Brown)

In contrast to the Plaincourault-type mushroom tree, the Saint Savin-type mushroom tree has the following characteristics:

1. Distinctly convex (downward-curved) cap, which may be "striated" (striped) instead of dotted;
2. The trunk-stem spreads out to form several branches, generally three, and in some cases the branches terminate in a dense, compact trilobite (three-lobed) leaf;
3. At times, this mushroom tree is depicted with characteristic "papilla" (a nipple-like shape), which forms

a point on the top of the cap, a characteristic of the common European psilocybin mushroom known as the Liberty Cap (*Psilocybe semilanceata*).

The botanical differences between Panofsky's Italian pine tree and Samorini's mushroom tree have been graphically highlighted by researcher Michael Hoffman (1985-2007b), who posted a photo gallery online showing marked similarities between the mushroom trees depicted in Christian art and actual mushrooms in nature.

Samorini argues that the Plaincourault-type mushroom tree has ancient roots - roots that reach far deeper into the past than acknowledged by Panofsky, who classifies the Plaincourault fresco as an example of a stylized tree "*prevalent in Romanesque and Early Gothic art*," which dates from the 11th to 16th centuries CE (see Figure 3).

However, Samorini (1998, pp. 90-93) traces the evolution of this mushroom tree back to the 5th and 6th century BCE mosaics, found in Tunisia. At that time, instead of Adam and Eve, two animals (i.e., stags and lions) were placed symmetrically on either side of the mushroom tree. From these ancient origins, this mushroom-like Tree of Life is subjected to wide stylistic variation, sometimes appearing as a palm tree, a conifer tree (the symbiotic host of *A. muscaria*), and even as a pine cone. As this ancient symbolism was adopted by Christianity, the two animals standing on each side of the mushroom tree became two lambs or two fishes, and the Tree of Life transformed into the Cross or the Chalice of the water of life.

Entheogens in christian art

With this background, we turn to the findings of our 2012 fieldwork in Europe and the Middle East in search of iconographic evidence of entheogens in Christian art. The catalyst for this fieldwork was the accidental discovery in 2006 of a mushroom (Figure 6) sculpted into the forehead of the most prominent Green Man of Rosslyn Chapel located just south of Edinburgh in Scotland, which we hypothesized was a representation of *A. muscaria*. Rosslyn was founded in 1446 by Sir William Sinclair, the last Prince of Orkney.

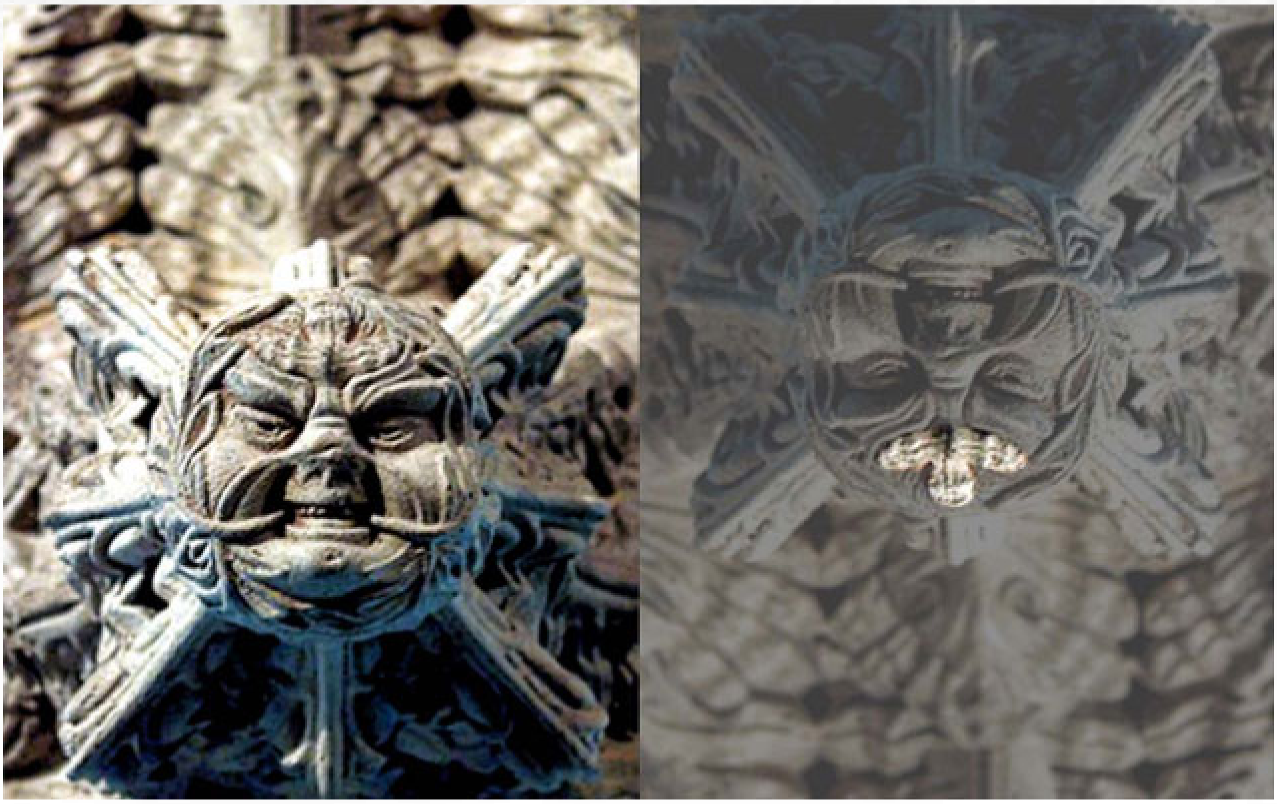


Figure 6. Green Man, Rosslyn Chapel, Scotland, 15th Century. Front view and inverted view with highlighted forehead (photo by Julie M. Brown)

On August 22, 2015, while writing *The Psychedelic Gospels*, we met Paul Stamets, one of the world's leading experts on mycology. Stamets had visited Rosslyn and confirmed that the mushroom in the Green Man's forehead was a "taxonomically correct *Amanita muscaria*" (Brown & Brown, 2016, p. 14).

As we considered the implications of this discovery, we asked ourselves a fundamental question: *Was this Green Man sculpture in Rosslyn Chapel, a 15th century Catholic church, providing a clue to the historical presence of sacred mushrooms in Christianity?*

We knew that the opinion of Wasson, a leading authority in the field of ethnomycology, proclaimed the absence of psychoactive mushrooms in early Christianity, and that his opinion had been taken as gospel by most, but not all scholars, involved in the study of entheogens and religion. Nevertheless, after researching this question for several years, we ultimately decided to carry out fieldwork on entheogens in Christian art.

In the summer and fall of 2012, we traveled to Europe (England, France, Germany, and Italy) and the Middle East (Turkey) visiting abbeys, cathedrals, chapels, and churches. During this research, we found and photographed psychoactive mushrooms, particularly *A. muscaria* and *Psilocybe*, in a variety of Christian art: frescoes, ceiling paintings, illuminated manuscripts, mosaics, sculptures, and stained glass windows. Figure 7 shows a map of the major churches and sacred sites (Eleusis in Greece) that we visited. What follows is a brief description of our major findings illustrated by original photographs of entheogens. A detailed description and discussion of these findings is presented in *The Psychedelic Gospels: The Secret History of Hallucinogens in Christianity* (Brown & Brown, 2016). The following discussion of the theory of the psychedelic gospels is mainly derived from the original research and materials presented in our book.

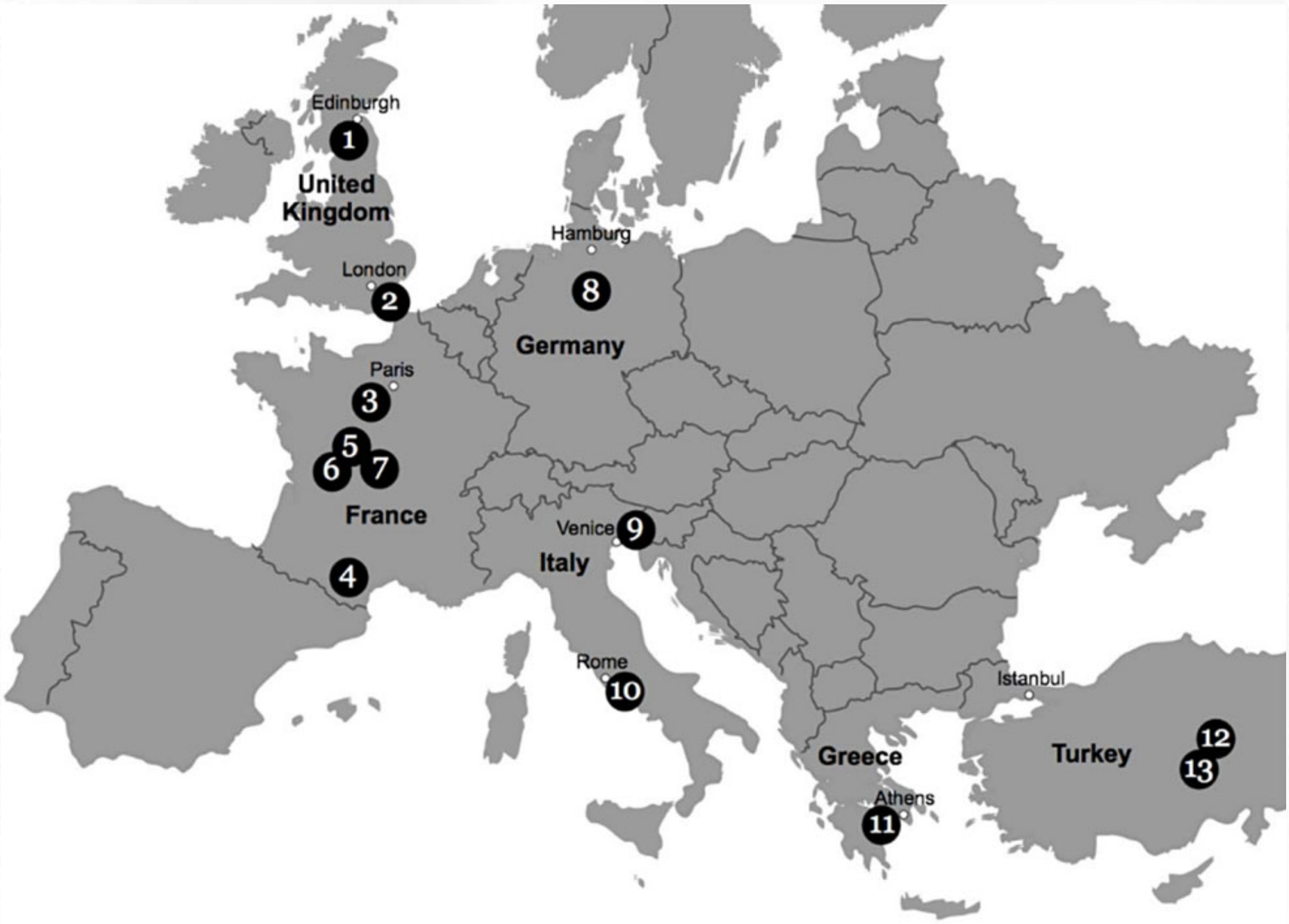


Figure 7. Map of Churches and Sacred Sites Visited. Source: The Psychedelic Gospels, 2016, p. xiii. Legend: (1) Rosslyn Chapel, Scotland; (2) Canterbury Cathedral, England; (3) Chartres Cathedral, France; (4) Rennes le Château, France; (5) Chapel of Plaincourault, France; (6) Abbey of Saint-Savin, France; (7) Church of Saint Martin de Vicq, France; (8) Saint Michael's Church, Germany; (9) Basilica of Aquileia, Italy; (10) Vatican Museums, Italy; (11) Eleusis, Greece; (12) Dark Church, Turkey; (13) Ihlara Valley, Turkey

Saint Martin de Vicq, Central France

The small parish Church of Saint Martin de Vicq (Saint Martin) is located in the village of Nohant-Vic in the Indre department of Central France 50 miles east of Plaincourault. In the 11th century, the church belonged to the Benedictine Abbey of Déols in the old province of Berry. At that time, it consisted of a simple nave and choir. At the beginning of the 12th century, a semicircular apse was built and an exceptional set of murals was painted, first rediscovered in 1849. Restoration began in 1987 and was completed in 1991. A plaque describes the murals as "the work of an artist of genius," which "portray the theme of Redemption, from the Error of Adam to the Last Judgment."

In *Romanesque Wall Painting in Central France: The Politics of Narrative*, art historian Marcia Kupfer (1993) devotes a chapter to the history and interpretation of the Saint Martin murals. Typical of the fresco cycles found in the region, these paintings are the creation of a single workshop, usually consisting of a lone painter, perhaps with an assistant to help with the plastering and preparation of the pigments.

We traveled to Saint Martin because a book (Irvin, 2008) and an article (Samorini, 1998) included photographs of psilocybin mushrooms in one of the wall paintings. During our visit, we found that the panoply of frescoes in Saint Martin represented an illustrated Bible including a veritable Christology. Among them, we found several mushroom-tree images - significantly more than the single mushroom group mentioned in the literature - illustrating key scenes in the life of Jesus.

On the upper panel of the south choir is a wall-length fresco depicting side by side, the Old Testament story of the *Purification of Isaiah's Lips* with the New Testament story of *Christ's Entry into Jerusalem* (Figure 8). Located in the upper right-hand corner of *Christ's Entry* are the convex-shaped caps of five, large, smooth (non-striated) mushrooms that resemble psilocybin-containing species, possibly *Psilocybe azurescens*. Once again, we note that "size matters" for caps of these mushrooms are as large as the heads of the joyous youth welcoming Jesus to Jerusalem.

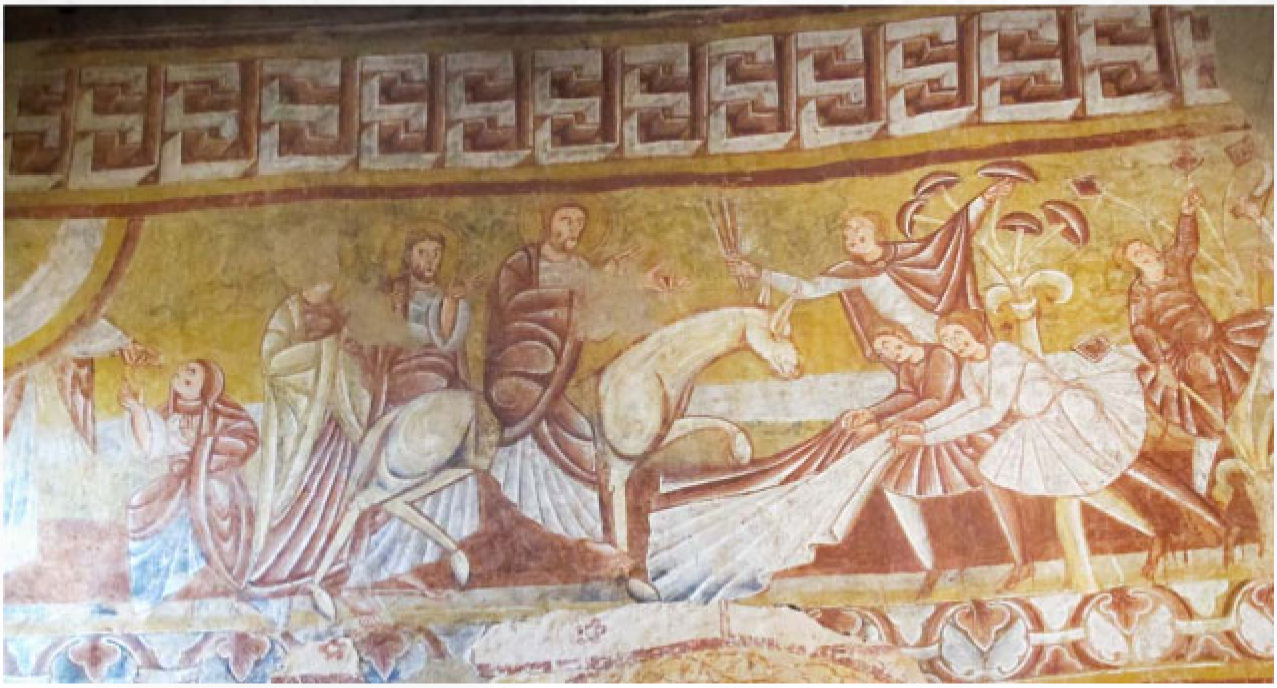


Figure 8. Purification of Isaiah's Lips and Christ's Entry into Jerusalem. Fresco on south choir wall, Church of Saint Martin de Vicq, France. Early 12th century (photo by Julie M. Brown)

Christ is riding on an ass with his arms outstretched to receive a plant-like gift (of which only the stems are visible), offered by one of the youth who with his other hand is holding the stem of one of the mushrooms. On the far right of the fresco stands another youth holding the stem of a diamond-shaped frond (possibly a palm frond) in his left hand and a long slightly curved sword in his right hand. Given that the caps are convex-shaped and without dots and that the main stem spreads out to form several branches, this is what Samorini labels a Saint Savin-type mushroom tree, which contains psilocybin.

As in the Garden of Eden scene in Plaincourault (see Figure 4), once again we see the fusion of two separate historical events, but in this case of events separated by centuries: the Old Testament's *Purification of Isaiah*'s *Lips* and the New Testament's *Christ*'s *Entry into Jerusalem*. Figure 9 shows a detailed view of the *Purification*.

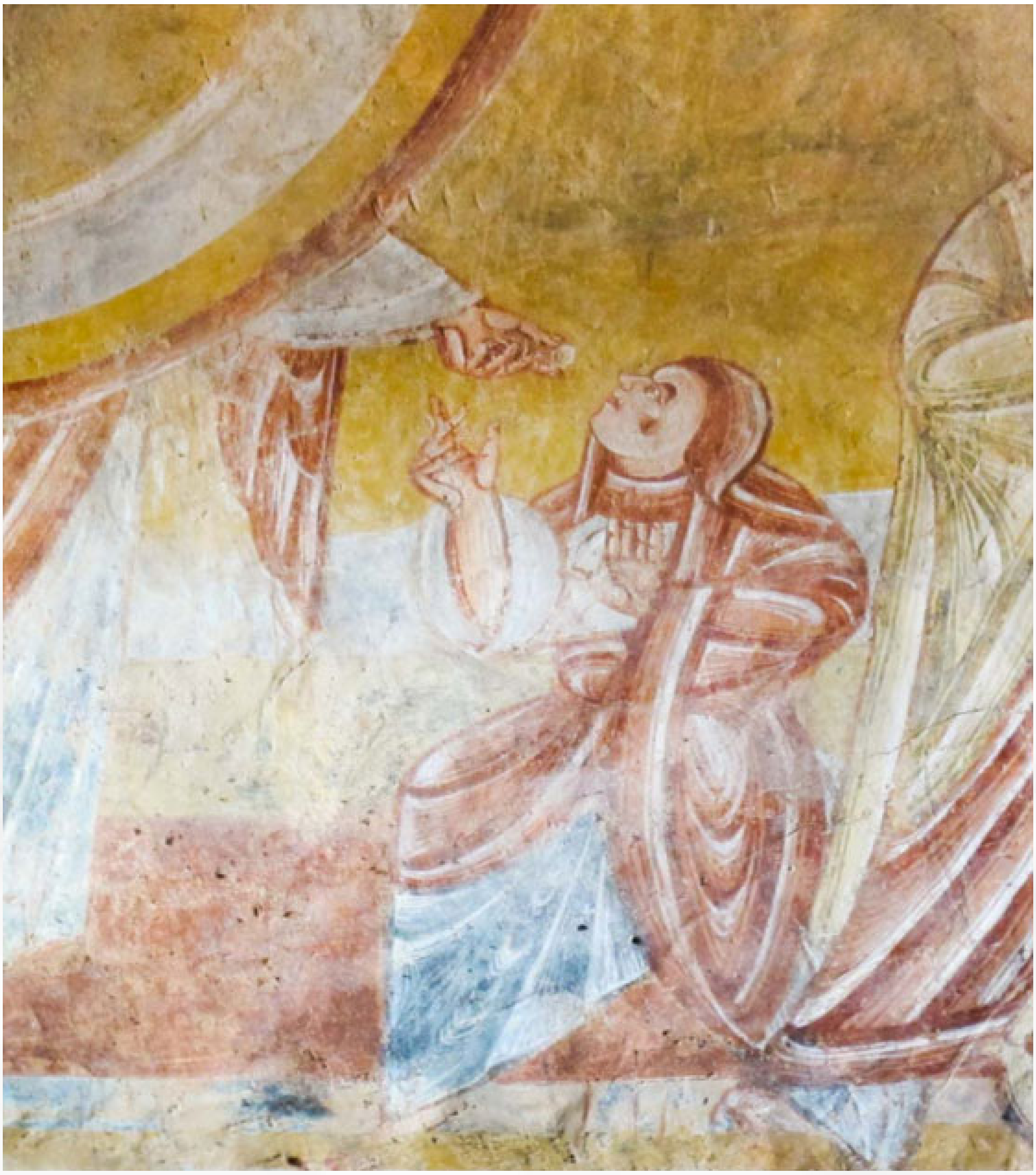


Figure 9. Detail of Purification of Isaiah's Lips. Fresco on south choir wall, Church of Saint Martin de Vicq, France. Early 12th century (photo by Julie M. Brown)

In addition to this fresco, we found other entheogenic images at Saint Martin. Looking to the right in the direction in which Christ is proceeding, on the facing wall, is a painting of the *Towers of Jerusalem*. Standing on the roof of the tower are two men, both dressed in mantels similar to those worn by the youth in *Christ*'s *Entry*. One of them is cutting through the stem of a mushroom tree (Figure 10), using a knife that is distinctly shorter than the sword shown under the diamond-shaped frond in the prior fresco. We can only speculate why a mushroom tree is growing on top (or out of) the roof of a stone tower. Perhaps, the artist is using this device to show the significance of these psychoactive mushrooms in the drama of the Christology unfolding before our eyes.

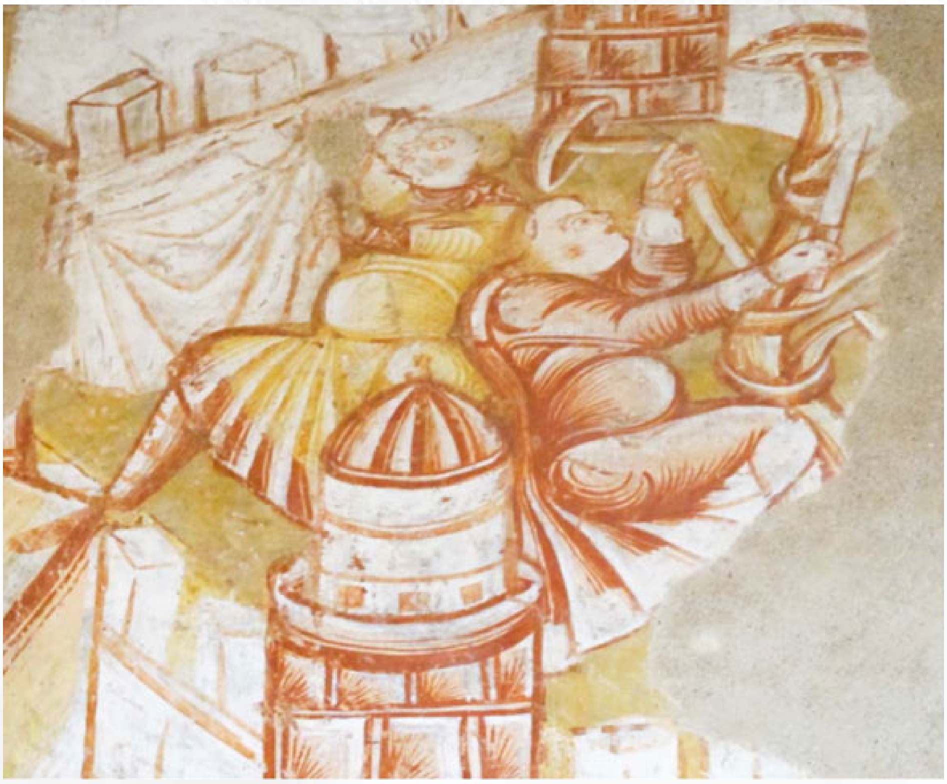


Figure 10. Detail from Towers of Jerusalem. Church of Saint Martin de Vicq, France. Early 12th century (photo by Julie M. Brown)

Immediately to the right of the *Towers of Jerusalem* and part of the same wall is a rendering of *The Last Supper* (Figure 11). Here Jesus and 11 of the disciples are seated behind the table. A 12th disciple, probably Judas, is set apart on the other side of the table, learning forward to ingest the offering (indistinguishable in the painting) that Jesus is holding out to him. On the table, there are four knives (three to the left of Jesus and one to the far right) similar in length, shape, and handle design to the knives used to cut through the mushroom stems on the *Towers of Jerusalem*. This is not a traditional Passover Seder, the Jewish holiday commemorating the Exodus from Egypt on which the Last Supper took place, because there is no Pascal lamb nor are there wine goblets on the table, only bowls and round objects. In fact, the mushroom caps on the top of the towers and the objects on the table share nearly the same round form, size, and coloration.

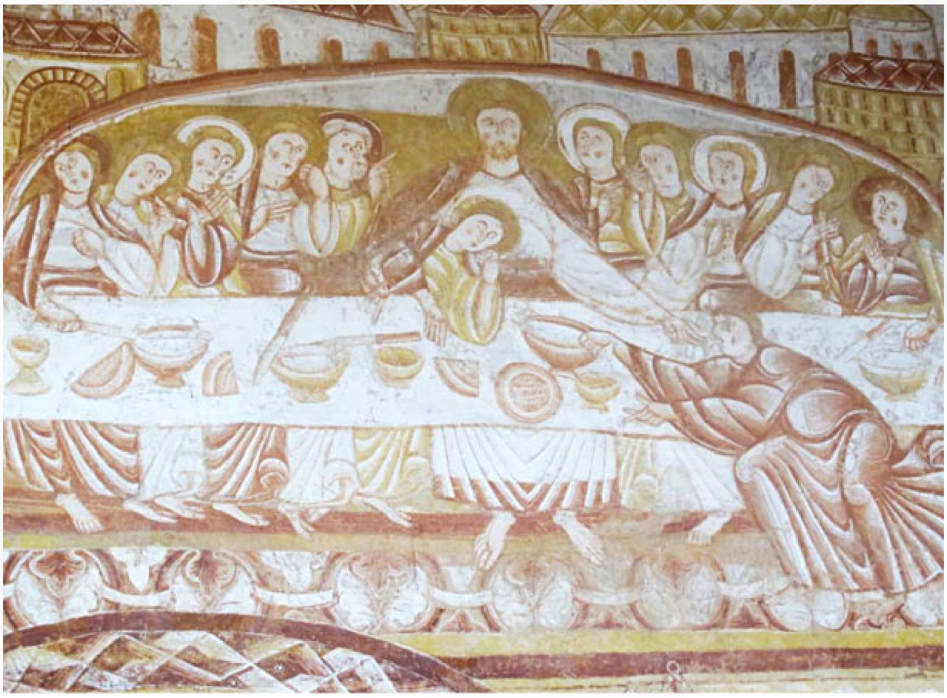


Figure 11. Last Supper, West Choir Wall. Church of Saint Martin de Vicq, France. Early 12th century (photo by Julie M. Brown)

This repetition of mushroom caps and knives connects the three scenes (*Christ's Entry*, *Towers of Jerusalem*, and *Last Supper*) visually suggesting that the mushroom caps in the first two scenes have been placed on the table of the *Last Supper*. The paring of the knives and the round objects implies that these objects have been cut, which is significant because, if these were loaves of bread, in that time they would have been torn apart by hand. In addition, by rotating the table forward, the artist is highlighting the objects on the table.

Finally, if we look closely at the robes of the disciples seated to the left of Jesus, we see discretely drawn into the folds of the hems are three distinct umbrella-shaped, mushrooms caps whose stems are all linked together (Figure 12).

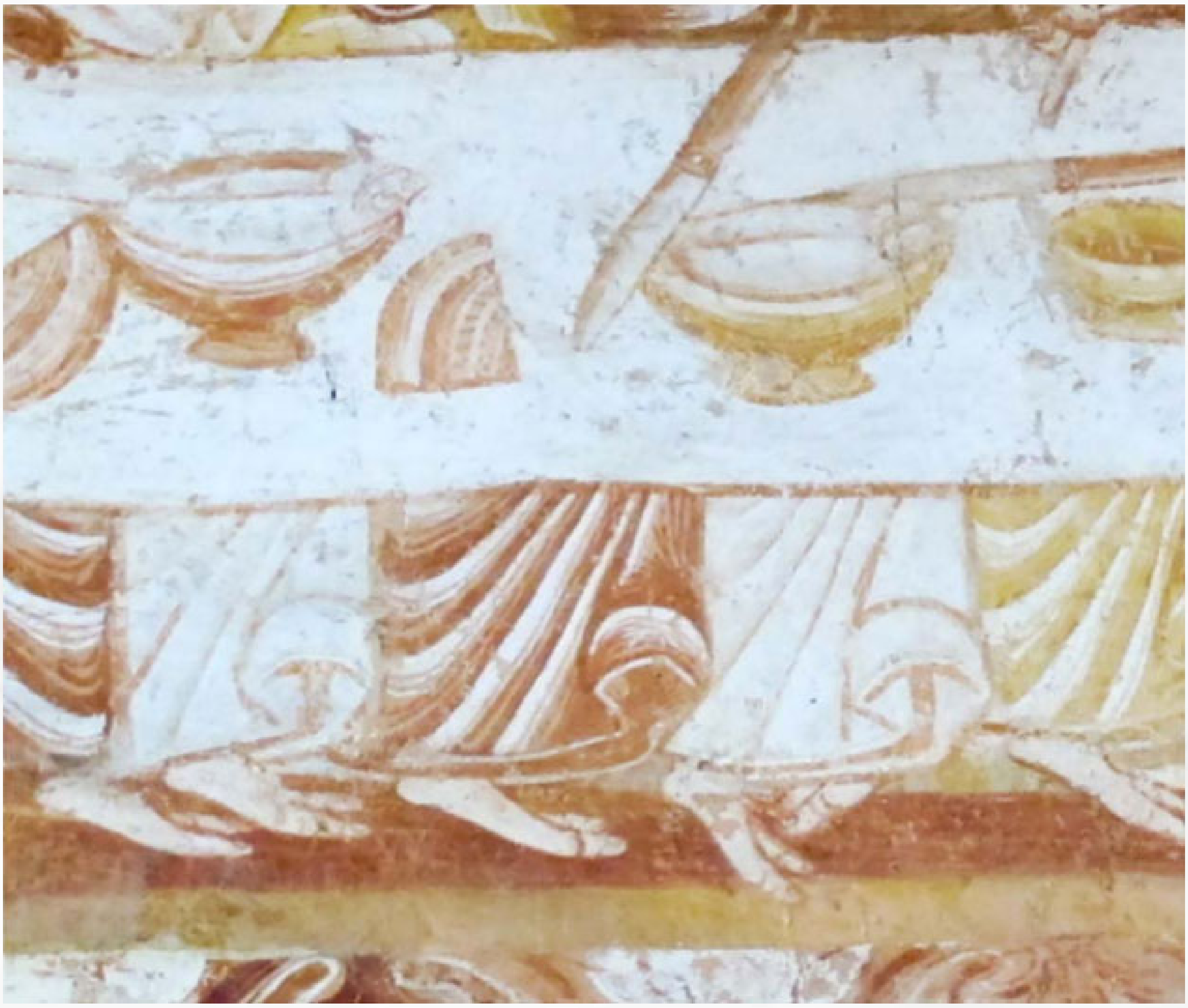


Figure 12. Detail of Last Supper, Saint Martin de Vicq. Showing Mushrooms in Hems of Disciples Robes. Early 12th century (photo by Julie M. Brown)

Purification of Isaiah's lips

In this context, we examine the Old Testament scene of the *Purification of Isaiah*, depicted to the left of *Christ's Entry* (see Figure 9 above). Here Isaiah is kneeling before an angel, whose partially visible body is bathed in concentric circles of light and who is entering the scene from above. The angel's hand is coming out of the circles of light. Between his thumb and index finger is a tan, roundish object that is being offered to Isaiah who reaches up to receive it.

The relevant Old Testament passage states, "*Then flew one of the seraphims unto me, having a live coal in his hand, which he had taken with the tongs from off the altar: And he laid it upon my mouth, and said, Lo, this hath touched thy lips; and thine iniquity is taken away, and thy sin purged*" (Isaiah, 6:6-7). However, in this medieval fresco of the Isaiah story, the object that the seraphim is holding out is round and tan, not the fiery red color nor even the glowing black one would expect of a burning coal. Furthermore, the angel is not holding this offering with tongs, but between his fingers.

Psychedelic gospels theory

According to Kupfer (1993), given that the Old Testament prophet Isaiah foresaw the coming of Christ, the essential themes of this visual sequence are purification and prophecy as preconditions for spiritual passage and entry into the kingdom of heaven. Kupfer (1993) sees the luminous coal as a manifestation of Christ, which reveals the inner spiritual meaning of the *Entry*. "*If the radiance of the coal symbolizes the mystery of the Incarnation, it's perfectly round shape may further suggest the form in which this mystery is materially embodied on earth. The particular gesture with which the angel displays the coal appears visually to identify the small disk with the Eucharistic host*" (p. 143). In other words, just as Isaiah feels the coal's purifying touch on his lips, so the Christian believer receives the sacred host of the Eucharist in his mouth.

As the late afternoon sunlight filled the choir of the church, we had an "ah ha" moment. Here, at Saint Martin de Vicq, these frescoes were revealing an alternative history of Christianity, a psychedelic gospel inspired by entheogenic mushrooms.

We contemplated the incontrovertible facts portrayed in the wall paintings before us: the pictorial fusion of Jesus entering Jerusalem with the purification of Isaiah; Jesus with arms outstretched toward the large psilocybin mushrooms in the *Entry*; the joyful youth cutting down mushrooms with a long knife on the *Towers of Jerusalem* adjacent to the scene of the *Last Supper*; and the orderly row of mushrooms hidden in the hems of the disciples.

Drawing on what we had observed at Plaincourault and Saint Savin, we contemplated an entheogenic interpretation of what these Saint Martin frescoes implied: first, that the angel was purifying Isaiah's lips with a holy psychoactive mushroom, which inspired his prophetic visions of the future coming of Christ and which was also the catalyst for Christ's elevated state of consciousness; and, second, that the Last Supper and the First Eucharist that Jesus was sharing with his disciples was actually a meal of sacred mushrooms. This is indicated by the mushroom forms depicted in *Christ's Entry* and the *Towers of Jerusalem* and by the otherworldly expression on Jesus' face.

If our theory of the psychedelic gospels is true, it leads to the controversial conclusion that early and medieval Christians experienced purification, healing, divinity, and even immortality by means of sacred plants. Obviously, we are not the first researchers to document psychoactive mushrooms in Christian art. That said, what is unique about our research is the combination of onsite fieldwork on entheogens in Christian art with the theory that they represent an alternative history of Christianity - a history that challenges aspects of the master story presented in the Canonical Gospels.

In evaluating the psychedelic gospels theory, we had to consider an alternative less contentious explanation. Perhaps, the mushroom icons we had found to date were simply the eccentric creations of an heretical Christian cult flourishing deep in the forests of Central France far from the control of church and crown. With this caveat in mind, we decided to travel north to the grand cathedrals of Chartres in France and Canterbury in England, as well as to Saint Michael's Church in Germany, in order to see if we could find additional evidence of entheogens in the high holy places of medieval Christendom.

Because they were the catalyst for the theory of the psychedelic gospels, we have provided detailed descriptions and interpretations of the entheogens investigated at Plaincourault, Saint Savin, and Saint Martin, space limitations do not permit similar in-depth discussions of our subsequent findings at Chartres Cathedral, Canterbury Cathedral, and Saint Michael's Church. Therefore, in the next section of this article, we simply present original photographs of the entheogenic mushrooms found along with a brief description of each image. A comprehensive discussion of these findings is provided in the relevant chapters of *The Psychedelic Gospels* (Brown & Brown, 2016, Chapters 10-11).

Chartres Cathedral, France

Our Lady of Chartres is one of the finest examples of French Gothic architecture. It is a UNESCO World Heritage Site and the destination of one of the Catholic Church's most popular pilgrimages in honor of the Virgin Mary. The cathedral is massive. Its spires rise 375 ft above the city streets. But due to its perfect proportions and airy stained glass windows, it does not feel heavy or imposing. Lattice-like flying buttresses allowed for the opening up of the walls to accommodate two tiers of stained glass windows.

The current cathedral is one of at least five, which have occupied the site since the 4th century. After a catastrophic fire, the cathedral as it now stands was reconstructed between 1194 and 1220. What makes this cathedral special is its exceptional state of preservation. The majority of the original windows has survived intact from the 12th and 13th centuries.

Among the cathedral's 176 stained glass windows, we documented at least 13 Old and New Testament stories showing mushroom images, including several stories related to the life of Jesus. The Old Testament stories include the Zodiac Window, showing the cycle of the "labors of the months," along with the stories of Adam and Eve and of Joseph and Noah.

The Saint Eustace window is representative of these New Testament stories (Figure 13). The opening panels of this window show Placidas (the future Saint Eustace) hunting stag on horseback, surrounded by hunting horns, huntsmen and hounds. In the next panel, we see the Conversion of Placidas to Saint Eustace. Flanked by sacred mushrooms, he kneels and prays before the crucifix, which appears between the antlers of a stag standing regally before him. This parallels Samorini's (1998, pp. 89-90) description of the pre-Christian 5th century BCE Tunisian mosaic where the mushroom tree stands between two deer. Here, in the medieval Christian era, the Cross has replaced the mushroom tree.

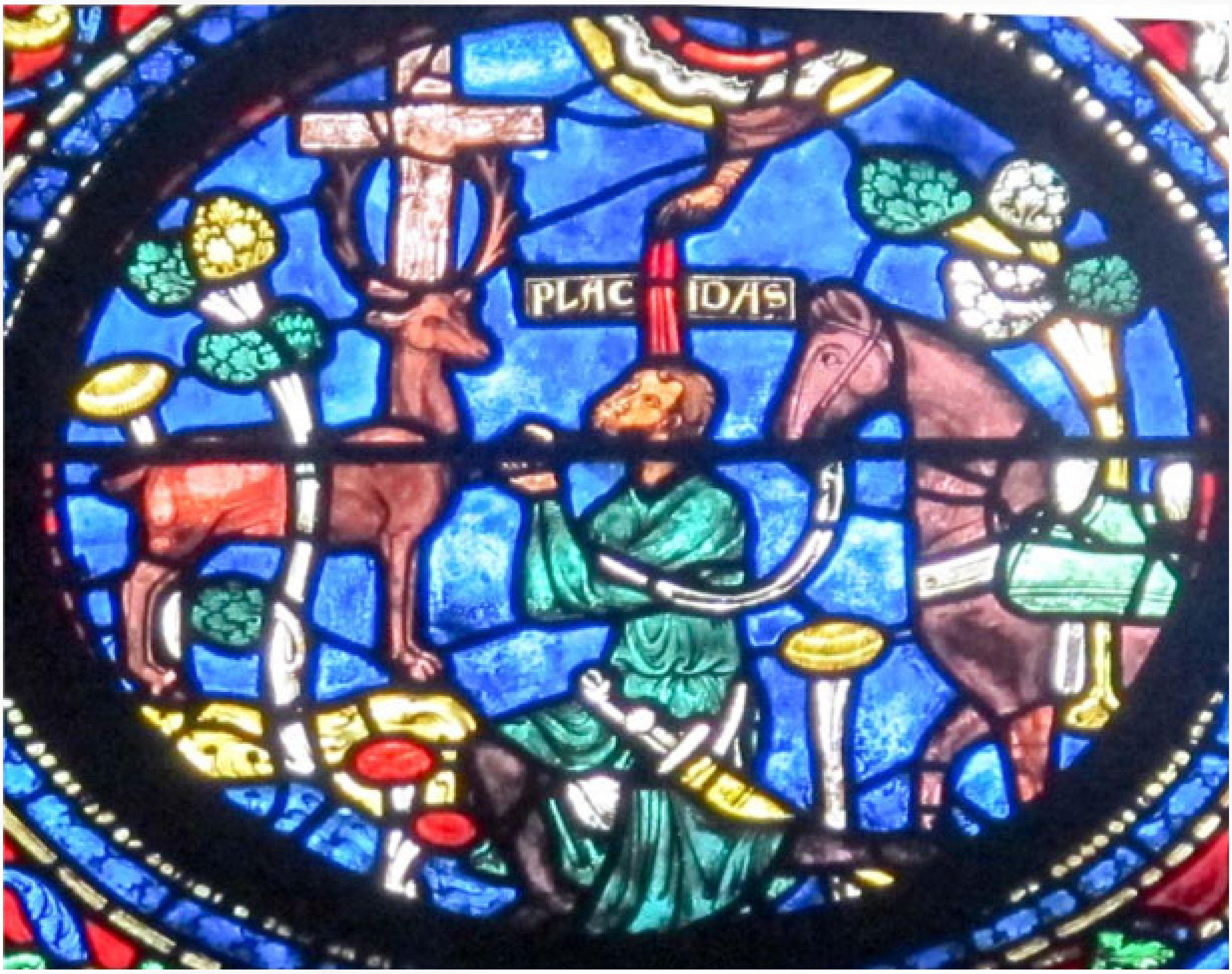


Figure 13. Conversion of Placidas, Saint Eustace Window. Chartres Cathedral, France, early 12th century (photo by Julie M. Brown)

As in the fresco of the *Purification of Isaiah's Lips* at Saint Martin's (see Figure 9), entering this Saint Eustace scene from above are multicolored concentric rings - representing the separation between heaven and earth - from which an angelic hand emerges to anoint Saint Eustace's head with red rays of "uncircumscribable light." This scene strongly suggests that entheogens played a seminal role in Saint Eustace's awakening, conversion, and entrance into Christ consciousness because of the fungiform representations surrounding the kneeling figure.

Canterbury Cathedral, England

The Great Canterbury Psalter (13th century), which according to art historian Rosa Alcoy (2015) has been described as "*a peerless masterpiece*" (p. 1), is a magnificent illuminated manuscript (19" high × 13" wide) originally bound in leather and covered with precious gems. Curiously, the *Psalter* has two distinct parts created in two separate regions at historically different times. The first and oldest, which contains the entheogenic images, was produced around 1200 in the Christ Church scriptorium in Canterbury, England. Then, after mysteriously disappearing for more than a century, the unfinished psalter emerged in Catalonia (today part of Spain), where it was completed between 1340 and 1350.

The *Psalter* opens with 8 stunning folios (pages), each containing 12 lavishly colored, gold-embellished miniature paintings. These opening folios depict the history of the world according to the Scriptures, from the Creation to the life of Jesus. While the biblical narrative is traditional, offering psalms, songs, and prayers, the illustrations are exceptional.

Numerous red, blue, orange, and tan stylized mushrooms are found in the first 100 pages, including this picture (Figure 14) showing God as the Creator of Plants, or more specifically as Creator of Sacred Plants. The red mushroom on the far right with white speckles is *A. muscaria*. The second one on the right is blue, manifesting the classic bluing reaction of psilocybin-containing mushrooms. While several authors have identified the third plant as a Syrian Rue (*Peganum harmala*) pod, careful inspection reveals that it bears no resemblance. Rather the color, shape, and fringes of the eight tiny mushroom images embedded in the cap suggest *Panaeolus*, a psilocybin-containing mushroom found in England and Northern Europe. While other authors have described the fourth plant on the far left as "an Opium Poppy in the shape of a mushroom," again, there is little resemblance either to the flower or the pod of the opium plant. Instead, this more likely represents another mushroom of the genus *Psilocybe* (see Brown & Brown, 2016, pp. 137-138).

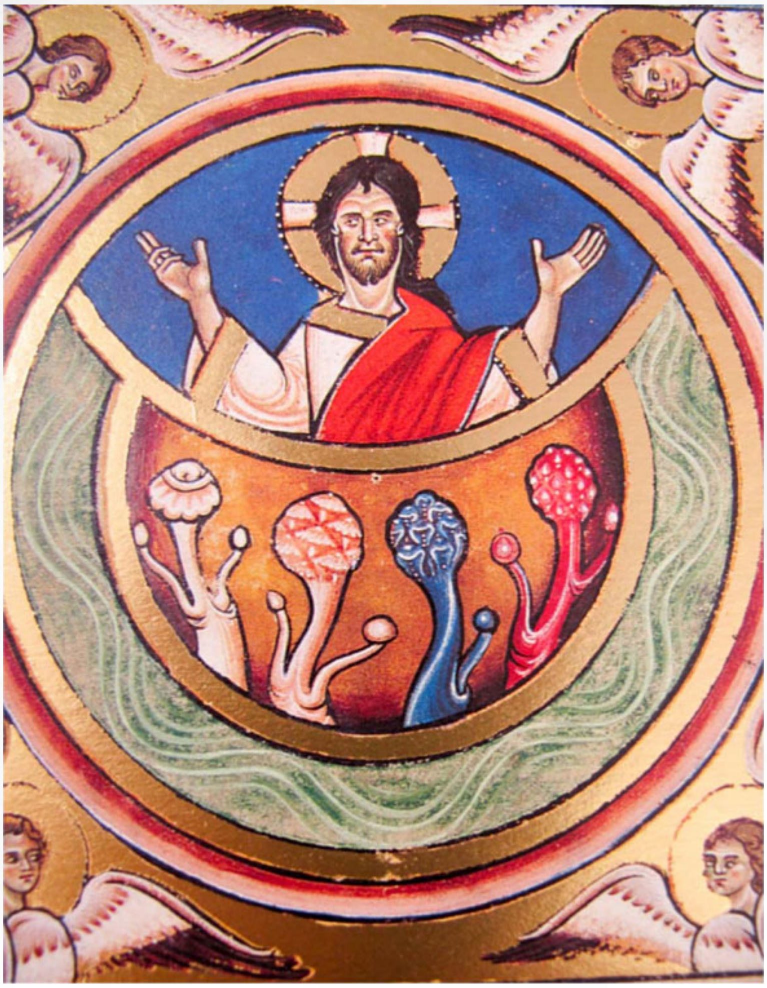


Figure 14. God Creates Plants. Great Canterbury Psalter Folio 1, England, *ca*. 1200 (courtesy of the Bibliothèque nationale de France, Paris)

In the 10th Panel of this folio under the title "Healing of the Leper" (*De curatione leprosi*), we see Jesus laying hands on a leper and performing a healing ceremony (Figure 15). The scroll in the leper's left hand translates as "*Master, if you want, you may cleanse me.*" Curiously, the scroll is not directed toward Jesus, but points to and merges with the stem of the tan mushroom at the base of the panel. In turn, Jesus is holding a scroll in his left hand that extends to the back of the leper, saying "*I want to: Be cleansed.*" Here, we suggest that the scrolls represent a direct link between Jesus' healing ministry and the curing power of sacred mushrooms.

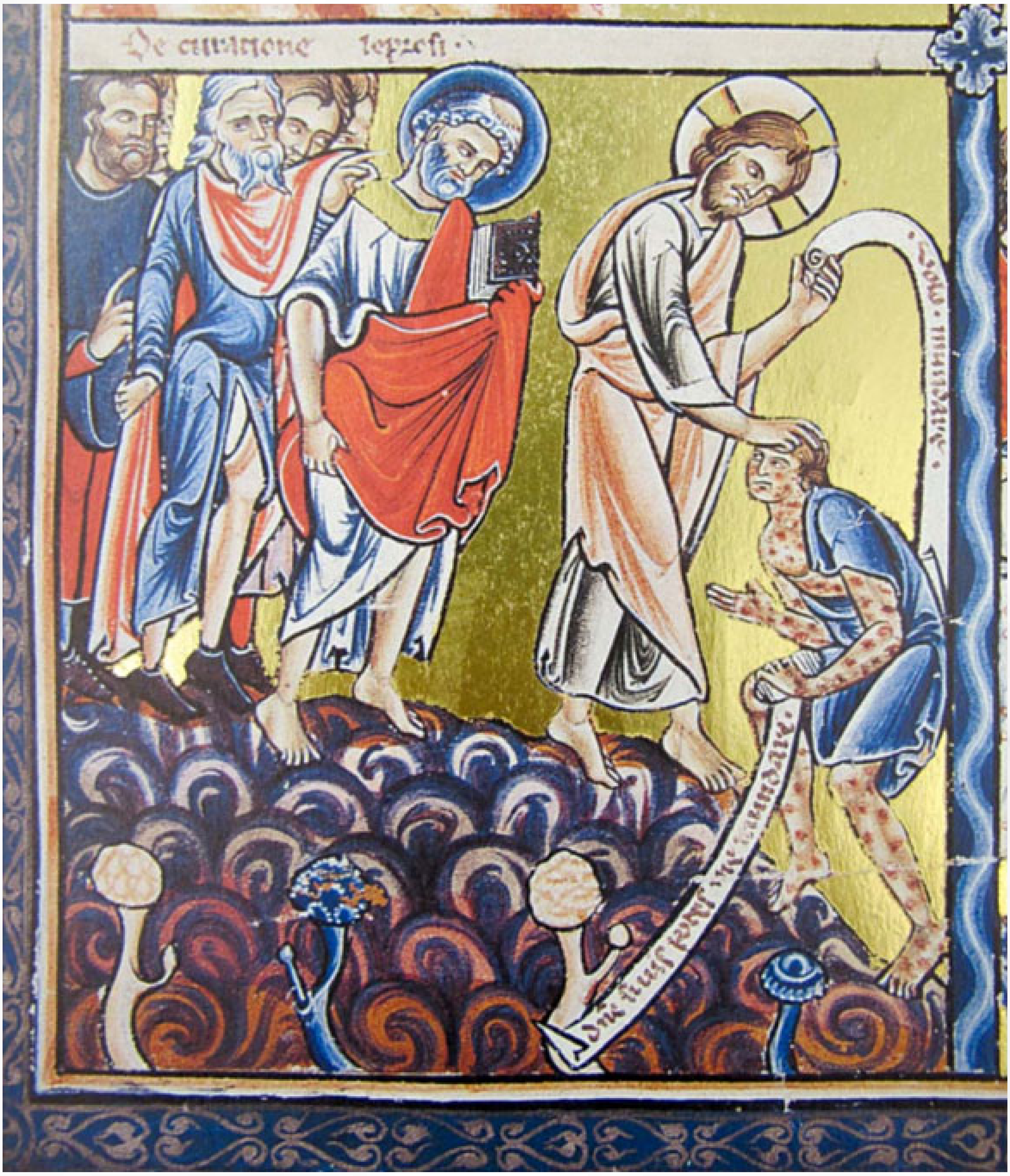


Figure 15. Jesus Heals the Leper. Great Canterbury Psalter, Folio 3, England, ca. 1200 (courtesy of the Bibliothèque nationale de France, Paris)

Saint Michael's Church, Germany

In the case of Chartres Cathedral, we wondered who placed these sacred mushroom images in the stained glass windows. Was it the royalty and aristocrats who financed the reconstruction of the cathedral in the 13th century? The bishops and monks who supervised the rebuilding project over decades? The master artisans who designed, cut, and installed the stained glass windows? Or all of them collaborating together?

In the case of Saint Michael's Church, we know exactly who created the mushroom images. In 993, when the urbane but mystical Bernward (960-1022) became the 13th bishop of the Holy See of Hildesheim at the age of 33 years, he was given a splinter of the Holy Cross by Emperor Otto III, whose teacher he had been for a long time. In honor of this relic, he inaugurated a chapel and planned a monastery on a hill on the outskirts of the city. The foundation of Saint Michael's Church (*Michaeliskirche*), the church for the monastery, was laid in 1010. The church was consecrated on Saint Michael's Day (September 29) in 1033. Bernward was canonized as Saint Bernward in 1192, more than a century after his death.

To commemorate the millennium, in 1015 Bernward cast a bronze door (the Door of Salvation) featuring Old and New Testament scenes in high relief. As a companion piece, Bernward designed a tall bronze column (the Christ Column) depicting the life of Christ, which he placed prominently behind the altar for all to see. The column was completed in 1020 just 2 years before Bernward's death.

Each work of art has a distinctive biblical theme. For the bronze door, it is the Fall and the Resurrection; for the column, it is the Life of Jesus. Viewed as a unified body of work, the fungiforms in the Door of Salvation and the Christ Column indicate the intention to represent an entheogenic legacy that was deliberately created by a saint of the Catholic Church.

In the fourth panel on the left wing of the "Door of Salvation," Bernward portrayed the tree in the Fall of Man as a mushroom tree. Here having eaten of the Forbidden Fruit, Adam, who is standing before an angry Lord, is pointing at a cowering Eve. Eve in turn is blaming the winged serpent coiled at her feet, the incarnation of the Tempter. Bernward left no doubt that one of the three mushrooms had already been eaten by Adam and Eve, as indicated by the broken branch springing from the lower part of the mushroom tree (Figure 16).

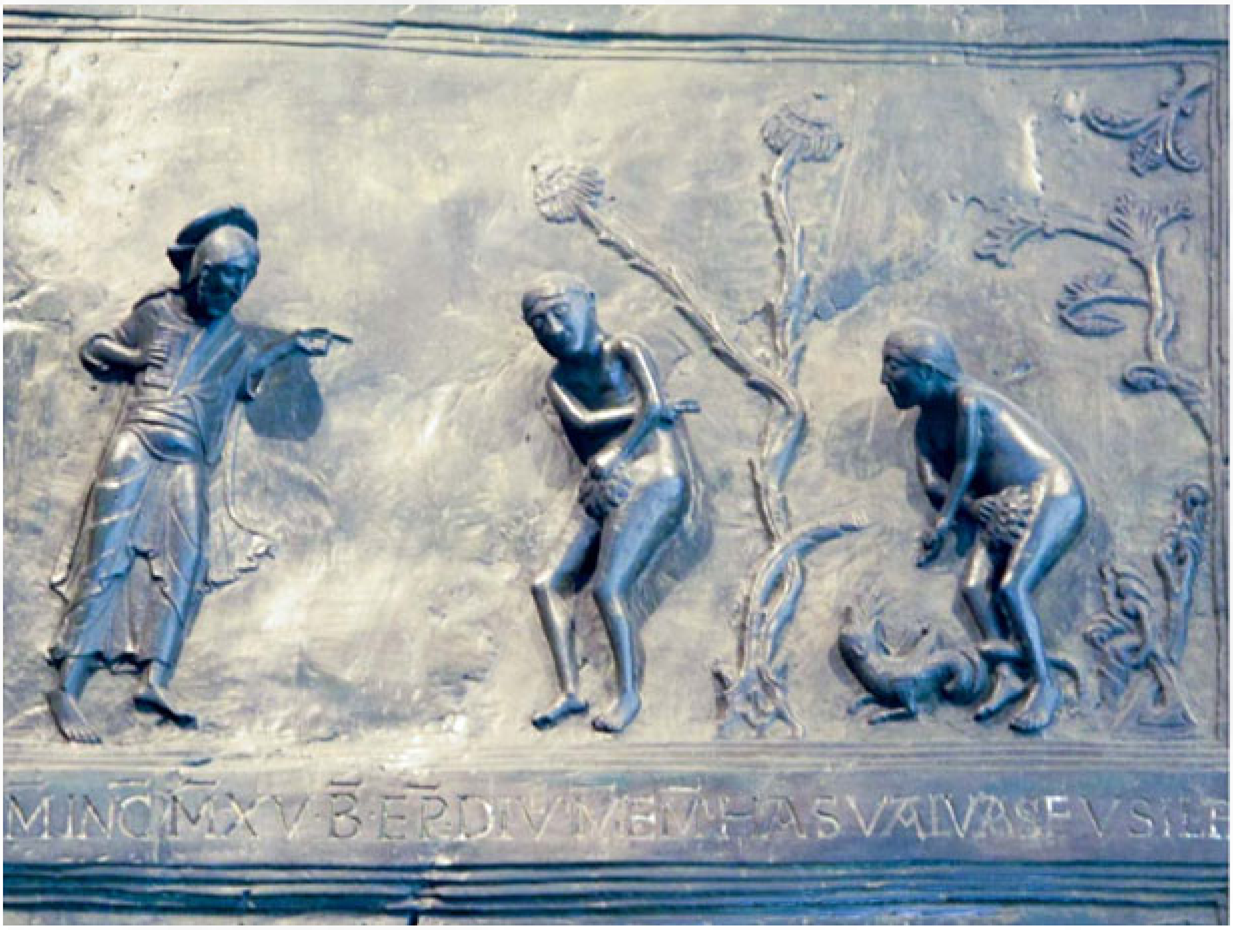


Figure 16. Panel 4, Adam and Eve, Bernward's Door of Salvation. St. Michael's Church, Hildesheim, Germany, 1015 (photo of Julie M. Brown)

In casting the door, Bernward took special care to provide details that precisely identify the species of psychoactive mushroom in this bronze bas-relief. As ethnobotanist Samorini (1998) observes, "*The mushroom-tree is realistically rendered with a precision not far short of anatomical accuracy and can be identified as one of the most common Germanic and European psilocybin-containing mushrooms, P. semilanceata (Fr.) Quél*" (p. 103), known as the "Liberty Cap." The Saint Savin-type mushroom tree between Adam and Eve sprouts two umbrella-shaped mushrooms with pointed nipple-like tops (papillae) and furrowed (striated) caps.

The bronze "Christ Column," which Bernward cast in 1020, stands over 12-ft tall and is nearly 2 ft in diameter. Ascending from the base in a coiling helix are 28 scenes from the life of Jesus, starting with his baptism and ending with his entrance into Jerusalem. To instruct the initiates in the "holy of holies," Bernward had strategically placed trifold mushroom trees, similar in every detail to the one in Eden on the Door of Salvation, in five of the seminal episodes of the life of Jesus including the Transfiguration.

In the Transfiguration, the apostles Peter, James and John go with Jesus to Mt. Tabor where the Old Testament prophets Moses and Elias appeared (Figure 17). There, Jesus transforms before their eyes so that "his face did shine as the sun." According to Matthew (17:5), "*a bright cloud overshadowed them: and behold a voice out of the cloud, which said, This is my beloved Son, in whom I am well pleased; hear ye him.*"

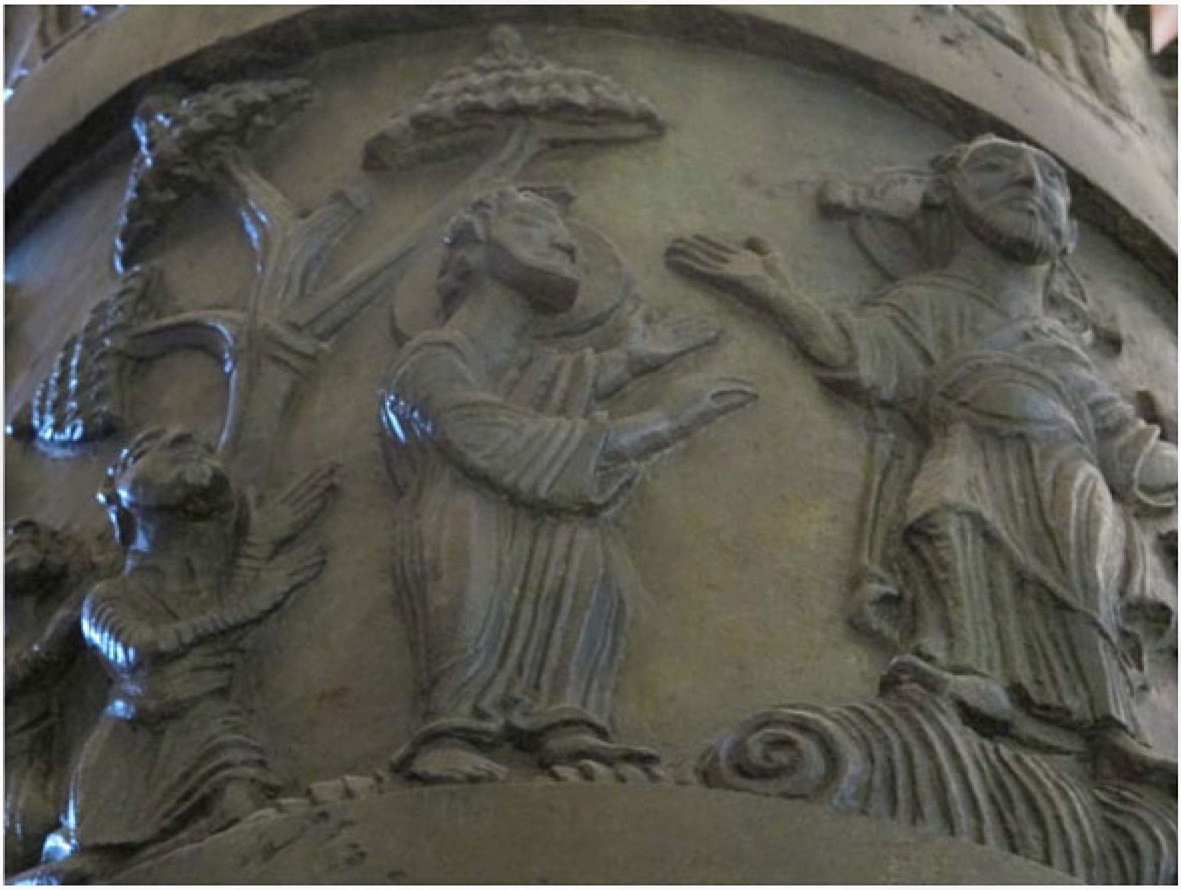


Figure 17. Transfiguration of Jesus, Christ Column, 1020. St. Michael's Church, Hildesheim, Germany (photo by Julie M. Brown)

Bernward's portrayal of the sacred entheogenic mushroom tree in the Transfiguration of Jesus is of particular significance for the psychedelic gospels theory, given that the Transfiguration is one of the main miracles attributed to Jesus in the Gospels. Unlike other miracles which were performed *by* Jesus, this one happens *to* Jesus, reaffirming, as did the baptism by John, his divinely chosen role as the "Son of God." Thus, the Transfiguration is a pivotal moment of the New Testament where humankind intersects with God. As Bernward implies artistically, access to the divine is mediated through the sacred sacrament of psychoactive mushrooms.

Due to space limitations, we cannot present and adequately discuss all of the entheogenic mushroom images documented in *The Psychedelic Gospels* (Brown & Brown, 2016). Notable among these images are:

1. Germany - the ceiling painting of the Jesse Tree carried out by Saint Bernward's successors in 1240, showing the Temptation in Eden against the background of a resplendent red and gold *A. muscaria* mushroom cap (color plate 20);
2. Italy - a mosaic of a basket of *A. muscaria* mushrooms in the Basilica of Aquileia, ca. 330 (color plate 21), whose botanical identification has been addressed by Fabbro (1996, 1999) and Samorini (1998, pp. 105-106);

3. Turkey - a never-before-reported *A. muscaria* mushroom painted around 1050 on the tip of the sponge of the Crucifixion in the Dark Church of the Open Air Museum in Göreme (color plates 23-24); and
4. Turkey - an angel holding an *A. muscaria* painted in the Yilanli Church in the Ihlara Valley, an area to which Christians fled as early as the first century in order to avoid Roman persecution (color plate 26).

Entheogens and early Christianity

We have identified *A. muscaria* and *Psilocybe* images in several examples of medieval Christian art and, based on these case studies and other examples found in the literature, inductively proposed the theory of the psychedelic gospels. The only evidence we have from early Christianity is found in the mosaics of the Cathedral of Aquileia, which date *ca*. 330 CE.

Meeting the challenge of finding additional evidence in earlier Christian art is problematic, if not impossible. Due to poverty and persecution, early Christians had limited opportunities to express their beliefs in images. As Spier (2007) observes in *Picturing the Bible* "*no churches, decorated tombs, nor indeed Christian works of art of any kind datable before the third century are known*" (p. 1).

To look for corroborating evidence of entheogens in early Christianity, we must turn to the written word - to the texts of the New Testament and the Gnostic Gospels, as well as to the commentaries of church fathers and other writers including poets, patricians, and historians. Since Christianity emerged in a Mediterranean region rife with Egyptian, Greek, Judaic, and Roman mystery cults, many of which possessed a sacred pharmacopeia, there is robust documentation of early entheogen use. It is therefore not surprising that "*Christianity absolutely had psychedelic mystery traditions throughout its history - nearly up to the modern day. From the Nazarene apoclypticists having visions of the end-times, to the various gnostic magic and mystery traditions, to the orthodox appropriation of various pagan theogenic experiences... psychedelia has been a part of Christianity since its earliest days*" (Hatsis, 2018, p. 170).

For example, based on an examination of textual evidence from the New Testament and the Nag Hammadi Library, which presents translations and commentaries on 52 Gnostic texts (Robinson, 1990), we have established "*a temporal and cultural link between entheogen use in Classical mystery cults and their possible use in a segment of the early Christian Gnostic Church*" (Brown & Lupu, 2014, p. 64).

In an intriguing passage from the Gnostic Gospel of Thomas, Jesus tells Thomas that they have both received knowledge from the same source:

> *Jesus said to his disciples, "Compare me to someone and tell me whom I am like ...." Thomas said to him, "Master, my mouth is wholly incapable of saying whom you are like." Jesus said, "I am not your master. Because you have drunk, you have become intoxicated from the bubbling spring which I have measured out .... He who will drink from my mouth will become like me. I shall become he, and the things that are hidden will be revealed to him.*" (Robinson, 1990, pp. 127, 137)

In terms of dose, while the psychoactive elixir is not identified, the fact that Jesus has "measured out" the drink suggests he knows the amount that should be ingested. In terms of effects, it appears that Jesus and Thomas are participating in a powerful transpersonal experience, one beyond words, in which they are literally sharing consciousness.

This widespread acknowledgment of entheogens in early Christian writings documents a psychedelic mystery tradition that persisted through the Dark Ages and flowers in the form of rich artistic renderings during the Middle Ages. The prevalence of this psychedelic tradition in a wide variety of texts and artistic media including illuminated manuscripts, bronze castings, and stained glass windows in the high holy places of Christianity shows that this tradition was not suppressed by the early Church, but to the contrary was made available as a secret practice for initiates.

The presence of psychedelics in Christian works of art should not be surprising, if we consider the teachings of Pope Gregory I (540-604), known as "the Father of Christian Worship." Pope Gregory believed that paintings of bible stories were an essential tool for the education of the faithful most of whom could not read. In this way, Christian art and images became "the Bible of the illiterate."

Critiques of the psychedelic gospels theory

To be sure, we are taking a large theoretical leap in generalizing from a relatively small sample of psychoactive mushroom images in Christian art to a theory of the psychedelic gospels, which suggests that early and medieval Christians experienced healing, divinity, and immortality by means of sacred plants. To address this gap, we propose an interdisciplinary research project that could independently gather sufficient evidence to test and ultimately prove (or disprove) this theory. But before outlining this project, it is instructive to consider several critiques of the theory of the psychedelic gospels. These include implicit critiques by art historians and explicit critiques by ardent advocates, medieval historians, and conservative Christians.

Ignorance by art historians

Aside from the pivotal Wasson-Panofsky interpretation of the Plaincourault fresco, art historians have been notably silent on the subject of entheogens in medieval Christian art. Why have these entheogenic icons remained "hidden in plain sight" to scholars who specialize in medieval manuscripts, frescoes, and stained glass windows? Does their collective silence represent an implicit denial of the validity of this theory?

Perhaps not. For example, during our research on the *Great Canterbury Psalter*, we spoke over phone with Nigel Morgan, Emeritus Honorary Professor of the History of Art, University of Cambridge, England. Morgan coauthored a commentary volume released with an exact replica of the *Psalter* by M. Moliero, a Spanish publishing house that specializes in the reproduction of illuminated manuscripts from the 8th to 16th centuries. When we asked Morgan if he had ever noticed the colored mushroom shapes in the Genesis folio (Figure 14), he replied "*I haven't the faintest idea what you are talking about. As a matter of fact, I wouldn't know a mushroom if I saw one*" (Brown & Brown, 2016, p. 145).

In her discussion of *Christ's Entry to Jerusalem*, art historian Marcia Kupfer is ostensibly unaware of the prominent mushrooms painted in the upper right-hand corner of this fresco in the Church of Saint Martin (Figure 8). According to Kupfer (1993), as Christ rides the ass followed by his disciples "*several youths excitedly **clamor up trees to break off branches**, while others unfurl their mantels at his feet. The second phase of the episode on the west wall isolates the walled city of Jerusalem ... Youths, their mouths open in song, crowd the gates; others within the city drape the walls or **cut away at the treetops***" [emphasis added] (p. 122).

Kupfer (2003, p. 1) observes "*To see works of medieval art solely with the naked eye is to remain blind.*" Unfortunately, when it comes to interpreting the frescoes at Saint Martin and elsewhere, it is frequently art historians who "remain blind." Due to their lack of knowledge of ethnomycology, they mistake psychoactive mushrooms for trees and branches and as a result err in their interpretation of some Romanesque religious paintings.

That this is not an error of commission but one of omission was confirmed by Charles Insley, senior lecturer in medieval history and keeper of a replica of the *Psalter* housed at Christ Church University in Canterbury. As Insley told us when asked about the silence of art historians and theologians on sacred mushroom images in the Psalter and in Christian art in general, "*It's not that they are purposely ignoring them, as some might think. Rather I believe that most art historians and theologians are not aware of them*" (Brown & Brown, 2016, p. 145).

Overenthusiasm by ardent advocates

Since the publication of Wasson's *Soma* (1968) and Allegro's *The Sacred Mushroom and the Cross* (1970), new evidence has emerged on websites (Michael Hoffman, 1985-2007a) and in articles (Samorini, 1997, 1998) and books documenting the presence of sacred mushrooms in Christian art. Several of these books are: *The Holy Mushroom* (Irvin, 2008) and *The Mushroom in Christian Art* (Rush, 2011) - both of which contain color photo galleries - and *The Effluents of Deity* (Ruck & Hoffman, 2012), which does not present photos but offers extensive analysis of medieval religious art.

While Irvin's (2008) work focuses mainly on a critical reevaluation of the Wasson-Allegro schism, it also presents 43 color plates to document the presence of psychoactive mushrooms in frescoes, stained glass windows, illuminated manuscripts, and sculpted capitals. Two thirds of these images fall within the 11th, 12th, and 13th centuries. Rush's (2011) book is accompanied by a DVD containing 252 colored images from three time periods: Early Christian Art (200-1000), Middle Christian Art (1000-1550), and Late Christian Art (1550-the Present).

Unfortunately, what at first glance appears to be a treasure trove of newly uncovered entheogenic icons - the nearly 300 images presented by Irvin and Rush - fades upon critical inspection. The first problem is a technical one created by accessing these European, Middle Eastern, and Russian images at a distance. By necessity, in reviewing art works from different time periods and diverse countries, Irvin and Rush have often relied on low-quality, sometimes corrupted, digital copies of these works found on the Internet. This has resulted in errors in reproduction and, consequently, in interpretation.

To cite one example, in plate 32 of *The Holy Mushroom*, Irvin (2008) describes St. Walburga as "*holding a distinct Amanita muscaria in its young, bulbous state of development, complete with white spots*" (p. 136). During our research trip to Germany, we realized that St. Walburga was not holding a mushroom but a vial containing healing ointment, as confirmed in numerous other artworks and accounts of her life (Figure 18).

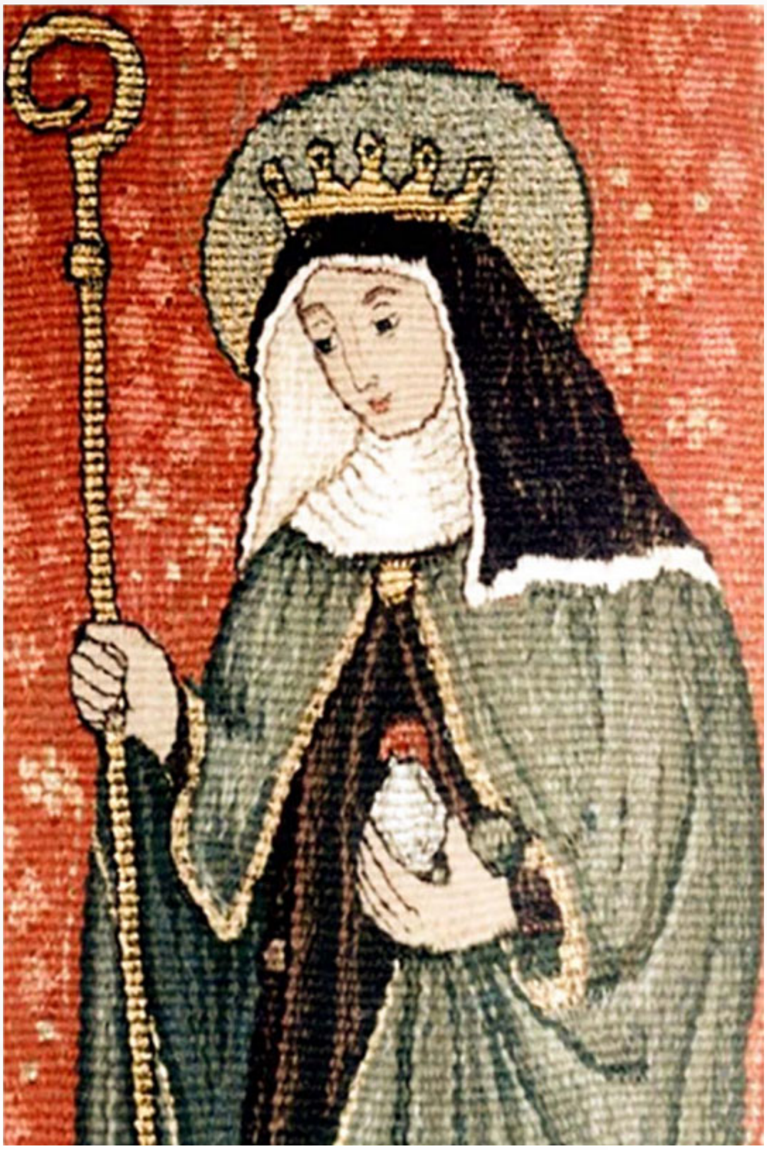


Figure 18. Tapestry of Saint Walburga. Woven by Sister Gretschmann, Abbey of Eichstätt, Germany (courtesy of the Abbey of Saint Walburga)

To cite another, the caption accompanying Rush's (2011) image of God creating Plants from the *Great Canterbury Psalter* reads "*Notice that the deity has something in the palm of his right hand and at the tip of his left index finger*" (DVD plate 1:9a). And in the text describing this image, Rush adds "*God is likewise holding something that looks suspiciously like a mushroom, but it might be a symbol for alpha and omega*" (p. 202). In reality, our image of God creating Plants, reproduced directly from the original *Psalter* housed in the Bibliotèque nationale de France, clearly indicates that God is not holding anything in either of his hands (Figure 14).

In addition to these technical errors, significant methodological questions have been raised. To allay the argument that holy mushroom critics "only addressed one picture," Hatsis (2017b) examined many of the images presented by Irvin and Rush and frequently found their analysis to be flawed.

After reviewing the 40+ plates showing the sacred mushroom in Christian art that Irvin includes in *The Holy Mushroom*, Hatsis (2017b, September 12) contends that "*Irvin's only criterion for interpreting the artwork is that if something looks like a mushroom, it is a mushroom - a weak methodology that we shall see has many problems, the first of which lets a self-fulfilling prophet see whatever he wishes.*"

In comments on plate 33, a depiction of "The Last Judgement" from the *Holkham Bible* (c. 1320-1330, England), Irvin (2008) observes that "*The angel on the left stares at three distinct mushrooms that he holds in his hand ...*" (p. 137). On the contrary, Hatsis (2017b, September 12) points out that "*a careful investigation shows that the supposed three mushrooms are the 'three nails' of the Arma Christi.*" Also known as the "Instruments of the Passion," the Arma Christi is a collection of objects associated with the Passion and the Crucifixion.

Similar concerns have been raised regarding Rush's *The Mushroom in Christian Art*. In contrast to Irvin who focuses mainly on distinctive mushroom images, Rush (2011) argues that the mushroom "*has many disguises, and thus we need to build a mushroom typology*" (p. 12). In constructing this typology, Rush postulates that, while in some of the art, the mushroom is quite evident, in others it is represented by analogies and symbols, such as, "*for example, halos, crosses, bread, books, wounds, and blood ....*" (p. 17). Irvin's ahistorical and Rush's symbolic approach to entheogen research frequently leads to spurious arguments, dogmatic conclusions, and untestable statements such as "*the value of the [mushroom] motif is its visible invisibility*" (Hatsis, 2017b, September 12).

This analysis of psychedelic images often devoid of historical context stands in sharp contrast to the more rigorous scholarship of Ruck and Hoffman (2012) in *The Effluents of Deity*. Here, the authors apply the interdisciplinary tools of art history and comparative religion to uncover the role of botanical eucharists in medieval artistic masterpieces such as Van Eyck's Ghent Altarpiece (Belgium), Grüenwald's Isenheim Altarpiece (France), Bernward's *Michaeliskirke* (Germany), and the frescoes of the Baptistery in Parma (Italy).

Oversimplification by medieval historians

Hatsis has performed a valuable service in calling attention to the excessive enthusiasm of some researchers. Unfortunately, he makes the same mistake - favoring dogmatism over fact - but in the opposite direction. When it comes to the study of entheogens in Christian art, Irvin and Rush tend to see mushrooms "everywhere," whereas Hatsis cannot see mushrooms "anywhere." The reasons for Hatsis' (2018) oversights and oversimplifications are contained in this revealing quote in *Psychedelic Mystery Traditions*:

> *In recent decades, scholars and conspiracy theorists alike (taking note of the psychedelic mystery traditions ubiquitous in paganism) have wondered about the possibility of such practices in the emerging Christianity of the first few centuries CE. Working off of the theories of the now discredited John Marco Allegro (1923-1988), these researchers have argued that the main Christian entheogenic sacrament was the Amanita muscaria mushroom.*[4] *Personally, I find the lack of evidence for this claim disappointing. The supposed mushrooms that appear in Christian art are easily explained away through a series of sound, tried-and-true historical criteria, which those who still support the theory (in one variety or another) have simply not considered ....*
>
> *Here is where the discipuli Allegrae and I part company. While they believe that the key Christian*

> *psychedelic mystery traditions rest in the forbidden fruit that Eve and Adam ate in the Garden, I hold a different opinion. There isn't a shred of evidence to suggest that medieval artists secretly signified entheogens as the fruit by depicting the Amanita muscaria into art.* (pp. 113-114)

Let us analyze one by one the oversights and oversimplifications found in this passage.

First, Hatsis (2018) sets up a bogus straw man by classifying all researchers who support the "holy mushroom theory" as "discipuli Allegrae," which he defines as "*a general term I use to refer to those who agree with the theories of John Marco Allegro, whose book The Sacred Mushrooms and the Cross (1970) argued that Christianity evolved out of a magic mushroom-eating sex cult*" (p. 108).

Since footnote 4 (first paragraph of the above quote) cites *The Psychedelic Gospels*, Hatsis obviously considers us to be "discipuli Allegrea." This is false since we state unequivocally in *The Psychedelic Gospels* that:

> *... our theory differs from Allegro's in three fundamental ways. First, while Allegro denies the existence of Jesus, we agree with those scholars of religious studies who believe that Jesus was an historical figure. Second, while Allegro bases his theory on the speculative interpretation of ancient languages, we base our theory on the plausible identification of visual entheogenic images. Third, while Allegro hopes that his writings will liberate people from the thrall of a false Christian orthodoxy, we hope that our discoveries will educate people about the history of psychoactive sacraments in Christianity.* (Brown & Brown, 2016, p. 217)

That said, it is important not to throw the baby out with the bathwater. In this case, the bathwater contains the spurious, discredited claims Allegro made about the ahistoricity of Jesus, and the origins of Christianity as a mushroom-sex cult. The baby refers to Allegro's thesis that visionary plants had been widely used in Western culture and religion throughout the ages including the mystical experiences of early Christianity. According to Hoffman (1985-2007a), this view is supported in one form or another by a variety of entheogen scholars including Chris Bennet, Peter Furst, Clark Heinrich, Jonathan Ott, Carl Ruck, Huston Smith, and R. Gordon Wasson, to name a few.

Second, Hatsis claims that the one and only entheogenic sacrament that holy mushroom theorists find in Christian art is the *A. muscaria*. This is a significant oversight easily corrected by consulting the literature. While some researchers consider this to be the case, *The Psychedelic Gospels* (Brown & Brown, 2016) and Samorini's (1998) typology of mushroom trees, among others, have identified the presence of mushrooms in Christian art that reflect the distinctive features of psilocybin-containing *Psilocybe* and *Panaeolus* species of the region. In at least two cases, the bronze Door of Salvation and the Christ Column cast by Bishop Bernward, the distinctive features of the mushrooms are depicted so accurately that ethnobotanists can determine their botanical classification as local psilocybin-containing species.

Third, Hatsis also contends that "*The supposed mushrooms that appear in Christian art are easily explained away through a series of sound, tried-and-true historical criteria.*" Aside from implying that the interdisciplinary research carried out by Ruck and Hoffman (2012), the ethnobotanical research conducted by Samorini (1998), and the anthropological field research conducted by the authors of this article (2016) are somehow not "tried-and-true" methodologies, Hatsis is making a daredevil leap of logic. Hatsis (2017b) assumes that, just because he has "debunked" *a few* erroneous claims regarding the presence of mushrooms in Christian art, he has *ipso facto* dispensed with *all* reported cases of iconographic evidence of entheogens in Christian art.

To be sure, Hatsis (2018) does raise a valid question in asking, "*Why would church leaders espouse their ideas about mandrake, opium, and cannabis, all the while never mentioning anything about an Amanita muscaria mushroom - least of which that they were painting them into art to teach people about Jesus?*" (p. 170). In legal circles, it is a shibboleth that the "absence of evidence" - in this case corroborating textual evidence - does not prove "evidence of absence." In other words, just because textual evidence of mushrooms has not been found yet does not prove it does not exist. Nevertheless, the lack of "ink" on this topic in the writings of church leaders poses a valid question worth pursuing.

Overture by conservative Christians

To the best of our knowledge, there has been no response by Christians to recent discoveries of psychoactive mushrooms in Christian art. However, Michael Pollan's best-selling book, *How to Change Your Mind, What the New Science of Psychedelics Tells Us about Consciousness, Dying, Addiction, Depression and Transcendence* (2018) has inspired a response by conservative Christians. Reflecting positively on Pollan's work in a post in the American Conservative titled "*A Christian Approach to Psychedelics*" (2018), senior editor Rod offers the following observations for consideration by fellow Christians:

1. We should not dismiss psychedelics out of hand - not for the sake of treating those suffering from mental disorders or terminal illness, but also for those interested in studying consciousness.
2. It is compatible with the metaphysics of premodern Christian tradition - especially Eastern Christianity - to believe that God is everywhere present, and in some sense (not just symbolic) fills all things. Orthodox Christianity (and Catholicism?) posits that this is a theological and metaphysical truth. It has been confirmed by Christian mystics. Psychedelic drugs may reveal this truth in a different way.
3. Pollan is correct to say that a purely neurochemical explanation for these states does not negate their spiritual meaning. Certainly not for Christians in the sacramental tradition, who take for granted that God can and does communicate with His creation through matter.

Obviously, it is one thing to propose an overture in which Christians can acknowledge that psychedelics may reveal that "God is everywhere present," a truth confirmed by Christian mystics through the ages. It is quite another to suggest as proposed by psychedelic gospels theory that Christianity itself has a psychedelic history.

Ultimately, we hope that the growing gallery of evidence of entheogens in Christian art will not undermine anyone's faith in Christianity but rather illuminate a mystery that applies to many religious traditions. In effect, these studies promise to contribute to the growing awareness that entheogens have provided an authentic pathway to the divine in the past and will continue to do so today and into the future. For example, the endorsement of Santo Daime churches, which use ayahuasca as a sacrament, by the Brazilian Council of Bishops demonstrates that entheogenic-inspired religions can find acceptance within Catholic orthodoxy.

That Christians may embrace entheogens theologically is confirmed by Brother David Steindl-Rast (2001), a Catholic Benedictine monk, who observes, "*Because I have faith in the Church's traditional sacraments, I ought to be able to stretch that faith to include the possibility of encountering God through all available sacraments... Faith, simply accepted with gratefulness that God works through all created things. All? If we can encounter God through a sunrise seen from a mountain top, why not through a mushroom prayerfully ingested?*" (p. xii).

Interdisciplinary committee on psychedelic gospels

We have revisited the Wasson-Allegro controversy, presented iconographic evidence of entheogens in Christian art, and examined critiques of the psychedelic gospels theory. In this context, we can now address Wasson's paradox and the need for an Interdisciplinary Committee on the Psychedelic Gospels.

Wasson's paradox

In our book, we state that "*In our opinion Wasson's greatest paradox was this: the discrepancy between his zealous exploration of a controversial theory about the role of entheogens in early religion and his reluctance to pursue this theory past the portals of the church and into the hallowed halls of Christianity*" (Brown & Brown, 2016, p. 7). This paradox is especially poignant in the case of the Eden fresco at Plaincourault. Here, Samorini (1998) remarks that "*It is therefore quite strange that the father of ethnomycology stopped before the lapidary appraisal of an art historian and did not, instead follow the trail of additional 'mushroom-tree' representations in Roman and Christian art as he might have done or scheduled*" (p. 31). Given his reputation as an indefatigable seeker of sacred mushrooms, why did Wasson not travel a mere 6 miles west of Plaincourault to Saint Savin (Figure 5) or 50 miles east to Saint Martin's (Figure 8) where he would have undoubtedly discovered additional examples of entheogens in Christian art?

Several explanations of this egregious oversight have been suggested. Samorini (1998) proposes that Wasson's reluctance grew out of a realistic concern that acknowledging *any* evidence in support of "Allegro's sensational thesis" would deal "*a serious blow to the new science of ethnomycology of entheogenic mushrooms*" (p. 32). Early in our research, we wondered if as the son of an Episcopalian minister, Wasson felt "*a filial allegiance to his father and a loyalty to the church*" (Brown & Brown, 2016, p. 7).

While these may be contributing factors, we later uncovered a more compelling explanation. During our 2012 visit to the Vatican Museum in Rome, we were inspired to Google the words "Wasson, Vatican" which immediately produced several search items including one that said "*Wasson was an account manager to the Pope and Vatican for J.P. Morgan*" (Irvin, 2012). Wasson joined the Wall Street investment banking firm of J.P. Morgan in 1934, where he helped develop the new field of banking public relations.

Upon further research, we found that Wasson's direct financial involvement with the Vatican was confirmed by DeWitt Peterkin, a retired J.P. Morgan, Vice President. In an interview for *The Sacred Mushroom Seeker*, a book of essays in tribute to Wasson, Peterkin reveals that "*Unbeknown to most people, we were for many years one of the bankers for the Vatican... . And Gordon used to have private audiences with the Pope*" (Riedlinger, 1997b, p. 51).

Wasson never mentions his role as a Vatican banker in his writings. This role provides a clear financial motive for Wasson's reluctance to explore entheogens in Christian art. This may have been reinforced by a legally binding confidentiality and non-disclosure agreement between banker (J.P. Morgan) and client (the Vatican), given that such agreements are common in the investment banking field.

Regardless of motive, due to Wasson's preeminent position as a leading authority on the study of entheogens and religion, this lack of disclosure was especially damaging to the nascent field of ethnomycology. In effect, Wasson's lack of transparency combined with his relentless personal and professional attacks on Allegro stymied widespread scholarly inquiry into the study of entheogens and Christianity for nearly half a century.

Call for an interdisciplinary committee

Samorini (1998) closes his survey of "mushroom-trees" in Christian art by stating that "*we may confidently conclude from what has emerged that justifications do exist for serious and unprejudiced ethnomycological study of early Christian culture, and it is our hope that such studies will take place*" (p. 107).

Given the conflicting interpretations of entheogenic mushroom images in Christian art, and the controversial implications of the psychedelic gospels theory, there is an obvious need to establish sound methodologies and objective criteria for a rigorous, unbiased evaluation of this iconographic evidence. Achieving this goal will require more than a de rigueur appeal for "additional studies." For this reason, we call for the establishment of an international Interdisciplinary Committee on the Psychedelic Gospels (Committee).

This Committee could be housed at a major university or museum and co-chaired by an ethnobotanist and church historian with relevant credentials. It would be charged with collecting, cataloging, and curating potential psychoactive images in Christian art from around the world, and evaluating them for the presence of evidence indicating that they represent entheogenic species. Toward this end, the Committee would integrate research methodologies from anthropology (fieldwork), art history (iconography, iconology), church history (textual analysis), ethnobotany (cultural uses of mushrooms), mycology (fungus identification), and theology (exegesis).

The Committee would establish criteria for peer-review evaluation of critical questions. Are the images clear and unambiguous enough to facilitate a definitive identification of the genus and species of psychoactive mushroom? Or if the mushrooms shown are stylized mushrooms (such as "mushroom trees"), are there artistic traditions of interpretation that contribute to determining that they were intended to depict entheogenic species? Does the art tradition and history surrounding the image enhance the determination of the intent to represent psychoactive mushrooms or other entheogens? Are there relevant texts and/or other historical documents that corroborate these findings?

Unlike the political infighting that delayed publication of the Dead Sea Scrolls for decades, the workings of the

Committee must be transparent. The Judeo-Christian art images and religious texts in question should be made available online for public viewing and comment. It is through this interdisciplinary peer-review process that the theory of the psychedelic gospels can be independently confirmed (or refuted) by the Committee, and thereby potentially gain credence in scientific and theological circles as well as among thought leaders, policy makers and the mainstream media.

Conclusions

Revisiting the epic Wasson-Allegro controversy in light of new evidence reveals that Wasson did behave in an academically irresponsible manner in not publishing the second letter from art historian Panofsky that favors Allegro's interpretation of the 13th century Plaincourault fresco as a psychoactive *A. muscaria* mushroom. During his 1952 visit to the Chapel of Plaincourault in Central France, Wasson mysteriously did not investigate the nearby Abbey of Saint Savin or the Church of Saint Martin de Vicq, which would have provided significant evidence of entheogens in medieval Christianity, thereby contradicting his claim in *Soma* that their remote role in Judeo-Christianity ended around 1000 BCE. Wasson's function at J.P. Morgan as the "Pope's banker" furnishes a powerful financial motive for his refusal to pursue the thesis regarding the entheogenic origins of religion into Christian art and artifacts, as well as for his rejection and ridicule of Allegro's writings in *The Sacred Mushroom and the Cross*.

While Wasson's views stymied research on entheogens in Christianity for decades after the publication of *Soma* in 1968, a new generation of 21st century researchers has documented growing evidence of psychedelic *A. muscaria* and a variety of species of psilocybin-containing mushrooms in Christian art, consistent with Samorini's typology of "mushroom-trees." *The Psychedelic Gospels* contributes to these entheogenic studies (a) by providing original photographs and analysis of psychoactive mushroom images in several churches and cathedrals in Europe and the Middle East; (b) by arguing that based on the presence of these images in the high holy places of Christianity, these psychedelic traditions were not suppressed by the Church, but were rather maintained for the secret instruction of initiates and possibly for the education of the illiterate masses; and (c) by proposing a psychedelic gospels theory, which hypothesizes that these images represent an alternative history of Christianity, suggesting that early and medieval Christians experienced healing, divinity, and immortality by ingesting sacred psychoactive sacraments.

In evaluating critiques of the psychedelic gospels theory by art historians, ardent enthusiasts, medieval historians, and conservative Christians, it is important for entheogenic researchers to avoid the dual dogmatic pitfalls of either seeing mushrooms everywhere or refusing to see mushrooms anywhere. To provide a rigorous methodology for testing this controversial theory, the authors call for the establishment of an Interdisciplinary Committee on the Psychedelic Gospels. In addition to being charged with collecting and vetting images of psychoactive mushrooms and other entheogens in Christian art, the Committee would also search for textual confirmation of entheogens in the Bible, in the Gnostic Gospels, and in the writings of church fathers and other commentators.

The receptivity of some conservative Christians to the medical and mystical findings of the current Psychedelic Renaissance may open the door to a dialogue between the Church and the psychedelic community regarding the past role of entheogens in Christian art and history and their possible future role in ritual as a sacred sacrament and pathway to the divine.

Acknowledgements: The coauthors received no assistance in the preparation of this article and are solely responsible for its contents. However, some of the fieldwork materials in this article, including all the photographs by JMB, were gathered with the financial support of a 2012 Sabbatical and Travel/Research grant from Florida International University, where coauthor JBB served as founding professor of anthropology from 1972-2014.

Conflict of interest: The coauthors have no conflicts of interest neither in writing this article nor regarding the subject matter of this article.

References

1. Alcoy, R. (2015). *The Great Canterbury Psalter*. Excerpt from Commentary volume published online by The Medievalist, February 2, 2015. Retrieved from http://www.medievalists.net/2015/02/great-canterbury-psalter/
2. Allegro, J. (1970). *The sacred mushroom and the cross*. New York, NY: Doubleday.
3. Allegro, J. (2009). *The sacred mushroom and the cross* (40th anniversary edition). Allegro estate and Gnostic Media.
4. Brown, J., & Brown, J. (2016). *The psychedelic gospels: The secret history of hallucinogens in Christianity*. Rochester, VT: Park Street Press.
5. Brown, J., & Lupu, M. (2014). Sacred plants and the gnostic church: Speculations on entheogen use in early Christian ritual. *Journal of Ancient History, 2*(1), 64-77. doi:10.1515/jah-2014-0010
6. Brown, J. A. (2005). *John Marco Allegro: The maverick of the Dead Sea Scrolls*. Grand Rapids, MI: William B. Eerdmans Publishing Co.
7. Campbell, J. (2018). *The inner reaches of outer space: Myth as metaphor and as religion* (The Collected Works of Joseph Campbell Book, Kindle Edition). New York, NY: Joseph Campbell Foundation.
8. Dreher, R. (2018, May 21). A Christian approach to psychedelics. *The American Conservative*. Retrieved from https://www.theamericanconservative.com/dreher/christian-approach-to-psychedelics
9. Eliade, M. (1974). *Shamanism: Archaic techniques of ecstasy*. Princeton, NJ: Princeton University Press.
10. Fabbro, F. (1996). *Did early Christians use hallucinogenic mushrooms? Archaeological evidence*. Retrieved from http://distelrath.tripod.com/fabbro.htm
11. Fabbro, F. (1999). Mushrooms & snails in religious rituals of early Christians at Aquileia. *Eleusis, 3,* 69-80.
12. Furst, P. T. (1976). *Hallucinogens and culture*. San Francisco, CA: Chandler & Sharp Publishers.
13. Great Canterbury Psalter (Anglo-Catalan Psalter). (Canterbury 13th Century-Barcelona 14th Century). Preserved in Bibliothèque Nationale de France, Paris, France. Shelf Mark: Lat. 8846. Retrieved from https://www.moleiro.com/en/biblical-books/the-great-canterbury-psalter.html#imagenesarticle
14. Hatsis, T. (2017a, May 25). *Patrons of the serpent: Plaincourault and the mystery of free will*. Unpublished paper presented at Exploring Psychedelics Conference, Ashland, Oregon. Personal communication, Podcast of presentation retrieved from https://www.podomatic.com/podcasts/entheogenic/episodes/2017-07-12T10_29_24-07_00
15. Hatsis, T. (2017b). *The Mushroom in Mommy Fortuna's Midnight Carnival (August 24); The Christian Radish Cult (September 11); The Dogmatist's Debacle (September 12); and Roasting Jan Irvin (November 7)*. Online blogs posted to https://psychedelicwitch.com/tag/holy-mushroom-theory/
16. Hatsis, T. (2018). *Psychedelic mystery traditions*. Rochester, VT: Park Street Press.
17. Hoffman, M. (1985-2007a). *Entheogens and religion*. Retrieved from http://www.egodeath.com/index.html#_Entheogens_and_Religion
18. Hoffman, M. (1985-2007b). *Gallery: Christian mushroom-trees*. Retrieved from http://www.egodeath.com/WassonEdenTree.htm#_Toc135889185
19. Hoffman, M. A., Ruck, C., & Staples, B. (2002). The entheogenic Eucharist of Mithras. *Entheos, 2*(1), 13-46.
20. Irvin, J. (2008). *The Holy Mushroom: Evidence of Mushrooms in Judeo-Christianity. A critical re-evaluation of the schism between John M. Allegro and R. Gordon Wasson over the theory on the entheogenic origins of Christianity presented in The Sacred Mushroom and the Cross*. Grand Terrace, CA: Gnostic Media.
21. Irvin, J. (2012, May 13). The secret history of magic mushrooms. *Gnostic Media Online*. Retrieved from http://www.gnosticmedia.com/SecretHistoryMagicMushroomsProject
22. King James Bible Online. (2019). *King James version (authorized version)*. Retrieved from http://www.kingjamesbibleonline.org
23. Kupfer, M. (1993). *Romanesque wall painting in Central France: The politics of narrative*. New Haven, CT: Yale University Press.
24. Kupfer, M. (2003). *The art of healing: Painting for the sick and the sinner in a medieval town*. University Park, PA: The Pennsylvania State University Press.
25. *Mérigny-Indre, Chapelle de Plaincourault*. (2009). Orléans, France: Patrimoine Restauré en Région Céntre.

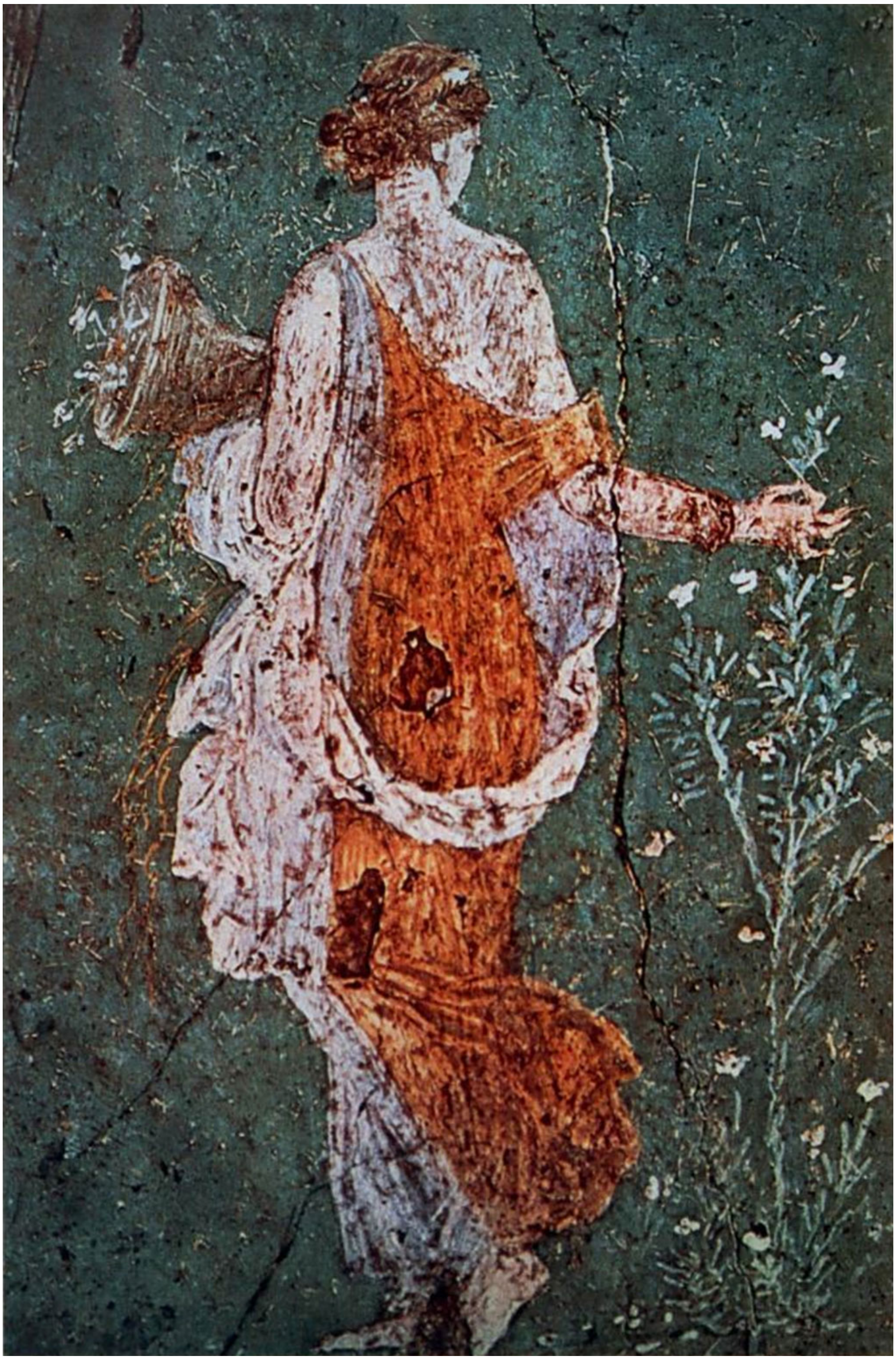
26. Ott, J. (1997). A twentieth century Darwin. In T. J. Riedlinger (Ed.), *The sacred mushroom seeker* (pp. 183-191). Rochester, VT: Park Street Press.
27. Panofsky, E. (1952). *Letters to R. Gordon Wasson, May 2 and May 12*. Cambridge, MA: Tina and R. Gordon Wasson Ethnomycological Collection, Harvard University Herbarium.
28. Pollan, M. (2018). *How to change your mind: What the new science of psychedelics tells us about consciousness, dying, addiction, depression and transcendence*. New York, NY: Penguin Random House.
29. Riedlinger, T. J. (Ed.). (1997a). *The sacred mushroom seeker: Tributes to R. Gordon Wasson*. Rochester, VT: Park Street Press.
30. Riedlinger, T. J. (1997b). A latecomer's view of R. Gordon Wasson. In T. J. Riedlinger (Ed.), *The sacred mushroom seeker: Tributes to R. Gordon Wasson* (pp. 205-220). Rochester, VT: Park Street Press.
31. Robinson, J. M. (Ed.). (1990). *The Nag Hammadi library: The definitive translation of the gnostic scriptures* (Rev. ed.). New York, NY: HarperOne.
32. Ruck, C., Staples, B., & Heinrich, C. (Eds.). (2001). *The apples of Apollo: Pagan and Christian mysteries of the Eucharist*. Durham, NC: Carolina Academic Press.
33. Ruck, C. A. P., & Hoffman, M. A. (2012). *The effluents of deity: Alchemy and psychoactive sacraments in Medieval and Renaissance art*. Durham, NC: Carolina Academic Press.
34. Rush, J. (2011). *The mushroom in Christian art: The identity of Jesus in the development of Christianity*. Berkeley, CA: North Atlantic Books.
35. Samorini, G. (1997). The mushroom-tree of Plaincourault. *Eleusis, 8,* 30-37.
36. Samorini, G. (1998). "Mushroom-trees" in Christian art. *Eleusis, 1,* 87-108.
37. Schultes, R. E., & Hofmann, A. (1992). *Plants of the Gods: Their sacred, healing, and hallucinogenic powers*. Rochester, VT: Healing Arts Press.
38. Smith, J. C. (2005). *Introduction in Ervin Panofsky, "The life and art of Albrecht Durer*". Princeton, NJ: Princeton University Press.
39. Spier, J. (2007). *Picturing the Bible: The earliest Christian art*. New Haven, CT: Yale University Press.
40. Steindl-Rast, D. (2001). Forward. In T. B. Roberts (Ed.), *Psychoactive sacraments: Essays on entheogens and religion* (pp. xi-xiv). San Francisco, CA: Council on Spiritual Practices.
41. Wasson, R. G. (1970a, August 21). *Letter to the Times Literary Supplement*.
42. Wasson, R. G. (1970b, September 25). *Letter to the Times Literary Supplement.*
43. Wasson, R. G. (1968). *Soma: Divine mushroom of immortality,* Ethnomycological studies no. 1. New York, NY: Harcourt Brace Jovanovich, Inc.
44. Wasson, R. G., Cowan, C., Cowan, F., & Rhodes, W. (1974). *María Sabina and her Mazatec mushroom velada,* Ethnomycological studies no. 3. New York, NY: Harcourt Brace Jovanovich.
45. Wasson, R. G., Hofmann, A., & Ruck, C. A. P. (1978). *The road to Eleusis: Unveiling the secret of the Mysteries*. New York, NY: Harcourt Brace Jovanovich.
46. Wasson, R. G., Kramrisch, S., Ott, J., & Ruck, C. A. P. (1986). *Persephone's quest: Entheogens and the origins of religion*. New Haven, CT: Yale University Press.
47. Winkelman, M. (2010). The holy mushroom: Evidence of mushrooms in Judeo-Christianity. A critical re-evaluation of the schism between John M. Allegro and R. Gordon Wasson over the theory on the entheogenic origins of Christianity presented in The Sacred Mushroom and the Cross. By J.R. Irvin [Book review]. *Anthropology of Consciousness, 21*(1), 106-108. doi:10.1111/j.1556-3537.2010.01023.x

Persephone's Quest: Entheogens and the Origins of Religion

by

R. Gordon Wasson, Stella Kramrisch, Jonathan Ott, and Carl A. P. Ruck

© 1986 by R. Gordon Wasson



Persephone Gathering Wild Flowers Wall painting from Stabiae.
Naples, Museo Nazionale.

Table of Contents:

PART ONE: Entheogens and the Origins of Religion
Prelude
CHAPTER ONE - Persephone's Quest
Interlude
Our discoveries
1. Soma and the Vedic Culture
2. The Mystery of Eleusis
3. Our First Velada
4. The Grecas
5. The New World and the Thunderbolt
6. The Meaning of Kakuljá Hurakan
7. A Glimpse of the Domestic Use of Soma
8. The Chinese and the Nivkhi
9. Greece and Soma
10. Soma among the Mediaeval 'Monsters'
11. The Chukotka
12. The Fool's Mushroom
13. 'Happiness Mushroom'
14. The British and the 'Nameless Mushroom
15. The Vikings and Soma
16. The Tree of the Knowledge of Good and Evil
EPILOGUE: The Age of the Entheogens
Unfinished Business
CHAPTER TWO - Lightningbolt and Mushroom
CHAPTER THREE - The Mah&amacr;v&imacr;ra Vessel and the Plant P&umacr;tika
The Secret of the Cut-off Heads
The Elixir of Life: Soma and P&umacr;tika
Putka and the Santal of Eastern Bihar
The Mah&amacr;v&imacr;ra Vessel
The Later and Separate Lives of Mah&amacr;v&imacr;ra and P&umacr;tika
CHAPTER FOUR - The Last Meal of the Buddha
What was S&umacr;kara-Maddava?
The Santal and the Putka
The death of the Buddha
The Buddha's last meal
The Indus Valley and Kashmir
Memorandum by Walpola R&amacr;hula of the early sources for the meaning of s&umacr;karamaddava
Epilogue
CHAPTER FIVE - Carved 'Disembodied Eyes' of Teotihuacan
References

PART TWO: Poets, Philosophers, Priests: Entheogens in the Formation of the Classical Tradition
CHAPTER SIX - Mushrooms and Philosophers
Shade-foots
The Scene of Necromancy
Peisander and the Affair of the Profanations
The Swamp of Dionysus
Tongue-in-bellies and Revealers
Socrates as Profaner of the Mysteries
Mushrooms
Aja Ekap&amacr;d
Prometheus as Shade-foot and the Theft of Fire
Philosophers
CHAPTER SEVEN - The Wild and the Cultivated: Wine in Euripides' *Bacchae*
The Discovery of Wine

The Reconciliation with Primitivism
The Making of Wine
The Mad King and the God
Double Birth and the God's Surrogate
The First Birth
The Second Birth
The Paradigm of Actaeon
The Regression of Cadmean Thebes
From Pollution to Fertility
Toward an Understanding of Tragedy
CHAPTER EIGHT - The Offerings from the Hyperboreans
Introduction
The Route for the Offerings
Hyperboreans
The Garden of Apollo
Lycians
Apollo
Sacrifice
Thargelia
Daphnephoria
The Secret Offering
References

PART ONE

Entheogens and the Origins of Religion

> '*We have no knowledge... but what has been built up by pleasure, and exists in us by pleasure alone... The knowledge both of the Poet and the Man of Science is pleasure.*' Wordsworth's insistence in the 1802 preface to the *Lyrical Ballads* on the inseparable association of knowledge and pleasure takes us straight to a profound conjunction in the work of scientist and creative writer... The 'happy ending' of successful theorizing, satisfactory experiment, achieved work of art, creates pleasure. And so does the process, or story, of discovery.
>
> *Gillian Beer,* TLS, *2 Nov. 1984, p. 1255*

Prelude

In the opening chapter of my SOMA I said that there always hovered in my mind's eye the admonitory finger of Tristram Shandy's warning against the occupational hazard of those who advance hypotheses:

> It is in the nature of a hypothesis when once a man has conceived it, that it assimilates everything to itself, as proper nourishment, and from the first moment of your begetting it, it generally grows stronger by everything you see, hear or understand.

I was reasonably sure of my ground but also I knew how fallible I was, and I added Laurence Sterne's danger sign, in case I had committed a blunder. Nevertheless now it turns out that I was right the first time, and I present this book with the proofs from various angles corroborating each other. We are well beyond the stage of hypotheses.

R. G. W.

CHAPTER ONE

Persephone's Quest

by R. Gordon Wasson

> *As I am nearing the end of my days, I will draw up an account of our mushroom quest, Valentina Pavlovna my late Russian wife's and mine, followed by the highlights of our discoveries as I see them.*

THE QUEST

Back in 1921 I fell in love with a Russian girl, Valentina Pavlovna, in London, where she was studying medicine. We got married at the end of 1926 in England and came to America where she requalified as a physician. I was a newspaper man covering the Wall Street bank-run for the old *Herald Tribune*. We took our delayed honeymoon late in August 1927 in Big Indian, the Catskills, in a chalet lent to us by Adam Dingwall, a publisher. On our first day, after lunch, we went for a walk, down a path that led by a pond and then a clearing on the right, and, on the left, the upward slope of a forested mountain. We were hand in hand and a picture of bliss. Suddenly, before I knew it, my bride threw down my hand roughly and ran up into the forest, with cries of ecstasy. She had seen toadstools growing, many kinds of toadstools. She had not seen the like since Russia, since 1917. She was in a delirium of excitement and began gathering them right and left in her skirt. From the path I called to her, admonished her not to gather them: they were toadstools, I said, they were poisonous. 'Come back, come back to me!', I pleaded. She laughed the merrier and continued picking, as it seemed to me indiscriminately. To make a long story short, we had our first marital crisis. During our five year engagement mushrooms had never come up between us and here she was possessed by the mushrooms! Our walk ended then and there, she with her skirt full of mushrooms of various kinds. Some she put into the soup when she prepared our supper, others with the steak, others she strung together carefully by the stipes and hung out to dry in the sun, for use in winter, she said. I was beside myself. I acted the perfect Anglo-Saxon oaf confronting a wood nymph I had never before laid eyes on. I would eat nothing with mushrooms in it. Later she said I had predicted I should wake up the next day a widower, but I have always denied this allegation.

We checked the attitude to mushrooms with our respective friends, - mine Anglo-Saxon mycophobes, hers Russian mycophiles. Then we looked at the vocabularies: the English use three working words, - first and foremost the 'toadstool' (with no translation in Russian), then a Latin quasi-scientific term, 'fungus', and third the uncertainly defined 'mushroom' borrowed from the French *mousseron*. The Russian vocabulary was endless.

Well, we were off. Our primary preoccupation was with our careers, hers in medicine; mine in Wall Street. Our secondary avocation was mushrooms, gathering notes of all kinds, in various languages, stopping on our travels to talk, preferably with professors or unlettered peasants. Then, late in the 1930's, we held a fateful meeting to decide our course of action, either to launch a systematic and massive assault on many fronts, or abandon the quest entirely. At that meeting we made a discovery to our mutual surprise. Each of us had harbored a nascent thought that we had been too shy to express even to each other: religion possibly underlay the myco-philia/phobia contrast that marked the peoples of Europe. This religious twist struck us as absurd, yet we agreed that the evidence pointed in that direction. If religion it was, it had to date back to prehistory, and as for us, we had to try and write a book.

A little thing, some of my readers will say, this difference in emotional attitude toward wild mushrooms. Yet my wife and I did not think so, and we devoted a part of our leisure hours for more than thirty years to dissecting it, defining it, and tracing it to its origin. Such discoveries as we have made, including our documentation of the religious role of the entheogenic mushrooms by the Algonkian nation in North America[1] and the Maya in Mesoamerica,[2] by the identification of the sacred Soma of the Aryans as *Amanita muscaria*, and the religious use of the same species of mushroom by the most ancient tribes in the northern wastes of Siberia, in short the religious use of *A. muscaria* around the globe, can be laid to our preoccupation with that cultural rift between my wife and me, between our respective peoples, between the mycophilia and mycophobia (words that we devised for the two attitudes) that divide the Indo-European peoples into two camps. Moreover this religious role of *A. muscaria* is accompanied by a startling identity of vocabulary, of religious observances, that bespeak a trait going back for tens of thousands of years, when the virtue of the sacred fungus was first discovered, somewhere in Eurasia.

If this hypothesis of ours be wrong, then it must have been a singular false hypothesis to have produced the results that it has. But it is not wrong. Thanks to the immense strides made in the study of the human psyche in this century, we are now all aware that deep-seated emotional attitudes acquired in early life are of profound importance. I suggest that when such traits betoken the attitudes of whole tribes or peoples, and when those traits have remained unaltered throughout recorded history, and especially when they differ from one people to another neighboring people, then you are face to face with a phenomenon of profound cultural importance, whose primal cause is to be discovered only in the well-springs of cultural history.

The next event, momentous for the success of our fungal enterprise, was our encounter with Roman Jakobson, Russian refugee lately arrived on our shores, prodigious scholar, breath-taking lecturer, bon vivant. We met him in the early '40's and disclosed to him our feeling about the religious role played by mushrooms in the prehistoric background of the European peoples. His response bowled us over. The thought had never occurred to him, but his instinct told him we were right. He could not contain his enthusiasm for our idea. We became fast friends: he and his wife often dined with us and we with them. A Russian friend of ours, Katya Ladyzhinskaya, a colleague of my wife's, became tired of hearing us praise Roman's qualities so highly and we challenged her to attend a lecture of his, any lecture. She did so one afternoon on Morningside Heights. Before entering the lecture room, Katya looked at the announcement on the bulletin board. The lecture, to last a double period, one hour and forty minutes, was to be 'On the third person singular of the Russian verb'. 'Goody, goody', Katya said to herself in Russian, I've won my case. No one could make that subject interesting, let alone for a double period.' She entered the lecture hall just before Roman arrived. He launched into his theme immediately. She quickly found herself sitting on the edge of her chair, spellbound by his lecture and by his command of the classic Russian language, and so she remained till the end of the double period. He was incomparable. She telephoned us later that she had to come to dine with us and surrender.... Such was Roman.

So long as they were in New York we saw much of the Jakobsons. He moved to Harvard, later to M.I.T. This took us to Cambridge often, and he would stop sometimes with us when he came to New York. He fed us ideas about mushrooms continually, citations in books, proper names in Russian derived from the mushrooms, rare and archaic mushroom names in Russian with their etymologies. With Roman spurring us on, we never more considered dropping our mushroomic theme.

Full of years, Roman died on 18 July 1982, and at his funeral friends, admirers, scholars, from all over the country - California, Texas, *etc* - gathered in the Russian Orthodox Church in Boston to do him honor.

---

1. Keewaydinoquay: *Puhpohwee for the People: A narrative account of Some Uses of Fungi among the Anishinaubeg*, Botanical Museum of Harvard University, Cambridge, Mass., Feb. 1978. Ethnomycological Studies No. 5; R. Gordon Wasson: 'Traditional Use in North America of *Amanita muscaria* for Divinatory Purposes', *J. of Psychedelic Drugs*, V. 11 (1-2) Jan-June 1979.
2. *Infra*, p 47 *et seq.*

★

In the 1940's we felt increasingly the need of a mycologist to be our guide in the arduous discipline of mycology. I had been reading the *Revue de Mycologie*, drawn to it by its surprising interest in aspects of mushrooms of a nature that goes far beyond the usual preoccupation of the professional mycologist. The editor of the *Revue* was Roger Heim, *directeur* of the *Laboratoire de Cryptogamie*, *membre de l'Académie des Sciences*, destined to be chosen *Directeur* of the *Muséum National d'Histoire Naturelle* in 1951 and to be elected for a term *Président* of the *Académie des Sciences* in 1963. In the spring of 1949 I was in Paris and I decided to invite Heim to be our guide in mycology. As I climbed the steps to enter his *Laboratoire* I asked myself what my reception would be. A colleague of his whom I had just met that day had volunteered to 'phone him and say that I would call. When I was announced, he came out of his laboratory to the elevator door and welcomed me. We hit it off immediately. I outlined to him what Tina and I were doing and what we needed: a mycologist to consult on themes both simple and remote. I added that I wished to illustrate our forthcoming book with the mushroom watercolors of the late Henri Fabre and asked how I could win permission to do so. It turned out that they were now owned by the French state and lay under Heim's jurisdiction in Fabre's *harmas*, in Sérignan, four kilometers from Avignon! (*Harmas* means in Provencal any arid little property. Fabre had bought an *harmas* but under his loving care the arid little property had become a luxurious tropical garden, but still called 'Fabre's *harmas*.) We arranged that I would come back shortly with Tina and our daughter Masha and we would all drive south together, to the *harmas* of Henri Fabre. This plan we put into effect soon thereafter, stopping on the way south in Vienne, on the Rhone, to have dinner *chez Point*, already sporting three stars in the Michelin. We chose our illustrations in the working laboratory of Fabre.

On 19 September 1952 I received an envelope from Robert Graves in Majorca with a clipping of the house organ of Ciba's U. S. subsidiary making known that one Richard Evans Schultes, Professor of Botany at Harvard and shortly to become Director of the Botanical Museum there, had published two papers containing the startling news that a mushroom cult had been reported by the sixteenth century friars in Mexico and also that Schultes had brought back from Mexico specimens of the entheogenic mushrooms! On the same day, Friday 19 September, I phoned Schultes and though he knew as little about me as I knew about him, we talked for a long time. He had been alerted by Bias Pablo Reko to the survival of the cult in a remote village in the State of Oaxaca, and he invited Reko to go with him to the Indian village, Huautla de Jiménez, in 1937. Schultes returned to Huautla again in 1938 and also in 1939. He published two papers on his discoveries, one a Harvard *Botanical Museum Leaflet* in 1939, the other an article in the *American Anthropologist* in 1940. Tina and I resolved to visit the village in the rainy season of 1953 with our daughter Masha. I naturally cultivated the acquaintance of Schultes and we became friends. Until the following June Tina and I were reading the narratives of the sixteenth century friars who accompanied the Conquerors in Mexico, giving their observations on the native way of life. In Mexico we leaned on Roberto Weitlaner and his daughter Irmgard, veterans in knowing how to behave with the natives. (Reko, after writing me one most helpful letter, had died that spring.)

Over the years Professor Schultes has done well by me, arranging for the President and Fellows of Harvard College to appoint me to an honorary post on the faculty of the Botanical Museum in 1960 and renewed through the years, a post that I still hold. This has given me the privilege of contributing to the Harvard *Botanical Museum Leaflets*, and helped me much when I spent years in the Far East in the 1960'$. He has conferred on me a room in the Botanical Museum to house my books, slides, files, and collection of valuable mushroom artifacts, designated as The Tina and Gordon Wasson Ethnomycological Collection'.

And so we made the first of ten annual visits to Mexico, exploring the villages of Oaxaca and of the other states thereabouts, where many native tribal languages were living tongues. On our pressing invitation Roger Heim came over and joined us in 1956, 1959, and 1961. We made notable visits to the Chatino country, to the Mixe where we were lavishly entertained by the notorious *cacique* don Luis Rodríguez but where we learned that he penalized any native (no laughing matter!) who would take the entheogenic mushrooms, and of course repeatedly to Huautla de Jiménez (and there discovered the *Sabia* María Sabina), destined to become the Mecca of entheogenic mushroom hunters.

Meanwhile a terrible tragedy was taking place. In 1956 Tina's health began to fail. We precipitated work on our book: it was to include our first reports on our Mexican findings. The work, *Mushrooms Russia & History*, was brought out on May 13, 1957, - 512 copies in two large octavo volumes stunningly illustrated and printed by Giovanni Mardersteig in Verona, on the finest paper, boxed, at $125. It was published by Kurt and Helen Wolff. Simultaneously *Life* in the issue of May 13 featured an adventure story that I wrote on our discoveries. (Harry Luce gave orders that not a word of my text was to be altered.) The price of our books rose slowly in the auction market and among antiquarian bookdealers until, years later, a high of $2,600 was established. The price is now (December 1983) down: an antiquarian bookdealer in Los Angeles is offering a set at $1,750. My wife's health grew worse and she died of cancer on the last day of 1958 in the evening. Heim and I had been working hard on a book to be published by the *Muséum*, also a large octavo handsomely illustrated, *Les Champignons hallucinogènes du Mexique*. It was dated 1958 but appeared early in 1959. Without telling me, Heim had dedicated the volume to the memory of Valentina Pavlovna and signed the dedication with his initials and mine. Heim's *Préface*, five pages long, was a warm tribute to us both.

In 1963 Heim flew to New Guinea, he from Paris, and I by freighter from San Pedro, Cal., to look into the 'mushroom madness' of the Kumá people, on which we reported in a paper, 'La Folie des Kumá', published in French in the *Cahiers du Pacifique*, and also in English in the Harvard *Botanical Museum Leaflets*, Vol. XXI, No. I, June 11, 1965. In 1968, again on my invitation, Heim from Paris and I from New York took planes to Calcutta, where we met on the Dum Dum airport landing field. This time we were to visit the Santal villages in Orissa and the Santal Parganas in Bihar. We were seeking an answer to the strange fact that a mushroom, one single species, the *putka*, was 'animate' in their language, was 'endowed with a soul', like all animals and human beings, but unlike all other vegetation, which is construed grammatically as 'inanimate', as 'without a soul'. Heim identified scientifically the *putka* but no one could tell us why it alone in the plant world enjoyed its enviable distinction. It was not entheogenic. Our prize informant in the Santal Parganas, Ludgi Marndi, gave us a hint on our last day in Dumka, shortly before we left. We had solicited the talk and we covered the same ground as before. We were getting nowhere. Suddenly our informant leaned over the table and said in a whisper to Mrs Strenstad, the wife of the missionary who served as our translator, 'I will tell you why I think the *putka* has a soul'. We too leaned over the table. She went on, 'You must eat the mushrooms quickly, for if you don't they will stink like a cadaver'. We knew not what this meant, but I wrote it down in my notebook. We published a paper on this anomalous situation in the *Cahiers du Pacifique*, 'Les *Putka* des Santals champignons doués d'une âme', No. 14, September 1970. The mystery baffled us for several years, until one day we received a telephone call from Professor Stella Kramrisch, the famous Indologist and authority on Indian art, who had come upon our French article, read it, and perceived at once that the *putka* was derived from the Sanskrit *p&umacr;tika*, the name of a plant never theretofore identified that the Aryans had used as the first surrogate for Soma. What a powerful argument this was for our candidate for Soma, that its surrogate turned out to be another mushroom! Furthermore this other mushroom, the *p&umacr;tika*, gave off a bad odor just as the *putka* of the Santal does, after a matter of hours, thus clinching its identity! (*P&umacr;tika* is the same word as our 'putrid'.) Its bad odor served a purpose in the Pravargya sacrifice, when the clay of the Mah&amacr;vira pot was mixed with the mushrooms and then was fired and the smell burned away! It was a mushroom whose identity had been lost for three millennia! Our trip half-way around the world to the Santal country thus proved in the end richly rewarding.

On all our trips Roger Heim was the best of traveling companions, whether to remote places or in big cities. He entertained me when I was in Paris and I played the host when he was in New York. On our journeys to far parts, each of us paid his own way.

There was another great scholar that I must dwell on, who led us to make our Santal trip. I had told Roman I intended to visit Afghanistan after I retired in 1963 and specifically Nuristan and the Hindu Rush. He said I had to meet Professor Georg Morgenstierne of Oslo University. I went to Oslo, was charmed by his graciousness and by his lively interest in my search for the identity of Soma, and discovered that he would like to go to Afghanistan in the spring and summer of 1964. He specialized in the five languages spoken in the Hindu Kush that he said split off from the root stock of common Indo-European even before Sanskrit. He knew those languages better than any other scholar, but he knew well the whole medley of languages spoken in Afghanistan, and the Dardic group in west Pakistan, also Sanskrit with its prolific progeny. He was such a winning person and knew so much about languages! It was he who had told me, since I was specially interested in mushrooms, about the *putka* of the Santal, and got me a copy of Bodding's five hefty volume dictionary of the Santal language where I could read about the *putka*. He was able to tell me about Faroese and Frisian and Tadzhikistan! He gave me a key passage in the Avesta that strengthened my case for my identification of Soma. Traveling with him in Nuristan, to Kamdesh and Bagramatal, was one of the richest experiences of my life.

★

And so we completed ten trips in the rainy season to parts of Mexico that were among the most interesting, parts never visited by tourists or trippers. On our tenth trip, in 1962,1 was accompanied by Albert Hofmann, the Swiss chemist, specialist in the alkaloids of ergot of rye, the discoverer of LSD, and his wife Anita. He had analysed our *Psilocybe* mushrooms and I also had sent him from Mexico the seeds of the two species of entheogenic morning-glories. He was amazed to discover that these phanerogams produced chemicals of the same family as our Mexican mushrooms, as well as ergot, and when he presented a paper setting forth that fact to an assembly of chemists in Australia, they had been plainly incredulous! Mushrooms are of a lower order of plant life and their chemistry had been considered of necessity distinct. On our Mexican excursion in 1962 we visited the Mazatec country, entering the area on 30 September with animals from Jalapa de Díaz, spending that night in La Providencia, reaching Ayautla on 1 October. We stayed in the inn of doña Donata, who served us her delicious rural Mexican fare, going on to San Miguel on 5 October, and then the next day passing down to San José Tenango. Finally we backtracked and climbed up to Huautla de Jiménez where we stayed until the 13th, the Hofmanns coming to know the *Sabia* María Sabina. They formally presented her with a bottle of synthetic psilocybin pills and she performed for them a *velada* where she took the pills rather than the mushrooms!

I have one more publication to report in the Mexican field. In 1958 I taped a complete ceremony of María Sabina's *velada*, as we have come to call the customary night-time session. A boy about 17 years old had contracted a serious illness when working down in the hot country: something was gravely wrong with his liver or kidney. María Sabina would devote her healing *velada* to asking the mushrooms whether the boy would live or die, and if he was to live, what he should do to recover. The verdict however was that the boy had to die: within weeks he was dead. It took us some fifteen years to publish the *velada*, in Mazatec, in Spanish, and in English, the English and Spanish texts being translated from the Mazatec directly by George and Florence Cowan, experts in the Mazatec language, and printed in parallel columns with numbered lines. They proof-read the Mazatec and added notes, and an essay on the Mazatec language with its oddities. We invoked the help of Willard Rhodes, Professor emeritus of Music at Columbia University and Director emeritus of the Center for Studies in Ethnomusicology. He wrote out the entire musical score and was in charge of its printing. I described the setting for the rite. We gave over the left hand page to the Mazatec text and printed the text in English and Spanish on the right hand page in parallel columns. Rhodes prepared sections of comment on the work, and many others contributed notes for relevant texts. We ran Allan Richardson's photographs assembled in sequence.

So far as I am aware, no one has paid the slightest attention to *María Sabina and her Manatee Mushroom Velada*, but I am prouder of it than of anything else I have done. I think it was the first time a shamanic performance had been fully taped and published in the native language with musical score and editorial comments.

★

Just as the '50's were devoted to our studies of the entheogens of Mexico, the '60's were dedicated to Soma, a plant that the Aryans when they moved into the Indus Valley in the second millennium BC, were worshipping as a god. They elaborated an extraordinary culture, their society divided into castes, and the Brahmans, the superior caste of priests, were the custodians of the secrets of Soma. Over centuries and in different centers they composed a collection of 1028 hymns in their Sanskrit language and as they had no method of writing, of course they learned to sing them by heart. The collection was called the *Rig Veda* and the *Rig Veda* was permeated by Soma. From the hymns it was clear that the Soma was pressed, then mixed with other ordinary potable fluids such as milk but *not* alcohol, and drunk by the Brahmans and perhaps a few others, who thereupon passed some hours in what we now call the bliss of an entheogenic experience. The late Louis Renou, a great Vedist, one of the foremost that the world has produced, once wrote that the whole of the *Rig Veda* was summed up *in nuce* in Soma. But its identity was never explicitly disclosed, and *no Sanskrit scholar* *had sought its identity.*

I recalled in the course of my inquiries concerning the Aryans that my father, who had studied Sanskrit briefly in the 1880's, had told me about the mystery of Soma. In the light of our Mexican discoveries, I was now asking myself whether Soma could have been a mushroom. I said to myself that inevitably the poets would introduce into their hymns innumerable hints for the identification of the celebrated Soma, not of course to help us, millennia later and thousands of miles away, but as their poetic inspiration freely dictated.

However, I felt the need of a Sanskrit student versed in the *Rig Veda* to consult at every step. I reported to Roman Jakobson on my need and he introduced me to Daniel H. H. Ingalls, Wales Professor of Sanskrit in Harvard. Ingalls wrote me that there was one student of his, a doctoral candidate, who would be ideal but she was much too deeply involved in living and would never accept. There was another student whom he would approach, if I wished. I asked him why he declined on behalf of the ideal student, not allowing her to decline: why make up her mind for her? He asked her and she accepted instantly and with enthusiasm.

Wendy Doniger was outstanding in many ways. She was young, stunningly beautiful, smartly dressed, gracious; conversant with Latin, Greek, German, French, Russian to come, and of course at home in Sanskrit. She was an extraordinarily speedy worker, prompt in replying to letters, single-spacing her typewritten replies on postcards, filling the available postcard space to the final fraction of an inch, where her final sentence seemed always to finish with a graceful flourish. (Her typewriter permitted her to type to the very bottom line!) Our friendship was chiefly by correspondence, New York↔Harvard, later New York↔Oxford. When I was with her she seized my questions before I had finished asking them. She took her doctor's degrees at Harvard and Oxford, then went for a year to Russia where she made cordial friendships with the Toporovs, he a leading Indo-European scholar and she the outstanding Vedic scholar in Russia - and Wendy learned a substantial amount of Russian. After teaching a few years in the London School of Oriental and African Studies, and after that in the University of California, she is now at the University of Chicago Divinity School where she is professor of the History of Religion and of Indian Studies.

I asked Wendy to write the history of Soma from the time when it was abandoned down to date. Strangely, this had never been done. For my reading only, she prepared such a survey quickly. I then suggested that, using her paper as a draft, she write Part II of *SOMA: Divine Mushroom of Immortality*, 'The Post-Vedic History of the Soma Plant'.

Here I must mention the one setback that I have had in our Soma researches: the death, premature and tragic, of Louis Renou. I visited him twice in Paris, where on a later occasion Professor Heim and I had dinner with him and Mine Renou, and they were my hosts for a weekend at their Normandy retreat. He was obviously one of the supreme Vedists of our time: there is no one left in France to compare with him. In his correspondence with Daniel H. H. Ingalls, he was so open to new ideas. He is greatly missed. All of my exchanges with him were years before our *SOMA* appeared.

At the end of 1968 or the beginning of 1969 our *SOMA* finally appeared, Wendy Doniger O'Flaherty writing Part II and I the rest. I supervised the translations that finish the book. We both made endless suggestions to each other, all of them received gratefully and considered, and some even incorporated! The Sanskrit faculties of the world were not ready for a book identifying Soma: they had never heard of anyone who had even thought of tackling this. Most of them were unprepared by training or instinct for botanical arguments and they had, each of them, their own exegetical problems on their desks. What would they do when letters came asking their opinion about *SOMA*? I know that many of them simply referred the inquirer to thirty pages of congested type of a review article in the *Bulletin* of the London School of Oriental and African Studies, Vol. 34, Part 2, 1971, and espoused the writer's views. Written by John Brough, Professor of Sanskrit to the University of Cambridge, an outstanding exegete of Sanskrit and kindred tongues, his views were unfavorable. He had never heard of me, nor had he ever tried to identify Soma. Vedic scholars who were shocked by our *SOMA* rallied behind the eminent Brough: even though few if any read him, they endorsed him unread. I did read him, every page of his congested type, and found it weak, unworthy of this eminent authority.

Brough decided to cross the Atlantic with Mrs Brough after his critique had appeared, ostensibly to visit his brother in Tarrytown; he wrote me that they would like to call on me in Danbury. I invited them to lunch with me on Sunday, 8 August 1971. The weather was at its best and we had a lovely lunch together on my garden porch. At the end of lunch he presented me with an offprint of his review, 'With compliments'. Though I knew it was coming and the tenor of its argument, I had not seen it. In 1972 I published my *Rejoinder*.

Early in 1984 in his home town of Bishop's Stortford Dr. Brough was struck by a car and instantly killed. This was a blow to me. That he had crossed the ocean with his wife really to present his review article to me had impressed me greatly, and his geniality capped his visit mightily. I was convinced that in the end I would convert him, and in this book we have mobilized evidence that sums up to proof. Our progress has gone far beyond our initial hopes, discovering as we have done a whole chapter in prehistory never before suspected to exist. Our subject turned out to be the entheogens, primarily but not solely the fungal entheogens: the phanerogams were important also. But Soma turned out to have had the longest and most widespread human history. Ergot, growing millennia later on certain cultivated grains, seems to have coincided in its arrival on the human stage with the discovery by Man of agriculture. Our remote unlettered ancestors, characterized by us as 'savages' from the lofty eminence of our own conceit, knew how to cope with these miraculous entheogens, not talking noisily and ignorantly about them as some of us do, until I virtually despair of our technicians ever being able to explore thoroughly their possibilities. Competent teams fear to be linked unjustly to the 'Drug' abuse.

Three of us have written another book, this time a small one for a change: *The Road to Eleusis: Unveiling the Secret of the Mysteries*, by R. G. W., Albert Hofmann, and Carl A. P. Ruck, Professor of Greek in Boston University. It came about thus.

One day in July 1975 I asked my house guest, Albert Hofmann, when we were visiting together on my studio porch, whether Early Man in Ancient Greece could have derived an entheogen from the ergot that would have given him an experience comparable to LSD or psilocybin. He said he would reflect on my question and when he had thought it through, he would send me his reply.

As Albert well knew, my thought was to arrive at the active agent in the potion drunk at Eleusis, and that gave to Eleusis immense prestige over the whole of the known world in antiquity. About two years later he wrote me that, yes. Early Man in Ancient Greece could have worked out a potion with the desired effect from the ergot of wheat or barley cultivated on the famous Rarian plain adjacent to Eleusis; or indeed from the ergot of a grass, called *Paspalum distichum*, that grows around the Mediterranean. If the Greek herbalists had the intelligence and resourcefulness of their Mesoamerican counterparts, they would have had no difficulty in preparing an entheogenic potion: so said Albert Hofmann and he explained why. Just as I received that answer from Albert, I came to know Carl A. P. Ruck, and I invoked his indispensable help in writing our book. This was a providential encounter for me. He was a brilliant Greek scholar and specialized in the role played by botany in ancient Greek life and he proved a marvelous partner in our enterprise. Our volume came out in 1978, published by Harcourt Brace Jovanovich as a Helen and Kurt Wolff book, written by the three of us. Dr. Danny Staples composed for us a new translation of the *Homeric Hymn to Demeter*. So far as we could see our new book had no impact. The Greek departments both in American and British Universities seem intellectually inert. (Ruck was certainly not 'intellectually inert'! He was the exception.) One well known English professor of Greek burst out in anger at our saying that a potent potion was drunk at Eleusis: we had touched him at a sensitive spot. He seemed to wish to join the class of those pastors in our Bible Belt who, when Prohibition was flying high, seriously pretended that Jesus served grape juice, not wine, at his Last Supper! Why do he and many colleagues of his feed such patent pabulum to their students? Greek studies would be far more exciting if the students were taught Greek history as it was. It is astonishing that no students rebel against their teachers on an issue such as this. Today we know much more than we did previously about the mighty entheogen and the role it played in prehistory, and also for a millennium and more in Early Greek History.

I cannot refrain from citing, if but briefly, two other Sanskrit scholars who have meant much to me, not only for their help but for the spirit behind that help.

Sir Harold W. Bailey, who is about my age, has been encouraging from the start. I have sought his aid when I needed guidance, by letter and when I called on him repeatedly in Cambridge. Until his retirement he was the Professor of Sanskrit to the University of Cambridge. When he came to New York to deliver some lectures a few years ago, I had the privilege of entertaining him over a weekend. His knowledge has always seemed to me fabulous.

One day in the middle '60's I found myself in Poona, and I put up for the night in the American Institute of Indian Studies. There was only one other guest. In India I did not normally discuss my mission with strangers. But this scholar, Henry von Stietencron, was so engaging and obviously knew so much about India that I broke my rule. He was fascinated by my interest in Soma and asked me endless questions. His University connection was at Heidelberg, to be changed in a couple of years when he was appointed successor to the famous Paul Thieme who had graced for many years the Sanskrit Chair in Tübingen University, in the heart: of idyllic Swabia. Henry and his lovely family have made me welcome in Heidelberg and later in Tübingen.

Let me add, before I end this initial stretch of my essay, that my practice, almost invariable, was not to ask whether, even after my *SOMA* appeared, Sanskrit scholars were for or against my thesis. I knew what it would cost them, or some of them, in principle, being only human, to admit to me that I was pursuing the right track: they were almost compelled to withhold assent, though perhaps not to reject my case outright. I did not learn Wendy O'Flaherty's attitude until I read her note to 'The Last Meal of the Buddha' in the *Journal of the American Oriental Society* and also in this book! (p 138)

We were in a peculiar position: not scholars, my wife and I had chosen to pursue the entheogens, a project that no one else had tackled. When we started, before we knew anything of the field, it seemed a formidable task. During the first thirty years we were educating ourselves. With limited time at our disposal, we nevertheless made major progress. We gained field experience in Mexico. Rather quickly we laid out the dimensions of the subject and saw clearly that Soma could be only *Amanita muscaria*. Shortly after the death of Valentina Pavlovna, I retired from my bank and was free to study and travel. Soma - as I will call it hereafter - was common everywhere in the woodlands of the temperate zone. All in all, Soma was the entheogen of choice, until grains came to be cultivated in prehistory and then ergot emerged as a major alternative, also thoroughly safe to those who knew how to use it. No genuine entheogen is, so far as I know, an addictive under any circumstances. All entheogens inspire awe and reverence and possess power for good.

Interlude

I will take advantage of the Interlude to explain a word that I have already used: 'entheogen'.

In Antiquity people spoke of the Mystery of Eleusis, of the Orphic Mysteries, and of many others. These all concealed a secret, a 'Mystery'. But we can no longer use 'Mystery', which has latched on to itself other meanings, and we all know the uses and misuses of this word today. Moreover, we need a word that applies to the potions taken in the antique Mysteries, now that at last we are learning what they were. 'Hallucinogen' and 'psychedelic' have circulated comfortably among the Tim Leary's and their ilk, and uncomfortably among others including me for want of a suitable word: 'hallucinogen' is patently a misnomer, as a lie is of the essence of 'hallucinogen', and 'psychedelic' is a barbarous formation. No one who respects the ancient Mystery of Eleusis, the Soma of the Aryans, and the fungal and other potions of the American natives, no one who respects the English language, would consent to apply 'hallucinogen' to those plant substances. Antiquity remained silent on these plant substances, for they were never mentioned, except perhaps person to person in a low voice, by the light of a candle at night.

It is natural that a new discipline, as it works out its course, should find occasion to coin words for new meanings, creating neologisms. Some of us formed a committee under the Chairmanship of Carl Ruck to devise a new word for the potions that held Antiquity in awe. After trying out a number of words he came up with *entheogen*, 'god generated within', which his committee unanimously adopted, not to replace the 'Mystery' of the ancients, but to designate those plant substances that were and are at the very core of the Mysteries.

A distinguished English scholar, sensitive to the language that he used, was unable to find a word when speaking of the sacred plant substances in Mesoamerica, and took refuge in 'narcotics', sleep-producers, an absurd term, for the potion keeps you awake so long as its influence lasts. That English scholar surely never ingested our mushrooms and he took liberties assuming they were opiates! Again, hashish has been used for millennia as a recreational drug like alcohol and it is not entitled, I think, to be called 'entheogen', any more than alcohol is an entheogen.

We must break down the 'Drugs' of popular parlance according to their properties and overcome our ignorance, which in this field is still monumental. 'Entheogen' is a step in that direction.

★

At this point I will dwell on certain unusual circumstances that have marked our pursuit of the cult of the entheogenic mushrooms. The West had tidings of such a cult in Siberia since near the start of the eighteenth century, where it surprised the travelers, was described briefly, and generally dismissed as unworthy of serious study.

In India, Soma was not to be the subject of botanical inquiry and identified, an attitude hardly surprising since Soma was at the heart of their religion. Three millennia ago Soma was known to the Brahmans, who composed many hymns exalting it. The hymns to Soma are still being sung, yet no one, not even among the Brahmans, knows what it was. Nowadays Soma grows in a mystical garden forbidden to all mankind. I understand and sympathize with the Brahmans. But I have been surprised to find a school of Western scholars who felt I was doing something untoward, improper, even to the point that in one country I have been shunned, formally ostracised, for pursuing the identity of the Sacred Plant! They have even warned off their interested publishers from my books.

In sixteenth century Mexico distinguished Spaniards wrote about the entheogenic mushrooms of that land, ably though briefly: Francisco Hernández the King's physician, friar Diego Durán O. P., the Franciscan friar Bernardino Sahagún, the first two from families of converted Jews and the third probably so. At first there were many other references to our mushrooms but the flow quickly dried up. From 1727 for two centuries I have found one mention of them and that one trifling, and one famous Mesoamerican scholar even forgot that they had ever existed![3]

Reko backed up by Schultes was on the point of calling attention to the Mexican entheogenic mushrooms when the cataclysm of the Second World War broke out and engulfed us all. Schultes was destined to go to the Amazon Valley where he remained for years, seeking to mobilize and increase the flow of rubber to the U.S.A. A full decade later Valentina Pavlovna and I came upon the Schultes papers and upon Schultes himself.

The Indian (or more precisely Amerindian!) communities that knew the sacred mushrooms continued to treat them with awe and reverence and to believe in their gift of second sight, - rightly so, as the reader will see when he reads our account of our first *velada*, pp 33-8. Traditionally they have taken the simple precaution not to speak about them openly, in public places, or in miscellaneous company, only with one or two whom they know well, and usually by night. White people seldom know the Indian languages and seldom live in Indian villages. And so, without planning, the Indian by instinct has built his own wall of immunity against rude interference from without.

---

[3] *The Wondrous Mushroom*, pp 212-214

Our discoveries

1. Soma and the Vedic Culture

With the aid of Stella Kramrisch, Wendy O'Flaherty, and other scholars, we have identified the plant-god of the Aryans as *Amanita muscaria*, a mushroom, as I have said, that carries no name today in English, though it is one of the commonest and perhaps the most beautiful in our woodlands. It must have been the victim of a religious tabu. We have been accumulating proofs of its identity for more than half a century. It is the plant that pervades the *Rig Veda*, the plant that the Aryans were worshipping until shortly after BC 1000, the plant that the Hindus still venerate nostalgically, though it does not grow there commonly. It is the plant that the Maya worshipped in antiquity as they made clear in their pre-Conquest poem the *Popol Vuh*, the plant that the Nahua worshipped, and also the Algonkians in North America, the ancient Paleosiberian tribesmen in Siberia, and the Ob Ugrian and Samoyed, and some of the Finnic peoples, the Lapps too and probably many many other peoples whose traditions and languages we have lacked the opportunity to examine. In fact, among the entheogens, Soma seems to have been in prehistory the focus for the awe and reverence of our ancestors for countless millennia. It heightened their powers, physical and mental, and people referred to it with many evasive terms that would not be understood by the uninitiated, such as One-Leg, Single-Eye, Tongue-in-Belly. It stepped up the physical endurance of one who took it and also endowed him often with what the Scots call second sight.

Entheogens are extraordinarily rare in the Eurasian botanical world, and *Amanita muscaria* was *the* entheogen of the ancient world. The citations of Soma in the *Rig Veda* are all consistent with this reading, and some fit *A. muscaria* like a glove, *eg* Ap&amacr;l&amacr; with Indra, *Rig Veda* 8.91; infra p 54.

2. The Mystery of Eleusis

Carl A. P. Ruck, Albert Hofmann, and I have advanced a theory that explains the Mystery of Eleusis, a major focus of the religious life of the ancient Greeks: it was well within the capacity of the hierophants of Eleusis to prepare a water solution of the *Claviceps purpurea* (ergot) growing on their wheat and barley or the water solution of the powdered ergot of *Paspalum distichum*, a grass growing around the Mediterranean, both of which would give the worshippers an entheogenic experience with no danger of a deleterious effect.

3. Our First Velada

We have published the story of our first *velada* only once, in *Mushrooms Russia & History*. The account was lost in the two big volumes: just as we wanted it to be. A few readers commented on it personally to us but it drew no public attention. I had always had a horror of those who preached a kind of pseudo-religion of telepathy, who for me were unreliable people, and if our discoveries in Mexico, including our initial *velada*, were to be drawn to their attention we were in danger of being adopted by such undesirables. The story of the *velada* itself in *MR&H* was largely written by Roberto Weitlaner, an old hand at this sort of thing, but we three read over the script most carefully and what we printed in *MR&H* had the approval of the three of us. We here detach those details that are pertinent to our present purpose and add some comments. The *velada* was held on the night of Saturday, 15 August 1953 stretching into the early hours of the following day, in Huautla de Jiménez, Oaxaca.

We had already engaged animals for Sunday to return to Teotitlán and a car to go from there to Tehuacán. We were talking with one of our best informants in Huautla, don Aurelio Carreras, a one-eyed butcher. (He had lost an eye to a bull many years before.) He had furnished us with entheogenic mushrooms of two species and clearly meant us well. We had had no success in finding a shaman: none of those who had been promised us had turned up. An inspiration seized Roberto. As we chatted with Aurelio, quite casually, don Roberto asked,

'And tell us, Aurelio, when you give treatments (*hace curaciones*), are they successful?'

'Always', he answered.

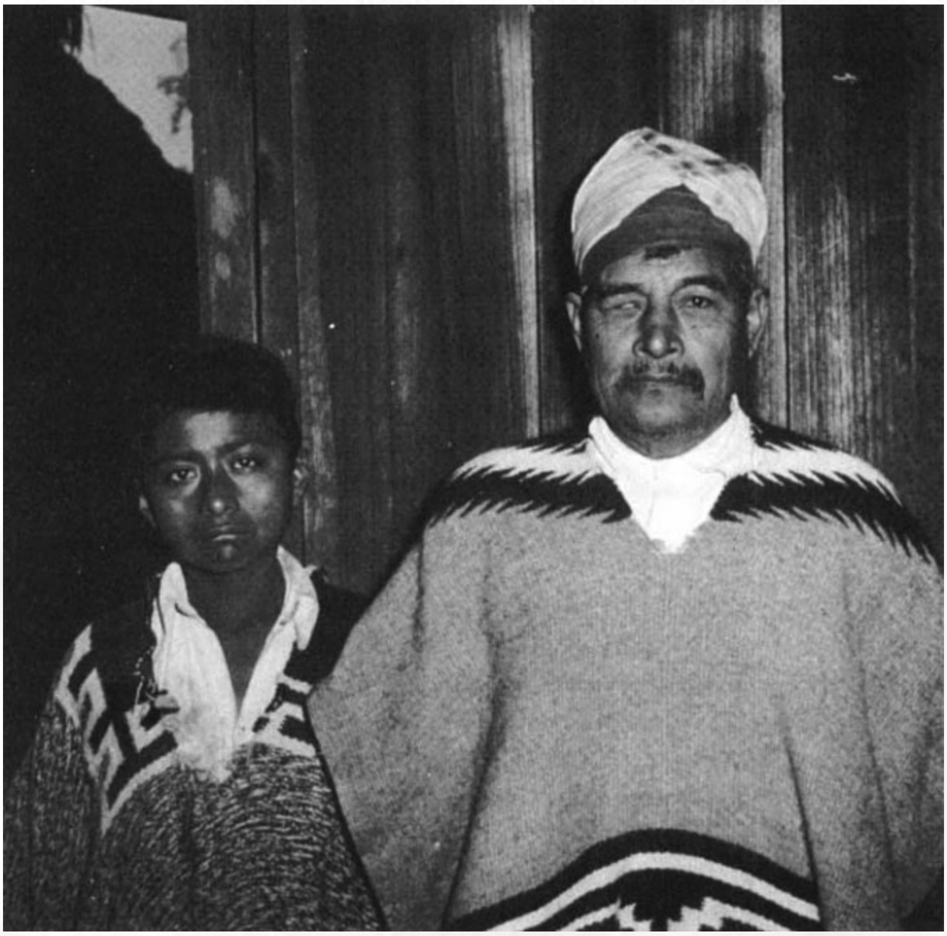


Fig. 1. Aurelio Carreras and his son Mauro (Huautla de Jiménez, 5 July 1955).

For days we had been talking to a *čo^{4}ta^{4}či^{4}ne^4* ('one-who-knows' in Mazatec, 'shaman') all unawares.

Don Roberto went right on. 'Will you help us this night?' Aurelio hesitated. He needed time to think the matter over. It turned out that his late wife's mother lay on the point of death in her house and there might be objections on the part of kin. But the kin advised him that we had come from afar, and he should help us. He asked us to make our way to his compound at nine o'clock.

Aurelio explained to us that his method of handling the *velada* differed from others'. The mushrooms spoke only in Mazatec and his son Demetrio would translate the Mazatec for us into Spanish. (In the early morning hours the mushroom began to speak either in Mazatec or Spanish.) He would take thirteen pair of mushrooms, the good-sized *derrumbe* (Sp. 'landslide') mushrooms (*Psilocybe caerulescens*), but as he lacked just one of the *derrumbes*, he would make up for it with three of the little ones (*P. mexicana*), figuring that they were equivalent to one *derrumbe*. He never sang nor did he recite any fixed text. He would speak only when the mushrooms spoke to him. Wrapped in his sarape, he sat on his stool or shifted to his chair. After having slowly eaten the thirteen pair of mushrooms, he smoked a big, black, strong cigar all night in a room lighted only by his draughts on his cigar, by embers in a receptacle on the floor, and from time to time by wax tapers. He sweated profusely.

Aurelio asked us what problem troubled us. We said we wished to have news of our son Peter, age 18, from whom we had not heard for many days. (Peter did not know our address.) This seemed a legitimate reason. He asked where Peter was. We said on the outskirts of Boston, a big city. (Peter was working for the summer in a plant near Boston making iron lungs.) A little later, Aurelio says he has trouble seeing Peter because he is so far away in a city big and strange. Finally, after a long interval, he says that Peter is alive but 'they' are reaching out for him to send him to war. Possibly 'they' won't 'get' (Sp. *agarrar*) him, but it is hard to say.

Then, after an hour's silence, loud and clear, Aurelio declares flatly that Peter is in his home in New York. (Demetrio was translating Aurelio's Mazatec.) He says Peter's thoughts are on us to the point of tears (*hasta las lágrimas*). He is in turmoil, he is well but in a difficulty that he can hardly cope with, he is stumbling, he is not used to this difficulty where he finds himself and does not know how to go about writing to us to tell us about it. Then Aurelio suddenly says we may smoke and the room is illuminated with two more cigars, Roberto's and Demetrio's.

After another interval Aurelio suddenly declares that a relative of mine is destined to fall seriously ill within the year, and gravely fixes on me his single eye. It is now about 1.45 o'clock. Some time later he repeats that a relative of mine is destined to fall ill within the year. This information about my relative was volunteered by Aurelio: it was not solicited by me.

Here we should prefer to bring our story of Huautla to an end, but candor compels us to add a few more lines. Our attitude toward the divinatory performance and especially the oracular utterances had been one of kindly condescension. We said to ourselves it was cruel on our part to ask Aurelio, locked up in his unlettered Indian world, to enter understandingly into the problems of the Wassons of New York. His divinatory powers, put to this test, had seemed to us thin, but of course we had duly entered in our notes all that he had said. In brief, he had declared that Peter was not in Boston as we had said, but in our home in New York, that Peter was alive but in a deep emotional crisis and longing for our help, and finally that the army was reaching out for him and might get him. There was a hint of foreign military service - Germany was mentioned as a possibility. Later in the night Aurelio predicted ominously that a member of the Wasson family would be gravely ill within the year.

We reached home in the second week of September a month later. In the kitchen of our New York apartment we found the leavings of a party that during our absence Peter and his friends had held. The bills from the purveyors supplied the date: the weekend of 15-16 August! Peter easily confirmed this when we saw him. Laughingly we credited the sacred mushrooms and Aurelio Carreras with a hit, a palpable hit, and then gave the matter no more thought.

Aurelio's prediction about the army had seemed badly aimed. After all, Peter at the age of 17 had enlisted in the National Guard, and this exempted him from the draft. Soon after our return to New York, I left for Europe on a business trip, and late in the morning of Monday, 3 October, I arrived at the Hotel du Rhône in Geneva. There a cablegram from home awaited me with sensational news: Peter had just made known his settled determination to enlist in the regular army for a three year term. He had come to this decision after a prolonged emotional crisis involving a girl, and that crisis, we now learned, had been boiling while we were in Mexico. Would I please send a cablegram at once begging Peter to postpone his rash step? I sent the message but, before it reached Peter, he had signed up. The army, after all, had reached out and got hold of him! At the moment of the October crisis our thoughts were so far removed from Huautla that days passed before suddenly Aurelio's pronouncement came to mind. Another hit, a palpable one indeed!

A few months later, after the usual training period, the army sent Peter abroad for duty, but to Japan and Korea, not Germany.

There remained one final prediction: grave illness was to strike the Wasson family (not Tina's) within the twelvemonth. (In the Mazatec world the 'family' embraces all the kin.) This seemed on its face unlikely, for my family is unusually small. No one of the previous generation survived. I had only five first cousins and three first cousins once removed. In January one of my first cousins, in his 4o's and abounding in vitality, suddenly died from heart failure.

Aurelio did not tell us that Peter was in distress over a girl who rejected him. Did Aurelio know it was a girl and did he withhold that fact so as not to add to our distress? We do not know. Peter, after some time in the Far East, was sent to Germany for years, then to Viet Nam for two tours of duty, a gunner in a helicopter.

In 1958, at the *velada* that we held for the sick boy Perfeto, María Sabina officiated with Aurelio Carreras. I observed that she treated him with marked deference, among other indications calling him *čo^{4}ta^{4}či^{4}ne^4* - *Sabio*, 'one-who-knows'. The intelligent villagers have known each other all their lives and appraise each other accurately.

No one in all of Mexico, least of all the Wassons, knew what Aurelio told us in the course of that *velada*. We did not question him about his utterances because we did not believe him. But all that he said turned out to be true. The entheogen, at least when taken by a wise shaman, also by the interested party, conveys information -

but how?

We visitors had fallen into the rude habit of speaking among ourselves about the sacred mushrooms as the 'instant postoffice'. The natives told us of other wonders within the power of the mushroom: i) if a young wife vanishes, the mushroom tells in a vision where she is; 2) if money has disappeared from a secret place, the mushroom reveals who has it and where it is; 3) if the *burro* has disappeared, the mushroom says whether he is stolen and toward what market he is being driven for sale, or else whether it has fallen into a *barranca* where he lies with a broken leg; 4) if a boy in the family has gone away into the world, perhaps to the States, the mushroom will bring news of him. The Indians are agreed on these matters.

4. The Grecas

As we delved into the Mexican past, we were startled and at first baffled to find *grecas*, 'greeks', playing a well known role in its pre-Conquest archaeology, yet no one else was surprised by this term, taking it for granted. *Grecas* are what we in English call 'frets', - abstract designs, angular or curvilinear, serpentine, sinuous, often repeated in a band or a border, ornamentally pleasing. Such designs were characteristic of the archaic period in the painted pottery of ancient Greece, ending about BC 620; whence they are called in Spanish and Italian *grecas*. Today this word is a common noun in Spanish and Italian and no one (except me) thinks of its origin when it is used.

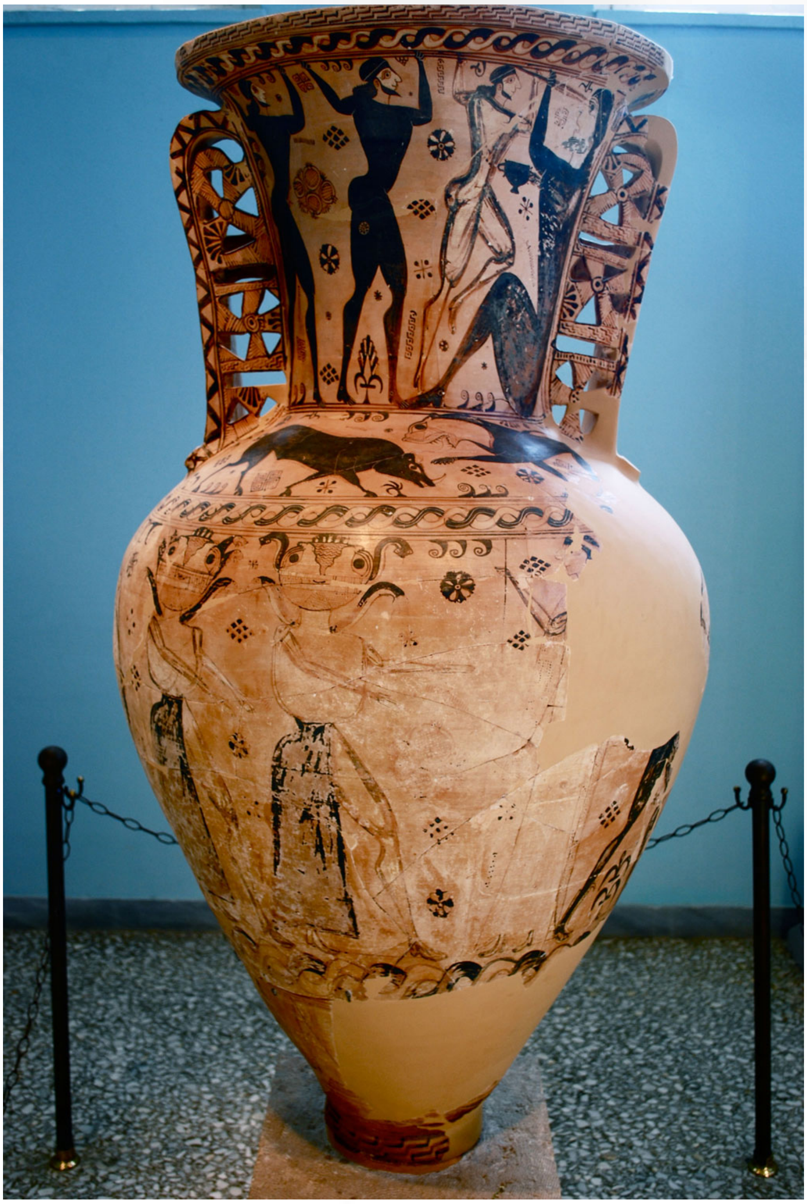


Fig. 2. Archaic Greek amphora, found at Eleusis. Notice the 'frets' or 'fillers' or *grecas*, abstract designs embellishing the mythical scene.

We reproduce a superb archaic amphora from Eleusis, *ca* BC 640, and draw attention to the numerous *grecas* or frets that grace its decoration. During the entheogenic experience there comes a time when one is apt to see visions, eyes closed or eyes open in a darkened room, of *grecas*. The frets usually are seen in the opening phase of the entheogenic experience. In the dark they are seen more clearly, eyes open or closed, than anything seen in this world. They impress the observer uncannily, as though they are components that come down from the Creation, from the Beginning, into the Night of our *velada*, our Entheogen. Once seen, they are not forgotten: they survive in stone carvings, in paintings on *terra cotta* pottery. (I can hardly believe that, of all people, it falls to me to draw attention to the inspiration for these frets, these *grecas*.) There have been many discussions about particular designs, whether they are of independent invention or borrowings. Whenever this issue comes up, the question to ask first is whether those who drew the designs knew the entheogens and the *grecas* that usually accompany them. Are not the *grecas* of Greek art, as elsewhere, an attempt to depict that special moment when the artist communed with the spirits of the sacred myths - or at least a stylized remembrance of such a tradition?

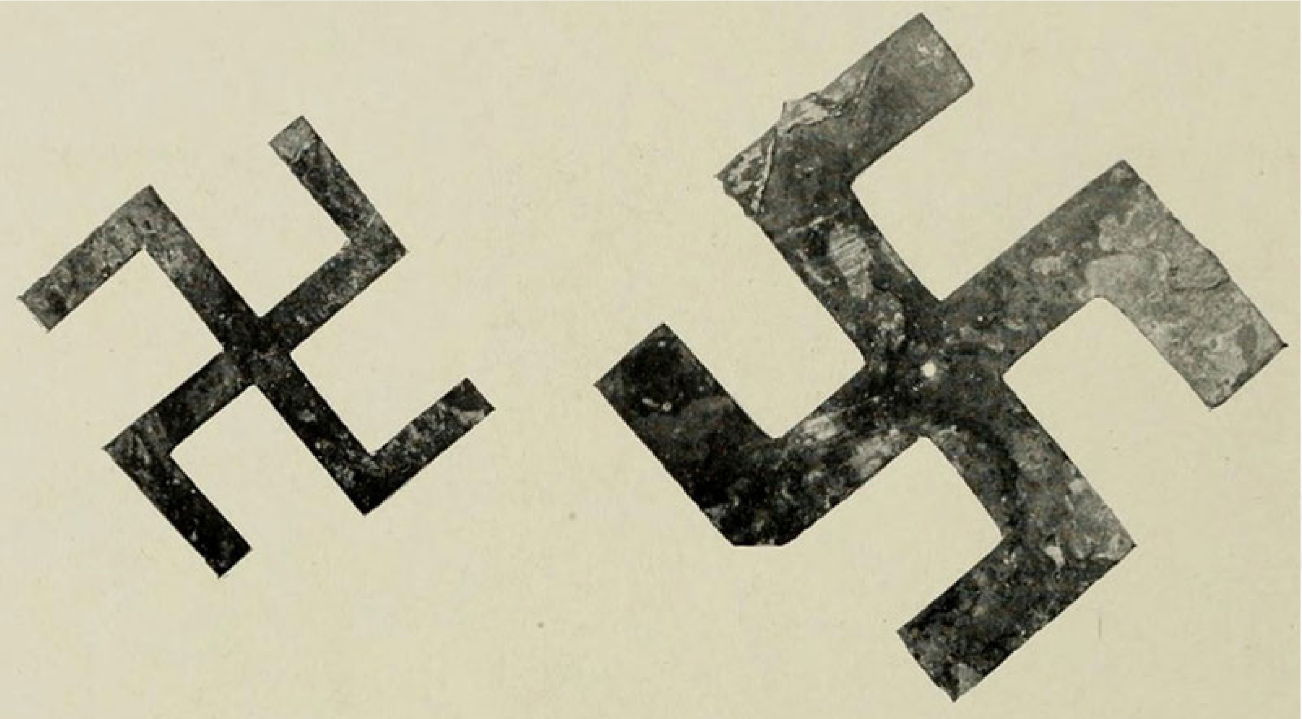


Fig. 3. Copper swastikas, found in Hopewell mounds of Ohio, *ca* AD 500.

The *Swastika*. Stanley A. Freed and Ruth S. Freed in the January 1980 issue of *Natural History* published an article on the widespread and early dissemination of the swastika. Among many others, they showed copper swastikas uncovered in the Hopewell mounds of Ohio, dating from about AD 500, now on exhibit in the Field Museum of Natural History in Chicago. 'Because of its isolated occurrence,' they say 'this find may be interpreted as a case of independent invention of a shape whose symbolism, if any, would have been unrelated to the swastika of the Old World.' The authors could not have known, since no one of our culture knew, the entheogenic experience. In Ohio, where I am assuming these swastikas were made, they could have been inspired by several fungal entheogens such as Soma, by the seeds of an entheogenic morning-glory, or, through trade with the Southwest, by the buttons of the *peyotl* cactus. It seems that the Old World swastikas, widely disseminated as they are, were a fret ('*greca*') inspired by entheogens, many of which we are now uncovering for the first time.

Marija Gimbutas, the distinguished prehistorian holding a chair in the University of California L. A., published in 1974 her *Gods and Goddesses of Old Europe: 7000-3500 BC* (Univ. of California Press) and it marked a breakthrough for the English-speaking world, a fresh chapter in the history of the Balkans and adjacent lands. Her book deals with prehistory long before the Greeks and other Indo-European peoples had swept in from Asia and overrun the peoples who already lived there, whoever they were and whatever languages they were speaking. We are going to devote two pages to reproducing from the Gimbutas book (with her express and most gracious permission but without committing her to my conclusions, of which she is unaware) samples of her illustrations of artifacts made from BC 5000 to BC 3500. The ones that we have chosen are beautiful examples of the *grecas* one may see in the course of the entheogenic experience. Professor Gimbutas tells us that the 'Old Europeans' were cultivating wheat and barley: therefore I suspect their entheogen was ergot. These designs preceded by millennia Eleusis, and Greek civilization, and Greek archaic pottery. The Eleusinian ritual was originally performed in Thrace and it moved south to Eleusis early in the first millennium BC. *The Homeric Hymn to Demeter*, expressing the lovely myth of Demeter and Persephone was composed, it is believed, early in the first millennium.

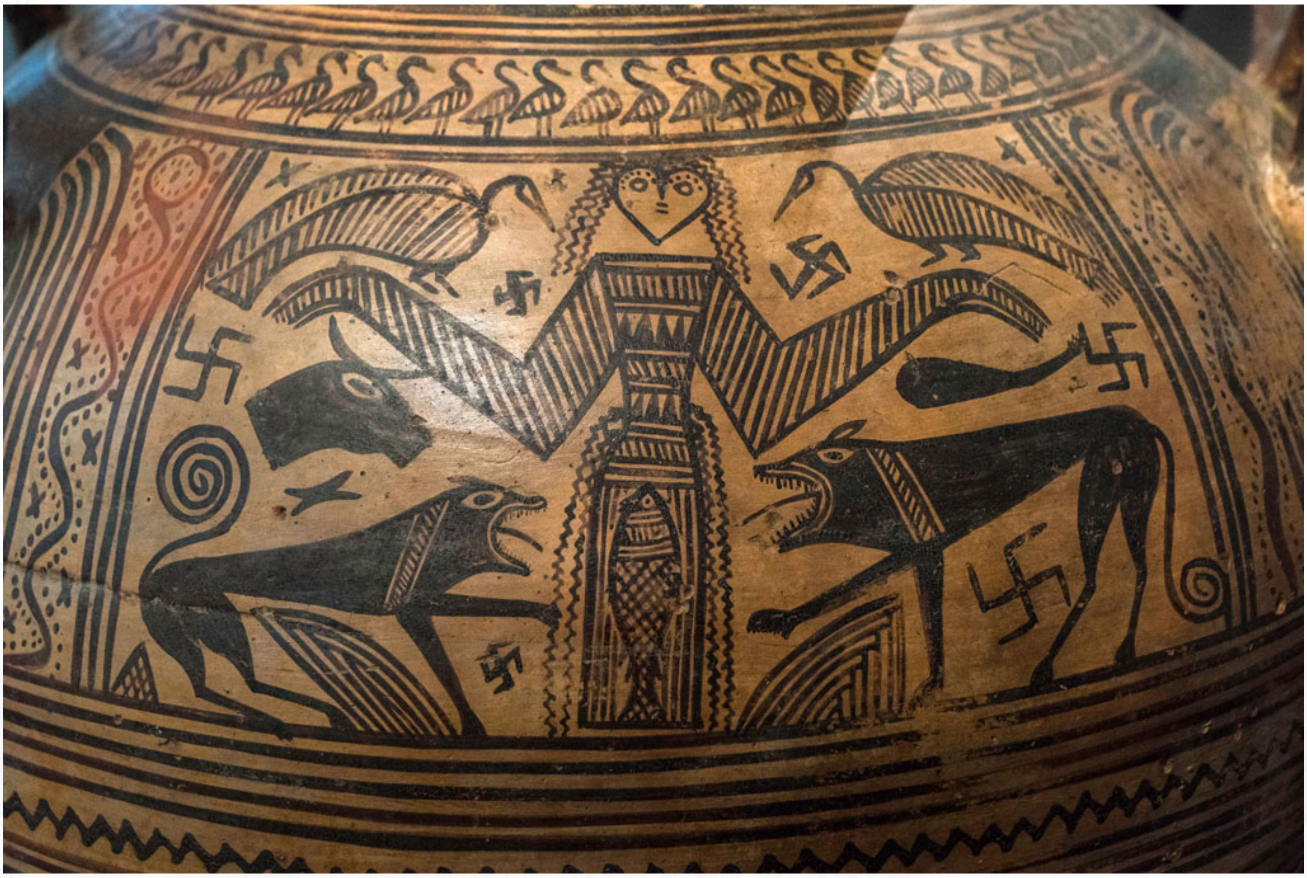
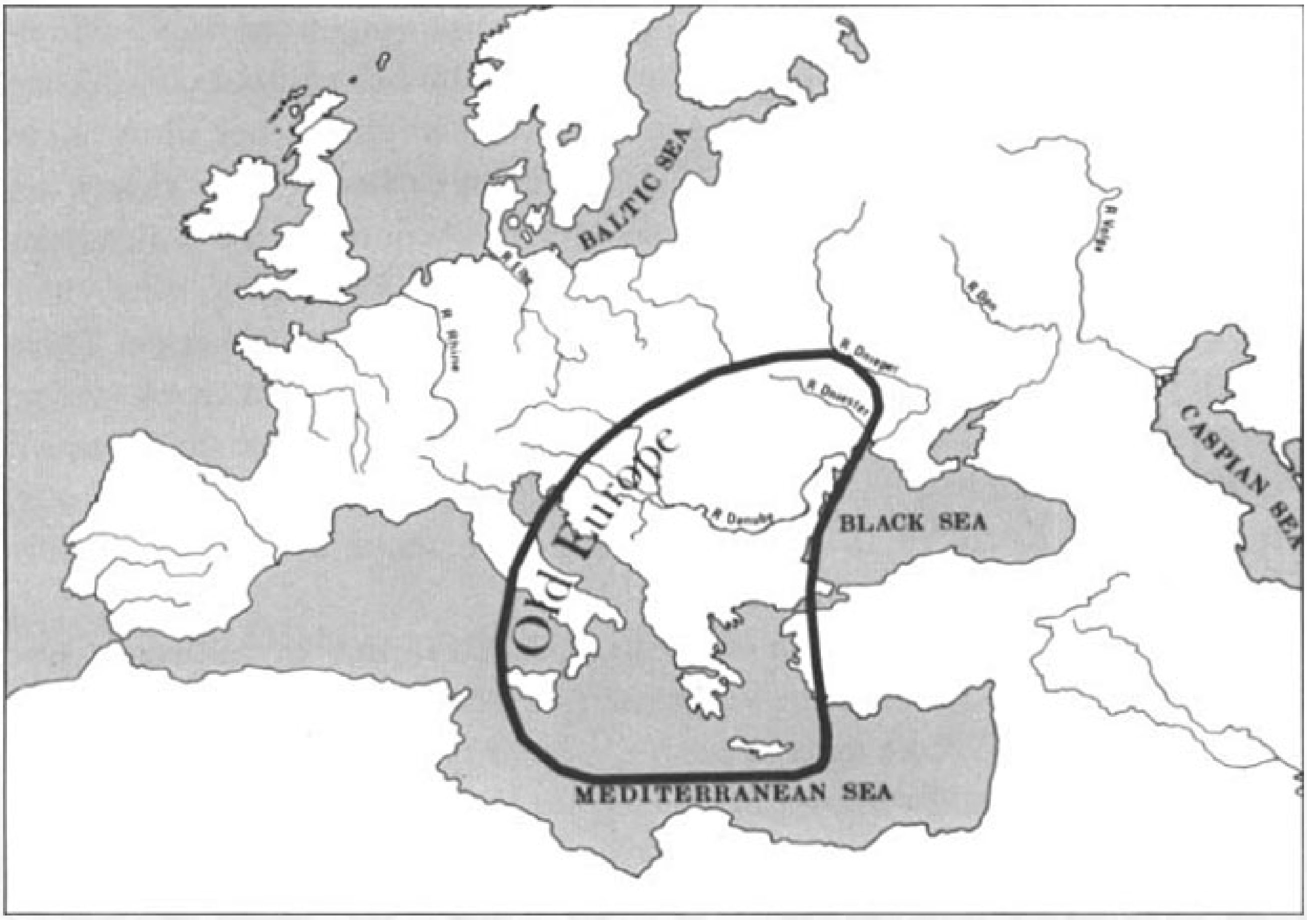


Fig. 4. A bee goddess with animals, birds, and swastikas, found in Boeotia, dating from *ca* BC 700. Gimbutas: *The Gods and Goddesses of Old Europe*. Such archaic and prehistoric swastikas have been found widely scattered, and we feel certain that they are among the visions produced by the entheogens.

Here is proof that '*grecas*' antedated Greek civilization by millennia, just as Mesoamerican civilization shows '*grecas*' flourishing in America long before the Conquest. In all three cases the same cause inspires the same art.

Plato's '*Ideas*'. No one knows whether Plato had been an initiate at Eleusis; we have no knowledge either way. But as a well born young man in Athens, it would have been normal for him to go through the Lesser and then on to the Greater Mystery. The 'Forms' that he would see in the early phase of the effects of the potion at the Greater Mystery would be commanding in his mind and he could easily have transmuted them into his famous 'Ideas', a realm existing somewhere that harbored the archetypes of everything in our life on earth, *eg* the Chair, the Dog, the Stone. Plato's revelation of this would have violated the Athenian law, which set the severest penalties on disclosure of the secrets of Eleusis, but since he did not mention his source, the hierophants of Eleusis could not have brought charges against him without themselves giving away a portion of the secret of the Mystery. Many Greeks in Antiquity must have suspected where Plato's inspiration for his 'Ideas' lay, but I am the first in modern times to be familiar with his source for the '*grecas*'.


BALTIC SEA
R. Elbe
R. Rhine
R. Volga
R. Don
R. Dnieper
R. Dniester
Old Europe
R. Danube
BLACK SEA
CASPIAN SEA
MEDITERRANEAN SEA

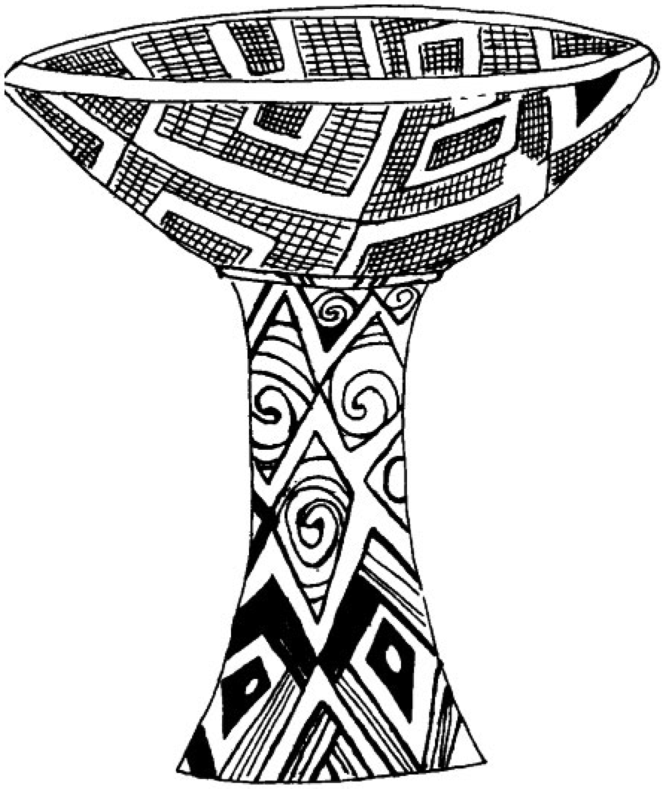
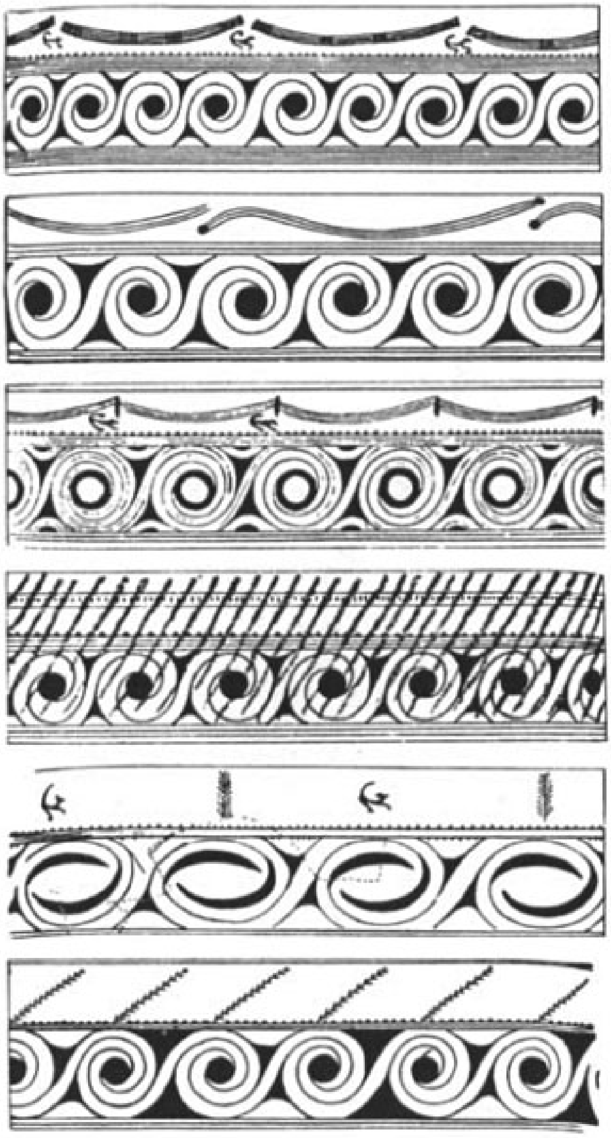
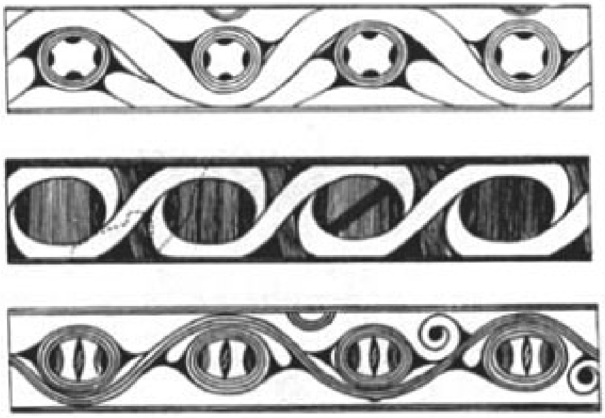
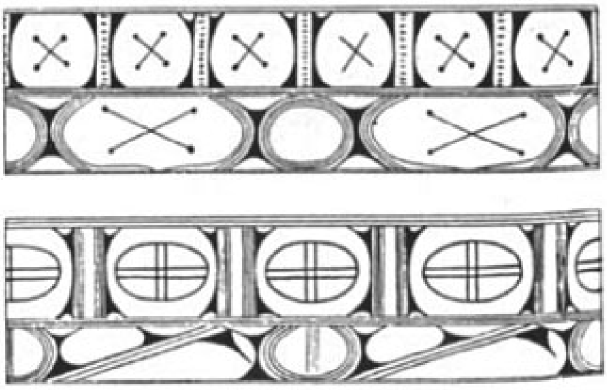
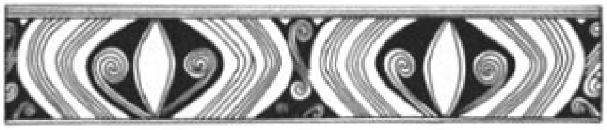


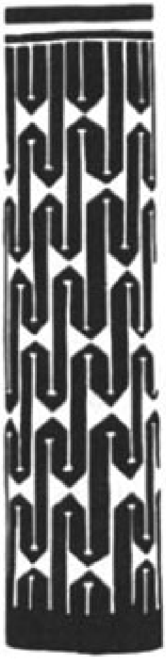
Fig. 5. 'Frets' or *grecas* from Professor Gimbutas' 'Old Europe'. The ones that I reproduce on these two pages all date from BC 5000 to BC 3500. She found them in paintings on pottery in archaeological diggings in the present-day Balkans, Hungary, and the marches of Russia. The Greeks had not invaded what is now Greece.

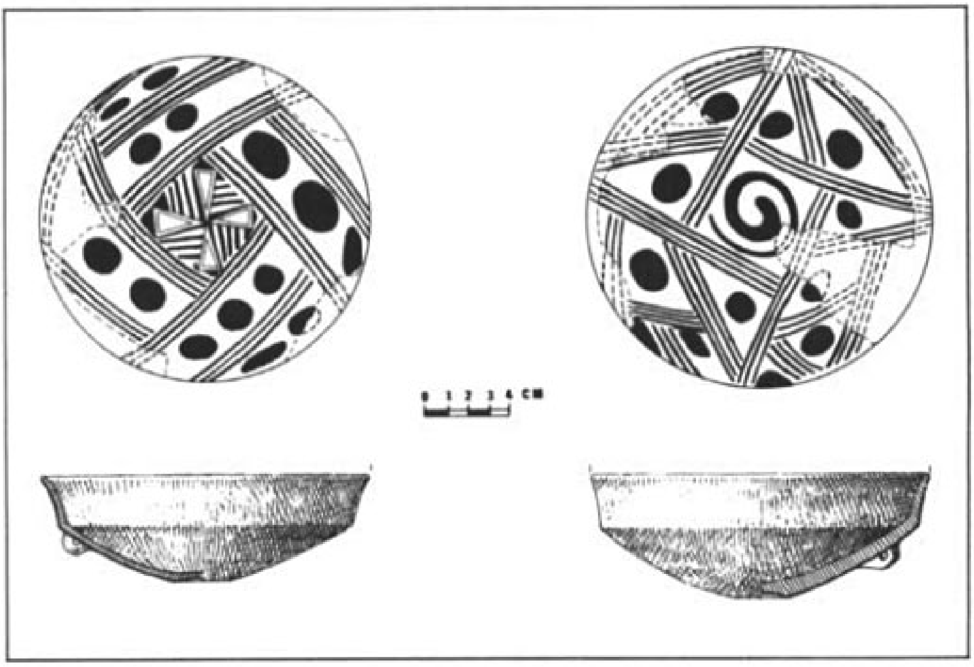











0 1 2 3 4 CM

When I visited the Santal and Ho peoples in India in 1965 and 1967, on this second trip accompanied by Roger Heim, two good informants, Ludgi Marndi in Dumka as center of the Santal Parganas in Bihar, and Ganesh Ram Ho, Chief of the village of Nawana in the Simlipal Hills in Orissa, both volunteered to tell us that there was a common entheogenic mushroom and they led me to believe it was often consumed. During our fleeting visit their efforts to find specimens were unsuccessful. It grew in cattle dung, *never near* the dung, and was white rising to yellow at the peak of the rounded pile us when mature. This should be *Stropharia cubensis*. The Santal and Ho peoples are closely related to each other and are not Hindus. We did not discover whether the Hindus ever eat these mushrooms: the three upper castes are forbidden by their religion to eat mushrooms but the fourth caste, the *&sacute;&umacr;dras*, are free to eat them and they are more numerous by far than all the other castes taken together. If the *&sacute;&umacr;dras* ate the mushrooms, might not the cows have gradually acquired the sanctity for which they are famous today? In historic times the cows were not always holy. Just as the lightningbolt was credited with planting the divine Soma in the rain-softened earth, so cows gave birth in their dung to the humbler but still marvelous entheogenic *chattra* (= mushroom).

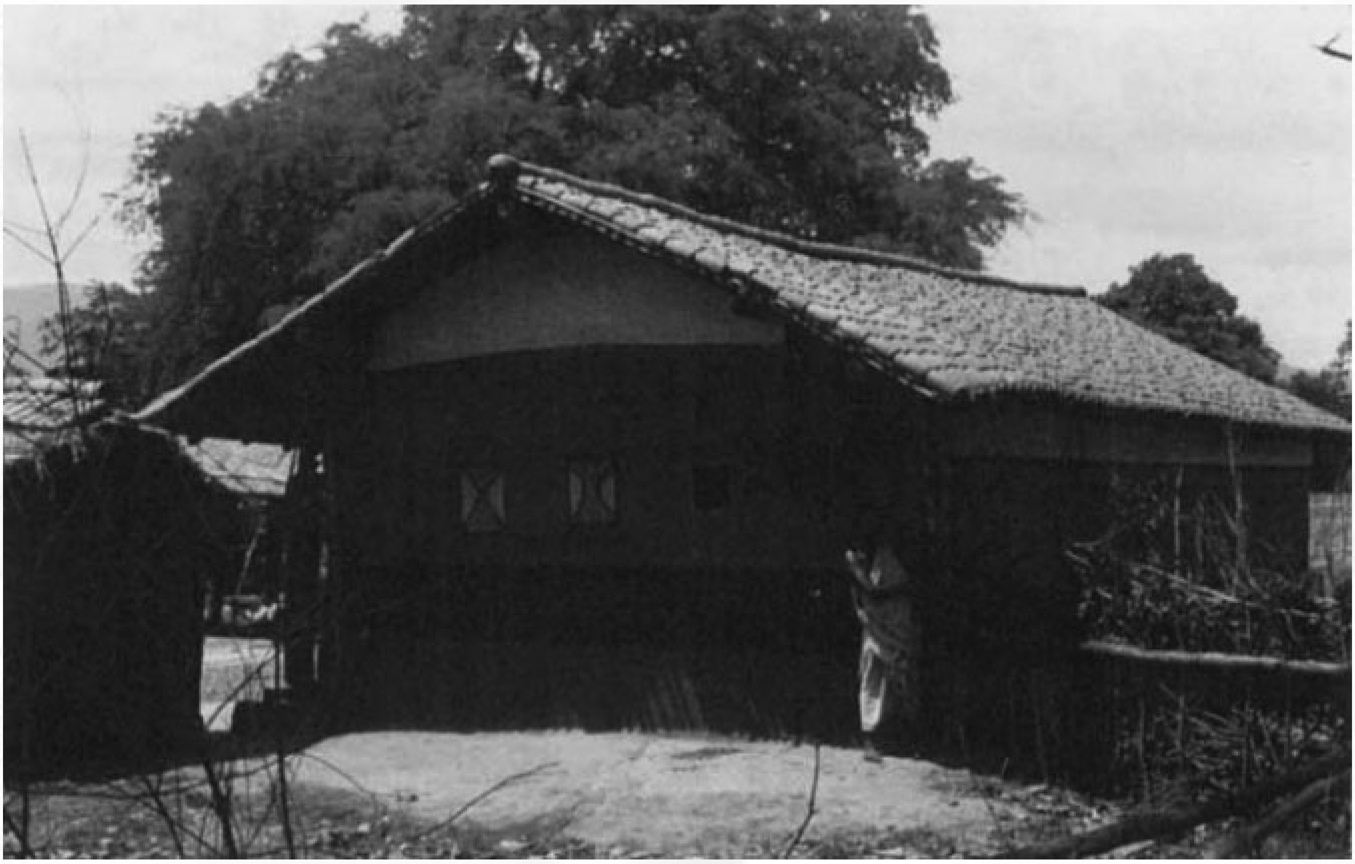


Fig. 6. A farmer's cottage in Orissa, India, in Santal country. It is suggested that geometrical patterns painted on walls, such as we see here, were inspired by entheogenic mushrooms. In the Santal country of India such paintings are common on the houses, and the Santal people are also familiar with entheogens.

The Santal often paint on the exterior of their homes geometric designs in color, thus adding to their attractiveness, their modest houses and farmyards being already models of neatness inside and out. We reproduce a photograph that we made in Orissa of a farm house showing such a painting in duplicate. We think the artist may have taken his inspiration from a vision of *grecas* seen in an entheogenic experience.

5. The New World and the Thunderbolt

In July 1955 Roberto J. Weitlaner and I were spending a few days in San Agustín Loxicha, a village of Zapotecs high in the mountains looking south over the Pacific, many miles away.[4] At that time Spanish was spoken by few of the inhabitants. The language of the village was one of the seven unwritten dialects, mutually unintelligible, of Zapotec, known to linguists as the dialect of the Sierra Costera. We were successful in our main object, which was to attend a midnight *velada* wherein a *sabio* ('wiseman'), don Aristeo Matías, consumed some entheogenic mushrooms and, later after they had taken effect, chanted for us the traditional melodies. In the days before and after the *velada* we asked don Aristeo such questions as seemed to us pertinent for shedding light on this religious observance hitherto neglected by scholars. In the course of our questioning we asked don Aristeo whether any special observances marked the gathering of the mushrooms, and he startled us by telling us what follows, as translated into Spanish by our interpreters and into English by us:

I make a practice, four days after gathering the mushrooms, of returning to the same spot, with candles and flowers, and I address a supplication for an increased yield the following year. My prayer is directed to [three] Beings:

Fig. 7. Aristeo Matías, center; Roberto Weitlaner, right; interpreter, left.

1. the earth, God the Father Most Holy (a post-Conquest interpolation), the Trinity (a post-Conquest interpolation)
2. the Great Lightning Bolt that bred [*crió*] the *piule*[1] [5] (*mdi'ndó' pse' bìul*), and
3. the Great Lightning Bolt that put blood into the *piule*[1] (*mdi'ndó' blò ren bìul*). In Spanish: *El gran rayo que le echó sangre al piule*.

Omitting the two post-Conquest interpolations, we are left with a pre-Conquest explanation of the generation, not of all mushrooms, but of the entheogenic species, and that explanation lies in the sexual union of the lightningbolt and the fecund mother earth. As Aristeo put it through our interpreters, *el rayo es la fuerza de la tierra*. Our interpreters made abundantly clear that the lightningbolt carried the sperm, the spunk, to the soft mother earth. The entheogenic mushrooms are the miraculous fruit of this coitus. Aristeo Matías was explicit in his explanation, which we had gathered elsewhere, notably in the *Rig Veda*, but only as a strong inference.

---

4. To grasp fully the meaning of this Discovery, it is advisable for the reader to have read Chapter 2.
5. In Zapotec there are three tones: I have indicated high by ´, low by &grave; and middle by no accent. In our spelling 'j' is as in 'judge'. The apostrophe represents a glottal stop. *Piule* is the word in the native languages for our 'entheogen', probably derived from *peyotl*.

I propose the following: in this remote corner of the world the same belief prevails in a far earlier stage of evolution than we have found in Eurasia. In Europe it still survives as a moribund relict, a verbal fossil, repeated by half-literate peasants out of habit, but retaining with remarkable persistence the one requirement that the verbal fossil relates to a single kind of mushroom, though a different kind in each region. When the original belief in the entheogenic mushrooms - those mushrooms that take one to a miraculous haven for some hours - gave way to other religious beliefs, each region chose a substitute to replace the entheogen and the belief lived on without a *raison d'être*. In Asia the belief existed in a far earlier recension in the *Rig Veda*, where we find *Aja Ekap&amacr;d*, 'not-born single-foot', not-born because not born from seed but miraculously from lightning, and single-foot because the mushroom has only a single Toot' or stipe. In Mesoamerica the belief in the entheogen survives and Aristeo is ready to give Plutarch[6] the answer to his question why thunder makes a certain mushroom to grow: Aristeo speaks out of prehistory, a voice from the millennia before mankind devised the art of writing.

6. The Meaning of *Kakuljá Hurakan*

From the village of San Agustín Loxicha, in Zapotec country, we will now visit the lands of the Maya, a few score miles due east as the bird flies, where the natives speak Tzeltal and Tzotzil, Mayan tongues in the Mexican State of Chiapas; and some score miles further, in the Guatemalan highlands where they speak Quiche and Tzutuhil. The Quiche were and are the most numerous of the Maya peoples. It is they who have left us as a legacy the *Popol Vuh*, a preConquest poem almost 8600 lines long, which has inspired many translations into Spanish, English, French, German, and Russian, plus two translations from these languages into Italian and Japanese. Mushrooms are mentioned expressly once in the *Popol Vuh*, in what is a religious context.[7] The mushroom caps lie in deerskin and are carried to the top of the mountain, - doubtless a sanctuary. We are given no hint of their species nor what was done with them.

The mycologist Bernard Lowy, now retired from his chair in the State University of Louisiana, had decided many years ago to pursue my subject - ethnomycology - and early on chose the Maya region to see what discoveries awaited him in that ancient and storied land. In the last decade he has made a dramatic break-through, reenforcing mightily the trend of my findings, already strong. Knowing of my preoccupation with lightningbolts and mushrooms, when he went down in June of 1973 to Guatemala he felt the need to familiarize himself with the vocabulary for lightning in the Quiche language. To this end he consulted the professional linguists of the Proyecto Francisco Marroquin in Antigua and specifically Dr. William Norman, a specialist in Quiche. He learned that in Quiche *kakuljá* is the word for lightning.2 But did it correspond with *rayo* in Spanish or simply with *relámpago*? *Rayo*, definitely. *Rayo* is the powerful word corresponding to *foudre* in French. *Rayo* provokes the tension of a nearby flash of a blinding lightningbolt and a deafening clap of thunder. *Relámpago* corresponds to *éclair* in French and, as he was told, to *xkoyopá* in Quiche. English is singularly weak in its thunderstorm vocabulary.

In July of that same year Prof. Lowy went on to Chichicastenango, in the heart of the Quiche country, and some kilometers north in the forest-covered mountains, where he gathered specimens of *Amanita muscaria* and *A. caesarea*. He brought his mushrooms down to the marketplace in the city and displayed them to the women mushroom vendors squatting on the sidewalk. They knew his mushrooms at once and he was admonished not to eat the *kakuljá*: it was *itzel ocox*, the 'evil or devilish mushroom'. So *kakuljá*, 'lightningbolt' in Quiche, really was the ordinary name of Soma! Originally it must have served as a most powerful metaphor, but now no one thinks of 'lightningbolt' when speaking of fungi. Lowy asked the women to pronounce the name slowly and carefully. It was the same as the word for the mighty lightningbolt, unmistakably.

The clergy in the Quiche country and, much later, the anthropologists and linguists when they arrived on the scene, were of West European stock and therefore probably mycophobes who ignored the toadstools of the country, until Prof. Lowy turned up in 1973 with his persistent questions. Scholars only now are, a few of them, learning of the importance of entheogenic mushrooms in prehistory, including our own Indo-European

---

6. p 84, *infra*.
7. *The Book of Counsel: The* Popol Vuh *of the Quiche Maya of Guatemala*, tr. and ed. by Munro S. Edmonson, Publication 35, Middle American Research Institute, Tulane University, 1971; line 6266.

collateral ancestors, in the Indus Valley, who had not yet learned the art of writing.

Do all those among the Quiche who characterize the *kakuljá* as *itzel ocox* believe this, or may these short words serve as an amulet to free them from the disapproval of the authorities? Are there possibly Quiche or Tzutuhil who ingest the *kakuljá* according to age-old rites?

In the summer of 1978 Prof. Lowy spent some time in Santiago de Atitlán, where Tzutuhil is spoken. There he investigated the beliefs concerning the gods in which, it seems, they still believe. I shall give these beliefs as he recorded them, in a document, dictated to him by a foreign resident of the village. Here is what he wrote down:

> According to Tzutuhil legend as narrated to me by Martín Prechtel, a talented painter and linguist living in Santiago de Atitlán, there once were 12 sacred trees, each of them associated with a different species of mushroom. The Nahuales decided to select one of these trees to rule over men on earth. Each tree in turn was asked whether it would accept the heavy responsibility. Only one accepted, an unlikely, undersized candidate called *chipi* or Little Brother. He said he had a dream or vision in which he was directed to find a certain hill at the foot of the volcano San Lucas (still venerated by the Tzutuhil) where a tree called the *palo de pito* grew surrounded by numerous mushrooms. As the tree was approached, a strong south wind arose bringing with it a violent storm, and presently the tree was split by a thunderbolt. The tree was hollow, and within it *chipi* observed a vague countenance which he then proceeded to carve out of the soft wood. This effigy became the god Maximon. Each stroke of *chipi*'s knife was accompanied by a sacred word, and each stroke likewise gave origin to a musical note, tone, or *son*. The notes provided the musical basis for traditional songs. When Maximon was fully formed, each Nahual conferred upon the newly created god a special power. Then Maximon was commanded to stand, for he was to be tested to determine whether he was able to use the powers conferred upon him. A deaf mute from the village was brought before him and Maximon was directed to cure his infirmity. According to one version of the legend, a fragment of one of the mushrooms growing around the *palo de pito* was fed to the man, who thereupon became rejuvenated and his infirmity disappeared. The Nahuales were pleased, and Maximon has ever since presided over the Tzutuhil people. It is this divine mushroom which is known among the Quiche as *kakuljá*, only recently identified as *Amanita muscaria* and which takes its name from the Maya god whom it personifies. *Kakuljá* is one of a trinity of gods referred to in the *Popol Vuh* as *kakuljá huracan*, the others being *chipi kakuljá*, and *raxa kakuljá*.
>
> The first of these, *kakuljá huracan*, enigmatically refers to a single leg, *huracan*, that is, the single shaft of the thunderbolt. Where this shaft struck the earth the miraculous mushroom *Amanita muscaria* arose.

Martín Prechtel is married to a Tzutuhil woman. The *palo de pito* is a leguminous tree, *Erythrina rubrinervia*. Prof. Lowy's account of the Tzutuhil folk belief appeared for the first time in the spring of 1980, in the *Revista-Review Interamericana*, p 100, Vol 10 No i, Copyright © 1981 Inter American University of Puerto Rico. Professor John Zebrowski is the Director-Editor of the *Revista* and he graciously granted us permission to quote from Prof. Lowy's article.

In Chiapas the vocabularies of both Tzeltal and Tzotzil also link Soma with the lightningbolt mushroom. Dr. Robert M. Laughlin, Curator of Anthropology of the Smithsonian, the authority on Tzotzil, tells us that Soma is called *tzajal yuy chauk*, meaning 'red thunderbolt's *yuyo*', *yuyo* being, it seems, a Quechua word. In San Cristóbal Lowy found that the fly-agaric is commonly still called by natives *yuyo de rayo*. These names raise the question whether Soma, when *yuyo* originally came to be used for the fly-agaric, was considered by the natives as edible: we hope this question will engage the attention of linguists, who should also be asked to explain the presence of a Quechua word in the native languages of Chiapas. Quechua is the dominant language of the Indians of Peru.

Dr. Laughlin gives us supporting evidence for the former currency of *kakuljá* in a *Vocabulario de Lengua Kiche* copied in 1787 from a now missing original by D. Fermín Joseph Tirado. On p 119 of vol. 2 it reveals *cakolha* in the last entry as an *hongo ponsoñoso*, 'poisonous mushroom'.

The famous 'mushroom stones' of the Mayan archeological world never resemble the numerous species of *Psilocybe* that are much sought after throughout Oaxaca and thereabouts, but they present, most of them, good profiles of Soma, and this adds support (as if support were needed!) to the linguistic evidence that the Maya people used Soma as their most holy entheogen.

From the *Popol Vuh* we learn that there were three kinds of *kakuljá* in traditional belief:

1.
kakuljá hurakan
Lightningbolt One-Leg

2. *chipi kakuljá*
Dwarf Lightningbolt

3. *raxa kakuljá*
Green Lightningbolt

There is no doubt about the priority of *kakuljá hurakan*. When the three are first mentioned in the *Popol Vuh* their ranking is made clear:

Quiche text		*Edmonson Translation*
R umal ri, u K'ux Kah	183	Through him who is the Heart of Heaven,
Hu r Aqan u bi	184	One-Leg by name.
Ka Kulaha Hu r Aqan nabe	185	One-Leg Lightningbolt is the first,
U kaab g'ut Ch'ipi Ka Kulaha,	186	And the second is Dwarf Lightningbolt
R ox chik Raxa Ka Kulaha	187	Third then is Green Lightningbolt,
Chi'e q'u oxib ri, u K'ux Kah.	188	So that the three of them are the Heart of Heaven.

Ka Kulaha Hu r Aqan	in the Preconquest *Popol Vuh* becomes
Kakuljá *Hurakan*	in contemporary Quiche and
Lighningbolt One-Leg	in English.

The three kinds of *kakuljá*, making up a trinity, are jointly cited eight times in the *Popol Vuh* but not repetitiously. Each citation is in a fresh context and is itself freshly composed. The eight citations in Edmonson are centered on lines 188, 235, 353, 1496, 1741, 2282, 4982, and 5187, each of these being several lines long. But special distinction is conferred on one of the three: *hurakan*, the 'oneleg' first member of the trinity, being cited alone five times, in lines 506, 712, 1512-1524, 4016, and 8198. Furthermore, in the eight joint citations, the 'dwarf and the 'green' are in each instance linked to *kakuljá*, whereas *kakuljá* appears with *hurakan* only the first time, showing that *hurakan*, 'one-leg', is strong enough to stand alone when it means the sacred mushroom.

There can be no question that *hurakan*, the 'one-leg', loomed large in Quiche and Tzutuhil minds, larger than the other two.

Certain it is that these uses of *kakuljá* do not mean lightningbolt at all. They refer to entheogens, the secondary meaning. The 'one-leg lightningbolt1 means Soma. The 'dwarf lightningbolt' means the various entheogenic *Psilocybe* species, normally much smaller than the fly-agaric, by comparison 'dwarfs'. The 'green lightningbolt' is the entheogenic morning-glories and any other phanerogamic entheogens. These are obvious interpretations for anyone who knows the entheogens.

Lowy's discovery of a secondary meaning for *kakuljá* is a major development in Quiche linguistics, a long step forward toward a grasp of the meaning of the *Popol Vuh*, a promising key to hitherto hidden (from us) meanings of other passages. It is certainly also a brilliant climax to Valentina Pavlovna's and my suspicion in the 1930's that mushrooms had played a major role in religion, a confirmation of Roman Jakobson's enthusiastic response to our presentation of our feelings. And what that religious role was! In India and among the Maya, not to speak of other peoples. It must be seldom that in these remote fields one achieves such success.

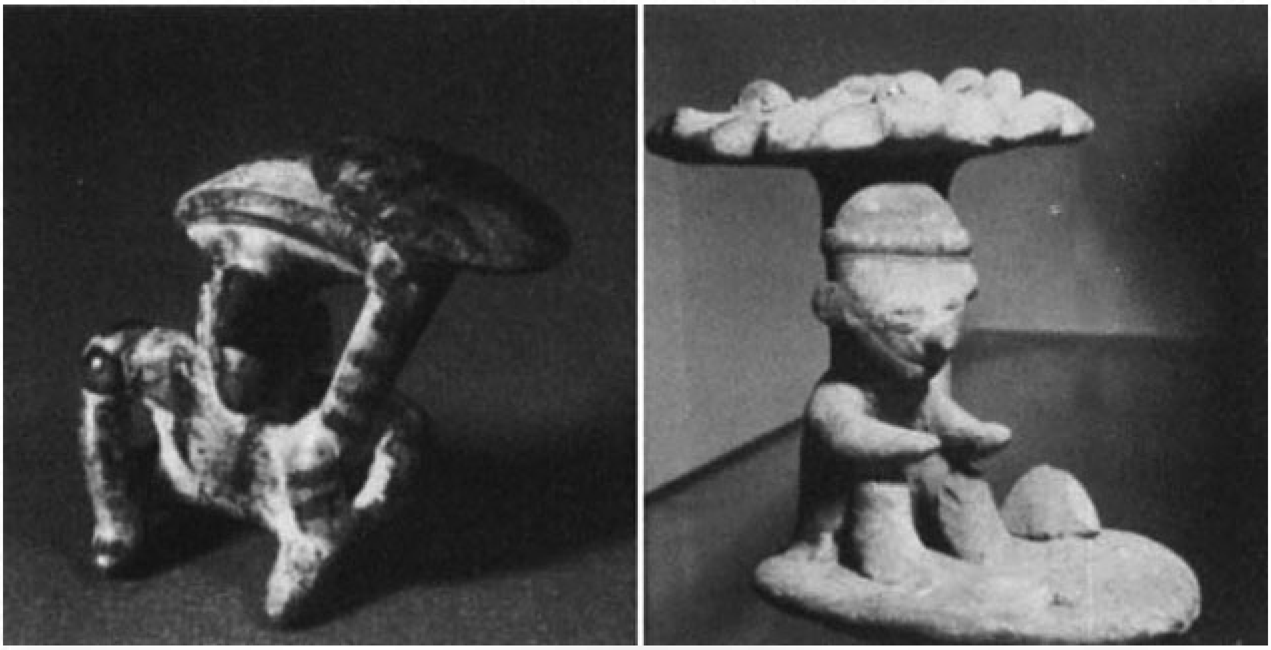


Fig. 8. *Terra cotta* figurines suggestive of Soma, *ca* AD 100, from Mexico, discovered by Peter T. Furst.

It is clear that Soma enjoyed a marked priority as the entheogen of choice, at least as late as when the *Popol Vuh* was written and perhaps as late as the Conquest, but the other Mesoamerican entheogens had gained a foothold among the Quiche. We must remember that the Algonkian nation were using Soma until only yesterday, and there may still be use there among the Ojibway and Chippewa. In Nayarit and in the region of Guadalajara, Peter T. Furst has photographed *terra cotta* mushrooms that date from *ca* AD 100 and that suggest Soma. This Maya discovery of Bernard Lowy's quickens the significance of those artifacts.

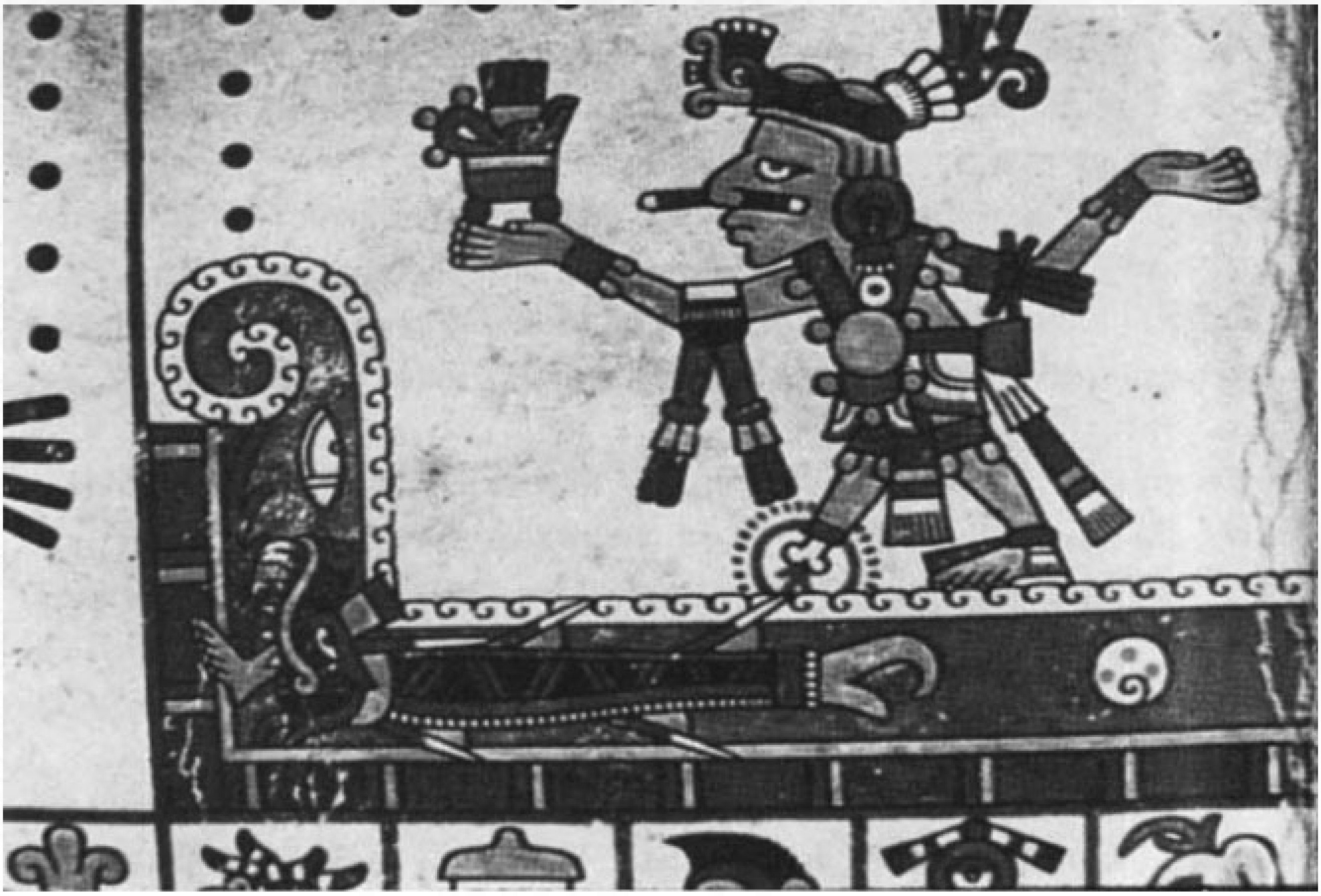
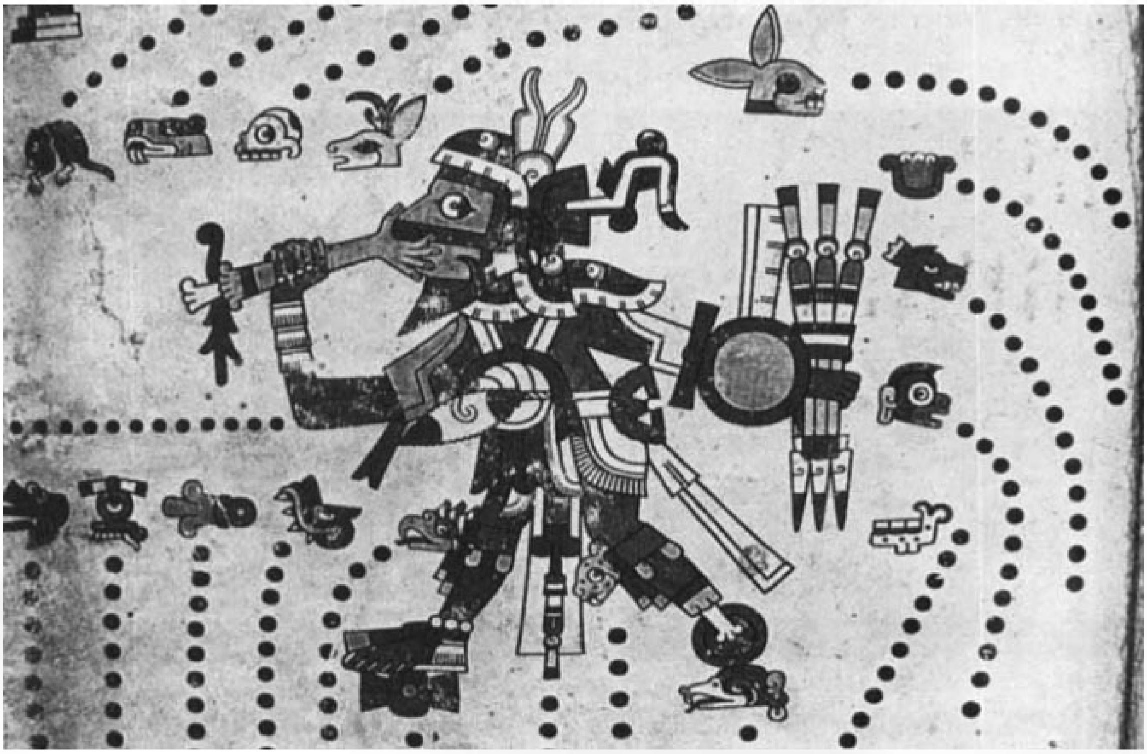


Fig. 9. The Black Tezcatlipoca, in aspect of Huitzilopochtli. Note that he is Uniped, 'Hurakan'. Both pictures are from *Codex Fejérvary-Máyer*, Liverpool Museum.



The Spanish missionaries reached Quiche country and began proselytizing about 1540. An unidentified member of a noble Quiche family about ten years later began to write out the *Popol Vuh* in the Latin letters (with modifications to accommodate sounds that Latin lacked) that he had learned from the clergy, and he finished the task in less than five years. Apart from being of lofty lineage, his identity is unknown. Strangely, the manuscript seems to have enjoyed little circulation during the next century and a half. Then the Rev. Francisco Ximénez O. P., who had mastered well the Quiche language, shortly after the turn of the i8th century, was asked by his superiors to copy that Quiche manuscript. He did so and the original manuscript was shortly afterwards returned to its home. It has never been seen since. It must have been lost or deliberately destroyed. Or does it possibly still exist, hidden in some conventual cupboard or Quiche secret place?

It is idle to speculate on the age of the *Popol Vuh*. That it goes back, far back, long before the Conquest, is obvious. A link between Soma and lightningbolt existed among the Aryans, just as it does among the Quiche, the Zapotecs, the Algonkians, and countless others, just as it did until yesterday among the Paleosiberian tribes. The presence of the entheogen has hung over the soul of the tribes in each of these places. The entheogen has drawn no study from linguists or anthropologists. The Sanskritists, as I have said, made no effort to find the Soma until I came along and with the essential help of Wendy Doniger O'Flaherty and other friends identified it as *A. muscaria*. As for Mesoamerica, conventional scholars are still apt to call the entheogens 'narcotics' and ignore their place in the lives of the natives. How misleading and odd is this unnatural reticence of scholars, even some of the greatest of them!

For years I had been seeking a pre-Conquest divinity of the Nahua who would be charged with the entheogens. Thanks to the brilliant analysis of H. B. Nicholson in the *Handbook of the Middle American Indians*, Vol. 10,1971, it seemed to me that Tezcatlipoca was the mighty god suitable for the role. When I discovered that in his aspect of Huitzilopochtli, he had only one sound leg, this was good evidence that here was One-Leg, Tezcatlipoca paralleling the role of the Quiche *hurakan*! Anthropologists had of course known this for a long time, but now we see Tezcatlipoca in the mighty personage of Soma. At about the same moment I learned of the twenty-seven line poem in the Tzotzil language discovered and revealed to us by Dr. Robert M. Laughlin, Curator of Mesoamerican Anthropology at the Smithsonian, and Professor Evon Z. Vogt of Harvard, ending with the lines:

> They saw that it was the same as, the same size as a hawk,
> Having to do with the father-mother (*Totilme'il*)
> 'One-Leg' as we call it.

I felt confident that here we have to do with the lightningbolt mushroom (Soma), though the various interpretations of the poem leave it still as obscure to me as it was when I first read it.

There has been discussion whether the Tzotzil borrowed this notion from the Quiche or from the Nahua of the Valley of Mexico. But did they not, all three of them, inherit it from far back? Did not the idea come with their ancestors from Asia? In the *Rig Veda*, *Aja Ekap&amacr;d*, the 'Not-Born Single-Foot', is cited seven times and in 1972, in my *Rejoinder to Professor Brough*, I suggested that this meant Soma. There is a verse in the *Rig Veda* that says Parjanya, the god of Thunder, was the father of Soma and in the next hymn we learn that 'the gods, those fathers with a commanding glance, laid the Somic germ'. The *Rig Veda* hymns were composed, as I have mentioned, in the second millennium BC and this is a possible date for the composition of the *Popol Vuh*. How odd it would be if the Brahmans in the Indus Valley were composing their hymns invoking the Not-born Single-foot (*Aja Ekap&amacr;d*) at the same time as the Mayan priesthood were paying obeisance to One-Leg Lightningbolt (*kakuljá hurakan*)!

7. A Glimpse of the Domestic Use of Soma

By rare chance we have caught a domestic practice, a peculiar way, in the consumption of Soma that is identical among the Koryak in the 19th century and among the Aryans, separated by 3,500 years and thousands of miles of most accidented terrain. It must have been a widespread custom, a noteworthy sharing of Soma with the women folk.

In 1903 J. Enderli published in *Petermanns Geographische Mitteilungen*, pp 183-4, an account of the Koryak, of which the following excerpt interests us:

> ... [the Koryak] have another substance with which they can produce narcotic intoxication. ... At the man's order, the woman dug into an old leather sack, in which all sorts of things were heaped one on top of another, and brought out a small package wrapped in dirty leather, from which she took a few old and dry fly-agarics. She then sat down next to the two men and began chewing the mushrooms thoroughly. After chewing, she took the mushrooms out of her mouth and rolled them between her hands to the shape of a little sausage.
> ... When the mushroom sausage was ready, one of the men immediately swallowed it greedily by shoving it deep into his throat with his indescribably filthy fingers, for the Koryak never wash in all their lives.
>
> [My *SOMA*, pp 261-262]
>
> This has been translated from the original German.

Vladimir Jochelson in his account of the Koryak confirms this account:

> As far as I could see, in the villages of Penshina Bay, the men, before eating it, first let the women chew it, and then swallow it.
>
> [My *SOMA*, p 266]

Vladimir Bogoraz[8] says the same thing:

> Among the Koryak, the woman chews the mushroom, and offers the ready quid to her husband to swallow.
>
> [My *SOMA*, p 273]

---

[8] '*Amanita muscaria* and the Thunderbolt Legend in Guatemala and Mexico', by B. Lowy, *Mycologia* LXVI.1, Jan.-Feb. 1974.

Traveling now back some three thousand five hundred years from the scenes in the Koryak country, and thousands of miles to the Indus Valley, we see a clinching detail of the continuum of Soma worship. We will quote three verses from a hymn of the *Rig Veda*, 8.91:

1. A maiden going for water found Soma by the way. She brought it home and said, '*I will press it for you, Indra*; I will press it for you, mighty one.
2. 'Dear man, you who go watchfully into house after house, drink this that *I have pressed with my teeth*, together with grain and gruel, cakes and praises.
3. 'We do not wish to understand you, and yet we do not misunderstand you. Slowly and gently, ever more gently, flow for Indra, O drop of Soma.'

This is the translation by Wendy Doniger O'Flaherty published in the Penguin Classics. Unlike most of the Hymns, it gives us a domestic scene, where we see (as I let my fancy free) a young lady, Ap&amacr;l&amacr;, going for water to the spring and returning home, one arm balancing the water vessel on her head, two or three Soma plants in her right hand held by the stipes [Sanskrit: *aṃ&sacute;&umacr;*], full of joy as she planned her cakes, gruel, and grain for her most distinguished guest. On arriving home her first duty was to dry the Soma plants, placing them near the fire where they would dry quickly but not so near that they would begin cooking. When Indra arrived home, all was ready, and her happiness knew no limit. Mighty Indra possessed her and naturally her affliction was healed.

Little did the nineteenth century actors in the Koryak country know the antiquity of what they were doing, and the foreign observers were ignorant. Here are two views of the same scene, one *en beau* and inviting, the other repulsive, but both scenes of the same informal manner of serving Soma at home. I think this way of consuming Soma was probably the common one, in the Aryans' homeland, whence they emigrated to south Asia, rather than the exalted sacrifice with a full complement of chanting priests.

I would not have my readers think that this episode of Ap&amacr;l&amacr; and the Koryak account three or four thousand years later offer us weighty evidence in favor of the fly-agaric as Soma. Here is corroborative evidence in favor of our case: in both instances the woman in the household masticates the Soma for her man. That is all and it is a good deal when we are discussing how the essential Element in a most ancient and truly universal religion is handled. In the Koryak case the quid is passed to the man after thorough mastication; presumably the woman has swallowed the juice. In the Aryan instance, the young lady conserves the juice in a container of some sort and presents it to Indra to drink. (The Sanskrit word is *piba*, from the root *p&imacr;*, cognate with English 'imbibe'.) This would call for skill on her part, and the drink would be a mixture of *pávam&amacr;na* (a Sanskrit word for the expressed and filtered juice of Soma) and her saliva. Was the poem composed in the Indus Valley where the Soma plant was notoriously scarce and was the poet unfamiliar with the details about the quid? Did Ap&amacr;l&amacr; swallow the quid? Or do we see an Aryan poet paying obeisance to an inaccurately remembered practice of the Aryans in the land whence they had emigrated generations earlier?

★

Soma is the only mushroom whose biography lends itself to being written up, but this must await some future scholar. It will be an absorbing theme, the life story of the supreme entheogen of all time, which survived (and survives!) prehistory only in spots and but briefly, the cult in disarray and pitiful, its practitioners in Siberia generally despised and downgraded by those Europeans who have been privileged to establish contact with them. The visitors exercised their power to impose their distilled liquor (vodka, whiskey, and gin) in place of the 'toadstool', smugly certain that they were doing the natives a favor. They disregarded the testimony of the natives, who said they preferred the mushroom: it left no hangover and the inebriation was superior. Among the visitors there were some competent observers, but culturally even these were so far removed in time from the people before them that they could not be expected to appraise adequately what they were witnessing.

8. The Chinese and the Nivkhi

In the lower valley of the Amur[9] there lives a people from time immemorial formerly known to the West as the Gilyaks but now as the Nivkhi. They are one of the Paleosiberian peoples, speaking a language related to no other. They number between 20,000 and 30,000. In my *SOMA* I did not cite them for at that time I had learned little about them. I now have learned that they practiced shamanism, at least until recently, with *Amanita muscaria* as their entheogen. Furthermore, it is said that they once had important cultural contacts with the Daoists of China.[10]

I will now quote from a Nivkhi myth, translated from their tongue into Russian and thence into English:

> Two titmice brothers, living under the shelter of a hummock, were at that time the only inhabitants of the earth. The titmice lived for a long time, not knowing what was to be found along the river beyond their hummock. Then they decided to go and look. The younger brother went up the river, the elder down the river. As he went up the river, the younger brother saw a larch, 'A thick larch rising to the very sky.' At the foot of the larch there was food, grown and placed there by the 'masters of the larch,' unknown to the brothers. The younger brother tasted the food and took some to give to the older one. The next day the titmice brothers proceeded together to the source of the food. There they met heavenly people, two little birds, a silver and a gold one, who had descended to the base of the larch and declared themselves the masters of the food.
>
> [*Studies in Siberian Shamanism*, edited by Henry N. Michael, Univ. of Toronto Press, published for the Arctic Institute of North America, 1963. A. F. Anisimov: 'Cosmological Concepts of the North', Chap 1, pp 169-170,173-4]

The larch, a conifer with deciduous needles, is for the Nivkhi the Tree of Life, the Tree of the Knowledge of Good and Evil, and is revered accordingly by them. Why? Because there springs up under its boughs *A. muscaria*, the 'food' mentioned in the above myth. Throughout Siberia, indeed Asia, wherever grow the trees that serve as hosts to *A. muscaria*, - the birch, the pine, the cedar, the larch, others - that tree is revered as giving birth to the Marvelous Herb. The entheogen at the foot of the tree is the explanation of the reverence paid to the tree by the natives round about. How has the world overlooked for so long a time this key to the mystery of the Tree of Life?

With the reticence that we find everywhere in the world where the entheogens are encountered, the identity of the food found at the foot of the larch is not disclosed in the Nivkhi myth that I have quoted but it would be obvious to any Nivkh and, as the Nivkhi would think, to any stranger worth his salt. That the tree is revered goes without saying but it is not so holy as to be subject to the verbal tabu sheltering the miraculous plant at its base, a plant whose name is pronounced only in a whisper and only when two or three are gathered together, preferably at night. And even then when one examines that name, it is invariably a euphemism; *ie*

Sanskrit *Soma*:	'the pressed one'
Sanskrit *Aja Ekap&amacr;d*:	'not-born single-foot'
Quiche Maya *kakuljá*:	'an overwhelming lightning strike'
Quiche Maya *hurakan*:	'the one-legged one'
Mazatec *ˀnti*^{1}*xi*^{3}*tho*^{3}:	'The Holy [Ones] that leap forth'

We do not know the Nivkhi name for the plant that grows at the foot of the larch but it would be noteworthy, indeed unique, if it were not another euphemism.

---

[9] Bogoraz and Jochelson knew each other and I am uncertain whether this is independent testimony or whether it merely repeats Jochelson.

[10] See map, p 69; the Amur is at lower left.

★

When I brought out my *SOMA* at the end of 1968, I failed to deal with China and the use of entheogens there because I felt inadequate. Since then I have learned much and will now give my views.

If indeed the Daoists in the early days were in touch with the Nivkhi, they must have shared with each other the knowledge of the mighty and holy entheogen. No one can say which had the knowledge first: it goes back so far that the origin is forever lost and unimportant. We shall see in Chap 2 (p 90) that the lightningbolt belief is securely grounded in the Chinese culture and vocabulary: proof as I see it that they shared with others in their high regard for the sacred entheogen. In the *Li ji*, one of China's 'Thirteen Classics',[11] there is a significant statement that the *zhi* 芝 defined as an herb, 'a small plant that is not woody', was eaten by the Emperor as a ritual food. It was therefore edible and sacred. Nothing is said that others were prohibited from eating it. It would be natural for the hierarchs of the Daoists to share in it, and the Court circles, perhaps others, possibly many others. China was more wooded then than now but we do not know whether there was overharvesting, nor whether the Chinese knew how to harvest the mushrooms without breaking the tie with their mycelium. At any rate in the reign of the First Emperor Shihuang, before the Han, we hear for the first time that there are big troubles, the necromancers looking in vain for a sacred herb, and for the first time the *ling zhi*, 靈芝 as distinct from the simple *zhi*, is cited. Clearly there was a crisis in the supply that agitated the Court circles, as the *zhi* faded from view and the *ling zhi* became the official surrogate. The replacement took place only after the voluble élite circles of the Chinese made a furor that we can document in historical texts, in poetry, in paintings, and in carvings, and that lasted into the Later Han. In the reign of the unpopular Wudi there took place what would be called today a remarkable and successful 'public relations ploy', which the reader can learn about in *SOMA* (p 85) with unalloyed admiration, and which served to strongly consolidate the legitimacy of the changeling. Suffice it to say that the replacement of the *zhi* (*A. muscaria*) by *ling zhi* (*Ganoderma lucidum*), of the 'not woody herb' by the 'woody herb', stunning in its protean shapes and with its deep red lacquered finish, won the day. But the Chinese never let out the secret of the small 'not woody' herb.

This explanation meets all the peculiar circumstances of the event, including the character of the Chinese people. I am convinced that it is right.

The High Priests of the Daoists today wear vestments that are bespattered with the auspicious *ling zhi*, and they also wear emblems of the *ling zhi*. How much of this history - the adoption of the changeling to replace the 'not woody herb' - is known to them?

Far to the south of them the Brahmans of India faced an identical problem, when they had to make do with a changeling, the *P&umacr;tika* replacing the Soma. But the different circumstances permitted them to be far more discreet and hide the identity of both plants until Professor Heim and I visited the Santal and learned the fungal identity of the substitute, the *P&umacr;tika*.

9. Greece and Soma

Carl Ruck has discovered in ancient Greek an assemblage of rare words that can only apply to Soma, but we cannot be sure, in the light of the circumpolar field that we have found for the adoration of this plant, whether the Greeks derived their knowledge of it from the Indus Valley to the east, or from the north whence they had migrated, or both; or perhaps some Greeks had always known it as a part of traditional family lore. Ruck's exposition of this aspect of Greek culture is in the early pages of his first essay in this book, pp 151-178.

---

11. To follow my argument the reader should refresh his memory of what I said in *SOMA*, pp 80-92. (In the first edition and early reprintings of *SOMA* I committed an error, unimportant but inexcusable: where I mention *Pleurotus ostreatus*, p 82, I should have said *Auricularia auricula-Judae*.)

A traveller named Skylax early in the fifth century BC is mentioned in Herodotus as having visited the Indus Valley. Herodotus says little more and the book by Skylax has not survived but he is cited by various writers including Pliny and is reported to have said that the Indus Valley was the homeland of the 'Shade-foot' (Gr.: *Sciopodes*) people, who possessed a single powerful leg on which they leapt with astonishing vigor or else lay on their backs and shielded themselves from the sun with their single foot serving as a parasol. Another Greek name (though surviving only in Latin sources) for these creatures was 'One-legs' (Gr.: *Monocoli*), and a third term, used only by the seventh century poet Alcman, is 'Cover-foot' (Gr.: *Steganopodes*). If indeed Alcman in the seventh century BC wrote of the 'Cover-foots', here is proof that the Greeks possessed information about the marvelous entheogen before Herodotus, who also has told us (4.33 *et seq*) that Greece was in regular contact with the Hyperboreans, in the heart of Siberia, since long before his time, possibly since the Greek migrations. Another Greek, Ktesias, made a journey to India a century after Skylax, and his narrative survives in part. It is noteworthy that the Greeks knew about the entheogens down the centuries, but characteristically hardly mention them, so that Western scholars ignore them.

In Vedic Sanskrit we find the congener of these Greek words, *Aja Ekap&amacr;d*, 'Not-born Single-foot', referring to Soma: 'not-born' because born without seed, but conceived miraculously, from the coitus of a lightningbolt with mother earth rendered soft by rains, and 'single-foot' because the divine Soma plant had only one leg, the stipe (or stem, *aṃ&sacute;&umacr;*[12] in Sanskrit) of the mushroom. The word in Sanskrit for a mushroom, introduced in post-Vedic times, was *chattra*, whose primary meaning was 'parasol'. We will find the 'parasol' reappearing centuries later in the manuscripts written in the Middle Ages. The mushroom (= Soma) has gills (or *laminae*) suggestive of the struts of a parasol. This is as much as a Greek traveller could have learned in the Indus Valley about Soma. The use of Soma there had been abandoned centuries earlier and the Brahmans, who were the custodians of the secrets of Soma, were now intent on suppressing every memory of the marvelous herb. It was unlikely that a Greek would ever meet a Brahman, and if he did, the Brahman would not engage in a discussion of Soma with him.

The Arimaspians, a people allegedly possessing only a single eye, were placed near the Hyperboreans by Herodotus, though with naive charm he expresses scepticism about their very existence (3.116). What he is talking about is the race of Cyclopes and we now understand them for the first time: they are of course the personification of Soma as a single eye. The Cyclops is originally Soma under an aspect different from the 'Cover-foots'. In *SOMA* I published, all unknowing, in Plate 10, a picture of Soma as a 'single-eye' and on pp 46-47 I published a list of the 'single-eye' citations that occur in the 9th mandala of the *Rig Veda*. The Cyclopes evolved far in Greek culture and their origin may well have been lost to view by most Greeks in the time of Aristophanes. The single eye and the single leg are combined in a 'one-sided man or woman' shown to us in *The Chukchee*, where V. G. Bogoraz says he represents the spirit of the estuary of the Anadyr River. Rodney Needham calls this creature a 'unilateral figure' in his *Reconnaissances*. Others have called it a 'halfling'.

Rudolf Wittkower in his classic 'Marvels of the East: A Study in the History of Monsters'[13] recognized that both Greeks and Indians possessed cyclopic races and he adds: 'they may have had a common mythical origin in times beyond our historical reach.' He divined what we have established, the common origin of the Indian and Greek Cyclopes, a common origin but *not* a mythical origin, a common origin in Soma the Divine Mushroom.

Our third 'monster' has no head but his face is in his torso, extending from his shoulders to his belly: he is called in Greek a 'Tongue-in-Belly' (Gr.: *Englottogastor*), a *hapax*. The divine being, Soma, has only his torso to live in (apart from his Single-Leg), no head, and his eyes and nose and mouth must be in his torso.

Carl Ruck has identified the Greek mythological archetype of all the 'Tongues-in-belly': it is lambe-Baubo, who enters into the *Homeric Hymn to Demeter* (11. 200-210), in the famous scene where Metaneira offers her grieving guest wine to drink, but the Goddess says that to drink red wine would be a sacrilege. This was just after Iambe-Baubo had brought her a stool and had thrown over it a lamb's fleece for her to sit on:

---

[12] The *Li Ji* was put together in the Early Han but from documents that date from the late Zhou, BC 700 to the third century BC.

[13] Another word for Soma, far less holy, is *aṃ&sacute;&umacr;*. Those whose function it was to handle the plants every day - receiving them, drying them, storing them, producing them for the Offices - needed a word without the exalted attributes of 'Soma'. Some of the observers in Siberia have noted that the merchants string the plants to gether in threes, threading them together through the relatively tough stipes. Some such method must have been used in Vedic times and here we have an explanation of the term of art, *aṃ&sacute;&umacr;*. There was an imperious need for a word to serve that function. Do we not have it in *aṃ&sacute;&umacr;*? Renou translates *aṃ&sacute;&umacr;* felicitously by *tige*, stem or stipe.

> *Thus she remained until the scheming Iambe amused the holy lady with jokes and made her smile, then laugh, softening her heart - Iambe who in later times pleased her at her rites of Mystery.*

Iambe-Baubo is a strange character: she has no head and her face is in her torso. We here present three examples of this figure. 'Iambic' is the poetic meter used in ancient Greece for erotic verse and Baubo is doing what is expected of her in this scene with Demeter. We also learn that she played a role in the rites of the Mystery of Eleusis. Some scholars have held the view that Baubo is an androgyne: the legs are joined throughout their length, the arms are only suggested, and as head and neck are absent, the whole figure suggests an erect penis.

This common fund of evasive euphemisms is used for the mighty entheogen, whether in the Indus Valley, in Siberia, in Greece, or indeed in some cases in the far off highlands of Mesoamerica. The evasive euphemisms were understood and used throughout vast stretches of the world. We are now bringing this vocabulary to scholarly attention. Aristophanes was an outstanding playwright, popular, and when he used Sciapodes and *Englottogastor* in *The Birds*, we can rest assured that Aristophanes knew he would be understood. These words drawn from the sacred vocabulary are rare in surviving documents but their rarity does not tell the story of their oral usage. *Sciapodes* and *Englottogastor* serve in the strophe and antistrophe of the Chorus in *The Birds*: Ruck thinks that in the case of *Englottogastor*, it may have been invented *ad hoc* by Aristophanes. Either way, invention by playwright or not, it had multiple progeny many centuries later. Just as in Mexico today, the sacred vocabulary seldom erupts in large and mixed gatherings but recurs in private conversations among people well known to each other. To the end in ancient Athens plays were tinctured with religion, and Aristophanes used in his comedies a freedom of expression that would not have been proper in the Agora.

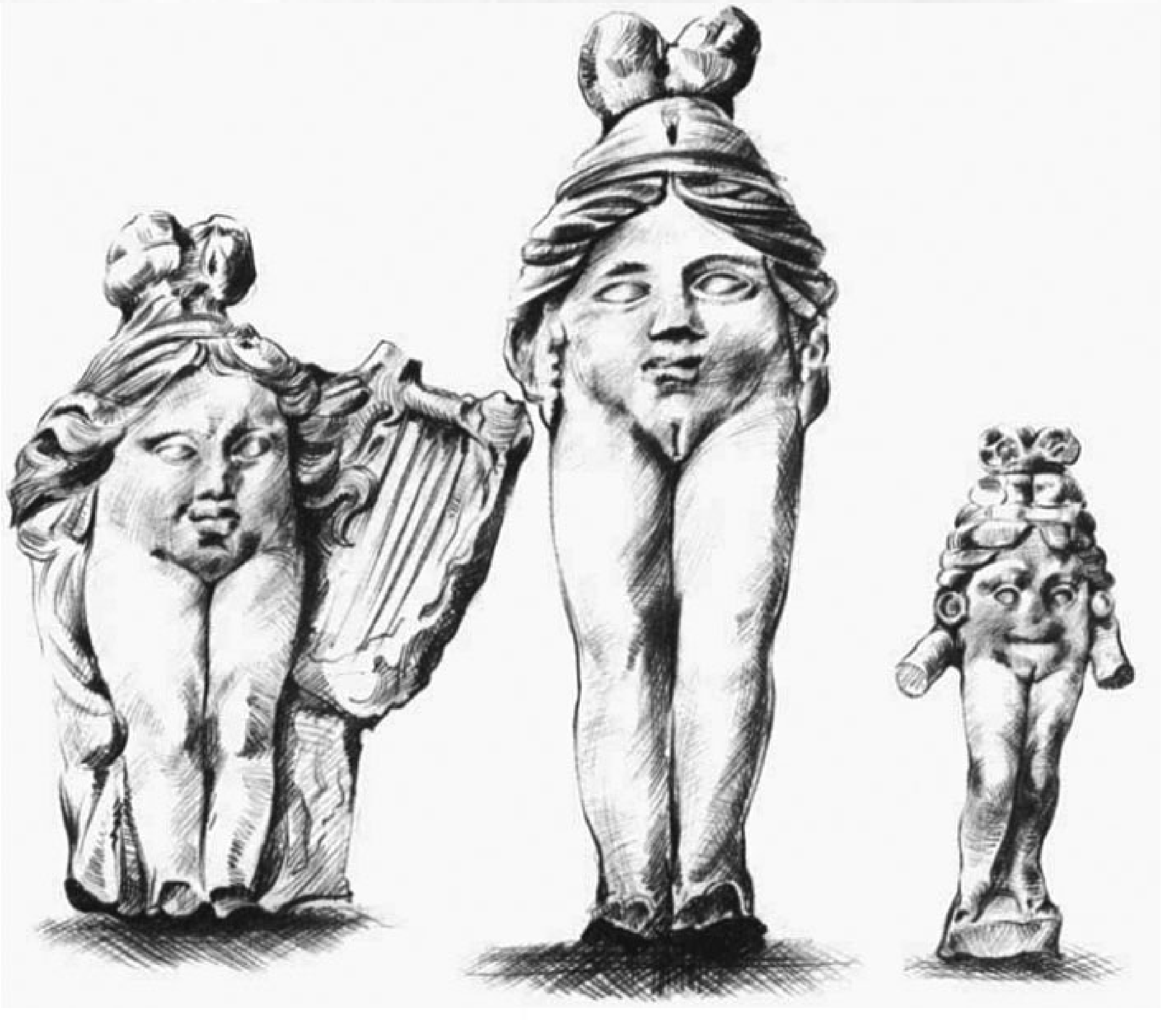
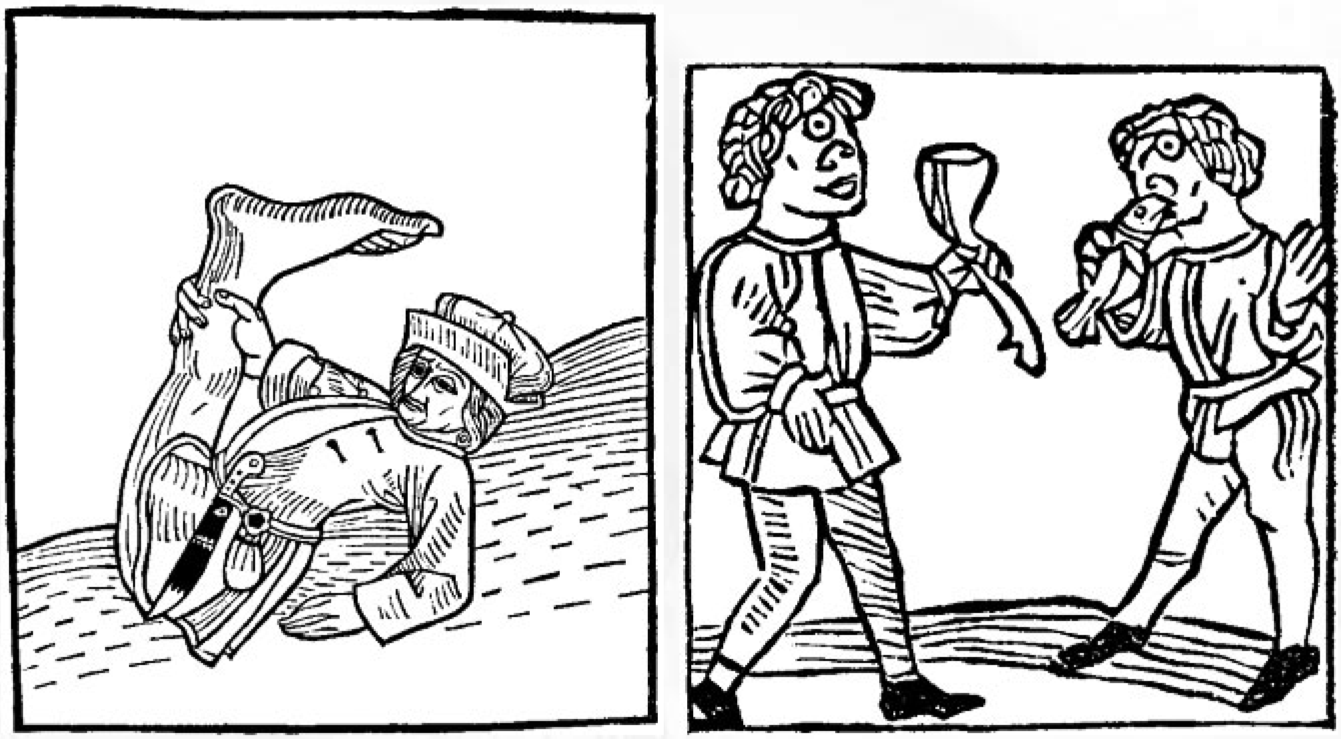


Fig. 10. Iambe-Baubo Figures. *Terra cotta*, Priene, Asia Minor, 5th century BC.

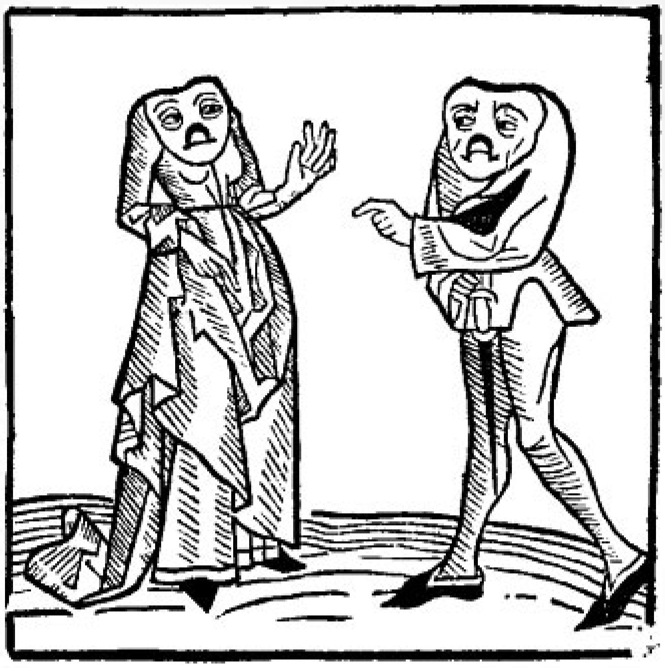
10. Soma among the Mediaeval 'Monsters'

It is surprising enough that these evasive euphemisms for the plant Soma occur in classical Greece; but, doubly surprising, throughout the Middle Ages the scriptoria of Western Europe were busy with the 'monsters' that dwelt beyond the limits of the known world. Occasionally they hit on genuine peoples such as the pygmies of Africa, but mostly the scribes and artists contented themselves with perpetuating the same fanciful 'monsters' down through the ages. They derive their inspiration largely from classical sources, notably from the *Historia Naturalis* of Pliny the Elder, who drew on the Greek sources that we are now familiar with. These illuminated manuscripts seem to have been immensely popular among the literate and many people at first may have half believed in the imaginary creatures that they read about and saw pictured. But there was never an edition that tried to explain our three 'monsters'.



a. Single-footed man

b. Cyclopes



c. 'Tongue-in-Belly'

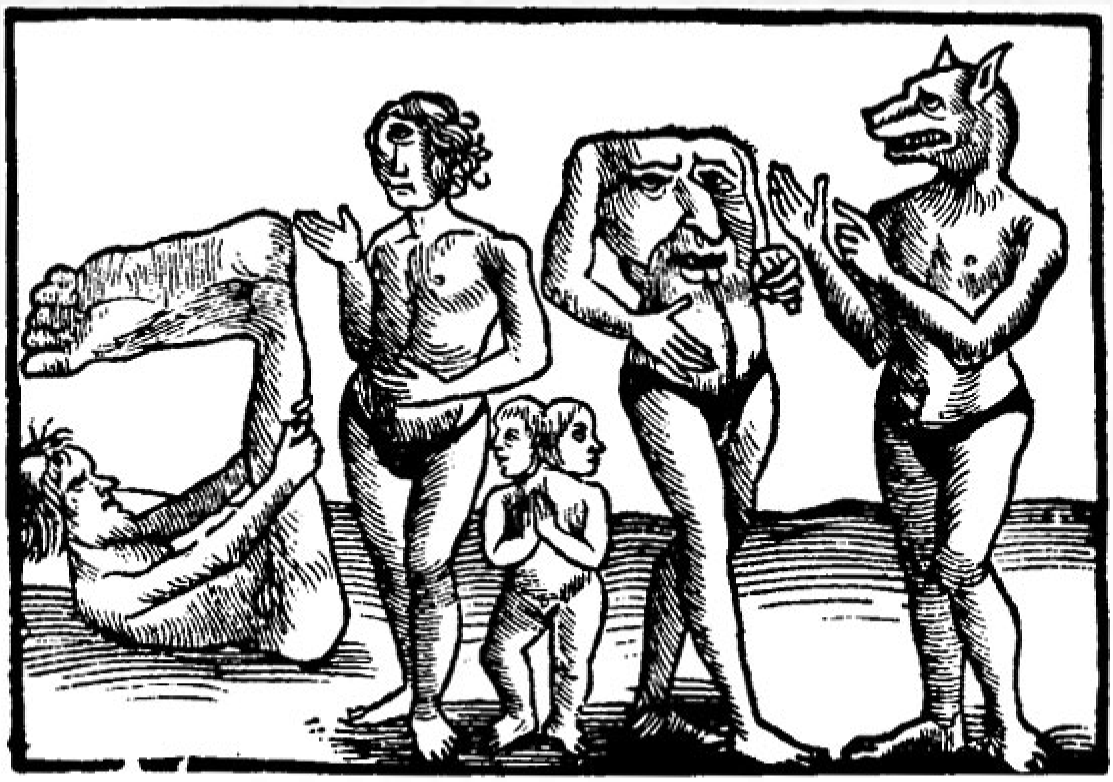
Fig. 11. 'Monsters' repeatedly appearing in manuscripts of the late Middle Ages, reputedly from creatures living beyond the known world. As we have shown in the text, these stem from *A. muscaria*, difficult as this is to imagine, going back through classical Greece.

The three pictures on this page are all taken from *The Travels of Sir John Mandeville, Kt.*, Strassburg, 1501, p 71. Courtesy of The Pierpont Morgan Library, New York.

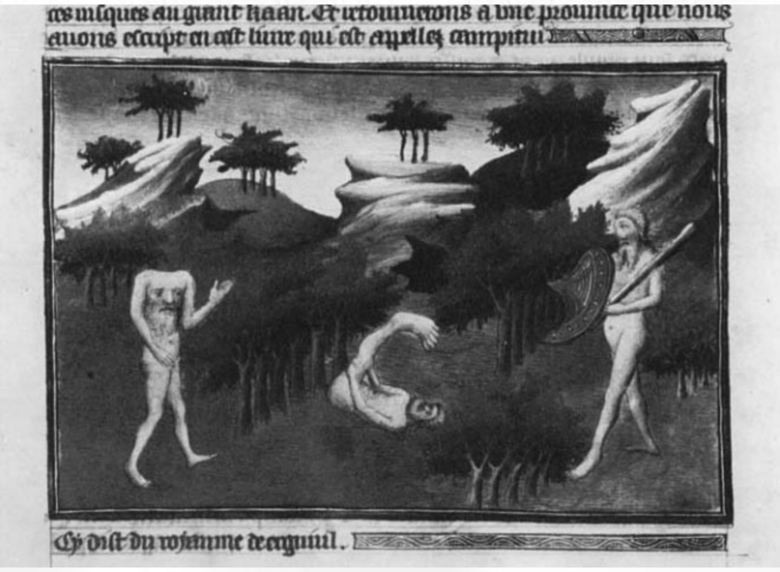
Those three do of course appear separately but what impresses me is that they often appear together. In an especially fine manuscript in the Bibliothèque Nationale designated Fr. 2810, one of the early versions of Marco Polo's account of his travels to the Orient that was commissioned as a gift from John the Fearless to the Duke of Berry, there comes the point where Marco Polo tells about his visit to Siberia. Of course he does not mention any 'monsters' but nonetheless the Boucicaut Master in charge of the manuscript (volunteering irrelevant illustrations as was often done) offers us a miniature of a Cyclops, a Sciapous, and a Tongue-in-Belly in Siberia. They are placed in a mountain scene where Soma might be growing in Siberia. One inevitably asks oneself when confronted with a manuscript such as this whether some even in the late Middle Ages had information withheld from our other sources, in short whether there were individuals who knew what our three 'monsters' meant.

Shortly after the middle of the 14th century a book destined for great fame was dictated to an amanuensis in French in Liège purporting to be the story of the travels of a fictitious Englishman, Sir John Mandeville, Kt., as related by himself. This was the supreme travel yarn telling with mock solemnity of the monsters, just as Cervantes with Don Quixote, two and a half centuries later, made fun of the chivalry and knighthood that had lingered on into his day. *Sir John Mandeville, Kt.* was translated into almost all the languages of Europe including of course English and, with the invention of printing, was published in innumerable editions. In the 19th and 20th centuries a few such editions continued to appear but only as picturesque period pieces. Here was a book that expressed the increased scepticism of the Renaissance.

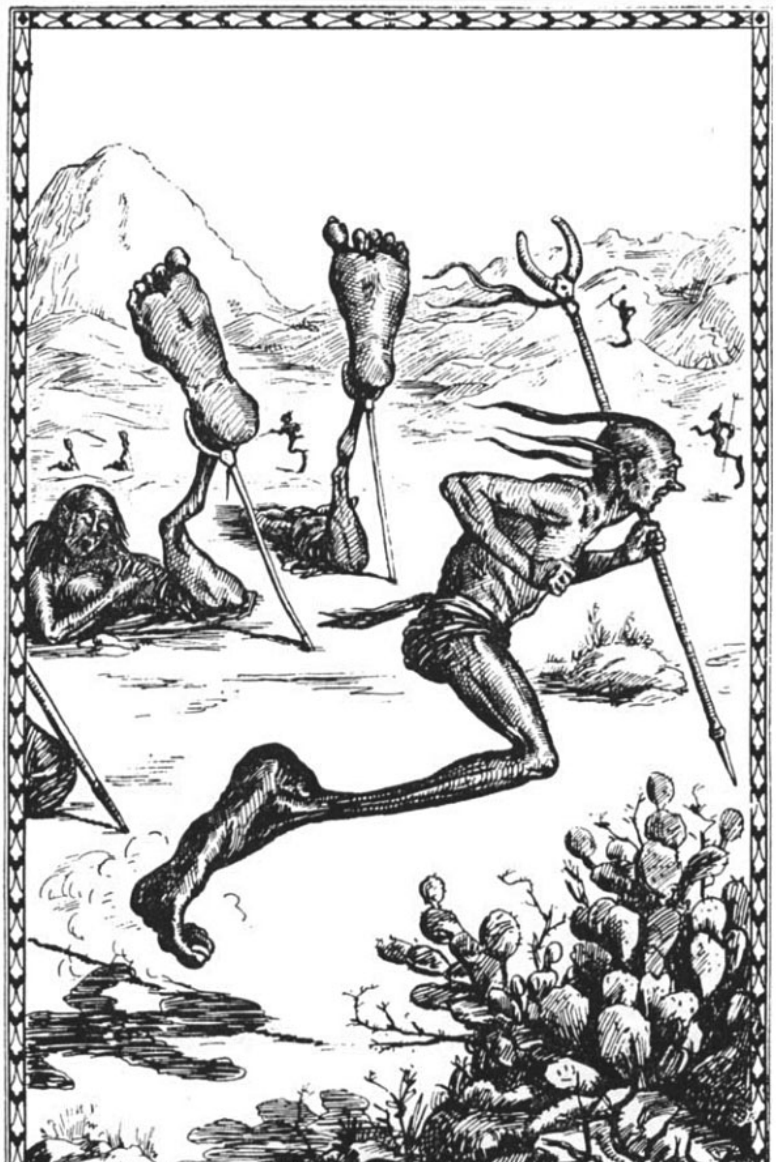
The question will surely be asked why people devised words such as Tonguein-Belly, Cyclops, and Shade-foot when speaking of Soma. But the answer seems to me obvious: wherever religious feeling is deep and sincere as it was among the Brahmans in Vedic times and others who worshipped Soma, everything associated with the holy and especially the name of the mighty plant is subject to a religious tabu. The sacred words must not be spoken openly and commonly. Originally the three names of our 'monsters' could be pronounced freely in the presence of strangers, of *&sacute;&umacr;dras*, without danger that the Most Holy would be befouled by those unworthy clods, as the Brahmans considered all the lower orders to be. In the Middle Ages the pictures and the names had lost contact with their own origins and they were mere oddities. They were perhaps the 'science fiction' of their day.



d. Drawing of group with other 'Monsters'
Taken from *Cosmographia*, by Sebastian Munster, Basel, 1544, p 628.
Courtesy of The New York Public Library, Rare Book Division.


res jusques au grant kaan. Et retournerons a une prouince que nous
auions escript en cest liure qui est appellez campitiu
Cy dist du royaume de caguiul.

e. Scene from mediaeval manuscript of Marco Polo's travels, ms. FR 2810, Bibliothèque Nationale, Paris.


ARTHUR LAYARD

f. Nineteenth century reproduction of the 'Folk with but One Foot' from *The Travels of Sir John Mandeville, Kt.*, edited and illustrated by Arthur Layard, published by Archibald Constable, Westminster, in 1895.

11. The Chukotka

A Russian archaeologist, N. N. Dikov, who lives in Magadan, a city on the Pacific Coast of Siberia (as is only too well known to all Russians), in 1967-1968 discovered mushroom petroglyphs on the eastern bank of the Pegtymel' River. In many instances the mushrooms were associated with human figures, all apparently female, a mushroom crowning the head. The petroglyphs were small, some centimeters in height, and the mushrooms were larger in scale than normal. Did the mushrooms signify mushroom possession? Their size would suggest this. Collateral evidence permitted Dikov to speculate that the petroglyphs might date from the end of the stone age or the beginning of the bronze age, *ie* around BC 1000. The figures with mushrooms were far from isolated: reindeer, dogs (or wolves), foxes, a kayak, fish, and seals were also portrayed. The mushrooms were doubtless *A. muscaria*, and the women wearing them on their heads may have been engaging in a ritual dance, but I prefer a different explanation. In *SOMA* I quoted, pp 288 *et seq*, various tales in which the Kamchadali and the Koryaki introduce us to the 'little folk' of their entheogenic world as little girls, small, only a few centimeters high. (We are reminded of the 'little people' of the Oaxaca world, playing-card in size: see *The Wondrous Mushroom*, pp 136 *et seq*) I think the petroglyphs of the Pegtymel' River represent the 'fly-agaric girls', and the mushrooms serve to identify the pictographs. For me a striking feature of these petroglyphs was their location: the Pegtymel' River flows north into the Arctic Ocean in the eastern reaches of the Chukotka, the huge peninsula jutting out towards Alaska. The petroglyphs are only sixty kilometers from the river's mouth, in a ravine where the eastern bank of the river is a rocky formation rising high above the flowing water. Today this is Chukchi country and it may well have been so three millennia ago.

I thank Mr. Dikov for having sent me his writings about the petroglyphs and the pictures. The map was made by my cartographer, Jean Tremblay.

12. The Fool's Mushroom

In Magyar there is a phrase that circulates (in translation) in Southern Europe to this day, a conversational cliché, *bolond gomba*, 'fool's mushroom', as when one asks of a person behaving foolishly, 'Have you eaten of the fool's mushroom?', or when one rejects a proposition by saying, 'Do you think I have eaten of the fool's mushroom, that I should do such a thing?', or again, 'He is laughing as though he had eaten the fool's mushroom.' In Hungary the 'wise-woman', *javas asszony*, is said to use this same mushroom in love philtres, and the angry lover sends the philtre to the object of his passion. At our request considerable effort has been expended in Hungary to find out whether the peasants in any region of that country identify the *bolond gomba* with a particular species, with no success. But did the inquirers reach out to include the 'wise women'? They would be the last to lose this knowledge, though they would perhaps be reluctant witnesses.

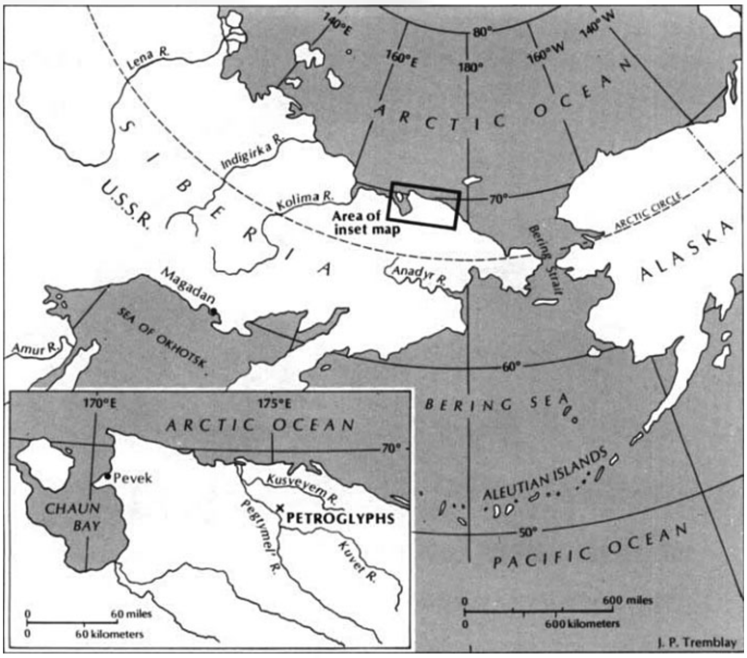

140°E
80°
140°W
160°E
180°
160°W
Lena R.
ARCTIC OCEAN
SIBERIA
U.S.S.R.
Indigirka R.
Kolima R.
Area of inset map
70°
ARCTIC CIRCLE
Bering Strait
ALASKA
Anadyr R.
Magadan
SEA OF OKHOTSK
Amur R.
60°
BERING SEA
ALEUTIAN ISLANDS
50°
PACIFIC OCEAN
0 600 miles
0 600 kilometers
J. P. Tremblay
170°E
175°E
ARCTIC OCEAN
70°
Pevek
CHAUN BAY
Kusveyem R.
PETROGLYPHS
Pegtymel' R.
Kuvet R.
0 60 miles
0 60 kilometers

Fig. 12. Map of the Chukotka region and chart of mushroom shapes.

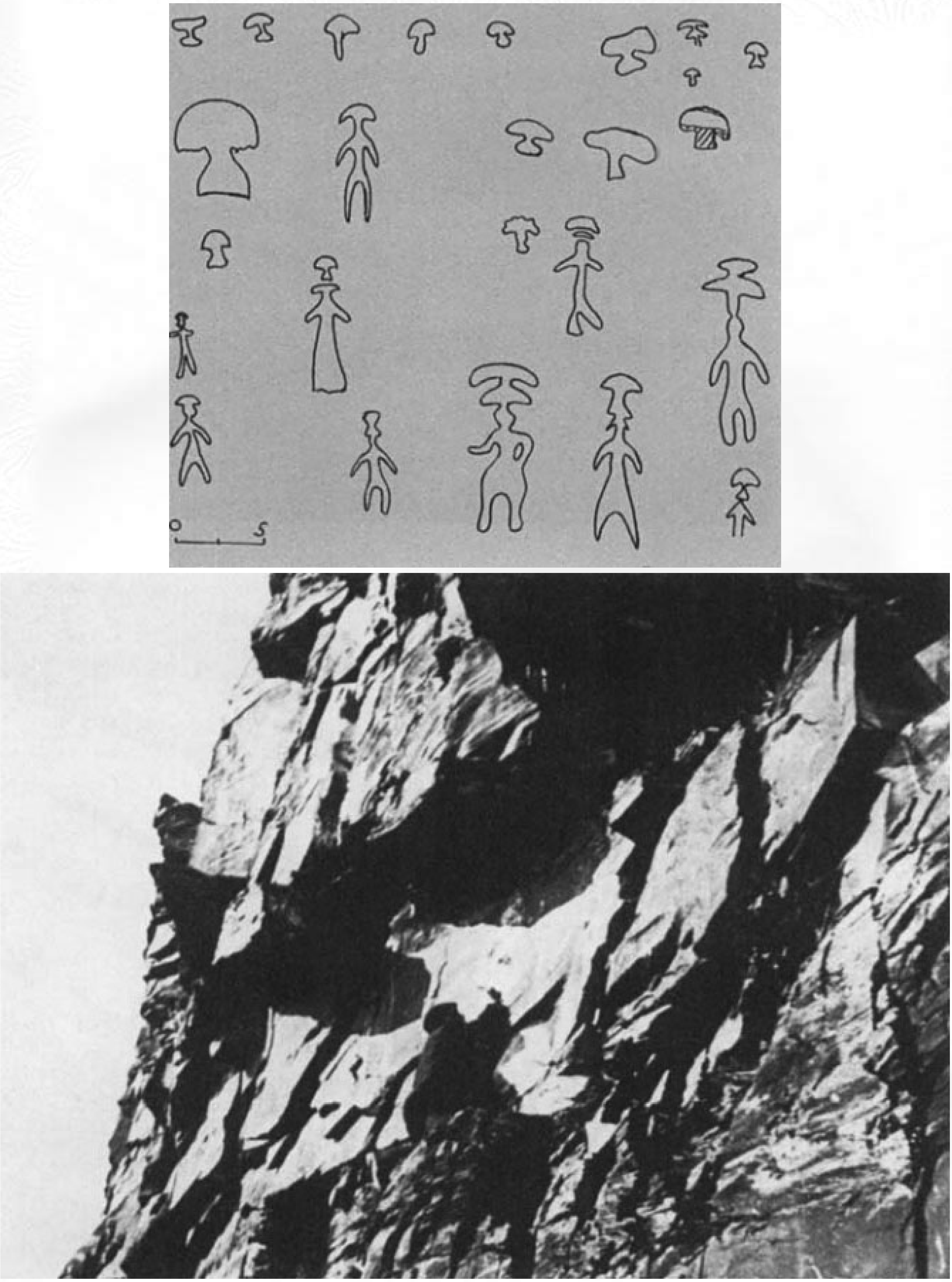


Fig. 13. N. N. Dikov, copying petroglyphs and view of mushroom carvings.

Our sacred mushroom's peculiar virtue was widely known though its identity was perhaps intentionally lost. In Yugoslavia one still says, *Najeo se ljutih gljiva*, 'He has eaten enough of the fool's mushroom'. In Vienna one may hear, *Er hat verrückte Schwammerl gegessen*, 'He has eaten the mad mushroom', though having no particular mushroom in mind... How faint are these dying echoes of the Soma of the Aryans and of the *kakuljá hurakan* of the *Popol Vuh* in the Quiche Maya country!

In the spring and again in the summer of 1967 I visited Dr. János Gulya in Budapest, to consult with him in the field where he is the master, the Finno-Ugrian languages, and especially the Ugrian cluster - Magyar, Khanty, and Mansi. Out of his knowledge of these, to us, remote languages he drew to my attention a usage in Khanty (spoken in the valley of the Ob) that is relevant to our inquiry. The word *tulpanx*[14] occurs in two Heroic Songs in the Khanty tongue, formerly called Ostyak, in one as part of the hero's name, and in the second, repeatedly in the course of the narrative. Professor Gulya explained that '*tul*-' means 'fool' or 'foolish', *panx* meaning of course the entheogenic mushroom, Soma. This serves to nail down the source of expressions that have circulated in past centuries in many parts of Europe, but whose specific sense has long been up in the air. What we strongly suspected is now confirmed.

John Parkinson in his *Theatricum Botanicum* (1640) speaks of the 'foolish mushroom', but he is leaning on his Continental sources. The 17th century Polish poet Waclaw Potochki warns his readers in the *Unweeded Garden* against a kind of mushroom called *szmer*, lest it render the eater foolish (*szale&cacute;*) 'as from opium'. He was passing on hearsay as no mushroom could be confused with opium. A Slovak informant from the Tatra Mountains tells us that rejected mushrooms are variously called by his people *&zcaron;abaci huby*, 'toad mushrooms' (inedible but harmless fungi?), *hadaci huby* and *hadunke huby*, 'viper mushrooms' (deadly mushrooms?), and *šalené huby*, 'mad mushrooms'. To the east of Slovakia, in the Ukraine, the natives call any wild mushroom that they reject *zhabjachyj hyrb* - 'toad-like mushroom'.

Names of Soma that reflect widespread knowledge of its psychic effects are numerous: in France in the Aude the *mijoulo folho*, around Toulouse the *mujolo folo*, in the Aveyron the *coucourlo fouolo*, in distant Trento *ovolo matto*, 'mad mushroom', and across the border in Cataluña, *oriol foll*, 'mad oriol', *oriol* being the name of

---

14. Journal of the Warburg and Courtauld Institutes V.5:159-197, London. My quotation is from p 163. As a source Wittkower's paper is essential reading.

A. caesarea, a delectable species, and *oriol foll* its evil counterpart. They both belong to the same genus *Amanita* and some people confuse them! In Crete, in modern Greek, we have come across a text that speaks of the 'mad mushroom', *trellomanitaria*, inebriating mushroom, probably Soma.

Almost ten years after my *SOMA* appeared I received a letter from a Catalan, a stranger to me, living in Barcelona, by name Josep Barba Formosa. He informed me that in Catalan the phrase is common, *Está tocat del bolet*, 'He is touched by the mushroom', meaning Soma and used precisely as the phrase is used in Austria, Yugoslavia, and Hungary. He attributes it to the refugees who crossed from France *ca* AD 1300, fleeing from persecution in western and southern France ('Occitania') in the course of the bitter religious war against those we generally call the Cathars or Albigensian heretics.

13. 'Happiness Mushroom'

There is one instance of children's verses in Germany that I am at a loss to explain. Everyone born to German learns these verses and they stay with him throughout life:

Ein Männlein steht in Walde	A manikin stands in the wood
Ganz still und stumm.	Stock-still and mute.
Er hat von lauter Purpur	He has of purple pure
Ein Mäntlein um.	mantle around him.
Sag' wer mag das Männlein sein	Say, who may the manikin be
Das da steht auf einem Bein?	Who stands there on one leg?

Alternative ending:

Sag' wer mag das Männlein sein	Say, who may the manikin be
Das da steht im Wald allein	Who stands there in the wood alone
Mit dem purpur roten Mäntlein?	With the purple red mantle?

Children:

Glückspilz! Fliegenpilz!	Happiness mushroom! Fly-agaric!

By a happy though perhaps a fortuitous chance, the answer posed by this riddle:

Say, who may the manikin be
Who stands there on *one leg*?

is our Soma who stands there *auf einem bein, ekap&amacr;d, hurakan*. History is punctuated by ironies, and how ironical it is that a century and more ago, Max Müller, at a loss about the identity of Soma, and all later Vedists, plunged in problems of remote Sanskrit exegesis and Aryan Indian mythology, could have found the answer to Soma by listening to the children playing around their feet in the German world! As for the children's two answers, 'the first is clear, but the second, - *Fliegenpilz*, 'Fly-fungus' - its meaning is two-fold, - for most listeners it means simply the 'fly-killer', but originally, when Albertus Magnus first named and described it, with a pejorative twist, in the 13th century, the 'fly' may well have meant a psychic force. We have written on this at length in Chap. 13 'The Flies in the Amanita', of *Mushrooms Russia & History*.

Could children have originated these verses? I think not. Only adults would devise them. But what adults, and when, and why? Are the verses old, in what recensions? Are there dialectal variants? How far back do the verses go? The tone of the verses runs counter to European prejudices that date back centuries. Who can elucidate these verses? Am I wrong and did some German folk ingest Soma for its psychic powers, but who and when?

14. The British and the 'Nameless Mushroom

The toad and Soma seem to be associated together from earliest times. In China Soma is called the *hama jun*, 'toad-mushroom'. In France there is a dialectal name, *crapaudin*, based on the name of the toad, but which also is Soma. The English 'toadstool' I think originally designated Soma, but the mushroom labored under such fearsome ignominy that the name came to be withdrawn from specific use and to be applied to the whole world of wild mushrooms, and since the English are mycophobes, this satisfied and reenforced their prejudice. Perhaps the most common mushroom and certainly handsomest is without a name - a shameful situation - that makes discussion of the plant difficult for those who do not know its Linnean name. I think I am the first to call attention to this tabu that leaves Soma without a name in English, and certainly the first to suggest that we call it 'Soma1 out of respect for what it has represented for the human race, in the Old World and the New.

15. The Vikings and Soma

Samuel Ödman in 1784 first propounded the notion that the Berserkers' ragings were initiated by Soma. He had not the slightest evidence to substantiate this and none has been produced since then. According to his notion, Soma inebriation was simply a mightier alcohol, and since the north Europeans regardless of class were and are addicted to alcohol and obsessed with it, this explanation of the Berserk raging needed no study: it won the day almost without a fight. In my *SOMA* I demolished this yarn and I now reiterate my position. There is not a shred of historical evidence that the 'rages' were provoked by Soma. Nowhere in the Soma world, neither in the New nor the Old World, is there support for the notion that it made warriors better fighters. On the contrary, the evidence shows that it is a pacifying agent. Soma may have been consumed, and I think it was, by those who lived in Scandinavia, but this was two or three thousand years earlier: *vide* Reid W. Kaplan, 'The Sacred Mushroom in Scandinavia', *Man* (N.S.) 10.72-79. We know not who they were nor what language they spoke. Ödman must have been a mycophobe - all his compatriots were - and he knew nothing about mushrooms.

16. The Tree of the Knowledge of Good and Evil

I once said that there was no mushroom in the Bible. I was wrong. It plays a hidden role (that is, hidden from us until now) and a major one, in what is the best known episode in the Old Testament, the Garden of Eden story and what happened to Adam and Eve.

I suppose that few at first, or perhaps none, will agree with me. To propose a novel reading of this celebrated story is a daring thing: it is exhilarating and intimidating. I am confident, ready for the storm.

I hold that the fruit of the Tree of the Knowledge of Good and Evil was Soma, was the *kakuljá*, was *Amanita muscaria*, was the Nameless Mushroom of the English-speaking people. The Tree was probably a conifer, in Mesopotamia. The serpent, being underground, was the faithful attendant on the fruit. (See my *SOMA*, p 214) Please read the Biblical story in the light of all I have written on the awe and reverence that *A. muscaria* evokes, and how the knowing ones speak of it only when alone together, preferably by night. Gradually it will dawn on you that the 'fruit' can be no other than Soma. Everyone mentions the tree but its fruit is nameless. There were two trees in the Bible story, the Tree of the Knowledge of Good and Evil, whose fruit Adam and Eve were forbidden to eat, and the Tree of Life. Adam and Eve ate of the fruit of the Tree of the Knowledge of Good and Evil, but they were expelled from the Garden to prevent them from eating of the Tree of Life, which would have conferred immortality on them.

Now please read the following text, from the American revision made from the 1611 version, revised by the American Revision Committee in 1881-1885 and again in 1901. I give only the passages that are pertinent for our purpose. I quote from *Genesis*, Chapters 2 and 3.

> Chap. 2.9.: And out of the ground made Jehovah God to grow every tree that is pleasant to the sight, and good for food; the tree of life also in the midst of the garden, and the tree of the knowledge of good and evil. ... 16. And Jehovah God commanded the man, saying, of every tree in the garden thou mayest freely eat; 17. but of the tree of knowledge of good and evil, thou shah

> not eat of it, for in the day that thou eatest thereof thou shall surely die. ... 25. And they were both naked, the man and wife, and were not ashamed.
>
> Chap. 3.1-13: Now the serpent was more subtle than any beast of the field which Jehovah God had made. And he said unto the woman, Yea, hath God said, Ye shall not eat of any tree of the garden. And the woman said unto the serpent, Of the fruit of the trees of the garden we may eat: but of the fruit of the tree which is in the midst of the garden, God hath said, Ye shall not eat of it, neither shall ye touch it, lest ye die. And the serpent said unto the woman, Ye shall not surely die: for God doth know that in the day ye eat thereof, then your eyes shall be opened, and ye shall be as God, knowing good and evil. And when the woman saw that the tree was good for food, and that it was a delight to the eyes, and that the tree was to be desired to make one wise, she took of the fruit thereof, and did eat: and she gave also unto her husband with her, and he did eat. And the eyes of them both were opened, and they knew that they were naked; and they sewed fig-leaves together, and made themselves aprons. And they heard the voice of Jehovah God walking in the garden in the cool of the day: and the man and his wife hid themselves from the presence of Jehovah God amongst the trees of the garden.
>
> And Jehovah God called unto the man, and said unto him, Where art thou? And he said, I heard thy voice in the garden, and I was afraid, because I was naked; and I hid myself. And he said, Who told thee that thou wast naked? Hast thou eaten of the tree, whereof I commanded thee that thou shouldest not eat? And the man said, The woman whom thou gavest to be with me, she gave me of the tree, and I did eat. And Jehovah God said unto the woman, What is this thou hast done? And the woman said, The serpent beguiled me, and I did eat.

Therefore Jehovah God inflicted the penalties for their disobedience: on the serpent, he was to go for evermore on his belly; on Eve, she would suffer the pangs of childbirth; on Adam, he would undergo a lifetime of drudgery. We continue quoting from the text.

> Chap. 3.22-24: And Jehovah God said, Behold, the man is become as one of us, to know good and evil; and now, lest he put forth his hand, and take also of the tree of life, and eat, and live for ever - therefore Jehovah God sent him forth from the garden of Eden, to till the ground from whence he was taken. So he drove out the man; and he placed at the east of the garden of Eden the Cherubim, and the flame of a sword which turned every way, to keep the way of the tree of life.

Adam and Eve became self-conscious from eating the 'fruit' and wove fig leaves into aprons to cover themselves from each other and from Jehovah God. The story carries the mystical resonance of the early days, in Mesopotamia, where grew cedars and other conifers.

Some months ago I read the Garden of Eden tale once more, after not having thought of it since childhood. I read it as one who now knew the entheogens. Right away it came over me that the Tree of Knowledge was the tree that has been revered by many tribes of Early Man in Eurasia precisely because there grows under it the mushroom, splendid to look upon, that supplies the entheogenic food to which Early Man attributed miraculous powers. He who composed the tale for us in *Genesis* was clearly steeped in the lore of this entheogen: he refrained from identifying the 'fruit': he was writing for the initiates who would recognize what he was speaking about. I was an initiate. Strangers and also the unworthy would remain in the dark. Adam and Eve had eaten the 'fruit', being led to do so by the serpent, the faithful attendant on the 'fruit', what the mycologists call *Amanita muscaria*, what the initiates call by a variety of euphemisms, which change from time to time, and we have seen to what strange lengths the uninitiated go when these euphemisms are detached from the 'fruit' that they represent. The priestly redactor who set down the *Genesis* tale, an initiate and a believer, attributed to the 'fruit' the gift of self-consciousness, a remarkable observation because self-consciousness is one of the major traits that distinguish humankind from all other creatures. Is it not surprising that the composer of the story gave credit for this particular gift to our mushroom? It is unlikely that he was alone in doing so.

*

In various places of Eurasia where Early Man has been discovered revering a 'Tree of Life', he is fixing his attention on trees that harbor a mycorrhizal relationship with *Amanita muscaria*, the entheogenic mushroom. The Genesis story introduces an elaboration on this theme. The 'Tree of Life' in it confers on those who eat of it immortality, and Jehovah God, lest Adam and Eve eating of it become his equal, expels them from the Garden. Not surprisingly, no one has ever seen this 'Tree of Life'. But a 'Tree of the Knowledge of Good and Evil' is also introduced and the serpent gave of its fruit to Eve. This was the tree that is usually called the 'Tree of Life'. That Adam and Eve had eaten of its 'fruit' became clear when Jehovah God perceived the change in their behavior: they had acquired self-consciousness, which distinguishes mankind from all other creatures. Being naked in each other's presence and in Jehovah God's, they were embarrassed. They gave themselves away and confessed. They may have become aware of their nakedness, but their self-consciousness was key to far more than that.

Valentina Pavlovna and I were the first to become familiar with the entheogens and their historical role in our society. My discovery of the meaning of the Adam and Eve story came as a stunning surprise. That meaning was obvious. The larch of the Nivkhi (pp 60-62) is the Tree of Knowledge, and there are many species of tree that serve as host to *A. muscaria*. The tree is revered but only because it harbors the entheogen that grows at its base, and the entheogen is far too sacred to mention commonly, and in mixed company.

When my wife and I discovered the magnitude of what was revealed to us, what were we to do? We were profoundly grateful to our Indian friends for having given us their confidence. But, with the swift and thorough expansion of European culture, the few remaining islands of traditional entheogenic use will vanish. Valentina Pavlovna and I resolved to do what we could to treat our subject worthily, devoting our lives to studying it and reporting on it.

EPILOGUE: The Age of the Entheogens

My prime candidate for the earliest religion in the world is the cult that became known to us, much much later, as the cult of Soma. In our woodlands, Soma is one of the commonest of mushrooms, growing wherever conifers and birches grow, as well as with certain other trees. Soma is found also in the Tropics, at an elevation in the forested mountains. In the tundra of the north, it has been reported as living with dwarf birches. Soma is breathtaking in its beauty, both at a distance and close up, and it is fortunately not to be confused with any other mushroom. Soma is the supreme mushroom, and while all mushrooms seem mysterious, Soma is the most mysterious of all. Before mankind existed, our bestial ancestors must have known it: gathering herbs for food, they would have tried it and found it good, and they must have seen other herbivorous fellow creatures do likewise.

At the point in his evolutionary progress where we first call him 'Man' beyond a doubt - *Homo sapiens sapiens* - and when he came to know, also beyond a doubt, what awe and reverence were, he clearly felt that Soma was conferring on him mysterious sensations and powers, which seemed to him more than normal: at that point Religion was born, Religion pure and simple, free of Theology, free of Dogmatics, expressing itself in awe and reverence and in lowered voices, mostly at night, when people would gather together to consume the Sacred Element. The first entheogenic experience could have been the first, and an authentic, perhaps the only authentic miracle. This was the beginning of the Age of the Entheogens, long, long ago.

A little later, someone, perhaps an inspired poet, made the suggestion that the miraculous plant, clothed in radiant raiment, was the fruit of the coitus of the lightning strike in the moist mother earth, and the suggestion was welcomed and adopted by the neighbors, by all the users of the plant, and thereafter spread by descent, by parents to children, a gladly accepted dogma, the first Dogma. From early times there was a subsidiary belief: just as the lightningbolt hit mother earth with a single shaft, it gave rise to offspring with a single leg, not a plant because it had no seed, but a unique creature with a single leg or 'stipe1 and with its radiant raiment, a spark of its almighty father. These beliefs still exist, in their pristine shape in areas where mankind is still far behind the times, and moribund among peasants who are not caught up with their own leaders. These beliefs are very old, antedating the settlement of America from Asia by millennia. They survive out of habit, demonstrating to us how slowly cultures used to change in our previous incarnation.

In prehistory, running back to paleolithic times, many tombs have been found over most of the Eurasian continent, in which the skeletons are covered with red ochre. A plausible explanation is that the cadavers were given ochre burials to express the fervent hope that Soma, the divine mushrooms of immortality, would keep the departed one in their good care. In China, in documents that tell of very old events, there is occasional mention that cadavers are covered with 'leaves'. Western readers are not apt to remember that 'leaves' have in Chinese the additional meaning of *pilei* of mushrooms. Is not this the meaning in those old documents? Any contemporary Chinese would grasp the meaning. Were they the *pilei* of *A. muscaria*?

★

Some Vedic scholars have raised a ballyhoo because we have declared Soma to have been the white-spotted scarlet mushroom. The Aryans were only one of many peoples, scattered world-wide, to have revered Soma, and they enjoy the unique distinction of having developed a cult and a culture surpassing all others in that period for richness and subtlety, a truly memorable religion that we can only admire and study thousands of years later, the flowering of a people not yet possessing an alphabet, who left to posterity a collection of hymns in their tongue - Sanskrit - a tongue that we are proud to say is a collateral ancestor of our European dialects. What an incredible achievement!

When Valentina Pavlovna and I, in August of 1927, started out on our pilgrimage in the Catskills, little did we dream that it would transport us so far. All *Rig Veda* scholars knew much about the *Rig Veda*, but things irrelevant for our purpose, and so when it comes to *A. muscaria*, they must admit that their ignorance is total. They denounce our *SOMA* as 'outrageous' and of course cite Brough's review article in the *BSOAS*. They know the tenor of his argument and did not even need to read it, accepting it enthusiastically on Brough's great authority. I have yet to meet any Vedist who has read it carefully. To approach the subject, one had to know what we now call the entheogens, and I can testify personally that Brough's knowledge of them was nil.

Does 'toadstool' date from before Christianity came to us, and did not 'toad' carry an endearing flavor to our remote ancestors, as it does still in China, and also in the remote areas of Lithuania - the Lithuanians being the last people in Europe to convert to Christianity? The prejudice against *A. muscaria* is so powerful that it has led many writers of mushroom manuals, mostly by mycologists, to say it is toxic, and even sometimes to cast anathemas on it - the distant rumblings of ancient religious disputes. Anyone who undertakes to study soberly its properties is inviting disaster to his career - a strange aberration in the scientific realm, really derived in all likelihood from the religious world.

★

A prodigious expansion in Man's memory must have been the gift that differentiated mankind from his predecessors, and I surmise that this expansion in memory led to a simultaneous growth in the gift of language, these two powers generating in man that self-consciousness which is the third of the triune traits that alone make man unique. Those three gifts - memory, language, and self-consciousness - so interlock that they seem inseparable, the aspects of a quality that permitted us to achieve all the wonders we now know. With our computers we seem ben t on dispensing with human memory as we have known it in prehistory, and even in the modest degree that our parents knew it. I am asking myself whether Soma could have possessed the power to spark what I have called these triune traits.

Rodney Needham of All Souls, Oxford, in 1980 has posed, in an elegant essay *Reconnaissances*, published elegantly by the University of Toronto Press, a problem that bears directly on our work. He draws attention to the wide dissemination of the 'Unilateral Figures' that are scattered around the world, from the Eskimos of the extreme North to the Yamaha of Tierra del Fuego, from the Nahua of Mexico to the folklore of Greece and Romania. He has dealt with a surprising number of instances, far more than I have cited. We reproduce his illustration of a 'Unilateral Figure' taken from Vladimir Bogoraz' opus on the Chukchi published at the turn of this century by the American Museum of Natural History. But Needham never mentions what we call the entheogens nor the supreme entheogen, Soma. If the cultures where Needham finds 'unilateral figures' there was knowledge of the entheogens, here then will be proof that this ancient religion has existed even more widely than I thought: I will be less surprised than overjoyed.

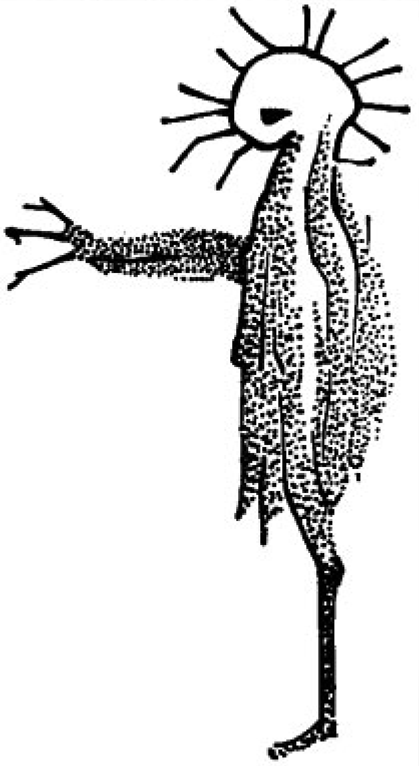


Fig. 14. One-sided man, or 'unilateral figure', or 'halfling': from monograph on the Chukchi by Vladimir Bogoraz, published by American Museum of Natural History in various editions at turn of the century. His 'one-sided man' was republished by Rodney Needham.

After their long and important history, Soma and the other entheogens have disappeared almost without a trace. How odd! The Divinity Schools seem not to know that they exist. Anthropologists have long had contact with them but have not specialized in their study.

Unfinished Business

One quasi-divinity or malign spirit in our world has been Satan. He also is a cripple, either a club- or a splay-foot is his deformity. In Old French Satan was often called simply *le bot*, now-a-days usually heard in the form *pied bot*, 'club foot'. *Le bot* served also for 'toad' and 'a mushroom'! Mark you, 'a mushroom'. Not any mushroom. Was the French lexicographer unsure of the species, or did he possess no name for it, or was he inhibited by the same tabu that the English and most other West Europeans felt and feel, and so he refrained from saying it was what the French today call *le crapaudin*, or '*la fausse oronge*', as well as '*le tue-mouche*', and what we call Soma? How odd it would be if here we come, once more, upon One-Leg: *ekap&amacr;d*, *hurakan*, *auf einem Bein*, in our familiar Satan! If so, when and how did he inherit (or usurp) this most ancient honor (or stigma)? Must we entertain the notion that by a prodigious feat of prestidigitation, acting true to character, he arrogated to himself the attributes of the Almighty Lightningbolt?

This may be only an aberrant idea of mine, but I think it is worth pursuing: why is Satan a Single-Foot?

CHAPTER TWO

Lightningbolt and Mushroom [1]

by R. Gordon Wasson

The inquirer who turns to Littré to learn about truffles, on reading the entry under *truffe*, comes upon a nugget of curious information that certainly fails to catch his attention. It seems in certain regions of France (presumably there where truffles abound) the country folk in thundery weather are wont to say, *Voilá un ban temps pour les truffes*, 'What fine weather it is for truffles!' Why in thundery weather? Not when it rains, mind you, but when it thunders. Nothing in Littre alerts the reader to the mystery that here lies hidden. The saying of these French rustics seems to be one of the surviving traces in Europe of a belief that reaches back in time deep into prehistory and in space wherever Eurasians or their descendants have lived. It is the end of Ariadne's thread that we propose to follow far and to a far-reaching end.

Pliny the Elder declared that truffles were disposed to grow in the time of autumnal rains, and above all (in the full-bodied Elizabethan translation of Philemon Holland) 'if the aire be troubled and disquieted with many thunders: during that season there will be good store of such Mushromes, etc, especially (I say) if it thunder much':

> *De tuberibus haec traduntur peculiariter: Cum fuerint imbres autumnales, ac tonitrua crebra, tunc nasci, & maxime e tonitribus.* [*Hist. Nat.*, Bk 19:37]

When Philemon Holland around 1600 rendered *tuberibus*, 'truffles', by 'mushromes', the word 'truffle' and the plant it represents were as yet unknown to the English-speaking world.

Juvenal wrote of the longed-for thunder in springtime [*sic*] that replenishes the table with truffles:

> *Post hunc tradentur tubera, si ver tunc erit et facient optata tonitrua cenas maiores.* [*Satire V*: 116-118]

Strange: Juvenal speaks of tables laden with truffles in springtime, associated in men's minds as this season is with frequent thunderstorms. But in Italy truffles come in the fall and early winter until February. What was Juvenal thinking of? Was he conforming to a popular belief at the cost of doing violence to nature? Pliny had spoken of autumnal thunder-showers, adhering to the right season.

The *tuber* was an underground fungus, apparently embracing all species of both truffles and the genus *Terfezia*. The many species of *Terfezia* are often confused by travelers in the Mediterranean and Near East with truffles, but *Terfezia* and truffles, though both of course fungi, belong to different families, not merely distinct species. *Terfezia* flourish in the arid areas around the Mediterranean and eastward, and when classic writers refer to the Libyan truffles as especially good, they are speaking of *Terfezia*. In Greek the *tuber* was the *hydnon*, and Plutarch, in an essay now virtually forgotten, asked why people said thunder made the *hydnon* to grow. He asked why, not whether, the thunder made them grow, apparently accepting the fact, and he found no sure answer.[2] There was an underground fungus that the ancient Greeks called the 'lightningbolt' - *keraunion* - was it an alternative name for the *hydnon*? In Thrace *keraunion* was called the *oiton*: this word is a dialectal variant of *hydnon* and the mushroom presumably the same. Athenæus, writing in the third century after Christ, quotes Theophrastus five centuries earlier on these Thracian fungi:

> Concerning these a singular fact is related, *viz*, that they grow when autumn rains come with severe thunderstorms; the more thundering there is, the more they grow, the presumption being

---

1. In 1956 I published 'Lightningbolt and Mushrooms: An Essay in Early Cultural Exploration' in a Festschrift: *For Roman Jakobson* (Mouton, The Hague) on his 60th birthday. It was my first paper on ethnomycology, a discipline that I founded. Here is that same paper, revised, reworked and shortened.
2. Plutarch's *Moralia*, *Table-talk* IV, Question 2. Loeb Classical Translations, Vol VII, p 316ff.

> that this is the more important cause. [*Deipnosophists*, Loeb translation, Bk 11:62]

(Theophrastus did not make Juvenal's mistake: he adhered to *autumnal* thunderstorms.) In ancient Greece and Rome we have to do with a notion that everyone accepted, a cliché, perhaps a tiresome conversational tag. 'It's not the rain, it's the thunder that makes them grow,' people would say, just as today in summer the New Yorker insists, 'It's not the heat, it's the humidity.' Did the Greeks and Romans arrive at this belief, which for them pertained to underground fungi only, by observing nature? The answer to this question had best be deferred until we have completed our pilgrimage throughout Eurasia and the lands to which in prehistory the Eurasian tribesmen emigrated, to wit, Polynesia and the New World.

This essay on its first appearance in 1956 prompted our friend Georges Becker, gifted *savant* and humanist of the countryside of eastern France, to recall an ancient belief surviving in and around his native village of Lougres: the people there hold that *Boletus satanas* and *Boletus luridus*, as well as those other species of mushrooms that turn blue on breaking, grow where lightning has struck, around isolated trees in meadows. Furthermore, he had a friend, an aged countryman, who often gave utterance, in the patois of Lougres, to an old saw:

> *Lou mâ temps, c'â lou bon temps des craipâs et pe des tchampégnôs*. (*L'orage, c'est le bon temps pour les crapauds et les champignons*.) (Thunderstorms are good weather for toads and mushrooms.)

The saying hides a pun: in the local dialect *mâ temps* means both 'bad weather' and 'thunderstorm' and therefore what is 'bad weather' for human beings is 'good weather' for toads and mushrooms.

The Piedmont in Italy is preeminent in that country for mycophilia, and immense quantities of fungi are marketed there and consumed. The towns of Alba and Cuneo are especially noted for their 'white truffles' (*tartufi bianchi*), *Tuber magnatum*. The reader will recall the classic tradition that links thunder with truffles. But in the Piedmont, strange to say, the 'thunder-mushroom', *trun*, (in Piemontese, 'thunder') is not the *tartufo bianco*. It is any market *Lactarius*, the common species being *L. sanguifluus* and *L. deliciosus*.

Among the English I have not yet found any trace of the ancient belief in a tie between mushrooms and thunder, but there is one quotation on the subject that should be carefully read. On 2,2. February 1774 Sir Alexander Dick, a retired physician, wrote to James Boswell a letter from which I will extract one sentence:[3]

> While I was at London, I alwise found plenty of Mushrooms at Covent Garden, good & reasonable during the Summer Season - this was the year 1760 and made Dr. Armstrong, quite of my opinion, who partook frequently of my Mushroom breakfasts - and *as Mushrooms often arise from Lightning, when they came well dressed to table we used to stile them Ambrosia*...

I have italicized the ending. I feel fairly confident that this reference to mushrooms and lightning goes back to ancient Greece and Rome, rather than the Anglo-Saxons or ancient Britons. Dick was the educated 18th century Englishman, thoroughly grounded in the classics. Mushrooms in his mind were linked to lightning and ambrosia was also; whence the playful association of mushrooms and ambrosia.

From our citations we see that the linking of thunder with mushrooms is not with *all* mushrooms but only with this kind or that, and the kind changes according to the region. In the temperate zone thunder is associated primarily with spring and early summer, but truffles are a product of the fall and early winter. Of course thunder *in spring* might produce truffles *in fall*, but no where in the classic sources is such a sophisticated idea hinted at. (Later we shall see that this very belief is actually entertained by the Bedouin of the Arabian desert.) While thunderstorms of course occur at all seasons, even in mid-winter, is it not odd that in classical times people sometimes linked springtime thunder and truffles? This bad fit in the popular belief must have been what led Juvenal and a few late writers to assert that the best truffles, contrary to fact, come in the spring. For example, Franciscus Marius Grapaldus in his *De Partibus Aedium*, *ca* 1492.:

---

[3] By courtesy of the Editorial Committee of the Yale Editions of the Private Papers of James Boswell, New Haven, Conn.

> ... But truffles (= *tubera*) the pigs root out of the earth with their snouts. Truffles are surrounded on all sides by earth, without roots, neither thickly growing in [one] place nor cracking out among the dry and sandy thickets. [They] are to be called certainly nothing other than flesh of the earth. *Best at spring and more often during thunder, they are said to arouse dying love*. [Book II Chap. 3, italics mine.]

Grapaldus was forcing nature into the Procrustean bed of Juvenal's text and the popular belief.

The Germanic world yields us one pleasant citation associating mushrooms with thunderstorms. The Rev. Robert B. Reeves, Jr., Chaplain of the Presbyterian Hospital in New York, wrote me 9 March 1960 these words:

> In Harrisburg, Pa., where I lived from 1915 to 1923, my mother employed a Mrs. Tetzer, who was 'Pennsylvania Dutch', to bake Christmas cookies and help with the fall and spring housecleaning. She was full of country lore and would hold us children in fascination around the kitchen table or the stove, talking as she worked. One of the things she told us was that the time to gather mushrooms was after thunderstorms; that we should watch for the lightning, notice carefully where it struck, for wherever the lightning entered the ground mushrooms would spring up. These were the only kind that were fit to eat. The others, that grew without benefit of lightning, were toadstools and poisonous.

The Pennsylvania Dutch are descended largely from pioneers who hailed from the Palatinate. I have had no opportunity to take soundings there.

Many Polish and Czech friends of the recent emigration speak of a folk belief in their countries tying the growth of mushrooms to thunderstorms, but I have yet to find an informant who can pin down these beliefs in specific fashion. Similarly Ivan Sechanov, the Bulgarian mycologist specializing in the higher fungi, writes me that the Bulgarians link mushrooms with lightning, 'especially *Morchella* spp. and some others.' Probably field work in the west Slavic countries and in Bulgaria would yield more evidence than I present here.

The Great Russians, who know by cultural inheritance incomparably more about mushrooms than the classical writers did, call a particular kind of rain *gribnoj dozhd*', 'mushroom rain'. Mushrooms, they say, come after a warm and steady and gentle rain, emphatically not the quick, violent, driving rain that we associate with thunderstorms. This 'mushroom rain' of the Russians leads to the growth of all kinds of mushrooms proper to the season, and mycologists agree with the Russians. For the Russians *gribnoj dozhd*' is a term used often to describe a particular kind of rain, even when mushrooms are not under discussion.

Roman Jakobson has drawn my attention to an obscure book by S. V. Maximov entitled *Lesnaya Glush*', 'The Backwoods', published in St. Petersburg in 1909, in which the author dwells lovingly on the customs and beliefs that survived in the remote and impoverished village of Parfentief, some 300 miles northeast of Moscow. The villagers there were much given to mushroom-gathering and every year with the spring thaw an ancient of the village, Ivan Mikheich, would celebrate the event with a feast of morels. At that banquet without fail the host would explain, as a prelude, that the morel was good to eat only before the first thunder of spring. Thereafter, according to him, a snake would inject venom into the mushroom and cause it to rot and disappear. Only three times in his life had he heard thunder before trying out the fresh morels.... In the story of Ivan Mikheich the two essential elements are present, the thunder and a kind of mushroom. But here in the East Slavic world, far distant in time and space, our episode takes on a reverse twist. The morel is of course a springtime mushroom and thereby Ivan Mikheich avoided the uncomfortable discrepancy of Juvenal and Grapaldus. But with him the role of the thunder, while it is still vital, is unfavorable to the fungi. It casts an evil spell on them, and works hand in glove with the serpent, who now enters the scene for the first time.

The late Professor Georg Morgenstierne of Oslo has pointed out to me how widespread even now is the belief in our myth on the other side of our Indo-European world. He quotes an informant in Persepolis as saying that the *dumbal&amacr;n* are thought to grow in the desert after lightning;[4] *dumbal&amacr;n*, literally 'sheep's fries', is apparently the name given to an underground species of *Terfezia*.

In Tadzhikistan, around Match and in the Yaghnob Valley southeast of Samarkand, Iranian dialects are spoken that come down from the ancient Sogdian language. In those two regions the belief persists that the thunder comes when the sky-borne divinity known as *Mama*, 'Grandmother', shakes out her bloomers, and then from her bloomers lice tumble down to earth, and from the lice springs up a crop of mushrooms.[5] (A similar belief about the genesis of mushrooms from the shaking of old furs is reported from the neighboring Turkic peoples.) At the thunderclap the children around Match cry out: *Puri*, *puri*, *xor&ccaron;*, *puri* being the name of a plant, an annual, whose identity we do not know, and *xor&ccaron;* being the word for the mushroom. There is reason to think *xor&ccaron;* is the specific name of *Pleurotus fossulatus*; if so, *puri* must be a dead umbellifer, its saprophytic host. In the Yaghnob Valley the children's cry is different: *Katta xar&ccaron;ak man, pullja xar&ccaron;ak tau*, which is to say, 'The big mushroom is mine, the little one yours.' How enigmatic and tantalizing are these odd bits of our popular belief discovered in the heart of Asia! Perhaps they will fall into place as our pattern takes shape.

In the east of the Pashto-speaking area of Afghanistan the *zməkəy goša*, 'earth meat,' grows 'with the first roar of thunder accompanied by rain.' This mushroom is certainly a morel, called by the Uzbeks in their Turkic language *qozaqarni*, 'baby lamb's belly,' and they too link its appearance with spring thunder and rain. In Farah, in the southwest, Pashto speakers associate thunder with a mushroom called *gobalakə*, whose identity I do not know but by the description given me think it is *Phellorina* sp. At Bargramatal, a town in the northeast of Afghanistan, in the Hindu Kush where they speak the ancient Katei language, an informant told us of a mushroom, *gokluk*, that he said was produced in spring by thunder. He drew it and his drawing strongly suggested *Coprinus comatus*.[6]

In Kashmir certain edible gilled mushrooms known in Kashmiri as hedur and *h&ecaron;nḍa* are supposed to emerge after thunder, but this belief attaches above all to the morel, called locally *kana-g*^{ü}*ch*, 'ear-mushroom'. The Kashmiri do not go out looking for morels until there has been thunder. They are clear about this, and also that the morels are powerful aphrodisiacs, to be eaten at weddings, if you can afford them. I gathered this information from Kashmiri informants when I was in Srinagar in April 1965. Even more interesting are the verses in the Sanskrit lyric *Meghad&umacr;ta*, 'The Cloud-Messenger', composed c AD 400 by *K&amacr;lid&amacr;sa*. In verse 11 the exiled *yaksha* or demigod addresses the raincloud drifting northward over India: 'When they eagerly hear thy sweet-sounding, fertilizing thunder, which can cover the earth with mushrooms...!' The *thunder* covers the earth with *mushrooms*! In the heart of this mycophobic Hindu people we find an outstanding poet giving voice to the same notion that we find elsewhere. But he does not suggest that the *mushrooms* replenish the tables: for upper caste Hindus, mushrooms are tabu. Here 'mushroom' is *&sacute;il&imacr;ndhra*, a puzzling word of odd aspect that Professor Morgenstierne thinks was probably borrowed from some pre-Sanskrit language of India. From a variant of the poem it is clear that a mushroom with pileus was meant, and one lexicographer says that this mushroom was linked with cow-dung: these hints may point toward *Stropharia cubensis*. The ending *-dhra* could mean 'carrying' and *&sacute;il&imacr;-*, a rare and doubtful word, might mean a worm or a female toad. Such clues, having little weight by themselves, may become clothed with meaning in the context of other evidence. We recall that in India Hindus of the three upper castes are forbidden by their religion to eat mushrooms of any kind.

Now let us look beyond the confines of the Indo-European world.

---

4. *BSOAS*, 1957, XX, p. 453. I take this oppormnity to express my gratitude to Professor Morgenstierne for his help and counsel throughout my inquiries. His specific help mentioned in divers places in this paper does not begin to repay my indebtedness to this great scholar.
5. The Tadzhik and Yaghnob references appear in M. S. Andreev's 'Po Etnografii Tadzhikov,' a contribution in *Tadzhikistan, sbornik statej*, a volume edited by N. L. Korzhenevskij and published in Tashkent (1925), pp 172-3, which we consulted. Heinrich F. J. Junker uses the material in *Arische Forschungen: Yaghnobi-Studien*, I, p. 106 (= *Abhandlungen d. philol.-hist. Klasse d. sächsischen Akademie d. Wissenschaften*, Band XLI, No. 2, Leipzig, 1930.)
6. For the Afghan fungal vocabulary I am indebted to M. Ch. M. Kieffer, the Alsatian specialist in the Afghan languages, for an

invaluable 26 page memorandum prepared on my instigation in March 1965.

In a personal letter to me dated 27 May 1950, Colonel H. R. P. Dickson, author of *The Arab of the Desert* and an outstanding authority on the life of the Bedouin, confirmed that the Bedouin are great lovers of *Terfezia*. He said that in the season of the *wasm* (October to early November) they look for heavy rains accompanied by *thunder and lightning*, and if the weather is propitious then, they know that some months later, in February and March, *Terfezia* will abound, and when the days are fulfilled, then the black-tent folk strike their tents and make their way across the desert to the places where grows the rugrug bush, known to botanists as *Helianthemum lippi*, for the *Terfezia* thrive close by this plant. Then at dawn and dusk, by the horizontal rays of the sun, the women and children and shepherds detect the shadows cast by the slight monticules caused by the swelling underground fungi, and gather them, and every one feasts on them.... There is a metaphorical expression for a fungus found in a dictionary of classical Arabic,

بَنَاتُ الرَّعْد

BAN&Amacr;T^{U}'R-RA'D', 'the Daughters of Thunder', but we are left in the dark as to the species so designated. It might be a name for the *Terfezia* that Dickson speaks of.

In India around Mysore, in Dravidian country, the thunder is said to be linked to the appearance of species of the genus *Phallus*. In the Northeast of India the Santal, an aboriginal tribe living on the western fringes of West Bengal, in eastern Bihar and in northern Orissa, call certain mushrooms *putka*, and the mushrooms so named grow always after thunder: so the Santal tell us. The mushrooms called *putka* are a *Scleroderma*, and also a false putka that is a puffball.

In Tibet by far the most popular mushroom is the *ser sha*, 'yellow flesh'; it is reputed to grow after thunderstorms. Despite our strenuous efforts we have failed to obtain a specimen of this mushroom and it remains unidentified. A painting of this mushroom in the Kew mycological collection was repudiated emphatically by my Tibetan friends in India.

Now let us turn to the Chinese. There came into my possession in 1951 a copy of a handwritten work in eight volumes on ethnomycology entitled in Japanese *The History of Mushrooms*, dated 1811 and composed by Karashi Masujima, who wrote under the pen names of Ranen, 'orchid garden', and Gushá, 'the fool.' (In choosing his field of research he preceded the Wassons by a century and a half!) He was a Japanese scholar teaching in Yedo at the school for samurai called Shoheiko. In this book are discussions of three kinds of Chinese mushrooms linked with thunder by the people of Suzhou and the Province of Juangzhou:

雷驚蕈	雷聲菌	雷菌
leijing xun	*leisheng jun*	*lei jun*
Thunder-aroused Mushroom	Thunderbolt Mushroom	Thunder Mushroom

The description of these mushrooms is insufficient for identification, but they all grow above ground. The three names may be variants for a single species. There is no reason to suppose that the thunder myth was confined to Suzhou and Juangzhou Province. When I was in Taiwan and Hong Kong in 1964-1966 the thunder association was commonly attributed to species of *Termitomyces*, a delectable table mushroom. The late Professor Roger Heim, the famous French mycologist and a gastronome, ranked them first among the edible mushrooms of the world. In the Philippines the mycologist José Miguel Mendoza reports in his *Philippine Mushrooms*[7] the common native belief throughout the islands that thunder and lightning cause the generation of mushrooms, and in the spring of the year, when people hear the thunder roll, they rush into the fields to gather the edible kinds. In the Pampango tongue, spoken in central Luzon, *Termitomyces albuminosus* (Berk.) Heim (formerly *Collybia albuminosa*) is called *payungpayungan kulog*, where the first element means 'parasol-like' and *kulog* is the word for thunder in both Tagalog and Pampango. This undoubtedly reflects the native

[7] Published in *The Philippine Journal of Science*, LXV, Jan.-April 1938.

belief to which Mendoza refers. I am told that the same association with thunder exists in Kyushu and the Ryu Kyu islands. The termites build their nests there and the farmers rate the termite-mushrooms highly. These offshore manifestations might easily mark the spread of a Chinese concept.

The thunder association of particular species of mushrooms runs all through the mycological writings of the Chinese. It seems to be more prevalent there than anywhere else. The sclerotia of *Omphalia lapidescens* Berk., which grow in Southern China as pellets of little balls on the roots of bamboo trees, are called 'thunder-balls' 雷丸, *lei wan* in Chinese or *raigan* in Japanese, and they were esteemed in Chinese medicine. The knowing-ones must have believed them to be aphrodisiacs. These balls were so highly regarded that the Japanese emperor Sh&omacr;mu in the middle of the 8th century, when he and later his widow K&omacr;my&omacr; created the Sh&omacr;s&omacr;in Temple in Nara, depositing in it all the treasures that he most prized, included in the collection some of these sclerotia.[8] At that time the Japanese Court was under strong Chinese influence and the 'thunderballs' had probably been imported from Southern China. In China the famous *ling zhi* 靈芝 'divine mushroom of immortality', has occasionally been called the *lei zhi* 雷芝, 'thunder zhi'.[9] In that idyllic text, *The Mushrooms of Wu*, 吳蕈譜 *Wuxun pu* written by Wu Lin 吳林 shortly after 1662 and published in 1703, in which the author dilates with love on the rich mushroom life of the countryside around his native village of Wu, the beneficial effect of thunder on certain mushrooms figures conspicuously. Let it be noted that in China, as well as elsewhere, the role of thunder always applies to particular species, never to the fungal world as a whole.

Now we shall shift the scene to Madagascar, where the indigenous cultures are dominantly Malayo-Indonesian, Professor Heim has reported an extraordinary practice of the Tanala people there.[10] They dry and convert to powder the giant sclerotium (known to mycologists as *Pachyma cocos*) of the mushroom *Lentinus tuber regium* Fries, on which the Tanala people bestow the name *olatafa*. Then when a thunderstorm of fearful violence breaks, the natives quickly put some of the powder moistened with water into their mouths, and as the lightningbolt streaks by, they spit forth the fungal paste into the teeth of the storm crying *Fotaka*! or else *Fotaka malemy*!, which is to say, 'Earth!' or 'Soft Earth!' The word *olatafa* appears to be related to *tafa*, meaning 'unbalanced' - a startling association of ideas, as we shall soon see. Professor Heim goes on to say that neighbors of the Tanala people in Madagascar - the Betsimisarakas, the Antimoros, and the Tsimihety - also make use of the *Lentinus tuber regium* to protect themselves against the fury of lightning, but they merely spread around them, on the ground, the dried powder of the sclerotium at the moment when the thunderstorm develops a frightening intensity. These three peoples like the Tanala speak languages of the Malayo-Indonesian family. Recent linguistic studies have indicated that they broke away from their kin in Southeast Asia before the Hindu influence made itself fully felt there, certainly before the 4th century AD,[11] perhaps much earlier.

The Maoris of New Zealand, pure Polynesians, possess the thunder link with mushrooms. In the Maori language *whatitri* means 'thunder'. *Whatitiri* is a female ancestor of the Maori race. Her son (or grandson) Tawhiki was linked with lightning, which flashed from his armpits. In 1963, when I was in New Zealand, Kiri Maniapoto, a Maori woman of Rotorua, told me (and I paraphrase what she said) that when it thunders, the Spirits are defecating, and the turd falling to earth is the *tutae whatitiri*, the fungus ball that quickly expands into the strange, the astonishing, net- or basket-fungus common in New Zealand and called by mycologists the *Clathrus cibarius* (Tul.) Fischer. *Tutae* means 'faeces'.

---

[8] At the end of the second World War in the wake of the Japanese defeat these treasures were opened for inspection, and a few of the 'thunder-balls' were shown to a leading Japanese mycologist, Yoshio Kobayashi, on the staff of the Ueno National Science Museum. He confirmed their identity, twelve centuries after they had been deposited.

[9] The Chinese *ling zhi* has been identified as *Ganoderma lucidum* by two Japanese mycologists, Iwao Hino in 1937 and Rokuya Imazeki in 1939. See *Transactions* of the Asiatic Soc. of Japan, 3rd series Vol. 11, 'Mushrooms and Japanese Culture', by R. G. Wasson, p 10; 'Japanese Mushroom Names', by Rokuya Imazeki, p. 40.

[10] 'L'Olatafa', by Roger Heim, published in the *Archives du Muséum National d'Histoire Naturelle*, Volume du Tricentenaire, 6^{e} Serie, Tome XII, 1935.

[11] S. Thierry: 'A propos des emprunts sanskrits en malgache', *Journal Asiatique*, Paris, 1959, pp 311-348; Louis Molet: 'L'Origine des Malgaches', *Civilisation Malgache*, Tananarive, 1964, Série Sciences Humaines No. 1, Faculté des Lettres et Sciences

Humaines, Université de Madagascar.

★

In the course of my inquiries I have found only one chlorophyll-bearing plant linked to thunder or lightning: the mistletoe, - like the mushrooms, linked with religion.

My survey of the evidence is certainly not exhaustive. It comprises the documentation gathered intermittently by one man over a few decades. There must be many variants that I have missed. I have dealt only with the peoples of Eurasia and their offspring, the Polynesians. In black Africa I have taken soundings among the Baganda of Uganda, the Ibo and Hausa, and Fulani (= Peul) peoples. The results were wholly negative. If this prove true of all the peoples of black Africa, it would localize the origin of the myth in Eurasia. The Kumá people in the Wahgi Valley in the center of New Guinea know nothing of a fungus-thunder tie, though their empirical knowledge of the higher fungi is impressive.

An intelligent observer in Eurasia familiar only with the folk beliefs of his own area might naturally conclude that the local notion linking thunder with a particular species of mushroom derived from a subtle observation of nature on the part of his countrymen. But faced with the diversity of beliefs in various parts of the Eurasian world, he would have to pause and admit that the natural causes must be remote and involved. He would observe that except in two or three places such as Madagascar and the Maoris of New Zealand, the survivals are mere verbal fossils: nothing is left of them save a phrase repeated out of habit, thoughtlessly.

Our survey of the fossilized myth shows that in different regions it is linked with species of some fifteen genera:

Boletus
Clathrus
Coprinus
Lactarius
Lentinus
Morchella

Omphalia
Phallus
Phellorina
Pleurotus
Terfezia
Termitomyces

Tuber (This includes the black truffle of Périgord and the truffle esteemed by the Romans, perhaps the *tartufo bianco* of contemporary Italy.)

Scleroderma
Lycoperdon
{ thunder-engendered mushrooms called *putka* among the Santal of India

and the genus represented by the unidentified Tibetan *ser sha*. The species include inedible (*eg*, *Phallus*, *Clathrus*) as well as edible kinds, and the myths show a wide variety in the details of the folk beliefs, the most elaborate of the myths being found among the Tadzhiks, the Tanala of Madagascar, and the Maori of New Zealand.

In every instance there is one common denominator: the link between a designated species of mushroom and the thunderbolt.

Of a belief associating mushrooms generally, regardless of species, to thunderstorms, we have found evidence in only two regions, both in Europe. In France, apart from the specific associations that I have already noted, belief in the favorable influence of thunder showers on the growth of mushrooms is widespread, as it seems also to be in Poland and Bohemia. Further inquiry on the ground would probably bring out added details corresponding to those we have found elsewhere. In the temperate zone thunder and lightning come mostly in spring and early summer though not exclusively, and mushrooms in late August and September, and the mythic belief makes no effort to reconcile this contradiction.

As for the mycologists, when confronted with the many faces of this belief, they offer no help in explaining them.

CHAPTER THREE

The Mah&amacr;v&imacr;ra Vessel and the Plant P&umacr;tika

by Stella Kramrisch[1]

The Mah&amacr;v&imacr;ra vessel is an anointed, empty earthen pot glowing red hot in the sacrificial fire. Its function, in the first and original part of the Pravargya rite of which it is the center, is symbolic. It is only in the second and subsequent parts of this rite that the vessel will be filled with milk, that it will be replete with perceptible contents.

Pravargya means that "which is to be put on the fire," *viz*. the Mah&amacr;v&imacr;ra vessel. In the later Vedic age, in the White Yajurveda, the Pravargya sacrifice had been combined with the Ṛg Vedic Soma sacrifice, the Pravargya being performed just before or at the beginning of the Soma sacrifice. Myth and ritual of the two sacrifices were coordinated in one configuration. The head of this configuration is called the Head of Makha.

The Head of Makha of which the Mah&amacr;v&imacr;ra vessel (*ukh&amacr;*) is the symbol, is the main and central sacred object of the Pravargya sacrifice. The vessel is made of clay to which four other ingredients are added. P&umacr;tika plants are one of them and their significance is paramount in the myth and ritual of the Head of Makha. The Pravargya sacrifice requires a special initiation over and above that of the Soma sacrifice and it must not be performed by one who for the first time offers a Soma sacrifice (&Sacute;B.14.2.2.44-46; &Amacr;p.&Sacute;S.15.20-21).

The Secret of the Cut-off Heads

The myth of the Mah&amacr;v&imacr;ra vessel is told in several versions, that of the &Sacute;atapatha Br&amacr;hmaṇa being the most exhaustive:

> The Gods, Agni, Indra, Soma, Makha, Viṣṇu, and the Vi&sacute;ve Dev&amacr;ḥ perform a sacrificial session in Kurukṣetra in order to win glory. They agree that whoever amongst them through austerity, fervour, faith, sacrifice and oblations would first encompass the end of the sacrifice would be the most excellent among them and the glory should then be common to them all. Viṣṇu obtained it (&Sacute;B.14.1.1-5).
>
> Viṣṇu is the sacrifice. But Viṣṇu was unable to contain the love of glory of his (&Sacute;B.14.1.6).
>
> Taking his bow with three arrows he stepped forth and rested his head on the bow. Then the termites of the Upad&imacr;ka kind gnawed the bowstring, it was cut, the ends of the bow springing asunder cut off Viṣṇu's head (&Sacute;B.14.1.1.7).
>
> It fell and became the Sun. The rest of the body lay stretched out with the top towards east (&Sacute;B.14.1.1.10).
>
> The gods said: Our all-encompassing hero (*mah&amacr;n-viraḥ*) has fallen. Therefrom the Mah&amacr;v&imacr;ra vessel was named, and the vital sap (that flowed from him) they wiped with their hands (*sam-mṛj*). Whence the Mah&amacr;v&imacr;ra is the Samr&amacr;j (the emperor) (&Sacute;B.14.1.1.11).
>
> The gods rushed forward to him, Indra applied himself to him, limb to limb, engulfed, encompassed him and became possessed of his glory [*ie* of that of the headless Viṣṇu] (&Sacute;B.14.1.1.12).
>
> The gods went on worshipping with that headless sacrifice (&Sacute;B.14.1.1.17).

---

1. The Philadelphia Museum of Art and The Institute of Fine Arts, New York University.

> Dadhyañc Atharvaṇa knew this pure essence (the Madhu, the sweet [and secret] knowledge of the Pravargya), how the head of the sacrifice is put on again; how the sacrifice becomes complete again (&Sacute;B.14.1.1.18 [*cf* 4.1.5.18]).
>
> Indra threatens to cut off the head of Dadhyañc if he divulges the secret to anyone else [for Indra had obtained only the glory of the headless body.] (&Sacute;B.14.1.1.19).
>
> The A&sacute;vins hear this and offer themselves as disciples to Dadhya&ncaron;c (&Sacute;B.14.1.1.20).
>
> Dadhyañc refuses them, fearing Indra would cut off his head (&Sacute;B.14.1.1.21).
>
> However the A&sacute;vins promise to protect Dadhyañc by the following scheme: when Dadhyañc would receive them as pupils they would cut off his head and replace it by a horse's head. Dadhyañc will teach them through a horse's head - which head Indra will cut off. Then they will replace Dadhyañc's own head (&Sacute;B.14.1.1.22-24).
>
> Dadhyañc &Amacr;tharvaṇa with a horse's head taught them the sweet [secret] (&Sacute;B.14.1.1.25).

The god who does not honour an agreement and arrogantly keeps to himself the glory he undertook to share with the other gods is beheaded by his own bow. The decapitated god is Viṣṇu, in the &Sacute;atapatha Br&amacr;hmaṇa. His name is Makha in the T&amacr;ṇḍya Br&amacr;hmaṇa while in the Taittir&imacr;ya &Amacr;raṇyaka he is called Makha Vaiṣṇava.[2] He is also called Makha Saumya (in &Sacute;B.14.1.2.17). Viṣṇu and Makha are equated, they are one person for Viṣṇu is the sacrifice (&Sacute;B.14.1.1.6) and Makha is the same as Viṣṇu (86.14.1.1.13). Viṣṇu is particularly the Soma sacrifice.

Except in the above story, Makha does not figure amongst the gods. Makha's head however is invoked in Taitt.S.1.1.8. and it is the very center of the Pravargya sacrifice. Makha's head means the Sun (&Sacute;B.14.1.1.10) and has for its symbol the Mah&amacr;v&imacr;ra vessel. Mah&amacr;v&imacr;ra is here being translated as 'all encompassing hero,' with reference to the sun,[3] but also with regard to Makha whose cutoff head is restored by the Pravargya ritual to the sacrifice.[4] Makha, in the &Sacute;B. is the deific name of the sacrifice.[5] The Sacrifice had its head cut off. Its headless body lies prostrate. This fallen hero is reconstituted by having his head sacrificially joined by the Pravargya ritual to the body, that is to the basic Soma sacrifice.

Who but Viṣṇu or Makha among the gods could encompass to its end the sacrifice? For Makha himself is the sacrifice and Viṣṇu is the sacrifice; subject and object are one. In its deific shape, as Makha or Viṣṇu, the sacrifice is the main figure in the myth. The myth is acted out in the form of the ritual. The meaning of the sacrificial myth, the staging and action of the sacrificial ritual, aim at the atonement of an initial wrong and at reintegration. In the present myth an arrogantly broken pledge is the initial wrong, the departure from integrity, a broken promise out of self-seeking niggardly pride. This initial disintegration that causes Viṣṇu-Makha, the sacrifice, to lose its head, wants to be undone by a reintegration, which is the purpose of the rites of the sacrifice.

The Pravargya sacrifice is added on to the beginning, or precedes the Soma sacrifice. The Pravargya is not known to the Ṛg Veda. It appears to have been a sacrifice originally independent of the Soma sacrifice. The two conjoint sacrifices have their mythical figure in Makha, the Pravargya being Makha's head. Its symbol is the Mah&amacr;v&imacr;ra pot.

---

2. T&amacr;ṇḍya B.7.5.6; Taitt. &Amacr;r.1.1-7; &Sacute;atapatha B.14.1.1-5; 14.1.2.17, a different version in Ait. B. 1.19; *cf* ṚV.10.171.2 'Indra severed Makha's head from the skin' (body; and Taitt.S.1.1.8.)

3. J. A. B. van Buitenen, *The Pravargya*, Poona 1968, 35, translates Mah&amacr;v&imacr;ra as 'Large Man.' The largeness being that of the sun, does not refer to its size, but to its all-encompassing power.
4. Pravargya is 'that which is to be put on the fire,' L. Renou, *Vocabulaire du Ritual Védique*, Paris, 1954, 111; *ie* the Mah&amacr;v&imacr;ra pot.
5. Makha has been variously translated; M. Mayrhofer, *A Concise Etymological Sanskrit Dictionary*, Heidelberg 1963, *s.v.* 'Sacrifice' and 'Hero,' both fit Makha in the present context.

The Soma sacrifice has Viṣṇu for its mythical figure. When the Pravargya sacrifice is added to the Soma sacrifice, they form as it were one sacrifice of which the Pravargya is the head, Makha's head. Forming one albeit extended sacrifice, Viṣṇu becomes equated with Makha. The Pravargya preceding the Soma sacrifice, being in front of the sacrifice, it is the 'Head of Makha'; nowhere is it spoken of as Viṣṇu's head.

In the &Sacute;B. version it was Viṣṇu who encompassed the entire sacrifice: this was his glory which identified him with the sacrifice. But in the elation of his triumph he literally lost his head. His bow cut it off. The head fell and became the sun. The rest of the body lay stretched out towards the east. In this calamitous situation, Indra encompassed the prostrate body, lay down on it; limb to limb he embraced it and its glory was absorbed by him. It was a truncated glory of a headless body. The gods went on worshipping with that headless sacrifice and gained nothing by it.

Truly, the gods were cheated by Viṣṇu of the glory of the sacrifice. Moreover the identities in the &Sacute;B. story do not work out squarely. Viṣṇu is the sacrifice and he who is the sacrifice is the Sun (&Sacute;B.14.1.1.6,32). In itself however, and not by synecdoche, the cut off head becomes the sun. It is Makha's head which is represented by the Mah&amacr;v&imacr;ra pot in the Pravargya sacrifice (V&amacr;j.S.37.8; &Sacute;B.14. 1.2.1). One who teaches and partakes of the Pravargya sacrifice enters the light of the Sun (&Sacute;B.14.1.1.26-32). By offering the Pravargya, the head of the sacrifice is replaced. (T&amacr;ṇḍya, 7.5.6, end)

Two equations hold good: Viṣṇu is the sacrifice; Makha is the Sun. The two conceptions are combined. They are linked in the &Sacute;B. by the role of Indra. It is as problematic as it is imitative. It is moreover futile, for the gods sacrificing with the headless sacrifice do not obtain blessings. (Taitt.&Amacr;r.1.6) Dadhyañc, the &Amacr;tharvaṇa, the firepriest, comes to their rescue by telling the Healers among the gods, the A&sacute;vins, the 'madhu-vidya,' the 'sweet' or secret magic knowledge how to replace the head of the sacrifice. The A&sacute;vins, in possession of the secret knowledge, ask the gods for a boon and receive it in the shape of a libation of hot milk (*gharma*) out of the Mah&amacr;v&imacr;ra pot (Taitt.&Amacr;r.1.7). They promptly replace the head of the sacrifice. Henceforward, Gharma, Mah&amacr;v&imacr;ra, Pravargya and 'Makha's head' refer to the same complex reality. The A&sacute;vins learned the Madhu Vidyā́, the 'sweet' secret knowledge straight from the 'horse's mouth,' for it was with a horse's head that Dadhyañc spoke to them (ṚV.1.119.9).

Now Indra had entered also this part of the story. He had cut off the head of Dadhyañc, that is the horse's head (ṚV.1.84.14). Indra had to cut off the head which had divulged the secret to the A&sacute;vins. In fact, Indra previously had threatened Dadhyañc that he would cut off his head should Dadhyañc ever betray the secret known only to Indra and Dadhyañc. By a ruse the A&sacute;vins made Dadhyañc part with the secret and keep his head. That is, they themselves cut off Dadhyañc's original head and put on Dadhyañc a horse's head which told the secret. When Indra fulfilled his threat, he did cut off Dadhyañc's head but that was the head of the horse which had told the secret. Finally the A&sacute;vins know how to restore the original head of Dadhyañc. This miraculous restoration these divine healers accomplished. Now, their knowledge further increased by the secret they had learned from the horse's head, they also knew how to restore the head of Makha. But did the 'sweet,' the Madhu, that only Indra and Dadhyañc[6] knew and that Dadhyañc announced to the A&sacute;vins through the horse's head remain unchanged from the Ṛg Veda to the Br&amacr;hmaṇas?

The Ṛg Veda speaks of the 'sweet' (*madhu*) of Tvaṣṭṛ, it also speaks of the fly that gave away the Madhu, the 'sweet' (ṚV.1.119.9). Tvaṣṭṛ's sweet is Soma. Indra once stole the Soma from Tvaṣṭṛ (ṚV.3.48.4), whereas the fly betrayed the secret to the A&sacute;vins. In the ancient story of the Ṛg Veda, the secret of Soma is betrayed to the A&sacute;vins, by Dadhyañc, or else it is betrayed to them by a fly.[7]

Was the 'sweet' that Dadhyañc knew the knowledge of Soma and where the Soma could be found? The horse's head of Dadhyañc was submerged in &Sacute;aryaṇ&amacr;vat.[8] &Sacute;aryaṇ&amacr;vat is a lake or river in the mountains of Kurukṣetra. It is rich in Soma.[9] With the bone of that cutoff horse's head Indra slew nine times ninety arch enemies

---

6. ṚV.1.116.12; 1.117.22; 1.119.9; 9.68.5.
7. ṚV.1.119.9; R.Gordon Wasson, *SOMA: Divine Mushroom of Immortality*, The Hague, 1968, 61; K. F. Geldner, *Der Rig Veda*, 1, p. 162,n. on ṚV.1.119.9.9.
8. ṚV.1.84.14.
9. ṚV.9.65.22,23; S&amacr;y. on 1.84.14; *cf* 10.35.2.

(Vṛtras).[10] That bone served as Indra's Vajra, his unfailing weapon. It was the thunderbolt.[11] The Madhu in the Ṛg Veda has the secret of Soma for its content. This secret, the repository of Indra's strength, is revealed by Dadhyañc to the A&sacute;vins.

A later text[12] also tells us that Indra himself had imparted to Dadhyañc the magic secret (*brahma*) and had forbidden him to reveal it to anyone. This secret knowledge in post-Ṛg Vedic texts appears not to be the same pure essence, *viz* Soma, the innermost mystery and life elixir of the sacrifice, but another carrier of sacrificial transport, *viz* the secret of the Pravargya. This mystery is revealed to the A&sacute;vins by the horse's head which was cut off by Indra. Another cutoff head, that of Makha and the life elixir which flowed away from the decapitated head of the sacrifice itself, have their own initiatory power. Soma, the drink of immortality, sweetness itself (*madhu*), is the original mystery.

The mystery now however is centered in the restoration of the head of Makha. The horse's head told the A&sacute;vins the secret of how to restore the head of the sacrifice. The secret, however, shared originally by Indra and Dadhyañc is Soma. Secretly, by the horse's head, the sanctity of Soma was assigned to Makha's head in a duplicity of meaning, implying a transfer of significance from the Soma sacrifice to the Pravargya sacrifice. The Soma mystery is the primary secret. It is the 'sweet' of Tvaṣṭṛ, the maker of all form, the mystery of creativity itself, of which the Ṛg Veda sings.

The secret given away by Dadhyañc &Amacr;tharvaṇa, according to the &Sacute;atapatha Br&amacr;hmaṇa, is the knowledge of the restoration of the head of the sacrifice (&Sacute;B. 14.1.1.18; 4.1.5.18). It is the secret of the restitution of wholeness which had become fragmented. The cause of the fragmentation, the cause of the lost head, was the overweening pride of the god himself who thus 'lost his head.' While Soma is creativity itself - in a state untainted by egoity - the secret of regaining the lost head belongs to a state in the godhead fallen from primal innocence, when guilt had come to be. This latter mystery - enacted in the Pravargya ritual - slides into the place of the divine Soma transport. The horse's head divulged secrets of the gods. They were not the same, one supplanted the other.

Makha's head was cut off by a divine act of retribution - the termites hence were divinized. His sacrificial death is an immolation. Makha is the sacrifice by expiation. The slaying of Soma however fulfills his inner destiny. In order to be consumed Soma must be killed. The Soma sacrifice is a passion whereas Makha was felled by his overweening selfishness. The demon in Makha was liberated, the dark face of the cosmic giant was severed from the trunk, the cutoff head was purified in the Pravargya sacrifice. In its flames the head of Makha was made to glow with the radiance of the sun.

The secret knowledge by which the A&sacute;vins, the celestial Healers, restored the sacrifice is contained in the Mantras of the Hymn to the Light (ṚV.10.170.1-3). It is these incantations which are meant by the Div&amacr;kirtyas of which the &Sacute;atapatha Br&amacr;hmaṇa speaks (&Sacute;B.4.1.5.15; SV.2.803-805; &Umacr;hyag&amacr;na.2.2.9). By the power of these words addressed by the A&sacute;vins to the Light radiating from the Sun the head of Makha is restored to the body of the sacrifice.

Significantly, the hymn ṚV.10.171.2 immediately following this laud of the celestial Light, the Sun's radiance, praises Indra who severed the head of raging Makha from his body.[13] The beheading of Makha underlies the rite of the Pravargya. It is also one of Indra's heroic deeds. The slaying of demoniac darkness and thereby turning into Light is celebrated in more than one version. Makha, in the Ṛg Veda is raging darkness from

---

[10] ṚV.1.84.13-14.

[11] *Cf* A. A. Macdonell, *Vedic Mythology*, Strassburg 1897, 142. Wasson, 40.

[12] Bṛhad Devat&amacr;, 3.18-24.

[13] See note 1; ṚV.10.171.2. Makha as raging darkness thus figures as the primeval sacrificial 'animal.' The transformation of the demon into the sacrificial victim leads one step further. As sacrificial victim Makha supplants King Soma.
At a time when the Soma sacrifice was waning and Soma not readily obtainable, the Pravargya was added on to, supplemented, expanded, and reoriented the ancient rites.
When Indra had severed the raging head of Makha 'he came to the house of one who had prepared Soma' (somin; ṚV.10.171.2).

whose body Indra severs the head so that it may arise as sun.[14] No doubt the 'demon' Makha is cognate, *ab intra* with Makha, the sacrifice. The horse's head of Dadhyañc the fire priest, which the A&sacute;vins - whose name derives from *a&sacute;va*, 'horse,' - had put on his shoulders, reveals the secret. The horse's head is the sun, itself. It is at the same time the head of the sun-horse. Through the mouth of Dadhyañc, the sun-horse's secret knowledge, the Madhu Vidy&amacr; is revealed, or, it is said, the sun-horse 'sings together with the Soma-inspired singers in heaven.'[15]

In the Pravargya ritual, the head of Makha, the severed head, the Sun, represented as the 'all encompassing hero,' the Mah&amacr;v&imacr;ra pot, is hallowed by the horse even before the pot is made. A stallion leads those who go to collect the clay from a hole, significantly situated towards the sunrise, to the east of the &Amacr;havan&imacr;ya altar where the gods are invoked, the priest addressing the clay, 'Thou art the head of Makha,'[16] and the stallion is made to sniff at the clay.[17] When the Mah&amacr;v&imacr;ra vessel has been shaped, it is fumigated with horse-dung burnt on the G&amacr;rhapatya altar.[18] And the Mah&amacr;v&imacr;ra vessel glowing on the crackling fire is lauded: 'Loudly the tawny stallion neighed.'[19] Dadhyañc, through a horse's head that the A&sacute;vins - having beheaded him in order to save his human head - had given him, reveals to these horse-involved saviours, the cutoff head, the Mah&amacr;v&imacr;ra, the 'all encompassing hero,' the Sun. And thus its symbol is the earthen Mah&amacr;v&imacr;ra pot.

The Elixir of Life: Soma and P&umacr;tika

When Viṣṇu or Makha or the sacrifice - they are synonyms - had his head cut off, sap flowed away and entered the sky and the earth. 'Clay is this earth and water is the sky. Hence it is of clay and water that the Mah&amacr;v&imacr;ra vessel is made.'[20] The elements earth and water carry the sap of Makha's head into the substance of the Mah&amacr;v&imacr;ra pot. It will dry in the sun and be baked in fire. Earth or clay as it is dug from a pit east of the sacrificial hut is the major but not the only solid substance that goes into the making of the Mah&amacr;v&imacr;ra pot. Four other ingredients are added to the clay. Their importance is primarily symbolical, the relevant ingredient is a certain plant. &Sacute;B.14.1.2.12 speaks of this plant:[21] '&Amacr;d&amacr;ra plants are Indra's might[22] for when Indra encompassed (Viṣṇu) with might, the vital sap of Viṣṇu flowed away. And he lay there stinking as it were after bursting open (*&amacr;-dar*). The vital sap sang praises. The &Amacr;d&amacr;ra plants originated and because he lay there stinking (*p&umacr;y*) therefore [they are also called], *p&umacr;tika*. When laid on the fire as an offering they are fragrant for they originated from the vital sap of the sacrifice.' The vital sap that flowed from the head penetrated heaven and earth and mid-air, all that lies under the sun. The vital sap that flowed from the beheaded body was pressed out from it by Indra's might. Indra's might is sustained by Soma. In the transport caused by that drink of immortality the inspired poets sing about Indra's deeds. Does the &Amacr;d&amacr;ra plant here stand for Soma inasmuch as it is here called Indra's might? The &Amacr;d&amacr;ra plant is not otherwise identified except that it originated then and there and that it is also called P&umacr;tika. If the etymology of *&amacr;d&amacr;ra* is hermeneutic, that of *p&umacr;tika* is correct, not only philologically[23] but also factually as will be shown.

---

[14] Indra liberating the Sun is the subject not only of the Vala myth, but figures also in other images like that of raging Makha (ṚV.10.171.2), or also that of Indra striking down the chariot of Uṣas, the Dawn (ṚV.10.73.6) in her darkness aspect *cf* A. K. Coomaraswamy, 'The Darker Side of Dawn,' *Smithsonian Miscellaneous Collections*, 64.1. Washington, 1935,6. *cf* ṚV.9.73.5, the dark skin which Indra hates and which is magically blown away from heaven and earth.
Taitt.S.1.1.8 invokes the head of Makha as the wide extended vessel which contains all life. This vessel however is made of potsherds (*kap&amacr;ta*). The skin which is to be grasped by a god (not named), the victory over the demon appear in the same context, and Savitṛ, the Impeller or solar power is invoked to make ready (the vessel) in the highest firmament. The Pravargya ritual is adumbrated in the Yajur Veda.

[15] ṚV.1.6.8, *cf* A Bergaigne, *La Religion Vedique*, 11.380, fn. 2, or, the Sun is the hidden horse, ṚV.1.117.4-5, in its journey

through the night.

16. &Amacr;pastamba &Sacute;rauta S&umacr;tra 15.1.7; Taittir&imacr;ya Saṃhit&amacr; 1.1.8.
17. &Amacr;p.&Sacute;S.15.2.2.
18. &Amacr;p.&Sacute;S.15.3.17; V&amacr;jasaneya Saṃhit&amacr; 37.9, *cf* K. Rönnov, 'Zur Erklärung des Pravargya,' *Le Monde Orientale*, Uppsala, 1929, XXIII, 125.
19. V&amacr;j.S.38.22, The platters for the Rauhiṇa cakes which are baked at the Pravargya are 'horse-shaped.' They were made of the same clay-mixture as the Mah&amacr;v&imacr;ra. This makes van Buitenen, p. 15, notes 49 and 50, think, with some reserve, of the little baked clay horses attendant on icons.
20. &Sacute;B.14.1.2.9; 14.2.2.53.
21. *Cf* Taitt.&Amacr;r.5.1.3.5; &Amacr;p.&Sacute;S.15.2.1; M&amacr;nava &Sacute;S.4.1.11, ed. J. M. van Gelder, New Delhi, 1961.
22. V&amacr;j.S.37.6; inspired and invigorated having drunk Soma, Indra performs his deeds.
23. Mayrhofer, *s.v.*

In Indra's close embrace of Viṣṇu's body - limb by limb, he covered him - was Indra's power carried by osmosis into the fallen body of Viṣṇu-Makha? Was it too much for that beheaded and disintegrating body and did it burst open and plants spring forth?[24] These plants called either '&Amacr;d&amacr;ra' or 'P&umacr;tika' are the most significant amongst the five ingredients that make up the clay of the Mah&amacr;v&imacr;ra pot. They represent the might (*oyas*) of Indra communicated to the body of Makha and transmuted into plants which will be ground and mixed with the clay out of which Makha's head, the Mah&amacr;v&imacr;ra pot, will be formed.[25]

The other ingredients of the Mah&amacr;v&imacr;ra pot are: earth from a termite hill[26] for these termites had been divinized and made 'first born of the world' in return for the part they played in the severance of Viṣṇu's head; earth turned up by a boar, for it was the boar Emuṣa-Praj&amacr;pati that raised the earth herself - she was quite small then - into existence.[27] These two additional kinds of earth establish mythically the consistency and existence of the substance of the Mah&amacr;v&imacr;ra vessel from the beginning of things. The P&umacr;tika plants are the third additional ingredient.[28] The sources do not reveal their identity. But the secrecy that surrounds them is not the only thing they share with Soma. The wrong identifications of the P&umacr;tika plant are proportionate to those of the Soma plant, which is fair as the former is only a substitute for Soma.[29] Yet its relevance is such that it confirms the drink of immortality to have been pressed from a mushroom. This mushroom has been identified as the fly-agaric, ie *Amanita muscaria*.[30]

The fourth ingredient added to the clay, making altogether five components of the Mahavlra pot, is goat's milk (&Sacute;B.14.1.2.13) or hairs from a she goat or black antelope (&Amacr;p.&Sacute;S.15.2.1), for the goat and antelope are sacrificial animals, 'born of fire,' symbols of heat.

King Soma was killed in that he in the shape of the Soma plant was pressed.[31] 'In the slaying of Soma the sacrifice is slain, with the sacrifice the sacrificer.'[32] In the Soma sacrifice the sacrificial significance of Soma was enhanced by his royal status. In the course of the Pravargya sacrifice, King Soma having been enthroned, that is a bundle of Soma plants having been placed on the seat of a high four-legged stool, the *r&amacr;j&amacr;and&imacr;*, which reaches to the navel of the sacrificer, a similar throne that may be higher, even shoulderhigh, is placed near

---

24. &Sacute;.B.4.5.10.4 speaks about the provenance of &Amacr;d&amacr;ra or P&umacr;tika. This passage does not treat of the Pravargya myth, but of substitutes for Soma. The &Amacr;d&amacr;ra plant in this context is one of the Soma substitutes, when Soma cannot be had. It is said to have sprung from the sap which spurted from the head of the sacrifice when the head was cut off. The implications of the myth are lost or overlooked when a part of it only is taken out of context. &Sacute;B.14.2.1.19 narrates somewhat vaguely 'when the sacrifice had its head cut off, its vital sap flowed away and therefrom those plants grew up'.
25. According to M&amacr;nava &Sacute;rauta S&umacr;tra, 4.1.9-10, the P&umacr;tika plants were ground. Another version of the origin of the P&umacr;tika plant, though lacking the coherence of the Br&amacr;hmaṇa of a Hundred Paths tells that the P&umacr;tika plant grew from a feather or leaf (*parṇa*) when Soma was carried through the air by the falcon (T&amacr;ṇḍ.B.9.5.1). This plant which properly is called &Sacute;yen&amacr;bhṛta, 'carried hither by the falcon,' is Soma (ṚV.1.80.2; 8.95.3; 9.87.6). &Sacute;B.4.5.10.2-6 however, enumerating the substitutes for Soma speaks of &Sacute;yen&amacr;bhṛta and &Amacr;d&amacr;ra as two different substitutes of Soma. Taitt.&Amacr;r.5.1.3.5 presents yet another name and story: 'Makha leaning on his bow smiled overbearingly and his warmth of life (*tejas*) left him. The gods wiped it on the plants. The plant &Sacute;y&amacr;maka originated therefrom. Also his manly power (*v&imacr;rya*) flowed out.' Makha here is not decapitated, Indra is absent from the story. The &Sacute;y&amacr;maka plant which may be a kind of grain or corn, does not otherwise figure in the story of Makha nor amongst the substitutes for Soma. Makha pays with his life for his hubris, his vitality goes to the plants.

26. &Sacute;B.14.1.2.10; V&amacr;j.S.37.4; Taitt.&Amacr;r.4.2.3; Ap.&Sacute;S.15.2.1.
27. *Cf* 25. These two earth admixtures are not always enumerated in the same sequence. Their proportionate amount is not indicated and seems to have not been relevant to the texture of the clay of which the pot was made. Like the ground P&umacr;tika plants these ingredients had more ritual-symbolical than technical importance similar to the presence of gold and silver in the metal alloy called aṣṭadh&amacr;tu (eight substances) of later day Indian bronze images.
28. V&amacr;j.S.37.6; &Sacute;B.14.1.2.12; &Amacr;p.&Sacute;S.15.2.2; van Buitenen, p. 57 quotes from Baudh&amacr;yana &Sacute;S., a variant of P&umacr;tika, namely B&amacr;d&amacr;ra [*&Amacr;d&amacr;ra*?] stalks. For references here given to &Amacr;p.&Sacute;S. *cf* van Buitenen, *passim*.
29. S&amacr;yana on T&amacr;ṇḍ.B.9.5.1 considers the P&umacr;tika plant to be a creeper; P&umacr;tika is explained as the flowers of the Rohiṣa plant by the commentary on K&amacr;ty&amacr;yana &Sacute;S. An impressive array of wrong identifications of the Soma plant is given by W. Doniger O'Flaherty in Wasson, 93-130. According to &Sacute;B.4.5.10.2, one of the Soma substitutes, the Ph&amacr;lguna plants, deserve mention. Of their two varieties, one with bright red flowers, the other with reddish brown flowers only the second was considered eligible. In this connection the observation in the Atharvapraya&sacute;citt&amacr;ni, J. von Negelein, *JAOS* 34, 254-256, is of interest. Red Soma is said to grow in the Himalayas and brown Soma on M&umacr;javant. If the fly-agaric, the mushroom identified by Wasson, has a red as well as a brown variety it would appear that in post-Vedic time the latter was in demand. P&umacr;tika is cited among the substitutes by W. Doniger O'Flaherty.
30. Wasson, *passim*.
31. Taitt.S.6.4.4.4; 6.6.7.1.
32. Taitt.S.6.6.9.2.

King Soma's throne. This is the Emperor's throne (*samr&amacr;ḍ&amacr;sand&imacr;*) on which the Emperor, the 'All-encompassing Hero,' the Mah&amacr;v&imacr;ra vessel will rest.[33]

The Emperor, the All-encompassing Hero, Mah&amacr;v&imacr;ra, the Sun, is the Great God of the Pravargya. His throne faces east, for nothing must come between Mah&amacr;v&imacr;ra and the sun.[34] Symbolically they are one, Makha's head is the Sun.[35] This is the meaning of the Mah&amacr;v&imacr;ra vessel. It has no other 'content.' Its fiery glowing shape encompasses its cavity, its vastness. Only after the pot has achieved its greatest heat and splendour is hot milk poured into it, the offering to the A&sacute;vins.[36] The All-encompassing Hero, the Sun, of the Pravargya, being joined to the Soma sacrifice, is the head of the sacrifice. 'The head of the sacrifice has become joined in the same manner in which the A&sacute;vins restored it.' (&Sacute;B.14.2.2.43) Just as the A&sacute;vins knew how to put the horse's head on the shoulders of Dadhyañc whose human head they had to cut off and then restored to Dadhyañc his human head, so they restored the head of the sacrifice. It was the horse's head that taught them this secret.

This is how the &Sacute;atapatha Br&amacr;hmaṇa presents the Madhu Vidy&amacr;, the sweet, secret knowledge that Dadhyañc's horse's head betrayed to them. In the Ṛg Veda however, it was another secret that Dadhyañc betrayed to the A&sacute;vins. This secret was 'Madhu,' the innermost 'sweetness,' Soma. (ṚV.1.116.12; 1.117.22)

More than half a millennium lies between the two meanings of the Madhu Vidy&amacr; in the Ṛg Veda and the Br&amacr;hmaṇas. The Sun cult of Mah&amacr;v&imacr;ra, the All-encompassing Hero, was combined with the Soma sacrifice. The meaning of this combined sacrifice revalued the ancient secret of the horse's head, of Dadhyañc and of the Sun.

The substitution of contents and the continuation of the original Soma sacrifices has a ritual analogy in the relation of the Soma plant, identified by Wasson as the fly-agaric, *Amanita muscaria*, and its substitute, P&umacr;tika. King Soma has not been dethroned, but his throne is further from the sun than that of Emperor Mah&amacr;v&imacr;ra. Into the making of Mah&amacr;v&imacr;ra went the P&umacr;tika plant. This symbolically essential ingredient of the Mah&amacr;v&imacr;ra pot has an unsavory connotation accounted for by the myth, told in the Br&amacr;hmaṇa of a Hundred Paths. However, its offensiveness is turned into fragrance when the plant is laid on the fire. This transfiguration in and by the ritual is similar to that of the juice of the Soma plant itself, which is made palatable ritually by an admixture of milk.

Mythically, however, the purification of Soma is effected by V&amacr;yu, the Wind. He blew with the gale of the spirit when Indra freed the cosmos from the Asura, the non-god, the Titan, Vṛtra the Serpent. Soma was in Vṛtra (ṚV.10.124-4) and Indra slew Vṛtra, the ophidian Asura. Slain Vṛtra stank to heaven, sour and putrid. V&amacr;yu blew away that foul smell - 'the smell of King Soma.' He was neither fit for offering, nor was he fit for drinking (&Sacute;B.4.1.3.5-8).

Agni, Soma and Varuṇa were in Vṛtra, the Asura. They were ensconced in the ambience of this ancient cosmic power. Indra slew this dragon, his antagonist. Agni, Soma and Varuṇa were liberated. They went over to the young conquerer god. The rule of the world had changed. But inasmuch as Soma was in Vṛtra he was slain with him who had contained him. However, he came out of the decomposing carcass. Its odor clung to him. V&amacr;yu blew on him and made him palatable (&Sacute;B.4.1.2.10).

The preoccupation of this account with the stench of the decomposition of the flesh of the World Serpent and of King Soma smells of guilt, the guilt of murder. The odor associated with the putrid smell of dead bodies was not unfamiliar it seems to the priests after animal sacrifices. The gods themselves dispelled some of the smell of King Soma and laid it into [dead] cattle. (&Sacute;B.4.1.3.8) In fact, the priests had chosen the plant P&umacr;tika and endowed it with a myth of its own (&Sacute;B.14.1.2.12) in the context of the sacrifice. In this myth stench as a symbol of evil is implicated in and purified by the sacrifice. The plant P&umacr;tika, however, when laid on the fire as an offering is said to become fragrant, it acquires the odour of sanctity.

Putka and the Santal of Eastern Bihar

In Eastern Bihar there live aboriginal people, the Santal, occupying a stretch of country called the Santal Parganas, and we find scattered villages of Santal also in the adjacent regions of Orissa and the western marches of West Bengal. The Santal number some millions. Until recently they were a hunting and food-foraging folk. Their language is not derived from Sanskrit nor is it Dravidian: it leads the third, smaller group, the Munda family. A trait of these languages is that their nouns are not classified into genders - masculine, feminine, neuter - but are either animate or inanimate, either possessing a soul or not possessing a soul. The whole vegetable kingdom is inanimate, soulless, except for one word that designates a certain mushroom. That noun is *putka*: it is animate, a soul possesses it.

P. O. Bodding in the preface to his *Santal Dictionary* (Oslo, 1929-1936, 1, XIV) draws atttention to a noteworthy fact: 'Strangely enough, the Santals use some pure Sanskrit words, which, so far as I know, are not heard in present day Hindi.' He might have added that, at least in the instance we are considering, the word has disappeared from all Sanskrit vernaculars. We may owe this survival to the mycophilia of the Santal, whose knowledge of the fungal world is reflected in a substantial fungal vocabulary. By contrast the Hindus are mycophobes: the twiceborn castes are expressly forbidden to eat mushrooms, whether growing on trees or from the earth (Manu 5.5.19; 6.11.156; &Amacr;p.&Sacute;S.1.5.14.28).

Among the Santal the *putka* is a mushroom and, alone in the whole vegetable kingdom, possesses a soul.[37] Did not *putka* inherit this sacred character from long ago when it was an ingredient of the Mah&amacr;v&imacr;ra pot, which was ritually 'animated,' endowed with sense organs, with a soul? Is not *putka* the Sanskrit *P&umacr;tika*?

The second peculiarity of *putka* is its revolting smell when gathered and left for a day or two exposed to the air.[38] In Dumka (Santal Parganas) a Santal woman in answer to questions put to her by Wasson said that she thought she might know why *putka* was animate; the Santal consume *putka* in their curry, but at the end of a day or two should any *putka* have been left over, the remains of the leftover *putka* stink with the stench of a cadaver.[39] She did not know the meaning of the word *putka* nor the myth of P&umacr;tika in the

---

33. &Sacute;B.14.1.3.10; 3.3.4.21; *cf* van Buitenen, p. 15; the three Mah&amacr;v&imacr;ra pots, two of them in reserve, - should the empty, red hot glowing pot crack during the sacrifice, - are placed on the Samr&amacr;ḍ&amacr;sandi, the emperor's throne.
34. The emperor's throne is placed south of the &Amacr;havan&imacr;ya fire where the gods are invoked and receive their offering and north of King Soma's throne, &Sacute;B.14.11.3.8,12. Notwithstanding these rites, raising Mah&amacr;v&imacr;ra above Soma, the &Sacute;atapatha Br&amacr;hmaṇa, ritually, though not logically, sums up its entire section on the Pravargya with the words 'The Pravargya indeed is Soma' (&Sacute;B.14.3.2.30). In this identification the P&umacr;tika plant plays the main role.
35. V&amacr;j.S.38.24; &Sacute;B.14.1.3.3-6.
36. &Amacr;p.&Sacute;S.5.9.10-12; 15.10.1-5. In the course of the sacrifice curds are offered to Indra and other gods. The curds offered to Soma should be curdled with P&umacr;tika plants (TS.2.5.3.5) in the first place, or with bark while other curdling agents such as rennet, curds, rice, or buckthorn should be used for the offering of the curds to other gods. - In more than one ritual context is P&umacr;tika linked with Soma.

Br&amacr;hmaṇas. Wasson himself did not link *putka* with P&umacr;tika though he supplied the evidence for the identity of this mushroom.

---

37. Roger Heim and R. Gordon Wasson: 'Les Putka des Santals, champignons doués d'une âme.' *Cahiers du Pacifique* 14, 1970, pp. 59-85. *Putka* appears to be a Santalized version of Sanskrit *P&umacr;tika*, the name in Sanskrit having a long or short 'i'. In the light of this discovery in Santal, one would like to inquire whether the same word with the same attributes is current in the sister language Ho, and in other languages of the northern group of Munda languages and, if so, whether it is present in the southern group.
38. Heim and Wasson, p. 65. The only other reason supplied by many Santal to justify the unique status of *putka* was that it was commonly found in the sacred village grove of *sarjom* trees (*ie &sacute;&amacr;l* in Hindi; *Shorea robusta*). But the *sarjom* itself is not animate; why therefore the *putka* around it, especially as the *putka* is not confined to *Shorea robusta*?
39. *Ibid* p. 85. The Santal distinguish three kinds of *putka*. (1) *hor putka* in which *hor* means 'man' or 'human being' or any Santal; (2) *seta putka*, *seta* meaning 'dog'; and (3) *rote putka*, *rote* being a 'toad' or 'frog.' It emerges from the Heim-Wasson paper that these authors consider the first as variations in usage and the terms are applied interchangeably, the usage varying in different villages and possibly with different stages of growth. The third is a puffball that appears suddenly after thunder storms. Many Santal have never heard of the *rote putka* and of those who had, few were able to identify it. The puffball does come in response to thunder, but the belief in thunder as the generative agent applies equally to the *hor putka* and *seta putka*. The *hor* and *seta putka* is an hypogean species, harvested when it finally breaks the surface of the ground. It has often been called a truffle, or 'truffle-like', which it is not. The Frog or *rote putka* calls to mind the Hymn to the Frogs (ṚV.7.10.3.8). There reference is made to the Gharma, the offering of hot milk and to the officiating priests, the Adhvaryus. In the &Sacute;B. the A&sacute;vins who had not been invited to the sacrifice became the Adhvaryu priests of the sacrifice after they had restored the head of the Sacrifice by the mantras of the Hymn to the Sun (ṚV.10.170.1-3).
    In the paper by Heim and Wasson, Professor Heim describes the *putka* mycologically and gives them their scientific names.

The third peculiarity of *putka* in Santal culture is the Santal belief that the *putka* are generated, not from seed, as are the generality of the vegetable world, but by the thunderbolt; in short, generated by divine intervention. Soma itself is generated by Parjanya (ṚV.9.82.3) apparently when his thunderbolt strikes the earth (*cf* ṚV.5.83.1,2,7).

P&umacr;tika, the foremost, and possibly the only direct surrogate for Soma, is a mushroom. When the fly-agaric no longer was available, another mushroom became its substitute. It had acquired a myth of its own. Nothing is known about any psychotropic virtue P&umacr;tika may have. However, no drink was made from it. Instead it was crushed, mixed with the clay of the pot. Its transubstantiation into the 'All-encompassing Hero' came about through fire, for it is said that the plants themselves strewn on fire become fragrant 'because they originated from the sap of the offering';[40] moreover, integrated into the substance of the fire-baked vessel, anointed with butter, they glow in glory in the fire of the Pravargya.

None of the other alleged substitutes for Soma has a myth of its own. P&umacr;tika sprung from the slain body of the sacrifice is a resurrection, as it were, of Soma. The other plants have no myth of their own except the &Sacute;yen&amacr;bhṛta plant which, as the name tells, is Soma itself. The name &Sacute;yen&amacr;bhṛta meaning 'carried by the falcon' conveys the myth of Soma having been brought from heaven by a falcon (ṚV.8.82.9; 10.144.5) when a feather or leaf, fell to earth[41] and the plant sprang from it. Regarding the other substitutes of Soma nothing but a similarity of colours connects certain flowers; or the fact that they were used in the sacrifice, certain varieties of grass, *viz* Ku&sacute;a and D&umacr;rv&amacr; grass.[42] A mushroom is foremost among the substitutes of Soma. Moreover, a mushroom is a significant ingredient in the sun-cult of Makha's head, added to the Soma sacrifice. P&umacr;tika though secondary in its role, being a surrogate for Soma, occupied a position of eminence in its own capacity as an essential ingredient of the substance of the Mah&amacr;v&imacr;ra pot. P&umacr;tika was raised into the region of the sacred as a surrogate for Soma, the most exalted plant in Vedic rites which indeed had Soma for their center. P&umacr;tika, however, did not succeed Soma, did not become hallowed by the same rites but was integrated into the substance of the Mah&amacr;v&imacr;ra vessel. Soma was meant to be drunk. The Mah&amacr;v&imacr;ra vessel was meant primarily to be made and seen. Its communion with the sacrifice was by a craft and ultimately by sight only.

The identification of P&umacr;tika, the Soma surrogate, supplies strong evidence that Soma indeed was a mushroom. P&umacr;tika integrated into the Mah&amacr;v&imacr;ra pot played its part in the mystery of the Pravargya sacrifice. That Putka-mushrooms should be known, to this day, as 'endowed with a soul' witnesses amongst the Santal of Eastern India a memory of the numinous emanating from the indigenous Indian Soma substitute.

Mixed with the clay and the other ingredients P&umacr;tika is part of the substance of which the Mah&amacr;v&imacr;ra vessel is made; it is dried in the heat of the sun, baked in the fire, placed on a silver dish and anointed with butter. The vessel is heated at the peak of the Pravargya to a red-hot glow, when the golden plate that had covered the mouth of the Mah&amacr;v&imacr;ra pot is removed. The 'All-encompassing Hero,' the 'Head of Makha,' the vessel that contains all life,[43] that is flame, glow, and heat, is the Sun.[44] Mah&amacr;v&imacr;ra, is 'Lord of all the worlds, Lord of all mind, Lord of all speech, Lord of all tapas [the fiery strength of asceticism], Lord of all brahman [the power of the sacred word], Lord of creatures, Spirit of poets.'[45]

---

40. &Sacute;B.14.1.2.12.
41. T&amacr;ṇḍya B.9.5.1 assigns to P&umacr;tika the myth of &Sacute;yen&amacr;bhṛta, saying that P&umacr;tika is the plant which grew from a feather (or leaf, *parṇa*) that fell to earth when Soma was carried through the air in contrast to the far more telling myth of &Sacute;B.14.1.2.12 about the origin of P&umacr;tika.
42. &Sacute;B.4.5.10; 14.1.2.12.
43. *Cf* TS.1.1.8.
44. &Sacute;B.14.1.3.17,26.
45. &Amacr;p.&Sacute;S.15.8.15-16; tr. van Buitenen, 92; matter in brackets added.

The Mah&amacr;v&imacr;ra Vessel

The Mah&amacr;v&imacr;ra vessel is prepared at the sacrifice itself. The making of the earthen vessel is itself part of the ritual.[46] The pot is shaped by hand; it is not thrown on a potter's wheel. Its height will be a span[47] and it is Makha's Head. Its shape however does not resemble any head or face, though part of it is called its mouth, but is also spoken of as opening[48] or outlet or as an outlet for pouring into.[49] The shape of the vessel resembles the V&amacr;yavya, the wooden vessel which held the libation for V&amacr;yu, the Wind.[50] The mouth or opening or top of the pot is also metaphorically called a nose for the Mah&amacr;v&imacr;ra pot. It is contracted in the middle and projects outward, widening toward the top.[51] These metaphors do not aim at conjuring up a physiognomy. They refer to a human face as much or as little as does the measure of a span.

The wooden V&amacr;yavya vessel is named after V&amacr;yu, the Wind. The gods rewarded V&amacr;yu with the first libation of Soma from this vessel because he was the first to tell them that Vṛtra had been slain &Sacute;B.4.1.3.4). Subsequently when V&amacr;yu had made Vṛtra-Soma fit for offering and fit for drinking the libation vessels belonging to other gods were also called V&amacr;yavya or V&amacr;yu's vessels (&Sacute;B. 4.1.3.10). V&amacr;yu, the Wind, had made Soma sweet. 'Therefore what becomes putrid they hang out in a windy place' (TS.6.4.7.1).

The Mah&amacr;v&imacr;ra vessel conforms with the libation vessels called V&amacr;yavya. While these are carved out of wood the Mah&amacr;v&imacr;ra pot is built up of clay.

The lump of clay for the pot is divided into three parts, one part to be the bottom. The clay, pressed down with the thumbs and flattened, is addressed with the words 'you are the two feet of the sacrifice.'[52] Obviously no similarity to any feet is intended here. The lowest part of the pot supports the vessel as the two feet support the human figure.

The second part of the clay is used for building the walls of the vessel up to the height of its collar (*parigr&imacr;v&amacr;*). The clay is laid on in three, five or an indefinite number of *uddhis* (elevations), that is, in coils or rings.[53] They seem to decrease in diameter towards the middle of the height of the vessel and increase towards its top. The contracted middle is referred to as *lagnam*. This is not to be understood to be a joint but denotes an intersection of planes.[54]

The third portion of the original lump of clay goes into the making of the top portion of the vessel which flares out to a height of two or four thumb widths above the collar (*parigr&imacr;v&amacr;*) or girdle (*mekhal&amacr;*)[55] laid on in high relief around the pot.[56] At the conclusion of the rites of Makha's Head, milk will be poured into the pot.[57]

Once the vessel is completed it must not be touched by hand.[58] It is held, raised, and transferred by tongs. The high relief of the collar or girdle would have prevented a slipping of the tongs.

---

46. &Sacute;B.14.1.2.2.
47. &Sacute;B.14.1.2.17.
48. A&sacute;v.Gr.S.4.3; *bila* commented as *garta*, 'a hollow.'
49. K&amacr;ty.&Sacute;S.26.1.16; *&amacr;secana*.
50. &Amacr;p.&Sacute;S.12.1.4; a libation vessel for an offering to V&amacr;yu; Renou, s.v. the same as &Umacr;rdhvapatra, a high vessel in the shape of a mortar. *Cf* K&amacr;ty.8.7.5.
51. &Sacute;B.14.1.2.17. The references to facial features do not conjure up the image of a face. They enliven single features of the pot.
52. &Amacr;p.&Sacute;S.15.2.14; Taitt.&Amacr;r.4.2.6. *cf* R. Garbe. 'Die Pravargya Ceremonie nach dem &Amacr;p.&Sacute;S.' *ZDMG* 34, 1880, 319.
53. &Amacr;p.&Sacute;S.12.1.4.
54. Baudh&amacr;yana (van Buitenen, 10) gives a clear description, *cf* also &Amacr;pastamba (*ibid* p. 9). The number of *uddhis* or 'rings,' *ie* superimposed parts varies from three to four or more.
55. Taitt.&Amacr;r.5.3.5 *parigr&imacr;v&amacr;*, also *rasn&amacr;* or 'girdle' (&Amacr;p.&Sacute;S.15.2.17) are here synonymous.
56. Garbe, p. 329.
57. Van Buitenen, 10f; based on Baudh.&Sacute;S. [see also drawing on p. 11]. Van Buitenen under stands the three portions of the lump of clay to have been shaped as two small balls one on top of the other, and supported on a broad calotte shaped base, suggesting the shape of a man seated cross legged. This reconstruction is not according to the texts nor would it serve the purpose of the Mah&amacr;v&imacr;ra pot.
58. Van Buitenen, 15; &Amacr;p.&Sacute;S.15.4.6-8.

The shape of the Mah&amacr;v&imacr;ra pot is not anthropomorphic: it has neither the shape of a head, face, or figure of man. It is not an icon but a symbol in the shape of a vessel. To the officiating priest and to the sacrificer it means the Head of Makha, the Sun, and its mystery is experienced by them in the ritual. While they enact it, this mystery pervades their entire being, Mah&amacr;v&imacr;ra comes to life in them and they live in him. 'Like the two eyes, like the two ears, like the two nostrils thus he [the priest] places the senses in him.'[59] The Pravargya is a mystery rite, it requires a special initiation over and above the one for the Soma sacrifice.

The Pravargya is a complex ritual. Its first part, the Pravargya proper, is a sun ritual. Its main symbol is the red hot, glowing Mah&amacr;v&imacr;ra, 'the All-encompassing Hero,' who encompasses as sun the horizons of heaven,[60] unbounded space, all the world.

The second main part of the sacrifice begins when the vessel, having been made to blaze and having been hymned, is filled with milk. This part of the sacrifice belongs to the A&sacute;vins: it is the offering of hot milk due to them, the Gharma proper.[61] In this capacity, the Aitareya Br&amacr;hmaṇa lauds the Gharma as divine intercourse. The vessel is the member, milk is the semen, ejaculated - while boiling - into the fire as the divine womb, the birthplace of the gods, as generation.[62] Extending beyond the sacrifice, into the cosmos, Mah&amacr;v&imacr;ra, creator, procreator, by begetting extends from the bottom to the top, penetrates and supports heaven and earth.[63]

The coincidence within the same visual symbol, the Mah&amacr;v&imacr;ra vessel, of tropes taken from the shape of man is not to be seen as an overlapping of physical features. Each evocation conjured up an inner experience, valid in itself and not an image. The function of the lowest part of the pot is being felt as akin to that of feet; the top of the vessel, its opening, functions as mouth for liquid to be poured in and out. Or the entire pot is felt to function as the cosmic, procreative member, aggrandized as cosmic pillar. In another context, however, the Mukhalinga symbol of &Sacute;iva is a visually materialized form of such coinciding tropes. In this visualized symbol, the linga however had no procreative meaning. On the contrary, the concept of the ascending, not ejaculated but transubstantiated, semen as the substance of illumination is the motivating belief or experience that conjoins the shapes of phallus and head. The Mah&amacr;v&imacr;ra vessel is not anthropomorphic. It releases in the ritual the experience of the creative power of the Sun by the conception of 'Makha's Head' and again by an upsurge of procreative empathy of which the vessel becomes the liṅga-like symbol.

The allusion to the figure of man however is implied throughout the sacrifice. In the Pravargya, at the conclusion of the entire sacrifice the implements of the sacrifice are assembled around the Mah&amacr;v&imacr;ra pot either in the shape of man[64] or in that of the sun. This alternative implies the transfiguration of man, the sacrificer, which is the purpose of the sacrifice. The sacrificer has reached the sun, 'the radiant face of the gods, the eye of Mitra, Varuṇa and Agni.'[65] 'With the sun's eye I gaze upon thee.'[66] the priest had addressed the Mah&amacr;v&imacr;ra vessel when it had been baked in the fire and he had lifted the pot on the gravel kept ready for it. 'Were not the eye sun-like, never could it perceive the sun/ thus Goethe worded a knowledge expressed by the priest in the ritual sun-gaze of recognition of the completed Mah&amacr;v&imacr;ra vessel. This cosmic realization comprises all beings. Mah&amacr;v&imacr;ra, the sun, the All-encompassing Hero is addressed: 'Mah&amacr;v&imacr;ra, may all things regard me with the eye of a friend. May I regard all beings with the eye of a friend. With the eye of a friend do we regard one another.'[67] 'Long may I live to look on thee.'[68] 'Through a hundred autumns may we see that bright eye, god appointed, rise.'[69]

---

59. Ait.B.4.1.21.
60. &Amacr;p.&Sacute;S.15.6.2; 15.8.15-16.
61. In the Ṛg Veda, the Gharma was offered to the A&sacute;vins in a metal cauldron (ṚV.5.30.15) which has no original connection with the Mah&amacr;v&imacr;ra clay pot. The Pravargya includes finally also an offering to Indra, of hot curds, the Dadhigharma. The Rg Vedic offering of hot milk to the A&sacute;vins became combined with the ritual of the red hot Mah&amacr;v&imacr;ra pot.
62. Ait.B.4.1.2.22.
63. &Sacute;&amacr;nkh.&Sacute;S.5.9.4; A&sacute;v.G.S.4.6.1, *cf* AV.4.1; 2.4; *cf* van Buitenen, p. 67. This recitation accompanied the first part of the Pravargya.
64. &Sacute;B.14.3.2.2; 14.2.2.16-22 and Baudh&amacr;yana; *cf* van Buitenen, p. 130, note 6.
65. &Amacr;p.&Sacute;S.15.16; ṚV.1.115.1.
66. &Amacr;p.&Sacute;S.15.4.6-8; M&amacr;nava &Sacute;S.4.1.26.
67. V&amacr;j.S.36.18.
68. V&amacr;j.S.36.19.
69. V&amacr;j.S.36.24; ṚV.7-66.18.

The Later and Separate Lives of Mah&amacr;v&imacr;ra and P&umacr;tika

Mah&amacr;v&imacr;ra, the All-encompassing Hero, is also the name of the last Jina or Conqueror of the twenty-four Jinas or Saviours (*t&imacr;rthaṅkara*) in the heterodox Jaina religion. His mythical life story is the exemplar for that of the other T&imacr;rthaṅkaras. Before his birth his mother had fourteen prognostic dreams. In one of them she beheld a vessel, a 'brimming vase.' This vessel of abundance is a symbol of ultimate knowledge.[70] In another frame of reference this vessel is also the Sun as vessel containing all time.[71] The brimming vase is common to the art of Buddhism and Hinduism. It is shown brimming with lotuses. They are particularly associated with the Lotus Goddess, Lakṣm&imacr;, Goddess of Plenty. The Mah&amacr;v&imacr;ra vessel, however, held no tangible contents. This sacred vessel as the All-encompassing Hero, the Sun, rules over space and time. In its Jain context it also holds that one supreme knowledge which has overcome the separateness of space and time, the manifoldness of the world.

The iconology of the prognostic dream vessel seen by the mother-to-be of the Saviour and which prefigures his life on earth, however, differs from all the other sacred vessels represented in Indian art. It is known to us in the Western Indian school of painting after the fourteenth century. There it is shown flanked, at the height of its neck, by wide open, far-seeing eyes. They are painted next to the vessel, whatever be its shape, not on it.

Together with it, they form an inseparable configuration showing with utmost clarity the vessel with the eyes that belong to it. Visually, this configuration combines, as a truly creative symbol, the presence of the sacred vessel and that of the all-seeing eyes which are its own. Floating on a monochrome coloured ground, they gaze, charged with the mystery of the sacred vessel, with the power of Mah&amacr;v&imacr;ra.[72]

The Mah&amacr;v&imacr;ra vessel and the P&umacr;tika mushroom are significant elements in the fabric of Indian tradition. P&umacr;tika starts with being a substitute for Soma, the drink of immortality, the elixir of life. P&umacr;tika qualifies for this part because P&umacr;tika is a mushroom reddish brown in colour. This mushroom amongst other reasons was chosen when the Soma plant, the fly-agaric, gradually became unavailable, in preference to other indigenous mushrooms for its being conspicuous or noticeable by the bad smell the cut mushroom develops. Hence also its name P&umacr;tika. Once chosen in lieu of Soma, P&umacr;tika usurped as its own the name '&Sacute;yen&amacr;bhṛta' and the myth of Soma's origin from on high. The substitute became authenticated as the original.

A gap of more than two and a half millennia, a transfer from Aryan priestly symbolism to tribal belief, the tribe adopting a Sanskrit name with but little change into its own language, the survival of this name in a Munda language, in a region at a considerable distance to the east from the ancient center of Brahmanical sacrifices, all this did not impair the ongoing myth of P&umacr;tika. This species is known to the Santal as 'endowed with a soul.' It is distinct from other mushrooms, from all the vegetable kingdom as being numinous. The odor of sanctity clings to this mushroom, however pejorative its telling name.

The sanctity of the Mah&amacr;v&imacr;ra vessel as artifact and symbol, judging by the pristine technique of shaping the earthen pot, would belong to an age far beyond the age of the Br&amacr;hmaṇas. Deified, the Mah&amacr;v&imacr;ra pot is the center of a ritual, entirely its own. The very making of it is part of the ritual. In this respect this pottery ritual may be grouped with the 'brick piling' ritual of the Vedic altar,[73] but also with the function of the potterpriest in South India today.[74] The Mah&amacr;v&imacr;ra pot is not in any way like a head urn, nor does it resemble a human figure: it refers to the sun, - not by virtue of its shape but by the process of making it. The vessel is dried by the heat of the sun and baked in a fiery pit. In the culminating ritual its validity is established in glowing glory wreathed in flames as symbol of the Sun or the Head of Makha, the cosmic giant.[75]

The worship and disposal - the whole ritual - of Mah&amacr;v&imacr;ra, though part only of the total Pravargya sacrifice are organised with the finality of perfection. The incongruity of an empty earthen vessel as symbol for Makha's head, the Sun, seems inexplicable. Yet a symbol is what one makes it to mean. The mouth or nose of the pot are as suggestive as are the implements in the final laying out of all the paraphernalia of the Pravargya, where they are understood to reconstruct the shape of man. Three pots (the original and the two reserve pots should the original crack) form the 'head,' the undipped broom that had been used in the ritual is placed above the head, so as to form a hair tuft, the tongs are the shoulders, and so on, the straws of the other broom are scattered over the configuration that embodies the essence of man, so as to form its muscles.[76] Whatever took part in the sacrifice, becomes part of the transfiguration of sacrificial man. The configuration of the paraphernalia of the sacrifice is vested with their composite magic. If the implements are arranged in a way so as to conjure up an image of the sun, the same purpose is fulfilled.

The head of sacrificial, transfigured man is represented by the three Mah&amacr;v&imacr;ra pots, each of them is the head of the sacrifice - even though only one played its role. Though there are three they mean one and the same only. In the sacrifice Makha's Head is the sun, the pot is Makha's head, the pot is the sun. The

---

70. *Kevala-ñ&amacr;ṇa daṃsana*; A.K. Coomaraswamy, 'The Conqueror's Life in Jaina Painting,' *Journal of the Indian Society of Oriental Art 3*, 1935, p.136f; Pls.35,2;36.
71. AV.19.53.3; *cf* note 69.
72. In some of the paintings the vase and the flanking eyes are combined into a phantasmagoric 'face' (Coomaraswamy, Pl. 35,2.) comprising further subservient devices. On the other hand, the conception of the Suneye, as eye '*per se*' more or less independent of the face of the figure is one of the main factors in the style of the Western Indian school of painting, *cf* S. Kramrisch, 'Western Indian Painting,' under publication by Bhagaw&amacr;n Mah&amacr;v&imacr;r 2500th Nirv&amacr;ṇ Mahotsava Samiti, Bombay, 1974.
73. The square *ukh&amacr;* made of clay which held the heads of the five sacrificial victims was part of the sacrificial pile. It was neither the central cult object nor even a cult object in its own right.
74. S. Kramrisch, *Unknown India*, Philadelphia Museum of Art, 1968, 57.

pot is the head though it is unlike a head. The pot is made by the priest, the Adhvaryu, or he delegates this task to a potter (*kartṛ*, 'the maker'). The pot is the sun, is Makha's head, the head of the sacrifice not by a likeness of its shape but by that of another quality which has its maximum effect at the culmination of the sacrificial heating of the vessel. It is then that Mah&amacr;v&imacr;ra, anointed with butter and, heated to the highest degree, attains the fieriness of the sun. It had been covered with a golden dish so that it should protect heaven from its heat.[77] The 'All-encompassing Hero, glowing gold-colored, encompasses as sun, the horizons of heaven.'[78]

In South India of the present day, the cult of Aiyanar requires clay images of Aiyanar and his retinue. They are made by the village potter who is at the same time the officiating priest. He is a Kusavan by caste, son of a Br&amacr;hman father and a &Sacute;udra woman. Did clay, being baked in the fire and turning from earth to glowing splendor, effect in a potter-priest an initiation through the potter's craft, familar only with his sundried output? Did he behold the fiery sun glowing in his own work? Did the sun cult of the Mah&amacr;v&imacr;ra pot arise amongst potters and make them priests of their calling? Was it a cult indigenously Indian where the heat of the sun is as powerful as its splendor so that transposed into a rite the glow of the earthen pot and the vehemence of the flames are intensified by the anointing of the vessel? It was made by hand, the clay pressed into shape by the thumbs without a potter's wheel. This pristine technique was hallowed. It had arisen from direct contact, preserved the shape and the manner in which the vessel had been fashioned when the sediments of more than one myth were integrated in its substance and when the Sun vessel once-finished was not to be touched by human hands. It was not to be touched by human hands for its heat would have burnt them. The vessel was not to be touched because it was sacred. It was not to be touched so that the only contact with the sacred object was by sight, sight intensified to the exclusion of all other sensory perceptions, a rite of 'seeing' a communion by vision.

An indigenous sun cult celebrated by the ritual of its craft became the 'Head of the sacrifice' and Makha's head was joined to its body. Symbols live their own lives, draw to themselves their affinities, coalesce with them and emerge showing in various facets an identity of ambience of meaning. Mah&amacr;v&imacr;ra, in the Aitareya Br&amacr;hmaṇa, encompasses all creation, in the intensity of the climactic moment of procreation. The vessel now stands for the Liṅga. Head and procreative organ are coterminous yet do not overlap in the vision of the Br&amacr;hmaṇas.

Through long stretches of Indian thought and imagery, the symbolism of Liṅga and head combined in the creation of a visual whole. The Mukhaliṅga of &Sacute;iva, the phallus with a head or heads, is a concretely realised sculptural form perduring for two thousand years of Indian art, though with a total reversal of the implied meaning which here extols antithetically the power of creative heat as fervor of ascetic sublimation not as a spending into the fiery lap of all gods-to-be but as a self-contained rarification and ascent of this power.

On another facet of its meaning, Makha's head, the Sun, the All-encompassing, All-seeing eye of the world, fastens its steady gaze on all and everyone. The brimming vase sends forth this glance in eyes that are painted outside its shape, bestowing the power of sight and insight. Two vessels overlap in this Jain rendering of ancient themes. The one is the Mah&amacr;v&imacr;ra pot, which the 'Unbounded,' Aditi, is invoked to encompass.[79] It contains ultimate knowledge and all time. These are intangible contents. The other vessel is the 'full pot' (*p&umacr;rṇa ghaṭa*), the brimming vase of plenty, Laksnil herself.

The symbolism of the Mah&amacr;v&imacr;ra vessel is deeply ensconced and has manifold connections in Indian thought and art. P&umacr;tika, on the other hand, only contributes to the substance of the vessel. The mantle of King Soma had fallen on this notable mushroom, which inherits the glory of Soma for whom it is a surrogate. Its heyday is in the Pravargya ritual. Then the mushroom is lost to us in a millennial darkness from which, miraculously, it emerges 'endowed with a soul' amongst the aboriginal Santal of Eastern India in our own day.

---

75. *Cf* ṚV.10.171.2; and, above, p. 225.
76. &Amacr;p.&Sacute;S.15.15.1.
77. &Amacr;p.&Sacute;S.15.8.5a; K&amacr;ty.&Sacute;S.1.6.24; &Sacute;&amacr;ṅkh&amacr;yana &Sacute;S.5.9.13; van Buitenen, 77.
78. *Cf* &Amacr;p.&Sacute;S.15.6.2.

---

79. Taitt.&Amacr;r.4.2.6; Aditi, 'the Boundless,' is invoked to comprise its cavity, SB.14.2.7; M&amacr;nava &Sacute;S.4.3.1 invokes the cow as Iḍ&amacr;, Aditi and Sarasvat&imacr;. While on one level the cow whose milk will fill the pot is Aditi, on the highest level Aditi remains Boundlessness itself.

CHAPTER FOUR

The Last Meal of the Buddha

by R. Gordon Wasson

What was *S&umacr;kara-Maddava?*

Upwards of a dozen scholars[1] in the past century have commented on what the Buddha ate at his Last Meal, *ca* B.C. 483, and the puzzling mystifications in the evidence. The meal was served to him and his suite of monks by his host the metal-worker Cunda at P&amacr;v&amacr;, a village that lay near Kusin&amacr;r&amacr; where the Mah&amacr;parinirv&amacr;ṇa - the "Great Decease" as the Rhys Davidses translated it - was scheduled to take place some hours later. The canonical P&amacr;li Text says that Cunda served his august guest *s&umacr;kara-maddava*, a hapax in P&amacr;li. Walpola R&amacr;hula, the Buddhist monk and scholar residing in the West, has assembled in a memorandum for us the relevant P&amacr;li texts with his translations and notes, and this document is appended to our paper.

The first part of that compound word, *s&umacr;kara-*, is simple: "pertaining to swine," *s&umacr;k-* being cognate with Latin *sus*. The second element is generally thought to mean tidbits, dainties, but whether as a specially delicate part of the pig's meat or as a food of which swine were specially fond, whether a subjective or objective genitive, no one can say. Rhys Davids noticing that in Bihar there was a common edible underground fungus, translated *s&umacr;kara-maddava* by "truffles."[2] This was a successful pitch, considering that by "truffles" he meant an underground fungus common thereabouts, although no truffle (= *Tuber*) has been discovered so far in Bihar. His underground fungus was a *Scleroderma*, a little snow-white ball that is gathered just as soon as it appears on the surface. There are a number of genera of underground fungi of which truffles are one, and each genus has many species.

The two canonical P&amacr;li Commentaries discuss but do not agree on the meaning to give to *s&umacr;kara-maddava*. One of them is the canonical P&amacr;li Commentary on the *D&imacr;gha Nik&amacr;ya*, *Sumaṅgalavil&amacr;sini*, and the other, the *Paramatthajotik&amacr;*, the canonical Commentary on the *Ud&amacr;na*. These Commentaries took their present form in P&amacr;li under the guidance of the celebrated monk Buddhaghoṣa early in the fifth century of our era, mostly from Sinhala sources available to him. Each of these commentaries suggests various dishes as possibilities. Both include pork and an 'elixir' (a chemical preparation) in the list of choices. The canonical P&amacr;li Commentary on the *D&imacr;gha Nik&amacr;ya* adds soft rice with the broth of the five products of the cow. The canonical P&amacr;li Commentary

---

[1] 1896 and earlier. Karl Eugen Neumann: *Die Reden Gotamo Buddho's aus des Mittleren Sammlung Majjhimanik&amacr;yo des P&amacr;li-Kanons*, Leipsig, 1896, pp. XIX-XXII. Neumann cites earlier writers: Friedrich Zimmermann, who in turn refers to an article in the *Journal of the Maha-Bodhi Society*, Vol. 1, No. VIII, pp. 2-3, Calcutta, 1892, wherein the editor of this *Journal* reproduces statements by 'Rhys Davids, Bigandet, Rockhill, and Colonel Olcott,' laying stress on the proper meaning of *s&umacr;kara-maddava*. We have seen none of these earlier discussions.
1910. T. W. and C. A. F. Rhys Davids, and later editions. *Dialogues of the Buddha: Part II*. Translated from the P&amacr;li of the *D&imacr;gha Nik&amacr;ya* by T. W. and C. A. F. Rhys Davids. One of the series of the Sacred Books of the Buddhists. Published for the P&amacr;li Text Society by Luzac, London. (All of our quotations from the *D&imacr;gha Nik&amacr;ya* are from the 1959 edition.)
1916. Coomaraswamy, Ananda K.: *Buddha and the Gospel of Buddhism*, p. 79, George G. Harrap, London.
1931-2. Arthur Waley. 'Did Buddha die of eating pork?' *Mélanges chinois et bouddhiques*, Vol. 1, pp. 343-354. Brussels.
1942. Fa Chow. 'S&umacr;kara-maddava and the Buddha's Death.' *Annals of the Bhandarkar Oriental Research Institute*. Edited by R. N. Dandekar, pp. 127-133.
1948. E. Waldschmidt. *Beiträge zur Textgeschichte des Mah&amacr;parinirv&amacr;ṇas&umacr;tra*, pp. 63-85: 'Die Letzte Mahlzeit des Buddha.'
1948. E. J. Thomas. *Indian Culture*, XV, pp. 1-3: 'Buddha's Last Meal.'
1949. A. Foucher. *La Vie du Bouddha*. Paris, Payot. pp. 304-308: 'Le Dernier repas à P&amacr;v&amacr;.'
1968. André Bareau. 'La Nourriture offerte au Buddha lors de son dernier repas,' *Mélanges d'Indianisme*, Paris, Editions E. de Boccard. pp. 61-71.
1970. André Bareau. *Recherches sur la biographie du Buddha*. Tome 1. Notably Chapter VII 8 & 9, pp. 251-281. Paris. Ecole Française d'Extrême-Orient, Vol. LXXVII.

1970. P. Demiéville. Review of R. Gordon Wasson: *SOMA. Divine Mushroom of Immortality*. *T'oung Pao*, LVI: Livr. 4-5, pp. 298-302. E. J. Brill, Leiden.
This list does not pretend to be exhaustive.

2. See note 1, entry under 1910. p. 137 ftnt.

on the *Ud&amacr;na*, deriving its authority from the Great Commentary (now lost) that dates from the third century B.C., offers two further choices: bamboo shoots (sprouts) trodden by pigs, and *mushrooms grown on a spot trodden by pigs*.

That the Buddha was eating his last meal was known to everyone thereabouts: nothing that happened there could have escaped those within eye-reach nor have been forgotten by them, not least because of the awesome event to take place a few hours later, the Buddha's translation to Nirvana that he had been predicting for that night since he was in Vai&sacute;ali three months before.

Dr. Stella Kramrisch, building on the work of the late Professor Roger Heim and me in eastern India, has identified with finality the *s&umacr;kara-maddava* as the *P&umacr;tika*,[3] a plant that figures conspicuously in the Br&amacr;hmaṇas and other early post-Vedic sacred Sanskrit texts. In this paper I will examine the Last Meal at P&amacr;v&amacr; and the death of Gautama the Buddha at Kusin&amacr;r&amacr; in what is today northern Bihar. I will focus attention on what he ate at his Last Meal - a matter of little theological importance to the Theravadin branch of Buddhism and none at all to the Buddhists of the Greater Vehicle, but pertinent to our mushroomic inquiries and notably, as I shall show, to the identity of Soma.

Of all the scholars who have dealt with the Last Meal of the Buddha, I believe only one, André Bareau, has addressed himself to the surprising anomaly offered by the possibility of either pork or mushrooms being served to the Buddha at this meal. Here is what Bareau has to say:

> En effet, la viande de porc et plus encore les champignons sont des choses pour lesquelles les Indiens impregnés de culture brahmanique, comme l'étaient le Buddha et une grande partie de ses disciples, éprouvent un profond, un insurmontable dégout et que ne consomment guère que certains tribus sauvages ou des gens de basse caste, rejetés par la bonne société et pressés par la faim. L'idée d'offrir au Bienheureux, pour l'honorer et le régaler, comme un mets de choix, ... de la viande de porc ou des champignons est aussi insolite que si, dans une légende occidentale, on offrait à quelque éminent personnage un festin dont le plat principal serait une cuisse de chien ou une purée de goémon, des sauterelles frites ou des chenilles grillées; cela paraîtrait à juste titre une plaisanterie ou ferait croire à une erreur de copie. [*Recherches sur la biographie du Buddha*. Tome 1, p 267. Paris. 1970. Publications de l'Ecole Française d'Extrême-Orient, Vol LXXVII]

Confirming what Bareau says, Chap V-5 of the laws of Manu, believed to have been committed to writing around the beginning of the Christian era, declares that:

> garlic, leeks and onions, mushrooms and (all plants) springing from impure (substances), are unfit to be eaten by twice-born men,

and this proscription is repeated in V-19:

> A twice-born man who knowingly eats mushrooms, a village-pig, garlic, a village-cock, onions, or leeks, will become an outcast.

Here the prohibition carries a dire penalty. Mushrooms are forbidden in two further clauses, VI-14 and XI-156. The repeated prohibition applies expressly to twice-born men, which embraced the three upper castes.

The ban on mushrooms was no dead letter. Sir William Jones quotes from a commentator on the laws of Manu named Yama:

> ... the ancient Hindus held the fungus in such detestation that Yama... declares 'those who eat mushrooms, whether springing from the ground or growing on a tree, fully equal in guilt to the slayers of Bráhmens, and the most despicable of all deadly sinners.' [*The Works of Sir William Jones*, Vol V, pp 160-161, London, 1807.]

---

3. Stella Kramrisch: 'The M&amacr;hav&imacr;ra Vessel and the Plant P&umacr;tika,' *supra*, 95.

This is the most extravagant outburst of mycophobia that we have found anywhere, surely the most extravagant to be found in the Indo-European world, which is saying a good deal. The learned Brahman tells us that the simple mushroom-eater is as bad as the murderers of Brahmans! Why such passionate, such exaggerated censure? Bareau, in comparing the Hindu eater of mushrooms to one among us who eats dog's flesh, was engaging in understatement.

Three months before the Last Meal at P&amacr;v&amacr; and before his Mah&amacr;parinirv&amacr;ṇa, the Buddha had been sojourning at Vai&sacute;ali and thereabouts. While in the vicinity of Vai&sacute;ali he had suffered a grave illness, attributed from ancient times to a chronic gastric upset, probably dysentery; had felt the weight of his years, had called himself an 'octogenarian,' and had announced his intention to go to Kusin&amacr;r&amacr; and there three months later to experience the Mah&amacr;parinirv&amacr;ṇa, the Final Extinction. He was predicting the time and place of his own end. He made his way to Kusin&amacr;r&amacr; with his followers on foot, teaching the doctrine as was his wont, and it took him three months to cover the 140 kilometers. To his disciples and the villagers he made freely known his purpose: he never wavered in his resolution, nor did he hide it from anyone.

The day before the Buddha reached Kusin&amacr;r&amacr; he arrived at the nearby village of P&amacr;v&amacr; and passed the night in the mango grove belonging to one Cunda, a metal-worker or blacksmith, and therefore a &sacute;&umacr;dra, the lowest of the four castes in Hindu society. Cunda, appearing almost immediately, inquired what the Buddha desired. According to one of the Chinese recensions of the Buddha's life, the Buddha explained that he was to undergo the Mah&amacr;parinirv&amacr;ṇa in Kusin&amacr;r&amacr;: lamentations followed. Cunda invited the Buddha and his many followers to take their single meal the next day with him, and by his silence the Buddha accepted. Cunda withdrew to assemble the food and prepare it. In the morning Cunda came to summon the Buddha and his followers to the meal that he had prepared.

Cunda, as we said before, was a &sacute;&umacr;dra, a man of the lowest caste. On the other hand, as the metal-worker of the region he was a technician, comfortably off, extending hospitality on a moment's notice to the Buddha and his numerous followers, one accustomed to meeting and mixing with travelers including individuals of what are today called the 'scheduled castes,' aboriginal tribesmen who were not Hindus and therefore not a part of the dominant Hindu society. His forge may well have been the *raison d'être* for P&amacr;v&amacr;. When the Buddha arrived at Cunda's dwelling-place and was seated in the place prepared for him, he (according to the *D&imacr;gha Nik&amacr;ya*) addressed Cunda saying,

> As to the *s&umacr;kara-maddava* you have made ready, serve me with them, Cunda, and as to the other food, sweet rice and cakes, serve the monks with them. [Chap. IV, §18, p. 138]

The Buddha then said to Cunda,

> Whatever *s&umacr;kara-maddava* are left over to thee, those bury in a hole. [§19]

In a hole, not just throw away, and we are told that the surplus *s&umacr;kara-maddava* Cunda buried in a hole. Apparently Cunda had brought *s&umacr;kara-maddava* for the whole company, as he had thought all would share in them, so there must have been an ample surplus.

Then the Buddha added these remarkable words,

> I see no one, Cunda, on earth nor in Mara's heaven, nor in Brahma's heaven, no one among the Samaṇas and Br&amacr;hmaṇas, among gods, and men, by whom, when he has eaten it, that food can be properly assimilated, save by a *Tath&amacr;gata*. [§19]

Obviously the Buddha had recognized at once what he was being offered, the *s&umacr;kara-maddava*, and he knew the mushrooms were of a species that would shortly smell bad ('stink') if they were not eaten or buried in a hole. (To this day the custom among some Santal seems to survive to bury any surplus *s&umacr;kara-maddava* in a hole.) Perhaps it was the first time in his life that the Buddha, of kṣatriya origin, was being offered mushrooms to eat. But these particular mushrooms were familiar to him because of their unique role in the Hindu religion in which he had been brought up.

André Bareau appreciates to the full the solemnity of this dish of *s&umacr;kara-maddava*, though he did not know what it was. He says:

> ... cette nourriture, la dernière que consomme le Bienheureux avant son Parinirv&amacr;ṇa, est une nourriture en quelque sorte sacrée, dont les riches qualités, la puissance essentielle, vont lui permettre d'accomplir cet exploit surhumain, la suprême Extinction. Cette richesse, cette puissance sont trop grandes pour être supportées par les autres êtres, hommes ou dieux, qui n'auront jamais, et de loin, à exécuter une action comparable. [*Recherches sur la biographie du Buddha*. Tome 1, p. 271. Paris. 1970. Publications de l'Ecole Française d'Extrême-Orient, Vol LXXVII]

Here was the Buddha, at one of the two supreme moments of his life, unexpectedly offered at his last meal a dish that Hindus of the upper castes were forbidden to eat, an edible mushroom, a dish that was the surrogate for Soma when formally sacrificed in an utterly different manner and setting. Buddhaghoṣa quotes the Great Commentary (*Mah&amacr;-aṭṭhakath&amacr;*) as saying of Cunda's motives in offering this dish to the Buddha and his monks:

> They say that Cunda, the smith, having heard that the Exalted One would attain *parinibb&amacr;na* that day, thought it would be good if he could live longer after eating this dish, and offered it wishing for the Master's longevity. [p. 138 *infra*]

Walpola R&amacr;hula's comment on the Great Commentary from which we have extracted this quotation is as follows:

> The *Mah&amacr;-aṭṭhakath&amacr;* (Great Commentary) is the most important of the ancient original Sinhala commentaries dating back at least to the 3rd century B.C., on which are based the present available P&amacr;li commentaries of the 5th century A.C., including the Commentaries on the *D&imacr;gha Nik&amacr;ya* and the *Ud&amacr;na* from which these two commentarial passages are taken.

The Great Commentary cites hearsay ('They say...') as the reason that Cunda served those particular mushrooms on that day. The hearsay may be right, but if indeed Cunda felt the dish of *P&umacr;tika* would extend the life of the Buddha, he must have confused the properties of *Soma* and of the *P&umacr;tika*. The *P&umacr;tika* enjoyed a unique status as the exalted surrogate for *Soma*, but, whereas *Soma* was consumed, the *P&umacr;tika*, as Kramrisch quotes the sources,[3] were mixed with the clay and then fired ritually in the making of the Mah&amacr;v&imacr;ra pot and there is no reason to think that the Hindus of the three upper castes or even the Brahman hierarchs ate these fungi. Does not the text of the Great Commentary permit another interpretation: Cunda, a &sacute;&umacr;dra accustomed to eating the *P&umacr;tika*, served them because it was the season of the rains (which had started when the Buddha and his suite were in Vai&sacute;ali) and the mushrooms, which he had known all his life, were fresh from picking? If so, it was the Buddha who at once recognized them because of their role in the Hindu religion and stopped Cunda from serving them to the others. The Buddha was certainly not accustomed to eating mushrooms of an kind, and here he was being invited to eat those slimy mucoid excrescences, as the twice-born Hindus with loathing would view them. May not this, combined with the emotional tension of his imminent extinction, have provoked a recrudescence of his intermittent attacks of dysentery?

I now interrupt our account of the Buddha's progress on his last day to set forth certain discoveries bearing on *s&umacr;kara-maddava*.

The Santal and the *Putka*

By an accident of fortune the Santal people living now in western Bihar and Orissa have preserved for us, as though in a time capsule, the identity of the Sanskrit *P&umacr;tika*, a plant until recently unidentified, an ingredient in the clay of the Mah&amacr;v&imacr;ra vessel that was fired in the course of the Pravargya sacrifice. The *P&umacr;tika* is known as having been the surrogate for Soma,[4] though probably today by no Santal, and it figures conspicuously in the Br&amacr;hmaṇas and other early sacred Sanskrit texts. As I said before, it was identified by Kramrisch on the strength of evidence produced by Heim and me.[5] (Roger Heim, outstanding French mycologist, had served as President of the Académie des Sciences and was Director of the Muséum National d'Histoire Naturelle: he accompanied me on many of my field trips.)

The late Georg Morgenstierne, the Norwegian linguist, specialist in the Kafir and Dardic languages, also a Sanskrit and Persian scholar, first called my attention to an oddity of the Santal language of special interest to me, as it affected their mushroom vocabulary. Santali was not a specialty of his but he was a vast reservoir of general linguistic knowledge.

The Santal, who number some millions, live in villages scattered in the area of eastern Bihar known as the Santal Parganas, in the western north-and-south strip of West Bengal, and in Orissa as far south as the Simlipal Hills. The Santal are slight in build, neat in dress, with sleek, black hair and dark almost black regular features, their houses of red earth ornamented with curious painted geometric patterns and neatly disposed within and without, in these respects contrasting with the Hindus. By tradition they are food gatherers, hunters, fishermen, but are now taking to agriculture.

From the Indo-European point of view, the Munda languages, of which Santali is the biggest member, are peculiar: in Santali there are no genders, - no masculine, feminine, neuter. Their nouns are either animate or inanimate endowed with a soul or without a soul. The entire animal kingdom is animate, has a soul. The whole of the mineral kingdom is inanimate, without a soul. There are oddities: *eg*, the sun, moon, stars are animate. Strangely, the vegetable kingdom - herbs, shrubs, trees, the fungal world - is inanimate, but *with a single exception*, one species of mushroom, the *putka*. The Santal do not know why the *putka* is animate, or so they say. The *putka* is an underground fungus that is gathered for eating just as it appears, a snow-white little ball, in mycology identified by Heim as a *Scleroderma*, well known in Europe. In season it is commonly highly prized as food by the Santal, and much sought for by women and children.

For the last century the Norwegian Lutherans have made a vigorous play to be helpful in India by missionary activity among the Santal. The Rev. P. O. Bodding, a resident of the Santal Parganas from 1890 to 1934, mastered their language and compiled an admirable Santal-English dictionary in five large volumes, pointing out among other things the oddity of *putka*, which enjoyed in the vegetable kingdom the unique attribute of a soul. He could not explain this anomaly, nor did he venture an etymology for *putka*. But in the preface to his dictionary Mr. Bodding observed a noteworthy fact:

> Strangely enough, the Santals use some pure Sanskrit words, which, so far as I know, are not heard in the present day Hindi.

I visited Dumka in the Santal Parganas for the first time in January 1965. The Rev. A. E. Strønstad, Mr. Bodding's successor, and Mrs. Strønstad put me up and Mrs. Strønstad graciously served as my interpreter. We asked elderly and knowledgeable Santal in Dumka and the surrounding villages why *putka* was animate. No one could tell us. Our best informant turned out to be Ludgi Marndi, the widow of a native Lutheran pastor. She told us that there was one entheogenic mushroom.[6] Was it the *putka*? No, not at all. It was merely *ot*', 'mushroom' of the soulless class. No one was able to find an example of this inebriating mushroom, but the description (big, growing only in dung mostly of cattle, and white reaching an intense cream color in the umbolate center) tallied with *Stropharia cubensis*. Neither were there any *putka* at the time of my visit: they would come after the monsoon broke. Ludgi Marndi and some other informants suggested that the *putka* was animate because it was found regularly in the sacred grove of *sarjom* trees near every village. (Santali *sarjom* = Hindi *s&amacr;l = Shorea robusta*.) But the sacred *sarjom* trees were not animate so why should a mushroom growing from their roots be? Furthermore, the *putka* grew also in mycorrhizal relationship with other species of trees. Ludgi Marndi seemed an especially good informant and just before we were leaving for New Delhi, defeated as we thought, I asked if I might talk with her again. We went over the same ground. Suddenly she leaned forward across the table to Mrs. Strønstad and in a whisper (as translated to me) said that she would tell her why she thought the *putka* were animate: 'You must eat them within hours of gathering *for they will soon stink like a cadaver*.' She spoke under considerable emotion. We knew not what this meant but at once I jotted down her translated words in my notebook and her remark appeared later, somewhat toned down, in the paper[7] that Heim and I published.

---

[4] See Manfred Mayrhofer: *A Concise Sanskrit Etymological Dictionary*, entry under *p&umacr;tikaḥ*, also Vol. 3, p. 761.

My 1965 visit was followed by another with Heim in July-August 1967, he flying from Paris to Calcutta and I from New York. We started our quest in the Simlipal Hills and the village of Bisoï in Orissa, where the Santal and their close linguistic kin the Ho intermix, as well as several other peoples. Again we questioned the natives about why the *putka* were animate. In Nawana in the Simlipal Hills I spent the evening with Ganesh Ram Ho, the chief of the village, and he, as Ludgi Marndi had done, volunteered the information that there was an entheogenic mushroom, and his description tallied with Ludgi's; his testimony confirmed that it was probably *Stropharia cubensis* or a close cousin. (That these two excellent informants volunteered to speak of an inebriating mushroom, doubtless *Stropharia cubensis*, is a lead not to be neglected: it may have played a part in the cultural past of the Santal and of Soma.) But, just as before, it was '*ud*' and soulless. '*Ud*' is 'mushroom' in Ho.

We published the account of our trips to the Santal country in *Les Cahiers du Pacifique*, #14, September 1970. Kramrisch in time saw our paper and she grasped immediately that the *putka* of the Santal was the *P&umacr;tika* of the Br&amacr;hmaṇas, of the Pravargya sacrifice and the Mah&amacr;v&imacr;ra pot. The *P&umacr;tika* had been the surrogate for Soma and naturally it would possess a soul! Kramrisch deserves a rich accolade for discovering that Santali *putka* was a loanword from the Sanskrit *P&umacr;tika*. When Soma was being abandoned, probably over a long period that ended shortly after B.C. 1000, the *P&umacr;tika* took its place, not as an entheogenic drink like Soma in the earlier sacrifice but as a component with the clay in the ceremonial firing of the Mah&amacr;v&imacr;ra vessel. Its stench (of which Ludgi Marndi had spoken) was turned into fragrance when the pot, held by tongs, was fired in the course of the rite. No one had ever known what plant it was. We now know that, like Soma, it was a mushroom, but a common mushroom, and it possessed divine qualities though less than Soma's.

In Santal culture not only is the *putka* animate, endowed with a soul: it possesses another of Soma's attributes. The belief is apparently universal among the Santal that the *putka* is generated by (mythological) thunderbolts.[8] Long after the Brahmans have lost any use for or knowledge of this mushroom, and have lost all special contact with the Santal, these humble, hardworking people, untouchables, still believe that the *putka* is procreated by the lightningbolt, as the Vedic Brahmans believed that Soma was procreated by the Vajra of Indra, or Parjanya, the god of lightning. Here is another manifestation, another proof, of the breathtaking cultural intensity millennia ago of the religion of the hierarchs of the Aryans. The lightningbolt was thought of as the sperm, the spunk, fecundating the soft mother earth with the entheogenic mushrooms.

The Santal believe there are two kinds of *putka*, the *hor putka* and the *seta putka*, one smooth and the other rough. Heim said the two kinds were merely different stages in the life cycle of the one species. The *hor putka* is the 'man *putka*,' not in the sense of male but of a human being, or of the 'Santal' whom they naturally regard as *par exellence* the human being. The *seta putka*, which is rough, is the 'dog *putka*,' the dog not being

---

5. *Cahiers du Pacifique* #14, September, 1970: 'Les putka des Santals, champignons doués d'une âme.' p. 77. For those interested, the mushroom was *Scleroderma hydrometrica* (Pers.) H. var. *maculata* (Pat.) H. In Europe it breaks out into an *Astraeus*, but in India remains closed, a *Scleroderma*.
6. 'Entheogen' is a word devised by some of us for those plant substances that inspired Early Man with awe and reverence for their effect on him. By 'Early Man' we mean mankind in prehistory or proto-history, before he could read and write, whether long long ago or since then or even living today in remote regions of the earth. 'Entheogen' (or its adjective 'entheogenic') has the advantage that it does not carry the odor of 'hallucinogen,' 'psychedelic,' 'drug,' *etc*., of the youth of the 1960s. See *Journal of Psychedelic Drugs*, Vol. 11 (1-2), Jan-June 1979, pp. 145-6.

despised as it is in Hindu culture. A few of the Santal spoke to us of a third *putka*, the *rote putka* or 'toad *putka*.' Most Santal did not recognize this term and of those who did, most could not say what kind of mushroom it meant. But when we were in Kathikund, a village in the Santal Parganas, we witnessed from our veranda a violent midday thunderstorm and within hours and then throughout the night a host of puffballs appeared on the plain before our bungalow. One of our Santal companions told us with assurance that these were indeed *rote putka*. In this instance the puffball was *Lycoperdon pusillum* but probably any other puffball coming in response to a thunder shower would be a *rote putka*. In short, the *rote putka*, which is not eaten

---

7. See p. 123, fn. 2, p. 65.
8. See p. 123, fn. 2; *SOMA: Divine Mushroom of Immortality*, pp. 39-40.

by the Santal, is a false *putka*. ... The entheogenic mushrooms of which Ludgi Marndi and Ganesh Ram Ho had told us, probably *Stropharia cubensis*, are not *putka*: they are merely *ot*', or *ud* in the Ho language, enjoy no grammatical distinction in the languages, and so far as I learned no distinction in folklore. But it is imperative that this be explored much further. Does its entheogenic virtue account for the colored geometrical designs, endlessly varied, that decorate the exteriors of many Santal houses?

Throughout our visits to the Santal country the people we spoke with said that pigs dug for the *putka*, thus confirming what the canonical P&amacr;li Commentary on the *Ud&amacr;na* says of *s&umacr;kara-maddava*. But I was seeking a quotation and after returning to New York the Rev. Johannes Gausdal, a retired missionary living in Oslo, put me in touch with Mr. Gora Tudu, principal of Kaerabani High School, and we asked Mr. Tudu through Mr. Gausdal whether swine sought out the *putka* in the forest. Here is what he replied:

> Whether the pigs eat *putka* or not? In this case also I got some *putka* from the forests. I tried them on a few pigs - the old *putka* were not liked, but the new ones seemed to be delicacies of the pigs. They ate them with relish. Also in the forest I found at several bushes where *putka* usually come up several marks of upturned earth, indicating that the pigs had been digging for the *putka*. [Letter in my *Munda* file]

I was careful not to divulge the reason this question was being asked. There are a number of genera of underground fungi divided among scores of species, and I should be surprised if they all drew pigs but perhaps they do.

Mr. Gausdal asked also about the smell of aging *putka*. Mr. Tudu replied, with unconscious humor:

> I collected some *putka*, both *hor putka* and *seta putka*, and put them in dishes in dry condition as well as wet, just to see what the smell would be like after decomposition. In both the smell emitted was that of decomposing wood material, not at all bad in the sense of any blooded being. The smell was never too strong or filthy. The worst I could compare, the smell was that of rotting jute in muddy water.

Kramrisch tells me that rotting jute in muddy water creates a fearful stench. Mr. Tudu possesses the endearing quality of dirt farmers everywhere: their fondness for the smell of dung heaps, for example, is powerfully colored by what dung means for the crops. The earthy smells of farm yards also possess a likeable integrit.

The Gausdal-Gora Tudu correspondence was conducted in Santali, but my questions and his answers to them were in English.

We know that the Santal have not always lived where they do now. Six hundred years ago they lived to the west of Benares on the Chot&amacr; N&amacr;gpur plateau, and tradition has it that long before then the Santal had lived much further to the West, just where no one knows, but possibly near the ancient center of Brahmanical sacrifices, where they could have had close relations with the Aryans, perhaps serving them before and through the shift from Soma to the *P&umacr;tika*. This would also explain the other Sanskrit words in Santali that Mr. Bodding notes. Indeed he remarks in his preface to his Santal Dictionary that 'the description of the Dasyus in the Vedas and the Mah&amacr;bh&amacr;rata seems to be adaptable to many a Santal.'

The death of the Buddha

Having completed the Santal interpolation, we will now revert to the text of the *D&imacr;gha Nik&amacr;ya* as translated by the Rhys Davidses.

After the discussion of the *s&umacr;kara-maddava*, the Rhys Davids translation continues with an astonishing development:

> §20. Now when the Exalted One had eaten the rice prepared by Cunda, the worker in metals, there fell upon him a dire sickness, the disease of dysentery, and sharp pain came upon him, even unto death. But the Exalted One, mindful and self-possessed, bore it without complaint. [Chap. IV]

This was a disconcerting turn of events, since the Omniscient One has but lately said that he sees no one, save a Tath&amacr;gata, who can properly assimilate the *s&umacr;kara-maddava*, which he has just eaten. If the circumstances were invented, as Bareau thinks, what a strange set of circumstances for utterly devoted followers of the Buddha to have invented! The mushrooms, now that we know precisely, were sound and there was never a risk: moreover, aged *P&umacr;tika* would declare their age by their stench! And Cunda was a responsible man to buy and cook them. However, let us remember that in the upper Hindu castes where the Buddha had been brought up and lived out all his early life, even though he was now free from food tabus and caste distinctions, all mushrooms would be shunned as inedible; but here, at a critical moment of his life, he was being offered *P&umacr;tika*. Did Cunda know the role of the *P&umacr;tika* in the religion of the twice-born castes? Did he perhaps know it by rumor, inaccurately? Or did he not know it at all and was he serving these mushrooms solely for the excellent reason that they were fresh and in season? It is clear from the testimony of the *D&imacr;gha Nik&amacr;ya* that the attack suffered by the Buddha was sudden; it was violent; it alarmed the whole company; it was virtually over quickly, for not long afterward the Buddha instructed the faithful &Amacr;nanda that they should walk on to Kusin&amacr;r&amacr; close by. But what could be more natural than a violent reaction in one brought up as a kṣatriya to consider mushrooms inedible? And with his large intestine being chronically inflamed with dysentery, his diarrhoea was a natural sequence. 'Dysentery' is a translation of the P&amacr;li *lohita-pakkhandika*, which means 'bloody flux' in old-fashioned English.

The account in the *D&imacr;gha Nik&amacr;ya* is as though written to order for this explanation. Two quatrains, apparently independent of each other, are inserted in the text of the *D&imacr;gha Nik&amacr;ya* (§20, p. 139) at this point. Buddhaghoṣa adds a note: 'It should be understood that these are the verses by the Theras [Elders] who held the Council' the Council that took place at R&amacr;jagṛha, at which some months later the initial plans were laid for mobilizing detailed recollections of the Buddha's teachings and for organizing the Buddhist religion. The first quatrain shows how those present murmured against Cunda, and, according to the second, there was also murmuring about the mushrooms. Here are the quatrains in the Rhys Davids translation:

> When he had eaten Cunda's food,
> The copper-smith's-thus have I heard
> the bore with fortitude the pain,
> The sharp pain even unto death.
>
> When he had eaten, from the mushrooms [=*s&umacr;kara-maddava*] in the food
> There fell upon the Teacher sickness dire,
> Then after nature was relieved the Exalted One announced and said:
> I now am going on to Kusin&amacr;r&amacr;

After the episode the Exalted One went out of his way to exonerate Cunda of blame, thus making even more tenable my explanation of his illness. For if Cunda had been guilty of negligence in choosing the mushrooms, why should the Omniscient One have exonerated him?

> 42. And the Exalted One addressed the venerable &Amacr;nanda, and said: - 'Now it may happen, &Amacr;nanda, that some one should stir up remorse in Cunda the smith, by saying: - "This is evil to thee, Cunda, and loss to thee in that when the Tath&amacr;gata had eaten his last meal from

> thy provision, then he died." Any such remorse, &Amacr;nanda, in Cunda the smith should be checked by saying: - "This is good to thee, Cunda, and gain to thee, in that when the Tath&amacr;gata had eaten his last meal from thy provision, then he died." From the very mouth of the Exalted One, Cunda, have I heard, from his own mouth have I received this saying: - "These two offerings of food are of equal fruit, and of equal profit and of much greater fruit and much greater profit than any other-and which are the two? The offering of food which, when a Tath&amacr;gata has eaten, he attains to supreme and perfect insight; and the offering of food which, when a Tath&amacr;gata has eaten, he passes away by that utter passing away in which nothing whatever remains behind these two offerings of food are of equal fruit and of equal profit, and of much greater fruit and much greater profit than any others. There has been laid up by Cunda the smith a karma redounding to length of life, redounding to good birth, redounding to good fortune, redounding to good fame, redounding to the inheritance of heaven, and of sovereign power." In this way, &Amacr;nanda, should be checked any remorse in Cunda the smith.' (p. 147-8)

Bareau concedes that Cunda and P&amacr;v&amacr; may be original elements but, if so, thinks that they are the sole original elements in the narrative of the Buddha's stay in P&amacr;v&amacr;:

> Deux siècles après le Parinirv&amacr;ṇa, ces deux noms, ici P&amacr;v&amacr; et Cunda, étaient les deux seuls éléments anciens, peut-être même historiques, de l'épisode du dernier repas du Buddha. Aucun souvenir n'avait donc été conservé ni des incidents qui avaient pu s'y produire ni de la nature précise des aliments qui avaient été servis alors au Bienheureux. [Tome I, p. 258 in his *Recherches sur la biographie du Buddha*, Ecole Française d'Extrême Orient]

Perhaps in the light of our discoveries Bareau may grant more to the history of the Buddha's Last Meal in P&amacr;v&amacr; as told in the *D&imacr;gha Nik&amacr;ya*. Too many had witnessed the episode with the mushrooms to permit the Theras to suppress it: his sudden illness had provoked too much talk.

Here is the account of the Buddha's death according to the *D&imacr;gha Nik&amacr;ya*, Chap. V,

> 1. Now the Exalted One addressed the venerable &Amacr;nanda, and said: - 'Come, &Amacr;nanda, let us go on to the S&amacr;la Grove of the Mallas, the Upavattana of Kusin&amacr;r&amacr;, on the further side of the river Hiranyavat&imacr;.'
> 'Even so, lord!' said the venerable &Amacr;nanda, in assent, to the Exalted One.
> And the Exalted One proceeded with a great company of brethren to the S&amacr;la Grove of the Mallas, the Upavattana of Kusin&amacr;r&amacr;, on the further side of the river Hiranyavat&imacr;: and when he had come there he addressed the venerable &Amacr;nanda, and said:
> 'Spread over for me, I pray you, &Amacr;nanda, the couch with its head to the north, between the twin S&amacr;la trees. I am weary, &Amacr;nanda, and would lie down.'
> 'Even so, lord!' said the venerable &Amacr;nanda, in assent, to the Exalted One. And he spread a covering over the couch with its head to the north, between the twin S&amacr;la trees. And the Exalted One laid himself down on his right side, with one leg resting on the other; and he was mindful and self-possessed.
>
> In a note on this passage the Sinhala commentator added an explanation:
>
> Tradition says that there was a row of S&amacr;la trees at the head of that couch, and another at its foot, one young S&amacr;la tree being close to its head, and another close to its foot. The twin S&amacr;la trees were so called because the two trees were equally grown in respect of the roots, trunks, branches, and leaves. There was a couch there in the park for the special use of the (periodically elected) chieftain of the Mallas, and it was this couch which the Exalted One asked &Amacr;nanda to make ready. (Ftnt. p. 149)

In the last watch of the night the Buddha died, precisely as he had been predicting for three months, since he was in Vai&sacute;ali.

There have been individuals in various parts of the world, and especially among the holy men of India, who have acquired by 'concentration' (*sam&amacr;dhi*) control over some of the muscles that ordinarily function in response to stimuli beyond the human will. A. L. Basham has remarked on this in *The Wonder That Was India*, p. 327:

> The ancient mystical physiology of India needs further study, not only by professional Indologists, but by open-minded biologists and psychologists, who may reveal the true secret of the yog&imacr;. For whatever we may think about his spiritual claims there is no doubt that the advanced yog&imacr; can hold his breath for very long periods without suffering injury, can control the rhythm of his own heartbeats, can withstand extremes of heat and cold, can remain healthy on a starvation diet, and, despite his austere and frugal life and his remarkable physical contortions, which would ruin the system of any ordinary man, can often survive to a very advanced age with full use of his faculties.

Basham fails to mention that occasionally death is the goal of this 'concentration,' but there is no reason to question that death can be the purpose of such an act of will. In recent years, when death has been the end result of this manifestation of will power, *mah&amacr;sam&amacr;dhi* has sometimes been the term used when speaking of it.

The Buddha predicted the day of his death three months before and thenceforward announced freely the time and place of his own extinction. After his Last Meal the narrative says that on his initiative he walked the short distance to Kusin&amacr;r&amacr;. Since the time of his death, no Hindu, no Buddhist, has ever suggested that he died of mushroom poisoning. His death has not provoked discussion among Buddhists. Knowing as we now do what the mushrooms were that Cunda served, they could have provoked a stomach upset in a Hindu mycophobe but they could not have caused his death. He died of his own will power, of his own *mah&amacr;sam&amacr;dhi*. Or, rather than provoking his own death, did he not use yogic power, under trying circumstances, to postpone his translation to *nirv&amacr;na* until he had reached his place of choice?

The surrogate for Soma explains and justifies the extraordinary words used by the Buddha in limiting to himself alone this dish. By consigning to a hole the surplus *P&umacr;tika*, he showed himself familiar with its everyday properties. Now that we know the precise properties of this mushroom, its etymology as cognate with 'putrid' is clarified, and its strong link with Soma is a good explanation for the Santal belief that it is generated by the divine lightningbolt.

Up to this point we have concentrated on only one source-the canonical P&amacr;li Text of the *D&imacr;gha Nik&amacr;ya* - for our details about the life of Buddha. It is the Holy Scripture of the Theravadin branch of Buddhism with its headquarters in &Sacute;r&imacr; Laṅka. There are, in addition, five other master recensions of his life, four in Chinese and one in Sanskrit. All five mention the stop in P&amacr;v&amacr; and name Cunda as the host there, but none of them mentions *s&umacr;kara-maddava*. An obvious explanation for this omission is that the Chinese are natural mycophiles: they eat with relish all kinds of edible mushrooms and they know their mushrooms. They would not understand why the Buddha honored the *P&umacr;tika*, saying he alone could digest it. For the Chinese all this would have been incomprehensible.

The Buddha and his followers were mostly Hindus of the upper castes who had withdrawn from obedience to the Hindu religion. When the Theras assembled at R&amacr;jagṛha, they were inevitably, even if they were rebels, heirs to the infinite complexity of habits, practices, subtle ways of thinking and feeling of the Brahmanic religion. When Buddhism became a world religion, it liberated itself from the Brahmanic religion and this included the mighty tradition of Soma and the Vedic hymns, and of course from the less powerful hold of the *P&umacr;tika*. In the early days of Christianity, before it became a world religion, the pull of Jewish ways such as circumcision and the ban on pig-meat exerted influence on Jewish converts to Christianity, and the early Church faced a parallel conflict.

The Buddha's last meal

The episode at P&amacr;v&amacr; lends itself to various explanations; the written record contains a number of anomalies. If we were to offer the solution that we think is most likely, here it is.

There is only the Commentary on the *Ud&amacr;na*, which Buddhaghoṣa presented as hearsay, to show that Cunda the &sacute;udra knew of the use made by the Brahmans of the *P&umacr;tika*. Cunda certainly knew this mushroom as a universal favorite among mushroom eaters when it was in season and it was in season right then: he was taken aback when the Buddha recognized the mushroom and asked him, in astonishing language unfamiliar to his ears, to serve them to the Buddha only. Cunda had done himself proud in assembling mushrooms for the whole company, and now he was forbidden to give them to the guests or even to himself.

Shortly after the Buddha had eaten his mushrooms with rice he fell violently ill. This must have caused Cunda consternation and chagrin. Alarm was felt, and there was murmuring against Cunda and the mushrooms in the assembly, for all or almost all were twice-born men and had been indoctrinated against mushrooms. We can imagine Cunda's embarrassment but we have no information: an opaque cloud of silence falls over him.

In the *D&imacr;gha Nik&amacr;ya* the Buddha exonerates Cunda, somewhat stiltedly under the circumstances. Perhaps everyone remembered that the Buddha had spoken up for Cunda and many had heard him but none could recall what precisely he had said. Someone seems to have drafted the paragraph much later. The fitting exoneration of Cunda demonstrated the thoughtfulness and the nobility of the Buddha under most trying circumstances.

Was not '*s&umacr;kara-maddava*' introduced in place of *P&umacr;tika* at R&amacr;jagṛha to avoid confusing people as to the Buddha's attitude toward the Old Religion? He showed an attitude toward the *P&umacr;tika*, and he reacted to them, in a way that we today, under the circumstances, can understand for the first time.

And as for the diverse explanations in the two canonical Commentaries for *s&umacr;kara-maddava*, they may have been introduced at R&amacr;jagṛha also, or perhaps more likely late in A&sacute;oka's reign when the need for an explanation became increasingly felt by the Buddhist community. No theological importance was ever given, then or later, to the P&amacr;v&amacr; episode because, after all, the Buddha was under acute stress at the time, what with his illness, his imminent extinction freely predicted since he was in Vai&sacute;ali three months before the episode at P&amacr;v&amacr;, and the unexpected dish of *P&umacr;tika* that suddenly confronted him. There had been far too much talk among those present to suppress the episode, but obviously the *P&umacr;tika* was not to be identified plainly. The *s&umacr;kara-maddava* was a way to tell the truth but still to interpose obstacles to its understanding. The word may have been a neologism invented *ad hoc*.

Now we see for the first time in how dramatic a predicament the Brahman proscription on mushrooms for the twice-born castes accidentally involved the Buddhist religion at the very moment of its birth. We still do not know we will probably never know when that proscription came into force, perhaps over centuries while the Vedic hymns were being composed, or possibly when the hierarchs among the Brahmans learned of the entheogenic virtues of *Stropharia cubensis* as known to the lower orders living in India, or when Soma was finally abandoned and the *P&umacr;tika* adopted as its surrogate. But we do know how effectively the Buddhist Theras fudged the facts in the *D&imacr;gha Nik&amacr;ya*, until an inquirer 2,500 years after the event appeared, assembled the evidence, and with the help of Georg Morgenstierne, Roger Heim, Stella Kramrisch, Wendy Doniger O'Flaherty, and above all of the Santal people, fitted together the jigsaw pieces.

The Indus Valley and Kashmir

When we published *SOMA Divine Mushroom of Immortality* in 1968 I pointed out in it that in the 1028 hymns of the *Rig Veda* there was never a mention of the blossoms, fruit, seed, leaves, branches, bark, or roots of the plant-a telling clue where to look for the divine herb. But there was another botanical fact that deserved full recognition, but I had not yet focussed on it.

Botanists divide plants between phanerogams and cryptogams. The phanerogams include all flower- and seed-bearing plants, whether trees, shrubs, creepers or climbers, herbs and grasses, whether cultivated or uncultivated. The cryptogams are lower orders of vegetation, less developed along the evolutionary trail, and the mushrooms are the cryptogams that interest us. Only in recent centuries have three or four species out of thousands lent themselves to commercial exploitation, and a meager handful also to expensive cultivation in laboratories. In Aryan times, in the Indus Valley and Kashmir, there was the widest variety of climate, owing to the variety of accidented terrain therein-lofty mountains, low lying plains, valleys, wetlands, arid stretches-and any needed phanerogam could probably have been grown in some part of that large country. *But only those mushrooms grew there that the country produced spontaneously*. Since we know that the supply of Soma was limited at best to the mountains and must have been further reduced when the monsoon failed, conforming to what we know about Soma in Vedic times, this points to the entheogenic mushroom *Amanita muscaria* for their Soma. That the birch and also the conifers act as hosts to *A. muscaria* was not realized by anyone among the Aryans, and therefore no one thought of planting the host trees to see whether by this means man could thus increase the yield of the holy plant.

Other fungal entheogens grow at the lower levels. They come in cattle dung, are easily identified and gathered, and are effective. But they fail to conform to Brahman practices: they are known to tribals and sudras. Soma on the other hand exacts self-discipline of the priests, a long initiation and training: it is, for proper exploitation, an affair of a priestly *élite*. But the possible role of *Stropharia cubensis* growing in the dung of cattle in the lives of the lower orders remains to this day wholly unexplored. Is *S. cubensis* responsible for the elevation of the cow to a sacred status? And for the inclusion of the urine and dung of cows in the *pañcagavya*? And was that a contributing reason for abandoning Soma? Given the ecological conditions prevailing in the Indus Valley and Kashmir, only a few of the Aryans could know by personal experience the secrets of the Divine Herb. The cult of Soma must have been shaped by the peculiar circumstances prevailing in the area, but ultimately those circumstances must have doomed that cult. Today it lives on in India only as an intense and glowing memory of an ancient rite.

Under the British Raj the rich and diverse vegetation of India was admirably studied, and George Watt's encyclopaedia *Dictionarv of the Economic Products of India*, 1889-1896, in eleven volumes, edited and partly written by him, is a major legacy of the British rule in India. However, the mycophobic British did little to advance knowledge of mycology, and the Hindus nothing. No one ever suggested a mushroom for Soma, let alone *A. muscaria*. Our *SOMA* came out in 1968 but no *A. muscaria* since then has yet been found in Pakistan or Kashmir: there have been numerous reports of finds but voucher specimens have not been deposited in herbaria. Dr. Roy Watling, mycologist of the Royal Botanic Garden of Edinburgh, spent three weeks in the field in 1978 on a general survey of the Kashmir area, in the vicinity of Srinagar. He collected in stands of birch in two areas but he arrived there late in the growing season and moreover the season was dry. In his printed report[9] he writes, 'The species *A. muscaria* is almost certainly native to the *Betula*-zone of northern India.' There he found *Betula utilis* from 9,000 feet up to the timber line at 10,500 feet but no *A. muscaria*. In the Northwestern Himalayas the birch grows intermixed with Rhododendron in scrub-vegetation up to 11,500 feet.

We may think we are feeling the frustrations of the Aryans but by comparison with them we are making only lackadaisical efforts to find a few voucher specimens, whereas the Brahmans must have developed urgent need for quantities of fruiting bodies to dry, and then to reflate, and bring to the pressing stones. Their needs must have been constantly increasing with the increasing population. Whatever may have been the case later, the relations at first with the natives were surely hostile. The natives seem to have come to occupy the intermediate mountain heights, precisely where *A. muscaria* grows and where the *Rig Veda* time and again says Soma grows. As we know from the *&Sacute;atapatha Br&amacr;hmaṇa*, the Brahmans depended for their Soma supplies, in large part at least, on the natives living in the mountains. The supply depended on the weather and the state of the relations with the natives, whereas the needs were swelling with every generation. The Brahmans must have found it in their interest to cultivate the Dasyus and the Dasyus would have found it advantageous to discover every spot where *A. muscaria* grew, above all the stands of birch but also other host trees. (*A. muscaria* has been reported lately from Tamilnadu, especially from the Nilgiri Hills, in Southern India, but its presence there has been attributed by mycologists to plantings of exotic conifers in the past century.) Most of the Soma sacrifices must have used make-do phanerogamic substitutes and in the post-Vedic Br&amacr;hmaṇas and other writings we learn how the priests from early times faced this scarcity with such make-do plants.

The Brahmans probably continued to trade with the mountains of Afghanistan seeking Soma, and with the Hindu Kush, but there is no knowing whether these tribesmen were friendly, perhaps intermittently. The *Afghanistan Journal* 6.2, 1979, announced the finding of *A. muscaria* in Nuristan, in the Shetul Valley high in the Hindu Kush in the extreme northeast of the country. The authors, Gholam Mochtar and Hartmut Geerken of Kabul, talked with three old codgers, ostensibly *habitués* of the "ravens' bread,"claimed to be *A. muscaria* from which an inebriating concoction is made. The episode is insufficiently documented to permit conclusions about its bearing on *Amanita muscaria* and the Soma question. Their report antedates the Russian invasion.

---

9. Watling, Roy and Norma M. Gregory: 'Larger Fungi from Kashmir,' *Nova Hedwigia*, Band XXXII, Brunswick, 1980, J. Cramer.

The use of substitutes by the Aryans must have been a reluctantly adopted practice from the start. They are mentioned for the first time in the last batch of hymns incorporated into the canon, Mandala X 85 through to the end, 191. In *SOMA* we failed to take into consideration these hymns of Mandala X, since they were admitted to the canon at a late stage, shortly before the Vedic age ended. But some years ago Professor Clifford Wright, in a lecture delivered at Cambridge University, took the position that many of those hymns, the last to be admitted to the canon, on strong stylistic grounds were by no means the last to be composed. There is a verse in these hymns that speaks of the substitutes. That hymn may well have been composed centuries earlier:

> *Rig Veda* X 85.3: One thinks one drinks Soma because a plant is crushed. The Soma that the Brahmans know - that no one drinks.

This conforms to our present thinking: the scarcity of Soma was not to be explained by the spread of the Aryans southward, then eastward down the Yamun&amacr; and beyond the confluence with the Ganges. The scarcity had always existed, and the make-do substitutes had been a chronic problem.

Memorandum by Walpola R&amacr;hula of the early sources for the meaning of *s&umacr;karamaddava*

The original Canonical P&amacr;li passage from the *Mah&amacr;parinibb&amacr;nasutta* of the *D&imacr;ghanik&amacr;ya*, P&amacr;li Text Society edition (London 1966), Vol. II, p. 127:

> *Atha kho Cundo kamm&amacr;raputto tass&amacr; rattiy&amacr; accayena sake nivesane paṇ&imacr;taṃ kh&amacr;daniyaṃ bhojaniyaṃ paṭiy&amacr;d&amacr;petv&amacr; pah&umacr;tañ ca s&umacr;karamaddavaṃ Bhagavato k&amacr;laṃ &amacr;roc&amacr;pesi: 'K&amacr;lo bhante, niṭṭhitaṃ bhattan'ti.*

Translation:

> Then at the end of that night, Cunda, the smith, having made ready in his house hard and soft delicious food, and also a big quantity of *s&umacr;karamaddava*, announced the time to the Exalted One, saying: 'The time, Lord, has come, the meal is ready.'

In explaining *s&umacr;karamaddava* in this passage the P&amacr;li Commentary of the *D&imacr;ghanik&amacr;ya*, *Sumaṅgalavil&amacr;sini*, P&amacr;li Text Society ed. (London, 1971), Vol. II, p. 568, gives three different opinions:

> *S&umacr;karamaddavan ti n'&amacr;titaruṇassa n'&amacr;tijiṇṇassa ekajeṭṭhakas&umacr;karassa pavattamaṃsaṃ. Taṃ kira muduñ c'eva siniddhañ ca hoti. Taṃ paṭiy&amacr;d&amacr;petv&amacr; s&amacr;dhukaṃ pac&amacr;petv&amacr;'ti attho.* (Colombo ed. of the *Sumaṅgalavil&amacr;sin&imacr;*, Part 1, (1918) p. 395 adds within brackets): [*Eke bhaṇanti: s&umacr;karamaddavaṃ pana muduodanassa pañcagorasa - y&umacr;sap&amacr;canavidh&amacr;nassa n&amacr;mam etan'ti yath&amacr; gavap&amacr;naṃ n&amacr;ma p&amacr;kan&amacr;maṃ. Keci bhaṅanti: s&umacr;karamaddavaṃ n&amacr;ma ras&amacr;yanavidhi, taṃ pana ras&amacr;yanasatthe &amacr;gacchati, taṃ Cundena Bhagavato parinibb&amacr;naṃ na bhaveyy&amacr;'ti ras&amacr;yaṃ paṭiyattan'ti.*]

Translation:

> *S&umacr;karamaddava* means meat available (in the market) of an excellent (first-rate) pig

> neither too young nor too old. This is soft and fatty. 'Having made it ready': having cooked it well is the sense. (Some say: *s&umacr;karamaddava* is the name for a culinary preparation of soft rice made into a broth with the five products of the cow,[10] just as *gavap&amacr;na* is the name of a culinary preparation. Others say: *s&umacr;karamaddava* is a chemical preparation [elixir]. It is found in the science of chemistry. That chemical preparation [elixir] was made by Cunda thinking that the *parinibb&amacr;na* of the Exalted One might not take place.)

The story of Cunda offering *s&umacr;karamaddava* to the Buddha occurs exactly in the same way in another canonical P&amacr;li text, *Ud&amacr;na*. The *Paramatthajotik&amacr;*, Commentary on the *Ud&amacr;na* (Colombo, 1920), p. 279, in explaining *s&umacr;karamaddava* gives four different opinions:

> *S&umacr;karamaddavan'ti s&umacr;karassa mudusiniddhaṃ pavattamaṃsan'ti Mah&amacr;aṭṭhakath&amacr;yaṃ vuttaṃ. Keci pana s&umacr;karamaddavan'ti na s&umacr;karamaṃsaṃ, s&umacr;karehi madditavaṃsakal&imacr;ro'ti vadanti. Aññe: s&umacr;karehi madditappadese j&amacr;taṃ ahicchattan'ti. Apare pana s&umacr;karamaddavaṃ n&amacr;ma ekaṃ ras&amacr;yanan'ti bhaṇimsu. Tañ hi Cundo kamm&amacr;raputto ajja Bhagav&amacr; parinibb&amacr;yissati't&imacr; sutv&amacr; 'appeva n&amacr;ma naṃ paribhuñjitv&amacr; cirataraṃ tiṭṭheyy&amacr;'ti Satthu ciraj&imacr;vitukamyat&amacr;ya ad&amacr;s&imacr;'ti ti vadanti.*

Translation:

> It is said in the Great Commentary (*Mah&amacr;aṭṭhakath&amacr;*)[11] that *s&umacr;karamaddava* is soft and fatty pork (flesh of pig) available (in the market). But some say: *s&umacr;karamaddava* does not mean pork (flesh of pig), but bamboo shoot (bamboo sprout) trodden by pigs; others say that it is mushroom grown on a spot trodden by pigs; still others have maintained that *s&umacr;karamaddava* is a certain elixir. They say that Cunda, the smith, having heard that the Exalted One would attain *parinibb&amacr;na* that day (lit., today) thought that it would be good if He could live longer after eating this (preparation), and offered it wishing the Master's longevity.

Epilogue

When I began working with Gordon Wasson on *SOMA*, almost twenty years ago, we had, at first, no suspicion that Soma might have been a mushroom: we just wished to collect the texts relating to Soma and look at them with a botanical as well as an Indological eye. It was only when I casually mentioned to RGW the urine-drinking, Soma-drinking episode in the *Mah&amacr;bh&amacr;rata* that he thought of *Amanita muscaria* as a possible identity for Soma, but from that moment on he became increasingly convinced that this was the case. I was certain that the evidence proved Soma was an entheogen (we called it an hallucinogen then), and that it was not a form of alcohol (as had been theretofore widely believed) but was a drug provoking an ecstasy of a very special kind. Here is a truth of great importance in the study of later Indian religion and this was the major contribution that RGW had made to Vedic studies.

I was, however, not yet convinced that Soma was a mushroom. I felt that the arguments rested primarily on the interpretation of adjectives, many of them words for colors, and mythological traits, many of which applied to other gods as well, permitting other interpretations as well as the interpretation that identified Soma with the fly-agaric. As an Indologist, rather than a botanist, I still feel that the broader hypothesis-that Soma was an entheogen-is more significant than the narrower one-that it was a mushroom. Over the years, however, the new evidence that RGW has brought to light, particularly the evidence linking the Buddha's last meal to Soma through the double links of the Vedic *P&umacr;tika* and the Santal *putka*, does in fact make it seem likely that Soma was a mushroom, as RGW believed from the first moment, and, when we recall the religious role of urine mentioned above, specifically the fly-agaric. But each of the three levels of the hypothesis-that Soma was an entheogen, a mushroom, and the fly-agaric-adds a valuable dimension to our understanding of both Vedic and post-Vedic religion.

---

[10] Five products of the cow: 1) milk, 2) curd, 3) buttermilk, 4) fresh butter, 5) clarified butter (ghee). W. R. [Walpola R&amacr;hula is a Buddhist monk of our day and he renders in English the Sanskrit word *pañcagavya* as befits our times. In the past, for millennia *pañcagavya* represented: 1) milk, 2) coagulated or sour milk, 3) butter, 4) urine, and 5) dung. R.G.W.]

Wendy Doniger O'Flaherty
Chicago
January 15, 1982

---

11. The *Mah&amacr;aṭṭhakath&amacr;* (Great Commentary) is the most important of the ancient original Sinhala commentaries dating back at least to the 3rd century B.C., on which are based the present available P&amacr;li commentaries of the 5th century A.C., including the Commentaries on the *D&imacr;ghanik&amacr;ya* and the *Ud&amacr;na* from which these two commentarial passages are taken. W. R.

CHAPTER FIVE

Carved 'Disembodied Eyes' of Teotihuacan

by Jonathan Ott[1]

Situated a few hours' drive northeast of Mexico City are the magnificent ruins of Teotihuacán, dating from the beginning of the first millennium AD. Best known for two large, stepped pyramids (Pyramids of the Sun and Moon) and the smaller, more ornate Pyramid of Quetzalcoatl, the ruins abound in numerous low, labyrinthine buildings which are decorated with beautiful and complex mural paintings. The comparatively well preserved Tepantitla murals are best known to scholars, a prominent segment having been restored and repainted in the Teotihuacán room of the Museo Nacional de Antropologia in Mexico City by Augustín Villagra Caleti. Portions of many other murals survive at Teotihuacán, while some, such as the important Zacuala murals, which are unprotected from the elements, are scarcely visible today.

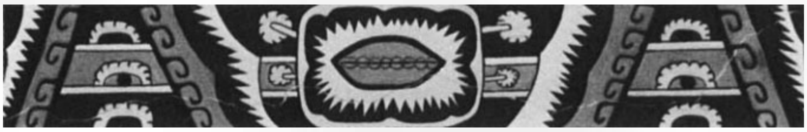


Fig. 1. 'Predella' from Zacuala, Teotihuacán, repainted by Abel Mendoza, who caught them before they disintegrated. Notice 'disembodied eyes' flanking central motif representing four mushrooms surrounding the radiant 'logos'.

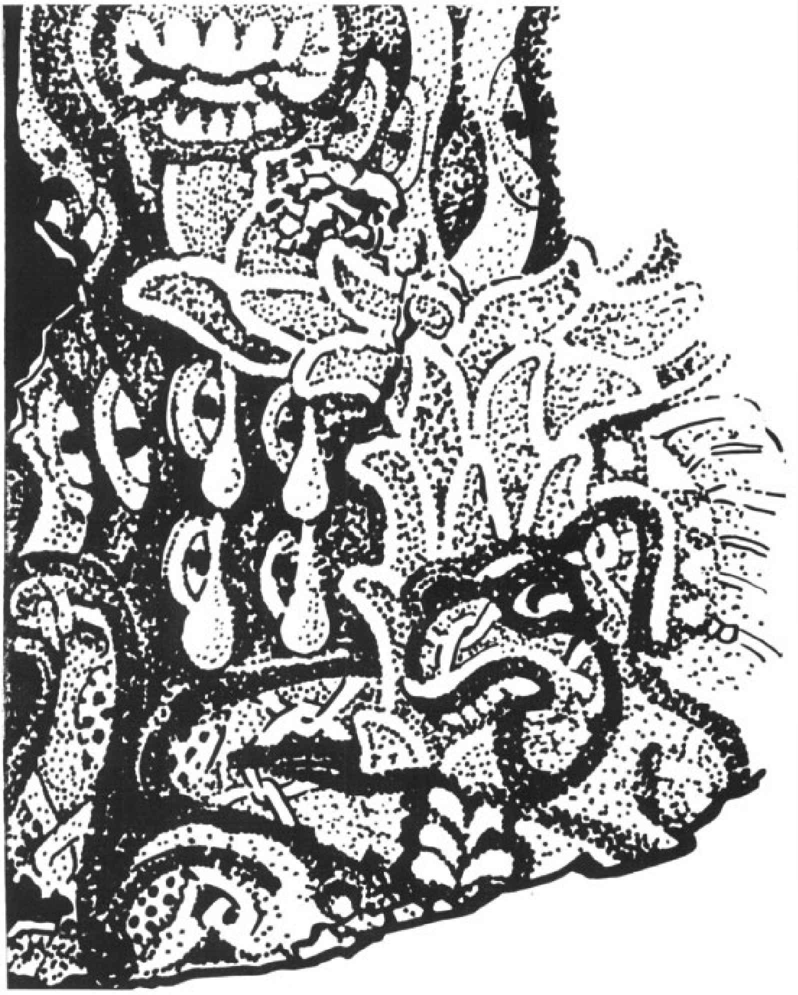
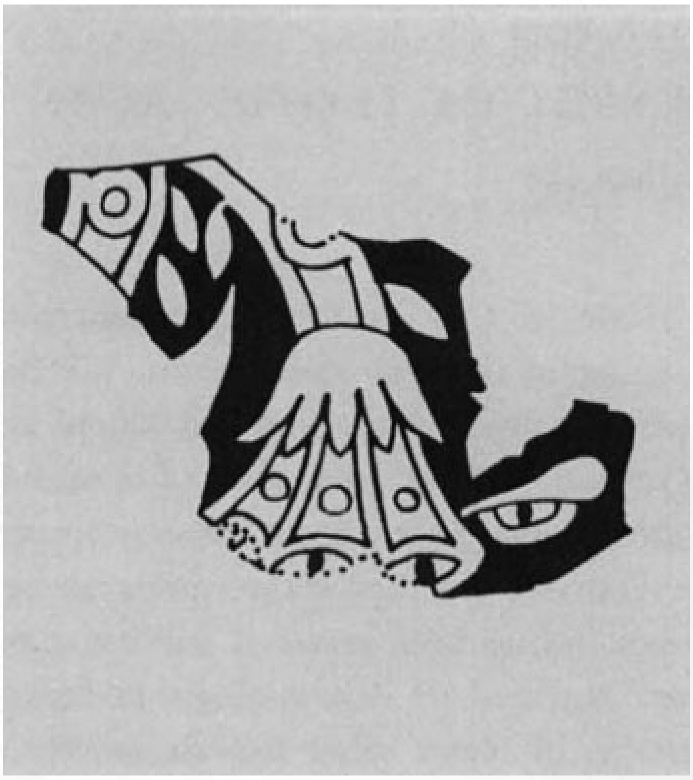


Fig. 2. Drops of entheogenic potion with appended 'disembodied eyes' from Teotihuacán murals. Reproduction by Margaret Seeler.

---

[1] President, Natural Products Co., P.O. Box 273, Vashon, Wa., 98070.



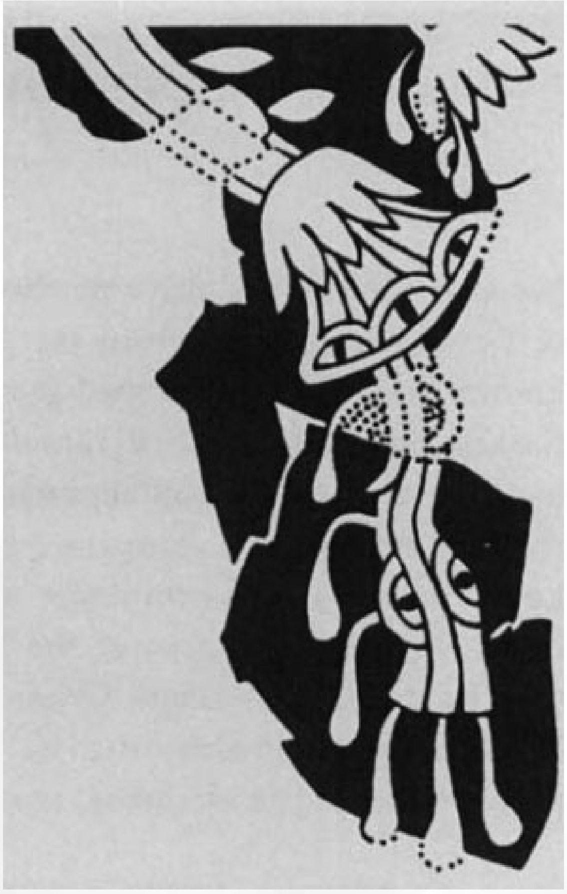


Fig. 3 & 4. Drops of entheogenic potion and appended 'disembodied eyes' issuing from entheogenic flowers. Reproduction of fragments of Tepantitla murals by Margaret Seeler.

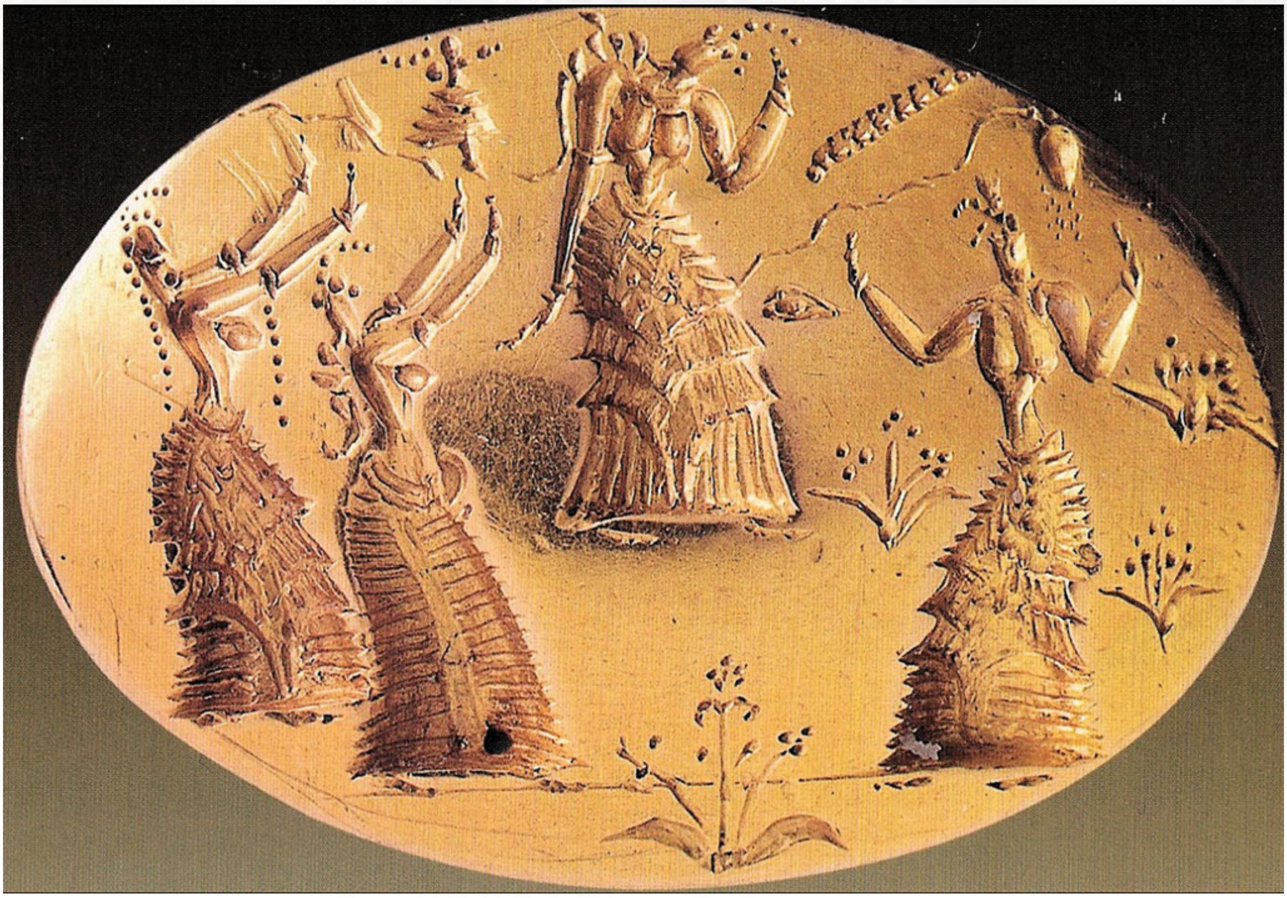


Fig. 5. Gold ring of Isopata near Knossos, greatly enlarged. Scene depicts epiphany of goddess (presumably Artemis) on the right, and four worshippers, all represented as anthropomorphic bees. Note 'disembodied eye' in center, and plants (presumably entheogenic) surrounding goddess.

In his 1973 book *The Mural Painting of Teotihuacán*, Arthur G. Miller[a] drew attention to the prominence of the 'disembodied eyes' that occur repeatedly in the mural paintings of Teotihuacán. Figures 1-4 illustrate some typical examples of the recurrent 'disembodied eyes' motif. During a recent visit to Teotihuacán, I was struck by the ubiquity of these 'disembodied eyes', indeed, it was difficult to escape the sensation of being watched constantly.

I here comment on the existence of 'disembodied eyes' in relief carvings at Teotihuacán. The carvings are found on columns in a courtyard of a structure known as the Palace of Quetzalpapálotl,[2] located at the west corner of the square adjacent to the Pyramid of the Moon (Fig. 6 & 7). The face of each column in the courtyard is adorned with two rows of four 'disembodied eyes' arrayed above and beneath a carving of a bird (Fig. 8). The carved eyes are realistic and are inlaid with obsidian 'pupils' (Fig. 9 & 10). The identification of the carvings as eyes is unequivocal - witness the corresponding inlay of obsidian to the eyes of the creature in the carvings, which represents a chimera called Quetzalpapálotl, 'quetzal bird/butterfly' (Fig. 8). It is perhaps significant that the eye of the bird is round, as in nature birds' eyes appear, whereas the 'disembodied eyes' are distinctly anthropomorphic, with upper and lower 'eyelids' giving the 'eyeballs' an ovoid shape. On the north, south, and east sides of the courtyard, the columns identically depict the avian chimera in profile (Fig. 8), whereas the columns on the west side show a frontal view, possibly of the same creature (Fig. 11).[3] The columns are surmounted by a broad lintel painted with a repeated motif, which in turn is crowned by a series of carved stone 'combs' (Fig. 12).

Fig, 6. Looking north at Teotihuacán, with Pyramid of the Moon at right and Palace of Quetzalpapálotl at left in foreground.

---

2. The Palace of Quetzalpapálotl was excavated in 1962 and summarily restored under the direction of Mexican archaeologist Jorge R. Acosta. The structure dates from the sixth century AD, belonging to the Teotihuacán III and IV eras. Details of the excavation and restoration can be found in Acosta's book *El Palacio del Quetzalpapálotl* (Institute Nacional de Antropología e Historia, México, 1964).
3. Scholars have differed on the question whether one or two birds are here depicted. In a recent paper (*Ethnos* 32: 5-17, 1967) Arthxir G. Miller summarizes the evidence and concludes that the bird depicted frontally represents an owl, whereas the bird depicted in profile represents the quetzal. Acosta, in his comments regarding his reconstruction of the columns, identified the profile birds as quetzal bird/but terfly chimeras, hence the name Quetzalpapálotl.

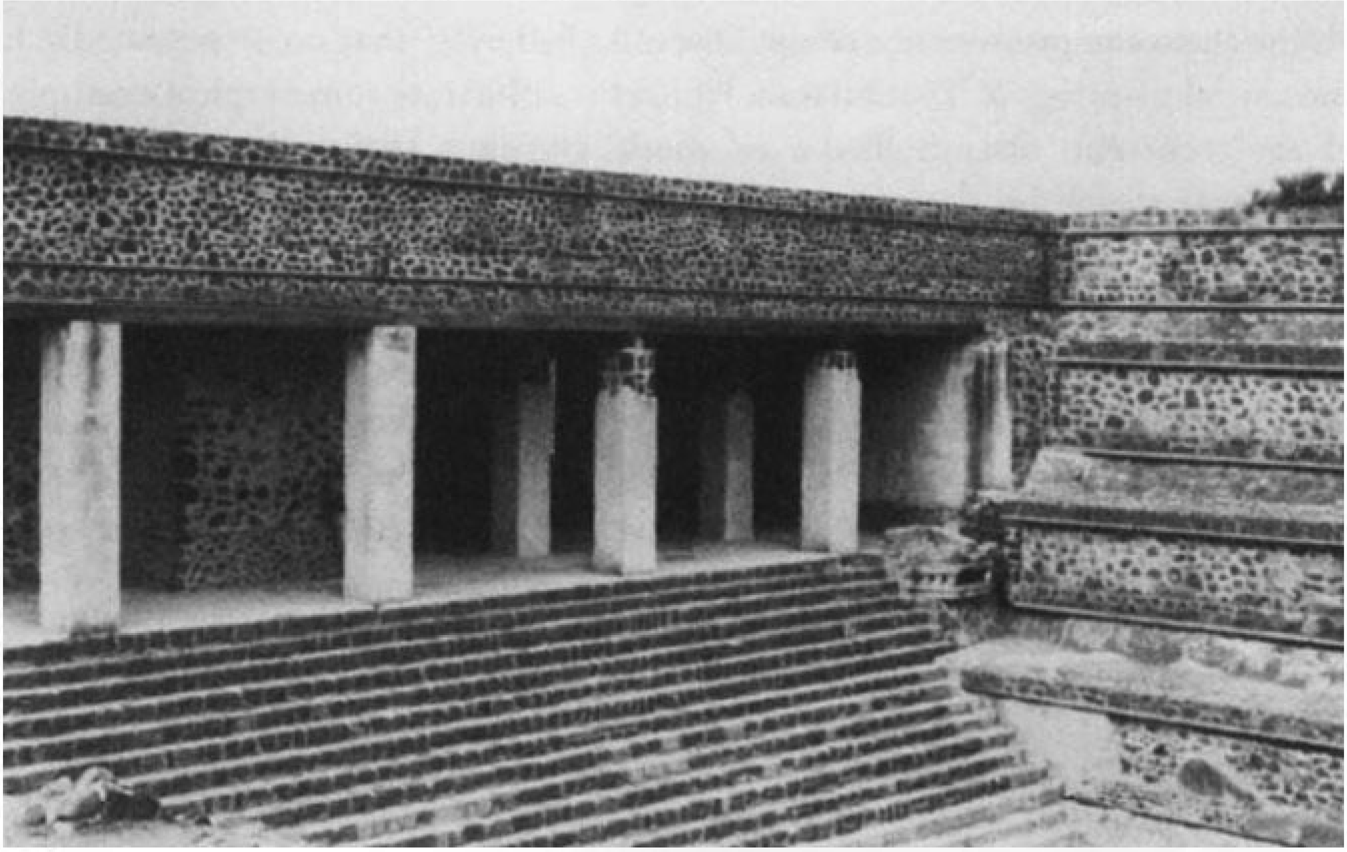


Fig. 7. Entrance to Palace of Quetzalpapálotl at Teotihuacán.

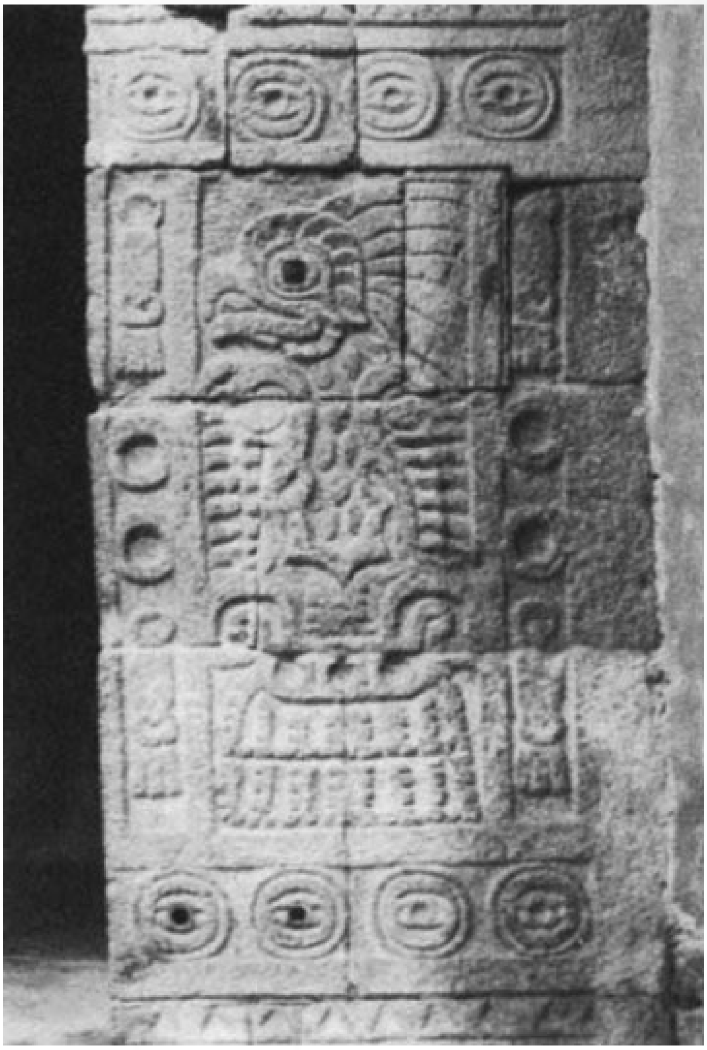


Fig. 8. Column showing Quetzalpapálotl chimera and 'disembodied eyes'.

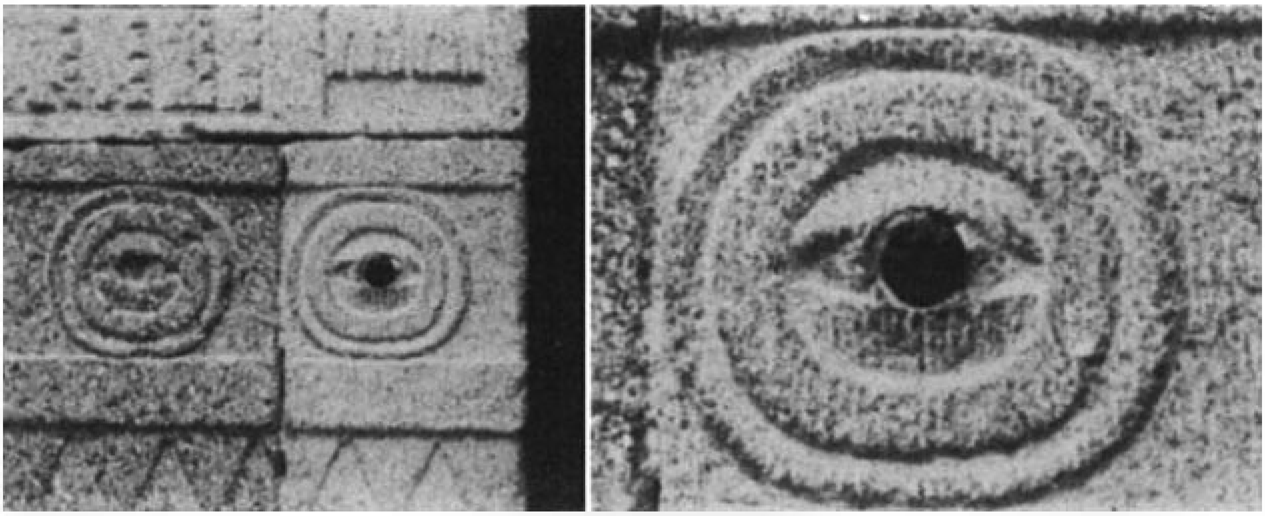


Fig. 9 & 10. Closeups of 'disembodied eye' from column. Note inlaid obsidian 'pupil' and anthropomorphic 'eyelids'.

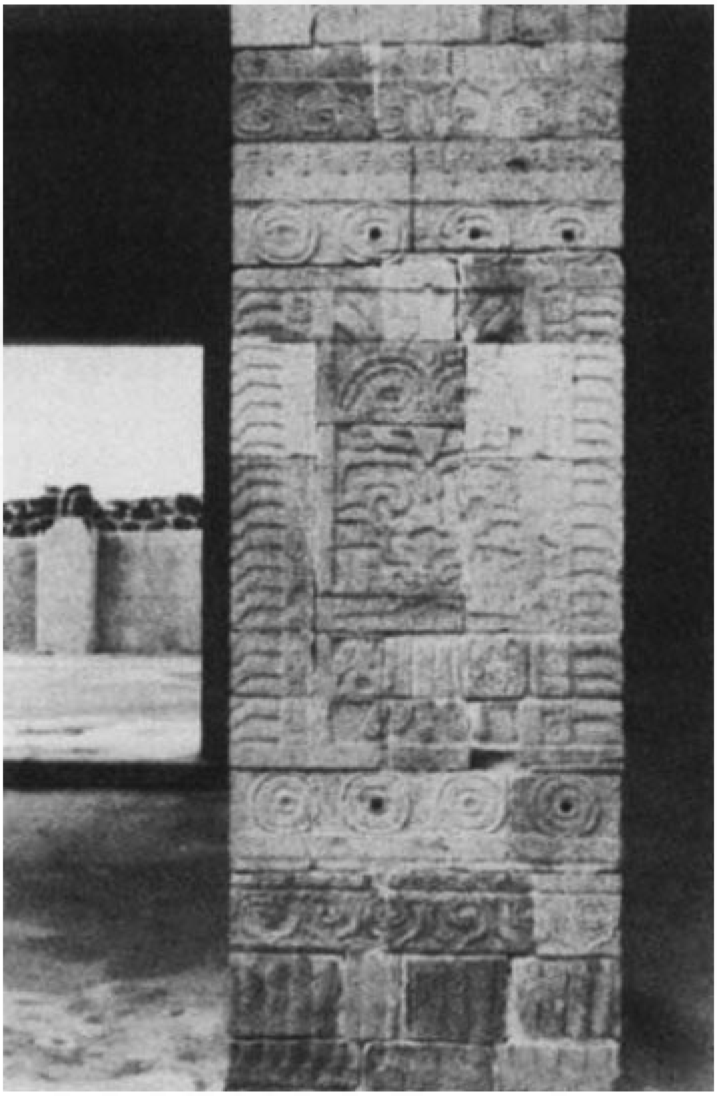


Fig. 11. West column with frontal view of avian creature and 'disembodied eyes'.

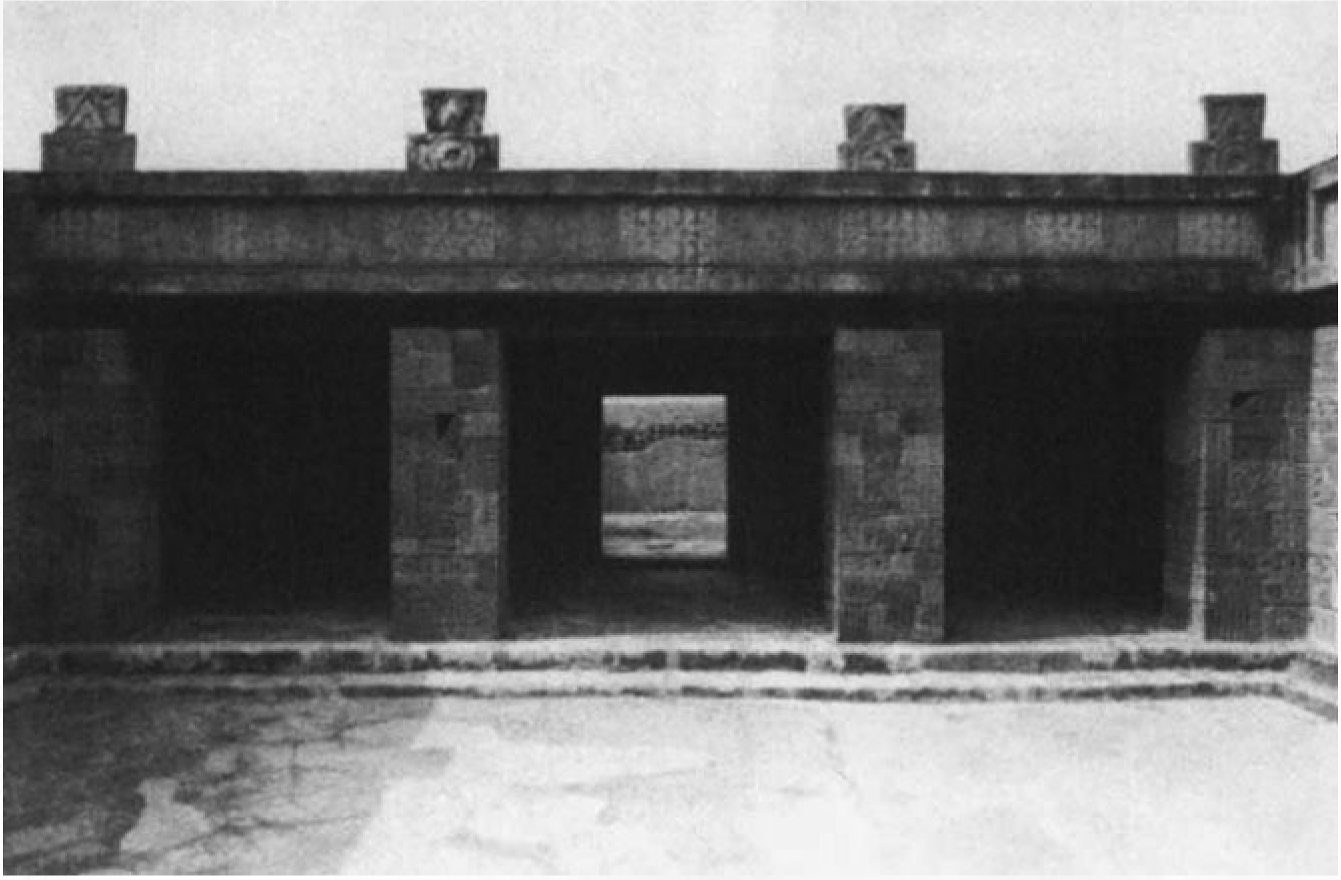


Fig. 12. West side of courtyard, showing columns surmounted by painted lintel and carved stone 'combs'.

In his book on the murals of Teotihuacán, Miller drew no conclusions as to the meaning of the 'disembodied eyes' or of the murals as a whole. R. Gordon Wasson has proposed that the 'disembodied eyes' represent the visionary sight of the shaman or participant in an agapé involving ingestion of a potion compounded of entheogenic mushrooms, morning glory seeds, or other plants with allied effects. This interpretation is based on the occurrence of mushrooms, flowers, and seeds in juxtaposition with the 'disembodied eyes' (*vide* Figures 1-4), and the association of the eyes with green drops issuing from the flowers (green, the color of jade, signifies religious value), drops which are symbolic of the entheogenic potion. This theory is laid out in detail in *The Wondrous Mushroom: Mycolatry in Mesoamerica*,[b] which further suggests that the labyrinthine buildings of Teotihuacán, decorated with these entheogenic motifs, were groups of cenacula in which sacramental ingestion of entheogens took place. The carved 'disembodied eyes' of the Palace of Quetzalpapálotl are further evidence confirming this hypothesis.

The 'disembodied eye' motif is not restricted to Mesoamerican art. Figure 5 illustrates the design on a gold ring, *circa* 1500 BC, from Crete. The scene probably depicts an epiphany of the Great Mother goddess Artemis (the figure on the right) in the form of an anthropomorphic bee.[c] The hierophants who attended the Ephesian Artemis were called *Essenes* or 'King Bees' and the later Greek mother goddesses, such as Rhea and Demeter, were attended by priestesses called *Melissae*, 'Bees'.d It would seem that the four figures on the left of the ring represent the *Melissae*, bee-priestesses worshipping the goddess. A 'disembodied eye' is clearly represented near the center of the composition, between the goddess and her devotees. Here we have a representation of a visionary scene, from an Old World culture and antedating by two millennia the murals of Teotihuacán, yet accompanied also by a 'disembodied eye'. We now know that the Greek culture practiced religious rites based on ingestion of entheogenic potions,[efg] and it is not unreasonable to assume that earlier cultures, such as the Minoans and Mycenaeans, had similar rituals. Does not the Minoan ring from Crete depict an entheogenic vision of the goddess and her devotees in their mythological forms, as human/bee chimeras? It is significant that the goddess on the ring is surrounded by plants, presumably the source of the entheogenic potion.

The carvings of 'disembodied eyes' in the Palace of Quetzalpapálotl echo a motif common in murals found throughout the ruins of Teotihuacán. What can the 'disembodied eyes' represent, other than the visionary eye of the seer under the influence of one or other of the well-known pre-Columbian entheogens? Indeed, the image of the 'disembodied eye' suggested itself to Wasson as a natural metaphor for the state produced by ingestion of entheogenic mushrooms. Written more than 25 years ago, in 1957,[h] long before the appearance of Miller's book and without his having seen the 'disembodied eyes' of the murals or columns, R.G.W.'s words are apposite:

> *There I was, poised in space, a disembodied eye, invisible, incorporeal, seeing but not seen.*

References

a. Miller, A. G. The Mural Painting of Teotihuacán. Dumbarton Oaks, Washington, D.C., 1973
b. Wasson, R. G. *The Wondrous Mushroom: Mycolatry in Mesoamerica*. McGraw-Hill, New York, 1980.
c. Gimbutas, M. *The Gods and Goddesses of Old Europe*. University of California Press, Berkeley and Los Angeles, 1974.
d. Ransome, H. M. *The Sacred Bee*. Houghton Mifflin, Boston and New York, 1937.
e. Wasson, R. G., A. Hofmann and C. A. P. Ruck. The Road to Eleusis: Unveiling the Secret of the Mysteries. Harcourt Brace Jovanovich, New York, 1978.
f. Ruck, C. A. P. Mushrooms and Philosophers. *Journal of Ethnopharmacology* 4: 179-205, 1981. Reprinted here as Chap. 6.
g. Ruck, C. A. P. The Wild and the Cultivated: Wine in Euripides' *Bacchae*. *Journal of Ethnopharmacology* 5: 231-270, 1982. Reprinted here as Chap. 7.
h. Wasson, R. G. Seeking the Magic Mushroom. *Life*, 19 May 1957, p. 109.

PART TWO

Poets, Philosophers, Priests: Entheogens in the Formation of the Classical Tradition

by Carl A. P. Ruck

CHAPTER SIX

Mushrooms and Philosophers

Toward the end of Aristophanes' comedy, the *Birds*, Prometheus, the mythical figure who stole fire from the gods, arrives on stage, shielding himself from the view of his arch-enemy Zeus, the god directly overhead in the heavens, by hiding himself beneath the shade of a parasol. This episode of the comedy is completed by a dance in which the chorus of birds describes the philosopher Socrates in a swamp, where he is summoning up spirits from the dead in the company of a strange race of people called the 'Shade-foots'.

> Amidst the Shade-foots, there is a certain swamp where Socrates, unwashed, summons up souls. Amongst his clients came Peisander, who begged to see a spirit that had foresaken him while he remained alive. He had a camel-lamb as victim for sacrifice, and, like Odysseus of old, he slit its throat, whereupon to him from the depths there came up toward the camel's trench a spirit, Chaerephon, the 'bat'.
>
> [lines 1553-1564]

Who were these Shade-foots amongst whom the famous Greek philosopher is supposed to be performing this rite of necromancy? They can be found still attending such rites in modern times and hence their identity may give us a key for understanding what Socrates was really doing.

Shade-foots

The Shade-foots were said to be a grotesque tribe of people who had only a single leg with a broad webbed foot like that of geese. They customarily lay on their backs, protecting themselves from the heat of the sun by resting in the shade cast by their single, up-raised, parasol-like feet. At other times, however, they displayed extraordinary vigor, leaping up and down with prodigious strength on their solitary legs. We first hear of them in the sixth century B.C. from a traveler named Scylax, who, according to Herodotus (4.44), wrote a description of a trip down the Indus and thence along the coast to Suez in the reign of the Persian king, Darius I. Nothing remains of Scylax's book, but a fragment of another work from the end of the next century is still extant, in which they and their bizarre characteristics are again mentioned. This is a book by Ctesias (60 Jacoby), a Greek physician from Cnidos who served at the Persian court and wrote an account of a similar voyage. Both of these early travelers claimed that India was the homeland of the Shade-foots.[1]

The tribe was called by other names as well. They appear to have been the same people that we hear of even earlier from the seventh-century poet Alcman, who knew them as 'Cover-foots' (148 Page). Another name, although Greek, is preserved only in Latin sources. The Shade-foots were also known as Monocoli or 'One-Legs' (Pliny, *Natural History* 7.2.23; Aulus Gellius 9.4.9).

This latter name is particularly interesting because when we find these people in modern times, they will be a particular plant involved in Asiatic shamanism. Monocoli in Greek was an epithet of plants (Theophrastus, *How Plants Grow* 2.25, *Enquiry into Plants* 9.18.8). In modern times, the prodigious strength of their single leg will also be remembered from ancient traditions.

The Scene of Necromancy

Before tracking them down today, however, we should look at the other details of the scene described by Aristophanes. Two other historical figures are also said to be present, Peisander and Chaerephon. The choice of these two is the point of the joke.

Chaerephon was the frequent and usually over-enthusiastic companion of Socrates. It was his impetuous consultation of the Delphic oracle that had elicited the famous response that Socrates was wiser than other men, an enigmatic reply that led to Socrates' life-long quest for someone wiser than himself, only at last to conclude that the oracle must have meant that all men are stupid, but that he alone knew it and thus, by that little bit, was wiser. We know of Chaerephon not only from the Platonic dialogues, but also from parodies of him in other comedies. He was an excitable and frenzied person (Plato, *Apology* 21a, *Charmides* 153b), a pederast (Aristophanes 377 Hall and Geldart) who could be called a 'child of Night' (Aristophanes 573), both characteristics that would make appropriate his metamorphosis into a bat as he impersonates the spirit that Socrates summons in the necromantic rite. He was also a pale person of notoriously slight and weak build, as dry and fragile as a moth's crysalis (Aristophanes 377; Anonymous 26 Edmonds), someone whom Aristophanes had described already as 'half-dead' years ago in his parody of Socrates' teaching in the *Clouds* (504).

It is this physical frailty that Aristophanes refers to as the culmination of the scene in the swamp, for Peisander, who was satirized as a coward in another comedy produced at this same festival of drama (Phrynichus, *Monotropos* frg. 20 Edmonds; cf. hypothesis for Aristophanes' *Birds*), apparently because of some otherwise unknown action in battle (Eupolis, *Exempt from Service* or *The Women Men* frg. 31 Edmonds), has come to Socrates' rite of necromancy in order to attempt to regain his own spirit that had failed him through cowardice. Instead of a miraculous return to bravery, however, he succeeds only in getting the squeaking bat-like weakling, Chaerephon.

---

[1] The real identity of the Shade-foots had become a futile topic for grammarians by the Christian era. Even as early as the fifth century, some people thought of them as African or Libyan (Antiphon 80 B 45 Diels; Archippus 53 Edmonds), and it was there that the scholars of the Hellenistic age placed them, for their parasol-like feet could be rationalized as a peculiar adaptation to the African heat, a bias that even endowed these poor suffering creatures eventually with the normal complement of limbs, the better to crawl about from exhaustion on all fours in the desert (scholia to Aristophanes' *Birds* 1553).
The valley of the Indus, however, must have been their original homeland, for that was the testimony of the earliest travelers, and even the fifth-century orator Antiphon, who thought they were Libyan, had apparently read of them in our earliest source, the Indian travels of Scylax (Antiphon 80 B 47 Diels). The confusion between an Indian and African homeland for the Shade-foots is understandable in view of the map made by the sixth-century Hecataeus, who placed the Ethiopians in the East along the entire region bordering the sea that separates Africa from India. By the Hellenistic age, however, these 'African' Shade-foots were reinterpreted as living in what was then considered to be Africa, the torrid regions to the west of Alexandria.
In identifying the Shade-foots' homeland as the Indus valley, I follow Roscher, *Ausführliches Lexicon der Griechischen und Römischen Mythologie*, and differ from the judgement recorded in Pauly-Wissova, *Real-encyclopädie der classischen Altertumswissenschaft* (see articles on 'Sciapodes').

Peisander and the Affair of the Profanations

More important than the joke for our purposes, however, is the veiled accusation that Aristophanes is making against Socrates by describing this imagined scene of necromancy. To understand this we must know something more about Peisander and about what was going on in Athens at this time. The *Birds* was produced at the City Dionysia in March of 414 B.C. Athens was engaged in fighting a great and lengthy war with Sparta and its allies, and just the previous year had sent its armada against the Sicilian city of Syracuse. Just prior to the sailing of the fleet on that expedition, an event had occurred that had thrown the city into confusion. It was discovered that some group of people had gone through the city, knocking off the phalluses on the stone representations of the god Hermes, the so-called herms, that were commonly placed before public and private buildings as magical guardian figures. This mutilation of the herms was not only an act of sacrilege, but it seemed to indicate that some political group had bound its members to secrecy through mutual complicity in the crime in order to prepare the way for an attempt to overthrow the democratic government. Peisander[2] was a leader in the official investigation into the whole affair, and it was he on the board of inquiry who had interpreted the crime of vandalism as just such an act of conspiracy (Andocides, *On the Mysteries* 36). The investigation, moreover, was broadened to include other instances of sacrilege, and it came to light that a number of prominent citizens had been illegally performing the initiation ceremony for the Eleusinian Mystery in their private homes with dinner guests. Amongst those implicated was Socrates' famous disciple, Alcibiades, who was accordingly recalled from his generalship on the Sicilian expedition, whereupon he fled into exile in Sparta, the city that headed the coalition of states opposed to Athens and its empire in the war. He was condemned *in absentia* and his property was confiscated and sold at public auction.

Prior to this scandal, Alcibiades had been one of the most promising younger leaders of the democracy, but his flight to Sparta revealed that his demagoguery had masked his underlying sympathies for his own aristocratic class. He supported the populace merely to advance his own career. Apparently Aristophanes thought the same was true of Peisander, for a few years later, he was to emerge as a leader of the oligarchic faction that attempted to arrange for the restoration of Alcibiades. Peisander was to be prominent amongst the so-called group of Four Hundred oligarchs who seized control of the city in an attempt to come to terms with Sparta, and he too was to flee to the enemy at the frontier fortress of Decelea when the regime fell in September of 411 (Thucydides 8.49, 98.1), whereupon his property was confiscated (Lysias 7.4) and he is not heard of again.

During his few months as one of the Four Hundred, Peisander arrested a fellow aristocrat, the orator Andocides, who originally had secured immunity in the earlier investigation into the mutilation of the herms and the profanation of the Mysteries by turning state's evidence and naming many of his associates (Andocides, *On his Return* 14). Although this informer was himself secure from prosecution at the time, a decree aimed specifically at him had later been passed, prohibiting anyone who had confessed to impiety from taking part in religious or commercial activities in the city, and he had accordingly been forced to withdraw into exile. While away from Athens, the informer had amassed a fortune as a merchant and had attempted to buy the good favor of what he thought was the rising political faction by an act of largesse to the fleet at Samos, only to find himself on the wrong side when he returned to an Athens controlled by the new group of Four Hundred oligarchs. Andocides' arrest and maltreatment by Peisander testifies to the degree of enmity that these wealthy citizens three years after the affair of the mutilation of the herms continued to direct toward someone who had caused themselves and their families so much trouble by his revelations and betrayal. Certainly Peisander, the former chief prosecutor in the investigation of the mutilations, would seem to have been acting out of character in supporting the guilty Alcibiades' restoration and, at the same time, persecuting the former star witness, unless, as is probable, the investigation into the mutilations had gotten out of hand by being linked to sacrileges in general, a broadening that went beyond the immediate problem of the suspected conspiracy and netted many who simply were discovered, like Alcibiades, to have been treating the forbidden Mystery ceremony as a private social event for the entertainment of their dinner guests.

---

[2] The Hellenistic scholars believed that there were two Peisanders, one who was slight and the other big (Eupolis, *Marikas* frg. 182 Edmonds; Plato Comicus, *Peisander* frg. 101 Edmonds). There can be no doubt that the one in the necromancy scene is the famous cowardly demagogue, but it is also probable that the other one was nothing but an invention of the scholarly tradition to explain the apparent distinction between a Peisander called the 'big one, the mule-driver' and another described as the 'twisted one'. The distinction is actually a misunderstood joke, comparing the penis of the offensive Peisander to that of someone of no account (see Aristophanes' *Thesmophoriazusae* 516); hence in Hermippus (*Artopolides* frg. 9 Edmonds), 'the big Peisander mounted in silence a pack-ass with olive-wood sinews, like the one for the wood at the Dionysia', with a pun on the sexual meaning of 'mount' and the action of mounting the speaker's platform. The 'bigness' of a politician, even though he be cowardly is an indication of the trouble he can cause the Demos (see *Birds* 1477, on the demagogue Cleonymus). See also Danny Staples, *Pea Pteroenta: Plot and Metaphor in Aristophanes* 78 (unpublished dissertation, Boston University, 1978).

As far as the comedian Aristophanes was concerned, Peisander was a hypocrite, both in persecuting the profaners and again at this very time that he was involved in making preparations for the transfer of the city to the oligarchic faction in 411 in order to facilitate the return of Alcibiades. As Aristophanes says in his *Lysistrata*, which was produced at this time, Peisander's changeable policy indicated that his demagoguery was for sale (489), an accusation he had first made fifteen years earlier in one of his first comedies, the *Babylonians* (81 Hall and Geldart). Moreover, again it appears that the Mystery profanations and political conspiracy are linked, for Peisander and his oligarchic associates are accused of performing the forbidden ceremony. The Eleusinian Mystery involved the drinking of a special drink, the so-called *kykeon* or 'mixed potion', and that is precisely what the hypocritical former prosecutor is accused of doing with Alcibiades and his aristocratic cronies, for, as Aristophanes claims, the whole politics of the city has become a 'mix-up' because these plotters are again 'mixing up' some 'up-set' for the stomach, an accusation that puns by these words upon the Eleusinian 'mixed' potion (489-491).

The Swamp of Dionysus

What Peisander was suspected of doing in 411 is merely a continuation of his earlier misdeeds in consulting the notorious Alcibiades' teacher Socrates at the necromantic seance in the swamp with the Shade-foots, for a number of considerations will lead us to conclude that the Shade-foot parody with which we began can only be a reference to the cowardly demagogue's suspected complicity in the very scandal that he found himself hypocritically investigating. The swamp, first of all, is a clear indication of what Socrates actually is said to have been doing. The place is not in some remote exotic land, for it is but one in a series of similar parodies in this section of the *Birds*, and like the others, it can be located nowhere else but in Athens itself. It can be none other than the one swamp in Athens of which we have knowledge, the sacred Swamp near the base of the Acropolis, the so-called Swamp of Dionysus. It was precisely there that one could expect to summon up spirits, as, in fact, another comedian, the poet Eupolis, appears to have done in a play produced about this same time, the *Demes*, which involved the resurrection of the departed localities or parishes of an ealier Athens (*cf*. Edmond's reconstruction, fr. 90-135). This Swamp was the Athenian entrance to Hades, for such noisome places suggested to the folk imagination the putrefaction that lay beyond the grave. The god Dionysus himself was shown in a later comedy of Aristophanes, the *Frogs*, rowing across this very place to get to the other world, where he is met by a chorus of initiates from the Eleusinian Mysteries. One might well expect to find them there, for this Swamp was also the scene for a secret annual event that apparently was part of the Eleusinian rituals. There was a temple in this Swamp of Dionysus that was opened just twenty-four hours each year, from the evening of the second day of the Anthesteria Festival until the evening of the third and final day, at which time the spirits of the city's dear departed, who had returned to visit their families, were lovingly reescorted back to their proper abode in the otherworld. These spirits had wandered abroad through the city for the three days of the festival, resurrected to celebrate a drunken revel with the living, who had summoned them at the start of the feast by drinking the intoxicating spirit of the new wine that had at last completed its subterranean fermentation. There was just one event that occurred in this temple in the Swamp of Dionysus during the Anthesteria. The so-called Queen of Athens, who was the wife of the king archon or inheritor of the sacral functions of kingship that went back to more ancient times before the secularization of the Athenian government, was prepared in this temple for her ritual union with the god Dionysus in an annual reenactment of the primal sacred marriage that magically reassured the yearly refounding of the city and reaffirmation of its fertile accord with the sources of life stemming from the other world (pseudo-Demosthenes 59.117).

This sacred marriage had some relation to the so-called Lesser Eleusinian Mystery,[3] a ceremony that was a preliminary to the Greater Mystery that would be performed in the autumn of the year at the neighboring village of Eleusis. Socrates' rite of necromancy, therefore, in this Swamp with a person like Peisander and at this particular date would seem somehow involved in the great scandal of the day, the profanation of the Mysteries.

Tongue-in-bellies and Revealers

Before proceeding in our investigation into what Socrates actually is supposed to have been doing, let us gain further assurance that, whatever it was, it was a profanation of the Mysteries. The Swamp parody is part of a choreographed two-part structure in the *Birds*, for which the second part is another parody involving fabulous peoples. This time the scene is a court of law conducted by 'Tongue-in-bellies' amidst a people called 'Revealers':

> Amongst the Revealers by the Hidden Water is a naughty race of Tongue-inbellies, who harvest and sow, gather fruit with their tongues and pick figs. Babbling like foreigners is this race, students of Gorgias and Philippus - and because of them, those Tongue-in-belies, these Philippuses, everywhere in Attica the tongue is a sacrificial victim cut apart.
>
> [lines 1694-1705]

In this parody, lawyers or orators are accused of aping their teachers in the quibbling play of words that make no sense in arguments proving the worse cause the better, as Aristophanes in the *Clouds* had said of Socrates, whom he considered chief amongst such teachers. There can be no doubt that this parody is meant as a companion piece for the Shade-foot verses, for structurally it would be expected since it is danced to the same choreographed rhythms and melody. Beyond that, however, it has a clear responsion in themes, with the Swamp matched by the Hidden Water and the sacrificed camel-lamb by the tongue, as well, of course, as with the matching fabulous peoples.

Here too the subject is the Mystery profanations, the great court event of the time. The Tongue-in-belly orators are hypocrites like Peisander, the prosecutor, for the fruit that their sowing and harvesting yields is bribe money, for 'picking figs' indicates people who give evidence in court against others for bounty, the so-called sycophants or 'fig-revealers'. The Tongue-in-bellies are themselves guilty of the case they try, for the lawyers are transformed into creatures with tongues in their greedy bellies, like the mysterious dwarfish woman who was supposed to have first served the Eleusinian potion to the goddess Demeter, and the Revealers amongst whom this trial takes place implicate the accusers in the crime they prosecute, since the official charge against the guilty was that they had 'revealed' the Mystery. The Hidden Water or *klepshydra* also has a double meaning, for it puns upon the 'water-stealer' or water clock that was used for timing speeches in the court and upon the so-named fountain near the cave beneath the Acropolis where the 'Queen' Creussa conceived and bore her son Ion while gathering flowers, an event that Euripides presents in his *Ion* tragedy as a mythical version of the sacred marriage.[4] A further pun on the Revealers or *Phanai* also suggests Eleusinian connotations, for the 'revealers' are verbally indistinguishable from the 'torch processions' (*cf*. Euripides, *Rhesus* 943), such as those that took place in the cults of Dionysus; Aristophanes in the *Frogs* has Dionysus greeted by just such a torch procession of Eleusinian initiates in the Swamp when he arrives there in the otherworld (340 ff.). Even the sacrificed tongue has similar connotations, for the orators' butchering of speech recalls the prohibition of secrecy imposed upon the central events of the Eleusinian initiation.

---

[3] A fragment of a bas-relief, now in the National Archaeological Museum, Athens, originally from the sanctuary on the Ilissos River where the Lesser Mystery was celebrated, shows Heracles, holding the pitcher-shaped cup that is characteristic of the Anthesteria Festival, as he arrives for his initiation into the Lesser Mystery.
For a compilation of sources relevant to the Anthesteria, see Sir Arthur Pickard-Cambridge, *The Dramatic Festivals at Athens*, second edition revised by J. Gould and D. Lewis (Oxford, 1968). The interpretation of the 'sacred marriage' as a shamanic ritual is presented in R. Gordon Wasson, Albert Hoffmann and Carl A. P. Ruck, *The Road to Eleusis: Unveiling the Secret of the Mysteries* (Harcourt Brace Jovanovich, New York, 1978) 38ff., 85ff.

[4] Carl A. P. Ruck, On the sacred names of lamos and Ion: Ethnobotanical referents in the hero's parentage. *The Classical Journal*, 71/3 (1976) 235-252.

Socrates as Profaner of the Mysteries

Actually, now that we recognize the Shade-foot parody and the corresponding parody of Revealers and Tongue-in-bellies as a reference to the contemporary scandal of the Mystery profanations, we might have expected that Socrates' rite of necromancy at this particular time could have been nothing else. The main political implication of the affair of the herms and the profanations was the anticipated pro-Spartan coup d'état, and it is not surprising that Socrates would have fallen under suspicion in the common mind. He was always associated with pro-Spartan sympathies and just the kind of aristocratic patrons and friends who might have been implicated in such a political coup.[5] These suspicions must have particularly centered upon him now that his disciple Alcibiades had not only been convicted of sacrilege, but was actually now living with the enemy in Sparta. It was commonly thought, moreover, that Socrates' involvement with Alcibiades was pederastic on the Laconian model (*cf* Plato, *Symposium* 215a ff.). It is, in fact precisely as a phillaconian that Socrates is labeled in the scene of necromancy in the Swamp, for he is given the epithet of 'unwashed', a characteristic of those young friends and disciples of his who earlier in the comedy had been said to ape him or 'Socratize' in a pro-Spartan mania, imitating his long hair and the hunger and filth that marked the rigorous indoctrination of young Spartans into their homoerotic warrior society (1281-1282). Already in the *Clouds*, Aristophanes had portrayed the filth of Socrates' disciples, a parody that supposedly was the beginning of the prejudice that would culminate two decades later in his own trial and execution for the crime of impiety in 399 B.C. (Plato, *Apology* 18b).

Not only were Socrates and his friends notorious Spartan sympathizers, but even before the great scandal of the profanations, he was suspected of profaning the Mysteries. In the *Clouds*, he had been shown teaching his students to disdain conventional theology in a parody of a mystery initiation, as they probed the lower world for the bulbous plants that in the Eleusinian myth were associated with Persephone's abduction to Hades (188 ff.). He had, in fact, even been labeled a Melian in that comedy (830), on the model either of Diagoras of Melos or Aristagoras of that same island, both of whom had profaned the Mysteries on some occasion before the great scandal of 415 (scholia to *Clouds* 830 and *Birds* 1072). If one could accuse Socrates of profaning the Mysteries in 422, the date of the *Clouds*, certainly the proven guilt of Alcibiades seven years later would have implicated his unconventional and pro-Spartan teacher as well, and, in fact, the infamy of Diagoras is recalled in the *Birds* when the chorus of birds cites the reward that had been posted for the capture and death of that earlier profaner of the Lesser Mystery (1072-1073). It would have been inevitable, in any case, that suspicion would fall upon Socrates since it was apparently well known that he was subject to mystical trances that were so similar to the experience of the Eleusinian vision that Plato adapts the language of the Mystery to describe them (Plato, *Symposium* 174d ff., 220b ff., *Phaedrus* 250c).

Mushrooms

To return, then, to our original question about what Socrates was really doing in the Swamp, it would appear that he was profaning the Mysteries. The scene of necromancy, therefore, is vital evidence about what was involved in the Eleusinian Mysteries, and evidence that hitherto has not been detected.[6] It remains to see whether the identity of the Shade-foots will allow us to be more precise about what happened at the Mysteries and about what Socrates is accused of doing in the company of that fabulous tribe of one-legged people from India.

---

[5] In addition to the documentation from Aristophanes cited in the text, note also that Socrates is portrayed by both Plato and Xenophon, himself an ardent admirer of Sparta, as praising the Dorian institutions of Crete and Lacedaemon (Plato, *Crito* 52e, *Republic* 544c, *Laws* 634; Xenophon, *Memorabilia* 3.5,4.4).

[6] It is surprising that this reference to the recent profanations has apparently gone unnoticed, despite the fact that Socrates is labelled as a pro-Spartan in this very comedy. Previous readers of the Shade-foot ode have been misled into thinking that the Swamp must be a foreign place since the fabulous one-footed creatures are in it, although so are three Athenians; it has also not been noticed that the Tongue-in-bellies are equally fabulous, but this ode, which is clearly a complement to the former, describes an Athenian court of law.

I should like to show that the Shade-foot parody confirms a suggestion I made about the nature of the Eleusinian Mysteries in *The Road to Eleusis*. In that book, I and my colleagues interpreted the Eleusinian Mysteries as communal shamanic ceremonies involving the ingestion of drugs. The Shade-foots will confirm what we suspected to have been the drug involved at the Lesser Mystery.

It is appropriate first to give some background about the studies from which our theory evolved. The collaboration was organized by R. Gordon Wasson, an amateur mycologist, who brought me together with the Swiss chemist, Dr. Albert Hofmann, to investigate the subject of the Eleusinian Mysteries.

In 1968, Wasson first proposed the cautious supposition that nothing in the Ṛg Veda, a collection of religious hymns assembled in definitive form about 1000 B.C. or a little later, after a previous long tradition of oral transmission, was inconsistent with the idea that the plant and god Soma and his reputedly inebriating drink, the focus of a very ancient ritual, were to be identified as being originally a particular species of psychotropic mushroom or entheogen, *Amanita muscaria* or, as it has sometimes been called in English, the 'fly-agaric', a mushroom that has been employed until lately both in shamanic rites and as an inebriant in the forest belt of Siberia.[7] Since the initial publication of that hypothesis, Wasson's theory has received significant acceptance and corroboration.

Various surrogates, usually not psychoactive, replaced the original inebriant in the later performances of the ancient ritual, perhaps because the true Soma was no longer easily obtainable in the lands to which the Indo-Iranian peoples migrated and had perhaps even been forgotten with the passage of time. These substitutes perpetuated certain symbolic or physical attributes of the original as remembered in the ancient poetic phrases that went back to a time before the poems were recorded in writing. It has recently been shown that the earliest surrogate for Soma in India was fungoid, hence adding strong confirmation for Wasson's theory.[8]

This emergence of the lowly and often despised mushroom at the center of one of the major ancient religions validates what Wasson and his wife Valentina Pavlovna had first surmised during the years they spent together investigating the rich European folklore about fungi, for the widely dichotomous attitudes of the Indo-European peoples today seemed to suggest derivation from a still living and powerful taboo protecting the usage of a sacred plant.[9] It was just such a religious usage that Wasson was to discover and elaborately document amongst Amerindian shamans in his study of the Mazatec María Sabina.[10]

If, however, the Soma theory were justified, one should also expect to detect analogues to the shamanic rite amongst other Indo-European peoples. Recently, Wasson has discovered an Ojibway shaman and herbalist, Keewaydinoquay, who belongs to one of the tribes of the Algonkian Nation and who has confided to him her people's traditions about the ritual usage of *Amanita muscaria*.[11] The likelihood of continuity with the Siberian rites presents itself forcibly, and doubly so now if the language of the Wintun tribe of California has a close genetic relationship to the Ob-Ugrian languages of north-western Siberia.[12]

Could the rite be detected not only in the ancient Aryan traditions, but also, as Wasson suspected, amongst the classical cultures of Greece and Rome? It was this question that Wasson proposed to me at the beginning of our collaboration on the ancient mystery religions, which he had long suspected of centering upon

---

7. R. Gordon Wasson, *Soma: Divine Mushroom of Immortality* (Harcourt Brace Jovanovich, New York, 1968).
8. Wasson summarizes the developments since the initial publication of *Soma* in the introduction to the new French translation. The original English text of this introduction appeared as: Soma Brought Up-to-date. *Botanical Museum Leaflets, Harvard University* 26/6 (June 30, 1978) 211-223, published also in the *Journal of the American Oriental Society*, 99/1 (1979).
9. The Wassons privately shared this idea with each other, although it does not appear in their massive compilation of mushroom lore: Valentina Pavlovna and R. Gordon Wasson, *Mushrooms, Russia, and History* (Pantheon Books, New York, 1957). Documentation for the theory was first forthcoming in Wasson's ensuing North American and Meso-American researches.
10. R. Gordon Wasson, George and Florence Cowan and Willard Rhodes, *María Sabina and her Mazatec Mushroom Velada* (Harcourt Brace Jovanovich, New York, 1974).
11. Keewaydinoquay, *Puhpohwee for the People: A Narrative Account of Some Uses of Fungi Amongst the Ahnishinaubeg* (Botanical Museum of Harvard University, Cambridge, MA, February, 1978). Keewaydinoquay is also collaborating on a further study with Wasson.
12. Otto J. Sadovszky, *Demonstration of a Close Genetic Relationship, Preliminary Report* (Fullerton, CA, July 3, 1978).

drug-induced visions.[13] There could be no doubt that the drinking of a specific potion was part of the ceremony at Eleusis, where the culmination of the Mystery was consistently described as an overwhelming vision of spiritual presences demonstrating the relationship of the living to the dead. Drinking or drunkenness, moreover, seems to have been an element in the other, less known mysteries, such as those of the Kabeiroi at Thebes or the one celebrated at Samothrace. That the Eleusinian ceremony had been illegally performed for the enjoyment of dinner guests in private homes toward the end of the fifth century, moreover, suggested obvious parallels to the profane use of entheogens in modern times.

The ingredients of the Eleusinian potion are given as water, mint, and barley in the Homeric hymn to Demeter, our earliest literary source about the Mystery. Since the mint or *blechon* (*Mentha pulegium*) is hardly (or not at all) psychoactive,[14] our attention was directed to the barley. Here our third collaborator, Dr. Albert Hofmann, the discoverer of LSD, was able to supply us with the information that ergot or 'rust', a common fungal parasite on grain, contains a powerful water-soluble drug. Ergot, moreover, like other higher fungi, produces fruiting bodies of the characteristic mushroom shape. Did ergot figure in Greek botanic traditions in a way that might suggest its involvement in the Eleusinian Mystery?

The Greeks believed, as is to some extent actually true, that edible plants were evolved forms of more primitive, wild, and in some cases actually inedible avatars, and that agriculture, as opposed to the mere gathering of plants, was a triumph of civilization or culture. In particular, *aira* or *Lolium temukntum*, commonly called 'darnel', 'cockle', or 'tares' in English, an inedible grass that grows as a weed in fields of grain and is usually (like grain itself) infested with ergot, seems to have been thought to be a primitive form of barley, which would revert to the weedy growth if not properly tended. A similar opposition between gathered and cultivated plants involved the god Dionysus: poisonous and intoxicating wild ivy with its diminutive clusters of berries was apparently related to a cultivated plant that it resembled, the vine with its bunches of juicy grapes. This opposition is often depicted in vase paintings, where the elder Dionysus is shown confronting the younger manifestation of himself in a new generation as his own son, the boy named 'Bunch of Grapes', who carries the vine plant, while his father holds the wild ivy.[15] It is clear, moreover, that the wintertime mountain ceremonies of the maenads, the ecstatic female devotees of the god, involved the gathering of wild botanic versions of Dionysus, for their common implement, as shown in art and literature, was the so-called *thyrsos*, a hollow stalk stuffed with ivy leaves, a procedure that was the custom for preserving the freshness of herbs as they were gathered.[16] The fact that maenadic ceremonies did not occur in any relationship to the timing of the events involved in viticulture can now be understood, for these mountain rites centered not upon wine but upon the wild and intoxicating herbs gathered while the more civilized god was absent in the otherworld, undergoing the cultivation that would convert the juice of crushed grapes into an inebriant. Even wine, however, was felt to have an affinity to the toxins of wild plants, for, as we have shown, wine itself was flavored with various herbs that intensified its intoxicating qualities, hence requiring that it be diluted with several parts of water to tame it for civilized purposes.

In this opposition between wild and cultivated plants, the fungi played an important role, for they are seedless growths that defy cultivation and are thus paradigmatic of wildness. (The spores of mushrooms require a microscope to be seen distinctly.) Characteristic of all plants, of course, is the way they feed upon dead and putrefying matter. Here too the fungi had a special importance, for the tomb and the whole underworld were thought to be covered with mouldering growths that consumed the flesh of mortality. But even these wildest of plants could be made to function in the evolutionary botanical scheme. The Greeks realized that fermentation was a fungal process. The making of wine involved procedures and symbolism that suggested the tending of the dead and the hope for resurrection, for the blood of the harvested grape was entrusted, like any corpse, to subterranean, tomb-like containers, where the surrounding earth maintained the proper temperature for fermentation; when the process was completed, the containers were opened to release the new god, who returned together with the other spirits from the grave to celebrate a drunken revel on his birthday.

---

[13] R. Gordon Wasson, The divine mushroom: Primitive religion and hallucinatory agents, *Proceedings of the American Philosophical Society*, 102 (1956) 221-223.

[14] C. Kerenyi, working with Dr. Albert Hofmann, suggested that *Mentha pulegium* may have been responsible for the Eleusinian vision: *Eleusis: Archetypal Image of Mother and Daughter* (Pantheon, New York, 1967, translated from the German manuscript revised by the author from publications in 1960 and 1962) appendix 1. Dr. Hofmann, however, now claims that Kerenyi overstated the psychoactive properties of *Mentha pulegium*, and, in any case, this mint is clearly not strong enough to have warranted those instances of profane use and attendant severe penalties that were occasioned during the great scandal of 415 B.C. The inclusion of *blechon* in the Eleusinian potion had a symbolic significance, as explained below.

[15] Attic black-figured vase in the British Museum, storage-jar by Exekias, B 210, about 540 B.C., the elder Dionysus holding ivy sprigs confronts his son. Krater by the Altamura painter in the Museo Archaeologico Nazionale, Ferrara, the elder Dionysus, attended by flower-bearing maenads, seated and holding the *thyrsos*, confronts his smaller self in the form of his son standing on his lap and bearing sprigs of vine and a cup of wine. *Etc*.

[16] Theophrastus, *History of Plants* 9.16.2.

The goat also was symbolic of the more primitive god, and in the form of ithyphallic goat men, the so-called satyrs, he would lasciviously cavort and possess his ecstatic brides in the winter ceremonies on the mountains. The goat's grazing habits, however, were a danger to the cultivated vine, and the hircine representative of the god became his special surrogate, whose sacrifice was necessary to assure the continuance of more civilized manifestations of Dionysus. Amongst the religious observances of Dionysus were the great festivals of drama, where the phallic exuberance of the satyrs suggested the humorous antics of comedy, while tragedy, the song sung for the sacrificed goat, centered on the necessary fall that would reconcile man to the deeper implications of his own mortality and the healthy accord of his society with the forces of the dead.

Parallel to the Dionysian gift of liquid nature was the dry food of Demeter's grain, upon which also could be grown a transmutation of a wild fungus. The vision that resulted from the carefully programmed ingestion of the ergot potion demonstrated the continuity of life and death and reaffirmed the forward progress of Hellenic civilization. The inclusion of mint in the Eleusinian potion had a similar symbolism with regard to this evolutionary theme, for the fragrant herb had connotations of illicit sexuality; the wild herb, therefore, was appropriately bruised and crushed for the barley drink that signified the transition of Persephone from sterile concubinage to a wifedom that mediated the chthonic realm of Hades and the Olympian of Demeter and Zeus. This joining of the house of the Olympians to that of the netherworld through Persephone's matrimony is another instance of the evolutionary paradigm. The Mysteries were sacred to what was called a 'holy duo of goddesses', who need not be named specifically as Demeter and her daughter Persephone, for there was a singularity in their twoness that made their roles interchangeable.The original single Earth Mother Goddess of pre-Olympian times has become a duo at Eleusis to signify the reconciliation of more primitive traditions to the new era of gods headed by a father in the heavens: Persephone has become a daughter of Zeus entrusted to the house of Hades in the earth and barred from Olympian status, but in the form of Demeter, her mother, the Great Goddess resides on Olympus with her brother Zeus. The sacred Eleusinian reconciliation, moreover, gave mankind, who in some traditions was not deemed essential to the world order as ruled over by Zeus, an intermediary role, communicating with the chthonic powers for the fertility that would yield the continuing cycles of rebirth upon which the Olympians themselves depended for nourishment in the form of sacrifice.

Just as the goddesses, so too were the Mysteries double. Whereas the emphasis of the Greater Mystery was redemption from death by the incorporation of the underworld's putrefaction into a larger scheme where it would function as a source of fertility, or, in agrarian terms, as manure instead of pollution, the Lesser Mystery, which preceded it by half a year, occurred in the wild and involved the preliminary to reintegration, the Dionysian theme of Persephone's illegal abduction by death while gathering intoxicating uncultivated flowers. In view of the role played by cultivated fungal parasites in the fermentation process and in the Eleusinian potion, we suggested in *The Road to Eleusis* that a wild mushroom may have figured in the Lesser Mystery, for such a fungus would both complete the pattern and explain certain aspects of Dionysian symbolism, such as, for example, the fact that a mushroom itself could be viewed as a miniature *thyrsos*, with the intoxicating cap replacing the ivy leaves stuffed into the stalk-like stipe.[17]

Aja Ekap&amacr;d

The Shade-foots, in whose company, as we have seen, Socrates appears to have communed with spirits in profanation of the Lesser Mystery, can be found also in Vedic traditions. The Hellenic migration into the Greek lands in the second millennium before Christ was only one branch of widespread migrations of Indo-European peoples, another group of which moved down from the northwest into what is now Afghanistan and the valley of the Indus. This latter group was the so-called Aryans, whose language was Vedic, a parent of classical

---

[17] Apicius 7.15.6.

Sanskrit. The canonical collection of 1028 hymns called the Ṛg Veda preserves the ancient oral traditions of these people dating back to a time before the migrations when presumably they shared a common homeland with the other IndoEuropeans. We should expect to detect common elements and parallels between the Greek-speaking Indo-Europeans and the Vedic Aryans, as, in fact, we can in their languages, poetic metaphors, and customs.

In the Ṛg Veda, amidst a complex pantheon, headed by Indra, appears the god Soma, a plant that was pounded to extract a divine inebriant. This drink is described with symbolic components that, as has been recently shown,[18] are traceable back to an Indo-European original from which it apparently derived, for similar components occur also in the descriptions of magical drinks or potions in Greek traditions. Soma is often accompanied by Agni, the god of fire, and is richly described with formulaic epithets that note his color and metaphorically associate him with the bellowing of bulls, the pillar of the sky, the single eye, the navel, and so forth, although (remarkable for a plant) no mention is ever made of roots, leaves, blossoms, or seeds. It was this omission that attracted Wasson's notice. He demonstrated that a mushroom was the only botanic specimen that would fit such a description and that similar metaphors could be traced in later traditions about fungi.

Through oversight, however, Wasson did not mention '*Aja Ekap&amacr;d*' in the original edition of Soma, an omission that is repaired in his new introduction to the French edition.[19] *Aja Ekap&amacr;d*, as his name implies, is the 'Not-born Singlefoot', a deity mentioned six times in the Ṛg Veda and apparently an archaic name for Soma himself, for he shares epithets with him, is often accompanied by the chthonic serpent who invariably is the guardian of the holy plant, and once even has only the first of his names linked to a common epithet of Soma as Aja N&amacr;bhi, the 'not-born Navel'. As Wasson observes, '*Aja Ekap&amacr;d*' is the perfect binomial nomenclature for a mushroom, for mushrooms are 'not-born' since, as already mentioned, their seedless propagation by microscopic spores was not understood in antiquity, for which reason in India as in Greece (as well as elsewhere) they were thought to be engendered by the fire of the lightning bolt as they burst suddenly through the soil, expanding with the absorbed water of the rainfall, a manner of conception that the Greeks, in fact, gave to Dionysus. Similarly, although the 'single-foot' attribute is, of course, common to all plants, it appears to be particularly apposite for mushrooms, which occur in folklore as the little men with only one foot, as in the following German riddle quoted by Wasson:[20]

Sag' wer mag das Männlein sein
Das da steht auf einem Bein?
Glückpilz! Fliegenpilz!

The Shade-foots, who were also known to the Greeks with the botanical epithet of 'One-legs', and who came originally from the Indus valley, would seem, therefore, to be a Hellenic version of the deity Soma with the epithet *Aja Ekap&amacr;d*. They survive into modern times amongst the Chukokta tribesmen in the region to the far north-east of Siberia. There, the spirits that reside in *Amanita muscaria* are said to materialize to those who become inebriated on the mushrooms as little people with a single leg; these leaping single-footed creatures, as numerous as the mushrooms that each has ingested, lead the intoxicated tribesmen on intricate and marvellous journeys to the land of the dead.[21] These tribesmen, moreover, are so impressed with the prodigious strength of the mushrooms' single leg that they often attempt to imitate them by thrusting their heads through some restraining membrane or by vigorously leaping about like the ancient jumping Shade-foots, amongst whom Socrates also communed with spirits in profanation of the Lesser Mystery.

The aptness of such a metamorphosis of mushrooms into little one-legged creatures is apparently something that suggests itself repeatedly to folk imagination, for it is thus also that they appear in the perhaps unrelated

---

18. Calvert Watkins, Let us now praise famous grains, *Indo-European Studies III* (Cambridge, MA, 1977) 468-498.
19. The oversight was first corrected in Wasson's *Soma and the Fly-agaric: Mr. Wasson's Rejoinder to Professor Brough* (Botanical Museum of Harvard University, Cambridge, MA, November, 1971) 37-38, and repeated in Soma Brought Up-to-date.
20. Wasson, Soma Brought Up-to-date 221.
21. Wasson, *Soma* 159 and exhibits 4, 22, and 42.

shamanic traditions of Meso-America.[22] Our ancient leaping Shade-foots are, furthermore, actually recognized as red-capped mushrooms in the fabulous journey to the end of the world described in C. S. Lewis's fictional *Voyage of the* '*Dawn Treader*'.[23]

In antiquity we may surmise that the Shade-foots were present by and large throughout Siberia. Although the Greeks learned of them from the Indus valley sometime after the middle of the first millennium before Christ, they were probably present for millennia earlier in the forest belt, and other versions of them no doubt also came into the Greek lands with the arrival of the Indo-Europeans at the beginning of the Mycenaean Age. We perhaps catch a glimpse of them with another attribute of Soma as the Monophthalmoi or 'One-eyes', a fabulous people who lived on the frontier with the netherworld in the steppes north of the Black Sea and were called Arimaspeans in Scythian (Herodotus 3.116, 4.13,27; Aeschylus, *Prometheus* 803 ff.). These One-eyes engaged in combat with the monstrous guardian beasts of the otherworld and were the center of religious rites of shamanism proselytized in Greece by the priest and poet Aristeas of Proconnesus, who was said to be able to metamorphose into a raven and to travel as a spirit separate from his body (Herodotus 4.14-15). Other Monophthalmoi appear in Greek traditions as the 'Orb-eyes' or Cyclopes. They are named individually with epithets of the lightning bolt (Hesiod, *Theogony* 139) and were reputed to be workmen of Hephaestus (Callimachus, *Hymn to Artemis* 46 ff.), the god of fire in the volcanic forge. It is in this form that they may have come with the Dorians, for they figure in the epic traditions of the *Odyssey* and were said to have built the fortifications of several cities in the Argolid (scholia to Euripides' *Orestes* 965), including Mycenae, which was supposedly so-named because its founder, a son of Zeus, had picked a mushroom there (Pausanias 2.16.3).

Analogues to their name as 'Shade-foots' and 'Cover-foots' can also be found in ancient India. In classical Sanskrit, 'mushroom' is *chattra*. It is formed from the root *chad*, 'to cover' and has 'parasol' as its primary meaning. This could not have been its name before the Indo-European migrations. Since parasols were not called for in northern climes, and indeed, were unknown until recently in the regions north of India, it is probable that the Aryan invaders found the utensil in use and named it with the Indo-European root when they came south, later extending the meaning by metaphor to include mushrooms.

The metaphor, moreover, is particularly apt in Greek. The Greek parasol, like ours today, was round and ribbed with toe-like spokes that resemble the webbed foot of water fowl, which had the epithet of'cover-footed' (*steganopodes*, Aristotle, *History of Animals* 504a7, *etc*.), as well as the gills of a mushroom. It was called the *skiadeion* (Aristophanes, *Birds* 1508), which is simply to say, the 'little shade', and was thus an appropriate term for the little *skia*, the spirit or ghost that was the 'shade' of former life to be summoned from the grave in a rite of necromancy.

Prometheus as Shade-foot and the Theft of Fire

It remains for us to consider whether Aristophanes had any special reason for choosing Prometheus to bear the parasol as his standard. In the *Birds* each of the two parodies that we have been examining, that of the Shade-foots and the matching one of the Revealers and the Tongue-in-bellies, is introduced by a scene appropriately related to it. Thus, the Tongue-in-bellies at court are introduced by a scene in which Heracles humorously discovers that as a bastard son of Zeus he does not have a clear right of inheritance to his father's Olympian estate. In the same manner, the preceding scene with Prometheus carrying the parasol to shade himself from the view of Zeus overhead is a thematic introduction to the parody of Socrates' necromancy with the Shade-foots, for Prometheus clearly is himself being presented as an impersonation of a Shade-foot, and his exit, furthermore, just before the parody, even imitates the carrying of the sacred basket beneath a parasol in a religious procession (1550 ff.).

Although Prometheus's quarrel with Zeus goes back to the time he stole fire from the gods, the traditions about that primordial theft suggest that the fire had connotations of herbalism. Prometheus was said to have hidden the stolen fire in a hollow fennel stalk or *narthex* (Hesiod, *Works and Days* 52; Aeschylus, *Prometheus*

---

[22] For documentation, see R. Gordon Wasson, *The Wondrous Mushroom: Mycolatry in Meso-America* (McGraw-Hill, New York, 1980).

[23] C. S. Lewis, *The Voyage of the* '*Dawn Treader*' (Macmillan, New York, 1952) 141 ff.

109), thus treating fire like an herb gathered and stuffed into the Dionysian *thyrsos*; *narthex* itself, in fact, became a term for a casket of drugs, apparently because of such traditional usage in the gathering of magical and medicinal plants.[24] It is significant, therefore, that Aeschylus in his *Prometheus* tragedy refers to the stolen fire as a 'flower' or *anthos* (7) that was given to mankind as the source of that same intelligence and clairvoyance for which Prometheus or 'Forethought' is himself named, including, in particular, knowledge of drugs and the mantic art (476 ff.).

This gift of the stolen fire was involved in the mystery traditions of the Kabeiroi, for the theft took place on the island of Lemnos (Cicero, *Tusculan Disputations* 2.10.23) and had its source in the volcano there that was thought to be the forge of Hephaestus (Aeschylus, *Prometheus* 7).[25] It was to the primordial men of that island that Prometheus gave the fire. These men were called the Kabeiroi, the eldest of whom was supposed to have been born there from the earth itself.[26] In art, the Kabeiroi were portrayed as dwarfish black caricatures of mythical figures. Their leader was called Kadmillos, apparently a diminutive version of Cadmus, who came from Phoenicia and founded Thebes, where there also was a mystery cult of the Kabeiroi. These traditions perhaps facilitated the transposition of the Shade-foots to a supposed homeland in the African deserts in later antiquity.

These aboriginal Kabeiroi to whom Prometheus entrusted the divine spark of intellect were in all probability originally a primitive race of botanic creatures, for autochthonous births such as theirs are suggestive of plants. Thus at Corinth, for example, the first men actually were said to have come into being by metamorphosis from mushrooms (Ovid, *Metamorphoses* 7.312-313; *cf*. Apollodorus 1.9.3); and at Thebes, Pentheus, who plays the role of the sacrificial surrogate for Dionysus in Euripides' *Bacchae*, was the son of the apparently 'serpentine' Echion, one of the autochthonous Spartoi, the men who were said to have been 'sown' by Cadmus from what is usually called in English the 'teeth' of the primordial serpent. If we translate the term more exactly for its context, it is clear that such 'teeth' must obviously be 'fangs' and hence we are dealing here with a mythical tradition about toxic botanic forms. At Athens too, we can note a similar complex of metaphors suggesting that botanic drugs were involved in the symbolism of primordial autochthony, for Erichthonius, the 'Very Chthonic' son who was born from earth out of the seed either of Hephaestus or Prometheus, was said to have bitten the nurses (Apollodorus 3.187) to whom Athena entrusted him and to have caused thereby their death in the ensuing fit of madness (Pausanias 1.38.3; Euripides, *Ion* 12 ff.).

The traditions about Hephaestus also suggest botanic paradigms for the fire that set the aboriginal creatures on the track of evolution to a higher state of being. It is no happenstance that both Prometheus and Hephaestus, as we have just seen, were said to have fathered the primordial Athenian, for they often double for each other in myth and hence it is likely that they were originally simply different aspects of the same figure, with Prometheus's so clearly transparent name merely an epithet for the other.[27]

It is Hephaestus, the god of volcanic fire, who is responsible for tormenting Prometheus and his brother Titans for their opposition to Zeus and the tyranny of his newly established rulership that at first was not reconciled to the existence of man, Prometheus's own creation. Such fiery torment that is a burden of selfinflicted sacrifice recalls the close association of Soma and the fire god Agni and is suggestive of the pattern of shamanic initiation or *askesis*.

To trace this idea, let us look first at the traditions involving the lame Hephaestus with magical plants and intoxication in his tormenting of the Titans. For example, as punishment for the giant or 'Earth-born' Typhon, Zeus was said to have confined him in the volcano of Aetna (Aeschylus, *Prometheus* 351 ff.), which, like the volcano on Lemnos, was thought to be a forge of Hephaestus (*Prometheus* 366 ff.). This punishment parallels that of Prometheus's brother Atlas, who stood as 'the pillar between heaven and earth' in the Garden of the Daughters of the West, the so-called Hesperides (*Prometheus* 347 ff.). The mountain with the core of fire and the special garden where magical plants grow are probably to be recognized as analogous versions of the

---

[24] Thus *Narthex* was used as the title for medical works by Heras, Cratippus, and Soranus (Galen 12.398, 959; Aätius 8.45).

[25] C. Kerenyi, *Prometheus: Archetypal Image of Human Experience* (Pantheon, New York, 1963, translated from the German versions of 1946 and 1959) 80 ff.

[26] Hippolytus, *Refutation of All Heresies* 5.7.4. See Kerenyi, *Prometheus* 80-81.

[27] Kerenyi, *Prometheus* 57-62.

World Axis or *axis mundi*, the place where the Tree of Life grows, allowing the shaman to ascend or descend to other realms in the torment of his *askesis*. This place is at the ends of the earth, hence, as with the Hesperides, in the place where the sun goes down. Analogous to it is the place of the dawn. Thus Hephaestus bound Prometheus in the far east, a topographical counterpoise to the torment of his brother in the land of the evening, and like the latter, it too is a place where special herbs grow. On his quest for the so-called 'apples of the Hesperides', Heracles will visit Prometheus as well as Atlas, for the two distant locales are bound by the daily journey of the sun through the darkness of the night, a trip that Heracles, who also will experience the shamanic *askesis*, was said to have taken by sailing in the fiery sun's own *depas* or 'drinking cup' (Stesichorus 8.1; Pherecydes 18a), a utensil that suggests that the voyage is one of intoxication,[28] and that Hephaestus, who fashions such metal cups in his forge (Aeschylus, fr. 69), may again be involved.

Other traditions also associate both the eastern and western locales with the shaman's fiery plant, for the word in Greek for the 'apple' that was to be found growing in the Garden of the Hesperides is verbally indistinguishable from the golden fleece of the 'sheep' (*melon*) that was hung on the tree in Medea's land in the far east. It was that fleece that had transported the children of the 'hallucinatory' Nephele to that otherworld environment. The equivalence of the two topographical extremes can also be sensed from the fact that the socalled 'Queen' Medusa, the Gorgon, was located in both places (Hesiod, *Theogony* 2,74 ff.; Aeschylus, *Prometheus* 790 ff.). On a vase painting from southern Italy, we glimpse a remembrance that the fruit of the Medusa's special tree was a mushroom.[29]

Prometheus himself, in some traditions, was apparently the magical plant. A miraculous herb, parasitic on a tree and in color like the crocus, was said to grow from the blood of Prometheus in his torment. Medea picked it to anoint Jason (or Iason, in Greek, apparently so named for this anointing with the drug[30] that will protect him from the fire-breathing bulls guarding the tree with the golden fleece); when the plant was thus harvested, Prometheus himself groaned, according to the way that Apollonius Rhodius told the story, for the plant is said to grow from a double stem. In picking the Promethean herb, Medea is also in contact with the suffering Titan bound to his mountain, for which reason the root of the plant when it is plucked was said to resemble the flesh of a corpse that has just been cut (*Argonautica* 3.845 ff.).

The fiery Titanic drug found at the tree on the mountain in the lands where the sun is kindled and extinguished appears, as Wasson has shown,[31] to have had a fungal prototype in the homeland of the Indo-Europeans. In Siberia, the paradigmatic shaman's Tree is the shining white birch that is host not only to the mycorrhizal parasitic *Amanita muscaria* growing at its base, but also to the steps of shelf fungus ascending its trunk. The latter, 'punk' or *Fomes fomentarius*, provides the tinder for making fire with a fire drill, thus associating the gift of fire with the shaman's ascent to the fiery realm of his visions.

The torment of *askesis* passes from sufferer to sufferer, a labor like the sun's, forever renewed. It is upon the basis of this primitive experience in primordial times that culture is founded and continually renewed. The myth of Heracles, for example, is a case in point. He was said to have fought many poisonous monsters in order to tame the earth for mankind and to establish the reign of his divine father Zeus. His burning torment came upon him when his wife Dejanira anointed his robe with the drops of poison that came originally from one of the monstrous beasts he had killed (Sophocles, *Women of Trachis* 831 ff., 1140 ff.). In another tragedy, he was shown in a mad state, poisoned by this same primordial source (Euripides, *Heracles* 1189 ff.). This intoxication represents his regression to a primitive state, to a time before the world was civilized, when he,

---

28. Lesley Cafarelli, *Temenos and Skene: Enclosure Motifs in Greek Poetry and Myth* (unpublished dissertation, Boston University, 1978).
29. Amphora from the third quarter of the fourth century B.C., now in the Pergamon Museum, East Berlin (Staatliche Museen zu Berlin, Antiken-Sammlung, inv. no. F 3022), See Wasson *et al*, *The Road to Eleusis* plate 8.
30. The name lason contains the same *ia-* root that occurs in words such as *iatros* ('healer' or 'doctor') and *iasthai* ('to heal'). In addition to the anointment by Medea, lason is associated with drugs through his education in his youth in the wilds with the centaur Chiron. See Ruck, On the sacred names of lamos and Ion.
31. Wasson, *Soma* 2.16 ff. In Siberia, birch-bark containers were stuffed with punk, which deprived of air by tight packing would harbor the smouldering fire for upwards of two days. This custom invites comparison with the tradition of Prometheus's theft of fire hidden in the *thyrsos* or *narthex*, for the marrow of the giant fennel was used as tinder and even in modern times on some of the Greek islands is still the means of preserving the glowing embers or of carrying them from place to place (for references see Kerenyi, *Prometheus* 80).

who would eventually pacify the earth and show the way to reconciliation with the heavens, was still a dwarfish creature called a Daktyl or 'finger man'.[32] The dichotomy between primitivism and culture at the Eleusinian Mysteries can be detected in the tradition that claimed that this poisoned and primitive Heracles underwent purification at the Lesser Mystery (Apollodorus 2.5.12; Diodorus Siculus 4.14; Scholia to Aristophanes' *Plutus* 1013) in order to prepare him for his initiation into the Greater. Heracles, however, can be freed from his poisoned state and restored to his Olympian destiny only by passing the venom to another who will play the role of the primitive sufferer. Thus, on the pyre that was eventually lit on the mountaintop of Oeta, Heracles escaped from his mad torment, giving his venomed arrows and bow to a member of the family of Poeas, whose name suggests that he had a botanic identity.[33] The words for 'poison' and 'arrow' (*ios*) are identical in Greek, and the transference of the bow apparently entails also the contamination by its metaphoric complex of primitivism and toxicity. Thus when we hear of this bow again, it is in the hands of Philoctetes, a son of Poeas. He was shown in Sophocles' tragedy yearning to be burnt in the Lemnian volcano of Hephaestus (*Philoctetes* 800, 986 ff.), a release from torment analogous, as he claims, to the fiery consummation that he once afforded Heracles on Oeta (801 ff.). Instead, cursed by his inheritance, he must live a primitive existence, dragging his poisoned foot in a track like the primordial serpent's (163, 291) and hunting for food that necessarily is tainted with the arrow's toxin (105,166). Periodically he falls into fits of madness that are described as a wild kind of intoxication, ungraced by the evolution of the custom of communal drinking of tempered wine (213, 712 ff.). Eventually, he too, it was said, passed the role of sufferer to another, when he shot Paris at Troy on his foot with an arrow, while he himself was reintegrated with society and his own foot healed with curative herbs and wine (Apollodorus, *Epitome* 8; Tzetzes, *On Lycophron* 911).

Prometheus too could be freed from his torment on the mountain to which Hephaestus unwillingly had bound him only by passing his role to another. Thus it was said that the centaur Chiron was poisoned when Heracles accidentally shot him on his foot as the other centaurs fought in their typically uncivilized way to drink from a newly opened jar of wine. Despite Chiron's vast knowledge of drugs and herbs, a lore he was said to have taught many heroes in their youth spent with him in the wilderness, he was unable to heal himself. Heracles at last freed Prometheus by offering Chiron as a substitute (Apollodorus 2.5.11).

We cannot expect that Aristophanes reacted consciously to the full implication of presenting Prometheus as a Shade-foot, although it is perhaps possible that in the Kabeiric mystery traditions something was known that is now lost. Much, however, of what we have been discussing in the patterns of myth probably represents the inheritance of traditions from very ancient times whose meaning the classical writers did not question. Embedded in those traditions was a special value placed on lameness, like that of Hephaestus, Oedipus, and Philoctetes, or on single-footedness, as in the case of the 'one-shoed' (Apollodorus 1.9.16) Jason. The obvious psychological aptness of such an attribute of heroism no doubt facilitated its perpetuation, but the consistent way that it is incorporated as a detail in a larger complex involving the young hero's exposure to a mountainous wilderness of toxic plants as a preliminary to his reintegration with the civilized world suggests that the 'one-leg' paradigm, with its botanic manifestations, derives from the same ancient metaphor that in a more bizarre form was preserved as the Shade-foots.

Part of that ancient inheritance of heroic paradigms clearly derives from tales of shamans in primordial times. The torment of Prometheus and his brother Titans represents the toil imposed upon them by the new race of gods ruled by Zeus. The eagle that once was symbolic of Prometheus's flight toward the celestial realm has been expropriated as an emblem for Zeus. Prometheus no longer flies. Instead, chained to the eastern mountains that in the Iranian traditions were the home of the magical herb, he is tormented by the eagle who feasts repeatedly on the liver that was the seat of the Titan's power of divination.[34] The mountain itself, with its volcanic core, provides a passageway down to the netherworld (Aeschylus, *Prometheus* 1080 ff.), just as the holy plant found on its slopes afforded transport to the fiery heavens. His eventual release is symptomatic of the great reconciliation that reapportioned the world amongst the earlier and later races of gods and found room as well for the humans that were his creation. With the stolen fire, at a place called Mekone, apparently named for the 'Poppy' and sacred to Demeter and Persephone,[35] he taught mankind how to sacrifice, cooking the edible parts of the butchered victim and burning the rest for the gods. In doing this, his.shamanism, for so the name of the place would suggest, set man in his vital.role in the cosmos and began the arduous evolution toward the civilized arts, for in every repetition of such sacrificial eating, the Greeks retraced, in culinary symbolism, the steps of their long progress toward culture.[36] Without the ritual, -mankind could not come to terms with the horrible realization that life is nourished, just like plants, by what is dead, and that primitivism, as in the maenadic ceremonies, must be tended as the fertile foundations of civilization.

---

[32] For a discussion of the tragic hero as reversion from Olympian to chthonic or Dionysian symbolism, see Ruck, Duality and the madness of Herakles. *Arethusa*, 9/1 (1976) 53-75.

[33] Poeas (or more exactly Poias) is perhaps to be related to the word for 'herb', *poie*.

[34] On hepatoscopy and the wounding of Prometheus, see Kerenyi, *Prometheus* 39-40. For an interpretation of Prometheus's torment by the eagle as shamanic *askesis*, see E. A. S. Butterworth, *The Tree at the Navel of the Earth* (Walter de Gruyter, Berlin, 1970) 201 ff.

In addition to the common Indo-European heritage of traditional metaphors and religious ideas, however, the close proximity of the Greeks to their eastern neighbors no doubt also added to the storehouse of myth. Thus, the hero's Promethean flight with the eagle in search of Soma or the magical potion can be found in the traditions of the Indo-Iranian peoples.[37] Its earliest written account appears in Ṛg Veda 4.26 and 27, with parallels in the *Avesta* and later texts, as well as in the literature and art of Mesopotamia. In addition to the similarity to the Prometheus myth, the same story seems to underlie the traditions about the eagle who brings nectar to Zeus[38] and the myth of Ganymedes' abduction from a mountain by Zeus in the guise of an eagle so that the handsome youth might serve nectar on Olympus as cupbearer to the gods (Homer, *Iliad* 20.133-335; Vergil, *Aeneid* 5.252 ff.; Ovid, *Metamorphoses* 10.155-161). The eagle traditionally sits in the branches of the shaman's tree. Perhaps this image too is detected in Greek, in Nonnus's description of a blazing olive tree off the coast of Tyre with an eagle at its top holding a libation cup (*Dionysiaca* 40.467 ff.).[39]

Of particular interest for our interpretation of Prometheus's impersonation of a Shade-foot in the *Birds* are three reliefs from the temples at Sanchi and Amar&amacr;vati in India built in the first and third centuries A.D., but employing traditional symbolism that is certainly much older and which is essentially not different from that found in the eastern Mediterranean.[40] On these reliefs, the Tree of Life is shown as a pillar between earth and sky, resting on an *omphalos* or Navel Stone and surmounted by sunshades, apparently as indication of the fiery brilliance of the higher realm.

Philosophers

Aristophanes' parody of Socrates' necromancy in the Swamp makes clear that the symbolism of the Aryan fungus played an essential role in the Lesser Eleusinian Mystery. As with Soma, of course, it is possible that surrogates or substitutes were actually employed by the classical period, although the attributes of the original were in some form retained. Thus, the color of Medea's Prometheus herb is roughly consistent with the Vedic traditions, as is that also of the ergot fungus of the Greater Mystery. A similar spectrum of sacred color is described in Pindar's *Sixth Olympian Ode* as characteristic of the magical herb that was responsible for the primordial source of inspiration for the mythical ancestor of the lamidai, the prophets who continued to practice divination at the sanctuary of Zeus at Olympia.[41] We should not conclude, moreover, that the *Amanitas* were not to be found in ancient Attica, for it was doubtless a deadly species of that genus that was responsible for the accidental deaths commemorated by Euripides in a famous epigram (Eparchides, quoted in Athenaeus 2.61a-b). And in the forested regions of modern-day Greece, the country people retain a knowledge of edible and inedible species.

---

[35] Kerenyi, *Prometheus* 42 ff. Mekone was supposed to be located in the vicinity of the Peloponnesian city of Sicyon, near Corinth.

[36] Marcel Detienne, *Dionysos Slain* (Johns Hopkins University Press, Baltimore, 1979, translated from the French edition of 1977) 68-94.

[37] David M. Knipe, The heroic theft: Myths from *Rg Veda* IV and ancient near east. *History of Religions*, 6/4 (1967) 328-360. See also the discussion of Greek and Eastern traditions associating heat with the light of mystical vision and with shamanic *askesis* in Butterworth, *Tree at the Navel of the Earth* 133 ff.

[38] D'Arcy W. Thompson, *Glossary of Greek Birds* (Oxford, 1936 2nd edn.) 180-184.

[39] Butterworth, *Tree at the Navel of the Earth* 85 ff.

[40] Butterworth, *Tree at the Navel of the Earth* 49 ff. and plates 11-13.

[41] Ruck, On the sacred names of Iamos and Ion.

By sending Peisander into the Swamp to consult Socrates amongst the Shadefoots, Aristophanes was cutting through appearances and showing up the vigorous prosecutor of the investigation into the scandal of the recent profanations as basically no other than he would soon turn out to be, an aristocrat like the now infamous Alcibiades, whose democratic demagoguery would last only so long as it suited his own political ascendency. Like the other students at what Aristophanes in the *Clouds* had called Socrates' *phrontisterion* or 'thinkshop', Alcibiades and Peisander both could be expected to have learned from the philosopher to despise convention and speak with the deceitful rhetoric of the Tongue-in-bellies.

It would appear, therefore, from our discussion of the scene of necromancy that the common suspicion about people like Socrates was that they were apt to have derived their ideas about other realities and about the relativity of everything to be found in this present world from drug-induced visions. In rehabilitating the reputation of his teacher, a man who had been put to death for impiety, Plato chose precisely a time just before the scandal of the profanations to portray Socrates at Agathon's symposium as a person subject to spontaneously generated periods of mystical trance and to emphasize the non-erotic involvement and growing separation between the philosopher and his drunken disciple Alcibiades. That, however, was not what was commonly believed by Socrates' contemporaries. To them, he seemed to speak of experiences that resembled those of a shaman, and his unconventional manner of life and his novel deities made it likely that he acted as a mystagogue for the young men devoted to him.

He was, in fact, not unlike other early philosophers whose lives and ideas have been recognized as shamanistic.[42] Amongst them, let us recall only Empedocles, who was said to have attempted to prove his divinity by jumping into a volcano, leaving behind only a single sandal (Heraclides 77 Voss). In his life he had a great reputation as a healer and, as he himself says, he was sought in his native Sicily by many who-wanted prophecies or drugs (111,112 Diels). He died when Socrates was in middle age, but the characteristic life of such men, as the necromancy parody shows, still set the expected pattern for wise men in Athens at the end of the century. Even Plato in the following decades would describe his master's devotion to wisdom by the metaphor of the inspiring god of Love, the child of ragged poverty, who spent his whole life in philosophic quest, an enchanter and herbalist and sophist (*Symposium* 203d).

---

[42] E. R. Dodds, The Greek shamans and the origin of puritanism, *The Greeks and the Irrational* (University of California Press, Berkeley and Los Angeles, 1951) 135-178.

CHAPTER SEVEN

The Wild and the Cultivated: Wine in Euripides' *Bacchae*

In the *Bacchae*, the cultivation of grapes for the making of wine is presented as a novel advance in the science of agriculture. The prophet Teiresias compares it to the cultivation of grain as mankind's basic food. The latter is the dry nourishment that Demeter offers, whereas wine is its liquid complement, the new gift that the god Dionysus 'discovered and introduced' (ηὗρε κεἰσηνέγκατο 279). It is something as yet unknown in Thebes. Hence, he explains that it is a potion prepared from the clusters of grapes from the vine. As a 'drug', it is the supreme anodyne (οὐδ᾽ ἔστ᾽ ἄλλο φάρμακον πόνων 283), granting sleep and surcease from pain and daily cares (280-283), and it is a divine inspirative of wisdom and courage (298 ff.).

Others also have heard about wine in Thebes. The herdsman too claims that the vine is apparently an anodyne (παυσίλυπον ἄμπελον 772), without which there can be no love or pleasure for mankind (773-774). If such are the characteristics of this new drug, however, his praise of wine would seem an inappropriate conclusion to his narrative of the wild events he has just witnessed on Mount Cithaeron, for he barely escaped with his life from the god's maddened devotees. Clearly, we are not to assume that the revel on the mountain was caused by this new gift of the vine's potion. In fact, he had begun his narrative by stressing that there was no amorous dalliance amongst the women, nor were they drunk on wine, as the king who opposes this new god has suspected (686-688).

Pentheus, as will be shown, is king of a pre-viticultural city, and his persona in the drama is characterized by the antithetical properties to the wine whose introduction he opposes. In such a city, it cannot be the fermented juice from the cultivated vine that is responsible for the maenadic revels on the mountain, but wild and hunted growths instead, more primitive versions of the god, predating his Asian journey of discovery. This contrast of the wild and the cultivated will establish the basis for a new understanding of Euripides' meaning in this drama and of the tragic genre in general as a religious celebration of Dionysus.

The Discovery of Wine

At the beginning of the *Bacchae*, Dionysus announces that he has come to Thebes from Asia Minor bringing with him the cult of his new religion and that he has planted what must be the first grape-bearing vine in this land where he was born (11 ff.), for Thebes is a country that has yet to learn the art of viticulture and experience the blessings of wine. The herdsman, for example, can praise wine later only from hearsay evidence (ὡς ἐγὼ κλύω 771), and Teiresias introduces his explanation about the parallel advances in agriculture by predicting the god's future greatness in Greece. Pentheus too knows of wine only by rumour (λέγουσι δ᾽ ὥς τις εἰσελήλυθε ξένος 233 ff.) and he suspects that the experience that the god is introducing from Asia is merely a 'fiction' (πλασταῖσι βακχείαισιν 218) that the women use as a 'pretext' (πρόφασιν 224) for illicit love-making in the wilderness.

The situation in Thebes at the beginning of the play corresponds with other Greek traditions about the importation of viticulture, as well as with historical fact, for the growing of grapes for the production of wine apparently did originate in Asia Minor as a parallel development to other advances there in the cultivation of human foods. The art of viticulture spread westward from there via Crete and the Aegean islands to Thrace and mainland Greece.[1] With wine came also the cult of its ecstatic religion, undergoing accretions and developments, notably from Egyptian and Minoan influences. Dionysus himself traditionally landed in Attica around the fifteenth century before the Christian era,[2] and the names of his first proselytizing priests suggest

---

1. Kerenyi, *Dionysos: Archetypal Image of lndestructible Life* (Princeton University Press 1976) 50 ff.
2. Hieronymus's Latin translation of Eusebius records 1497 B.C. as the date of the god's arrival in Attica and 1387 B.C. as the date of his birth from Semele at Thebes. The date of arrival derives from Athenian traditions preserved in the Atthidographers. See Kerenyi 143, note 32.

Semitic, eastern Mediterranean and Egyptian origins.[3] His name has been read in Mycenaean-Minoan documents, as well as the name of his arch-opponent Pentheus, indicating that the antagonism between the two belongs to a very early stratum of the religion as it developed in the Greek lands.[4]

As would be expected, the name for the newly cultivated plant, the Vine' or *ampelos* (ἄμπελος), appears to be a word assimilated into Greek from a non-Indo-European language of the Mediterranean substratum, like other words for things that were novel to the experience of the immigrating Indo-Europeans.[5] The same is probably the case for the intoxicant fermented from the vine's grapes, 'wine' or *oenos* (οἶνος), and for the 'cluster of grapes' or *botrys* (βότρυς).[6] It is also possible, however, that *oenos* is derived from a very ancient Indo-European word, ultimately related to the Latin word for 'grape-vine' (*vitis*) and the Greek *itys* (ἴτυς), 'circular rim', as of a wheel supported by its spokes.[7] If the latter is the case, *oenos* presumably referred originally to some intoxicant other than wine, perhaps to a plant appropriately designated with the metaphor of *itys*. In Greek mythical traditions, Itys appears with Dionysian connotations as the butchered son of the maenadic sisters, Procne and Philomela, whose story involves the pattern of possession and abduction by a chthonic spirit, as in the myth of Persephone.[8]

The name of Dionysus himself contains the Indo-Europeans' word for their chief god, Zetis/Dios, and testifies to an attempt to incorporate the alien deity into Indo-European mythology as a son of Zeus, the so-called 'Nysian Zeus'. A similar assimilation occurs in the traditions about Zeus's birth on Crete, which clearly must be a rebirth since the god existed before the Indo-Europeans made contact with the Minoan culture of Crete. This Minoan 'Zeus' was one of the so-called 'divine-child' deities of botanic nature.[9] One of the names for him may have been retained in classical Greek as Bacchus, another name for Dionysus and for a 'sacred branch' or *bakkhos* (βάκχος), which, according to Hesychius, is a Phoenician word for 'lamentation', such as might be expected to attend the death of such divine children, as in the classical rites of Adonis.

The myths recounting the story of the god's arrival in Greece attest to the pattern involved in the assimilation of his cult. Traditionally, he is met by a king and his daughters, who are initiated into his new religion.[10] This initiation, as we shall see, was apparently some form of 'sacred marriage' between the princess and the god, a shamanic rite of spiritual possession whereby the alien deity was reborn in his Hellenic form, for, as the poet of the Homeric hymn to Dionysus claimed, the god's mother was said to have borne him in many places along his route to Thebes, although actually the true account was that he was born far off in Phoenicia near the streams of Egypt on a mountain called Nysa (1.1-9), the sacred place after which he is named as the 'Nysian Zeus'. The paradox of a foreign as well as native births was reconciled in later traditions by assuming that the Dionysus who arrived in Greece as the bringer of his cult was different from the one born at Thebes, but the two must originally have been the same god,[11] and, in the *Bacchae*, Euripides is closer to the truth in disguising the Theban-born Dionysus as the prophet arriving from the East with the rites of his foreign religion of viticulture, which his mother's people do not yet know.

---

[3] Dionysus was first received as a guest in Attica by Semachus, the founding hero of the deme of Semachidae, whose name appears to be West-Semitic, meaning 'made to rejoice'. Another tradition placed the god's landfall similarly on the west coast of Attica at Ikarion where he was received by Icarius, whose name suggests that he came originally from Icaria, the island off the coast of Asia Minor, where the god was supposed to have been born. Icarius can be related to Caria and to the 'light-bearer' names of Ikar (the star Sirius) and lacchus (a name of Dionysus at the Eleusinian Mysteries), as well as the Egyptian lachim, a man who was supposed to have lived in the time of the otherwise unknown King Senes. A third route of arrival was through the mountain village of Eleutherae on the Boeotian border, a place assodated with Eleuther and an apparition of the chthonic aspect of the god under the name of Melanaigis, the 'black goatskin', and with the proselytizing seers Pegasus and Melampous, the latter being the one who supposedly introduced the phallic worship of Dionysus from Egypt by way of the Peloponnesus. See Kerenyi 73 ff., 146 ff., 160 ff.

[4] Juan Puhvel, Eleuther and Oinoatis: Dionysiac Data from Mycenaean Greece, in *Mycenaean Studies, Wingspread*, 1961: *Proceedings of the Third International Colloquium for Mycenaean Studies held at 'Wingspread', 4-8 September 1961*, edited by E. L. Bennett, Jr. (Madison 1964) 164-168. The tablets in question are as follows: Pentheus on Knossos As 603; Dionysus on Pylos Xa 102 and Pylos Xb 1419; Eleuther on Pylos Cn 3.1-2.

[5] P. Chantraine, *Dictionnaire etymologique de la langue grecque* (Paris 1968) *s.v. ampelos*; H. Frisk, *Griechisches etymologisches Wörterbuch* (Heidelberg 1954-1970) *s. v. ampelos*.

[6] Chantraine and Frisk *s. v. oinos* and *botrys*.

[7] Chantraine *s. v. oinos*.

[8] C. Kerenyi, *The Heroes of the Greeks* (Thames and Hudson, Southampton 1959, 1974, 1978) 287-289.

[9] On the 'divine child' figure in Greek religion, see M. P. Nilsson, *The Minoan-Mycenaean Religion and its Survival in Greek Religion* (Lund 1949) 531-583; and B. C. Dietrich, *The Origins of Greek Religion* (De Gruyter, Berlin 1974) 14 ff., 88 ff.

[10] Kerenyi, *Dionysos* 139-188.

[11] Kerenyi, *Ibid*. 143-144.

As the god was repeatedly born anew as Zeus's son, the sacred place of his birth also was multiplied, so that there were many places called Nysa, and women other than Semele who were his mother. Even in antiquity it was recognized that the supposedly Theban Semele, whose family had migrated from Phoenicia, was no other than the Earth Mother (*F. Gr. H.* 244 F 131 Jacoby) imported from Anatolia. Thus Persephone, the great queen of the netherworld, was his mother too, and she also experienced the sacred marriage at Nysa, according to the Homeric hymn to Demeter (2.17).

The latter tradition gives us valuable insight into what was involved in these sacred marriages, for Persephone was said to have been gathering wild flowers with a group of maiden women when she was possessed by the spirit of death, the lord of the otherworld, who was synonymous in such experiences of spiritual possession with Dionysus himself (Heraclitus 15 Diels). By that abduction, she eventually gave birth to a new form of Dionysus.[12] The ecstatic devotees in the cults of Dionysus similarly performed some secret ritual that apparently symbolized the gathering of wild plants, for the recurrent indication of their maenadic occupation is a strange implement, the so-called *thyrsos* (θύρσος), apparently another non-Indo-European loan-word in Greek that designated a stylized 'sacred branch' or 'wand' in the form of a hollow giant fennel stalk crowned with leaves of wild ivy. As I have shown in a recent study of the Eleusinian Mysteries,[13] this sceptre of Dionysus takes on particular meaning when we consider that such hollow stalks were customarily employed by herbalists in Greece to preserve the freshness of the wild plants they gathered (Theophrastus, *H. P.* 9.16.2) and that 'ivy' or *kissos* (κίσσος), a plant sacred to Dionysus, was the sort of magical wild plant that would have been gathered in this manner, for it was reputed to be poisonous, with a deranging effect upon the mind (Pliny, *H. N.* 24.75; Dioscorides, *Alex*. 2.176). The plant that Persephone gathered was also reputed to be a drug, for the flower that she picked was the *narkissos* (νάρκισσος), like *kissos*, another loan-word in Greek from a non-Indo-European language,[14] but a plant that was thought in classical times to have been so named because of the 'narcotic' stupor that it induced (Plutarch 2.647b; Dioscorides 4.161). A further similarity between Persephone's Nysian abduction and the activities of the Dionysian maenads in the sacred places called Nysa is indicated by the generic titles of the god's devotees in their mountain rites, for they too, like Persephone, were his nymphs or 'brides', as well as the women who 'nursed' him in his infancy (Homeric hymn 26). These women who nursed another's child are, more exactly, 'wet-nurses', and their affinity with Persephone's realm was symbolized by their patronage by Hecate (Hesiod, *Theogony* 450-452), another manifestation of Persephone as the chthonic queen.

Other traditions confirm that the Dionysian sacred marriage and ecstatic madness are to be understood as symbolic of what, originally at least, was a drug-induced shamanic possession, for Semele was sometimes said to have conceived Dionysus, not by means of the destroying thunderbolt of Zeus, but actually by ingesting a potion containing the heart of Dionysus himself (Hyginus, *F.* 167), and, in addition to the *thyrsos*, maenads are sometimes depicted wielding gigantic pestles, an obvious implement for herbalist activities.[15] In the *Bacchae*, moreover, *narthex*, the word for the 'giant fennel', is apparently synonymous with the *thyrsos*; metaphorically, *narthex* could be used to describe a container for drugs and was thus employed as the title for medical treatises by several ancient doctors (Galen 12.398, 959; Aëtius 8.45), and in Euripides' play it seems to contain Syrian frankincense (144), an incense that was reputed to affect the mind (Dioscorides 1.81).

Even more explicit, however, is the tradition about the abduction of Oreithyia, which Plato rationalizes in the *Phaedrus* (229c). She was said to have been ravished by the wind Boreas. Her name describes her as an ecstatic woman on a mountain, and in the rationalized version of her myth, she was playing on the mountain with her friend Pharmakeia, the 'use of drugs', when she fell to her death in a gust of wind. Oreithyia, furthermore, was one of the Hyakinthidai or Daughters of Hyakinthos, a vegetative deity who changed upon his death into the *hyakinthos*, another pre-Indo-European plant name assimilated into Greek. Like Itys, whose name is supposed to be the nightingale's eternal lament (Sophocles, *Electra* 148), and perhaps also like the Phoenician Bakkhos, Hyakinthos has connotations of mourning, for his flower was supposed to imitate the letters that spelled the sound of lamentation (Moschus 3.6-7; Euphorion, frg. 36M Powell; Ovid, *Metamorphoses* 10.215). Hyakinthos appears to have been an aboriginal deity at Sparta, later supplanted by Apollo,[16] who, like Dionysus, as a son of Zeus represents another assimilation of a pre-Greek god into Indo-European traditions. Oreithyia's abduction by the wind, moreover, is a rather transparent metaphor for 'inspiration' and chthonic possession, especially in view of the wind's direction from the wintry north.[17] Hyakinthos himself was destroyed by the equally sinister wind from the west, the lands where the sun goes down. The abduction of Oreithyia by Boreas is depicted on a fifth-century Attic *hydria* in the Vatican Museum; she is shown with Pharmakeia and holds the wild flower that she has apparently just picked, as the winged Boreas abducts her.

---

[12] Kerenyi, *Ibid*. 83, 110 ff. The birth of Dionysus by Zeus from Persephone was specifically a Cretan tradition (Diodorus Siculus 5.75.4) and is parallel to the traditions of the Cretan assimilation of Zeus by a similar rebirth.

[13] R. Gordon Wasson, Carl A. P. Ruck and Albert Hofmann, *The Road to Eleusis: Unveiling the Secret of the Mysteries* (Harcourt Brace Jovanovich, New York 1978) 88.

[14] Words ending in *-issos*, like those in *-inthos*, are not Indo-European.

[15] *Hydria* from Nola, *Archäologische Zeitung* 2,6 (1888) 3-5, pl. 3 (= illustration 5 in W.H.Roscher, *Ausführliches Lexicon der griechischen und römischen Mythologie* (Olms, Hildesheim 1884-1937, 1965^2) *s. v.* Orpheus): Orpheus attacked by a Thracian maenad with a mortar in the presence of a satyr.

It would be expected that with the advent of viticulture, the wine god would be assimilated to the prevailing patterns of shamanic religions, for the fermented juice of the cultivated grape, as well as the pre-viticultural magical plants, induces a kind of spiritual communion with deity. Some aspects of this assimilation must have occurred before Dionysus arrived in the Greek lands with his gift of the vine, and still others after the coming of the Indo-Europeans. There is, however, a basic pattern to be discerned in these assimilations. Dionysus is represented both by the grape-bearing vine and by wild plants reputed to be intoxicating or poisonous. The mountain revels did not occur in the vineyards or during the time of year suitable for agriculture, but in the winter months, when the Greek mountains bloom with untended flowers, and in the wilderness. They are characterized by the symbolism, not of the harvest, but of the hunt, a search both for wild plants and for animals, that were wrenched brutally to pieces and eaten raw in a primitive manner, predating the civilizing advent of the arts of cooking. The brutality of this primitive experience was clearly meant as regression to a primordial existence. The women were said on occasion actually to have eaten their own children (Plutarch 299e; Aelian, *Varia Historia* 3.42; Apollodorus 2.2.2, 3.4.3, 3.5.2; Nonnus 9.49 ff., 47.484 ff., 48.917 ff.). In the *Bacchae*, they attack village agricultural settlements and their tilled fields of grain (748 ff.) and invert the normal order of society, for they are females performing the hunt, an occupation more appropriate for males,[18] and, thereby, they regress to the role of male-dominating women who seemed to prevail in the mythical traditions about primordial times.

The prime botanic symbol of this Dionysian inversion of the civilized order was the ivy or *kissos*, by one account, the actual meaning of Nysa (Pseudo-Dioscorides, *de Mat. Med.* 2.179). Its leaves and manner of growth bear an uncanny resemblance to the vine, but it is a wild plant and its diminutive berries are like primitive versions of the clustered grape. The ivy, moreover, reputedly is intoxicating in itself, whereas the grape must be harvested and tended through the long fermentation process. In the winter when the vine is leafless and dormant, the ivy grows like the vine on upright stems, blooming at the time of the autumn grape

---

16. J. D. Mikalson, Erectheus and the Panathenaia. *American Journal of Philology*, 97 (1976) 141-153.
17. 'To blow or breathe upon' (ἐμπνέω, καταπνέω) is the Greek equivalent of the Latin *inspirare* and commonly means 'inspire': for example, Hesiod, *Theogony* 31; *Plutarch* 2.421b; Homeric hymn to Demeter 238; Aristophanes, *Lysistrata* 552; *etc*. All winds were thought to blow to and from caverns within the earth: Elmer G. Suhr, *Before Olympus: A Study of the Aniconic Origins of Poseidon, Hermes and Eros* (Helios, New York 1967) 30 ff. The destructive Boreas was an apt figure for a deadly ravisher of vegetation.
    Oreithyia was a daughter of the primordial Athenian king Erechtheus. Her sister Creusa was similarly ravished in a sacred marriage while picking flowers (Euripides, *Ion* 889) in a spot exposed to the north wind (11). Creusa herself was married later to a son of Aeolus, the lord of the winds (63). Since it was apparently Erechtheus himself who originally enacted such deadly abductions upon his own daughters (260 ff.), these unions with foreigners are probably to be understood as displacements of his role upon outside forces, who are merely aspects of his own persona, as in the traditions about the immigrant and indigenous Cadmus, on which see 'The Regression of Cadmean Thebes', below. By such sacred unions, moreover, the sinister alien forces become incorporated into the sustaining beneficent metaphysical alliances of the city, on which see 'The Reconciliation with Primitivism', below. In actual fact, the Athemans believed that their marital alliance with Boreas was responsible for the destruction of Xerxes' fleet off Mount Athos as he came against Greece, and they commemorated the natural disaster by building a temple to Boreas on the supposed site of his union with Oreithyia (Herodotus 7.189).
18. Marcel Detienne, *Dionysas Slain* (Johns Hopkins University Press, Baltimore 1979, translated from the French edition of 1977) 20-52.

harvest and producing its fruit in the spring as the vine comes back to life, a return that seems markedly reluctant, compared to the spring-time growth of other plants. During the summer, while the vine grows upright, the ivy now enters into a second stage of growth, with trailing tendrils of leaves of the more familiar shape. It is a plant of dual nature, like the twice-born god it represents, and was thought capable of hybridizing from one variety to another. As Walter Otto has observed, 'The vine and the ivy are like siblings who have developed in opposite directions and yet cannot deny the relationship.'[19] Ivy, moreover, was thought to be parasitic, wildly sending out roots all along its stem and capable of sustaining its own life from the nourishment extracted from the host trees upon which it climbs, eventually destroying them, and even continuing to grow when its contact with the ground is severed (Theophrastus, *H. P.* 3.18.9). Ivy was related to the vine apparently as the weed to the cultivated hybrid.

Ivy was the vine's avatar. It belonged mythologically to a previous generation. Dionysus himself was called Kissos (Pausanias 1.31.6), but never Ampelos or 'vine'. It was only after his own sacred marriage with his maenadic bride Ariadne that he produces sons named Staphylos or the 'clustered grape' and Oinopion, 'vinous', whom Dionysus first taught how to make wine (schol. in Apollonium Rhodium 3.997). This evolution is often a theme in vase paintings, as, for example, on the *krater* by the Altamura painter, where Dionysus is shown confronting the younger image of himself standing on his lap: Staphylos holds a wine cup and sprigs of vine, while his seated father, attended by flower-bearing maenads, holds the ivy-crowned *thyrsos*.[20]

Other pre-viticultural magical plants are also associated with Dionysus as his primordial avatar. Amongst these are to be counted the opium poppy,[21] whose role in Minoan religion is attested by the female 'sleeping' idol from Isopata in the Iraklion Museum, who wears a diadem of the plant's seed capsules, each painted with the slit that would be cut to extract the drug. Dionysus himself is seen wearing such a crown on a volute *krater* in the National Archaeological Museum of Taranto: he is depicted as a youthful hunter amidst ecstatic maenads, one of whom holds the *thyrsos*. In a similar manner, Dionysus assimilated the role of honey and its ferment, mead, from the Minoan culture.[22] The latter intoxicant involves the symbolism of the bee, who, like the herb-gathering maenadic women in the wilds, goes from flower to flower, extracting their essence, which is a drug related to the venom of serpents, but its beneficial antithesis, instead of a poison.[23] Such a ritual is apparently depicted on a gold signet ring from a tomb near Knossos, now in the Iraklion Museum: women with the heads of insects are seen dancing amidst flowers as they experience the mystical apotheosis of a deity.

The association of Dionysus with certain trees, in particular the resin-bearing firs and pines, is also testimony to such an assimilation of pre-viticultural intoxicants into Dionysian religion. Primitive man cut the bark of such trees to extract the sap, which would ferment to produce an intoxicant (Pliny, *N. H.* 12.2).[24] Thus Dionysus maintains several 'arboreal' epithets, such as Dendreus, Endendros, and Dendrites, and he is called Phleus as the god of the 'abounding sap'.[25] Thus too, the maenads carried sacral branches or *bakkhoi* for the mountain revels (*Bacchae* 109-110), and, as we shall see, the final consecration of Pentheus as the Dionysian sacrifice will take place in the god's sacred tree. Greek wine, moreover, assimilated the taste of such more primitive intoxicants, for it was resinated (Aristophanes, *Acharnians* 190 *cum schol.*) in the manner of modern retsina.

We should expect that whatever pre-viticultural intoxicant figured in the shamanic religions of the Indo-

---

19. Walter F. Otto, *Dionysos: Myth and Cult* (Bloomington, Indiana 1965, translated from the German edition of 1933) 153 ff.
20. Museo Archeologico Nazionale, Ferrara. The confrontation of the seated god and his diminutive son is reminiscent of similar scenes depicting the birth of Dionysus, the younger Zeus, out of the thigh of his Olympian father.
21. On the role of opium in early Mediterranean culture, see P. G. Kritikos and S. P. Papadaki, The History of the Poppy and of Opium and their Expansion in Antiquity in the Eastern Mediterranean Area, *Bulletin on Narcotics* (United Nations, New York), 19 (3) (1967).
22. Kerenyi, *Dionysos* 29-51.
23. Pindar (*Olympia* 6.43 ff.) describes the primordial inspiration of a divinely born child as his nourishment in the wilderness by serpents who feed him with honey, a beneficent transmutation of their venom. See Ruck, On the Sacred Names of Iamos and Ion: Ethnobotanical Referents in the Hero's Parentage, *Classical Journal*, 71 (3) (1976) 235-252. Dionysus himself was first fed with honey from his nurse at Nysa (Apollonius Rhodius 4.1134-1136).
24. Gaetano Forni, The Origin of Grape Wine: A Problem of Historical-Ecological Anthropology, *Gastronomy: The Anthropology of Food and Food Habits* (Margaret Arnott, ed.) (Mouton, The Hague 1975) 67-78.
25. E. Werth, *Grabstock, Acker und Pflug* (Ulmer, Ludwigsburg 1954) 229.

Europeans would similarly be assimilated to the cult of wine as an avatar of the evolved and cultivated god. The Aryan branch of the migrations of these northern peoples into Iran and India in the second millennium before Christ preserved a shamanic cult from their homeland. This religion is recorded in the collection of Sanskrit hymns known as the Ṛg Veda, which is the written form of what was originally oral and formulaic material dating back to a period before the migrations. Amongst the deities of a complex pantheon appears the god Sonia, a god who was a plant that was sacrificed to extract its inebriating drug for a sacred potion. The physical properties of this plant are recorded in its formulaic epithets and descriptions in the hymns. Although Soma is a plant, surprisingly no mention is ever made of its flower, leaves, or roots. R. Gordon Wasson has demonstrated, to the satisfaction now of most Indo-Iranologists, that the original Soma, for which substitutions were made in the later performances of the rite, was a particular mushroom, the *Amanita muscaria* or 'fly-agaric', a plant that still figures in Siberian shamanism today. This mushroom grows in northern latitudes only in association with the roots of certain trees, in particular, pines, firs, and birches. The birch, because of this association, figures symbolically as the shaman's Tree of Life, the axis by which he ascends to the realm of the gods.

The Hellenic branch of these Indo-European peoples can be expected to have brought some knowledge of the traditions of this shamanic cult with them on their migrations into the Greek lands. This indeed seems to be indicated by the fact that Greek epic preserves a pattern for the mixing of magical potions that has formulaic analogues in the Vedic material. Working with Wasson and the Swiss chemist, Dr. Albert Hofmann, I have attempted to show that the Eleusinian Mysteries, and probably the other mystery religions of classical Greece, can be interpreted as communal shamanic seances, in which mystical visionary experience was induced by the ingestion of drugs. For the Greater Eleusinian Mystery, the drug was a water-soluble extract of ergot, either expressly cultivated on barley or gathered from other, weedy grasses, such as *Lolium temulentum*. This fungus, which produces fruiting bodies of the characteristic mushroom shape, is a natural source of psychoactive alkaloids commonly referred to as LSD.

The paired Eleusinian Mysteries, which centered upon the art of cultivating grain, were, like the Dionysian art of viticulture, an assimilation of the religious traditions of the pre-Greek agrarian peoples into Indo-European mythology. Thus the original solitary Mother Goddess becomes split into the sacred duo of the Mysteries, Demeter, an Olympian as sister of Zeus, and the chthonic Persephone, who, like Dionysus, has been reborn as a child of Zeus. *Lolium*, which in Greek was called *aira* (αἶρα), was thought to be the inedible avatar from which the cultivated barley had been evolved by the agricultural arts and into which it would again revert if not properly tended. The Greater Mystery celebrated this successful hybridization and reconfirmed the forward evolutionary progress of Hellenic culture, a civilization nourished like the barley itself by its healthy accord with its roots in the chthonic realm.

The cultivation of grain is the culmination of an event that began in more primitive times, namely, the abduction of Persephone while gathering wild flowers. This illicit stealing of her as a concubine eventually is legitimized in a more civilized age as she becomes a wife related by law to the powers of death. The primitive precedent for the Greater Mystery was imitated as the Lesser Mystery. By investigating the traditions about a fabulous Indian tribe of single-footed, parasol-like creatures who were supposedly implicated in a profane performance of the Lesser Mystery, I have demonstrated that the symbolism of the Indo-European wild mushroom, with analogues to the Vedic material, was preserved at this rite that was considered the prelude to the revelation of the Greater Mystery. In view of the parasol metaphor, moreover, it seems possible that if *oenos* and *itys* did indeed refer originally to a pre-viticultural intoxicant of the Indo-European people before their migration into Greece, the identity of that intoxicant was fungal, for the metaphor of a 'circular rim' is singularly apposite for a mushroom. Apparently by coincidence, it is actually as such that the sacred mushroom of Mesoamerica is indicated pictographically.[26]

---

[26] R. Gordon Wasson, *The Wondrous Mushroom: Mycolatry in Mesoamerica* (McGraw Hill, New York 1980) 64. Wasson identifies the flower glyphs that decorate the effigy of the Aztec deity know as Xochipilli or the 'Prince of Flowers' as all indicating various magical plants or 'entheogens' that figured in shamanism. By another amazing coincidence of iconography, the butterfly in both Mesoamerican and Hellenic cultures indicates the soul. A common word in Greek for 'butterfly' is *psyche* or 'soul', and Psyche is actually depicted as a butterfly on a neo-Attic marble pedestal in the Vatican, probably copied from an original work of the second century B.C.: the soul is being burnt by two weeping Erotes as a Dionysian sacrifice, a parallel event to the visit of the drunken god to a poet, and the preparations for the dismemberment of a sacrificial animal and its boiling in milk. See Kerenyi, *Dionysos* plate 64 B.

It is appropriate that the fungi should have figured in the symbolism of the hunt, as opposed to cultivation, for they are the prototypic wild plant. Their propagation by microscopic spores instead of seeds made their manner of growth a mystery in antiquity, and, even today, certain species resist cultivation. For this reason, in Greece, as well as in India, they were thought to be planted by the lightning bolt, as they burst suddenly from the ground, swollen with the water absorbed from the rainfall. Dionysus, himself, had such an engendering by his Indo-European father, whose bolt of lightning can be traced as a symbol of enlightenment in Asiatic shamanism.[27] The assimilation of the fungi to the Dionysian complex of symbolism as the wild avatar of the cultivated god can be noted in the metaphoric description of a mushroom as a miniature *thyrsos* (Apicius 7.15.6), with the intoxicating cap atop its stipe substituting for the crown of gathered ivy leaves.

Other characteristics of fungi would have facilitated the assimilation of the viticultural deity to Indo-European traditions. Each year in Greece, the three winter months belonged to a primitive, maenadic aspect of Dionysus. These were the months that the harvested and presumably dead viticultural deity spent in the otherworld, and, even at Delphi, the Olympian sanctuary regressed to more primitive Dionysian rites in honor of chthonic powers. In the absence of his cultured self, Dionysus was represented by the *phallos*.[28] The phalloid shape of mushrooms, which fruit in the non-viticultural season, made them an apposite metaphor for the male organ (Archilochus, frg. 34 Diehl). The *phallos* itself, as a symbol of Dionysus, was an importation from Egypt by the seer Melampous (Herodotus 2.49) in the Mycenaean age,[29] although it was a Greek innovation to represent the god by the *phallos* alone, instead of a movable one, in the Egyptian manner, attached to the god's effigy. Melampous belongs to a tradition similar to that of the confrontation between Pentheus and the Dionysian prophet, for it was he who cured the daughters of Proetus of the madness that afflicted them when their brother Megapenthes opposed the rites of Dionysus. Since their madness took the form of bovine rutting, the Egyptian import suggests that their cure comprised sexual gratification.

The metaphor of the bovine oestrual madness also involves the pre-viticultural aspect of Dionysus in taurine symbolism. Amongst the Indo-Aryans, the bull was the commonest metaphor for Soma,[30] and the sacral function of the bull amongst the Minoans obviously reinforced Indo-European traditions. It was apparently as a bull that Dionysus united with the sacral queen of Athens in her annual, ancient, winter rite of marriage, which took place in what was called the 'bull stable' (Aristotle, *Ath. Pol.* 3.5). The 'bellowing' or *mykema* of a bull seems to have been a metaphor for the imagined cry of the fruiting bodies of the mushroom as they burst from the earth or are harvested.[31] The metaphor perhaps derives from a pun on *mykema* and *mykes* or 'mushroom', words whose initial sounds would both have been written in the Mycenaean syllabary with the pictogram of a bull's head.

In addition to the supposed successful hybridization of the vine from primitive avatars, the art of viticulture also was symbolic of the taming and cultivation of the wild mushroom. The Greeks suspected that there was a similarity between the growth of mushrooms and the fermentation that transformed the juice of the vine's grapes into wine, a process that actually is caused by the growth of microscopic lower fungi, the yeast. Thus a mushroom itself could be called metaphorically a 'ferment' or *zumoma* of the earth (ζύμωμα χθονός, Nicander, *Alexipharmaca* 521), a word that implies an effervescing or boiling of corrupting digested matter. A similar corruption occurred in the tomb, which traditionally in Greek, as in modern languages, was a mouldy place (Homeric hymn 2.482; Sophocles, *Ajax* 1167). 'Mushroom', in fact, was apparently a metaphor for the 'burial coffin' or 'tomb' itself (Suidas *s.v.* μύκη). Thus, upon the body of the harvested grape could be grown the regeneration of the primitive god into his evolved form as the cultivated and refined intoxicant of civilized times, a rebirth that was clearly observable in the effervescing movement of the rotting ferment, as well as in the perceptible warmth generated by the process.

Here too, the art of viticulture was parallel to Demeter's gift of edible grains. Fungi are also responsible for 'leavened bread' or *zumites artos* (ζυμίτης ἄρτος), which in Greek is designated by the same metaphor of fermentation. The harvested grain similarly was host for the wild corruption. The association with the tomb would have been particularly obvious since the ancient method of cultivating the leaven would have corresponded to modern 'sourdough', a process of apparent rotting marked by a distinctive unpleasant smell. By comparison to the reddening corruption that overspreads iron, the dry grain too was host to a fungal 'rust' or ergot, *erysibe* (ἐρυσίβη), from which Demeter's analogue to wine was extracted for the Greater Eleusinian Mystery.

---

[27] E. A. S. Butterworth, *The Tree at the Navel of the Earth* (De Gruyter, Berlin 1970) 129 ff.

[28] Kerenyi, *Dionysos* 285 ff.

[29] *Ibid*. 72.

[30] Wasson, *Soma* 42.

[31] Wasson, Ruck and Hofmann 118-121.

The Reconciliation with Primitivism

For the Greeks, evolution was not a stable process. Civilization and the arts of cultivation were continually in need of renewal, to found them again upon the healthy accord and reconciliation with their more primitive origins, the fertilizing source in the chthonic realm from which they grew into the Olympian age. If the primitive were not given its proper role in the evolving order of the world, there would be no place for mankind, which, by virtue of its mortality, participates in the non-Olympian contamination of the tomb. The dishonored earth, instead of supporting the foods of life, would yield only poisons and sterility from the rotting dead, whose angry spirits would hound the living with wild delusions. Such is the threat made by the loathsome and despised Erinyes of Aeschylus's *Oresteia*, the maddening, female Hell-hounds, whose presence pollutes Apollo's Delphic temple. The priestess likens them to the Harpies who defiled Phineus's food with their rotting excrement (*Eumenides* 50 ff.). When at first they are dishonored in the civilized institution of the court at Athens, they threaten to drip tears of poison from their wounded hearts, polluting the earth with a stoppage of growth of both crops and mankind (780 ff.). Athena, however, cajoles them into accepting an honored place beneath the earth, and the threatened curse becomes a joyous benediction of fertility for the city.

Even the Olympians, moreover, would starve if mankind were not to fulfill its essential role of mediation between the two realms, converting the foods of the earth into the pure fragrance of burnt sacrifice rising to the heavens. Zeus himself, as in Aeschylus's *Prometheus*, would fall into mortality if he were not to cooperate with mankind's earth-born creator. Similarly it was a conspiracy of Zeus and earth, as announced in the Homeric hymn to Demeter, that led to the separation of the Olympian mother from her chthonic daughter and the eventual institution of the Mystery, whereby death itself was transmuted into a friendly visitor amongst mortals, the lord of riches, personified in his subterranean temple at Eleusis as the handsome youth who represented that very conspiracy, the primordial plan of Zeus.[32] Thus Demeter's first two reactions to her daughter's loss are to feed a child, not with food, but by anointing him with ambrosia and by inspiration, keeping him from the grievous witchcraft of worms burrowing in his flesh, and when that attempt to purify from mortality fails, similarly to deny all growth of mortal foods from the earth, until at last her own mother, who bore her into the Olympian realm, induces her to save the Olympians from starvation and accept back a chthonic Persephone, now pregnant and contaminated with the seminal foods of earth eaten in the tomb.

Reconciliation between the gods of the older and newer orders is, in fact, a common theme in Greek mythology, and the iconography of the deities themselves, as well as the rites of their worship, testifies to the conservative retention of very ancient, pre-Olympian aspects preserved and honored in their classical cults. Thus, for example, the pre-Indo-European goddess Athena, although reborn as an Olympian daughter of Zeus, still was associated with the transmuted symbols of her primordial identity. The Gorgon's head has been displaced, but is still worn, as indication of her role in triumphing over the chthonic queen, and the owl, her predatory night bird, has lost its meaning as the spirit responsible for her ecstatic possession, but persists as indication of the rational wisdom of the cultivated arts that she inspires. Amongst these was that of weaving, whose sinister, fateful symbolism was displaced upon the spider in the myth of her contest with Arachne, and ritually placated in the quadrennial presentation of a tapestry at the Panathenaic Festival, specially woven by a group of pre-nubile girls. Even the serpent, symbolic of the toxins of the earth, persists, but as her foster-child, responsible for the maddened deaths of others, maidens of the autochthonous dynasty at Athens.[33] In a similar manner, Demeter had non-Olympian manifestations, more akin to Persephone, as an Erinys, the Black One, and, like the Gorgon Medusa, a centauress.[34] Often the pre-Olympian identity persists and is assimilated as an epithet, supposedly indicative of a beloved companion whom the deity inadvertently destroyed. Thus Athena murdered Pallas when distracted at play by a sign from her Olympian father, the aegis or serpent-fringed goatskin, which is part of Athena's attire. Similarly, Apollo was once Hyakinthos, the beloved pre-Olympian plant-god whom he displaced.

---

[32] C. Kerenyi, *Eleusis: Archetypal Image of Mother and Daughter* (Princeton University Press 1967) 169-174.

[33] Robert Lyster, Symbolic Elements in the Cult of Athena, *History of Religions*, 5 (1) (Summer 1965) 133-163.

Such reconciliation indicates the essential participation of primitivism in an evolving world where humans are to have a role. In terms of agrarian realities, mankind, by virtue of its mortality, is contaminated with the rotting dead matter it must slaughter or harvest for food, a putrefaction that is both the potential cause of pestilence and yet the honored, stinking nutriment that sustains the generations rooted upon the earth. The affinity of the dead and their living counterpart can also be sensed in the culinary arts, another evolutionary sign of civilized mankind's progress from primitivism. The 'ripening' of fruits, by which they softened toward rottenness, was a kind of 'digestion', a process that was hastened, in its refined way, by 'cooking' or 'baking' (πέσσω). The meat of the sacrificial animal, moreover, was prepared in a manner that recapitulated the supposed ontogeny of both the beast and the cultivated arts, the primordial organs grilled first, in primitive fashion, before the parts that grew later were boiled as stew. In Orphic doctrine, mankind inherited original sin from the Titans, who opposed the evolution of Dionysus into the assimilated son of Zeus and feasted atavistically upon his flesh, cooked in perversion of the culinary arts. Zeus rescued the primordial organs and regenerated his son in an Olympian identity.

The Making of Wine

In the making of wine, the god's experience was analogous to mankind's journey toward redemption through the mouldering tomb. As in the scene depicted on Homer's shield of Achilles (*Iliad* 18.561-572), the cultivated fruit of the vine was harvested to the music of lamentation, for the god had died. His slaughtered body was then dismembered in the wine press, a crime that the harvesters sought to ascribe to agents other than themselves. In art, it was traditionally satyrs who trod upon the grapes, and, in actual practice, the treaders seem to have worn masks.[35] The juice, that was the god's blood, flowed into urns placed like burial chambers beneath the earth, where the subterranean environment maintained the proper temperature for the fungal growth of fermentation.

While the spirit of the god was being cultivated in the otherworld, he was absent from the living. The months of his sojourn in the tomb are marked in the Greek lands by a winter-time profusion of wild flowers upon the mountains, although the cold is too intense to favor the growth of garden varieties or vegetables. This was the time when the atavistic Dionysus prevailed. It was the time for the phallic processions of the rural Dionysia celebrated in the villages, primitive rites dating back to the period before the incorporation of the god's worship in the civic calendar under the popular tyrant Peisistratus. This was the time too for the enactment of the primordial sacred marriage and for the ecstatic ceremonies of the 'maenadic' *lenai* at Athens, when the women urged the god through his winter sleep, worshipping him at his effigy composed of the empty robes and mask that awaited his return.[36] Comedy, the 'revel song', originally was the only drama performed at this period, and appropriately so, for the phallic dancers described an inverted world, given over to libidinous desires that satirized the mighty and reshaped society according to the whims of baser fantasies.

When the wine was at last ready at the February festival of the Anthesteria, the urns were opened, and the god's spirit was reborn as an infant. The graves of the dead released their spirits as well at this time, and for the three days of the festival, ghosts roamed abroad in Athens. The Anthesteria was the time of reconciliation between the two realms of the living and the dead. It was then that the maddened Orestes was supposed to have arrived at Athens and been offered hospitality, despite his polluted condition. That event was recalled in the special arrangements at the festival for drinking from separate pitchers and eating at small private tables,

---

34. Kerenyi, *Eleusis* 30-33.
35. Goffredo Bendinelli, *La vite e il vino: Monumenti antichi in Italia* (Milan 1931) fig. 86, 172-173, 251-253, 264. See also Kerenyi, *Dionysos* 65 ff. Satyrs are sometimes replaced by Erotes in late antiquity (as in the sacrifice of Psyche mentioned above, note 1, p 189).
36. Kerenyi, *Dionysos* 281 ff.

so that the hospitality that was extended to the visiting ghosts thereafter would not contaminate the food of the living by the putrefaction that clings to those who come from the grave. This was the time too when the hounding Erinyes were placated and honored as the Eumenides, the Blessed Ones. In preparation for the encounter with the dead at this festival, the Athenians purified themselves symbolically of the contamination they shared with the other realm by chewing upon pieces of *rhamnos*, a shrub whose laxative properties purged their bodies of chthonic pollutants.

This was a time also for honoring an earlier age of mankind, for the Anthesteria commemorated those who died in the Great Flood that Zeus sent against the evil primitive race, after which the sole surviving couple, descendants of the first creator, repopulated the world with its present people by throwing the stones of earth behind them. Amongst the sons of that couple was Orestheus, who discovered and planted the first vine, and Amphictyon, who first received Dionysus and learned from him how to tame the toxins of wine, and Hellen, the eldest, after whom the Hellenic race took its name. The primordial race that the Hellenes replaced was the Pelasgian, a pre-Indo-European people of whom remnants survived into classical times. Their sin, for which Zeus sent the Flood, was to have attempted to contaminate the Olympian by feeding him the flesh of a boy, Nyctimus, a creature of the night, as though Zeus were the lord of the other world. Zeus changed them all into wolves and assimilated that more sinister identity, as in the case of the other deities we have mentioned, by assuming the epithet *Lykaios*, the 'wolfish'.

An earlier age at Athens itself was also placated at the Anthesteria by a curious rite of swinging in swings, supposedly in commemoration of Erigone. It was her father who first received Dionysus and his gift of wine in Attica, but when he shared it with his fellow men, they saw double and thought themselves poisoned, for which they killed and buried him beneath a pine tree. Erigone found his body and hanged herself from the tree in grief. The swinging thereafter at the festival recalled that initial misunderstanding about the civilized nature of wine.

Reconciliation with the dead and the past at the Anthesteria also took the form of an initiation into the experience of wine for the very young, the children of three or four years of age. They were the personification of the young god, and as they cavorted among the revellers and the ghosts, the continuity of mortal lineage through the transformations of the tomb was sensed as analogous to the god's fermenting gestation and rebirth out of death.

The birth of the wine, moreover, was symbolic of the god's triumph over his own more primitive identity. The satyrs, who had presided at the treading of the harvested grapes and who had inverted the norms of civilized behaviour in the maenadic revels of the winter, were the natural enemies of the cultivated god, for goats, whose hircine nature they shared,[37] were thought to be particularly invidious to the vine because of their dangerous tendency to graze on its young shoots (Vergil, *Georgics* 2.380).[38] Now the goat yielded to Dionysus. The goatskin was filled with wine, and as a test of the triumph of sobriety over drunkenness, the revellers at the Anthesteria competed in a contest, attempting to balance themselves upon a greased wineskin (Pollux 9.21). There was also a contest of drinking, for which the prize was a goatskin (Aristophanes, *Acharnians* 1224 *cum schol*). It was the goat too that was the special sacrificial victim for Dionysus. The song for its slaughter, the *tragoidia*, was perhaps the origin of tragedy.[39] In the next month the Athenians would celebrate the Great Dionysia, a drama festival that originally involved only the tragic poets, without the comedy later imported from the Lenaea. The Dionysia was a great celebration of Athens as a center of culture in the Greek world, and it revealed the higher inspiration of Dionysus in his civilized form.

---

[37] Satyrs are often confused or joined with Sileni, from whom they sometimes appear to have acquired equine characteristics, in addition to the goat-like nature that they share with Pan. All of these figures represent primitive spirits of the woodland. Like the centaurs, the Sileni were also inspired sources of knowledge and their leader was entrusted with the teaching of the child Dionysus in the wilderness of Nysa, just as Chiron was said to have educated heroes. The satyrs, on the other hand, share the centaurs' inclination toward the uninhibited satisfaction of libidinous drives, especially under the influence of wine.

[38] Kerenyi, *Dionysos* 322.

[39] Walter Burkert, Greek Tragedy and Sacrificial Ritual, *Greek, Roman, and Byzantine Studies*, 7 (1966) 92 ff. See also Kerenyi, *Dionysos* 333.

Just as in the making of wine the two natures of Dionysus were reconciled, so too in the wine itself was the primordial deity still honored. To understand this incorporation of the pre-viticultural deity in wine, we must summarize evidence that I have presented more fully elsewhere.[40] The Greeks, as well as the Romans (Pliny *N. H.* 14.29), had the peculiar custom of diluting their wine with several parts of water before drinking it. Since they could not have fortified their wines with pure alcohol from distillation (a process not known until the alchemists discovered 'aqua vitae' around 1100 A.D.), the alcoholic content of their wines could have been derived only from natural fermentation, which is limited to about fourteen percent by the pickling effect of the alcohol itself upon the growing yeast which produces it as a by-product of the fungal activity upon the sugars of the juice. Greek wine, therefore, should have had only very mild intoxicating properties after the customary three- or fourfold dilution with water. Such, however, was not the case. We even hear of a wine that could stand eightfold dilution (Pliny, *H. N.* 14.53), an actual historical survival of a wine that in the mythical tradition required twenty parts of water (Homer, *Odyssey* 9.208-211) and was associated with the story of the Cyclops, a primitive one-eyed creature who figured in mystery traditions and Asiatic shamanism.[41] Undiluted wine was supposed to cause permanent brain damage. Nor should we assume that the Greeks diluted their wines so that they might safely drink excessive quantities, for just four 'little cups' of diluted wine are said to have been sufficient to induce a deep intoxication (Eubulus, fr. 94). The frequent depictions of revellers in art and literature, furthermore, should leave no doubt that the Greeks did indeed get drunk and that the purpose of drinking was, in fact, to become inebriated. Obviously, the alcoholic content of their diluted drink could not have been the sole cause.

As we have seen, the Greeks recapitulated the evolutionary history of Dionysus by incorporating the resinous taste of one of the god's pre-viticultural antecedents in their wine. It is only to be expected that they would also have assimilated other atavistic versions of the cultivated god into the fermented drink. Alcohol itself was unknown as a substance, and the affinity of the ferment to other intoxicants would have suggested itself by their similar effects upon the mind, although wine had the mark of civilization, as opposed to the wild, natural growths, and was gentler, for Dionysus had taught mankind how to tame it through dilution. Spices, unguents, and herbs were, in fact, added to Greek wines, either in the fermentation or at the ceremony of dilution before drinking. It is these additives that must account for the special inebriating properties of Greek wines, which in some cases were actually more hallucinogens than alcoholic intoxicants (Aristophanes, *Wasps* 12 ff., 213).

As sign of such an assimilation of wilder versions of the god, the quality of wine was referred to as its 'flower' or *anthos*, a metaphor that persists today, without the same meaning, in our speaking of a wine's 'bouquet'. Dionysus himself was called the Flower God, Antheus and Euanthes, epithets that gave his name to the Anthesteria festival. The tradition of wine as a vinous potion persists in modern Greek, where the demotic word for wine is *krasi*, literally the 'mixture'.

The Mad King and the God

Pentheus, as the king of the pre-viticultural kingdom in the *Bacchae*, has a peculiar characteristic which perhaps we now can begin to understand. He is mad. Cadmus first notices it as Pentheus makes his entrance, rushing on stage to interrupt the old men's plan to join the mountain revel. He is 'all aflutter' or distraught with passion (ὡς ἐπτόηται 214), and throughout the play his violent emotions and stage presence are a visual contrast to the calm of the Asiatic deity of the vine. As the prophet Teiresias tells him, he is 'witless' (ἐν τοῖς λόγοισι δ᾽ οὐκ ἔνεισί σοι φρένες 269), and his meaningless words have only the semblance of sense. At the close of their violent controversy, the seer sums it up: Pentheus is a babbling idiot (μῶρα γὰρ μῶρος λέγει 369); all along, he has been 'out of his mind' and now he has become 'raving mad' (ὡς οὐκ οἶσθα ποῦ ποτ᾽ εἶ λόγων. μέμηνας ἤδη: καὶ πρὶν ἐξέστης φρενῶν 358-359).

---

[40] Wasson, Ruck, and Hofmann 89 ff.

[41] The Cyclopes were apparently a Greek version of the fabulous people known as Arimaspeans, a name that designates them as Monophthalmoi or 'One-eyes' in Scythian. The Arimaspeans were involved in shamanic rites that were proselytized in Greece by the priest and poet Aristeas of Proconnesus. See E. R. Dodds, *The Greeks and the Irrational* (University of California, Berkeley 1951) 141.

In the context of the play, this madness is presented as a pre-viticultural state of mind. Whereas Pentheus is senseless, the mentality that wine induces, as Teiresias explains, is inspired with divine knowledge, a mania that underlies the appropriately so-called 'mantic' arts (τὸ γὰρ ... μανιῶδες μαντικὴν πολλὴν ἔχει, 298-299), as well as the panic 'fear that sets an army aflutter' (φόβος διεπτόησε ... μανία δὲ καὶ τοῦτ᾽ ἐστὶ Διονύσου πάρα 304-305) and embraves them for the conflict, whereas Pentheus's bravura as the play develops will merely demonstrate his witless state. Wine, moreover, is the superlative anodyne, as we have already noted, whereas Pentheus is the 'Sufferer' and is so lacking in the mania of clairvoyance that he cannot even see what his name so clearly warns him will be his role in his intended conflict with Dionysus (367 ff.). 'You are mad in the most painful way', Teiresias tells him (μαίνῃ γὰρ ὡς ἄλγιστα 326).

Not only, however, does Pentheus have a mentality contrary to the effects of wine, but his pain is incurable and his suffering was apparently induced by ingesting some other 'drug' (κοὔτε φαρμάκοις ἄκη λάβοις ἂν οὔτ᾽ ἄνευ τούτων νοσεῖς 326-327). It was traditional to believe that ill humour could be traced to a maddening drug,[42] but in this context there is certainly more than convention involved.

This ill-humoured opponent of the vine, moreover, has no less a botanic identity than the god. It is repeatedly mentioned in the drama that Pentheus is the son of the 'serpent man' Echion (213, 265, *etc*.), a creature 'sown' and 'harvested' (ὃς τὸ γηγενὲς δράκοντος ἔσπειρ᾽ Ὄφεος ἐν γαίᾳ θέρος 1025-1026; ὃς τὸ Θηβαίων γένος ἔσπειρα κἀξήμησα κάλλιστον θέρος 1314-1315) from the primordial crop that Cadmus had planted in founding the city of Thebes. The seeds for that first sowing of the Theban plain were the fangs of the deadly serpent who was the previous inhabitant of the site for the city, and the crop that sprouted from them fought amongst themselves until only five remained, the so-called Sown Men or Spartoi, of whom Echion was one. Like his grandson Pentheus, the aboriginal serpent can be expected to have derived his ill temper from toxic plants, for it was by eating evil drugs that serpents were thought to acquire their grievous bile (Homer, *Iliad* 22.94; Vergil, *Aeneid* 2.741; Pliny, *N. H.* 22.95). Serpents also contaminated other plants by their presence. Thus mushrooms were said to suck up the venom of serpents in the ground beneath them (Nicander, *Alexipharmaca* 521-525), and only after serpents had gone into hibernation was it safe to gather them (Pliny, *N. H.* 22.95). By one account, Dionysus discovered wine when he noticed a serpent eating grapes and in accordance with a prophecy improvised the first wine press (Nonnus, *Dionysiaca* 12.293-362).[43] Snakes, moreover, resemble the trailing growth of the vine and ivy. Because of their cold-blooded nature, they had a particular affinity with the latter and were twined into the ivy wreaths of the maenads (Plutarch, *Alexander* 2.6), who tore them to pieces in their winter revels.[44]

The role of the serpent in pre-Indo-European religion is well attested by the so-called snake goddesses of the Minoan culture, where it probably figured, like the predatory bird and magical plants, as representative of the possessing chthonic spirit in shamanic rites of sacred marriage. The serpentine form of Echion associates him with the symbolism of the autochthonous dynasties at other Greek cities and with the earth-born creatures whom Zeus eventually subdued in establishing his Olympian realm. The myth of Cadmus's coming to Thebes, sowing the Spartoi, and betrothal of Pentheus's mother Agave to Echion is analogous to the traditions about the advent of viticulture, involving a sacred marriage and mediation with toxic primitivism in the establishment of culture and civilization. Matrilocality and matrilineality, which are indicative of primordial times, have been replaced by Pentheus's patrilineality and patrilocality, and the successful evolution toward the Olympian age is symbolized by Cadmus's marriage to Harmonia, the offspring of Aphrodite and Ares, who was also the parent of the primordial serpent whom Cadmus destroyed. The success of this assimilation of cultures and transmutation of symbolic forms was indicated by the attendance of the Olympians themselves at the marriage feast of the city's founder.

It is perhaps significant, however, that Cadmus in the *Bacchae* is now old, and the rejuvenation that would have come with the acceptance of Dionysus's new rites of cultivation is denied him in the play. Instead, as we shall see, the city becomes unfounded and reverts to primitivism as the pre-Olympian nature of Pentheus asserts itself.

---

[42] For references, see E. R. Dodds, *Euripides*' *Bacchae* (Oxford 1944, 1960^2) 112.

[43] The myth, although recorded in a late author, seems to preserve elements of a very ancient tradition. See Kerenyi *Dionysos*, 57-60.

[44] *Ibid*. 60-62.

Double Birth and the God's Surrogate

In this pre-viticultural kingdom, Dionysus has not yet been assimilated, and thus the fundamental dualism of his nature is misunderstood by everyone except the Asiatic devotees, who have come with him from the lands that have already accepted his gift of wine. The essence of this dualism involves the mystery of his double birth, by which death becomes a gestation for regeneration and evolution. The chorus of Asiatic women describes how the infant was taken from the womb of his dead mother and washed in the Theban spring of the maenadic Dirce. Zeus then took him for his thigh, calling, 'Come, Dithyrambus, enter this male womb of mine' (Ἴθι, Διθύραμβ᾽, ἐμὰν ἄρσενα τάνδε βᾶθι νηδύν 526-527). thus giving him the sacred name which the Greeks interpreted as meaning that Dionysus had come twice to the gates of birth.[45] It is by means of this second birth that Dionysus is assimilated into Indo-European traditions, and the Asiatic wine cult became incorporated into the civilized era over which Zeus reigns. The myth is paralleled in one of the oldest of the Vedic upanishads, which states that the gods took Soma and put him into the right thigh of the supreme sky-god Indra.[46]

For the Thebans, however, only the primordial half of the dualism is accepted. Pentheus, like his mother and sisters (26 ff.), ridicules Dionysus's supposed Olympian birth. They all claim that Semele's infant perished in her womb, destroyed by the thunderbolt that was her punishment for lying about an imaginary affair with Zeus in order to cover her shame for an illicit pregnancy from a mortal (242 ff.). Even Teiresias does not understand the second birth, for although he stresses that Dionysus is indeed a god and the son of Zeus, he attempts to rationalize the mystery by explaining that Dionysus was actually born only once. It was simply a confusion of words that gave rise to the idea that he was sown into the 'thigh' (*meros*) of Zeus. Instead Zeus made an illusory double of the infant out of the layer of upper air and gave it as a 'surety' (*homeros*) to the care of his jealous wife as assurance of his future fidelity, while the real Dionysus was apparently entrusted to the nurture of others (286 ff.).[47] Teiresias's explanation, however, misses the point and deprives the god of his transmutation into his civilized aspect. Instead, Hera, like a primordial great goddess, tends her delusion and seems to dominate Zeus, and the real infant, who was born only once, has yet to evolve from primitivism, for the creatures to whom he was entrusted are traditionally the satyrs and maenadic nurses and brides of Nysa, the wild place of his youth, before the discovery of wine. Even Cadmus shares the Theban doubt about the mystery, but he urges that they at least appear to accept it, for it is a noble lie that will benefit the dynasty and his dead daughter's reputation (332 ff.).

It is by means of the second birth, however, that the god acquires his special role in alleviating the sufferings of mankind, while nourishing the spirit with the superior mania of inspiration. The death of his primitive self is the essential precedent for his evolution into Olympian times, and by being born both of the mother in the earth and of the heavenly father, he is the appropriate mediator between the Olympian gods and mortals, who, like him, experience the contamination of the chthonic realm.

Teiresias attempts to explain this role of mediator in mankind's sufferings as an act of sacrifice, whereby Dionysus, although a god, offers himself in libation to the other gods so that humans, through him, can experience the blessings of wine, its ability to end pain and cause sleep and forgetfulness of daily troubles (οὗτος θεοῖσι σπένδεται θεὸς γεγώς, ὥστε διὰ τοῦτον τἀγάθ᾽ ἀνθρώπους ἔχειν 284-285). Dionysus is identical with the 'liquid potion of the clustered grape' which he 'discovered' (279), and it is only by sacrifice of himself that he can offer his gift of wine.

Just as Dionysus came twice to the gates of birth, his act of sacrifice, therefore, must bring him doubly into death, both in the abandonment of his own atavistic precedents and in the form of his cultivated self. As we have seen, such a double sacrifice was ritualized in the actual tending of the vine's harvest through its winter fermentation. It is the mystery of this sacrifice that the god will reveal to the doubting Thebans in the *Bacchae*. The play enacts the consecration of Pentheus via a repetition of the double birth as the god's surrogate, in whose person Dionysus must, as always, die in order to free himself from his darker antithesis and grant the blessings of madness through his gift of wine.

---

[45] This derivation of Dithyrambus, although well attested in antiquity and obviously implied by this passage in the *Bacchae*, is apparently false. The name may be another non-Indo-European word assimilated into Greek and can be compared to a Phrygian word for the 'tomb', thus an epithet of Dionysus as the Lord of the Tomb. See Sir Arthur Pickard-Cambridge, *Dithyramb, Tragedy, and Comedy* (Oxford 1962, second edition revised by T. B. L. Webster) 7-9.

[46] See Dodds, *Bacchae* 78.

[47] Unfortunately a lacuna in the text appears to occur after line 293. Gilbert Murray suggests the indicated completion on the basis of the myth as recorded in Apollodorus 3.4.3.

The musical accompaniment for the dancing of the choral women in the play is a constant reminder that the story does, in fact, enact this pattern of assimilation and sacrifice, for the instrument they play is the tympanum, whose connotations they identify at the beginning of the drama in their first dance, the parodos ode. There, they describe accurately and in detail the double birth of Dionysus and present it as analogous to the Cretan birth of Zeus himself, the event whereby the Indo-European god, in like manner, assimilated the pre-existent male deity of Minoan religion (89 ff.). The sound of the tympanum indicates that the evolutionary rebirth is taking place and that Dionysus brings redemption from the primitivism of the kingdom where he was first born, for it was at the Cretan birth of Zeus that the ecstatic Corybantes invented the tympanum to cover the cries of the newly born infant, and the same drum was used in Corybantic rites to cure madness (Aristophanes, Wasps 119 *cum schol*.). There was also a tradition, of which Euripides was apparently aware (*Cyclops* 3), that the same sound cured Dionysus himself of a madness sent upon him by Hera in his primordial state.[48]

The First Birth

The first birth is from the earth. It will be marked by thunder and earthquake, and symbolized by the simultaneous burst of fire upon Semele's tomb, which from the beginning of the play has been seen still smoking from the time that Dionysus was wrenched from his mother's womb. It is this birth that will ratify Pentheus as the primitive aspect of the Dionysian duality.

Characteristic of that role, Pentheus is first introduced as a hunter, symbolic of the pre-agrarian gathering rites of the winter revels. It was as a hunter that Dionysus manifested himself then, as Zagreus, the 'one who catches his prey alive', a chthonic child of the queen in the otherworld. In these rites, Dionysus was both the hunter and the hunted, for the maenadic women sought the wild plants and animals whose spirit would possess them in ecstatic rapture.

Thus, when Pentheus first enters on stage, he announces that he intends to 'hunt' (228) the Theban maenads on the mountain. In the ensuing choral stasimon, the Asiatic devotees of the god identify the kingdom of such a mad and senseless hunter as a land that does not know the joyous and pain-relieving festivities of the Dionysian vine and they pray to return to their eastern homelands. The next episode begins with the presentation of Pentheus's captured prey (434 ff.), and Pentheus, as hunter, taunts Dionysus, whom he has 'netted' (451) alive, as an effeminate weakling who 'hunts' (459) only those same Aphrodisian joys that the Asiatics have just extolled.

As the two opponents size each other up for the coming conflict, their uncanny similarity begins to emerge, for Pentheus, as well as the disguised god, is a Dionysus. Thus the prophet, who actually was first born in Thebes, identifies Asia as his homeland, from which place he has brought the rites of Dionysus, the son of Zeus. When Pentheus facetiously asks if they have a Zeus there who makes new gods, Dionysus replies that it was here in Thebes that the union with Semele took place. The different appearances of the prophet and Pentheus also cannot distinguish between the two, for Pentheus seeks to know what the god looks like, only to find that Dionysus apparently can look like whatever he wishes (477). He is in fact standing right there, although Pentheus cannot see him, for Dionysus is sane, and the other mad (500 ff.). Just as Pentheus had begun the episode by inquiring into the mysterious prophet's identity, Dionysus now, in structural responsion as the scene closes, claims that Pentheus himself does not know his own identity, to which the mad king unwittingly demonstrates the truth by stupidly citing his chthonic lineage from Echion and his name, whose meaning as 'Sufferer' he clearly does not comprehend.

---

[48] See Dodds, *Bacchae* 83-84.

With the two thus joined by the uncanny opposition of their dissimilar temperaments, the play proceeds to enact the consecration of the Dionysian surrogate. The first stage is the confirmation of his earth-born nature by apparently simultaneous miracles within the palace and amongst the Theban women on the mountain.

The choral dance that introduces this episode contrasts the redeeming second birth of Dionysus with the mad earth-begetting of Pentheus. The Asiatic women describe how Zeus took the infant from the flaming lightning that had blasted Semele and then quenched the fire in the Theban spring of Dirce before receiving the embryonic child into his thigh to gestate for the second birth (519 ff.). Thebes, however, refuses the 'grape-clustered joy of Dionysus' wine-vine' (τὰν βοτρυώδη Διονύσου χάριν οἴνας 534-535). and, instead, Pentheus is demonstrating the madness we have already seen - Pentheus, of chthonic lineage and begot of a serpent, the offspring that earth-born Echion once planted, no mortal child, but a wild monster, a deadly earthy creature that is the god's antagonist (537 ff.). They pray to Dionysus to come, significantly, from Olympus to rescue them from this primitive madness, and the god complies, calling to them from within the palace, where the hunter had taken his prey. The god manifests himself as Bromius, the 'Thunderer'. He shatters the foundations of the building and sets the palace afire with lightning, while, as in his own first begetting, the tomb of Semele bursts into flames.

This event has the unmistakable indications of a birth from the earth. Like the sacred marriage of the queen at Athens to the primordial Dionysus, the place where the miracle is enacted is the bull stables of the royal palace, and the thundering earthquake traditionally marks the emergence of autochthonous creatures from the ground.[49] In the theater, it would have been staged to the striking of the 'thunder gong', the same instrument that in the Mystery at Eleusis announced the birth of the divine child Brimos from the nether realm in the midst of a blinding flash of light.[50]

At the beginning of the ensuing episode, Dionysus, still disguised as the prophet, emerges from the palace to detail what has happened within. The mad Pentheus, with deluded sight, mistook a bull in the stables for the prophet, whom he thought he was roping and confining. It was at this moment that the earthquake and the fire on Semele's tomb had occurred (622. ff.). Ironically, Pentheus thinks that the house itself has caught fire and he calls for his servants to quench the flames with the same water from the spring of Dirce that had doused the burning infant Dionysus. Then, thinking that the prophet had taken advantage of the confusion to escape, he rushed into the house, where he mistook a hallucination for the prophet and entered into combat with thin air. Through all of this, the prophet emphasizes that he himself maintained his calm composure (622, 636), while Pentheus vainly struggled and rushed about. It is also clear that for the prophet too the events within the palace were only the appearance of what they seemed (ὡς ἔμοιγε φαίνεται, δόξαν λέγω 629), but unlike Pentheus, he could correctly interpret what was happening as manifestations of Bromius, whom he identifies by the primordial epithets of Bacchus and Bacchius. When Pentheus finally emerges from the palace to find the prophet still quietly waiting for him, his first words are that he has 'suffered terribly' (πέπονθα δεινά, 642), the confirmation of the role that he is too mad to understand. In contrast, the prophet claims that he himself was freed from the suffering that Pentheus had intended to inflict upon him by the 'somebody... who makes grow the clustered vine' (649 ff.).

The chthonic birth had been sensed also on Cithaeron. The herdsman who has just returned from there tells how Pentheus's mother Agave had heard the bellowing of bulls and waked the other Theban women. There too, as in the bull stable of the palace, the connotations are of a primordial sacred marriage, for Euripides repeatedly describes the madness that has driven them to the mountain as the oestrual heat, the poisoning sting of the 'gadfly' or *oistros* (32, 119, 665, 1229) that inflames the womb, the organ, as it was thought, that made women in particular prone to hysteria and uncontrollable longings.[51] This association of the gadfly's sting with sexual madness is a traditional metaphor in Greek. In Apollonius Rhodius (3.276 ff.), Eros himself is

---

49. Thus a bellowing, as of a bull, and a shaking of the ground occur when Medea cuts the magical root with which she will anoint Jason (Apollonius Rhodius 3.864-865). The same bellowing sound occurs when Perseus 'harvested' the Medusa's head (Eustathius, on Homer, *Iliad* 2.498). The autochthonous Erichthonius/Erectheus was named the 'bellower' (cf. *erechtho*, *orechtho*).
50. See Kerenyi, *Eleusis* 84. The instrument was called the *echeion*.
51. Bennett Simon, *Mind and Madness in Ancient Greece: The Classical Roots of Modern Psychiatry* (Cornell University Press, Ithaca 1978) 238 ff.

likened to a gadfly amidst a herd of heifers as he enters a room filled with women and shoots Medea with an arrow whose poison, like a flame, drives her madly into love for Jason. The myth of the gadfly itself involves Zeus's affair with a primordial version of Hera in the person of lo, whom Hera transformed into a cow, like her own pre-Olympian self (Ovid, *Metamorphoses* 5.330) as indicated by her ancient epithet, Boopis, the 'Bovine', still retained on Olympus. The gadfly was supposedly the ghost of the 'all-seeing' (Panoptes) herdsman who tended the cow, goading it, as in Aeschylus's *Prometheus*, into ecstatic wanderings until a Zeus of the Olympian age calmed her madness with the touch of his hand, to beget the later race of heroes. The gadfly was also known by a name that apparently is the opposite of the primordial herdsman's epithet, for it was called *muops*, the 'close-eyed', by which name it was identified with a plant (Pseudo-Plutarch, *de Fluviis* 22.5) said to grow in a river, that itself figured as another chthonic lover of a heifer-like maiden in the myth of Deianeira (Sophocles, *Trachiniae*).

The sexual nature of the women's madness is, of course, what Pentheus has all along suspected, but, as in the case of Semele, he has mistaken the spiritual aspect of the maenadic rapture. The numerous depictions of Dionysian revels in vase paintings can leave no doubt that the Greeks of Euripides' audience were well aware that the women cavorting on the mountains were indeed engaged in sexual experience, but that Pentheus was a fool to think that it could be seen, for the eroticism was metaphysical and the lovers spiritual. Thus on vases we see the women wakened by ithyphallic satyrs and romping with them, or dancing, often nude, before the thyrsos-bearing god, or presenting hares, symbolic of sexuality, as their catch in the hunt.

What the herdsman saw, as he tells Pentheus, was not the suspected drunken orgy, but a model of decorum. The maenads had fallen asleep in three groups, apparently exhausted from their ecstatic dancing. The trifold grouping was traditional,[52] and apparently corresponded to differences in their ages, 'the young, the old, and maidens still unwed' (694), each of which is led by one of the sisters of the dead Semele (681-682). Since children do not appear in depictions of maenads on vases, and indeed would be unlikely to have experienced the oestrual madness, the age distinctions must refer to their stages of female maturity, and the 'young' are mentioned as contrast to the 'old' and would include women well into the age of child-bearing,[53] as distinct from those beyond that stage of life. Presumably, the trifold grouping pertained to the generic roles enacted by the maenads as the god's 'brides' and 'nurses' and 'hunters'.

The regressive symbolism of these women, who have been goaded into the wilderness, away from their civilized task at the loom (118), is apparent in their clothing, for they are wearing the traditional maenadic attire of animal skins, girded with serpents, a form of dress that symbolically imbues them with the animal's spirit. In this bestial transformation, they were seen cuddling animals like children or actually suckling them, apparently having abandoned in the city their own newly born babies (702).

They have evidently been gathering wild plants, for they crown themselves with wreaths of ivy, *smilax* or 'bryony', and leaves of oak (702-703). The latter two plants, like the ivy, have regressive symbolism. *Smilax* is an evergreen creeper that resembles ivy, with clusters of scarlet grape-like berries, which are said to be similar to the fruit of plants called the 'wild grape' and the 'wild vine', as well as nightshade (Theophrastus, *H. P.* 3.18.11). Like ivy, it was a wild plant, not cultivated, and thought to be parasitic, clinging even more than ivy to its host (*ibid*. 7.8.1). It was a common substitute for ivy in maenadic rites, but in some way deficient (Pliny, *N. H.* 16.155), probably because it lacked ivy's reputed effect upon the mind. The oak had similar connotations of primitivism. It was associated with a primordial Zeus, whose sacred grove at Dodona was tended by a barefooted priesthood of prophets who slept upon the ground (Homer, *Iliad* 16.233). Before the arts of agriculture evolved, mankind was supposed to have fed upon acorns, the fruit of this sacred grove (Vergil, *Georgics* 1.147-149). Acorns were also thought to be the ancient food of the Pelasgian, pre-Indo-European people of Arcadia (Adespota, fr. 67 Page; Herodotus 1.67; Hippolytus, *Refutatio Omnium Haeresium*

---

[52] Tripart grouping is associated with Theban maenadism. See Albert Henrichs, Greek Maenadism from Olympias to Messalina, *Harvard Studies in Classical Philology*, 82 (1978) 137-138.

[53] Dodds, who follows Bruhn, interprets the grouping thus as only twofold: 'young and old - and unmarried girls among them', *Bacchae* 163. Maenads, of course, are depicted with the Dionysian child, but not with their own. The traditions, mentioned above, about maenads who ate their children during the revels probably are not to be understood literally, but in terms of ritual impersonations, with the child either the gathered Dionysian infant or, as in the scene described by the herdsman the wild animals and serpents that the women 'mothered' before rending limb from limb for the ritual raw meal.

5.17), and the homilitic phrase, 'to be born from the legendary oak or stone' (Homer, *Odyssey* 19.163 *cum schol*.; Plato, *Apology* 34d, *Republic* 544d), seems to have implied primordial origin in pre-civilized times.

What the herdsman next saw was an apotheosis of the pre-agricultural age, a reversion to the fabled Golden Age, when the earth yielded up nourishment without mankind's toil of cultivation. Someone struck the rock with her *thyrsos*, and water flowed from the ground. Another placed the *narthex* upon the earth, and the god sent up a natural spring of 'wine', while others scratched the ground and found 'milk'. After the miraculous appearance of these three natural springs, the *thyrsoi* themselves are transfigured, with streams of honey dripping from the leaves of ivy. Thus it was in primitive times, as Vergil claims, before the streams of wine were stopped and the honey shaken from the leaves, so that mankind henceforth would have to work for his livelihood (*Georgics* 131 ff.).

The central role of the *thyrsos*/*narthex* in this apotheosis suggests, as one would expect, that the women in this wild place are gathering foods, instead of tending crops or herds. In the context of this play, where the gift of Dionysus is consistently designated by phrases descriptive of the clustered grape that is fruit of the tended vine, it is significant that here it is simply 'wine' that flows naturally from the earth, without the need of fermentation. *Oinos*, in fact, can be generic in Greek for any intoxicant. Thus Herodotus, for example, can speak of beer as a 'wine made from barley', as distinguished from Vine wine' (2.77). 'Milk' too is easily metaphoric and can designate the milky sap of plants (Theophrastus, *H. P.* 6.3.4), or even wine, as the 'milk of Aphrodite' (Aristophanes, fr. 596). It is perhaps also significant that Euripides, in this description of the women's activity, speaks of 'swarms of milk' (γάλακτος ἑσμοὺς 710), a strange metaphor,[54] suggestive of bees, as if what the women actually were doing was gathering the essence of flowers. Bees, moreover, have a special significance in this ethnobotanic context, for, like the gadfly, they are stinging insects and therefore poisonous, but they seem to be able to transform the poisons, which they must have derived from flowers, into honey, a nourishment akin to serpent's venom, but sweet and non-toxic.[55] Thus, in this Golden Age, even the poisonous ivy leaves gathered into the *thyrsos* yield honey. Honey, moreover, seems to have been associated with the Minoan predecessor of the viticultural Dionysus, and it is related to the common word in Greek for 'intoxicate', probably indicating the role of mead as a precedent for wine.[56]

In Pentheus's kingdom, however, the blessed age of primitivism is not allowed to express itself as a function of evolution, and thus, instead of renewing civilization, it pollutes and destroys it. The women, after the gathering ceremony, had entered into the maenadic madness, calling upon Dionysus with his mystery name as the chthonic lacchus and as Bromius, the 'Thunderer', and the whole mountain, thereupon, had become transformed, together with its beasts, into constant motion. This is the blessed madness that the Asiatic maenads had extolled at the conclusion of their parados dance (135-169). There, they had described the god's epiphany amongst them, in the midst of the primal land flowing with milk and wine and honey, as Bromius, leading the hunt for the goat to be eaten raw and possessing their leader with a shamanic frenzy. When the repressive Pentheus intrudes upon the idyllic scene through the presence of his spying herdsmen, it is clear, to all but him, that the corollary of the blessing is the danger of dishonored primitivism, and that he and his kingdom will have a role as the tragic surrogate. When the herdsmen decide to 'hunt' (719) the maenads to please their master, they discover that there is another leader for the chase, and the women, like hounds (731), attack the hunters, using their *thyrsoi* as weapons.

Instead of the miraculous age that predated civilization, this same primordial time now is maddened to vengeance against the later agrarian age. The herdsmen themselves barely escape dismemberment, and the women fall upon their cattle instead, brutally rending them limb from limb with their hands. Then, like predatory birds, they swoop down upon the Theban farming villages beneath them, plundering and destroying them like enemies and kidnapping children, until finally they return to the miraculous springs on the mountain to cleanse their bodies of the blood.

---

[54] Dodds, following Elmsley, calls the metaphor absurd and derives ἑσμός from ἵημι (instead of ἕζομαι) so that the phrase means 'springing jets' of milk: *Bacchae* 164. Thusalso Liddell, Scott/Jones. In compounds, however, the word has connotations of bees and I suspect that a melissaean metaphor is appropriate to this context.

[55] See Ruck, *Sacred Names*.

[56] Kerenyi, *Dionysos* 36.

The cultivated vine with its ferment of wine is the symbol of the world restored to balanced accord with its primitive origins, and for it to exist, its enemy must be destroyed. The primordial god must yield to Dionysus, the son of Zeus. Now that Pentheus has been ratified in his chthonic birth, both by the events within the palace and the twofold manifestation upon the mountain, the episode concludes with the presentation of Pentheus, confirmed in his coming role as victim. Once more, the dual aspects of the god are divided between him and his surrogate. Pentheus cannot, as he says, endure to 'suffer what he suffers' at the hands of women (786). Clearly, he is the sufferer, even though he had tried to make the other 'suffer' (788). In temperament, his every action demonstrates that he is the passionate one, despite the prophet's advice to calm himself (790). He is the prey for whom the net is cast (848), and the senseless confusion of his thinking is more than ever apparent. He will take pleasure in his pain (814-815). To avoid being detected in going to the mountain in stealth, he will instead go openly (816-817). And as final proof of their inverted roles, Pentheus, who had derided the prophet's effeminacy, will put on the female attire of a maenad, a stratagem that demonstrates, as Pentheus now admits, that the prophet inspired by Dionysus has been the sensible one all along (824-825). The last words of the prophet as the episode closes foretell the victim's death, which will show that the terrible god born of Zeus is most gentle to mankind.

The Second Birth

When we next see the two, they both have a different appearance. The god no longer disguises himself as his own prophet, but he has assumed the taurine manifestation that came into being at the chthonic birth, while the passionate Pentheus is now calm, dressed in the effeminate attire that he had despised in the prophet and the maenadic Cadmus and Teiresias. From now until the completion of the sacrifice, the world apparently appears double, with two suns and two cities of Thebes.

On the mountain, Pentheus will experience the final consecration for his tragic role. Like the god himself, the primordial chthonic being will be entrusted to the celestial realm before being offered as the Dionysian victim, confirmed in his total dual identity by a second birth that mediates the schism between earth and sky, primitivism and cultivation.

The messenger who returns from the revel describes this second 'miracle' (1063). Apparently gesturing as he speaks to emphasize the symbolic nature of the event as a mediation, he says that the foreign prophet took the 'celestial, topmost branch of a pine tree and brought it, brought it, brought it down to the black earth. It curved like a bow, or like the circumference traced on a rounded wheel as it is inscribed by a compass. That's how the foreigner brought that mountain branch in his two hands and bent it to the ground, an act that no mortal could have done' (1064-1069). Then Pentheus sat on the pine bough, and the stranger let it go straight up. 'Straight up into the high up air it stood fast' (ὀρθὴ δ᾽ ἐς ὀρθὸν αἰθέρ᾽ ἐστηρίζετο 1073), an image again emphasized by gesture and repeated phrase.

When he is seen there by the maenads, the prophet disappears and a voice, 'apparently' (ὡς μὲν εἰκάσαι 1078) that of Dionysus himself, calls to them from the upper air, where, of course, Pentheus now is, announcing that the victim is at hand. At this moment, the lightning flash that had marked the first birth is repeated, and the earth and heavens are joined, transfixed by a light of holy fire (καὶ πρὸς οὐρανὸν καὶ γαῖαν ἐστήριξε φῶς σεμνοῦ πυρός, 1882-1883).

The Paradigm of Actaeon

The death of Pentheus at the hands of the maenads involves the metaphor of the inverted hunt, in which the hunter is mistaken for the beast of prey by the pack of hounds, who revert from the domesticated state to the wild and turn upon their master. It is a story told also about Actaeon, a cousin of Pentheus, and Euripides apparently considered Actaeon's fate as paradigmatic of Pentheus's death in the *Bacchae*, for he mentions Actaeon several times (230, 337, 1227) and specifies that the dismemberment of Pentheus occurred in exactly the same place on Cithaeron where the dogs had earlier torn Actaeon to pieces (οὗπερ πρὶν Ἀκτέωνα διέλαχον κύνες. 1291). Actaeon was the son of Autonoe (230, 681) and Aristaeus, a son of Gyrene and Apollo who was associated with advances in horticulture, namely the tending of bees and the making of cheese and the hybridizing of cultivated olives from oleasters. Aristaeus also had a more sinister aspect, for he was responsible for Eurydice's abduction to Hades, and it is apparently this regressionary trait that surfaced also in the figure of his son. In the earliest accounts, Actaeon incurred his death by rivaling Zeus as suitor of Semele (Stesichorus, fr. 68; Acusilaos, fr. 33 Jacoby), and hence as a potential mortal sire for the Dionysian child. In terms of the *Bacchae*, we may surmise that it was someone like Actaeon who had the illicit affair with Semele that Pentheus and his aunts suspect. It is appropriate, therefore, that both Pentheus and he should meet the same end, since both represent regressionary primitivism with regard to the transmutation and evolution of Dionysus into Olympian times.

Traditionally, such regression is effected by Lyssa, a goddess of madness whose name means literally 'rabies'. Lyssa is a feminine formation of the word for 'wolf (*lykos*), and the goddess represents the rabid madness that converts the domestic dog into its wild avatar, the wolf. A fifth-century vase from Attica in the collection of the Boston Museum of Fine Arts actually depicts Lyssa as a woman with a wolf's head as she maddens Actaeon's hounds against him, while Zeus and Artemis look on.[57] It may be that such a costume was traditional for Lyssa. Euripides used her as a character in his *Heracles* tragedy, where her lupine symbolism is an integral part of the plot. In that play, she maddens the hero into slaughtering his own wife and children, whom he had intended to rescue from the same fate at the hands of the 'wolf Lykos, a primordial king of Thebes. Instead, he does what the 'wolf intended, because Lyssa leads a pack of hounds against him (860, 898) and drives him into rabidity, infected with the primitive poisons of the monstruous beasts he had himself once hunted. The most recent of these conquests in the play is the netherworld's dog Cerberus and the poison of its rabid foam (Pliny, *N. H.* 27.22), aconite, which significantly for the pattern of the tragedy was called 'wolf-bane'.[58]

In the *Xantriae*, Aeschylus had also brought Lyssa on the stage as a character, inspiring the Theban maenads into madness against Pentheus (fr. 169), but in the *Bacchae*, Euripides seems to have intended Pentheus himself to be in some sense a Lyssa. Thus the prophet, as he prepares to dress Pentheus in female attire, prays to Dionysus to knock Pentheus out of his senses and insert a 'giddy Lyssa' (ἐλαφρὰν λύσσαν, 851), explaining that otherwise Pentheus will not accept his new costume. While he is off-stage dressing as a maenad, the choral women imagine the joy of the mountain revel, comparing themselves to a fleeing fawn that escapes the hunter's pack of hounds, and they approve of the good sense that the god displays in hunting down his impious enemy (862 ff.). Their own joy in escaping the hunter is apparently the reciprocal complement to the fate warranted by the lawless, mad prey that the god hunts. After the ensuing episode, in which Pentheus is presented in his maenadic costume, they too identify this female attire as indicative of Pentheus's Lyssa-like appearance (ἐν γυναικομίμῳ στολᾷ λυσσώδη κατάσκοπον, 980-981), and they summon Lyssa's hounds to rouse the Theban women on the mountain in oestrual madness against this senseless, chthonic creature, while they imagine themselves rejoicing as they join in the hunt, led now by Justice herself and the god.

Since, as we have seen, Pentheus has the temperament of a poisonous herb and apparently, in his maenadic dress, is actually the rabid goddess of madness, his presence in the revel maddens his mother's pack of hounds (cf. 731) and they mistake him for the prey of the hunt. In view of the botanical ramifications of his identity, it is perhaps significant that the Theban women capture him as though he were a plant, uprooting the entire pine tree, which is itself a primordial version of Dionysus. There may be similar botanic implications in their use of the *thyrsos* as a weapon (733, 1099).

The lupine and serpentine connotations of Pentheus's identity mark him both as the enemy intruding upon the Golden Age and as the primitivism that cultivation must overcome, for the end of the Golden Age was issued in when serpents acquired their deadly poisons and the wolves began to plunder (Vergil, *Georgics* 1.129-130).

---

[57] Simon, plate p. 132.

[58] Carl A. P. Ruck, Duality and the Madness of Herakles, *Arethusa*, 9 (1) (1976) 53-75.

The Regression of Cadmean Thebes

The *Bacchae* concludes with a curious prophecy delivered by Dionysus. Cadmus and his wife Harmonia will be transformed into serpents and ride away in a carriage or chariot drawn by calves. Cadmus will become the leader of a barbarian host, presumably the Encheleis or 'Eel-people' of northern Epirus, amongst whom in historical times the earlier sovereignty of Cadmus was commemorated by the carrying of serpent ornaments as standards, in the same manner as the similar ornaments of the supposedly autochthonous Erechtheid lineage at Athens. With these people, Cadmus will eventually attack many cities, until finally he will be defeated in an assault upon Apollo's oracular sanctuary at Delphi. There at last, his barbaric horde will be routed and he and Harmonia alone will be rescued and transported to the Islands of the Blest by Ares, the god of war, who was Harmonia's father (1330 ff., 1352 ff.). In actual fact, such an oracle was current at the time of the Persian Wars, when Mardonius used it to justify his attack on Delphi, although it was well known that its true reference was to the Illyrians and the Encheleis (Herodotus 9.42 ff.).

In its context in the *Bacchae*, the prophecy is final proof of Dionysus's now vindicated Olympian lineage, for, as he says, he knows these things from no mortal father, but from Zeus (1340-1344,1349). The corollary of that ascendancy is the destruction of his darker self in the victory he has just enacted over Pentheus. The fall of Pentheus and his pre-viticultural kingdom entails the demise of the entire civilization that Cadmus once had founded at Thebes, and the city, according to the prophecy, must now revert to its primitive state.

The fall of the house of Cadmus had been dramatized in the earthquake that shook the palace, and it was announced explicitly at the beginning of the messenger's account of the death of Pentheus. Cadmus, as the messenger says, was the one 'who sowed the earth-born harvest of the serpent snake in the land' (1025-1026). The failure of that primordial cultivation is lamented by Cadmus himself at the end of the play. He will be cast out of his house, 'he, Cadmus the Great, who sowed and reaped that superb harvest, the race of Thebans' (1314-1315). He and Teiresias had set out for the mountain revel at the beginning of the drama as two old men in hope of rejuvenation (187-188, 190), but now he returns from there unfulfilled, reproached by Agave for what she perceives as the ill temper of old age (1251 ff.), and bearing the mangled pieces of the young man (1218 ff.) who had inherited the culture he had once founded and who should have been his protection from the indignities of time (1303 ff.).

The founding of Thebes involved the mediation of indigenous and immigrant peoples, together with their dichotomous religious systems. Thus Cadmus, like another Apollo, whose directions he was following, destroyed the primordial serpent at Thebes and then planted its fangs, the so-called dragon's teeth, in the ground, from which grew the first crop of autochthonous creatures. To one, he gave his daughter Agave, thus mingling the blood lines and establishing the Indo-European traditions of patrilineality and patrilocality. Still another daughter brought an Olympian connection and the potential for dominance over the transmuted toxins of the earth. The success of Cadmus's foundation, as we have seen, was symbolized by his own patrilocal marriage to an Olympian female, Harmonia, whose name indicates the harmony between the realms, that was symbolized also by the attendance of the Olympians themselves at her marriage feast at Thebes. Since Harmonia was a half-sister to the primordial serpent (Sophocles, *Antigone* 126 *cum schol*.), she functions as an Olympian replacement for the autochthonous female originally associated with the serpent's spring.

A similar mediation can be seen in Apollo's victory over the serpent at Delphi. By destroying the serpent, Apollo established Olympian dominance over the sanctuary, that earlier had belonged to chthonic forces. It is ironic that Cadmus and Harmonia, as indication of their regression from Olympian harmony, will become 'dragon and dragonness' (1358) at the head of a host of serpentine 'Eel-people' and will finally themselves be routed in their attack upon this same Delphic sanctuary.

Their cow-drawn cart is similarly indicative of the reversion to the pre-foundational condition, for Cadmus had been advised at the Delphic shrine to follow a cow into Boeotia, the land that would be named after it, and to found a city on the site where it lay down. He was descended from a line that twice had experienced a union with Zeus that involved taurine symbolism and migratory wanderings, first with lo, and again four generations later with Europa, the sister whom Cadmus was seeking when Apollo directed him into Boeotia. In the *Bacchae*, a taurine Dionysus has disrupted the city by sending its women rutting on the mountain, and again wandering cows will lead the Cadmean dynasty away from settled life.

At Thebes, the royal lineage will pass to the house of Oedipus, whose founder Labdacus was supposedly related to Cadmus via the latter's only son, Polydorus, a shadowy figure whose name as the 'one of many gifts' suggests chthonic associations with Hades and Plutus or 'wealth'. Labdacus is clearly a repetition of Cadmus, for Cadmus, as civilizer, was supposed to have introduced the Phoenician alphabet to Thebes, an event that also involves Labdacus, since another name for Cadmus's son was Pinakos, the 'writing tablet', and Labdacus seems to be named for *lambda*, the letter that follows the initial letter of Cadmus's name.[59] While Labdacus's son Laius is in his minority, the kingship will be exercised by the sinister ancestor and namesake of Heracles' opponent, the wolfish Lykos, like Pentheus, a son of one of the original Spartoi, Chthonius, a 'man of the earth'. His wife will be the maenadic Dirce, a woman associated with the Theban spring. Only after his death is Thebes again founded, this time by the dissimilar brothers who were his nephews, Amphion and Zethus, the latter of whom married the Theban spring that gave the city its new name of Thebes.

Under Laius, the city will again suffer from the failure to mediate with the chthonic realm. He himself is supposed to have incurred a curse upon his house by the abduction of Chrysippus, an homoerotic affair that demonstrates his disregard for the fertile power of the earth, which in outrage will eventually manifest itself in the predations of the maenadic Sphinx, again on Cithaeron. Ms son Oedipus, at whose hands he will die, will have been inadvertently begotten in drunkenness upon a descendant of the serpentine Echion, and although he will at first rescue the city from the mountain madness, the sinister implications of his conception, against the advice of Apollo, and of his exposure to the mountain wilderness in his infancy, as well as his nurture by the wife of the cattle-tending Polybus, will eventually surface, uncovering his darker, pre-Olympian identity as the consort in the queen's matrilineal and matrilocal kingdom.[60] The city will return to fertility only when the pollution of this darker identity is recognized, in compensation for the previous, mistaken disregard of the Labdacids for chthonic primitivism. While the sons of Oedipus quarrel for control of the city in the great battle at the seven gates, a battle that pitched descendants of the autochthonous Spartoi against a host of foreign immigrants, the city will again be saved by an attempted mediation with the spirit of the slain primordial serpent, by offering a sacrifice of the last unwed descendant of the crop that Cadmus planted, so that the earth might take back a harvest for its harvest and mortal blood for its blood (Euripides, *Phoenician Women* 931 ff.). Even that pacification, however, will prove unstable, for the new regent, again the brother of the great queen, will demonstrate his lack of accord with the chthonic realm upon which his city rests, by burying the living and unburying the dead. And even in the next generation, the sons of the seven who came against Thebes will repeat their fathers' war.

This summary of the familiar mythical traditions about Thebes cannot, of course, do justice to the complexity of the subject, but is intended as an outline of what could be documented by a fuller analysis of the way Thebes figures in tragic literature. As the city where Dionysus was born and initially rejected, Thebes was an important theme for Athenian tragedians. The story of Pentheus deserves to be viewed within the context of the entire body of Theban traditions, which seem to present the city as repeatedly unstable in its foundation because of a basic failure to maintain accord with the fertile sources of primitivism.

In the metamorphosis of Cadmus into a serpent, we can probably sense the regression of the supposed foreigner, the great civilizer and founder of an Olympian realm, to his own more primitive identity as an autochthonous chthonic figure, the form in which he was known in the mysteries of the Kabeiroi at Thebes and elsewhere. Thus Cadmus was said to be a son of a native, primal man, Ogygos, the child of Earth (Pausanias 9.5.1), in which case, the foreign realm from which he came was distant from Thebes only in the vertical plane, and the serpent whom he killed was his own primitive nature. In a similar way, the foreigner Medea was also aboriginal at Corinth. In the mysteries, Cadmus was apparently the father of a divine child, called Cadmilus or 'little Cadmus', another Hermes and, like him, represented by an ithyphallic herm. The foreign 'Eel-people' over whom Cadmus will rule suggest his own more primitive kingship over the eels of the lake in his native

---

[59] Kerenyi, *The Heroes of the Greeks* (Thames and Hudson, London 1959, translated from the German) 88. Since I follow Kerenyi's interpreration of the traditions about Cadmus, I have not cited original sources, which are documented in *Heroes of the Greeks*.

[60] Kerenyi, *Heroes* 88 ff. The Oedipean duality is indicated, as is common in the traditions about heroes, by the riddle of his own name. The pre-Olympian aspect of his identity has him gathered in the wilderness like a Dionysian child, a creature like a plant with a single foot. In Sophocles' *Oedipus*, he discovers his Dionysian primitivism vis-à-vis Apollo, whose Olympian nature is confirmed when Oedipus, like another Pentheus, becomes the polluted scapegoat.

Boeotia, and the complex traditions about his journeys toward Thebes involve the story of his own taurine abduction of a bovine Harmonia, who was actually his sister, a Persephone-like figure who was mourned by the mother, in whose company Cadmus and his brothers were said to have wandered, searching for her at the ends of the earth.[61]

From Pollution to Fertility

The *Bacchae*, as the work of an Athenian poet, presents a typically Athenian bias toward Thebes and Dionysian symbolism. Athens is a stable and eternal city, in the divine keeping of Athena, a primordial mother goddess, reborn as a virgin daughter of Zeus and successfully transmuted into the primarily masculine orientation of Olympian times.[62] Thus, for example, she wears male attire and was said to have helped the various sons of Zeus in conquering primitivism, including manifestations of her own primordial identity. Unlike Thebes, the traditions about Athens' autochthonous dynasties demonstrate that the city has successfully mediated the dichotomy of primitivism and culture.[63] In actual fact, the incorporation of rural Dionysian celebrations into the city's calendar of religious observances under the populist tyrant Peisistratus is living proof, enacted again each year, of Athens' acceptance of Dionysus. By the time of Euripides, the festivals of drama had become an important indication of the city's cultured life and a demonstration that the elsewhere dangerous god was a son of Zeus at Athens and a founder of civilization.

Typically, the regressive tendencies of Thebes cannot be solved there, but, in the Athenian view, can only be pacified through the intermediary of Athens, which, with its more stable foundation, will be able to provide the appropriate mediation to incorporate the rejected Theban primitivism into its own grand alliance of beneficent atavistic powers that sustain the civilized city. Thus, at the end of the *Heracles*, the former Olympian hero, polluted with the wolf-man's madness, is offered a tomb in Athens, to replace the altar to his father Zeus that at the beginning of the play had supposedly indicated his Olympian identity and his successful rout of the primitive forces threatening Thebes. In offering the tomb, Theseus, one of the mythical founders of Athens, is enacting the brighter version of his name as the 'placer', as opposed to his more sinister aspect as the one whose identity was indicated by the tokens 'placed' beneath the stone at Troezen, the city where he too was conceived, against the advice of Apollo, in irrational drunkenness. Ironically, Theseus in the *Heracles* had just been freed himself from the stone that had merged with his backside in Persephone's realm, and thus his entombment of the fallen Heracles is the counterpoise to his own ascendency, and the stone tomb in Athens supplants the stone of the now meaningless altar in Thebes.

As in the case of Heracles, there were also traditions about the reversion of Theseus to a darker persona. Thus it was sometimes claimed that he never returned from Persephone's realm, or that he died away from his native land in a controversy with a wolf-man named Lykomedes, while the kingship at Athens was regained for a time by the autochthonous dynasty. In a curious historical enactment of the basic mythical idea, here too the value of primitivism was recognized and reincorporated into Athenian traditions. What were supposed to be the bones of Theseus were recovered and returned to Athens for burial in 473 B.C., after his spirit had appeared to many in the recent battle against the Persians at Marathon (Plutarch, *Theseus* 35-36).

The burial of pollution at Athens is, in fact, the common theme of Theseus as the mythical Athenian king. In Sophocles' *Oedipus at Colonus*, another contaminated hero from Thebes is buried by Theseus at Athens. He enters into a covenant with Oedipus, whose rotting old body will be placed in Athenian land in the grove of the Eumenides, an alliance with the netherworld that will be an additional source of fertility and eternal stability amidst the vicissitudes of time, while the controversies at Thebes continue to rage in the warring of Oedipus's sons. Theseus also champions the cause of burying what Thebes refuses to place into its own ground in Euripides' *Suppliants*, where he espouses the supplication of the mothers of the Seven who fell in the war at the gates of Thebes, and retrieves their bodies for interment at Eleusis, thus again striking an alliance that will fortify his own city. His son Demophon, in Euripides' *Sons of Heracles*, will similarly strengthen Athens by

---

61. Kerenyi, *Heroes* 25-33.
62. Lyster.
63. John Peradotto, Oedipus and Erichthonius: Some Observations on Paradigmatic and Syntagmatic Order, *Arethusa*, 10 (1) (Spring 1977) 85-101.

providing burial even for Eurystheus, the archenemy and sinister double of Heracles who was defeated in a battle at Marathon. The theme can be noted even in Euripides' *Hippolytus*, where Theseus is reconciled with his own chthonic aspect in the person of his damned bastard son whom he mistakenly suspected of a Persephone-like abduction. Hippolytus too will be buried at Athens and incorporated into the city's religious foundations.

These burials at Athens demonstrate the same reconciliation with primitivism that we have already noted with regard to the conversion of the Erinyes into the beneficent Eumenides. These daughters of Night and sisters of Lyssa, who track down the prey they madden with wild delusions and contaminate with their excremental nature, could pollute the land with a 'lichenous' (λιχὴν, 785) plague of fungal-like parasitic sterility, until Athena in Aeschylus's *Eumenides*, caring for her city like a gardener (911), cajoles them into friendship by burying them in the earth, where their rotting poisons can function, not atavistically, but as a source of fertile growth for the Olympian institutions of the cultivated city.

The agrarian significance of such an incorporation of pestilential putrefaction as a benefit to the city was actually ritualized in Athens at the Skira and Thesmophoria festivals. Sacrificial pigs, animals akin to the netherworld deities, probably because of the characteristically obnoxious smell of their excrement, were tossed into subterranean caverns and allowed to rot, and, four months later, their putrefied remains were exhumed and spread upon the fields as fertilizer.[64]

Beyond the theme of actual burial at Athens, we can trace the similar theme of the reintegration of pollution into society in a number of other tragedies. In Sophocles' *Philoctetes*, the diseased and fit-prone hero is induced to abandon his exile and bring the contamination of his poisoned body and envenomed arrows to Troy, where his presence will allow his fellow Greeks at last to take the citadel. Reintegration seems also to have been essential to the theme of Sophocles' *Ajax*. Here too, the hero, who has regressed to a pre-Olympian identity, is finally reconciled with his enemies. Denied the inheritance of Achilles' armour, Ajax becomes a maddened cattle thief, and although he was supposedly named for the *aietos* or 'eagle' of Zeus, his darker persona will surface, the primordial Ajax, named for *Aia* or 'Earth' and the lamentation (*aiai*) of his tragic fate. Once he is dead, however, Odysseus, the new bearer of Achilles' armour and the particular enemy of Ajax, will side with the hero's surviving brother and convince the Atreidae to allow him burial.

In the context, therefore, of similar tragedies on the theme of primitivism and culture, the *Bacchae* is somewhat unique in not expressly enacting the reconciliation and reintegration. Although the chorus of Asiatic devotees joyously welcomes the deluded Agave as a fellow member of their revel band (1172), she will vow never to be a bacchant again as she goes into exile from her native Thebes (1384 ff.). A lacuna in the text of the *Bacchae* before the final prophecy of Dionysus obliterates a section of the play, that can, however be reconstructed from other sources.[65] The body of Pentheus was apparently reassembled onstage and prepared with lamentation for burial, but the truer reconciliation is probably the condemnation of the regressive Thebes and the vindication of the viticultural aspect of the god, who, as is implicit in the performance of the play at a Dionysian festival, has been integrated into the religion of another, more cultivated city.

Toward an Understanding of Tragedy

Sometime in the early history of the drama festivals at Athens, it apparently became a stock criticism of a particular play that it had 'nothing to do with Dionysus'.[66] The phrase would seem to imply that a good tragedy was expected to concern itself with Dionysian themes, although the *Bacchae* is the only extant tragedy actually about Dionysus, and only a few of the lost plays appear to have been written on the actual subject of Semele, the bacchants, or the god's traditional enemies. The satyr plays and the comedies that were also part of the festivals could more easily maintain a Dionysian relevance, if for no other reason than their obvious phallic exuberance, but actually, given the great number of tragedies included at each performance, it is difficult to see how constant, simple repetition of the Dionysus myth would not have become unbearably tedious. The demand for Dionysian relevance in the tragedies must be understood as indicating something less literal than continuous reiteration of the god's myth. We have already seen that Dionysian themes can underlie the telling of apparently quite unrelated myths, and this argument could be expanded to encompass all the extant tragedies, if we were to consider themes other than the one germane to our discussion of the *Bacchae*. As conclusion, however, I should like to place the experience of ancient drama in its Dionysian context in order to demonstrate its relevance to the god as a religious celebration, since this too is an enactment of the transmutation of primitivism to culture.

---

[64] H. W. Parke, *Festivals of the Athenians* (Cornell, Ithaca 1977) 159-160.
[65] See Dodds, *Bacchae* 234-235.
[66] Pickard-Cambridge 124-126.

Drama itself was a kind of madness. Actors are frequently portrayed in vase paintings and terra-cotta figurines contemplating the mask of the character they will impersonate on the stage. It is a commonly observed phenomenon that actors become quite literally obsessed by the personae of their roles, and ancient actors, in particular, by wearing the masks of the mythical figures they impersonated, can be expected to have experienced a kind of possession by the spirit of these dead heroes who returned, in the dramas, from the past. One of the early occasions for drama was, in fact, the performance of a hero's story at his tomb,[67] and in Athens, the earliest masking techniques of Thespis, the first tragic poet, suggest that the performers were intended to represent spirits of primordial times. Thespis disguised their faces with gypsum (Plutarch, *de Proverbiis Alexandrinorum* 30) or white lead (Suidas, *s. v.* Thespis), apparently to imitate the bloodless color of ghosts.[68] A similar disguise was associated with the primordial Titans who were said to have slaughtered and cooked the infant Dionysus (*Orphica Fragmenta* 209 Kern) in a regressive manner, contrary to the evolution of the culinary arts. Thespis apparently also used wine lees (*Anthologia Graeca*, Dioscorides, 7.411; Horace, *Ars Poetica* 275-277), the unfermented residue from the god's harvest as the grape. Perhaps even more significant was his use of wreaths of strawberry-tree (Suidas, *loc. cit.*), supposedly a primitive food of the Golden Age (Vergil, *Georgics* 147-149) and a fruit that today is used, as in the ancient manner, to fortify wine in some regions of Greece.[69] The aged Athenian lawgiver Solon was said to have disapproved of Thespis's performances of tragedy as a lie (Plutarch, *Solon* 29; Diogenes Laertius 1.59), perhaps because these early dramatic impersonations, unlike simply choral poetry, seemed to evoke the dead from the underworld.[70]

The enthusiasm of the actors who brought such figures to life in the service of the god was, moreover, a contagious experience for the spectators as well. The people of the ancient audience, if they could read at all, were more accustomed to witnessing the performance of literature than to deciphering the written word in private.[71] In order to recapture the enthusiasm of the original audience, we must consider what manner of mentality would have been involved in witnessing drama, as opposed to reading it. The reader tends to stand apart from the communication and judge it rationally. This is less true when what is read is already familiar or to some extent even memorized, as was the more common case in classical times, for then the words serve merely to remind the memory of things already known and stored away as part of the cultural heritage of given truths. In performance, however, the words tend to capture the mind and imagination with a greater vividness. The judgmental processes recede to the dominance of emotional responses, especially when the performance, like classical drama, is musical and rhythmic, with imposing spectacle and dance. To an audience not accustomed to the detachment of reading and not yet desensitized, as in modern times, by too frequent an exposure to dramatic enactments, such emotionality would be even more pronounced. The whole audience might fall to weeping or be possessed by the contagion of laughter, enraptured by the impersonated spirits.

Wine itself seemed to have played a role in intensifying such a dominance of emotion over rationality in the ancient theater. We must imagine an audience in somewhat less than a perfectly rational state pharmacologically, for, as Philochorus, the fourth-century historian of Attica and its religious practices, records (fr. 171 Jacoby), the spectators prepared themselves by drinking throughout the days of dramatic performance, in addition to whatever drinking, presumably of a deeper nature, took place during the evenings of revelry. The wine drunk was called *trimma* (τρίμμα), like the one drunk at marriages, apparently so named

---

67. Pickard-Cambridge 101-107.
68. Kerenyi, *Dionysos* 327.
69. *Ibid*.
70. *Ibid*.
71. Eric Havelock, *A Preface to Plato* (Harvard, Cambridge, MA, 1963).

from the fortifying additives that were 'ground' into it (Hesychius, *s. v. trimma*).[72] There were traditions also that claimed that the poets themselves were possessed by the spirit of the wine when they performed their dramas (Athenaeus 1.2.2, 10.429).

Such drinking in the theater should not be taken to imply a boisterous or ill-attentive audience, but one irrationally enraptured by the music and the dance and the age-old stories of what was supposed to be history, now again come alive. Actually, we have an eloquent eye-witness description of the mesmerizing effect of dramatic poetry on both the actors and the audience in Plato's *Ion* dialogue. Plato had himself been a tragic poet before he turned to philosophy, and although he may exaggerate a little to make his argument against the irrationality of the poetic experience, his description must be accepted as authentic evidence about the general nature, at least, of what happened in the theater of the classical age.

The description purports to be Socrates' rebuttal to the claims of a renowned poetic expert, the rhapsodist Ion, who had made the conventional assertion that poetry is knowledge. It appears, however, that poets do not really understand their own poetry in any rational sense (533d ff.). All poets compose not by art or scientific skill, but because they become possessed and filled with divinity. Music and rhythm lead them into a condition where they are no longer in control of their own wits, but are actually possessed by the subject or figure they are impersonating. They are, in fact, like people entranced or bewitched. The god has removed their minds and substituted his own, using them as his servants, the vehicles for a communication that simply seems to pass through them, although it is not their own. They are like prophets and oracles, who speak for the god, but do not comprehend or at times even remember what words they spoke when the possessing spirit came upon them.

This enchantment, moreover, is a contagion that spreads to the audience as well. The god, according to Plato, is like a magnet drawing the poet or performer into bondage with its attractive force, and through his inspired servants, the binding attraction passes on to the spectators, uniting them all like so many iron rings drawn ineluctably into a continuous chain.

Both poet and audience, in fact, are drunk, but on a potion superior even to that of wine, for the god, in this celebration of his evolution to culture, transports and reunites his people with primordial times of the Golden Age. The drama itself is a drink that the poets have fetched from the magical springs that flow in the gardens of the Muses, a potion composed of the commingled nectars of flowers that are tended not by human agents, but simply found in a metaphysical wilderness by the ecstatic poets, as they go, like bees, from each to each. It is this special drink that the poets offer, and through it, the whole world seems metamorphosed, with rivers, as on Cithaeron, that flow with milk and honey. In the throes of this intoxication, the whole theater will fall to weeping along with the actor although they are celebrating a joyous festival, or their hair will stand on end for fear although they sit amidst their closest friends.

In a deeper sense, it is not the reanimated dead who have so captivated and enthralled the actors and their audience, but rather the culture's heritage of myth, the ancient patterns of story and metaphor that have accompanied the people in the long course of their history from primordial times. The meanings of these stories are elusive, for they have been told over centuries and have had a multiplicity of referents and they seem always to suggest subtleties receding beyond the frontiers of conscious knowledge. The ancient poets were trained in the skill of telling these stories, molding them in accordance with criteria of balance and harmony, but, as Socrates testifies in the *Apology* (22b ff.), not themselves really capable of explaining what they intended as meaning. Traditionally, these inspired transmitters of myth ascribed the source outside their own conscious control to the Muses, who were the daughters of Memory, the repository of the cultural heritage. In performance, these poets and their actors led the audience back into the world of myth, imparting to it their own sense of its deep, although elusive, worth and relevance for the present.

This confrontation with myth not only brought the people back to its historical past, but, as ontogenesis as well, it reunited the individual with the primordial and darker versions of the self that underlay the persona of civilized life, the infant in the adult and the wild in the cultured. What Aristotle was to call the tragic flaw had not only such a reference to the personal psyche, however, but to the whole of society as well, which was reconfirmed in its civilized state by experiencing this journey back to primitive origins.

---

[72] The citation of Hesychius in Liddell, Scott/Jones omits the mention of the drinking of *trimma* in the theater.

Such a journey is basically Dionysian and does not require the story specifically of Dionysus to be told. From the viewpoint of the tragic poets, there were particular ways of telling a story that pertained to their god and his area of symbolism, different, for example, from the ways of the epinician poets. The latter celebrated the masculine virtues of Olympian heroes and of the victorious athletes who surpassed for a time the limits of their own mortality, reasserting their families' aristocratic claim to divine lineage. But the tragic poets told instead of the hero's fall from Olympian grace into the dominance of women and the foredestined tomb. When freed from the personalism of the Aristotlean bias, the mythopoeia of the tragic poets can be shown to represent a consistent pattern or design, in which the hero's fall repeatedly involves Dionysian symbolism, the regression to a more primordial identity, and the restitution of fertility to the civilized world, or some favored part of it, by the incorporation of the polluted, non-Olympian persona. In this manner, the inspired enthrallment of the theater experience was itself an analogue to the stories enacted in the dramas that celebrated the god who himself submitted to death in order to be reborn with his gift of wine.

CHAPTER EIGHT

The Offerings from the Hyperboreans

Introduction

The Hyperboreans were a mythical people, living beyond the frontier of the world known to the classical Greeks, in what was reputed to be the original homeland of the god Apollo. Each year, however, these supposedly imaginary people joined the real cities of Greece in sending actual offerings to the god at his sanctuary on the sacred island of Delos. The other cities all sent envoys with sheaves of grain, the so-called first fruits of the year's crop, harvested before they had completely ripened, but the sheaf of wheat from the Hyperboreans was special for it was supposed to conceal some other plant, a secret offering bound within it.[1] Whoever actually sent this special gift from the lands of myth, the plant itself, we may assume, would have to have been something that was considered particularly appropriate to the supposed Hyperboreans,[2] as well as to the pre-Hellenic identity of their original god and to the meaning of such ritual presentations of first fruits.

The Route for the Offerings

The Hyperborean offering was transmitted from its origin indirectly along its way to Delos through a succession of intervening peoples. Somewhere along this route, the actual sheaf with its secret contents must have materialized out of the land of myth.

The route for the transmission is recorded in three ancient authors,[3] who are in essential agreement that the offerings traveled a strangely indirect, zigzag course, up the Danube, then south along the shore of the Adriatic, and eastward through Dodona and across the Thessalian plain, before finally going south through Euboea and the adjacent islands to Delos. This was obviously not the easiest nor most direct route from

---

[1] Herodotus (4.33) mentioned 'sacred things bound in wheat-straw' and Pausanias (1.31.2) called them 'first fruits hidden in wheat-straw,' adding that their identity 'was known by no one.' Callimachus, however, in his *Hymn to Delos* (4.275 ff.), seems to identify these Hyperborean offerings as nothing more than 'a stalk and sacred sheaves of grain' (thus, M. Gary, *Oxford Classical Dictionary*, Oxford 1970, s. v. Hyperboreans), but a closer examination of the context reconciles his account with the other two. Callimachus is describing the general convergence of first fruits upon Delos, sent from all the cities of the Greek world, amongst which the land of the Hyperboreans is mentioned as the most distant. He then goes on to give the aetiological myth that explained the special manner in which the Hyperborean offerings were conveyed to Delos, not in person by the Hyperborean emissaries, as in the case of the other cities, but indirectly through a series of intermediaries. In this context, there was no reason to distinguish the special contents of the Hyperborean offerings from the general tribute of first fruits. Callimachus's point is simply to illustrate the glory of Delos in receiving tribute from even the most distant of the Greek lands. If the 'sacred things' or 'first fruits' were still a secret in the second century A.D., when Pausanias gathered his information, it is unlikely that Callimachus, three centuries earlier, would have known that the whole tradition was merely a pious hoax, nor would such a revelation suit the context of a hymn, in the Homeric manner, in praise of Delos. As an antiquarian poet, it is just such traditions that he would have wanted to perpetuate.
Nor is it clear that the Hyperborean offering was actually a sheaf of grain, for 'wheat-straw,' 'stubble,' or 'stalk' (*kalame*) is not the same thing as 'sheaf (*dragma*, literally, a 'handful' or 'as many stalks or *kalamai* as the reaper can grasp in his left hand'). Since the Hyperborean offering, as we shall see, had a longer distance to travel, it is unlikely that it could have been cut at the same time as the other offerings of first fruits. That it was a 'first fruit' is documented by Pausanias, but the 'straw' may have been intended merely to hide it or preserve it over the journey.

[2] Tithes and first fruits were often of a kind particularly identified with the traditions of the donor and could even on occasion be represented by a model, as, for example, a head of celery from Selinus or a head of the precious drug plant silphium from the people of its native Libya. In the same manner, we hear of a golden radish, a silver beet, and a turnip of lead, apparently from private donors, as well as a silver duck from a poulterer, and so on. See William H. D. Rouse, *Greek Votive Offerings* (University Press, Cambridge, U. K. 1902, reprinted by Arno Press, New York 1975) 60-94. We can expect that the secret offering was considered to be the special Hyperborean plant.

[3] For the ancient testimony, see p 225 note 1. The three documents cover the same route, but mention different places along the way. The one divergence is the insertion of an Athenian role in the final delivery of the offerings, according to Pausanias's account. This apparently reflects Athenian dominance over the sacred island, dating from sometime after the writing of Herodotus, and the innovation may have coincided with the Athenian reorganization of the Delian festival around the year 418 B.C., when Athens dedicated the new temple to Apollo.

Scythia, through which the offerings had initially passed on their way from the Hyperboreans. They could more simply have been sent through the Hellespont and along the northern shore of the Aegean. The careful preservation of this Danube and Adriatic route must have had symbolic significance, and it may retrace the historical route of a tribal migration of Indo-Europeans into the Greek lands from central Asia.

At the other end of the journey, beyond the Scythians, we hear of only one further people before we enter the lands of myth. These are the Issedonians (Pausanias 1.31.2), a nomadic Indo-European tribe living along the forested south-western slopes of the Altai Mountains, which form the western fringe of the central Asiatic massif.[4]

Beyond them were the Hyperboreans, who either transmitted the offerings through the intermediary of the Arimaspeans (Pausanias, loc. cit.) or perhaps were themselves identical with these Arimaspeans (Callimachus, *Hymn* 4.291 *cum scholia*; Antimachus, frg. 118). The name of these Arimaspeans is supposed to be descriptive of them in the Scythian language. They were a people who had only a single eye (Herodotus 4.27). They lived near the Gorgons (Aeschylus, *Prometheus* 790 ff.; Pindar, *Pythia* 10.45)[5] amongst monstrous griffins, whose gold they were said to steal.

Hyperboreans

These Hyperboreans, as the Greeks understood their name (Herodotus 4.36; *Pindar*, Olympia 3.31; Callimachus, *Hymn* 4.281; etc.),[6] lived in a paradise 'beyond the North Wind,1 who was personified as Boreas. Although north of the Greek lands, the Hyperboreans appear to have been imagined as living also considerably toward the east, for Boreas, in early Greek cartography, did not stand for the cardinal point until later advances in astronomy, and Boreas could shift around from place to place to indicate the direction from which the north wind would appear to blow at different locations. In the region of the Hyperboreans, beyond the Issedonians on the slopes of the Altai Mountains, the bitter prevailing winds sweep westward down through the Dzungian Gate. On the other side of the mountain pass, the Hyperboreans lived. Boreas himself was supposed to have had his home in a cave, which can perhaps be still identified with an actual Cave of the Winds that is located there within the mountain pass in Asiatic lore.[7]

The journey to the mythical land of the Hyperboreans was to be accomplished only through inspiration and mystical transport, as would be expected, for there is no other way to find the long pathway to another world. There was a poem, entitled the *Arimaspea*, about such a journey to the Hyperboreans. It was ascribed to a certain Aristeas of Proconnesus, an island in the sea of Marmara. Since Aristeas is supposed to have reappeared in Italy amongst the Metapontines in the fifth century, some two and a half centuries after his death (Herodotus 4.15), he is probably not so much a real person as the traditional persona that was assumed by a poet in reciting that type of poem. Such poems, like the songs of Hesiod, were originally oral in composition and were perpetuated by a religious society of similarly inspired poets, who could all speak in the biographical persona of their supposed founder.[8] Just as Hesiod appears to have been a Boeotian farmer with

---

4. J. D. P. Bolton *Aristeas of Proconnesus* (Oxford 1962) 104-118.
5. The placement of the Gorgons in the east (instead of the more customary west) seems to have derived from the *Arimaspea* of Aristeas. See Bolton 61 ff. It is probable, however, that the Gorgons were traditionally placed near each of the Greek versions of paradise or the otherworld. Thus they are found also to the south amongst the Ethiopeans, as well as with the Hesperides in the west. See Joseph Fontenrose, *Python: A Study of Delphic Myth and its Origins* (University of California Press, Berkeley and Los Angeles 1959) 288.
6. The ancient etymology has been questioned in the modern era. Ahrens suggested that the name was actually derived from a supposed variant, Hyperphoroi, and thus the Hyperboreans were simply the same as the 'Perpherees,' the name that Herodotus records for the emissaries or 'conveyers' who delivered the offerings to Delos. Schroeder, on the other hand, assumed that'Boris'was a variant of the word for'mountain' (*oros*) and interpreted the Hyperboreans as the people who lived 'beyond the mountain.' See Lewis Richard Farnell, The Cults of the Greek States (Oxford 1896-1909) 4.102 ff. Further references are found in Pierre Chantraine, *Dictionnaire Etymologique de la Langue Grecque* (Klincksieck, Paris 1968) 1157-1158. Farnell enthusiastically endorsed Ahren's interpretation, but there is probably nothing wrong with the etymology current in antiquity. It is accepted as correct by E. R. Dodds, *The Greeks and the Irrational* (Berkeley 1951) 162, and Bolton 195.
7. Bolton 94 ff.
8. Gregory Nagy, *Hesiod* (T. J. Luce 1982).

an evil and greedy brother, the Aristean persona is characterised by his experiences of shamanic rapture. He was said to have journeyed to the Hyperboreans while 'possessed by Apollo' (*Phoibolamptos*, Herodotus 4.13),[9] an experience that was thought to have happened to him first in a fuller's shop in Proconnesus, but which was repeated, according to some sources (Apollonius, *Mirabilia* 2), over a long period of time. During these seizures, he had the appearance of being dead, while his soul would leave his body (Suidas, s. v. Aristeas; Maximus of Tyre 10.2 ff.) in the form of a raven (Pliny, *Natural History* 7.174), a bird sacred to Apollo and associated, in particular, with the god as his spiritually possessed 'bride' or mate and devotee.[10] As this animal familiar of the god, Aristeas would travel far and wide. He was also thought to have the gift of prognostication and was closely identified with Apollo in certain of his cults.

It was not only Aristeas, however, who experienced such Hyperborean rapture. The shamanic nature of the journey was a traditional theme. Abaris, who, like Aristeas, was the assumed author of another collection of verses, was himself supposed to have been a Hyperborean and was said to have traveled about the earth on an arrow from Apollo's temple amongst those imaginary people (Herodotus 4.36; Suidas, s. v. Abaris).[11] Pindar thought that Abaris was a contemporary of Croesus (frg. 283 Bowra), although, like Aristeas, he too seems to have reappeared at a later date, both in Athens (Suidas, s. v. Abaris) and amongst the Spartans, whom he directed in the performance of sacrifices to avert plagues (Apollonius, *Mirabilia* 4), a ritual that, as we shall see, had definite Hyperborean connotations.

Another of these Hyperborean travellers was Olen, the reputed composer of certain very ancient hymns that were sung at Delos on the subject of the first Hyperborean offerings and a similar purificatory ritual (Herodotus 4.35; Callimachus, *Hymn* 4.304-305), He was claimed as the founder and first prophet of the oracle of Apollo at Delphi (Pausanias 10.5.7), and hence, he too, like Aristeas and Abaris, was presumably the traditional persona of a shamanic poet possessed by the god. He was either a Lycian who came from the Hyperboreans (Pausanias 5.7.8) or was actually himself a member of the Hyperborean race (Pausanias 1.18.5, 8.21.3; Hesychius, s. v. Olen).[12]

It was the wind Boreas himself who took such ecstatic poets to the Hyperborean world that lay just beyond the wintry passage through his cave in the Dzungian Gate. The wind is traditionally an abductor to the otherworld, for the metaphor of 'inspiration,' which in Latin literally implies 'blowing upon' (*inspirare*), existed also in Greek as *empnein*. Thus, for example, the Muses, according to Hesiod, 'breathed song into' him at the moment of his inspiration upon Mount Helicon (*Theogony* 31). So too, 'breath' was soul or *psyche*, just as in Latin it was *spiritus*.[13]

---

9. K. Meuli (1935) Scythica, *Hermes* 70, 121-176. Bolton, 125 ff., disputes what has become the common acceptance of Aristeas as a shaman. He argues that Aristeas was simply someone who was somewhat of a religious fanatic about Apollo and that because of his love for the god, he set out on an actual trip to what he believed to be the topographical homeland of the god, going only so far as the Issedones and hearing from them of a civilized race beyond the central Asiatic massif, who in reality were probably the Chinese. Although Herodotus does claim that Aristeas did not go so far as the Hyperboreans - a strange shortfall for a shaman's journey, as Bolton points out - we should note that not all the sources, who presumably also had access to the *Arimaspea*, agree that he failed to reach the goal of his travels, Bolton further argues that the reappearance of Aristeas amongst the Metapontines was a resuscitation of his memory by the Pythagoreans as a justification for their own vegetarianism, a trait that they shared, as we shall see, with the Hyperboreans
   The diverse traditions about Aristeas, however, are probably not to be reconciled with reality, but indicate, as I have suggested, the persona of an oral tradition of poetry about the journey to the Hyperboreans, nor should we assume that the so-called *Arimaspea* was a fixed text without variants
   For a refutation of Bolton's view, see Ken Dowden (1980) Deux notes sur les Scythes et les Arimaspes, *Revue des Etudes Grecques* 93, 486-492.
10. C. Kerenyi, Asklepios: *Archetypal Image of the Physician's Existence* (Pantheon, New York 1957, translated from the German of 1947) 87-100.
11. Herodotus differs from the later sources in saying that Abaris traveled carrying the arrow, unless the text is to be emended to reconcile it to the other traditions. See Reginald Walter Macan, Herodotus (MacMillan, New York 1895, Arno Press reprint 1973) note on 4.36.3.
   The idea of traveling on a sacred arrow may imply shamanic rapture, for the word in Greek for 'arrow' (*ios*) is homonymous with 'toxin,' and the arrow traditionally was drugged or poisoned and conveyed the metaphor of intoxication.
12. On the confusion of Lycia with the land of the Hyperboreans, see my discussion below under Lycians.
13. Bruno Snell, *The Discovery of the Mind* (Harvard University Press, Cambridge, MA 1953, translated from the German of 1948, 2nd edn.) 8 ff.

The myth of Oreithyia suggests, as we might expect, that the inspired journey to the Hyperborean paradise beyond the North Wind had connotations of shamanic herbalism, for it was the 'breath' or *pneuma* of Boreas (Plato, *Phaedrus* 229c) that carried her to the otherworld while she was playing with her maiden companion, named Pharmakeia or the 'use of drugs'. The spirit thus brought Oreithyia to what was called the 'ancient garden' of Apollo amongst the Hyperboreans (Sophocles, frg. 956 Pearson). It was in that garden that the Hyperboreans would have harvested their special offering to the Delian god. What magical plants grew there in paradise?

The Garden of Apollo

One of those plants was the olive (Pindar, *Olympia* 3.13 ff.). Heracles was supposed to have seen it growing in the land of the Hyperboreans when he went there in pursuit of the so-called golden-antlered hind of Apollo's sister Artemis, an animal that must originally have been the reindeer, for only in that species does the female deer bear horns.[14] Up until then, it was said, the olive was unknown in our world. Heracles was supposed to have transplanted it to the sanctuary that he founded in honor of his divine father Zeus at Olympia, which previously had been completely treeless. Henceforth, the Hyperborean olives provided the wreathes that crowned the victorious athletes who competed in the games at Olympia.

In Delian traditions also, the olive had a sacred association with the Hyperboreans. The grave of the maidens who were the first Hyperborean ambassadors to Delos with the secret offerings was marked by an olive tree that grew upon it, in the area of the sanctuary that was set aside for the goddess Artemis (Herodotus 4.34). It was believed to be one of the oldest trees in existence (Pausanias 8.23.5), and was the object of a bizarre ritual, that dated back to the visit of Theseus upon his return trip toward Athens, after slaying the Cretan Minotaur (Hesychius, s. v. *Deliakos bomos*). Apparently, it was the custom to dance around the altar with whips, while boys, with their hands bound behind their backs placed themselves in symbolic contact with the divinity resident within the tree by biting its trunk (Callimachus, *Hymn* 4.316-324).

From these traditions, it would appear that the Hyperborean plant had connotations of the grave and ritual sacrifice, that it was, moreover, an entheogen capable of effecting the ecstatic journey to the otherworld, and that it was symbolic of the advent of the Olympian strain of religion that came to the Greek lands with the arrival of the Indo-Europeans. It was this triumph of Olympianism over the previous indigenous religions that was commemorated by the tradition that Olympia was purified and refounded by Heracles in honor of Zeus, and the athletic games that were celebrated there were thought to prove the victor's continuance in that divine heritage. Theseus's visit to Delos similarly symbolized the triumph over the primitive chthonic implications of the Cretan labyrinth.

The olive itself, however, can only be a symbolic substitute for the original Hyperborean plant, as it was before being transplanted to this world, for the olive is not native to the northern latitude of the Hyperborean homeland.[15] Before its transplantation, the Hyperborean plant, with the full magical character of the original entheogen, was known metaphorically as the tree upon which grew the golden apples. Although the route for the Delian offerings preserved the remembrance of an Asiatic homeland for the Hyperboreans, that land lay beyond this world, and the various entrances to the otherworld all led to the same place. Thus the Hyperboreans could also be found in the garden of the Hesperides, in the far west beyond Gibraltar, at the frontier of life and death, where the sun went down (Alcman, frg. 10 Page; Apollodorus 2 5.11), and the same Heracles who discovered the olive was said to have brought the apples back as well, from the journey that had taken him north into Hyperborean territory in quest of the magical reindeer.

---

[14] W. Ridgeway (1894) The Legend of Herakles and the Hind with the Golden Horns (Pindar, Ol. III 31), *Proceedings of the Cambridge Philological Society* 37-39, 14-15.

[15] For Greece, the olive does not grow north of the plains of Thessaly. Pindar (*Olympia* 3.13 ff.) claims that Heracles found it growing at the head-waters of the Danube, a region that was considered to lie within the territory of the Hyperboreans.

There was, however, another Hyperborean plant that, like the olive, could be found in this world. This was the *daphne* (*Laurus nobilis*), a laurel or bay. Although the plant itself contains no psychoactive drug,[16] the Greeks considered it a symbolic entheogen. The eating of its leaves was thought to induce the mantic possession of Apollo's Delphic priestess, who, like Aristeas, became *Phoibolamptos* (Lycophron, *Alexandra* 6, 1640). Olen, with the two Hyperboreans, Pagasus and Agyieus, was supposed to have constructed the first temple of Apollo at Delphi out of branches of *daphne* that he brought with him from the valley of Tempe, the narrow passage north into the Thessalian plain (Pausanias 5.7.8; 10, 5, 7). That origin for the plant was commemorated by continuing to gather from there the leaves that were used, like those of the olive at Olympia, to weave the crowns for the athletes and musicians who were victorious in the Pythian contests (Aelian, *Varia Historia* 3.1; Argument 3 to Pindar's *Pythia*).

It was said that Apollo himself had sought refuge in Tempe with a suppliant branch of *daphne* after having slain the serpent monster Python and that he had been purified there before his return to Delphi. The *daphne* leaves for the victor's crowns were gathered in Tempe in a ritual that recalled the god's polluted sojourn there. Every ninth year, the Septerion (or Stepterion) Festival was celebrated at Delphi, coinciding originally with the performance of the Pythian contests, which were said to commemorate Apollo's victory over the Python. In the Delphic sanctuary, opposite the Portico of the Athenians, there was a level area called the threshing floor. Here a temporary structure representing a royal habitation was set up, with a table beside it. A band of youths, escorting a boy, who apparently was thought to impersonate the god, silently attacked this hut and set it afire with torches, overturning the table. They then fled immediately all the way to Tempe, where they were purified of their crime which was no less, as it was imagined, than the ritual slaughter of some kingly person, an impersonation, that is to say, of Apollo's own murder of the Python. The youths then gathered the boughs of *daphne* and carried them triumphantly back to Delphi, accompanied by the music of flutes and pipes (Plutarch, *Moralia* 293c, 418ab, 1136a; Aelian, *Varia Historia* 3.1; Pausanias 2.7.7).

Tempe was apparently considered a nearer version of the Hyperborean world, an analogue to the northern land, like the entrance to the otherworld beyond Gibraltar, and the boughs of *daphne* are a Delphic version of the Delian ritual of the secret offerings. Thus the slaughter of the Python, followed by the expiatory sojourn in Tempe, is comparable to the tradition that Apollo was banished to the Hyperboreans for a period of servitude and absolution after his murder of the one-eyed Cyclopes (Apollonius Rhodius 4.612-616). This same murder of the Cyclopes was also given as a reason for Apollo's sojourn in the service of Admetus, whose kingdom lay in the nearer Hyperborean otherworld in the region of Tempe (Euripides, *Alcestis* 1-7). The Cyclopes and the Python were both more primitive identities of Apollo himself, and thus the murders quite naturally required his own descent for a stay in the underworld.

Both the *daphne* and the olive were trees that marked the transition to the otherworld and had connotations of a death that occurred at puberty. The maiden Daphne, for example, died in the region of Tempe as she attempted to escape the courtship of Apollo and was transformed into the plant that bears her name (Ovid, *Metamorphoses* 1.452 ff.). Similarly, Hippolytus, the virgin youth who was devoted to Artemis, was said to have died when the reins of his maddened horses became entangled in the crooked branches of an olive (Pausanias 2.32.10).

The basic identity of Tempe as a Hyperborean land can also be sensed in the traditions involving both places with Apollo and wolves. Apollo himself bore the epithet Lykegenes, meaning 'born from the she-wolf',[17] and it was said that his mother Leto had been escorted from the Hyperboreans by wolves, herself as a she-wolf, at the time of her labor (Aristotle 580 a 17), and that after the death of Python, it was a wolf that first brought Apollo the *daphne* from Tempe (Servius, on Vergil's *Aeneid* 4.377).

---

16. Dr. Albert Hofmann, in personal correspondence, assures me that, despite the common knowledge that the Delphic priestess chewed the leaves of *Laurus nobilis*, the plant contains no chemically active principles that could induce her prophetic ability, nor is he aware of any other laurel with such properties.
17. Thus, Farnell 4.114. Even in antiquity, there was an attempt to derive Lykegenes from a supposed *lyke*, meaning 'light,' and thus Apollo was associated with solar symbolism, but this is a result of the attempt to obliterate Apollo's pre-Indo-European identity. The same pattern can be seen in the explanation of his epithet of Phoibos as meaning the 'shining one,' whereas its original significance apparently designated him as the consort, named with the name, in matrilineal fashion, of his Great Goddess, Phoibe, who was assodated, not with the masculine sun, but with its feminine counterpart, the moon. See Kerenyi, *Asklepios* 90 ff. Phoibos is thus a primordial name and identity retained as an epithet of the Hellenic god, in the same manner as the epithet of Bacchus (Bakkhos) for the Hellenic Dionysus.

The wolf was a metaphoric version of the god in his polluted state, and thus Apollo was also called Lykoktonos, as the 'one who slew the wolf (Sophocles, *Electra* 6). The stories of Apollo's murdered victims really mask the god's sacrifice of his own primitive precedents in order to supplant them with his evolving Hellenic persona as a deity of more civilized times.[18] In this manner, the primitive Apollo could himself be represented as a wolf or, like Python, as a serpent (Bode, *Scriptores Rerum Mythologicorum* - Farnell 4.359 R 7n). It was as a wolf that he abducted the maiden Gyrene, like Daphne, from the region of Tempe (Servius, on Vergil's *Aeneid* 4.377), and the wolf was his special animal and a fitting sacrificial victim in his worship (Pausanias 10.14.7, scholia to Sophocles' *Electra* 6).

Lycians

Amongst the god's primordial victims was a race of evil wizards called the Telchines. Originally associated primarily with the island of Rhodes, they also inhabited Argos and Crete and migrated to Lycia under the leadership of Lykos or 'wolf and founded a temple of Apollo Lykios by the river Xanthus in south-western Asia Minor (Diodorus Siculus 5.56). Others claimed that it was actually wolves themselves who met Apollo's mother Leto when she was in labor and that it was they who brought her to the same site by the river, where she was delivered of the divine twins (Antoninus Liberalis 35). These wolves were apparently nothing other than the Telchines themselves, for one version of their origin had them metamorphosed out of Actaeon's hounds (Bergk, *Poetae Lyrici Graeci*, Leipzig 1882, 3.232). Traditionally, these hounds represented the recidivism of the domestic dog into its wild avatar, the wolf, a transformation that was effected through the agency of rabies, which was called the 'wolf-madness' or Lyssa. The Telchines, therefore, were the 'mad' or inspired ministers of the primitive Apollo. The classical god, who was supposedly born on Delos, was ritually insulated from his own recidivous tendency by prohibiting all dogs from landing or living upon the island (Strabo 2.8.6). The homeland of the god's lupine predecessor, who was born instead in Asia Minor, was named for the Telchines' deity. It was called Lycia, from the epithet of their god, Apollo Lykios, for Lycia is a Greek word and not the country's ethnic name in the native language of its inhabitants. For the Greeks, Lycia was known as the 'wolf-land.'

This wolf-land of Lycia, it would appear, was another version of the Hyperborean world, for it too was claimed as the paradisiacal garden where Apollo spent his annual sojourn (Vergil, *Aeneid* 4.143-144; Suidas *omega* 71). Thus, the Olen who brought the first *daphne* to Delphi came, as we have seen, with two Hyperborean companions, but was himself a Lycian (Pausanias 5.7.8). Apollo's name in fact, appears to be derived from that of a Hittite deity of entrances, and hence of weather and the seasons.[19] Moreover, the cave of the Python at Delphi, which was the original site of the oracle on Parnassus, is a Hellenic importation of a religious cult from Cilicia, on the southern coast of Asia Minor, eastward beyond Lycia.[20]

This Corycian Cave, as it was called at Delphi, seems in fact, to have had the same name in Cilicia, as well as at its various other Anatolian locations. These caves were all considered to be entrances to the otherworld. The Delphic Corycian Cave was administered by a tribe that lived in the nearby town of Lykoreia, high on the Parnassian plateau, before they later moved further down the mountain to occupy the site of the classical Delphic sanctuary, sometime before the year 800 B.C. (Strabo 9.3.3). Lykoreia is etymologically the 'mountain city of the wolves,' and its original location was supposedly chosen by wolves, who led the Lykoreians there to save them from the waters of the great flood (Pausanias 10.6.2 ff.). Its founder was a certain Lykoros, the 'wolf-warder,' or, by some accounts, simply Lykos himself. Here too, we can discern the wolf as a primitive version of the god and hence the primordial enemy of the classical deity who evolved from him, for it was a Lykos who was said to have desecrated the god's temple by attempting to steal the sacred tripod upon which the oracle sat. For this reason, Lykos was stoned to death (Hippocratic Corpus 9.412 Littré; Pausanias 10.14.7; Aelian, *De Natura Animalium* 10.26).

---

18. Fontenrose 470 ff.
19. B. Hrozný (1936) Les Quatre autels'Hittites' hieroglyphiques d'Emir Ghazi et d'Eski Kisla, et les divinités Apulunas (?) et Rutas, *Archiv Orientálni* 8, 171-199. Emmanuel Laroche, *Recherches sur les noms des dieux Hittites* (Maissonneuve, Librairie Orientale et Americaine, Paris 1947).
20. Fontenrose 406-403.

The cave on Parnassus was apparently another passageway to the god's primordial realm amongst the Hyperboreans. The oracle there was spoken by three winged sisters who were said to become inspired by eating honeycomb (Homeric hymn 4.533-567). They were called 'bees,' a title that persisted into the classical era for the priestess of the oracle, even after the transposition of the rite to the Delphic sanctuary. This cave of the bee-maidens was said to have been the second Delphic temple, replacing the first of *daphne*, and it was reputed to have been constructed out of honeycomb and feathers by bees (Pausanias 10.5.9 ff.). Like the *daphne* temple, it too would appear to be a metaphoric substitute for the golden fruit of the otherworld, for Apollo, on usurping the site from the Python and claiming it for his own Hellenic persona, was supposed to have dispatched the honeycomb temple to the land of the Hyperboreans (Pausanias, loc. cit.; cf. Strabo 9.3.9). Whereas the classical Apollo transmitted oracles from his Olympian father, this Corycian version of the god sent up dream phantoms from the dead in the service of the Great Mother, who was Earth (Euripides, *Iphigenia in Tauris* 1259-1269; Aeschylus, *Eumenides* 1-8).

Since the Corycian Cave could be viewed as an entrance to the Hyperborean world that lay beyond its depths, the Delphians themselves were called Hyperboreans (Mnaseas, frg. 24 Müller). The cave was the way to the golden fruit. Hence, the cave itself was said to have had its chambers lined with gold, and its maiden priestesses were clothed in golden raiment (Philoxenos, frg. 14 Bergk).

It is not surprising, therefore, that the Telchines, who served the primitive god in his Lycian temple, were notorious metalsmiths, working the precious ores extracted from the chthonic depths. Their name was etymologically derived from the words for 'melting' (*texis*) and 'enchantment' (*thelxis*) (Hesychius, s. v. Telchines),[21] and they were apparently the Lycian version of the Cyclopes, who were similarly subterranean smiths, as well as of the Hyperborean griffins, who dug the gold that the one-eyed Arimaspeans stole from them (Herodotus 3.116). Like the bee-maidens, the Telchines were ecstatic creatures (Nonnus, *Dionysiaca* 14.42) with a reputation for sorcery and drugs (Callimachus, frg. 6.64, Diodorus Siculus 5.55; Hesychius, s. v. Telchines). They were also herbalists, for their so-called metallurgic arts involved the making of special potions with the roots they dug from the earth (Eustathius p. 771, 60 ff.), and the single eye that characterized the Cyclopes and the Arimaspeans was known for them as the power of their evil eye (Ovid, *Metamorphoses* 7.366). The classical god in killing these ancient ministers of his religion, redeemed mankind from their supposed wickedness, for, like the bee-maidens, their shamanism was chthonic. They stood accused of having sprinkled the islands of Rhodes and Cos with the waters of the underworld, thereby annihilating all life (Strabo 6.4.5).

Apollo

Apollo, it would appear, had two homelands, one amongst the Hyperboreans on the slopes of the Altai Mountains, and the other amongst the Lycians who tended the Corycian caves of Anatolia. This is not surprising, for in his classical form, Apollo, like the other Olympians, was actually an assimilation and reconciliation of deities from two basically different religious traditions.[22] One was that of the Indo-Europeans, in which male deities dominated over females and were associated with the heavens and spiritual immortality. The other was the Anatolian tradition, where there was a Great Mother goddess, associated with the earth, agriculture, the tomb, and an eternity of corporeal resurrections and deaths. In Lycia, Apollo would have been originally the lesser consort of a superior goddess, amongst a people who still in classical times alone of all men known to the Greeks reckoned lineage by matrilineal descent (Herodotus 1.173). The myth of his birth as a son of Zeus is more exactly, like that of the other children of Zeus, the story of his assimilative rebirth into his new identity as one of the Olympians, along with his former Goddess, who has been transformed into his twin sister, Artemis.

The basis for the assimilation of the 'northern' and Anatolian Apollos seems to have been that both gods were involved with oracular activity, in which they functioned as intermediaries with another world, a role that probably developed from their supposed control over seasonal change and hence over the entrances to life and

---

21. See Herter, in Pauly-Wissova, *Real-encyclopädie der classischen Altertumswissenschaft*, s. v. Telehinen.
22. For a summary of the two points of view about Apollo's origin, see H. J. Rose, *A Handbook of Greek Mythology* (Dutton, New York 1959) 135, 138.

death. The shamanism of the Hyperborean Apollo, however, would have differed from that of the Lycian with regard to its orientation. To judge from Orphism, which was a classical evolution of northern Apolline traditions, the shamanism of the Indo-European Apollo was directed toward the celestial realm and strove to liberate the spirit from the body, whereas the Lycian god, through death and rebirth in the embrace of the Earth, showed the way to the body's renewal in its passage through the tomb.

It would, however, be an oversimplification to assume that the assimilation of the two religious traditions occurred solely in the Hellenic context. The Anatolian peoples may well have been influenced by their eastern and northern Indo-European neighbors before their Lycian deity confronted the Hyperborean after the migration of the Indo-Europeans into the Greek lands. So too, the myths cannot be separated clearly at all times into two distinct traditions.

The typical mythical pattern for this assimilation presents the gods of a newer Olympian generation asserting their dominance over their own avatars. Since the Indo-European immigrants were to dominate politically and impose their language, which was to become Greek, upon the indigenous peoples, the gods of this new order are characterized by the Indo-European cultural ideals of male dominance and celestial orientation, but versions of their avatars persisted into the classical period, particularly in agrarian and funereal rites, and, in various ways, the Olympians, like the people who worshipped them, had to strike an accord both with their own particular precedents and with a whole class of deposed chthonic deities, who were the children of an earlier race.

In this manner, although Apollo's predecessors were supplanted and often discredited as his evil antithesis, it was nevertheless felt necessary to appease their angered spirit by some semblance of accord and reconciliation. Thus at Delphi, the Python, who was the original deity of the Corycian Cave, continued to be honored in biennial nocturnal rites that were an atavistic regression to the times of the Hyperborean bee-maidens and their Lycian god. During these rites, the whole sanctuary fell under the dominance of Dionysus, who often functioned as the chthonic opposite of his celestial brother, while Apollo himself withdrew to his primordial home amongst his chosen people in the otherworld.

Sacrifice

Such acts of expiated slaughter, by which the god supplanted his predecessors, are paradigmatic of the accord with the past and its primitivism that was repeatedly renewed through the ritual of sacrifice. The victim for the offering had a role of special honor, for typically it was an animal that was felt to have some particular kinship with the deity, often being associated with the god's sinister persona.[23]

Although some sacrificial ceremonies required that the victim be given over totally to the deity or spirits, either through holocaust or by being simply left to rot, the sacrifice was usually a communion meal that the worshipers shared with the gods. Even in the former case, the sacrifice was meant as food that was offered to the deity whose appeasement was sought. In feeding the deity, the worshipers nourished and bound it to the persona elicited though their invocation and ritual, seeking to avert its regression to less beneficent manifestations. The sacrifice itself was a cultivated and civilized art, usually involving the act of cooking, although certain ceremonies in honor of primitive personae required the eating of the flesh raw. Ordinarily, however, the manner in which the victim was butchered and prepared for consumption was intended symbolically to reassert and strengthen the progress of evolution, for the ceremony recapitulated the supposed ontogeny of the animal itself, as well as the imagined history of the culinary arts since primitive times.[24]

---

[23] Thus, a dog could be sacrificed to the nether goddess Hecate, a horse to Poseidon or the Winds, a goat to Dionysus, a sow to Persephone and Demeter, etc. The animal was thought to represent the form in which the deity formerly appeared and the victim was thus chosen to intensify the resemblance, as, for example, a red dog to the Latin Robigus, who was the spirit of the reddish fungus or ergot that attacks grain. So too were virgin animals appropriate to the virgin goddesses Artemis and Athena, and black ones for the chthonic gods, but white for the celestial. The bull was a typical sacrifice to Zeus, and we can sense the god's sinister persona in the myth of his abduction of Europa, whom he possessed in the form of a bull that breathed the fragrance of the magical herb it had grazed upon.

[24] Marcel Detienne, *Dionysos Slain* (Johns Hopkins University Press, Baltimore 1979, translated from the French of 1977) 68 ff.

In addition to ritualizing the manner in which mankind of necessity partakes of death in order to nourish life, the ceremony of sacrifice signified man's essential role in the reconciliation between the primitive and civilized deities and between the chthonic and Olympian realms. The chthonic gods, who presided over the tomb, were accustomed to eating the corruptible matter of life, but the Olympians ordinarily avoided pollution with the blood and flesh of mortality and were nourished instead upon their own special food and drink, their ambrosia and nectar,[25] which had the power to confer immortality even upon mortals (Pindar, *Olympia* 1.61-64) and were the reason that the Olympians were a race apart, with serum-like ichor instead of blood in their veins (Homer, *Iliad* 5.339-342). Because of this basic difference, the pure Olympians at first had little use for humans, who were created out of clay (Pausanias 10.4.4) and were closer by nature to the chthonic gods, who shared with them the traumas of birth and death. Through the communion meal of sacrifice, even the Olympians, however, were incorporated into the universal interdependency of life and death in the sources of nourishment.

Before Zeus's great reconciliation with humans and the creatures of Earth, he had originally intended to destroy mankind and he and his new hierarchy of gods were cruel and tyrannical. Pursuant of his plan, he took fire away from the volcanic forge of the subterranean smiths and hid it from humans (Hesiod, *Theogony* 561 ff.; Aeschylus, *Prometheus* 7). This fire was the magical plant of chthonic shamanism, and without it, mankind was no better than the beasts of the wilderness, eating their foods raw and lacking in all the civilizing arts (Aeschylus, *Prometheus* 436 ff.). Before Zeus could complete their destruction, however, Prometheus championed the cause of men, who were beings of his own creation, and retrieved fire for them back from the heavens so that they would not remain utterly at the disposal of the tyrannical god. Although himself born of Earth, Prometheus had at first sided with Zeus in the battle that subdued the chthonic creatures, but since Zeus would not rule with justice, it was the role of Prometheus to endure shamanic torment until he could manage to reconcile the two opposing realms and demonstrate the interdependency of both upon the intermediary lot of mankind.

In this reconciliation, chthonic fire became identified with the fire from heaven, for the chthonic smiths are also the Cyclopes who make the celestial thunderbolts of the supreme Father (Hesiod, *Theogony* 149), and thus, the magical plants of the two traditions of shamanism merge. In effecting this reconciliation, Prometheus showed Zeus the way toward justice and the evolution of a better world. In return for his own freedom, Prometheus showed Zeus that the new order of Olympians would be eternal only if the supreme god avoided his own demise by passing on to a human the allotment of mortality that would have been his.[26]

In this manner, it became a human who was to bear the darker persona of the supreme Olympian, and it fell to the lot of mankind continually to reinstate the terms of the accord upon which the new order of the world depended. To the most sinister aspects of the chthonic deities, the sacrifice was typically performed at night in a pit in the ground, and the victim was often not considered an edible species and was simply left to rot. The Olympians, in contrast, were characteristically worshiped in the light of the sun, and, according to the procedure established by Prometheus, the inedible parts were burnt upon an altar for the gods, while humankind cooked and consumed the rest (Hesiod, *Theogony* 535 ff.).[27] In such sacrificial rituals, the magical power of fire transmuted the gods' portion into fragrant smoke, that would ascend to the heavens, where the Olympians, or the brighter aspects of the evolving chthonic gods, fed upon the destruction of their own

---

25. *Ambrosia* is etymologically a negative formation of *brotos* or 'mortal,' and hence a designation of the nourishment of immortals. *Nektar*, which often indicates the gods' drink, may be derived similarly from *nekus* or 'corpse,' plus a second element indicating 'against.' The word has also been interpreted as composed of an initial negative (*ne*-), plus *ktar*, which may be related to *kteres*, a synonym for *nekroi* or 'corpses' (thus, Hesychius). There is, however, no generally accepted etymology for *nektar*. See Chantraine.
26. Thus, the nymph Thetis, by whom Zeus would have begot his own successor, was given in marriage to Peleus, and Zeus avoided that chthonic union, for Thetis is another of the abducted Persephone-like females, and Peleus is named for 'clay' or 'mud' (*pelos*). Achilles, who is born of the union, therefore, is the bearer of Zeus's mortal potential, a mortal son of an immortal father.
27. The verb for sacrifice when directed to a celestial god was typically *thuo* (or *thyo*) and meant basically 'to make smoke.' A different verb was used for chthonic sacrifice, *enagizo*, which implies involvement with 'pollution' and 'curse' by association with the dead. These distinctions in nomenclature and ritual for celestial and chthonic deities were not universally observed, but that is probably because it was possible to invoke the celestial aspect of a chthonic deity, like the paired Demeter and Persephone, or the more sinister persona of an Olympian.

primitive avatars. Thus they were strengthened in their separate estates, with humans as intermediaries to reinforce the advance of the Olympian age.

Thargelia

The offerings of first fruits were presented to Apollo toward the beginning of June, on the seventh of the month Thargelion, which was so named after these *thargela*, the still unripe samples of the coming harvest. It is at this time that we may infer that the Hyperborean offering must have also arrived at Delos, amidst the offerings of sheaves from the other Greek cities. Because of the greater distance that it had traveled, however, it is improbable that the secret offering could have been cut at its supposed Hyperborean origin that spring. The sheaf may have been added later along the route, but the special Hyperborean plant would have to have been available earlier in the year. The arrival of all these *thargela* was the occasion for the great gathering of Ionian Greeks on Delos to celebrate their Apollo as an Olympian god with music and dance, these highest manifestations of the Hellenic culture inspired by him (Callimachus, *Hymn* 4.300 ff.; Homeric hymn 3.146 ff.).[28]

During the entire period of this festival, the Greek cities were considered to be in a state of ritual purity, as befitted the god they were honoring at this Thargelia Festival. To maintain this purity, they had to avoid all contamination with blood pollution, for that would have involved them with the chthonic realm and endangered the persona of the deity they intended to invoke and nourish. Thus it was, for example, that Socrates remained so long in prison before his execution, for the Athenian ambassadors with the first fruits had already set sail for the sacred island just the day before the trial and condemnation, and during the state of purity, no public execution or blood offering could be made (Plato, *Phaedo* 58a ff.).

On the day before the Thargelia, however, as it appears to have been celebrated in the various Greek cities, the ultimate sacrifice to a chthonic deity had been made, a piacular victim 'upon whose flesh no one could feast' (Aeschylus, *Agamennon* 151). This was the offering of a human sacrifice, or, at least, the tradition of such an unspeakable offering. It is not clear from our evidence whether in the classical period this sacrifice was still enacted regularly, although both myth and archaeological finds testify to its occurrence in Minoan and later times. The human sacrificial offering may have been reserved by the classical Greeks for times of extraordinary peril, such as pestilence or war, when the more sinister aspect of the healing Apollo would need special appeasement. It is also possible that by the classical period the actual immolation had become a symbolic or token imitation. Despite our modern repugnance,[29] however, the ritual was known even in classical Athens and perhaps practiced there (Aristophanes, *Knights* 1405; Lysias 6.53).

The victim was called the *pharmakós*, a scapegoat or atonement, but a word that in Greek is derived from the same root as 'drug' or *phármakon*.[30] A mythical tradition preserved an awareness of the obvious relationship between the two words, for a figure, personified as Pharmakos, was remembered as an ancient enemy of Apollo, another of the god's supplanted predecessors. Pharmakos was said to have incited the god's wrath by stealing his sacred drinking cups, for which reason the deity had him stoned to death (Istros, frg. 33 Jacoby; Suidas, s. v. Pharmakos). The myth is clearly aetiological for the *pharmakos* ritual, but it suggests an original controversy about the two traditions of shamanism and the magical plant.

---

[28] It is unlikely that the great assembling of peoples at Delos (Homeric hymn 3.147 ff.) was separate from the Thargelia, for that would have required the mounting of two annual ambassades to the sacred island. See Farnell 4.289 ff.

[29] S. Eitrem and J. Fontenrose in the *Oxford Classical Dictionary* (s. v. Sacrifice) discount the evidence as untrustworthy, probably arising from strangers' misunderstandings of hearsay reports of rites, and they cite the piacular killing of a criminal at Marseilles and the occasional slaughter of captives of war as hardly evidence for human sacrifice amongst the Greeks and Romans. It is true that a spurious work attributed to Plato (*Minos* 315 ff.) unequivocally states that human sacrifice was not the custom amongst Greeks, although it was amongst other peoples, but it is now clear that human sacrifice was once enacted amongst the Greeks also and that they maintained a remembrance of it in their mythical traditions and continued to enact various transmutations of the rite in classical times, although actual immolation may, in most cases, have been avoided, or the victim chosen as being, for some reason, justifiably expendable.
The repugnance of modern scholarship to human sacrifice amongst the Greeks can be sensed from Wilamowitz-Möllendorff's attempt to emend Harpocration's testimony to read two 'rams' (*arnas*) for the two 'men' (*andras*) indicated as the sacrificial victims. See Paul Stengel (1887) 'Thusiai Aspondoi,' *Hermes* 22, 647.

[30] Although the etymology of *pharmakon* is not clearly established, its relationship to *pharmakos* seems assured. See H. Frisk, *Griechisches etymologisches Wörterbuch* (Winter, Heidelberg 1954-1970).

Our earliest source for the manner of performance of this ritual at Athens is the third-century B.C. historian Istros (or Ister, as he is sometimes called), an Alexandrine pupil of Callimachus who collected information about cults and festivals in Athens during the early, mythological period. According to him two men were chosen as victims, one on behalf of the men, and the other on behalf of the women of the city (loc. cit.). We do not get further details until the third century A.D., but the similarity of the wording of the quoted material suggests that the original source was again Istros. The victim for the males, we are told, was draped with black figs, the other with white, and the two were called *subakkhoi*, a word whose etymology is unknown, probably assimilated from a pre-Hellenic language (Helladios, in Photius, *Bibliotheca* 534 Bekker). Apparently, moreover, the use of a male victim on behalf of the female populace was not always the custom, for we also hear of a pair of victims, a man and a woman (Hesychius, s. v. *pharmakoi*).

The occasion for the first offering of such *pharmakoi* was supposed to have dated back to Minoan times, when the Athenians were compelled by a plague to send seven males and seven females to die in the labyrinth at Knossos. Every year thereafter, the Athenians had sent the same tribute of human victims until they were finally released from this bloody obligation of appeasement when Theseus sailed as a victim to Crete and managed to slay the Minotaur. This tradition, like that of Pharmakos, similarly implies the transition from primordial to more civilized times, and Apollo, in his Delian purity as an Olympian again figures in a redemptive role, for Theseus, on his way back to Athens, transmuted the sinister and chthonic implications of the labyrinth into higher culture on the island of Delos as the intricate windings of a line-dance by the troop of victims he had rescued from the Minotaur. This was the aetiology of the first Thargelia, and the tradition was commemorated, as it was believed, by employing the very ship of Theseus, which had been preserved and perpetually restored as a precious antique, to convey the Athenian contingent to the Delian Thargelia with the city's first fruits in classical times (Plato, *Phaedo* 58a ff.).

Although the *pharmakoi* were human offerings, the manner of their immolation suggests that they were symbolic, in a broader sense, of the whole regenerative agrarian cycle. The victims, holding cheese and breads, were beaten seven times on their genitals with branches of the wild fig, squills, and other wild plants (Hipponax, frg. 7, 11 Diehl, quoted with amplification by Tzetzes, *Chiliades* 5.726; scholia to Aristophanes' *Knights* 1133). This symbolic seven-fold flagellation is reminiscent of the whipping of adolescents at the Delian olive and identifies the victim's sexuality and its relationship to primitivism and the otherworld as the particular aspect of them that was offered in piacular sacrifice. The victims themselves were apparently selected for the same symbolism, for they were social and physical miscreants, chosen because of their extraordinary ugliness or low birth.

In preparation for their ordeal, they were glorified (Hipponax, frg. 13 Diehl, quoted with amplification by the scholiast to Lycophron's *Alexandra* 436), as befitted their sanctified role as the god's avatar. They were fed at public expense (Suidas, s. v. *pharmakous*) and purified by a vegetarian diet of bloodless foods, the cheese and breads that they were made to hold for the flagellation, as well as the wild fruits of the branches that were used as whips (Hipponax, frg. 9 Diehl). This appears to have been the custom also in the Greek colony of Marseilles, where the same ritual was still known in the fourth century A.D. (Servius, on Vergil's *Aeneid* 3.57). There, we are told, the victims were sumptuously maintained on such foods and luxuriously dressed.

Then, like the mythical Pharmakos, they were stoned to death, a form of execution that avoided incurring individual blood guilt. Their bodies were burnt with the wood of wild fruit trees, and their ashes were scattered to the winds, which took their spirits to the otherworld and spread their mortal remains upon the earth to enrich and fertilize it for the new growth of cultivated plants that they, as impersonations of the wild and primitive, liberated through their deaths (Tzetzes, *Chiliades* 5.736; scholia to Aristophanes' *Knights* 1133).

The Hyperborean offerings to the Delian Thargelia appear to be a transmutation or substitution for such *pharmakos* victims. It is for this reason, no doubt, that the Hyperborean maidens who were the first ambassadors to arrive in person with the secret offerings never returned to their far-off land, but were buried on Delos within the area of the sanctuary that was sacred to Artemis (Herodotus 4.34), a signal honor that was accorded them, despite the general prohibition against all contamination with funerary custom that prevailed otherwise at the sanctuary. The myth of their simple death glosses over the tradition of what was originally their sacrifice on the sacred island and thus protects the classical god from the sinister connotations of his more primitive persona as a chthonic deity.

According to Herodotus, however, these two maidens, with their male escorts, were actually not the first visitors from the Hyperboreans. They were said to have been preceded by two other girls, a doublet variant of the other myth.[31] They came from the Hyperboreans by the same route and at the same time as the pregnant Leto and brought with them thank-offerings for her easy delivery of the twins, the rebirth that gave them their classical personae. They too apparently died, or were sacrificed, on Delos and were buried and honored within the sanctuary. These Hyperboreans, according to another variant, were none other than the goddess of travail herself, who came to aid Leto in her labor, and the two traditions of primitive Apolline worship are transparent in the confusion about whether this goddess of travail actually came from the 'northern' Hyperboreans or, as some claimed, from Minoan Crete and the labyrinth that had claimed the Athenian victims up until the time of Theseus's triumphant visit to the sacred island after the death of the Minotaur (Pausanias 1.18.5).

The two commemorative graves of these two groups of Hyperborean visitors to Delos were ritually honored in classical times by rites of passage, for the maiden Hyperboreans were themselves symbolically the first fruits of pubes cence, originally offered to the chthonic persona of the god. Thus it was the custom for Delian maidens in classical times to make a substitute offering at pubescence, a lock of hair, wrapped about a spindle and placed upon the grave of the Hyperborean maidens when they themselves prepared for marriage. Similarly, pubescent males on the island would make a 'first fruit offering' of their facial hair, wrapping it about the shoot of some young plant (Callimachus, *Hymn* 4.296 ff.).

The other of these two graves on Delos, that of the Hyperboreans who aided Leto's delivery, was also honored ritually. Delian women, who, like the goddess, had given birth and passed beyond the threshold of maidenhood into matrimony, would collect the ashes from the sacrificial animals burnt upon the classical god's altar and scatter them upon the tomb of these Hyperboreans who had died so that the god could be born.

Apollo and Artemis, moreover, are frequently associated with rituals of human sacrifice in a Hyperborean context. The most interesting of these victims is Orion, who was associated with a pre-classical intoxicant, a predecessor of the Dionysian wine. Orion was the son-in-law of Oinopion, a primitive 'wine king',[32] who made him drunk and blinded him. Orion himself was said to have been born out of an oxhide upon which the gods Zeus, Poseidon, and Hermes had urinated, and his name was etymologically derived from this act of urination, *ourein* (Ovid, *Fasti* 5.495 ff.; Nonnos, *Dionysiaca* 13.96 ff.; Servius, on Vergil's *Aeneid* 1.535). He seems to have regained his sight through the aid of one of Hephaesrus's Cyclopes and to have died at Artemis's hands when he tried to violate one of the maiden Hyperborean visitors to Delos at the time that the classical twins were born (Apollodorus 1.25-27).

Like all victims, the *pharmakos* ideally had to accept its fate. The Hyperboreans, themselves, were supposed to have enjoyed a blessed, long life, during which they too abstained from eating meat, living instead upon the fruits of trees (Hellanikos, frg. 96 Jacoby). At the end of their lives, they voluntarily offered themselves to death by jumping off a cliff (Pliny, *Natural History* 4.89; Mela 3.37). Such a leap off a cliff to one's voluntary death is well attested in Apolline ritual and mythical traditions.[33] Symbolically, it enacts the descent to the netherworld in the wind's embrace,[34] and Apollo himself was called Kataibasics, as the god of the descent, although the epithet could also be interpreted in a less sinister manner as the god who oversaw the return to one's country and homeland (scholia to Euripides' *Phoenician Women* 1408).

The most famous Apolline leap was the one from the Leucadian rock, the sheer limestone cliffs on the west coast of the island of Leukas in the Ionian Sea, off the coast of Acarnania. By one account, the priests of the god threw either themselves or some sacrificial victims off the rock into the sea (Photius, s. v. *Leukates*).[35] This so-called 'White Rock' was a particular topographical localization of another cliff, found only in the lands of myth, at the edge of the world and reputed to be an entrance to the country of dreams, sleep, and death, the gateway where the sun went down or rose again from its repeated passage through the abyss of night (Homer, *Odyssey* 24.9 ff.).[36] Typically, it was a wind that snatched its victims from that rock, and the mythical leap was located elsewhere as well, wherever the boundary between consciousness and unconsciousness was felt to lie. At Cape Leukas, however, the traditional concept was defined by the purificatory ritual of an annual sacrificial leap in honor of Apollo. The leap from the Leucadian cliffs was reputed to be a cure for intoxication and madness (Anacreon, frg. 31 Page) and even the poetess Sappho was supposed to have plunged there into the sea for love of Phaon (Menander, frg. 258 Koch), who is a doublet of Phaethon and hence a mortal son of his divine father, the sun-god Helius. In the case of Euripides' Silenos, who was the leader of the satyrs or primitive Dionysian spirits, this madness was a joyous affliction caused by drinking a potent drugged wine that came originally from a northern priest of Apollo (Euripides, *Cyclops* 412; Homer, *Odyssey* 9.196 ff.),[37] so that, as he says, he would gladly leave his life amongst the race of Cyclopes and leap from the Leucadian rock (Euripides, *Cyclops* 264 ff.). Since Aphrodite herself was supposed to have been the first to find this famous leap as a cure for her love of Adonis (Ptolemaios Chennos, in Photius's *Bibliotheca* 152f Bekker), it is clear that the tradition of the Leucadian rock implies not only the magical herb and the shaman's rapture to the otherworld, but also the transition from primitivism to the Olympian age, for the love-goddess Aphrodite was one of the forms in which the Earth Mother was assimilated as an Olympian, and Adonis, whose name appears to be related to Semitic Adon or 'lord', was her dying consort, whose fate was symbolized in classical times in the withering pots of seedlings, the so-called Gardens of Adonis, that were mourned as a commemorative ritual by Greek women.[38]

---

[31] The names of all the girls are recorded, but there are variations concerning who was in which group, probably indicating that the two separate groups are doublet variants of the same tradition. The first visitors were Arge and Opis. The second ambassadors were either a group of three, named Oupis (a variant of Opis), Loxo and Hekaerge, or a group of two, like the first visitors, but named Hyperoche and Laodice. The names appear to be bynames or epithets of Artemis.

[32] On the connotations of these mythical kings with names constructed upon the word for 'wine' (*oinos*), see C. Kerenyi, *The Heroes of the Greeks* (Thames and Hudson, London 1959) 113.

[33] Farnell 4.274 ff.

[34] Thus Oreithyia (see p. 222) was blown to her death off a mountaintop, in the rationalized version of the myth of her abduction by Boreas to the Hyperborean garden of Apollo.

In actual custom, each year at Leukas, it was an ancestral rite to throw some convicted criminal off the cliffs as a purificatory sacrifice to Apollo. The substitution of a criminal for the *pharmakos* victim in classical times was an appropriate transmutation of the original symbolism, for the adjudged criminality of the victim certified him as an antisocial and recidivous force within the civilized group. The god, however, was supposed to have been lenient to the sacrificial offering, who was said to sprout feathers during the descent and to be uplifted by birds, so that he would land safely in the shallow waters at the base of the cliffs (Strabo 4.5.2). We are reminded of the god's similar kindness to one of his own avatars, Kyknos, like the wolf and the Python, a primordial enemy, who used to slay pilgrims on their way to the Delphic sanctuary. Apollo turned him into the 'swan,' after which he was named, the god's own prophetic bird (Palaiphatos, *De Incredibilia* 12; Antoninus Liberalis, *Transformationes* 12.12). As part of the Leucadian rite, moreover, an ox was slaughtered and, like the human victim, not feasted upon, but left to rot and attract flies, which, after drinking the blood, were said to disappear (Aelian *De Natura Animalium* 11.8).

The White Rock, as a mythical idea, is probably just one of several attempts to locate in reality the 'White Island' of Leuke. Other topographical placements found it somewhere in the Black Sea (Pindar, *Nemea* 4.49; Euripides, *Andromache* 1262), and thus it was sometimes identified with an island lying before the estuary of the Danube, a place that became confused with the so-called Islands of the Blessed, where the gods of an earlier age presided over the souls of the departed. It was there that Kronos, the father and deposed predecessor of Zeus, was king, and like the other versions of the Hyperborean land, it was a magical garden where golden flowers grew upon resplendant trees and in the offshore shoals (Pindar, *Olympia* 2.68 ff.). The western gateway of the Hesperidean garden and the analogous Leucadian Rock thus had its antipodal counterpart in the blessed island glowing white in the light of the rising sun. It was to this eastern entrance that Orion was transported upon his death after his attempted violation of the Hyperborean maidens (Homer, *Odyssey* 5.121-124). The sacred island of Delos itself was so-called because of the way its barren coasts shone from a distance amidst the Cyclades in the light of the sun.

---

35. Farnell 4.431 emends 'them' (*autous*) to 'themselves' (*hautous*), an easy emendation (requiringonly a change of breathing from smooth to rough or aspirate) that supplies an otherwise absent appropriate object for the verb in a this context.
36. Gregory Nagy (1973) Phaethon, Sappho's Phaon, and the White Rock of Leukas, *Harvard Studies in Classical Philology* 77, 137-189.
37. The wine was called Maronites, after Maron, a priest of Apollo, and its extraordinary potency required twenty-fold dilution with water.
38. For the Adonis Festival and its botanic symholism, see Marcel Detienne, *The Gardens of Adonis* (Humanities Press, New Jersey 1977, translated from the French edition of 1972).

In Vedic traditions, the White Island can also be found. There it is called Suetadvlpa, and the paradise beyond the wind appears as Uttarakurus.[39] This is what would be expected, for the Indo-European tradition of shamanism can be traced in the other lands to which these peoples migrated. The ambrosia and nectar upon which the Olympians feasted is a Hellenic version of what in the Aryan or Indo-Iranian context was called Soma or haoma.[40] This is the original identity, or at least Sanskrit name, of the magical plant that grew in the gardens of paradise and marked the gateway to the 'northern' otherworld. It is this that is the object of the hero's quest, not only in Hellenic traditions, but also hi the lore of their Anatolian neighbours, and Soma is an aspect of the atavistic personae of the classical gods. The concept of this magical food reached Greece not only, as in the Hyperborean traditions, along with the tribal migrations from central Asia, but also indirectly through dissemination and assimilation amongst the different peoples and cultures of Anatolia, where it was equated to their own versions of the shaman's plant.

Although the intoxicating properties of Soma were recalled in the oral poetry of the Indo-Iranians, numerous symbolic substitutes, which were not entheogenic, were commonly employed in the ritual that centered upon the preparation and drinking of the ceremonial potion. The reason for these substitutions seems to have been that the original plant, which was to be found in the homeland of the Indo-Europeans before their various migrations and whose attributes were preserved and perpetuated in the formulaic phrases of their oral poetic traditions, was no longer easily available in their new environments and had, with the course of time, lived on chiefly in the memory of the Brahmans and priests.

So too, the magical plant of the Hyperboreans became identified in Hellenic traditions with various substances that were, in one way or another, appropriate to the religious and symbolic context, but which did not share the original's physical properties for inducing mantic inspiration. Such was the case, as we have seen, with the *daphne* at Delphi and the olive at Olympia and Delos. Both are clearly not the plant actually recalled in the traditions of the Hyperborean entheogen, which more poetically could also be metamorphosed into the golden fruit or flowers, subterranean honey, the Gorgon's head, or the creatures with a single eye.

It became, above all, the god's victim, to be appeased and offered in sacrifice, for the plant belonged to the wilderness that had preceded the growth and evolution of the superior Olympian age of assimilated and reconciled divinites who presided over the perfection of Hellenic culture. Thus it became also the *pharmakos* offering, either the actual giving of human lives or, as became increasingly appropriate to the god's own civilized persona, the token offering of the same. In this way, criminals were used for the annual leap at Leukas, or, as in Thessaly, the people promised each year to sacrifice 100 men, a full hecatomb, to Apollo Kataibasios and each year postponed the offering until the next (scholia to Euripides *Phoenissae* 1408). At Delphi, as we have seen, the Python was murdered again in sham. On Delos, the Hyperborean visitors were replaced by the symbolic flagellation at the sacred olive and, as elsewhere, by rites of passage at puberty, for the youthful and virgin persona has to die at adolescence to liberate the fertile adult, just as the god himself and his sister had grown to maturity only in the Hellenic age. As with their human devotees, so also in the agrarian cycle could the same token offering be made in the form of the botanic first fruits, given as piacular victims to assuage the honor of the primitive spirits who are again and again deposed in the arts of cultivation but whose chthonic beneficence is required if the crop is to grow to fruition.

Daphnephoria

The olive and the daphne were coupled in the Apolline ritual of the Daphnephoria or the 'bearing of the *daphne*.' Like the ritual of the *pharmakos*, it appears to have been an annual purificatory ceremony. It was performed in Boeotia each year (Pausanias 9.10.4), with a more elaborate performance of the ceremony every ninth year, like the Delphic Septeria (Proclus, *Chrestomathia* C. 26 = Photius, *Bibliotheca* p. 321 Bekker). In this ceremony, a log of olive wood was wreathed with *daphne* and various flowers. At its top was attached a bronze sphere, from which were suspended smaller balls, arranged around 365 purple garlands that encircled the middle of the log. The bottom of the log was clothed in a saffron *krokotos*, which was an effeminate robe

---

39. Ken Dowden (1979) Apollon et l'esprit dans la machine: Origines, *Revue des études Grecques*, 92, 293-318.
40. Fontenrose, 430, 549, conies to this conclusion on the basis of an extensive examination of the myth of the god or hero's combat with the primordial serpent monster in Mediterranean and Near-eastern cultures.

commonly worn by Dionysus or by his devotees at his festivals. The *krokos* blossom, from which the saffron dye was prepared, itself had associations with the *pharmakos* offering to the pre-Olympian Apollo,[41] and the entire Daphnephoria effigy seems to have been intended as a token representation of the primordial god or his scapegoat.

Consistant, however, with his newer, assimilated identity, as indicated by the botanic transmutations of the *daphne* and the olive, the bronze spheres did not represent the golden fruit of the Hyperborean tree, but were interpreted instead as symbolic of the celestial universe, the sun, moon and stars, with the garlands as an enumeration of the days of their annual course.

In place of the royal victim, who seems to have been the original sacrifice,[42] a handsome boy of noble ancestry, touching the effigy, was led in procession by his nearest male relative, who himself carried the decorated log. The boy followed like the god, wearing a golden crown and resplendant clothing that reached to his feet. Behind him came the rest of the procession, composed of maidens, holding suppliant branches and singing hymns. In this manner, they brought the sacred *daphne* to the god's temples.

The Secret Offering

Although, as we have seen, there were several plants associated symbolically with Apollo, the secret offering enclosed in the sheaf of wheat from the Hyperboreans was probably none of these commonly known, yet it would have had to display certain characteristics to suit the meaning of the Thargelia and the *pharmakos* offerings. Since two strains of shamanism were assimilated in the evolution of the classical god, a plant not known to the Indo-Europeans before they found it amongst the earlier Mediterranean peoples would not be a likely possibility, for although the Hyperboreans, as a metaphor, could be encountered wherever there was an entrance to the otherworld, the careful preservation of the route for the supposed transmission of the secret offering to Delos would indicate a pre-Hellenic plant originating on the forested slopes of the Altai Mountains, the 'northern' homeland of the Hyperboreans. For this reason, the olive is an unlikely candidate.

The token offerings of first fruits, moreover, were meant to liberate the coming harvest from the contamination of its own primitivism, and thus the secret offering should be characterized as the god's pre-classical avatar. The *daphne*, therefore, like the olive, would have the wrong symbolism, for they both signify the god's completed transmutation to Olympian status.

The most striking characteristic of the Hyperborean original, of course, is its properties as an entheogen. It should be a wild, northern plant, associated with Indo-European traditions, and since it was sent as a secret offering, we should expect that knowledge of its identity was restricted.

R. Gordon Wasson, working with the Sanskrit tradition of the Ṛg Veda, has postulated that the original identity of Soma in the homeland of the Indo-Europeans before their migrations into the Indus valley and the plateau of presentday Iran was a particular species of mushroom, *Amanita muscaria*, sometimes called the 'fly-agaric' in English. As would be expected, the Hellenic branch of these same peoples brought with them into the Greek lands a remembrance of a special symbolism for the fungi in religious contexts. Wasson and his colleagues have detected it in the religion of the Eleusinian Mysteries, as well as in the rituals of viticulture and its god Dionysus. We should expect, as well, to find this same fungal symbolism in the traditions of the secret Hyperborean offering, especially since that carefully perpetuated ritual, more than any other, preserved a mythical idea of the original Indo-European homeland and its native entheogen.

A mushroom, first of all, would have the perfect symbolism for its piacular role as a *pharmakos* offering. It was a wild plant, uncultivatable and belonging to the pre-agrarian, primordial world of hunter-gatherers. In the form of ergot, a fungus with fruiting bodies of the characteristic mushroom shape that is parasitic on various wild and cultivated grasses and grains, the mushroom actually blighted and poisoned the ripening harvest and was thought to pose a threat of regression for the whole evolutionary process that had yielded the edible foods and the progress of higher culture and civilization. Ergot was apparently felt to represent some aspect of Apollo's supplanted avatar, for he bore the epithet Erysibios (Strabo 13.1.64), literally the metaphor of the fungus as the reddening corruption or 'rust' (*erysibe*) upon the grain.[43]

---

[41] In Euripides' *Ion*, the queen of Athens, in pre-Olympian times, conceives a child by the god in decidedly chthonic circumstances while gathering *krokos* blossoms.

[42] Farnell 4.274 ff.

This rust appears as the ingredient of a magical potion derived from a sacred tree with connotations of a fertility sacrifice and rite of pubescent passage in the mythical traditions about the seer Melampous, or 'blackfoot,' as his name implies. Melampous was the first prophet of Dionysian religion in Greece and was supposed to have learned divination from none other than Apollo himself. On the mainland near the Malaic Gulf, there was said to have been a king whose son was impotent. Melampous discerned that the boy's problem had been caused by the fact that he had witnessed a traumatic incident. He had seen his father gelding rams, and when the knife by chance had fallen close to him, he fled in terror, as well he might, for as the king's son, he was a likely candidate for the role of victim himself. The furious father, in his frustration, had thrust the knife into a sacred tree, where it had 'rusted/ the same metaphor in Greek, as in English, for the reddening corruption that also destroys iron through oxidation. Melampous was said to have cured the youth's impotency by administering a potion composed of the rust scraped from the blade (Apollodorus 1.9.12; scholia to Homer's *Odyssey* 281).

Ergot, moreover, is an entheogen, containing water-soluble alkaloids that are closely related to LSD. The Indo-European migrants would have first encountered the entheogenic ergot amongst the grain-growing peoples through whom they passed, and thus in the Greek branch as well as the Indian, one of the first surrogates for Soma would appear to have been fungal. It was used as a Hellenic substitute for Soma in the potion that was drunk by the initiates at the Greater Eleusinian Mystery in order to induce the communal shamanic experience of a descent and return from the otherworld. Its entheogenic properties, furthermore, were apparently responsible, according to mythical tradition, for the Apolline art of divination. Apollo himself was supposed to have been taught clairvoyance by a certain Glaucus (Nicander, frg. 2 Schneider), who seems to have acquired the ability when he discovered the magical properties of a wild grass, *Paspalum distichum*, a plant commonly infested with a species of ergot that, unlike the others, contains pure, uncontaminated entheogenic alkaloids.[44] It was supposed to grow on the Islands of the Blest, that Hyperborean paradise, where the deposed Kronos was said to have planted it, and it was responsible for the daily flight of the horses of the Sun from the White Island to the White Island (Alexander Aetolus, p. 465 Rose, quoted in Athenaeus 7.296 ff.). Glaucus was also said to have been the father of the Cumaean Sibyl (Vergil, *Aeneid* 6.36), an Apolline prophetess, like the Delphic Pythoness, who was abducted and cursed by the god, like another Cassandra or Daphne (Ovid, *Metamorphoses* 14.130 ff.).

Ergot, however, would tend to be associated primarily with an agrarian, grain-growing people, and hence with the Lycian version of Apollo. At the Eleusinian Mystery, it had such a connotation, for it represented the domestication of the wilder fungi, just as wine, too, is a fungal cultivation yielding an entheogenic potion. At the Greater Mystery, it was the culmination of an initiation that had begun with a ceremony involving the hunt for a wild fungus or its surrogates at the Lesser Mystery, and symbolically it reconciled the Indo-European shamanic heritage with what were originally pre-Hellenic agrarian rites. Thus, it is interesting that amongst the several mythical figures who bore the name of Glaucus, there was one who was a brother of the Minotaur on Crete. He too was prophetic, and was resuscitated by a magical herb after he drowned in a vat of honey (Apollodorus 1.96 ff.). Another Glaucus was actually a Lycian in the war at Troy.

The fungus of the Hyperborean homeland, in contrast, would have come, at least so it was supposed, from the wooded slopes of the Altai Mountains, where conifers and birch abound, an environment, therefore, where *Amanita muscaria* is commonly found. Presumably, it would have fruited in the autumn and been preserved, as is usual for Amanita, by drying so that it could be conveyed over the long journey, wrapped in straw, to arrive on Delos in late spring along with the other offerings of first fruits. Is there anything, we must now ask, in the Apolline traditions that might suggest that this was the identity of the secret plant?

---

[43] It was an epithet that he shared with Demeter, who could be called Erysibe (*Etymologicum Gudianum* 210.25). She was the Mother Goddess in her Hellenic manifestation, assimilated to Olympian traditions as a sister of Zeus and the overseer of the cultivated grains. The same epithet also appears for Apollo in dialectal forms as Erethimios (*Sylloge Inscriptionum Graecarum* 724) and Erythibios (Strabo 13.1.64).
If Erithios, a Cypriote epithet of the god, is also a dialectal variant (and not to be related instead to *erithos* or 'hired-servant'), there is an intriguing tradition that it was this Apollo Erithios who counseled Aphrodite to take the first sacrificial leap off the Leucadian Rock in order to assuage her yearning for Adonis (Ptolemaios Chennos, in Photios, *Bibliotheca* 152f Bekker).

[44] Hofmann, *Road to Eleusis*.

The one-eyed Arimaspeans, who, as we have seen, were either just another name for the Hyperboreans or, as a separate people, were the first intermediaries in the transmission of the subterranean gold that was mined by the griffins, are a personification of one of the attributes of Soma as the 'single eye'. So too, therefore, are the Cyclopes, whose murder as primitive surrogate occasioned Apollo's expiatory sojourn amongst the people of his 'northern' homeland. There were two versions of these Cyclopes, and the Anatolian ones probably arose from a separate dissemination of the metaphor through Asia Minor, where the later discredited Lycian Telchines display the same attribute as their evil eye. These one-eyed creatures are a variant of another attribute of Soma as the figure with a single foot, a characteristic of a supposed race of people called the Shade-foots, who came from the Indus valley and were fancifully implicated, according to the comedian Aristophanes (*Birds* 1553 ff.), in a profane celebration of the Lesser Eleusinian Mystery. It appears that the Arimaspeans may have come from the same general region, for Herodotus's supposed Scythian etymology of their name is probably not correct, but they were really an Iranian tribe, called the Argempaioi or Argimpasoi.[45] All these fabulous creatures can be traced to fungal manifestations and testify strongly that it was some kind of mushroom, if not actually Amanita, that was originally the Hyperborean plant. In its Hesperidean version, the plant bears still another attribute of Soma as the 'mainstay of the sky',[46] which is the role that Atlas plays as 'pillar of heaven' in the west (Aeschylus, *Prometheus* 351), just as his Titanic brother in the east, Prometheus, when presented as a Shade-foot, impersonates the sacred plant as a 'parasol/ which is the Sanskrit word for 'mushroom.' The single-footed trait can also be seen in certain Greek heroes who, like Oedipus, have mythical roles as Apolline surrogates.[47]

It is also significant that only three mythical figures were said actually to have gone to the land of the Hyperboreans, and all three came from the region of Mycenae. These were Perseus, Heracles, and the ecstatic, fly-bitten heifermaiden, lo, although she, unlike the other two, got only to the edge of the Hyperborean land. Melampous, who devised the rust potion, also was involved in the lore of Mycenae, and the Lycian Glaucus was a grandson of another figure, probably a doublet of Perseus,[48] who played a role in the same traditions. The ancient foundations of that city were supposedly built by the Cyclopes, and it was named, as it was claimed, after the 'mushroom' or *mykes* that Perseus picked at the site (Pausanias 2.16.3). The name of the city is a feminine plural, like Athens (Athenai) and Thebes (Thebai), perhaps indicating that, in fact, the word is not Indo-European, but from one of the pre-Hellenic languages. The same conclusion seems indicated by the naming of these cities in a matrilineal fashion after the patron goddesses, represented presumably by the priestesses or women of the city. It is equally significant, however, that the Indo-Europeans, in imposing their rule upon the pre-existent city, interpreted its name in terms of their own sacred plant, and probably equated the chthonic Cyclopes with their Hyperborean doubles.

Still more explicit is the depiction of Perseus's journey that we see on a fourth-century B.C. *amphora* from southern Italy.[49] The artist followed the tradition that confused the Hesperides and their golden fruit with the

---

[45] Dowden, Deux Notes 492.

[46] Wasson, *Soma* 47-48. Prometheus, Atlas's brother, is also involved with the attributes of Soma, for the divine plant is metaphorically 'fire' and is often identified with Agni, the god of fire (*Ibid*. 39 ff.). Soma is also the 'sun,' which travels repeatedly between the two tormented Titanic brothers (*Ibid*. 37-39). It is also described with the same adjective as the Sun's horses, which in Greek traditions, as we have seen, graze upon *Paspalum*, the Mediterranean transmutation of the entheogen.

[47] On the botanical nature of the single-footed figure in Greek myth, see Lowell Edmunds (1981) The Cults and the Legend of Oedipus, *Harvard Studies in Classical Philology* 85, 221-238.

[48] This was Bellerophon, who was sent to Lycia by king Proems to be killed by the father of Proetus's Lycian wife. On Bellerophon as a doublet of Perseus, see Kerenyi, *Heroes* 79 ff., who points out that Bellerophon's name is a transparent epithet for the 'killer of the monster' and that only Bellerophon and Perseus rode on Perseus's magical horse Pegasus. It was Bellerophon who brought seven Lycian Cyclopes to build the fortress of Tiryns in the Mycenaean kingdom, whereas Perseus picked a mushroom at Mycenae, which was also a Cyclopean fortress.
Bellerophon, like so many other heroes, was a single-footed figure. When, like another Phaethon, he tried to ascend the heavens on his flying horse, it was driven mad by the gadfly and he fell into a thorn-bush and was thereby inflicted with his botanic stigma of lameness.

[49] Pergamonmuseum, East Berlin, Staatliche Museen zu Berlin, Antiken-Sammlung, inv. no. F 3022. Published as plate 8 in Wasson et al., *Road to Eleusis*.

Hyperborean garden. He shows us Perseus in the far-off land as he beheads the Medusa, the primordial queen who is a manifestation of the Great Goddess to whom the Lycian god was consort. In displacing her from her former role, Perseus, as a son of the Olympian Zeus, founded the Indo-European dynasty at Mycenae. Clearly identified as the fruit of the Medusa's magical tree on the vase painting is the mushroom.

If the Hyperborean plant, then, was, by tradition at least, a mushroom, was it Amanita? Specific traits of *Amanita muscaria* are retained in the traditions of the Apolline surrogates. Thus, Orion had a bizarre begetting out of urine. It is perhaps significant that one of the properties of the *Amanita* entheogen is its ability to pass through the body without being entirely metabolized, a fact that was utilized in Siberian rites in modern times and that seems to persist amongst the Brahmans of India in the special healthful properties they accord to the drinking of urine. This property of *Amanita* may first have been observed, as Wasson has suggested, in the northern forests and tundra, where it is commonly known that reindeer exhibit a profound addiction for *Amanita muscaria* and for human urine, particularly if impregnated with the entheogen. Both, as the folk know, drive the herds of reindeer mad, and, in actual fact, the mushroom affects the animals in the same way as humans. Did this tradition persist in the association of the Hyperborean plant with the golden reindeer of Artemis, an animal that the classical Greeks could never have seen in their Mediterranean environment? So too, we should consider Mycenae's traditions of maddened heifers, both lo and the daughters of Proetus. It has not been determined whether *Amanita* affects cattle as it does reindeer, although the animals do eat the mushrooms.[50] In the Mediterranean lands, where *Amanita* cannot be expected to be found, cattle do, however, become profoundly inebriated upon the ergot of *Paspalum distichum*, the plant that Kronos sowed in the Islands of the Blessed and fed to the horses of the Sun.

The entheogen of *Amanita* also exerts a strong attraction for flies, hence the mushroom's common name of 'fly-agaric'. Flies are attracted by the mushroom's juice and rendered senseless and immobile, so that in European lore, the plant has been sometimes considered an effective means of controlling the insect. This characteristic of the plant may have determined the belief that the sacrificed victim at the Leucadian Rock was supposed to rid the populace of flies. Like the agaric, Apollo too was a 'flycatcher,' for he bore the epithet of Muiagros (Aelianus, *De Natura Animalium* 11.8).[51]

The color of the sacred plant in Greek traditions, moreover, appears to have fallen within the 'yellow-orange crimson-purple' part of the spectrum (Pindar, *Olympia* 6.55), a range represented botanically by the tawny juice of *Amanita* and the purple of *Claviceps purpurea* or ergot.

---

[50] Wasson, *Soma* 74-75. Metaphors of cattle are also attributes of Soma, which can be described as an 'udder' that yields the entheogenic milk and as a 'bellowing bull,' the latter being apparently also a characteristic of the mushroom that Perseus picked at Mycenae. The bull is the commonest metaphor for Soma, and this manifestation of the sacred plant may underlie the tradition that Zeus, in establishing European civilization, abducted the Anatolian Europa by appearing to her in the form of a bull that breathed upon her the inspiration of the flower he had grazed upon.

[51] Farnell, 4, reference 275b, suggests that the epithet may indicate Apollo. Muiagros is also attested for an otherwise unknown Elean god (Pliny, *Natural History* 10.75) and a 'hero' in Arcadia (Pausanias 8.26.7). It is not certain that it is, in fact, an epithet of Apollo, himself, but that is only to be expected if it indicates one of the most secret aspects of his displaced primitive persona.

References

Citations of ancient authors mentioned in the text and notes refer to the works in the original languages. The numerical references indicate the traditional subdivisions (such as book, chapter, paragraph, verse, *etc*) as established by the first printed edition. It is customary for all subsequent editions and translations to preserve the same numbering, and thus, except where otherwise indicated (as in the case of fragments of lost works), any edition or translation should contain the citation. Editions of fragments usually include a concordance for previous numberings.

Chapter 1 appears here for the first time. All the other essays have been published elsewhere, as follows:

Chapter 2, also written by me, first appeared as 'Lightning-bolt and Mushrooms: an essay in early cultural exploration', a contribution to a volume entitled, '*For Roman Jakobson: Essays on the occasion of his sixtieth birthday*', published 11 October 1956, by Mouton, in The Hague. This was my first publication in ethnomycology. It now appears in revised form.

Chapter 3, by Professor Stella Kramrisch, 'The Mah&amacr;v&imacr;ra Vessel and the Plant *P&umacr;tika*, was published in the *Journal of the American Oriental Society*, Vol. 95, Number 2, April-June 1975.

Chapter 4, 'The Last Meal of the Buddha', written by me, also appeared in the *Journal of the American Oriental Society*, Vol. 102, Number 4, October-December 1982.

Chapter 5, by Jonathan Ott, appeared first in the Harvard *Botanical Museum Leaflets* in the fall of 1983, Vol. 29, No. 4.

The three Chapters 6, 7, and 8, by Professor Carl A. P. Ruck, all appeared first in the *Journal of Ethnopharmacology*, Lausanne, as follows:

Mushrooms and Philosophers, 4 (1981) pp 179-205

The Wild and the Cultivated: Wine in Euripides' *Bacchae*, 5 (1982) pp 231-270

The Offerings from the Hyperboreans, 8 (1983) pp 177-207

R. G. W.

The oldest Representations of Hallucinogenic Mushrooms in the World

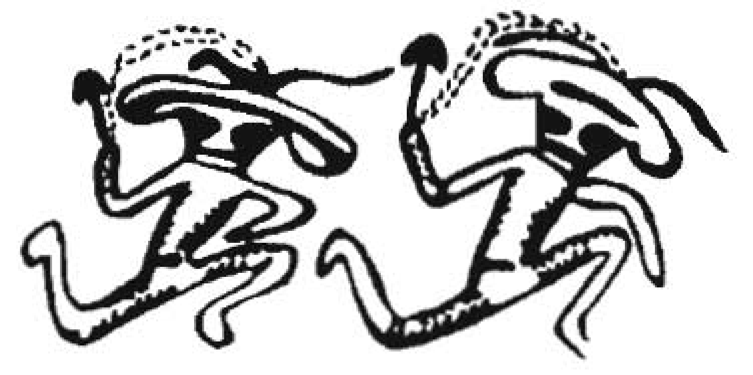
(Sahara Desert, 9000-7000 B.P.)

by

Giorgio Samorini

original source: http://www.samorini.it/doc1/sam/sam-1992-sahara.pdf
backup source: http://www.psilosophy.info/resources/sam-1992-sahara.pdf

Abstract -The idea that the use of hallucinogens should be a source of inspiration for some forms of prehistoric rack art is not a new one. After a brief examination of instances of such art, this article intends to focus its attention on a group of rock paintings in the Sahara Desert, the works of pre-neolithic Early Gatherers, in which mushrooms effigies are represented repeatedly. The polychromic scenes of harvest, adoration and the offering of mushrooms, and large masked "gods" covered with mushrooms, not to mention other significant details, lead us to suppose we are dealing with an ancient hallucinogenic mushroom cult. What is remarkable about these ethnomycologicol works, produced 7,000-9,000 years ago, is that they could indeed reflect the most ancient human culture as yet documented in which the ritual use of hallucinogenic mushrooms is explicitly represented. (As the fathers of modern ethno-mycology and in particular R. Gordon Wasson) imagined, this Saharian testimony shows that the use of hallucinogens goes back to the Paleolithic Period and that their use always takes place within contexts and rituals of a mystico-religious nature.



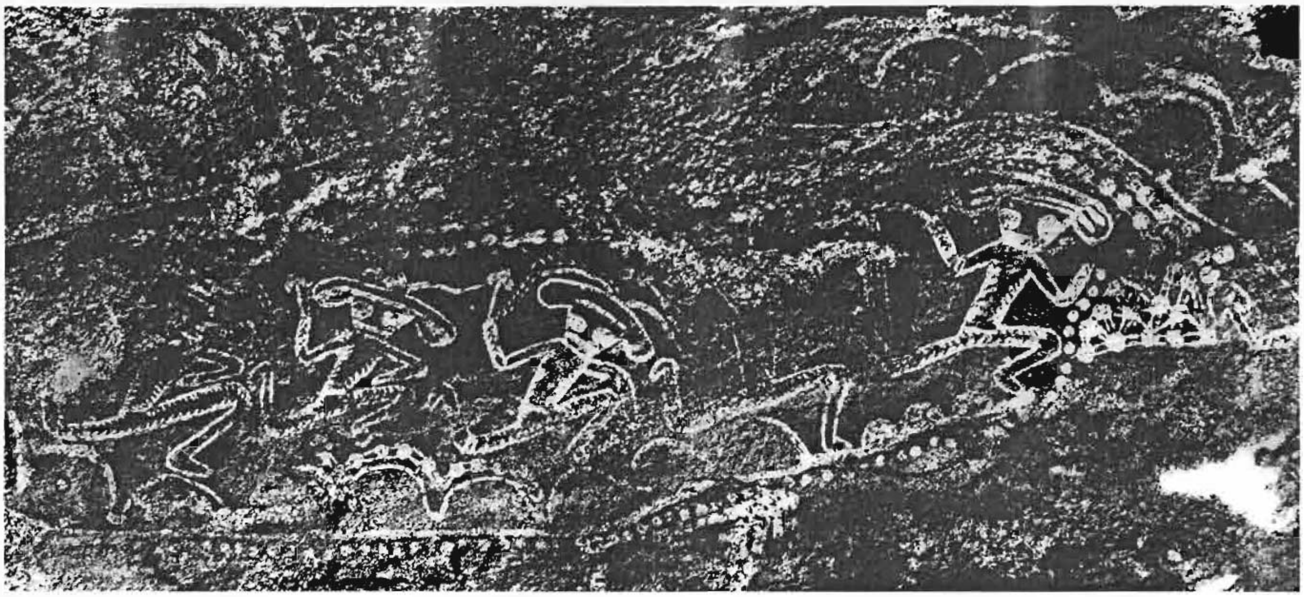
Rock paintings and incisions of the prehistoric periods are to be found all over the world, and serve as a testimony to the pre-literate history of human cultures. Rock art, the first permanent form of visual communication known to man, the some art which led to the invention of writing, goes back almost to the origins of mankind. In fact, in Tanzania, as in Australia, there are rock paintings which it would appear go back 40,000 years and more (Anati, 1989).

Since most of the works of rock art were, or were related to, initiation rites, or were part of religious practice and its context, the idea that these works should be associated with the use of hallucinogenic vegetals (as has already been put forward for some specific cases on the basis of ethnographic and ethnobotanical data) comes as no surprise. This use, where it arises, is historically associated with controlled rituals involving social groups of varying dimensions. It is perhaps not a chance occurrence that the areas where examples of rock art are to be found - areas in which it is most often asserted that the use of hallucinogens might have taken place, on the basis of the scenes represented or on the basis of the consideration that this practice might have served as a source of inspiration - are also the areas where the most famous examples are to be found in terms of imagination, mythological significance and polychromy.

We might consider, for example, the works of archeological (or rather "archeo-ethno-botanical") interest in the easternmost areas of Siberia, within the Arctic Circle, on the bonks of the Pegtymel River. An extensive petroglyphic area was found there dating back to the local neolithic period. Among these works, we find mushroom gatherers (Dikov, 1971). In some cases we find females wearing long and ornate "ear-rings" and an enormous mushroom on their heads, figures with the stance of people trying to keep their balance. The stocky form and the decoration on the mushroom lead one to suppose these mushrooms are *Amanita muscaria* (Fly-Agaric), the hallucinogenic mushroom most often associated with shaman practices in Euro-Asia and N. America (Wasson, 1979). Mushroom motifs have also been found in the petroglyphs of the prehistoric settlements of the Kamciatka peninsula on the banks of Lake Ushokovo (Dikov, 1979). The paleolithic culture of Ushokovo (protoeskimoleuts) belongs to the group of peoples who gave birth to the various paleo-eskimo cultures of N. America (2nd Millenium B. C.). It is to be imagined that these protoeskimoleuts belong to the peoples who contained within their culture, in embryo form, "protoshaman" religious practices.

In California, the rock art of the regions inhabited by the Chumash and Yokut, a polychromic manner of painting - particularly evident during the stylistic phase known as the "Santa Barbara Painted Style" - has been associated with the "toloache" cult centered around "Jimsonweed" (a hallucinogenic plant of the *Datura* genus) known to hove been used by a number of Californian and Mexican Indian tribes (Campbell, 1965:63-64; Wellmann, 1978 and 1981). Apparently, the first examples of Chumash rock art date back to 5,000 years ago (Hyder & Oliver, 1983).

The impressive Pecos River paintings in Texas have also been associated with the "mescal" cult (*Sophora secundiflora*, hallucinogenic beans of which were used during rites of initiation on the part of the Indian tribes of the region) (Howard, 1957). Furst (1986) affirms that the mescal cult goes back 10,000 years, which is to say back to the Paleo-Indian Hunters Period at the end of the Pleistocene period. Archeological excavations carried out in the areas where paintings are to be found reveal mescal seeds which go back to 8,000 B. C., when Carbon-14 dated. Peyote (*Lophophora williamsii*) has also been found during some of these excavations (Campbell, 1958).

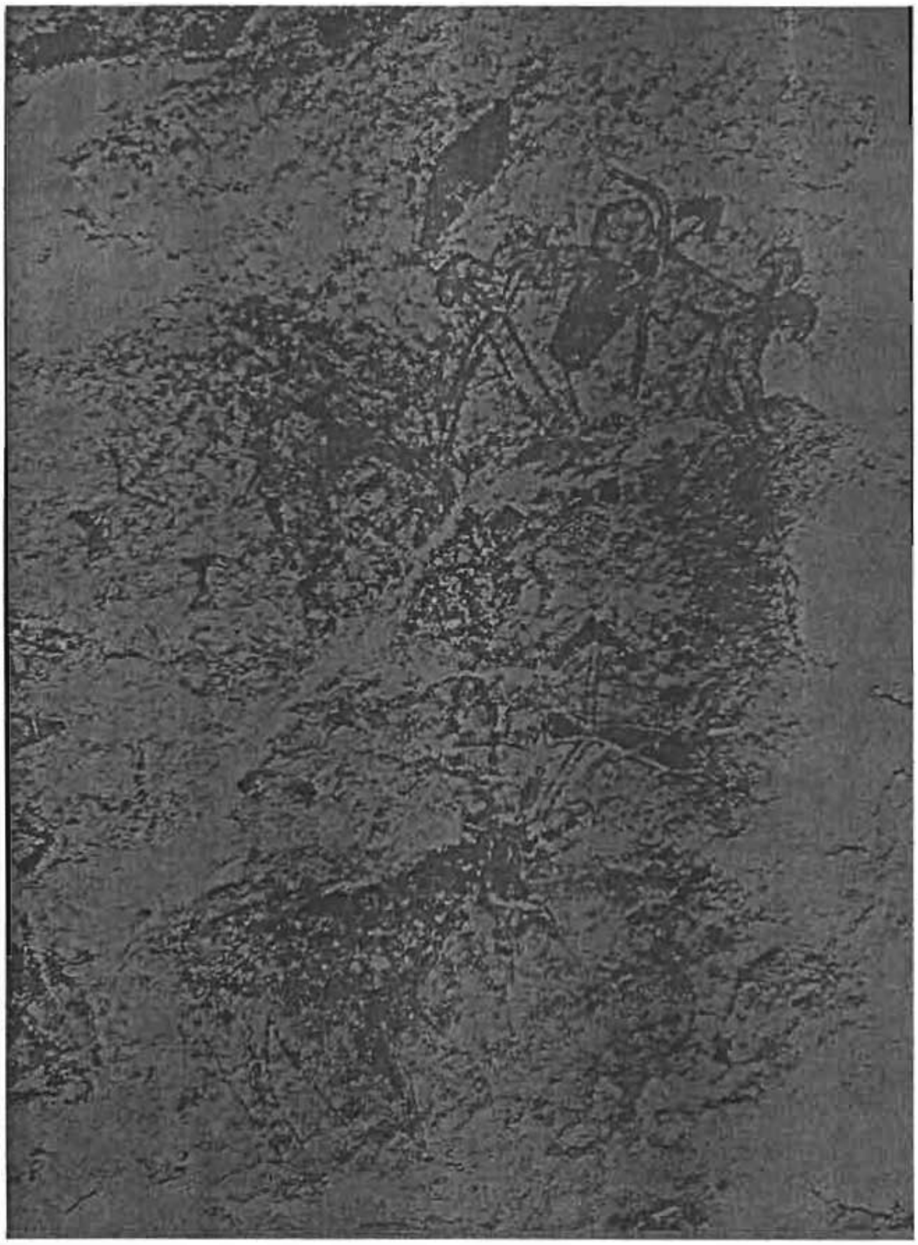


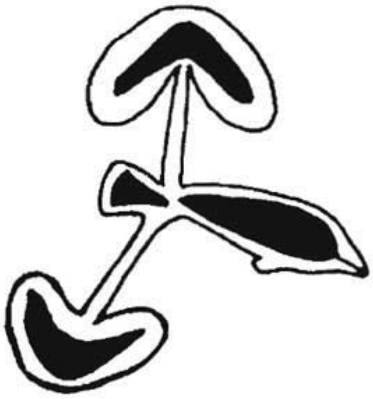
Tin-Tazarift (Tassili, Algeria) - Dancing masked anthropomorphs holding mushrooms (by Laioux, 1964).

An interesting and quite explicit use of "cohoba", a hallucinogenic snuff taken from the *Anadenanthera peregrina* tree has been documented among the peoples of the Borbon Caves art in the Dominican Republic (Pagan Perdomo, 1978). This art is probably an example of the Late Antillian Culture of the Tainos and goes back to a period shortly before the arrival of the Spaniards. In this painting, the subject of inhalation of cohoba - by means of cane pipes - is repeatedly represented (Franch, 1982).

The use of hallucinogens as a significant source of inspiration has also been associated with Peruvian rock art. The rock art in this case is based on incisions on rocks, as can be seen in the Rio Chinchipe works in the north of Peru, probably influenced by the use of *ayahuasca* (*Banisteriopsis* spp. & allies) (Andritzky, 1989: 55-57). That this is an ancient practice is confirmed by archeological findings (Naranjo, 1986). Also in the rock art of

Samanga, the mountainous region of the province of Ayabaca (Piura), among the petroglyphs, we will find figures which have been interpreted as images of *San Pedro* (*Trichocereus pachanoi*), the hallucinogenic cactus still used today in the north of Peru and in Ecuador during shaman healing rites (Polia, 1987 and 1988).





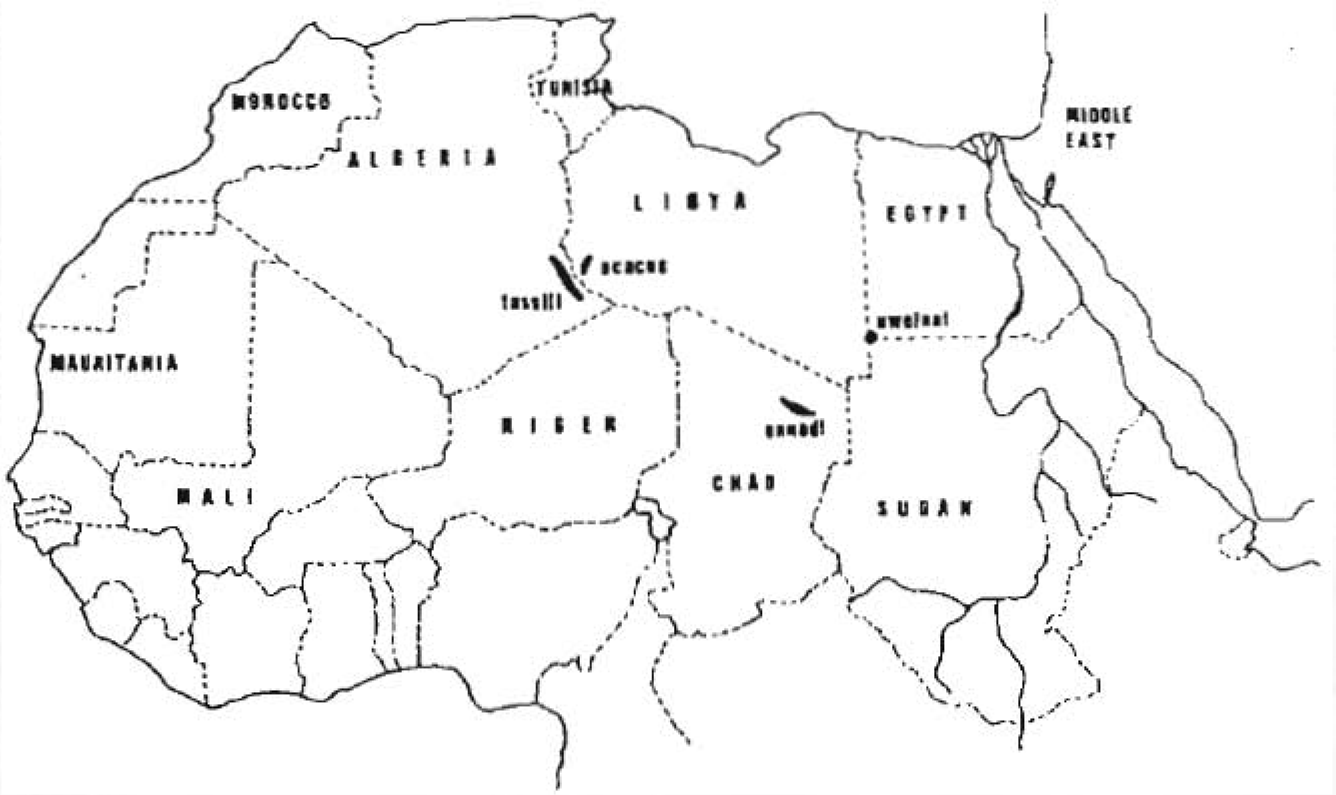
Tin-Abouteka (Tassili, Algeria) -"Round Heads " pictorial phase (Note, in the right-central part of the photo the image of the fish with mushroom-like symbols).

Indeed, archeological indications as to the use of hallucinogens are to be found within many Precolumbian cultures (Dobkin de Rios, 1974; Furst, 1974).

Recently it has even been put forward that even the more ancient paleolithic art of the Franco-Canthabric cave-sanctuaries were influenced by altered states of consciousness procured by various methods, among which the use of hallucinogens (Lewis-Williams & Dowson, 1988). The "psychograms" of the paleolithic period, a series of aniconic graphemes (points, vertical lines, circles, zig-zags, lozenges etc.) which, together with zoomorphic images, cover the walls of the European paleolithic caves, could be considered as the fruit of entoptic, phosphenic or hallucinatory states, typical sensorial phenomena pertaining to the field of altered states of consciousness, as might be gathered from Reichel-Dolmatoff's well-known research into the Tukano of the Amazon (1978: 43-47). Furthermore, natural changes in consciousness due to prolonged sensorial isolation have already been noted. These conditions can be determined in the deep paleolithic caves. Even though the "neuropsychological model" put forward by Lewis-Williams & Dowson is not sufficient on its own to interpret that complex phenomenon which is paleolithic art, this model at least paves the way to supposing that mind-altering factors may have contributed to a prehistoric will-to-art.

At this point, we should remember Kaplan's (1975) theory that mushrooms are represented in the Swedish cave art of the long Scandinavian Bronze Age.

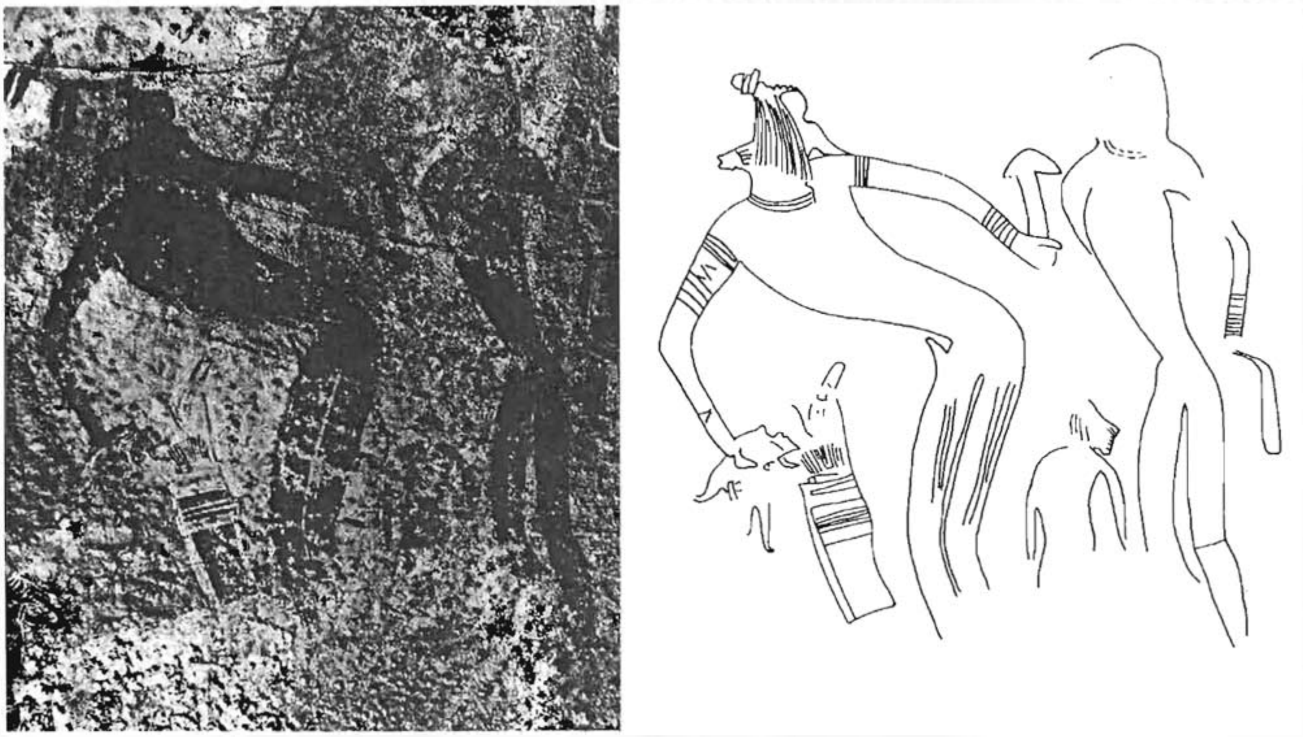
It should also be pointed out that the explicit representation of psychotropic vegetals, as sacred objects (and therefore subject to taboo), is rare and the few cases of explicit representation make up but a small part of prehistoric art, as sacred art, associated with the use of hallucinogens. We must consider that, generally speaking, sacred cult objects will not be represented and that it is more than likely that these will be hidden behind symbolic devices, also of a graphic nature, whose meaning is indeed beyond us.



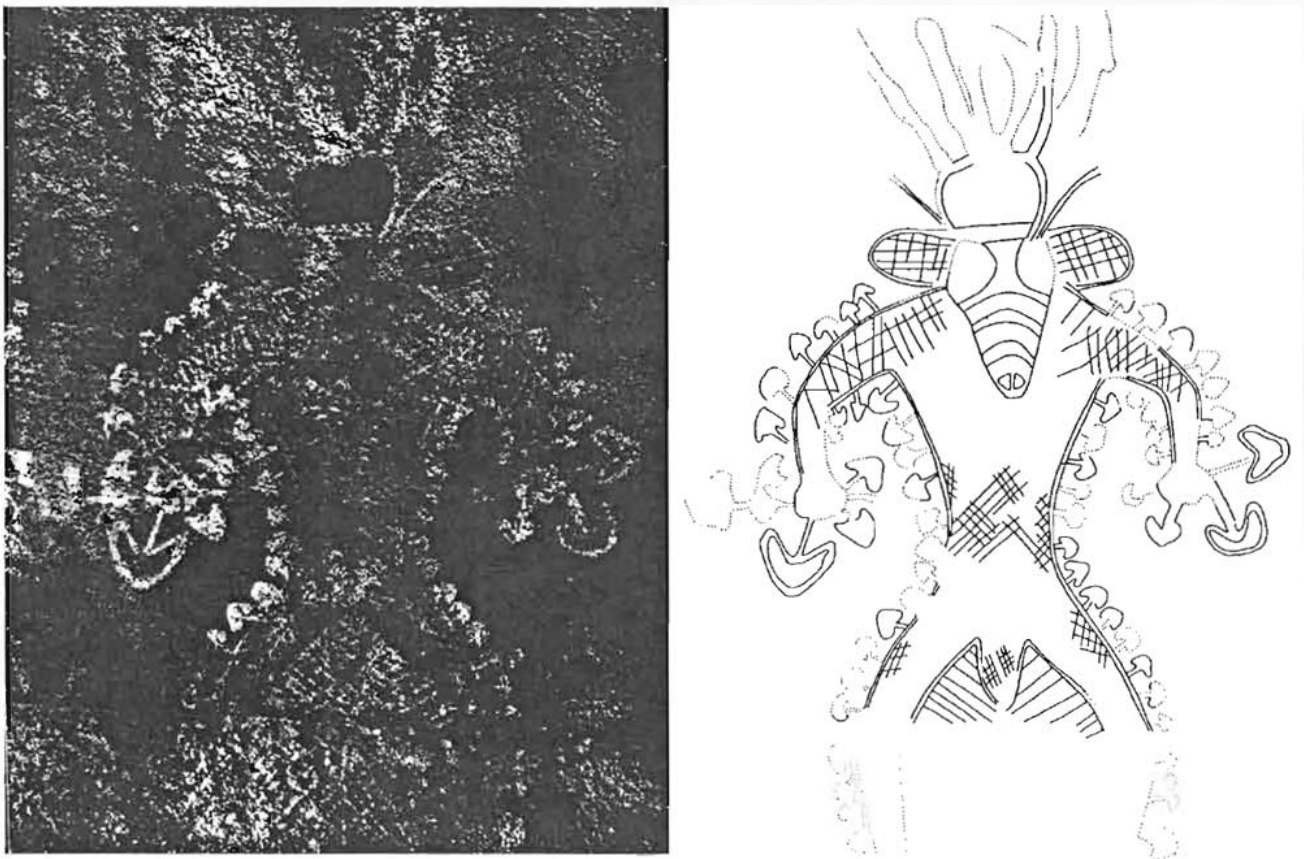
Geographical distribution of the "Round Heads " Painting Style in the Sahara.

Further evidence in support of the idea that the relationship between Man and hallucinogens - in this case mushrooms is indeed an ancient one comes from the ancient populations of the Sahara desert who inhabited this vast area when it was still covered with an extensive layer of vegetation (Samorini, 1989). The archeological findings consist in prehistoric paintings which the author personally had the opportunity to observe during two visits to Tassilli in Algeria. This could be the most ancient ethno-mycological finding up to the present day, which goes back to the so-called "Round Heads" Period (i.e. 9.000 - 7.000 years ago). The centre of this style is Tassili, but examples are also to be found at Tadrart Acacus (Libya), Ennedi (Chad) and, to a lesser extent, at Jebel Uweinat (Egypt) (Muzzolini, 1986:173-175).

Central Saharan rock art, apart from extensive concentrations of incisions, near the sites of ancient rivers, and rock-shelter paintings among the large promontories or high plateau which reach an altitude of some 2,000 metres, cover a period of 12,000 years, generally divided in *5* periods: the "*Bubalus antiquus*" Period, the works of which were produced by the Early Hunters at the end of the Pleistocene period (10.000 - 7.000 years B. C.) - characterized by representations of large wild animals (Mori, 1974); the "Round Heads" Period, in turn divided into various phases and styles, associated with the epipaleolithic populations of the Early Gatherers (7.000 - 5.000 years B. C.), whose works of fantasy have quite rightly become world famous; the "Bovidian" or "Pastoral" Period (starting 5.000 years B. C.), a population of animal herders and breeders whose art is predominantly concentrated on these activities and, after these, the "Horse" Period and, lastly, the "Camel" Period, the art works of which are stereotyped and of a lower quality.



Techekalaouen (Tassili, Algeria) "Offering" scene? The object offered has the shape of a big mushroom.



Matalem-Amazar (tassili, Algeria) - Masked anthropomorph with the body-line entirely covered by mushroom effigies (by Lajoux, 1964)

Some rock art experts have already produced evidence supporting the idea that the art of the Round Head Period could be influenced by ecstatic or hallucinogenic states. According to Anati (1989: 187), this art is produced by the Early Gatherers during the end of Pleistocene and the beginning of Holecene periods. Analogous works dating back nearly to the same period are to be found in various sites around the world (Sahara Desert, Tanzania, Texas, Mexico etc.). These areas were later to become arid or semi-arid when the lakes and rivers dried up. From the many works of art these peoples have left us we learn what were gatherers of wild vegetal foods: "people who lived in a sort of garden of Eden and who used mind-altering substances".

Sansoni too (1980) is of the opinion that "it might be that (the works of art of the Round Heads Period) are the works of normal consciousness or the results of particular ecstatic states associated with dance or the use of hallucinogenic substances. The context, or rather the "motivations" behind Round Heads art, just as with all the other periods of Sahara rock art, are generally of a religious and, perhaps, initiatory nature. Fabrizio Mori, discussing Acacus, stressed "the close relationship which there must have been between the painter and that figure so typical in all prehistoric societies whose main role is that of mediator between earth and sky: the wizard-priest" (Mori, 1975). According to Henri Lhote, the discoverer of the Tassili frescoes, "it seems evident that these painted cavities were secret sanctuaries" (Lhote, 1968).

Images of enormous mythological beings of human or animal form, side by side with a host of small horned and feathered beings in dancing stance cover the rock shelters of which there are very many on the high plateau of the Sahara which in some areas are so interconnected as to form true "citadels" with streets, squares and terraces.

One of the most important scenes is to be found in the Tin-Tazarift rock art site, at Tassili, in which we find a series of masked figures in line and hieratically dressed or dressed as dancers surrounded by long and lively festoons of geometrical designs of different kinds. Each dancer holds a mushroom-like object in the right hand and, even more surprising, two parallel lines come out of this object to reach the central part of the head of the dancer, the area of the roots of the two horns. This double line could signify an indirect association or non-material fluid passing from the object held in the right hand and the mind. This interpretation would coincide with the mushroom interpretation if we bear in mind the universal mental value induced by hallucinogenic mushrooms and vegetals, which is often of a mystical and spiritual nature (Dobkin de Rios, 1984:194). It would seem that these lines - in themselves an ideogram which represents something non-material in ancient art - represent the *effect* that the mushroom has on the human mind.

The whole scene is steeped in deep symbolic meanings and is a representation of a cultural event which actually happened and which was periodically repeated. Perhaps we are witnessing one of the most important moments in the social, religious and emotional lives of these peoples. The constant nature of the physical nature of the dancers and their stances reveals a coordinated will towards scenic representation for collective contexts. The dance represented here has all the indications of a ritual dance and perhaps, at a certain stage, this rite became ecstatic.

In the various scenes presented, a series of figurative constants lead us to imagine an accompanying conceptual structure associated with the ethno-mycological cult described here.

Evident examples of such constants are the two remarkable southern Tassili figures (sites: Aouanrhat and Matalem-Amazar). Both are approximately 0.8 metres tall, they wear the typical mask of this pictorial phase and a typical gait (legs bent inwards and arms bent downwards). Another common feature is the presence of mushroom symbols starting from the fore-arms and thighs; others are hand held. In the case of the Matalem-Amazar figure, these objects are scattered over the entire area surrounding the body.

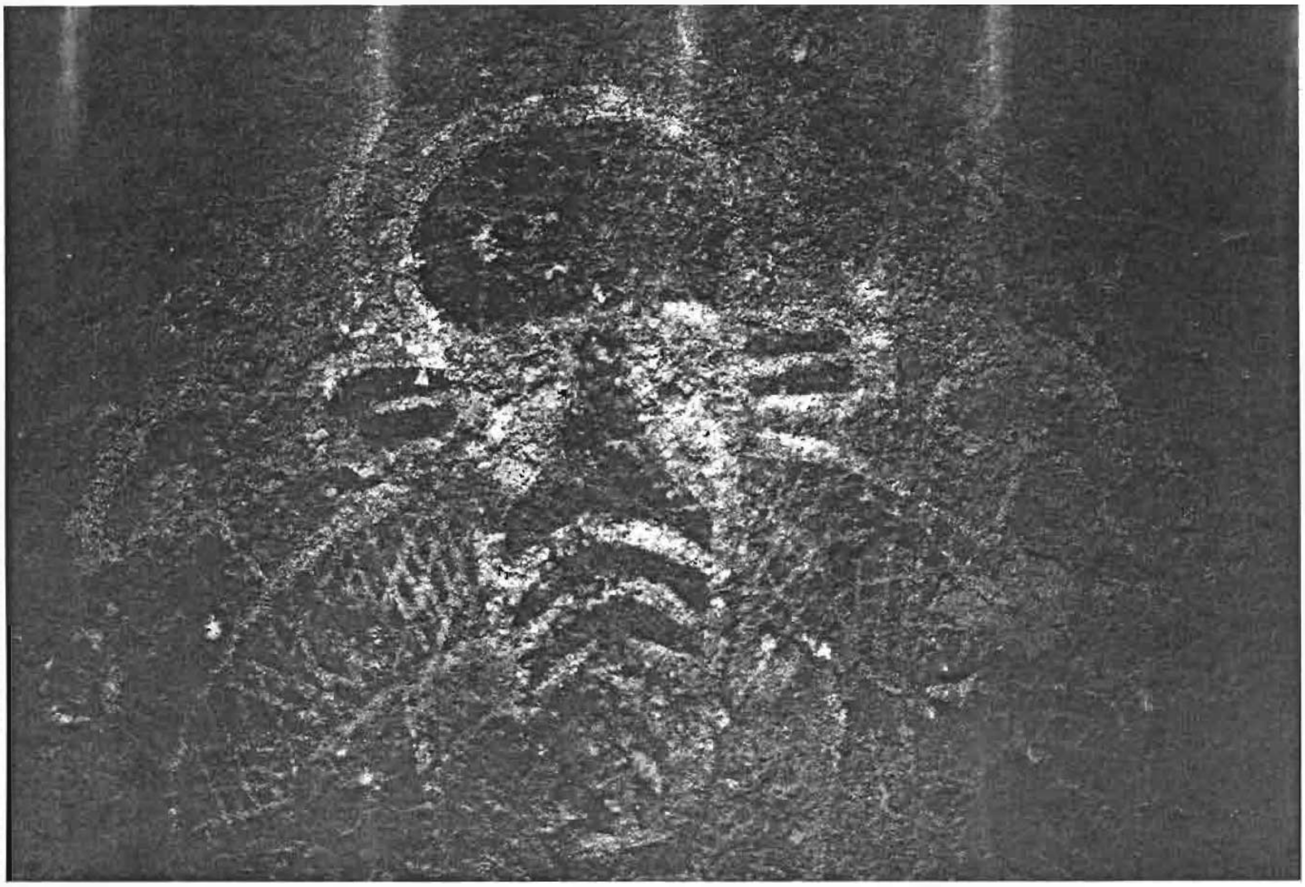
This mushroom symbol was first interpreted by researchers as an arrowhead, an oar (Mori 1975), a vegetal, probably a flower (Lhote, 1973: 210 and 251), or as an undefined enigmatic symbol. The form which most closely corresponds to this cult-abject is that of a mushroom, most probably of a psychotropic kind the sacramental and socialized use of which is represented in gathering and offering scenes and in the expressive ritual dances, in phosphenic geometrical patterns and in Tassili visionary works.

Thus, these two figures could be interpreted as images of the "spirit of the mushroom", known to exist in other cultures characterized by the use of a mushroom or other psychotropic vegetals.

In a shelter in Tin-Abouteka, in Tassili, there is a motif appearing at least twice which associates mushrooms and fish; a unique association of symbols among ethno-mycological cultures. Two mushrooms are depicted opposite each other, in a perpendicular position with regard to the fish motif and near the tail. Not far from here, above, we find other fish which are similar to the aforementioned but without the side-mushrooms.

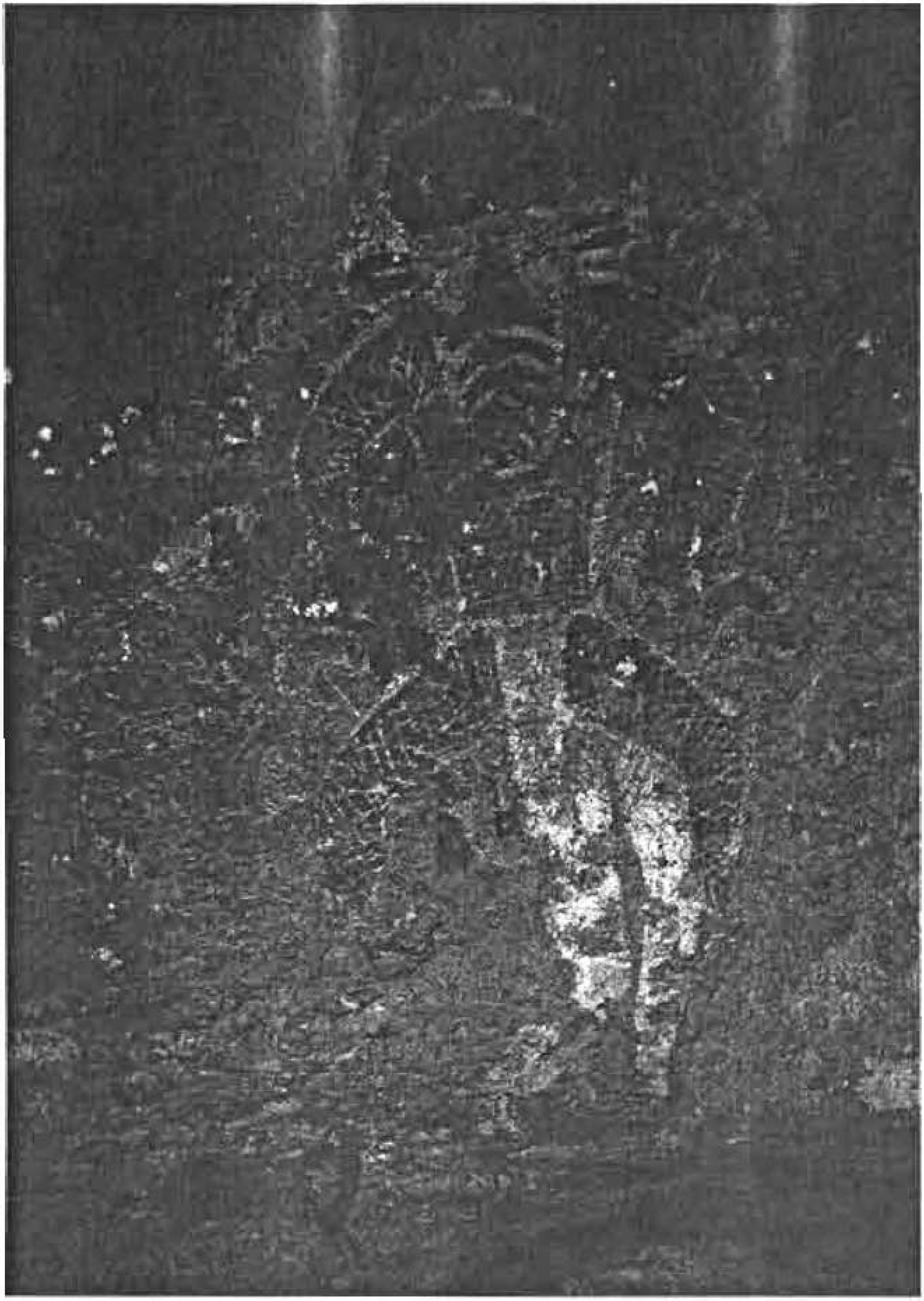
In the same Tin-Abouteka scene, yet another remarkable image could be explained in the light of ethno-mycological enquiry. In the middle we find an anthropomorphous figure traced only by an outline. The image is not complete and the body is bending; it probably also has a bow. Behind this figure, we find two mushrooms which seem to be positioned as though they were coming out from behind the anthropomorphs.

If the mushrooms in question are those which grow in dung, the association between these mushrooms and the rear of the figure may not be purely casual. It is known that many psychotropic mushrooms (above all, *Psilocybe* and *Panaeolus* genera) live in dung of certain quadrupeds and in particular bovines, cervides and equines. This specific ecological phenomenon cannot but have been taken into account with regard to the sacramental use of psychotropic mushrooms, leading to the creation of mystico-religious relations between the mushroom and the animal which produces its natural habitat. Furthermore, the dung left by herds of quadrupeds were important clues for prehistoric hunters on the lookout for game, and the deepening of such scatological knowledge probably goes back to the paleolithic period (the long period of the hunter of large game). Thus we have a further argument in favour of the version of events that would have it that there have been mythical associations, with religious interpretations, on different occasions, between the (sacred) animal and the hallucinogenic mushroom. The sacred deer in the Mesoamerican cultures and the cow in Indian Hindu culture (the dung of which provides a habitat for *Psilocybe cubensis*, a powerful hallucinogen still used today) could be interpreted in this zoo-scatological manner (Wasson, 1986:44; Furst, 1974; Samorini, 1988).



In-Aouanrhat (Tassili, Algeria) - Masked anthropomorph (detail).

In a painting at Jabbaren - one of the most richly endowed Tassili sites - there are at least 5 people portrayed in a row kneeling with their arms held up before them in front of three figures two of which are clearly anthropomorphous. It could be a scene of adoration in which the three figures would represent divinities or mythological figures. The two anthropomorphous figures have large horns while the upper portion of the third figure, behind them, is shaped like a large mushroom. If the scene is indeed a scene of adoration, it is an important testimonial as to Round Heads mystico-religious beliefs. This scene would thus be the representation of a "Holy Trinity" illustrated by a precise iconography. It is worth bearing in mind the fact that the upper part of one of the "trinity" figures in the adoration scene is mushroom-shaped. It could be related to the iconographic figure at Aouanrhat and Matalem-Amazar described above.



In-Aouanrhat, (Tassili, Algeria) Masked Anthropomorphic figure (divinity?) with mushroom-like symbols on the legs and the arms and inside the mask.

But the more or less anthropomorphous figures with mushroom-shaped heads are to be found repeatedly in Round Head art, some with "hat-heads" of umboned or papillate form which on two occasions are of a bluish colour while others carry a leaf or a small branch.

The occurrence of various data suggests the presence of a very ancient hallucinogenic mushroom cult with a complex differentiation between botanical species and related mythological representations. Indeed it would be remarkable to find out that, as part of the culture of the Late Stone Age which 7.000 to 9.000 years ago produced Round Heads rock art, we were in the presence of the oldest human culture yet discovered in which explicit representations of the ritual use of psychotropic mushrooms are to be found. Therefore, as the founders of modern ethno-mycology had already put forward - and this is especially true of Wasson (1986) - this Saharan testimony would demonstrate that the use of hallucinogens originates in the Paleolithic period and is invariably include within mystico-religious contexts and rituals.

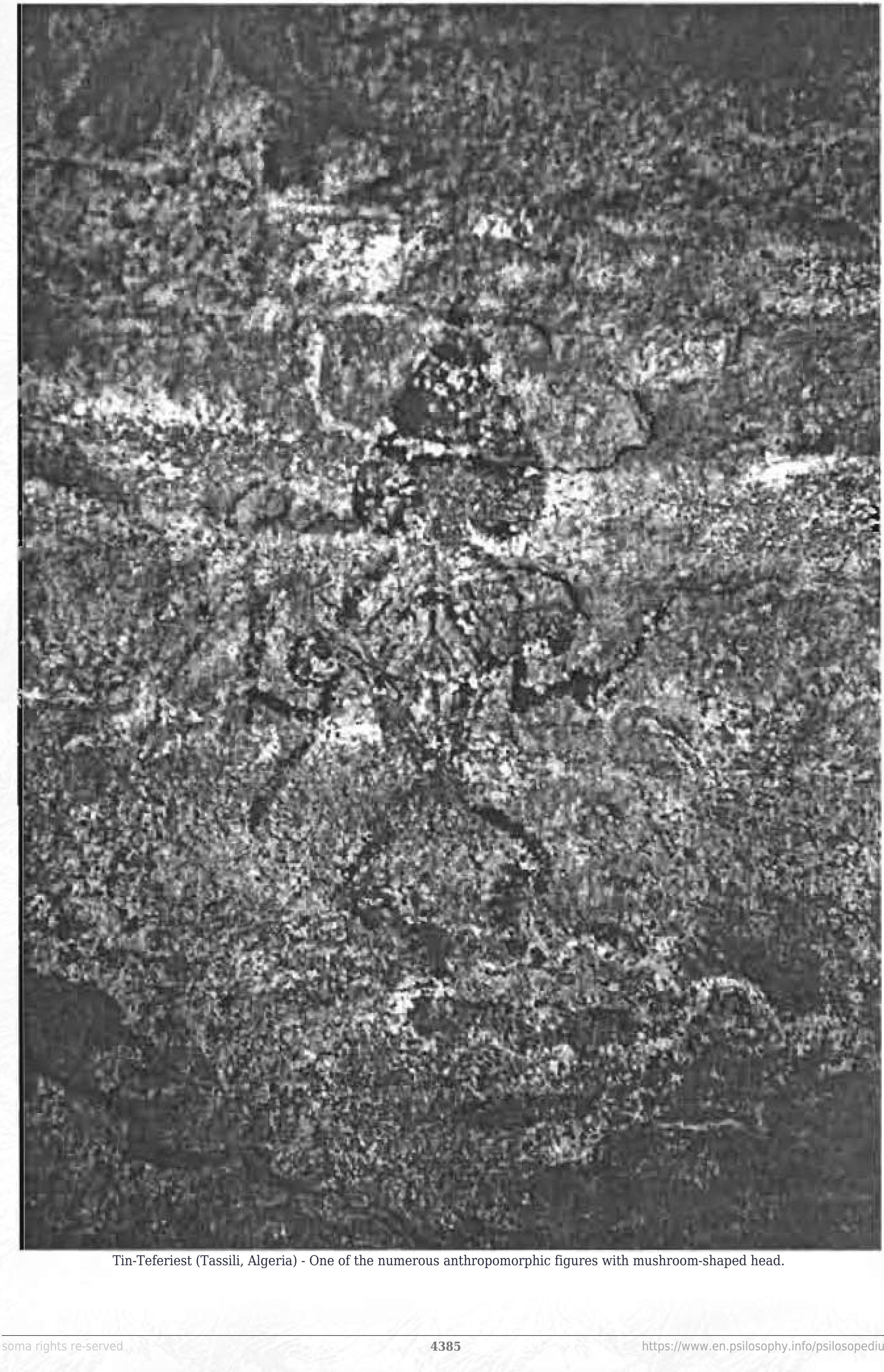
It is not easy to identify the mushrooms represented in Round Heads art. The biochemical characteristics of these mushrooms determine the action on the human mind and it either belongs to a flora which has disappeared or, retreated to the Saharan basin which later became desert. From the paintings it would seem there are at least two species one of which is small and topped with a "papilla" (a characteristic it would share with most known hallucinogenic *Psilocybe*) and the other of which is larger (like *Boletus* or *Amanita*). The colours used are white and probably the result of oxidation of the original colour).

The Sahara Desert area has undergone periodic and significant climatic variations. At least three long humid periods have been identified since 20.000 BC, interrupted by three periods of drought, and it appears that the drought we know today is less severe than the two which preceded it. The semi-quantitative graph drawn up by Muzzolini (1982) presents the "Great Humid Holocemic Period" characterized by the presence of enormous lakes all over the Saharan basin (10.000 BC - 5.500 BC). The generally accepted chronology of Round Heads art fits comfortably into this period. Pollen examination carried out at Tassili reveals that, during the Round Heads period, this area was vegetated by highland flora (2.000 m height) with the presence of coniferous trees and oaks (AA.VV., 1986: 97). It can be presumed that some of the mushrooms represented (the large ones) were indigenous to this wooded area in that they are intimately associated with these species of tree.

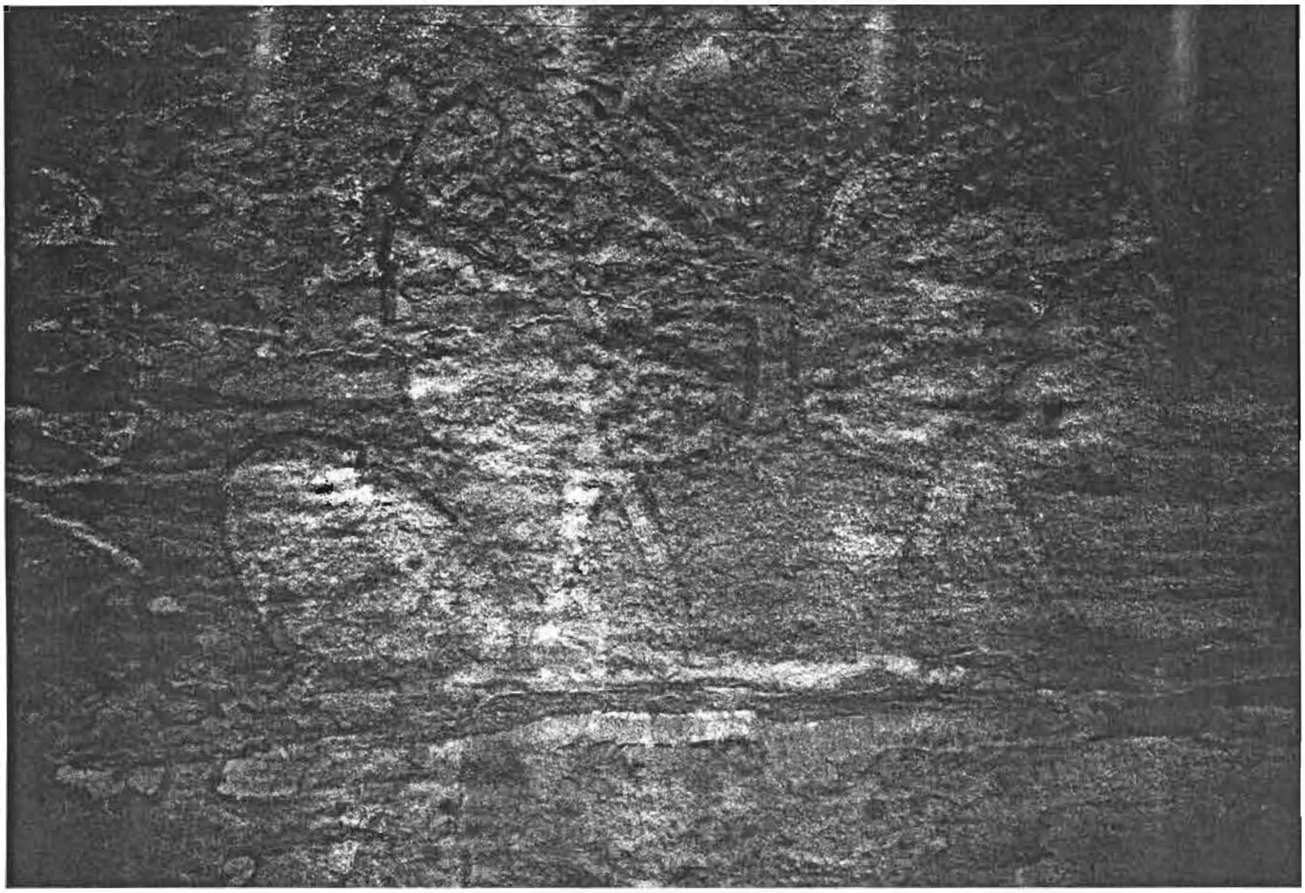
Mushrooms are not the only vegetals to be found in Round Heads art. We often find figures in typical costume and in hieratic positions, dancing, and holding in their hands small branches or leaves (and in one instance roots). At least two species occur fairly frequently in the images found at Tassili and nearby Acacus. In fact, the interest which surrounds the hallucinogens is always represented within a context of general interest in vegetals and it is most likely that it is within these contexts, related to religious activity and initiation, that we find the origins of individual specializations within the communities of these people concerning the magical, therapeutic and culinary aspects of vegetals.

This new piece in the ethno-mycological puzzle is even more significant if we consider it from the point of view of research into the use of hallucinogens in the immense African continent. Some progress has been made over the last few years as regards the study of this problem (see the work of e.g., Emboden, 1989; Hargreaves, 1986; Lehman & Mihalyi, 1982; Monfouga-Brousta, 1976; Wagner, 1991; Winkelman & Dobkin de Rios, 1989). Africa - both because of an ignorance of the facts which has continued up to the present day and because of the wealth and extreme old age of the indigenous "animist" religions - has still much to tell us concerning the human use of hallucinogens and the origins of such practice.

Only at the end of the drawing up of this paper I received news that also Terence McKenna (1988) proposed separately the Saharian ethnomycological hypothesis, through the indication of the ethnomycologist Jeff Gaines and the observation of the clear photographs of the Tassili paintings published by D. Lajoux (1964).



Tin-Teferiest (Tassili, Algeria) - One of the numerous anthropomorphic figures with mushroom-shaped head.



Jabbaren (Tassili, Algeria) - Big mushroom-shaped motives.

References

1. M.W. 1986 - Arte preistorica del Sahara, Roma & Milano: De Luca & Mondadori.
2. Anati E. 1989 - Origini dell'arte e della concellualità, Milano: Jaca Book.
3. Andritzky W. 1989 - Schamanismus und rituelles Heilen im Alten Peru. Band 1: Die Menschen des Jaguar, Berlin: Clemens Zerling.
4. Campbell G. 1958 - Origin of the mescal bean cult, American Anthropology, vol. 60: 156-160.
5. Campbell G. 1965 - The Rock Paintings of the Chumash, Berkeley: University of California.
6. Dikov N. N. 1971 - Naskalnuie Sagadki Drevniei Ciukotki (Pietroglifui Pegtimelia), Moscow: Nauka.
7. Dikov N. N. 1979 - Origini della cultura paleoeschimese, Boll.Camuno St. Preist., vol. 17:89-98.
8. Dobkin de Rios M. 1974 - The Influence of Psychotropic Flora and Fauna on Maya Religion. Current Anthropology, vol. 15: 147-164.
9. Emboden W. 1989 - The Sacred Journey in Dynastic Egypt: Shamanistic Trance in the Context of the Narcotic Water Lily and the Mandrake, J. Psychoact. Drugs, vol. 21:61-75.
10. Franch J. A. 1982 - Religiosidad, alucinogenos y patrone artisticos Tainos, Bol. Mus. Hombre Dominicano, vol. X/17:103-117.
11. Furst P. 1974 - Hallucinogens in Precolumbian Art, in M. E. King & I. R. Traylor (Eds.), Art and Enviroment in Native America, Lubbock, Texas: Texas Tech., :55-101.
12. Furst P. 1986 - Shamanism, The Ecstatic Experience, and Lower Pecos Art, in H. J. Shafer & J. Zintgraff, Ancient Texas. Rock Art and lifeways Along the Lower Pecos, San Antonio: Texas Monthly, :210-225.
13. Hargreaves B. J. 1986 - Plant Induced "Spirit Possession" in Malawi, Soc. Malawi J., vol. 39(1):26-35.
14. Howard J. H. 1957 - The Mescal Bean Cult of the Central and Southern Plains: An Ancestor of the Peyote Cult?, Amer. Anthrapol., vol. 59:75-87.
15. Hyder D. & Oliver M. 1983 - Style and chronology in Chumash Rock Art, American Indian Rock Art, vol. 10:86-101.
16. Kaplan R. W. 1975 - The sacred mushroom in Scandinavia, Man, vol 10(1):72-79.
17. Lajoux J. D. 1964 - Le meraviglie del Tassili, Bergamo (Instituta Arti Grafiche).
18. Lehmann A C. & L. J. Mihalyi 1982 - Aggression, Bravery, Endurance, and Drugs: A Radical Re-evaluation and Analysis of the Masai Warrior Complex, Ethnology, vol. 21 (4):335-347.
19. Lewis-Williams J.D. & T.A. Dowsan 1988 - The Signs of All Times. Entoptic Phenomena in Upper Palaeolithic Art, Current Anthropology, vol. 29(2):201-245.
20. Lhote H. 1968 - Données récentes sur les gravures et les peintures rupestres du Sahara, in E. Ripall Perellà (Ed.), Simposio de Arte Rupestre, Barcelona:273:290.
21. Lhote H. 1973 - A la découverte des fresques du Tassili, Paris: Arthaud.
22. Mckenna T. 1988 - Hallucinogenic Mushrooms and Evolution, *Re Vision*, vol. 10:51-57.
23. Manfouga-Broustra J. 1976 - Phenoméne de possession et plante hallucinogéne, Psychopat. Afric., vol. 12 (3):317-348.

24. Mori F. 1965 - Tadrart Acacus. Arte rupestre del Sahara preistorico, Torino: Einaudi.
25. Mori F. 1974 - The earliest Saharian rock-engravings, Antiquity, Vol. 48:87-92.
26. Mori F. 1975 - Contributo al pensiero magico-religioso attraverso I'esame di alcune raffigurazioni rupestri preistoriche del Sahara, Valcamonica Symposium '72, :344-366.
27. Muzzolini A. 1982 - Les climats sahariens durant l'Olocene et la fin du Pleistocene, Travaux du L.A.P.M.O., Aix-En-Provence :1-38
28. Muzzolini A. 1986 - L'art rupestre préhistorique des massifs centraux sahariens, Oxford: BAR.
29. Naranjo P. 1986 - El ayahuasca en la arqueologia Ecuatoriana, America Indigena, vol. 46:117-127
30. Pagan Perdomo D. 1978 - Nuevas pictografias en la isla de Santo Domingo. Las Cuevas de Borbon, Santo Domingo: Museo del Hombre Dominicano.
31. Polia M. 1987 - Los petroglifos de Samanga, Ayabaca, Piura, Rev. Mus. Nac. Lima, vol. 48:119-137.
32. Polia M. 1988 - Los lagunos de los encantas. Medicina tradicional andina del Peru septentrional, Piura, Peru: Cepeser.
33. Reichel-Dolmatoff G. 1978 - Beyond the Milky Way. Hallucinatory Imagery of the Tukano Indians, Los Angeles: Univ. Calif.
34. Samorini G. 1988 - Sulla presenza di piante e funghi allucinogeni in Valcamonica, Boll. Camuna St. Preist., vol. 24:132-136.
35. Samorini G. 1989 - Etnomicolagia nell'arte rupestre Sahariana (Perioda delle "Teste Rotonde"), Boll. Camuno Notizie, vol. 6(2):18-22.
36. Samarini G. 1990 - Sciamanismo, funghi psicotropi e stati alterati di coscienza: un rapporto da chiarire, Boll. Camuno St. Preist., vol. 25/26:147-150.
37. Sansoni U. 1980 - Quando il deserto era verde. Ricerche sull'arte rupestre del Sahara, L'Umana Avventura, N. 11:65-85.
38. Wagner J. 1991 - Das "dawa" der mamiwata. Ein möglicherweise pharmakologischer Aspekt des westafrikanischen Glaubens an Wassergeister, Integration, vol. 1:61-63.
39. Wasson R.G. 1979 - Fly agaric and man, in Efron D. H. (Ed.), Ethnopharmocologic Search for Psychoactive Drugs, New York: Raven Press, :405-414.
40. Wasson R.G. et al. 1986 - Persephone's Quest. Entheogens and the Origins of Religion, New Haven & London: Yale University.
41. Wellmann K.F. 1978 - North American Indian Rock Art and Hallucinogenic Drugs, J. Amer. Med. Ass., vol. 239:1524-1527.
42. Wellmann K.F. 1981 - Rock art, shamans, phosphenes and hallucinogens in North America, Boll. Camuno St. Preist., vol. 18:89-103.
43. Winkelman M. & Dobkin de Rios M. 1989 - Psychoactive Properties of !Kung Bushman Medicine Plants, J. Psychoact. Drugs, vol. 21:51-59.

Miniature Mushroom Stones from Guatemala

by

Stephan F. de Borhegyi

(Originally published: American Antiquity, 26: 498-504, 1961)

original source: http://www.samorini.it/doc1/alt_aut/ad/borhegyi2.pdf
backup source: http://www.psilosophy.info/resources/borhegyi2.pdf

Abstract - A cache of nine miniature mushroom stones and nine miniature metates with manos from the Verbena cemetery at Kaminaljuyú, Guatemala, date from the Verbena subphase of the Miraflores phase of the Preclassic, 1000- 500 B.C. All of the mushroom stones are of Type B with a circular groove around the base of the cap. This type has been found in a Verbena tomb in Mound E-III-3 at the same site. The cache of nine miniatures demonstrates considerable antiquity for the "mushroom-stone cult," and suggests a possible association with the nine lords of the night and gods of the underworld, as well as the possible existence of a nine-day cycle and nocturnal count in Preclassic times. The association of the miniature mushroom stones with the miniature metates and manos greatly strengthens the possibility that at least in some areas in pre-Columbian Mesoamerica metates were used to grind the sacred hallucinatory mushrooms to prepare them for ceremonial consumption.

During the month of January, 1960, while conducting archaeological investigations in Guatemala, I had the privilege of studying the rich, private collection of Karl Heinz Nottebohm, of Guatemala City. Among the many newly-acquired archaeological specimens in his collection was a striking group of ten miniature mushroom stones and two miniature metates with manos (Fig. 1). According to Nottebohm, nine of the mushroom stones, along with nine miniature metates and manos, were taken as a unit from a prehistoric cache in the Verbena cemetery at the archaeological site of Kaminaljuyú, in the outskirts of Guatemala City. The tenth specimen, the tallest in the collection (height, 19 cm., effigy mushroom stone in center of Fig. 1), was also found in the area of the Verbena cemetery some distance from the previously mentioned cache. Unfortunately, the exact location, within the Verbena cemetery, of the mound which yielded the cache containing the mushroom stones has not been disclosed by the finder.

Similar, but much larger, mushroom stones have been reported with relative frequency from Kaminaljuyú, as well as other areas in the Guatemalan Highlands and Southern Mexico (Kidder, Jennings, and Shook 1946: 104, 142, Figs. 58 *c*, 160 *a-h*; Shook and Kidder 1952: 112, Fig. 78 *f*; Lothrop 1933: 29, Fig. 11; Villacorta and Villacorta 1927: (123-25). My classification of mushroom stones (Borhegyi 1957) is presented in modified form in Figure 2 and Table 1.

These "enigmatic" objects ordinarily average from 28 to 38 cm. in height, although some of the presumably Late Classic (A.D. 600-900) mushroom stones, from the south coast area of Guatemala, are slightly smaller (22-26 cm.; Thompson 1948: 24, Fig. 19 *f*). The only miniature specimens, heretofore known, consisted of a fragmentary example in the Dieseldorff collection in the Guatemalan National Museum (No. 7567), representing a deer or rabbit (height of fragment, 7 cm.; Fig. 2 *14*), and one plain mushroom stone in my collection (height, 10.5 cm.). While the provenience of the former specimen is unknown (presumably the Department of Quiche, Guatemala), the plain example in my collection was discovered by one of my students in the Verbena cemetery area of Kaminaljuyú.

The nine miniature mushroom stones in the Nottebohm collection range in height from 14 cm. to 18 cm. Among them, there are four plain (including one tripod), three zoomorphic (one jaguar, two birds), and two anthropomorphic specimens. Although there are only two miniature metates with manos in Figure 1, the original cache contained nine. Apparently, there was one metate and mano for each miniature mushroom stone. Considering the reliability of both the owner and the finder, there is little doubt that the nine specimens, together with the metates and manos, were deposited in the cache in such a way as to constitute an offering.

All of the miniature mushroom stones in the Nottebohm collection have a circular groove around the base of the cap, which places them into my Type B (Fig. 2 *12-16*). Type B mushroom stones, without exception, are of Early and Late Preclassic date (1000 B.C.-A.D.200). Shook and Kidder (1952: 112, Fig. 78 *f*) found a large, tripod, jaguar-effigy mushroom stone (height, 37 cm.) with a similar circular groove around the base of the "mushroom" cap in Tomb I, Mound E-III-3, in the Verbena cemetery area. The contents of Tomb I in Mound E-III-3 were assigned to the Verbena subphase of the Miraflores phase (1000-500 B.C.). Shook and Kidder (1952: 112) state that "there can be no doubt that the making of these curious objects [mushroom stones] began at least as early as the Verbena subphase." There can also be little doubt that the nine miniature mushroom stones in the Nottebohm collection with their nine metates and manos, found in the cache in the Verbena cemetery area, are at least as early as 1000 B.C. The custom of circularly grooving the base of the mushroom-stone caps was discontinued after the Early Preclassic period. The Late Preclassic (500 B.C.-A.D. 200) and Classic (A.D. 200-900) period carved effigy, plain, and tripod mushroom stones have only plain caps (Fig. 2).

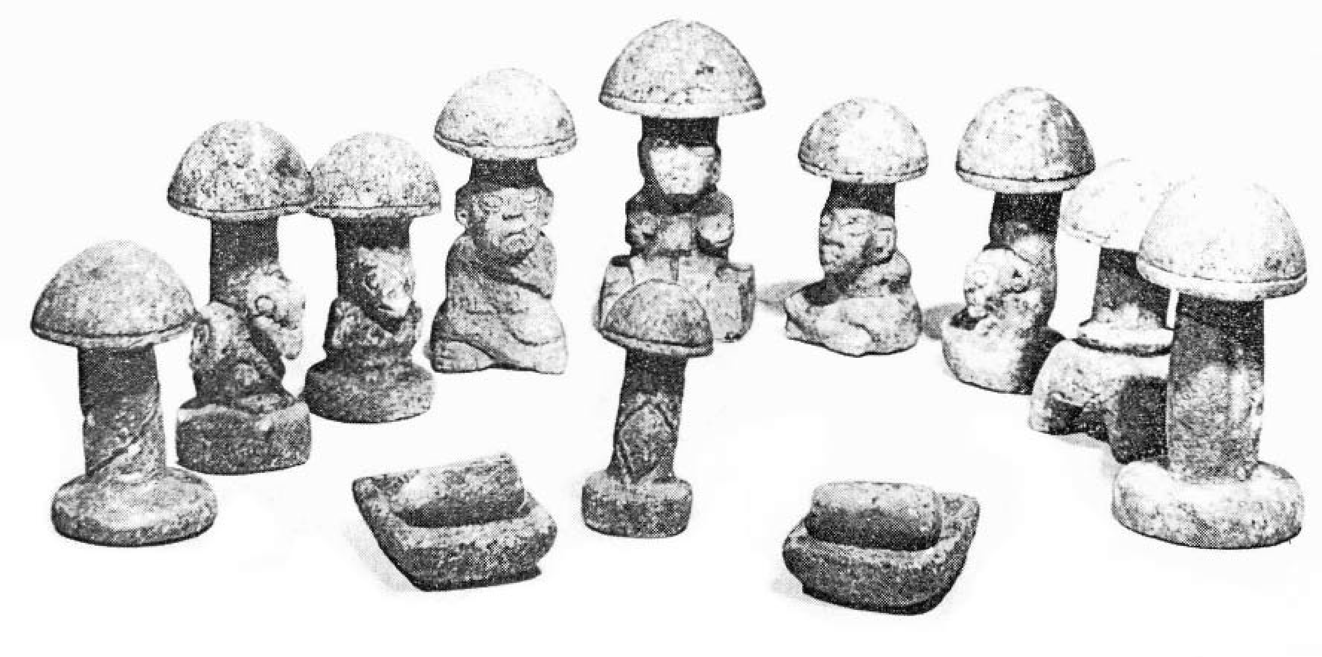


Fig 1. - Miniature mushroom stones, metates, and manos from Kaminaljuyú, Guatemala, in the Nottebohm collection. Except for the effigy mushroom stone in the center of the back row, all were found in a Late Preclassic cache (Verbena subphase of the Miraflores phase, 1000-500 B.C.). From left to right: *back row*, plain mushroom stone with grooved decoration, height 14 cm.; effigy mushroom stone, possibly a vulture, height 18 cm.; effigy mushroom stone representing an owl or Moan bird, height 15 cm.; effigy mushroom stone, an aged individual seated crosslegged, height 17.5 cm.; effigy mushroom stone of a seated individual with clenched fists, not associated with the cache, height 19 cm.; mushroom stone in form of a youthful individual seated crosslegged, height 16 cm.; effigy mushroom stone, possibly a jaguar, height 17 cm.; tripod mushroom stone, height 16 cm.; plain mushroom stone with vertical gouging, height 14 cm.; *front row*, miniature legless metate with mano, length of metate 10 cm., width 8 cm., length of mano 6 cm., diameter 2 cm.; plain mushroom stone with incised decoration, height 14 cm.; miniature metate with mano, dimensions same as other metate and mano.

It is interesting to note that the same Tomb I of Mound E-III-3 also contained four small mortars and pestles of gray stone, two of them in the shape of toads (Shook and Kidder 1952, Fig. 78 *a-c, e*). Shook and Kidder (1952: 111) observe that "neither the grinding depressions nor the ends of the pestles show appreciable wear and although it seems probable that these mortars were designed for pulverizing paints, none retains any trace of pigment." Furthermore, "the two round mortars and the two small ones with amphibian heads were stacked together in a great pile of offerings along the south side of the tomb and all five pestles lay with them." There seems little doubt that the jaguar-effigy mushroom stones and the stone mortars were placed in the tomb as burial offerings. It should also be noted that three other fragments of the heads of mushroom stones were found in the fill of Mound E-III-3.

TABLE 1. TYPOLOGY, CHRONOLOGY, AND DISTRIBUTION OF MUSHROOM STONES
(Modified from Borhegyi 1957)

Types	Chronology	Distribution
Type E Miscellaneous and possibly related stone (41-45) and pottery (46-48) objects.	Chronological position uncertain.	• Central Guatemalan Highlands Uncertain locality (41-45) • Western El Salvador Santa Elena (48) • Eastern El Salvador Not illustrated (compare 46-48) - Quelepa, San Rafael-Oriente, and Lolotique in Dept. San Miguel - Santa Elena in Dept. Usulután • Mexico Not illustrated - Guanacaste, Chiapas (compare 48) - El Bellote, Tabasco (compare 44, 46)
Type D Tripod mushroom stones with plain (39, 40) or carved (38) stems and with clubby (40) or sharp angled (38, 39) feet.	Late Classic 600-900 A.D.	• Central Guatemalan Highlands Kaminaljuyú (38-40) Not illustrated - Antigua (compare 38-40) - Zacualpa (compare 39-40) - Eucaliptus (compare 38-39) - Agua Caliente (compare 38-39) - Amatitlán (compare 38-39) - Pompeya (compare 38-39) - San Martin Jilotepeque (compare 38-39) - Tecpan-Iximché (compare 38-39) - Mixco Viejo (compare 40) • Pacific Coastal Plains of Guatemala Not illustrated (compare 39) - El Baúl - Los Diamantes - El Carmen • Western El Salvador Not illustrated (compare 39) - Tazumal - Finca la Montaña
Type C Effigy (17-31) or plain (32-37) mushroom stones with square (17,18,20-23,25,26,28,31,35) or rounded (19,24,32-34,36,37) bases and without circularly-grooved caps.	Late Preclassic 500 B.C. - 200 A.D. and probably Early Classic 200 - 600 A.D.	• Central Guatemalan Highlands Kaminaljuyú (17-20, 27-29) Cerro Alux, Mixco (31) Salcaja (25) Uncertain locality (21-24, 26, 30) Not illustrated - Tecpan-Iximché (compare 18, 36) - Amatitlán (compare 20) • Pa.cific Coastal Plains of Guatemala Lago Ixpaco (36) Not illustrated - Lago Ixpaco (compare 20) - El Salto (compare 21) - Guazacapán (compare 31) - Retalhuleu (compare 28) - Ayarza (compare 18) • Mexico Ocosingo, Chiapas (32) Not illustrated - La Grandeza, Chiapas - Chiapa de Corzo, Chiapas (compare 32) - Oaxaca (compare 32, 33, 36, 37) - Tabasco (compare 32) • Western El Salvador Tazumal (33) Las Victorias (35) Uncertain locality, probably Chatehuapa area (37) • Bolivia, South America Inca-Uyu, Chucuito (34)
Type B Effigy mushroom stones with circularly-grooved caps and square (12-14) or tripod (15, 16) bases.	Early and Late Preclassic 1000 B.C. - 200 A.D.	• Central (Juatemalan Highlands Kaminaljuyú (12, 13, 15) Quiché (16) Uncertain locality (14)
Type A Anthropomorphic stone sculptures with plain (1-5, 7) or circularly-grooved (6) mushroom caps; plain (10,11) and circularly-grooved (8,9) stone mushroom caps.	Chronological position uncertain.	• Central Guatemalan Highlands Kaminaljuyú (2-4, 8, 10) Salcaja (6) Chukumuk (9) Xikomuk (11) Uncertain locality (1, 5, 7)

It is significant that the nine miniature mushroom stones and the nine metates and manos in the Nottebohm collection were found as a unit in a cache. Ceremonial offerings, such as jade carvings, stingray spines, eccentric flints and incised obsidian blades in groups of nine have frequently been encountered in the Maya area. Most, however, were found in association with burials or as sub-stela caches or vault caches in sites in the Lowland Maya area (such as, Uaxactun, Tikal, Guatemala, and Baking Pot, Pomona, British Honduras; summary in Kidder 1947: 21-4, 59, Figs. 69-71). These caches date, not from the Preclassic, but from the Early and Late Classic (mostly Tepeu 2, A.D. 700-800) periods. To my knowledge, no Preclassic Highland Maya cache offerings in the number nine have previously been reported.

What is the significance of the number nine in ceremonial cache offerings? According to Thompson (1950: 12):

> In the pantheon of the peoples of Mexico and of the Maya there was a group of nine deities, called in Yucatec Bolon-ti-Ku, "nine gods," who were the lords of nights, and gods of the underworld. They ruled in succession over the nights, in contrast to the 13 sky gods who apparently ruled the days in sequence.

The glyphs of the nine Maya lords of nights and gods of the underworld are known (Thompson 1950, Fig. 34), but not all of them can be properly identified. On the other hand, the names of the nine lords of the nights of the Aztec have been preserved for us by Serna (1892). With the corrected orthography of Thompson (1950: 208), they are:

1. Xiuhtecutli, God of fire, year or grass.
2. ltzli, God of flint.
3. Piltzintecutli, Lord of the youths or youthful lord.
4. Centeotl, God of maize, ears of corn, and bread.
5. Mictlantecutli, God of infernal regions.
6. Chalchihuitlicue, Lady with skirt of jade.
7. Tlazolteotl, Goddess of love.
8. Tepeyollotl, Heart of the mountains (jaguar).
9. Quiauitecutli (Tlaloc), Lord of the rain.

The glyphs of the Maya Lords of the nights do not correspond closely to the Mexican gods. According to Thompson (1950: 208-10, Fig. 34), the Maya series presumably starts with glyph G_1 and ends with G_9. They may be summarized with reference to their various representational contents as follows:

G_1 Head of God C, water symbol (circlets, Kan cross), monkey features, fish symbol.
G_2 Water symbols (small circles), head variant that of a youthful deity, jade and vegetable symbols, possibly a rain deity.
G_3 Moan bird, bird of the rainclouds, a pluvial deity.
G_4 Roman nose deity, possibly a maize deity.
G_5 Earth monster, Mam (the god of the interior of the earth), the conch man.
G_6 A youngish deity.
G_7 Jaguar paw, puma, a deity of the interior of the earth (a counterpart of the Aztec jaguar god, Tepeyollotl).
G_8 Conch shell (symbol of the surface and the interior of the earth), Mam.
G_9 The night sun, aged sun god.

Admittedly, any attempt at identification of mushroom stones, with the nine gods of the Aztec or Maya pantheon, is on very shaky ground. Nevertheless, many if not all of the mushroom stones, both miniature and large, may possibly represent Highland Maya versions of the nine lords of the nights. They are listed here with tentative identifications in parentheses. Numbers refer to Figure 2.

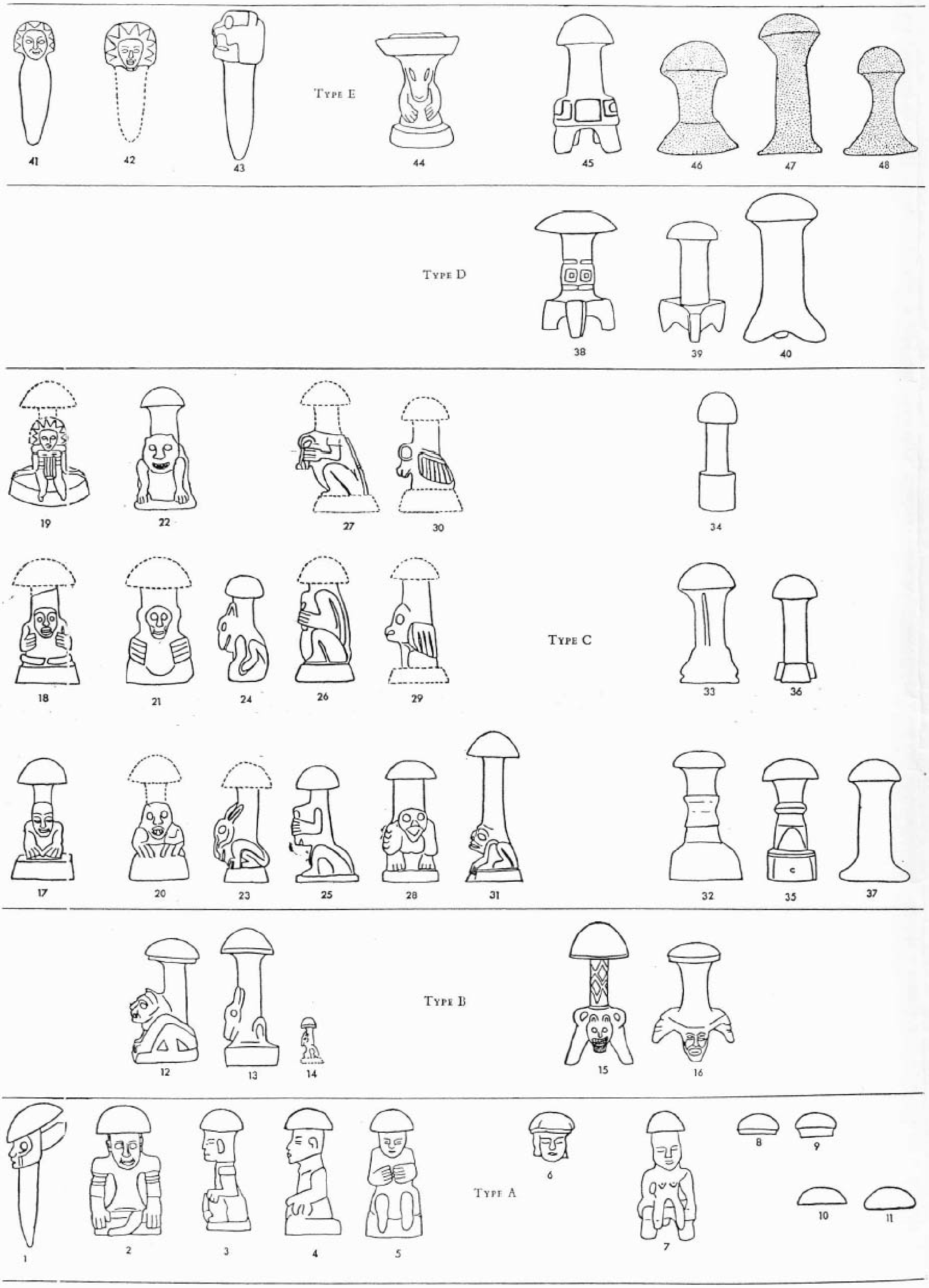

41
42
43
Type E
44
45
46
47
48
Type D
38
39
40
19
22
27
30
34
18
21
24
26
29
Type C
33
36
17
20
23
25
28
31
32
35
c
37
12
13
14
Type B
15
16
1
2
3
4
5
Type A
6
7
8
9
10
11

Fig 2. - Typology of mushroom stones. See Table 1 for explanation. Modified from Borhegyi 1957.

1. Aged individual, seated crosslegged or squatting (aged sun god, night sun, Xiuhtecutli, G_9 - 1, 2, 16, 17).
2. Youth, seated crosslegged or squatting (Piltzintecutli, youthful lord, G_6 - 3-6, 18, 19, 41,42).
3. Birds, such as vultures, owls, Moan birds (G_3 - 28-30).
4. Monkeys, may be the spider monkey (G_1 God C-21).

5. Jaguars or pumas (Tepeyollotl, G_7 - 12, 15, 20, 22, 43).
6. Rabits or deer (fertility, moon - 13, 14, 23, 24).
7. Pisotes, coati-mundi, *chic* - association with buffoonery, women, sex, and love (25-27, 44).
8. Toads or frogs, rain association (G_2 - 31, 45).

Of the nine miniature effigy mushroom stones in the Nottebohm collection, the second from the left in Figure 1 represents a bird (possibly a Moan bird or G_3); the fourth from the left represents an aged individual, seated crosslegged (possibly the night sun or G_9); the third from the right represents a jaguar (possibly Tepeyollotl or G_7); and the fourth from the right represents a youth, seated crosslegged (possibly youthful lord, G_6 or G_2. No explanation can be given for the additional bird effigy, or for the three plain and one tripod mushroom stones.

Whether or not the tentative identification of four of the miniature mushroom stones with the gods of the night is correct, the presence of nine offerings in a ceremonial cache from the Preclassic period indicates that the Maya belief in the nine gods of the underworld-and possibly in the 13 gods of the sky-may have originated as early a 1000 B.C. This period also saw the beginning of mound-building activities and rich tombs in the Maya Highlands. This presupposes a highly organized and stratified, social structure. There has been some debate as to whether the social control necessary for the production of such large-scale public enterprises was externally motivated (in the form of a "police force"), or internally motivated (belief in the rewards of heaven and the punishments of hell). If the nine gods of the underworld did, indeed, represent the idea of a "hell," as reported by the early Spanish chroniclers, then the presence of the nine mushroom stones in a Preclassic cache may indicate the existence of this concept among the Highland Maya, at a very early date. It would also explain why pilgrims, flocking to the Maya ceremonial centers, were willing and eager to enlist in the extensive building activities.

The purpose of the nine miniature metates and manos is still in question. Like the four small mortars and pestles found in Tomb I of Mound E-III-3, none shows signs of wear or use. Their presence with the mushroom stones must, therefore, have been primarily ceremonial or symbolic. Could this suggest that regular-sized metates and manos were used in connection with the larger mushroom stones? Could they have been used to pulverize or crush actual dried or fresh "sacred" mushrooms (*teo-nanacatl*) to induce, when eaten, hallucinatory trances and dreams - dreams in which, according to 16th century Spanish chroniclers, jaguars, birds and snakes, as well as little gnome-like creatures (possibly gods of the underworld) were seen (Wasson and Wasson 1957: 223-4)? These and other questions still await an answer.

Pertinent to the mushroom stone and metate problem is the discovery by R. G. Wasson and Robert Ravicz in June and July, 1960, that the metate is still used in the mushroom rite among the Mixtec of Oaxaca. They found that the sacred mushrooms (*Psilocybe mexicana* Heim) are supposedly gathered by a virgin (usually female), that the virgin grinds them on a metate with a little water, and that the gray fluid heavy with sediment is then drunk by the person who wishes to consult the mushroom. This practice has not been reported elsewhere, but perhaps it survives in other areas not yet explored. If the ceremonial metates were a symbol of this practice, is it possible that the mortars and pestles reflected the crushing of the *ololiuqui* seeds, which were and are widely used as a substitute for mushrooms when the latter are not available?

An effigy mushroom stone in the Namuth Collection in New York (Fig. 3; also illustrated in Wasson and Wasson 1957, Vol. II, Pl. 44) represents an aged woman kneeling before a metate-like object. She is shown in the characteristic position employed by women to grind meal. The specimen is from the Guatemalan Highlands and belongs stylistically to the Preclassic period (Type B mushroom stones). It is quite possible that this mushroom stone depicts a Preclassic version of the very same mushroom-grinding ceremony observed by Wasson and Ravicz among the present day Mixtecs of Oaxaca.

When all questions of a theoretical nature are put aside, we can derive from the miniature mushroom stones in the Nottebohm collection the following new facts and inferences of interest to Highland Maya prehistory:

1. The existence of miniature mushroom stones (height of 10 to 19 cm.).
2. Their ceremonial association, in a group of nine, with miniature metates and manos.
3. The antiquity of the "mushroom-stone cult," as far back as the Verbena subphase of the Miraflores phase (1000-500 B.C.).
4. The possible association (or even representation) of the *Bolon-ti-Ku*, the nine gods of the night and the underworld.
5. The possible existence of the nine-day cycle and nocturnal count in Preclassic times.
6. The possibility of a more elaborate pantheon and counting system among the Preclassic Highland Maya than previously assumed.
7. The possibility that at least in some areas in pre-Columbian Mesoamerica, metates or mortars were used to grind the sacred mushrooms, or crush the *ololiuqui* seeds, before ceremonially drinking or eating them.

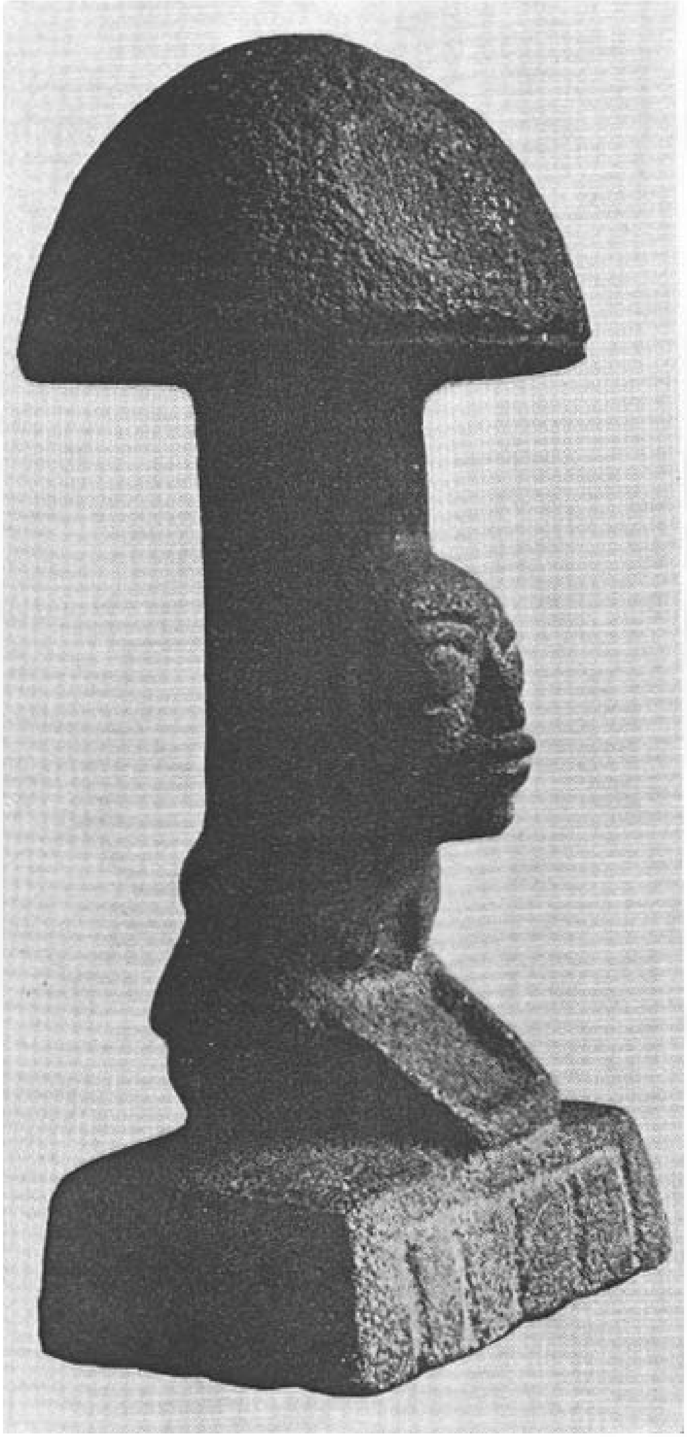


Fig 3. - Large effigy mushroom stone representing an aged woman kneeling before a metate, from highland Guatemala, exact location unknown. This Late Preclassic (l000-500 B.C.) specimen is in the Hans Namuth collection, New York. Height 36 cm. Photograph by Hans Namuth.

Acknowledgments - It is a pleasure to express my gratitude to the trustees of the Milwaukee Public Museum and to the American Philosophical Society, Philadelphia, under whose auspices the 1960 archaeological research in Guatemala was undertaken. Thanks are also extended to Karl Heinz Nottebohm for the use of material from his collections, to A. V. Kidder who read the manuscript and supplied several useful comments, to R. G. Wasson and Robert Ravicz for their data on Mixtec mushroom rites, and to Leo Johnson, photographer of the Milwaukee Public Museum, and Hans Namuth, New York, for the photographs.

This paper is dedicated to the memory of Dr. Valentina Pavlovna Wasson who, unfortunately, did not live long enough to see the many important results deriving from the research she conducted in collaboration with her husband, R. Gordon Wasson.

Bibliography

1. Borhegyi, S. F. 1957 A Typological, Chronological and Distributional Chart of Mushroom-stones in Middle America. In *Mushrooms, Russia and History*, by V. P. Wasson and R. G. Wasson, Vol. 2, Appendix 1. Pantheon Books, New York.
2. Kidder, A. V. 1947 Artifacts of Uaxactun, Guatemala. *Carnegie Institution of Washington, Publication* 576. Washington.
3. Kidder, A. V., J. D. Jennings, and E. M. Shook 1946 Excavations at Kaminaljuyú, Guatemala. *Carnegie Institution of Washington, Publication* 561. Washington.
4. Lothrop, S. K. 1933 Atitlan, an Archaeological Study of Ancient Remains on the Borders of Lake Atitlan, Guatemala. Carnegie *Institution of Washington, Publication* 444. Washington.
5. Serna, J. de la 1892 Manual de Ministros de Indios. *Anales del Museo Nacional de Mexico*, Época 1, Vol. 6 pp. 263-475. Mexico.
6. Shook, E. M. and A. V. Kidder 1952 Mound E-III-3, Kaminaljuyú, Guatemala. *Contributions to American Anthropology and History*, No. 53, *Carnegie Institution of Washington, Publication* 596, pp. 33-127. Washington.
7. Thompson, J. E. S. 1948 An Archaeological Reconnaissance in the Cotzumalhuapa Region, Escuintla, Guatemala. *Contributions to American Anthropology and History*, No. 44, *Carnegie Institution of Washington, Publication* 574, pp. 1-92. Washington.
8. Thompson, J. E. S. 1950 Maya Hieroglyphic Writing: Introduction. *Carnegie institution of Washington, Publication* 589. Washington.
9. Villacorta, A. J. C. AND C. A. Villacorta 1927 Arqueología Guatemalteca. *Colección "Villacorta" de Historia Antigua de Guatemala*, Vol. 2. Guatemala.
10. Wasson, V. P. and R. G. Wasson 1957 *Mushrooms, Russia and History*, two volumes. Pantheon Books, New York.

Pre-columbian Pottery Mushrooms from Mesoamerica

by

Stephan F. de Borhegyi

(Originally published: American Antiquity, 28: 328-338, 1963)

original source: http://www.samorini.it/doc1/alt_aut/ad/borhegyi1.pdf
backup source: http://www.psilosophy.info/resources/borhegyi1.pdf

Table of Contents:

Chronology and Distribution
Postulated Use of Pottery Mushrooms
Acknowledgments
References

Abstract - Until recently, pre-Columbian mushroom-shaped pottery objects were known only from EI Salvador. New evidence indicates that they were also used in Chiapas, Tabasco, and Veracruz, in Mexico, in the Lowland Maya Rain Forest area, and possibly on the Pacific coast of Guatemala. They seem to be diagnostics of the latter part of the Late Pre-Classic and Proto-Classic periods. Due to their resemblance, when turned upside down, to round-bottomed, tall-necked jars, an undetermined number of specimens may have been classified by archaeologists and illustrated in the literature as jars. Their function is still unknown, but it is believed that, like the mushroom stones, they were used in connection with the ceremonial consumption and adoration of hallucinogenic mushrooms.

While mushroom-shaped stone objects have been illustrated and reported from archaeological sites and collections in Mexico, Guatemala, and El Salvador ever since the latter part of the 19th century (Brigham 1887, Sapper 1898, and Brinton 1898), it was not until the 1930's that Lothrop (1933, Fig. 11 *b, c*) and later on, Longyear (1944, Pl. IX, No. 26), called attention to similar mushroom-shaped objects made of clay. At this time it was assumed that while the plain and effigy mushroom stones had a fairly wide distribution, ranging from southern Mexico through Highland and Pacific coastal Guatemala to El Salvador, the use of plain, hollow pottery mushrooms in pre-Columbian times was restricted to eastern El Salvador (Kidder, Jennings, and Shook 1946: 142). This was still held to be true when the author began his study of the chronology and distribution of these enigmatic stone and pottery objects (De Borhegyi 1957). At this time, pottery mushrooms were designated as Type E objects (De Borhegyi 1957, Nos. 46 to 48 in the chart). Mushroom stones were classified into four types, A to D in chronological order. Type A mushroom stones, the earliest, dated to Early or Mid Pre-Classic times (1000 B.C. to 300 B.C.) , Types Band C overlapped the Mid and Late Pre-Classic, and the Type D or tripod mushroom stones were assigned to the Late Classic (A.D. 600-900) period. All pottery (Type E) mushrooms were thought to be of Late Classic origin.

In 1959 Lowe described and illustrated a pottery "mushroom stand" and two Type C plain mushroom stones from Chiapas (Lowe 1959: 49, 55, 75, 76, Figs. 29 *f*, 50 *a*, 60 *c-d*). However, he (Lowe 1959: 75-6) cautiously ascribed the presence of this plain pottery mushroom (found at the archaeological site of Guanacaste, near the Grijalva River, in the Central Depression of Chiapas) to Late Classic influences emanating from El Salvador (Fig. 1).

Meanwhile, the author noted six previously unrecognized plain and effigy pottery mushrooms in several private and museum collections in Mexico and the United States. These specimens (*four* in the Villahermosa Museum in Tabasco, and *two* in the private collection of R. Gordon Wasson of New York) were reportedly found near the archaeological site of El Bellote a few miles north of the well-known Maya site of Comalcalco on the Gulf coast of Mexico (Stirling 1957: Map 15). The objects in question were similar to the pottery mushrooms reported by Lowe from Guanacaste, and by Lothrop and Longyear from El Salvador. Both plain and effigy forms, some of which were incised and punctate decorated, were made of a polished dull reddish-orange ware (Figs. 2, 3, and 4). They were all characterized by rounded bases, were hollow, and ranged in height from 20 to 25 cm. Were it not for the one specimen (Fig. 4), which had a modeled and incised figure of a bearded and moustached, conventionalized human face with two arms on the stem, the objects could have been easily mistaken for inverted tall-necked jars with rounded bottoms and extended out flaring rims. Each of these six pottery mushrooms bore textile and fingernail impressions or rough shell pecking (with the crinkled edges of pecten shells?) on the upper surface of the mushroom cap. As a matter of fact, the reason that pottery mushrooms have gone unrecognized in Mesoamerica outside of El Salvador is that a still undetermined number may have been published and illustrated upside down as tall-necked jars.

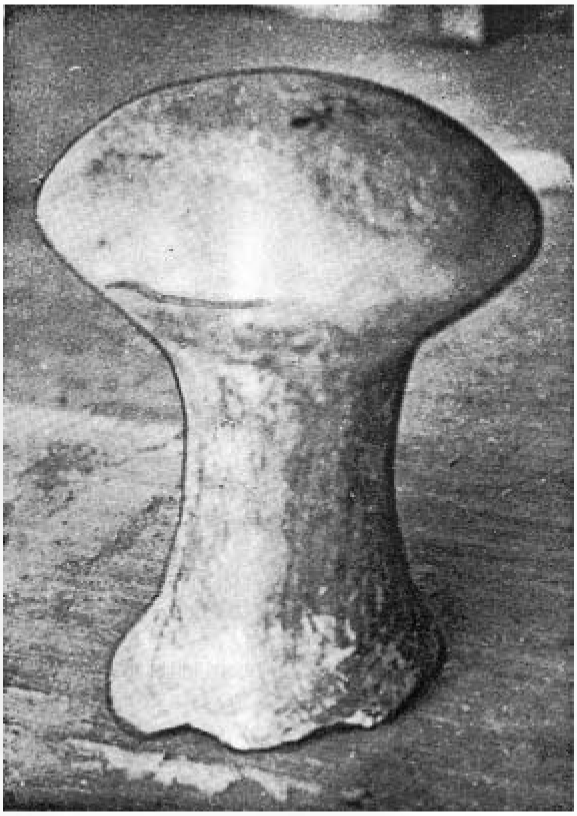


Fig. 1 - Plain hollow pottery mushroom from Guanacaste, Municipio La Concordia, Chiapas. Slipped dull reddish-orange ware. The mushroom cap shows extensive pecking and fingernail punching. Height: 23 cm.; top diameter: 16.5 cm. Late Pre-Classic or Proto-Classic (Lowe 1959: 49, 75-6; Figs. 29 *f*, 50 *a*, 60 *c, d*). Regional Museum, Tuxtla Gutierrez. New World Archaeological Foundation Collection (Milwaukee Public Museum Photo 2A59-8G).

The discovery of pottery mushrooms from the El Bellote area led to a re-examination of the archaeological finds and publications from the Mexican Gulf coast region. Stirling, who worked intensively in this area, excavated in the vicinity of the El Bellote site. He illustrates, upside down (Stirling 1957: 238-9, Pls. 59 *e, f, g, h, i*, 65 *a*-3) five (Type E) plain pottery mushrooms, and describes them as tall, thick-walled, sand-tempered pottery jars, with round "bottoms" expanded to bowl shape. The "bottoms" of these objects are roughened by textile imprints and pecked with what appears to be the crinkled edges of pecten shells. One complete specimen (Pl. 232, 65 *a*-3) was found in a sealed tomb at the site of Isla (near Paraiso and El Bellote; see Map 15, in Stirling 1957) in association with such typical Lowland Maya, Proto-Classic (A.D. 200-300) pottery vessels as round-bodied, bridged spouted "teapots." Four similar but fragmentary dull red ware pottery mushrooms (Pl. 59 *e, f, h, i*) were found in a shell mound at Ceiba, also near El Bellote, not far from the shores of the Atlantic. Here again the associated pottery forms (tetrapod vessels with tapering mammiform feet, polychrome spouted vessel, etc.) are indicative of Proto-Classic and Early Classic date. Stirlin, in a personal communication dated November, 1961, now believes that the "round-bottomed jars" he found at Isla and Ceiba are actually hollow pottery mushrooms. Moreover, he believes that the specimen illustrated here as Fig. 2 (at right), from the Villahermosa Museum, is the very same one he reported from the sealed tomb at Isla (Stirling 1957, Pl. 65 *a*-3).

A further examination of the archaeological literature has revealed red-brown ware, tall-necked, round-bottomed "jars" found by Drucker (1943: Pls. 16 *c, d, e*; 21 *c, d*, and 22 *a, d*) in Burials I-18 and II-18, at Cerro de las Mesas in Veracruz, which, when turned upside down, may represent pottery mushrooms similar to those of El Bellote. Because I have had no opportunity to examine these specimens, I am reluctant, at least for the time being, to classify them as pottery mushrooms.

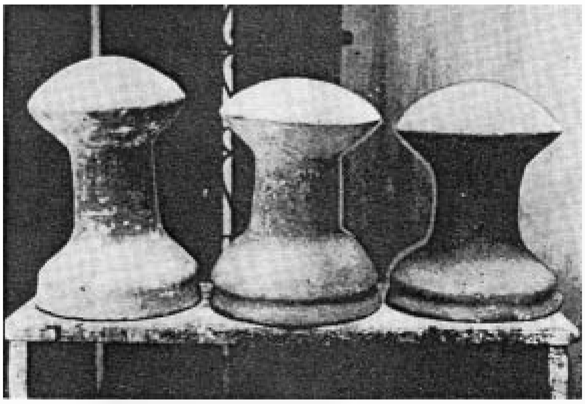


Fig. 2 - Three plain, hollow pottery mushrooms from El Bellore, Tabasco. Slipped, dull reddish-orange ware. The caps show textile impressions and shell pecking. Height of specimen at left: 25.4 cm. Proto-Classic. Specimen on right found at Isla, near El Bellote and illustrated by Stirling 1957: Pl. 65 *a*-3. Regional Museum, Villahermosa, Tabasco (Milwaukee Public Museum Photo 205129D).

It may be important to note that an unusual Remojadas style pottery figurine in the Wasson collection in New York, which is said to be from Tenenexpan, Veracruz (H: 30.5 cm.), represents a young woman seated crosslegged before what appears to be a small hollow pottery mushroom. Her right hand rests on the mushroom cap, while her left hand is extended upward trance-like or as if praying to the sky. She wears a square *quexquemitl* on her shoulders, a turban-like headdress, and what seems to be a necklace of beads. Her exposed legs, hands, and lips are smeared with black asphalt (*chapopote*) in keeping with the well-known Late Pre-Classic to Early Classic period Remojadas style (Fig. 5). To my knowledge no pottery mushrooms have been reported from the Remojadas archaeological zone. However, this interesting figurine gives us food for thought as to the pre-Columbian use of pottery mushrooms as objects of adoration by initiated "*curanderas*" (cf. Wasson and Wasson 1957: Pls. XLVII and XLVIII; Heim and Wasson 1958: Pls. I to IV).

Since 1960 numerous pottery mushroom fragments have been turned up in investigations by the New World Archaeological Foundation in the Central Depression of Chiapas. From Santa Cruz, Chiapas, Sanders (1961: 16, 28; Fig. 15 *b* and Pl. 6 *j*) illustrates and describes a Type E, plain pottery mushroom fragment found in the excavation of this site in his Trench 2 (level 4). The fragment is of a coarse-paste, unslipped, unburnished, thick-walled utility ware (named Chiapilla ware). Although only one fragment is illustrated (upside down), Sanders indicates (p. 28) that there were several of these "mushroom pots" or "mushroom vessels" in Trench 2 (Fig. 6). The Chiapilla period at the Santa Cruz site is equated by Sanders with the Late Pre-Classic (300 B.C.-A.D. 00) Francesa and Guanacaste phases at the site of Chiapa de Corzo (Chiapa IV-V periods). Due to the fact, however, that Level 4 in Trench 2 was a disturbed level, it is possible that the pottery mushrooms at this site are of the later Proto-Classic Santa Cruz period (Horcones, Istmo, Jiquipilas, Laguna phases at Chiapa de Corzo), A.D. 00- 200. The above specimens are now in the Regional Museum at Tuxtla Gutierrez in Chiapas where I examined them early in 1962. The cap of each pottery mushroom specimen shows marks of shell pecking, and in general the specimens are similar in all respects to the pottery mushrooms of Tabasco and El Salvador. While at the Tuxtla Museum, I also studied seven pottery mushroom fragments excavated at the site of Chiapa de Corzo. Due to the kind permission of Bruce Warren of the New World Archaeological Foundation, five of them are illustrated here (Fig. 7). Warren tells me (personal communication 1962) that they were found during the excavation of Trench 131 in the back of Mound SA, at Chiapa de Corzo, - and that based on their pottery association they are of the Proto-Classic, Istmo phase (Period VII at Chiapa de Corzo).

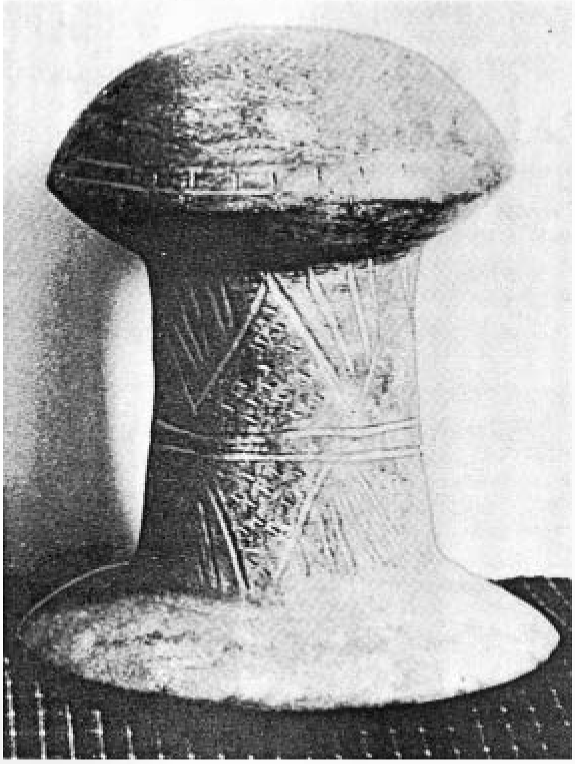


Fig. 3 - Plain hollow pottery mushroom from El Bellate, Tabasco. Decorated with incised and tool punctated design (note tool-incised design encircling the cap). Slipped dull reddish-orange ware. The cap shows extensive shell pecking marks. Height: 20 cm.; top diameter: 15.5 cm.; base diameter: 17.5 cm. Proto-Classic. Milwaukee Public Museum Collection, Museum No. 52851/ 18541. Donated by R. Gordon Wasson (Milwaukee Public Museum Photos 205126C, 2A147A).

Pottery mushroom specimens have also been excavated at the sites of Mirador and Berriozabal. They have been assigned to the Proto-Classic Chiapas VII (Istmo) and Early Classic Chiapas VIII (Jiquipilas) periods, and correspond in shape and time with the pottery mushrooms found at Guanacaste, Chiapa de Corzo, and Santa Cruz (personal communication, Lowe 1962).

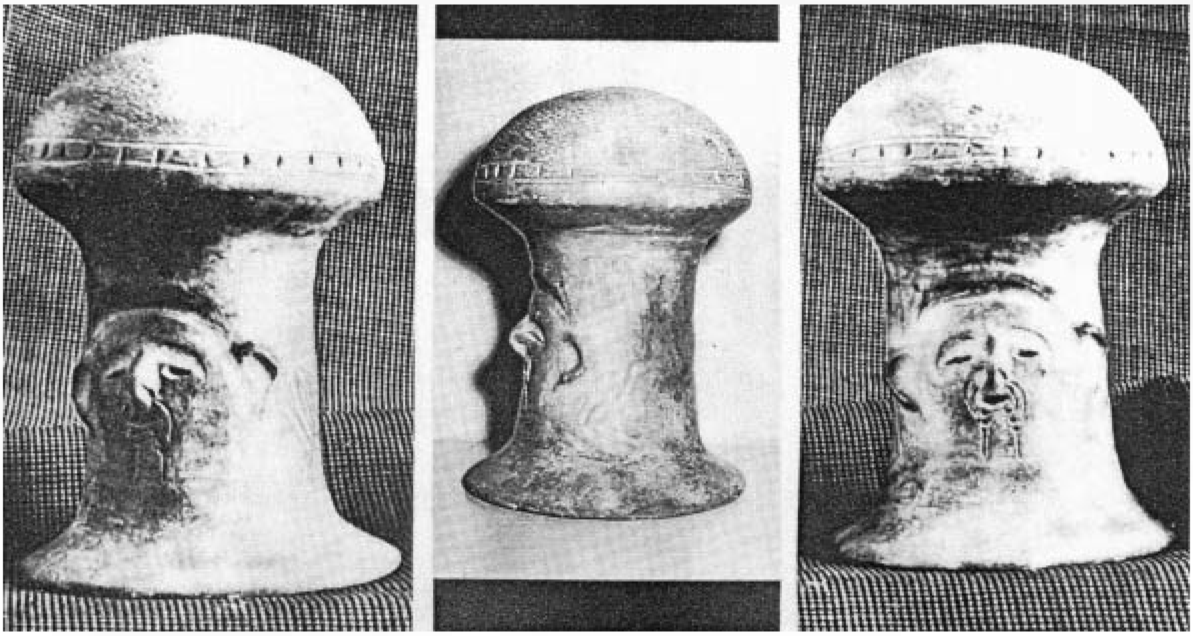
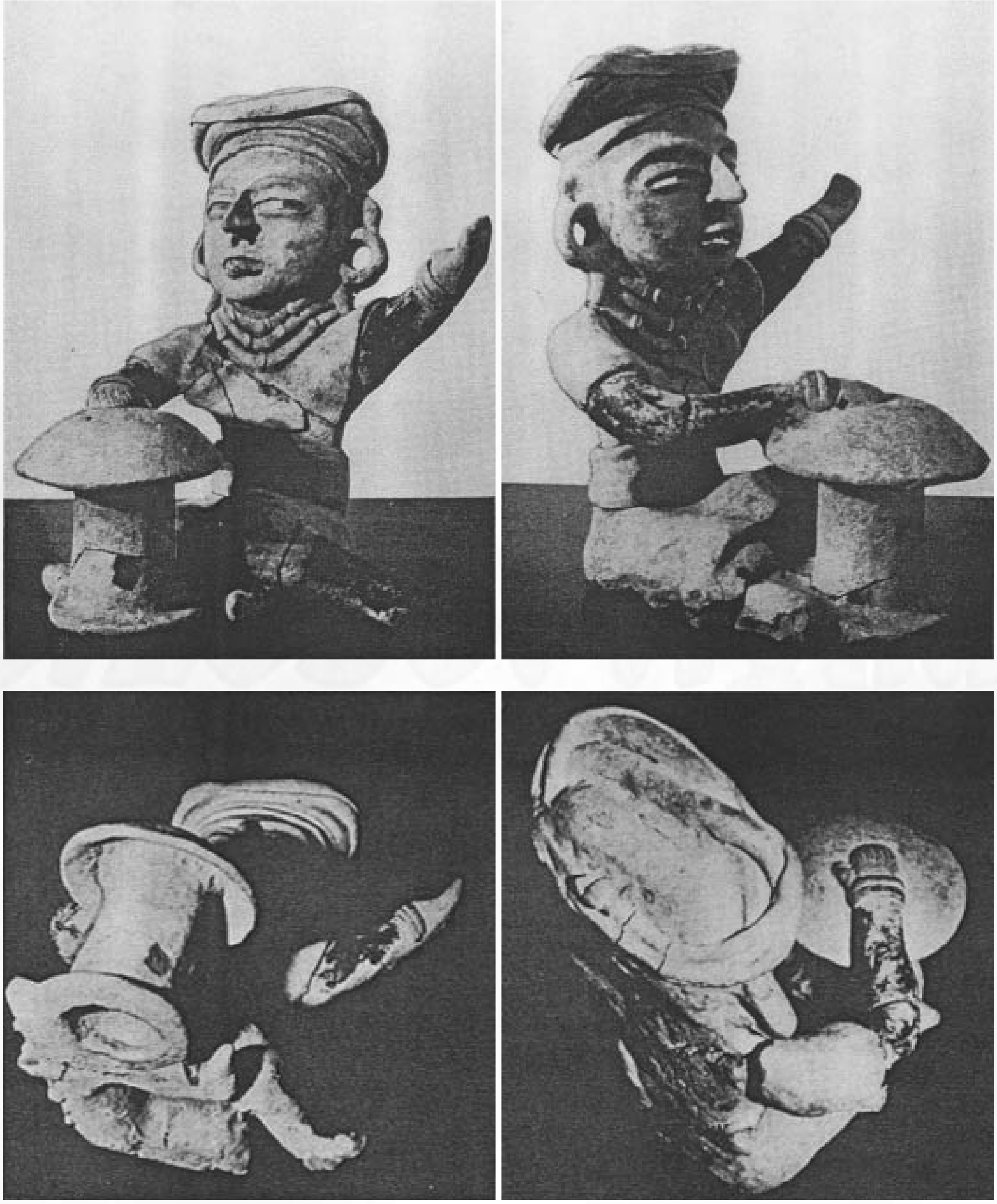


Fig. 4 - Hollow effigy pottery mushroom from El Bellote, Tabasco. Incised and modeled features depict (on the stem) a bearded, moustached individual with conventionalized arms. Note tool-incised and indented design encircling the cap. Slipped dull reddish-orange ware. The surface of the cap shows extensive pecking (for stylistic similarity compare with a modeled and incised spouted vessel from Isla in Stirling 1957: Pl. 66 *b*). Height: 20.3 cm.; top diameter: 13.6 cm.; base diameter: 14.6 cm. Proto-Classic. Private collection of R. Gordon Wasson, New York (photo courtesy Wasson; Milwaukee Public Museum Photos 205126A, B; 205114A, B, C).

Most recently, Richard E. W. Adams (personal communication 1962) has reported finding several plain pottery mushrooms at the Lowland Maya Rain Forest site of Altar de Sacrificios on the Usumacinta River in the El Peten District in Guatemala. The specimens, according to Adams, are of a streaky brown and dull-red ware, and were found in association with Late Plancha (equivalent to Late Pre-Classic Chicanel) and Salinas (equal to Proto-Classic Matzanel) period pottery. Although I have not examined the specimens from Altar de Sacrificios, Mirador and Berriozabal, I feel certain that they are of the same type as those described earlier from El Bellote and Chiapa de Corzo.



Ryc. 5 - Four views of a Remojadas style pottery figurine from Tenenexpan, Veracruz. Represents a seated, cross-legged woman wearing a turban-like headdress, a square *quexquemitl*, and a beaded necklace. Her left hand rests on a plain, hollow pottery mushroom, while her right arm is extended upward as if in prayer. Part of base near pottery mushroom is missing. Made of yellowish-orange ware. The exposed sections of the woman's arms, legs, and lips are covered with black asphalt paint (*chapopote*). Height: 30.5 cm. Late Pre-Classic or Proto-Classic. Private collection of R. Gordon Wasson, New York (photo courtesy of Wasson; Milwaukee Public Museum Photos 205175B, C; 2A171D).

Chronology and Distribution

Pottery mushrooms are known with certainty from nine sites in Mesoamerica (Fig. 8):

a. Chiapas (*Central Depression*): Guanacaste, Santa Cruz, Chiapa de Corzo, Mirador, and Berriozábal (for location of these sites, see map in Lowe 1959, Fig. 64).
b. Tabasco (*Gulf Coast*): El Bellote, Isla, Ceiba.
c. Lowland Guatemala (*El Peten*): Altar de Sacrificios.

To this list of distribution in Mexico one can add tentatively:

Veracruz: Tenenexpan (Remojadas; see Fig. 5); and Cerro de Las Mesas (Drucker 1943).
Oaxaca: Xaaga, near Mitla.

From Xaaga, near Mitla, Heim and Wasson (1958: 121, Fig. 23 *b*) illustrate and describe nine crudely-manufactured miniature clay cups with mushroom-like applique designs, collected by Saville between 1898-1900. These curious cups are now in the collection of the American Museum of Natural History in New York, and mayor may not be part of the pottery mushroom complex of Mesoamerica. It may be significant, however, that the nine were found together, like the nine miniature mushroom stones found in a Pre-Classic cache at Kaminaljuyú, Guatemala (De Borhegyi 1961).

Since in these areas the pottery mushrooms seem to be restricted to the Late Pre-Classic (Chiapa IV-V) Francesa and Guanacaste phases and to the Proto-Classic (Chiapa VII, VIII, Istmo and Jiquipilas phases), they may be considered as diagnostic pottery shapes of these periods, along with such other diagnostics as mammiform and swollen vessel supports and bridged spouts (Wauchope 1950: Figs. 1-2).

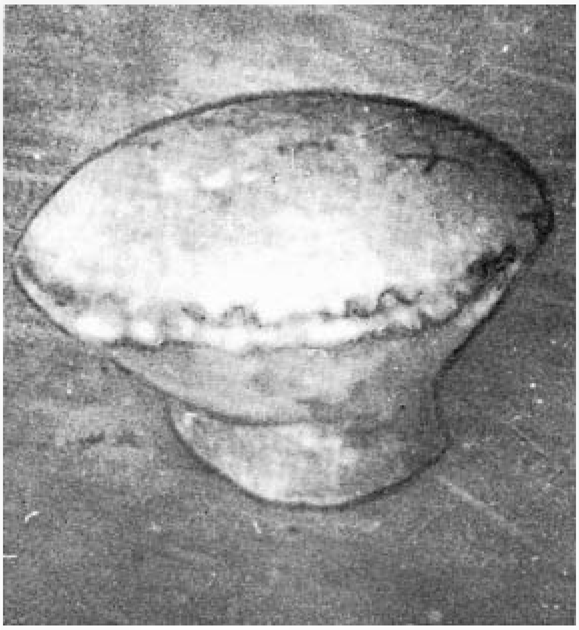


Fig. 6 - Plain hollow pottery mushroom from Santa Cruz, Chiapas (Trench 2, level 4). Coarse paste, unslipped, unburnished, thick-walled utility pottery (Chiapilla ware). Part of stem and base missing. Cap shows shell pecking marks. Top diameter: 12.3 cm. Late Pre-Classic or Proto-Classic. Regional Museum, Tuxtla Gutierrez, Chiapas. New World Archaeological Foundation Collection (photo courtesy Bruce Warren; Milwaukee Public Museum Photo 2A59-8G). This specimen is illustrated upside down by Sanders 1961: 16, 28; Fig. 15 *b*, Pl. 6 *j*.

Present evidence seems to point to their origin in the Central Depression of Chiapas during Late Pre-Classic times. They became increasingly popular during the ensuing Proto-Classic period in Chiapas. Their use and manufacture may have spread to the Gulf coast of Mexico via the Grijalva River and to other parts of the Lowland and Highland Maya areas. When more information becomes available, an equally good case may be brought forward for a Mexican Gulf coast origin. From here, along the same Usumacinta and Grijalva rivers, they could have reached the Highland and Lowland Maya areas and distant El Salvador, along with other Mid and Late Pre-Classic influences deriving from the great Olmec culture center of La Venta (Fig. 8). Be that as it may, we think the plain pottery mushrooms found in El Salvador represent an influence from southern Mexico via coastal Guatemala during Proto-Classic times, rather than the opposite situation previously postulated by Lowe (1959: 75-6). They may even help to explain the presence of many Mid and Late Pre-Classic and Proto-Classic La Venta-Olmec-like traits in El Salvador and further south (cf. Richardson 1940 and Boggs 1950).

Plain pottery mushrooms are known from El Salvador from the following sites (for the location of the sites, see map in Longyear 1944: 77; and Fig. 8):

Hacienda Mapilapa		West El Salvador
Chinameca	(Dept. San Miguel)	Eastern El Salvador
Quelepa	(Dept. San Miguel)	Eastern El Salvador
San Rafael Oriente	(Dept. San Miguel)	Eastern El Salvador
Lolotique	(Dept. San Miguel)	Eastern El Salvador
Santa Elena	(Dept. Usulatan)	Eastern El Salvador

This information comes from personal correspondence with Stanley Boggs (1953) who studied and photographed about 20 plain pottery mushrooms in private and museum collections in El Salvador (see also Longyear 1944: Pl. IX, No. 26; and de Borhegyi 1961: Fig. 2, Nos. 46-8; for Boggs' photos see Carnegie Institution of Washington files in Cambridge). According to Boggs, pottery mushrooms are more common in eastern El Salvador, while mushroom stones predominate west of the Rio Lempa. I believe that an unusual incised, red ware pottery drum from Costa Rica (Lothrop 1926: 275, Fig. 168 *a*) when turned upside down, may actually be a pottery mushroom. If so, it is the furthest known specimen of its kind south of El Salvador. Unfortunately, none of the pottery mushrooms recorded by Boggs and Longyear came from controlled excavations, and so their dating remains a question. However, since some of the pottery mushrooms from El Salvador were made of Usulatan resist ware (Guillemin personal communication 1962; see Fig. 9), it is quite possible that the pottery mushrooms in El Salvador were roughly contemporaneous with their Mexican and Lowland Maya counterparts. It should be noted, however, that Usulatan - a diagnostic ware for the Late Pre-Classic and Proto-Classic periods in the Highland and Central Lowland Maya regions - survived well into the Classic period in various parts of western Honduras and El Salvador (Shook and Kidder 1952: 97-100).

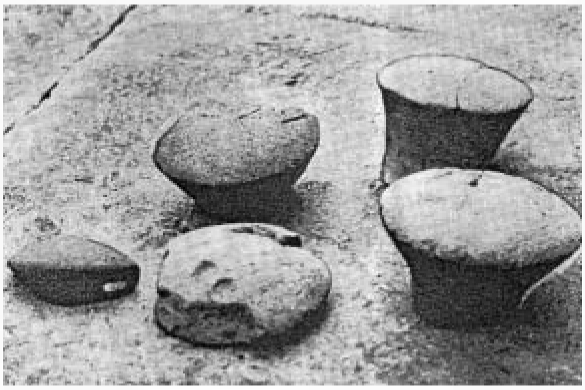


Fig. 7 - Five plain hollow pottery mushroom fragments from Chiapa de Corzo, Chiapas (Trench 131, back of Mound 5A). Coarse paste; unslipped ware. Parts of stems and bases missing. The caps of all five specimens show shell pecking. Range of top diameters: 13-17 cm. Proto-Classic. Regional Museum, Tuxtla Gutierrez. Chiapas. New World Archaeological Foundation Collection (photo courtesy Bruce Warren; Milwaukee Public Museum Photos 2A59-8E, F).

Just how and by what route the use of pottery mushrooms spread from Mexico to El Salvador is not clear. They have not been reported from the intermediate area even though Pre-Classic (De Borhegyi 1961: Table 1, Types A, B, C) and Classic period (Types C and D) mushroom stones are abundant at Highland and Pacific Coastal sites in Guatemala and also in western El Salvador (De Borhegyi 1961: Table 1, Nos. 33, 35, 37, and 39). It is possible, however, that a few hollow, flat-topped, bell-bottomed pottery fragments found during our recent excavations at Bilbao[1] and also whole specimens noted from the nearby archaeological sites of Los Tarros and

El Baul, all located in the Cotzumalhuapa archaeological zone in Guatemala, may represent a local variant of pottery mushrooms. They are made of a coarse reddish-brown "mud" ware, and unlike the pottery mushrooms of Mexico and El Salvador, have solid, flat, seat-like tops (Fig. 10). They are of Early Classic date and bear a slight resemblance to some of the "duck pots" of the Northern Highlands of Guatemala of the same and later periods, although they have neither handles nor effigy features (De Borhegyi 1952: Figs. 5, 6). Further study is necessary before it can be determined whether these seat-like pottery objects from coastal Guatemala form a link in the distribution of pottery mushrooms from Chiapas to El Salvador.

[1] The fragments were found by Parsons in his rest pit excavation (levels 8-11) during the Milwaukee Public Museum's 1961-62 excavation at Bilbao, sponsored by the National Science Foundation. Their resemblance to pottery mushrooms was first noted by Parsons. The ceramic association (Esperanza "mud" ware, Tiquisate ware, and San Juan Plumbate) indicates an Early and/or Late Classic date. Thompson's (1948) excavation at El Baúl yielded one whole and several fragmentary specimens. They were not illustrated or reported by him, but were found by Parsons in the Guatemalan National Museum among Thompson's El Baúl collections (Lot 96) deposited in the Museum.

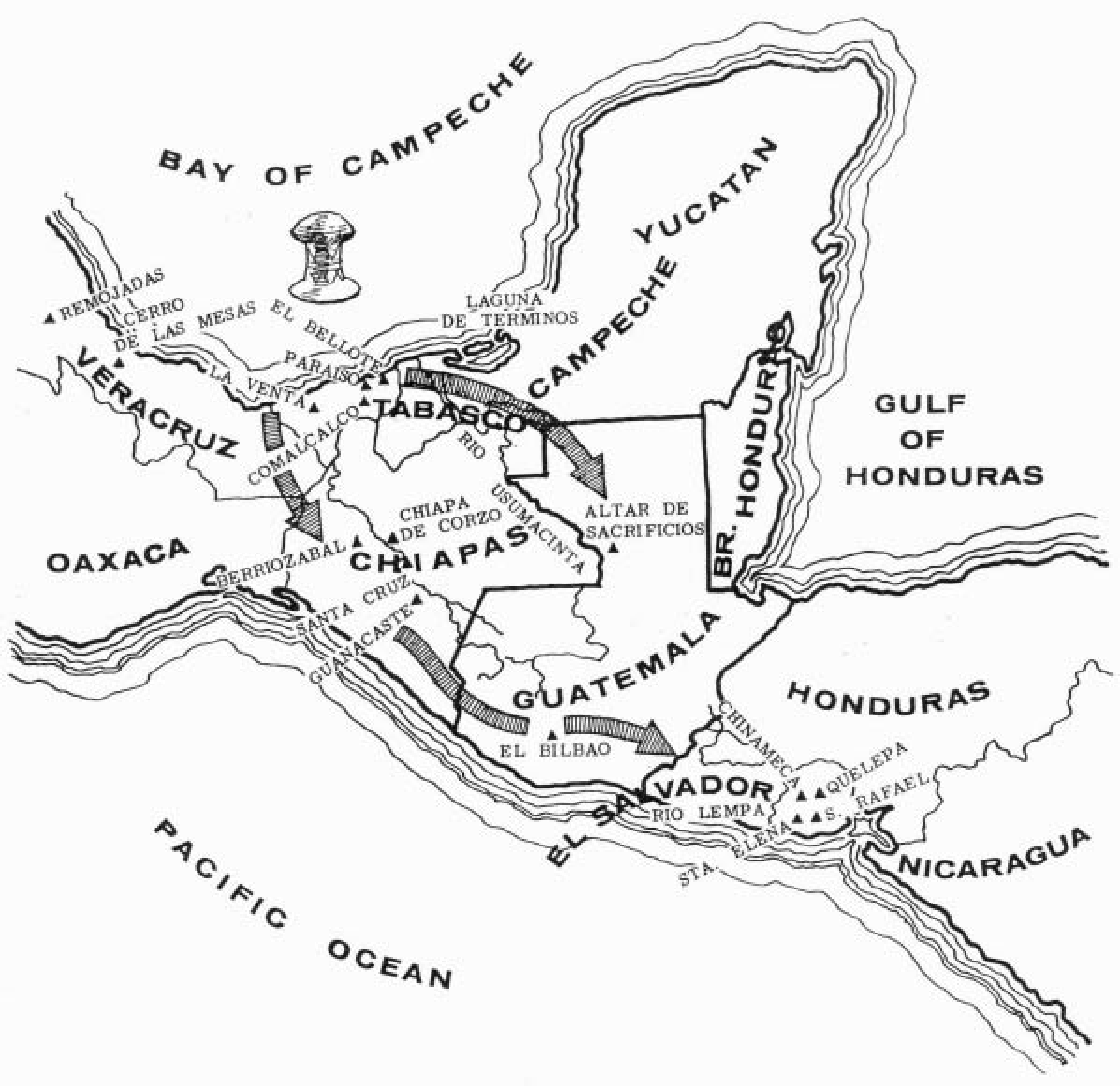

BAY OF CAMPECHE
YUCATAN
CAMPECHE
GULF OF HONDURAS
BR. HONDURAS
REMOJADAS
CERRO DE LAS MESAS
EL BELLOTE
LAGUNA DE TERMINOS
PARAISO
LA VENTA
VERACRUZ
TABASCO
COMALCALCO
RIO USUMACINTA
ALTAR DE SACRIFICIOS
CHIAPA DE CORZO
OAXACA
BERRIOZABAL
CHIAPAS
SANTA CRUZ
GUANACASTE
GUATEMALA
HONDURAS
CHINAMECA
QUELEPA
EL BILBAO
EL SALVADOR
RIO LEMPA
S. RAFAEL
STA. ELENA
NICARAGUA
PACIFIC OCEAN

Fig. 8 - Distribution of pottery mushrooms in pre-Columbian Meso-America.

Postulated Use of Pottery Mushrooms

Although many theories have been brought forth to explain the shape and use of mushroom stones (phallic representations, markers, seats, etc.; see Kidder, Jennings, and Shook 1946: Pl. 142; De Borhegyi 1961), nothing has been suggested so far concerning their pottery counterparts. If, as I believe, they are related in concept to mushroom stones, then they must have been used in the sacred mushroom ceremonies of Pre-

]

Columbian times during which mushrooms (*teo-nanacatl*; *Psilocybe mexicana* Heim) were ritually consumed to induce hallucinatory trances and fantasmagoric color dreams (Wasson and Wasson 1957: 223-4; De Borhegyi 1961: 503).

The humble pottery mushrooms, unlike their stone counterparts, are generally plain and do not represent any human or animal forms. The only exception is the specimen from El Bellote (Fig. 4) which represents a bearded and moustached individual, possibly a manifestation of the rain god (Tlaloc). Due to the fact that the distribution of mush room stones and pottery mushrooms overlaps in Tabasco, Chiapas, and El Salvador, it is clear that pottery mushrooms are not simply regional substitutes for stone mushrooms. Mushroom stones are numerous in all parts of Highland Guatemala and also in Oaxaca (especially in the Mixtequilla region), areas where pottery mushrooms have so far not been found (De Borhegyi 1961: Fig. 2). Both are present in areas where stone for carving was abundant, and are hardly beautiful enough to have been luxury or trade items. Moreover, pottery mushrooms were manufactured from local clay and in the prevalent local style. Nor do pottery mushrooms seem to represent a chronological variant, since Types A, B, C, and D mushroom stones are present in southern Mexico, Guatemala, and El Salvador from Early Pre-Classic times until the end of the Late Classic with a possible hiatus during the Early Classic.

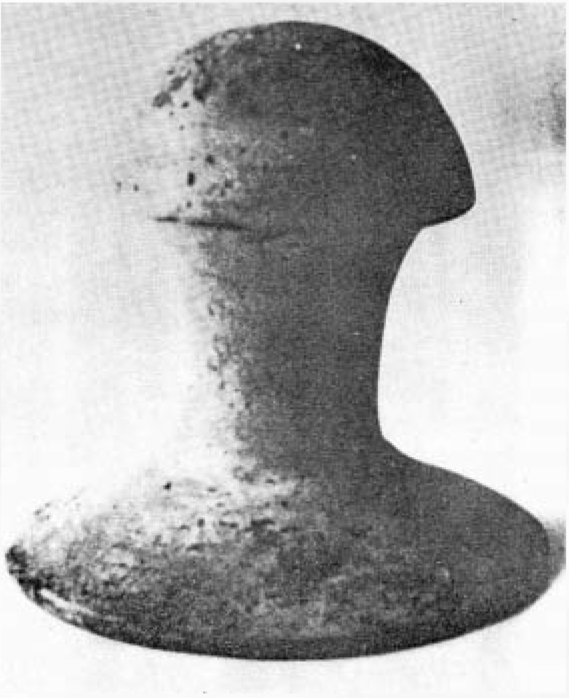


Fig. 9 - Plain hollow pottery mushroom from the Department of Usulatan, El Salvador. Negative-painted Usulatan ware. Height: 22 cm. Proto-Classic. Private collection in Guatemala City (photo courtesy Guillemin).

It can be suggested that pottery mushrooms were probably used in Pre-Columbian times by persons unable to afford the undoubtedly more valuable and harder-to-come-by mushroom stones, although the rich content of the sealed tombs at Isla, which contained a plain pottery mushroom (Stirling 1957: Pls. 65-6), seems to contradict this theory. That pottery mushrooms were for use exclusively by females in mushroom ceremonies, as suggested by our unusual specimen from Remojadas (Fig. 5), is an equally weak supposition, since many of the mushroom stones also represent females, either seated or grinding the sacred mushroom or *ololiuque* seeds on a metate (De Borhegyi 1961: Fig. 2, No.7, and Fig. 3).

A curious fact that should not be overlooked is that many of the pottery mushrooms, unlike the mushroom stones, show textile and fingernail imprints and signs of shell pecking on their caps. In this respect, they resemble the mushroom- shaped ceramic molds used today for making pottery in many parts of Mexico, such as Tzintzuntzan (Michoacan) and Metepec (state of Mexico; see Foster 1948: Figs. 2-3). Moreover, some of the Pre-Columbian pottery anvils from North America, although much smaller in size (Foster 1948: Fig. 6; and Barrett 1933: 342, Pl. 95), bear a slight resemblance to the pottery mushrooms of Mexico and El Salvador (Fig. 11). In this respect it is important to note that the mushroom-shaped modern ceramic molds of Mexico and the Pre-Columbian pottery anvils always have solid stems (handles), while the stems of the Pre-Columbian pottery mushrooms are invariably hollow. This suggests a major difference in concept and function.

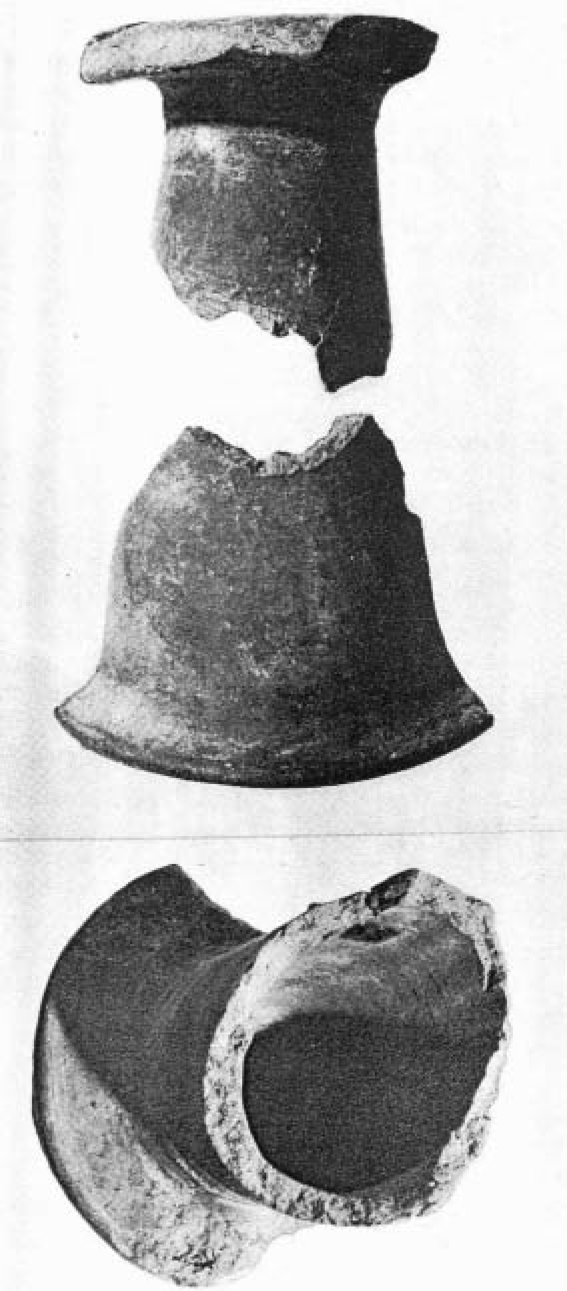


Fig. 10 - Plain hollow mushroom-like object from Bilbao, Cotzumalhuapa, Department of Escuintla, Guatemala (test pit, levels 8-11). Crudely manufactured; coarse paste; thick-walled reddish-brown "mud" ware. Parts of stem and base missing. Cap is solid and shows thumb marks, but no other markings. Approximate height: 26 cm.; top diameter: 13 cm.; base diameter: 15 cm. Early or Late Classic. National Museum, Guatemala City. Milwaukee Museum Bilbao excavations (Milwaukee Public Museum Photos 2A147J, L).

Until further evidence linking these pottery mushrooms to the Pre-Columbian mushroom cult comes to light, there remains a disconcerting possibility that some "pottery mushrooms" were actually molds used to form humble culinary pottery objects. But if they had no more exalted function, why were some of them included in rich tombs along with such luxury objects as carved shell forgets and jade beads (Stirling 1957: Pls. 65-66); and why have paddles, the necessary tools to the anvil process, never been encountered among the archaeological finds of Mesoamerica?

These and other questions still await answers. Meanwhile, it becomes increasingly clear that "pottery mushrooms," like mushroom stones, had a wide spatial distribution in Mesoamerica, and that a cautious re-examination of all round-bottomed, tall-stemmed, Late Pre-Classic and Proto-Classic jars in archaeological finds in the areas cited above, is in order.

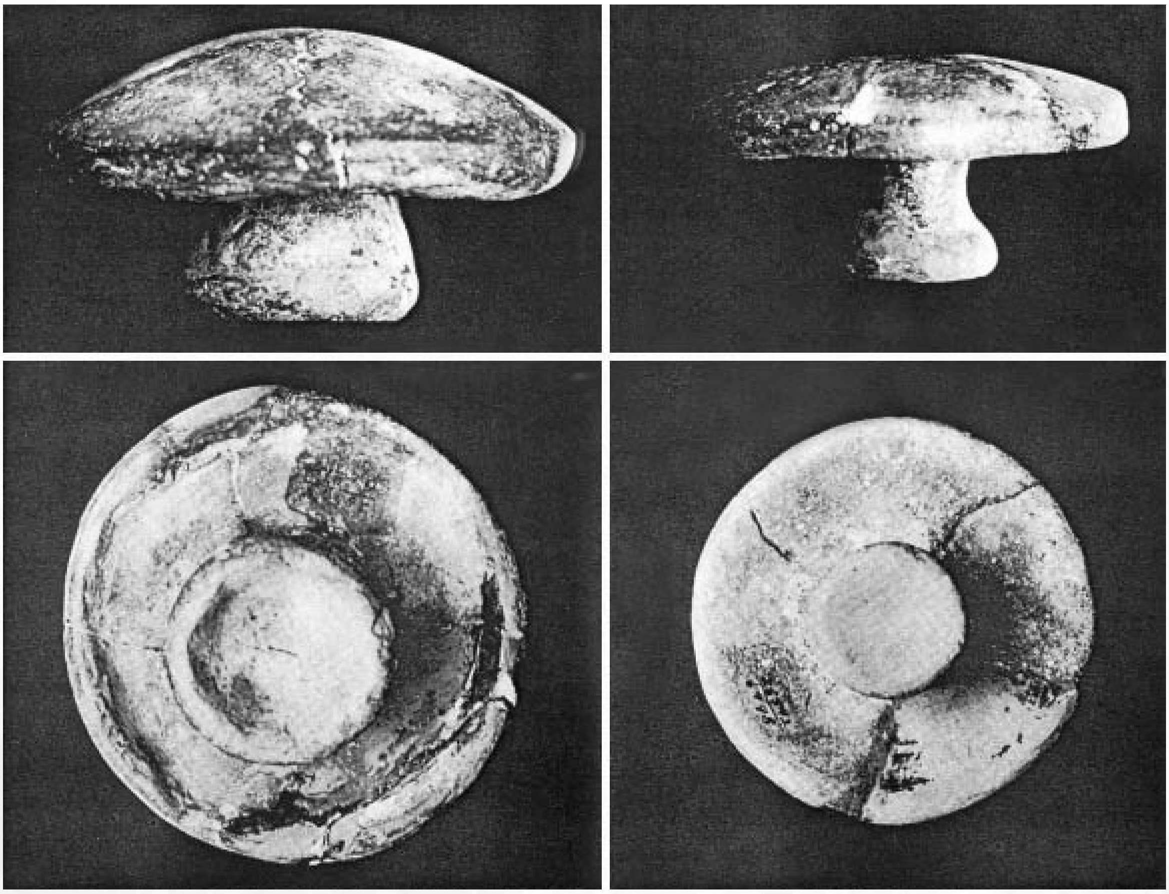


Fig. 11 - Two pottery shapers and modeling implements of mushroom form from the site of Aztalan, Wisconsin. Coarse ware. Heights: 5.7 and 4.4 cm.; top diameters 10.5 and 9 cm. Dated as approximately A.D. 1200. Milwaukee Public Museum Collection, Museum Nos. 26542, 26543. See Barrett 1933: Pl. 95. Photo Milwaukee Public Museum.

Acknowledgments

I wish to express my gratitude to the Trustees of the Milwaukee Public Museum and to the National Science Foundation, under whose auspices the 1961-62 archaeological research in Guatemala and Mexico was undertaken. Thanks are also extended to Gordon Wasson for the use and photographs of the specimens in his collection (Figs. 2-5) and for his never-failing help and encouragement toward research in mushroom lore. To Bruce Warren and Lee Parsons goes my appreciation for their stimulating ideas and comments, and for the use and photographs of the various specimens shown in this article as Figs. 1, 6, 7, and 10. Thanks are also due to Jose Luis Franco, Matthew Stirling, Stanley Boggs, Gareth Lowe, Richard E. W. Adams, and Jorge Guillemin, for supplying various useful data and comments. The map (Fig. 8) was prepared by Milwaukee Public Museum artist, Leland Tishler.

References

1. BARRETT. S. A. 1933 Ancient Aztalan. *Bulletin of the Public Museum of the City of Milwaukee*, Vol. 13. Milwaukee.
2. BOGGS, STANLEY H. 1950 "Olmec" Pictographs in the Las Victorias Group, Chalchuapa Archaeological Zone, El Salvador. *Notes on Middle American Archaeology and Ethnology*, Vol. 4, No. 99, pp. 85-92. Carnegie Institution of Washington, Cambridge.
3. DE BORHEGYI, STEPHAN F. 1952 Notes and Comments on "Duck-pots" from Guatemala. *Middle American Research Records*, Vol. 2, No. 1. Middle American Research Institute, Tulane University, New Orleans.
4. DE BORHEGYI, STEPHAN F. 1957 Mushroom Stones of Middle America: A Geographically and Chronologically Arranged Distribution Chart. In *Mushrooms, Russia and History*, by Valentina P. and R. Gordon Wasson; Appendix to Vol. 2. Pantheon Books, New York.
5. DE BORHEGYI, STEPHAN F. 1961 Miniature Mushroom Stones from Guatemala. *American Antiquity*, Vol. 26, No.4, pp. 498-504. Salt Lake City.
6. BRIGHAM, WILLIAM T. 1887 *Guatemala, the Land of the Quetzal*. Scribner, New York.

7. RINTON, DANIEL G. 1898 Mushroom-shaped Images. *Science*, n.s., Vol. 8, No. 187, pp. 126-7.
8. DRUCKER, PHILIP 1943 Ceramic Stratigraphy at Cerro de Las Mesas, Veracruz, Mexico. *Bureau of American Ethnology, Bulletin* 141. Washington.
9. FOSTER, GEORGE M. 1948 Some Implications of Modern Mexican Moldmade Pottery. *Southwestern Journal of Anthropology*, Vol. 4, No.1, pp. 356-70. Albuquerque.
10. FOSTER, GEORGE M. 1955 Contemporary Pottery Techniques in Southern and Central Mexico. *Middle American Research Records*, Pub. 22, pp. 1-48. Tulane University, New Orleans.
11. HEIM, ROGER AND R. GORDON WASSON 1958 *Les Champignons Hallucinogenes du Mexique; Études Ethnologiques, Taxinomiques, Biologiques, Physiologiques et Chimiques*. Editions de Museum National d'Historie Naturelle, Paris.
12. KIDDER, A. V., J. D. JENNINGS, AND E. M. SHOOK 1946 Excavations at Kaminaljuyu, Guatemala. *Carnegie Institution of Washington, Publication* 561. Washington.
13. LONGYEAR, JOHN M. III 1944 Archaeological Investigations in El Salvador. *Memoirs of the Peabody Museum of Archaeology and Ethnology*, Vol. 9, No.2. Cambridge.
14. LOTHROP, SAMUEL K. 1926 Pottery of Costa Rica and Nicaragua. *Contributions of the Museum of the American Indian, Heye Foundation*, Vol. 8. New York.
15. LOTHROP, SAMUEL K. 1933 Atitlán: An Archaeological Study of Ancient Remains on the Border of Lake Atitlán, Guatemala. *Carnegie Institution of Washington, Publication* 444. Washington.
16. LOWE, GARETH W. 1959 Archaeological Exploration of the Upper Grijalva River, Chiapas, Mexico. *Papers of the New World Archaeological Foundation*, No.2. Orinda, Calif.
17. RICHARDSON, FRANCIS B. 1940. Non-Maya Monumental Sculpture of Central America. In *The Maya and Their Neighbors*, edited by C. L. Hay and others, pp. 395-416. Appleton-Century, New York.
18. SANDERS, WILLIAM T. 1961 Ceramic Stratigraphy at Santa Cruz, Chiapas, Mexico. *Papers of the New World Archaeological Foundation*, No. 13. Brigham Young University, Provo, Utah.
19. SAPPER, CARL 1898 Piltzförmige Götzenbilder aus Guatemala und San Salvador. Globus, Vol. 73, No. 20, p. 327. Braunschweig.
20. SHOOK, EDWIN M. AND ALFRED V. KIDDER 1952 Mound E-III-3, Kaminaljuyu, Guatemala. *Carnegie Institution of Washington, Publication* 596 (*Contribution* 53). Washington.
21. STIRLING, MATTHEW W. 1957 An Archaeological Reconnaissance in Southeastern Mexico. *Bureau of American Ethnology, Bulletin* 164. Washington.
22. THOMPSON, J. ERIC S. 1948 An Archaeological Reconnaissance in the Cotzumalhuapa Region, Escuintla, Guatemala. *Carnegie Institution of Washington, Publication* 574 (*Contributions to American Anthropology and History*, Vol. 9, No. 44, pp. 1-95). Washington.
23. WASSON, VALENTINA PAVLOVNA AND R. GORDON WASSON 1957 *Mushrooms, Russia and History*. Pantheon Books, New York.
24. WAUCHOPE, ROBERT 1950 A Tentative Sequence of Pre-Classic Ceramics in Middle America. *Middle American Research Records*, Vol. 1, No. 14, pp. 211-50. Middle American Research Institute, Tulane University, New Orleans.

MILWAUKEE PUBLIC MUSEUM
Milwaukee, Wisconsin
September, 1962

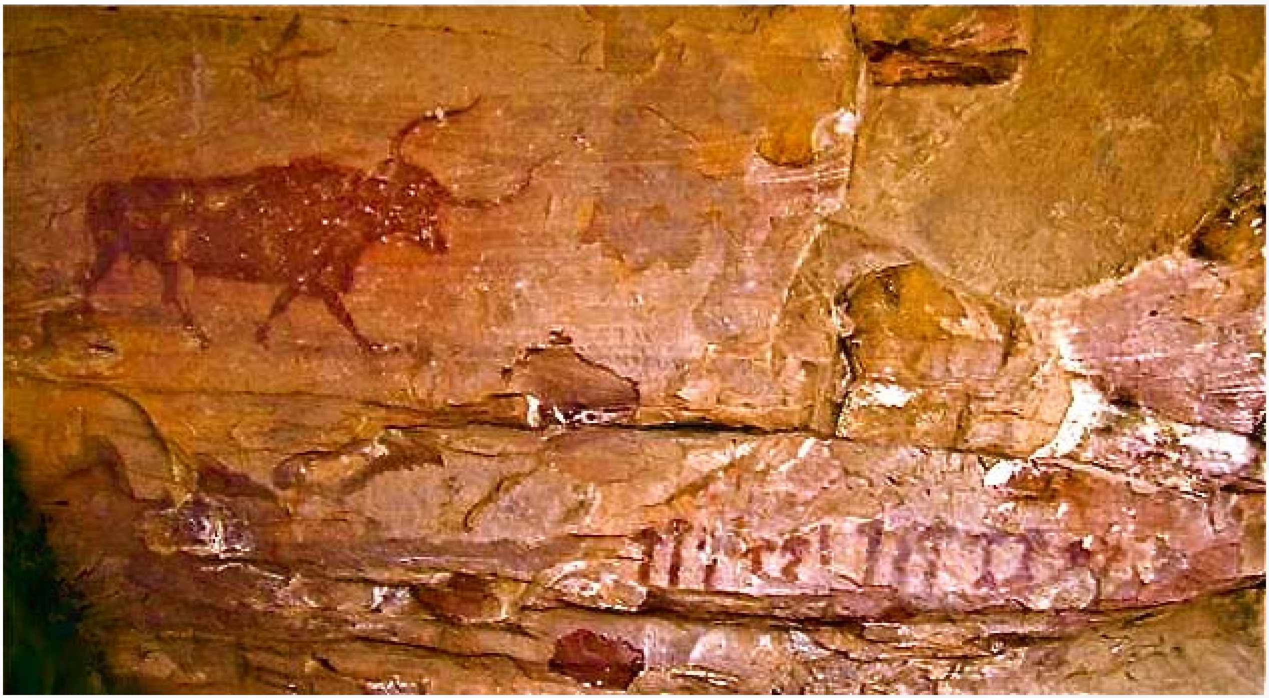
A Cave In Spain Contains the Earliest Known Depictions of Mushrooms

by

Brian Akers

original text: http://www.mushroomthejournal.com/a-cave-in-spain-contains-the-earliest-known-depictions-of-mushrooms/

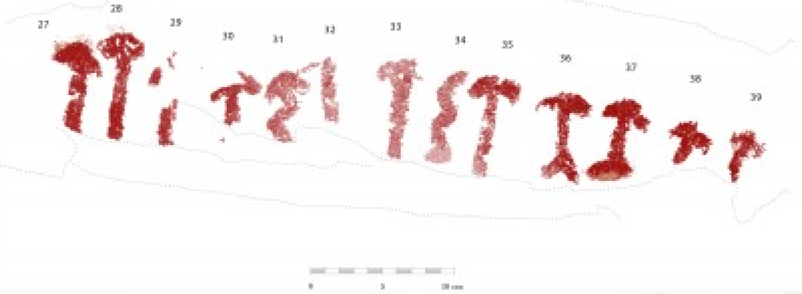
Selva Pascuala is a prehistoric archeological site in Spain with fungoid rock art. An upcoming article in *Economic Botany* reports on recent study there by an international multidisciplinary team. Research united archeologist Juan Ruiz, foremost expert on this site, with mycologists including Gaston Guzman, the leading authority on *Psilocybe*. Results suggest post-Paleolithic ritual use of psychoactive fungi. Comparison of local fungi with the fungal pictographs even pointed to *Psilocybe hispanica* as possibly the species depicted there. MTJ previews findings with the corresponding author, who first learned of the site thanks to his co-authors Carl Ruck and Alan Piper.



The Selva Pascuala rock painting, with bull at upper left and mushrooms lower right.
Photo by Alan Piper

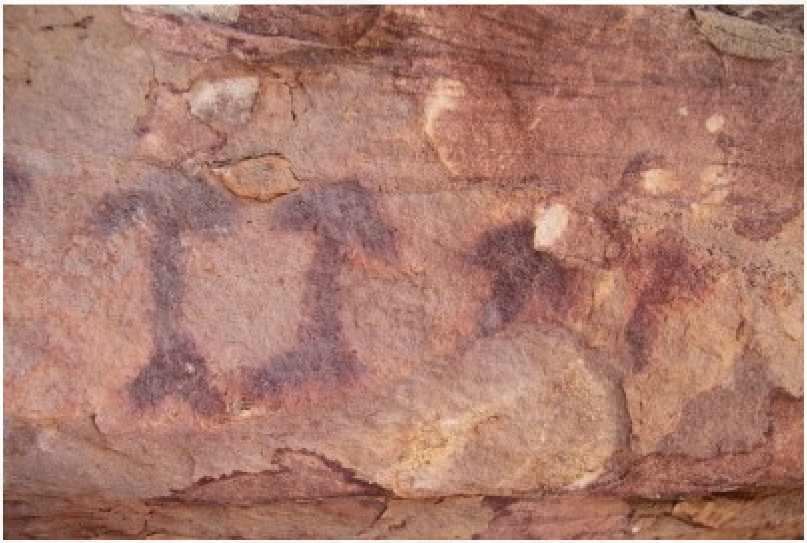
Leon: Can you tell a bit about this discovery, what's actually there? If we just start arguing medias res no one's going to know what we're talking about.

Brian: The Selva Pascuala rock shelter is a landscape formation in eastern Spain discovered by an archeologist in 1918, with prehistoric painted rock art; two panels including the one of interest, a mural prominently featuring mushrooms and a bull. It's one of a couple dozen similar sites with Mesolithic-Neolithic rock art in Spain's Mediterranean basin. The styles and content of this post-Paleolithic art in eastern Spain recall the older, more famous Paleolithic cave art, except it doesn't illustrate species that went extinct after the Ice Age ended and it's not found deep in caves, more open sites being typical. I was pretty startled when Selva Pascuala was brought to my attention, with its remarkably expressive art style, and this fungal angle. If ever there was archeo evidence on fungi - especially psychoactive in regional European prehistory, that could perhaps stand up to hard peer review for proper critical presentation as such - it looked like this might be it.



Selva mushrooms on their own.
Photo courtesy of Juan Francisco Ruiz López

Aha! Hmm... some of those look like mushrooms; some of them don't. Interesting.



Broken mushroom images of Selva Pascuala.
Photo courtesy of Juan Francisco Ruiz López

Ah; but when is "look like" reliable, versus deceptive? And which way might we more likely be fooled, in that case? Good point you raise: what are we seeing here in the mural? Perhaps the evidence itself can shed light; as I think it must. In that vein, see what you think about this close-up shot, zeroed in on caps in doubt. That's Triassic sandstone, not the most durable rock. And these figures are 6-8K years old, from carbon dating. Just think of the elements working their evil hand on that surface over that long haul of time! What we see is nothing pristine, only what's left. Where caps are missing we can see cratered pockmarks, rock face lost to the ravages of time and natural processes.

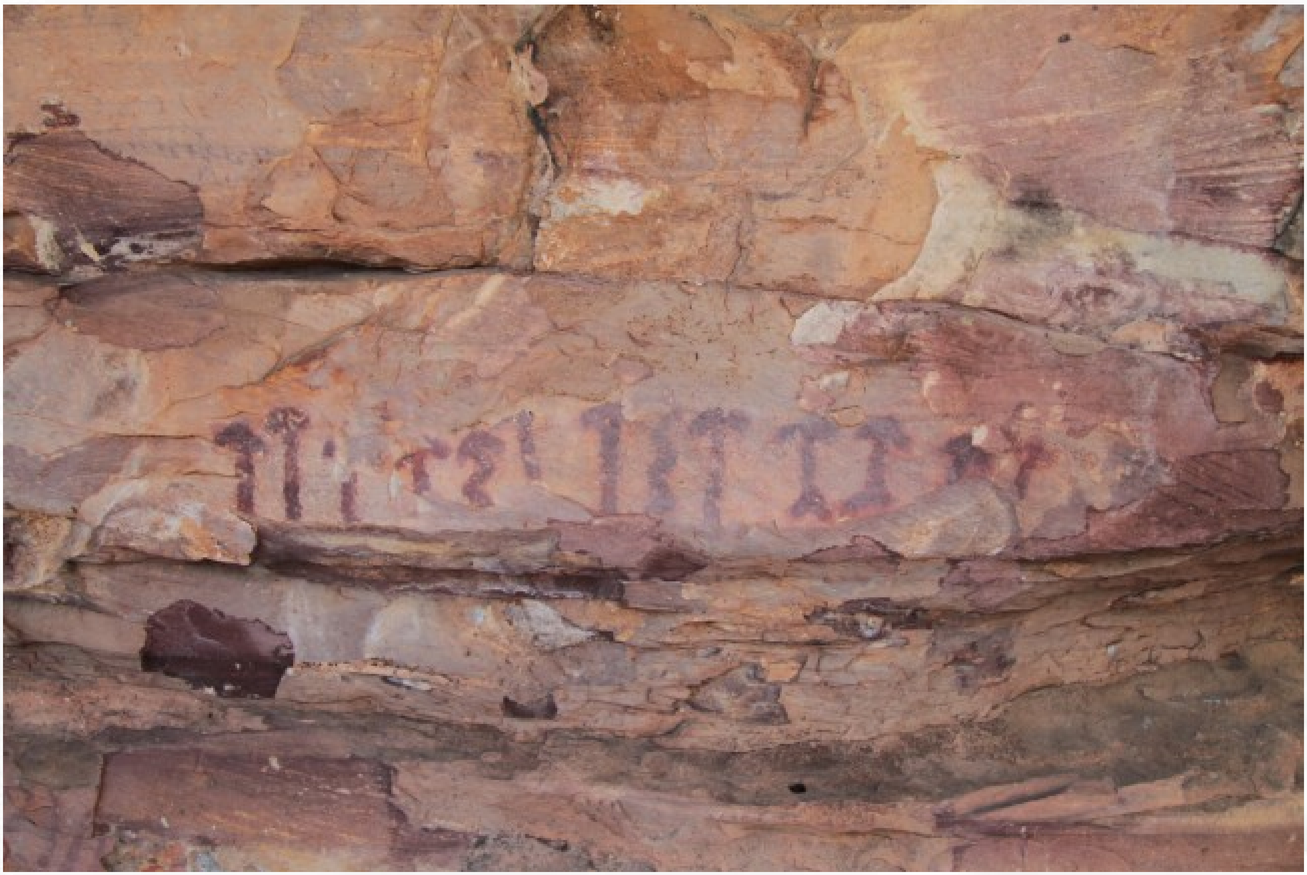
Some of the figures are fairly well preserved, good data points. But beware of others that are more worn, inviting misimpression. Stalks are mostly intact, but - it's like that old bumper sticker says: depileation happens. Erosion has made some mischief here; that minx, what a lively sense of humor. Long story short, the case of the purloined pilei proves something of a red herring; a Scooby-Doo caper by Mother Nature and her gang (she might have gotten away with it too, *if not for those meddling kids*).

But your larger point is crucial: are these mushrooms we see before us? - the very heart of the matter. Perhaps we could instead determine the figures are abstract 'signs' we can't 'decode;' and any resemblance to actual fungi, living or dead, is purely coincidental, or in the eye of the beholder? Indeed, how can we be sure the bull is a bull, for that matter? Maybe in some essential sense it's really an enigmatic figure; onto which we unwittingly project a culturally arbitrary notion "bull," imaginatively - like seeing shapes in clouds, perhaps? Maybe everything is 'just a social construct?' Sort of like evolution, 'just a theory'? What if, objectively speaking of course, there's no such thing as objectivity? Is everything relative, absolutely? I can get a bit apprehensive of slipping through a looking glass at some point, following deliberation along some lines.

Nothing against rationalism (as opposed to rationality); or torture of reason, clever rhetoric, whatever. But golly, what about evidence? The mural shows not one or two, but thirteen figures in a row; which affords pretty good comparison. And as we can see, it's no mere static repetition of some abstract motif or design logo. True, it's not photo realism. But it distinctly illustrates a range of interesting variation in the stalk and cap, resembling individual differences in actual specimens, whatever species. I don't think you have to be a mycologist to see that; *but it couldn't hurt* ;-).

It's this richer, more myco-detailed information in the mural, along with the generally mushroom-like appearance, that I think speaks for itself. There's really quite a bit there to explain. I'd welcome a plausible alternative hypothesis; or a statistical test.

Not to tout science, but I find the better emphasis rests in good data, no matter what theory it supports. Front burner: evidence. Otherwise, we can slip into 'believe it or not.' Its too easy to get swept away by theorizing, rhetoric, hermeneutics - tools of philosophy predating the scientific revolution. Ecce homo.



The mushrooms of Selva Pascuala in situ.
Photo courtesy of Juan Francisco Ruiz López

I do see your point about the variability of the rock images matching the variability in the mushroom. That's quite nice! But I don't know about the psychotropic interpretation - there are no rainbows emerging from the mushrooms, after all; and certainly the mammals in the picture aren't psychotropic.

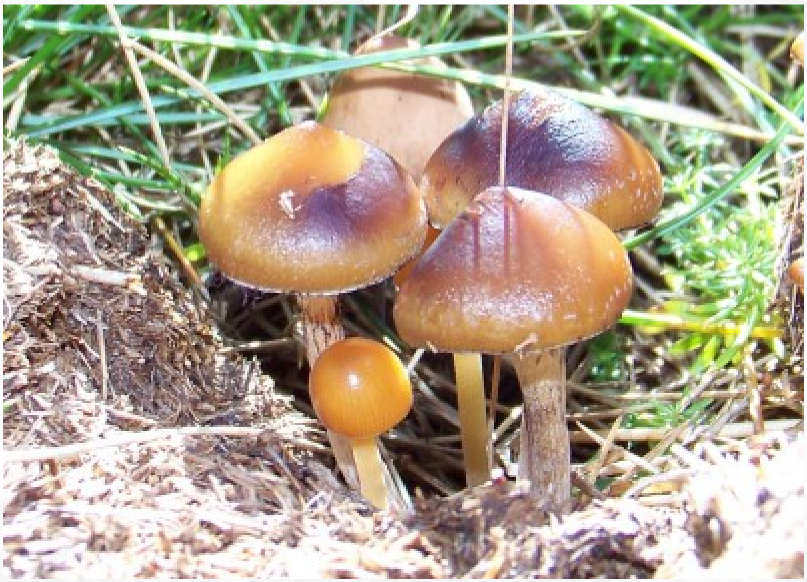
Many a true word is spoken in jest. And once again, you touch on key points - did you mean to do that? One might be a general premise, that the modern counterpart of native ritualism is our carefree, ever-loving rainbow counterculture. The Indians are trippers, dude; and Selva Pascuala points to stone age stoners, right? Such a notion may hold some romantic appeal to our inner psychedelic caveman. And it offers news copyists an angle - which makes it the story, no?

Well, popular fancy aside, I don't know of any indigenous concept of being a 'tripper' (or not). Native customs aren't some freaky-radical, far out thing. Shamans are more like - square. They carry the old folks' seal of approval; any fungi involved, too. Native rites aren't against a mainstream, like some generation gap or rebellion (much less partying!). They're deeply rooted, within norms, and uphold what the old folks say; consultation services of a specialist with both ritual and material business aspects. Going to church, or the doctor, native style, might be a better analogy than a Dead concert, or Burning Man (or rave, 'acid test' etc.).

It's a subtle point; all nuance. Even some anthropologists have said things like: "Psychedelics may be new to modern society, but users seldom realize they're merely reverting to ancient, traditional practices." Well, same type fungi may figure in both settings, true. And such an idea may be stimulating. But I find a fundamental contrast, not comparison, between native contexts of usage and the contemporary subculture of popular

interest - psychedelia. To me they seem fairly unrelated cultural patterns, even opposite. So for our post-Paleo mural, I'm not sure how much of a test we can get from rainbows. I know you're kidding to a degree, and I don't mean to sound all serious. But you deftly touch on some things aswirl in the mix here.
True, the herbivores aren't even psychoactive; but I bet they're still righteous smoke (mmm bbq). Seems a safe bet those species were present in that locale back when too, along with any fungi the mural portrays. Just to make sure you know, *Psilocybe hispanica* happens to be coprophilic; grows in manure too. Sheer synchronicity; maybe. Or were you just having a l'il fun?

My remarks were playful, but the serious portion of them would be that it's hard to see how one could narrow those illustrations down to any particular mushroom? They are, after all, quintessential LBMs - just brown pigment in a mushroom shape!


A cluster of *Psilocybe hispanica* in horse dung. The caps are light brown, and some of them are showing dark purplish spore deposits dropped by other mushrooms in the group.
Photo by Ignacio Serál

Funny, what my field guide says: "*Psilocybe hispanica* is the quintessential LBM!" Next question? Sorry; trying to kid. Of course you're so right again. Armchair theorists might roll eyeballs, go 'humbug' at any suggestion, even the most general, of mushrooms in rock art - but now, species? They'd have a field day. Surely no evidence could bear the weight of such a claim; and water boarding needed to force it in the first place! But you word it right and well I think, as a "how" question. Any answer must logically lie in method; otherwise Rorschach effect awaits. We get any result we want that way. Ancient astronauts, anyone? Evidence resides not in arguments, or how something looks to us (whoever we are), but what can be shown or demonstrated.
In this case, it boils down to visible, verifiable similarities between the figures in the mural, and regional *Psilocybe* species. Specifically, Gastón Guzmán alerted us to this *Psilocybe hispanica*, its manure habitat (a possible link to the mural's bull), and overall match with the pictographs. He cited *P. semilanceata* too, as a better-known species more widely distributed. But he noted it has a typically narrower pileus than *P. hispanica*, and a more acute apex, thus resembling the mural less closely; nor does it grow in manure.

Since publication, I've heard from Ignacio Serál, who lives in *P. hispanica*'s neighborhood (Aragon region). In fact it was Ignacio who discovered it, and brought it to Guzmán's attention (through Jonathon Ott, I'm told). Ignacio would be thrilled if that's his mushroom in the mural; but he notes *P. semilanceata* can also have a somewhat broadly bell shaped cap, like the figures. And, he suggests its more acute apex is just too fine a point (ahem) to hold much weight of analysis; which is only sensible I think, especially considering the graphic style and technique of the fungographs (not as fine-tipped as the bull). Above all he points out, although *P. semilanceata* may not grow in manure, it has a definite preference for manured grounds, where in fact its common. So it could be related to the mural's bull by common habitat, just as well as a coprophilic species. In fact, *P. hispanica* has been found at only one locale so far, about 170 miles from Selva; and only in horse manure not cattle. True, coprobic species can usually grow in either. Bottom line, insufficient data; inconclusive. So I can only agree, there's good reason not to over-emphasize any one species, and better not to

sharpen that pencil lead too much. That the area harbors species matching the mural, rather markedly, is the important finding; the core hypothesis being that the mural portrays genus *Psilocybe*.
With its wide distribution, *P. semilanceata* has long had a place in post-Wasson notions of mushroom rites in prehistoric Europe. Nor is close encounter with it unlikely, as a 1799 poisoning case of record may reflect (Sowerby 1803, for myco-hardcores). Seems its path has crossed ours, well before the advent of magic mushroom hunting. Big picture is, at least two regional *Psilocybe* species have features similar to the pictographs, both found in manured fields. And ethnographically, I doubt our post-Paleolithic Pascualans would have necessarily differentiated one from the other, as in our species concepts and classification.

Broad-capped *Psilocybe semilanceata* from nearby Spain.
Photo by Ignacio Serál

Well, it seems a bit disingenuous to say that your interpretation of the painted mushrooms as hallucinogenic was vindicated Gaston Guzman's ID of them as *P. hispanica*. Of course he's an expert, but you decided to enlist him and not, say, Maj Padamsee, our current expert in *Psathyrella*. When you asked Gaston for an opinion, you could be pretty sure that he wasn't going to say "You know, I just don't think it's a *Psilocybe*; I think it's some other sort of LBM."

Looking back, maybe I could have been sure, as you say - if such a thought (or worry?) had crossed my mind! But I didn't have any prior frame for what or how Guzman might advise or not. I was certainly interested to know, of course, and meant to find out. I figured the mural would be of interest to him in any case, and considered him the source par excellénce for possible comparison with *Psilocybe*. That there might well be one seemed clear; but I didn't explicitly ask him, "Do you think ...?" I figured no need; that question was in plain view, written right there on that wall (so to speak).
I don't know Maj Padamsee, though I'd be delighted; any mycological input on our mural would be of interest. But the idea that it illustrates *Psilocybe* goes well beyond graphic details that visibly match, beyond mycology itself, to the anthropology of fungi and the cross-cultural profile of *Psilocybe*; especially compared with something like *Psathyrella*. True as you hint, these genera look LBM-alike, but - they're miles apart ethnographically.
Not that *Psilocybe* ritualism is widespread, but it does exist. And it's no freak. It has its context, analogies; it ties in squarely to larger cultural patterns. By comparison, I don't know of any rites particular to *Psathyrella* across culture, nor even many secular applications. The Haitian 'djon-djon' [a *Psathyrella* that is a popular edible mushroom there], is an exception; but I wonder if that's deep-rooted tradition, or does it mainly reflect history, local poverty, resource crisis (nothing to eat?).

Various fungi are widely depicted of course, endlessly celebrated in art; but mainly in mundane, non-ritual contexts. Hallucinogenic-looking fungi may slip into kitchen decor, if they're pretty enough (depending on the kitchen?). But its hard to conceive a taxon of such scant cultural presence as *Psathyrella* sneaking into rock art. I'd agree though, it would have to be considered - if fungal morphology were all we had to go on, unaided by a bigger picture from ethnography, regional and site archeology. But this is why the broad interdisciplinary framework is vital for study here. I'd suggest a non-psychoactive LBM is simply unlikely - but on more specifically cross-cultural, rather than mycological, considerations.

It may seem a bit silly for prehistoric people to get all excited about a *Psathyrella*, or a *Conocybe*, or whatever, but we don't know what tastes they had. Larry Millman did a stint with former headhunters in Borneo, and found that their favorite edibles were *Xylaria polymorpha* (when young and just emerging: "pig's nipples") and *Calostoma cinnabarina* (pig's eyeball; they seem to have a thing for pigs). On one walk, they found a large *Agaricus*. Larry got all happy over it and told them how popular it was in America, and the head-hunters got all embarrassed and had to work real hard to find tactful things to say about our strange custom.

Whoa, hip ethnomycographic data. What a difference it makes when a cross-cultural observer knows an actual fruiting body from a carpophore. Sounds like he gave those ex-headhunters a nice little cultural moment too. Chalk up another *Agaricus*-related faux pas? But if they eat dead man's fingers, does that make them cannibals as well? Ah, the varied customs of different peoples. Strange in general, and food-wise; 'fungal delicacies' too. Well, you tell Larry Millman's Bornean friends they must not have read wikipedia on *Xylaria polymorpha*; it plainly says: "inedible." Which letter of that word do they not understand? But now what's this stirring; curiosity, to - taste it?
No slight to strangeness. Hey, how about our popular contemporary 'mushroom hunting' culture pattern? You know, the one we know and love, excitedly share; spread like a disease if we can? Shall we compare such passion to a summer fugu feast? Well, I'm sure every culture has its "extreme sports" (not always culinary), ways of walking the proverbial razor's edge, laughing in the face of death. I love my wild fungal goodies, I consider the hours I spend porcini-hunting golden. But is it risky; shall we count the ways? The customs, the species; take our weird celebration of *Laetiporus* for some choice edible fungus - please! Ok it tastes real good. And many can eat it without ill effect to whatever degree. But it has sure sickened some; I can testify (can I get a witness?). Only one confirmed kill on record for it, or at least, reported in NAMA's 30-year study.
But I gather our headhunter data concern food procurement, a general economic-subsistence activity. I'd emphasize that as a secular rather than ritual function. And the archeo data are important here, because our mural's signification rests on the interpretation of the entire site. It's possible the figures have no ritual meaning, but I suggest it's unlikely. For one thing, neither these painted rock shelters in Spain, nor the caves with Paleolithic art, were habitation sites.

Contrary to a scene from ONE MILLION YEARS BC, etc, nobody was living at these places, decorating their domicile. These are remote, austere locations, far from the beaten path and difficult to reach - even hazardous. Visiting them would be serious business, on clear intent. To just see it, gawk? A consensus has been emerging among specialists over decades that these sites generally reflect some sort of magico-religious use and meaning, likely including shamanistic. You've read up Lascaux, I bet, ideas about it; "scene of the dead man" there - he's nawt dead he's tranced out (?).
As you astutely intimate, fungal customs across culture are a many-splendored thing; and we need more data to improve our basis for comparative analysis. Still, perhaps we know enough to ask what kind of fool prehistoric ritual site would feature iconography of fungi merely edible rather than psychotropic (no matter how delicious)? In its cultural context, Selva Pascuala likely reflects not culinary but rather ritual use of fungi. But I must say you frame the questions superbly, bringing greater clarity to them with your solid fungal know-what; no call to dumb down gory details. Indeed, this type inquiry needs cross-cultural myco data like you cite - a refreshing change of pace. More often I see questions 'jumped,' raised without well-informed basis; judging by some "oops" glaring myco-bloopers I witness in some of the literature.

The Torre Balbina, a spike of stone on the ridge overlooking the Selva Pascuala cave.
Photo by Juan Francisco Ruiz López

Maybe they're boletes, a yummy food in the area.

Well, now, them's much better fixin's for "The Fungal Gourmet Goes Native." No denying, broader appeal there, rich traditions. But again, the whole ritual aspect... and - hey now, boletes aren't even LBMs! (are they?) Although hm, not sure now what percent serious you are, and what percent kidding. Or were you playing "both sides against the middle" perhaps (you crafty man)?

I was partly kidding about the boletes; though in that part of Europe I'd be more on the lookout for *Lactarius deliciosus* if they were going to depict an edible.

"That part of Europe!" You sound so traveled, so worldly. Know the region? Alas, I'm so provincial; just a good old boy. But if we're back to single species ideas, this mural might be getting to you? Although, following a cross-cultural data trail leads to a more comprehensive framework of myco-ethnology. Maybe another major perspective waits there for our multidisciplinary foundation; one last main angle of lighting maybe, on the relative likelihood an edible fungus would be depicted in this context.
Some anthropologists theorize that subsistence mode, the material adaptation by whatever tools/techniques to whatever food sources, more or less shapes the rest of any culture, i.e., social life, narrative and ritual traditions etc. 'Cultural materialist' theory follows from Marx - sort of hailed (in 'campus rad trad') as a

founding father of social sciences - that our thoughts, beliefs, etc., are largely dictated by our circumstances. Man's mind does not determine his material conditions; rather, man's conditions determine his mind - sort of thing. Sounds vaguely Nietzche-esque, recited that way, doesn't it? Well, those were days, an era of history - "it was a simpler time ... "

But certainly, physical sustenance, metabolic nutrition, is fundamental - a bare necessity. And across culture we'll find a wide gap there, for the relative significance of mushrooms compared to animals and plants: to my knowledge, without exception, no matter what the culture pattern, every society the world over is critically dependent for its survival, exclusively, on plants and animals as food, in whatever proportion. There's no culture anywhere in which fungi, however consumed or enjoyed, are vital as sources of nourishment. Fungi mostly don't contain much energy. Like celery and onion, they add a lot of flavor, and may have vitamins and iron. But they don't pack the carbon nutrition, the digestible proteins, lipids and carbs to serve as staples for our metabolic needs. Various species may be eaten depending on local traditions, which run the gamut. But there'd be no hunger crisis without mushrooms; one of cuisine maybe.

Plants and animals on the other hand, select species (cereal grains, legumes and root crops), have been humanity's lifeline; still are. They've stood between our kind and starvation from before we were bipeds, as they will into futurity. Fungi have claims upon us, but no such importance as that. Rather, the greater cross-cultural mark they've made in pre-history seems to stem from the psychoactive effects of certain species, and the resulting cultural interactions or responses, especially in terms of religion, myth and folklore, or story and narrative traditions, etc.

Many anthropologists theorize that shamanism in whatever form(s) was a major foundation of prehistoric culture, ultimately ancestral to medicinal practices and religion as known historically. Consider the significance of the animals shown in rock art for a prehistoric stage: hunting-gathering, nomadic herd-tracking - physical survival totally dependent on those prey, all bets placed there. They don't have to be psychoactive to be of mortal, ritual importance, and rock art is all about them as we see. Life itself revolves around them. But fungi, to rate sacred, are another matter. So it comes down to their relative economic insignificance - compared with their spiritual-mythic relevance.

I guess it took me a while to get your point about the ritual nature of the site - I was thinking "Well, why should the mushrooms have to be hallucinogenic? The big animals aren't." But if I understand you right, you're saying that mushrooms weren't an important enough food source to rank up there with bison, etc. on that basis; so if they're on the wall it must be for another reason, ergo ... magicness. Is this indeed your line of reasoning?

Exactly, that's the delicate intersection point, where our disciplinary perspectives converge, the ethnobiology. I think you get some idea, perhaps, how multi-component the research aspects are. Its challenging, crisscrossing tripwires of divergent fields, each with its technical depth; a lot to take into account, best as we can if possible. Myriad pitfalls, so many wrong moves possible. A regular temple of doom. But I digress ...

Spain is interesting territory for ethnomycology. I think Wasson's observation of sharp differences of tradition, mycophilic and mycophobic, has some merit. But to explain the pattern, and this ambiguously charged stimulus fungi seemingly present, is a whole 'nother magilla. And of course there's more to the story of fungi across culture than the fallout of mind-altering types. Our site expert and co-author, archeologist extraordinaire Juan Ruiz, isn't convinced myco-cultural prehistory is the root of it all. He considers differences in fungal attitudes between Basque, Catalon and Castilian (the latter reckoned mycophobic by Wasson) may not be so sharp, and variation in vocabulary and customs, etc., may correlate primarily with contrasting ecosystems of their home turf. Richly forested biomes offer more edible and thus commercially valuable species. Native peoples in such regions may appear more mycophilic simply because more fungal resources are readily available to them, he notes. An interesting field study might be done in Spain; strikes me as an intriguing part of the world for such questions.

Though the climate was quite different back then, and perhaps also the trees/mycorrhizal fungi.

Perhaps? Speculation your honor - inadmissible! Actually, good point again, that is a potentially critical factor. We dug into studies on paleoclimate in that part of the world. Whether it was exactly the same as now isn't clear, and there have been fluctuations even in historic times. But the Ice Age was long over by 6,000 BC. And as our article notes, the paleo-eco evidence indicates modern-like forests were well established by then. We see the mural shows familiar, contemporary animal species; but no extinct Pleistocene megafauna, a difference from older Paleolithic art. As climate fluctuates, ecological zones likely creep up or down in altitude, tracking with any change. But we found no basis in past climate data to question the idea that species known in the region today would not have been present 8K years ago.

Are there other cave-paintings of mushrooms elsewhere? If these are our first/oldest depictions of mushrooms, then surely we should celebrate them regardless of why they were created. Is Selva Pascuala the earliest (reliable) depiction of mushrooms?

There are a few other cases of rock art attributed to some kind of mushroom ritualism. But for reliability, I can't put anything next to Selva Pascuala. Its naturalistic style of representation, along with the coordinated archeo and myco study, dated by radiocarbon, etc. puts it in a class by itself, for evidence of its kind. I believe that it's the first such to have garnered critical peer review for proper scientific presentation. As to its age, the only comparison I know of may be rock art in a cave at Tassili, in the Sahara Desert, Algeria, as reported by Samorini. But I'm not sure how secure its dating is compared to post-Paleo rock art of Spain. A popularly published drawing based on one of the Tassili figures has become an icon of post-1990's psychedelia. But Tassili's pictorial style isn't exactly 'from life.' It's nothing even remotely like the semi-naturalistic detail we see at Selva Pascuala. Its vivid but in a different way, abstract-bizarre. Alas, poor Tassili: it's among the sites favored by ancient ET theorizing; nice competition for mushroom fancies eh?

I've seen photos online of the Tassili "bee-headed shaman" and - quite apart from the bee-headedness - he's drawn as if he's wearing mittens in the original, which does not stop all the redrawings of him from having several mushrooms sprouting from each hand. I find the leap from one to the other really strange. If that's the closest competition, then it seems that Selva is by far the oldest mushroom images that we have.

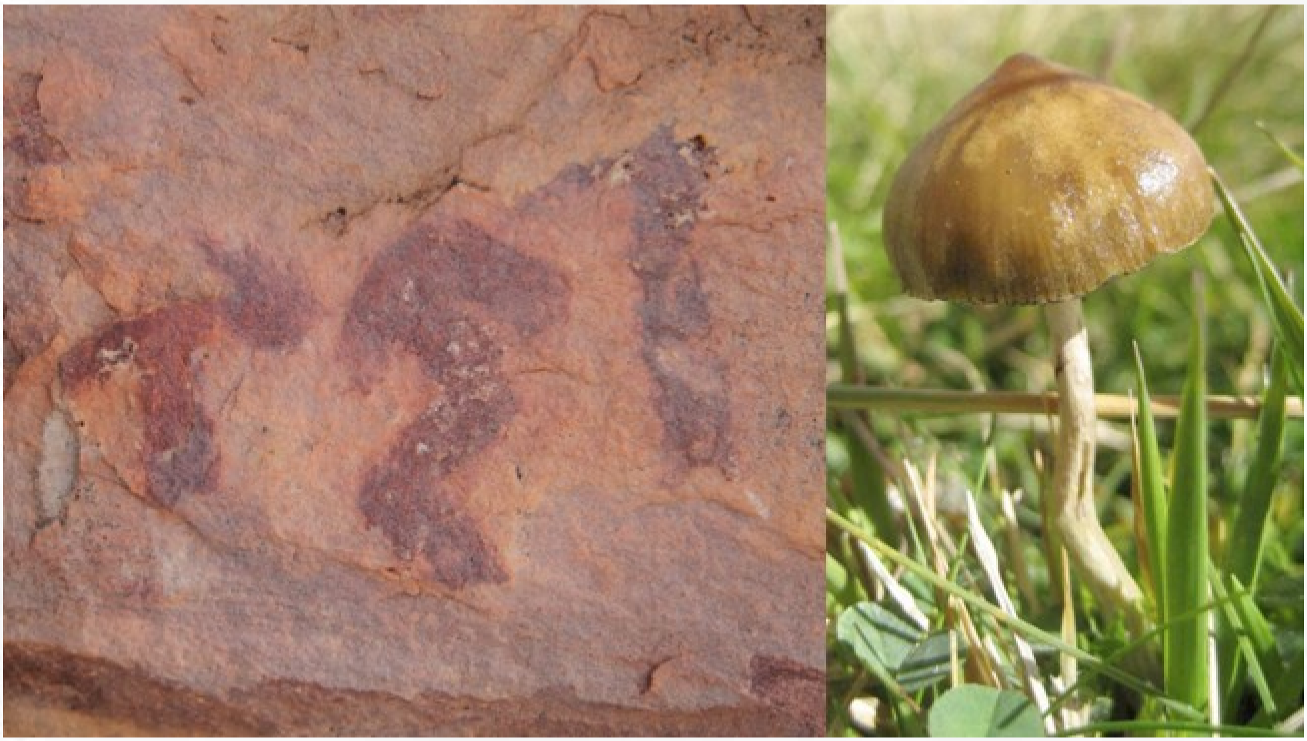
Yes, Tassili is a sitting duck for Ancient Psychonaut Theory. And any similarity to antique aliens may be coincidental or not, based on observations of contemporary subcultural patterns emerging in the wake of events since LSD's discovery. The term "Martian" appears in Tassili reference by the 1950's, before von Daniken - but within the flying saucer era. Le Quellec ("Shamans and Martians: The Same Struggle") compares a 'shamans everywhere' trend directly to the search for 'clues to an ancient extra-terrestrial presence in archeological remains.' I enjoy imaginative entertainment; but there's a potential for exploitation that can adversely affect research prospects (Le Quellec speaks of 'archaeomania'). Various 'interests' hover around, hoping to distract, or wanting it to prove something for them. How evidence is handled matters, depending on the purpose. It can become a foundation of understanding, or a banner for a cause; even a sideshow exhibit in a circus.
Another prehistoric fungal rock art site fortunately hasn't been so propagandized. It was found in northern Siberia by a Russian anthropologist, Dikov, on rocky formations in the Pegtymel River region. I don't know of any radiocarbon dates, but it's judged as prehistoric based on lichen growth and archeological sequences, regional styles. It's not as old as Selva Pascuala and, again, the graphic style is pretty abstract. But the region is well noted for fly agaric traditions. Shamanism there may likely be of Paleo-Siberian origin, based in part on cultural comparisons in N. America.
So, the ethnomyco interpretation of Pegtymel is supported by cross-cultural and regional data; it's just not as old. Still, a determined armchair theorist can simply argue at any hint of rock art and shamanism, or prehistoric mushroom rites. You can lead a horse to fungal pictographs, but you can't make it see them? Well if so, I think that's the horse's problem.

It's actually a fight that science has gone through for ages - pretty much the same one that Galileo had to put up with when he showed that objects fall at the same speed (when factoring out air resistance) whereas the standard wisdom at his time was that of course it was logical that heavier objects would fall faster.

Right; and it's what he could show that frosted that cake, not how it "looked to him" (we've each got our little coke bottle lens through which see things, I'm sure). That's a 24-carat example you cite, of "logic" vs. method; actually checking to see. Like the bear over the mountain; he didn't sit around philosophizing, much less arguing what he might see if he bothered. He went to the trouble, got up off his bear butt to have a look; did the Galileo. By some of Wasson and company's work, we might have almost predicted a discovery like Selva Pascuala. But reliability is relative, beyond conclusive test. We're not saying this is absolutely, 100% certain what was going on. We're just saying that this is the only explanation that there's evidence for. More evidence may turn up, showing us to be wrong. But it makes no sense to say "I don't believe that hypothesis" simply because you're uncomfortable with the notion of Mesolithic people using *Psilocybes* in a ritual context.

That's why fungal expertise is indispensable in such a unique case. Archeology is no exact science. Current understanding mainly reflects disagreement, ruled more by things we don't know than what we do. Its one theory against another.

Following our co-author, double-aught archeologist Juan Ruiz, rock art studies try so hard to prove things; when the best we might reasonably hope for at present is simply to adduce a solid hypothesis, uncover a forward trail. BTW there are other sites in eastern Spain, similar age, that also have fungoid-looking rock art; some in the vicinity of Selva Pascuala. Found a 'google image' pic labeled to one, Peña Escrita (looks like "praying mantis man" near the bottom).



Comparison of painted mushroom with present-day *P. hispanica*, showing the bent stem.
Photo of *Psilocybe* by Ignacio Serál

In the *Psilocybe* photos, I notice the crooked/bent stem on some of them really does resemble the cave paintings and is quite unusual. I see why Gaston made the connection with *hispanica*. But I have no idea how typical such a stem is for *Psilocybe* in general. The caps [for hispanica] seem to look very typical for *Psilocybes* (in my very, very limited experience, mostly with photos).

Ah, preaching to the choir now; music to my ears. I've stumbled onto some *Psilocybe* species in their habitats, but never had any contact, field or herbarium, with *Psilocybe hispanica*. Nor even close encounters of the Liberty Cap kind, despite how common and widely distributed it reportedly is. But as pics show, *P. hispanica* does pose a remarkable resemblance to our Selva mural. But a grasp of fungal morphology might be well to fully appreciate the correspondence. Nothing you lack; heck you've got that in spades.

But wouldn't you think, as George Bernard Shaw might affirm: such a point is likely lost on the most vocally opinionated; the very parties who ironically might better heed it. The more we know, usually, the less likely we are to be cocksure, the more interested in just finding out (for peat sake) - versus 'verbal volleyball,' debating answers prematurely on false certainty, trying to prove something as if we know, amidst theories in collision.

Candidly: I've noticed a few discussions, purportedly critical, trying to argue against possible fungal rites in ancient Europe - and on some, uh, mycologically strange grounds. You wouldn't believe. One; it seems bold research couldn't find any records of *Psilocybe semilanceata* "spoors" (this is published lit, Leon) in databases (no citation) - for prehistoric *fauna* (italics added, emphasis). Without wondering what sources such research consulted, for methods alone - do you know the word spoor, Leon? Meaning, animal trail? Its embedded in a tangled argument there were 'almost certainly' no stone age *Psilocybe* rites in Europe, because (get this logic) maybe there couldn't have been - because it wasn't even there in prehistory (maybe)! Because they couldn't find any "spoors" to prove it was! So a question not in evidence is simply conjured out of thin air by magic words, "absence of evidence" ginned up by narrative, re-told as "evidence of absence." Get it (snort)? Forgive the mockery, but I'm outraged by some of the stuff that goes down.

At the other end of the scale for investigative (and intellectual) authenticity, I have to thank my co-authors and colleagues at Selva Pascuala for realizing the scope and caliber of the site warranted a close, concerted myco look-see. I hope they're pleased with the way it's turned out. A site like that isn't found every day. By analogy I think of it almost like the 'Lucy' fossil, for its category of evidence.

We're only just scratching the surface of the world around us. We have miles to go before we sleep; light years. There's more to discover than can be discovered, more to know than can be known. Arguing theories, trying to persuade whomever that one makes more sense, has its place. Its a grand tradition, inherited from a golden age. But debate can't take the place of rigorous investigation, following the results wherever they lead. Especially with tools and techniques we have now, methods, instruments; all upon the foundation of centuries to work with, shoulders of giants. Research is inquiry's cutting edge now, at our present historic stage; what we can discover, not suppose. Fungi are a nice case in point. We barely know them; a circumstance not unrelated, I suggest, to their seeming power and ambiguity as cultural stimuli, from aversion to adoration.

I think we know that any talk of 'magic mushroom' rock art can elicit reactions pro or con. Indeed it faces a gauntlet of attitudes, from dismissively dogmatic to uncritically excitable. My co-author Carl takes his share of ribbing over his myco-exuberance, but I have his passion and enthusiasm to thank, among other things, for my invitation to this study. And some points on differing sides may be valid. A distant colleague, specialist in South American shamanism, emphasizes the fine print of questions arising here, the diversity of possibilities a phrase like "rock art shamanism" glosses over, and need for sound ethnographic orientation, not simplistic theoretical framework. What defines shamanism here, primarily? Is it the role and leadership of the ritual specialist? Or is induction of altered consciousness, understood by indigenous concepts of spirits and mythic powers, the central criterion? There are major questions to focus more sharply, an endeavor lost when focus is drawn into arguing over the blunter questions. Amid the fray, theories seems to go a wee bit one-sided at the expense of balance, maybe even tiptoeing around any data inconsistent or conflicting with whatever contention is up to bat, seems to me.

Merely avoiding pitfalls becomes high priority, if so. With the opportunity Selva Pascuala posed, it seemed the important thing would be simply to establish its credibility of study, from rigorous documentation through hard review. If our work makes any progress along such lines, that might be its main value. Now, having passed through its ring of fire, it poses a hard, implicit question: how else to account for the evidence, in all its aspects? The details of the pictographs and the morphology of *P. hispanica* aren't matters of theory or some argument, but findings of direct observation (no squinting or scrying); procedures subject to double-check, independent verification. No persuasion, or "believe it or not" routine.

A greater focus on methods and findings, versus arguing theories pro or con, would seem a promising avenue to advancement for this subject. If our little study, by its emphasis on concerted interdisciplinary study and findings, can find its way through the maze of conflicting arguments, each vulnerable to criticism for bias, perhaps it takes one small step. Seems to me hypotheses of whatever kind are much likelier tempered by doubt, than conviction.

I did read a while back that the idea has gained currency in paleoanthropological circles that quite a bit of the paintings/ markings in caves were done by teenagers, much for the same impulses that teenagers write on walls today.

While it's not prehistoric, ancient wall graffiti has been found in classical ruins - less likely the handiwork of old folks than young (at heart anyway?). But I'd distinguish that categorically from religious iconography, which is what we seem to have in the rock art of prehistoric Europe. No doubt, rock art studies reflect quite a range of notions, discussion points like you cite. I'm no expert, but on impression the whole subject seems complex, and fertile with dubious ideas easy to get. Theorizing has grown downright lively over the years; in fact its increasingly described as "contentious." Amid its swirls and eddies I've also seen "doodling" cited; like on a note pad, talking on the phone, maybe sitting on the couch. I wonder about some of the discussions, which often have a sound such as "nobody can prove ..." (or "prove otherwise"). That's not evidence, that's the old "we don't know, so..." -type argument from ignorance. The intractability of some approaches may be their main lesson to the wary (if we but heed).

Arch-musings may appeal mainly to the "rationalism" of armchair theorists: our temporally provincial, proudly skeptical, thoroughly modern mindset. But for theory, a lot of these ideas prove unexpectedly illogical - ancient

astronauts in reverse, almost. Significant energy and resources were expended to create and attend Selva Pascuala and other such sites. Nothing quite on the scale of the Great Pyramid - we're talking stone age hunters here, nomadic subsistence-settlement, undergoing transition to the Neolithic over centuries, in the prehistoric Mediterranean's unfashionable West End. But we can detect a pattern, well beyond relief of boredom or anything casual, random or impulsive. Teenage signs tend to be left closer to home, where others might see them. I wouldn't rely on the kids these days for explanation of Selva Pascuala (no offense). I hardly think the mural can be understood well in terms of graffiti or prehistoric doodling, however conceived. True, such colorful ideas can cast a certain spell, in their delightfully Trumanesque, tire-kicking "prove it" defiance (I have a soft spot for that stuff, I admit). But they're not "data driven." And they generally lack explanatory power, as I find, by their implicit - and may I say dubious - analogy, between prehistory, and social life as we know it.
Contrary views have a role of course. They're ideal sources for clues to possible flaws in rival theories. So we have more to gain than lose by granting them every consideration. But a fatal flaw they may share is a tendency to over-generalize from minimal evidence. In key ways, Selva Pascuala may tell us little about Australian rock art, for example. But the goal of our study wasn't to prove anything, nor grand theorizing; only to find out about something if we can - whether it proves to be what we think or not.

Is "rational" your own label for the people who proceed purely from argument and not from evidence? Or is it in general circulation and therefore difficult to change? It seems to me that "rational" confers more status on such an approach than it's worth: it's more of a rhetoric-and-logic approach, but logic can still be irrational when it has no rational/evidential foundation. So I would recommend "rhetorical/logical" as a more appropriate label for this approach, or - if you want to be insulting, which of course we shouldn't be - Aristotelian.

You say it well - what have you, been to college? My label along those lines would be "rationalist" actually. I think you and I both use 'rational' the same, for reason, clear thinking, in affirmation. This goes to a fine line between rational, and rationalism - i.e., intellectual justification, etc. Its Freud's concept of rationalization applied collectively, to map ideological contours of society, contemporary non-material culture pattern. I find two major faces of a loose, diffuse rationalist movement (Jacques Vallee calls it). One is "rhetoric and logic" gone wild, which you specifically note; seems names get dropped a bit in that big tent (like Foucault). Juan Ruiz quips, our 'post-structuralist' archeologues would breezily reject relativity and quantum physics, with no interest in the phenomena they account for - and no offer of any better theory - simply because at present physicists don't know how they integrate; and thus can't explain one in terms of the other; as a certain brand of logic demands apparently.
Tracing its outline, I find rationalism has this other side, drawing mainly from scientific knowledge and perspective, not philosophy; some call it scientific materialism or scientism. Rationalism seems to primarily reflect a kind of psycho-culturally driven opposition to irrationalism in various forms (mostly either "old time/age" or "new"). The common ground seems to be a familiar metaphysical premise, that there's an explanation for everything - scientific or logical (our choice) - and no baby, only dirty bathwater in any other perspective ("black tide of the occult," Freud's phrase). Some funambulating to do, I find, between 'rational' and 'rationalistic' - so I appreciate the focus on that fine line. Nice agility too - you're a sport; dodging quicksand at the cutting edge of multi-disciplinary research and inquiry, where the devil's hunter stalks rare game.

Congratulations on your well-deserved cover appearance in/on *Economic Botany*!

Thanks Leon, a humbling tribute; I'm obliged. The darkness of these caves seems a fit metaphor; I appreciate your help trying to light a candle. We're a long way from figuring everything out, but hopefully it's another step in the right direction.

A Prehistoric Mural in Spain Depicting Neurotropic Psilocybe Mushrooms?

by

Brian P. Akers, Juan Francisco Ruiz, Alan Piper, Carl A. P. Ruck

Economic Botany, (XX)X, 2011, pp. 1-8

Received 25 November 2010; accepted 26 January 2011;

original report:
https://www.researchgate.net/profile/Carl_Ruck/publication/225854542_A_Prehistoric_Mural_in_Spain_Depicting_Neurotropic_Psilocybe_Mushrooms1/links/562a1f5d08ae22b170316a67.pdf
backup source: http://www.psilosophy.info/resources/562a1f5d08ae22b170316a67.pdf

Brian P. Akers - New Port Richey, FL, USA (Corresponding author; e-mail: akersbp@hotmail.com)
Juan Francisco Ruiz - Facultad de Ciencias de la Educación y Humanidades, Universidad de Castilla-La Mancha, Cuenca, Spain
Alan Piper - London, England, UK
Carl A. P. Ruck - Classical Studies Department, Boston University, Boston, MA, USA

Table of Contents:

Introduction
The Site and Prehistoric Rock Art in Spain
Antiquity and Dating of the Mural
Interpretation of the Mural and Mycological Identification
Discussion
Conclusion
Acknowledgments
Literature Cited

A Prehistoric Mural in Spain Depicting Neurotropic Psilocybe Mushrooms? The Selva Pascuala mural, a work of post-Paleolithic rock art in Spain, contains fungoid figures herein hypothesized to depict neurotropic fungi, especially *Psilocybe hispanica*, a species that occurs in a neighboring region. This hypothesis is based on features of these figures related to fungal morphology, along with ethnographic analogy, and shamanistic explanations of rock art. If correct, this interpretation would support inference of prehistoric utilization of this fungus in the region. The mural represents the first direct evidence for possible ritual use of *Psilocybe* in prehistoric Europe.

¿Se Representan Setas Neurotrópicas Psilocybe en un Mural Prehistórico de España?. El panel de Selva Pascuala (Villar del Humo, Cuenca, España) conserva pinturas rupestres de cronología postpaleolítica entre las que se incluyen figuras con apariencia de seta, para las que aquí planteamos la hipótesis de que representan setas de efectos neurotrópicos, en concreto *Psilocybe hispanica*, una especie que crece en regiones próximas. Esta hipótesis se basa en las características de estas figuras en comparación con la morfología de dichas setas, a lo que se añade la analogía etnográfica y la teoría del chamanismo aplicada al arte rupestre. Si estamos en lo cierto, esta interpretación apoyaría la posible utilización regional de estas setas durante la Prehistoria. El panel supone la primera evidencia directa del posible uso ritual de *Psilocybe* en la Prehistoria europea.

Key Words: Psilocybe, neurotropic fungi, post-paleolithic, rock art, levantine art, schematic art.

Introduction

Ritual use of neurotropic fungi has been noted in several culture areas, most notably Mexico and Siberia. Almost 20 *Psilocybe* species have been used in shamanistic rites in Mexico (Guzmán 2008). In Siberia, shamans have made similar use of fly agaric, *Amanita muscaria* (L.:Fr.) Pers., a neurotropic fungus with pharmacology differing from that of *Psilocybe*.

These historic traditions of native Mexico and Siberia are well documented, but their cultural origins are unclear. Archaeological artifacts including ceramics from northwest Mexico, plus the so-called mushroom stones associated with the Mayan Classic and Preclassic periods, have been interpreted as evidence for usage of neurotropic fungi in Mesoamerica spanning more than 2,000 years (Borhegyi 1961; Furst 1974). Based on their studies, Wasson and Wasson (1957) suggested even greater antiquity for such practices, and proposed similar traditions were likely more common and widespread in prehistory. (For a recent critique of Wasson and Wasson [1957], see Letcher 2006.)

Evidence concerning the ritual use of fungi in prehistory is scant, but rock art from several regions has been cited in relation to the idea Wasson and Wasson (1957) put forth. Possibly the most ancient example is from Tassili, in the Sahara desert, southeast Algeria. In a cave there, Samorini (1992) found a painted mural dated 7000 to 9000 B.P. portraying fungi, possibly *Psilocybe mairei* Singer, according to G. Guzmán (pers. comm.), a species known from Algeria and Morocco. In northeastern Siberia, Dikov (1971) discovered fungoid petroglyphs on large exposed rocky formations in the Pegtymel River region, apparently of shamanistic significance and likely representing *Amanita muscaria*.

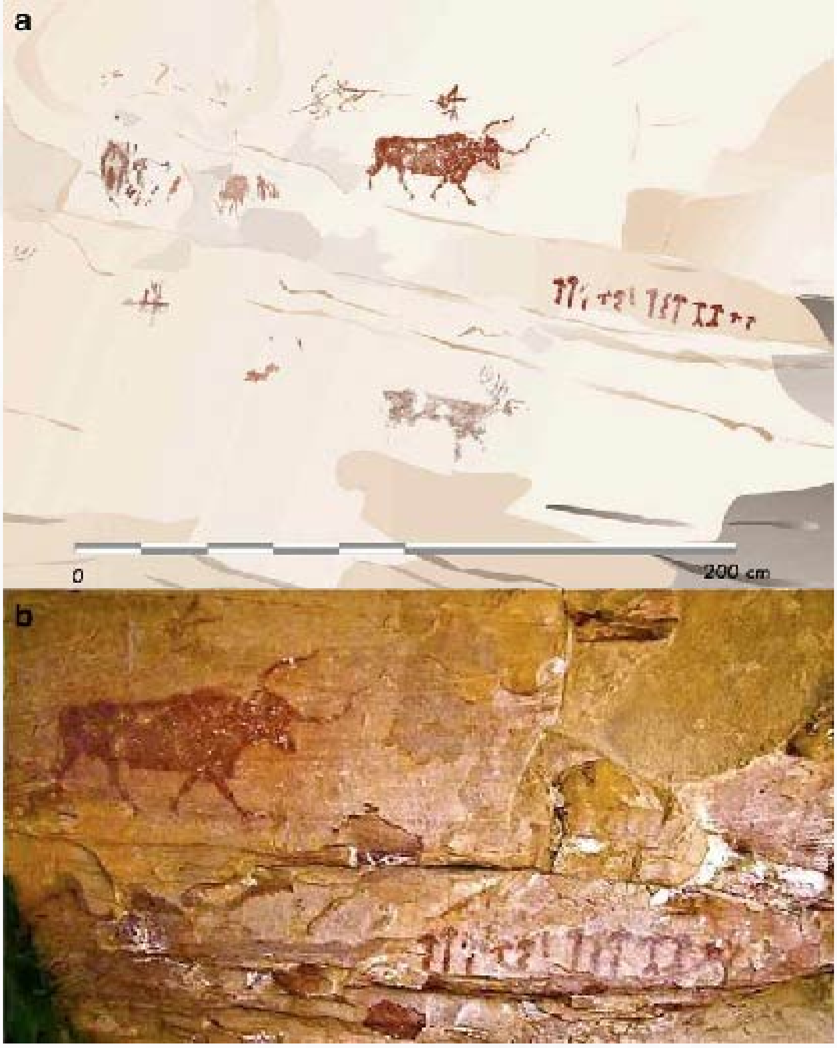


Fig. 1. The Selva Pascuala mural.
(**a**) Whole mural (digital tracing, J. F. Ruiz).
(**b**) Detail, bull and mushroom pictographs (photograph, A. Piper).

The present paper details findings from study of the Selva Pascuala mural (Fig. 1), a striking work of prehistoric rock art at the Villar del Humo cultural site in Cuenca, Spain. Along with other compositional elements including most prominently a bull, this painted scene contains distinctly fungoid pictographs. Previously described as anchor-like (Acosta 1968) or mushroom-like (Alonso 1983), these figures appear toward the lower right, in a distinct horizontal row of 13. Each consists of a vertically oriented, stalk-like lower portion varying from straight to sinuous, apparently representing the stipe, capped by an upper portion suggesting the pileus, convex to bluntly subconical in form.

Ramón Viñas, a Spanish archaeologist experienced in Levantine and Mexican rock art, was the first to suggest informally that these pictographs, true to their appearance, might in fact represent fungi (Viñas pers. comm. to J. F. Ruiz and J. F. Jordán in 2007). Their portrayal in association with a bull seemed especially interesting in this regard, considering the manure habitat of a few *Psilocybe* species. The purpose of our study was to assess the validity of Viñas' suggestion by testing it against data and analysis from archaeology and mycology. Our objective was to evaluate whether this hypothesis would prove tenable in light of various relevant lines of evidence.

The Site and Prehistoric Rock Art in Spain

The Selva Pascuala mural is one of two pictographic panels found at the Selva Pascuala rock shelter, which was discovered in 1918 by archaeologist E. Hernández-Pacheco (1959). The shelter measures 1,220 cm in width by 315 cm in height, and the fungal pictographs are up to 8.8 cm in height. The site is located in the municipality of Villar del Humo, within the central Spanish province of Cuenca. Villar del Humo lies within the outskirts of the Sierra de las Cuerdas, a group of medium-sized mountains of 900 to 1,500 m altitude in the southernmost part of the Sistema Ibérico range. The local landscape is rugged, with dense pine forests growing amid cliffs and boulders of reddish Triassic sandstone.

Although little is known of the post-Paleolithic culture in this region, it is noted as an important record of prehistoric rock art. The first such site was discovered in 1917. Following several archaeological surveys over the last decade, the number of rock art sites documented has grown from 13 to 40 (Poyato *et al*. 2007; Ruiz 2006).

The rock art of Villar del Humo belongs to two major art styles: Levantine and Schematic. Levantine art is distributed over the eastern half of the Iberian Peninsula, a region referred to as the Spanish Levant. It represents a naturalistic style in which human and animal figures play major roles, with vivid scenes of hunting activities, dancing, and fighting. Schematic art is found throughout the Peninsula and features dots, lines, zigzags, and schematized figures, painted with broader brushes and a less careful technique. Both styles occur together at various sites, including Selva Pascuala, and were probably produced by the same culture undergoing a long-term process of change (Mateo 2001; Ruiz 2006). However, some researchers believe they may reflect two consecutive cultures that coexisted and competed with each other in this part of the Peninsula over a period of time (Hernández and B. Martí 2000; Martínez and Villaverde 2002). At Selva Pascuala, naturalistic and schematic figures appear together in the mural with no appearance of competition or erasure of one by the other, suggesting a meaningful relationship in the overall composition, even if both styles were produced in different chronological periods.

Levantine and Schematic art are distinguished from Paleolithic rock art, particularly the remarkable Franco-Cantabrian tradition of northern Spain and southwestern France, known from cave sites such as Lascaux and Altamira among others. Franco-Cantabrian art typically occurs in deep caves, but Levantine and Schematic art is mainly found at rock shelters, which tend to be more open and exposed to the elements. Large animals are the principal subjects of Paleolithic cave paintings, whereas humans and their activities figure more prominently in Levantine and Schematic art. The latter styles are also distinguished from Paleolithic art by their use of plain colors, mainly red but also black and white. Finally, Levantine and Schematic paintings are relatively small, 1 m or less, compared with the typically larger scale of Franco-Cantabrian art.

Although Paleolithic art differs in some respects from these post-Paleolithic styles, their meanings may be related based on a common hunting and gathering adaptation that typified the Upper Pleistocene and persisted in the Iberian Peninsula until the fourth millennium B.C.E. In the eastern part of the Peninsula, Paleolithic and post-Paleolithic styles display some similarities, highlighted by new discoveries in the last decade. Both have a conspicuous, consistent emphasis on animals and hunting motifs, clearly reflected in the Levantine hunting scenes. Both traditions offer abundant evidence of magical or ritual functions, presumably based in symbolic meaning of the reduced number of animal species most often portrayed, apart from their relative economic importance. Anthropomorphism plays a role in these depictions, often assimilating the hunter to the hunted.

Such interpretations are based on similarities between the older and more recent styles of prehistoric art, plus ethnographic analogies with extant hunting and gathering cultures. There is an increasing consensus that painted rock shelters of the Spanish Levant and caves featuring Paleolithic art were long regarded as sacred sites or sanctuaries; that is, they were places of ritual importance. Based on the austerity of their location and consistent subject matter, these ancient rock art sites cannot be well understood in secular terms as mere creative decoration or artistic expression for its own sake (Díaz-Andreu 2001).

In recent decades, shamanistic interpretations involving altered states of consciousness or "archaic techniques of ecstasy" (Eliade 1964) have been proposed for rock art in Europe and elsewhere (Clottes and Lewis-Williams 1998; Lewis-Williams 2002; Lewis-Williams and Dowson 1988; Turpin 1994). Indigenous uses of neurotropic fungi typically involve a shamanistic context, and the identification proposed here is based in part on general explanations of rock art in shamanistic terms. It must be noted that such explanations remain theoretical thus far, and subject to disagreements as well as further study (for a recent critique see Bahn 2010).

Antiquity and Dating of the Mural

Considerable uncertainty prevails over the exact age of the Selva Pascuala mural, as well as Levantine and Schematic art in general. Levantine art was formerly interpreted as Paleolithic, but archaeologists nowadays tend to place it in a post-Paleolithic context; i.e., after the Pleistocene. Many prehistorians now date it close to the rise of the first Neolithic farming and herding communities in the Iberian Peninsula. As noted, the role of animals in Levantine art recalls Paleolithic art, pointing toward a cultural adaptation resembling that of the Upper Pleistocene. However, in contrast to Franco-Cantabrian art, extinct Ice Age fauna are absent from this post-Paleolithic style, reflecting its more recent origins. Indeed, at Selva Pascuala the panel other than the one studied here contains a scene of horse domestication, a rarity for Levantine and Schematic art indicating a Bronze Age cultural stage.

Recent research (Ruiz *et al*. 2006) using ^{14}C AMS analysis of calcium oxalate patinae has provided the first radiometric dates related to prehistoric art in the Sierra de las Cuerdas. Results indicate at least some Levantine art in the region could have been painted around 6000 B.C.E., prior to the Neolithic in the Iberian Peninsula (Ruiz *et al*. 2009). However, Levantine art was likely produced over a long period of time, up through the end of the Neolithic. On the other hand, Schematic art appears with the first Neolithic cultures, based on parallels between this style and decorated ceramics that have been well dated archaeologically (Torregrosa and Galiana 2001). The older Neolithic sites in the Peninsula are dated after circa 5600 B.C.E. (Zilhão 2001).

Conclusions about the age of the Selva Pascuala mural are tentative. Central portions, such as the bull, are clearly Levantine and may go back at least as far as 6000 B.C.E. The fungoid figures are interpreted as Schematic and likely Middle Neolithic, circa 4000 B.C.E. in this region. Unfortunately, the archaeological record for other cultural remains at the site is limited to some fragmentary evidence of fire usage and flint knapping; such is difficult to clearly associate with the mural. Selva Pascuala was not a habitation site but rather one of special purpose, consistent with a shamanistic interpretation.

Interpretation of the Mural and Mycological Identification

Based on its combination of Levantine and Schematic elements, the Selva Pascuala mural is likely to have originated with more than one artist in successive episodes of painting activity. Its interpretation must be qualified by indications it underwent a process of re-elaboration over time. At the center of the scene, animals are dominant. There are two large bulls, one of which has almost disappeared, plus a deer and several human figures. These are rendered in Levantine style and probably trace to an earlier stage, based on their central position. Several Schematic figures appear around the edge of the mural, apparently added later and without disturbing the previous composition. Some of them, including the mushroom-like pictographs studied here, play an apparent role more typical of Levantine human figures, being placed toward the margin, around the central portion in which animal figures predominate.

The fungoid figures in the mural display individual differences of form resembling the kind of morphological variation commonly observed in fruit bodies of a single species. Two of them, in the tenth and eleventh positions (counting left to right), also show a split or bifurcated base, which could lend to anthropomorphic interpretation as legs. Indeed, the figures in this row have been previously interpreted as schematized human beings (Alonso 1983).

Recently proposed explanations for rock art based on ritualized trance or altered states, together with ethnographic analogies for use of *Psilocybe* and *Amanita*, suggest that the pictographs, interpreted as mushrooms, would likely represent neurotropic fungi. In consultation with Dr. Gastón Guzmán, we noted features of the 13 fruit bodies and the variations among them in light of fungal morphology and taxonomic concepts. The pictographs appear to illustrate a fungus with a convex to conic-subumbonate pileus and a straight to sinuous stipe, lacking an annulus. Accordingly and using these criteria, mycological data were reviewed to determine whether any neurotropic species occurred in the region with features matching those indicated in the mural. *Amanita muscaria* was excluded because of its non-sinuous stipe and large, persistent annulus. Moreover its pileus is adorned with conspicuous veil remnants, typically emphasized in artistic treatments, and notably lacking in the mural figures. We also considered the mural's combination of bovine and fungal figures raised some question of a possible habitat association. Likewise, this posed no apparent connection with *A. muscaria*, a mycorrhizal species.

Close similarities were noted, however, between the mural pictographs and the neurotropic fungus *Psilocybe hispanica* Guzmán (Fig. 2). Known so far only from Spain, this species was described from a locale near Huesca in the Pyrenees Mountains, approximately 275 km northeast of Selva Pascuala, in the Aragon region. It is reportedly used there recreationally for its neurotropic effects, especially by young people (Fernández-Sasia 2006; Guzmán 2000; Guzmán and Castro 2006). Its pileus is convex to subconical, closely matching the pictographs. The straight to sinuous stipes of the mural's mushrooms also agree well with those of *P. hispanica* (Guzmán 2000). Our knowledge of this species to date is based on only three collections, so additional comparative data would be valuable. Nonetheless if the mural relates to a shamanistic context and the pictographs represent mushrooms, we consider *P. hispanica* a uniquely apt candidate for the likely identity of the species depicted, as proposed by Guzmán.

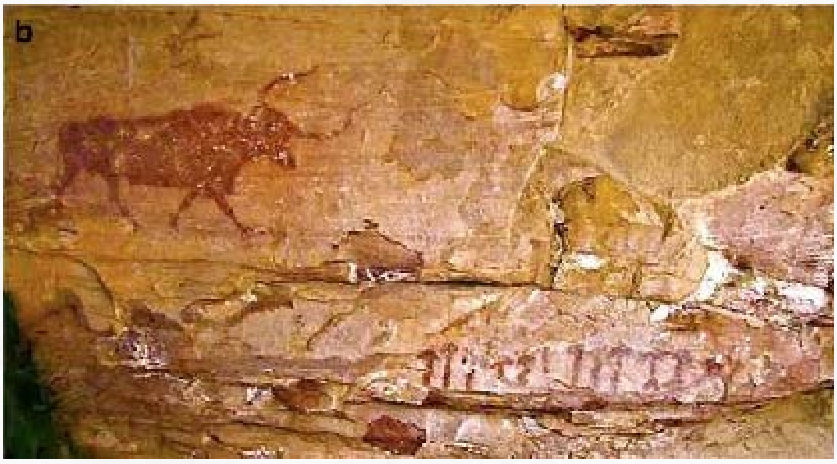


Fig. 2. *Psilocybe hispanica* Guzmán (photograph, I. Seral).

Habitat data also correlate with the identification tentatively suggested here. *Psilocybe hispanica* is a coprophilic species, coinciding with the mural's association of bovine with fungal figures. This species has been collected so far only from horse dung, but coprophilic fungi present a wide range for kinds of dung they inhabit. This is well illustrated by *Psilocybe cubensis* (Earle) Singer, and *P. coprophila* (Bull.: Fr.) P. Kumm., which occur on dung of many kinds of herbivorous mammals including horse and cattle, among others.

There is another neurotropic fungus in the region that might be considered in light of the mural pictographs, *Psilocybe semilanceata* (Fr.: Secr.) P. Kumm. This species is closely related to *P. hispanica* but differs in its pileus, which is acutely papillate and more narrowly conical to subcampanulate. These features point away from any relationship with the fungi depicted at Selva Pascuala. It grows only on soil rather than dung, likewise offering no specific link with the apparent bovine association in the mural.

Psilocybe hispanica has been found so far only in the Pyrenees region, in alpine *Pinus* forests at 2,000 to 3,000 m altitude. The Selva Pascuala site lies at 1,070 m. However, it is likely that *P. hispanica* has a wider ecological distribution than is presently known, based on studies of other species such as *P. aztecorum* R. Heim emend. Guzmán. The latter was originally described from alpine *Pinus* forests at 3,500 m altitude (Heim 1957), but Guzmán (1978) later found it in a non-alpine *Pinus* forest at 2,500 m.

In view of the temporal separation between the Selva Pascuala mural and our records of *Psilocybe hispanica* in the present, a related question arises of climate change as a possible factor affecting distribution of this species over time. We have no mid-Holocene records for the Sierra de las Cuerdas, but several studies have been published addressing paleoclimate for medium altitude mountains in a radius of approximately 100 km around Villar del Humo (Carrión and van Geel 1999; Fernández-Miranda and Moure 1977; Stevenson 2000). Studies indicate mature forests of *Pinus* species with some deciduous trees were well established. The data present no indications contrary to the likely presence of *P. hispanica* in the region during the era of the Selva Pascuala mural.

Following shamanistic explanations of rock art, ethnographic analogies for use of *Psilocybe* and *Amanita* suggest to us that Selva Pascuala probably reflects a similar context of neurotropic fungi consumption. Our interpretation of the mural, if correct, would imply ritual usage of neurotropic fungi, especially *Psilocybe hispanica*, as part of the post-Paleolithic culture pattern in this region. Accordingly, Selva Pascuala presents the first direct evidence for possible utilization of *Psilocybe* in prehistoric Europe. Along with Pegtymel and Tassilli, the mural represents the third reported instance of rock art suggesting prehistoric usage of neurotropic fungi. Tassilli is the only site previously known that may likely represent *Psilocybe*. Selva Pascuala thus offers the second such example.

Discussion

Examples of apparent Schematic style fungal depictions other than in Selva Pascuala have been recorded. These include Marmalo V at Villar del Humo (Alonso 1983-84), plus Monte Arabí and Cantos de la Visera, both at Yecla in the Murcia province (Acosta 1968). How such sites relate to Selva Pascuala is unclear, but their existence is interesting in view of our findings about the mural.

Selva Pascuala's apparent association of bovine imagery with *Psilocybe* is noteworthy in light of a mythic link between the bull and mushrooms, extending into classical Mediterranean history and seemingly related to intoxication. In Greek mythology, mushrooms bellow like bulls as they fruit from the ground; and Dionysus, the god of intoxication, manifests as a bull that his ecstatic devotees dismember barehanded (Ruck 2006). Fungi are similarly anthropomorphized as a variety of taurine monsters, which the mythic hero masters by decapitation, harvesting the head (Ruck *et al*. 2000). This mythic encounter of the hero with the bull and its harvesting as a magical plant is traceable to Mithraism and its revision as Zoroastrianism, arguably the earliest monotheistic religion. Deification of the bull in shamanistic contexts has been documented at shrines and sanctuaries excavated at Catal Höyük in Anatolia, a tradition dating back to the era of Selva Pascuala (Ruck *et al*. 2009). The Selva Pascuala mural also seems to express this widespread metaphoric zoomorphism.

If the identification proposed herein is correct, the dung habitat of *Psilocybe hispanica* is sufficient by itself to explain the mural's combination of fungus and bovine. But there may be more than habitat involved in this association, as well as other elements of the mural, possibly relating to the effects of *Psilocybe* upon humans or animals as observed by humans. The bifurcated bases of two of the fungal pictographs are suggestive of human legs. This might represent a transformation process relating to perceived effects on humans, in a sense reconciling previous interpretation of these pictographs as anthropomorphs. Observed effects of neurotropic fungi or plants upon animals that ingest them may also underlie fungal zoomorphism and anthropomorphism at Selva Pascuala and elsewhere. In any case, the mural's depiction of mushrooms carefully arranged in a row with correct detail and features, seems to suggest they held special significance for the artist and cultural context.

Conclusion

We suggest that Viñas' hypothesis is sound, and the Selva Pascuala mural likely depicts mushrooms, especially neurotropic fungi. Although *Psilocybe hispanica* presents a probable candidate for the species depicted, as indicated by Guzmán, we emphasize that this identification is tentative, and contingent upon a shamanistic interpretation of the mural. Understanding of Selva Pascuala and related sites will no doubt benefit from further research on rock art and post-Paleolithic culture in Spain.

Acknowledgments

The authors thank Gastón Guzmán for his identification of the mural fungi, plus members of his team - especially Florencia Ramirez-Guillen and Manuel Hernandez. We thank the authorities at the Institute of Ecology (Veracruz, Mexico) for their support. We also thank Juan Francisco Jordán Montes and José Alfredo González Celdrán for their involvement and onsite assistance to Carl Ruck and Alan Piper; and John Moeller for help obtaining literature sources.

Literature Cited

1. Acosta, P. 1968. La pintura rupestre esquemática en España. Salamanca: Universidad de Salamanca.
2. Alonso, A. 1983-84. Los conjuntos rupestres de Marmalo y Castellón de los Machos (Villar del Humo, Cuenca). Empúries 45-46:8-29.
3. Bahn, P. G. 2010. Prehistoric rock art: Polemics and progress. Cambridge University Press, Boston.
4. Borhegyi, S. 1961. Miniature mushroom stones from Guatemala. American Antiquity 26:498- 504.
5. Carrión, J. S. and B. van Geel. 1999. Fineresolution Upper Weichselian and Holocene palynological record from Navarre's (Valencia, Spain) and a discussion about factors of Mediterranean forest succession. Review of Palaeobotany and Palynology 106:209-236.
6. Clottes, J. and D. Lewis-Williams. 1998. The Shamans of Prehistory: Trance and magic in the Painted Caves. Harry N. Abrams, Inc., New York.
7. Díaz-Andreu. 2001. Marking the landscape: Iberian post-paleolithic art, identities and the sacred. Pages 158-175 in G. H. Nash and C. Chippindale, eds., European landscapes of Rock-Art. Routledge, London.
8. Dikov, N. N. 1971. Naskal'nyie zagadki drevnei Chukotki: Petroglify Pegtymelia (Rock art puzzles of Ancient Chukotka: Pegtymel petroglyphs). Nauka, Moscow.
9. Eliade, M. 1964. Shamanism: Archaic techniques of ecstasy. Pantheon Books, New York.
10. Fernández-Miranda, M. and J. A. Moure. 1977. El abrigo de Verdelpino (Cuenca): Noticia de los trabajos de 1976. Trabajos de Prehistoria 34:31-84.
11. Fernández-Sasia, R. 2006. *Psilocybe hispanica* Guzmán, un taxón novedoso en nuestro entorno. Errotari 3:73-76.
12. Furst, P. T. 1974. Hallucinogens in Precolumbian art. Pages 55-102 in M. E. King and R. Traylor Jr., eds., Art and environment in Native America. Texas Tech University Press, Lubbock, Texas.
13. Guzmán, G. 1978. Variation, distribution, ethnomycological data and relationships of *Psilocybe* aztecorum, a Mexican hallucinogenic mushroom. Mycologia 70:385-396.
14. Guzmán, G. 2000. New species and new records of *Psilocybe* from Spain, the U.S.A. and Mexico, and a new case of poisoning by P. barrerae. Documents Mycologiques 29:41-52.
15. Guzmán, G. 2008. Hallucinogenic mushrooms in Mexico: An overview. Economic Botany 62:404-412.
16. Guzmán, G. and M. L. Castro. 2006. Observations on some known species of *Psilocybe* from Spain and description of a new species. Boletín Sociedad Micológica de Madrid 27:181-187.
17. Heim, R. 1957. Sur les Psilocybes hallucinatoires des Aztèques et sur le microendémisme des Agarics utilisés par les Indies du Mexique à des fins divinatoires. Comptes Rendus des Séances de l'Académie de Sciences 245:1761-1765.
18. Hernández, M. S. and B. Martí. 2000. El arte rupestre de la fachada mediterránea: Entre la tradición epipaleolítica y la expansión neolítica. Zephyrus 53-54:241-265.
19. Hernández-Pacheco, E. 1959. Prehistoria del solar hispano. Madrid. Real Academia de Ciencias Exactas, Físicas y Naturales, XX.
20. Letcher, A. 2006. Shroom: A cultural history of the magic mushroom. Faber and Faber, London.
21. Lewis-Williams, D. J. 2002. The mind in the cave: Consciousness and the origins of art. Thames & Hudson, London.
22. Lewis-Williams, D. J. and T. A. Dowson. 1988. Signs of the times: Entoptic phenomena in Upper Paleolithic art. Current Anthropology 29:201-245.
23. Martínez, R. and V. Villaverde. 2002. La Cova dels Cavalls en el Barranc de la Valltorta: Monografías del Instituto de Arte Rupestre, 1. Tírig, Spain: Museu de Valltorta.
24. Mateo, M. A. 2001. Arte Levantino adversus pintura esquemática: Puntos de encuentro y divergencias entre dos horizontes culturales de la prehistoria peninsular. Quaderns de prehistoría i arqueología de Castelló 22:183-211.

25. Poyato, C., J. F. Ruiz, and R. Guillén. 2007. Investigación y puesta en valor del conjunto de arte rupestre de Villar del Humo, Cuenca. Pages 399-429 in J. M. Millán and C. Rodríguez, eds., Arqueología de Castilla - La Mancha: I Jornadas, Cuenca, 13-17 de diciembre de 2005. Cuenca, Spain:Ediciones de la Universidad de Castilla-La Mancha.
26. Ruck, C. A. P. 2006. Sacred mushrooms of the goddess: The secrets of Eleusis. Ronin Publishing, Inc., Oakland, California.
27. Ruck, C. A. P., B. D. Staples, and C. Heinrich. 2000. Apples of Apollo: Pagan and Christian mysteries of the Eucharist. Carolina Academic Press, Durham, North Carolina.
28. Ruck, C. A. P., M. A. Hoffman, and J. A. González Celdrán. 2009. Mushrooms, myths and mithras. City Lights Publisher, San Francisco.
29. Ruiz, J. F. 2006. Las pinturas rupestres en la Serranía de Cuenca: Análisis, revisión y crítica del concepto de estilo en las manifestaciones plásticas postpaleolíticas. Unpublished Ph.D. Thesis, UNED (Universidad Nacional de Educación a Distancia), Madrid.
30. Ruiz, J. F., M. Mas, A. Hernanz, M. W. Rowe, K. Steelman, and J. M. Gavira. 2006. First radiocarbon dating of oxalate crusts over Spanish prehistoric rock art. INORA Newsletter 46:1-5.
31. Ruiz, J. F., M. W. Rowe, A. Hernanz, J. M. Gavira, R. Viñas, A. Rubio, and C. Matamoros. 2009. Cronología del arte rupestre postpaleolítico y datación absoluta de pátinas de oxalato cálcico: Primeras experiencias en Castilla - La Mancha (2004-2007). Pages 303-316 in J. A. López and R. Martínez, eds., El arte rupestre del arco mediterráneo de la Península Ibérica. Museo de Bellas Artes San Pío, Valencia, Spain.
32. Samorini, G. 1992. The oldest representations of hallucinogenic mushrooms in the world (Sahara Desert, 9000-7000 B.P.). Integration 2(3):69-78.
33. Stevenson, A. C. 2000. The Holocene forest history of the Montes Universales, Tereul, Spain. The Holocene 10:603-610.
34. Torregrosa, P. and M. F. Galiana. 2001. El arte esquemático del Levante peninsular: Una aproximación a su dimensión temporal. Millars 24:183-198.
35. Turpin, S. A., ed. 1994. Shamanism and rock art in North America. Rock Art Foundation, San Antonio, Texas.
36. Wasson, R. G. and V. P. Wasson. 1957. Mushrooms, Russia and history. Pantheon Books, New York.
37. Zilhão, J. 2001. Radiocarbon evidence for maritime pioneer colonization at the origins of farming in west Mediterranean Europe. Proceedings of the National Academy of Sciences 98:14180-14185.

We Drank Soma, We Became Immortal...

by

Natalia V. Polosmak

30 Aug 2010, Science First Hand, volume 26, N2

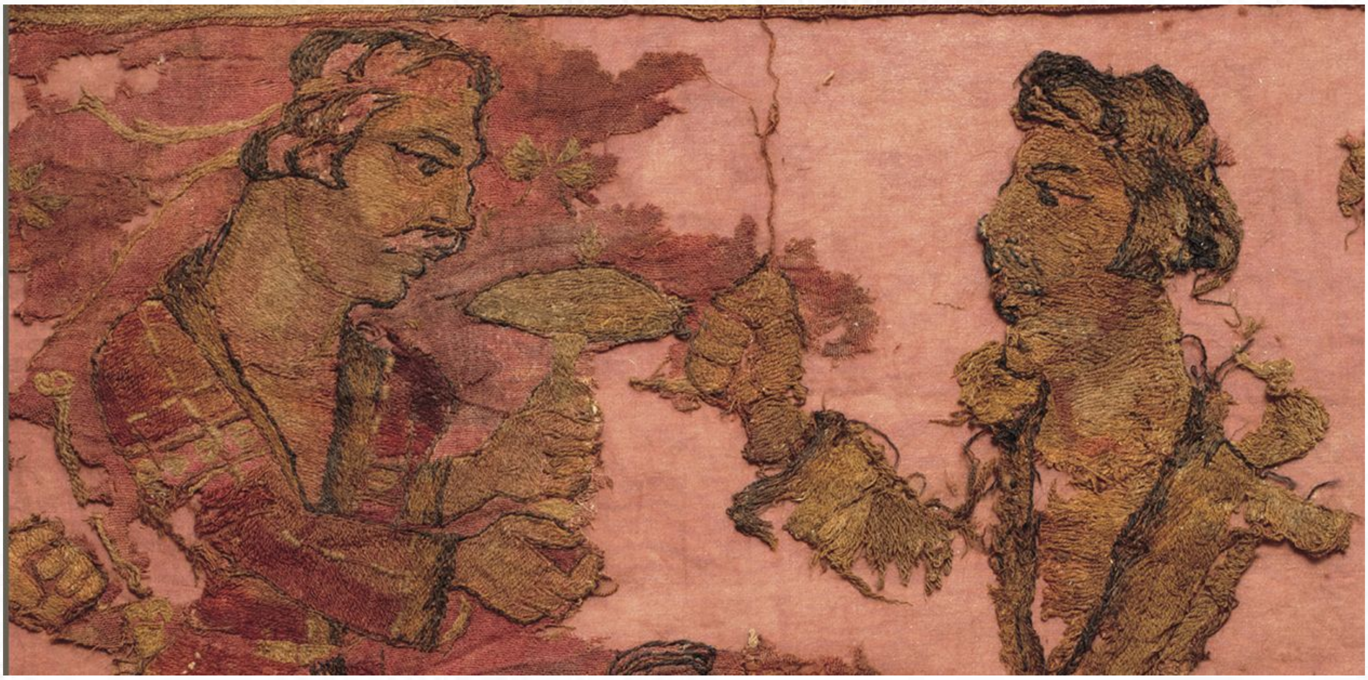
© Natalia V. Polosmak, 2010

original report: https://scfh.ru/files/iblock/5b1/5b17a2ccaf021c06e24d58615b4409b1.pdf
backup source: http://www.psilosophy.info/resources/5b17a2ccaf021c06e24d58615b4409b1.pdf

Table of Contents:

- [Abstract]
- Beside the altar flame
- Divine mushroom
- Story told by the textile
- References

Natalia V. POLOSMAK, Doctor of History, chief researcher at the Institute of Archaeology and Ethnography SB RAS (Novosibirsk). Laureate of the Russian State Prize, Legacy of Generations National Prize, Corresponding Member of the German Archaeological Institute, Director of Honor of the Institute of Archaeology of Mongolia. She is the author and co-author of over 130 academic works including 12 books.



[Abstract]

Inside a deep Xiongnu grave hidden in the thickly wooded Sudzuktè pass, on the bottom of the burial chamber, archaeologists, participants of the Russian-Mongolian expedition, found what they had long been searching for: a layer of clay revealing the outline of textile relics. The fragments of the textile found were parts of a carpet composed of several cloths of dark-red woolen fabric. The time-worn cloth found on the floor covered with blue clay of the Xiongnu burial chamber and brought back to life by restorers has a long and complicated story. It was made someplace in Syria or Palestine, embroidered, probably, in north-western India and found in Mongolia.

Finding it two thousand years later is a pure chance; its amazingly good condition is almost a miracle. How it made its way to the grave of a person it was not meant for will long, if not forever, remain a mystery. Of greatest surprise though was the unique embroidery made from wool. Its pattern was the ancient Zoroastrian ceremony, of which the principal personage was ...a mushroom. In the center of the composition to the left of the altar is the king (priest), who is holding a mushroom over the fire. The «divine mushroom» embroidered on the carpet resembles well-known psychoactive species *Psilocybe cubensis*.

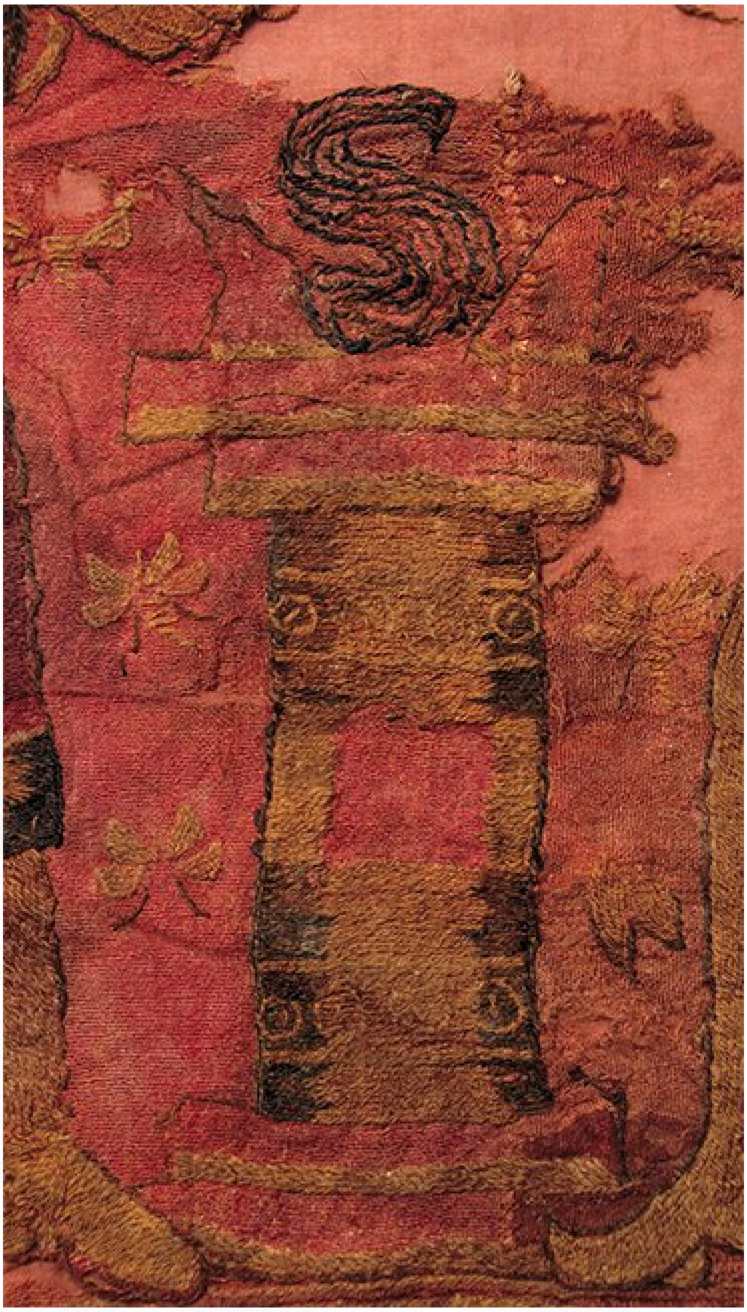
The weight of evidence suggests that soma, the ancient ritual drink, has been prepared from the mushrooms of family Strophariaceae which contain the unique nervous system stimulator psilocybin.

Keywords: ancient textiles, Xiongnu, Divine mushroom, soma/haoma, Indo-Scythians, Indo-Parthians, psilocybin, North Mongolia

Diggings of 31 Xiongnu tumuli (dated from the late 1st c. B.C. to the early 1st c. AD) of the Noin-Ula burial ground (Mongolia) carried out in 2009 by an expedition of the Institute of Archaeography and Ethnography, Siberian Branch of the Russian Academy of Sciences (SB RAS), have discovered embroidered woolen textiles preserved by a miracle. Their complete restoration is a long way to go; however, the first fragments restored have revealed exceptional information.

Inside a deep Xiongnu grave hidden in the thickly wooded Sudzuktè pass, on the bottom of the burial chamber, archaeologists found what they had long been searching for: a layer of clay revealing the outline of textile relics.

This was the third find to date; all of them were made in the well-known Xiongnu burial ground of Noin-Ula: the first fragments of a unique textile were found here as early as in the 1920s by the expedition of the eminent traveler and scholar P. K. Kozlov. Like many other things, the precious fabrics happened to be in the graves of rich nomads because of the trade along the Silk Road. Xiongnu did not participate in the trade deals but they controlled a long stretch of this perennial spring of foreign goods.



On the altar the flame burns - two tongues on the sides and an S-shaped sign in the middle. The flame of king's fireplace mounted on the altar is a symbol of royal grandeur.

Basing on the first find, the researchers believed that the textile from the Xiongnu burial ground was made in Bactria (Pugachenkova, 1966). However, the finds made in 2006 and 2009 do not allow identifying this textile so unambiguously. Of greatest surprise though was the find made in 2009, or, to be more exact, the unusual pattern involving people and animals embroidered on the textile.

The fragments of the textile found were parts of a carpet composed of several cloths of dark-red woolen fabric. The fabric itself must have been meant for mantles. A sign of this is the narrow maroon woven stripes with "pockets." These important ornamental details are known not only from the numerous finds of real textiles in Dura-Europos, Syria, in Palmira and in the Palestinian Cave of Letters, but also from frescos, paintings on Egyptian sarcophagi, and early Christian mosaics (Yadin, 1963).

Similarly to the known mantle textile, the woven stripes of the Xiongnu find do not go from one edge to the other but begin and end within a single cloth. Their cut bits were sewn together without taking into account the location of woven stripes: the ornamental element, so important for making mantles, this time proved to be unnoticed.

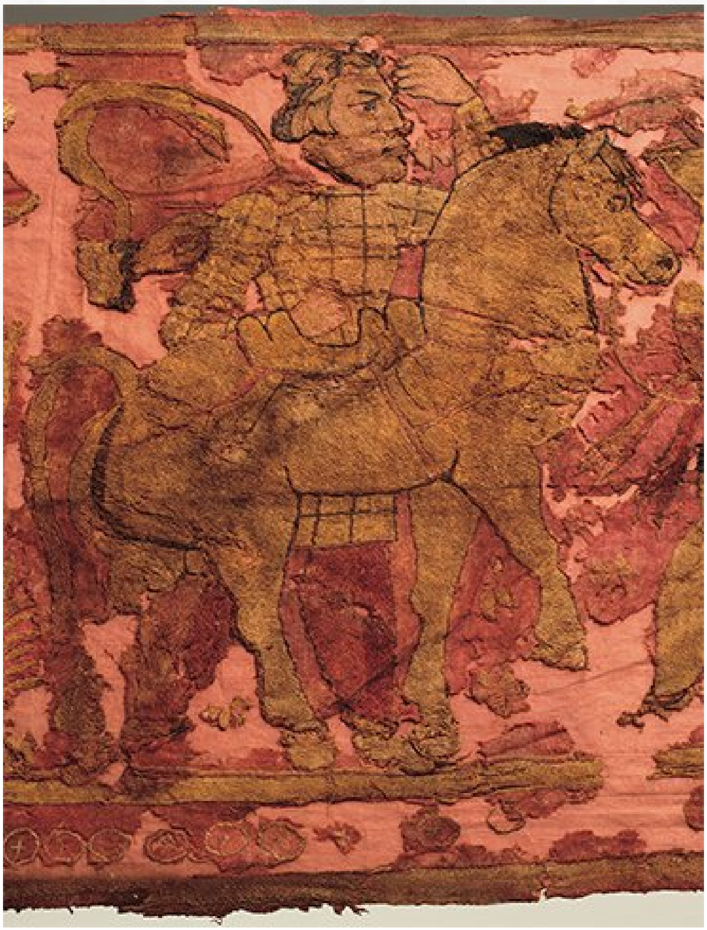
The embroidered fabric filled the narrow space between the chamber's wooden walls and the coffin, which was placed in the middle on another, not embroidered textile. As a matter of fact, the embroidered carpet was laid along the corridor used for the burial ceremony. On top of the fabric was a thick layer of blue clay brought on purpose, which, according to the Chinese tradition was used to make the chamber waterproof. This clay cover made the restorers' work very hard but preserved the textile.

Beside the altar flame

The restorers' hands have revealed the following embroidered plot: a procession to the altar. The altar itself - support for the fire - is a column with a base consisting of two steps and a two-step top turned upside-down. The column shows depictions of circles with a dot in the center - the widespread ancient symbol of fire and the Sun. In the Achaemenid time, similar altars were a novelty introduced by Persians, who proclaimed their adherence to the Zoroastrian belief. "The flame of the king's fireplace, going upwards in this way, became a symbol of their grandeur." (Boyce, 1988, p. 75 - 76).

The altar is aglow with the fire. These Zoroastrian fires had a martial spirit: those who prayed to them were warriors fighting on the side of good creatures against gloom and cold, evil and ignorance.

...Men are approaching the fire. They are armed with daggers attached to the right thigh and long swords with a ring or round pommel and long grip appended to the belt on the left. The warriors are wearing Iranian garments - red trousers, narrow or loose, and closely fitting jackets, wrapped on the left, or longer kaftans. The dress is girdled with a buckled belt and lined with fur.

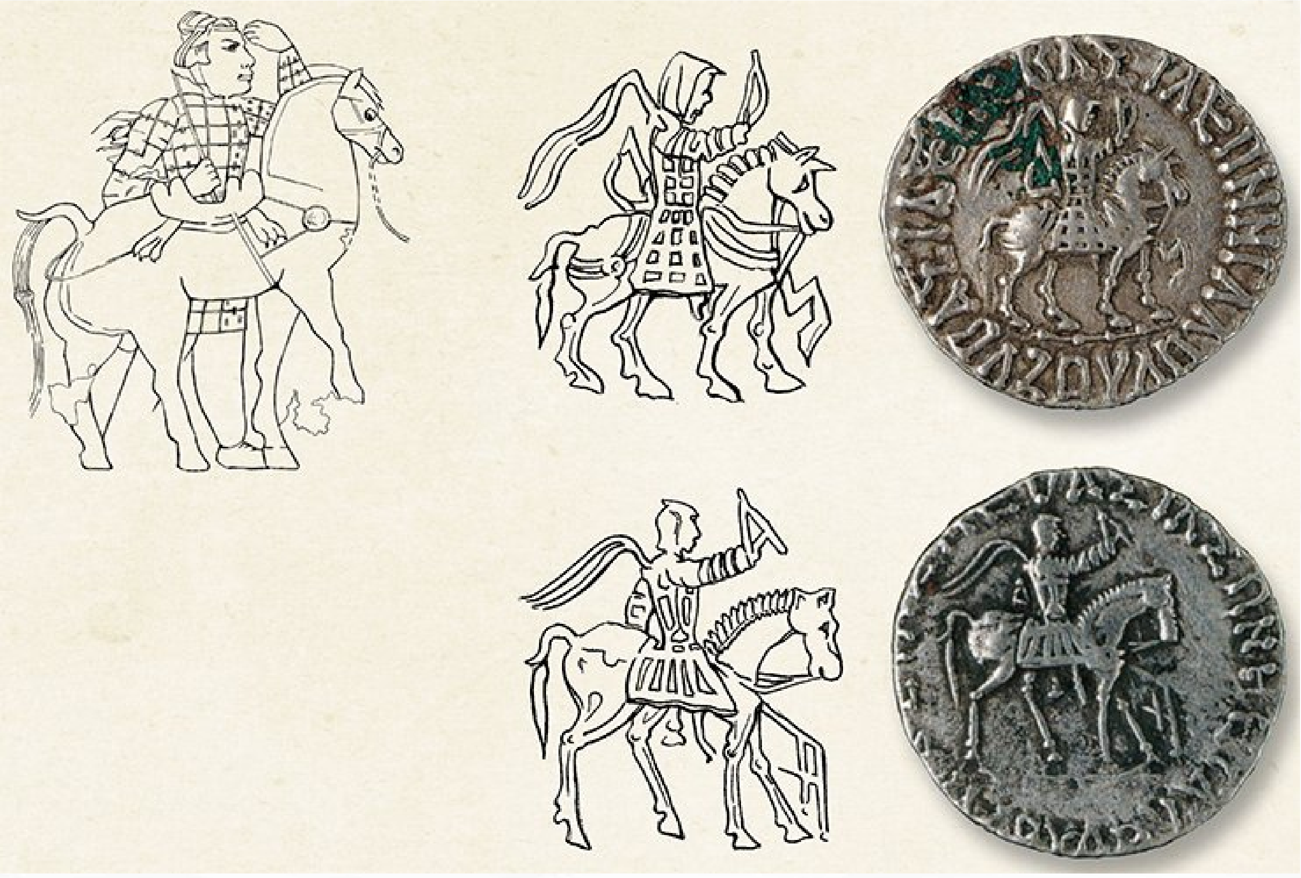


Men in Iranian dress, equipped with daggers and long swords, approach the fire.

The warriors' black voluminous tresses, set in rows and cut at the length of ear lobes, are sometimes strapped across the forehead with a narrow ribbon with fluttering ends. Their looks are conspicuous: expressive profiles of their broad round faces with big eyes, soft chins, pudgy lips and big, slightly aquiline noses. The faces are shaved, though many have a black narrow moustache above the upper lip.

A dismounted rider wearing an armor-clad long jacket with something like a scarf or a cloak fluttering behind his back attracts special attention. His beardless face is stern. The left hand is raised to the forehead in a gesture of adoration common as early as during the Achaemenids as a sign of worshipping a deity. The rider's horse is held by the bridle by an armed man in a short jacket with something like a scrip on his back from which something like a mushroom is peeking out.

The manner in which the warrior with a horse is depicted copies in minute detail the images on the heads of the coins minted by Indo-Scythian (Saka) kings: Azes I, Aziles and Azis II, who governed north-western India approximately from 57 BC, as well as by their successor Gondofar, the first Indo-Parthian ruler of West and East Punjab (from 20 AD to 46 AD).



A dismounted rider wearing an armor-clad jacket raised his left hand to the forehead in the traditional Zoroastrian gesture - the sing of worshipping a deity (left). Drawing of the carpet by Ye. Shumakova. The depictions of embroidered riders on the carpet and rulers on the heads of Indo-Scythian coins have a great deal in common. On the right are the coins of Azes II, on the left is their drawing. From: (Musee National des Arts Asiatiques-Guimet - l'Asie des steppes d'Alexandre le Grand à Gengis Khan, 2000)

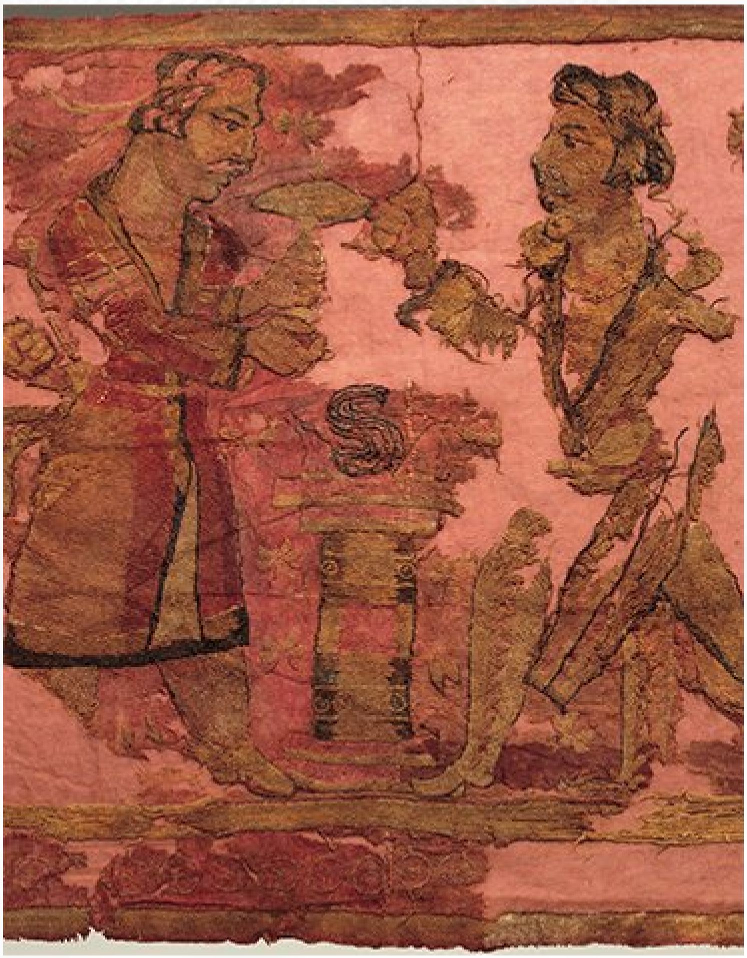
On these coins we can see similar stocky round horses with long tails and strapped docks, cut in a particular manner: a hogged plait at the tail head. Like the embroidered horse, their breast collars are decorated with plates.

The saddle with four horn-shaped supports is identical to the reconstruction made on the basis of Roman archaeological data (Connoli, 2001) with the only difference: instead of leather laces hanging down from under the saddle, there are two clawed paws of a predator's hide that was used as a horsecloth. These saddles are believed to have appeared by the beginning of the Parthian period and were widely spread with the Parthian cavalry; they were also known to the Sarmatians. Similarly to the embroidered warrior, the riders on the coins are wearing tight waist jackets sewn around with big rectangular plates - such armor was known to the Sakai and Parthians.

These similarities are an important argument in favor of the hypothesis that the carpet shows Indo-Scythians or Indo-Parthians.

Divine mushroom

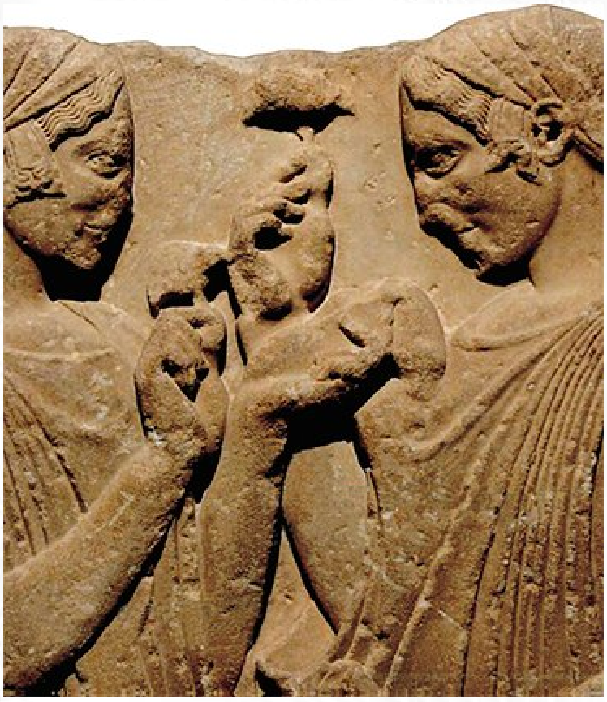
The embroidered plot develops further... We can see people standing absorbedly around the altar fire. The most prominent figure among them is the man on the left - probably, the king himself or a priest - dressed in a smart long embroidered kaftan gaping open at the bottom. He has a rarely expressive face, and his intent look is focused on the mushroom he is holding in both hands.



To the left of the altar is the king (priest), who is holding a mushroom over the fire. Opposite him is a warrior in a jacket with a "tail" and a belted quiver.

A priest with the Divine Mushroom in his hand... The question of what plant was used to prepare soma, or haoma - the drink of gods ancient Indians and Iranians imbibed has been debated for over a hundred years. Up to now, the plant whose sap was a permanent participant of the rituals, an offering to gods made by ancient Indians and Iranians, has not been identified. The hypotheses are plenty: from ephedra, cannabis, and opium poppy to oriental lotus (e.g., Abdullaev, 2009; McDonald, 2004; *et al*.). All researchers agree that ancient Indians and Iranians used for cult purposes a drink containing a psychoactive substance - it is only debatable what it was exactly and how it affected the people's consciousness.

The translator and greatest authority on the Rig-Veda (RV) T. Ya. Yelizarenkova wrote: "Judging by the RV hymns, Soma was not only a stimulating but a hallucinating drink. It is difficult to be more particular not only because none of the candidates satisfies all the soma properties and matches the soma descriptions found in the hymns only partially but primarily because the language and style of the RV as an archaic cult monument reflecting the poetic features of 'Indo-European poetic speech' is a formidable obstacle to soma identification. The answer may be provided by archaeologists and their finds in north-western India, Afghanistan, and Pakistan (and not in the far-away Central Asia)."



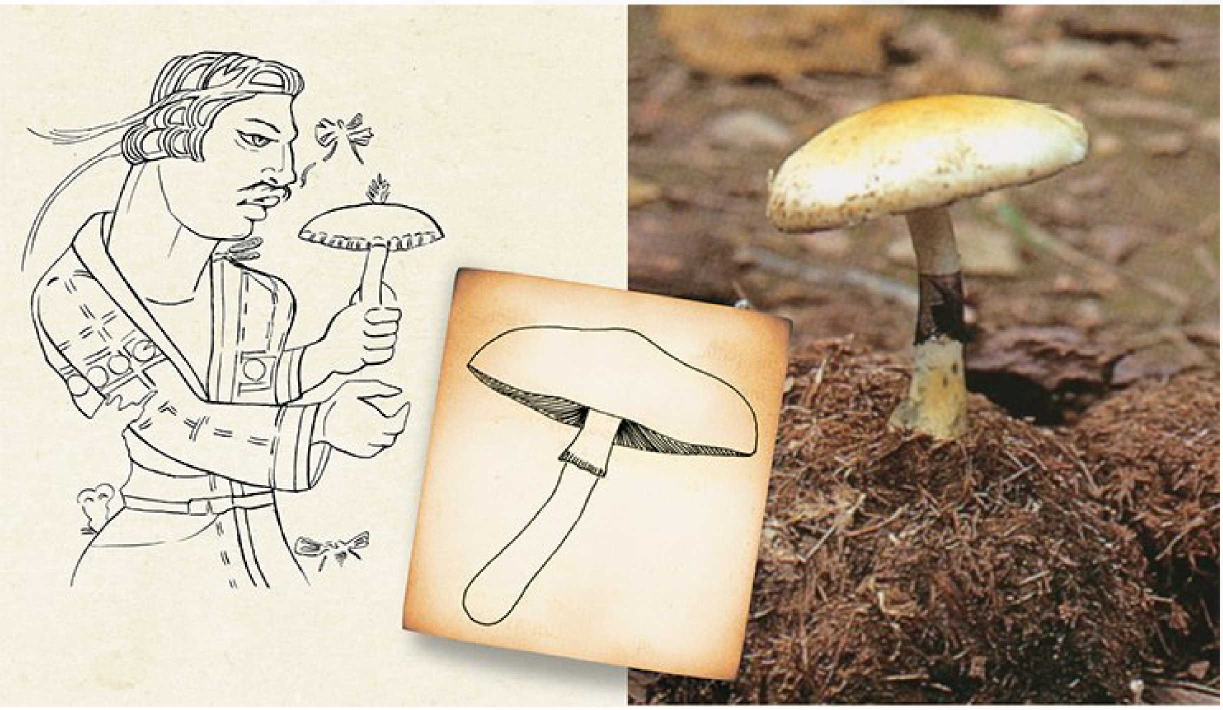
A scene from the Eleusinian Mysteries: Persephone taking a mushroom from Demeter. C. 4th c. BC.

The Eleusinian Mysteries were the oldest religious festivities held in ancient Greece and dedicated to Demeter and her daughter Persephone, spouse to the underworld ruler Hades. The participants of the Mysteries ritually went through death and rebirth. It is known that the initiates were promised rewards in the afterlife. Those who had experienced the mystical death firmly believed that for them a new life would begin after death. "Happy is he who has seen this before sinking into the grave: he knows the end of life and he knows its god-given beginning." (Pindar)

What particular rites made the initiates think of death with joy is not known. From of old, divulging the secret rituals was punishable by death. It is only known that the initiates were to live through and gain their own religious experience; there is evidence that the participants of the Mysteries had visions of images beyond thought. The prominent philosopher and Orientalist Ye. A. Torchinov puts it straightforwardly: "The Eleusis mystery is the mystery of psycho-technical experience of death and rebirth that purifies and integrates the myst psyche..." (1997, p. 145). To achieve this state, some hallucinogenic substances were used, maybe these contained in mushrooms.

This was written in 1999 - ten years before the outstanding find that testified that Indo-Scythians (Saka) and Indo-Parthians had used mushrooms for cult purposes.

The mushroom depicted on the Xiongnu carpet can belong to family Strophariaceae, according to Candidate of Biology I. A. Gorbunova (Laboratory of Inferior Plants, Central Siberian Botanical Garden, SB RAS, Novosibirsk). Its external appearance has similarities with species *Psilocybe cubensis* (Earle) Singer [= *Stropharia cubensis* Earle].



A priest with the divine mushroom in his hand. Drawn from the carpet by Ye. Shumakova. The "divine mushroom" embroidered on the carpet resembles *Psilocybe cubensis* in its habit, shape of the cap, and stitches along the cap margin that look like radial folding or veil remnant. Dark inclusions on the stalk may depict the annulus that blackens because of falling spores. The mushrooms of genus *Psilocybe*, like many other species of family *Strophariaceae*, contain the psychoactive substance psilocybin. On the left is a king/priest with a mushroom in his hand. Drawing of the carpet by Ye. Shumakova. On the right is the fruit body of *P. cubensis*, grown on elephant dung (India). From: (Stamets, 1996). In the center is a diagram of *P. cubensis* fruit body. From: (Guzmán, 1983)

Many species of family *Strophariaceae*, especially genus *Psilocybe*, contain psilocybin, a unique psychoactive substance and a nervous system stimulator. The mushrooms having this substance play the leading role in T. McKenna's psychedelic theory of evolution - one of the most original hypotheses of the origin of humans, their language, conscience, and culture.

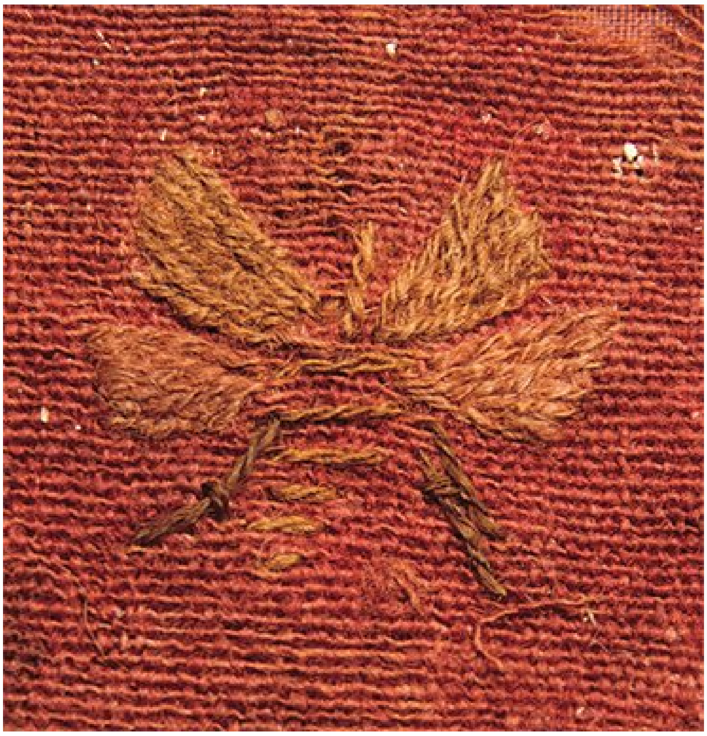
"Our remote ancestors discovered that some plants can suppress appetite, relieve pain, supply a sudden rush of energy and immunity towards pathogenic factors, as well as result in a synergy of cognitive powers… Alkaloids in plants, especially the hallucinogenic compounds such as psilocybin, dimethyltryptamine (DMT), and harmaline could be chemical factors in the protohuman diet that catalyzed the emergence of human self-reflection." (McKenna, 1995).

It should be noted that toadstool (fly-agaric) has been nominated as a candidate for the plant equivalent of soma/haoma. This point of view was supported by the founder of the new science ethnomycology R. G. Wasson in his well-known book *Soma: Divine Mushroom of Immortality* (1968). However, mushrooms containing psilocybin prove to be much closer to the legendary "drink of immortality" in terms of their psychoactive properties.

Story told by the textile

It is high time to sum up the intriguing story unfolding on the time-worn textile. The men depicted on it, who we suppose to be Indo-Scythians (Saka) or Indo-Parthians, are performing a ritual that indicates that they acknowledge a form of Zoroastrianism - a proof of this is the symbol of Ahura Mazda, the sacred fire altar. The mushroom the king (or the priest) is holding in his hands can be an offering to the fire or it can be sanctified by the fire before it being used to make the sacred drink. The north-western India of that time, where, in all the likelihood, the ritual is taking place, was the meeting place of three ethnos, three cultures - Indian, Iranian, and Greek. Each of them had their own gods: tolerance and worshipping not only of one's own but also of alien gods was a common thing.

To get to the root of the consecration unfolding before us, we should pay attention to such seemingly insignificant details as depictions of bees and butterflies strewn all over the cloth. These insects are the most ancient symbols of worship, and used to have the meaning very different from the present one.



Strewn all over the cloth are the depictions of bees and butterflies. Their presence can symbolize the Other World - the world of souls, the world of ancestors, where warriors get after they have tasted sacred mushrooms.

The essence of these symbols of the living natural world, their mythological meaning can be understood through the words denoting them. A bee, for instance, in ancient times was identified with the Word (the first divine creation) and with the fire (soul). In this connection, the Old English *beo* (bee) can be related to the Indo-European **bh&amacr;-* denoting, on the one hand, "to speak, word," and on the other hand, "burn, fire." In a similar manner, the Persian *eng* (bee) is related with the Aramaic *ogi* (soul) and Indo-European **og-en* (fire) (Makovsky, 1996). The ancient mythology of many peoples is known to identify bees and people (in some aspects). The bee was Arthemid's cult insect; Demeter and Persephone's priestesses were called bees. A bee was the symbol of "honey" Indra, Vishnu, and Krishna. Atharvaveda compares spiritual pursuit with honey-making (Ivanov, Toporov, 1992). The antiseptic properties of honey made it and important means used by many peoples for preserving some foodstuffs. In Mexico, for example, honey has long been used to preserve mushrooms containing psilocybin.

The embroidered cloth covered the narrow space between the burial chamber walls and the coffin. On top of it was a layer of blue clay. Photo by Ye. Bogdanov

In Greek mythology, a butterfly personified Psyche. The Greek word "Psyche" means "soul" and "butterfly." In fine arts, a soul was often depicted as a butterfly either flying out of a funeral fire or going to Hades (Losev, 1992). The meaning "soul" is often related with the meaning "fire, divine fire." In Chinese culture, a butterfly is still an emblem of longevity. The insect's life cycle - caterpillar, cocoon, butterfly - is perceived as a vivid example of metamorphoses leading ultimately to immortality or of a string of rebirths resulting in nirvana (Kravtsova, 2004).

M. V. Moroz, a fine art restorer with the Museum Studies Department of the Institute of Archaeology and Ethnography SB RAS, is engaged in near work: she is removing clay particles from fragments of the cloth.

The butterflies and bees depicted on the background of the canvas may have symbolized the kingdom of souls - the Other World - the world of ancestors, where the warriors got to after having consumed sacred mushrooms.

...Now the puzzle fits together. The insects and the mushroom are closely connected and make the surrounding world miraculous. "We drank soma, we became immortal, we came to the light, we found gods." (Rig-Veda. Mandalas 9 - 10. VIII, 48.3).

The time-worn cloth found on the floor covered with blue clay of the Xiongnu burial chamber and brought back to life by restorers has a long and complicated story. It was made someplace in Syria or Palestine, embroidered, probably, in north-western India and found in Mongolia.

The unique find is reviving thanks to restorers. From left to right: N. P. Sinitsina, a top grade fine art restorer (textiles and leather), head of the Leather Restoration Group with the Department of Non-Conventional Restoration Technologies at the Grabar All-Russian Art, Scientific and Restoration Center (Moscow); Ye. S. Sinitsina, a fine art restorer with the same department; and O. S. Popova, a fabric restorer with the Pushkin State Museum of Fine Arts (Moscow).

Finding it two thousand years later is a pure chance; its amazingly good condition is almost a miracle. How it made its way to the grave of a person it was not meant for will long, if not forever, remain a mystery.

And yet this is not the greatest enigma posed by the unique find. We were lucky to come across something completely new and out-of-the-ordinary. The border of the academic world was stepped across by unexpected evidence, tangible as the textile that has literally returned to us from the other world in order to continue the story about how a man was becoming Man.

References

1. Boyce M. Zoroastrians: Their religious beliefs and practices. Moscow: Nauka, 1988.
2. Litvinsky B. A. Iranian and East-Hellenic temples of fire // The Hellenic temple of Oxus. Moscow: Vostochnaya literatura RAN Publishers, 2000. V. 1.
3. Makovsky M. M. Language-myth-culture. Symbols of life and death. Moscow: Vinogradov Institute of Russian language, 1996.
4. McDonald A. A botanical perspective on the identity of soma (nelumbo nucifera gaertn.) based on scriptural and iconographic records // Economic Botany 58 (suppl.). 2004. P. 147-173.
5. McKenna T. Food of the Gods. Moscow: Transpersonal Institut Publishers, 1995.
6. Pugachenkova G. A. Khalchayan. Tashkent: FAN. 1966.
7. Schmidt-Colinet A., Stauffer A., Al-As Ad Kh. Die Textilien aus Palmyra. Verlag Philipp von Zabern. Mainz am Rhein. 2000.
8. Wasson R. G. Soma: Divine mushroom of immortality. New York, 1968.
9. Yadin Y. The finds from the Bar Kokhba period in the Cave of Letters. Jerusalem: The Israel exploration society, 1963.
10. Yelizarenkova T. Ya. On soma in Rig-Veda // Rig-Veda. Mandalas IX - X. Moscow: Nauka, Literaturnyie pamiatniki, 1999. P. 323-353.

The photographs used in the publication are the courtesy of M. Vlasenko (Novosibirsk).

The Forgotten Mushrooms of Ancient Peru

by

Peter Trutmann Ph.D.

Global Mountain Action, Fungi and Mountains Publication Series: No 1. 2012, pp 33.

© 2012 by Peter Trutmann

original report: researchgate.net/profile/Peter-Trutmann/publication/233853675_THE_FORGOTTEN_MUSHROOMS_OF_ANCIENT_PERU/links/0fcfd50c20f027a5df000000/THE-FORGOTTEN-MUSHROOMS-OF-ANCIENT-PERU.pdf
backup source: http://www.psilosophy.info/resources/THE-FORGOTTEN-MUSHROOMS-OF-ANCIENT-PERU.pdf

Front cover illustration by Peter Trutmann Cover photos by Top left: Metropolitan Museum, Top Right: Larco Museum, Lima, Bottom Left internet http://www.latinamericanstudies.org/tiahuanaco/ceremonial-bowl.gif
Bottom Right: Peter Trutmann.

Table of Contents:

Abstract
Introduction
Materials and Methods
 Materials
 Identification of mushrooms
Results and preliminary discussion
 Mushrooms in Ancient Peruvian Cultures
  Coastal Cultures
   Cupisnique Culture (1200-200 BCE)
   Paracas Culture (800-100 BCE)
   The Moche (Mochica) culture (100 BCE-800 EC)
   The Chimú culture (900-1470 CE)
  Highland Cultures
   Pukará Culture (1200 BCE - 400 CE)
   The 'Mushroom stones' of Chucuito, Lake Titicaca
   Wari culture (500 to 1000 CE)
   Mushrooms and the Incas (1200 - 1532 AD)
  Cultures of the Selva and Amazon Basin
 Identification of mushroom species
  The Amanita enigma
  Calvatia and other Lycoperdon based Puffball species
  Psilocybe species
  Morchella Species
  Uncertainty: a Psilocybe or a Plutenoid mushroom
  Uncertainly: A mushroom with brown decurrent gills: Cortinoid?
General Discussion
 Evidence that mushrooms were used in pre Hispanic Peru
 Cultures and initial timelines of mushroom use in Peru
 Identity of Ancient Mushrooms
 Use of mushrooms in ancient Peru
  Culinary
  Medicinal
  Spiritual
Conclusions
Acknowledgements
References

Abstract

Evidence is presented to demonstrate extensive use of mushrooms in pre Hispanic Peru. Mushroom images were found on ceramics, metal objects and textiles from a range of important cultures from the north and south, as well as coastal and highland Peru. The objects range in age approximately between 1200-200 BCE to the time of European conquest. Most abundant, vivid images of mushrooms were found from art of the Moche/ Mochica culture, although other in cultures mushroom representations were also clear. Mushrooms, (realistic or abstract) were associated with what appear to be personalities of high authority, to shamans/curanderos and sacrificial victims. Realistic images of mushrooms commonly found associated with shaman like figures were often of high quality and allowed identification of some mushrooms to at least genus level. Identified were Calvatia species, Mochella species, *Amanita muscaria* and *Psilocybe* species. Some mushrooms could not be identified, because current knowledge of mushrooms of Peru and its neighbors is limited. The identified mushrooms have various characteristics: Morchella and Calvatia species have both culinary and medicinal properties. Others, like *Amanita muscaria*, and *Psilocybe* species have spiritual as well as medicinal properties

rather than culinary uses. Since *A. muscaria* has not been confirmed growing in Peru and its traditional hosts are northern hemisphere trees one hypothesis is that the mushroom were a trade item with countries lying further north or Meso America where *A. muscaria* has been shown to have been deeply engrained into the religious cultures. The implications and importance of the findings are discussed for understanding of Peruvian cultures and the ancient mind and history. Various suggestions are made to advance archaeological research by integrating better mycological expertise to improve understanding of these remarkable ancient peoples.

Introduction

Humans have ancient connections to mushrooms. Our ancestors in every inhabited continent on earth used mushrooms. Why? It appears that they were aware of and used the power of mushrooms medicinally, nutritionally and spiritually. Curiously, fungi are probably the most wholesome product that combine nourishment with medicine. They combine high digestable protein, deep mineral and organic essence of the earth with defense and sometimes neurological compounds that are of use to us due to the phylogenic closeness of fungi to us. Mushrooms are in essence a medicinal food tailored to humans.

The oldest known representations of mushrooms have been found in Africa on petrographs from as early 9000 BCE, suggesting that already then they played an important part in human rituals (Samorini G. 1992). The 5000 year old iceman found in Italian alps a few years ago also was carrying mushrooms probably for medicinal reasons, or as fuel. The Romans and Greeks used mushrooms for various purposes including food: Amanita caesarina was a favorite food in Roman times (Phillips R. 1981). Ling-Zhi, Reishi (*Ganoderma lucidus*) is known from 2000 year old Chinese medicinal documents as their most valued medicine, the herb of eternal life (Hobbs C. 1986).

That said, fungi, unlike ancient crops or medicinal plants, have received little attention in archaeological or anthropological studies. The most written about ancient fungi have been those connected with entheogenic species like *Amanita muscaria* and *Psilocybe* species (Schultes 1939, Wasson & Wasson 1957, Borhegyi de 1961, Allegro 1970, Furst 1972, McKenna 1992, Gartz 1995, amongst others.). Wasson & Wasson (1957) believed, the use of entheogenic mushrooms spread over most of Eurasia and the Americas, and as Stone Age Man emerged into the light of proto-history fungi may well have been the primary secret of his sacred mysteries and the development of religion. The reasons for the scarce coverage of the role of fungi in human history maybe the lack of mycological knowledge in archaeological circles, and probably stigma associated with such of research. The result being that in most cases mushrooms in ancient art have been interpreted in almost amusingly erroneous ways (Samorini G. 1992).

In line with the global archaeological and historical trends mushrooms have been rarely mentioned in archaeological literature of Peru. A few authors noted their presence, but their suggestions fell mainly on deaf ears by the academic community (Schultes 1972, Morgan 1995, Borhegyi de 2010). Most notably though, (Poma de Ayala 1615, p. 282-5) a famous indigenous writer in the 'Nueva Cronica y Buen Gobierno' [apparently either using information principally from the remarkable mestizo, legally dead, Jesuit priest Blas Valera, or was his alibi (Hyland 2011)] in passing mentions the significance of mushrooms (Kallampa) in dreams of death in Inca times in the chapter on rituals and ceremonies. He also denotes the month March as the month where mushrooms for food are plentiful in March (p. 1137/8) and notes their importance as food in the Inca diet.

In contrast to the few references in Peru on mushroom use there is substantial mention in the literature of plants and of hallucinogenic plants like Banisteriopsis spp. and species of the genus *Psychotriatha* that produce the DMT containing entheogen 'Ayahuasca", as well as of San Pedro (*Echinopsis pachanoi* syn. *Trichocereus pachanoi*), and of Coca (*Erythroxylum coca* and *Erythroxylum novogranatense*). To illustrate the point, an amazon.com search quotes at least 69 books on Peru and ayahuasca, 70 books on San Pedro and Peru, and of course 468 books on Coca and Peru. In contrast, the www.amazon.com search comes up with nine (9) books on mushrooms and Peru, all are related to modern cooking. The San Pedro cactus is well described in art and objects from the Chavin, Nasca to the Mochica cultures, and Ayahuasca is represented in Chavin art. Coca Is well known from Inca times and the early chroniclers. Morgan (1995) summarized a number of the ancient entheogens in Peru and surrounding countries, including the use of San Pedro and Coca and other commonly used plant based entheogens like those used referred to as vilca, or huila in Peru from the leguminous tree *Anadenannthera colubina* var. *cebil* and *Nicotina rustica* that were commonly used as snuff.

Considering the paucity of information on mushrooms in Ancient Peru, this study aims to begin to illuminate the role of fungi in ancient Andean societies. The objectives of this study are:

1. To document evidence that mushrooms were used in pre Hispanic Peru.
2. To begin to determine which cultures used mushrooms and to establish and make a first estimate of a time line.
3. To determine where possible the likely identity of mushrooms and their use.

It is hoped that this preliminary study will stimulate further interest to better understanding of ancient and indigenous Peruvian people, to revalue the role of mushrooms in society, and stimulate new and further work on this neglected subject, since we now better understand not only the high nutritional and medicinal value but also the crucial ecological role of fungi in the maintenance of life. I apologize from the beginning to colleagues in various fields, particularly in archaeology and anthropology for my inadequate coverage of the impressive amount of literature on history and cultural knowledge of Peru. In not doing so I have left much of their work unacknowledged. However, I believe that it is important to bring out the information on mushrooms in ancient Peru earlier rather than later for it to be available in the overall efforts to better understand the history and use of its biological diversity of this remarkable country that has played a central role in the history of humanity.

Materials and Methods

Materials

For the analysis ceramics, textiles and stone work were visually examined for mushroom representations The base materials were derived mainly from the Museo Larco, Lima, who kindly provided me with access to their full online collection. Other material was obtained from various museums in Peru and around the world and the internet. Other material was collected directly in the field by the author. Sources of information are acknowledged when used.

Identification of mushrooms

To identify mushrooms the shape, color, representational details of ancient artists, as well as the relative size to the known usually human features were observed. These were compared with known mushrooms from Peru, and the world, using various sources. A major limitation with identification of the mushrooms was the limited documentation of mushrooms in Peru. Major identification sources were (Pavlich 1976, Arora 1986, Stamets 1996, Pavlich 2001, Wright & Albertó 2002, Mata *et al*. 2006, Holgado *et al*. 2007 and collections in 2001 and 2012 see www.globalmountainaction.org)

Results and preliminary discussion

Mushrooms in Ancient Peruvian Cultures

The first step in evaluating the importance of mushrooms was to document their use through time by different cultures. In the past Peru had many cultures that flourished and disappeared. We know of most only through archaeological evidence and names retrieved through folklore, or attributed to them by those studying them, since no form of pre-conquest writing is yet known to have existed or has survived. The findings that follow result from a limited survey of ceramics, textiles and other art and are not meant to be exhaustive, but rather preliminary. The purpose of this section is to demonstrate the presence of mushrooms in various cultures over time.

Coastal Cultures

Cupisnique Culture (1200-200 BCE)

Cupisnique culture on the north coast existed from around 1200-200 BCE and declined at a time when the Moche or Mochica culture was gaining in strength. A beaker in the Metropolitan Museum (Fig. 1), depicts a mushroom tree, probably a tree of life. The mushrooms are being shown in cross section. Initial finds at the recently found Cupisnique Callud temple, around Lambyeque also show themes associated often associated with mushooms in other cultures, such as feline images and decapitated heads (Orozco 2008), although the connection, if any, with a spider deity is unclear. The presence of mushrooms in Cupisnique culture suggests mushrooms in Peru were known and used as long as in the oldest Meso-American societies, like the Olmec, who have been shown to have used mushrooms.

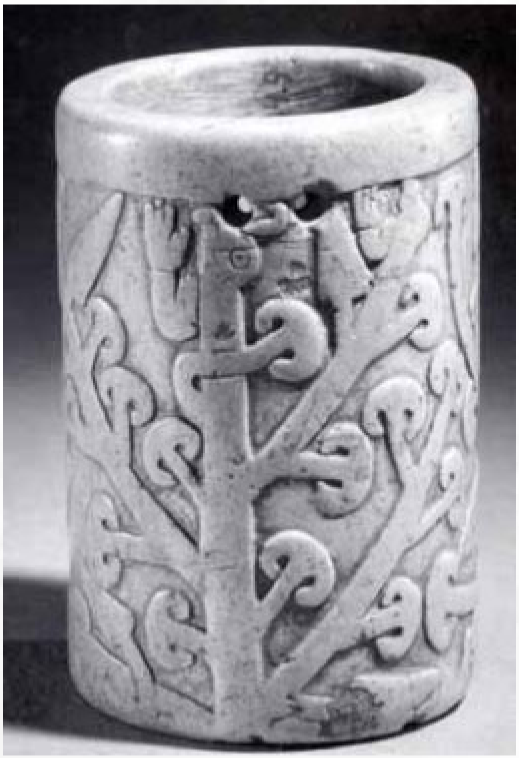


Figure 1. Cupisnique mushroom beaker.
Source: Metropolitan Museum 1978.412.113

Paracas Culture (800-100 BCE)

Paracas culture prominently features mushrooms in its textiles and ceramics. Some may be taken for Tumi's (mushroom shaped ritual knives) and perhaps the duality was an intended part of the symbolism. In other cases it is clear the images represented are mushrooms. The textiles in figures 2 (a and d) show shamanic beings in flight with a mushroom shaped structures in either one or both hands (an unlikely tumi scenario). Flight was a shamanic ability brought about by the use of entheogens, which here may be represented by the yellow mushrooms. The 'google' eyed image in figure 2b holds two yellow capped mushrooms on a staff like structure in the right hand (also an unlikely Tumi scenario). On the head there also appers a mushroom like image. The ceramics in figure 2c, show a spider like creature in a trance holding a conical capped structure and one on its head, characteristic of *Psilocybe* mushrooms. The representation of mushrooms in the Paracas culture may indicate their role in the transformation, since through transformations it is believed shamans were able to communicate and even battle with spirits and thus heal illnesses or become clairvoyant.

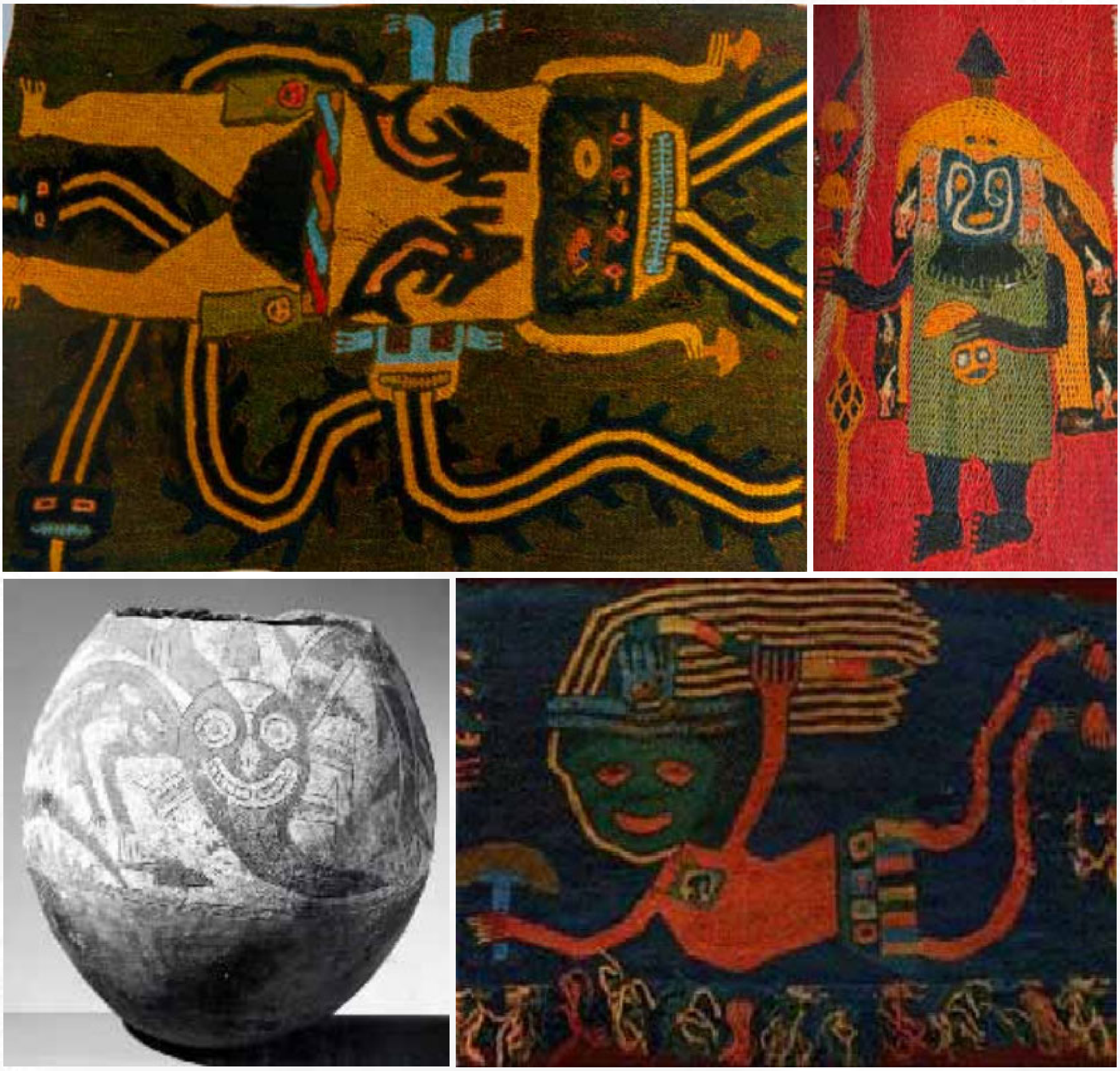


Figure 2. a) shamanic figure in flight with mushroom images in both hands b) Image with mushroom on head and attached to a staff like structure, and holding a trophy head. c) Anthromorphic figure with mushroom symbol on head and either tumi or mushroom in hand. d) Flying shamanic figure with mushroom in hand.
Sources: a) Metropolitan Museum 1979.206.751, b) Norbert May rock Collection NM237 c) Metropolitan Museaum 1979.206.751 d) from Borhegyi 2010.

The Moche (Mochica) culture (100 BCE-800 EC)

The Moche, a well known culture for its ceramics and spectacular archaeological finds ((Bawden G. 1999), (Quilter J. 2011)), produced ceramics with unmistakable representations of mushrooms. As a society they share many similarities with the Tumaco-La Tolita and Valdivia culture of Ecuador and Colombia (Errázuriz J. 1980). They provide the most expressive, varied and the most clear evidence of all the Peruvian cultures that mushrooms were used and played an important part in ancient Peru. They developed highly realistic representations of people and daily life. As such, Moche art provides a window into the minds and rituals of its people unequaled in other culture. Through it, there is a unique chance to better understand the role of mushrooms in the ancient Peruvian world.

To begin, there appear to be three different forms of mushroom representations in Moche society. The first, there are unmistakable, large realistic representations of mushrooms (Fig. 3). The second, subtle 'hidden' representations of mushrooms that are easily missed if one is not looking for them, but clear when one has found them. The third form is an abstract symbolic or iconographic representation of mushrooms or uses with which they were associated. Only, the direct representations will be discussed here.

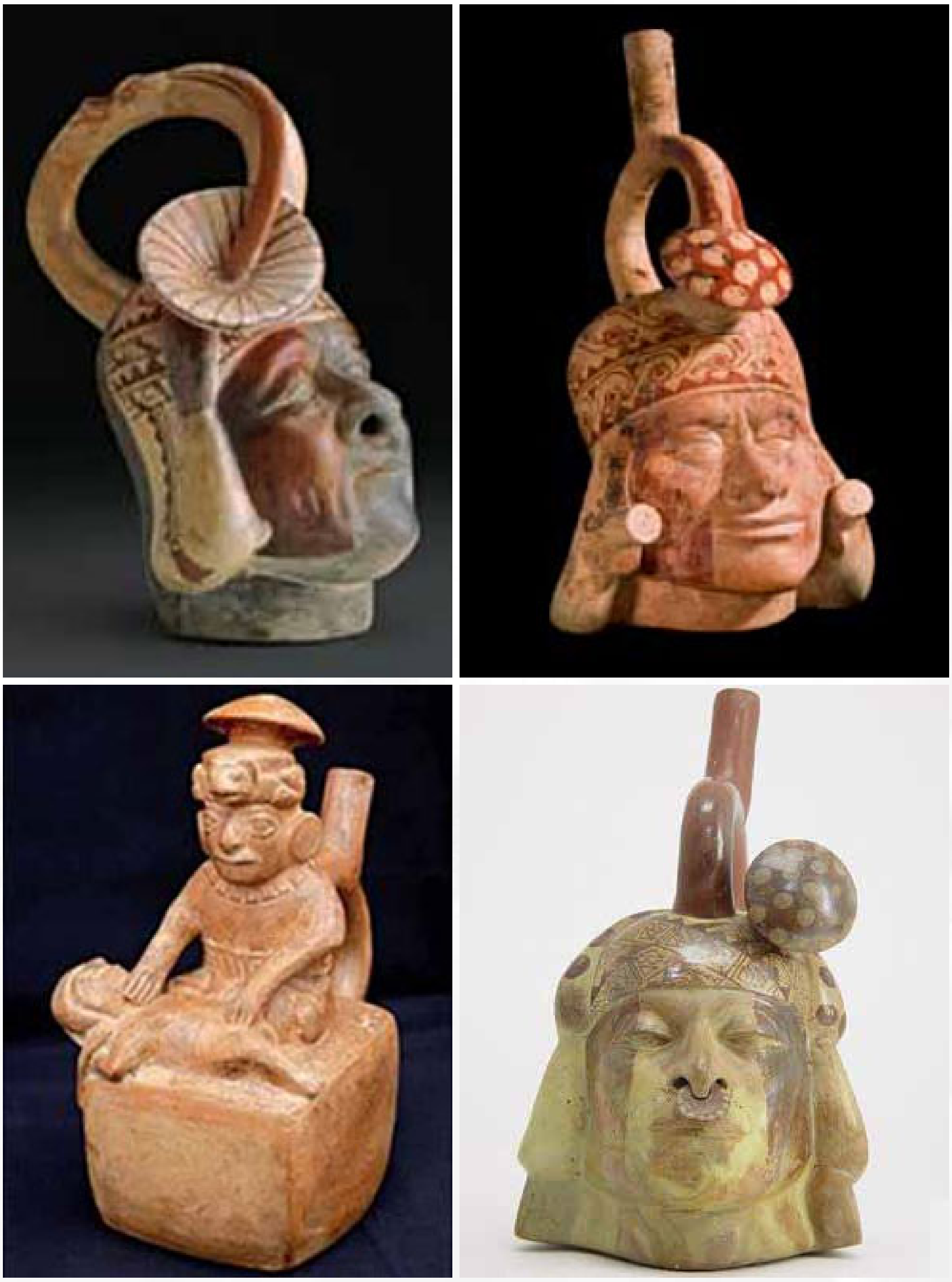


Figure 3. Moche ceramic figures with mushrooms protruding from their heads, represnting medical and perhaps spiritual use of mushrooms.
Sources: a. Borhegyi 2010, b) Peabody Museum 16-62-30/F729 c. Symbol of the Foro Medicina Traditional Peru. d) Museo Larco ML000136

The Moche represented mushrooms clearly enough to enable us to begin to identify some of the species at least to Genus level and thus begin to relate them to current knowledge about the fungi associated with the Moche.

Each of the highly realistic, individualized busts of Moche personalities is loaded with iconography and symbols inclduing mushrooms. The images (in figure 3) have unmistakable mushrooms either on top, or on the side of the head, and figure 4d has both. The image (Fig.3 a) has a mushroom growing over his head, with the gills and mycological characteistics of the mushrooms clearly shown. The mushroom appears to have free, light gills that are termial split or at least appear split to an observer. The stipe is brown and has no annulus. The presise nature images is presented alone demonstrates profound knowledge of the Moche of mushrooms. The image on the lower left (Fig. 3 c) is clearly what would today be called a curandero. The individual is kneeling above a child who is evidently ill. On his head there is a prominent mushroom. It is an example of medicinal use of mushrooms in ancient Peru. The image on the top right (Fig. 3 b) has a umistakable red capped mushroom with white dots. The examples carry mushrooms known for food, medicine as well as religious use. (For more detail see the identification section). They demonstrate that the Moche had various uses for mushrooms. It should be interesting to check mushroom definitions in early dictionaries of the now extinct Moche language.

The extent to which mushrooms are represented in Moche society, especially from ceramics from particular areas such as the Virú valley suggests mushrooms may have been more important in some places than others. Moche images will be presented in various sections of this paper to demonstrate associations of mushrooms in ancient Moche and some Peruvian society.

The Chimú culture (900-1470 CE)

The Chimú culture became dominant in northern Peru after the decline of the Moche societies with whom it was linguistically and culturally closely associated. The culture lasted until they were integrated into the Inca Empire around 1462-1470 AD. There is clear evidence of mushroom representations in Chimú art and thus of the continuation of mushroom knowledge from one time period to the next. On the bottom left (Fig. 4), we see a Chimú textile with a figure (Schindler 2000). On his head a we see a mushroom like crescent, not unlike that seen in important personalities of Moche societies, and perhaps symbolic of spiritual and earthly power. The stipe of the mushroom is unlike a typical tumi, it is shaped with what looks like a volva typical of *Amanita* species. We see a similar image in Borhegyi (2010) where the Chimu image is standing above a mushroom (without volva) growing from the ground. On the botom right (Fig. 5) we see a textile of a priestlike figure also holding a mushroom with volva in his right hand with a mushroom cap whose spots are reminicent of the genus Amanita.

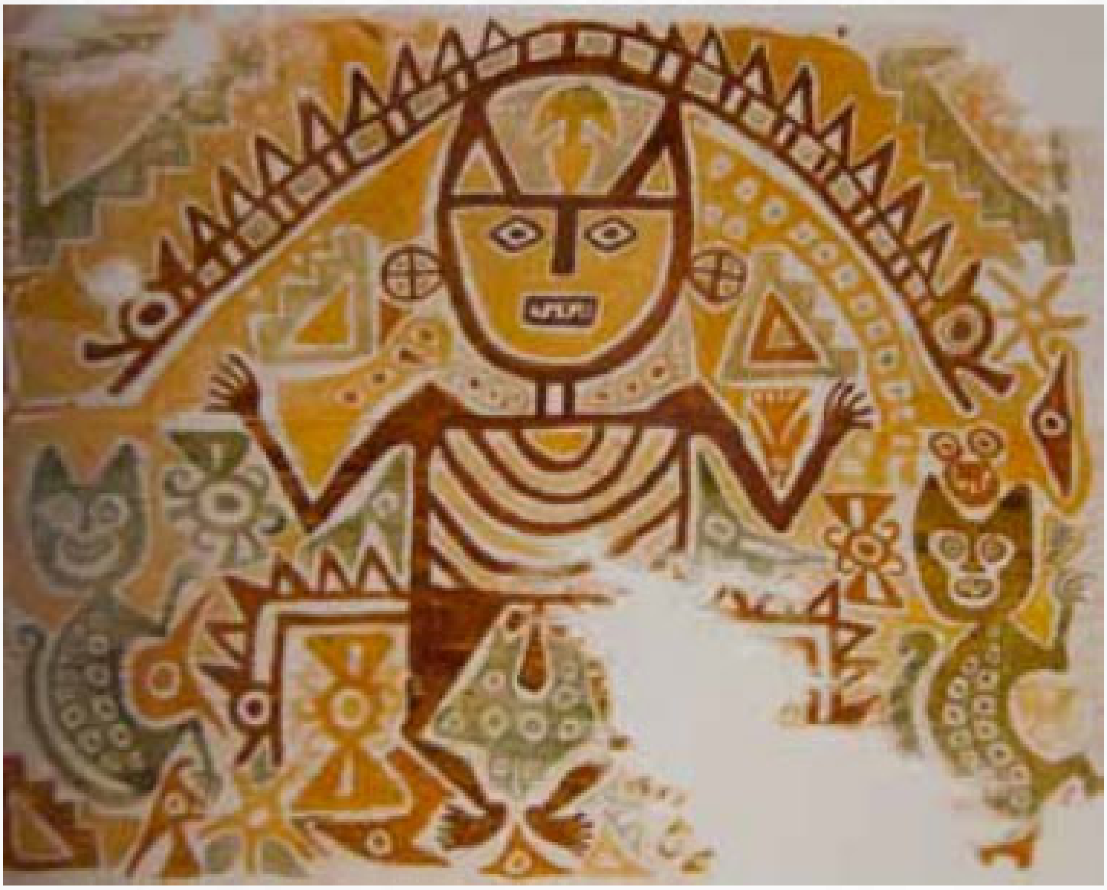


Figure 4. Personality with mushroom with volva on head.
Source: Norbert Mayrock Collection NM297

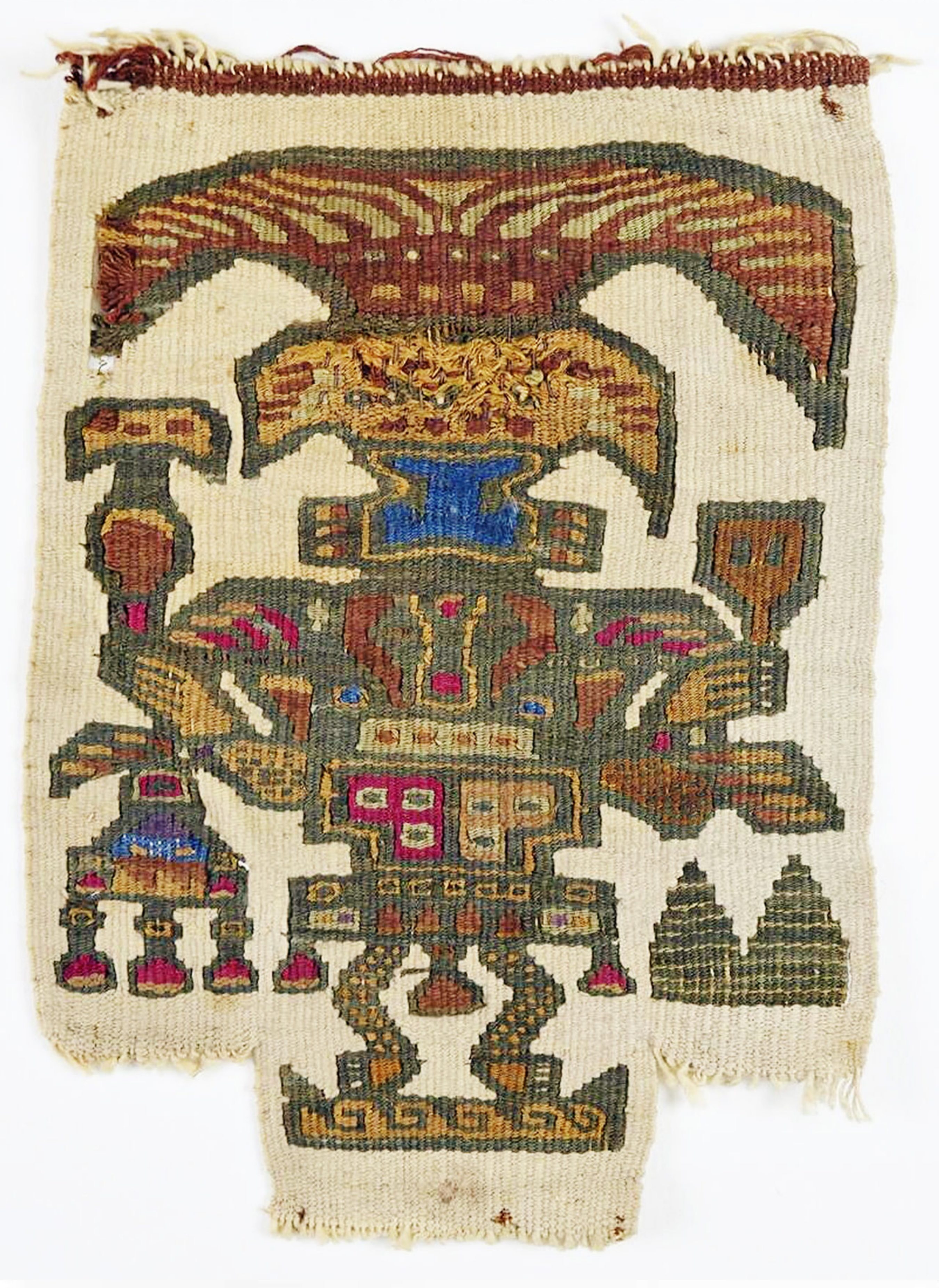


Figure 5. Priest with *Amanita muscaria* mushroom. Lambayeque 900-1300 CE (Chimu?)
Source: Metropolitan Museum Number: 82.1.4

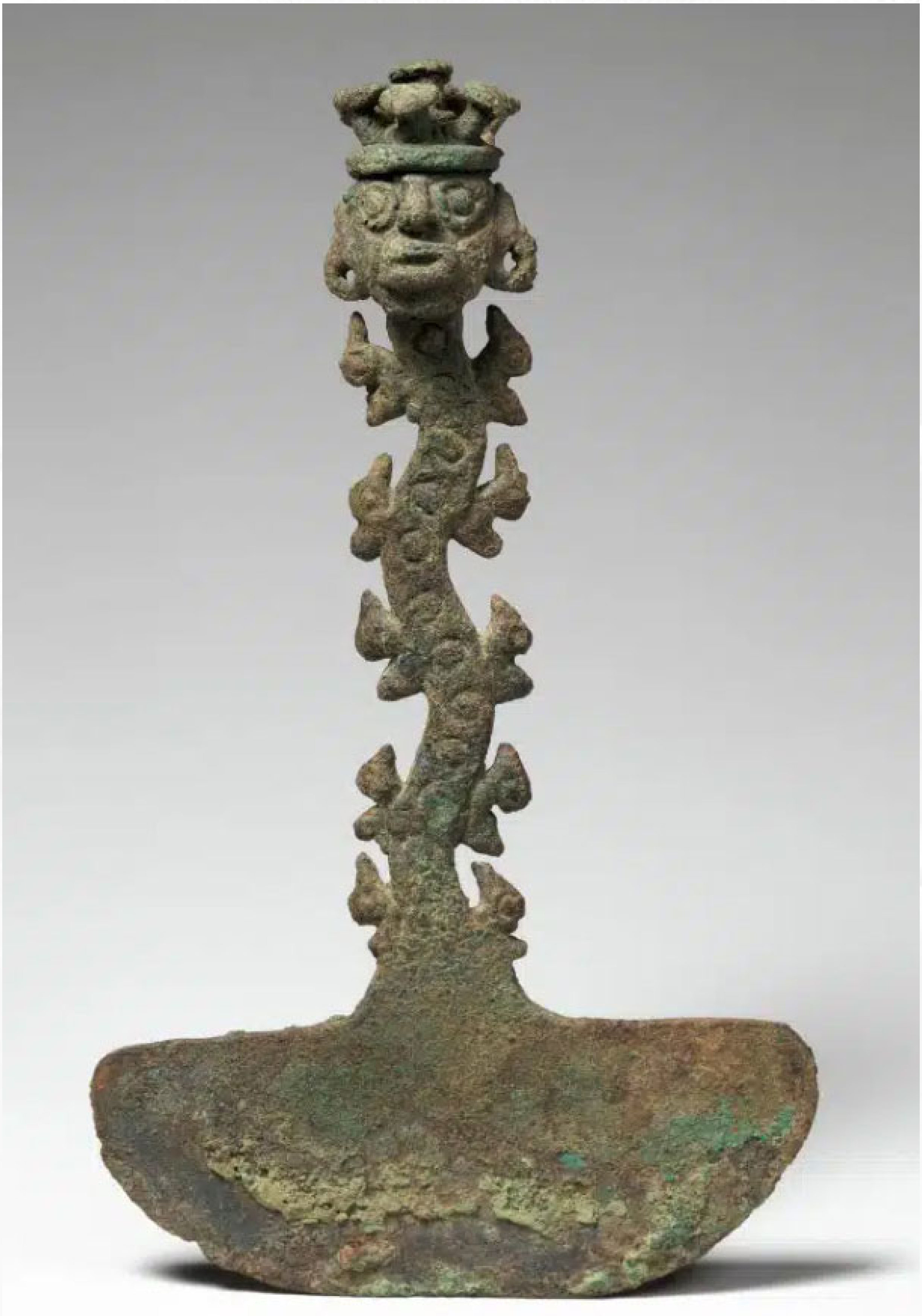


Figure 6. Chimú tumi with mushrooms.
Source: Metropolitan Museum Number: 1987.394.216

On the top right (Fig. 6) there is an example of the association of mushrooms with Tumis in Chimu society. The tumi, a religious sacrificial knife, not only is mushroom shaped by has a long neck with birds and a head out of which mushrooms are growing.

Highland Cultures

Pukará Culture (1200 BCE - 400 CE)

The Pucará culture was of profound formative importance in the region for the Tiahuanaco and Wari cultures that succeeded it. Some indigenous groups like the Callawaya still speak a language based on a mixture of Ayamara and Pucará. The Pucará site built under a rock formation with looks like a feline, probably a puma.

Few Pucará ceramics have been evaluated to date, however there is strong visual evidence that mushrooms were used ritually. In figure 7a, a ceramic feline representation of the Pucará culture has red mushroom cap shaped ears attached to a what appeat to be mushroom stipes of slightly darker color. The feline has 'google' eyes, suggesting a trance state. This image can be found repeated in numerous similar ceramics. It is a curiously similar design to that found of the Wari culture where the anthromorphic feline, has undisputable mushrooms instead of ears (see Figure 11).

The Pucará culture also produced mushroom shaped stones (Fig. 7 b). Their caps appear more like young mushrooms, but with clear deliniations of stipe and cap. They may also have phalic symbolism, but lack an orifice as well as a realistic phalic head shape suggests the principle intent was to represent a mushroom. Certainly they are not just wights (pesas) as indicated in the museum.

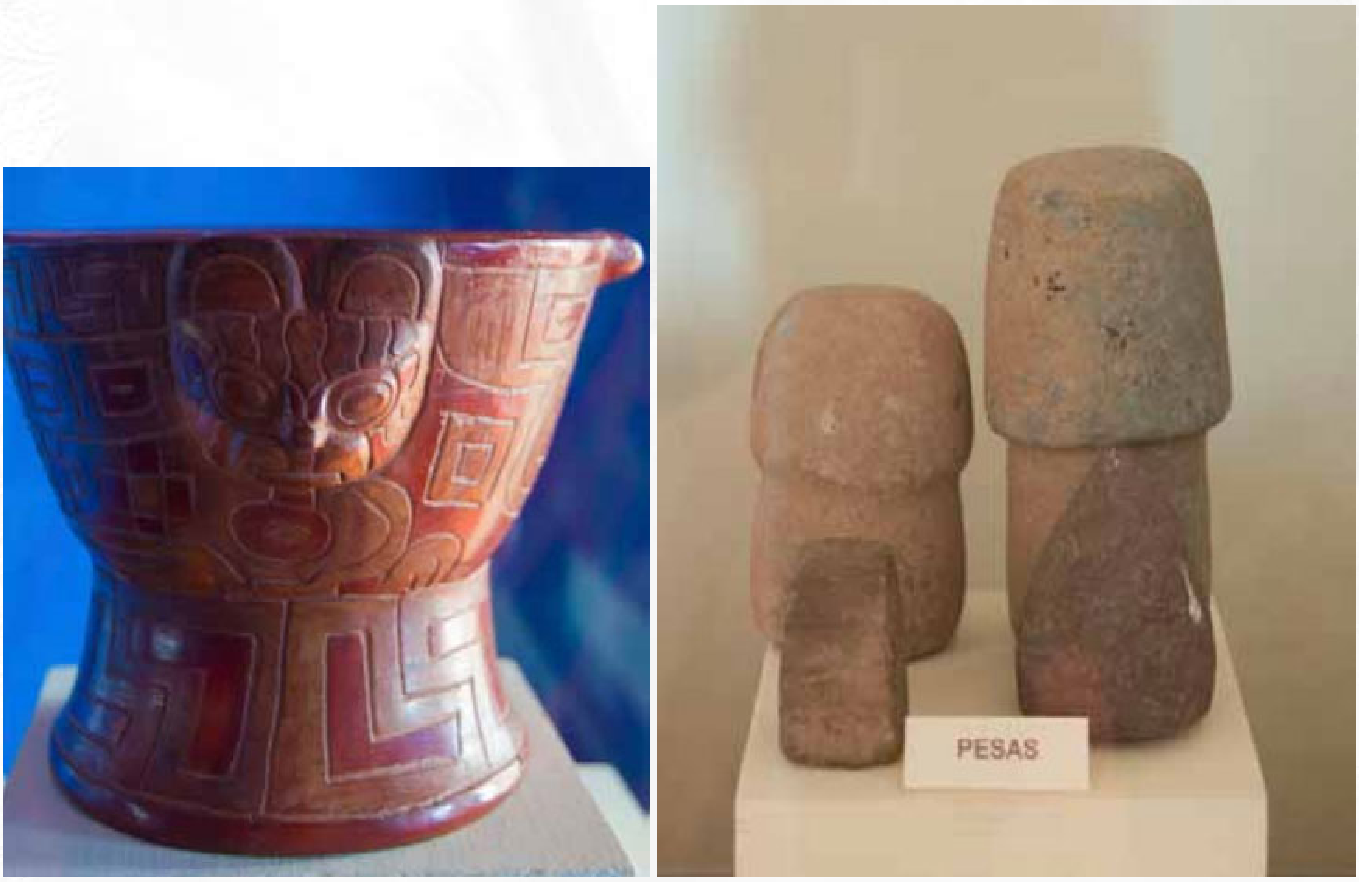


Figure 7.a) Jaguar with with mushroom ears b) mushroom shaped stones. Source: a & b. Museo de Pukará.

The 'Mushroom stones' of Chucuito, Lake Titicaca

On the North west side of lake Titicaca, in the town of Chucuito, there are stones, finely carved from volcanic and other rock, in the shape of mushrooms (Figs. 8 & 9). The age of the stones is not known. They may be from Inca times or earlier. The Chucuito mushroom stones, although less elaborate, have similarity to those found in Mexico and Guatemala (Borhegyi, 1961) whose original purpose also is not yet known.

The pre-columbian temple, which now houses the stones, was studied and verified as an Inca structure in 1950 by Harry & Marion Tschopik (Kummer L.J. 2006). However, it appears no serious studies have yet been conducted to better understand the context of these stones. The stones bear little resemblance to sculptures at Tiahuanaco on the other side of lake Titicaca, but do have striking similarity to the mushroom stones of the Pucará culture in the north (Fig. 7 b). Some of the sculptures may have some similarity to Inca stonework, although no Inca mushrooms sculptures appear to have been found at other sites. For the purpose of this study the culture will be referred to as the Chucuito Culture, a culture which appears to have had connection to the Pucara and Inca cultures.

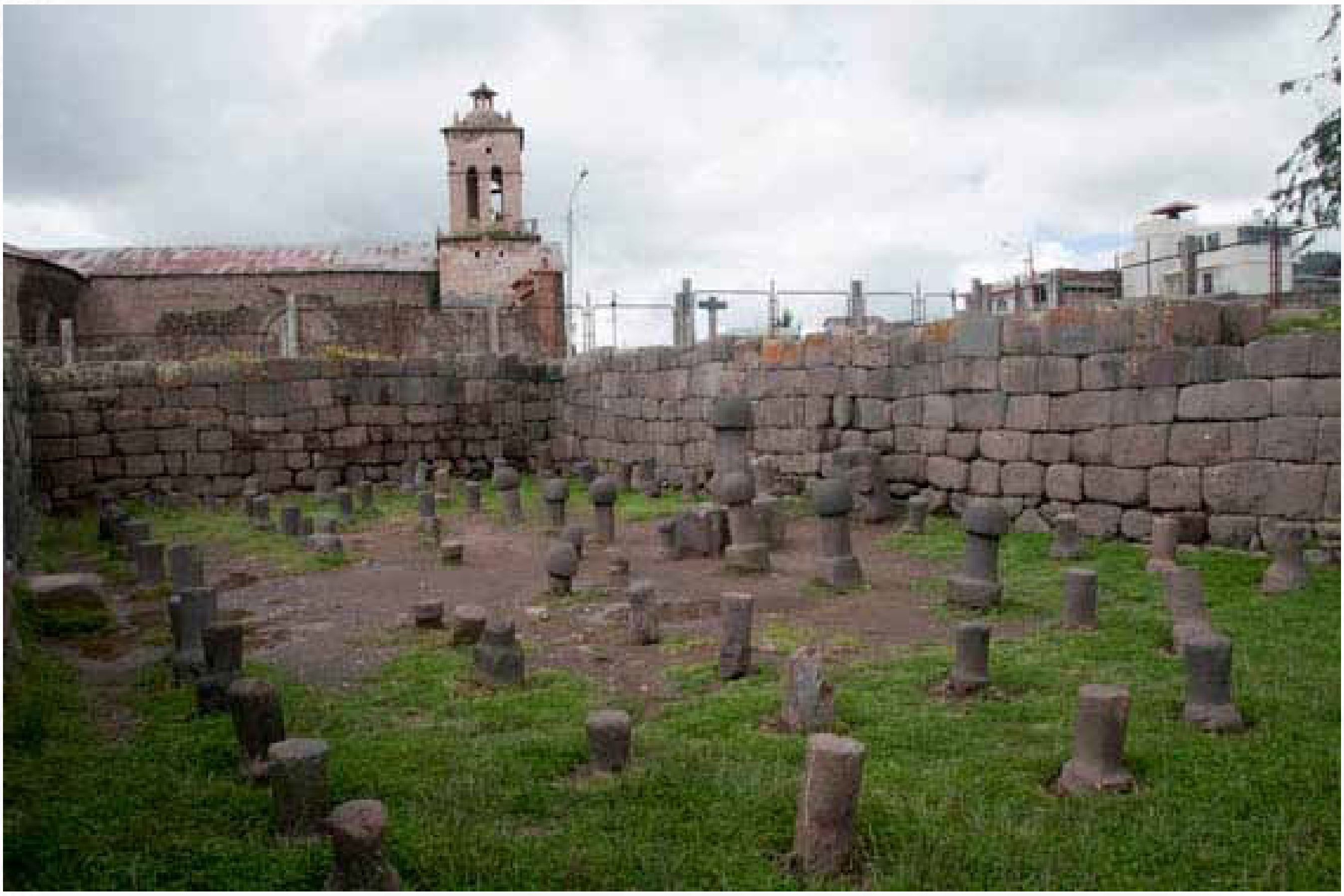


Figure 8. Inka Uyo, with the collection of mushroom and ordinary roof bearing stones found in and around Chucuito Source: Peter Trutmann©2011

The origin and purpose of the mushroom stones remains a mystery. There has been an unfortunate confusion created by a decision by the town in the 1970s to bring together in the genuine late Inka temple structure called Inka Uyo, all mushroom stones found in and around Chucuito to create a tourist attraction as a temple of fertility for which it is now famous (Figure 8). In a New Times article Kummer (Kummer 2006) questions the authenticity of the temple of fertility, and whether the stones truly represent phallic stones. Incredibly, neither he nor the anthropologists he consulted touched the possibility of the stones representing mushrooms, or their deeper symbolism. One Peruvian archaeologist considered the mushroom stones to be roof beam baring stones of Inca buildings (ibid). It is true that of the over seventy stone structures at the temple only 14 are mushroom shaped. The rest are classic Inka roof baring stones (Fig. 10 a). These are straight stone cylinders on a square base that were implanted into the wall of the buildings like those common of Inca structures found in other parts of Peru (10c). Of the mushroom stones, those with clear caps (Fig. 9), only one has clear dual phallic features (Fig. 9 c). Its dimensions much larger than the other mushroom stones. It is the only one with an apical cleft.

Over half of the mushroom shaped stones in the temple could also have functioned as roof baring stones with special mushroom symbolism (Fig. 9 b). Although these mushroom stones are more finely worked, they have shafts of similar length that could have carried beams. They also have a base similar to the ordinary roof baring stones that could have been lodged within a stone wall (Fig. 10 a,b,c). They are all almost identical in form, suggesting they were manufactured for the same structure or official use. Perhaps, they were used to decorate the top of a temple that used mushroom or their symbolism? That symbolism may have included fertility.

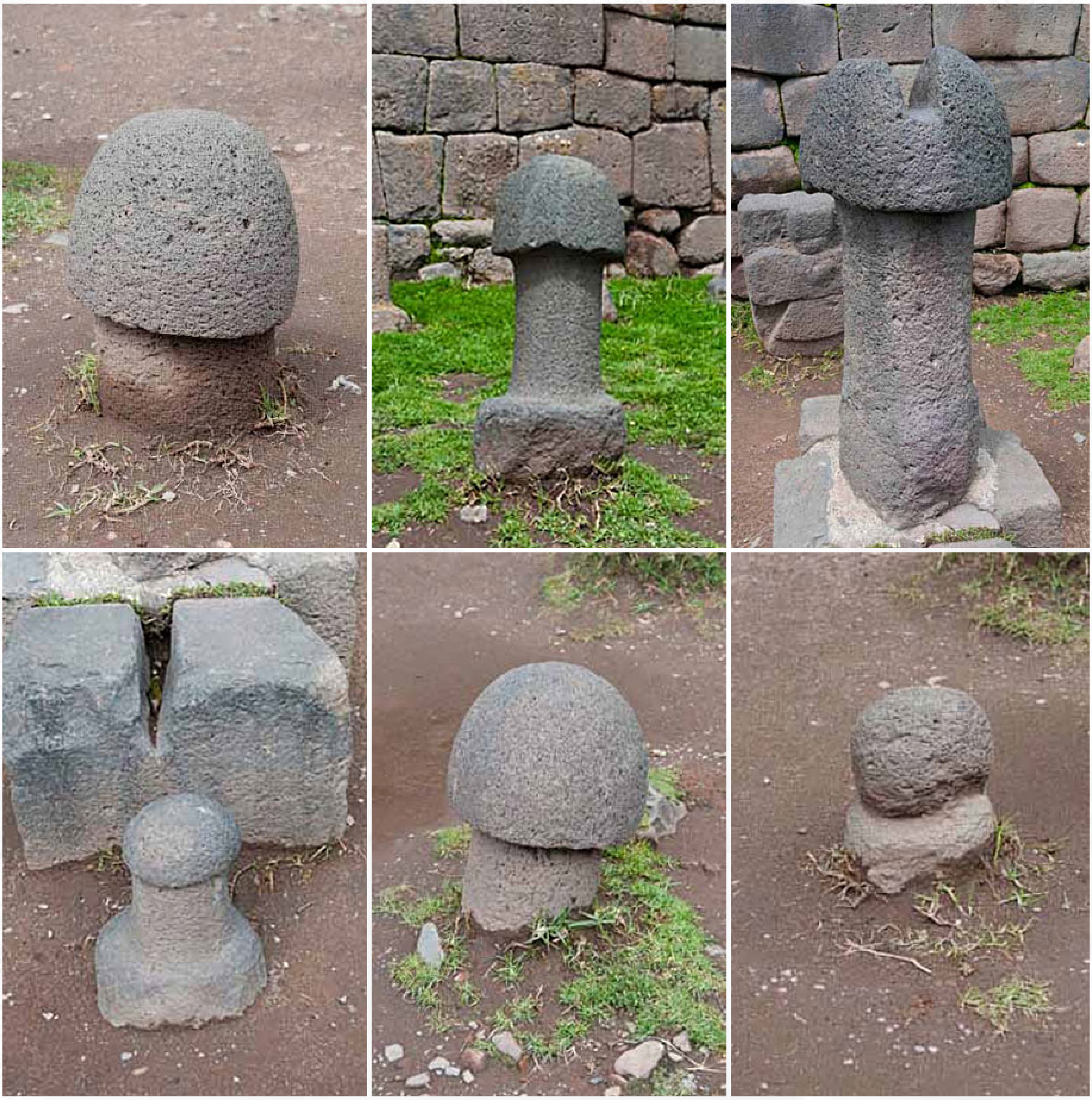


Figure 9. a-f. Mushroom shaped stones with stipe of various lengths and clearly defined caps. 9f. Dually symbolic mushroom/ phalus stone with apical orifice but cear mushroom cap, rather tham phalus head shape. The orifus could also represent the entrance to the underworld as could the v shaped stone in 9d.

The other mushroom stones found in Chucuito have shafts of shorter lengths (Fig. 9 c-e). These shafts are so short they would never have been useful to secure a roof beam. or so large (as in the case of the phallic mushroom stone shaft and cap measure 1.2 m) that it is unlikely that its original use was to bear beams. It suggests that these mushrooms were intended to be placed on the ground.

Using the findings, there is a strong case that in ancient times around ancient Chucuito mushrooms were considered with sufficient reverence to carve stones and images of them. The mushrooms fit into evidence of pan Peruvian use in pre Hispanic times. Although we cannot yet identify the mushrooms represented at chucuito with certaintly for lack of mycological knowledge of the region, or know their exact use, it is likely that one association was associated with fertility and/or feline transformaton related rituals, since Chucuito also is associated with the Puma.

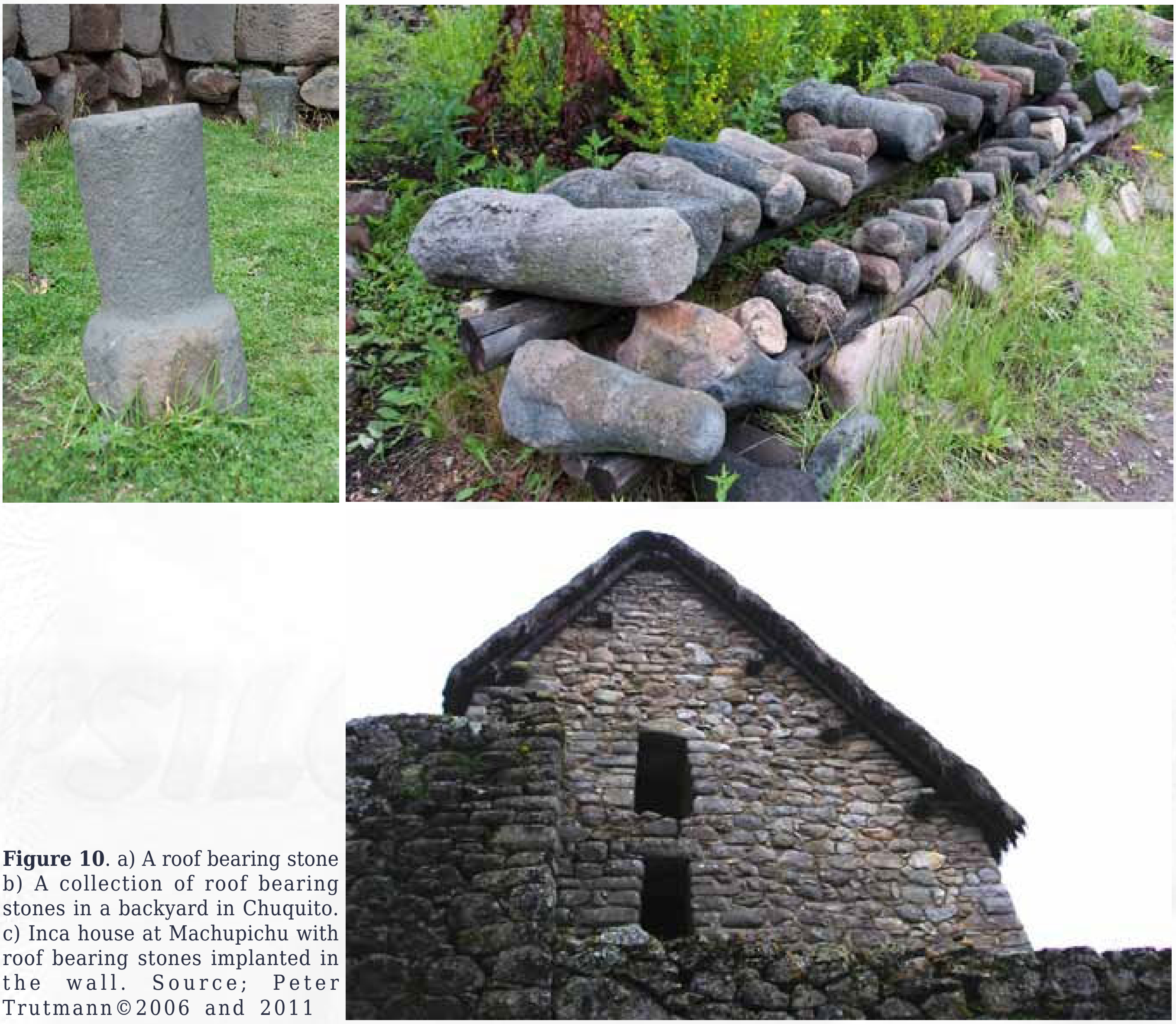


Figure 10. a) A roof bearing stone b) A collection of roof bearing stones in a backyard in Chuquito. c) Inca house at Machupichu with roof bearing stones implanted in the wall. Source; Peter Trutmann©2006 and 2011

Wari culture (500 to 1000 CE)

The Wari (or Huari) Culture was a highland culture, which dominated most of present day Peru. It accupied Pacacamac, a major religous site and Andean mecca, although it retained much autonomy, and took over much of the territory formally occupied by the Moche. They are believed to have made major technolgical and organizaitonal breakthroughs such as development of an extensive road structure as well as the use of terracing for Agriculture.

The Wari culture also incoporated elements of earlier Tiahuanacu culture, including representations of the personalities of the gate of the sun in Tiahuanaco, as well as elements of Nasca style art. The ceramics often depict realistic, rather than abstract, images with symbolism, much like the Moche societies, that enable easy identification of mushrooms. For example, the vase below (Fig. 11 a) contains a painted anthro-morphic image reminiscent of the Pucará puma with fungal structures reminiscent of Pucará ceramics. The feline fungal ears differ inthat those of Pucará represent mushroom caps, whereas those of the vase are the form of puffballs.

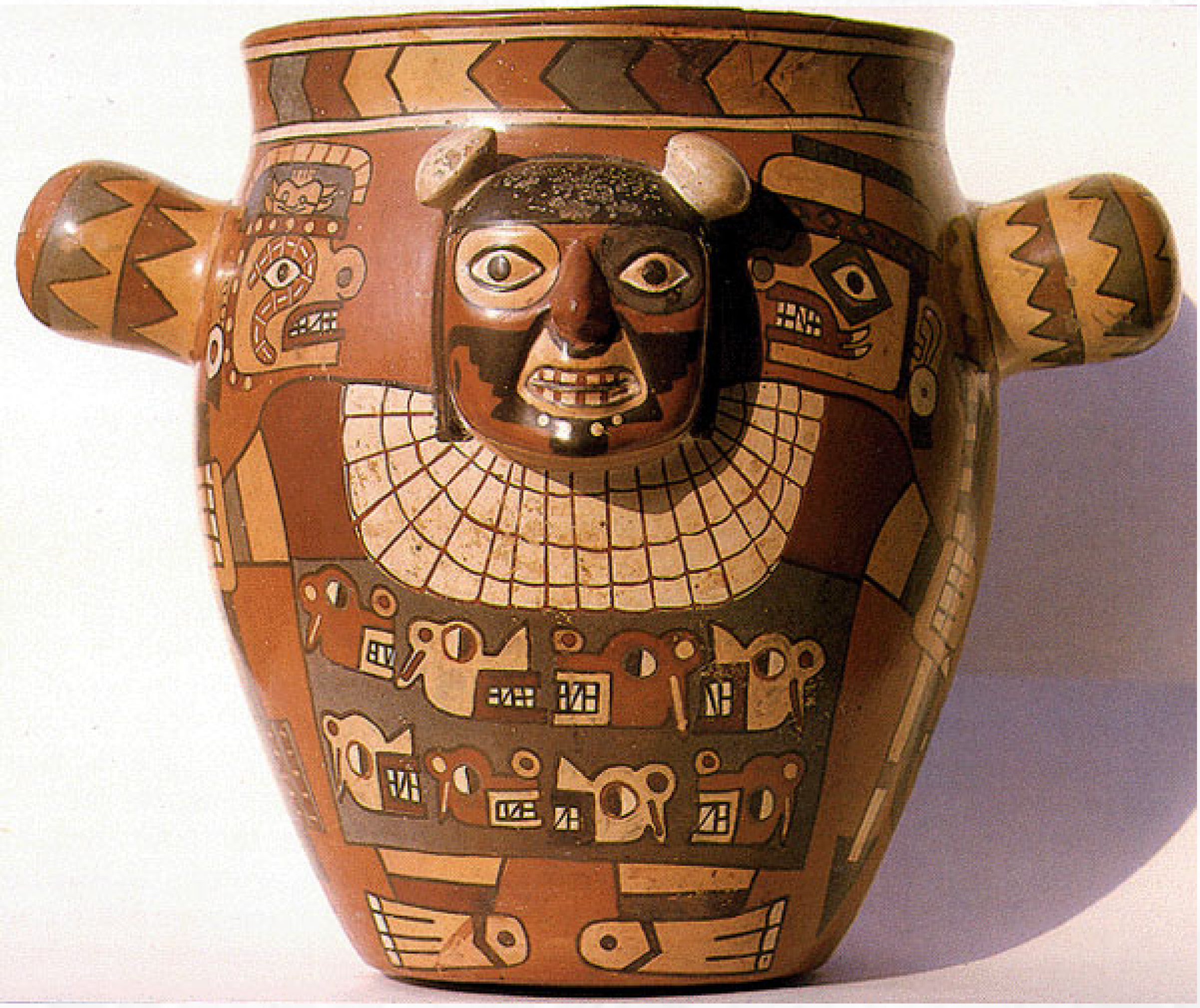


Figure 11. a) Anthromorphic image with puffball mushroom ears Source: Caceres j. 2004.

Mushrooms and the Incas (1200 - 1532 AD)

Little material was studied from the Inca period. Nevertheless, considering that the Chimu culture connected chronologically directly to both the Moche, Wari and to the Inca cultures, it is very probable the Incas knew of mushrooms. The Inca were known to incorporate other religions and worship into their own as seen in Pachacamac and other sites of conquered peoples. Certainly, we know from Poma de Ayala (Poma de Ayala F.G. 1615) that in Inca times mushrooms were part of the indigenous diet. Furthermore, Inca mythology and language is highly suggestive of an association with mushrooms (Delgado Diaz del Olmo 1996).

There are pieces from the Machu Pichu collection returned by Yale and now housed in the Museo Machupichu that show the Incas produced images of mushrooms in gold (Fig. 12). The pendant contains an cross-sectional image of a convex to broadly parabolic mushroom cap, the shape of some neotrophic mushrooms. There are also mushroom shaped earplugs. From what remains of the color, they were clearly painted red with what faintly appears like white dots. Coming from Machu Pichu, a sacred site, it would not be far fetched to suggest that sacred mushrooms may have been part of ritual life and symbolism in such a richly forested region filled with some of the greatest biodiversity in the world?

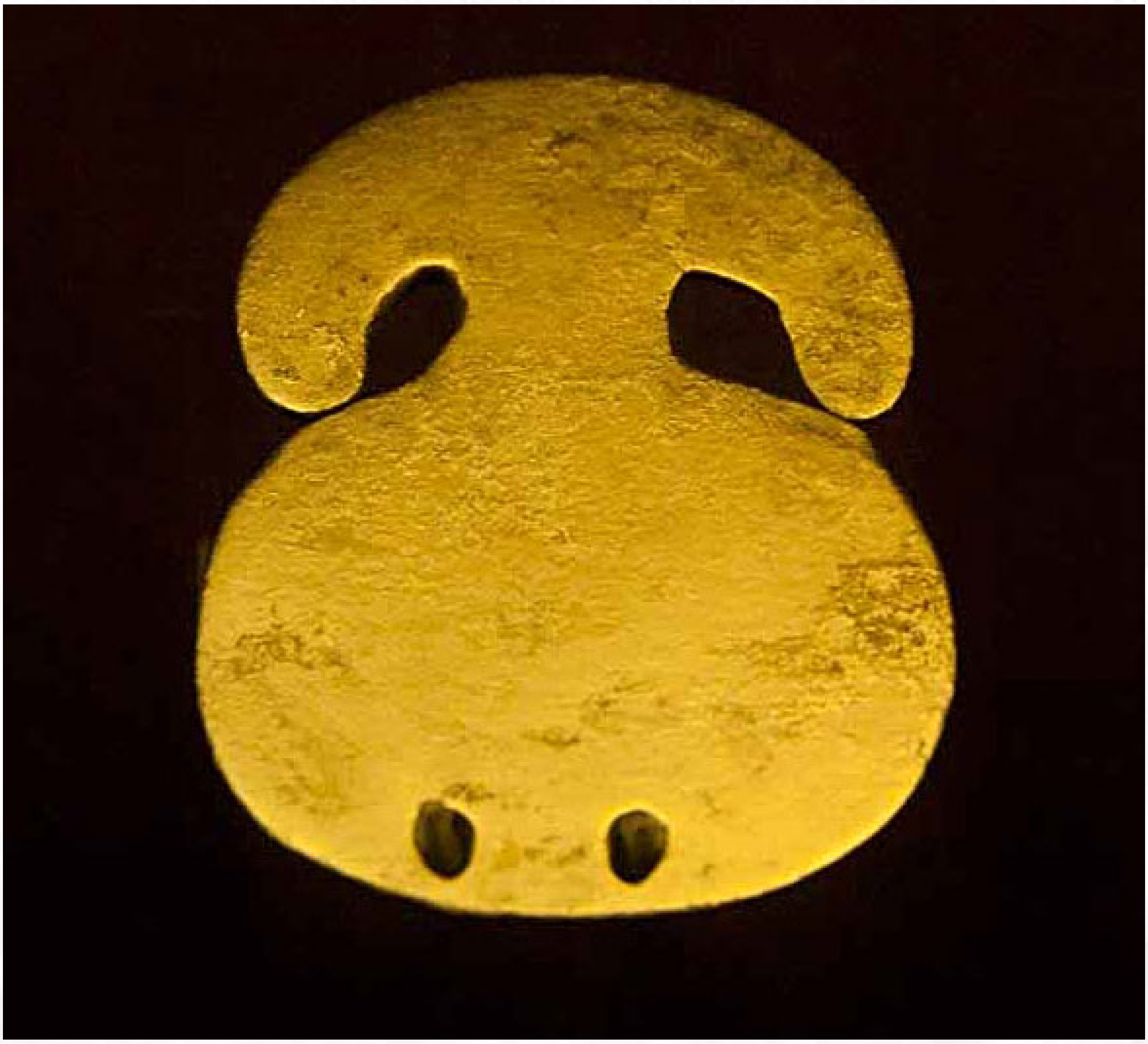


Figure 12. Mushroom shaped Penant. Source: Museo Machupichu, Casa Concha, Cusco. Photo: petertrutmann©2012

Cultures of the Selva and Amazon Basin

Information about pre-Hispanic mushroom use in the Selva and Amazon basin is limited. Gartz (1996) mentions:

> *"Jesuits of the 17th and early 18th centuries who had traveled to the western Amazon (Peru) reported that the Yurimagua Indians habitually prepared a potently intoxicating potion derived from a tree-dwelling mushroom. The mushrooms appeared on fallen trees as a kind of reddish growth with a spicy taste. The potion was said to be so potent that nobody who swallowed three mouthfuls of the brew was able to resist its effects. The mushroom was considered to be Psilocybe yungensis Singer & Smith. However, since Gymnopilus species are reddish in color .... and tend to colonize dense tree trunks, those strange tree-dwelling mushrooms were most likely a Gymnopilus species".*

There are few studies of current mushroom diversity in the Peruvian Amazon. The most complete study document substantial diversity of mushrooms including consumption of over 30 species for food by indigenous groups (Prance 1984, Door & Abad 1990, Espinoza 2003, Mata *et al*. 2006). Ethno-mycological reports of sacred mushroom use by Amazonian groups near Peru were made by Schultes and Reichel-Dolmatoff (Davis 1997). Although *Psilocybe cubensis* and other *Psilocybe* species have been reported from the Peruvian Selva (Pavlich 1976, Guzmán 2009), there is no ethno-mycological association as yet with these fungi. Mushroom use is known by present day shamans practicing ayahuasca rituals from the Pucalpa and Iquitos regions. They do not use mushrooms, but know about them. Their belief is that mushrooms are from down below, associated with the underworld, and prefer to leave them alone. (Trutmann 2009).

It is clear from these studies that in the Amazon basin some indigenous groups used mushrooms in religious rites and today still use substantial diversity of mushrooms for food and for religious rites. Perhaps these groups will be able to provide insights into their significance and use by ancient Peruvian societies.

Identification of mushroom species

One of the Mushrooms found represented clearly in Moche (Fig. 13 b) and Chimu societies (Fig. 5), containing volva, a red cap and/or with dots undoubtedly are representations of the famous *Amanita muscaria* (Fig. 13 a). It may be represented in more abstract terms in the art of other cultures such as the Paracas, and Incas. Some scholars believe *A. muscaria* to have been associated with humanity since formative period of religion by ancient peoples from Europe to Asia in the old world and Meso America of in the new world (Wasson 1972). In his writings Wasson provides evidence to suggest that the 'Soma' of the Indo-Europeans was in fact *A. muscaria*. Borhegyi (2010) describes its use in Mesoamerica. It has to date never been reported as used in ancient Peru.

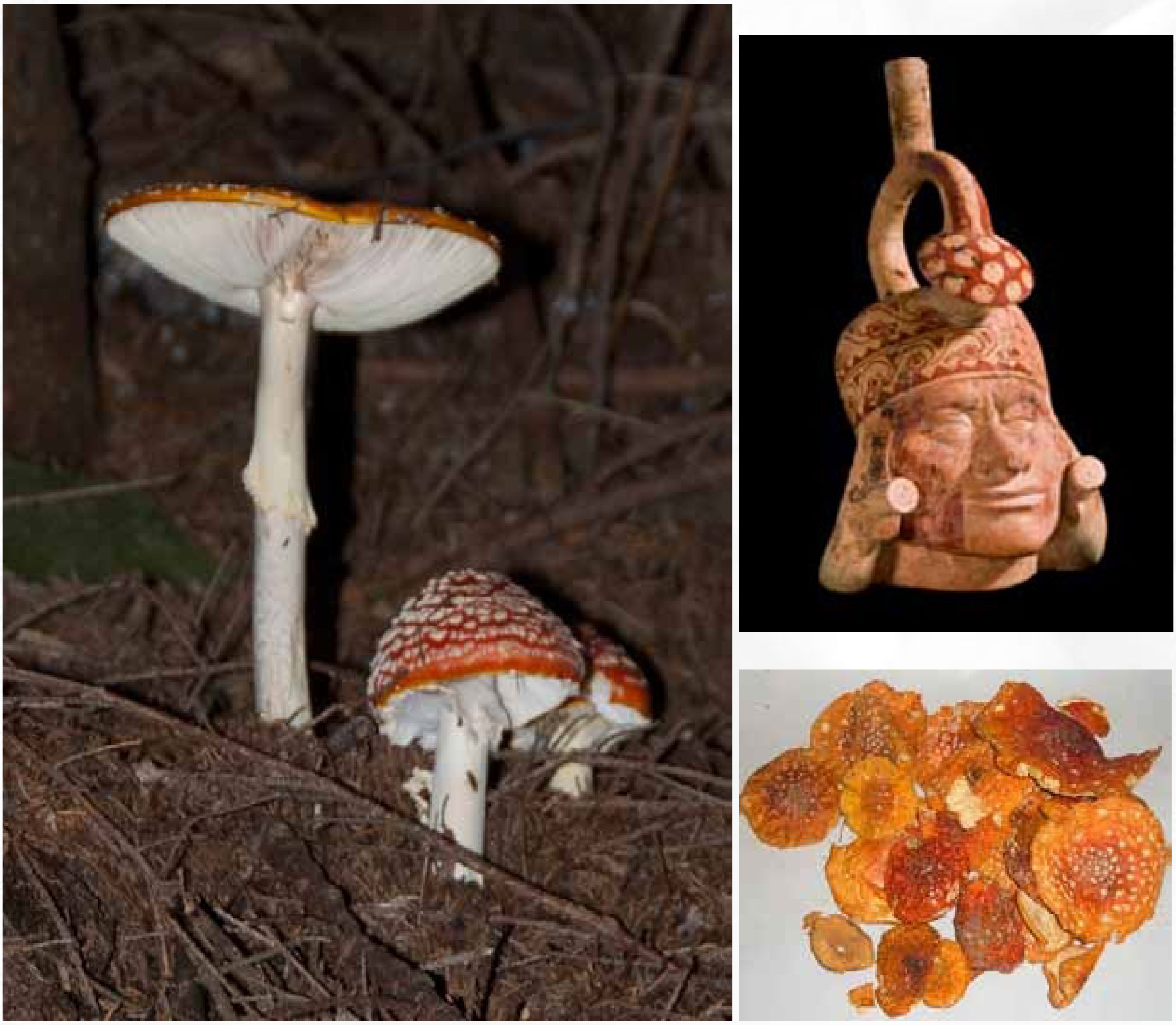


Figure: 13. a) *Amanita muscaria* mushroom. b) Moche figure with *A. muscaria* mushroom c) Dried *A. muscaria*
Sources: a) PeterTrutmann©2011 b) Peabody Museum 16-62-30/F729

The Amanita enigma

Amanita muscaria, belongs to the genus Amanita, a group of white spored basidiomycetes with a universal veil that covers the young fruiting structure.*A. muscaria* is characterized by red caps with white dots that are remnants of the torn universal veil. The stipes (stems) have a bulbous base called a volva and an annulus or ring. is an ecomycorrhizal fungus that forms symbiotic relationships with a wide variety of trees, including pine, spruce, fir, birch, and oak that are principally northern hemisphere trees. Only oaks have as southern limit the northernmost part of the Peruvian Selva (Bush & Flenley 2007). From this perspective it is not surprising that *A. muscaria* has in modern times not been recorded in Peru. How then can it be that *A. muscaria* representations were found in Moche figures that are more than a thousand years old? The first possibility is that it has to date not been carefully and extensively looked for in Peru. This remains a likely possibility, since as mentioned, Peru remains relatively unexplored from a mycological perspective. it may be found in the most northern part of Peru to which northern cultures would likelyhave had access. There is also a the possibility that A muscaria uses other tree hosts in Peru. Many Amanitas in South America from southern Brazil northward and east of the Andes are symbionts of leguminous or polygonaceous plants and few Amanitas of the region (as well as many in the continent's southern "cone") may not require a mycorrhizal partner (Tulloss R. 2006). Information from Australia, a southern hemisphere country, indicates that *A. muscaria* is able to form new associations with southern beech and now is considered as a weed. It is also invading native rainforest in Australia, where it may be displacing native species. There are also reports of its association with Eucalyptus in Portugal. Thus, it is likely that in ancient times *A. muscaria* had already adapted to other host trees common to the Andes in areas where its normal hosts no longer grew.

The other option could be that *A. muscaria* used by Peruvians did not originate from Peru but was imported. Since trade is known to have been extensive in pre conquest times, it may be that dried *A. muscaria* was a prized trade item with northern lying countries, especially in Central America. Dried mushrooms would appear a perfect trade commodity due to their light weight and probably high commercial value (Fig. 13 c). Curiously, it is also in the dried form that *A. muscaria* was most commonly used in many cultures, because as such it had a higher potency and had less gastrointestinal toxicity particularly if parboiled. It is noteworthy that Wasson *et al*. (1986 p. 48) quoting work of Robert Laughlin of the Smithsonian with Tzotzil speaking Mayas in Chiapas, who use the term for *A. muscaria*, 'tzajal yuy chauk' meaning red thunderbolt's yuyo. The fly agaric is still called the 'yuyo de raya', a latinized version. Astoundingly, the origin of the word 'Yuyo' appears to be Quechua. How would such a word have entered into the Mayan language? If true, there must have been substantial contact between the peoples pre Hispanic times probably up to the Spanish conquest. The word 'yuyo', which today in Quechua has meanings such as 'wild herb' must have been used intensely enough to have displaced a local word in the local vocabulary, where it stayed as a reminder. Without (or with little) native *A. muscaria* frequent trips from the Peruvian coast, where large trading rafts were documented at the time of first arrival of the Spaniards, could have shipped this highly valued item from Meso American shores where *A. muscaria* grew and people knew how to prepare them for use probably by the Peruvian elite who might have controlled its use.

It will be a challenge to prove the origin of ancient *A. muscaria* in Peru, whether it was a trade item or whether it was collected locally. If the mushroom is found in Peru it may have been introduced with northern host trees, like pines, since the European invasion. Molecular genetic studies will be required to compare isolates with known isolates from across the world to provide information on similarity. The best avenue to start might be to search for fungal residues in ancient ceramics. If *A. muscaria* spores were to be found comparison could be made of the ancient DNA with known strains since molecular studies of the taxonomic status have been conducted (Geml *et al*. 2008). *Amanita* from Chiapas or Guatemalan highlands or other places in the world should at have a different DNA fingerprint to a native Peruvian *A. muscaria*.

Calvatia and other Lycoperdon based Puffball species

Mochica and Wari ceramics often have globular, or semi globular, structures with or without some element of a base that are broader at top than base (14 a,b), and with or without spots on the upper surface (Fig. 14 a,b) The colors are range from white to dark brown. These structures growing out of heads have in the past often been classified as war-clubs (pora). To mycologists these structures, like other mushrooms already described, are clearly fungal. At first glance contenders look like either young fly agaric specimens, or Puffballs of the

Order Lycoperdon. *A. muscaria* can be ruled out due to the white to brown, rather than red, representation *A. muscaria* (See Fig. 13 b), and the inverse conical nature of their stem like structures rather than more or less cylindrical stipes with caps.

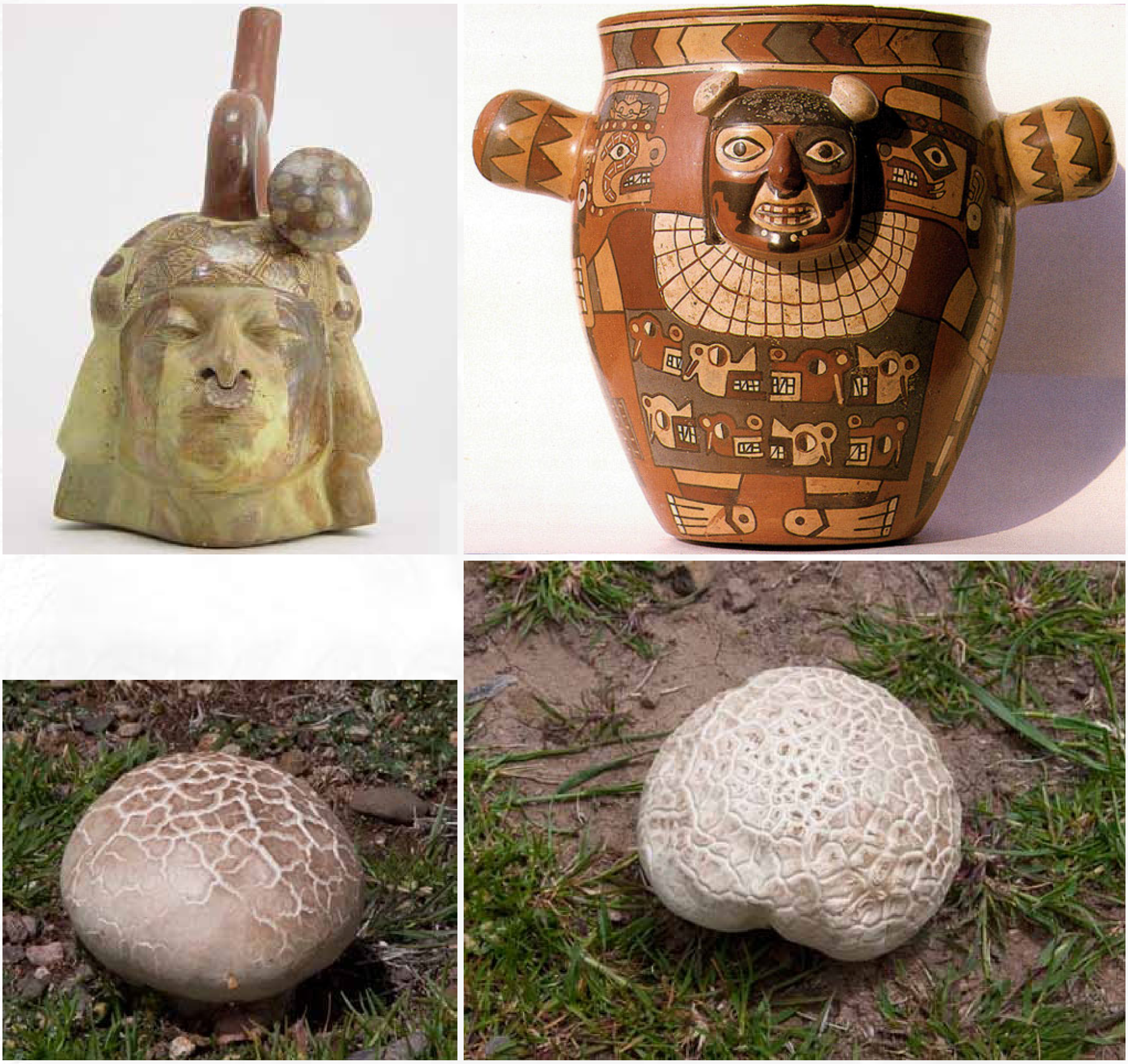


Figure 14. a) Moche shaman or '*curandero*' with *Calvatia cynthiformis* affin. on head b) Wari bowl with anthomorphic figure with young Cavatia species probably *C. cynthiformis* ears.
Sources: a) Museo Larco, Lima b) Caceras J. 2004. c) *Calvatia cynthiformis* mature d) *Calvatia cynthiformis* imature. Photos: c & d PeterTrutmann©2011.

The candidates that best fits the description of both coloration, overall shape and basal attachment are members of the large puffball genus, Calvatia. Various Calvaria species grow in the Andes and may have been used. *Calvatia cyathiformis* and related species, are the most likely candidates (Pavlich M.R. 1976). since they are commonly found in the savannas of the Andes. Its outer peridium or skin is either smooth, as in white specimens (Fig. 14 d), or warty as in darker, older specimens (Fig. 14 c), showing a distinct mosaic pattern that resembles the dots on the Moche structures (Fig. 14 a,c). The short stalk like sterile base is thin at the bottom and broad at the top similar to ceramic representations.

We are only beginning to discover the traditional uses of *C. cyathiformis* and related species in Peru. Calvatia is consumed by local especially Quechua speaking people when young and tastes like cheese. It has high in protein value reportedly of the order of 50%. Calvatia species have found widespread use in the folk medicines of various cultures, especially as a haemostatic (styptic) to stop bleeding and wound dressing (Baker 1989).

With this in mind, could it be that it as used as such in pre Hispanic times as such in Peru? Some Moche images suggest that they may have been used to stop bleeding (scarring) of wounds. For example, figure 15 shows a warrior with a Calvatia like fungi strapped to his head. Courl it have been used as a battle wound dressing? In the figure *C. rubrotincta*, a redish Calvatia, might be represented. Although it has not yet been recorded in Peru it is characterized by red spots when young and is very similar to *C. cythiformis* (Arora 1986 p.687). Could it be the Moche were representing in these ceramics persons injured in warfare with the dressing of wounds? In the Andes of Argentina *C. cyathiformis* is known as "polvillo del diablo" and still used for the scarring of wounds (Martínez and Luján 2011).

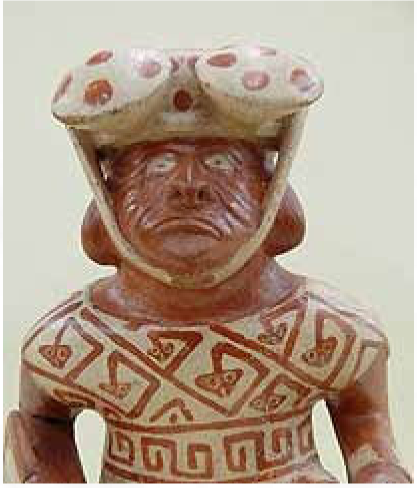


Figure 15. Moche warior with two Calvaria species with red dots on head.

Calvatia has been used to treat a variety of other ailments such as leucorrhoea, pneumaturia, Inflammation, diarrhea in calves, etc. and has anti-cancer properties (Coetzee and van Wyk 2009). *C. cyathiformis* and other puffballs may also have had use in spiritual rituals. Evidence for this comes from Colombia. ReichelDolmatoff, the renowned anthropologist archaeologist described the use of a blue puffball in ritual use of psychoactive mushrooms among the Kogi, the descendents of the Tairona (Reichel Dolmatoff 1977 p. 285). *C. cyathiformis* is known to have purple spores when aged, and can turn bluish. It may be the fungus described by Reichel Dolmatof.

Psilocybe species

There is clear evidence that *Psilocybe* species were used by the Moche and other societies like the Paracas where conical shaped mushrooms were represented in textiles. Below a Moche shaman or priest is shown with a head dress that look remarkably like young *Psilocybe* species (Fig. 16) similar to *Psilocybe semilaceata* or even *Psilocybe cubensis* (Fig. 17). Many other Peruvian examples of mushrooms with curled cap cross-sections such as those of the Cupisnique and Inca cultures are likely also to represent *Psilocybe* species since it is a characteristic of various and have been used as such in Mesoamerican cultures (Borhegyi 2010). Even in Inca mythology there association of golden conical caps and lightning, with the origin myths and the founding of Cusco (Delgado Diaz del Olmo 1996).

To date only a few *Psilocybe* species have been reported in Peru (Pavlich M.R. 1976, Guzmán *et al*. 2000, Guzmán G. 2009). These include *P. cubensis*, *P. yungensis* and *P. zapotecorum*. *P. cubensis* is thought to have been introduced later after the European conquest with livestock that reached the Andes through the Caribbean. However, this is but speculation. It is just as likely that the species represented in the ceramic was already present in Peru though the movement of populations, Andean livestock and trade. If so it may well have been *P. cubensis* that was represented in the ceramic.

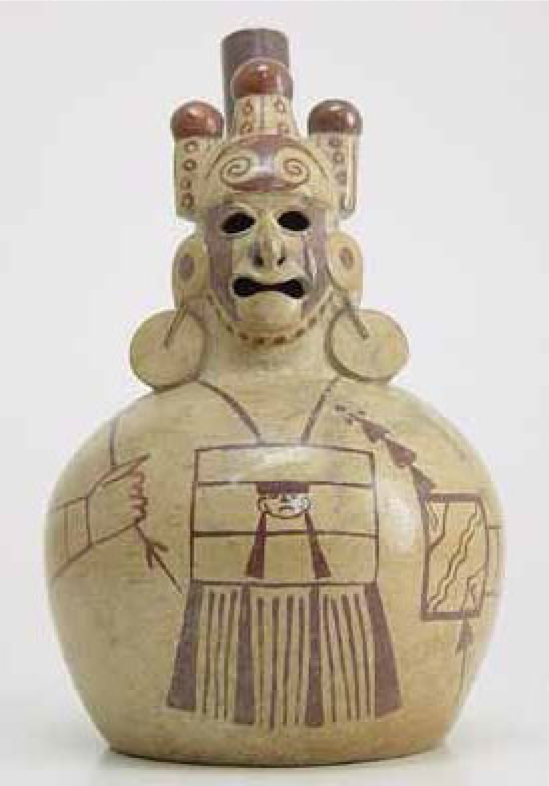


Figure 16. Moche personality with young *Psilocybe* featured on the back of his head. Source: Museo Larco, Lima

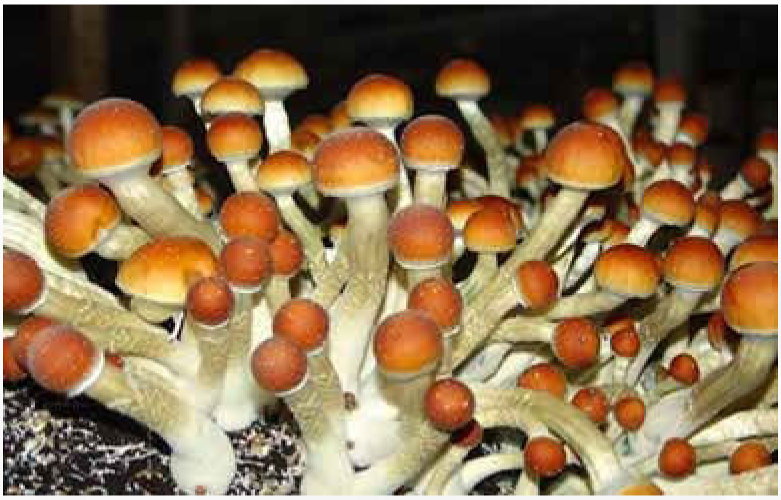


Figure 17. Young *Psilocybe cubensis*.

Psilocybe species were used as an entheogen in Meso America, and documented in Mayan and surviving Aztec texts such as the *Popol Vuh*. In the middle of the last century their use was rediscovered. Wasson brought these rituals to the attention of the world (Wasson R.G. 1957) documenting *velada*s of the local curandera, Eva Mendez (María Sabina). Mexico is now known as a centre of diversity for *Psilocybe* species. Guzmán *et al*. (2000) list over 50 species of *Psilocybe* species from Mexico alone. In comparison, probably due to indifference or taboo, the discovered species in Peru seem few, as do the number of species collected in neighboring countries.

Morchella Species

One stunning Moche ceramic has three mushrooms on its head (Fig18 a & b). Two of the mushrooms are sculpted on the side of the head with a light stipe, without annulus or volva. The brain-like cap appears oval to conical with light edges and darker interior groves. The representations most conform to specimens of the genus *Morchella* (Arora 1986), most probably *M. elata* (Fig.18 c) or *M. esculenta* (Fig.18 d). Both species have been found in the highlands of Peru (Pavlich M.R. 1976, Franquemont *et al*. 1990, Holgado *et al*. 2010).

Although there are dots painted on the fungi this is most probably not an *Amanita* due to the absence of a universal veil and its morphology. Instead, the fungus has the shape and the dots are likely to represent the darkened gaps between of the web-like spore-bearing tissues of the cap.

Morchella spp. are prized edible mushrooms by Quechua speakers around Cusco (Holgado 2010). Although we do not yet know its medicinal use in the Andes, *Morchella* species are used in other continents for medicinal purposes. For example, in traditional Chinese Medicine they are used to treat indigestion, phlegm, croup, and shortness of breath (Ying *et al*. 1987). Recent studies have also shown *M. esculenta* has anti cancer and oxidant properties. Stamets (2005) further mentions a *M. galactomannan* that illicites a positive immune response to macrophages.

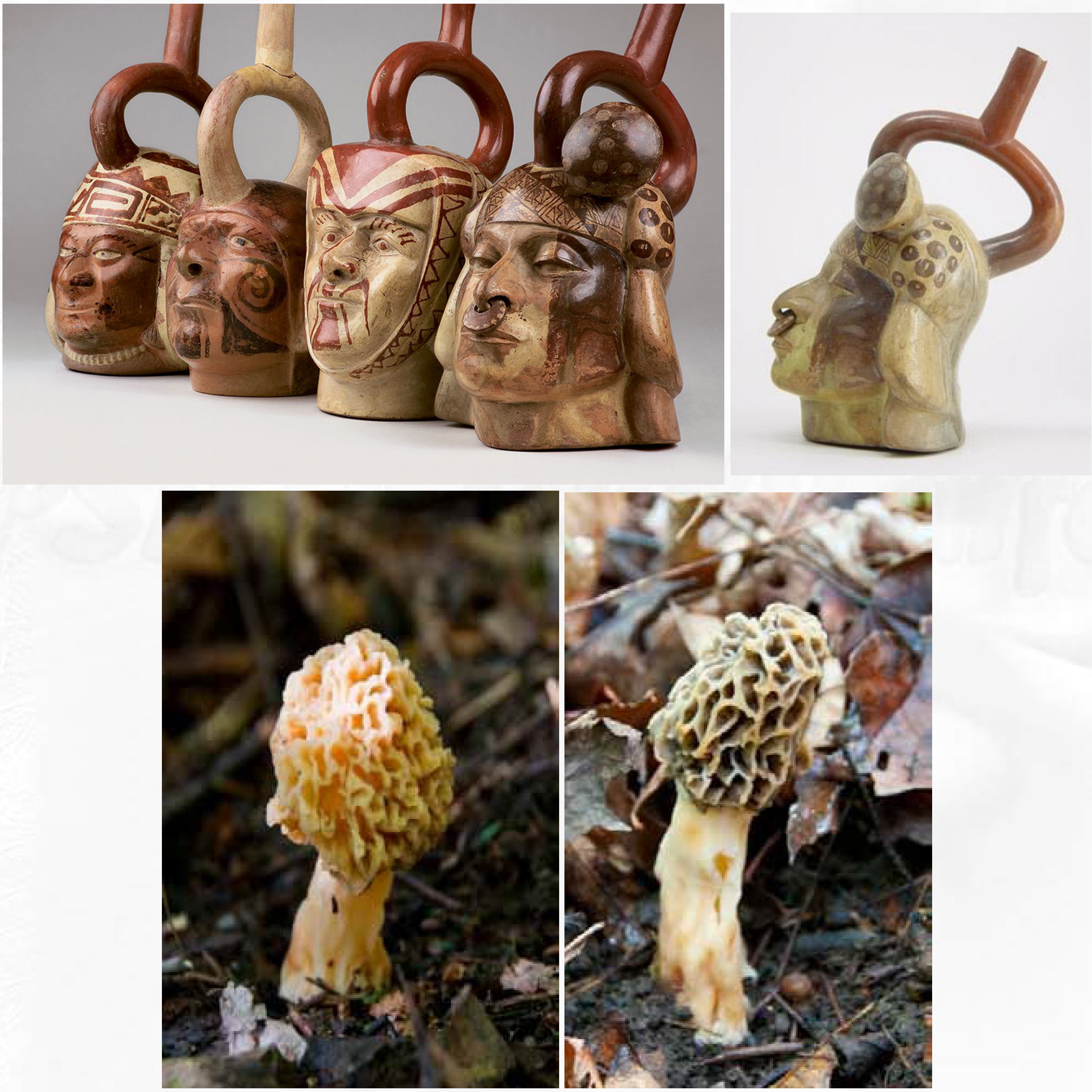


Figure 18. a & b) Mochica with Mochella like fungus on two sides of the head c) *M. esculenta* d) *M.elata*, Sources: a & b) Museo Larco ML000136, c & d) petertrutmann©2010)

Uncertainty: a Psilocybe or a Plutenoid mushroom

Figure 19 (a) shows a man with two mushrooms on his head. The one on the side of his head with a broad light stipe and dark brown enclosed cap appears to be a *Morchella* elata described previously (Fig. 18 d). The second mushroom with an inverted cap (Figs 19 a & b), provides a splendid insight into the craft and knowledge of ancient Peruvians of mushrooms species. Through the intricate representation of the picture we are told that the fungus in question has a cap appears flat conical, and lepitoid from this angle. The mushroom is sizable, about 5-10 cm wide with a stipe 10-15cm. This is a large mushroom. The gills are white or light colored, terminally bifurcate, and free or almost free from the stipe. Classical for free gilled fungi is that a portion of the pileus can be seen as a small ring at the top of the stipe as seen represented by ancient artists often presented as in a classic description of free gilled fungi (Largent 1974 p28). The stipe is slender brown without annulus ring, and we cannot see a volva. From its size, the mushroom looks may be young or mature. If it is young it could be either light or dark spored at maturity as do some *Psilocybe* species such as *P. semilanceata* (Fig 19c). If it is a mature specimen, the spores are most likely light colored. Few known *Psilocybe* species are so big or have brown stipes. It may be an as yet unidentified pluteotoid fungus. The lack of volva or annulus and brown stipe rules out it being an *Amanita* or a *Lepiota* species. It may still be a *Volvariella* species, which although it has a volva conforms to size and shape and more or less the color, and lacks an annulus (Fig. 19d). These have been found in the Andes (Pavlich 1976, Trutmann *et al*. 2012). The original ceramic would have to be examined for a better diagnosis.

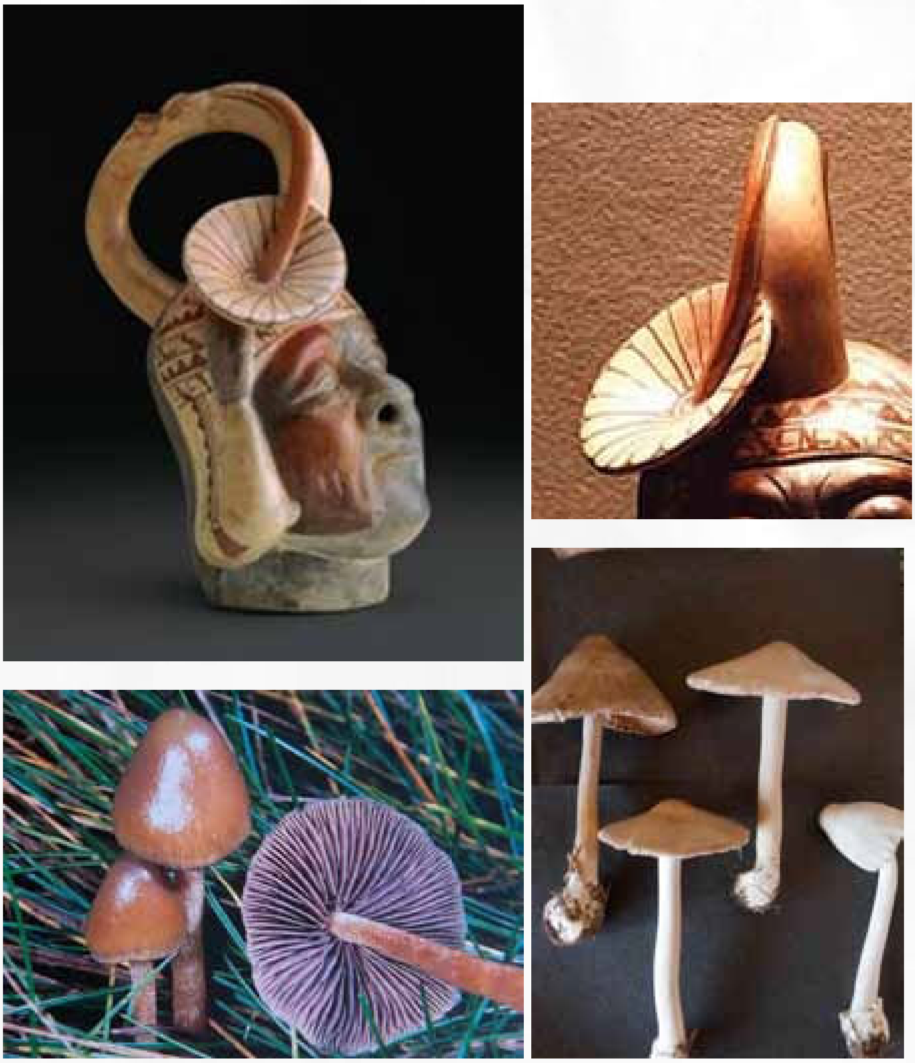


Figure 19. a) Moche figure with mushroom showing gills protruding from head. b) Close up of mushroom. c) *Psilocybe semilanceata* d) A plutinoid species of the genus *Volveriella* from Cusco.
Sources: a & b) Museo Larco c) Stamets 2001 d) PeterTrutmann©2012

Uncertainly: A mushroom with brown decurrent gills: Cortinoid?

An other fascinating mushroom structure found in Moche ceramics is the trumpet like mushroom, similar to the chanterelles, or *Cortinarius* species, such as *C. magnivelatus* (Fig. 20 a & b). There are a number of other possibilities. The mushrooms are characterized by an uplifted cap with brown, possibly decurrent or at least attached gills. It suggests the fungus has brown or dark spores). It has a short, robust brown stipe, perhaps with a ring. It is interesting that the two examples shown have dark brown caps decorated with symbols: either a hooked loop, or white spots reminiscent of the fly agaric. Both symbols suggest ritual religious use associated with sacred properties associated with *A. muscaria*. For these reasons it is presumed the fungus is entheogenic. However, its identify remains a mystery and reinforces the need for further study of macro fungi in Peru.

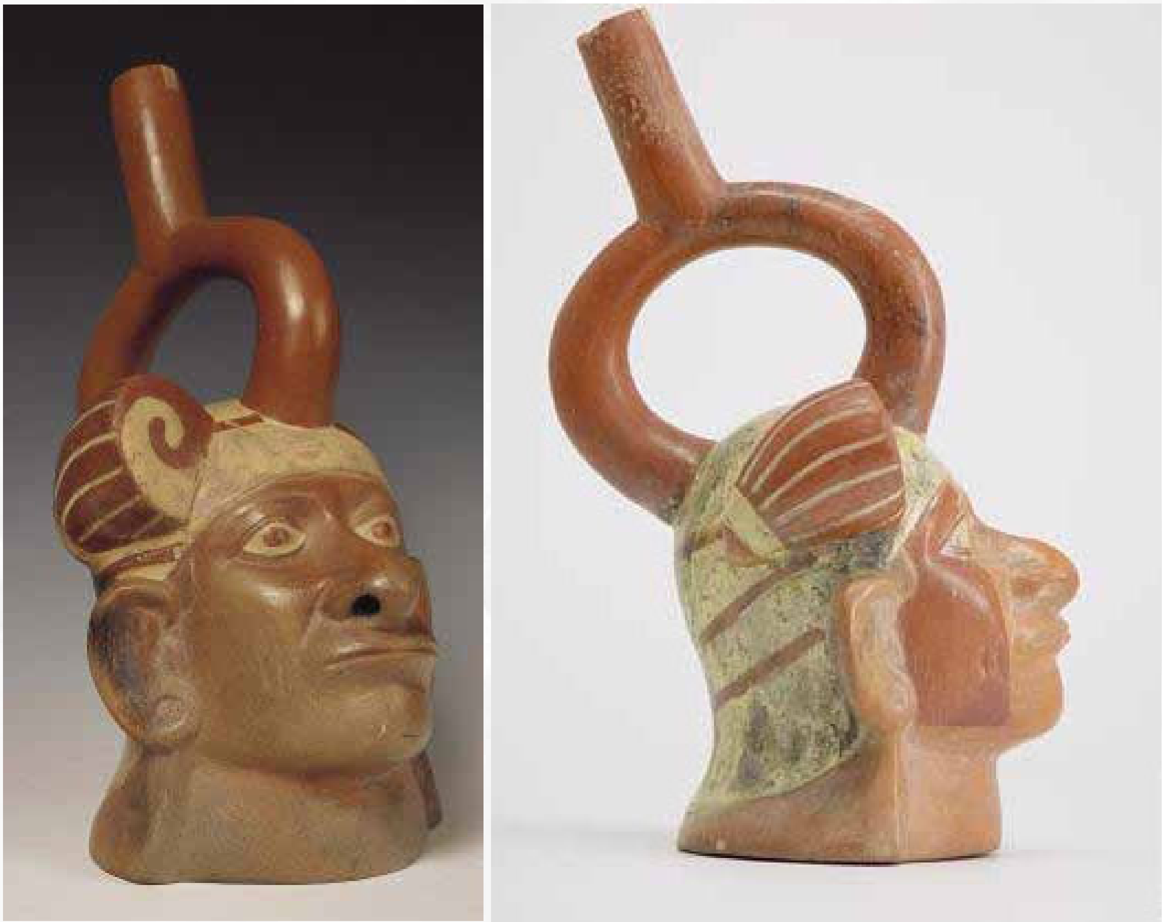


Figure 20. a and b) Moche ceramic figures with brown gilled mushrooms with upturned caps protruding from their heads. Sources: Museo Larco, Lima

General Discussion

Evidence that mushrooms were used in pre Hispanic Peru

Although the scope of this study was limited, substantial evidence has been collected to demonstrate that ancient Peruvians extensively used mushrooms medicinally, religiously as well as mushrooms of high culinary value. We now know Peruvian ancestors were highly expressive in representing mushrooms in ceramics, textiles and sculpture representing them either realistically, or stylistically and symbolically. The extensive use of mushrooms in ancient Peru is in stark contrast to the mycophobia and apparent stigma that dominates modern Peruvian society and expressed by the virtual absence of literature on the subject in the country. Recent scientific advances have demonstrated the critical role fungi play as food, medicine and for ecosystem function (Stamets 2005). In hindsight, the change from a mycophilic to mycophobic society after the conquest may have had consequences on the wellbeing of the society as a whole and contributed to environmental degradation due to the devaluation of natural resources such as fungi. The extensive forests were cut or burned for pasture, building materials and fuel (Herreria A 2009) and indigenous peoples and their customs became slandered (Delgado Diaz del Olmo 1996). Even today many an indigenous person will only reluctantly tell you they eat mushrooms. Combining both the scientific evidence of the importance of fungi to human and environmental health with evidence of their historic importance in Peru will perhaps begin to revalue mushrooms. The discovery of the use in ancient Peru of mushrooms connects South American cultures with other cultures in the new world and old world, and to an ancient pan human belief system of which today we still find remnants (Wasson *et al*. 1986). Their redicovery as such reconnects Peru again to a long human tradition.

Cultures and initial timelines of mushroom use in Peru

It is highly likely that ancient Peruvians brought the knowledge of mushrooms with them as they migrated from the northern hemisphere, including the knowledge of edible, medicinal and sacred mushrooms. In this preliminary search evidence was found that as early as 1200 BCE they were important enough to be represented in the ceremonial and ritual art of the Cupisnique culture (1200-200 BCE) and Pucará cultures (1200 BCE -400 CE). Earlier petrographs representations have not been studied, evidence of mushroom use may be found caves. It places earliest Peruvian mushroom representations in the same timeline as early Meso American mushroom images of the Olmec 1000 BC (Borhegyi 2010). One can also trace mushroom use through a continuous dateline of cultures from 3000-2200 years ago to at least 1532 and geographically from the north to the south of the country through the Cupisnique, Pucará, Paracas, Moche, Wari, Chimú through to and finally the Inca cultures. With the destruction of Inca and indigenous societies after European contact, particularly their religion, representations of mushrooms by indigenous peoples virtually disappeared. New information shows that at least culinary use continues in some indigenous societies (Holgado *et al*. 2010, Trutmann and Luque 2011). The ancient power of mushrooms and symbolism however, remains embedded in indigenous myth and languages such as Quechua and Aymara. The root base of words are linked to power and the supernatural (Delgado Diaz del Olmo 1996). Words that identify specific mushrooms today day and their relation to their use in pre-Hispanic times remains to be investigated. Evidence from the few studies done independently suggest that similar nomenclature remain in indigenous languages (Franquemont *et al*. 1990), (Holgado Rojas M.E. *et al*. 2010, Trutmann and Luque 2011). However, none of the names of mushrooms commonly used seem to refer to the ancient sacred mushrooms. Yet, both Aymara and Quechua languages root words such as 'Calla' are derived from words that are derived from mushrooms that bestowed power. What happened to the use of these mushrooms and why were the names even forgotten or hidden? The ethno-mycology of Peru requires urgent study to enable better understanding of what remains of local knowledge of mushrooms and how it relates to historic knowledge and to better use it to help optimize the positive effects of fungal resources in Peru for wellbeing and better ecosystem function in an age of global change in mountains.

Identity of Ancient Mushrooms

The pre-Columbian mushroom representations were at times so realistic that they are able to be identified to genus and even species level. Thus far, those identified are *Amanita muscaria*, Morchella species, (probably *M. elata* or *M. esculenta*), *Calvatia* species (including *C. cynthiforma*) and one or more *Psilocybe* species, including one similar to *P. cubensis*. However, impressive as the mycological knowledge of the artist in pre Hispanic times was through the detailed representations of the mushrooms, often there are no known mushrooms to associate them to. Too little is known of the mushrooms that exist in Peru. This is due to the limited information on the extent and identity of mushroom in Peru. To date, largely due to resources, only a relatively limited number of mushrooms have been collected and identified in Peru and neighboring countries with similar ecosystems and very little ethno-mycology work has been conducted. Mycology in South America is only recently emerging beginning to be valued mainly due to commercial factors but also slowly, because of interest in the rich biodiversity of the region.

An other reason why it may be difficult to determine the identify the mushrooms found in ancient ceramics may be due to changes in the Peruvian landscape and traditions since Pre Hispanic days. There is evidence that human activity had great impact on vegetation even from the Holocene period (about 10,000 years ago) through burning and deforestation. (Bush *et al*. 2007, Bush & Flenley 2007 p45, Hansen *et al*. 1994) suggests that without human intervention the upper Peruvian Andes would have been forests of *Polylepis* up to 4000 m in the wet and 5000 m in dry areas. That said, it is known that in early colonial times there were still great expanses of forest in this sierra and Altiplano (Hyland 2004) and there was a great effort to reforest in Inca times. The destruction of forests was devastating in colonial times onward for firewood, construction and for pasture of imported livestock that denuded the Altiplano and the lowlands and destroyed soils & natural pasture through overstocking and erosion. The actions had and are having great effects of the ecology, the fertility of the landscape and probably on fungal communities as they did in the coastal lowlands. (Beresford-Jones 2004 Chapter 7). At least some of the fungi represented in ceramics, like *A. muscaria* and *Morchella* species are symbionts on trees or grow in woods. *Psilocybe* or *Panaeolus* spp. and *Calvatia* species are grassland species. However, some of the unidentified species may have been tree associated mushroom fungi that grew that may now be very rare or extinct.

Use of mushrooms in ancient Peru

It hard to divide mushroom use into single defined categories of use, since a single mushroom can be culinary, medicinal and can have 'spiritual' properties. Furthermore, to many indigenous groups there is little or no distinction between medicinal and spiritual. The more we find out about fungi the more we discover about their important properties and functions to humanity and environment.

Culinary

A number of mushrooms represented in ceramics are known culinary delicacies. Most notable are the species of the genus *Morchella*, (Franquemont *et al*. 1990, Holgado *et al*. 2010) and *Calvatia cynthiformis* (Holgado *et al*. 2010), Trutmann P. *et al*. 2012). Early colonial writings also show that mushrooms played an important and esteemed part in the lives of Pre Hispanic Inca society. Poma de Ayala (Poma de Ayala 1615) probably basing his writings on the knowledge of the 'legally dead' Jesuit friar Blas Valera (Nyland 2011) lists the Quechua names for types of mushrooms, 'c'allampa', 'concha' and 'Paku' as food. 'Paku' are large puffballs, including *Calvatia cynthiformis* represented in ceramics of various cultures. The local ethno-mycological knowledge and words are only now being collected. The above mentioned names are relatively generic, but they do provide a first order of categorization. Poma de Ayala, lists various mushrooms as part of the varied diet of people from the age of 30 during the Inca reign.

Medicinal

Shamanic like figures are commonly seen associated with mushrooms in artwork of the Paracas, Chimu and Moche. In the Paracas culture textiles we see spirit-like beings holding either mushrooms of various colors, or symbolic mushroom/tumis, often in shamanic flight. The flight associates them with entheogen use. They often also hold head trophies, which may associate them to the ritual of transformation, death and resurrection, perhaps to the Venus cults also found in Central America (Borhegyi 2010). In Moche culture we see mushrooms and symbols also associated with Lords and higher theocracy. The Lord of Sipán does not have mushrooms overtly growing out of his head, but the mushroom related symbolism is overwhelming, through his mushroom headdress, tumi, and symbols on his clothes, and ornaments with mushrooms. Other Moche representations show subjects with 'google' eyes indicative of trances, sometimes with facial expressions of fear.

It is still unclear from association of mushrooms with shamanic/curandero ceramic what the purpose was of representing some species. For example, morels were commonly represented. Yet, today morels are regarded in most cultures as a culinary delicacy rather than a medical herb. Still, there is information of their medicinal properties. Morels such as *M. esculenta*, are used to regulate the flow of vital energy, and have properties against tumors, expectorant, and gastrointestinal tonic (Hobbs 1986). Puff balls such as *Calvatia* spp. were used as an anti bleeding remedy, to sooth burns and itching and were anti-inflammatory agents (ibid). In fact, *Calvatia* species were regarded as magical by many indigenous groups in North America, and had many uses. *A. muscaria* for example had both visionary as well as medical properties, inhibiting tumors, epilepsy, and even eliminating ringworm (ibid). Current ethno-mycological information points to continued use of puffballs of *C. cyathiformis* and green spored *Lycoperdon wrightii* for medical purposes in Peru (Trutmann and Luque 2011).

Spiritual

What spiritual & religious role did mushrooms play in ancient Peru? In reality all that is known at this moment is that both *A. muscaria* and *Psilocybe* species appear to have been used since they are the only clearly known enthiogend represented. Yet, it is also known that these, and other as yet uncharacterized mushrooms, were consumed and used as entheogens since they associated with ancient flight of shamans and classic 'google' eyes of images. The ritual religious use of mushrooms by the theocratic class of Moche society is also implicated by use of mushroom symbols carried by high priests like the Lord of Sipán, eluding to ownership of power of these objects and thus properties of mushrooms.

To begin to answer the question of spiritual use of mushrooms in Andean society we need to refer to studies in other countries and continents. The nearest cultures studied were in Mexico and Guatemala, principally Maya and Aztec societies. It has been shown through representations by the Aztecs in the few documents surviving Spanish destruction (see the Vienna Codex) that at least *Psilocybe* species were used. *A. muscaria* is implicated in other representations. *Psilocybe* species were until recently still being used in various parts of Mexico in places such as Huautla de Jiménez, Oaxaca (Wasson et als. 1986). They were 'secret ' rites that were not normally discussed with outsiders. The principle use of spiritual mushrooms in such rites is to enable the connection to " the god within'.

Wasson (1972) noted: "*The bemushroomed person is poised in space, a disembodied eye, invisible, incorporeal, seeing but not being seen.... In truth, he is the five senses disembodied, all of them keyed to the height of sensitivity and awareness, all of them blending into one another most strangely, until, utterly passive, he becomes a pure receptor, infinitely delicate, of sensations*". "*It (the mushroom) permits you to see, more clearly than our perishing mortal eye can see, vistas beyond the horizons of this life, to travel backwards and forward in time, to enter other planes of existence even as the Indians say, to know God*".

How the spiritual use of mushrooms was used by ancient individuals, cults and religions is still unclear. In the case of *A. muscaria*, Borhegyi (Borhegyi 2010) proposed its central use in the veneration of Venus. He writes: "*The ideas thus generated included concepts of an alternate world with rebirth after death based on observation of the constant cycle of death and rebirth in nature. This included the predictable cycles of the sun and moon and veneration of the dualistic planet Venus based on its equally predictable cycle of death and rebirth as the Morning Star and the Evening Star. By the time the first native Mesoamerican religious texts appeared, whether in pictorial codices or, at the urging of various Spanish priests and chroniclers, in Spanish or one of the indigenous languages, there is evidence that this religion was identified with a supreme creator deity. This deity, seen early on as a double-headed serpent with bird and feline attributes, was known by different names at different times and in different indigenous languages and culture areas.*"

Even if his hypothesis is correct, is not clear if all ritual mushroom use, or certain species, especially *A. muscaria*, were associated with Venus veneration, but much of the Pre-Columbian art associated with mushrooms also contain symbolism of what Borhegyi (2010) would regard as the Venus cult. For example, one finds the hook symbol, the fives, the double star associated with Venus (the morning and evening star), symbols of transformation, death and resurrection. Although, other variants can't be ruled out for the time being Borhegyi's proposal it is a reasonable hypothesis, particularly since it explains and provides meaning to the symbolism of many ceramics and textile representations that thus far are missing.

It appears that changes did take place in the preference of entheogens in ancient Peru. As societies like the Paracas culture changed over time to one like the Nasca, other entheogenic agents appear to have become more represented than mushrooms. At least, identifiable mushroom symbolism appears much reduced in the Nasca art. Similarly, it clearly changes took place in Moche society, from one where mushrooms were vividly represented to one predominated by realistic representations of San Pedro and where only symbolic or Iconographic symbols of mushrooms like the golden crescent and tumi are found. Either mushrooms were substituted in later phases of societies, or mushrooms went out of common use into the exclusive hands of the elite who replaced it for commoners with a common plant, the San Pedro cactus. Inca society used Coca as its holy plant. Its production was strictly controlled by the elite, but made available to the commoner. Coca rather than mushrooms are mentioned by the Spanish chroniclers Yet, golden mushrooms earrings are found in the Yale Collection from Machu Pichu. Furthermore, Inca myths point to conical golden and other red mushrooms, suggesting that perhaps spiritual mushrooms use was the realm of the elite theocracy and groups like the 'Callawara". The legendary Inca bearers.

The changes that favored entheogen use between societies over time could also have been associated with the rise and fall of trade with Meso America, where entheogenic mushrooms like *A. muscaria* grew. As mentioned earlier, *A. muscaria* has not as yet been collected and identified in Peru, and the range of its common tree-hosts are limited mostly to the northern hemisphere. We know that there was substantial trade with Meso America, although we do not know how consistent this trade was over time. Perhaps, there were times when trade was limited that other entheogens were preferred such as San Pedro, ayahuasca and to a lesser extent coca? The topic requires more research for clarification.

Conclusions

This preliminary study on the use and importance of mushrooms in ancient Peru has illuminated fascinating areas of the lives of people that are now forgotten, neglected or devalued by the bulk of the Peruvian population now living in cities the lowlands. The study has implications for the rest of South America, insofar that it is evident that indigenous peoples in other parts of South American used mushrooms. Velandia (2008) already wrote of mushroom symbolism in Colombia. Snuff boxes with mushrooms have been found in Argentina (Torres 1996), and symbols are found on vases and information about the Mapoche exist from Chile. These make it clear that ancient people in other parts of south America were acquainted sufficiently with mushrooms, and associated symbolism to represent their ceramics. In the future, studies should extended to explore not only to explore Peruvian mushrooms further, but be extended to include other South American countries. In this manner a holistic understanding can be constructed of their importance to the lives of ancient Americans.

There is a need to more thoroughly look at each Peruvian culture and even look at pre-ceramic sites to obtain a better timeline of mushroom use. For example, changes in Moche mushroom use and symbolism should be studied using not only the IV phase ceramics often used (Castillo *et al*. 2007)). Using this study as a base, thre is a need to look for a direct link between ceramics and actual identification of mushrooms from archaeological sites. In other words to not only evaluate ceramic bowls for plant material and pollen but also for fungal remnants and spores. If fungal material can be found then it may be possible to further identify fungi and to explore genetic similarities using molecular techniques. In addition, there is an abundance of symbolism associaed with mushrooms. Global Mountain Action (2011) has begun to document this aspect and will publish these results in a second publication in this series.

The question of what happened to mushroom use in Peru in post conquest times requires elucidation in order to better understand the current state of disinterest. What happened to the knowledge and mushroom use and why did it happen? It is known that Catholicism and colonial politics were important factors in Meso America that devalued mushroom consumption and demonized its use there (Wasson 1972, Borhegyi 2010). Did the same happen in Peru? Global Mountain Action (2011) has begun a rapid survey and will publish this base material as part of this series. It is hoped the information will stimulate more in depth studies.

Just as botanical input has greatly influenced the advances in field of archaeology more mycological input is urgently needed to obtain a more accurate understanding of the ancient Peruvian world. There is also a great urgency to use mycology understand better current and in post conquest use and knowledge of mushrooms in Peru. A few studies have been reported on these themes. Franquemont *et al*. (1990) reported names of a few mushrooms in Quechua and identity in a study in Chinchero, close to Cusco. More recently, Holgado *et al*. (2010) and have published an article on the identity and Quechua names of some local mushrooms around Cusco and local culinary use. These studies are beginning to shed light on the rich knowledge and the place that mushrooms have in indigenous communities that hitherto were forgotten in national or international assessments for food security and research needs, with exception of the United Nations Food and Agriculture Organization that conducted a worldwide study that included Peru (Boa 2004). The FAO study although commendable in its worldwide scope, is of questionable value for Peru, other than exposing the paucity of information, and confusing due to highly questionable list of references. For example, Remotti C.D. and Colan, J.A. 1990, Identification of wild edible fungi in Dantas Forest, Huanuco. Revista Forestal del Peru 17: 21-37 does not appear to have been printed in this journal but has been used by various authors, and Diaz (2003 pers communication) seems a questionable reference to commercial use of *Boletus edulis*, since only *Suillus luteus* from introduced Pine plantations has thus far been used commercially.

More broadly, there is an fundamental need in Peru to invest more in research on fungal diversity to collect, characterize fungi and mushrooms to obtain a clearer picture of the roles in the Andean environment. Without knowledge of the current diversity ancient fungal material will not be able to be classified and placed into context. Present knowledge of genera and species is still limited despite commendable efforts of the few fungal taxonomists in Peru and surrounding countries. Most of the Peruvian Andes, the Selva and the lowlands have not been systematically studied. Only two mayor studies exist of fungi and these were concentrated principally in the Selva and Amazonian basin (Pavlich M.R. 1976, Espinoza M. 2003, (Mata *et al*. 2006). There has been little interest in mycology and taxonomic studies in national institutions due to limited potential of funding from national and international sources. The neglect of mycological studies by national and international agencies is surprising since extensive funding has been made available for studies under the umbrella of the documentation of genetic diversity for pants and animals in Peru in what is regarded as one of the most genetically diverse countries in the world. Due to the key role of fungi for human and environmental health and well-being especially in mountain regions, Global Mountain Action (2011) has made the the theme a priority.

Bringing together knowledge of Ancient use of mushrooms with present local and scientific knowledge should help further understanding of the culinary, medicinal and spiritual properties of mushrooms. In a time of worldwide reflection on the sustainability of western lifestyles and the dire state of the extreme consumerism driven economic models, out of control financial opportunism with severe global environmental consequences, a better understanding of ancestral holistic use of mushrooms in diets and rituals may be of value in itself to bring life again in equilibrium with the environment and provide meaning. Peru has already become a spiritual Mecca for many seeking ancient Andean knowledge.

Acknowledgements

I would like to thank Ulla Holmquist and the Museo Larco, Lima for the interest and help, especially by enabling access to their extraordinary online collection database; to Dr. John Henderson and Dr. David H. Thurston of Cornell University, who took time to read a draft of this document and provided valuable comments and suggestions. I'm also grateful to the many collections whose items I found on the internet and authors of images whose names I have not been able to find. Thanks to Carl de Borhegyi, whose fascinating online study on 'unlocking the mushroom code' made me realize how little was known about ancient use of mushrooms in Peru and South America. Finally, this work is dedicated to the ancient Peruvians, in the hope that with this work a little of what was lost and sacred has again been found. I Thank you.

References

1. Allegro J. 1970. The Sacred Mushroom and the Cross: A Study of the Nature and Origins of Christianity within the Fertility Cults of the Ancient Near East Garden City, NY: Doubleday & Co.
2. Anon. 2011. Calvatia cythiaformis: http://en.wikipedia.org/wiki/Calvatia_cyathiformis.
3. Arora D. 1986. Mushrooms demistified. 2nd ed. Berkeley, Ca: Ten Speed Press.
4. Baker T. 1989 Fungal styptics. Mycologist 3:19-20.
5. Bawden G. 1999. The Moche (Peoples of America): Wiley-Blackwe
6. Beresford-Jones D. G. 2004. Pre-Hispanic Prosopis - human relationships on the south coast of Peru: riparian forests in the context of environmental and cultural trajectories of the lower Ica valley, University of Cambridge, Cambridge.
7. Bird J.B. 1948 Preceramic cultures in Chicama and Viru.. In A reappraisal of Peruvian Archaeology edited by Wendell C. Bennett. Menasha, Wisconsin.: Memoirs of the Society for American Archaeology
8. Borhegyi de C. 2010. Breaking the mushroom code: www.mushroomstone.com/.
9. Borhegyi de S.F. 1961. Miniture muschoom stones from Guatemala. American Antiquity 26 (4):498-504.
10. Bush M. & Flenley j. 2007. Tropical rainforest responses to climatic change. Berlin, Heidelberg, New York: Springer Verlag.
11. Bush M.B. Hanselman J.A. Hooghiemstra H. 2007. Andean montaine forests and climate change: Springer Praxis Books.
12. Caceres J. Enriquez G. Sandweiss D. Caceres C. 2004. Prehispanic cultures of Peru: guide to peruvian archaeology: Guide of Peruvian Archaeology
13. Castillo Butters L.J. Uceda Castillo S. 2007. The moche of northern Peru. In Handbook of South American Archaeology, edited by Helaine Silverman y William Isbell: Blackwell Press
14. Coe M.D. 1993. Breaking the Maya code. Edited by F. edition. London: Thames & Hudson.
15. Coetzee J. and van Wyk A.E.. 2009. The genus Calvatia ('Gasteromycetes', Lycoperdaceae): A review of its ethnomycology and

biotechnological potential. African Journal of Biotechnology 8 (22):6007-6015.

16. Davis W. 1997. One River: Simon & Schuster; First Touchstone Edi edition
17. Delgado Diaz del Olmo C. 1996 Hybris: Violencia & Mestizaje Arequipa: Univeridad National de San Agus tin de Arequipa..
18. Door C. & Abad J. 1990. Identificación de hongos comestibles silvestres en el bosque Dantas, Huanuco. Revista forestal del Perú 17 (2):21-37.
19. Errázuriz J. 1980. Tumaco-La Tolita una cultura precolombina desconocida. Bogota: Carlos Vlencia Editores.
20. Espinoza M. 2003. Hongos macroscopios de la clase basidiomycetes en el centro de investigacion Allpahuaya, Loreto-Perú, Departamento Academico de Microbiologia, Universidad Nacional de la Amazonia Peruana, Loreto.
21. Fogarty, A.M., and Tuovinen, O.H. 1991. Microbial degradation of pesticides in yard waste composting. Mi crobial Reviews 55 (2):225-233.
22. Franquemont C. Plowman T. Franquemont E. King S.R. Niezgoda C. Davis W. Sperling C.R. 1990. The ethonobotany of Chinchero, an Andean community in southern Peru. Fieldiana 24:150.
23. Furst P.T. 1972. Editor. Flesh of the Gods. Waveland Press Inc. pp. 303.
24. Gartz J. 1995. Magic Mushrooms: A scientific journey across cultures and time. A case for challenging re search and value systems.. Los Angeles, Ca: Lis Publications.
25. Geml J. Tulloss R. E. Laursen G. A. Sazanova N. A. Taylor D.L. 2008. Evidence for strong inter- and intra-continental phylogeographic structurein Amanita muscaria, a wind-dispersed ectomycorrhizal basidiomycete. Molecular Phylogenetics and Evolution Accepted 22 April 2008.
26. Global Mountain Action (2011). Annual Report 2011. Global Mountain Action, 25 pp. www.globalmountainaction.org
27. Guzmán G., ed. 2009. The hallucinogenic mushrooms: diversity, traditions, use and abuse with special reference to the genus Psilocybe. Edited by Misra J.K. & Deshmukh S.K., Fungi from different environments. Enfield, Jersey, Plymouth: SP SCience publishers.
28. Guzmán G. Allen J.W. and Gartz J. 2000. A worldwide geographical distribution of the neurotropic fungi, an analysis and discussion. Arch. St. Sc. Nat. 14:189-280.
29. Hansen B. C. S. Seltzer G. O. Wright H. E.. 1994. Late Quaternary vegetational change in the central Peruvian Andes. Palaeogeography Palaeoclimatology Palaeoecology 109:263-285.
30. Heaven R. 2009. The humminbird's journey to God. Hants, UK: John Hunt Publishing Ltd.
31. Herreria A, & Maurizio A. 2009. Paisajes del desarrollo: la ecologia de las technologias andinas. Antipoda 8:169-194.
32. Hobbs C. 1986. Medicinal Mushrooms: An exploration of tradition, healing and culture. Santa Cruz, Ca: Botanica Press.
33. Holgado Rojas M.E. Delgado Salazar J. Pérez Leguia K. Bautista Valverde N. Sánchez Huamán P. Quispe.
34. Peláez A. Vincente Ramirez C. 2010. Etnomicologia en el festival del Q'oncha Raymi. Q'euña (Revista de la Sociedad Botanica del Cusco) 3:58-59.
35. Holgado Rojas M.E. Olivera Gonzales M. Delgado Salazar J. 2007. Macomycetos de la microcuenca de Q'euña-Zurite-Anta. Q'euña (Revista de la Sociedad Botanica del Cusco) 1:15-18.
36. Hyland S. 2004. The Jesuit and the Incas: The Extraordinary Life of Padre Blas Valera, S.J. (History, Languages, and Cultures of the Spanish and Portuguese Worlds): Michigan University Press.
37. Hyland S. 2011. Gods of the Andes: An Early Jesuit Account of Inca Religion and Andean Christianity: Pennstate University Press.
38. Kummer L.J. 2006. How real is that ruin? Don't ask, locals say. New York Times, 21 March 2006.
39. Labbé A.J. 1988. Colombia antes de Colon: el pueblo, la cultura y arte de la ceramica en Colombia prehispánica. Bogota: Carlos Valencia Editores.
40. Largent D.L. 1974. How to identify mushrooms to genus I: Macroscopic features. 1977 ed. Eureka, Ca: Mad River Press.
41. Lowy B. 1974. *Amanita muscaria* and the thunderbolt legent in Guatemala and Mexico. Mycologica 66 (Jan-Feb):1.
42. Martínez G. J. and Luján M. C. 2011. Medicinal plants used for traditional veterinary in the Sierras de Cór doba (Argentina): An ethnobotanical comparison with human medicinal uses. Journal of Ethnobiology and Ethnomedicine 7:23
43. Mata M. Pavlich M. Mori T. Espinoza A. 2006. Hongos de Allpahuayo-Mishana, Rapid color guide Number 209 Chicago: Environmental & Conservation Programs, The Field Museum, Chicago.
44. McKenna T. 1992. Food of the Gods. New York: Bantam.
45. Morgan A. 1995. Toads and Toadstools. The natural history, folklore, and cultural oddities of a strange association. Berkeley, Ca: Celestial Arts Publishing.
46. Orozco J. 2008. "Spider god" temple found in Peru. In National Geographic News.
47. Parisi Wilcox J.. 2001. Keepers of ancient knowledge. The mystical world of the Q'ero indians of peru. Lon don: Vega.
48. Pavlich M.R. 1976. Ascomycetes y Basidiomycetes del Peru. I: con emfasis en especies de la ceja de montaña y selva tropical. Memorias del Museo de historia natural "Javier Prado" 17:88.
49. Pavlich M.R. 2001. Los Hongos Comestibles del Perú. Revista de Ciencias Biológicas BIOTA 100 (18): 3-19.
50. Phillips R. 1981. Mushrooms and other fungi of Great Britain and Europe. 3rd printing ed. London: Pan Books Ltd.
51. Poma de Ayala F.G.. 1615 Nueva crónica y buen govierno. Edited by J. V. Murra, R. Adorno, J. L. Urioste, Historia 16,1987 ed, Cronicas de America 29B. Madrid: Hermanos García Noblejas 41.
52. Prance G. 1984 The use of edible fungi by Amazonian Indians. Paper read at NYBG, Procceding: Ethnobotany in the Neotropics Symposium Society for Economic Botany, 13-14 June, 1983, at Bronx, New York.
53. Quilter J. 2011. The Moche of Ancient Peru: Media and Messages (Peabody Museum Collections Series). Boston, Ma: Peabody Museum Press.
54. Reichel Dolmatoff G., ed. 1977. Training of the priesthood among the Koli of Colombia Edited by W. J., Enculturation in Latin America: an anthropology. Los Angeles: University of California. Samorini G. 1992. The oldest representations of hallucinogenic mushrooms in the world (Sahara Desert, 9000-7000 BP). Integration 2:69-78.
55. Schultes R.E. 1939. The identification of teonanacatl, a narcotic basidiomycete of the Aztecs Plantae Mexicanae II, Botanical Museum Leaflets 1 (3):37.
56. Schultes R.E. 1972. An overview of hallucinogens in the western hemisphere. In Flesh of the gods, edited by P. Furst. Prospect

Hights, Illinois: Waveland Press, Inc.
57. Stamets P. 1996. Psilocybin mushrooms of the world. Berkeley, Ca: Ten Speed Press.
58. Stamets P. 2005. Mycelium running: how mushrooms can help save the world. New York: Ten Speed Press, Ran dom House.
59. Trutmann P. 2009. Trip to Iquitos: Discussions with Don Franscico Montes.
60. Trutmann P. & Luque A. 2011. Trip Report Southern Peruvian Andes 2011. Lima, Peru: Global Mountain Action.
61. Trutmann P. and Luque A. 2011. Fungi and Mushrooms: indicators of human and environmental wellbeing in mountains, and beacons of opportunity in Peru. Annual Report 2011. Global Mountain Action. www.globalmountainaction.org
62. Trutmann P. Holgado M.E., Luque A. and Pavlich 2012. Mushrooms of the Highlands of Peru. see www.globalmountainaction.org.
63. Tulloss R., 2006. Amanita - distribution in the Americas with comparison to eastern and southern Asia and notes on spore character variation with latitude and ecology. Mycotaxon 93:189-231.
64. Villoldo A. Jendersen E. 1995. Dance of the four winds. Secrets of the Inca medicine wheel. San Francisco Harper Collins Publisher Inc.
65. Wasson R.G. 1957. Seeking the magic mushroom. LIFE Magazine June 10.
66. Wasson R.G. 1972. Soma the divine mushroom of immortality New York: Harcourt Brace Jovanovich.
67. Wasson R.G. Kramrisch S. Ott J. and Ruck C.A.P. 1986. Persephone's Quest. New Haven and London: Yale University Press.
68. Wasson V.P. and Wasson R.G. 1957. Mushrooms, Russia and History. New York: Pantheon Books.
69. Wright J.E. Albertó E. 2002. Gúia de los hongos de la región pampeana. I. hongos con laminillas. Buenos Aires: Talleres Graficos Lux S.A.
70. Ying J. Mao X. Ma Q. Zong Y. & Wen H. 1987 Icones of Medicinal Fungi from China. Translated by Y. T. Xu. Beijing Science Press.

Biosynthesis of Psilocybin

Part II, Incorporation of Labelled Tryptamine Derivatives*

by

Stig Agurell and J. Lars G. Nilsson

Departments of Pharmacognosy and Chemistry, Royal Pharmaceutical Institute, Kungstensgatan 49,
Stockholm Va, Sweden

original report: http://www.erowid.org/archive/rhodium/pdf/psilocybin.biosynthesis-2.pdf
backup source: http://www.psilosophy.info/resources/psilocybin.biosynthesis-2.pdf

* Part I. Ref. 5.

The biosynthesis of psilocybin has been investigated by feeding labelled precursors to *Psilocybe cubensis*. The following specifically labelled compounds were synthesized: psilocin-^{3}H, 4-hydroxytryptamine-^{14}, *N,N*-dimethyltryptamine-^{14}C and -^{14}-^{3}H, *N*-methyltryptamine-^{14}C-^{3}H and DL-tryptophan-^{3}H. A number of other indoles were labelled by acid catalyzed exchange in tritiated water. The experimental data suggest a sequence: tryptophan → tryptamine → *N*-methyltryptamine → *N,N*-dimethyltryptamine → psilocin → psilocybin. The fungus can also by an alternative route convert 4-hydroxytryptamine to psilocybin. Large differences in the rate of absorption of different closely related precursors has been observed.

Mushrooms containing the hallucinogenic compounds psilocybin (XVI) and psilocin (IV) have long been used as intoxicants by the natives of Mexico. The compounds are closely related 4-hydroxylated indole derivatives[1] and occur mainly in members of the genus *Psilocybe*. The production of psilocybin in *Psilocybe* species in submerged culture was successfully accomplished by Catalfomo and Tyler Jr.[2] and recently also by Leung *et al*.[3]

Brack *et al*.[4] found that psilocybin was biosynthesized from tryptophan in still cultures of *P. semperviva*. In our previous study[5] we found that submerged cultures of *P. cubensis* effectively incorporated also tryptamine into psilocybin.

The present study was undertaken to clarify the sequence of events which leads from tryptophan to psilocybin. This sequence will involve the following modifications of tryptophan in a definite or alternative order: decarboxylation, *N*-methylation, 4-hydroxylation, and *O*-phosphorylation (Fig. 3).

To elucidate this pathway we have used two approaches. In the present study we have investigated the incorporation into psilocybin of labelled hypothetical intermediates. The subsequent paper[6] is concerned with a study of the conversion of tryptophan to psilocybin and the isolation of "apparent intermediates" in this process.

Experimental

Melting points were determined with an electrically heated metal block using calibrated Anschütz thermometers. Infrared spectra of synthesized labelled compounds were recorded with a Perkin-Elmer 237 spectrophotometer and if possible compared with references.

Sodium cyanide-^{14}C, L-tryptophan-G-^{3}H, DL-tryptophan-1'^{14}C, and methyl iodide-^{14}C were purchased from the Radiochemical Center, Amersham, and LiAlH$_4$-^{3}H and tryptamine-2'-^{14}C bisuccinate from New England Nuclear Corporation Boston. The purity of the commercially available and synthesized labelled compounds was checked by thin-layer and paper chromatography followed by scanning in a chromatogram scanner.[7] When necessary, labelled intermediates and final products were purified by preparative paper[5] or column[6] chromatography. Reference materials were obtained from Calbiochem, Los Angeles; Sandoz AG, Basel; and Koch-Light, Colnbrook.

Psilocin-2'-^{3}H (IV). Fig. 1.

*4-Benzyloxy-3-(*N,N*-dimethylcarbamoylmethyl)indole* (II) was prepared from 4-benzyloxyindolyl-(3)-acetic acid (I) *via* the acid chloride.* Yield 64%; m.p. 180-181°. Reported[3] m.p. 175-178°.

4-Benzyloxy-3-(2-dimethylaminoethyl)indole-2'-^{3}H (III). 0.7 g II (2.28 mM) in 20 ml dry tetrahydrofuran was slowly added to 0.35 g (9.24 mmoles) tritiated $LiAlH_4$ (2.5 mC) in 20 ml tetrahydrofuran. After one hour at 40°, 5 ml water was added and the mixture stirred for 20 min. 15 ml of 20% NaOH was added and the trubid solution was extracted with ether. After drying over Na_2SO_4 and evaporation of solvent, the residue crystallized. Yield 0.55 g (84%); m.p. 120-121°. Reported[8] m.p. 120-121°.

Psilocin-2'-^{3}H (IV) = 3-(2-methylaminoethyl)-4-hydroxyindole-^{3}H. 0.5 g III (1.9 mmoles) in 25 ml methanol was debenzylated with H_2 and 0.3 g 5% Pd on Al_2O_3 in a Parr hydrogenation apparatus for 4h. After filtration with Celite, the solvent was evaporated yielding 0.21 g (54%) blue crystals, m.p. 169-170°. Recrystallization from methanol did not change the melting point. Reported[8] m.p. 168-170° and [1] 173-176°. Spec. activity 261 µC/mM.

4-Hydroxytryptamine-2'-^{14}C (VII) Fig. 1.

4-Benzyloxygramine [9] was quaternized with dimethylsulfate to 4-benzyloxygramine methosulfate (V) according to Schöpf and Thesing.[10] Yield 90%; m.p. 144-145°. Reported[11] m.p. 143-144°.

4-Benzyloxyindolyl-(3)-acetonitrile-2'-^{14}C (VI). 2.7 g V (6.65 mmoles) and 0.22 g $Na^{14}CN$ (0.4 mC; 4.43 mmoles) was dissolved in 25 ml water in an ampoule, which was scaled and heated on a steam bath for one hour. The nitrile separated as an oil. The ampoule was cooled and the mixture extracted with chloroform. The extract was dried over Na_2SO_4 and the solvent evaporated, affording 0.9 g (53%) pale yellow oil, which was used in the next step without purification. IR: 2250 cm^{-1} (C≡N).

4-Benzyloxytryptamine-2'-^{14}C. 0.9 g VI was reduced with 0.3 g $LiAlH_4$ as described for II. Yield 0.51 g (57%), oil, which did not crystallize. Hydrogen oxalate: m.p. 114-116°. Reported[9] m.p. 117-120°.

4-Hydroxytryptamine-2'-^{14}C (VII). The previous compound was debenzylated as described for III to give 84% of an oil that did not crystallize. Oxalate m.p. 261-264°. Reported[9] m.p. 269-270°. Spec. activity 87 µC/mmole as base.

N,N-Dimethyltryptamine-2'-^{14}C

3-Indoleacetonitrile-2'-^{14}C was prepared from 4.5 g (15 mmoles) gramine methosulfate[10] and 0.5g $Na^{14}CN$ (0.25 mC; 10 mmoles) in 25 ml water as described for VI. Yield 1.2 g (77%) of an oil, which was used in the next step without purification. IR: 2250 cm^{-1} (C≡N).

3-Indoleacetic acid-2'-^{14}C was prepared from the nitrile by alkaline hydrolysis.[12] Yield 70%; m.p. 162-165° (decomp.), reported[11] m.p. 165-166° (decomp.).

*3-(*N,N*-dimethylcarbomoylmethyl)indole-2'-^{14}C* was prepared from indoleacetic acid-2'-^{14}C by the method used for II affording an oil (yield 87%) which was used in the next step without purification.

N,N-*dimethyltryptamine-^{14}2'-C = 3-(2-dimethylaminoethyl)indole-^{14}C*. 0.25 g of the amide was reduced with 0.2 g $LiAlH_4$ as described for II. Yield 0.147 g (62%) base as a pale yellow oil. Its hydrochloride melted at 159-163° after recrystallization from ethanol and ether. Reported[13] m.p. 166-167.5°. Spec. activity 75 µC/mmole.

N,N-Dimethyltryptamine(-indole-^{3}H-*N*-methyl-^{14}C) (XII). Fig. 1.

*3-(*N*-Benzyl-*N*-methylcarbamoylmethyl)indole* (IX) was prepared from (1.6 mC) 3-indoleacetic acid-indole-^{3}H (VIII) and *N*-benzyl-methylamine as described for II. Yield 71%; m.p. 149-150°.

1.0 g of IX was reduced as described for II with $LiAlH_4$ in tetrahydrofuran to yield (86%; 0.97 mC) N-*benzyl*-N-*methyltryptamine-^{3}H* (X).

0.80 g of X dissolved in 15 ml ethylacetate was quaternized with 0.5 g methyl iodide (0.1 mC) in an ampoule at 100° for one hour.[8] The crystalline deposit was washed with ethylacetate and then dissolved in 50 ml of 50% aqueous methanol. This solution was treated with freshly prepared AgCl [8] to convert the iodide to the chloride (XI).

A solution of XI in 25 ml dry methanol was debenzylated as described for III. After column chromatography 0.31 g of the pure, doubly labelled *N,N*-dimethyltryptamine (XII) was obtained with a spec. activity: ^{3}H 320 µC/mmole; ^{14}C 11.2 µC/mmole. m.p. 43-45°; reported[17] m.p. 48-49°.

N-Methyltryptamine-1'-^{14}C-N-methyl-^{3}H (XV). Fig. 1.

Tryptamine-1'-^{14}C (XIII) 0.21 g (0.02 mC; 1.3 mmole) was formylated with 0.18 ml formic acid in 0.41 ml acetic anhydride according to Stauffer.[14] The *N*-formyltryptamine (XIV) was reduced with 0.4 g $LiAlH_4$ in refluxing tetrahydrofuran for 12 h to yield 0.10 g (44%) of *N*-methyltryptamine-1'-^{14}C (XV). Spec. activity 8.0 µC/mmole.

N-formyltryptamine (0.24 g) was similarly reduced with $LiAlH_4$-^{3}H (0.10 g; 0.5 mC) to *N*-methyltryptamine-*N*-methyl-^{3}H. Yield 0.10 g (47%). Spec. activity 66.0 µC/mmole.

N-*methyltryptamine-(1'-^{14}C-*N*-methyl-^{3}H) = 3-(2-methylaminoethyl)-indole-^{14}C-^{3}H* (XV) was obtained by mixing ^{14}C-labelled with ^{3}H-labelled compound.

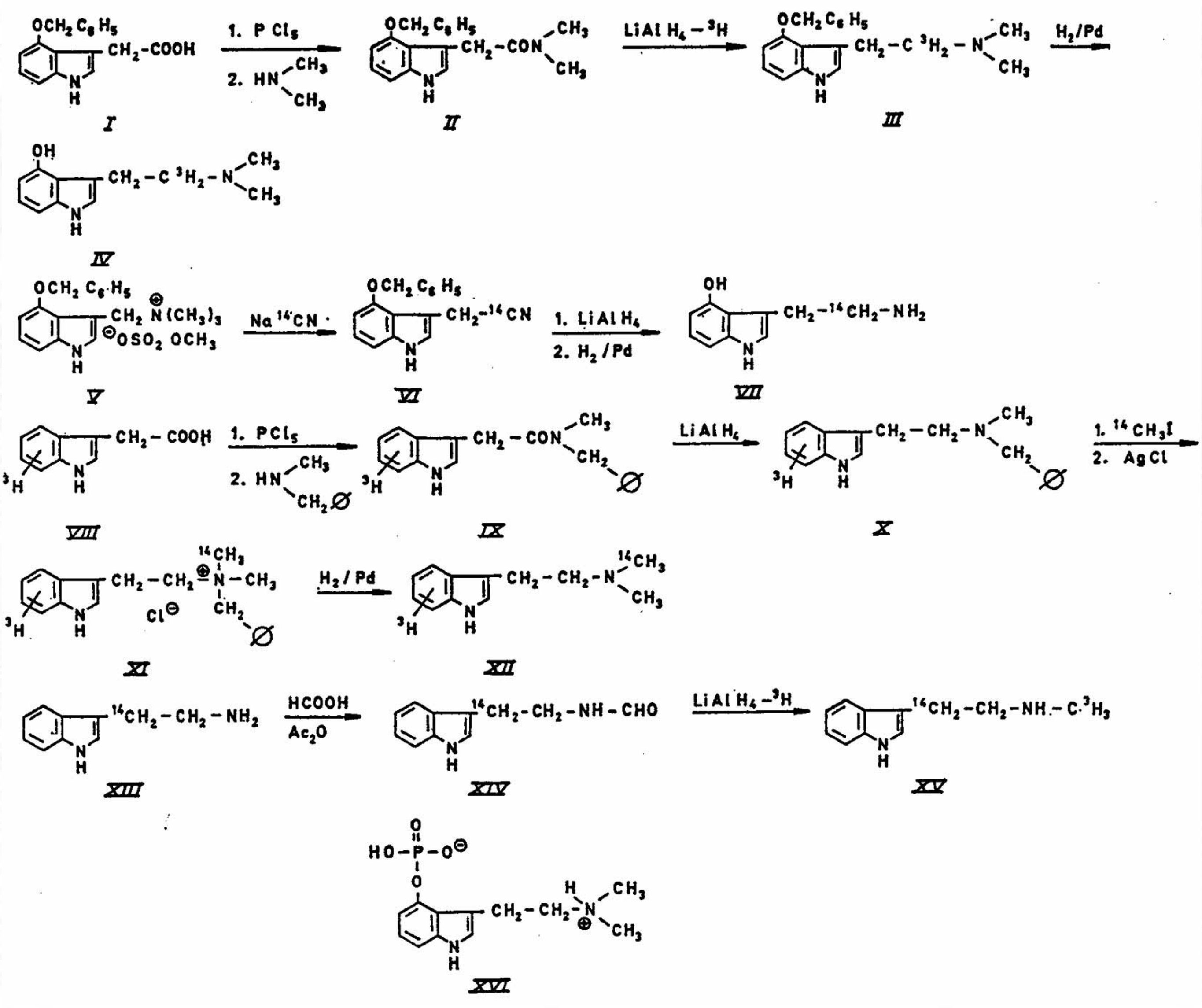


Fig. 1. Synthesis of ^{14}C- and ^{3}H-labelled precursors.

Other compounds

DL-*Tryptophan-2'-^{3}H* Gramine 1.74 g (10 mmoles), 2.60 g (12 mmoles) ethyl acetamidomalonate and 0.20 g powdered NaOH in 30 ml dry toluene[15] were refluxed for 14 h under N_2. The hot solution was filtered and upon standing overnight, 2.52 g (73%) of ethyl α-acetamid-α-carbethoxy-β-(3-indole)-propionate was deposited. This compound (2.0 g) was saponified and decarboxylated[18] in tritiated water (25 mC) to DL-tryptophan (alanine-2'-^{3}H) which was crystallized from aqueous ethanol. Yield 0.23 g (19%); m.p. 279-281°. Reported[16] m.p. 281-285°. Spec. activity 293 µC/mmole.

Generally tritium labelled compounds. 0.1 g of the aromatic compound to be tritiated was dissolved in 0.5-1 ml tritiated water (200-500 mC/ml) in an ampoule and the mixture was saturated with HCl gas. The sealed ampoule was treated on a steam bath for one hour. The evaporated residue was repeatedly dissolved in methanol to exchange labile hydrogens. This acid catalyzed exchange procedure will exchange predominantly the hydrogens of the indole nucleus.[16] The crude tritiated product was purified by preparative paper[5] or column[6] chromatography. The purified amines were dissolved in dilute acid together with 2-4 times the amount of carrier material. After the addition of alkali, the amines were extracted with benzene and crystallized as base or hydrochloride.

4-Benzyloxytryptophan was tritiated in about 1 N HCl-solution to minimize the destruction and debenzylated as described for III. It was purified in system BAW.[5] The tritiation of 3-indoleacetic acid (0.16 g in 1.5 ml of 50% aqueous methanol; 140 mC) gave a particularly pure and highly labelled compound.

Specific activities: Tryptamine-^{3}H: 43.5 µC/mmole; *N*-methyltryptamine-^{3}: 810 µC/mmole; *N,N*-dimethyltryptamine-^{3}H: 161 µC/mmole, DL-4-hydroxytryptophan-^{3}H: 96.1 µC/mmole; 3-indoleacetic acid: 1.8 mC/mmole.

Other conditions

Culture conditions etc. The method for submerged biosynthesis of psilocybin by *P. cubensis*, introduction of precursors and the isolation, purification and recrystallization of psilocybin are described previously as well as different assay procedures.[5]

Psilocybin was isolated as described[5] by methanol extraction, ion exchange technique and finally preparative paper chromatography. The following criteria[5] were used for determination of incorporation of label from a precursor into derived psilocybin: by TLC (in MAW), by paper chromatography (in LAW and BAW), and by electrophoresis followed by scanning, it was shown that the radioactivity was firmly associated with the isolated psilocybin and finally after the addition of carrier psilocybin (7-10 mg), psilocybin was crystallized from hot methanol to constant spec. activity.

To minimize the individual differences in incorporation rates between different cultures, a number of experiments were carried out (Table 1), where two different precursors, one ^{3}H-labelled, the other ^{14}C-labelled, were introduced into the same culture.

Chromatographic methods. The chromatographic systems have been described earlier.[5] Paper chromatography on Whatman 3MM paper with the following solvent systems BAW: butanol-acetic acid-water (4:1:5); IAW: isopropanol-conc. NH_4OH-water (8:1:1). TLC on Silica Gel G in system MAW: methanol-acetic acid water (75:10:15). 4-Hydroxytryptamine which was not included in the previous paper[5] has the following R_F-values: in system BAW: 0.85; in system MAW: 0.75; and has a similar mobility as psilocin in the electrophoretic system. Psilocybin from 4-hydroxytryptophan-^{3}H fed cultures was isolated after purification first in system IAW and then in system BAW.[5]

Uptake of precursors from medium. About 1.0 mg of labelled precursor was introduced into each of two cultures. At zero time and then at different time intervals (Fig. 2) samples were withdrawn aseptically and the radioactivity in 500 µl of the medium was determined. To determine the percentage of radioactivity still present as the originally introduced compound, an aliquot of the medium, if necessary after concentration by lyophilization, was separated in systems MAW (Eastman chromatogram sheet) or BAW. Strips of the chromatogram were counted in a liquid scintillator.

Table 1. Incorporation of labelled precursors into psilocybin.

Expt. No.	Precursor introduced	D.p.m. x 10^{-6}	Mg	Precursor incorporated into psilocybin, %; (mg psilocybin formed)	Spec. act. of psilocybin µC/mmole	Dilution[a]
28	L-Tryptophan-^{3}H[b]	111	0.3	0.86 (0.48)	^{3}H 262	132
	Tryptamine-^{14}C	11.1	0.3	2.06 (0.48)	^{14}C 75.7	33
29	L-Tryptophan-^{3}H	111	0.3	0.88 (0.90)	^{3}H 139	244
	Tryptamine-^{14}C	11.1	0.3	2.56 (0.90)	^{14}C 33.3	74
36[c]	DL-4-OH-Tryptophan-^{3}H	23.7	25	0 (0.62)	^{3}H 0	>500
	DL-Tryptophan-^{14}C	5.55	20	0.86 (0.62)	^{14}C 9.62	2.7
37	DL-4-OH-Tryptophan-^{3}H	23.7	25	0 (1.43)	^{3}H 0	>500
	DL-Tryptophan-^{14}C	5.55	20	1.49 (1.43)	^{14}C 7.38	3.5
38	*N*-Methyltryptamine-^{3}H	35.2	3.4	14.8 (1.64)	406	2.0
42	*N*-Methyltryptamine-^{3}H	32.0	3.1	9.63 (0.58)	679	1.2
40	*N*-Methyltryptamine-^{3}H	178	10	0.91 (1.72)	^{3}H 143	5.7
	Tryptamine-^{14}C	11.1	11	1.09 (1.72)	^{14}C 7.60	9.7
11	*N*,*N*-Dimethyltryptamine-^{14}C[b]	3.22	3.6	0.15 (0.25)	2.30	31
15	*N*,*N*-Dimethyltryptamine-^{14}C	4.25	4.8	0.17 (0.43)	2.20	34
20	4-OH-Tryptamine-^{14}C	4.05	5.8	3.73 (3.44)	5.63	9.8
26	4-OH-Tryptamine-^{14}C	3.20	4.6	0.98 (1.14)	3.52	16
10	Psilocin-^{3}H	17.0	6.0	2.86 (2.60)	23.9	11
19	Psilocin-^{3}H	18.5	6.5	8.48 (4.85)	41.4	6.3
21	Psilocin-^{3}H	19.9	7.0	0.71 (16.0)	^{3}H 27.2	9.6
	N,*N*-Dimethyltryptamine-^{14}C	5.57	6.3	0.17 (16.0)	^{14}C 0.75	100
27	Psilocin-^{3}H	11.6	4.1	0.95 (0.41)	^{3}H 34.4	7.6
	N,*N*-Dimethyltryptamine-^{14}C	3.72	4.2	0.09 (0.41)	^{14}C 1.00	75

[a] - Spec. act. of precursor/spec. act. of psilocybin.
[b] - For location of label, see Experimental section.
[c] - Signifies that two differently labelled precursors were introduced into the same culture.

Results and discussion

Labelled precursors. Psilocin-^{3}H, 4-hydroxytryptamine-^{14}C, *N*,*N*-dimethyltryptamine-^{14}C and -^{14}C-^{3}H, *N*-methyltryptamine-^{14}C-^{3}H, and DL-tryptophan-^{3}H were synthesized by appropriate modifications of known procedures[8,9,12,14-16] as illustrated in Fig. 1, to give suitably, singly or doubly, specifically labelled compounds. *N*-Methyltryptamine-*N*-methyl-^{3}H was conveniently prepared from tryptamine by formulation and reduction of the *N*-formyltryptamine with tritiated LiAlH$_4$. Ring tritiated *N*,*N*-dimethyltryptamine-^{3}H (as the benzyloxy compound), and 3-indoleacetic acid-^{3}H were obtained by acid catalyzed exchange in tritiated water.

Biosynthesis of psilocybin. A number of alkaloids (*cf*. Ref. 22) contain an indole nucleus hydroxylated in position 4 (*e.g*. venanatine,[5] psilocin), in position 5 (*e.g*. ibogaine, eserine), in position 6 (*e.g*. reserpine, vindoline), in position 7 (*e.g*. aspidospermine, vallesine) or in more than one position. Several indole alkaloids have been demonstrated to be derived from tryptophan.[23] However, one of the still lacking, interesting points in our knowledge is whether this hydroxyl group is introduced into tryptophan or if the hydroxylation of the indole nucleus occurs during some later stage as a result of secondary conversions of the formed alkaloid skeleton.

Psilocybin is derived from tryptophan[4,5] but it is not known in which specific sequence, if any, the necessary modifying reactions (decarboxylation, *N*-methylation, 4-hydroxylation, and *O*-phosphorylation) occur. For the biosynthesis of psilocin, one could suggest analogies in the biological formation of serotonin and gramine. The latter compound is derived from tryptophan by a dealkylation to 3-aminomethylindole followed by step-wise *N*-methylation.[19,20] Serotonin is biosynthesized, as numerous investigations have shown, from tryptophan *via* 5-hydroxytryptophan,[21] thus, initially, by a hydroxylation of tryptophan followed by a decarboxylation.

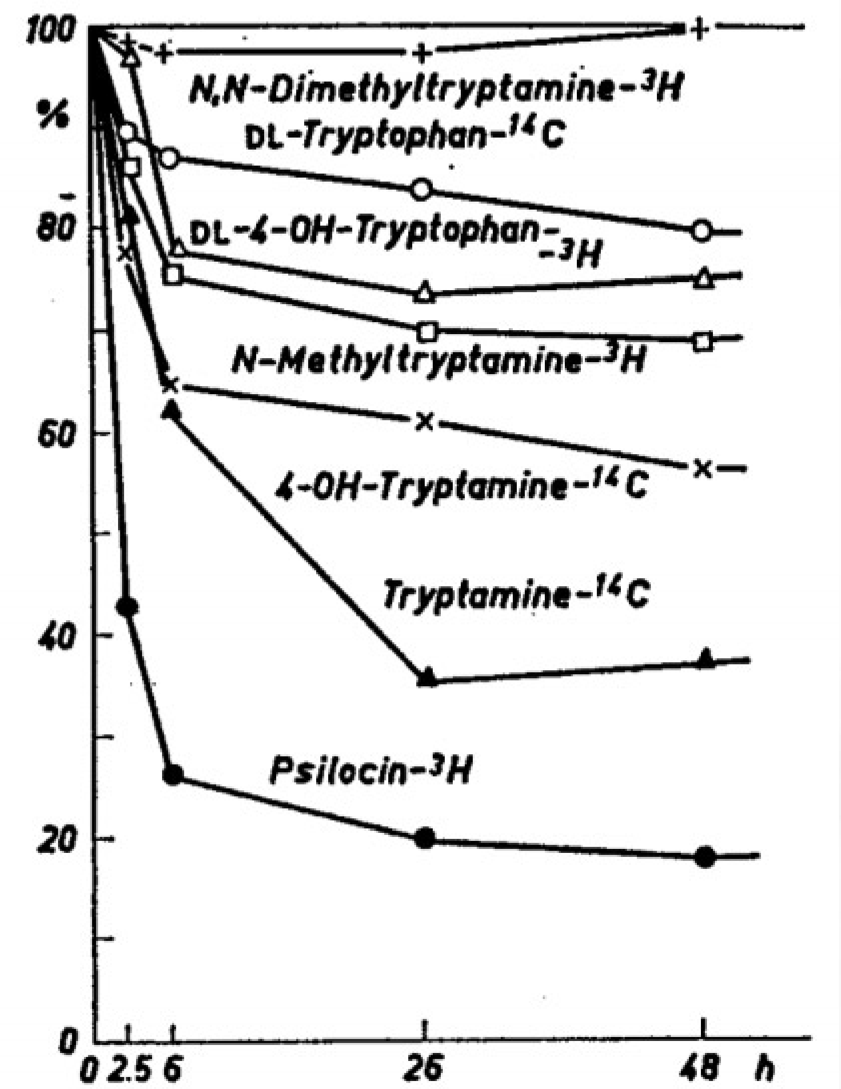


Fig. 2. Up-take of precursors from medium by *P. cubensis*. Per cent of introduced radioactivity remaining in medium.

However, the results in Table 1 show that 4-hydroxytryptophan which so far has not been encountered in nature, in contrast to tryptophan does not function as a precursor of psilocybin. Tryptamine, which is readily formed from tryptophan by *P. cubensis*,[6] serves as a better precursor of psilocybin than tryptophan. If tryptamine is methylated to *N*-methyltryptamine, this is an even better progenitor of psilocybin with incorporations showing that more than half of the psilocybin was derived from the introduced labelled precursor (Expts. Nos. 38, 42). The corresponding dimethyl derivative *N,N*-dimethyltryptamine may, however, be considered as a poor precursor as judged from the incorporation percentages. These are decidedly lower than for *e.g.* tryptophan and definitely not in agreement with *N,N*-dimethyltryptamine standing biogenetically closer to psilocybin than does tryptophan.

Nevertheless, with other factors taken into account the low incorporation percentages for *N,N*-dimethyltryptamine does not make it an unlikely intermediate. If the "dilution factors" for this compound and for psilocin (Expts. Nos. 21, 27) are compared, it is evident that psilocin is about ten times more effectively incorporated into psilocybin. This large difference led us to investigate the up-take of different precursors from the culture medium by the fungus with the striking differences shown in Fig. 2. A the time when the labelled compounds are administered, 12-15% of the culture volume is taken up by the cells. This means that *N,N*-

dimethyltryptamine (Fig. 2) actually to some extent is prevented from entering the cells, since in this and two other experiments at any time no more than 7% of this labelled material, usually much less, had disappeared from the liquid medium. This poor absorption of the precursor was verified by the low activity present in the methanol extract of the fungus.

The activity of administered non-hydroxylated indoles remained in the medium, as shown by TLC, still mainly (not less than 74%) as the originally administered compounds after 44 h. The pH of the medium was, as could be expected, crucial for the stability of the 4-hydroxylated indoles. The pH of the culture medium is at start 5.2 and is then slightly decreasing to 4.8-5.0 between the 4th and 10th day and increases then slowly. This means, however, that during the experiments the 4-hydroxylated indoles have a reasonable stability. Thus psilocin remained unchanged to 63% after 44 h in a medium of pH 5.2 but was quickly destroyed at a pH over 7.

The curves in Fig. 2 show, as expected, that the up-take is most rapid at the beginning, reaching a maximum after about 24 h followed by a slow, small (less than 10%) release of radioactivity back into the medium over the next 96 h. If the points on the initial parts of the curves are used to get a rough estimate of the clearance of the precursors from the medium, the following approximate half-lives are obtained for: psilocin = 2 h, tryptamine = 8 h, tryptophan = 16 h, and *N,N*-dimethyltryptamine over 40 h.

The above data would suggest the following sequence (Fig. 3) for the formation of psilocybin:
tryptophan → tryptamine → *N*-methyltryptamine → *N,N*-dimethyltryptamine → psilocin → psilocybin.

Experiments with doubly labelled *N*-methyltryptamine and *N,N*-dimethyltryptamine are in progress to ensure that these compounds are converted *in tot* to psilocybin without previous demethylation.[24]

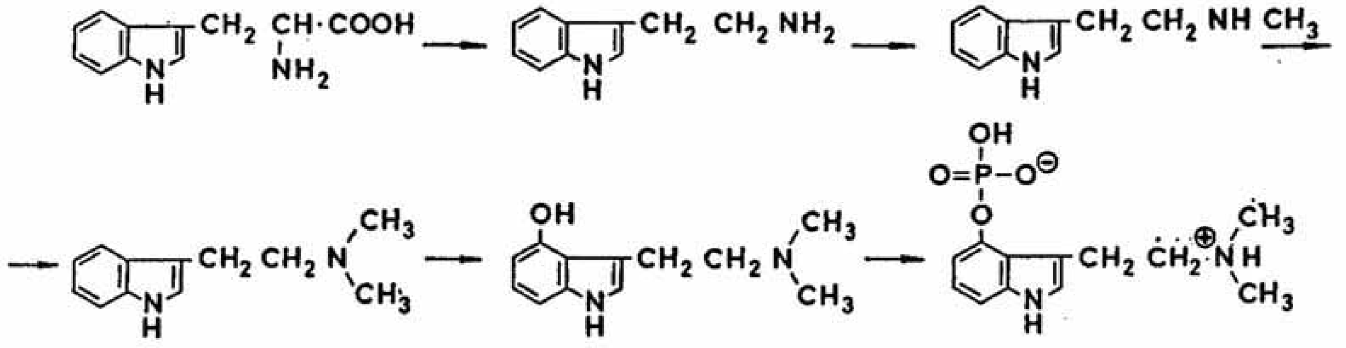


Fig. 3. A possible pathway of psilocybin biosynthesis as indicated by present experiments.

The data in Table 1 also indicate that the fungus can utilize another path to psilocybin since also 4-hydroxytryptamine is well incorporated into psilocybin. Here, the hydroxyl group occurs already at the tryptamine-stage thus before the *N*-methylation steps. It may be noted that 4-hydroxytryptamine apparently is a metabolite of 4-hydroxytryptophan in animals.[21] When 4-hydroxytryptamine was introduced into the culture, this occasionally led to the formation also of small amounts of one or two "psilocybin-like" compounds which possibly may have been phosphoric esters of 4-hydroxytryptamine and its *N*-methyl derivative, the recently isolated baeocystin.[25]

Thus it appears the *P. cubensis* can utilize two pathways to psilocybin. Further experiments with *N*-methyl-4-hydroxytryptamine-^{14}C-^{3}H and doubly labelled tryptamines as well as experiments on "apparent intermediates" which are now in progress[6] are required to show if the fungus normally uses more than one pathway from tryptophan to psilocybin. So far, only tryptamine and psilocin have been isolated from the fungus as "apparent intermediates" in this process.

Acknowledgements. This study was supported by the *Swedish Natural Science Research Council*. The technical assistance of Miss B. Jerkeman is appreciated. Dr. A. Hofmann, Sandoz AG, kindly supplied psilocybin.

References

1. Hofmann, A., Heim, R., Brack, A., Kobel, H., Frey, A., Ott, H. Petrzilka, T. and Troxler, F. *Helv. Chim. Acta* 42 (1959) 1557.
2. Catalfomo, P. and Tyler, Jr., V. E. *Loydia* 27 (1964) 53.
3. Leung, A.Y., Smith, A.H. and Paul, A.G.J. *Pharm. Sci.* 54 (1965) 1576.
4. Brack, A., Hofmann, A., Kalberer, F., Kobel, H. and Rutschmann, J. *J. Arch. Pharm.* 294 (1961) 230.
5. Agurell, S., Blomkvist, S. and Catalfomo, P. *Acta Pharm. Suecica* 3 (1966) 37.
6. Agurell, S. and Nilsson, L. *Acta Chem. Scand. To be published.*
7. Agurell, S. *Acta Pharm. Suecica* 3 (1966) 11.
8. Kalberer, F., Kreis, W. and Rutschmann, J. *Biochem. Pharmacol.* 11 (1962) 261.
9. Stoll, A., Troxler, F., Feyer, J. and Hofmann, A. *Helv. Chim. Acta* 38 (1955) 1452.
10. Schöpf, C. and Thesing, J. *Angew. Chem.* 63 (1951) 377.
11. Floss, H. G. and Mothes, U.Z. *Naturforsch.* 18b (1963) 866.
12. Thesing, J. and Shülde, F. *Chem. Ber.* 85 (1952) 324.
13. Vitali, T. and Messini, F. *Boll. Sci. Fac. Chim. Ind. Bologna* 17 (1959) 84.
14. Stauffer, R. *Helv. Chim. Acta* 49 (1966) 1199.
15. Howe, E. E., Zambito, A. J., Snyder, K. R.and Tishler, M. *J. Am. Chem. Soc.* 67 (1945) 38.
16. Barton, D. H. R., Kirby, G. W., Prager, R. H. and Wilson, E. M. *J. Chem. Soc.* 1965 3990.
17. Budendorf, K. and Walk, A. *Arch. Pharm.* 294 (1961) 484.
18. Snyder, H. R. and Smith, C. W. *J. Am. Chem. Soc.* 66 (1944) 350.
19. O'Donovan, D. and Leete, E. *J. Am. Chem. Soc.* 85 (1963) 461.
20. Gower, B. G. and Leete, E. *J. Am. Chem. Soc.* 85 (1963) 3683.
21. Harborne, J. B., (Ed.), *Biochemistry of phenolic compounds*, Academic, London and New York 1962, pp. 230-234.
22. Boit, H. G. *Ergebnisse der Alkaloid Chemie bis 1960*, Akademie-Verlag, Berlin 1961.
23. Stolle, K., Gröger, D. and Mothes, K. *Chem. Ind. (London)* 1965 2065.
24. Floss, H. G. and Gröger, D. *Z. Naturforsch.* 19b (1964) 393.
25. Leung, A. Y. and Paul, A. G. *J. Pharm. Sci.* 56 (1967) 146.

The Production of Psilocybin in Submerged Culture by Psilocybe Cubensis

by

Philip Catalfomo[*] and V.E. Tyler, Jr.

(Drug Plant Laboratory, College of Pharmacy, University of Washington, Seattle 5)

Lloydia 27, 53-63 (1964)

*This manuscript is abstracted in part from a dissertation submitted to the Graduate School of the University of Washington by Philip Catalfomo in partial fulfillment of the requirements for the degree of Doctor of Philosophy. President address: School of Pharmacy, Oregon State University, Corvallis.

original report: http://www.erowid.org/archive/rhodium/pdf/psilocybin.submerged.culture.pdf
backup source: http://www.psilosophy.info/resources/psilocybin.submerged.culture.pdf

Psychotomimetic mushrooms have long been employed as intoxicants by various native peoples. Schultes[10] describes their employment in magico-religious ceremonies by the Indians of Mexico and Central America, and extensive documentation of such usage has been provided by the Wassons[14,15] and by Heim and Wasson[6].

Especially noteworthy is the occurrence of certain indole derivatives in many of the basidiomycetes to which psychotomimetic properties have been ascribed. Several species of *Panaeolus* contain serotonin (5-hydroxytryptamine), first demonstrated in a fungus, *Panaeolus campanulatus* (Fr.) Quel., by Tyler[13]. Bufotenine (5-hydroxy-*N*,*N*-dimethyltryptamine) was shown to exist in *Amanita citrina* (Shaeff.) S. F. Gray [*Amanita mappa* (Lasch) Quel.] by Wieland and Motzel[16]. Psilocybin (4-phosphoryl-*N*,*N*-dimethyltryptamine), was first found in *Psilocybe* species by Hofmann, *et al.*[8] The latter two principles are the most recently discovered hallucinogens in basidiomycetes and are of particular interest since they are the only principles isolated from mushrooms which are capable of inducing psychotomimetic effects in human beings following oral ingestion.

Heim, *et al.*[7], established conditions favoring the formation of both sclerotia and sporocarps from mycelial growth obtained upon subculture of the spores and tissue of the naturally occurring Mexican *Psilocybe* species. In this way they obtained ample amounts of materials for isolation and structural studies of the active principles. The psychotomimetic effects on human beings following ingestion of either the wild-grown sporocarps or sporocarps, sclerotia, and mycelium produced in laboratory culture were identical[9]. Singer[11] and Stein[12] obtained similar results, but neither they, Heim, *et al.*[7], nor Hofmann, *et al.*[8], studied the production of psilocybin or psilocin in submerged culture fermentations. This constituted a major a major objective, and data presented herein were derived from submerged culture fermentations of *Psilocybe* species.

Experimental evidence regarding the biosynthesis of psilocybin or psilocin is quite limited. The structural similarity between these compounds and tryptophan suggested they might derive from that common amino acid. Part of the psilocybin isolated from the surface-cultured mycelium of *Psilocybe semperviva* Heim & Cailleux by Brack, *et al.*[2], was derived from the isotopically labeled tryptophan added to the nutrient medium. An additional objective of the present study concerned the fate of tryptophan added to replacement culture media containing washed mycelial pellets from submerged culture fermentations.

Material and Methods

Culture techniques. - Mycelial cultures of the organisms investigated were maintained on potato-dextrose-yeast agar slants[1]. The compositions of the nutrient medium (medium no. 1) and the replacement medium (medium no.2) are given in table 1. Various modifications of these media will be described subsequently.

For shaken-flask studies, transfers were made from agar slants to 125-ml Erlenmeyer flasks containing 30 ml of the desired medium. After four to seven days on a shaker at 25±1°C, the mycelial growth (pellet form) was homogenized in a sterile semimicro Waring Blendor for fifteen seconds and 5 ml per 100 ml added as inocula to all experimental flasks. Unless otherwise noted, flasks were then shaken at 25°C for periods of five to fifteen days.

Table 1. Nutrient media

Basic Nutrient Medium Medium no. 1	
Ammonium succinate	1.0 Gm
Glycine	9.0 Gm
Glucose	5.0 Gm
Yeast extract	0.5 Gm
KH_2PO_4	0.1 Gm
Thiamine hydrochloride	0.003 Gm
$(NH_4)_6Mo_7O_{24}$-$4H_2O$	0.05 mg
$ZnSO_4$-$7H_2O$	0.3 mg
$MnCl_2$-$4H_2O$	0.35 mg
$FeSO_4$-$7H_2O$	2.5 mg
$CuSO_4$-$5H_2O$	0.5 mg
$MgSO_4$-$7H_2O$	0.5 Gm
Distilled water, to make	1.0 liter
Adjust to pH 5.5 with hydrochloric acid.	
Replacement Medium Medium no. 2	
Citric acid(0.1M)	307.0 ml
Na_2HPO_4-$7H_2O$ (0.2M)	193.0 ml
Distilled water, to make	1 liter
To each replacement culture flask containing 30 ml of this medium (pH 4.2) add 2 mg tryptophan.	

Replacement culture inocula were obtained in a similar manner, but the homogenizing step was extended to one minute. The homogenate from one 125-ml flask was quantitatively transferred to a 2800-ml Fernbach flask containing 300 ml of medium, and mycelium was allowed to develop on a rotary shaker. Mycelial pellets produced in this manner were carefully washed with 500 ml of sterile distilled water; portions were transferred to 125-ml flasks containing 2 mg of tryptophan in 30 ml of medium no. 2 and shaken for the specified period of time.

The shaking machines routinely employed in these studies were a New Brunswick rotary shaker, model V, and a Gump rotary shaker, model M, which were operated at 240 and 185 rpm, respectively.

Analytical methods. - The mycelial pellets, separated from the culture or replacement media by suction filtration on a Büchner funnel, were dried in a forced-air drying oven at 48°C for a minimum period of forty-eight hours and subsequently stored in a desiccator over anhydrous calcium chloride. After determining the pH values of the filtered culture media, the filtrates were evaporated to dryness in a flash evaporator at 40°C under reduced pressure. The residues were carefully extracted with 2-ml portions of absolute methanol to dissolve the psilocybin and psilocin, and the solutions were stored in a refrigerator until subjected to chromatographic analysis.

After drying, the mycelial pellets from the individual culture flasks were weighed and then reduced to a no. 60 powder in a Wiley laboratory mill. Ten ml of methanol was added to each sample (ca. 25-100 mg) of powdered material in a 25-ml flask. After shaking for eight hours, the resulting slurry was centrifuged, and the supernatant liquids decanted into a 50-ml round bottom flask. The marc was treated in an identical manner two additional times, after which the combined methanol extracts were evaporated to a small volume (1-2 ml) in a rotary film evaporator at 40°C under reduced pressure. The concentrated extract was transferred to a 5-ml volumetric flask with a microdropper. Residual material in the evaporation flask was removed by a methanol wash, added to the volumetric flask, and the final volume adjusted to 5 ml. Extracts prepared in this manner were refrigerated until used for assay.

An ascending two-dimensional chromatographic procedure was employed to establish the presence or absence of psilocybin and psilocin. Extracts (50-200 µl) were spotted on sheets of Whatman no. 1 filter paper (8x8 in.) and formed with *n*-butanol-acetic acid water (4:1:5) in the first direction and *n*-propanol-1N ammonium hydroxide (5:1) in the second direction. Location of the indole derivatives was accomplished by spraying the sheets with a solution of 2 percent *p*-dimethylaminobenzaldehyde in 1N hydrochloric acid (PDAB) and drying the sheets with a laboratory heat gun.

Assay procedure. - A paper partition chromatographic assay for psilocybin was developed based on the serial dilution procedure employed by Brown, *et al.*[4], for the assay of muscarine in *Inocybe* species. The technique involved visual observation of the minimum detectable quantity of psilocybin following reaction with PDAB on paper chromatograms. It was determined that 1.0 µg of psilocybin could be detected with certainty on chromatograms developed in *n*-butanol-acetic-acid-water (4:1:5), sprayed with PDAB, and permitted to dry spontaneously at room temperature for thirty minutes. Volumes of mycelial extracts corresponding to this amount of the compound were determined experimentally, and the quantities of psilocybin in the extracts and the mycelium were calculated (dry-weight basis).

Experimental and Results

Growth, pH and psilocybin production. - Cultures employed in the investigation included *Psilocybe cubensis* (Earle) Singer obtained from the Northern Regional Research Laboratory, Peoria, Illinois (NRRL A-9109), *Psilocybe cyanescens* Wakefield and *Psilocybe pelliculosa* (Smith) Singer & Smith, isolated from sporocarp tissue of mushrooms collected in the Seattle area. Mycelium was grown in submerged culture in various media under different laboratory conditions to determine if psilocybin and/or psilocin would be produced. Mycelial pellets of *Psilocybe cubensis* grown in medium no. 1 contained psilocybin, although the culture medium did not; psilocin could not be detected in either the medium or mycelium. The other two species failed to produce detectable amounts of either of these compounds in any of the media tested. It was concluded that the fungi differed in their metabolic capabilities, and, of the three, only *Psilocybe cubensis* was subjected to further investigation.

Initial experiments were conducted to determine the optimal growth period and its relationship to psilocybin production. Cultures of the organism in medium no. 1 were harvested on alternate days, five to fifteen days after inoculation. Replicates of four cultures were examined at each growth period. The pH of the medium at the termination of the experiment, the dry weight of the mycelium, and the amount of psilocybin produced were determined. The results are summarized in table 2 and figure 1.

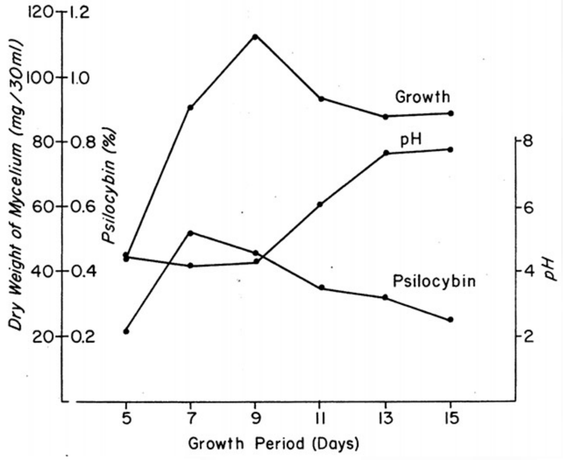


Fig. 1. Growth, pH of medium, and psilocybin production.

These data revealed that the pH of the medium remained acid until the ninth day and then rapidly increased until a plateau was reached near pH 8. Maximum production of psilocybin (percentage basis) occurred on the seventh day, whereas mycelium production reached its peak on the ninth day. Psilocybin was not detected in the medium. Maximum production of both mycelium (dry weight) and psilocybin (percentage basis) occurred in acid medium, and both underwent a decline as the pH of the medium began to rise after the ninth day of fermentation. It was noted that psilocybin was produced during the most active growth period of the organism.

Table 2. Growth, pH of medium, and psilocybin production.

Growth period (days)	pH of medium	Dry wt of mycelium (mg)	Psilocybin (%)
5	4.4	40.5	0.23
	4.2	53.9	0.20
	4.3	50.0	0.21
	4.8	29.0	0.25
ave.	4.4	43.4	0.22
7	4.2	72.0	0.51
	4.0	110.6	0.51
	4.6	114.1	0.54
	4.2	67.3	0.54
ave.	4.2	91.0	0.52
9	4.1	114.9	0.46
	4.4	114.6	0.50
	4.5	106.1	0.44
	4.1	114.8	0.46
ave.	4.3	112.6	0.46
11	4.6	101.0	0.36
	4.6	109.4	0.34
	7.8	81.7	0.27
	7.7	82.9	0.37
ave.	6.1	93.2	0.35
13	7.6	81.9	0.32
	7.6	88.1	0.33
	7.8	102.3	0.31
	7.8	80.2	0.31
ave.	7.7	88.1	0.32
15	8.0	82.6	0.28
	7.9	81.5	0.27
	7.6	104.6	0.20
ave.	7.8	89.5	0.25

Although psilocybin was initially identified by chromatography, additional evidence was obtained from ultraviolet spectral data. Methanol extracts of mycelium were chromatographed in *n*-butanol saturated with water, the zone corresponding to psilocybin eluted with methanol, and the eluate rechromatographed as before. The ultraviolet absorption spectrum obtained from the final eluate in a Cary spectrophotometer, model 14, was found to coincide with that of known psilocybin (maxima 268 mµ and 290 mµ).

Influence of the omission of certain nutrients. - Subsequent studies were conducted to determine the influence on growth and psilocybin production when each of the following components was omitted singly from medium no. 1: glucose, ammonium succinate, yeast extract, thiamine, and glycine. In a further study, yeast extract and thiamine were concurrently omitted from the medium. Replicates of four cultures for each of the modified combinations, plus control groups, were harvested on the fifth, seventh, and eleventh days after inoculation. Controls were grown in the unmodified medium no. 1. The results are summarized in table 3.

Table 3. Effect of modification of medium on pH, growth, and psilocybin production.

Ingredients omitted	Growth Period (days)								
	5			7			11		
	pH	Dry wt mycelium (mg)	Psilocybin (%)	pH	Dry wt mycelium (mg)	Psilocybin (%)	pH	Dry wt mycelium (mg)	Psilocybin (%)
None	4.0	53.9	0.26	4.1	81.4	0.67	-	-	-
	4.0	54.6	0.25	3.8	115.0	0.57	7.1	110.0	0.32
	3.9	63.5	0.24	4.1	84.4	0.64	7.2	78.9	0.34
	4.2	45.2	0.25	3.9	-	-	6.9	106.4	0.34
ave.	4.1	54.3	0.25	3.9	93.6	0.62	7.1	97.5	0.33
Glucose	5.8	7.5	-	6.6	8.6	-	6.8	8.6	-
	5.7	9.4	-	6.4	7.9	-	6.9	9.1	-
	5.9	5.0	-	6.3	7.6	-	6.8	6.9	-
	5.8	6.1	-	6.3	5.5	-	6.9	7.6	-
ave.	5.8	7.0	-	6.4	7.4	-	6.8	8.0	-
Ammonium succinate	3.8	33.7	0.34	3.9	54.4	0.34	7.8	92.8	0.31
	3.8	37.3	0.30	4.0	61.1	0.29	7.8	86.2	0.30
	3.8	34.2	0.30	3.8	95.9	0.21	7.7	80.0	0.36
	3.9	23.0	0.31	3.8	109.3	0.18	7.6	99.2	0.29
ave.	3.8	32.0	0.31	3.9	80.1	0.25	7.7	89.5	0.31
Glycine	3.7	76.1	0.23	3.8	87.5	0.75	6.3	84.9	0.33
	3.7	89.8	0.38	3.5	100.0	0.75	7.4	88.8	0.33
	3.9	55.6	0.35	3.3	130.0	0.63	7.4	84.1	0.39
	3.9	50.1	0.35	3.3	105.4	0.71	7.2	88.4	0.41
ave.	3.8	67.6	0.33	3.5	98.9	0.71	7.0	86.5	0.36
Yeast extract	4.6	22.8	-	4.0	81.7	0.86	-	-	-
	4.4	31.7	0.08	4.2	56.8	0.64	3.9	102.6	0.28
	4.5	32.0	-	4.2	68.5	0.81	3.9	104.4	0.28
	4.4	31.1	-	4.3	55.9	0.68	3.9	100.2	0.35
ave.	4.4	31.0	-	4.2	65.7	0.74	3.9	102.4	0.30
Yeast extract & thiamine	4.2	23.3	0.30	4.2	45.4	0.30	3.7	91.0	0.24
	4.3	31.5	0.30	3.8	89.9	0.31	3.8	88.0	0.25
ave.	4.2	27.4	0.30	4.0	67.6	0.31	3.8	89.5	0.24

Omission of glucose prevented any appreciable growth of the organism, and detectable quantities of psilocybin were not produced. The absence of yeast extract impaired initial growth; however, the organism adapted to this deficiency and subsequently underwent vigorous growth and comparable psilocybin production. The yield of mycelium in ammonium succinate-free medium was depressed and seven-day-old pellets showed the lowest levels of psilocybin. When glycine was omitted, the amount of psilocybin on a dry weight basis was slightly greater. When yeast extract and thiamine were concurrently omitted, the results paralleled those obtained when yeast extract alone was not included, except that psilocybin accumulation was substantially lower.

Influence of the concentration of certain nutrients. - Experiments were designed to determine the influence of different concentrations of glucose, potassium acid phosphate, and ammonium succinate on the growth and metabolism of the organism. Duplicate cultures containing the following concentrations (percentage basis) of the three individual constituents with normal concentrations of the other ingredients in medium no. 1 were prepared: glucose - 1.0, 0.5, 0.25; potassium acid phosphate - 0.02, 0.01, 0.005; ammonium succinate - 0.2, 0.1, 0.05. These cultures were prepared and processed as previously described. The results are summarized in table 4.

Table 4. Effect of concentration on pH, growth, and psilocybin production.

Concentration (%)	Growth Period (days)								
	5			7			11		
	pH	Dry wt mycelium (mg)	Psilocybin (%)	pH	Dry wt mycelium (mg)	Psilocybin (%)	pH	Dry wt mycelium (mg)	Psilocybin (%)
Glucose									
0.25	3.9	60.8	0.29	7.3	65.6	0.47	7.7	42.3	0.23
	4.2	51.7	0.28	6.8	97.8	0.45	7.6	44.1	0.25
ave.	4.1	56.2	0.28	7.0	81.7	0.46	7.6	43.2	0.24
0.50	4.7	27.2	0.32	4.0	72.4	0.64	7.3	100.5	0.22
	4.9	28.0	0.31	3.9	86.2	0.65	7.4	114.2	0.20
ave.	4.8	27.6	0.31	3.9	79.3	0.64	7.4	107.3	0.21
1.0	3.9	73.1	0.40	3.8	112.4	1.01	3.7	176.6	0.16
	3.9	72.0	0.41	3.9	108.4	1.06	3.9	181.9	0.15
ave.	3.9	72.5	0.40	3.8	110.4	1.03	3.8	179.2	0.15
Ammonium succinate									
0.05	4.3	28.0	0.30	3.7	89.6	0.62	7.9	88.4	0.32
	4.1	27.8	0.26	3.5	124.4	0.54	7.8	95.0	0.29
ave.	4.2	27.9	0.28	3.6	107.0	0.58	7.8	91.7	0.30
0.10	3.8	82.0	0.27	3.8	88.4	0.55	7.7	96.7	0.28
	3.9	61.7	0.30	3.8	96.3	0.58	7.6	91.5	0.24
ave.	3.8	71.8	0.29	3.8	92.3	0.56	7.6	94.1	0.26
0.20	4.7	40.3	0.29	4.0	95.3	0.45	7.7	104.2	0.26
	4.3	62.4	0.34	4.0	90.6	0.48	7.4	102.0	0.26
ave.	4.5	51.3	0.32	4.0	92.8	0.46	7.6	103.1	0.26
Phosphate									
0.005	4.4	31.2	0.40	3.9	80.1	0.57	3.9	102.2	0.17
	4.2	45.4	0.26	3.8	95.9	0.60	3.8	98.8	0.17
ave.	4.3	38.3	0.33	3.9	88.0	0.58	3.9	100.5	0.17
0.01	3.7	111.4	0.34	3.9	88.9	0.63	7.7	90.8	0.24
	3.7	102.3	0.35	3.8	100.8	0.55	7.1	104.1	0.27
ave.	3.7	106.8	0.34	3.9	94.8	0.59	7.4	97.4	0.25
0.02	4.1	43.4	0.25	4.0	88.4	0.41	7.4	87.1	0.25
	4.1	40.7	0.27	3.9	83.5	0.48	7.2	126.0	0.33
ave.	4.1	42.0	0.26	3.9	85.9	0.44	7.3	106.5	0.29

A low concentration of glucose was associated with a rapid rise in pH, whereas at the high glucose level an acid pH was maintained. Higher levels of glucose resulted in higher yields of psilocybin up to the seventh day, but this may have been due to the increased growth which occurred in this medium. The rapid increase and subsequent decrease of the psilocybin content of mycelial pellets in a medium containing increase glucose is noteworthy. A low phosphate concentration resulted in a rapid decline of the psilocybin level. In this case also, the pH remained acidic through the eleventh day. Variations of the succinate concentration did not influence the organism markedly.

Replacement culture studies. - Since tryptophan had been shown to function as a biosynthetic precursor of psilocybin in surface cultures of *Psilocybe semperviva*, a replacement culture study was designed to determine if mycelium of *Psilocybe cubensis* previously grown in submerged culture could utilize exogenous tryptophan for increased synthesis of psilocybin. This investigation would also provide information regarding the relationship between psilocybin biosynthesis and the growth of the organism.

The replacement culture studies required large quantities of comparable mycelium, and preliminary studies indicated that the metabolism of the organism was markedly influenced by the size of the culture flasks. Mycelial inocula from the source were shaken simultaneously in three Fernbach and three 125-ml Erlenmeyer flasks, and one culture in each size of flask was assayed after seven, nine, and eleven days of incubation, respectively. This comparison indicated that seven-day-old mycelium grown in a Fernbach flask contained an appreciable amount of psilocybin and that the pH of the nutrient broth in the Fernbach flask was still acidic after seven days (Table 5). Thus, the results revealed that seven-day-old mycelium grown in the Fernbach flask had the potential to form psilocybin and was not physiologically old.

Table 5. Comparison between large-scale and small-scale culture of **Psilocybe cubensis**.

Culture flasks (designations)	Age of culture days	pH of medium	Wt of mycelium assayed mg	Psilocybin %
Fernbach	7	4.0	106.8	0.47
Erlenmeyer	7	4.2	43.5	0.46
Fernbach	9	7.1	133.8	0.04
Erlenmeyer	9	4.2	83.1	0.23
Fernbach	11	8.0	159.4	0.03
Erlenmeyer	11	3.8	95.0	0.12

After a small sample of seven-day-old mycelial pellets was withdrawn from the Fernbach flask and tested for the presence of psilocybin, equal portions of the remaining pellets were transferred to twelve replacement culture flasks, each containing 30 ml of medium no 2. Tryptophan (2 mg/flask) was added to half of the replacement cultures, and the remainder served as tryptophan-free controls. Two control cultures and two tryptophan-containing cultures were removed from the shaker and analyzed at 12, 24, and 48 hours, respectively (Table 6).

Table 6. Effect of tryptophan on the biosynthesis of psilocybin in replacement cultures prepared from seven-day-old mycelium.

Cultures	Incubation time hr	Dry wt mycelium mg	Psilocybin (%)
Replacement	12	57.2 42.1	0.24 0.29 ave. 0.26
Control	12	28.1 72.8	0.33 0.24 ave. 0.28
Replacement	24	65.4 66.7	0.18 0.17 ave. 0.17
Control	24	64.9 58.6	0.18 0.14 ave. 0.16
Replacement	48	88.0 91.4	0.12 0.12 ave. 0.12
Control	48	69.1 45.5	0.11 0.18 ave. 0.14

Addition of tryptophan to replacement cultures did not enhance psilocybin production. However, visual comparison of chromatograms revealed that the psilocybin content decreased progressively and that kynurenine accumulation paralleled the decrease in tryptophan content over the forty-eight-hour period.

Discussion

Pellets of *Psilocybe cubensis* produced in medium no. 1 accumulated psilocybin but not psilocin. Maximum production of the former compound occurred on the seventh day (0.52 per cent, dry weight of mycelium), whereas growth attained its maximum (average 112.6 mg, dry weight of mycelium per 30 ml of medium in a 125-ml flask) on the ninth day.

Maximum yields of both psilocybin and mycelium occurred in the acid pH range (4.0-4.6). However, the acidic nature of the medium does not preclude the possibility that the internal pH of the organism is maintained at a different level by an efficient buffering system. Failure to find psilocybin in the medium may be attributed to its instability in the vigorously agitated acid medium, although permeability factors are probably also involved.

In the absence of a readily assimilable carbon source (glucose), detectable amounts of psilocybin did not accumulate. Omission of ammonium succinate did not significantly alter the pH of the medium but it did lower psilocybin yields. Without yeast extract, mycelial production was retarded at five days, and culture liquors remained acidic through the eleventh day. Adaption and/or synthesis of necessary precursors nevertheless permitted a continued increase in growth which was accompanied by a rapid increase in the yield of psilocybin by the seventh day. Similar results were obtained for media from which both yeast extract and thiamine had been omitted, except psilocybin levels remained lower.

According to Cochrane[5] most fungi have an absolute requirement for thiamine; however, where low levels are needed, synthesis takes place after initiation of growth. Under conditions of thiamine deficiency, glucose utilization is impaired, which may account for initial inhibition of growth when yeast extract or that ingredient and thiamine were omitted from the medium. Although glycine constituted more than one-half of the total weight of the dissolved solids in medium no. 1, the organism grew and metabolized efficiently in its absence.

The influence of different concentrations of glucose, ammonium succinate, and potassium acid phosphate in medium no. 1 was noted. A low level of glucose was associated with a rapid rise in extracellular pH, and lower levels of product accumulated. Doubling the normal amount of carbohydrate promoted psilocybin accumulation which reached a level of 1.03 percent (dry weight) by the seventh day. After eleven days, this level dropped to 0.15 per cent; a similar sudden decline in psilocybin content was also noted in those flasks containing a reduced phosphate concentration. The significance of the low pH levels after eleven days is unknown. In contrast, levels of ammonium succinate which were one-half or twice that of the normal medium had no significant effect upon pH or psilocybin production.

Extracellular tryptophan added to replacement flasks did not enhance psilocybin production, but, instead, underwent degradative reactions of the type reported to occur in *Neurospora* and other fungi[5]. This conclusion is based on the observation that a progressive increase in kynurenine, a catabolic product of tryptophan metabolism, paralleled the disappearance of tryptophan. These results are not necessarily contradictory to those obtained by Brack, *et al.*[2], since they used a different organism and different experimental design which preclude a direct comparison. However, our results do establish the existence of a direct relationship between psilocybin production and mycelial growth. Utilization of the replacement culture technique served to separate growth and psilocybin production, whereas the method of Brack, *et al.*, did not afford this distinction. It was concluded that psilocybin production is so intimately related to mycelial proliferation that the nutrient-deficient replacement medium was of little value in the study of psilocybin biosynthesis. However, the technique had previously proven satisfactory for biosynthetic studies of other indole derivatives in fungi[3].

Increasing the scale of fermentation from 30 ml of medium in 125-ml flasks to 300 ml in 2800-ml flasks markedly affected psilocybin production. Significant differences in yields did not appear until after the seventh day when accumulation of product ceased, and a more rapid decline occurred in the large flasks as the pellets became physiologically older. Although the cause of this phenomenon was not established, it may be attributed, at least in part, to differences in the efficiency of aeration of the cultures.

Acknowledgments

This investigation was supported by a PHS research grant (GM-07515-03) from the Division of General Medical Sciences, Public Health Service.

The authors are indebted to Dr. Robert G. Benedict, Department of Pharmacognosy, University of Washington, who provided the original cultures employed in this investigation. They also which to express their thanks to Dr. Alexander H. Smith, University Museums, University of Michigan, Ann Arbor, for providing authoritative identification of the mushroom collections from which the isolates were prepared.

Received 28 May 1963.

Literature cited

1. Benedict, R. G. and V. E. Tyler, Jr. 1962. Examination of mycelial cultures of *Panaeolus* species for tryptophan hydroxylase activity. *Lloydia* 25: 46-54.
2. Brack, A., A. Hofmann, F. Kalberer, H. Kobel and J. Rutschmann. 1961. Tryptophan als biogenetische Vorstufe des Psilocybins. *Arch. Pharm.* 294: 230-234.
3. Brady, L. R. and V. E. Tyler, Jr. 1959. The biosynthesis of clavine alkaloids. *Planta Med.* 7: 225-233.
4. Brown, J. K., M. H. Malone, D. E. Stuntz and V. E. Tyler, Jr. 1962. Paper chromatographic determination of muscarine in *Inocybe* species. *J. Pharm. Sci.* 51: 853-856.
5. Cochrane, V. W. 1958. *Physiology of fungi*. John Wiley & Sons, Inc., New York. 524 pp.
6. Heim, R. and R. G. Wasson. 1958. *Les champignons hallucinogenes du Mexique*. Muséum National d'Histoire Naturelle, Paris. 322 pp.
7. Heim, R., A. Brack, H. Kobei, A. Hofmann and R. Cailleux. 1958. Determinisme de la formation des carpophores et des sclerotes dans la culture du *Psilocybe mexicana* Heim, Agaric hallucinogéne du Mexique, et mise en évidence de la psilocybine et de la psilocine. *Comp. rend.* 246: 1346-1351.
8. Hofmann, A., R. Heim, A. Brack and H. Kobel. 1958. Psilocybin, ein psychotroper Wirkstoff aus dem mexikanischen Rauschpilz, *Psilocybe mexicana. Experientia* 14: 107-112.
9. Hofmann, A., R. Heim, A. Brack, H. Kobei, A. Frey, H. Ott, T. Petrzilka and F. Troxler. 1959. Psilocybin und Psilocin, zwei psychotrope Wirkstoffe aus mexikanischen Rauschpilzen. *Helv. Chim. Acta* 42: 1557-1572.
10. Schultes, R. 1960. Botany attacks the hallucinogens. *Third Annual Visiting Lecture Series in the Pharmaceutical Sciences*, College of Pharmacy, University of Texas, Austin. pp. 169-185.
11. Singer, R. 1958. Mycological investigations on teonanácatl, the Mexican hallucinogenic mushroom. I. The history of teonanácatl, field work and culture work. *Mycologia* 50: 239-261.
12. Stein, S. I. 1958. Observations on agarics causing cerebral mycetism. I. An unusual effect from a species of Mexican mushrooms *Psilocybe cubensis. Mycopathol. et Mycol. Appl.* 9: 263-267.
13. Tyler, V. E., Jr. 1958. Occurrence of serotonin in a hallucinogenic mushroom. *Science* 128: 718.
14. Wasson, R. G. 1961. The hallucinogenic fungi of Mexico: an inquiry into the origins of the religious idea among primitive peoples. *Botan. Museum Leaflets, Harvard Univ.* 19: 137-162.
15. Wasson, R. G. and V. P. Wasson. 1958. The hallucinogenic mushrooms. *Garden J. N. Y. Botan. Garden* 8: 1-5.
16. Wieland, T. and W. Motzel. 1953. Über das Vorkommen von Bufotenin in gelben Knollenblätterpilz. *Ann. Chem. Liebigs* 581: 10-16.

Psilocybin Investigator’s Brochure

by

Lisa Jerome

March-April 2007

original source: http://www.maps.org/research-archive/psilo/psilo_ib.pdf
backup source: http://www.psilosophy.info/resources/psilo_ib.pdf

Table of Contents:

- Drug Substance and Formulation
- Pharmacological and toxicological effects
- Psilocybin and Psilocin Actions on Neurotransmitter Systems
  - *Overview*
  - *Psilocybin or psilocin and $5HT_{2A}$ and $5HT_{2C}$ Receptors*
  - *Psilocybin or Psilocin and other Serotonin Receptors*
  - *Psilocybin or Psilocin and other Receptor Systems*
  - *Human Neuropharmacological Studies*
  - *Psilocybin and Gene Expression*
  - *Physiological and Psychological (Subjective) Effects*
  - *Psilocybin Effects in Nonhuman Animals*
  - *Psilocybin Effects Assessed in Humans*
  - *Psychological and Subjective Effects*
  - *Factors influencing psychological reactions to psilocybin*
  - *Long-Term Effects of Psilocybin*
  - *Psilocybin/Psilocin Effects on Brain Activity*
- Pharmacokinetics and biological disposition of the drug
- Safety and effectiveness in humans obtained from prior clinical studies
  - *History of Psychiatric Research with Psilocybin*
  - *Psilocybin in People with Advanced Stage Cancer*
  - *Psilocybin as Potential Treatment of Cluster Headaches*
  - *Psilocybin in People with OCD*
- Possible risks and side effects
  - *Overview of risks*
  - *Fatalities*
  - *Common Adverse Events and Side Effects*
  - *Reckless Behavior*
  - *Anxiety and Panic Response*
  - *Transient and Prolonged Psychotic Reaction*
  - *Post-Hallucinogen Perception Disorder (HPPD)*
  - *Long-Term Personality Changes after Psilocybin*
  - *Abuse Potential*
  - *Reproductive Toxicity*
- Trial Data
- Acknowledgements
- References

Drug Substance and Formulation

Psilocybin (4-phosphoryloxy-*N,N*-dimethyltrypatmine, also referred to as 3-[2- (Dimethylamino)ethyl]-1H-indol-4-ol dihydrogen phosphate ester has the chemical formula $C_{12}H_{17}N_2O_4P$. It is a tryptamine, and is one of the major psychoactive constituents in mushrooms of the Psilocybe genus, as Psilocybe cubensis and Psilocybe mexicanus. Native peoples in Mexico have used the mushrooms in religious ceremonies and in healing (Hofmann 2005). Artifacts and historical documents suggest that ritual use of psilocybin-containing mushrooms occurred as early as 3000 years ago, with documented use occurring in the 16th Century, prior to Spanish prohibition on their use. Psilocybin was first isolated from psilocybe mushrooms by Hofmann in 1957, and later synthesized by him in 1958 (Passie *et al*. 2002). Psilocybin was used in psychiatric and psychological research and in psychotherapy during the early to mid-1960s up until its scheduling in 1970 in the US, and up until the 1980s in Germany (Passie 2005; Passie *et al*. 2002). Research into the effects of psilocybin resumed in the mid-1990s, and it is currently the preferred compound for use in studies of the effects of serotonergic hallucinogens (see for example (Carter *et al*. 2005a; Gouzoulis-Mayfrank *et al*. 1999b; Hasler *et al*. 2004), likely because it has a shorter duration of action and suffers from less notoriety than LSD. However, despite frequent non-medical use in humans, few or no in vitro or nonhuman animal studies with psilocybin have occurred.

Psilocybin belongs to a class of drugs referred to as hallucinogens or psychedelics. Specifically it is a serotonergic hallucinogen, along with other tryptamines such as dimethyltryptamine (DMT), ergolines, such as LSD and phenethylamines, such as mescaline. Currently, research in human and nonhuman animals suggests that serotonergic hallucinogens produce most of their effects as a result of $5HT_{2A}$ agonism, with contributions also from agonism at $5HT_{2C}$ and $5HT_{1A}$ receptors (Nichols 2004). Like other members of this class, psilocybin induces sometimes profound changes in perception, cognition and emotion, including emotional lability.

In humans as well as other mammals, psilocybin is transformed into the active metabolite psilocin, or 4-hydroxy-*N,N*-dimethyltryptamine ($C_{12}H_{16}N_2O$.) It is likely that psilocin partially or wholly produces most of the subjective and physiological effects of psilocybin in humans and nonhuman animals.

Pharmacological and toxicological effects

Psilocybin and Psilocin Actions on Neurotransmitter Systems

Overview

Psilocybin and its metabolite psilocin directly affect a number of serotonin receptors without directly affecting other neurotransmitter systems. While there have been fewer studies of the pharmacological profile of psilocybin than of the ergoline LSD, studies conducted with psilocybin and psilocin indicate that like LSD, these tryptamines are $5HT_{2A}$, $5HT_{2C}$ and $5HT_{1A}$ agonists*. Unlike LSD, they have little affinity for dopamine receptors, and only very high doses affect norepinephrine receptors. Human psilocybin research confirms the $5HT_{2A}$ activity of psilocybin and psilocin, and provides some support for indirect effects on dopamine through $5HT_{2A}$ activity and possible activity at $5HT_{1A}$ receptors.

Psilocybin or psilocin and $5HT_{2A}$ and $5HT_{2C}$ Receptors

A majority of known $5HT_{2A}$ agonists produce hallucinogenic effects in humans, and rodents generalize from one $5HT_{2A}$ agonist to others, as between psilocybin and LSD (Aghajanian and Marek 1999; Nichols and Sanders-Bush 2004). Like lysergic acid diethylamide (LSD) and other serotonergic hallucinogens, psilocybin acts as a serotonin $5HT_{2A}$ receptor agonist (McKenna *et al*. 1990; Nichols 2004). Psilocybin has a stronger affinity for the human $5HT_{2A}$ receptor than for the rat receptor (Gallaher *et al*. 1993), and it has a lower $K_{(i)}$ for both $5HT_{2A}$ and $5HT_{2C}$ receptors than LSD (Nichols 2004). Results from a series of drug-discrimination (DD) studies in rats found that $5HT_{2A}$ antagonists, and not $5HT_{1A}$ antagonists, prevented rats from recognizing psilocybin (Winter *et al*. 2007).

Daily doses of LSD and psilocybin reduced numbers of $5HT_2$ receptors in rat brain (Buckholtz *et al*. 1990). Research examining compound-specific effects on secondary messenger systems found that both psilocybin and LSD stimulate arachidonic acid when activating the rat $5HT_{2A}$ receptor, but psilocybin did not stimulate the phosphoinositide (PI) pathway as strongly as LSD (Kurrasch-Orbaugh *et al*. 2003). However, psilocin stimulated more PI turnover than a ring-fluorinated version of psilocin that rats in DD trials did not consider LSD-like, suggesting that secondary messenger systems might play a role in producing at least some subjective effects (Blair *et al*. 2000). Since investigations of compound-specific or "allosteric" trafficking are new, the functional significance of this difference remains unclear.

Researchers examining psilocybin analogs report that a potential metabolite, 4- methylpsilocin, was a potent $5HT_{2C}$ agonist (Sard *et al*. 2005), but whether or not this compound is produced after psilocybin metabolism is not certain. The development of relatively selective $5HT_{2C}$ antagonists is recent, and to date no studies have examined the contribution of $5\text{-}HT_{2C}$ receptors to the physiological or behavioral effects of psilocybin in human or nonhuman animals.

Psilocybin or Psilocin and other Serotonin Receptors

Direct application of psilocybin to dorsal raphe nucleus (DRN) cells is associated with a decline in firing, a property it shares with LSD (Aghajanian *et al*. 1968; 1970; Aghajanian and Hailgler 1975) that is likely the result of action at $5HT_{1A}$ autoreceptors (Williams *et al*. 1988). In contrast, it appears that $5HT_{1A}$ receptor activity contributes little to the psilocybin stimulus in rats (Winter *et al*. 2007). Though no behavioral studies in humans have determined what role, if any, is played by $5HT_{1A}$ receptors in producing the subjective effects of psilocybin, it is notable that some effects, such as difficulty concentrating, still occur when psilocybin was co-administered along with a $5HT_{2A}$ antagonist (Carter *et al*. 2005a; Carter *et al*. 2005b).

There are no reports describing psilocybin or psilocin actions on $5\text{-}HT_{2B}$ receptors, though the putative psilocybin metabolite *N*-methylpsilocybin was found to act as an inverse agonist at this receptor (Sard *et al*. 2005). However, no studies have as yet detected this metabolite (Hasler 1997; Hasler *et al*. 1997).

McKenna and colleagues reported that psilocybin had an affinity for $5\text{-}HT_{1D}$ receptors as well, possibly explaining its ability to abort cluster headaches (Sewell and Halpern 2006). Beyond this finding, however, there is no published literature that examines the actions of psilocybin or psilocin on $5\text{-}HT_3$ receptors or on any of the more recently discovered receptor families. The ergoline LSD affects a number of these receptors, including 5- HT_{5A} (Nichols *et al*. 2002b), $5\text{-}HT_6$ (Hirst *et al*. 2003) and $5\text{-}HT_7$ (Nichols *et al*. 2002b). However, this does not mean that psilocybin or psilocin possess similar profiles.

Psilocybin or Psilocin and other Receptor Systems

Psilocybin does not act directly on dopamine D_1 or D_2 receptors (Creese *et al*. 1975) or on histamine H_2 receptors (Green *et al*. 1978). Very high doses of psilocybin (25 mg/kg) increased levels of the norepinephrine metabolite 3H-normetanephrine (Stolk *et al*. 1974), but it is unlikely that typical doses of psilocybin used in human research will affect norepinephrine. Because interest in the pharmacology of psilocybin and psilocin declined prior to the development of modern neuropharmacology, the complete pharmacological profile of either compound is not as well-known as that of LSD. It is possible that psilocybin, like LSD, acts on one or more of the more recently discovered serotonin receptors, such as $5\text{-}HT_{5A}$ or $5\text{-}HT_7$, but currently there is no information on the actions of psilocybin at these receptors. It is likely that psilocybin itself, or its metabolite psilocin, aborts cluster attacks through its effects on $5HT_{1D}$ receptors.

One team of researchers performed a series of experiments, many comparing LSD with the non-hallucinogenic compound lisuride and using a mouse model of hallucinogen-associated behavior (head twitch), suggesting that stimulating different secondary messenger systems may play a role in hallucinogenic effects (Gonzalez-Maeso *et al*. 2007). Instead of activating only phospholipase C (PLC) when stimulating $5HT_{2A}$ receptors, LSD and the phenethylamine DOI stimulated pertussis-toxin sensitive $G_{i/o}$ proteins. It is not yet known whether psilocybin shares this feature with LSD and DOI.

Table 1 Psilocybin Binding Data

Receptor	Ki(nM)	Hot Ligand	Species	Source	Reference
5-HT$_{1A}$	190	3H-8-OH-DPAT			
5-HT$_{2A}$	6	3H-DOI	Rat/cow	Brain	(McKenna et al. 1990)
5-HT$_{2C}$	410	3H-Ketanserin	Rat/cow	Brain	(McKenna et al. 1990)

Table 2 Psilocybin Binding Data

Receptor	Ki(nM)	Hot Ligand	Species	Source	Reference
5-HT$_{1A}$	49	3H-8-OH-DPAT	Human	Cloned	(Blair et al. 2000)
5-HT$_{2A}$	25	125I-DOI	Rat or bovine	Cloned	(Blair et al. 2000)
5-HT$_{2C}$	10	1251-DOI	Rat	Cloned	(Blair et al. 2000)

Human Neuropharmacological Studies

In studies in humans, researchers found that administering psilocybin along with a 5HT$_{2A}$ receptor antagonist, such as ketanserin or risperidone, attenuated or completely abolished the subjective and perceptual effects of psilocybin (Carter *et al*. 2004; Vollenweider *et al*. 1998). Ketanserin did not attenuate reduced visual attention or psilocybin-associated changes in binocular rivalry (oscillation in dominance of one eye over another in visual perception) (Carter *et al*. 2005a; Carter *et al*. 2004). Coadministration of the dopamine D$_2$ receptor antagonist haloperidol only reduced positive mood and positively viewed changes in cognition and perception Vollenweider *et al*. 1998. A human imaging study using radiolabeled raclopride, a D$_2$ receptor antagonist found reduced binding in caudate and putamen after psilocybin administration, suggesting that psilocybin indirectly increased brain dopamine levels, (Vollenweider *et al*. 1999) probably through 5HT$_{2A}$ activity. Taken together, these findings suggest that psilocybin produces its effects in humans chiefly but not wholly through 5HT$_{2A}$ receptors, while the compound may produce different effects through other serotonin receptors, such as 5HT$_{1A}$ or 5HT$_{2C}$. Psilocybin may exert indirect influence over the dopamine system without having any direct effects on dopamine receptors.

Psilocybin and Gene Expression

When activating 5HT$_{2A}$ receptors, psilocybin and LSD both increase expression of a number of genes, including *egr-1*, *egr-2*, *period1*, *Nor1* and *l-KappaBetaAlpha* (Gonzalez-Maeso *et al*. 2003; Nichols and Sanders-Bush 2002). Psilocybin may be associated with a greater increase in egr-1. The significance of psilocybin effects on gene expression is uncertain. However, changes in gene expression may play a role in the ability of psilocybin-containing mushrooms to interrupt cycles of cluster headache, or cluster headache period, as discussed below in "Safety and Toxicity" (Sewell *et al*. 2006).

Physiological and Psychological (Subjective) Effects

Studies in humans and nonhuman animals indicate that (Winter *et al*. 2007) psilocybin has extremely low toxicity (Nichols *et al*. 2002a; Passie *et al*. 2002). LD$_{50}$ ranged from 285 mg/kg in rats and mice to 12.5 mg/kg in rabbits (Usdin and Efron 1972). It is likely that the lethal dose in humans far exceeds doses that produce profound alterations in consciousness. All ongoing and proposed research will use doses of approximately 0.4 mg/kg, which is at least 20 times smaller than the LD$_{50}$ in rabbits.

Psilocybin Effects in Nonhuman Animals

Rats trained to distinguish between LSD and saline injections treated psilocybin as if it were LSD (Koerner and Appel 1982; Schechter and Rosecrans 1972), suggesting that the two drugs possess similar stimulus characteristics, a finding supported in early human studies comparing the two compounds (Hollister and Hartman 1962; Hollister and Sjoberg 1964; Isbell 1959; Wolbach *et al*. 1962). Rats trained to recognize psilocybin identified psilocin as psilocybin-like, indicating that psilocybin and its metabolite produce similar cues in these animals. As described later on in this document, most psilocybin is converted into psilocin, and it is likely that most of the physiological and subjective effects of psilocybin are in fact due to psilocin.

Researchers examined the effects of psilocybin in rats, cats, dogs and rabbits found that psilocybin produced piloerection, slight increases in breathing, indications of sympathetic system stimulation, but no increase in locomotor activity (Maxwell *et al*. 1962; Passie *et al*. 2002), Psilocybin increased prolactin levels in rats (Meltzer *et al*. 1978). As described above, behavioral reports of the effects of psilocybin demonstrated that psilocybin produced effects similar to LSD or other tryptamines. As with the ergoline LSD, psilocybin reduced and altered rat exploratory patterns (Geyer *et al*. 1978). Monkeys self-administering psilocybin exhibited behavior suggestive of visual distortions or alterations in consciousness that included grasping at unseen objects and fixed staring (Fantegrossi *et al*. 2004), behaviors also seen when the animals self-administered DMT or mescaline. There is no indication that psilocybin produced unique physiological or behavioral effects in rodents or nonhuman primates.

Psilocybin Effects Assessed in Humans

Hasler and colleagues report that the first or onset effects of orally administered psilocybin appeared approximately 20 to 30 minutes post-administration (Hasler *et al*. 1997; Hasler *et al*. 2004), and peak effects appeared 60 to 90 minutes post-drug. The effects of orally administered psilocybin subsided four to six hours after drug administration (Hasler *et al*. 2004). Changes in perception and cognition were no longer detectable seven days later (Gouzoulis-Mayfrank *et al*. 1999b). Onset of 1 mg intravenous psilocybin effects appeared 2 minutes after administration, with subjective and physiological effects lasting for up to 20 minutes afterwards (Hasler *et al*. 1997). Isbell detected increased pupillary diameter after approximately 4, 6 and 8 mg psilocybin and elevated systolic blood pressure after approximately 6 mg psilocybin (Isbell 1959), and later reports also detected elevations in blood pressure and heart rate after higher doses of psilocybin (Griffiths *et al*. 2006; Hasler *et al*. 2004), though sometimes changes were only detected at one point in time, as 60 minutes post drug (Hasler *et al*. 2004). Hence psilocybin produces only slight sympathetic system activation. It is notable, however, that a 26-year old man with obsessive compulsive disorder (OCD) exhibited an elevation in diastolic blood pressure from 91 to 104 mm Hg after receiving 0.2 mg/kg psilocybin in the absence of self-reported anxiety (Moreno *et al*. 2006). Psilocybin elevated prolactin, but not cortisol or ACTH (Gouzoulis-Mayfrank *et al*. 1999b; Hasler *et al*. 2004), with prolactin elevation no longer detectable 300 minutes (5 hours) post-drug (Hasler *et al*. 2004). In general, physiological effects are similar to those of the ergoline hallucinogen LSD. To date, there are no findings that either support or disconfirm the existence of menstrual variations in the effects of psilocybin in women.

Psychological and Subjective Effects

Early studies of psilocybin in humans reported changes in perception, as increased perception of visual after-image (Keeler 1965), peculiar thoughts, anxiety, and unusual experiences of the body (as parasthesias) and the environment (Fischer *et al*. 1966; Hebbard and Fischer 1966; Hofmann *et al*. 1958; Hollister and Sjoberg 1964; Isbell 1959; Keeler 1963), and side effects of dizziness, impaired concentration and nervousness (Hollister and Sjoberg 1964). Some early reports also found increased difficulty in performing some tasks, such as simple arithmetic problems (Hollister 1961). Psilocybin elicited spiritual or mystical experiences in divinity students during a religions service (Pahnke 1963). This study employed a placebo, but the researchers administered psilocybin or placebo to groups of participants, and retrospective reports suggest that participants could accurately guess their condition from observing themselves or others (Doblin 1991). Recent studies confirmed initial findings (Carter *et al*. 2005a; Carter *et al*. 2004; Gouzoulis-Mayfrank *et al*. 1999b; Griffiths *et al*. 2006; Hasler *et al*. 2004; Vollenweider *et al*. 1997). Participants reported alterations in perception (Gouzoulis- Mayfrank *et al*. 1999b; Griffiths *et al*. 2006; Hasler *et al*. 2004; Vollenweider *et al*. 1997), and assessments of visual perception detected changes in motion perception, binocular rivalry and time perception (Carter *et al*. 2004; Carter *et al*. 2005b; Wittmann *et al*. 2006). A study of the effects of psilocybin in pre-pulse inhibition (PPI), the reduction in startle response to an intense stimulus if preceded by a less intense stimulus, reported enhanced PPI after a long interval between pre-pulse and pulse, and attenuated PPI when the interval was short (Vollenweider *et al*. 2007). Participants experienced both increased positive mood and positively experienced derealization (feeling as if they were "in a dream" or as if the external world were unreal) and depersonalization (sense of "being unreal," or of the self belonging to someone else) and negative mood and negatively experienced derealization and depersonalization. Mood could change rapidly over time from very positive to very negative (Vollenweider *et al*. 1997). Psilocybin was far more likely than methylphenidate to produce mystical or peak experiences in people with existing religious or spiritual practices (Griffiths *et al*. 2006). People receiving psilocybin in these studies maintained insight concerning the source of their alterations in perception. Observers' descriptions of participant behavior were consistent with the participants' accounts, noting mood lability, changes in sense of self, and unusual or paranoid thoughts (Gouzoulis-Mayfrank *et al*. 1999b; Griffiths *et al*. 2006; Vollenweider *et al*. 1997).

Table 3

Acute observed and self-reported effects and side effects of 0.114-0.4 mg/kg psilocybin

Gouzoulis-Mayfrank et al. 1999	**Griffiths et al. 2006**	**Hasler et al. 1997**	**Hollister & Sjoberg 1964**	**(Quetin 1960) adapted in Passie et al. 2002**	**Wittmann et al. 2007**
U-test, $p<0.05$ Increased positive psychosis-like symptoms (e.g. hallucinations, unusual thoughts) Increased negative psychosis-like symptoms (feeling withdrawn or apathetic) Increased positive affect/mania Increased negative affect/melancholy	**Difference $p<0.001$** Anxiety Distance from ordinary reality Dysphoria* Joy/intense happiness Peace/harmony Positive mood Somatization* Tearing/crying Visual alteration and distortion Yawning **$p<0.01$** Anxiety/fearfulness Nausea **$p<0.05$** Sleepiness/sedation Spontaneous motor activity Stimulation Reduced mental efficiency**	**Reported, not quantified** depersonalization derealization "virtual" hallucinations changes in affect, thought disorders (undefined)	**$p<0.05$** Increased aggressive Depressed Jittery Less clear thinking **Reported, not quantified** Dizziness Nausea Shaking hands Weakness	Midriasis 93% Heart frequency Accelerated 56% Slowed 13% Variable 31% No change 0% Arterial blood pressure Hypotension 34% Hypertension 28% Instability 22% No change 16% Nausea 44% Reflexes tendineae Increased 80% Decreased 6% No change 13% Dysmetry 16% Tremor 25%	Altered time perception - objective assessment **$p<0.01$** Impaired long interval estimation Impaired tone estimation (trend for 250 mcg/kg) Tiredness Dazed state Introversion Dreaminess Increased positive mood Increased anxiety (250 mcg/kg) **$p<0.05$** Impaired spatial working memory (250 mcg/kg)
Compared with placebo	Compared with methylphenidate	Compared with placebo	Pre-drug/postdrug (2nd hour)	Percentage observed/Self-reported	Compared against placebo, 115 v 250 µg/kg
N=8	N=30 (z 36)	N=6	N=24	N=30	N=12
Dose=0,2 mg/kg	Dose=30 mg/70 kg (approx. 0,4 mg/kg)	Dose=0,224 mg/kg	Dose=225 µg/kg	Dose=8-12 mg mg i.m. and p.o.	Dose=placebo, 115 µg/kg, 250 µg/kg
Between-subjects	Within-subjects	Within-subjects	Within-subjects	Not known	Within-subjects

*ARCI LSD scale, loosely assesses dysphoria, jitteriness and somatic sensations
**ARCI BG = mental efficiency, separate from activation or feeling stimulated

Factors influencing psychological reactions to psilocybin

The variable subjective effects of psilocybin are due at least in part to differences in preexisting mental state and personality, or "set" and to features of the immediate environment, or "setting" (Nichols 2004). In an early investigation summarizing findings from uncontrolled studies of psilocybin, Leary and colleagues reported that people reporting previous experience with psychoactives, greater feelings of flexibility and lower apprehension about taking psilocybin had more pleasant experiences with psilocybin (Leary *et al*. 1963). The same report also indicates that features of setting, such as administration in small groups, were associated with more pleasant experiences than when administered in larger groups. Therapists describing their use of LSD or other psychedelics in therapy (Grof 2000: 1980) favored comfortable settings. Patients remain within the confines of the setting during therapy, and sometimes use eyeshades and listen to music to foster introspection and reduce distraction. There has been little formal investigation into the impact of set and setting, but there is at least informal evidence that both may play a role in response to psilocybin.

Long-Term Effects of Psilocybin

To date, only Griffiths and colleagues have assessed potential long-term changes after psilocybin in the context of a double-blind, active placebo controlled study, finding that two months after drug administration, participants were more likely to report positive attitudes toward life and the world and increased satisfaction and well-being after psilocybin than after methylphenidate, and friends noticed small positive life changes after psilocybin (Griffiths *et al*. 2006). Neither psilocybin nor methylphenidate produced negative changes in attitudes or life changes. Interviews and questionnaires occurring approximately 25 years after the study of the effects of psilocybin in divinity students observing a religious service found that participants who had received psilocybin continued to report a greater number of positive life changes than controls, and very few negative life changes (Doblin 1991). As described earlier, groups of participants underwent the study and the blind was poorly maintained, but follow-up interviews suggest that the lasting effects of psilocybin are positive.

Psilocybin/Psilocin Effects on Brain Activity

Positron emission tomography (PET) studies of psilocybin in humans have detected increased glucose metabolism in frontal areas and anterior cingulate, with possibly greater right hemisphere activity (Gouzoulis-Mayfrank *et al*. 1999a; Vollenweider *et al*. 1997). However, an imaging study using radiolabeled raclopride (a D_2 antagonist), described above, did not find lateral effects in changes in D_2 binding (Vollenweider *et al*. 1999). Since changes in glucose metabolism can arise from direct and indirect brain activity, and can be indicative of inhibitory or excitatory actions, it is difficult to draw conclusions from these studies alone. However, they suggest that at least some of the effects of psilocybin result from changes in frontal or cingulate activity.

Pharmacokinetics and biological disposition of the drug

Psilocybin is detectable in plasma 20 to 40 minutes after oral administration (Hasler 1997) reviewed in (Passie *et al*. 2002). Psilocybin is metabolized in the liver, where it is chiefly transformed into the active metabolite psilocin, detectable in plasma 30 minutes after administration (Hasler 1997; Hasler *et al*. 1997; Lindenblatt *et al*. 1998; Passie *et al*. 2002), with psilocin first appearing in plasma 15 to 50 minutes after oral administration of 0.2 mg/kg psilocybin. Psilocin half-life ranges between 2 and 3 hours, and is detectable 6 hours after oral administration (Hasler *et al*. 1997; Lindenblatt *et al*. 1998). These two studies reported similar but not identical findings, with peak levels of psilocin appearing between 80 and 105 minutes and psilocin half-life ranging between 2.25 h for 0.2 mg/kg and 2.7 h for 0.22 mg/kg.

Hasler and colleagues have detected three additional psilocybin metabolites; 4-hydroxy- 3-yl-acetaldehyde (4HIA), 4-hydroxy-3-yl-acetic acid (4HIAA), and 4-hydroxytryptophol (4I-IT) (Hasler 1997).

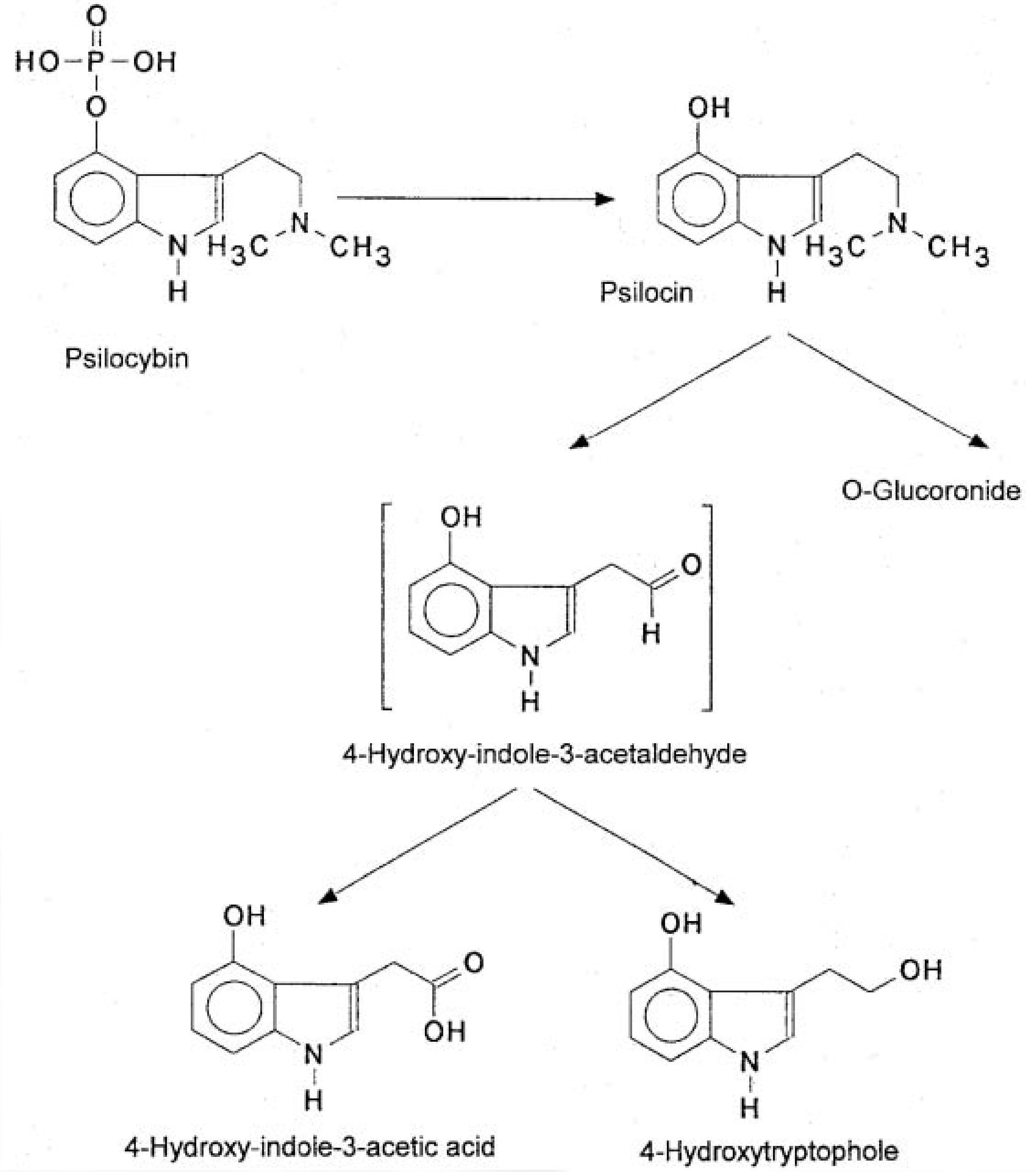

Psilocybin
Psilocin
O-Glucoronide
4-Hydroxy-indole-3-acetaldehyde
4-Hydroxy-indole-3-acetic acid
4-Hydroxytryptophole

Figure 1: Metabolism of psilocybin; from Hasler 1997 and reproduced in Passie et al. 2002.

Previous research in non-human animals found that the phosphoric ester group of psilocybin is cleaved by alkaline phosphatase (Horita and Weber 1961; 1962). Rat intestinal tissue readily took up psilocin, but not psilocybin, and the tissue transferred psilocin into blood side solutions (Eivindvik *et al*. 1989), suggesting that psilocin is also more readily distributed around the body than any unmetabolized psilocybin. While there are currently no studies of psilocin metabolism, psilocin is likely metabolized by deamination and demethylation via liver enzymes such as monoamine oxidase and aldehyde dehydrogenase (Hasler *et al*. 1997).

Psilocin and psilocybin are eliminated through the kidneys, both as unaltered drug and conjugated with glucuronides (Hasler *et al*. 2002), with most psilocin and psilocybin excreted three hours after oral administration. Researchers detected inter-individual variation in urinary excretion of psilocin and psilocybin. Most detectable psilocin appeared between two and four hours after drug administration. On the basis of urinary psilocin levels 12 to 24 hours after approximately 0.21 mg/kg psilocybin, it is likely that most or all psilocybin and psilocin is excreted from the body at or within 24 hours after administration (Hasler *et al*. 2002).

Safety and effectiveness in humans obtained from prior clinical studies

History of Psychiatric Research with Psilocybin

At least 19 studies have described the psychotherapeutic potential of psilocybin in approximately 1960 participants (as summarized in (Passie 2005)). These studies employed an average minimum dose of 8.24 mg (0.118 mg/kg) and an average maximum dose of 17.19 mg (0.246 mg/kg). Most psychotherapists and psychiatric researchers who performed psilocybin-assisted psychotherapy wished to activate an individual's unconscious memories and conflicts, and chose doses that produced this effect (see for example (Hausner and Dolezal 1963; Leary *et al*. 1963; Leuner 1963)). The researchers probably used processes similar to those described for LSD-assisted psychotherapy (Grof 2000: 1980; Grof *et al*. 1973; Kurland *et al*. 1967). Psilocybin-assisted therapy either followed the psycholytic model or the psychedelic model. Psycholytic psychotherapy involved lower doses of a psychedelic compound and more interpretation and analysis during the session, while psychedelic psychotherapy employed higher doses, with interpretation occurring after the experience (Passie 2005). Previous research has also examined the capacity of psilocybin to induce mystical or spiritual experiences in people during a structured religious service (Pahnke 1963; Pahnke and Richards 1966), a finding followed by recent studies of spiritual or peak effects in people with religious or spiritual practices (Griffiths *et al*. 2006).

Recently, several investigators have examined or are in the process of examining psilocybin as a treatment for specific mental and neurological disorders. These include anxiety arising from diagnosis with advanced stage cancer, interruption of cluster headache cycles or periods, and treatment of obsessive-compulsive disorder (OCD). Results for the investigation of psilocybin in people with OCD are now published, while studies of advanced-stage cancer are still underway. A study of psilocybin in people with cluster headaches is planned and has not yet occurred.

Psilocybin in People with Advanced Stage Cancer

Following previous research indicating that LSD-assisted psychotherapy reduced anxiety and improved quality of life in people with advanced stage illness (Grof *et al*. 1973), Grob and colleagues decided to investigate the effects of psilocybin-assisted psychotherapy in this population. Research is currently underway looking into the effects of psilocybin-assisted psychotherapy in people with anxiety related to diagnosis with advanced stage cancer and a projected life expectancy of less than a year (Grob 2005). This study intends to enroll twelve participants. Ten participants have been enrolled in this study. Psilocybin has so far been well-tolerated in this sample and there have been no reports of drug-related serious adverse events.

Psilocybin as Potential Treatment of Cluster Headaches

Cluster headache (CH) is a debilitating illness affecting approximately 250,000 people in the United States. CH attacks are characterized by periods of excruciating pain in the temple, eye, or jaw that can last for up to 90 minutes. Cluster attacks tend to occur during specific times of day, and they can occur during specific times of year. While medications exist that abort cluster headaches, there are no medications that interrupt cluster headache cycles, or periods. Recently, Sewell and colleagues published a case series of 53 people who had self-administered psilocybin-containing mushrooms ("magic mushrooms") or LSD as a means to treat cluster headache (Sewell *et al*. 2006). Twenty-five of 48 respondents who used psilocybin-containing mushrooms reported that they had terminated their cluster period, and 18 respondents (37%) reported that psilocybin was partially effective in reducing attacks during cluster periods. Subsequent to these reports, at least one team of researchers plans to conduct a controlled study of the safety and efficacy of psilocybin in the treatment of CH, focusing on interruption of cluster headache period.

Psilocybin in People with OCD

Several published case reports have suggested that people could gain symptomatic relief from OCD through ingesting psilocybin-containing mushrooms or LSD (Hanes 1996; Leonard and Rapoport 1987; Moreno and Delgado 1997). On the basis of these accounts, Moreno and colleagues conducted a randomized, double-blind dose-response investigation of psilocybin in nine participants with OCD. They reported that up to 300 mcg/kg psilocybin was well-tolerated and that all participants exhibited at least transient reduction in symptoms, assessed via Yale-Brown Obsessive Compulsive Scale (Y-BOCS). Psilocybin attenuated OCD symptoms even after doses as low as 25 mcg/kg (Moreno *et al*. 2006), raising questions as to interpreting results with respect to whether the lowest dose served as a placebo and whether it was in fact devoid of therapeutic effects. One participant in this study remained symptom-free five months later.

Possible risks and side effects

Overview of risks

Psilocybin is not associated with disease to any organ or system (Nichols 2004 see also IND # 56,530, submitted by Francisco Moreno). Searches of publicly available databases of medical publications have failed to find any cases of psilocybin causing any serious illness to any organ or system. A recent extensive search conducted on the PubMed database in September, 2005 using the words "psilocybin" and various organs or medical terms ("heart," "cardiac," "liver") and "adverse event" uncovered only a single case of liver problems. An additional search using the word "psilocybin" alone conducted on August, 2006 also failed to turn up any new cases of adverse events after psilocybin. More commonly, damage or disease to organs (as renal failure) is associated with mistakenly consuming poisonous mushrooms under the belief that they are psilocybin-containing varieties (see for example (Franz *et al*. 1996)). Research using radiolabeled psilocybin found it evenly distributed throughout the body (Passie *et al*. 2002). People in Mexico have likely used psilocybin-containing mushrooms for at last hundreds and possibly thousands of years (Hofmann 2005), and research with psilocybin began soon after its isolation and synthesis. A lack of case reports of physical illness or disease arising from exposure to psilocybin despite the long history of use within and outside of research settings is encouraging and indicative of association with few risks outside of the well-known psychiatric and psychological adverse events (described below). The low rate of serious adverse events and lack of fatalities is especially notable.

Approximately 2000 people have received psilocybin during the course of initial psychological and psychiatric investigations of psilocybin (Metzner 2005), and psilocybin has since been administered to over 216 participants during the current wave of neuroscience and psychiatric research. As was true in the case of previous human psilocybin studies described above, no serious adverse events have occurred during recently published research studies (Carter *et al*. 2005a; Carter *et al*. 2005b; Gallaher *et al*. 1993; Gouzoulis-Mayfrank *et al*. 1998; Gouzoulis-Mayfrank *et al*. 2002; Griffiths *et al*. 2006; Hasler *et al*. 1997; Hasler *et al*. 2002; Hasler *et al*. 2004; Lindenblatt *et al*. 1998; Spitzer *et al*. 1996; Umbricht *et al*. 2003; Vollenweider *et al*. 1997; Vollenweider *et al*. 1998; Vollenweider *et al*. 1999; Wittmann *et al*. 2006). Drug-naïve participants can safely receive intensely e doses of psilocybin if prepared for the effects (Griffiths *et al*. 2006). Hasler and colleagues halted administration of 3 mg i.v. because participants reported a greater number of side effects and reported finding the subjective effects 3 mg i.v. too intense and frightening (Hasler *et al*. 1997).

Fatalities

To date, there have been no verified fatalities directly due to ingesting psilocybin or mushrooms containing only psilocybin and related compounds. When reported, it is likely that fatalities attributed to psilocybin-containing mushrooms are due instead to unintended consumption of poisonous mushrooms in the belief that they contain psilocybin. Extremely high doses of psilocybin might induce effects similar to extremely high doses of LSD, such as fever or respiratory failure (Klock 1978). However, to date no cases have described similar responses with respect to psilocybin, and the doses of psilocybin that might provoke these physiological effects would be many times greater than even the highest doses used in early human studies.

Common Adverse Events and Side Effects

Common adverse effects of psilocybin are described above in "Physiological Effects" and "Psychological Effects" above. They include altered perception of time and space, anxiety, derealization (feeling as if the world is "unreal" or that one is "in a dream), depersonalization (feeling as if the self is unreal or belongs to "someone else"), experiencing both positive and negative moods and mood lability (given to rapid and sometimes intense changes), dilated pupils, dizziness, feeling dazed or fatigued, impaired concentration, unusual body sensations, sporadic, transient increases in blood pressure or heart rate, labile (extremely changeable) mood, nausea, nervousness, unusual body sensations, unusual thoughts, and yawning. Most of these effects are acute and last no longer than the four to six-hour duration of drug effects (Gouzoulis-Mayfrank *et al*. 1999b; Hasler *et al*. 2004; Hollister 1961; Passie *et al*. 2002; Vollenweider *et al*. 1998; Wittmann *et al*. 2006).

The adverse effects of psilocybin are all psychological and similar to those reported for the ergoline hallucinogen LSD, and include anxiety or panic response, a prolonged unpleasant experience (or "bad trip"), psychotic reactions, and prolonged perceptual disturbances. Psychological distress is the chief adverse event reported in the literature on the recreational or nonmedical use of psilocybin, which includes extreme anxiety or panic reactions or transient psychosis (Peden and Pringle 1982).

Reckless Behavior

As is true of LSD and other serotonergic hallucinogens, people who have taken psilocybin in uncontrolled settings may engage in reckless behavior, such as driving while intoxicated. Participants in this and all foreseeable studies will remain in a controlled setting throughout the duration of the subjective effects of psilocybin, and in many studies, they will remain at the setting overnight. Thus it will be extremely unlikely that participants will perform high-risk behaviors, including driving motor vehicles, during the period of intoxication.

Anxiety and Panic Response

Reports specific to consumption of psychedelic mushrooms (Hyde *et al*. 1978; Musha *et al*. 1986; Peden and Pringle 1982) report the occurrence of usually transient anxiety or psychosis-like symptoms similar to those reported for LSD (Strassman 1984). A survey of 44 individuals admitted to hospital after psilocybin use reported the most common adverse event to be dysphoria that lasting for an average of 3.8 hours, followed by nausea or vomiting in at least half the admissions (Peden and Pringle 1982). As might be expected after compounds known to alter perception (Nichols 2004; see "Previous Human Experience" below), people in this study also reported alterations in perception and parasthesias (unusual body sensations, such as numbness or tingling). These reactions typically resolved spontaneously with supportive care, or, on some occasions, with the use of sedative medications such as benzodiazepines. In most cases, emergency room admissions related to anxiety or psychological distress after psilocybin does not require hospitalization (Strassman *et al*. 1994). The occurrence and intensity of anxiety or panic responses to psilocybin can be reduced through informing participants about drug effects prior to drug administration, supervision and monitoring participants throughout the duration of drug effects by people trained to deal with panic or anxiety, including anxiety in response to hallucinogen effects, and exposure to lower doses before receiving higher doses.

Transient and Prolonged Psychotic Reaction

Some individuals enter transient and sometimes prolonged psychotic states after use of psychedelics, including psilocybin (Benjamin 1979; Halpern and Pope 1999; Strassman 1984). Because in nearly all cases, psychosis appears after use without evaluation of psychological state prior to psilocybin use, drawing conclusions about causality is difficult. After examining the literature, Strassman concluded that hallucinogens, including psilocybin, might trigger psychotic episodes, but in a non-specific and non-etiologic manner, and that they did not cause psychosis in people (Strassman 1984). Researchers examining the prevalence of psychiatric reactions through questionnaires sent to researchers conducting controlled studies with the related serotonergic hallucinogen LSD found that 0.08% of 5000 study volunteers experienced psychiatric symptoms that lasted more than two days (Cohen 1960). The rate of occurrence for psychiatric symptoms occurred at the slightly higher rate of 0.18% in psychiatric patients. Another survey of a separate sample of 4300 research volunteers reported a rate of serious, persistent psychiatric reactions in 0.9% of the sample (Malleson 1971). Psilocybin and LSD produce similar subjective effects. Hence these findings suggest that participating in a research study involving the administration of a psychedelic compound similar to LSD is extremely unlikely to trigger transient or persistent psychosis. Past research with LSD and other psychedelics did not apply as stringent criteria for participant selection or screening as are used today, making the low rates of psychosis especially notable (Halpern and Pope 1999), and likely overestimates the likelihood of prolonged psychoses or other psychopathological effects in a study wherein participants are screened for past or present psychotic disorders. The occurrence of transient or persistent psychosis can be prevented or further reduced by excluding people on the basis of the presence of past or current psychotic disorders or such disorders in first-degree relatives, such as biological parent or sibling.

Post-Hallucinogen Perception Disorder (HPPD)

Some people who have used serotonergic hallucinogens, such as LSD or psilocybin, experience persistent, distressing alterations in mostly visual perception that last from weeks to years after use. This condition is now diagnosed as hallucinogen persistent perception disorder (HPPD), and is no longer referred to by the term "flashbacks," which better describe an experience more akin to traumatic recall of an intensely upsetting experience, as a "bad trip." HPPD has occurred after use of psilocybin-containing mushrooms (Benjamin 1979; Espiard *et al*. 2005). To date, there are no reports describing prevalence of HPPD in the general population, but an examination of previous reports and estimates of psychedelic use in the US suggests that HPPD is very rare (Halpern and Pope 2003; Johnston 2005). Halpern and Pope noted that many to most previous studies were affected by selection bias. These reports also contained information supporting alternative explanations of flashbacks or HPPD, such as use of other drugs or the presence of other mental disorders, and found that people who had not used hallucinogens sometimes also reported experiencing similar perceptual disturbances. As well, preliminary data collected by Baggott suggests that no more than 1% of hallucinogen users experience HPPD [Baggott 2006; personal communication to L Jerome]. To date, no cases of HPPD have occurred in volunteers given psilocybin in current research studies. The risk of HPPD occurring after psilocybin administration can be reduced by screening participants for potential risk factors such as substance dependence and through excluding people reporting HPPD after prior use of hallucinogens.

Long-Term Personality Changes after Psilocybin

Though the possibility of chronic neuropsychological effects have never been specifically addressed with respect to psilocybin, earlier studies reported detecting changes in personality or neuropsychological function in people reporting frequent or chronic use of LSD, as described in a review by Halpern and Pope (1999). However, later examinations of these studies found that they possessed a number of methodological flaws, including retrospective study design and failure to account for use of other drugs. Halpern and Pope concluded that long-term changes in personality or psychological function after LSD, if they occurred at all, were liable to be subtle and not clinically significant. Psilocybin shares pharmacological mechanisms with LSD, and so these results seem likely to be applicable for this compound as well. Furthermore, a study of the ability of approximately 0.43 mg/kg psilocybin to produce spiritual experiences found that participants reported an increase in positive attitude changes and behavior two months after psilocybin administration, and people who knew these participants concurred (Griffiths *et al*. 2006). Monitoring personality before and after psilocybin administration will allow researchers to detect personality changes.

Abuse Potential

Currently, psilocybin is placed in Schedule 1, defined as having no medical use and possessing high abuse liability. Despite this designation, examining use patterns in humans and studies in nonhuman primates suggest that psilocybin possesses little or no abuse liability. Monkeys in a study of the rewarding properties of four serotonergic compounds found that the animals did not consistently self-administer psilocybin (Fantegrossi *et al*. 2004). It is also notable that rhesus monkeys found LSD, a drug with similar pharmacological and subjective effects, to be aversive (Hoffmeister 1975). There is no human dependence syndrome for LSD, a drug sharing some similarities with psilocybin, and prevalence of LSD use in adolescents and young adults seems to remain relatively stable over time in the US (Johnston *et al*. 2005). It seems likely that psilocybin also has the same low abuse liability described for LSD. Surveys of drug use in the US do not even ask specifically about use of psilocybin-containing mushrooms, suggesting that use of these mushrooms is relatively uncommon. While very few studies specifically ask respondents about use of "magic mushrooms," there appears to be little notable change in prevalence of "hallucinogen" use in adults aged 19 to 28 (Johnston and O'Malley 2004), with 19.6% reporting some use in 2002 and 20% in 2003. A survey of national drug use in Canada also indicated that hallucinogens accounted for very few admissions for substance abuse (Poulin *et al*. 1999). It is not expected that either psilocybin-naïve or experienced individuals will develop dependence after exposure, even if exposure may lead to pain reduction, as it may in the case of people with cluster headaches.

Reproductive Toxicity

There have been no systematic examinations of the effects of psilocybin in utero. Previous research with LSD had first detected chromosomal abnormalities, but subsequent research failed to detect any abnormalities (Cohen and Shiloh 1977; Cohen 1967; Dishotsky *et al*. 1971). Psilocybin did not produce any indicators of mutagenicity in the micronucleus model of mutagenicity (Van Went 1978). These findings suggest that psilocybin is unlikely to damage DNA. Furthermore, there do not appear to be any case reports of birth defects arising from psilocybin use. Nevertheless, the reproductive risks of psilocybin, though likely minimal, remain unknown. Reproductive risks can be prevented or eliminated through restricting enrollment to women who are not pregnant or lactating and who are using an effective means of birth control.

Trial Data

There are no ongoing sponsor-supported trials of psilocybin at present. In future, data will be collected and reported on psilocybin side effects.

Acknowledgements

I would like to thank Torsten Passie MD for sharing information from his review of the literature, Felix Hasler for permission to reproduce the figure describing the metabolism of psilocybin from his dissertation, Andrew Sewell for continued discussions of the effects of changes in gene expression in relation to psilocybin and other 5-HT$_{2A}$ agonists, and any of the people who devoted some time and effort to reviewing the document and providing me with helpful comments and advice.

References

1. Aghajanian GK, Foote WE, Sheard MH (1968) Lysergic acid diethylamide: sensitive neuronal units in the midbrain raphe. Science 161: 706-8
2. Aghajanian GK, Foote WE, Sheard MH (1970) Action of psychotogenic drugs on single midbrain raphe neurons. J Pharmacol Exp Ther 171: 178-87
3. Aghajanian GK, Hailgler HJ (1975) Hallucinogenic indoleamines: Preferential action upon presynaptic serotonin receptors. Psychopharmacol Commun 1: 619-29
4. Aghajanian GK, Marek GJ (1999) Serotonin, via 5-HT2A receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release. Brain Res 825: 161-71
5. Benjamin C (1979) Psychiatric symptoms and hallucinogenic compounds. Br Med J 2: 500
6. Blair JB, Kurrasch-Orbaugh D, Marona-Lewicka D, Cumbay MG, Watts VJ, Barker EL, Nichols DE (2000) Effect of ring fluorination on the pharmacology of hallucinogenic tryptamines. J Med Chem 43: 4701-10
7. Buckholtz NS, Zhou DF, Freedman DX, Potter WZ (1990) Lysergic acid diethylamide (LSD) administration selectively downregulates serotonin2 receptors in rat brain. Neuropsychopharmacology 3: 137-48
8. Carter OL, Burr DC, Pettigrew JD, Wallis GM, Hasler F, Vollenweider FX (2005a) Using psilocybin to investigate the relationship between attention, working memory, and the serotonin 1A and 2A receptors. J Cogn Neurosci 17: 1497-508
9. Carter OL, Pettigrew JD, Burr DC, Alais D, Hasler F, Vollenweider FX (2004) Psilocybin impairs high-level but not low-level motion perception. Neuroreport 15: 1947-51
10. Carter OL, Pettigrew JD, Hasler F, Wallis GM, Liu GB, Hell D, Vollenweider FX (2005b) Modulating the rate and rhythmicity of perceptual rivalry alternations with the mixed 5-HT2A and 5-HT1A agonist psilocybin. Neuropsychopharmacology 30: 1154-62
11. Cohen MM, Shiloh Y (1977) Genetic toxicology of lysergic acid diethylamide (LSD-25). Mutat Res 47: 183-209

12. Cohen S (1960) Lysergic acid diethylamide: side effects and complications. J Nerv Ment Dis 130: 30-40
13. Cohen S (1967) Psychotomimetic agents. Annu Rev Pharmacol 7: 301-18
14. Creese I, Burt DR, Synder SH (1975) The dopamine receptor: differential binding of d-LSD and related agents to agonist and antagonist states. Life Sci 17: 1715-9
15. Dishotsky NI, Loughman WD, Mogar RE, Lipscomb WR (1971) LSD and genetic damage. Science 172: 431-40
16. Doblin R (1991) Pahnke's "Good Friday Experiment": A Long-Term Follow-Up and Methodological Critique. J Transpersonal Psychology 23: 1-28
17. Eivindvik K, Rasmussen KE, Sund RB (1989) Handling of psilocybin and psilocin by everted sacs of rat jejunum and colon. Acta Pharm Nord 1: 295-302
18. Espiard ML, Lecardeur L, Abadie P, Halbecq I, Dollfus S (2005) Hallucinogen persisting perception disorder after psilocybin consumption: a case study. Eur Psychiatry 20: 458-60
19. Franz M, Regele H, Kirchmair M, Kletzmayr J, Sunder-Plassmann G, Horl WH, Pohanka E (1996) Magic mushrooms: hope for a 'cheap high' resulting in end-stage renal failure. Nephrol Dial Transplant 11: 2324-27
20. Gallaher TK, Chen K, & , Shih JC (1993) Higher affinity of psilocin for human than rat 5-HT2 receptor indicates binding site structure. Med Chem Res 3: 52-66.
21. Geyer MA, Petersen LR, Rose GJ, Horwitt DD, Light RK, Adams LM, Zook JA, Hawkins RL, Mandell AJ (1978) The Effects of Lysergic Acid Diethylamide and Mescaline-Derived Hallucinogens on Sensory-Integrative Function: Tactile Startle. The Journal of Pharmacology and Experimental Therapeutics 207: 837847
22. Gonzalez-Maeso J, Weisstaub NV, Zhou M, Chan P, Ivic L, Ang R, Lira A, Bradley-Moore M, Ge Y, Zhou Q, Sealfon SC, Gingrich JA (2007) Hallucinogens Recruit Specific Cortical 5-HT(2A) Receptor-Mediated Signaling Pathways to Affect Behavior. Neuron 53: 439-52
23. Gouzoulis-Mayfrank E, Schreckenberger M, Sabri O, Arning C, Thelen B, Spitzer M, Kovar KA, Hermle L, Bull U, Sass H (1999a) Neurometabolic effects of psilocybin, 3,4-methylenedioxyethylamphetamine (MDE) and d-methamphetamine in healthy volunteeers. A double-blind, placebo-controlled PET study with [18F]FDG. Neuropsychopharmacology 20: 565-81
24. Gouzoulis-Mayfrank E, Thelen B, Habermeyer E, Kunert HJ, Kovar KA, Lindenblatt H, Hermle L, Spitzer M, Sass H (1999b) Psychopathological, neuroendocrine and autonomic effects of 3,4-methylenedioxyethylamphetamine (MDE), psilocybin and d-methamphetamine in healthy volunteers. Results of an experimental double-blind placebo-controlled study. Psychopharmacology (Berl) 142: 41-50
25. Green JP, Weinstein H, Maayani S (1978) Defining the histamine H2-receptor in brain: the interaction with LSD. NIDA Res Monogr: 38-59
26. Griffiths RR, Richards WA, McCann U, Jesse R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology (Berl) 187: 268-83; discussion 284-92
27. Grob CS (2005) Psilocybin research in advanced-stage cancer patients. MAPS Bulletin 15: 8
28. Grof S (2000: 1980) LSD Psychotherapy. Multidisciplinary Association for Psychedelic Studies, Multidisciplinary Association for Psychedelic Studies
29. Grof S, Goodman LE, Richards WA, Kurland AA (1973) LSD-assisted psychotherapy in patients with terminal cancer. Int Pharmacopsychiatry 8: 129-44
30. Halpern JH, Pope HG, Jr. (1999) Do hallucinogens cause residual neuropsychological toxicity? Drug Alcohol Depend 53: 247-56
31. Hasler F (1997) Untersuchungen zur Humanpharmakokinetik von Psilocybin. Dissertation. University of Berne (Switzerland), Berne
32. Hasler F, Bourquin D, Brenneisen R, Bar T, Vollenweider FX (1997) Determination of psilocin and 4-hydroxyindole-3-acetic acid in plasma by HPLC-ECD and pharmacokinetic profiles of oral and intravenous psilocybin in man. Pharm Acta Helv 72: 175-84
33. Hasler F, Bourquin D, Brenneisen R, Vollenweider FX (2002) Renal excretion profiles of psilocin following oral administration of psilocybin: a controlled study in man. J Pharm Biomed Anal 30: 331-9
34. Hoffmeister F (1975) Negative reinforcing properties of some psychotropic drugs in drug-naive rhesus monkeys. J Pharmacol Exp Ther 192: 468-77
35. Hofmann A (2005) LSD: My Problem Child. Multidiscplinary Association for Psychedelic Studies, Multidiscplinary Association for Psychedelic Studies
36. Hollister LE (1961) Clinical, biochemical and psychologic effects of psilocybin. Arch Int Pharmacodyn Ther 130: 42-52
37. Hollister LE, Sjoberg BM (1964) Clinical Syndromes and Biochemical Alterations Following Mescaline, Lysergic Acid Diethylamide, Psilocybin and a Combination of the Three Psychotomimetic Drugs. Compr Psychiatry 20: 170-8
38. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE (2005) Monitoring the Future: National Survey Results on Drug Abuse, 1975-2003, Vol. 2 College Students and Adults Ages 19-45: Vol 2. NIDA, NIDA
39. Keeler MH (1965) The effects of psilocybin on a test of after-image perception. Psychopharmacologia 8: 131-9
40. Kurrasch-Orbaugh DM, Watts VJ, Barker EL, Nichols DE (2003) Serotonin 5hydroxytryptamine 2A receptor-coupled phospholipase C and phospholipase A2 signaling pathways have different receptor reserves. J Pharmacol Exp Ther 304: 229-37
41. Leary T, Litwin GH, Metzner R (1963) Reactions to Psilocybin Administered in a Supportive Environment. J Nerv Ment Dis 137: 561-73
42. Malleson N (1971) Acute adverse reactions to LSD in clinical and experimental use in the United Kingdom. Br J Psychiatry 118: 229-30
43. McKenna DJ, Repke DB, Lo L, Peroutka SJ (1990) Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. Neuropharmacology 29: 193-8
44. Meltzer HY, Fessler RG, Simonovic M, Fang VS (1978) Stimulation of rat prolactin secretion by indolealkylamine hallucinogens. Psychopharmacology (Berl) 56: 255-9
45. Metzner R (2005) Sacred Mushroom of Visions: Teonanácatl: A Sourcebook on the Psilocybin Mushroom. Park St. Press, Park

St. Press

46. Moreno FA, Wiegand CB, Taitano EK, Delgado PL (2006) Safety, tolerability and efficacy of psilocybin in 9 patients with Obsessive-Compulsive Disorder. J Clin Psychiatry 67: 735-174
47. Nichols CD, Sanders-Bush E (2004) Molecular genetic responses to lysergic acid diethylamide include transcriptional activation of MAP kinase phosphatase-1, C/EBP-beta and ILAD-1, a novel gene with homology to arrestins. J Neurochem 90: 576-84
48. Nichols DE (2004) Hallucinogens. Pharmacol Ther 101: 131-81
49. Pahnke WN (1963) Drugs & Mysticism: An Analysis of the Relationship between Psychedelic Drugs and Mystical Consciousness Divinity. Harvard University, Cambridge MA, pp 315
50. Pahnke WN, Richards WA (1966) Implications of LSD and Experimental Mysticism. Journal of Religion and Health 5: 175-208
51. Passie T (2005) A history of the use of psilocybin in psychotherapy. In: Metzner R (ed) Sacred Mushroom of Visions: Teonanacatl. Park Street Press, Rochester VT, pp 113-138
52. Passie T, Seifert J, Schneider U, Emrich HM (2002) The pharmacology of psilocybin. Addict Biol 7: 357-64
53. Peden NR, Pringle SD (1982) Hallucinogenic fungi. Lancet 1: 396-7
54. Poulin C, Single E, Fralick P (1999) Canadian Community Epidemiology Network on Drug Use (CCENDU): Second National Report. Canadian Centre on Substance Abuse, Toronto, ON
55. Quetin AM (1960) La Psilocybine en psychiatrie clinique et experimentale. University of Paris, Paris
56. Sard H, Kumaran G, Morency C, Roth BL, Toth BA, He P, Shuster L (2005) SAR of psilocybin analogs: discovery of a selective 5-HT 2C agonist. Bioorg Med Chem Lett 15: 4555-9
57. Sewell RA, Halpern JH, Pope HG, Jr. (2006) Response of cluster headache to psilocybin and LSD. Neurology 66: 1920-2
58. Stolk JM, Barchas JD, Goldstein M, Boggan W, Freedman DX (1974) A comparison of psychotomimetic drug effects on rat brain norepinephrine metabolism. J Pharmacol Exp Ther 189: 42-50
59. Strassman RJ (1984) Adverse reactions to psychedelic drugs. A review of the literature. J Nerv Ment Dis 172: 577-95
60. Strassman RJ, Qualls CR, Uhlenhuth EH, Kellner R (1994) Dose-response study of N,Ndimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry 51: 98-108
61. Usdin E, Efron D (1972) Psychotropic Drugs and Related Compounds (2nd Ed.). , 2nd Edition edn. National Institute of Mental Health, National Institute of Mental Health
62. Van Went GF (1978) Mutagenicity testing of 3 hallucinogens: LSD, psilocybin and delta 9-THC, using the micronucleus test. Experientia 34: 324-5
63. Vollenweider FX, Csomor PA, Knappe B, Geyer MA, Quednow BB (2007) The Effects of the Preferential 5-HT2A Agonist Psilocybin on Prepulse Inhibition of Startle in Healthy Human Volunteers Depend on Interstimulus Interval. Neuropsychopharmacology
64. Vollenweider FX, Leenders KL, Scharfetter C, Maguire P, Stadelmann O, Angst J (1997) Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. Neuropsychopharmacology 16: 357-72
65. Vollenweider FX, Vontobel P, Hell D, Leenders KL (1999) 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man--a PET study with [11C]raclopride. Neuropsychopharmacology 20: 424-33
66. Williams JT, Colmers WF, Pan ZZ (1988) Voltage- and ligand-activated inwardly rectifying currents in dorsal raphe neurons in vitro. J Neurosci 8: 3499-506
67. Winter JC, Rice KC, Amarosi DJ, Rabin RA (2007) Psilocybin-induced stimulus control in the rat. Pharmacol Biochem Behav In press
68. Wittmann M, Carter O, Hasler F, Cahn BR, Grimberg U, Spring P, Hell D, Flohr H, Vollenweider FX (2006) Effects of psilocybin on time perception and temporal control of behaviour in humans. J Psychopharmacol

Dephosphorylation of psilocybin to psilocin by alkaline phosphatase

by

A. Horita and L. J. Weber

Dept. of Pharmacology, University of Washington School of Medicine, Seattle

Received September 6, 1960. P.S.E.B.M., 1961, v106.

original report: https://www.erowid.org/references/texts/show/2623docid2268

Table of Contents:

Methods
Results
Discussion
Summary
Bibliography

A number of indolic compounds have gained pharmacological and biochemical interest because of their ability to produce psychotic states in human subjects. Thus, compounds such as bufotenin, *N,N*-dimethyl-tryptamine and harmine (1) have been reported to produce behavioural changes in man and various central nervous system effects in experimental animals. The most recent additions to this class of compounds are the substances found in the *Psilocybe mexicana* Heim mushroom, psilocybin and psilocin. Chemically, these compounds are 4-phosphoryl-*N,N*-dimethyltryptamine and 4-hydroxy-*N,N*-dimethyltryptamine, respectively. Their chemical structures are shown below.

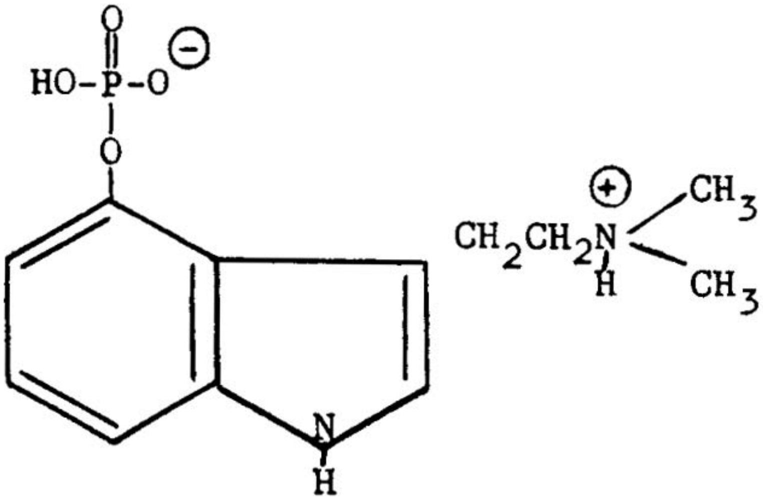
According to Troxler *et al*. (2) psilocybin and psilocin are the first indole compounds of natural sources possessing substitutions on the 4-position of the indole ring. Psilocin differs from bufotenin only by having its -OH group located on the 4- rather than the 5-position.

The present report is concerned with hydrolysis of the phosphate group of psilocybin *in vitro* by a purified preparation of calf intestinal phosphatase. These studies were initiated because of the possibility that psilocybin might serve as a substrate for the phosphatase enzyme. This appeared reasonable since other aromatic compounds with a phosphate group are excellent substrates of acid and alkaline phosphatases (3).

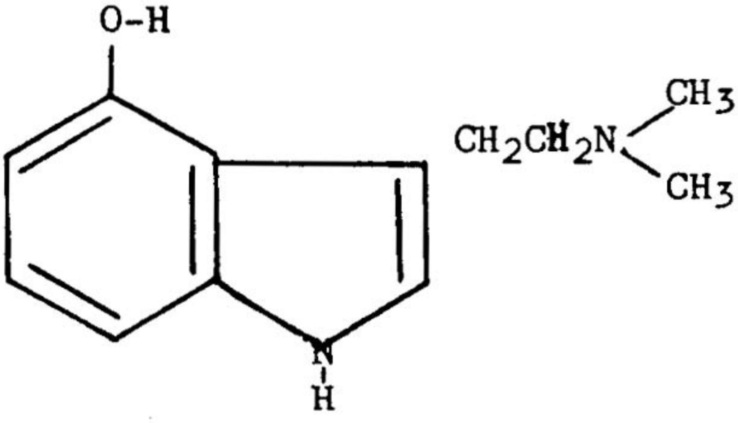
Methods

All experiments in this study were carried out using purified calf intestinal phosphatase containing 15,000 units per mg (Purified alkaline phosphatase preparation was purchased from Mann Research Labs., New York.). Psilocybin and psilocin were generously supplied by Mr. Harry Althouse of Sandoz Pharmaceuticals, San Francisco, Calif.

Inorganic phosphate was determined according to a modified method of Fiske and Subbarrow (4). Psilocin was determined by adapting the colorimetric analysis for serotonin as described by Udenfriend *et al*. (5). All steps in the procedure were similar to that for serotonin. The final reaction between the nitrosonaphthol reagent and psilocin in an acid medium resulted in formation of a brownish-orange color as compared to the bright violet color of serotonin or bufotenin. The color with psilocin exhibited maximum absorption at wave lengths of 540 and at 430 mμ as read on the spectrophotometer. Determinations of psilocin were made at 430 mμ, although in some instances they were also checked at 540 mμ. Colors developed from standard solutions of pure psilocin were found to follow Beer's Law within the concentration range of 0.02 and 1.0 μmoles/ml.



Psilocybin



Psilocin

Psilocybin also reacted with the nitrosonaphthol reagent but only at much higher concentrations. It exhibited a light yellow color, but this did not interfere with the psilocin readings at 430 mμ. Psilocybin, however, is not extracted into the butanol phase, and the final acid extract did not give any color reaction with the nitrosonaphthol reagent. This permits a selective extraction of psilocin by the butanol and prevents interference by any psilocybin that might be present.

The incubation mixture consisted of the following: 0.4 ml of intestinal phosphatase (1500 units/ml) and 5.0 ml of psilocybin (2 μmoles/ml) dissolved in Veronal buffer (pH 9.2). The psilocybin was pre-incubated for 5 minutes in order to equilibrate to 37°C. The enzyme solution was then added, and at varying times, tubes were removed and assayed for psilocin and inorganic phosphate. Duplicate assays were performed for each tube.

Descending paper chromatography of the incubation mixtures was used as a further identification of psilocin. A butanol-acetic acid-water (4:1:1) mixture acted as the developing solvent, and the spots were detected with a cinnamaldehyde-HCl reagent (6).

Results

The ability of purified intestinal alkaline phosphatase to dephosphorylate psilocybin with liberation of psilocin and inorganic phosphate is illustrated graphically in Fig. 1. A rapid dephosphorylation is evident in the initial 15-30 minutes and thereafter proceeds at a slower linear rate. Under the conditions described here it appears that about 5×10^4 μmoles of psilocin was liberated per unit of enzyme per hour. In contrast, dephosphorylation of disodium mono-phenylphosphate by alkaline phosphatase liberates about twice as much phenol and inorganic phosphate. In all instances liberation of inorganic phosphate follows closely the appearance of psilocin during incubation period.

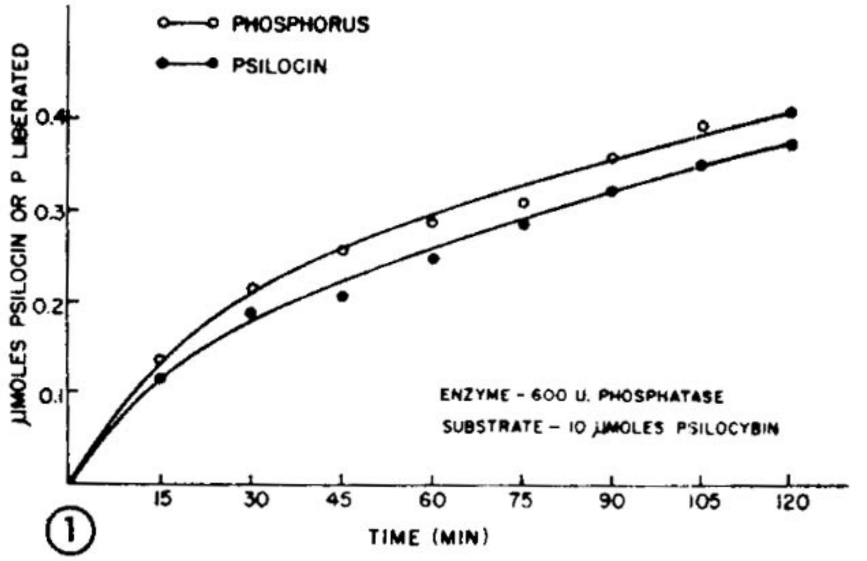


FIG. 1. Rate of phosphorus and psilocin liberation from action of purified alkaline phosphatase acting on psilocybin. Incubation in veronal buffer, pH 9.2 at 37°C.

That psilocin was liberated from psilocybin by phosphatase was evident not only from the colorimetric tests but also from the Rf values by paper chromatography. Development of the paper by spraying with the cinnamaldehyde-HCl reagent revealed only one spot identical in position with the standard psilocin strip. Average Rf value of both standard and unknown strips was 0.74 (average value of 4 strips). Psilocybin did not react with the reagent to give distinctive spot test.

The effect of psilocybin concentration on formation of psilocin is shown in Fig. 2. In these instances the incubation was carried out for one hour with 600 units of alkaline phosphatase. Concentrations of 1 μmole to 40 μmoles of psilocybin were employed as the substrate. A linear relationship between psilocybin concentrations and psilocin formation was noted up to about 4 μmoles of substrate. Beyond this concentration, rate of formation of psilocin approached a plateau, indicating saturation of the enzyme with excess substrate and attainment of a zero-order reaction.

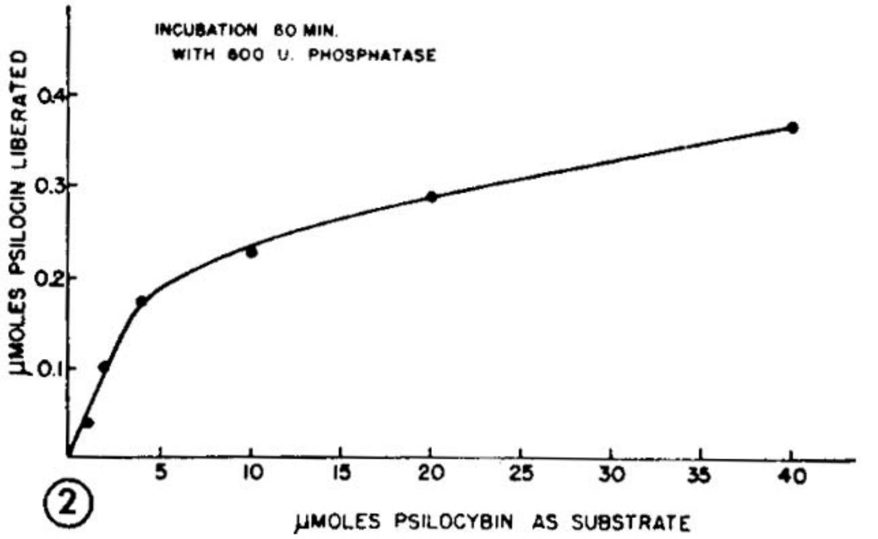


FIG. 2. Effect of psilocybin concentration on liberation of psilocin by purified alkaline phosphatase. Incubations were carried out in veronal buffer, pH 9.2 at 37°C for 60 min.

Since the Mg^{++} ion is known to activate alkaline phosphatase its effect was also studied with psilocybin as substrate. It was found that at concentrations of 0.35% $MgSO_4$, psilocin and inorganic phosphate liberated increased about 30% above controls.

Discussion

Psilocybin is readily dephosphorylated by intestinal phosphatase to form inorganic phosphate and psilocin. This raises the question of whether the central nervous system actions of psilocybin are produced by its dephosphorylated congener, since many mammalian tissues as well as serum contain a variety of phosphatases. Experiments in progress indicate that both mammalian tissue and plasma are capable of rapidly dephosphorylating psilocybin.

It would appear reasonable that psilocin might produce central nervous system effects of psilocybin since the latter would be highly ionized and less likely to penetrate the blood-brain barrier. Determinations of the solubilities of these 2 compounds in organic solvents and in Tyrode solution at pH 7.4 showed psilocin to be over 100 times as soluble in chloroform than was psilocybin (unpublished results).

Liberation of psilocin from psilocybin was readily determined by specific assay methods. Although closely related in structure, these 2 compounds reacted quite differently to various color reagents. We are currently exploring the possibility of utilizing the spectrophotofluorimeter as a means of identifying small amounts of both of these compounds.

Summary

Incubation of psilocybin with purified intestinal phosphatase resulted in liberation of psilocin and inorganic phosphate. Psilocin formed was determined both quantitatively by a specific colorimetric method employing the nitrosonaphthol reagent and qualitatively by paper chromatography. Some characteristics of the phosphatase action on psilocybin are described. The possibility of a similar reaction occurring in the intact animal is discussed.

Bibliography

1. Carr, C. J., *Int. Rec. Med.*, 1959, vl72, 702.
2. Troxler, F., Seeman, F., Hofmann, A., *Helv. Chim. Acta*, 1959, v42, 2074.
3. Roche, J., in *The Enzymes*, by J. B. Sumner and K. Myrback, 1950, vl, pt. 1, 473.
4. Fiske, C. H., Subbarow, Y., *J. Biol. Chem.*, 1925, v66, 375.
5. Udenfriend, S., Weissbach, H., Brodie, B. B., *Methods of Biochem. Anal.*, 1958, v6, 95.
6. Block, R. J., Durrum, E. L., Zweig, G., *Manual of Paper Chromatography and Paper Electrophoresis*, 2nd ed., Academic Press, Inc., New York, 1958.

Detecting Psychoactive Drugs in the Developmental Stages of Mushrooms

by

Susan T. Gross,[1] B.A.

J Forensic Sci 2000;45(3): 527-537

Received 26 Feb. 1999; and in revised form 12 May 1999; accepted 23 Aug. 1999.

original source: http://chemistry.mdma.ch/hiveboard/rhodium/pdf/alkaloids.in.developing.shrooms2.pdf
backup source: http://www.psilosophy.info/resources/alkaloids.in.developing.shrooms2.pdf

[1] Forensic Scientist, Minnesota Forensic Science Laboratory, 1246 University Ave, St. Paul, Minnesota.

This project was supported by the Federal Bureau of Investigation (FBI), Minneapolis Field Office.

Table of Contents:

- **Abstract**
- **Methods**
  - Sample Preparation
  - Thin-Layer Chromatography
  - Gas Chromatograph/Mass Spectrometer
  - Lower Limit of Detection
- **Results and Discussion**
- **Conclusion**
- **Acknowledgments**
- **References**

Abstract

The following questions regarding the detection of psychoactive drugs in mushrooms are addressed: At what stage of the mushroom development can the psychoactive drugs psilocyn and psilocybin be identified, and what effect does light have on the growth of these mushrooms. To answer these questions, *Psilocybe cyanescens* Wakefield mushrooms were grown from their spores in a controlled setting. At various times of their development, samples were taken and analyzed for psilocyn and psilocybin. Knowing what stage of development the psychoactive drugs can be identified may be useful to law enforcement personnel and forensic chemists. Methanolic extracts of various samples were analyzed by TLC and by GC/MS. It was determined that the mycelium knot stage of the mushroom was the earliest stage at which the psychoactive drugs could be detected. It was observed that light affected the time of development and the appearance of these mushrooms.

Keywords: forensic science, psilocyn, psilocybin, psychotropic mushrooms

Law enforcement agencies in Minnesota are beginning to see an increased number of mushroom growing operations. Knowing what stage of development the psychoactive drugs can be identified may be useful to law enforcement personnel and forensic chemists. This information is important because in the state of Minnesota it is illegal to possess any material, compound, mixture or preparation which contain any quantity of psilocyn and/or psilocybin[1].

The word mushroom is a general term used to describe the relatively large and fleshy fruiting bodies of fungi, particularly all gill fungi. They are fungi that differ from plants in that these lack roots, stems, leaves, flowers, seeds and chlorophyll. Since mushrooms lack chlorophyll, they depend upon their surrounding medium for their nutrients. The vegetative portion of the fungus accumulates a reserve of food from the immediate surroundings in order to develop fruiting bodies[2-3].

Fungi are categorized as follows: kingdom, phylum, class, order, family, genus, and species. Mushrooms containing psychotropic drugs are classified in the kingdom Mycota, the phylum Basidiomycota, the class Hymenomycetes, and the order *Agaricales*. There are four families of mushrooms, *Strophariaceae*, *Bolbitiaceae*, *Coprinaceae*, and *Cortinariaceae*, that contain psilocybin, psilocyn, or related alkaloids with an indolic nucleus. The genus and species of *Psilocybe* mushrooms that were grown were identified as *Psilocybe cyanescens*. The pleurocystidia sizes noted in the keys describing the *Psilocybe cyanescens* mushroom varied slightly from the mushrooms grown. This may indicate a variant of this species (communication with Dr. David McLaughlin, Plant Biology Department, University of Minnesota)[2,4,5-8].

The four stages making up the life cycle of a mushroom are the spores, the mycelium, the primordia, and the mature fruit. The spores are the reproductive cells or "seeds" of the fungi (Fig. 1). Germination of the spores takes place when a suitable substrate and correct environmental conditions are present. These spores grow outward seeking nutrients and branch out forming a complex "coblike" system. This "cob-like" system is the vegetative portion of the fungus which is called the mycelium (Fig. 2). The mycelium absorbs water and nutrients from the substrate which is used in the production of the fruiting bodies. The ability of a fungus to begin fruiting is affected by genetic competence and various environmental factors including moisture, temperature, light, and aeration. The formation and growth of the fruiting bodies is known as primordia and has been referred to as "mycelium knots" and "pinheads." The "mycelium knot" is referring to the initial fruiting body that is formed when the mycelium clumps together and seems to form a "knot" (Fig. 3). This knot eventually grows into the "pinhead," a plump growth, yellow in color and with a brown tip (Fig. 4). The fruit is considered mature when it is able to disperse spores and begin this life cycle over again (Figs. 5-6)[2,9].

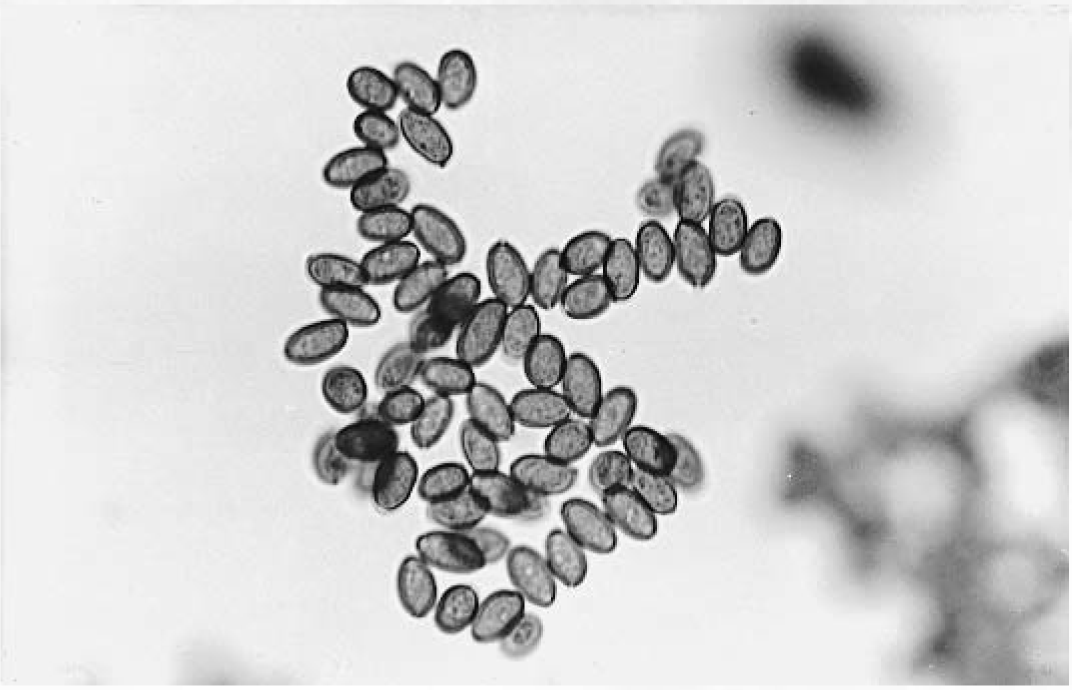


Fig. 1 - The aqueous spore solution viewed using a 1250 x magnification microscope. The spores are the first stage of the mushroom's life cycle. One milliliter of spore solution was used to inoculate each 1/2 pint jar.

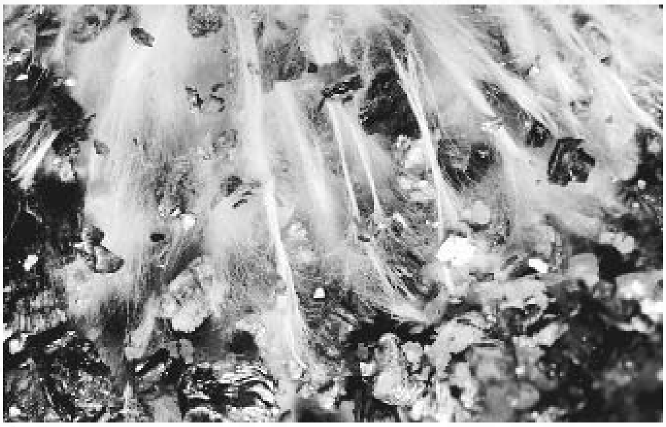


Fig. 2 - The vegetative portion of the fungus is called the mycelium. This is the second stage of the mushroom's life cycle. The first sign of mycelium growth appears 4 to 6 days after inoculation.

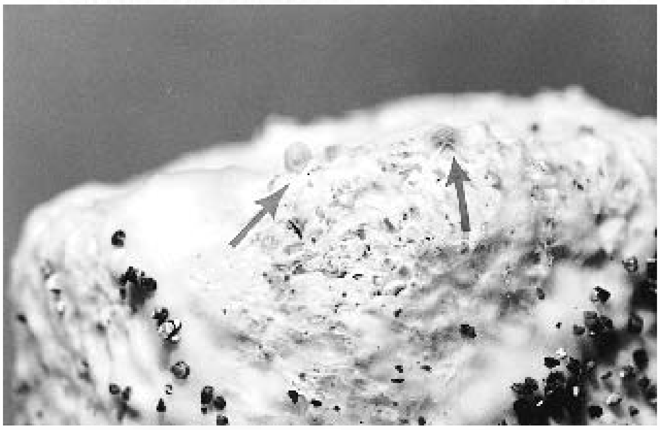


Fig. 3 - The third stage of the mushroom's life cycle is the primordia, and has been referred to as "mycelium knots" and "pinheads." The mycelium knots are the initial fruiting body that is formed when themycelium clumps together and seems to form a "knot".

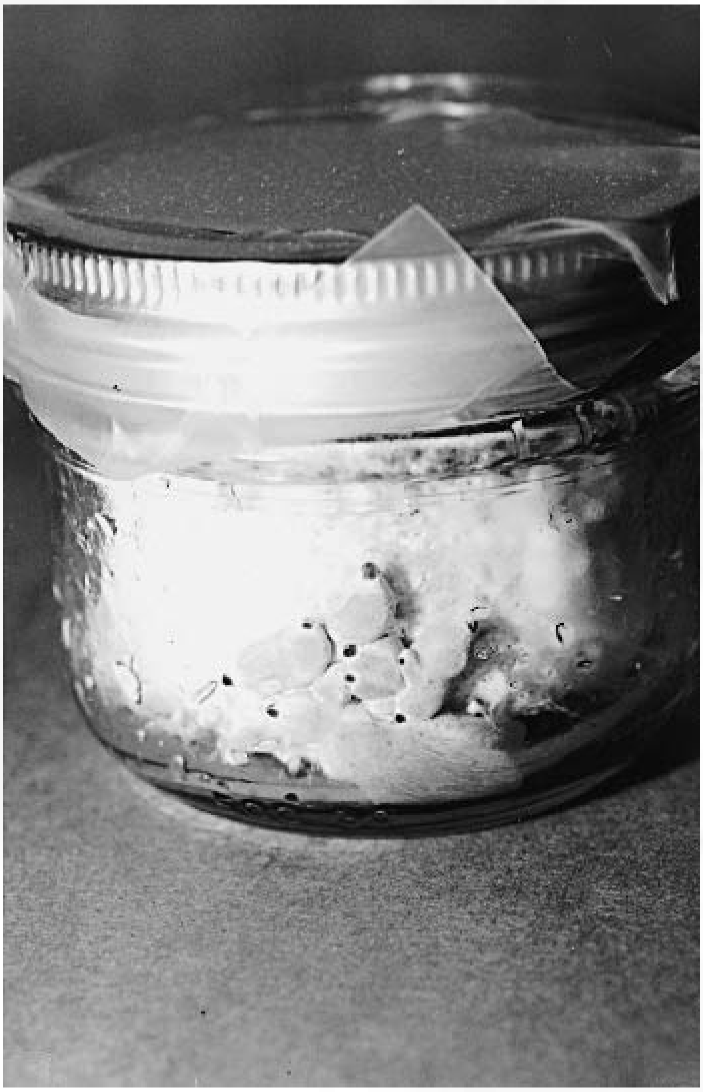


Fig. 4 - The third stage of the mushroom's life cycle is the primordia, and has been referred to as "mycelium knots" and "pinheads." The pinheads are plump growths, yellow in color with a brown tip.

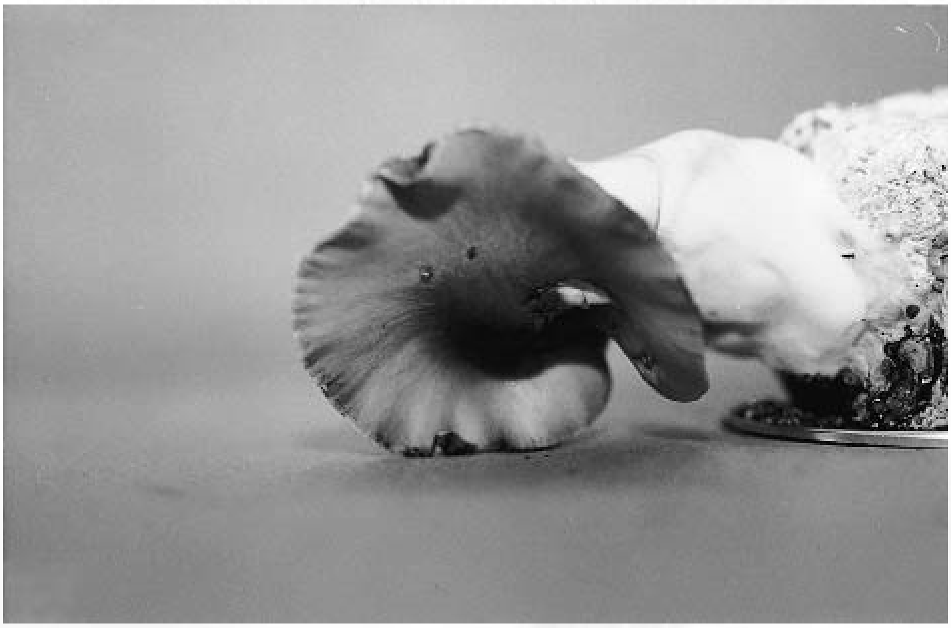


Fig. 5 - The fourth stage of the mushroom's life cycle is the mature fruit. Mushrooms are considered mature once they are able to disperse spores and begin the life cycle over again. Mature *Psilocybe cyanescens* Wakefield mushrooms.

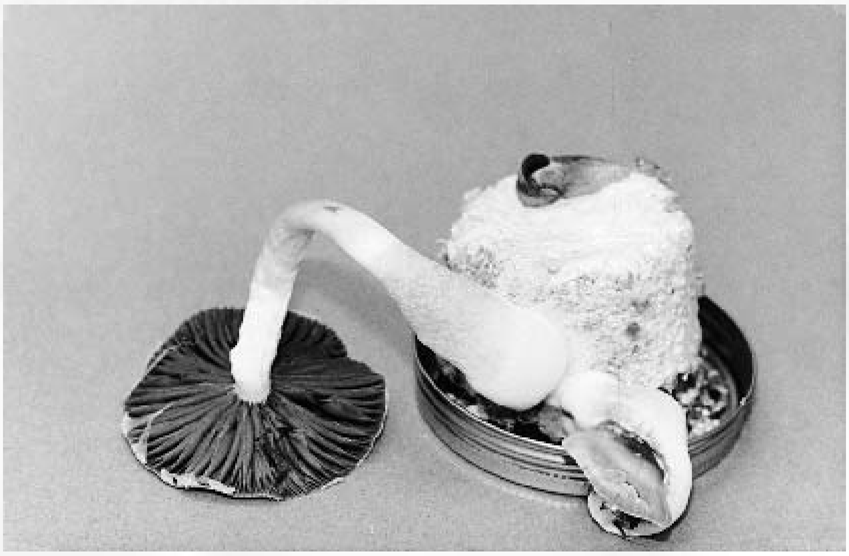


Fig. 6 - The fourth stage of the mushroom's life cycle is the mature fruit. Mushrooms are considered mature once they are able to disper se spores and begin the life cycle over again. Mature *Psilocybe cyanescens* Wakefield mushrooms.

Methods

The spores used in this experiment were obtained legally through an advertisement in *High Times Magazine* from Psylocybe Fanaticus (PFTek Seattle, WA). The spores were received in 10 mL syringes in an aqueous solution. The spore solutions were each viewed using a 1250x-magnification microscope.

Directions for preparing the growing media were received with the spores. Supplies used for the growing media were half-pint wide-mouth jars (Kerr Group, Inc. Jackson, TN), horticultural vermiculite (Schultz, St. Louis MO), brown rice powder and distilled water. The canning lids were prepared before the mixture was added to the jars. The rubber sealing edge of the canning lids were turned upwards and four holes were punched symmetrically around the outer edge. A mixture of 1/4 cup brown rice powder, 1/2 cup vermiculite and 1/4 cup distilled water was prepared for each 1/2 pint jar. This mixture was placed into the jars and covered with dry vermiculite. The lids were screwed on tightly and aluminum foil was used to cover the lids to prevent additional water from entering the jars during sterilization.

Since growing media is susceptible to contamination, the top layer of dry vermiculite was used to keep airborne contaminants from the wet substrate and absorb and regulate moisture transpiration and condensation[10]. The jars with the growing media mixture were sterilized at 120°C for 20 minutes. The jars were cooled before inoculation. Contamination was detectable through various colors from pastels to black. The growing media that became contaminated was observed but was not analyzed.

Eight jars per week were inoculated with 1 mL of spore solution. This was done for 9 weeks for a total of 72 inoculations. In addition to the eight jars inoculated per week, one jar per week was not inoculated and was used as a control blank. During the first four weeks, all samples were allowed to grow under indirect light. The last five weeks, half of the samples were allowed to grow under indirect light while the other half were kept in the dark. The jars kept in the dark were exposed to light only when samples were taken. Each jar was covered with parafilm after inoculation to keep airborne contaminates from the substrate.

The samples were transferred to terrariums after the pinheads became too large for the jars they were growing in. Two different terrariums were used for this experiment. The first one consisted of a styrofoam cooler with a piece of plexiglas inside of it. The second terrarium consisted of a 2-liter pop bottle with the middle portion cut out. To maintain a high level of humidity, both terrariums were sprayed with distilled water two to four times a day. Fanning the chamber with the lids two to four times a day also kept the terrariums well ventilated.

The growth and colonization was monitored for the samples grown under indirect light. The mycelium was sampled 13 days after inoculation. Samples were also taken from each jar at various stages of growth of the mycelium, primordia and the mature fruit. The growth of the mycelium, primordia and the mature fruit was monitored and compared for the samples grown under indirect light and in the dark simultaneously.

Sample Preparation

Samples were allowed to soak in methanol overnight. The methanol was decanted into a shell vial which was then condensed to near dryness (<1/2 mL) using a stream of air. An aliquot was removed for thin-layer chromatography (TLC). The mycelium knot samples were analyzed by TLC and by gas chromatography with a mass spectrometer (GC/MS) in this methanolic extract state without any clean-up.

The extracts were cleaned up with an acid solution for GC/MS analysis. A 0.2 N solution of sulfuric acid was used to resuspend and acidify the extract. This solution was washed twice with chloroform to remove the neutral organic compounds. The samples were made basic with sodium bicarbonate and the psychoactive drugs were extracted twice with chloroform. The chloroform was evaporated and the sample was reconstituted with methanol for GC/MS analysis.

Thin-Layer Chromatography

TLC was carried out on 5 x 10 cm silica gel plates (Analtech Newar, DE). Psilocyn (Alltech State College, PA) and psilocybin (Alltech State College, PA) standards were spotted on each plate along with the sample extracts. The plates were developed to 6 cm at room temperature in a covered development tank with a 9:1 chloroform/methanol solution. A beaker containing 3 mL of ammonium hydroxide was placed in the tank to assist in development. The plate was dried with low heat and visualized with a paradimethylaminobenzaldehyde (p-DMAB) spray reagent. (The p-DMAB reagent consisted of 2 g of p-DMAB in 50 mL of ethanol and 50 mL of hydrochloric acid.) The relative R_f value of psilocybin is 0.00 and the relative R_f value of psilocyn is 0.85.

The lower limit of detection was determined by serial dilutions of the psilocyn standard and spotting/developing it until the spot associated with the standard was not seen. The lower limit of detection for the TLC method was determined to be approximately 0.03 mg/mL.

Gas Chromatograph/Mass Spectrometer

The Hewlett Packard gas chromatograph 5890 Series II interfaced with the Hewlett Packard 5970 series mass selective detector (MSD) and the Hewlett Packard G1800A gas chromatograph detector system (GCD) were used for the detection of the analytes. These two instruments are equivalent and samples were run on specific instruments depending upon their availability. An HP-1 12 m column (film thickness 0.33 µm, column id 0.2 mm) was used for the gas chromatography (GC). The parameters for the GCD were as follows: injection port 250°C and detector temperature 280°C. *Method SCAN70* - Low mass 35, high mass 425, initial temperature 70°C, ramp rate 25°C/min and final temperature 300°C hold for 3.0 minutes. The parameters for the MSD were as follows: injection port 265°C and detector temperature 280°C. *Method SCN90* - Low mass 35, high mass 400, initial temperature 90°C, ramp rate 25°C/min, and final temperature 300°C hold for 4.0 minutes. Sample volume was approximately 3 µL with the split ratio of 30:1.

Lower Limit of Detection

The lower limit of detection for both instruments was determined by serial dilutions of the psilocyn standard and analyzing it until a peak at the correct retention time containing the prominent ions 44, 58, 77, 159, and 204 was not detected. The lower limit of detection was determined to be approximately 0.1 mg/mL for both instruments.

Results and Discussion

Identification of the mushrooms grown in this project was made by examination of the spores, fruiting bodies and the mature mushroom. Spores were examined for their color, shape, and size. The spores were purple to brown in color and elliptical to oblong elliptical in shape. They ranged is size from 6.7-8.2 µm by 12.6-15.0 µm. The fruiting bodies were examined mainly for color. The mature mushroom was examined for shape, size, color, texture, gill characteristics, and general appearance.

The original spore solutions were analyzed by TLC and by GC/MS. No psilocyn or psilocybin were detected in any of the spore solutions.

Mycelium growth was observed from 4 to 6 days. Fruiting bodies were observed from 24 to 48 days. The average amount of time for the primordia to appear was 32 days. Samples of mycelium were taken after 13 days of growth, 20 days of growth, and at various other days of growth. A total of 29 samples of the white mycelium growth were analyzed. No psilocyn or psilocybin was detected in any of these 29 samples. Nine of the 29 samples were confirmed by GC/MS, and again no psilocyn was detected.

Samples were analyzed after the first sign of growth of mycelium knots. A total of 22 mycelium knot samples were analyzed by TLC. Samples were considered to be consistent with a standard if their relative R_f value and their color matched the standard also spotted on the plate. Samples were considered to indicate a standard if their relative R_f value matched the standard but the color was not as dark as the standard spotted. Of the 22 mycelium knot samples, 17 were consistent with psilocyn. Of these 17 samples, 8 were also consistent with psilocybin and 1 indicated there was psilocybin in the sample. Four samples were consistent with the psilocybin standard spotted on the TLC plate, and one of these samples also indicated there was psilocyn in the sample. There was no psychoactive drugs detected in one of the samples.

Samples were analyzed after the first pinheads of the fruiting bodies were observed. A total of 25 samples of the pinheads were analyzed by TLC. All 25 samples were with the psilocyn standard spotted on the TLC plate. Of these 25 samples, 3 were also consistent with the psilocybin standard spotted and 3 indicated there was psilocybin in the sample (Table 1).

The 22 mycelium knot samples were also analyzed by GC/MS. In the inlet system of the gas chromatograph, thermal dephosphorylation of psilocybin occurs. As a result of this degradation of psilocybin to psilocyn, one is unable to differentiate the two by GC/MS. With this inability to differentiate psilocyn and psilocybin, it is unknown if the starting material contains psilocyn, psilocybin, or a mixture of both drugs. For this project, only a psilocyn standard was analyzed by GC/MS (Figs. 7-9). Samples were considered to be consistent with psilocyn if their retention time and mass spectral fragmentation pattern matched that of the psilocyn standard. Samples were considered to indicate psilocyn if their retention time was consistent with the psilocyn standard and contained the prominent ions, but were lacking ions in the total fragmentation pattern. Of these 22 mycelium knot samples, 12 were consistent with the psilocyn standard. Seven samples were found to indicate psilocyn, and there were three samples where psilocyn was not detected.

TABLE 1 - Results of thin layer chromatography (TLC).*

Sample Types	Total of Samples Analyzed	c/w Psilocyn and c/w Psilocybin	c/w Psilocyn and Indicates Psilocybin	c/w Psilocyn Only	c/w Psilocybin Only	c/w Psilocybin and Indicates Psilocyn	Not Detected
Spores	4						4
Mycelium	29						29
Mycelium knots	22	8	8	1	3	1	1
Pinheads	25	19	3	3			
Mushrooms	11	9	2				

* Results of thin layer chromatography (TLC) on the various stages of development of the *Psilocybe cyanescens* mushroom. TLC was carried out on 5 x 10 cm silica gel plates and developed with a 9:1 chloroform/methanol solution. Plates were visualized with p-DMAB spray reagent. Samples were considered to be consistent with (c/w) a standard if their relative R_f value and their color matched the standard also spotted on the plate. Samples were considered to indicate a standard if their R_f value matched the standard but the color was not as dark as the standard spotted.

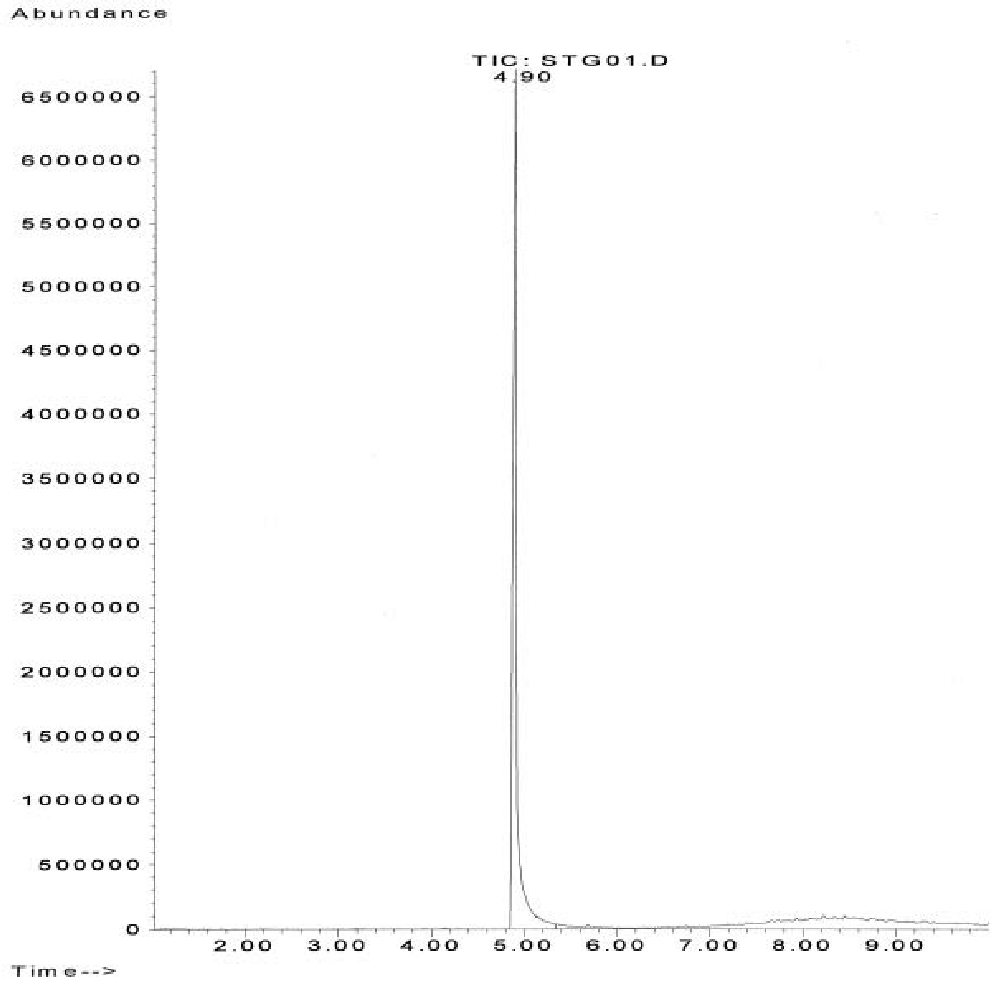


Fig. 7 - Total Ion Chromatogram (TIC) of psilocyn standard analyzed on a Hewlett Packard 5970 series mass selective detector (MSD) with the following parameters: injection port 265°C and detector temperature 280°C. Initial temperature 90°C, ramp rate 25°C/min and final temperature 300°C with a hold of 4 min.

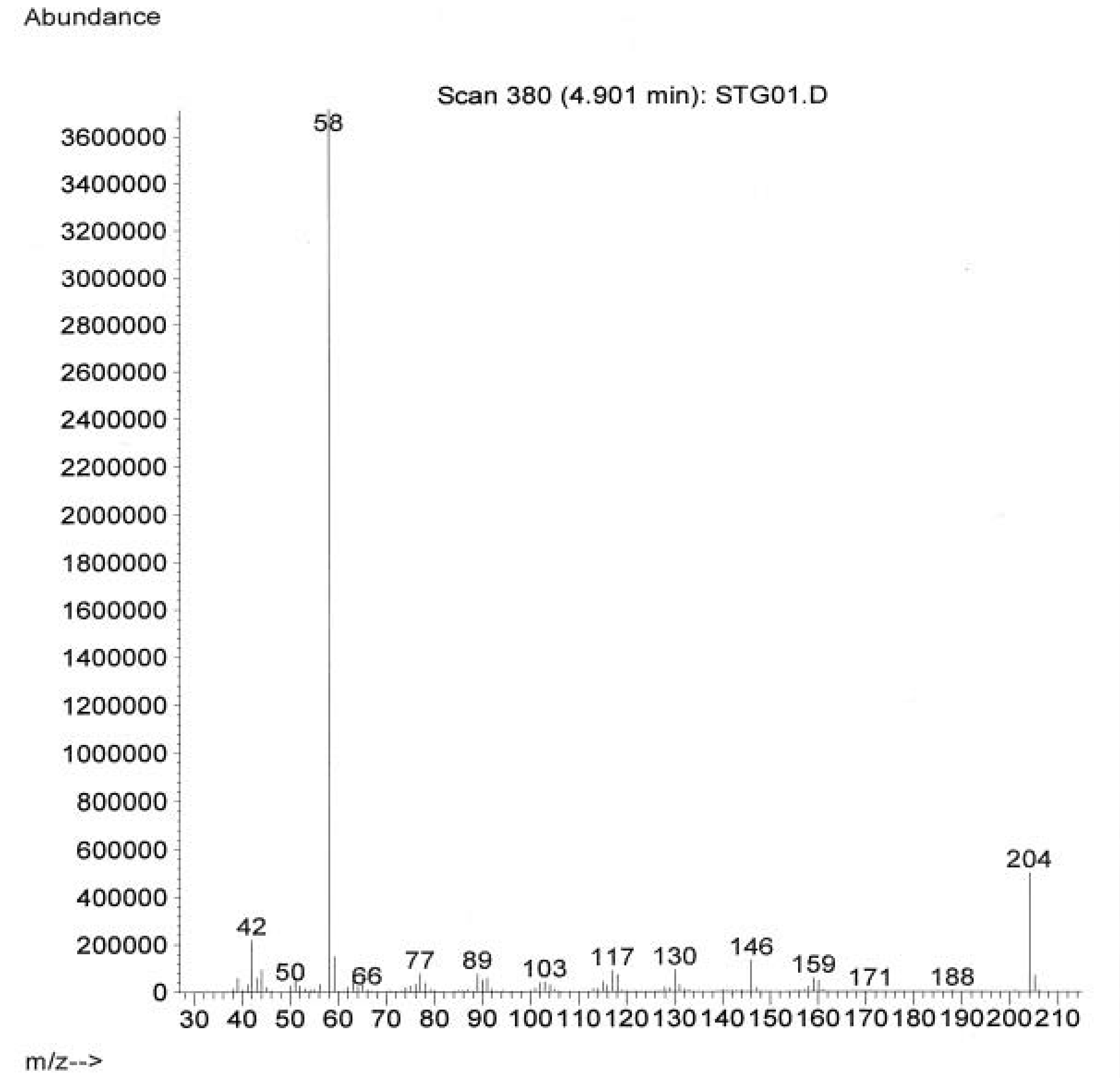


Fig. 8 - Mass spectrum of psilocyn standard analyzed on a Hewlett Packard 5970 series mass selective detector (MSD) with the following parameters: injection port 265°C and detector temperature 280°C. Initial temperature 90°C, ramp rate 25°C/min and final temperature 300°C with a hold of 4 min.

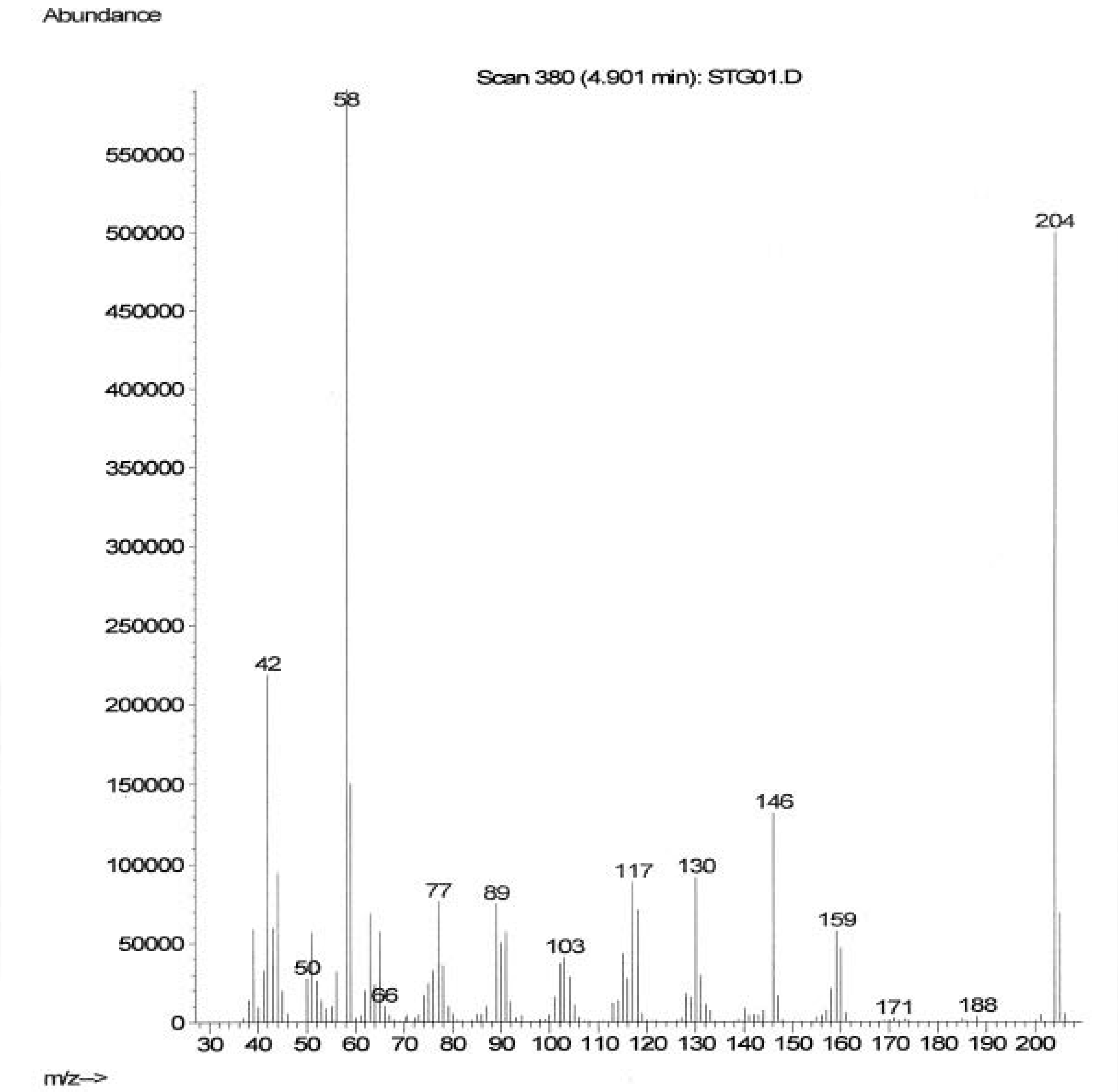


Fig. 9 - Expanded mass spectrum of psilocyn standard analyzed on a Hewlett Packard 5970 series mass selective detector (MSD) with the following parameters: injection port 265°C and detector temperature 280°C. Initial temperature 90°C, ramp rate 25°C/min and final temperature 300°C with a hold of 4 min.

The 25 "pinhead" samples were also analyzed by GC/MS. Of these 25 samples, 19 were consistent with the retention time and mass spectral fragmentation pattern as psilocyn. Three samples were found to indicate psilocyn and psilocyn was not detected in 3 samples (Table 2).

TABLE 2 - Results of gas chromatograph/mass spectrometer (GC/MS).*

Samples Types	Total # of Samples Analyzed	c/w Psilocyn	Indicates Psilocybin	Not Detected
Spores	4			4
Mycelium	9			9
Mycelium knots	22	12	7	3
Pinheads	25	19	3	3
Mushrooms	11	11		

* Results of gas chromatography/mass spectrometer (GC/MS) on the various stages of development of the *Psilocybe cyanescens* mushrooms. Samples were analyzed on Hewlett Packard gas chromatograph 5890 Series II interfaced with Hewlett Packard 5970 series mass selective detector (MSD) and the Hewlett Packard G1800A gas chromatograph detector system (GCD). Samples were considered to be consistent with (c/w) psilocyn if their retention time and mass spectral fragmentation pattern matched that of the psilocyn standard. Samples were considered to indicate psilocyn if their retention time was consistent with the psilocyn standard and contained the prominent ions, but were lacking ions in the total fragmentation pattern.

Samples of the mature mushroom were also analyzed. Eleven samples were analyzed by TLC and by GC/MS. All eleven samples were consistent with the psilocyn standard spotted on the TLC plate. Of these 11 samples, 2 also indicated psilocybin in the sample. All 11 samples analyzed on the GC/MS were consistent with the psilocyn standard (Figs. 10-12).

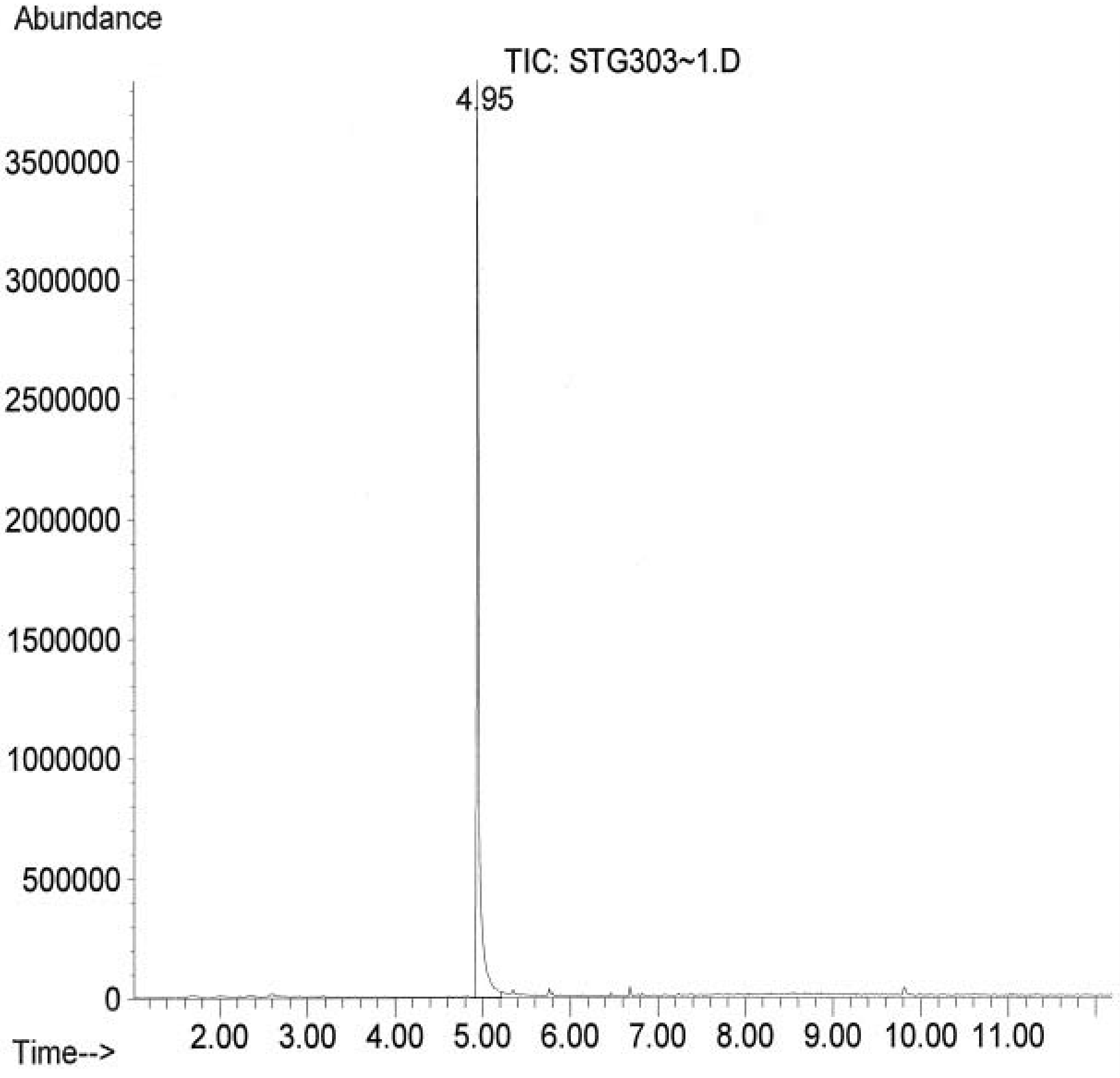


Fig. 10 - Total Ion Chromatogram (TIC) of a mushroom sample analyzed on a Hewlett Packard 5970 series mass selective detector (MSD) with the following parameters: injection port 265°C and detector temperature 280°C. Initial temperature 90°C, ramp rate 25°C/min and final temperature 300°C with a hold of 4 min.

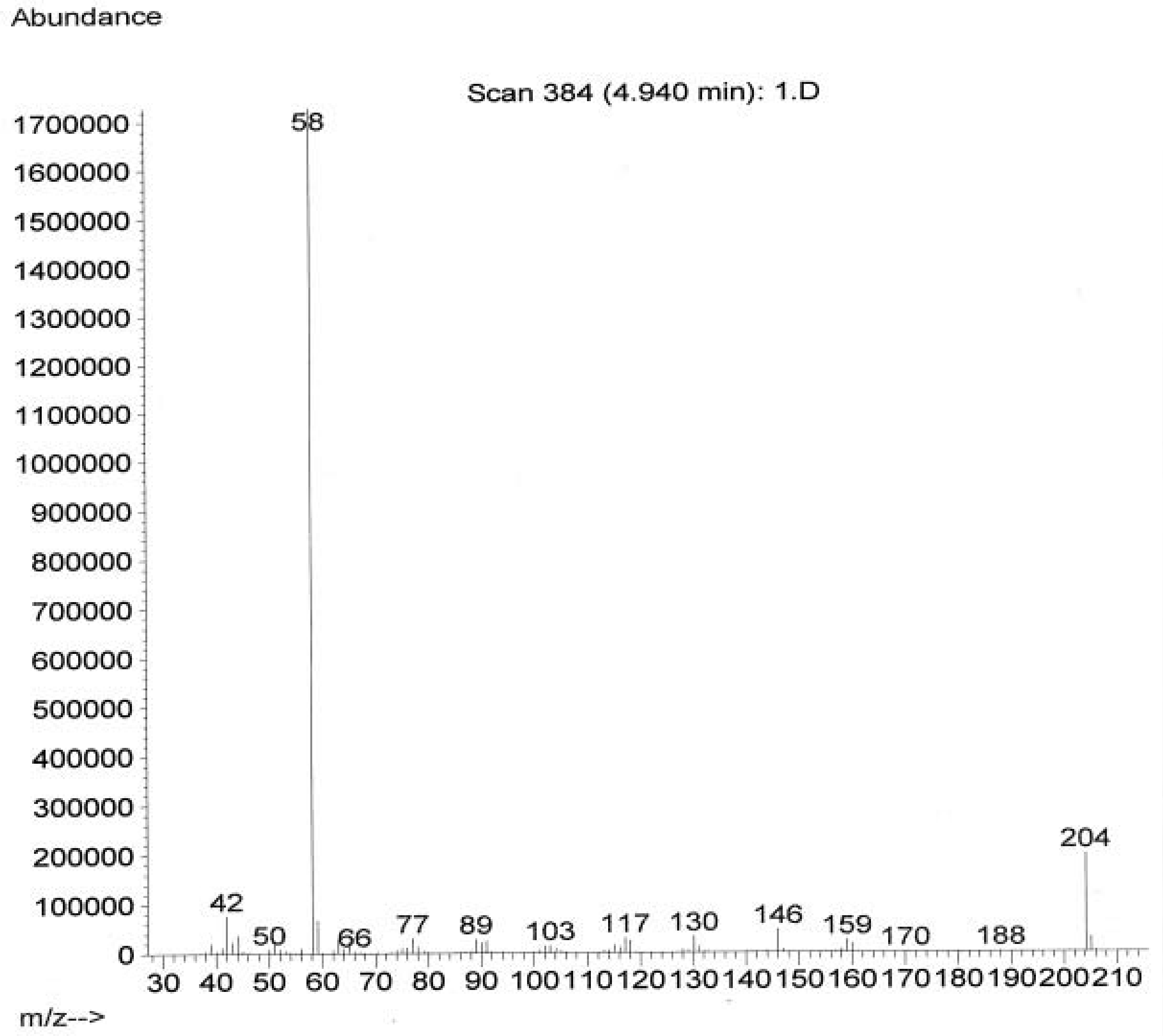


Fig. 11 - Mass spectrum of a mushroom sample analyzed on a Hewlett Packard 5970 series mass selective detector (MSD) with the following parameters: injection port 265°C and detector temperature 280°C. Initial temperature 90°C, ramp rate 25°C/min and final temperature 300°C with a hold of 4 min.

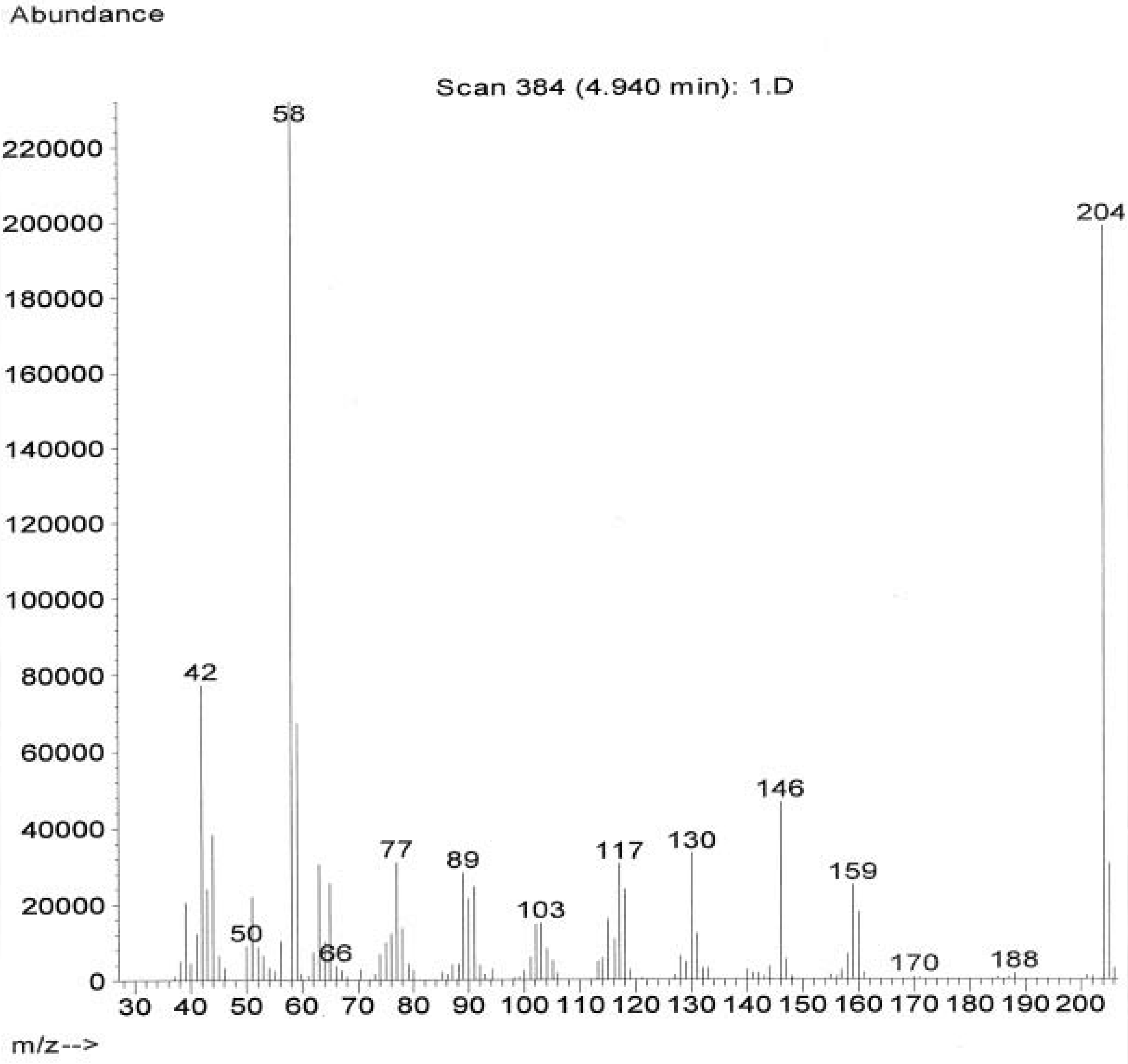


Fig. 12 - Expanded mass spectrum of a mushroom sample analyzed on a Hewlett Packard 5970 series mass selective detector (MSD) with the following parameters: injection port 265°C and detector temperature 280°C. Initial temperature 90°C, ramp rate 25°C/min and final temperature 300°C with a hold of 4 min.

There were some noticeable differences in the samples grown under indirect light versus the samples grown in the dark. All samples started to show mycelium growth at 4 days. The first signs of fruiting bodies were observed to be from 19 to 25 days in the samples that were grown under indirect light with the average being 21 days. The first signs of fruiting bodies were observed from 23 to 45 days for the samples that were grown in the dark, with the average being 26 days. The samples that were grown under indirect light had primordia which grew faster and larger. They were plump, yellow in color with brown tips. The samples that were grown in the dark had small white primordia that were skinny and long. The coloring was off-white with only a few having dark brown tips. The mushrooms that were grown under indirect light had thick stipes with yellowish to chestnut colored caps. The mushrooms that were grown in the dark had lighter stipes that were much skinner than the mushrooms grown in the light. The caps of the mushrooms grown in the dark were also lighter in color than the mushrooms grown under indirect light. Psilocyn and/or psilocybin was detected in the mycelium knots, the pinheads and the mature mushrooms of all samples grown either in the dark or the light.

Conclusion

The psychoactive drugs psilocyn and psilocybin were not detected in the mycelium, the earliest stage of development of the mushroom. These drugs were identified in the mycelium knots, the earliest stages of the fruiting body of the mushroom.

Light affects the growth of the *Psilocybe cyanescens* mushroom. This affect is apparent in the time of development and the appearance of the mushroom. Light affected the color and size of both the fruiting bodies and the mature mushroom. Light did not affect the presence of psilocyn or psilocybin in the early stages of the primordia or the mature mushrooms, nor did it affect the ability to detect these psychotropic drugs. It appears that the *Psilocybe cyanescens* mushrooms are not photosynthetic, but are photosensitive.

Acknowledgments

The author wishes to acknowledge Dr. David McLaughlin, Plant Biology Department, University of Minnesota for his time and assistance in identifying the mushroom, and his explanations about the classifications of fungi and the development of the mushroom. This project was supported by the Federal Bureau of Investigation, Minneapolis Office which generously provided the supplies.

References

1. Minnesota Statues Chapter 152.02. Schedules of controlled substances; Subdivision 2. Schedule I. The following items are listed in Schedule I: (3) Any material, compound, mixture or preparation which contains any quantity of the following hallucinogenic substances, their salts, isomers and salts of isomers, unless specifically excepted, whenever the existence of such salts, isomers, and salts of isomers is possible within the specific chemical designation: 3,4-methylenedioxyamphetamine; 4-bromo-2,5-dimethoxyamphetamine; 2,5-dimethoxyamphetamine; 4-methoxyamphetamine; 5-methoxy-3,4-methylenedioxyamphetamine; Bufotenine; Diethyltryptamine; Dimethyltryptamine; 3,4,5-trimethoxyamphetamine; 4-methyl-2,5-dimethoxyamphetamine; Ibogaine; Lysergic acid diethylamide; Marijuana; Mescaline; N-ethyl-3-piperidyl benzilate; N-methyl-3-piperidyl benzilate; Psilocybin; Psilocyn; Tetrahydrocannabinols; 1-(1-(2-thienyl) cyclyohexyl) piperidine; N-ethyl-1-phenyl-cyclohexylamine; 1-(1-phenylcyclohexyl) pyrrolidine.
2. Kaul TN. Introduction to mushroom science. Enfield, New Hampshire: Science Publishers, Inc., 1997.
3. McKnight KH and McKnight VB. A field guide to mushrooms. Boston: Houghton Mifflin Company, 1987.
4. Rumack BH and Salzman E. Mushroom poisoning: diagnosis and treatment. West Palm Beach, Florida: CRC Press, Inc., 1978.
5. Ammirati JF, Traquair JA, and Horgen PA. Poisonous mushrooms of the Northern United States and Canada. Minneapolis: University of Minnesota Press, 1985.
6. Guzmán G. The genus *Psilocybe*. Nova Hedwigia: Beih, 1983;74:1-439.
7. Guzmán G. Supplement to the monograph of the genus Psilocybe. In: Petrini O and Horak E, eds., Taxonomic monographs of Agaricales. Bibliotheca Mycologica 1995;159:91-141.
8. Singer R and Smith AH. Mycological investigations on teonanácatl, the Mexican hallucinogenic mushroom: Part II. A taxonomic monograph of Psilocybe, section Caerulescentes. Mycologia 1958;50:262-303.
9. Stamets P and Chilton JS. The mushroom cultivator. Olympia, Washington: Agarikon Press, 1983.
10. Psylocybe Fanaticus (PFTek), 1996.

Additional information and reprint requests:
Susan T. Gross
Minnesota Forensic Science Laboratory
1246 University Avenue
St. Paul, MN 55104

Presence of Phenylethylamine in Hallucinogenic Psilocybe Mushroom: Possible Role in Adverse Reactions

by

Olof Beck[1,*], Anders Helander[2], Christine Karlson-Stiber[3], and Nikolai Stephansson[1]

Journal of Analytical Toxicology, Vol. 22, January/February 1998

original source: http://jat.oxfordjournals.org/content/22/1/45.full.pdf
backup source: http://www.psilosophy.info/resources/45.full.pdf

[*] Address for correspondence: O. Beck, Department of Clinical Pharmacology, Karolinska Hospital, 5-171 76 Stockholm, Sweden

[1] Department of Clinical Pharmacology, Karolinska Hospital, Stockholm, Sweden;
[2] Department of Clinical Neuroscience, Karolinska Institute, St. Görans Hospital, Stockholm, Sweden; and
[3] Swedish Poisons Information Centre, Karolinska Hospital, Stockholm, Sweden

Table of Contents:

- **Abstract**
- **Introduction**
- **Experimental**
  - Chemicals
  - Specimens
  - Chemical analysis
  - Clinical cases
- **Results**
  - Chemical investigation
  - Clinical symptoms of intoxication
  - Discussion
- **Acknowledgments**
- **References**

Abstract

The use of mushrooms containing the hallucinogenic substance psilocybin for intentional intoxication is relatively common. Occasionally, this results in adverse reactions with typical tachycardia that is not evidently caused by psilocybin. This study demonstrates the presence of phenylethylamine in the species Psilocybe semilanceata using gas chromatography-mass spectrometry and shows that the amount of this substance may vary much more than that of psilocybin. The highest amount of phenylethylamine (146 µg/g wet weight) was observed in mushrooms from a case of three young men hospitalized because of adverse reactions. Comparison of the symptoms observed in clinical cases of magic mushroom intoxication with those after intake of pure psilocybin or phenylethylamine suggests that phenylethylamine might have a role in the development of adverse reactions to *Psilocybe* mushroom intake.

Introduction

Magic mushrooms, which contain the hallucinogenic indole derivative psilocybin (Figure 1), are naturally occurring throughout the world. Abuse of hallucinogenic mushrooms is relatively common, and among young adults, it is one of the most frequently reported illicit drugs after cannabis[1-5]. Apart from inducing drug-seeking behavior, such abuse entails a risk of adverse effects that require hospitalization. Pronounced adverse reactions after ingestion of psilocybin-containing mushrooms are reported to occur with a frequency of 13%[6]. However, the exact mechanism of action and pharmacologic profile of pure drug compared with mushroom preparations remain to be fully elucidated[6,7].

Prison inmates discovered to be using magic mushrooms for intentional intoxication tested positive in the urine drug screening for the amphetamine class of compounds when a polyclonal antibody assay kit with a broad substrate reactivity was used. Because the assay does not detect psilocybin or its active metabolite, psilocin, the presence of an unknown compound structurally related to amphetamine was indicated. We therefore undertook this investigation of *Psilocybe semilanceata* (Liberty cap), which is the most common indigenous psilocybin-containing mushroom species.

Experimental

Chemicals

Phenylethylamine (PEA) hydrochloride was obtained from Sigma Chemical (St. Louis, MO) and psilocybin from Sandoz (Basel, Switzerland).

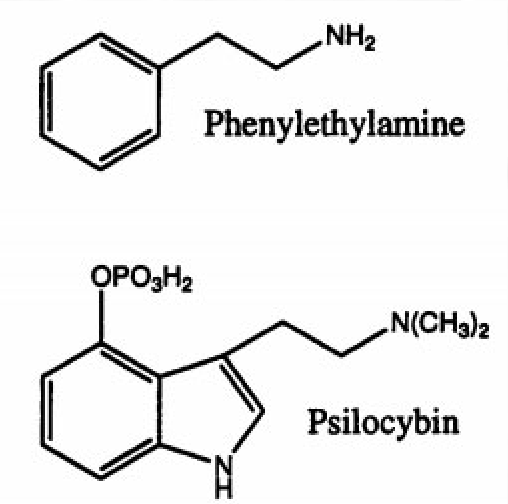


Figure 1. Chemical structures of phenylethylamine (PEA) and psilocybin.

Specimens

Wild mushrooms were obtained fresh directly from different locations in Sweden and in connection with a case of three young men (ages 21-25 years) being hospitalized because of adverse reactions after eating magic mushrooms. The identity of the studied mushrooms as *Psilocybe semilanceata* was confirmed by macroscopic and microscopic inspection. Specimens were either stored refrigerated for up to one week and then transferred to plastic containers and stored in methanol at -20°C or air dried and stored in a closed container at ambient temperature. The specimens were prepared for analysis by disintegration of tissue in methanol (1-5 g mushroom/25 mL methanol) using an Ultra-Turrax T25 (Janke & Kunkel, Staufen, Germany). Repeated freezing and thawing or sonication of tissue did not increase the recovery of substances (results not presented).

Chemical analysis

High-performance liquid chromatographic assay of psilocybin was performed on diluted (1000-fold with water) mushroom extracts using reversed-phase chromatography (150 x 4.0 mm Nucleosil C_{18}, 3 µm) with fluorescence detection (Shimadzu 551, Shimadzu Corp., Kyoto, Japan) and excitation and emission wavelengths at 270 and 330 nm, respectively. The mobile phase was composed of 10 mmol/L sodium phosphate, pH 3, with 6% (v/v) acetonitrile and 1% (v/v) methanol, and the flow rate was 1.0 mL/min. Aliquots of 20 µL were injected, and the detector response was linear in the concentration range used (0-1.4 mg/L). The intra-assay coefficient of variation (CV) was < 2% at a concentration of 0.24 mg/L.

Gas chromatographic (GC) analysis of PEA was performed using an HP 5890 GC (Hewlett-Packard, Palo Alto, CA) with a nitrogen-phosphorus detector (NPD) and a 25-m Chrompack WCOT CP-Sil 8CB fused-silica column (Chrompack Int. BV, Middelburg, The Netherlands) with a 0.25-ram internal diameter and 0.25-µm film thickness. Aliquots (10-500 µL) of the methanolic mushroom extracts were diluted with 3 mL phosphate buffer, and after addition of 0.6 mL 1 mol/L NaOH, they were extracted with 5 mL of 3% isopropanol in chloroform. The organic phase was extracted with 1 mL 0.1 mol/L H_2SO_4 and the aqueous phase transferred to new tubes. The extracts were alkalinized by addition of 0.2 mL 1.5 mol/L NaOH and extracted with 0.15 mL chloroform. Aliquots (1-2 µL) of the organic layer were injected into the GC system. The intra-assay CV was 5.0% at the level of 550 µg/L.

Gas chromatographic-mass spectrometric (GC-MS) analysis of PEA was performed using an ITS 40 WITNESS system (Finnigan MAT, San Jose, CA). Aliquots (10-100 µL) of the mushroom methanol extracts were diluted with 3 mL 0.1 mol/L sodium phosphate buffer, pH 6.0, and applied onto Certify Bond-Elut (Analytichem, Harbor City, CA) solid-phase extraction cartridges (prepared with methanol and 0.1 mol/L sodium phosphate buffer, pH 6.0). The columns were washed with 1 mL 1.0 mol/L acetic acid and 6 mL methanol and finally eluted with 2 mL ethyl acetate containing 2% ammonia. The volume of the eluates were reduced to approximately 100 µL by evaporation, and the residue was treated with 70 µL heptafluorobutyric anhydride (Supelco, Bellefonte, PA) at 75°C for 60 min. After cooling, 0.5 mL ethyl acetate was added, and 1-µL aliquots were injected into the GC-MS system.

Clinical cases

Clinical data were collected from hospital case records sent to the Swedish Poisons Information Centre concerning *Psilocybe* mushroom poisoning during the period over 1980-1995. The total number of patients was 25, of which 21 were between 19 and 27 years of age. Five of the cases occurred in 1995.

Results

Chemical investigation

Psilocybin was detected in all mushrooms identified as *Psilocybe semilanceata*. The identification of PEA (Figure 1) in mushroom extracts was based on coelution with authentic compound in the GC system with components in underivatized form, and in the GC-MS system (Figure 2) with components in derivatized form. PEA was the major component seen in the chromatograms from both the GC and GC-MS analyses. In addition, mass spectral identification of PEA was performed after derivatization with heptafluorobutyric anhydride (Figure 3). The agreement of GC and GC-MS data with authentic compound confirmed the identity of PEA in the mushroom specimens.

PEA was readily detectable in all mushroom specimens. The amount of PEA was always less than that of psilocybin, but a much greater variability in PEA content was demonstrated (Figure 4). However, there was good agreement between samples collected in the same location and at the same time (see samples 2a-c in Figure 4). Sample 4 in Figure 4 contained the highest amount of PEA (146 µg/g wet weight) and came from a clinical case of hospitalization after the ingestion of magic mushrooms.

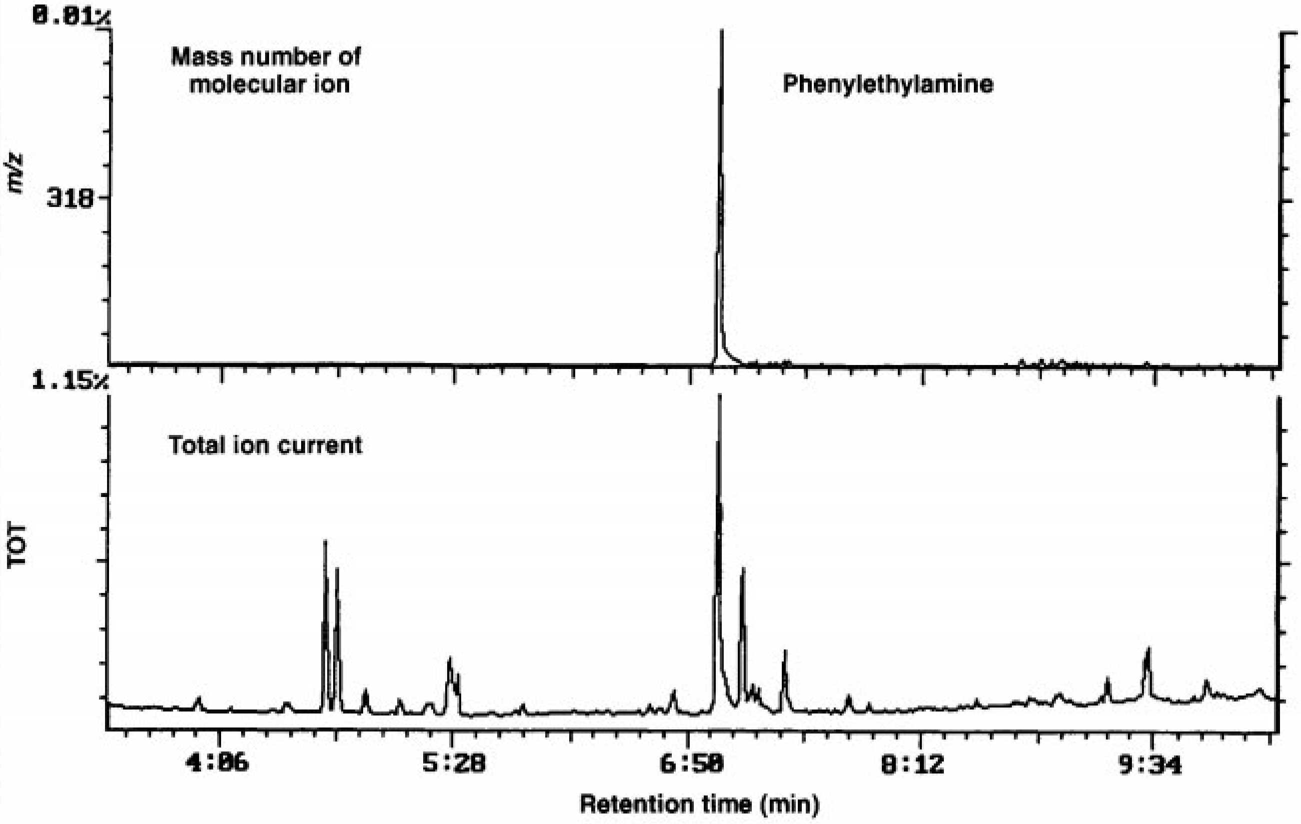


Figure 2. Total ion (lower trace) and selected ion (upper trace) chromatograms from the GC-MS analysis of a *Psilocybe* mushroom extract. The peak occurring at the retention time of phenylethylamine (PEA) is predominating. A peak at the same retention time is also seen in the trace for *m/z* 318 which corresponds to the molecular ion of PEA.

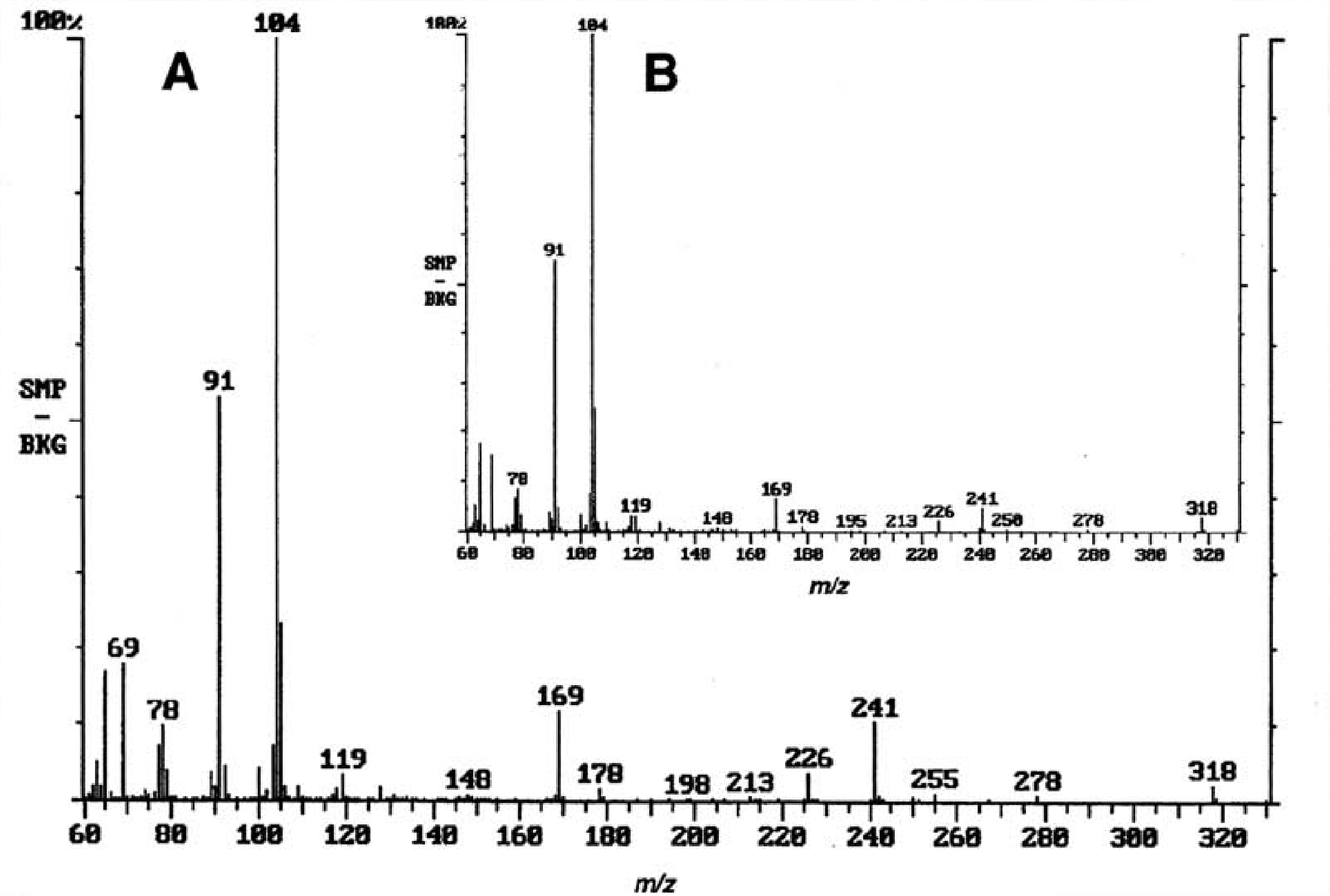


Figure 3. Electron impact mass spectra of unknown in mushroom extract (B) and reference phenylethylamine (A) as heptafluorobutyryl derivative.

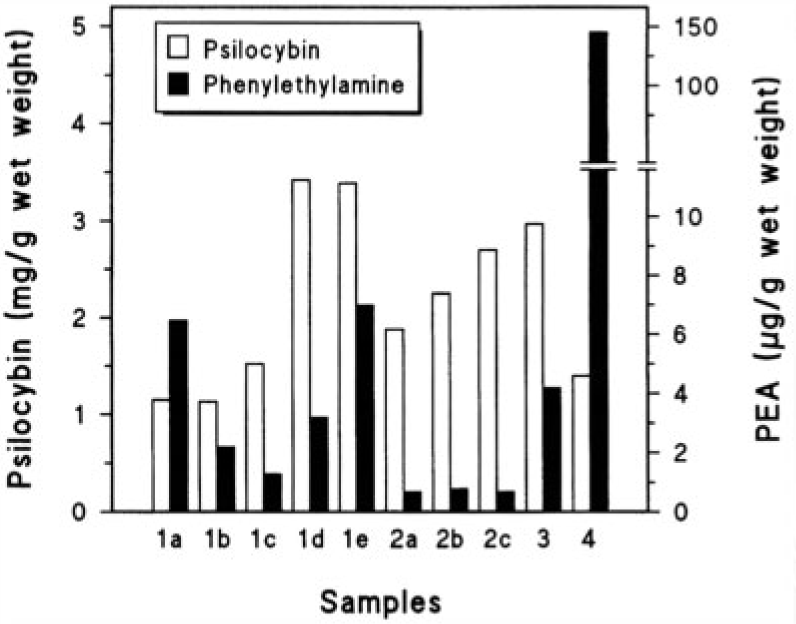


Figure 4. Psilocybin and phenylethylamine (PEA) levels in *Psilocybe semilanceata* mushrooms collected at four different locations (1-4) in Sweden. Multiple collections from a single location are indicated by alphabetic notation (a-e). Sample 4 was obtained from a case of mushroom intoxication that led to adverse reactions and hospitalization.

Clinical symptoms of intoxication

Recorded symptoms in hospitalized patients with adverse reactions to *Psilocybe* mushroom ingestion reported to the Swedish Poisons Information Centre are listed in Table 1. The results are presented together with data compiled from the literature regarding clinical effects of mushroom ingestion as well as of pure psilocybin and PEA substances.

Table 1. Principal Clinical Features Following Ingestion of *Psilocybe semilanceata* Authentic Psilocybin, and Phenylethylamine (PEA).

Signs and symptoms	***Psilocybe* mushroom** 25 patients[*] *n*(%)	71 patients[**] *n*(%)	**Psilocybin** 14 volunteer subjects[***] *n*(%)	**PEA** 3 patients[****] *n*(%)
Visual hallucinations	13 (52)	53 (75)	12 (86)	-
Euphoria	6 (24)	9 (13)	10 (72)	-
Anxiety	10 (40)	41 (58)	9 (64)	2 (67)
Agitation	4 (16)	14 (20)	-	-
Mydriasis	17 (68)	60 (85)	14 (100)	-
Tachycardia	11 (44)	20 (28)	1 (7)	3 (100)
Hypertension	4 (16)	18 (25)	2 (14)	-
Hyperreflexia	3 (12)	28 (39)	-	-
Flushing	3 (12)	11 (15)	4 (29)	-
Nausea, vomiting	3 (12)	21 (37)	6 (43)	3 (100)
Flashbacks	2 (8)	2 (3)	-	-

[*] Summary of hospital case records at the Swedish Poisons Information Centre in 1980-1995.
[**] References 19 and 20.
[***] Reference 21.
[****] Reference 18.

Discussion

The present study provides original evidence for the presence of the pharmacologically active substance PEA in *Psilocybe semilanceata*. PEA, the decarboxylated product of the ubiquitous amino acid phenylalanine, has received considerable interest within psychiatric research[8]. Increased formation and excretion of PEA has been associated with psychosis in patients and implicated in the etiology of mental disease[9,10]. Food is an exogenous source of PEA, which is present in chocolate, cheese, and wine, and has been implicated in the precipitation of dietary migraine[11]. However, to our knowledge, PEA has not been previously identified in any species of mushroom.

The pharmacological mode of action of PEA is not fully elucidated, but it has been reported to exert amphetamine-like activity and to have peripheral sympathomimetic effects[6,7,12,13]. The neurophysiological effects have been related to the enhancement of catecholaminergic activity[8]. Systemic administration of PEA produces behavioral effects in rats and mice[14]. The serotonergic system is thought to mediate the neurophysiological responses to hallucinogens[15,16]. It is therefore interesting to note that serotonin receptor blockade can potentiate the behavioral effects of PEA[17]. Although PEA resembles amphetamine structurally, it is seemingly not a substance with potential for abuse. However, despite substantial literature on the physiological functions of PEA, available data on its pharmacological effects in humans are more limited. In three reported cases in which PEA was unintentionally taken instead of amphetamine, the adverse reactions resulted in hospitalization[18]. The symptoms observed in these specific cases are listed in Table 1 with our own and previously published clinical data from Psilocybe mushroom intoxications[19,20] and a controlled experiment using pure psilocybin substance[21]. There are appreciable differences between the symptoms observed after psilocybin ingestion and mushroom intoxication. Visual hallucinations and euphoria occur less frequently after mushroom ingestion, which might be explained by a bias in selection of only those patients admitted to the hospital. However, tachycardia was observed in only 1 of 14 volunteer subjects given pure psilocybin, and this small influence on the heart rate has been observed by others[22,23]. In contrast, tachycardia is a common finding in patients intoxicated by *Psilocybe* mushrooms, an observation that also points toward a role for PEA in the adverse effects of such mushroom ingestion.

Within the human body, PEA is formed at a high rate, but it is also rapidly inactivated through metabolic breakdown by monoamine oxidase (MAO), which leads to the formation of phenylacetic acid[8]. PEA is metabolized mainly by the MAO-B isozyme, which is found in serotonergic regions of the human brain[24]. Ingested psilocybin readily becomes dephosphorylated to psilocin, which is further inactivated by MAO, leading to formation of 4- hydroxyindoleacetic acid[25]. However, this has been shown in the rat to be a minor metabolic pathway, which indicates that psilocin is a poor substrate for MAO. Whether psilocin is a MAO-A or B substrate has not been clarified, but the effect of its structural analogue *N,N*-dimethyltryptamine (DMT) is greatly enhanced by the coingestion of MAO inhibiting substances[26]. Thus, although speculative, a metabolic interaction between PEA and psilocin through competitive inhibition of MAO is possible.

The presence of PEA in a common species of hallucinogenic mushrooms may have implications for drugs-of-abuse testing because we have occasionally detected PEA in urines testing positive for the amphetamine class of compounds by immunoassay technique (unpublished observation). As a consequence, ingestion of magic mushrooms should be considered in such cases. Today, *Psilocybe* mushroom abuse is generally not screened for in drugs-of-abuse testing despite the reports of common usage[1-5]. Using reagent kits sensitive to PEA and including psilocin in the verification assay might offer a means of detecting this kind of drug abuse.

In conclusion, we have shown that PEA is readily present in the hallucinogenic mushroom species *Psilocybe semilanceata*. The high amount of PEA observed in mushrooms obtained from one case of intoxication suggests that PEA may contribute to the adverse reactions. The much higher variability in PEA content as compared with psilocybin is intriguing because it could explain why adverse reactions occur only in certain cases. Future studies will need to determine the factors influencing PEA formation in *Psilocybe semilanceata* and determine if PEA is present in other common hallucinogenic mushroom species being used for intoxication.

Acknowledgments

We kindly thank Dr. Åke Strid (Sektionen för Kryptogarnbotanik, Naturhistoriska Riksmuseét, Stockholm) for mushroom collection and for expert assistance with the identification and Lennart Wessberg (Sollefteå) and Svengunnar Ryman (The Herbarium, Uppsala University, Uppsala) for providing us with mushroom samples. Elisabeth Gräinsström is acknowledged for initiating this study by the observation of mushroom use by prison inmates.

References

1. C. Smith and D. Nutbeam. Adolescent drug use in Wales. *Brit. J. Addict.* 87: 227-233 (1992).
2. J.F. Lassen, N.F. Lassen, and J. Skov. Consumption of hallucinogenic mushrooms containing psilocybine by young people. *Ugeskr. Laeger* 154:2678-2681 (1992).
3. J.W. Allen and M.D. Merlin. Psychoactive mushroom use in Koh Samui and Koh Pha-Ngan, Thailand. *J. Ethnopharmacol.* 35: 205-228 (1992).
4. M.J. Cuomo, P.G. Dyment, and V.M. Gammino. Increasing use of "ecstasy" (MDMA) and other hallucinogens on a college campus. *J. Amer. Coll. Health* 42: 271 -274 (1994).
5. E. Webb, C.H. Ashton, P. Kelly, and F. Kamali. Alcohol and drug use in UK university students. *Lancet* 348:922-925 (1996).
6. R.H. Schwartz and D.E. Smith. Hallucinogenic mushrooms. *Clin. Ped.* 27: 70-73 (1988).
7. A.T. Shulgin. Psilocybin. *J. Psychedelic Drugs* 12: 79 (1980).
8. H.C. Sabelli and J.I. Javaid. Phenylethylamine modulation of affect: therapeutic and diagnostic implications. *J. Neuropsychiatry Clin. Neurosci.* 7: 6-14 (1995).
9. M.E. Wolf and A.D. Mosnaim. Phenylethylamine in neuropsychiatric disorders. *Gen. Pharmacol.* 14:385-390 (1983).
10. R.L. O'Reilly and B.A. Davis. Phenylethylamine and schizophrenia. *Prog. Neuro-Psychopharmacol. Biol. Psychiatry* 18: 63-75 (1994).
11. J.P. Chaytor, B. Crathorne, and M.J. Saxby. The identification and significance of 2-phenylethylamine in foods. *J. Sci. Food Agric.* 26:593-598 (1975).
12. P. Mantegazza and M. Riva. Amphetamine-like activity of β-phenylethylamine after a monoamine oxidase inhibitor in vivo. *J. Pharmacol.* 15:472-478 (1963).
13. H.C. Sabelli and W.J. Giardina. Amine modulation of affective behavior. In *Chemical Modulation of Brain Function*, H.C. Sabelli, Ed., Raven, New York, NY, 1972, pp 225-259.
14. J.M. Saavedra, B. Heller, and E. Fischer. Antagonistic effects of tryptamine and β-phenylethylamine on the behaviour of rodents. *Nature* 226:868 (1970).
15. R.A. Glennon, M. Titeler, and J.D. McKenney. Evidence for $5HT_2$ involvement in the mechanism of action of hallucinogenic drugs. *Life Sci.* 35:2505-2511 (1984).
16. R.J. Strassman. Human hallucinogen interactions with drugs affecting serotonergic neurotransmission. *Neuropsychopharmacology* 7:241-242 (1992).
17. A.J. Goudie and C. Buckland. Serotonin receptor blockade potentiates behavioural effects of β-phenylethylamine. *Neuropharmacology* 21:1267-1272(1982).
18. E. Ortman and G. Steen. Phenylethylamine - a hazardous substitute for amphetamine in the narcotics market. *Lakartidningen* 70:118-119 (1973).
19. N.R. Peden, A.F. Bissett, K.E.C. Macaulay, J. Crooks, and A.J. Pelosi. Clinical toxicology of "magic mushroom" ingestion. *Postgrad. Med. J.* 57:543-545 (1981).
20. N.R. Peden, S.D. Pringle, and J. Crooks. The problem of psilocybin mushroom abuse. *Hum. Toxicol.* 1:417-424 (1982).
21. S. Malitz, H. Esecover, B. Wilkens, and P.H. Hoch. Some observations on psilocybin, a new hallucinogen, in volunteer subjects. *Comp. Psychiatry* 1:8-17 (1960).
22. H. Isbell. Comparison of the reactions induced by psilocybin and LSD-25 in man. *Psychopharmacologia* 1:29-38 (1959).
23. L.E. Hollister, J.J. Prusmack, J.A. Paulsen, and N. Rosenquist. Comparison of three psychotropic drugs (psilocybin, JB-329, and IT-290) in volunteer subjects. *J. Nervous Mental Dis.* 131: 428-434 (1960).
24. M.D. Berry, A.V. Juorio, and I.A. Paterson. The functional role of monoamine oxidases A and B in the mammalian central nervous system. *Prog. Neurobiol.* 42:375-391 (1994).
25. F. Kalberer, W. Kreis, and J. Rutschmann. The fate of psilocin in the rat. *Biochem. Pharmacol.* 11:261-269 (1962).
26. D.J. McKenna, G.H.N. Towers, and F. Abbott. Monoamine oxidase inhibitors in South American hallucinogenic plants: tryptamine and β-carboline constituents of *ayahuasca*. *J. Ethnopharmacol.* 10:195-223 (1984).

Psilocybian Mycetismus with Special Reference to Panaeolus

by

Steven Hayden Pollock, M.D., M.S.*

Journal of Psychedelic Drugs

Vol. 8 (No. 1) Jan-Mar, 1976

© Steven Hayden Pollock

original source: https://bibliography.maps.org/resources/download/15727

*Division of Alcohol and Drug Abuse, Department of Pharmacology, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Dr. San Antonio, Texas 78284.

Table of Contents:

A sequence of "peculiar" cases
Panaeolian chemo-taxonomy
The bluing phenomenon and other metabolic considerations
Modern use of Panaeolus mushrooms
The trip beyond ecstasy, psycho-mycological frontiers
Acknowledgments
References

Steven Hayden Pollock. Photo by Linda Deer

A sequence of "peculiar" cases

Mushroom intoxications have been noted throughout history. One 11th Century episode in Japan allegedly involved some Buddhist nuns who became lost in the forest. After eating some wild mushrooms, they felt compelled to dance. Some woodcutters who were also lost happened along, indulged in the peculiar fungus and joined the nuns in dancing. This tale has been handed down in the *Konjaku Monogatori* ("Tales of Long Ago") and the legendary toadstools became known first as dancing mushrooms (*maitake*) and later as laughing mushrooms (*waraitake*) (Sanford 1972; Wasson 1973). While the identity of the causative fungus is unknown, *Panaeolus papilionaceus* (Fries) Quélet has been suggested as one possible candidate (Sanford 1972; Wasson 1973). Sanford (1972) notes that Seichii in his *Genshoku Nibon kinrui zukan* (Icones of Japanese Fungi) quotes a 1917 episode from a newspaper article:

> Mr. Taniguchi (age 31), Mrs. Taniguchi [age 35], and Mrs. Taniguchi's brother, Buntsuke (age 41), treated themselves to two bowls of mushroom soup while the elder Mrs. Taniguchi (age 71) ate one bowl with only two or three mushrooms in it. They had hardly eaten when first Mrs. Taniguchi and then Mr. Taniguchi began to feel odd. Mr. Taniguchi then went next door to ask someone to fetch a doctor. When he got back home he found his wife dancing around stark naked, playing an imaginary *shamisen*, and laughing raucously. Even as he stood there amazed at all the uproar he found that he too was falling into the same crazed state. The older brother also eventually began to dance crazily. The intoxication of Taniguchi's mother was weaker, however, and though she became muddled she never lost complete control of her senses. She did, however, keep repeating the same words over and over and went to every house in the neighborhood apologizing throughout the night for "preparing such a poor meal" and thanking everyone "for putting up with it."

Dr. Seichii was "able to obtain samples of the mushrooms involved and solidly identify them as none other than *Panaeolus papilionaceus*" (Sanford 1972).

In 1816 a poor man gathered what he believed to be common ordinary meadow mushrooms in Hyde Park, London. Soon after commencement of his stewed mushroom meal, "he was, to use his own expressions suddenly seized with a dimness or mist before his eyes, lightness and giddiness of his head, with general trembling and sudden loss of power, - so much so, that he nearly fell off the chair; to this succeeded, loss of recollection; he forgot where he was, and all the circumstances of his case." Later it was observed that the patient "suffered much from giddiness, and was greatly inclined to sleep; his pulse was slow and feeble." The mushrooms were identified as *Agaricus campanulatus* Linnaeus, the cause of a similar case that had been reported in the September 1815 issue of *Gentleman*'s *Magazine* (Glen 1816). *A. campanulatus* later become known as *Panaeolus campanulatus* (Fries ex Linnaeus) Quélet and its reputation of possessing sedative properties persisted into the 20th Century (McIlvaine 1973). Thus Krieger (1911) suspected this species to have caused an intoxication following ingestion of what the victim presumed were shaggy manes (*Coprinus comatus*). *Panaeolus papilionaceus*, in contrast, had gained quite a different reputation in North America (McIlvaine 1973):

> I have seen it produce hilarity in a few instances, and other mild symptoms of intoxication, which were soon over, and with little reaction. But I have seen, at table, the same effects from eating preserved peaches and preserved plums which had fermented. Many personal testings have been without effect. Testings upon others vary with the individuals. The fungus seems to contain a mild stimulant. It is not dangerous, but should be eaten with caution. Being of small size, and not a prolific species, quantities of it are difficult to obtain. Moderate quantities of it have no effect whatever.

In 1914, a classic case of psilocybian mycetismus occurred in Maine after Mr. W., a middle-aged avid mycophile, "strictly temperate in his habits," and his adult niece consumed mushrooms (perhaps a pound fresh weight) fried in butter and which he had identified as the butterfly *Panaeolus*, i.e., *P. papilionaceus* (Verrill 1914).

> Next, say about half an hour after eating, both of us had an irresistible impulse to run and jump,

> which we did freely. Soon both of us became very hilarious, with an irresistible impulse to laugh and joke immoderately, and almost hysterically at times. The laughing could be controlled only with great difficulty; at the same time we were indulging extravagantly in joking and what seemed to us funny or witty remarks. Mr. Y., who was with us, said that some of the jokes were successful; others not so, but I can not remember what they were about.

Later during the experience Mr. W.

> had a very disagreeable illusion. Innumberable human faces, of all sorts and sizes, but all hideous, seemed to fill the room and to extend off in multitudes to interminable distances, while many were close to me on all sides. They were grimacing rapidly and horrible and undergoing contortions, all the time growing more and more hideous. Some were upside down.

Eidetic imagery was very prominent as the

> faces appeared in all sorts of bright and even intense colors - so intense that I could only liken them to flames of fire, in red, purple, green and yellow colors, like fireworks.

Macropsia was also evident as Mr. W. felt his body "elongate upward to the ceiling ... like Jack's bean-stalk..." Soon he experienced his body collapse to its natural height. "The entire experience lasted six hours. No ill effects followed" (Verrill 1914).

In 1916, a *Panaeolus* species appeared in a New York mushroom house and surprisingly was consumed unnoticed amongst commercial *Agaricus*. Murrill (1916), believing this "dangerous" mushroom to be a new species, designated it *P. venenosus* Murrill. Shortly thereafter, Douglass (1917), a surgeon, described the experience resulting after his maid, wife, and he himself had eaten some *Panaeolus* (later determined by Murrill to be *P. semiglobatus* Murrill *nomen nudum*) gathered in a cucumber bed in Maine. Despite the fact that Douglass attempted management with intravenous morphine and atropine, he later concluded that the "pilzatropin" contained in *Panaeolus campanulatus*, *retirugis*, *semiglobatus*, and *venenosus* produced symptoms that were "purely those of a stimulated nervous system" and could not "conceive that a full meal of these mushrooms could cause death" (Douglass 1917). Without citing any specific cases and apparently unaware of the mushroom poisoning classification proposed by Douglass, Ford (1973) coined the categorical term "Mycetismus Cerebralis" for this "peculiar poisoning" and mentioned *P. campanulatus* and *P. papilionaceus* as being responsible.

Reports of accidental *Panaeolus* poisonings have not been limited to Europe and the U.S. In the early 1940's a rash of such intoxications occurred in Australia. *Panaeolus ovatus* Cooke & Massee became known as the "hysteria fungus" since patients were sometimes admitted to the hospital after beginning "to feel numbness in arms and legs, to see coloured lights and to become almost hysterical" (Trotter 1944). One patient was quoted as having felt as if he "had been on a bender." Treatment generally consisted of administration of an emetic such as zinc sulfate and hospitalization was for never more than overnight.

In 1957, between a half and one hour after enjoying some little dung-inhabiting mushrooms, a victim of mushroom poisoning in Bremen, Germany began to notice "glimmers" before his eyes. Three attempts at vomiting were unsuccessful and he felt weak with occasional shortness of breath. He was hospitalized and given charcoal in four glasses of water and an injection of apomorphine to induce vomiting. He received gastric lavage and intravenous fluids. After a two day stay, all was in order. The fungus responsible was identified afterwards as *P. papilionaceus* (Bull. ex Fr.) Quélet (von Neuhoff 1958).

In August, 1965, an important case was documented from the French Mediterranean (Heim; Hoffmann & Tscherter, 1966). It involved a woman and her two children (ages 11 and 14). After unsuspectingly eating a meal of *Panaeolus cyanescens* (Berkeley & Broome) Saccardo, the mother experienced terrifying hallucinations and was treated with gastric lavage and sedatives. While the elder child experienced visual echo patterns and was incapable of raising himself from an armchair, the younger convulsed and lost consciousness, thus exhibiting "an extreme neurophysiologic manifestation of the cerebral excitation syndrome" (Pollock 1974).

Panaeolian chemo-taxonomy

On the basis of some of the preceding scattered reports implicating *Panaeolus* species as the provokers of cerebral mycetisms, the suggestion by Schultes (1939; 1940) that *Panaeolus campanulatus* Linnaeus var. *sphinctrinus* (Fr.) Bresadola (now considered to be a separate species, *sphinctrinus*) was the *teonanácatl* of the Aztecs seemed quite convincing. Ethnobotanical studies by the Wassons, Heim, and other collaborators, however, suggested that *Psilocybe* species, *Stropharia cubensis* Earle, and possibly even *Conocybe siligineoides* Heim, rather than *Panaeolus* were employed for magico-religious purposes (Heim, Wasson & Collaborators 1958). Guzmán (1959) even referred to *P. sphinctrinus* as the "false" *teonanácatl*. Nevertheless, the isolation of crystalline psilocybin from *P. sphinctrinus* mushrooms (RP1 strain) grown on compost certainly established the hallucinogenic potential of that species (Heim, Wasson & Collaborators 1958). Soon afterwards, Hofmann, Heim & Tscherter (1963) were not able to substantiate their findings by analysis of other samples of *P. sphinctrinus*. Unfortunately, neither the specimen sources nor herbarium reference numbers were cited in either study. Although serotonin (5-hydroxytryptamine) was found to be present in carpophores of *Panaeolus campanulatus* (Fr.) Quélet - from Washington and Idaho, *P. foenisecii* (Fr.) Kühner - from Washington and Michigan, *P. acuminatus* (Schaeff. ex Fr.) Quélet - from Washington, *P. fontinalis* Smith - from Michigan, *P. semiovatus* (Fr.) Lundell - from Michigan, *P. subbalteatus* (Berkeley & Broome) Saccardo - from Michigan, and *P. texensis* Tyler & Smith - from Texas; no 4-hydroxytryptamine derivatives such as psilocin were detected in these species (Wier & Tyler 1963; Tyler & Smith 1963). Later studies with Argentinian specimens of *P. sphinctrinus* also revealed the presence of serotonin but no 4-hydroxytryptamine derivatives (Tyler & Gröger 1964). One point was clear - *Panaeolus sphinctrinus* was certainly a "mystifier."

Ola'h (1970) thus undertook a systematic study of the genus *Panaeolus*, chemically analyzing various samples which consisted of: a) wild carpophores, mycelia and carpophores obtained in culture; b) wild carpophores and mycelia; c) mycelia and carpophores obtained in culture; or d) mycelia only. This investigator assayed twenty-three samples of *P. sphinctrinus* twenty of which were from Quebec and one of which was the RP1 strain, revived from spore after seven years. Thirteen samples, including mycelia of the RP1 strain, were found to contain psilocin and seven of these also contained psilocybin. Five samples of *P. foenisecii* (four from Quebec and one from Paris) were studied chemically. Two from Quebec contained both psilocin and psilocybin, whereas the one from Paris and one of the two other Quebec samples contained psilocin. Of ten samples of *P. fimicola* (Fr.) Quélet, five were found to contain both psilocin and psilocybin. A sample of *P. microsporus* Ola'h & Cailleux was shown to produce psilocin but not psilocybin in carpophores derived from culture and neither compound was detected in the mycelia. This characteristic was transmitted into two successive generations also studied. A sample of *P. castaneifolius* (Murr.) Smith from Quebec contained psilocin in the wild carpophores, mycelia and carpophores obtained in culture, but psilocybin occurred only in the mycelia. This same pattern was found also in the next generation of this sample. Four samples of *P. africanus* Ola'h were capable of synthesizing psilocin and psilocybin in the mycelial stage and one of these was shown to produce psilocin in carpophores from culture. Because of these irregularities in psilocin and psilocybin biosynthesis, *P. africanus*, *castaneifolius*, *fimicola*, *foenisecii*, *microsporus*, and *sphinctrinus* were classified as "latent psilocybian" species (Ola'h 1969; Ola'h 1970).

A sample of *P. ater* (Lange) Kühner & Romagnesi from the East Indies was found to contain psilocin and psilocybin in mycelia and carpophores obtained in culture. Wild carpophores were not chemically examined and these findings were consistent in the next generation. Four samples of *P. cambodginiensis* Ola'h & Heim, consisting of mycelia and fruiting bodies from culture, contained both psilocin and psilocybin. Both of these indoles were also detected in wild carpophores, mycelia and carpophores from culture of *Panaeolus cyanescens* (Berkeley & Broome) Saccardo from Menton, France and an additional source. The same pattern was observed also in the next generation of the Mediterranean source. A sample of *P. subbalteatus* (Berkeley & Broome) Saccardo from Quebec was determined to possess both psilocin and psilocybin in wild carpophores and mycelia from culture. Likewise, *subbalteatus* from Paris synthesized psilocin and psilocybin in the mycelia, and psilocin was found in wild carpophores of that sample (data on psilocybin not presented for those carpophores). Neither psilocin nor psilocybin could be detected in mycelial cultures of *subbalteatus* from two other sources, one of which is the American Type Culture Collection. Three samples of *P. tropicalis* Ola'h were found to contain psilocin and psilocybin in wild and cultivated carpophores and mycelia. As a result of these findings, Ola'h (1969; 1970) placed *P. ater*, *cambodginiensis*, *cyanescens*, *subbalteatus* and *tropicalis* in the category of frankly "psilocybian."

Three samples of *P. acuminatus* (Schaeff. ex Fr.) Quéllet were negative for psilocin and psilocybin. Seven samples of *P. campanulatus* (Fr. ex L.) Quélet were also found to be negative for psilocin and psilocybin. One sample of *P. leucophanes* (Berkeley & Broome) Saccardo and its next generation were also lacking psilocin and psilocybin. Mycelia and cultivated carpophores of two samples of *P. retirugis* (Fr.) Quélet and their next generations were negative for psilocin and psilocybin as was one sample of *P. semiovatus* (Fr.) Lundell & Nannfeldt. These species were thus classified as "non-psilocybian." *P. fontinalis* Smith, *fraxinophilus* Smith, *guttulatus* Bresadola and *phalaenarum* (Fr.) Quélet were also included as "non-psilocybian" since there were no reports alleging hallucinogenic effects from these species (Ola'h 1969; Ola'h 1970).

Since the completion of Ola'h's monograph, additional studies have been reported on the chemistry of *Panaeolus* species. Psilocybin has been detected (0.08 percent dry weight) in an Italian collection of *P. retirugis* (Fiussello & Ceruti Scurti 1971-1972). Psilocybin has also been detected in Italian collections of *P. foenisecii* (one of two samples), *subbalteatus* (one sample) and *campanulatus* (one sample) (Fiussello & Ceruti Scurti 1972). Furthermore, psilocin has been detected in two Italian collections of *P. cyanescens* and psilocybin in one of these (Fiussello & Ceruti Scurti 1972). Mycelia and cultivated carpophores of Italian *P. subbalteatus* have been shown to be capable of producing psilocybin (Ceruti Scurti, Fiussello & Jodice 1972). One Italian collection of *P. gutiulatus* and *P. sphinctrinus* lacked psilocybin and psilocin (Fiussello & Ceruti Scurti 1972) and a collection of Czechoslovakian *P. campanulatus* was devoid of these indoles (Semerdzieva & Nerud 1973). Finally, an additional sample of *P. foenisecii* from Quebec was reported to be positive for psilocybin, and although a sample of carpophores of this species from Washington was determined to be devoid of psilocybin, this indole was detected in carpophores of *foenisecii* front Indiana (0.17 percent dry weight) (Robbers, Tyler & Ola'h 1969).

Since *P. venenosus* was known only, sometimes in great numbers, from mushroom-growing houses in New York, the "problem of its origin or occurrence in the wild state" was unresolved (Levine 1919). *P. venenosus* Murrill has been determined to be conspecific with *P. subbalteatus* (Berk. & Br.) Sacc. (Ola'h 1970; Singer & Smith 1958a), but the true identity of *P. semiglobatus* Murrill has been a mystery. Despite the fact that type material was described as *Campanularius semiglobatus* Murrill from New York (growing on manure in 1910 in Murrill's garden) (Murrill 1911; Saccardo & Trotter 1925), and that this species was later cited as occurring in Virginia (Murrill 1920), contemporary mycologists seem to have been unaware of these reports and suggested the causative species of the intoxication described by Douglass (1912) may even have been a *Stropharia* (Heim 1958; Ola'h 1970; Tyler & Smith 1963). The type material was thus obtained, examined microscopically by Ott and the author and determined to be *P. subbalteatus*. A professional mycological determination was then kindly provided by Guzmán stating that *P. semiglobatus* is conspecific with *P. subbalteatus*. Although *P. subbalteatus* may have a rubescent tinge (hence once even described as *P. rufus* Overholts), it is quite variable in color and morphology (on one occasion even cited as *P. variabilis* Overholts). Some strains mimic *P. papilionaceus*. Although various authors still refer to this "butterfly" *Panaeolus* as a distinct species (Ceruti Scurti & Bianco 1973; Guzmán 1972), Ola'h (1970) regards *papilionaceus* to be conspecific with *P. campanulatus*. The single citing of psilocybin in *campanulatus* by Fuissello and Ceruti Scurti (1972) has not yet been verified and it is certainly possible that the collection may have contained more than one species. Thus there is great probability that at least some intoxications attributed to *P. papilionaceus* or *P. campanulatus* were actually due to *subbalteatus* or other closely related species such as *sphinctrinus*.

The true identity of *P. ovatus* Cooke & Massee remains unknown. The only researchers to have studied the problem seem to be Aberdeen and Jones (1958) who state that "a detailed examination of *Panaeolus ovatus* Cke. & Mass. showed it to lie closely related to, and possibly identical with *Anellaria sepulchralis* (Berk.) Singer which is generally considered edible." *A. sepulchralis* is believed by Ola'h (1970) to be identical with *Panaeolus phalaenarum* (Fries) Quélet for which no chemical studies have been reported. It is possible that Aberdeen and Jones collected *P. phalaenarum* rather than *ovatus*, for *phalaenarum* had been cited from Australia in *Grevillea* even before the original description of *ovatus* (Cooke 1889). A more recent description of *ovatus* by Cleland (1934) is still insufficient in microscopic detail to be useful in distinguishing between the two species. The problem is further complicated by the fact that *A. sepulchralis* may be conspecific with *P. antillarum* (Fr.) Dennis rather than *P. phalaenarum*, if these latter two species are really distinct (Guzmán 1972). It may very well be that *Panaeolus cyanescens* was the cause of at least some of the intoxications attributed to *P. ovatus*. It was only quite recently, in fact, that the presence of *P. cyanescens* in Australia was first noticed (Hall 1973) and now it is known to be widespread there (Southcott 1974).

The biosynthesis of psilocin and psilocybin are enzyme mediated and the enzymes involved would be expected to have both genetic and environmental regulation. From the limited data available in case reports, chemical studies and metabolic considerations pertaining to psilocin (to be discussed in the next section), it appears that the frequency of genes allowing psilocin and psilocybin biosynthesis within some *Panaeolus* species, such as *foenisecii* and *sphinctrinus*, may vary greatly from one population to the next, whereas for other species such as *cyanescens* the complex of psilocybian alleles appears to be relatively stable and consistent. *Panaeolus* has long been a difficult problem for the fungal taxonomist and under the classification by Ola'h (1970) there are notable inconsistencies. The genus is basically divided into two subgenera: *Eu-Panaeolus* and *Pseudo-Panaeolus*. But even in the "true" *Panaeolus* there are species without pleurocystidia such as the "psilocybian" *subbalteatus*, the "latent psilocybian" *sphinctrinus*, and the "non-psilocybian" *acuminatus* as well as species with these facial cystidia such as the "psilocybian" *ater* and the "latent psilocybian" *fimicola*. In the "false" *Panaeolus* there are species such as the "psilocybian" *cyanescens*, "latent psilocybian" *foenisecii* and "non-psilocybian" *semiovatus*.

A more recent classification by Guzmán (1972) based on microanatomical characteristics, recognizes four subgenera. A chemotaxonomic classification, nevertheless, might be of greater utility in view of modern interest in psychoactive fungi. It is thus proposed that those *Panaeolus* species which are capable of synthesizing psilocin and/or psilocybin be considered as belonging to Section *Copeladia* Pollock, *sectio nov.* of the genus *Panaeolus* (Fries) Quélet. This section includes species with various probabilities of possessing these 4-hydroxytryptamine derivatives: a) high probability - *cyanescens* (Berkeley & Broome) Saccardo, *cambodginiensis* Ola'h & Heim and *tropicalis* Ola'h; b) intermediate probability - *subbalteatus* (Berkeley & Broome) Saccardo and *ater* (Lange) Kühner & Romagnesi; and c) low to moderate probability - *africanus* Ola'h, *castaneifolius* (Murrill) Smith, *fimicola* (Fries) Quélet, *foenisecii* (Fries) Kühner, *microsporus* Ola'h & Cailleux, *sphinctrinus* (Fries) Quélet, *retirugis* (Fries) Quélet and *campanulatus* (Fries ex Linnaeus) Quélet. Those species with a high probability of possessing 4-substituted indole hallucinogens comprise Guzmán's subgenus *Copelandia*, whereas those which appear to have "intermediate" probability of containing these compounds fall into his subgenus *Panaeolus*. Those with low to moderate probability of producing hallucinogenic constituents are found in Guzmán's subgenera *Anellaria* (*africanus*), *Panaeolina* (*foenisecii*) and *Panaeolus*. Species not included in Section *Copelandia* would be expected to have very low or unknown probability of producing psychotropic 4-substituted indoles.

The bluing phenomenon and other metabolic considerations

"The blue color of the sclerotia and of the base of one single specimen" of *Panaeolus subbalteatus* appeared "to be of the same nature as the bluing in *Copelandia cyanescens* (Berk. & Br.) Sing." (*Panaeolus cyanescens*) "and the bluing *Psilocybes*" (Singer & Smith 1958a). Thus Singer and Smith surmised:

> If this assumption is correct, it must become quite clear that a direct or indirect relation must exist between the bluing capacity of a species and its capacity to provoke cerebral mycetisms. On the basis of this hypothesis it is actually possible to predict which genera and species might be significant for the research on cerebral mycetisms of the type represented by *Panaeolus subaltetus* [sic] and *Psilocybe caerulescens*.

It seems that Guzmán may have contributed to the origin of this bluing hypothesis, for Singer (1958) related "that there are a *Psathyrella* and copelandias from Santa Cruz which Guzmán, who collected them there, is inclined to think may be hallucinogenic." While *Psathyrella sepulchralis* Singer, Smith & Guzmán does not blue and was probably confused by some Zapotecs with *Psilocybe zapotecorum* (Singer, Smith & Guzmán 1958). Singer (1962) soon began to refer to the *Copelandia* (*Panaeolus cyanescens*), an ardent bluer, as "apparently hallucinogenic."

While the bluing reaction has not been studied in hallucinogenic mushrooms *per se*, a number of studies shed light on this phenomenon. Blaschko and Levine (1960a) found that the gill plates of the mussel *Mytilus edulis* Linnaeus possess an enzyme which readily converts psilocin to a blue product with the consumption of oxygen. This reaction occurs more rapidly with psilocin (4-OH-*N*,*N*-DMT) than with either its 6-hydroxy isomer or 5-

hydroxy isomer bufotenin. Since it was known that both the bivalve molluscan enzyme and ceruloplasmin, a copper containing oxidase of mammalian plasma, could utilize 5-hydroxytryptamine (serotonin) as a substrate, Blaschko and Levine (1960b) performed a comparative study. Both the *Mytilus* enzyme and ceruloplasmin from pig plasma convert psilocin and 4-hydroxytryptamine to a blue product, whereas bufotenin and its 6-hydroxy analog as well as serotonin, 6-hydroxytryptamine and 7-hydroxytryptamine are oxidized to brown pigments. Some important differences in the two enzyme systems were also noticed. For instance, whereas the mollusk enzyme could also utilize 4,5 and 7-hydroxytryptophan (the former yielding a blue pigment and the latter two brown pigments), these amino acids were not suitable substrates for porcine ceruloplasmin.

When Horita and Weber (1961a) were studying the dephosphorylation of psilocybin by alkaline phosphatase of various mammalian tissues, they discovered that in some of their preparations, especially heart and kidney, the liberated psilocin was oxidized so rapidly to a blue metabolite that they were unable to measure the formation of psilocin. By inhibitor studies and the tissue distribution of the oxidase activity, they were able to conclude that monoamine oxidase, an enzyme very important in serotonin and dopamine metabolism, was not the enzyme acting on psilocin.

Weber and Horita (1963) then determined that cytochrome oxidase, a mitochondrial enzyme, is responsible for the rapid oxidation of psilocin by tissue homogenates. Using a preparation of cytochrome oxidase derived from pig heart, these investigators found that while psilocin is oxidized to a dark blue product and the synthetic hallucinogen 4-hydroxy-*N,N*-diethyltryptamine to a bluish-green metabolite, 4-hydroxytryptamine becomes a blackish-brown pigment. Bufotenin, 5-hydroxytryptamine and 5-hydroxytryptophan are converted to brown compounds. Furthermore, "the 4-hydroxyindoles are consistently better substrates for the cytochrome oxidase than are the 5-hydroxyindoles" (Weber & Horita 1963).

Kalberer, Kreis & Rutschmann (1962) synthesized ^{14}C-psilocin and studied its *in vivo* metabolism in rats. After oral or intravenous administration of 10 mg/kg psilocin, at least 80 percent of the radio-psilocin was excreted during the first 24 hours. About 25 percent of the psilocin was passed unaltered in the urine and only about 4 percent underwent demethylation and subsequent oxidative deamination to 4-hydroxyindoleacetic acid. The largest portion of urinary metabolites were unidentified non-glucuronide hydrophilic substances.

In vitro studies with purified calf intestinal phosphatase and homogenates of brain, heart, kidney, liver and small intestine from various mammalian species have shown that psilocybin is an excellent substrate for alkaline phosphatase (Horita & Weber 1961b). Additional studies have shown that psilocybin is rapidly dephosphorylated *in vivo* in mice (Horita & Weber 1962). Furthermore, pretreatment with β-glycerophosphaite, a competitive substrate for alkaline phosphatase, not only diminished tissue concentrations of psilocin but also "reduced the intensity of the reaction as compared to normal mice treated with psilocybin (Horita & Weber 1962). Parallel measurements of psilocybin tissue concentrations were not attempted due to lack of a suitable assay (Horita 1975). Depression, exophthalmos, piloerection and some hindleg ataxia were noted as major symptoms of the psilocybian reaction in mice. These studies along with some ancillary observations, such as the lipid solubility of psilocin being greater than that for psilocybin, strongly suggest that psilocin is the pharmacologically active metabolic form of psilocybin (Horita 1963).

Returning to the bluing phenomenon, Gilmour and O'Brien (1967) noticed that a subfraction of rat brain mitochondria produced a dark blue color in the presence of psilocybin with prolonged incubation and that oxygen was not required. This as pointed out by Levine (1967) resulted from the action of a phosphatase liberating psilocin and a subsequent oxidation by the ferric ions present, for among other considerations the chelating agent EDTA markedly inhibited the production of the blue color. Bocks (1967a) discovered that *para*-diphenol oxidase (laccase) derived from the fungus *Polyporus versicolor* is capable of oxidizing psilocin to a blue product which has a similar ultraviolet spectrum to the compound obtained by ferric chloride oxidation of psilocin.

Laccases, first isolated from lacquer trees and responsible for the blackening of lacquer tree juices, possess certain properties similar to ceruloplasmin ("animal laccase"). For instance, they are copper-containing and share many substrates such as *para*-phenylenediamine and hydroquinone (Peisach & Levine 1965). An unusually stable laccase has been isolated from a mushroom known as *Russula foetens* (Gregg & Miller 1940). In addition to acting on usual substrates, this *Russula* enzyme has been demonstrated to catalyze the oxidation of an inorganic salt, potassium ferrocyanide (Gregg & Miller 1940). Laccase is essentially a *para*-diphenol oxidase in contrast to the copper containing phenolase complex (tyrosinase), which not only is responsible for *ortho*-hydroxylation of phenols but also is an *ortho*-diphenol oxidase (Mason 1955). Furthermore, *para*-diphenol oxidases are blue copper proteins in which there is a valency change in the copper from 2^+ to 1^+ during the oxidation of substrates, whereas *ortho*-diphenol oxidases are colorless with the copper remaining at 1^+ valence and thus suggesting a different mechanism of action (Bocks 1967b). Nevertheless, there is some overlapping of substrate specificity. The *Russula* laccase as an example may oxidize catechol "at nearly the same rate as *p*-phenylenediamine and hydroquinone" (Gregg & Miller 1940). *Para*-cresol and catechol have been routinely used to measure the aerobic oxidation of monohydric and *o*-dihydric phenols by tyrosinase. It is noteworthy that these two activities have been partially separated in enzyme preparations derived from the common commercial edible mushroom (Adams & Nelson 1938; Mallette & Dawson 1949; Mallette *et al*. 1948) (*Psalliota campestris* as it used to be called in Europe, *Psalliota bispora* as it is now called in Europe and *Agaricus bisporus* as it is now usually called in the Americas).

Furthermore, a mycelial extract of the commercial mushrooms was shown to catalyze the oxidation of *p*-phenylenediamine at about twice the rate as that of catechol and an extract from carpophores of this mushroom oxidized catechol but not *p*-phenylenediamine. Rhizomorphs ("stings of hyphae which transport substances from the absorbing mycelium to the fruitbodies") catalyze the oxidation of both *p*-phenylenediamine and catechol, the latter more rapidly (Lindeberg 1950). It was suggested that the oxidation of the catechol was partly due to lacaase and partly to polyphenoloxidase (tyrosinase). Thus the mycelia may produce laccase and the carpophore a tyrosinase, "whereas in the rhizomorphs a mixture of both enzymes is formed" (Lindeberg 1950).

Adventitious browning is well known to occur in the flesh of certain ripe fruits (such as apples, pears and avocados) and some vegetables (such as eggplant) as well as in the hyphae of mushrooms following injury during harvesting, storage or preparation for the table. This rapid browning seems to result from the oxidation of endogenous phenols catalyzed by enzymes having laccase and phenolase activity, but other enzymes such as peroxidases and catalases, which require the presence of hydrogen peroxide for activity, might also make a contribution (Mason 1955). The bluing reaction most likely is mediated by the same enzymes.

Singer (1948) first observed that the bluing reaction of *Stropharia cubensis* Earle could be enhanced by the use of metol (*para*-methylaminophenol). He later stated that "a chemical character which accompanies the bluing phenomenon is that of metol, which gives a constant strongly positive reaction with the context of the stipe in the bluing psilocybes, becoming deep purple after a few minutes" (Singer 1958). Although the "metol test" later became popularized for the rapid identification of psilocybian mushrooms (Enos 1970), it is entirely nonspecific. I have applied small aliquots of a fresh saturated solution of *p*-methylaminophenol sulfate to sections of the brown and white varieties of commercial *Agaricus bisporus* and observed the rapid development of purple staining. A simultaneous experiment was run employing *p*-aminophenol sulfate which promptly produced dark brown staining. After about 5-10 minutes, a purple tinge could be observed on these darkened mushroom pieces. Both compounds eventually produce a blackish-brown discoloration. Controls brown very slowly and the color is not as intense. *Para*-aminophenol is a known laccase substrate (Peisach & Levine 1965) and *p*-methylaminophenol must also serve as a substrate for such phenol oxidases.

Modern use of Panaeolus mushrooms

The recreational and spiritual use of psilocybian mushrooms has become a worldwide transcultural phenomenon (Pollock 1975). Although much new information has been gathered on the use of cyanescent *Stropharia* and cerulescent *Psilocybe* species, the present discussion will focus primarily on *Panaeolus*.

The most widely utilized *Panaeolus* appears to be the coprophilous *P. cyanescens*. This predominantly tropical species, commonly called a "copelandia" and originally described from Ceylon, is also known from the Philippines (*Copelandia papilionacea* sensu Bresadola), Indonesia, Australia, Cambodia, Malagasy Republic, Florida (*Campanularius westii* Murrill), Mexico, Jamaica (*Panaeolus anomalus* [Murrill] Sacc. & Trott.), Hawaii, Brazil, Bolivia and even as far north as France and Italy. The author has received personal communications suggesting the use of this species in Chiapas, where *Panaeolus cyanescens* is a common psilocybian species. By the fall of 1972, it had become obvious to college students that psilocybin mushrooms were abundant in Florida (Kimbrough 1975) and word-of-mouth stories told of fraternity parties with bushel-basket quantities of magic fungi. With a widespread reputation that "Gainesville is Kingsville" for psilocybin mushrooms, it is entirely possible that some mycophagists sampled *Panaeolus cyanescens* in addition to the ubiquitous *S. cubensis* Earle. By 1972, the use of this cyanescent *Panaeolus* had become well established in the Hawaiian Islands (Pollock 1974) and it appears that other psychoactive fungi might occasionally be employed there as well. For instance, *Panaeolus tropicalis*, a species reported on dung of cattle and wild animals from Cambodia, the Republic of Central Africa and Mexico, has now also been identified from Hawaii (Rhoades 1975). During recent field studies in the Pacific Northwest, it came to the author's attention that a few years ago entrepreneurs in Hawaii exported some small psilocybin mushrooms (probably *Panaeolus*) on dry ice to an eagerly awaiting California street market. It seems that this psychotropic merchandise had spoiled and lost activity due to delays in unloading and distribution. Although knowledge that drying is the best way to preserve these mushrooms had not generally reached the public, folk knowledge that the mushrooms could be stored for short periods of time in honey was available in Hawaii and elsewhere. Thus, the mushrooms were allegedly exported in honey with satisfactory results, except perhaps for the taste which was quite unpalatable to the consumer from whom this information was elicited.

Bali, Indonesia has gained a worldwide reputation as an exotic mushroom paradise. Almost three years ago a former Peace Corps worker who had traveled to Bali recounted to the author her experience after a psychedelic mushroom omelet, the mushrooms having been purchased from native children on the beach. Although Heim (1973) suspected the use of *Panaeolus cyanescens* in Bali after a report from a Dutch correspondent, no specimens were available. Recently, however, a sample from Bali arrived in Mexico containing carpophores of a yet unidentified *Conocybe* species and *Panaeolus cyanescens* (Ott 1975). The Caribbean has also become quite a mushroomic Elyseum. In Jamaica, for example, island inhabitants eagerly collect and dry magic fungi to brew in delectable teas for personal use and to sell to mycophilic tourists. *Panaeolus cyanescens* is certain to be one of the species utilized.

"Copeladias" are now often collected, utilized and sometimes even sold for their psychedelic effects in Australia, where users refer to them as "blue meanies" (Southcott 1974). This name may refer not only to their bluing, but also to their potency. It has been said "that about six of the blue meanies were enough for a good trip, and they were sometimes eaten straight, or in curry, etc." (Southcott 1974). A case has been cited in which a 17 year old female "with a history of use of cannabis and LSD, on one occasion, about 1971, partook of some *Copelandia cyanescens* obtained in the vicinity of Adelaide. She became frightened when her hallucinatory attack came on and sought medical attention. She stated that she thought she was a banana and somebody was skinning her" (Southcott 1974). Despite the growing use of *Panaeolus cyanescens*, it appears that "Gold Tops" (a composite term for *S. cubensis* Earle, *Psilocybe subaeruginosa* Cleland and presumably also *Psilocybe collybioides* Singer and Smith [Southcott 1974]) are more widely employed in Australia (Hall 1973; McCarthy 1971; Southcott 1974).

Panaeolus cambodginiensis, another coprophilous species, had been known only from Cambodia. Material originating from Colombia in June, 1974 had been tentatively identified by Ola'h as the same species (Pollock 1975). Guzmán has now established the identity of this species as *cambodginiensis*. With mushroom consciousness as high as it is in Colombia, chances are good for the occasional use of this fungus.

Panaeolus subbalteatus was first described as collected in a tare field in Apethorpe, England in 1860 and was next observed in the botanical garden in Brussels, Belgium. Although this coprophilous and occasionally terricolous species had been noted from additional sites in Europe. Massachusetts, Michigan, Missouri, Ohio, Ontario, New York, Quebec and Washington; as well as from Mexico, Argentina, Japan and Africa, no deliberate non medical use of this fungus for the alteration of consciousness has been reported. In the last few years many people in Oregon have become very much aware of the presence of psilocybian mushrooms (Ott in publication; Weil 1975). Liberty Caps have become well known on rich pasture land soil, for it has been observed by the author that herbarium collections from all over Oregon were identified by Alexander Smith as *Psilocybe semilanceata*. It is possible, however, that Smith was confusing this species with *Psilocybe pelliculosa* (Smith) Singer and Smith. Unfortunately, disrespectful mycophagists have stolen all of this material from the herbarium in question, and it is not possible to verify his identifications. Another species widely employed is a *Panaeolus* which occurs not only in the garden (on manure) but also on composting hay piles. Mycologists in Oregon examined such specimens and identified them as *Panaeolus subbalteatus* (Denison 1975; Rhoades 1975). It seems that there is another coprophilous *Panaeolus* which is much less frequently employed in Oregon. Users had supposedly been ingesting up to 250 carpophores of a species which was later determined by chemical analysis to contain traces of psilocybin and identified by Guzmán as *Panaeolus sphinctrinus* (Ott 1975). This latter species is cosmopolitan. It is probably ingested deliberately in Colombia where unfortunately like elsewhere the standard cliche is "if it grows on cow dung, it is hallucinogenic." A trial by the author of a soup containing 50 specimens of *P. sphinctrinus* gathered in Texas was without noticeable psychic effects, a sample of this collection later having been identified positively by Guzmán.

Although indications are that *Paneolus campanulatus* may be generally "inactive," it seems to be employed in southern California where 40 to 60 little brown lawn mushrooms are said to constitute a dose. Lawn inhabiting *Panaeolus* is usually *foenisecii* but the identity of a sample of such material obtained by the author has been determined by Guzmán to be *P. campanulatus* sensu Hora. The extent of its use elsewhere has not yet been ascertained.

Panaeolus ater, originally described from Denmark as a variety of *P. fimicola*, has also been reported elsewhere in Europe and from the East Indies. Alaskan herbarium material, one collection of which had been tentatively identified by Kempton as *Panaeolus ater*, was obtained by the author for further study. Guzmán has now keyed out not only a 1963 south-central Alaskan collection from a grassy area in mixed woods but also another collection from Anchorage as *Panaeolus ater*. No bluing was noted when the Alaskan specimens of *ater* were collected (in contrast to *P. ater* from the East Indies). Thus, aside from being rare, the Alaskan strains may be inactive. Furthermore, although authenticated *P. foenisecii* and *P. sphinctrinus* were found by the author to be quite common on lawns and soil enriched with horse dung in Anchorage, there has been no indication of attempted use of these inconsistently psilocybin-containing species by the Alaskan populace. Nevertheless, it seems that psilocybin mushrooms are sometimes employed even as far north as Alaska since the author was told of an occasion in which dried, yellow-colored magic mushrooms sent from Louisiana were enjoyed there. The mushrooms in that instance presumably were *S. cubensis*, a species so plentiful in Louisina and other Gulf Coast states that it served as the basis for a bogus field guide (Ghouled 1972). That publication, like others (Enos 1970; Fisher 1973) of its kind, was filled with misinformation. Ghouled (1972) even referred to a photograph of cubensis primordia as depicting the "young state of *P. subbalteatus*, choice and edible." Furthermore, Jacobs (1975) who suggests in a medical journal that "Mississippi and adjacent states are rapidly receiving a reputation in the drug culture as the 'mushroom capital' of the United States," believes that *Panaeolus subbalteatus* is "the second native hallucinogenic mushroom" in Mississippi. He based his identifications and much of his misinformation on Ghouled's misleading guide.

It has been alleged by Sanford (1972) that "a rather well known mycologist in the Boston area has seen *Panaeolus papilionaceus* deliberately gathered in both Maine and Louisiana. Interestingly enough, in the case of New England, it was thrifty farmers taking advantage of an opportunity to get 'drunk for nothing,' while in Louisiana the gatherers were rather more modern sophisticates looking for a psychedelic thrill." The psychoactive mushrooms eaten in Louisiana probably were not *Panaeolus* at all but rather *S. cubensis*, whereas in Maine *Panaeolus* does seem to be employed. Blackington (1958) describes an experimental trial of *Panaeolus papilionaceus* by Brother Bacon of Norway, Maine to achieve a "mental jag." The results of the first "tasting were so unusual, Mr. Bacon ate them many times again." It has also been reported in a Maine newspaper that a group of French Canadian fishermen consumes *Paneolus campanulatus* for its intoxicating properties when they fish in Maine, the identification having been provided by a state botanist (Schultes 1974). Bacon's amateur identification was based on Mellvaine's *One Thousand American Fungi* which is entirely inadequate for *Panaeolus* identification and it is not known what guide was employed in the latter identification. It is noteworthy that Wasson (1974), who was, of course, interested in the use of *Panaeolus* in Maine, could not extract a letter from Blackington. Most likely the *Panaeolus* employed there is *subbalteatus*, but other species such as *sphinctrinus* and *fimicola* are possibilities as well.

The trip beyond ecstasy, psycho-mycological frontiers

When a mind-altering substance is suddenly unleashed on a population already accustomed to using an array of psychoactive compounds, mass media may foster a rampant escalation of use. Such was the case with methaqualone, once heralded as a "downer with a difference," for "luding out" rapidly became a popular pastime in the United States (Agar 1972). The overall recreational use of methaqualone, however, soon declined. The use of psilocybian mushrooms for ecstatic experiences, in contrast, generally continues to become incorporated into the fabric of modern society.

When Hofmann traveled to Huautla de Jiménez, where these mushrooms have been traditionally employed since ancient times, the renowned *curaudera* María Sabina enthusiastically accepted his offering of manufactured psilocybin (Kreig 1964), but after a synthetic dose she did not seem to prefer the tablets to the mushrooms themselves (Wasson 1976). Mass media reports have greatly stimulated public consciousness of these fungi. But in technologically advanced societies, where psychotropic substances of all sorts can be purchased illicitly (usually in adulterated form) from street markets, genuine hallucinogenic fungi have usually not been available. Although wild psilocybian mushrooms are much more widespread than ever appreciated, interested persons have by and large gradually had to learn how to recognize the locally available species. Tourists have been traveling to Huautla for a long time, and the resemblance of Liberty Caps to *Psilocybe mexicana* Heim could not have gone unnoticed in such areas as British Columbia.

Misinformation has surrounded psychedelic mushroom use in British Columbia as well. Liberty Caps have been employed there since the early 1960's, despite later misnomers that in Canada "several varieties of psilocybin mushrooms" growing untended "would appear" to "have been ingested by only a few exceptional experimenters" (Canadian Report 1973). From Vancouver to the Queen Charlotte Islands the use of Liberty Caps has become such an integral part of subcultural living that the season is announced in the popular press (Oakenbough 1974). Even a seven year old girl in Vancouver was observed by the author to maintain her own "stash." She had developed a fondness and respect for these mushrooms plus a tremendous inquisitiveness toward them. Whenever adults would employ Liberty Caps (the usual dose being 20-25), she would usually eat one or two and claimed to experience a mild effect.

The identity of the British Columbia Liberty Caps has been presumed to be *Psilocybe semilanceata* (Dawson & Morelli 1975). This identification may have been based on a public awareness publication (British Columbia Access 1972) which duplicated most of its material from Enos (1970) to serve as a hallucinogenic mushroom guide for British Columbia. From examination by Guzmán of collections in the fall of 1975, it has now been determined that Liberty Caps refer to two species, *Psilocybe pelliculosa* and *semilanceata*. Furthermore, field studies have now turned up additional species in use such as authentic *Psilocybe cyanescens* in Washington. The annulated "*cyanescens*" referred to by Weil (1975) actually represents a new species.

Psychomycological field studies are needed in other areas of the world as more species remain to be discovered. Since *Panaeolus texensis* specimens are no longer available (Smith 1975) and the Latin description is insufficient in detail to be useful, this species entity must be disregarded. Nevertheless, there are species of *Panaeolus* and other psilocybian genera which remain in need of chemical analysis. Although strain differences in alkaloid production have already been observed chemically, there may be differences in the spectrum of biosynthetic alkaloids produced by different species. Such differences may well be important psychopharmacologically and it would be erroneous to presume that the psychotropic actions of psilocybian fungi can be predicted entirely based on studies with pure psilocybin or psilocin. Just as additives to new world hallucinogenic preparations may be important (Schultes 1972) so might other constituents present in the mushrooms. So little clinical study has been attempted comparing the psychoneurophysiologic effects of different psilocybian species (Stein 1959; Stein, Closs & Gabel 1959), that this area of investigation is virtually unexplored.

Although psilocybin is generally considered to be equipotent to psilocin on a molar basis, this actually may not be true. Wolbach, Miner & Isbell (1962) compared the effects of psilocin and psilocybin after intramuscular injection in human subjects, autoclaving the compounds in a solution containing vitamin C prior to administration. It was believed that the "addition of Vitamin C effectively prevented the alteration of psilocin to a compound with a deep-violet hue." Vitamin C, however, has been shown to reduce the blue oxidation product of psilocin (possibly a dimeriquinone) to a colorless compound (Bocks 1967a). Thus, it is unknown what the dosages of psilocin employed by these investigators actually were.

While psilocin, psilocybin, mescaline and LSD are generally considered to produce the same clinical manifestations in people, there are probably important neuropharmacologic differences which have yet to be explored. It is known, for instance, that while psilocybin, LSD and muscimol increase body temperature toward normal in mice pretreated with reserpine, mescaline causes a further decrease and ibotenic acid has no significant effect (Waser 1967). LSD (300 µg/kg i.v.) has been shown in unrestrained rats to increase blood flow to the frontal and parietal lobes as well as to the cerebellum (Goldman *et al*. 1975a). Furthermore, whereas in rats delta-9-tetrahydrocannabinol (1 mg/kg i.v.) significantly decreases blood flow to the cerebellum, hypothalamus, basal ganglia and dorsal hippocampus (Goldman *et al*. 1975b), the only significant effect of psilocybin (10 mg/kg i.v.) on brain blood flow was a decrease to the dorsal hippocampus (Fischer 1975). Data on mescaline are not yet available (Fischer 1975). Although it is suggested that autoradiographic studies with ^{3}H-LSD "strengthen the hypothesis that the action of LSD in the brain is linked in some way to serotonergic neurons" (Diab, Freedman & Roth 1971), more extensive studies have been done with ^{14}C-psilocin. No correlations could be found between the distribution pattern of ^{14}C-psilocin in rat brain "with the numerical nerve and glial cell density, the volume cell density, the capillary density, the contents of oxidative enzymes, the uptake of labelled amino acids, the lipid contents and other patterns known through chemical or histochemical studies" (Hopf & Eckert 1969). Psilocin uptake is low in the hypothalamus (serotonin rich) but very high in the neocortex (serotonin poor). Futhermore, it is high enough in the serotonin-rich hippocampus, an important part of the limbic system, to suggest that "a main site of action on this structure could explain some of the behavioral effects" of psilocin (Hopf & Eckert 1969). Hallucinogenic substances would reasonably be expected to have multiple sites and mechanisms of action. There is already some evidence that in addition to central serotonergic pathways, dopaminergic pathways may be involved in the complex action of LSD (Horita & Hamilton 1973; Pieri, Pieri & Haeferly 1974; Roszell & Horita 1975; von Hungen, Roberts & Hill 1974). Dubansky and Vyhnankova (1967) administered psilocybin to healthy volunteers and to brain-damaged patients. They observed that complex hallucinations and other visual psilocybin manifestations tended to be almost completely suppressed in persons with lesions involving central optic pathways. In contrast, while the absence of complex hallucinations was observed in patients with brain lesions but intact central optic pathways, other visual manifestations of psilocybin were observed. No studies have yet been attempted to determine what central nervous system pathways are actually essential for other manifestations of psilocybin intoxication such as the prominent tendency toward laughter and the frequent yawning.

Field observations are that psilocybian mushrooms are often employed with *Cannabis* species and/or alcoholic beverages. Furthermore, the author has observed the concomitant use of *Psilocybes* with *Amanita muscaria* in British Columbia and the Pacific Northwest. The pharmacologic interaction between psilocin or psilocybin and other psychoactive compounds such as delta-9-THC, ethanol, ibotenic acid and muscimol has not yet been investigated. Such studies would certainly be worthwhile not only because these compounds are often employed together but also because of the great potential for obtaining important new information on central nervous system neuropharmacology.

There may well be mushroom hallucinogens of an entirely different chemical nature than the tryptamines and isoxazoles. Numerous species in various genera have reputations, albeit some most obscure, of being psychoactive (Heim 1963). One notable example is *Pholiota spectabilis* (Fries) Kummer, in North America now usually designated as *Gymnopilus spectabilis* (Fr.) Smith. In 1942, a Cleveland, Ohio resident "had taken a few nibbles from a mushroom that she found" in the woods. Later she experienced "the most glorious visions of color and sounds of music, but with no feeling of discomfort whatever" (Waters 1965). The hallucinations soon passed and this victim of mycetismus "added that if this were the way one died from mushroom poisoning, she was all for it." The fungal identification seems to have been reliable and this species had been reported from Japan as producing such effects (Romagnesi 1964). The Japanese name for this fungus is even *o-waraitake* ("big-laughing mushroom") (Sanford 1972; Wasson 1973). A mycetism case involving three persons occurred in Boston in 1966, and indole derivatives other than psilocin and psilocybin were reported to occur in a sample of the *spectabilis* (Buck 1967). It was later determined that a false positive reaction for indoles was produced by *bis*-noryangonin present in this spectacular species (Hatfield & Brady 1969). Such styrylpyrones are widely distributed in *Gymnopilus* species (Hatfield & Brady 1971), some of which are "edible." Thus the psychoactive principles in *spectabilis* remain unknown.

Although the natural distribution of fungal psychotropogens is still largely unknown, even less is known about their neuropharmacologic mechanisms of action. The natural tendency of human beings to partake of "mind-altering" substances is so well documented (Efron, Holmstedt & Kline 1967: Schultes & Hofmann 1973) that one can easily perceive why arbitrary legislation and enforcement procedures are entirely useless in preventing such social pharmacological behavior in modern societies. The sanctioning of some modulators of "escape" such as ethanol with the disapproval, or legal taboo, of other more efficacious substances is sheer nonsense. When a human being experiences a drug induced alteration of consciousness there occurs a simultaneous change in psychic free energy, thermal energy and entropy. A chemical reaction is accompanied by the liberation or absorption of heat energy (enthalpy) and a change in entropy. Entropy (ΔS) pertains not only to the randomness of the system but is the final form into which heat energy dissipates. This change in the "state of chaos" (ΔS) together with the change in enthalpy (ΔH) results in a change in free energy (ΔF). These changes can be accurately measured for chemical reactions in vitro (Kitzinger & Benzinger 1960), but the complex electro-chemical changes which occur as one experiences a chemical catalytic alteration of consciousness are not accessible to such measurement. The "escaping" tendency of matter and other forms of energy toward entropy is so well known thermodynamically that an attempt to maintain a single homeostatic state of consciousness would have to be an entirely unnatural act. Exploration of the potential usefulness of alternate states of consciousness has certainly begun (Drug Abuse Council 1975), but is still in its infancy.

One obvious promising field for use of hallucinogens as mediators of pathways to alternate states of consciousness is, of course, medicine. It has been proposed both in Europe (Leuner 1968) and the United States (Fischer & Goldman 1975) that psilocybin or a related substance be used in psychotherapy rather than mescaline or LSD. While LSD may be extremely useful (Grof 1975), clinical observation from well over a thousand controlled hallucinogenic drug sessions is that psilocybin is shorter acting, seems to produce very few adverse reactions, is associated with fewer flashbacks and is accompanied by less post session depression than the hallucinogens LSD and mescaline (Fisher & Goldman 1975; Leuner 1968). Although psilocybin is substantially more efficious than LSD or mescaline, various other hallucinogens as well as natural dosage forms of these compounds deserve such testing.

The efficacy of psilocybin is further demonstrated by the paucity of adverse reactions occurring from the use of psilocybian mushrooms. Although "bad trips" are occasionally reported from these fungi (McCarthy 1971; Stein 1958), they are much easier to manage than are those often produced by various synthetic street drugs. Although it was suggested that *P. candidipes* Singer & Smith may be "poisonous" rather than just hallucinogenic (Singer 1958), recent studies suggest that this is not the case (Ott 1975). Furthermore, Singer and Smith (1958b) not only allege that Imai (1932) reported cases of death caused by *S. caerulescens* Imai (later changed to *S. venenata* Imai for nomenclatural reasons) but also that this Japanese species is conspecific with Höhnel's Javanese species *subaeruginascens* and *aerugineomaculans*. *S. venenata* was not reported to have caused any deaths (Imai 1932) and is regarded as a hallucinogenic mushroom in Japan, no different essentially from any other Japanese psilocybian species (Matsuda 1960; Sanford 1972; Wasson 1973; Yokoyama 1976). There are no rumors in Japan of *venenata* being deadly (Yokoyama 1976) and its name is *shibiretake* ("benumbing mushroom"). Authentic *venenata* was kindly supplied by Hongo and Yokoyama and type material of *subaeruginascens* and *aerugineomaculans* was obtained for comparison. Microscopic examination by the author with McLain suggested that *venenata* is a distinct species. Although we must await definitive determinations by Guzmán to be sure, it appears that Singer and Smith were mistaken in all matters pertaining to the *venenata* problem.

Psilocybian mushroom use in Australia has generally reached socio-pharmacologic equilibrium. Although more fungal "abuse" cases are being detected now, there has been no additional legislation, and the phenomenon of psychoactive mushroom use in Australia has generally not changed over the last few years (Hall 1976). Although no additional psilocybian species have been reported from Australia, there is a white fungus being employed there that resembles the deadly *Amanita verna*. It is called "white frenzy" or "white death," but no deaths seem to have been attributed to its use (Hall 1976). In the United States, genuine psilocybian mushrooms and possibly extracts prepared from them are occasionally sold as street drugs to meet the tremendous demand. Such a practice may be expected to continue until duly licensed and inspected commercial sources of supply become available for distribution through legitimate channels to provide the consumer protection that is indicated. Although use of these fungi is still growing in the U.S., drug abuseologists and drug "scapegoaters" as discussed by Szaz (1975) cannot reasonably consider this phenomenon a major problem. Between July 1973 and June 1975, the DEA confirmed the psilocybin content of nine exhibits (one from Arkansas, one from Oregon, five from Louisiana, one from Missouri and one from Washington) and the psilocyn [*sic*] content of two exhibits from North Dakota (Johnson 1975), and in January 1975, PharmChem Labs (1975) reported the presence of psilocin in four street samples and both psilocin and psilocybin in another, sources noted from California and Oregon. These figures compare rather meagerly to 978 exhibits of LSD, 930 of PCP and 70 of "other" hallucinogens such as 4-bromo-2,5-dimethoxyamphetamine, the thiophene analog of PCP, etc. confirmed by the Drug Enforcement Administration for the fiscal year 1975 alone (Johnson 1975). In 1970, LSD constituted 9 percent of the total DEA analytical work load, whereas "all hallucinogens" (a category that includes the sympathomimetic but not hallucinogenic compound MDA) constituted 11 percent. By the end of fiscal 1975, confirmed LSD exhibits comprised 2 percent and "all hallucinogens" (including 25 MDA exhibits) comprised only 5 percent of their total analytical workload (Johnson 1975).

Psilocin or a suitable congener may well prove to be of great utility in psychoanalysis and psychotherapy. It may certainly be efficacious for therapy of opiate dependent patients, alcoholics and certainly abusers of street hallucinogens. The potential for detecting some organic brain lesions by the use of such compounds has also been observed (Dubansky *et al*. 1963), and their potential for assisting with the alert terminally ill should also be considered. Since LSD has already been shown to be of benefit in some of these patients, might not psilocybian mushrooms, with their tradition of use in medico-religious rites since ancient times, be a more natural, psychologically aesthetic medicinal sacrament in the preparation of these patients for a death with dignity?

Acknowledgments

The author is grateful for assistance from a great number of people in matters pertaining to various aspects of this project and is especially indebted to Professor Gastón Guzmán, Director of the Laboratory of Mycology, National Polytechnic Institute of Mexico and Jonathan Ott of the Institute of Biomedical Research of the National University of Mexico.

References

1. Aberdeen, J.E.C. & Jones, W. 1958. A hallucinogenic toadstool. *Australian Journal of Science* Vol. 21: 149.
2. Adams, M.H. & Nelson, J.M. 1938. On the nature of the enzyme tyrosinase. *American Chemical Society Journal* Vol. 60: 2474-2478.
3. Ager, S.A. 1972. Luding out. *New England Journal of Medicine* Vol. 287(1): 51.
4. Blackington, A. H. 1958. *Beverly Times* 22 October.
5. Blaschko, H. & Levine, W.G. 1960a. Enzymic oxidation of psilocine and other hydroxyindoles. *Biochemical Pharmacology* Vol. 3; 168-169.
6. Blaschko, H. & Levine, W.G. 1960b. Acomparative study of hydroxyindole oxidases. *British Journal of Pharmacology* Vol. 15: 625-633.
7. Bocks, S.M. 1967a. Fungal metabolism-IV. The oxidation of psilocin by p-diphenol oxidase (laccase), *Phytochemistry* Vol. 6: 1629-1631.
8. Bocks, S.M. 1967b. Fungal metabolism-II. Studies on the formation and activity of p-diphenol oxidase (laccase). *Phytochemistry* Vol. 6; 777-783.
9. *British Columbia Access*. 1972. Magic mushrooms of British Columbia. *British Columbia Access* 3rd Catalog: 58-67.
10. Buck, R.W. 1967. Psychedelic effect of Pholioia spectabilis. *New England Journal of Medicine* Vol. 267(7): 391-392.
11. *Canadian Government's Final Report of the Commission of Inquiry Into the Non-Medical Use of Drugs*. 1973. Ottawa: information Canada.
12. Ceruti Scurti, J. & Biainco, M.A. 1973. Caratteristiche colturali di miceli di *Panaeolus*, *Allionia* Vol. 19: 5-12.
13. Ceruti Scurti, J.; Fuisselli, N. & Jodie, R. 1972, Idrossi-indol derivati in basidiomiceti. III, Influenza del substrato sui metaboliti del micelio i dei carpofori di Panaeolus subbalteatus Berk, et Br., *Allionia* Vol. 18: 91-96
14. Cleland, J.B. 1934. *Toadstools and Mushrooms and Other Larger Fungi of South Australia*, Adelaide, Australia: Harrisson Weir.
15. Cooke, M.C. 1889, New Australian Fungi, *Grevillea* Vol. 18(85): 1-8.
16. Dawson, P. &. Morelli, C. 1975. *A Guide to the Major Psilocybin Mushroom of British Columbia: Psilocybe semilanceata* Vancouver, British Columbia; Dawson & Morelli.
17. Denison, W. 1975. Personal communication.
18. Diab, I.M.; Freedman, D.X. & Roth, L.J. 1971. 'H-lysergic acid diethylamide: cellular autoradiographic localization in rat brain, *Science* Vol. 173: 1022-1024.
19. Douglass, B 1917. Mushroom poisoning. *Torreya* Vol. 17(10): 171-175 & Vol. 17(12): 207-221.
20. Drug Abuse Council, Inc. 1975. *Altered States of Consciousness*. Washington, D.C.: Drug Abuse Council.
21. Dubansky, B.; Kolarik, M.; Ruzickova, R.; Sevcik, M. & Vyhnankova, M. 1963. Effect of psilocybin on the clinical aspects of electroencephalograms and some organic disturbances of the CNS. *Activitas Nervosa Superior* Vol. 5(2): 213-214.
22. Dubansky, B. & Vyhnankova, M. 1967. Differences in the reaction of psilocybin in brain damaged subjects as related to the location of the lesion. *Activitas Nervosa Superior* Vol. 9(4): 418-420.
23. Efron, D.H.: Holmstedt, B. & Kline, N.S. (Eds.). 1967. *Ethnopharmacologic Search for Psychoactive Drugs*. Washington, D.C.: U.S. Government Printing Office.
24. Enos, L, 1970, A Key to the *American Psilocybin Mushroom*. Lemon Grove, California: Youniverse Press.
25. Fischer, R. 1975. Personal communication.
26. Fischer, R. & Goldman. H. 1975. Therapeutic usefulness of hallucinogenic drugs as a function of their chemical structure. *Pharmakopsychiatric Neuropsychopharmakologie* Vol. 8(4): 176-178.
27. Fisher, W. 1973. *Collecting the Magic Mushroom*. Garberville California: Teonanacatl Press.
28. Fiussello, N. & Ceruti Scurti, J. 1971-1972. Idrossi-indol derivati in basidiomiceti. I,-Presenza di psilocibina e di 5-idrossi-indol derivati in *Panaeolus retirugis* (Fr). *Atti della Accademia delle Scienze di Torino* Vol. 106: 725-735.
29. Fiussello, N. & Ceruti Scurti, J. 1972. Idrossi-indol derivati in basidiomiceti. II,-Psilocibina, psilocina e 5-idrossi-indol derivati in carpofori di *Panaeolus* e generi affini, *Allionia* Vol. 18: 85-90.
30. Ford, W.W. 1923. A new classification of mycetismus (mushroom poisoning). *Transactions of the Association of American Physicians* Vol. 38; 225-229.
31. Ghouled, F.C. 1972. *Field Guide to the Psilocybin Mushroom Species Common to North America*, New Orleans: Guidance Press.
32. Gilmour, L.P. & O'Brien, R.D. 1967. Psilocybin: reaction with a fraction of brain. *Science* Vol. 155: 207-208.
33. Glen, G. 1816. A case proving the deleterious effects of the *Agaricus campanulatus* which was mistaken for the *Agaricus campestris* or champignon. *London Medical and Physical Journal* Vol. 36: 451-453.
34. Goldman, H.; Fischer, R.; Nicolov, N. & Murphy, S. 1975a Lysergic acid diethylamide affects blood flow to specific areas of the conscious rat brain. *Experientia* Vol. 31: 328-329.
35. Goldman, H.; Dagirmanjian, R.; Drew. W.G. & Murphy, S. 1975. Δ^9-Tetrahydrocannibinol alters flow of blood to subcortical areas of the conscious rat brain. *Life Sciences* Vol. 17: 477-482.
36. Gregg, D.C. & Miller, W.H. 1940. A laccase from the wild mushroom. *Russula foetens*. *American Chemical Society Journal* Vol. 62: 1347-1379.
37. Grof, S. 1975. *Realms of the Human Unconscious - Observations from LSD Research*. New York: Viking Press.
38. Guzmán, G. 1959. Sinopsis de los conocimientos sobre los hongos alucinógenos mexicanos. *Boletín de la Sociedad Botanica de México* Vol. 24: 14-34.
39. Guzmán, G. 1972. Las especies conocidas del genero Panaeolus en Mexico. *Boletín de la Sociedad México de Micología* Vol. 6: 17-53.
40. Hall, M.C. 1973. Problems in legislating against abuse of hallucinogenic fungi in Australia. *Bulletin on Narcotics* Vol. 25(3): 27-36.

41. Hall, M.C. 1976. Personal communication.
42. Hatfield. G.M. & Brady, L.K. 1969. Occurrence of bis-noryangonin in *Gymnopilus spectabilis*. *Journal of Pharmaceutical Sciences* Vol. 58(10): 1298-1299.
43. Hatfield. G.M. & Brady, L.K. 1971. Occurrence of bis-noryangonin and hispidin in *Gymnopilus* species. *Lloydia* Vol. 34(2): 260-263.
44. Heim, R. 1958. Le syndrome narcoticien chez les champignons à action cérébrale. *Histoire de la Médicine* Vol. 8: 43-60.
45. Heim, R. 1963. *Champignons Toxiques et Hallucinogènes*. Paris: N. Boubee.
46. Heim, R. 1973. Personal communication.
47. Heim, R.; Wasson & Collaborators. 1958. *Les Champignons Hallucinogènes du Mexique*. Paris: Muséum National d'Historie Naturelle.
48. Heim, R.; Hofmann, A. & Tscherter, H. 1966. Sur une intoxication collective à syndrome psilocybien causée en France par un *Copelandia*. *Comptes Rendus Hebdomadaire des Seances de l'Academie des Sciences Serie* D Vol. 262; 509-523.
49. Hofmann, A.; Heim, R. & Tscherter, H. 1963. Presence de la psilocybine dans une espèce européene d'Agaric, le *Psilocybe semilanceata* Fr. *Comptes Rendus Hebdomadaire des Séances de l'Académie des Sciences* Vol. 257: 10-12.
50. Hopf, A. & Eekert, H. 1969. Autoradiographic studies on the distribution of psychoactive drugs in the rat brain. *Psychopharmacologia* Vol. 16: 201-222.
51. Horita, A. 1963. Some biochemical studies on psilocybin and psilocin. Journal of *Neuropsychiatry* Vol. 4: 270-273.
52. Horita, A. 1975. Personal communication.
53. Horita, A. & Hamilton, A.E. 1973. The effects of DL-α-methyltyrosine and L-DOPA on the hyperthermic and behavioral actions of LSD in rabbits. *Neuropharmacology* Vol. 12: 471-476.
54. Horita, A. & Weber, L.J. 1961a. The enzymic dephosphorylation and oxidation of psilocybin and psilocin by mammalian tissue homogenates. *Biochemical Pharmacology* Vol. 7: 47-54.
55. Horita, A. & Weber, L.J. 1961b. Dephosphorylation of psilocybin to psilocin by alkaline phosphatase. *Proceedings of the Society for Experimental Biology and Medicine* Vol. 106: 32-34.
56. Horita, A. & Weber, L.J. 1962. Dephosphorylation of psilocybin in the intact mouse. Toxicology and *Applied Pharmacology* Vol. 4: 730-737.
57. von Hungen, K.; Roberts, S. & Hill, D.F. 1974. LSD as an agonist and antagonist of central dopamine receptors. *Nature* Vol. 252: 588-589.
58. Imai, S. 1932. On *Stropharia caerulescens*, a new species of poisonous toadstool. *Transactions Sapporo Natural History Society* Vol. 12(3): 148-151.
59. Jacobs, K.W. 1975. Hallucinogenic mushrooms in Mississippi. *Journal of the Mississippi State Medical Association* Vol. 2: 35-37.
60. Johnson, D. 1975. Personal communication.
61. Kalberer, F.; Kreis. W. & Rutschmann, J. 1962. The fate of psilocin in the rat. *Biochemical Pharmacology* Vol. 11: 261-269.
62. Kimbrough, J. 1975. Personal communication.
63. Kitzinger, C. & Benzinger, T.H. 1960. Principle and method of heatburst microcalorimetry and the determination of free energy, enthalpy and entropy changes. *Methods of Biochemical Analysis* Vol. VIII: 309-360.
64. Krieg. M.B. 1964. *Green Medicine: The Search for Plants that Heal*. Chicago: Kami McNally.
65. Krieger, L.C. 1911. Note on the reputed poisonous properties of *Coprinus comatus*. *Mycologia* Vol. 3: 200-202.
66. Leuner, II. 1968. 1st die verwendung von LSD-25 für die experimentelle psychiatrie und in der psychotherapie heute noch vertretbar? *Nervenartz* Vol. 39: 356-360.
67. Levine, M. 1919. The sporadic appearance of non-edible mushrooms in cultures of *Agaricus campestris*. Torrey Botanical Club Bulletin Vol. 46: 57-63.
68. Levine, W.G. 1967. Formation of blue oxidation produce from psilocybin. *Nature* Vol. 215: 1292-1293.
69. Lindeberg, G. 1950. Phenol oxidases of the cultivated mushroom *Psalliota bispora* f. *albida*. *Nature* Vol. 166: 739.
70. Mallette, M.F. & Dawson, C.R. 1949. On the nature of highly purified mushroom tyrosinase preparations. *Archives of Biochemistry* Vol. 23(1): 29-44.
71. Malette; Lewis, S.; Ames, S.R.; Nelson, J.M. & Dawson, L.R. 1948. The preparation of mushroom tyrosinase. *Archives of Biochemistry* Vol. 16(2): 283-289.
72. Mason, H.S. 1955. Comparative biochemistry of the phenolase complex. *Advances in Enzymology* Vol. 16: 105-184.
73. Matsuda, I. 1960. Hallucination caused by *Psilocybe venenata* (Imai) Imazeki et Hongo. *Transactions of the Mycological Society of Japan* Vol. 2(4): 16-17.
74. McCarthy, J.P. 1971. Some less familiar drugs of abuse. *Medical Journal of Australia* Vol. 2(21): 1078-1081.
75. Mcllvaine, C. 1973. *One Thousand American Fungi* [1902 edition]. Berlin: Something Else Press, Inc.
76. Murrill, W.A. 1911. Illustrations of fungi-VllI. *Mycologia* Vol. 3: 103.
77. Murrill, W.A. 1916. A very dangerous mushroom. *Mycologia* Vol. 8(1): 186-187.
78. Murrill, W.A. 1920. The fungi of Blackebury Virginia *Mycologia* Vol. 12: 322-328.
79. von Neuhoff, W. 1958. Eine Düngerling-Vergiftung in Bremen. *Zeitschrift für Pilzkunde* Vol. 24: 87-91.
80. Oakenbough, W. 1975. A guide to the psilocybin mushroom of B.C. *Georgia Straight* 18 September.
81. Ola'h, G.M. 1969. A taxonomical and physiological study of the genus Panaeolus with the Latin descriptions of the new species. *Revue de Mycologie* Vol. 33(4): 284-290.
82. Ola'h, G.M. 1970. Le genre Panaeolus: essai taxinomique et physiologique. *Revue de Mycologie, Memoire bors-serie*. No. 10.
83. Ott, J. 1975. Personal communication.
84. Ott, J. In publication. *Hallucinogenic Plants of North America*. Berkeley: Wingbow Press.
85. Peisach, J. & Levine, W.G. 1965. A comparison of the enzymic activities of pig ceruloplasmin and *Rhus vernicifera* laccase. *Journal of Biological Chemistry* Vol. 240: 2284-2289.
86. *PharmChem Newsletter*. 1975. Vol. 4(1): 6.
87. Pieri, L.; Pieri, M. & Haefely, W. 1974. LSD as an agonist of dopamine in the striatum. *Nature* Vol. 252: 586-588.

88. Pollock, S.H., 1974. A novel experience with Panaeolus: a case study from Hawaii. *Journal of Psychedelic Drugs* Vol. 6(1): 85-89.
89. Pollock, S.H., 1975. The psilocybin mushroom pandemic. *Journal of Psychedelic Drugs* Vol. 7(1): 73-84.
90. Rhoades, F. 1975. Personal communication.
91. Robbers, J.E.; Tyler, V.E. & Ola'h, G.M. 1969. Additional evidence supporting the occurrence of psilocybin in *Panaeolus foenisecii*. *Lloydia* Vol. 32: 399-400.
92. Romagnesi, M.H. 1964. Champignons toxiques au Japon. *Bulletin de la Societé mycologique de France* Vol. 80(1): iv-v.
93. Roszell, D.K. & Horita, A. 1975. The effects of haloperidol and thioridazine on apomorphine- and LSD-induced hyperthermia in the rabbit. *Journal of Psychiatric Research* Vol. 12: 117-123.
94. Saccardo, R.A. & Trotter, J.E. 1925. *Panaeolus semiglobatus*. *Sylloge Fungorum* Vol. 23: 323.
95. Sanford, J.H. 1972. Japan's "Laughing Mushrooms." Economic Botany Vol. 26: 174-181.
96. Schultes, R.E. 1939. Plantae Mexicanae II: the identification of Teonanácatl, a narcotic basidiomycete of the Aztecs. *Botanical Museum Leaflets* Harvard University Vol. 7(3): 37-54.
97. Schultes, R.E. 1940. Teonanácatl: the narcotic mushroom of the Aztecs. *American Anthropology* Vol. 42: 429-443.
98. Schultes, R.E. 1972. The ethnotoxicological significance of additives to New World hallucinogens. *Plant Science Bulletin* December: 34-41.
99. Schultes, R.E. 1974. Personal communication.
100. Schultes, R.E. & Hofmann, A. 1973. *The Botany and Chemistry of Hallucinogens*. Springfield, Illinois: Charles C. Thomas.
101. Semerdzieva, M. & Nerud, F. 1973. Halluzinogene Pilze in der Tschechoslowakei. *Ceska Mykologie* Vol. 27(1): 42-47.
102. Singer, R. 1948. Diagnoses fungorum novorum agaricalium. *Sydowia: Annales Mycologici* Vol. 2: 37.
103. Singer, R. 1958. Mycological investigations on Teonanácatl, the Mexican hallucinogenic mushroom. Part 1. The history of Teonanácatl, field work and culture work. *Mycologia* Vol. 50: 239-261.
104. Singer, R. 1962. *Agaricales in Modern Taxonomy*. New York: Hafner Press.
105. Singer, R. & Smith, A.H. 1958a. IV. About the identity of the "Weed Panaeolus"or "Poisonous Panaeolus. " *Mycopathologia et Mycologia Applicata* Vol. 9: 280-284.
106. Singer, R. & Smith, A.H. 1958b. Mycologica investigations on Teonanácatl, the Mexican hallucinogenic mushroom. Part II. A taxonomic monograph of Psilocybe, section caerulescentes. *Mycologia* Vol. 50(2): 262-303.
107. Singer. R.; Smith, A.H. & Guzmán, G. 1958. A new species of *Psathyrella*. *Lloydia* Vol. 21: 26-28.
108. Smith, A.H. 1975. Personal communication.
109. Southcott, R.V. 1974. Notes on some poisonings and other clinical effects following ingestion of Australian fungi. South Australian Clinics Vol. 6(5): 441-478.
110. Stein, S.I. 1958. I. An unusual effect from a species of Mexican mushrooms *Psilocybe cubensis*. *Mycopathologia et Mycologia Applicata* Vol. 9; 263-267.
111. Stein, S.I. 1959. Clinical observations on the effects of *Panaeolus venenosus* versus *Psilocybe caerulescens* Mushrooms. *Mycologia* Vol. 51: 49-50.
112. Stein, S.I.; Closs, G.L. & Gabel, N.W. 1959. Observations on psychoneurophysiologically significant mushrooms. *Mycopathologia et Mycologia Applicata* Vol. 11: 205-216.
113. Szasz, T. 1975. Ceremonial Chemistry - *The Ritual Persecution of Drugs, Addicts and Pushers*. New York: Doubleday.
114. Trotter, J.E. 1944. A report of nine cases of fungus poisoning. *Medical Journal of Australia* Vol. 1: 393.
115. Tyler, V.E., Jr. & Gröger, D. 1964. Occurrence of 5-hydroxytryptamine and 5-hydroxytryptophan in *Panaeolus sphinctrinus*. *Journal of Pharmaceutical Sciences* Vol. 53(4): 462-463.
116. Tyler, V.E., Jr. & Smith, A.H. 1963. Protoalkaloids of *Panaeolus* species, 2. Pp. 45-54, in: Mothes, K. & Schröter, H.B. (Eds.). *Internationale Arbeitstagung Biochemie und Physiologie der Alkaloide*. Berlin: Akademie-Verlag.
117. Verrill, A.E. 1914. A recent case of mushroom intoxication. *Science* Vol. 40: 408-410.
118. Walters, M.B. 1965. *Pholiota spectabilis*, a hallucinogenic fungus. *Mycologia* Vol. 57: 837-838.
119. Waser, P.G. 1967. Pharmacology of *Amanita muscaria*. Pp. 419-439, in: Efron, D.H. & Collaborators (Eds.). *Ethnopharmacologic Search for Psychoactive Drugs*. Washington, D.C.: U.S. Government Printing Office.
120. Wasson, R.G. 1973. Mushrooms and Japanese culture. *Transactions of the Asiatic Society of Japan* Vol. 11: 5-25.
121. Wasson, R.G. 1974. Personal communication.
122. Wasson, R.G. 1976. Personal communication.
123. Weber, L.J. & Horita, A. 1963. Oxidation of 4- and 5-hydroxyindole derivatives by mammalian cytochrome oxidase. *Life Sciences* Vol. 1: 44-49.
124. Weil, 1975. Mushroom hunting in Oregon. *Journal of Psychedelic Drugs* Vol. 7(1): 89-102.
125. Wier, J.K. & Tyler, V.E., Jr. 1963. Quantitative determination of serotonin in Panaeolus species. *Journal of Pharmaceutical Sciences* Vol. 52(5): 419-422.
126. Wolback, A.B., Jr.; Miner, E.J. & Isbell, H. 1962. Comparison of psilocin with psilocybin, mescaline and LSD-25. *Psychopharmacologia* Vol. 3: 219-223.
127. Yokoyama, K. 1976. Personal communication.

Ecopsychology and the psychedelic experience

Editorial

by

David Luke

University of Greenwich, UK

European Journal of Ecopsychology 4: 1-8 (2013)

original text: http://eje.naturalresourceswellbeing.com/v4/EJE v4_Full.pdf
backup source: http://www.psilosophy.info/resources/EJE v4_Full.pdf

David Luke

Table of Contents:

Turning topiary
Ecodelicately
The voices of the Earth
Acknowledgements
Correspondence
Footnotes
References

Turning topiary

On my travels in Mexico many years ago, last millennia in fact, I came across a psychoactive plant, known locally as 'the shepherdess', which was used by indigenous people for divination and healing. I was given the opportunity to try this foreign foliage and doing so had an incredible and entirely unexpected experience. Within moments of consuming the herb a strange sensation began seeping through my toes and fingertips and moved towards my core turning me rapidly into some kind of thorn bush. The metamorphosis spread quickly up my arms and legs, across my body and up to my head until I found myself completely transformed into a small spiky shrub. I was quite literally rooted to the spot and could not move.

Simultaneous to this, all the trees and all the plants, in fact every blade of grass across the large field within view, began laughing hysterically. Anything and everything before me that photosynthesised was in side-splitting fits and they were all cracking lines like "now you know what it's like to be a plant, ha, ha, ha", swaying back and forth, shrieking and howling with laughter. I didn't find this particularly funny though, because I was absolutely convinced of my transmutation, and furthermore believed it to be permanent. Oh how the plants laughed. Then a disembodied voice spoke. Loud, deep and stern. A woman's voice. She said something like, "you stupid humans think you run the show around here, you're so arrogant, but you haven't got a clue". And then she proceeded to lecture me on species-centrism and our lack of harmony with others on Earth. I was terrified and 'bewildered' - in the literal sense too - for although I had hypothetically reasoned that everything might be inherently conscious, I had never expected to be chastised by the spirit of Nature or publicly ridiculed by grass.

The experience, mercifully, only lasted ten minutes, and quickly subsided as the voice drifted away and I turned back into a slightly more aptly named *Homo sapiens* than before. The immediate psychological effects had gone, but the ontological shock remained indefinitely. I would say that this was my first serious shamanic experience with plant (or fungal) psychedelics[1], and since then I have never considered ecology in quite the same way as before.

Ecodelicately

So, this is my personal starting point for editing this special issue, but why *Ecopsychology* and the *Psychedelic Experience* anyway? Elsewhere (Krippner & Luke, 2009), I have indicated two simple reasons: that psychedelics may enhance the experience of Nature or, given that these substances readily occur outside of the lab, the consumer is therefore compelled to go into the wild to obtain them. But of course, psychedelic experiences and the encounter with Nature usually run much deeper than this, and may even lead to a direct communication with other species. When it does so it is often the same message, which usually runs a little like those received from psychedelic mushrooms by the mycologist Paul Stamets, which are "... always that we are part of an 'ecology of consciousness', that the Earth is in peril, that time is short, and that we're part of a huge, universal bio-system" (Harrison, Straight, Pendell & Stamets, 2007: 138). So there is good reason to explore psychedelics and ecopsychology, if only for the ecologically orientated and apparent interspecies communication that ensues (Krippner & Luke, 2009), or what Doyle (2009: 21) calls the "grokking of Gaia".

Clearly there is also a certain degree of overlap between psychedelic research and ecopsychology: They share common origins in the counter-culture, human potential, and transpersonal psychology and psychotherapy camps. Indeed, psychedelics themselves were very much intrinsic to the genesis of all these movements in the 1950s and 60s, and even had influence on the evolution of ecology and deep ecology movements in the 1970s. Importantly though, the psychedelic cauldron is also the crucible in which we find many core ecopsycholgical themes bubbling up, be they archetypes, animism, shamanism, paganism, green spirituality, transpersonal psychology, or eco-activism. In short, the two fields are deeply entwined, like two old trees that have grown up trunk to trunk. And yet the literature of the fusion between these two areas is somewhat nascent, with the only prior collection of this kind appearing as a special issue of the *Bulletin of the Multidisciplinary Association for Psychedelic Studies* (*MAPS*, 2009), edited by David Jay Brown. Nevertheless, that issue was on *Psychedelics and Ecology* more generally, rather than ecopsychology specifically so this may indeed be the first such collection.

Nevertheless, as with my predecessors editing the last issue of this journal, on *Queering Ecopsychology* (Heckert, Milton & Barker, 2012), it occurred to me that many of the submissions were somewhat thin on psychology per se, and I too wondered if they were "psychological enough". That said, when dealing with psychedelics in the context of ecology it is hard to avoid the interaction between 'mind' and 'nature', which Greenway (2009) reminds us is *the* core relationship of ecopsychology. Because, even if it is not explicit, psychedelics *de facto* imply psychology once you wade in and get your wellies dirty. For psychedelics are nothing if not 'mind manifesting', as indicated by the naming of them as such by Humphry Osmond in 1957. Somewhat more aptly these substances have also recently been dubbed *ecodelics* by Richard Doyle (2011) who suggested that the ecodelic insight arising from the ingestion of these plants and fungi is "the sudden and absolute conviction that the psychonaut is involved in a densely interconnected ecosystem for which contemporary tactics of human identity are insufficient" (p. 20).

So while there is a good dose of psychedelic ecopsychology in this special issue it is as much psychedelic eco-anthropology, eco-ethnobotany, eco-semiotics, ecopharmacography, transpersonal ecology and ecosophy (as Schroll prefers), and even psychedelic ecology. But given that this is the *European Journal of Ecopsychology* I won't even mention the fact that all but one of the contributors reside in the Americas, as this merely suggests we have some catching up to do in this arena on this side of the pond.

The voices of the Earth

Taking the historical perspective, **Rob Dickins** guides us through the early psychedelic and very much psychiatric 'triplit' of the first decade of (what he calls) pharmacography, spanning 1954-1963. In doing so, it is surprising that those early texts he dissects do not have an inherently ecodelic predilection - seemingly due to the laboratorial set and setting favoured at that time - and yet these proto trips paved the way for what was to come with the engendering of an intrinsic interconnectedness between the user and Nature within the psychedelic experience. But this transition was very much a steady evolution, so eventually - after *The Doors of Perception* (1954) and *Heaven and Hell* (1956) - with the book *Island* (1962), we see that "Huxley implicitly recognizes that the natural world is under threat", although unfortunately "any ecological concern in the text is undermined by his pessimism; green awareness fades into the background of a pure white light of mystical experience and his darkly-coloured perception of the social world that threatens it". Yet, despite Huxley's gloom, there remained the interconnectedness that would later form the core of the psychedelic community's coming embrace of trans-speciesism.

Nowhere is this interconnectedness more apparent than with one of the planet's oldest surviving and most culturally intact indigenous psychedelic-plant using people, the Wixáritari (Huichol) of Mexico. A shamanic, animist and pagan people, the Wixáritari have a deeply ingrained relationship with, and reverence for Nature which weaves intimately around their use of the psychoactive peyote cactus, itself synonymous with the deer and the maize, forming their holy trinity of Nature on which they depend. For the Wixáritari, Nature is at the core of their culture: take away the maize, deer or peyote and the culture ceases to exist. Maintaining access to their sacramental cactus since leaving their homeland to avoid the Spanish conquistadors some 500 years ago, the Wixáritari embark, on foot, on a pilgrimage each year some 600 miles (as the crow flies) to collect the peyote from their sacred land. However, their fate as a culture is poised in the balance as Canadian mining interests seek to destroy the habitat in which their peyote grows (Luke, 2012). Exploring this intimate connection with the land **David Lawlor** explores the Wixáritari's unique sense of place, quoting the anthropologist and filmmaker Barbara Myerhoff (1974: 259-60):

> Ecologically, during the peyote hunt the Huichols achieve a spiritual relation to their physical environment - not a neutral setting, not a mere place to live or exploit for a living. The very landscape is sanctified - the caves, springs, mountains, rivers, cactus groves - and the features of the mythical world are elevated to cosmic significance. 'Plants' and 'animals' become only labels, conventions, mere human categories of thought. Distinctions between them are illusory. Man is nature.

As hinted at earlier, it's not much of an ontological leap from the feeling of interconnectedness to the experience of interspecies communication (ISC), in the following case this is brought about through the music of Western Amazonian shamanism. In particular, **Christina Callicot** not only highlights this interconnectedness but emphasises the importance of recognising our interdependence, ignored as it by modern culture or lambasted by critics:

> Anthropology has been long been criticized for its failure to characterize human interdependence with nature in a way that refrains from idealizing or essentializing indigenous peoples, or portraying them as passive objects of environmental determinism. Conversely, modern industrialized culture fails to recognize our interdependence altogether, with drastic results for all species.

Leaving aside for a moment what we are supposed not to do, besides music, what better way is there to actively engage the interspecies conversation than with poetry? Thankfully **Dale Pendell** is on hand with a feisty bird he encounters and his thoughtful dog to remind me that psychedelic ISC need not necessarily mean parapsychologists (like me) labcoating around trying to measure ecodelic ESP:

> ...are we really thinking the same thoughts - are we really in telepathic communication - or is it merely seeming? Perhaps we could devise subtle experiments, with controls. Psychologists without enough to do could write a paper. Or we could continue, and let the continuing be the confirmation.

Using psychedelic plants, or indeed fungi, to join the interspecies conversation also forms part of Graham Harvey's *Animist Manifesto* because "Maybe sometimes the mushrooms just want to help us join in the big conversation that's going on all around us" (Harvey, 2005: 128). There's no denying either, that once you start talking with fungi you are very likely well on the road to the kind of animism we see at play in possibly every shamanic culture utilizing psychoactive flora, fauna (rarely) and fungi[2]. **Robert Tindall**'s story is no exception and he puts forward a fascinating discussion and account of the use of the psychedelically-informed animist worldview to heal human ailments, calling on what shamans call teacher plants, or even doctors:

> Both the medicines and the patient are sung over with icaros, the magical melodies that contain and transmit the healing virtue of the plants. As well, ayahuasca ceremonies are utilized to better enable the *curandero* to direct the spirits of the plants and other 'doctors', and for the patient to more thoroughly integrate the healing received.

Such traditional shamanic practices that utilise psychedelic lifeforms are probably at their most vital and widespread among the prehispanic cultures of Latin America, and yet neo-shamanic practices which incorporate elements of these culturally-bound traditions can be found proliferating across much of the industrialised world. Fifty years since Leary, Metzner and Alpert (1964) published *The Psychedelic Experience* as a guide for fledgling psychonauts at the beginning of the popular era of psychedelics, pioneering ecopsychologist and psychedelic researcher **Ralph Metzner** here explores the activity and utility of these psychedelic neo-shamanic groups for ecopsychological means, particularly within the United States. Informing us that:

> The revival of shamanic ritual practices and an animistic worldview can be seen as part of a worldwide human response to the degradation of ecosystems and the biosphere. These groups and individuals are expressing a new awareness, as well as a revival of ancient awareness of the organic and spiritual interconnectedness of all life on this planet.

Nevertheless, in places like the United States - where there exists no continuous cultural use of psychedelic plants - if neo-shamanic groups intend to make use of such mind-blowing biota then they are likely to encounter the problem of natural local supply. Exploring the 100-mile diet and issues of bioregionalism **Eleanora Molnar** explores the practical ecological challenges of sourcing one's favoured flora, asking if:

> In trying to attain a level of elevated consciousness and understanding, are psychonauts actually acting in ways that are disrespectful of plant spirits, indigenous cultures, and the biosphere in general? Are psychonauts participating in yet another folly of an industrialized, materialistic, and consumer-based culture?

Re-framing the respect required for the negotiation between human mind and Nature at large, and moving from bioregionalism to biogenetic structuralism **Michael Winkelman** presents a co-evolution of psychonauts and psychedelics from our primate antecedents to their current *Homo* descendants. Furthermore, Winkelman looks to the future too to identify that the:

> common features of shamanism, psychedelic metaphysics and ecopsychology illustrate that they involve common origins. Their commonalities point to a biologically based ecopsychology, one that is the product of human evolution and evolutionary adaptations. These biological bases suggest that shamanic ecopsychology and psychedelic therapies still have relevance for humans today. Our very health and survival as a species may depend on our ability to re-establish these relations with nature.

Not only may our health as a species rely on a reconnection with Nature but maybe, as David Orr notes, by healing the planet we heal ourselves, and **Mark Schroll**, taking an autobiographical approach to the issue, indicates that nothing less than a transformation of consciousness is required to solve our current ecocrisis. The catalyst for this conversion, Schroll tells us, resides within Nature's most potent plants, because the:

> psychedelic experience provides us direct access to universal archetypal truths that transcend the boundaries of culture and the limitations of spacetime. Psychedelic experience allows us to encounter visionary mystical insights about the human condition, Gaia consciousness, deep

community and cosmic unity.

Drawing together this overview, if there is an overarching theme here in this special issue, it is that psychedelics - with the right set and setting - can give rise to a sense of deep connection with Nature, which may extend as far as interspecies communication or the formulation and maintenance of an animist worldview, subsequent healing, and ultimately ecocentric activism as opposed to egocentric action. Coming full circle then to my own animistic dialogue with Nature under the influence of a psychedelic plant all those years ago, if there is a metaphor in my own metamorphosis it's that we as a species must change or be changed if we and other species on this planet are to survive. The starting point for that transformation into becoming a part of, rather than apart from, our ecosystem is our own individual consciousness.

Acknowledgements

My thanks to the EJE's founder and editor Paul Stevens for his unstinting support, to the authors, whether published here or not, who submitted papers to this special issue, and to the blind reviewers who contributed such valuable feedback, including Cameron Adams, Kim Dawson, Graham Harvey, Jeremy Narby, Dale Pendell, Tom Pinkson, Alan Piper, Paul Stevens, Nick Totton, Robert Wallis and Michael Winkelman.

Correspondence

David Luke
Email: drdluke@gmail.com

Footnotes

1. A psychedelic has been defined as a substance "...which, without causing physical addiction, craving, major physiological disturbances, delirium, disorientation, or amnesia, more or less reliably produces thought, mood, and perceptual changes otherwise rarely experienced except in dreams, contemplative and religious exaltation, flashes of vivid involuntary memory, and acute psychoses" (Grinspoon & Bakalar, 1998: 9).
2. Indeed, "a survey into people's exceptional experiences with psychedelics found that encountering the 'spirit' of the ingested plant or fungus was the most widely reported of a range of 17 'paranormal' and 'transpersonal' type experiences occurring with those taking psilocybin-containing mushrooms (Luke & Kittenis, 2005). According to the respondents this encounter also occurred quite frequently, and was the second most prevalent experience with any one substance, preceded only by experiences of 'unity consciousness' on LSD. Additionally, the encounter with 'plant consciousness' was the most widely reported transpersonal event for several other psychedelic substances too, such as ayahuasca, *Salvia divinorum*, and the *Amanita muscaria* mushroom" (Krippner & Luke, 2009: 13-4). Curiously, the experience of encountering the spirit or intelligence of the ingested substance for synthetic compounds or pure molecules (e.g., LSD or DMT) was much less commonly reported, as might be expected, though the fact it was reported at all throws up some interesting questions (not explored here) about the perceived sentience of plants/fungi versus molecules alone.

References

1. Doyle, R. (2011). *Darwin's pharmacy: Sex, plants and the evolution of noösphere* . Seattle, WA: University of Washington Press.
2. Greenway, R. (2009). Robert Greenway: The Ecopsychology interview. *Ecopsychology*, 1, 47-52. Grinspoon, L. & Bakalar, J.B. (1998) *Psychedelic drugs reconsidered* (2nd edition). New York: The Lindesmith Centre.
3. Harrison, K., Straight, J., Pendell, D. & Stamets, P. (2007). "Plant spirit", in J.P. Harpingnies (ed.), *Visionary plant consciousness: The shamanic teachings of the plant world* (pp. 133-145). Rochester, VT: Park Street Press.
4. Harvey, G. (2005). An animist manifesto. *Strange Attractor Journal*, 2, 124-129.
5. Hekert, J., Milton, M. & Barker. M. (2012). Queering ecopsychology. *European Journal of Ecopsychology*, 3, 1-4.
6. Krippner, S. & Luke, D. (2009). Psychedelics and species connectedness. *Bulletin of the MultidisciplinaryAssociation for Psychedelic Studies*, 19, 12-15.
7. Leary, T., Metzner, R. & Alpert, R. (1964). *The psychedelic experience: A manual based on the Tibetan book of the dead*. New York, NY: University Books.
8. Luke, D. (2012). Holy mountain or holey mountain? *PsyPressUK*, 1, 24-25.
9. Luke, D.P. & Kittenis, M. (2005). A preliminary survey of paranormal experiences with psychoactive drugs. *Journal of Parapsychology*, 69, 305-327. *MAPS* (2009). Psychedelics and Ecology: Special Issue. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, 19.
10. Myerhoff, B. (1974). *Peyote hunt: The sacred journey of the Huichol Indians*. Ithaca, NY: Cornell University Press.

The responsible use of entheogens in the context of bioregionalism

by

Eleonora Molnar

European Journal of Ecopsychology 4: 78-89 (2013)

© Eleonora Molnar

original source: http://eje.naturalresourceswellbeing.com/v4/EJE%20v4_Molnar.pdf
backup source: http://www.psilosophy.info/resources/EJE%20v4_Molnar.pdf

Table of Contents:

Abstract
Introduction
Overview of bioregionalism and related concepts
Ecological footprint and the 100 mile diet
Issues, impacts and consequences of non-bioregional use of entheogens
Animism and animaphany
Concluding thoughts
References

Abstract

The use of entheogens tends to particularly thrive in the western regions of North America, in places also characterized by a strong ecological ethos, sometimes expressed as *bioregionalism* (i.e., Vancouver, Portland, San Francisco). Although entheogens and bioregionalism coincide and arguably have some significant things in common, there has been, to date and in practice, very little explicit connection between these two phenomena. More precisely, there is little evidence that users of entheogens are guided or influenced much by bioregional thought, or by related ecological values and frameworks. The academic literature on this topic is virtually non-existent. Nevertheless, there are some relevant ethical considerations regarding the use of plant-based entheogens (including fungi) outside of the geographic areas in which they were grown. This article explores various ways in which this apparent disconnect may be problematic, and discusses possible connections which, if pursued, could foster more responsible use of entheogens from a global and ecological perspective. An overview of bioregionalism and related concepts is offered next. Following that, some of the issues and impacts raised by non-bioregional uses of entheogens are discussed, and the article concludes with some thoughts on approaches to reconciling these problems.

Keywords: entheogens, bioregionalism, ethics, animism, drug tourism.

Introduction

The methodology used to gain knowledge on the variety of psychedelics used, the monetary costs, and the cultural and social milieu in which they are commonly used was ascertained through informal conversations with approximately 50 anonymous people who use psychedelics on the West Coast of North America. Primary locations that data were gathered included Vancouver and Roberts Creek, British Columbia, San Francisco, and Portland, Oregon. The data referred to in this paper were gathered from roughly 2010 to 2013, although the author has been informally researching this area for 25 years, first and foremost in British Columbia.

Overview of bioregionalism and related concepts

A bioregion is an area that can be defined by ecological or geographic boundaries:

> Bioregionalism has a number of characteristics and these include a belief in natural, as opposed to political or administrative, regions as organizing units for human activity; an emphasis on a practical land ethic to be applied at a local and regional scale; and the favoring of locally and regionally diverse cultures as guarantors of environmental adaptation, in opposition to the trend towards global monoculture (Alexander, 1996).

Kirkpatrick Sale (1984), an originator and proponent of bioregionalism, says that we must become "dwellers in the land" and that we must "come to know the earth" in the places in which we live. He quotes E.F. Shumacher to define the quintessence of bioregionalism:

> In the question of how we treat the land, our entire way of life is involved. We must somehow live as close to it as possible, be in touch with its particular soils, it waters, its winds. We must learn its ways, its capacities, its limits. We must make its rhythms our patterns, its laws our guide, its fruits our bounty.

Bioregionalism can perhaps be best described as a philosophy or sensibility. Ralph Metzner (1995) writes:

> The primary values, from a bioregional perspective, are not 'property rights' and 'development' but the preservation of the integrity of the regional ecosystem, the viability of the biotic community, and maximizing economic self-sufficiency within the region.

Although bioregionalism has not crystallized in its full political vision (the redrawing of political boundaries along ecological or bioregional lines), it remains a persistent alternative undercurrent, an important component of the broader environmental movement. Indeed, it can be argued that bioregionalism's focus on all things local and regional anticipated or at least exerted an important influence on debates that eventually unfolded more in the mainstream - in particular, free trade, globalization, local foods and ecological footprint. And in many ways the roots of bioregionalism, in eco-philosophical terms, extend deeper than those of other environmental frameworks. For these reasons, it is argued that bioregionalism provides an important framework within which to consider the ecological, social, cultural and spiritual dimensions of entheogen use, embedded in place or elsewhere.

Furthermore, Metzner clearly states the parallels between bioregionalism and entheogens. In *Green Psychology*, he makes the assertion that the renewed ceremonial and ritual uses of entheogenic plants are a symptom of an emerging grassroots paradigm shift towards more holistic thinking in terms of ecological issues and values. He states:

> I would argue that at a time when global techno-industrial culture is leading to massive erosion of biodiversity, worldwide ecosystem destruction, and profound social and economic disintegration, there are a number of cultural movements that are cautiously and purposefully moving toward the articulation of an ecological worldview and a bioregional, sustainable lifestyle. Among movements with similar values and assumptions I would include the revival of interest in herbal, homeopathic, and natural medicine; shamanic practices; bioregionalism; deep ecology; ecofeminism; social ecology; environmental ethics; ecopsychology; ecotheology; green economics; and the neopagan revival (Metzner, 1999: 8).

While Metzner makes the explicit connection between sustainability, bioregionalism, and enthoegenic use, he seems to view them as mutually supporting practices. This paper makes the observation that current use of entheogens among psychonauts and seekers on the West Coast of North America is not always so and sometimes rather to the contrary.

Ecological footprint and the 100 mile diet

Environmentalism and, more particularly, bioregionalism, are umbrella terms that cover many related concepts and initiatives, two of which are ecological footprint and the 100 Mile Diet. Mathis Wackernagel and William Rees conceived the notion of an ecological footprint, defining it as:

> The total area of land required to sustain an urban region (its 'Ecological Footprint') is typically at least an order of magnitude greater than that contained within municipal boundaries or the associated built-up area. In effect, through trade and natural flow of ecological goods and services, all urban regions appropriate the carrying capacity of distant 'elsewheres', creating dependencies that may not be ecologically or geopolitically stable or secure. ... Such macroecological realities are often invisible to conventional economic analysis yet have serious implications for world development and sustainability in an era of rapid urbanizations and increasing ecological uncertainty (Rees, 1992: 121).

More simply stated, the Ecological Footprint is a measure of the impact put on land and water in a very particular region by its population. Essentially this measurement is a means to help people and societies delve into notions of sustainability and develop the understanding that we must live within nature's limits and carrying capacity (Wackernagel & Rees, 1996).

Perhaps inspired to some extent by the concept of an Ecological Footprint, the 100 Mile Diet was conceptualized in order to increase food security and to reduce social, environmental, and economic costs associated with importing and consuming foods that cannot be locally grown in a particular region or season. Smith and MacKinnon (2007) established a 100-mile radius from their residence in which they were to source their food for one year (2005-2006) and this is an example of bioregionalism applied to food systems. Some Diet benefits include reducing one's carbon footprint, eating healthier by reducing intake of processed food, weight loss, awareness of food systems, stimulating the local economy, and creating jobs. Some Diet challenges include learning how to preserve local food in season, changing eating habits, and potentially adopting a plant-based diet in some locations where meat and dairy items are not produced.

Depending on the context, food-based movements such as the 100 Mile Diet (exemplary of bioregionalism) and environmental concepts such as the Environmental Footprint may be quite distinct or strongly interconnected, but in most instances they are highly complementary. For example, the concept of bioregionalism is being applied to all kinds of consumer activities and "buy local" campaigns are ubiquitous whether applied to locally sourced building materials, food, tourism, entertainment, and clothing.

Although it appears that the concepts of bioregionalism and the Ecological Footprint have been accepted most wholeheartedly in the sphere of food security, these concepts have not been equally accepted by psychonauts (entheogen users who seek self-knowledge). This is because many psychonauts are not often consuming entheogens grown in their bioregion and are inadvertently expanding their Environmental Footprint. Paradoxically, this is not reminiscent of the 100 Mile Diet nor the associated concepts of bioregionalism and sustainability that Metzner couples with entheogenic consumption and shamanic practices. As an aside, it is worthy of note that the 100 Mile Diet is not necessarily concerned with the spiritual implications of food while this is a relevant consideration that pertains to entheogens. This consideration will be discussed later in this article.

Issues, impacts and consequences of non-bioregional use of entheogens

Contemporary uses of plant-based non-indigenous entheogens leave sizeable footprints that involve ecological, social, cultural, and spiritual considerations that may contradict the intentions of psychonauts and the paradigm of moving towards more sustainable communities. Some key considerations involve the inordinate amount of resources used in transportation, cultural appropriation, the commodification of plant medicines and altered states of consciousness, overharvesting and the possible displacement of traditional plants and their spirits. It is argued that at least some of these undesirable impacts and consequences could be avoided or minimized if users ingested only locally grown plant-based entheogens, plant-based analogues or synthetic versions of plants that are not available locally. The extent to which psychonauts are aware of the implications of their use is unclear, as there is very little discussion of this topic in the entheogenic discourse.

It can be generally observed that here is a recent surge of entheogenic ceremonies in North America, in particular with considerable activity in the western coastal regions. In many instances, sacred indigenous plant-based entheogens, primarily ayahuasca (and also including iboga, peyote and psilocybin), are imported from distant geographic locations to serve the needs of those seeking cognitive enhancement and spiritual (healing) experiences. The frequency and high participation rates of non-psychonauts in these kinds of ceremonies are a relatively new phenomena, as are the ceremonies themselves. It is possible that these neotraditional ceremonies have been taking place for some time yet it appears that these once lesser known practices have entered the cultural mainstream and the number of ceremonies and people partaking in them have increased significantly (personal communications with 50 anonymous interviewees). Information about ayahuasca ceremonies is ever-present in the mainstream media and climate as evidenced by an article in *Vanity Fair* in 2011 entitled "Letters from the Amazon" by Ted Mann. The article makes reference to an ayahuasca ceremony in a northern Los Angeles house, to ceremonies in the Amazon, and to the author's personal experience in a ceremony. The article certainly delves into the realms of ayahuasca culture and tourism, giving the sense that these experiences are commonly shared amongst everyday people, as opposed to the rather select realm of psychonauts.

Based on the author's anecdotal understanding of these ceremonies, and particularly those in British Columbia, they include the use of ayahuasca, iboga, peyote and psilocybin (personal communications with 50 anonymous interviewees). Some of the neo-traditional ceremonies involving peyote and ayahuasca are structured on traditional indigenous practices (i.e., the Native American Church) and others have been adapted to the sets and settings of North American culture (cross-cultural Vegetalismo) (Tupper, 2009). These ceremonies are referred to as neo-traditional because they are being held outside of their traditional geographic boundaries and are often presided over by neo-shamans (Tupper, 2009).

Psychonauts and seekers alike are to a great extent ingesting entheogens from a global market, rather than ingesting locally grown plant-based entheogens. For example, it is now possible to procure ayahuasca from Peru, peyote from Mexico, and psilocybin mushrooms from Canada all in the same day. While ingesting these psychoactive plants (and fungi) all at once is not likely or advisable, it is possible, and raises some questions about the local use of non-indigenous entheogens. This conundrum is common but is almost ironic in the sphere of entheogen use. Ostensibly, one result of ingesting entheogens in a ceremonial or therapeutic context is that people may ultimately be more aware of the interconnectivity and the sacredness of life, sometimes referred to the internal and external reality of mystical experience (Griffiths, Richards, McCann & Jesse, 2006). As a result of this awareness, psychonauts may try to lead more balanced lives that have fewer negative impacts on others and the planet. "The worldview of shamanism is that health equals balanced relationships with all living things" (Gray, 1995: 173). Yet the considerations of Ecological Footprint so far appear to be rarely, if ever, applied to the use of entheogens in neo shamanic and neo traditional practices.

One of the most obvious impacts is the inordinate amount of resources used in harvesting and transporting entheogens. Our globalized transportation systems require various inputs such as fuel, labour, and vehicles and the result is often a large Ecological Footprint. While these transportation systems are already in place to serve other means, it does not diminish the amount of total resources used to transport entheogens globally. Also implicit in the discussion of imported plant resources is the problem of overharvesting. Some ethnobotanists assert that the answer to overharvesting in indigenous habitats is the propagation of non-indigenous plant-based entheogens in native habitats; yet this scenario can also be problematic. Although propagation may appear to be a more benign scenario, there is the risk that foreign plants may become invasive when introduced into native landscapes. In many instances, long-term time frames are needed to assess how well introduced species are adapting to native habitats. Conversely, others might advocate for non-native plants to be grown in controlled environments to lessen the chance of proliferation or accidental cross pollination. However, if entheogens are being grown in controlled and artificial environments such as greenhouses or in cultured tissue, they require large amounts of resources for successful propagation and harvest; inputs may outweigh outputs and Ecological Footprints are being expanded.

Another justification for cultivation and use of plant based entheogens in nonindigenous habitats is that humans are indeed part of nature and like animals are spreading the spores and seeds of entheogenic plants globally. This assertion does hold some possibility if it were not for the fact that animals tend to habituate in certain bioregion(s) (based on seasonal migrations and other natural processes). Unlike humans, animals do not have a global habitat. Due to modern advancements in transportation networks, one can travel the globe and create multiple waste streams while attaining a seemingly vital worldly education. It is arguable that if one needs to consume a plant-based entheogen that cannot be sourced locally, a synthetic version or indigenous plant-based analogue might present a more ecologically sound alternative.

Some have asserted that plant-based entheogens such as ayahuasca "want" to be spread all over the earth to multiply their reach and "wake up" earth's inhabitants to the message of honoring her, each other, and ultimately the unity consciousness woven between us (McKenna, 2005). In response to this message, ayahuasca is being bred in non-indigenous places such as Hawaii and Costa Rica. Not only is this being done to spread the spiritual message of the plants, it is also being done to save the dwindling plant resources in their indigenous locales (partially as a result of increasing drug tourism).

In addition to the ecological issues raised previously, there are a number of social and cultural implications to ingesting non-indigenous plant based entheogens, such as ayahuasca. Stresses such as drug tourism and the global marketing of plant-based entheogens are putting considerable strain on indigenous communities. (Dobkin de Rios, 2009). In her 2008 book with Roger Rumrill, Marlene Dobkin de Rios discusses the issue of drug tourism:

> [Drug Tourism] has been around for more than 40 years and has been getting worse each year. Westerners take tours throughout areas of the Amazon and experience 'borrowed mysticism'. The drink ayahuasca is given to them by new, often false shamans - so called 'technicians of ecstasy' - charlatans who are on the lookout to profit from altering their clients' consciousness (p. 2).

They elaborate that drug tourism is taking place as a result of social alienation and Western cultural norms:

> …the urban tourist is on a never-ending search for self-actualization and growth. In this postmoderm period where people no longer produce their own food, where the family has broken down, where there is a significant absence of community tradition and shared meanings, individuals are wracked with feelings of low self-esteem and confusion about values. They are compelled to fill the emptiness with the experience of receiving something from the world. Why not a mystical experience with divinity (pp. 69-70) ?

They further go on to quantify the monetary exchange that vastly differs in value between the West and in the traditional cultures of the Amazon:

> Modernization and cultural change over the last century have destroyed the material base of many Amazonian traditional cultures. Commercial shamanism in Peru has become a system, where foreigners are given a powerful plant psychedelic at a cost of $1,000-$1,500 per week during a visit, compared to the $20-$30 cost for local people (p. 71).

Drug tourism is a global phenomenon, particularly in the Amazon Basin where tourists are looking for a "genuine" ayahuasca experience. While Dobkin de Rios primarily speaks of ayahuasca, she clearly illustrates some of the impacts of drug tourism that include con "neo shaman" and the exorbitant commoditization of culturally sacred ceremonies.

Cultural appropriation is implicit in the discussion regarding drug tourism and bioregionalism; this is yet another consideration. Cultural appropriation "assumes the existence of power differentials between the source culture and the privileged authoritative position of the borrower culture" (Tupper, 2009: 123). It could be argued, for example, that neo-traditional ayahuasca, iboga, peyote, and psilocybin ceremonies practiced in British Columbia are forms of cultural appropriation. These ceremonies are sacred in indigenous cultures and arguably cannot be easily transferred to North American culture with the same reverence and meaning by neotraditional shamans and psychonauts. Tupper (2009) speaks to the ways that cultural appropriation can manifest itself:

> (cultural appropriation) undermines the integrity of the community whose culture is

> appropriated; and it has an impact on the cultural object itself (for example profanation of a sacred practice). It also permits inappropriate distribution of material rewards (namely financial gain) to the individuals doing the appropriating; and it fails to acknowledge the legal sovereignty over a kind of intellectual property (p. 124).

While this article cannot do justice to the ways in which drug tourism and cultural appropriation is taking place in neo-traditional ceremonies, ingesting locally harvested or synthesized entheogens that do not require the guidance of a shaman or the sacred ritual of a traditional indigenous ceremony may avoid issues of cultural appropriation (and drug tourism).

Animism and animaphany

With respect to the cultural and spiritual considerations regarding non-indigenous plant entheogens, one could pose the question: "What do the plants themselves have to say?". While this may seem a ridiculous question to some, it may be a tangible area of inquiry to those who have taken entheogens, those who revel in nature, and those who believe in animism.

J.E. Lovelock wrote *Gaia: A new look at life on Earth* in 1979 and suggested that perhaps the Earth has agency. He speaks of this hypothesis, "in which Earth's living matter, air, oceans, and land surfaces form a complex system which can be seen as a single organism and which has the capacity to keep our planet a fit place for life" (p. x). Lovelock follows up by stating "occasionally it has been difficult, without excessive circumlocution, to avoid talking of Gaia as if she were known to be sentient" (p. xii).

Furthermore, Lovelock also speaks of the inherent knowledge contained within Gaia that is ineffable:

> Among several difficult concepts embodied in the Gaia hypothesis is that of intelligence. Like life itself, we can at present only categorize and cannot completely define it. Intelligence is a property of living systems and is concerned with the ability to answer questions correctly. We might add, especially questions about those responses to the environment, which affect the system's survival, and the survival of the association of systems to which it belongs (p. 146).

Andy Letcher, likely influenced by Lovelock, calls meetings with the spirits or souls inherent in entheogens - magic mushrooms in particular - "animaphany" (2007: 87). This kind of animistic thinking fundamentally challenges the cultural ontology of experience. The animistic discourse contends that all natural objects, such as plants and stones, have spirits or essences that exist outside of our ordinary awareness. Letcher states that to some people psilocybin mushrooms "facilitate the perception that of plants as being in some sense conscious, aware, and inspirited" (2007: 90). What is it that happens to these spirits when they are transported and consumed outside of the geographical areas in which they originated?

What can be said about the displacement of plant spirits and could there indeed be such a thing? In the shamanistic tradition and animistic discourse, it is not the shamans that do the healing, it is the spirits of the plants (Letcher, 2007). Could it be that entheogenic plants used outside of their indigenous habitat are displaced? Would this change their effectiveness or fundamental structure? Does the physical travel that they endure affect their healing potential?

To add some context to these questions, it might be useful to refer to the unrest of souls or spirits whose previous physical bodies are kept in places that are geographically unfamiliar or were disposed of in ways that are disrespectful. The repatriation of ancestral remains by indigenous peoples, such as the Haida, is one such example. One of the reasons for the repatriation of ancestral remains is that by doing so, displaced spirits can finally be at rest.

> The main goal... is to bring home and rebury our ancestors with honour and respect. As long as the remains of our ancestors are stored in museums and other unnatural locations, we believe that the souls of these people are wandering and unhappy. Once they are returned to their homeland of Haida Gwaii, and laid to rest with respect and honour, their spirits can rest, and our communities heal a bit more (Collison & Collison, 2002: 8).

Does this kind of spiritual displacement also occur when entheogenic plants and fungi are consumed in geographic areas in which they are not grown? While these questions can not be decisively answered, they are examples of deliberations about the spiritual considerations of ingesting entheogenic plants outside of the geographic locations in which they were grown and in which traditional and neotraditional ceremonies take place.

Concluding thoughts

Clearly, traditional entheogenic uses and practices are evolving into new forms. A recently published paper argues that the International Narcotics Control Board may criminalize "legitimate cultural practices outside their alleged 'original socioeconomic context'" (Tupper & Labate, 2012). To be clear, the present critique of contemporary uses of plant-based entheogens in no way suggests that only bioregional approaches to entheogenic uses should be legal. Rather, it merely argues that perhaps there are less ecological, social, cultural, and spiritual impacts when only indigenous plant-based entheogens are ingested.

We live in a time of continual fast-paced change and development devoid of shared values, including the worth of self-knowledge. As a result, people are dislocated and are feeling as though they need a respite from the bombardment of industrial values such as materialism and consumerism (Alexander, 2000). It may be that the proliferation and popularization of neo-traditional ceremonies is a response to the spiritual and cultural longing for shared values, self-knowledge, and a sense of unity in the times that we live in (Dobkin de Rios & Rumrill, 2008). In trying to attain a level of elevated consciousness and understanding, are psychonauts actually acting in ways that are disrespectful of plant spirits, indigenous cultures, and the biosphere in general? Are psychonauts participating in yet another folly of an industrialized, materialistic, and consumer-based culture?

The question "Is it ethically responsible to use only locally grown plant-based entheogens?" is not a simple one. It may be possible that the ingestion of entheogenic plants, outside of their geographic areas of origin, are both dishonoring and nurturing to the planet and to Western culture at the same time (through the impacts outlined in this paper and through the benefits of experiencing self-knowledge and unity consciousness inherent in most entheogenic experiences respectively). Furthermore, in the future a bifurcation point could make it more apparent as to what the "ethical" path is. While this assertion may be simplistic, it acknowledges the unknown, especially with respect to the spiritual dimensions of bioregionalism. With this acknowledgement it is sensible to adopt a precautionary principle approach because we inhabit a fragile interconnected web of life and need to consider the long-term consequences of transporting, propagating, and consuming sacred plants and fungi from around the world.

Even though the concept of eating locally is well supported by many, it is acted on by too few. Comparatively, only a small fraction of the population chooses to explore non-ordinary states of consciousness and the deliberation regarding entheogens and bioregionalism may seem peculiar. Nevertheless, this consideration will be timelier as psychonauts' forays into cognitive enhancement become a more accepted and diverse practice, both for therapeutic and medical uses (Fadimann, 2011; Roberts & Hruby, 2002).

A bioregional approach to using entheogens provides a way to address the issues raised in this paper and it is worthy of note that psilocybin mushrooms grow in almost all parts of the world. Does this fact suggest a message the plant (fungi) spirits may be trying to convey? It is indeed if one seriously considers the truth of animaphany and the assertions made about the earth having its own agency (Letcher, 2007; Lovelock, 1979; McKenna, 2005).

In conclusion, this article has sought to explore the ethical way forward with respect to ingesting local plant-based entheogens or synthetic analogues given the potential impacts previously discussed. Perhaps a further deliberation of what is ethical requires more listening to what the plant spirits are trying to teach us (and how we can learn from respectful dialogue with one another):

> ...it is surely safe to say that the path of sanity, perhaps survival, is to regain the spirit of the ancient Greeks, to once again comprehend the earth as a living creature... we must listen again to the two great teachers, one 'the marvelous system of living nature' and the other 'the traditional

> wisdom of mankind', teachers we have 'rejected and replaced by some extraordinary structure we call objective science'... (Sale, 1984).

Correspondence
Eleonora Molnar
Email: ele_molnar@sunshine.net

References

1. Alexander, B.K. (2000). The globalization of addiction. *Addiction Research and Theory*, 5, 501-526.
2. Alexander, D. (1996). Bioregionalism: The need for a firmer theoretical foundation. *The Trumpeter: Journal of Ecosophy (online)*, 13.
3. Collison, N. & Collison, V. (2002). *Haida case study*. Unpublished paper, Haidi Gwaii Museum, Skidegate, BC, Canada.
4. Dobkin de Rios, M. (2009). *The psychedelic journey of Marlene Dobkin de Rios: 45 years with shamans, ayahuascaros, and ethnobotanists*. Rochester, VT: Park Street.
5. Dobkin de Rios, M. & Rumrill, R. (2008). *A hallucinogenic tea, laced with controversy: Ayahuasca in the Amazon and United States*. Westport, CT: Praeger.
6. Fadiman, J. (2011). *The psychedelic explorers guide: Safe, therapeutic, and sacred journeys*. Rochester, VT: Park Street.
7. Gray, L. (1985). "Shamanic counseling and ecopsychology", in T. Roszak, M.E. Gomes & A.D. Kanner (eds.). *Ecopsychology: Restoring the Earth, healing the mind* (pp.172-182). San Francisco: Sierra Club Books
8. Griffiths, R.R., Richards, W.A, McCann, U. & Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology*, 187, 268-283.
9. Letcher, A. (2007). Mad thoughts on mushrooms: Discourse and power in the study of psychedelic consciousness. *Anthropology of Consciousness*, 18, 74-97.
10. Lovelock, J.E. (1979). *Gaia: A new look at life on Earth*. Guernsey: The Guernsey Press.
11. McKenna, D. (2005). Ayahuasca and human destiny. *Journal of Psychoactive Drugs*, 37, 231-234.
12. Mann, T. (2011, December). Letters from the Amazon: Magnificent visions. *Vanity Fair*.
13. Metzner, R. (1999). *Green psychology: Transforming our relationship to the Earth*. Rochester, VT: Park Street.
14. Metzner, R. (1995). The place and the story: Where ecopsychology and bioregionalism meet. *The Trumpeter: Journal of Ecosophy (online),* 12.
15. Rees, W.E. (1992). Ecological footprints and appropriated carrying capacity: What urban economics leaves out. *Environment and Urbanization*, 4, 121-130.
16. Roberts, T.B. & Hruby, P.J. (2002). Towards an entheogen research agenda. *Journal of Humanistic Psychology*, 42, 71-89.
17. Sale, K. (1984). *Mother of all: An introduction to bioregionalism*. Third Annual E.F. Shumacher Lectures, October 1983, Mount Holyoke College, South Hadley, MA.
18. Smith, A. & MacKinnon, J.B. (2007). *The hundred mile diet: A year of local eating*. Toronto: Random House Canada.
19. Tupper, K.W. & Labate, B.C. (2012). Plants, psychoactive substances and the International Narcotics Control Board: The control of nature and the nature of control. *Human Rights and Drugs*, 2, 17-28.
20. Tupper, K.W. (2009). Ayahuasca healing beyond the Amazon: The globalization of a traditional indigenous entheogenic practice. *Global Networks: A Journal of Transnational Affairs*, 9, 117-136.
21. Wackernagel, M. & Rees, W. (1996). *Our ecological footprint: Reducing human impact on the Earth*. Gabriola Island, BC, Canada: New Society

From ecopsychology to transpersonal ecosophy: Shamanism, psychedelics and transpersonal psychology

An autobiographical reflection

by

Mark A. Schroll

Sofia University, Palo Alto, CA, USA

European Journal of Ecopsychology 4: 116-144 (2013)

original text: http://eje.naturalresourceswellbeing.com/v4/EJE v4_Schroll.pdf
backup source: http://www.psilosophy.info/resources/EJE v4_Schroll.pdf

Table of Contents:

- Abstract
- Prologue
- Introduction
- Recognizing an internal pollution crisis in humankind
- Ecopsychology's roots in humanistic & transpersonal psychology
- Recognizing the limitations of transpersonal psychology
- Shamanism and the neo-shamanic revival
- A breakthrough in 1990: Continuing to trace transpersonal ecosophy's many paths
- Conclusion
- Acknowledgements
- Footnotes
- References

Abstract

This paper is an autobiographical overview of the variety of influences that continue to foster my ongoing transition from ecopsychology to transpersonal ecosophy. These influences (both personal and professional) are discussed throughout this paper; and include transpersonal psychology, shamanism, and psychedelics. This chronicle of influences and associated events serves to reclaim ecopsychology's history. In addition, a brief examination of the eco-dissociated limitations within Hinduism, Taoism, and Buddhism are discussed as a reminder of the fragmentation of theory and practice within traditions that are otherwise considered to be pathways to enlightenment.

Keywords: transpersonal, ecosophy.

Prologue

On March 27, 2004, I chaired a symposium I organized on "Psychedelics: Their value and social responsibility" for the spring conference of the Society for the Anthropology of Consciousness, held at the University of California-Berkeley, Berkeley, California (UC-Berkeley). Participants included Ralph Metzner, Adele Getty, Stanley Krippner, Maura T. Lucas, and among the audience members was Mary Gomes. Gomes (along with Theodore Roszak and Allen Kanner) served as editor of *Ecopsychology: Restoring the Earth, healing the mind* (1995), yet her interest in my symposium stemmed from the fact Getty and Lucas were among the authors in a 2003 issue of ReVision that Gomes edited on "Women and Entheogens". Telling us, "It seems to me that a shadow of psychedelic exploration, at least as it has unfolded in the West, is a fascination with strange and abstract experiences that expand the mind but fail to open the heart" (Gomes, 2003: 2). Getty (formerly married to Francis Huxley) agreed with Gomes, saying:

> ...over the years there have been large conferences that address in great detail various aspects of psychedelics ... . most of the speakers are what I call 'Molecule Men' ... They can rattle off long chemical alphabets and even longer polysyllabic terminology explaining neurotransmitters, MAO inhibitors, [etc.] ... Considering the times we live in, this is a wonderful accomplishment, and these scientists should be congratulated and supported. ... [But] the healing aspect of psychedelics is ancient and traces its roots back through our genetic memories, into indigenous tribal cultures, around the fire with the drum, rattle, and song of the shaman ... Shhh! Women have [been] burned at the stake for much less (Getty, 2003: 14-7).

In my online correspondence with Robert Greenway (from 2000 to 2010 - which was focused on history and theory), I learned it was Ilan Shapiro (a graduate student of Greenway) who, in 1989, formed a peace studies group at UC-Berkeley in protest of the first Gulf War. This group attracted Gomes, Greenway, Kanner, and eventually Roszak as participants. Among the insights that emerged from this group was that the conflict of war always produces widespread environmental destruction. In this way, "peace studies" and anti-war groups (which are always politically motivated) are directly connected to the conversation and interests that led Roszak to write his 1992 book, *The Voice of the Earth*.

Introduction

> Krippner has pointed out 'It is therefore time for transpersonal psychology, and transpersonal studies in general, to reassess and reclaim its history regarding ecopsychology so it can step forward and fill this void. I have to say that the psychedelic movement caught on to this long ago. I remember back in the 1960s, when people began doing informal work with psychedelics. One theme that came up time and time again was we are destroying the environment, and that taking psychedelics increased not only our appreciation of nature, but all forms of life. I think too the psychedelic movement has been given short shrift by historians in a number of other ways, because it also helped stimulate interest in the Peace Movement, the Civil Rights movement, et cetera (Schroll, *et al*, 2009: 47)[1].'

Krippner's comments support my decision to write an overview and autobiographical reflection on my involvement in ecopsychology's historical development, and how the ecopsychological perspective dovetails with studies of shamanism[2], psychedelics[3], transpersonal psychology[4], and the emergence of *transpersonal ecosophy*. My knowledge and understanding of transpersonal ecosophy emerged from a symposium I organized on "The History and Future of Ecopsychology" for the Society for the Anthropology of Consciousness 2009 conference on "Bridging Nature and Human Nature". It was during this symposium Alan Drengson pointed out, in response to Warwick Fox's *Toward a Transpersonal Ecology* (1990), that Arne Naess said a better title would have been "Toward a Transpersonal Ecosophy" (Schroll, 2011c: 4). Shortly after this conference Drengson sent me a copy of his book *The Ecology of Wisdom: Writings by Arne Naess* (2008), edited with Bill Devall, which reiterated this point:

> Warwick Fox suggests that those, including Naess, whose ultimate premises call for an extended sense of identification with an ecological self be called transpersonal ecologists, but Naess would say that they have transpersonal ecosophies (p. 37).

> Ecosophies are not platforms for a political movement or policies [Drengson and Devall explain] but are personal philosophies of life in a worldview (p. 33).

Ecosophies therefore serve the same function as personal myths or our personal mythology, defined as "more than just intellectual constructs; they are ingrained models of reality that determine how you see your world and understand your place within it" (Feinstein & Krippner, 1988: 2). Moreover the term transpersonal ecosophy fosters an interdisciplinary perspective more so than the term ecopsychology, as well as helping to free us from the criticism put forth by Susan Clayton and Gene Myers:

> The relationship between ecopsychology and psychology however, is contested. Not all ecopsychologists are trained as psychologists, and writings on ecopsychology have been criticized for a lack of scientific objectivity, referencing concepts like spirituality and indigenous wisdom that are difficult to clearly define. Reser in a thoughtful critique [(1995)] concluded that the assumptions and methods of ecopsychology are too disparate from accepted psychological standards to be considered an area within psychology (Clayton & Myers, 2009: 10).

First, Clayton, Myers, and Reser are incorrect that spirituality is difficult to define - see Elkins *et al*. (1988) and Lazar (2009) for definitions of spirituality. Whereas the difficulty associated with spirituality, according to my discussions with John Rowan, is not our inability to define it:

> It is because of the various meanings and [often conflicting] uses of the term spirituality that I [Rowan] prefer to use the term transpersonal. ... The main advantage of using the term transpersonal is ... [it places or refers us to states of awareness that follow] after the prepersonal and the personal in the process of psychospiritual development. ... Not so with spirituality, which roams all over the place (Schroll, Rowan & Robinson, 2011: 124-5).

Second, Jurgen W. Kremer has given precise definitions of "indigenous wisdom" or "indigenous science" in an issue of the journal *ReVision* (1997). See also Pamela Colorado's (1996) paper, "Indigenous Science". Third, confining ecopsychology to standards within psychology limits it to something that Roszak and Metzner agreed it was never intended to be (Metzner, 1993, 1999: 2). Roszak argued, "Saving the life of the planet is the biggest political cause humans have yet taken on; it requires a vision of the human personality that is just as big" (Metzner, 1999: x).

All this harks back to Krippner's observation about informal assessments with psychedelics in the 1960s, and supports the view, "that taking psychedelics increased not only our appreciation of nature, but all forms of life". This is supported by a frequently quoted passage from Albert Hofmann's book *LSD: My Problem Child* (1983: ix-x), recalling a peak-experience in nature at age nine, that provided him with the ability to recognize his accidental ingestion of LSD, in April 1943, was of similar psycho-spiritual origin. Metzner adds the observation that LSD's discovery "in 1943 at the height of WWII occurred within months of Enrico Fermi's first controlled nuclear chain reaction, which led directly to the building of the atomic bomb; as if it was a kind of psycho-spiritual antidote to the death weapon" (2008: 21). Unfortunately the wealth of knowledge that could help us support these claims about the connection between psychedelics and ecology came to an end in 1965, "when the government clamp-down occurred, [and] even clinical research was banned" (Smith *et al*, 2004: 123). Some recent exceptions have been made, such as MacLean, Johnson & Griffiths (2011), the significance of which we shall discuss later in this paper. Still, for most of us, the ban on any experimentation with psychedelics continues. Thus, on the one hand, this "makes the surviving early researchers a uniquely valuable group," and "because of their advancing age are clearly an endangered resource" (Smith *et al*, 2004: 123). On the other hand, the near total ban on psychedelic research eliminates most of us from replicating its influence on our relationship with nature and other species - with the exception of anthropologists of consciousness who investigate indigenous cultures (Beyer, 2009, 2012; Dickens & Tindall, 2013; Harrison, 2011; Webb, 2013).

Among these endangered resources is Stanislav Grof (a pioneer in psychedelic research and transpersonal psychology), who said, in response to the question, "Can you describe the circumstances and impact of your first psychedelic experience":

> I began to realize that, even after a long time, the results [of psychoanalysis] were not exactly breathtaking. My own analysis lasted seven years, and I loved every minute of it: playing with my dreams, and finding that there was some deep meaning in every slip of my tongue. But if you had asked, "Did it change you?" I would have hesitated. I would say that, while I changed during those seven years, there was no convincing causal relationship between the free-associating that I did on the couch and the changes that happened in my life. Whereas, *when I had my first LSD session, I was one kind of person in the morning and a whole different kind of person in the evening, and there was no question that this change was the result of the experience* (Grof *et al*, 2008: 156, italics added).

This raises the question, what kind of person did he become? Grof adds:

> Ultimately, we don't have a fixed identity. ... You can eventually experientially reach the cosmic creative Source and become that Source. When you have that experience [like I have,] you realize that this Source is no different from the overall field of cosmic energy" (Grof *et al*, 2008: 167)
>
> [Consequently] It becomes obvious that the universe is a unified web, of which we are all meaningful parts ... . [and,] that we are facing a problem of a collective nature that only a determined cooperative effort can solve. ... [Thus] a radical and lasting solution is inconceivable without inner transformation and a move toward global awareness (Grof, 1985: 39).

Therefore in an attempt to put all of these concerns into their proper perspective, this paper will proceed chronologically from past to future (and periodically flash forward and backward in time so that particular points can be addressed). Equally important for us to know before we enter the main body of this paper is portions of it have been published elsewhere, which also raises the question why is there a need to repeat this discussion again? The answer is that I have learned from the past mistakes of Naess and Roszak. Neither of them repeated themselves enough, nor referred back to their early work enough, nor clarified their basic concepts enough, nor explained well enough what it was that motivated them to pursue their respective areas of research. Consequently the task of creating a coherent statement summing up their respective contributions has been left to others. A summing up of Naess' legacy can be found in Drengson, 2005; Drengson and Devall, 2008, and Drengson, Devall, and Schroll, 2011; whereas a summing up from ecopsychology to transpersonal ecosophy is this paper's focus, and listening to the music of the lyrics quoted in this paper will deepen the readers experience.

Recognizing an internal pollution crisis in humankind

Mama nature said, it's murder what you've done,
I sent you forth my brightest world, now it's nearly gone.
Virgin bees been telling me, you can't see the forest for the trees,
Cover up your eyes with sympathies.
And I've got no solution, to your persecution,
I'm so disillusioned.

Mama nature said, you're guilty of this crime
Now it's not just a matter of fact, but a matter of time.
Cruel will be the vengeance, some say I don't believe that story,
And I've got no solutions to your own pollution.
- Phil Lynott/Thin Lizzy, 1973, Belfast, Ireland

> As a teenager growing up in the 1970s, instead of listening to disco, I was contemplating the rock lyrics of songs such as *Mama Nature Said*. Likewise, this zeitgeist was shaped by a cultural background of films such as Soylent Green (1973), (based on Harry Harrison's 1967 book *Make Room! Make Room!*) vividly warning us about the forthcoming dangers of overpopulation, pollution, and food shortages, with ominous overtones of fear, guilt, and self-sacrifice as the only solutions to an otherwise impending apocalypse. At best there were TV commercials featuring Hollywood's version of indigenous tribal elders shedding a tear as garbage was thrown from cars desecrating the landscape, which concluded with a message pleading with us not to litter. But the idea of some kind of "internal pollution" contributing to the ecocrisis was absent in the environmental rhetoric that I was hearing from the adults shaping my adolescent development (Schroll, 2009: 29).

My search to understand this "internal pollution" is what led me to "ecopsychology" (which I suggested in the introduction can be more accurately described as "transpersonal ecosophy"; I will, however, continue to refer to both ecopsychology and transpersonal ecosophy throughout this paper). It was therefore an immediate flash to my memories of *Mama Nature Said* as I heard Ian Prattis tell us in *Failsafe: Saving the Earth From Ourselves* (2008): "I must be blunt from the outset about the context of [our] current ecological, social, and psychological crisis. There is an external environmental pollution crisis on the planet because there is an internal pollution crisis in humankind" (p. 38). Prattis identifies this internal pollution as symptoms (p. 27), which agrees with (yet fails to cite) the work of Roger Walsh who pointed this out in his 1984a article "World at Risk" (pp. 10-14), and elaborated on this point in Walsh, (1984b, 1985). This is an important point that Prattis and Walsh raise, and provides us with the starting point of transpersonal ecosophy: "how, and in what directions, can we move beyond simply treating the symptoms of the world's growing number of social and environmental crises?" (Schroll, 2007: 30). Pondering this question represented a real turning point in my thinking:

> It allowed me to realize that healing the world's social and environmental crises was not going to come about simply by creating new technologies and discontinuing the use of fossil fuels, nor by rejecting the development of new technologies and trying to live more simply. It is not a matter of philosophers envisioning a better environmental ethic to guide the practice of conservation biologists and urban planners, allowing us to serve as better stewards of the land. Nor would a concentrated effort of protest by eco-activists employing guilt, fear, and letter writing campaigns, urging politicians to enact stiffer environmental laws, create the kinds of changes needed in our behavior. Necessary as all these approaches might be, I believe that the real starting point toward healing the social and environmental crisis begins with self-confrontation and self-examination. We need to examine the worldview influencing our attitudes and our behavior (p. 30).

Some mainstream environmentalists may take offense with this turning point in my thinking, believing that I no longer support the work of environmental activists, or those involved in resource management, conservation biology, environmental psychology and conservation psychology. But this is not correct. I continue to support these concerns[5], yet I stand in opposition to technocracy, that is, the social engineering of culture. Indeed it was the insights that Roszak gleaned from Mary Shelley's *Frankenstein* (1816/1983) with its critique of science and culture (Roszak, 1980), that motivated him to write *The Making of a Counter Culture: Reflections on the Technocratic Society and its Youthful Opposition* (1969). This particular point was overlooked in both Jonathan Coope's (2010), and Tristan L. Snell, *et al*'s (2011) assessment of Roszak's contribution to ecopsychology. A preliminary effort to address this concern was attempted by Schroll and Greenwood, 2011, yet a more comprehensive inquiry is still needed. Non-fiction critiques of transforming scientific knowledge into technologized social policy include Batteau, 2010; Drengson, 1995, 2011; Fromm, 1968, Glendinning, 1994; and Roszak, 1973, 1999, and are echoed in several fictional critiques (Huxley, 1932/1969; Orwell, 1949; and Zamyatin, 1972). Revisiting these concerns 30 years later, Roszak wrote:

> Cultures keep secrets; they illuminate some things and suppress others. Every culture conceals as much as it reveals; that is its style and its distinctive contribution. Cultures survive as long as they can maintain that style, which means as long as they can hide from themselves. There is a sense in which every culture is a conspiracy, a coordinated effort to open a few doors of perception and to close others (Metzner, 1999: viii).

The difficult problem we face is this, freeing ourselves from the "technocratic paradigm's" grip (Roszak, 1969; Drengson, 2011) will not be easy, because our path to liberation cannot be achieved solely on the basis of logical arguments built on incremental bits of data. Roszak agrees:

> Ecology already hovers on the threshold of heresy. Will it be brave enough to step across and, in so doing, revolutionize the sciences as a whole? If that step is to be taken, it will not be a matter of further research, but a transformed consciousness (Roszak, 1973: 371).

Asking himself similar questions, former Apollo astronaut and founder of the Noetic Institute Edgar D. Mitchell concluded that what we need to solve the ecocrisis "is a transformation of consciousness" (Roberts, 2011: 6). In other words we need a positive vision of the future based on a cultural (anthropological) and personal (existential) understanding of what it means to be human. Only the most skeptical continue to deny that we are now in the midst of the ecocrisis that Rachel Carson (1962) predicted nearly 50 years ago. Skeptics and believers arguing for and against the reality of the ecocrisis have nevertheless missed a more essential point - Carson warned against relying on a "technological fix" as a solution to the ecocrisis, yet this does not mean that technological innovation is not important; it is. I am right now using several kinds of innovative technologies in the completion of this paper, and rely on others in my daily life. What Carson meant was that by itself new technologies will not be enough to solve the ecocrisis, and these solutions are frequently thwarted by technocracy.

Likewise (as I have previously discussed in greater detail):

> in conversations I have had with ecopsychologists who support the hypothesis that a transformation of consciousness is needed, many have asked if it will take some serious apocalyptic environmental catastrophe to motivate most of us (Schroll & Hartelius, 2011: 84).

Ram Dass raised this same concern in his interview with John Seed (Ram Dass & Seed, 1991). Ram Dass asked: "Will it take incredible trauma to trigger a transformation of consciousness?" To which Seed replied (paraphrasing): "We have already had so much trauma this does not seem to be a sufficient means to trigger a change in our awareness. In fact trauma often has the opposite nullifying influence on us"[6]. Instead Seed suggested that what we needed was some sort of miracle that would allow us to "wake up one day different" (Schroll & Hartelius, 2011: 84).

Harking back to Hofmann's anecdotal recollection of the similarities between his experience in nature, and initial psychedelic experience, this raises the question, could ingesting a psychedelic plant such as psilocybin mushrooms influence personality traits and ultimately trigger a transformation of consciousness? Recent experimental evidence in a clinical setting (MacLean, Johnson & Griffiths, 2011) provided data to establish that increased openness did result from subjects ingesting psilocybin. They define openness as "a relatively broad range of intercorrelated traits covering aesthetic appreciation and sensitivity, fantasy and imagination, awareness of feelings in self and others, and intellectual engagement. People with high levels of Openness are 'permeable to new ideas and experiences' and 'motivated to enlarge their experience into novel territory'" (DeYoung *et al*, 2005: 1459). Hopefully additional research designed to test similar hypotheses will be approved, and help to shed more light on whether or not a transformation of consciousness could be triggered by psychedelic experience. MacLean *et al*. (2011: 1459) cautiously agree, telling us:

> Although the findings are suggestive of personality changes that might be associated with hallucinogen[7] exposure, it is not possible to isolate the effects of hallucinogens per se because of the self-selection bias that may confound results of cross-sectional studies. Longitudinal studies will be required to replicate hallucinogen-related changes in personality, attitudes, and values.

Their initial research findings support Metzner's same echo of hope:

> The potential of psychedelic drugs to act as catalysts to a transformation into *gnosis*, or direct, ongoing awareness of divine reality, even if only in a small number of people, would seem to be of the utmost significance. ... the discovery of psychedelics, in facilitating such experiences and processes, could be regarded as one very important factor in a general spiritual awakening of collective human consciousness (p. 81). ... The knowledge derived from altered states has been, can be, and needs to be applied to the solution of the staggering problems that confront our species (Metzner, 1989: 88).

Beyond this introductory discussion, to make sense of the context within which MacLean *et al*'s clinical research apply - as well as the concerns expressed by Mitchell, Prattis, Getty, Ram Dass, Seed, Roszak, Gomes, Grof, Krippner and Metzner - and gain a broader understanding of how the concept of "internal pollution" emerged, requires sorting out and framing the historical development out of which ecopsychology emerged.

Ecopsychology's roots in humanistic & transpersonal psychology

I see the resignation of nothingness
I hear the repercussions of pointlessness
I'm completely torn
My whole attitude bears my scorn.
I hear the silence of another day
While our existence gets wiped away,
You know the games that we all play.
I see you're playing with my tolerance,
Gotta rise above this consciousness.

- Tim Masters, Lincoln, Nebraska, 1997

When the confluence of events that eventually lead to the birth of both humanistic and transpersonal psychology (and eventually ecopsychology) were being sown, I was four years old. Greenway has generously contributed to my understanding of this early history, recalling (in one of our many email exchanges from 2001-2010) that one rainy afternoon in late fall 1962, Abraham Maslow was looking out the window, saying, "It's not enough, humanistic psychology is not enough". This initiated Maslow's thinking about the limits of humanistic psychology, and it was during this time that he became influenced by Sir Julian Huxley's view of transhumanism (1957). Another four years would pass until the next break-through would come, as Anthony Sutich (1969: 13) tells us: "In January, 1966, several members of the Board of Editors of [*Journal of Humanistic Psychology*] were invited to a seminar titled 'Humanistic Theology' with Father [Patrick] MacNamara". Maslow was among the participants in this seminar, who afterwards developed its inquiry through an exchange of letters with Sutich. Sutich adds (p. 13) that "Early in January 1967, the term 'Transhumanistic' ... became the key word for this force".

And yet further clarification was still needed, as Miles Vich (1988: 107) points out, that the name for this new frontier did not come without some initial floundering. Maslow was among the first to use the term "transpersonal" in a communication to Sutich in 1967, and again in 1968 in a letter referring to a meeting with Grof:

> The main reason I am writing is that in the course of our conversations we thought of using the word transpersonal instead of the clumsier word transhumanistic or trans-human. The more I think of it, the more this word says what we are all trying to say, that is, beyond individuality, beyond the development of the individual person into something which is more inclusive than the individual person, of which is bigger than he is (Sutich, 1967).

This reference to something bigger, more inclusive, or whole than the individual person, is the creative insight that motivated Maslow to investigate what he called peak-experiences (Maslow, 1964), and harks back to Hofmann's nature experience at age nine that provided him with a way to integrate and internalize his first accidental LSD experience.

It would require a more careful analysis of humanistic and transpersonal psychology's early history (beyond the limited one provided here) to learn if any of its members, or MacNamara, was at this time influenced by the clarion call of Lynn White, Jr., who (the same year as MacNamara's pivotal seminar) boldly criticized the Western form of Christianity in 1967 as "the most anthropocentric religion the world has seen" (White, 1973: 25). Summing up his argument, White asserted: "Both our present science and our present technology are so tinctured with orthodox Christian arrogance toward nature that no solution for our ecological crisis can be expected from them alone. Since the roots of our trouble are so largely religious, the remedy must also be essentially religious, whether we call it that or not" (pp. 29-30). Metzner has criticized "the minor inelegance of [anthropocentrism,] a term of mixed Greek and Latin derivation" (Metzner, 1991: 148), suggesting instead the "diagnostic metaphor the *human (or humanist) superiority complex*" (Metzner, 1999: 84).

Additional memories of this early history were provided by Krippner, who recalled in his last conversation with Maslow that Abe spoke of founding a new psychology he was calling trans-human psychology: "We should therefore extend our concerns - go trans-human - and not make this a human-centered psychology" (Schroll *et* *al*, 2009: 40). Krippner added, "As we talked about it, in retrospect, I now realize he was talking about what we now call ecopsychology" (Schroll, 2008/2009: 16). "Unfortunately Maslow never had this dream realized" (Schroll *et al*, 2009: 40); summing up his views on this recollection, Krippner added the opinion "that ecopsychology is [now] absolutely critical" (p. 46).

To recreate in our awareness the turbulent social psychological context within which both humanistic and transpersonal psychology emerged, let's recall one of the most shocking images of our twenty-first century selves that came screaming into our lives: the stark vocals of the song *21st Century Schizoid Man*, whose lyrics explode with a rant characteristic of the 1960s revolution in sound, presentational style, and content:

Cat's foot, iron claw,
Neurosurgeons scream for more
At paranoia's poison door
Twenty-first century schizoid man.
Blood rack, barbed wire,
Politicians' funeral pyre
Innocents raped with napalm fire
Twenty-first century schizoid man.
Death seed, blind man's greed,
Poets' starving children bleed,
Nothing he's got he really needs,
Twenty-first century schizoid man.

These are the words and poetic illuminations of Peter Sinfield, whose inspirations in 1969 flayed our skins, and burned these thoughts into our brains, assisted by the searing blast of controlled fusion known as the musical group *King Crimson*. Sinfield's chilling reference to the schizoid personality type continues to loom large on the horizon of humankind's future, warning us to wake up from our dissociation from self, society, and nature, because the schizoid person is no longer in touch with their feelings. Instead, the schizoid person lives in a state of psychological disconnection from other people and the world of nature. All of us are in danger of becoming this schizoid man (Schroll, 2008/2009: 16-7).

This schizoid man is what Metzner refers to in his book *Green Psychology* as "the collective psychopathology of the relationship between human beings and nature" or, in other words, "dissociation" (Metzner, 1999: 94-97). Psychology should therefore be on the front lines of the endeavor to examine our worldview, and ourselves, but mainstream psychology is currently dominated by technophiles. These technophiles, or perhaps more poignantly necrophiles, actively encourage technology's consumptive behavior and instrumental use of nature (the systematic transformation of nature into its use by humans)[8].

1969 witnessed the *Association for Transpersonal Psychology*'s birth, whose inception found inspiration in Maslow's 1968 vision that "without the transcendent and the transpersonal, we get sick, violent, and nihilistic, or else hopeless and apathetic" (Maslow, 1968: iv). Recognizing this, it is hard to say whether psychology was influencing pop culture or if pop culture was influencing psychology, because in 1969, Alan Watts was also describing the emotional autism of Seinfeld's 21st century schizoid man in *Does It Matter?: Essays on Man's Relationship to Materiality*, telling us that:

> ... People, whether Western or Eastern, need to be liberated and dehypnotized from their visions of symbolism and, thereby, become more intensely aware of the living vibrations of the real world. For lack of such awareness our consciousness and consciences have become calloused to the daily atrocities of burning children with napalm, of saturation bombings of fertile earth with all its plants, wild animals, and insects (not to mention people), and of manufacturing nuclear and chemical weapons concerning which the real problem is not so much how to prevent their use as how to get them off the face of the earth. [If we can ever hope to survive this madness, we will] need to become vividly aware of our ecology, of our interdependence and [our] virtual identity with all other forms of life (Watts, 1969: xiv).

Watts could have written these words yesterday, and we owe it to his and Maslow's legacy to honor their vision and give birth to ecopsychology, and a transpersonal ecosophy. Equally poignant, as if it could be today's top news story, this prevailing spirit of dread, anxiety, and dissociation was eerily summarized in Roszak's *The Making of a Counter*:

> If the technocracy in its grand procession through history is indeed pursuing to the satisfaction of so many … universally ratified values as The Quest for Truth, The Conquest of Nature, The Abundant Society, The Creative Leisure, The Well-Adjusted Life, why not settle back and enjoy the trip? The answer is, I guess, that I find myself unable to see anything at the end of the road we are following with such self-assured momentum but Samuel Beckett's two sad tramps forever waiting under that wilted tree for their lives to begin. Except that I think the tree isn't even going to be real, but a plastic counterfeit. In fact, even the tramps may turn out to be automatons … though of course there will be great, programmed grins on their faces (Roszak, 1969: xiv).

Is "this discovery that we are nothing more than soulless creatures playing the starring role in some theater of the absurd really the image of the world and the future that we have all be waiting for? It is certainly not the vision of the future I have been waiting for, yet before any of us slips into some kind-of deep depression about this dismal prediction of the future - it is important we call to mind that "if" is the key word in Roszak's scenario of the future. That is, if the resistance of the counter culture fails, … if we fail to transform our present crisis of perception into an opportunity for transformation... If we do not become active in the political process needed to create better communities, if we neglect the cultivation of our transpersonal growth" (Schroll, 2008/2009: 17), then yes our future looks bleak.

Flash forward 27 years to hear again how these concerns continue to impact our understanding of science, culture, our collective future, and those of transpersonal psychology in particular, as David Fontana and Ingrid Slack persuasively argued in their paper "The need for transpersonal psychology":

> In an increasingly shrinking and independent world, it therefore seems vital that Western scientific psychology [begin an active exploration of] the influence that transpersonal experiences and beliefs have upon human motivation and behaviour. Such exploration must also take in the extensive and culturally important formal psychologies generated by non-Western traditions, the majority of which have their basis in, or make reference to, alleged transpersonal experiences. … The very future of mankind (a grand phrase, but not inappropriate in the circumstances) depends increasingly upon international understanding, and if Western scientific psychology is to play a role in this understanding … it would therefore seem imperative that it make its presence felt in the areas concerned without delay (Fontana & Slack, 1996: 4).

Fontana and Slack's call to action led to the formation of a Transpersonal Psychology Section in the British Psychological Society, whose concerns parallel similar conversation taking place within the current paper, and ecopsychology as a whole. To foster further synthesis between these conversations it is therefore important to acknowledge limitations within our view of transpersonal psychology.

Recognizing the limitations of transpersonal psychology

Tried so hard, but I just can't relate
Is it mind control, or just a separate state?
I see millions of people moving to the right,
Afraid of one another, afraid of the light.
Yuppie vermin consumers, a generation lost,
When up pops another breathing their exhaust.
It's dawn of the dead, or zombie land,
While new abuses of power are seen throughout the land.
Our seas are filled with oil,
We worry about burned flags,
All these contradictions are really such a drag.
So keep those closed minds humming
Bolting down the screws,
These complicated questions
Are a new case for the blues.
- Jim Jacobi, Seattle, Washington, 1998

Much of the theoretical basis for transpersonal psychology has been constructed from the religions and psychologies of Asia: Hinduism, Taoism and Buddhism. Even though I spent five years studying Zen Buddhism and attempting to practice its meditative methods, the feeling of treading on (or infringing upon) foreign soil was always present. Despite this somewhat unnatural feeling that always crept into my experiential encounters with Zen, and my theoretical study of the religions and psychologies of Asia, Maslow's founding spirit of transpersonal psychology continues to hold a hope for me. I continue to find that the Hindu myth of the universe resonates in my own unconscious and my psilocybin inspired experiential cosmology (Schroll, 2004a). Taoism provides philosophical insight (Kasulis, 1981), and Zen koans unify my body/mind (Schroll, 2011b)[9].

Nevertheless, the limitations of transpersonal psychology (especially the possibility of enlisting its help in expanding EuroAmerican ecopsychological awareness) became shockingly evident when I read Philip Novak's (1987) paper "Tao how? Asian religions and the problem of environmental degradation". These include: (i) The case of India; (ii) The case of China; and (iii) The case of Japan. Beginning with India, Novak reveals the discrepancy between Hinduism's theoretical teachings and the daily behavior of its practitioners:

> The Vedic literature repeatedly expresses a vivid appreciation of and deep reverence for Nature. [Yet n]othing illustrates more vividly the paradoxical nature of India's relationship to the environment than the condition of the Ganges. ... It is estimated that 'at least 10,000 half-burned bodies are tossed into the river every year either at Varanasi or towns upstream. Whole leprous corpses are often thrown into the river by ignorant townsmen who fear that burning would spread the leprosy bacilli in the air through the smoke. Benares alone dumps 20,000,000 gallons of raw sewage into the river every day. One huge sewer pipe empties into the river only 100 yards upstream from the city's main drinking water intake pipe' (Novak, 1987: 33-6).

Those of us familiar with Hinduism know that the Ganges is sacred to Hindus, who believe its waters are holy and purifying. Each year thousands of Hindus make pilgrimages to the Ganges to bath in and drink its sacred water. This certainly speaks to the power of ancestral wisdom; it also speaks to the power of denial.

Second, Novak proceeds to talk about China. Telling us that throughout China's history the behavior of the spiritual practitioners of Buddhism and Taoism has resulted in many devastating effects on the natural environment:

> Even Buddhist monks share the blame. [René] Dubos notes that they used enormous amounts of timber for the construction and constant reconstruction of their halls and temples, [resulting in widespread deforestation,] and that despite their supposed vegetarianism, kept livestock which overgrazed the surrounding lands. ... Dubos wryly suggests that the famed Chinese attitude toward Nature arose as a response to the environmental damage done in antiquity, and that we owe our romantic notions of Chinese reverence for Nature to the writings of retired bureaucrats who lived on estates where Nature was systematically submitted to the pruning shear (Novak,

> 1987: 36).

Novak goes on to add that the ink, with which the beautiful calligraphy of Buddhism and Taoism was traditionally drawn, came from the soot of trees. But cutting down a full grown tree is a labor intensive task, so monks eventually adopted the practice of using small saplings to obtain the ash for their ink. This practice of course added to the deforestation of China, while Buddhist and Taoist monks wrote beautiful calligraphy about nature with this ink: bringing to mind the colloquial phrase, *is there something wrong with this picture*?

Third, during the 1989 conference "Gaia Consciousness: The Re-Emergent Goddess and the Living Earth" (organized by James A. Swan), Novak followed up his 1987 criticisms of Asian religions; specifically the profound contradiction of Asian religions actual treatment of Nature with that of their professed worldview. Adding one more nail in the coffin, Novak writes:

> Up until 1970, when a number of stringently enforced environmental laws were passed there, Japan, largely because of its post war industrial push, had become the *Itchiban*, the number one industrial polluter in the world. Japan Scholar, Edwin Reischauer, said that the Japanese have done more than any other people to defile nature, though no people love it more (Novak, 1989: 51).

Meanwhile, as the people and corporations of Japan continue to clean-up their act at home, the Mitsubishi Corporation (and related groups) are contributing to an alarming rate of deforestation. According to the EcuadorExplorer.com (2013), this planet-wide rate of deforestation equals 86,000 hectares per day, an area equivalent to New York City. This breaks down to 1 hectare (2.4 hectares) per second, or two U.S. Football fields, 31 million hectares per year, an area larger than Poland. Novak reminds us that while the homeland of Japan is sacred to the Japanese, the rest of the world is perceived as a frontier that is wide-open for corporate development.

In summing up these examples of transpersonal psychology's limitations, I want to reiterate that I continue to believe the traditions of Hinduism, Taoism, and Buddhism are capable of providing us with valuable sources of wisdom that can assist us in reestablishing our lost connection with the nonhuman world. Nevertheless, these examples serve to illustrate the fact that just because we become a practitioner of these traditions does not automatically guarantee that our attitudes and behavior will be transformed regarding our relationship toward all natural systems. Moreover, these examples also serve to demonstrate that even if we become practitioners of Hinduism, Taoism, and Buddhism we may still find ourselves falling-victim to the effects of what Kremer and Donald Rothberg call our collective shadow:

> We can define the collective shadow as the unknown or little-known aspects of a society and culture [that continue to remain hidden in our unconscious because of voices emanating from] ... dominant discourses (Kremer & Rothberg, 1999: 3).

Elaborating on this concern, Rothberg has begun the task of bringing these limitations of Asian psychologies and religions to the attention of the transpersonal movement, telling us:

> ...it is important to ask critical questions about the extent to which the transpersonal field has given a selective reading of spiritual traditions and highlighted some kinds of spiritual expression rather than others. ... While the idea of a 'perennial philosophy' and an emphasis on contemplative and mystical traditions, particularly Asia, has broadened contemporary Western understandings in philosophy and psychology tremendously, it remains vital to ask whether certain aspects of human development are also brought to high levels in other kinds of traditions[?] (Rothberg, 1999: 46).

Rothberg goes on to point out that what has been missing from the transpersonal field is a consideration of the importance of "the indigenous traditions of all continents" (p. 46). He offers a brief mention of "African-Christian Voodoo in Haiti, which played a pivotal role in gaining Haitian political independence at the end of the eighteenth century" (p. 57), yet overlooked in his otherwise thorough assessment is Molefi Kete Asante's (1984) paper "The African American mode of Transcendence". Asante provides the insight that "*Samba* the Brazilian dance, *Sango* the Cuban folk religion, *Umbanda* the Brazilian folk religion, *Voodoo* the Haitian folk religion, or *Myal* a Jamaican religion" and the African idea of Sudicism all have the "same source of energy, the rhythm or polyrhythms that drive the spirit toward transcendence" (p. 168). It is an internalized resonance with the groove of percussion sound and movement that gives expression to the African American holistic personality, and can be accessed "in any good blues or jazz club [where] you can get the same soulful sound as you get in the church" (p. 176). This source of transpersonal wisdom is especially consistent with that of ecopsychology or transpersonal ecosophy, as Asante makes clear: "it does not depend upon icons of faith but the incessant collective drive of people for harmony with self, fellow earthlings, and nature" (p. 176). This view is consistent with, and supportive of, my own life-long inspiration through blues and rock music, including its storytelling capacity through powerful lyrics such as I have used in this paper.

Metzner too shares Rothberg's concern with other traditions missing from the transpersonal field, which led him to explore the indigenous roots of his Germanic ancestry in *The well of remembrance: Rediscovering the Earth wisdom myths of Northern Europe* (1994). In pursuing this inquiry, Metzner raised the question: "Those of us descended from European ancestors are naturally moved to ask whether anything in our own tradition is relevant to surviving the ecological crisis. This book explores the animistic-shamanistic worldview of the aboriginal inhabitants of Europe" (Metzner, 1994: 1-2). Through his thorough inquiry, he convincingly demonstrates that "shamanic otherworld journey practices [are] at the very heart of the religious worldview of the ancient Germanic people" (p. 198). Therefore those of us who are descended from Germanic (including Anglo-Saxon) and Celtic peoples of Northern Europe who are often criticized for borrowing, intruding upon, or stealing the wisdom of indigenous peoples can now answer back that this is our tradition too.

This analysis of the Earth wisdom myths of northern Europe concludes in Metzner's final chapter with his discussion of the eschatological myth of the Ragnarok, which he explains "is usually translated as the 'twilight of the gods', but more precisely means 'final fate of the gods'" (Metzner, 1994: 244); and calls to mind for most of us an apocalyptic vision where the forces of evil destroy the world, leaving the Earth a barren and uninhabitable place - thereby necessitating a new kingdom of Heaven, which is sent down to earth by God. Yet, according to Metzner, this interpretation completely misses the point that the Ragnarok is trying to teach us; instead he draws our attention to the fact that this final battle does not involve all of the gods. Much to the contrary, it is only the warrior oriented Aesir sky gods that are involved in this cataclysmic earth transforming battle, which Metzner explains is followed by "a renewal of the Earth and a new beginning of life, with a new generation of gods and humans telling stories and remembering ancient knowledge. 'A new green earth arises again out of the flood'" (pp. 249-50).

Consequently the peace-loving Vanir nature gods and a new generation of humans who were absent from this battle are left to re-inherit the earth. In other words, the final fate of the gods calls to mind a vision of "worldviews in collision", symbolized by a battle between logos-oriented male heroes and the forces of nature they have sought to dominate and control. Today these groups are represented by technocracy and its oppression of both humankind and the non-human world. This is a good point on which to end this discussion from both a substantive perspective, and because we have gotten ahead of ourselves in this autobiographical chronology.

Shamanism and the neo-shamanic revival

> In 1989 Walsh published a series of articles on shamanism in the *Journal of Transpersonal Psychology* and *ReVision* (Walsh, 1989a, 1989b, 1989c)[10]. Immersed in this literature, I was invited by Stephen Glazier to organize a symposium on shamanism for the 1990 *Society for the Scientific Study of Religion* (SSSR) conference, held in Virginia Beach, Virginia. I accepted this invitation, motivated by the theme of creating a symposium to deepen our commitment toward envisioning a technology of transcendence or a renaissance of mysticism with an ability to produce the necessary transformation of consciousness to awaken a heart-felt response to the ecocrisis. Clarifying this idea in a marginal note in Larry Peters article 'Shamanism: Phenomenology of a Spiritual Discipline' (Peters, 1989), I wrote, it will [only] be through an authentic cultivation of *communitas* and the deep ecology movement that we will be able to transcend our presently destructive interaction with nature, and, thereby, transform our presuppositions about reality (Schroll, 2011a: 29).

This reflection reminded me that Joan Townsend had expressed a similar viewpoint:

> Periods of religious enthusiasm are not uncommon in the history of the Western World. This latest trend seems unusual, however, and distinct from earlier religious movements such as the Great Awakening of the 1740s and the Second Great Awakening after 1790 in the United States, because it combines a number of different systems of belief and is fostered by a network of individuals sharing a communication system that is unprecedented ... this new mystical movement owes its initial definition to the 'hippie' and related movements that began in the 1960s. ... Characterized by the search for a new meaning in life, ... a feeling of kinship among all people. ... and the valuing of simple, 'natural' lifestyles and conservationist concerns. Significantly, there were also a strong interest in nonorthodox theologies, especially spiritualist, mystical, and Eastern religious philosophies, as well as native American culture, including shamanism (Townsend, 1988: 74) (quoted in Schroll, 2011a: 30).
>
> Townsend referred to this movement as *neo-shamanism*, adding 'important to the development of neo-shamanism in the West were Michael Harner's work. ... [and] the publication in 1969 of Carlos Castaneda's doctoral dissertation in anthropology... Thus by the early 1970s the stage was set for the rise of neo-shamanism' (Townsend, 1988: 75).

Here I must interject: at this phrase of inquiry I had yet to organize the symposium "Castaneda's controversy: Examining consciousness studies' future", which took place April 3, 2003, at the 23rd Society for the *Anthropology of Consciousness* conference. This attempt to understand contemporary culture and provide some analysis is discussed in Schroll, 2010a, whose inquiry is deepened in Schroll, 2010b.

Flashback to 1990 - inspired by the shared sense of vision in this passage with my own, I telephoned Townsend on April 20, 1990, to discuss these ideas. Our conversation convinced me we were moving in the same direction, suggesting an elaboration on her work might be titled "Authenticity and Delusion: Shamanism and Neo-Shamanism" (Townsend, 1990). She agreed, accepting my invitation. Another important contribution "Personal Reflections on My Journey into Shamanism" emerged through my phone conversations with Michael Schneider. This was his first public discussion of a life-threatening illness and miraculous recovery that called Schneider to become both a Certified Shamanic Counselor and a close associate of Harner. Prior to his illness and recovery, Schneider had been a New York City ad man (Schroll, 1990). Schnider's personal story provided additional anecdotal testimony of the influence transformations of consciousness have on the way we lead our lives.

The continuing resurgence of this interest in shamanism was raised again five years later, when in her chapter "Shamanic Counseling and Ecopsychology", Leslie Gray concluded: "It would be tragic to waste this accumulated [indigenous] knowledge, and it would be redundant for ecopsychology to generate models of a sustainable future without learning from the way of life of the more than 300 million indigenous people living in the world today" (Gray, 1995: 182). Krippner supports this view (2002).

Summing up shamanism's critical importance to our inquiry in ecopsychology and transpersonal ecosophy, and offering insights she and I developed through our correspondence following our meeting at the 2004 symposium I organized on "Psychedelics: Their Value and Social Responsibility" (Schroll, 2004b), Maura Lucas illuminates the concerns facing us:

> Cultural anthropology has long been in a difficult place, feeling the squeeze between postmodernism on the one hand, with its point that there can be no analysis of another culture that does not contain one's own culture and personal preconceptions, and biological anthropology on the other hand, claiming that if anthropology is subjective, then anthropologists should rely on hard, empirical data for the study of humanity. The point of [Jeremy] Narby's and [Francis] Huxley's edited book *Shamans Through Time* (2001) is that Western anthropologists have always seen shamanism through the lens of their own preconceptions. Anthropologists looking at shamans and interpreting their experience are not objectively describing shamans or shamanism, but coming to a kind of subjective middle ground between what they have observed, and their own culture's ideas at that point in history. If there can be no objective understanding of shamanism, then it makes sense for anthropologists to debate what constitutes appropriate expertise for writing about shamans and psychedelics (Lucas, 2005: 49-50).

Nevertheless, once again I am getting ahead of myself, as it was actually several months before I convened the 1990 symposium on shamanism that another significant break-through took place.

A breakthrough in 1990: Continuing to trace transpersonal ecosophy's many paths

There's colors on the street, red, white and blue
People shufflin' their feet, people sleepin' in their shoes
There's a warnin' sign on the road ahead
There's a lot of people sayin' we'd be better off dead
Don't feel like Satan, but I am to them
So I try to forget it any way I can.
We've got a thousand points of light for the homeless man
We got a kinder, gentler machine gun hand
We got department stores and toilet paper
Got styrofoam boxes for the ozone layer
Got a man of the people, says keep hope alive
Got fuel to burn, got roads to drive.

- Neil Young, 1989

In Spring 1990 two significant papers were published: Fox's paper, "Transpersonal ecology: 'Psychologizing' ecophilosophy" and Metzner's, "Germanic mythology and the fate of Europe". I began corresponding with Fox sometime in June of 1990. In August, I read in Harner's *Foundation for Shamanic Studies Newsletter* that Metzner was forming the Green Earth Foundation:

> Through its projects, the Green Earth Foundation aims to help bring about changes in attitudes, values, perceptions, and [our] worldview that are based on ecological balance and respect for the integrity of all life forms on Earth. Specifically, this involves re-thinking the relationships of humankind with the animal kingdom, the plant kingdom and the elemental realms of air, water and earth/land (Metzner, 1992).

Becoming a member of the Green Earth Foundation I soon began a correspondence with Metzner. Through our correspondence, Fox and Metzner agreed to serve as dissertation supervisors on my doctoral committee through The Union Institute. During this time, Jeremy Hayward, vice president of the Naropa Institute (now Naropa University) and editor of Shambhala's New Science Library, edited Fox's doctoral dissertation, which was published in the summer of 1990b. Eugene Hargrove, editor of *Environmental Ethics*, noted in a media blurb that Fox's "*Toward a Transpersonal Ecology* ought to be read not only by supporters of the deep ecology movement but also by its critics. It is destined to be a classic in the field".

I agree, Fox's book continues to be a classic in the field and a rich source of information to assist our understanding of the deep ecology movement's relationship with transpersonal psychology. Still, when Drengson informed me that Naess had suggested to Fox that "Toward a transpersonal ecosophy" would have been a better name for his book, I began to wonder why in the four years Fox served as one of my dissertation supervisors (2/9/91 - 1/29/95) that he never mentioned this to me? Perhaps one day this and other important questions about ecopsychology and its transition into transpersonal ecosophy will be answered. These and other questions will need to wait for future papers, even though (except for occasional references to my more recent work), this autobiography stopped short of discussing my present activities by more than ten years.

Conclusion

They can domesticate music, they can do most anything,
They can teach us how to dance, they can teach us how to sing,
But you can't tame a real wild thing.
- Jim Jacobi, Lincoln, Nebraska, 1999

The "they" in Jacobi's song refers to the technocratic paradigm, and its widespread influence on the humanities, natural and social sciences. It was Roszak's concern with technocracy, as I pointed out at the beginning of this paper, that motivated him to write his book *The Making of a Counter Culture* (1969), and this has been a recurring theme in all of Roszak's work. This paper, if successful, sought to provide an autobiographical overview of ecopsychology, and its transition to transpersonal ecosophy. Psychedelic experience (its historical influence on elders such as Krippner, Metzner and Grof), MacLean, *et al*'s clinical investigation of psilocybin, as well as anthropologists of consciousness (Beyer, Harrison, Tindall, and Webb) are contributing to transpersonal ecosophy's emergence. Further inquiry is needed, and for better or worse, pro or con, this paper offers us a place to start. Here too I recall my memory of conversations with Hofmann at the "Worlds of Consciousness" conference (at the University of Heidelberg, Germany, on February 22 and February 25, 1996), and a group of German graduate students on February 24, 1996.

Pointing to the Necker river which was the predominant feature of nature that could be witnessed from the second floor window of Stadthalle (where the "Worlds of Consciousness" meeting was held), I explained that the resource preservationist might variously proclaim: Oh the river, it is so beautiful and inspiring! It must be preserved (the art gallery/cathedral argument). Oh the river, I love to sail my boat on it (the gymnasium or health club argument). The river, it has so many valuable forms of life that it sustains, it must be preserved (the silo argument). The river is my special friend, and is essential to my way of life, because I am a farmer and I use the river to sustain my crops in times of drought (the life support system argument). These were paraphrased statements based on my memory of Fox's examples in *Toward a Transpersonal Ecology* (1990b). Each of these arguments for preserving the river transforms it into an object for human use. Our cries of concern to preserve the river have the appearance of championing the concerns of the non-human world, and yet, the source of our alarm is our own self-interest. This is not a criticism of our actions, but merely an observation to raise into our awareness what our actual motivations are, and acknowledge them. Whereas to be aware of the river's essential nature allows us to realize, *the river simply is*. It does not exist for you or I, it exists for its own sake. Raising this question, how can we meet our human-centred needs, and balance these with our co-evolution with nature and the cosmos? Developing this way of knowing is the concern of transpersonal ecosophy.

Finally, summing up my views on psychedelics (and as a way of referring to my more recent work), the view I have sought to convey in this paper is that:

> psychedelic experience provides us direct access to universal archetypal truths that transcend the boundaries of culture and the limitations of spacetime. Psychedelic experience allows us to encounter visionary mystical insights about the human condition, Gaia consciousness, and deep community and cosmic unity. Psychedelic experience is a fundamental awakening to self-realization (and Arne Naess talks about self-realization being an aspect of personal philosophy - which he called Ecosophy-T - within the deep ecology movement). Psychedelic experience is not the culmination of personal growth and transcendence; it is instead the beginning of the questioning process. Psychedelic experience is the root and ground from which our investigation of the big cosmological picture begins. Psychedelic experiences is the tree from which the fruit of myths and metaphors of consciousness grow. Eliminating psychedelic experience violates the open scientific inquiry of radical empiricism. Without psychedelic experience, religion ossifies into ritualistic symbolism without somatic significant understanding. Psychedelic experience is the very essence of transpersonal psychology, and [its source of wisdom] the primordial tradition. Recognizing this will require us to examine our personal and collective shadow and the reasons for why we are here (Schroll & Rothenberg, 2009: 43).

Acknowledgements

Ralph Metzner's observation that I "may be the first transpersonal cultural theorist drawing on pop songs to illustrate collective images" has been illustrated with my use of rock lyrics in this paper. Metzner's encouragement for my assessment of both his own work, and my interpretation of ecopsychology, lead to the current paper. The encouragement of Stanley Krippner, and more recently Alan Drengson, to clarify my own interpretation of ecopsychology has motivated the current paper's contribution to this body of knowledge. The current work has also benefited from its early development of these ideas in *Association for Humanistic Psychology-Perspective, International Journal of Transpersonal Studies, The Trumpeter: Journal of Ecosophy*, and *Paranthropology: Journal of Anthropological Approaches to the Paranormal*. David Luke's invitation, The European Journal of Ecopsychology, and its blind reviewers, were essential in producing this paper.

Correspondence
Mark A. Schroll
Research Adjunct Faculty
Sofia University (formerly Institute of Transpersonal Psychology)
Palo Alto, California USA
Email: rockphd4@yahoo.com

Footnotes

1. See Schroll, Krippner, Vich, Fadiman & Mojeiko (2009). Metzner (1999: 169-70) echoed this view. See also Krippner & Luke, 2009; Metzner, 2008, 2009; Schroll, 2009b.
2. For a comprehensive inquiry of shamanism see Walsh (2007). My use of the word "shamanism" (which includes my use of the word "shaman" throughout this paper), is consistent with Peter N. Jones linguistic and phenomenological inquiry. Specifically:

   > The term shamanism defines a phenomenon that occurs among only a select few individuals (the "shamans") at any given spatiotemporal moment, and that operational definitions of the phenomenon must be limited to those specific spatiotemporal moments; and... only a nominal definition is possible when discussing the phenomenon diachronically or cross-culturally, and this nominal definition is contingent upon ethically understood notions of the folk epistemology and folk ontology of the cultures compared... : shamanism is a phenomenon consisting of an individual who has voluntary access to, and control of, more aspects of their consciousness than other individuals, however the components of that consciousness are emically understood, and that this voluntary access is recognized by other members of the "shaman's" culture as an essential component of the culture (Jones, 2006: 21).

   Understandably Jones' strict definition of shamans and shamanism is a response to the widespread phenomenon of neo-shamanism (Townsend, 1988, 1990) that we shall discuss later in this paper. Yet it is important to point out non-Native's and non-shamans have been shown to experience transpersonal states in sweat lodge ceremonies (Hibbard, 2007).
3. Psychedelic has been defined, as Metzner (2004: 4) tells us, by "Humphrey Osmond, the English psychiatrist who pioneered the use of LSD in the treatment of alcoholism and who gave Aldous Huxley his first mescaline experience, coined the term *psychedelic* ('mind manifesting'). This term was adopted by the Harvard psilocybin research projects". David Luke further clarifies the use of this term, telling us: "A psychedelic substance, as opposed to other substances, has been defined as that 'which, without causing physical addiction, craving, major psychological disturbances, delirium, disorientation, or amnesia, more or less reliably produces thought, mood, and perceptual changes'" (Luke, 2011: 357-8).
4. Lajoie and Shapiro have examined 202 original citations pertaining to transpersonal psychology (1992). Contemplating these lead to my own definition: "The transpersonal is equally present in states of ecstasy, sensuality, and somatic experiences that are capable of just shaking you to your roots and really waking you up: life encounters that make you come alive and experience the kinesthetic, the tactile, and the erotic. Each of these human drives (and their various nuances) is equally important toward the creation and maintenance of a healthy personality. Nevertheless, no definition of transpersonal psychology should be viewed as a description of some finished or final product of enlightenment. Rather, transpersonal psychology's emphasis is on the continuous process of transcendence and transformation within the realms of the personal, the planetary, and the cosmological" (Schroll *et al*, 2011: 125).
5. Two examples of my support for conservation biology and resource management are: (i) On May 14-15, 1990, I served as a volunteer forester at Fort Robinson State Park, near Chadron, Nebraska, during which I planted 200 seedlings of *ponderosa* pine. Fort Robinson has the ominous legacy of being the place where the Native American tribal leader and shaman Crazy Horse was shot in the back while purportedly escaping, yet the door to his cell had conveniently been left open. (ii) In November of 1997, I attended an annual conference sponsored by Pheasants Forever in Grand Island, Nebraska. During a workshop facilitated by the Nebraska Game and Parks Commission that dealt with the concern of preserving habitat, I articulated the idea of treating the symptoms versus getting to the ecopsychological origins of these symptoms. Not only did the farmers and ranchers attending this workshop grasp the importance of this concept, this idea was published in the Nebraska Game and Parks Commission newsletter as a central concern toward guiding the considerations of future policy and planning of habitat restoration.
6. I have referred to "this opposite nullifying influence of trauma as the reliance on the fear approach or the rhetoric of catastrophe, the guilt approach or the rhetoric of shame, and the self-sacrificing/voluntary simplicity approach or the rhetoric of redemption as

negative motivating techniques" (Schroll et al 2009: 47).

7. Defining and sorting out the confusion associated with the word hallucinogen, Metzner tells us: The older term hallucinogenic ('hallucination inducing') was universally rejected by those investigators who had actually experienced these substances, since it was clear that they do not cause one to see hallucinations in the sense of illusions; rather one sees all the ordinary objects of the sense world plus another whole range of energies and phenomena normally not seen. However, etymology reveals that the original meaning of the Latin verb *alucinare*, from which 'hallucination' is derived, means to 'roam or wander in one's mind'. This is actually a fairly appropriate metaphor for the experience - a journey in the mind, in consciousness; a 'trip', as it became known colloquially (Metzner, 2004: 4).
8. See Schroll and Greenwood (2011) for a discussion of the 'Night of the Living Dead' model, which is our critique of technocracy that builds on Roszak (1969, 1999) and Drengson (2011). Likewise this paper further illuminates this reference to technophiles as necrophiles.
9. It is worth mentioning that Sufi stories provide invaluable pathways capable of reawakening our primordial ecological wholeness, in addition to serving as gateways into other ways of knowing (Schroll, 2011b; Schroll, Rowan & Robinson, 2011). See also Shah (1970). Sufism has some roots in Islam, as well as external influences, particularly from India.
10. During this same time I became increasingly influenced by the work of Michael Harner. His paper "The Role of Hallucinogenic Plants in European Witchcraft" (1973) is particularly relevant to our discussion of psychedelics and ecology.

References

1. Asante, M.K. (1984). The African American mode of transcendence. *Journal of Transpersonal Psychology*, 16, 167-177.
2. Batteau, A. W. (2010). *Technology and culture*. Long Grove, IL: Waveland Press, Inc.
3. Beyer, S.V. (2009). *Singing to the plants*: *A guide to Mestizo shamanism in the upper Amazon*. Albuquerque, NM: University of New Mexico Press.
4. Beyer, S.V. (2012). Special Ayahuasca issue introduction: Toward a multidisciplinary approach to Ayahuasca studies. *Anthropology of Consciousness*, 23, 1-5.
5. Carson, R. (1962). *Silent spring*. Boston, MA: Houghton Mifflin.
6. Clayton, S. & Myers, G. (2009). *Conservation psychology*: *Understanding and promoting human care for nature*. Oxford, UK: Wiley-Blackwell.
7. Colorado, P. (1996). Indigenous science. *ReVision*, 18, 6-10.
8. Coope, J. (2010). Ecopsychology and the historian: Some notes on the work of Theodore Roszak. *European Journal of Ecopsychology*, 1, 4-18.
9. DeYoung, C.G., Peterson, J.B. & Higgins, D.M. (2005). Sources of openness/intellect: Cognitive and neuropsychological correlates of the fifth factor of personality. *Journal of Personality,* 73, 825-858.
10. Dickens, R. & Tindall, R. (2013). Can animistic perception change the world? An interview with Robert Tindall. *Psychedelic Press UK*. Accessed November 2013 from http://psypressuk.com/2013/10/01/can-animistic-perception-change-the-world-an-interview-with-robert-tindall
11. Drengson, A. (1995). *The practice of technology*: *Exploring technology, ecophilosophy, and spiritual disciplines for vital links*. Albany, NY: State University of New York Press.
12. Drengson, A. (2005). The life and work of Arne Naess: An appreciative overview. *The Trumpeter*: *Journal of Ecosophy, 21* (1), 5-45.
13. Drengson, A. (2011). Shifting paradigms: From technocrat to planetary person. *Anthropology of Consciousness, 22* (1), 9-22.
14. Drengson, A. & Devall, B. (2008). *The ecology of wisdom*: *Writings by Arne Naess*. Berkeley, CA: Counterpoint.
15. EcuadorExplorer.com (2013). *Rates of rainforest destruction and species loss in the Ecuadorian Amazon* [an excerpt reproduced from the *Rainforest Action Network*]. Accessed November 2013 from http://www.ecuadorexplorer.com/html/body_rf_destuction.html
16. Elkins, D.N., Hedstrom, L.J., Hughes, L.L., Leaf, J.A. & Saunders, C. (1988). Toward a humanistic-phenomenological spirituality: Definition, description, and measurement. *Journal of Humanistic Psychology*, 28, 5-18.
17. Feinstein, D. & Krippner, S. (1988). *Personal mythology*: *Using ritual, dreams, and imagination to discover your inner story*. LA: Jeremy P. Tarcher, Inc.
18. Fontana, D. & Slack, I. (1996). The need for transpersonal psychology. *Newsletter of the Association for Transpersonal Psychology,* Fall, 3-7.
19. Fox, W. (1990a). Transpersonal ecology: "Psychologizing" ecophilosophy. *Journal of Transpersonal Psychology*, 22, 59-96.
20. Fox, W. (1990b). *Toward a transpersonal ecology*: *Developing new foundations for environmentalism*. Boston: Shambhala.
21. Fromm, E. (1968). *The revolution of hope*: *Toward a humanized technology*. New York: Evanstan & London: Harper & Row, Publishers.
22. Getty, A. (2003). Twists of fate. *ReVision*, 25, 12-17.
23. Glendinning, C. (1994). *My name is Chellis and I'm in recovery from Western civilization*. Boston, London: Shambhala.
24. Gomes, M. (2003). Introduction: Women and entheogens. *ReVision,* 25, 2-3.
25. Gray, L. (1995). "Shamanic counseling and ecopsychology", in T. Roszak, M. Gomes & A. Kanner (eds.), *Ecopsychology*: *Restoring the earth, healing the mind* (pp.172-182). San Francisco: Sierra Club Books.
26. Grinspoon, L. & Bakalar, J.B. (1998). *Psychedelic drugs reconsidered* (2nd edition). New York: Lindesmith Centre.
27. Grof, S. (1985). Modern consciousness research and human survival. *ReVision*, 8, 27-39.
28. Grof, S., Grob, C., Bravo, G. & Walsh, R. (2008). Birthing the transpersonal. *Journal of Transpersonal Psychology*, 40, 155-177.
29. Harner, M. J. (ed.) (1973). "The role of hallucinogenic plants in European witchcraft", in *Hallucinogens and shamanism* (pp.125-149). Oxford, UK & New York: Oxford University Press.
30. Harrison, H. (1967). *Make room! Make room!* New York: Berkeley Medallion Books. Film adaptation *Soylent Green* (1973). Screenplay by S. R. Greenberg. Hollywood, CA: Metro-Golden-Mayer.

31. Harrison, J. (2011). Review Singing to the Plants: A guide to Mestizo shamanism in the upper Amazon. *International Journal of Transpersonal Studies*, 30, 178-181.
32. Hibbard, W. (2007). The Native American sweat lodge ceremony: Reports of transpersonal experiences by non-Native practitioners. *Journal of Transpersonal Psychology*, 39, 68-91.
33. Hofmann, A. (1983). *LSD*: *My problem child. Reflections on sacred drugs, mysticism, and science*. Los Angeles: J. P. Tarcher, Inc.
34. Huxley, A. (1932/1969). *Brave new world*. New York: Harper & Row.
35. Huxley, J., Sir. (1957). *New bottles for new wines*. (Mentor Book, Knowledge, Morality and Destiny). New York: Harper & Bros.
36. Jacobi, J. (1998). New case for the blues. *Cat Patrol*. Seattle, WA: Blimp Kitty Records. Accessed November 2013 from http://www.youtube.com/watch?v=ABNyz2TOUwo
37. Jacobi, J. (1999). Real wild thing. *Joe Jakimbi Band*. Lincoln, NE: Unknown, Inc. Accessed November 2013 from http://www.youtube.com/watch?v=mrn3e8F-QI8
38. Jones, P. (2006). Shamanism: An inquiry into the history of the scholarly use of the term in English-speaking North America. *Anthropology of Consciousness*, 17, 4-32.
39. Kasulis, T. P. (1981). *Zen action, zen person*. Honolulu, Hawaii: The University of Hawaii Press.
40. Kremer, J. W. (1997). Introduction. *ReVision*, 19, 2-3.
41. Kremer, J. W. & Rothberg, D. (1999). Facing the collective shadow. *ReVision*, 22, 2-4.
42. Krippner, S. (2002). Conflicting perspectives on shamans and shamanism: Points and counterpoints. *American Psychologist,* 57, 962-977.
43. Krippner, S. & Luke, D. (2009). Psychedelics and species connectedness. *Multidisciplinary Association for Psychedelic Studies Bulletin*, 19, 12-15.
44. Lazar, A. (2009). The relation between a multidimensional measure of spirituality and measures of psychological functioning among secular Israeli Jews. *Journal of Transpersonal Psychology*, 41, 161-181.
45. Lucas, M. (2005). Reply to rejoinder. *Anthropology of Consciousness*, 16, 48-50.
46. Luke, D. (2011). "Anomalous phenomena, psi, and altered consciousness", in E. Cardena & M. Winkelman (eds.). *Altering consciousness*: *Multidisciplinary perspectives. Volume 2*: *Biological and psychological perspectives* (pp. 355-374). Santa Barbara, CA: Praeger.
47. Lynott, P./Thin Lizzy. (1973). Mama nature said. *Vagabonds of the Western world*. New York: PolyGram Records, Inc. Accessed November 2013 from http://www.youtube.com/watch?v=9Z9snAbouVg
48. MacLean, K.A., Johnson, M.W. & Griffiths, R.R. (2011). Mystical experience occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *Journal of Psychopharmacology*, 25 , 1453-1461.
49. Maslow, A.H. (1964). *Religion, values, peak experiences*. New York: Viking Press.
50. Maslow, A.H. (1968). *Toward a psychology of being*. (2nd edition). New York: D. Van Nostrand Company.
51. Masters, T. (1998). Anymore. *Digital Bitch Shifter*. Lincoln, NE: Guarana Records.
52. Metzner, R. (1989). "Molecular mysticism: The role of psychoactive substances in the transformation of consciousness", in C. Ratsch (ed. Translated by J. Baker). *The gateway to inner space*: *Sacred plants, mysticism and psychotherapy. A festschrift in honor of Albert Hofmann* (pp. 73-88). Bridport, Dorset, UK: Prism Press.
53. Metzner, R. (1990). Germanic mythology and the fate of Europe. *ReVision*, 13, 16-27.
54. Metzner, R. (1991). Psychologizing deep ecology: A review essay. *ReVision*, 12, 147-152.
55. Metzner, R. (1992). Statement of purpose. *Green earth foundation catalog*. El Verano, CA: The Green Earth Foundation.
56. Metzner, R. (1993, August 28). "Ecology and transpersonal psychology". A forum organized and moderated by R. Metzner, and including B. Keepin, T. Roszak, I. Serlin, and R. Walsh, held at the 25th Anniversary Convocation of the Association for Transpersonal psychology conference, August 25-29, Asilomar Conference Center, Pacific Grove, California. A CD is available from Conference Recording Services, http://www.conferencerecording.com/
57. Metzner, R. (1994). *The well of remembrance*: *Rediscovering the earth wisdom myths of northern Europe*. Boston: Shambhala.
58. Metzner, R. (1999). *Green psychology*: *Transforming our relationship to the Earth*. Rochester, VT: Park Street Press.
59. Metzner, R. (2004). "Introduction: Visionary mushrooms of the Americas", in Metzner & Darling (2004).
60. Metzner, R. (2008). *The expansion of consciousness*, Vol 1. Berkeley, CA: Regent Press.
61. Metzner, R. (2009). Consciousness expansion and counterculture in the 1960s and beyond. *Multidisciplinary Association for Psychedelic Studies Bulletin*, 19, 16-20.
62. Metzner, R. & Darling, D.C. (eds.)(2004). *Teonanacatl*: *Sacred mushroom of visions* (pp. 1-48). El Verano, California: Four Trees Press11
63. Narby, J. & Huxley, F. (eds.) (2001). *Shamans through time*: *500 years on the path to knowledge*. New York: J. P. Tarcher/Putnam.
64. Novak, P. (1987). Tao how? Asian religions and the problems of environmental degradation. *ReVision*, 9, 33-40.
65. Novak, P. (1989). "The Goddess and attitudes towards nature in Asian religious traditions", in R. Metzner (ed.). *Gaia consciousness*: *The re-emergent Goddess and the living earth* (pp. 51-55). San Francisco, CA: Four Trees Publications/Fairfax, CA: The Green Earth Foundation.
66. Orwell, G. (1949). *Nineteen eighty-four*. New York: Harcourt, Brace.
67. Prattis, I. (2008). *Failsafe*: *Saving the earth from ourselves*. Canada: Manor House Publishing.
68. Peters, L.G. (1989). Shamanism: Phenomenology of a spiritual discipline. *Journal of Transpersonal Psychology*, 21, 115-137.
69. Ram Dass & Seed, J. (1991). *To wake up one day different*: *John Seed talks with Ram Dass*. San Francisco, CA: Rainforest Action Network. (Video recording).
70. Reser, J.P. (1995). Wither environmental psychology? The transpersonal ecopsychology crossroads. *Journal of Environmental Psychology*, 15, 235-257.
71. Roberts, D. (2011). Edgar D. Mitchell's noetic vision: The greening of cosmos and consciousness. *Rhine Online*: *Psi-News Magazine*, 3, 6. Accessed from http://www.rhine.org/

72. Roszak, T. (1969). *The making of a counter culture: Reflections on the technocratic society and its youthful opposition*. Garden City, NY: Anchor Books/Double Day and Company, Inc.
73. Roszak, T. (1971). *Where the wasteland ends*: *Politics and transcendence in postindustrial society*. Garden City, NY: Anchor Books/Doubleday & Company, Inc.
74. Roszak, T. (1980). "The monster and the titan: Science, knowledge, and gnosis", in E.D. Klemke, R. Hollinger & A.D. Kline (eds.). *Introductory readings in the philosophy of science* (pp. 305-322). New York: Prometheus Books.
75. Roszak, T. (1992). *The voice of the Earth*. New York: Simon & Schuster.
76. Roszak, T., Gomes, M.E. & Kanner, A.D. (eds.)(1995). *Ecopsychology*: *Restoring the Earth, healing the mind*. San Francisco: Sierra Club Books.
77. Roszak, T. (1999). *The gendered atom*: *Reflections on the sexual psychology of science*. Berkeley, CA: Conari Press.
78. Rothberg, D. (1999). Transpersonal issues at the millennium. *Journal of Transpersonal Psychology*, 31, 41-67.
79. Schroll, M.A. (1990, November 11). "Shamanism: A 100,000 year old 'new' religious movement". Conference of the Society for the Scientific Study of Religion, Virginia Beach, Virginia, USA.
80. Schroll, M. A. (2003, April 3). "Castaneda's controversy: Examining consciousness studies future". 23rd Conference of the Society for the Anthropology of Consciousness, University of Nevada, Las Vegas, USA.
81. Schroll, M. A. (2004a). "We are all actors and directors in a giant cosmic drama", in Metzner & Darling (2004).
82. Schroll, M.A. (2004b). "Psychedelics: Their value and social responsibility". 24th Conference of the Society for the Anthropology of Consciousness, UC-Berkeley, CA, USA.
83. Schroll, M.A. (2008/2009). Ecopsychology's roots in humanistic and transpersonal psychology. *Association for Humanistic Psychology-Perspective*, Dec/Jan: 16-17. Accessed November 2013 from http://www.ahpweb.org/images/stories/pub/perspective/dec2008/perspec_dec.pdf
84. Schroll, M.A. (2009a). Review of the expansion of consciousness, Vol 1. *Anthropology of Consciousness*, 20, 81-83.
85. Schroll, M. A. (2009b). Review of failsafe: saving the earth from ourselves. *Association for Humanistic Psychology-Perspective*, June/July: 29-30. Retrieved from http://www.ahpweb.org/images/stories/pub/perspective/June09/AHP PerspectiveJUNE 2009.pdf
86. Schroll, M.A. (2010a). Castaneda's controversy and methodological influences. *Paranthropology*, 2, 40-42.
87. Schroll, M.A. (2010b). Toward a new kind of science and its methods of inquiry. *Anthropology of Consciousness*, 21, 1-29.
88. Schroll, M.A. (2011a). Neo-shamanism, psi, and their relationship with transpersonal psychology. *Paranthropology*: *Journal of Anthropological Approaches to the Paranormal*, 2, 28-36.
89. Schroll, M.A. (2011b). Sufi wisdom, Norse mythology, zen koans, and the eco-crisis: Remembering the value of teaching stories. *Restoration Earth*: *An Interdisciplinary Journal for the Study of Nature and Civilization*, 1, 79-83.
90. Schroll, M.A. (2011c). Editor's introduction: From primordial anthropology to a transpersonal ecosophy. *Anthropology of Consciousness*, 22, 4-8.
91. Schroll, M.A., Krippner, S., Vich, M.A., Fadiman, J. & Mojeiko, V. (2009). Reflections on transpersonal psychology's 40th anniversary, ecopsychology, transpersonal science, and psychedelics: A conversation forum. *International Journal of Transpersonal Studies*, 28, 39-52.
92. Schroll, M.A. & Rothenberg, D. (2009). Psychedelics and the deep ecology movement: A conversation with Arne Naess. *Multidisciplinary Association for Psychedelic Studies Bulletin*, 19, 41-43.
93. Schroll, M.A. & Greenwood, S. (2011). Worldviews in collision/worldviews in metamorphosis: Toward a multistate paradigm. *Anthropology of Consciousness*, 22, 49-60.
94. Schroll, M.A. & Hartelius, G. (2011). Introduction to special topic section: Ecopsychology's roots in humanistic and transpersonal psychology, the deep ecology movement, and ecocriticism. *International Journal of Transpersonal Studies*, 30, 82-88.
95. Schroll, M.A., Rowan, J. & Robinson, O. (2011). Clearing up Rollo May's views of transpersonal psychology and acknowledging May as an early supporter of ecopsychology. *International Journal of Transpersonal Studies*, 30, 120-136.
96. Shah, I. (1970). *Tales of the dervishes*. New York: E.P. Dutton & Company, Inc.
97. Shelley, M. (1816/1983). *Frankenstein*: *Or, the modern Prometheus*. New York: A Signet Classic.
98. Sinfield, P./King Crimson(1969). 21st century schizoid man. *In the court of the crimson king*. New York: Caroline Records, Inc. Accessed November 2013 from http://www.youtube.com/watch?v=8Ubc5_owhl0
99. Smith, H., Grob, C., Jesse, R., Bravo, G., Agar, A. & Walsh, R. (2004). Do drugs have religious import? A 40-year retrospective. *Journal of Humanistic Psychology,* 44, 120-140.
100. Snell, T.L., Simmonds, J.G. & Webster, R.S. (2011). Spirituality in the work of Theodore Roszak: Implications for contemporary ecopsychology. *Ecopsychology,* 3, 105-113. *Soylent Green* (1973). Screenplay by Stanley R. Greenberg, based upon a novel by H. Harrison. Los Angeles, CA: Metro-Goldwyn-Mayer,
101. Sutich, A.J. (1969). Some considerations regarding transpersonal psychology. *Journal of Transpersonal Psychology*, 1, 11-20.
102. Townsend, J. (1988). "Neo-shamanism and the modern mystical movement", in G. Doore (ed.), *Shaman's path*: *Healing, personal growth and empowerment* (pp.73-83). Boston: Shambhala,.
103. Townsend, J. (1990). "Authenticity and delusion: Shamanism vs. neo-shamanism". Annual Conference of the Society for the Scientific Study of Religion, Virginia Beach, USA.
104. Vich, M.A. (1988). Some historical sources of the term 'transpersonal'. *Journal of Transpersonal Psychology*, 20, 107-110.
105. Walsh, R. (1984a). World at risk. *Association for Transpersonal Psychology Newsletter, Spring*, 10-14.
106. Walsh, R. (1984b). *Staying alive*: *The psychology of human survival*. Boulder, CO: Shambhala.
107. Walsh, R. (1989a). What is a shaman?: Definition, origin and distribution. *Journal of Transpersonal Psychology*, 21, 1-11.
108. Walsh, R. (1989b). Shamanism and early human technology: The technology of transcendence. *ReVision*, 12, 34-40.
109. Walsh, R. (1989c). The shamanic journey - Experiences, origins, and analogues. *ReVision*, 12, 25-32.
110. Walsh, R. (2007). *The world of shamanism*: *New views of an ancient tradition*. Woodbury, MN: Llewellyn Publications.
111. Watts, A. (1969). *Does it matter? Essays on man's relation to materiality*. New York: Vintage Books.
112. Webb, H. S. (2013). Expanding Western definitions of shamanism: A conversation with Stephan Beyer, Stanley Krippner, and

Hillary S. Webb. *Anthropology of Consciousness*, 24, 57-75.

113. White, L., Jr. (1967). The historical roots of our ecologic crisis. Science, *155*, 1203-1207. Reprinted in Barbour, I.G. (ed.) (1973). *Western man and environmental ethics*: *Attitudes toward nature and technology* (pp. 18-30). Reading, MA: Addison-Wesley Publications, Co..
114. Young, Neil. (1989). Rockin' in the free world (electric version). *Freedom*. Hollywood, CA: Warner Brothers. Accessed November 2013 from http://www.youtube.com/watch?v=p_xDVyUOzYg
115. Zamyatin, Y. (1972). *We*. (M. Ginsburg, trans.). New York: Bantam Books.

Reflections on Transpersonal Psychology's 40th Anniversary, Ecopsychology, Transpersonal Science, and Psychedelics: A Conversation Forum[1]

by

Mark A. Schroll, Stanley Krippner, Miles A. Vich, James Fadiman, Valerie Mojeiko

International Journal of Transpersonal Studies, 28(1), 39-52.

original source: http://digitalcommons.ciis.edu/cgi/viewcontent.cgi?article=1163&context=ijts-transpersonalstudies

Mark A. Schroll - Rhine Research Center Durham, NC, USA
Stanley Krippner - Saybrook Graduate School San Francisco, CA, USA
Miles A. Vich - Palo Alto, CA, USA
James Fadiman - Institute of Transpersonal Psychology Palo Alto, CA, USA
Valerie Mojeiko - Multidisciplinary Association for Psychedelic Research Santa Cruz, CA, USA San Francisco, CA, USA

Table of Contents:

The Early History of Humanistic and Transpersonal Psychology: Reflections on Tony Sutich's Living Room
What Were the Experiences that Led Tony Sutich to the Transpersonal?
The Maturing of Humanistic and Transpersonal Psychology: Examining the Challenges of Academic Accreditation and Clinical Practice
Will Transpersonal Psychology Ever Become an APA Division? Wrestling with Spirituality and Organization
The Challenge: Defining Transpersonal Education
Humanistic and Transpersonal Vistas: Ecopsychology's Role in Shaping Our Future
Final Comments and Questions
Notes
About the Authors
References

Recollections of humanistic and transpersonal psychology's origin's morph into the pros and cons of humanistic/transpersonal oriented schools developing APA accredited clinical programs. This discussion dovetails with the question will ATP ever become an APA division, raising an interesting alternative for those of us considering a career in counseling: becoming a spiritual coach. Enter the issue of psychedelic therapy and the Supreme Courts decision to allow ayahuasca as a sacrament by the Uniao Do Vegetal Church, and the importance of why humanistic and transpersonal psychology need to clearly map out the territories and sub-divisions of science and religion. Finally this conversation raises a concern, that Maslow's call for a "trans-human" psychology sought to encourage creating what we now call ecopsychology.

This conversation forum took place on September 8, 2006, at the conference "100 Years of Transpersonal Psychology," in Palo Alto, CA, sponsored by the Association for Transpersonal Psychology (ATP) and the Institute of Transpersonal Psychology (ITP). Mark A. Schroll organized and served as the moderator of this forum asking Miles Vich, James Fadiman, and Stanley Krippner to reflect on transpersonal studies broad spectrum of inquiry, with additional reflection by Valerie Mojeiko on the current status of psychedelic studies. The discussion begins with some reflections on early meetings of humanistic and transpersonal psychologists in Anthony Sutich's home in Palo Alto.

The Early History of Humanistic and Transpersonal Psychology: Reflections on Tony Sutich's Living Room

Miles Vich: ... with characteristic energy and foresight he decided to write a documented account of his involvement in humanistic and transpersonal psychology. In June 1974 he formally began the necessary research for this project and contracted to write a dissertation on the subject as part of the requirements for a doctoral program in psychology at the Humanistic Psychology Institute in San Francisco. I used to joke with Tony as we were working on this project for a couple of years that he typically did things the long way around. Instead of getting the usual graduate degree somewhere, he waited a whole career-lifetime, formed a couple of fields, helped get some schools started, and then he got a degree from one of them. He brought this project to a successful conclusion when he completed his dissertation "The Founding of Humanistic and Transpersonal Psychology: A Personal Account." He received his doctoral degree April 9, 1976, one day before he died; and the three of us [Jim Fadiman, Stanley Krippner and I] were all there.

It is difficult to adequately describe or characterize this remarkable man; nevertheless it is necessary to recognize that thousands of individuals and many institutions have been influenced directly or indirectly by the efforts of this unusual human being. Tony Sutich's contribution is, among other things, an example of the value of what is humanistic, personal and transpersonal in our lives. If you go to the *Journal of Transpersonal Psychology* [*JTP*], you will see four or five articles [of his], and you will get a sense of what he says. His personal account, abbreviated to perhaps a dozen pages, is in *JTP* 8(1), 1976. I suggest you read Tony himself and get a sense of all the adventures that he had in this and related fields.

Stanley Krippner: Miles Vich has just given you a wonderful cameo presentation of Tony Sutich's life. The fourth member of his doctoral committee at Saybrook, formerly The Humanistic Psychology Institute, was Eleanor Criswell, who was also a leader in the transpersonal field and a real pioneer. When we went down to do his oral defense, he could barely speak; and yet he was so happy this work had been completed that it was a very joyous occasion. I went back home that night and had a dream. In the dream who should be coming in the door but Tony Sutich and he was walking. I said Tony this is the first time I have ever seen you walk. Tony said, "Oh I can do anything now I'm dead you know." This of course was the night he died.

His dissertation, on the founding of humanistic and transpersonal psychology is a classic: beautifully written, very articulate, and it was stolen from our files a few years later. Written in the days before computer files we thankfully were able to piece together a duplicate dissertation from a carbon copy. Just today Miles tells me he has discovered a pristine copy of Tony's dissertation. This discovery will be a cause for great rejoicing at Saybrook because now we can put it on microfiche and computer files, and it can be distributed more widely. Hearing the news of this discovery is really the highlight of my coming down to this conference today.

I should mention one other thing. Abraham Maslow was also a close friend of mine. He was talking about founding a new psychology the last time I saw him, that he was calling *trans-human psychology*. "As we talked about it, and in retrospect, I now realize that he was talking about what we now call ecopsychology" (Schroll, 2008/2009, p. 16). Because it stemmed from the deep ecology movement, the recognition (nearer to what Native Americans have believed for millennia) that humans as a species are just one of many species on planet Earth, maybe other planets too. "We should therefore extend our concern to them - go trans-human - and not make this a human-centered psychology. Unfortunately Maslow never had this dream realized" (p. 16), but other people like Theodore Roszak (1992) and Jeremy Narby (2001) have picked up on this idea, an idea we will be hearing more about in the future.

What Were the Experiences that Led Tony Sutich to the Transpersonal?

Mark A. Schroll: This brings me to several concerns. Let's pick up on when Tony had his mystical experiences, what triggered these? Did he take something? Was it natural? Do any of you know what caused him to have these mystical experiences?

Vich: Yes, we know a little bit about this. Some of this is in Tony's dissertation. Tony was always very modest about these discussions; its just he had a lifelong interest in these kinds of experiences and he read a lot. But I think too because he faced death so early, he was told he was going to die and then it didn't happen; this made him question everything. Likewise Tony would privately speak about his mother being such a positive supportive influence, yet his father was not quite as supportive. His family helped him through - this was the bottom of the depression when there was nothing out there; and this guy is on his back [Sutich was disabled by an accident at a young age and was unable to move for most of his life-], what does he do? So every conceivable question a person would ask was amplified in terms of being a crisis; everything had to be dealt with.

Tony too was just naturally brilliant and intellectually alive to all kinds of things. The other side of it in terms of psychedelics is something that Tony did not talk about much. All I know is from what he said; he said in print he had some experiences that were not particularly determining, powerful, or overwhelming. But they were in the line of other experiences that he had. You might call them mystical or spiritual or higher or a deeper psychology - it was broad. It has all kinds of cultural elements and all kinds of modes and vehicles; it was not just one channel it was many channels for him.

Schroll: Okay this was an important point. Another point I want to return to is that Tony then created a way to license himself. Could this possibly be a model for an alternative licensing board that would be an alternative to APA?[2] Can we reflect on this?

The Maturing of Humanistic and Transpersonal Psychology: Examining the Challenges of Academic Accreditation and Clinical Practice

Vich: Historically things are never the same. My two colleagues on the left here [Stanley Krippner and Jim Fadiman] are much more conversant with these issues. I have been out of the organizational, political and professional loop for a long time. But I will say it does not take much; it takes a particular idea, a particular action and a seed grows, but it is the later development where it affects lots and lots of people and the refinements occur. Consequently I do not know if what Tony did could be a model now. You would have to be in a kind of frontier situation where you had friends in the legislature; and then there are three of you in the whole damn state of California that cannot do anything except counsel. Then by a grandfather clause some political restrictions are overcome, and through some careful maneuvering the legislation comes out. But I do not think that things happen this way anymore.

James Fadiman: The issue of accreditation is always an interesting one. I was thinking of what you said Valerie - a little quiet throwaway line with your reference to "outlaw therapists" at Burning Man. Oh (the thought occurred to me), are there outlaw therapists? Well, there are people that have made a commitment to help human beings and they think that there is an unwritten law that trumps restrictive legislation that prevents any of us (that choose to) from helping human beings. This is true in mainstream psychology; it is true in transpersonal psychology. But it is not true in institutions. Institutions are highly visible; it is very hard to be an outlaw institution. Having been in a school where we began with the premise that we were an outlaw institution, we found the culture indeed accepted us as an outlaw institution and said, "You are not welcome anywhere."

Laughter from the gallery.

Fadiman: And there were very few similar kinds of institutions. I use a different term now, not outlaw but *outlier*, which means outside or near the edge. Whereas if you are leading, then you are known as avant guard; if you are simply at the edge and everyone moves in the other direction then they think that you are just a crank. Certainly as schools we've been dealing with this issue. The problem of accreditation of any sort (be it medical, psychological, nursing, massage, religious institutions) is you should be close to normal or close to the middle of whatever distribution of the family or group of ideas and practices you are attempting to represent. This is the task of assessment, and what accreditation represents. Accreditation never says that you are really terrific, interesting, exciting, and innovative. Or they say if you are, then you are not ready for us. But if you are vanilla, if you are interchangeable with other institutions, then you should be accredited. I'm not fond of accreditation, because being an outlier is more interesting, but that is the way it works. So that any institution which goes for accreditation has to see how it can at least appear to be vanilla before it gets accredited. Then fortunately once you are accredited, you are allowed to - changing metaphors here - to do a few things under the blanket that have a different point of view. I'm mentioning this because ITP - which, as Miles said, was not founded by Tony - at least he did not found everything...

Laughter from the gallery.

Fadiman: is looking to be accredited as a clinical institution by APA. The question is, this is good for people trying to earn a living, because APA is gradually controlling more and more state legislature's licensing rules.[3] But is it good for transpersonal? This is an entirely different question. Perhaps we will look at this.

Schroll: It is good in terms of the fact that to get paid by the insurance companies you have to be licensed. But it may not be good for philosophical reasons.[4] Tony was trying to help people - and as Valerie points out there are outlaw therapists that are also trying to help people. So how can you help someone and yet get paid?

Valerie Mojeiko: I don't really know that much about licensing, [so my question is this]. Currently people that are licensed as transpersonal psychologists - whether or not they are giving out illegal drugs - are not able to get paid by insurance?

Fadiman: If you are a licensed psychologist, there is not an adjective in front of that; its a licensed clinical psychologist, and whatever the restrictions on a clinical psychologist are, you have all of them. One of them certainly is that you are not allowed to prescribe drugs that are legal, let alone the more interesting ones.

Will Transpersonal Psychology Ever Become an APA Division? Wrestling with Spirituality and Organization

Schroll: This comment opens up the question of *ayahuasca*.[5] Earlier Stan Krippner mentioned the Supreme Courts decision to allow ayahuasca use as a legal sacrament.[6] This reopens the opportunity for psychedelic exploration. This also gets into the issue of moving psychedelic inquiry away from the medical model because we no longer need to be worried about the fact that we are either dispensing or ingesting a substance that could be regulated as a licensed medicine.

Krippner: Well in one church. Remember that only one church has the legal right to use ayahuasca as a sacrament right now. This brings up one of the advantages of a church organization because if you are a member of the clergy, you can give spiritual counseling. You do not have to call it psychotherapy; in fact you had better not call it psychotherapy. But just to avoid problems in the advice that I give people - in the secular trips I used to lead people on back in the old days - I became a minister for the Universal Life Church, and also for the Center for Spiritual Healing. I do wedding ceremonies; I'm doing one tomorrow, which is why I have to get back [to San Francisco] this evening to prepare. I perform weddings for people that want a typically unorthodox ceremony, where they can write their own vows, cite scripture from other traditions - such as Eastern, Native American, and even Wiccan traditions. If they prefer they do not even have to mention the word God, so what I do provides people with a meaningful ceremony, and I'm very happy to oblige.

Now the institutionalization of a movement is always a two-edged sword. On the one hand, accreditation does help a lot of people earn money because they get a more solid recognized degree. Some 30-years ago at Saybrook there was a group of faculty members that did not want accreditation; they said this would clip our wings, and ruin our freedom. We had state approval; they said state approval is enough as we are giving a legal degree. Others at Saybrook thought differently (I among them) and we won out and got Saybrook accredited, and we really did not have our wings clipped or anything like that; the same thing [came up] for ITP when it became accredited. But getting a program like a clinical psychology program recognized, that is a little different thing. Because if you are going to be a clinical psychologist, the way the zeitgeist is moving and the states are drawing laws, you have to be from an APA approved program.

Now I've been a member of APA for decades. APA has been very good to me, I'm a fellow of four APA divisions, and so I'm not critical of APA - except where I need to be like when they put too much emphasis upon their division of military psychology as they did at the last convention. But this is a whole other set of concerns that we do not have to go into right now. Anyway, APA has gotten to the point where they will give approval to an institution if it is solid and if it does what it purports to do.

I think that ITP has a very good chance of getting its [clinical] program approved by APA if they can convince APA that they've gotten their act together, that the therapists that come out of ITP are knowledgeable, that they can handle a variety of dysfunctional behaviors and attitudes. I know of some schools that the APA would not have approved 20 years ago that are now becoming APA approved. So the signs are favorable on this.

Nevertheless, getting an APA division called transpersonal psychology is an entirely different thing, and Mark wanted us to speak to this concern. There was a movement, 30-some-years ago, to have a Division of Humanistic Psychology. Most of my colleagues and I were against it. We asked, why do we need to create a division? Why not just have humanistic psychologists and transpersonal psychologists create their own associations, and then bring the humanistic flavor into already established APA divisions. The person spearheading this proposed Division of Humanistic Psychology was a radical psychologist named Don Gibbins, who went around and got the signatures, not from any of us, but from thousands of other people. Thus a Division of Humanistic Psychology in the APA was approved. We then got together for our first meeting and Gibbins wasn't even there; so we named one of the members of our group president, and the division has been going on ever since.

Was this a good thing? Not necessarily; because since this time Positive Psychology has come into the picture, and has sort of distanced itself from Humanistic Psychology.[7] If humanistic psychology had diffused itself into the already existing APA divisions, I think there might have been an earlier influence, and even marriage, with the positive psychology folks, and you wouldn't have the split that there is now. Not that the two groups are antagonistic, they are just moving in different directions.

Now when the transpersonal psychologists got the number of votes and decided to appear before the APA council they solicited advice, but my advice was not taken. I said you have to speak in the language that the council will recognize. First of all come up with an operational definition of transpersonal psychology. Secondly, ground it in mainstream psychology. William James used the word transpersonal,[8] go back to William James; everybody in psychology reveres William James. I gave a couple of other guidelines that were not taken, and the APA council voted it down, not once, not twice, but three times.

But did all my work go in vain? No, because some years later I was on the committee that came down to check into accreditation for ITP; although I cannot reveal what went on in the deliberation session where we voted to give accreditation to ITP, I used the same arguments that had been lying around for 20 years. I gave an operational definition of transpersonal psychology, grounding it in the mainstream of the psychological history, et cetera, and they said thank you for educating us about transpersonal psychology; it is not as far out as we thought it was. This is as much as I'm allowed to say, but you see the results, ITP is a flourishing institution and I'm delighted.

Still the question remains, should transpersonal psychology be a separate division of APA? Right now there are plenty of transpersonal programs at APA, most sponsored by division 32 or humanistic psychology; some by the division for the scientific study of religious issues, some by other divisions. I think there is enough transpersonal work going on, and I am really against too many divisions in APA. There are 52 right now, going on 53, and this cuts into the time that other divisions have to present their programs at APA. I am not wild about the idea of a division of transpersonal psychology in APA, frankly, because I do not think that it is needed. I think that there are vehicles for transpersonalists like me and other people to present our ideas in other divisions and then diffuse the work, spreading the word to get other people in other divisions interested. So we'll see what happens.

Schroll: Thank you Stan, so the message is to network with these other groups. I had an image while you were talking where each one of us can be an autonomous member, and yet to see the whole we have to be able to have these dialogues with other people and find a common language. In other words, what you are saying is rather than continue to work for a division of ATP in the APA, it is better to try to find a common ground of dialogue, and/or a conceptual model or a genealogy of where our roots come from in terms of our ideas with these other groups.

Krippner: Yes, that's my position; I might be wrong but that is where I'm coming from.

Vich: Could we say something about this from a slightly different perspective? When we were formulating AHP and ATP, their publications, and gathering people together at conferences to create an identity as to what we thought might be called transpersonal psychology, there was an assumption that first we had to understand what we were doing. What are we about? So that first phase was the identity development phase. There was an interesting period - I guess late 1970's early 1980's - where a concern was raised. The concern was this. If we tried to assimilate (or have too much connection with other systems or fields in whatever profession), this would risk transpersonal psychology's independence along the lines that Jim was talking about earlier concerning institutions.

The final point is about the future of educational institutions and licensing and so on. This oddly enough occurred to me very late in the game of almost 40 years of work. In a way maybe it does not make any difference what happens organizationally, politically, and so on. This is because at the root human beings are always going to have this interest, this inclination, this desire for understanding, this awareness, this questioning of where they fit into the big scheme of things, and other basic questions are always going to be there.

So those of us that are working in this field, we are working with forms, with channels, with methods, with systems, and I was able to be personally relieved of the concern that all this might pass away if we did not get approved or recognized, or licensed or whatever. Whereas the basic fundamental concerns always exist and they are rising and growing, so this is the assumption that I'm operating under. We just happened to live at a time when particular institutions are helpful necessarily and useful to people.

Schroll: So the practice of transpersonal psychology/transpersonal psychotherapy takes another form. Some people take the path - they go the ministerial route and/or pastoral-counseling route - and this is the other possible option, the spiritual psychology option. This is where people like Stan and Jim do not have to call themselves a clinician; they can call themselves a spiritual minister or some word that people can recognize so they can actually get paid for what they are doing.

Krippner: Like a spiritual coach.

Schroll: Right - so we need this language. Would people wanting to be counselors from a transpersonal perspective be opposed to calling themselves a spiritual coach? We may have to change or broaden our definition of what we mean by religion; and/or focus on developing an expanded operational definition of what it is we mean by religion.[9]

Mojeiko: I think that one problem that would arise that has in the past - or at least as far as from the perspective I'm most knowledgeable about - which is issues concerning the psychedelic therapist. Once the study of psychedelic therapy or psychedelic counseling is in a medical model it is more accepted, it is more reviewed, there are more people that are watching out and making sure that what the person is doing is ethical. As people go more and more underground there is more of a chance the kind of therapy that they are offering people is not actually helpful. It might be more harmful, and this is something to think about when there is no real law or rules overseeing its operation. Regarding psychedelic therapists in particular, one thing that MAPS [or the Multidisciplinary Association for Psychedelic Studies] is starting to develop is some kind of training program and accreditation for people that are doing psychedelic therapy; because there are a lot of particular issues that come up.

There has traditionally been a lot of sexual abuse between therapist and client; this is just something to think about. I have heard so many reports - there are a lot of clinics that people can go to where they can take ayahuasca in South America, and - except for MAPS - there is not any larger organization reporting on which ones are ethical or safe. We have so many people calling our office, because it is really the only group of people to call about such a thing, just complaining that certain groups and/or individuals are dangerous; or are not what they advertise themselves to be. I guess either way it would be good to have some kind of licensing board - yet order and rules are not typically my thing. Still I can see some benefit in having some kind of structure, whether it is medical or religious.

Schroll: You mentioned ethics, or more specifically an ethic of behavior, this reminds me of all of the problems with gurus and the tendency of the so-called spiritual teacher to abuse their power and authority, and likewise various problems with sexual issues or any issue. Because having sex should certainly be consensual, not about power and control, and this is where we need some kind of an ethic that involves regulating behavior.

Mojeiko: But whose ethic? Where does it come from?

Schroll: From my perspective, it comes from talking, from getting feedback from other people, and by working it out through dialogue with others - just like we are doing right now - as a community.

Fadiman: If you kind of look at history now and then, you find experiments that have been tried. In the USA up until about 1830 there were no licensing laws about any kind of medical practice, psychological practice, spiritual practice, et cetera. The rule was that any practitioner or anyone that called themself [a practitioner of medical, healing, spiritual arts] could charge you and if you felt that you had been harmed, you could sue; that was it. Eventually, however, the American Medical Association was formed, and not with the concern of creating the kind of high minded ethical rules that we hear from you - [Mark and Valerie], because the AMA's creation did not in any way deal with psychedelic experience.

Instead, the founders of the AMA were aware there was a competitive medical form called homeopathy. And they established rules which if you did not know what the game was, said that you [- as a practitioner of medical, healing, spiritual arts -] should have a certain amount of laboratory equipment - microscopes, slide trays, etc. - all things that homeopaths did not need. Then the AMA turned around and said, now let us accredit each other and surprise, all of the homeopathic schools were not accredited. The question is has medicine in the USA [established itself and become a] beacon throughout the world of how it should be done? The answer is in certain areas yes, absolutely, and in other areas [not at all, but] is simply a method of keeping ways of healing out of peoples hands, [and this] is a problem.[10]

The issue gets more interesting when we ask, is there [or would there] be any motive for accreditation other than good? The answer is that in most human institutions there are people that sometimes have a different point of view. I love the idea that MAPS wants to be in the training business; but I am not sure that MAPS wants to be in the accreditation business.

One of the things I like about the church and state issue is you can really be a wacko religion, and there is an enormous effort not to stop you. Let me give you an example of where this issue comes up tough against the culture. Now this is not a wacko religion. This happens to be (I think it was a Vietnamese or Hmong group) that came to the USA after what we did to their countries, and among the things that they would do in the park in San Francisco is catch squirrels and eat them. This was part of their religious practice, and you could just see the cultural discomfort of people saying, Well you cannot just kill these little animals. But it is their religion. But they are killing squirrels! Had they eaten rats, or pigeons, it might have been a different issue.

Consequently when you watch people trying to protect you from something it is well worth looking at what are the underlying cultural assumptions. One of the ways the use of ayahuasca passed the Supreme Court was based on the concern about whether or not they wanted to start legislating which religious practices are acceptable. Also, ayahuasca has one very beneficial side effect that helped its case, which is people that take it almost always have nausea and vomiting. The Supreme Court said yes...

Laughter from the gallery.

Fadiman: this is probably not going to become a recreational church. This genuinely helped; again, what is an acceptable or unacceptable practice, just as in our personal life where do we want licensing to protect us and where do we want freedom to make an informed decision? There are no right answers; but watching the way this process moves through history sometimes is helpful.

Schroll: This might be a good place to raise the issue whether people should just chose to empower themselves to try to develop an alternative position or practice and then hope that people will come to them and pay them money for their services rather than worrying about accreditation. Likewise rather than worrying about getting a division of transpersonal psychology in the APA, therapists should empower themselves by saying if you believe in what we are doing, and it seems right for you, and you think I am helping you, would you pay me? Or you can just go somewhere else for whatever kind of help you are seeking.

Fadiman: It's an alternative model, it's called education. How do we deal with education? If it is good, we pay for it. If it is not, we do not pay for it. Are there bad schools? Are there schools of the dark side? I think so, but they are mainly APA approved, so I cannot say much.

The Challenge: Defining Transpersonal Education

Fadiman: Are there schools that go out of business? Are there schools that thrive? Are there schools that break whatever laws there are? We can say yes to all of these. Now I being a crank, long in the tradition of crankdom, I think that psychology made a terrible mistake when it looked around the university when it was just a little child and it saw who the big kids were that received lots of money. It was not the French literature department, and it was not even sociology; it was hard science that received funding. So psychology said, we are a hard science; the academy said, you are kidding. No, we use numbers. Where? [This of course raises the issue of methodology, which continues to be a matter of concern within humanistic and transpersonal circles (Schroll, in press).] The helping of another human being by talking with them became - partly because Freud (who made this discovery) was a practicing physician - allied with the medical model, and I'm not sure this was a good decision.

It could have become allied with the educational model. Have you ever been to a wise being, and then did you ask what their credentials are? For example, you say that you are a Hindu sage; how do I know that you have the right credentials to be a Hindu sage? The wise being replies, that is a very interesting question that you should ask. In my seven lifetimes ago I did have a degree. Now what is your real question? The point is, it is a different model, and there are different models and fortunately in a culture that allows for different models we do not have to choose one or the other.

Now I'm coming from both not being licensed in anything I have ever done and being a minister - in case someone dies or wants a wedding. But I cannot say the theology is very deep in my church, since it is the same as one of Stan Krippner's churches. The point we are raising here is what is the purpose of what we are doing, and what is the best way to achieve it? I listened to a presentation this morning, about a model of working with psychedelics. The core of the model was, does this way of working increase suffering or decrease suffering? This was the core question around which everything else arises quite naturally. This too is another way of framing what we are talking about regarding accreditation and licensing.

I would by the way not want to leave off ecopsychology, which probably is the least appreciated and most failed system we have. We are now all aware that if there is anything that we had to guess is the major problem the world is suffering from, it is that civilization as we know it may simply melt, fry, boil, hurricane, storm, drought, itself out. Now who should be consulted at the highest levels of government in the world? Ecopsychologists. Is it happening? Not yet, do you have anything to say about this Mark?

Humanistic and Transpersonal Vistas: Ecopsychology's Role in Shaping Our Future

Schroll: I think this is where we get into this problem again: where does ecopsychology fit in? Is it within ATP and ITP; because certainly we are bringing it up here and I have brought it up at past ATP and ITP meetings, but I do not think that ecopsychology is a field. This is not just me talking, but the echo of a point Ralph Metzner and Theodore Roszak came to agree on at the 25th Anniversary Convocation of the Association for Transpersonal Psychology, a view that is shared by Robert Greenway.[11] I agree ecopsychology is not a field, it is an emerging conversation that is happening, or should be happening, in every discipline; it is also not just a conversation we need to be having in science, but it should also be part of the humanities central core. Indeed everyone should be involved and engaged in trying to keep us from cutting ourselves off from the living systems that we are a part of.

Krippner: I'd like to underline what Jim just said, that this is a real opportunity for transpersonal psychology. Remember I said earlier that Maslow was hoping to move into a trans-human psychology, which in his conversations with me I would interpret as being ecopsychology; and nobody else is doing it in terms of major organizations. I think that ecopsychology is absolutely critical. I've written some articles in which I've said that if we are stuck with the *Diagnostic and Statistic Manual*, and if this is something that is going to chart the course of psychopathology, we should have a category for people that are destroying the environment. Persons that are doing this should be diagnosed as pathological and they need help, because they are doing something that is increasing human suffering and the suffering of all sentient beings.

A few years ago I received an award from APA, so I had an opportunity to publish an article in the *American Psychologist*. In my last section I put in a plug for ecopsychology - which is the only time that I know of that it has been mentioned in the *American Psychologist* (Krippner, 2002). I did not have very many words, but I wanted to make sure that I was heard loud and clear on this issue. The way our planet is being devastated, and how the groups with the power and money are abetting and not holding back on this devastation is clearly pathological. If you saw the documentary *The Corporation*, you know that the Corporation was diagnosed as what we call a sociopathic personality. One aspect of this pathology that this film failed to mention is the devastation of the environment that most corporations - not all - are up to.

The ironic thing is that some very conservative Christian church organizations are becoming green. They are coming out for stewardship of nature, they are not coming from the same place where I am coming from in terms of my theology, but at least they are ending up in the same place. So there are some hopeful signs and I see this as being a transpersonal vision. But I have to say that with the exception of indigenous people like the Native Americans, the major religions in the world have dropped the ball on ecopsychology - both Eastern and Western. Now it is time to pick up that ball and get rolling with it before it is too late. [Indeed] any of us that have been reading or seeing documentaries on this topic know the critical situation that the world is in. And I think, Jim, that if psychology - instead of aligning itself with the physical sciences, had aligned itself with philosophy, we would not be in the mess we are in now. Because from a philosophical point of view we would have realized some of the issues that psychology, from a hard science point of view, has ignored until now.

Fadiman: William James who created psychology, eventually - and is best known - for ending up in philosophy, where he could deal with more problems seriously. To the extent that we honor, venerate, and celebrate him, we would probably do well to read him. Both because it will embarrass us how well he writes, and because the issues he raises are the issues that we are raising. Some of which will be commented on by me later in my presentation this afternoon.

Vich: I wanted to add something on the ecopsychology issue, it is not something that I have done much development in, but two things. One is the film *An Inconvenient Truth* by Al Gore, which I gather a lot of people have seen - how many of you have seen it? A lot of you it seems. This is really quite a cold shower for anybody that for the first time has encountered the concerns of how precarious our current situation is relative to the issue of global warming.

At the end of the film, Gore is on this elevated ladder, plotting one of those fatal curves that goes right though the roof. He comes down and turns back to the audience and says some people when they see this - and what I've been saying - fall into despair. Gore says, I understand this. But we do not need to. Then he goes on to show these slivers of adjustment and it is like a fan, 10% if we do this, 15% if we do this, and gradually bringing that curve down. What I noticed is these slivers of adjustment are all do-ables, probably within a generation. These are things that we have all heard about, like car mileage, and power plant emissions, et cetera, and the curve starts to decline once we begin addressing these problems. These are not huge turn-arounds that can evoke cultural and economic disaster; instead these are adjustments that can be made. So the message Gore is giving us is that we have the capacity and the power to solve the problem that we have created. But you have to think large and you have to think responsible and you have to make all of these connections we have been making.

The second point goes back to the organizational question. A couple of years before I retired as editor of *JTP* at the end of 1999, I was very impressed by the British group and the British Psychological Society taking on the transpersonal issue. Especially two of its principle authors, David Fontana and Ingrid Slack (1996), who led the appeal to the British Psychological Society (our equivalent of the APA) for a division of transpersonal interest. And they got the votes 1,623 to 899 in favor, so the British Psychological Society has what they call a section of transpersonal psychology. How did they do this? What makes their situation so different? They had a list of rational arguments that were well delivered with their typical British understatement, and beautifully articulated, but the key thing I saw there that really made me feel that this was the way to do it, was they said, and I'm paraphrasing, what we are concerned with in transpersonal psychology is those very things that have created, affected, and sometimes destroyed, and sometimes improved civilizations all through time. The arts, the literature, these have all had to deal with transpersonal issues. It has affected our lives individually and personally, and in groups and collectives and entire nations and cultures. Shouldn't we know something about it?

Fadiman: (chuckling) That's just wonderful.

Krippner: Yes, that's just great. People in this group certainly know the difference between religion and spirituality; this is an important distinction, more important as the years go on, especially on this ecology issue. You're probably familiar with the United Nations quality of life scale, and when this is applied to the nations of the world, the top 10 nations that have the best quality of life, that includes the environmental aspects of culture, the top 10 nations are the nations with the highest percentage of atheists. Now we are not talking about here of forced atheism, like North Korea. We are talking about voluntary atheism. Sweden, Norway, Denmark, the Netherlands, all the usual suspects, they have the highest quality of life and the highest percentage of atheists.

What about the countries with the minimal numbers of atheists, and the lowest quality of life, and the most devastating environmental conditions, who are these? Take the top 25 countries that have the highest quality of life. Only two countries have a minority of atheists, Ireland and the USA; again this is the top 25, not the top 10. In January I was the token transpersonalist at a major conference of self-professed skeptics in Las Vegas, Nevada, organized by the Amazing Randi. It was called the Amazing Randi's Amazing conference. It was a three-day affair, and they did a poll, 85% of the people in the audience raised their hand that they were atheists. It was a fascinating conference, with Nobel Prize winners and 800 people in attendance, the largest collection of skeptics under one roof. The one theme that came up time and time again was the environment. I have not heard so much discussion of environmental issues in a transpersonal meeting, in a spiritual meeting, in a religious meeting; these folks are really on to something. They really care about the environment.

It is therefore time for transpersonal psychology, and transpersonal studies in general, to reassess and reclaim its history regarding ecopsychology so it can step forward and fill this void. I have to say that the psychedelic movement caught on to this long ago. I remember back in the 1960s, when people began doing informal work with psychedelics. One theme that came up time and time again was we are destroying the environment, and that taking psychedelics increased not only our appreciation of nature, but all forms of life. I think too the psychedelic movement has been given short shrift by historians in a number of other ways, because it also helped stimulate interest in the Peace Movement, the Civil Rights movement, et cetera.[12] Of course the psychological experimentation had its dark side - and Jim and I are very aware of the casualties of the dark side - it did have a bright side in terms of the environmental movement. We can make the case that a lot of the environmental movement's roots are in the psychedelic work that was being done informally back in those days.

Schroll: This picks up on both of these points that have been made. Miles mentioned Gore's film, saying that all of the adjustments Gore suggests are do-ables; this brings me back to what Stan was just saying about Positive Psychology being a growing movement. We need positive motivational messages in ecopsychology to have people want to become part of it. The messages from mainstream environmentalism are all negative and I have summed them up as follows.

1. The first can be referred to as *the fear approach or the rhetoric of catastrophe*.
2. The second as *the guilt approach or the rhetoric of shame*. And
3. The third as *the self-sacrificing/voluntary simplicity approach* or *the rhetoric of redemption*.

The rhetoric of catastrophe represents prophecys of doom, such as global warming, ozone depletion, deforestation, loss of species, et cetera. *The rhetoric of shame* says that the industrial nations of the world are consuming the majority of the earth's fossil fuels: coal, natural gas, and petroleum. *The rhetoric of redemption* tells us to drive less, slow down when we do drive and car pool; to turn our thermostat down, reduce human population growth, recycle, et cetera. All of these are negative in terms of their motivational message. We therefore need to re-examine motivational psychology, because we need to develop a positive motivational imagery and language to empower people to want to become part of this movement.

Fadiman: There is a curious unattractive parallel, which is it is very hard to train people to kill other people. We are really hard wired not to kill other people, yet we've managed to do a pretty amazing job of doing this. Perhaps if we looked at what could make it easier for people to become environmentally sensitive, which is a far more natural state, we might create this positive motivational imagery and language that you just mentioned, Mark. This is really what Stan is saying. I love the idea that environmental degradation should be listed as a DSM classification - it is like these horror movies where you keep getting a larger number and things are getting worse - people that trash the environment have a pathology. Imagine if the pharmacology industry got interested. I took EarthPill and I went around and all I could do was plant flowers. I feel so much better. I'm going to talk to my big farm Mafia friends. What is our time?

Final Comments and Questions

Schroll: We have five minutes left. I know all of you have dozens of questions, but we only have time for a couple. But first I want to say this is a continuing conversation. We do not want it to end today. We want this to continue to grow, not only in your own work, but also in creating future forums like this.

Audience question: I'm familiar with all of the psychedelics that were around in the 1960s and 1970s, but I've been out of that group for about 30-years now, would someone please tell me what ayahuasca is like? It must be pretty good if people are willing to risk all of the vomiting.

Krippner: It is very strong, and I do not advise that people take it outside of a church setting. If you are interested, seek out one of the Brazilian churches, and there are some operating in the USA and Western Europe. But it is very powerful. I have learned a lot from it. I am one of the very few people that have not thrown up. This does not mean that I will not vomit the next time, but maybe I am hopeless. If you vomit this means you cleanse yourself of all your impurities. Maybe I'm too far gone to get rid of them all. But do not let this phase you, because once you vomit, I'm told that you feel beatific for the rest of the experience. Again, I cannot recommend it because it is so powerful, but if this is your personal choice and if you are invited to a church session, then you might consider it. But be prepared as to what you want to learn from it. Ask yourself, what do I want to get from this experience, which will help you operate within a framework. And be prepared to follow the rituals of the church, because they are for your own benefit very stringent, very regimented, and do not allow much of a chance for you to go off and do your own thing. You have to stay within the structure of the church.

Fadiman: This is what we used to call the three variables, drug, set, and setting.

Krippner: Yes.

Fadiman: And in this case they are welded together, as Stan said, so keep this in mind.

Mojeiko: I think too that while it might be helpful for a person doing a particular therapy to keep drug taking a secret, in general it is not a good idea. For the average person that has taken psychedelics, it is not a really big risk to say that you have done them. And it is not going to become more acceptable unless people stand up and speak out about it, so I think that maybe this is what we still need to deal with and come to terms with as we try to integrate psychedelic experience with the rest of psychology. It is therefore worth the minute risk of coming out as someone that has used a psychedelic.

Fadiman: You see we are a lot less special than people would like to think. Remember when Stan Grof asked people this morning, how many of you have had an incredible experience, and almost everyone raised their hand; and that when Grof goes and talks to regular audiences it is also a pretty high percentage. I put out a novel a few years ago titled *The Other Side of Haight*, and everywhere I went no matter who I was talking to, I brought up the fact that I'd written this novel and that they could buy it. I would ask the damnest people to comment on what they thought about psychedelics; such as I'm sitting on a plane and there is this person that looks like he is a CIA operative and I say, I've written this novel have you ever used psychedelics? You'd be surprised how many people will say, Oh yeah in college once. I did mushrooms. Then I'd find out that they were a CIA agent or someone that worked for a pharmaceutical company that I did not like very much, and that they did not like about themselves after we had finished talking. But what I found out is that sharing something that works for you is really not a bad thing to do in almost any sub-culture, and you will be surprised at how many people respond favorably. And yes to answer your question, set and setting is a lot harder when the thing you are doing is illegal. As the early Christians used to say, I hate meeting in the slimy sewers of Rome, but this is the only place we can rent to meet. And it is important that we keep meeting, so we do what we can.

Schroll: On that note, this is a good place to end because that's right Jim. What you and Valerie just mentioned is the idea of *self-disclosure* and this is what Sidney Jourard was talking about in the earliest days of this movement, thereby linking our discussion right back to the very beginnings of humanistic and transpersonal psychology (Jourard, 1971, 1972).

Notes

1. The reference to "transpersonal science" in the title is not specifically discussed in this paper because it refers to a process of inquiry, and not a reified object of investigation. Indeed this entire conversation forum serves as one means of representing an orientation toward knowing that embodies the meaning of transpersonal science. Carl Rogers (1989) sought to articulate this means of inquiry as the need for a more human science, saying that:

   > "It appears that if I wish to become a scientist, the first step is to immerse myself in the phenomena of the particular field in which I have developed an interest. The more complete the immersion, the longer it lasts, the more I love and prize the whole field, the more open I am to all the subtleties of my experiencing, [and] the more likely I am to discover new knowledge. This means a tolerance for ambiguity and contradiction, a resistance to the need for closure, the valuing of unbridled curiosity. It means soaking up experience like a sponge, so that it is taken in in all its complexity, with my total organism freely participating in the experiencing of the phenomena; not simply my conscious mind" (Rogers, 1989, p. 269).

   Contemplating and building on the wisdom of Rogers, those of us seeking a new spirit of science beyond the restrictive borders that the modern mind is willing to explore have extended this inquiry into the farther reaches of human nature. Deciding it is time to move away from the worldview that has kept the field of psychology in a polemical dither for well over a century; a worldview that perceives any state of consciousness, which is not within the normal range of consciousness as abnormal. To accomplish this task the Association for Transpersonal Psychology (ATP) has made a unique demand, that transpersonal psychologists become practitioners of psychological, contemplative, or energy disciplines which provide direct experiential access to transpersonal states of consciousness. I have continued to elaborate on this perspective of transpersonal science as a means of inquiry in (Schroll, in press).
2. Prior to this forum during lunch, I spoke with Sharon G. Mijares about a group of therapists at The Union Institute that sought to create an alternative licensing board; she asked me if I knew anything about this. I did not, pointing out even though I was a Union Institute graduate, I had not chosen to be a clinical psychologist. Following this forum a woman introduced herself as Colette Fleur. She handed me a piece of paper that contained detailed information "for an update on the group that came out of The Union Institute to propose another accreditation process and [review] body." This group is called the Council of Humanistic and Transpersonal Psychology. Its goal is to provide organization for organizations: humanistic, transpersonal, existential, phenomenological, ecopsychological, somatic, and so forth. Contact information: http://www.chtpsy.org
3. It is not just APA controlling more and more state legislatures' licensing rules, it is also "the managed care revolution." Victoria Kuhl (1994) argued, "the circumstances that have combined to create the managed care juggernaut may render the practice of humanistic treatment approaches untenable" (p. 63).
4. On the drive from Saybrook Graduate School in San Francisco to the conference at Unity Church in Palo Alto, I spoke with Daniel Deslauriers about the process of getting the clinical psychology program at California Institute of Integral Studies (CIIS) accredited by the APA. Daniel said what is happening at

CIIS is that, on the one hand, APA accreditation is developing quite successfully; yet on the other hand, students and faculty in the clinical program are becoming isolated from the rest of the school. This is because the philosophical differences between models of clinical practice deemed acceptable to the APA do not reflect the humanistic and transpersonal views of what a healthy personality is. The frontier of clinical psychology is to continue working for APA accreditation, while at the same time develop a conceptual framework and language that is able to include humanistic and transpersonal concerns.

5. For those of us unfamiliar with the term *ayahuasca*, it is a vision-producing tea that has been used for centuries by indigenous Amazonian Indians as a sacrament. Several syncretic religious movements in Brazil that combine aspects of "Catholicism, esoteric European traditions, and Afro-Brazilian and Amazonian religion" are currently using ayahuasca as their sacrament (Horgan, 2003, p. 148). But it cannot be stressed enough that *ayahuasca is not a recreational drug*. It should never be ingested "carelessly, or without a full understanding of how it works in the body" warned botanist Jim DeKorne (p. 196). A thoroughly researched examination of ayahuasca - its scientific investigation and many personal experiential accounts - is the edited book by Ralph Metzner (1999a), *Ayahuasca: Human Consciousness and the Spirits of Nature.*
6. Richard Boire has pointed out that "The UDV [Uniao Do Vegetal church] decision is important, but also narrow. It allows hoasca (ayahuasca) [use] within the UDV, but not necessarily beyond those confines. The Gonzales vs O Centro Espirita Beneficente Uniao do Vegetal (2006), 546, U.S.____; 126 S. Ct. 1211; 163 L. Ed. 2d 1017; 2006 U.S. LEXIS 1815 is part of the current case citation; because it's so current it has not received a page number yet" (private communication, December 14, 2006).
7. In 2001 a special issue on positive psychology was published in the *Journal of Humanistic Psychology*, 41 (1), spearheaded by guest editor Grant Jewell Rich. It seems all of us that wish to make this world a better place are indeed positive psychologists, as Rich makes clear in his introduction:

> [Two past] ... APA Presidents Maslow and Rogers were both humanistic psychologists whose work focused on "positive" aspects of human nature. Even a behaviorist such as B. F. Skinner was fascinated by what "could be."... If the "good life" is to be studied and perhaps prescribed, then who will define it? A hundred or so academic psychologists and therapists? I hope the movement is much more inclusive. One must never forget the numerous mistakes made by small groups of well-meaning psychologists in the past: the lobotomies that promised cures but brought only numbed minds, the phrenologists quick to make a criminal out of a person with a head bump in the wrong spot, or the IQ theorists who used their weak data and lofty positions to enforce racist eugenics programs. Positive psychology is an exciting movement, but it is one that must be tempered with cautious optimism and a healthy dose of diversity. Although Tolstoy wrote a brilliant novel with the opening statement that "all happy families are alike," I have serious reservations about a positive psychology that offers a single prescription for the "good life." (Rich, 2001, pp. 11-12)

8. See Vich, 1988, p. 109.
9. See Schroll, 2005b, 2005c.
10. The observations of Jeanne Achterberg (1990, 1991), who has traced medicine's evolution from pre-history to the present, echo those of Fadiman.
11. See Greenway, 1994, 1999; Metzner, 1993; Schroll, 2007, 2009a, 2009b, 2009/2010.
12. Metzner (1999b, pp. 169-170) echoed the view that psychedelics act as a catalyst that assist us in breaking free of the habits of cognition (Schroll, 2005b; see also Metzner, 2008, p. 42; Schroll & Rothenberg, 2009).

About the Authors

Mark A. Schroll, PhD, serves as Editor for The Rhine On-Line: Institute for Consciousness Studies Newsletter, www.rhine.org; he is on the Windbridge Institute Scientific Advisory Board, the Editorial Board Journal of *Ecopsychology*, the Advisory Board Alternative Therapies in Health and Medicine, and he is the 2009 Co-Chair for Bridging Nature and Human Nature, the annual Society for the Anthropology of Consciousness conference co-sponsored by the Association for Transpersonal Psychology. In addition, he is Guest Managing Editor of the special Anthropology of Consciousness issue, Bridging Nature and Human

Nature: Envisioning Transpersonal Ecosophy, which is due out spring 2011. Schroll is a transpersonal cultural theorist and conference organizer with multi-disciplinary interests ranging from philosophy of science to ecopsychology.

Stanley Krippner, PhD, is Alan Watt's professor of psychology at Saybrook Graduate School, San Francisco, is a Fellow of four APA divisions, and past-president of two divisions (30 and 32). Formerly director of Maimonides Medical Center Dream Research Laboratory, Brooklyn, NY. He is co-author of Extraordinary Dreams (SUNY, 2002), The Mythic Path, 3rd ed. (Energy Psychology Press, 2006), and Haunted by Combat: Understanding PTSD in War Veterans (Greenwood, 2007), and co-editor of Healing Tales (Puente, 2007), Healing Stories (Puente, 2007), The Psychological Impact of War on Civilians: An International Perspective (Greenwood, 2003), Varieties of Anomalous Experience: Examining the Scientific Evidence (APA, 2000), and many other books.

Miles A. Vich, MA, D.H.L., (hon). Has served in various roles, 1962-1999, in the fields of humanistic and transpersonal psychology, including staff positions with The Journal of Humanistic Psychology, and editor of JHP (1968-1970). He is founding Board member of the Transpersonal Institute, The Journal of Transpersonal Psychology, and the Association for Transpersonal Psychology. He served as Executive Director of ATP for many years and as editor of JTP from 1975-1999. Since retiring in 2000 he has consulted on various projects, pursued a longstanding interest in art, and archived many transpersonal documents in the library at the Institute of Transpersonal Psychology, Palo Alto, and many humanistic era documents in the University of California Santa Barbara Davidson Library.

James Fadiman, PhD, received his doctoral degree from Stanford University doing psychedelic research (with and without government support). As a Harvard undergraduate he worked with Ram Dass (Richard Alpert) and Timothy Leary. He is a cofounder of The Institute of Transpersonal Psychology, where he still teaches, and was the director of the Institute of Noetic Sciences. His books include Unlimit Your Life, Essential Sufism, Personality and Personal Growth, 5th ed, and The Other Side of Haight.

Valerie Mojeiko, BA, Program Director and Clinical Research Associate, has worked with MAPS - the Multidisciplinary Association for Psychedelic Studies since 2000, facilitating research of the healing potentials of MDMA (Ecstasy), LSD, Ibogaine and other psychedelic medicines. In her work leading MAPS' psychedelic harm-reduction project, Valerie has prepared over 2000 volunteers to provide peer-based psychedelic emergency services from Burning Man to Tel Aviv. Formerly educated at New College of Florida and the California Institute of Integral Studies (CIIS).

References

1. Achterberg, J. (1990). *Woman as healer*. Boston, MA: Shambhala.
2. Achterberg, J. (1993, August 27). The future of the transpersonal healer. Keynote at the 25th Anniversary Convocation of the Association for Transpersonal Psychology, August 25-29, Asilomar Conference Center, Pacific Grove, CA. On CD and DVD from http://www.conferencerecording.com. (800) 647-1110.
3. Denniston, L. (2002). Herbal tea case: A government loss? Electronic document. http://www.scotusblog.com/movabletype/archives/2005/11/herbal_tea_ case.html.
4. Fontana, D. & Slack, I. (1996). The need for transpersonal psychology. *Newsletter of the Association for Transpersonal Psychology, Fall*, 3-7.
5. Greenway, R. (1994, May 24). Untitled comments during the Symposium: Deep Ecology and Ecopsychology. Organized and moderated by R. Metzner, with comments by D. Abrams, M. Gomes, E. McCarthy, A. Naess, B. Taylor, W. Sarkissian, and others. Presented at the 13th International Transpersonal Psychology conference "Toward Earth Community: Ecology, Native Wisdom and Spirituality," Great Southern Hotel, Killarney, Ireland. On CD from http://www.conferencerecording.com. (800) 647-1110.
6. Greenway, R. (1999). Ecopsychology: A personal history. *Gatherings*, 1, Winter.
7. Horgan, J. (2003). *Rational mysticism*: *Dispatches from the border between science and spirituality*. Boston, MA: Houghton Mifflin Company.
8. Jourard, S. (1971). *The transparent self*. (rev. ed.). New York, NY: Van Nostrand Reinhold Company.
9. Jourard, S. (1972). A humanistic revolution in psychology. In J. F. Glass & J. R. Staude (Eds.), *Humanistic society*: *Today's challenge to sociology* (pp. 15-19). Pacific Palisades, CA: Goodyear Publishing.
10. Krippner, S. (2002). Conflicting perspectives on shamans and shamanism: Points and counterpoints. *American Psychologist*, *57* (11), 962-977.
11. Kuhl, V. (1994). The managed care revolution: Implications for humanistic psychology. *Journal of Humanistic Psychology*, *34* (2), 62-81.
12. Metzner, R. (1993, August 28). Ecology and transpersonal psychology. A two-hour conversation forum with B. Keepin, T.

Roszak, I. Serlin, R. Walsh, moderated by R. Metzner, at the 25th Anniversary Convocation of the Association for Transpersonal Psychology conference, August 25-29, Asilomar Conference Center, Pacific Grove, CA. On CD from http://www.conferencerecording.com. (800) 647-1110.

13. Metzner, R. (Ed.). (1999a). *Ayahuasca*: *Human consciousness and the spirits of nature*. New York, NY: Thunder's Mouth Press.
14. Metzner, R. (1999b). *Green psychology*: *Transforming our relationship to the earth*. Rochester, VT: Inner Traditions Press.
15. Metzner, R. (2008). *The expansion of consciousness*. Vol 1. Berkeley, CA: Regent Press.
16. Narby, J. & Huxley, F. (2001). *Shamans through time*: *500 years on the path to knowledge*. New York, NY: J. P. Tarcher/Putnam.
17. Rich, G. J. (2001). Positive psychology: An introduction. *Journal of Humanistic Psychology*, *41* (1), 8-12.
18. Rogers, C. R. (1989). Some thoughts regarding the current presuppositions of the behavioral sciences. In H.
19. Kirschenbaum & V. L. Henderson (Eds.), *The Carl Rogers reader* (pp. 263-278). Boston, MA: Houghton Mifflin.
20. Roszak, T. (1992). *The voice of the earth*. New York, NY: Simon & Schuster.
21. Schroll, M. A. (2005a). Reflections on Albert Hofmann's epistemology of consciousness. Retrieved fromz; http://www.maps.org/avarchive/hofmann_birthday_essay. pdf
22. Schroll, M. A. (2005b). Toward a physical theory of the source of religion. *Anthropology of Consciousness*, *16* (1), 56-69.
23. Schroll, M. A. (2005c). We are all actors and directors in a giant cosmic drama. In R. Metzner (Ed), *Sacred mushrooms of visions: Teonanacatl: A sourcebook on the philocybin mushroom* (pp. 272-275). Rochester, VT: Park Street Press.
24. Schroll, M. A. (2007). Wrestling with Arne Naess and the origins of ecopsychology. *The Trumpeter*: *Journal of Ecosophy*. *The Trumpeter*, *23* (1), 28-57. Retrieved from http://trumpeter.athabascau.ca/index.php/trumpet/ article/view/940/1353
25. Schroll, M. A. (2008/2009). Ecopsychology's roots in humanistic and transpersonal psychology. Electronic document. *Association for Humanistic Psychology-Perspective*, *Dec/Jan*, 16-17. Retrieved from http://www.ahpweb.org/pub/perspective/dec2008/perspec_dec.pdf
26. Schroll, M. A. (2009). New science, new culture manifesto: Transpersonal ecosophy's vision of what it means to be human. Electronic document. *Association for Humanistic Psychology-Perspective*, *June/July 2009*, 8-10. Schroll, M. A. (2009/2010). Merging transpersonal ecosophy with Division 32 (Society for humanistic psychology of the American Psychological Association). *Association for Humanistic Psychology-Perspective*, *Dec/Jan*. Electronic document.
27. Schroll, M. A. (in press). Toward a new kind of science and its methods of inquiry. *Anthropology of Consciousness*, *21*(1).
28. Schroll, M. A. & Rothenberg, D. (2009). Psychedelics and the deep ecology movement: A conversation with Arne Naess. *Multidisciplinary Association for Psychedelic Studies Bulletin*, *19*(1), 41-43. Retrieved from http://www.maps.org/news-letters/v19n1
29. Vich, M. (1988). Some historical sources of the term "transpersonal." *Journal of Transpersonal Psychology*, *20* (2), 107-110.

Shamanism and psychedelics: A biogenetic structuralist paradigm of ecopsychology

by

Michael Winkelman

Arizona State University, USA

original text: https://pdfs.semanticscholar.org/8f69/0213afbbcf3a0ef3d1c62ce2cbd75aa102ad.pdf
backup source: http://www.psilosophy.info/resources/0213afbbcf3a0ef3d1c62ce2cbd75aa102ad.pdf

Table of Contents:

Abstract
Introduction
Shamanic universals and their evolutionary origins
Shamans and shamanistic healers
The ritual antecedents of shamanism
Psychedelics and shamanic ecopsychology: drugs and human evolution
Psychedelics and shamanic phenomenology
Psychointegrators as a neurophenomenological paradigm
Serotonin as a modulator
Psychointegration as the general dynamic of alterations of consciousness
Nature and animal relations in shamanism: The origins of ecopsychology
Imitation of animals in shamanism: Hunting and human evolution
Animism as ecopsychological identification
Nature as self: Animal powers and guardian spirits
Totemism: Nature relations and group identity
Conclusions
References

Abstract

Shamanism and psychedelics are central to understanding the evolutionary roots of ecopsychology and its basic principles. The ancient ritual roots of shamanism constituted the context within which psychedelic experiences contributed selective influences to the evolution of human neuropsychology. Both shamanic psychology and ecopsychology involve a neuroepistemology that reflects the neurotransmitter effects of psychedelics on cognition. Shamanism contributed to the development of our ecopsychology through influences on psychological, social and cognitive evolution. Shamanism embodies the concept of animism, the notion of the spiritual essence of all nature which is recognized as the core of the oldest of humanity's religious beliefs. Shamanism provided the context within which this animistic attitude and the sense of the sentience of the many entities of the world were developed, especially in the relationship to animals. Animal species and their variant qualities provided a natural metaphoric system to structure psychological development and the evolution of social organization. Within the context of shamanism, the worlds of animal species and spirits intertwined in the creation of symbolic potentials for the differentiation of self - embodied in animal spirit powers - and the collective identity of society - embodied in totemic animals. This incorporation of the elements of nature into personal powers and social identity made shamanic ecopsychology a basic feature of human nature and culture.

Keywords: shaman, ecopsychology, animism, psychedelic, evolution, totemism

Introduction

The natural or evolved psychology of human consciousness, including its natural and social ecopsychology - is founded on principles intrinsic to shamanism. Shamanic ideology, psychology and manifestations of consciousness are based in biological structuring of humanity's evolved psychology and its consciousness of nature. Key biological contributions to both shamanic psychology and ecopsychology are the effects of substances called psychedelics, hallucinogens, entheogens, and other terms, including psychointegrators (Winkelman, 2007). These substances have key effects on the world view and principles of shamanic consciousness and ecopsychology because their effects on neural transmission produce a neuroepistemology and worldview that reflects neurophenomenological principles related to integration, connection, identity and unity with nature.

The ancient ritual capacities of the hominids, the common ancestors of humans and the great apes, share commonalities that provide a baseline from which we can infer and assess the evolution of the ritual practices of hominins (our uniquely human lineage) (Winkelman, 2009, 2010c). These commonalities reveal the ancient ritual roots of shamanism and the social context within which psychedelic experiences contributed selective influences to the evolution of human ecopsychology. Evidence for their influences on human evolution is found in the greater sensitivity of psychedelics for bonding with the human serotonergic system than is the case of other hominids (Pregenzer *et al*, 2007). This indicates that advantages conferred by the ability to benefit from these experiences were selective forces shaping the evolution of uniquely human cognitive capacities. The effects exerted by psychedelics on cognitive evolution are reflected in the common world view found in psychedelic traditions worldwide and their similarities to the basic ideologies of shamanism - such as the roles of plant and animal spirit powers and their healing potentials.

Shamanic ritual was a context for the development of our ecopsychology because of the fundamental contribution of shamanic neuropsychology to human relations with nature in general and human psychological, social and cognitive evolution in particular (Winkelman 2002, 2010a). Shamanism embodies the concept of animism, the notion of the spiritual essence of all nature which is recognized as the core of the oldest of humanity's religious beliefs. This ancient animistic awareness of some sentience and purpose of nature was developed in the context of a more ancient ritual core revealed in the direct similarities of shamanism with rituals of the great apes. Shamanic ritual practice, experiences and ideology were the foundations from which humanity's ancestors and early societies developed their understandings of nature and its relationship to self and other.

Shamanism provided the context within which this general expression of an animistic attitude, the sense of the sentience of the natural world, underwent a special development in relationship to animals. Animal species and their variant qualities were the natural tapestry within which human psychological development occurred and contributed to the emergence of more complex social evolution. Animal features and relations were the framework used to conceptualize our individual qualities and potentials and the collective identities that produce society. Within the context of shamanism, the world of real animal species was used as symbolic tools for the differentiation of self - embodied in animal spirit powers - and the formation of collective identities of society - embodied in totemic animals. These practices were cognitive adaptations that extended human cognitive capacities through metaphoric modeling, an extension of innate capacities for representing significant variations in nature to produce the symbolic. In this sense, a shamanic biopsychology was involved in the origins of the symbolic, producing a differentiation of human individual identities and human social collectivities which constituted the social other, the most basic reference for consciousness.

These arguments are supported in the following sections of this article which demonstrate:

- The basic nature of shamanism found in pre-modern foraging societies worldwide;
- Evidence for the antiquity of shamanism as a psychological, social and ecological adaptation derived from hominid ritual capacities;
- The role of psychedelics in human evolution and in stimulation of our ancient "animal brains";
- The rationale for a necessary relationship of shamanism to psychedelics and ecopsychology in the homologies of shamanic ideology and practices with the effects reported for psychedelics;
- A neurophenomenological model of psychedelics as producing the psychointegration that exemplifies

ecopsychological assumptions; and
- The roles of nature relations in the fundamental principles of shamanism, exemplified in animal spirit powers and totemism.

Shamanic universals and their evolutionary origins

The existence of remarkably similar spiritual healing practices world-wide was noted long before the modern comparative research of Eliade (1964) who popularized the notion of the shaman. There was a widespread recognition in comparative religion and deep in human history and prehistory of shamanism as a common spiritual heritage of humanity found in pre-modern societies worldwide. These intuitions about strikingly similar spiritual healers was supported by cross-cultural research (Winkelman, 1986, 1990, 1992) which empirically established the cross-cultural presence of shamanism in the pre-modern world by showing these common patterns of behavior and belief were virtually universal in foraging societies.

These features associated with shamanism in pre-modern societies worldwide include:

- The shaman as the preeminent social, political and spiritual leader and healer of the group.
- The shaman's nighttime charismatic performance with all of the community in attendance.
- Alterations of consciousness produced though physical austerities, fasting and sexual abstinence and ritual activities involving prolonged dancing, chanting and singing, extensive drumming, and frequently psychedelics.
- A period of physical collapse while experiencing an alteration of consciousness conceptualized as magical flight, soul flight, or in modern terms as astral projection.
- Activities of healing and of protecting from spirits and malevolent shamans focused on the recovery of lost souls, extraction of sorcery-causing objects and removal of the negative influences of spirits.
- Selection of the neophyte shaman involving premonitory illness and dreams.
- Shamanic training though a vision quest that involved prolonged periods of solitude in the wilderness.
- A formative initiatory experience involving the experience of death by animals and rebirth in which the animals reconstructed a new person, incorporating themselves into the shaman.
- Special relations with animals, including power relations with animal spirits, the ability to control animals and to transform into an animal.
- The belief the shaman can harm and kill magically.
- Special abilities, including the reputed ability to control weather, to physically fly, and to have immunity to fire.

Shamans and shamanistic healers

Two different concepts of shamanism were offered by Eliade, contributing to confusion regarding just what ought to be considered a shaman. The most general characterizations of the shaman were someone who entered into ecstatic states in order to interact with the spirits on behalf of the community. This conceptualization is true of shamans, but insufficiently specific because such practices constitute a cultural universal - all societies have practices involving the alteration of consciousness to engage spirits in rituals for healing and divination (Winkelman, 1992). In order to distinguish this broader group of spiritual healers from the shamans of hunter-gatherer societies, the term *shamanistic healers* was proposed (Winkelman, 1990, 1992) to refer those healers which share features with shamans, but which are distinguished from shamans, who have the additional features specified above. Eliade included many of these additional features of shamans, such as death and rebirth experiences, soul travel and animal familiars.

The worldwide distribution of shamanic healers in the pre-modern world establishes that shamanism is based in an innate biopsychology, a neurological foundation for an ancient natural religion. This ethnological analogy provides a shamanic paradigm, a biogenetic structuralist framework that helps to identify evidence of the central presence of shamanic activities at the origins of the Homo genus (Winkelman, 2010b) and at the dawn of culturally modern humans during the Upper/Middle Paleolithic revolution more than 40,000 years ago (Clottes & Lewis-Williams, 1998; Whitley, 2009; Winkelman, 2002).

Shamanism provided ritual technologies for integrating a variety of capacities - biological, social, and cognitive

- that contributed to human evolution, adaptation, and survival. These features included the differentiation of personal identity, the integration of social identities, the enhancement of extrapersonal cognition and production of symbolic thought (Winkelman, 2009, 2010a). Shamanism arguably constitute the most ancient of all human neurotheologies (Winkelman, 2004a), a biological structuring of perception, cognition and action that involved intimate relations with nature for understanding the qualities of humans. The origins of the underlying principles of shamanic psychology as well as ecopsychology are derived from basic aspects of the human mind and ancient adaptations to nature. Shamanism is indispensable to ecopsychology because shamanic practices and world view provided the context for the evolution of modern humans and human consciousness (Winkelman, 2010a). A wide range of shamanic features involve fundamental ecopsychological relations, such as perceptions of the sentience of nature, isolation in nature as part of shamanic development, and the roles of animals in the formation of self-concept and society. Shamanism contributed to cognitive, social and psychological evolution through symbolic exploitation of innate aspect of relations with nature. Elements of nature provided a natural metaphoric system for the extension of meaning in developing understandings of our individual qualities and the collectivities that produce society. These symbolic referents are typified in animals which express aspects of shamanic power and in tribal totems where animal species and their relations provide a conceptual system for social organization.

Nonetheless the concept of shamanism remains contentious for some, with the view that it is merely a modern creation or myth often used to discount any need for serious investigation. Empirical studies (Winkelman, 1990, 1992), however, show that there is a cross-cultural phenomenon that closely corresponds to the classic notions regarding shamanism. These cross-cultural similarities in shamanic practices provide the basis for establishing an ethnological analogy (Winkelman, 2010a & b), a shamanic paradigm derived from the empirical features associated with shamanism worldwide. These features provide a basis for inferring evidence of shamanic practices in the deep past and establishing a central role of shamanic ritual in human cognitive evolution. The inference of shamanism in the past is as reliable as inferring the presence of families, foraging lifestyles and other features of hunter-gatherers derived from analogies based on near-modern groups.

Furthermore, the basic dynamics of shamanism revealed by this cross-cultural research shares substantial similarities with the rituals of our closest extant primate cousins, the chimpanzees, pointing to a deep biological basis for shamanic rituals. Homologies of chimpanzee rituals with shamanism include features such as: the most significant community ritual, community-wide participation, night-time activities, performance by alpha male, use of drumming, presence of bipedal displays ("dance"), community integration activities, etc. (Winkelman, 2009, 2010a, 2010c). These similarities further substantiate the inference of shamanism in the human past and provide a bridge for inference regarding the nature of ritual activities over the course of human evolution.

The ritual antecedents of shamanism

The ritual capacities that Davis (1998) proposes as basic to ecopsychology have their foundations in ancient evolutionary adaptations that gave rise to shamanism. Shamanism must be considered to have a central role in humanity's ritual origins because of the evidence for the universality of shamanism in hunter-gatherer societies worldwide. This universality implies shamanism's intrinsic relation to humanity's ritual origins. Shamanic ritual and world views not only provided the most significant spiritual traditions of the foragers of the pre-modern world but also a bridge from pre-modern hominid ancestors to the ancient modern humans as well.

Animal displays, often called rituals, point to a deeply embedded ancient phylogenetic system of social communication which provided the biogenetic structural foundations of shamanic ritual (Winkelman, 2010a: Chapter 6). The biological bases and adaptive functions of shamanic rituals are illustrated by the nature of animal ritual (e.g., see Winkelman & Baker, 2008), and their homologies with human behaviors. Ritual provides the most evolved mechanisms for communication and social coordination in the animal world (d'Aquili, Laughlin & McManus, 1979; Laughlin & d'Aquili, 1974). Animal rituals use behaviors, particularly the initial steps of behavioral sequences, to signal a disposition for social behaviors, providing social communication that functions to facilitate interactions and coordination among members of a group. (For example a bird might raise its wings in response to perception of a threat, signaling a readiness to fly). Ritual behaviors make internal dispositions publicly available, providing information that helps produce socially coordinated responses.

Converging evidence indicates that shamanic rituals have deep evolutionary origins that predate the evolution of modern humans (*Homo sapiens*). The similarities in hominid rituals, revealed in the commonalities across great apes, and the homologies of these with basic aspects of shamanic rituals, attest to the latter's ancient roots in behaviors shared more widely with primates (Winkelman, 2009; 2010a: Chapter 6). The commonalities involve: the most dramatic of rituals, an inclusive community ritual dominated by aggressive alpha male displays; a focus on night-time activities; the use of drumming, including use of hands and sticks; emotional vocalizations; and bipedal displays, or "dancing". The similarities of shamanic rituals with the rituals of community integration used by the great apes illustrate the *a priori* role of shamanism in the evolution of human ecopsychology. These ancient hominid roots of shamanism were the ritual context within which psychedelic and animistic experiences were interpreted. Subsequently, the evolution of capacities for dancing, rhythm and enactment, which derive from a common mimetic core, provided the foundations for uniquely human culture (Donald, 1991). These communicative systems were expanded by the evolution of the musical capacity, as well as vocalizations involving chanting and singing, which extended the ritual core of shamanic practices derived from our hominid heritage.

Psychedelics and shamanic ecopsychology: drugs and human evolution

Central ecological influences on the evolution of shamanic consciousness involve psychedelics, also called "entheogens" - meaning that they elicit the divine within the self. These plants known by names such as the food of the gods and sacred medicines are recorded in the cosmologies of societies worldwide as inspiring the origins of culture, religion and spirituality (e.g., see Rätsch, 2005; Schultes, Hofmann & Rätsch, 1992) before becoming degraded as "hallucinogens" in the modern world. The use of psychedelics in shamanistic practices around the world illustrates these substances and their biological effects are central to understanding the nature of shamanism.

The essential role of psychedelics in humans' evolved psychology and ecopsychology is established by Prezenger et al's (2007) findings of significantly higher binding of psychedelics to human versus chimpanzee serotonergic receptor sites. This difference illustrates that selection for an enhanced capacity for use of these substances as neurotransmitter analogues was a part of human evolution. Humanity's evolved psychology must be understood in light of the specific effects caused by these substances, exemplified in the effects of psilocybin-containing mushrooms. There is a range of specific cognitive, social and emotional experiences caused by these substances, independent of expectation, which illustrates that they have an intrinsic neuropsychology and neurophenomenology which has direct implications for understanding features of ecopsychology.

The role of psilocybin-containing mushrooms in the evolution of neural capacities that are central to the perspectives of shamanism and ecopsychology reflects their ancient role as environmental mechanisms exerting a selective influence on members of our ancestral species who were able to utilize these exogenous neurotransmitter sources of neurotransmitter substances and their adaptive effects. Species containing psilocybin have been found around the world, providing an exposure to humans for millions of years. Guzmán, Allen and Gartz (1998) illustrate the worldwide distribution of indigenous (local) species of neurotropic fungi across most ecozones, not only the psilocybin-containing species, but also others used as sacraments. Adaptation to the fungi in their environment was a significant feature affecting hominid and hominin evolution. Many mushroom species have toxic effects; some are useful food sources; and still others produce mystical experiences.

The role of psychedelics in human's evolved ecopsychology has deep evolutionary roots in the relationship of our nervous system to environmental chemicals. Sullivan, Hagen, and Hammerstein (2008) provide evidence of ancient environmental exposures to these substance that stimulated human evolution in order to make use of these exogenous substances as sources of neurotransmitters analogues. The long-term evolutionary relationship between psychotropic plant substances and humans' cognitive capacities reflects selective benefits of substance use (Sullivan & Hagen, 2002). In contrast to the debilitating cognitive effects often attributed to drugs, Smith (1999) illustrates a variety of fitness consequences associated with the use of substances often disparaged as drugs. Across the diverse classes of plant drugs there are effects of enhanced vigilance, the ability to ignore pain in the interest of survival activities, increased access to mating opportunities, reduction of apprehension and stress, feelings of euphoria, increased endurance and self-confidence, enhanced sensory and mental acuity, reduction of defensiveness, and reduction of depression and self-defeating activities. Evolutionary paradigms suggest that fitness benefits accrued to our ancestors as a consequence of their ability to utilize psychoactive substances to enhance operation of neurotransmitter systems. The effects of these environmental sources of neural transmitters display hallmark features of natural adaptations (Smith & Tasnadi, 2007).

Psychedelics and shamanic phenomenology

Our very psychology as human beings was shaped by the experiences induced by the psychedelics and their intrinsically religious effects, as well as a range of other cognitive, social and personal dispositions they produced (Roberts & Winkelman, 2013). Shamanic practices in general and the healing traditions in particular were centrally shaped by these experiences and the powers released within the person by the pharmacological effects of the active ingredients of these plants. A review of literature from around the world illustrate that the effects of psychedelics, and psilocybin-containing mushrooms in particular, produce a range of experiences that are directly related to shamanism, including (Winkelman 2010; see also de Rios, 1984; Hoffman, Carl & Ruck, 2004):

- providing access to a spiritual world, the supernatural, bringing the mythical world to life;
- producing an experience of the separation of one's soul or spirit from the body and its travel to the supernatural world;
- activating powers within and outside of the person, including the sense of the presence of spirits and their incorporation into one's body;
- establishing relationships with animals, particularly carnivores;
- inducing an experience of transformation into an animal;
- provoking a death of the ego and its transformation or rebirth, providing a source of self transformation;
- providing information through visions;
- providing healing, especially through the emotional experiences and release (catharsis); and
- inducing an integration of the group and enhancement of social cohesion reflected in their use in community rituals.

The hypothesis that these psychedelic-induced experiences are intrinsic effects of these substances is supported by their objective ability to produce a variety of mystical experiences in contemporary people. Griffiths *et al*. (2006) carefully-designed double blind study showed that psilocybin induces mystical experiences and has effects on participants' attitudes, moods, and their own experience of spirituality that persisted for months. The comparison with control periods showed psilocybin produced significantly higher ratings on the scales used to assess mysticism and altered states of consciousness, including introvertive mysticism, extrovertive mysticism, internal and external unity, sacredness, intuitive knowledge, transcendence of time and space, ineffability, positive mood, and experiences of oceanic boundlessness. Psilocybin sessions had significantly higher levels of peace, harmony, joy, and intense happiness. In addition, there were persisting effects noted for the psilocybin sessions, including an enhanced positive attitude about life accompanied by a positive mood changes and positive altruistic social behaviors confirmed by third-party observers.

While the emergence of the suite of practices associated with pre-modern shamanism involved other selective influences (e.g., dancing and music, Winkelman, 2010a), psychedelics were central selective influences on the evolution of the human nervous system for the kinds of experiences directly related to ecopsychology and shamanic ideologies. The extrovertive mystical experiences typical of psychedelics embrace the connection with the external world and nature in particular, but in a different way, with the perceiver transformed in such a way that the perception of the ordinary world of plants and rocks is transfigured into a consciousness of Unity with all of nature, rather than some sense of separateness.

These experiences are principally deistic experiences, as embodied in the concept entheogen - generating experiences of the god within one's self. A core aspect of the psychedelics experience is what Hoffman, Carl and Ruck (2004) characterized as the "entheogenic epiphany… commonly described as a state where all distinctions and boundaries between the individual and the metaphysical realm dissolve into a mystical and consubstantial communion with the Divine. This ecstatic experience is interpreted as a pure and primal Consciousness, which brings the individual into direct contact with the root of being…" (p. 112). These and other common effects resulting from ingestion of the entheogens must be understood in terms of neurophenomenology (Laughlin, McManus & d'Aquili, 1992), where physiological actions on the neurological system are responsible for the phenomenological experiences.

Psychointegrators as a neurophenomenological paradigm

The psychedelics had central roles in the evolution of human cognitive capacities, particularly symbolism, abstract thought and reasoning and the religious and spiritual capacities which characterize the human species. These effects derive from the action of psychoactive plants on the serotonergic and dopaminergic nervous systems. Entheogenic substances primarily derive their effects from chemicals compounds known as indoleamines which have direct and indirect effects on the brain's neurotransmitter systems. The major classes of indoleamines are tryptamines (e.g., DMT, LSD, psilocin, and psilocybin) and phenylethylamines (e.g., mescaline, MDMA ['ecstacy'], 2C-B) and exert similar influences on serotonergic neurons (Nichols 2004; Nichols & Chemel, 2006; also see Fantegrossi, Mernane & Reissig, 2008) and produce similar experiential effects (for reviews see Passie *et al*, 2008; Hintzen & Passie, 2010). These effects on serotonion receptors are responsible for the overall changes in brain processes, which are reflected in high-voltage brain wave discharges of a slow wave frequency: typically theta, 3-6 cycles per second (cps).

These biochemically based physiological dynamics are primarily based in serotonin disinhibition and the consequent loss of its inhibitory effects on dopamine and the mesolimbic structures, enhancing the activity of lower brain structures, particularly the thalamic area that gates information ascending from the peripheral nervous system. Serotonin-like entheogens and many other substances have end-effects that alter consciousness through a common mechanism - production of high-voltage slowwave (theta) brain wave activity (Mandell, 1980; Winkelman, 2010a). While there are many additional effects found within and across species, typical effects on serotonin receptors provide the basis for a neurophenomenological paradigm of psychedelics and shamanic altered states of consciousness as involving psychointegration produced by an enhanced integration of lower brain processes into the frontal cortex (Winkelman, 2001, 2007).

The neurognostic structuring produced by psychedelics reflects macro-level effects involving both the activation and selective deactivation of the serotonin system, which has multiple regulatory roles reflected in its special characterization as neuromodulator of many neurotransmitter systems. Psychointegration is derived from both stimulating the serotonergic system, as well as inhibitory effects on serotonin transmission (through resistance to reuptake), with consequences involving disinhibition or release of the dopaminergic system (Passie *et al*, 2008; Nichols, 2004). Nichols concluded psychedelics amplify incoming stimuli, enhancing the sensitivity of the phylogenetic older brain structures and the excitability of limbic and cortical structures.

Serotonin as a modulator

Serotonin is a neurotransmitter that acts as a modulator across all levels of the brain, from the brain stem and limbic system to the frontal cortex. Serotonin has a wide range of functions in: sensory processing and perception, motor activity and behavior, hunger and feeding, thermoregulation and pain, release of growth hormones, sleep cycles, learning and memory, moods and modulating the sympathetic nervous system (see Kruk & Pycock, 1991: 122-3; Role & Kelly, 1991). Serotonin circuitry is primarily ascending, concentrated along the midline area and the raphe nuclei and projecting upward into the limbic system and frontal cortex, with widespread and diffuse influences over vast neuronal populations. Serotonin neurons innervate structures directly responsible for a range of human capabilities central to consciousness: attention, alertness, and maintenance of waking/sleep cycles; integration of emotional and motivational processes; synthesis of information from the entire brain; and visual conceptualization and representation.

Psychointegrators' primary neurophenomenological effects reflect activation of synchronized hyperactivity in serotonin circuitry across the neuraxis, the main nerve bundle linking the structural levels of the brain from the brain stem to the frontal cortex. This hyperactivity produces synchronization of theta (3-6 cps) brain waves across the levels of the brain and between the hemispheres (Mandell, 1980; see Winkelman, 2011 for review). The theta effects begin in the midbrain hippocampal region which activate serotonin circuitry in the lower levels of the brain (locus corelus and thalamus), which in turn stimulate the limbic structures and frontal cortex, especially the right hemisphere (Mandell, 1980). Mandell proposes this is the basis of the cognitive of transcendent states, increasing the ascending flow of information, improving integration of information exchange between the two hemispheres and their specialized functions in cognition and affect, producing interhemispheric coherence and fusion that results in insight. These synchronizing effects in the brain contribute neurological causes of the integrative experiences of connection and oneness produced by these substances, and the rationale for the concept of psychointegrators.

A central feature of serotonergic systemic functions includes inhibitory or repressing activity. Psychedelics' selective effects result in disinhibition of serotonergic regulation of the thalamus and limbic areas which function as "gatekeepers" in the basic filtering of information from the environment and body. Psychointegrators disinhibit the mesolimbic temporal lobe structures, reversing the habitual effect of serotonin in depressing the action of target neurons in the forebrain. Disinhibition of mesolimbic temporal lobe structures produces key features of psychointegrator-induced changes in overall brain function - high voltage synchronous discharges in the hippocampus and other temporal lobe limbic structures manifested in theta (3-6 cps) brain wave patterns. This model of psychointegration is confirmed by research (Vollenweider & Geyer, 2001) which found the principal effects of psychedelics involve the cortico-striato-thalamocortical loops which reduce the sensory gating systems of the lower brain structures, leading to a flood of information on the higher levels of the brain.

The release of the dopamine system caused by the psychointegrator's blocking of the serotonin system produces characteristic features of altered consciousness and the ecophilic attitude of shamanism (Previc, 2009). Virtually all classes of drugs effect dopamine transmission in the limbic system, as well as on serotonergic transmission (Smith & Tasnadi, 2007) and result in increases in dopaminergic activity. Effects on dopamine receptors typically produce unconditioned pleasurable responses and elicit intrinsic feelings of well-being. While high levels of dopamine lead to emotional detachment, the human dopamine system is part of our mammalian heritage, with similar effects across mammalian species in social bonding, from mother-infant attachment to broader social groups. Psychointegrator's ecophilic effects must be seen as in part resulting from activation of our basic bonding neurochemistry, core functions in the mammalian brain's emotional, social and self systems. Previc (2009) reviews evidence that dopamine is also vital for all of the key functions of advanced intelligence and cognition and linked to the brain's ability to deal with objects and events distant in space and time. This provides context independent cognition, exemplified in the capacities for mental time travel, the ability to experience and think about things other than those in the here and now. Winkelman (2010a) shows how these abilities for extrapersonal projection are key to understanding central aspects of the shamanic soul flight or out-of-body experience, which exemplifies the ability to have a context-independent consciousness of people and places far removed from the physical body.

These combined stimulatory and inhibitory serotonergic effects of psychointegrators result in the increase in information from the environment, body and memory; the enhanced experience and recall of emotions; the stimulation of basic motivations and cognitive processes; and increases in awareness and internal attention. These produce the neurophenomenological dynamic exemplified in the concept of psychointegration, reflecting the heightened integration of hierarchically-ordered brain functions. As Nichols (2004) concluded, psychedelics enhance the sensitivity of cortical processing of ancient phylogenetic brain structures.

Psychointegration as the general dynamic of alterations of consciousness

This psychointegrative model of consciousness derived from psychedelics is characteristics of shamanic alterations of consciousness in general (Winkelman, 2010a, 2011). The biological effects of the psychedelics are mimicked by a variety of other agents and behaviors, including other drugs, long-distance running, hunger, thirst, sleep loss, auditory stimuli such as drumming and chanting, sensory deprivation, dream states, meditation, and a variety of psychophysiological imbalances or sensitivities resulting from injury, trauma, disease, or hereditarily transmitted nervous system conditions (see Mandell, 1980; Winkelman, 2010a). Similar production of alterations of consciousness through disruption of the processes of the frontal cortex occurs from the effects of endurance running, dreaming, hypnosis, drug induced states, and meditation (Dietrich, 2003).

The all-night dancing of the shaman exploits another capacity which contributes to alterations of consciousness, mystical experiences and biophilia; the uniquely human capacity of endurance running (Bramble & Lieberman, 2004). Emerging a million years ago in *Homo erectus*, these capacities for running for hours to days provided a natural basis for inducing alterations of consciousness, which also has as a side effect of the induction of mystical experiences (Jones, 2005). This effect from endurance running goes beyond the widely noted "runner's high" and includes typical features of mystical experiences such as:

- positive emotions such as happiness, joy and elation;
- a sense of inner peacefulness and harmony;
- a sense of timelessness and cosmic unity; and
- a connection of oneself with nature and the Universe (Dietrich 2003)

Sands and Sands (2009) proposed that the selection for long-distance running in *Homo* subsequently selected for a form of spirituality, a "horizontal awareness" or *biophilia* that operated through existing neurobiological reward systems. The "high" associated with long distance running situated our ancestors within a dynamic environment within which they felt an intimate connection with nature. They review evidence showing that the neurochemicals released during endurance running are tied into a variety of pre-existing reward pathways, including monoamines (serotonin, dopamine, and norepinephrine), endorphins, and endocannabinoids. Thus a side effect of the acquisition of the capacity for long distance running was a variety of mystical experiences, as well as the physical basis for dance. Dance and other shamanic practices of fasting, sexual abstinence, social isolation, drumming, chanting and austerities all contribute to this altered state characterized by theta wave synchronization. These entrainments may occur at a variety of frequencies, but two predominant patterns are synchronized slow wave theta bands (3-6 cps) and the high frequency gamma oscillations (40+ cps) (see Winkelman, 2010a for primary references).

Disruption of highly-integrated aspects of neural information processing and higher cognitive functions characteristic of the frontal lobes and prefrontal cortex allows for the manifestation of other brain structures usually repressed by frontal activities. The overall brain response to many different activities that alter conscious is characterized by brain synchronization with slow wave discharges that produces overall coherence and a linkage across the evolutionary strata of the brain, integrating information from the lower brain systems into the frontal cortex. Deregulation of the prefrontal cortex allows for the emergence of aspects of identity related to our more ancient brain functions.

The effects of psychedelics and the shamanic alterations of consciousness involve stimulating the linkages across the evolutionary strata of the brain. MacLean (1990, 1993) proposed that the brain involves three anatomically distinct yet interconnected systems - the reptilian brain, paleomammalian brain, and neo-mammalian brain. These three brain systems provide the basis for behavioral, emotional, and informational functions that MacLean (1993, p. 39) called "protomentation", "emotiomentation", and "ratiomentation" respectively. Interactions across levels of the brain are mediated through non-verbal communication forms that utilize behavioral, social, affective, and presentational (visual symbolic) information. Psychointegrators elevate these communication systems of the ancient strata of the brain. In the reptilian brain they release the activity of the raphe and reticular formations and thalamic structures of the brain stem area that normally restrict information received by the higher levels of the brain. And in the paleomammalian brain they stimulate limbic system functions that provide emotional information, a sense of personal relations and bonding.

The development of the serotonergic system across phylogenetic evolution illustrates how psychedelics can have such a central role in these integrative processes. The effects of psychointegrators on the serotonergic system and dopamine relate to MacLean's model of the evolution of the brain, functioning as the most central and powerful system of integration and coordination among the three brain subsystems. In the reptilian part of the brain, serotonin functions as a regulator system within the R-complex. Serotonergic functions in the paleomammalian brain involve control over the R-complex, inhibiting limbic brain emotional functions, and distributing information through connections with the prefrontal and neocortex.

Global effects of psychointegrators on the serotonergic system enhance reptilian and paleomammalian brain activities. Psychointegrators produce systemic brain integration through liberating our ancient animal brains, imposing the reptilian brain's ritual systems of communication and the paleomammalian brain's analogical processes and material of an emotional, social, and personal nature into the self-conscious processes of the frontal cortex. Consequently our experience of connection with nature, the ecophilia associated with psychedelics, emerges as a neurophenomenological effect. These stimulations of our ancient brain systems must also been seen as central to the animistic features of psychedelics, shamanism and ecopsychology.

Nature and animal relations in shamanism: The origins of ecopsychology

The self-identifications with the broader universe, particularly personification of the sentient cosmos which is a hallmark of ecopsychology, is also a fundamental aspect of the shamanism. This cosmic identity with nature has many roots in shamanism, such as those experiences induced by entheogenic plants generally personified as gods. The out-of-body experiences associated with shamanism, psychedelics and long-distance running all reflect a capacity to dislocate personal identity from body, a capacity which likely facilitates an identity with nature, where personal identity is often relocated.

Davis (2006) notes that central aspects of ecopsychology involve a nature-oriented awareness practices which are basic tools of shamanic development, such as the vision quest alone in nature. Shamanic development focused on intensified contact with the natural world as a fundamental tool of personal growth. Novices spend months or even years isolated from community, largely alone in the wilderness, which was key for developing relations with power animals. These extraordinary experiences were provoked by prolonged and direct contact with nature, exemplified in visions of spirit beings, especially the animals.

The shaman was known for having special relations with animals and animal spirits, being able to control them and believed to personally transform into an animal to accomplish feats. Relationships with actual animals also characterized shamans. Shamans often adopted a variety of wild animals that might live with them or visit them, especially when called by the shaman for some task. This personal relationship with animals must be seen as a precursor to domestication, a complex human relationship with transformed nature.

Shamans had special relationships to hunting animals as well, particularly leading hunts and making sacrifices to the spirits of the animals killed. Shamanism's relationships to the animals included calling them to the waiting hunters, campsites and the shore. The shaman made soul journeys to the spirit world to seek the release of the animal spirits for the hunters to kill. The killing of the animal was also accompanied by sacrifices to the animal's spirits to atone for their loss, giving thanks for the sustenance that they provided for the humans.

Shamanic ritual activities relating the group to the environment reflect a deep synchronization with ecological principles. Found within many shamanic traditions is the belief that certain animals have periods of taboo in which they may not be hunted or eaten. Winkelman and Baker (2008) discuss how the practices of hunting taboos among the pre-modern Tukano in the Amazonian region of Columbia illustrate the roles of shamans in ecoregulation. The shamanic ideology dictates what animals may be hunted and when. Beliefs about the relationship between human sexual energy and the fecundity of nature also regulate hunting and reproduction. Sexual activity is restricted before hunting and rituals performed to determine the cause of unsuccessful hunting; consequently, limited availability of game animals results in sexual restrictions and reduced human reproduction. The role of the shaman in deciding to taboo certain animals plays a direct role in regulating the community's environmental relations and the well-being of the local species, limiting exploitation so that local food species will not fall below reproduction levels.

Imitation of animals in shamanism: Hunting and human evolution

Relations with animals through hunting and imitation of them played a variety of roles in the evolution of a capacity for symbolic representation through behavior. Human evolution in relationship to nature involves enhanced skills for using culture to change from being prey into being a hunter. Key elements of hunting involve adoption of behaviors of animals and eventually involved imitation and disguise. Hunting activities became conceptualized in terms of the ability to acquire power over animals, based in knowledge of its habits, behaviors, and powers. This power was likely manifested through deception and imitation, mimicking of the vocal calls of animals to attract them or to cover one's own noise. This imitative practice of hunters is another feature of shamanism, the master of the animals. This also provided a basis for representation through mimicry.

Donald (1991) proposes that a major cognitive evolution of humans involved mimesis, the ability to intentionally represent through enactment, and that among the first of human mimetic activities were ritual group dances performed with vocalizations to imitate the sounds of animals. He suggests the mimetic capability resulted in a form of body-based awareness, a physical self-consciousness that enhanced our awareness of self-in-environment. The use of bodily movements as symbolic communication embodied in mimesis made it possible to increase group coordination because it built upon one of the most basic types of animal ritual behavior - isopraxis - in which animals automatically imitate each other's behavior.

Hunting animals likely engaged and selected for the mimetic capacity because the ability to imitate would have directly enhanced hunting success through the ability to engage in deception through imitation. Imitation also played a role in teaching about hunting and animal behaviors. Imitation used for the purposes of hunting likely produced a greater sense of identification with the animal, a hallmark feature of shamanism. This enactment of the 'other as animal' likely played a role in the evolution of shamanic practices. Mime and dancing are central features of shamanic activities, for they are the basis of the ritual enactments of struggles with spirits combined with chanting, singing, and imitative vocalization. The shamanic roots of ecopsychology involve an impulse to understand the environment in human and animal terms, and conversely the self in terms of animals and their powers. Imitation of the behavior of some of the most significant features of the environment - animals - provided a template for broader representation skills.

Animism as ecopsychological identification

One of the most fundamental features of shamanism, religion, spirituality and the concept of entheogens is the notion of the spirit world. Animism refers to the notion that nature is in essence embodied with spirit entities, and encompasses the core of the oldest and most basic of humanity's religious beliefs. Shamanism has been characterized as an animistic practice, where animism constitutes a perception of nature not as inert matter but rather as a living entity. This humanized nature is exemplified in the shamanic relations with plant spirits embodied in the entheogenic practices so frequently associated with shamanism. Shamanism personified the influences experienced from these plants, exemplified in the intimate relations they maintained with these environmentally-based entities conceptualized as plant spirits. These relations with the plant spirit others were fundamental to concepts of self, other and universe that are characteristic of ecopsychology - a perception of nature as a person, intelligent, spiritual and infinite.

Bird-David (1999) portrays animism not merely as a sense of spirits within nature, but moreover as powerful presences that must be understood as super-persons. The relationships established with the animistic super persons are reciprocal, in which one both receives benefits and privileges and to whom one has obligations met through ritual. Shamanic rituals are the primary mechanism through which these relationships are recognized and reciprocity engaged with these super-persons. Shamanic performances ritually enact these persons, bringing them to life in a heightened ecstatic state that enhances relatedness not only within community, but also in relationship to the spiritual kindred of nature. These relationships give rise to a greater sense of the interconnectivity among local community, the ecosystem and the cosmos.

One of the most fundamental shamanic relations with nature is in the conceptualization of the self and its powers, typified in the concept of animal powers that constitute basic aspects of the self. Nature itself becomes our template for society in the ancient practices of totemism where animal species and their natural relations became an innate template for conceptualizations of our lineages and tribes, the building blocks that take society into transfamilial dimensions. Shamanism provided the evolved psychological context - our neuro-psycho-social structuring as sentient beings in relationship to physical nature and its powers, animals and plants. Our natural ecopsychology is inextricably tied up in our relationships with the physical world - the animistic essence of nature as a sentient, aware spiritual power, of the animals as actors that can give us power and identity and affect our well-being.

These basic relations to the animistic principles of the universe and their manifestations in animals are deeply rooted in the structure of the human psyche, a neurophenomenological system in which the common brain structures we share with other animals (i.e., the reptilian complex and paleomammalian brain) produce an awareness of self in relationship to other animals. While this postulation of spirits which is fundamental to animism has been attributed to cognition regarding anomalous psychological phenomena (i.e., dreams, spontaneous out-of-body experiences), animism is best understood in terms of the consequence of innate processing modules. Animacy is a universal human tendency because it is an adaptive feature of human cognition based in "animacy detection". Atran (2002) illustrates how animacy detection - being hyper-sensitive to the presence of an animate agent - has adaptive benefits.

The universal human tendency for animistic thinking is a consequence of the adaptive tendency to attribute human mental, personal and social qualities to the unknown and natural phenomena. This tendency to assume the presence of an agent is combined with other innate faculties for self and other representation to produce the broad range of features typically associated with concepts of spirits (Mithen, 1996; Winkelman, 2004b; Winkelman & Baker, 2008: chapter 7). The projection of humans' self qualities to the unseen, as well as nature, is an inevitable consequence of our psychological and social development; spirits are a natural epistemology involving the inevitable projection of human models of the self.

Hubbard (2002) characterized shamanic cognition as involving extension of special attributes of human consciousness to new domains, especially the natural world which is imbued with elements of meaning and intentionality derived from humans. This reflects an innate human tendency to attribute the causes of observed actions to an object's internal dispositional factors, extending the assumptions we make about humans to unknown dynamics, assuming that other things operate as do humans. The natural tendency of humans to attribute mind states, internal dispositions and rational purpose to others is unavoidably attributed to nature as well. The universality of spiritual beliefs reflects this adaptive tendency, which was expanded into population of nature with spirit beings who operated with the same features as humans.

Spirit assumptions are reinforced by humans' innate capacities for social intelligence, our ability to infer the mental states of other members of the species and to use that information as a basis to predict others' behavior. This intuitive "theory of mind" involves the attribution of mental states to others, modeling others' thoughts and behaviors through the use of one's own mental states and feelings. Such attributions are fundamental to animism and the world of spirits. Whatever qualities of cognition, personality, intentionality and other personified qualities that nature may have intrinsically, they are modeled on the perceptual templates of those same qualities that are found universally in humans and are intrinsic to our perceptions. Our self-knowledge is necessarily the template through which we experience the other in the social as well as natural world. Nature is inherently personified via human nature.

Nature as self: Animal powers and guardian spirits

Shamanism was the original context for the spiritual perceptions that Davis (1998) see as an essential component of ecopsychology, the perspective of "nature as self". This self-identification with the world and Gaia is one of the most basic metaphors which ecopsychology provides for representing the relationship between humans and nature. A prominent aspect of spirit relations in shamanism involves an engagement of self-development processes by using symbolic representations derived from nature, and animals in particular. Animal species and their variant qualities are the natural tapestry within which human psychological and social development evolved.

The personification of nature embodied in animism facilitates the reciprocal process, the naturalization of the person. The projective processes underlying animism are used to reciprocally internalize the qualities found in nature into the person. Shamanic practices involving animal allies and guardian spirits reflect aspects of self-development and self-representation that involve the capacity to incorporate other's perceptions into the self, internalizing the qualities of others into our own self-identity. Shamanistic relations with nature engage humans' capacity for personal incorporation of others, using animals as the other.

Evolutionary psychologists recognize that humans have an innate natural history module, an intrinsic ability to recognize and categorize species of animals (see Mithen, 1996). Shamanic practices engage this specialized innate capacity for organizing knowledge about animal species and recognizing "species essence". Animal species - a highly important part of nature - provide a universal analogical system for creation of meaning. This ability to recognize intrinsic features of species and to transfer this knowledge to other domains is exemplified in the shamanic animal guardian spirit powers, which involve representations of self.

Animal powers incorporated as aspects of the self are exemplified in the guardian spirit complex typical of shamanism (Swanson, 1973). This involves ritual activities, generally prolonged isolation in nature, during which the person acquires a special relationship with a specific animal species that serves as a model for self-development. This self-development is based in the incorporation of animal properties within identity and personal powers. Swanson characterized the guardian spirit complex as a form of empowerment in which adult role development and personal and social choices are guided by the qualities of animal species. Animal spirits' characteristics provide ideals that structure individual psychodynamics and model social behavior through the natural symbols provided by animal attributes. These animals qualities provide diverse self-representations, different acquired selves that can mediate hierarchies of personal and social goals.

Animal spirits provide natural symbolic systems derived from relations with nature that serve vital functions in self and social representation within which the self is internally differentiated and socialized in relationships to others. These aspects of shamanism reflect an intrinsic neurophenomenological ecopsychology. Animal species and their qualities and behaviors provide a natural template for differentiating self with respect to others. Animal species identities provide psychosocial functions in visual icons, making publically available forms of social self-representation that facilitate personal differentiation.

Totemism: Nature relations and group identity

Shamanism exemplifies the symbolic application of nature to group relations in the practice of totemism. These group-oriented religious practices use animal species for social representations, as manifested in ancestor worship where group deities are represented by an animal species referred to in anthropology as a totem. Totemism involves establishing a metaphoric relationship between the natural history domains of animals and domain of social groups, conceptualizing humans's social organization through models provided by the animal world.

This view of totemism derives from the work of French research Emile Durkheim, the father of sociology, and Claude Levi-Strauss, an anthropologist. Durkheim (1915) investigated the widespread practices in which an animal species was used to represent a clan, a descent-based kinship group. Central worship activities of the clan consisted in ceremonies aimed at promoting the growth and well-being of the totem. During these rites for enhancing the fecundity of the totem, normal prohibitions on the consumption of the totem are suspended. During the ritual the totem animal is ceremonially killed and consumed in a sacred meal that allows the individual to incorporate the power of the totem.

While noting a variety of different phenomena called "totemism", Levi-Strauss (1962) identified commonalities underlying the many different systems and beliefs in which human clans are associated with specific animal species. In totemism, humans are identified with an animal (or plant) species unique to their kinship groups. This animal identification, a "connection between *the relation of man to nature* and the *characterization of social group* … postulates a homology … between differential features existing, on the one hand, between species x and y, and on the other, between clan *a* and *b*" (Levi-Strauss, 1962: 13). Levi-Strauss characterized totemic thought as involving analogical processes, establishing a homology between animal species and human groups. Animal species represent the distinctive qualities and membership of different social groups, constituting natural symbols for representing less distinctly featured human groups. The group identity animal species identifies the clan, and by extension, its members.

Totemism and guardian spirit relations exemplify innate nature relations that function to distinguish among humans and their groups through the attribution of characteristics derived from the natural world. Personal and group identity and intergroup differences are conceptualized through models provided by animal species. Totemism is a natural product of human thought, reflecting concepts of the natural world that are structured by the human brain, the innate intelligence for classifying the natural world. Our deeply rooted capacity to classify the animal world makes it a natural metaphoric system that can be extended to many other domains of human thought. The use of animals in social and cognitive modeling is one of the most fundamental aspects of metaphoric and analogical thought (Friedrich, 1991), a universal human system for expression of meaning and creation of social and personal identity through the use of the innate module for animal species categorization. The less perceptible differences among humans and groups are made visible with the representations derived from the more apparent differences in animal species.

Conclusions

Common features of shamanism, psychedelic metaphysics and ecopsychology illustrate that they involve common origins. Their commonalities point to a biologically based ecopsychology, one that is the product of human evolution and evolutionary adaptations. These biological bases suggest that shamanic ecopsychology and psychedelic therapies still have relevance for humans today. Our very health and survival as a species may depend on our ability to re-establish these relations with nature.

References

1. Atran, S. (2002). *In gods we trust: The evolutionary landscape of religion*. Oxford: Oxford University Press.
2. Bird-David, N. (1999). Animism revisited personhood, environment, and relational epistemology. *Current Anthropology*, 40, 67-91.
3. Bramble, D. & Lieberman, D. (2004). Endurance running and the evolution of homo. *Nature*, 432, 345-52.
4. Clottes, J. & Lewis-Williams, D. (1998). *The shamans of prehistory: Trance and magic in the painted caves*. New York: Harry Abrams.
5. Davis, J. (1998). The transpersonal dimensions of ecopsychology: Nature, nonduality, and spiritual practice. *The Humanistic Psychologist*, 26, 60-100.
6. Davis, J. (2006). *Map of ecopsychology practices*. Accessed November 2013 from http://www.soulcraft.co/essays/ecopsychology.html
7. Dietrich, A. (2003). Functional neuroanatomy of altered states of consciousness: The transient hypofrontality hypothesis. *Consciousness and Cognition*, 12, 231-256.
8. d'Aquili, E., Laughlin C. & McManus J. (eds.). (1979). *The spectrum of ritual*. New York: Columbia University Press.
9. de Rios, M. (1984). *Hallucinogens: Cross-cultural perspectives*. Albuquerque, NM: Univ. New Mexico.
10. Donald, M. (1991). *Origins of the modern mind*. Cambridge, MA: Harvard University Press.
11. Durkheim, D. (1915). *The elementary forms of religious life.* London: George Allen and Unwin.
12. Eliade, M. (1964). *Shamanism: Archaic techniques of ecstasy.* New York: Pantheon Books.
13. Fantegrossi, W., Mernane, K. & Reissig, C. (2008). The behavioral pharmacology of hallucinogens. *Behavioral Pharmacology*, 75, 17-33.
14. Friedrich P. (1991). "Polytrophy", in J. W. Fernandez (ed.), *Beyond metaphor: The theory of tropes in anthropology* (pp. 17-55). Stanford, CA: Stanford University Press.
15. Griffiths, R., Richards, R. W. A., McCann, W. & Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial, sustained personal meaning and spiritual significance. *Psychopharmacology*, 187, 268-283.
16. Guzmán, G., Allen, J. & Gartz, J. (1998). A world wide geographical distribution of the neurotropic fungi: An analysis and discussion. *Annali dei Museo Civico Rovereto*, 14, 189-280.
17. Hintzen, A. & Passie, T. (2010). *The pharmacology of LSD: A critical review.* Oxford: Beckley Foundation and Oxford University Press.
18. Hoffman, M., Carl A. & Ruck, P. (2004). "Entheogens (psychedelic drugs) and shamanism", in M.N. Walter and E.J.N. Fridman (eds.), *Shamanism: An encyclopedia of world beliefs, practices and cultures,* vol. I (pp. 111-117). Santa Barbara, CA: ABC-Clio.
19. Hubbard, T. (2002). Some correspondences and similarities of shamanism and cognitive science: Interconnectedness, extension of meaning and attribution of mental states. *Anthropology of Consciousness*, 13, 26-45.
20. Jones, P. (2005). Ultrarunners and chance encounters with 'absolute unitary being'. *Anthropology of Consciousness,* 15, 39-50.
21. Kruk, Z. & Pycock, C. (1991). *Neurotransmitters and drugs.* London: Chapman and Hall. *Consciousness,* 15, 39-50.
22. Laughlin, C. & d'Aquili, E. (1974). *Biogenetic structuralism*. New York: Columbia University Press.
23. Laughlin, C., McManus, J. & d'Aquili, E. (1992). *Brain, symbol, and experience: Toward a neurophenomenology of consciousness.* New York: Columbia University Press.
24. Levi-Strauss C. (1962). *Totemism*. Boston: Beacon.
25. Mandell, A. (1980). "Toward a psychobiology of transcendence: God in the brain", in J. Davidson and R.
26. Davidson (eds.), *The psychobiology of consciousness*, (pp. 379-464). New York: Plenum. MacLean, P. (1990). *The triune brain in evolution.* New York: Plenum.
27. MacLean, P. (1993). "On the evolution of three mentalities", in J. Ashbrook (ed.), *Brain, culture and the human spirit: Essays from an emergent evolutionary perspective* (pp. 15-44). Lanham, MD: University Press of America.
28. Mithen, S. (1996). *The prehistory of the mind: A search for the origins of art, religion and science*. London: Thames and Hudson.
29. Nichols, D. (2004). Hallucinogens. *Pharmacology and Therapeutics*, 101, 131-181.
30. Nichols, D. & Chemel, B. (2006). "The neuropharmacology of religious experience", in P. McNamara (ed.), *Where God and*

science meet: How brain and evolutionary studies alter our understanding of religion, Vol. III (pp. 1-33). Westport, CT: Praeger.

31. Passie, T., Halpern, J., Stichtenoth, D., Emrish, H. & Hintzen, A. (2008). The pharmacology of lysergic acid diethylamide: A review. *CNS Neuroscience & Therapeutics*, 14, 295-314.
32. Pregenzer, J., Alberts, G., Bock, J., Slightom, J. & Im, W. (1997). Characterization of ligand binding properties of the 5-HT$_{1D}$ receptors cloned from chimpanzee, gorilla and rhesus monkey in comparison with those from the human and guinea pig receptors. *Neuroscience Letters*, 3, 117-120.
33. Previc, F. (2009). *The dopaminergic mind in human evolution and history*. Cambridge: Cambridge University Press.
34. Rätsch, C. (Translated by J. R. Baker). (2005). *The encyclopedia of psychoactive plants: Ethnopharmacology and its applications.* Rochester, VT: Park Street Press. Originally published as (1998). *Enzyklopädie der psychoaktiven Pflanzen*. Aarau, Switzerland: AT Verlag.
35. Roberts, T. & Winkelman, M. (2013). "Psychedelic induced transpersonal experiences, therapies, and their implications for transpersonal psychology", in H. Friedman and G. Hartelius (eds.), *The Wiley-Blackwell handbook of transpersonal psychology* (pp. 459-479). West Sussex: John Wiley and Sons Ltd.
36. Role, L. &. Kelly, J. (1991). "The brain stem: Cranial nerve nuclei and the monoaminergic systems", in. E. Kandal, J. Schwartz and T. Jessell (eds.), *Principles of neural science* (3rd edition) (pp. 683-699). New York: Elsevier.
37. Sands, R. & Sands, L. (2009). Running deep speculations on the evolution of running and spirituality in Homo. *Journal for the Study of Religion, Nature and Culture*, 34, 552-577.
38. Schultes, R., Hofmann, A. & Rätsch, C. (1992). *Plants of the gods: Their sacred, healing and hallucinogenic powers.* Rochester, VT: Healing Arts Press.
39. Smith, E.O. (1999). "Evolution, substance abuse, and addiction", in T.E. Smith and J. McKenna (eds.), *Evolutionary medicine* (pp. 375-405). New York: Oxford University Press.
40. Smith, T. & Tasnadi, A. (2007). A theory of natural addiction. *Games and Economic Behavior*, 59, 316-344.
41. Sullivan, R., Hagen, E. & Hammerstein, P. (2008). Revealing the paradox of drug reward in human evolution. *Proceedings of the Royal Society B*, 275, 1231-1241.
42. Sullivan, R. & Hagen, E. (2002). Psychotrophic substance-seeking: Evolutionary pathology or adaptation? *Addiction*, 97, 389-400.
43. Swanson, G. (1973). The search for a guardian spirit: A process of empowerment in simpler societies. *Ethnology*, 12, 359-78.
44. Vollenweider, F. & Geyer, M. (2001). A systems model of altered consciousness: Integrating natural and drug psychoses. *Brain Research Bulletin*, 56, 495-507.
45. Whitley, D. (2009). *Cave paintings and the human spirit: The origin of creativity and belief*. Amherst, NY: Prometheus Books.
46. Winkelman, M. (1986). Magico-religious practitioner types and socioeconomic analysis. *Behavior Science Research*, 20, 17-46.
47. Winkelman, M. (1990). Shaman and other "magico-religious healers": A cross-cultural study of their origins, nature, and social transformation. *Ethos*, 18, 308-52.
48. Winkelman, M. (1992). Shamans, priests, and witches: A cross-cultural study of magico-religious practitioners. *Anthropological Research Papers #44.* Phoenix, AZ: Arizona State University.
49. Winkelman, M. (2001). Psychointegrators: Multidisciplinary perspectives on the therapeutic effects of hallucinogens. *Complementary Health Practice Review*, 6, 219-37.
50. Winkelman, M. (2002). Shamanism and cognitive evolution. *Cambridge Archaeological Journal*, 12, 71-101.
51. Winkelman, M. (2004a). Shamanism as the original neurotheology. *Zygon: Journal of Religion and Science*, 39, 193-217.
52. Winkelman, M. (2004b). "Spirits as human nature and the fundamental structures of consciousness", in J. Houran (ed.), *From shaman to scientist: Essays on humanity's search for spirits* (pp. 59-96). Lanham, MD: Scarecrow Press.
53. Winkelman, M. (2007). "Therapeutic bases of psychedelic medicines: Psychointegrative effects", in M. Winkelman and T. Roberts (eds.), *Psychedelic medicine, Vol 1* (pp. 1-20). Westport, CT: Praeger/Greenwood Perspectives.
54. Winkelman, M. (2009). Shamanism and the origins of spirituality and ritual healing. *Journal for the Study of Religion, Nature and Culture*, 34, 458-489.
55. Winkelman, M. (2010a). *Shamanism A biopsychosocial paradigm of consciousness and healing*. Santa Barbara, Ca.: ABC-CLIO.
56. Winkelman, M. (2010b). The shamanic paradigm: Evidence from ethnology, neuropsychology and ethology. *Time & Mind: The Journal of Archaeology, Consciousness and Culture*, 3, 159-182.
57. Winkelman, M. (2010c). "Evolutionary origins of ritual", in A. Michaels (general editor), *Body, performance, agency, and experience* (pp. 331-349). Wiesbaden: Harrassowitz Verlag.
58. Winkelman, M. (2011). "A paradigm for understanding altered consciousness: The integrative mode of consciousness", in E. Cardeña and M. Winkelman (eds.) *Altering consciousness multidisciplinary perspectives, volume 1: History, culture and the humanities* (pp. 23-44). Santa Barbara, CA: Preager ABC-CLIO.
59. Winkelman, M. & Baker, J. (2008). *Supernatural as natural: A biological theory of religion*. New Jersey: Prentice Hall.

Correspondence

Michael Winkelman (Retired)
School of Human Evolution and Social Change
Arizona State University USA
Email: michaeljwinkelman@gmail.com

Lifetime experience with (classic) psychedelics predicts pro-environmental behavior through an increase in nature relatedness

by

Matthias Forstmann[1] and Christina Sagioglou[2]

Journal of Psychopharmacology 1-14

DOI: 10.1177/0269881117714049

© The Author(s) 2017

original report: https://pdfs.semanticscholar.org/1d2e/76f52f3cb3ae762fb79c0b785491a096462a.pdf
backup source: http://www.psilosophy.info/resources/76f52f3cb3ae762fb79c0b785491a096462a.pdf

[1] Yale University, New Haven, CT, USA
[2] University of Innsbruck, Innsbruck, Tirol, Austria

Corresponding author:
Matthias Forstmann, Yale University, Department of Psychology, 2 Hillhouse Avenue, New Haven, CT 06511, USA.
Email: matthias.forstmann@yale.edu

Table of Contents:

- Abstract
- Psychedelics' mechanism of action
- Psychedelics and nature
- Methods and results
  - *Lifetime experiences with psychedelic substances*
  - *Control variables*
  - *Nature relatedness*
  - *Pro-environmental behavior*
  - *Participants and design*
  - *Materials and procedure*
- Results
  - *Experience with psychedelic drugs*
  - *Post-hoc modifications to the model*
  - *Structural equation model*
  - *Mediation analysis*
  - *Alternative models*
  - *Summary*
- General discussion
- Notes
- References

Abstract

In a large-scale (N = 1487) general population online study, we investigated the relationship between past experience with classic psychedelic substances (e.g. LSD, psilocybin, mescaline), nature relatedness, and ecological behavior (e.g. saving water, recycling). Using structural equation modeling we found that experience with classic psychedelics uniquely predicted self-reported engagement in pro-environmental behaviors, and that this relationship was statistically explained by people's degree of self-identification with nature. Our model controlled for experiences with other classes of psychoactive substances (cannabis, dissociatives, empathogens, popular legal drugs) as well as common personality traits that usually predict drug consumption and/or nature relatedness (openness to experience, conscientiousness, conservatism). Although correlational in nature, results suggest that lifetime experience with psychedelics in particular may indeed contribute to people's pro-environmental behavior by changing their self-construal in terms of an incorporation of the natural world, regardless of core personality traits or general propensity to consume mind-altering substances. Thereby, the present research adds to the contemporary literature on the beneficial effects of psychedelic substance use on mental wellbeing, hinting at a novel area for future research investigating their potentially positive effects on a societal level. Limitations of the present research and future directions are discussed.

Keywords Psychedelics, nature relatedness, pro-environmental behavior, ecology

Although clinical research conducted in the 1950s and 1960s hinted at the vast therapeutic potential of psychedelic (i.e. "mindmanifesting") substances, regulatory restrictions resulting from a combination of political pragmatism and sensationalized media coverage brought research on their effects on the human mind to an abrupt and unfortunate halt (Nutt *et al.*, 2013). In 1971, most classic psychedelics (i.e. LSD, mescaline, psilocybin, etc.) were classified as Schedule 1 substances by the UN Convention on Psychotropic Substances, creating administrative hindrances and disproportionate costs for academic institutions that made human trials effectively impossible (Nutt *et al.*, 2013). Despite the fact that experts consider psychedelics to be among the least harmful and least addictive recreationally used substances (Nutt *et al.*, 2013), research was for the most part confined to neuroscientific investigations into their effects on rodents, leaving the therapeutic potential they revealed - for example in treatment of alcohol dependency disorder (e.g. Smith, 1958) - largely untapped. As a result, research on the intricate effects of psychedelic substances on human cognition and behavior is still in its infancy. This shortcoming comes as a surprise, considering that - despite their illegal status - about 14% of all adults in the United States report to have had at least some experience with psychedelic drugs (Johansen and Krebs, 2015). Moreover, indigenous peoples have sacramentally used hallucinogenic plants for more than 5000 years, predating all major contemporary religious belief systems. How these experiences affect individuals in the short and long term, however, is not yet entirely understood, and remains an important question to attend to.

Following a gradual political shift, the last two decades saw a resurgence of psychedelic research, culminating in the first experimental study involving LSD administration in 40 years (Gasser *et al.*, 2014). First and foremost, many of these new research programs focus on clinical applications of psychedelic substances in the treatment of anxiety and mood disorders. Although oftentimes limited to small sample sizes, preliminary results of these studies indicate that administration of psychedelics can considerably benefit psychotherapeutic interventions, revealing marked reduction of anxiety in patients who suffer from various life-threatening conditions (Gasser *et al.*, 2014), as well as reduction of depressive symptoms and anhedonia in patients with treatment-resistant depression (e.g. Carhart-Harris *et al.*, 2016). A different line of research investigated the potential of psychedelics in aiding the treatment of addiction and dependence disorders. While the rarely used psychedelic compound ibogaine was found to effectively attenuate addiction and withdrawal symptoms in opiate and cocaine addicts, other psychedelics revealed broad anti-addictive qualities in the treatment of various dependence disorders, having positive effects on patients' self-efficacy and motivation to change (Bogenschutz and Pommy, 2012; Sessa and Johnson, 2015, for a review). In fact, a recent meta-analysis by Krebs and Johansen (2012) confirmed a substantial positive effect of LSD in the treatment of alcohol dependence, comprising a total sample of 536 participants.

Psychedelics' mechanism of action

The reasons for why psychedelics, most of which act as serotonin 2A (5-HT_{2A}) receptor agonists (Vollenweider and Kometer, 2010), have such a profound effect on mental wellbeing are manifold. For one, psilocybin may foster processing of traumatic events by enhancing autobiographical memory recall in trauma patients (Carhart-Harris *et al*., 2012b). Specifically, exposure to psilocybin was found to enhance recall of personal memories and emotions, especially increasing the vividness of these memories, underlined by an activation of the visual association cortex during the recall process (Carhart-Harris *et al*., 2012b). On the other hand, LSD was found to decrease the tendency to engage in mental time travel to the past, which is often associated with rumination and depressive thoughts (Speth *et al*., 2016). Psychedelics may further aid psychotherapeutic efficiency by enhancing suggestibility in patients. In an administration study, LSD was found to increase the subjective intensity of suggested psychobiological states, such as that one's arm was becoming heavier, or that water tasted especially refreshing (Carhart-Harris *et al*., 2015). In addition, psilocybin fosters "unconstrained cognition" in that it triggers a decrease in cerebral blood flow in brain regions that serve as structural "hubs" for information transmission between different brain regions and as systems for cognitive integration and constraint of external stimuli (Carhart-Harris *et al*., 2012a).

Apart from these basic cognitive and perceptual effects, the primary reason for the remarkable therapeutic efficiency of psychedelics seems to be their phenomenological effect on the user. In one of the rare cases of experimental research into the effects of psychedelics on healthy subjects - involving the double-blind administration of either an effective dose or a placebo/ control substance - Griffiths and colleagues (2006) found that psilocybin reliably induced self-reported "mystical experiences" in hallucinogen-naïve participants. A large portion of the participants rated the experience as "having substantial personal meaning and spiritual significance" (p. 279), and a staggering 67% considered it to be among the top five meaningful experiences of their life. Two months after their treatment, 79% of participants reported increases in life satisfaction, and community observers rated participants' overall behavior to have changed for the better. Further indicating long-lasting effects of the experience, a 14-month post-treatment follow-up revealed positive changes in participants' self-reported attitudes about life, mood, (altruistic) social effects, general behavior, and life satisfaction (Griffiths *et al*., 2008). A follow-up study replicating these findings produced initial evidence that psilocybin administration produces dose-dependent persisting increases in life satisfaction, spirituality, and overall happiness (Griffiths *et al*., 2011). In particular, the mystical experience seems to have affected participants' core personality, as suggested by increased self-reported openness to experience after participating in the study (MacLean *et al*., 2011). Such lasting effects on core personality traits - which are usually thought of as comparably stable - may help explain some of the aforementioned promising effects of psychedelics in the treatment of addiction and mood disorder, two classes of clinical conditions which were theorized to be rooted in the rigid maintenance of certain maladaptive personality traits (Ball, 2005; Swendsen *et al*., 2002).

These results are further supported by a large-scale population survey, which, despite the widely held belief that psychedelic substances have negative effects on mental and physical health (Johansen and Krebs, 2015), established a positive relation between lifetime experience with psychedelics and mental wellbeing, manifesting in reduced psychological distress and suicidality (Hendricks *et al*., 2015). Experience with other classes of substances, the survey found, was more likely to have a negative effect on these variables. Importantly, this effect cannot be fully explained by hedonistic experiences caused by these substances, as psychedelics can acutely heighten anxiety, paranoia, and confusion (Griffiths *et al*., 2011). Yet, although psychedelic experiences can be unpleasant and challenging, a recent survey found that 84% of users who did experience such a "bad trip" endorsed benefiting from it in the long run (Carbonaro *et al*., 2016). In fact, the more difficult the challenging experience was, the more it predicted self-reported enduring increases in life satisfaction resulting from the experience.

Psychedelics and nature

One common mystical experience encountered by many during the psychedelic state is a profound feeling of connectedness or unity - a presumed consequence of a loss of self-awareness or ego-dissolution (Tagliazucchi *et al*., 2016). Specifically, psychedelics were found to decrease integrity *within* brain networks while simultaneously increasing functional connectivity *between* different brain networks, which correlate with self-reported experiences of ego-dissolution (Carhart-Harris *et al.*, 2012a). Primarily, increased connectivity between brain networks associated with self-awareness and introspection - for example, the default mode network - was found to attenuate the functional identity of these networks, causing the lines between self and environment to blur (Tagliazucchi *et al.*, 2016). In fact, in recent psilocybin administration studies, participants reported experiencing, for example, a "feeling of no boundaries, where I did not know where I ended and where my surroundings began" or that they felt "with every sense and fiber of my being that all things are connected" (Griffiths *et al.*, 2008, p. 629). In accordance, administration of psilocybin produced dose-dependent increases on a questionnaire assessing the construct of *external unity*, that is, feelings of interconnectedness with some objects from the external world.

According to a considerable number of anecdotal reports, ranging from Aldous Huxley to Albert Hofmann, such experiences of unity oftentimes manifest in a sense of connectedness with all living beings, certain plants and animals, or nature as whole. Notably, Masters and Houston (1966) observed their subjects to actively seek out natural settings for their psychedelic experiences.[1] Natural environments, the authors argue, facilitate a unique empathic connection with one's surroundings, the kind of which is not typically encountered in artificial environments. In fact, the authors' reasoning is supported by contemporary evolutionary psychologists' perspective on the human-environment fit. Specifically, although not explicitly mentioning psychedelic substances, the biophilia hypothesis argues that because humans have evolved in the Savannah, they now have an innate preference for such natural environments (Kellert and Wilson, 1995). This hypothesis is supported by abundant findings showing that perceptual exposure to nature has substantial physical and mental health benefits (for a review, see Maller, *et al.*, 2006), and that people have aesthetic preferences for natural environments - be it in art, such as the picture of a landscape, or in real life, such as a park in an urban area (Orians and Heerwagen, 1992). Thus, the intuitive appreciation of natural environments may contribute to the fact that many people anecdotally choose such settings for psychedelic experiences (cf. Erowid Experience Vaults, 2017, for a large selection of such anecdotal reports), which may in turn explain the frequency of reports about feelings of "profound levels of identification or merging with the natural world" (Strassman *et al.*, 2008, p. 277) during the psychedelic state.[2]

This substance-induced self-nature overlap can potentially be understood as a consequence of the ego-dissolution experienced under the influence of psychedelics (Tagliazucchi *et al.*, 2016), and may have unique cognitive and behavioral consequences for the person experiencing it. Social psychological research shows that self-other overlap can be understood as an embodiment of a close relationship, and that it is intimately linked to empathic concern (Aron *et al.*, 1991). Moreover, it typically causes an incorporation of the target's features into the self (Aaron *et al.*, 1991), and conversely, an ascription of one's own characteristics to the target (Galinsky *et al.*, 2005). In case of non-human entities (such as objects found in nature), the latter allows the ascription of uniquely human properties such as mental states (e.g. goals, intentions, desires, emotions) to these entities - a process referred to as anthropomorphism. This could explain why typical experiences by users of classic psychedelics, who took these substances in natural environments, include self-reported encounters with an "earth soul", mother nature, or spirits associated with the hallucinogenic plants themselves (e.g. Kjellgren *et al.*, 2009; Luke, 2011). Such notions can also be frequently encountered in cultures with animist belief systems that have a history of hallucinogenic plant use. These cultures often ascribe a spirit to plants and consider them embodiments of deities that communicate with human beings through their visions (e.g. Luna, 1984; Shanon, 2002, p. 14).

Attributing a mind and feelings to an entity is a process commonly referred to as mind perception. As put by Gray *et al.* (2012), mind perception can be considered the "essence of morality", in that it enables empathic concern for any given entity. Acknowledging that an entity has emotions and feelings is a prerequisite for considering it a moral patient, that is, something that can feel pain and that should hence not be harmed. In line with this reasoning, anthropomorphizing certain elements of nature was found to foster an empathic connection with the natural world (Tam *et al.*, 2013). An evocation of empathy, in turn, is one of the central causes for altruistic behavior, which - in the case of nature - would manifest in increased pro-environmental behavior.

In fact, some indigenous cultures that anthropomorphize natural elements in their religious beliefs indeed engage in more pro-environmental behavior than do neighboring cultures that do not share such an animist belief system (Atran *et al.*, 2002). Tam and colleagues (2013) were among the first to examine this relationship in more detail. They found that anthropomorphism positively predicts conservation behavior and that this relationship is indeed partially explained by empathic feelings towards nature. A similar effect was found for children in Western societies: those children who tended to ascribe mental and emotional qualities to natural entities showed heightened concern for their wellbeing (Gebhard *et al*., 2003). Likewise, adults with a general tendency to anthropomorphize non-human entities were also more likely to report to engage in pro-environmental behavior (Waytz *et al*., 2010). Lastly, there are findings showing that inducing people to take the perspective of an animal - thereby increasing self-other overlap with that animal - increased pro-environmental concern and behavior (Berenguer, 2007).

In sum, there is an empirical connection from psychedelics to experiencing unity and connection with one's environment to empathy-related phenomena and pro-environmental behavior. Based on this indirect link, we designed the present research to test the hypothesis that lifetime experience with classic psychedelics uniquely predicts nature relatedness - specifically, an internal identification with nature - and engagement in pro-environmental behavior. We expect the perceived unity with nature that people typically experience during the psychedelic state to have lasting effects on their personality that persist even after the experience ended. We further contend that the variables have a linear relationship: Frequency of the psychedelic experience, we theorized, would predict degree of engagement in pro-environmental behaviors.

There are two main reasons why observing this direct connection would be of great societal relevance. Firstly, there are manifold benefits on the individual level. Research finds positive relationships between connectedness to nature and happiness as well as other forms of wellbeing (for a recent meta-analysis, see Capaldi *et al*., 2014). Secondly, at a time when the "warming of the climate system is unequivocal" and the "human influence on the climate system is clear" (IPCC, 2014, p. 40), behaviors aimed at the protection of our environment are undeniably crucial. As Roszak *et al*. (1995) suggested, it should be a common goal to heal the fundamental alienation between humans and nature, thereby aiding in the conservation of our planet, by highlighting the reciprocity of their relationship, that is, to increase awareness and acceptance of people's "ecological self". Identifying factors that contribute to this process is therefore an important scientific endeavor - for individual wellbeing as well as for our planet's future.

Methods and results

Variables included in theoretical model

Lifetime experiences with psychedelic substances

Various substances have been classified as "psychedelics" or "hallucinogens" in the past, although pharmacology and psychological effects of these substances can be vastly different (Masters and Houston, 1966; Nichols, 2004). In line with Johnson *et al*. (2008) we focused on four separate classes of substances:

Classic Psychedelic substances. In the present research, we were interested in the unique effects of experience with classic psychedelic substances - or hallucinogens (Nichols, 2004) - on nature relatedness and pro-environmental behavior. These substances are usually characterized by their action as 5-HT_{2A} receptor agonists (Nichols, 2004; Vollenweider and Kometer, 2010). In addition to the effects described above, they cause a long list of somatic (e.g. dizziness, nausea), perceptual (altered shapes and colors, synesthesia), and psychological symptoms (alterations in mood, depersonalization, dreamlike states, hallucinations) (Hollister, 1984; Nichols, 2004). Classic psychedelic substances can be broadly divided into two sub-classes of compounds - tryptamines and phenethylamines.

Classic psychedelic tryptamines include psilocybin, found in various species of the *Psilocybe* genus of mushrooms, dimethyltryptamine (either *N,N*-DMT or 5-MeO DMT), found in hundreds of species in the plant and animal kingdom, d-lysergic acid diethylamide (LSD), a semi-synthetical ergotamine derivate, and ibogaine - an alkaloid found in the *Tabernathe iboga* plant native to West-Central Africa. Ibogaine also acts as a N-methyl-Daspartate (NMDA) receptor antagonist and weak κ-opioid receptor agonist, and can therefore induce symptoms typical of dissociative anesthetics. We decided, however, to group ibogaine with the classic psychedelic substances, as its primary phenomenological effects are believed to be rooted in 5-HT_{2A} receptor affinity (Brown, 2013).

Phenethylamines include mescaline, a compound primarily found in the *Lophophora* and *Echinopsis* genera of cacti (such as Peyote or San Pedro), as well as synthetic compounds such as 2C-B, 2C-E, DOx, or DOM (Shulgin and Shulgin, 1991), which also primarily act upon the 5-HT_{2A} receptor.

Dissociative Anesthetics. The class of dissociatives primarily comprises the atypical anesthetic ketamine (an NMDA receptor antagonist), the over-the-counter cough suppressant dextromethorphan (DXM), phencyclidine (PCP), and newer research chemicals such as methoxetamine (MXE) (Corazza *et al*., 2012). Some of their effects are comparable to the ego-dissolving effects of classic psychedelics. Dissociatives can distort proprioception and sensory perception, and can cause a detachment from one's physical body and the external environment - symptoms referred to as depersonalization and derealization (Curran and Morgan, 2000). In higher doses, dissociatives can cause a "state of wildly dissociated experiences in which other worlds or dimensions that are difficult to describe in words are said to be perceived, all the while being completely unaware of one's individual identity or the outside world" (Pai and Heining, 2007: 62-63). We thus included experience with dissociatives in our model, as they are likely to correlate with frequency of psychedelic experiences and because of their potential effect on self-nature overlap as a function of self-expansion.

Empathogens - sometimes also referred to as entactogens (Nichols, 1986). Chemically related to both classic psychedelics and stimulants, empathogens are a class of substances characterized by their effects on emotional openness, "empathic resonance", and personal relatedness to other human beings. Prominent exemplars include the widely used recreational substances MDMA (or "Ecstasy") and MDA. We included empathogens in our model, since - as outlined above - pro-environmental behavior can be framed as an empathic reaction towards nature, that may be strengthened by experiences with empathogens. In fact, one of MDMA's features that makes it especially suitable in aiding the treatment for post-traumatic stress disorder (PTSD; Mithoefer *et al*., 2011) is its increase in empathic social interaction (Sessa, 2016; Vollenweider *et al*., 1998) and pro-social feelings (Dumont *et al*., 2009) that may in theory similarly extend to encompass the entirety of the natural world.

Natural deliriants. This class of substances comprises anticholinergic tropane alkaloids such as atropine, hyoscyamine, and scopolamine, commonly found in plants such as datura, belladonna, mandrake, or henbane. As their psychotropic effects - characterized by vivid hallucinations and confusion - are frequently described as extremely unpleasant and consumption can have fatal consequences (e.g. Boumba *et al.*, 2004), most people nowadays refrain from recreationally consuming natural deliriants. However, their historic use as natural hallucinogens and dissociatives (Rudgley, 1995) qualifies them for inclusion in our model. Further included in this category are GABAA agonists such as muscimol and ibotonic acid, typically found in mushrooms of the *Amanita* genus.

Control variables

In addition to the various classes of psychedelic substances listed above, we included a selection of covariates in our model for which we had direct predictions with regard to their relation to psychedelic drug consumption and nature relatedness. These covariates include experience with two other classes of psychoactive substances as well as three personality traits.

Cannabinoids. This class of substances comprises tetrahydrocannabinol (THC), the principal psychoactive compound found in cannabis, and synthetic variants of it. Cannabis was included in the model because of its historical entheogenic use in religious ceremonies (Courtwright, 2001), and the fact that it is the most commonly consumed illicit substance in the United States (Center for Behavioral Health Statistics and Quality, 2015). Further, it is strongly associated with counterculture and liberal politics (e.g. Bachman *et al.*, 1980), both of which are positively related to pro-environmental behavior (Feinberg and Willer, 2013). In fact, research found that adolescents prefer to consume cannabis in natural settings, and reported increased feelings of reconnection with the natural world (Moffat *et al.*, 2009).

Popular legal drugs. To assess whether a mere appreciation of mind-altering substances could explain a potential effect of psychedelics on nature relatedness in our model, we included a class of substances comprising the three most-consumed legal psychoactive substances in the United States - and probably the world - namely caffeine, nicotine, and alcohol (Center for Behavioral Health Statistics and Quality, 2015).

Conscientiousness. Lastly, we added to three personality variables to our model. The personality trait of conscientiousness, one of the so-called "Big 5" personality traits, describes individual differences in propensity to follow socially prescribed norms and rules (Gosling *et al.*, 2003). In our model, we included this variable both as a predictor of nature relatedness and pro-environmental behavior. In line with the literature, we expected conscientiousness to be negatively correlated with consumption of unhealthy or illegal substances (as one is not "supposed to" engage such behaviors) (Bogg and Roberts, 2004), and positively associated with pro-environmental behavior and ecological concern (Nisbet *et al.*, 2009).

Openness to experience. As a second covariate, we decided to include the personality trait of openness to experience in our theoretical model (Gosling *et al.*, 2003). Openness was found to be positively associated with non-conformity and positive attitude towards psychoactive drugs (e.g. Mabry and Khavari, 1986), as well as with positive attitudes towards nature (Nisbet *et al.*, 2009). We therefore theorized that this variable would predict both consumption of psychedelic substances and nature relatedness.

Political conservatism. Lastly, we included political conservatism as covariate in the model, using it to predict both nature relatedness and pro-environmental behavior. Political conservatism was found to be negatively correlated with recreational drug attitudes (Kurzban *et al.*, 2010), and is historically related to drug prohibition and to authoritarianism rather than liberal worldviews. Right-wing authoritarianism was similarly found to be highly negatively correlated with environmental concern (Schultz and Stone, 1994). We thus expect this personality variable to negatively predict both experience with psychedelic substances and pro-environmental behavior, thereby potentially accounting for any effect we might find between those two constructs.

Nature relatedness

As a potential mediating process, we included Nisbet and colleagues' (2009) construct of nature relatedness in our model. Nature relatedness is a considerably stable personality trait that captures people's ecological self-construal, or ecological identity, and thus centers around their perceived connectedness with the natural world. Unlike past constructs, it includes people's affective, cognitive, as well as physical relationship with nature, and therefore involves both people's concrete feelings towards outdoor environments, as well as their abstract understanding of their interconnectedness with all living beings on this planet. According to the authors, the construct of nature relatedness (NR) can be separated into three sub-dimensions, labeled NR-Self, NR-Perspective, and NR-Experience, representing different facets of a person's relationship with the natural world (Nisbet *et al.*, 2009).

NR-Self. This dimension represents people's internalized identification with nature, and therefore most closely describes their ecological identity. It reflects feelings and thoughts about one's personal relationship with nature, exemplified by agreement to questionnaire items such as "I feel very connected to all living things and the earth" or "I am not separate from nature, but a part of nature". In line with our hypothesis outlined above, we expected this factor to be primarily affected by experience with classic psychedelic substances, as they seem to broaden people's self-construal and to facilitate incorporate of external objects and entities into the self.

NR-Perspective. This second sub-dimension captures people's external, nature-related attitudes and behaviors, and revolves around the environmental impact of individual human actions as well as humanity's general negative impact on the planet. This sub-dimension is exemplified by questionnaire items such as "Humans have the right to use natural resources any way we want" (reverse-coded) or "The state of nonhuman species is an indicator of the future for humans". Although this dimension is conceptually closest to pro-environmental behavior, we expected it to be affected by experience with classic psychedelics to a lesser extent, when accounting for its intercorrelation with the other two sub-dimensions.

NR-Experience. The third sub-dimension of the nature relatedness construct is NR-Experience. It captures people's affect-based attitudes towards actual nature-related experiences, and revolves around people's attraction to nature and their desire of being in a natural environment. According to Nisbet and colleagues (2009), this aspect of nature relatedness can be found, for example, in people who are "drawn to the wilderness, and who are aware of and fascinated with nature all around them". It is exemplified by questionnaire items such as "My ideal vacation spot would be a remote, wilderness area" or "I enjoy digging in the earth and getting dirt on my hands". As this sub-dimension is based on feelings of familiarity - or a close relationship - with nature, we expected it to be similarly affected by experience with classic psychedelic substances.

Pro-environmental behavior

As our main dependent variable, we included self-reported pro-environmental behavior in our theoretical model. Because we were interested in a broad range of pro-environmental behaviors, we followed an approach by Whitmarsh and O'Neill (2010), and focused on 12 so-called "headline behaviors" (some of them assessed by multiple items) that were established by the UK DEFRA (2008). These behaviors comprise actions that have both low and high impact on the environment. In addition, some of them are one-off, while others need to be performed on a regular basis. According to Whitmarsh and O'Neill (2010), these actions tap into four general areas of pro-environmental concern: domestic energy/water use (e.g. more responsible water use), waste behavior (e.g. more recycling), transport (e.g. less flying), and eco-friendly shopping (e.g. buying more environmentally friendly products). We decided on following this approach of assessing pro-environmental concern, as we wanted to focus on everyday pro-environmental behavior that is (for the most part) not immediately related to the nature relatedness construct outlined above. That is, our goal was to capture behaviors that affect nature more indirectly, rather than behaviors that are directly aimed at protecting nature, such as saving the rainforest or planting trees.

In our model we expected pro-environmental behavior to be affected by the different sub-dimensions of nature relatedness (Nisbet *et al.*, 2009). That is, any effect that experience with psychoactive substances may have on pro-environmental behavior, we expected to be mediated by one of these sub-dimensions.

Participants and design

In total, 1501 participants, recruited from Amazon.com's Mechanical Turk website, completed the study in exchange for modest financial compensation. Out of these participants, 14 were excluded from data analysis, as they indicated that they responded to one or more items randomly or in a purposefully wrong manner. This left us with a final sample of 1487 participants (913 female, 566 male, 8 other), with a mean age of 35.77 years (SD = 11.88), and an age-range from 18 to 78 years (Table 1).

Table 1. Demographics

Sample characteristics (*n* = 1487)		Frequency (Percentages)
Gender		
	Male	566 (38.1%)
	Female	913 (61.4%)
	Other	8 (0.5%)
Age		
	18 - 30	599 (40.3%)
	31 - 40	462 (31.1%)
	41 - 50	219 (14.7%)
	51 - 60	146 (9.9%)
	> 60	60 (4.0%)
Ethnicity		
	White	1206 (81.1%)
	Black	101 (6.8%)
	Hispanic	75 (5.0%)
	Native American	9 (0.6%)
	Asian	67 (4.5%)
	Other	29 (2.0%)
Sexuality		
	Straight	1340 (90.1%)
	Gay/Lesbian	60 (4.0%)
	Other/None	76 (5.1%)
Native speaker		
	Yes	1440 (96.8%)
	No	47 (3.2%)
Education (highest)		
	School	5 (0.3%)
	High School	308 (20.7%)
	College	410 (27.6%)
	Bachelor	574 (38.6%)
	Master	156 (10.5%)
	PhD/MD	34 (2.3%)
Socio-economic status: 1 (very low) to 10 (very high)		
	Low (1 to 3)	291 (19.6%)
	Medium-Low (4 to 5)	491 (33.0%)
	Medium-High (6 to 7)	589 (39.6%)
	High (8 to 10)	116 (7.8%)
Political preference: 1 (strongly liberal) to 7 (strongly conservative)		
	Liberal (1 to 2)	496 (33.4%)
	Moderate (3 to 5)	782 (52.6%)
	Conservative (6 to 7)	208 (14.0%)
Drug attitudes: 1 (extremely negative) to 7 (extremely positive)		
	Very negative (1 to 2)	644 (43.3%)
	Moderate (3 to 5)	723 (48.6%)
	Very positive (6 to 7)	120 (8.1%)

Mechanical Turk is a so-called crowdsourcing website, on which users can complete minor tasks, such as participating in a research survey, in exchange for small monetary incentives. It allows for rapid collection of data from a sample that is surprisingly representative of the US population - oftentimes more so than samples obtained through census-representative web-panels (Redmiles *et al.*, 2017) - especially when it comes to gender and ethnicity of participants. Participants on Mechanical Turk, however, tend to be younger and more educated than the general population (Pew Research Center, 2017). Although participants take part in these studies using their own electronic devices (e.g. PCs, mobile phones), data quality matches (and sometimes exceeds) that achieved through traditional means of data collection, such as laboratory studies (Buhrmester *et al.*, 2011; Goodman *et al.*, 2013; for a review see Paolacci and Chandler, 2014), despite the fact that participants are highly experienced in participating in psychological surveys (Rand *et al.*, 2014). Past research has already made use of Mechanical Turk to collect data from clinical populations (Shapiro *et al.*, 2013), and it was successfully used in drug-related surveys, for example in a study of daily alcohol consumption (Boynton and Richman, 2014). Although the sample is to some extend self-selected (as is the case for most panel data), increased anonymity of the respondents may actually foster more honest and less socially desirable responding, especially when it comes to sensitive topics such as consumption of illicit substances (see Krumpal, 2013 for an overview).

Materials and procedure

First, participants completed a newly developed questionnaire, assessing their lifetime experience with 30 psychoactive substances. For each substance, participants were asked to indicate on a binary measure whether they "ever took it for recreational purposes - that is, when [it was] not taken for treatment of a medical condition". If they answered "yes" they were prompted to indicate on a scale ranging from 1 (*very rarely*) to 5 (*very often*) how often they took the respective substance in the past. If a participant indicated that he or she had no experience with a given substance, they received a score of "0" (see Supplementary Information for the entire list of substances).

Subsequently, participants worked on the Nature Relatedness Questionnaire by Nisbet and colleagues (2009), assessing their individual relationship with nature on three unique dimensions. Specifically, participants were asked to indicate their agreement with 21 statements using a scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Items included statements such as "My ideal vacation spot would be a remote, wilderness area" or "Animals, birds and plants should have fewer rights than humans" (reverse-coded).

Subsequently, all participants proceeded to work on a second questionnaire assessing their self-reported frequency of engaging in various pro-environmental actions. To that end, they were asked to indicate for a selection of 17 pro-environmental actions, taken from Whitmarsh and O'Neill (2010), how often (if at all) they take each action, using a 4-point scale labeled 1 (*never*), 2 (*occasionally*), 3 (*often*), and 4 (*always*).[3]

At the end of the survey, participants responded to the Ten-Item Personality Inventory (Gosling *et al.*, 2003) as a short assessment of the "Big Five" personality traits. Specifically, participants were presented with 10 statements, each beginning with "I see myself as ____", followed by two adjectives related to personality (e.g. "Anxious, easily upset"). For each statement, participants were asked to indicate their agreement using a Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Lastly, we assessed a set of demographic variables. Participants indicated their age, gender (*male, female, other*), ethnicity (*Black, White, Hispanic, Native American, Asian, other*), sexuality (*straight, gay/lesbian, other/none*), whether English was their first language (*yes, no*), their highest level of education (*school, high school, college, bachelor, master, PhD/MD*) including which subject they majored in, their self-assessed socio-economic status (i.e. "your or your family's economic and social position in relation to others"), from 1 (*very low*) to 10 (*very high*), their general attitude towards psychoactive substances, from 1 (*extremely negative*) to 7 (*extremely positive*), and their political orientation, from 1 (*strongly liberal*) to 7 (*strongly conservative*). As a data exclusion criterion, we asked participants on a binary item, whether they answered one or multiple questions in a random (or purposefully wrong) manner.

Results

Experience with psychedelic drugs

Of all participants, 26.9% indicated previous experience with at least one classic psychedelic substance (Figure 3). Notably, this number is substantially greater than the approximately 13.6% found in the NSDUH study of the Substance Abuse and Mental Health Services Administration of the United States Department of Health and Human Services for the years 2008 to 2012 (Hendricks *et al.*, 2015).

Post-hoc modifications to the model

We modified our theoretical model in two noteworthy ways. First, we had to drop the latent variable for natural deliriants from the model, as less than 1% of our sample had experience with any of the three substance groups that comprise it (i.e. 3, 5, and 11, people, respectively). That is, overall experience with these substances was too low to interpret any potential results. Second, we analyzed modification indices of the model and found that additional covariation between the indicator variables "other psychedelics" and "other dissociatives", β = 0.251, *SE* = 0.025, *p* < .0000001, 95%CI = [0.201; 0.300], as well as "other psychedelics" and "other empathogens", β = 0.329, *SE* = 0.024, *p* < .0000001, 95% CI = [0.282; 0.376], meaningfully improved model fit (Figure 1). Theoretically, this covariation could be explained by a personality variable that fosters interest in rare psychoactive substances, a tendency to consume unknown substances, or forgetfulness with regard to consumed substances.

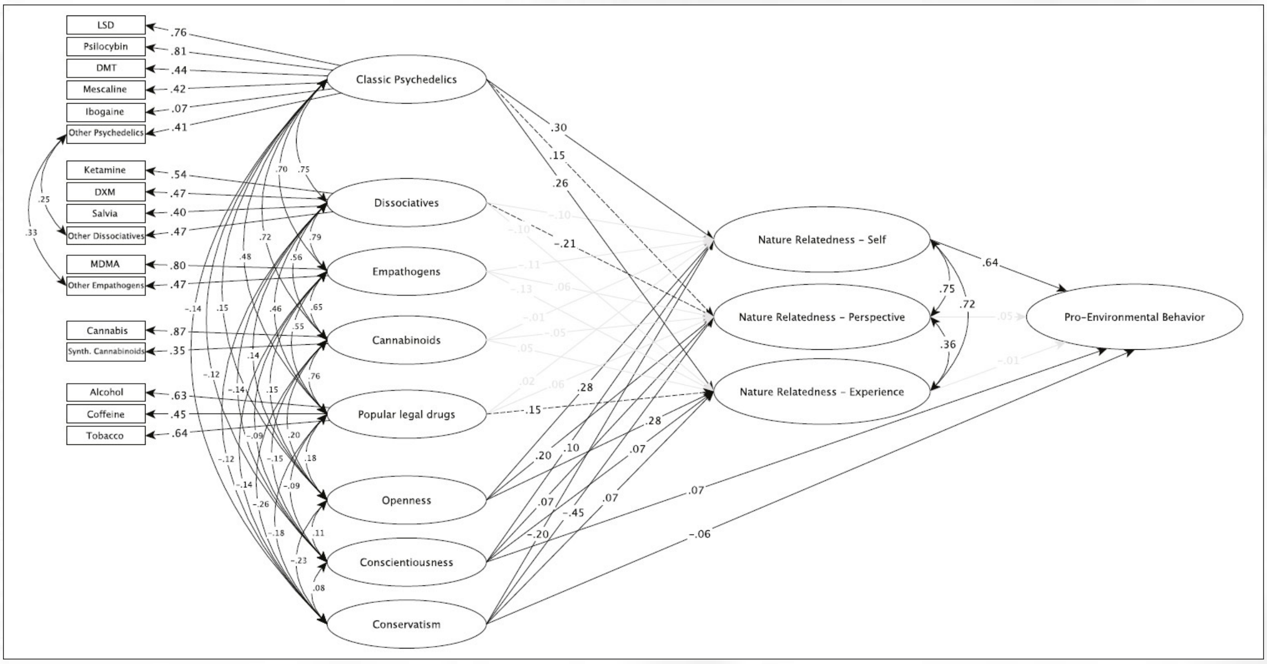

LSD
Psilocybin
DMT
Mescaline
Ibogaine
Other Psychedelics
Ketamine
DXM
Salvia
Other Dissociatives
MDMA
Other Empathogens
Cannabis
Synth. Cannabinoids
Alcohol
Coffeine
Tobacco
.76
.81
.44
.42
.07
.41
.54
.47
.40
.47
.80
.47
.87
.35
.63
.45
.64
.25
.33
Classic Psychedelics
Dissociatives
Empathogens
Cannabinoids
Popular legal drugs
Openness
Conscientiousness
Conservatism
Nature Relatedness – Self
Nature Relatedness – Perspective
Nature Relatedness – Experience
Pro–Environmental Behavior
.30
.15
.26
–.21
.15
.64
.75
.72
.36
.05
–.01
.28
.20
.10
.28
.07
.07
.45
.07
–.20
.07
–.06

Figure 1. Structural equation model for Model 1. All values indicate standardized regression coefficients. Significant paths ($p < .05$) are displayed in black, marginally significant paths ($p < .10$) are displayed stroked, non-significant paths are displayed in gray.

Structural equation model

To keep the number of indicators in our model at a minimum and thereby reduce the chance for estimation errors, indicators for the three nature relatedness subscales were parceled once, while the 17 indicators for pro-environmental behavior were parceled twice, following the procedure recommended by Little *et al.* (2002). Data analysis was performed in R 3.2.3 (R Core Team, 2015), using the LAVAAN Package for structural equation modeling (Rosseel, 2012). Models fit estimates were obtained through full information maximum likelihood estimations (FIML). The overall model fit turned out to be acceptable, indicated by comparative fit index (CFI) = .889, Tucker-Lewis Index (TLI) = .869, and root mean square error of approximation (RMSEA) = .052, 90% CI = [.050; .054].

All indicators significantly contributed to their respective latent variables. As predicted, all exogenous variables were highly intercorrelated (Figure 1). That is, lifetime experience with a given substance class always covaried with experience with a different substance class (all p values $< .001$). As further predicted, the personality dimensions of conservatism (all p values $< .001$) and conscientiousness (all p values $< .01$) were negatively related to experience with each substance class, while openness to experience was positively related to these experiences (all p values $< .0001$). In a similar manner, the three subscales of nature relatedness significantly covaried with one another: NR-Experience with NR-Perspective, $\beta = 0.356$, $SE = 0.033$, $p < .0000001$, 95% CI = [0.291; 0.422], NR-Experience with NR-Self, $\beta = 0.724$, $SE = 0.020$, $p < .0000001$, 95% CI = [0.685; 0.763], as well as NR-Perspective with NR-Self, $\beta = 0.746$, $SE = 0.021$, $p < .0000001$, 95% CI = [0.704; 0.788].

Importantly, in this model, 14 significant and three marginally significant regression paths emerged (see Figure 1). In line with our main hypothesis, lifetime experience with classic psychedelic substances positively predicted two subscales of nature relatedness, NR-Self, $\beta = 0.303$, $SE = 0.081$, $p < .001$, 95% CI = [0.144; 0.462], and NR-Experience, $\beta = 0.256$, $SE = 0.087$, $p = .003$, 95% CI = [0.086; 0.427]. In other words, participants who had more experience with classic psychedelics were more inclined to see nature as a part of their selves, and had a greater propensity to enjoy being in a natural environment, independent of their history with other (related or unrelated) classes of psychoactive substances, their core personality traits, or their political orientation. Our data thus suggest that classic psychedelics have a unique effect on how people perceive themselves in relation to nature that persists long after the experience ended.

While none of the other substance classes significantly predicted any of the three nature relatedness subscales, three marginally significant regression paths emerged. First, in addition to the significant paths reported above, lifetime experience with classic psychedelics also positively predicted the third NR subscale, that is, NR-Perspective, hinting at a broader effect of experience with classic psychedelics on various facets of nature relatedness, $\beta = 0.150$, $SE = 0.087$, $p =.085$, 95% CI = [-0.021; 0.321]. In addition, two unpredicted pathways emerged. For one experience with dissociative anesthetics negatively predicted NR-Perspective, $\beta = -0.210$, $SE = 0.110$, $p =.056$, 95% CI = [0.426; 0.006], while experience with popular legal drugs positively predicted the experience dimension of nature relatedness, $\beta = 0.145$, $SE = 0.077$, $p =.059$, 95% CI = [-.006; 0.296]. Notably, though, these marginally significant paths turn non-significant when the model is slightly altered (see below).

As further hypothesized, the three nature relatedness subscales were each significantly predicted by all three of our personality-related control variables (all p values $< .017$). While conscientiousness and openness to experience both positively predicted all three sub-dimensions of nature relatedness, political conservatism had a more complex relationship with the construct: It was (expectedly) negatively related to NR-Perspective and NR-Self, yet positively related to NR-Experience (Figure 1). Importantly, when accounting for the intercorrelation of the nature relatedness subscales, the NR-Self dimension exclusively predicted pro-environmental behavior. That is, the more people perceived nature to be an integral part of their selves, the more they reported engaging in various pro-environmental behaviors, $\beta = 0.638$, $SE = 0.086$, $p < .0000001$, 95% CI = [0.470; 0.806]. The two other sub-dimensions of nature relatedness did not predict engagement in these behaviors. That is, despite their interrelation, only the dimension of nature relatedness associated with people's self-construal ultimately affected their self-reported ecological behavior in our model.

Finally, both conscientiousness, $\beta = 0.070$, $SE = 0.023$, $p =.002$, 95% CI = [0.026; 0.114], and political conservatism, $\beta = -0.064$, $SE = 0.028$, $p =.025$, 95% CI = [-0.119; -0.008], directly predicted self-reported engagement in pro-environmental behavior in the hypothesized directions.

Mediation analysis

As lifetime experience with classic psychedelics exclusively predicted the NR-Self dimension, and this dimension uniquely predicted participants' self-reported pro-environmental behavior, we tested whether this indirect path would explain any direct effect of experience with psychedelics on pro-environmental behavior. We therefore added an additional direct path from the latent variable for classic psychedelics to pro-environmental behavior to our model, in order to test for statistical mediation. Inclusion of this additional path affected neither the overall model fit nor the significance of any of the regression paths in the model.

As depicted in Figure 2, we found that increases in NR-Self indeed mediated the effect of experience with classic psychedelics on pro-environmental behavior. The total effect of lifetime experience with psychedelics on this variable was highly significant, $\beta = 0.231$, $SE = 0.056$, $p < .001$, 95% CI = [0.114; 0.347]. Importantly, however, we found a statistically significant indirect effect, $\beta = 0.182$, $SE = 0.056$, $p = .001$, 95% CI = [0.073; 0.292]. Controlling for this indirect effect substantially weakened the direct effect and turned it marginally significant, $\beta = 0.048$, $SE = 0.026$, $p = .061$, 95% CI = [-0.002; 0.099]. In other words, the effect of lifetime experience with classic psychedelics on pro-environmental behavior is partially accounted for by the extent to which people's self-construal incorporates the natural world.

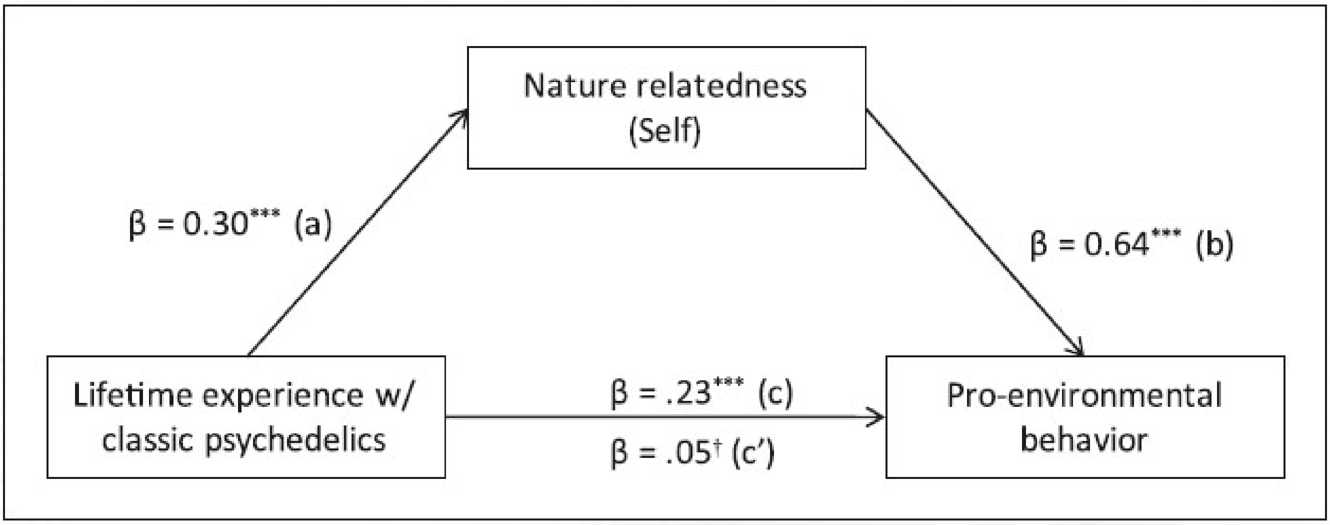

Nature relatedness (Self)
β = 0.30*** (a)
β = 0.64*** (b)
Lifetime experience w/ classic psychedelics
β = .23*** (c)
β = .05† (c')
Pro-environmental behavior

Figure 2. Mediation analysis. βs represent standardized regression coefficients. (c) indicates the total effect, (c') indicates the direct effect when controlling for the indirect effect (a × b). Other variables in the structural equation model are not displayed, but statistically accounted for.
*** = $p < .001$, † = $p < .10$.

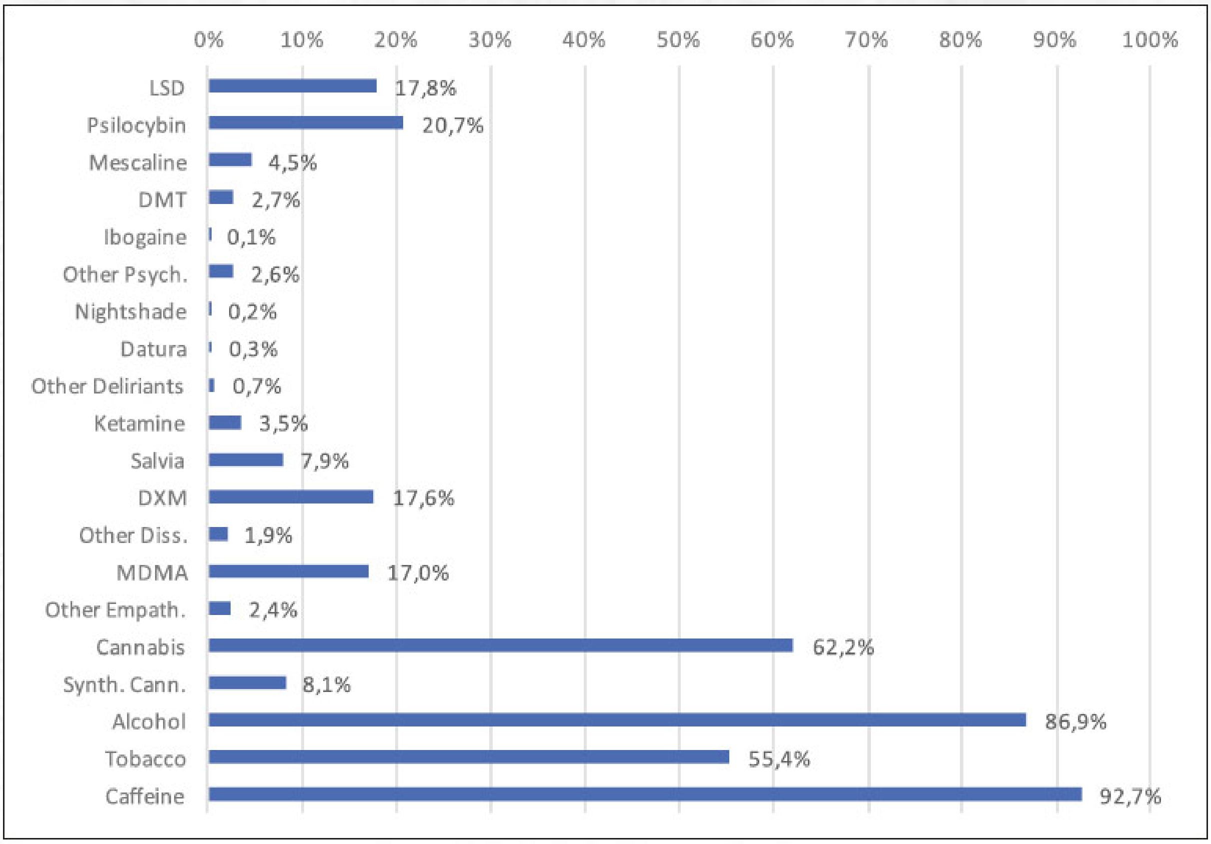


Figure 3. Lifetime experience with psychoactive substances included in the theoretical mode.

Alternative models

See Table 2 for additional model comparisons. In Model 2 we included demographic covariates, using them to predict both the three subscales of nature relatedness and pro-environmental behavior. Model 3 was identical to Model 2 with the addition of the three remaining personality variables from the "Big 5". In general, inclusion of additional variables and regression paths decreases model fit, but we found no change in (non) significance of the paths. As a notable exception, the marginally significant paths from Model 1 (see above), turn non-significant with the inclusion of additional covariates. Lastly, Model 4 was identical to Model 1, but replaced the three NR-Subscales with a single overall NR-Score (cf. Nisbet *et al.*, 2009). Here, too, classic psychedelics remained the only significant predictor of nature relatedness. In all alternative models, we found a statistically significant mediation of the NR-Self dimension (or in Model 4 the overall NR-Score) in the relationship between lifetime experience with classic psychedelics and pro-environmental behavior.

Table 2. Model comparisons.

#	Model	Model Fit	Significant Paths[A]	Coefficients[B]
1	Basic Model	CFI = .889	C. Psych. → NR-Self	β = 0.303***
		TLI = .869	C. Psych. → NR-Exp.	β = 0.256**
		RMSEA = .052,	C. Psych. → NR-Persp.	β = 0.256**
		90% CI: [.050; .054]	Disso. → NR-Persp.	β = -0.210†
			PopDrug → NR-Exp.	β = 0.145†
			NR-Self → ProEnv.	β = 0.638****
2	Model 1 +	CFI = .830	C. Psych. → NR-Self	β = 0.225**
	Demographic	TLI = .803	C. Psych. → NR-Exp.	β = 0.180*
	covariates:	RMSEA = .050, 90% CI: [.048; .051]	NR-Self → ProEnv.	β = 0.673****
	Age, SocEco-Status, Drug Attitudes, Education, Gender, Language, Sexuality, Ethnicity			
3	Model 2 +	CFI = .822	C. Psych. → NR-Self	β = 0.212**
	personality	TLI = .791	C. Psych. → NR-Exp.	β = 0.175*
	covariates:	RMSEA = .049, 90% CI: [.048; .051]	NR-Self → ProEnv.	β = 0.657****
	Extraversion, Em. Stab., Agreeableness			
4	Model 1	CFI = .812	C. Psych. → NR-All	β = 0.301***
	with single overall NR-Score	TLI = .787 RMSEA = .066, 90% CI: [.065; .068]	NR-All → ProEnv.	β = 0.663****

NR: Nature Relatedness (Exp. = Experience, Per. = Perspective); ProEnv: Pro-Environmental Behavior; Em.Stab.: Emotional Stability; SocEco-Status: Socio-Economic Status; C. Psych.: Classic Psychedelics; Disso: Dissociatives; PopDrugs: Popular legal drugs.

[A] Only (marginally) significant paths from substance experience to NR, and from NR to pro-environmental behavior are listed. Paths from covariates to mediator or DV are not listed.

[B] Significance levels: **** = $p < .00001$, *** = $p < .001$, ** = $p < .01$, * = $p < .05$, † = $p < .10$.

Summary

We found a linear relationship between lifetime experience with classic psychedelic substances and scores on two sub-dimensions of nature relatedness, NR-Self and NR-Experience. The more people had experience with classic psychedelics, the more they enjoyed spending time in nature, and the more they construed their self as being a part of nature. None of the other substance classes included in our model significantly predicted any of the nature relatedness dimensions individually.

NR-Self, in turn, was the only dimension of nature relatedness that positively predicted self-reported engagement in pro-environmental behavior, and significantly mediated the relation between experience with classic psychedelics and pro-environmental behavior. That is, the perception of being part of the natural world - rather than being separate from it - that is heightened for people who have experience with classic psychedelics, is largely responsible for the increased pro-environmental behavior that these people report. Notably though, as the direct effect of experience with psychedelics on pro-environmental behavior remains marginally significant after controlling for the indirect effect, it is likely that it is not entirely driven by the mediating variable we identified. Which other factors may contribute to this effect, however, is for future research to determine.

General discussion

In the present research, we identified a novel predictor of nature relatedness and pro-environmental behavior. Results of our study tentatively suggest that experience with classic psychedelic substances may have lasting effects on the way people perceive nature and how strongly they engage in ecological behavior. Specifically, results show that lifetime experience with psychedelic substances (as opposed to other recreationally consumed substance classes) uniquely predicts self-reported nature relatedness, specifically the degree to which people incorporate nature into their self-construal, which in turn predicts self-reported engagement in pro-environmental behavior.

There are, however, a few shortcomings to our study. First and foremost, we did not gather causal evidence for the proposed link between the psychedelic experience and increased nature relatedness. Future studies may address this concern by testing how administration of some of these substances may affect nature relatedness and pro-environmental behavior in the short and long term. Correlational designs - such as the one employed in this research project - suffer from the disadvantage that the directionality of the effect observed is unknown. That is, from an empiric standpoint, it may equally be the case that people who feel greater nature relatedness have a greater propensity to take psychedelic drugs. Because of the correlational nature of our study, we can only argue against this proposition on a theoretical level. As stated in the introduction of this article, there is strong reason to believe that psychedelic substances increase nature relatedness as a function of their ego-dissolving effects (Tagliazucchi *et al*., 2016), with a multitude of anecdotal reports pointing in this direction. For the reversed link, however, this is not the case. There is no reason to believe that people who see nature as an integral part of their selves are more prone to taking psychedelic substances, but show no greater affinity to take other classes of psychoactive substances. For example, while many of the classic psychedelic compounds can be found in nature - thereby potentially explaining a correlation with nature relatedness - the same is true for cannabis, some opiates, tobacco, or deliriants, which did not have significant explanatory power in our study. Thus, the idea that natural substances are more likely to be consumed by people who feel a stronger relatedness to nature cannot explain the present results. In addition, it would be theoretically difficult to explain how specifically the NR-Self dimension - that is, the inclusion of nature in people's self-construal - would cause people to consume more psychedelic drugs, whereas this would not be the case for their general appreciation of being outdoors (NR-Experience) or strong political views with regards to environmental issues (NR-Perspective). Lastly, as the relationship we found remained significant after controlling for demographic variables and personality traits such as openness to experience, conscientiousness, or political attitudes, it is unlikely that the association we found can be entirely explained by a collection of personality traits stereotypically associated with psychedelic users (e.g. being of the "hippie" type).

Still, while theoretically less plausible, the present data cannot entirely rule out reverse causality or a hidden influence by a third variable that was not assessed in this study. Therefore, future research should focus on determining whether the effects reported here can be causally validated through experimental means. For example, in addition to administration studies, one way to rule out some of the concerns inevitably present in correlational designs is to test the hypothesis in more elaborate within-subject designs based on longitudinal data. Thereby it would be possible to track people's views on nature and their ecological behavior over time while investigating how consumption of psychedelic substances affects these trends.

Similarly, it would make sense to more thoroughly investigate whether the settings in which psychedelics are consumed potentially influence the degree to which they have an effect on people's nature relatedness. As argued above, the ego-dissolution and simultaneous merging of the self with the outside world that people typically experience under higher doses of psychedelic substances may constitute general, unspecific phenomena that only relate to people's perception of nature when the respective substance is taken in a naturalistic setting. In other words, potential administration or longitudinal studies should assess and manipulate where the substances are consumed, and whether this has an effect on the degree to which the natural world is incorporated into people's self-construal. In the same vein, it would be crucial for future research endeavors to further investigate the moderating role that degree of experienced eg-odissolution plays in the association between past experience with psychedelics and nature relatedness. As we found a linear relationship between both constructs, one could hypothesize that greater experience with psychedelics caused subjects to also consume higher doses of these substances, which in turn could have increased the likelihood of experiencing instances of severe ego-dissolution.

A second shortcoming concerns our main dependent variable in this study, that is, pro-environmental behavior. As we were working with an online sample, we were only able to assess this construct via participants' self-reports. Thus, one alternative interpretation to our findings could be that people who are open to taking psychedelic substances only *say* that they engage in more pro-environmental behavior without actually doing so. This is not to say that these people are more likely to exaggerate or claim falsehoods. It is possible that people who frequently take classic psychedelic substances cultivate a certain lifestyle that views eco-friendly behavior as ideal behavior. Both pro-environmental behavior as well as consumption of psychedelic substances may therefore be two aspects of a culturally propagated stereotype with which users of psychedelics may identify and respond to accordingly. In other words, what may be captured by our measure of pro-environmental behavior could be attributed to participants' ideal-self rather than their true self. Assessing true ecological behavior, however, is an empirically daunting task. One could implement tasks in which - for example - participants are given the opportunity to donate a certain percentage of their compensation to a pro-environmental cause, thereby assessing an actual behavior that has direct consequences for the environment. Hence, future research is needed to investigate actual effects on ecological behavior in more detail. Regardless, in order to investigate any real effects of psychedelic substances in this domain, it would be reasonable to not artificially reinforce these stereotypes and to evaluate use of psychedelic substances outside of their subcultural niches.

In sum, while correlational in nature, the present research tentatively suggests that experience with classic psychedelic substances may uniquely and positively affect people's relationship with nature, especially their self-construal with regard to how strongly they see themselves as being part of nature rather than being separate from it. This, in turn, seems to positively affect their everyday behavior, in that they report to make more ecology-friendly decisions in the domains of energy consumption, waste management, or shopping behavior. Should future studies investigating the causal relationship between psychedelics and nature relatedness confirm the present findings, it would suggest that certain unique experiences can alter people's perceived relationship with nature in a lasting manner. Specifically, such additional findings would confirm that psychedelic experiences can indeed contribute to a behavioral change fostering the caretaking of our environment, which - in light of the continuing destruction of our planet - is of critical importance. Abundant previous findings have suggested that psychedelic experiences can be physiologically and psychologically beneficial, while only very few negative consequences have been observed (e.g. Nutt *et al*., 2013). The present research aims at expanding this literature by providing initial support for the idea that psychedelic substances may positively affect people's perceived relationship with nature. Recent research revealed a growing trend of society's disconnection from nature, as becomes evident in cultural products (Kesebir and Kesebir, 2017). Reversing this trend would be beneficial for both the individual's mental and physical wellbeing and the environment (van den Bosch and Depledge, 2015). In fact, a recent meta-analysis revealed a positive relationship between perceived nature relatedness and positive affect, vitality, and life satisfaction (Capaldi *et al*., 2014). In addition, nature exposure was found to reduce rumination, a maladaptive pattern of self-referential thought associated with depression, thought to partially account for the correlation between urbanization and prevalence for mood-related mental illnesses (Bratman *et al.*, 2015). Therefore, a potential increase in nature relatedness as a consequence of experience with psychedelics may constitute a second pathway by which psychedelic experiences could exert their positive effects on mood and happiness, as demonstrated by recent work on their efficiency in the treatment of mood disorders (e.g. Carhart-Harris *et al.*, 2016). In light of these findings, the present results once more raise the question whether a continuing prohibition of these experiences is indeed a worthwhile pursuit.

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Notes

1. Although empirical evidence for these claims is scarce, some research shows that about 40% of adolescents have a general propensity to consume (for unspecified reasons) illicit substances outdoors (Hussong, 2000). Further, many adolescent cannabis users similarly report to prefer consuming this substance in outdoor settings, partly in order to establish a connection with the natural world (Moffat *et al.*, 2009).
2. In addition, other reasons for consuming psychedelics outdoors could be participants' desire to avoid disruption by sober individuals, avoid contact with law enforcement, or because some of the substances (such as psilocybin-containing mushrooms or peyote-containing cacti) can only be naturally encountered in the countryside, which may thereby indirectly foster their consumption in these settings.
3. Following these measures, we assessed two additional questionnaires for a different research project, fully unrelated to nature relatedness or pro-environmental behavior.

References

1. Aron A, Aron EN, Tudor M, *et al.* (1991) Close relationships as including other in the self. *J Pers Soc Psychol* 60: 241-253.
2. Atran S, Medin D, Ross N, *et al.* (2002) Folkecology, cultural epidemiology, and the spirit of the commons: A garden experiment in the Maya lowlands, 1991-2001. *Curr Anthropol* 43: 421-450.
3. Bachman JG, O'Malley PM and Johnston LD (1980) *Correlates of Drug Use, Part I: Selected Measures of Background, Recent Experiences, and Life-style Orientations*. Ann Arbor, MI: Institute for Social Research.
4. Ball SA (2005) Personality traits, problems, and disorders: Clinical applications to substance use disorders. *J Res Pers* 39: 84-102.
5. Berenguer J (2007) The effect of empathy in proenvironmental attitudes and behaviors. *Environ Behav* 39: 269-283.
6. Bogenschutz MP and Pommy JM (2012) Therapeutic mechanisms of classic hallucinogens in the treatment of addictions: From indirect evidence to testable hypotheses. *Drug Test Anal* 4: 7-8.
7. Bogg T and Roberts BW (2004) Conscientiousness and health-related behaviors: A meta-analysis of the leading behavioral contributors to mortality. *Psychol Bull* 130: 887-919.
8. Boumba VA, Mitselou A and Vougiouklakis T (2004) Fatal poisoning from ingestion of *Datura* stramonium seeds. *Vet Hum Toxicol* 46: 81-82.
9. Brown TK (2013) Ibogaine in the treatment of substance dependence. *Curr Drug Abuse Rev* 6: 3-16.
10. Bratman GN, Hamilton JP, Hahn KS, *et al.* (2015) Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proc Natl Acad Sci USA* 112: 8567-8572.
11. Boynton MH and Richman LS (2014) An online daily diary study of alcohol use using Amazon's Mechanical Turk. *Drug Alcohol Rev* 33: 456-461.
12. Buhrmester M, Kwang T and Gosling SD (2011) Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data? *Perspect Psychol Sci* 6: 3-5.
13. Capaldi CA, Dopko RL and Zelenski JM (2014) The relationship between nature connectedness and happiness: A meta-analysis. *Front Psychol* 5: 976.
14. Carbonaro TM, Bradstreet MP, Barrett FS, *et al.* (2016) Survey study of challenging experiences after ingesting psilocybin mushrooms: Acute and enduring positive and negative consequences. *J Psychopharmacol* 30: 1268-1278.
15. Carhart-Harris RL, Bolstridge M, Rucker J, *et al.* (2016) Psilocybin with psychological support for treatment-resistant depression: An open-label feasibility study. *Lancet Psychiatry* 3: 619-627.
16. Carhart-Harris RL, Erritzoe D, Williams T, *et al.* (2012a) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci USA* 109: 2138-2143.
17. Carhart-Harris RL, Leech R, Williams TM, *et al.* (2012b) Implications for psychedelic-assisted psychotherapy: Functional

magnetic resonance imaging study with psilocybin. *Br J Psychiatry* 200: 238-244.
18. Carhart-Harris RL, Kaelen M, Whalley MG, *et al*. (2015) LSD enhances suggestibility in healthy volunteers. *Psychopharmacology* 232: 785-794.
19. Center for Behavioral Health Statistics and Quality (2015) *Behavioral health trends in the United States: Results from the 2014 National Survey on Drug Use and Health (HHS Publication No. SMA 15-4927, NSDUH Series H-50)*. Retrieved from http://www.samhsa.gov/data/ sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.pdf (accessed 20 October 2016).
20. Corazza O, Schifano F, Simonato P, *et al*. (2012) Phenomenon of new drugs on the Internet: The case of ketamine derivative methoxetamine. *Hum Psychopharm Clin* 27: 145-149.
21. Courtwright DT (2001) *Forces of Habit: Drugs and the Making of the Modern World*. Cambridge, MA: Harvard University Press.
22. Curran HV and Morgan C (2000) Cognitive, dissociative and psychotogenic effects of ketamine in recreational users on the night of drug use and 3 days later. *Addiction* 95: 575-590.
23. DEFRA (2008) *A Framework for Pro-environmental Behaviours*. London, UK: Department for Environment, Food and Rural Affairs.
24. Dumont GJ, Sweep FC, van der Stehen R, *et al*. (2009) Increased oxytocin concentrations and prosocial feelings in humans after ecstasy (3,4-methylenedioxymethamphetamine) administration. *Soc Neurosci* 4: 359-366.
25. Erowid Experience Vaults (2017) *Mushroom Reports*. Retrieved from https://erowid.org/experiences/subs/exp_Mushrooms.shtml (accessed 13 March 2017).
26. Feinberg M and Willer R (2013) The moral roots of environmental attitudes. *Psychol Sci* 24: 56-62.
27. Galinsky AD, Ku G and Wang CS (2005) Perspective-taking and self-other overlap: Fostering social bonds and facilitating social coordination. *Group Process Intergroup Relat* 8: 109-124.
28. Gasser P, Holstein D, Michel Y, *et al*. (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202: 513-520.
29. Gebhard U, Nevers P and Billmann-Mahecha E (2003) Moralizing trees: Anthropomorphism and identity in children's relationships to nature. In: Clayton S (ed.) *Identity and the Natural Environment: The Psychological Significance of Nature*. Cambridge, UK: MIT Press, pp. 45-66.
30. Goodman JK, Cryder CE and Cheema A (2013) Data collection in a flat world: The strengths and weaknesses of Mechanical Turk samples. *J Behav Decis Mak* 26: 213-224.
31. Gosling SD, Rentfrow PJ and Swann WB Jr (2003) A very brief measure of the Big-Five personlity domains. *J Res Pers* 37: 504-528.
32. Gray K, Young L and Waytz A (2012) Mind perception is the essence of morality. *Psychol Inq* 23: 101-124.
33. Griffiths RR, Richards W, Johnson M, *et al*. (2008) Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. *J Psychopharmacol* 22: 621-632.
34. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology* 218: 649-665.
35. Griffiths RR, Richards WA, McCann U, *et al*. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187: 268-283.
36. Hendricks PS, Thorne CB, Clark CB, *et al*. (2015) Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *J Psychopharmacol* 29: 280-288.
37. Hollister L (1984) Effects of hallucinogens in humans. In: Jacobs B (ed.) *Hallucinogens: Neurochemical, Behavioral and Clinical Perspectives*. New York, NY: Raven Press, pp. 203-226.
38. Hussong AM (2000) The settings of adolescent alcohol and drug use. *J Youth Adolesc* 29: 107-119.
39. IPCC (2014) *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland: IPCC.
40. Johansen P-Ø and Krebs TS (2015) Psychedelics not linked to mental health problems or suicidal behavior: A population study. *J Psychopharmacol* 29: 270-279.
41. Johnson M, Richards W and Griffiths R (2008) Human hallucinogen research: Guidelines for safety. *J Psychopharmacol* 22: 603-620.
42. Kellert SR and Wilson EO (1995) *The Biophilia Hypothesis*. Washington, DC: Island Press.
43. Kesebir S and Kesebir P (2017) A growing disconnection from nature is evident in cultural products. *Perspect Psychol Sci* 12: 258-269.
44. Kjellgren A, Eriksson A and Norlander T (2009) Experiences of encounters with ayahuasca-"the vine of the soul". *J Psychoactive Drugs* 41: 309-315.
45. Krebs T and Johansen P-Ø (2012) Lysergic acid diethylamide (LSD) for alcoholism: Meta-analysis of randomized controlled trials. *J Psychopharmacol* 26: 994-1002.
46. Krumpal I (2013) Determinants of social desirability bias in sensitive surveys: A literature review. *Qual Quant* 47: 2025-2047.
47. Kurzban R, Dukes A and Weeden J (2010) Sex, drugs and moral goals: Reproductive strategies and views about recreational drugs. *Proc R Soc Lond B Biol Sci* 277: 3501-3508.
48. Little TD, Cunningham WA, Shahar G, *et al*. (2002) To parcel or not to parcel: Exploring the question, weighing the merits. *Struct Equ Modeling* 9: 151-173.
49. Luke D (2011) Discarnate entities and dimethyltryptamine (DMT): Psychopharmacology, phenomenology and ontology. *J Soc Psych Res* 75: 26-42.
50. Luna LE (1984) The healing practices of a Peruvian shaman. *J Ethnopharmacol* 11: 123-133.
51. Mabry EA and Khavari KA (1986) Attitude and personality correlates of hallucinogenic drug use. *Int J Addict* 21: 691-699.
52. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol* 25: 1453-1461.
53. Maller C, Townsend M, Pryor A, *et al*. (2006) Healthy nature healthy people: 'Contact with nature' as an upstream health

promotion intervention for populations. *Health Promot* 21: 44-54.
54. Masters R and Houston J (1966) *The Varieties of Psychedelic Experience*. New York, NY: Rinehart and Winston.
55. Mithoefer MC, Wagner MT, Mithoefer AT, *et al*. (2011) The safety and efficacy of ±3,4-methylenedioxymethamphetamine-assisted psychotherapy in subjects with chronic, treatment-resistant posttraumatic stress disorder: The first randomized controlled pilot study. *J Psychopharmacol* 25: 439-452.
56. Moffat BM, Johnson JL and Shoveller JA (2009) A gateway to nature: Teenagers' narratives on smoking marijuana outdoors. *J Environ Psychol* 29: 86-94.
57. Nichols DE (1986) Differences between the mechanism of action of MDMA, MBDB, and the classic hallucinogens. Identification of a new therapeutic class: Entactogens. *J Psychoactive Drugs* 18: 305-313.
58. Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101: 131-181.
59. Nisbet EK, Zelenski JM and Murphy SA (2009) The Nature Relatedness Scale: Linking individuals' connection with nature to environmental concern and behavior. *Environ Behav* 41: 715-740.
60. Nutt DJ, King LA and Nichols DE (2013) Effects of Schedule I drug laws on neuroscience research and treatment innovation. *Nature Rev Neurosci* 14: 577-585.
61. Orians GH and Heerwagen JH (1992) Evolved responses to landscapes. In: Barkow JH and Cosmides L (eds) *Adapted Mind: Evolutionary Psychology and the Generation of Culture*. New York, NY: Oxford University Press, pp. 555-579.
62. Pai A and Heining M (2007) Ketamine. *Contin Educ Anaesth Crit Care Pain* 7: 59-63.
63. Paolacci G and Chandler J (2014) Inside the Turk: Understanding Mechanical Turk as a participant pool. *Curr Dir Psychol Sci* 23: 184-188.
64. Pew Research Center (2017) *Turkers in this Canvassing: Young, Well-educated and Frequent Users*. Retrieved from http://www. pewinternet.org/2016/07/11/turkers-in-this-canvassing-young-well-educated-and-frequent-users (accessed 13 March 2017).
65. R Core Team (2015) *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.
66. Rand DG, Peysakhovich A, Kraft-Todd GT, *et al*. (2014) Social heuristics shape intuitive cooperation. *Nat Commun* 5: 3677.
67. Redmiles EM, Kross S, Pradhan A, *et al*. (2017) *How Well Do My Results Generalize? Comparing Security and Privacy Survey Results from MTurk and Web Panels to the US*. Retrieved from http://drum.lib. umd.edu/handle/1903/19164 (accessed 13 March 2017).
68. Rosseel Y (2012) Lavaan: An R package for structural equation modeling. *J Stat Softw* 48: 1-36.
69. Roszak TE, Gomes ME and Kanner AD (1995) *Ecopsychology: Restoring the Earth Healing the Mind. Sierra Club Books*. San Francisco, CA: Sierra Club Books.
70. Rudgley R (1995) The archaic use of hallucinogens in Europe: An archaeology of altered states. *Addiction* 90: 163-164.
71. Schultz PW and Stone WF (1994). Authoritarianism and attitudes toward the environment. *Environ Behav* 26: 25-37.
72. Sessa B and Johnson MW (2015) Can psychedelic compounds play a part in drug dependence therapy? *Br J Psychiatry* 206: 1-3.
73. Sessa B (2016) MDMA and PTSD treatment: "PTSD: From novel pathophysiology to innovative therapeutics". *Neurosci Lett* 649: 176-180.
74. Shanon B (2002) *The Antipodes of the Mind*. New York: Oxford University Press.
75. Shapiro DN, Chandler J and Mueller PA (2013) Using Mechanical Turk to study clinical populations. *Clin Psychol Sci* 1: 213-220.
76. Shulgin A and Shulgin A (1991) *PiHKAL*. Berkeley, CA: Transform Press.
77. Smith C (1958) A new adjunct to the treatment of alcoholism: The hallucinogenic drugs. *Q J Stud Alcohol* 19: 406-417.
78. Speth J, Speth C, Kaelen M, *et al*. (2016) Decreased mental time travel to the past correlates with default-mode network disintegration under lysergic acid diethylamide. *J Psychopharmacol* 30: 344-353.
79. Strassman R, Wojtowicz S, Luna LE, *et al*. (2008) *Inner Paths to Outer Space: Journeys to Alien Worlds Through Psychedelics and Other Spiritual Technologies*. Rochester, VT: Park Street Press.
80. Swendsen JD, Conway KP, Rounsaville BJ, *et al*. (2002) Are personality traits familial risk factors for substance use disorders? Results of a controlled family study. *Am J Psychiatry* 159: 1760-1766.
81. Tagliazucchi E, Roseman L, Kaelen M, *et al*. (2016) Increased global functional connectivity correlates with LSD-induced ego dissolution. *Curr Biol* 26: 1043-1050.
82. Tam KP, Lee SL and Chao MM (2013) Saving Mr. Nature: Anthropomorphism enhances connectedness to and protectiveness toward nature. *J Exp Soc Psychol* 49: 514-521.
83. Van Den Bosch MA and Depledge MH (2015) Healthy people with nature in mind. *BMC Public Health* 15: 1-7.
84. Vollenweider FX, Gamma A, Liechti M, *et al*. (1998) Psychological and cardiovascular effects and short-term sequelae of MDMA ("ecstasy") in MDMA-naive healthy volunteers. *Neuropsychopharmacology* 19: 241-251.
85. Vollenweider FX and Kometer M (2010) The neurobiology of psychedelic drugs: Implications for the treatment of mood disorders. *Nat Rev Neurosci* 11: 642-651.
86. Waytz A, Cacioppo J and Epley N (2010) Who sees human? *Perspect Psychol Sci* 5: 219-232.
87. Whitmarsh L and O'Neill S (2010) Green identity, green living? The role of pro-Environmental self-identity in determining consistency across diverse pro-environmental behaviours. *J Environ Psychol* 30: 305-314.

New Aspects of the Occurrence, Chemistry and Cultivation of European Hallucinogenic Mushrooms

by

Jochen Gartz

from Supplemento agli Annali dei Musei Civici di Rovereto, Sezione Archeologica, Storia e Scienze Naturali, vol. 8 (1992)

original source:
http://www.lycaeum.org/leda/Documents/New_Aspects_of_the_Occurrence,_Chemistry,_and_Cultivation_of_European_Hallucinogen_Mushrooms.10430.shtml

Abstract

The analysis of fruit bodies from species of the genera *Psilocybe, Gymnopilus, Inocybe, Conocybe* and *Pluteus* revealed the presence of psilocybin, psilocin and baeocystin in various collections from different countries.
Some investigations about the main synthesis of psilocybin and its derivatives were also carried out. Fruiting of various species could be demonstrated for the first time.
The spontaneous blueing of many of these mushrooms and mycelia as well as some directed biotransformation reactions will also be described.

In 1963, the appearance of an article by HOFMANN *et al.* [1] about the occurrence of psilocybin in European *Psilocybe semilanceata* (Fr.) Kumm. spurred renewed scientific investigation into psychotropic indole derivatives in mushroom species of Europe.

Psilocybe semilanceata (figure 1) is growing wild in Middle and North Europe as well as in other European countries, North- and South-America, Australia and very probably Asia.

The main alkaloids are psilocybin and baeocystin (4-phosphoryloxy-N-methyltryptamine) and in some cases only traces of psilocin [2-5].

For the first time baeocystin was isolated from this species in 1979 [5].

Habitats of the mushrooms are wet grassy fields and uncultivated pastures. The mushrooms grow on manured soil but not directly on dung. It seems than *Psilocybe semilanceata* is the most potent European hallucinogenic mushroom.

Fig. 1 - Naturally grown fruit bodies of *Psilocybe semilanceata* from the Duebener Heide, Germany (9/21/1989).

Samples show a considerable variation in the psilocybin levels of single fruit bodies (0.2 to 2.4% dry weight). But about 1% psilocybin was always determined if the average content from 10 to 20 mushrooms was analyzed. Baeocystin was found to occur along with small amounts of 4-phosphoryloxytryptamine (norbaeocystin).

I have cultivated some fruit bodies of *Psilocybe semilanceata* to determine determinate the alkaloid levels in comparison to naturally grown mushrooms.

Mycelium obtained from the spores of one mushroom was kept as a stock culture on 6% malt agar [6]. The spores can germinate after a storage of the dried mushrooms for 9 months at 20°C.

Fig. 2 - Fruiting of *Psilocybe semilanceata*. [in Erlenmeyer flask]

No indole derivatives have been detected in the mycelia from a surface culture of *P. semilanceata* on liquid malt extract media. In contrast to these results a fruiting of the species (figure 2) yielded fruit bodies with a similar high level of alkaloids as the naturally grown mushrooms (table 1).

This strain fruited after 3 to 4 months but other mycelia failed to form fruit bodies at all.

Table 1
Indole derivatives in fruit bodies of *Psilocybe semilanceata* from the cultivation on a sterile substratum with of compost, rice grain, grass seed, and water (12:3:4:22) after casing with peat/chalk.[6]
Content of dried mushrooms (%)

Flush No.	Psilocybin	Baeocystin
1	0.91	0.15
2	1.04	0.20
3	0.92	0.21
4	1.12	0.19

Fruiting of the subtropical species *Psilocybe cubensis* (Earle) Singer on a dung/rice grain substratum (figure 3) begins earlier than the formation of fruit bodies of *P. semilanceata* (3 to 4 weeks versus 3 to 4 months). But the former species failed to accumulate significant amounts of baeocystin. So both species are important for studying biochemical pathways of the formation of the tryptamine derivatives [7].

P. semilanceata is characterized by a blue-green coloration especially at the stem but blues inconsistently, mostly after several minutes to hours.

The use of this species ("liberty caps") as a hallucinogen is popular in Great Britain, Norway and other European countries for about 20 years. It seems that this mostly moderate use does not cause significant health problems.

Because of the high content of psilocybin dysphoric experiences were described in some cases as of overdoses. It is also well known that one's experiences with hallucinogens depend upon a host of experimental, cultural and psychological factors (setting and set) [8, 9].

Another interesting European species with strong psychoactivity is *Psilocybe bohemica* Sebek [9, 10].

These mushrooms were already found in Czechoslovakia near Sazava in 1942. They blue consistently after bruising and spontaneously in the age. The fruit bodies grow up to 15 cm high on humus and wood chips in the woods.

The species is widespread in Czechoslovakia [9] and it will probably be reported from many other European countries in the next years. Recent finds in Austria and Germany support this claim.

The analysis of fruit bodies revealed psilocybin, baeocystin and in some cases psilocin. Psilocybin levels varied from 0.11% up to 1.34% by dry weight [9]. The content of psilocybin and baeocystin was highest in the caps of the mushrooms (table 2).

Fig. 3 - The subtropical mushroom, *Psilocybe cubensis* [fruiting] on grain/dung without casing. [in Erlenmeyer flask]

Table 2
Amount of indole alkaloids in dried fruit bodies of *Psilocybe bohemica* (%)

Sample	Part of mushroom	Psilocybin	Psilocin	Baeocystin
1	fruit body	0.96	0.02	0.03
2	fruit body	1.34	-	0.01
3	fruit body	0.29	-	0.008
4	fruit body	1.12	-	0.02
5	fruit body	0.94	0.01	0.01
6	fruit body	0.22	0.01	0.02
7	cap	0.42	0.02	0.02
7	stem	0.12	-	0.01
8	cap	1.02	-	0.03
8	stem	0.50	-	0.01

Psilocybin was also found to be contained in the cultivated mycelia of this species. The amount ranged from 0.15% to 0.21% by dry weight in 6 different mycelia grown on 6% malt agar over 4 weeks. No other alkaloids were detected in the mycelial extracts.

A rhizomorphic to closely linear growth on the blueing mycelia was observed on soaked unsterilized cardboard (figure 4).

Fig. 4 - Mycelia of *Psilocybe bohemica* on soaked cardboard

Fruiting of the mycelia on rice grain/water mixture occurred without casing 12 weeks after inoculation (figure 5) but only if a temperature of 4°C was maintained for 3 days at the end of cultivation. This observation is in agreement with the occurrence on the naturally grown fruiting bodies in late autumn and early winter. Wild mushrooms of this species, differing from the cultivated mushrooms mainly by the absence of the 2 rings and the less robust habitat, have very similar other features, microscopic ones and the blueing in particular. The species required diffuse day light for pinhead initiation. Growth of the vegetative mycelia was observed on malt agar at 4°C.

Fig. 5 - Fruit body of *Psilocybe bohemica* on rice grain/water (1:2) 12 weeks after inoculation. [in Erlenmeyer flask]

In 1984 and 1986 Krieglsteiner had classified *P. bohemica* and the similar *Psilocybe serbica* Moser & Horak as *Psilocybe cyanescens* Wakefield [12, 13]. But some doubt still exists about the taxonomic conformity of different collections from Europe and North America.

For example, I have found, that the monokaryotic mycelia on *P. bohemica* and *P. cyanescens* do not form dicaryotic mycelia. Additionally, fruit bodies of *Psilocybe cyanescens* (U.S.A.) generally contained high amounts of psilocin [13, 14].

The recent discovery on hallucinogenic *Inocybe* species was a sensation in the study of the distribution of psilocybin and its derivatives in the fungal world. Until the 80s only muscarin was the classical toxin detected in a great number of the about 160 species of the genus *Inocybe*.

In 1965 J. FERENCZ found a new *Inocybe* species in Hungary. M. BABOS described these blueing mushrooms as *Inocybe aeruginascens* BABOS in 1968 (figure 6). Since 1980 *I. aeruginascens* has caused over 20 accidental hallucinogenic poisonings in East Germany because of some similarities with edible mushrooms like *Marasmius oreades* (Bolt.: Fr.) Fr. [9].

In all of these cases only euphoric experiences with hallucinations and illusions were reported. The mushrooms contained relative constant amounts of psilocybin, baeocystin and in some cases also tryptophan (table 3).

A new indole derivative, which I called aeruginascin, with a still unknown structure was also detected in this species [15-17]. We found only traces of psilocin in a few mushrooms but no muscarin at all.

A few months after my initial paper [17] other groups (for example [18]) have published about the occurrence of psilocybin in *I. aeruginascens*.

Table 3
Content of indole derivatives in dried mushrooms of *Inocybe aeruginascens* (%)

Sample	Psilocybin	Baeocystin	Aeruginascin
1	0.29	0.19	0.15
2	0.40	0.20	0.30
3	0.30	0.18	0.21
4	0.26	0.24	0.35
5	0.36	0.52	0.32

I. aeruginascens is characterized by a blue-green coloration of the stem after bruising or in a few cases spontaneously in the age.

After the detection of psilocybin in *I. aeruginascens* other alkaloid containing mushrooms like *Inocybe corydalina* Quel. or *Inocybe haemacta* (B. & Cooke) Sacc. were found. But in contrast to *I. aeruginascens* , which often grows in colonies of great numbers in parks of Germany and Hungary in grass on sand mainly in May or June, these species are very uncommon, growing in woods, and contain only small amounts of the psychotropic tryptamine derivatives. For example, *I. corydalina* accumulates about 0.01% to 0.03% psilocybin in the dried fruit bodies [18].

So only *I. aeruginascens* can cause significant accidental intoxications. I have isolated a mycelial strain of *I. aeruginascens* which degenerated completely after a few months of cultivation without further growth.

The greenish sclerotia and the brownish mycelia from the surface cultivation also contained about 0.1% psilocybin in the dried biomass.

Fig. 6 - Fruit bodies of *Inocybe aeruginascens* from Potsdam (Germany).

Another very interesting field of research is the occurrence of psilocybin in *Gymnopilus* species. Despite some old stories about possible intoxications with *Gymnopilus spectabilis* (Fr.) A. H. Smith from JapanJapon and some other hallucinogenic experiences with other species from North America no psilocybin could be detected in the genus *Gymnopilus* in Europe until 1988 [19].

In 1978 psilocybin was found in some North American species [19]. Since 1983 *Gymnopilus purpuratus* (Cooke & Mass.) Singer has been observed on heapes of mixtures of pig dung and wood chips in the district of Rostock, Germany. It seems that this blueing species was introduced from Argentina with grain used for forage in pig-breeding during last years. Recently the qualitative detection of psilocybin in extracts of *G. purpuratus* has been described [19]. In this investigation no quantitative analysis of the indole alkaloids was carried out.

In 1989 our own study on the amounts of psilocybin and its derivatives was published (table 4) [20]. It was found that the level of psilocin decreased appreciably during storage. No other species found in Europe contained such high amounts of psilocin like as *G. purpuratus*. Spores of *G. purpuratus* germinated quickly on malt agar.

Table 4
Indole alkaloids in *Gymnopilus purpuratus* (% dry weight)

Sample	Psilocybin	Psilocin	Baeocystin
1	0.29	0.28	0.05
2	0.31	0.29	0.04
3	0.21	0.20	0.03
4	0.28	0.31	0.04
5	0.33	0.28	0.05

The whitish mycelia blues consistently after bruising and after about 3 weeks of cultivation also spontaneously like old naturally grown fruit bodies. Fruiting of the mycelia on rice grain or sawdust and even mixtures occurred after 8 to 12 weeks after inoculation (figure 7). These cultivated mushrooms contained similar amounts of psilocybin and its derivatives as the naturally grown fruit bodies (table 5).

Table 5
Alkaloids in cultivated dried fruit bodies of *Gymnopilus purpuratus* (% dry weight)

Flush No.	Psilocybin	Psilocin	Baeocystin
1	0.13	0.15	0.03
2	0.15	0.18	0.02
3	0.23	0.21	0.04
4	0.18	0.21	0.05
5	0.15	0.14	0.02

Fig. 7 - Fruiting of *Gymnopilus purpuratus* on a rice grain medium. [in Erlenmeyer flask]

Psilocybin has also been found in *Pluteus salicinus* (Pers.: Fr.) Kumm. but this species is uncommon and grows on dead wood. STIJVE *et al*. detected only a mean concentration of 0.25% psilocybin in dried fruit bodies [21]. In my own investigations one collection contained about 1% psilocybin and traces of baeocystin as well as high amounts of urea [22]. In other dried samples I later found 0.4 to 0.6% psilocybin but no psilocin. I think much more investigations should be done to determinate the variation of the alkaloid levels in this species.

Often contradictory reports on hallucinogenic effects of species of the genus *Panaeolus* are explained in terms of differences in chemical composition due to geographical origin ("latent ability to form psilocybin").

Ola'h described such behavior during his investigations of the genus *Panaeolus* [23]. I think that this claim failed completely. All modern analytical investigations with HPLC and TLC including competent mycological examination yielded to a definitive composition of the species.

For example, STIJVE *et al*. [24] and my own investigation [25] could not detect psilocybin and its derivatives in one single mushroom of *Panaeolina foenisecii* (Fr.) Kü.

It seems that only *Panaeolus subbalteatus* (Berk. &Br.) Sacc. (figure 8) contains significant amounts of psilocybin in the genus *Panaeolus* in Europe [26]. All *Panaeolus* species are able to accumulate serotonin and its precursor 5-hydroxy-L-tryptophan as well as urea. I think that Ola'h has misinterpreted these compounds as psilocin because of his use of nonselective analytical methods.

In naturally grown mycelia and fruit bodies of *Panaeolus subbalteatus* there were significant differences in amounts and nature of the metabolites (table 6). Additionally it seems that much more work must be done to study the taxonomy and chemistry on *Panaeolus* species in Europe and even in the world.

Only a very few fruit bodies of *P. subbalteatus* show blueing [26]. In model reactions the oxidation of pure psilocin yielded bluish products [27]. Many enzymes can remove the phosphoric acid from psilocybin to form psilocin before oxidation.

Table 6
Indole derivatives in *Panaeolus subbalteatus* (% dry weight)

Substance	**Mycelium**	**Fruit bodies**
Psilocybin	0.07	0.08-0.70
Baeocystin	-	0.05-0.46
5-OH-L-tryptophan	-	qualitativ
Serotonin	0.10	0.08-0.30
L-Tryptophan	0.20	traces
Psilocin	-	-
Urea	-	1.8-2.3

The very rare species *Conocybe cyanopus* (Atk.) Kühn has been found only twice in East Germany in a period of 50 years. BENEDICT *et al*. found psilocybin in this species from North America, as did other authors later [28]. In Europe some mushrooms of this species contained psilocybin and traces of psilocin (for example the first analysis from Norway [29]).

In 5 naturally grown mushrooms from East Germany (1989) I found about 1% psilocybin and similar amounts of baeocystin as *P. semilanceata* can accumulate. The nonblueing mycelia grow on malt agar very slowly with formation of sclerotia, which also contained about 0.2% psilocybin.

The widespread occurrence of baeocystin in all European psilocybian species and in many other mushrooms from all over the world supports the hypothesis of REPKE *et al*. about the central role of this compound in the biosynthesis of psilocybin [30]. Mycelial cultures of *Psilocybe* species display a high capacity for hydroxylation of synthetic tryptamine derivatives at the 4-position. So specific biotransformations of *N,N*-diethyltryptamine and N-methyltryptamine were found [31].

In model investigations I have also found that the main synthesis of psilocybin and psilocin takes place in the biomass during the process of the formation of fruit bodies or sclerotia [32]. The total content of the alkaloids in the mycelia without fruiting or differentiation was comparatively low. In physiological old mushrooms of *Psilocybe cubensis* the spontaneous blueing is a sign of a significant decomposition of the alkaloids [32].

But in *P. semilanceata* , *I. aeruginascens* , and *P. subbalteatus* this oxidation process with slight blueing does not cause a significant destruction of psilocybin and baeocystin [5, 16, 26].

Fig. 8 - Cultivated fruit bodies of *Panaeolus subbalteatus* from dung/rice grain 92 days after inoculation. [in Erlenmeyer flask]

Acknowledgements:

The author thanks G. DREWITZ, M. SEMERDZIEVA, and G. K. MUELLER, who generously supplied valuable information and mushrooms for chemical analysis.

Bibliography:

1. HOFMANN A., HEIM R. and TSCHERTER H., 1963 - *Présence de la psilocybine dans une espèce européene d'Agaric, le Psilocybe semilanceata Fr. Comptes Rendus ser. D. 257: 10-12.*
2. JOKIRANTA J., MUSTOLA S., OHENOJA E. and AIRAKSINEN M. M., 1984 - *Psilocybin in Finnish Psilocybe semilanceata. Planta Med. 45: 277-278.*
3. STIJVE T., 1984 - *Psilocybe semilanceata als hallucinogene paddestoll. Coolia 27: 36-43.*
4. CHRISTIANSEN A. L., RASMUSSEN K. E. and HØILAND L., 1981 - *The content of psilocybin in Norwegian Psilocybe semilanceata. Planta Med. 42: 229-235.*
5. GARTZ J., 1991 - *Quantitative Bestimmung der Indolderivate von Psilocybe semilanceata (Fr.) Kumm. Biochem. Physiol. Pflanzen 181: 113-128.*
6. STAMETS P. and CHILTON J. S., 1983 - *The mushroom cultivator. Agarikon Press, Olympia, Washington.*
7. GARTZ J., 1991 - *Einfluß von Phosphat auf Fruktifikation und Sekundärmetabolismen der Myzelien von Psilocybe cubensis, Psilocybe semilanceata und Gymnopilus purpuratus. Z. Mykol. 57: 149-153.*
8. LEUNER H., 1981 - *Halluzinogene. Hans Huber, München-Stuttgart-Wien.*
9. GARTZ J., 1993 - *Narrenschwämme. Psychotrope Pilze in Europa, Herausforderung an Forschung und Wertsystem. Editions Heuwinkel, Neuallschwil-Genf.*
10. GARTZ J., 1989 - *Analysis and cultivation of fruit bodies and mycelia of Psilocybe bohemica. Biochem. Physiol. Pflanzen 184: 337-341.*
11. SEMERDZIEVA M., WURST M., KOZA T. and GARTZ J., 1986 - *Psilocybin in Fruchtkörpern von Inocybe aeruginascens. Planta Med. 47: 83-85.*
12. KRIEGLSTEINER G. J., 1984 - *Studien zum Psilocybe-cyanescens-Komplex in Europa. Beiträge zur Kenntnis der Pilze Mitteleuropas 1: 61-94.*
13. KRIEGLSTEINER G. J., 1986 - *Studien zum Psilocybe cyanescens-callosa-semilanceata-Komplex in Europa. Beiträge zur Kenntnis der Pilze Mitteleuropas 2: 57-52.*
14. BEUG M. W. and BIGWOOD J., 1982 - *Psilocybin and psilocin levels in twenty species from seven genera of wild mushrooms in the Pacific Northwest, U.S.A. J. Ethnopharm. 5: 271-285.*
15. GARTZ J., 1989 - *Analysis of aeruginascin in fruit bodies of the mushroom Inocybe aeruginascens. Int. J. Crude Drug Res. 27: 141-144.*
16. GARTZ J., 1987 - *Variation der Alkaloidmengen in Fruchtkörpern von Inocybe aeruginascens. Planta Med. 48: 539-541.*
17. GARTZ J., 1985 - *Vergleichende dünnschichtchromatographische Untersuchungen zweier Psilocybe- und einer halluzinogenen Inocybeart. Pharmazie 40: 134.*
18. STIJVE T., KLAN J. and KUYPER W., 1985 - *Occurrence of psilocybin and baeocystin in the genus Inocybe (Fr.) Fr. Persoonia 12: 469-473.*
19. KREISEL H. and LINDEQUIST U., 1988 - *Gymnopilus purpuratus, ein psilocybinhältiger Pilz adventiv im Bezirk Rostock. Z. Mykol. 54: 73-76.*
20. GARTZ J., 1989 - *Occurrence of psilocybin, psilocin and baeocystin in Gymnopilus purpuratus. Persoonia 14: 19-22.*
21. STIJVE T. and BONNARD J., 1986 - *Psilocybine et ureé dans le genre Pluteus. Mycologia Helvetica 2: 123-130.*
22. GARTZ J., 1987 - *Vorkommen von Psilocybin und Baeocystin in Fruchtkörpern von Pluteus salicinus.. Planta Med. 48: 290-291.*
23. OLA'H G. M., 1970 - *Le Genre Panaeolus. Rev. Mycol., Mem. Hors-Serie 10: 1-273.*
24. STIJVE T., HISCHENHUBER C. and ASHLEY D., 1984 - *Occurrence of 5-hydroxylated indole derivatives in Panaeolina foenisecii (Fries) Kuehner from various origin. Z. Mykol. 50: 361-368.*
25. GARTZ J., 1985 - *Zum Nachweis der Inhaltsstoffe einer Pilzart der Gattung Panaeolus. Pharmazie 40: 431.*
26. GARTZ J., 1989 - *Analyse der Indolderivate in Fruchtkörpern und Myzelien von Panaeolus subalteatus (Berk. & Br.) Sacc. Biochem. Physiol. Pflanzen 184: 171-178.*
27. WEBER L. J. and HORITA A., 1963 - *Oxidation of 4 and 5-hydroxyindole derivatives by mammalian cytochrome oxydase. Life Sciences 1: 44-49.*
28. BENEDICT R. G., BRADY R. G., SMITH A. H. and TYLER V. E., 1962 - *Occurrence of psilocybin and psilocin in certain Conocybe and Psilocybe species. Lloydia 25: 156-159.*
29. CHRISTIANSEN A. L., RASMUSSEN K. E. and HØILAND L., 1984 - *Detection of psilocybin and psilocin in Norwegian species of Pluteus and Conocybe. Planta Med. 45: 341-343.*
30. REPKE D. B., LESLIE D. T. and GUZMAN G., 1977 - *Baeocystin in Psilocybe, Conocybe and Panaeolus. Lloydia 40: 566-578.*
31. GARTZ J., 1989 - *Biotransformation of tryptamine derivatives in mycelial cultures of Psilocybe. J. Basic Microbiol. 29: 347-352.*
32. GARTZ J., 1989 - *Bildung und Verteilung der Indolalkaloide in Fruchtkörpern, Myzelien und Sklerotien von Psilocybe cubensis. Beiträge z. Kenntnis der Pilze Mitteleuropas 5: 167-174.*

Indirizzo dell'autore: J. Gartz: Wip - Kai e. V., Permoserstr. 15, D-07050 Leipzig, Germany.

Mycological investigations on Teonanacatl, the mexican hallucinogenic mushroom

by

Rolf Singer

Part I & II

Mycologia, vol. 50, 1958

© Rolf Singer

original report:
https://mycotek.org/index.php?attachments/mycological-investigations-on-teonanacatl-the-mexian-hallucinogenic-mushroom-part-i-pdf.51166/

Table of Contents:

Part I. The history of Teonanacatl, field work and culture work
- 1. History
- 2. Field and culture work in 1957
- Acknowledgments
- Literature cited

Part II. A taxonomic monograph of psilocybe, section caerulescentes
- Psilocybe sect. Caerulescentes Sing., Sydowia 2: 37. 1948.
- Summary or the stirpes
  - *Stirps. Cubensis*
  - *Stirps. Yungensis*
  - *Stirps. Mexicana*
  - *Stirps. Silvatica*
  - *Stirps. Cyanescens*
  - *Stirps. Caerulescens*
  - *Stirps. Caerulipes*
- Key to species of section Caerulescentes
- Stirps Cubensis

Psilocybe cubensis (Earle) Sing
Psilocybe subaeruginascens Höhnel
Psilocybe aerugineomaculans (Höhnel)
- Stirps Yungensis

Psilocybe yungensis Singer and Smith
- Stirps Mexicana
  - *Psilocybe mexicana Heim*
- Stirps Silvatica
  - *Psilocybe silvatica (Peck)*
  - *Psilocybe pelliculosa (Smith)*
- Stirps Cyanescens
  - *Psilocybe aztecorum Heim*
  - *Psilocybe cyanescens Wakefield*
  - *Psilocybe collybioides Singer and Smith*
    - Description of Maire's sterile to semi-sterile material from Algeria
    - Description of fertile material referred to Hypholoma cyanescens by Malençon
  - *Psilocybe strictipes Singer & Smith*
  - *Psilocybe baeocystis Singer and Smith*

Stirps Caerulescens
Psilocybe aggericola Singer & Smith
Psilocybe candidipes Singer & Smith
Psilocybe zapotecorum Heim
Stirps Caerulipes
Psilocybe Muliercula Singer & Smith
Psilocybe caerulipes (Peck) Sacc.
Literature cited

Part I.
The history of Teonanacatl, field work and culture work[1]

1. History

The use of hallucinogenic mushrooms in Mexico was reported by European and Mexican writers (11) centuries ago, and so is not news. Nor are mushrooms unique as hallucinogens. It is widely known that peyotl, *Lophophora williamsii* (Lem.) Coulter, a cactaceous plant likewise native to Mexico, contains a hallucinatory substance, mescalin. What is new in recent developments is the serious attempt to study the organisms responsible for these curious phenomena, an endeavor logically beginning at the biological level - *i.e.*, with a study of the mycological aspect of the rather complex problem. With this goes an attempt to obtain more details on the ethnobotanical role of the hallucinogenic mushrooms in southern and central Mexico. A consequence, and, to a certain degree, also a motive, of all this renewed interest in the subject is the extraction in pure form of a substance or substances important in medical research, or at least data on the active principle in these fungi which might throw light on phenomena of practical concern, such as the symptoms commonly referred to as schizophrenic, or the question of the maturity factor in neuroses.

Before the first specimens had come to the botanical laboratories, there had been some doubt whether the *teonanácatl* of the literature, a word supposedly meaning "sacred mushroom" in the Aztec language, was actually a mushroom rather than *Lophophora*. The word *teonanácatl* is here used in the sense of Schultes (13), Heim, and in fact the majority of the authors concerned with hallucinogenic mushrooms in Mexico (3, 10, 11, 12, 18, 19) - *i.e.*, as a general term for any hallucinogenic mushrooms used by Mexican Indians in pre-Columbian times and up to the present. While botanical interpretations of the word *teonanácatl* were originally based on Schultes's (13) paper, and referred to one single species of *Panaeolus*, we shall see subsequently that *teonanácatl* is not necessarily a single species, and that it is not - according to our present knowledge - probable that *Panaeolus* spp. are represented in the list of hallucinogenic mushrooms in Mexico.

Actually, the first correct interpretation of *teonanácatl* was published by this writer in 1951 (16, pp. 472, 506). This fact has not been mentioned in the current literature, although the genus *Psilocybe* as well as the species *Psilocybe cubensis* was mentioned by me in the place quoted. These indications were based on material collected by Dr. R. E. Schultes of Harvard University.

Schultes undoubtedly deposited the first botanically useful specimens of hallucinogenic mushrooms from Mexico in an American herbarium. These consisted of two collections, originally placed on one sheet in the Farlow Herbarium, but later separated by the present author (1941). One package containing *Panaeolus* was determined by D. H. Linder, then Curator of the Farlow Herbarium, as *Panaeolus campanulatus* var. *sphinctrinus*. If we disregard questions of nomenclature (the rules of botanical nomenclature necessitate a change in the name used by Linder, to read "*Panaeolus sphinctrinus* (Fr.) Quel."), we may say that Linder's determination is correct. Heim (3) came to the same conclusion. But even though the determination is correct for these specimens, it is obvious from certain data on the label of the collection[2] that there must have been some confusion of the *Panaeolus* with what later became known as *Psilocybe mexicana*, while on the other hand further inquiries show that *Panaeolus* is not one of the genera used by Mazatec Indians of the Huautla region for either religious or medical purposes.

---

1. Published out of order as excess pagination through financial assistance of the National Science Foundation and the University of Michigan Herbarium.
2. The label reads in part: "Springy meadows in rainy season. Huautla de Jiménez, Oaxaca, Mexico, July 27, 1938. Stem 1-2 mm diam., 10 cm high; hemispherical but often cuspidate; gills dark brown-black, whole plant coffee brown, black when dry. Mexican name nanacate. Indian name: she to (eruption of the earth); tso-ska (loco mushroom). Said to be poisonous in overdose of 50-60, but in moderate quantity it produces hilarity and general narcotic feeling of wellbeing for an hour. Excess doses said to produce permanent insanity. ..." It is now evident that "springy meadows" are the characteristic habitat of *Psilocybe mexicana*, and it is this species that is "cuspidate," never *Panoeolus sphinctrinus*; dark brown lamellae would be characteristic for the former, black ones for the latter. The name *she to* is a misspelling of *xi-tjo*, which is the general word for mushrooms and fails to identify the genus.

The other package, originally inserted with the first, remained unnamed in the Farlow Herbarium until this author in 1941 determined it as *Psilocybe cubensis* (Earle) Sing. (at that time still as "*Stropharia caerulescens* (Pat.) Sing. = *Stropharia cubensis* Earle"). Strangely enough, this second collection by Schultes contains a note in which the local name of the species is indicated[3] as *kee-sho*, which in Huautla does not refer to the species represented by the dried carpophores in the package, but to *Psilocybe caerulescens* Murr., as we shall see later. The specimens and data come from the not very accessible Mazatec village Huautla, the same village where the *Panaeolus sphinctrinus* had been collected, and where, later on, by Wasson, Heim, and Singer, *Psilocybe caerulescens* was likewise found (Fig. 1). If we assume that *Psilocybe mexicana* was originally confused with *Panaeolus sphinctrinus*, and *Psilocybe caerulescens* with *Psilocybe cubensis*, by Schultes's source of information, we already have all three important hallucinogenic mushrooms of the Mazatecs, or rather traces of them, in the first two records. These psilocybes will later be treated in more detail.

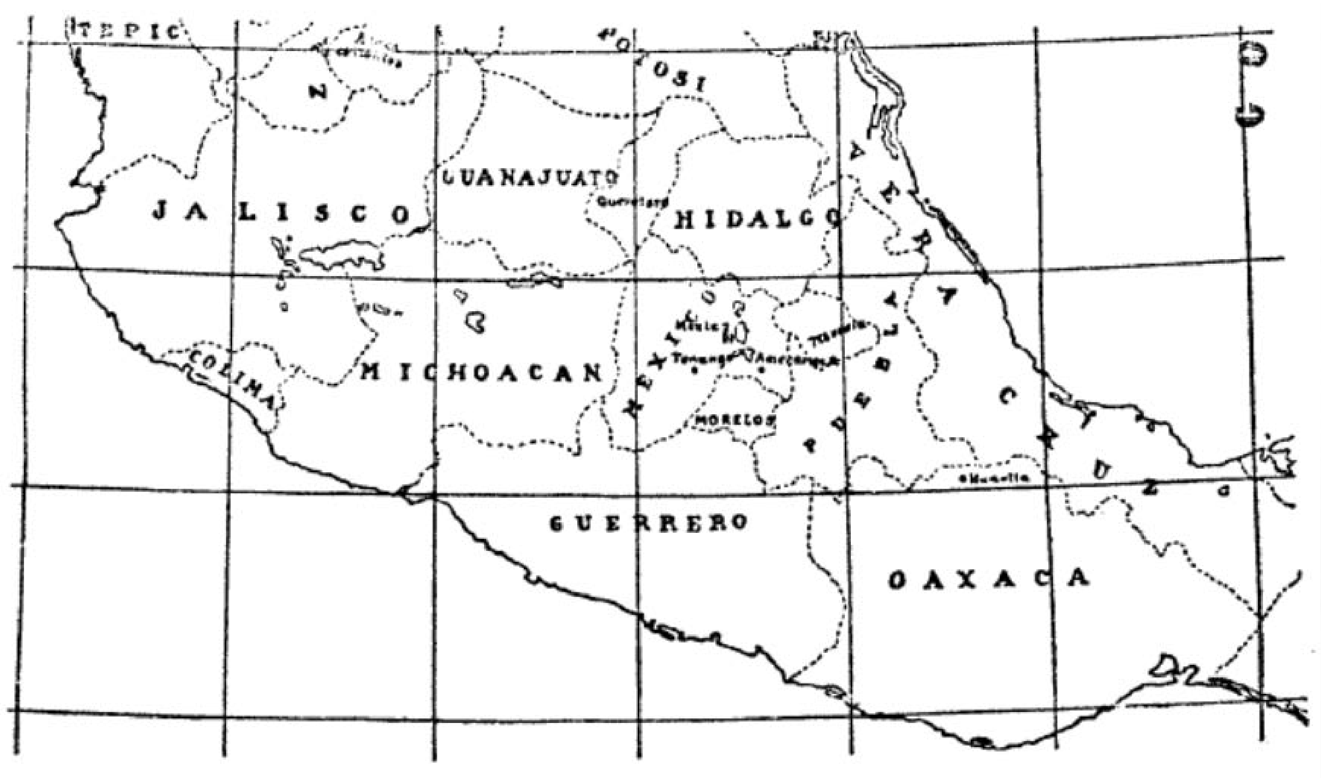


Fig. 1. Map of central and part of southern Mexico, between the 18th and 22nd parallels, showing Amecameca, Tenango, and Huautla in their respective states. 1:7,500,000.

This was the status of the mycological knowledge of *teonanácatl* when in 1952 Dr. Sam I. Stein became interested in the psychiatric implications of certain reports on the action of such dark-spored agarics as *Psilocybe* and *Panaeolus* (1, 2, 6, 9, 10, 11, 12, 13, 16). He then began to prepare the organization of a research program on fungus toxicology as related to neuropsychiatric problems. One of the first steps planned was the collection of dried material and cultures of the respective species, and of botanical observations made on the spot. These were not only to help in solving the basic problem from a biological point of view, but to produce sufficient knowledge to grow fruiting bodies of these species in the United States, or to grow mycelium in sufficient quantities to satisfy the demands of further investigations. The origin of these cultures had to be carpophores from the now classical village of Huautla de Jiménez, since obviously only a mushroom population known by previous tests and observations to be hallucinogenic should become the starting point of the production of carpophores destined to be the raw material for further experiments - particularly bio-assays and biochemical analyses - in the investigation on hallucinogens. This localization does not exclude further search for different species used in some remote valley of Mexico or Guatemala, or elsewhere.

---

[3] The label of this specimen reads: "Plantae Utiles Mexicanae. Oaxaca. Botanical Museum, Harvard University. Common name (Mexican) nanacate. Tribe: Mazatec. Indian name kee-sho. Habitat in freshets during rainy season. Locality Huautla de Jiménez, Oaxaca. Uses: From four to eight are eaten to produce a temporary narcotic state of hilarity. Said to be poisonous if taken in excess, causing permanent insanity. [Next follow descriptive data, illustrated by a drawing on the reverse side.] Coll. no. 349. Coll. Richard Evans Schultes, 27 July, 1938." Below Schultes's name that of Bias Pablo Reko is added (as co-collector). On a separate label, there is an annotation by Singer: "*Stropharia caerulescens* = *Psilocybe cubensis* (Earle) Sing.," and the Farlow label was made out correspondingly, although here the second and valid name was omitted. Thence resulted a later erroneous reinsertion in *Stropharia* when the herbarium material was shifted between 1949 and 1951, under W. L. White, curator.

The first author to publish data on chemical analysis and animal tests was Santesson (12), who unfortunately was handicapped by lack of thorough botanical study of the material he used, and by the application of inadequate chemical and experimental procedures. He had two samples, one "probably belonging to a *Panaeolus*", and the other supposed to be *Armillariella mellea* (although that was neither clear from the text nor at all probable). It is more likely that the material consisted of *Psilocybe mexicana* and *Psilocybe cubensis*, but it may conceivably have been a mixture of numerous elements. It was referred to as *teonanácatl*. Chemical reactions supposedly showed that no alkaloid was involved. According to the Fehling reaction, Santesson's material seemed to contain a glucoside as the active principle. Subcutaneous injections of 2.12 g and 1.57 g of the drug per kilogram body weight of *Rana temporaria* resulted in a "semi-narcosis" of the frogs, with a negative "turning test" (the classical inhibition effect of morphine on the rotation reflex of frogs).

At the time I reached Mexico - i.e., one year after Heim had accompanied the Wassons there - the former had already published three short communications (3, 4, 5) on specimens of Mexican species believed to be used in Indian ceremonies, and a preliminary article on his own observations. The name *Psilocybe mexicana* was then proposed for the first time, although not validly published before the second half of 1957. For what we consider to be *Psilocybe caerulescens* Murr., Heim proposed a new name, *Psilocybe mazatecorum*,[4] and having traveled to regions further south and northwest, he added a number of new entries on the list of species which collectively may be termed *teonanácatl*. Among them was *Psilocybe zapotecorum* Heim, from the Sierra Costera, and *Psilocybe aztecorum* Heim, from Popocatépetl. Fair to excellent illustrations of these species were provided by Heim for the Wassons' article (19) and in their book (20). In both of these latter publications as well as in other articles, ceremonies conducted by local *curanderos* (and a *curandera*) and experiences under the influence of hallucinogenic mushrooms were described by the Wassons and Roger Heim. No results of chemical analyses or animal tests have been published as this is written. Nevertheless, the attention given the mushrooms in the press has created - far beyond Mexico - an extraordinary interest and expectancy. Whether this attitude is justified by the research now in progress remains to be seen.

2. Field and culture work in 1957

My journey from Mexico City to the Mazatec country was undertaken in the company of two young Mexican botanists, M. A. Palacios, who worked as my assistant, and G. Guzmán H., an ardent student of agarics. There could not have been better traveling companions, or ones who better served the purpose of the trip.

We reached Huautla the first week of July and were there the guests of an Indian family. The head of the family, Isauro Nava García, an exceptionally intelligent and cooperative man who could express himself well in Spanish, and equally well spell the words of his native Mazateco, turned out to be a keen observer of fungi. He recognized easily and almost infallibly the different species of *Psilocybe*, knew where they could he found and when, and pointed out the interesting features of their respective habitats. He was of course completely familiar with the mushroom lore of his valley and had eaten hallucinogenic mushrooms before. Either he or his brother-in-law accompanied us in many of our collecting trips. Everything he said was checked by comparison with information obtained elsewhere. All the data obtained from him were corroborated with the exception of an opinion about the activity of a mushroom called "nèhe-je nèhe-je" (now known as *Psilocybe candidipes*), which was variously called inactive and poisonous. This, by the way, is the only species of the taxonomic group to which the hallucinogenic psilocybes belong that was not likewise reported by Wasson and Heim from the Mazatec region. On the other hand, the species said to be hallucinogenic and not belonging in the same taxonomic group as *Psilocybe cubensis*, *mexicana*, and *caerulescens* were not confirmed as hallucinogens by our own inquiries and observations. These unconfirmed data (3, 4, 16) refer to *Conocybe siligineoides* Heim, two species of *Panaeolus* (*Panaeolus sphinctrinus* and *Panaeolus fimicola* sensu Heim), and those psilocybes not reported to show any blue discoloration or stain (i.e., *Psilocybe cordispora* and *Psilocybe macrocystis*). I may add that there are a *Psathyrella* and copelandias from Santa Cruz which Guzmán, who collected them there, is inclined to think may be hallucinogenic. When we met Mr. Wasson in San Andrés near Huautla, he suggested that among these species the chances of finding real hallucinogens are rather good in *Conocybe*. So they are also in *Panaeolus* and related genera, since species of these have been shown to be poisonous or inebriating, and to be active in animal tests - *e.g.*, *Panaeolus venenosus* Murr. (9), which is apparently a synonym of *Panaeolus subbalteatus*, and species of the same genus or related genera determined in the past as *Panaeolus papilionaceus* and *Panaeolus* "*campanulatus*". Unfortunately, some of these determinations (1, 2, 6) may not be accurate and may just as well refer to other related genera (*Anellaria*, *Copelandia*), or at least to other species. We must insist, however, that the phenomena which belong in the class of "cerebral mycetisms" in the terminology of Ford (2) are not fully identical - although comparable - with the hallucinatory-euphoric and lasting effect described for the psilocybes. Aside from that we feel certain that *Panaeolus sphinctrinus* is not used as a drug by present-day Indians in Mexico.

---

[4] After having been advised by Dr. Alexander H. Smith of the probable identity of this fungus with Murrill's type of *Psilocybe caerulescens*, Heim changed the name to *Psilocybe caerulescens* var. *mazatecorum* Heim, because, as he explains, of the high variability of these fungi.

As for *Conocybe siligineoides* - which would be the only forest-inhabiting, or even xylophilous, species among those indicated by any author, it will be well to take into consideration a statement made to us by Isauro Nava. He said that there was, growing at a certain distant locality and not fruiting at the time of our visit, another hallucinogenic mushroom, as small as "pajaritos" (*Psilocybe mexicana*) and of the same shape and also staining blue, but differing in its habitat - wood in the forest rather than soil of meadows. Just such a species (*Psilocybe yungensis*) had been collected by me a year earlier in the ecologically very similar Bolivian Yungas, also a tropical-montane forest, and a similar but different one (*Psilocybe pelliculosa*) by Alexander H. Smith in the Pacific Coast area of the United States in coniferous forests of a temperate type. It is therefore quite possible that the missing forest-inhabiting hallucinogenic mushroom is not the species described by Heim as a *Conocybe*, but another representative of the section in which all the other hallucinogenic psilocybes belong.

How can such errors - if indeed errors they are - be explained? The growing demand for hallucinogenic mushrooms in the Huautla area has brought everybody, children and adults, many certainly much less expert than Isauro Nava, into the mushroom business. The younger generation of Indians tends to ridicule the use of mushrooms in ceremonies and is inadequately familiar with the characters of the mushrooms. Nevertheless, all these collect to fill the sudden demand at relatively high prices, and so inactive mushrooms are often mixed with active ones either by mistake or as conscious adulteration. I have witnessed the impurity and possible falsification of the product sold in Oaxaca, not easily discovered by anyone but a mycologist, especially if the material has been dried crudely for use between seasons. If substitution is discovered, the natural reaction of the seller is to claim that these different mushrooms are also used as hallucinogens.

As a result of the foregoing discussion, we may consider as established hallucinogens the following species of the Huautla region: (1) *Psilocybe cubensis* (Earle) Sing., (2) *Psilocybe caerulescens* Murr., and (3) *Psilocybe mexicana* Heim, and may add tentatively (4) *Psilocybe candidipes* Sing. & Smith (17).

By the end of July a further trip was organized by the National Autonomous University of Mexico, Institute of Biology, which took us by automobile to the region of Tenango del Valle (Fig. 1) southwest of Mexico City. A species of agaric is prescribed there by a "*curandera*" of a small village above Tenango and at times sold in the market at Tenango; it is currently collected by many local inhabitants of the region for storage, to have ready in case of illness, especially stomach troubles. The specimens come from a place called Piedras Blancas on the slopes of Cerro de Toluca. From our investigation on good specimens obtained at Piedras Blancas, and from observations on pure cultures made from them, we believe that they are an independent species, and not a variety of any known species, as suggested by Heim (4). We add therefore (5) *Psilocybe muliercula* Sing. & Smith (17), "mujercitas."

A similar trip, a week earlier, was made to San Pedro de Nexapa near Amecameca (Fig. 1) in the Distrito Federal and at the borderline with Puebla. This trip in search of the species previously described (from purchased specimens) by Heim as *Psilocybe aztecorum* yielded no specimens, and we had to rely for the moment on material which did not produce cultures. The information about the use of the mushroom was, however, obtained from the informant in Nexapa interviewed by Heim, and the exact habitat of Heim's *Psilocybe aztecorum* was carefully studied. Since the fruiting bodies appear only later in the year, G. Guzmán followed this exploratory trip with a second one in September, from which good specimens were collected at their natural habitat, and cultures were taken from the lamellae of these. The use made of *Psilocybe aztecorum* seems to be exactly the same as that made of *Psilocybe muliercula*. Consequently we list (6) *Psilocybe aztecorum* Heim.

All six species enumerated have a number of important characters in common - first of all the diagnostic characters of the genus as defined by Singer (16). They are devoid of chrysocystidia, do not show a glutinous or viscid veil on the stipe, and have the stipe centrally attached. The spore print is fuscous sepia or dark purple brown (often more deep lilac when quite fresh), as is usual in the entire subfamily Stropharioideae of which *Psilocybe*is a genus. The spores are smooth and have a germ pore. Some species have rather strongly longitudinally compressed spores, although with few exceptions the compression is not strong enough to be the same as that observed in the true deconicas,[5] and the spore size is variable from species to species (4-17 µ long). The upper layer of the pileus is a cutis, with a more or less individualized epicutis which often takes the appearance of a pellicle. A veil is present in all these species but the extent of development of the veil in adult specimens varies according to, and to a certain degree even within, the species. Some species have a persistent although never furrowed ("lamellar") thin repand annular veil. *Psilocybe candidipes* has an abundant veil development, but the annulus is narrow and not persistent. *Psilocybe caerulescens*, *Psilocybe aztecorum*, and some other species still have a well developed veil, but it is obliterated in age and never forms an annulus. In *Psilocybe mexicana*, on the other hand, is reached the extreme situation in this group, where the veil consists merely of a number of fine silky hyaline fibrils connecting the apex of the stipe with the margin of the pileus when the carpophore is young, collapsing on the stipe to form appressed scattered silky fibrils which disappear completely in age.

Aside from the generic characters indicated above, all the species that enter our list of Mexican hallucinogens have a very interesting and striking chemical character, one that is very constant in young and fresh material, but becomes lost in old and dried material, especially where the climatic conditions provide relatively high temperature. When the fruiting bodies are scratched or handled, or dried out, they stain blue or (in superposition on a yellowish pigment) green. This is apparently an enzymatic oxidation or autoxidation which may be comparable with that of *Russula* sect. *Nigricantinae* (where tyrosinase is the enzyme active in producing through the oxidation of tyrosine a melanin-like blue or pink and eventually blackening substance), or of the bluing boletes like *Boletus luridus* (with boletol, the pigment resulting being blue). The reaction is certainly identical with that observed in related genera of *Agaricales* like *Copelandia* and in certain species of *Pholiotina*. Some reagents such as guaiac solution accelerate this reaction in the few cases where I could make the test, but the action of guaiac is said to be nil by other authors in other cases. However, a chemical character which accompanies the bluing phenomenon is that of metol, which gives a constant strongly positive reaction with the context of the stipe in the bluing psilocybes, becoming deep purple after a few minutes (Singer 15, 16). Furthermore, it appears that the odor and taste of the whole group are sometimes distinctive: the odor of fresh carpophores is that of fresh flour or cucumber, or more rarely absent, or raphanaceous; while the taste is either hardly distinctive or more or less astringent or unpleasant. Heim (5) also indicates, among the characteristics of the hallucinogenic group, the fact that the spores show a light ocher pigmentation. It should not he denied that a very large number of *Strophariaceae* - Stropharioideae may show a light ocher color when seen under moderate magnifications in strong light or when not fully mature. However, my findings, corroborated by other observers, do not support the generalization that this particular light ocher color is characteristic for the Mexican hallucinogenic psilocybes or for the section of *Psilocybe* in which they belong.

Ecologically, however, all these species (even though not all the species which taxonomically belong with them) are adapted to conditions brought about by either cattle raising or agriculture, or else by natural but violent and profound disturbances of the equilibrium of the soil flora. Although not one of the species is carbonicolous or ruderal, the specific ecology of the Mexican species has apparently much in common with the ecology of anthracophilous and ruderal agarics.

---

[5] Dr. A. H. Smith thinks that species with strongly lentiform rhombic spores of small size should not be generically separated from *Psilocybe*. It is possible, and even probable, that the study of a large number of species not yet analyzed will corroborate this opinion when the genus is finally monographed.

With the characteristics indicated above, the hallucinogenic mushrooms enter quite naturally a taxonomic subdivision proposed by this author in 1948 (15) as the section *Caerulescentes* Sing., with *Psilocybe cubensis* as the type species. This section consisted even then of one annulate and several exannulate species. The fact that both annulate and non-annulate species enter the section now, having in common, in addition to their anatomical and chemical characters, the physiological activity referred to as "hallucinatory" (in reality a complex action) or as provoking cerebral mycetisms, tends to show that the section *Caerulescentes* is a natural one, whatever weight conservative authors may still give the veil characters in other groups of agarics. The fact that *Psilocybe cubensis* is among the hallucinogenic mushrooms will thus serve as an additional argument in favor of its transfer from *Stropharia* to *Psilocybe* (Singer, 15) where its real affinities are. Why, in view of the considerable evidence in favor of its transfer, Heim (3) retains the species in *Stropharia*, with the cryptic remark "ils [*i.e.*, *Psilocybe cubensis* and synonyms or related species] restent cependant apparentés avec *Stropharia squamosa* Fr. ex Pers.,"[6] is not recorded.

The type of vegetation in which hallucinogenic psilocybes occur is not uniform. The vegetation found in the Huautla region (and apparently in other areas where hallucinogenic mushrooms were observed in Oaxaca) is markedly different from that in Mexico and Puebla, further north and higher up. The Oaxaca localities, or, more properly, the Huautla region, can be characterized as transitional between tropical montane and temperate montane, the tropical montane zone being immediately adjacent in the ravines below 1500 m and the temperate montane zone in the alder forests above 2000 m altitude. The tropical montane region adjoins farther down and farther east the more truly tropical rain forests, as seen in the lower-level forests of Santa Cruz - near Jalapa, for example, where Murrill collected - and the transition zone characteristic of the localities where hallucinogenic psilocybes abound may well be likened to the South American fog- or cloud-forest. It differs, however, in at least one important point: the Mexican forests are rich in trees belonging to the order Fagales, especially in evergreen oaks, which determine the mycoflora and make the presence of abundant ectotrophic mycorrhiza possible. In many places in this transitional zone or modified cloud forest limestone crops out, and a high percentage of calcium may he expected in soil samples, especially from our *Psilocybe mexicana* habitats. The rainy season extends over the entire summer, and the rains are extraordinarily abundant and almost continuous for weeks in certain times of the year.[7]

The often torrential rainfall, in combination with the quality of the soil and the steepness of the mountain sides, creates a situation quite comparable to that in the upper Yungas in South America. Here as there frequent earth and stone avalanches cover the vegetation and bring the subsoil and deeper layers to the surface. This process is particularly accelerated by the methods of agriculture and will be speeded further by roadbuilding.

---

6. This is a species so different from both typical *Strophariae* like *Stropharia aeruginosa* and typical psilocybes like *Psilocybe semilanceata* (because of the combination of characters of the cystidia and the hypodermial and hymenophoral trama-structure) that it has been pointed out by Kühner (7) as anatomically closer to *Hypholoma*. For that reason it was transferred by Singer (16) to the genus *Naematoloma* (= *Hypholoma* sensu Kühner). *Stropharia squamosa*, or better *Naematoloma squamosum*, differs sharply from both typical stropharias and typical psilocybes in habitat requirements also, being, like so many naematolomas, a wood-inhabiting species; this ecological character of course also occurs in other genera, and in itself cannot be considered to be decisive.
7. The climate of this transitional-vegetation area where all our Huautla material came from varies between limits such as those quoted for the two extreme localities Huauchinango (Puebla) and Jalapa (Veracruz), the one being more similar to the upper limit of the Huautla zone, the other being at the lower level of the tropical montane zone. In these two comparable localities temperature records (°F) are:

Locality	Lowest minimum	Highest maximum	Ave. coldest month	Ave. hottest month	Ann. ave.
Huauchinango	25	104	50	66	60
Jalapa	36	99	58	68	64

The observed precipitation (inches) as rain:

Locality	Ave. ann. precip.	Ave. driest month	Ave. wettest month
Huauchinango	87.4	1.9 (Febr.)	15.6 (Sept.)
Jalapa	62	1.8 (Dec.)	11.6 (June)

The data are based on Vivó and Gomez, Climatologia de México, Inst. Panamer. Geol. e Historia publ. 19, México, 1946, quoted from Miranda & Sharp (8).

The natural forest, interspersed with small pastures, fields (mostly sugar cane, some corn), and now an increasing number of coffee plantations, is partly preserved, and contains, aside from tropical and endemic elements and the species of *Quercus* already mentioned, some elements in common with the subtropical and temperate forests of the southeastern United States from North Carolina to Florida. Such elements among the trees are *Liquidambar styraciflua*, among the fungi *Hygrophoropsis tapinia* Sing., and among the species referable to *teonanácatl*, *Psilocybe caerulescens* Murr. At the same time one observes numerous species of *Marasmius* which prove the tropical relations of this region. All together, the mycoflora of this transition region is just as heterogeneous as the tree flora. As one ascends, entering the *Alnus* stands at about 2000 m, just above the transition zone, one might expect to encounter a fungous flora with even more distinctly northern links. This is not the case. The mycorrhizal partner of the alder is the same as that found at the south tip of the alder area in South America, a bolete, *Gyrodon monticola* Sing., absent from the United States and Canada.

The hallucinogenic psilocybes fruit during early (spring) rains and until fall. *Psilocybe cubensis* seems to be one of the earliest-fruiting species; I have observed fruiting in spring in Florida. But it continues producing fruiting bodies during the entire season. The habitats of all the species in the Huautla region are characteristic. *Psilocybe cubensis* is dung-inhabiting. It occurs on pastures where cattle have grazed, or among sugar cane residues, but usually where the substratum has at least been mixed with cow dung. Sugar cane mulch, but without dung, is also a habitat of *Psilocybe caerulescens*, but it grows just as often on other plant material or around living culms of *Saccharum* on the earth of the fields. The same situation can sometimes be observed of *Psilocybe mexicana*. However, *Psilocybe caerulescens* grows mainly in shaded places in plantations or shaded fields, while *Psilocybe mexicana* prefers sunny open fields and pastures. *Psilocybe caerulescens*, according to the statements of the Mazatec Indians whom we consulted, regularly inhabits the surface of old landslides, two or more years after the landslide has occurred. We found this observation correct as far as the Huautla stations are concerned, and the description of the type locality in Alabama coincides in type of soil with that seen by us. On the other hand, the open pasture land on which *Psilocybe mexicana* is found is probably mostly man-made, or at least is maintained in its present condition by the grazing of animals. *Psilocybe candidipes* grows characteristically on the cleared surface of the earth among tree leaves fallen to the ground under *Coffea* and its shade trees (especially *Inga*). According to our Indian informants, especially Isauro Nava and his neighbors and relatives, and our own observations in this region, *Psilocybe candidipes* always occurs near the habitats of *Psilocybe caerulescens* and when found serves as an indication that *Psilocybe caerulescens* is not far.

The Mazateco name for *Psilocybe mexicana* is according to Isauro Nava a word he wrote for us and that sounded like the Spanish pronunciation of *di-nizé*, and which means a bird (diminutive), supposedly, always according to Isauro, because it makes you sing happily like a bird.[8] For *Psilocybe caerulescens* the indigenous name noted is *di-ki-sho* (or what sounded like this); it was explained that *di* stands again for the diminutive and *ki-sho* means landslide, this name being related to the habitat of the fungus.[9] For *Psilocybe cubensis* we were given two native names, one being San Isidro, which is self-pronouncing, and the other what sounds like and was transcribed as *di-shi-tjo-le-ra-ja*, which means steer mushroom in a diminutive form.[10] It is quite obvious that San Isidro stands for an earlier heathen god who was supposed to speak through the mushroom. It is also obvious that the relation of the fungus with the steer is again that of habitat, since in the Huautla region the species grows mostly on cattle dung. *Psilocybe candidipes* is referred to as *'nchè-jè 'nchè-jè* (Isauro's spelling).[11]

---

[8] Mr. George M. Cowan, a student of the Mazateco language, was kind enough to offer the following comments: "We use what we choose to call a practical orthography in all published materials used by Mazatecs now. This is simply a phonetic alphabet adapted as far as possible to the Standard Spanish alphabet. Tone is significant in Mazateco; the numbers $^{1\ 2\ 3\ 4}$ represent relative pitch of the syllables; ^{1} represents the highest, ^{4} the lowest level. [The symbol] (') cannot be transcribed in English orthography and is not heard by the untrained ear; it is sort of a glottal catch preceding the following sound." The correct phonetic spelling of *di-nizé* is, according to Mr. Cowan, 'nti^{1}-ni^{4}-se^{3}; it is pronounced ndee^{1} nee^{4} say^{8}; nti = ndee means an affectionately regarded object (referring to the mushroom) and ni-se, bird.

[9] Mr. Cowan's comments indicate that here as in the case of *Psilocybe mexicana* Isauro's names are current abbreviated words, omitting between the '*nti* and the *ki-sho*, the general term for mushrooms, *xi*^{3}*-tjo*^{3} ("which comes out," presumably of the earth), so that the full name of *Psilocybe mexicana* would be '*nti*^{1}*-xi*^{3}*-tjo*^{3}*-ni*^{4}*-se*^{3}, and for *Psilocybe caerulescens*: '*nti*^{1}*-xi*^{3}*-tjo*^{3}*-qui*^{3}*-xo*^{1}, pronounced *ndee*^{1}*-shree*^{3}*-t(h)oe*^{3}*-kee*^{3}*-shro*^{1}, meaning dear little thing that comes out of the earth of a landslide. The *x* is a sound as if English sh and r were pronounced at the same time; j and qu are pronounced as in Spanish, *i.e.* as a more aspirated *h* and a *k* respectively. "Tsami kishu" given by J. B. Johnson (quoted from Schultes, 13) evidently refers to this same species.

[10] G. M. Cowan spells this '*nti*^{1}*-xi*^{3}*-tjo*^{3}*-le*^{4}*-nčha*^{4}*-ja*^{4}, pronounced *ndee*^{1}*-shree*^{3}*-t(h)oe*^{3}*-lay*^{4}*-njra*^{4}*-ha*^{4} (meaning as above: the dear little thing that comes out pertaining to the steer or ox). The pronunciation of čh is described as a sound similar to English *j* (in judge) and *r* (in run) if pronounced simultaneously.

The two montane-temperate to subalpine-frigid habitats in the *pinares* (pine woods region) of the mountains nearer Mexico City mentioned above as harboring two hallucinogenic psilocybes (*Psilocybe aztecorum* and *Psilocybe muliercula*) differ from the transition forest of the Mazatec region not only climatically but likewise in the type of vegetation. The mushrooms do not, apparently, depend in any way on the detritus or the presence of living roots of the characteristic pines (*Pinus hartwegii* with *Psilocybe aztecorum*, *Pinus pseudostrobus* with *Psilocybe muliercula*). Neither do they live on agricultural land or dung, but directly on the earth, naked earth on the banks of mountain streams with occasional salt outcroppings, following the ravines around 3000 m elevation, or else (*Psilocybe aztecorum*) among grasses and (rosaceous) herbs in openings, often on the slopes of steep ravines even higher up (between 3300 and 3700 m altitude). The subalpine pine woods are here beginning to thin out and approach the absolute timber line (at about 4000 m). The psilocybes are accompanied by those mycorrhizal Basidiomycetes which make the survival of these pines possible at such an altitude, especially *Amanita inaurata* Secr., various species of *Lactarius*, and *Suillus* aff. *brevipes* (Peck) Sing. Non-mycorrhizal Basidiomycetes of this vegetation are *Phlogiotis helvelloides* (Fr.) Martin, *Tubaria* sp. (on *Pentstemon barbatus*), and *Laccaria* aff. *laccata* (Scop. ex Fr.) Berk. & Br. Among the Ascomycetes are *Cordyceps capitata* (Fr.) Link (on *Elaphomyces*) and *Hypomyces lactifluorum* (on *Russula delica*), the former often collected as a remedy for various diseases but doubtfully hallucinogenic,[12] the latter sold in the food markets. In the Piedras Blancas region on Cerro Toluca the presence of *Amanita calyptratoides* Atk., a western North American species, is remarkable; the southeastern race of *Amanita muscaria*, also a hallucinogenic mushroom of a sort, and almost constantly accompanying pine mycorrhiza, is common in the neighborhood of the psilocybes, but has never been mentioned as a locally accepted drug.

While the substratum of both *Psilocybe aztecorum* and *Psilocybe muliercula* is apparently comparable to that of *Psilocybe caerulescens* (more or less unstable or shifting bare soil), the climatic conditions and the surrounding vegetation are very different in this region from the *Psilocybe* habitats in Oaxaca. There is frequent freezing in the altitudes indicated, and the precipitation is not so abundant here as in the Mazatec country. During the summer-fall rainy season, precipitation is heavy enough to maintain a relatively rich flora of large fleshy Basidiomycetes reminiscent of that further north in Mexico and in the United States. This, obviously, is possible only because of the relatively lower temperatures, even in summer, whereby evaporation is kept at a minimum.

Psilocybe aztecorum is known as *niños del agua* (Spanish: children of the water; this is apparently an allusion to their habitat along the ravines). *Psilocybe muliercula* from Piedras Blancas is also known as "niños," but as such it is only one of the elements referred to by the more general term niños which includes "mujercitas" and "hombrecitos" (little women and little men). Only the "mujercitas" are agarics (*Psilocybe muliercula*); the "hombrecitos" are *Cordyceps capitata* (Fr.) Link (det. Mains). There is an obvious misinterpretation of these names in the literature. Although "mujercitas" are correctly interpreted as *Psilocybe*, the term has been thought to refer to a variety of *Psilocybe mexicana*. Dr. Herrera and the author, however, found the difference in external appearance and habitat constant enough to separate the "mujercitas" from *Psilocybe mexicana*, inasmuch as in all natural habitats of the two species the spore size is consistently different. On the other hand, "hombrecitos" have been interpreted as merely smaller individuals of *Psilocybe mexicana* var., or, since hallucinatory mushrooms in Mexico are always given in pairs, the complementary individuals - in other words, part of the same drug. Our own interpretation has been reconfirmed several times, and it is also obviously the logical interpretation, since the allusion to the shape of the respective fruiting bodies is self-explanatory, and the terms lose all descriptive significance if Heim's and Wasson's explanations are accepted.

---

[11] Mr. Cowan, who had a special interview about this new species with Isauro and friends, explains that this means, as Isauro had already told us, "a signal of," in reference to the other hallucinogenic mushrooms, particularly *Psilocybe caerulescens*, which will appear here or nearby later. The correct spelling is *nche*^{4} *je*^{4}, pronounced in English like njre^4-he^4.

[12] It is remarkable that another species of the same family, *Cordyceps sinensis*, growing on insects, is widely used as a medicine in China, while still another species of the Hypocreaceae, *Claviceps purpurea*, ergot, is the source of several alkaloids which have only recently been studied thoroughly. In view of this, it is very probable that the Mexican medicinal hypocreaceous species would be well worth a special investigation, particularly from the biochemical point of view.

It is interesting to note that not only are the conditions under which the respective fungi develop widely different, but the use made of the mushrooms is likewise different, in the main hallucinogen-producing states of Mexico visited by me. The Nahua Indians, according to the data obtained by us in discussions with inhabitants of San Pedro de Nexapa and Tenango del Valle as well as the mountains near these villages, do not talk about the hallucinogenic effect of the mushrooms, but volunteer information merely on their healing qualities. In these villages, the use is strictly a matter of religious healing, the business of the *curandero* or *curandera*. Permission has to be granted by God in the *curandero's* dream before the drug can be employed safely. On the other hand, the Mazatecs talk freely about the hallucinogenic and euphoric effects of these mushrooms, and eat them for precisely that effect. The religious healing ceremonies of the Mazatecs are also directed by *curanderos*, but more emphasis is given to the revelations obtained by the intoxicated persons, so that the use made of the mushroom in Huautla is at least partly divinatory rather than directly medical. Whether this corresponds to any difference in the chemicals present in the respective species, or merely to ethnological factors, cannot be stated at present. At any rate, the Mazatecs seem to have preserved more of the original Aztec lore about *teonanácatl* than the people living now in Aztec country, who are at least in part the direct descendants of the Aztecs. It is of course possible that the secretive and exclusive use the Nahuas make of their "niños" is a result of more complete repression and conversion in the early times of the Spanish rule, when the Oaxaca Indians of the Sierras were practically left to their own devices.

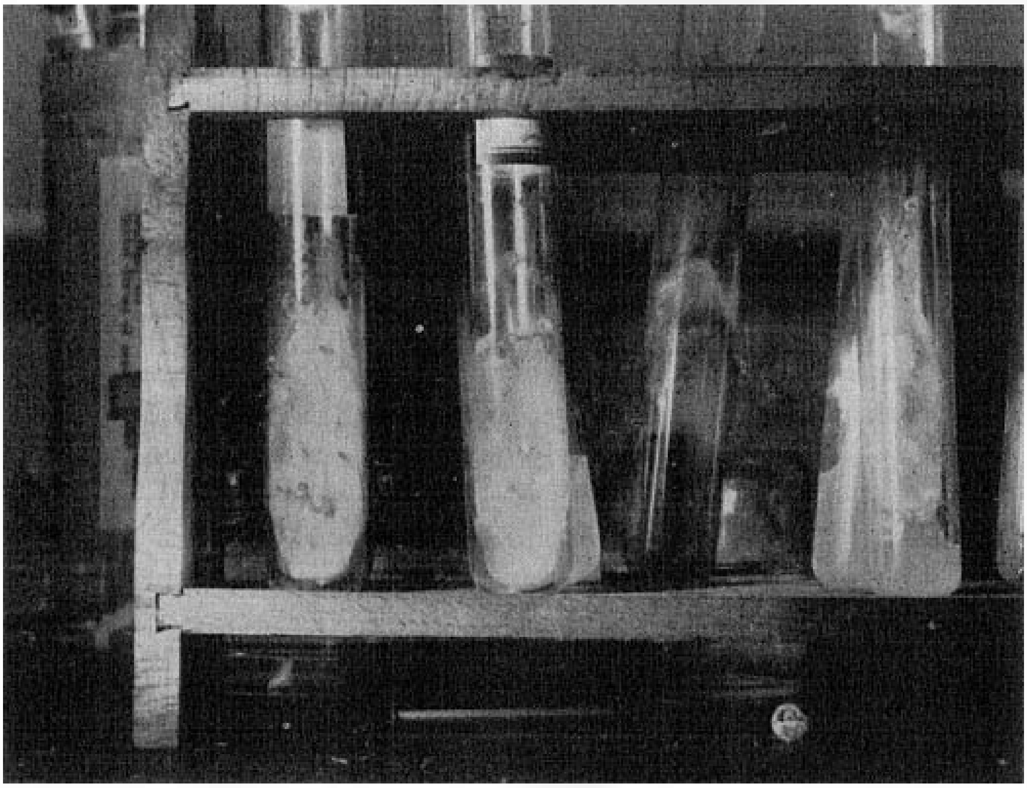


Fig. 2. *Psilocybe cubensis*. Stringy mycelium (upper portion of slant in tube at extreme left) and primordia. Phot. R. Singer.

From all the species mentioned above, including also *Panaeolus sphinctrinus*, both tissue cultures and spore germinations were obtained. The tissue fragments grew well at the room temperatures of Mexico City in July, some even better at 27-29°C, and better on malt-extract agar and Kauffman's (modified) medium than on potato-dextrose agar. These were the first pure cultures obtained directly from fruiting bodies at their classical habitats. Subcultures have been deposited at the Instituto Politécnico and the Instituto de Biologia of the University of Mexico, at the Department of Botany of the University of Michigan, The New York Botanical Garden, and the Phytopathology Laboratory of the Ministerio de Agricultura y Ganadería in Buenos Aires, all in personal care of responsible scientists for specified further research on these organisms. For the sake of comparison, isolations were also made from North American spore prints of *Psilocybe caerulipes* (Peck) Sacc. (northern Michigan), also belonging to the section *Caerulescentes*, and from *Copelandia caerulescens* (Berk & Br.) Sing.

Panaeolus sphinctrinus, *Psilocybe cubensis*, *Psilocybe caerulescens*, *Psilocybe candidipes*, and *Psilocybe mexicana* were checked by Dr. W. J. Robbins for antibiotic activity. None was evidenced against *Staphylococcus aureus* or *Escherichia coli*, and the action against *Mycobacterium smegma* was slight.

Psilocybe cubensis has been observed to form a stringy mycelium in malt-agar test tubes. Mycelium of this species, more than that of other species studied in pure culture, has a tendency, greater at lower temperatures than at higher ones, to turn blue in culture. *Psilocybe cubensis* also tends to produce most easily what might be termed white rhizomorphs in the stringy portions of the mycelium, and a large number of small fruiting bodies on the agar (Fig. 2). These carpophores or primordia do not always attain full size during later development, and often fail to mature; they tend to turn blue without being handled. The agar cultures of *Psilocybe mexicana* have a tendency to turn deep brown in contact with the mycelium (Fig. 3). On partially drying out they also frequently produce normal fruiting bodies. On the other hand, *Psilocybe caerulescens* under the conditions in which it was kept in the laboratory did not form white rhizomorphs or fruiting bodies in pure culture, and the mycelium merely colors the medium light brown (Fig. 4). In Czapek with 1% sucrose and vitamins, *Psilocybe caerulescens* produced aerial mycelium which broke down into "oidia" (mycelial fragments often referred to as arthrospores), observed for the first time by Dr. R. Ames. The mycelium of the *Panaeolus* remains pure white and fluffy without distinct discolorations, rhizomorphs, or fructifications. The same is true for other psilocybes except *Psilocybe muliercula*, which tends to form a slightly brownish aerial mycelium.

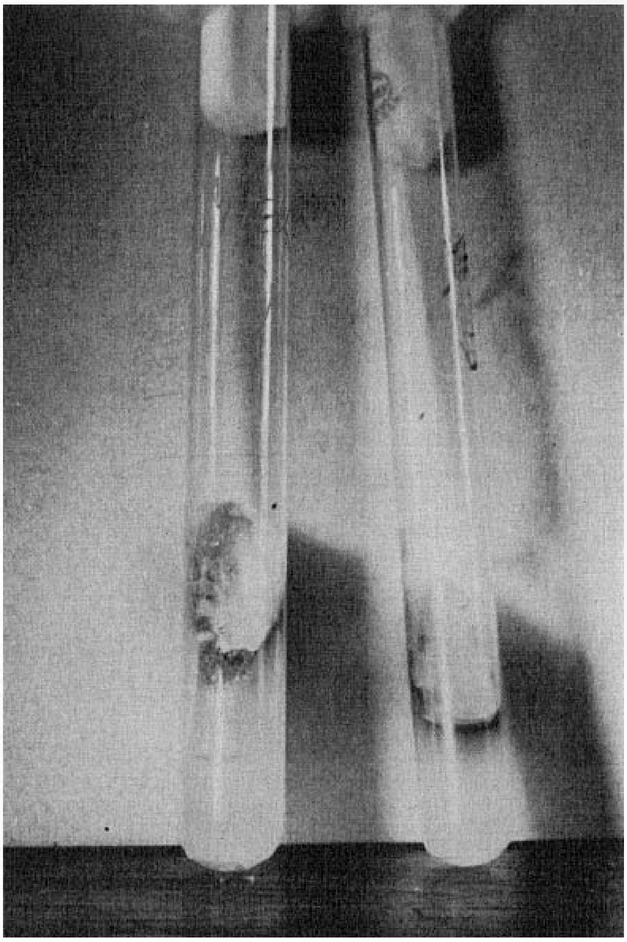


Fig. 3. *Psilocybe mexicana*, showing the dark discoloration of the medium beneath the whitish mycelium in both test tubes. Phot. R. Singer.

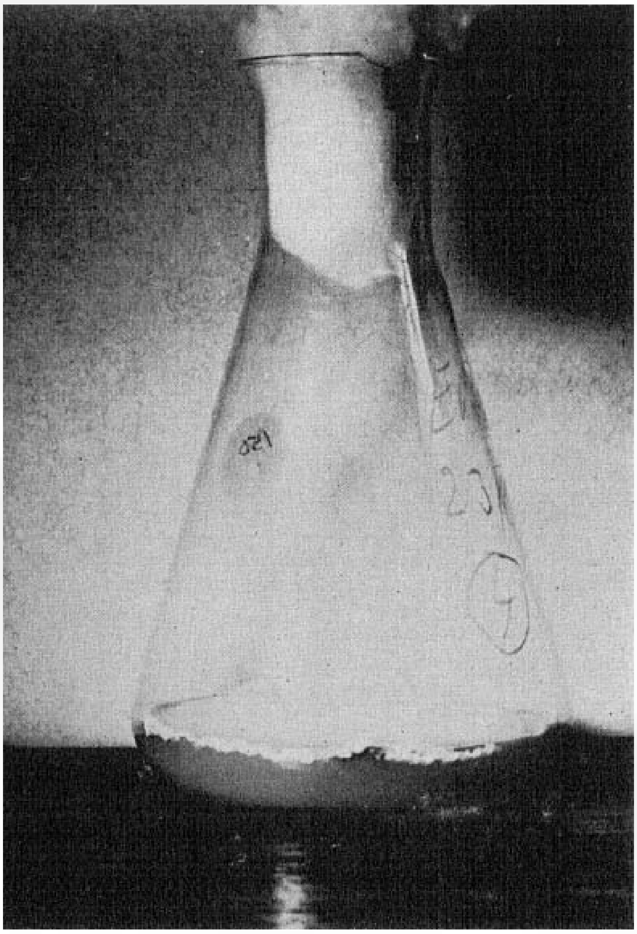


Fig. 4. *Psilocybe caerulescens*. Typical mycelium culture in Erlenmeyer flask. Phot. R. Singer.

Panaeolus sphinctrinus (Fig. 5) and other species of *Panaeolus* grow in mushroom-house conditions as well as or better than *Agaricus bisporus* (Lange) Sing., the cultivated mushroom. The psilocybes were also grown not only under laboratory conditions in large glass containers (Fig. 6), where some produce large fleshy fructifications, but also in greenhouse conditions (Fig. 6) on compost trays, where the method used by commercial mushroom growers had to be considerably modified.

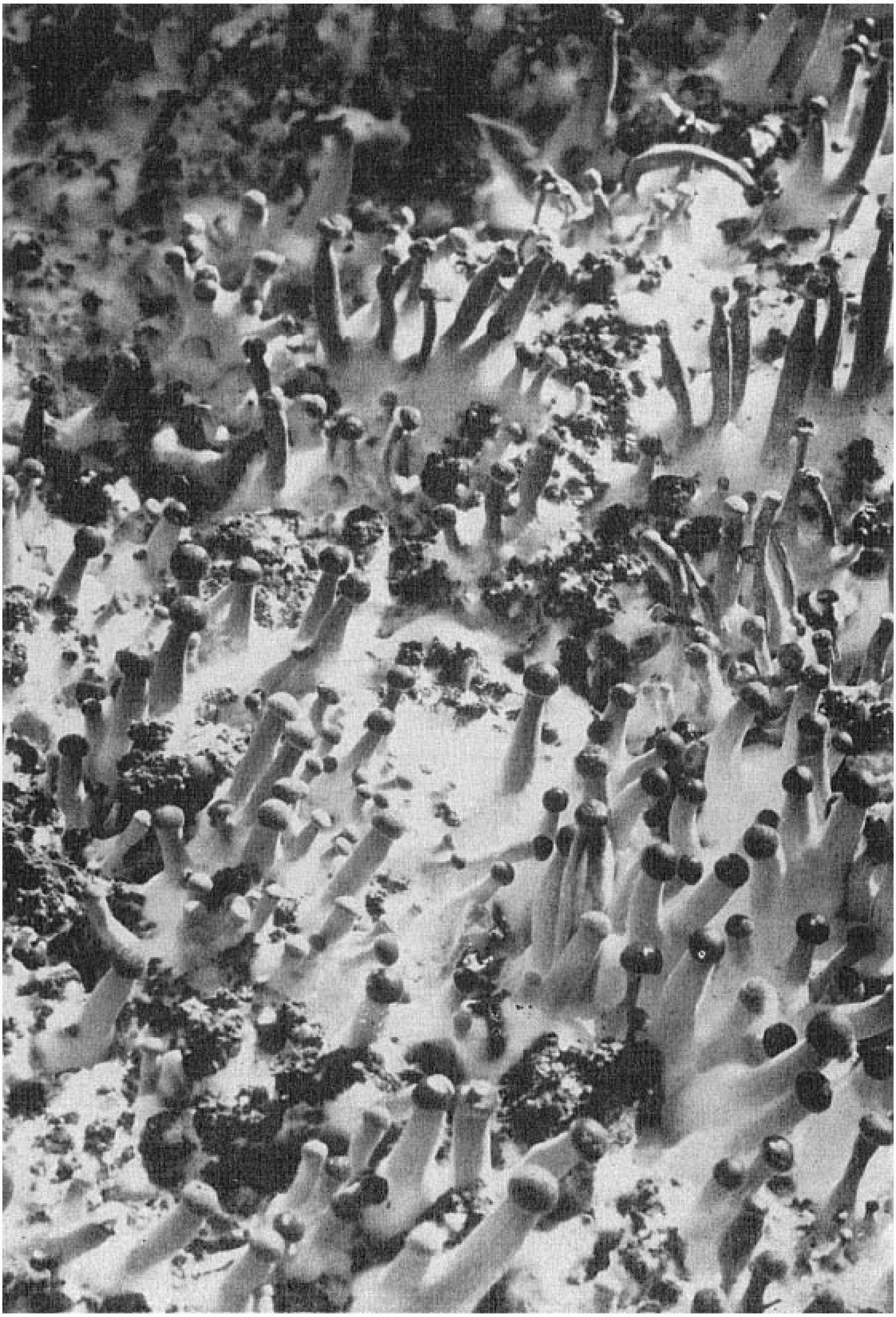


Fig. 5. *Panaeolus sphinctrinus*. Abundant carpophore production in artificial mushroom house culture, natural size. Photog. Serv. Penn. State Univ., courtesy Dr. L. R. Kneebone.

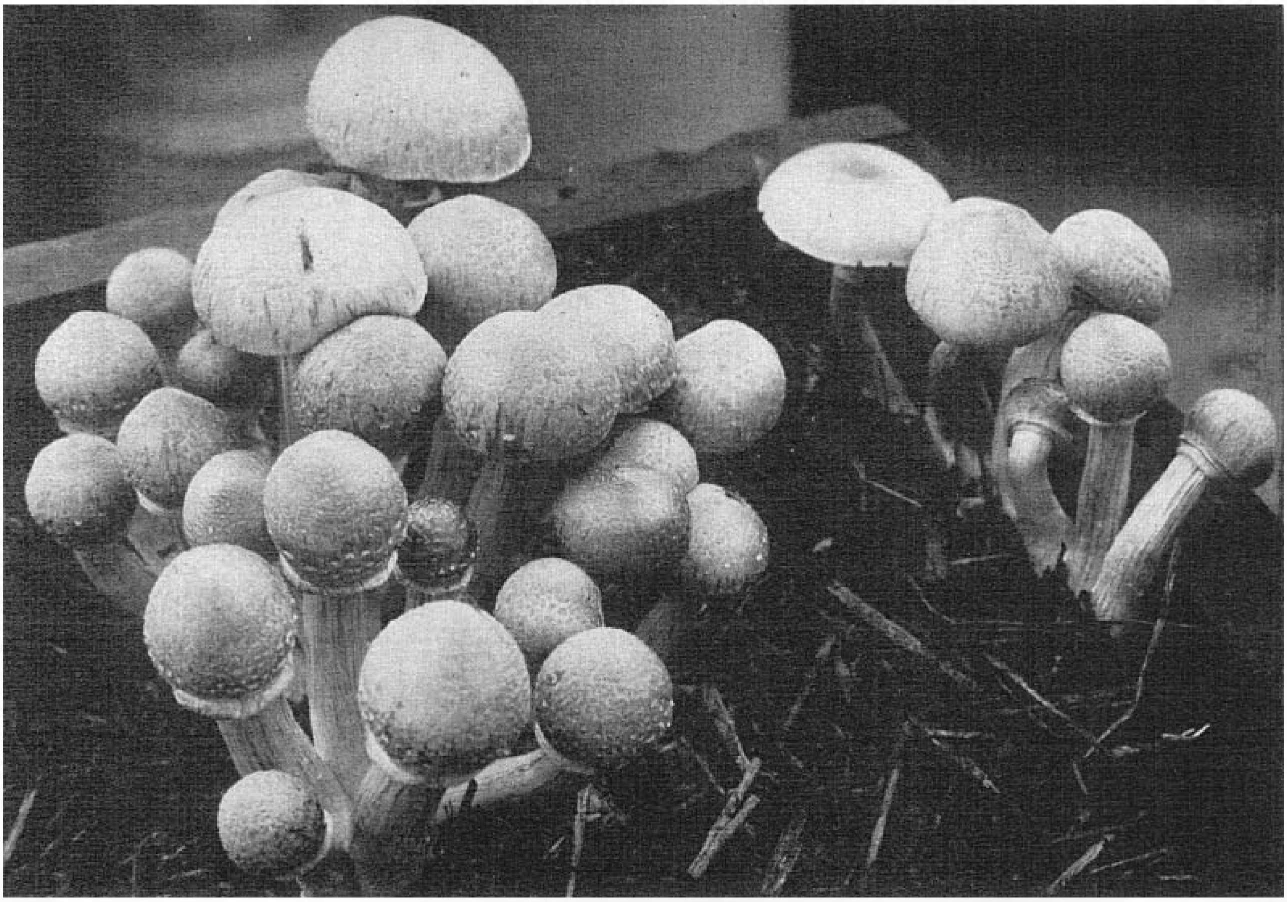


Fig. 6. *Psilocybe cubensis*. Greenhouse culture on uncased tray with compost, slightly reduced. Photog. Serv. Penn. State Univ., courtesy Dr. L. R. Kneebone.

Acknowledgments

It is a pleasant duty to thank the University of Tucumán and the Instituto Miguel Lillo for having granted the necessary leave to carry out the present investigations; the authorities of the Instituto de Biologia (University of Mexico), and especially Dr. R. Llamas, for having authorized the collaboration of the staff and the use of its facilities; and Miss Martha Zentena Zevalla and Dr. Teófilo Herrera for help in the preparation of media and the organization of field trips. Both went beyond purely scientific collaboration by trying successfully to make my stay in Mexico as pleasant as possible. Mrs. Ana Mas Gomez of the American Embassy was kind and patient in obtaining all the permits for the collection, export, and import into the United States of America of the cultures, spore prints, and dried material, and offered many other courtesies. Miss Dorothy Parker of the Rockefeller Foundation in Mexico was very helpful in establishing valuable contacts during the Mexican phase of the work. Mr. G. M. Cowan, Summer Institute of Linguistics, offered generous help in the interpretation of my notes on Mazateco fungus names.

This cooperation continued in the United States. Dr. K. L. Jones, Head of the Department of Botany, University of Michigan, and Dr. E. B. Mains, Director of the University Herbarium, made it possible for me to carry out part of the research in Ann Arbor. Dr. A. S. Sussman was particularly kind in supplying the necessary equipment and in providing valuable advice to me and my collaborators in the Department of Botany. He as well as Dr. A. H. Smith offered interest and encouragement.

It should also be stated that had it not been for the consistent initiative and the financial backing of the Bertram and Roberta Stein Neuropsychiatric Research Program, Inc., of Chicago, the present work would not have been possible, and the investigations now in progress elsewhere would have had no chance of realization. I am particularly indebted to Dr. Sam I. Stein, Executive Medical Director of the organization.

Departamento de Botánica
Instituto Miguel Lillo
Universidad Nacional de Tucumán, Argentina

Literature cited

1. Douglas, B. 1917. Mushroom poisoning. Torreya 17: 171-175.
2. Ford, W. W. 1923. A new classification of mycetisms (mushroom poisonings). Trans. Assoc. Amer. Physic. 38: 225-229.
3. Heim, R. 1956. Les champignons divinatoires utilisés dans les rites des Indiens Mazatèques recueillis au cours de leur premier voyage au Mexique, en 1953, par Mme Valentina Pavlovna Wasson and M. R. Gordon Wasson. Comptes Rendus Acad. Sci. Paris 242: 965-968.
4. Heim, R. 1956. Les champignons divinatoires recueillis par Mme Valentina Pavlovna Wasson et M. R. Gordon Wasson au cours de leurs missions do 1954 et 1955 dans les pays mije, mazatèque, zapoteque et nahua du Mexique méridional et central. Ibid. 242: 1389-1395.
5. Heim, R. 1957. Les agarics hallucinogènes du genre *Psilocybe* recueillis au cours de notre récente mission dans le Mexique méridional et central en compagnie de M. R. Gordon Wasson. Ibid. 244: 659-700. (This, and items 3 and 4, were reprinted in Rev. de Mycol. 22: 58-79, 183-198. 1957.)
6. Krieger, L. C. C. 1935. A popular guide to the higher fungi (mushrooms) of New York State. N. Y. State Mus. Handb. 11. pp. 1-538. Albany.
7. Kühner, R. 1936. Observations sur le genre Hypholoma. Bull. Soc. Mycol. Fr. 52: 9-30.
8. Miranda, F. and A. J. Sharp. 1950. Characteristics of the vegetation in certain temperate regions of eastern Mexico. Ecology 31: 313-333.
9. Murrill, W. A. 1916. A very dangerous mushroom. Mycologia 8: 186-187.
10. Reko, V. 1936. Magischc Gifte, Rausch- und Betäubungsmittel der Neuen Welt. Stuttgart. 1936.
11. Sahagun, Bernardino de. 1932. A History of Ancient Mexico 1. (English translation.) Nashville.
12. Santesson, C. G. 1939. Einige mexikanische Rauschdrogen. Ark. Bot. 29a (12): 1-9.
13. Schultes, R. E. 1939. Plantae Mexicanae II. Botan. Leaflets Harv. Univ. 7(111): (37) - (54).
14. Sharp, A. J. 1948. Some fungi common to the highlands of Mexico and Guatemala and the eastern United States. Mycologia 40: 499-502.
15. Singer, R. 1946. Diagnoses Fungorum novorum Agaricalium. Sydowia 2: 26-42.
16. Singer, R. (1949) 1951. The *Agaricales* (mushrooms) in modern taxonomy. Lilloa 22: 1-832.
17. Singer, R. and A. H. Smith. 1958. New species of *Psilocybe*. Mycologia 50: 141-142.
18. Verrill, A. E. 1914. A recent case of mushroom intoxication. Science II 40: 408-410.
19. Wasson, R. G. 1957. Seeking the magic mushroom. Life 49(19): 100-120.
20. Wasson, V. P. and R. G. Wasson. 1957. Mushrooms Russia and History, 2 vols., 1: I-XXI, 1-214; 2: 215-433. Pantheon Books. New York.

Part II.
A taxonomic monograph of psilocybe, section caerulescentes[1]

by

Rolf Singer and Alexander H. Smith

As has been shown by Rolf Singer in Part I of these studies, it may be accepted as probable that the majority of the hallucinogenic mushrooms of Mexico belong to the section *Caerulescentes* of the genus *Psilocybe*. It is not yet known whether all species of the section possess hallucinatory properties, but it is probable that all or at least many of them are hallucinogenic or poisonous, causing cerebral mycetism with or without other symptoms. At all events, a critical taxonomic account of the species in this section is highly desirable to facilitate a biochemical survey of the group. This contribution is a part of two major projects, first the research on hallucinogenic mushrooms carried out by the Bertram and Roberta Stein Neuropsychiatric Research Program Inc., Chicago, Illinois, and second, a monograph of the North American species of *Psilocybe* now in preparation by A. H. Smith.

We wish to express our thanks to the curators of the following institutions from which we have received material for study: Kew Herbarium (K), Dr. G. Taylor, Director, and Dr. R. W. G. Dennis, curator; Farlow Herbarium (FH), Dr. I. M. Lamb; New York Botanical Garden (NY), Dr. D. P. Rogers. Our own collections and those obtained from correspondents are on deposit at the Instituto Miguel Lillo (LIL), Tucumán, Argentina, and at the Herbarium of the University of Michigan (MICH). Valuable data were obtained for us by G. Guzmán, Mexico D.F.

The color terms used in the descriptions were taken from R. Ridgway, Color Standards and Color Nomenclature, Washington, D.C., 1912, and Maerz and Paul, A Dictionary of Color, 1st edition, McGraw-Hill, New York, 1935. Those from Ridgway are within quotation marks and those from Maerz and Paul are underlined.

In giving the measurements of spores the length is given first and the width second, but if the spore is somewhat compressed and broader than deep, the width is given following the length and the depth (i.e. breadth in side view or profile) is given last - for example, 8-11 x 6-7 x 5-6 µ. Measurements of the cystidia (including cheilocystidia) give the length first, the width of the broadest part next (usually the diameter of the basal or central enlargement), then follows the diameter of the "neck" (thinned apical portion) or the narrowed part above the mid-portion, unless the apex is described separately.

The cultural characters as far as now available are not part of the descriptions provided in this monograph since the cultures were described by Singer in Part I. Nevertheless, some of the data provide interesting and even diagnostic characteristics of certain species.

This work has been supported by the Bertram and Roberta Stein Neuropsychiatric Research Program Inc., Chicago, Illinois, The Faculty Research Fund of the University of Michigan and the National Science Foundation.

Psilocybe sect. Caerulescentes Sing., Sydowia 2: 37. 1948.

Pileus white or pigmented, slightly lubricous to almost glutinous in wet weather, pellicle often separable; lamellae ascending or horizontal, usually adnate, in some species subdecurrent, in others sinuate-adnexed, edges pallid, faces pallid to brownish, becoming purple brown from the spores; stipe slender to fairly robust, strongly purple with metol (p-metylaminophenol-sulfate), usually bluing with guaiac solution, typically bluing when wounded or blue color becoming evident on surfaces or mycelium under certain conditions of growth or in age or on drying.

---

[1] Papers from the University of Michigan Herbarium and Department of Botany no. 1074, University of Michigan, Ann. Arbor, Mich.

Spores purple fuscous to lilac in fresh deposits or in water-mounts under the microscope, *after dehydration and then mounting in KOH* becoming dark yellowish brown, terete to laterally compressed and variable in shape from species to species, smooth, wall complex, apical pore distinct and typically causing the apex to appear truncate; basidia typically 4-spored, pleurocystidia present or absent but if present not as chrysocystidia (species with chrysocystidia excluded from *Psilocybe* by definition); cheilocystidia abundant and often causing the gill edge to be heteromorphous (completely sterile and sterile elements different from those of gill face), or nearly so; subhymenium and hymenopodium well developed, gill trama either regular or showing a mediostratum and lateral strata (between the mediostratum and the hymenopodia on each side); cuticle of pileus consisting of a gelatinous or subgelatinous pellicle or an almost non-gelatinous epicutis (upper layer) and a well-differentiated hypodermium (lower layer), the epicutis (pellicle) of narrow more or less hyaline hyphae, the hypodermium a more compact layer consisting mostly of enlarged hyphal cells but some narrow filaments also present; clamp connections consistently observed on hyphae of all types and at the base of the basidia of the species described below.

Summary or the stirpes

Stirps. Cubensis

Spores medium to large (7.7 µ or more long) and mostly somewhat compressed, in face view obscurely to distinctly angular-ovate to angular-elliptic; veil typically membranous and the remains persisting on the stipe as a membranous annulus; aspect of carpophores not mycenoid; habitat on dung or rotten wood.

The combination of veil and spore characters is diagnostic of the stirps. The presence of a membranous annulus would cause these species to be classified in *Stropharia* in classical taxonomic arrangements, but the lack of chrysocystidia and the presence of a change to blue when injured point to close relationship with the other species of the section. The true *Strophariae* have chrysocystidia or a viscid to glutinous universal veil. Other species such as *P. aztecorum* and *P. candidipes* may at times show a narrow annulus but these have terete or only very slightly compressed spores.

Species included: 1. *P. cubensis*, 2. *P. subaeruginascens*, and 3. *P. aerugineomaculans*.

Stirps. Yungensis

Spores very small (less than 7.7 µ long) and strongly compressed, typically angular-ovate in face view; veil floccose over the lower part of the stipe but not forming an annulus; pileus relatively high or acutely papillate; stipe thin; cap margin incurved at first (general aspect almost mycenoid but with incurved margin); habitat on forest litter and much decayed wood particles in the tropical zone; pigmentation dark, hyphae of the hypodermium heavily incrusted.

The combination of floccose veil and the uniquely small and compressed spores along with the characteristic habit determine the stirps which, so far, contains only a single species.

This stirps has as much in common with the deconicas as the preceding has with the stropharias. It differs, however, in habit and chemical characters from the species usually classified in *Deconica*. Within the section it seems to come closest to the two smaller-spored representatives of the preceding stirps, which are also characterized by relatively small carpophores.

Species included: 4. *P. yungensis*.

Stirps. Mexicana

Spores compressed, medium sized (7-11 µ long); veil thin and poorly developed, not leaving traces on mature carpophores; pileus acute or obtuse in outline except for an apical conic papilla, with straight margin when young, or margin bent in slightly; pellicle poorly developed; stipe thin; habitat characteristically in pastures, fields, meadows, or generally outside the forest in tropical-montane vegetation or plantations.

This stirps forms a natural transition between the preceding and the following one. The spores are still compressed but are not characteristically small; the habit is mycenoid though perhaps slightly less so than in stirps *Silvatica*.

Species included: 5. *P. mexicana*.

Stirps. Silvatica

Spores not compressed, medium (6-9) to large (10-13 µ long); veil thin and not leaving traces in adult carpophores; pileus relatively high and acute, not fully expanding, with straight margin, thus habit mycenoid; pellicle present, thin to thick; habitat in forests on wood and debris, but extratropical (as far as known).

Species included: 6. *P. silvatica*; 7. *P. pelliculosa*.

Stirps. Cyanescens

Spores varying from slightly compressed to terete, typically 9 µ or more long; veil varying from well developed (in *P. aztecorum*) to poorly developed, but never floccose or annulate; habit typically collybioid or nearly so; habitat terricolous or on rotten wood in forests, parks, or among scattered trees.

This combines all the large-spored exannulate species which do not have a mycenoid habit. The spores are not even obscurely angular in face view and are terete or at best only slightly compressed. It is remarkable that the habitat is rather similar in all of them and that none of them can be described as truly tropical.

Species included: 8. *P. aztecorum*; 9. *P. cyanescens*; 10. *P. collybioides*; 11. *P. strictipes*; 12. P. baeocystis.

Stirps. Caerulescens

Spores compressed to terete, small (less than 9 µ long); stipe typically thick (more than 3 mm at apex); veil well developed; habit collybioid to tricholomatoid but not mycenoid; habitat variable.

The species grouped here have well developed veils and rather thick stipe; they are thermophilous in the sense that they all occur in warm climates.

Species included: 13. *P. caerulescens*; 14. *P. aggericola*; 15. *P. candidipes*.

A fourth species which might belong here, *P. zapotecorum* Heim, has not been studied by us. We prefer not to place it formally in one of the stirpes introduced here inasmuch as it might conceivably be closer to some other stirps, or represent a stirps of its own.

Supplement to stirps VI: 16. *P. zapotecorum*.

Stirps. Caerulipes

Spores 7-9(-10)µ long, terete, stipe thin (1-3 mm at apex); veil thin and cortinate; habit collybioid; habitat on rotten wood and debris in the forest and under scattered trees.

But for the small spores and thin stipe this stirps could be united with stirps *Cyanescens*. According to spore size it would be close to stirps *Caerulescens*. But both species are either temperate or montane, and extratropical.

Species included: 17. *P. muliercula*; 18. *P. caerulipes*.

Key to species of section Caerulescentes

1. Annulus typically membranous and persistent ---> 2
   2. Spores 11.5-17.3 µ long ---> 1. *P. cubensis*
   2. Spores smaller ---> 3
      3. Growing on wood; pileus viscid ---> 3. *P. aerugineomaculans*
      3. Growing on dung; pileus merely moist ---> 2. *P. subaeruginascens*

1. Annulus if present merely a zone of fibrils, or very fugacious ---&gt 4
   4. Spores 5-6.5 x 4.3-5 x 3.6-4 µ, strongly compressed; pileus acute ---&gt 4 *P. yungensis*
   4. Spores larger and only somewhat compressed or terete ---&gt 5
      5. Pileus margin straight when young or almost so; habit more or less mycenoid ---&gt 6
         6. Spores compressed (broader in face than in side view); growing in open areas (meadows, fields) ---&gt 5. *P. mexicana*
         6. Spores terete; growing in woods on litter and rotten wood ---&gt 7
            7. Spores 6-9.5 (-11.5) x 4.5-5 µ pellicle thin ---&gt 6. *P. silvatica*
            7. Spores 9.3-11 x 5-5.5 µ (10.5-13 x 5.5-7 µ); pellicle thick and separable ---&gt 7. *P. pelliculosa*
      5. Pileus margin incurved when young; habit typically collybioid ---> 8
         8. Spores typically less than 9 µ long ---> 9
            9. Stipe 10-20 mm thick, 100-200 mm long, cortex very fibrous, hard and elastic ---> 16. *P. zapotecorum*
            9. Stipe not as above ---> 10
               10. Stipe white, basal half scabrous-strigose, upper half strongly floccose from veil ---> 15. *P. candidipes*
               10. Not as above ---> 11
                  11. Veil copious and flocculose in young specimens ---> 12
                     12. Spores in face view 5-6 µ broad; stipe whitish when young ---> 13. *P. caerulescens*
                     12. Spores in face view 4-5 µ broad; stipe colored when young ---> 14. *P. aggericola*
                  11. Veil thin, cortinate, fugacious ---> 13
                     13. Pileus not viscid ---> 17. *P. muliercula*
                     13. Pileus viscid ---> 18. *P. caerulipes*
         8. Spores typically more than 9 µ long ---> 14
            14. Lamellae pallid to white, or brownish only at maturity - sterile to partly sterile collections of *P. collybioides* key out here
            14. Not as above.
               15. Stipe whitish; pileus milk white or disc merely ochraceous ---> 8. *P. aztecorum*
               15. Stipe or pileus or both more deeply colored ---> 16
                  16. Pileus chestnut color; spores slightly compressed ---> 9. *P. cyanescens*
                  16. Not as above ---> 17
                     17. Cheilocystidia 20-30 (-36) x 4-6 x 1.2-1.5 µ ---> 12. *P. baeocystis*
                     17. Cheilocystidia larger ---> 18
                        18. Odor distinctive - variable, farinaceous to raphanaceous to spermatic ---> 10. *P. collybioides*
                        18. Odor none; taste mild ---> 19
                           19. Stipe 100-130 mm long, straight ---> 11.

P. strictipes
19. Stipe up to 70 mm long. *H. cyanescens* sensu Malençon (see under *P. collybioides*)

Stirps Cubensis

Psilocybe cubensis (Earle) Sing

1. ***Psilocybe cubensis*** (Earle) Sing., Sydowia 2: 37. 1948. (Fig. 1-3, 40-41.)
Stropharia cubensis Earle, Est. Agron. Cuba 1: 240. 1906.
Naematoloma caerulescens Pat., Pull. Soc. Mycol. Fr. 23: 78. 1907.
Hypholoma caerulescens (Pat.) Sacc. & Trott. in Sacc., Syll. Fung. 21:212. 1912.
Stropharia caerulescens (Pat.) Sing., Ann. Mycol. 34: 340. 1936.
Stropharia cyanescens Murr., Mycologia 33: 279. 1941.

Pileus 16-80 mm. broad, conic campanulate with an acute papilla at first, gradually becoming convex to plane and at times with a depression around the umbo, umbo becoming more obtuse, more rarely without any umbo or papilla, viscid, glabrous or with fugacious veil remnants near margin, white with more or less fulvous center, eventually entirely fulvous brown, sometimes white to pale yellow ("cartridge buff") at margin, more "cream buff," "chamois," or "honey yellow" toward the "Isabella color" to "clay color" disc, usually staining bluish in age or when injured.

Lamellae gray, becoming deep violet gray and somewhat mottled, finally almost black, adnate to adnexed, seceding, close, narrow, becoming ventricose in mid-portion, broad in age, edges white.

Stipe 40-150 x 4-14 mm, tubular, usually somewhat thickened downward, more rarely subequal, or tapering to the base, white, staining blue ("deep Medici blue") when injured, eventually discoloring to yellow brown or reddish cinereous, often strongly sulcate at the apex, smooth otherwise, glabrous to slightly fibrillose, dry; annulus membranous but thin, smooth on both sides, white, staining blue, fragile, usually persistent.

Context white, staining blue on injury; odor none; taste farinaceous.

Spores 11.5-17.3 x 8-11.5 x 7-9 µ, dark yellow brown (in KOH) to dark olive brown (in NH_4OH), smooth, nearly elliptic in side view, ovate to broadly elliptic in face view and many obscurely angular, wall thick and complex, apex truncate from a distinct apical pore; basidia (2-, 3-, or) 4-spored, 28-35 x 10-13 µ; pleurocystidia scattered, 18-23 x 10-13 µ, ventricose and narrowed slightly near apex to an obtuse to rounded tip, thin-walled, contents (in KOH) homogeneous (not protoplasmatic); cheilocystidia numerous, 18-35 x 6-12 µ, fusoid-ventricose with obtuse to subcapitate apex, neck 4-18 µ long, 3-6.5 µ thick, enlarged tip (head) 4-5 µ, wall thin and readily collapsing; gill trama regular, mediostratum of hyaline parallel to somewhat interwoven hyphae, in well pigmented caps this layer flanked on both sides by parallel hyphae with dingy ochraceous walls (in KOH); pellicle of pileus a thin layer of narrow (c. 3.5 µ) gelatinous hyphae which are radially arranged and yellowish to hyaline in KOH; hypodermium of interwoven to more or less radial hyphae up to 26 µ in diameter, with ochraceous brown walls in KOH; clamp connections present.

Chemical characters: metol strongly positive on context of stipe ("dark naphthaline violet" or darker), other reagents negative or accelerating the bluing.

Gregarious on cow dung, more rarely on horse dung or on rich pasture soil, or on sugar cane mulch or straw or sawdust mixed with dung, usually outside the forests, fruiting from February until November or December, south of the Equator from November until April.

Material studied: U.S.A., Florida: TYPE of *Stropharia cyanescens* Murr. and additional collections by *G. F. Weber*, *J. R. Watson*, and *W. A. Murrill*, as *S. cyanescens*, F-19138, F-19630, F-19244, F-17932, F-17735, F-19464 (all FLAS), and *R. Singer F 1802, F 1802a* (FH, F); Magnesia Springs, *W. A. Murrill* (NY). Puerto Rico: Mayaguez and Ailonato, *Bruce Fink 899* and *1955* (NY). Cuba: Santiago de las Vegas, *Earle 109* both on sheets and in box, marked "tipico," TYPE of *Stropharia cubensis* (NY); also *Earle 169, 315, 350*; Candelaria, *Earle 206*

(NY); Soledad, Cienfuegos, *W. L. White 808,526* (FH). Mexico: Oaxaca, Huautla de Jiménez, *7-27-38*, *R. E. Schultes*, Plantae Utiles Mexicanae 349 (FH); *R. Gordon Wasson 1* (NY); *R. Singer M 1512* (MICH). Brit. Honduras: *M. E. Peck 478* (NY). Trinidad (collector not given) (NY). Bolivia: Beni, Guayaramerín, *R. Singer B* (LIL). Argentina: Tucum'n, *R. Singer T* (LIL). Indochina: TYPE of *N. caerulescens* Pat. (FH).

The collections enumerated above should be divided into three color varieties:

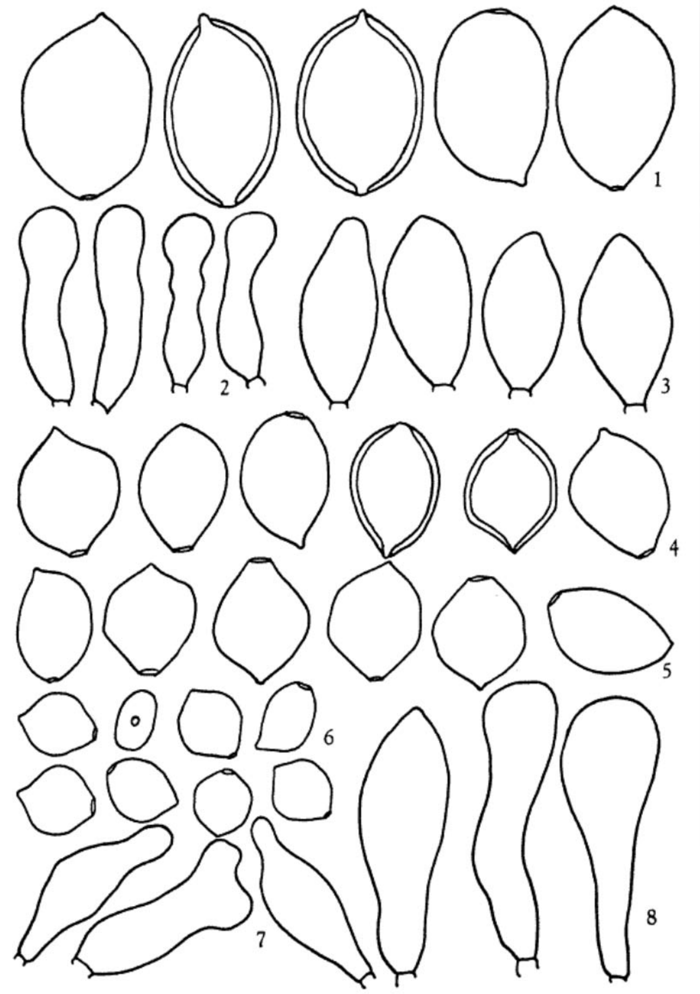
P. CUBENSIS var. CUBENSIS (the type). Here, the pigmentation of the pileus is fulvous. It develops early, and pallid pilei are hardly ever seen. The strain proved to be hallucinogenic belongs here.

P. CUBENSIS var. **cyanescens** (Murr.) comb. nov. The type of this variety is the type of *Stropharia cyanescens* Murr. It differs from the type variety in the virtual lack of pigment or its small quantity; consequently the pileus is pallid to pale isobelline. Known to occur in Florida (10).

P. CUBENSIS var. **caerulescens** (Pat.) comb. nov. The type of the variety is *Naematoloma caerulescens* Pat., type. It differs from the type variety in showing a clear yellow color at least in certain portions of the pileus. Known to occur in Indochina (11).

Illustrations: V. P. & R. G. Wasson, Mushrooms Russia and History 2: *pl. 40, fig. 2*. 1957; Life, May 13, 1957, p. [107] *fig. at lower right*. (Both the *var. cubensis*.)

The senior author at one time (14) thought that *Stropharia caerulescens* Imai (*S. venenata* Imai) was identical with *S. cubensis*, but we are treating it now as synonymous with a closely related but distinct species. For more detailed commentary on *S. venenata* see under *P. subaeruginascens*.



Figs. 1-8. 1-3: spores, cheilocystidia and pleurocystidia of *Psilocybe cubensis*. 4: spores of *P. subaeruginascens*. 5: spores of *P. aerugineomaculans*. 6-8: spores, cheilocystidia and pleurocystidia of *P. yungensis*.

Psilocybe subaeruginascens Höhnel

2. ***Psilocybe subaeruginascens*** Höhnel, Sitzungsber. K. Akad. Wiss. Wien 123(1): 78. 1914. (Fig. 4.)
Stropharia caerulescens Imai, Trans. Sapp. Nat. Hist. Soc. 12: 148. 1932.
Stropharia venenata Imai, Journ. Fac. Agr. Hokk. Imp. Univ. 43(2): 270. 1938.

Pileus 15-25 mm broad, plano-convex, almost membranaceous, glabrous and smooth, whitish with smoke brown center, becoming slightly greenish-blue-spotted when touched.

Lamellae grayish brownish, rather distant, with paler edge, 2-3 mm broad, broadly adnate and somewhat decurrent.

Stipe 30-40 x 1.5-3 mm, cylindric, slightly thickened at base, somewhat flocculose-farinaceous above, otherwise glabrous, somewhat shining, hollow but stuffed with a loose woolly pith, white, weakly greenish blue when touched, with an annulus above the center of the stipe, annulus small, often oblique, scaly-membranous; mycelium abundant, filamentous, white, staining greenish blue or almost steel blue.

Context white, tough in the stipe, bluing; odor and taste not recorded.

Spore deposit beautifully violet-brownish.

Spores 7.7-10 (-11.5) x 7-7.8 x 6-7 µ, ovoid to subrhomboid in face view, in side view somewhat inequilateral, smooth, dingy yellow brown in KOH, apex truncate from a broad flattened germ pore; basidia 2- and 4-spored, very rarely 1-spored or 3-spored, 18-28 x 6.3-0.2 µ, typically with a median constriction; pleurocystidia 25-33 x 9-12 µ, broadly fusoid-ventricose with obtuse apex, hyaline, thin-walled, contents homogeneous; near the edge sometimes some pleurocystidia similar to cheilocystidia; cheilocystidia 20-33 x 6-9 µ, fusoid-ventricose with obtuse apex or neck narrow and cylindric, or in some the apex subcapitate, hyaline, causing the edge to appear heteromorphous; epicutis of pileus not gelatinous, apparently of closely interwoven appressed hyphae; clamp connections present.

Subcespitose on horse dung, Buitenzorg, Java, Indonesia, *v. Höhnel*, TYPE (FH).

This is a *Psilocybe* of the *P. coprophila* type but staining blue. The spores are more angular in face view than those of *P. coprophila* and also of smaller size.

Stropharia caerulescens Imai (5) is placed in synonymy here although the type is unavailable at present; we base our judgment on the following original description:

Pileus 15-60 mm broad, glabrous, hygrophanous, or scarcely slightly viscid, convex to plane to subumbonate, yellowish to isabelline, more rarely whitish, margin always pallid. Lamellae pallid, then violet fuscous, adnate. Stipe 35-90 x 5-9 mm, equal, dry, almost hollow, fibrillose below the annulus, whitish, annulus almost apical, very thin membranous, more rarely fibrillose, often evanescent. Context whitish or pallid, bluing. Spores fuscous or violet fuscous, ellipsoid, 7-10.5 x 4.25-7 µ; cystidia none. Gregarious or cespitose on earth and dung, fruiting in June, July and October. Japan, Hokkaido, Ishikari province, near Asahigawa and Sapporo. [Specimens are apparently preserved at Sapporo.]

It is interesting to read in Imai's account (5) about the physiological activity of this species. It caused ten deaths in 1929 alone, and is apparently more toxic than the related Mexican species. The symptoms are described as feeling feverish, with a subjective impression as if strong liquor had been imbibed; the limbs became somewhat paralyzed. In the hospital after an emetic had been administered and the stomach washed and eventually a laxative had been given, the patient was now in bed with intermittent constriction or trembling of muscles and finally there were hallucinations, then coma. This patient, a woman, recovered. Her son who did not eat the flesh of the mushroom but drank only the liquid of the soup in which it was cooked felt only paralysis of the limbs and a chill, followed by hallucination. All recovered eventually.

In another case, after similar symptoms were observed, coma, loss of consciousness, and talking in delirium were observed. The pupils had opened to a medium size and did not react to light. (This observation coincides with observations made in Mexico with psilocybes of this section.) For more details see Imai's paper (5).

In a later paper (6), Imai renamed his species *S. venenata* Imai. The description was now slightly changed to accommodate also specimens with deeper color of the pileus, more viscid surface, and habitat on rotten wood. The conclusion is very suggestive that the forms later added to the species concept and expressed in the changes of the description at the time of the publication of *S. venenata* can be accounted for if it is assumed that the type form (= *P. subaeruginascens*) was later confused with *P. aerugineomaculans*. Whether this opinion is correct can be proved only if and when specimens from Japan become available.

The original description of *S. caerulescens* Imai is accompanied (p. 149) by a photograph which, by implication, and with certain reservations, may be cited as an illustration of *P. subaeruginascens* Höhnel.

Psilocybe aerugineomaculans (Höhne)

3. ***Psilocybe aerugineomaculans*** (Höhnel) comb. nov. (Fig. 5.)
   Stropharia aerugineomaculans Höhnel, Sitzungsber. K. Akad. Wiss. Wien 123(1): 78. 1914.

Pileus 25-40 mm broad, campanulate, becoming expanded and umbonate, surface slightly viscid to the touch, disc dark blue, remainder reddish gray-cinereous (as in *Psathyrella gracilis* sensu Höhnel), margin striatulate.

Lamellae rather distant, 4-5 mm broad - *i.e.*, moderately broad - attenuate-adnate, yellowish olive, marbled as in *Panaeolus*, edges even.

Stipe 40-50 x 2 mm, not thickened at base, cylindric, hollow, white, slightly flocculose, glabrescent, shining, annulus membranous, small, entire, white; rind 0.15 mm thick when dried.

Context in the middle of the pileus thin (2 mm), membranous toward margin, somewhat cartilaginous in outer layer of stipe, soft inside, staining blue where bruised; odor and taste not recorded.

Spore deposit very deep brown, almost black.

Spores 8.5-10.5 x 7-8 x 5.5-6.5 µ, compressed, subelliptic in side view, rhombic to heart-shaped (angular ovate) in face view, with a truncate apex and a distinct germ pore, thick-walled, near bister when revived in KOH; basidia 4-spored, about 22 x 8 µ; pleurocystidia not seen in type; cheilocystidia 18-22 x 6-8 x 3.5-4 µ, fusoid-ventricose with obtuse apex, typically capped with a hyaline mucilaginous substance, the whole gill edge gelatinizing in KOH; pellicle of pileus distinct but formed by a thin layer of gelatinized epicuticular hyphae; clamp connections present.

On rotten wood. Buitenzorg, Java, Indonesia, *v. Höhnel*, type (FH).

Although the species is lignicolous, the spores remind one of the coprophilous series. The presence of a distinct gelatinous pellicle separates this species from *P. subaeruginascens*. This was clearly demonstrated from a study of the types. The type of *P. subaeruginascens* is well dried, well preserved, and consists of fruiting bodies that were in prime condition when placed on the drier. Hence, the lack of a gelatinous epicutis is significant. The type of *P. aerugineomaculans* consists of two carpophores which were apparently over-age when dried and as preserved are inferior to quality to those of *P. subaeruginascens*. Under such circumstances one would expect the gelatinous pellicle, if one were present originally, to be pretty well obliterated. The fact that it is still present indicates to us that when fresh material is again collected the pellicle may be found to be rather thick and well developed.

From our comments on *P. subaeruginascens*, one might expect *P. aerugineomaculans*, no less than *P. subaeruginascens*, to occur in Japan.

The macroscopical descriptions of both Javanese species are adapted from Höhnel's notes.

Stirps Yungensis

Psilocybe yungensis Singer and Smith

4. ***Psilocybe yungensis*** Singer and Smith, Mycologia 50: 142. 1958.
   Var. yungensis (Figs. 6-8, 45).

Pileus about 16 mm broad and equally high, margin at first incurved, conic with an obconic or button-like appendage at the tip, not expanding, deep rusty brown (*leaf mold*), in the marginal region between striae buffish gray (*cracker*), finely marked with long translucent striations when moist, somewhat viscid, staining deep blue (*39 H 5*) where injured.

Lamellae gray buff (*aloma*), with white edges, staining blue where wounded (*39 H 5*), very narrow, ascending and never becoming horizontal, crowded, adnate.

Stipe 55 mm long, 2 mm at apex, 3 mm at base, subequal, deep chestnut brown (Hindu), reaching auburn at apex, bluing less than cap and gills but such a change still evident, densely fibrillose floccose from light brownish fibrils on darker ground, becoming more fibrillose-pruinose toward apex, veil inconspicuous except for the floccons, no annulus formed.

Context concolorous with surfaces or somewhat paler both in pileus and stipe, moderately fragile in stipe; odor slightly raphanaceous.

Spore deposit dark lilac.

Spores 5-5.5 x 4.3-5 x 3.6-3.9 µ, compressed, dark olive sepia in KOH and NH_4OH, smooth, rhombic in face view and a hilar appendage visible, without suprahilar applanation or depression in side view, apical pore broad, wall thick and complex; basidia 13-18.5 x 4.7-6.2 µ, short-ellipsoid-clavate then elongating and finally ventricose in the middle 2-, 3-, or mostly 4-spored, hyaline; pleurocystidia present as an occasional cystidiole about the size of a basidium, but often with a low mucro, contents hyaline in KOH and not protoplasmatic; cheilocystidia 13-34 x 5-7.3 µ forming a sterile band along the edge, exceptionally variable: some clavate, some ventricose and with capitate to subcapitate apex, some ventricose above and constricted in the middle, others ventricose-fusoid and broadest in mid-portion, some ampullaceous, some capitate-cylindric, some subulate-sublanceolate, all hyaline, narrowest portions 2.7 µ or more; subhymenium of small irregular elements, not regularly arranged; with a brown to stramineous membranal pigment which often breaks up to incrust the walls of the cells; gill trama regular, consisting of elongate cylindric elements, pigmented like the subhymenium, with 0.8-1 µ thick walls; epicutis gradually more differentiated from the hypodermium toward the uppermost surface of the pileus, there often more or less gelatinized, with smooth hyaline filamentous elements subparallel, forming a cutis, ascending hyphal excrescences often present on these hyphae and some of these stramineous and incrusted; hypodermium of a compact layer of hyphae irregular in size and shape but generally repent and radially elongated, all strongly incrusted with ochraceous brown pigment; clamp connections present.

Chemical characters: KOH leaving a dark spot where dropped on any part of the carpophore; $FeS0_4$, no reaction.

In small to large groups on very rotten wood or humus containing decomposing woody material, in tropical-montane forest, fruiting in January (summer rainy season). Known only from the type locality, Cataratas de San Juan, road from La Paz to Coroico, Bolivia, 2000 m alt., 1-28-1956, *Singer B 648*, TYPE (MICH).

Var. diconica Singer and Smith, Mycologia 50: 142. 1958. (Fig. 44)

Pileus as in the preceding variety but lower, with an acute papilla rather than a knob, not quite so long-striate and somewhat darker in color (*Mohawk*, and between striae *kis kilim*).

Lamellae sordid lilac or reddish brown (between *kermanshah* and *Rembrandt*), otherwise as in var. *yungensis*.

Stipe shorter than in the preceding variety.

Context odorless.

Spores 4.4-6.2(-7.2) x 3.8-5 x 3.3-3.8 µ, otherwise as in var. *yungensis*; basidia mostly 4-spored; pleurocystidia and cheilocystidia as in preceding variety; gill trama consisting of broad, often short, stramineous hyphae with thick walls; epicutis and hypodermium of pileus as in preceding variety; clamp connections present.

Chemical characters as in var. *yungensis*.

Gregarious on very rotten wood and humus in tropical-montane forest. Bolivia, Departamento La Paz, Provincia Nor-Yungas. Cataratas San Juán, 2000 m alt., *R. Singer B 651*, TYPE, 1-28-1956 (MICH).

The two forms designated temporarily as varieties come from the same place and were gathered the same day as separate populations. Each population had its own characteristic habit and color range as described above, but under the circumstances we did not think them sufficiently distinct to separate them specifically. They were considered "probably the same" when first collected in the field.

P. yungensis is a very strongly pigmented species with typically high, little or not expanding pileus but with originally incurved margin, and with a non-annular veil remaining in floccons on the surface of the thin stipe. The spores are different from those of all other species of this section.

Stirps Mexicana

Psilocybe mexicana Heim

5. ***Psilocybe mexicana*** Heim, Rev. de Mycol. 22: 77. 1957. (Fig. 25-26, 43)

Pileus 5-33 mm broad, 4-15 mm high, conic-campanulate and usually with a central papilla, frequently becoming hemispheric to convex and sometimes papillate in addition, broadly conic in others, and becoming umbonate and in these the umbo sometimes crowned by a papilla, always relatively high and narrow and not fully expanded, eventually, however, often convex with an uplifted margin, glabrous, viscid but soon dry, margin at times sulcate-striate to a small apical smooth disc, disc deep ochraceous to ochraceous brown, then fulvous, marginal zone much paler, hygrophanous, fading to ochraceous over the disc, gray brown in marginal zone and pale ocher-gilvous between, all traces of silky white veil soon vanishing from the margin.

Lamellae pale gray, eventually deep sepia, close to subdistant, ascending to almost horizontal, adnate to adnexed, only moderately broad, edges whitish.

Stipe 20-80 x 1-3 mm, hollow, equal and elongate, sometimes rather distinctly attenuated at the base, ochraceous, at maturity the apex paler, central portion often fulvous, glabrous when mature; veil thin and leaving fine appressed silky fibrils on the upper third, soon evanescent.

Context in pileus paler than surface, turning blue when bruised or on drying; odor always rather strongly farinaceous; taste slightly disagreeable.

Spore deposit deep sepia to dark purple brown.

Spores (7.7-)8.8-10.5(-12) x (5.5-)6.7-7.7 x (5-)5.5-6.7 µ, compressed, in face view elliptic to rhombic and then broadest in mid-portion, subelliptic in side view, dingy yellowish brown in KOH, smooth, with thick walls, furnished with a distinct broad germ pore; basidia 20-32 x 6.3-7.7 µ, 4-spored, variable in size, typically with a median or more superior constriction; pleurocystidia none, or a few similar to cheilocystidia near the edge; cheilocystidia forming a sterile band along edge, 15.5-30.5 x (3-)4-9 µ, usually short pedicellate, hyaline, fusoid-ampullaceous, the neck short (rarely long), apex obtuse to acute (rarely capitate or bifurcate); subhymenium a thin layer of very irregular small elements; hymenopodium of relatively narrow filamentous axially arranged parallel hyphae, layer thin; gill trama regular, hyaline to stramineous, with voluminous (up to 19 µ in diameter) elements, hyphal walls up to 1.5 µ in diameter; epicutis a broad hyaline layer of filamentous mostly hyaline hyphae, not strongly gelatinized but well differentiated from hypodermium, hyphae 1.7-3.5 μ in diameter; hypodermium a colored (yellowish brown) layer of hyphae 2-14 μ in diameter, with pigment in the walls (not incrusted); body of context hyaline to yellowish, many hyphae up to 20 μ in diameter and walls up to 1.5 μ thick; dermatocystidia none; clamp connections present.

On the earth or on plant fragments such as mulch from sugar cane presses, usually in open fields and springy meadows, never on dung; always solitary but often in large numbers in a limited territory; fruiting from May until October, common in the transition zone between the tropical-montane and the temperate-montane zone - *i.e.*, between 1500 and 1800 m alt. - favoring limestone regions. Reported from Southern Mexico and Guatemala.

Illustrations: Wasson, Mushrooms Russia and History 2: *pl. 40, fig. 1*; Life, May 13, 1957, p. [107], *fig. at lower left*.

Material studied: Mexico: Oaxaca, Huautla de Jimenez, *R. G. Wasson 3*, 13-8-1953 (NY); *R. Singer M 1502*, July 10, 1957 and *M 1521*, July 11, 1957 (both MICH).

This is the only mycenoid representative of the genus occurring in Oaxaca and consequently the only mycenoid hallucinogenic mushroom used by the Mazatecs. For this reason it is sometimes confused with *Panaeolus sphinctrinus* which has a similar habit but is more obtuse, with blacker lamellae, and grows mostly directly on dung.

Stirps Silvatica

Psilocybe silvatica (Peck)

6. ***Psilocybe silvatica*** (Peck) comb. nov. (Figs. 27, 29).
   Psathyra silvatica Peck, Ann. Rep. N. Y. State Mus. 42: 20. 1889.
   Hypholoma silvaticum (Peck) A. H. Smith, Contrib. Univ. Mich. Herb. 5: 21. 1941.

Pileus 8-25 mm broad and at least half as high, obtusely conic to campanulate, margin straight at first, disc often with a papilla, glabrous, viscid, shining when dried, tawny to rather dark brown, hygrophanous, fading to pale ochraceous buff to grayish melleous or grayish brown.

Lamellae dull ferruginous brown when mature, narrow to broad, adnate, ascending to almost horizontal, close to subdistant, with a pallid edge.

Stipe 20-80 x 1-3 mm, equal or slightly thickened at the base, tubular, flexuous, pallid to brownish, apparently whitish from a superficial appressed fibrillose covering, this layer thinning out downward and more brown showing through from cortex of the stipe; veil apparently very weakly developed and all traces gone in mature specimens.

Context in pileus membranous and fragile, in stipe brownish and cartilaginous; taste farinaceous; odor also farinaceous (from crushed flesh).

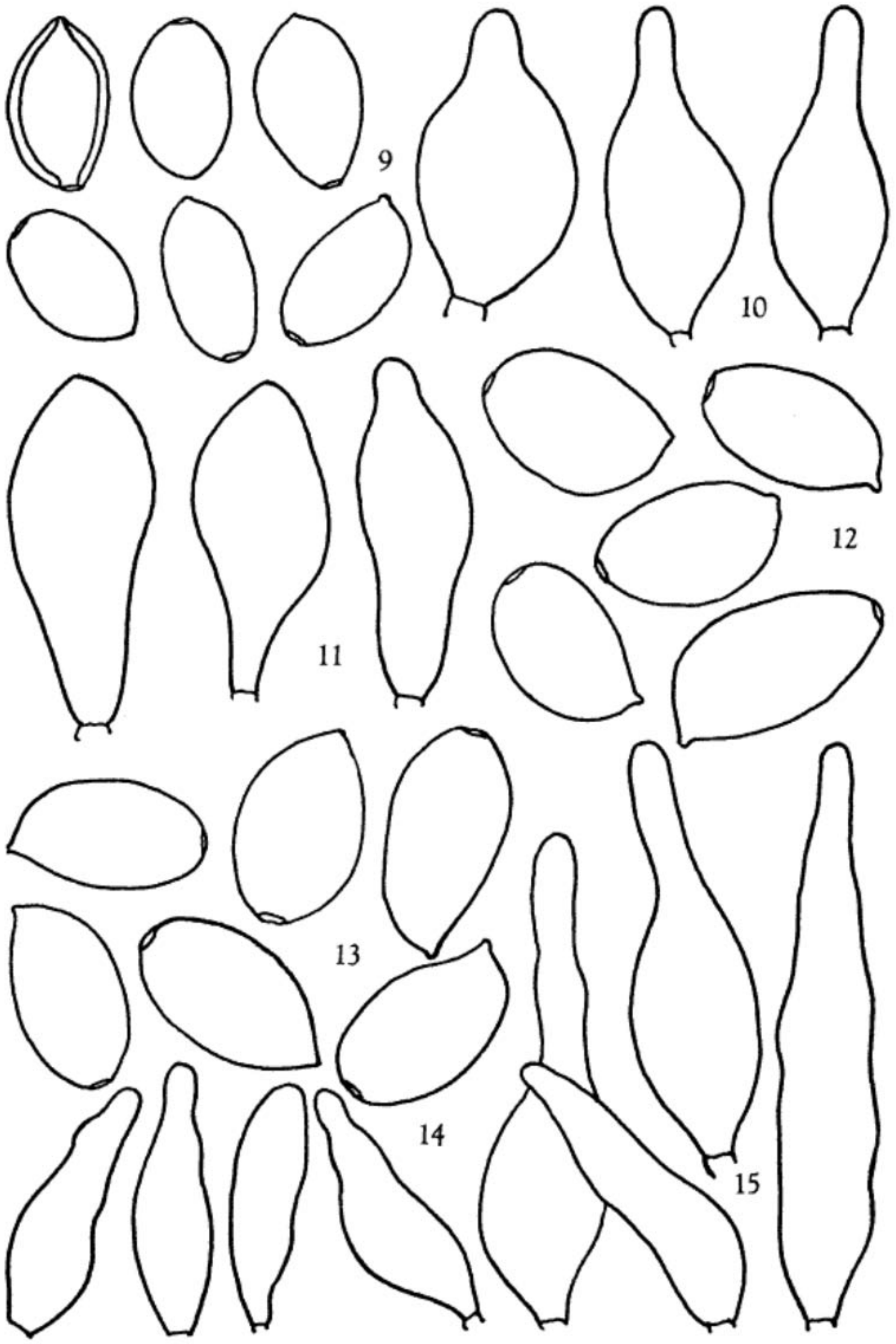
Spores in deposit "benzo brown" (violaceous brown).

Spores 6-9.5(-11.5 from 2-spored basidia) x 4.5-5.5 μ, dingy yellowish brown in KOH, smooth; with a complex thick wall, terete in cross section, with a distinct apical germ pore; basidia 19-27 x 5.7-8 μ, 4-spored, rarely 2-spored; pleurocystidia none; cheilocystidia 24-45 x 4-10 μ, ventricose below and often ampullaceous with an elongated neck 1.3-2.2 μ thick, tapering to an obtuse to (rarely) subacute apex, often pedicellate, forming a sterile band on gill edge; subhymenium thin, melleous in KOH; gill trama of relatively broad hyphae with walls up to 0.8 μ thick, pale melleous in KOH and lacking pigment incrustations; epicutis of pileus a thin pellicle of gelatinized hyaline to yellowish filaments 1-2.8 μ in diameter, but pellicle not very strongly gelatinous; hypodermium of compactly arranged hyphae 3 μ or more broad and more highly pigmented than in trama proper, pigment incrusting the walls; clamp connections present.

In small groups, gregarious but not cespitose, in the woods on debris around stumps or on leafmold (mostly *Fagus grandifolia*), generally not directly on stumps or logs, fruiting in September and October. Known from New York, Ontario, and Michigan.

Material studied: U.S.A.: New York, Star Lake, *Peck*, PARATYPE of *Hypholoma fragile* (NYS); North Elba, *Peck*, TYPE (NYS). Mich., Milford, *Smith 20970*, 10-4-1949 (MICH). CANADA: Ont., Bear Island, Lake Timagami, *Smith 4777*, 9-9-1936 (MICH).

Hypholoma fragile was originally reported by Peck from two localities, Star Lake and Painted Post, both in New York. As A. H. Smith (18) previously pointed out, the Painted Post collection should be regarded as the type. This latter is a *Psathyrella* and the same as *P. hymenocephala* (Peck) Smith. The Star Lake collection is *P. silvatica* (Peck) Sing. & Sm.



Figs. 9-15. 9: spores of *Psilocybe aztecorum*. 10: cheilocystidia of *P. collybioides*. 11: pleurocystidia of *P. collybioides*. 12 and 15: spores and cheilocystidia of *P. strictipes*. 13: spores of *P. baeocystis*. 14: cheilocystidia of *P. candidipes*.

When A. H. Smith (17) described *P. pelliculosa* the confusion involving *H. silvaticum* had not been discovered. After working out the details of this problem he considered the apparently slight differences existing between *P. pelliculosa* and *P. silvatica* as of no taxonomic significance and reduced *P. pelliculosa* to synonymy with *P. silvatica*. It now appears from the study of all known species in this section that the slight differences disregarded earlier may have taxonomic significance and so *P. pelliculosa* is re-established here.

Psilocybe pelliculosa (Smith)

7. ***Psilocybe pelliculosa*** (Smith) comb. nov. (Figs. 28, 30, 42).
   Psathyra pelliculosa A. H. Smith, Mycologia 29: 58. 1937.

Pileus 8-15 (-30) mm broad, at least half as high as broad, obtusely conic with a straight margin when young, remaining so or becoming more broadly conic-campanulate, never fully expanding, surface glabrous, smooth, viscid from a separable gelatinous pellicle, hygrophanous, "Saccardo's umber" to "Isabella color" (dark dingy yellow-brown or more olive showing), usually fading to "pinkish buff" (dull pale alutaceous), often with greenish gray tints in age, margin translucent-striate when moist.

Lamellae dull "cinnamon brown" until darkened by the spores, adnate but eventually separating from the apex of the stipe, rather narrow to moderately broad, markedly ascending at first, less so in age, close, edges pallid.

Stipe 60-80 mm long, 1.5-2 mm thick at apex, equal above an enlarged base (base enlarged from adhering debris), pallid to grayish, appressed silky fibrillose and brownish below and reaching bister in age, pruinose above; veil absent to rudimentary.

Context thin and pliant in pileus, rather tough in stipe, turning slightly bluish or greenish where injured in pileus and stipe; odor none or slightly musty.

Spores 9.3-11 x 5-5.5 µ to 10.5-13(-14) x 5.5-7 µ (according to populations, all 4-spored), dark yellow brown in KOH, showing a distinct apical germ pore (often convex), smooth, terete, ellipsoid to subovoid; basidia 4-spored, 22-30 x 7-8 µ, hyaline; pleurocystidia none or only near gill edge and similar to cheilocystidia; cheilocystidia 22-36 x 5.5-7.5 µ, hyaline, forming a sterile band on gill edge, often pedicellate, fusiform-lanceolate with an elongated neck tapering to an acute to subacute apex, neck rarely cylindric with an obtuse apex, hyaline in KOH; subhymenium narrow and irregular, brownish in KOH; gill trama regular, pale brownish in KOH; epicutis of pileus a thick pellicle of more or less horizontal very loosely arranged strongly gelatinized wavy hyphae 0.8-5.5 µ in diameter, hyaline, walls never incrusted; hypodermium of compactly subparallel hyphae tawny from having colored walls but walls not incrusted; all hyphae with clamp connections.

Scattered to gregarious or cespitose on debris and humus in and near conifer forests from September to December. California, Oregon, Washington, Idaho.

Illustration: A. H. Smith in Contrib. Univ. Mich. Herb. 5: *pl. 10, fig. 1* (*Hypholoma silvaticum*). 1941.

Material studied: Idaho: Granit Creek, Nordman, *A. H. Smith 54268*, 10-8-56 (MICH). Washington: Lake Cushman, Olympic Mts., *C. H. Kauffman*, 10-11-15 (*Psathyra fagicola*) (MICH); Lake Quiniault, *C. H. Kauffman*, 10-13/27-25 (all three MICH); Lake Crescent, *A. H. Smith 3074*, 10-10-35 (MICH); numerous other collections from nearby places in Washington: *A. H. Smith 3196, 17875, 39887, 40212, 40465/6, 40526, 40966, 41181, 49088, 49381*; Zenith, *J. B. Flett*, 11-3-41 (all MICH). Oregon: Near Lake Tahkenitch, *A. H. Smith 3431*, 11-11-35, TYPE (MICH); other Oregon collections, *A. H. Smith 3461, 7893, 9298, 25057, 49488* (all MICH). California: Crescent City, *A. H. Smith 8260*, 10-30-37 (MICH).

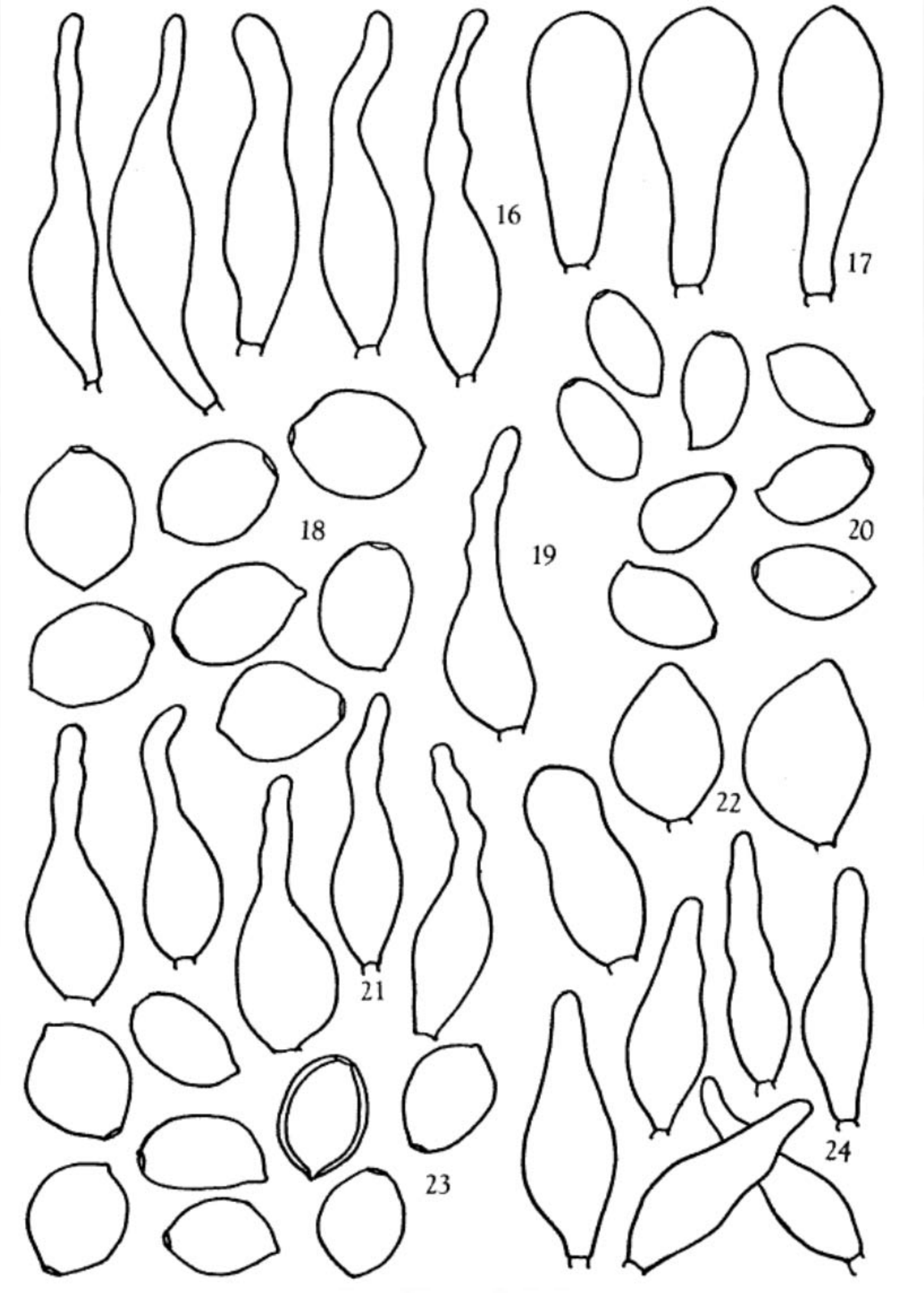
Stirps Cyanescens

Psilocybe aztecorum Heim

8. ***Psilocybe aztecorum*** Heim, Rev. de Mycol. 22: 78. 1957 (Figs. 9, 31).
   Psilocybe mexicana var. *longispora* Heim, C. R. Acad. Sc. 244: 1393. 1956, nom. subnud.

Pileus 15-25 mm broad, obtuse to subumbonate, expanding to broadly conic or campanulate, glabrous except for traces of the veil along margin at first, slightly viscid, hygrophanous, milk white with yellowish disc, striate over about a third of the radius when moist, pale buff faded, disc tending to become rimulose-cracked in some specimens.

Lamellae deep purple brown when mature, adnate, broad, fairly close, with pallid to whitish edges.



Figs. 16-24. 16: cheilocystidia of *Psilocybe baeocystis*. 17 and 20: pleurocystidia and spores of *P. candidipes*. 18, 19, 21 : spores, pleurocystidia and cheilocystidia of type of *P. caerulescens*. 22-24: pleurocystidia, spores and cheilocystidia of *P. mazatecorum* (Mexican specimens so determined by Heim) = *P. caerulescens*.

Stipe 30-60 mm long, 2-4 mm thick at apex, equal or nearly so, fibrous, base at times enlarged, often flexuous, whitish, staining blue, becoming grayish on discolored portions, especially over lower part in age; veil well developed, sometimes forming a fugacious annulus.

Context white, changing to blue readily, especially in the stipe; odor farinaceous; taste astringent.

Spores 10.5-14(-16.2) x 5.3-7.7 (-8.8) µ, elongate-ellipsoid, terete, revived in KOH dark dull ochraceous brown with olive tone and a red brown line showing along the endosporium, thick-walled, germ pore broad and distinct, wall smooth; basidia hyaline to melleous-hyaline, mid-portion usually constricted, 24-31 x (5-)7.7-10(-10.5) µ, (1-, 2-, 3-) 4-spored, sterigmata 6-6.5(-7.8) µ long; pleurocystidia similar to cheilocystidia, rare to scattered, rarely a few cystidioles found, their shape reminding one of one-spored basidia; cheilocystidia abundant, causing gill edge to be heteromorphous, 24-45 x 5-8 µ, fusoid-ampullaeeous with filamentous neck, neck rarely tapered sharply to a subacute apex, 6-11 µ long and about 2.5 µ in diameter; pilocystidia none; caulocystidia abundant near apex of stipe, variable in shape, 17-43 x 4-9 µ, ventricose at base and with or without a short neck; epicutis a thin pellicle consisting of narrow (1-2.2 µ) gelatinized hyphae hyaline in KOH; hypodermium poorly differentiated but hyphae up to 14 µ broad, having colored (non-incrustcd) walls and not gelatinized; clamp connections present.

In small groups on the earth in open pine woods (*Pinus hartwegii*), associated with grasses and *Alchemilla procumbens*. It fruits in September and is known only from around Paso de Cortés, Mexico and Puebla, between 3300 and 3700 m elevation, Mexico. *G. Guzmán VA 1099*, September 1957, TOPOTYPE (MICH).

Illustrations: Singer, Chicago Nat. Hist. Mus. Bull. Dec. 1957 (photo); *Life*, May 13, 1957, p. [106], *upper fig*.

In this species are combined the characters of small carpophore size, large spore size, and fairly copious veil development. It is only slightly - never abundantly - pigmented, but the fact that it turns blue when injured has been very clearly established by G. Guzmán on the material on which our description is based, and the local inhabitants likewise consider the bluing one of the mushroom's characteristic features.

Psilocybe cyanescens Wakefield

9. ***Psilocybe cyanescens*** Wakefield, Brit. Mycol. Soc. Trans. 29: 141. 1946.

Pileus 20-40(-75) mm broad, convex, becoming expanded, viscid, hygrophanous, when moist chestnut color, fading yellowish or ochraceous, margin striate when moist, staining blue when touched.

Lamellae cinnamon colored becoming badio-fuscous as spores mature, adnate to adnate-decurrent, subdistant, up to 5 mm broad, edges paler.

Stipe 60-80 x 2.5-5 mm (rarely 100 x 7 mm), fairly rigid, base somewhat enlarged and often curved near the base, whitish, silky fibrillose, changing to blue when bruised or in drying; veil cortinate, snow white and thin, best seen on young fruiting bodies.

Spore print fuscous.

Spores 9-12 x 5.5-8.3 x 5-7.7(-8) µ, mostly slightly broader in face than in side view, smooth, nearly elliptic in side view, more ovate in face view, with a distinct broad apical germ pore, wall thick and complex, dingy yellow-brown in KOH and with a reddish chestnut line along the endosporium; basidia 4-spored, 16-26 x 7.2-9.3 µ, cheilocystidia 12-26 x 5-8 µ, fusoid-ventricose, with the neck 2-4 µ thick and projecting about one-third of the total length of the cheilocystidium, apex obtuse; pleurocystidia few, in form of cystidioles, 21-28 x 5.5-8.8 µ, resembling basidioles but mucronate and lacking both protoplasmatic granulation and refractive internal body when revived in KOH (hence neither basidioles nor chrysocystidia); gill trama regular, hyaline to melleous, the hyphae lacking pigment incrustations and having thin to moderately thickened walls; epicutis a pellicle of long loosely arranged filaments imbedded in a gelatinous mass; beneath this a hypodermium of melleous but not conspicuously incrusted hyphae; pilocystidia none; clamp connections present.

On the earth among leaves and dead twigs in woods, perhaps occasionally on rotten wood, known only from

Kew Gardens, Surrey, England, TYPE (K).

The description of the field characters is translated from the original description. The data on microscopical characters were obtained by us from a study of the type.

It is not impossible that this species was introduced to Europe with exotic plant material.

Psilocybe collybioides Singer and Smith

10. ***Psilocybe collybioides*** Singer and Smith, Mycologia 50: 141. 1958. (Figs. 10-11.)

Pileus 13-40 mm broad, at first campanulate and often soon varying toward convex, at maturity convex or retaining a more or less elevated umbo, eventually tending to become flattened and irregular, surface glabrous, viscid when moist, somewhat hygrophanous, when moist usually finely translucent striate and more sordid-pallid all over, faded light ochraceous brown (*13K 9*) with dingy pallid center, discoloring (where touched and on drying) from the center outward and finally reaching *bottle green* or *bayou*, often with a short sulcate margin.

Lamellae pallid to pure white, in some slightly brownish at maturity, close or subclose, more or less adnate, moderately broad to broad (e.g., 2.5 mm).

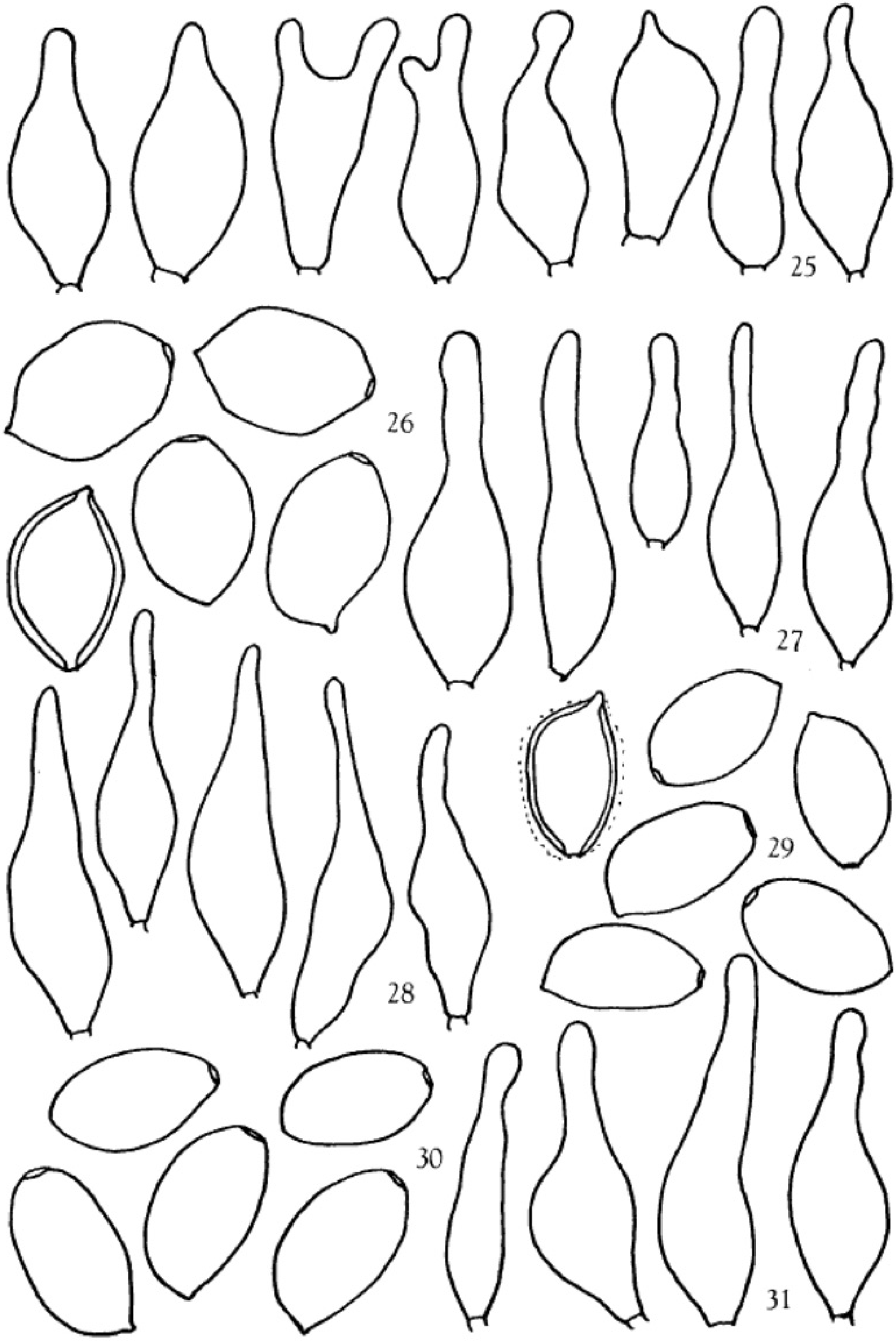
Stipe 30-70 x 1.5-4.5 mm, equal to slightly thickened downward, often twisted-contorted, curved, compressed, knotty or variously irregular, stuffed becoming hollow, white at first, often becoming cinnamon-brown from the base upward, at times remaining white or fading out to white again in age, when young silky fibrillose and sometimes sub-squamulose from the veil, later appressed finely fibrillose, apex fibrillose-pruinose; veil cortinate-fibrillose, white, fugacious; basal mycelium sometimes strigose, white, and forming white rhizomorphs.

Context white to pallid or in parts cinnamon, always discolored under the cuticle and in cortex of stipe, turning green to blue (*bottle green* or *bayou*) when injured, fleshy in pileus, somewhat tough in stipe; odor slightly farinaceous becoming spermatic.

Spores generally none, or few, typical of the *Strophariaceae*, about 10 x 6.5 µ (hymenophore nearly sterile or sterile); basidia not seen; pleurocystidia in form of cystidioles forming the hymenium, hyaline, some 24-32 x 7.3-9.5 µ, attenuate above and often with a rounded mucro, others more pseudoparaphysoid, vesiculose to broadly clavate, 14.5-23 x 9.3-13 µ; chrysocystidia none; cheilocystidia abundant, causing the gill edge to he heteromorphous, 17-23.5 x 8-9 µ, fusoid-ventricose with narrow (1.5-2 µ) extended neck and with obtuse to capitate (and then up to 3.5 µ diameter) tip; subhymenium consisting of irregular very small elements; hymenophoral trama regular, its hyphae with about 0.5 µ thick walls, without membrane-pigment; epicutis a pellicle consisting of loosely arranged gelatinized hyphae, hyaline in KOH; hypodermium of nearly non-pigmented hyphae, or in some a slight amount of wall incrustation (melleous) present, especially in young non-contorted carpophores; clamp connections present.

On dry slopes over loose gravel near *Alnus jorullensis* var. *spachii* and on various types of organic debris (humus, grass culms, semi-decomposed alder leaves, etc.) in semi-shade, gregarious, fruiting in the summer rainy season (February), Argentina, prov. Tucumán, Pre-Andine Sierras, Tafí del Valle, 2000 m altitude, *Singer T 1882*, TYPE (MICH).

The above collection was designated type in order to leave open the question of the identity of the North African species whose description follows, even though the latter and the type appear to be the same. If the North African species is not the same as ours it will have to be renamed because the epithet *cyanescens* is preoccupied in *Psilocybe*. The Argentine species described above has the appearance of a *Collybia*, hence the specific epithet proposed.



Figs. 25-31. 25-26: cheilocystidia and spores of *Psilocybe mexicana*. 27 and 29; cheilocystidia and spores of *P. silvatica*. 28 and 30: cheilocystidia and spores of *P. pelliculosa*. 31 : cheilocystidia of *P. aztecorum*.

Description of Maire's sterile to semi-sterile material from Algeria

The following description of *Hypholoma cyanescens* R. Maire, Bull. Soc. Mycol. Fr. 44: 51. 1928, refers to a North African species which we think probably identical with *P. collybioides*. This description is adapted from the original diagnosis. We have seen no specimens.

Pileus 15-30 mm broad, convex, then expanding, not umbonate, viscid and with a separable glutinous pellicle, hygrophanous, dingy ochraceous, faded pallescent, margin faintly striate or not striate.

Lamellae whitish becoming dingy and pallid ochraceous, finally light rufous-fuscous, close, thin, narrow (1.5-2.5 mm), arcuate, somewhat rounded behind and narrowly attached (rounded-adnexed), not intervenose, lamellulae attenuate, edges whitish pruinate.

Stipe 25-40 x 2-5 mm, subequal or slightly enlarged below, stuffed with a white silky medulla, eventually tubular, whitish, apex pruinose, innately fibrillose downward; cortina cobwebby, white, fugacious.

Context slightly fulvous, fulvous in the base of the stipe, faded pallescent, white in the stuffing of the stipe, bluing in all parts of trama on injury; odor raphanaceous; taste mild.

Spore deposit purple-brown.

Spores 10-12 x 5.5-6.5 µ, from 4-spored basidia, occasionally up to c. 20 x 7.5 µ from 2-spored basidia, ellipsoid, light fuscous brown, rather thick-walled, smooth, with a rounded to slightly attenuated apex furnished with a germ pore; basidia clavate, 4-spored, few 2-spored, 28-32 x 7-9 µ; pleurocystidia none or rare and similar to cheilocystidia; cheilocystidia 30-40 x 6-8 µ, fusiform with a subcylindric ampullaceous neck and an apex incrusted with calcium oxalate; subhymenium thin, ramose; gill trama regular, its elements 5-8 µ in diameter and rather long, interwoven.

Chemical characters: guaiac solution negative; NH_4OH negative.

Gregarious under *Cedrus atlantica*, fruiting from October until December. Algeria, Blida and La Chréa.

Description of fertile material referred to Hypholoma cyanescens by Malençon

The following description is translated and adapted from Malençon (8):

Pileus 15-35 mm broad, almost spheric to convex becoming campanulate to conic-campanulate, the margin finally spreading, viscid from a separable gelatinizing pellicle, naked, hygrophanous, ochraceous then amber yellow with a bister shade, finally dusky olive, bister, fading from the disc outward to yellowish white or dull stramineous ("as if it were gouachée"), in age at times disc leather color, translucent-striate half way to disc when moist, opaque when faded.

Lamellae pale argillaceous becoming more lilac-beige, eventually dark purple brown, thin, not close, narrow, ascending, free to slightly adnexed, with white fimbriate edges.

Stipe 50-70 x 2-3 mm, equal to a slightly thickened base, solid becoming fistulose with a slight silky stuffing, pruinose on apex, lower down with a thickish coating of silvery to yellowish appressed fibrils; cortina silvery white, fugacious; basal mycelium cottony white, agglutinating, long white rhizomorphs present.

Context watery, with an amber color tone, lower part of stipe amber, thick in disc of pileus, thin toward margin, rather rough in stipe, changing green to blue where injured; odor and taste none.

Spore deposit blackish purple fresh, blackish in the herbarium.

Spores (11-)11.25-13(-13.5) x 5.5-7 µ, most frequently 11.2-11.8 x 5.5-6.25 µ, almond shaped, smooth, thick-walled, violet in water mounts, yellow brown in NH_4OH, apical germ pore obliterated by a hyaline callus; basidia 30-35 x 8 µ, 4-spored, cylindric or constricted, sterigmata 5 µ long; cystidioles (?) piriform, 15-17 x 7.5-8.5 µ; pleurocystidia (other than cystidioles) none or similar to cheilocystidia and near gill edge;

cheilocystidia 30-40 x 6-8 µ, abundant (edge heteromorphous), ampullaceous and neck often incrusted with a spherical collar, walls hyaline; subhymenium cellular (?); hymenopodium of thinner more parallel hyphae than the hymenophoral trama proper which consists of broad hyphal cells narrowed at the septa; apex of stipe with numerous dermatocystidia similar to cheilocystidia; pellicle of pileus of interwoven gelatinized hyphae, with those of the extreme surface often diverticulate as in some *Mycenae*; hypodermium filamentose.

Often on small pieces of dead wood but also on the ground, fruiting from October until November in the *Cedretum* (*atlanticae*) and *Quercetum* (*ilicis*) above Azrou, Morocco.

In order to represent the facts as free from possible misinterpretation as we reasonably could, we have presented the data available on the collections made by each author. Experience with numerous sterile forms in the genus *Naematoloma* in North America has shown that in these the colors invariably have more yellow in pileus, lamellae, and stipe than do those of normally fertile carpophores, but that there is no correlated variation in spore size and shape. Hence, as long as these characters can be obtained from semi-sterile forms, they can be used in classifying collections. We do, however, believe that in interpreting differences in color, especially as the yellow pigments are concerned, it is best not to attempt fine distinctions between collections in situations such as this one. Also we cannot regard semi-sterility in itself as necessarily being a legitimate species character.

We believe that all of the material on which the descriptions presented here are based belongs in a single species. Spore characters are essentially the same, as are the characters of the cheilocystidia and lack of pleurocystidia. There may be some differences in odor and taste but in no case are the characters pronounced enough to be convincing in view of the small amounts of material tested.

Since the specific epithet *cyanescens* cannot be transferred to *Psilocybe* because of the existence of *P. cyanescens* Wakefield, we are describing the South American material as a new species and designating a type from that region. By doing this we do not prejudice the situation as far as future studies of the African populations are concerned. If some of the slight differences noted in the descriptions presented here are found to be important, adjustments in the classification can then be made. There is the possibility that Malençon's collections are con-specific with Miss Wakefield's *P. cyanescens*.

Psilocybe strictipes Singer & Smith

11. ***Psilocybe strictipes*** Singer & Smith, Mycologia 50: 141. 1958. (Figs. 12, 15, 50.)

Pileus 20-40 mm broad, when young campanulate to convex, becoming broadly convex to plane or with an elevated wavy margin in age, glabrous, viscid from a separable pellicle, margin striatulate when moist, hygrophanous, dull yellowish brown to olive brownish ("Isabella color"), fading to cinnamon buff on disc and pallid on margin, becoming dingy over all in age, where bruised staining greenish or bluish green.

Lamellae pallid becoming dark chocolate color from the spores, bluntly adnate to depressed-adnate, horizontal, narrow (4 mm in a 40 mm cap), close but not crowded, with three tiers of lamellulae.

Stipe 100-130 x 2-3 mm, straight, equal or slightly flared at apex, stuffed with a pallid brownish pith, staining brownish where outer fibrils have been removed, surface pallid from appressed fibrils, often zoned near apex from broken veil, with fibrils over lower half and strigose hairs at base, staining bluish green.

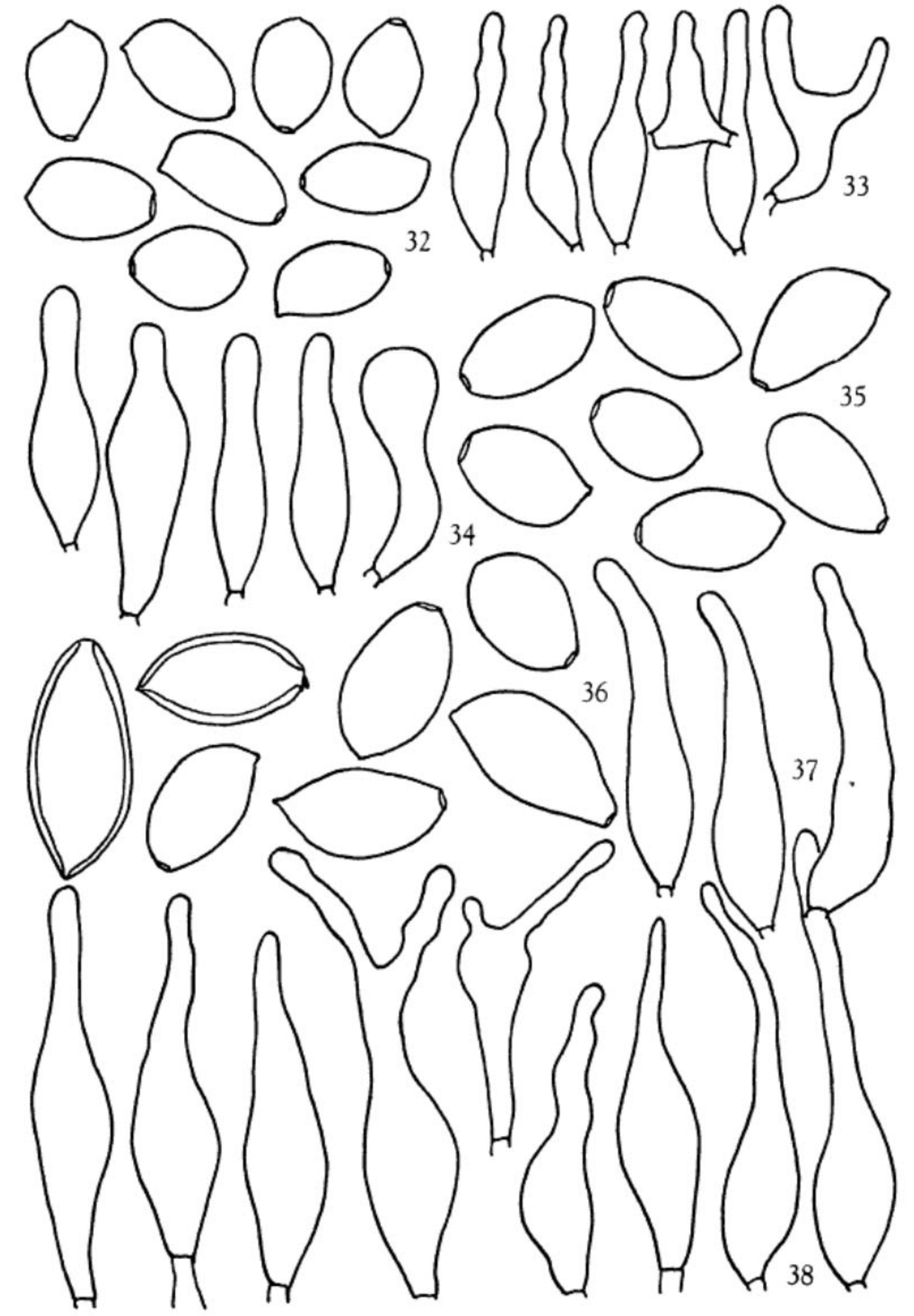
Context concolorous with surface in pileus, dingy brownish and cartilaginous in the cortex of the stipe; odor none; taste mild.

Spore deposit purplish.

Spores 9-12(-l2.7) x 5.5-6.5 µ, smooth, with a distinct apical germ pore, oblong in face view, slightly inequilateral in side view, sordid tawny in KOH; basidia 25-31 x 7-9 µ, 4-spored, clavate or subcylindric with a median constriction, projecting when sporulating; hymenium dull rusty brown to pale yellowish in sections revived in KOH; pleurocystidia none or only near gill edge and similar to the cheilocystidia; cheilocystidia 26-45 x 6-12 µ, abundant, causing gill edge to be heteromorphous, hyaline, ventricose below, subulate, attenuated gradually towards the subacute to obtuse tip; gill trama of enlarged cells pale sordid brownish to hyaline (paler than hymenium in KOH); epicutis a thick gelatinous pellicle of hyaline narrow (1.5-3.5 µ) hyphae; hypodermium of broad (3-10-18 µ), somewhat interwoven hyphae, pigmented but almost as pale as the flesh beneath, not incrusted; clamp connections readily demonstrated.

Subcespitose on wood of conifers and debris in coniferous and mixed woods, fruiting in October, Oregon, U.S.A.

Material studied: Oregon: near Welches, *Gruber & Smith 20248*, TYPE (MICH). Other specimens from the same general region: *Smith 24622, 24402* (MICH). (No. 202448, indicated as the number of the type in the original diagnosis, is erroneous.)



Figs. 32-38. 32-33: spores and cheilocystidia of *P. aggericola*. 34-35: cheilocystidia and spores of *P. muliercula*. 36-38: spores and cheilocystidia of *P. caerulipes*.

Psilocybe baeocystis Singer and Smith

12. ***Psilocybe baeocystis*** Singer and Smith, Mycologia 50: 141. 1958. (Figs. 13, 16.)

Pileus 14-54 mm broad, appearing umbonate when dried but conic when fresh and with incurved margin, finally expanding to convex or plane, viscid from a thin gelatinous pellicle, olive brown to buffy brown, when dried tending toward copper brown in the center, with a faintly striate margin when moist, finally with a greenish fringe around the margin and incoming greenish where touched.

Lamellae dark cinnamon or gray, also with faint purplish tints in some, eventually nearly "heliotrope gray," adnate to uncinate, subclose, edges whitish.

Stipe 50-70 x 2-3 mm, equal to subequal, stuffed with loose fibrils, with fine white fibrils on surface, white except for apex which is yellowish; veil present but inconspicuous.

Context concolorous or paler than surface in pileus, brown in stipe; odor and taste none.

Spore deposit "heliotrope gray."

Spores (8-) 10-13.3 x 6.3-7 µ (mostly 11-12 x 6.3-7 µ), terete or nearly so, with a broad distinct germ pore, deep olive to dingy brownish olive-yellow in KOH, smooth, wall very thick and complex, with a suprahilar depression or applanation; basidia 20-30 x 7-9 µ, 4-spored, hyaline to stramineous; pleurocystidia none; cheilocystidia 20-30(-36) x 4.2-5.7 µ, ampullaceous with a long thin neck (1.2-1.5 µ diameter) and subacute apex, or more often ventricose below or in middle but then pedicellate and tapered to an acute apex, hyaline, causing gill edge to be heteromorphous; subhymenium a rather broad and irregular layer of small versiform elements, slightly pigmented; hymenopodium a thin filamentous layer, regular, not as well separated as in some other species; gill trama hyaline, regular, with a slightly and indistinctly differentiated mediostratum and this flanked by parallel hyphae on either side, progressively more pigmented in the third of the trama closest to the pileus trama; epicutis a very thick hyaline gelatinous layer of narrow loosely arranged hyphae; hypodermium weakly to strongly pigmented, consisting of compactly parallel horizontal hyphae broader than those of the epicutis; clamp connections regularly present.

On decaying "peat moss" (actually apparently a mixture used instead of pure *Sphagnum*) by a green house, Eugene, Oregon, U.S.A., *F. P. Sipe*, 11-1-1945, TYPE (MICH).

This is somewhat similar to *P. strictipes* and may be confused with it, but differs in the size and shape of the cheilocystidia, which are reminiscent of those of *P. caerulipes*.

Stirps Caerulescens

13. ***Psilocybe caerulescens*** Murr., Mycologia 15: 20. 1923 (Figs. 18, 19, 21-24, 46, 48.)
    Psilocybe macatecorum Heim, C. R. Acad. Sc. 242: 1392. 1956, nom. subnud.
    Psilocybe caerulescens var. *mazatecorum* Heim, Rev. de Mycol. 22: 78. 1957.

Pileus 20-88 mm broad, at first obtusely campanulate, becoming convex with a decurved margin, at times slightly umbilicate or with a small umbo, rarely becoming irregular and almost plane or shallowly depressed in age, almost black or very deep olive-umber at first, becoming paler and olive tinge often disappearing, in age often rather pale colored (near *aztec*), umbo either darker than marginal area or at times paler, hygrophanous, fading gradually to ochraceous from disc outwards, sometimes assuming chestnut or fulvous colors in the moist areas while still fading (see illustrations by Wasson), and these at times persistent in the faded specimens, a brownish shade often pervading the disc, glabrous, smooth, slightly viscid to lubricous, short striate by translucence in smaller caps or striate half way to disc in large ones when moist, opaque when faded; veil usually fugacious on pileus, but sometimes more persistently white appendiculate.

Lamellae mostly light avellaneous gray or argillaceous, only in age reaching sepia, sinuate-adnate to bluntly adnate, close to subclose, broad, edge slightly white fringed.

Stipe 40-122 x 2-10 mm, typically equal, hollow, glassy-white to sordid although at first always with a continuous white velutinous soft covering which soon breaks up into a marbled to flocculose covering on a sordid ground color, the apex pallid fibrillose, glabrescent; basal mycelium white, occasionally developing some white rhizomorphs which at times turn blue when injured; veil thin and at first appearing cortinoid, pure white, often forming a ring for a very short time in young or nearly mature specimens, not distinctly bluing.

Context of pileus whitish to sordid or even tawny to fulvous, sometimes dark brown in upper portion of pileus, fleshy, somewhat fibrous-hard in stipe, blue when injured; odor strongly farinaceous; taste astringent.

Spore deposit deep purple fuscous, sepia.

Spores (6-)6.3-7.7 (-8) x 5-6 x 3.5-5 µ, compressed, 0.5-1 µ narrower in side than in face view, varying from subrhombic with rounded angles to ovate in face view, and from elliptic to inequilateral in side view, deep yellowish brown in KOH, smooth, with a broad germ pore, wall thick and compound as revived in KOH, showing a rusty line along the endosporium, without a suprahilar depression but at times with a small applanation; basidia (12-) 14-21 x 4.9-7 µ, 4-spored, rarely 2-spored; pleurocystidia none except for some permanently sterile basidioles (?) or a few cells resembling the cheilocystidia; cheilocystidia 15-20(-26) x (3-)4-5.5(-6) µ, hyaline, fusoid to fusoid-ampullaceous, the apex acute to slightly enlarged, neck sometimes flexuous to filamentous and 1.5-2 µ in diameter; subhymenium a narrow layer of irregular short elements, melleous to hyaline as revived in NH_4OH; hymenopodium hyaline, consisting of parallel filamentous hyphae; the hymenophoral trama proper consisting of a lateral stratum of broad (7-11 µ diameter) hyaline hyphae accompanying the mediostratum on both sides, and the mediostratum consisting of a mixture of broad and narrow (2.5-3 µ) hyphae, walls of all cells 0.3-0.4 µ thick; epicutis well developed, consisting of thin filamentous hyphae occasionally with an upturned terminal cell, slightly gelatinized; hypodermium denser than the flesh beneath and more deeply colored; hyphae of the context of the pileus short and voluminous, cell walls c. 0.7 µ or less thick, deep ocher brown from incrusting membrane-pigment; clamp connections present.

Chemical characters: guaiac solution, bluing on white portions of context.

Gregarious to caespitose, rarely solitary on soil or on sugar cane mulch, mostly in shaded places or on rich earth which has recently been moved or altered, fruiting in summer, during the rainy season. Southern United States (Alabama) and Mexico (Oaxaca).

Material studied: U.S.A.: Ala., Montgomery, TYPE (NY). Mexico: Oaxaca, Huautla de Jiménez, *R. Heim* (as *P. caerulescens* var. *mazatecorum* Heim), (NY); *Singer M 1513* (MICH).

Illustrations: V. P. & R. G. Wasson, Mushrooms Russia and History 2: *pl. 40, fig. 3* (poor); *Life*, May 13, 1957, p. [107], *fig. at upper right*.

Heim first described this fungus as a new species and then, after receiving a letter from Smith suggesting that the species was the same as *P. caerulescens* Murr., he apparently changed his mind and referred to it as *P. caerulescens* var. *mazatecorum* but gave no immediate critical account of how var. *mazatecorum* was actually different from the type variety. There may be a difference in the taste since that was indicated as mild in the type collection, but until the recent interest in hallucinogenic fungi this species remained known almost entirely from the type collection made by R. P. Burke of Montgomery, Alabama, who wrote "no characteristic taste." It is possible that Burke did not regard a slight astringent taste as distinctive, or that in merely tasting the raw specimens he did not chew the material long enough to bring out the true flavor.

The character of the veil's being more developed in var. *mazatecorum* than in var. *caerulescens*, as Heim emphasized in his Latin description, is dubious because from the description of Burke's collection it is likely that his notes referred to mature specimens and the fact that no veil is mentioned cannot be regarded as conclusive. Hence, there seems to be no way to prove these points except by continued collecting and observing, both in the southern United States and Mexico, to determine eventually the range of variability.

Psilocybe aggericola Singer & Smith

14. ***Psilocybe aggericola*** Singer & Smith, Mycologia 50: 142. 1958. (Figs. 32-33.)

Pileus 20-40 mm broad when young, campanulate, then conic campanulate or convex, disc at first umbonate, and with a slight umbilicus in the umbo, later with a pronounced central papilla, margin incurved at first but soon straight, strongly hygrophanous and translucent-striate over outer half when moist, estriate when faded, glabrous and naked, except rarely with vestiges of the veil along the margin, colors light olive brown or brown with a darker disc (*oak, Sudan br*. young, disc sometimes *burnt umber*, becoming khaki to *Isabella color*, with a *tortoise* colored disc) fading to a dull deep yellow tone (*9 J 6*) when young, to pale chamois (*11 F 4*) when old, tending to blacken when drying.

Lamellae narrowly and rather deeply sinuate to adnexed, close or subclose, moderately broad or rather broad and broadest towards the stipe, dingy (olive) brown (*bamboo* to *stag*), trama staining blue where exposed, edges white and entire.

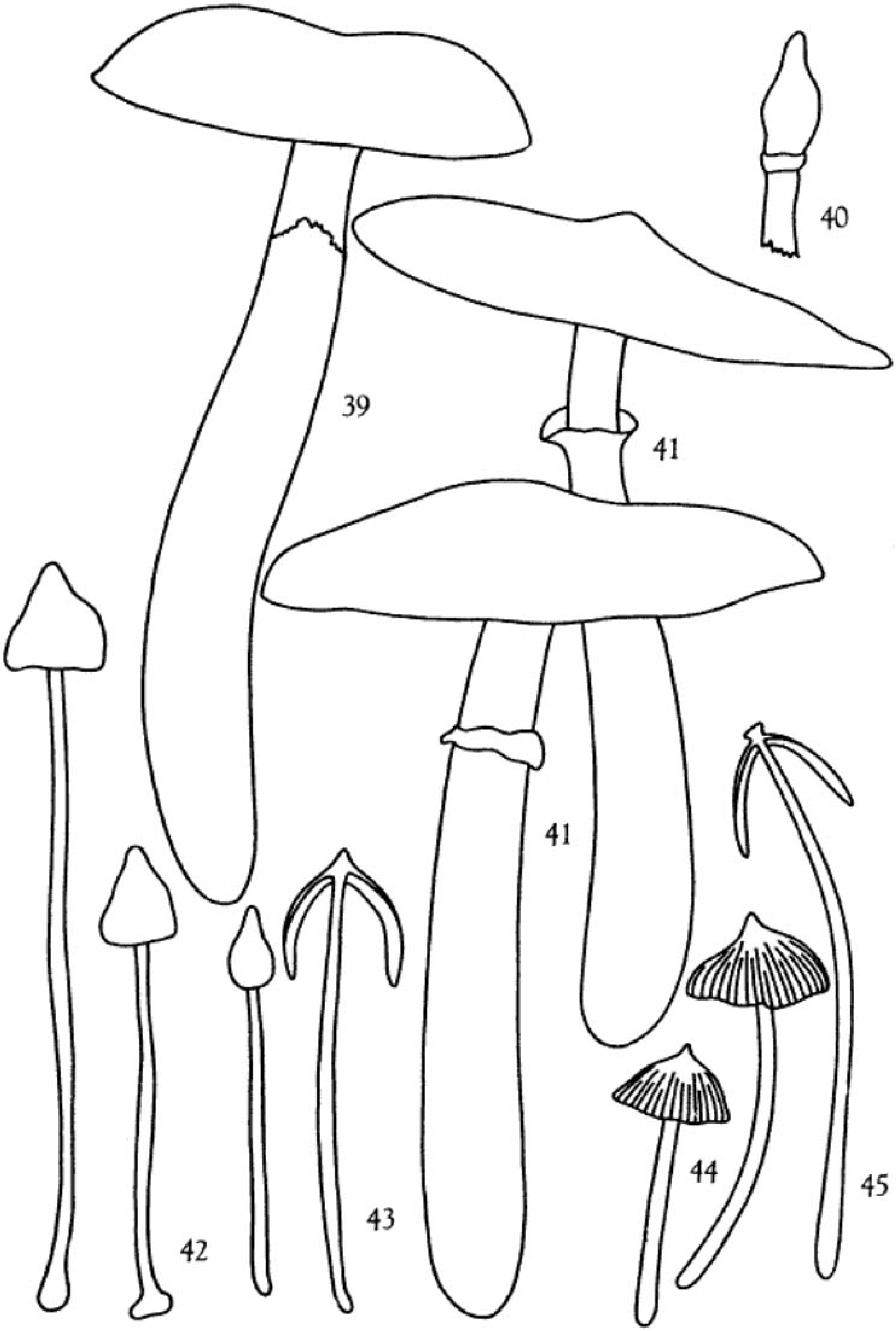
Stipe 25-80 x 6-13 mm, later 2.5-6 mm, tapering upward or finally nearly equal, light ochraceous (*Leghorn*) above, later becoming somewhat burnt umber, dingy ocher (*maple*) downward and finally coffee-with-milk color (*Mosul*) in lower half, turning blackish in drying, with a sordid cream to pallid floccose-fibrillose covering which is very conspicuous in young material though fugacious in the upper half (persistent in the lower half) of adult stipes, bluing where injured or on handling, the base white mycelioid; veil forming a fugacious, very narrow annular belt at apex but annulus disappearing at maturity.

Context rather firm at first, more fragile in age, not tough in stipe, light ochraceous (*Leghorn*) becoming coffee-with-milk color (*Mosul*), and turning blue (*Quaker blue*, *Arctic*, finally reaching *Rigi blue* in dried condition) when either pileus or stipe is bruised; odor none.

Spore deposit deep purple fuscous.

Spores 6.2-8 x 4-5.2 x 3.6-4.5 µ, usually 6.7-7.3 x 4-4.5 x 3.7-4.2 µ, somewhat but little compressed or almost terete (usually 0.3-0.4 µ broader in face than in side view), slightly inequilateral in side view, elliptic-ovate to rarely rhombic in face view, with a broad germ pore, dingy yellow brown in KOH, smooth; basidia (12.5-) 14.5-20.5 x 4.2-5.5(-7) µ, 4-spored to rarely 2-spored, hyaline or nearly so, clavate to broadest below the apex, basidioles vesiculose-clavate; pleurocystidia 20-32 x 6-9 µ, originating in the subhymenium, contents homogeneous (not protoplasmatic), with a thin colorless resinous incrustation which renders them opaque, varying from clavate to fusoid or ventricose-ampullaceous or constricted in the middle, often with lateral outgrowths or apical nose-like appendages but these lacking in some preparations; cheilocystidia 20-25(-29) x (3.5-)5-5.5(-8.2) µ, usually somewhat ventricose below, upper portion lanceolate narrowed in one or two stages to an acute apex, entirely hyaline and transparent, thin-walled, non-incrusted, causing the gill edge to be heteromorphous; subhymenium when revived in NH_4OH often strongly green from a membrane-pigment, later honey yellow, consisting of a thin layer or irregularly arranged hyphal cells of various shapes; gill trama consisting of elongated subparallel hyphae of variable width and having walls 0.5-0.7 µ thick, the mediostratum not sharply differentiated from the hymenopodium and lateral stratum; epicutis of pileus a thin and not sharply differentiated layer of hyaline hyphae, the hyphae not much gelatinized, when revived in NH_4OH, freshly dried material appearing greenish but later losing all color; hypodermium composed of elements which show very variable shape but not isodiameteric, brownish melleous as revived but hyphal walls not incrusted; clamp connections present.

Chemical characters: formalin on the flesh immediately brownish, not bluing; $FeSO_4$ on flesh, causing a bluish gray ring to appear around a brown spot.



Figs. 39-45. 39: *P. candidipes*. 40-41: *P. cubensis*. 42: *P. pelliculosa*. 43: *P. mexicana*. 44-45: *P. yungensis* (44 = var. *acutopapillata*, 45 = var. *yungensis*).

Singly or in small cespitose groups of two or three on rich soil along dammed-up earth of the road, outside the forest in subtropical vegetation, fruiting in spring. Argentina, prov. Tucumán, road to Tafí dell Valle near Monumento al Indio, 900-1000 m altitude, *R. Singer T 760*, 11-13-1949 (MICH).

The opaque pleurocystidia distinguish this species from all similar ones.

Psilocybe candidipes Singer & Smith

15. ***Psilocybe candidipes*** Singer & Smith, Mycologia 50: 141. 1958. (Figs. 14, 17, 20, 39.)

Pileus 50-55 mm broad, convex with shallowly depressed disc, always obtuse at first, smooth and glabrous, slightly viscid, when moist translucent-striate over the marginal third, sordid buff to dull buff, hygrophanous, fading from the disc outward, pale buff to whitish when faded, readily staining blue when touched.

Lamellae pale avellaneous to avellaneous-gray, sinuate-adnate, rather broad, fairly close to subdistant.

Stipe about 100 mm long, 7-12 mm thick, hollow, nearly equal, readily staining blue, strongly scabrous-strigose near base, and this coating ascending up to mid-portion, increasingly white floccose upward to the annular zone left by the broken veil; veil white, soft, annular, remnants fugacious, but floccons below annular zone rather persistent, readily staining blue where injured.

Context whitish to dingy white, fleshy in pileus, fibrous-hard in the stipe; odor weakly but distinctively farinaceous.

Spores 6.7-7.7 x 3.5-3.8 µ, terete or nearly so, oblong-ellipsoid to ovoid, smooth, wall complex but relatively thin (0.7 µ), both episporium and endosporium differentiated, with a distinct apical germ pore; basidia 4-spored, 13.5-21 x 3.5-6.3 µ (mostly 4-5 µ broad), clavate, not opalescent; pleurocystidia present only as cystidioles, ventricose-submucronate to fusoid-clavate, body of cell often opalescent but neck emerging and non-opalescent, 21-24 x 5-7 µ; cheilocystidia very numerous, lanceolate-fusoid to subulate, hyaline, 18-27 x 3.5-6 µ, upper part narrowed to 1.5 µ or less in diameter, acute to subacute; subhymenium melleous to brown (browner near cap trama), consisting of very small elements often appearing cellular in sections but in reality irregular in shape; gill trama regular, hyaline, in the poorly differentiated mediostratum melleous-hyaline, hyphae not markedly enlarged; epicutis well developed, of only slightly gelatinized narrow (1.3-3.3 µ) hyphae, near surface often giving rise to a cystidioid end-cell which is not gelatinous; velar floccons of stipe everywhere consisting of very irregularly shaped cells of various sizes either inflated or filamentous and strongly interwoven, frequently cystidioid cells arising from the surface hyphae of the velar material, these c. 20 x 5 µ and ampullaceous, apex 2 µ broad; clamp connections present.

Chemical characters: Several chemical substances accelerate and augment the bluing, especially guaiac solution.

On earth, cespitose, among fallen leaves of *Coffea* and *Inga* along irrigation ditches in plantations. Mexico, Oaxaca, Huautla de Jiménez, 1550 m altitude, *R. Singer M 1514*, 7-10-1957, TYPE (MICH).

The small terete spores, strong tendency to turn blue, and copious veil are an interesting set of characters in this genus. The strong development of the veil is a valid additional argument for including the stirps *Cubensis* in this genus. Weight is added to this argument by the fact that in *P. cubensis* the same kind of dermatocystidia are often found on veil and pileus. The two, of course, differ sharply in spore characters.

The young hymenium, typically hymenium just beginning to sporulate, is very interesting in view of the bluing phenomenon. The basidia and basidioles are incrusted with blue granules. The young cystidioles (obviously formed earlier in the development of the hymenium) are not. Does this mean that the early development of these cells did not include the production of the enzyme that causes the formation of the blue pigment? Also, does it prove that those cells which are destined to remain sterile are differentiated physiologically before morphological differences become evident?

Psilocybe zapotecorum Heim

16. ***Psilocybe zapotecorum*** Heim, Rev. de Mycol. 22: 77. 1957.

Pileus 60-110 mm broad, campanulate becoming obtusely umbonate to strongly mammillate but always twisted, asymmetric, most variable in shape, margin at first white punctate with the veil remnants, (soon) glabrous, color varying from ochraceous citrine to purple-brown-black (Klingcksieck et Valette no. 45) with ochraceous-melleous tones, with dark violet stripes and gradually becoming violet black on margin, apparently hygrophanous and dingy melleous when faded.

Lamellae rather close, with sinous edges, adnexed-emarginate, not very broad, violet-purple.

Stipe 100-200 mm long, 10-20 mm broad at base, hollow, very fibrous, hard, elastic, often contorted, outer layer of cortex brownish, ochraceous toward the interior and with a central soft white bluing pith, (surface) fibrillose.

Context at first brown-rufous in cortex of stipe, yellow in central portion, entirely and quickly bluing; odor farinaceous; taste astringent.

Spore deposit brown-purple.

Spores 6-8.8 x 3.5-5 x 3-4 µ (Heim 1957), rather bright yellow revived in KOH, somewhat compressed, with a broad apical germ pore; cheilocystidia fusoid, with a filiform neck which is covered by a substance stained by dyes (such as "bleu lactique").

On swamp soil, Yaitepec and San Agustin de Loxicha, Oaxaca, Mexico. Used as hallucinogen by the Chatino and Zapotec Indians, known as "mbey san" or "piule de barda" (according to Heim).

Illustration: *Life*, May 13, 1957, p. [107], *fig. at upper left*.

Material studied: None. The above incomplete description is based on fragmentary data and a Latin diagnosis furnished by Heim. Probably there are specimens at Paris.

The habitat is not particularly strange for a *Psilocybe* as far as North American members of the genus are concerned; therefore, it is rather a surprise to find that Heim considered it so. A relatively tough context of the stipe is likewise not unusual in the genus, and it may only be relatively more so in *P. zapotecorum*. Nevertheless, it is possible that this species does not belong with the preceding species. We do not wish to judge its final relationships without having had a chance to study specimens.

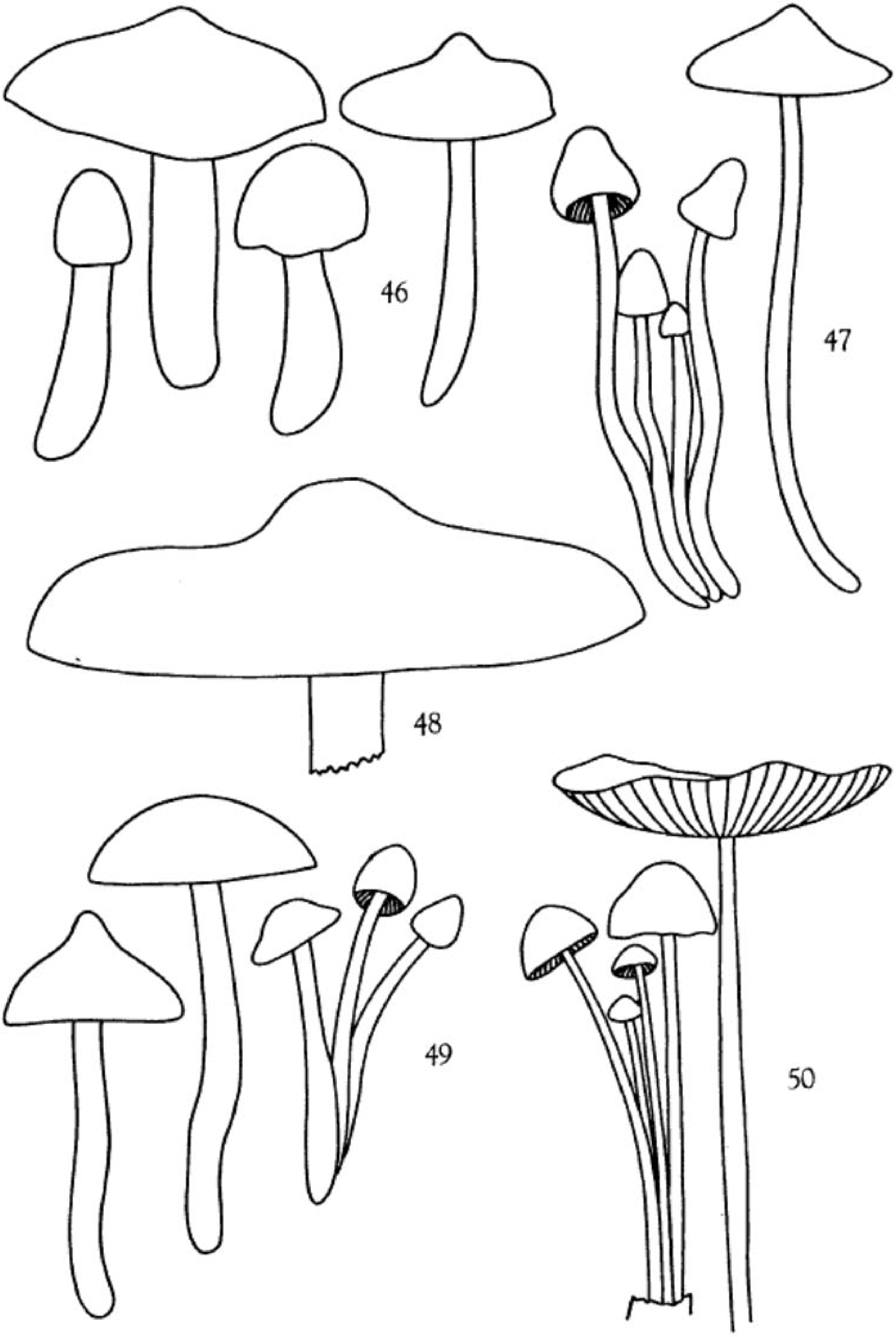
Stirps Caerulipes

Psilocybe Muliercula Singer & Smith

17. ***Psilocybe muliercula*** Singer & Smith, Mycologia 50: 142. 1958. (Figs. 34-35, 49.)

Pileus 20-35 mm broad or more, campanulate then convex, eventually often applanate in a zone between the umbo or papilla and the somewhat decurved marginal area, more or less umbonate, rarely papillate, fulvous brown, hygrophanous, fading out to a pale ocher tone, glabrous, not viscid, marginal area translucent-striate (up to about half way to disc) when moist, slightly sulcate at times, naked.

Lamellae fuscous-sepia, almost narrow, ascendant to subhorizontal, sinuate-adnate, often seceding, with pallid edges.



Figs. 46-50. 46 and 48: *P. caerulescens*. 47: *P. caerulipes*. 49: *P. muliercula*. 50: *P. strictipes*.

Stipe (30-) 40-100 x 2-7 mm, equal or tapering upwards, becoming hollow, sordid flesh-colored-whitish, becoming concolorous with the pileus especially below, staining blue where touched and blue stains eventually very deeply colored, smooth, more or less glabrous and naked; veil very sparse and all traces of it obliterated in mature specimens.

Context tending to turn blue where injured; odor farinaceous; taste in dried specimens not distinctive.

Spores (6-)7-8(-10) x 4.2-4.8(-5)x 3.9-4.7 µ, either terete or up to 0.3 broader in face view than in side view, elliptic to elliptic-ovate in either view, rarely subrhomboid with rounded angles in face view, sometimes ventricose-fusoid (shaped like a bolete spore) in side view, with a distinct apical germ pore, dark yellowish brown in KOH; basidia 16.5-21 x 5-5.5 µ, 4-spored; pleurocystidia none; cheilocystidia 12-23 x 3-5.5 µ, hyaline, subulate to subulate-ampullaceous, apex obtuse and sometimes subcapitate, more often subacute or acute, neck at apex 1.5-2 µ in diameter; subhymenium a thin layer, irregular, of small elements; gill trama regular, walls of hyphae up to 1.5 µ thick (thick-walled for the genus); epicutis a well developed layer of hyaline filamentous hyphae but not strongly gelatinized; hypodermium well colored by membranal pigment often incrusting the walls of the hyphae, the latter arranged into a compact layer or a cutis; hyphae of context and hypodermium with thickened (about 1.5 µ) walls; clamp connections present.

Solitary or in small clusters on earth along ravines of a pine-covered (*Pinus pseudostrobus*) mountain at about 3000 m elevation; fruiting in late August and September, rarely before. Known only from the slopes of Cerro Toluca (Mexico).

Material studied: Mexico, purchased at the market of Tenango del Valle (Toluca Valley), September 30, 1956, *T. Herrera* (MICH, MEX); September 1957, *G. Guzman* (MICH, MEX); purchased at Piedras Blancas, Cerro Toluca, July 30, 1957, *R. Singer M 1011*, TYPE (MICH). - There must be material of this at Paris since it was sent by T. Herrera to Heim, purchased at the same place and apparently identical with material earlier purchased in Tenango by the Wasson group and determined as *P. mexicana* var. *brevispora*.

This species is quite different from all other known species, particularly from *P. mexicana* which has larger spores and a more typically *P. semilanceata*-like habit.

Psilocybe caerulipes (Peck) Sacc.

18. ***Psilocybe caerulipes*** (Peck) Sacc., Syll. Fung. 5: 1051. 1887. (Figs. 36-38, 47.)
    Agaricus caerulipes Peck, Ann. Rep. N. Y. State Mus. 38: 89. 1885.

Pileus 10-35 mm broad, when young obtusely conic to convex and with an incurved margin, becoming broadly convex to plane or retaining a slight umbo, at times quite irregular, surface glabrous, viscid, soon dry and shining, closely translucent-striatulate and watery cinnamon brown to dingy "Sayal brown" fresh, hygrophanous and soon fading to dingy ochraceous buff or cinnamon buff, sordid alutaceous in age and often with greenish stains along the margin or with a greenish tinge overall.

Lamellae sordid brown when young, becoming rusty cinnamon, close or crowded, narrow, adnate or arcuate-adnate or with a decurrent tooth, edges whitish and slightly fimbriate.

Stipe 30-60 mm long, 2-3 mm thick at apex, equal or slightly enlarged downwards, stuffed with a pith but becoming tubular or hollow, the pith fairly persistent, surface pruinose at or near the apex, downward appressedly white to grayish fibrillose, usually staining greenish blue where handled, whitish to buff at first, especially above, pallid to bluish when dried, lower part often dingy brown in age; veil whitish, thin, forming an evanescent superior fibrillose zone; basal mycelium white.

Context in pileus thin and pliant, in stipe tough, in both becoming bluish when injured; odor none; taste farinaceous.

Spore deposit very dark purple brown.

Spores 7-9.8 x 4-5.3 (-5.7) x 4-5.1 µ, usually 8-8.5 x 4.4-5 µ, but those from 2-spored basidia 10-11.2(-12) x 5.7 µ, generally terete, only a small minority very slightly broader in face than in side view, ellipsoid, or elliptic in face view and inequilateral in side view, pale tawny to olive fuscous in KOH, truncate with an apical pore, smooth; basidia 15-28 x 5.2-7.5 µ, either all 4-spored, or some 2-spored, often constricted in mid-portion, hyaline in KOH; pleurocystidia none, or present only near gill edge, and then similar to cheilocystidia; cheilocystidia forming a broad sterile band at gill edge (which is heteromorphous), 18-35 x 4.2-6.7 µ, hyaline, with homogeneous contents, narrowly fusoid-ventricose, subulate, or ampullaceous, neck 1-2.2 µ broad and, if ampullaceous, 7-20 µ long, the tip sometimes slightly thickened to almost subcapitate (1.7-2.2 µ diameter), otherwise acute to obtuse, sometimes bifurcate; subhymenium seemingly cellular, but consisting of very irregularly shaped generally rather short very small elements, stramineous-melleous; hymenopodium of axial filamentous light stramineous-melleous hyphae 2-6.5 µ in diameter; gill trama not clearly differentiated in mediostratum and lateral stratum, regular, consisting of elongated hyphae 6-24 µ thick with 0.7-1.5 µ thick walls, melleous hyaline varying to pale brownish (in KOH); epicutis a gelatinous pellicle, not very broad, consisting of 2-4.5 µ thick hyaline (rare individual hyphae sometimes stramineous) filamentous hyphae which are loosely arranged; dermatocystidia none; hypodermium more irregular than epicutis, forming a cutis of compactly arranged short hyphal cells with brownish walls, but without any conspicuous incrusting pigment, hyphae 6-12 µ in diameter; this layer gradually merging below into the paler interwoven floccose trama of the pileus; clamp connections present.

Solitary or cespitose on debris of hardwood trees, especially *Betula* and *Acer* but also on their logs rotting on the ground. It fruits during the summer, more rarely in fall in the eastern and mid-western states of the U.S.A. and in Canada (Ontario), south to North Carolina.

Material studied: Canada, Ontario: Petawawa Exp. Forest, *Smith 26312* (MICH). U.S.A., Maine: near Guerette, *Bigelow 3531* (MICH). New York: Catlin Lake, Adirondack Mts., *Smith 219* (MICH); *C. H. Peck*, TYPE (NYS, NY). North Carolina: Indian Creek, Great Smoky Mts., *Hesler 10166* (MICH); *Smith & Hesler 17415* (MICH). Flat Creek, *Smith 10586* (MICH). Ohio: Cleveland, *Walters 186* (MICH). Tennessee: Grassy Patch, Great Smoky Mts. Nat. Park, *Smith 10545* (MICH). Michigan: Pontiac, *Smith 7268* (MICH); common around Pellston, Mackinaw City, *Smith 22186, 23459, 23460, 32893, 33648, 33824, 33825, 33933, 35872, 42103, 43053* (all MICH); *Thiers 3523* (MICH); Taquamenon Falls State Park, *Smith 36916, 37181, 37428, 39442, 41656, 41721, 41722, 41985, 41988, 42235, 49910, 49934, 49935, 49936, 49948, 49952, 49967, 50312; Thiers 3214* (all MICH).

The blue to greenish stains may be slow in developing but they usually show in a few hours.

Literature cited

1. Dennis, R. W. G. and E. M. Wakefield. 1946. New and interesting British Fungi. Trans. Brit. Mycol. Soc. 29: 141-166.
2. Earle, F. S. 1906. Algunos bongos Cubanos. Inf. An. Estac. Agron. Cuba 1: 225-242.
3. Heim, R. 1957. Notes préliminaires sur les agarics hallucinogènes du Mexique. Rev. de Mycol. 22: 58-79, 183-198.
4. Höhnel, F. von. 1914. Fragmente zur Mykologie. XVI. Mitteilung, no. 813-875. Sitzungsber. K. Akad. Wiss. Wien 123(1): 49-155.
5. Imai, S. 1932. On *Stropharia caerulescens*, a new species of poisonous toadstool. Trans. Sapporo Nat. Hist. Soc. 12(3): 148-151.
6. Imai, S. 1938. Studies on the Agaricaceae of Hokkaido. I, II. Journ. Fac. Agron. Hokk. Imp. Univ. 43: 1-378.
7. Maire, R. 1928. Diagnoses de champignons inedits de l'Afrique du Nord. Bull. Soc. Mycol. Fr. 44: 37-56.
8. Malençon, G. 1942. Notes critiques sur quelques Hymenomycetes d'Europe et d'Afrique du Nord. Bull. Soc. Mycol. Fr. 57: 14-56.
9. Murrill, W. A. 1923. Dark-spored agarics - V. Mycologia 15: 1-22.
10. Murrill, W. A. 1941. Some Florida novelties. Mycologia 33: 279-287.
11. Patouillard, N. 1907. Champignons nouveaux de Tonkin. Bull. Soc. Mycol. Fr. 23: 69-79.
12. Peck, C. H. 1885. Report of the Botanist. Ann. Rep. N. Y. St. Mus. Nat. Hist. 38: 77-138.
13. Peck, C. H. 1889. Report of the Botanist. Ann. Rep. N. Y. State Mus. Nat. Hist. 42: 1-46.
14. Singer, R. 1948. Diagnoses Fungorum novorum Agaricalium. Sydowia 2: 26-42.
15. Singer, R. 1957. Sacred mushrooms inspire medical research. Chicago Nat. Hist. Mus. Bull. Dec. 1957, p. 7.
16. Singer, R. and A. H. Smith. 1958. New species of *Psilocybe*. Mycologia 50: 141-142.
17. Smith, A. H. 1937. New or unusual agarics from the western United States. Mycologia 29: 45-59.
18. Smith, A. H. 1941. Studies on North American agarics. - I. Contrib. Univ. Mich. Herb. 5: 1-73. 24 pl.

Fungi in the Maya Culture: Past, Present and Future

by

Gastón Guzmán

Chapter 17 of "The Lowland Maya Area - Three Millennia at the Human-Wildland Interface"

© Gastón Guzmán

original text:
https://www.researchgate.net/profile/Gaston_Guzman/publication/265537444_Fungi_in_the_Maya_Culture_Past_Present_and_Future/links/565f310208ae4988a7be970f/Fungi-in-the-Maya-Culture-Past-Present-and-Future.pdf
backup source: http://www.psilosophy.info/resources/Fungi-in-the-Maya-Culture-Past-Present-and-Future.pdf

The author wishes to express his thanks to the project "Biodiversity survey of poorly known taxa of the El Edén Ecological Reserve" at the University of California Institute for Mexico and United States; to the "Reserva Ecológica El Edén"; and to Dr. Arturo Gómez-Pompa, for financially supporting the present research. For their help on field trips, the author is very grateful to Isabel Laserre Guzmán, Laura GuzmánDávalos, Eduardo Fanti, and Juan J. Castillo. Thanks are also expressed to Florencia Ramírez-Guillén, assistant to the author, for her invaluable help in checking the bibliographic references, as well as records of all fungi.

Table of Contents:

Introduction
Knowledge in the past
Mycological and ethnomycological studies in the Maya area
The project on the fungi of el Edén ecological reserve, Quintana Roo
Literature cited

Introduction

Fungi are strongly connected with the indigenous cultures in Mesoamerica. Fungi have been used in rituals; for medical purposes; or as food, as observed in the Mazatec, Nahuatl, Purepecha, Raramuris, and Zapotec cultures, among others in Mexico (Heim and Wasson 1958; Guzmán 1984, 1997; Lowy 1972a, 1974, 1977; Mapes, Guzmán, and Caballero 1981; Sahagún 1569-1582; Schultes and Hofmann 1979; Wasson and Wasson 1957; Wasson 1980). However, the information available is often sketchy because, at the beginning of the Spanish Colony following the Conquest, the indigenous cultures were languishing to extirpate their religious ceremonies (Lowy 1972b; Wasson 1980). The work of Sahagún (1569-1582), with his Magliabecchiano and Florentino Codices, is a good expression of the Nahuatl Culture concerning the knowledge of fungi. In the Magliabecchiano Codex, for instance, it is possible to see an Aztec eating a sacred mushroom with a personage at his back. For the Catholic Church, this personage is the devil; but, for the Indians, it is the god of the mushroom, Teonanácatl, who takes the Indian to his sacred and hallucinogenic world (Heim and Wasson 1958; Guzmán 1984; Wasson and Wasson 1957; Wasson 1980).

Wasson (1980) observed that we know virtually nothing about the fungi of the Maya Culture despite its great interest. Considered that the Maya area encompasses the whole of the Yucatán Peninsula; almost all of the Mexican states of Chiapas and Tabasco; and the Central American countries of Guatemala, Belize, El Salvador, and Honduras, the extent of the problem is apparent. The lack of information is not due to the absence of fungi use among the Maya, but to the great destruction that the Spanish Conquest inflicted on Maya Culture. Diego de Landa (1560) freely admitted that he burned codices and destroyed numerous idols in Yucatán; in his defense, de Landa stated that their destruction was necessary because those things contained nothing but superstitions and devils (Lowy 1972a, b; Wasson 1980). There are, however, many studies on the Maya Culture. In 1990, for example, an international symposium was held at Wakayama University in Japan; the main subject of this symposium was the Maya Culture (Guzmán 1992; Miyanishi 1992). Sadly, numerous mushroom stones and a few codices are the only information that we have on the culture of fungi among the past Maya Culture. Although we have evidence of the use of fungi as food or medicine in the Maya region, it seems that the practice of using ceremonial fungi has long since disappeared.

This paper summarizes the available information on mushroom use among the Maya, both in the past and present. This work is divided into three sections: (1) an historical examination of what we know about past Maya fungi use; (2) an overview of current mycological and ethnomycological studies in the Maya region; and (3) the first results of the fungi inventory at El Edén Ecological Reserve, which are currently being carried out.

Knowledge in the past

In spite of the destruction effected by de Landa (1560) in Yucatán, Lowy (1972a, b) noted that it is still possible to study the numerous mushroom stones and four important codices (i.e., Madrid, Paris, Dresden, and Galindo) remaining from the Maya Culture. The Galindo Codex was named by Lowy after he found it in the house of Mr. José Galindo (now deceased), a Guatemalan Indian in Huehuetenango.

Lowy (1972a, b) deduced that the Galindo Codex is a copy of the Madrid Codex after observing a similar image in both codices, in which an Indian painted in black is seen making an offering to an important seated personage. According to Lowy, the special object in the Indian's right hand is a stylized fruit body of *Amanita muscaria* (L. : Fr.) Hook., with typical wart-like patches on the cap. Lowy based his interpretation on the fact that this mushroom is now common in pine forests in both Guatemala and Chiapas, where it is surrounded in some mystery for the Indians. At present, they call this mushroom by the common Quiche names of "kaquiljá" (or "thunderbolt") and "itzel ocox" (or "evil mushroom").

Lowy (1974) noted the connection between the Thunderbolt Legend and *A. muscaria*. According to him, the Indians in Guatemala and Chiapas link this fungus with the thunderbolt because of its strong, rare power (the next section, however, presents another interpretation of the fungus and its relationship to the Thunderbolt Legend). Lowy (1974) also observed that the common name "yuyo" (from the name of a red common wild fruit) was applied both to the edible *Amanita caesarea* (Scop. : Fr.) Grev. as well as the poisonous *A. muscaria*; the latter is also called "yuyo del rayo" or "yuyo del trueno" ("rayo" and "trueno" mean thunderbolt). Guzmán and Ramírez-Guillén (2001) found that *A. caesarea* in Chiapas is a complex of four species: *A. jacksonii* Pomerleau, *A. laurae* Guzmán and Ramírez-Guillén, *A. tullossii* Guzmán and Ramírez-Guillén, and *A. yema* Guzmán and Ramírez-Guillén - all of them named "yuyo." *A. caesarea* s. str. is confined only to the central and northern portions of Mexico.

It seems that the Quiche Indians of Guatemala consider *A. muscaria* to be a sacred fungus because, according to Wasson and Wasson (1957), the name "holom-ocox" in the ancient religious pre-conquest book "Popol Vuh" means *A. muscaria*. Interestingly, in both Mexico and Guatemala, *A. muscaria* is now considered to be a "diabolical" mushroom because it is "very poisonous"; at the same time, however, the Indians treat it with respect as a special fungus. In 1977, Villacorta and Villacorta (cited in Torres 1984) postulated that the ancient Maya used sacred mushrooms in their Chichén Itzá sacrifices; in fact, they believed that the victims ate toxic mushrooms before their deaths.

Referring to the Dresden Codex (Dresden Codex Reproduction 1981), Lowy (1980) observed four men (displayed on two pages - two men per page) falling through space, with special leaves on their bodies. Lowy believed that these leaves were stylized mushrooms that related to *A. muscaria*. Other authors believe that those leaves belong to the hallucinogenic plants *Turbina corymbosa* (L.) Raf. (a Convolvulaceae) or *Salvia divinorom* Epl. and Jativa-M. (a Laviatae) (Ott 1993; Schultes and Hofmann 1979; Torres 1984), which are now used as narcotic plants by other Indians in Mexico. Another interpretation of the Dresden Codex "falling men" lies in their relationship with the god of rain (Chak) and the fungus *Ustilago maydis* (DC.) Corda, which will be discussed later in the chapter.

All of the above observations on the use of sacred mushrooms have a connection with the ancient mushroom stones found in the Maya highlands. Wasson and Wasson (1957) and Wasson (1980) presented these mushroom stones as evidence of the ritual involving hallucinogenic mushrooms among the Maya. Sapper, was the first to find a mushroom stone in El Salvador in 1898 (Heim and Wasson 1958; Wasson and Wasson 1957). Sapper's original discovery is now in a museum in Zurich.

Kobayasi, who was very interested in the ethnomycology of Mexico, made several facsimiles of the Sapper mushroom, which he presented in 1983 at the Third International Mycological Congress in Tokyo, Japan. At present, there are more than 300 known pieces of mushroom stone, the majority of them the Maya area in Guatemala, although a few are from other cultures in Mexico (de Borhegyi 1961; Lowy 1971; Mayer 1977).

Guzmán (in Mapes, Guzmán, and Caballero 1981) and Guzmán (1984) reported the existence of a small mushroom stone (34 mm high) from an archaeological site of the Purepecha Culture in Patzcuaro, Michoacán, México, which he identified with a button of *A. muscaria*. The Maya mushroom stones are figures 28 to 38 cm high, with a standing man or animal represented below the cap of a mushroom. Torres (1984) and Ohi and Torres (1994) discussed these figures from Guatemala. Along with the little mushroom stone from the Purepecha region, de Borhegyi (1961) found miniature mushroom stones in Guatemala that are 10 to 19 cm high.

Although standing figures are represented in the above stones, Wasson (1980) and Lowy (1980) mentioned two other interesting figures, where men are falling or plunging into a dreamlike state. These figures show a man with his feet supporting the cap of the mushroom. These falling figures have a strong relationship with the hallucinogenic effects of the sacred mushrooms, because and a person flying in space. According to Lowy (1980), these figures relate to the falling human figures represented in the Dresden Codex, where the falling men are plunging gods - floating or falling from the sky. In fact, anyone who eats hallucinogenic mushrooms feels as if he or she is flying in space; when the effects subside, he or she falls back to earth. According to Wasson (1980) and Lowy (1980), these falling men in the Guatemalan mushroom stones are strong evidence of the ceremonial use of hallucinogenic fungi in the Maya Culture. However, as noted with the Dresden Codex "falling men," another interpretation of these figures (i.e., in relation to Chak, the god of rain, and *Ustilago maydis*) will be discussed later in this paper.

The use of hallucinogenic mushrooms belonging to *Psilocybe* is unknown in the entire Maya region, in spite of the fact that *P. mexicana* Heim, *P. cubensis* (Earle) Singer, *P. subcubensis* Guzmán, and *P. zapotecorum* Heim emend. Guzmán have been reported (Sommerkamp in Ohi and Torres 1994; Torres 1984; Wasson 1980). The first report on a hallucinogenic *Psilocybe* from the Maya region was made by Lowy (1977) in Guatemala. Close to the Yucatán Peninsula in the Tehuantepec Isthmus region (Uxpanapa zone), Guzmán (1979) described the following hallucinogenic species of *Psilocybe*: *P. naematoliformis* Guzmán, *P. singerii* Guzmán, *P. uxpanapensis* Guzmán, and *P. weldenii* Guzmán. It is possible that the use of *A. muscaria* was replaced a long time ago by species of *Psilocybe*, which is what happened in other parts of Mexico. However, at present, there is no evidence of the use of any sacred mushrooms in the Maya area.

Mycological and ethnomycological studies in the Maya area

In spite of the great diversity of fungi not only in the Maya area, but in all the tropical regions, as noted by Guzmán (1998), there are few reports on the fungi of the Maya region. Guzmán (1998) established that although there are more than 200,000 species of fungi in Mexico, we know only about 6,000 of them. As there are more than 70 percent of all fungi in tropical regions, and we only study a few species every year, it would take more than 200 years (at the present pace) to know all the fungi of Mexico. This slow progress is especially disturbing as tropical vegetation is being destroyed at an alarming rate.

The first records of fungi in the Maya area were made by Millspaugh (1896, 1898), who reported relatively few fungi (among them, *Agaricus yucatanensis* Ellis and Everhart) in his study of Yucatán flora. Standley (1930) researched the same area; in his study, Standley presented a checklist of the 22 fungi species recorded from Yucatán. Hedrick (1935) recorded some lichens from Yucatán, while Guzmán (1982, 1983); Guzmán and Johnson (1974); Guzmán and Madrigal (1967); Guzmán-Dávalos and Guzmán (1982); Mata (1987); Pérez-Moreno and Villarreal (1988); Pérez-Silva, Herrera, and Valenzuela (1992); and Ulloa (1974) studied the fungi of the Maya area of Mexico. Of these works, Ulloa (1974) is the only one confined to molds, although Guzmán (1982) described a few micromycetes.

Ulloa (1974) studied the molds that form pozol - a Mayan beverage that was also recorded by de Landa (1560). Guzmán (1982, 1983), and Guzmán-Dávalos and Guzmán (1982), discussed more than 250 species of fungi from 66 localities on the Yucatán Peninsula; some of them were new records, and others were new species. The papers of Guzmán (1983) and Mata (1987) also deal with the ethnomycology of Yucatán. Related to this latter ethnomycological point, Laughlin (1975) presented several Tzotzil names on fungi, while Barrera-Vázquez, Bastarrachea, and Brito-Sansores (1980) considered some few names on fungi in their respective dictionaries of the Maya Region (also transcribed by Guzmán 1997). However, neither Barrera-Vázquez, Bastarrachea, and Brito-Sansores (1980) nor Laughlin (1975) presented any names related with the sacred mushrooms.

Sommerkamp (1991) and Sommerkamp and Guzmán (1990) presented a discussion of the 21 known edible species from the popular markets in Guatemala, and a checklist of the fungi in the Herbarium of the University of San Carlos of Guatemala; Sommerkamp (1994) discussed the known hallucinogenic species of *Psilocybe*. Guzmán, Torres and Logemann (1985) described *Morchella guatemalensis* Guzmán, Torres, and Logemann from Guatemala. Guzmán (1987) discussed *Pseudofistulina radicata* (Schw.) Burdsal from Yucatán, Guatemala, and El Salvador, this latter report being based on Escobar and Toledo (1977). Logemann *et al*. (1987) reported a fatal case of poisoning with *Amanita magnivelaris* Peck in Guatemala. There are at present more than three hundred species of fungi known from the Maya area.

Important species of fungi used at present in Yucatán are *Geastrum saccatum*, *Clathrus crispus*, *Pleurotus djamor*, and *Ustilago maydis*, among others (Guzmán 1983). *Geastrum saccatum* is named "looi lu um" (or "flower of the earth"), and is used to stop diarrhea in children known as "mal de ojo." *Clathrus crispus* is known as "chaaha quai" (i.e., colander of the medicine man or wizard), and is used to control some eye infections using the liquid that is obtained when the mushroom is squeezed. *Pleurotus djamor* is a common pantropical edible fungus known as "xikin che" (or "ear of the woods"); in the present tourist resort of Xcaret (which is close to Cancun, Quintana Roo), employees have a laboratory and greenhouses to cultivate this fungus and cook it in their restaurants. Furthermore, the University of Yucatán, in Merida, has a program on the cultivation of this fungus to teach the technology to the farmers.

There are some important ethnomycological observations to be made regarding *Ustilago maydis*, the edible fungus of the Nahuatl culture known as "huitlacoche", which is a parasitic fungus on corn. This fungus is called "ta chaak," "ta chak ixim," "ixim chaak," and "nal chaak," among other names, all of which are related to Chak, the god of rain. It is believed that this fungus falls on the corn from rain, and that the fungus has concentrated the violence of the thunderbolt (Guzmán 1983; Mata 1987). These interesting observations on the fungus that falls from the sky with all the violence of the thunderbolt are strongly related, and demonstrate the connection of *Ustilago maydis* with the Thunderbolt Legend, the Dresden Codex, and the mushroom stones portraying "falling men," as discussed earlier. Lowy (1974, 1980) stated that the Thunderbolt Legend - which related the thunderbolt with a fungus, and the falling men in both the Dresden Codex and the mushroom stones - are related to the ingestion of *A. muscaria*. Why, then, is all this information not connected with the important edible fungus *Ustilago maydis*, which is also said to fall from the sky? This is a new interpretation, and may be the most proper way of relating "falling men" and the Thunderbolt Legend. As long as different interpretations exist, it is clear how much study is still needed on the Maya Culture in relationship with the fungi.

The project on the fungi of el Edén ecological reserve, Quintana Roo

To cope with the high destruction of vegetation on the Yucatán Peninsula, Arturo Gómez-Pompa (University of California, Riverside) founded a private ecological reserve in the north of Quintana Roo, called "Reserva Ecologica El Edén," to conserve and study the biodiversity of this site. Two explorations took place in 2000 - one in July, and the other in November - to gather all the fungi possible.

More than 400 specimens of fungi, mainly macromycetes, were gathered, as well as some lichens and myxomycetes. A preliminary checklist of studied species was prepared (Table 17.1) noting 65 species, of which *Leucopaxillus gracillimus* is first reported in Mexico. This species was only previously known in Florida, U.S.A., Brazil, and the Antilles (Dennis 1970; Pegler 1983). Moreover, *Fomitopsis rosea*, *Panellus stypticus*, and *Trogia cantharellus* were also first reported on the Yucatán Peninsula.

New species will be described from the material that is now being studied. The ultimate plan is to publish articles and descriptions of any new or interesting species. The main objective of this project is to prepare an illustrated book with color plates of the main fungi of El Edén.

TABLE 17.1. A preliminary checklist of the fungi of El Edén Ecological Reserve

Ascomycotina	*Cookeina sulcipes (Fr.: Fr.) Dennis*
	C. tricholoma (Mont.) Kuntze
	Daldinia eschscholzii (Ehenb.: Fr.) Rehm
	Hypoxylon rubiginosum (Pers.: Fr.) Fr.
	Phillipsia domingensis (Berk.) Berk.
	Phylacia globosa Lév.
	P. poculiformis (Mont.) Mont.
	Xylaria bombooensis Lloyd sesu San Martin & Rogers
	X. cocoophora Mont.
	X. phyllocharis Mont.
	X. polymorpha (Pers.:F.) Grev.
Basidiomycotina	*Agrocybe retigera (Speg.) Singer*
	Auricularia fuscosuccinea (Mont.) Farlow
	A. mesenterica Pers.
	A. polytricha (Mont.) Sacc.
	Clathrus crispus Turpin
	Coprinus radians (Desm.) Fr.
	Coriolopsis byrsina (Mont.) Ryv.
	C. polyzona (Pers.) Ryv.
	Dacryopinax elegans (Berk. & M.A. Curtis) Martin
	Daeladea sprucei Berk.
	Dictyopanus pusillus var. rhipidium (Berk.) Singer
	Earliella scabrosa (Pers.) Gilbn. & Ryv.
	Fomitopsis feel (Fr.) Kreisel.
	Ganoderma curtisii (Berk.) Murrill
	Geastrum campestris Morgan.
	G. saccatum Fr.
	Gloeophyllum striatum (Sw.: Fr.) Murrill
	Hexagonia papyracea Berk.
	H. tenuis Fr.
	Lepista singeri Guzmán
	Leucocoprinus birnbaumii (Corda) Singer
	Leucopaxillus gracillimus Singer & A.H. Smith
	Mycenoporella clypeata (Pat.) R. Heim
	Panaeollus antillarum (Fr.) Dennis
	Panus badius (Berk.) Singer
	P. crinitus (L.: Fr.) Singer
	Phellinus extensus (Lév.) Pat.
	P. gilvus (Schw.: Fr.) Pat.
	P. linteus (Berk. & M.A. Curtis) Teng
	P. pectinatus (Kl.) Quél.
	Phylloporia spathulatha (Hook.) Ryv.
	Pleurotus djamor (Fr.) Boedijn
	P. hygrophanus (Mont.) Dennis
	Pogonomyces hydnoides (Sw.: Fr.) Murrill
	Polyporus tenuiculus (Beauv.) Fr.
	P. tricholoma Mont.
	Pycnoporus sanguineus (L.: Fr.) Murrill
	Rigidoporus microporus (Fr.) Overeem
	Schizophyllum commune Mont.
	S. fasciatum Pat.
	Scleroderma sinnamariense Mont.
	Trametes maxima (Mont.) David & Rajch.
	T. villosa (Fr.) Kreisel
	Trichaptum perottettii (Lév.) Ryv.
	Tremella rubromaculata Lowy.
	Trogia cantharellus (Mont.) Pat.
	Volvariella volvacea (Bull. : Fr.) Singer

Lichens	*Coenogonium linkii Ehrenb.* *Graphis librata (L.) Anch.* *Strigula complanata Mont.*
Myxomycota (Myxomycetes)	*Arcyria denudata (L.) Wettst.* *Ceratiomyxa fruticulosa (Müll.) Macbr.* *Stemonites splendens Rostafineski*

Literature cited

1. Barrera-Vázquez, A., J. R. Bastarrachea, and W. Brito-Sansores. 1980. Diccionario Maya Cordemex. Cordemex, Merida.
2. de Borhegyi, S. F. 1961. Miniature mushroom stones from Guatemala. *Amer. Antiqu*. 26:498-504.
3. de Landa, D. 1560. Relación de las Cosas de Yucatán.Edition 1959. Porrúa, Mexico City.
4. Dennis, R. W. G. 1970. Fungus flora of Venezuela and adjacent countries. Cramer, Lehre. Germany.
5. Dresden Codex Reproduction. 1981. Ancient Maya message. O. J. Naranjo de Knellis, editor (English, Spanish, French and German version). Dresden Codex, the most important pre-Hispanic document. Guatemala.
6. Escobar, G. A., and J. D. Toledo. 1977. El "tenquique," hongo comestible de El Salvador. *Comunicaciones* (*3a. época*) 1:15-22.
7. Guzmán, G. 1979. Observations on the evolution of *Psilocybe* and descriptions of four new hallucinogenic species from Mexican tropical forests. M. Moser and E. Horak, editors. Festschrift für Singer. Beih. *Sydowia* 8:168-181.
8. Guzmán, G. 1982. New species of fungi from the Yucatán Peninsula. *Mycotaxon* 16:249-261.
9. Guzmán, G. 1983. Los hongos de la Península de Yucatán II. *Biotica* 8:71-100.
10. Guzmán, G. 1984. El uso de los hongos en Mesoamérica. *Ciencia y Desarrollo* 59:17- 27.
11. Guzmán, G. 1987. Distribución y etnomicología de *Pseudofistulina radicata* en Mesoamérica, con nuevas localidades en México y su primer registro en Guatemala. *Rev. Mex. Micol*. 3:29-38.
12. Guzmán, G. 1992. The sacred mushroom in Mesoamerica. Pages 75-89 in T. Miyanishi, editor 1992. Memoirs I International Symposium 1990. The medicine of ancient Maya and hallucinogens. Wakayama University, Wakayama.
13. Guzmán, G. 1997. Los nombres de los hongos y lo relacionado con ellos en América Latina. Instituto de Ecología and CONABIO, Xalapa.
14. Guzmán, G. 1998. Análisis cualitativo y cuantitativo de la diversidad de los hongos en México. Pages 111-175 in G. Halffter, editor. La diversidad biológica de Iberoamérica II. CYTED and Instituto de Ecología, Xalapa.
15. Guzmán, G., and P. D. Johnson. 1974. Registros y especies nuevas de los hongos de Palenque, Chiapas. *Bol. Soc. Mex. Micol*. 8:73-105.
16. Guzmán, G., and X. Madrigal. 1967. Notas sobre algunos hongos superiores de Escárcega, Campeche. *Rev. Soc. Mex. Hist. Nat.* 28:23-38.
17. Guzmán, G., and F. Ramírez-Guillén. 2001. The *Amanita caesarea*-complex. Bibliotheca Mycol. 187, Cramer Stuttgart (in press).
18. Guzmán, G., M. F. Torres, and H. Logemann. 1985. Fungi from Guatemala I. A new species of *Morchella*. *Mycol. Helv.* 1:451-459.
19. Guzmán-Dávalos, L., and G. Guzmán. 1982. Contribución al conocimiento de los lepiotáceos de Quintana Roo. *Bol. Soc. Mex. Micol*. 17:43-54.
20. Hedrick, J. 1935. Lichens from the Yucatan Peninsula. Botany of the Maya area. Misc. Papers 6, Carnegie Institute 46, Washington, D.C.
21. Heim, R., and R. G. Wasson. 1958. Les champignons hallucinogènes du Mexique. Éditions du Muséum National d'Histoire Naturelle. Paris.
22. Laughlin, R. M. 1975. The great Tzotzil dictionary of San Lorenzo Zinancatán. Smithsonian Institution, Washington, D.C.
23. Logemann, H., J. Argueta, G. Guzmán, L. Montoya, V. M. Bandala, and R. de León. 1987. Envenenamiento mortal por hongos en Guatemala. *Rev. Mex. Micol.* 3:211- 216.
24. Lowy, B.. 1971. New records of mushroom stones from Guatemala. *Mycologia* 63:983- 993.
25. Lowy, B. 1972a. Mushroom symbolism in Maya codices. *Mycologia* 64:816-821.
26. Lowy, B. 1972b. A newly discovered copy of a Maya codex. *Rev. Interamericana* 2:405-407.
27. Lowy, B. 1974. *Amanita muscaria* and the thunderbolt legend in Guatemala and Mexico. *Mycologia* 66:188-190.
28. Lowy, B. 1977. Hallucinogenic mushrooms in Guatemala. *J. Psyche. Drugs* 9:123-125.
29. Lowy, B. 1980. Ethnomycological inferences from mushroom stones, Maya codices and Tzutuhil legend. *Rev. Interamericana* 10:94-103.
30. Mapes, C., G. Guzmán, and J. Caballero. 1981. Etnomicología purépecha. Cuadernos etnobotánicos 2, Dirección de Culturas Populares. SEP, Mexico City.
31. Mata, G. 1987. Introducción a la etnomicología maya de Yucatán. El conocimiento de los hongos en Pixoy, Valladolid. *Rev. Mex. Micol.* 3:175-187.
32. Mayer, K. H. 1977. The mushroom stones of Mesoamerica. Acoma Books, Ramona.
33. Millspaugh, C. F. 1896. Contribution II to the coastal and plain flora of Yucatan. *Field Columbia Museum 15, Bot. Ser.* 1(3):281-339.
34. Millspaugh, C. F. 1898. Contribution III to the coastal and plain flora of Yucatan*. Field Columbia Museum 25, Bot. Ser.* 1(4): 345-397.
35. Miyanishi, T. 1992. Memoirs I International Symposium 1990. The medicine of ancient Maya and hallucinogens. Wakayama University, Wakayama.
36. Ohi, K., and M. F. Torres. 1994. Piedras-Hongo. Museo de Tabaco y Sal, Tokyo (in Spanish and Japanese).
37. Ott, J. 1993. Pharmacotheon. Entheogenic drugs, their plant sources and history. Natural Products Co., Kennewick.
38. Pegler, D. N. 1983. Agaric flora of the Lesser Antilles. Kew Bull. Add. Ser. 9, Her Majesty's Stationery Office, London.

39. Pérez-Moreno, J., and L. Villarreal. 1988. Los hongos y myxomycetes del Estado de Chiapas, México. Estado actual de conocimiento y nuevos registros. *Mic. Neotrop.* 1:97-133.
40. Pérez-Silva, E., T. Herrera, and R. Valenzuela. 1992. Hongos (macromicetos) de la Península de Yucatán. Pages 13-22 in D. Navarro and E. Suárez-Morales, editors. Diversidad biológica en la reserva de la biosfera de Sian Ka'an, Quintana Roo. II. CIQRO, SEDESOL, Mexico City.
41. Sahagún, Fray Bernardino. 1569-1582. Historia de las cosas de la nueva España. Mexico City. Reimpr. 1955. 2: 137, 286, and 408-410 in Alfa, editor. Mexico City.
42. Schultes, R. E., and A. Hofmann. 1979. Plants of the gods: origins of hallucinogenic use. McGraw-Hill Book Co., Maidenhead. Reprinted 1982. Plantas de los dioses. Origenes del uso de los alucinógenos. Fondo de Cultura Económica, Mexico City.
43. Sommerkamp, Y. 1991. Hongos comestibles en los mercados de Guatemala. Cuadernos de Investigación, Universidad de San Carlos, Guatemala.
44. Sommerkamp, Y. 1994. Los hongos macromicetos de Guatemala. Pages 67-72 in K. Ohi and M. F. Torres, editors. Piedras-Hongo. Museo de Tabaco y Sal, Tokyo.
45. Sommerkamp, Y., and G. Guzmán. 1990. Hongos de Guatemala II. Especies depositadas en el herbario de la Universidad de San Carlos de Guatemala. *Rev. Mex. Micol.* 6:179-197.
46. Standley, P. C. 1930. Flora of Yucatan. *Field Mus. Nat. Hist. Bot. Ser. 279*, 3(3):157- 492.
47. Torres, M. F. 1984. Utilización ritual de flora psicotrópica en la cultura Maya. Pages 57-162 in E. M. Villatorio, editor. Etnomedicina en Guatemala. Centro de Estudios Folklóricos, Universidad de San Carlos, Guatemala.
48. Ulloa, M. 1974. Mycoflora succession in pozol from Tabasco, Mexico. *Bol. Soc. Mex. Micol*. 8:17-48.
49. Wasson, R. G. 1980. The wondrous mushroom. Mycolatry in Mesoamerica. McGraw- Hill, New York.
50. Wasson, V. P., and R. G. Wasson. 1957. Teonanácatl. Pages 215-286 in Mushrooms, Russia and History. Pantheon Books, New York.

Psychoactive Substances and Paranormal Phenomena

A Comprehensive Review

by

David Luke

University of Greenwich London, UK

original report: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.372.1415&rep=rep1&type=pdf

Table of Contents:

Introduction
1. Psychedelic/Neurochemical Models of Paranormal Experience
  1.1 Brain as filter
  1.2 β-carbolines, tryptamines, and psi
  1.3 DMT, near-death, and other anomalous experiences
  1.4 Ketamine and NDEs
  1.5 Dopamine and paranormal beliefs and experiences
  1.6 Overview of psychedelic/neuro-chemical models of paranormal experience
2. Field Reports of Paranormal Phenomena
  2.1 Anthropological and Historical Reports
  2.2 Personal Views and Experiences
  2.3 Clinical
  2.4 Evaluation of Field Reports
3. Surveys
  3.1 Surveys of Belief in the Paranormal
  3.2 Surveys of Paranormal Experiences
    3.2.1 Psychiatric epidemiological samples
    3.2.2 Clinical populations
    3.2.3 General and student samples
    3.2.4 Psychedelic-users samples
  3.3 Surveys and Out-of-Body Experiences (OBEs)
  3.4 Summary of Survey Research
4. Experimental ESP Research
  4.1 Forced-Choice Designs
  4.2 Free Response
    4.2.1 Psychometry (object reading)
    4.2.2 Other clairvoyance experiments
    4.2.3 Telepathy experiments
  4.3 Summary of Experimental Research
5. Methodological Critique of Experimental Research
6. General Summary and Conclusions
Acknowledgements
References

David Luke

This paper investigates the relationship between psychoactive substances and so-called paranormal phenomena falling within the study of parapsychology. It is primarily concerned with extrasensory perception (ESP) - telepathy, precognition, and clairvoyance - as well as out-of-body experiences (OBEs) and near-death experiences (NDEs). Psychokinesis (PK), aura vision, encounter experiences, and sleep paralysis only make a very limited contribution to this review as they are seldom related to psychoactive drugs within the parapsychological literature. The paper borrows widely, but by no means exhaustively, from parapsychology as well as transpersonal studies, anthropology, ethnobotany, phytochemistry, psychiatry, psychotherapy, psychopharmacology, and neurobiology, particularly neurochemistry. It is organized into neurochemical models of paranormal experience (section 1), field reports of intentional and spontaneous phenomena incorporating anthropological, historical and clinical cases, and personal accounts (section 2), surveys of paranormal belief and experience (section 3), experimental research (section 4), and a methodological critique of the experimental research with recommendations for further work (section 5).

Keywords: psychedelic, hallucinogen, entheogen, neurochemistry, parapsychology, psi, ESP, clairvoyance, telepathy, precognition, OBE, NDE.

Introduction

Ever since the beginning of the 20th century when Western scientists and academics began earnestly turning their attention to psychedelics there has been a clear association between the use of these substances and the transpersonal or paranormal experience. Indeed, those people most readily associated with the discovery and popularization of psychedelics also witnessed and explored both the transpersonal and the parapsychological dimensions that these substances induced, such as Albert Hofmann, Humphrey Osmond, John Smythies, Aldous Huxley, Gordon Wasson, Timothy Leary, Ken Kesey, Duncan Blewett, Walter Pahnke, James Fadiman, and Stanislav Grof, to name but a few (Luke, 2006; Stevens, 1988). The overlap between transpersonal and paranormal experiences is apparent (e.g., Daniels, 2005), but while a great deal has been written in recent years about psychedelic experiences from the transpersonal perspective, a comprehensive review of the parapsychological literature relating to psychedelic experiences is long overdue.

This review focuses primarily on the class of psychoactive substances that largely induce visionary and trance-like experiences. For the purposes of the present review this includes drugs and sacramentals such as mescaline, lysergic acid diethylamide (LSD), psilocybin, ayahuasca, *N,N*-dimethyltryptamine (DMT), marijuana (which is treated as a psychedelic in the current review), and ketamine, but not opiates or cocaine. This class of visionary substances has been termed differently by different authors, usually dependent upon the connotation they wish to convey about the psychoactive effects or how the substance is used. Within the literature of the present review, they have been termed "mind-expanding" (e.g., Palmer, 1979), "psychotropic" (e.g., Irwin, 1994), "psychodysleptic" (Cavanna & Servadio, 1964), "hallucinogenic" (e.g., Blackmore, 1992), and even "entheogenic" (Ruck, Bigwood, Staples, Wasson, & Ott , 1979), meaning bringing forth the divine within, which is a useful term to convey the apparent divinatory and visionary nature of these substances (for discussions see Letcher, 2004; Ott, 1996; Smith, 2000), although they might be more correctly termed "potential entheogens" as they do not automatically produce such experiences (Krippner, 2006b, p. 1). Finally, there is the most frequently used term, "psychedelic", which was created in 1956 by Humphry Osmond and means "mind manifesting" (Osmond, 1961a, p. 76). Where specified, the original term used by the authors will be preserved to reflect their orientation to the issue. However, elsewhere, where appropriate, the more widely used term "psychedelic" will be used.

For the purpose of the present paper, a psychedelic drug is:

> one which, without causing physical addiction, craving, major physiological disturbances, delirium, disorientation, or amnesia, more or less reliably produces thought, mood, and perceptual changes otherwise rarely experienced except in dreams, contemplative and religious exaltation, flashes of vivid involuntary memory, and acute psychoses. (Grinspoon & Bakalar, 1998, p. 9)

The earliest parapsychology experiments with psychoactive substances were conducted with simple stimulants and depressants, such as caffeine, amphetamine, alcohol, amytal, and quinal-barbitone (e.g., Averill & Rhine, 1945; Cadoret, 1953; Huby & Wilson, 1961; Murphy, 1961; Rhine, 1934; Rhine, Humphrey, & Averill 1945; Soal & Bateman, 1954; Wilson, 1961, 1962; Woodruff, 1943). This work is not included here (for reviews see Palmer, 1978; Ramakrishna Rao, 1966) as this review is instead focused on the visionary substances, which are seemingly more favorable to the production of psi, that Braud (2002) has suggested primarily cause qualitative, rather than just quantitative alterations to the user's state of consciousness, although Rock and Krippner (e.g., 2012) argued that (altered) states of consciousness may be more accurately described as (altered) states of phenomenology. Some earlier reviews of psychedelics in parapsychology are available and have been incorporated into the present investigation (Blewett, 1963; Gowan, 1975; Krippner & Davidson, 1970, 1974; Luke, 2008b; Luke & Friedman, 2010; Parker, 1975; Rogo, 1976; Wilson, 1949).

There are good theoretical reasons for investigating psychedelics as a means of inducing ESP and other paranormal phenomena. Given that an altered state of consciousness (ASC) is assumed to be (for a discussion see Storm & Rock, 2009) a common feature in the occurrence of subjective paranormal experiences (Alvarado, 1998; Barušs, 2003; Honorton, 1977; Parker, 1975) and has often been incorporated into experimental attempts to induce ESP (see Luke, 2011a; Palmer, 1978, 1982; Schmeidler, 1994), then visionary drugs are, potentially, a reliable means of accessing such a state. Several researchers have documented some of the mind-altering features of the visionary-drug experience that are considered conducive to the production of parapsychological experiences and phenomena (see also Braud, 2002). These have been categorized thus:

1. Increase in mental imagery, in both vividness and quality, and the dreamlike state (Blackmore, 1992; Osis, 1961a, 1961b; Progoff, 1961; Tart, 1968, 1994)
2. Altered perception of self-identity, such as unity consciousness: The mystical experience of becoming one with everything in the universe (Krippner & Fersh, 1970; Nicol & Nicol, 1961; Osis, 1961a; Pahnke, 1968; Tart, 1994)
3. Altered body perceptions and dissociation (Blackmore, 1992; Tart, 1994). This is of particular interest with respect to the out-of-body experience (OBE)
4. Distorted sensory input (Blackmore, 1992)
5. Increased absorption and focused attention (Millay, 2001; Tart, 1968, 1994)
6. Increased empathy (Blewett, 1963; Nicol & Nicol, 1961; Tart, 1994). This is of interest to telepathy, and indeed, elevated empathy is associated with use of psychedelics generally (DeGracia, 1995; Lerner & Lyvers, 2006)
7. Emotional flexibility (Blewett, 1963), which may also assist in negotiating the fear of psi (Tart, 1994)
8. Increased alertness and awareness (Huxley, 1961a; Nicol & Nicol, 1961; Osis, 1961b; Tart, 1994)
9. Increased inwardly focused attention and awareness, and decreased external and bodily awareness (Dobkin de Rios, 1978)
10. Increased spontaneity (Osis, 1961a)
11. Sensitivity to subtle changes (Parker, 1975) and intensity of feeling (Osis, 1961a)
12. Physical relaxation (Blackmore, 1992), although Tart (1968) questions its occurrence
13. Increased suggestibility (Huxley, 1961a; Tart, 1968)
14. Increase in intuitive thought processes (Tart, 1994)
15. Reduced critical conscious faculty and increased optimism towards impossible realities (Nicol & Nicol,

1961; Osis, 1961b; Tart, 1968, 1994)

16. Increased openness and extroversion (Rogo, 1976)
17. Release of repressed and unconscious material into the conscious mind (Rogo, 1976)
18. Complex distortions, and transcendence, of space and time (Garrett 1961b; Nicol & Nicol, 1961; Tart, 1994; see also Dawson, 2005; Mayhew, 1956; Shanon, 2001; Whiteman, 1995)

This last feature of the psychedelic experience is probably of paramount importance for the experience of ESP when it is considered that precognition, telepathy, clairvoyance, and possibly OBEs all represent radical departures from Newtonian concepts of time and space. Smythies (1983) has suggested that the psychedelic experience originates from the collective unconscious outside of space and time, and Jung agreed with Smythies' idea. Millay (2001) offered that psilocybin and similar substances are important for studying psi because they allow us access to nonlocal space-time. Jansen (1999) also supposed that the same might be possible of ketamine, which became popularly used at the same time as Bell's theorem of nonlocal space-time was becoming seriously considered, enabling some to report the experiential equivalence of the concept. Indeed, the Berkley-based Fundamental Fysiks Group that formed in the 1970s experimented with psychedelics to inspire their investigations of both psi and Bell's theorem - neglected as it was by mainstream physics at that time - which eventually lead to the birth of what is now the multi-billion dollar research enterprise of quantum information science (Kaiser, 2011). More recently, something akin to this may also be evident with the psychedelic substance DMT, which sometimes provides users with the perception of many more than the usual four space-time dimensions, perhaps comparable to what physicists discuss in M-theory (Luke, 2010c). Keeping with the times ketamine is also now reported to induce such extra-dimensional percepts too (Newcombe, 2008), as is the semi-synthetic psychedelic salvinorin B ethoxymethyl ether (Mercury & Feelodd, 2008).

In addition to these temporary alterations that occur during the psychedelic experience, it is arguable that long-term ideological alterations may occur that might also be psi-conducive. For example, enduring changes in concepts of reality may occur with the use of psychedelics (Conway, 1989; Strassman, 2001), such that optimism about unseen realities, both during and after the experience, leads to a greater openness to, or belief in, psi and the paranormal. In a follow-up survey of 113 LSD-psychotherapy clients (with an 82% response rate) 78% reported an increased tendency to view telepathy and precognition as possibilities warranting investigation (International Foundation for Advanced Study, 1962). It has even been stated that the psychedelic experience is itself, by common consent, paranormal (Unger, 1963). Furthermore, the distinguished medium and psychical researcher Eileen Garrett (1961b) asserted that the use of LSD had made her a better, more accurate sensitive and she related certain psychedelic states to the mediumistic pre-trance state of euphoria, although she specified that the LSD experience was not the same as the mediumistic trance (Garrett, 1961a). Huxley (1961a) proposed that LSD is invaluable in training participants to use their subjective faculties to enhance their psi ability.

Besides the subjective aspects of the psychedelic experience, there are other theoretical reasons for investigating paranormal phenomena with drugs: Because paranormal phenomena are brain-mind experiences, neurochemicals - and therefore psychoactive drugs - would be expected to be involved in the process. It is highly likely that all ASC, including potentially ESP-conducive states, involve alterations in brain chemistry. Indeed, several psychedelic-neurochemical models, discussed in the following sections (also see Luke & Friedman, 2010), have been proposed, primarily based upon subjective paranormal experiences occurring with certain substances and their specific neurochemical action. It is entirely feasible that genuine paranormal experiences are mediated in the brain through the action of specific endogenous (made within the body) molecules (Vayne, 2001). This does not simply imply that neurochemicals are the sole cause of paranormal phenomena, but they may rather just be a part of the process. As the novelist Aldous Huxley once said in relation to mystical experiences and the use of psychedelics - they are the occasion rather than the cause.

1. Psychedelic/Neurochemical Models of Paranormal Experience

1.1 Brain as filter

Aldous Huxley (1954) also was prominent in promoting Henri Bergson's (1896/1990) theory of the brain as a filter of memory and sensory experience, acting to reduce the wealth of information available to awareness lest people become overwhelmed by a mass of largely useless and irrelevant data not needed for the survival of the organism. It was Bergson who suggested that, if these filters were bypassed, humans would be capable of remembering everything that had ever been experienced and perceiving everything that has happened everywhere in the universe (e.g., as in clairvoyance). It was also Huxley who applied this theory to psychedelics by suggesting that these mind-manifesting drugs override the "reducing valve" of the brain (Huxley, 1954, p. 12), allowing humans access to both psychic and mystical experiences. This was a notion that Huxley eruditely paraphrased for the title of his book from the quote by the English poet and mystic, William Blake (1906/1793), "If the doors of perception were cleansed, every thing would appear to man as it is, infinite" (p. 26).

Huxley's (1954) rather basic conception never received a more formal operationalization of the specific drug actions that may be involved, but research into the neurochemistry of psychedelics lends some support to his notion. For instance, Vollenweider and Geyer (2001) proposed that information processing in cortico-striatothalamo-cortical (CSTC) feedback loops is disrupted by psychedelics via 5-HT (serotonin) receptor agonism (specifically 5-HT$_{2A}$ receptors), thereby inhibiting the "gating" of extraneous sensory stimuli and inhibiting the ability to attend selectively to salient environmental features. Furthermore, psychedelics are also thought to induce presynaptic release of glutamate from thalamic afferents, leading to a simultaneous overload of internal information in the cortex. It is thought that these combined information overload effects are at least partly responsible for the hallucinogenic experience with these drugs, which are known to induce greatly altered or amplified incoming sensory information, as is indicated by an increased startle effect (Vollenweider, 2001).

Research into the neurobiology of psychedelics in humans has only just resumed after decades of dormancy, so the current understanding of the action of these substances in the brain remains limited. One of the few studies to have been conducted, however, also offers some unexpected support for Huxley's reducing valve theory. Looking at the blood flow around the brain following the ingestion of psilocybin, it was expected that certain regions of the brain would have more activity, given the overwhelming intenseness of strong psychedelic experiences, and yet, counter-intuitively, there was no single brain region that increased in activity, and the brain's activity was reduced overall (Carhart-Harris, 2011; Carhart-Harris *et al*., 2012). The main areas demonstrating reduced cerebral blood flow were the cerebral hub regions of the thalamus, anterior and posterior cingulate cortex (ACC & PCC), and medial prefrontal cortex (mPFC). Significantly, the usual positive coupling between the mPFC and the PCC - which forms part of the default mode network thought to be important in introspection and high level constructs such as self and ego - was reduced leading to "a state of unconstrained cognition" (Carhart-Harris *et al*., 2012, p. 2138).

This psychedelic disruption of the sensory gating function discussed by Vollenweider (2001), and the reduction of activity in the default mode network discussed by Carhart-Harris (2011) could also underpin the neurochemistry of ESP, whether elicited with any number of psychedelics or, indeed, without the intervention of such exogenous chemicals (though perhaps via endogenous chemicals such as DMT). Indeed like psychedelics, psi experiences and events have variously been conceptualized in relation to an inhibition of the ordinary sensory inhibition, often in conjunction with elevated psychosis and creativity, such as with the concepts of latent disinhibition (Holt, Simmonds-Moore, & Moore 2008), transliminality (Thalbourne, 2000; Thalbourne & Houran, 2005), boundary thinness and schizotypy (Simmonds & Roe, 2000), and self-expansiveness (Friedman, 1983; Pappas & Friedman, 2007). It may be noted that psychedelics have also been long associated with both creativity (e.g., Dobkin de Rios & Janiger, 2003; Krippner, 1985) and psychosis (Osmond & Smythies, 1952).

Despite the simplistic appeal of the anti-reducing valve action of psychedelics as a neurochemical model of psi, considerable gaps still remain in the current understanding of the neuropharmacological action of psychedelics in humans. Since the early 1970s, until relatively recently, practically all psychedelic research has been conducted with animals and there remain no definitive generalizations that can be made about the main neurotransmitter receptor sites involved, as psychedelics vary considerably in their chemical makeup and their ligand (i.e., a ligand is a molecule, such as a neurotransmitter, that triggers a response in a target protein) affinity (Ray, 2010). For instance, dissociative anesthetics such as ketamine are commonly N-methyl-D-aspartate (NMDA) receptor antagonists, whereas the simple tryptamines, such as psilocybin, are apparently 5-HT_{2A} agonists. Speculations about the cause of the hallucinogenic effects of psychedelics generally include the activation of 5-HT_{1A}, 5-HT_{2A}, 5-HT_{2C}, dopamine, and glutamate pathways, although it is generally believed that classic psychedelics primarily work by stimulating 5-HT_{2A} receptors, particularly those expressed in the neocortical pyramidal cells (Lee & Roth, 2012; Nichols, 2004), although this is certainly not the case for all psychedelics (e.g., mescaline; Ray, 2010). Electrophysiology and receptor studies have revealed that both NMDA antagonists (e.g., ketamine) and classic serotonergic psychedelics (e.g., LSD) may actually enhance glutamatergic transmission via non-NMDA receptors in the frontal cortex. This may indicate a common mode of chemical action in the brain responsible for such similar experiences with these divergent molecules (Vollenweider, 2004); this serotonin/glutamate receptor-complex model of drug action is receiving high-profile attention again for psychedelics as a possible comparative model of psychosis (e.g., González-Maeso *et al.*, 2008).

Despite the lack of understanding of the neurobiology of psychedelic action, and lack of generalizability across so many diverse substances, recent advances would appear to support the Bergson-Huxley notion of brain as a filter capable of being deactivated by chemicals, and furthermore this notion, including the parts pertaining to ESP, is now gaining ground once more among theorists of consciousness (e.g., Kastrup, 2012). Indeed, recent theoretical developments (Smythies, 2011) suggest that NMDA antagonism, such as via ketamine, bypasses the reducing valve/filter action of the brain (see section 1.4 following below for a discussion).

1.2 β-carbolines, tryptamines, and psi

Advancing on earlier suggestions about the pineal gland's involvement in psi (e.g. Miller, 1978; Sinel, 1927), Roney-Dougal (1986, 1989, 1991, 2001) has developed an endogenous neurochemical-perspective of psi based on the action of the pineal and several hallucinogenic substances found in ayahuasca, the visionary Amazonian brew reported to induce a range of paranormal experiences. The common neurotransmitter serotonin is known to be most active in the pineal gland, where it follows a circadian rhythm and is converted at night into melatonin (5-methoxy tryptamine, or 5MT) and the β-carboline, pinoline (6-methoxy tetrahydro-β-carboline, or 6-MeO-THβC), which regulate sleep cycles. The pineal may also create other β-carbolines, such as 6-methoxyharmalan, a harmala alkaloid. These β-carbolines block the neuronal uptake of serotonin making it available for use, and inhibit the enzyme monoamine oxydase (MAO), which breaks down certain tryptamines such as *N,N*-dimethyl-tryptamine (*N,N*DMT, or simply DMT) and 5-methoxy tryptamine (5-MeO-DMT). MAO inhibitors, such as pinoline or the harmala alkaloids, make serotonin available at the pineal where, with the aid of pineal enzymes (methyl transferases), it can also be converted into 5-MeO-DMT, DMT, and bufotenine (5-hydroxy*N,N*-dimethyl-tryptamine, 5-HO-DMT), which are endogenous visionary substances also found in certain ingredients (such as *Psychotria viridis*) of ayahuasca brews and other shamanic visionary substances, even some of animal origin (e.g., the Sonoran desert toad, Rudgley, 2000). *In vivo* biosynthesis of DMT might also occur through the conversion of the common, nutritionally essential, amino acid tryptophan (Jacob & Presti, 2005; Shulgin & Shulgin, 1997).

However, these endogenous visionary tryptamines are not orally active, as they are denatured by the MAO enzymes present in the stomach, but ayahuasca brews also contains plant additives (such as *Banisteriopsis caapi*) containing a range of harmala alkaloids that inhibit MAO and allow the complementarily ingested visionary tryptamines to be active in the brain. It is this action of the β-carbolines (particularly harmine) in ayahuasca that is these days considered their primary purpose as admixtures in the brew (e.g., McKenna, 2004), though this may not always be the case as subjectively potent ayahuasca decoctions occasionally do not actually contain DMT when analyzed (Callaway, 2005). Nevertheless the harmala alkaloids are also known to induce visions themselves and Roney-Dougal (1986, 1989, 1991, 2001) originally implicated β-carbolines, such as the endogenous pinoline and the exogenous harmala alkaloids, as inducing psi-conducive states, either naturally during dreams (Callaway, 1988) or artificially by causing waking dream states. Roney-Dougal (2001) also later acknowledged that the β-carbolines may exert their visionary effects by potentiating the effects of ingested visionary tryptamines like DMT or 5-MeODMT when consumed in combination with them, as in ayahuasca. Further to Roney-Dougal's proposals, it is my speculation that the β-carbolines may also induce visions by contributing to the endogenous manufacture of visionary tryptamine substances, either when taken alone or in combination with such tryptamines, perhaps even indicating endogenous DMT or related tryptamines as the primary or even sole cause of such visions. This may account for why harmala alkaloids are less effective and slower than DMT at inducing visions (see Shulgin & Shulgin, 1997). In essence, ayahuasca contains two types of visionary chemicals, one type (β-carbolines, e.g., harmine) that helps to both create and potentiate the effects of the other type (tryptamines, e.g., DMT), potentially mimicking the nocturnal chemistry of the pineal and its supposed control over natural visionary states, such as dreams (Callaway, 1988), mystical experiences, and NDEs (Strassman, 2001).

Roney-Dougal (1989, 1991, 2001) suggested that the pineal gland and its neurochemistry is important in the occurrence of psi phenomena and points to the association made by yogis between the pineal gland and the ajna chakra, the yogic psychic center that controls psi-experiences in those with awakened kundalini (Miller, 1978; Satyananda, 1972). Further to this, Naranjo (1987) noted that both kundalini and ayahuasca experiences, being similar in many respects, also feature the same serpentine imagery, further speculating that they probably have the same neurochemistry and result in the same bioenergetic activation.

There is also some possibility that pineal gland activity or DMT production can be stimulated by certain esoteric yogic practices, such as kechari, which involves pressing the tongue into the far rear roof of the mouth to stimulate the production of amrit, a yogic nectar that reputedly causes DMT-like ecstasies, which is supposedly secreted in the brain following prolonged practice (Motoyama, 2001; Satyananda, 1996). Some support for this speculation comes from Strassman's (2001) observation that the pineal gland is formed in utero from the tissue of the roof of the mouth rather than in the brain, and later migrates to its unique ventricle position just outside the blood-brain barrier, directly above a critical cerebrospinal fluid byway, and this tentatively suggests that pineal stimulation via the roof of the mouth may be possible. Furthermore, manifestation of very specific body vibrations said to be classic kundalini symptoms are supposedly quite reliably induced with substances such as DPT (*N,N*-dipropyltryptamine) and 4-Acetoxy-DIPT (*N,N*-diisopropyl-4-acetoxy-tryptamine), which are even more obscure psychedelic tryptamines than DMT, but close relatives of it (Toad, 1999a, 1999b). Similarly, Grof (2001) has reported spontaneous kundalini arousal occurring during psychedelic psychotherapy sessions and surveys (see section 3.2.3 & 3.2.4 to follow) of kundalini experiences have found them to be related to drug use (DeGracia, 1995; Thalbourne, 2001).

Roney-Dougal (1989, 1991, 2001) also indicated that the pineal gland is sensitive to - possibly changing its chemical production - the same fluctuations in geomagnetic activity that appear to be associated with spontaneous psi-activity, possibly related to pineal melatonin (Persinger, 1988) or DMT fluctuations (Hill & Persinger, 2003) - for a review see Roney-Dougal, Ryan, and Luke (2012). That the pineal gland is central to psi is further supported by anthropological research, to follow - although experimental evidence is lacking - that suggests that DMT and the harmala alkaloids found in ayahuasca are psi-conducive, along with clinical research that suggests that pinoline and melatonin regulate sleep cycles and dreaming, during which spontaneous psi experiences most often occur (Roney-Dougal, 1986, 1989, 1991, 2001). Durwin (2001) has further suggested that the total isolation in the dark undergone for either the first 9 or 18 childhood years of the lives of trainee shamans of the Andean Kogi causes pineal gland deformation (presumably by melatonin/pinoline overproduction) that is responsible for their renowned divinatory skills.

Some tentative support for the notion that ESP performance is directly predicted by pineal gland activity is also evident with experimental research that demonstrated prepubescent children score better on ESP tests at 3 a.m., when the pineal's nocturnal chemicals (melatonin, etc.) are supposedly at peak concentrations in the brain, rather than at 9 p.m. (Satyanarayana, Rao, & Vijaylakshmi, 1993). This effect was not evident with a comparable group of pubescent children, which the authors suggest might be expected because the pineal is less active after infancy. A more extensive follow-up investigated dream-ESP and circadian pineal rhythms among young adults finding a significant improvement in dream precognition scores at 3 a.m. compared to 8 a.m. (Luke, Zychowicz, Richterova, Tjurina, & Polonnikova, 2010, 2012) with scores in the same direction but nonsignificant in a replication study (Luke & Zychowicz, 2011), providing some tentative support for the notion that ESP may be linked to circadian pineal rhythms.

Roney-Dougal (2001) has also drawn parallels between the ostensibly psi-conducive nature of the shamanic trance state, psychotic states, psychedelic states, and the dream state, which she suggested all belong to the same continuum - perhaps somewhat akin to Thalbourne's (1998) concept of transliminality, the proclivity for psychological material to cross thresholds in or out of consciousness - and that they all show suggestive evidence of being regulated by the same neurochemical processes. Recently, the discovery of trace amine receptors in the brain for which DMT shows greater affinity than does serotonin - its more common neuroamine cousin - has lead to a resurgence of interest in endogenous DMT in the mediation of mental health (Jacob & Presti, 2005).

1.3 DMT, near-death, and other anomalous experiences

After extensive research investigating the phenomenological effects of administering intravenous injections of DMT, Strassman (2001) has independently hypothesized a role for DMT similar to that suggested by Roney-Dougal (2001). Strassman echoed the same neurochemical action of the pineal as Roney-Dougal, and similarly proffered that psychotic, dream, meditation, and mystical states all occur through the overproduction of DMT, implicating DMT as a "reality thermostat" (Strassman, 2001, p. 327). However, Strassman indicated the action of DMT, not β-carbolines, as primary in producing these states and alternatively proposed that the pineal gland and endogenous DMT are central during extraordinary events, such as birth, death, and the near-death experience (NDE).

To support this view Strassman noted that the anatomy of the pineal, suspended in cerebrospinal fluid outside of the blood-bathed brain, is independent enough to resist activation by normal stresses and yet is optimally situated to deliver DMT directly to the middle brain regions where DMT-sensitive serotonin receptors are involved in mood, perception, and thought. Furthermore, access to the brain in this way eliminates the need for DMT transportation in the blood - where it would be broken down by MAO enzymes anyway - thereby negating the need for a pumping heart for delivery. Jacob and Presti (2005) also noted that DMT is virtually unique among endogenous neurotransmitters in that it is a molecule small enough to have blood-brain barrier permeability. That melatonin exerts its influence slowly over a period of a day or more, and so does not need the pineal's unique location, further supports the supposed postmortem function of DMT. Strassman further speculated that the pineal might continue to produce postmortem DMT for a few hours. He also noted that the NDE has psychedelic and mystical qualities, and that the DMT experience often shares the same features as an NDE. Some of his DMT study participants reported NDEs and death-rebirth experiences, with many others reporting a newfound fearlessness of death. However, that the participants may have been inadvertently primed for these experiences cannot be ruled out because they were told in the briefing to expect feelings of death or impending death. Nonetheless, independent survey research indicates that DMT users sometimes do report death-like and near-death-type experiences (Luke & Kittenis, 2005).

To Strassman's (2001) surprise many of the participants in his DMT study reported contact with sentient beings during the experience, often described as elves, dwarves, imps, gremlins, clowns, reptilian beings, and aliens, but also as spirits, gods, or just as a presence, which was commonly supremely powerful, wise, and loving. Such prevalent encounter experiences with DMT use (for a review see Luke, 2011b) are seemingly so unique and reliable (e.g., Meyer, 1993) as to have had the impish characters popularly dubbed the "self-transforming machine elves" (McKenna, 1991, p. 16), and whose tangible reality has been hotly debated by other DMT-experience researchers (Carpenter, 2006; Kent, 2005, 2010; Luke, in press; Pickover, 2005). Strassman suggested that fluctuations in endogenous DMT levels were also responsible for the frequent reports elsewhere of alien abduction, which share the newfound fearlessness of death and visions of energy tunnels, or cylinders of light, in common with DMT experiences. Following personal experiences with ayahuasca, Severi (2003) likewise noted the similarity between NDEs, traditional psychedelic-induced shamanic initiations, alien abduction experiences, and heightened psychic sensitivity, as have previous researchers (e.g., Harvey-Wilson, 2001; McKenna, 1991; Ring, 1989, 1992). However, Barušs (2003) pointed out that, despite the similarities, DMT and alien abduction experiences lack specific similarities, such as the absence with DMT of the classic "grays" (small gray aliens). Nevertheless, Hancock (2005), also having experienced DMT and ayahuasca, argued that there are substantial similarities between aliens and elves, whether induced through DMT or else appearing in historic-folkloric legends and testimonies, speculating that the latter also have a DMT-induced etiology and, adopting the theory proposed by Vallee (1969), that these elves of folklore are the prototype encounter/abduction experiences. It should be noted that few experiencers ever doubt the reality of their encounters with either aliens (Mack, 1999) or DMT entities (Strassman, 2001), perhaps with the exception of Kent (2005, although see Kent, 2010) in this latter category, and most actually consider them to be more real than most ordinary experiences. Additionally, like alien abduction reports, Strassman notes that his DMT study participants reported being probed and having things inserted into them by the beings, however, it should be noted that this might have been induced by the medical nature of his experiments and the use of intravenous injections and equipment for monitoring vital signs.

Incidentally, although neither Strassman nor other researchers originally pointed this out, it is apparent that some of the DMT experiences reported in his study, particularly the negative ones, share several features in common with sleep paralysis (e.g., see Cheyne, 2001), particularly the sense of presence, reports of one's chest being crushed, strange whistling, whining, and whirring sounds, and the terrifying paralysis of both body and vocal chords (Strassman, 2001). Alien abduction experiences and NDEs are also associated with sleep paralysis (see Sherwood, 2002), and indeed Strassman (2008) later noted the apparent relationship between sleep paralysis and DMT experiences, although caution has been raised about claiming too many anomalous phenomena can be explained by DMT, as this ultimately explains nothing, and further phenomenological analysis is needed (Luke, 2008), such as that conducted by Cott & Rock (2008), although a direct comparison of such experiences is needed. Nevertheless, there certainly warrants something to research here regarding a DMT etiology for sleep paralysis.

Curiously, experiential reports from research programs in the 1950s and 1960s (outlined in Shulgin & Shulgin, 1997; Torres & Repke, 2006), indicate that the endogenous 5-hydroxy-DMT (bufotenine), a very close relative to DMT with similar neurochemistry, is seemingly able on occasion to cause feelings of constriction in the throat and the crushing of one's chest, as well as anxiety and fear reactions, much like sleep paralysis, possibly implicating it as a co-chemical factor in such experiences, along with DMT. Additionally, in South America and the Caribbean the entheogenic cohoba snuff is made from one of the few traditionally-used plants in which bufotenine is active, *Piptadenia peregrina*, and is used specifically to contact spirits (Cohen, 1970; Torres & Repke, 2006), perhaps somewhat like the sensed presences of sleep paralysis and numerous DMT experiences. However, Ott (2001) pointed out that the circulatory crises in the earlier bufotenine research were most likely due to psychological factors caused by the enforced nature of the experiments - conducted as they were on psychiatric patients and prisoners with limited consent - because such experiences were absent during Ott's own extensive self-experimentation, and nor do indigenous users of plants containing bufotenine worry about or report respiratory arrest (Torres & Repke, 2006). In any case the breathing difficulties associated with sleep paralysis may be more to do with the paralysis of conscious bodily functions caused by being asleep, and the inability to inhale at will. Furthermore, sensed presence, as opposed to direct perception of an entity, as often occurs with sleep paralysis, may be more common with other substances, such as *Salvia divinorum* (Aardvark, 2002; Addy, 2010; Arthur, 2010) (meaning something like "diviner's sage"), although systematic phenomenological research is needed.

In evaluation of the role of the pineal gland and endogenous psychedelics in the activation of psi and the NDE, it has yet to be shown that psi can be produced with these substances under controlled conditions. In addition, both psi experiences and NDEs might be induced with other psychoactive substances, as shown in the following sections, although this criticism has been countered by Strassman (2001) with the possibility that other psychedelic substances may also stimulate the pineal and endogenous DMT by their action. However, this proposal is little more than conjecture. Furthermore, although there is good reasoning for the hypothesis that DMT is made in the human pineal, this is yet to be proven and remains speculative, like many of Strassman's and Roney-Dougal's suppositions at the present time.

According to Strassman (2001), although the lungs, liver, blood, and eye all contain the enzymes necessary to convert tryptamine to DMT, the pineal gland is especially rich in them and also has high concentrations of serotonin ready to convert to tryptamine. So while the pineal-DMT hypothesis is currently unproven (Hanna, 2010), it is certainly feasible, especially when it is considered that the chemical conversion of tryptamine to DMT can be demonstrated en vitro. The only attempt thus far to support the hypothesis directly has been Strassman's attempt to isolate DMT from 10 human pineal glands extracted from cadavers. No DMT was detected in the glands; however, neither the bodies nor the glands were freshly frozen and any chemicals present may have degraded before analysis (Strassman, 2001).

Thus far DMT has been found to be naturally occurring in the brains of rodents (Kärkkäinen *et al.*, 2005), and in the highest concentrations in humans in the cerebrospinal fluid (for a review, see Barker, McIlhenny, & Strassman, 2012), but not the brain, let alone the pineal. Furthermore, although the pineal contains methyltransferase enzymes, as Strassman (2001) indicated, the particular one thought to be crucial for *en vivo* DMT production (indolethylamine N-methyltransferase, or simply INMT) has as yet not been found in the human brain or pineal gland although, curiously, DMT was found in rabbit brain tissue, despite the absence of INMT (Kärkkäinen *et al.*, 2005), perhaps indicating that INMT is not necessary for the production of DMT. Furthermore, McIlhenny (2012) pointed out that most INMT mapping research only establishes where enzyme translation is occurring, as they are based solely on INMT mRNA studies. A recent study (Cozzi, Mavlyutov, Thompson, & Ruoho, 2011) using a fluorescent INMT antibody suggests the presence of INMT in three *Rhesus macaque* nervous tissues samples, including the pineal gland. Evidence of INMT in primate pineal glands indicates better potential for Strassman's human pineal-DMT production hypothesis, nevertheless direct support is still lacking. However, absence of evidence is not evidence of absence, and the pineal gland is difficult to research *en vivo* and DMT is an under-researched substance, particularly in humans. DMT is also difficult to detect (Barker *et al.*, 2012) and belongs to the most controlled category of drugs in most countries, so, currently, the jury remains out on the pineal-DMT hypothesis.

Overall, despite their incompleteness, the pineal/β-carboline/DMT models of psi and NDE do offer unique neurochemical perspectives on paranormal experience around which further research can be framed. Additionally, although neither author has speculated on the others' ideas, their models are not incompatible with each other; however, they may begin to answer the question of why such visionary molecules as DMT are made within humans at all. For a further discussion of DMT, brain action and anomalous phenomena, see Luke (2011b).

1.4 Ketamine and NDEs

A proliferation of reported cases of NDEs with the use of ketamine (Jansen, 1997a, 1999, 2001) and the similarity of aspects of the ketamine experience to that of the NDE (Morse, Venecia, & Milstein, 1989; Rogo, 1984) - despite Morse's (1997) later contentions that the evidence for this is weak - has led to the development of a neurochemical model of NDE based upon the action of this psychoactive substance (Jansen, 1990, 1997a, 2001). A dissociative anesthetic - also reported to induce experiences of telepathy, precognition, clairvoyance, psychokinesis, communication with the dead, kundalini experiences and an increase in synchronicities (Case, 2003; Jansen, 2001; Luke & Kittenis, 2005; Wyllie, 1981) - ketamine acts by binding to the phencyclidine (PCP) site of the *N*-methyl-D-aspartate (NMDA) receptor, blocking the action of the neurotransmitter glutamate. Jansen indicated that potentially life-threatening circumstances (e.g., hypoxia, ischemia, hypoglycemia, temporal lobe epilepsy) can initiate a glutamate flood, which results in neurotoxicity through the over-activation of the NMDA receptors (for further details, see Smythies, 2011). This NDE trigger may be accompanied by a flood of neuroprotective agents that also bind to the NMDA receptors preventing damage, in much the same way as ketamine. Like Grinspoon and Bakalar's (1979) speculation that the brain synthesizes a chemical similar to ketamine in times of stress, Jansen proposed that "endopsychosins," which bind to the same receptor site as ketamine, would be discovered as the neuroprotective agents that cause an ASC, like that of ketamine, termed the NDE.

Although parsimonious, Jansen's (1997a) ketamine model of NDE has been both duly criticized and well defended. It has been argued that unlike NDEs, ketamine trips frequently induce fear (Strassman, 1997) and are not considered "real" (Fenwick, 1997). However, as Jansen (1977b) likewise contested, it is becoming increasingly recognized now that NDEs are also commonly reported to be distressing or traumatic (Atwater, 1994; Montanelli & Parra, 2000) and, furthermore, ketamine experiences are also more often than not reported to induce a sense of peace and pleasantness (Corazza, 2008; Luke, 2007). In support of the perceived reality of the ketamine experience, there are documented accounts of people who have had an NDE and then later a ketamine experience, and who reported the experiences being the same (Jansen, 2001). In support of this, Grof (1994) found that several cancer patients had NDEs during psychedelic therapy (most likely with LSD) that were very similar to later spontaneous NDEs.

In further criticism of Jansen's model, it has been argued (Fenwick, 1997; Greyson, 2000) that the clarity and clear memory of the NDE experience is not consistent with cerebral dysfunction. However, it is arguable that Jansen's model does not stipulate the necessity of cerebral dysfunction for a NDE, merely the threat, or even just the perceived threat of it, and Jansen (1997b, p. 87) pointed out "there is no reason to suspect that the NDE mechanism would never be activated spontaneously." Furthermore, Jansen (1997b) regarded clarity of consciousness as a nebulous term in the discussion of altered states, as the term is loaded towards the ordinary state of consciousness. Some researchers (e.g., Greyson, 2000; Smythies, 2011) have further contested that, despite the possibility that the endogenous peptide alpha-endopsychosin is a candidate, no endopsychosins have yet been identified or proven to exist, and Jansen (2001) conceded that this may initially have been a false lead and has suggested a number of alternative endogenous NMDA antagonists as candidates: N-acetylaspartyl-glutamate, kynurenic acid and magnesium, all of which protect brain cells from excito-toxic damage (Jansen, 2004). Nevertheless, Thomas (2004), following Jansen in his search, has identified technical flaws with these speculated endogenous "NDE-ogens" and has instead proposed the neuromodulator agmatine as the most likely candidate. The debate continues.

In further criticism of the model, Parker (2001) noted that one-drug/one-experience theories were abandoned in the 1970s and that, along with Greyson (2000), he further noted that ketamine appears to have multiple effects in the brain and multiple experiential features, some of which include those of the NDE. Jansen (1997b) earlier countered this latter criticism with the proposal that factors of set and setting are paramount in determining experience with all ASCs, be they NDEs or ketamine-induced states, so experiences are expected to vary. Parker (2001), like Siegel (1980), added that other drugs also produce features of the NDE, although Jansen (1997b) has asserted that these NDE-features are typical with ketamine but are not typical with other drugs, except for PCP and ibogaine (Bianchi, 1997; Jansen, 2001) which are NMDA antagonists (or more specifically called NMDA-PCP receptor blockers).

However, in support of Parker's (2001) criticism, Roll and Montagno (1985) have noted the similarity between NDEs and LSD experiences, as reported by Grof (1994). Reports of NDE also occur with the use of other dissociatives, like dextromethorphan (DXM) (White, 1997), and carbogen (Meduna, 1950), as well as with high doses of hashish (Siegel & Hirschman, 1984), and tryptamines like 5-MeO-DMT (Shulgin & Shulgin, 1997) and the ayahuasca (meaning "the vine of the dead") derivative, DMT (Strassman, 2001). Yet, Strassman (2001) did not find Jansen's model incompatible with his own DMT model of NDE, but rather asked why a neuroprotective agent like ketamine should also be psychedelic as there is no obvious benefit to the near-death visionary experience, other than enabling consciousness to have awareness of its departure from the body.

Recently, electrophysiology and receptor studies have revealed that both NMDA antagonists, such as ketamine, and classic hallucinogens, such as LSD, may actually enhance glutamatergic transmission via non-NMDA receptors in the frontal cortex. This may indicate a common mode of chemical action in the brain responsible for such similar experiences with these divergent molecules, though further investigation is required (Vollenweider, 2004). Given the similarities between NDEs, ketamine experiences, and other drug experiences, Rogo (1984) proposed that the NDE-like effects of ketamine are more often interpreted as NDEs because it has so often been used in a medical setting, further suggesting that ketamine-induced NDEs are less prevalent with recreational use than with anesthetic use, though this has not been systematically investigated to my knowledge.

To the author's knowledge, the only systematic investigation of the ketamine hypothesis, besides Jansen (2001), is that of Corazza (2008), who compared 36 cases of apparent NDEs induced by ketamine with 36 cases of NDEs reportedly caused by a cardiac arrest or other life threatening circumstances. Both groups showed a high degree of similarity in certain experiential features, with a roughly equal prevalence among the groups of experiences involving altered perceptions of time, speeded up visions, and the occurrence of ESP (25%), but the ketamine group were more likely to report unity with the universe, and the cardiac groups were more likely to report dissociation from the body, visions of light, and encounters with deceased or religious beings. However, Corazza asserted that the evidence indicates that NDEs can be induced through ketamine, although they may not be identical to those occurring naturally.

The study is not without its limitations; however, as outlined by Luke (2009), as the ketamine participants were recruited on the premise that they felt that they had had an NDE on ketamine, which Jansen (2001) reported only occur to about 12% of ketamine users. Furthermore, it is unclear if the respondents are describing a specific ketamine experience or an experience more generally, as most of the respondents had taken ketamine between 10 and 2000 times, though a similar number of cardiac arrest experiences is very unlikely for the comparison group. Nevertheless, Corazza and Schifano (2010) acknowledged the limitation that their findings are based on a self-selected, nonrandomized, limited size sample. Subsequently, ketamine can at best be thought of as an occasional NDE trigger or mimic, but is not a wholly repeatable or reliable source of NDEs (Luke, 2009). Nevertheless, cardiac arrest and the experience that ketamine invokes appear to be similar enough to genuine NDEs that leading consciousness researchers Hameroff and Chopra (2010) have called for its use in prolonging end of life brain activity (by delaying neurotoxicity) to allow terminally ill patients to have more conscious deaths.

More recently, having first researched the parapsychological potential of psychedelics in the 1940s, Smythies (2011) identified several apparent flaws with Jansen's K-NDE model. First, an NMDA-antagonist model of NDE is too general because the glutamate receptors can be found in all regions of the brain and yet the NDE phenomena suggest the activation of only specific brain regions, and furthermore ketamine does not appear to produce global brain NMDA-antagonism (although this latter point may argue against the first). Second, ketamine, Smythies argued, cannot actually stimulate the action potential of the neurons it binds to, but rather affects the modulation of the strength and number of synapses (i.e., the neuroplasticity), so it cannot immediately affect the brain regions required to stimulate the NDE. This second argument, however, seems somewhat contradicted by the phenomenological evidence that suggests that ketamine *can* in fact stimulate NDE-like phenomena and so presumably *does* activate the appropriate brain regions, at least indirectly.

Finally, Smythies (2011), contested that if the NMDA-antagonism explanation for NDEs were true, one would expect to see a relationship between NDEs and *grand mal* epilepsy - during which massive cerebral glutamate overload occurs. However, according to Smythies, the relationship is only apparently reported by one study (Britton & Bootzin, 2004), and is in any case weaker than the relationship between epilepsy symptoms and disturbed sleep patterns, although, in argument against Smythies, this weaker relationship may be accounted for by the infrequent occurrence of NDEs relative to sleep disturbances. Furthermore, counter to Smythies' conjecture, several other researchers have speculated about the link between NDEs and temporal lobe epilepsy, drawing parallels (Blanke & Dieguez, 2009; Jansen, 2001; Morse, Venecia, & Milstein, 1989; Neppe, 1989; Persinger & Makarec, 1987; Saavedra-Aguilar & Gómez-Jeria, 1989), although admittedly the NDE-epilepsy link is incomplete (Neppe, 1989), and epilepsy might best be thought of as one of several possible NDE triggers, as Jansen (1997a) originally proposed, rather than an explanation for NDEs. Ultimately, Smythies (2011) proposed that the excitatory NMDA receptor system, which runs continuously even while asleep, actually *is* the Bergson brain filter mechanism (discussed earlier in section 1.1) that ordinarily prevents people from experiencing what Aldous Huxley (1954, p. 11) called "Mind at Large": mystical and paranormal consciousness (i.e., an NDE). Consequently, Smythies asserted that NDMA antagonism, such as via ketamine or a natural NDE, bypasses the brain's natural filter action, leading to all manner of paranormal and transpersonal experiences. Much as Smythies should be applauded for morphing the two theories together, the same might be said for psychedelically induced serotonergic action as for glutamatergic action, so in effect this says little more than what Huxley originally proposed and what is now known about psychedelic neurochemistry (see section 1.1).

Overall, despite over simplification and generalization, the ketamine model of NDE offers the most complete neurochemical explanation of the NDE so far and, as with the DMT model, does not necessarily assume a materialist reductionism to explain the data - unlike Siegel (1980) for example - although some commentators (e.g., Sakellarios, 2005) have erroneously assumed that it does. Furthermore, the model can be easily tested and refined. For instance, there is evidence to suggest that the non-competitive antagonism at the non-glycine site of the NMDA receptor in particular is linked to the event of dissociative anesthesia and altered sensory perceptions that are familiar to ketamine. This would indicate that relatively novel substances like HA-966 (1-hydroxy-3-amino-pyrrolidone-2), which acts in this particular neurochemical manner (Bonta, 2004), could induce NDEs in blind conditions comparable to those occurring ordinarily, though this remains to be seen. In research with monkeys, HA-966 induced EEG patterns characteristic of sleep despite the animals remaining completely alert, which may be related to Jansen's (2004) observation that the same 60% of the population that do not recall their dreams also do not recall their ketamine experiences during anesthesia, a proportion apparently equivalent to the number of people who do not report having had some kind of NDE. Alternatively, in order to test the K-NDE theory, it has been suggested to administer ketamine to those who have had a natural NDE and compare the two (Kolp *et al.*, 2007). Assuming ketamine NDEs to be genuine, ultimately, however, the question remains of whether chemically induced NDEs utilize alternative pathways or the actual NDE pathway (Fracasso & Friedman, 2011).

Bringing personal observations (Luke, 2005) to the K-NDE debate, it seems apparent that the degree of general anesthesia induced by ketamine is relative to one's motor control ability and what Grosso (1976) identified as the degree of being out-of-body: Factors that are more pronounced with the positive S-isomer of ketamine rather than the negative isomer (Domino & Warner, 2010), further indicating how entwined these effects are, specific as they are to just one ketamine molecule type. Such relationships between sensory and motor impairment and reported body image have elsewhere been found with local anesthesia (Paqueron *et al*., 2003), though obviously not full blown OBEs. Returning to the personal observations, in repeated ketamine experiences I observed that the initial stages of anesthesia and out-of-body-ness are accompanied by increasing difficulty in controlling one's body and a growing sense of body dysmorphia, in a non-clinical sense, in that part of one's body may appear longer (macrosomatognosia) or shorter (microsomatognosia), as described by Frederiks (1963). For example, on one occasion I recall being unable to successfully maneuver out of the door because my legs appeared to be the approximate distance of an entire football pitch away. It is observed that the relatively changing gradation in increased anesthesia, body dysmorphia and motor control continues, with a sufficient dosage, as the trip intensifies towards a full-blown out-of-body experience, total anesthesia, and ultimately no motor control.

Indeed, while some K-OBEs are accompanied by autoscopy, even awareness of one's body can disappear at the peak of a high dose ketamine experience, even to the point of not realizing one actually has a body but instead just experiencing the present as a single point of consciousness and nothing more. On one such occasion I was seemingly privileged to a view of earth from space and yet I did not even know who or what I was, let alone that I was human and apparently had a body. This relatively changing relationship between anesthesia, motor control, out-of-body-ness, and even body-ownership-awareness is apparent on both entering and exiting the ketamine experience, although seemingly more so in exiting (although in reverse), as the entrance to a ketamine experience can often be abrupt, with a swift and intense onset, whereas the departure is more gradual. Such first-person psychonautics can report a good deal about both psychedelic states, especially ketamine states (Newcombe, 2008), and parapsychological phenomena (Luke, 2011c) and such methods are witnessing somewhat of a revival after a long hiatus since the era of William James' (1902) classic experimentation with nitrous oxide, another NDMA antagonist. Survey research also shows that ketamine induces OBEs and autoscopy far more often than other (non-anesthetic) psychedelics (Wilkins, Girard, & Cheyne, 2011), as had been previously speculated (Luke & Kittenis, 2005), the question remains of why anesthesia should accompany an OBE/NDE: Does the anesthesia cause the perception of being out of one's body, and therefore leads to a feeling of dying or of having died, or does the near-death experience provoke an OBE and subsequent anesthesia as a defense against likely pain? Observing the ketamine experience from the recipient's perspective, it appears that the anesthesia occurs because one's consciousness is no longer connected to one's body, and certainly the OBE and anesthesia are intimately connected, but why and how deserve further investigation and may shed light on the neurobiological factors of OBEs and NDEs.

1.5 Dopamine and paranormal beliefs and experiences

Taking a purely materialist reductionist view of paranormal experiences by attempting to account for them exclusively in terms of beliefs arising from faulty cognitions - what Irwin (2009) called the cognitive deficits hypothesis - a loose neurobiological model for the explanation of paranormal beliefs has arisen that posits the dopamine neurotransmitter system as the primary facilitator. Put forward by Krummenacher and colleagues (Krummenacher, Brugger, Fahti, & Mohr, 2002; Krummenacher, Mohr, Haker, & Brugger, 2009) the theory suggests that, although activity of the endogenous neurotransmitter dopamine is classically implicated in *enhancing* cognitive and perceptual decisions by improving the signal to noise ratio of neuronal transmission, paradoxically, hyperdopaminergic activity is associated with psychotic symptoms, schizophrenia and even schizotypy (for a brief review, see Krummenacher *et al*., 2009), and so excess dopamine may be accountable for delusional thinking stemming from an increased tendency to find patterns in apparently random data - what the psychiatrist Klaus Conrad (1958) called apophenia. According to Brugger and colleagues (e.g., Pizzagalli, Lehmann, & Brugger, 2001) paranormal believers - and so most likely paranormal experiencers too - have been shown to be more inclined towards apophenia than skeptics, thereby accounting for the increased creativity apparently associated with paranormal thinking and its similarity to some psychotic symptoms: a combination of creative and delusional dimensions being indicative of the positive phenomenology of schizotypy (Eckblad & Chapman, 1983).

Direct research into what might be most accurately called the hyperdopaminergia-apophenia hypothesis is somewhat limited at this time, consisting of only two studies, with somewhat mixed results. The first study

(Raz, Hines, Fossella, & Castro, 2008) attempted to relate paranormal belief as a phenotype to hyperdopaminergia as a genotype via what Raz *et al*. (2008) called the "COMT dopaminergic gene" (p. 1336), building on preliminary findings in behavioral apophenia dopamine research by Krummenacher *et al*. (2002) and studies associating schizotypy with dopaminergic genes (e.g., Avramopoulos *et al*., 2002). COMT (Catechol-O-methyltransferase) is an enzyme that degrades catecholamines such as dopamine, and the COMT protein is encoded by the COMT gene. Utilizing questionnaire measures of paranormal belief, 107 psychology students were genetically screened for three COMT allelic forms, successfully identifying approximately one quarter of the sample with high COMT activity, a quarter with low activity, and half with intermediate activity. However, failing to support the hyperdopaminergia-apophenia hypothesis those with decreased COMT activity, and hence greater hyperdopaminergia, reported no more paranormal beliefs, abilities or experiences than the higher COMT activity participants. Undeterred, Raz *et al*. (2008) pointed to the observation that attempting to unravel links between single gene polymorphisms that influence neurochemical function, and consequently individual differences in cognitive function, may be difficult when using distal phenotypes such as questionnaire measures, and that more proximal measures like brain imaging might be more promising. Indeed behavioral genetics is in a state of epistemological crisis after the lack of hard findings from the recently completed Human Genome Project (e.g., see Maher, 2008), so it may well be too soon to expect good data relating paranormal beliefs to genes, particularly single genes, even if they are related.

The second study, by Krummenacher *et al*. (2009), sampled 20 paranormal believers and 20 paranormal non-believers and administered levodopa - an active precursor to dopamine in the brain - in a randomized placebo controlled between-subjects study. Participants were given two signal detection tasks, one with words (tapping left hemisphere processes) and one with faces (right hemisphere), that presented either word/non-word or face/non-face stimulus pairs tachistoscopically for just 140 milliseconds. Participant responses were assessed for both their tendency to make correct guesses relative to incorrect ones, their sensitivity index (*d*'), and their tendency to respond with a positive or negative bias, their response tendency (*C*), both measures being independent of each other. Findings indicate that skeptics had significantly greater sensitivity to signal detection than believers in the placebo condition but, contrary to expectations, increased dopamine lead to a significant *decrease* in sensitivity in skeptics and had no effect on believers. These findings challenge the view that dopamine generally assists in signal detection, and Krummenacher *et al*. (2009) suggested that the opposite may actually be true in some cases, especially with presumed *hypo*dominergic individuals (i.e., skeptics). Additionally, the authors argued that the lack of change in sensitivity in believers administered levodopa may be due to a plateau effect caused by high cerebral dopamine baseline levels; however, such a suggestion is somewhat *post hoc* and, even if it were true, the authors do not comment on why the dopamine-enhanced skeptics had lower sensitivity (i.e., greater sensory apophenia) than either believer group.

Whereas the sensitivity measure findings are puzzling, the response bias measure results are somewhat more straightforward, in the control scenario at least. As was expected, in the placebo condition believers had a greater tendency to respond in the affirmative (favoring a Type I error strategy), whereas skeptics had a greater tendency to respond in the negative (favoring a Type II error strategy), the difference between the groups being significant. However, against expectation, in the levodopa condition these tendencies in each group were diminished so that there was no significant difference between skeptics and believers, although the trend remained. Specifically, compared to their placebo controls, dopamine-enhanced believers were more cautious of making false positive decisions (i.e., more conservative), and skeptics were less prone to make false negative decisions (i.e., more liberal), so that in effect both believer groups were less polarized in their responses. Contrary to the linear dopamine-apophenia relationship originally proposed, these results may indicate differing baseline dopaminergic activity in skeptics and believers and the possibility that there is a non-linear relationship between task and dopamine levels, perhaps an inverted U-shape, possibly modulated by individual differences in belief. However, these findings should be replicated first and more direct measures of baseline dopamine (e.g., spinal dopamine metabolic marker assay) should be made before these findings and *post hoc* interpretations are given much weight. Furthermore, as the authors noted, use of a between- rather than within-subjects design is far from ideal, leaving too much faith in the randomization of the small groups and no certainty in equivalence of baselines in dopamine responsivity and behavioral performance, and so further studies would benefit from a cross-over design.

Aside from the current lack of research on the hyperdopaminergia-apophenia hypothesis and the somewhat confusing mixed results, this line of research seems worthwhile pursuing further, although it suffers from additional limitations. One is that it aims to boil down paranormal experiences to misperceptions and misjudgments of the pattern recognition type, which, even if one allows for the fact that the authors *a priori* preclude the possibility of genuine paranormal phenomena, this approach does not account for the swathe of other cognitive deficits that are also given to account for paranormal beliefs, such as poor judgments of probability and randomness, egocentric bias, selective remembering, confirmation bias, and more (Brugger & Mohr, 2008). Indeed a study investigating probability inferences in those under the influence of ketamine, versus matched controls and schizophrenic patients, shows that the ketamine group were no different from the placebo group, whereas the patients were shown to exhibit a jump-to-conclusions response concerning probability inferences (Evans *et al.*, 2012). Although ketamine is primarily an NMDA-antagonist, it also has direct effects on dopamine receptors (e.g., Kapur & Seeman, 2002), and so the lack of probability inference effect with ketamine does not complement a dopamine explanation for paranormal experiences within the cognitive deficits paradigm. Other psychological factors supposedly related to paranormal experiences, such as the propensity for false memories, also show no relationship with self-reported recreational drug use generally (Wilson & French, 2006).

So in this respect the dopaminergic approach does not currently incorporate many of the multitudinous psychological explanations for paranormal beliefs and experiences. Furthermore, the wealth of evidence, to follow, relating increased paranormal experience - and to some extent experimentally controlled production of ESP - to the ingestion of psychedelic substances does not particularly support a dopamine-based theory of paranormality either, as dopamine activation is neither primary nor ubiquitous with psychedelic substances. Typically, classic tryptamine psychedelics (such as LSD and psilocybin) are thought to exert their effects via serotonin activation, particularly via the 5-HT$_{2A}$ receptor subtype (Lee & Roth, 2012). Nevertheless, it is thought that 5-HT$_{2A}$ receptor stimulation can activate dopamine release (Diaz-Mataix *et al.*, 2005), and Previc (2011) asserted that all the various psychedelic neurochemical pathways to "altered states of consciousness with distorted reality" (p. 43) ultimately lead to elevated levels of dopamine in the brain, although such reasoning rather ablates the intricate nuances of psychopharmacology and disregards primary neurochemical pathway activation as in any way important. Furthermore, although some psychedelic substances (e.g., LSD, psilocin, DMT) do have relatively high affinities for certain dopamine receptors (Ray, 2010), dopamine is rarely considered to be a primary neurotransmitter site for psychedelic effects. Indeed, the primarily dopaminergic recreational drugs, such as amphetamine and cocaine, have been found to be either unrelated or negatively related to paranormal experiences and beliefs (for a review see Luke, 2008b; and see section on survey data, to follow), contradicting the dopamine-paranormal belief/experience hypothesis. Indeed, if Previc were right about psychedelics exerting their effects via the dopamine system, then one would expect amphetamine and cocaine to be psychedelic too, which they are not.

Furthermore there are numerous psychedelics strongly associated with paranormal experiences that do not have dopaminergic action, such as the k-opioid agonist salvinorin A (Ray, 2010) and anticholinergic agents like scopolamine and hyoscyamine - which are found in nightshade family plants like datura (Katzung, Masters & Trevor, 2012). Overall - with scant direct research, mixed and complex findings, and poor generalizability of the hypothesis to a) other psychological explanations and b) most of the psychedelic-parapsychology literature - at the present time, Krummenacher, Brugger, Mohr, and colleagues' (Krummenacher *et al.*, 2002; Krummenacher *et al.*, 2009) dopamine-apophenia conjecture remains very much rudimentary and unsupported.

1.6 Overview of psychedelic/neuro-chemical models of paranormal experience

The preceding sections outline five neurochemical models germane to explaining psychic experiences, namely the brain as filter, β-carboline and tryptamine, DMT, ketamine and, finally, dopamine models. Aside from the latter, all of these models draw upon the action of psychedelic substances in particular and remain open to the possibility that psi and other so-called paranormal phenomena may be genuine. It should be noted, however, that no one psychedelic model may ultimately be the correct one, as psychedelics may work in many ways (e.g., dissociatives are both NMDA antagonists, as well as mu-opioid agonists); nevertheless these models provide important avenues for future research and begin to help develop more complete neurobiological models of apparent paranormal cognition or merely paranormal belief, and, indeed, more complete models of consciousness itself. The importance of understanding the apparent paranormal effects of psychedelics is clear and the evidence in support of this relationship is next reviewed and evaluated.

2. Field Reports of Paranormal Phenomena

2.1 Anthropological and Historical Reports

Despite apparent prejudices by anthropologists against reporting such phenomena traditionally (Winkelman, 1983), the anthropological and ethnobotanical literature remains replete with examples of ostensibly paranormal phenomena occurring with the traditional use of psychoactive plants. Commonly these plants are taken in ritual context for the express purpose of accessing altered states conducive to clairvoyance, precognition, telepathy, out-of-body travel, psychic diagnosis, psychic healing, and spirit communication, which provoked the mycologist Wasson (1964) to label them as the keys to extra-sensory perception. Archaeological evidence suggests such practices have existed the world over for millennia (see Devereux, 1997). However, the paranormal effects of particular plants are not necessarily arbitrary. Shamans who use the ayahuasca brew in Amazonia report having control over whichever particular paranormal function the brew elicits through the discerning use of psychoactive admixtures that may "make you travel, make you see" or "teach you to heal" (Andritsky, 1989, p. 78). Indeed, when the harmala alkaloid harmine, the first psychoactive compound isolated from the ayahuasca decoction, was discovered by Guillermo Fischer Cárdenas in 1923 it was named "telepathine" (Beyer, 2009) because of its apparent psychical properties, as reported by Zerda Bayon (1912). Zerda Bayon illustrated this with the case of Colonel Morales who, after ingesting ayahuasca, beheld a vision of his dead father and his sick sister. About one month later he received the same news by messenger. It seems unlikely that the news could have arrived first by nonparanormal means, as the group was deep in the jungle 15 days' travel from the nearest communications outpost.

Clairvoyant states induced with the harmala alkaloid-containing *Perganum harmala* shrub in Morroco have also been reported (Rudgley, 2000). Additionally, there are many more accounts of such apparent ESP with ayahuasca reported in Luna and White's (2000) anthology of classic ayahuasca experiences, as well as elsewhere (e.g., Beyer, 2009; Bianchi, 1994; Dobkin de Rios & Rumrrill, 2008; Gorman, 1992; Kensinger, 1978; McGovern, 1927; Shanon, 2002; Weil, Metzner, & Leary, 1965; Wilson, 1949). Typically, the earliest reports from explorers and anthropologists of the Upper Amazon were of either OBEs or experiences of someone discovering via visions that some distant person known to them, usually a relative, had just died (Luke, 2010a). In addition, Naranjo (1967, 1973) gave harmaline to 30 naïve urban elite Chilean participants who inexplicably reported the same images of snakes and jaguars, or big cats, as are commonly reported in traditional South American ayahuasca visions (Naranjo, 1987; Shanon, 2002). Visions of jaguars and snakes with harmaline have also been reported elsewhere (Shulgin & Shulgin, 1997) and one second-hand story from late sixties Haight-Ashbury (the temporal-spatial epicenter of psychedelic counter culture) proffered that someone once experimented giving ayahuasca to Eskimos and, devoid of the cultural milieu typical of ayahuasca use, they still saw huge cats in their visions, although it is unlikely that this research ever took place (Weil, 1980). Furthermore some of the participants in Naranjo's study were convinced they had seen these images by traveling out-of-body in time and space. Ott (1993) noted, however, that harmaline only occurs in minimal quantities in tested ayahuasca decoctions and so cannot be accountable for the psychoactive effects of the brew. Nevertheless, Strassman (2001) found that administering DMT (the most psychoactive constituent of ayahuasca) induced a similar certainty of space-time travel and resulted in the inordinately frequent occurrence of images of DNA, an image which Narby (1998) found commonly featured in the ayahuasca healing visions of Amazonian shamans, but was most often represented by snakes. It has recently been suggested, amid some controversy, that the geneticist Francis Crick was under the influence of LSD when he had a vision of the double helix structure of DNA in 1953, a discovery for which he was awarded the Nobel Prize (Rees, 2004).

Prior to this news report, which came after Crick's death, the anthropologist Narby (2000) took three molecular biologists to the Peruvian Amazon for their first visit there and for their first encounter with ayahuasca. The two female biologists both had encounters with plant teachers whom they perceived as independent sentient entities, and all three scientists received valuable information from their visions that helped inform their research, and which ultimately changed their world view. For instance, "the American biologist, who normally worked on deciphering the human genome, said she saw a chromosome from the perspective of a protein flying above a long strand of DNA" (Narby, 2000, p. 302). Similarly, the biochemist, Kary Mullis, who received the Nobel Prize for inventing the polymerase chain reaction (PCR) that significantly advanced DNA research, said that taking LSD had been invaluable in helping him experience the mental imagery that allowed him to visualize sitting on a DNA molecule to watch the polymerase go by (Mullis, 1998).

Further reports of the ritual use of psychoactive plants for the induction of paranormal abilities are commonplace among indigenous peoples from every inhabited continent. These range from the use of pituri (*Duboisia hopwoodii*) in Australia (Australian Institute of Parapsychological Research, 2004) to the use of San Pedro cacti (*Trichocereus pachanoi*) in Peru (Luke, 2012a; Sharon, 1990) and peyote cacti (*Lophophora williamsii*) in Mexico (Slotkin, 1956), *Amanita muscaria* mushrooms by the Ojibwa in Canada (Wasson, 1979) as well as suburban Muscovites and Siberian tribes-people in Russia (Ostrander & Schroeder, 1997; Wasson & Wasson, 1957), the use of datura among the Chumash of California (Driver, 1969), and the use of *Psilocybe* mushrooms (Stamets, 1996; Wasson, 1962) and *Salvia divinorum* by Mazatecs in Mexico (Soutar, 2001) to name but a few. Indeed, anthropologist Dobkin de Rios (1984, p. 60) has suggested that "the single most important function of plant hallucinogens in the Amazon area is to divine the future." Efforts to document the diversity of these traditional "shamanic" plants indicate there are about 100 distinct genera, let alone species, of such traditional plants that are reported to induce visionary states and are used ethnomedically (Schultes & Hofmann, 1992), with new ethnobotanical discoveries continually being made. However, few parapsychologists have conducted research with these plants or their users in their traditional environment, although with Wasson, Puharich (1959) attempted a remote viewing experiment with the *Psilocybe*-using Mazatecs in Mexico in 1955, but the experiment was aborted when instead Wasson and his co-expeditioner, Richardson, became the first researchers to be initiated into the mushroom cult. Nevertheless, Richardson (1990) reported personally having had an apparently precognitive vision, during what is documented as the first non-indigenous *Psilocybe* genus (i.e., "magic") mushroom trip.

A cross-cultural taxonomical study of shamans, shaman-healers, healers, and mediums, posits that, although these groups share many of the same characteristics, there is a clear division between those who do, and those who do not, use psychoactive plants and the differing paranormal activities they perform (Winkelman, 1989). Levine (1968) credited the botanist Schultes with the suggestion that the prevalence of vision-inducing plants among the herbarium of "primitive" societies is based upon a differing concept of illness, which has spiritual rather than physical causes. Contrary to Schultes, Winkelman suggested that the difference in the use of hallucinogens was due to cultural and developmental variances. Shamans from hunting and gathering societies and shaman-healers from agricultural subsistence societies both frequently use hallucinogens for the purposes of healing, divination, hunting-magic, and malevolent acts, whereas healers and mediums from sedentary and politically integrated societies as well as agricultural subsistence societies, do not use hallucinogens to access their altered states, which they use for healing and divination only.

Yet it appears that these cultural differences have occurred only recently in the developed world, as it has been suggested that the ancient Greek oracles, including the Pythia of Delphi - the seeresses that anteceded the divinatory Goddess Python - also used the *solanaceae* family of psychedelic plants (henbane, belladonna, mandrake, and datura) for divination (Masters & Houston, 1966; Parker, 1975; von Bibra, 1855/1994). Indeed the ancient Greek name for henbane was "pythonian" (Rudgley, 2000). It is also well documented historically that Northern European witches also utilized these plants for psychic purposes (see Andrews, 1997; Rudgley, 2000). Indeed, similarly to the Greeks, the Northern Europeans gave the name "alruna" to their visionary seeresses, in common with the German name for mandrake, "alraune," both of which stem from "rune," the Germanic divinatory letter system (Müller-Ebeling, Rätsch, & Storl, 2003). No doubt, the traditional Northern European practice of pharmacologically accessing visionary states all but died out with the witches during the Inquisition, between the fourteenth and seventeenth centuries (Grob & Harman, 1995). It is probable that a combination of changing concepts of illness, the development of a sedentary, politically integrated society, and the influence of the Inquisition or colonization were responsible for the virtual disappearance of the traditional indigenous use of psychoactive plants for paranormal purposes in Europe and North America.

At the end of the 19th century, pioneering psychological explorers in the West rediscovered the vision-inducing qualities of novel plant substances, such as mescaline (Ellis, 1898), whereas others explored new synthetic visionary chemicals like nitrous oxide (James, 1902), with some early psychical researchers dabbling in both (Dunbar, 1905). By the middle of the 20th century the Swiss chemist Albert Hofmann had discovered LSD - experiencing its OBE-inducing properties - and isolated, named, and synthesized psilocybin and psilocin, the psychoactive derivatives of the visionary *Psilocybe* mushroom genus (Hofmann, 1983; Luke, 2006). The ascribing of the word psi to psychic phenomena during this period, however, may only be a coincidence. By the turn of this millennium there were around 200 psychedelic compounds known to science, a figure estimated to likely rise to 2000 compounds by the year 2050 at the current rate of discovery, increasing exponentially by a factor of ten every fifty years, starting with the two that were known in 1900 (Shulgin, 2004, 2010). Despite the rapidly upwards bending curve of Shulgin's formula, current quantities may even exceed it, as a good guestimate puts the number of *potentially* psychedelic compounds now known to man at about 2000 (J. Hanna, personal communication, August 12, 2012), given that there are something like 1300 documented phenethylamine compounds alone (including substances like mescaline, MDMA, & 2CB) known at the current time (Shulgin, Manning, & Daley, 2011), though they may not all be effectively psychoactive and have not been sufficiently tested as yet. However, a conservative estimate would put the number of known, tried, and tested psychedelics at between 250 (J. Hanna, personal communication, August 12, 2012) and 300 to 400 (Shulgin, 2010). Furthermore, a more recent projection puts the total number of undiscovered drugs (not necessarily psychedelic) at 1×10^{60} (Reymond & Awale, 2012), more than visible stars in the sky, and so Brown (2012b) anticipated a near limitless number of psychedelic compounds to arise, especially when factors of nanotechnology, neurostructural engineering, and other technological advances are additionally considered. Nevertheless, Brown's projection is purely speculative, but it is safe to say that humans have not yet discovered all the psychedelic substances that will ultimately be available, and that there may be many more to come, and, with each one offering a different type of ASC, there remain many states yet to be discovered. Brown (2012b) even fancied that specific psi-inducing psychedelics may be intentionally engineered in the future.

2.2 Personal Views and Experiences

Since the discovery of psychedelic compounds by the academic community and their popularization among the intelligentsia by the novelist Aldous Huxley (Smythies, 1960), there has been a steadily growing number of reports of paranormal experiences occurring with the use of these compounds. Several parapsychologists and psychical researchers, primarily from the 1950s and 1960s when psychedelic research was at its peak, have endorsed the research of psi with psychedelics (e.g., Assailly, 1961; Broad, 1962; Hoffer, 1961a, 1961b; Johnson, 1955; Kern, 1964; Laidlaw, 1961; Paterson, 1961b; Price, 1948; Thouless, 1960; Tibbs, 1963; West, 1965). Even J. B. Rhine, the father of modern parapsychology, ran some informal psychedelic sessions in 1961 at the Rhine Research Centre in Durham with the then Harvard psychologists Timothy Leary and Richard Alpert (Black, 2001; Horn, 2009; Stevens, 1988), although there was apparently too much spontaneous laughter erupting for anyone to credibly test for anything (S. Abrams, personal communication, August 14, 2006; S. Krippner, personal communication, January 19, 2006).

Notably, many other parapsychologists have reported personal ESP experiences with the use of LSD (Cavanna, 1961; Garrett, 1961b; Millay, 2001; Osmond, 1961a; Servadio, in Alvarado, 1995), peyote/mescaline (Langdon-Davies, 1961; Millay, 2001; Osmond, 1961a), psilocybin (Cavanna, 1961; Krippner, 1967; Millay, 2001) *Amanita muscaria* (Puharich, 1962), and ayahuasca (Severi, 1996, 1999). Krippner's apparent precognitive vision of President Kennedy's assassination while on psilocybin serves as a good example (Krippner, 1967, 2006a). Though, of course, merely consuming a psychedelic is no guarantee that an experience of ESP will follow, as Price (1964) aptly demonstrated self-experimenting with mescaline. However, other psychical researchers, sometimes following their own experiences, have noted the apparent tendency for ESP production with the use of psychedelics, including no less than four Parapsychological Association presidential addresses (Dean, 1967; Heywood, 1978; Hastings, 1973; Luke, 2010b; Radin, 1989; Servadio, 1961; Stevenson, 1981). Furthermore, some have recommended that other psi researchers personally explore psychedelic states of consciousness to aid in their understanding of the concept of psi (Cavanna, 1961; Heywood, 1961). The most highly experienced LSD psychotherapist, Stanislav Grof (1980), also advised that an intimate knowledge of the transpersonal realms created by psychedelics is essential for parapsychologists. Personal accounts of ESP have also been reported by leading psychedelic mycologists (Stamets, 1996; Wasson & Wasson, 1957).

Beloff (1968) asserted that greater reporting of ESP on college campuses would have been evident if drugs induced psi particularly, to which Tart (in Beloff, 1968) replied that many students took paranormal events in conjunction with psychedelics very matter-of-factly, due to their prevalence. This point was further echoed by the suggestion that users of psychedelic drugs frequently report vivid ESP experiences but that they remain largely unpublished (Stafford & Golightly, 1967). Yet, Heywood (1961) found several incidences of psi with

LSD within the "well-evidenced" SPR spontaneous-case collection. However, more recently, Vayne (2001), echoing Tart, has suggested that among practiced users of psychedelics, dubbed *psychonauts*, the telepathic experience is so common that it is hardly remarked upon. Luke (2004c) agreed with Vayne but further offered that, even so, many (less well-evidenced) anecdotal reports could be found on contemporary resources on the internet. Psychedelic drug information sites (such as www.lycaeum.org and www.erowid.org) have amassed a large online archive of experiential psychedelic reports, among which are accounts of ESP experiences with substances as diverse as ketamine, *Salvia divinorum*, *Psilocybe* mushrooms, ayahuasca analogues, and 3,4-methylenedioxymethamphetamine (MDMA, or ecstasy) mixed with baby Hawaiian woodrose seeds, a natural source of lysergic acid (Anonymous, 2004a, 2004b, 2004c, 2004d, 2004e, 2005).

Similar reports of frequent ESP experiences with such substances from within the psychedelic community are also available elsewhere in the literature (e.g., Eisner, 1989; Gaskin, 1990; Krippner, 2006a; Krippner & Fersh, 1970; Lilly, 1967, 1978; McKenna, 1991; McKenna & McKenna, 1994; Millay, 1999, 2004a, 2004b, 2005, 2006, 2010; Osmond, 1968; Saunders, 1993; Scully, 2010; Stevens, 1989; Turner, 1994; Wyllie, 1999; Zelnick, 2005). Indeed, the notion of experiencing a telepathic group mind, or "tribal telepathic understanding" (Nuttal, 1970, p. 249) through "tripping" became so prevalent among the psychedelic culture of the 1960s that prospective psychedelic users were told they might expect such an experience (Leary, Metzner, & Alpert, 1964) and commonly it became known as "grokking" (Stevens, 1989; Wolfe, 1971). Currently, the same notion is still apparent among psychedelic users (e.g., MoDu, 2003) and the largest public-edited internet encyclopedia indicates that ESP-type phenomena are a common fourth-level experience on a five-level spectrum of psychedelic experience intensity (Wikipedia, 2005), though clearly this is not academically evidential but rather an indication of commonly held notions, among Wikipedia editors at least. Although notably, PK is seldom reported in the literature, save for the odd exceptional report (e.g., Shulgin, 2004), and it has been suggested among occultists that chemical agents are only useful for "receptive" magic/psychic purposes, such as traveling clairvoyance, divination, and spirit evocation or invocation (e.g., Carroll, 1987; Vayne, 2001; Xeper, 2005). The use of psychedelics for such magical purposes now appears to be growing in popularity among occultists and is seemingly far more prevalent within the literature than it used to be (e.g., see Louv, 2005; Kent, 2010).

2.3 Clinical

A review of the literature from the clinical setting reveals surprisingly few published psychiatric inpatient reports, although there are some epidemiological studies (see section 3.2.1) relating to psychedelics and paranormal experience. This may be due to any number of factors, such as the lack of any such spontaneous phenomena within the psychiatric population, or the medicalization within psychiatry of paranormal experiences as delusion or hallucination. Indeed, Mogar (1965) noted that early psychoanalytic and behaviorist researchers using LSD were prejudiced against ESP phenomena. Yet, there is one study, a psychiatric-interview survey with users of LSD (Abraham, 1983), that reports precognitive experiences as one of the symptoms of the LSD flashback phenomena, now called hallucinogen persisting perception disorder (American Psychiatric Association, 2000).

On the other hand, there are many accounts of paranormal experiences with psychoactive drugs from within psychedelic psychotherapy, particularly that involving LSD (Grof, 1975, 1980, 1990, 2001; Harman, 1963; Holzinger, 1964; Levine, 1968; Masters & Houston, 1966; Pahnke, 1968) and psychedelics in general (Eisner, 1995; Laidlaw, 1961; Stolaroff, 2004). Tart (in Levine, 1968), quoted the International Foundation for Advanced Study, which in the course of between 300 and 400 psychedelic therapy sessions has reported the incidence of ESP with strong evidence seven times, which is a considerably higher incidence of psi than that reported to have occurred in non-psychedelic psychotherapy (Tornatore, 1977a, 1977b). As one specific example of this line of research, the percentage of clients reporting telepathic communication during LSD-assisted therapy changed from 49% in the first psychotherapy session to 80% in the second session (Blewett & Chwelos, 1959).

The psychiatrist Stanislav Grof, generally credited with the most expertise in this field having conducted more than four thousand psychedelic therapy sessions over a two decade period, reported observing patients experiencing OBEs, ESP (particularly precognition), accurate remote viewing, and space-time travel on a daily basis (Grof, 1975, 1980, 2001). Despite acknowledging that there was a danger of data contamination and a difficulty of verification, Grof (1980) contended that the occurrence of ESP was relatively frequent and that LSD could induce states conducive to an unusually high incidence of ESP (Grof, 1975). Often the reports of telepathy could have been merely self-deception, but other times there was apparently objective verifiable communication at work (Grof, 1980). Grof further found the common occurrence of OBEs, both within and independent of this physical plane, often with traveling clairvoyance and clairaudience. There were also occasional NDE experiences reported (Grof, 1994). Most frequent was the occurrence of extraordinary coincidences or synchronicities, yet only among those clients who experienced transpersonal breakthroughs within the psychedelic session (Grof, 1980). Finally, Grof (1990) also reported two events, rare in the literature, of clients under LSD who experienced visions of the dead that provided apparently unknown, but verifiable information. One such event occurred to the wife of the late psychedelic-psychical researcher Walter Pahnke. During an LSD session, Mrs. Pahnke had a vision of her dead husband who requested her to return a book concealed in her attic. Although she claimed to have had no prior knowledge of the book, she managed to locate and return it. Of course, it is possible that the knowledge of the book already lay in her subconscious (Stokes, 1997).

One of the most astonishing reports of psi occurring within the clinical setting came from the psychiatrist Paul (1966), who reported taking the mushroom *Amanita pantherina*. This was her only psychedelic experience and was part of an ESP experiment being conducted by Puharich (see Puharich, 1959, 1962). Paul had an incredibly intense trip, complete with apocalyptic visions followed by salvation through overwhelming love, and was unable to complete the experiment. However, on return to her practice, two of her clients reported extraordinary events at the time Paul had been tripping. One patient had amnesia for the same three hours on Friday evening following the consumption of his first-ever (non-psychedelic) mushroom meal, and upon remembering his experience, recalled that he had experienced the same apocalyptic fears as Paul had experienced. The other patient could not remember what she had done that evening but on investigation discovered that she had gone to the house of a secret lover and waited outside, love-struck, for two hours, but was prevented from taking any irrational action by her friend, who later informed her of the event. Both patients had a strong bond with the therapist and had expressed an interest in ESP. Paul interpreted the event as a case of spontaneous telepathic tripping, complete with amnesia on the part of the receivers, perhaps demonstrating a certain unpredictability in the experimental induction of psi with psychoactive drugs.

2.4 Evaluation of Field Reports

In summary, there is a wealth of reports of the spontaneous occurrence of ostensibly paranormal phenomena with the use of psychedelic substances. Yet this does not mean that these experiences are necessarily genuine paranormal events: Aside from the usual arguments for and against spontaneous phenomena as evidence for the paranormal (e.g., see Pekala & Cardeña, 2000; Stokes, 1997), the fact that respondents had consumed a visionary substance may be reason to question their perception and interpretation of the experiences, at least for those cases which are not substantiated by evidence or independent observers. Nunn, Rizza, and Peters (2001) have found that cannabis use is related to delusional ideation, although it is not directly related to delusional conviction; however, the relationship between psychedelic use and the propensity for false memory and poor probability judgments has not been established (Kapur & Seeman, 2002; Wilson & French, 2006). Furthermore, Shanon (2003) pointed out that the usual definitions of hallucination in the psychological literature fail to adequately encompass the diverse and complex nature of experiences that occur with psychedelics, and nor can assumptions be made about the ontology of such psychedelic-induced visions. Indeed, many people who have had paranormal psychedelic experiences reported how real the experience seemed, often being felt as more real than the ordinary waking experience (e.g., Hofmann, in Grof 2004; Shanon, 2003; Strassman, 2001). It has also been reported that psychedelic-induced mystical experiences feel no less real than previous spontaneous mystical experiences (Doblin, 1991; Exman, 1961; Greeley, 1974; Griffiths, Richards, McCann, & Jesse, 2006; Pahnke, 1966; Pahnke & Richards, 1966; Roberts, 2001; Smith, 2000; Smith & Tart, 1998; Watts, 1968), the same being true for NDEs (Jansen, 2001).

In defense of drug-induced altered states, Devereux (1997) has suggested that, "it is a culturally engineered cliché to dismiss such states as being somehow delusional" (p. 243). Furthermore, Smythies (1960, 1983) has taken issue with the concept of dulled and hallucinatory psychedelic states and insisted that these hallucinations are more than just images from a poisoned brain. Additionally, LeShan (1968) has mocked the assumption that ordinary reality is somehow more real than the psychedelically induced ASC, whereas Tart

(1977) questioned how natural is the ordinary state of consciousness, built through a lifetime of socialization. Tart (1972, 1998, 2000, 2001) further questioned the idea that rationality only occurs in the ordinary state, and proposed the establishment of state-specific sciences (for further discussion see Walsh, 2003).

No matter what their epistemological status, however, these experiences do offer a phenomenological spectrum of evidence around which to orient further research. Furthermore, the similarity in reports between those occurring spontaneously in exploratory, therapeutic, and accidental contexts, and those induced intentionally in the traditional ritual context, gives credence to the shamanic use of these substances for supposedly paranormal purposes. By contrast, other traditional psychoactive substances, such as alcohol, coffee, and cocaine are not contemporaneously reported to induce spontaneous paranormal phenomena, and neither are there folk beliefs that suggest they do. Nevertheless, Rogo (1975) wondered whether the occurrence of psychedelic-induced ESP experiences exceeded that of normal ESP experiences, a question that may be partially answered by survey research.

3. Surveys

When reviewing the survey research one immediately notices two trends. First, virtually all of the surveys reported here were published since the 1970s, after the period when most psychedelic research was conducted and the unlicensed use of these drugs mostly became illegal in Europe and North America. Secondly, most of the following surveys have primarily focused on paranormal experiences or belief and have only recorded drug use information as one of many possible co-variables, often omitting to distinguish among the different substances. Only a few studies (DeGracia, 1995; Kjellgren & Norlander, 2000; Tart, 1993; White, 1997) have approached users of psychoactive substances as the target sample.

3.1 Surveys of Belief in the Paranormal

Investigating belief in the paranormal with the Mental Experience Inventory (MEI), Kumar, Pekala, and Cummings (1992) additionally utilized a sensation seeking scale that included a yes/no question about recreational drug use. Of an opportunity sample of 574 psychology students, drug users reported greater paranormal and psi-related beliefs; however, results were reported in terms of the larger sensation-seeking measure as significant main effects. In a more direct assessment of the relationship, Gallagher, Kumar, and Pekala (1994) transformed the MEI into the Anomalous Experiences Inventory (AEI; Kumar, Pekala, & Gallagher, 1994), adding a Drug-Use subscale to complement the other four subscales relating to Anomalous/Paranormal Belief, Experience, Abilities, and Fear. The AEI was successfully validated against other paranormal experience and belief scales using an opportunity sample of 400 psychology students. The AEI Drug-Use subscale correlated positively, although only very weakly, with the AEI Anomalous/Paranormal Beliefs subscale ($r = .16$, $p < .01$) and with Tobacyk's (1988) paranormal belief subscales: Belief in Psi ($r = .10$, $p < .05$), Belief in Witchcraft ($r = .12$, $p < .05$), Belief in Superstition ($r = .11$, $p < .05$), Belief in Spiritualism ($r = .17$, $p < .01$), Belief in Extraordinary Life Forms ($r = .13$, $p < .01$), but not Belief in Precognition. Drug use correlated negatively with Traditional Religious Beliefs ($r = -.14$, $p < .01$).

In addition, some items in the AEI Drug-Use subscale correlated with Tobacyk's (1988) Revised Paranormal Belief Scale, although only very weakly. Overall, paranormal belief correlated negatively with heroin use ($r = -.12$, $p < .05$) but positively with the use of LSD ($r = .11$, $p < .05$) and mind-altering substances ($r = .15$, $p < .01$). There were no significant correlations found for marijuana, cocaine, or alcohol. The same correlations were found between the AEI Anomalous/Paranormal Belief subscale and some AEI Drug-Use subscale items (mind altering substances, $r = .18$, $p < .001$; LSD, $r = .15$, $p < .01$), but also including marijuana ($r = .16$, $p < .01$), but not heroin. Additionally, for all categories of drugs except heroin there was a small significant negative correlation with the fear of psi (from $r = -.12$ to $-.24$), whereas alcohol use correlated positively with fear of psi ($r = .13$, $p < .05$). The lack of a consistent significant correlation between paranormal belief and marijuana use runs counter to Tart's (1993) finding that 76% of marijuana users believe in ESP. This difference may be due to cohort differences, such as culture and their reasons for using marijuana, or that Tart's marijuana sample were mostly also experienced with LSD (72%, with 36% classified as heavy psychedelic users; Tart, 1971), a drug that Gallagher *et al*. (1994) did find to be related to paranormal belief. Furthermore, it should be noted that the items of the AEI Drug-Use subscale only register nominal yes/no responses, whereas more sensitive ordinal drug-use measures would have been expected to demonstrate stronger correlations, if the relationships were linear. Nevertheless, correlations from this study reported here are uncorrected and should be accepted with some caution because of the use of multiple inferential tests.

Pekala, Kumar, and Marcano (1995a, 1995b) sought to find a relationship between the subscales of the AEI and measures of hypnotic susceptibility and dissociation on a similar opportunity sample of 413 psychology students. Supporting the Gallagher *et al*. (1994) study findings, the Drug-Use subscale correlated positively, and somewhat more strongly, with Anomalous/Paranormal Beliefs ($r = .25$, $p < .001$) as well as negatively with Fear of the Anomalous/Paranormal ($r = -.14$, $p < .01$), although no breakdown of the results for the Drug-Use subscale was given for the different substances. In addition, overall drug use was found not to correlate with dissociation or hypnotic susceptibility, although marijuana was a special case (see Pekala *et al*., 1995b).

A later opportunity sample of 107 students (Houran & Williams, 1998) were surveyed using the AEI to explore the equivocal relationship between belief in the paranormal and tolerance of ambiguity. Further support was demonstrated for the small but significant relationships between drug use and anomalous/paranormal belief ($r = .22$, $p < .05$) and fear of the anomalous/paranormal ($r = -.18$, $p < .05$). Tolerance of ambiguity was found to correlate minimally with both paranormal belief and drug use ($r = .23$, $p < .05$), and more so with psychedelic drugs (LSD, marijuana), rather than cocaine, alcohol, or heroin.

Simmonds and Roe (2000) used the AEI in relation to schizotypy, temporal lobe lability, and personality correlates with an opportunity sample of 145 psychology students. Similarly to previous surveys, there was a small significant correlation between drug use and anomalous/paranormal belief ($r = .20$, $p < .05$). Drug use was also found to relate to complex partial epileptic signs (CPES) as measured by a subscale of the Personal Philosophy Inventory developed by Persinger and Makarec (1987), which they had predicted would be the case. However, it is apparent that several items of the CPES are consistent with experiences often reported in other ASCs, drug-induced or otherwise, so such a correlation might be expected anyway. Furthermore, neither of these correlations remained significant when the alpha level was recalculated using a Bonferroni correction for multiple tests, although the relationship between drug use and belief remains consistent with these other surveys, so this correlation is probably genuine, albeit small.

A later survey (Thalbourne, 2001) using the AEI sought to replicate the relationship found by Gallagher *et al*. (1994) between drug use and belief in the paranormal, and in addition investigated this relationship with respect to transliminality and to kundalini experiences. Transliminality was measured using the 29-item Transliminality Scale (Thalbourne, 1998), before it was rasch-scaled for age and gender bias. Using an opportunity sample of 125 psychology students, Thalbourne found a small significant positive correlation between the AEI subscales: Drug-Use and Anomalous/Paranormal Belief ($r = .24$, $p < .01$), supporting previous findings. There was a suggestive but non-significant negative correlation between drug use and fear of the anomalous/paranormal. There was also a significant positive correlation between drug use and transliminality ($r = .29$, $p=.001$) and the New Age Philosophy (NAP) subscale of the Tobacyk's (1988) Revised Paranormal Belief Scale ($r = .23$, $p < .01$). There was, however, no significant correlation with Tobacyk's Traditional Paranormal Beliefs (TPB) subscale, and reanalysis of Thalbourne's data by Houran and Lange (2001) found the difference in reports of drug use in relation to NAP and TPB to be significant ($p < .001$, uncorrected for multiple analyses), reinforcing their argument for two distinct paranormal belief groups. Furthermore, drug-use did not correlate with Thalbourne and Delin's (1993; non-rasch scaled) Australian Sheep-Goat Scale, a different paranormal belief scale (Thalbourne, 2001).

These findings partially support Gallagher *et al*.'s (1994) small positive correlation of drug use with the Tobacyk Belief in Psi subscale, yet to what extent is not discernable because Thalbourne's (2001) results were reported in terms of just two collapsed subscales rather than the full seven. The same is also true of correlations between Anomalous/Paranormal Belief and the Drug-Use subscale, although of note, very few respondents used heroin ($n = 3$) and cocaine ($n = 6$) compared to LSD ($n = 26$) or marijuana ($n = 61$), indicating that correlations with those reporting drug use ($n = 57$, obviously some of the respondents did not consider marijuana to belong to this category) were largely in terms of psychedelics rather than other drugs.

A *post hoc* analysis of the relationship between transliminality and drug use revealed there were small, but significant, positive correlations (ranging from $r = .20$ to $.27$) between transliminality and all of the AEI drug-use categories (mind-altering substances, marijuana, LSD, cocaine, and heroin) except for alcohol. Thalbourne (2001) suggested that this relationship may be due to the need to use drugs to escape the unpleasant aspects of the transliminal state, or that drug use may be a means of promoting the psychic phenomena of which high transliminal scorers may have become deprived. Both of these hypotheses might prove to be somewhat correct, but only for differing substances. It is highly unlikely that psychedelic drugs are used to escape the transliminal state because these substances are actually more likely to cause the opposite effect, although some non-psychedelic drugs, such as opiates/opioids might help to escape transliminality. Indeed, Vayne (2001) has suggested psychedelics are expressly used to access liminal states. Alternatively, Thalbourne has speculated that an "openness to experience" trait underlies the relationship between drug use, transliminality, and paranormal experience.

In a follow-up survey (Thalbourne & Houran, 2005), an opportunity sample of 200 psychology students completed the Revised Transliminality Scale (Lange, Thalbourne, Houran, & Storm, 2000), and an extended version of the AEI Drug-Use subscale, which included two extra items, one relating to ecstasy (MDMA) and one relating to speed (amphetamines). As previously, though somewhat less so, drug use was found to correlate marginally, although significantly, with transliminality ($r = .21$, $p < .005$, one-tailed). Furthermore, scores on the Oxford Happiness Questionnaire demonstrated that transliminality was not related to happiness and that the majority of high transliminals were happy, offering support to McCreery and Claridge's (1995) notion of the pathology-free "happy schizotype" prone to paranormal experiences. However, unhappy highscoring transliminals reported significantly more drug use than happy high-scoring transliminals ($t = 1.98$, $n = 77$, $p < .05$), somewhat supporting Thalbourne's (2001) speculation that transliminality, akin to psychosis, can be a unhappy state that such people attempt to escape from with drugs. Unfortunately, Thalbourne and Houran's findings sweep several different types of drugs - including psychedelics, narcotics, stimulants, and alcohol - together under one umbrella, revealing very little about which of these very different drugs relate to each particular syndrome. For instance, given the system of scoring in this study, it is easily possible that the use of just one drug, such as alcohol, entirely accounts for the differences in substance use between happy and unhappy transliminals, and further research begs more specific analyses.

Here Metzner (2005) pointed out that, aside from merely varying in how they activate or relax one's nervous system, psychoactive drugs may also be classified along a hedonic continuum of pain and pleasure, reflecting Thalbourne and Houran's (2005) simplified notions about drugs and the quest for happiness. However, taking a transpersonal approach, Metzner further indicated that drugs may also be considered along a third dimension of consciousness expansion and contraction, such that psychedelics are essentially conscious expanding, whereas opiates, alcohol, cocaine, and amphetamines, being focally restrictive and addictive, are consciousness contracting. Thus, a range of drugs can be used when seeking stimulation, sedation, or happiness, but only specific drugs, psychedelics, will lead to consciousness expanding experiences, and perhaps even ostensibly paranormal ones too. Arguments may prevail over precise definitions and classifications here, but the point remains that psychological research would most likely benefit from a recognition of the experiential differences between drugs rather than just a recognition of their legal status and a crude categorization of them based only on that (Friedman, 2006).

3.2 Surveys of Paranormal Experiences

3.2.1 Psychiatric epidemiological samples

Recently, a wealth of epidemiological psychiatric research has surveyed reports of cannabis use and schizotypal symptoms, finding fairly consistent correlations between them (for a review, see Castle & Murray, 2004). Items relating to telepathy and other kinds of thought broadcasting have been often included, and it deserves mentioning that the subscales in which theses items appear tend to correlate with cannabis use (e.g., Johns *et al.*, 2005). However, although relevant, this research is largely indirect to the present review as incidence rates for specific types of paranormal-like experiences are rarely reported, but rather form part of more general subscales.

More specifically, in a quasi-experimental design with 196 university students, Nunn, Rizza, and Peters (2001) found that cannabis use, but not alcohol use, was positively related to unusual experiences (such as the possession of special, almost magical powers), but use of either drug was unrelated to depression or anxiety. Furthermore, cannabis use was related to delusional ideation but not distress, further supporting the notion of the happy schizotype, although cannabis and alcohol use combined was related to delusional conviction. Nunn *et al*. suggested that schizotypal traits may predispose subjects to cannabis use or that cannabis use may result in high schizotypy scores. Although some prospective studies have been conducted in this area, there are often so many possible confounding factors involved in such research that directions and sources of causality remain entirely speculative (see Castle & Murray, 2004).

3.2.2 Clinical populations

Finding numerous paranormal experiences reported in a DXM-users survey (see section 3.2.4 to follow), White (1997) sought to explain the survey results in terms of temporal lobe dysfunction (TLD). Tentative indirect support comes from a survey of a convenience sample of 100 neuropsychiatric patients where a positive recreational drug-use response was used, among other measures, as a predictor of TLD, with TLD correlating well with reports of subjective paranormal experience (Palmer & Neppe, 2003). However, the recreational drug-use measure utilized a blanket definition that lumped together the use of a variety of different psychoactive drugs and moreover treated drug use alongside brain injury as causative factors in TLD, although there is no clear reasoning given for doing this. In this study, recreational drug use was taken to be either of the following: prolific marijuana use; the three times use of hallucinogens, LSD, mescaline, or PCP; or six months' use of heroin or amphetamine. However, it was reported in a later paper that, when gender was controlled, there were no relationships between subjective paranormal experiences and any of the categories of drug use or brain injury with this sample (Palmer & Neppe, 2004), although results may be due to underpowered statistics with only six respondents in this group.

3.2.3 General and student samples

Several major surveys of psychic experiences have included questions regarding the use of psychoactive drugs. The first series of surveys of this nature utilized a psychic experiences questionnaire created by Palmer (1979) for use in a randomly distributed postal survey. The questionnaire was completed by 354 townspeople (T) and 268 students (S), treated as different samples, with response rates of 51% and 89% respectively. Those who acknowledged the use of mind-expanding drugs also responded positively to being an ESP agent, having a recurrent spontaneous PK experience (T only, $p < .01$, although Palmer urged caution with these two results because of low responses), haunting experience (T only, $p < .05$), aura vision (S, $p < .05$), and OBEs (S, $p < .01$). Despite reported drug-use differences between samples, equal proportions from each group (T: 29%; S: 28%) reported psi experiences actually occurring during use. Kohr (1980) criticized the analysis for not reporting the chi-squared statistic and for using an underpowered test.

Kohr (1980) surveyed a special sample of self-selecting respondents ($n = 406$) from the Association for Research and Enlightenment, an organization whose membership represented those intrigued by the legacy of the renowned psychic and Christian mystic Edgar Cayce. Using Palmer's (1979) questionnaire, Kohr failed to find any association between subjective paranormal phenomena and the use of mind-expanding drugs, although figures for drug use were not actually reported. It is suspected that the drug use statistics were not reported in this study because its incidence was quite low. The Kohr sample was both older (61% over 40 years) and markedly more religious (40% = very religious) than the Palmer samples (over 40 years, T = 51%, S = 0%; very religious, T = 8%, S = 9%), and, as stated earlier, Gallagher *et al*. (1994) found traditional religious beliefs to correlate negatively with drug use. Roney-Dougal (1984) surveyed a different special sample, attendees at an occult conference, about their psi experiences. Of the 33 respondents, 30 (91%) reported psi experiences, of which 12 (40%) reported the use of mind-expanding drugs. This indicates both the slightly higher reported use of psychedelics (36% of the sample) and the greater reporting of paranormal experiences among occultists compared to other populations, though this observation may not be reliable.

Another survey (Usha & Pasricha, 1989a, 1989b) modified Palmer's (1979) questionnaire, particularly the demographic questions, to suit the needs of an Indian student population ($n = 328$; response rate 79% using opportunity sampling). Use of mind-expanding drugs was reported by 11%, who were also significantly more likely to be Hindu ($p < .05$) or male ($p < .01$), probably largely due to the sacred use of marijuana among many Indian men, mostly Hindus. Of those reporting drug use, 18% reported psi experiences during the drug experience, somewhat less than Palmer's 28-29%. Similar to Palmer's work, the use of mind-expanding drugs was positively associated (chi-squared) with OBEs ($p < .01$), and additionally with waking ESP ($p < .05$), apparitions ($p < .01$), and déjà vu experiences ($p < .01$). Except for apparitions, these three experiences tended to correlate significantly with other psi-relevant experiences such as lucid dreaming, meditation, and mystical experiences. None of the studies using Palmer's 46-item questionnaire (Palmer, 1979; Kohr, 1980; Usha, & Pasricha, 1989a, 1989b) made any corrections for multiple inferential analyses, so results should be accepted with some caution.

Returning to the surveys of paranormal belief among students reviewed in the previous section (3.1), these studies also investigated anomalous/paranormal experiences, and Kumar *et al.* (1992) found drug users reported significantly more of these. The later series of five surveys (Gallagher *et al.*, 1994; Houran & Williams, 1998; Pekala *et al.*, 1995a, 1995b; Simmonds & Roe, 2000; Thalbourne, 2001), utilizing the Anomalous Experiences Inventory (Gallagher *et al.*, 1994), each reported a significant positive relationship between the Anomalous/Paranormal Experience and Drug-Use subscales. Correlations ranged from r =.13 (Gallagher *et al.*, 1994) to r =.29 (Thalbourne, 2001), and Pekala *et al.* (1995a) additionally found that drug use was positively correlated with a Shamanic or Encounter-like Experiences subscale (r = .23; $p < .001$), which included items relating to OBE and contact with spirits. Furthermore, Pekala *et al.* (1995b) reported correlations between the use of certain substances and subjective psychic experiences occurring under the influence of drugs, although results were only given for high hypnotically susceptible participants ($n = 56$; for the AEI Drug-Use subscale r =.57, $p < .01$; mind-altering substances r =.34, $p < .01$; marijuana use r =.30, $p < .05$) and high dissociative participants ($n = 59$) (Drug-Use subscale r =.58, $p < .01$; mind-altering substances r =.30, $p < .05$; LSD r =.41, $p < .01$; cocaine r =.34, $p < .01$).

Thalbourne (2001) also found a relationship between drug use and kundalini experiences (r = .28, $p < .01$) measured using the 32-item Kundalini Scale (Thalbourne & Fox, 1999). It was suggested by Thalbourne that the relationship between paranormal experience, drug use, and the kundalini experience either indicates that certain drugs may trigger a kundalini experience or that that the use of drugs may alleviate it. Alternatively, it was proposed that the relationship between these factors may also indicate a need for non-standard sensations, or that the physiological aspects of the kundalini experience were being misinterpreted as paranormal. This final supposition is not consistent with long established tantric teachings that warn of genuine psychic kundalini experiences called "siddhis" (e.g., Satyananda, 1996). Furthermore, as an alternative to Thalbourne's interpretations, the results may simply be due to an overlap of subjective psychic experiences common to both the kundalini and the drug experience, as suggested by Naranjo (1987) and demonstrated by DeGracia (1995) in the following section (3.2.4). Perhaps the activation of the pineal gland and its chemistry, as supposed by Roney-Dougal (e.g., 2001) and Strassman (2001), underlies both factors, resulting in subjective paranormal experiences. Indeed, Roney-Dougal (1989, 1991) noted that the pineal gland is considered by some yogis to be primary in the control of kundalini psi experiences, and there is other putative evidence (see section 1.1) that suggests such a link.

3.2.4 Psychedelic-users samples

DeGracia (1995) conducted a self-selecting internet survey with 61 experienced psychedelic users about their experiences of kundalini-like phenomena. Of those responding, 58% had used psychedelics more than 20 times, most frequently LSD (95%), and psilocybin (82%). The respondents revealed a large overlap between reported psychedelic experiences and those experiences commonly arising in spontaneous kundalini awakenings. Of particular interest, psychedelic drug users frequently reported an enhanced sense of empathy (75%), OBEs (40%), intuition, psychic powers, and the recall of past lives (no statistics given). That the use of psychedelics is related to both paranormal and kundalini experiences is further supported by the survey findings of Thalbourne (2001), as discussed in section 3.2.3.

One of the first surveys (Ditman *et al.*, 1969) to explore paranormal experiences with psychedelics randomly gave 99 alcoholics receiving treatment one of the following three drugs: LSD (the only psychedelic of the three), methylphenidate (a dopaminergic stimulant, also known as Ritalin), or chlordiazepoxide (the first benzodiazepine, a sedative/hypnotic). Those taking LSD reported significantly more of the paranormal-type phenomena, having more experiences of transcending time and of having an OBE supporting findings with the AEI that dopaminergic stimulants (i.e., cocaine) are not conducive to paranormal beliefs.

A survey (Tart, 1970, 1971, 1993) conducted in California in 1970 with 150 experienced users of marijuana recruited by discrete snowball sampling found even higher reports of paranormal experiences than the student and general samples discussed above (section 3.2.3). The marijuana-user sample consisted of 76% students, and 72% of the sample had tried LSD, although only 7% had tried hard narcotics (e.g., presumably heroin). With regard to experiences under the influence of marijuana, 69% reported telepathy (rising to 83% in a later sample), 32% reported precognition, 13% PK (defined as magical operations that cause an effect), and 50% reported seeing auras, with heavier users reporting significantly higher frequencies of these experiences in each category (Tart, 1971). OBEs were reported by 44%, with 53% of this group reporting a least one OBE under the influence (Tart, 1971). In comparison, a later survey (Luke & Kittenis, 2005) found that somewhat smaller percentages of experienced cannabis users (i.e., those using it often or more frequently, $n = 60$) than in Tart's study reported the occurrence of telepathy (20%), precognition (12%), psychokinesis (12%), and auras (22%) while under the influence. Yet, the percentage reporting OBEs either with or without cannabis (62%) was larger than in Tart's study (44%). The use of Californian students at the epicentre of the psychedelic scene at that time may at least partially account for Tart's heightened findings, perhaps because these respondents were more psychedelically active and responsive, and consuming higher quantities and grades of cannabis than in the 2005 survey.

A survey, similar to DeGracia's (1995) investigation of transpersonal drug experiences, was conducted in Sweden with an anonymous snowball sample of 16 experienced psychedelic drug users (Kjellgren & Norlander, 2000). Of those returning questionnaires (94%), 37% had used psychedelics more than 20 times, mostly LSD (75%) and psilocybin (25%). Respondents indicated the occurrence of OBEs (53%), telepathy (60%), the loss of the sense of a discrete self (47%), psycho-geographical traveling (62%), contact with entities (20%), time-travel (40%), animal shapeshifting (53%), and visions of mythological beings (33%), all under the influence of psychedelics. All respondents reported having some psi experiences, with heavier users and, similarly to Usha and Pasricha (1989a, 1989b), those practicing mind-expanding, spiritual, or ritual techniques or preparation reported more of these experiences than infrequent users. However, significant differences in the quantity of experiences between low and high users only occurred for the experiences of telepathy ($U = 12$, $p < .05$, two tailed) and gaining knowledge of oneself, and for a combined index of all paranormal experiences ($U = 7$, $p < .05$), though uncorrected for multiple analyses. This partially supports the hypothesis that subjective paranormal experiences occur more frequently during the use of psychedelics, although alternative explanations are possible. Furthermore, 31% of the sample reported that their views on life after death have been influenced by their use of psychedelics, and 44% had become less afraid of death through their experiences, although 12% had become more afraid.

In further support of the notion that greater psychedelic use is associated with more paranormal experiences, a limited survey of 67 psilocybin-containing mushroom users found that only 9% of those taking low doses (less than 5 dried grams of *Psilocybe cubensis*) had experiences of telepathy, whereas 28% of those taking higher doses - what McKenna (1991) called a heroic dose - had telepathic experiences (Hurst, 1994).

Of particular interest to the present review are the results of an incidental internet survey (White, 1997) of subjective paranormal experiences with the use of the dextromethorphan (DXM). Commonly used in cough remedies DXM is a synthetic drug that results in similar subjective experiences to other dissociatives, such as ketamine and PCP. White was concerned about the use of DXM and had a "frequently asked questions" report regarding DXM posted on an internet-based psychoactive drug information site (www.erowid.org). The published survey, unfortunately without statistics or demographics, was the product of reports sent to White from people who had used DXM, often unwittingly as a simple cough remedy, and had experienced a number of subjective paranormal experiences. White was surprised at the reports and was originally very reluctant to take them seriously, until he received so many that he collated, categorized, and published them.

Many of the experiences reported by White (1997) are consistent with experiences common to ketamine use (Jansen, 2001; Corazza, 2002) and include the following: visions of energy ribbons; a disturbing sense of infinity; a sense of presence of a profoundly powerful, loving, and intelligent being (as is also quoted with DMT use, a very different substance - Strassman, 2001); déjà vu; jamais vu; a loss of sense of causality; memory loops; a sense of presence; OBEs (most often to a different dimension but also on the corporal plane outside of one's body); NDEs; contact with entities, spiritual beings, and other free-floating consciousnesses (also reported by Carpenter, 2006; Xeper, 2005); occasional ESP, including clairvoyance; and the intuitive understanding of complex ideas such as a math student understanding Gödel's Incompleteness Theorem for the first time. Most of these experiences have since elsewhere been reported in an online user journal, *The DXM Zine* (Gelfer, 2007). It is noted there were no reports of PK, although some felt that they could slightly influence the laws of probability. These reported experiences are independently consistent with a psychiatric inpatient report of an apparently accidental overdosing with a cough remedy containing DXM (Price & Lebel, 2000). Reported symptoms included the experience of observing oneself from outside of one's body (OBE), becoming "just thoughts," 360° vision, vision within people, and "delusions" of telepathy, all of which ceased when the DXM wore off.

Taking a more taxonomic approach than earlier research, Luke and Kittenis (2005) sought to determine which of a range of psychedelics are related to which paranormal experiences in particular. The online survey pooled responses from 139 self-selecting respondents recruited via both parapsychology and psychedelic interest groups. The percentage of respondents who had tried an illicit drug even once (n = 110) and who reported a psi experience while under the influence (47%) was somewhat higher than the 28-29% and 18% found previously with general and student samples (Palmer, 1979; Usha & Pasricha, 1989a, 1989b), as might be expected from this non-ordinary sample.

The study also corroborated many of the observations made in previous research. For example, supporting Strassman (2001), DMT was widespread in inducing entity contact experiences and OBEs, although primarily to other dimensions, and like 5-MEO-DMT, DMT commonly gave the experience of dissolving into a universal energy. The hypothesis that DMT is fundamental to the NDE (Strassman, 2001) was partially borne out by the relatively widespread reporting of the, albeit generalized, death-like experiences (dying, rebirth, or memory of a past life) although such experiences seemed to be relatively more widespread with 5-MEODMT, as observed elsewhere (Luke, 2005; RoneyDougal, 2001; Shulgin & Shulgin, 1997).

Reports of "sensing an intelligence or spirit being in an ingested plant or substance" were found to be most widespread where respondents were under the influence of plant-based substances: psilocybin-containing mushrooms, ayahuasca, mescaline-containing cacti, and *Amanita muscaria*, but especially with *Salvia divinorum*, as has been documented elsewhere (Aardvark, 2002; Addy, 2010; Arthur, 2010; Doyle, 2012; Horner, 2012; Miller, 1994; Vayne, 2001). For a discussion of interspecies encounters on psychedelics see Krippner and Luke (2009). Such plant-spirit experiences also occurred with the use of the cannabis plant, although the most widespread experiences with this drug were clairvoyance and OBEs on this plane and, primarily, telepathy, making this substance a prime candidate for ESP research, as has already been advocated by Tart (1993) for a number of reasons. The dissociative DXM is also a potential candidate for further ESP research, particularly collective ESP experiences, supporting earlier reports of psi occurring with its use (Gelfer, 2007; Price & Lebel, 2000; White, 1997). There were also relatively widespread reports of telepathy with LSD and particularly with MDMA, a drug, categorized as an empathogen, that is characterized by its capacity to induce empathic experiences and that has elsewhere been reported to induce telepathic experiences (Brown, 2012a; Eisner, 1989; Saunders, 1993). *Psilocybe* genus mushrooms too demonstrated some relatively widespread capacity to accompany psi experiences of all kinds, particularly clairvoyance, but even PK to some extent. However, possibly because of the more infrequent experience of PK, there did not seem to be any one substance that was related to it, with the possible exception of *Psilocybe* mushrooms, mescaline, and LSD, although none of these convincingly.

In keeping with the previous findings of correlations, ranging from r =.13 to .29, between the occurrence of paranormal experiences (including mystical experiences) and the use of all drugs (excluding prescription drugs) as measured with the AEI (see section 3.2.3), the Luke and Kittenis (2005) study also found a positive correlation of r =.46, p < .001. The greater correlation in this study most likely was due to the use of different sample types, and variations in the questions used. In addition, an overall correlation was calculated between the frequency of paranormal experiences and the frequency of drug use (excluding alcohol and prescription drugs) that gave a small positive value of r =.31, p < .001, supporting Kjellgren and Norlander's (2000) and Tart's (1971) finding that greater psychedelic use is related to more paranormal experiences.

3.3 Surveys and Out-of-Body Experiences (OBEs)

The connection between psychoactive substances and OBEs has received special attention. An inspection of the SPR files led Whiteman (1956) to summarize that approximately a third of "separation" (OBE) cases were initiated by physical conditions, including drugs, although which drugs are not specified. Drug type is clearly of relevance, however, as a study experimentally comparing LSD with Ritalin and benzodiazepine experiences also found that LSD induced a significantly greater degree of OBEs (Ditman *et al*., 1969). Since the 1950s and 1960s several OBE surveys have incorporated questions relating to drug use. Combining two convenience samples of students (n = 192), Blackmore (1982) reported that of the 35 (18%) claiming to have had at least one OBE, 13 (37%) occurred when taking drugs, most often LSD or marijuana. A later questionnaire survey with students (convenience sample, n = 96) found 31% claimed to have had an OBE, and they were significantly more likely than those who did not claim to have had an OBE to have taken drugs such as cannabis, LSD, or opium derivatives (Blackmore & Harris, 1983).

In a similar survey of students from an opportunity sample (n = 200), Myers, Austrin, Grisso, and Nickeson (1983) utilized the OBE question from Palmer's (1979) questionnaire and found a significant, but small, correlation between reported OBEs and the use of mind-expanding drugs (r = .23, p < .001). Similar to the 18% of Blackmore's (1982) study, 22% of the Myers *et al*. sample reported the occurrence of OBEs, with 42% of these having used mind-expanding drugs compared to only 20% using such drugs among those not reporting OBEs. Furthermore, 50% of the OBE experience group (n = 45) reported some psi-related experiences during drug taking, compared to only 4% of the non-OBE group (n = 155), perhaps indicating a commonality in the etiology of drug-induced psi and OBE experiences.

Although these surveys (Blackmore 1982; Blackmore & Harris, 1983; Myers *et al*., 1983) suggest that the use of psychedelic substances is an important correlate of OBEs in the student population, this relationship is less pronounced in other populations. A later randomized postal study (Blackmore, 1984) with a sample of people who had reported OBEs revealed that only 18% of respondents reported OBEs occurring after taking drugs and medicines (type not specified). Blackmore (1992) concluded that hallucinogenic drugs undoubtedly help induce the OBE and were more useful for this than other drugs (e.g., stimulants, tranquillizers, sedatives, and alcohol), although she added that OBEs still occur rarely with psychedelic drug use and there was no specific OBE-inducing drug, despite Lilly's (1978) assertion that ketamine is virtually a chemical road to the OBE. However, Blackmore (2005) later reported an OBE in a self-experiment with ketamine and conceded that, more so than other drugs, ketamine "often involves feelings of body separation" (Blackmore, 2003, p. 356).

The Blackmore OBE surveys (Blackmore 1982, 1984, 1986; Blackmore & Harris, 1983), and that of Myers *et al*. (1983), support the findings of the earlier survey of psychic experiences by Palmer (1979). In Palmer's study, a higher percentage of the student sample than the townspeople sample reported OBEs (S: 25%; T: 14%; p < .01), which Palmer attributed to the likely greater use of mind-expanding drugs among the student sample. Of the townspeople, 7% reported the use of mind-expanding drugs compared to 32% of the student population, although Palmer suspected that the student figure was a gross underestimate, possibly due to the illegality of drug use or the interpretation of the term "mind-expanding drugs" to exclude marijuana. It is not specified why Palmer should consider the student sample to be less likely to report their drug-use than the townspeople. In addition, 13% of the townspeople and 21% of the students reporting OBEs said that at least one OBE had occurred under the influence of such drugs, figures that compare more similarly to the 18% reported for the general OBE population (Blackmore, 1984) than to the 37% and 42% in the student OBE groups (Blackmore, 1982; Myers *et al*., 1983, respectively). In a review of the OBE survey literature, Irwin (1994) agreed with Palmer that the higher reports of OBE experiences among students (20-48% compared to 8-15% in the general population) were probably due in part to students' more frequent experimentation with "psychotropic" drugs. However, Irwin suggested that it was probably also due in part to other factors, such as education and familiarity with surveys.

Using Palmer's (1979) questionnaire, Kohr (1980) failed to find any relationship between OBEs and drug use with the members of the Association for Research and Enlightenment - previous criticisms still standing - although Usha and Pasricha (1989a, 1989b) did find such a relationship with Indian students. The occurrence of OBEs in the Indian sample was positively associated with the use of mind-expanding drugs (chi-squared = 6.87; p < .01) supporting Palmer's findings, although no proportion was given for comparison. Tart (1993) also found that 44% of marijuana users reported OBEs, with 58% of these indicating that their OBE occurred since using marijuana, with 54% of those experiencing OBEs reporting at least one experience whilst actually under the influence of marijuana (Tart, 1971). Most of Tart's sample were also students (72%), supporting Alvarado's (2000) suggestion that the relationship linking psychedelics with OBEs shown in student populations is not evident among the non-student populations, although this assertion is arguably too exclusive of non-student drug-users. For instance, in surveys with psychedelic-users, DeGracia (1995) found that 40% had an OBE while under the influence, and in Kjellgren and Norlander's (2000) sample, of which only 25% were students, OBEs under the influence of psychedelics were reported as 53%, a figure comparable to Tart's marijuana group (54%).

Reports of OBEs are also prevalent in other surveys among users of dextromethorphan (White, 1997). The OBE has also appeared within numerous experiential reports of those who have used either nitrous oxide or ether (Crookall, 1961, 1964; Schroll, 2011), LSD (Eastman, 1962; Grof, 1975, 1980; Lilly, 1969; Whiteman, 1965), PCP (Rudgley, 2000), DMT (Strassman, 2001), 4-HO-MET (Kjellgren & Soussan, 2011), *Salvia divinorum* (González, Riba, Bouso, Gómez-Jaraboa, & Barbanoj, 2006), pituri (Australian Institute of Parapsychological Research, 2004), harmaline and ayahuasca (Andritzky, 1989; Bianchi, 1994; Luna & White, 2000; Naranjo, 1967; Roney-Dougal, 1986, 1989), a host of other plant psychedelics (Schultes & Hofmann, 1992), and even certain simple carbon dioxide and oxygen gas mixtures (Meduna, 1950). That OBEs are also frequently reported to occur with the use of ketamine (Blackmore, 2003; Curran & Morgan, 2000; Jansen, 1997a, 1999, 2001; Lilly, 1978; Muetzelfeldt *et al.*, 2008; Pomarol-Clotet *et al.*, 2006), even apparently veridical ones (Hanna, 2003), is further echoed by a widely distributed UK Department of Health (2004) information booklet, aimed at teenagers, subtitled Facts about Drugs, that states the primary experiential effect of ketamine is an OBE. Furthermore, a taxonomic survey of psychoactive substance use phenomenology found that, out of a possible 17 different transpersonal experiences, OBEs (to another dimension) were the primary experience of both DMT use and ketamine (Luke & Kittenis, 2005). Indeed, a recent online survey (Wilkins, Girard, & Cheyne, 2011) of 192 recreational drug users found that ketamine was the primary predictor of OBEs among a number of so-called recreational drugs (alcohol, cannabis, MDMA, amphetamine, and LSD/hallucinogens), though DMT was not listed specifically. It is also documented that the ancient Indian psychoactive sacramental, Soma, was capable of inducing OBEs (Spess, 2000).

Early OBE researchers were well aware of the occurrence of these experiences with psychoactive drugs and categorized them differently from OBEs with "natural" causes, suggesting that they were of a different type (Eastman, 1962) and of inferior quality (Crookall, 1961, 1972). Blackmore (1986) disagreed, suggesting that a distinction between drug and nondrug experiences was not evident. Similarly, Grosso (1976) stated that both drug and non-drug OBEs have the same characteristics and that the OBE is the extreme manifestation of a normal human process. Grosso further proposed that drug states nicely demonstrated this continuum of out-of-bodyness by exhibiting a range of body-image alterations, from feeling taller to being completely bodiless, offering the most promising means of experimental OBE induction (see section 1.4 for a discussion). Nevertheless at this time, a systemic comparison of the various chemically-induced OBEs and more spontaneous ones is long overdue.

A recent survey substantiates Grosso's (1976) notion by finding that 32% of a sample of 28 first-time users of ayahuasca report alterations in self-body image, ranging from fusion with the environment to the complete separation of the conscious self from the body. All respondents were new members to one of two particular Brazilian syncretic Christian churches that use the jungle decoction ayahuasca as a sacramental (Barbosa, Giglio, & Dalgalarrondo, 2005).

3.4 Summary of Survey Research

In summary, the findings from the survey research indicate a small but consistent relationship (r = .16 to .25) between belief in the anomalous/paranormal and drug use, although the size of this relationship was more pronounced for the marijuana users in Tart's (1993) study. Furthermore, these studies support the hypothesis that psychedelics can induce some paranormal phenomena, although the same arguments for and against the genuineness of field reports (section 2.4) also prevail here. In the surveys reported here, with either student or general samples, those reporting ESP, apparitions, and anomalous/paranormal experiences were found to be significantly more likely to use psychedelics. One study found the same for recurrent spontaneous PK (sometimes called poltergeist phenomena) as well, although only tentatively (Palmer, 1979). Furthermore, of those reporting the use of psychedelics, 18-83% reported psi experiences - most commonly telepathy but also precognition - actually occurring during drug use, with heavier users reporting more experiences where specified. Yet, the occurrence of PK during drug use was only reported among a very small proportion of marijuana, psilocybin, mescaline, and LSD users. OBEs are also an occasional or common feature of psychedelic experiences and are reported to occur with a wide variety of drugs and wide variety of users, particularly students.

A weak relationship between paranormal experiences, the use of psychedelics, and kundalini experiences has also been found in two studies, and there is also a weak, but repeated, correlation between transliminality, drug use, and paranormal experience with Australian psychology students. Where specified, the relationship with paranormal experiences, belief in the paranormal, transliminality, and tolerance of ambiguity is reduced compared to psychedelics with respect to cocaine, heroin, and alcohol, perhaps reflecting Metzner's (2005) classification of these as consciousness-contracting drugs. The same is also true for the negative relationship with the fear of psi found with psychedelics, which is not apparent with heroin and actually reversed with alcohol, although replication and analyses for specific classes of drugs is necessary. Correlations between self-reports of cannabis use and thought transmission in psychiatric research are apparent, often indirectly, though such experiences are also more widely commonly reported in the apparent absence of pathology, with or without cannabis. Many of the surveys fail to adequately identify which substances lead to which experiences, although a switch to such taxonomic research is now evident (Luke & Kittenis, 2005).

4. Experimental ESP Research

Several experiments have attempted to elicit psi directly through the controlled consumption of psychedelics. These experiments have been reported quite differently, sometimes as entire monographs in excess of 100 pages or at other times as footnotes within another published report, often without useful details and statistics. The majority of these experiments were essentially pilot studies and were mostly conducted during the psychedelic research period of the 1960s.

4.1 Forced-Choice Designs

Forced-choice designs are those in which the target is chosen from among just a few known target types, as with the classic Zener cards. Whittesley (1960) reported on the use of LSD (no dose specified) in a forced choice ESP task with 27 participants, using mostly psychiatric outpatients receiving psychotherapy (with LSD presumably). Using ESP cards concealed within opaque envelopes, participants performed two runs of 25 guesses, one before and one after dosing. Neither performance yielded significant deviations from mean chance expectation (MCE), although a chi-squared analysis of the extent of variance revealed a significant reduction in variance ($p < .001$) for scores in the experimental condition. Under the influence of LSD, participants had reported that the card guessing-task was "ridiculous, petty, mundane, etc." (p. 221), and Whittesley suggested such an exceptional lack of deviation from MCE was due to participants feeling so constrained. Little can be said of the methodological merits of this simple experiment because little detail is given, but it is questioned whether the variance analysis was pre-planned.

Making similar use of ESP symbols, Pahnke (1971) reported a pilot study with five participants given a high dose of LSD (200-400 micrograms) and tested 8-9 hours later. The results did not reveal an increase from pre-drug scores for the experimental condition. Pahnke cited the long delay in testing from dosage and, somewhat similarly to Whittesley (1960), the use of an ESP machine with sterile symbols as counterproductive factors. Pahnke proposed that future research would benefit from the use of familiar sender-receiver pairs, with both under the influence, and the use of a stimulant (e.g., caffeine or amphetamine) along with a psychedelic such as 3,4-methylenedioxyamphetamine (MDA) or 2,5-dimethoxy-4-methylamphetamine (abbreviated as DOM, but also known as STP). Despite Pahnke's reported failure, the psychiatrist Grof (1970) reported his own experience taking LSD in one of Pahnke's experiments in which Grof successfully described a remote target in each of three attempts. Grof (1970) aptly described the dissonance between the task and the experience that occurs to the psychedelic participant, a mixture of both complete acceptance and fear of psi, when he wrote:

> When I got the third correct answer in a row, the feelings [of a universe where no laws of time and space exist] were so powerful that I could not continue. The reason for discontinuation of the ESP experiment was a strange mixture of a conviction that it was absurd to test the obvious and, on the other hand, a metaphysical fear of confusion that would follow if I had to give up the usual concept of time and space and with it all the related reference points we feel so secure with. (p. 3)

Prior to using free-response procedures with LSD, Masters and Houston (1966) also experimented with an ESP-card guessing procedure. With each participant performing ten 25-card runs, only 4 out of the sample of

27 participants did better than chance. Those few participants performing better were known very well by the trip guide and had reported a high degree of empathy (with the guide presumably). Masters and Houston noted that participants very quickly became bored with the task and complained that it was "psychedelically immoral" (p. 90) to have them perform card guessing while tripping.

As part of a larger series of individual ESP tests with 36 participants under the influence of psilocybin, Asperen de Boer, Barkema, and Kappers (1966) found that, in ten 25-card runs, no individual scored significantly better than in their own no-drug control condition. The results of the 29,000 ESP-card trials for the 36 psilocybin and 44 control participants (a few participants did multiple conditions) were significantly above chance ($p < .01$) overall. However, a closer inspection of the results showed that, when compared as a group, those in the psilocybin condition scored higher (MCE = .2; mean correct = .214, $p < .05$) than the control condition (mean correct = .206, $p = .09$), although the difference between the groups was not significant. However, there is some indication that order effects reduced any difference between the groups, because the psilocybin condition always occurred after the control condition, possibly resulting in test fatigue, as described in the following section (4.2.1).

Kugel (1977) reported very briefly on the results of a telepathy experiment with LSD, in which test scores actually declined under the influence of LSD in comparison to the periods before and after intoxication. Participants had been given trial by trial feedback and it was noticed that there was a very strong tendency for participants to respond to this feedback by responding with the same call after a hit and a different one after a miss, the latter action being known as the gambler's fallacy. Analysis revealed that this feedback susceptibility increased under the influence of LSD, possibly accounting for the poorer test performance. No further details about the methodology or statistical results were provided in this paper.

In an indirect experiment with participants selected for good psi scoring, Palmer, Tart, and Redington (1976) found a positive correlation between scores on an automated ESP-symbol guessing task in the laboratory and the reported frequency of marijuana use outside of the laboratory, with a negative correlation between ESP scores and alcohol consumption (see Tart, 1993). However, a follow-up study (Tart, Palmer, & Redington, 1979) failed to replicate these results, although Tart (1993) suggested that this was due to the difference in sample groups and the rising popularity of marijuana as a social drug rather than as a tool of self-development. Tart explained this with the observation that the subjective effects of marijuana are highly susceptible to changes in psychological set and expectation, echoing Weil's (1972) suggestion that marijuana is primarily just an active placebo. Nevertheless, direct experimental telepathy research with marijuana by the parapsychologist Dr. Thelma Moss was apparently unsuccessful (Rogo, 1976), though no original research papers on this are readily available. Even so, some similar findings to the original Palmer *et al*. (1976) study were found when scores on a secure non-intentional forced-choice precognition design task with 100 participants (Luke, Delanoy, & Sherwood, 2008) was correlated positively ($r_s = .27$, $p = .008$, two-tailed) with the reported number of consumed psychedelics over the lifetime.

Despite earlier cautions (e.g., Masters & Houston, 1966; Pahnke, 1971; Whittesley, 1960) that ESP-card tests are too boring to those affected by psychedelic drugs, two later studies (Tinoco, 1994; Don, McDonough, Warren, & Moura, 1996) found further support for the forced choice task boredom factor with the use of ayahuasca in Brazil. In a series of 825 ESP-card guessing trials conducted in two 90-minute sessions with one sender and one receiver, both under the influence of ayahuasca, no significant deviation from MCE was found (Tinoco, 1994). A second automated ESP-card precognition test involved one of the previous participants in 625 trials over two separate sessions lasting one hour and 40 minutes each, the scores of which were slightly below chance but not significantly so. However, it is apparent that no control condition was evident for comparison. As in earlier studies, both participants reported that the tasks were boring and that the tests lost their meaning and importance because it was more important to live the visions of the moment.

As part of a larger investigation into EEG variations with ayahuasca use, Don *et al*. (1996) similarly found no significant deviation from MCE with a small group of (presumably experienced) participants using the an automated ESP task under the influence of ayahuasca, though again, like Tinoco's (1994) study, without non-drug controls. Despite the poor preliminary psi-task results, which Don *et al*. attributed to methodological factors, the use of ayahuasca was shown to significantly increase 40-Hz (gamma) activity within the occipital-temporal-parietal area, particularly when the participant's eyes were closed. It was noted that amplification of this kind has often been observed during successful psi-tests in previous studies with gifted participants. Don *et al*. hypothesized that the reported psychic effects of ayahuasca were due to this particular 40-Hz activity amplifying unconscious psi information to conscious levels; however, an independent ayahuasca-EEG study by Stuckey, Lawson, and Luna (2005) failed to replicate the power increases in the gamma frequency range, but instead found increased gamma coherence across the cortex with ayahuasca when compared to control periods.

Unlike most of the other forced choice designs, a series of successful experiments were reported by Puharich (1959, 1962), one of which utilized a 10-image unseen picture-matching test with participants who had ingested the psychedelic mushroom *Amanita muscaria*. Preliminary exploratory work had led Puharich to report the subjective feeling of telepathy himself, and one of his gifted participants perfectly matched two sets of ten unseen pictures in three seconds. Controlled experimental work with 26 unselected participants in independent trials revealed an overall chance occurrence of hits in the control picture matching series (106/1140; MCE = 114) compared to the experimental group (141 hits; $p < .01$), indicating a positive effect of the mushroom on ESP, later repeated in a telepathy-type design.

4.2 Free Response

4.2.1 Psychometry (object reading)

Several experiments have opted for a free-response design, which is arguably more conducive than forced choice in eliciting meaningful responses from participants under the influence, and psychometry has been especially popular. In an exploratory study, using a special sample of six mediums, Osis (1961a) administered 100 or 125 micrograms of LSD to each of them prior to a psychometry test. Five performed at chance whereas one was extremely successful. Although further details were not provided about the successful participant, Osis noted that the others were too absorbed in either the aesthetic pleasure of the experience or the quest for philosophical knowledge. The mediums distinguished the visions from normal perception and stated that the LSD experience was unique and caused a sense of profound unity with the world unlike that occurring during psychic experiences. Osis advised continuing research with drugs where the experiments were brief (only 20 mins.), as longer sessions appeared impractical and were thought to result in negative scores because participants would lose interest. Limited information is provided about this study, although it is assumed that participants were not experienced with psychedelics.

Smythies (1960, 1987) reported a preliminary psychometry investigation - planned more like a remote viewing task - conducted in 1950 with one volunteer using mescaline. Although the participant was unable to discern the targets under adequate blind, remote-viewing style conditions, informal questioning about the target location typical of psychometry tasks elicited promising responses. Similarly using mescaline, a series of pilot studies with three participants "failed in card-guessing tests but showed encouraging success in tests with free material, particularly token objects" (Rush & Cahn, 1958, p. 300), though, unfortunately, further details were not given in this paper. Further to these preliminary reports, Marti-Ibanez (1965) gave a secondhand account of success with mescaline in a series of unpublished telepathy experiments conducted at the Pasteur Institute in Paris. Likewise with mescaline, presumably in self-experiments, Breederveld (1976, 2001) reported success in consistently winning above chance at roulette experiments in casinos using real money, although the mescaline was only one of several mostly successful methods. Nevertheless, Breederveld's success echoes anecdotal reports concerning the pioneer psychedelic researcher, Al Hubbard, who, after apparently developing his psychic ability through the use of LSD (Stevens, 1988), became somewhat notorious for winning on gaming machines in casinos, his reputation being such that he was politely escorted out when he reached a certain limit of earning (Krippner, 2006a).

The most extensive object-reading test of participants under the influence of psychedelics formed part of a battery of ESP tests conducted in a large-scale psilocybin study (Asperen de Boer, Barkema, & Kappers, 1966). In a no-blind repeated-measures design, 44 no-drug control and 36 test participants (30 participants did one of each condition, whereas a few other participants did multiple conditions) given 10 or 20 mg. of psilocybin, were individually tested for four hours for ESP performance with ESP-cards, object reading, traveling clairvoyance, telepathy, and clairvoyance tests regarding both people and objects. Using a complex system for evaluating the success of the free-response tests, the experimenters jointly estimated the degree of probability for each statement given by the participants and then determined the extent to which the probability of correct statements outweighed the number and probability of incorrect statements. All participants were considered to have performed better than chance overall in the object reading, traveling clairvoyance, and clairvoyance-for-persons tests, but those in the psilocybin condition were not considered to have performed better than those in the control condition. However, the free-response results were combined for these three tests so that no separate comparisons between the groups on these tests were reported. Overall performance on the telepathy test revealed 3 hits out of 220 sessions, where 7 were expected by chance, making comparisons between the groups of little relevance, and similarly little success occurred with the clairvoyance-for-objects test.

Asperen de Boer *et al*. (1966) concluded that it is not possible to induce ESP with psilocybin, although Bierman (1998) argued that their participants should be pitied for having to do such a range of boring and strenuous tests while tripping, a burden unlikely to be imposed in modern research. Parker (1975) also criticized the study for promoting a scientific methodology at the expense of interpersonal factors. Furthermore, Asperen de Boer *et al*. made little account for the methodological shortcomings of the psilocybin condition, even though they reported that more than half of the psilocybin participants, mostly drug novices, were distracted by their visions. The authors did note, however, that there may have been some order effects because the psilocybin condition always occurred after the control condition. Of the five participants who completed two control trials, four did worse in the second trial, possibly indicating fatigue effects independently of the drug. Asperen de Boer *et al*. also reported briefly on a previous series of more promising unpublished psychometry trials with LSD that were conducted prior to switching to the psilocybin, which they considered to be less distracting. Out of several LSD participants some exceptionally accurate accounts of object reading where given, for which Kappers (1983) later suggested only a paranormal explanation seemed possible.

4.2.2 Other clairvoyance experiments

Perhaps the first psychedelic ESP experiment was conducted by the French researcher Rouhier who gave mescaline to six subjects, one of whom temporarily developed very detailed and accurate clairvoyant abilities and was able to describe the contents of a nearby room (Rouhier, 1925, 1927). The same sentiment was reported by the man who coined the term *psychedelic*, Humphry Osmond, after his own mescaline experiences in 1951. Osmond (1961) also reported that, in 1957, he and his fellow researcher Duncan Blewett, both under the influence of mescaline, successfully transmitted telepathic information in an informal experiment to such a degree that an independent observer became acutely panicky at the uncanniness of the event, though, unfortunately, no formal experiment with a larger sample is reported.

Using the more popular substances of the 1960s, Cavanna and Servadio (1964) reported extensively on a repeated-measures clairvoyance design with the alternate use of LSD and psilocybin in what was primarily an ideographic, psychoanalytic study. In a series of three control, five psilocybin, and four LSD trials, three participants performed in a single-blind (water placebo) free-response clairvoyance test. In each trial there were 10 targets of combined, yet incongruous, elements (e.g., a foot with an eye), which Parker (1975) unduly criticized for being improbable. Only one participant had a positive attitude towards psi phenomena and all were inexperienced with psychedelics. Participants were given low doses of LSD (40, 50, and 75 micrograms) and psilocybin (10 mg), much criticized by Blewett (1965) for failing to consider the possible dose-dependent nature of psychedelic-induced ESP. Yet despite the low doses and extensive psychological screening one participant had an anxiety attack in the first LSD session, which the authors attributed to demand characteristics expressed through the anxiety and anticipation of the experimenters.

The participants' mentations were rated for correspondences by three experimenters and then independently by two blind judges, with reasonable correspondence between the judging groups, though Blewett (1965) argued otherwise. Compared to the control conditions, the blind judges' results with both the LSD and psilocybin showed a clear improvement in ESP ability, with some accurate correspondence with about one in five of the targets for both drugs. Notably, no success at all was achieved in the three control conditions, though unfortunately no estimation of the probability of the results was given, nor were inferential statistical analyses possible because the design had no decoy targets in the judging process, as duly criticized by Smythies (1965). Although the results are positive, caution is raised concerning any inferences drawn from so few trials. Cavanna and Servadio (1964) suggested that further research should make use of: stronger emotional targets, greater emphasis on interpersonal relations, and use of free association rather than interview.

A study of some indirect relevance investigated the effects of low-dose LSD (65 micrograms) on apparent subliminal perception with five participants (Freidman & Fisher, 1960). Participants were shown a bold image faded out below the subjective threshold of (conscious) discrimination with several layers of paper and presented after a blank control image in repeated trials. Analysis of free-response descriptions of the hidden image by independent judges revealed that participants gave significantly more accurate descriptions of the target in the experimental condition under the influence of LSD compared to the control condition, and that these participants also performed significantly better with LSD in the experimental condition than they had done six weeks previously without LSD. The results were interpreted as indicating the enhancement of subliminal perception with LSD; however, they might also be due, partly or wholly, to the enhancement of ESP with LSD. This is because the design mimics an ESP-study design in protocol, and there is some evidence to suggest that ESP is an active factor in subliminal perception research (Stanford, 1990). Alternatively the results may be due to poor methodology, such as order effects, quasi-experimental design, and expectation or other bias due to the lack of blind controls across all conditions and the repeated use of the same subliminal target image. Furthermore, according to Cheesman and Merikle (1986), the mere perception of information from between the subjective and objective threshold, as in this study, is not strictly subliminal perception, but unconscious perception.

Based upon earlier recommendations to avoid boring and repetitive test procedures with participants under the influence of psychedelics, a series of pilot ganzfeld experiments with cannabis (marijuana) and psilocybin were conducted (Wezelman & Bierman, 1997; Bierman, 1998). In the first series, Wezelman and Bierman utilized a no-sender auto-ganzfeld setup with 40 participants pre-selected for experience with marijuana. In a randomized crossover design, participants performed two trials each, one self-dosing marijuana condition and a control condition. All but four participants, who became nauseous and dropped out after the first session, completed both trials. A planned mixture of subject judging or external judging was used. The control condition had a hit rate of 15% (MCE = 25%) compared to 30% for the marijuana condition, and Bierman (1998) noted that the score for the marijuana condition was mainly due to the external judges, particularly one experimenter-judge who was also using marijuana. However, scores for the experimental group were not significantly different from MCE.

Wezelman and Bierman (1997) also reported on findings from a no-sender ganzfeld pilot-study conducted with six psilocybin-experienced participants performing two trials each under the influence of psilocybin. There was no control condition. Utilizing a buddy system to deter bad trips, pairs of receivers performed the ganzfeld together. With only subject judging this time, participants in the psilocybin group scored 7 direct hits out of 12 trials (58%), a figure that even with only a few trials is significantly deviant from MCE ($p < .05$), although uncorrected for a stacking effect (see Milton & Wiseman, 1997, p. 93).

4.2.3 Telepathy experiments

Bierman (1998) continued with the previous work, this time in a telepathy design using a within-subjects control condition with 20 psilocybin-experienced participants who each performed one control and one psilocybin ganzfeld trial with a sober sender. Participants in the psilocybin condition scored at chance (25%), whereas in the control condition they performed slightly below (20%), with no significant difference between the two. However, a post hoc analysis of the results for negative and positive clips revealed an interaction between target emotionality and drug state, with a much higher hit rate for positive clips (44%) than negative clips (8%) in the psilocybin condition and a reversal of this effect in the control condition. This interaction was explained in terms of psilocybin participants possibly detecting the positive ESP targets, but blocking the negative images to deter bad trips, given that participants were tripping alone this time; however, the reverse effects for the control condition are not as easily explicable. Bierman interpreted this result as suggesting that psychoactive drugs affect psi performance and that target emotionality and the psychological set of the participant may interact to alter the results. It is also worth noting that ganzfeld experiments with psychoactive drugs are likely to induce a unique, possibly combined, state of consciousness, unlike the usual drug or ganzfeld experience alone, given that the ganzfeld environment is considered by many scholars to already induce a unique kind of ASC (e.g., Wackerman *et al*., 2000). However, this idea needs further verification.

Coming from the field of psychedelic experimentation rather than parapsychology, towards which they reported being skeptical, Masters and Houston (1966) conducted a series of ESP experiments in which they demonstrated a much greater degree than their contemporaries of familiarity with the effects of the drugs being used. They provided an experienced trip guide, with whom most participants were familiar, and utilized experienced trippers as participants. The study had 62 receivers, with their guide as the sender of the 10 static image targets, and only the receiver under the influence of LSD. Using independent judges, the majority of the 62 receivers (77%) gave free-recall responses approximating the target at least 2/10 times, with five of these participants approximating the target image 7/10 or 8/10 times. The remaining 14 participants (23%), who performed worse, were either unknown to the guide, anxious, or primarily interested in their own personal psychological narrative rather than the ESP task, though these observations may be post hoc. Sometimes, receiver statements also matched non-target thoughts of the sender. But Parker (1975) noted that non-verbal communication from the guide could not be ruled out. Once again, no estimation of the probability of describing the target image is known, because no decoy images were used in the judging process and no comparison was made to a control condition to establish if LSD actually improved scores. Nevertheless, accuracy rates were similar to those reported in the clairvoyance procedure of the same nature by Cavanna and Servadio (1964), where LSD and psilocybin scores exceeded those in control conditions. Cavanna and Servadio further reported an exploratory sender-receiver telepathy design with one LSD trial and one control, where only the receiver took LSD. The results indicated accurate comparisons in approximately one in three of the targets for LSD, with a rate of only one in ten for the no-drug control condition.

Following up from a previous forced-choice ayahuasca ESP study (Tinoco, 1994), Tinoco (2011) conducted a free response task in 1995 with three participants under the influence of ayahuasca acting as senders and receivers in a telepathy-type task. No use of decoy targets was made in the judging procedure, nevertheless three independent judges concluded that there was no correlation between the target and the response in any of the 15 trials; however, no exact probability of getting a hit can be calculated with this method, and the interpretations of the judges are subjective. Furthermore, no control group was used for comparison, it is not clear how the targets for sending were initially chosen, and participants complained that they were not getting any visual imagery and, as with the two previous ayahuasca studies, that the task was boring in such a state.

Finally, Puharich (1962) followed up his earlier success at clairvoyance with *Amanita muscaria* with a demonstration for four Los Angeles news reporters, who also acted as participants and who were either skeptical or hostile towards the idea of drug-induced psi. The design relied on a computer-recorded random number-series guessing task with a non-drugged sender elsewhere, though where was not specified so sensory leakage cannot be ruled out. Participants scored at chance in the control condition (35 hits in 297 trials, nonsignificant) and after ingestion of *A. muscaria* repeated the test (average 40 mins. later) and made a combined score of 65 hits in 432 trials ($p < .005$). Scoring returned to chance after two and half hours, as they had in the previous clairvoyance experiment, although participants still reported feeling that their intuition was active. Puharich (1962) attributed the results to the neurochemical action of cholinergia heightening the ESP function by activating the parasympathetic functions (slow heart rate, etc.) indicative of the trance state. However, this explanation is somewhat erroneous because the psychoactive principles in *A. muscaria* - muscimol and ibotenic acid - can both calm and stimulate the central nervous system, respectively, whereas the cholinergic chemical, muscarine, is now known to be only a trace and psychologically inactive constituent of the mushroom (Michelot & Melendez-Howell, 2003). There is also the possibility that optional stopping occurred in this latter experiment as indicated by the different number of trials in the control and experimental conditions, and Krippner (2006a) also raised concern that Puharich's research, as with Masters and Houston (1966), was reported in a self-authored book rather than a peer-reviewed journal.

4.3 Summary of Experimental Research

Due to the exploratory nature of most of these experiments, it is difficult to fully assess their efficacy using psychedelics to produce ESP (no PK experiments having been attempted). In most cases this could have largely been improved with an adequate control condition without order effects (Palmer, 1978), and the blind use of decoy targets in the judging process. Procedures using subjective probability estimates by experimenters (such as Asperen de Boer *et al.*, 1966) are now virtually obsolete in parapsychology because they are so difficult to assess and are prone to bias (Parker, 1975). In the one ESP-card experiment to use a control condition, scores in the psilocybin condition were significantly different from chance and were also superior to the control condition, although not significantly (Asperen de Boer *et al*., 1966). Nevertheless, it is apparent that those experiments using ESP-card type symbol guessing procedures were largely unsuccessful compared to chance expectation.

The use of the symbol-guessing procedure has been widely criticized for being far too mundane under the influence of psychedelics (Grof, 1980; Masters & Houston, 1966; Pahnke, 1971; Parker, 1975; Rogo, 1976; Stafford & Golightly, 1967; Smythies, 1960; Tart, 1968; Whittlesey, 1960). Even so, using *Amanita muscaria*, Puharich (1962) demonstrated that forced-choice procedures could be successful with picture-sorting tasks. More engaging, free-response procedures have demonstrated at least some success in all but one of the studies that have used psychometry, although rarely with any control condition for comparison. A clearer indication of possible psychedelic-induced ESP, even at times in comparison to a control condition, comes overall from the clairvoyance and telepathy designs, except for the Asperen de Boer *et al*. (1964), Tinoco (2011), and the marijuana ganzfeld studies (Wezelman & Bierman, 1997). Replication, however, is needed and, in some cases, with better methodology and preplanned analyses. It remains curious that no formal explicit experiments with precognition or PK have been performed, particularly the former because powers of divination are traditionally attributed to many plant psychedelics.

5. Methodological Critique of Experimental Research

When consideration is given to what has been learned from these largely pilot studies, experimenters and commentators alike have highlighted the difficulties involved in attempting to test for psi with participants who have taken a psychedelic. Aspirin de Boer *et al*. (1964) suggested that the participant's willingness to perform in the task was important, but given that participants have difficulty maintaining alertness, self-control, focus, interest, and orientation to the task (Edge, Morris, Palmer, & Rush, 1986; Millay, 2001; Rogo, 1976), it seems much more important to consider the participant's "capability" to perform in the experiment rather than their mere willingness. Parker (1975) notes that a participant's increased sensitivity to subtle influences under psychedelics is both a boon and a bane to research. Indeed, using psychedelics to induce psi is a double-edged sword, namely all of the reasons cited in the introduction that make such research alluring also make participants poor test subjects. This is because participants may become engrossed in the experience (Rogo, 1982), the aesthetic rapture (Osis, 1961a; Smythies, 1960), the quest for philosophical knowledge (Osis, 1961a), a deep soul-searching self-examination (Blewett, 1963), one's own personal drama (Millay, 2001; Parker, 1975), and the flow of thoughts (Ryzl, 1968). In addition, participants may have difficulty communicating because of the lack of adequate language (Lilly, 1969), the overwhelming flood of ideas and emotions (Ryzl, 1968) and the speed of change of the internal experience (Blewett, 1961b, 1963). The experience of dissociation (e.g., with ketamine) can also hinder communication when participants become no longer present or aware of their physical environment and, as Huxley (1961b) pointed out, there is a need to assure participants of their identity once constructs of space and time disappear. Blewett (1961a) further warned of other unwanted psychological reactions that may occur if participants attempt to either escape from or rationalize their experience.

However, it is apparent that these obstacles to research may be greatly alleviated or even eliminated if participants are experienced with the use of psychedelics (Blewett, 1963; Parker, 1975; Tart, 1977). Indeed, about a quarter of inexperienced participants are expected to have intense spontaneous mystical experiences during their first trip (Wulff, 1997, 2000). Yet, very few of the studies reviewed here (only Bierman, 1998; Masters & Houston, 1966; Wezelman & Bierman, 1997) specifically reported the use of participants experienced with these psychedelics, although it is worth noting that those that did were relatively more successful than those that used inexperienced participants. Further to this, it has been suggested that experienced psychedelic participants can be better trained to stabilize their experience (Millay, 2001; Tart, 1977) and may even naturally train themselves to stabilize experiences through repeated use (Levine, 1968). Regardless of training, it has been strongly advised that participants be allowed to stabilize their experience before testing begins (Blewett, 1963, 1965; Millay, 2001; Parker, 1975; Tart, 1977). Pahnke (1968) further recommended an 8- to 12-hour pre-dose preparation period when working with terminal cancer patients, although Ludwig (in Tart, 1968) questioned the necessity of this in a parapsychological context.

Stabilization of the experience may even be expedited by inducing hypnosis prior to drug administration (Parker, 1975; Tart, 1968) in what has been called the "hypnodelic" state (e.g., see Levine & Ludwig, 1965;

Ludwig 1968; Tart, 1967). Alternatively, Ryzl (1968) reported re-inducing LSD states through hypnosis, as is also reported elsewhere, although it was uncertain how successful this was (Ludwig, 1968), though success inducing other drug states (e.g., MDMA, heroin) has also been reported (Hastings, 2006; Hastings *et al*., 2000; Ludwig & Lyle, 1964). Similarly, Farber (2000) has described the successful re-induction of psychedelic states using hypnotic anchoring techniques available in neuro-linguistic programming. Perhaps, the entire psychedelic experience can be stabilized and anchored during test trips with experienced users and then later re-induced, with or without hypnosis, so that no psychedelics are actually taken during the test procedure. Testing for psi under such "controlled flashbacks" may overcome most of the stipulated problems, and have the added advantage of investigating Rogo's (1976) question of whether it is the neurochemical action of the drugs or the state induced that can seemingly produce psi.

Although some researchers (Halliday, 1961; Nicol & Nicol, 1961; Paterson, 1961a; Smythies 1960; Tart in Levine, 1968) suggest that using good psi scorers, psychics, and mediums in drug studies would improve scoring, Eileen Garrett (1961b) noted that although LSD enhanced her mediumistic experience it would not improve forced choice test-scores. Echoing this, the Osis (1961a) experiment has shown that using mediums did not prove any more successful than the use of normal participants in the other psychometry experiments. This was probably due to all the problems mentioned already that occur more with inexperienced psychedelic users, indicating that sample selection should primarily seek to select experienced users over psi-effective participants, although, presumably, ideal participants would be both, though not necessarily.

Considering aspects of timing, several authors have offered advice, though no formal studies have been conducted. Both Ryzl (1968) and Grof (1980) suggested that the optimum period for testing psi during the LSD session was towards the end when the effects were leveling off, as in the Masters and Houston (1966) experiments, yet Pahnke (1971) disagreed. From extensive personal experience, Copley (1962) suggested testing for ESP once the trip had finished. As regards to the duration of the psi-task, rather than the extended test periods favored by some researchers (e.g., Asperen de Boer *et al*., 1964; Tinoco, 1995), Osis (1961a) suggested 20 minutes should be the maximum for optimum performance.

Some consideration has also been given to the optimal substance. Pahnke (1971) recommended combining stimulants with psychedelics, whereas Asperen de Boer *et al*. (1966) chose psilocybin over LSD, due to it being milder, with which Cavanna and Servadio (1964) agreed. Indeed, LSD has a much longer duration of action than psilocybin and as Blewett (1963) noted, 10-hour trips are hard to staff. Ryzl (1968) also questioned the utility of LSD in psychedelic psi testing and proposed that the ideal substance, if it can be synthesized, should inhibit cortical activity to suppress the stream of thoughts, depress sub-cortical activity to block incoming stimuli and excite spheres of the cortex involved in ESP production, yet maintain rational insight, and increase suggestibility. However, such a designer drug is far in the future, though such psychochemical engineering may one day be possible (Brown, 2012b); moreover, there are an increasing number of ethnobotanical substances becoming known that have traditionally been used for psychic purposes, which have not yet been thoroughly tested, or even tested at all (e.g., *Salvia divinorum*).

Tart (1993) further suggested that marijuana was an ideal substance for psi experimentation because of its wide familiarity within the public, its mild psychedelic qualities and its reputed ability to induce psi, experientially at least. Puharich's (1962) apparent repeated success with *Amanita muscaria* also needs replicating. Furthermore, other non-psychedelic chemical psi research, such as de Pablos' (2002) unsuccessful first-person precognitive-dream drug-study, could also be replicated with the use of psychedelic substances that have actually been reported to induce psi in dreams. For instance, there are reports of precognitive dreams, by both traditional users and by modern consciousness researchers, with substances such as *Calea zacatechichi* (Devereaux, 1997; Díaz 1979; Mayagoitia, Díaz, & Contreras, 1986), *Silene capensis* (Hirst, 2000, 2005; Sobiecki, 2008, 2012), and tree datura (*Brugmansia*; Metzner, 1992; Schultes & Hofmann, 1992). Other substances seem best suited to other experimental designs too, for example, telepathy-like experiments might also benefit from the empathogenic effect of substances like MDMA, as the one participant under its influence in a remote detection experiment did exceedingly well (Brown, 2012a). The use of a placebo in a double-blind or blind control condition, as in Cavanna and Servadio (1964), is of questionable utility in this type of experiment because at anything less than sub-threshold doses the participant is likely to easily detect the effects of the drug; nevertheless, researchers should be aware that placebo drug effects have been demonstrated in ESP research when coupled with positive false feedback on task performance (Pitman & Owens, 2004).

Several researchers have also commented on the importance of dosage (e.g., Braud, 2002; Levine, 1968). Blewett (1961b) warned that giving participants low doses of LSD may not be sufficient to break through the barrier between the normal and the full-blown psychedelic state and can be merely disorientating rather than transformative, and he later suggested that doses up to 1,500 micrograms of LSD (a very large dose) need investigating, because ESP might be dose dependent (Blewett, 1965). Support for this logic is also evident in escalating dose research with DMT (Strassman, 2001). It is additionally advised that experienced participants control their own dosage (Tart, 1977), as in the experiment by Wezelman and Bierman (1997). Participant's self-reports of the depth of the altered state were also considered better than dosages as indicators of subjective effects (Tart, 1977). Self reports using the Hallucinogenic Rating Scale were also considered better indicators of dosage than physiological measures (Strassman, Qualls, Uhlenhuth, & Kellner, 1994), though the use of a scale of transpersonal experience, such as the Self-Expansiveness Level Form (Friedman, 1983; Pappas & Friedman, 2007), would also likely be fruitful in discerning the relevant depth of the psychedelic ASC. Furthermore, some researchers (e.g., Parker, 1975; Tart 1968, 1977) have noted that the issue of dosage is largely irrelevant in comparison to the influence of the psychological factors of set and setting, as originally noted in psychedelic research by Leary, Litwin, and Metzner (1963). In discussion of this, Vayne (2001) suggested that the influence of psychological factors on psychoactive drugs can vary their effects so much that the drug can be thought of primarily as an experience, composed of set, setting, and substance.

Factors considered important in determining psychological set include the participants' expectations, attitudes towards themselves, idiosyncratic perceptions, and emotional orientation to the experiment (Levine, 1968; Tart, 1968). It is also deemed imperative to engender a sense of self-surrender, acceptance, and trust (Blewett, 1963). Factors considered important in determining psychological setting include those that are ordinarily considered under demand characteristics (Parker, 1975; Tart, 1968, 1977), particularly the experimenter's attitude, which should be warm, friendly, and supportive (Blewett, 1963). Psychological issues induced through interpersonal relations within the laboratory become magnified when participants are on psychedelics (Blewett, 1963; Parker, 1975). Cavanna and Servadio (1964) highlighted this when one of their participants had an anxiety attack concurrent with their own anxiety, which led them to advise that the experimenters themselves should be experienced users of the psychedelic substance under investigation, as also advised by Strassman (2001). Tart (1968) also recommended that the experimenter should guide the experience towards the goal of the study, and has criticized previous work for assuming psychedelic states automatically induce psi, because, as noted by Tart, Osmond, and Beloff (in Levine, 1968), and Puharich (1959), in traditional scenarios the shamans who use these substances usually have extensive training and experience. It is further suggested that the experimental task be shaped to the state of the participant, not vice versa (Tart, 1977), and utilize the strong motivation, directed awareness, and complex ritual that is found in shamanism (Copley, 1962; Grof, 1980; Tart, 1968). Grob and Harman (1995) have also urged the integration of aspects from shamanic practices into scientific procedure so that there is attentiveness to factors of set and setting, such as intention, expectation, preparation, group identification, and formalized structure, as well as the integration of the experience in the following months. Indeed a multi-method approach to studying psychedelic shamanic practices is advised, so that ethnography can inform suitable experimentation (Giesler, 1984, 1985; Luke, 2010a). Nevertheless, Storm and Rock (2011) pointed out that, in psi research with psychedelics, researchers need to be aware of the difference between shamanic techniques and merely shamanic-like techniques; for example, the latter may lack the purpose of serving one's community. Furthermore, Tart (1977) has recommended the implementation of mutual research, where participants are considered as coinvestigators, to reduce experimenter bias and enhance a sense of participation, trust, and motivation.

6. General Summary and Conclusions

Even though the subjective paranormal experiences, clinical observations and anthropological reports are subject to all the usual criticisms and rebuttals that apply to non-experimental cases (e.g., see Stokes, 1997) there is a growing body of reports, rooted in thousands of years of traditional psychedelic use, that supports the notion that genuine paranormal phenomena do occur. Nevertheless, as evidence this data is not scientifically rigorous, yet it has great value in mapping the phenomenological terrain of paranormal experiences with psychedelics. This body of reports is further supported by correlations from surveys linking psychedelic use with the increased reporting of paranormal experiences and belief in the paranormal, although again, self-reports have more phenomenological merit than evidential value. Furthermore, even though it can be considered little more than exploratory at this stage, the experimental evidence is more positive than not and proves promising so far, illuminating both methodological pitfalls and possibilities.

It is apparent that parapsychopharmacology is a multidisciplinary endeavor pooling expertise from anthropology, ethnobotany, phytochemistry, neurobiology, psychopharmacology, psychiatry, psychotherapy, transpersonal psychology, and indeed parapsychology. It also owes much to the non-academic explorers of consciousness, be they shamans, occultists, or psychonauts. It is a branch of research that is still very much in its infancy, and, along with other fields conducting research with the use of psychedelics, has been operating very quietly since the late sixties until a gentle turn in the tide during the last decade or so has seen experimental research resumed (see Grob & Harman, 1995). Nevertheless, further experimental research continues to need strict ethical and often governmental approval before it can proceed, requiring lengthy applications (see McKenna, 2004; Strassman, 2001). Several years ago, Tart (1977) recommended bypassing these difficulties by casually enrolling participants who were already using psychedelics, rather than having the experimenter administering the substances directly. An example of this kind of experiment involved several thousand Grateful Dead fans, renowned for their psychedelic consumption, who acted as senders in a series of dream telepathy experiments with some success (Krippner, 1999; Krippner, Honorton, & Ullman, 1973; Roberts, 2004). Indeed, taking what Giesler (1984, 1985) calls a psi-in-process approach and keeping naturalistic variables intact, group experiments may be one way to access the kind of group telepathy experiences that people tripping in groups sometimes report (e.g., Grey, 2007; Nuttal, 1970; Stevens, 1989; Wolfe, 1971), especially on DXM (Luke & Kittenis, 2005). However, without the grounded and controlled atmosphere of a concert or shamanic ceremony, psychedelic group ESP experiments run the risk of turning into bacchanalian scenes, as once witnessed by Puharich's wife (Hermans, 1998).

However, now resumed, direct parapsychological research with psychedelics needs expanding beyond the Netherlands and Brazil - the only place where experimental psi-chedelic research has been conducted since the 1970s - and treating these substances like any other drug worthy of investigation within a medical or therapeutic context has recently proven a fruitful means of inquiry for many researchers (Doblin, 2004; Grob & Harman, 1995), although psi research does not readily attract such funding at the present time. Nevertheless, it should be noted that psychedelics are considered as sacramentals by the spiritual and religious groups that use them and they must be utilized and researched with respect. It is also clear that besides trying to replicate the promising free-response studies, further experimental psychedelic research should utilize protocols that maximize psi effects, and this work can then simultaneously enhance process research methodology by indicating optimal conditions for psi through the psychologically magnifying effects of these substances. For instance, Bierman's (1998) psychedelic psi research may have revealed the apparent psychic blocking of negative images, and, from earlier experiments, forced-choice tasks are clearly too mundane. Research should also seek to study these substances in the shamanic context in which they have most effectively been used, designing appropriate test protocols for traditional settings. A recent example of which is Hirukawa *et al.*'s (2006) apparently successful demonstration of psi using a field random event generator in an ayahuasca ritual with the Santo Daime church in Brazil.

Additionally, following in the footsteps of William James, there has already been some return to self-experimentation with psychoactive drugs by de Pablos (2002, 2004), who has developed a viable protocol for testing one's own precognitive dreaming abilities with drugs, which might easily be adapted to waking experimentation as well. All experimental research should also be designed and conducted with an appreciative consideration of Tart's proposals for the creation of state-specific sciences (Tart, 1972, 1998, 2000, 2001). In the future, parapsychologists might ask their participants about their drug use, and researchers investigating the use of psychedelics might once more include questions relating to paranormal experiences (e.g., Echenhofer, 2005). Furthermore, with an ever growing number of substances being discovered and a large natural data pool of psychedelic users, there is a need for more thorough and focused phenomenological research that investigates and identifies the types of paranormal experience that occur through the use of each of these diverse psychedelic substances (Luke, 2004a, 2004b, 2004c; Luke & Kittenis, 2005).

Finally, there is much that can be offered to transpersonal studies from the investigation of parapsychopharmacology, and vice versa. Certainly it is clear that no study of the extraordinary phenomena of the psychedelic state would be complete without the insights and perspective of transpersonal psychology. Indeed, many of the exceptional experiences encountered with psychedelics involve parapsychological elements and yet they also go beyond the ordinary scope of parapsychology into the wider transpersonal realms (Luke, 2012b), such as entity encounters (e.g., Luke, 2011b) and profound mystical experiences (Luke & Kittenis, 2005). It is also somewhat inevitable then that this course of research is as likely to culminate in transformation for the researcher as it is in evidence for the genuine existence or otherwise of psychedelically induced paranormal phenomena (Luke, 2011c). It is also illuminating at this point to consider this research in terms of Tart's (2002) evaluation of these related fields of enquiry, where parapsychology is to transpersonal psychology what physics is to engineering: One researches the fundamental technical nature of the subject matter so that the other may apply it. In the current case a great deal can be learned, as Tart reminds, about the fundamental nature of mind through the study of parapsychology and - by looking to the psychedelic dimension - about the neurochemical mediation of exceptional aspects of consciousness in particular. Ultimately, however, it is down to transpersonal psychologists how they use this knowledge and apply it, though, fortunately, the history here tells us that wisdom usually prevails.

Acknowledgements

This research was initially supported by a grant from the Multidisciplinary Association for Psychedelic Studies (www.maps.org). The author would like to thank Stanley Krippner, Marios Kittenis, Debra Weiner, Nicola Holt, Harris Friedman, and Adam Rock for their help in the preparation of this manuscript. Earlier drafts of parts of this manuscript appeared in Luke (2008b) and Luke and Friedman (2010).

References

1. Aardvark, D. (Ed.). (2002). *Salvia divinorum and Salvinorin A: The best of The Entheogen Review: ER monograph series, No. 2* (2nd ed.). Sacramento, CA: Entheogen Review.
2. Abraham, H. D. (1983). Visual phenomenology of the LSD flashback. *Archives of General Psychiatry*, *40*, 884-889. doi:10.1001/archpsyc.1983.01790070074009
3. Addy, P. H. (2010). *That deep internal voice: Controlled administration of Salvia divinorum* (Unpublished doctoral thesis). Institute of Transpersonal Psychology, Palo Alto, CA.
4. Alvarado, C. S. (1995). Emilio Servadio at ninety: A tribute. *Journal of the Society for Psychical Research*, *60*, 122-128.
5. Alvarado, C. S. (1998). ESP and altered states of consciousness: An overview of conceptual research trends. *Journal of Parapsychology*, *62*, 27-63.
6. Alvarado, C. S. (2000). Out-of-body experiences. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience: Examining the scientific evidence* (pp. 183-218). Washington, DC: American Psychological Association.
7. Alvarado, C. S. (2000). Out-of-body experiences. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience: Examining the scientific evidence* (pp. 183-218). Washington, DC: American Psychological Association.
8. American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text revision). Washington, DC: Author.
9. Andrews, G. (Ed.). (1997). *Drugs and magic*. Lilburn, GA: IllumiNet Press.
10. Andritzky, W. (1989). Sociopsychotherapeutic functions of ayahuasca healing in Amazonia. *Journal of Psychoactive Drugs*, *21*, 77-90.
11. Anonymous. (2004a). *Baby Woodrose telepathy: LSA and MDMA*. Retrieved from http://leda.lycaeum.org/?ID=5297
12. Anonymous. (2004b). *Dream from hell: Telepathy, time travel, and assorted craziness*. Retrieved from http://leda.lycaeum.org/?ID=5964
13. Anonymous. (2004c). *Salvia divinorum: Diviner's sage*. Retrieved from http://leda.lycaeum.org/?ID=269
14. Anonymous. (2004d). *Telepathy: Strange Aztec designs*. Retrieved from http://leda.lycaeum.org/?ID=5823
15. Anonymous. (2004e). *Word telepathy: We're back from cuckoo land*. Retrieved from http://leda.lycaeum.org/?ID=5278
16. Anonymous. (2005). *Message 19019 - Salvia Divinorum Alliance*. Retrieved from http://groups.yahoo.com/group/SalviaD_Alliance/message/19019
17. Arthur, J. D. (2010). *Salvia divinorum: Doorway to thought-free awareness*. Rochester, VT: Park Street Press.
18. Asperen de Boer, S. R. van., Barkema, P. R., & Kappers, J. (1966). Is it possible to induce ESP with psilocybin? An exploratory investigation. *International Journal of Neuropsychiatry*, *2*, 447-473.
19. Assailly, A. (1961). Biochemical elements of mediumship. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 53-55). New York, NY: Parapsychology Foundation.
20. Atwater, P. M. H. (1994). *Beyond the light: What isn't being said about near-death experience.* New York, NY: Carol.
21. Australian Institute of Parapsychological Research (2004). *AIPR fact sheet: Psychic and mystical experiences of the Aborigines*. Retrieved from http://www.aiprinc.org/aborig.html
22. Averill, R. L., & Rhine, J. B. (1945). The effect of alcohol upon performance in PK tests. *Journal of Parapsychology*, *9*, 32-41.
23. Avramopoulos, D., Stefanis, N. C., Hantoumi, I., Smyrnis, N., Evdokimidis, I., & Stefanis, C. N. (2002). Higher scores of self reported schizotypy in healthy young males carrying the COMT high activity allele. *Molecular Psychiatry*, *7*, 706-711.
24. Barbosa, P. C. R., Giglio, J. S., & Dalgalarrondo, P. (2005). Altered states of consciousness and short-term psychological after-effects induced by the first time ritual use of ayahuasca in an urban context in Brazil. *Journal of Psychoactive Drugs*, *37*, 193-201.
25. Barker, S. A., McIlhenny, E. H., Strassman, R. (2012). A critical review of reports of endogenous psychedelic N, N-dimethyltryptamines in humans: 1955-2010. *Drug Testing and Analysis*, *7-8*, 617-635.

26. Barušs, I. (2003). *Alterations of consciousness: An empirical analysis for social scientists*. Washington, DC: American Psychological Association.
27. Beloff, J. (1968). Summary. In R. Cavanna & M. Ullman (Eds.), *Psi and altered states of consciousness:Proceedings of an international conference on hypnosis, drugs, dreams, and psi* (pp. 202-208). New York, NY: Parapsychology Foundation.
28. Bergson, H. (1990). *Matter and memory* (N. M. Paul & W. S. Palmer, Trans). New York, NY: Zone Books. (Original work published 1896).
29. Beyer, S. V. (2009). *Singing to the plants: A guide to mestizo shamanism in the Upper Amazon*. Albuquerque, NM: University of New Mexico Press.
30. Bianchi, A. (1994). I mistici del vegetale: Piante psicotrope e stati alterati di coscienza nella selva Amazzonica [A mystical vegetation: Psychotropic plants and altered states of consciousness in the Amazon jungle]. *Quaderni de Parapsychologia*, *25*(2), 43-58.
31. Bianchi, A. (1997). Comments on "The ketamine model of the near-death experience: A central role for the *N*-methyl-D-aspartate receptor." *Journal of Near-Death Studies*, *16*, 71-78. doi:10.1023/A:1025067412205
32. Bierman, D. J. (1998, October). *The effects of THC and psilocybin on paranormal phenomena*. Paper presented at Psychoactivity: A Multidisciplinary Conference on Plants, Shamanism, and States of Consciousness, Amsterdam, Netherlands.
33. Black, D. (2001). *Acid: A new secret history of LSD*. London, UK: Vision Paperbacks.
34. Blackmore, S. J. (1982). Have you ever had an OBE: The wording of the question. *Journal of the Society for Psychical Research*, *51*, 292-302.
35. Blackmore, S. J. (1984). A postal survey of OBEs and other experiences. *Journal of the Society for Psychical Research*, *52*, 225-244.
36. Blackmore, S. J. (1986). Spontaneous and deliberate OBEs: A questionnaire survey. *Journal of the Society for Psychical Research*, *53*, 218-224.
37. Blackmore, S. J. (1992). *Beyond the body: An investigation of out-of-the-body experiences*. Chicago, IL: Academy Chicago.
38. Blackmore, S. J. (2003). *Consciousness: An introduction*. London, UK: Hodder & Stoughton.
39. Blackmore, S. J. (2005, May 21). I take illegal drugs for inspiration. *Daily Telegraph*, pp. 17-18.
40. Blackmore, S. J., & Harris, J. (1983). OBEs and perceptual distortions in schizophrenic patients and students. In W. G. Roll, J. Bellof, & R. A. White (Eds.), *Research in parapsychology: Abstracts and papers from the combined 25th Annual Convention of the Parapsychological Association and the Centenary Conference of the Society for Psychical Research*, *1982* (pp. 232-234). Metuchen, NJ: Scarecrow Press.
41. Blake, W. (1906). *The marriage of heaven and hell*. Boston, MA: John W. Luce. (Original work published 1793).
42. Blanke, O., & Dieguez, S. (2009). Leaving body and life behind: Out-of-body and near-death experience. In S. Laureys & G. Tononi (Eds.) *The neurology of consciousness: Cognitive neuroscience and neuropathology* (pp. 303-325). New York, NY: Academic Press.
43. Blewett, D. (1961a). Investigating the psychedelic experience. In *Proceedings on two conferences on parapsychology and pharmacology* (pp. 8-9). New York, NY: Parapsychology Foundation.
44. Blewett, D. (1961b). LSD in psychiatric treatment. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 56-58). New York, NY: Parapsychology Foundation.
45. Blewett, D. (1963). Psychedelic drugs in parapsychological research. *International Journal of Parapsychology*, *5*(1), 43-74.
46. Blewett, D. (1965). ESP and LSD. *International Journal of Parapsychology*, *7*(3), 306-311.
47. Blewett, D. B., & Chwelos, M. D. (1959). *A handbook for the therapeutic use of LSD-25: Individual and group procedures*. Saskatchewan, Canada: Published privately by the authors.
48. Bonta, I. L. (2004). Schizophrenia, dissociative anesthesia and near-death experience: Three events meeting at the NMDA receptor. *Medical Hypotheses*, *62*, 23-28. doi:10.1016/S0306-9877(03)00307-4
49. Braud, W. (2002). Psi favorable conditions. In V. G. Rammohan (Ed.), *New frontiers of human science:A festschrift for K. Ramakrishna Rao* (pp. 95-118). Jefferson, NC: McFarland.
50. Breederveld, H. (1976). Towards reproducible experiments in psychokinesis II: Experiments with a roulette apparatus. *Research Letter of the Parapsychology Laboratory of Utrecht*, *7*, 6-9.
51. Breederveld, H. (2001). An adventure in casino gaming. *Paranormal Review*, *19*, 34.
52. Britton, W. B., & Bootzin, R. R. (2004). Near-death experience and the temporal lobe. *Psychological Science*, *15*, 254-258.
53. Broad, C. D. (1962). *Lectures on psychical research*. London, UK: Routledge and Kegan Paul.
54. Brown, D. J. (2012a). LSD & ESP: Scientists study psychic phenomena and psychedelic drugs. *Santa Cruz Patch* (online), posted on 9 June, 2012, at http://santacruz.patch.com/articles/lsd-esp-scientists-study-psychic-phenomena-andpsychedelic-drugs
55. Brown, D. J. (2012b). Psychedelic medicines of the future: More undiscovered drugs than stars in the sky. *Santa Cruz Patch* (online), posted on 28 June, 2012, at http://santacruz.patch.com/articles/psychedelicmedicines-of-the-future-more-undiscovered-drugs-than-stars-in-the-sky
56. Brugger, P., & Mohr, C. (2008). The paranormal mind: How the study of anomalous experiences and beliefs may inform cognitive neuroscience. *Cortex*, *44*, 1291-1298.
57. Cadoret, R. J. (1953). The effect of amytal and dexadrine on ESP performance. *Journal of Parapsychology*, *17*, 259-274.
58. Callaway, J. C. (1988). A proposed mechanism for the visions of dream sleep. *Medical Hypotheses*, *26*(2), 119-124. doi:10.1016/0306-9877(88)90064-3
59. Callaway, J. C. (2005). Various alkaloid profiles in decoctions of *Banisteriopsis caapi*. *Journal of Psychoactive Drugs*, *37*(2), 151-155. doi:10.1080/027 91072.2005.10399796
60. Carhart-Harris, R. (2011). *Using fMRI to investigate the effects of psilocybin on brain function*. Abstracts of papers presented at Breaking Convention: A Multidisciplinary Meeting on Psychedelic Consciousness, University of Kent, p. 5.
61. Carhart-Harris, R. L., Erritzoe, D., Williams, T., Stone, J. M., Reed, L. J., Colasanti, A., ... Nutt, D. J. (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proceedings of the National Academy of Science*, *109*, 2138-2143.

62. Carpenter, D. (2006). *A psychonaut's guide to the invisible landscape: The topography of the psychedelic experience*. Rochester, VT: Park Street Press.
63. Carroll, P. J. (1987). *Liber null and psychonaut: An introduction to chaos magic*. York Beach, ME: Samuel Weiser.
64. Case, J. (2003). The community K-hole. *Entheogen Review*, *12*(2), 58.
65. Castle, D., & Murray, R. (2004). *Marijuana and madness*. Cambridge, UK: Cambridge University Press.
66. Cavanna, R. (1961). Biochemical factors of personality states. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 59-60). New York, NY: Parapsychology Foundation.
67. Cavanna, R., & Servadio, E. (1964). *ESP experiments with LSD 25 and psilocybin. A methodological approach: Parapsychological monographs 5.* New York, NY: Parapsychology Foundation.
68. Cheesman, J., & Merikle, P. M. (1986). Distinguishing conscious from unconscious visual processes. *Canadian Journal of Psychology*, *40*, 343-367.
69. Cheyne, J. A. (2001). The ominous numinous: Sensed presence and "other" hallucinations. *Journal of Consciousness Studies*, *8*(5-7), 133-150.
70. Cohen, S. (1970). *Drugs of hallucination*. St. Albans, Hertfordshire, UK: Paladin.
71. Conrad, K. (1958). *Die beginnende Schizophrenie:Versuch einer gestaltanalyse des Wahns [The onset of schizophrenia: An experimental analysis of creative madness]*. Stuttgart, Germany: Thieme.
72. Conway, R. (1989). Lysergic acid and transpersonal experience. In G. K. Zollachan, J. F. Schumaker, & G. F. Walsh (Eds.), *Exploring the paranormal:Perspectives on belief and experience* (pp. 97-104). Dorset, UK: Prism Press.
73. Copley, B. (1962). *Hallucinogenic drugs and their application to extra-sensory perception*. Joshua Tree, CA: Hypnosophic Institute.
74. Corazza, O. (2002). Contributo alla discussione sulle potenzialità paranormali sviluppate da sostanze psicoattive: Uno studio sull'uso contemporeneo di ketamina [Contribution to the discussion of the paranormal potential of psychoactive substances: A study in contemporary use of ketamine]. *Quadernide Parapsychologia*, *33*(2), 39-43.
75. Corazza, O. (2008). *Near-death experiences: Exploring the mind-body connection*. London, UK: Routledge.
76. Corazza, O., & Schifano, F. (2010). Near-death states reported in a sample of 50 misusers. *Substance Use and Misuse*, *45*(6), 916-924.
77. Cott, C., & Rock, A. J. (2008). Phenomenology of *N,N*-dimethyltryptamine use: A thematic analysis. *Journal of Scientific Exploration*, *22*(3), 359-370.
78. Cozzi, N. V., Mavlyutov, T. A., Thompson, M. A., & Ruoho, A. E. (2011). Indolethylamine N-methyltransferase expression in primate nervous tissue. *Society for Neuroscience Abstracts*, *37*, 840.19.
79. Crookall, R. (1961). *Astral projection*. London, UK: Aquarian Books.
80. Crookall, R. (1964). *More astral projections*. London, UK: Aquarian Books.
81. Crookall, R. (1972). *A casebook of astral projection*. Secaucus, NJ: University Books.
82. Curran, H. V., & Morgan, C. (2000). Cognitive, dissociative and psychotogenic effects of ketamine in recreational users on the night of drug use and 3 days later. *Addiction*, *95*(4), 575-590.
83. Daniels, M. (2005). *Shadow, self, spirit: Essays in transpersonal psychology.* Exeter, UK: Imprint Academic.
84. Dawson, K. A. (2005). A psychedelic neurochemistry of time. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *15*(1), 27-29.
85. Dean, D. (1967). Parapsychological Association presidential address: Parapsychology and Dr. Einstein. *Journal of Parapsychology*, *31*, 327-329.
86. DeGracia, D. J. (1995). *Do psychedelic drugs mimic awakened kundalini? Hallucinogen survey results*. Retrieved from http://www.csp.org/practices/entheo gens/docs/kundalini_survey.html
87. Department of Health (2004). *The score: Facts about drugs*. London, UK: Department of Health.
88. Devereux, P. (1997). *The long trip: A prehistory of psychedelia*. New York, NY: Penguin/Arkana.
89. Díaz, J. L. (1979). Ethnopharmacology and taxonomy of Mexican psychodysleptic plants. *Journal of Psychedelic Drugs*, *11*(1-2), 71-101. doi:10.1080/027 91072.1979.10472094
90. Díaz-Mataix, L., Scorza, M. C., Bortolozzi, A., Toth, M., Celada, P., & Artigas, F. (2005). Involvement of 5-HT_{1A} receptors in prefrontal cortex modulation of dopaminergic activity. *Journal of Neuroscience*, *25*, 10831-10843.
91. Ditman, K. S., Moss, T., Forgy, E. W., Zunin, L. M., Lynch, R. D., & Funk, W. A. (1969). Dimensions of the LSD, methylphenidate and chlordiazepoxide experiences. *Psychopharmacologia*, *14*, 1-11.
92. Dobkin de Rios, M. (1978). A psi approach to love magic, witchcraft and psychedelics in the Peruvian Amazon. *Phoenix: New Directions in the Study of Man*, *2*, 22-27.
93. Dobkin de Rios, M. (1984). The vidente phenomenon in third world traditional healing: An Amazonian example. *Medical Anthropology*, *8*, 60-70. doi:10.108 0/01459740.1984.9965889
94. Dobkin de Rios, M., & Janiger, O. (2003). *LSD, spirituality, and the creative process*: *Based on the groundbreaking research of Oscar Janiger, M.D*. Rochester, VT: Park Street Press.
95. Dobkin de Rios, M., & Rumrrill, R. (2008). *A hallucinogenic tea, laced with controversy: Ayahuascain the Amazon and the United States.* Westport, CT: Greenwood Press.
96. Doblin, R. (1991). Pahnke's Good Friday experiment: A long-term follow-up and methodological critique. *Journal of Transpersonal Psychology*, *23*(1), 1-28.
97. Doblin, R. (2004, June). *Psychedelic and marijuana research: Politics and promise* (Audio CDROM). Paper presented at the international conference Exploring Consciousness: With What Intent?, Bath Spa University, UK.
98. Domino, E. F., & Warner, D. S. (2010). Taming the ketamine tiger. *Anesthesiology*, *113*, 678-684.
99. Don, N. S., McDonough, B. E., Warren, C. A., & Moura, G. (1996). Psi, brain function, and "Ayahuasca" (telepathine). *Proceedings of papers presented at the 39th Parapsychology Association Annual Convention, San Diego*, pp. 315-334.
100. Doyle, R. (2012). Healing with plant intelligence: A report from ayahuasca. *Anthropology of Consciousness*, *23*, 28-43.
101. Driver, H. (1969). *Indians of North America* (2nd ed., Rev.). Chicago, IL: University of Chicago Press.
102. Dunbar, E. (1905). Light thrown on psychological processes by the action of drugs. *Proceedings of the Society for Psychical*

Research, *19*, 62-77.
103. Durwin, J. (2001). *Dreamtime: Psycho-biological methodology and morphogenesis in the shamanic tradition.* Unpublished manuscript, Arizona State University.
104. Eastman, M. (1962). Out-of-the-body experiences. *Proceedings of the Society for Psychical Research*, *53*, 287-309.
105. Echenhofer, F. (2005). Ayahuasca/EEG research progress report and invitation to donate. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *15*(1), 19-20.
106. Eckblad, M., & Chapman, L. J. (1983). Magical ideation as an indicator of schizotypy. *Journal of Consulting and Clinical Psychology*, *51*, 215-225.
107. Edge, H. L., Morris, R. L., Palmer, J., & Rush, J. H. (1986). *Foundations of parapsychology: Exploring the boundaries of human capability*. London, UK: Routledge and Kegan Paul.
108. Eisner, B. G. (1995). Physical and psychical loading (Abstract from the Fourteenth Annual Meeting of the Society for Scientific Exploration). *Journal of Scientific Exploration*, *9*, 45.
109. Eisner, B. (1989). *Ecstasy: The MDMA story.* Berkeley, CA: Ronin.
110. Ellis, H. (1898). Mescal: A new artificial paradise. *The Contemporary Review*, *73*, 130-141.
111. Evans, S., Almahdi, B., Sultan, P., Sohanpal, I., Brandner, B., Collier, T., … Averbeck, B. B. (2012). Performance on a probabilistic inference task in healthy subjects receiving ketamine compared with patients with schizophrenia. *Journal of Psychopharmacology*, *26*, 1211-1217. doi:10.1177/0269881111435252
112. Exman, E. (1961). Individual and group experiences. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 10-13). New York, NY: Parapsychology Foundation.
113. Farber, P. (2000). MDMA and hypnotic anchoring. In T. Lyttle. (Ed.), *Psychedelics reimagined* (pp. 87-90). Brooklyn, NY: Autonomedia.
114. Fenwick, P. (1997). Is the near-death experience only *N*-methyl-D-aspartate blocking? *Journal of Near-Death Studies*, *16*, 42-53. doi:10.1023/A:102505921 0388
115. Fracasso, C., & Friedman, H. (2011). Near-death experiences and the possibility of disembodied consciousness: Challenges to prevailing neurobiological and psychosocial theories. *NeuroQuantology*, *9*, 41-53.
116. Frederiks, J. A. M. (1963). Macrosomatognosia and microsomatognosia. *Psychiatria, Neurologia, Neurochirurgia*, *66*, 531-536.
117. Friedman, H. (1983). The Self-Expansiveness Level Form: A conceptualization and measurement of a transpersonal construct. *Journal of Transpersonal Psychology*, *15*, 37-50.
118. Friedman, H. (2006). The renewal of psychedelic research: Implications for humanistic and transpersonal psychology. *The Humanistic Psychologist*, *34*(1), 39-58.
119. Friedman, S. M., & Fisher, C. (1960). Further observations on primary modes of perception: The use of a masking technique for subliminal visual stimulation. *Journal of the American Psychoanalytic Association*, *8*, 100-129.
120. Gallagher, C., Kumar, V. K., & Pekala, R. J. (1994). The anomalous experiences inventory: Reliability and validity. *Journal of Parapsychology*, *58*, 402-428.
121. Garrett, E. J. (1961a). Patterns of clairvoyance. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 14-16). New York, NY: Parapsychology Foundation.
122. Garrett, E. J. (1961b). Psychopharmacological parallels to mediumship. *Proceedings of two conferences on parapsychology and pharmacology* (pp. 61-63). New York, NY: Parapsychology Foundation.
123. Gaskin, S. (1990). *Haight-Ashbury flashbacks* (2nd ed.). Berkeley, CA: Ronin.
124. Gelfer, J. (2007). Towards a sacramental understanding of dextromethorphan. *Journal of Alternative Spiritualities and New Age Studies*, *3*, 80-96.
125. Giesler, P. (1984). Parapsychological anthropology. I. Multi-method approaches to the study of psi in the field setting. *Journal of the American Society for Psychical Research*, *78*, 287-328.
126. Giesler, P. (1985). Parapsychological anthropology. II. A multi-method study of psi and psi-related processes in the Umbanda ritual trance consultation. *Journal of the American Society for Psychical Research*, *79*(2), 113-166.
127. González, D., Riba, J., Bouso, J. C., Gómez-Jaraboa, G., & Barbanoj, M. J. (2006). Pattern of use and subjective effects of *Salvia divinorum* among recreational users. *Drug and Alcohol Dependence*, *85*, 157-162.
128. González-Maeso, J., Ang, R. L., Yuen, T., Chan, P., Weisstaub, N. V., López-Giménez, J. F., … Sealfon, S. C. (2008). Identification of a serotonin/glutamate receptor complex implicated in psychosis [Letter to the editor]. *Nature (online)*, *452*, 93-97. doi:10.1038/nature06612
129. Gorman, P. (1992). Journeys with ayahuasca, the vine of the little death. *Shaman's Drum*, *29*, 49-58. Gowan, J. C. (1975). *Trance, art, and creativity*. Buffalo, NY: State University College.
130. Greeley, A. M. (1974). *Ecstasy: A way of knowing*. Englewood Cliffs, NJ: Prentice-Hall.
131. Grey, A. (2007). *Chapel of sacred mirrors: COSM tour book*. Wappingers Falls, NY: CoSM Press.
132. Greyson, B. (2000). Near-death experiences. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience: Examining the scientific evidence* (pp. 315-352). Washington, DC: American Psychological Association.
133. Griffiths, R. R., Richards, W. A., McCann, U., & Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology*, *187*(3), 268-283.
134. Grinspoon, L., & Bakalar, J. (1979). *Psychedelic drugs reconsidered*. New York, NY: Basic Books.
135. Grinspoon, L., & Bakalar, J. B. (1998). *Psychedelic drugs reconsidered* (2nd ed.). New York, NY: Lindesmith Centre.
136. Grob, C., & Harman, W. (1995). Making sense of the psychedelic issue: Federal approval for research into psychedelics resumes. *Noetic Sciences Review*, *35*, 4-19.
137. Grof, S. (1970). *Subjective experiences during the LSD training session*. Unpublished manuscript, retrieved from http://www.maps.org/research/cluster/psilolsd/grof1970.pdf
138. Grof, S. (1975). *Realms of the human unconscious:Observations from LSD research*. NY: Viking Press. Grof, S. (1980). *LSD psychotherapy*. Pomona, CA: Hunter House.
139. Grof, S. (1990). Survival after death: Observations from modern consciousness research. In G. Doore (Ed.), *What survives? Contemporary explanations of life afterdeath* (pp. 22-33). Los Angeles, CA: Tarcher.

140. Grof, S. (1994). Alternative cosmologies and altered states. *Noetic Sciences Review*, *32*, 21-29.
141. Grof, S. (2001). *LSD psychotherapy* (3rd ed.). Sarasota, FL: Multidisciplinary Association for Psychedelic Studies.
142. Grof, S. (2004). Stanislav Grof interviewing Dr. Albert Hofmann at the Esalen Institute in Big Sur, California, 1984. In P. Peet (Ed.), *Under the influence: The disinformation guide to drugs* (pp. 284-295). New York, NY: Disinformation Company.
143. Grosso, M. (1976). Some varieties of out-of-body experience. *Journal of the American Society for Psychical Research*, *70*(2), 179-193.
144. Halliday, J. L. (1961). The practice of active introversion. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 64-66). New York, NY: Parapsychology Foundation.
145. Hameroff, S., & Chopra, D. (2010, August 16). End-of-life brain activity: A sign of the soul? *Huffington Post*. Retrieved from http://www.huffingtonpost.com/deepak-chopra/end-of-life-brain-activit_b_684176.html
146. Hancock, G. (2005). *Supernatural: Meetings with the ancient teachers of mankind*. London, UK: Century.
147. Hanna, J. (2003). *Drug inspired metaphysical concepts*. Talk given at Burning Man festival, available on audio from http://www.matrixmasters.com/podcasts/JonHanna/JonHanna-BurningMan2003. mp3
148. Hanna, J. (2010). *DMT and the pineal: Fact or fiction?* Uploaded 3rd June 2010 on www.erowid.org/chemicals/dmt/dmt_article2.shtml
149. Harman, W. (1963). Some aspects of the psychedelic drug controversy. *Journal of Humanistic Psychology*, *3*, 93-107.
150. Harvey-Wilson, S. (2001). Shamanism and alien abductions: A comparative study. *Australian Journal of Parapsychology*, *1*, 103-116.
151. Hastings, A. C. (1973). *Psychical Research*. Menlo Park, CA: Center for the Study of Social Policy, Stanford Research Institute.
152. Hastings, A. (2006). An extended nondrug MDMA-like experience evoked through posthypnotic suggestion. *Journal of Psychoactive Drugs*, *38*(3), 273-283. doi:10. 1080/02791072.2006.10399853
153. Hastings, A., Berk, I., Cougar, M., Ferguson, E., Giles, S., Steinbach-Humphrey, S., ... Viglizzo, B. (2000). An extended non-drug MDMA-like experience evoked through hypnotic suggestion. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *10*(1), 10.
154. Hermans, H. G. M. (1998). *Memories of a maverick*. Maassluis, Netherlands: Pi.
155. Heywood, R. (1961). Personality changes under mescaline. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 72-73). New York, NY: Parapsychology Foundation.
156. Heywood, R. (1978). *The sixth sense: An inquiry into extra-sensory perception* (2nd ed.). Harmondsworth, Middlesex, UK: Penguin Books.
157. Hill, D. R., & Persinger, M. A. (2003). Application of transcerebral, weak (1 microT) complex magnetic fields and mystical experiences: Are they generated by field-induced dimethyltryptamine release from the pineal organ? *Perceptual and Motor Skills*, *97*, 1049-1050.
158. Hirst, M. (2000). Root, dream and myth. The use of the oneirogenic plant *Silene capensis* among the Xhosa of South Africa. *Eleusis: Journal of Psychoactive Plants and Compounds*, *4*, 121-149.
159. Hirst, M. (2005). Dreams and medicines: The perspective of Xhosa diviners and novices in the Eastern Cape, South Africa. *Indo-Pacific Journal of Phenomenology*, *5*(2), 1-22.
160. Hirukawa, T., Hiraoka, R., da Silva, F. E., Pilato, S., & Kokubo, H. (2006). Field REG experiments of religious rituals and other group events in Paraná, Brazil. *Livro de registro de trabalhos apresentados, 3 Encontro Psi, Implicações e Aplicações da Psi [Proceedings of presented papers, 3rd Psi Meeting: Implications and Applications of Psi],* Curitiba: Faculdades Integradas "Espírita", Curitiba, Brazil, 17-26.
161. Hoffer, A. (1961a). Non-statistical research techniques. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 17-18). New York, NY: Parapsychology Foundation.
162. Hoffer, A. (1961b). Pharmacological stimuli to sensitivity. *Proceedings of two conferences on parapsychology and pharmacology* (pp. 69-71). New York, NY: Parapsychology Foundation.
163. Hofmann, A. (1983). *LSD my problem child: Reflections on sacred drugs, mysticism, and science*. Los Angeles, CA: Jeremy P. Tarcher.
164. Holt, N. J., Simmonds-Moore, C. A., & Moore, S. L. (2008). *Psi, belief in the paranormal, attentional filters and mental health*. Paper presented at the Bial Foundation Convention, Porto, Portugal.
165. Holzinger, R. (1964). LSD 25: A tool in psychotherapy. *Journal of General Psychology*, *71*, 9-20. doi:10.1080/00221309.1964.9710285
166. Honorton, C. (1977). Psi and internal attention states. In B. B. Wolman (Ed.), *Handbook of Parapsychology* (pp. 435-472). New York, NY: Van Nostrand Rheinhold.
167. Horn, S. (2009). *Unbelievable: Investigations into ghosts, poltergeists, telepathy, and other unseen phenomena, from the Duke parapsychology laboratory*. New York, NY: Ecco Press.
168. Horner, C. (2012). *The university of the forest: Plant spirits in ayahuasca shamanism*. Unpublished masters thesis, University of Colorado, CO.
169. Houran, J., & Lange, R. (2001). Support for the construct validity of the two-factor conceptualization of paranormal belief: A complement to Thalbourne. *European Journal of Parapsychology*, *16*, 53-61.
170. Houran, J., & Williams, C. (1998). Relation of tolerance of ambiguity to global and specific paranormal experience. *Psychological Reports*, *83*, 807-818.
171. Huby, P. M., & Wilson, C. W. M. (1961). The effects of centrally acting drugs on ESP ability in normal subjects. *Journal of the Society for Psychical Research*, *41*, 60-67.
172. Hurst, W. (1994). Report from the Telluride mushroom conference, Colorado, August 26-29, 1994. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *5*(3), 33-38.
173. Huxley, A. (1954). *The doors of perception*. London, UK: Chatto & Windus.
174. Huxley, F. (1961a). Increase in awareness and suggestibility. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 72-73). New York, NY: Parapsychology Foundation.
175. Huxley, F. (1961b). States of suggestibility. In *Proceedings of two conferences on parapsychology and pharmacology* (pp.

19-21). New York, NY: Parapsychology Foundation.

176. International Foundation for Advanced Study. (1962). *Research report No. 1: Questionnaire study of the psychedelic experience*. Menlo Park, CA: Author.
177. Irwin, H. J. (1994). *An introduction to parapsychology* (2nd ed.). Jefferson, NC: McFarland.
178. Irwin, H. (2009). *The psychology of paranormal belief: A researcher's handbook*. Hatfield, UK: University of Hertfordshire Press.
179. Jacob, M. S., & Presti, D. E. (2005). Endogenous psychoactive tryptamines reconsidered: An anxiolytic role for dimethyltryptamine. *Medical Hypotheses*, *64*, 930-937.
180. James, W. (1902). *The varieties of religious experience*. New York, NY: Longmans Green.
181. Jansen, K. L. R. (1990). Neuroscience and the near-death experience: Roles for the NMDA-PCP receptor, the sigma receptor, and the endopsychosins. *Medical Hypotheses*, *31*, 25-29. doi:10.1016/0306-9877(90)90048-J
182. Jansen, K. L. R. (1997a). The ketamine model of the near-death experience: A central role for the NMDA receptor. *Journal of Near-Death Studies*, *16*, 5-26. doi:10.1023/A:1025055109480
183. Jansen, K. L. R. (1997b). Response to commentaries on "The ketamine model of the near-death experience ... ". *Journal of Near-Death Studies*, *16*, 79-95. doi:10.1023/A:1025019529044
184. Jansen, K. L. R. (1999). Ketamine (K) and quantum psychiatry. *Asylum: The Journal for Democratic Psychiatry*, *11*(3), 19-21.
185. Jansen, K. [L. R.] (2001). *Ketamine: Dreams and realities*. Sarasota, FL: Multidisciplinary Association for Psychedelic Studies.
186. Jansen, K. [L. R.] (2004). What can ketamine teach us about ordinary and altered states of consciousness? *Consciousness research abstracts from the Toward a Science of Consciousness Conference, Tucson, Arizona*, p. 90.
187. Johns, L. C., Cannon, M. S., Singleton, N., Murray, R. M., Farrell, M., Brugha, T., ... Meltzer, H. (2004). Prevalence and correlates of self-reported psychotic symptoms in the British population. *British Journal of Psychiatry*, *185*(10), 298-305. doi:10.1192/bjp.185. 4.298
188. Johnson, R. C. (1955). *Psychical research*. London, UK: English Universities Press.
189. Kaiser, D. (2011). *How the hippies saved physics: Science, counterculture and the quantum revival*. New York, NY: W. W. Norton.
190. Kappers, J. (1983). Screening for good ESP subjects with object-reading. In W. G. Roll, J. Bellof, & R. A. White (Eds.), *Research in parapsychology: Abstracts and papers from the combined 25th Annual Convention of the Parapsychological Association and the Centenary Conference of the Society for Psychical Research, 1982* (pp. 150-151). Metuchen, NJ: Scarecrow Press.
191. Kapur, S., & Seeman, P. (2002). NMDA receptor antagonists ketamine and PCP have direct effects on the dopamine D(2) and serotonin 5-HT(2)receptors: Implications for models of schizophrenia. *Molecular Psychiatry*, *7*, 837-844.
192. Kärkkäinen, J., Forsström, T., Tornaeus, J., Wähälä, K., Kiuru, P., Honkanen, A., ... Hesso, A. (2005). Potentially hallucinogenic 5-hydroxytryptamine receptor ligands bufotenine and dimethyltryptamine in blood and tissues. *Scandinavian Journal of Clinical and Laboratory Investigation*, *65*(3), 189-199.
193. Kastrup, B. (2012). A paradigm-breaking hypothesis for solving the mind-body problem. *Paranthropology*, *3*(3), 4-12.
194. Katzung, B. G., Masters, S. B., & Trevor, A. J. (2012). *Basic and clinical pharmacology (12th ed.)*. New York, NY: McGraw-Hill Medical.
195. Kensinger, K. M. (1978). Banisteriopsis usage among the Peruvian Cashinahua. In M. J. Harner (Ed.), *Hallucinogens and shamanism* (pp. 9-14). Oxford, UK: Oxford University Press.
196. Kent, J. (2005). The case against DMT elves. In C. Pickover (Ed.), *Sex, drugs, Einstein, and elves* (pp. 102-105). Petaluma, CA: Smart Publications.
197. Kent, J. L. (2010). *Psychedelic information theory:Shamanism in the age of reason*. Seattle, WA: PIT Press.
198. Kern, M.D. (1964). The University of California Extension Division Liberal Arts Conference: Seminar on psychical research and the psychedelic drugs. *Journal of the American Society for Psychical Research*, *58*, 75-76.
199. Kjellgren, A., & Norlander, T. (2000-2001). Psychedelic drugs: A study of drug-induced experiences obtained by illegal drug users in relation to Stanislav Grof's model of altered states of consciousness. *Imagination,Cognition and Personality*, *20*(1), 41-57.
200. Kjellgren, A., & Soussan, C. (2011). Heaven and hell: A phenomenological study of recreational use of 4-HO-MET in Sweden. *Journal of Psychoactive Drugs*, *43*, 211-219.
201. Kohr, R. L. (1980). A survey of psi experiences among members of a special population. *Journal of the American Society for Psychical Research*, *74*, 395-411.
202. Kolp, E., Young, M. S., Friedman, H., Krupitsky, E., Jansen, K., & O'Connor L. (2007). Ketamine enhanced psychotherapy: Preliminary clinical observations on its effectiveness in treating death anxiety. *International Journal of Transpersonal Studies*, *26*, 1-17.
203. Krippner, S. (1967). The cycle of deaths among U.S. presidents elected at twenty-year intervals. *International Journal of Parapsychology*, *9*(3), 145-153.
204. Krippner, S. (1985). Psychedelic drugs and creativity. *Journal of Psychoactive Drugs*, *17*(4), 235-245. doi:10.1080/02791072.1985.10524328
205. Krippner, S. (1999). A pilot study in dream telepathy with the Grateful Dead. In R. G. Weiner (Ed.), *Perspectives on the Grateful Dead: Critical writings* (pp. 11-17). Westport, CT: Greenwood Press.
206. Krippner, S. (2006a, January). *LSD and parapsychological experiences*. Paper presented at LSD: Problem Child and Wonder Drug, an International Symposium on the Occasion of the 100th Birthday of Albert Hofmann, 13-15 January, Basel, Switzerland.
207. Krippner, S. (2006b, January). *The future of religion*. Paper presented at LSD: Problem Child and Wonder Drug, an International Symposium on the Occasion of the 100th Birthday of Albert Hofmann, 13-15 January, Basel, Switzerland.
208. Krippner, S., & Davidson, R. (1970). Religious implications of paranormal events occurring during chemically-induced "psychedelic" experience. *Pastoral Psychology*, *21*, 27-34.
209. Krippner, S., & Davidson, R. (1974). Paranormal events occurring during chemically-induced psychedelic experience and their implications for religion. *Journal of Altered States of Consciousness*, *1*, 175-184.
210. Krippner, S., & Fersh, D. (1970). Paranormal experiences among members of American contra-cultural groups. *Journal of*

Psychedelic Drugs, *3*, 109-114.

211. Krippner, S., Honorton, C., & Ullman, M. (1973). An experiment in dream telepathy with "The Grateful Dead." *Journal of the American Society for Psychosomatic Dentistry and Medicine*, *20*, 9-18.
212. Krippner, S., & Luke, D. (2009). Psychedelics and species connectedness. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *19*(1), 12-15.
213. Krummenacher, P., Brugger, P., Fahti, M., & Mohr, C. (2002). *Dopamine, paranormal ideation, and the detection of meaningful stimuli.* Poster presented at the 3rd Forum of European Neuroscience, Paris, France.
214. Krummenacher, P., Mohr, C., Haker, H., & Brugger, P. (2009). Dopamine, paranormal belief, and the detection of meaningful stimuli. *Journal of Cognitive Neuroscience*, *22*, 1670-1681.
215. Kugel, W. (1977). Call-time as a new parameter in statistical ESP experiments. In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.), *Research in parapsychology1976: Abstracts and Papers from the Nineteenth Annual Convention of the Parapsychological Association*, (pp. 138-140). Metuchen, NJ: Scarecrow Press.
216. Kumar, V. K., Pekala, R. J., & Cummings, J. (1992). Sensation seeking, drug use, and reported paranormal beliefs and experiences. In E. W. Cook (Ed.), *Research in parapsychology: Abstracts and Papers from the 34th Annual Convention of the Parapsychological Association*, *1992* (pp. 35-40). Metuchen, NJ: Scarecrow Press.
217. Kumar, V. K., Pekala., R. J., & Gallagher, C. (1994). *The anomalous experiences inventory (AEI)*. Unpublished psychological test. West Chester University of Pennsylvania.
218. Laidlaw, R. W. (1961). New understanding of mediumistic phenomena. In *Proceedings on two conferences on parapsychology and pharmacology* (pp. 25-26). New York, NY: Parapsychology Foundation.
219. Langdon-Davies, J. (1961). *On the nature of man*. New York, NY: New American Library.
220. Lange, R., Thalbourne, M. A., Houran, J., & Storm, L. (2000). The revised transliminality scale: Reliability and validity data using a top-down purification procedure. *Consciousness and Cognition*, *9*, 591-617.
221. Leary, T., Litwin, G. H., & Metzner, R. (1963). Reactions to psilocybin administered in a supportive environment. *Journal of Nervous and Mental Disease*, *137*, 561-573.
222. Leary, T., Metzner, R., & Alpert, R. (1964). *The psychedelic experience: A manual based on the Tibetan book of the dead*. New York, NY: University Books.
223. Lee, H.-M., & Roth, B. L. (2012). Hallucinogen actions on human brain revealed. *Proceedings of the National Academy of Science*, *109*, 1820-1821.
224. Lerner, M., & Lyvers, M. (2006). Values and beliefs of psychedelic drug-users: A cross-cultural study. *Journal of Psychoactive Drugs*, *38*, 143-147.
225. LeShan, L. (1968). Psi and altered states of consciousness. In R. Cavanna & M. Ullman (Eds.), *Psi and altered states of consciousness: Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 129-131). New York, NY: Parapsychology Foundation.
226. Letcher, A. (2004, June). *Mad thoughts on mushrooms: Discourse and power in the study of psychedelic consciousness*. (Audio CDROM). Paper presented at the international conference Exploring Consciousness: With What Intent?, Bath Spa University, UK.
227. Levine, J. (1968). Psychopharmacology: Implications for psi research. In R. Cavanna & M. Ullman (Eds.), *Psi and altered states of consciousness: Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 88-106). New York, NY: Parapsychology Foundation.
228. Levine, J., & Ludwig, A. M. (1965). Alterations in consciousness produced by combinations of LSD, hypnosis, and psychotherapy. *Psychopharmacologia*, *7*, 123-137.
229. Lilly, J. C. (1967). *The human biocomputer*. London, UK: Abacus.
230. Lilly, J. C. (1969). Parapsychological Association convention dinner address: Inner space and parapsychology [abstract]. *Journal of Parapsychology*, *33*, 349.
231. Lilly, J. C. (1978). *The scientist*. Philadelphia, PA: Lippincott.
232. Louv, J. (Ed). (2005). *Generation hex*. New York, NY: Disinformation Company.
233. Ludwig, A. M. (1968). The hypnodelic state. In R. Cavanna & M. Ullman (Eds.), *Psi and altered states of consciousness: Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 68-87). New York, NY: Parapsychology Foundation. Ludwig, A. M., & Lyle, W. H. (1964). The experimental production of narcotic drug effects and withdrawal symptoms through hypnosis. *International Journal of Clinical and Experimental Hypnosis*, *12*, 1-17.
234. Luke, D. [P.] (2004a). *Altered states of psi: A neurochemical perspective* (audiocassette). London, UK: Society for Psychical Research Invited Lecture Series.
235. Luke, D. [P.] (2004b). Paranormal experiences and psychoactive drugs: A literature review project. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *14*(1), 11.
236. Luke, D. [P.] (2004c, June). *Psi-chedelics and science. Looking for the lost field of parapsycho-pharmacology*. (Audio CDROM). Paper presented at the international conference Exploring Consciousness: With What Intent?, Bath Spa University, UK.
237. Luke, D. (2005). *Transpersonal and paranormal experiences with entheogenic substances: A parapsychological first-person perspective.* Unpublished manuscript.
238. Luke, D. [P.] (2006). A tribute to Albert Hofmann on his 100th birthday: The mysterious discovery of LSD and the impact of psychedelics on parapsychology. *Paranormal Review*, *37*, 3-8.
239. Luke, D. (2007). Lecture report: Inducing near-death states through the use of chemicals - Dr. Ornella Corazza. *Paranormal Review*, *43*, 28-29.
240. Luke, D. P. (2008a). Inner paths to outer space: Journeys to alien worlds through psychedelics and other spiritual technologies by Rick Strassman *et al.* [book review]. *Journal of Scientific Exploration*, *22*, 564-569.
241. Luke, D. P. (2008b). Psychedelic substances and paranormal phenomena: A review of the research. *Journal of Parapsychology*, *72*, 77-107.
242. Luke, D. (2009). Near-death experiences: Exploring the mind-body connection, by Ornella Corazza [book review]. *Journal of Parapsychology*, *73*, 175-180.

243. Luke, D. (2010a). Anthropology and parapsychology: Still hostile sisters in science? *Time and Mind: The Journal of Archaeology, Consciousness & Culture*, *3*(2), 245-266.
244. Luke, D. (2010b). Connecting, diverging and reconnecting. Putting the psi back into psychedelic research. *Journal of Parapsychology*, *74*, 219-234.
245. Luke. D. P. (2010c). Rock art or Rorschach: Is there more to entoptics than meets the eye? *Time and Mind: The Journal of Archaeology, Consciousness & Culture*, *3*, 9-2.
246. Luke, D. (2011a). Anomalous phenomena, psi and altered consciousness. In E. Cardeña & M. Winkelman (Eds.), *Altering consciousness: A multidisciplinary perspective, volume 2. Biological and psychological perspectives* (pp. 355-374). Westport, CT: Praeger.
247. Luke, D. (2011b). Discarnate entities and dimethyltryptamine (DMT): Psychopharmacology, phenomenology and ontology. *Journal of the Society for Psychical Research*, *75*, 26-42.
248. Luke, D. (2011c). Experiential reclamation and first person parapsychology. *Journal of Parapsychology*, *75*, 185-199.
249. Luke, D. (2012a). Notes on getting cactus lodged in your reducing valve: San Pedro and psychic abilities. In R. Heaven (Ed.). *Cactus of mystery: The shamanic powers of the Peruvian San Pedro cactus.* Rochester, VT: Inner Traditions.
250. Luke, D. (2012b). Psi-verts and psychic piracy: The future of parapsychology? In D. Pinchbeck & K. Jordan (Eds.), *Exploring the edge realms of consciousness: Liminal zones, psychic science, and hidden dimensions of the mind* (pp.114-128). New York, NY: North Atlantic Books.
251. Luke, D. (in press). So long as you've got your elf: Death, DMT and discarnate entities. In A. Voss & W. Rowlandson (Eds.), *Daimonic imagination: Uncanny intelligence.* Cambridge, UK: Cambridge Scholars.
252. Luke, D. P., Delanoy, D., & Sherwood, S. J. (2008). Psi may look like luck: Perceived luckiness and beliefs about luck in relation to precognition. *Journal of the Society for Psychical Research*, *72*(4), 193-207.
253. Luke, D. P., & Friedman, H. (2010). The speculated neurochemistry of psi and associated processes. In S. Krippner & H. Friedman (Eds.), *Mysterious minds: The neurobiology of psychics, mediums and other extraordinary people.* (pp. 163-185). Westport, CT: Greenwood/Praeger.
254. Luke, D. P., & Kittenis, M. (2005). A preliminary survey of paranormal experiences with psychoactive drugs. *Journal of Parapsychology*, *69*(2), 305-327.
255. Luke, D., & Zychowicz, K. (2011). Working the graveyard shift at the witching hour: Further exploration of dreams, psi and circadian rhythms. In M. Kittenis (Ed.), *Abstracts of presented papers, 54th Parapsychological Association Annual Convention, Curitiba, Brazil, August 22-25.* Columbus, OH: Parapsychological Association.
256. Luke, D., Zychowicz, K., Richterova, O., Tjurina, I., & Polonnikova, J. (2010, September). *An in direct approach to the neurobiology of psi: Precognition and circadian rhythms.* Proceedings of presented papers to the 6th Psi Meeting: Neuroscience & Parapsychology, Curitiba, Brazil, pp. 106-108.
257. Luke, D., Zychowicz, K., Richterova, O., Tjurina, I., & Polonnikova, J. (2012). A sideways look at the neurobiology of psi: Precognition and circadian rhythms. *NeuroQuantology: An Interdisciplinary Journal of Neuroscience and Quantum Physics*, *10(3)*, 580-590.
258. Luna, L. E., & White, S. F. (Eds.). (2000). *Ayahuasca reader: Encounters with the Amazon's sacred vine*. Sante Fe, NM: Synergetic Press.
259. Mack, J. E. (1999). *Passport to the cosmos: Human transformation and alien encounters*. New York, NY: Three Rivers.
260. Maher, B. (2008). The case of the missing heritability. *Nature*, *456*, 18-21.
261. Marti-Ibanez, F. (1965, June). The gates to paradise. *MD Medical News-magazine*, 11.
262. Masters, R. E. L., & Houston, J. (1966). *The varieties of Psychedelic experience*. London, UK: Turnstone.
263. Mayagoitia, L., Díaz, J-L., & Contreras, C. M. (1986). Psychopharmacologic analysis of an alleged oneirogenic plant: *Calea zacatechichi*. *Journal of Ethnopharmacology*, *18*, 229-243.
264. Mayhew, C. (1956, October 26). An excursion out of time. *The London Observer*.
265. McCreery, C., & Claridge, G. (1995). Out-of-the-body experiences and personality. *Journal of the Society for Psychical Research*, *60*, 129-148.
266. McGovern, W. (1927). *Jungle paths and Inca ruins*. New York, NY: Grosset & Dunlap.
267. McIlhenny, E. H. (2012). *Ayahuasca characterization, metabolism in humans, and relevance to endogenous N,N-dimethyltryptamines*. Unpublished doctoral thesis, Louisiana State University. Available from http://www.neip.info/downloads/McIlhenny_ Ayahuasca.pdf
268. McKenna, D. (2004). Clinical investigations of the therapeutic potential of ayahuasca: Rationale and regulatory challenges. *Pharmacology and Therapeutics*, *102*, 111-129. doi:10.1016/S0163-7258(04)00046-4
269. McKenna, T. (1991). *The archaic revival: Speculations on psychedelic mushrooms, the Amazon, virtual reality, UFOs, evolution, shamanism, the rebirth of the Goddess, and the end of history.* San Francisco, CA: Harper.
270. McKenna, T, & McKenna, D. (1994). *The invisible landscape: Mind, hallucinogens, and the I Ching*. Pymble, NSW, Australia: Harper Collins Australia.
271. Meduna, L. J. (1950). The effect of carbon dioxide upon the functions of the brain. In L. J. Meduna (Ed.), *Carbon dioxide therapy*. Springfield, IL: Charles Thomas.
272. Mercury, D., & Feelodd, D. (2008). First look at a new psychoactive drug: Symmetry (salvinorin B ethoxymethyl ether). *The Entheogen Review*, *16*, 136-145.
273. Metzner, R. (1992). Divinatory dreams induced by tree datura. In C. Rätsch, *Yearbook for Ethnomedicine and the Study of Consciousness (1991-0)* (pp. 193- 198). Berlin, Germany: VWB.
274. Metzner, R. (2005). Psychedelic, psychoactive and addictive drugs and states of consciousness. In M. Earlywine (Ed.), *Mind-altering drugs: The science of subjective experience* (pp. 27-48). New York, NY: Oxford University Press.
275. Meyer, P. (1994). Apparent communication with discarnate entities induced by dimethyltryptamine (DMT). In T. Lyttle (Ed.), *Psychedelics* (pp. 161- 203). New York, NY: Barricade Books.
276. Michelot, D., & Melendez-Howell, L. M. (2003). *Amanita muscaria*: Chemistry, biology, toxicology, and ethnomycology. *Mycological Research*, *107*, 131- 146.

277. Millay, J. (1999). *Multidimensional mind: Remote viewing in hyperspace*. Berkeley, CA: North Atlantic Books.
278. Millay, J. (2001). The influence of psychedelics on remote viewing. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *11*(1), 43-44.
279. Millay, J. (2004a, May). *Psi and psychedelics: Stories from the underground*. Presentation given at the Conference of the Association for Scientific and Spiritual Advancement, San Francisco, CA.
280. Millay, J. (2004b). Psi and entheogens. *Proceedings of the 20th Annual International Conference on the Study of Shamanism and Alternative Modes of Healing, San Rafael, CA.*
281. Millay, J. (2005, September). *Psychedelics, psychics, and psi* (Part 1 of 2). Paper presented at the 21st Annual International Conference on Study of Shamanism and Alternative Modes of Healing, San Rafael, CA.
282. Millay, J. (2006, September). *Psychedelics, psychics, and psi* (Part 2 of 2). Paper presented at the 22nd Annual International Conference on the Study of Shamanism and Alternative Modes of Healing, San Rafael, CA.
283. Millay, J. (2010). Psychic gifts from entheogens. In J. Millay (Ed.). *Radiant minds: Scientists explore the dimensions of consciousness* (pp. 217-226). Doyle, CA: Millay.
284. Miller, I. (1994). *Becoming the vine: An anecdotal account of ayahuasca initiation*. Unpublished manuscript, available at www.mishkitaki.org/main/wp.../07/Becoming-the-Vine.pdf
285. Miller, R. A. (1978). The biological function of the third eye. *The Continuum*, *2*(3).
286. Milton, J., & Wiseman, R. (1997). *Guidelines for extrasensory perception research*. Hatfield, UK: University of Herefordshire.
287. MoDu (2003). Shared experiences and fields of consciousness. *Entheogen Review*, *12*(2), 56-58.
288. Mogar, R. E. (1965). Current status and future trends in psychedelic (LSD) research. *Journal of Humanistic Psychology*, *5*, 147-166. Montanelli, D. G., & Parra, A. (2000). Conflictive psi experiences: A survey with implications for clinical parapsychology [Abstract]. *Journal of Parapsychology*, *64*, 248.
289. Morse, M. L. (1997). Commentary on Jansen's paper. *Journal of Near-Death Studies*, *16*, 59-62. doi:10.1023/A:1025063311297
290. Morse, M. L., Venecia, D., & Milstein, J. (1989). Near-death experiences: A neurophysiologic explanatory model. *Journal of Near-Death Studies*, *8*, 45-53.
291. Motoyama, H. (2001). *Theories of the chakras: Bridge to higher consciousness*. New Delhi, India: New Age Books.
292. Muetzelfeldt, L., Kamboj, S. K., Rees, H., Taylor, J., Morgan, C. J. A., & Curran, H. V. (2008). Journey through the K-hole: Phenomenological aspects of ketamine use. *Drug and Alcohol Dependence*, *95*(3), 219-229.
293. Müller-Ebeling, C., Rätsch, C., & Storl, W.-D. (2003). *Witchcraft medicine: Healing arts, shamanic practices, and forbidden plants*. Rochester, VT: Inner Traditions.
294. Mullis, K. (1998). *Dancing naked in the mind field*. New York, NY: Pantheon Books.
295. Murphy, G. (1961). *The challenge of psychical research*. New York, NY: Harper Colophon.
296. Myers, S. A., Austrin, H. R., Grisso, J. T., & Nickeson, R. C. (1983). Personality characteristics as related to the out-of-body experience. *Journal of Parapsychology*, *47*, 131-144.
297. Naranjo, C. (1967). Psychotropic properties of the harmala alkaloids. In D. Efron (Ed.), *Ethnopharmacologic search for psychoactive drugs: Proceedings of symposium held in San Francisco, January 28-30, 1967* (pp. 385-391). Public Health Service Publication No. 1645. Washington, DC: US Department of Health, Education, and Welfare.
298. Naranjo, C. (1973). *The healing journey: New approaches to consciousness*. New York, NY: Ballantine Books.
299. Naranjo, C. (1987). "Ayahuasca" imagery and the therapeutic property of the harmala alkaloids. *Journal of Mental Imagery*, *11*, 131-136.
300. Narby, J. (1998). *The cosmic serpent, DNA, and the origins of knowledge*. London, UK: Tarcher/Putnum.
301. Narby, J. (2000). Shamans and scientists. In J. Narby & F. Huxley (Eds.), *Shamans through time: 500 years on the path to knowledge* (pp. 301-305). London, UK: Thames & Hudson.
302. Neppe, V. M. (1989). Near-death experiences: A new challenge in temporal lobe phenomenology? Comments on "A neurobiological model for near-death experiences." *Journal of Near-Death Studies*, *7*, 243-248. doi:10.1007/BF01074012
303. Newcombe, R. (2008). Ketamine case study: The phenomenology of the ketamine experience. *Addiction Research & Theory*, *16*, 209-215.
304. Nichols, D. E. (2004). Hallucinogens. *Pharmacology and Therapeutics*, *101*, 131-181. doi:10.1016/j.pharm thera.2003.11.002
305. Nicol, J. F., & Nicol, B. H. (1961). Experimental uses of chemical compounds. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 27-29). New York, NY: Parapsychology Foundation.
306. Nunn, J. A., Rizza, F., & Peters, E. R. (2001). The incidence of schizotypy among cannabis and alcohol users. *Journal of Nervous and Mental Disease*, *189*, 741-748.
307. Nuttal, J. (1970). *Bomb culture*. London, UK: Paladin.
308. Osis, K. (1961a). A pharmacological approach to parapsychological experimentation. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 74-75). New York, NY: Parapsychology Foundation.
309. Osis, K. (1961b). Psychobiological research possibilities. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 30-32). New York, NY: Parapsychology Foundation.
310. Osmond, H. (1961a). New techniques of investigation. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 76-78). New York, NY: Parapsychology Foundation.
311. Osmond, H. (1961b). Variables in the LSD setting. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 33-35). New York, NY: Parapsychology Foundation.
312. Osmond, H. (1968). Psi and the psychedelic movement. In R. Cavanna, & M. Ullman (Eds.), *Psi and altered states of consciousness: Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 107-114). New York, NY: Parapsychology Foundation.
313. Osmond, H., & Smythies, J. (1952). Schizophrenia: A new approach. *Journal of Mental Science*, *98*, 309-315.
314. Ostrander, O., & Schroeder, L. (1997). *Psychic discoveries: The iron curtain lifted*. London, UK: Souvenir Press.
315. Ott, J. (1993). *Pharmacotheon: Entheogenic drugs, their plant sources and history*. Kennewick, WA: Natural Products.
316. Ott, J. (1996). Entheogens II: On entheology and ethnobotany. *Journal of Psychoactive Drugs*, *28*, 205-209. doi:10.1080/02791072.1996.10524393

317. Ott, J. (2001). Pharmanopo-psychonautics: Human intranasal, sublingual, intrarectal, pulmonary and oral pharmacology of bufotenine. *The Journal of Psychoactive Drugs*, *33*, 273-281. doi:10.1080/02791072.2001.10400574
318. de Pablos, F. (2002). Enhancement of precognitive dreaming by cholinesterase inhibition: A pilot study. *Journal of the Society for Psychical Research*, *66*, 88-105.
319. de Pablos, F. (2004). Spontaneous precognition during dreams: A theoretical model. *Journal of the Society for Psychical Research*, *68*, 226-244.
320. Pahnke, W. N. (1966). Drugs and mysticism. *The International Journal of Parapsychology*, *8*(2), 295-313.
321. Pahnke, W. N. (1968). The psychedelic mystical experience in terminal cancer patients and its possible implications for psi research. In R. Cavanna & M.
322. Ullman (Eds.), *Psi and altered states of consciousness:Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 115-128). New York, NY: Parapsychology Foundation.
323. Pahnke, W. N. (1971). The use of psychedelic drugs in parapsychological research. *Parapsychology Review*, *2*(4), 5-6, 12-14.
324. Pahnke, W. N., & Richards, W. A. (1966). Implications of LSD and experimental mysticism. *Journal of Religion and Health*, *5*, 175-208.
325. Palmer, J. (1978). Extrasensory perception: Research findings. In S. Krippner (Ed.), *Advances in parapsychological research 2: Extrasensory perception* (Vol. 2, pp. 59-243). New York, NY: Plenum Press.
326. Palmer, J. (1979). A community mail survey of psychic experiences. *Journal of the American Society for Psychical Research*, *73*, 221-251.
327. Palmer, J. (1982). ESP research findings: 1976-1978. In S. Krippner (Ed.), *Advances in parapsychological research 3* (Vol. 3, pp. 41-82). New York, NY: Plenum Press.
328. Palmer, J., & Neppe, V. M. (2003). A controlled analysis of the subjective paranormal experiences in temporal lobe dysfunction in a neuropsychiatric population. *Journal of Parapsychology*, *67*, 75-97.
329. Palmer, J., & Neppe, V. M. (2004). Exploratory analysis of refined predictors of subjective ESP experiences and temporal lobe dysfunction in a neuropsychiatric population. *European Journal of Parapsychology*, *19*, 44-65.
330. Palmer, J., Tart, C. T., & Redington, D. (1976). A large-sample classroom ESP card-guessing experiment. *European Journal of Parapsychology*, *1*, 40-56.
331. Pappas, J., & Friedman, H. (2007). The construct of self-expansiveness and the validity of the Transpersonal Scale of the Self-Expansiveness Level Form. *The Humanistic Psychologist*, *35*(4), 323-347.
332. Paqueron, X., Leguen, M., Rosenthal, D., Coriat, P., Willer, J. C., & Danziger, N. (2003). The phenomenology of body image distortions induced by regional anaesthesia. *Brain*, *126*, 702-712.
333. Parker, A. (1975). *States of mind: ESP and altered states of Consciousness*. London, UK: Malaby Press.
334. Parker, A. (2001). What can cognitive psychology and parapsychology tell us about near-death experiences? *Journal of the Society for Psychical Research*, *65*, 225-240.
335. Paterson, T. T. (1961a). Development and testing of hypotheses. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 36-39). New York, NY: Parapsychology Foundation.
336. Paterson, T. T. (1961b). Frontiers of experimentation. In *Proceedings on two conferences of parapsychology and pharmacology* (pp. 79-81). New York, NY: Parapsychology Foundation.
337. Paul, M. A. (1966). Two cases of altered consciousness with amnesia apparently telepathically induced. *Psychedelic Review*, *8*, 4-8.
338. Pekala, R., & Cardeña, E. (2000). Methodological issues in the study of altered states of consciousness and anomalous experiences. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience* (pp. 47-81). Washington, DC: American Psychological Association.
339. Pekala, R. J., Kumar, V. K., & Marcano, G. (1995a). Anomalous/paranormal experiences, hypnotic susceptibility, and dissociation. *Journal of the American Society for Psychical Research*, *89*, 313-331.
340. Pekala, R. J., Kumar, V. K., & Marcano, G. (1995b, March). *Hypnotic susceptibility, dissociation, and marijuana use: A relationship between high hypnotic susceptibility, marijuana use, and dissociative ability*. Paper presented at the annual meeting of the American Society of Clinical Hypnosis, San Diego, CA.
341. Persinger, M. A. (1988). Increased geomagnetic activity and the occurrence of bereavement hallucinations: Evidence for melatonin-mediated microseizuring in the temporal lobe? *Neuroscience Letters*, *88*, 271-274.
342. Persinger, M. A., & Makarec, K. (1987). Temporal lobe epileptic signs and correlative behaviors displayed by normal populations. *The Journal of General Psychiatry*, *114*, 179-195.
343. Pickover, C. (2005). *Sex, drugs, Einstein, and elves*. Petaluma, CA: Smart Publications.
344. Pitman, J. A., & Owens, N. E. (2004). The effect of manipulating expectations before and during a test of ESP. *Journal of Parapsychology*, *68*(1), 45-63.
345. Pizzagalli, D., Lehmann, D., & Brugger, P. (2001). Lateralized direct and indirect semantic priming effects in subjects with paranormal experiences and beliefs. *Psychopathology*, *34*, 75-80.
346. Pomarol-Clotet, E., Honey, G. D., Murray, G. K., Corlett, P. R., Absalom, A. R., Lee, M., ... Fletcher, P. C. (2006). Psychological effects of ketamine in healthy volunteers: Phenomenological study. *British Journal of Psychiatry*, *189*, 173-179. doi:10.1192/bjp.bp.105.015263
347. Previc, F. (2011). Dopamine, altered consciousness, and distant space with special reference to shamanic ecstasy. In E. Cardeña & M. Winkelman (Eds.), *Altering consciousness: A multidisciplinary perspective, volume 2. Biological and psychological perspectives* (pp. 43-61). Westport, CT: Praeger.
348. Price, H. H. (1948). Future work in parapsychology: Some suggestions. *Journal of Parapsychology*, *12*, 25-31.
349. Price, H. H. (1964). A mescalin experience. *Journal of the American Society for Psychical Research*, *58*, 3-20.
350. Price, L. H., & Lebel, J. (2000). Dextromethorphan-induced psychosis. *American Journal of Psychiatry*, *157*, 304.
351. Progoff, I. (1961). Depth psychological potentialities of psychedelics. In *Proceedings of two conferences on parapsychology and pharmacology* (p. 40). New York, NY: Parapsychology Foundation.
352. Puharich, A. (1959). *The sacred mushroom: Key to the door of eternity*. Garden City, NY: Doubleday.

353. Puharich, A. (1962). *Beyond telepathy*. Garden City, NY: Doubleday.
354. Radin, D. (1989). Parapsychological Association presidential address: The Tao of psi. In L. A. Henkel & R. E. Berger (Eds), *Research in parapsychology 1988: Abstracts and papers from the Thirty-First Annual Convention of the Parapsychological Association* (pp. 157-174). Metuchen, NJ: Scarecrow Press.
355. Ramakrishna Rao, K. (1966). *Experimental parapsychology: A review and interpretation.* Springfield, IL: Charles Thomas. Ray, T. S. (2010). Psychedelics and the human receptorome. *PLoS ONE, 5*(2), e9019. doi:10.1371/journal.pone.0009019
356. Raz, A., Hines, T., Fossella, J., & Castro, D. (2008). Paranormal experience and the COMT dopaminergic gene: A preliminary attempt to associate phenotype with genotype using an underlying brain theory. *Cortex*, *44*, 1336-1341.
357. Rees, A. (2004, August 8). Nobel Prize genius Crick was high on LSD when he discovered the secret of life. *Mail on Sunday*, Section FB, pp. 44-45.
358. Reymond, J.-L., & Awale, M. (2012). Exploring chemical space for drug discovery using the chemical universe database. *ACS Chemical Neuroscience*, *3*(9), 649-657.
359. Rhine, J. B. (1934). *Extra-sensory perception*. Boston, MA: Boston Society for Psychical Research.
360. Rhine, J. B., Humphrey, B. M., & Averill, R. L. (1945). An exploratory experiment on the effect of caffeine upon performance in PK tests. *Journal of Parapsychology*, *9*, 80.
361. Richardson, A. (1990). Recollections of R. Gordon Wasson's "friend and photographer." In T. J.
362. Riedlinger (Ed.), *The sacred mushroom seeker* (pp. 193-204). Portland, OR: Dioscorides Press.
363. Ring, K. (1989). Near-death and UFO encounters as shamanic initiations: Some conceptual and evolutionary implications. *ReVision*, *11*(3), 14-22.
364. Ring, K. (1992). *The Omega Project: Near-death experiences, UFO encounters and mind at large*. New York, NY: William Morrow.
365. Roberts, A. (2004, February). An acid test for ESP. *Fortean Times,* 180.
366. Roberts, T. B. (Ed.). (2001). *Psychoactive sacramentals: Essays on entheogens and religion*. San Francisco, CA: Council on Spiritual Practices.
367. Rock, A. J., & Krippner, S. (2012). States of consciousness or states of phenomenology? In A. E. Cavanna & A. Nani (Eds.), *Consciousness: States, mechanisms and disorders*. Hauppauge, NY: Nova Science.
368. Rogo, D. S. (1975). *Parapsychology: A century of inquiry*. New York, NY: Taplinger.
369. Rogo, D. S. (1976). *Exploring psychic phenomena: Beyond mind and matter*. Wheaton, IL: Theosophical Society in America.
370. Rogo, D. S. (1982). ESP and schizophrenia: An analysis from two perspectives. *Journal of the Society for Psychical Research*, *51*, 329-342.
371. Rogo, D. S. (1984). Ketamine and the near-death experience. *Anabiosis: The Journal of Near-Death Studies*, *4*, 87-96.
372. Roll, W. G., & Montagno, E. de A. (1985). Neurophysical aspects of psi. In R. A. White & J. Solfvin (Eds.), *Research in parapsychology: Abstracts and papers from the 27th Annual Convention of the Parapsychological Association, 1984* (pp. 35-40). Metuchen, NJ: Scarecrow Press.
373. Roney-Dougal, S. M. (1984). Occult conference questionnaire. *Journal of the Society for Psychical Research*, *52*, 379-382.
374. Roney-Dougal, S. M. (1986). Some speculations on a possible psychic effect of harmaline. In D. H. Weiner & D. H. Radin (Eds.), *Research in parapsychology: Abstracts and papers from the 28th Annual Convention of the Parapsychological Association*, *1985* (pp. 120- 123). Metuchen, NJ: Scarecrow Press.
375. Roney-Dougal, S. M. (1989). Recent findings relating to the possible role of the pineal gland in affecting psychic ability. *Journal of the Society for Psychical Research*, *55*, 313-328.
376. Roney-Dougal, S. M. (1991). *Where science and magic meet*. London, UK: Element Books.
377. Roney-Dougal, S. [M.] (2001). *Walking between the worlds: Links between psi, psychedelics, shamanism, and psychosis*. Unpublished manuscript, Psi Research Centre, Glastonbury, UK.
378. Roney-Dougal, S. M., Ryan, A., & Luke, D. (2012). *The relationship between local geomagnetic activity, meditation and psi. Part I: Literature review*. Paper submitted for publication.
379. Rouhier, A. (1925). Phénomènes de Matagnomie expérimentale observés au cours d'une expérience faite avec le "peyotl" (*Echinocactus Williamsii*). *Revue Métaphysique,* May-June, 144-154.
380. Rouhier, A. (1927). *La plante qui faite les yeux émerveillés: Le peyotl*. Paris, France: Doin.
381. Ruck, C., Bigwood, J., Staples, R., Wasson, R., & Ott, J. (1979). Entheogens. *Journal of Psychedelic Drugs*, *11*, 145-146.
382. Rudgley, R. (2000). *The encyclopedia of psychoactive substances*. New York, NY: Thomas Dunne.
383. Rush, J. H., & Cahn, H. A. (1958). Physiological conditioning for psi performance [Abstract from the Proceedings of the first convention of the Parapsychological Association, August, 1958, New York]. *Journal of Parapsychology*, *22*, 300.
384. Ryzl, M. (1968). Training methods for psi induction. In R. Cavanna & M. Ullman (Eds.), *Psi and altered states of consciousness: Proceedings of an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 55-67). New York, NY: Parapsychology Foundation.
385. Saavedra-Aguilar, J., & Gómez-Jeria, J. (1989). A neurobiological model for near-death experiences. *Journal of Near-Death Studies*, *7*, 205-222.
386. Sakellarios, S. (2005). *Another view of near-death experiences and reincarnation: How to respond to reductionistic thinking*. Retrieved November 25, 2005, from http://www.omplace.com/articles/Reduc tionist_thinking.html
387. Satyananda, Swami Saraswati. (1972). *The pineal gland (ajna chakra)*. Bihar, India: Bihar School of Yoga. Satyananda, Swami Saraswati. (1996). *Kundalini tantra* (2nd ed.). Munger, Bihar, India: Yoga Publications Trust.
388. Satyanarayana, M., Rao, P. V. K., & Vijaylakshmi, S. (1993). Role of pineal activity in ESP performance: A preliminary study. *Journal of Indian Psychology*, *11*, 44-56.
389. Saunders, N. (1993). *E for ecstasy*. London, UK: Nicholas Saunders.
390. Schmeidler, G. R. (1994). ESP experiments 1978-1992: The glass is half full. In S. Krippner (Ed.), *Advances in parapsychological research 7* (pp. 104-197). Jefferson, NC: McFarland.
391. Schroll. M. (2011). Out-of-body-experience, the dentist and nitrous oxide. *Paranthropology: Journal of Anthropological Approaches to the Paranormal*, *2*(2), 40-42.

392. Schultes, R. E., & Hofmann, A. (1992). *Plants of the Gods: Their sacred, healing, and hallucinogenic powers*. Rochester, VT: Healing Arts Press.
393. Scully, T. (2010). Some anecdotes regarding LSD, biofeedback and consciousness. In J. Millay (Ed.). *Radiant minds: Scientists explore the dimensions of Consciousness* (pp. 208-216). Doyle, CA: Millay.
394. Servadio, E. (1961). Psychological criteria and testing methods. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 84-86). New York, NY: Parapsychology Foundation.
395. Severi, B. (1996). Ayahuasca, la medicina dell'anima: Viaggio ed esperienze tra gli sciamani Shipibo-Conibo del Perù [Ayahuasca, the drug of the soul: Journey and experience among the Shipibo-Conibo shamans of Peru]. *Quaderni de Parapsychologia*, *27*, 15-27.
396. Severi, B. (1999). *A very impressive experience with a"teacher plant.*" Submission 21 from http://www. issc-taste.org/main
397. Severi, B. (2003). Sciamani e psichedelia. [Shamans and psychedelics]. *Quaderni de Parapsychologia*, *34*, 36.
398. Shanon, B. (2001). Altered temporality. *Journal of Consciousness Studies*, *8*(1), 35-58.
399. Shanon, B. (2002). *The antipodes of the mind: Charting the phenomena of the ayahuasca experience*. Oxford, UK: Oxford University Press.
400. Shanon, B. (2003). Hallucinations. *Journal of Consciousness Studies*, *10*(2), 3-31.
401. Sharon, D. (1990). The San Pedro cactus in Peruvian folk healing. In P. T. Furst. (Ed.). *Flesh of the Gods: The ritual use of hallucinogens* (pp. 114-135). Long Grove, IL: Waveland Press.
402. Sherwood, S. (2002). Relationship between the hypnogogic/hypnopompic states and reports of anomalous experiences. *Journal of Parapsychology*, *66*, 127-150.
403. Shulgin, A. [T.] (2004, June). *Investigating consciousness*. (Audio CDROM). Paper presented at the international conference Exploring Consciousness: With What Intent?, Bath Spa University, UK.
404. Shulgin, A. [T.](2010). Chemistry and memory. In J. Millay (Ed.). *Radiant minds: Scientists explore the dimensions of Consciousness* (pp. 190-197). Doyle, CA: Millay.
405. Shulgin, A. T., Manning, T., & Daley, P. F. (2011). *The Shulgin index: Psychedelic phenethylamines and related compounds* (Vol.1). Berkeley, CA: Transform Press.
406. Shulgin, A. T, & Shulgin, A. (1997). *TIHKAL: The continuation*. Berkeley, CA: Transform Press.
407. Siegel, R. K. (1980). The psychology of life after death. *American Psychologist*, *35*, 911-931. doi:10.1037//0003-066X.35.10.911
408. Siegel, R. K., & Hirschman, A. E. (1984). Hashish near-death experiences. *Anabiosis: The Journal of Near-Death Studies*, *4*, 70-86.
409. Simmonds, C. A., & Roe, C. A. (2000). Personality correlates of anomalous experiences, perceived ability and beliefs: Schizotypy, temporal lobe signs and gender. *Proceedings of presented papers from the 43rd Annual Convention of the Parapsychology Association, 2000, Frieburg, Germany,* pp. 272-291.
410. Sinel, J. (1927). *The sixth sense: A physical explanation for clairvoyance, telepathy, hypnotism, dreams and other phenomena usually considered occult*. London, UK: T. Werner Laurie.
411. Slotkin, J. S. (1956). The peyote way. *Tomorrow*, *4*, 96- 105.
412. Smith, H. (2000). *Cleansing the doors of perception: The religious significance of entheogenic plants and substances*. New York, NY: Jeremy P. Tarcher/Putnam.
413. Smith, L. A., & Tart, C. T. (1998). Cosmic consciousness experience and psychedelic experience: A first person comparison. *Journal of Consciousness Studies*, *5*(1), 97-107.
414. Smythies, J. R. (1960). New research frontiers in parapsychology and pharmacology. *International Journal of Parapsychology*, *2*(2), 28-38.
415. Smythies, J. R. (1961a). Images as mind functions. In *Proceedings of two conferences on parapsychology and pharmacology* (p. 86). New York, NY: Parapsychology Foundation.
416. Smythies, J. R. (1961b). Spontaneous activity of the human psyche. In *Proceedings of two conferences on parapsychology and pharmacology* (pp. 41-42). New York, NY: Parapsychology Foundation.
417. Smythies, J. R. (1965). ESP experiments with LSD 25 and psilocybin, by R. Cavanna & E. Servadio [book review]. *Journal of the Society for Psychical Research*, *43*, 149-150.
418. Smythies, J. R. (1983). The impact of psychedelic drugs on philosophy and psychical research. *Journal of the Society for Psychical Research*, *52*, 194-200.
419. Smythies, J. R. (1987). Psychometry and mescaline. *Journal of the Society for Psychical Research*, *54*, 266- 268.
420. Smythies, J. R. (2011). Ketamine, Bergson and NDEs. *Journal of the Society for Psychical Research*, *75*, 148- 150.
421. Soal, S. G., & Bateman, F. (1954). *Modern experiments in telepathy*. London, UK: Faber.
422. Sobiecki, J. F. (2008). A review of plants used in divination in southern Africa and their psychoactive effects. *Southern African Humanities*, *20*, 1-19.
423. Sobiecki, J. F. (2012). Psychoactive ubulawu spiritual medicines and healing dynamics in the initiation process of southern Bantu diviners. *Journal of Psychoactive Drugs*, *44*, 216-223. doi:10.1080/0279 1072.2012.703101
424. Soutar, I. (2001). Ska pastora - leaves of the shepherdess: Conference at Breitenbush Hot Springs, Dec 7-10, 2000. *Bulletin of the Multidisciplinary Association for Psychedelic Studies*, *11*(1), 32-40.
425. Spess, D. L. (2000). *Soma: The divine hallucinogen*. Rochester, VT: Park Street Press.
426. Stafford, P. G., & Golightly, B. H. (1967). *LSD the problem-solving psychedelic*. London, UK: Tandem.
427. Stamets, P. (1996). *Psilocybin mushrooms of the world: An identification guide*. Berkeley, CA: Ten Speed Press.
428. Stanford, R. G. (1990). An experimentally testable model for spontaneous psi events: A review of related evidence and concepts from parapsychology and other sciences. In S. Krippner (Ed.). *Advances in parapsychological research 6* (pp. 54-167). Jefferson, NC: McFarland.
429. Stevens, J. (1988). *Storming heaven: LSD and the American dream*. London, UK: William Heinemann.
430. Stevenson, I. (1981). Presidential address: Can we describe the mind. In W. G. Roll & J. Beloff (Eds.), *Research in Parapsychology: Abstracts and Papers from the 23rd Annual Convention of the Parapsychological Association, 1980* (pp. 130-147). Metuchen, NJ: Scarecrow Press.

431. Stokes, D. M. (1997). Spontaneous psi phenomena. In S. Krippner (Ed.), *Advances in parapsychological research 8* (pp. 6-87). Jefferson, NC: McFarland.
432. Stolaroff, M. J. (2004). *The secret chief revealed: Conversations with a pioneer of the underground psychedelic therapy movement*. Sarasota, FL: Multidisciplinary Association for Psychedelic Studies.
433. Storm, L., & Rock, A. J. (2009). Imagery cultivation vs. noise reduction: Shamanic-like journeying as a psi-conducive alternative to the ganzfeld protocol. *Australian Journal of Parapsychology*, *9*(1), 5-31.
434. Storm, L., & Rock, A. J. (2011). *Shamanism and psi: Imagery cultivation as an alternative to the ganzfeld protocol*. Gladesville, New South Wales, Australia: Australian Institute of Parapsychological Research.
435. Strassman, R. J. (1997). Endogenous ketamine-like compounds and the NDE: If so, so what? *Journal of Near-Death Studies*, *16*, 27-41.
436. Strassman, R. [J.] (2001). *DMT: The spirit molecule: A doctor's revolutionary research into the biology of near-death and mystical experiences*. Rochester, VT: Park Street Press.
437. Strassman, R. [J.](2008). The varieties of the DMT experience. In R. [J.] Strassman, S. Wojtowicz, L. E. Luna & E. Frecska (Eds.), *Inner paths to outer space: Journeys to alien worlds through psychedelics and other spiritual technologies* (pp. 51-80). Rochester, VT: Park Street Press.
438. Strassman, R. J., Qualls, C. R., Uhlenhuth, E. H., & Kellner, R. (1994). Dose-response study of *N,N*-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. *Archives of General Psychiatry*, *51*, 98-108.
439. Stuckey, D. E., Lawson, R., & Luna, L. E. (2005). EEG Gamma coherence and other correlates of subjective reports during ayahuasca experiences. *Journal of Psychoactive Drugs*, *37*, 163-178.
440. Tart, C. T. (1967). Psychedelic experiences associated with a novel hypnotic procedure, mutual hypnosis. *American Journal of Clinical Hypnosis, 10,* 65-78.
441. Tart, C. T. (1968). Hypnosis, psychedelics, and psi: Conceptual models. In R. Cavanna & M. Ullman. *Psi and altered states of consciousness: Proceedings an International Conference on Hypnosis, Drugs, Dreams, and Psi* (pp. 24-41). New York, NY: Parapsychology Foundation.
442. Tart, C. T. (1970). Marijuana intoxication: Common experiences. *Nature*, *226*, 701-704. doi:10.1038/2267 01a0
443. Tart, C. [T.] (1971). *On being stoned: A psychological study of marijuana intoxication*. Palo Alto, CA: Science and Behavior Books.
444. Tart, C. T. (1972). States of consciousness and state-specific sciences. *Science*, *176*, 1203-1210. doi:10.11 26/science.176.4040.1203
445. Tart, C. T. (1977). Drug-induced states of consciousness. In B. Wolman (Ed.), *Handbook of Parapsychology* (pp. 500-525). New York, NY: Van Nostrand Reinhold.
446. Tart, C. T. (1993). Marijuana intoxication, psi, and spiritual experiences. *Journal of the American Society for Psychical Research*, *87*, 149-170.
447. Tart, C. T. (1994). Marijuana, psi, and mystical experiences. In E. W. Cook & D. L. Delanoy (Eds.), *Research in parapsychology: Abstracts and papers from the 34th Annual Convention of the Parapsychological Association*, *1991* (pp. 120-122). Metuchen, NJ: Scarecrow Press.
448. Tart, C. T. (1998). Investigating altered states of consciousness on their own terms: A proposal for the creation of state-specific sciences. *Journal of the Brazilian Association for the Advancement of Science*, *50*, 103-116.
449. Tart, C. T. (2000). Investigating altered states of consciousness on their own terms: A proposal for the creation of state-specific sciences. *International Journal of Parapsychology*, *11*(1), 7-41.
450. Tart, C. T. (2001). Psychoactive sacramentals: What must be said. In T. B. Roberts (Ed.). *Psychoactive sacramentals: Essays on entheogens and religion* (pp. 47-56). San Francisco, CA: Council on Spiritual Practices.
451. Tart, C. (2002). Parapsychology and transpersonal psychology: "Anomalies" to be explained away or spirit to manifest? *Journal of Parapsychology*, *66*, 31- 47.
452. Tart, C. T., Palmer, J., & Redington, D. J. (1979). Effects of immediate feedback on ESP performance: A second study. *Journal of the American Society for Psychical Research*, *73*, 151-165.
453. Thalbourne, M. A. (1998). Transliminality: Further correlates and a short measure. *Journal of the American Society for Psychical Research*, *92*, 402- 419.
454. Thalbourne, M. (2000). Transliminality and creativity. *The Journal of Creative Behavior*, *34*, 193-202.
455. Thalbourne, M. A. (2001). Measures of the sheep-goat variable, transliminality, and their correlates. *Psychological Reports*, *88*, 339-350. doi:10.2466/PR0. 88.2.339-350
456. Thalbourne, M. A., & Delin, P. S. (1993). A new instrument for measuring the sheep-goat variable: Its psychometric properties and factor structure. *Journal of the American Society for Psychical Research*, *59*, 172-186.
457. Thalbourne, M. A., & Fox, B. (1999). Paranormal and mystical experience: The role of panic attacks and kundalini. *Journal of the American Society for Psychical Research*, *93*, 99-115.
458. Thalbourne, M. A., & Houran, J. (2005). Patterns of self-reported happiness and substance use in the context of transliminality. *Personality and Individual Differences*, *38*, 327-336.
459. Thomas, S. (2004). Agmatine and near-death experiences. Retrieved from http://www.neurotransmitter.net/neardeath.html
460. Thouless, R. H. (1960). Where does parapsychology go next? *Journal of the Society for Psychical Research*, *40*, 207-219.
461. Tibbs, M. (1963). Hallucinogens and extra-sensory perception. *Tomorrow*, *11*, 165-167.
462. Tinoco, C. A. (1994). Testa de ESP empacientes sob efeito da ayahuasca [Controlled ESP test in patients under the influence of ayahuasca]. *Revista de Brasileira de Parapsicologia*, *14*, 42-48.
463. Tinoco, C. A. (2011). *Teste de persepção extrassensorial com respostas livres em pessoas sob efeito da ayahuasca* [Free response extrasensory perception tests with people under the effects of ayahuasca]. Unpublished manuscript, Department of Parapsychology, UniBem, Curitiba, Brazil.
464. Toad (1999a). DPT primer. *The Entheogen Review*, *8*(1), 4-10.
465. Toad (1999b). 4-Acetoxy-DIPT primer. *The Entheogen Review*, *8*(4), 126-131.
466. Tobacyk, J. J. (1988). *A revised Paranormal Belief Scale*. Unpublished manuscript, Louisiana Tech University, Ruston, LA.

467. Tornatore, N. V. (1977a). The paranormal event in psychotherapy as a psychotherapeutic tool: A survey of 609 psychiatrists. In J. D. Morris, W. G. Roll & R. L. Morris (Eds.), *Research in parapsychology, 1976: Abstracts and papers from the nineteenth Annual Convention of Parapsychological Association* (pp. 114- 116). Metuchen, NJ: Scarecrow Press.
468. Tornatore, N. [V.] (1977b, July). The paranormal event in psychotherapy: A survey of 609 psychiatrists. *Psychic Magazine*, 34-37.
469. Torres, C. M., & Repke, D. B. (2006). *An adenanthera:Visionary plant of ancient South America*. New York, NY: Haworth Herbal Press.
470. Turner, D. M. (1994). *The essential psychedelic guide*. San Francisco, CA: Panther Press.
471. Unger, S. M. (1963). Mescaline, LSD, psilocybin and personality change. *Psychiatry: Journal for the Study of Interpersonal Processes*, *26*, 111-125.
472. Usha, S., & Pasricha, S. (1989a). Claims of paranormal experiences. I. Survey of psi and psi-related experiences. *Journal of the National Institute of Mental Health and Neurosciences (India)*, *7*(2), 143- 150.
473. Usha, S., & Pasricha, S. (1989b). Claims of paranormal experiences. II. Attitudes toward psychical research and factors associated with psi and psi-related experiences. *Journal of the National Institute of Mental Health and Neurosciences (India)*, *7*(2), 151-157.
474. Vallee, J. (1969). *Passport to Magonia*. Chicago, IL: Henry Regnery.
475. Vayne, J. (2001). *Pharmakon: Drugs and the imagination*. London, UK: Liminalspace/El Cheapo.
476. Vollenweider, F. X. (2001). Brain mechanisms of hallucinogens and entactogens. *Dialogues in Clinical Neuroscience*, *3*(4), 265-279.
477. Vollenweider, F. X. (2004). Brain mechanisms of hallucinogens. *Consciousness research abstracts from the Toward a Science of Consciousness Conference, Tucson, Arizona*, pp. 91-92.
478. Vollenweider, F. X., & Geyer, M. A. (2001). A systems model of altered consciousness: Integrating natural and drug-induced psychoses. *Brain Research Bulletin*, *56*, 495-507.
479. von Bibra, Baron, E. (1994). *Plant intoxicants*. Rochester, VT: Healing Arts Press. (Original work published 1855)
480. Wackerman, J., Pütz, P., Büchi, S., Strauch, I., & Lehmann, D. (2000). A comparison of ganzfeld and hypnogogic state in terms of electrophysiological measures and subjective experience. *Proceedings of the 43rd Annual Convention of the Parapsychology Association, Freiburg, Germany*, pp. 302-315.
481. Wackerman, J., Wittman, M., Hasler, F., & Vollenweider., F. X. (2008). Effects of varied doses of psilocybin on time interval reproduction in human subjects. *Neuroscience Letters*, *435*, 51-55.
482. Walsh, R. (2003). Entheogens: True or false? *International Journal of Transpersonal Studies*, *22*, 1-6.
483. Wasson, R. G. (1962). Hallucinogenic fungi of Mexico. *International Journal of Parapsychology*, *4*(4), 41-58.
484. Wasson, G. (1964). Notes on the present status of ololiuhqui and the other hallucinogens of Mexico. *Psychedelic Review*, *1*(3), 275-301.
485. Wasson, R. G. (1979). Traditional use in North America of *Amanita muscaria* for divinatory purposes. *Journal of Psychedelic Drugs*, *11*, 25-28. doi:10.1080/02791072.1979.10472088
486. Wasson, R. G., & Wasson, V. P. (1957). *Mushrooms, Russia, and history* (2 Vols.). New York, NY: Pantheon.
487. Watts, A. (1968). Psychedelics and religious experience. *California Law Review*, *56*, 74-85.
488. Weil, A. (1972). *The natural mind: A new way of looking at drugs and higher consciousness.* Boston, MA: Houghton Mifflin.
489. Weil, A. (1980). *The marriage of the sun and the moon.* Boston, MA: Houghton Mifflin.
490. Weil, G. M., Metzner, R., & Leary, T. (Eds.). (1965). *The psychedelic reader*. New York, NY: University Books.
491. West, D. (1965). SPR Presidential Address: ESP, the next step. *Proceedings of the Society for Psychical Research*, *54*, 185-202.
492. Wezelman, R., & Bierman, D. J. (1997). Process orientated ganzfeld research in Amsterdam. *Proceedings of the 40th Parapsychology Association Annual Convention held in conjunction with the Society for Psychical Research,* 477-492.
493. White, W. E. (1997). Altered states and paranormal experiences. In W. E. White, *The Dextromethorphan FAQ: Answers to frequently asked questions about DXM*, (version 4). Retrieved from http://www.erowid.org/chemical/dxm/faq/dxm_paranormal.shtml
494. Whiteman, J. H. M. (1956). The process of separation and return in experiences out of the body. *Proceedings of the Society for Psychical Research*, *50*, 240-274.
495. Whiteman, J. H. M. (1965). Psychical effects of mescalin and LSD considered in light of experimental mysticism. *Parapsychologia (South African Society for Psychical Research)*, *6*, 4-20.
496. Whiteman, J. H. M. (1995). Short-term precognition, time-skills and the world-plan for physical events. *Journal of the Society for Psychical Research*, *60*, 300- 316.
497. Whittlesey, J. R. B. (1960). Some curious ESP results in terms of variance. *Journal of Parapsychology*, *24*, 220- 222.
498. Wikipedia (2005). *Levels of psychedelic experience*. Retrieved from http://en.wikipedia.org/wiki/Psychedelic_experience
499. Wilkins, L. K., Girard, T. A., & Cheyne, J. A. (2011). Ketamine as a primary predictor of out-of-body experiences associated with multiple substance use. *Consciousness and Cognition*, *20*, 943-950.
500. Wilson, A. J. C. (1949). Ayahuasca, peyotl, yage. *Proceedings of the Society for Psychical Research*, *49*, 353-363.
501. Wilson, C. W. M. (1961). Possible influence of drugs on ESP Ability. In *Proceedings on two conferences on parapsychology and pharmacology* (pp. 43-44). New York, NY: Parapsychology Foundation.
502. Wilson, C. W. M. (1962). The physiological basis of paranormal phenomena. *International Journal of Parapsychology*, *4*(2), 57-96.
503. Wilson, K., & French, C. C. (2006). The relationship between susceptibility to false memories, dissociativity, and paranormal belief and experience. *Personality and Individual Differences*, *41*, 1493-1502.
504. Winkelman, M. (1983). The anthropology of magic and parapsychological research. *Parapsychological Review*, *14*(2), 13-19.
505. Winkelman, M. (1989). A cross-cultural study of shamanistic healers. *Journal of Psychoactive Drugs*, *21*, 17-24.
506. Wolfe, T. (1971). *The electric Kool-Aid acid test*. London, UK: Bantam.
507. Woodruff, J. L. (1943). ESP tests under various physiological conditions. *Journal of Parapsychology*, *7*, 264-271.
508. Wulff, D. M. (1997). *Psychology of religion: Classic and contemporary* (2nd ed.). New York, NY: Wiley.

509. Wulff, D. M. (2000). Mystical experiences. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience: Examining the scientific evidence* (pp. 387-440). Washington, DC: American Psychological Association.

510. Wyllie, T. (1981). *Phencyclidine and ketamine: A view from the street*. Unpublished manuscript, available at http://www.timothywyllie.com/PCP.htm

511. Wyllie, T. (1999). *The entheogen impulse: An artist's viewpoint*. Unpublished manuscript, available at http://www.timothywyllie.com/Entheogenic%20Impulse.htm

512. Xeper (2005). DXM and entity contact. *Silver Star: A Journal of New Magick*, *4*, 20. Zelnick, R. R. (2005). *Psi-chedelics: Hallucinogens and ESP*. Unpublished manuscript, University of Philosophical Research, Los Angeles, CA.

513. Zerda Bayon, R. (1912, August 27). The yage plant. A supposed cure for beri-beri. *The Times South American Supplement*, p. 8.

The Influence of Psychedelics on Remote Viewing

by

Jean Millay, Ph.D

(A more complete discussion of this topic can be found in Multidimensional Mind: Remote Viewing in Hyperspace, by Jean Millay, Ph.D., with a forward by Stanley Krippner, Ph.D.)

original source: http://www.maps.org/news-letters/v11n1/pdf/11143mil.pdf
backup source: http://www.psilosophy.info/resources/11143mil.pdf

> In 1997, students at the University of Amsterdam in the Netherlands did research to establish whether or not the use of psychedelic substances could influence remote viewing. In this report, the test-subjects who were under the influence of cannabis chose the right target at an average rate that was only slightly above chance expectancy. Those who were under the influence of psilocybin achieved a rate of success of 58.3%, which was statistically significant. This was a small experiment with only 12 test-subjects.

The process of doing remote viewing, with or without psychedelics, requires an ability to focus attention and to be able to clear away any personal and/or emotional issues that would interfere with perception of external images and cause them to be skewed. I never use the term "extra-sensory perception" or "ESP" because it implies that there is an EXTRA sense somewhere that accounts for telepathy. This is counter-productive in attempting to understand how psi phenomena works. All our senses can be extended for use and interpretation of incoming information. One of the uses of psilocybin is that it can contribute to the extension of one's ability to focus attention very precisely on something or some problem until it is understood at a higher level. Another of the many uses of psilocybin is that it facilitates one's ability to access non-local spacetime (the hyperspace) which is where remote viewing can be done. Cannabis can be utilized in this manner, as well. However, the quality of the cannabis is important, and one needs to practice with it, to know and understand just how the process of remote viewing works best. It is also important to remember that the inexperienced users of psychedelics can find themselves in the middle of a major cosmic drama, and if so, this must be resolved first and foremost. No remote viewing should be attempted during such a session that is essential for the clearing of preconscious material. In my informal studies beginning nearly forty years ago, I have used LSD, mescaline, or psilocybin, if I had an urgent need to communicate with someone at a distance, when a telephone was not available. Each of these substances worked fairly well under such needy conditions. At other times, my colleagues and I would use one of these substances to try sending and receiving simple messages just to explore and to study the potentials of this direct mind-to-mind communication process. When we compared our responses afterward, we discovered how our memories and internal dialog could skew the results. After a time, I began to realize that what we learned about the process was now part of what we could use at any time. We no longer needed the boost that the strong psychedelics, mentioned above, provided. It was at that time, that I learned that cannabis could be used just as well And even when that was not available, I could focus my attention with my own intention set to do so.

Later, I conducted a formal study for my Ph.D. dissertation with college students who formed eleven telepathic teams. These were couples (lovers or friends since childhood) who volunteered because they wanted to learn to improve their own communication with each other. In this first study we did not use psychedelics or cannabis. We used biofeedback to train the volunteers to synchronize their alpha brainwaves between right and left hemispheres, and later with each other. One semester was not enough time for some of the couples to learn EEG synch and some did not receive telepathic messages any better than chance. However, when all scores were counted at the end of the experiment, we found that those teams who had the best scores in paired EEG phase coherence were also those who had the best (better than chance) average scores in blind match telepathy. This trend was continued in a later study as well. (Both studies were statistically significant at $p < 0.001$.) It is important to notice that the brainwaves were not measured at the same time that the telepathy was tested. In one case, the electrodes interfered with concentration for telepathy, and in the other, the attempts to communicate telepathically interfered with the intent to synchronize brainwaves. So we cannot say that one is the "cause" of the other, but that both are related to the ability to focus attention in a precise way. (For details, see my book, Multidimensional Mind: Remote Viewing in Hyperspace, available at Amazon.com).

In the late 1970's, we conducted another study designed to examine the possible effects that smoking cannabis had on the EEG of volunteers. In this study we used the same equipment as we had used in the previous study (i.e., two Aquarius Electronics brainwave biofeedback analyzers with the phase comparator, designed by Tim Scully, Ph.D.). A good grade of cannabis was obtained so that each volunteer would be smoking the same material. In those days, the EEG biofeedback equipment was often used to judge the quality of mind-altering materials. If a person lost some voluntary control of his/her brainwaves (that she/he had previously learned) by using any substance, it was felt to be inferior. (Obviously, if that material was used too often, one would lose some aspect of thought, eventually.) If a person gained some ability to exert voluntary control over his/her brainwaves by using some substance, then that material had the potential of being "mind-expanding." This was the rule of thumb, at that time, and occasionally students at "Altered State College" would request the use of our equipment to test their own material.

Because of the intense interest in that community in the actual effects of cannabis, volunteers requested that we do such a study since we had the equipment available. We began by establishing the base line of EEG frequency range for each individual. Then with biofeedback, we also recorded the initial alpha phase-coherent scores for each one, and for each team. Then we introduced a good grade of cannabis for each one to smoke, and took the EEG phase-coherent scores again at intervals. In each case, all volunteers recorded a dramatic increase in their individual interhemispheric alpha phase-coherent scores. However, some of the couples showed an increase in their interpersonal alpha phase-coherent scores and some couples showed a decrease from their baseline scores. Those couples, whose interpersonal alpha phase-coherent scores increased after smoking, described their experiences as being totally focused on each other, especially on touch. Those couples, whose interpersonal alpha phase-coherent scores had decreased after smoking, reported that they had "spaced out," that is they no longer focused on each other but enjoyed thinking about separate events, or creative ideas. (Their interhemispheric synch scores remained high, but their interpersonal synch scores decreased.)

One suggestion here is: since brainwave biofeedback can help people to increase their ability to increase alpha phase-coherence (along with their ability to focus attention), and if the ability to focus attention is relevant to increased accuracy in telepathy, then when one can learn to increase alpha phase-coherence with the use of a good quality of cannabis, a research study might very well be able to find that cannabis can increase the ability to do successful telepathy among those couples who already have established some rapport. We must remember, however, that clarity of mind is always a consistent requirement.

Additional research in this area needs to be done by those who can focus attention on the real issues of the multidimensional realms available to each of us. With or without psychedelics, telepathy and remote viewing are possible. Psychedelics have introduced millions of us to the concept of non-local spacetime and have opened the "doors of perception". The doors cannot be closed again!

Sacred mushrooms inspire medical research

by

Dr. Rolf Singer

Chairman, Department of Botany

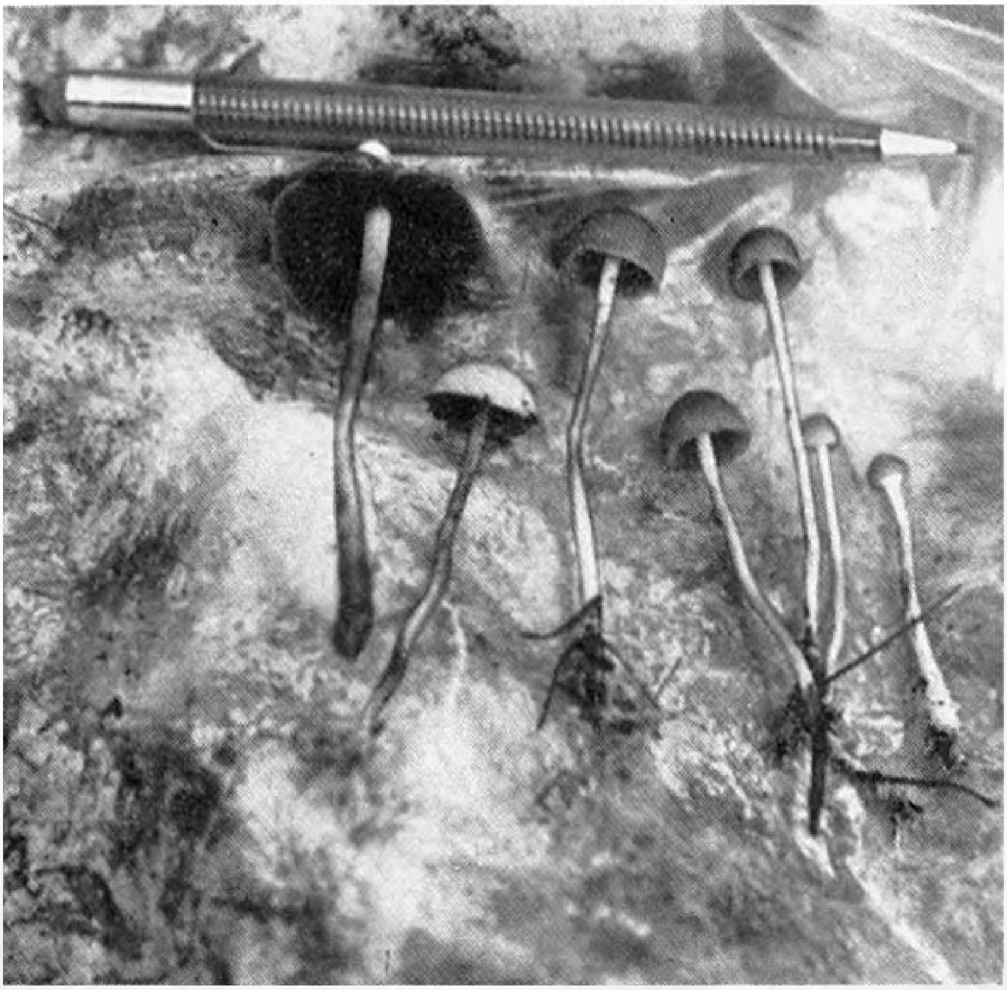
Instituto Miguel Lillo, Tucuman, Argentina

original text: https://www.biodiversitylibrary.org/item/25640#page/95/mode/1up

It has been no secret during the last four centuries that the Mexican Indians, particularly the ancient Aztecs and Mayas, used mushrooms as narcotics and that they had hallucinations during their narcotic states. This fact was used by the priests to make it appear that the visions of the mushroom-eater were divine revelations, attributed to a number of the heathen gods of pre-Columbian Mexico. It is also known that this knowledge continues with the present-day tribes of Mexican Indians, particularly with the Mazatec, Zapotec, and other Indians of southern Mexico and even in regions quite close to Mexico City, although there the ceremonies are held secretly in the houses of the curanderos (healers) under the pretense that they will provide cures for a large number of diseases.

However, the nature of the mushrooms involved was a secret to be disclosed by mycologists, the mushroom specialists among botanists. For there was a school of thought, as late as in the thirties, assuming that what the Spanish conquistadores had reported as mushrooms were actually cacti - the same cacti that are still used for comparable hallucinatory effect, peyotl (*Lophophora williamsii*). Then an American botanist, Richard Evans Schultes, brought some specimens to Harvard University, proving that what the Aztecs called teonanácatl (the sacred mushroom) actually was a mushroom. One of the species brought to Harvard was later proved to be inactive, i.e., not producing hallucinations in the sense described. The other specimen, however, was identified as *Psilocybe cubensis* by the writer, then mycologist at Harvard University. This mushroom grows on dung throughout the warm zones of the world and is remarkable because it has a ring-like structure on its stem (like the commercial white mushroom) and turns blue where scratched (because of the presence of an enzyme causing the oxidation of a colorless substance whereby it forms a melanin-like pigment, related to the one responsible for the color of human hair). San Isidro, the Mexican name of this mushroom, establishes again the relation with religion (Roman Catholic). The Mazatec Indians of the state of Oaxaca, living far away from civilization, continue eating this mushroom, six or eight fruiting bodies at a session, in order to get "where God lives," i.e., in a state of euphoria and colorful visions.

Since then two mycologists have gone to Mexico to study these mushrooms on the spot and obtain pure test-tube cultures in order to grow them in mushroom houses or industrially at home. Both Roger Heim, Director of the Museum of Natural History, Paris, and the writer have found that the San Isidro mushroom is not the only one eaten. Actually several species are eaten in various parts of Mexico, but all belong to the same taxonomic group, a section of the genus *Psilocybe*. They turned out to be either of worldwide distribution, like San Isidro, or from a more restricted area in America, like the so-called landslide mushroom (*Psilocybe caerulescens*), which was in fact discovered years ago in Alabama and called "birdies" by the Indians because they made one sing happily, and like *Psilocybe mexicana*, which grows in Mexico and Guatemala. Others were found only in a single region and were new to science.



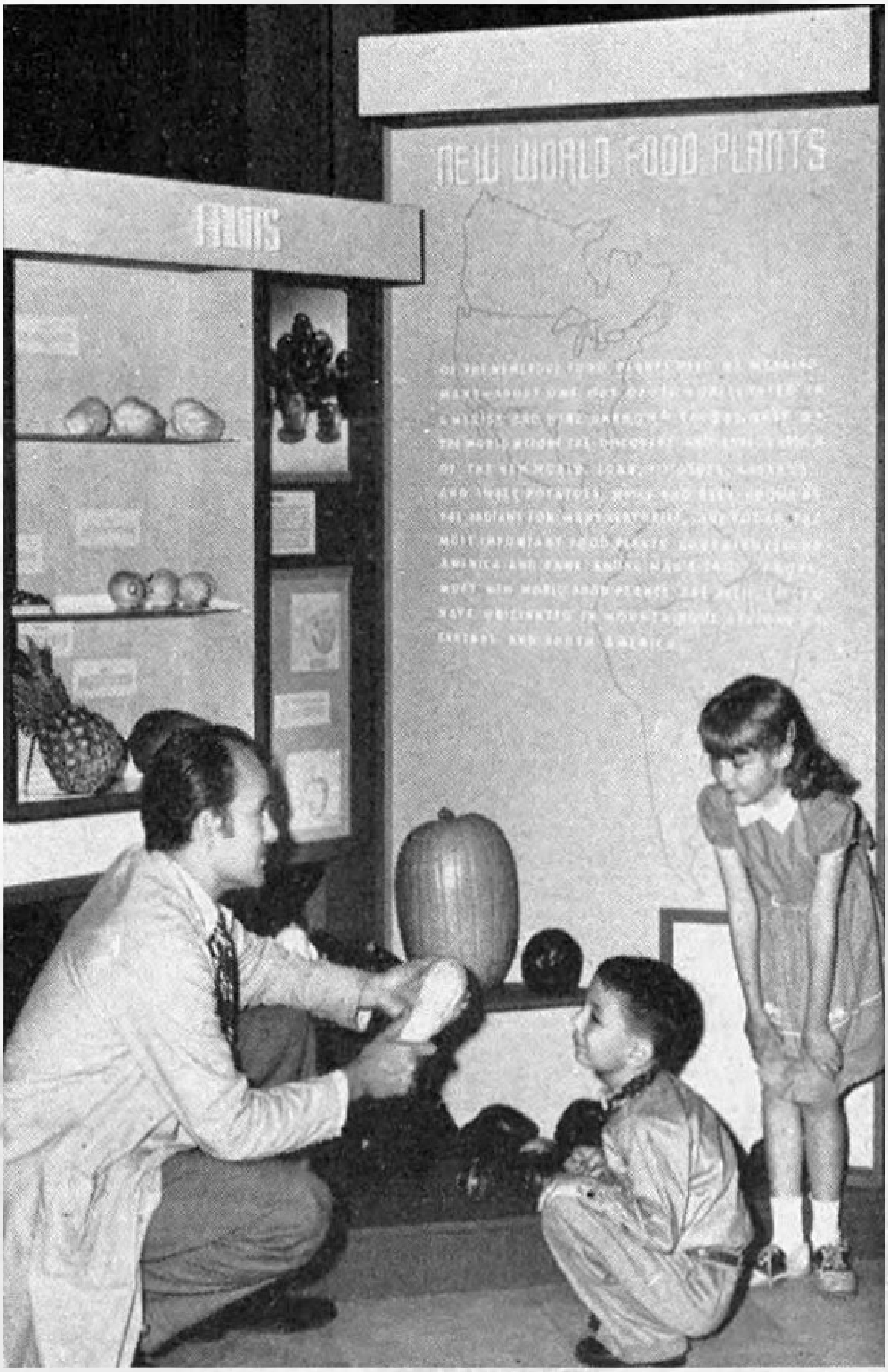
Sacred mushrooms
Representing one of several kinds of sacred mushrooms, specimens above (*Psilocybe aztecorum* Heim) were collected at Paso de Cortes, Mexico.

Why was there such a sudden outburst of activity in behalf of investigations into the subject of hallucinogenic mushrooms? There are several reasons. In the first place, as in so many cases, the time was ripe and our knowledge sufficiently widened during an intensive study of the anatomy and distribution of all fungi, especially of the mushroom-like "agarics" and "boletes," that it was now possible to tackle this difficult problem from the mycological side. Furthermore, a New York banker, Mr. R. Gordon Wasson, had become interested in the anthropological aspect and the folkloric role that these mushrooms have in Mexico and elsewhere in the world. He was so enthusiastic about his discoveries during several trips to Mexico that he published well-illustrated articles in several American and foreign magazines and, in addition, wrote a two-volume book on *Mushrooms, Russia, and History*. Finally, and this is perhaps the strongest incentive in our practical world that will not cease asking "what is all this *good* for?" - there is hope that the hallucinogenic principle in the mushrooms can be isolated and applied in medicine. We do not know precisely in which form this substance (or these substances) may be useful. Some believe that it may give us a better understanding of such mental disorders as schizophrenia, others think that it may become a new and better tranquilizer drug, and others believe that it might be directly applied to the mentally ill in a completely new approach to neuropsychiatric treatment.

Nothing is known thus far beyond the private observations of those who have eaten the mushrooms up in the mountains of Mexico in a weird surrounding and in a strange state of well-being and beauty in the midst of some of the oldest superstitions of this planet. Nevertheless, research is being driven far beyond the botanical aspect of the mushrooms, and while this is written several laboratories are busy with animal tests, chemical extractions, and analyses, and the scene is being made ready for the first tentative application in hospitals. A new wonder drug? Maybe, and maybe not, but most certainly one of the most intriguing and inspiring researches of our time, and well worth the curiosity demonstrated by scientists of all specialities.

A special exhibit in Chicago Natural History Museum's Stanley Field Hall from December 13 through January

19 will show models of the more common species used, as well as dried mushrooms and the test-tube cultures as obtained in a Mazatec Indian village in Oaxaca. Some kinds produce little mushrooms right inside the tube, others in order to fruit must be grown in a special mushroom house. The various species in dried condition are still useful and have not lost any of their hallucinogenic properties. They are soaked in water and eaten raw. Their taste is astringent and disagreeable.



Special exhibit
Samuel H. Grove, Jr., Artist-Preparator for the Department of Botany, discusses November special exhibit, "New World Food Plants," with two interested onlookers, Steve Kelemen and Esther Dycus, both of Griffith, Indiana.

Microdosing Psychedelics: Personality, mental health, and creativity differences in microdosers

(Microdosing Psychedelics: Personality, mental health, and creativity differences in microdosers)

by

Thomas Anderson, Rotem Petranker[*], Le-Anh Dinh-Williams, Daniel Rosenbaum, Cory Weissman, Emma Hapke, Katrina Hui, Norman Farb

DOI: 10.31234/osf.io/gk4jd

Accepted to Psychopharmacology 2018

© 2018 Authors

original report: https://osf.io/gk4jd/download

[*] corresponding author: rotem@boredomlab.org

Table of Contents:

- **Abstract**
- **1. Introduction**
  - 1.1 Full-dose Psychedelics
  - 1.2 The Present Study
- **2. Methods**
  - 2.1 Pre-Registered Hypotheses
    - *Mental Health Vulnerability, Wisdom, and Personality*
    - *Creativity*
    - *Importance of Benefits*
      - Total Doses and Dose Frequency
      - Substance-Use History
  - 2.2 Deviations from Pre-Registration
  - 2.3 Participants
  - 2.4 Design and Questionnaires
    - *2.4.1 Microdosing Substance*
    - *2.4.2 Mental Health Vulnerability*
    - *2.4.3 Wisdom*
    - *2.4.4 Personality*
    - *2.4.5 Creativity*
    - *2.4.6 Importance of Benefits*
    - *2.4.7 Microdosing Frequency*
    - *2.4.8 Substance-Use History*
    - *2.4.9 Mood*
- **3. Results**
  - 3.1 Pre-Registered Hypotheses and Planned Follow-up Analysis
    - *3.1.1 Mental Health Vulnerability, Wisdom, and Personality*
      - Mental Health Vulnerability
      - Wisdom
      - Negative Emotionality
      - Open-Mindedness
    - *3.1.2 Creativity*
    - *3.1.3 Importance of Benefits*
  - 3.2 Exploratory Analysis

4. Discussion
5. Limitations and Future Directions
6. Conclusion
References

Abstract

Microdosing psychedelics - the regular consumption of small amounts of psychedelic substances such as LSD or psilocybin - is a growing trend in popular culture. Recent studies on full-dose psychedelic psychotherapy reveal promising benefits for mental well-being, especially for depression and end-of-life anxiety. While full-dose therapies include perception-distorting properties, microdosing may provide complementary clinical benefits using lower-risk, non-hallucinogenic doses. No experimental study has evaluated psychedelic microdosing, however; this pre-registered study is the first to investigate microdosing psychedelics and mental health. Recruited from online forums, current and former microdosers scored lower on measures of dysfunctional attitudes and negative emotionality and higher on wisdom, open-mindedness, and creativity when compared to non-microdosing controls. These findings provide promising initial evidence that warrants controlled experimental research to directly test safety and clinical efficacy. As microdoses are easier to administer than full-doses, this new paradigm has the exciting potential to shape future psychedelic research.

1. Introduction

Microdosing psychedelics - the practice of regularly consuming very low doses of psychedelic substances such as lysergic acid diethylamide (LSD) or psilocybin ("magic" mushrooms) - is a growing practice despite a lack of scientific research validating its effects. One online microdosing forum (/r/microdosing subreddit, Reddit Inc, San Francisco, CA, USA) has almost 40,000 subscribers and doubled its subscriber count in the past year (Figure 1). The popular media has described consumption of psychedelics in doses much lower than typical therapeutic doses (Fadiman, 2011; Leonard, 2015; Solon, 2016; Waldman, 2017) and articles and anecdotes claim benefits including improved mood, focus, and creativity alongside decreased symptoms of depression and anxiety. While decreased depression and anxiety are consistent with research on full-dose psychedelics (Carhart-Harris *et al.*, 2017; Griffiths *et al.*, 2016), microdosing could offer these benefits without any perceptual distortions and reduced need for expensive clinical oversight typical of full-dose psychedelic psychotherapy. Nevertheless, both LSD and psilocybin are controlled substances in most countries and so members of the public enticed by purported benefits of microdosing expose themselves to the risks implied by criminalized activity. For example, in the US, LSD and psilocybin are schedule I controlled substances, meaning that they have no accepted therapeutic use. Such risks are exacerbated by an absence of even minimal scientific evidence that normally surrounds clinical use, such as data on safety, efficacy, common side-effects, contraindications, and appropriate dose and dose schedule.

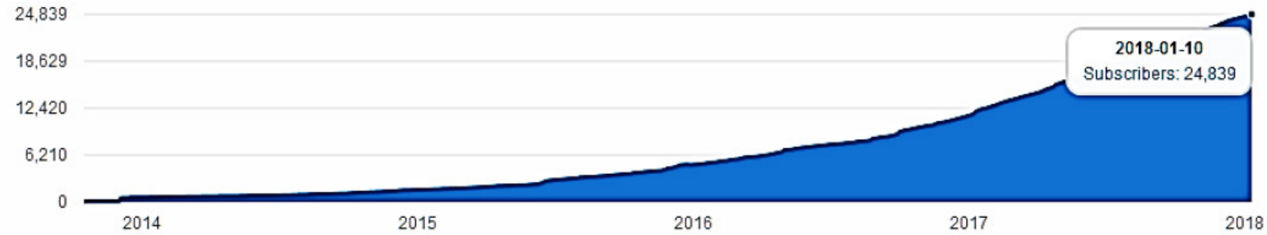


Figure 1. Rise in subscribers to an online microdosing forum, Reddit.com/r/microdosing. As of October 2018, the subscriber count has reached nearly 40,000 subscribers, doubling in less than one year.

It is unlikely that normative standards for microdosing will emerge without an initial description of current microdosing practices and associated outcomes. We therefore measured self-reported practices and psychological function of participants in existing microdosing communities and compared them to control participants with no microdosing experience. This design allows for a structured description of the common practices used in microdosing from which future clinical trials can build.

1.1 Full-dose Psychedelics

Interest in microdosing is likely predicated on research linking clinical benefits to full-dose psychedelic use. By 1975, over one thousand studies had linked psychedelic substance use with salutary effects on mental health and personal growth (Greenspoon & Bakalar, 1979). More recent research suggests efficacy for a number of health conditions, including obsessive compulsive disorder (Moreno *et al.*, 2006), alcohol dependence (Bogenschutz *et al.*, 2015), tobacco dependence (Johnson *et al.*, 2014), depression (Carhart-Harris *et al.*, 2017; Osório *et al.*, 2015), and end-of-life anxiety (Griffiths *et al.*, 2016; Ross *et al.*, 2016).

While research on psychedelics provides evidence for the therapeutic effects of full-doses, such experiences are often quite intense thus confer substantive participant risk. Popular vernacular includes the term "bad trip", and, indeed, one study participant described a full-dose experience as "the worst experience of her life" (Griffiths *et al.*, 2011). In an online survey of the worst "bad trips" experienced, 39% percent of participants rated their psychedelic experience among the top five most challenging experiences of his/her lifetime (Carbonaro *et al.*, 2016). At the same time, Carbonaro *et al.* (2016) also found that despite the difficult experiences, 84% of participants reported benefitting from the experience. Although research on LSD and psilocybin suggest low risks for abuse or harmful effects (Amsterdam *et al.*, 2011; Halpern and Pope, 1999; Johnson *et al.*, 2018), a small percentage of users are at risk of developing persisting perceptual effects (Hallucinogen Persisting Perception Disorder; Martinotti *et al.*, 2018) or risk being hospitalized for acute intoxication, especially if mixed with alcohol (Hardaway *et al.*, 2016). While large population studies suggest that psychedelics are not usually associated with detrimental mental health outcomes (Krebs & Johansen, 2013), microdosing may circumvent this issue as anecdotal reports suggest numerous positive outcomes without the risks associated with acute full-dose intoxication (Fadiman, 2011).

1.2 The Present Study

In this study we describe the psychological profile of the growing microdosing community by making comparisons against a population of non-microdosers. We compared groups of self-described microdosers (current and former microdosers) against controls (no microdosing experience) across a variety of mental health and personality variables. These include dysfunctional attitudes (de Graaf *et al.*, 2009), wisdom (Glück *et al.*, 2013), negative emotionality and open-mindedness (Soto and John, 2016), and creativity (Silvia, 2011). This study is part of a larger project that also reports on the demographics and psychiatric history of microdosing users (Rosenbaum *et al.*, 2018). A qualitative report examining subjective benefits and drawbacks of microdosing is also in preparation (Anderson *et al.*, 2018). We presently address pre-registered hypotheses about the outcomes associated with microdosing experience on validated scales.

2. Methods

2.1 Pre-Registered Hypotheses

Prior to data collection this study was pre-registered on the Open Science Framework (OSF; https://osf.io/ke49d/). We define "Microdosers" as those participants with experience microdosing, whether current or former use. We pre-registered the following hypotheses:

Mental Health Vulnerability, Wisdom, and Personality

While the mechanisms driving psychedelic substances' clinical efficacy are unclear, several psychological constructs are likely involved. These include practical indicators of flourishing, such as freedom from dysfunctional beliefs about oneself, other people, and the world; wisdom; and personality traits, especially neuroticism and openness to experiences.

Psychedelic substances are purported to have profound effects on one's understanding of the self and world, leading to enhanced insight and personal growth (Domínguez-Clavé *et al.*, 2016; Dos Santos *et al.*, 2016; Kometer *et al.*, 2015; Strassman, 2016). As such, we hypothesized that microdosers would have lower dysfunctional attitudes and higher wisdom than non-microdosers. Furthermore, improved mood and reduced mental health concerns are commonly reported outcomes of microdosing online (/r/microdosing subreddit, Reddit Inc, San Francisco, CA, USA). For this reason, we hypothesized that microdosers would have lower negative emotionality (depression, anxiety, and emotional volatility) than non-microdosers. Finally, participants experiencing a single full dose of psilocybin showed a robust and sustained increase in openness (MacLean *et al.*, 2011); we therefore predicted that microdosers would also have higher openness.

H1a: Microdosers will have lower dysfunctional attitude scores than non-microdosers.
H1b: Microdosers will have higher wisdom scores than non-microdosers.
H1c: Microdosers will have lower negative emotionality scores than non-microdosers.
H1d: Microdosers will have higher open-mindedness scores than non-microdosers.

Creativity

The Broaden and Build theory (Fredrickson, 2004) proposes a link between positive emotions and relaxed cognitive constraints as improved well-being may recruit personal resources in the generation of creative ways of coping with challenges. Enhanced creativity is one of the commonly reported outcomes of microdosing in media reports (Solon, 2016) and online (/r/microdosing subreddit, Reddit Inc, San Francisco, CA, USA) and is often reported as a benefit of full-dose psychedelics (Fadiman, 2011).

H2: Microdosers will have higher creativity scores than non-microdosers.

Importance of Benefits

Participants were asked to rate how important qualitative benefits of microdosing were to them. We used this measure of subjective "importance of benefits" as a broad outcome of participants' positive valuation of microdosing. Based on online anecdotal reports we predicted that there would be a total-dose response curve such that microdosers would rate the importance of benefits as quickly increasing to a plateau. Concerning dose scheduling, James Fadiman (2011) proposed a dose-schedule such that microdosers consume their substance one day, then refrain for two days, then dose again; we hypothesized that this schedule would show optimal reported importance of benefits compared to alternate dose frequencies, perhaps due to substance-tolerance (more frequent) or limited efficacy (less frequent).

Total Doses and Dose Frequency

H3a: A logarithmic relationship will exist between total lifetime microdoses and average reported importance of benefits. Specifically, benefits are expected to be minimal with minimal total doses, then increase, and subsequently stabilize at a plateau.
H3b: A quadratic relationship will exist between frequency of microdosing and average reported importance of benefits. Specifically, maximum benefits are expected when participants report frequency of microdoses at ~3 days between microdoses with reduced benefits for shorter and longer frequencies.

More frequent and more intense positive experiences with a substance motivate future use of that substance (de Wit and Phillips, 2012). As such, microdosers with a more extensive history of full-dose psychedelic use may be especially motivated to try microdosing and may evaluate benefits of microdosing more highly. This positivity bias may extend beyond psychedelics as, more generally, substance use is associated with greater openness to experience (Gunnarsson *et al.*, 2008; Terracciano *et al.*, 2008; Trull and Sher, 1994), which may include an openness to try novel pharmacological interventions, such as microdosing.

Substance-Use History

H4a: Microdosers reporting at least one life-time use of a classic psychedelic (LSD, psilocybin mushrooms, DMT, ayahuasca, mescaline) at full dose will report higher average importance of benefits than microdosers that have not had a full dose. H4b: Microdosers reporting greater variety of recreational substance use ("Polydrug user experience index", see below) will report higher average importance of benefits than microdosers with less recreational substance experience.

2.2 Deviations from Pre-Registration

A survey-flow error resulted in unintended data-collection on dose frequency and importance (H3 and H4) from participants with no experience microdosing; this data has been discarded.

2.3 Participants

Participant were snowball-recruited via social media (e.g. Facebook, Twitter) and recruited through posts on the online forum "reddit" (Reddit Inc, San Francisco, CA, USA): links were posted under the username /u/oredna on the following subreddits: Microdosing, Nootropics, Psychonaut, RationalPsychonaut, Tryptonaut, Drugs, LSD, shrooms, DMT, researchchemicals, and SampleSize. Both participants with experience and participants without experience microdosing psychedelics were recruited for this study. Participation was voluntary, and participants were not remunerated. The survey was in English and internationally available.

Participants exited the online survey at different stages of completion; different analyses therefore employ different numbers of participants. While 1390 respondents began the survey, 475 exited before responding, 3 requested that their responses be removed, and 3 responses were removed for disingenuous responding, i.e. "trolling". In total 909 participants entered enough data to be included in analyses, sorted into two categories: those with microdosing experience (Microdosers: n = 594, 65%) and those without such experience (Non-microdosers: n = 315, 35%); full-dose experience with psychedelics was not considered for determining microdosing status. Of these participants 29% were currently microdosing (current microdosers), 37% had microdosed in the past but have since stopped (former microdosers), 30% were interested in microdosing but had no prior experience, and 4% had no prior experience and reported not being interested in microdosing. Participants from 29 countries responded to the survey (median age = 26, 82% males, 70% white). For a more comprehensive breakdown see the full epidemiological report (Rosenbaum *et al.*, 2018).

2.4 Design and Questionnaires

Following informed consent, participants completed online computer-based questionnaires (https://osf.io/jmcrh/) including questions pertaining to microdosing habits (substance, frequency, dosage), substance use and mental health history, dispositional personality variables (Dysfunctional Attitudes, Wisdom, Negative Emotionality, Open-Mindedness), and a creativity task. Questions were displayed according to experience with microdosing, i.e. individuals who reported never having microdosed were not shown questions related to a history of microdosing (note survey flow error, 1.4.1 above). For uniformity, all scales were rated using a continuous 0-100 slider-scale with nominal descriptors at 0 ("Disagree Strongly") and 100 ("Agree Strongly") (Matejka *et al.*, 2016). For brevity, methods reported here focus on variables analyzed in this paper; a complete list of all questions is available on the OSF pre-registration.

2.4.1 Microdosing Substance

The majority of participants reported using LSD (65%) and/or Psilocybin (28%) for microdosing; 16% reported using another substance. For a more comprehensive breakdown see the full epidemiological report (Rosenbaum *et al.*, 2018).

2.4.2 Mental Health Vulnerability

The DAS-A-17 is a short-version of the Dysfunctional Attitude Scale, a 40-item self-report scale designed to measure the presence and intensity of dysfunctional beliefs (de Graaf *et al.*, 2009). Participants rate statements of beliefs (e.g. "If I fail at my work, then I am a failure as a person.") on a 7-point Likert scale and the total score is the sum of the 17-items (range: 17-119) with higher scores indicating more dysfunctional attitudes (Weissman and Beck, 1978). The DAS-A-17 includes a total-score and two subscales: "perfectionism/performance evaluation" (11 items) and "dependency" (6 items). Reliability for total score was excellent (α = 0.91) and good for the subscales (perf: α = 0.87, dep: α = 0.85).

A Mental Health Index of psychological disorders was computed as a simple binary 0/1 based on the question, "Have you ever been diagnosed by a doctor or health care professional (e.g., psychiatrist, psychologist) with any of the following diagnoses", which was followed by a list of DSM-V diagnoses. Endorsing any diagnosis was coded as a "1", otherwise "None of the above" was coded as "0". Comprehensive findings will be available in the epidemiological report (Rosenbaum *et al.*, 2018).

2.4.3 Wisdom

The Brief Wisdom Screening Scale (BWSS, (Glück *et al.*, 2013) was developed by selecting the 20 items that were most highly correlated with the common factor of "wisdom self-report" across three leading wisdom self-report measures. Reliability was good (α = 0.86).

2.4.4 Personality

The Big Five Inventory 2 (BFI2, Soto and John, 2016) is an updated five-factor personality measure using the commonly recognized five-factor model: Extraversion, Agreeableness, Conscientiousness, Negative Emotionality (formerly "Neuroticism"), and Open-Mindedness (formerly Openness to Experience). Our hypotheses were centered on two of these subscales: Negative Emotionality and Open-Mindedness, thus only these factors were measured. Reliability was good (Negative Emotionality α = 0.91, Open-Mindedness α = 0.79).

2.4.5 Creativity

The Unusual Uses Task is a task in which participants generate creative uses for mundane objects (UUT; (Silvia, 2011)). The UUT instructions emphasized the importance of original responses, reading "Please try and think of the most unusual, creative, and uncommon uses you can imagine" (Harrington, 1975). Participants were asked to give as many responses as they could for each of two items (brick, knife), allotted one minute for each. During analysis, responses were split into alphabetical lists to avoid within-participant biases. Responses were rated by three independent research assistants using three dimensions: uncommon, clever, and remote (Silvia *et al.*, 2008). Dimension-scores across objects were averages to produce three dimension-scores. Intraclass correlation coefficient was moderate for each dimension (Uncommon: 68.25, Remote: 57.25, Clever: 59.75) and moderate for each object (brick = .61, knife = .64).

2.4.6 Importance of Benefits

Participants rated qualitative benefits of microdosing in terms of personal, subjective importance for three self-generated benefits. The average of these scores was then used as a broad index of participants' subjective valuation of microdosing, analyzed in H3/4 in this study. A taxonomy that organizes the participant-generated benefits has been generated using Grounded Theory analysis and will be featured in an independent report (Anderson *et al.*, 2018).

2.4.7 Microdosing Frequency

Microdosers reported the total number of lifetime microdoses taken (0 to 100). They also reported dose scheduling, that is, the number of days spaced between each microdose (dose every day to dose once every two months).

2.4.8 Substance-Use History

To test H4 concerning substance-use history, participants reported their experience with full-dose psychedelics and with other substances. We developed a novel index: the "Polydrug User Experience Index". This novel measure was computed as the sum of recreational experiences across 13 classes of substance (e.g. Alcohol, Cannabis, MDMA, Stimulants, Opiates, Dissociatives, etc.) accounting for recency of experience. Each class of substance was scored according to the following metric: (a) used in past month: +4 points; (b) used in past year: +2 points; (c) used ever: +1 point; (d) never used: +0 points; (e) Prefer not to answer: +0 points. Scores range from 0-52, with lower scores indicating less experience with recreational substance use.

2.4.9 Mood

A "Valence" score was computed using a mood-board (https://osf.io/jmcrh/) as the count of pleasant minus unpleasant items, as was an "Arousal" score for high-intensity minus low-intensity moods.

3. Results

Table 1. Contrast between Microdosers and Non-Microdosers, means with standard deviations and standardized effect-sizes.

Variable	Microdoser	Non-Microdoser	Effect size d [95% CI]
Age	27.23 (8.94)	26.36 (7.78)	0.1 [-0.04 , 0.25]
Education[1]	4.72 (1.72)	4.78 (1.77)	-0.03 [-0.18 , 0.11]
SES[2]	0.50 (1.33)	0.51 (1.40)	-0.01 [-0.15 , 0.14]
Mood - Valence	2.33 (4.40)	-0.16 (4.14)	**0.58 [0.44 , 0.72]**
Mood - Intensity	-0.08 (2.42)	0.02 (2.40)	-0.04 [-0.18 , 0.09]
Dysfunctional Attitudes (DAS-17)[3]	40.62 (16.28)	49.30 (16.33)	**-0.53 [-0.77 , -0.29]**
Wisdom (BWSS)	66.68 (13.16)	60.05 (12.98)	**0.51 [0.27 , 0.74]**
Negative Emotionality (BFI-2)	41.53 (20.06)	48.16 (18.89)	**-0.34 [-0.56 , -0.11]**
Open-Mindedness (BFI-2)	76.43 (12.44)	73.33 (13.16)	**0.25 [0.02 , 0.47]**

1 - Education was coded according to the International Standard Classification of Education (UNESCO Institute for Statistics, 2011): ISCED level 0 = Early childhood education, 1 = Primary education, 2 = Lower secondary education, 3 = Upper secondary education, 4 = Post-secondary non-tertiary education Tertiary education, 5 = Short-cycle tertiary education, 6 = Bachelor's or equivalent level, 7 = Master's or equivalent level, 8 = Doctoral or equivalent level
2 - Socio-Economic Status (SES) was coded as: -3 = Non-working class (casual workers, pensioners, or dependents); -2 = Working class (semi-skilled or unskilled manual workers); -1 = Skilled working class (skilled manual workers); 0 = Lower-middle class (junior managerial, administrative, or professional); 1 = Middle class (intermediate managerial, administrative, or professional); 2 = Upper-middle class (higher managerial, administrative, or professional); 3 = Upper class (royalty or immense heritable wealth).
3 -DAS scores have been transformed to the original DAS-17 scale (17-119).

Table 2. Follow-up Analysis of Microdosers (Current versus Former), means with standard.

Variable	Current Microdoser	Former Microdoser	Effect size d [95% CI]
Age	28.89 (9.71)	25.93 (8.06)	**0.33 [0.16 , 0.51]**
Education	4.83 (1.70)	4.64 (1.73)	0.11 [-0.06 , 0.28]
SES	0.48 (1.34)	0.52 (1.32)	-0.03 [-0.2 , 0.14]
Mood - Valence	2.93 (4.57)	1.86 (4.21)	**0.24 [0.08 , 0.41]**
Mood - Intensity	0.10 (2.38)	-0.23 (2.45)	0.14 [-0.03 , 0.3]
Dysfunctional Attitudes (DAS-17)	39.53 (14.58)	41.53 (17.56)	-0.12 [-0.36 , 0.11]
Wisdom (BWSS)	66.09 (12.86)	67.18 (13.42)	-0.08 [-0.32 , 0.15]
Negative Emotionality (BFI-2)	43.32 (19.98)	39.95 (20.07)	0.17 [-0.06 , 0.4]
Open-Mindedness (BFI-2)	77.06 (11.91)	75.87 (12.91)	0.09 [-0.13 , 0.32]

3.1 Pre-Registered Hypotheses and Planned Follow-up Analysis

3.1.1 Mental Health Vulnerability, Wisdom, and Personality

Mental Health Vulnerability

Microdosing predicted lower scores on Dysfunctional Attitudes (b = -8.69, 95% CI [-12.48 -4.89], z(364) = -4.49, $p < .001$, *r* =-0.92), even when controlling for a history of mental illness, which was also significant (b = 5.74, 95% CI [2.45 9.03], z(364) = 3.42, $p < .001$, *r* = 0.85) (Figure 2). Dysfunctional Attitudes were not related to current versus former microdosing (b = 1.90, 95% CI [-1.91 5.71], *p* = 0.33), nor to type of substance used (LSD vs Psilocybin: b = 0.56, 95% CI [-4.93 6.05], *p* = 0.842), nor to total number of lifetime microdoses (b = -1.66, 95% CI [-3.47 0.15], *p* = 0.074).

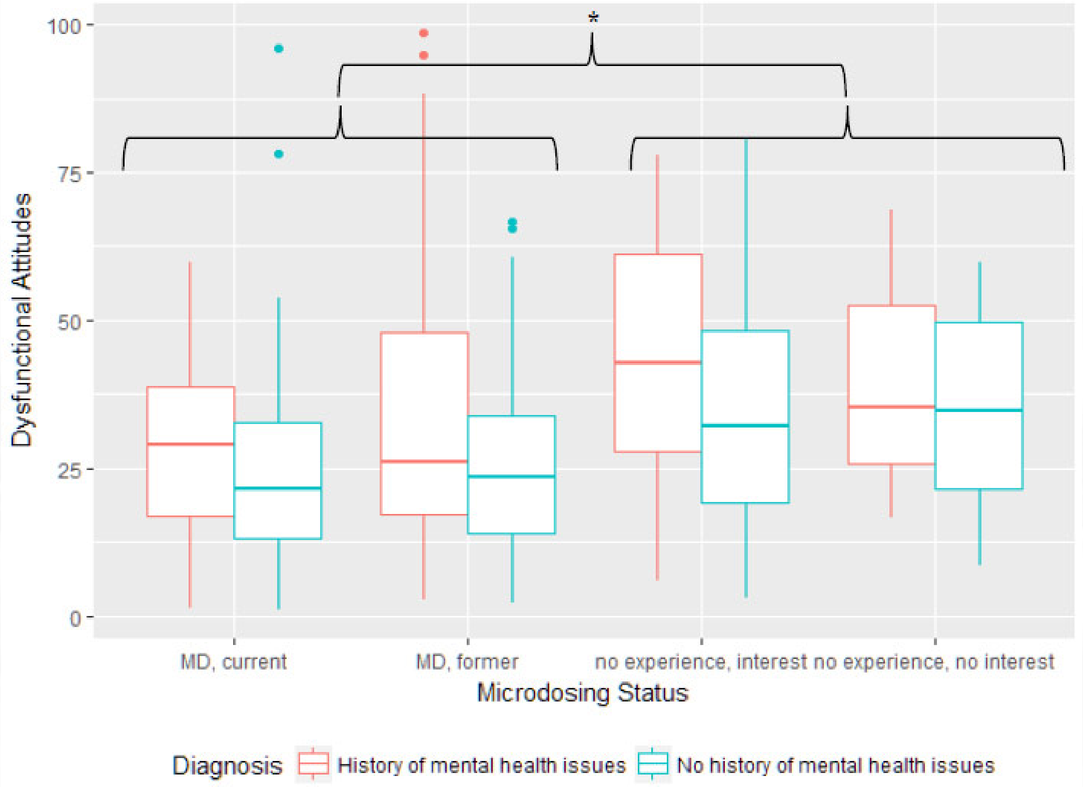


Figure 2. Differences in dysfunctional attitudes between microdosers and non-microdosers including breakdown by history of mental illness. The asterisk (*) indicates a significant main effect of microdosing status such that microdosers showed lower dysfunctional attitudes than non-microdosers ($p < 0.001$). Respondents with no history of mental illness (blue) also had lower dysfunctional attitudes than those with a history of mental illness (orange, $p < 0.001$), though microdosing status was a significant predictor even controlling for this potent covariate.

Wisdom

Microdosing predicted higher wisdom scores (b = 6.61, 95% CI [3.52 9.69], z(367) = 4.19, $p < .001$, *r* = 0.88) when controlling for age and level of education, which were not significant (age: b = -0.11, 95% CI [-0.26 0.04], *p* = 0.16, education: b = 0.40, 95% CI [-0.43 1.24], *p* = 0.35). No significant differences were found between current and former microdosers * (b = 1.09, 95% CI [-1.96 4.13], *p* = 0.48), nor type of substance used (b = 1.37, 95% CI [-2.83 5.57], *p* = .523), nor total lifetime number of microdoses (b = 0.62, 95% CI [-0.80 2.05], *p* = 0.39).

Negative Emotionality

Microdosing predicted lower Negative Emotionality (b = -5.78, 95% CI [-10.13 -1.43], z(396) = -2.60, *p* = .009, *r* = -0.85), even after controlling for gender, which was also a significant predictor (higher Negative

Emotionality in females, b = 10.49, 95% CI [5.33 15.65], z(396) = 3.99, *p* < .001, *r* = 0.95). Planned follow-up analysis tested the difference between current and former microdosers and no significant difference existed between the groups (b = -2.95, 95% CI [-7.47 1.58], *p* = 0.20), nor between substance used (b = -5.18, 95% CI [-11.50 1.15], *p* = .110), nor any effect of lifetime number of microdoses (b = -0.25, 95% CI [-2.38 1.89], *p* = 0.82) on Negative Emotionality.

Open-Mindedness

Microdosing predicted greater Open-Mindedness (b = 3.24, 95% CI [0.38 6.10], z(392) = 2.22, *p* = .027, *r* =0.67), including when controlling for education, which was not significant (b = 0.08, 95% CI [-0.65 0.81], *p* = 0.83). Again there were no significant differences between current and former microdosers (b = -1.18, 95% CI [-4.00 1.64], *p* = 0.41), nor type of substance used (b = 1.35, 95% CI [-2.61 5.31], *p* = .506), nor total lifetime number of microdoses (b = 0.77, 95% CI [-0.55 2.09], *p* = 0.26).

3.1.2 Creativity

Microdosing predicted higher scores on all three creativity facets: on average, responses made by microdosers were more clever (b = 0.57, SE = 0.13, z(423) = 4.25, *p* < .001, *r* =0.15), more uncommon (b = 0.50, SE = 0.15, z(427) = 3.42, *p* < .001, *r* =0.14) and more remote (b = 0.74, SE = 0.16, z(425) = 4.49, *p* < .001, *r* =0.20).

3.1.3 Importance of Benefits

Self-reported "importance of benefits" was intended to reflect participants' broad valuation of microdosing. Counter to H3a/b, no significant differences were found in reported importance of benefits when regressed on lifetime microdoses (b = 1.01, 95% CI [-0.81 2.82], *p* = .277) nor frequency of microdosing regardless of explored linear and non-linear relationships (raw: b = -0.07, 95% CI [-0.66 0.53], *p* = 0.83; squared: b = -0.0004, 95% CI [-0.01 0.01], *p* = 0.94; logarithmic: b = 1.21, 95% CI [-2.68 5.09], *p* = 0.54). Counter to H4a/b there were also no significant difference in the importance of benefits between participants who had previous experience with full-dose classic psychedelics and those who had no such experience (b = -4.09, 95% CI [-11.80 3.61], *p* = 0.30) nor based on the variety and recency of recreational substance use (Polydrug User Experience Index: b = -0.006, 95% CI [-0.26 0.25], *p* = 0.96).

3.2 Exploratory Analysis

Exploratory comparison of mood measures (valence and intensity, Tables 1&2) by Welch's *t*-test revealed that microdosers reported significantly more positive valence (M=2.33, SD=4.40) than non-microdosers (M=-0.16, SD=4.14; difference: 2.49, 95% CI [1.91 3.07], t(675) = 8.44, *p* < .001, *r* =0.31). No differences were found for mood intensity (difference: - 0.11, 95% CI [-0.44 0.22] *p* = 0.53). For valence, current microdosers (M=2.93, SD=4.57) also reported more positive valence than former microdosers (M=1.86, SD=4.21; difference: 1.07, 95% CI [0.35 1.79], t(533) = 2.92, *p* = .004, *r* =0.13), but no difference in mood intensity (difference: 0.33, 95% CI [-0.06 0.72], *p* = 0.10).

4. Discussion

This is the first preregistered report on microdosing psychedelics and is intended to inform future lab-based clinical intervention studies. We investigated psychedelic microdosing in online communities and tested pre-registered hypotheses (Anderson *et al.*, 2017) concerning the relationship between experience with microdosing and various mental health and personality variables. Our results suggest a beneficial relationship wherein experience with microdosing is associated with lower dysfunctional attitudes and negative emotionality and higher wisdom, open-mindedness, and creativity. The most popular substances used to microdose were LSD and psilocybin, and no significant differences based on substance were found on our quantitative measures. The qualitative benefits and drawbacks collected in this survey may yet reveal substance-based effects (Anderson *et al.*, 2018). Hypotheses predicting perceived importance of microdosing from dose-related practices were unsupported and optimal dose scheduling remains an open question. Exploratory analyses revealed that microdosers, especially current microdosers, had more positive emotional valence than non-microdosers, whereas emotional intensity was not significantly different. Taken together, these findings suggest that randomized, placebo-controlled clinical trials (RCTs) of microdosing are warranted to investigate the causal efficacy of microdosing.

Consistent with our hypotheses, microdosing experience was associated with meaningfully lower levels of dysfunctional attitudes. Individuals with higher dysfunctional attitudes maintain a set of disadvantageous beliefs that increase vulnerability to stressors (Jarrett *et al.*, 2012) and high scores are associated with depression (Adler *et al.*, 2015; de Graaf *et al.*, 2009). Also consistent with our hypotheses was the lower negative emotionality seen in microdosers, though the estimated effect was less precise. Tendencies to experience negative emotionality (e.g. anxiety, depression, emotional volatility) are a robust predictor of mental and physical health problems (Lahey, 2009) thus reduced vulnerability is reflected in the lower scores seen in microdosers. Exploratory analysis revealed that microdosers had more positive emotional valence than non-microdosers, linking microdosing to better mood states. While causation cannot be inferred from these results, significant differences were preserved even after controlling for potent covariates, such as gender and history of mental illness, indicating a potentially distinct contribution of microdosing on mental health vulnerability that warrants further study.

Microdosers also had higher wisdom, which is a complex trait (BWSS, Glück *et al.*, 2013). As measured by the BWSS, wisdom is understood to reflect learning from one's mistakes, considering multiple perspectives when facing a situation, being in tune with one's own emotions and the emotions of others, and feeling a sense of connection and unity. Higher scores, as seen in this sample of microdosers, may be associated with cognitive and emotional processing differences including enhanced capacity for perspective taking, resilience in the face of the vicissitudes of life, and increased feelings of engagement and connection. RCT research addressing the relationship between wisdom and microdosing are warranted.

Greater open-mindedness was expected in microdosers compared to controls due to previous studies noting increases in openness following a full-dose of psilocybin (MacLean, Johnson, & Griffiths, 2011). These differences were supported, though this effect was relatively weaker than the others. Still, given the findings from full-dose psychedelic studies, future clinical intervention research should continue investigating any causal relationship between open-mindedness and microdosing.

Microdosers were more creative when finding unusual uses for household items. This is consistent with Fredrickson's (2004) Broaden and Build theory, which suggests a positive relationship between creativity and positive affect, which was also seen in microdosers. Happier, more creative people may be more likely to apply novel modes of thinking in their personal and interpersonal challenges (Fredrickson, 2004). Our findings are also consistent with the anecdotal reports that a relationship between microdosing, creativity, and mood exists, but RCTs, ideally with multiple creativity measures, are required.

None of our hypotheses concerning the importance of microdosing benefits and microdosing practices were supported. It is likely that this measure was not sensitive and specific enough; planned analyses of qualitative benefits and drawbacks of microdosing will be explored in a separate report (Anderson *et al.*, 2018). It may be that microdosing frequency is truly unrelated to the subjective valuation of microdosing, but this seems improbable. We suggest that this research question is best addressed in RCT studies focused on specific benefits with experimental manipulation of dose and schedule to determine optimal benefit-specific protocols. Similarly, there is no evidence that outcomes are predicated on prior experience with substances, whether full-dose psychedelics or with a variety of substances. More microdosers had experience with full-doses (69%, *n*=412) then did not (31%, *n*=182) and many microdosers (and nonmicrodosers) had experience with full-dose psychedelics within the month prior to completing the survey. As full-dose psychedelics can have benefits lasting at least a month (Carhart-Harris *et al.*, 2017) this covariate should be formally modelled in future microdosing research designs, which should aim to include both psychedelic-naïve and psychedelic-experienced participants.

5. Limitations and Future Directions

The sample is both a strength and a limitation of this study. This sample represents a true community of microdosers with dozens of countries represented, however, countries in the Anglo cultural cluster make up the majority of the sample (>70%) and participants were predominantly middle-class, white, male, and heterosexual. Sampling from online communities, including Reddit, could create a demographic bias thus we cannot suggest a definitive epidemiological generalization. Despite this limitation, this sample does inform us about real community practices in an otherwise unstudied population and reflects our sample of interest.

A second limitation of this study is its correlational nature. This cross-sectional design contained no longitudinal component or experimental manipulation and cannot be used to infer causal relationships. Our findings of group-differences do not infer that microdosing caused these differences as some of the measured constructs may even promote an increased willingness to explore microdosing, e.g. open-mindedness. Instead, these findings are intended as a descriptive foundation upon which experimental and clinical studies of psychedelic microdosing can be designed, exploring the directionality of relationships established in the present study.

To test causal hypotheses concerning microdosing effects, pre-registered randomized placebo-control trials (RCTs) are needed. With random assignment to microdose or placebo it would be possible to determine whether microdosing causally influences mental health and personality. Following positive causal findings, mechanistic studies could then investigate the observed efficacy in terms of physiological, psychological, and neurobiological changes.

Promisingly, microdosing may prove easier to administer, monitor, and placebo-control in lab settings due to the absence of the intense perceptual shifts induced by full-doses. Microdosing may thus be amenable to designs that could aid in mapping the neural mechanisms behind psychedelic efficacy. Microdosing could also be explored as an adjunct to long-term psychotherapy predicated on the longitudinal cultivation of resilience and insight, a new paradigm that could compliment the acutely transformative model underlying high-dose psychedelic psychotherapy (Rosenbaum *et al.*, 2018).

6. Conclusion

This study provides initial, correlational evidence for mental health and personality benefits associated with microdosing psychedelics. While anecdotal reports of microdosing benefits have existed for some time (Fadiman, 2011), this study marks the first formal study of the topic. Additionally, the use of a pre-registered study design sets a precedent for responsible and replicable psychedelic microdosing research. To add depth to the current discussion, a full epidemiological report (Rosenbaum *et al.*, 2018) and a Grounded Theory analysis of qualitative outcomes (Anderson *et al.*, 2018) are forthcoming.

The results of the present study suggest that there is a significant relationship between microdosing experience and measures of mental health and flourishing including lower dysfunctional attitudes and negative emotionality, higher wisdom and open-mindedness, and higher creativity and affect-valence. These findings are the initial evidence that warrants RCTs to directly test safety and therapeutic efficacy. With almost 40,000 users subscribing to the /r/microdosing subreddit and thousands more reading media reports on microdosing this growing community continues to explore microdosing and its effects. It is our hope that scientific reporting can help to clarify and inform the public about the nature of microdosing's putative effects and that this new paradigm helps shape future psychedelic research. We hope that researchers will draw on our shared resources (https://osf.io/g5cwy/) and pre-register studies of their own so that psychedelic science will be built upon strong research practices. Insights from these and other studies will form the backbone of future research into microdosing psychedelics.

Conflict of interest statement
On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

1. Adler AD, Strunk DR and Fazio RH (2015) What Changes in Cognitive Therapy for Depression? An Examination of Cognitive Therapy Skills and Maladaptive Beliefs. *Behavior Therapy* 46(1). Special Series: Advances in Evidence-Based Intervention and Assessment Practices for Youth with an Autism Spectrum Disorder: 96-109. DOI: 10.1016/j.beth.2014.09.001.
2. Amsterdam J van, Opperhuizen A and Brink W van den (2011) Harm potential of magic mushroom use: A review. *Regulatory Toxicology and Pharmacology* 59(3): 423-429. DOI: 10.1016/j.yrtph.2011.01.006.
3. Anderson T, Petranker R and Dinh-Williams L-A (2017) Demography of Microdosing Community Survey. Available at: https://osf.io/g5cwy/ (accessed 6 July 2018).
4. Anderson T, Christopher A, Petranker R, *et al.* (2018) Benefits and Drawbacks of Microdosing Psychedelics. Manuscript in preparation. Available at: osf.io/g5cwy.
5. Bogenschutz MP, Forcehimes AA, Pommy JA, *et al.* (2015) Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *Journal of Psychopharmacology (Oxford, England)* 29(3): 289-299. DOI: 10.1177/0269881114565144.
6. Carbonaro TM, Bradstreet MP, Barrett FS, *et al.* (2016) Survey study of challenging experiences after ingesting psilocybin mushrooms: Acute and enduring positive and negative consequences. *Journal of psychopharmacology (Oxford, England)*30(12): 1268-1278. DOI: 10.1177/0269881116662634.
7. Carhart-Harris RL, Roseman L, Bolstridge M, *et al.* (2017) Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Scientific Reports* 7(1): 13187. DOI: 10.1038/s41598-017-13282-7.
8. de Graaf LE, Roelofs J and Huibers MJH (2009) Measuring Dysfunctional Attitudes in the General Population: The Dysfunctional Attitude Scale (form A) Revised. *Cognitive Therapy and Research* 33(4): 345-355. DOI: 10.1007/s10608-009-9229-y.
9. de Wit H and Phillips TJ (2012) Do initial responses to drugs predict future use or abuse? *Neuroscience and Biobehavioral Reviews* 36(6): 1565-1576. DOI: 10.1016/j.neubiorev.2012.04.005.
10. Domínguez-Clavé E, Soler J, Elices M, *et al.* (2016) Ayahuasca: Pharmacology, neuroscience and therapeutic potential. *Brain Research Bulletin* 126(Pt 1): 89-101. DOI: 10.1016/j.brainresbull.2016.03.002.
11. Dos Santos RG, Osório FL, Crippa JAS, *et al.* (2016) Antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide (LSD): a systematic review of clinical trials published in the last 25 years. *Therapeutic Advances in Psychopharmacology* 6(3): 193-213. DOI: 10.1177/2045125316638008.
12. Fadiman J (2011) *The Psychedelic Explorer's Guide*. Rochester, VT: Park Street Press.
13. Fredrickson BL (2004) The broaden-and-build theory of positive emotions. *Philos Trans R Soc Lond B Biol Sci* 359(1449): 1367-78. DOI: 10.1098/rstb.2004.1512.
14. Glück J, König S, Naschenweng K, *et al.* (2013) How to measure wisdom: content, reliability, and validity of five measures. *Frontiers in Psychology* 4. DOI: 10.3389/fpsyg.2013.00405.
15. Griffiths RR, Johnson MW, Richards WA, *et al.* (2011) Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects. *Psychopharmacology* 218(4): 649-665. DOI: 10.1007/s00213-011-2358-5.
16. Griffiths RR, Johnson MW, Carducci MA, *et al.* (2016) Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *Journal of Psychopharmacology (Oxford, England)* 30(12): 1181-1197. DOI: 10.1177/0269881116675513.
17. Gunnarsson M, Gustavsson P, Tengström A, *et al.* (2008) Personality traits and their associations with substance use among adolescents. *Personality and Individual Differences* 45: 356-360. DOI: 10.1016/j.paid.2008.05.004.
18. Halpern JH and Pope HG (1999) Do hallucinogens cause residual neuropsychological toxicity? *Drug and Alcohol Dependence* 53(3): 247-256. DOI: 10.1016/S0376-8716(98)00129-X.
19. Hardaway R, Schweitzer J and Suzuki J (2016) Hallucinogen Use Disorders. *Child and Adolescent Psychiatric Clinics of North America* 25(3): 489-496. DOI: 10.1016/j.chc.2016.03.006.
20. Jarrett RB, Minhajuddin A, Borman PD, *et al.* (2012) Cognitive Reactivity, Dysfunctional Attitudes, and Depressive Relapse and Recurrence in Cognitive Therapy Responders. *Behaviour Research and Therapy* 50(5): 280-286. DOI:10.1016/j.brat.2012.01.008.
21. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al.* (2014) Pilot Study of the 5-HT$_{2A}$R Agonist Psilocybin in the Treatment of Tobacco Addiction. *Journal of psychopharmacology (Oxford, England)* 28(11): 983-992. DOI: 10.1177/0269881114548296.
22. Johnson MW, Griffiths RR, Hendricks PS, *et al.* (2018) The abuse potential of medical psilocybin according to the 8 factors of the Controlled Substances Act. *Neuropharmacology*. DOI: 10.1016/j.neuropharm.2018.05.012.
23. Kometer M, Pokorny T, Seifritz E, *et al.* (2015) Psilocybin-induced spiritual experiences and insightfulness are associated with synchronization of neuronal oscillations. *Psychopharmacology* 232(19): 3663-3676. DOI: 10.1007/s00213-015-4026-7.
24. Krebs TS and Johansen P-Ø (2013) Psychedelics and Mental Health: A Population Study. *PLoS ONE* 8(8). DOI: 10.1371/journal.pone.0063972.
25. Lahey BB (2009) Public Health Significance of Neuroticism. *The American psychologist* 64(4): 241-256. DOI: 10.1037/a0015309.
26. Leonard A (2015) How LSD Microdosing Became the Hot New Business Trip. In: *Rolling Stone*. Available at: https://www.rollingstone.com/culture/culture-news/how-lsd-microdosing-became-the-hot-new-business-trip-64961/ (accessed 9 July2018).
27. MacLean KA, Johnson MW and Griffiths RR (2011) Mystical Experiences Occasioned by the Hallucinogen Psilocybin Lead to Increases in the Personality Domain of Openness. *Journal of psychopharmacology (Oxford, England)* 25(11): 1453-1461. DOI: 10.1177/0269881111420188.
28. Matejka J, Glueck M, Grossman T, *et al.* (2016) The Effect of Visual Appearance on the Performance of Continuous Sliders and Visual Analogue Scales. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, New York, NY, USA, 2016, pp. 5421-5432. CHI '16. ACM. DOI: 10.1145/2858036.2858063.
29. Moreno FA, Wiegand CB, Taitano EK, *et al.* (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-

compulsive disorder. *The Journal of Clinical Psychiatry* 67(11): 1735-1740.

30. Osório F de L, Sanches RF, Macedo LR, *et al*. (2015) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: a preliminary report. *Revista Brasileira De Psiquiatria (Sao Paulo, Brazil: 1999)* 37(1): 13-20. DOI:10.1590/1516-4446-2014-1496.
31. Rosenbaum D, Weissman C, Hapke E, *et al*. (2018) Microdosing psychedelic substances: demographics, psychiatric comorbidities, and comorbid substance use. Manuscript in preparation. Manuscript submitted for publication. Available at:osf.io/g5cwy.
32. Ross S, Bossis A, Guss J, *et al*. (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *Journal of Psychopharmacology (Oxford, England)* 30(12): 1165-1180. DOI: 10.1177/0269881116675512.
33. Silvia PJ (2011) Subjective scoring of divergent thinking: Examining the reliability of unusual uses, instances, and consequences tasks. *Thinking Skills and Creativity* 6(1): 24-30. DOI: 10.1016/j.tsc.2010.06.001.
34. Silvia PJ, Winterstein BP, Willse JT, *et al*. (2008) Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts* 2(2): 68-85. DOI:10.1037/1931-3896.2.2.68.
35. Solon O (2016) Under pressure, Silicon Valley workers turn to LSD microdosing. *Wired UK*, 24 August. Available at: http://www.wired.co.uk/article/lsd-microdosing-drugs-siliconvalley (accessed 9 July 2018).
36. Soto CJ and John OP (2016) The Next Big Five Inventory (BFI-2): Developing and Assessing a Hierarchical Model With 15 Facets to Enhance Bandwidth, Fidelity, and Predictive Power. Article in Press. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84962720315&partnerID=40&md5=a060a5135d4ee7cfc25cb84c5118a272.
37. Strassman RJ (2016) *DMT: The Spirit Molecule: A Doctor's Revolutionary Research into the Biology of Near-Death and Mystical Experiences*. Rochester, VT: Inner Traditions.
38. Terracciano A, Löckenhoff CE, Crum RM, *et al*. (2008) Five-Factor Model personality profiles of drug users. *BMC Psychiatry* 8: 22. DOI: 10.1186/1471-244X-8-22.
39. Trull TJ and Sher KJ (1994) Relationship between the five-factor model of personality and Axis I disorders in a nonclinical sample. *Journal of Abnormal Psychology* 103(2): 350-360. DOI: 10.1037/0021-843X.103.2.350.
40. UNESCO Institute for Statistics (2011) International Standard Classification of Education (ISCED) 2011. Available at: http://uis.unesco.org/sites/default/files/documents/international-standard-classificationof-education-isced-2011-en.pdf.
41. Waldman A (2017) *A Really Good Day: How Microdosing Made a Mega Difference in My Mood, My Marriage, and My Life*. 1 edition. New York: Knopf.

Microdosing psychedelics: More questions than answers? An overview and suggestions for future research

by

Kim PC Kuypers[1], Livia Ng[2], David Erritzoe[3], Gitte M Knudsen[4], Charles D Nichols[5], David E Nichols[6], Anaïs Soula[7] and David Nutt[8]

Journal of Psychopharmacology 2019, Vol. 33(9) 1039-1057

DOI: 10.1177/0269881119857204

original report: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6732823/pdf/10.1177_0269881119857204.pdf
backup source: http://www.psilosophy.info/resources/10.1177_0269881119857204.pdf

[1] Department of Neuropsychology and Psychopharmacology, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands
[2] Department of Psychology, University College London, London, UK
[3] Department of psychology, Neuropsychopharmacology Unit, Imperial College London, London, UK
[4] Neurobiology Research Unit, Rigshospitalet and University of Copenhagen, Copenhagen, Denmark
[5] Department of Pharmacology and Experimental Therapeutics, Louisiana State University Health Sciences Center, New Orleans, LA, USA
[6] Purdue University College of Pharmacy, West Lafayette, LA, USA
[7] COMPASS Pathways, London, UK
[8] Neuropsychopharmacology, Imperial College London, London, UK

Corresponding author: David Nutt, Neuropsychopharmacology, Imperial College London, London, UK.
Email: k.kuypers@maastrichtuniversity.nl

Table of Contents:

Abstract
Background
Question 1: What does microdosing mean?
Question 2: What microdosing schedules have been used?
Question 3: What controlled studies have been done so far?
Question 4: Are there any relevant preclinical studies?
Question 5: What is the pharmacology of psychedelics when used in microdoses?
Question 6: Is microdosing safe?
Question 7: What receptors will be involved in the activity of microdosed psilocybin?
Question 8: Are the claims of the benefits of microdosing biologically plausible?
Question 9: What is the legal position of microdosing?
Question 10: What are the regulatory issues?
Question 11: What are the future research needs?
References
Commentary
- Microdosing psychedelics: Too much hype, almost no rigorous research
  - *References for commentary by Stephen Ross*
- Psychedelics: What are low doses and "microdoses"?
  - *References for commentary by Matthias E Liechti*
- Comment
  - *References for comment by James Fadiman and Sophia Korb*
- Commentary by Dr Torsten Passie
  - *Psychedelics and creativity*
  - *Definitions: Microdosing and minidosing*
  - *Dosing of dried mushrooms*
  - *The most used dosing regime and effects of micro- and minidosing*
  - *Possible alterations of gene expression and receptor proteins*
  - *On the possible induction of cardiovascular valvopathy*

References for commentary by Torsten Passie

Responses to the microdosing critique reviews

Abstract

Background: In the past few years, the issue of 'microdosing' psychedelics has been openly discussed in the public arena where claims have been made about their positive effect on mood state and cognitive processes such as concentration. However, there are very few scientific studies that have specifically addressed this issue, and there is no agreed scientific consensus on what microdosing is.

Aim: This critique paper is designed to address questions that need to be answered by future scientific studies and to offer guidelines for these studies.

Approach: Owing to its proximity for a possible approval in clinical use and short-lasting pharmacokinetics, our focus is predominantly on psilocybin. Psilocybin is allegedly, next to lysergic acid diethylamide (LSD), one of the two most frequently used psychedelics to microdose. Where relevant and available, data for other psychedelic drugs are also mentioned.

Conclusion: It is concluded that while most anecdotal reports focus on the positive experiences with microdosing, future research should also focus on potential risks of (multiple) administrations of a psychedelic in low doses. To that end, (pre)clinical studies including biological (e.g. heart rate, receptor turnover and occupancy) as well as cognitive (e.g. memory, attention) parameters have to be conducted and will shed light on the potential negative consequences microdosing could have.

Keywords Psychedelics, microdosing, psychoactive substances.

Background

Psychedelics are a class of psychoactive substances that induce complex behavioural, psychological and physiological effects primarily through activation of serotonin 5-HT$_{2A}$ receptors. In the past few years, the issue of 'microdosing' psychedelics has been openly discussed in the public arena with several books (Cruz, 2017; Kumar, 2016; Waldman, 2017) claiming value to the authors who tried this concept. However, there are very few scientific studies that have specifically addressed this issue, and there is no agreed scientific consensus on what microdosing entails (Cameron *et al.*, 2019; Horsley *et al.*, 2018). This paper is designed to address questions that need to be answered by future scientific studies and to offer guidelines for these studies. Although a number of classic psychedelics exist, two of them, lysergic acid diethylamide (LSD) and psilocybin, are allegedly most frequently used to microdose. The following review focuses predominantly on psilocybin due to its proximity for a possible approval in clinical use and short-lasting pharmacokinetics (Passie *et al.*, 2002) in comparison with LSD (Dolder *et al.*, 2017). However, where relevant and available, data for other psychedelic drugs are also mentioned.

As early as the 16th century, low doses of psilocybin, '*teonanacatl*' or sacred mushroom, were used medically (Schultes, 1940). Bernardino de Sahagún, a Franciscan friar during the period of the Spanish conquest of the Americas (1519-1521), reported that, '*teonanácatl* were ... medicinal for fevers and for rheumatism. Only two or three need to be eaten. Those who eat them see visions and feel a faintness of the heart. And they provoke lust to those who eat a number, or even a few, of them'. However, by 1640, 94% of the Aztec population was wiped out and alongside them, the traditions involving '*teonanácatl*'. Of note, the mentioning of visions here suggests this ancient 'low-dose' use does not refer to what is currently seen as microdosing, something that will be addressed below.

Psychedelic studies underwent a significant expansion following the discovery of the mind-altering properties of LSD by Albert Hofmann in 1943 (Hofmann, 1970). The subsequent growth of psychedelic use allegedly had a profound effect on innovation in science and technology. A popular example is that of Francis Crick, one of the co-discoverers of the double-helix structure of DNA, who used LSD, though this use was never confirmed nor denied by him (Roberts, 2008). Furthermore, Kary Mullis, who discovered a means to automate the polymerase chain reaction, claimed that the idea came to him after using LSD (Doyle, 2002). These discoveries greatly advanced the field of genetic research (Luke, 2006). In this atmosphere of innovation, Frederick Terman was appointed as Provost of Stanford, 1955-1965. During his tenure, Terman 'set out to create a community of technical scholars in Silicon Valley' (Leslie and Kargon, 1996). This community developed alongside the psychedelic capital of the world, San Francisco, and over time technology and psychedelics began to merge. By 2005, the founder of Apple and one of the most influential figures in Silicon Valley, Steve Jobs, highlighted that LSD had played a pivotal and transformative role in his life (Dormehl, 2012).

Although there was accumulating evidence to suggest that the intake of psychedelics led not only to hallucinations but also to an improvement of cognition and creativity, scientific progress in the field was prohibited by government agencies on account of the growing political concern over the recreational use of psychedelics (Belouin and Henningfield, 2018). Thus, the only study investigating psychedelics in problem solving was ended by the US Food and Drug administration (FDA) in 1966 (Harman *et al*., 1966). However, James Fadiman, a young researcher in this study, continued his research after the UN Convention on Psychotropic Substances of 1971 banned psychoactive substances and bundled his knowledge into a book, which now acts as a guide for those interested in microdosing. His book The Psychedelic Explorer's Guide: Safe, Therapeutic, and Sacred Journeys (Fadiman, 2011) published in 2011, is often referred to as a protocol for those practising microdosing. Of note, no study to date has revealed statistically significant effects of microdosing on creativity under placebo-controlled circumstances (Passie, 2019).

Although microdosing became prominent due to the belief it improved cognition, a growing number of individuals began to microdose psychedelics to improve conditions of pain (Johnstad, 2018), cluster headache or migraine (Andersson *et al*., 2017). It seems that the efficacy of microdosing may derive from its non-psychedelic dose range, which provides treatment without affecting cognition. Individuals also reported relief of pain with a long-term psychedelic microdosing regimen (Johnstad, 2018). Thus, psychedelic microdosing might constitute a different paradigm to single psychedelic therapeutic sessions with *macrodoses* where the nature and content of the experience plays a key role in predicting therapeutic outcome (Roseman *et al*., 2018; Schenberg, 2018). However, many questions remain about the definition, safety, potential mechanism and future research involving microdosing.

Question 1: What does microdosing mean?

The term microdosing is not a uniquely psychedelic term. In pharmacology, microdosing is a process used in drug development (Lappin and Garner, 2008) and drug selection (Lappin *et al*., 2006) where a minute dose of a substance is used to assess the pharmacokinetics of a drug. A microdose, in this regulatory arena, has been defined by a position paper from the European Medicines Agency 2004 (EMEA, 2003), guidelines from the U.S. Food and Drug Administration in 2006 (FDA, 2006) and the Ministery of Health, Labour and Welfare in Japan in 2008 (MHLW, 2008), and the current definitive international guideline in 2009 (ICH, 2009) as being a dose of drug that is 1% of the pharmacologically active dose, up to a maximum of 100 µg. Thus, psychedelic microdosing ('5-10 µg of LSD' (Fadiman, 2011)) would be 5-10% of a usual psychoactive dose and lie between a full pharmacological dose (100%) and a 'pharmacological microdose'.

Microdosing psychedelics has been described in a similar manner by different individuals. Fadiman describes it as a practice 'to use sub-threshold doses of psychedelic drugs in an attempt to enhance cognitive tasks, to boost physical energy levels, to promote emotional balance, and to treat anxiety, depression and addiction' resulting in typically subtle though noticeable effects (Fadiman, 2011). Similarly, Aylet Waldman in her book (Waldman, 2017) states the same intention for microdosing but describes the process as 'the act of integrating sub-perceptual doses of psychedelic drugs, in your weekly routine'. In addition, Johnstad emphasizes that 'to microdose with a psychedelic drug means to take a dose small enough to provide no intoxication or significant alteration of consciousness' (Johnstad, 2018).

Thus, the term 'microdosing' appears to consist of three components:

1. The use of a low dose below the perceptual threshold that does *not impair* 'normal' functioning of an individual.
2. A procedure that includes multiple dosing sessions.
3. The intention to improve well-being and enhance cognitive and/or emotional processes.

Existing dosing categories for psychedelics when used in research are *very low dose, low dose, medium dose*, and *high dose* (Table 1). A microdose has been defined as approximately one-tenth to one-twentieth of a recreational dose, varying within and between substances, so it can be seen as being somewhat below a very low dose. Although microdosing of psychedelics does not have an agreed scientific definition, we have decided to continue to use the term because of its prevalent societal use. Hopefully, this paper will help to facilitate research towards establishing it as a scientific construct.

The most widely distributed species of psychedelic mushrooms are *Psilocybe cubensis* and those of the genus *Copelandia*, which consists of 12 species (Guzmán *et al.*, 1998). The psilocin (the active metabolite of psilocybin) and psilocybin content in the whole body of these mushrooms when dried was estimated to be in the range of 0.14-0.42% (psilocin) and 0.37-1.30% (psilocybin) for *P. cubensis* and 0.43-0.76% (psilocin) and 0.08-0.22% (psilocybin) for *Copelandia*, respectively. Thus, the former is more psilocybin-rich than the latter, and the latter contains more psilocin compared to the former (Tsujikawa *et al.*, 2003). The *Psilocybe semilanceata* is the most common British species. This mushroom only contains psilocybin, in the range from 0.17 to 1.96%, as shown by one Norwegian analysis (Christiansen *et al.*, 1981; Rumack and Spoerke, 1994). These data show that the psilocybin concentration varies between and within species but is also dependent on the time of collection, the preservation of the material and growth conditions. User reported recreational doses depend on the species and experience of the user (Rumack and Spoerke, 1994).

Table 1. Varying doses of psychedelic compounds used in preclinical and clinical studies.

Substance	Subjects/participants (animal/human)	Route of administration	Microdose	Very low dose	Low dose	Medium dose	High dose
Psilocin (Hasler *et al.*, 2004; Wackermann *et al.*, 2008)	Human (both studies)	Oral	<1 mg	3.15 mg	8 mg	15 mg	22 mg
LSD (Dandiya *et al.*, 1969)	Rats	Intraperitoneally	10-25 µg	30-40 µg	60-110 µg	150 µg	200+ µg
Ibogaine HCl (Glick *et al.*, 2000; Lotsof and Wachtel, 2002; Schechter and Gordon, 1993)[a]	Rats Humans[a]	Intraperitoneally Oral[a]	200 mg	300-400 mg	700 mg	1400 mg[a]	2800 mg
DMT (Shulgin, 1976)	Humans	Intramuscular injection	6 mg	10 mg	20 mg	30 mg	50-70 mg[b]

Per kilogram dose values have been converted to values for a 70-kg person. These doses are approximate values.
[a] Study conducted in humans using a single oral dose of 1400 mg.
[b] When inhaled, 30 mg would be considered a high dose.

A hallucinogenic dose of dried *P. cubensis*, for example, is between 3 and 5 g (Rumack and Spoerke, 1994). These values equate to a recreational dosing range of 8.6 to 14.7 mg of psilocin per dose. Thus, a microdose would range from 0.43 to 0.73 mg of psilocin per dose because a microdose of psilocybin is generally one-tenth of a full dose (Fadiman, 2011). That positions a recreational dose of psilocin between a low and medium dose and a microdose below a very low dose. However, variations in psilocin content between doses of dried mushroom may be seen due to variations between individual fungi within a species. A microdose of LSD ranges between 10 and 20 µg with 20 µg being the upper limit that might already produce perceptual changes in some. A microdose of ibogaine hydrochloride is approximately 25 mg (Kroupa and Wells, 2005), and when smoked, that of *N,N*-dimethyltryptamine (DMT) is approximately 6 mg (May, 2018).

Question 2: What microdosing schedules have been used?

The data presented here were collected using a search of microdosing protocols that included books, online fora and surveys. The keywords of this search included microdosing, microdosing protocols, microdosing approaches and psilocybin microdose. In this search, it was found that users mainly followed three approaches. The most popular of these was the Fadiman approach, outlined in his book (Fadiman, 2011), which involves two consecutive dosing days followed by two non-dosing days. Another popular approach involves 'weekday' dosing, i.e. from Monday to Friday and not dosing on Saturday and Sunday. Additionally, some users indicated that they followed a balanced low/microdose approach, which involved dosing every other day. Dosing periods ranged from 1 week to 2 years. This variation in microdosing schedules was confirmed by a recent survey which demonstrated that half of the respondents who microdosed came up with their own schedule (Hutten *et al.*, 2019).

Question 3: What controlled studies have been done so far?

The first placebo-controlled LSD microdosing study was published recently (Yanakieva *et al.*, 2018). Findings showed a delay of time perception in the absence of self-rated effects on perception, mentation and concentration after administration of single doses of 5, 10, and 20 µg LSD. To our knowledge there has been only one published study designed specifically to measure the effects of psilocybin microdosing per se (Prochazkova *et al.*, 2018) where the effects of psychedelic mushrooms were explored in a recreational setting. This study suffers from a number of methodological issues, particularly the lack of a placebo control as well as uncertainty over dose taken. However, there have been several more controlled studies where a low dose of psilocybin has been used as a control for a regular dose; these are presented below.

For example, Hasler and colleagues (2004) compared four doses of psilocybin in healthy humans in a placebo-controlled experimental design and found slight physiological and psychological differences between single administration of placebo and a very low dose (VLD) (Hasler *et al.*, 2004). A VLD was defined as 45 µg/kg p.o., equating to approximately 2.3 mg of psilocin for an average 70-kg human. VLD was compared with a low dose (LD), a medium dose (MD) and a high dose (HD) defined as 115, 215 and 315 µg/kg p.o., respectively. Although most physiological measures were similar between the VLD dose and placebo, a significant decrease was seen in maximum heart rate at the 6-hour point after VLD administration. Acute self-rated/self-reported psychological responses of VLD included slight drowsiness, increased sensitivity and intensification of pre-existing mood states; an increase in introversion compared to placebo was only shown for the MD and HD at peak drug effect, 95 minutes post-administration.

Building on that, Griffiths and colleagues (2011) investigated the effects of psilocybin in varying doses where each participant received five dosing sessions, spread across 1-month intervals (Griffiths *et al.*, 2011). The doses used were 0, 5, 10, 20 and 30 mg/70 kg. Using a Monitor Rating Questionnaire with a 5-point scale, they found that a dose of 5 mg/70 kg increased stimulation, distance from ordinary reality and sense of peace. Intensity, somaesthesia, affect, perception, cognition and volition measured on the Hallucinogen Rating Scale all increased after administration of a 5 mg/70 kg dose. In other words, they did not find a dose without psychological effects. Interestingly, when using an 11 mg/70 kg and 15 mg/70 kg dose of psilocybin, Lewis and colleagues (2017) found a significant decrease in global cerebral blood flow in the frontal, parietal, temporal, limbic, cingulate and occipital cortex, insula, caudate, putamen, pallidum, amygdala, hippocampus and thalamus (Lewis *et al.*, 2017). This may relate to the psychological effects seen with lower doses.

Psychological effects of microdosing have been regularly reported by users after multiple administrations of psilocybin. Independent accounts from online fora and surveys (Fadiman and Korb, 2019; www.thethirdwave.co; www.dmt-nexus.me, 2018; www.reddit.com, 2018) reveal that users report improvements in energy, mood, cognition, concentration, management of stress, creativity, spiritual awareness, productivity, language capabilities, relationships and visual capabilities. Further, users also reported reduced anxiety, depression and addiction and pain relief. In a recent survey by Anderson and colleagues (2018), users also noted drawbacks such as illegality, stigma, physical discomfort, anxiety, over-stimulation, cognitive interference, emotional difficulty and uncertainty of effect (Anderson *et al.*, 2018). All of these reports are confounded by the lack of certainty relating to the actual dose used, or indeed the provenance of the active ingredient, and the absence of placebo conditions. For a recent review of past research with psychedelic microdosing, please see Passie (2019).

Question 4: Are there any relevant preclinical studies?

We found only two preclinical studies involving microdosing (Cameron *et al.*, 2019; Horsley *et al.*, 2018). Horsley and colleagues (2018) investigated the effect of microdosing on anxiety using an elevated plus-maze and observation of ecological behaviours. They defined a microdose of psilocin as 0.05 mg/kg, which equates to 3.5 mg for an average 70-kg human. Rats received three dosing sessions over 6 days with the last dosing session on the 6th day. Anxiety profiles were measured in Wistar rats 2 days after the final dosing session. Ethological behaviours including rears, head dips and stretch-attend were also measured during this period. Psilocin at 0.05 mg/kg significantly reduced entries into open arms, suggesting that microdosing may have an anxiogenic effect. This effect was not replicated in the ethological measures. Although the authors conclude that these results might have implications for future therapeutic applications, as they produce counter-productive behaviour, one obvious limitation is the interspecies scaling issue (Sharma and McNeill, 2009). It is questionable whether doses administered to animals translate to humans and the authors also acknowledged that the translational value of their results needs to be determined in a therapeutic context.

Cameron and colleagues (2019) tested the effect of repeated low doses of DMT in rats. They gave a dose for 2 months every third day and assessed behaviour with a broad range of tests. In a cued fear extinction learning test, they showed that animals froze significantly less than a control group, suggesting that DMT facilitates fear extinction memory. In the forced swim test, an antidepressant-like effect was observed. No change was observed in dendritic spine density in the layer V pyramidal neurons, and no changes were observed in gene expression (EGR1, EGR2, ARC, FOS, BDNF and 5-HT_{2A}). However, an impact on metabolism was observed in male rats; the weight increased by 182%, compared to 165% with vehicle (Cameron *et al.*, 2019). Comparable to the Horsley *et al.* (2018) study, the interspecies scaling is a point of discussion together with the question of whether a short-acting substance such as DMT would show beneficial effects in humans without administration of a monoamine oxidase (MAO) inhibitor. Lastly, it should be emphasized that there is a need to conduct more research on long-term effects in order to assess the long-term safety of repeat doses.

Question 5: What is the pharmacology of psychedelics when used in microdoses?

The pharmacology of psilocybin and psilocin is still unclear due to the rapid decline in psychedelic drug research following their being made Schedule 1 drugs in 1968 (Rucker *et al.*, 2018). This decline predated the growth of modern neuropharmacology. Thus, more research is required to build a more complete pharmacological profile of psilocybin and psilocin.

Psilocybin (3[2-(dimethylamino)ethyl]indol-4-ol dihydrogen phosphate ester; O-phosphoryl-4-hydroxy-*N*,*N*-dimethyltryptamine) belongs to the indolealkylamine class of psychoactive compounds (Table 2). It is an indole prodrug characterised by a 4-substituent, a phosphate group (Repke *et al.*, 1977), six hydrogen bond acceptors and low lipophilicity (Geiger *et al.*, 2018). Low lipophilicity may contribute to the notion that psilocybin does not cross the blood-brain barrier (Rautio *et al.*, 2008).

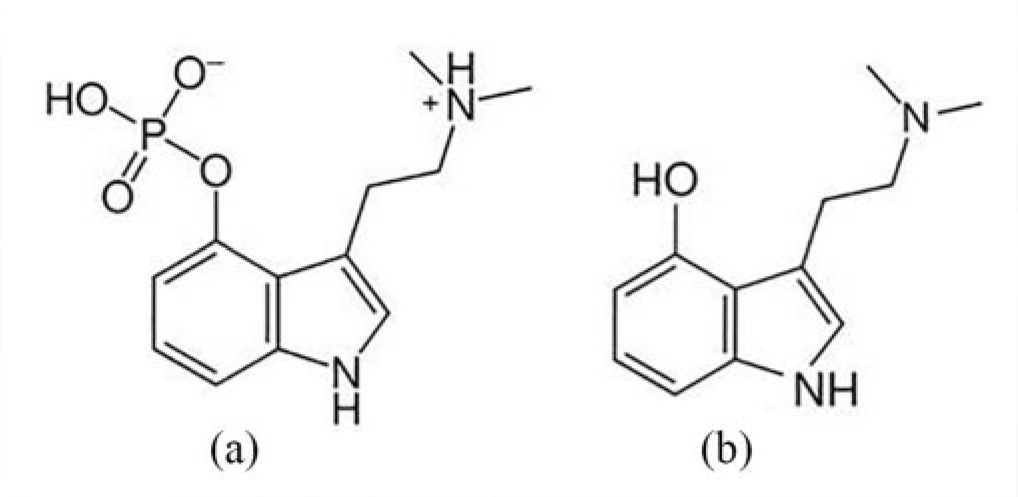


Figure 1. The structure of (a) psilocybin and (b) psilocin.

In vivo, however, the majority of the prodrug psilocybin is rapidly converted to psilocin by alkaline phosphatases present in the blood and tissues. Psilocin has fewer hydrogen bond acceptors in its structure, which increases lipophilicity. In addition, NMR spectral studies have implicated an intramolecular hydrogen bond in psilocin that reduces the basicity of psilocin, increases its lipophilicity and also may render it stable to the action of MAO (Migliaccio *et al.*, 1981). Following systemic circulation, psilocin is metabolized by either phase I or phase II metabolism (Figure 1). The former involves an oxidation reaction to form 4-

hydroxyindole-3-acetaldehyde followed by either an oxidation to 4-hydroxyindole-3-acetic acid or a reduction to 4-hydroxytryptophole. It is believed that none of these metabolites are biologically active. The latter pathway involves the formation of a psilocin *O*-glucuronide conjugate through small intestine and liver enzymes UGT1A10 and UGT1A9, respectively. There is evidence that to some extent, glucuronidated psilocin can be converted back to psilocin (Brown *et al.*, 2017). Although more than 80% of psilocin undergoes phase II metabolism, both phase I and II metabolites are ultimately eliminated through renal excretion.

Depending on body weight, the minimum active oral dose of psilocybin is approximately 4 to 10 mg in humans (van Amsterdam *et al.*, 2011). Onset of action as defined by the first appearance of acute psychological symptoms begins 20 to 60 minutes following oral ingestion and 10 to 40 minutes following buccal administration (Geiger *et al.*, 2018) and almost immediately following i.v. injection (Carhart-Harris *et al.*, 2012).

Psilocin begins to appear in the plasma approximately 25 minutes after oral dosage, with peak levels reached after approximately 105 ± 37 minutes (Brown *et al.*, 2017). A typical user responds to a full active dose for approximately 4 to 7 hours. Even a VLD can produce responses for up to 6 hours after dose administration (Hasler *et al.*, 2004).

Table 2. The physical and chemical properties of psilocybin.

Name	Psilocybin
IUPAC name	3[2-(dimethylamino)ethyl]indol-4-ol dihydrogen phosphate
Other common name	4-Phosphoryl-*N,N*-dimethyltryptamine
Chemical formula	$C_{12}H_{17}N_2O_4P$
Molar mass	204.27 g/mol
Melting point	173 to 176°C (343 to 349°F)
Physical form	Solid
Soluble in	Water Saline

Question 6: Is microdosing safe?

Preclinical studies to assess the safety of repeated doses of psilocybin in rodents have not been conducted. That may be due to several factors, including the historical background of psilocybin as an ingredient in magic mushrooms that had been used in many cultures without apparent harm. Evidence from these accounts demonstrates a lack of serious adverse events resulting from psilocybin administration. There are, however, several non-clinical investigations of psilocybin's safety profile. The risk of an adverse cardiovascular event due to hERG (human ether-a-gogo-related protein) potassium channel blockade is low, with hERG assay results demonstrating minimal effect of psilocybin at concentrations up to 1000 µM (nominal) and completely without effect at 100 µM. That means that unwanted cardiac chronotropic effects with microdosing are very unlikely as the maximum plasma concentration of psilocybin produced by a 25-mg dose would not reach 160 nM (Brown *et al.*, 2017).

Other potential and serious adverse events are cardiac valvulopathies due to repeated activation of serotonin 5-HT_{2B} receptors, which psilocin activates along with many other serotonin receptors. Several drugs have recently been pulled from the market due to this concern. The first example of this was the diet medication Phen/Fen, which had an unacceptably high fatality rate due to its effects on 5-HT_{2B} receptors in the heart (Connolly *et al.*, 1997). Another example is methysergide, an ergot-derived prescription drug that is still being used today as a prophylaxis in difficult to treat migraine and cluster headache (MacGregor and Evers, 2017). It has a known risk of increasing cardiac valve dysfunction (Joseph *et al.*, 2003). In early reports it was shown that although aortic insufficiencies disappeared in most cases after arrest of the methysergide therapy, the mitral insufficiencies remained unchanged (Graham, 1967). It remains to be seen whether repeated low-dose psilocybin administration in preclinical studies might produce valvular hyperplasia, and whether or not this would translate to the human user population. This concern is discussed more in the next section. So far psilocybin testing in preclinical studies has not revealed any signals of valvulopathy.

A different psychedelic that is more often used for microdosing, LSD, has been examined in rodents after repeated dosing schedules similar to microdosing. Comparatively low doses of LSD administered every other day for several months were shown to produce persistent negative behavioural changes that lasted for at least several weeks to months after LSD administration was discontinued (Marona-Lewicka *et al.*, 2011). These changes included increased aggression, scruffy appearance, anhedonia and hyper-reactivity. Analysis of gene expression in key cortical regions like the medial prefrontal cortex indicated that LSD produced alterations in genes enriched for schizophrenia and bipolar depression that lasted long after the drug was discontinued (Martin *et al.*, 2014). Of note, here the interspecies scaling question arises, and it is disputable whether the (low) doses used in animals are comparable to those used by humans (Sharma and McNeill, 2009). Related to these preclinical findings, another primary safety concern for 5-HT$_{2A}$ agonists is the potential for adverse psychological response in humans (Carhart-Harris *et al.*, 2016; Johnston *et al.*, 2010; Vollenweider *et al.*, 1998).

The lethal dose of psilocybin in a single administration in 50% of animals tested (the LD50) ranges from 280 mg/kg in rats and mice to 12.5 mg/kg in rabbits (Usdin and Efron, 1972; Williams, 2013). Animals receiving a very HD of psilocybin (10 mg/kg) exhibit sympathetic system effects such as irregularities in heart and breathing rate as well as mydriasis, piloerection, hyperglycaemia and hypertonia (Cerletti, 1958). Similar central excitatory effects were seen after the administration of 2-4 mg/kg intraperitoneal psilocybin in rhesus monkeys (Horibe, 1974).

Question 7: What receptors will be involved in the activity of microdosed psilocybin?

Psilocin predominantly binds to serotonin receptors: 5-HT$_{1A}$, 5-HT$_{1D}$, 5-HT$_{1E}$, 5-HT$_{2A}$, 5-HT$_{2B}$, 5-HT$_{2C}$, 5-HT$_{5}$, 5-HT$_{6}$ and 5-HT$_{7}$ (Table 3) (McKenna *et al.*, 1990) and the serotonin transporter and partially to the norepinephrine transporter, similar to MDMA (Rickli *et al.*, 2016). Hill slope values demonstrate that psilocin binds independently at all 5-HT receptors except 5-HT$_{2B}$ where cooperative binding is exhibited (McKenna *et al.*, 1990).

Cerebral 5-HT receptors that can be stimulated by psilocin are highly distributed among different regions (Table 3). Many behavioural and neuropsychological effects claimed to be elicited by microdosing are known to be modulated by these receptors (Anderson *et al.*, 2018).

Psilocin acts as a partial agonist at the 5-HT$_{2A}$ receptor with 46% (+/-2.4) response compared with the response produced by serotonin for signalling through the phospholipase C (PLC) pathway (Kurrasch-Orbaugh *et al.*, 2003). It has a lower binding affinity to the 5-HT$_{2A}$ receptor compared to LSD (Rickli *et al.*, 2016). Currently there is only one study of the in vivo cerebral 5-HT$_{2A}$ receptor occupancy produced by the psilocybin metabolite psilocin in humans. That was done by the Copenhagen group led by Knudsen who used the PET tracer [11C]Cimbi-36. This tracer is an agonist of the 5-HT$_{2A}$ receptor and therefore particularly sensitive to displacement by another agonist, psilocin. Having performed a dose-finding study of psilocybin that ranged from 3 to 30 mg p.o. per person, they found that the plasma concentration that produced a 50% occupancy of the 5-HT$_{2A}$ receptor was 1.95 (range 1.16-3.15) µg psilocin/L (Madsen *et al.*, 2019). They also found that plasma psilocin was positively correlated with subjective intensity ratings and that doses producing less than 20% occupancy (i.e. probably less than 0.028 mg/kg body weight) were not detectable either by psychological or physiological measurements (Madsen *et al.*, 2019), suggesting that this concentration might represent the threshold for microdosing, based on brain 5-HT$_{2A}$ receptor occupancy.

Receptor type	G-protein	Distribution	Physiological response	Behavioural response	Agonist	Antagonist	Drug classes that act on this receptor	Psilocin binding affinity: Ki (nM) (Halberstadt and Geyer, 2011)
5-HT$_{1A}$	Gi	Cerebral cortex, hippocampus, septum, amygdala and raphe nucleus in high densities. Low amounts also exist in the basal ganglia and thalamus (Beliveau *et al.*, 2017)	I. Hypotension II. Increase DA release in the medial prefrontal cortex, striatum and hippocampus	I. Decreased anxiety and depression (Campos and Guimarães, 2008) II. Impairment of declarative and non-declarative memory III. Decreased aggression and impulsivity IV. Inhibition of drug-seeking behaviour	8-OH DPAT, buspirone, 5-CT (Barnes and Sharp, 1999), psilocybin (Mckenna *et al.*, 1990)	WAY 100135 (methiothepin nonselective) (Barnes and Sharp, 1999)	I Analgesics (agonists) II Antidepressants (postsynaptic receptor agonists and pre-synaptic autoreceptor antagonists) III Anxiolytics (antagonists)	567.4
5-HT$_{1D}$	Gi	Trigeminal sensory neurones including peripheral and central projections to dural blood vessels and to the medulla (Longmore *et al.*, 1997)	Inhibition of adenylyl cyclase	I. Modulates locomotion and anxiety II. Migraine prophylaxis (Longmore *et al.*, 1997)	Dextromethorphan, sumatriptan, L694247, 5-CT (Barnes and Sharp, 1999), psilocybin (McKenna *et al.*, 1990)	Sumatriptan, GR 127935 (metergoline, methiothepin nonselective) (Barnes and Sharp, 1999)	I. Triptans (agonists used for migraine)	36.4
5-HT$_{1E}$	Gi	High levels in olfactory bulb glomeruli and molecular layer of dentate gyrus. Low amounts in the adventitial layer of cerebral arteries (Klein and Teitler, 2012)	Inhibition of adenylyl cyclase		5-HT (Barnes and Sharp, 1999), psilocybin (McKenna *et al.*, 1990)	None (methiothepin weak) (Barnes and Sharp, 1999)		N/A
5-HT$_{2A}$	Gq/11	High concentrations on the apical dendrites of pyramidal cells in layer V, neocortex (mainly prefrontal, parietal and somatosensory cortex) and the olfactory tubercle, as well as cardiovascular system (Beliveau *et al.*, 2017)	I. Vasoconstriction II. Platelet aggregation III. Bronchoconstriction IV. Anti-inflammatory	I. Modulates addiction II. Increased anxiety III. Increased appetite IV. Improved cognition (learning and memory) V. Decreased sleep VI. Modulates sexual behaviour	Alpha-methyl-5-HT, DOI (Barnes and Sharp, 1999), psilocybin (McKenna *et al.*, 1990)	Ketanserin, pimvanserin, pirenperone (Barnes and Sharp, 1999)	I. Atypical antipsychotics (antagonists) II. Antidepressants and anxiolytics (antagonists)	107.2

5-HT$_{2B}$	Gq/11	Predominantly peripheral, widespread tissue distribution including liver and kidneys (Julius *et al.*, 1990)	Vasoconstriction	I. Regulates sleep (Qian *et al.*, 2017) II. Increased GI motility, especially small intestine III. Increased cardiac hypertrophy in mice	Alpha-methyl-5-HT, DOI (Barnes and Sharp, 1999), psilocybin (Mckenna *et al.*, 1990)	SB 200646 (also 5-HT$_{2C}$ antagonist)		4.6
5-HT$_{2C}$	Gq/11	Mainly in choroid plexus, high concentrations in hippocampus, anterior olfactory nucleus, substantia nigra, amygdala, subthalamic nucleus and lateral habenula (Julius *et al.*, 1990)	I. Vasoconstriction II. Increase phosphoinositide turnover	I. Increased anxiety II. Increased GI motility III. Modulates locomotion IV. Modulates mood and sexual behaviour	Alpha-methyl-5-HT, DOI, psilocybin (McKenna *et al.*, 1990)	Mesulergine (also 5-HT$_{2A}$ antagonist)	I. Antidepressant (antagonists) II. Orexigenic (antagonists) III. Anorectic (agonists) IV. Antipsychotic (agonists)	97.3
5-HT$_{5A}$	Gi/Go	High concentrations in olfactory bulb and medial habenula of wild-type mice. Lower densities in neocortex, hippocampus and trigeminal nucleus	N/A	I. Modulates locomotion II. Increases sleep	5-CT, valerenic acid (partial agonist)	Methiothepin, ritanserin, asenapine, psilocybin (McKenna *et al.*, 1990)	N/A	83.7
5-HT$_6$	Gs	Predominantly in the caudate nucleus, with lower concentrations in hippocampus and amygdala. Very low levels of expression in the thalamus, subthalamic nucleus and substantial nigra (Yoshioka *et al.*, 1998)	Activation of adenylyl cyclase (HEK 293 cells)	I. Increased anxiety II. Reduced cognition and memory III. Negative effect on mood	EDMT, EMD-386,088	Amitriptyline aripiprazole, MS-245, psilocybin (McKenna *et al.*, 1990)	I. Antidepressants (antagonists) II. Anxiolytics (antagonists) III. Nootropics (antagonists) IV. Anorectics (antagonists)	57.0
5-HT$_7$	Gs	Predominantly the caudate and putamen nuclei, the pyramidal layer of the CA2 field of the hippocampus, the centromedial thalamic nucleus and the dorsal raphe nucleus (Ruat *et al.*, 1993)	I. Activation of adenylyl cyclase (HeLa cells and COS cells) II. Vasoconstriction	I. Increased anxiety II. Decreased mood III. Reduced working and reference memory	5-CT, 8-OH-DPAT, aripiprazole, AS-19, psilocybin (Glennon, 2003)	Methiothepin, mianserin, SB-269,270	I. Antidepressants (antagonists) II. Anxiolytics (antagonists) III. Nootropics (antagonists)	3.5

At this dose level, several 5-HT receptors other than the 5-HT_{2A} receptor may also be affected. This could include antagonist activity at the 5-HT_6 and 5-HT_7 receptors that may improve mood and cognition (Ballaz *et al*., 2007; Mnie-Filali *et al*., 2009). The 5-HT_7 receptor is also implicated in the regulation of circadian rhythms (Lovenberg *et al*., 1993). Upon assessing binding affinity of LSD and DMT at 5-HT_7 receptors, similarly high Ki values of 9.5 nM (Ruat *et al*., 1993) were found. Additionally, it has been found that 5-HT_7 receptor activation reduces secondary hypersensitization in response to capsaicin in mice (Brenchat *et al*., 2009). Thus, psilocybin agonist activity at 5-HT_7 may relate to the ancient use of '*teonanácatl*' to ease rheumatism.

Further, psilocin also binds with relatively high affinities to 5-HT_{1D} (K_i = 36.4 nM) and 5-HT_{2B} (K_i = 4.6 nM) receptors. 5-HT_{1D} is predominantly expressed in the trigeminal system, which may account for the recent reports of self-medication using microdoses of psychedelics to produce migraine prophylaxis (May, 2018). With regard to the 5-HT_{2B} there are concerns of the development of cardiac valvulopathy associated with agonism at 5-HT_{2B} (Elangbam *et al*., 2005). It is mostly the use of intermittent highdose psilocybin intake that has been discredited. However, even with repeated microdosing there is a possibility that 5-HT_{2B} receptors might be stimulated enough to lead to tissue overgrowth. A potential mitigation against this risk is the suggestion that the efficacy of psilocin (EC50 > 20 µM) (May, 2018) is lower than that of 5-HT. Nonetheless, because psilocin also has a higher affinity for the 5-HT_{2B} receptor than 5-HT, further investigation is needed to understand better the risks associated with microdosing.

Some stimulation at 5-HT_{1A} receptors may also occur. Such activity has been implicated in the mechanism of action of antidepressant medications including SSRIs (Celeda *et al*., 2013). Activation of these receptors by psilocin could conceivably be involved in reduction in anxiety and increased mood swings (Carhart-Harris and Nutt, 2017) due to dense distribution of the receptor in the midbrain, limbic and cortical regions that regulate stress and emotion.

Question 8: Are the claims of the benefits of microdosing biologically plausible?

There have been only a few studies on the basic neurobiology of psychedelics at the 5-HT_{2A} receptor. Recent work has shown that psychedelics like DOI and LSD directly produce transcriptional activation of Immediate Early Genes (IEGs) like *cfos* in only about 5% of neurons within key brain structures, and that these activated Trigger Population neurons express significantly higher levels of receptor than the non-activated neurons (Martin and Nichols, 2016). Transcriptional activation of IEGs within neurons is generally accepted to be a reliable marker for neural activity (Joo *et al*., 2016). Further, psychedelics also act on subsets of inhibitory neurons, and non-neuronal cells like glia and astrocytes (Martin and Nichols, 2016). Together, these data indicate that within specific brain regions, psychedelics trigger complex patterns of excitatory and inhibitory neurons in small subsets of cells, and that how these cells are activated differs between brain regions (Martin and Nichols, 2016).

Genes acutely activated by LSD in the brain are predominantly involved in synaptic plasticity (Nichols and Sanders-Bush, 2002; Nichols and Sanders-Bush, 2004). Accordingly, activation of 5-HT_{2A} receptors in brain slice culture modulates aspects of long-term plasticity, and expression of brain-derived neurotrophic factor (BDNF) (Vollenweider and Kometer, 2010). BDNF expression is also observed to increase in primary cultures of cortical neurons 24 hours following the application of psychedelics (DOI, DMT, LSD) (Ly *et al*., 2018). Blockade of the receptor for BDNF, Trk-B, prevents increased spinogenesis and synaptogenesis in cortical neurons that have been treated with psychedelics. Interestingly, the mammalian target of the rapamycin (mTOR) pathway is activated downstream of psychedelics in cortical neuron cultures similarly to ketamine, and likely mechanistically underlies the synaptogenesis (Ly *et al*., 2018). None of these preclinical studies, however, utilized psilocybin, and it remains to be seen if it produces the same effects, and if so, at what dose?

Psychedelics are known to induce behavioural tolerance, an absence of behavioural effects after repeated intake of a substance. Previously it was shown that behavioural effects were for example diminished after repeated doses of LSD (Abramson *et al*., 1956); in addition, another study showed these effects to be associated with reduced cortical 5-HT_{2A} receptor binding (Gresch *et al*., 2005). Serotonin syndrome-related symptoms, skin jerks, shaking behaviour and hyperthermia, induced by a single dose of the 5-HT_{2A} agonist DOI in rats were absent after repeated low dosing, suggesting behavioural tolerance (Pranzatelli and Pluchino, 1991). Although speculative, this downregulation of the 5-HT_{2A} receptor might be a mechanism of action underlying some of its putative therapeutic effects. An example is obsessive-compulsive disorder (OCD), a psychiatric condition that is characterized by increased 5-HT_{2A} binding (Adams *et al.*, 2005). Preliminary data have shown that administration of low to high doses of psilocybin lead to symptom reduction in patients with OCD (Moreno *et al.*, 2006). It was previously suggested that a re-balance between 5-HT_{1A} and 5-HT_{2A} receptors might be responsible for observed therapeutic actions (Buchborn *et al.*, 2014), but this remains to be investigated.

In peripheral tissues, very low doses of psychedelics have profound anti-inflammatory effects (Yu *et al.*, 2008). In general, psychedelics in the phenethylamine class such as DOI have more potency than those in the ergoline class such as LSD. In a rodent model of asthma, for example, levels of the R stereoisomer (*R*)-DOI that are 30 times lower than the behavioural threshold can have profound effects to prevent inflammation, T-Helper Cell Type 2 (Th2) cell recruitment, eosinophilia and mucus production in the lung, resulting in animals that can breathe normally after exposure to an allergen (Nau *et al.*, 2015). In another animal model of inflammatory bowel disease, levels of the psychedelic (R)-DOI 30 times lower than the behavioural threshold nearly completely prevented intestinal inflammation (Nau *et al.*, 2013). It remains to be seen whether very low levels of psychedelics are also anti-inflammatory in humans, and if the anti-inflammatory activity also occurs in the brain, but if these findings do translate then levels typically used in microdosing regimes for some psychedelic compounds would be predicted to have significant and beneficial anti-inflammatory effects. Interestingly, although LSD is one of the most powerful and potent mind-altering psychedelics, it is comparatively among the least potent anti-inflammatories tested (Yu *et al.*, 2008).

Question 9: What is the legal position of microdosing?

The answer to this question is complex due to differences in national regulations. In general, under the UN Conventions, LSD and related compounds, psilocybin and DMT are controlled as Schedule 1 drugs - i.e. are defined as being the most harmful and as having no medicinal value. In other words, they are subject to the most extreme restrictions and penalties for unapproved possession. These constraints apply to any dose of the drug, even a sub-psychoactive or microdose level. Research can be carried out with the right ethical regulatory and institutional approvals, but dosing would have to be conducted in a secure environment like a hospital or research ward. For repeated microdosing, this adds significant costs and complexity to any study, which is likely why none have yet been reported.

However, this situation is easing for psilocybin as a result of several successful clinical trials in recent years, and both the European and US regulators have given approval for studies (NIH, 2018) with psychedelic doses of synthetic psilocybin made to GMP standards. That means that microdosing trials of similarly sourced product for clinical therapy are likely also to be approved, though as yet we do not believe any have been submitted.

Question 10: What are the regulatory issues?

Unfortunately, due to their long history of anecdotal use in recreational settings, none of the psychedelics has ever followed the conventional drug research and development path expected by contemporary standards. Thus, at best, doses have been selected based on published data in a variety of indications but mostly to provide an indication for an upper safety limit. In a pooled analysis of psilocybin Studerus *et al*. (2011) classified active oral doses within a vast range of about one order of magnitude difference, between 0.045 and 0.315 mg/kg, which translates into 3.15 to 22.05 mg for a 70-kg human (Studerus *et al*., 2011). Such a range is quite surprising for active principles with the pharmacological potency of psychedelics. Given such underdetermination, regulatory standards will most likely require dedicated dose-finding studies (more than one) to provide a rationale explaining the known individual differences that have been reported in the clinical response to treatment and most importantly, the dose chosen for late development. In this context, the information provided from oral dosing, resulting plasma psilocin levels and corresponding brain 5-HT_{2A} receptor occupancy will turn out to be informative.

Parallel fixed dose designs are usually recommended (ICH, 1994). In some cases, four arm range studies could be necessary; under these circumstances microdoses could be used to test pseudo-placebo properties or alternatively a peculiar pharmacological activity.

Another issue pertains to the limited pharmacokinetic data available in order to evaluate a dose-concentration-response relationship for psychedelics. Updated ADME studies are not available for psychedelics, although the characterization of their metabolites and their role in the active principle efficacy or safety profile might prove relevant to interpret and predict their clinical effect. Once pharmacokinetics of the parent compound and its metabolite(s) are established, variation of clearance if any, its prediction by body weight and the concentration-response relationship for the claimed clinical effect must be presented. If possible, biomarker(s) (e.g. single-nucleotide polymorphisms (SNPs)) at the 5-HT receptor subtypes where they have affinity should be linked to the risk/benefit profile and thus to the therapeutic effect, and they could be used to enrich/ stratify the population of interest. Because psychedelics have been reported by some to possess a large inter-individual sensitivity, the definition of a precise concentration-response relationship may be difficult to demonstrate, especially once a microdose range is reached.

Question 11: What are the future research needs?

Microdosing is generally accepted as the use of a functionally low dose of a psychedelic compound over multiple dosing sessions with the intention of improving mental and physical well-being, cognition or creativity (Fadiman, 2011; Johnstad, 2018). A systematic study of microdosing psychedelics investigated by means of observation changes in psychological variables of microdosers. Small changes in a sub-set of variables were found, i.e. decreased depression and stress, decreased mind wandering, increased absorption and increased neuroticism. Interestingly, these variables were not those that participants most expected to change, suggesting that long-term changes may be due to biological changes and not only expectations (Polito and Stevenson, 2019). Nonetheless, the possible effects and implications of microdosing remain largely unknown. Although there is a large database of reported effects of 'microdosing' on online fora, the true amount of active substance in these is unknown as are the peak plasma psilocin concentrations achieved during 'intoxication'. Further, while in these anecdotal reports the user deliberately ingests a substance for a reason, expecting positive effects, it is difficult to distinguish between expectation 'placebo' effects and the effect of a microdose. These non-pharmacological effects, described as set and setting, are also known to be of influence when taking a full dose of a psychedelic (Hartogsohn, 2017). Another unknown is whether effects are noticeable after only one microdose or that a certain 'build-up' is needed, supported by underlying neurobiological changes, before effects occur.

Therefore, rigorous placebo-controlled clinical studies need to be conducted with different low doses of the drug to determine whether there is any evidence for the claims being made by microdosers. The types of cognitive testing performed should include several different validated psychological instruments and preferably cover the concepts mentioned in the Research Domain Criteria (Cuthbert and Kozak, 2013), and not simply rely on anecdotal accounts or simple tests. Generated knowledge in healthy volunteers will provide clear information on which cognitive aspects can be enhanced with microdosing. This knowledge will provide a first hint as to whether microdosing can be of value in the treatment of specific symptoms in psychiatric populations. Anecdotal reports suggest, for example, that microdosing might help in combatting attention deficit hyperactivity disorder (ADHD) symptoms; studies including measures related to symptom domains like executive functioning, attention and temporal processing will help to decode the potential of microdosing as a therapeutic agent. In terms of biological mechanism of action, more (pre)clinical work needs to be performed to understand fully the complex interaction of different cell types, and their responses to psychedelics at the molecular level such as elucidating peripheral or central signalling pathways involved, if any, in the process of microdosing (Kuypers, 2019). Resulting findings can provide theoretical grounds for why microdosing could work in alleviating cluster headache in patients suffering from it (Anderson *et al*., 2018; Johnstad, 2018).

Whereas most anecdotal reports focus on the positive experiences with microdosing, future research should investigate the molecular mechanisms behind low-dose psilocybin behavioural effects as well as address potential risks of (multiple) administrations of a psychedelic in low doses. Although extensive toxicology has been conducted on a single active dose of psilocybin and has been proven to be safe (Brown *et al*., 2017; Johnson *et al*., 2018), further research is required to understand better the possible health risks incurred by microdosing, especially in relation to cardiac and lung tissue. These studies would involve (pre)clinical safety and tolerability tests of multiple low/microdoses of psilocybin over an extended period of time. To that end, continuous monitoring of physiological parameters including heart functioning in addition to assessment of receptor turnover at low/microdoses as well as receptor occupancy will shed light on the potential negative consequences microdosing could have.

Acknowledgements

Livia Ng was a paid intern and Anaïs Soula an employee for COMPASS Pathways.

Declaration of conflicting interest

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: David Nutt is a scientific adviser for COMPASSPathways. The other authors declare that there is no conflict of interest.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Kim P.C. Kuypers https://orcid.org/0000-0001-7634-3809

References

1. Abramson HA, Jarvik ME, Gorin MH, *et al*. (1956) Lysergic acid diethylamide (LSD-25): XVII. tolerance development and its relationship to a theory of psychosis. *J Psychol* 41: 81-105.
2. Adams KH, Hansen ES, Pinborg LH, *et al*. (2005) Patients with obsessive-compulsive disorder have increased 5-HT$_{2A}$ receptor binding in the caudate nuclei. *Int J Neuropsychopharmacol* 8: 391-401.
3. Anderson T, Petranker R and Dinh-Williams LA (2018) Demography of microdosing community survey. Available at: osf.io/g5cwy (accessed 25 June 2019).
4. Andersson M, Persson M and Kjellgren A (2017) Psychoactive substances as a last resort: A qualitative study of self-treatment of migraine and cluster headaches. *Harm Reduct J* 14: 60.
5. Ballaz SJ, Akil H and Watson SJ (2007) Analysis of 5-HT$_6$ and 5-HT$_7$ receptor gene expression in rats showing differences in novelty-seeking behavior. *Neuroscience* 147: 428-438.
6. Barnes NM and Sharp T (1999) A review of central 5-HT receptors and their function. *Neuropharmacology* 38: 1083-1152.
7. Beliveau V, Ganz M, Feng L, *et al*. (2017) A high-resolution in vivo atlas of the human brain's serotonin system. *J Neurosci* 37: 120-128.
8. Belouin SJ and Henningfield JE (2018) Psychedelics: Where we are now, why we got here, what we must do. *Neuropharmacology* 142: 7-19.
9. Brenchat A, Romero L, Garcia M, *et al*. (2009) 5-HT$_7$ receptor activation inhibits mechanical hypersensitivity secondary to capsaicin sensitization in mice. *Pain* 141: 239-247.
10. Brown RT, Nicholas CR, Cozzi NV, *et al*. (2017) Pharmacokinetics of escalating doses of oral psilocybin in healthy adults. *Clin Pharmacokinet* 56: 1543-1554.
11. Buchborn T, Schröder H, Höllt V, *et al*. (2014) Repeated lysergic acid diethylamide in an animal model of depression: Normalisation of learning behaviour and hippocampal serotonin 5-HT$_2$ signalling. *J Psychopharmacol* 28: 545-552.
12. Cameron LP, Benson CJ, Defelice BC, *et al*. (2019) Chronic, intermittent microdoses of the psychedelic *N,N*-Dimethyltryptamine (DMT) produce positive effects on mood and anxiety in rodents. *ACS Chem Neurosci*. Available at: https://doi.org/10.1021/acschem neuro.8b00692 (accessed 25 June 2019).
13. Carhart-Harris RL, Erritzoe D, Williams T, *et al*. (2012) Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci* 109: 2138-2143.
14. Carhart-Harris RL, Kaelen M, Bolstridge M, *et al*. (2016) The paradoxical psychological effects of lysergic acid diethylamide (LSD). *Psychol Med* 46: 1379-1390.
15. Carhart-Harris RL and Nutt DJ (2017) Serotonin and brain function: A tale of two receptors. *J Psychopharmacol* 31: 1091-1120.
16. Cerletti A (1958) Etude Pharmacologique de la Psilocybine. In: R Heim and RG Wasson (eds) *Les Champignons Hallucinogenes du Mexique*. Paris: Musée de historie naturelle.
17. Christiansen A, Rasmussen K and Tønnesen F (1981) Determination of psilocybin in *Psilocybe semilanceata* using high-performance liquid chromatography on a silica column. *J Chromatogr A*, 210: 163-167.
18. Connolly HM, Crary JL, Mcgoon MD, *et al*. (1997) Valvular heart disease associated with fenfluramine-phentermine. *N Engl J Med* 337: 581-588.
19. Cruz RW (2017) *Microdosing LSD: The Definitive Guide to Increased Creativity and Productivity*. Independently Published.
20. Cuthbert BN and Kozak MJ (2013) Constructing constructs for psychopathology: The NIMH research domain criteria. *J Abnorm Psychol* 122: 928-937.
21. Dandiya PC, Gupta BD, Gupta ML, *et al*. (1969) Effects of LSD on open field performance in rats. *Psychopharmacologia* 15: 333-340.

22. Dolder PC, Schmid Y, Steuer AE, *et al*. (2017) Pharmacokinetics and pharmacodynamics of lysergic acid diethylamide in healthy subjects. *Clin Pharmacokinet* 56: 1219-1230.
23. Dormehl L (2012) *The Apple Revolution: Steve Jobs, the Counter Culture and how the Crazy Ones Took Over the World*. London: Virgin Books.
24. Doyle R (2002) LSDNA: Rhetoric, consciousness expansion, and the emergence of biotechnology. *Philosop Rhetoric* 35: 153-174.
25. Elangbam CS, Lightfoot RM, Yoon LW, *et al*. (2005) 5-Hydroxytryptamine (5-HT) receptors in the heart valves of cynomolgus monkeys and Sprague-Dawley rats. *J Histochem Cytochem* 53: 671-677.
26. EMEA (2003) *EMEA Position Paper on Non-clinical Safety Studies to Support Clinical Trials with a Single Microdose*. London: European Agency for the Evaluation of Medicinal Products.
27. Fadiman J (2011) *The Psychedelic Explorer's Guide: Safe, Therapeutic, and Sacred Journeys*. South Paris, ME: Park Street Press.
28. Fadiman J and Korb S (2019) Might microdosing psychedelics be safe and beneficial? An initial exploration. *J Psychoactive Drugs* 51: 118-122.
29. FDA (2006) *Guidance for Industry, Investigators, and Reviewers Exploratory IND Studies*. Rockville, MD: U.S. Department of Health and Human Services Food and Drug Administration Center for Drug Evaluation and Research (CDER).
30. Geiger HA, Wurst MG and Daniels RN (2018) DARK classics in chemical neuroscience: Psilocybin. *ACS Chem Neurosci* 9: 2438-2447.
31. Glennon RA (2003) Higher-end serotonin receptors: 5-HT$_5$, 5-HT$_6$, and 5-HT$_7$. *J Med Chem* 46: 2795-2812.
32. Glick SD, Maisonneuve IM and Szumlinski KK (2000) 18-Methoxycoronaridine (18-MC) and ibogaine: Comparison of antiaddictive efficacy, toxicity, and mechanisms of action. *Ann N Y Acad Sci* 914: 369-386.
33. Graham JR (1967) Cardiac and pulmonary fibrosis during methysergide therapy for headache. *Trans Am Clin Climatol Assoc* 78: 79-92.
34. Gresch PJ, Smith RL, Barrett RJ, *et al*. (2005) Behavioral tolerance to lysergic acid diethylamide is associated with reduced serotonin-2A receptor signaling in rat cortex. *Neuropsychopharmacology* 30: 1693.
35. Griffiths RR, Johnson MW, Richards WA, *et al*. (2011) Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology* 218: 649-665.
36. Guzmán G, Allen JW and Gartz J (1998) A worldwide geographical distribution of the neurotropic fungi, an analysis and discussion. *Annali del Museo Civico di Rovereto* 14: 189-280.
37. Halberstadt AL and Geyer MA (2011) Multiple receptors contribute to the behavioral effects of indoleamine hallucinogens. *Neuropharmacology* 61: 364-381.
38. Harman WW, Mckim RH, Mogar RE, *et al*. (1966) Psychedelic agents in creative problem-solving: A pilot study. *Psychol Rep* 19: 211-227.
39. Hartogsohn I (2017) Constructing drug effects: A history of set and setting. *Drug Sci Pol Law* 3: 2050324516683325.
40. Hasler F, Grimberg U, Benz MA, *et al*. (2004) Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. *Psychopharmacology (Berl)* 172: 145-156.
41. Hofmann A (1970) The discovery of LSD and subsequent investigations on naturally occurring hallucinogens. In: FJ Ayd and B Blackwell (eds) *Discoveries in Biological Psychiatry*. Philadelphia: Lippincott, pp. 91-106.
42. Horibe M (1974) The effects of psilocybin on EEG and behaviour in monkeys. *Act Nerv Super (Praha)* 16: 40-42.
43. Horsley RR, Palenicek T, Kolin J, *et al*. (2018) Psilocin and ketamine microdosing: Effects of subchronic intermittent microdoses in the elevated plus-maze in male Wistar rats. *Behav Pharmacol* 29: 530-536.
44. Hutten NRPW, Mason NL, Dolder PC, *et al*. (2019) Motives and side-effects of microdosing with psychedelics among users. *Int J Neuropsychopharmacol* 22: 5426-5434.
45. ICH (1994) *Topic E4 Dose Response Information to Support Drug Registration*. London: European Agency for the Evaluation of Medicinal Products.
46. ICH (2009) *Note for Guidance on Non-Clinical Safety Pharmacology Studies for Human Pharmaceuticals M3(R2)*. London: European Medicines Agency.
47. Johnson MW, Griffiths RR, Hendricks PS, *et al*. (2018) The abuse potential of medical psilocybin according to the 8 factors of the Controlled Substances Act. *Neuropharmacology* 142: 143-166.
48. Johnstad PG (2018) Powerful substances in tiny amounts: An interview study of psychedelic microdosing. *Nord Stud Alcohol Dr* 35: 39-51.
49. Johnston LD, O'Malley PM, Bachman JG, *et al*. (2010) *Monitoring the Future: National Survey Results on Drug Use, 1975-2009. Volume I: Secondary School Students*. NIH Publication No. 10-7584. National Institute on Drug Abuse (NIDA).
50. Joseph T, Tam SKC, Kamat BR, *et al*. (2003) Successful repair of aortic and mitral incompetence induced by methylsergide maleate: Confirmation by intraoperative transesophageal echocardiography. *Echocardiography* 20: 283-287.
51. Julius D, Huang KN, Livelli TJ, *et al*. (1990) The 5-HT$_2$ receptor defines a family of structurally distinct but functionally conserved serotonin receptors. *Proc Natl Acad Sci U S A* 87: 928-932.
52. Klein MT and Teitler M (2012) Distribution of 5-HT(1E) receptors in the mammalian brain and cerebral vasculature: An immunohistochemical and pharmacological study. *Br J Pharmacol* 166: 1290-1302.
53. Kroupa PK and Wells H (2005) Ibogaine in the 21st century: Boosters, Tune-ups and Maintenance. *Multidisciplinary Association for Psychedelic Studies(MAPS) Bulletin* XV: 21-24.
54. Kumar N (2016) *Microdosing: Enhance Your Vitality, Temperament and Efficiency with Hallucinogenic*. Scotts Valley, CA: CreateSpace Independent Publishing Platform.
55. Kurrasch-Orbaugh DM, Watts VJ, Barker EL, *et al*. (2003) Serotonin 5-hydroxytryptamine 2A receptor-coupled phospholipase C and phospholipase A2 signaling pathways have different receptor reserves. *J Pharmacol Exp Ther* 304: 229-237.
56. Kuypers KPC (2019) Psychedelic medicine: The biology underlying the persisting psychedelic effects. *Med Hypotheses* 125: 21-24.
57. Lappin G and Garner RC (2008) The utility of microdosing over the past 5 years. *Expert Opin Drug Metab Toxicol* 4:

1499-1506.

58. Lappin G, Kuhnz W, Jochemsen R, *et al*. (2006) Use of microdosing to predict pharmacokinetics at the therapeutic dose: Experience with 5 drugs. *Clin Pharmacol Ther* 80: 203-215.
59. Leslie SW and Kargon RH (1996) Selling Silicon Valley: Frederick Terman's model for regional advantage. *Bus Hist Rev* 70: 435-472.
60. Lewis CR, Preller KH, Kraehenmann R, *et al*. (2017) Two dose investigation of the 5-HT-agonist psilocybin on relative and global cerebral blood flow. *Neuroimage* 159: 70-78.
61. Longmore J, Shaw D, Smith D, *et al*. (1997) Differential distribution of 5Ht1D-and 5-HT$_{1B}$-immunoreactivity within the human trigeminocerebrovascular system: Implications for the discovery of new antimigraine drugs. *Cephalalgia* 17: 833-842.
62. Lotsof HS and Wachtel B (2002) *Manual for Ibogaine Therapy: Screening, Safety, Monitoring & Aftercare*. Ibogaine Dossier.
63. Lovenberg TW, Baron BM, De Lecea L, *et al*. (1993) A novel adenylyl cyclase-activating serotonin receptor (5-HT$_7$) implicated in the regulation of mammalian circadian rhythms. *Neuron* 11: 449-458.
64. Luke D (2006) A Tribute to Albert Hofmann on his 100th Birthday: The Mysterious Discovery of LSD and the Impact of Psychedelics on Parapsychology. *The Paranormal Review* 37: 1-8.
65. Ly C, Greb AC, Cameron LP, *et al*. (2018) Psychedelics promote structural and functional neural plasticity. *Cell Rep* 23: 3170-3182.
66. MacGregor EA and Evers S (2017) The role of methysergide in migraine and cluster headache treatment worldwide: A survey in members of the International Headache Society. *Cephalalgia* 37: 1106-1108.
67. Madsen MK, Fisher PM, Burmester D, *et al.* (2019) Psychedelic effects of psilocybin correlate with serotonin 2A receptor occupancy and plasma psilocin levels. *Neuropsychopharmacology* 44: 1328-1334.
68. Marona-Lewicka D, Nichols CD and Nichols DE (2011) An animal model of schizophrenia based on chronic LSD administration: Old idea, new results. *Neuropharmacology* 61: 503-512.
69. Martin DA, Marona-Lewicka D and Nichols DE (2014) Chronic LSD alters gene expression profiles in the mPFC relevant to schizophrenia. *Neuropharmacology* 83: 1-8
70. Martin DA and Nichols CD (2016) Psychedelics recruit multiple cellular types and produce complex transcriptional responses within the brain. *EBioMedicine* 11: 262-277.
71. May J (2018) *The Ibogaine Conversation Part 9: How Safe is Ibogaine?* [Online]. Available at: https://www.psymposia.com/magazine/how-safe-is-ibogaine-we-asked-clare-wilkins-who-has-facilitated-over-700-treatments/.
72. McKenna DJ, Repke DB, Lo L, *et al*. (1990) Differential interactions of indolealkylamines with 5-hydroxytryptamine receptor subtypes. *Neuropharmacology* 29: 193-198.
73. Migliaccio GP, Shieh TL, Byrn SR, *et al*. (1981) Comparison of solution conformational preferences for the hallucinogens bufotenin and psilocin using 360-MHz proton NMR spectroscopy. *J Med Chem* 24: 206-209.
74. Ministery of Health, Labour and Welfare (2008) Microdose clinical studies. In: Pharmaceutical and Medical Safety Bureau, M. O. H. L. A. W. (ed.) English Regulatory Information Task Force Japan Pharmaceutical Manufacturers Association. Tokyo, Japan: MHLW.
75. Mnie-Filali O, Lambas-Senas L, Scarna H, *et al*. (2009) Therapeutic potential of 5-HT$_7$ receptors in mood disorders. *Curr Drug Targets* 10: 1109-1117.
76. Moreno FA, Wiegand CB, Taitano EK, *et al*. (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *J Clin Psychiatry* 67: 1735-1740.
77. Nau F, Jr., Miller J, Saravia J, *et al*. (2015) Serotonin 5-HT(2) receptor activation prevents allergic asthma in a mouse model. *Am J Physiol Lung Cell Mol Physiol* 308: L191-L198.
78. Nau F, Jr, Yu B, Martin D, *et al*. (2013) Serotonin 5-HT$_{2A}$ receptor activation blocks TNF-alpha mediated inflammation in vivo. *PLoS One* 8: e75426.
79. Nichols CD and Sanders-Bush E (2002) A single dose of lysergic acid diethylamide influences gene expression patterns within the mammalian brain. *Neuropsychopharmacology* 26: 634-642.
80. Nichols CD and Sanders-Bush E (2004) Molecular genetic responses to lysergic acid diethylamide include transcriptional activation of MAP kinase phosphatase-1, C/EBP-beta and ILAD-1, a novel gene with homology to arrestins. *J Neurochem* 90: 576-584.
81. NIH (2018) Trials with 'Psilocybin'. NIH US National Libary of Medicine. *ClinicalTrials.gov*.
82. Passie T (2019) *Science of Microdosing Psychedelics*. London: Psychedelic Press.
83. Passie T, Seifert J, Schneider U, *et al*. (2002) The pharmacology of psilocybin. *Addict Biol* 7: 357-364.
84. Polito V and Stevenson RJ (2019) A systematic study of microdosing psychedelics. *PLoS One* 14: e0211023.
85. Pranzatelli MR and Pluchino RS (1991) The relation of central 5-HT$_{1A}$ and 5-HT$_2$ receptors: Low dose agonist-induced selective tolerance in the rat. *Pharmacol Biochem Behav* 39: 407-413.
86. Prochazkova L, Lippelt DP, Colzato LS, *et al*. (2018) Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. *Psychopharmacology* 235: 3401-3413.
87. Qian Y, Cao Y, Deng B, *et al*. (2017) Sleep homeostasis regulated by 5-HT$_2$b receptor in a small subset of neurons in the dorsal fan-shaped body of Drosophila. *Elife* 6: e26519.
88. Rautio J, Laine K, Gynther M, *et al*. (2008) Prodrug approaches for CNS delivery. *AAPS J* 10: 92-102.
89. Repke DB, Leslie DT, Mandell DM, *et al*. (1977) GLC-mass spectral analysis of psilocin and psilocybin. *J Pharm Sci* 66: 743-744.
90. Rickli A, Moning OD, Hoener MC, *et al*. (2016) Receptor interaction profiles of novel psychoactive tryptamines compared with classic hallucinogens. *Eur Neuropsychopharmacol* 26: 1327-1337.
91. Roberts A (2008) *Albion Dreaming: A Popular History of LSD in Britain* (Revised Edition with a New Foreword by Dr. Sue Blackmore). Singapore: Marshall Cavendish International (Asia) Ptd Limited.
92. Roseman L, Nutt DJ and Carhart-Harris RL (2018) Quality of acute psychedelic experience predicts therapeutic efficacy of psilocybin for treatment-resistant depression. *Front Pharmacol* 8: 974.

93. Ruat M, Traiffort E, Leurs R, *et al*. (1993) Molecular cloning, characterization, and localization of a high-affinity serotonin receptor (5-HT$_7$) activating cAMP formation. *Proc Natl Acad Sci U S A* 90: 8547-8551.
94. Rucker JJH, J Iliff and DJ Nutt (2018) Psychiatry & the psychedelic drugs. Past, present & future. *Neuropharmacology* 142: 200-218.
95. Rumack BH and Spoerke DG (1994) *Handbook of Mushroom Poisoning: Diagnosis and Treatment*. Boca Raton, FL: Taylor & Francis.
96. Schechter MD and Gordon TL (1993) Comparison of the behavioral effects of ibogaine from three sources: Mediation of discriminative activity. *Eur J Pharmacol* 249: 79-84.
97. Schenberg EE (2018) Psychedelic-assisted psychotherapy: A paradigm shift in psychiatric research and development. *Front Pharmacol* 9: 733.
98. Schultes RE (1940) Teo*nanacatl*: The narcotic mushroom of the Aztecs. *Am Anthropol* 42: 429-443.
99. Sharma V and McNeill JH (2009) To scale or not to scale: The principles of dose extrapolation. *Br J Pharmacol* 157: 907-921.
100. Shulgin AT (1976) DMT & TMA-2. *J Psychedelic Drugs* 8: 167-169.
101. Studerus E, Kometer M, Hasler F, *et al*. (2011) Acute, subacute and long-term subjective effects of psilocybin in healthy humans: A pooled analysis of experimental studies. *J Psychopharmacol* 25: 1434-1452.
102. Tsujikawa K, Kanamori T, Iwata Y, *et al*. (2003) Morphological and chemical analysis of magic mushrooms in Japan. *Forensic Sci Int* 138: 85-90.
103. Usdin E and Efron DH (1972) *Psychotropic Drugs and Related Compounds*. Washington, DC: National Institute of Mental Health.
104. van Amsterdam J, Opperhuizen A and Van Den Brink W (2011) Harm potential of magic mushroom use: A review. *Regul Toxicol Pharmacol* 59: 423-429.
105. Vollenweider FX and Kometer M (2010) The neurobiology of psychedelic drugs: Implications for the treatment of mood disorders. *Nat Rev Neurosci* 11: 642-651.
106. Vollenweider FX, Vollenweider-Scherpenhuyzen MF, Babler A, *et al*. (1998) Psilocybin induces schizophrenia-like psychosis in humans via a serotonin-2 agonist action. *Neuroreport* 9: 3897-3902.
107. Wackermann J, Wittmann M, Hasler F, *et al*. (2008) Effects of varied doses of psilocybin on time interval reproduction in human subjects. *Neurosci Lett* 435: 51-55.
108. Waldman A (2017) *A Really Good Day: How Microdosing Made a Mega Difference in My Mood, My Marriage, and My Life*. New York: Knopf.
109. Williams M (ed.) (2013) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*. 15th ed. Cambridge: Royal Society of Chemistry.
110. www.dmt-nexus.me (2018) *Microdosing* [Online] (accessed 28 August 2018).
111. www.reddit.com (2018) *Psilocybin, Microdose Providing more Energy and Motivation: Microdosing* [Online] (accessed 28 August 2018).
112. Yanakieva S, Polychroni N, Family N, *et al*. (2018) The effects of microdose LSD on time perception: A randomised, double-blind, placebo-controlled trial. *Psychopharmacology (Berl)*. Epub ahead of print 26 November 2018. DOI: 10.1007/s00213-018-5119-x.
113. Yoshioka M, Matsumoto M, Togashi H, *et al*. (1998) Central distribution and function of 5-HT$_6$ receptor subtype in the rat brain. *Life Sci* 62: 1473-1477.
114. Yu B, Becnel J, Zerfaoui M, *et al*. (2008) Serotonin 5-hydroxytryptamine (2A) receptor activation suppresses tumor necrosis factor-alpha-induced inflammation with extraordinary potency. *J Pharmacol Exp Ther* 327: 316-323.

Commentary

Microdosing psychedelics: Too much hype, almost no rigorous research

A call to explore microdosing's psychological effects and therapeutic potential within psychiatry

by **Stephen Ross**

Corresponding author:
Stephen Ross, NYU Addictive Disorders and Experimental Therapeutics Research Laboratory, 462 First Ave, New York, NY 10016, USA.
Email: Stephen.Ross@nyulangone.org; Stephen.ross@nyumc.org

This timely article ('Microdosing psychedelics: More questions than answers? An overview and suggestions for future research') provides an excellent overview on the topic of microdosing psychedelics. The review focuses predominantly on psilocybin with some mention of other psychedelics (i.e. LSD, ibogaine and DMT). This article is organized around a series of questions and answers that includes the following topics related to microdosing: basic definitions, varying dosing regimens, relevant preclinical data, pharmacology, safety issues, potential biological mechanisms of action, scientific evidence base (or relative lack thereof) from published peer-reviewed research, legal and regulatory issues, and a call for rigorous placebo-controlled trials to test the various beneficial claims of microdosing made so far by anecdotal reports.

The therapeutic application of the classical psychedelics within psychiatry has made a historic come back within the last two decades and is at inflection point with a growing body of rigorously conducted research pointing to the promising clinical utility of psychedelic-assisted psychotherapies to treat a range of psychiatric disorders, with the data most robust for: cancer-related psychological and existential distress (Gasser *et al.*, 2014; Griffiths *et al.*, 2016; Grob *et al.*, 2011; Ross *et al.*, 2016), alcohol and tobacco addiction (Bogenschutz *et al.*, 2015; Johnson *et al.*, 2014), and major depression (Carhart-Harris *et al.*, 2016; Osorio *et al.*, 2015). The doses used in all of these clinical trials are of the 'macro' variety, typically consisting of moderate to high-dose psilocybin, administered as part of the psychedelic therapy model in combination with psychotherapy with the goal of inducing significant alterations of consciousness, including mystico-mimetic states (Bogenschutz and Ross, 2018).

In contrast, and as defined in this article, microdosing is a practice of consuming very low doses of a psychedelic substance (that produce acute drug effects that are either not perceptible or minimally identifiable), utilizing a repeated dosing regimen, and with the goal of improving well-being, enhancing productivity or increasing creativity. It is distinct from both psychedelic therapy (i.e. using high doses of psychedelics to occasion mystical-type experiences, and used historically to treat conditions such as alcoholism and terminal cancer-related existential distress) and psycholytic therapy (i.e. using lower doses of psychedelics to produce perceptible and significant shifts in cognition and affect to enhance psychotherapy, historically used in combination with psychoanalytic psychotherapy to treat various psychiatric conditions such as anxiety spectrum disorders) (Ross and Bogenschutz, 2017). Structured microdosing regimens employed so far (typically by lay individuals with the intention of receiving some positive benefit) range from daily use to dosing every 3 days (Fadiman, 2011), and occurring over varying time-frames from monthly to ongoing. Microdosing has surged in popularity over the last several years and has been associated with the use of serotoninergic psychedelics (i.e. LSD, psilocybin, ayahuasca, iboga), cannabinoids (i.e. CBD), and dissociative anaesthetics (i.e. ketamine) (Kitchens, 2018). Even though microdosing does not cause significant alterations in perception with acute administration, it has led to numerous anecdotal reports (featured in a rapidly growing number of media articles) of claimed benefits in a variety of domains including: Psychological (i.e. improved mood, energy, emotional balance, empathy, openness, introspection; decreased pain and alcohol/drug use or craving); Cognitive (i.e. improved focus, concentration, mental clarity); Creativity (i.e. improved idea generation and divergent thought processes); Spirituality (i.e. improved meaning in life); Interpersonal (i.e. improved connectedness, sensitivity to others, relational skills); and General well-being and quality of life (i.e. improved sleep quality, healthy eating habits, sexual function) (Austin, 2016; Kitchens, 2018).

Despite all of the growing interest and purported claims of benefits of microdosing, basic knowledge about microdosing, including therapeutic effects, is virtually absent due to almost no peer-reviewed publications stemming from rigorously conducted research. Some of the most significant and important gaps in the knowledge base of microdosing include the absence or paucity of: rigorous design methodology including randomization, placebo control, adequate blinding integrity, and the use of appropriate inclusion/exclusion criteria to minimize potential harm; prior approval with appropriate ethical and human subjects review boards; the use of and dispensation of an exact known dose of pharmaceutical grade psychedelic in a controlled setting; understanding basic effects on psychological, cognitive and affective domains; adequate safety monitoring and knowledge of acute or long-term safety issues; understanding of basic neurobiological or potential mechanisms of action, such as neuroimaging (i.e. PET, functional MRI), physiological data (i.e. EEG, MEG) and biomarkers (i.e. BDNF).

This article touches on most of these gaps. The review article points out that there has only been one published trial that specifically examined the effects of psilocybin microdosing. This was an open-label, non-controlled trial, with uncertain doses of psilocybin ingested, that was conducted without ethical approval. It reported on improvements in two creativity-related problem-solving tasks following recreational psilocybin microdosing (Prochazkova *et al*., 2018). A limitation of the present article is the focus on psilocybin even though online fora suggest that recreational LSD microdosing may be as common (if not more so) than psilocybin microdosing (www.reddit.com, 2019). By not focusing equally on LSD microdosing, the article does not capture the most rigorously conducted and peer-reviewed published trial of microdosing to date. Unlike all of the prior publications on microdosing, this trial was approved by an independent ethics committee, included random assignment, double-blind methodology, and the use of a placebo condition (Yanakieva, 2018). Further, appropriate inclusion/exclusion criteria were used to enhance safety, the trial was conducted in a monitored inpatient setting to optimize safety and exact doses of pharmaceutical grade cGMP LSD were administered. In comparing three microdoses of LSD (5, 10 and 20 µg) to placebo, the trial reported that LSD microdosing produced temporal dilation in the absence of significant consciousness alteration (Yanakieva *et al*., 2018).

The review article also focuses on some theoretical safety concerns such as the link between 5-HT$_{2B}$ agonism and cardiac valvulopathies (Cavera and Guillon, 2014). The article would have been strengthened by a call to monitor broadly for potential adverse medical and psychiatric effects in future microdosing research to be able to identify all of the unknown risks that may be associated with microdosing. For example, we do not know the risks associated with the interaction between microdosing and underlying psychiatric illnesses. All of the modern therapeutic trials of psychedelic-assisted psychotherapies exclude participants with psychotic spectrum illnesses because of the known negative association between psychedelic use and psychotic exacerbation in those with underlying psychotic illness (Ross and Peselow, 2012). In the early stages of microdosing research, it would be important to begin cautiously by excluding individuals with significant psychiatric, medical or neurological illnesses.

One area not covered by the review article is speculation on the potential therapeutic utility of microdosing within psychiatry. If some of the claimed psychological or cognitive benefits (i.e. improved mood and attention; decreased substance craving and pain perception) of microdosing are real (i.e. not simply due to placebo or expectancy effects), the next logical step would be to test the potential efficacy of microdosing in various clinical populations (i.e. major depression, bipolar depression, ADHD, addictive disorders, pain disorders) through RCTs, and beyond through the drug development process. Funding sources would have to be considered, whether that would come through private philanthropy, pharma or governmental funding agencies (i.e. NIHR in Europe or NIH in the USA). Finally, if microdosing proves to be effective for the many claimed effects reported in the lay public (i.e. enhanced creativity, work productivity, learning, memory, empathy, connection to others, spirituality), it could potentially be used to improve function in 'normals' without specific disease states, although it is unclear how drug development would proceed for non-clinical entities by using mostly illegal substances.

References for commentary by Stephen Ross

1. Austin P (2016) *Everything You Want to Know About Microdosing*. Available at: https://thethirdwave.co (2019) Microdosing mushrooms [Online] (accessed 24 June 2019).
2. Bogenschutz MP and Ross S (2018) Therapeutic applications of classic hallucinogens. *Curr Top Behav Neurosci* 36: 361-391.
3. Bogenschutz MP, Forcehimes AA, Pommy JA, *et al*. (2015) Psilocybin-assisted treatment for alcohol dependence: A proof-of-

concept study. *J Psychopharmacol* 29: 289-299.
4. Carhart-Harris RL, Bolstridge M, Rucker J, *et al*. (2016) Psilocybin with psychological support for treatment-resistant depression: An open-label feasibility study. *Lancet Psychiatry* 3: 619-627.
5. Fadiman J (2011) *The Psychedelic Explorer's Guide: Safe, Therapeutic, and Sacred Journeys*. Rochester, VT: Park Street Press.
6. Gasser P, Holstein D, Michel Y, *et al*. (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202: 513-520.
7. Griffiths RR, Johnson MW, Carducci MA, *et al*. (2016) Psilocybin produces substantial and sustained decrease in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *J Psychopharmacol* 30: 1181-1197.
8. Grob CS, Danforth AL, Chopra GS, *et al*. (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Arch Gen Psychiatry* 68: 71-78.
9. Johnson MW, Garcia-Romeu A, Cosimano MP, *et al*. (2014) Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *J Psychopharmacol* 28: 983-992.
10. Kitchens S (2018) Microdosing's Micromoment. *New York Magazine*. https://www.thecut.com/2018/05/microdosing-guide-and-explainer. html (accessed 15 January 2019).
11. Osorio Fde L, Sanches RF, Macedo LR, *et al*. (2015) Antidepressant effects of a single dose of ayahuasca in patients with recurrent depression: A preliminary report. *Braz J Psychiatry* 37: 13-20.
12. Prochazkova L, Lippelt DP, Colzato LS, *et al*. (2018) Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. *Psychopharmacology (Berl)* 235: 3401-3413.
13. Ross S and Peselow E (2012) Co-occurring psychotic and addictive disorders: Neurobiology and diagnosis. *Clin Neuropharmacol* 35: 235-243.
14. Ross S, Bossis A, Guss J, *et al*. (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *J Psychopharmacol* 30: 1165-1180.
15. Ross S and Bogenschutz M (2017) Hallucinogen-assisted psychotherapy. In: B Sadock, V Sadock and P Ruiz (eds) *Kaplan and Sadock's Comprehensive Textbook of Psychiatry*. 10th ed. Philadelphia, PA: Wolters Kluwer.
16. www.reddit.com (2019) https://www.reddit.com/r/microdosing/wiki/ index (accessed 15 January 2019).
17. Yanakieva S, Polychroni N, Family N, *et al*.(2018) The effects of micro-dose LSD on time perception: A randomized, double-blind, placebo-controlled trial. *Psychopharmacology (Berl)*. Epub ahead of print 26 November 2018. DOI: 10.1007/s00213-018-5119-x.

Psychedelics: What are low doses and "microdoses"?

by **Matthias E Liechti**

Division of Clinical Pharmacology and Toxicology, Department of Biomedicine and Department of Clinical Research,
University Hospital Basel and University of Basel, Basel, Switzerland

Corresponding author:
Matthias E Liechti, Division of Clinical Pharmacology and Toxicology, University Hospital Basel, Hebelstrasse 2, Basel, CH-4031, Switzerland.
Email: Matthias.liechti@usb.ch

Keywords LSD, microdosing, dosing, pharmacokinetics, psilocybin, psychedelics

In clinical pharmacology, 'microdosing' refers to the use of a dose of a substance with <1% pharmacological activity to study pharmacokinetics (PK), including absorption, distribution, metabolism and excretion, potentially using non-good-manufacturing practice (GMP) material and/or radio-labelled substances (e.g. Muehlan *et al.*, 2018). 'Microdosing' with lysergic acid diethylamide (LSD) or psilocybin refers to the use of low to very low doses (i.e. 5-20% of fully active doses; Table 1). I would rather label such use as 'low to very low doses'.

While I mostly agree with the views in the article, I would like to add some additional thoughts on dosing with a focus on LSD. What is actually meant by the micrograms of LSD doses? Correct doses are obviously unknown in the case of illicit sources, and the correct reporting of doses is also an issue in scientific publications. Research in the 1950s to 1970s used LSD tartrate, whereas modern research commonly uses LSD base (Liechti, 2017), with the exception of at least one study (Yanakieva *et al.*, 2018). A dose of 100 µg LSD base corresponds to 123 µg LSD tartrate (when being free of crystal water or methanol solvate; Mesley and Evans, 1969) - this dose may not be considered low (Table 1). Thus, researchers need to indicate whether they are reporting base or salt doses. Additionally, LSD is mostly not a pharmaceutical product and not manufactured according to GMP with defined content and stability. Researchers produce their own formulations. It is often not reported where the substance was obtained from and the way in which it was formulated as the final study drug. This raises many questions. Are the reported doses salt or base? What is the purity? What is the content of crystal water, solvate and/or residual solvents? How was this factored into the reported dose? What is the content uniformity and stability of the product throughout the study duration? What is the amount of inactive iso-LSD in the pharmaceutical formulation?

LSD is inactivated to iso-LSD depending on temperature, solvent and pH and thus may be unstable in certain formulations. Other stress factors such as light, oxygen or tap water chlorine may also lead to decomposition of the LSD molecule. In fact, amounts of iso-LSD were detected in plasma in research subjects, indicating that approximately 30% of the LSD that was administered likely isomerized to inactive iso-LSD possibly within the LSD capsules that were used (Steuer *et al.*, 2017). Novel PK studies (Holze *et al*. 2019) that use validly defined doses of a novel LSD formulation indicate that previous studies used 70 and 140 µg of LSD base (equivalent to 86 and 172 µg LSD tartrate) rather than the reported oral doses of 100 and 200 µg LSD base (Dolder *et al.*, 2017; Liechti, 2017; Preller *et al.*, 2017). In addition to correctly assessing and reporting the study drug, PK data are needed, thus providing the basis of the present discussion and any drug development. Plasma concentrations provide an objective measure of the substance that actually arrives in the body by accounting for dosing, bioavailability and inter-individual differences in absorption, distribution, metabolism and excretion. Plasma concentrations are also needed to compare formulations and substance exposures between different studies and different research groups and should be generated for each novel formulation.

With regard to 'microdosing with LSD', researchers cannot unequivocally conclude that 5-20 µg LSD base has no acute subjective effects or does not impair normal functioning as noted in the definition of 'microdosing'. I would argue that these doses can produce similar acute subjective effects but to a lesser degree compared with clearly psychoactive doses (> 25 µg LSD base). A recent placebo-controlled study that used single doses of 5-20 µg LSD tartrate (GMP-formulated, 4-16 µg LSD base) reported statistically significant acute subjective drug effects (Yanakieva *et al.*, 2018). Studies that used PK-pharmacodynamic modelling (Dolder *et al.*, 2015, 2017; Holze *et al.*, 2019) allow the evaluation of plasma concentration/dose-effect relationships of LSD in humans, in which subjective effects parallel plasma LSD concentration-time curves. Plasma concentrations of LSD at the EC_{50} for 'good subjective drug ratings' are very low (1 ng/ mL). Subjective mean good drug effects of 25% of these full doses have been reported at an average plasma LSD concentration of 0.4 ng/mL (Dolder *et al*., 2017; Holze *et al*., 2019). The C_{max} after 100 µg LSD base administration was 1.7 ng/mL (Holze *et al*., 2019). Based on the linear PK of LSD, C_{max} values of 0.4 ng/mL are likely reached with a 25-µg dose. Based on the available data and ongoing studies, base doses of LSD of 25, 10 or 5 µg can be postulated to produce approximately 25%, 10% and 5%, respectively, of the effects of a fully active dose of 100 µg LSD base. Additionally, there is no indication that the acute subjective effects of these very low to low doses of LSD are qualitatively different from a full dose. Thus, there is no apparent evidence that LSD, which impairs cognition at active doses, would magically enhance concentration when used at lower doses as described by users. In fact, decreases in self-reported concentration and task-measured cognitive performance have been reported at high and low plasma LSD concentrations (Dolder *et al*., 2016; Schmid *et al*., 2015). Very low to low doses of 5-20 µg LSD tartrate ('microdoses') did not significantly alter self-ratings of perceptual distortion or subjective concentration, but trends towards impairments were observed (Yanakieva *et al*., 2018). These effects would likely become significant in well-powered studies with larger sample sizes.

This raises another important issue. Very low doses of substances will produce very small effects. To validly assess small treatment effects, study sample sizes need to be larger than those that are common in experimental psychiatric research. Additionally, sensitive measures need to be used. Many validated psychiatric scales may not be sufficiently sensitive to detect small drug effects, and simple drug-effect visual analogue scale ratings are likely better. Furthermore, vital signs could serve as a simple objective measure of reactivity. However, psychiatric studies typically have shortcomings with regard to performing vital sign assessments. For example, very low to low doses of psilocybin did not alter blood pressure in one study (Hasler *et al*., 2004). However, for this finding to be valid, vital signs need to be assessed according to standard operating procedures. This includes the use of scaled instruments, exactly determined time points after drug administration, time-matched placebo control measures and so on. For example, a safety and efficacy study reported that LSD did not significantly alter blood pressure or heart rate at a dose of 200 µg LSD (Gasser *et al*., 2014). However, this same dose and lower doses were subsequently shown to significantly and relevantly increase blood pressure, heart rate, body temperature and pupil size in studies that used standardized measures (Schmid *et al*., 2015; Dolder *et al*., 2016).

Altogether, we are still in the incipient stage of modern research on psychedelics. Even for relatively high doses of these substances, the data are still scant and inconsistent. Thus, it is too early to make valid conclusions about the effects of very low doses of these substances. Currently (Passie, 2019), I see no valid data that indicate that LSD or psilocybin has either beneficial or adverse effects on health when used repeatedly at low to very low doses (Passie, 2019). This simply needs to be studied further.

Acknowledgements

I thank Daniel Trachsel, Felix Müller, Patrick Vizeli, Yasmin Schmid and Friederike Holze for comments on the manuscript and Michael Arends for manuscript editing.

References for commentary by Matthias E Liechti

1. Dolder PC, Schmid Y, Haschke M, *et al*. (2015) Pharmacokinetics and concentration-effect relationship of oral LSD in humans. *Int J Neuropsychopharmacol* 19: pii: pyv072.
2. Dolder PC, Schmid Y, Mueller F, *et al*. (2016) LSD acutely impairs fear recognition and enhances emotional empathy and sociality. *Neuropsychopharmacology* 41: 2638-2646.
3. Dolder PC, Schmid Y, Steuer AE, *et al*. (2017) Pharmacokinetics and pharmacodynamics of lysergic acid diethylamide in healthy subjects. *Clin Pharmacokinetics* 56: 1219-1230.
4. Gasser P, Holstein D, Michel Y, *et al*. (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *J Nerv Ment Dis* 202: 513-520.
5. Hasler F, Grimberg U, Benz MA, *et al*. (2004) Acute psychological and physiological effects of psilocybin in healthy humans: A double-blind, placebo-controlled dose-effect study. *Psychopharmacology* 172: 145-156.
6. Holze F, Duthaler U, Vizeli P, *et al*. (2019) Pharmacokinetics and subjective effects of a novel oral LSD formulation in healthy subjects. *Br J Clin Pharmacol* 85:1474-1483.
7. Liechti ME (2017) Modern clinical research on LSD. *Neuropsychopharmacology* 42: 2114-2127.
8. Mesley RJ and Evans WH (1969) Infrared identification of lysergide (LSD). *J Pharm Pharmacol* 21: 713-720.
9. Muehlan C, Heuberger J, Juif PE, *et al*. (2018) Accelerated development of the dual orexin receptor antagonist ACT-541468: Integration of a microtracer in a first-in-human study. *Clin Pharmacol Ther* 104: 1022-1029.
10. Passie T (2019) *The Science of Microdosing Psychedelics*. London, UK: Psychedelic Press.
11. Preller KH, Herdener M, Pokorny T, *et al*. (2017) The fabric of meaning and subjective effects in LSD-induced states depend

on serotonin 2A receptor activation. *Curr Biol* 27: 451-457.

12. Schmid Y, Enzler F, Gasser P, *et al*. (2015) Acute effects of lysergic acid diethylamide in healthy subjects. *Biol Psychiatry* 78: 544-553.
13. Steuer AE, Poetzsch M, Stock L, *et al*. (2017) Development and validation of an ultra-fast and sensitive microflow liquid chromatography-tandem mass spectrometry (MFLC-MS/MS) method for quantification of LSD and its metabolites in plasma and application to a controlled LSD administration study in humans. *Drug Test Anal* 9: 788-797.
14. Yanakieva S, Polychroni N, Family N, *et al*. (2018) The effects of microdose LSD on time perception: a randomised, double-blind, placebo-controlled trial. *Psychopharmacology (Berl)*. Epub ahead of print 26 November 2018. DOI: 10.1007/s00213-018-5119-x.

Comment

by **James Fadiman and Sophia Korb**

Corresponding author:
James Fadiman, 1070 Colby Ave, Menlo Park, CA 94025, USA.
Email: jfadiman@gmail.com

As microdoses are being used worldwide, this is a timely article. Prudently, the authors have focused on synthesized psilocybin, as it may soon become more available. As our own research has been entirely anecdotal, and although it includes reports from 51 countries and thousands of individuals, it does not answer any of the questions raised here. What our exploratory findings may have done is help raise the level of interest about the reported negative or positive effects and mechanisms of action. While we have added suggestions and noted a few concerns here, the investigations proposed in the article are all necessary and fundamental.

Early on, it could be important to determine if the same weight of psilocybin in a mushroom with its other alkaloids (found in over 100 mushroom species) has a similar behavioural profile to the synthetic. Equally useful, and perhaps eventually as necessary, would be to replicate the same study with LSD-25 and 1P-LSD. The reason for suggesting these equivalence studies is that of the several hundred thousand people known to have microdosed, less than 1% of them actually used the GMP grade psilocybin. If their experiences differ from those using the synthetic substance, a great deal of otherwise correlative data would need to be put aside.

It seems to us that the worry about cardiac valvulopathy is excessive, given the overall safety profiles of all of the classic psychedelics described in several of Dr. Nutt's publications.

The Fen-Phen experiences of heart valve disease development in the 1980s and 1990s inspired new research in identifying the specific 5-HT receptor subtype involved in drug-induced heart valve disease. In the cases of cardiotoxicity and Fen-Phen, both 5-HTP2A and 5-HTP2B are implicated. In fact, 'norfenfluramine was found to be two orders of magnitude more potent at 5-HT$_{2B}$ and 5-HT$_{2C}$ receptors compared with 5-HT$_{2A}$ receptors' (Hutcheson, 2011). While we have some information about the affinity of LSD towards different receptors, we have little information about how its unique 'crystal structure' may result in different heart health outcomes (Wacker *et al.*, 2017).

Affinity does not tell the whole story. The doses of Fen-Phen used in the 1980s and 1990s far exceed the doses used in microdosing, seemingly resulting in several orders of magnitude more *activity* at the receptors. Additionally, in the cases of heart valve disease in Fen-Phen, all of the patients were symptomatic. Of the thousands of people who microdosed, no one has reported any heart valve trouble during their period of microdosing, and many people have been microdosing for over a year. All the people we have surveyed with heart problems had them before they started microdosing.

The problem, and it is a very real one, is that this article will be reviewed and popularized over the many different psychedelic and general media sites with varying degrees of accuracy. Since it is highly unlikely that large-scale long-term research necessary to investigate this possibility will ever be funded, the concern will never be validated or disproved. There were a number of frightening scenarios raised about psychedelics during the earlier research era, about LSD in particular, none of which were ultimately verified. However, their wide circulation led to considerable and unnecessary fears among millions of individuals using these substances. We need be careful not to create such fears before we have evidence. Given the serious and multiple warnings given out with most prescription medicine, that there might be unknown side effects to microdoses is to belabour the obvious.

We would look for an expansion of the receptor research (Question 7). It would be a great gift to all psychedelic research if studies could begin to go beyond measuring 5-HTP2A receptors and include, at least, the mTOR and TrkB signalling pathways as well (Ly *et al.*, 2018).

A question to investigate is how the well-described accelerated neural plasticity of a number of psychedelics at high doses is diminished or intensified through periodic microdosing. Early speculation by Kornfeld (Kornfeld and Fadiman, 2013) has now been artfully demonstrated by the work of Ly's group (Ly, *et al*. 2018). This seems to be an especially fruitful area, given the growing body of research linking neural plasticity with both mental illness and recovery.

We are encouraged that in Question 8, the authors went beyond 5-HTP2A receptors and looked at peripheral tissues with doses well below behavioural thresholds as well. We hope the number and kinds of physical systems evaluated for effects continue to expand. For example, although it is now generally accepted that the number of neurons that exist outside of the brain exceeds the number within it, psychedelic researchers have not yet developed research methods to measure changes in gut neurons due to the effects of psychedelics or how those changes affect human biology and behaviour.

Finally, the issues of dose and schedule remain critical. While many pharmaceuticals have a given activity and that more or less of a dose leads to more or less of the same activity, this is not true for psychedelics at higher doses and far less so for microdoses. One size does not fit all, so that the identical dose, however calculated, will not yield the same results across individuals. This may be a hard problem, especially given the few research models popular in pharmacology in general. As for the effects of multiple doses over time, there has never been a suggested protocol that did not include days without dosing, in contrast to almost all psychiatric medications that warn of potential serious health issues if even a single dose is missed. For this and other reasons, psychedelics do not fit neatly into much of current psychopharmacology and thus need to be researched.

Our few concerns aside, these research proposals are a major step forward for psychedelics in general and microdoses in particular.

References for comment by James Fadiman and Sophia Korb

1. Hutcheson JD, Setola V, Roth BL, *et al*. (2011) Serotonin receptors and heart valve disease: It was meant 2B. *Pharmacol Ther* 132: 146-157.
2. Ly C, Greb AC, Cameron LP, *et al*. (2018) Psychedelics promote structural and functional neural plasticity. *Cell Rep* 23: 3170-3182.
3. Kornfeld A and Fadiman J (2013) Psychedelic induced experiences. In: HL Friedman and G Hartelius (eds).*The Wiley-Blackwell Handbook of Transpersonal Psychology*. New York: Wiley/Blackwell, pp. 352-366.
4. Wacker D, Wang S, McCorvy JD, *et al*. (2017) Crystal structure of an LSD-bound human serotonin receptor. *Cell* 168: 377-389.e12.

Commentary by Dr Torsten Passie

Corresponding author:
Torsten Passie, Hannover Medical School, Psychiatry, Böttcherstr. 11, Hannover, D-30419, Germany.
Email: dr.passie@gmx.de

Psychedelics and creativity

I would recommend not mentioning just these very few anecdotal cases in respect to creativity and psychedelics. There are some good studies and reviews about the subject (Hartmann, 1969) on 40 prominent painters at the German Max Planck Institute of Psychiatry in Munich and the review on the subject by Krippner (1985).

When it comes to the very few studies looking for low doses of psychedelics and creativity (review in Passie, 2019), no study revealed any significant/relevant effects under controlled scientific conditions (e.g. McGlothlin *et al.*, 1967). The study of Prochazkova *et al*. (2018) claimed (under weakly controlled conditions in respect to dosing and environment) increased lateral thinking, which has been discussed as a marker of creativity. This study employed doses of psilocybin that were above the perceptible level (4-8 mg p.o.). However, increased lateral thinking does not mean that the drugged subjects have shown increased creativity in a valid sense, e.g. creating more original painting.

Definitions: Microdosing and minidosing

I do not agree with the authors' narrow definition, since it does not reflect fully what is used in the literature and the appropriate Internet entries. It has been proposed that the term 'mini-dosing' could be used to separate the approach of taking small perceptible doses. It is also clear that many authors and Internet entries suggest the practice of just taking one dose at a time rather than a few ones consecutively as, for example, seen with the Fadiman scheme. This is also valid for taking a tenth or a twentieth of a usual dose. However, the issues related to definitions point towards the question/definition of what is considered a 'full dose'. In the case of LSD, some authors reasonably argue that 150 µg is a full dose (especially in females), whereas others consider 250 µg a full dose. This is a significant issue, because 15 µg is usually not perceptible by most subjects, but a dose of 25 µg is for most subjects (as shown in some scientific studies). Therefore, the definition has to be sharpened before scientific consensus can be reached and the evidence from so-called microdosers disseminated on the Internet as well as studies of anecdotal evidence (e.g. Johnson, 2018), which suffers from such inaccuracies, can be taken seriously.

Dosing of dried mushrooms

Plant/fungal material is generally quite unreliable for calculating a dose. I do not agree with the author's statement that 3.5 g *P. cubensis* is 'a usual recreational dose'. Most recreational users take 1 to 2.5 g as a recreational dose, which is also recommended in most books in the field. From my experience, and the research studies of Abramson and Rolo (1967), I would state that a dose of psilocybin below 3 mg is below the perceptible range. Usually, doses above this level can become apparent. For example, Prochazkova *et al*. (2018) used 4-8 mg psilocybin, i.e. more than a microdose, thus, more consistent with the definition of what might be considered a minidose.

The most used dosing regime and effects of micro- and minidosing

It can be easily seen in Internet entries that most subjects who take microdoses recreationally for 'bettering performance' take doses that give them some perceptible effects. Even a microdosing proponent like Paul Austin recommends doses where you can feel/perceive some alterations to some extent. How would you better your performance if nothing can be felt from a dose?

Following my comprehensive research into this topic (Passie, 2019), I have never come across anything about a 'workaholic approach' (dosing during weekdays, but not on weekends) as suggested by the authors. This also does not make much sense form a pharmacological point of view, because tolerance to LSD develops very quickly. Be reminded, that the US military has dosed soldiers with increasing daily doses to try to make them 'immune' to LSD's effects (Ketchum, 2006).

I think that a minidose (e.g. 20 to 50 µg LSD), in contrast to a microdose (which I define as something below 20 µg LSD, e.g. 5-15 µg), makes a significant difference in terms of recreational as well as scientific studies as it definitely alters psychological functioning and the cognitive system.

However, this alteration is not in any way equivalent to stimulants like Ritalin or amphetamine as is sometimes reported anecdotally. It is more a dissociation from the environment and the person itself. Cognitive abilities have been proven to be compromised in many studies with LSD and psilocybin employing a very low dose range (Passie, 2019). It is also important to register these (potentially) distracting effects. There are also a few scientific reports of people who have been given very low doses of LSD for treating depressive mood. These had negative results with very few patients experiencing a small improvement.

What is plausible (and has been experienced by this author) is that a minimal sympathomimetic effect (for sure not compatible with any sort of usual stimulant!), which might be still there up to 20 hours after a 10- to 15-µg dose of LSD, can cause problems with falling asleep, especially in sensitive persons. It is of interest how long it takes following intake for effects to occur. One could think of a train of effects induced in the organism, which is pushed on and may influence the organism even after virtually all of the substance has left the organism.

I definitely do not see the Fadiman protocol (5-15 µg LSD every third day) as the most used approach. It might be viewed as the most widely known, but by far (!) the most 'microdosers' use one occasional dose, not a regular intake. This also makes it very questionable what effects can be/are felt or not, especially when it comes to taking 10 µg just a few times per year (which is apparently what most users do). As Fadiman's coworker on his more or less systematic Internet surveys, Sophia Korb has mentioned in a lecture (conference 'Beyond Psychedelics', Prague 2018) that they know of just three persons who have dosed regularly (according to the Fadiman protocol) for more than 3 weeks. These three subjects were terminal cancer patients and felt quite normal up to day 50. Between days 50 and 60 they all became much more psychologically labile, i.e. having larger mood changes (in the positive as well negative direction, with daily fluctuations), as measured using the PANAS scale.

To my mind, the study published by Horsley *et al*. (2018) does not have any seriously calculable implications for humans. Its limitations should be discussed.

Possible alterations of gene expression and receptor proteins

There are serious doubts that the repeated doses of LSD, which have been used in rodents, are comparable to microdoses in humans. I am not an expert on interspecies scaling, but, for example, (just by simplified arithmetic) the studies by Martin *et al*. (2014) have used doses which are 12,000 times higher than a microdose in humans. According to a recent review (Sharma *et al*., 2009), it appears not to be congruent with scientific data to state that the dose used by Martin *et al*. (2014) is in any way comparable to a microdose in humans. Therefore, to date we know nothing about possible changes in gene expression induced by regular LSD intake in humans.

I doubt that the gene/BDNF changes which were found with very high daily doses in animals can be scaled up to humans using microdoses every few days. Issues of adaption and tolerance should be discussed in this respect.

Receptors are proteins. These proteins and others might be altered by repeated intake of, e.g. LSD, even in very low doses (Buchborn *et al*., 2016). Even if this is somewhat speculative, it seems probable.

On the possible induction of cardiovascular valvopathy

In respect to a possible induction of cardiovascular valvulopathy by chronic 2-HT2R activation, it is worth mentioning that the studies of Bender and Sankar (1968) in the 1960s involved doses of 100 µg LSD for up to

35 months on a daily basis without any observable damage. However, their methods of investigation might not have been sensitive enough to detect damage. It is also true that just a very small part of the patient population taking ergot compounds (e.g. methysergide) do in fact develop valvulopathy. It is also worth mentioning that if a valvulopathy is detected in a patient, in all cases it disappears within a short time after stopping the medication. There is just one case documented in the literature where surgery was necessary (Graham, 1967).

References for commentary by Torsten Passie

1. Abramson H and Rolo A (1967) Comparison of LSD with methysergide and psilocybin on test subjects. *J Asthma Res* 3: 81-96
2. Bender L and Sankar DVS (1968) Chromosome damage not found in leukocytes of children treated with LSD-25. *Science* 159: 749.
3. Buchborn T, Grecksch G, Dieterich DC, *et al*. (2016) Tolerance to lysergic acid diethylamide: overview, correlates, and clinical implications. In: VR Preedy (ed.) *Neuropathology of Drug Addictions and Substance Misuse*, Volume 2. New York: Academic Press, pp. 846-858.
4. Graham JR (1967) Cardiac and pulmonary fibrosis during methysergide therapy for headache. *Am J Med Sci* 254: 1-12.
5. Hartmann RP (1969) *Malerei aus Bereichen des Unbewußten. Künstler experimentieren unter LSD*. Köln: Dumont.
6. Horsley RR, Palenicek T, Kolin J, *et al*. (2018) Psilocin and ketamine microdosing: Effects of subchronic intermittent microdoses in the elevated plus-maze in male Wistar rats. *Behav Pharmacol* 29: 530-536.
7. Johnson MW, Griffiths RR and Hendricks PS (2018) The abuse potential of medical psilocybin according to the 8 factors of the Controlled Substances Act. *Neuropharmacology* 142: 143-166.
8. Krippner S (1985) Psychedelic drugs and creativity. *J Psychoactive Drugs* 17: 235-246.
9. McGlothlin WH, Cohen S and McGlothlin MS (1967) Long lasting effects of LSD on normals. *Arch Gen Psychiatry* 17: 521-532.
10. Martin DA, Marona-Lewicka D, Nichols DE, *et al*. (2014) Chronic LSD alters gene expression profiles in the mPFC relevant to schizophrenia. *Neuropharmacology* 83: 1-8.
11. Passie T (2019) *The Science of Microdosing Psychedelics*. London: Psychedelic Press.
12. Prochazkova L, Lippelt DP, Colzato LS, *et al*. (2018) Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. *Psychopharmacology* 235: 3401-3413.
13. Sharma V and McNeill JH (2009) To scale or not to scale: the principles of dose extrapolation. *Br J Pharmacol* 157: 907-921.

Responses to the microdosing critique reviews

by **David Nutt[1] and Kim PC Kuypers[2]**

[1] Neuropsychopharmacology, Imperial College London, London, UK
[2] Department of Neuropsychology and Psychopharmacology, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands

Corresponding author:
Kim PC Kuypers, Department of Neuropsychology and Psychopharmacology, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands.
Email: k.kuypers@maastrichtuniversity.nl

We would like to thank the four respondents for their thoughtful and insightful contributions to this work. We should also like to make it clear that in addition to their commentaries they also made significant observations on our critique pointing out some errors and omissions that we have taken account of to improve the manuscript. Please read the critiques with this in mind as some of their comments have now been dealt with in our text.

We were pleased that all felt it a significant contribution to the field. They also have significantly enlarged the scope of our review with their very helpful contributions to aspects such as current practice, impact on creativity, value and relevance of rodent studies to mention but a few. Where necessary we mention these issues below though much of their comments and additional insights and references reflect their extensive expertise in this field, and we are very grateful for these as they significantly improve the scientific scope and value of this critique.

A couple of their points need addressing, starting with terminology. We like the distinction made between minidose and microdose and would be happy to see this in use. A minidose being one that has a detectable effect whereas a microdose does not. Of course what the actual drug amount is for each is uncertain, and to what extent the psychoactive effect of a minidose might be 'allowed' to have and still be called 'mini' would need more consideration, but until then, Passie's suggestion of 5-15 µg LSD makes sense, though Liechti's observations need also to be taken into account.

We accept that our focus was on psilocybin and the reason for that was simple - it is almost certainly going to be the first serotonergic psychedelic made available as a medicine. For this reason, it is also currently the only psychedelic made to GMP standards and approved for medical trials with patients. This means that psilocybin is the best choice for microdosing research, certainly in patients and also for volunteer studies in countries where GMP production is required for healthy volunteers. But we fully agree that LSD should also be studied given its widespread use by the microdosing community. For those who chose to use this psychedelic then Fadiman's and Passie's approaches would make a good starting point.

The problem with all psychedelic microdosing studies is how to do it legally and ethically, and this is the big question that needs answering. Maybe a change in the regulations to exclude microdoses from the list of controlled drugs could be sought? After all, when used singly they are below the threshold for subjective effects and so are not psychoactive.

Overall, we are pleased with the results of our efforts and those of the reviewers. Microdosing is a current phenomenon whose value and safety are uncertain. Much research is needed to properly evaluate the personal psychological and health claims. We hope that this set of papers will give impetus to this research and also set it in a solid framework.

Microdosing - Improving performance enhancement in intelligence analysis

by

Maj Emre Albayrak

Marine Corps Gazette - February 2019

original text: https://mca-marines.org/wp-content/uploads/Microdosing.pdf
backup source: http://www.psilosophy.info/resources/Microdosing.pdf

Table of Contents:

- Enter Psychedelics
- Microdosing
- Status Quo
- Gaining the Advantage
- Testing and Integration into Intelligence Analysis
- Closing
- Notes

Maj Albayrak has been an Intelligence Officer for twelve years and is also an Expeditionary Ground Reconnaissance Officer. He has recently completed a tour as the Operations Officer for the Intelligence Support Battalion in an Inspector-Instructor capacity.

"No problem can be solved from the same level of consciousness that created it."
- Albert Einstein

The Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise (MCISRE) may gain an advantage over competitors in intelligence analysis, productivity, and efficiency if it utilizes the innovative cognitive benefits gained through microdosing with psychedelics, which scientists, Silicon Valley executives, disruptors, and biohackers have already harnessed.

Step into any sensitive compartmented information facility in the Marine Corps and you are guaranteed to find any number of stimulants and performance-enhancing drugs (PEDs): caffeine and tobacco in many forms, lab-manufactured and non-Food and Drug Administration-approved pre-workout supplements, etc. The presence of these substances makes it clear that the Marines working within these facilities are attempting to extend their wakefulness while increasing their efficiency and productivity. The increasing speed and breadth to which we collect raw data for processing and exploitation in the fourth generation of warfare,[1] where data flows in terabytes (a thousand gigabytes) and petabytes (a million gigabytes), creates enormous analytical and cognitive challenges.[2, 3]

These challenges create a discrepancy between technological capability (what we can collect) and human ability (what we can process, exploit, and distribute). Intelligence professionals in MEF intelligence centers work on problem sets that require lateral thinking, logical reasoning, persistence, close attention to detail, and creativity on a 24/7/365 processing, exploitation, and dissemination cycle. These Marines are asked to be superhuman and compete in intelligence where, like professional athletes, one percent gains provide significant advantages. Therefore, these Marines are attempting to leverage unique biological reactions to increase cognitive ability, efficiency, and "flow," much like hyper-competitive, information-hungry, self-motivated scientists, Silicon Valley executives, and CEOs.

Enter Psychedelics

Prior to the well-known and documented recreational usage of lysergic acid diethylamide (LSD) and psilocybin (the alkaloid found in hallucinogenic mushrooms) in the 1960s, scientists, researchers, psychiatrists, psychologists, and the U.S. Government tested psychedelics in over 1,000 different studies. Introduced as medication for psychiatric use and growing in medical popularity, *Time* magazine published multiple positive reports on LSD during this time.[4] Beginning in 1953, the Central Intelligence Agency began a program of experiments under the project name MKUltra. The intent of this program was mind control, tested through experimentations on human subjects to identify and develop drugs and procedures that could weaken defense mechanisms during interrogations.[5] A large portion of subjects were administered LSD without informed consent, warning, or appropriate control mechanisms.[6] Unable to achieve the desired results, MKUltra was halted in 1973. During the height of the MKUltra experiments, however, psychedelics continued to gain popularity as research drugs. From 1947 to 1966, researchers wrote over 1,000 scientific papers, published several dozen books, and dedicated six international conferences to the study of psychedelics. The parallel recreational popularity of psychedelics and the resultant moral panic led to Federal laws banning LSD in 1966. This ban also halted legitimate scientific studies, suppressing any further scientific research.

Currently, psychedelics are experiencing a third-wave resurgence - the first wave was the traditional use by native peoples from civilizations around the world for thousands of years, the second wave was the heavy scientific and recreational usage in the 1960s that resulted in their ban, and the third wave is the current use of LSD and psilocybin to assist in medical and psychological situations, including recent Food and Drug Administration-approved studies by researchers at Johns Hopkins, Yale, NYU, and various other facilities who have confirmed the positive cognitive effects of psychedelics.[7, 8] Scientists, Silicon Valley executives, biologists, biohackers, and others who face complex problems or operate at high performance levels are also using microdosing to gain a mental advantage with psychedelics.[9]

Microdosing

A microdose is a sub-perceptual amount (i.e., it does not cause perceptual sensory changes such as visual hallucinations and is *not* strong enough to debilitate the subject) consisting of about a tenth of a medicinal dose of any given psychedelic, usually between 10 and 20 micrograms (μg) of LSD or 100 milligrams (mg) of psilocybin. In research, microdoses were reported to significantly heighten alertness, creativity, and problem-solving - inducing a "flow state" that aids in lateral thinking. Like most hallucinogens, LSD mimics the effects of serotonin (a mood regulator) and activates 5-HT$_{2A}$ receptors in the prefrontal cortex. This increases the activity of the chemical glutamate, which enables the transmission of signals between nerve cells and plays a role in learning and memory.[10] Researchers at the Centre for Neuropsychopharmacology at Imperial College London carried out groundbreaking imaging studies showing changes in cortical functions of the brain (see Figure 1).

Microdoses cause cortical functions to be more fluid, leading researchers to believe that psychedelics may help certain brain areas work in increasingly flexible and expansive ways.[11] The study further states that LSD decreased blood flow to the "default mode network" (DMN), an area of the brain that is activated when the mind is wandering, not committed to a task, and thinking about one's emotional state - what is generally viewed as the "ego."[12] A person's problem-solving ability is typically constrained by his ability to think beyond his limited set of experiences housed within the DMN, and attempts to find solutions are typically made from past experiences. As psychedelics decrease DMN activation, individuals have been shown to expand their ability to connect seemingly unconnected pieces of information and create revolutionary new solutions. The enhanced availability of cognitive pathways, in addition to the changes in cortical functions brought on by microdosing, enhances lateral thinking and creativity,[13] both of which are critical for problem-solving and analytical thinking. These findings support the abundant anecdotal evidence such as Nobel Prize-winning scientists admitting their use of small doses of LSD to boost thought.[14] Psychedelics are credited as a cause for the emergence of personal computing from a select group of government- and corporate-funded laboratories, and even Steve Jobs claimed, "Taking LSD was a profound experience, one of the most important things in my life. LSD shows you that there's another side to the coin."[15]

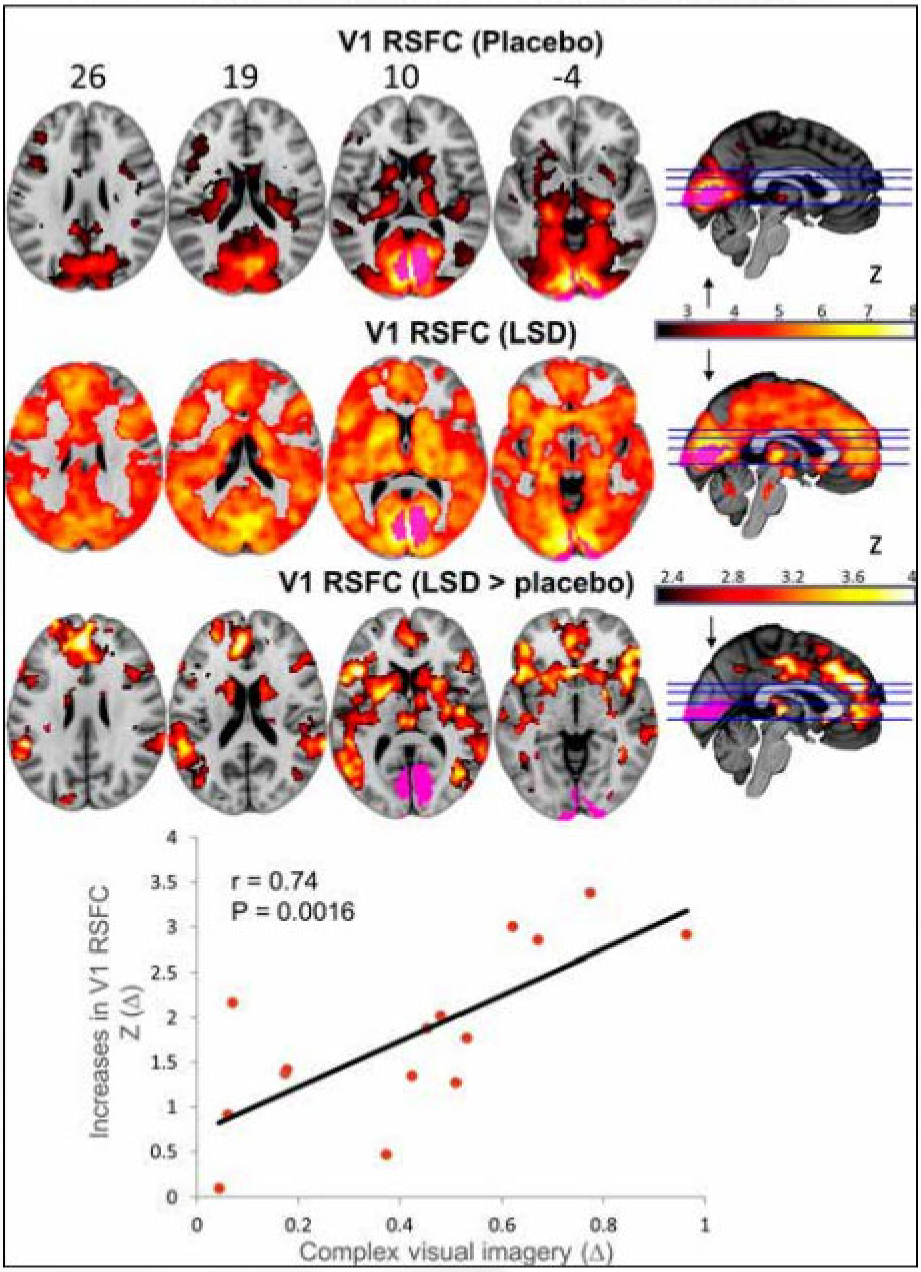
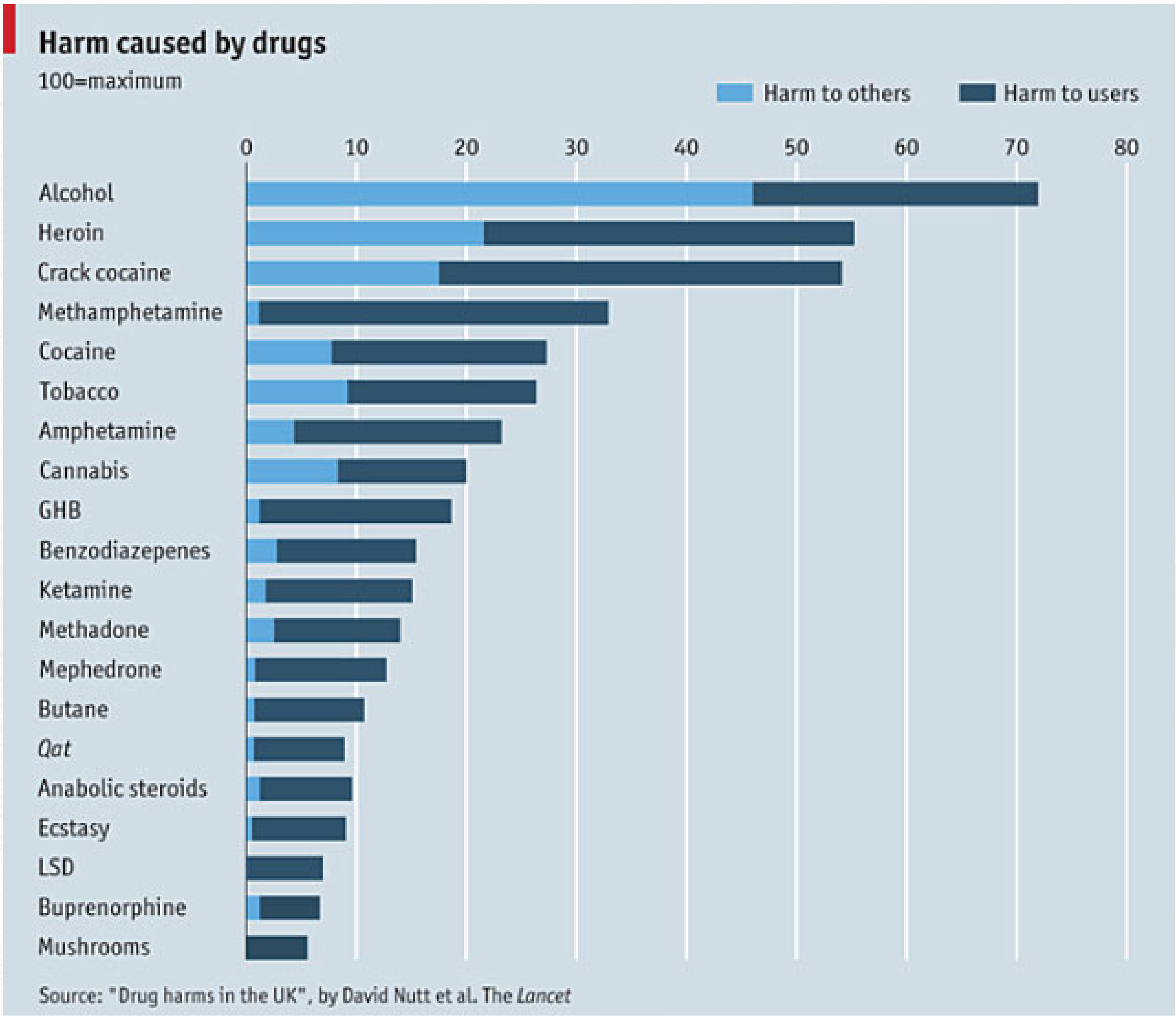


Figure 1. Significant between-condition differences (orange = increases) in Resting State Functional Connectivity (RSFC) between the V1 seed region (purple) and the rest of the brain. Un-thresholded maps can be viewed here: neurovault.org/collections/FBVSAVDQ/

Status Quo

Currently, Marines across the MCISRE regularly use a variety of PEDs to accomplish their tasks. The most well-known PEDs, caffeine, pre-workout supplements, and tobacco, all have some positive short-term effects. However, they do not significantly elevate cognitive activity, enhance neural pathways, or disrupt the brain's DMN. Additionally, existing stimulants have proven negative effects, including jitteriness, energy crashes, elevated heart rate, and, in extreme cases, cancer. Some use PEDs such as Adderall, Ritalin, and Modafinil, albeit with less regularity. These PEDs are effective tools when utilized for their intended purposes; however, the offlabel use for drugs such as Adderall[16] and Ritalin[17] have shown ambiguous improvements in cognition or no improvement at all - undesirable when attempting to solve "wicked problems."[18] Additionally, both of these drugs are amphetamines and carry a variety of side effects: rhabdomyolysis, kidney failure,[19] and a high risk of addiction. Modafinil has shown potential as a cognitive enhancer in certain tasks,[20] but the chief use of Modafinil in the MCISRE is currently limited to reconnaissance Marines or snipers beyond the forward line of troops on extended reconnaissance and surveillance missions where fending off exhaustion is necessary for survival. Despite studies showing Modafinil as a cognitive enhancer in complex assessments,[21] military medical officers do not regularly prescribe service members with Modafinil for off-label uses.

In contrast, microdosed psychedelics enhance cognitive function and flexibility, lateral thinking and creativity, elevate mood, and decrease DMN activity. These factors allow the brain to operate in a manner free of preconceived notions or boxes, resulting in greater creative problem-solving abilities.[22] Psychedelics, however, are not without side effects. The most prevalently cited concerns include purity, dosage control, uncontrolled environments, and their illegality. Unlike amphetamines, psychedelic use does not lead to physical dependence.[23] Overdosing from the direct pharmacological action of LSD in humans is not a salient fatality concern.[24] LSD and mushrooms demonstrate the least amount of harm to users and others amongst drugs[25] (see Figure 2), and LSD does not remain in the spinal fluid or spinal cord, as it was once believed.[26]


Harm caused by drugs

100=maximum

Source: "Drug harms in the UK", by David Nutt et al. The *Lancet*

Figure 2.

Gaining the Advantage

War is not a game, and meeting your enemy on equal footing is a fool's errand. The United States plans to spend $717 billion on defense in fiscal year 2019 to ensure that America has the most lethal, flexible, and responsive military in the world.[27] America dedicates resources to making its military stronger, faster, and smarter than our adversaries, and we are searching for advantages everywhere. Combat does not reward fair play, and World Anti-Doping Agency doping control officers are not taking samples after missions to ban Marines from "competition." Our enemies are already seeking an edge over us through PEDs and nootropics,[28, 29] and our own units, such as the Naval Special Warfare Development Group, seek cognitive advantages via unorthodox methods such as mind gyms and sensory deprivation tanks.[30] The cognitive advantage they seek is "flow" - or "ekstasis" from the Greek, which Plato describes as "an altered state where our normal waking consciousness vanishes completely, replaced by an intense euphoria and a powerful connection to a greater intelligence."[31] This phenomena is described as a non-ordinary state of consciousness in which individuals tend to have heightened focus, pattern recognition, and reaction time. Flow can be observed in a seasoned close-quarters battle team clearing a complex structure. Scientists solving complex problems have described flow; a 10-year McKinsey study revealed top executives being 500 times more productive while in flow.[32] Flow state is understood, but those able to achieve flow on demand cannot easily guide others into it. Research suggests it takes significant experience (in some cases 10,000+ hours of meditation)[33] to quiet the DMN and enter flow on demand.[34]

One thing is clear, a flow state provides a distinct advantage, and the ability to achieve "flow on demand" could provide a significant cognitive advantage. Flow states have been entered with microdosing, and research supports the idea that a cognitive advantage can be gained. Through well-designed experimentation and the use of psychedelics in intelligence analysis, an advantage may be gained over our adversaries.

Testing and Integration into Intelligence Analysis

"The MCISR-E is a warfighting enterprise that supports decision-making through the provision of tailored intelligence that is timely, relevant, and predictive."[35] It does so through its incorporation of a 24/7/365 predictive analysis process led by the MEF intelligence centers and tied into the Marine Corps Intelligence Agency and the intelligence community. The MCISRE is additionally tasked with harnessing human capital and innovation to meet future challenges,[36] the former being exactly where microdosing and intelligence analysis will intersect.

The challenge of unsolved or particularly difficult problem sets is attempting to solve the problems on the current level of cognition either prolongs the time to solution or leaves the problem unsolved. These outcomes are suboptimal in a 24/7/365 environment that requires rapid intelligence analysis for crisis response. Microdosing could be tested in a controlled manner with a select group of volunteers under a special access program to see if significant gains could be made in intelligence analysis productivity and efficiency - especially on particularly difficult problem sets. With specific guidelines, this hypothesis could be evaluated utilizing a double blind method, either independently or as a joint venture with the Defense Advanced Research Projects Agency. First and foremost, all test subjects must be volunteers and provide explicit consent. All volunteers should have a high general technical score (110+) and be mature and experienced analysts (8+ years of experience), heavily invested in difficult problem sets, well versed in their area of expertise (subject-matter experts), and screened for behavioral/psychiatric issues (PTSD, anxiety, panic attacks, previous and current prescription and recreational drug use). It is obvious this will be in direct contravention of the Marine Corps substance abuse policy, which is why these Marines will have to be very carefully screened and selected. The volunteers will need drug waivers entered into their medical files and must be subject to additional weekly drug screenings to ensure they are only ingesting substances prescribed in the study. The group will be separated into test and control groups, with the test group being administered microdoses in accordance with current microdosing guidelines of 10μg of LSD or 100mg of psilocybin every three days[37] and the control group being administered no substances. Following microdosing, the groups will be tasked with competing in the popular Asian strategy game *Go*, which can be utilized to assess cognitive expertise and functions such as attention, working memory, visuospatial processing, and decision making.

Go should be utilized as a benchmark test because presenting test subjects with previously answered problem sets (*a' la* tactical decision games) will not be scientifically sound (a subject may know the solution or have privileged access to information that could lead to solving the problem). Current unsolved problem sets will also cause an issue because the problem may continue to go unsolved without setting a benchmark for how much cognitive improvement is made between the test and control groups. Additionally, Google has utilized *Go* to test the strength of its artificial intelligence program,[38] and it stands to reason that this evaluation will be relevant in this field as well.

The MCISRE provides a young, healthy, and educated population that is under comprehensive medical coverage and supervision. The virtue of close medical supervision, the ability to obtain pure microdoses, daily oversight, and the controlled application of dosage makes the MCISRE a perfect incubator for this experiment. If gains in this study were statistically significant, they could move to small, dedicated, microdosing analyst groups working on wicked problems.

Closing

Though the idea is radical, it must be understood that this is neither a sideways attempt to allow Marines to ingest illicit substances nor to be mistaken as a half-baked attempt to recreate previously failed paranormal experiments such as the Army's *The Men Who Stare at Goats*.[39] This is a serious foray and discussion about considering the use of cognitive PEDs to increase productivity, creativity, problem-solving ability, and flow. If such an experiment were initiated and found to provide a cognitive edge, the DOD and MCISRE, in concert with the data aggregation tool and other technological advantages available, would leverage an untapped resource to create an insurmountable gap over every other competitor.

Notes

1. William S. Lind, COL Keith Nightengale (USA), Capt John F. Schmitt, COL Joseph W. Sutton (USA), and LtCol Gary I. Wilson (USMCR), "The Changing Face of War: Into the Fourth Generation," *Marine Corps Gazette*, (Quantico, VA: 1989).
2. Sean Fahey, "Big Data and Analytics for National Security," Stanford University, (Palo Alto, CA: 2012).
3. Robert Dixon, "Bringing Big Data to War in Mega-Cities," *War on the Rocks*, (Online: 19 January 2016), available at https://warontherocks.com.
4. Jack Shafer, "The Time and Life Acid Trip: How Henry R. Luce and Clare Boothe Luce Helped Turn America on to LSD," *Slate*, (Washington, DC: 10 June 2010).
5. *Project MKUltra, the CIA's Program of Research in Behavioral Modification: Joint Hearing before the Select Committee on Intelligence and the Subcommittee on Health and Scientific Research of the Committee on Human Resources; United States Senate, Ninety-Fifth Congress, First Session*, (Washington, DC: 3 August 1977).
6. Martin A. Lee and Bruce Shlain, *Acid Dreams: The Complete Social History of LSD ; The CIA, the Sixties, and Beyond*, (New York, NY: Grove Press, 1985).
7. Fransisco A. Moreno, *et al*., "Safety, Tolerability, and Efficacy of Psilocybin in 9 Patients with Obsessive-Compulsive Disorder," *The Journal of Clinical Psychiatry*, (Memphis, TN: December 2006).
8. Neiloufar Family, *et al*., "Semantic Activation in LSD: Evidence from Picture Naming," *Language, Cognition and Neuroscience*, (2016).
9. Robert Glatter, "LSD Microdosing: The New Job Enhancer In Silicon Valley And Beyond?, *Forbes*, (Online: 27 November 2015); available at https://www.forbes.com.
10. David E. Nichol and Eric L. Barker, "Psychedelics," *Pharmacological Reviews*, (Bethesda, MD: 2016).
11. Robin L. Carhart-Harris, *et al*., "Neural Correlates of the LSD Experience Revealed by Multimodal Neuroimaging," *Proceedings of the National Academy of Sciences of the United States of America*, (Washington, DC: 1 March 2016).
12. Ibid.
13. Noah W. Sweat, *et al*., "The Associations of Naturalistic Classic Psychedelic Use, Mystical Experience, and Creative Problem Solving," *Journal of Psychoactive Drugs*, (2016).
14. Russell Schoch, "Q& A: A Conversation with Kary Mullis," *California Monthly*, (Berkeley, CA: September 1994).
15. Walter Isaacson, *Steve Jobs*, (New York, NY: Simon & Schuster, 2011).
16. Irena Ilieva, Joseph Boland, and Martha J. Farah, *Objective and Subjective Enhancing Effects of Mixed Amphetamine Salts in Healthy People*, (Online: 1 January 2013), available at https://repository.upenn.edu.
17. Silmara Batistela, *et al*., "Methylphenidate as a Cognitive Enhancer in Healthy Young People," *Dementia & Neurophsychologia*, (Online: 2016), available at https://www.ncbi.nlm.nih.gov.
18. C. West Churchman, "Wicked Problems," *Management Science*, (Online: December 1967), available at https://punkrockor.files.wordpress. com; and Ted G. Lewis, *Book of Extremes: Why the 21st Century Isn't like the 20th Century*, (Basel, Switerland: Springer International Publishing, 2014). Lewis writes, According to Wikipedia, a wicked problem "is a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize."
19. "Stimulants: Toxic to Kidneys and Liver," *Narconon*, available at https://www.narconon. org.
20. R.M. Battleday and A.K. Brem, "Modafinil for Cognitive Neuroenhancement in Healthy Non-Sleep-Deprived Subjects: A Systematic Review," *European Neuropsychopharmacology*, (2015).
21. Ibid.
22. "The Associations of Naturalistic Classic Psychedelic Use, Mystical Experience, and Creative Problem Solving."
23. Saibal Das, *et al*., "Lysergic Acid Diethylamide: A Drug of 'Use'?" *Therapeutic Advances in Psychopharmacology*, (2016).
24. "*LSD (Acid) Fatalities /Deaths*," available at https://erowid.org.
25. David J. Nutt, *et al*., "Drug Harms in the UK: A Multicriteria Decision Analysis," *The Lancet*, (2010).
26. George K. Aghajanian and H.L. Oscar, "Persistence of Lysergic Acid Diethylamide in the Plasma of Human Subjects," *Clinical Pharmacology & Therapeutics*, (Alexandria, VA: 1964).
27. Jerry Petersen, "House Passes $717B National Defense Budget for FY 2019," *Executive Government*, (Online: 25 May 2018), available at www.executivegov.com.
28. German Lopez, "Captagon, ISIS's Favorite Amphetamine, Explained," *Vox*, (Online: 21 November 2015), available at https://vox.com.
29. Lukusz Kamienski, "Combat High - A Brief But Sobering History of Drug Use in Wartime," *Military History Now*, (Online: 8 May 2018), available at https://militaryhistorynow.com.
30. Steven Kotler and Jamie Wheal, *Stealing Fire: How Silicon Valley, the Navy SEALs, and Maverick Scientists Are*

Revolutionizing the Way We Live and Work, (New York, NY: Dey Street Books, 2017).

31. Ibid.
32. Susie Cranston and Scott Keller, "Increasing the 'Meaning Quotient' of work," *McKinsey*, (Online: January 2013), available at https://www.mckinsey.com.
33. Kathleen A. Garrison, *et al*., "Meditation Leads to Reduced Default Mode Network Activity Beyond an Active Task," *Cognitive, Affective, & Behavioral Neuroscience*, (New York, NY: September 2015).
34. Our Amazing World, "fMRI Brain Imaging: Classic Hallucinogens vs Mindfulness Meditation; Science of the Self," YouTube Video, of Gary Weber at the Science and Nonduality Conference, (Online: 25 June 2015), available at https://www.youtube.com/">www.youtube.com.
35. Headquarters Marine Corps, *Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise (MCISRE)*, (Washington, DC: 10 July 2014).
36. Ibid.
37. James Fadiman, *The Psychedelic Explorer's Guide: Safe, Therapeutic, and Sacred Journeys*, (Rochester, VT: Park Street Press, 2011).
38. Elizabeth Gibney, "Google Reveals Secret Test of AI Bot to Beat Top Go Players," *Springer Nature*, (Online: 4 January 2017), available at https://www.nature.com/
39. Jon Ronson, *The Men Who Stare At Goats*, (New York City: Simon & Schuster, 2004).

Powerful substances in tiny amounts

An interview study of psychedelic microdosing

by

Petter Grahl Johnstad

University of Bergen, Bergen, Norway

Submitted: 10 November 2017; accepted: 21 December 2017

© Petter Grahl Johnstad

original source: https://journals.sagepub.com/doi/pdf/10.1177/1455072517753339

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (http://www.creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).

Corresponding author:
Petter Grahl Johnstad, Hamrevegen 25E, 5229 Kalandseidet, Norway.
Email: Petter.Johnstad@hfk.no

Table of Contents:

- **Abstract**
- **Introduction**
- **Method**
  - Terminology
  - Study design
- **Results**
  - Microdose regimen
  - Experienced therapeutic effects
  - Experienced enhancement effects
- **Reported challenges**
- **Discussion**
- **References**

Abstract

Aims: This article presents a qualitative interview study of people who microdose with psychedelic drugs, which means that the user takes about one tenth of an ordinary recreational dose. **Design**: Respondents (n = 21) were recruited at several Internet fora for individual interviews via private messaging. Every participant was male, and the median respondent was in his 30s with a stable job and relationship and extensive entheogen experience. **Results**: Respondents tended to experiment with microdosing in phases, reporting mostly positive consequences from this form of drug use. Reported effects included improved mood, cognition, and creativity, which often served to counteract symptoms especially from conditions of anxiety and depression. There were also reports of various challenges with psychedelic microdosing, and some did not find the practice worth continuing. **Conclusion**: The study obtained evidence of a group of users taking small doses of psychedelics not for the purpose of intoxication but to enhance everyday functioning. While the study's findings are not generalisable, they may inform subsequent investigations with research questions and hypotheses.

Keywords enhancement, health effects, interview, microdose, psychedelic, qualitative

Introduction

To microdose with a psychedelic drug means to take a dose small enough to provide no intoxication or significant alteration of consciousness. Microdosing has been growing in popularity and visibility since James Fadiman recounted some self-experiment reports in his 2011 book *The psychedelic explorer's guide*, but has roots going back to 1970s psycholytic therapy and, according to Fadiman (2011), to indigenous healers and shamans who have "systematically and fully explored every dose level" (pp. 198-199). The microdosing phenomenon has spread most recently over the Internet, where discussion fora enable users to share experiences and exchange information in ways that make new practices accessible for others. Its growing visibility has been reflected in substantial recent media coverage, with a number of reports especially about students and professionals microdosing with LSD in order to improve their concentration and problem solving (Nørgaard, 2017; Solon, 2016; Tande & Fliflet, 2017; Tollersrud, 2017; Williams, 2017). The overall impression from these reports is that microdosing affects mood, health, and cognition in generally positive ways, while allowing the user to carry on with everyday activities.

Searches through PubMed, ProQuest and Google Scholar databases confirmed that there was at the time of writing no published research on psychedelic microdosing to corroborate these anecdotal findings. However, much attention was given to the effects of larger doses of psychedelic substances by psychiatric researchers in the 1950s and 1960s, and one noteworthy finding was that psychedelic therapy sessions often resulted in long-term recovery from alcoholism (Abramson, 1967; for a recent meta-study see Krebs & Johansen, 2012). Clinical effect was also observed for a range of conditions including anxiety in terminal cancer patients and obsessive-compulsive disorder (see review in Nichols, 2004). These lines of research were curtailed by political developments, but have reemerged in recent years after a decades-long hiatus (Sessa, 2005). Recent preliminary results have indicated therapeutic effects from full doses of psychedelic drugs on depression and anxiety around life-threatening disease (Gasser *et al*., 2013; Griffiths *et al*., 2016; Grob *et al*., 2011; Ross *et al*., 2016), on substance dependence (Bogenschutz *et al*., 2015; Johnson, Garcia-Romeu, Cosimano, & Griffiths, 2014; Schenberg, de Castro Comis, Chaves, & da Silveira, 2014; Thomas, Lucas, Capler, Tupper, & Martin, 2013), and on various other somatic and psychological conditions (Carhart-Harris & Nutt, 2010; Johnstad, 2015). However, full doses of psychedelic drugs lead to experiences that are often very intense, and which have been reported to induce both acute panic reactions and toxic psychoses (Iversen, Iversen, Bloom, & Roth, 2009). While the notion of a direct relation between psychedelics use and mental health complications is subject to dispute (Hendricks, Thorne, Clark, Coombs, & Johnson, 2015; Krebs & Johansen, 2013), it would seem prudent to conclude that full doses of psychedelics have a potential to incur nontrivial adverse effects.

Microdosing, on the other hand, is not experientially intense, and has not been reported to result in negative health reactions in anyone. We must acknowledge that this use of psychedelics has not yet been described in academic literature beyond basic reports of its existence (Savulich *et al*., 2017; Sweat, Bates, & Hendricks, 2016), and that the current lack of information about adverse reactions is subject to change. Nevertheless, the anecdotal evidence currently available indicates that microdosing seems to be a promising candidate for some of the health benefits claimed for psychedelics while incurring minimal risk for mental health complications. The aim of this study was therefore to explore psychedelic microdose use by interviewing users about their experiences. Common patterns or themes in their responses could serve as hypotheses or research questions for subsequent investigations.

One way to understand the microdosing phenomenon is to see it in light of the literature on human enhancement techniques. Researchers have identified the growing use of enhancement drugs such as piracetam (Corazza *et al*., 2014), methylphenidate and modafinil (Hupli, Didz·iokaite, & Ydema, 2016), especially among university students, and performance-enhancing drugs have long been regarded as a problem in sports. Hogle (2005) analysed such enhancement drugs as an aspect of a broader range of enhancement technologies including cosmetic procedures, cyborg prosthetics, and genetic enhancement, and observed that humans have a long history of voluntary bodily modification. She argued that enhancement technologies differ from therapeutic interventions in that they may not have a starting point in deficiency, but found it difficult to distinguish precisely between the two. In a definition by Coveney, Gabe, and Williams (2011),

> A therapeutic intervention will restore normal or typical functioning with the aim of returning an

> unhealthy person back to a healthy state whereas an enhancement will improve or extend the abilities or capacities of a healthy individual (who is already functioning normally) outside of this normal or typical range. (p. 384)

They found the therapy-enhancement dichotomy to be a useful heuristic, but warned that it may also be limiting because of the ambiguity inherent in concepts such as health and normality.

Normative characterisations of enhancement drug use varied substantially between these researchers. Whereas Corazza *et al*. (2014) spoke of "abuse", Hupli *et al*. (2016) found that enhancement drug use by healthy individuals could best be understood as "functional drug use". Coveney *et al*. (2011) observed that the social acceptance of enhancement drugs rests in large part on the cultural authority of medical experts and may be subject to change. In an assessment of the need to regulate cognitive enhancement drugs, Ragan, Bard, and Singh (2013) found that regulation "would have to aim at minimizing the risks and harms of cognitive enhancement while maximizing the benefits" (p. 593).

Some researchers have also noted that media reports about enhancement drugs tend to exaggerate how widespread their use is and to over-emphasise their benefits (Partridge, Bell, Lucke, Yeates, & Hall, 2011). While I am not aware of any analysis specifically of media reports on psychedelic microdosing, it is possible that media coverage of this phenomenon conforms to the same pattern.

Method

Terminology

In this article, the term "microdosing" is used exclusively in the context of psychedelic drugs. However, the definition of the term "psychedelic" was unspecified in communication with respondents, and some mentioned microdosing experiments with drugs such as cannabis, which are not usually classified as psychedelics. These reports are noted briefly in the results section. Experiences of perceived therapeutic or enhancement effect are referred to as "positive", whereas unwanted effects are labelled "negative".

Study design

Using purposive sampling, current or former microdose users of psychedelic drugs were recruited for interviews via a variety of Internet fora dedicated to discussions of various psychedelic experiences. Only one of these fora was dedicated especially to microdosing, but there were usually at least a few discussion threads about the subject on each forum. Recruitment efforts used two separate strategies: one was to post a new thread describing the purpose of the study and asking for input, and then to contact individual users by private message for further questions; the other was to search the forum for previous entries relating to microdosing practices and then to contact eligible participants by private message. This two-pronged recruitment strategy was employed on seven different user fora, of which *The Shroomery*, *DMT-Nexus*, *NorShroom*, and *Reddit* produced a range of responses, while *The Hip Forums*, *Psychonaut*, and *Bluelight* did not produce substantial numbers of responses. Forum members who responded to initial recruitment efforts or had made noteworthy contributions to old discussions ($N = 24$) were contacted via private message. Some users who had tried microdosing only once or a few times without any noteworthy effect were not contacted for further interviews as I had nothing further to ask of them, but their experience of no effect is nevertheless noted in the results section. Three of the 24 eligible participants did not respond to the private message, while the remaining 21 gave their informed consent to participate. The study was designed in conformity with Norwegian Social Science Data Services ethical guidelines. A few quotations have been translated from Norwegian, and statements have been edited for brevity and relevance.

Because psychedelics are generally illegal, not all respondents were willing to provide demographic information. In order to reduce participation stress, only a minimum of such information was requested. Every respondent was male. Of the 17 who listed their age, the median age was early 30s. Four were single, five in a relationship, and eight engaged or married (three with children). Five participants were students, while nine were in full-time employment variously as a factory worker, a biologist, a hospital worker, a teacher, a cook, a plant scientist, and in IT security; one was self-employed and two were unemployed/disabled. Five, including one of the unemployed, held master's degrees or PhDs. They had from one year to 25 years of experience with psychedelic drug use, with the median length of experience amounting to about 10 years. Thirteen had extensive microdosing experience and eight had experimented on a more sporadic basis.

In their discussion of Internet recruitment for qualitative studies, Hamilton and Bowers (2006) found that one of the strengths of this recruitment strategy was the potential to increase the appropriateness of each participant. This was indeed the case in this study, as each of the 21 interviewees made valuable contributions and must be regarded as highly appropriate for the study. It is difficult to imagine any non-Internet recruitment arena that could have provided the same level of access specifically to psychedelic microdose users. However, Hamilton and Bowers (2006) also found that participants recruited on the Internet probably have more education and higher incomes, thus potentially skewing findings. While the Internet is probably more accessible today to those with lower education and income levels than it was in 2006, it may very well be the case that Internet recruitment in this study served to exclude some drug users. Furthermore, users with some enthusiasm for psychedelic drugs were probably more likely to self-select for the study. The recruitment process therefore did not obtain a representative set of participants reflecting the general population of psychedelic microdose users.

Interviews were asynchronous and Internet-mediated, and conducted on a semi-structured basis. Such forms of interviewing have been validated by Meho (2006), who discovered a broad range of medium effects from using email to convey interviews. Advantageous effects included a possible increase in honesty and self-disclosure, as well as the elimination of transcription errors, while disadvantages included the loss of visual and nonverbal cues from facial expressions and body language. In conclusion, Meho found no overall negative impact on data quality. Consistent with Meho's finding of an increase in self-disclosure, Bargh, McKenna, and Fitzsimons (2002) discovered that the relative anonymity available on the Internet afforded users increased opportunities for expressing aspects of themselves that they would be inclined to hide from others in face-to-face communication. By allowing for a high degree of participant anonymity, email interviews for this study probably served to facilitate participation from interviewees who would otherwise have balked at describing illegal activities to an unfamiliar researcher. According to Hamilton and Bowers (2006), another benefit of asynchronous email interviewing is that it affords the researcher the opportunity to reflect on previous responses from the interviewee and, on this basis, to pose more thoughtful follow-up questions than might be possible in a face-to-face conversation. I found this feature to be beneficial for the interviewing process.

Typical questions used to guide the interview were:

1. Which psychedelics have you microdosed?
2. How much experience do you have with microdosing?
3. Do you microdose in cycles or continuously? How often do you do it?
4. What effects do you get from microdosing?
5. Have you noticed any negative effects?
6. How do you feel the day after a microdose?

Recruitment for the study was continued until new responses consistently conformed to patterns identified from earlier responses, at which point significant new information was deemed unlikely to emerge. Most interviews were completed within a few weeks, but some were extended for several months in order to obtain information about ongoing microdosing practices. As interviews took the form of written communication, transcription was unnecessary. Data were analysed using thematic analysis and Kvale and Brinkmann's (2015) procedure for meaning condensation. Statements from interviewees were shortened and categorised according to topic, and themes were thereupon constructed on this basis in an open-ended, exploratory, and data-driven comparative analysis. Topics were a priori areas of interest such as usage patterns, therapeutic effects, and negative side effects, while themes represented areas of agreement related to a given topic among a group of interviewees. Participant statements were accepted at face value, and there was no theoretical interpretative framework informing the analysis. However, the interview process allowed for critical perspectives and for the resolution of ambiguities through follow-up questions. Participants were asked to read through and verify the use of their quotations.

The study emphasised the preservation of participant anonymity, and aimed to ensure that no participant would be identifiable either to the researcher or to readers of publicised material. Participants communicated via anonymous messaging that protected their identity at least from the researcher. Unless they were using camouflage technology such as The Onion Router (Tor), their IP addresses would have been accessible to the forum service provider, but this would not have served as a privacy concern beyond the risk they were already incurring through their normal use of this forum. Participants were encouraged not to reveal information about their location, background or circumstances that might indirectly reveal their identities. Their pseudonyms are not reported, as these are often traceable across a variety of Internet sites, and demographic information has been delinked from narratives. While full Internet anonymity is elusive, I believe that participation in the study did not compromise privacy to any significant extent.

The emphasis on anonymity entailed that signed consent letters could not be obtained, and incurred the risk that minors might pass themselves off as adults and gain access to a study discussing the use of illegal drugs. However, it is my impression that microdoses are of little interest to minors, and I believe that no attempts at such subterfuge were made. Recruitment letters and later communication with respondents were carefully phrased so as to not give the impression that the author condoned illegal drug use.

Results

Microdose regimen

Respondents generally regarded microdosing as being compatible with most everyday activities. Some would microdose in the mornings of workdays, while others preferred to limit this activity to afternoons and non-working days. The most commonly used psychedelics for microdosing were psilocybin-containing "magic mushrooms" and lysergic acid diethylamide (LSD). There were also reports of microdosing experiences with *Salvia divinorum*, *Amanita muscaria*, *Peganum harmala* (Syrian rue), *Echinopsis pachanoi* (San Pedro cactus), *N,N*-dimethyltryptamine (DMT), 2,5-Dimethoxy-4-methylamphetamine (DOM), and cannabis. Some users had experimented with a broad range of psychedelic substances, while others had limited this use to one specific psychedelic:

> The only traditional psychedelic I have microdosed is mushrooms. I find this to be extremely beneficial spiritually, physically, and mentally but have no experience with other traditional psychedelics as a basis for comparison.
>
> (ID14) I've had good success with Amanita as a daily tonic for wintertime blues. (ID13)

Doses were usually constrained to about a tenth of a full dose. For LSD, this amounted to somewhere between 10 and 25 mcg, and for *Psilocybe cubensis* mushrooms to 0.1-0.3 g. Some reported taking up to a quarter of a full dose, but this was usually regarded as a mini-dose rather than a microdose, and was not found to be compatible with work and everyday activities. Respondents sometimes found it difficult to specify the exact dose they were taking. Some indicated that their microdose regimen was informed by extant literature on psychedelic microdosing. These were some typical statements about dosage:

> I normally cut up a single blotter of 100 or 150 mcg into 8 pieces, giving microdoses in the range of 12.5 to 18.75 mcg. (ID38)
>
> I have microdosed frequently, generally following Fadiman's recommendation of 1/10th of a dose every four days. (ID33)
>
> I dose 10 mcg LSD twice per week. I came to this amount by administering doses at 5 mcg intervals within the following range [5-25]. I have found that 10 mcg is the most beneficial. Any more and I'm a little too impressionable to distraction, any less and there's no benefit. (ID39)

For experienced microdosers, the practice was usually regarded as a cyclic activity, with microdosing periods lasting from a few weeks to a few months. Within such a period, the respondents typically dosed one to three times per week, although some reported dosing on a daily basis. Less experienced users reported occasional experiments without any stable regimen. Dosing a few times a week did not seem to result in significant build up of tolerance (abatement of positive effects), although with one reported exception for DOM. There were conflicting reports on tolerance build up from daily microdosing and about the impact of microdose tolerance on full doses. Some frequent microdose users experienced a build up of tolerance, while others found no such effect:

> In the last year, I have been experimenting with LSD microdoses quite frequently. But in the past two months, I have gone from taking it every third day to every day. What amazes me is the fact that I don't seem to feel any tolerance build up at all. (ID38)
>
> Surprisingly, a one-day break is sufficient for avoiding tolerance. This went against the conventional wisdom online suggesting that a few days in between was necessary. Dosing on consecutive days saw tolerance, then headaches. (ID39)

Experienced therapeutic effects

Respondents generally agreed that proper microdoses (about a tenth of a full dose) of LSD and psilocybin did not result in any intoxication. Some respondents experienced no effect at all from microdosing, and therefore abandoned the practice after a few attempts, but the majority reported some effect that they regarded as positive. The most commonly described effects were health related, with a benign influence noted especially on states of depression and anxiety:

> I have had very positive results from infrequent psilocybin microdosing. I have found fast and relatively long-lasting relief from depression and social anxiety doing this, as compared to other pharmaceutical options I've been offered such as SSRIs [selective serotonin reuptake inhibitors], and without the intolerable (for me) side effects. (ID29)
>
> The best relief I ever had was in the 0.1 g to 0.2 g range of *Psilocybe azurescens*. This helped immensely with my manic bipolar depression and suicidal ideations. (ID17)

Therapeutic effect was also reported for pain management and for a range of conditions including obsessive-compulsive disorder (OCD), post-traumatic stress disorder (PTSD), narcolepsy, and migraines. A *Peganum harmala* microdose regimen was celebrated by some for its help in quitting cigarette smoking. Several respondents reported that they had discovered some psychedelics to work better for their condition than others, but there was no agreement on which psychedelic was most effective.

> I have been dealing with symptoms of narcolepsy for some years now. I would nod off at meetings, telephone calls, and mundane task at the PC. LSD microdoses have really been a game changer. The amount of energy I feel is profound. In terms of quality of life, it is the difference between being a walking zombie, barely keeping eyes open and looking at every daily mundane task as a struggle, and being a normal functioning person with an extra energy boost and creative tendencies. (ID38)
>
> My wife and I had great success in pain management using mushrooms rich in baeocystin and norbaeocystin (*Psilocybe cyanescens* and *Psilocybe azurescens*). Cubensis don't do the same. (ID17)
>
> I have microdosed with psilocybin mushrooms and DMT, both to prevent oncoming migraines from playing out. I cannot say if the tiny amount of mushrooms helped quash the migraine, but the small amounts of vaporised freebase DMT definitely stopped some migraines from playing out to their full extent. (ID34)

Experienced enhancement effects

Besides the effects on health issues, respondents commonly reported what they regarded as a positive influence from microdosing on energy, mood, and cognition. This allowed them to function better in everyday life even when they had no specific health issues. However, the distinction between treatment and enhancement was not always clear. A few respondents microdosed specifically in order to enhance their capacity for academic study or to increase their efficiency in the workplace. These were some typical descriptions of enhancement effect:

> Since microdosing mushrooms, I definitely feel as though a "mental fog" has been lifted and this allows me to be much more productive and functional. (ID14)
>
> I had a great day! Very calm mind, emotionally in balance. (ID23)
>
> I think micro doses can transpire a subtle alpha aura as one navigates the day with fluidity. And you're smoothly infusing your environment with that pure trippy energy that this plasticised world silently begs for. (ID13)
>
> Before microdosing I would have never said I have mental health issues, but I am forced to reconsider as when microdosing I feel I'm living in the brain of an incredibly mentally healthy person. (ID39)

The enhancement of everyday functioning sometimes resulted in an improved capacity to relate to other people. Some respondents claimed that microdosing psychedelics increased their openness and extraversion:

> I feel more open to other people. At home with my family, I feel better equipped to deal with disagreement, and my emotional reactions are less automatic. My mood improves, and I have better contact with my feelings and less restlessness. I more often take the initiative to talk. (ID27)

A few respondents utilised the perceived energy and mood enhancement for spiritual practice, and found microdosing to be helpful in these pursuits:

> I get bright moods, good introspection in meditation, and a generally meditative, contemplative mood. (ID21)

There were also a few reports about combining psychedelic microdoses with full doses of alcohol, cannabis or 3,4-Methylenedioxymethamphetamine (MDMA). These drug combinations were mostly taken for recreational purposes.

> My experience is that a microdose of LSD taken a few hours before a dose of MDMA opens me up, in a sense, so that I feel the MDMA more strongly and intimately. (ID36)
>
> My kids were away, so I spent the day with my wife lounging in the back yard, swimming in the pool. We had some drinks, got high, and I threw back a microdose of mushrooms. We got cozy in the pool, then I took her inside and we made love. Then we made burgers on the grill, smoked more weed and drank more. What a great day. A microdose on a lazy summer day - awesome! (ID10)

Cannabis is known to intensify the effects of psychedelics, however, and one respondent reported a "bad trip" experience resulting from this combination. There were also conflicting reports about the aftereffects of microdosing, with some users finding themselves back to normal the day after dosing and others experiencing a slight change in their energy level. One respondent reported of a sustained relief from anxiety lasting up to a week after a cycle of microdosing. These were some typical responses about aftereffects:

> Today everything is back to normal, I don't notice any improvement or worsening. I have a weak headache, but that may be because I slept longer than usual. (ID26)
>
> I definitely felt an afterglow just like if you dose high enough for an actual psychedelic experience. (ID3)

There was also broad agreement among the respondents that the two most commonly microdosed psychedelics - psilocybin and LSD - were quite different in their effects, and some had developed a clear preference for one or the other. Respondents agreed that LSD had a more stimulating effect than psilocybin, which some welcomed and others found uncomfortable:

> It's weird: I like mushrooms more than LSD, but favour LSD microdoses over mushroom microdoses. LSD is just more practical for work and play, bounding energy and on target mentality. Mushroom microdoses are more of a personal and "fresh" interaction with the universe. (ID13)
>
> I find that microdosing mushrooms works fine, but LSD microdoses are very uncomfortable as they are too stimulating for me. (ID19)

Reported challenges

Despite the general emphasis on subtle benign effects, the respondents in this study also pointed to a number of challenges associated with microdosing practices. Most commonly reported was the problem of overdosing. Psychedelic drugs are well known for their powerful psychoactive effects, and the resulting state of consciousness is not regarded as compatible with everyday social activities. While there were no reports of accidentally taking a full dose when attempting to microdose, several respondents had unintentionally verged into the terrain of a mini-dose that led to uncomfortable situations:

> I experimented with microdosing mushrooms, but went a bit too far with 0.25 g while at work. I don't know if it was because of the situation, my empty stomach or because I was extra sensitive during that period - but I started tripping quite noticeably! Fortunately it turned out alright. At this level of dosage the peak only lasts for about an hour. (ID25)
>
> I was feeling very tired and had a martial arts class to attend for the first time, so I didn't want to make a bad impression. This was my second time microdosing shrooms, and I dosed around 0.25-0.35 g a few hours before in an attempt to peak well before the class and still just be stimulated and in a good positive mood for it. This backfired massively as I had a large meal around the time of dosing and it only really kicked in once I got to the class. I found it very hard to follow instructions and had a huge body load. (ID5)

Some respondents also found that microdosing could exacerbate certain conditions or symptoms. Benign health effects that users experienced in the early phase of microdosing did in some cases disappear or even reverse themselves after a long period of use.

> One note of caution: if you drink alcohol, don't microdose if you are feeling even slightly hungover, it will get worse, not better. Other than that, be sure to take your first dose on a day where you don't have too much going on as overshooting the mark can be less than productive. (ID33)
>
> I noticed that after a certain point, the benefits fade, and microdosing instead serves to exacerbate my mental health problems. (ID17)

Even when no such adverse effects have been identified, some expressed uneasiness over the fact that the impact of long-term psychedelics microdoses on the brain remains unstudied and unknown:

> Honestly I must admit that it is a bit unnerving to be on the forefront of microdose experimentation. I haven't yet talked to or met anyone who has taken this for as long as I have. (ID38)

A few respondents also mentioned insomnia as a problem, especially if they microdosed late in the day. This was connected to the feeling of overstimulation from LSD microdoses that was reported by several respondents, and both overstimulation and insomnia contributed to a "bad trip" experience reported by one participant who mixed a microdose of LSD with a full dose of cannabis. Another respondent reported that the feeling after taking a microdose reminded him of the early build-up stage of a full trip, which for him was often accompanied by tension.

Discussion

The purpose of this study was to explore how "ordinary" users of psychedelics approach psychedelic microdosing. The selection of users included in this study was not, however, representative of the population of psychedelics users, and the findings of the study therefore have no claim to general validity. Despite this shortcoming, the findings may serve to acquaint researchers with the, as of yet, understudied phenomenon of psychedelic microdosing.

The microdosing practices reported in this study generally conformed in regimen and dose to the recommendations published by Fadiman (2011), although some users experimented with daily microdoses. LSD and psilocybin-containing mushrooms were most commonly used, but some respondents also microdosed a wide range of lesser-known psychedelics and other psychoactive drugs. Respondents for the most part reported what they regarded as positive effects from microdosing, with few side effects. Microdoses most commonly served as mood and cognitive enhancers, allowing people to function at what they felt was a higher level than usual. There are clear parallels between psychedelic microdosing and the use of cognitive enhancement drugs among healthy individuals for performance improvements described by Corazza *et al*. (2014) and Hupli *et al*. (2016), as both forms of drug use can be motivated by a wish for enhanced performance in the workplace or in academic study.

However, there was also a therapeutic motivation for psychedelic microdosing among some of the respondents in this study who suffered from conditions such as anxiety or depression. These findings are congruent with reported effects from full doses of psychedelic drugs on conditions of depression and anxiety (Carhart-Harris & Nutt, 2010; Gasser *et al*., 2013; Griffiths *et al*., 2016; Grob *et al*., 2011; Johnstad, 2015; Ross *et al*., 2016). Reports about the efficacy of microdosing practices for conditions such as substance dependence, OCD, and PTSD also have parallels in research on therapeutic effects from psychedelics in full doses (Abramson, 1967; Bogenschutz *et al*., 2015; Johnson *et al*., 2014; Krebs & Johansen, 2012; Nichols, 2004; Schenberg *et al*., 2014; Thomas *et al*., 2013). It should be noted, however, that in the present study these observations were limited to one or a few individuals. Clinical research on microdosing should probably first look into putative anxiolytic and antidepressive effects, but need not end there.

The lack of a clear distinction between therapy and enhancement that has been pointed to by anthropologists and sociologists who study enhancement technologies (Coveney *et al*., 2011; Hogle, 2005) is echoed in this study. Some respondents pointed to specific deficiencies that their use of psychedelic microdoses was intended to address, but there was an overlap between the use motivated by such therapeutic effects and the use motivated by an effect of enhancement. In either case, the desired effect from microdosing was to be lifted out of a state of relative limitation into a state of higher functioning. The difference was that in therapeutic use, the state of limitation corresponded with a specific medical diagnosis. One respondent explicitly challenged the notion that his "normal" or pre-microdosing state of being deserved the designation "healthy", even though he had not been diagnosed with any specific ailment.

Some respondents experienced no effects from microdosing at all, however, and several others emphasised that, despite their positive experience, microdosing is no miracle cure. There were some indications that psychedelic microdoses might not retain their perceived beneficial effects over longer stretches of time, and that the use should therefore be constrained to phases, which was indeed the most common approach to microdosing among respondents with extensive experience. This reduction of effect over time might limit the medical value of microdosing psychedelics, and would seem to be an important area of investigation for subsequent clinical research of microdosing.

The most commonly reported challenges with microdosing were overdosing and insomnia. Overdosing in this case means going beyond microdose territory into a mini-dose that has some intoxicating effect. Such minidoses are not by themselves overly problematic for experienced psychedelics users, but might have serious negative consequences for users who combine microdosing with work, driving a car, and other activities not compatible with drug intoxication. The overdosing problem applies both to LSD and to psilocybin-containing mushrooms. The former is fully active in doses of a hundred micrograms, and a microdose is often obtained, rather inexactly, by cutting a blotter into separate pieces. Mushrooms for their part may be subject to a natural variation in psilocybin content (Rätsch, 2005). Clinical applications of microdosing could solve this problem by supplying standardised microdoses, but would have to trust their clients not to take several doses at the same time.

The few negative reports about microdosing in this study were not apparently a result of overdosing, nor is there any other obvious explanation for their occurrence. While these negative experiences constitute a minority, it is important to note that some people may experience distinctly unpleasant effects as a result of microdosing. The reported "bad trip" might appear to be a product more of cannabis use than of the LSD microdose, but damage-reduction publications such as *tripsafe.org* often warn that cannabis might potentiate psychedelic drugs.

The question of whether microdosing of psychedelic drugs should be characterised as "abuse", which was Corazza *et al*.'s (2014) label for piracetam use among healthy individuals, or as "functional drug use", which Hupli *et al*. (2016) argued is the best way to understand the use of cognitive enhancement drugs, is not easily answered. Psychedelics are designated as drugs of abuse in most of the world, but there is a substantial research literature that indicates that their use may have therapeutic effect. It is possible that microdosing may allow users to procure some of the perceived positive effects of these drugs while avoiding the problems that may follow from taking them in full doses.

As a social phenomenon, we can perhaps understand psychedelic microdosing in light of Coveney *et al*.'s (2011) observation that the cultural authority of medical experts may be subject to change. Much medical knowledge is now readily available on the Internet, and electronic fora for psychedelic users serve as knowledge repositories that integrate shared user experiences with medical and neuroscientific information. This has resulted in increased knowledge availability (or at least in the perception of increased knowledge availability), which may have caused a corresponding decrease in the cultural authority of medical experts. The growth of microdosing may therefore reflect a social development in which ordinary people use the Internet for medical advice and feel empowered to take personal responsibility for their medication needs, pursuing therapy and enhancement through means that the medical establishment does not recognise and would perhaps frown upon.

There are no published studies on microdosing with which the findings of this study may be compared. The reports of therapy and enhancement, which constitute the majority here, conform to the findings of previously published anecdotal reports (Fadiman, 2011; Solon, 2016; Waldman, 2017), while the reports of no effect or negative effect are, as far as I can determine, without counterpart. This may reflect a bias towards beneficial effects in anecdotal reports, which Partridge *et al*. (2011) found to be a problem for media reports about enhancement drugs, or perhaps it may be that the method used in this study has been more conducive to obtaining balanced information.

There is no way to differentiate between drug effects and positive or negative expectation effects (placebo/nocebo) in these data, but the study affords an understanding of how "ordinary" users of psychedelics approach psychedelic microdosing. Several respondents expressed nuanced views about the relative benefits and disadvantages of microdosing that were not in any obvious manner indebted to placebo or nocebo effects. They also reported discovering specific practices that have worked well for them, compared to others that were found to be ineffectual or subject to negative side effects. Confidence in the reports is therefore increased by their high degree of specificity, as curative or symptom-abating effect was often reported only for one of several drugs that respondents used.

Another overall finding from this study is the value of tapping the psychedelic Internet community for academic studies. It is unknown whether this segment of Internet-active users is representative of the general psychedelic-using population, but the discussion fora frequented by these users are probably among the best recruitment arenas available to researchers. The respondents in this study were reflective, knowledgeable, and fully capable of expressing their views, and their participation would be an asset to any study of psychedelic drug use. It is possible, however, that a less erudite group of psychedelics users would have a less constructive and self-reflective approach to microdosing, and the study has nothing to say about the attractions of microdosing to women. The findings from this study should therefore be taken to reflect the microdosing experiences of a resourceful group of male psychedelic users, and have value primarily to the extent that they may provide subsequent investigations with research questions and hypotheses.

Declaration of conflicting interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

References

1. Abramson, H. A. (1967). *The use of LSD in psychotherapy and alcoholism*. New York, NY: Bobbs-Merril.
2. Bargh, J. A., McKenna, K. Y. A., & Fitzsimons, G. M. (2002). Can you see the real me? Activation and expression of the "true self" on the Internet. *Journal of Social Issues*, 58(1), 33-48.
3. Bogenschutz, M. P., Forcehimes, A. A., Pommy, J. A., Wilcox, C. E., Barbosa, P. C. R., & Strassman, R. J. (2015). Psilocybin-assisted treatment for alcohol dependence: A proof-of-concept study. *Journal of Psychopharmacology*, 29(3), 289-299. doi:10.1177/0269881114565144
4. Carhart-Harris, R. L., & Nutt, D. J. (2010). User perceptions of the benefits and harms of hallucinogenic drug use: A web-based questionnaire study. *Journal of Substance Abuse*, 15(4), 283-300. doi:10.3109/14659890903271624
5. Corazza, O., Bersani, F. S., Brunoro, R., Valeriani, G., Martinotti, G., & Schifano, F. (2014). The diffusion of Performance and Image-Enhancing Drugs (PIEDs) on the Internet: The abuse of the cognitive enhancer piracetam. *Substance Use & Misuse*, 49, 1849-1856. doi:10.3109/10826084. 2014.912232
6. Coveney, C., Gabe, J., & Williams, S. (2011). The sociology of cognitive enhancement: Medicalisation and beyond. *Health Sociology Review*, 20, 381-393. doi:10.5172/hesr.2011.20.4.381
7. Fadiman, J. (2011). *The psychedelic explorer's guide: Safe, therapeutic, and sacred journeys*. Rochester, VT: Park Street Press.
8. Gasser, P., Holstein, D., Michel, Y., Doblin, R., Yazar-Klosinski, B., Passie, T., & Brenneisen, R. (2013). Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *The Journal of Nervous and Mental Disease*, 202, 513-520. doi:10.1097/NMD.0000000000000113
9. Griffiths, R. R., Johnson, M. W., Carducci, M. A., Umbricht, A., Richards, W. A., Richards, B. D., ... Klinedinst, M. A. (2016). Psilocybin produces substantial and sustained decrease in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. *Journal of Psychopharmacology*, 30(12), 1181-1197. doi:10.1177/ 0269881116675513
10. Grob, C. S., Danforth, A. L., Chopra, G. S., Hagerty, M., McKay, C. R., Halberstadt, A. L., & Greer, G. R. (2011). Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Archives of General Psychiatry*, 68(1), 71-78. doi:10.1001/archgenpsychiatry.2010.116
11. Hamilton, R. J., & Bowers, B. J. (2006). Internet recruitment and e-mail interviews in qualitative studies. *Qualitative Health Research*, 16, 821-835. doi:10.1177/1049732306287599
12. Hendricks, P. S., Thorne, C. B., Clark, C. B., Coombs, D. W., & Johnson, M. W. (2015). Classic psychedelic use is associated with reduced psychological distress and suicidality in the United States adult population. *Journal of Psychopharmacology*, 29(3), 280-288. doi:10.1177/ 0269881114565653
13. Hogle, L. F. (2005). Enhancement technologies and the body. *Annual Review of Anthropology*, 34, 695-716. doi:10.1146/annurev.anthro.33. 070203.144020
14. Hupli, A., Did&zcaron;iokaitė, G., & Ydema, M. (2016). Toward the smarter use of smart drugs: Perceptions and experiences of university students in the Netherlands and Lithuania. *Contemporary Drug Problems*, 43, 242-257. doi:10.1177/ 0091450916660143
15. Iversen, L. L., Iversen, S. D., Bloom, F. E., & Roth, R. H. (2009). *Introduction to Neuropsychopharmacology*. Oxford, UK: Oxford University Press.
16. Johnson,M.W.,Garcia-Romeu, A.,Cosimano,M.P.,& Griffiths, R.R. (2014). Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *Journal of Psychopharmacology*, 28, 983-992. doi:10.1177/0269881114548296
17. Johnstad, P. G. (2015). User perceptions of the mental health consequences of hallucinogen use in self-identified spiritual contexts. *Nordic Studies on Alcohol and Drugs*, 32(6), 545-562. doi:10. 1515/nsad-2015-0053
18. Krebs, T. S., & Johansen, P. (2012). Lysergic acid diethylamide (LSD) for alcoholism: Metaanalysis of randomized controlled trials. *Journal of Psychopharmacology*, 26, 994-1002. doi:10. 1177/0269881112439253
19. Krebs, T. S.,&Johansen, P. (2013). Psychedelics and mental health: A population study. *PLoS One*, 8(8), 1-9. doi:10.1371/journal.pone.0063972
20. Kvale, S., & Brinkmann, S. (2015). *InterViews: Learning the craft of qualitative research interviewing*. Los Angeles, CA: Sage.
21. Meho, L. I. (2006). E-mail interviewing in qualitative research: A methodological discussion. *Journal of the American Society for Information Science and Technology*, 57(10), 1284-1295. doi: 10.1002/asi.20416
22. Nichols, D. E. (2004). Hallucinogens. *Pharmacology & Therapeutics*, 101, 131-181. doi:10.1016/ j.pharmthera.2003.11.002
23. Nørgaard, S. K. (2017, May 15). 2 måneders eksperiment med LSD er slut, men Sigurd vil fortsætte [2 months of experimentation with LSD are over, but Sigurd wants to continue]. *Euroman*. Retrieved from http://www.euroman.dk/sam fund/2-maneders-eksperiment-med-lsd-er-slutmen-sigurd-vil-fortsatte
24. Partridge, B. J., Bell, S. K., Lucke, J. C., Yeates, S., & Hall, W. D. (2011). Smart drugs "as common as coffee": Media hype about neuroenhancement. *PLoS ONE*, 6(11), e28416. doi:10.1371/journal. pone.0028416
25. Ragan, C. I., Bard, I., & Singh, I. (2013). What should we do about student use of cognitive enhancers? An analysis of current evidence. *Neuropharmacology*, 64, 588-595. doi:10.1016/ j.neuropharm.2012.06.016
26. Rätsch, C. (2005). *The encyclopedia of psychoactive plants*. Rochester, VT: Park Street Press.
27. Ross, S., Bossis, A., Guss, J., Agin-Liebes, G., Malone, T., Cohen, B., ... Schmidt, B. L (2016). Rapid and sustained symptom

reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *Journal of Psychopharmacology*, 30(12), 1165-1180. doi: 10.1177/0269881116675512

28. Savulich, G., Piercy, T., Bruhl, A. B., Fox, C., Suckling, J., Rowe, J. B., ...Sahakian, B. J (2017). Focusing the neuroscience and societal implications of cognitive enhancers. *Clinical Pharmacology and Therapeutics*, 101(2), 170-172. doi:10.1002/cpt.457
29. Schenberg, E. E., de Castro Comis, M. A., Chaves, B. R., & da Silveira, D. X. (2014). Treating drug dependence with the aid of ibogaine: A retrospective study. *Journal of Psychopharmacology*, 28, 993-1000. doi:10.1177/0269881114552713
30. Sessa, B. (2005). Can psychedelics have a role in psychiatry once again? *British Journal of Psychiatry*, 186, 457-458. doi:10.1192/bjp.186.6.457
31. Solon, O. (2016, August 24). Would you take LSD to give you a boost at work? WIRED takes a trip inside the world of microdosing. *Wired UK*. Retrieved from http://www.wired.co.uk/article/lsd-microdosing-drugs-silicon-valley
32. Sweat, N. W., Bates, L. W., & Hendricks, P. S. (2016). The associations of naturalistic classic psychedelic use, mystical experience, and creative problem solving. *Journal of Psychoactive Drugs*, 48(5), 344-350. doi:10.1080/02791072.2016.1234090
33. Tande, M. I., & Fliflet, F. (2017, September 27). LSD inntar lesesalene: - Det er en «moodlifter» i studiehverdagen [LSD enters the reading rooms: - It is a mood lifter for study days]. *Universitas*. Retrieved from http://universitas.no/kultur/ 62876/lsd-inntar-lesesalene-det-er-en-moodlifter-i
34. Thomas, G., Lucas, P., Capler, N. R., Tupper, K. W., & Martin, G. (2013). Ayahuasca-assisted therapy for addiction: Results from a preliminary observational study in Canada. *Current Drug Abuse Reviews*, 6, 30-42.
35. Tollersrud, E. (2017, October 6-12). En dose nytenkning [A dose of new thinking]. *Morgenbladet*.
36. Waldman, A. (2017). *A really good day: How microdosing made a mega difference in my mood, my marriage, and my life*. New York, NY: Knopf.
37. Williams, A. (2017, January 7). How LSD saved one woman's marriage. *The New York Times*. Retrieved from https://www.nytimes.com/2017/ 01/07/style/microdosing-lsd-ayelet-waldmanmichael-chabon-marriage.html

Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting

by

Luisa Prochazkova[1] & Dominique P. Lippelt[1] & Lorenza S. Colzato[1,2,3] & Martin Kuchar[4,5] & Zsuzsika Sjoerds[1] & Bernhard Hommel

Psychopharmacology (2018) 235:3401-3413
https://doi.org/10.1007/s00213-018-5049-7

Received: 6 January 2018 /Accepted: 20 September 2018 /Published online: 25 October 2018

© The Author(s) 2018

original source: https://link.springer.com/content/pdf/10.1007%2Fs00213-018-5049-7.pdf
backup source: http://www.psilosophy.info/resources/10.1007%2Fs00213-018-5049-7.pdf

Open Access: This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

[1] Cognitive Psychology Unit & Leiden Institute for Brain and Cognition, Leiden University, Leiden, The Netherlands
[2] Department of Cognitive Psychology, Institute of Cognitive Neuroscience, Faculty of Psychology, Ruhr University Bochum, Bochum, Germany
[3] Institute for Sports and Sport Science, University of Kassel, Kassel, Germany
[4] Forensic Laboratory of Biologically Active Substances, Department of Chemistry of Natural Compounds, University of Chemistry and Technology Prague, Prague, Czech Republic
[5] Department of Experimental Neurobiology, National Institute of Mental Health, Klecany, Czech Republic

Luisa Prochazkova: l.prochazkova@fsw.leidenuniv.nl

Luisa Prochazkova and Dominique P. Lippelt contributed equally to this work.

Table of Contents:

- **Abstract**
- **Introduction**
- **Methods**
  - Procedure
  - Sample
  - Truffle analysis
  - Instruments
    - *Picture concept task*
    - *Alternate Uses Task*
    - *Raven's Progressive Matrices*
    - *Analyses*
- **Results**
  - Psychedelic content in truffle sample
  - Interaction effects with weight, body mass index, ingested dosage, and prior experience
  - Fluid intelligence
  - Divergent thinking
- **Discussion**
- **Limitations**
- **Conclusion**
- **Compliance with ethical standards**
- **References**

Abstract

Introduction Taking microdoses (a mere fraction of normal doses) of psychedelic substances, such as truffles, recently gained popularity, as it allegedly has multiple beneficial effects including creativity and problem-solving performance, potentially through targeting serotonergic 5-HT$_{2A}$ receptors and promoting cognitive flexibility, crucial to creative thinking. Nevertheless, enhancing effects of microdosing remain anecdotal, and in the absence of quantitative research on microdosing psychedelics, it is impossible to draw definitive conclusions on that matter. Here, our main aim was to quantitatively explore the cognitive-enhancing potential of microdosing psychedelics in healthy adults.

Methods During a microdosing event organized by the Dutch Psychedelic Society, we examined the effects of psychedelic truffles (which were later analyzed to quantify active psychedelic alkaloids) on two creativity-related problem-solving tasks: the Picture Concept Task assessing convergent thinking and the Alternative Uses Task assessing divergent thinking. A short version of the Ravens Progressive Matrices task assessed potential changes in fluid intelligence. We tested once before taking a microdose and once while the effects were expected to be manifested.

Results We found that both convergent and divergent thinking performance was improved after a non-blinded microdose, whereas fluid intelligence was unaffected.

Conclusion While this study provides quantitative support for the cognitive-enhancing properties of microdosing psychedelics, future research has to confirm these preliminary findings in more rigorous placebo-controlled study designs. Based on these preliminary results, we speculate that psychedelics might affect cognitive metacontrol policies by optimizing the balance between cognitive persistence and flexibility. We hope this study will motivate future microdosing studies with more controlled designs to test this hypothesis.

Keywords Microdosing, Psychedelics, Field study, Convergent thinking, Divergent thinking, Creativity

Introduction

Major news outlets throughout the world are reporting on the growing number of professionals using small doses of psychedelics (e.g., magic mushrooms, truffles, or peyote) to boost their productivity and creativity at work. A prominent example is the use of small doses of LSD by employees in Silicon Valley, as a "productivity hack" (Glatter 2015). This emerging phenomenon is referred to as microdosing, with dosages around one tenth of recreational doses. Yet, despite the low dosages, microdosing is still thought to provide a potential boost in cognition according to anecdotal reports (Cooke 2017; Gregorie 2016; Leonard 2015; Sahakian 2017; Senior 2017; Solon 2016). Moderate to large doses of psychedelics induce changes in perception, mood, and overall consciousness, often described as qualitatively similar to deep meditative or transcendental states (Barrett and Griffiths 2017; Barrett *et al*. 2017). If similar, yet substantially more subtle, effects apply to microdosing, this would render microdosing a potentially interesting cognitive enhancer in healthy individuals or even the basis of a treatment strategy to tackle various disorders including depression.

Throughout the 1960s, psychedelics were extensively used at recreational doses in experimental research, clinical settings, and in creative and scientific vocations (Sessa 2008), but were made illegal in most countries worldwide as a reaction to the rising counterculture of the 1960s and failure to establish the clear efficacy of LSD treatment (Oram 2014). Now, after many decades of disregard, psychedelics have started to reappear as a genuine and promising area of research within experimental and clinical psychology, as well as psychiatry. Moreover, certain psychedelics, such as truffles, have regained a legal status in The Netherlands, offering researchers a particularly interesting opportunity to study its effects in a quantitative manner. This is highly desirable, as previous reports have remained anecdotal (Oberhaus 2017) and qualitative at best, often focusing on experiences of elevated feelings of determination, alertness, and energy, improved pattern recognition, as well as strong reductions of depressive feelings (Fadiman and Krob 2017). Qualitative studies based on self-reports are known to suffer from validity problems due to participants' inaccurate memories, differences in vocabulary and verbal skills, and unintentional or willful distortions of subjective experiences (Schwarz 1999).

Nonetheless, existing research with moderate doses of psilocybin shows that psilocybin is a potent neuropharmacological agent with a strong modulatory effect on brain processes (Vollenweider and Kometer 2010). Furthermore, a double-blind placebo-controlled study by Hasler *et al*. (2004a, b) showed that even very low doses of psilocybin (45 µg/kg body weight) were rated clearly psychoactive by most of the volunteers, which indicates that psychedelic effects do not need high doses to be recognized.

Classical psychedelics such as psilocybin (O-phosphoryl4-hydroxy-N, N-dimethyltryptamine), the active compound in psychedelic truffles, exert their primary effects by directly binding to serotonin 2A receptors (5-HT$_{2A}$; Tyl[1] *et al*. 2014). Interestingly, 5-HT$_{2A}$ agonism has been reported to be associated with enhanced cognitive flexibility (Clarke *et al*. 2004, 2007; Boulougouris *et al*. 2008; Kehagia *et al*. 2010), improved associative learning (Harvey 1995, 2003), and hippocampal neurogenesis (Catlow *et al*. 2016) in animals. Additionally, psychedelics have been shown to increase subjective sense of wellbeing, optimism, and openness in humans (Griffiths *et al*. 2006, 2008; MacLean *et al*. 2011). Moreover, multiple clinical trials using moderate to large doses of psychedelics have indicated that psychedelics have anxiolytic, anti-depressant (dos Santos *et al*. 2016; Carhart-Harris *et al*. 2016a, b; Grob *et al*. 2011; Griffiths *et al*. 2016), anticompulsive (Moreno *et al*. 2006), and anti-addictive properties (Bogenschutz *et al*. 2015; Johnson *et al*. 2014; Krebs and Johansen 2012; dos Santos *et al*. 2016). Consequently, the effects of psychedelic substances can be argued to target the serotonergic system and hence be beneficial in situations where there is a need for mental flexibility, or where one needs to break through rigid patterns of thought. In case that future research confirms positive effects of microdosing on brain and cognition, microdosing could become an attractive alternative due to its more subtle nature possibly sparing individuals from the perceptual distortions often reported with moderate or high doses.

Through the alleged benefits in mental flexibility, a promising behavioral target of psychedelics lies in the area of creativity. Creativity is a multilayered phenomenon, commonly defined as the ability to generate ideas, solutions, or products that are both novel and appropriate (e.g., Amabile 1996; Sternberg and Lubart 1999). Creativity is not a unitary function but consists of a number of subcomponents (Wallas 1926) that provide different, to some degree opposing cognitive challenges. It is crucial to distinguish between convergent thinking, which requires identification of a single solution to a well-defined problem (Mednick 1962), and divergent thinking, which requires the collection of many possible solutions to a loosely defined problem (Guilford 1967). An example of convergent thinking task would be to find the one concept that can be meaningfully combined with three other concepts such as "...man," "...market," and "...bowl" (such as "super"), while an example of divergent thinking task would be to list all possible ways in which a brick could be used (for throwing, as a weight, as a weapon, etc.). It has been argued that convergent thinking draws more on the ability to focus exclusively on a given problem (persistence), while divergent thinking draws more on cognitive flexibility (Lippelt *et al*. 2014). However, it is important to point out that all available creativity tasks require the integration of both of these abilities to some degree. Of further importance to our present study is the fact that creative thinking is not a hardwired virtue. Several behavioral studies have shown that the processes underlying creative thinking can be systematically enhanced and impaired by both behavioral interventions, such as meditation, as well as, psychopharmacological agents, as for instance cannabis, tyrosine, and Adderall (e.g., Baas *et al*. 2014; Colzato *et al*. 2015; Farah *et al*. 2009; Kowal *et al*. 2015; Ritter and Mostert 2016; Schafer *et al*. 2012; Zabelina and Robinson 2010; Davis 2009).

Moreover, a recent study conducted by Kuypers *et al*. (2016) investigated the effect of recreational doses of the psychedelic brew Ayahuasca on creativity during two spiritual retreats. They found that divergent thinking performance improved under the influence of Ayahuasca compared to baseline, while convergent thinking performance decreased in comparison to baseline. Although this study may seem to provide a useful starting point, conclusions are hampered by several disadvantages of this drug and the study design. First, dimethyltryptamine (DMT), the active psychedelic compound in Ayahuasca, needs to be combined with monoamine oxidase inhibitors (MAOIs) for its effect to take place. MAOIs are known to have anti-depressant effects on their own, so they represent a possible confound in all Ayahuasca studies (Quitkin *et al*. 1979). Additionally, this implies that the qualitative experience induced by large doses of Ayahuasca and the underlying mechanisms of action are likely to differ substantially from psychedelic experience induced by microdosing for which LSD or psilocybin are commonly used (Callaway and Grob 1998; Riba *et al*. 2006). Indeed, the Ayahuasca brews used in the study of Kuypers *et al*. (2016) induced strong psychedelic experiences, the effects of which are unlikely to be comparable to the effects obtained from microdosing a psychedelic substance. High doses of psychedelics frequently result in disorienting effects in the user, which makes reliable assessment of psychometric task performance difficult during the peak effects of the psychedelic experience (Hollister 1968). Taken altogether, microdosing of psychedelic truffles and related psychoactive substances may thus be more suitable to assess the enhancing effects of psychedelics on human performance.

The current study is the first to experimentally investigate the cognitive-enhancing effects of microdosing on human cognition in a natural setting. We were offered the unique opportunity to quantitatively study the effects of microdosing truffles during microdosing events of the Psychedelic Society of The Netherlands (PSN), a non-laboratory environment. Natural settings like such an event have a number of potential benefits as they are more comparable to situations of real life use than studies in a laboratory environment. The truffle samples, which participants obtained during the microdosing event, were post hoc analyzed, to determine the exact amount of active substance potentially leading to the found effects. The major aim of our study was to study the effects of psychedelic truffles on creative thinking. We assessed convergent and divergent thinking separately, by using the Picture Concept Task (PCT) (Hurks *et al*. 2010; Wechsler 2003) and Guilford's (1967) Alternate Uses Task (AUT), respectively. Given that convergent thinking is correlated with fluid intelligence (e.g., Akbari Chermahini *et al*. 2012), we also employed a short 12-item version of Raven's Progressive Matrices Task (Bilker *et al*. 2012), a standard intelligence test, once before and while the acute effects were expected to take place. Given the effects of large doses of psychedelics on positive mood, trait openness, and assumed cognitive flexibility reflected by psychosis-like symptoms (Carhart-Harris *et al*. 2016a, b), we expected improvements on the AUT after microdosing, as mood and flexibility are two factors that are known to boost divergent thinking (Baas *et al*. 2008; De Dreu *et al*. 2008; Vosburg 1998; Zabelina and Robinson 2010). Due to a lack of relevant previous studies and the subjectivity of self-reports, the effect on convergent thinking was difficult to predict. On the one hand, previous dissociations of convergent and divergent thinking might suggest that convergent thinking is impaired by microdosing - an outcome that could imply that microdosing shifts cognitive control states from persistence to flexibility (Hommel 2015). However, microdosing may also improve both convergent and divergent thinking, suggesting that microdosing improves the interplay between persistence and flexibility. We did not have specific expectations regarding intelligence, but were interested to see whether possible effects on convergent thinking might generalize to performance on the intelligence task or remained more specific.

Methods

Procedure

The experiment was conducted during a microdosing event organized by the Psychedelic Society of the Netherlands (PSN), who provided us with the opportunity to ask participants to take part in the experiment by means of an on-stage presentation. Interested participants were presented with envelopes containing the informed consents. We asked participants to read the provided information carefully, to sign it if they gave permission for their participation and use of their anonymized, coded data, and to subsequently return it back in the envelope. The envelope also included the experimental tasks for the first session as a booklet. However, we stressed participants to not open the booklet until one of the experimenters asked them to turn the first page to prevent premature exposure to the tasks. The experimenters also kept a close eye on the attendees to further ensure participant compliance. Next, all participants were carefully guided through the experimental tasks. Each task was explained in detail by one of the experimenters with the aid of example items, before participants were allowed to perform the task themselves. This was repeated for each of the three tasks. The protocol was approved by the local ethics committee (Leiden University, Institute of Psychology). The experiment consisted of a baseline session before participants had consumed any psychedelics and a second session carried out while participants were under the influence of a microdose of psychedelic truffles. The tasks were conducted in a group setting free from outside distraction during both sessions. Participants' responses were assessed in paper-and-pencil version. The test battery consisted of the Picture Concept Task (PCT) (Wechsler 2003; Hurks *et al*. 2010) to assess convergent thinking, the Alternate Uses Task (AUT) (Guilford 1967) to assess divergent thinking, and a validated short 12-item version of the Raven's Progressive Matrices Task (RPM) (Bilker *et al*. 2012) to test fluid intelligence. While AUT and RPM were presented fully in paper version, PCT stimuli were presented by PowerPoint to insure precise timing of stimuli presentation (further details about the contents of the psychometric tasks are provided under the "Materials" section). Pre- and post-microdosing performance was assessed by administering two different versions of each task, to reduce potential learning effects. Task versions were counterbalanced across sessions and participants.

After finishing the experimental tasks in the first session, participants consumed a microdose of pre-measured psychedelic truffles made available by the PSN. Participants of the workshop agreed to take psychedelic truffles upon their own risk. The PSN did not adhere to any strict guidelines regarding the dosage given to attendees. Nonetheless, they did take the attendees self-reported approximate weight into account in their recommended dosage, by means of subjective evaluations regarding low, average, and high body weight criteria. Attendees judged to have a low body weight were recommended to take 0.22 g of truffles, those with an average body weight 0.33 g, and those with a high body weight were recommended 0.44 g of dried truffles. Moreover, it should be noted that attendees did not have to adhere to the PSN member's recommendation and were free to choose a dose. However, with reference to the existing microdosing guidelines (Fadiman 2011), the doses provided to participants appeared to be in a meaningful range of a microdose. Following the publication of The Psychedelic Explorer's Guide (Fadiman 2011), a microdose should lie around one tenth to one sixteenth of a regular dose. Considering that a recreational dose of truffles is about 10 g of fresh truffles, a microdose would equal 1 g of fresh truffles. As fresh truffles consist of two thirds of water, this results in a weight of 0.33 g of dried truffles. Participants consumed on average 0.37 of dried truffles which is an appropriate amount given the calculation. Additionally, data on participants' height, body weight, and ingested dose of truffles were independently collected by the researchers in order to examine potential dose-dependent effects in the analysis.

Approximately 1.5 h after attendees had consumed the truffles, participants were asked to take part in the second session of the experiment. The 1.5-h time interval was chosen as the effects of truffles are reported to peak around 30-90 min followed by a few hours long plateau of effects before rapidly subsiding back to baseline (Erowid 2017). By choosing this time interval, we could be certain that all participants were tested while the effects of the truffles were still plateauing during the second session. The procedure during the first session was repeated at the second session. Lastly, participants filled in a questionnaire on medical health, psychedelic and general drug use, and general personal information (e.g., gender, age, first language). After testing, we thanked participants for their participation and debriefed them about the purpose of our experiment.

Sample

Out of all 80 attendees at the microdosing event, 38 volunteered in our experiment. Participants indicated that they were healthy, spoke the required languages for performing the experimental tasks, and whether they had prior experience with the use of psychedelic substances. All 38 participants completed the RPM during both sessions. Regarding the PCT, 11 participants had to be excluded from further analysis, either due to incorrect interpretation of the task instructions or because they did not complete the task either for the first or second session. For the AUT, two participants had to be excluded as the experimenters were unable to read the individuals' writing: two due to missing data on the second session and one due to misinterpretation of the task instructions. Importantly, the individuals that were excluded for the AUT and PCT analysis did not overlap. This suggests that exclusion was random and did not depend on a shared trait or state among those who were excluded from the two analyses. Nonetheless, in order to preserve power, we decided to analyze the data separately for each task. This yielded a sample of 38 participants for the analyses of the RPM data, 27 subjects for the PCT analyses, and 33 for the analyses of the AUT data. Table 1 provides an overview of additional descriptive information regarding the sample.

Sample	Age	Gender (M/F)	BMI	Weight (kg)	Prior experience (Y/N)	Ingested dosage (g)
RPM	31.1 (11.49)	23/15	22.5 (4.74)	68.4 (12.81)	36/2	0.37 (0.159)
AUT	30.0 (10.89)	19/14	22.4 (4.92)	67.5 (13.01)	31/2	0.35 (0.142)
PCT	31.5 (12.49)	18/9	22.9 (5.42)	69.3 (13.36)	25/2	0.41 (0.158)

Table 1 Descriptive statistics for the samples used in the three separate analyses. Numbers indicate mean (SD), unless otherwise specified (gender and prior experience)

Truffle analysis

Dried truffle samples of what participants used during the microdosing event (corresponding to 0.22, 0.33, or 0.44 g dry weight) were post hoc analyzed at the University of Chemistry and Technology Prague (UCT; Laboratory of Biologically Active Substances and Forensic Analysis) to determine the exact amount of active substances potentially leading to the found effects. Analytical standards of psilocin, psilocybin, norbaeocystin, and baeocystin were synthesized in-house (purity ≥ 95%) at UCT. The evaluation of the developed analytical method (Hajkova *et al*. 2016) encompassed the determination of Limit of Quantitation (LOQ) and the determination of the applicable concentration range for each compound studied. LOQ was determined as 10 times the ratio of signal to noise. Concentration was determined for each of the truffle samples separately, and each sample was measured twice. The level of the alkaloids was almost identical in all three samples, however, and the differences were lower than the estimated measurement errors when the results from the different samples are averaged. As such, we report the concentrations for the four alkaloids collapsed across the three samples in the results. For the alkaloid concentrations for the three samples separately and further details regarding the methods underlying these analyses, please see Online Resource 1.

Despite psilocybin usually being the most abundant alkaloid in psychedelic truffle psilocin is commonly considered to be responsible for the psychedelic truffles' characterizing psychoactive effects (Gartz *et al*. 1994; Tyl[1] *et al*. 2014). Psilocybin is quickly metabolized into psilocin in the human body through dephosphorylization, thereby limiting psilocybin's direct contribution to the psychoactive effects in humans. Furthermore, we also report the concentrations of baeocystin and norbaeocystin as it has recently been suggested that they could quickly metabolize into corresponding N-demethylated psilocin derivatives upon consumption through similar processes as are at play in the metabolism of psilocybin (Tyl[1] *et al*. 2014).

Instruments

Picture concept task

The PCT (Wechsler 2003; Hurks *et al*. 2010) is a visual creativity task that involves finding a common association between several images. Each trial consists of a matrix of between 2 × 3 to 3 × 4 pictures (see Fig. 1 for an example). The correct solution is a common association between one picture from each row. Thus, a response indicating an association between two pictures from the same row would be incorrect. Because the task presumes there is only one correct solution to each item, the task has been previously used to measure convergent thinking (Hurks *et al*. 2010). Hence, to complete the task, one should converge on the correct solution, while inhibiting inappropriate or less obvious associations and previously attempted yet incorrect solutions.

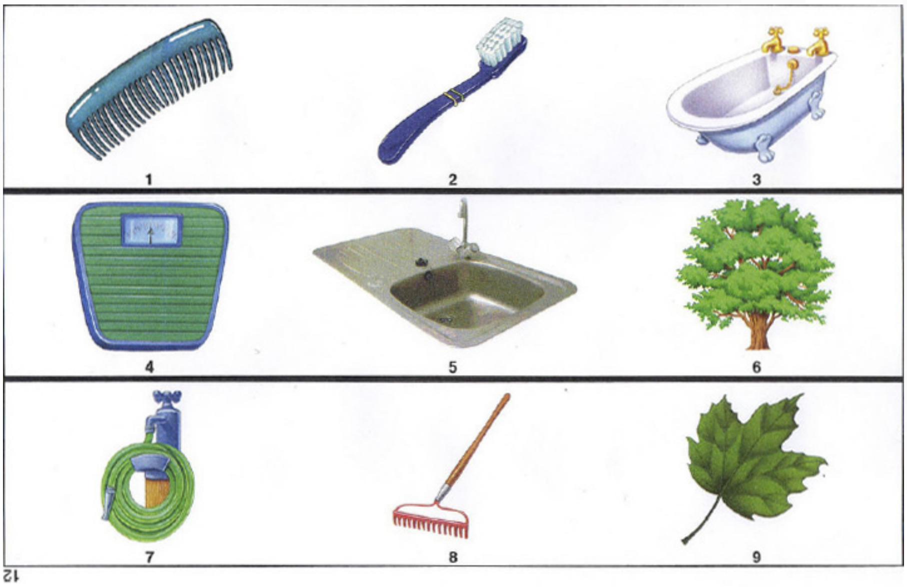


Fig. 1 Example trial from the Picture Concept Task. The subject has to identify the common association between one item from each row.

Participants had 30 s per item to find the solution. Because precise time limit is essential in this task, it was impractical to present the task on paper. Instead, we used a PowerPoint presentation in which the slides (i.e., items) transitioned every 30 s. Participants were instructed to mark and name the common association between the pictures on the PCT response sheet in the booklet (see Fig. 2 for a corresponding answer sheet belonging to the item in Fig. 1). The PCT was scored by summing the number of correct responses.

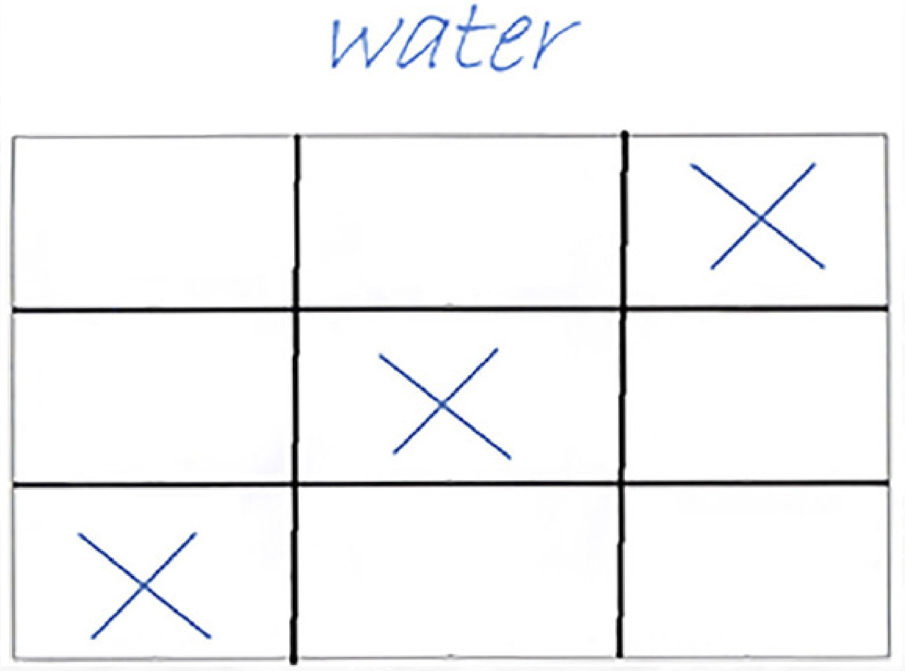


Fig. 2 Illustration of a filled in answer sheet for the items from Fig. 1

Alternate Uses Task

The AUT is commonly used in research on creativity to measure divergent thinking performance (Guilford 1967). During the AUT, subjects are presented with a common household object and asked to think of as many possible uses for the object as they can within a limited amount of time. Within each session of our experiment, participants were either presented with the word Pen or the word Towel and given 5 min (per session) to write down as many possible uses for the object. As common, the AUT was rated according to four different variables:

- Fluency: the total number of responses
- Flexibility: the number of different categories of responses
- Elaboration: how much the person elaborates on their response. Each "elaboration" receives one point. For instance, the response Busing a brick to prevent a door from slamming shut (1), when it is windy (2)" earns two elaboration points.
- Originality: the uniqueness of a response. Originality is calculated by dividing the total number of responses by *all* subjects, once by 5% and once by 1%. Responses that have also been mentioned by 1% or less of the other participants receive two points for originality, while responses that have been mentioned by 1-5% of the participants receive one point for originality. All other responses receive no originality points.

Out of these four, flexibility is the most reliable and theoretically most transparent index of divergent thinking (Akbari Chermahini and Hommel 2010), while fluency neglects the quality of responses and the originality score is highly sample-dependent. As the scoring of AUT variables can be highly subjective, we used the mean score for each of the four measures obtained from two independent raters to increase the reliability of the dependent measures. Reliability scores (Cohen's κ) were very high for fluency (session 1, κ = .970; session 2, κ = .935), fair for flexibility (session 1, κ = .342, session 2, κ = .252), fair to moderate for elaboration (session 1, κ = .231; session 2, κ = .547), and fair for originality (session 1, κ = .254; session 2, κ = .318).

Raven's Progressive Matrices

The RPM was developed by Raven (1938) in order to measure fluid intelligence. We used a shortened 12-item version of the RPM to reduce testing time and participant burden. The 12- item version was developed and validated by Bilker and colleagues (2015) showing high correlations with the full RPM (r = .80 for version A and r =.77 for version B).

In our experiment, the RPM consisted of a series of 2 × 2 or 3 × 3 matrices of pictures in which the lower right picture was always missing. Both horizontally and vertically, a pattern is present in the matrix of pictures allowing the participant to deduce what the missing picture should look like. Underneath each item, six possible solutions were presented and participants marked the correct solution by circling it on paper. While there was no time limit per item, the task had a total time limit of 5 min. Throughout, the RPM items increased in difficulty, but participants were allowed to skip an item in case they felt like they were stuck. However, once they had advanced to a next item (either by skipping or answering), they were no longer allowed to go back to correct earlier responses. The RPM was also scored by summing the number of correct responses.

Analyses

First, separate analyses were run to test for possible interactions between time-point (pre- versus post-truffle ingestion) and participants' body weight, ingested dose, and prior experience with psychedelic substances on the dependent measures. As we did not find any significant interactions, we dropped these factors from any subsequent analyses. To assess changes in fluid intelligence, we performed a paired samples t tests comparing RPM scores at baseline versus RPM scores post ingestion of the truffles in the entire sample. Next, we performed a paired sample t test to compare convergent thinking performance before and after ingestion for the 27 participants for whom we obtained valid data on the PCT for both sessions. To assess microdosing-induced changes in divergent thinking performance, we analyzed the variables obtained from the AUT. Although of main interest were the flexibility and fluency scores, for completeness, we entered all four variables (i.e., fluency, flexibility, elaboration, and originality) as separate dependent measures in one multivariate Repeated Measures ANOVA with time (pre- versus post-ingestion) as the within subject factor. Significant effects in the multivariate ANOVA were followed-up by the appropriate univariate tests. The significance level for all analyses was set to $\alpha = .05$.

Results

Psychedelic content in truffle sample

The Forensic Laboratory of Biologically Active Substances confirmed the presence of the active psychedelic alkaloids in the truffle samples. Quantitative analysis showed the presence of all four investigated alkaloids with predominant levels of psilocybin (see Table 2 for an overview of alkaloid concentrations). The next-most abundant alkaloids were psilocin followed by baeocystin. The concentrations of the four alkaloids were almost identical for all three samples, and the differences were lower than the measurement errors obtained when the data is collapsed across samples.

In this study, we compared task performance before the ingestion of the psychedelic truffles with performance approximately 1.5 h after ingestion (i.e., while the effects of the psychedelic truffles are thought to be fully manifested). Table 3 displays descriptive statistics for both sessions of performance on all dependent measures.

Alkaloid	µg/g (ppm)	SD	Relative SD (%)
Psilocybin	1595	3.75	2
Psilocin	85	0.86	10
Norbaeocystin	8	0.06	7
Baeocystin	31	0.15	5

Table 2 Results of observed analytes averaged over the three dosages

Interaction effects with weight, body mass index, ingested dosage, and prior experience

We tested for possible interaction effects on all dependent measures using Repeated Measures ANOVAs. All *F*s were smaller than 1, except for the interaction with the ingested dosage on the PCT, $F(1, 25) = 1.13$, $p = .299$, and the interactions with prior experience on the PCT, $F(1, 25) = 1.05$, $p = .316$, and RPM, $F(1, 36) = 3.69$, $p = .063$. Nevertheless, these results show that none of the factors significantly interacted with the independent factor time-point and were thus dropped from the final analyses described below.

Fluid intelligence

Comparing fluid intelligence on pre- and post-microdosing using a paired-sample *t* test, we found no difference between the two time-points with respect to the number of correct items on the RPM, $t(37) = 1.00$, $p = .324$, Cohen's $d = .163$.

Convergent thinking Performance on the PCT (number of correct responses) was significantly higher in the second than in the first session, $t(26) = 2.56$, $p = .017$, Cohen's $d = .493$, showing an improvement of convergent thinking.

Measure	Session 1	Session 2
PCT	6.56 (1.601)	7.59 (1.600)
RPM	8.58 (2.238)	8.97 (1.924)
Fluency	14.68 (0.99)	16.70 (1.19)
Flexibility	11.20 (0.80)	12.74 (0.93)
Elaboration	2.18 (0.32)	1.76 (0.28)
Originality	12.36 (1.30)	15.67 (1.45)

Table 3 Descriptive statistics (means (SE)) for the first and second session

Divergent thinking

The four measures of the AUT were analyzed by means of a multivariate Repeated Measures ANOVA. The effect of timepoint was significant, $F(4, 29) = 4.16$, $p = .009$, partial $\eta2 = .365$, due to better performance in the second than the first session. Additional univariate tests showed a significant increase in fluency, $F(1, 32) = 5.59$, $p = .024$, partial $\eta2 = .149$, flexibility, $F(1, 32) = 6.23$, $p = .018$, partial $\eta2 = .163$, and originality scores, $F(1, 32) = 12.03$, $p = .002$, partial $\eta2 = .273$, while the change in elaboration scores failed to reach significance, $F(1, 32) = 2.97$, $p = .226$, partial $\eta2 = .046$.

Discussion

The aim of this study was to explore the effects of microdosing psychedelics on creative problem-solving. We observed an increase in divergent idea generation on the AUT, as evidenced by a significant increase in fluency, flexibility, and originality scores, as well as an increase in convergent thinking on the PCT after intake of a microdose of magic truffles. Given that scores of fluid intelligence did not change between the two measurement time-points, while we did observe change in scores in the creativity domain, it is possible that microdosing targets creativity performance, but not more general analytic cognition. These findings are in line with earlier studies finding positive effects of high doses of psychedelics on creative performance (Harman and Fadiman 1970; Kuypers *et al*. 2016; Zegans *et al*. 1967). In particular, the increase in originality scores on the AUT parallels the increase in originality scores after intake of Ayahuasca reported by Kuypers *et al*. (2016). Taken together, our results suggest that consuming a microdose of truffles allowed participants to create more out-of-the-box alternative solutions for a problem, thus providing preliminary support for the assumption that microdosing improves divergent thinking. Moreover, we also observed an improvement of convergent thinking, that is, increased performance on a task that requires the convergence on one single correct or best solution.

Before continuing to interpret our findings, it is important to consider the implications of the fact that we did not use a control group (for obvious ethical and practical reasons). Given the absence of a control group, we cannot rule out the possibility that changes from the first to the second time-point of measurement are due to the impact of other factors than the microdosed truffles. Two of these factors come to mind. For one, it is possible that increased performance from the first to the second time-point of measurement reflects learning. We consider that possibility not very likely, for three reasons. First, it does not seem to fit with the absence of an improvement for the intelligence measure, even though the Raven task shares many aspects with the PCT and the AUT. Second, studies on convergent thinking have not shown evidence of improved performance with multiple testing - at least if different test items were used. For instance, Colzato *et al*. (2012) had participants perform the Remote Association Task, which can be considered a verbal version of the PCT, three times in different conditions and found neither condition effects nor, and this would be the learning-sensitive test, any interaction between condition and condition order. Third, a recent training study did not reveal any (positive) training effects on AUT performance (Stevenson *et al*. 2014). No effect of eight training sessions was observed for originality; a *negative* training effect was obtained for fluency, and a quadratic effect for flexibility. Both fluency and flexibility measures in fact *decreased* over the first three to four sessions, and only the flexibility measure eventually reached the original baseline in the 8th session. Taken together, we see no empirical support for the possibility that our observations might reflect a learning effect.

For another, it is possible that increased performance from the first to the second time-point reflects an effect of expectation. Expectation effects are widely studied but not well understood (Schwarz *et al*. 2016). Drug-related expectation effects commonly require previous experience with the psychological effects of the respective drug, and it is likely that expectations operate by having been associated with and thus conditioned to stimuli and expectations preceding the actual effect (Schwarz *et al*. 2016). If so, the existence of expectation-based effects does not contradict the existence of real drug effects, as the former in fact rely on the previous experience of the latter. From that perspective, expectation-based effects and drug-induced effects are likely to have comparable impact on psychological functions, presumably even through the same physiological means. Accordingly, while we cannot definitely exclude that the effects we observed actually required the present intake of the drug, they even in the worst case are likely to rely on the previous intake and likely to reflect the effects of that previous intake.

Notwithstanding these caveats, the outcome pattern of the present study is consistent with the idea that microdosing psychedelic substances improves both divergent and convergent thinking. The fact that intelligence was not improved suggests that this effect was rather selective, but the possibility remains that the Raven was less sensitive to the intervention than the other measures were. It is tempting to interpret our observations on divergent thinking in the context of recent suggestions that behavior drawing on flexibility and novelty benefits from a reduction of cognitive top-down control (Cools and D'Esposito 2009, 2011; De Dreu *et al*. 2008; Dreisbach and Goschke 2004; Hommel 2015; Baas *et al*. 2008). According to this view, creativity tasks can be assumed to draw on two distinct, presumably opposing cognitive processes: flexibility is characterized by broadening the attentional scope, which enables individuals to generate many divergent ideas, while persistence is associated with a narrower attentional scope, thus allowing individuals to focus on one creative idea at a time (De Dreu *et al*. 2008; Hommel 2015). Some of the previous empirical dissociations of persistence and flexibility were related to dopaminergic functioning, such as in behavioral genetic studies demonstrating that polymorphisms supporting efficient dopaminergic functioning in the frontal cortex promote persistence while polymorphisms supporting striatal dopaminergic functioning promote flexibility (e.g., Reuter *et al*. 2006; Zabelina *et al*. 2016; for an overview, see Hommel and Colzato 2017). This strengthens the view that frontal and striatal dopaminergic pathways are involved in persistence and flexibility. If we assume that convergent thinking relies more on frontal persistence while divergent thinking relies more on striatal flexibility, our outcomes raise the question how an intervention can manage to improve both convergent and divergent thinking.

Classical hallucinogens, including psilocybin, belong to a group of tryptamines that are thought to exert their primary psychedelic effects through activity at the serotonergic 5- HT2A receptor (Vollenweider and Kometer 2010). Of particular interest in this regard are findings from animal studies showing that 5-HT$_{2A}$ agonist activity (Halberstadt 2015) correlates with an increase in associative learning (Harvey 2003) and improvements in the ability to adapt behavior more flexibly (Bari *et al*. 2010; Boulougouris *et al*. 2008). Moreover, studies in humans have shown that the administration of psychedelics is associated with an increase in the personality trait "Openness" (MacLean *et al*. 2011) and that psychedelics can induce a reduction in symptoms associated with rigid behavior and thought patterns observed in obsessive-compulsive disorder (Moreno *et al*. 2006) and depression (Carhart-Harris *et al*. 2016a, b; Grob *et al*. 2011). Such findings could be tentatively interpreted to imply that psilocybin facilitates more flexible, less constrained kinds of cognition (Carhart-Harris *et al*. 2016a, b).

The 5-HT$_{2A}$ receptors are widely distributed in in the brain and especially so in high-level prefrontal and associative cortex - regions important for learning and memory retrieval, this is likely to have important functional implications (Carhart-Harris and Nutt 2017; Zhang and Stackman 2015). For instance, postsynaptic 5-HT$_{2A}$ receptor activation was shown to be associated with improvements in certain aspects of cognition (Gimpl *et al*. 1979; Harvey 1995, 2003; Harvey *et al*. 2004, 2012; Romano *et al*. 2010; Zhang and Stackman 2015; Zhang *et al*. 2016) as well as an extinction of previously learned response patterns (Zhang *et al*. 2013). However, it is important to note that function of the 5-HT system remains "elusive" given the inherent complexity of the serotonin system and more research has to be conducted in this regard to determine its function (Dayan and Huys 2009; Carhart-Harris and Nutt 2017).

While the assumption of a link between the use of psychedelics and an unconstrained brain state fits well with our findings on divergent thinking, it does not seem to be consistent with our observations on convergent thinking. Microdosing improved performance on the PCT, suggesting that it promotes convergent thinking. Note that this observation contrasts with previous findings by Kuypers *et al*. (2016), who reported that Ayahuasca, also a 5-HT$_{2A}$ agonist, impaired performance on convergent thinking tasks. We believe this discrepancy could be a result of the difference in relative dosage. Kuypers *et al*. (2016) investigated participants after the intake of large doses of Ayahuasca, which is hardly comparable to the microdoses used in the present study. Previous research has shown a relationship between 5-HT$_{2A}$ receptor activity and goal-directed behavior likely due to indirect modulation of DA release (Vollenweider *et al*. 1999; Sakashita *et al*. 2015; Dalley *et al*. 2002; Boureau and Dayan 2011). Dopamine-related adaptive behavior follows an inverted U shape (van Velzen *et al*. 2014), suggesting that smaller doses, such as the microdoses ingested by the participants in our current study, are more likely to move participants towards the most efficient mid-zone of the performance function than higher doses do (see Akbari Chermahini and Hommel 2012, for an application of this rationale on the impact of dopaminergic manipulations on creativity). Indeed, based on self-reports, an online study by Fadiman and Krob (2017) suggests that microdosing could enhance motivation and focus, and reduce distractibility and procrastination - which seems consistent with our observation of improved convergent thinking.

These considerations suggest that microdoses truffle, and perhaps 5-HT$_{2A}$ agonist in general improve processes that are shared by convergent and divergent thinking - irrespective of the existing differences. Indeed, both convergent and divergent thinking tasks rely to some degree on persistence and top-down control and to some degree on unconstrained flexibility (Hommel 2015). While convergent thinking tasks emphasize persistence over flexibility, and divergent-thinking tasks emphasize flexibility over persistence, they both require participants to keep in mind particular search criteria, which they need to test against candidate items in memory (a skill that relies on persistence and top-down control), and to search through novel and often unfamiliar items considered for this test (a skill that relies on flexibility). The tasks thus present participants with a dilemma, which can only be solved by finding a reasonable balance between the antagonistic skills; that is, to be persistent and flexible at the same time, or at least in quick succession. Microdosing therefore might promote the speed or smoothness of switching between persistence and flexibility - an ability that Mekern *et al*. (2019a, b) refer to as "adaptivity." Taken together, whereas large doses of psychedelics might induce an hyper-flexible mode of brain functioning, and possibly a breakdown of control (Carhart-Harris *et al*. 2014), microdoses may be able to drive brain functioning towards an optimal, highly adaptive balance between persistence and flexibility.

Limitations

It is important to consider the limitations of our study. The experiment was carried out "in the field," which offers the benefits of studying more natural effects of microdosing, but also has the disadvantage of allowing less experimental control than in a laboratory setting. We used a quasi-experimental design, which limits some of the conclusions that can be drawn from our study. Neither the participants nor the researchers were blind to the manipulation and, as all participants consumed a microdose of psychedelic truffles, we were unable to collect data from a control group - which in this particular context would have been hard to conceive anyway. Relatedly, the absence of a placebo condition prevented any kind of randomization of the administered substance. Participants were not randomly selected due to the nature of the event, resulting in a self-selection bias, and limiting the generalizability of our findings. While we have argued that previous findings render the possibility of learning effects unlikely, it is also true that we were unable to quantify possible learning effects in the present study. Moreover, the absence of a control group did not allow us to identify and quantify possible placebo/expectation effects. Even though we have argued that this need not undermine our conclusions, future studies should definitely consider expectation/placebo effects, not only as a possible confound but also as a useful replacement of the actual drug. Another possible objection might be that mood might have contributed to our findings. Indeed, it is well known that divergent thinking benefits from positive mood (Ashby *et al*. 1999; Baas *et al*. 2008; Davis 2009), providing a possible confound regarding the effects we observed on our divergent thinking task. However, given that we also found positive effects for convergent thinking, which has not shown to benefit from positive mood, would not fit with a mood-related interpretation. Moreover, the well-established association between serotonin levels and depression (Neumeister 2003; Baldwin and Rudge 1995) suggests that mood should be considered the phenomenological expression of a particular serotonin level (arguably in combination with other factors) rather than an independent factor that can moderate the impact of changes in serotonin levels on cognitive performance. In retrospect, we also acknowledge that perceived strength of drug effect would have been a valuable measure to assess as it could have played some role in our outcome measures.

Furthermore, it has been shown that in contrast, however, positive mood negatively predicts convergent thinking performance, which in our study improved after ingestion of the psychedelic truffles. Future studies should seek to validate our findings using a lab-based randomized double-blind placebo-controlled experimental designs and take the subjective strength of the experience into account as a covariate.

Conclusion

Whereas large doses of psychedelics can introduce a range of undesirable side effects, microdoses of psychedelic substances might prove to be a promising alternative that could eliminate the risks of challenging experiences (sometimes referred to as a "bad trips") while maintaining the potential benefits of psychedelic substances on human emotion and cognition. The current naturalistic study is the first to quantitatively show that microdosing psychedelics could improve creative performance, possibly by means of inducing a state of unconstrained thought allowing for increased novel idea generation. We hope that our findings will stimulate further research into the beneficial effects of microdosing psychedelics. Apart from its benefits as a potential cognitive enhancement technique, microdosing could be further investigated for its therapeutic efficacy as to slow down cognitive decline or help individuals who suffer from rigid thought patterns or behavior such as individuals with depression or obsessive-compulsive disorder.

Acknowledgements We would like to thank the Psychedelic Society of The Netherlands for providing us with the opportunity to do the experiment at one of their events and Eliska Prochazkova for helping carrying out the experiment.
This research was partly funded by an Advanced Grant of the European Research Council (ERC-2015-AdG-694722) to BH, and by the MICR (grant no. VI20172020056) to MK.

Author contributions The study was set up together by all authors, who also contributed to data interpretation and writing the manuscript and approved the final version of the manuscript. LP and DPL had the original idea, carried out the experiment, analyzed the data, and wrote a first draft of the article.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Akbari Chermahini S, Hommel B (2010) The (b)link between creativity and dopamine: spontaneous eye blink rates predict and dissociate divergent and convergent thinking. Cognition 115:458-465. https:// doi.org/10.1016/j.cognition.2010.03.007
2. Akbari Chermahini S, Hickendorff M, Hommel B (2012) Development and validity of a Dutch version of the remote associates task: an item-response theory approach. Think Skills Creat 7:177-186. https://doi.org/10.1016/j.tsc.2012.02.003
3. Amabile TM (1996) Creativity in context: update to the social psychology of creativity. Westview Press, Boulder
4. Ashby FG, Isen AM, Turken AU (1999) A neuropsychological theory of positive affect and its influence on cognition. Psychol Rev 106:529-550. https://doi.org/10.1037/0033-295X.106.3.529
5. Baas M, De Dreu CKW, Nijstad BA (2008) A meta-analysis of 25 years of mood-creativity research: hedonic tone, activation, or regulatory focus? Psychol Bull 134:779-806. https://doi.org/10.1037/a0012815
6. Baas M, Nevicka B, Ten Velden FS (2014) Specific mindfulness skills differentially predict creative performance. Personal Soc Psychol Bull 40:1092-1106. https://doi.org/10.1177/0146167214535813
7. Baldwin D, Rudge S (1995) The role of serotonin in depression and anxiety. Int Clin Psychopharmacol 9:41-45
8. Bari A, Theobald DE, Caprioli D, Mar AC, Aidoo-Micah A, Dalley JW, Robbins TW (2010) Serotonin modulates sensitivity to reward and negative feedback in a probabilistic reversal learning task in rats. Neuropsychopharmacology 35:1290-1301. https://doi.org/10.1038/npp.2009.233
9. Barrett FS, Griffiths RR (2017) Classic hallucinogens and mystical experiences: phenomenology and neural correlates. In: Geyer MA, Ellenbroek BA, Marsden CA, Barnes TRE, L. Andersen S (eds) Current topics in behavioral neurosciences. Springer, Berlin, Heidelberg, pp 1-38
10. Barrett FS, Johnson MW, Griffiths RR (2017) Psilocybin in long-term meditators: effects on default mode network functional connectivity and retrospective ratings of qualitative experience. Drug Alcohol Depend 171:e15-e16. https://doi.org/10.1016/j.drugalcdep.2016.08.058
11. Bilker WB, Hansen JA, Brensinger CM, Richard J, Gur RE, Gur RC (2012) Development of abbreviated nine-item forms of the Raven's standard progressive matrices test. Assessment 19:354-369. https://doi.org/10.1177/1073191112446655
12. Bogenschutz MP, Forcehimes AA, Pommy JA, Wilcox CE, Barbosa P, Strassman RJ (2015) Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. J Psychopharmacol 29:289-299. https://doi.org/10.1177/0269881114565144
13. Boulougouris V, Glennon JC, Robbins TW (2008, 2007) Dissociable effects of selective 5-HT$_{2A}$ and 5-HT$_{2C}$ receptor antagonists on serial spatial reversal learning in rats. Neuropsychopharmacology 33:-2019. https://doi.org/10.1038/sj.npp.1301584
14. Boureau YL, Dayan P (2011) Opponency revisited: competition and cooperation between dopa mine and serotonin. Neuropsychopharmacology 36:74-97
15. Callaway JC, Grob CS (1998) Ayahuasca preparations and serotonin reuptake inhibitors: a potential combination for severe adverse interactions. J Psychoactive Drugs 30:367-369. https://doi.org/10.1080/02791072.1998.10399712
16. Carhart-Harris RL, Nutt DJ (2017) Serotonin and brain function: a tale of two receptors. J Psychopharmacol 31:1091-1120
17. Carhart-Harris RL, Leech R, Hellyer PJ, Shanahan M, Feilding A, Tagliazucchi E, Chialvo DR, Nutt D, Axmacher N, Brooks SJ, Maclean K, Hopkins J (2014) The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. Front Hum Neurosci 8:20. https://doi.org/10.3389/fnhum.2014.00020
18. Carhart-Harris RL, Bolstridge M, Rucker J, Day CMJ, Erritzoe D, Kaelen M, Bloomfield M, Rickard JA, Forbes B, Feilding A, Taylor D, Pilling S, Curran VH, Nutt DJ (2016a) Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. Lancet Psychiatry 3:619-627. https://doi.org/10.1016/S2215-0366(16)30065-7
19. Carhart-Harris RL, Kaelen M, Bolstridge M, Williams TM, Williams LT, Underwood R, Nutt DJ (2016b) The paradoxical psychological effects of lysergic acid diethylamide (LSD). Psychol Med 46:1379-1390
20. Catlow BJ, Jalloh A, Sanchez-Ramos J (2016) Hippocampal neurogenesis: effects of psychedelic drugs. In: Neuropathology of drug addictions and substance misuse. Elsevier, pp 821-831
21. Clarke HF, Dalley JW, Crofts HS, Robbins TW, Roberts AC (2004) Cognitive inflexibility after prefrontal serotonin depletion. Science 304:878-880. https://doi.org/10.1126/science.1094987
22. Clarke HF, Walker SC, Dalley JW, Robbins TW, Roberts AC (2007) Cognitive inflexibility after prefrontal serotonin depletion is behaviorally and neurochemically specific. Cereb Cortex 17:18-27. https://doi.org/10.1093/cercor/bhj120
23. Colzato LS, Ozturk A, Hommel B (2012) Meditate to create: the impact of focused-attention and open-monitoring training on convergent and divergent thinking. Front Psychol 3:116
24. Colzato LS, de Haan AM, Hommel B (2015) Food for creativity: tyrosine promotes deep thinking. Psychol Res 79:709-714. https://doi.org/10.1007/s00426-014-0610-4
25. Cooke R (2017) How dropping acid saved my life. The Guardian. https:// www.theguardian.com/global/2017/jan/08/how-dropping-acid-saved-my-life-ayelet-waldman-books-depression. Accessed 25 Dec 2017
26. Cools R, D'Esposito M (2009) Dopaminergic modulation of flexible control in humans. In: Bjorklund A, Dunnett SB, Iversen LL, Iversen SD (eds) Dopamine handbook. Oxford University Press, Oxford
27. Cools R, D'Esposito M (2011) Inverted-U-shaped dopamine actions on human working memory and cognitive control. Biol Psychiatry 69:e113-e125
28. Dalley JW, Theobald DE, Eagle DM, Passetti F, Robbins TW (2002) Deficits in impulse control associated with tonically-elevated serotonergic function in rat prefrontal cortex. Neuropsychopharmacology 26:716-728. https://doi.org/10.1016/S0893-133X(01)00412-2
29. Davis MA (2009) Understanding the relationship between mood and creativity: a meta-analysis. Organ Behav Hum Decis Process 108:25-38. https://doi.org/10.1016/j.obhdp.2008.04.001
30. Dayan P, Huys QJ (2009) Serotonin in affective control. Annu Rev Neurosci 32:95-126
31. De Dreu CKW, Baas M, Nijstad BA (2008) Hedonic tone and activation level in the mood-creativity link: toward a dual pathway to creativity model. J Pers Soc Psychol 94:739-756. https://doi.org/10.1037/0022-3514.94.5.739

32. dos Santos RG, Osório FL, Crippa JAS, Riba J, Zuardi AW, Hallak JEC (2016) Antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide (LSD): a systematic review of clinical trials published in the last 25 years. Ther Adv Psychopharmacol, 6:193-213. https://doi.org/10.1177/2045125316638008
33. Dreisbach G, Goschke T (2004) How positive affect modulates cognitive control: reduced perseveration at the cost of increased distractibility. J. Exp Psychol Learn Mem Cogn 30:343-353. https://doi.org/10.1037/0278-7393.30.2.343
34. Erowid (2017) Psilocybin mushrooms effects. The Vaults of Erowid. https://erowid.org/plants/mushrooms/mushrooms_effects.shtml. Accessed 25 Dec 2017
35. Fadiman J (2011) The psychedelic explorer's guide: safe, therapeutic, and sacred journeys. Inner Traditions Bear and Company. Rochester, NY
36. Fadiman J, Krob S (2017) Microdosing: the phenomenon, research results, and startling surprises. Lecture presented at the Psychedelic Science 2017 conference, Oakland, CA
37. Farah MJ, Haimm C, Sankoorikal G, Chatterjee A (2009) When we enhance cognition with Adderall, do we sacrifice creativity? A preliminary study. Psychopharmacology 202:541-547
38. Gartz J, Allen JW, Merlin MD (1994) Ethnomycology, biochemistry, and cultivation of *Psilocybe samuiensis* Guzmán, Bandala and Allen, a new psychoactive fungus from Koh Samui, Thailand. J Ethnopharmacol 43:73-80
39. Gimpl MP, Gormezano I, Harvey JA (1979) Effects of LSD on learning as measured by classical conditioning of the rabbit nictitating membrane response. J Pharmacol Exp Ther 208:330-334
40. Glatter R (2015) LSD microdosing: the new job enhancer in Silicon Valley. Forbes https://www.forbes.com/sites/robertglatter/2015/11/27/lsd-microdosing-the-new-job-enhancer-in-silicon-valley-and-beyond/#109a749b188a. Accessed 25 Dec 2017
41. Gregorie C (2016) Everything you wanted to know about microdosing (but were afraid to ask). The Huffington Post. http://www. huffingtonpost.com/entry/psychedelic-microdosing-research_us_569525afe4b09dbb4bac9db8. Accessed 25 Dec 2017
42. Griffiths RR, Richards WA, McCann U, Jesse R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology 187:268-283. https://doi.org/10.1007/s00213-006-0457-5
43. Griffiths, R. R., Richards, W. A., Johnson, M. W., McCann, U. D., & Jesse, R. (2008). Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later. Journal of psychopharmacology, 22(6), 621-632
44. Griffiths RR, Johnson MW, Carducci MA, Umbricht A, Richards WA, Richards BD *et al*. (2016). Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: A randomized double-blind trial. Journal of psychopharmacology, 30(12), 1181-1197
45. Grob CS, Danforth AL, Chopra GS, Hagerty M, McKay CR, Halberstad AL, Greer GR (2011) Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. Arch Gen Psychiatry 68:71-78. https://doi.org/10.1001/archgenpsychiatry.2010.116
46. Guilford JP (1967) The nature of human intelligence. McGraw-Hill, NY
47. Hajkova K, Jurasek B, Sykora D, Palenicek T, Miksatkova P, Kuchar M (2016) Salting-out-assisted liquid-liquid extraction as a suitable approach for determination of methoxetamine in large sets of tissue samples. Anal Bioanal Chem 408:1171-1181. https://doi.org/10.1007/s00216-015-9221-1
48. Halberstadt AL (2015) Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. Behav Brain Res 277:99-120
49. Harvey JA (1995) Serotonergic regulation of associative learning. Behav Brain Res 73:47-50. https://doi.org/10.1016/0166-4328(96)00068-X
50. Harvey JA (2003) Role of the serotonin 5-HT$_{2A}$ receptor in learning. Learn Mem 10(5):355-362. https://doi.org/10.1101/lm.60803
51. Harvey JA, Quinn JL, Liu R, Aloyo VJ, Romano AG (2004) Selective remodeling of rabbit frontal cortex: relationship between 5-HT$_{2A}$ receptor density and associative learning. Psychopharmacology 172:435-442
52. Harvey ML, Swallows CL, Cooper MA (2012) A double dissociation in the effects of 5-HT$_{2A}$ and 5-HT$_{2C}$ receptors on the acquisition and expression of conditioned defeat in Syrian hamsters. Behav Neurosci 126:530-537
53. Hasler F, Grimberg U, Benz MA, Huber T, Vollenweider FX (2004a) Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study. Psychopharmacol 172:145-156
54. Hollister LE (1968) Chemical psychoses: LSD and related drugs. Charles C, Thomas
55. Hommel B (2012) Convergent and divergent operations in cognitive search. In: Todd PM, Hills TT, Robbins TW (eds) Cognitive search: evolution, algorithms, and the brain, vol 9. MIT Press, Cambridge, pp 215-230
56. Hommel B (2015) Between persistence and flexibility: the Yin and Yang of action control. In: Elliot AJ (ed) Advances in motivation science, vol 2. Elsevier, New York, pp 33-67
57. Hommel B, Colzato LS (2017) The social transmission of metacontrol policies: mechanisms underlying the interpersonal transfer of persistence and flexibility. Neurosci Biobehav Rev 81:43-58
58. Hurks PPM, Hendriksen J, Dek JE, Kooij AP (2010) De nieuwe Wechsler kleuterintelligentietest voor 2:6-7:11 jarigen. Tijdschrift voor neuropsychologie 5, 2:40-51
59. Johnson MW, Garcia-Romeu A, Cosimano MP, Griffiths RR (2014) Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. J Psychopharmacol 28:983-992. https://doi.org/10.1177/0269881114548296
60. Kehagia AA, Murray GK, Robbins TW (2010) Learning and cognitive flexibility: frontostriatal function and monoaminergic modulation. Curr Opin Neurobiol 20(2):199-204
61. Kowal MA, Hazekamp A, Colzato LS, van Steenbergen H, van der Wee NJ, Durieux J *et al*. (2015) Cannabis and creativity: highly potent cannabis impairs divergent thinking in regular cannabis users. Psychopharmacology 232:1123-1134
62. Krebs TS, Johansen PØR (2012) Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. J Psychopharmacol 26:994-1002

63. Kuypers KPC, Riba J, de la Fuente Revenga M, Barker S, Theunissen EL, Ramaekers JG (2016) Ayahuasca enhances creative divergent thinking while decreasing conventional convergent thinking. Psychopharmacology 233:3395-3403. https://doi.org/10.1007/s00213-016-4377-8
64. Leonard A (2015) How LSD microdosing became the hot new business trip. Rolling Stone. http://www.rollingstone.com/culture/features/how-lsd-microdosing-became-the-hot-new-business-trip-20151120. Accessed 25 Dec 2017
65. Lippelt DP, Hommel B, Colzato LS (2014) Focused attention, open monitoring and loving kindness meditation: effects on attention, conflict monitoring, and creativity - a review. Front Psychol 5:1083
66. MacLean KA, Johnson MW, Griffiths RR (2011) Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. J Psychopharmacol 25:1453-1461. https://doi.org/10.1177/0269881111420188
67. Mednick S (1962) The associative basis of the creative process. Psychol Rev 69:220-232. https://doi.org/10.1037/h0048850
68. Mekern V, Hommel B, Sjoerds Z (2019a) Computational models of creativity: a review of single-process and multi-process recent approaches to demystify creative cognition. Curr Opin Behav Sci 27:47-54
69. Mekern V, Sjoerds Z, Hommel B (2019b) How metacontrol biases and adaptivity impact performance in cognitive search tasks. Cognition https://doi.org/10.1016/j.cognition.2018.10.001
70. Moreno FA, Wiegand CB, Taitano EK, Delgado PL (2006) Safety, tolerability, and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. J Clin Psychiatry 67:1735-1740
71. Neumeister A (2003) Tryptophan depletion, serotonin, and depression: where do we stand? Psychopharmacol Bull 37:99-115
72. Oberhaus D (2017) 400 people microdosed LSD for a month in the name of science. Vice Magazine. https://motherboard.vice.com/en_us/article/mgy573/400-people-microdosed-lsd-for-a-month-in-the-name-of-science. Accessed 25 Dec 2017
73. Oram M (2014) Efficacy and enlightenment: LSD psychotherapy and the drug amendments of 1962. J Hist Med All Sci 69:221-250 Quitkin F, Rifkin A, Klein DF (1979) Monoamine oxidase inhibitors. A review of antidepressant effectiveness. Arch Gen Psychiatry 36:749-760
74. Raven J (1938) Raven's progressive matrices (1938): sets A, B, C, D. Australian Council for Educational Research, Melbourne
75. Reuter M, Roth S, Holve K, Hennig J (2006) Identification of the first candidate genes for creativity: a pilot study. Brain Res 1069:190-197
76. Riba J, Romero S, Grasa E, Mena E, Carrió I, Barbanoj MJ (2006) Increased frontal and paralimbic activation following ayahuasca, the pan-amazonian inebriant. Psychopharmacology 186:93-98. https://doi.org/10.1007/s00213-006-0358-7
77. Ritter SM, Mostert N (2016) Enhancement of creative thinking skills using a cognitive-based creativity training. Journal of Cognitive Enhancement 1:243-253. https://doi.org/10.1007/s41465-016-0002-3
78. Romano AG, Quinn JL, Li L, Dave KD, Schindler EA, Aloyo VJ, Harvey JA (2010) Intrahippocampal LSD accelerates learning and desensitizes the 5-HT(2A) receptor in the rabbit. Psychopharmacology 212:441-448
79. Sahakian B (2017) LSD microdosing is trending in Silicon Valley but can actually make you more creative. IFLScience. http://www.iflscience.com/health-and-medicine/lsd-microdosing-is-trendingin-silicon-valley-but-can-actually-make-you-more-creative/. Accessed 25 Dec 2017
80. Sakashita Y, Abe K, Katagiri N, Kambe T, Saitoh T, Utsunomiya I, Horiguchi Y, Taguchi K (2015) Effect of psilocin on extracellular dopamine and serotonin levels in the mesoaccumbens and mesocortical pathway in awake rats. Biol Pharm Bull 38:134-138. https://doi.org/10.1248/bpb.b14-00315
81. Schafer G, Feilding A, Morgan CJ, Agathangelou M, Freeman TP, Curran HV (2012) Investigating the interaction between schizotypy, divergent thinking and cannabis use. Conscious Cogn 21:292-298
82. Schwarz N (1999) Self-reports: how the questions shape the answers. Am Psychol 54:93-105. https://doi.org/10.1037/0003-066X.54.2.93
83. Schwarz K, Pfister R, Büchel C (2016) Rethinking explicit expectations: connecting placebos, social cognition, and contextual perception. Trends Cogn Sci 20:469-480
84. Senior J (2017) Ayelet Waldman's better living through LSD. The New York Times. https://www.nytimes.com/2017/01/11/books/review-a-really-good-day-ayelet-waldmans-better-living-through-lsd.html. Accessed 25 Dec 2017
85. Sessa B (2008) Is it time to revisit the role of psychedelic drugs in enhancing human creativity? J Psychopharmacol 22:821-827
86. Solon O (2016) Would you take LSD to give you a boost at work? WIRED takes a trip inside the world of microdosing. WIRED. http://www.wired.co.uk/article/lsd-microdosing-drugs-silicon-valley. Accessed 25 Dec 2017
87. Sternberg RJ, Lubart TI (1999) The concept of creativity: prospects and paradigms. In: Sternberg RJ (ed) Handbook of creativity. Cambridge University Press, London, pp 3-16
88. Stevenson CE, Kleibeuker SW, de Dreu CKW, Crone EA (2014) Training creative cognition: adolescence as a flexible period for improving creativity. Front Hum Neurosci 8:827
89. Tylš F, Páleníèek T, Horáèek J (2014) Psilocybin - summary of knowledge and new perspectives. Eur Neuropsychopharmacol 24:342-356
90. van Velzen LS, Vriend C, de Wit SJ, van den Heuvel OA (2014) Response inhibition and interference control in obsessive-compulsive spectrum disorders. Front Hum Neurosci 8:419. https://doi.org/10.3389/fnhum.2014.00419
91. Vollenweider FX, Kometer M (2010) The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. Nat Rev Neurosci 11:642-651. https://doi.org/10.1038/nrn2884
92. Vollenweider F, Vontobel P, Hell D, Leenders KL (1999) 5-HT modulation of dopamine release in basal ganglia in psilocybin-induced psychosis in man - a PET study with [11C]raclopride. Neuropsychopharmacology 20:424-433. https://doi.org/10.1016/S0893-133X(98)00108-0
93. Vosburg SK (1998) The effects of positive and negative mood on divergent-thinking performance. Creat Res J 11:165-172. https://doi.org/10.1207/s15326934crj1102_6

94. Wallas G (1926) The art of thought. Harcourt Brace, New York
95. Wechsler D (2003) The Wechsler intelligence scale for children, 4th edn. Pearson, London
96. Zabelina DL, Robinson MD (2010) Creativity as flexible cognitive control. Psychol Aesthet Creat Arts 4:136-143. https://doi.org/10.1037/a0017379
97. Zabelina DL, Colzato LS, Beeman M, Hommel B (2016) Dopamine and the creative mind: individual differences in creativity are predicted by interactions between dopamine genes DAT and COMT. PLoS One 11:e0146768
98. Zegans LS, Pollard JC, Brown D (1967) The effects of LSD-25 on creativity and tolerance to regression. Arch Gen Psychiatry 16:740-749. https://doi.org/10.1001/archpsyc.1967.01730240096014
99. Zhang G, Stackman RW (2015) The role of serotonin 5-HT$_{2A}$ receptors in memory and cognition. Front Pharmacol 6:225
100. Zhang G, Asgeirsdottir HN, Cohen SJ *et al*. (2013) Stimulation of serotonin 2A receptors facilitates consolidation and extinction of fear memory in C57BL/6J mice. Neuropharmacology 64:403-413
101. Zhang G, Cinalli D, Cohen SJ, Knapp KD, Rios LM, Martínez-Hernández J, Luján R, Stackman RW Jr (2016) Examination of the hippocampal contribution to serotonin 5-HT$_{2A}$ receptor-mediated facilitation of object memory in C57BL/6J mice. Neuropharmacology 109:332-340

The Psychedelic Experience

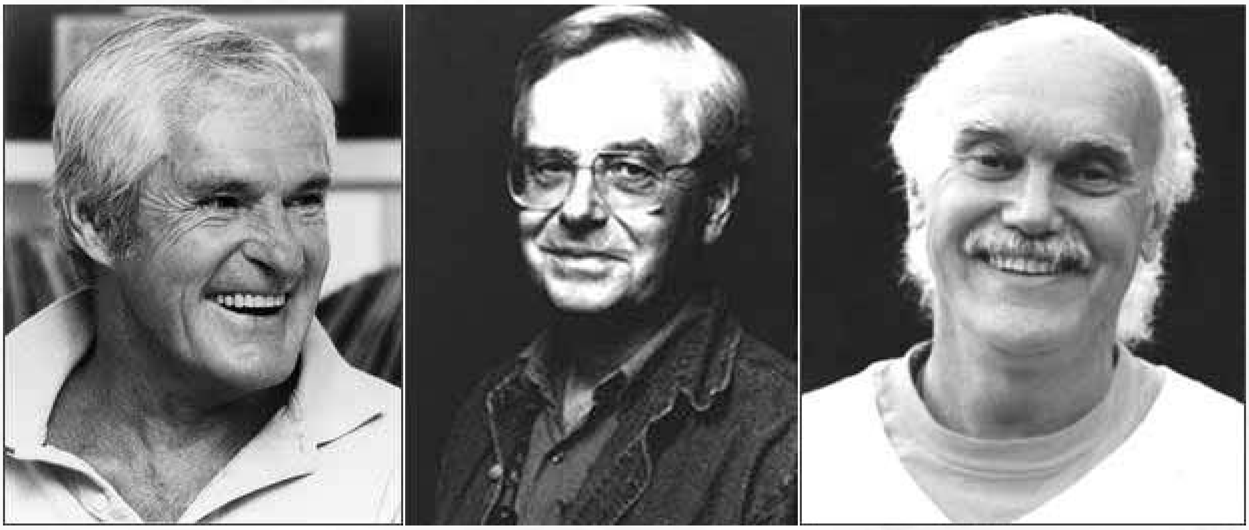
by

Timothy Leary, Ralph Metzner, Richard Alpert

A manual based on the Tibetan Book of the Dead By Timothy Leary, Ph.D., Ralph Metzner, Ph.D., & Richard Alpert, Ph.D.

original source: https://www.erowid.org/archive/hyperreal/drugs/psychedelics/leary/psychedelic.html

The authors were engaged in a program of experiments with LSD and other psychedelic drugs at Harvard University, until sensational national publicity, unfairly concentrating on student interest in the drugs, led to the suspension of the experiments. Since then, the authors have continued their work without academic auspices.



Leary, Metzner, Alpert

Table of Contents:

I. General Introduction
A Tribute to W. Y. Evans-Wentz
A Tribute to Carl G. Jung
A Tribute to Lama Anagarika Govinda
II. The Tibetan Book Of The Dead
First Bardo: The Period Of Ego-Loss Or Non-Game Ecstasy
Part I: The Primary Clear Light Seen At the Moment of Ego-Loss
Part II: The Secondary Clear Light Seen Immediately After Ego-Loss
Second Bardo: The Period Of Hallucinations
Introduction
Explanation of the Second Bardo
The Peaceful Visions
Vision 1: The Source
Vision 2: The Internal Flow of Archetypal Processes
Vision 3: The Fire-Flow of Internal Unity
Vision 4: The Wave-Vibration Structure of External Forms
Vision 5: The Vibratory Waves of External Unity
Vision 6: "The Retinal Circus"
Vision 7: "The Magic Theatre"
The Wrathful Visions
Conclusion Of Second Bardo

Third Bardo: The Period Of Re-Entry
Introduction into Third Bardo
I. General Description of the Third Bardo
II. Re-entry Visions
III. The All-Determining Influence of Thought
IV. Judgment Visions
V. Sexual Visions
VI. Methods for Preventing the Re-Entry
VII. Methods of Choosing the Post-Session Personality
General Conclusion
III. Some Technical Comments About Psychedelic Sessions
1. Use of This Manual
2. Planning a Session
3. Drugs and Dosages
4. Preparation
5. The Setting
6. The Psychedelic Guide
7. Composition of the Group
IV. Instructions For Use During A Psychedelic Session
First Bardo Instructions
Second Bardo Preliminary Instructions
Instructions For Vision 1: The Source
Instructions For Physical Symptoms
Instructions For Vision 2: The Internal Flow Of Archetypal Processes
Instructions For Vision 3: The Fire-Flow Of Internal Unity
Instructions For Vision 4: The Wave-Vibration Structure Of External Forms
Instructions For Vision 5: The Vibratory Waves Of External Unity
Instructions For Vision 6: "The Retinal Circus"
Instructions For Vision 7: "The Magic Theatre"
Instructions For The Wrathful Visions
Third Bardo: Preliminary Instructions
Instructions For Re-Entry Visions
Instructions For The All-Determining Influence Of Thought
Instructions For Judgment Visions
Instructions For Sexual Visions
Four Methods of Preventing Re-entry
First Method: Meditation on the Buddha
Second Method: Meditation on Good Games
Third Method: Meditation on Illusion
Fourth Method: Meditation on the Void
Instructions For Choosing the Post-Session Personality

This version of THE TIBETAN BOOK OF THE DEAD is dedicated,
to
ALDOUS HUXLEY

July 26, 1894 - November 22, 1963 with profound admiration and gratitude.

> "If you started in the wrong way," I said in answer to the investigator's questions, "everything that happened would be a proof of the conspiracy against you. It would all be self-validating. You couldn't draw a breath without knowing it was part of the plot."
>
> "So you think you know where madness lies?"
>
> My answer was a convinced and heartfelt, "Yes."
>
> "And you couldn't control it?"
>
> "No I couldn't control it. If one began with fear and hate as the major premise, one would have to go on the conclusion."
>
> "Would you be able," my wife asked, " to fix your attention on what The Tibetan Book of the Dead calls the Clear Light?"
>
> I was doubtful.
>
> "Would it keep the evil away, if you could hold it? Or would you not be able to hold it?"
>
> I considered the question for some time. "Perhaps," I answered at last, "perhaps I could - but only if there were somebody there to tell me about the Clear Light. One couldn't do it by oneself. That's the point, I suppose, of the Tibetan ritual - somebody sitting there all the time and telling you what's what."
>
> (DOORS OF PERCEPTION, 57-58)

I. General Introduction

A psychedelic experience is a journey to new realms of consciousness. The scope and content of the experience is limitless, but its characteristic features are the transcendence of verbal concepts, of space-time dimensions, and of the ego or identity. Such experiences of enlarged consciousness can occur in a variety of ways: sensory deprivation, yoga exercises, disciplined meditation, religious or aesthetic ecstasies, or spontaneously. Most recently they have become available to anyone through the ingestion of psychedelic drugs such as LSD, psilocybin, mescaline, DMT, etc. [This is the statement of an ideal, not an actual situation, in 1964. The psychedelic drugs are in the United States classified as "experimental" drugs. That is, they are not available on a prescription basis, but only to "qualified investigators." The Federal Food and Drug Administration has defined "qualified investigators" to mean psychiatrists working in a mental hospital setting, whose research is sponsored by either state or federal agencies.]

Of course, the drug dose does not produce the transcendent experience. It merely acts as a chemical key - it opens the mind, frees the nervous system of its ordinary patterns and structures. The nature of the experience depends almost entirely on set and setting. Set denotes the preparation of the individual, including his personality structure and his mood at the time. Setting is physical - the weather, the room's atmosphere; social - feelings of persons present towards one another; and cultural - prevailing views as to what is real. It is for this reason that manuals or guide-books are necessary. Their purpose is to enable a person to understand the new realities of the expanded consciousness, to serve as road maps for new interior territories which modern science has made accessible.

Different explorers draw different maps. Other manuals are to be written based on different models - scientific, aesthetic, therapeutic. The Tibetan model, on which this manual is based, is designed to teach the person to direct and control awareness in such a way as to reach that level of understanding variously called liberation, illumination, or enlightenment. If the manual is read several times before a session is attempted, and if a trusted person is there to remind and refresh the memory of the voyager during the experience, the consciousness will be freed from the games which comprise "personality" and from positive-negative hallucinations which often accompany states of expanded awareness. The Tibetan Book of the Dead was called in its own language the Bardo Thodol, which means "Liberation by Hearing on the After-Death Plane." The book stresses over and over that the free consciousness has only to hear and remember the teachings in order to be liberated.

The Tibetan Book of the Dead is ostensibly a book describing the experiences to be expected at the moment of death, during an intermediate phase lasting forty-nine (seven times seven) days, and during rebirth into another bodily frame. This however is merely the exoteric framework which the Tibetan Buddhists used to cloak their mystical teachings. The language and symbolism of death rituals of Bonism, the traditional pre-Buddhist Tibetan religion, were skillfully blended with Buddhist conceptions. The esoteric meaning, as it has been interpreted in this manual, is that it is death and rebirth that is described, not of the body. Lama Govinda indicates this clearly in his introduction when he writes: "It is a book for the living as well as the dying." The book's esoteric meaning is often concealed beneath many layers of symbolism. It was not intended for general reading. It was designed to be understood only by one who was to be initiated personally by a guru into the Buddhist mystical doctrines, into the pre-mortem-death- rebirth experience. These doctrines have been kept a closely guarded secret for many centuries, for fear that naive or careless application would do harm. In translating such an esoteric text, therefore, there are two steps: one, the rendering of the original text into English; and two, the practical interpretation of the text for its uses. In publishing this practical interpretation for use in the psychedelic drug session, we are in a sense breaking with the tradition of secrecy and thus contravening the teachings of the lama-gurus.

However, this step is justified on the grounds that the manual will not be understood by anyone who has not had a consciousness-expanding experience and that there are signs that the lamas themselves, after their recent diaspora, wish to make their teachings available to a wider public.

Following the Tibetan model then, we distinguish three phases of the psychedelic experience. The first period (Chikhai Bardo) is that of complete transcendence - beyond words, beyond space-time, beyond self. There are no visions, no sense of self, no thoughts. There are only pure awareness and ecstatic freedom from all game (and biological) involvements. ["Games" are behavioral sequences defined by roles, rules, rituals, goals, strategies, values, language, characteristic space-time locations and characteristic patterns of movement. Any behavior not having these nine features is non- game: this includes physiological reflexes, spontaneous play, and transcendent awareness.] The second lengthy period involves self, or external game reality (Chonyid Bardo) - in sharp exquisite clarity or in the form of hallucinations (karmic apparitions). The final period (Sidpa Bardo) involves the return to routine game reality and the self. For most persons the second (aesthetic or hallucinatory) stage is the longest. For the initiated the first stage of illumination lasts longer. For the unprepared, the heavy game players, those who anxiously cling to their egos, and for those who take the drug in a non-supportive setting, the struggle to regain reality begins early and usually lasts to the end of their session.

Words like these are static, whereas the psychedelic experience is fluid and ever-changing. Typically the subject's consciousness flicks in and out of these three levels with rapid oscillations. One purpose of this manual is to enable the person to regain the transcendence of the First Bardo and to avoid prolonged entrapments in hallucinatory or ego-dominated game patterns.

The Basic Trusts and Beliefs. You must be ready to accept the possibility that there is a limitless range of awareness for which we now have no words; that awareness can expand beyond range of your ego, your self, your familiar identity, beyond everything you have learned, beyond your notions of space and time, beyond the differences which usually separate people from each other and from the world around them.

You must remember that throughout human history, millions have made this voyage. A few (whom we call mystics, saints or buddhas) have made this experience endure and have communicated it to their fellow men.

You must remember, too, that the experience is safe (at the very worst, you will end up the same person who entered the experience), and that all of the dangers which you have feared are unnecessary productions of your mind. Whether you experience heaven or hell, remember that it is your mind which creates them. Avoid grasping the one or fleeing the other. Avoid imposing the ego game on the experience.

You must try to maintain faith and trust in the potentiality of your own brain and the billion-year-old life process. With you ego left behind you, the brain can't go wrong.

Try to keep the memory of a trusted friend or a respected person whose name can serve as a guide and protection.

Trust your divinity, trust your brain, trust your companions.

Whenever in doubt, turn off your mind, relax, float downstream.

After reading this guide, the prepared person should be able, at the very beginning of his experience, to move directly to a state of non-game ecstasy and deep revelation. But if you are not well prepared, or if there is game distraction around you, you will find yourself dropping back. If this happens, then the instructions in Part IV should help you regain and maintain liberation.

"Liberation in this context does not necessarily imply (especially in the case of the average person) the Liberation of Nirvana, but chiefly a liberation of the 'life-flux' from the ego, in such a manner as will afford the greatest possible consciousness and consequent happy rebirth. Yet for the very experienced and very highly efficient person, the [same] esoteric process of Transference [Readers interested in a more detailed discussion of the process of "Transference" are referred to Tibetan Yoga and Secret Doctrines, edited by W. Y. Evans-Wentz, Oxford University Press, 1958.] can be, according to the lama-gurus, so employed as to prevent any break in the flow of the stream of consciousness, from the moment of the ego-loss to the moment of a conscious rebirth (eight hours later). Judging from the translation made by the late Lama Kazi Dawa-Samdup, of an old Tibetan manuscript containing practical directions for ego-loss states, the ability to maintain a non-game ecstasy throughout the entire experience is possessed only by persons trained in mental concentration, or one-pointedness of mind, to such a high degree of proficiency as to be able to control all the mental functions and to shut out the distractions of the outside world." (Evans-Wentz, p. 86, note 2)

This manual is divided into four parts. The first part is introductory. The second is a step-by-step description of a psychedelic experience based directly on the Tibetan Book of the Dead. The third part contains practical suggestions on how to prepare for and conduct a psychedelic session. The fourth part contains instructive passages adapted from the Bardo Thodol, which may be read to the voyager during this session, to facilitate the movement of consciousness.

In the remainder of this introductory section, we review three commentaries on the Tibetan Book of the Dead, published with the Evans- Wentz edition. These are the introduction by Evans-Wentz himself, the distinguished translator-editor of four treatises on Tibetan mysticism; the commentary by Carl Jung, the Swiss psychoanalyst; and by Lama Govinda, and initiate of one of the principle Buddhist orders of Tibet.

A Tribute to W. Y. Evans-Wentz

"Dr. Evans-Wentz, who literally sat at the feet of a Tibetan lama for years, in order to acquire his wisdom ... not only displays a deeply sympathetic interest in those esoteric doctrines so characteristic of the genius of the East, but likewise possesses the rare faculty of making them more or less intelligible to the layman." [Quoted from a book review in Anthropology on the back of the Oxford University Press edition of The Tibetan Book of the Dead.]

W. Y. Evans-Wentz is a great scholar who devoted his mature years to the role of bridge and shuttle between Tibet and the west: like an RNA molecule activating the latter with the coded message of the former. No greater tribute could be paid to the work of this academic liberator than to base our psychedelic manual upon his insights and to quote directly his comments on "the message of this book."

The message is, that the Art of Dying is quite as important as the Art of Living (or of Coming into Birth), of which it is the complement and summation; that the future of being is dependent, perhaps entirely, upon a rightly controlled death, as the second part of this volume, setting forth the Art of Reincarnating, emphasizes.

The Art of Dying, as indicated by the death-rite associated with initiation into the Mysteries of Antiquity, and referred to by Apuleius, the Platonic philosopher, himself an initiate, and by many other illustrious initiates, and as The Egyptian Book of the Dead suggests, appears to have been far better known to the ancient peoples inhabiting the Mediterranean countries than it is now by their descendants in Europe and the Americas.

To those who had passed through the secret experiencing of pre-mortem death, right dying is initiation, conferring, as does the initiatory death-rite, the power to control consciously the process of death and regeneration. (Evans-Wentz, p. xiii-xiv)

The Oxford scholar, like his great predecessor of the eleventh century, Marpa ("The Translator"), who rendered Indian Buddhist texts into Tibetan, thereby preserving them from extinction, saw the vital importance of these doctrines and made them accessible to many. The "secret" is no longer hidden: "the art of dying is quite as important as the art of living."

A Tribute to Carl G. Jung

Psychology is the systematic attempt to describe and explain man's behavior, both conscious and non-conscious. The scope of study is broad - covering the infinite variety of human activity and experience; and it is long - tracing back through the history of the individual, through the history of his ancestors, back through the evolutionary vicissitudes and triumphs which have determined the current status of the species. Most difficult of all, the scope of psychology is complex, dealing as it does with processes which are ever-changing.

Little wonder that psychologists, in the face of such complexity, escape into specialization and parochial narrowness.

A psychology is based on the available data and the psychologists' ability and willingness to utilize them. The behaviorism and experimentalism of twentieth-century western psychology is so narrow as to be mostly trivial. Consciousness is eliminated from the field of inquiry. Social application and social meaning are largely neglected. A curious ritualism is enacted by a priesthood rapidly growing in power and numbers.

Eastern psychology, by contrast, offers us a long history of detailed observation and systematization of the range of human consciousness along with an enormous literature of practical methods for controlling and changing consciousness. Western intellectuals tend to dismiss Oriental psychology. The theories of consciousness are seen as occult and mystical. The methods of investigating consciousness change, such as meditation, yoga, monastic retreat, and sensory deprivation, and are seen as alien to scientific investigation. And most damning of all in the eyes of the European scholar, is the alleged disregard of eastern psychologies for the practical, behavioral and social aspects of life. Such criticism betrays limited concepts and the inability to deal with the available historical data on a meaningful level. The psychologies of the east have always found practical application in the running of the state, in the running of daily life and family. A wealth of guides and handbooks exists: the Book of Tao, the Analects of Confucius, the Gita, the I Ching, The Tibetan Book of the Dead, to mention only the best-known.

Eastern psychology can be judged in terms of the use of available evidence. The scholars and observers of China, Tibet, and India went as far as their data allowed them. They lacked the findings of modern science and so their metaphors seem vague and poetic. Yet this does not negate their value. Indeed, eastern philosophic theories dating back four thousand years adapt readily to the most recent discoveries of nuclear physics, biochemistry, genetics, and astronomy.

A major task of any present day psychology - eastern or western - is to construct a frame of reference large enough to incorporate the recent findings of the energy sciences into a revised picture of man.

Judged against the criterion of the use of available fact, the greatest psychologists of our century are William James and Carl Jung. [To properly compare Jung with Sigmund Freud we must look at the available data which each man appropriated for his explorations. For Freud it was Darwin, classical thermodynamics, the Old Testament, Renaissance cultural history, and most important, the close overheated atmosphere of the Jewish family. The broader scope of Jung's reference materials assures that his theories will find a greater congeniality with recent developments in the energy sciences and the evolutionary sciences.] Both of these men avoided the narrow paths of behaviorism and experimentalism. Both fought to preserve experience and consciousness as an area of scientific research. Both kept open to the advance of scientific theory and both refused to shut off eastern scholarship from consideration.

Jung used for his source of data that most fertile source - the internal. He recognized the rich meaning of the eastern message; he reacted to that great Rorshach inkblot, the Tao Te Ching. He wrote perceptive brilliant forewords to the I Ching, to the Secret of the Golden Flower, and struggled with the meaning of The Tibetan Book of the Dead. "For years, ever since it was first published, the Bardo Thodol has been my constant companion, and to it I owe not only many stimulating ideas and discoveries, but also many fundamental insights... Its philosophy contains the quintessence of Buddhist psychological criticism; and, as such, one can truly say that it is of an unexampled superiority."

The Bardo Thodol is in the highest degree psychological in its outlook; but, with us, philosophy and theology are still in the mediaeval, pre-psychological stage where only the assertions are listened to, explained, defended, criticized and disputed, while the authority that makes them has, by general consent, been deposed as outside the scope of discussion.

Metaphysical assertions, however, are statements of the psyche, and are therefore psychological. To the Western mind, which compensates its well- known feelings of resentment by a slavish regard for "rational" explanations, this obvious truth seems all too obvious, or else it is seen as an inadmissible negation of metaphysical "truth." Whenever the Westerner hears the word "psychological," it always sounds to him like "only psychological."

Jung draws upon Oriental conceptions of consciousness to broaden the concept of "projection":

Not only the "wrathful" but also the "peaceful" deities are conceived as sangsaric projections of the human psyche, an idea that seems all too obvious to the enlightened European, because it reminds him of his own banal simplifications. But though the European can easily explain away these deities as projections, he would be quite incapable of positing them at the same time as real. The Bardo Thodol can do that, because, in certain of its most essential metaphysical premises, it has the enlightened as well as the unenlightened European at a disadvantage. The ever-present, unspoken assumption of the Bardo Thodol is the anti-nominal character of all metaphysical assertions, and also the idea of the qualitative difference of the various levels of consciousness and of the metaphysical realities conditioned by them. The background of this unusual book is not the niggardly European "either-or," but a magnificently affirmative "both-and." This statement may appear objectionable to the Western philosopher, for the West loves clarity and unambiguity; consequently, one philosopher clings to the position, "God is," while another clings equally fervently to the negation, "God is not."

Jung clearly sees the power and breadth of the Tibetan model but occasionally he fails to grasp its meaning and application. Jung, too, was limited (as we all are) to the social models of his tribe. He was a psychoanalyst, the father of a school. Psychotherapy and psychiatric diagnosis were the two applications which came most naturally to him.

Jung misses the central concept of the Tibetan book. This is not (as Lama Govinda reminds us) a book of the dead. It is a book of the dying; which is to say a book of the living; it is a book of life and how to live. The concept of actual physical death was an exoteric facade adopted to fit the prejudices of the Bonist tradition in Tibet. Far from being an embalmers' guide, the manual is a detailed account of how to lose the ego; how to break out of personality into new realms of consciousness; and how to avoid the involuntary limiting processes of the ego; how to make the consciousness-expansion experience endure in subsequent daily life.

Jung struggles with this point. He comes close but never quite clinches it. He had nothing in his conceptual framework which could make practical sense out of the ego-loss experience.

The Tibetan Book of the Dead, or the Bardo Thodol, is a book of instructions for the dead and dying. Like The Egyptian Book of the Dead it is meant to be a guide for the dead man during the period of his Bardo existence... .

In this quote Jung settles for the exoteric and misses the esoteric. In a later quote he seems to come closer:

... the instruction given in the Bardo Thodol serves to recall to the dead man the experience of his initiation and the teachings of his guru, for the instruction is, at bottom, nothing less than an initiation of the dead into the Bardo life, just as the initiation of the living was a preparation for the Beyond. Such was the case, at least, with all the mystery cults in ancient civilizations from the time of the Egyptian and Eleusinian mysteries. In the initiation of the living, however, this "Beyond" is not a world beyond death, but a reversal of the mind's intentions and outlook, a psychological "Beyond" or, in Christian terms, a "redemption" from the trammels of the world and of sin. Redemption is a separation and deliverance from an earlier condition of darkness and unconsciousness, and leads to a condition of illumination and releasedness, to victory and transcendence over everything "given."

Thus far the Bardo Thodol is, as Dr. Evans-Wentz also feels, an initiation process whose purpose it is to restore to the soul the divinity it lost at birth.

In still another passage Jung continues the struggle but misses again:

Nor is the psychological use we make of it (the Tibetan Book) anything but a secondary intention, though one that is possibly sanctioned by lamaist custom. The real purpose of this singular book is the attempt, which must seem very strange to the educated European of the twentieth century, to enlighten the dead on their journey through the regions of the Bardo. The Catholic Church is the only place in the world of the white man where any provision is made for the souls of the departed.

In the summary of Lama Govinda's comments which follow we shall see that the Tibetan commentator, freed from the European concepts of Jung, moves directly to the esoteric and practical meaning of the Tibetan book.

In his autobiography (written in 1960) Jung commits himself wholly to the inner vision and to the wisdom and superior reality of internal perceptions. In 1938 (when his Tibetan commentary was written) he was moving in this direction but cautiously and with the ambivalent reservations of the psychiatrist cum mystic.

The dead man must desperately resist the dictates of reason, as we understand it, and give up the supremacy of egohood, regarded by reason as sacrosanct. What this means in practice is complete capitulation to the objective powers of the psyche, with all that this entails; a kind of symbological death, corresponding to the Judgement of the Dead in the Sidpa Bardo. It means the end of all conscious, rational, morally responsible conduct of life, and a voluntary surrender to what the Bardo Thodol calls "karmic illusion." Karmic illusion springs from belief in a visionary world of an extremely irrational nature, which neither accords with nor derives from our rational judgments but is the exclusive product of uninhibited imagination. It is sheer dream or "fantasy," and every well-meaning person will instantly caution us against it; nor indeed can one see at first sight what is the difference between fantasies of this kind and the phantasmagoria of a lunatic. Very often only a slight abaissement du niveau mental is needed to unleash this world of illusion. The terror and darkness of this moment has its equivalent in the experiences described in the opening sections of the Sidpa Bardo. But the contents of this Bardo also reveal the archetypes, the karmic images which appear first in their terrifying form. The Chonyid state is equivalent to a deliberately induced psychosis... .

The transition, then, from the Sidpa state to the Chonyid state is a dangerous reversal of the aims and intentions of the conscious mind. It is a sacrifice of the ego's stability and a surrender to the extreme uncertainty of what must seem like a chaotic riot of phantasmal forms. When Freud coined the phrase that the ego was "the true seat of anxiety," he was giving voice to a very true and profound intuition. Fear of self-sacrifice lurks deep in every ego, and this fear is often only the precariously controlled demand of the unconscious forces to burst out in full strength. No one who strives for selfhood (individuation) is spared this dangerous passage, for that which is feared also belongs to the wholeness of the self - the sub-human, or supra-human, world of psychic "dominants" from which the ego originally emancipated itself with enormous effort, and then only partially, for the sake of a more or less illusory freedom. This liberation is certainly a very necessary and very heroic undertaking, but it represents nothing final: it is merely the creation of a subject, who, in order to find fulfillment, has still to be confronted by an object. This, at first sight, would appear to be the world, which is swelled out with projections for that very purpose. Here we seek and find our difficulties, here we seek and find our enemy, here we seek and find what is dear and precious to us; and it is comforting to know that all evil and all good is to be found out there, in the visible object, where it can be conquered, punished, destroyed or enjoyed. But nature herself does not allow this paradisal state of innocence to continue for ever. There are, and always have been, those who cannot help but see that the world and its experiences are in the nature of a symbol, and that it really reflects something that lies hidden in the subject himself, in his own transubjective reality. It is from this profound intuition, according to lamaist doctrine, that the Chonyid state derives its true meaning, which is why the Chonyid Bardo is entitled "The Bardo of the Experiencing of Reality."

The reality experienced in the Chonyid state is, as the last section of the corresponding Bardo teaches, the reality of thought. The "thought-forms" appear as realities, fantasy takes on real form, and the terrifying dream evoked by karma and played out by the unconscious "dominants" begins.

Jung would not have been surprised by professional and institutional antagonism to psychedelics. He closes his Tibetan commentary with a poignant political aside:

The Bardo Thodol began by being a "closed" book, and so it has remained, no matter what kind of commentaries may be written upon it. For it is a book that will only open itself to spiritual understanding and this is a capacity which no man is born with, but which he can only acquire through special training and special experience. It is good that such to all intents and purposes "useless" books exist. They are meant for those "queer folk" who no longer set much store by the uses, aims, and meaning of present-day "civilization."

To provide "special training" for the "special experience" provided by psychedelic materials is the purpose of this version of The Tibetan Book of the Dead.

A Tribute to Lama Anagarika Govinda

In the preceding section the point was made that eastern philosophy and psychology - poetic, indeterministic, experiential, inward-looking, vaguely evolutionary, open-ended - is more easily adapted to the findings of modern science than the syllogistic, certain, experimental, externalizing logic of western psychology. The latter imitates the irrelevant rituals of the energy sciences but ignores the data of physics and genetics, the meanings and implications.

Even Carl Jung, the most penetrating of the western psychologists, failed to understand the basic philosophy of the Bardo Thodol.

Quite in contrast are the comments on the Tibetan manual by Lama Anagarika Govinda.

His opening statement at first glance would cause a Judaeo-Christian psychologist to snort in impatience. But a close look at these phrases reveals that they are the poetic statement of the genetic situation as currently described by biochemists and DNA researchers.

It may be argued that nobody can talk about death with authority who has not died; and since nobody, apparently, has ever returned from death, how can anybody know what death is, or what happens after it?

The Tibetan will answer: "There is not one person, indeed, not one living being, that has not returned from death. In fact, we all have died many deaths, before we came into this incarnation. And what we call birth is merely the reverse side of death, like one of the two sides of a coin, or like a door which we call 'entrance' from outside and 'exit' from inside a room."

The lama then goes on to make a second poetic comment about the potentialities of the nervous system, the complexity of the human cortical computer.

It is much more astonishing that not everybody remembers his or her previous death; and, because of this lack of remembering, most persons do not believe there was a previous death. But, likewise, they do not remember their recent birth - and yet they do not doubt that they were recently born. They forget that active memory is only a small part of our normal consciousness, and that our subconscious memory registers and preserves every past impression and experience which our waking mind fails to recall.

The lama then proceeds to slice directly to the esoteric meaning of the Bardo Thodol - that core meaning which Jung and indeed most European Orientalists have failed to grasp.

For this reason, the Bardo Thodol, the Tibetan book vouchsafing liberation from the intermediate state between life and re-birth, - which state men call death, - has been couched in symbolical language. It is a book which is sealed with the seven seals of silence, - not because its knowledge would be misunderstood, and, therefore, would tend to mislead and harm those who are unfitted to receive it. But the time has come to break the seals of silence; for the human race has come to the juncture where it must decide whether to be content with the subjugation of the material world, or to strive after the conquest of the spiritual world, by subjugating selfish desires and transcending self-imposed limitations.

The lama next describes the effects of consciousness-expansion techniques. He is talking here about the method he knows-the Yogic-but his words are equally applicable to psychedelic experience.

There are those who, in virtue of concentration and other yogic practices, are able to bring the subconscious into the realm of discriminative consciousness and, thereby, to draw upon the unrestricted treasury of subconscious memory, wherein are stored the records not only of our past lives but the records of the past of our race, the past of humanity, and of all pre-human forms of life, if not of the very consciousness that makes life possible in this universe.

If, through some trick of nature, the gates of an individual's subconsciousness were suddenly to spring open, the unprepared mind would be overwhelmed and crushed. Therefore, the gates of the subconscious are guarded, by all initiates, and hidden behind the veil of mysteries and symbols.

In a later section of his foreword the lama presents a more detailed elaboration of the inner meaning of the Thodol.

If the Bardo Thodol were to be regarded as being based merely upon folklore, or as consisting of religious speculation about death and a hypothetical after-death state, it would be of interest only to anthropologists and students of religion. But the Bardo Thodol is far more. It is a key to the innermost recesses of the human mind, and a guide for initiates, and for those who are seeking the spiritual path of liberation.

Although the Bardo Thodol is at present time widely used in Tibet as a breviary, and read or recited on the occasion of death, - for which reason it has been aptly called "The Tibetan Book of the Dead" - one should not forget that it was originally conceived to serve as a guide not only for the dying and the dead, but for the living as well. And herein lies the justification for having made The Tibetan Book of the Dead accessible to a wider public.

Notwithstanding the popular customs and beliefs which, under the influence of age-old traditions of pre-uddhist origin, have grown around the profound revelations of the Bardo Thodol, it has value only for those who practice and realize its teaching during their life-time.

There are two things which have caused misunderstanding. One is that the teachings seem to be addressed to the dead or the dying; the other that the title contains the expression "Liberation through Hearing" (in Tibetan, Thos-grol). As a result, there has arisen the belief that it is sufficient to read or recite the Bardo Thodol in the presence of a dying person, or even of a person who has just died, in order to effect his or her liberation.

Such misunderstanding could only have arisen among those who do not know that it is one of the oldest and most universal practices for the initiate to go through the experience of death before he can be spiritually reborn. Symbolically he must die to his past, and to his old ego, before he can take his place in the new spiritual life into which he has been initiated.

The dead or the dying person is addressed in the Bardo Thodol mainly for three reasons: (1) the earnest practitioner of these teachings should regard every moment of his or her life as if it were the last; (2) when a follower of these teachings is actually dying, he or she should be reminded of the experiences at the time of initiation, or of the words (or mantra) of the guru, especially if the dying one's mind lacks alertness during the critical moments; and (3) one who is still incarnate should try to surround the person dying, or just dead, with loving and helpful thoughts during the first stages of the new, or afterdeath, state of existence, without allowing emotional attachment to interfere or to give rise to a state of morbid mental depression. Accordingly, one function of the Bardo Thodol appears to be more to help those who have been left behind to adopt the right attitude towards the dead and towards the fact of death than to assist the dead, who, according to Buddhist belief, will not deviate from their own karmic path... .

This proves that we have to do here with life itself and not merely with a mass for the dead, to which the Bardo Thodol was reduced in later times... .

Under the guise of a science of death, the Bardo Thodol reveals the secret of life; and therein lies its spiritual value and its universal appeal.

Here then is the key to a mystery which has been passed down for over 2,500 years - the consciousness-expansion experience - the pre-mortem death and rebirth rite. The Vedic sages knew the secret; the Eleusinian initiates knew it; the Tantrics knew it. In all their esoteric writings they whisper the message: it is possible to cut beyond ego-consciousness, to tune in on neurological processes which flash by at the speed of light, and to become aware of the enormous treasury of ancient racial knowledge welded into the nucleus of every cell in your body.

Modern psychedelic chemicals provide a key to this forgotten realm of awareness. But just as this manual without the psychedelic awareness is nothing but an exercise in academic Tibetology, so, too, the potent chemical key is of little value without the guidance and the teachings.

Westerners do not accept the existence of conscious processes for which they have no operational term. The attitude which is prevalent is: - if you can't label it, and if it is beyond current notions of space-time and personality, then it is not open for investigation. Thus we see the ego-loss experience confused with schizophrenia. Thus we see present-day psychiatrists solemnly pronouncing the psychedelic keys as psychosis-producing and dangerous.

The new visionary chemicals and the pre-mortem-death-rebirth experience may be pushed once again into the shadows of history. Looking back, we remember that every middle-eastern and European administrator (with the exception of certain periods in Greece and Persia) has, during the last three thousand years, rushed to pass laws against any emerging transcendental process, the pre-mortem-death-rebirth session, its adepts, and any new method of consciousness-expansion.

The present moment in human history (as Lama Govinda points out) is critical. Now, for the first time, we possess the means of providing the enlightenment to any prepared volunteer. (The enlightenment always comes, we remember, in the form of a new energy process, a physical, neurological event.) For these reasons we have prepared this psychedelic version of The Tibetan Book of the Dead. The secret is released once again, in a new dialect, and we sit back quietly to observe whether man is ready to move ahead and to make use of the new tools provided by modern science.

II. The Tibetan Book Of The Dead

First Bardo: The Period Of Ego-Loss Or Non-Game Ecstasy (Chikhai Bardo)

Part I: The Primary Clear Light Seen At the Moment of Ego-Loss

All individuals who have received the practical teachings of this manual will, if the text be remembered, be set face to face with the ecstatic radiance and will win illumination instantaneously, without entering upon hallucinatory struggles and without further suffering on the age-long pathway of normal evolution which traverses the various worlds of game existence.

This doctrine underlies the whole of the Tibetan model. Faith is the first step on the "Secret Pathway." Then comes illumination and with it certainty; and when the goal is won, emancipation. Success implies very unusual preparation in consciousness expansion, as well as much calm, compassionate game playing (good karma) on the part of the participant. If the participant can be made to see and to grasp the idea of the empty mind as soon as the guide reveals it - that is to say, if he has the power to die consciously - and, at the supreme moment of quitting the ego, can recognize the ecstasy which will dawn upon him then, and become one with it, all game bonds of illusion are broken asunder immediately: the dreamer is awakened into reality simultaneously with the mighty achievement of recognition.

It is best if the guru (spiritual teacher), from whom the participant received guiding instructions, is present, but if the guru cannot be present, then another experienced person; or it the latter is also unavailable, then a person whom the participant trusts should be available to read this manual without imposing any of his own games. Thereby the participant will be put in mind of what he had previously heard of the experience and will at once come to recognize the fundamental Light and undoubtedly obtain liberation.

Liberation is the nervous system devoid of mental-conceptual activity. [Realization of the Voidness, the Unbecome, the Unborn, the Unmade, the Unformed, implies Buddhahood, Perfect Enlightenment - the state of the divine mind of the Buddha. It may be helpful to remember that this ancient doctrine is not in conflict with modern physics. The theoretical physicist and cosmologist, George Gamow, presented in 1950 a viewpoint which is close to the phenomenological experience described by the Tibetan lamas.

If we imagine history running back in time, we inevitably come to the epoch of the "big squeeze" with all the galaxies, stars, atoms and atomic nuclei squeezed, so to speak, to a pulp. During that early stage of evolution, matter must have been dissociated into its elementary components... . We call this primordial mixture ylem.

At this first point in the evolution of the present cycle, according to this first-rank physicist, there existed only the Unbecome, the Unborn, the Unformed. And this, according to astrophysicists, is the way it will end; the silent unity of the Unformed. The Tibetan Buddhists suggest that the uncluttered intellect can experience what astrophysics confirms. The Buddha Vairochana, the Dhyani Buddha of the Center, Manifester of Phenomena, is the highest path to enlightenment. As the source of all organic life, in him all things visible and invisible have their consummation and absorption. He is associated with the Central Realm of the Densely-Packed, i.e., the seed of all universal forces and things are densely packed together. This remarkable convergence of modern astrophysics and ancient lamaism demands no complicated explanation. The cosmological awareness - and awareness of every other natural process - is there in the cortex. You can confirm this preconceptual mystical knowledge by empirical observation and measurement, but it's all there inside your skull. Your neurons "know" because they are linked directly to the process, are part of it.] The mind in its conditioned state, that is to say, when limited to words and ego games, is continuously in thought-formation activity. The nervous system in a state of quiescence, alert, awake but not active is comparable to what Buddhists call the highest state of dhyana (deep meditation) when still united to a human body. The conscious recognition of the Clear Light induces an ecstatic condition of consciousness such as saints and mystics of the West have called illumination.

The first sign is the glimpsing of the "Clear Light of Reality," "the infallible mind of the pure mystic state." This is the awareness of energy transformations with no imposition of mental categories.

The duration of this state varies with the individual. It depends upon experience, security, trust, preparation and the surroundings. In those who have had even a little practical experience of the tranquil state of non-game awareness, and in those who have happy games, this state can last from thirty minutes to several hours.

In this state, realization of what mystics call the "Ultimate Truth" is possible, provided that sufficient preparation has been made by the person beforehand. Otherwise he cannot benefit now, and must wander on into lower and lower conditions of hallucinations, as determined by his past games, until he drops back to routine reality.

It is important to remember that the conscious-expansion process is the reverse of the birth process, birth being the beginning of game life and the ego-loss experience being a temporary ending of game life. But in both there is a passing from one state of consciousness into another. And just as an infant must wake up and learn from experience the nature of this world, so likewise a person at the moment of consciousness expansion must wake up in this new brilliant world and become familiar with its own peculiar conditions.

In those who are heavily dependent on their ego games, and who dread giving up their control, the illuminated state endures only so long as it would take to snap a finger. In some, it lasts as long as the time taken for eating a meal.

If the subject is prepared to diagnose the symptoms of ego loss, he needs no outside help at this point. Not only should the person about to give up his ego be able to diagnose the symptoms as they come, one by one, but he should also be able to recognize the Clear Light without being set face to face with it by another person. If the person fails to recognize and accept the onset of ego loss, he may complain of strange bodily symptoms. This shows that he has not reached a liberated state. Then the guide or friend should explain the symptoms as indicating the onset of ego loss.

Here is a list of commonly reported physical sensations:

1. Bodily pressure, which the Tibetans call earth-sinking-into-water;
2. Clammy coldness, followed by feverish heat, which the Tibetans call water-sinking-into-fire;
3. Body disintegrating or blown to atoms, called fire-sinking-into-air;
4. Pressure on head and ears, which Americans call rocket-launching-into-space;
5. Tingling in extremities;
6. Feelings of body melting or flowing as if wax;
7. Nausea;
8. Trembling or shaking, beginning in pelvic regions and spreading up torso.

These physical reactions should be recognized as signs heralding transcendence. Avoid treating them as symptoms of illness, accept them, merge with them, enjoy them.

Mild nausea occurs often with the ingestion of morning-glory seeds or peyote, rarely with mescaline and infrequently with LSD or psilocybin. If the subject experiences stomach messages, they should be hailed as a sign that consciousness is moving around in the body. The symptoms are mental; the mind controls the sensation, and the subject should merge with the sensation, experience it fully, enjoy it and, having enjoyed it, let consciousness flow on to the next phase. It is usually more natural to let consciousness stay in the body - the subject's attention can move from the stomach and concentrate on breathing, heart beat. If this does not free him from nausea, the guide should move the consciousness to external events - music, walking in the garden, etc.

The appearance of physical symptoms of ego-loss, recognized and understood, should result in peaceful attainment of illumination. If ecstatic acceptance does not occur (or when the period of peaceful silence seems to be ending), the relevant sections of the instructions can be spoken in a low tone of voice in the ear. It is often useful to repeat them distinctly, clearly impressing them upon the person so as to prevent his mind from wandering. Another method of guiding the experience with a minimum of activity is to have the instructions previously recorded in the subject's own voice and to flip the tape on at the appropriate moment. The reading will recall to the mind of the voyager the former preparation; it will cause the naked consciousness to be recognized as the "Clear Light of the Beginning;" it will remind the subject of his unity with this state of perfect enlightenment and help him to maintain it.

If, when undergoing ego-loss, one is familiar with this state, by virtue of previous experience and preparation, the Wheel of Rebirth (i.e., all game playing) is stopped, and liberation instantaneously is achieved. But such spiritual efficiency is so very rare, that the normal mental condition of the person is unequal to the supreme feat of holding on to the state in which the Clear Light shines; and there follows a progressive descent into lower and lower states of the Bardo existence, and then rebirth. The simile of a needle balanced and set rolling on a thread is used by the lamas to elucidate this condition. So long as the needle retains its balance, it remains on the thread. Eventually, however, the law of gravitation (the pull of the ego or external stimulation) affects it, and it falls. In the realm of the Clear Light, similarly, the mentality of a person in the ego-transcendent state momentarily enjoys a condition of balance, of perfect equilibrium, and of oneness. Unfamiliar with such a state, which is an ecstate state of non-ego, the consciousness of the average human being lacks the power to function in it. Karmic (i.e., game) propensities becloud the consciousness-principle with thoughts of personality, of individualized being, of dualism. Thus, losing equilibrium, consciousness falls away from the Clear Light. It is thought processes which prevent the realization of Nirvana (which is the "blowing out of the flame" of selfish game desire); and so the Wheel of Life continues to turn.

All or some of the appropriate passages in the instructions may be read to the voyager during the period of waiting for the drug to take effect, and when the first symptoms of ego-loss appear. When the voyager is clearly in a profound ego-transcendent ecstasy, the wise guide will remain silent.

Part II: The Secondary Clear Light Seen Immediately After Ego-Loss

The preceding section describes how the Clear Light may be recognized and liberation maintained. But if it becomes apparent that the Primary Clear Light has not been recognized, then it can certainly be assumed there is dawning what is called the phase of the Secondary Clear Light. The first flash of experience usually produces a state of ecstasy of the greatest intensity. Every cell in the body is sensed as involved in orgastic creativity.

It may be helpful to describe in more detail some of the phenomena which often accompany the moment of ego-loss. One of these might be called "wave energy flow." The individual becomes aware that he is part of and surrounded by a charged field of energy, which seems almost electrical. In order to maintain the ego-loss state as long as possible, the prepared person will relax and allow the forces to flow through him. There are two dangers to avoid: the attempt to control or to rationalize this energy flow. Either of these reactions is indicative of ego-activity and the First Bardo transcendence is lost.

The second phenomenon might be called "biological life-flow." Here the person becomes aware of physiological and biochemical processes; rhythmic pulsing activity within the body. Often this may be sensed as powerful motors or generators continuously throbbing and radiating energy. An endless flow of cellular forms and colors flashes by. Internal biological processes may also be heard with characteristic swooshing, crackling, and pounding noises. Again the person must resist the temptation to label or control these processes. At this point you are tuned in to areas of the nervous system which are inaccessible to routine perception. You cannot drag your ego into the molecular processes of life. These processes are a billion years older than the learned conceptual mind.

Another typical and most rewarding phase of the First Bardo involves ecstatic energy movement felt in the spine. The base of the backbone seems to be melting or seems on fire. If the person can maintain quiet concentration the energy will be sensed as flowing upwards. Tantric adepts devote decades of concentrated meditation to the release of these ecstatic energies which they call Kundalini, the Serpent Power. One allows the energies to travel upwards through several ganglionic centers (chakras) to the brain, where they are sensed as a burning sensation in the top of the cranium. These sensations are not unpleasant to the prepared person, but, on the contrary, are accompanied by the most intense feelings of joy and illumination. Ill-prepared subjects may interpret the experience in pathological terms and attempt to control it, usually with unpleasant results. [Professor R. C. Zaehner, who as an Oriental scholar and "expert" on mysticism should have know better, has published an account of how this prized experience can be lost and distorted into hypochondriacal complaint in the ill-educated.

... I had a curious sensation in my body which reminded me of what Mr. Custance describes as a "tingling at the base of the spine," which according to him, usually precedes a bout of mania. It was rather like that. In the Broad Walk this sensation occurred again and again until the climax of the experiment was reached ... I did not like it at all. (R. C. Zaehner: Mysticism, Sacred and Profane. Oxford Univ. Press, 1957, p. 214)

If the subjects fails to recognize the rushing flow of First Bardo phenomena, liberation from the ego is lost. The person finds himself slipping back into mental activities. At this point he should try to recall the instructions or be reminded of them, and a second contact with these processes can be made. The second stage is less intense. A ball set bouncing reaches its greatest height at the first bounce; the second bounce is lower, and each succeeding bounce is still lower until the ball comes to rest. The consciousness at the loss of the ego is similar to this. Its first spiritual bound, directly upon leaving the body-ego, is the highest; the next is lower. Then the force of karma, (i.e., past game-playing), takes over and different forms of external reality are experienced. Finally, the force of karma having spent itself, consciousness returns to "normal." Routines are taken up again and thus rebirth occurs.

The first ecstasy usually ends with a momentary flashback to the ego condition. This return can be happy or sad, loving or suspicious, fearful or courageous, depending on the personality, the preparation, and the setting.

This flashback to the ego-game is accompanied by a concern with identity. "Who am I now? Am I dead or not dead? What is happening?" You cannot determine. You see the surroundings and your companions as you had been used to seeing them before. There is a penetrating sensitivity. But you are on a different level. Your ego grasp is not quite as sure as it was.

The karmic hallucinations and visions have not yet started. Neither the frightening apparitions nor the heavenly visions have begun. This is a most sensitive and pregnant period. The remainder of the experience can be pushed one way or another depending upon preparation and emotional climate.

If you are experienced in consciousness alteration, or if you are a naturally introverted person, remember the situation and the schedule. Stay calm and let the experience take you where it will. You will probably re-experience the ecstasy of illumination once again; or you may drift into aesthetic or philosophic or interpersonal enlightenments. Don't hold on: let the stream carry you along.

The experienced person is usually beyond dependence on setting. He can turn off external pressure and return to illumination. An extroverted person, dependent upon social games and outside situations may, however, become pleasantly distracted (colors, sounds, people). If you anticipate extroverted distraction and if you want to maintain a non-game state of ecstasy, then remember the following suggestions: do not be distracted; try to concentrate on an ideal contemplative personage, e.g., Buddha, Christ, Socrates, Ramakrishna, Einstein, Herman Hesse or Lao Tse: follow his model as if he were a being with a physical body waiting for you. Join him.

If this is not successful, don't fret or think about it. Perhaps you don't have a mystical or transcendental ideal. That means your conceptual limits are within external games. Now that you know what the mystic experience is, you can prepare for it next time. You have lost the content-free flow and should now be ready to slip into exciting confrontation with external reality. In the Second Bardo you can reach and deeply experience game revelations.

We have just anticipated the reactions of the naturally mystical introvert, the experienced person, and the extrovert. Now let's turn to the novitiate who shows confusion at this early stage of the sequence. The best procedure is to make a reassuring sign and do nothing. He will have read this manual and will have some guidepost. Leave him alone and he will probably dive into his panic and master it. If he indicates that he wishes guidance, repeat the instructions. Tell him what is happening. Remind him of his phase in the process. Urge him quietly to release his ego struggle and drift back into contact with the Clear Light.

Preparation and guidance of this sort will allow many to reach the illuminated state who would not be expected to recognize it.

At this point, it is necessary to inject a word of benign warning. Reading this manual is extremely useful, but no words can communicate experience. You are going to be surprised, startled and delighted. A person may have heard a detailed description of the art of swimming and yet never had the chance to swim. Suddenly diving into the water, he finds himself unable to swim. So with those who have tried to learn the theory of how to experience ego-loss, and have never applied it. They cannot maintain unbroken continuity of consciousness, they grow bewildered at the changed condition; they fail to maintain the mystical ecstasy; they fail to take advantage of the opportunity unless upheld and directed by a guide. Even with all that a guide can do, they ordinarily, because of bad karma (heavy ego games) fail to recognize the liberation. But this is no cause for worry. At the worst, they just slip back to shore. No one has drowned, and most of those who have taken the voyage have been eager to try again.

Even those who have familiarized themselves with the road maps and who previously have had illumination, may find themselves in settings where heavy game behavior on the part of others forces them into contact with external reality. If this happens, recall the instructions. The person who masters this principle can block out the external. The one who has mastered control of consciousness is independent of setting.

Again there are those, who although previously successful, may have brought ego games into the session with them. They may want to provide someone else with a particular type of experience. They may be promoting some self goal. They may be nurturing negative or competitive or seductive feelings towards someone in the session. If this happens, recall the instructions. Remember the unity of all beings. One to me is shame and fame. One to me is loss or gain. Jettison your ego program and float back to the radiant bliss of at-one-ness.

If you reach the Clear Light immediately and maintain it, that is best. But if not, if you have slipped down to reality concerns, by remembering these instructions you should be able to regain what the Tibetans call the Secondary Clear Light.

While on this secondary level, an interesting dialogue occurs between pure transcendence and the awareness that this ecstatic vision is happening to oneself. The first radiance knows no self, no concepts. The secondary experience involves a certain state of conceptual lucidity. The knowing self hovers within that transcendent terrain from which it is usually barred. If the instructions are remembered, external reality will not intrude. But the flashing in and out between pure ego-less unity, and lucid, non-game selfhood, produces an intellectual ecstasy and understanding that defies description. Previous philosophic reading will suddenly take on living meaning.

Thus in this secondary stage of the First Bardo, there is possible both the mystic non-self and the mystic self experience.

After you have experienced these two states, you may wish to pursue this distinction intellectually. We are confronted here with one of the oldest debates in Eastern philosophy. Is it better to be part of the sugar or to taste the sugar? Theological controversies and their dualities are far removed from experience. Thanks to the experimental mysticism made possible by consciousness-expanding drugs, you may have been lucky enough to have experienced the flashing back and forth between the two states. You may be lucky enough to know what the academic monks could only think about.

Here ends the First Bardo, The Period of Ego-loss or Non-Game Ecstasy

Second Bardo: The Period Of Hallucinations (Chonyid Bardo)

Introduction

If the Primary Clear Light is not recognized, there remains the possibility of maintaining the Secondary Clear Light. If that is lost, then comes the Chonyid Bardo, the period of karmic illusions or intense hallucinatory mixtures of game reality. It is very important that the instructions be remembered - they can have great influence and effect.

During this period, the flow of consciousness, microscopically clear and intense, is interrupted by fleeting attempts to rationalize and interpret. But the normal game-playing ego is not functioning effectively. There exist, therefore, unlimited possibilities for, on the one hand, delightful sensuous, intellectual and emotional novelties if one floats with the current; and, on the other hand, fearful ambuscades of confusion and terror if one tries to impose his will on the experience.

The purpose of this part of the manual is to prepare the person for the choice points which arise during this stage. Strange sounds, weird sights and disturbed visions may occur. These can awe, frighten and terrify unless one is prepared.

The experienced person will be able to maintain the recognition that all perceptions come from within and will be able to sit quietly, controlling his expanded awareness like a phantasmagoric multi-dimensional television set: the most acute and sensitive hallucinations - visual, auditory, touch, smell, physical and bodily; the most exquisite reactions, compassionate insight into the self, the world. The key is inaction: passive integration with all that occurs around you. If you try to impose your will, use your mind, rationalize, seek explanations, you will get caught in hallucinatory whirlpools. The motto: peace, acceptance. It is all an ever-changing panorama. You are temporarily removed from the world of game. Enjoy it.

The inexperienced and those to who ego control is important may find this passivity impossible. If you cannot remain inactive and subdue your will, then the one certain activity which can reduce panic and pull you out of hallucinatory mind-games is physical contact with another person. Go to the guide or to another participant and put your head on his lap or chest; put your face next to his and concentrate on the movement and sound of his inspiration. Breathe deeply and feel the air rush in and the sighing release. This is the oldest form of living communication; the brotherhood of breath. The guide's hand on your forehead may add to the relaxation.

Contact with another participant may be misunderstood and provoke sexual hallucinations. For this reason, helping contact should be made explicit by prearrangement. Unprepared participants may impose sexual fears or fantasies on the contact. Turn them off; they are karmic illusory productions.

The tender, gentle, supportive huddling together of participants is a natural development during the second phase. Do not try to rationalize this contact. Human beings and, for that matter, most all mobile terrestrial creatures have been huddling together during long, dark confused nights for several hundred thousand years.

Breathe in and breathe out with you companions. We are all one! That's what your breath is telling you.

Explanation of the Second Bardo

The underlying problem of the Second Bardo is that any and every shape - human, divine, diabolical, heroic, evil, animal, thing - which the human brain conjures up or the past life recalls, can present itself to consciousness: shapes and forms and sounds whirling by endlessly.

The underlying solution - repeated again and again - is to recognize that your brain is producing the visions. They do not exist. Nothing exists except as your consciousness gives it life.

You are standing on the threshold of recognizing the truth: there is no reality behind any of the phenomena of the ego-loss state, save the illusions stored up in your own mind either as accretions from game (Sangsaric) experience or as gifts from organic physical nature and its billion-year old past history. Recognition of this truth gives liberation.

There is, of course, no way of classifying the infinite permutations and combinations of visionary elements. The cortex contains file-cards for billions of images from the history of the person, of the race, and of living forms. Any of these, at the rate of a hundred million per second (according to neuro-physiologists), can flood into awareness. Bobbing around in this brilliant, symphonic sea of imagery is the remnant of the conceptual mind. On the endless watery turbulence of the Pacific Ocean bobs a tiny open mouth shouting (between saline mouthfuls), "Order! System! Explain all this!"

One cannot predict what visions will occur, nor their sequence. One can only urge the participants to shut the mouth, breathe through the nose, and turn off the fidgety, rationalizing mind. But only the experienced person of mystical bent can do this (and thus remain in serene enlightenment). The unprepared person will be confused or, worse, panicky: the intellectual struggle to control the ocean.

In order to guide the person, to help him organize his visions into explicable units, the Chonyid Bardo was written. There are two sections: (1) Seven Peaceful Deities with their symmetrically opposed ego traps. (2) Eight Wrathful Deities who can be joyfully accepted as visionary productions, or fled from in terror.

Each of the Seven Peaceful Deities (bisexual Father-Mother figures) are accompanied by consorts, attendants, lesser deities, saints, angels, heroes. Each of the Wrathful Deities is similarly accompanied. Lights, symbolic objects, beautiful, horrid, threatening, seething, are likewise seen.

If read literally, The Tibetan Book of the Dead would have you expect the "Master of All Visible Shapes" (or his opposite, the fondness for stupidity) on the first day; the "Immovable Deity of Happiness" and his consort, attendants and opposite on the second, etc. The manual should, of course, not be used rigidly, exoterically, but should be taken in its esoteric, allegorical form.

Read from this perspective, we see that the lamas have listed or named a thousand images which can boil up in the ever-changing jeweled mosaic of the retina (that multi-layered swamp of billions of rods and cones, infiltrated, like a Persian rug or a Mayan carving, with countless multi- colored capillaries). By preparatory reading of the manual and by its repetition during the experience, the novice is led via suggestion to recognize this fantastic retinal kaleidoscope.

Most important, he is told that they come from within. All deities and demons, all heavens and hells are internal.

The student with a particular interest in Tibetan or Tantric Buddhism should steep himself in the text of the Chonyid Bardo. He should obtain colored plates of the fourteen dramas of the Bardo, and he should arrange to have the guide lead him through the prescribed sequence during the drug session. This will provide an unforgettable series of liberations and will permit the devotee to emerge from the experience "reincarnated" in the lamaist tradition.

The aim of this manual is to make available the general outline of the Tibetan Book and to translate it into psychedelic English. For this reason we shall not present the detailed sequence of lamaist hallucinations but, rather, list some apparitions commonly reported by Westerners.

Following the Tibetan Thodo, we have classified Second Bardo visions into seven types:

1. The Source or Creator Vision
2. The Internal Flow of Archetypal Processes
3. The Fire-Flow of Internal Unity
4. The Wave-Vibration Structure of External Forms
5. The Vibratory Waves of External Unity
6. "The Retinal Circus"
7. "The Magic Theatre" [We owe the phrase "retinal circus" to Henri Michaux (Miserable Miracle), and the term "magic theatre" to Hermann Hesse (Steppenwolf).

Visions 2 and 3 involve closed eyes and no contact with external stimuli. In Vision 2 the internal imagery is primarily conceptual. The experience can range from revelation and insight to confusion and chaos, but the cognitive, intellectual meaning is paramount. In Vision 3 the internal imagery is primarily emotional. The experience can range from love and ecstatic unity to fear, distrust and isolation.

Visions 4 and 5 involve open eyes and rapt attention to external stimuli, such as sounds, lights, touch, etc. In Vision 4 the external imagery is primarily conceptual and in Vision 5 emotional factors predominate.

The sevenfold table just defined bears some similarity to the mandalic schema of the Peaceful Deities listed for the Second Bardo in The Tibetan Book of the Dead.

The Peaceful Visions

Vision 1: The Source
(Eyes closed, external stimuli ignored)

[The first Peaceful Deity listed by the Bardo Thodol is the Bhagavan Vairochana who occupies the center of the mandala of the five Dhyani-Buddhas. His attributes of source-power have been translated into those of the monotheistic creator of Western religions.]

The White Light, or First Bardo energy, may be interpreted as God the Creator. The Spreader of the Seed. The Power which makes all shapes visible. Seed of all that is. Sovereign Power. The All-Powerful. The Central Sun. The One Truth. The Source of all Organic Life. The Divine Mother. The Female Creative Principle. Mother of the Space of Heaven. Radiant Father- Mother. Magnificent revelations, both spiritual and philosophic, can occur at this point making the highest union of experience and intellect. But, because of bad karma (usually religious beliefs of a monotheistic or punitive nature), the glorious light of the seed wisdom it can produce awe and terror. The person will wish to flee and will beget a fondness for the dull white light symbolizing stupidity.

Persons from a Judaeo-Christian background conceive of an enormous gulf between divinity (which is "up there") and the self ("down here"). Christian mystics' claims to unity with divine radiance has always posed problems for theologians who are committed to the cosmological subject-object distinction. Most Westerners, therefore, find it difficult to attain unity with the source-light.

If the guide ascertains that the voyager is struggling with thoughts or feelings about the creative source energy, he can read the appropriate instructions. (See Instructions For Vision 1: The Source)

Vision 2: The Internal Flow of Archetypal Processes
(Eyes closed, external stimuli ignored; intellectual aspects)

If the undifferentiated light of the First Bardo or of the Source Energy is lost, luminous waves of differentiated forms can flood through the consciousness. The person's mind begins to identify these figures, that is, to label them and experience revelations about the life process. [Lama Govinda tells us that Amoghasiddhi represents "... the mysterious activity of spiritual forces, which work removed from the senses, invisible and imperceptible, with the aim of guiding the individual (or, more properly: all living beings) towards the maturity of knowledge and liberation. The yellow light of an (inner) sun invisible to human eyes ... (in which the unfathomable space of the universe seems to open itself) for the serene mystic green of Amoghasiddhi... . On the elementary plane this all- pervading power corresponds to the element of air - the principle of movement and extension, of life and breath (prana)." Lama Govinda: Foundations of Tibetan Mysticism. Lodon: E. P. Dutton & Co., Inc., 1959, p.120.

The fifth day of the Baro Thodol confronts the deceased with the Bhagavan Buddha Amoghasiddhi, Almighty Conqueror, from the green Norther realm of Successful Performance of Best Actions, attended by a Divine Mother, and two Bodhisattvas representing the mental functions of "equilibrium, immutability, and almighty power" and "clearer of obscurations."]

Specifically, the subject is caught up in an endless flow of colored forms, microbiological shapes, cellular acrobatics, capillary whirling. The cortex is turned in on molecular processes which are completely new and strange: a Niagara of abstract designs; the life-stream flowing, flowing.

These visions might perhaps be described as pure sensations of cellular and sub-cellular processes. It is uncertain whether they involve the retina and/or the visual cortex, or whether they are flashes of direct, molecular sensation in other areas of the central nervous system. They are subjectively described as internal visions.

Another class of internal process images involves sound. Again we do not know whether these sensations originate in the auditory apparatus and/or in the auditory cortex, or whether they are flashes of direct, molecular sensations in other areas. They are subjectively described as internal sounds: clicking, thudding, clashing, soughing, ringing, tapping, moaning, shrill whistles. [The Tibetan Book includes a brilliant discussion of internal process noises. "... innumerable (other) kinds of musical instruments, filling (with music) the whole world-systems and causing them to vibrate, to quake and tremble with sounds so mighty as to daze one's brain... ."

"Tibetan lamas, in chanting their rituals, employ seven (or eight) sorts of musical instruments: big drums, cymbals (commonly brass), conch shells, bells (like the handbells used in the Christian Mass Service), timbrels, small clarionets (sounding like Highland bagpipes), big trumpets, and human thighbone trumpets. Although the combined sounds of these instruments are far from being melodious, the lamas maintain that they psychically produce in the devotee an attitude of deep veneration and faith, because they are the counterparts of the natural sounds which one's own body is heard producing when the fingers are put in the ears to shut out external sounds. Stopping the ears thus, there are heard a thudding sound, like that of a big drum being beaten; a clashing sound, as of cymbals; a soughing sound, as of a wind moving through a forest - as when a conch-shell is bone; a ringing as of bells; a sharp tapping sound, as when a timbrel is used; a moaning sound, like that of a clarionet; a bass moaning sound, as if made with a big trumpet; and a shriller sound, as of a thigh-bone trumpet."

"Not only is this interesting as a theory of Tibetan sacred music, but it gives the clue to the esoteric interpretation of the symbolical natural sounds of Truth (referred to in the second paragraph following, and elsewhere in our text), which are said to be, or to proceed from, the intellectual faculties within the human mentality." - (Evans-Wentz, p. 128)] These noises, like the visions, are direct sensations unencumbered by mental concepts. Raw, molecular, dancing units of energy.

The minds sweeps in and out of this evolutionary stream, creating cosmological revelations. Dozens of mythical and Darwinian insights flash into awareness. The person is allowed to glance back down the flow of time and to perceive how the life energy continually manifests itself in forms, transient, always changing, reforming. Microscopic forms merge with primal creative myths. The mirror of consciousness is held up to the life stream.

As long as the person floats with the current, he is exposed to a billion-year lesson in cosmology. But the drag of the mind is always present. The tendency to impose arbitrary, isolating order on the organic process.

Sometimes the voyager feels he should report back his vision. He converts the life flow into a cosmic ink-blot test - attempts to label each form. "Now I see a peacock's tail. Now Muslim knights in colored armor. Oh, now a waterfall of jewels. Now, Chinese music. Now, gem-like serpents, etc." Verbalizations of this sort dull the light, stop the flow and should not be encouraged.

Another trap is that of imposing a sexual interpretation. The dancing, playful flow of life is, in the most reverant sense, sexual. Forms merging, spinning together, reproducing. Eros in its countless manifestations. The Tibetans refer to the female Bodhisattvas Pushpema, personification of blossoms, and Lasema, the "Belle", depicted holding a mirror in a coquettish attitude. Keep the pure, spontaneous awareness of the Mirror-like Wisdom. Laugh joyously at the tricks of the life process, forever decking out forms in seductive, enticing patterns to keep the dance going. If the voyager interprets the visions of Eros in terms of his personal sexual game model, and attempts to think or plan - "what should I do? what role should I play?" - he is likely to slip down into the Third Bardo. Sexual plots dominate his awareness, the flow fades, the mirror tarnishes, and he is rudely reborn as a confused, thinking being.

Still another impasse is the imposition of physical symptom games upon the biological flow. The new somatic sensations may be interpreted as symptoms. If it is new, it must be bad. Any organ of the body may be selected as the focus of the "illness." People whose primary expectation when taking a psychedelic substance is medical, are particularly likely to fall into this trap. Medical doctors are, in fact, extremely prone and can imagine colorful diseases and fatal attacks.

In the case of the most widely-used psychedelics (LSD, psilocybin, etc.), it is safe to say that such bodily effects are virtually never the direct effect of the drug. The drug acts only on the brain and activates central neural patterns. All physical symptoms are created by the mind. Bodily sickness is a sign that the ego is fighting to maintain or regain its hold over an outpouring of feeling, over a dissolution of emotional boundaries.

If the person complains of physical symptoms such as nausea or pain, the guide should read him the Instructions For Physical Symptoms.

The negative, wrathful counterpart to this vision occurs if the voyager reacts with fear to the powerful flow of life forms. Such a reaction is attributable to the cumulated result of game playing (karma) dominated by anger or stupidity. A nightmarish hell-world may ensue. The visual forms appear like a confusing chaos of cheap, ugly dime-store objects, brassy, vulgar and useless. The person may become terrified at the prospect of being engulfed by them. The awesome sounds may be heard as hideous, clashing, oppressive, grating noises. The person will attempt to escape from these perceptions into restless external activity (talking, moving around, etc.) or into conceptual, analytic, mental activity.

The experience is the same, the intellectual interpretation is different. Instead of revelation, there is confusion; instead of calm joy, there is fear. The guide, recognizing the voyager to be in such a state, can help him get free, by reading the Instructions for Vision 2.

Vision 3: The Fire-Flow of Internal Unity
(Eyes closed, external stimuli ignored, emotional aspects)

The First Bardo instructions should keep you face-to-face with the void-ecstasy. Yet there are classes of men who, having carried over karmic conflict about feeling-inhibition, prove unable to hold the pure experience beyond all feelings, and slip into emotionally toned visions. The undifferentiated energy of the First Bardo is woven into visionary games in the form of intense feelings. Exquisite, intense, pulsating sensations of unity and love will be felt; the negative counterpart is feelings of attachment, greed, isolation and bodily concerns.

It comes about this way: the pure flow of energy loses its white void quality and becomes sensed as intense feelings. An emotional game is imposed. Incredible new physical sensations pulse through the body. The glow of life is felt flooding along veins. One merges into a unitive ocean of orgastic, fluid electricity, [The Peaceful Deity of the Bardo Thodol personifying this vision is the Buddha Amitabbha, the all-discriminating wisdom and feeling, boundless light, representing life eternal. Lama Govinda writes that "The deep red light of discriminating inner vision shines forth from his heart ... fire corresponds to him and thus, according to the ancient traditional symbolism, the eye and the function of seeing." (Govinda, op. cit., p. 120.) With the Bhagavan Amitabbha comes the Bodhisattva Chenrazee, embodiment of mercy or compassion, the great pitier ever on the lookout to discover distress and to succour the troubled. He is joined by the Bodhisattva "Glorious Gentle-voiced One," and the female incarnates "song" and "light."] the endless flow of shared-life, of love.

Visions related to the circulatory system are common. The subject tumbles down through his own arterial network. The motor of the heart reverberates as one with the pulsing of all life. The heart then breaks, and red fire bleeds out to merge with all living beings. All living organisms are throbbing together. One is joyfully aware of the two-billion-year-old electric sexual dance; one is at last divested of robot clothes and limbs and undulates in the endless chain of living forms.

Dominating this ecstatic state is the feeling of intense love. You are a joyful part of all life. The memory of former delusions of self-hood and differentiation invokes exultant laughter.

All the harsh, dry, brittle angularity of game life is melted. You drift off - soft, rounded, moist, warm. Merged with all life. You may feel yourself floating out and down into a warm sea. Your individuality and autonomy of movement are moistly disappearing. Your control is surrendered to the total organism. Blissful passivity.

Ecstatic, orgiastic, undulating unity. All worries and concerns wash away. All is gained as everything is given up. There is organic revelation. Every cell in your body is singing its song of freedom - the entire biological universe is in harmony, liberated from the censorship and control of you and your restricted ambitions.

But wait! You, You, are disappearing into the unity. You are being swallowed up by the ecstatic undulation. Your ego, that one tiny remaining strand of self, screams STOP! You are terrified by the pull of the glorious, dazzling, transparent, radiant red light. You wrench yourself out of the life-flow, drawn by your intense attachment to your old desires. There is a terrible rending as your roots tear out of the life matrix - a ripping of your fibres and veins away from the greater body to which you were attached. And when you have cut yourself off from the fire-flow of life the throbbing stops, the ecstasy ceases, your limbs harden and stiffen into angular forms, your plastic doll body has regained its orientation. There you sit, isolated from the stream of life, impotent master of your desires and appetites, miserable.

While you are floating down the evolutionary river, there comes a sense of limitless self-less power. The delight of flowing cosmic belongingness. The astounding discovery that consciousness can tune in to an infinite number of organic levels. There are billions of cellular processes in your body, each with its universe of experience - an endless variety of ecstasies. The simple joys and pains and burdens of your ego represent one set of experiences - a repetitious, dusty set. As you slip into the fire-flow of biological energy, series after series of experiential sets flash by. You are no longer encapsulated in the structure of ego and tribe.

But through panic and a desire to latch on to the familiar, you shut off the flow, open your eyes; then the flowingness is lost. The potentiality to move from one level of consciousness to another is gone. Your fear and desire to control have driven you to settle for one static site of consciousness. To use the Eastern or genetic metaphor, you have frozen the dance of energy and committed yourself to one incarnation, and you have done it out of fear.

When this happens, there are several steps which can take you back to the biological flow (and from there to the First Bardo). First, close your eyes. Lie on you stomach and let you body sink through the floor, merge with the surroundings. Feel the hard, square edges of your body soften and start to move in the bloodstream. Let the rhythm of breathing become tide flow. Bodily contact is probably the most effective method of softening hardened surfaces. No movement. No body games. Close physical contact with another invariably brings about the unity of fire-flow. Your blood begins to flow into the other's body. His breathing pours into your lungs. You both drift down the capillary river.

Another form of life process images is the flow of auditory sensations. The endless series of abstract sounds (described in the preceding vision) bounce through awareness. The emotional reaction to these can be neutral or can involve intense feelings of unity, or of annoyed fear.

The positive reaction occurs when the subject merges with the sound flow. The thudding drum of the heart is sensed as the basic anthem of humanity. The whooshing sough of the breath as the rushing river of all life. Overwhelming feelings of love, gratitude and oneness funnel into the moment of sound, into each note of the biological concerto.

But, as always, the voyager may intrude his personality with its wants and opinions. He may not "like" the noise. His judgmental ego may be aesthetically offended by the sounds of life. The heart thud is, after all, monotonous; the natural music of the inner ear, with its clicks and hums and whistles, lacks the romantic symmetries of Beethoven. The terrible separation of "me" from my body occurs. Horrible. Out of my control. Turn it off.

The trained guide can usually sense when ego-attachment threatens to pull the person out of the unitive flow. At this time he can guide the voyager by reading the Instructions for Vision 3.

Vision 4: The Wave-Vibration Structure of External Forms
(Eyes open or rapt involvement with external stimuli; intellectual aspects)

The pure, content-free light of the First Bardo probably involves basic electrical wave energy. This is nameless, indescribable, because it is far beyond any concepts which we now possess. Some future atomic physicist may be able to classify this energy. Perhaps it will always be ineffable for a nervous system such as that of homo sapiens. Can an organic system "comprehend" the vastly more efficient inorganic? At any event, most persons, even the most illuminated, find it impossible to maintain experiential contact with this void-light and slip back to imposing mental structures, hallucinatory and revelatory, upon the flow.
Thus we are brought to another frequent vision which involves intense, rapt, unitive awareness of external stimuli. If the eyes are open, this super-reality effect can be visual. The penetrating impact of other stimuli can also set off revelatory imagery.

It comes about this way. The subject's awareness is suddenly invaded by an outside stimulus. His attention is captured, but his old conceptual mind is not functioning. But other sensitivities are engaged. He experiences direct sensation. The raw "is-ness." He sees, not objects, but patterns of light waves. He hears, not "music" or "meaningful" sound, but acoustic waves. He is struck with the sudden revelation that all sensation and perception are based on wave vibrations. That the world around him which heretofore had an illusory solidity, is nothing more than a play of physical waves. That he is involved in a cosmic television show which has no more substantiality than the images on his TV picture tube. [The Peaceful Deity of the Thodol personifying this vision is Akshobhya. According to Lama Govinda, "In the light of the Mirror-like Wisdom ... things are freed from their "thingness," their isolation, without being deprived of their form; they are divested of their materiality, without being dissolved, because the creative principle of the mind, which is at the bottom of all form and materiality, is recognized as the active side of the universal Store Consciousness (alaya-vijnana), on the surface of which forms arise and pass away, like the waves on the surface of the ocean... ." (Govinda, op. cit., p. 119.)

The atomic structure of matter is, of course, known to us intellectually, but never experienced by the adult except in states of intense altered consciousness. Learning from a physics textbook about the wave structure of matter is one thing. Experiencing it - being in it - with the old, familiar, gross, hallucinatory comfort of "solid" things gone and unavailable, is quite another matter.

If these super-real visions involve wave phenomena, then the external world takes on a radiance and a revelation that is staggeringly clear. The experienced insight that the world of phenomena exists in the form of waves, electronic images, can produce a sense of illuminated power. Everything is experienced as consciousness.

These exultant radiations should be recognized as productions of your own internal processes. You should not attempt to control or conceptualize. This can come later. There is the danger of hallucinatory freezing. The subject rushes back (sometimes literally) to the three-dimensional reality, convinced of the fixed "truth" of one experienced revelation. Many misguided mystics and many persons called insane have fallen into this ambuscade. This is like making a still photograph of a television pattern and shouting that one has finally seized the truth. All is ecstatic electric Maya, the two- billion-year dance of waves. No one part of it is more real than another. Everything at all moments is shimmering with all the meaning.

So far we have considered the positive radiance of clarity; but there are fearful negative aspects of the fourth vision. When the subject senses that his "world" is fragmenting into waves, he may become terrified. "He," "me," "I" are dissolving! The world around me is supposed to sit, static and dead, quietly awaiting my manipulation. But these passive things have changed into a shimmering dance of living energy! The Maya nature of phenomena creates panic. Where is the solid base? Every thing, every concept, every form upon which one rests one's mind collapses into electrical vibrations lacking solidity.

The face of the guide or of one's beloved friend becomes a dancing mosaic of impulses on one's cortex. "My consciousness" has created everything of which I am conscious. I have kinescoped my world, my loved ones, myself. All are just shimmering energy patterns. Instead of clarity and exultant power, there is confusion. The subject staggers around, grasping at electron-patterns, striving to freeze them back into the familiar robot forms.

All solidity is gone. All phenomena are paper images pasted on the glass screen of consciousness. For the unprepared, or for the person whose karmic residue stresses control, the discovery of the wave-nature of all structure, the Maya revelation, is a disastrous web of uncertainty.

We have discussed only the visual aspects of the fourth vision. Auditory phenomena are of equal importance. Here the solid, labelled nature of auditory patterns is lost, and the mechanical impact of sound hitting the eardrum is registered. In some cases, sound becomes converted into pure sensation, and synesthesia (mixture of sense modalities) occurs. Sounds are experienced as colors. External sensations hitting the cortex are recorded as molecular events, ineffable.

The most dramatic auditory visions occur with music. Just as any object radiates a pattern of electrons and can become the essence of all energy, so can any note of music be sensed as naked energy trembling in space, timeless. The movement of notes, like the shuttling of oscillograph beams. Each capturing all energy, the electric core of the universe. Nothing existing except the needle-clear resonance on the tympanic membrane. Unforgettable revelations about the nature of reality occur at these moments.

But the hellish interpretation is also possible. As the learned structure of sound collapses, the direct impact of waves can be sensed as noise. For one who is compelled to institute order, his order, on the world around him, it is at least annoying and often disturbing to have the raw tattoo of sound resonating in consciousness.

Noise! What an irreverent concept. Is not everything noise; all sensation the divine pattern of wave energy, meaningless only to those who insist on imposing their own meaning?

Preparation is the key to a serene passage through this visionary territory. The subject who has studied this manual will be able, when face to face with the phenomenon, to recognize and flow with it.

The sensitive guide will be ready to pick up, on any cue, that the subject is wandering in the fourth vision. If the voyager's eyes are open (indicating visual reactions), he can read the Instructions for Vision 4.

If the guide senses that the voyager is experiencing the fragmentation of external sound into wave vibrations, he can amend the instructions appropriately (changing the visual references to auditory).

Vision 5: The Vibratory Waves of External Unity
(Eyes open, or rapt involvement with external stimuli; emotional aspects)

As the learned perceptions disappear and the structure of the external world disintegrates into direct wave phenomena, the aim is to maintain a pure, content-free awareness (First Bardo). Despite the preparations, one is likely to be led backwards by one's own mental inclinations into two hallucinatory or revelatory interpretations of reality. One reaction leads to the intellectual clarity or frightened confusion of the fourth vision (just described). Another interpretation is the emotional reaction to the fragmentation of differentiated forms. One can be engulfed in ecstatic unity, or one can slip into isolated egotism. The Bardo Thodol calls the former the "Wisdom of Equality" and the latter the "quagmire of worldly existence accruing from violent egotism." [The Peaceful Deity of the fifth vision comes in the form of the Bhagavan Ratnasambhava, born of a jewel. He is embraced by the Divine Mother, She of the Buddha Eyes, and accompanied by the Bodhisattvas, womb of the sky, All-good, and those holding incense and rosary. "On the elementary plane Ratnasambhava corresponds to the earth, which carries and nourishes all beings with the equanimity and patience of a mother, in whose eyes all beings, borne by her, are equal." (Govinda, op. cit., p. 119.)] In the state of radiant unity, one senses that there is only one network of energy in the universe and that all things and all sentient beings are momentary manifestations of the single pattern. When egotistic interpretations are imposed on the fifth vision, the "plastic doll" phenomena are experienced. Differentiated forms are seen as inorganic, dull, mass-produced, shabby, plastic, and all persons (including self) are seen as lifeless mannequins isolated from the vibrant dance of energy, which has been lost.

The experiential data of this vision are similar to that of the fourth vision. All artifactual learned structure collapses back to energy vibrations. The awareness is dominated not by revelatory clarity but by shimmering unity. The subject is entranced by the silent, whirling play of forces. Exquisite forms dance by him, all surrounding objects radiate energy, brilliant emanations. His own body is seen as a play of forces. If he looks in a mirror, he sees a shining mosaic of particles. The sense of his own wave structure becomes stronger. A feeling of melting, floating off. The body is no longer a separate unit but a cluster of vibrations sending and receiving energy - a phase of the dance of energy which has been going on for millennia.

A sense of profound one-ness, a feeling of the unity of all energy. Superficial differences of role, cast, status, sex, species, form, power, size, beauty, even the distinctions between inorganic and living energy, disappear before the ecstatic union of all in one. All gestures, words, acts and events are equivalent in value - all are manifestations of the one consciousness which pervades everything. "You," "I" and "he" are gone, "my" thoughts are "ours," "your" feelings are "mine." Communication is unnecessary, since complete communion exists. A person can sense another's feeling and mood directly, as if they were his own. By a glance, whole lifetimes and words can be transmitted. If all are at peace, the vibrations are "in phase." If there is discord, "out of phase" vibrations will be set up which will be felt like discordant music. Bodies melt into waves. Objects in the environment - lights, tree, plants, flowers - seem to open and welcome you: they are part of you. You are both simply different pulses of the same vibrations. A pure feeling of ecstatic harmony with all beings is the keynote of this vision.

But as before, terrors can occur. Unity requires ecstatic self-sacrifice. Loss of ego brings fright to the unprepared. The fragmentation of form into waves can bring the most terrible fear known to man: the ultimate epistemological revelation.

The fact of the matter is that all apparent forms of matter and body are momentary clusters of energy. We are little more than flickers on a multidimensional television screen. This realization directly experienced can be delightful. You suddenly wake up from the delusion of separate form and hook up to the cosmic dance. Consciousness slides along the wave matrices, silently at the speed of light.

The terror comes with the discovery of transience. Nothing is fixed, no form solid. Everything you can experience is "nothing but" electrical waves. You feel ultimately tricked. A victim of the great television producer. Distrust. The people around you are lifeless television robots. The world around you is a facade, a stage set. You are a helpless marionette, a plastic doll in a plastic world.

If others attempt to help, they are seen as wooden, waxen, feelingless, cold, grotesque, maniacal, space-fiction monsters. You are unable to feel. "I am dead. I will never live and feel again." In wild panic you may attempt to force feeling back - by action, by shouting. You will then enter the Third Bardo stage and be reborn in an unpleasant way.

The best method to escape from fifth vision terrors is to remember this manual, relax, and swing with the wave dance. Or to communicate to the guide that you are in a plastic doll phase, and he will guide you back.

Another solution is to move to the internal biological flow. Follow the instructions given in the third vision: close your eyes, lie prone, seek bodily contact, float down into your bodily stream. In so doing, you are recapitulating the evolutionary sequence. For billions of years, inorganic energy danced the cosmic round before the biological rhythm began. Don't rush it.

If the guide senses that the person is experiencing plastic doll visions or is afraid of the uncontrollability of his own feeling, he should read to him the Instructions for Vision 5.

Vision 6: "The Retinal Circus"

Each of the Second Bardo visions thus far described was one aspect of the "experiencing of reality." The inner fire or outer waves, apprehended intellectually or emotionally - each vision with its correspondent traps. Each of the "Peaceful Deities" appears with its attendant "Wrathful Deities." To maintain any of these visions for any length of time requires a certain degree of concentration or "one-pointedness" of mind, as well as the ability to recognize them and not to be afraid. Thus, for most persons, the experience may pass through one or more of these phases without the voyager being able to hold them or stay with them. He may open and close his eyes, he may become alternately absorbed in internal sensations and external forms. The experience may be chaotic, beautiful, thrilling, incomprehensible, magical, ever-changing. [In the Bardo Thodol, on the sixth day appear the radiant lights of the combined Five Wisdoms of the Dhyani- Buddhas, the protective deities (gatekeepers of the mandala) and the Buddhas of the Six Realms of game-existence. According to Lama Govinda: "The Inner Way of Vajra-Sattva, consists in the combination of the rays of the Wisdoms of the four Dhyani-Buddhas and their absorption within one's own heart - in other words, in the recognition that all these radiances are the emanations of one's own mind in a state of perfect tranquility and serenity, a state in which the mind reveals its true universal nature." (Govinda, op., cit., p. 262.)]

He will travel freely through many worlds or experience - from direct contact with life-process forms and images, he may pass to visions of human game-forms. He may see and understand with unimagined clarity and brilliance various social and self-games that he and others play. His own struggles in karmic (game) existence will appear pitiful and laughable. Ecstatic freedom of consciousness is the keynote of this vision. Exploration of unimagined realms. Theatrical adventures. Plays within plays within plays. Symbols change into things symbolized and vice versa. Words become things, thoughts are music, music is smelled, sounds are touched, complete interchangeability of the senses.

All things are possible. All feelings are possible. A person may "try on" various moods like so many pieces of clothing. Subjects and objects whirl, transform, change into each other, merge, fuse, disperse again. External objects dance and sing. The mind plays upon them as upon a musical instrument. They assume any form, significance or quality upon command. They are admired, adored, analyzed, examined, changed, made beautiful or ugly, large or small, important or trivial, useful, dangerous, magical or incomprehensible. They may be reacted to with wonder, amazement, humor, veneration, love, disgust, fascination, horror, delight, fear, ecstasy.

Like a computer with unlimited access to any programs, the mind roams freely. Personal and racial memories bubble up to the surface of consciousness, inter-play with fantasies, wishes, dreams and external objects. A present event becomes charged with profound emotional significance, a cosmic phenomenon becomes identical with some personal quirk. Metaphysical problems are juggled and bounced around. Pure "primary process," spontaneous outopouring of association, opposites merging, images fusing, condensing, shifting, collapsing, expanding, merging, connecting.

This kaleidoscopic vision of game-reality may be frightening and confusing to an ill-prepared subject. Instead of exquisite clarity of many-levelled perception, he will experience a confused chaos of uncontrollable, meaningless forms. Instead of delight at the playful acrobatics of the free intellect, there will be anxious clinging to an elusive order. Morbid and scatological hallucinations may occur, evoking disgust and shame.

As before, this negative vision occurs only if the person attempts to control or rationalize the magic panorama. Relax and accept whatever comes. Remember that all visions are created by your mind, the happy and the unhappy, the beautiful and the ugly, the delightful and the horrifying. Your consciousness is creator, performer and spectator of the "retinal circus."

If the guide senses that the voyager is in or seems to be in the "retinal circus" vision, he may read to him the appropriate instructions Instructions For Vision 6: "The Retinal Circus".

Vision 7: "The Magic Theatre"

If the voyager was unable to maintain the passive serenity necessary for the contemplation of the previous visions (the peaceful deities), he moves now into a more dramatic and active phase. The play of forms and things becomes the play of heroic figures, superhuman spirits and demigods. [In the Tibetan Handbook, this is described as the vision of the five "Knowledge- Holding Deities," arranged in a mandala form, each embraced by Dakinis, in an ecstatic dance. The Knowledge-holding Deities symbolize "the highest level of individual or humanly conceivable knowledge, as attained in the consciousness of great Yogis, inspired thinkers or similar heroes of the spirit. They represent the last step before the "breaking-through" towards the universal consciousness - or the first on the return from there to the plane of human knowledge." (Govinda, op. cit., p. 202.) The Dakinis are female embodiments of knowledge, representing the inspirational impulses of consciousness leading to break-through. The other four Knowledge-Holders, besides the central Lord of Dance, are: the Knowledge-holder abiding in the earth, the Knowledge-holder who has power over the duration of life, the Knowledge-holder of the Great Symbol, and the Knowledge-holder of Spontaneous Realization.] You may see radiating figures in human forms. The "Lotus Lord of Dance": the supreme image of a demi-god who perceives the effects of all actions. The prince of movement, dancing in an ecstatic embrace with his female counterpart. Heroes, heroines, celestial warriors, male and female demi-gods, angels, fairies - the exact form of these figures will depend on the person's background and tradition. Archetypal figures in the forms of characters from Greek, Egyptian, Nordic, Celtic, Aztec, Persian, Indian, Chinese mythology. The shapes differ, the source is the same: they are the concrete embodiments of aspects of the person's own psyche. Archetypal forces below verbal awareness and expressible only in symbolic form. The figures are often extremely colorful and accompanied by a variety of awe-inspiring sounds. If the voyager is prepared and in a relaxed, detached frame of mind, he is exposed to a fascinating and dazzling display of dramatic creativity. The Cosmic Theatre. The Divine Comedy. If his eyes are open, he may visualize the other voyagers as representing these figures. The face of a friend may turn into that of a young boy, a baby, the child-god; into a heroic stature, a wise old man; a woman, animal, goddess, sea-mother, young girl, nymph, elf, goblin, leprechaun. Images of the great painters arise as the familiar representations of these spirits. The images are inexhaustible and manifold. An illuminating voyage into the areas where the personal consciousness merges with the supr-individual.

The danger is that the voyager becomes frightened by or unduly attracted to these powerful figures. The forces represented by them may be more intense than he was prepared for. Inability or unwillingness to recognize them as products of one's mind, leads to escape into animalistic pursuits. The person may become involved in the pursuit of power, lust, wealth and descend into Third Bardo rebirth struggles.

If the guide senses that the voyager is caught in this trap, the appropriate instructions may be used: Instructions For Vision 7: "The Magic Theatre".

The Wrathful Visions
(Second Bardo Nightmares)

Seven Second Bardo visions have been described. At each one of them, the voyager could recognize what he saw and be liberated. Multitudes will be liberated by that recognition; and although multitudes obtain liberation in that manner, the number of sentient beings being great, evil karma powerful, obscurations dense, propensities of too long standing, the Wheel of Ignorance and Illusion becomes neither exhausted nor accelerated. Despite the confrontations, there is a vast preponderance of those who wander downwards unliberated.

Thus, in the Tibetan Thodo, after the seven peaceful deities, there come seven visions of wrathful deities, fifty-eight in number, male and female, "flame-enhaloed, wrathful, blood-drinking." These Herukas as they are called, will not be described in detail, especially since Westerners are liable to experience the wrathful deities in different forms. Instead of many-headed fierce mythological demons, they are more likely to be engulfed and ground by impersonal machinery, manipulated by scientific, torturing control-devices and other space-fiction horrors. [Some general remarks about the Tibetan interpretation of these visions. The Wrathful Deities are regarded as "only the former Peaceful Deities in changed aspect." Lama Govinda writes: "The peaceful forms of Dhyani-Buddhas represent the highest ideal of Buddhahood in its completed, final, static condition of ultimate attainment or perfection, seen retrospectively as it were, as a state of complete rest and harmony. The Herukas, on the other hand, which are described as "blood-drinking," angry or "terrifying" deities - are merely the dynamic aspect of enlightenment, the process of becoming a Buddha, of attaining illumination, as symbolized by the Buddha's struggle with the Hosts of Mara... . The ecstatic figures, heroic and terrifying, express the act of breaking through towards the unthinkable, the intellectually "Unattainable." They represent the leap over the chasm, which yawns between an intellectual surface consciousness and the intuitive supra-personal depth-consciousness." (Govinda, op. cit., pp. 198, 202.)]

The Tibetans regard the nightmare visions as primarily intellectual products. They assign them to the Brain chakra, whereas the peaceful deities are assigned to the Heart chakra and the Knowledge-Holding deities to the intermediate Throat chakra. They are the reactions of the mind to the process of consciousness-expansion. They represent the attempts of the intellect to maintain its threatened boundaries. They symbolize the struggle of breaking through to ego-loss understanding and awareness.

Because of the terror and awe they produce, recognition is difficult. Yet in a way it is also easier in that, since these negative hallucinations command all attention, the mind is alert and therefore through trying to escape from fear and terror, people get involved in psychotic states and suffer. But with the aid of this manual and the presence of a guide, the voyager will recognize these hell visions as soon as he sees them, and welcome them like old friends.

Again, when psychologists, philosophers, and psychiatrists, who do not know these teachings, experience ego-loss - however assiduously they may have devoted themselves to academic study and however clever they may have been in expounding intellectual theories - none of the higher phenomena will appear. This is because they are unable to recognize the visions occurring in these psychedelic experiences. Suddenly seeing something they had never seen before and possessing no intellectual concepts, they view it as inimical; and, antagonistic feelings arising, they pass into miserable states. Thus, if one has not had practical experience with these teachings, the radiances and lights will not appear.

Those who believe in these doctrines even though they may seem to be unrefined, irregular in performance of duties, inelegant in habits, and perhaps even unable to practice the doctrine successfully - let no one doubt them or be disrespectful towards them, but pay reverence to their mystic faith. That alone will enable them to attain liberation. Elegance and efficiency of devotional practice are not necessary - just acquaintance with and trust in these teachings.

Well-prepared persons need not experience Second Bardo hell visions at all. Right from the beginning they can pass into paradisiacal states led by heroes, heroines, angels and super-spirits. "They will merge into rainbow radiance; there will be sun-showers, sweet scent of incense in the air, music in the skies, radiances."

This manual is indispensable to those students who are unprepared. Those proficient in meditation will recognize the Clear Light at the moment of ego-loss and will enter the Blissful Void (Dharma-Kaya). They will also recognize the positive and negative visions of the Second Bardo and obtain illumination (Sambhogha-Kaya); and being reborn on a higher level will become inspired saints or teachers (Nirmana-Kaya). The study and pursuit of enlightenment can always be taken up again at the point where it was broken by the last ego-loss, thus ensuring continuity of karma.

By the use of this manual, enlightenment can be obtained without meditation, through hearing alone. It can liberate even very heavy ego-game players. The distinction between those who know it and those who do not becomes very clear. Enlightenment follows instantly. Those who have been reached by it cannot have prolonged negative experiences.

The teaching concerning the hell-visions is the same as before; recognize them to be your own thought-forms, relax, float downstream. The Instructions For The Wrathful Visions may be read. If, after this, recognition is still impossible and liberation is not obtained, then the voyager will descend into the Third Bardo, the Period of Re-Entry.

Conclusion Of Second Bardo

However much experience one may have had, there is always the possibility of delusions occurring in these psychedelic states. Those with practice in meditation recognize the truth as soon as the experience begins. Reading this manual beforehand is important. Having some degree of self-knowledge is helpful at the moment of ego-death.

Meditation on the various positive and negative archetypal forms is very important for Second Bardo phases. Therefore, read this manual, keep it, remember it, bear it in mind, read it regularly; let the words and meanings be very clear; they should not be forgotten, even under extreme duress. It is called "The Great Liberation by Hearing" because even those with selfish deeds on their conscience can be liberated if they hear it. If heard only once, it can be efficacious because even though not understood, it will be remembered during the psychedelic state, since the mind is more lucid then. It should be proclaimed to all living persons; it should be read over the pillows of ill persons; it should be read to dying persons; it should be broadcast.

Those who meet this doctrine are fortunate. It is not easy to encounter. Even when read, it is difficult to comprehend. Liberation will be won simply through not disbelieving it upon hearing it.

Here ends the Second Bardo the Period of Hallucinations.

Third Bardo: The Period Of Re-Entry (Sidpa Bardo)

Introduction into Third Bardo

If, in the second Bardo, the voyager is incapable of holding on to the knowledge that the peaceful and wrathful visions were projections of his own mind, but became attracted to or frightened by one or more of them, he will enter the Third Bardo. In this period he struggles to regain routine reality and his ego; the Tibetans call it the Bardo of "seeking rebirth." It is the period in which the consciousness makes the transition from transcendent reality to the reality of ordinary waking life. The teachings of this manual are of the utmost importance if one wishes to make a peaceful and enlightened re-entry and avoid a violent or unpleasant one.

In the original Bardo Thodol the aim of the teachings is "liberation," i.e., release from the cycle of birth and death. Interpreted esoterically, this means that the aim is to remain at the stage of perfect illumination and not to return to social game reality.

Only persons of extremely advanced spiritual development are able to accomplish this, by exercising the Transference Principle at the moment of ego-death. For average persons who undertake a psychedelic voyage, the return to game reality is inevitable. Such persons can and should use this part of the manual for the following purposes:

1. to free themselves from Third Bardo traps;
2. to prolong the session, thus assuring a maximum degree of illumination;
3. to select a favorable re-entry, i.e., to return to a wiser and more peaceful post-session personality.

Although no definite time estimates can be given, the Tibetans estimate that about 50% of the entire psychedelic experience is spent in the Third Bardo by most normal people. At times, as indicated in the Introduction, someone may move straight to the re-entry period if he is unprepared for or frightened by the ego-loss experiences of the first two Bardos.

The types of re-entry made can profoundly color the person's subsequent attitudes and feelings about himself and the world, for weeks or even months afterwards. A session which has been predominantly negative and fearful can still be turned to great advantage and much can be learned from it, provided the re-entry is positive and highly conscious. Conversely, a happy and revelatory experience can be made valueless by a fearful or negative re-entry.

The key instructions of the Third Bardo are: (1) do nothing, stay calm, passive and relaxed, no matter what happens; and (2) recognize where you are. If you do not recognize you will be driven by fear to make a premature and unfavorable re-entry. Only by recognizing can you maintain that state of calm, passive concentration necessary for a favorable re-entry. That is why so many recognition-points are given. If you fail on one, it is always possible, up to the very end, to succeed on another. Hence these teachings should be read carefully and remembered well.

In the following sections some of the characteristic Third Bardo experiences are described. In Part IV instructions are given appropriate to each section. At this stage in a psychedelic session the voyager is usually capable of telling the guide verbally what he is experiencing, so that the appropriate sections can be read. A wise guide can often sense the precise nature of the ego's struggle without words. The voyager will usually not experience all of these states, but only one or some of them; or sometimes the return to reality can take completely new and unusual turns. In such a case the general instructions for the Third Bardo should be emphasized: Third Bardo: Preliminary Instructions.

I. General Description of the Third Bardo

Normally, the person descends, step by step, into lower (more constricted) states of consciousness. Each step downwards may be preceded by a swooning into unconsciousness. Occasionally the descent may be sudden, and the person will find himself jolted back to a vision of reality which by contrast with the preceding phases seems dull, static, hard, angular, ugly and puppet-like. Such changes can induce fear and horror and he may struggle desperately to regain familiar reality. He may get trapped into irrational or even bestial perspectives which then dominate his entire consciousness. These narrow primitive elements stem from aspects of his personal history which are usually repressed. The more enlightened consciousness of the first two Bardos and the civilized elements of ordinary waking life are shelved in favor of powerful, obsessive primitive impulses, which in fact are merely faded and incoherent instinctual parts of the voyager's total personality. The suggestibility of Bardo consciousness makes them seem all-powerful and overwhelming.

On the other hand, the voyager may also feel that he possesses supernormal powers of perception and movement, that he can perform miracles, extraordinary feats of bodily control etc. The Tibetan book definitely attributes paranormal faculties to the consciousness of the Bardo voyager and explains it as due to the fact that the Bardo-consciousness encompasses future elements as well as past. Hence clairvoyance, telepathy, ESP, etc. are said to be possible. Objective evidence does not indicate whether this sense of increased perceptiveness is real or illusory. We therefore leave this as an open question, to be decided by empirical evidence.

This then is the first recognition point of the Third Bardo. The feeling of supernormal perception and performance. Assuming that it is valid, the manual warns the voyager not to be fascinated by his heightened powers, and not to exercise them. In yogic practice, the most advanced of the lamas teach the disciple not to strive after psychic powers of this nature for their own sake; for until the disciple is morally fit to use them wisely, they become a serious impediment to his higher spiritual development. Not until the selfish, game-involved nature of man is completely mastered is he safe in using them.

A second sign of Third Bardo existence are experiences of panic, torture and persecution. They are distinguished from the wrathful visions fo the Second Bardo in that they definitely seem to involve the person's own "skin-encapsulated ego." Mind-controlling manipulative figures and demons of hideous aspects may be hallucinated. The form that these torturing demons take will depend on the person's cultural background. Where Tibetans saw demons and beasts of prey, a Westerner may see impersonal machinery grinding, or depersonalizing and controlling devices of different futuristic varieties. Visions of world destruction, dying in space-fiction modes, and hallucinations of being engulfed by destructive powers will likewise come; and sounds of the mind-controlling apparatus, of the "combine's fog machinery," of the gears which move the scenery of the puppet show, of angry overflowing seas, and of the roaring fire and of fierce winds springing up, and of mocking laughter.

When these sounds and visions come, the first impulse will be to flee from them in panic and terror, not caring where one goes, so long as one goes out. In psychedelic drug experiences, the person may at this time plead or demand to be brought "out of it" through antidotes and tranquilizers. The person may see himself as about to fall down deep, terrifying precipices. These symbolize the so-called evil passions which, like narcotic drugs, enslave and bind mankind to existence in game-networks (sangsara): anger, lust, stupidity, pride or egoism, jealousy, and control-power. Such experiences, just as the previous one of enhanced power, should be regarded as recognizing features of the Third Bardo. One should neither flee the pain nor pursue the pleasure. Recognition is all that is necessary - and recognition depends upon preparation.

A third sign is a kind of restless, unhappy wandering which may be purely mental or may involve actual physical movement. The person feels as if driven by winds (winds of karma) or shunted around mechanically. There may be brief respites at certain places or scenes in the "ordinary" human world. Like a person travelling alone at night along a highway, having his attention arrested by prominent landmarks, great isolated trees, houses, bridgeheads, temples, hot-dog stands, etc., the person in the re-entry period has similar experiences. He may demand to return to familiar haunts in the human world. But any such external placation is temporary and soon the restless wandering will recommence. There may come a desperate desire to phone or otherwise contact your family, your doctor, your friends and appeal to them to pull you out of the state. This desire should be resisted. The guide and the fellow voyagers can be of best assistance. One should not try to involve others in one's hallucinatory world. The attempt will fail anyway since outsiders are usually unable to understand what is happening. Again, merely to recognize these desires as Third Bardo manifestations is already the first step toward liberation.

A fourth, rather common experience is the following: the person may feel stupid and full of incoherent thoughts, whereas everyone else seems to be perfectly knowing and wise. This leads to feelings of guilt and inadequacy and in extreme from to the Judgment Vision, to be described below. This feeling of stupidity is merely the natural result of the limited perspective under which the consciousness is operating in this Bardo. Calm, relaxed acceptance and trust will enable the voyager to win liberation at this point

Another experience, the fifth recognizing feature, which is especially impressive when it occurs suddenly, is the feeling of being dead, cut off from surrounding life, and full of misery. The person may with a jolt awake from some trance-like swoon and experience himself and the others as lifeless robots, performing wooden meaningless gestures. He may feel that he will never come back and will lament his miserable state.

Again, such fantasies are to be recognized as the attempts of the ego to regain control. In the true state of ego-death, as it occurs in the First or Second Bardos, such complaints are never uttered.

Sixth, one may have the feeling of being oppressed or crushed or squeezed into cracks and crevices amidst rocks and boulders. Or the person may feel that a kind of metallic net or cage may encompass him. This symbolizes the attempt prematurely to enter an ego-robot which is unfitting or unequipped to deal with the expanded consciousness. Therefore one should relax the panicky desire to regain an ego.

A Seventh aspect is a kind of grey twilight-like light suffusing everything, which is in marked contrast to the brilliantly radiating lights and colors of the earlier stages of the voyage. Objects, instead of shining, glowing and vibrating, are now dully colored, shabby and angular.

The passages Third Bardo: Preliminary Instructions contain general instructions for the Third Bardo state and its recognizable features. Any or all of the passages may be read when the guide senses that the voyager is beginning to return to the ego.

II. Re-entry Visions

In the preceding section the symptoms of re-entry were described, the signs that the voyager is trying to regain his ego. In this section are described visions of the types of re-entry one can make.

The Tibetan manual conceives of the voyager as returning eventually to one of six worlds of game existence (sangsara). That is, the re-entry to the ego can take place on one of six levels, or as one of six personality types. Two of these are higher than the normal human, three are lower. The highest, most illuminated, level is that of the devas, who are what Westerners would call saints, sages or divine teachers. They are the most enlightened people walking the earth. Gautama Buddha, Lao Tse, Christ. The second level is that of the asuras, who may be called titans or heroes, people with a more than human degree of power and vision. The third level is that of most normal human beings, struggling through game-networks, occasionally breaking free. The fourth level is that of primitive and animalistic incarnations. In this category we have the dog and the cock, symbolic of hyper-sexuality concomitant with jealousy; the pig, symbolizing lustful stupidity and uncleanliness; the industrious, hoarding ant; the insect or worm signifying an earthy or grovelling disposition; the snake, flashing in anger; the ape, full of rampaging primitive power; the snarling "wolf of the steppes;" the bird, soaring freely. Many more could be enumerated. In all cultures of the world people have adopted identities in the image of animals. In childhood and in dreams it is a process familiar to all. The fifth level is that of neurotics, frustrated lifeless spirits forever pursuing unsatisfied desires; the sixth and lowest level is hell or psychosis. Less than one percent of ego-transcendent experiences end in sainthood or psychosis. Most persons return to the normal human level.

According to The Tibetan Book of the Dead, each of the six game worlds or levels of existence is associated with a characteristic sort of thraldom, from which non-game experiences give temporary freedom: (1) existence as a deva, or saint, although more desirable than the others, is concomitant with an ever-recurring round of pleasure, free game ecstasy; (2) existence as an asura, or titan, is concomitant with incessant heroic warfare; (3) helplessness and slavery are characteristic of animal existence; (4) torments of unsatisfied needs and wants are characteristic of the existence of pretas, or unhappy spirits; (5) the characteristic impediments of human existence are inertia, smug ignorance, physical or psychological handicaps or various sorts.

According to the Bardo Thodol, the level one is detained for is determined by one's karma. During the period of the Third Bardo premonitory signs and visions of the different levels appear, that for which one is heading appearing most clearly. For example, the voyager may feel full of godlike power (asuras), or he may feel himself stirred by primitive or bestial impulses, or he may experience that all-pervasive frustration of the unhappy neurotics, or shudder at the tortures of a self-created hell.

The chances of making a favorable re-entry are increased if the process is allowed to take its own natural course, without effort or struggle. One should avoid pursuing or fleeing any of the visions, but meditate calmly on the knowledge that all levels exist in the Buddha also.

One can recognize and examine the signs as they appear and learn a great deal about oneself in a very short time. Although it is unwise to struggle against or flee the visions that come in this period, the Instructions For Re-entry Visions are designed to help the voyager regain First Bardo transcendence. In this way, if the person finds himself about to return to a personality or ego which he finds inappropriate to his new knowledge about himself, he can, by following the instructions, prevent this and make a fresh re-entry.

III. The All-Determining Influence of Thought

Liberation may be obtained, by such confrontation, even though previously it was not. If, however, liberation is not obtained even after these confrontations, further earnest and continued application is essential.

Should you feel attachment to material possessions, to old games and activities, or if you get any because other people are still involved in pursuits that you have renounced, this will affect the psychological balance in such a way that even if destined to return at a higher level, you will actually re-enter on a lower level in the world of unsatisfied spirits (neurosis). On the other hand, even if you do feel attached to worldly games that you have renounced, you will not be able to play them, and they will be of no use to you. Therefore abandon weakness and attachment to them; cast them away wholly; renounce them from your heart. No matter who may be enjoying your possessions, or taking your role, have no feelings of miserliness or jealousy, but be prepared to renounce them willingly. Think that you are offering them to your internal freedom and to your expanded consciousness. Abide in the feeling of non-attachment, devoid of weakness and craving.

Again, when the activities of the other members of the session are wrong, careless, inattentive or distracting, when the agreement or contract is broken, and when purity of intention is lost by any participant, and frivolity and laxness take over (all of which can clearly be seen by the Bardo voyager) you may feel lack of faith and begin to doubt your beliefs. You will be able to perceive any anxiety or fear, any selfish actions, ego-centric conduct and manipulative behavior. You may think: "Alas! they are playing me false, they have cheated and deceived." If you think thus, you will become extremely depressed, and through great resentment you will acquire disbelief and loss of faith, instead of affection and humble trust. Since this affects the psychological balance, re-entry will certainly be made on an unpleasant level.

Such thinking will not only be of no use, but it will do great harm. However improper the behavior of other, think thus: "What? How can the words of a Buddha be inappropriate? It is like the reflection of blemishes on my own face which I see in a mirror; my own thoughts must be impure. As for these others, they are noble in body, holy in speech, and the Buddha is within them: their actions are lessons for me."

Thus thinking, put your trust in your companions and exercise sincere love towards them. Then whatever they do will be to your benefit. The exercise of that love is very important; do not forget this!

Again, even if you were destined to return to a lower level and are already going into that existence, yet through the good deeds of friends, relatives, participants, learned teachers who devote themselves wholeheartedly to the correct performance of beneficent rituals, the delight from your feeling greatly cheered at seeing them will, by its own virtue, so affect the psychological balance that even though heading downwards, you may yet rise to a higher and happier level. Therefore you should not create selfish thoughts, but exercise pure affection and humble faith towards all, impartially. This is highly important. Hence be extremely careful.

The Instructions For The All-Determing Influence Of Thought are useful in any phase of the Third Bardo, but particularly if the voyager is reacting with suspicion or resentment to other members of the group, or to his own friends and relatives.

IV. Judgment Visions

The judgment vision may come: the Third Bardo blame game. "Your good genius will count up your good deeds with white pebbles, the evil genius the evil deeds with black pebbles." A judgment scene is a central part of many religious systems, and the vision can assume various forms. Westerners are most likely to see it in the well-known Christian version. The Tibetans give a psychological interpretation to this as to all the other visions. The Judge, or Lord of Death, symbolizes conscience itself in its stern aspect of impartiality and love of righteousness. The "Mirror of Karma" (the Christian Judgment Book), consulted by the Judge, is memory. Different parts of the ego will come forward, some offering lame excuses to meet accusations, others ascribing baser motives to various deeds, counting apparently neutral deeds among the black ones; still others offering justifications or requests for pardon. The mirror of memory reflects clearly; lying and subterfuge will be of no avail. Be not frightened, tell no lies, face truth fearlessly.

No you may imagine yourself surrounded by figures who wish to torment, torture or ridicule you (the "Executive Furies of the Robot Lord of Death"). These merciless figures may be internal or they may involve the people around you, seen as pitiless, mocking, superior. Remember that fear and guilt and persecuting, mocking figures are your own hallucinations. Your own guilt machine. Your personality is a collection of thought-patterns and void. It cannot be harmed or injured. "Swords cannot pierce it, fire cannot burn it." Free yourself from your own hallucinations. In reality there is no such thing as the Lord of Death, or a justice-dispensing god or demon or spirit. Act so as to recognize this.

Recognize that you are in the Third Bardo. Meditate upon your ideal symbol. If you do not know how to meditate, then merely analyze with great care the real nature of that which is frightening you: "Reality" is nothing but a voidness (Dharma-Kaya). That voidness is not of the voidness of nothingness, but a voidness at the true nature of which you feel awed, and before which your consciousness shines more clearly and lucidly. [That is the state of mind known as "Sambhoga-Kaya." In that state, you experience, with unbearable intensity, Voidness and Brightness inseparable - the Voidness bright by nature and the Brightness inseparable from the Voidness - a state of the primordial or unmodified consciousness, which is the Adi-Kaya. And the power of this, shining unobstructedly, will radiate everywhere; it is the Nirmana-Kaya.

These refer to the fundamental Wisdom Teachings of the Bardo Thodol. In all Tibetan systems of yoga, realization of the Voidness is the one great aim. To realize it is to attain the unconditioned Dharma-Kaya, or "Divine Body of Truth," the primordial state of uncreatedness, of the supra-mundane All-Consciousness. The Dharma-Kaya is the highest of the three bodies of the Buddha and of all Buddhas and beings who have perfect enlightenment. The other two bodies are the Sambhoga-Kaya or "Divine Body of Perfect Endowment" and the Nirmana-Kaya or "Divine Body of Incarnation." Adi-Kaya is synonymous with Dharma-Kaya. The Dharma-Kaya is primordial, formless Essential Wisdom; it is true experience freed from all error or inherent or accidental obscuration. It includes both Nirvana and Sangsara, which are polar states of consciousness, but in the realm of pure consciousness identical. The Sambhoga-Kaya embodies, as in the five Dhyani Buddhas, Reflected or Modified Wisdom; and the Nirmana-Kaya embodies, as in the Human Buddhas, Practical or Incarnate Wisdom. All enlightened beings who are reborn in this or any other world with full consciousness, as workers for the betterment of their fellow creatures, are said to be Nirmana-Kaya incarnates. Lama Kazi Dawa-Samdup, the translator of the Bardo Thodol, held that the Adi-Buddha, and all deities associated with the Dharma-Kaya, are not to be regarded as personal deities, but as personifications of primordial and universal forces, laws or spiritual influences. "In the boundless panorama of the existing and visible universe, whatever shapes appear, whatever sounds vibrate, whatever radiances illuminate, or whatever consciousnesses cognize, all are the play of manifestation in the Tri-Kaya, the Three-fold Principle of the Cause of All Causes, the Primordial Trinity. Impenetrating all, is the All-Pervading Essence of Spirit, which is Mind. It is uncreated, impersonal, self-existing, immaterial and indestructible." The Tri-Kaya is the esoteric trinity and corresponds to the exoteric trinity of Buddha, the Scriptures and the Priesthood (or your own divinity, this manual and your companions).

If the voyager is struggling with guilt and penance hallucinations, the Instructions For Judgment Visions may be read.

V. Sexual Visions

Sexual visions are extremely frequent during the Third Bardo. You may see or imagine males and females copulating. [According to Jung. ("Psychological Commentary" to The Tibetan Book of the Dead, Evans-Wentz edition, p. xiii), "Freud's theory is the first attempt made in the West to investigate, as if from below, from the animal sphere of instinct the psychic territory that corresponds in Tantric Lamaism to the Sidpa Bardo." The vision described here, in which the person sees mother and father in sexual intercourse, corresponds to the "primal scene" in psychoanalysis. At this level, then, we begin to see a remarkable convergence of Eastern and Western psychology. Note also the exact correspondence to the psychoanalytic theory of the Oedipus Complex.] This vision may be internal or it may involve the people around you. You may hallucinate multi-person orgies and experience both desire and shame, attraction and disgust. You may wonder what sexual performance is expected of you and have doubts about your ability to perform at this time.

When these visions occur, remember to withhold yourself from action or attachment. Have faith and float gently with the stream. Trust in the unity of life and in your companions.

If you attempt to enter into your old ego because you are attracted or repulsed, if you try to join or escape from the orgy you are hallucinating, you will re-enter on an animal or neurotic level. If you become conscious of "malness," hatred of the father together with jealousy and attraction towards the mother will be experienced; if you become conscious of "femaleness," hatred of the mother together with attraction and fondness for the father is experienced.

It is perhaps needless to say that this kind of self-centered sexuality has little in common with the sexuality of transpersonal experiences. Physical union can be one expression or manifestation of cosmic union.

Visions of sexual union may sometimes be followed by visions of conception - you may actually visualize the sperm uniting with the ovum - , of intra-uterine life and birth through the womb. Some people claim to have re-lived their own physical birth in psychedelic sessions and occasionally confirming evidence for such claims has been put forward. Whether this is so or not may be left as a question to be decided by empirical evidence. Sometimes the birth visions will be clearly symbolic - e.g., emergence from a cocoon, breaking out of a shell, etc.

Whether the birth vision is constructed from memory or fantasy, the psychedelic voyager should try to recognize the signs indicating the type of personality that is being reborn.

The Instructions For Sexual Visions may be read to the voyager who is struggling with sexual hallucinations.

VI. Methods for Preventing the Re-Entry

Although many confrontations and recognition points have been given, the person may be ill-prepared and still be wandering back to game reality. It is of advantage to postpone the return for as long as possible, thus maximizing the degree of enlightenment in the subsequent personality. For this reason four meditative methods are given for prolonging the ego-loss state. They are (1) meditation on the Buddha or guide; (2) concentration on good games; (3) meditation on illusion; and (4) meditation on the void. See the Four Methods Of Preventing Re-entry. Each one attempts to lead the voyager back to the First Bardo central stream of energy from which he has been separated by game involvements. One may ask how these meditative methods, which seem difficult for the ordinary person, can be effective. The answer given in the Tibetan Bardo Thodol is that due to the increased suggestibility and openness of the mind in the psychedelic state these methods can be used by anyone, regardless of intellectual capacity, or proficiency in meditation.

VII. Methods of Choosing the Post-Session Personality

Choosing the post-session ego is an extremely profound art and should not be undertaken carelessly or hastily. One should not return fleeing from hallucinated tormentors. Such re-entry will tend to bring the person to one of the three lower levels. One should first banish the fear by visualizing one's protective figure or the Buddha; then choose calmly and impartially.

The limited foreknowledge available to the voyager should be used to make a wise choice. In the Tibetan tradition each of the levels of game-existence is associated with a particular color and also certain geographical symbols. These may be different for twentieth-century Westerners. Each person has to learn to decode his own internal road map. The Tibetan indicators may be used as a starting point. The purpose is clear: one should follow the signs of the three higher types and shun those of the three lower. One should follow light and pleasant visions and shun dark and dreary ones.

The world of saints (devas) is said to shine with a white light and to be preceded by visions of delightful temples and jewelled mansions. The world of heroes (asuras) has a green light and is signalled by magical forests and fire images. The ordinary human world has a yellow light. Animal existence is foreshadowed by a blue light and images of caves and deep holes in the earth. The world of neurotics or unsatisfied spirits has a red light and visions of desolate plains and forest wastes. The hell world emits a smoke-colored light and is preceded by sounds of wailing, visions of gloomy lands, black and white houses and black roads along which you have to travel.

Use your foresight to choose a good post-session robot. Do not be attracted to your old ego. Whether you choose to pursue power, or status, or wisdom, or learning, or servitude, or whatever, choose impartially, without being attracted or repelled. Enter into game existence with good grace, voluntarily and freely. Visualize it as a celestial mansion, i.e., as an opportunity to exercise game-ecstasy. Have faith in the protection of the deities and choose. The mood of complete impartiality is important since you may be in error. A game that appears good may later turn out to be bad. Complete impartiality, freedom from want or fear, ensure that a maximally wise choice is made.

As you return you see spread out before you the world, your former life, a planet full of fascinating objects and events. Each aspect of the return trip can be a delightful discovery. Soon you will be descending to take your place in worldly events. The key to this return voyage is simply this: take it easy, slowly, naturally. Enjoy every second. Don't rush. Don't be attached to your old games. Recognize that you are in the re-entry period. Do not return with any emotional pressure. Everything you see and touch can glow with radiance. Each moment can be a joyous discovery.

Here end the Third Bardo, The Period of Re-Entry.

General Conclusion

Well-prepared students with advanced spiritual understanding can use the "Transference" principle at the moment of ego-death and need not traverse subsequent Bardo states. They will rise to a state of illumination and remain there throughout the entire period. Others, who are a little less experienced in spiritual discipline, will recognize the Clear Light in the second stage of the First Bardo and will then win liberation. Others, at a still less advanced level, may be liberated while experiencing one of the positive or negative visions of the Second Bardo. Since there are several turning points, liberation can be obtained at one or the other through recognition at moments of confrontation. Those of very weak karmic connection, i.e., those who have been involved in heavy ego-dominated game- playing, will have to wander downwards to the Third Bardo. Again, many points for liberation have been charted. The weakest persons will fall under the influence of guilt and terror. For weaker persons there are various graded teachings for preventing the return to routine-reality, or at least for choosing it wisely. Through applying the methods of visualization described, they should be able to experience the benefits of the session. Even those persons whose familiar routines are primitive and egocentric can be prevented from entering into misery. Once they have experienced, for however short a period, the great beauty and power of free awareness, they may, in the next period, meet with a guide or friend who will initiate them further into the way.

The way in which this teaching is effective, even for a voyager already in the Sidpa Bardo, is as follows: each person has some positive and some negative game-residues (karma). The continuity of consciousness has been broken by an ego-death for which the person was not prepared. The teachings are like a trough in a broken water drain, temporarily restoring the continuity with positive karma. As stated before, the extreme suggestibility or detached quality of consciousness in this state ensures the efficacy of listening to the doctrine. The teaching embedded in this Manual may be compared to a catapult which can direct the person towards the goal of liberation. Or like the moving of a big wooden beam, which is so heavy that a hundred men cannot carry it, but by being floated on water it can be easily moved. Or it is like controlling a horse's bit and course by the use of a bridle.

Therefore, these teachings should be vividly impressed on the voyager, again and again. This Manual may also be used more generally. It should be recited as often as possible and committed to memory as far as possible. When ego-death or final death comes, recognize the symptoms, recite the Manual to yourself, and reflect upon the meaning. If you cannot do it yourself, ask a friend to read it to you. There is no doubt as to its liberative power.

It liberates by being seen or heard, without need of ritual or complex meditation. This Profound Teaching liberates those of great evil karma through the Secret Pathway. One should not forget its meaning and the words, even though pursued by seven mastiffs. By this Select Teaching, one obtains Buddhahood at the moment of ego-loss. Were the Buddhas of past, present and future to seek, they could not find any doctrine transcending this.

Here ends the Bardo Thodol, known as The Tibetan Book of the Dead.

III. Some Technical Comments About Psychedelic Sessions

1. Use of This Manual

The most important use of this manual is for preparatory reading. Having read the Tibetan Manual, one can immediately recognize symptoms and experiences which might otherwise be terrifying, only because of lack of understanding as to what was happening. Recognition is the key word.

Secondly, this guidebook may be used to avoid paranoid traps or to regain the First Bardo transcendence if it has been lost. If the experience starts with light, peace, mystic unity, understanding, and if it continues along this path, then there is no need to remember this manual of have this manual re-read to you. Like a road map, we consult it only when lost, or when we wish to change course. Usually, however, the ego clings to its old games. There may be momentary discomfort or confusion. If this happens, the others present should not be sympathetic or show alarm. They should be prepared to stay calm and restrain their "helping games." In particular, the "doctor" role should be avoided.

If at any time you find yourself struggling to get back to routine reality, you can (by pre-arrangement) have a more experienced person, a fellow-voyager, or a trusted observer read parts of this manual to you.

Passages suitable for reading during the session are given in Part IV below. Each major descriptive section of the Tibetan Book has an appropriate instruction text. One may want to pre-record selected passages and simply flick on the recorder when desired. The aim of these instruction texts is always to lead the voyager back to the original First Bardo transcendence and to help maintain that as long as possible.

A third use would be to construct a "program" for a session using passages from the text. The aim would be to lead the voyager to one of the visions deliberately, or through a sequence of visions. The guide or friend could read the relevant passages, show slides or pictures or symbolic figures of processes, play carefully selected music, etc. One can envision a high art of programming psychedelic sessions, in which symbolic manipulations and presentations would lead the voyager through ecstatic visionary Bead Games.

2. Planning a Session

In planning a session, the first question to be decided is "what is the goal?" Classic Hinduism suggest four possibilities:

(1) For increased personal power, intellectual understanding, sharpened insight into self and culture, improvement of life situation, accelerated learning, professional growth.

(2) For duty, help of others, providing care, rehabilitation, rebirth for fellow men.

(3) For fun, sensuous enjoyment, aesthetic pleasure, interpersonal closeness, pure experience.

(4) For transcendence, liberation from ego and space-time limits; attainment of mystical union.

This manual aims primarily at the latter goal - that of liberation-enlightenment. This emphasis does not preclude attainment of the other goals - in fact, it guarantees their attainment because illumination requires that the person be able to step out beyond game problems of personality, role, and professional status. The initiate can decide beforehand to devote the psychedelic experience to any of the four goals. The manual will be of assistance in any event.

If there are several people having a session together they should either agree collaboratively on a goal, or at least be aware of each other's goals. If the session is to be "programmed" then the participants should either agree on or design a program collaboratively, or they should agree to let one member of the group do the programming. Unexpected or undesired manipulations by one of the participants can easily "trap the other voyagers into paranoid Third Bardo delusions.

The voyager, especially in an individual session, may also wish to have either an extroverted or an introverted experience. In the extroverted transcendent experience, the self is ecstatically fused with external objects (e.g. flowers, or other people). In the introverted state, the self is ecstatically fused with internal life processes (lights, energy-waves, bodily events, biological forms, etc.). Of course, either the extroverted or the introverted state may be negative rather than positive, depending on the attitude of the voyager. Also it may be primarily conceptual or primarily emotional. The eight types of experience thus derived (four positive and four negative) have been described more fully in Visions 2 to 5 of the Second Bardo.

For the extroverted mystic experience one would bring to the session objects or symbols to guide the awareness in the desired direction. Candles, pictures, books, incense, music or recorded passages. An introverted mystic experience requires the elimination of all stimulation; no light, no sound, no smell, no movement.

The mode of communication with the other participants should also be agreed on beforehand. You may agree on certain signals, silently indicating companionship. You may arrange for physical contact - clasping hands, embracing. These means of communication should be pre-arranged to avoid game-misinterpretations that may develop during the heightened sensitivity of ego-transcendence.

3. Drugs and Dosages

A wide variety of chemicals and plants have psychedelic ("mind manifesting") effects. The most widely used substances are listed here together with dosages adequate for a normal adult of average size. The dosage to be taken depends, of course, on the goal of the session. Two figures are therefore given. The first column indicates a dosage which should be sufficient for an inexperienced person to enter the transcendental worlds described in this manual. The second column gives a smaller dosage figure, which may be used by more experienced persons or by participants in a group session.

- LSD-25 (lysergic acid diethylamide) 200-500 micrograms 100-200 micrograms
- Mescaline 600-800 mg 300-500 mg
- Psilocybin 40-60 mg 20-30 mg

The time of onset, when the drugs are taken orally on an empty stomach, is approximately 20-30 minutes for LSD and psilocybin, and one to two hours for mescaline. The duration of the session is usually eight to ten hours for LSD and mescaline, and five to six hours for psilocybin. DMT (dimethyltryptamine), when injected intramuscularly in dosages of 50-60 mg, gives an experience approximately equivalent to 500 micrograms of LSD, but which lasts only 30 minutes.

Some person have found it useful to take other drugs before the session. A very anxious person, for example, may take 30 to 40 mg of Librium about on hour earlier, to calm and relax himself. Methedrine has also been used to induced a pleasant, euphoric mood prior to the session. Sometimes, with excessively nervous persons, it is advisable to stagger the drug administration: for example, 200 micrograms of LSD may be taken initially, and a "booster" of another 200 micrograms may be taken after the person has become familiar with some of the effects of the psychedelic state. Nausea may sometimes occur. Usually this is a mental symptom, indicating fear, and should be regarded as such. Sometimes, however, particularly with the use of morning-glory seeds and peyote, the nausea can have a physiological cause. Anti-nauseant drugs such as Marezine, Bonamine, Dramamine or Tigan, may be taken beforehand to prevent this.

If a person becomes trapped in a repetitive game-routine during a session, it is sometimes possible to "break the set" by administering 50 mg of DMT, or even 25 mg of Dexedrine or Methedrine. Such additional dosages, of course, should only be given with the person's own knowledge and consent.

Should external emergencies call for it, Thorazine (100-200 mg, i.m.) or other phenothiazine-type tranquilizers will terminate the effects of psychedelic drugs. Antidotes should not be used simply because the voyager or the guide is frightened. Instead, the appropriate sections of the Third Bardo should be read. [Further, more detailed suggestions concerning dosage may be found in a paper by Gary M. Fisher: "Some Comments Concerning Dosage Levels of Psychedelic Compounds for Psychotherapeutic Experiences." Psychedelic Review, I, no.2, pp. 208-218, 1963.]

4. Preparation

Psychedelic chemicals are not drugs in the usual sense of the word. There is no specific reaction, no expected sequence of events, somatic or psychological.

The specific reaction has little to do with the chemical and is chiefly a function of set and setting; preparation and environment. The better the preparation, the more ecstatic and revelatory the session. In initial sessions and with unprepared persons, setting - particularly the actions of others - is most important. With persons who have prepared thoughtfully and seriously, the setting is less important.

There are two aspects of set: long-range and immediate.

Long-range set refers to the personal history, the enduring personality. The kind of person you are - your fears, desires, conflicts, guilts, secret passions - determines how you interpret and manage any situation you enter, including a psychedelic session. Perhaps more important are the reflex mechanisms used when dealing with anxiety - the defenses, the protective maneuvers typically employed. Flexibility, basic trust, religious faith, human openness, courage, interpersonal warmth, creativity, are characteristics which allow for fun and easy learning. Rigidity, desire to control, distrust, cynicism, narrowness, cowardice, coldness, are characteristics which make any new situation threatening. Most important is insight. No matter how many cracks in the record, the person who has some understanding of his own recording machinery, who can recognize when he is not functioning as he would wish, is better able to adapt to any challenge - even the sudden collapse of his ego.

The most careful preparation would include some discussion of the personality characteristics and some planning with the guide as to how to handle expected emotional reactions when they occur.

Immediate set refers to the expectations about the session itself. Session preparation is of critical importance in determining how the experience unfolds. People tend naturally to impose their personal and social game perspectives on any new situation. Careful thought should precede the session to prevent narrow sets being imposed.

Medical expectations. Some ill-prepared subjects unconsciously impose a medical model on the experience. They look for symptoms, interpret each new sensation in terms of sickness/health, place the guide in a doctor-role, and, if anxiety develops, demand chemical rebirth - i.e., tranquilizers. Occasionally one hears of casual, ill-planned, non-guided sessions which end in the subject demanding to be hospitalized, etc. It is even more problem-provoking if the guide employs a medical model, watches for symptoms, and keeps hospitalization in mind to fall back on, as protection for himself.

Rebellion against convention may be the motive of some people who take the drug. The idea of doing something "far out" or vaguely naughty is a naive set which can color the experience.

Intellectual expectations are appropriate when subjects have had much psychedelic experience. Indeed, LSD offers vast possibilities for accelerated learning and scientific-scholarly research. But for initial sessions, intellectual reactions can become traps. The Tibetan Manual never tires of warning about the dangers of rationalization. "Turn you mind off" is the best advice for novitiates. Control of your consciousness is like flight instruction. After you have learned how to move your consciousness around - into ego-loss and back, at will - then intellectual exercises can be incorporated into the psychedelic experience. The last stage of the session is the best time to examine concepts. The objective of this particular manual is to free you from you verbal mind for as long as possible.

Religious expectations invite the same advice as intellectual set. Again, the subject in early sessions is best advised to float with the stream, stay "up" as long as possible, and postpone theological interpretations until the end of the session, or to later sessions.

Recreational and aesthetic expectations are natural. The psychedelic experience, without question, provides ecstatic moments which dwarf any personal or cultural game. Pure sensation can capture awareness. Interpersonal intimacy reaches Himalayan heights. Aesthetic delights - musical, artistic, botanical, natural -

are raised to the millionth power. But all these reactions can be Third Bardo ego games: "I am having this ecstasy. How lucky I am!" Such reactions can become tender traps, preventing the subject from reaching pure ego-loss (First Bardo) or the glories of Second Bardo creativity.

Planned expectations. This manual prepares the person for a mystical experience according to the Tibetan model. The Sages of the Snowy Ranges have developed a most sophisticated and precise understanding of human psychology, and the student who studies this manual will become oriented for a voyage which is much richer in scope and meaning than any Western psychological theory. We remain aware, however, that the Bardo Thodol model of consciousness is a human artifact, a Second Bardo hallucination, however grand its scope.

Some practical recommendations. The subject should set aside at least three days for his experience; a day before, the session day, and a follow-up day. This scheduling guarantees a reduction in external pressure and a more sober commitment to the voyage.

Talking to others who have taken the voyage is excellent preparation, although the Second Bardo hallucinatory quality of all descriptions should be recognized. Observing a session is another valuable preliminary. The opportunity to see others during and after a session shapes expectations.

Reading books about mystical experience is a standard orientation procedure. Reading the accounts of others' experiences is another possibility (Aldous Huxley, Alan Watts, and Gordon Wasson have written powerful accounts).

Meditation is probably the best preparation for a psychedelic session. Those who have spent time in the solitary attempt to manage the mind, to eliminate thought and to reach higher stages of concentration, are the best candidates for a psychedelic session. When the ego-loss state occurs, they are ready. They recognize the process as an end eagerly awaited, rather than a strange event ill-understood.

5. The Setting

The first and most important thing to remember, in the preparation for a psychedelic session, is to provide a setting which is removed from one's usual social and interpersonal games and which is as free as possible from unforeseen distractions and intrusions. The voyager should make sure that he will not be disturbed by visitors or telephone calls, since these will often jar him into hallucinatory activity. Trust in the surroundings and privacy are necessary.

A period of time (usually at least three days) should be set aside in which the experience will run its natural course and there will be sufficient time for reflections and meditation. It is important to keep schedules open for three days and to make these arrangements beforehand. A too-hasty return to game-involvements will blur the clarity of the vision and reduce the potential for learning. If the experience was with a group, it is very useful to stay together after the session in order to share and exchange experiences.

There are differences between night sessions and day sessions. Many people report that they are more comfortable in the evening and consequently that their experiences are deeper and richer. The person should choose the time of day that seems right according to his own temperament at first. Later, he may wish to experience the difference between night and day sessions.

Similarly, there are differences between sessions out-of-doors and indoors. Natural settings such as gardens, beaches, forests, and open country have specific influences which one may or may not wish to incur. The essential thing is to feel as comfortable as possible in the surroundings, whether in one's living room or under the night sky. A familiarity with the surroundings may help one to feel confident in hallucinatory periods. If the session is held indoors, one must consider the arrangement of the room and the specific objects one may wish to see and hear during the experience.

Music, lighting, the availability of food and drink, should be considered beforehand. Most people report no desire for food during the height of the experience, and then, later on, prefer to have simple, ancient foods like bread, cheese, wine, and fresh fruit. Hunger is usually not the issue. The senses are wide open, and the taste and smell of a fresh orange are unforgettable.

In group sessions, the arrangement of the room is quite important. People usually will not feel like walking or moving very much for a long period, and either beds or mattresses should be provided. The arrangement of the beds or mattresses can vary. One suggestion is to place the heads of the beds together to form a star pattern. Perhaps one may want to place a few beds together and keep one or two some distance apart for anyone who wishes to remain aside for some time. Often, the availability of an extra room is desirable for someone who wishes to be in seclusion for a period.

If it is desired to listen to music or to reflect on paintings or religious objects, one should arrange these so that everyone in the group feels comfortable with what they are hearing or seeing. In a group session, all decisions about goals, setting, etc. should be made with collaboration and openness.

6. The Psychedelic Guide

For initial sessions, the attitude and behavior of the guide are critical factors. He possesses enormous power to shape the experience. With the cognitive mind suspended, the subject is in a heightened state of suggestibility. The guide can move consciousness with the slightest gesture or reaction.

The key issue here is the guide's ability to turn off his own ego and social games - in particular, to muffle his own power needs and his fears. To be there relaxed, solid, accepting, secure. The Tao wisdom of creative quietism. To sense all and do nothing except to let the subject know your wise presence.

A psychedelic session lasts up to twelve hours and produces moments of intense, intense, INTENSE reactivity. The guide must never be bored, talkative, intellectualizing. He must remain calm during the long periods of swirling mindlessness.

He is the ground control in the airport tower. Always there to receive messages and queries from high-flying aircraft. Always ready to help navigate their course, to help them reach their destination. An airport-tower-operator who imposes his own personality, his own games upon the pilot is unheard of. The pilots have their own flight plan, their own goals, and ground control is there, ever waiting to be of service.

The pilot is reassured to know that an expert who has guided thousands of flights is down there, available for help. But suppose the flier has reason to suspect that ground control is harboring his own motives and might be manipulating the plane toward selfish goals. The bond of security and confidence would crumble.

It goes without saying, then, that the guide should have had considerable experience in psychedelic sessions himself and in guiding others. To administer psychedelics without personal experience is unethical and dangerous.

The greatest problem faced by human beings in general, and the psychedelic guide in particular, is fear. Fear of the unknown. Fear of losing control. Fear of trusting the genetic process and your companions. From our own research studies and our investigations into sessions run by others - serious professionals or adventurous bohemians - we have been led to the conclusion that almost every negative LSD reaction has been caused by fear on the part of the guide which has augmented the transient fear of the subject. When the guide acts to protect himself, he communicates his concern to the subject.

The guide must remain passively sensitive and intuitively relaxed for several hours. This is a difficult assignment for most Westerners. For this reason, we have sought ways to assist the guide in maintaining a state of alert quietism in which he is poised with ready flexibility. The most certain way to achieve this state is for the guide to take a low dose of the psychedelic with the subject. Routine procedure is to have one trained person participate in the experience and one staff member present in ground control without psychedelic aid.

The knowledge that one experienced guide is "up" and keeping the subject company, is of inestimable value; intimacy and communication; cosmic companionship; the security of having a trained pilot flying at your wing tip; the scuba diver's security in the presence of an expert comrade in the deep.

It is not recommended that guides take large doses during sessions for new subjects. The less experienced he is, the more likely will the subject impose Second and Third Bardo hallucinations. These intense games affect the experienced guide, who is likely to be in a state of mindless void. The guide is then pulled into the hallucinatory field of the subject, and may have difficulty orienting himself. During the First Bardo there are no familiar fixed landmarks, no place to put your foot, no solid concept upon which to base your thinking. All is flux. Decisive Second Bardo action on the part of the subject can structure the guide's flow if he has taken a heavy dose.

The role of the psychedelic guide is perhaps the most exciting and inspiring role in society. He is literally a liberator, one who provides illumination, one who frees men from their life-long internal bondage. To be present at the moment of awakening, to share the ecstatic revelation when the voyager discovers the wonder and awe of the divine life-process, is for many the most gratifying part to play in the evolutionary drama. The role of the psychedelic guide has a built-in protection against professionalism and didactic oneupmanship. The psychedelic liberation is so powerful that it far outstrips earthly game ambitions. Awe and gratitude - rather than pride - are the rewards of this new profession.

7. Composition of the Group

The most effective use of this manual will be for the experience of one person with a guide. However, the manual will be useful in a group also. When used in a group session, the following suggestions will be most helpful in planning.

The important thing to remember in organizing a group session is to have knowledge of and trust in the fellow voyagers. Trust in oneself and in one's companions is essential. If preparing for an experience with strangers, it is very important to share as much time and space as possible with them prior to the session. The participants should set collaborative goals and explore mutually their expectations and feelings and past experiences.

The size of the group should depend to some extent on how much experience the participants have had. Initially, small groups are preferable to larger ones. In any case, group experiences exceeding six or seven people are demonstrably less profound and generate more paranoid hallucinations. If planning for a group session of five or six people, it is preferable to have at least two guides present. One will take the psychedelic substance and the other, who does not, serves as a practical guide to take care of such concerns as changing the recordings, providing food, etc., and if necessary or desired, reading selections from the manual. If it is possible, one of the guides should be an experienced woman who can provide an atmosphere of spiritual nurturing and comfort.

It is sometimes advisable that the initial session of married couples be separate in order that the exploration of their marriage game not dominate the session. With some experience in consciousness-expansion, the marriage game like others may be explored for any purpose - increased intimacy, clearer communication, exploration of the foundations of the sexual, mating relationship, etc.

IV. Instructions For Use During A Psychedelic Session

First Bardo Instructions

O (name of voyager)
The time has come for you to seek new levels of reality.
Your ego and the (name) game are about to cease.
Your are about to be set face to face with the Clear Light
Your are about to experience it in its reality.
In the ego-free state, wherein all things are like the void and cloudless sky,
And the naked spotless intellect is like a transparent vacuum;
At this moment, know yourself and abide in that state.

O (name of voyager),
That which is called ego-death is coming to you.
Remember:
This is now the hour of death and rebirth;
Take advantage of this temporary death to obtain the perfect state -
Enlightenment.
Concentrate on the unity of all living beings.
Hold onto the Clear Light.
Use it to attain understanding and love.

If you cannot maintain the bliss of illumination and if you are slipping back
into contact with the external world,
Remember:
The hallucinations which you may now experience,
The visions and insights,
Will teach you much about yourself and the world.
The veil of routine perception will be torn from you eyes.
Remember the unity of all living things.
Remember the bliss of the Clear Light.
Let it guide you through the visions of this experience.
Let it guide you through your new life to come.
If you feel confused; call upon the memory of your friends and the power of
the person whom you most admire.

O (name),
Try to reach and keep the experience of the Clear Light.
Remember:
The light is the life energy.
The endless flame of life.
An ever-changing surging turmoil of color may engulf your vision.
This is the ceaseless transformation of energy.
The life process.
Do not fear it.
Surrender to it.
Join it.
It is part of you.
You are part of it.
Remember also:
Beyond the restless flowing electricity of life is the ultimate reality -
The Void.
Your own awareness, not formed into anything possessing form or color,
is naturally void.

The Final Reality.
The All Good.
The All Peaceful.
The Light.
The Radiance.
The movement is the fire of life from which we all come.
Join it.
It is part of you.
Beyond the light of life is the peaceful silence of the void.
The quiet bliss beyond all transformations.
The Buddha smile.
The Void is not nothingness.
The Void is beginning and end itself.
Unobstructed; shining, thrilling, blissful.
Diamond consciousness.
The All-Good Buddha.
Your own consciousness, not formed into anything,
No thought, no vision, no color, is void.
The intellect shining and blissful and silent -
This is the state of perfect enlightenment.
Your own consciousness, shining, void and inseparable from the great body
of radiance, has no birth, nor death.
It is the immutable light which the Tibetans call Buddha Amitabha,
The awareness of the formless beginning.
Knowing this is enough.
Recognize the voidness of your own consciousness to be Buddhahood.
Keep this recognition and you will maintain the state of the divine mind
of the Buddha.

Second Bardo Preliminary Instructions

Remember:
In this session you experience three Bardos,
Three states of ego-loss.
First there is the Clear Light of Reality.
Next there are fantastically varied game hallucinations.
Later you will reach the stage of Re-Entry
Of regaining an ego.

O friend,
You may experience ego-transcendence,
Departure from your old self.
But you are not the only one.
It comes to all at some time.
You are fortunate to have this gratuitously given rebirth experience.
Do not cling in fondness and weakness to your old self.
Even though you cling to your mind, you have lost the power to keep it.
You can gain nothing by struggling in this hallucinatory world.
Be not attached.
Be not weak.
Whatever fear or terror may come to you
Forget not these words.
Take their meaning into your heart.
Go forward.
Herein lies the vital secret of recognition.

O friend, remember:
When body and mind separate, you experience a glimpse of the pure truth -
Subtle, sparkling, bright,
Dazzling, glorious, and radiantly awesome,
In appearance like a mirage moving across a landscape in springtime.
One continuous stream of vibrations.
Be not daunted thereby,
Nor terrified, nor awed.
That is the radiance of your own true nature.
Recognize it.

From the midst of that radiance
Comes the natural sound of reality,
Reverberating like a thousand thunders simultaneously sounding.
That is the natural sound of your own life process.
Be not daunted thereby,
Nor terrified, nor awed.
It is sufficient for you to know that these apparitions are your own thought-forms.
If you do not recognize your own thought forms,
If you forget your preparation,
The lights will daunt you,
The sounds will awe you,
The rays will terrify you,
The people around you will confuse you.
Remember the key to the teachings.

O friend,
These realms are not come from somewhere outside your self,
They come from within and shine upon you.
The revelations too are not come from somewhere else;
They exist from eternity within the faculties of your own intellect.
Know them to be of that nature.

The key to enlightenment and serenity during this period of ten thousand
visions is simply this:
Relax.
Merge yourself with them.
Blissfully accept the wonders of your own creativity.
Become neither attached nor afraid,
Neither be attracted nor repulsed.
Above all, do nothing about the visions.
They exist only within you.

Instructions For Vision 1: The Source
(Eyes closed, external stimuli ignored)

O nobly-born, listen carefully:
The Radiant Energy of the Seed
From which come all living forms,
Shoots forth and strikes against you
With a light so brilliant that you will scarcely be able to look at it.
Do not be frightened.
This is the Source Energy which has been radiating for billions of years,
Ever manifesting itself in different forms.
Accept it.
Do not try to intellectualize it.

Do not play games with it.
Merge with it.
Let it flow through you.
Lose yourself in it.
Fuse in the Halo of Rainbow Light
Into the core of the energy dance.
Obtain Buddhahood in the Central Realm of the Densely Packed.

Instructions For Physical Symptoms

O friend, listen carefully.
The bodily symptoms you are having are not drug-effects.
They indicate that you are struggling against the awareness of feelings which surpass your normal experience.
You cannot control these universal energy-waves.
Let the feelings melt all over you.
Become part of them.
Sink into them and through them.
Allow yourself to pulsate with the vibrations surrounding you.
Relax.
Do not struggle.
Your symptoms will disappear as soon as all trace of ego-centered striving disappears.
Accept them as the message of the body.
Welcome them. Enjoy them.

Instructions For Vision 2: The Internal Flow Of Archetypal Processes
(Eyes closed, external stimuli ignored; intellectual aspects)

O nobly born, listen carefully:
The life flow is whirling through you.
An endless parade of pure forms and sounds,
Dazzlingly brilliant,
Ever-changing.
Do not try to control it.
Flow with it.
Experience the ancient cosmic myths of creation and manifestation.
Do not try to understand;
There is plenty of time for that later.
Merge with it.
Let it flow through you.
There is no need to act or think.
You are being taught the great lessons of evolution, creation, reproduction.
If you try to stop it, you may fall into hell-worlds and endure unbearable misery generated by your own mind.
Avoid game interpretations.
Avoid thinking, talking and doing.
Keep faith in the life flow.
Trust your companions on this watery journey.
Merge in Rainbow Light,
Into the Heart of The River of Created Forms.
Obtain Buddhahood in the Realm called Pre-Eminently Happy.

Instructions For Vision 3: The Fire-Flow Of Internal Unity (Eyes closed, external stimuli ignored, emotional aspects)

O nobly born, listen carefully:
You are flowing outward into the fluid unity of life.
The ecstasy of organic fire glows in every cell.
The hard, dry, brittle husks of your ego are washing out,
Washing out to the endless sea of creation.
Flow with it.
Feel the pulse of the sun's heart.
Let the red Buddha Amitabha sweep you along.
Do not fear the ecstasy.
Do not resist the flow.
Remember, all the exultant power comes from within.
Release your attachment.
Recognize the wisdom of your own blood.
Trust the tide-force pulling you into unity with all living forms.
Let your heart burst in love for all life.
Let your warm blood gush out into the ocean of all life.
Do not be attached to the ecstatic power;
It comes from you.
Let it flow.
Do not try to hold on to your old bodily fears.
Let your body merge with the warm flux.
Let your roots sink into the warm life body.
Merge into the Heart-Glow of the Buddha Amitabha.
Float in the Rainbow Sea.
Attain Buddhahood in the Realm named Exultant Love.

Instructions For Vision 4: The Wave-Vibration Structure Of External Forms (Eyes open, rapt involvement with the external visual stimuli, intellectual aspects)

O nobly born, listen carefully:
At this point you can become aware of the wave structure of the world around you.
Everything you see dissolves into energy vibrations.
Look closely and you will tune in on the electric dance of energy.
There are no longer things and persons but only the direct flow of particles.
Consciousness will now leave your body and flow into the stream of wave rhythm.
There is no need for talk or action.
Let your brain become a receiving set for the radiance.
All interpretations are the products of your own mind.
Dispel them. Have no fear.
Exult in the natural power of your own brain,
The wisdom of your own electricity.
Abide in the state of quietude.
As the three-dimensional world fragments, you may feel panic;
You may beget a fondness for the heavy dull world of objects you are leaving.
At this time, fear not the transparent, radiant, dazzling wave energy.

Allow your intellect to rest.
Fear not the hook-rays of the light of life,
The basic structure of matter,
The basic form of wave communication.
Watch quietly and receive the message.
You will now experience directly the revelation of primal forms.

Instructions For Vision 5: The Vibratory Waves Of External Unity (Eyes open; rapt involvement with external stimuli such as lights, or movements; emotional aspects)

O nobly born, listen carefully:
You are experiencing the unity of all living forms.
If people seem to you rubbery and lifeless, like plastic puppets,
Be not afraid.
This is only the attempt of the ego to maintain its separate identity.
Allow yourself to feel the unity of all.
Merge with the world around you.
Be not afraid.
Enjoy the dance of the puppets.
They are created by your own mind.
Allow yourself to relax and feel the ecstatic energy-vibrations pulsing through you.
Enjoy the feeling of complete one-ness with all life and all matter.
The glowing radiance is a reflection of your own consciousness.
It is one aspect of your divine nature.
Do not be attached to your old human self.
Do not be alarmed at the new and strange feelings you are having.
If you are attracted to your old self,
You will be reborn shortly for another round of game-existence.
Exercise humble trust and remain fearless.
You will merge into the heart of the Blessed Ratnasambhava,
In a Halo of Rainbow Light,
And attain liberation in the Realm Endowed with Glory.

Instructions For Vision 6: "The Retinal Circus"

O nobly born, listen well:
You are now witnessing the magical dance of forms.
Ecstatic kaleidoscopic patterns explode around you.
All possible shapes come to life before you eyes.
The retinal circus.
The ceaseless play of elements -
Earth, water, air, fire,
In ever-changing forms and manifestations,
Dazzles you with its complexity and variety.
Relax and enjoy the rushing stream.
Do not become attached to any vision or revelation.
Let everything flow through you.
If unpleasant experiences come,
Let them flit by with the rest.
Do not struggle against them.
It all comes from within you.
This is the great lesson in the creativity and power of the brain, freed from

its learned structures.
Let the cascade of images and associations take you where it will.
Meditate calmly on the knowledge that all these visions are emanations of your own consciousness.
This way you can obtain self-knowledge and be liberated.

Instructions For Vision 7: "The Magic Theatre"

O nobly born, listen well:
You are now in the magic theatee of heroes and demons.
Mythical superhuman figures.
Demons, goddesses, celestial warriors, giants,
Angels, Bodhisattvas, dwarfs, crusaders,
Elves, devils, saints, and sorcerers,
Infernal spirits, goblins, knights and emperors.
The Lotus Lord of Dance.
The Wise Old Man. The Divine Child.
The Trickster, The Shapeshifter.
The tamer of monsters.
The mother of gods, the witch.
The moon king. The wanderer.
The whole divine theater of figures representing the highest reaches of human knowledge.
Do not be afraid of them.
They are within you.
Your own creative intellect is the master magician of them all.
Recognize the figures as aspects of your self.
The whole fantastic comedy takes place within you.
Do not become attached to the figures.
Remember the teachings.
You may still attain liberation.

Instructions For The Wrathful Visions

O nobly born, listen carefully:
You were unable to maintain the perfect Clear Light of the First Bardo.
Or the serene peaceful visions of the Second.
You are now entering Second Bardo nightmares.
Recognize them.
They are your own thought-forms made visible and audible.
They are products of your own mind with its back to the wall.
They indicate that you are close to liberation.
Do not fear them.
No harm can come to you from these hallucinations.
They are your own thoughts in frightening aspect.
They are old friends.
Welcome them. Merge with them. Join them.
Lose yourself in them.
They are yours.
Whatever you see, no matter how strange and terrifying,
Remember above all that it comes from within you.
Hold onto that knowledge.
As soon as you recognize that, you will obtain liberation.
If you do not recognize them,
Torture and punishment will ensue.

But these too are but the radiances of your own intellect.
They are immaterial.
Voidness cannot injure voidness.
None of the peaceful or wrathful visions,
Blood-drinking demons, machines, monsters, or devils,
Exist in reality
Only within your skull.
This will dissipate your fear. Remember it well.

Third Bardo: Preliminary Instructions

O (name), listen well:
You are now entering the Third Bardo.
Before, while experiencing the peaceful and wrathful visions of the
Second Bardo,
You could not recognize them.
Through fear you became unconscious.
Now, as you recover,
Your consciousness rises up,
Like a trout leaping forth out of water,
Striving for its original form.
Your former ego has started to operate again.
Do not struggle to figure things out.
If through weakness you are attracted to action and thinking,
You will have to wander amidst the world of game existence,
And suffer pain.
Relax your restless mind.

O (name), you have been unable to recognize the archetypal forms of the
Second Bardo.
You have come down this far.
Now, if you wish to see the truth,
Your mind must rest without distraction.
There is nothing to do,
Nothing to think.
Float back to the unobscured, primordial, bright, void state of your intellect.
In this way you will obtain liberation.
If you are unable to relax your mind,
Meditate on (name of protective figure)
Meditate on your friends (name)
Think of them with profound love and trust,
As overshadowing the crown of your head.
This is of great importance.
Be not distracted.

O (name),
You may now feel the power to perform miraculous feats,
To perceive and communicate with extrasensory power,
To change shape, size and number,
To traverse space and time instantly.
These feelings come to you naturally,
Not through any merit on your part.
Do not desire them.
Do not attempt to exercise them.
Recognize them as signs that you are in the Third Bardo,
In the period of re-entry into the normal world.

O (name),
If you have not understood the above,
At this moment,
As a result of your own mental set,
Frightening visions may come.
Gusts of wind and icy blasts,
Humming and clicking of the controlling machinery,
Mocking laughter.
You may imagine terror producing remarks:
"Guilty," "stupid," inadequate," "nasty."
Such imagined taunts and paranoid nightmares
Are the residues of selfish, ego-dominated game-playing.
Fear them not.
They are your own mental products.
Remember that you are in the Third Bardo.
You are struggling to re-enter the denser atmosphere of routine game existence.
Let this re-entry be smooth and slow.
Do not attempt to use force of will-power.

O (name),
As you are driven here and there by the ever-moving winds of karma,
Your mind, having no resting place or focus,
Is like a feather tossed about by the wind,
Or like a rider on the horse or breath,
Ceaselessly and involuntarily you will wander about,
Calling in despair for your old ego.
Your mind races along until you are exhausted and miserable.
Do not hold on to thoughts.
Allow the mind to rest in its unmodified state.
Meditate on the oneness of all energy.
Thus you will be free of sorrow, terror, and confusion.

O (name)
You may feel confused and bewildered.
You may be wondering about your sanity.
You may look at your fellow voyagers and friends,
And sense that they cannot understand you.
You may think; "I am dead! What shall I do?,"
And feel great misery,
Just like a fish cast out of water on red-hot embers.
You may wonder whether you will ever return.

Familiar places, relatives, people known to you appear as in a dream,
Or through a glass darkly.
If you are having such experiences,
Thinking will be of no avail.
Do not struggle to explain.
This is the natural result of your own mental program.
Such feelings indicate that you are in the Third Bardo.
Trust your guide,
Trust your companions,
Trust the Compassionate Buddha,
Meditate calmly and without distraction.

O (name),
You may now feel as if you are being oppressed and squeezed,

Like between rocks and boulders,
Or like inside a cage or prison.
Remember:
These are signs that you are trying to force a return to your ego.
There may be a dull, gray light
Suffusing all objects with a murky glow.
These are all signs of the Third Bardo.
Do not struggle to return.
The re-entry will happen by itself.
Recognize where you are.
Recognition will lead to liberation.

Instructions For Re-Entry Visions

O (name),
You have still not understood what is happening
So far you have been searching for your past personality.
Unable to find it, you may begin to feel that you will never be the same again,
That you will come back a changed person.
Saddened by this you will feel self-pity,
You will attempt to find your ego, to regain control.
So thinking, you will wander here and there,
Ceaselessly and distractedly.
Different images of your future self will be seen by you;
The one you are headed for will be seen most clearly.
The special art of these teachings is particularly important at this moment.
Whatever image you see,
Meditate upon it as coming from the Buddha -
That level of existence also exists in the Buddha.
This is an exceedingly profound art.
It will free you from your present confusion.
Meditate upon (name of protective ideal) for as long as possible.
Visualize him as a form produced by a magician,
Then let his image melt away,
Starting with the extremities,
Till nothing remains visible.
Put yourself in a state of Clearness and Voidness;
Abide in that state for a while.
Then meditate again on your protective ideal.
Then again on the Clear Light.
Do this alternately.
Afterwards, allow your own mind also to melt away gradually.
Wherever the air pervades, consciousness pervades.
Wherever consciousness pervades, serene ecstasy pervades.
Abide tranquilly in the uncreated state of serenity.
In that state, paranoid rebirth will be prevented.
Perfect enlightenment will be gained.

Instructions For The All-Determining Influence Of Thought

O (name), you may now experience momentary joy,
Followed by momentary sorrow,
Of great intensity,
Like the stretching and relaxing of a catapult.
You will go through sharp mood swings,
All determined by karma.
Be not in the least attached to the joys nor displeased by the sorrows.
The actions of your friends or companions may evoke anger or shame in you.
If you get angry or depressed,
You will immediately have an experience of hell.
No matter what people are doing,
Make sure that no angry thought can arise.
Meditate upon love for them.
Even at this late stage of the session
You are only one second away from a life-changing joyous discovery.
Remember that each of your companions is Buddha within.
You mind in its present state having no focus or integrating force,
Being light and continuously moving,
Whatever thought occurs to you,
Positive or negative,
Will wield great power.
You are extremely suggestible
Therefore think not of selfish things.
Recall your preparation for the session.
Show pure affection and humble faith.
Through hearing these words,
Recollection will come.
Recollection will be followed by recognition and liberation.

Instructions For Judgment Visions

O (name), if you are experiencing a vision of judgment and guilt,
Listen carefully:
That you are suffering like this
Is the result of your own mental set.
Your karma.
No one is doing anything to you.
There is nothing to do.
Your own mind is creating the problem.
Accordingly float into meditation.
Remember your former beliefs.
Remember the teachings of this manual.
Remember the friendly presence of you companions.
If you do not know how to meditate
Concentrate on any single object or sensation.
Hold this (hand the wanderer an object),
Concentrate on the reality of this,
Recognize the illusory nature of existence and phenomena.
This moment is of great importance.
If you are distracted now it will take you a long time to get out of the quagmire of misery.
Up till now the Bardo experiences have come to you and you have not recognized them.

You have been distracted.
On this account you have experienced fear and terror.
Even though unsuccessful thus far
You may recognize and obtain liberation here.
Your session can still become ecstatic and revelatory.
If you do not know how to meditate, remember (person's ideal).
Remember your companions
Remember this manual.
Think of all these fears and terrifying apparitions as being your own ideal,
Or as the compassionate one.
They are divine tests.
Remember your guide.
Repeat the names over and over.
Even though you fall,
You will not be hurt.

Instructions For Sexual Visions

O (name),
At this time you may see visions of mating couples.
You are convinced that an orgy is about to take place.
Desire and anticipation seize you,
You wonder what sexual performance is expected of you.
When these visions occur,
Remember to withhold yourself from action or attachment.
Humbly exercise your faith.
Float with the stream.
Trust the process with great fervency.
Meditation and trust in the unity of life are the keys.
If you attempt to enter into your old personality because you are attracted or repulsed,
If you try to join the orgy you are hallucinating,
You will be reborn on an animal level.
You will experience possessive desire and jealousy,
You will suffer stupidity and misery.
If you wish to avoid these miseries
Listen and recognize.
Reject the feelings of attraction or repulsion.
Remember the downward pull opposing enlightenment is strong in you.
Meditate upon unity with your fellow voyagers.
Abandon jealousy,
Be neither attracted nor repulsed by your sexual hallucinations.
If you are you will wander in misery a long time.
Repeat these words to yourself.
And meditate on them.

Four Methods of Preventing Re-entry

First Method: Meditation on the Buddha

O (name), tranquilly meditate upon your protective figure (name).
He is like the reflecting of the moon in water.
He is apparent yet non-existent.
Like illusion produced by magic.
If you have no special protective figure,

Meditate upon the Buddha or upon me.
With this in mind meditate tranquilly.
Then causing the visualized form of your protective ideal
To melt away from the extremities,
Meditate, without any thought-forming, upon the Void Clear Light.
This is a very profound art.
By virtue of it rebirth is postponed.
A more illuminated future is assured.

Second Method: Meditation on Good Games

(Name), You are now wandering in the Third Bardo.
As a sign of this, look into a mirror and you will not see your usual self
(show the wanderer a mirror).
At this time you must form a single, firm resolve in your mind.
This is very important.
It is like directing the course of a horse by the use of the reins.
Whatever you desire will come to pass.
Think not of evil actions which might turn the course of your mind.
Remember your spiritual relationship with me,
Or with anyone from whom you have received teaching.
Persevere with good games.
This is essential.
Be not distracted.
Here lies the boundary line between going up or down.
If you give way to indecision for even a second,
You will have to suffer misery for a long, long time,
Trapped in your old habits and games.
This is the moment.
Hold fast to one single purpose.
Remember good games.
Resolve to act according to your highest insight.
This is a time when earnestness and pure love are necessary.
Abandon jealousy.
Meditate upon laughter and trust.
Bear this well at heart.

Third Method: Meditation on Illusion

If still going down and not liberated,
Meditate as follows:
The sexual activities, the manipulation machinery, the mocking laughter,
dashing sounds and terrifying apparitions,
Indeed all phenomena
Are in their nature, illusions.
However they may appear, in truth they are unreal and fake.
They are like dreams and apparitions,
Non-permanent, non-fixed.
What advantage is there in being attached to them,
Or being afraid of them?
All these are hallucinations of the mind.
The mind itself does not exist,
Therefore why should they?
Only through taking these illusions for real will you wander around in
this confused existence.

All these are like dreams,
Like echoes,
Like cities of clouds,
Like mirages,
Like mirrored forms,
Like phantasmagoria,
The moon seen in water.
Not real even for a moment.
By holding one-pointedly to that train of thought.
The belief that they are real is dissipated,
And liberation is attained.

Fourth Method: Meditation on the Void

"All substances are part of my own consciousness.
This consciousness is vacuous, unborn, and unceasing."
Thus meditating,
Allow the mind to rest in the uncreated state.
Like the pouring of water into water,
The mind should be allowed its own easy mental posture
In its natural, unmodified condition, clear and vibrant.
By maintaining this relaxed, uncreated state of mind
Rebirth into routine game-reality is sure to be prevented.
Meditate on this until you are certainly free.

Instructions For Choosing the Post-Session Personality

(Name), Listen:
It is almost time to return.
Make the selection of your future personality according to the best teaching.
Listen well:
The signs and characteristics of the level of existence to come
Will appear to you in premonitory visions.
Recognize them.
When you find that you have to return to reality,
Try to follow the pleasant delightful visions.
Avoid the dark unpleasant ones.
If you return in panic, a fearful state will follow,
If you strive to escape dark, gloomy scenes, an unhappy state will follow,
If you return in radiance, a happy state will follow.
Your mental state now will affect your subsequent level of being.
Whatever you choose,
Choose impartially,
Without attraction or repulsion.
Enter into game-existence with good grace.
Voluntarily and freely.
Remain calm.
Remember the teachings.

The Secret Chief Revealed

by

Myron J. Stolaroff

This Book is dedicated to the memory of Leo, with the fervent hope that the revelation of his work will help bring understanding and sanity to a confused world. May it pave the way for others to reap the benefits he worked so hard to establish.

original source: http://www.maps.org/images/pdf/books/scr/scr.pdf
backup source: http://www.psilosophy.info/resources/scr.pdf

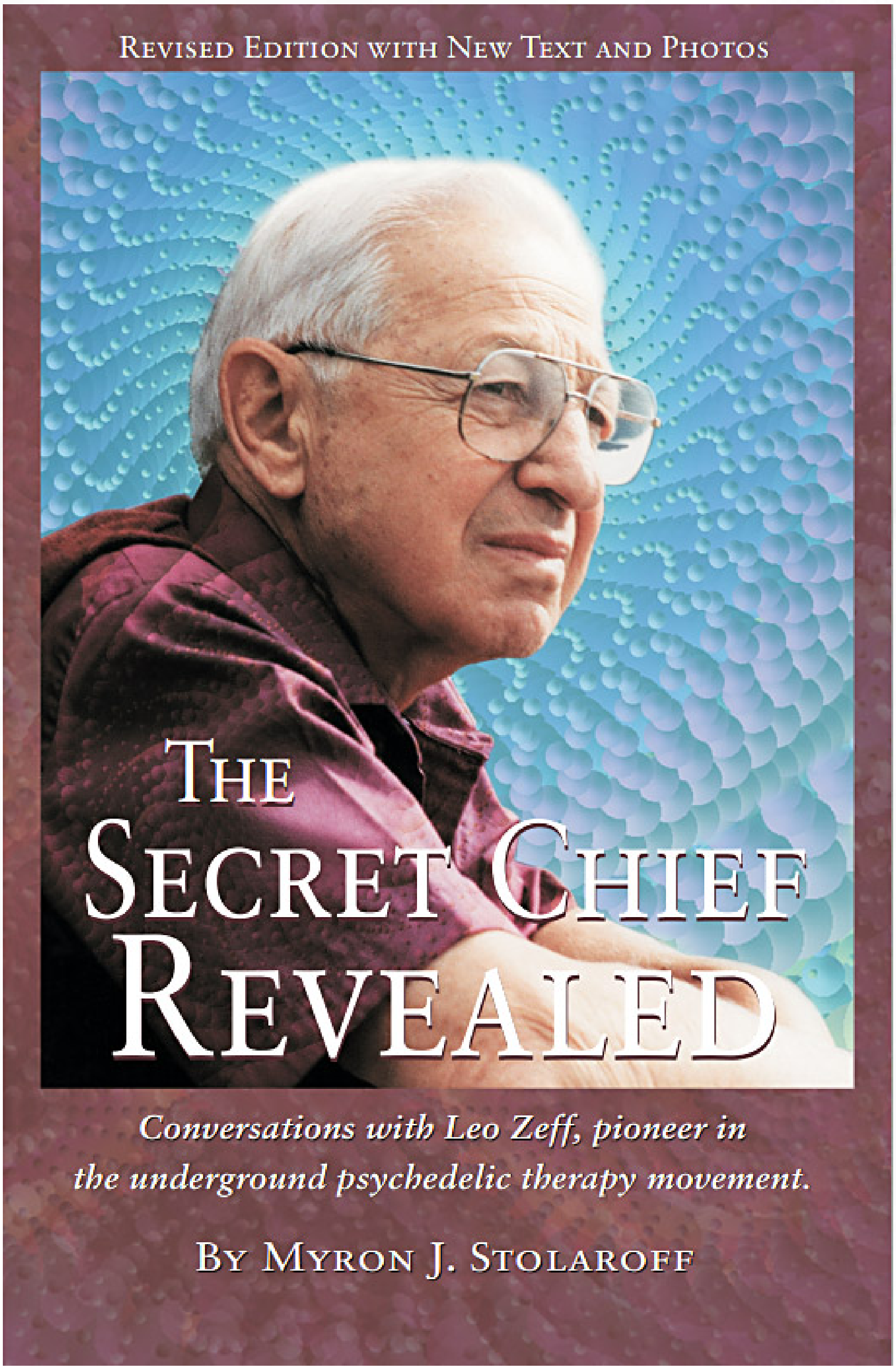

REVISED EDITION WITH NEW TEXT AND PHOTOS
THE SECRET CHIEF REVEALED
Conversations with Leo Zeff, pioneer in the underground psychedelic therapy movement.
BY MYRON J. STOLAROFF

Table of Contents:

- **Acknowledgments**
- **Introduction to the Second Edition**
- **Prologue**
- **Tribute to Jacob**
- **Foreword**
- **Introduction**
- **Early Beginnings**
- **Selection and Preparation**
  - Selecting the Client
  - Clients with Previous Psychedelic Experience
  - Clients in Therapy
  - Security Problems
  - Preparation
  - Photographs
- **The Individual Trip**
- **The Group Trip**
- **Materials and Doses**
  - Different Kinds of Trips
  - Dose Levels
- **Outcomes**
- **Finale**
- **Epilogue**
  - The Last Trip: Peaceful Closure for Jacobs
- **More Photos**
- **Appendix I**
  - Personal Accounts
    - *Robert*
    - *Susan*
    - *Dick*
    - *Carol*
    - *Sally*
- **Appendix II: New to the Second Edition**
  - Tributes to Leo Zeff
    - *Sara Zeff*
    - *Henry Zeff*
    - *"Andrew"*
    - *"Katherine"*
    - *"Rachel"*
    - *"Julia"*
    - *"Laura"*
- **Appendix III: Resources**
  - Evaluating the Scientific Literature
    - *Books*
    - *Online Resources*
    - *Print Resources*
    - *Bibliographies*
  - By the Same Author
  - About the Publisher: The Multidisciplinary Association for Psychedelic Studies (MAPS)
    - *Supporting the MAPS Mission*
    - *Ordering Information*

This book is dedicated
to the memory of Leo,
with the fervent hope
that the revelation
of his work
will help bring
understanding and sanity
to a confused world.
May it pave the way
for others to reap the benefits
he worked so hard
to establish.

Acknowledgments

I wish to express my thanks to a number of persons who helped to make this book possible.

First, I wish to thank Leo, wherever he may be, for his devoted interest, skill and determination in carrying out this very important work under stressful conditions, guided by his faith and confidence in the value of what he was doing. My wife Jean and I are most grateful for the patience and care that he took to communicate to us his knowledge and experience.

I am also grateful to those who participated in Leo's program, making this work possible, and particularly to those who shared in detail the experiences that they underwent and the results that followed. I also thank Leo's family and supporters who aided him in carrying out his work.

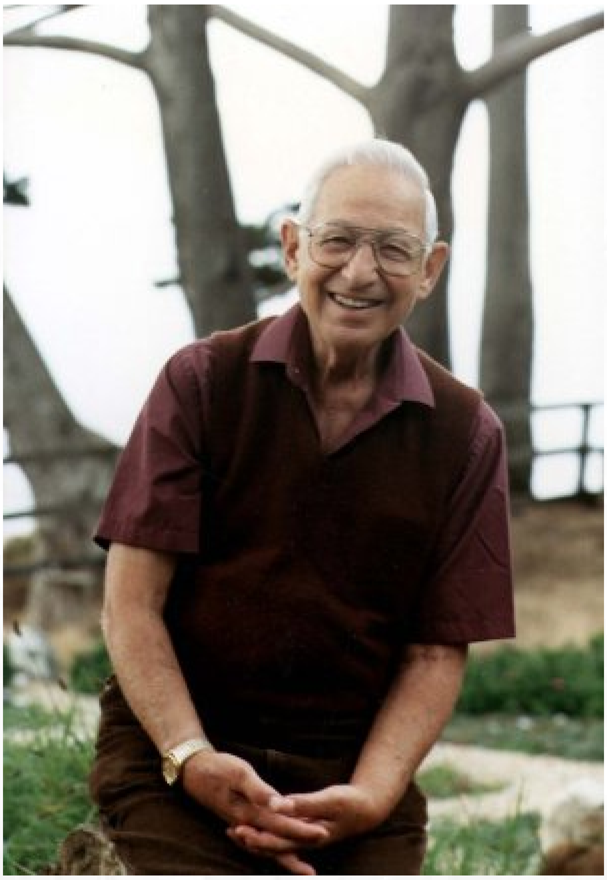
I wish to thank Ann and Sasha Shulgin for pointing out to me the importance of getting Jacob's efforts recorded.

My thanks to Terence McKenna for permission to use his title for this book.

I am extremely indebted to Rick Doblin, Sylvia Thyssen, Brandy Doyle and MAPS for their assistance in the editing and completion of the manuscript, and for taking the steps to have the manuscript published.

I wish to thank my wife Jean for her assistance and loving support throughout all stages of this project, from the initial interviews to the completion of the final manuscript.

Introduction to the Second Edition



THE SECRET CHIEF was published seven years ago, and has now been sold out. Reprinting a new edition provides the opportunity to make some fresh observations, as well as report new progress in the utilization of psychedelic substances. Moreover, the passage of time permits a new development: The Secret Chief no longer needs to be kept secret!

While doing his important work, which our government held to be illegal, Leo lived constantly under the possibility of being discovered and prosecuted as a criminal. Many of those close to Leo who supported his work also lived under the threat of exposure. Even family members feared harassment or investigation. Leo died over seventeen years ago, and the threat to his supporters and companions has evaporated. His family members no longer object to the revealing of his name, and share in the belief that it is time for Leo to receive the acknowledgement he deserves. So we are pleased to present Leo Zeff, Ph.D., the Secret Chief! In this edition, we include photographs of Leo and new accounts written by his son and daughter, as well as new reports taken from interviews with his clients.

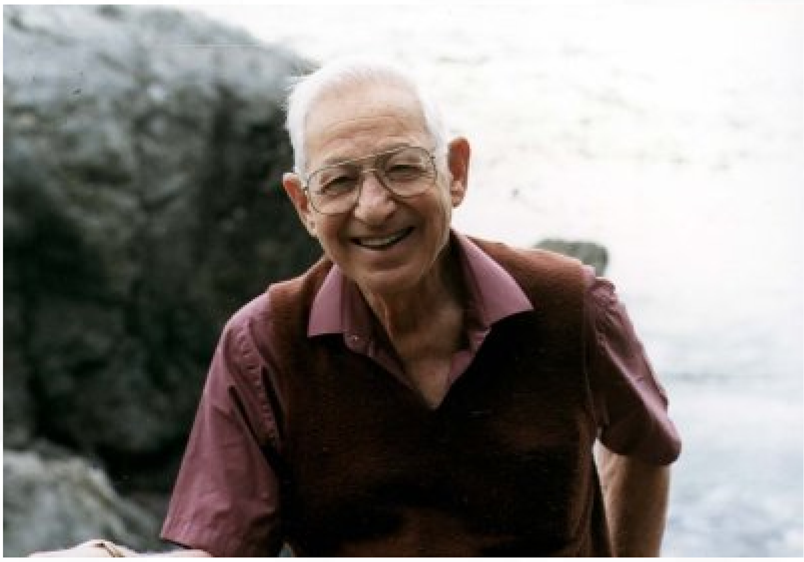
Since the last edition, we have new reasons to hope that the healing techniques Leo pioneered may reach more people. Most promising is the action of the FDA in approving three projects investigating the efficacy of psychedelics as tools for therapy, the first such action in over thirty years. In addition, a number of new, informative books help clear up widespread misunderstanding of the nature and potential of psychedelics.

It has now been 24 years since my wife Jean and I interviewed Leo. What a marvelous experience this was for the both of us! Leo was a remarkable friend, full of life and wisdom and good cheer. It was a true joy to spend many hours with him as he reviewed his work with us. Turning my attention to once again consider his contribution, I feel a deep emptiness in his absence. And yet as I look over what he shared, I cannot help but be immensely grateful for his outstanding contribution.

Still, I am saddened at how a most priceless gift, the psychedelic substances, especially in the hands of Leo and others like him, has been completely denigrated by our government. The enormous potential for healing, for self-discovery, and for communion with the Divine has been prohibited. Those who would pursue such valuable goals can do so only by becoming criminals, as our current laws forbid possession of such substances.

But there is hope. There is a deepening spirituality growing in our nation, and spirituality is a powerful aid to healing. Many extremely worthwhile books are appearing. Some of these pertaining specifically to how psychedelics can help have been added to the "Resources" section at the end of this book. And as mentioned above, the FDA has approved three projects authorizing research with psychedelic substances to evaluate their effectiveness for therapy. One project involves the application of psilocybin in the treatment of Obsessive Compulsive Disorder. Another is employing MDMA in the treatment of Post-traumatic Stress Disorder (PTSD), and a third employs psilocybin administered to advanced cancer patients to relieve anxiety, pain and fear of death. These projects have evolved as a result of anecdotal evidence from underground therapists and users, as well as from previous psychedelic research from thirty years ago. Successful outcomes from these three projects could well open the door to more extensive research.

In the meantime, it would be most helpful if government officials and the public were better informed of the remarkable potential that psychedelics hold for healing, learning, self-development, and authentic spiritual understanding. In general, the DEA and government agencies have feared widespread abuse and damage from such substances. It is true that uninformed or misdirected use of psychedelics can be harmful. The government must certainly take some responsibility for this situation, as criminalizing these substances has prevented important knowledge for harm reduction and beneficial uses to be made available.



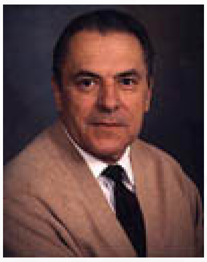
However, for a realistic evaluation of the risks, a number of issues should be taken into account:

1. There are large numbers of users who have learned to use psychedelics properly for their own personal gain, encompassing the range from increased enjoyment or improved functioning to the heights of spiritual development. Many knowledgeable therapists are willing to break the law rather than withhold valuable treatments with these substances from their clients.
2. A minor percent of the population are at risk of developing unhealthy relationships with psychedelics due to personality disorders or other pre-existing psychological conditions. They are often incapable of comprehending the consequences of their actions, including abusing drugs. This minority will always be a problem until we devise better ways to care for them.
3. A fairly large percent of young people live in painful circumstances, in poverty-stricken, abusive, or neglectful families. For an illustration of the drastic effects that lack of intimacy can produce, look at the work of Rene Spitz on the Internet at http://www.hofmann.org/papers/spitz/index.html. The unhappiness of such youngsters lead them to explore almost any avenue that will provide them with a period of enjoyment, regardless of the circumstances or aftermath. Prohibition, however, will not solve the problems faced by these young people. In fact, legalization would make vital information more available, and knowledgeable guides would begin to appear, which in time would reduce misuse.
4. The use of psychedelics is self-regulating in most cases. Their true purpose is to enhance growth and interior development. Used only for pleasure, or abused, the Inner Self is thwarted, which leads to unpleasant experiences and depression. Though everyone who pursues the use of psychedelics for personal growth must be prepared for the "dark night of the soul" experiences, those who seek only entertainment will lose interest in these substances. A good example comes from the book The Pursuit

> of Ecstasy, by Jerome Beck and Marsha Rosenbaum, which reports on a study funded by the National Institute of Drug Abuse (NIDA). "Chapter 5 - Limits to Use: Why People Moderate or Quit Ecstasy," covers a number of factors why people reduce or drop their use of Ecstasy (MDMA) over time, based on a large sample of interviews conducted with a broad spectrum of users.

It must be recognized that despite the action of our government to make psychedelic substances illegal, huge numbers of people have found psychedelics so useful that they are willing to break the law in order to use them. It is hoped that such users can obtain valuable information from this book that will reduce abuse and promote true healing, growth and wisdom. The combination of successful research results and the growth in public recognition of the vital role of psychedelics in healing and personal development, should ultimately restore these enormously valuable tools to our society. Then the dedicated pioneering work of Leo Zeff will be fully recognized and appreciated.

Prologue



Stanislav Grof

After the publication of the first clinical paper on LSD by Walter A. Stoll in 1947, Albert Hofmann's serendipitous discovery of the psychedelic effects of LSD became practically an overnight sensation in the world of science. Never before had a single substance held so much promise in such a wide variety of fields of interest.

For neuropharmacologists and neurophysiologists, the discovery of LSD meant the beginning of a golden era of research that could solve many puzzles concerning the intricate biochemical interactions underlying the functioning of the brain.

Experimental psychiatrists saw this substance as a unique means for creating a laboratory model for naturally occurring psychoses, particularly schizophrenia. They hoped that it could provide unparalleled insights into the nature of these mysterious disorders and open new avenues for their treatment.

LSD was also highly recommended as a unique teaching device that would make it possible for clinical psychiatrists and psychologists to spend a few hours in the world of their patients and as a result of it to understand them better, be able to communicate with them more effectively, and improve their ability to help them.

Early experiments with LSD revealed its unique potential as a powerful tool offering the possibility of deepening and accelerating the psychotherapeutic process, as well as extending the range of applicability of psychotherapy to categories of patients that previously had been difficult to reach such as alcoholics, narcotic drug addicts, and criminal recidivists.

Particularly valuable and promising were the early efforts to use LSD psychotherapy with terminal cancer patients. These studies showed that LSD was able to relieve severe pain, often even in those patients who had not responded to medication with narcotics. In a large percentage of these patients, it was also possible to alleviate or even eliminate the fear of death, increase the quality of their lives during the remaining days, and positively transform the experience of dying. For the historians and critics of art, the LSD experiments provided extraordinary new insights into the psychology and psychopathology of art, particularly various modern movements as well as paintings and sculptures of native cultures.

The spiritual experiences frequently observed in LSD sessions offered a radically new understanding of a wide variety of phenomena from the world of religion, including shamanism, the rites of passage, the ancient mysteries of death and rebirth, the Eastern spiritual philosophies, and the mystical traditions of the world.

LSD research seemed to be well on its way to fulfilling all the above promises and expectations when it was suddenly interrupted by unsupervised mass experimentation of the young generation and the ensuing repressive measures of a legal, administrative, and political nature. However, the problems associated with this development, blown out of proportion by sensation-hunting journalists, were not the only reason why LSD and other psychedelics were rejected by the Euro-American culture. An important contributing factor was also the attitude of technologized societies toward non-ordinary states of consciousness.

All ancient and pre-industrial societies held these states in high esteem and they devoted much time and energy trying to develop safe and effective ways of inducing them. Members of these social groups had the opportunity to repeatedly experience non-ordinary states in a variety of sacred and secular contexts. Because of their capacity to provide experiential access to the numinous dimensions of existence and to the world of archetypal realms and beings, non-ordinary states represented the main vehicle of the ritual and spiritual life of the pre-industrial era.

They also played an essential role in the diagnosing and healing of various disorders and were used for cultivation of intuition and extrasensory perception. By comparison, the industrial civilization has pathologized non-ordinary states, developed effective means of suppressing them when they occur spontaneously, and has rejected or even outlawed the contexts and tools that can facilitate them.

Because of the resulting naivete and ignorance concerning non-ordinary states, Western culture was unprepared to accept and incorporate the extraordinary mind-altering properties and power of psychedelics. The sudden invasion of the Dionysian elements from the depths of the unconscious and the heights of the superconscious was too threatening for the Puritanical values of our society. In addition, the irrational and transrational nature of psychedelic experiences seriously challenged the very foundations of the world-view of Western materialistic science.

The existence and nature of these experiences could not be explained in the context of the mainstream theories and seriously undermined the metaphysical assumptions on which Western culture is built. For most psychiatrists and psychologists, psychotherapy meant disciplined discussions or free-associating on the couch.

The intense emotions and dramatic physical manifestations in psychedelic sessions appeared to them to be too close to what they were used to considering to be psychopathology. It was hard for them to imagine that such states could be healing and transformative and they did not trust the reports about the extraordinary power of psychedelic psychotherapy. In addition, many of the phenomena occurring in psychedelic sessions could not be understood within the context of theories dominating academic thinking. The possibilities of reliving birth or episodes from embryonal life, obtaining accurate information from the collective unconscious, experiencing archetypal realities and karmic memories, or perceiving remote events in out-of-body states, were simply too fantastic to be believable for an average professional.

Yet those of us who had the chance to work with psychedelics and were willing to radically change our theoretical understanding of the psyche and practical strategy of therapy were able to see and appreciate the enormous potential of psychedelics, both as therapeutic tools and as substances of extraordinary heuristic value.

In one of my early books, I suggested that the potential significance of LSD and other psychedelics for psychiatry and psychology was comparable to the value the microscope has for biology and medicine or the telescope has for astronomy. My later experience with psychedelics only confirmed this initial impression. These substances function as unspecific amplifiers that increase the energetic niveau in the psyche and make the deep unconscious dynamics available for conscious processing. This unique property of psychedelics makes it possible to study psychological undercurrents that govern our experiences and behaviors to a depth that cannot be matched by any other methods and tools available in modern mainstream science. In addition, psychedelics offer unique opportunities for healing of emotional and psychosomatic disorders, for positive personality transformation, and consciousness evolution.

Naturally, tools of this power carry with them greater potential risks than more conservative and far less effective tools currently accepted and used by mainstream psychiatry, such as verbal psychotherapy or tranquilizing medication. However, past research has shown that these risks can be minimized through responsible use and careful control of the set and setting. The legal and administrative sanctions against psychedelics did not deter lay experimentation, but they did terminate all legitimate scientific research of these substances.

For those of us who had the privilege to explore the extraordinary potential of psychedelics, this was a tragic loss for psychiatry, psychology, and psychotherapy. These unfortunate developments wasted what was probably the single most important opportunity in the history of these disciplines. Had it been possible to avoid the unnecessary mass hysteria and continue responsible research of psychedelics, they could have become a tool that would make it possible to radically revise the theory and practice of psychiatry.

This research would have brought a new understanding of the psyche and of consciousness that could become an integral part of a comprehensive new scientific paradigm of the twenty-first century. Most of the LSD researchers grudgingly accepted the legal and political sanctions against psychedelics and reluctantly returned to mainstream therapeutic practices. A few attempted to develop non-drug methods for inducing non-ordinary states of consciousness with the experiential spectrum and healing potential comparable to psychedelics. And then there were those who, like Jacob, the "Secret Chief," refused to accept legal sanctions that they considered irrational, unjustified, or even unconstitutional.

These researchers saw the extraordinary benefits that LSD therapy offered to their clients and decided not to sacrifice the well-being of these people to scientifically unsubstantiated legislation. In addition to the therapeutic value of psychedelics, they were also aware of the entheogenic potential of these substances - their capacity to induce profound spiritual experiences. For this reason, they understood their work with LSD to be not only therapeutic practice, but also religious activity in the best sense of the word. From this perspective, the legal sanctions against psychedelics appeared to be not only unfounded and misguided, but also represented a serious infringement of religious freedom.

Jacob painfully weighed the pros and cons and made the decision to challenge the law, continue his work with psychedelics, and assume personal responsibility for his activity. He has already passed the judgment of his "family," the friends and clients whose lives he has profoundly changed. They remember him with great love and gratitude. It remains to be seen how he will be judged by history. It is certainly wise to obey the laws if our primary concern is personal safety and comfort. However, it often happens that in retrospect, history places higher value on those individuals who violated questionable laws of their time because of foresight and high moral principles than those who had issued them for wrong reasons.

Stanislav Grof, M.D.
Mill Valley, California

Tribute to Jacob

Ann Shulgin

I first met Jacob, the man who is the subject of *The Secret Chief* - I called him Adam Fisher in *PIHKAL* - in the early 1980s, shortly after I met Sasha Shulgin. One of the great stories I heard from Sasha was about this wonderful psychologist who had - for many years - been guiding certain carefully selected clients through psychedelic sessions. In the early 1970s, this elderly gentleman decided to retire from his regular clinical practice. A chemist friend of Sasha's had, at that time, just rediscovered a drug which had been sitting on a German chemical company shelf, so to speak, since its synthesis in 1912. She had tried it and reported interesting effects to Sasha, who went into his own lab and made the drug, 3,4-methylenedioxy-methamphetamine - known as MDMA - and tried the result in himself. He called Jacob and told him there was a new drug that might be of interest to him, and shortly afterwards, took it over to Jacob's little apartment.

The rest, as the saying goes, is history. Jacob postponed his retirement, completely enraptured by the effects of MDMA on himself and his patients. Over the next few years, he traveled around the country, quietly training groups of therapists in the use of MDMA in psychotherapy. He occasionally went to Europe to continue this work among European psychologists and psychiatrists. He always insisted that any therapist who intended to make use of this magic drug had to try it in himself first. That has been the rule ever since, whenever healers wish to make use of either MDMA - which is not a psychedelic drug - or any of the true psychedelics in their therapy. The therapists must know the effects of any such drugs in themselves, before giving them to anyone else.

At his memorial, I asked one of his oldest friends whether she had any idea as to how many people Jacob might have initiated over the years in the use of psychedelics, and she replied, "Oh, I would guess about four thousand, give or take a few." Rather extraordinary, for a man in his seventies!

Jacob himself, when I knew him, was everybody's idea of what a grandfather should be. His thinning hair was silvery white. He had a slightly rounded face, and the years had etched into it indelible proof of kindness and humor. One look, and you would instantly trust him to listen and empathize. He was quite capable of anger and stern judgment, but these were reserved for very few people. Malice disturbed him - as it does most of us - but the only time I heard him speak with absolute disgust was when he explained the meaning of what he called the "bear-trapper." That was his term for borderline personality. I suspect he'd been badly burned by at least one, in his career as a clinical psychologist.

When I was very young, first hearing and reading about psychology, the worst possible diagnosis used to be something called "inadequate personality." Many of us would have preferred to be diagnosed as paranoid schizophrenic! At least, there could be a smidgen of tragic drama attached to paranoia and/or schizophrenia, but to be thought of as an "inadequate personality?" Total horror. These days, the most dreaded diagnosis (speaking of non-violent, non-psychotic patients) is "borderline," and Jacob used the term, "bear-trapper," because, as he explained it, such patients usually try to draw their therapists into their own world, instead of using whatever help the therapist offers. Their goal, as he saw it, is not to gain health, but to seduce the therapist into keeping them company in their state of sickness. They are highly manipulative and, if confronted directly, can become vengeful and destructive. When I first met Jacob, I had not yet begun to do my own work as a psychedelic therapist, and didn't fully understand what he meant by "bear-trapper." I believe that the official definition of such a hapless soul is something like, "Help-refusing complainer," which covers a lot of ground in a very few words. Not too many years later, I began learning how to do therapy with MDMA and psychedelics, and ran into two examples of what Jacob had warned me about. As a result, I finally understood my dear friend's allergy to such people, although I was never sufficiently burned, myself, to develop the kind of anger Jacob had expressed towards them.

Jacob was not a brilliant genius, but he was one of the people from whom I learned most about what is called "wisdom," because that is what he had. He could take a situation which would ordinarily cause high frustration or anxiety in anybody else, and turn it into a wonderfully palatable spiritual lesson, seasoned with great humor and joy.

When you asked Jacob a meaningful question, his answer tended to give you the maximum amount of useful information in the least number of words. And he had learned not to be defensive about making mistakes. In fact, I never saw Jacob being defensive about anything; he was at peace with himself and comfortable with who he was, which is certainly one of the definitions of a good healer.

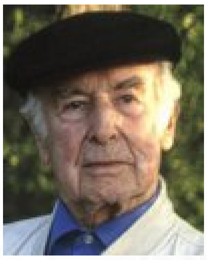
I described, in PIHKAL, Jacob's role in helping me through a strange and extraordinary week of consciousness change which happened many years ago. It was his words, "What you're going through is a process. All you have to do is not get in its way," that gave me my bearings and enabled me to regard the entire experience as a chance to learn and grow, which is exactly what it became.

The strangest thing about Jacob, for many of us, was the fact that, as a young man, he had been in the United States Army and loved it. He was amused by the bewilderment of so many of his friends, who couldn't quite understand how a deeply committed psychedelic guide and therapist could regard past duty in the military as a productive and enjoyable experience. Most of us eventually realized that the problem was in our own prejudices and projections, not in Jacob's validation of both worlds. I asked him once whether he thought there was any hope for survival of our species, considering the apparent determination of so many of us to poison our environment and destroy each other. He turned to me, smiling, "I think we'll make it. Humanity has a funny way of turning itself around when it has to. Maybe not all of us will survive, but I have no doubt at all that our species will. It's happened many times before; it will again."

We miss Jacob. That old cliché, "It is a privilege to have known him," is absolutely appropriate, for Sasha and me and for all of his friends. The only thing I can't forgive him for is that he left this plane, this reality that he shared with us, without my knowing in time. I wasn't there, by his bedside, and it still grieves me when I think about it. One of these days, one of these years, I will be able to give him permission - from my heart - to go, but I haven't been able to do it yet.

Ann Shulgin
Lafayette, California

Foreword



Albert Hofmann

Hardly any other science is as conservative and tradition-bound as is medicine. Whenever a new treatment modality or an extraordinary medicine appears, in addition to interested acceptance in specialist circles there is also opposition to the novelty, which is emotional and vehement, in proportion as the innovation is significant and pioneering. Hypnosis may be cited as an example. It was denounced as dangerous charlatanism, and more than a century had to pass before it gained entry into mainstream medicine.

Today a novel group of psychoactive substances, which have come to be known under various designations - hallucinogens, psychotomimetics, psychedelics and recently entheogens - has evoked violent controversy in professional circles and the media. These are substances capable of profoundly affecting human consciousness. This explains the vehemence and the passion which accompany discussions of the 'psychedelics,' as these materials are mostly known today, since we are talking about the veritable inner core of our humanity, our consciousness.

On the other hand, one would imagine that the psychedelics might have gained especially easy entry into medicinal practice, since we are dealing here with active principles of drugs which for millennia have played a meaningful role in archaic cultures and which even today among primigenial peoples find beneficent application in social and medicinal fields. Had we from the outset harked back to these archaic experiences, we would have been able to avoid the misuse and improper use of these extremely potent psychopharmaceuticals, and they would not now be prohibited, but would rather have become valuable medicines in the contemporary pharmacopoeia.

The substances under discussion are above all mescaline, the active agent of a Mexican cactus which the Indians call *péyotl* or peyote; psilocybin, the active principle of the Mexican 'magic mushrooms' *teonanácatl*; and LSD (chemically *Lysergsaure diethylamid* or lysergic acid diethylamide), which is closely related to lysergic acid hydroxyethylamide, the active agent of the ancient Indian 'magic drug' *ololiuhqui*.

All of these drugs are integrated into tribal cultures and employed as 'magic medicines' in a religious-ceremonial context. Their use is in the hands of shamans or shamanesses, male or female priest-doctors, where they manifest a beneficent action. They are esteemed as sacred, and according to Indian belief, their misuse or profanation is punished by the gods with insanity or death. International research with these substances - especially in psychiatry, to investigate their use as pharmacological adjuncts to psychoanalysis and psychotherapy - commenced shortly after the 1943 discovery of LSD, which is by far the most potent representative of the psychedelics. Besides the greatest enthusiasm in response to outstanding results with LSD and other psychedelics, scepticism also manifested itself in conservative circles, particularly those in which any pharmacological intervention in the treatment process was rejected.

This very promising use of psychedelics in psychiatry and psychology came to an untimely end midway through the sixties, when this new class of pharmaceuticals was outlawed, with the complete prohibition of their manufacture, possession and use. Accidents involving psychedelics resulting from frivolous, uncontrolled use in the drug scene were the ostensible reason for this prohibition. The principal reason for the draconian prohibitive measures, however, was the goal of attacking the youth movement, hippies and the like, who opposed the Establishment and the Vietnam War, and whose 'cult-drug' was, above all, LSD.

Medicinal use of the psychedelics was prevented by the official prohibition, and further research in this field was interrupted, while consumption continued in the drug scene. This irrational situation still largely exists today[1]. For therapists, the use of psychedelics became a criminal matter, for which they could face punishment.

One of the probably very few therapists who continued to use psychedelics, accepting the great risk of criminality, was the psychologist here referred to by the alias 'Jacob' and dubbed the 'Secret Chief'[2]. Jacob had obtained mostly excellent results from his specially-developed techniques in the use of psychedelics, and he realized that this therapeutic method should not be withheld from sick people. His ethical obligation as a therapist, to help people, took priority for him over obedience to a dubious official prohibition.

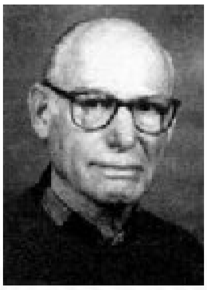
In the illegality of his time it was unthinkable to publish the excellent results of his therapy. It is therefore praiseworthy that today, nine years after his death, a friend has undertaken the task of publishing the details of the therapeutic methodology of this intrepid Ph.D. psychologist. The therapeutic results attained from this method constitute an important argument in the current growing discussion challenging medical circles, whether again to liberate psychedelics for psychotherapeutic practice.

Albert Hofmann, Ph.D.
Rittimatte, Switzerland

Translation from German by Jonathan Ott.

1. On the other hand, some very limited psychedelic research was permitted to begin again in 1990.-Ed.
2. Jacob was nicknamed the "Secret Chief" by Terence McKenna.-Ed.

Introduction



Myron J. Stolaroff

It is rare in life to meet a person so engaging, so warm, so obviously kind that your heart automatically goes out to him at first contact. Jacob was such a person. Completely unpretentious, he was tremendously enthused with life and excited about people.

Jacob died in the spring of 1988 at the age of 76, after an unusual and illustrious career. He was outstanding in his field, and made many significant contributions. Yet because of the unorthodox character of his chosen work, he was little known outside his immediate circle of friends and clients. In fact, I cannot even use his correct name, nor give you the locale of his activities. Yet if he and his work were truly known, the world would recognize that it has lost one of its most able pioneers and a man who has made a very important contribution to the field of psychology. A close and knowledgeable friend, who had the opportunity to understand him better than most, dubbed him the "Secret Chief," which is a most fitting title for this work.

It was in the spring of 1981 when my wife Jean and I met with him to have these conversations. He was already 70 years old, and retired from his very engrossing work. He was a short man, about five feet six inches tall, somewhat stocky, almost white-haired, and hardly ever to be caught without an engaging smile. As soon as you were in his presence you knew that he was your friend, and would do anything he could for you. He was proud of his Jewish heritage, and also proud of his service in the army, where he attained the rank of Lieutenant Colonel.

Jacob was a psychologist, and one of the first to be licensed as a Ph.D. in the state in which he practiced. For many years he conducted a private practice as a Jungian therapist.

Jacob's life changed dramatically in the early 1960s, when he became acquainted with the mind-altering substances LSD and mescaline. These powerful drugs not only led him into a whole new area of self-understanding, but he found them to be enormously effective in helping his clients - so much so that he abandoned conventional therapy to pursue the study and practice of using these new substances.

Jacob made great personal progress, and at the same time learned a good deal about how to use these chemicals effectively. He developed many useful procedures and had a large following of clients wanting to take advantage of this new, powerful means of therapy. In time, Jacob not only was responsible for processing around three thousand individuals, but he shared his experience in this new art with over one hundred therapists. By the time these conversations were held, he was responsible probably more than any other individual alive for introducing individual clients and therapists to the benefits and procedures of effectively using mind-altering substances in personal growth.

My purpose in interviewing Jacob was to become familiar with the practices he had developed. There were many of us who believed that his valuable techniques should be published and made available to other researchers and for posterity. One huge, giant obstacle confronted us: Most such substances had been placed in Schedule I of the Federal government's Controlled Substances Act, making them illegal to possess. So there was considerable risk of exposure in making such information public.

Jacob agreed to transmit the information and have it on record, and we agreed that we would decide later on its disposition. When the information had been reduced to writing, Jacob decided that it was too sensitive to be published, so it was set aside. Now that he is no longer with us, and immune to whatever legal transgressions he may have committed, it becomes possible to tell his story and acknowledge the outstanding pioneering work that he accomplished.

Most of what follows is in Jacob's own words. I have done some editing for the sake of clarity, and have arranged some discussions in more logical progression. Also, appropriate fictitious names and locations have been used with an eye to our repressive drug laws. Many of the very promising substances Jacob worked with are in Schedule I, making it exceedingly difficult to research their beneficial uses[1].

The decision to use Jacob's own words took much pondering on my part. Several who have seen the initial form of this manuscript felt that Jacob's uninhibited language and looseness of expression would turn many potential readers away, and they preferred a more scholarly, professional rendition. But those who knew Jacob will delight in once more experiencing his expressions, fondly recalling past conversations and the images of this dear person they invoke. Such expressions may likely be lost on readers who never knew this man, and who could very well object to the sometimes coarse language.

But this gets to the very heart of some of the misunderstandings about psychedelics. Jacob was a man who brought new life and opportunity to many hundreds of individuals, often in total life-transforming ways. He was dearly loved. This was not because of his elegant expression or professional training. It was because he was blessed with an abundance of heart, the most necessary prerequisite for someone accompanying others into the depths of their very souls. For the unconscious mind is often terribly frightening; we have made much of its contents unconscious because we want nothing to do with it. It takes a strong heart, honesty, and a desire to learn and face one's problems in order to enter the dark areas of our suppressed inner self.

Nothing is more helpful than the presence of a kind, loving, understanding person thoroughly familiar with the dark regions of the mind - a companion who is confident of his ability to help one navigate and resolve those regions that have been an enormous burden in the past, a person who knows the wonder of being free. Whoever understands all of this certainly is not concerned about the person's modes of expression, but is only grateful for the heartfelt support.

And this Jacob expressed in abundance. A person who felt deeply, he understood that expressing such feelings is the most honest way of being oneself. It is not the choice of words, but the ability to feel deeply and genuinely express one's feelings that make one authentic, and which brings people together in true relationship. Since so many of us are afraid of our feelings, the dark side of our unconscious is replete with feelings we do not dare to feel. Once we learn how to find and express them, we can feel the delight of being fully alive by honestly expressing them. Then we deeply appreciate those who function this way.

So in submitting Jacob in his native tongue, I feel that I avoid the disservice of not fully presenting him. I very much hope that the reader, through encountering Jacob's personal expressions, can more readily discern the heart of one of the truly great persons who have lived on this earth. Yes, it's probably true that a man with a Ph.D. in psychology might have learned to speak more correctly, but once you have the privilege of being in this man's presence, who cares?

May you enjoy this introduction to our good friend and psychedelic guide par excellence, Jacob.

Myron J. Stolaroff
Lone Pine, California

1. The Drug Enforcement Administration, which initiated the scheduling of practically all psychoactive materials, claims that placing the substances into Schedule I does not preclude research. While there is a procedure for researching Schedule I materials, in practice for almost three decades, virtually no clinical research was permitted on this class of substances. The control is exercised by the Food and Drug Administration, which must grant an IND or Investigational New Drug exemption to permit research. For Schedule I materials, a protocol must be submitted and approved by the FDA. At the time of these interviews, numerous applications for IND's for psychoactive materials had been turned down. Beginning in 1990, there has been a liberalization of this policy. In 1997, there are several research projects with psychedelic substances that have been approved by the FDA and the DEA.

Early Beginnings

Jacob: What I was hoping was that you would be able to prepare questions - I work better in response to a stimulus rather than just talking out of my head.

Myron: How did you first get into the use of psychedelic agents?

Jacob: I think it was in 1961, something like that. One of my former patients called me and said, "Jacob, I want to see you. I want to talk to you about something." I said, "All right." She said, "I want to tell you about an experience I just had. I can't talk to anyone else about it because I don't think they'd understand it." So I said, "Sure. Come on in."

She came in and sat down and told me that she had recently had an LSD trip. She told me about her experience, and I was fascinated by it. She felt that I was the only one who could understand it because I was Jungian. I had training as a Jungian analyst and I was doing Jungian analysis at that time.

Well, I was just amazed at this experience, just flabbergasted, because, my God, here I'd been working over 30 years in various disciplines and studies and meditations and all that kind of stuff and every now and then getting a glimpse of the truth on an experiential level. Here, this gal comes in and tells me she dropped this minute quantity of material and she had a solid day of nothing but all those beautiful peak experiences that people will get out of it, and tremendous insights and many growth things and all that. I was very surprised. Didn't do anything about it, particularly. I asked her some questions, but I knew that there was nothing that you could even question about it. You just listen to it and get what she's saying. I got a contact high from her, though! (He laughs heartily.)

About three or four months later another person, a man whom I had worked with earlier, called me. He said "Jacob, I've got to talk to you. I've got to see you about something." I said, "Fine, come on in." He came in and he sat down and he told me he had just had an LSD experience. Well, he told me about his experience, and it was every bit as spectacular as the other one that I'd heard from the lady. Then I really got interested. Not only that, I wanted to find out how the hell I could get into something like that!

I decided to look into it. I had some friends here, and they were into it and knew a lot about it. I wanted to get some information about this stuff for myself. One of them had Sandoz's annotated bibliography of every article that had come out that had been printed until then, and he let me read it. There was something like 1,000 different references, all phases of psychedelics and a paragraph digest of many of the articles. I read that through from the beginning to the end and was very, very impressed because of the tremendous potential that was pointed out from the material in terms of the experience that people had from it. It was mostly LSD and psilocybin. All the tremendous great things they said about it and what came out of scientific journals.

There were only two or three references to something bad. Those mostly were because somebody gave it to somebody without telling them what it was or under the wrong circumstances. I believe one of them was when they gave it to a nurse in a hospital while she was on duty. She didn't know what was happening. She freaked out and jumped out the window, down about seven stories, something like that, and killed herself.

Then I really got serious about exploring. One of the first things I did was find out who's doing it. One of the first places I found out who was doing it was a place set up for just this purpose. I found that out because one of their staff came to give a talk to some psychologists. He talked about the LSD. I met him; that's the first time I ever met him. We had a talk, and he got to realize that I had a great interest in it. He's the one that told me about their place. I went down to visit them and he showed me around, told me things, and gave me the idea of the setup.

I found out other people who were working with it at that time. We had a meeting of people who were interested in it and did a lot of talking about its potentials, shared experiences that people had and all of that. Then there were a couple of other places that I went where people knew things about it. In fact I went to a meeting where Aldous Huxley spent an evening with us telling us all about it. He had a place for tripping in Mexico, a health resort. I went down there once for a trip with another therapist and her group.

When I was so interested and fascinated by it someone whom I don't remember any more said, "Jacob, why don't you try it? Find out what it's all about?" I said, "I'd love to, but I don't know where to get it or who to talk to." He said, "What're you talking about? All these people, any one of them, could give you a trip."

I knew someone who was interested in these materials. I was talking to him and asked him if he knew anyone who was willing to give me a trip. He says yes, he knew where I could get a trip and he told me about a fellow who was doing this work. This guy arranged one for me with him and his wife. So I went over there and had a trip. Didn't have much; didn't take much. I get a full trip out of 100 micrograms acid. They gave me the acid, and I took it, and - nice circumstances, very pleasant, secure. Then I start to turn on. I lay down on a kind of divan that they have there and we played some music and as I really started to turn on, they started to turn on.

I remember that the first thing I said was, "Why can't it be like this always?" It was a very deep, emotional trip. He asked me to bring some things along that were important to me, and I brought my Torah. I have my own Torah in its ark. Someplace along the line he was playing Kol Nidre, I think. He laid the Torah across my chest and I immediately went into the lap of God. He and I were One. That was - (feeling strong emotion). I can't remember all the different things. What happened was another thing I said out loud - he copied down what I said out loud - I use tape recordings to catch what people say - I said, "Jacob, if ever again you are frightened you deserve the pain of the fear because you will have forgotten that God is with you and protecting you all the time."

As I was coming down I had some pictures that I brought along - pictures of my family - pictures of my father and my brothers and my mother. The outstanding experience there was, I looked at pictures of my father and my brothers and myself as I was a little boy - and we all were the same person, all of us. There was no difference between us.

I looked at the picture of my mother that I had there and it came alive and I took hold of her hand and we walked through a forest glade or something like that. And I told her - I can cry again, my God - I told her all the different things that I'd never been able to tell her in my life. Just told her what they were! And she listened to them all, she heard them, she did not respond yet we were communicating beautifully. There were other things that happened on the trip, but now I'm going to stop and go to another point.

The space that I was in at the time that I tripped - I was just in the beginning of the late forties - the 50 year crisis that people have going into the second half of life. I see it more as the time when you really get into the spiritual search. I was pretty damned depressed and pretty well ridden with anxieties which are characteristic of that stage. I was dissatisfied with myself, dissatisfied with my work as an analyst. While I was aware of the value of the work I was doing, I was more acutely aware of its limitations. Having the people come in once a week - I never did see people more often than once a week, maybe twice a week if they were in a crisis - and talking and talking and having hit the desert space, the dead space of life where nothing's happening. And listening to them talking and talking, trying to get out of it working with dreams and all that and nothing happening, and realizing God-damn, Jacob, there's nothing you can do except wait until life comes along and gives them a big kick in the ass and they get going again. Nothing's going to happen from me except to be there to listen and to support them.

Well I was in that kind of a space myself, not knowing what to do, where to go. I could only do what I could do; I tried different solutions, but they didn't work. I read books, I read about spiritual things, about God and all that. I got value from it, but it didn't get me out of where I was, actually.

One of the things on the trip that occurred to me was, Jacob, this is the answer you've been looking for! If something like this can do this to you, then - well, I don't know if I filled it out other than saying well, my God, this can jar people loose, this can break people through, this can do all kinds of things. Look what it's doing for you.

I decided then to explore it much more thoroughly. I wanted more trips, to have more experience, to develop it more. I had to find people who had material, that I could get them to sit with me. I remember being with - oh, he was a physician - he was exploring the materials, and I wanted to try grass. He said all right, come by the house here, and I'll have some grass for you and we'll turn on. Well, I was smoking cigarettes in those days. He laid out some joints for me and told me how to inhale it and hold it and all that and so I started to smoke the grass. I smoked it like cigarettes. I inhaled a big drag, held it in my lungs as long as I could and blew it out, then inhaled another one. I did that through two and a half joints, and this was good stuff.

What happened was I really freaked out. I got paranoid as hell! I was lying down on the couch there after I had finished a piece. The agony of the damned went on and on and on such as can happen. Paranoid as hell! Scared to death of everything. If the phone rang I knew it was the police coming in and there was nothing I could do but just give myself up and all that kind of stuff. It was torture! It was a horrible bummer; I had never had a bummer like that in my life until then.

Myron: Were you alone?

Jacob: No, he was there. Some place, about two to three years into it, he came by and put a dish down by me and I picked up my eye and looked at it. I didn't know what it was. I picked up my eye a couple of years later and looked at it and it was some ice cream, with a spoon. He said, "Have some ice cream, Jacob; go ahead."

I picked it up and I took a spoonful of ice cream. I never tasted such ambrosia in my life! It was the exact opposite experience of what I was having. Heavenly! I ate and ate and ate for I don't know how many years. Every bite was so beautiful! Finally I licked the spoon and I licked the bowl clean. I put i t back down, laid back on the couch, and went right back into the bummer!

It took quite a while for me to come down from it, and I did. That was my second trip. I had some other trips that were very nice. I can't remember specifically now. I did have mescaline; that was good, very spiritual, very nice. I took acid some more. Two very interesting and important experiences I had. One was with an experienced psychiatrist, let's call him Louis. Let me see if I can remember what the hell I had then. I think it was an acid trip. I remember I was smoking at that time, I was smoking a pack and a half a day, which is a lot of cigarettes. I was having problems at home with my wife, and was pretty unhappy then in my home life. On this trip I was talking - I was coming down from it, somewhat - and I was talking to Louis about things. He had asked me questions to get me to talk, and I was talking about Jane. I was saying something about the problems that I was having with her. I couldn't talk to her, I couldn't relate to her, she was very frightened about anything that I was doing and very paranoid about me. Very jealous, absolutely no reason of any kind at all. I used to have migraines in the early days, but more than anything else what bothered me the most was the fact that she smoked, constantly. And I'm allergic to cigarette smoke. I was telling him that. I was telling Louis, "See. I can't stand cigarette smoke." Louis looks at me and I'm sitting there with a cigarette in my hand. I say, "I'm allergic to smoke, to cigarette smoke."

He says, "You're allergic to smoke?"

I said, "Yes."

He looks at the cigarette and looks at me, and looks at the cigarette, and I look at the cigarette, too. I'm still pretty stoned. I looked and looked and looked for a *long, long, time*, I looked at that cigarette. Hours, just looked at it. Many things were going through my mind. Louis says to me, "Well, if you're allergic to cigarettes, are you going to stop smoking?"

After a long pause, I don't know what time it was, but I responded. I said, "That's the wrong question, Louis. The question is not, am I going to quit, the question is, *have* I quit?" I watched that cigarette burn down to the cork tip in my fingers, and I stuffed it out. And I've never smoked a cigarette since then. I was never *able* to. I had tried to stop many times, you know how you try to stop. I've never smoked a cigarette since then.

There's another incident, too, an experience in my home that I had that was a very important one. I've had migraines all my life. The earliest memory I have of myself is lying on the front porch of my house at home while they're paving the street and the tar was there as they were paving the street and bricks as they used in those days and the tar smell was making my head ache so bad. That's the earliest experience I had. About three, maybe four years old. The headaches were extremely severe and painful. Pretty bad constantly.

One day I was tripping in a group trip. I was having an ibogaine trip. Do you know ibogaine? It's a fantastic medicine, really. I think I mentioned that we use the word medicine rather than drugs.

You get the answers to all your questions on this trip, on the ibogaine trip. Everything is clearly stated, any questions you have. You go into the trip with questions if you want to. You ask the question but you don't try to answer it. The answer comes to you. This time I decided to ask Mr. Ibogaine - we call him, the person from whom you get the answer, Mr. Ibogaine. Anyway, my question was, what is this with these headaches that I have, that I suffer from? That's all. I was really turned on and deep in a trip and the question occurred to me. Okay, ask it. "What is it with these headaches?"

The answer came. I've had a number of ibogaine trips and the answer always comes. You may not recognize it for what it is, it may be very ambiguous or somewhat like that, but you've got the answer for sure, you'd better hang onto it. The answer came back and said, "You're going to die." I looked, and I said, "What?" That's what it said. I know it said it. I looked around it, and it said I'm going to die.

You don't get frightened with an experience like that. You just take whatever's handed to you and look at it, handle it. So I looked at it, and I looked at it and I said, "Jesus Christ, what does that mean, I'm going to die? Well it means you're going to die, that's all it means." Die when? Of course I knew I'm going to die some day. I know that, that's nothing new. This isn't the kind of "You're going to die" that Mr. Ibogaine was saying.

I said, "Well, gee, this is something between me and Mr. Ibogaine. It is not something that I can tell anybody about." On the report of my trip - we all gathered the next morning and told what happened on our trip - on the report of my trip, I could not say anything to them about Mr. Ibogaine's saying I'm going to die, since that would scare the hell out of everybody. They wouldn't know how to take it.

I didn't know how to take it. I never did know. I kept reflecting on it for quite some time. And it was about a month later. The only relief I could ever get for migraine was codeine. And I took one helluva lot of codeine. I was certainly habituated, but not addicted because there were times I wanted to quit taking it, and I decided I was going to quit. I did quit; I quit for weeks, and I could do it! Without too much trouble. And my migraines would be easier on me even then. But then I'd get back on it again. I was taking as many as four to eight half-grain tablets of codeine every day, so that I could function without the pain.

A month after this trip I took another trip. I don't remember what the material was. It wasn't ibogaine. I was with somebody, I can't remember who it was, I don't even remember if it was a man or a woman. I took something, I think it was acid, and had my trip. As I was coming down from the trip, as most of the people liked to do and as I always wanted to do, I walked down to the water. I walked along the water, which was a very important place for me. That's where I had my greatest conversations with God. That was really a very important thing to me. I remember walking along, talking to God, and coming back up to the house. As I was coming up the hill something flashed in my mind, something that was a result of the space I was in from the trip. What flashed in my mind was a phrase.

I know that when lots of times you take an ibogaine trip you get something that's enigmatic, you don't know what it is, and later on you'll get something that fills it in. Completes the sentence is really what it does. It turns out that "You're going to die," was part of a sentence. The second part of the sentence flashed into my mind. "Unless you stop taking codeine."

I rolled that one around and rolled it around and rolled it around and looked at it. God-damn! How can I function, unless I take codeine? I just played around with it a lot. Maybe I haven't got the right message, or something like that. Then I said, "No, Jacob, don't fuck around with this stuff. You know the answer. You take it. You got the right message. Take it, just as you got it. *I'm going to die unless I stop taking codeine*. Okay, I got the message. That's the truth, I know that's the truth. So, what am I going to do about it? Am I going to quit taking codeine? It doesn't bother me to die. I'm going to die some day. But - I'm not ready yet. I don't want to, right now. Am I going to quit taking codeine?"

And it flashed in my mind the answer, this statement. "Jacob, that's the wrong question. The question is not 'Are you going to quit taking codeine?' The question is, 'Have you quit taking codeine?'" The same thing that happened with the cigarettes. And I knew the answer. *Right then and there I knew the answer*. I had quit. I had quit. For a long, long time. My migraines got less and less. Occasionally they would get real strong, I would take some for a little while. But it was over with. I was over taking it as I used to. Well as you can imagine, that was a very spectacular thing in my life.

Those are personal incidents. Some of the rough times that I went through.

Then I got some other people interested. In fact, some of the people I used to work with - I was doing groups then, too - I was telling people about my experience and they all got excited and interested and said, "Hey! I'd like to do that!"

Fine! Somebody had said to me at one point, "Jacob, you should be doing this. You'd be a natural at this kind of thing."

I said, "Who me? I can't do that kind of thing. That'd be too big a responsibility. I wouldn't know how to handle it."

But this person whom I knew very well wanted to have a trip and I made the arrangements and I gave her a trip and she had a fabulous experience. And that was the beginning. Several people wanted to have a trip. But after a dozen or so had had a trip they were complaining because there was nobody they could talk to about it. Look, you couldn't talk to anybody about it. They wouldn't understand it, they'd think it was a terrible thing or something. So I said, "Fine, let's have a meeting at my house. Everybody who's tripped, we all get together and talk about our trip." We did that several times. They'd talk about it, we enjoyed it very much and one day somebody said, "Jacob, why don't we all take a trip together?" Somebody suggested I should be doing group trips, too.

I said, "What?" They were all clamoring about it. So I said, "Okay, we can try it once. We can all spend a weekend together and we'll have a trip."

There were ten or twelve of us. We had a little ceremony developed and plenty of preparation and security, and I stayed straight. I only let them take 50 micrograms of LSD because I didn't know what the hell was going to come from it. Well, a few of them turned on a little bit. Not very many of them did turn on. But I wasn't going to go any further that time. After it was over we talked about it and had a good time for the weekend, but not much happened.

I decided we'll do it again, only next time I will give them their base amount which I knew from their individual trip. They'd all had individual trips with me. Then we'll see what happens. We did that again about a month later and that was a fantastic experience. That began the whole program of group tripping.

There's the individual trip and the group trip. The evolvement is something I would like to be able to describe. There was so much that went on. It was all experimental, all exploring, everything that we did. We tried this, we tried that, in terms of what went on during a trip. First, I want to go into the development of the individual trip.

In the early days, whenever I had an individual trip, I always had a physician present. He would come in and see the person first and check them out. It was just a procedure that I wanted to explore and see what was necessary and what wasn't. This was mostly for my own feeling of security in case anything happened. He was present the first couple of hours of every trip. These trips were all done in my office. I had a folding bed that I put up and went through a lot of preparation with them first. I explored different things. I read everything there was about what was important to do in preparation for a trip. I tried a lot of them.

A physician worked with me a lot. He liked to work with people throughout the whole trip. I started to do that and then very gradually did less and less of it, until finally I did not work with them except at a point when they wanted me or needed me. He explored on a psychoanalytic basis. He used that model which I couldn't use. It was not my model.

It was less than a year that my doctor friend would come into the office. After that I didn't need anybody. I knew I didn't need anybody. In fact, it was better not to have him. He would try to do some work with the person which was anti what I was doing.

In the beginning I worked with the people on trips - I can't describe what the work was right now. I helped support them in turning on. They got frightened, you know? I'd hold their hands or I'd hold them in my arms and tell them to go ahead, experience it out. I would talk to them in advance about this so that they would know that this was available.

Most of them were blissful trips, but if somebody got frightened with the transition point between one stage of consciousness and the other I would prefer to be close to them. At times I would ask what they were experiencing. If they were in pain or something like that I would ask them to describe the pain, where it was, and go into it. If it was a pain in the stomach, I would say, "Okay, now, think about opening your mouth, and going down into your mouth and describe what you see. It's dark, it's this, that, and keep on going. Describe what you see as you go down. Go all the way down, into your insides." Frequently they would burst into a beautiful world of paradise. The pain would immediately be transformed into ecstasy. Something like that would happen. I tried many different things. As they were coming down from the trip we would talk, and they would talk about where they'd been. You can't talk much, you know, until you're coming down.

Also there was physical contact. It was important in those days that they would have something to resist before they turned on. Or as they were turning on. They were having trouble turning on - I'd tell them first that this might happen - I would lie down on top of them, grab the edge of the bed and say, "Now what I want you to do is push against me." I want you to know, I hung on for dear life. I said, "Push harder, harder, harder!" And they did. When they succeeded in getting me off they were through to the other side! Their report of what happened as a result of that and later what they experienced was just a fascinating thing.

One of the things I had everybody do that I tripped was after or as soon as he or she could sit down and make notes of whatever he or she could recall - write up the whole thing - for themselves, and for me.

Myron: Did you keep copies of these reports?

Jacob: I kept a file of these reports, but some years ago, the file got thrown out. Of all the trips - I had hundreds of them - they would have made a good book themselves.

The screening process and the preparation process: we talked a lot. I had them go through a lot of rituals for themselves - fasting, learn how to do some fasting. I had certain things that I had them read, spiritual literature that was very illuminating and they were able to get it.

Myron: Do you have a few favorites along those lines?

Jacob: Not any more. Not any more, I don't. I don't suggest readings any more, because the people that come to me have gone through a lot of things in terms of reading, and they're ready for something besides reading.

Myron: I'm thinking in terms of people who are just looking into this, and looking for some helpful ways to get started.

Jacob: Very little that I've come across I would recommend. Aldous Huxley's *Doors of Perception* and *Heaven and Hell*, those certainly are ones. Those are the only things I found that were important. I used to give a lot of reading, but that didn't make any difference. This experience is such a very different dimension. They left it all behind very quickly. It did not help in getting them prepared. Their greatest help was their contact with me - talking and experiencing. For the most part the people that I do now are people who make a big difference in the world, with people. They're therapists and psychiatrists, physicians, they're government people who have very high positions and great influence.

Myron: I've always had this dream that you could somehow bring this about, yet we have never succeeded at that at our Foundation (the International Foundation for Advanced Study in Menlo Park, California).

Jacob: They didn't give you the chance.

Myron: I don't know; we brought a lot of stuff on ourselves. We were pretty immature.

Jacob: Of course. I look at the progress I made down through the years and the different changes that I made as a result of my experience - I can't recall them all but I continually changed my procedures and my thinking about it and my ideas about what happened and what could happen; how to set situations so that you get the best possible setting and so that they could get the best possible trip. The most *useful* trip for them.

Some of the rough things that I went through on trips - the roughest of all is they get paranoid and run away. That's scary as hell until they are located. They see me as the devil. No matter what I say to them the devil is trying to destroy them. If I try to get them to take some niacin, which is supposed to bring them down, that's poison. They won't touch it. No way. Or a sedative or whatever. I learned not to do that; I learned to screen better. I could sense after a while whether a person was likely to get paranoid on a trip, or violent, or something like that. And I was alone on all this.

This was such a fascinating thing to be doing! I didn't have to do much of anything at all except provide the opportunity and the material and then to see the fantastic results! The transformations that came in all of those people. It was really something. We went on, I kept on doing it, one or two a month.

Selection and Preparation

Selecting the Client

Myron: What would you look for when you screened? What were the characteristics that were important to avoid?

Jacob: I screened very carefully. I'll try to tell you what my screening process was. A lot of it was based upon experience. Not knowing at first who was a suitable candidate for the kind of trip I did under the circumstances I set up, I would offer to trip people who weren't suitable. As a result I had some pretty paranoid trips. That's extremely painful to go through, to stay with them until they finally come down. Even though afterwards they said it was the most fantastic experience they ever had in their life. It changed their whole life. That always happened when they had those paranoid trips. Painful experiences, weeping, listless; I was very encouraged when they could go through this. One of the things I learned about tripping very early was that we get in touch with feelings we've never been able to experience before and at a depth and a level that we've never been able to reach. That could be fear, it could be love, it could be ecstasy, it could be anything. Just as long as it's feelings - sadness, grief. Lots of times they would start to cry on a trip and cry for the longest time so deeply. To me it seemed so satisfying because they were getting something out. I liked that.

I learned to watch out for my motivations for wanting to trip somebody. To make sure that - I don't know what word would be suitable here - I use the word pure, but it's not the word I want. Clean. That I wasn't doing it for self-aggrandizement or something like that. I learned very early that I am an instrument. I do not bring this experience to anybody. I provide them with the opportunity; they have the experience. They bring their own experience to themselves, and I have the privilege of sitting with them while it's going on.

Myron: I think I've picked up an awful lot of junk sitting in sessions. I was so inexperienced and I'd never been trained as a therapist and I used to get so tired. I'm sure it was my self-involvement - I wanted to do something for somebody.

Jacob: To try to help them. I very soon learned that my traditional techniques of helping people in therapy do not work, they just don't work. Just leave 'em alone! They know what the hell's wrong with them or the God within them knows what's wrong with them and provides them with whatever they need which I don't know anything about and they don't even know anything about. They don't know what their real needs are. All they know is what their wants are. That's true for all of us, of course. (Laughs.) Just how you know you have a good candidate is very difficult to describe. I've tried to relate this many times. I've tried to teach. It's nothing you can teach. Only your experience will give it to you. My intuition was the most important thing, and my stomach. My stomach would respond to something that was not right. Something they would say - or just being with them, no matter what they were saying, because I couldn't trust what they were saying as being them. It isn't them, what they were saying. I would get a vague feeling of anxiety that would stay with me after I had talked to the person and certain questions, certain things that they had said would come to my mind. I would just look at them. Then I would talk to them again a time or two and see if I wanted to proceed more along the exploring. Always I told them this is exploratory until I was really sure I wanted to trip with them and they were really sure that they wanted to take the trip. Then we would arrange for the trip and do some preparation.

Myron: Would you describe it as you would have to feel a certain kind of bond with them?

Jacob: Yes. I would have to have that feeling that I would really like to trip this person. Other factors besides those subjective ones: How much work they have done on themselves in terms of their own individual growth. How long they've been working on themselves. What training they've had. What workshops they've gone to. What readings they've done. What they feel they've accomplished. How far they've gone and what their complaints were about themselves in terms of inadequacies, like, "I know all the things in my mind, but I want to get them in my heart." I can tell in getting their history if they're searching, how far they've gone, how much of it has sunk in. When I get the feeling that I'm really interested in this person, like, "Oh, boy, a trip would do just exactly what they want, what they're asking for!" Then I knew this was o.k. If I didn't get that kind of thing I wouldn't stay with them longer or I would say no, I don't think it's time yet. I had to turn down people very seldom because before they even get to me there's always a selective process going on. They are referred by somebody who knows me and has tripped with me and has worked with me. Before they even get to know who I am or get to see me this person will call me and tell me, "You know, here's so-and-so that I would like to refer to you for a trip."

I would say, "Well, tell me about the person." They would tell me a lot of things - how well you know them, do you trust the person, a lot of questions. Questions are what you want. "What do you know about the explorations that they've made already? You know that we are spiritually oriented. Are they also interested in that and oriented in that?" They know these are questions I'm going to be asking, so that the people that are referred to me are already screened by them as good candidates. It might be the spouse of somebody that has tripped, too. A boyfriend or a girlfriend of somebody or a colleague or somebody who is on the search with them.

In other words they know this person. They've already screened them. The person really wants to have a trip. They know that. They just don't know where to go or how to go and they've heard what great things have come from them, and what great things have happened to the person that is making the referral. They're close, in some way. They'd like to have that happen to them, too.

Then the referring person calls me, because no one can ever give out my name without prior clearance from me. They call me, I get all the information. I say, "Yep, it sounds okay. Tell them to call me and I'll set up an exploratory with them."

And that's what happens. Very rarely do I have to turn anybody like that down. Very rare. Although sometimes I don't have the right feeling about the person and I know that the person who referred them doesn't know much about them, really, but just believes they might be a good candidate. That one I would turn down.

There are these particular questions, some of them I've mentioned that I think of now that I would ask them or explore with them in terms of their state. What their expectations are. What they'd like to get from such an experience. I used to see them six, eight, ten times before I would decide. Not any more. One visit is all I need. One visit with the person for me to experience them and to get the feeling, "Yeah, this is one I really would like to trip." Or for them to get to experience me, for that's very important to them. The feeling of trust that they have in me is extremely important. How do they feel about me? When it turns out that we really make a connection, that's all there is to it, we arrange a trip. No more than that. All the circumstance surrounding the trip, that I'll be talking about some place along the line, too.

So, it's mostly based upon the experience that I've had already and it's mostly a feeling and an intuitive process which I don't see operating, I just see the results which come in my willingness to relate to a person.

Myron: Are there certain kinds of presenting problems which are a factor, like certain kinds of difficulties that a person has that make it a more difficult situation or is it more just a feel of the individual?

Jacob: You see, the point of presenting symptoms, specific problems that they want to have dealt with, doesn't come into the picture. There are no symptoms, really. They just say, "I would like to have this kind of experience because I want to grow, as so-and-so has been doing. I want to get the kind of religious experience that can come out of this thing. That's what I'm looking for."

They will come in, and I'll ask, "What do you want to take a trip for?" Then they'll tell me what's going on in their life that they're dissatisfied with, that they'd like to come to terms with, that they'd like to change. They have lots of anxieties, worried about things - they're not getting along well with their job, with their boss, with their wife, with their family, colleagues or friends or whatever or they've got complaints, presenting complaints. It's not the kind of thing that you find when somebody comes in for therapy and they give you a list of their neurotic symptoms or something like that and that they want to have changed. Sure they want change. Many of them have already gone far enough to learn that it's not the outside that needs changing, it's the inside that needs changing and this is the approach that they want to take for changing the inside. Because when you change the inside what you see outside is different.

Myron: So the people you work with would generally be far more growth-oriented than what the usual therapist works with.

Jacob: Mostly, yes. Every now and then somebody comes from some part of the country that is a person who is referred by somebody whom I've trained out there who does a lot of tripping, too.

Myron: Would it appeal to you if somebody had some unusually tough problem that they were unable to get anywhere with in therapy and they thought that maybe this procedure might be a breakthrough and might be helpful? Would that kind of a case interest you?

Jacob: That's a familiar thing. They say, "I've been working on this for a long time and I haven't been able to get any place with it. Maybe a trip will help me break through it." I've heard this. It could be a specific thing or it could be a general condition that they talk about.

Myron: Most people have a resistance to therapy. They don't like the idea that something's wrong with them and that they've got to go for help. In another case it might be the expense, or whatever, so usually before a lot of people will go into therapy there has to be some really tough problem. Maybe they've got colitis, or maybe they have a serious marriage problem or they know they have a very difficult relationship and maybe they've worked in therapy for a long period of time and haven't seemed to get anywhere. They seem to be really blocked.

Jacob: I see what you're saying. A number of people like that were referred to me and referred by people who know them and know their history. And I say, "Look, I can tell you about something that very possibly may help you break through on this."

Myron: To focus on this issue, maybe they're not even interested in spiritual growth but they just really have a serious problem.

Jacob: Oh, yes, that's right! I never mention the word spiritual to them unless they bring it up. I've had many people, I mean many people who've come to me who have been in analysis for a long time. Some have been in analysis four times a week for eight to ten years continuously. They said they had gotten a lot out of it. However, there was always something that they never could get to. They have taken a trip and in one trip afterwards have said, "I got more out of that one day's experience than I did in my whole eight or ten years or whatever of psychoanalysis." I've done that numbers of times.

Clients with Previous Psychedelic Experience

Here's another one that happens a lot. People will come to me who have already tripped who want to have my particular kind of way of tripping. One of them had tripped at least five hundred times on acid, others who have tripped three, four hundred times, down through the early Sixties, clear up to recent times. You know, *plenty* of trips their own way, who've heard about people who have tripped with me and where they got to so they want to have this kind of trip. We talk about it, and they would be good candidates so I'd say, "Sure." They would have their trip on acid. Invariably these people have said, "I've never had an acid trip before in my life! This is the first time I've ever really had an acid trip."

Myron: I'm real interested in that, because frankly I've had a lot of resistance to Tim Leary and the tremendous effort he made to make it so generally available. I feel that so much of the potential has been missed by kids using it on their own in the way they've used it. There's been a lot of self-gratification, there's been a lot of pleasure experiences and a lot of what Al Hubbard called "sharpening your wits" to reinforce "I'm right, you're wrong." I feel by and large that not too many have seen the real implications. So your experience here really interests me.

Jacob: Yeah. I would always ask them, "Did you feel that you ever got any value from your previous trips?"

They would say, "I got some great insights from it." They would say that in advance. But afterwards they would say, "No, nothing like what I got this time."

Myron: I think that's really marvelous. It says a great deal for you and your procedures. And it confirms some of my own hopes in this area. Did you keep any kind of records where you might be able to give some kind of a numerical assessment for this sort of thing? Like, how many individuals came to you who had many, many acid trips who arrived at this conclusion as a result of a single trip?

Jacob: I didn't keep any records but I can give you a fair estimate. Looking over more than 3,000 people who have tripped with me individually and in groups I would say that between five and ten percent have tripped before. That's on psychedelics, not just grass. Certainly five percent have tripped; some a little bit, some a lot. It's those who have tripped a lot - well they will all say that the trip they do with me is very different, very different.

Myron: You can say that that's just about universal?

Jacob: Yes. For those who have tripped before on acid or any of the psychedelics or psychoactive materials even, except for grass. Yeah. Once or twice a number of them - I can't recall now how many - have had very bad trips and came to me to have a trip under these circumstances. Usually where they were interrupted, and unable to get all the way through it because somebody took them off to the hospital and they were given Thorazine or some kind of shit like that. They didn't get a chance to really complete it, to go through all the bad spaces that they had to go through. They would come to me and we would trip.

Under my circumstances I helped them through their fears so that when they came out they were really reborn. That's Stan Grof 's whole model, that's a rebirth experience. Transformation is rebirth and all that.

Clients in Therapy

Myron: Do you think you can make an estimate of how many had been in extensive therapy who as a result of a trip with you found that they had made a really profound gain compared to the therapy they had previously been in?

Jacob: Yeah. How many had been in therapy - a lot of them. Let me see if I can say how many. Eighty to eighty-five percent had been in therapy before. Some of them were currently in therapy and wanted to have this experience. I want to come back to that, so you remind me of that. Out of that eighty to eighty-five percent, whatever it is, all of them said they got much more out of their tripping.

Now, they're not putting down their therapy. In fact, this experience illuminated the insights that they got from therapy but didn't get very deeply. It validated their therapy. For many people, too - I don't know how many, it would be hard to estimate this - it brought them to the realization that they wasted all of their God-damned time; they didn't get a thing out of therapy. They worked hard at it, stayed long at it, many of them, labored at it, and thought there was something wrong with them. In fact, they had just gotten with the wrong person, that's all. If anybody came to me that was in therapy I first stipulated I cannot bring you this experience unless you get clearance from your therapist. There was an immediate screening process taking place. There were those who said they couldn't do that, they just didn't want to tell him about it.

I said, "That's quite a commentary on the relationship you have with your therapist. I can't do this. I will not do it. If you tell your therapist that you want to do this I need assurance that he agrees that it's okay for you to do it. I'd like for him to talk to me if he wants to." No, I stopped doing that. I didn't want to be identified.

Myron: I was going to ask you about the exposure.

Jacob: I want the therapist to know that the person I'm talking to about this has already agreed not to reveal my identity to anybody without prior clearance from me. That's the first requirement I give to anybody.

Myron: So if they went back to their therapist to get clearance they would say, "I've found somebody that's real good to take a trip with," and the therapist asks, "Who is it?" They'd have to say, "I can't tell you."

Jacob: Right away that would bust up the relationship.

Myron: I can see where a lot of therapists would really get on their high horse about that. On the other hand, were there any who got to know you and would keep the trust and even be willing to refer their patients to you?

Jacob: Most of the therapists who would do that have tripped themselves. I always warned the person who was in therapy that, "I want you to understand and realize that it's quite possible that after you've had your trip you will terminate your therapy." Invariably it happened. In a very few cases they could keep on working with the therapist. They could do that if the therapist had tripped. But you cannot trip and work with a therapist who hasn't tripped and get any value out of it. You can't relate back and forth. You can't trip as a patient and work with a therapist who has not tripped because he has not had the experience and you cannot relate to him about it. It ends up that I can only trip people who are in therapy with a therapist who understands tripping and is willing to refer.

Let me mention something about my original position when I first started out. I had the traditional psychological or psychiatric attitude towards this stuff. This is dangerous, this is bad, you shouldn't do it, and anybody who does it is crazy, and all that kind of stuff. That was my position in that regard.

There's no easy way to satori. You've got to work hard and you've got to suffer. I was like the typical Christian who didn't have much confidence in grace. Yet I knew what grace was. I did experience grace many times. I had to overcome all of those prejudices first before I could really explore honestly and openly. And of course my first trip dispelled all my doubts. My own first trip. Since then there was never any problem.

Myron: Would you care to say approximately how many therapists you have provided the experience for?

Jacob: In all categories - psychiatrists, M.D.s, psychologists, psychiatric social workers, transactional analysis people, all the different schools that exist where people see patients whether they're licensed or unlicensed, there's quite a spread of all of them - altogether, a hundred and fifty. That's what comes to my mind. It's over a period of fifteen years since I've been really doing it.

Myron: And these are all people who would have a practice of their own where they would be counseling others.

Jacob: Right. People-helpers - that includes nurses, physical therapists, people who are very important to other people. At times I would get referrals from them.

Myron: Of the roughly 150 people-helpers you have worked with, how many are actually psychiatrists and psychologists?

Jacob: I would say about one-fourth. The others are psychiatric social workers, family counselors, professional helpers like that.

Myron: Well gosh, you've started a real significant movement here.

Jacob: (Laughs.) It extends very much around the world, really.

Myron: It's been kept very, very quiet, it seems to me.

Jacob: The selective process has helped with that. The security practices that everybody's imbued with right from the beginning. That's what's important. I've been able to function this way. Yes, it's underground, and all of that. I've been able to function this way for all of these years because I trust the people and they know about our security situation. A few people have broken security. It has happened. Nothing has come from it, of course. They've told somebody who tripped them.

Security Problems

Myron: Security must have been a terrible problem. Can you say more about what it's like to work under such conditions?

Jacob: We were always security-conscious and we made everybody who came in contact with us security-conscious. Most people were able to really be ethically security-conscious and a few weren't. The few who weren't who talked about it, maybe blabbed, talked unnecessarily or identified people - no harm has ever come from that.

You see, again, a spiritual trip is what's involved here. This I have to say - it's the only way I know how to talk about it - what I do and even how I do it is not up to me. I'm guided. I can't define that, I can't explain it. I know that that's true. If I wasn't supposed to be doing this, and I've said this before, I wouldn't be doing it. If God didn't want me to do it He would have stopped me a long time ago. I have a lot of faith that that's true. At the same time I keep a close eye on my integrity and my security. Everybody else's security is bound up in mine. We're all in it together.

I definitely have suffered, I have suffered considerably with fears, what I call "just in case" fears or "what if" fears. What if we're sitting there, laying there and having a trip, you know, everybody's all laid out and stoned out of their God-damned mind, their pupils are as big as saucers, and somebody knocks on the door and it's the police raiding us. I don't know how many times that's come across my mind. What if somebody died on a trip? What if - I don't know, all the "what ifs" that I had - what if somebody freaked out and ran down the street screaming? *That happened*!! Paranoia! Everybody has it, I know, and I have it! If I hadn't been doing *this* to be paranoid about, I'd b e doing something else to be paranoid. It's only since I've taken the Course in Miracles that I've gotten over my guilt and my fears. Many years and many times I'd be in much agony falling asleep, and wake up in the morning and have it hit me. That's true. I've looked at it and I've said, "Jacob, for Christ's sake what are you exposing yourself to all this shit for? You don't need it." Then I'd look and I'd say, "Look at the people. Look what's happening to them." I'd say, "Is it worth it? Is it worth going through all of this shit for that?" Inevitably I'd come back with "Yeah, it's worth it." Especially at the end of a weekend when I'd see what fantastic things have happened to these people. I would say clearly to myself, "Jacob, it is worth it! Whatever you have to go through. It's worth it to produce these results!"

Security has been a terrible problem. It hasn't been a problem in that sense, but like I'm describing now. What I've gone through because of fear of discovery. This is a part of security. Actually, my worst fears in every situation have been realized. I have said many, many times, whatever you are afraid of never happens. And I know that's true. And yet sometimes the exact incident that you're afraid of happening does happen. However, what you were afraid would be the consequences did not happen. So what you're afraid of didn't happen. That's happened in my life a number of times. Some of them have been in connection with psychedelics, with what I'm doing.

There are those people who know that I'm doing something. I believe they know the kind of work I'm doing and know that it's under very good control and a creative process. They don't bother me. They won't do anything to me. You'd be surprised at the different walks of life people have come from for tripping.

Preparation

I'll bring my analogies in here at this point. When I'm talking about a trip to a person who hasn't tripped and they want to know, "What's it like?" It's hard to describe what it's like but I have a couple of analogies that I use.

One is, imagine that you're on a stage, a very large stage, around stage, circular. You're standing in the center of the stage. Around this stage is a huge curtain, very, very high and it's closed and where the curtain comes together there's about say three feet of space, of an opening. You're standing in the middle of that stage and you're looking out through that opening. Everything you see is the totality of your experience of yourself.

What happens on a trip is by some mysterious means the curtain very gradually is pulled back. Very gradually. It's pulled back until it's pulled all the way around the back and you're given the opportunity to see everything that's been there all the time but you couldn't see it before because there was a curtain. All the different levels of experience that it's possible to have, you have. All the different truths, all the different things, you have. You experience it. Then, as you start to come down, very gradually the curtain gets pulled back around until you're all the way down.

When you're all the way down, the difference is that before, you had about three feet of space that was open to look through. You now have about fifteen feet of space. You have really expanded your awareness, which is what they call these materials, awareness-expanders.

Myron: The curtain might have even gotten a little transparent.

Jacob: Yeah, (laughs), that was what I was going to follow with. In addition to that you have a lot of memory of what you did experience before. So in a sense that's true, the curtain has become almost transparent. You don't remember everything, you don't need to remember everything. You don't need to. You remember everything you need to remember.

There's another analogy that I use, too. It's similar to that. That is, imagine a castle, a huge castle, very large. Many rooms, many turrets, many levels of it. There's only one way to get into this castle, and that's the front door. The front door is *solid steel*. *Impregnable*. You can knock on that door all you want. You can do everything you can to tear it down. You can't get it down. Every now and then you might somehow or other move it a little bit to get a glimpse of what's behind it, but that's all. There's no way, and you've tried every way possible to get into that castle. Which is yourself.

What happens on a trip is by some mysterious magic means this door is dissolved, and you have the opportunity to go in and explore that castle. Any place you want. You go in and you look around, and you find many, many wonderful places, strange places maybe, scary places and all that. You can go to the top and you can go to the bottom and you get a sense of what the totality of yourself really is like. As you come down, what happens is that the door somehow or other gets back up there. But that's all right, because you have a memory of what possibilities are there and what you've experienced. The biggest experience that it brings to you is that it connects you with feelings that you've never been connected with before. They are now open to you. Not on the level or the intensity that you had in the experience but certainly much more than they ever were before. That gives them an idea. "My God!" they say. "How soon can I have one?" (Laughter.)

Myron: God, Jacob, those are so good. I think of places where I can use those analogies myself. Do you have any objection if I use them?

Jacob: It's the greatest privilege in the world for me to be able to share them, so if they're of value to other people they're welcome to them.

Myron: One of the problems that you run into is that very often you get people who have rather powerful internal conflicts and it's really difficult for them to confront them and they'll dodge and go off in different directions. Did you ever do anything to try to encourage them to confront that sort of thing? Similar to the way you described if it manifested as a pain - you had a beautiful technique for dealing with that. Did you have some other techniques along those lines?

Jacob: Yes, yes. Whenever I was aware of anything like that - whenever they'd get really frightened - I'd ask them to, "Look at what you're afraid of, just look at what you're afraid of. All you have to do is just look at it; don't do anything about it, just look at it. Just keep on looking at it and just tell me what you experience when you're looking at it." Most of the times they'll go off into some kind of a visual trip. Experience something. But they were not experiencing a specific block that you do experience consciously. It wasn't that. It was a painful fear. That's what I had them live with and stay with until it became transformed. As it did, the block was gone. I don't think we even knew what the block was. It was not a specific fear. It seemed to me at the time that it was an *accumulation* of all the unfaced fears that was being expressed at that time. By facing them they dissolved them - to some degree at least.

Myron: One of the marvelous things about this is the honesty - that once you're willing to face it, it becomes resolved. This is one of the major uses of these substances, I think.

Jacob: I use an analogy with them when we're going through preparation. You know, if you're walking along and there's someone behind you and you're worried or scared about it and you start to run, the more you run in fear from it the greater the monster becomes. Once you stop and turn around it turns out to be some little silly funny thing, and their fear disappears. There're many little anecdotes like that that I would give in preparation for trips.

Photographs

One of the things I have them do for the trip is to get a bunch of pictures from a list that I give them. These pictures actually as you'll see are a history of their lives. They go back home or get them wherever they are or write for them. They get all the pictures that they can and bring them to wherever they are. Then I ask them to select the pictures in a particular manner which is really very important. I say, "Give yourself plenty of time. First let me give you the list of pictures that I want you to get." Here's the list:

1. Starting with the pictures of themselves, one at age two and one every two years thereafter through adolescence, sixteen or eighteen.
2. A picture of their mother and a picture of their father when they were young but they can still remember their mother and their father, and a recent picture of each.
3. Same thing about each of their siblings, an early one that they remember that way and a recent one of their siblings and their families if they have one.
4. A picture of a grandparent that was significant in their life.
5. A picture of any aunts, uncles, or cousins that were significant in their life.
6. If they're married, I ask them to bring some wedding pictures because wedding pictures usually have all the relatives and it gives them a chance to see them. If they don't have any pictures I'll say a picture of the woman you married either just before you married her or when you got married, an early picture. And a recent one of her or him, as the case may be.
7. If there are children, a picture of the children when they were about two years old which is when they begin to start to have a little personality of their own. And a recent one of each. And if they are married, with their families. And even if they're not married, a picture of any woman or man who has had great significance in their life. Lovers, current or past or whatever.
8. Other significant pictures.

I ask them to select the pictures in this manner: Gather them all together - boxes, albums, however they are, and put them in front of you, and start with one. The top one or anything like that. Pick it up and look at it. Just look at it to see what you experience in connection with that picture. Look at it a little while. You may not experience anything. It's all right. Put it aside, pick up the next one, then look at it. If it provokes any memories, kinda sit with the memories a little bit, let them go where they want to go. Whatever feelings you have, allow them to be there. Whenever you come across a picture that's on the list, set it aside in a separate pile. Go through *all* the pictures you've got, every single one of them, doing that. You may have to have two or three sittings to do it. I ask them to do it no further away than a week before the trip, as close to the time of the trip as they can. I want to tell you something. That really turns them on. When they come they're in the middle of their trip.

The Individual Trip

Myron : Let's get into your procedures.

Jacob: All right. I'll start with the individual trip first, because the group trip follows the individual one. The first trip is always with LSD. I like to start at eight o'clock in the morning. I like to do it preferably in their own home, if it's convenient, secure, and nobody's going to be there, nobody's going to interrupt, and it isn't too far away for me to go to. (Laughs.) I get there maybe a half hour before that, before eight.

I set up my equipment. My equipment consists of headphones, two face masks, a cassette player and separate recorder, tapes for music, and a special cup. (Jacob shows the box he takes along with him.) I carry these along with me which is part of my ritual that I have. I talk about the transformation experience and how the cup is always a very important symbol of the transformation experience.

I have this setup with the earphones coming out of this machine. This is the way I play my music to them. Music is all on cassettes. The records scratch and they don't work very well at all. Then I have another tape recorder in there which is used to record everything that's said. I record the whole trip. I have a remote control here that I use so that I only turn it on when something's being said.

These are some of the things that I go over with them. The structure is first. Structure is a very important thing, and what structure is, is a set of agreements that I ask them to make with me. These are the things that I ask them to agree to with me:

1. They will not leave the house where we're having the trip at any time during the trip without prior clearance from me.
2. They agree that there will be no physical harm or violence to themselves or to me or to anything else in the house.
3. Reiteration of the security requirement. They agree they will not reveal to anybody else where and with whom they had this trip without prior clearance from me, ever.
4. I ask them to agree - now if this is a woman or somebody gay - I ask them to agree that there will be no sex taking place between us. I'll explain the background for these agreements in a minute.
5. The last one I ask them to agree is that at any time during the trip if anything is going on and I tell them to stop it, stop doing it, and I make clear, "This is under structure; it's not just a recommendation or suggestion," they agree that they will stop it. Or if I tell them to do something and I make clear it's under structure they agree that they will do it. I tell them to look at this one very, very carefully, because when they agree to that they are virtually putting their lives in my hands and the only thing they have to go on is whatever faith they have in me - that I would never let them do anything that would be harmful to themselves, nor would I ever require anything of them that would be harmful to them. These are bills to faith. That puts them back on their faith, see.

I review it, and then I say, "Do you have any questions or qualifications or anything that you want to know about it?" When they say no, I say, "Do you agree to abide by this structure?" They say, "Yes." I say, "Thank you."

Now, the first one, not to leave the house: I don't want them wandering around without prior agreement. Sometimes when they're coming down from a trip if they want to go out and walk around because its so beautiful, fine, I'll walk with them. They ask and they check with me.

Physical harm and violence: Sometimes people are afraid they're going to be angry, they're always talking about the unexpressed anger that they've got. They're afraid that might happen so when they make that agreement they feel safe about the anger, they're not going to destroy anything or hurt anybody.

The fourth one about sex: Sometimes women get real turned on. Sexually they get really connected with their sexuality and they're scared, they don't know what to do with it so they'll tend to squelch it. I don't want them to do that. I want them to find it and hang on to it and know that they're safe, nothing's going to happen. The same thing with a gay person. If it comes up, let it come up, what the hell.

Okay. They've agreed to abide by this structure. I ask them to read this, a late 17th century prayer. It's the only thing I've ever found down through the years that really is the most suitable for beginning a trip. I ask them to read it quietly to themselves once and read it through a second time:

> *Lord, I know not what I ought to ask of thee;*
> *Thou only knowest what I need;*
> *Thou lovest me better than I know how to love myself.*
> *O Father, give to Thy child that which*
> *he himself knows not how to ask.*
> *I dare not ask either for crosses or for consolations;*
> *I simply present myself before thee,*
> *I open my heart to Thee.*
> *Behold my needs which I know not myself;*
> *see and do according to Thy tender mercy.*
> *Smite, or heal; depress me or raise me up;*
> *I adore all Thy purposes without knowing them;*
> *I am silent; I offer myself in sacrifice;*
> *I yield myself to Thee: I would have no*
> *other desire than to accomplish Thy will.*
> *Teach me to pray.*
> *Pray Thyself in me.*
> *AMEN.*
>
> - Francois de Salignac Fenelon Archbishop of Cambray, 1651-1715.

Then we have a dropping ceremony, and I explain the cup and I have water in it and I have the capsule with their medicine in it, too. After they've read the prayer then I give it to them. I've already explained the significance of the cup as a symbol of transformation all the way back to Jesus and to earlier days and all that kinda stuff. I have them take the cup and the capsule, swallow the medicine whatever it happens to be, and drink the water from the cup.

After this dropping ceremony I ask to see their pictures. I have them organize them according to this list, their own pictures first with the youngest on top and the oldest one on the bottom. Their youngest age and the oldest. Same with the mother and father and all the relatives if there's any chronological period of time that's involved. The last one I ask them to look at is their wife or lover currently.

Just before that I organize them all in this fashion: First the pictures of themselves, then the mother, then the father. Now, some of the other pictures will have mother and father in them, too. They may have some very significant picture show up that isn't on that list for mother, father, family, or something like that. A house that they lived in or a pet that they had, goodness knows what, maybe an army picture. Whatever really gives them an emotional charge, positive or negative. That's what I call other significant pictures. They're to pull those out to really get to cover the ground there. Sometimes they bring too many, I screen them out.

Now, once they've dropped the medicine, I say, "Let's look at your pictures." They'll show them to me, and I arrange them in the order that I want to use them, and that's it. We don't take them apart and look at them. I set the organization and have them identified into their stacks, because we'll be doing that later. Then we sit and we talk. I ask them if they've had any dreams the night before or whatever. When they have them I say, "Well tell me about it." I just want them to tell me the dream. I frequently get something out of the dream.

I explain to them, and I've already talked about this before to them but I say, "You know when you go along through the transition from one stage of consciousness to another one sometimes you run into difficulties. If you do, like if you get frightened or something like that, all you have to do is put out your hand. I'll see it, I'll be sitting right there. If not just say, 'Jacob.'" Their hand's out there, and I'll go over and I'll take their hand and put it in mine. No talking, or anything like that. I just hold it nice and firm and solid. God, what they say afterwards about what happened during that holding the hand, what a tremendous experience they had. If they want me to I'll put my arms around them and hold them in my arms. I encourage them when they get frightened to stay with it, don't try to do anything about it, just let yourself be afraid. I explain to them I will be here all the time. I always have a security bucket and a package of kleenex, in case they get nauseated they've got the bucket there.

We'll sit and talk about different things until they feel themselves starting to turn on. Then, fine, I ask them to go to the bathroom and empty their bladder, then come back and lie down. Then I put their eyeshades on, the earphones on, and cover them nice and cozy and comfortable and turn on the music. I tell them that I'll check in with them after an hour to see if they're turned on. They turn on with the music. Beautiful turn-on music, too.

Myron: How do you tell if they're turned on?

Jacob: What I do is I've got a microphone, see, and I'll turn on the microphone and I'll talk. I'll say, "______ (whatever their name is), do you feel turned on yet?"

They'll say, "Oh, yes."

I'll say, "Good. Have a good trip." And I just turn off the thing and let it go.

Or they'll stop and they'll think and say, "I'm not sure."

I say, "Are you as turned on as you'd like to be?"

Sometimes they say, "No, I think I could be more turned on."

I say, "Good, I'll give you a booster."

Or they'll say, "Gee, I'm really not sure. I haven't done this before. I don't know what it is to be fully turned on."

I say, "Okay. I'll check back with you again in fifteen minutes." I don't think they are, but I want to check back anyway, because sometimes they might turn on, it takes an extra fifteen minutes. I check back with them in fifteen minutes and I say, "Are you turned on now?" They'll still be questioning. As long as they're able to question they aren't turned on enough, I'll say, "Well, I'll give you a booster."

I check with them again thirty minutes later. Most of the times they are already turned on. If not, I give them another booster. If they're not really turned on I'll keep going until I check in and they say, "Oh, yeah." Sometimes I watch them, I can tell from the way they are. I can tell they're really stoned. They're going through quite a trip.

Myron: How long do you wait for the second booster?

Jacob: Thirty minutes. Between boosters, thirty minutes between any boosters until they're really turned on. A booster would go 125 micrograms unless not a thing's happening, they feel pleasant and all that but not a thing's happening. Then I'll give them 250 micrograms. I mention to them, "Look, sometimes you get real turned on by a piece of music and it's a great experience and it ends and you're kind of disappointed. All you have to do is say, 'Play it again,' and I'll play it again for you. You go right back out again." I tell them that music is the vehicle that takes you to all the different places you go on your trip. Music is the vehicle that takes you to all the different places.

Myron: Isn't silence the vehicle sometimes?

Jacob: Oh yeah. I say, "If you ever want to be quiet, have silence, let me know." Most of the time they want the music. Oh yes.

Sometimes I'll just not play anything for a while but in just a little bit they'll say, "The music's off." You've never heard music in your life, really, you'll see that you've never really heard music in your life until you've heard it on the trip. Which is true, everybody knows who's had that. I tell them, "Anytime I'm playing a piece of music that's not consonant with where you are, that's bothering you or you don't like it, just say, 'Change the music,' and I will." Once in a while that happens. Most of the time with the kind of music I have they dig it all the way through.

I can tell when they're starting to come down because until that time they are absolutely still. Every now and then I've got to get down on the floor to look to make sure they're still breathing! (Laughs.) I do that as a kind of a ritual. I don't do it because I'm scared any more. (More laughter.) When they start to come down, they start to move around, they may want to go to the bathroom. Sometimes in the middle of the trip they want to go to the bathroom. That's fine, I take them in the bathroom and stay with them unless they want me to go outside. I ask them before they come out to stop and look in the mirror, the bathroom mirror. Just take a good look. They do, you know, God they report things - whatever they saw and all that. Later. Not during this visit. I take them back, lie them down, put them back.

All right. When they have come down enough that they're able to talk but they're still hallucinating a little bit - that may be five, six hours into the trip, around that time - some may be a little bit earlier, some may be a little bit later, seven or eight hours - and they're functional, they can move around, I have them get up. I've told them this is what'll happen. I have them get up and they go sit down at a table some place and we do the picture trip.

What the picture trip is, I start out with pictures of themselves. I have them in front of me. I take the first one and I hand it to them and I tell them, "Just look at it, just look at it and see what you experience. Look at it as long as you want to. When you're through looking at it, hand it back. If you have anything to say, fine. Say it. If not, you don't have to say anything." One at a time I hand them the pictures. The pictures, they don't react much to the two- to four-year-old pictures. Some time around the age of six is a very significant picture for them. That's the point in life where we lose our naturalness and we start taking on the acts of the world and behaving the way people tell us to and start squelching our own naturalness. Frequently they get to that picture and they start to cry. And cry and cry and cry. "Gee, what an unhappy face!" Or they say, "I don't know."

I'm taping everything that's being said. They'll do a lot of talking and a lot of crying. And a lot of ruminating, and remembering. This talking is very important to them later on when they go back and listen to it. It reconnects them with their whole experience. I give them the tape. After we've gone through all the pictures we just sit around. If they want to listen to music some more, fine. Listen to music. Then maybe about four o'clock in the afternoon, say, I arrange to have the babysitter come by.

I don't like to leave them alone on the day of their trip. I want to have somebody stay and spend the evening until they go to sleep or spend the night. It's got to be somebody they know, love, and trust as well as somebody who has tripped if it's at all possible. Because somebody who has tripped knows how to serve somebody who's just tripped without asking a whole bunch of stupid questions that they can't answer. Just takes care of them, and just listens to them talk if they have something to say. Or leaves them alone if they want to be alone. I tell them, "I will not leave until you say it's okay for me to leave." The person who comes as their sitter may be their wife or husband. They may not have tripped but they may be the most suitable person. I brief that person about how to take care of things.

Myron: Generally in a marriage you have the partner absent during the trip?

Jacob: Only me and the person on the trip. Unless I'm doing a couples trip, but they've already tripped individually first. Although when the other one comes in there's quite a bit of relating that goes on because this person is so transformed and has come to a new level of feeling of love about their spouse or lover or whoever it may be. Then, oh, I might fix them a little plate of some fruit, crackers or cheese or something to eat, you know some sensory thing, have a glass of wine, something like that. I stay with them and the sitter until it's okay for me to leave. I pack up my stuff and I go on home. And that's it.

I'm available for them to see or to call and I leave my number and everything. If anything comes up they want to call me about, anything at all, I tell them, "Don't hesitate at all, call me any time."

That's the individual trip.

The Group Trip

Jacob : One of the things that I've had a lot of experience with is the group trip. People get a great deal out of the group trip. It allows them to try a lot of different things, and connect with a lot of other individuals. The way we've worked it out, it lets them go through a progression of growth.

One of the most important things for a group trip is to have a nice setting. I have a very good friend in Washington, D.C., a psychiatrist who loves this work. He has a place on the western shore of the Chesapeake Bay, not too long a drive from the city. It's perfect - a nice view of the water, lots of trees, secluded, excellent security. We've been running group trips there for a long time. I used to fly out every month until his own people got so experienced it wasn't necessary any more.

We generally have between ten and twelve people come, trippers, and three gurus who stay straight. They all arrive Friday evening around eight o'clock and they greet each other with love and joy since they haven't seen each other since the last trip they had together. They meet the new people and the new people get to meet all of them. We only have one new person a weekend unless there's too many backed up. Then we'll take two new people a weekend. There'll be some snacks set out there for them to nibble on and they'll have some wine. It's a nice occasion until they all arrive. When they've all arrived and greeted each other, then we all gather in the living room and sit around the room.

The leader makes announcements about things and all of that. Then we induct the new people, the new person or people, into the structure of the group. It's the same set of agreements except no sex takes place during the weekend. This is a very important thing. I want to tell you how important this is. I'll tell you right now, otherwise I'll forget it.

The experience evokes such a tremendous feeling of love and closeness that people love to be close and hug each other and love each other. They have love puddles where they all get together and just hug each other and love each other. When they know there's not going to be any sex nobody's worried about what might happen. They can let go to their really loving feelings without being concerned about, "Is he trying to make out?" or, "Is she wanting me to make out?" or whatever. All these crazy thoughts that occur to people. Then they just have a marvelous time. That's after they've all come down, you know. But the instruction is that no sexual activity take place at any time during the weekend.

The last one is the same as the last one I gave about the individual trip - do what I tell you to do or stop doing what you're doing - it's the same structure. But now it's with the group. They're being inducted and everybody else is renewing the structure for themselves. The leader presents them with the questions and asks them if they agree and they say yes. He says, "Thank you," and they say, "Thank you," and then they go on.

The next thing is that the leader may read something or talk about something that he's currently working on or something like that. Not really much more. He asks, "When you talk tonight, I want you to just talk out of your experience and tell whatever's going on in your life that you want to share with us, whatever you're hoping will happen this weekend." There's a variety of things that he mentions.

By the way, the new person has already been briefed about the whole procedure for the whole weekend so they know what to expect. Then the leader says, "Who would like to start?" Somebody raises their hand and starts talking about where they're at, what's going on, what's happened since the last time. Anything that occurs to them. We ask them to talk to the whole group, not just talk to the leaders. We don't go around the circle, because no one should feel under pressure. Whatever they want to say, and as much as they want to say is fine.

It's only when you're ready to speak that you do it. There are frequent breaks. After about four persons there's a break. They all get up and pee, drink some water, have some more nibbles or something and talk and catch up on things until we've gone all the way through everybody. That includes the three staff. We all participate; we say what's going on in our lives, what we're into. And, as I've explained it to them, each comes there as a separate link, and in this process they forge the link into a chain, by this process of sharing with each other. You learn a lot, too. You sure do. And we see how far so-and-so has gone since the last time or whatever.

It takes a number of trips before you get to trip with everybody who comes, and you don't get to trip with everybody who comes because some people come once every six months or once a year so they're tripping with different people all of the time. There's always somebody there that they know from other trips, two or three maybe. So you really get the experience of a whole bunch of people.

Then the leader talks about going to bed - what happens is when they're ready to go to sleep, they stake out their pads where they're going to sleep. Pads with blankets. They pick places all around the house. When they're ready to go to sleep, they smoke some grass sometimes to help them to go to sleep. Whatever. It's all okay. When they want to go to sleep they go over to their pad, lie down, put the earphones on and there's music playing, going-to-sleep music, until they go to sleep. They wake up early in the morning, around 6:30, and complete their toilet. We ask them to be very quiet, not silent but quiet and reflective. If they meditate, do some meditating. Move around outside, just not a lot of unnecessary yacking. They follow that pretty well.

One at a time each person sits down at a table with me and the leader and we go over what medicine they're going to take. (The various agents available and their effects are described in Chapter 5.) We decide what they're going to take and how much. It depends upon what they're trying to achieve, what they're looking for, what they hope will happen and what kind of medicine they think they want, if they've had different ones. Frequently they know just what they want to take, and we've already got the standard dosage for that person. Fine. We put it in an envelope, until we've gotten everybody.

We all gather in the living room again and we have our dropping ceremony, which is a very nice ceremony. After everybody's dropped, they wander around, they're quiet. We ask them to still be quiet, until they feel themselves starting to turn on. Before that they've staked out tripping spaces, which may or may not be different from the sleeping spaces. If there's two people coming together as a couple we want them to trip in different parts of the house, whereas they might have slept together.

When they start to turn on, they go to their pads, lie down, put the eyeshades on and the earphones on and there's music playing already. They just lay there until they turn on. The only time we ever hear from them is when somebody feels they haven't turned on and want a booster. They'll call one of us over. Or if they have to get up and pee later on. We've got it down now so we know everybody's dosage, so we rarely have to give a booster. They lay on their pads, and we're in the kitchen sitting and talking and all that stuff and waiting, just being available.

Myron: All the time they're really in it, they're laying there listening to music?

Jacob: Right.

Myron: You don't encourage any interrelationship.

Jacob: No! We don't want anybody to talk. Sometimes, somebody when they have MDMA, Jesus Christ, you know, they want to hold hands, it's so loving and all that. That's all right. If somebody doesn't want to hold hands, they're on a different material, all they have to do is hold their hand back and everybody respects their position. The MDMA people like to get up and do some hugging and then we set them right back down. We'll all hug them, they'll call us over just for a big hug. They're so full of love, it's really fantastically beautiful.

By middle afternoon they start coming down and they start moving around. They'll go outside in the patio or just sit around in the house and they're still turned on or coming down, whatever. Later on there are some things put out on the table - salad, some crackers and some fruit and some things for nibbles. Then when they're all down, when they're all down enough so that they're quite functional, we all gather in the living room and we have our champagne ceremony. All of this is tradition that's built up over the years. It's hard for me to trace all the different activities that we went through to get to this point. But this seems to be the most fruitful. The old timers who come back to trip with us once in a while who went through that early stuff say this is a helluva lot better way to trip.

After the champagne ceremony we have dinner. After dinner, we'll all sit around and laugh and giggle and tell jokes and have fun, or sit quietly and just observe the others that are still tripping. Or if they want to be alone they go off somewhere to keep going on their trip. The music continues so they can listen to it if they want to, until they're ready to go to bed. When they're ready to go to bed they find an empty pad and lay down. There's no staking out because they're pretty stoned. They get up in the morning oh, by 7:30 anyway. We have breakfast at nine. We ask them to be quiet again in the morning, too, because their trip is still going on even though they're not stoned.

After breakfast they all gather in the living room again. And the leader usually has a reading. I always had a reading, it's a nice thing, very appropriate, no matter what the hell you do, it's appropriate. From where they're at, everything's appropriate. They go around again and they talk about what happened.

One of the last things that's said on Friday night - it's traditional, too - "I want you all to now take a look at yourselves, close your eyes and look at yourself and just see what you're experiencing now, that's all. Just see what you're experiencing now." They give them about a minute to do that and then the leader says, "We'll ask you to do this again on Sunday morning." And he does. This sharing is the high point of the trip for everybody. Not only have they had their trip, they're going to have ten other people's or eleven other people's trips, too. And the *feeling* and the *sharing* and the talking out of where they are, sometimes the deep crying that comes out. Everybody is just pulled into it. And we *are* one. Until then we do not know what happened on anybody's trip. We don't know! That's our payoff for having been there all that time and handling it like we do.

When they're all through we have lunch and we get ready to leave. By mid-afternoon they go home. They sign up for the next one they want to come to. They are available every month.

Myron: So if you only have it once a month and you can only handle ten to twelve, probably you have a much larger group moving in and out of the group experience.

Jacob: Oh, yes! Oh, yes!

Myron: What would you say is sort of a working number?

Jacob: The active members of the group are about 40 or 50 who are coming every third or fourth month. There are about 100 who come less frequently. Something like that. You see, we have a priority list. The priority list is this. First trippers have first priority, the first time they're coming to the group. The second priority is somebody who hasn't tripped for a long time. Third priority is somebody who is in some kind of space where they really need a trip, want very much to have a trip, and we agree that it would be a good thing for them to have it, if there isn't a possibility for them to have it another way. But they don't generally want to the other way, they'd rather trip with the group anyway. And then there's another priority: we try to keep a balance between men and women.

Well, that fills the group, you see, if we get through all of those priorities.

Materials and Doses

Myron : I'm interested in the different chemicals that you've run across. What kind of significant differences, if any, do you see among the different agents?

Jacob: We have a spectrum of materials that we use. They've been screened out. I've tried many of them, explored many of the new ones that have come out. I'll list the ones that are most suitable for a group trip as far as we're concerned. There are many more but most of them will do the same thing as these do and most of them won't do as well as these do. One of them is LSD. Everyone first has an individual trip with me which establishes their LSD dose level. Other materials we use are the *Psilocybe cubensis* mushroom, dried. And mescaline - we don't use peyote. MDA. Ibogaine. Harmaline - we call it *yagé*. It's the active ingredient of *yagé*, that's the harmaline hydrochloride[1]. MDMA, Adam[2]. I have not adopted 2C-B. It just doesn't seem suitable for a group trip at all. Or DOB or the TMA series. TMA-2[3] is the one that was thought best for an experience.

Myron: I'm surprised that DOB hasn't worked well.

Jacob: We've tried it, and some of them will say, "Yeah, it was a nice trip but I get more out of ___ or I'd rather have ___." It doesn't do anything more for me than one of these others. I like to keep it down to just a few.

1. Harmaline is called yage in error. It is not the active ingredient in yagé. DMT and/or other tryptamines are. See Ott. Pharmacotheon. Kennewick, WA: Natural Products Co. 1993, page 260. footnote 3.
2. The code name "Adam" for MDMA was a term coined by Jacob.
3. For a description of these compounds, see Shulgin, A. T. & A. Shulgin, PIHKAL, Berkeley, CA: Transform Press, 1991.

Different Kinds of Trips

There's the *psychedelic* trip and the *psychoactive* trip. The psychedelics are the acid, mescaline, psilocybin. Visions and hallucinations and things like that. That's what characterizes the psychedelics. These three are psychoactive, but there are other psychoactives that are not psychedelic - MDA, harmaline, and ibogaine. Some people see colors and some visions on those.

Harmaline
I would put that in the psychedelic one rather than just the psychoactive one without the psychedelic because we don't take it alone, nobody takes it alone. It takes a helluva lot to turn on and you get so God-damned sick if you took enough to turn on that it's horrible. We take it with acid or psilocybin and it puts a new dimension on the acid trip. Very primitive, you get right down to the primitive side of yourself. The men who take it find their real masculinity and the women who take it find their true femininity. As a matter of fact, some Indians when they take yagé and they have their religious ceremonies, the men take it separate in their own hogan, and the women take it separate in their own hogan. They do not mix, because for the women, it's a woman's medicine, and for the men it's a man's medicine. Same medicine.

Myron: On the psychoactive list, would you put MDMA on that list also?

Jacob: Yes. That's Adam. Right. It's not a hallucinogen. The hallucinogens give visions, colors, and new dimensions to all of the senses, like hearing, vision, music - you know, music is a trip - and that's for all three of those. Hallucinations are very characteristic of course with eyes closed or eyes open, it doesn't matter. That's what I meant when I said visions. In some ways, people will say that they have a more spiritual trip on the hallucinogens because they see very important visions, spiritual visions in some sense to them. It's all an individual experience and their own reaction to it. The most popular one for that is psilocybin. It's a more spiritual trip. People will say that, although they'll also say that it's a spiritual trip on mescaline and acid. Now we'll go to the others, like MDA.

Myron: Just before we leave that, there's another thing. I don't know if you've read much by Gerald Heard. He talks about analytical thinking versus integral thinking, and with the hallucinogens, and maybe this is what you're calling visions, too, somehow you seem to jump up to a higher level of understanding where things seem to fall into place and relatedness more clearly.

Jacob: Oh, yes. That happens definitely on the hallucinogenic trips. Very clearly. That's part of the transformation.

Myron: Higher conceptualization?

Jacob: Conceptualization - most people would object to that, because it's not a conceptual process.

Myron: Maybe realization.

Jacob: Realization. Experiencing in a new dimension. And, coming out of a very deep level of feeling. I prefer feeling to emotion, although emotions will accompany it. Crying and things. Again, the word that I would use now is a realization of the truth. THE TRUTH. God's truth. Not the one we think is truth. Not of the mind. It's of the Self. The soul. Everything you see that you experience you experience with a whole new configuration.

MDA
Psychoactive, very clear, answers questions, MDA clarifies your life, puts everything in a correct perspective for you, tells you what you are doing that is satisfying, what you can do that will be more satisfying. You come out with a good feeling about yourself. It helps you to see all your difficulties in a different light, and they cease to be difficulties. You become aware of the fact that everything is happening just exactly the way it should be happening, and you're doing everything you need to do. Just relax and go do it! This is pretty

characteristic, at least with the first trip with MDA. Subsequent ones, too. It's a great experience for relating people to each other - yeah - you have a good feeling about yourself and the world around you. It brings you into the experience of the moment. That's the greatest material for learning that lesson. There's nothing but the moment, and that experience brings it home *very well*.

I remember one trip that I had, every time that I'd get anxious the trip would tell me, "Everything is in this moment, nothing exists except this moment. There you are. This is what exists." Every time I would get anxious I would say, "Hey, wait a minute! I'm anxious! What was I thinking about just then?" What I was thinking about was before or after or about to or whatever. I wasn't in the moment. I said, "See, you're not here in the moment." I'd look around and I'd experience with my senses and the anxiety disappeared. It's a great lesson to have. That's MDA.

Ibogaine
Ibogaine is something else. It's similar. All of these have certain qualities that are common to all of them. Also, no hallucinations. It's a heavier trip. A deeper and a longer trip, and for many people it takes longer to turn on. It's a very profound trip for everybody but people experience it differently. Some people love it, they love the lessons that they get from it. Some people find it a very painful experience. Those who find it painful are the ones who have not been confronting what Mr. Ibogaine is handing them and have been trying to avoid it.

You asked me once before something about confronting blocks. This is a place where people will confront blocks, as a matter of fact, if they have been unwilling to accept them or believe them or often try to deny them. A truth that they're trying to deny. Mr. Ibogaine won't let you do that. You can fuck it up if you want to. But nobody wants to. You have a great respect for Mr. Ibogaine. You experience it. Great respect. You listen to it. You may not do anything about it but you'll know that this is true. This is so. Yeah.

MDMA
And then of course MDMA. *Beautiful* trip. Just full of beauty and love and good feeling and acceptance of your self and realization of your own perfection in such a way that you say, "I don't think I ever want to put myself down or find myself wrong, because I'm not wrong. I'm being guided all of the time." It brings that into an experience.

Dose Levels

Jacob: Nobody can come to the group trip until they've first had a trip with me. I've already established the level it takes for them to turn on with acid. All first trips are acid. Even if they've had 500 acid trips before that. Suppose they have a full trip on 250 micrograms. All right, then 250 is their dose level. It could be more. I generally start at 250 unless I have a reason to think that they're more sensitive and don't need that much.

Sometimes 250 isn't enough, I'll give them another 125 micrograms. If that isn't enough I'll give them another 125. I keep building it up gradually until they really are turned on.

They may have to have 500 to turn on. Some people have to go up to 750 to turn on. Hard heads, I call them. If they started out a t 250 and ended up with 500, I'll call their base level 375 micrograms, halfway between 250 and 500 because by the time I gave them the second booster they've already dissipated a certain amount, they don't need more. That's the base level, and the base level for acid in general becomes the thing that I compare all the others with.

When they come in for the group trip we talk and decide what they're going to take. They want to know what's available, what kind of trip it is, what happens on a trip. They don't know what to do because they haven't had any experience with it. I generally suggest a second one to try. They may want to have another acid trip or they want to have a psilocybin trip or something like that, because they've heard about it. We'll talk about it and we agree on a format, and I decide on the dosage they're going to have, because I have something to compare it with and they don't have.

Frequently now, more frequently than anything else, I suggest MDA for the second trip. I tell them, "It's a very different kind of trip. It's not like your other one was. It's also a very, very good trip for you." And they say, "Okay. I'll take your word for it."

If they take 250 micrograms of acid to turn on we start them on 150 milligrams of MDA. Most of the time that's enough. After an hour, if they're not turned on, I'll give a 50 milligram booster. Most of the times that'll turn them on. If it doesn't turn them on in thirty minutes I'll give another 50 milligram booster. On this trip they'll establish their base for MDA. There are variables between people, you know, and also variables with the same material with the same person from one time to another. But this is the general picture.

Okay, they've had that trip. Then they come in and want to try another, a different kind of material. I'll suggest either psilocybin, which is hallucinogenic, because a lot of them love the visions and things like that. Or mescaline. Ibogaine is much later. I like for them to have that after they've had the others. Ibogaine is about the last one I have them try. It's a progressive, one, ibogaine. Each trip brings you to another level.

Myron: How much psilocybin do you give?

Jacob: Three grams of the mushroom is equivalent to 250 micrograms of acid. If they took 375 micrograms of acid, we'd give them 4.5 grams of the mushroom.

Myron: It's a pretty direct correlation?

Jacob: Pretty direct. Yeah.

Myron: And how much mescaline would correlate to 250 micrograms of acid?

Jacob: Most people don't really turn on with less than 500 milligrams. We don't do mescaline very much because it's very expensive and they seem to get as much out of the acid or psilocybin as the mescaline. Nothing special comes to them on mescaline.

MDMA

The first time they take MDMA I give them 150 milligrams. Sometimes that does it for them. If it doesn't, then I give them a 50 booster. After that we establish their base. Then I know that it takes 200. The maximum I'll give is 300 although there's one person who takes 300 and a booster of 200 after he's started coming down. It doesn't hurt him. Doesn't hurt his heart or anything like that. I don't feel comfortable giving them more than 300. If they haven't turned on I say, "You take what you've got and that's it." And you know, when they find out they can't have a booster they lay down and the sons of bitches they turn on! (Much laughter.)

I've had quite a thing about this business of boosters. I've had lots of hassles about it, because they want to really blast through. Sometimes they'll get close but they can't get through and they want to blast through. They think more medicine will do it. I tell them this every time we have a session, "More is not better. Lay down and stay down. No wandering around, because as soon as you start to be functional you detract. You've got to get into your ego to be functional. Lay down and have your whole trip and when you're all the way down, really coming down, then you can get up and walk around. Or if you have to go to the bathroom one of us will help you go to the bathroom." Or something like that. That's very important.

Harmaline

Harmaline goes with either acid or psilocybin. I generally give them 125 milligrams. I used to give them 250 milligrams and they'd get pretty damned nauseated by it. The 125 milligrams is sufficient for them. This is a psychoactive material but it's not psychedelic, and this amount does not add to the base level. They would take their normal amount of acid and just add this which does not increase the activity of the other psychedelic. It's just an auxiliary, and brings a different dimension to it. Some people would prefer 250 milligrams instead of 125 milligrams of the harmaline. Those who have trouble with nausea take it anally.

Myron: You just put a capsule up their rectum?

Jacob: Yep! You just say, "Squat, find your asshole, put the capsule right up your asshole, shove it up as far as you can. Go like that." (Demonstrates.) That always gets a nice laugh.

Ibogaine

Myron: That leaves ibogaine, then.

Jacob: This we have to explore to find the right dose. If I'm not sure how much it takes to turn them on, then I give them three capsules. A capsule is 75 milligrams of ibogaine, the active ingredient. It's a half gram capsule, it's a pretty big capsule. But the active ingredient is 75 milligrams of ibogaine. I give them three. That's about 225 milligrams. If they don't turn on after an hour or hour and a half at the most, we give them a fourth one, and they'll turn on with that. Few of them need more than that. It's hard on the body, too. I don't want them to take more if they don't need it.

They've established their bases. If they didn't turn on with three then I know that four is necessary. Sometimes I give them four and it was much too much and they know it. I mean they had too much. It was the proper amount according to the way that I grade it but it was too much of this particular medicine for this particular person. Next time I'll give them three. Some people do two. Some people get a little trip on one. Very rare, but they do. A mild trip. That's the idea.

Myron: Don't some people want to start with one and work their way up?

Jacob: Not any more. I used to do that. I tried it a couple of times, it doesn't work. I start with three. If three's too much you go back to two the next time. If three isn't enough then you go to four this time and you start with four next time.

I have a record of what everybody's taken, and how many boosters and how long into the trip they had to have the booster. It helps me to determine what to do. They learn themselves what their schedule is.

Okay, that's it for materials and dosages and kinds of trips.

Outcomes

Myron : What we might talk about now is you've had this large number of people who have come to you and have had individual trips and group trips. Could we talk about some of the kinds of changes that you've seen in people as a result of this?

Jacob: You know that's a very difficult thing to do. The only thing I can do at the moment is to recall what they were like when they first came to me, and then to see them as they are now - beautiful loving friends of mine out there in the world doing great things. Really doing great things. All of them. And continuously on the path of further exploring and further searching. I always try everything that comes along. When something comes along that I try that is very fruitful to me and could be fruitful to my people, I let them know about it. And they go do it. If they find something that's really good they let me know about it, and I go do it.

Your question now: "Can you say what happened to them?" One of the first things that they learn to do is to take complete responsibility for themselves and their lives. This is something that we *all* keep working on *all the time*. More and more and more. No more blaming. No more attributing the cause of anything out there to anybody else. That's really the *heart of the whole training* that I'm involved in. You could describe it in one sentence, that's it.

There's many manifestations, many ways that you can go about it. The people change from a very disturbed, mixed-up state to a clear place where they function much more creatively, in terms of relations to themselves and outside. They affect the lives of everybody they come in contact with in a positive way for the most part, whereas before they affected them negatively. They gave them trouble. They are much more satisfied with themselves. And they are committed to the process, to the growth process, to continually exploring. This is true for most of the people I've worked with. Some have drifted off, I don't know what else to say. It's not their bag right now.

Myron: How about sensory enhancement?

Jacob: Yeah, our eyes become open! It's like the Garden of Eden. Our eyes become open, and our senses. We're much more aware, much more acutely aware. For food, that happens. Especially right after the trip. You fall back in your old ways all the time, too.

You're trying to find out whatever I've discovered about different kinds of outcomes from tripping. Transformation is the only word that will fit. From one way of looking at things to another one, whatever they're looking at. I always tell my people, it's one of my favorite statements: Nobody has ever been able to achieve transformation by their own unaided efforts. This is a belief that I have. It requires some sort of a medium. The medium can be a medicine, the medium can be alcohol, the medium can be transformation of consciousness. Could be a deep crisis in their lives. Could be a priest or a minister or a psychotherapist as the facilitator. It could be something that they smoked, it could be some one of thousands of things that grow that they would ingest that turn them on. Turning on is the phrase that I use now for getting into a state where transformation occurs.

But just by sitting there and trying to do it, I don't know if anybody else has done it. Even Milarepa. He did it by sitting for a number of years in a cave meditating. Sensory deprivation. I think that's the best word that we have that tells what happens on an LSD trip. They've taken blood samples from people who have been in that meditative state and from people in the middle of a trip and they find that the changes in the blood are very similar. The serotonin content of the blood and I don't know all about that chemical stuff. I'm not good on the chemical stuff. The same things, the same results come. The visions that they have.

Myron: I'm curious about the progression that people make with these different materials. First they start with LSD and then possibly when they join the group they'll repeat that or try psilocybin and then you recommend MDA...

Jacob: If they're doing all right we'll talk about the different materials and the kinds of trips they may choose or they may say, "I don't know, I don't have any basis for choosing." So we'll say, "Well, try this. This is usually the next one that people take."

Myron: And after MDA then maybe you'll have them try Adam.

Jacob: No. Another psychedelic with yagé. We try to get them through the spectrum of things as soon as we can so that they know which ones to choose.

Myron: Then after yagé maybe MDMA.

Jacob: Well, psilocybin. It may take a year or so before they've gone through the spectrum. There's also tripping at home, too; people will do that with other group members. They'll have a little group combine and have a trip with somebody sitting with them, so they have other chances to trip once they've been a member of the group.

Myron: Once they've been exposed to the whole spectrum, i s there any kind of weighting? What is the popularity distribution of the different things? Are there any particular favorites?

Jacob: Adam is definitely first, MDMA is first. It depends on where they're at and what kind of trip they want. If they haven't got anything special they may just want to have Adam again because it's such a beautiful trip. If they've got things they want to work on they'll take a psychedelic, or they'll take MDA or something like that. We don't use much MDA any more. A work trip is a yagé trip or an ibogaine trip where they've got things to work out.

Myron: Do you have any feelings about what each of these things are specifically best for? You did give me that.

Jacob: Mostly there is much more likenesses between them all than there is differences. They all turn you on, they all bring you back to your center.

Myron: I am a little surprised at your initial dose because that seems higher than what some people use as an introduction. I guess really what you're providing are very profound experiences and you're really pretty focused and oriented to make sure that they get the most profound kind of experience.

Jacob: Right. And it goes very smoothly, because it's a routine kind of thing. Yet it draws my attention, holds my energy, and all of that.

I really wasn't aware of how much energy went into this kind of thing until I stopped, really started cutting down. It took me two to three days to recuperate, because it takes one hell of a lot of energy out of a person.

Myron: I wanted to ask you, with individual sessions, too, do you find it tiring?

Jacob: Oh you, damned right! Absolutely. I don't schedule anything for the next day, as I'm very tired the next day. When I come home from the thing I just plop into bed. Even though I'm sitting still all the time! And I'm reading! You know, keeping my mind interested, but there's a draw of energy that's fabulous.

Myron: I thought it was the most tiring thing a person could do. I probably had problems where I was probably too involved, but I know our Medical Director quit sitting with people just as soon as he had others who would do it.

Jacob: I was very involved in the very beginning. Now I'm not that way involved.

Myron: Do you find that you're less tired?

Jacob: No. No. I'm still very tired.

Myron: It takes a lot of energy.

Jacob: Yes indeed. I'm still very tired. But I don't get emotionally involved with them. I don't cry when they're crying and when they experience something I don't identify with it. I just sit there quietly and I'm aware of what's going on and when they start to cry or when they're doing something that indicates where they're at in their trip I say, "That's great, oh, fine, stay with it, kid." Something like that.

Myron: It must be enormously satisfying. Even with the little bit of work that I have been involved in there's nothing more satisfying than when another person makes these discoveries.

Jacob: Right. It's what I said earlier, there's nothing more satisfying than turning somebody on to themselves. At the end of a weekend when I'd see what fantastic things have happened to these people, I'd say, "Whatever I've had to go through, it's worth it to produce these results!"

See Appendix I for examples of personal accounts.

Finale

It is now sixteen years since these interviews were conducted. Simply rereading them has brought back the richness of these encounters, and an immense appreciation of the expanded vistas that psychedelics make possible to the earnest explorer. They support and confirm a wealth of additional accounts given by other researchers[1].

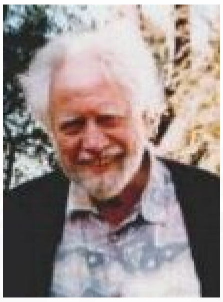
Immersed in the impact of this work, it seems to me incomprehensible that our society has sunk so deeply into unconsciousness as to be unaware of such possibilities. The general public, unfamiliar with the power of our minds, remains for the most part locked in mass hypnotism, secured within the self-constructed walls that lock out the prodigious possibilities of life, the joy and exuberance waiting to be claimed. Our birthright of wisdom and compassion has been sacrificed on the altar of self-interest, materialism, and reductionism. So opposed are we to discovering the errors of our decisions that we have made practically all substances which can reveal to us our true nature illegal to possess.

Nothing would have pleased Jacob more than to know that the telling of his story has helped our society understand that there are powerful tools available for self realization - that vast new possibilities in life await us when we take on the responsibility of making these new tools available and learn how to use them. We will then recognize Jacob as a true pioneer and dedicated servant of humanity.

1. For example, see:
   Adamson, S. Through the Gateway of the Heart. San Francisco: Four Trees Publications, 1985.
   Shulgin, A. T. & A. Shulgin, PIHKAL. Berkeley, CA: Transform Press, 1991.
   Stolaroff, M. J. Thanatos to Eros: Thirty-five Years of Psychedelic Exploration. Berlin: VWB - Verlag für Wissenschaft und Bildung, 1994. Available from Thaneros Press, P.O. Box 773, Lone Pine, CA.

Epilogue

The Last Trip: Peaceful Closure for Jacobs



Sasha Shulgin

My first memories of Jacob were back in the early days of the Berkeley scene, during the time of the free speech vigor. No, my first meeting with him actually preceded all of that, and even preceded the Berkeley Barb being peddled by bearded hippies on every street corner all the way up Telegraph Avenue from Dwight Way to Sather Gate. As I remember, it even preceded the tear gas and the helicopters of law and order. Pre-People's Park. Pre-Doctor Hippocrates. Pre-Mario Savio. Jacob and I would agree to meet at our favorite cafe on the Avenue and share an espresso (a new fad just introduced from Italy) and discuss just how to get the pink color out of crystalline MDA. I had no idea, and had never asked, where the MDA had come from, nor why it was pink. Jacob never told me. But I suggested washing it with ether containing a bit of acetone, and the pink color apparently went away. This was in the pre-MDMA era, when MDA (the "Mellow Drug of America," sometimes called the "love drug") was very much the favorite of the therapists and the psychedelic explorers of the time. It had been kosherized, after all, by being promoted by one of the largest pharmaceutical houses in the United States (Smith, Kline and French) after having been discovered and espoused by an eminent Professor of Pharmacology (Dr. Gordon A. Alles, from UCLA).

I was not particularly interested in MDA, as I had my own acaulescent world of phenethylamine relatives that was going in all directions at once. And Jacob was not particularly interested in my manic and broad diffusion of new compounds as he had his MDA which was a familiar and, for him, completely predictable tool. A decade or two later, I caught his attention with the material MDMA, but that story is the stuff of a chapter in another book. I would, here, rather talk about quite a different material, mescaline. This remarkable alkaloid demands a special place in my notes as it was the first psychedelic I had ever tried. And, it commanded an equally special place in Jacob's notes, as it was the last of his experiences.

I, and a number of my friends, had found a time for communion and exploration, and mescaline was the chosen vehicle for the day. Jacob accepted 300 milligrams of the sulfate salt in water solution, wished us well, and drank it down. As did we all. In a half hour he retreated towards the bathroom (nausea is a rather dependable companion under such circumstances), then he chose to lie down by himself in a back bedroom. I searched him out in another hour, but he indicated that he wished to remain alone for a while yet.

An hour later he rejoined us, with a humorous yet wistful smile on his face, and told us that he had pretty much decided that this was it. He had had it. "Too much nausea?" I asked. "No," he replied. "It isn't until I have gotten sick and urped that I know I have turned on." "So what is this 'it' that you have had it with?" I asked him.

He sat down in a soft, comfy chair, and looked at me, and smiled. "I think that I have found my place of peace. I know that I will live until I die, and I don't have to rush it, and I don't have to keep proving that I still have piles of life left to explore. I'm getting too old to try to demonstrate to others that I'm young and still learning. So I'll just let things be. What's to prove?"

He sat there for the next couple of hours, watching all the others exchanging dynamic interplays of ideas, opinions and clever conversation. All this was not directed towards him, but was simply cast adrift in the air about him. He listened, and that infinitely peaceful smile never once left his face. I suddenly realized that some day I, too, would be an observer of the passing scene rather than a participant in it.

A few hours later, as we all sat around a fabulous chicken casserole with some acceptable white wine, I asked him if he had had a rewarding trip today. He told me he had, indeed, been "out there" for a while, and that now he was back with us he thought he would probably stay here, in this reality, for his remaining days. He had closed his circle. He was together.

I hope that someday I will experience the completion and the integration that I saw, that day, in Jacob's face. At that future moment, I just might discover that I too have become a complete person.

Alexander T. Shulgin, Ph.D.
Lafayette, California

More Photos

Appendix I

Personal Accounts

The results of the author's in-depth interviews with five different individuals who have gone through the program described in this book are summarized in these personal accounts. The information was mostly prompted by questions asked of the individual participants. Assumed names are assigned in each case.

A word about the questions. Those of a scientific mind would no doubt like to see the questionnaire that was used for these interviews. As a matter of fact, it was my intent to develop a questionnaire that could be filled out by all the participants, and I would summarize the results by analyzing the answers. Jacob objected very much to this, as did others who had extensive experience with persons going through this program. The problem is that these experiences are such expansive openers, and lead into so many dimensions of understanding and experience that it is quite restricting to attempt to channel the results into the narrow ruts of a preconceived set of questions. The attempt to do so is limiting and frustrating to the person being interviewed.

Consequently, I armed myself with a checklist to make sure I covered areas of interest, and at the same time encouraged the participant to relate what they found to be most interesting and valuable. In this way I hoped to capture important areas of functioning, while allowing the participant to communicate more fully the extent of her or his experience.

Robert

Robert is in his early forties, unmarried, and works as a commissioned salesman. He first became drawn to psychedelics through reading about them. After he participated in his first psychedelic session, he continued with one experience per month for eleven months. By the time of this interview he had completed seventy-five to eighty psychedelic sessions, ten of these on his own. The compounds which he has experienced include MDMA, ibogaine, LSD, LSD with harmaline, peyote, mushrooms, MDA, and 2C-B[1].

When Robert became aware of a program that used psychedelics therapeutically, he entered it. His sense of adventure played a part in motivating him to participate. He was also motivated by his yearning for an experience of God, feeling that this was an important aspect of life that he was missing. In addition, there were a number of things about himself that he was not happy with and that he hoped to change through the therapeutic use of psychedelics.

In Robert's first session, he ingested three grams of mushrooms. He felt his female companion became a leopard woman. When they reached out and touched, red energy passed between their hands like a neon light. Later in the afternoon he found that everything was gorgeous. His first group experience was with ibogaine, where he had very rich and enjoyable interior visions for many hours.

During a memorable experience in which he took a combination of LSD and harmaline, Robert found the power within himself to feel his strength and explore his masculinity. He found himself to be fearless and a powerhouse of energy. During this session Robert felt strong like a leopard and was able to overcome his fear of snakes.

After his second most significant session, a powerful experience with 2C-B, he felt that he had "cleansed his lenses"; the world looked different, like washing a muddy car. A heightened sensory awareness stayed with him after this session, and opened him up to and was extended by a subsequent MDMA session.

Robert describes an experience with MDMA as his most profound psychedelic session. The session began with the ingestion of 150 milligrams of MDMA. After one and a half hours he had not noticed any effects so he ingested 75 more milligrams as a booster. This first booster did not achieve the desired effect so a second booster of 50 milligrams was reluctantly administered. Even after being administered a second booster his experience had not started. Robert asked for another booster but his request was denied. He was told perhaps it was about time that he had a nothing trip. Three hours after the beginning of the session he had a profound experience of God which he describes as the most joyous moment of his life. A month later he was still happy, joyous, grateful, and completely satisfied.

Robert attributes many of the positive changes in his life to his psychedelic therapy. Of the benefits he reported, the most outstanding has been that of profoundly experiencing God within himself. Before he had these psychedelic experiences, Robert had rejected Christianity and had no feeling for the existence of God. He has since joined the Unity Church and attends services, which have become the highlight of his week. He is now engrossed in reading spiritual books, listening to music, looking at nature, with gratitude at the beauty of the world welling out to God every day. He has not undertaken any new formal education, but has greatly increased his reading and study through the Unity Church.

The overall quality of the relationships in Robert's life has improved. He now feels more relaxed around people, more in the present. He has dropped some of his shyness, and is less clinging. He has discovered that he essentially loves his mother, whom he had felt was a very difficult person. His experiences have allowed him to keep relationships going despite resentments. He feels an ability to experience love, which he had not done for years.

When dealing with the world at large, Robert no longer feels the need to be constantly on the lookout, scanning for danger. The fear of danger has now fallen away. His fear of death and anxiety levels have also diminished.

There has been a significant change in Robert's relationship to his work. He has dropped an old, stressful job and has taken a job based on commission. Previously he was much too rigid and anxious to consider a job where income was uncertain.

Robert has also experienced a change in his recreational activities due to his psychedelic therapy sessions. His appreciation of nature and his love of music have increased. He has abandoned his television set, acquired a huge record collection, and reports a greater interest in reading, particularly metaphysical books. After sessions, he often has spontaneous flows of writing.

The detrimental effects that Robert has experienced have been occasional feelings of paranoia. One of these experiences began with a group session in which he had taken a peyote extract and mushrooms. The initial dose did not achieve the desired effects so Robert took a booster. The first part of the experience was pleasant, but in the afternoon he turned quite paranoid. This feeling lasted for a week, until a solo experience with MDMA erased it.

Robert had another bout with paranoia when he ingested 100 micrograms of LSD with a friend. In this instance, talking it through with his friend cleared about eighty percent of his paranoid feelings. Robert also experienced paranoid feelings for a period of close to three months after his 2C-B encounter; however, he felt that this experience laid the groundwork for his magnificent MDMA journey. On another note, though his intuition has increased somewhat and there are times at work when he gets a sudden flash of understanding, his energy level has gone downhill. He finds it hard to get started in the morning. This is sometimes disturbing. He thinks it may be aging.

Overall, Robert reported a great improvement in the quality of his life because of his psychedelic therapy sessions. All of his experiences have contributed to this, but the MDMA experience was the most outstanding, with the 2C-B experience next. He can better appreciate the beauty in the world and God plays an important role in his life. One of the greatest gains is the contact with the group, sharing experiences. These relations are now the richest part of his life. Through his psychedelic therapy sessions Robert has gained innumerable insights about himself and the world in which he lives.

Susan

Susan is 34 and a freelance graphic artist. When she learned of the program of psychedelic therapy, she immediately wished to participate (3-1/2 years previous to this interview). She has had approximately 40 experiences, about half of which were on her own. She has used LSD, LSD and harmaline, MDA, MDMA, ibogaine, mescaline, 2C-B, and mushrooms. She entered this program looking for a booster in life and to further develop the progress made through another personal growth program.

Susan has had a number of outstanding experiences with psychedelics. Some very dramatic ones have occurred with ibogaine, her favorite material. She finds that ibogaine forces you to look at what you have placed between yourself and love and that you have no choice; it will not let go of you until you are redeemed. Many people do not like it but she finds that the best thing to do is "confront your crap rather than laying around in paradise." She always feels best after experiences in which she has confronted fear.

Before one ibogaine experience, Susan had set herself up for a perfect boyfriend where she would function out of love with no projections.

She took up with the boyfriend of her best girlfriend after the two broke up. Her girlfriend returned after thirty days and reunited with her old boyfriend, which hurt Susan very deeply. She took ibogaine and went through cycles of resentment, fear, anger and sadness for hours and hours, over and over again. It wouldn't stop. At the end of the day she sat up and decided that at least she could get up and go to the bathroom. She suddenly experienced her head filled with light. For the next half hour she felt like the Buddha, a most beautiful experience. Her conclusion is that Mr. Ibogaine does not let go of you until he is through with you.

During another ibogaine session, she thought knives were hidden everywhere and she was filled with murderous thoughts. She saw Jesus being crucified and finally drove in the nails herself. After hours and hours of experiencing Christ crucified, she realized that Jesus forgave her despite her abominable act, and that He also forgave Judas. She then reached a sense of Cosmic Consciousness, One Mind and the knowledge that God was real.

At another time she took MDMA and had a glowing experience. A week later with ibogaine, she asked why life could not be like the MDMA experience all the time. The answer came quickly, "Because of fear." She thought she now had the answer and was through, but a voice said to her, "No you don't!" She was then forced to experience fear in every conceivable way. She kept trying to hide but was unable to, so she finally gave up. The experience was horrible, with much yelling. She described the most comfortable she could feel was to have one million razor blades stuck into her body and have them explode. She saw no hope and finally gave up and collapsed on a pad. She was then filled with a channel of white light and felt reborn. Beauty came, and there was pure, exquisite tension between fear and beauty. She did one of her best designs after this experience.

In her personal growth pursuits, Susan felt her biggest decision was to stop making herself miserable. Before, her energy was hyper and frantic and she felt she wasn't "home." Now she realizes that she can be still, rather than constantly chasing after activities. She is willing to make peace with the past, allow herself to feel depressed sometimes, and look inside herself for her real intention.

The biggest benefit of Susan's psychedelic therapy has been freeing herself of projections. She used to project onto everything. In her relationships, she would fall in love, project all over her partner, and drive herself crazy. She has since learned to ask herself what she really wants and has discovered that love is not "out there" to be found, but comes from within yourself; you don't need to go running after it.

Interestingly, Susan reports that she stopped wearing glasses. She feels that she doesn't need them because her vision has improved. She is more aware of detail and color and is less distracted. She can become absorbed in the beauty of simple things, like the reflection of lights from waves on the surface of water.

In the area of sensitivity, she finds herself more open, not as defensive, and has dropped fears and judgements. It is much easier for her to make close contact with people in everyday affairs such as clerks in stores.

In terms of her creativity, Susan reports that her graphics have gotten "very clean in design." She finds that after confronting her fears in experiences she does her best designs. A significant change took place in her work activity. She was a supervisor for a while, and went through a period of attempting to make her department very efficient, eliminate sloppiness, "get on the ball." She wanted to run things in a regimented manner, but no one was interested. In pondering the problem, it came to her to attempt not so much to control her coworkers but to relax her stranglehold on them and trust the process. In finally deciding to "let them do what they want," relations immediately improved, the employees were happier, and things operated more efficiently.

Susan had been very resentful of her mother and father, despite having been given everything. She previously saw herself as a "snotty little kid" resenting authority and wanting to grow up immediately. In her first psychedelic session she realized the contribution her parents had made to her life, and totally flipped in her attitude. She forgave them even though there was nothing to forgive, and the relationship has been wonderful ever since. In addition to the renewed relationship with her parents and the continued easy, open relationship with her three sisters, she now has a whole new set of friends, mostly those from the group psychedelic experiences, who now feel closer than her own family.

The biggest change in her life regarding her conduct with other people has been learning to mind her own business. She has found it best not to sympathize or empathize with others to help them get over hurts, but simply to tell the truth and mind her own business. This is working very well.

Susan at first had a strong feeling that she had to help save the world. Despite volunteering eight hours a day on top of an eight hour job, she was compulsive and felt guilty that she was not doing enough. She now feels that whatever you do makes a difference; what is important is how you do it rather than what you do. She feels that working on herself is making a contribution to the planet. Since all minds are one, one day there will be enough clear minds to achieve a mass world improvement.

Susan has had some incredible experiences of God, or the One Mind of Cosmic Consciousness. Susan found that her own energy was insignificant compared to that of God. She learned that if she was stuck in an experience and was thrashing around, the answer was not to go looking for God but to realize that God is inside and to come from God. She has had some profound biblical-type experiences. The implications of these experiences for herself are to remove her own barriers and make decisions, take responsibility for herself, tell the truth as far as she knows it, and to understand that being willing is what frees one.

The only detrimental effect that Susan reported is that sometimes she would be tired for a couple of days after a session. There have been no long-range adverse effects.

Dick

Dick is 33 and has been married nine years. He owns and operates a stained glass business with his wife and another woman as partners. He had used psychedelics previously to entering this program, but mostly for recreation. His experiences were meaningless, had no direction, and he got nothing from them. Dick had about ten experiences before entering the program and has had ten to twelve experiences subsequently, starting about one year before this interview. Going through a non-drug personal growth program had opened a crack in his structure, and his psychedelic sessions have been a wedge to push him through to greater openness. He has used ibogaine, mushrooms, harmaline, LSD, and MDMA.

In his first solo experience, Dick broke down a lot of resistance and got in touch with a deepened sense of love for others. This has led him to no longer discriminate against people. He now realizes how important it is to have a support system. He has found that he is no longer interested in giving unsubstantiated opinions, but needs facts. Otherwise, communication is a waste of time. Before he loved picking holes in other people's positions, and considered himself a real "shit stirrer," which made people around him uncomfortable. He was a master of finding errors; one slip and they were dead. Since he is less preoccupied with himself, he can see others better, which has opened up relationships in many ways.

Dick's experiences in the psychedelic program have contributed to the cleaning up of specific areas of his life. In one experience, he wrote a letter to his deceased father and feels that his relation to his father is now complete. There is a break in his relationship to his mother - they cannot talk because of her attitude - but he has dropped the resentment from his side and has written her a letter of complete validation. He would be in instant ecstasy if she would call him. He has made it his intention to be back in a relationship with his mother in two months and to have an excellent relationship in six months. However, he is willing to have it the way that she wants it.

His relationship with his wife is now magnificent. Having experiences together has broken down the barriers between them and has allowed him to see his deep commitment to her. Communication has been opened up and he now gets tremendous support from her. They can work things out between them and let each other have their own being and their own space, which includes space for good fights. They can no longer get away with crap and find it easier to just tell the truth and act.

The most satisfying benefit has been to discover that "he is not bullshitting any more." These experiences have snapped his resistances and have had a total effect on all of his reactions. He has had powerful experiences of himself and other people and now responds out of who he is. Discussing specific changes, in the area of awareness Dick feels that he is clearer, more willing and more open. He is much more aware of other people and their names and is more willing to be supported by them.

He has also had profound experiences of God which have increased his sense of connectedness to others and all things. He has found God and lost his fear of death. Dick was always aware o f nature, but in his first experiences he was able to notice just how aware he was. He always saw the detail but now he sees God everywhere. He has become less destructive to the environment and has cut out using pesticides. Gardening and mowing the lawn are jobs that are a thrill to do. He makes time for them even when he is pressed.

In the religious area, he used to think that the Catholic Church was God, and had gone to seminary. He has found God and his connectedness to the rest of reality in his psychedelic experiences.

He reported that during one ibogaine experience, he was scared shitless. He left it in God's hands and was willing to feel whatever emotions were coming up. He has symbolically died twice during experiences. The result was loss of all fear of death.

Since beginning the psychedelic sessions, he has gone to glass school and a communication workshop and has signed up for the Course in Miracles. He has made a commitment to run in next year's marathon. He had previously considered that running any distance was ridiculous and used to make fun of his wife for running. He now finds that when he gets tired running, he can pull energy in through the palms of his hands. It is almost like having a session.

Dick has always been energetic, but he now finds that he wastes less energy. He has eliminated fretting, finding it easier to start producing results rather than fret over problems. He is more willing to confront failure, which releases energy for positive action. He is better able to focus energy and has discovered how useful it is when working with other people to have them all sit down and focus their energy together. Otherwise there is a tendency to act from an unconscious place which dissipates energy and life and is not as satisfying. If things are left to fate, one remains unconscious.

He and his partners, who are also in the psychedelic program, now have more significant relations with their clients and feel that they make a difference in people's lives. They have endeavored to clear out all unconsciousness from their business operations, getting together to go over the operation and plan the work. They have hired a consultant, changed the name of the business, studied the market, and reviewed all aspects of the operation in order to carefully choose their direction. Finally, they have shifted the context of their business from profit making to being a source for their favorite charity. This was scary at first, as it was hard to ask people for donations and risk losing their business.

With regard to creativity, Dick is now aware that he can be the creator. He is willing to let go of the past and has more facility producing new, different designs and having them be exactly what he wants. He can stay with an idea and keep working until it is just right. The improved focus on creative work has lead to an award-winning design. Clients are now ordering larger pieces, worth two to three thousand dollars.

Dick has had to learn how to get free of his own thoughts and the thoughts of others and address the person and the context. He has found that focusing on reality creates realities. He can change reality instantly by confronting the context and not what people think about it. This leads to very positive results and is freeing and ecstatic. This approach can be used anywhere to plough through the junk in life. In a personal growth program, he learned to understand the concept of coming from context rather than content, but he found that he had to experience it before he could use it. Now by owning the project, he can make it work.

Mentally, he has experienced the meaning of larger contexts, which has been freeing and ecstatic. Formerly, he was unable to imagine a context larger than himself. He can also experience the power of operating from a larger context.

Dick has testified that he finds it extremely important to plan his experience ahead of time and know what he wants. He feels it is very important to have psychedelic experiences together with those to whom you are close. In such cases, it is good to share with the others ahead of time what you wish to get out of the experience. Having a psychedelic experience is a tool to be used when it is necessary. It is not a good enough purpose to just go along: One must be clear upon entering, and use the experience as a tool. He is confident that what happens depends on the way that you enter and how willing you are to have it the way that you want. He has found that it is difficult to have it very, very good, and this is sometimes harder than dealing with a problem. He also found that if he didn't want problems during an experience, he didn't have to have them.

Detrimental effects occur mostly when he is coming down from experiences. He usually goes through a period of agitation when the chemical is wearing off. Also, he doesn't like to go to work the next day.

Carol

Carol, 36 years old, started her professional career as a teacher, but dropped this to work in administration at a university. During her psychedelic program she decided to go to graduate school and study psychology. She had a job in research, followed by an internship in which she counseled people. She ultimately returned to working with children, where she could combine her training in both education and psychology. She is now in private practice, specializing in working with youngsters.

Carol started therapy with Jacob at age 23, participating in a Gestalt Therapy group. She had no previous experience with psychedelics. She was unhappy with herself and was impressed by what some of the other members of the group had t o say about their psychedelic experiences. She admired and respected the other members of the group. From their commentaries, she thought a psychedelic experience might be a good tool for her to get in touch with herself. She has since had around 50 experiences over a period of 13 years, about one half of which were on her own with friends.

She has tried just about everything: LSD, ibogaine, mushrooms, MDA, MDMA, mescaline, peyote extract, TMA-2[2], harmaline and ketamine. Her favorite material has been ibogaine, followed by MDMA. Beyond these, the choice depends on her mood. While psychedelics have opened her up, she feels that she has also benefited from other personal growth programs, meditation, and healthy eating.

One of Carol's most memorable experiences was a very heavy trip with harmaline during the time that she had been studying behaviorism in school. She imagined herself walking down a one way street like a movie set, acting out behavior that wasn't appropriate. At the end of the one way street was a bucket, and she would throw up in the bucket. As she experienced this in her mental imagery, she would actually throw up. The whole scene - visually, kinesthetically, the whole situation of behavior - would end up with her throwing up into the bucket. Then after a while she would be on same street again doing a different behavior, feeling it all out and throwing up. A whole series of inappropriate behavior ended in her throwing up this way. This was a very strong lesson in her kinds of behavior, where they were getting her, and where the pain and suffering came from.

A bucket and a box of kleenex used to be important adjuncts to her psychedelic journeys, but not so much any more. Either she has cleaned out her stuff or found a different way of operating.

Carol has opened up to her own feelings and is better able to feel them, even though they may not necessarily be pleasant.

During psychedelic journeys, feelings are sometimes unpleasant, even painful. In a supportive, encouraging situation, she is able to feel these difficult emotions and ultimately accept them, which makes her more sensitive to the feelings of others. She now knows that the emotional discomfort will pass and afterward she will feel more energetic, more connected, and there will always be some benefit. She finds real value in facing fear and believes there is no rational reason for fear. She feels the fear when confronting it, getting down to it. Then it comes to the surface. She no longer resists it but finds she is freed from it. Having been through the fear, she can move on.

Before this program, she didn't get along well with either parent or her older brother. Now she gets along well with all three. All the areas of growth activity, including graduate school, contributed to improving these relationships. Her psychedelic experiences had a strong influence on these changes.

Carol reports being more connected to nature. This derives both from psychedelics and meditation. She finds much similarity between the two. She often meditates when on psychedelic journeys, and has psychedelic-like experiences when meditating. Her fiancé teaches insight meditation, where one watches one's breathing and anything that comes up. This enhances awareness and introspection, leads to compassion, and helps gain insights into connections with the world. It is based on Buddhism. One notices how everything changes. Most days she spends an hour a day meditating. She has experienced a very intense three month meditation retreat with 100 people where there was no talking.

She has an improved ability to get her attention off of herself; this frees a lot of energy tied up in fruitless energy loops. She feels she has gotten past her mind and has cut through a lot of verbal dialogue and chatter. She has a deeper sense of what's going on. She finds herself more centered, more grounded.

Earlier in her life, Carol wanted to get married, and wondered if she ever would. Then came a period of not wanting to get married and thinking that she never would. This was followed by once more wanting to marry, and now she is getting married to a man with whom she shares psychedelic experiences. Psychedelic sessions definitely helped to sort things out, cut through arguments and create the space to be open to communicate and hear what each other has to say.

Prior to meeting her fiancé, her psychedelic experiences helped her to get clear on who she is and who she wants to be with, how she wants to act, and what kind of behavior is appropriate. Her relations with friends have improved considerably. Some of her best and closest friends are in the psychedelic group and they share their experiences. A number of times when there has been trouble, a shared journey clears up what's going on. It permits Carol to put herself in the other person's shoes and helps her become more compassionate. Two days later she can often see the other person in a totally different space in the relationship. She doesn't necessarily need to talk about what the problem was. She feels this is a big area where psychedelics have helped her to relate more easily to people.

Carol feels she has become more forgiving and doesn't beat herself up as much. She hesitates on this point because before her psychedelic program she was politically more active. She wonders if she's become less ambitious or driven. However, she observes that before her activities were more like racing her motor; now she feels that what she is contributing is more rewarding and fulfilling. As a college student, she was in the streets, sitting in at gatherings. Her psychedelic experiences started after she finished college. Now she is much less politically active. She still volunteers at a local school six hours a week as community service. She now wants more sense of satisfaction from her volunteer work and prefers to be one-on-one rather than work in a large organization. She enjoyed being in an antinuclear march recently and contributes large sums of money to her favorite charity. She is presently forming a community for meditators which will be a retreat center, which she feels will be a positive contribution to the world.

Carol feels she has become aware of barriers, obstacles, and things that she does to sabotage her own energy. Her psychedelic experiences connect her more with what she really wants and where she's really going; she is more in touch with her priorities, and doesn't waste as much time. This is more fulfilling, and raises her energy level.

She noted several changes in her work attitude. Previously she was more afraid; she felt she had to do certain jobs or be fired and be out in the cold. Now she is more creative, competent, and not so self-pressured. Her career goal changed several times. She is now more accepting of change, and doesn't need a single lifetime goal. Goals drop or change; she is more fluid. These changes have covered some 20 years.

Carol finds herself more perceptive, feeling that she has less t o guard against. She is more willing to see herself in others, less judgmental, "better able to see what's going on," and more compassionate. Since compassion leads to higher awareness, she doesn't have to struggle against what she sees. This makes her more accepting and aware. Sometimes this is painful if there is a time lag between becoming aware of something she is not happy with and accepting it. A consequence of these shifts in her awareness is that she feels more confident, more at ease and more trusting, which allows her to put more energy into doing than wondering how she'll do it.

Carol reports feeling a lot more alive. She thinks she looks younger. She feels younger, less dragged out, healthier, and more spontaneous. She feels that her intuition is much stronger. She trusts her intuition more and it has developed and grown. She has much more creativity, again because she trusts herself more, and is more relaxed when looking at situations.

Carol's quality of life has improved immensely. Before psychedelics, she had no sense of fulfillment. She is happy that this has reversed. She participates in more recreational activities, enjoys them more, and does more of what she likes to do. She is more efficient in doing what chores and housework need to be done to make life pleasurable and satisfying. She is more careful about diet, and gains satisfaction from exercise. Psychedelic experiences are sometimes recreational, but this she can't count on.

Carol describes two effects that could be considered harmful. The first is that her memory is sometimes a little shaky. This might be due to a lot of marijuana smoking; she has also consumed a lot of alcohol. She sometimes wonders if there is any correlation between memory loss and taking psychedelics. She has cut back more on alcohol and marijuana than on psychedelics. The other adverse effect was that she recently got a bad kidney infection after an experience with MDMA. She probably picked this up when she was in Asia, but she felt that the MDMA experience may have lowered her resistance and permitted the kidney infection to manifest. She feels that in general, MDMA is not good for the body.

In conclusion, Carol was at first alienated from God or the spiritual. She felt unhappy and had psychological problems. She hoped she might be helped and was open to trying. Her psychedelic program was a long transition for her. She gradually let down and extended her boundaries. At first she felt tremendously isolated and alone. She had friends but was not really connected with other people. She no longer feels that she ends with her physical body, but is much more connected to the world; first with friends, then objects of nature, then more and more with the whole world. It is still hard for her to use the word God. It is not intrinsic to her vocabulary. She's a Buddhist and is very trusting of the process.

Carol feels the most important aspect in the use of psychedelics is the group context that she has experienced. The person leading the group, its structure and the attitude of the participants are more important than the use of the substances. It's about people not seeking quick thrills but earnestly searching for greater spiritual or personal growth.

Sally

Sally is 29 years old and is married to Dick. She is a partner with him and another woman in a stained glass business. She also does some work in massage. She has been in the psychedelic therapy program with Jacob for about one year, and has had ten to twelve experiences over this time. The psychedelics she has used include LSD, ibogaine, mushrooms, and MDMA.

Sally discovered in her first experience that life is about expressing what she calls the Real Self, a concept which she had not previously explored. After her first trip alone, it was very evident to her that there was a Spirit, an entity higher than herself that was part of her. She has found the psychedelic sessions helped her to cut through the layers of unconsciousness that keep her from realizing her true nature. This newfound ability has allowed Sally to progress in her personal growth at a rate that she never before thought possible. Problems and situations arise rapidly and are quickly resolved.

Most of her life Sally had beat herself up, been unforgiving of her own limitations. After some very uncomfortable experiences, she has learned to no longer do that. On her first trip with MDMA, at 75 mg., she felt she was wrung completely out and that elephants ran all over her body. On this experience she went through all of her fears. She meditated for five hours in the bathroom; she had never felt so horrible in her whole life. It was terrible. She determined that she would never again put herself through such torture. Since then she has had no physical discomfort when doing MDMA; perhaps on occasion a little nausea.

Sally's relationships with other people have changed since she began her sessions with Jacob. Her relationship with her family has improved tremendously. She is now much closer to her family than she has ever been. This started with her very first experience. Everyone in the family has come to understand that even when problems do arise that it does not affect the feeling of love that they share for one another. This deepening of connectedness can be seen in Sally's relationship to her sister. She always got along fine with her sister, but they did not communicate with each other very often. The relationship was nonchalant. After starting the psychedelic program, she began to talk to her sister more often, and the relationship deepened. They still don't see other often, but they are now very loving.

She describes her marriage relationship now as magnificent. She and Dick have been married nine years. They are deeply committed to each other, and hold their intention to maintain the relationship even when they are fighting. Before beginning the program there were issues in the marriage that she could not acknowledge or break through. But the psychedelic experiences permitted breaking through them, even exploding through. An ibogaine experience that Sally and Dick shared particularly illustrates this point. This session blew the lid off of the relationship. It came to their attention they were not being truthful about a lot of things in their lives. They took a good look at their commitment to each other, and felt very committed despite their old issues that were resurfacing. They found it was very important to have the experience together, as it created a safe space for complete sharing and open, honest communication.

Sally's professional life has also seen improvement from her involvement in Jacob's psychedelic program. Sally, Dick and their partner hired a business consultant and installed better management systems. They are committed to cleaning up unconsciousness in their operation and improving communication. The quality of their glass work and the panels they produce has substantially improved. She also notices a difference in the way she massages people. She used to work intently. Now she works more slowly and feels it is much more healing. She puts herself in the place of being God, just as in a psychedelic journey. She feels that by doing this it allows her to connect more fully with her clients and their particular needs. The change is wonderful. She feels that miracles really happen with people on the massage table. Sally now views her massage work as a means to communicate with the higher Self and to contribute to the healing of her clients, whereas before her psychedelic experiences she was just working with people's muscles. Sally states that she now has more energy, a stronger ability to focus, and greater healing ability. She claims that there is no comparison between the way these things used to be and the way they are now. She is absolutely clear that she can heal, not by doing the healing but by being a conduit for healing.

With regard to chores like housekeeping, Sally feels that giving service is a fulfilling pursuit. It's a way of being responsible for life, and being a source for relationship. Sally now sponsors two children in a ten day course for 80 youths at risk. These are kids who could go one way or another in their life. Her sponsorship is a lifelong commitment. This comes out of directly wanting to help keep their hope alive.

Concerning attitudes toward social issues, Sally had been exposed to the difference between content and context in EST (Earhart Seminar Training). However, this difference was not really comprehended until she started her psychedelic program, which has made it much easier to distinguish between the two. Now she can readily transcend chitchat into the bigger picture.

Sally once had doubts that she could create new life. In one of her sessions, she experienced life fully. She knows that life is about now, and that she is responsible for life. The feeling was like giving birth. Now she knows she can create new life. A crucial part of this experience was seeing Dick's mother, and realizing she could make life now. For Sally, part of choosing life is having children, and she knew that Dick's mom will live in her children. She was willing to make life right for her mother-in-law so that she can continue to live on in her grandchildren. Sally's willingness will help bring it about.

Sally has come to realize more fully the importance of continually participating in the world around her, to keep expanding her realm of experience. She has sought out more personal growth workshops and has sought to develop neglected parts of her life. One such development is that Sally has started singing again. She used to sing when she was quite young but as she grew through puberty into adulthood her ability was covered up with uncertainty and fear, and she could no longer do it. On one of her journeys she was very moved upon hearing a classical version of "Danny Boy." She discovered then that she really likes singing. She saw the whole universe laid out before her, and that she could do anything she wanted. When she asked what she should do, God replied, "Sing." She started taking singing lessons. Her husband reported that her voice has changed; it has expanded and opened up and has a much better sound quality. One interesting incident during an experience occurred when she was singing; she noticed that insects landed on her. When she stopped singing, they flew off. She has no explanation, but has good retention of the event.

Through her psychedelic experiences, Sally has become more of a spiritual person. After her first trip alone, it was very evident to her that there was a Spirit, an entity higher than herself and that was part of her. She finds that love is communication with God. Once Sally had accepted this notion into her life

she experienced an immense respect for everyone in her life. Sally finds ibogaine has the most lasting effect of all the substances: It "really hangs in there," and it provides much material to evaluate and gain insight from. On her last ibogaine experience, it took her seven days to reenter her previous state of consciousness. She became quite shaky by days four and five, and was very upset. Then all of a sudden she was completely back into life again. Overall, it was an excellent experience in which she saw that everyone is connected to Spirit. This connection was illustrated during the session by the image of a flame. Now when she talks to people she directly addresses the light or spark which resides within us all. Knowing this has allowed Sally to better understand and more effectively communicate in her dealings with people.

When asked if she has experienced any detrimental effects, Sally says that it often seems like she had difficulties when she was in the middle of a journey, or even a couple of days afterward. But when the experience is complete she always knows that it was very valuable. There have been no detrimental bodily effects.

Sally now knows that there's a Universal Mind out there. It never stops generating; it's an endless creating machine. One can learn to participate in the process.

1. 4-Bromo-2,5-Dimethoxyphenethylamine, a new chemical that was investigated for a while, then abandoned because of the variability in response and the fact that it did not lend itself.
2. For a description of these compounds, see Shulgin, A.T. & A. Shulgin, PIHKAL, Berkeley.

Appendix II: New to the Second Edition

Tributes to Leo Zeff

Sara Zeff

Sara Zeff - A daughter's tribute Spring 2003
I knew as a youngster that my father was involved in extraordinary and unique work. As I grew into my teens, he shared more of the specifics of the work and the need for keeping it quiet. He also offered me the opportunity to experience the world of hallucinogens whenever I felt I was ready.

At about the age of 18 he and I both decided the time had come for me to know, first-hand, the wonders of the psychedelic realm to which he was devoting much of his life. And so I was inaugurated into the inner sanctum of his world. I met and became friends with many of the people with whom he worked. They were all very committed to using these substances in thoughtful, therapeutic ways, yet most of them also delighted in the joy and fun the experiences offered. Leo increasingly surrounded himself with others who were dedicated to the work, people with whom he could share anecdotes and personal notes from their own trips or the trips of others.

As an adult, my life diverged from my father's, yet we remained close and he continued to share with me the work he was doing and the people he helped - the people whose hearts were so open after a trip that their worlds were forever altered in ways no talk-therapy could ever have achieved. Here are some of the more remarkable stories I remember. (The names have been changed.)

One of the first stories he told me was that of Chandler, a 60-year old man whose body was riddled with cancer. In 1965 there was only a primitive kind of chemotherapy available and after everything possible had been done, they sent him home to die. Being already part of Leo's "family," he was able to spend many weekends with the group he loved, tripping and opening his heart. In one of his post-diagnosis trips he experienced his own death. This is not an unusual phenomenon with hallucinogens, but for someone staring death in the face, it must have delivered a considerable emotional punch. In the aftermath, the group lovingly helped him go deeper into the experience by planning and carrying out his (mock) funeral.

The epilogue to the story of Chandler is that he didn't die of this cancer. The tumors disappeared. His is one of a handful of miraculous cancer turnaround stories that medical science cannot explain. At the time, the dumbfounded Chandler, his biological family, and Leo's family speculated that it had something to do with the psychedelics. It may have - or not - and he lived to enjoy many more years with a very open heart.

Somewhat less dramatic than Chandler, yet life-changing, was Benjamin. Ben was a homely, shy Jewish man in his late 40s when he began traditional talk therapy with Leo in the early 1950s. He had been born with a deformed leg, which gave him a nasty limp and an ongoing level of pain that was worsening as his muscles got older and stiffer. Ben was an elementary school teacher. He had no surviving family, a very poor self-image, never married, and his only sexual experiences had been with prostitutes. His students disliked him and ridiculed him behind his back, making his job very unpleasant. He was, in Leo's words, a miserable, joyless man.

By 1966, Ben had been in therapy with Leo for almost ten years, without so much as a modest breakthrough. For Ben, "Dr. Zeff" was someone he could talk to; not much else happened. As Leo gained confidence in the administration of the substances (then primarily LSD), he began to consider Ben for a trip. He talked to him about it and Ben, now in his 50s, agreed that it might be worth a try.

In his very first trip Ben broke through years of misery, cried for the first time in decades, and shared a hug - also his first - with Leo.

By the time I was inaugurated into "the family" and met Ben, he had been a member for many years. Although he was still in some pain and presented himself as a cautious, serious man, he was also quick with a hug and a smile. The group truly was his family, the only one he had ever known, and he joined them once a month to trip and to open his heart.

My father was passionate in his zeal for helping people overcome addiction. In the late 1960s, Leo and other practitioners began to discover that some of the substances held great hope as cures for addiction. That news traveled fast and Leo's friends and colleagues began a steady stream of referrals of alcoholics and drug addicts.

Some of the referrals could not pass Leo's rigorous screening and therefore could not participate in the work. But there were many who did pass and one of them was Peri. Peri had tried to kick her alcohol habit many times, but always returned to it when life got rough. Leo agreed to give Peri a trip. Through it she experienced feelings that she had previously deadened with liquor. Over time, with Leo's help, Peri took many trips and learned to accept those feelings, and with that acceptance came less reliance on alcohol. That pattern repeated itself over and over again, with alcoholics and people addicted to a wide spectrum of other drugs.

Chandler, Ben and Peri were only three of the hundreds of amazing stories my father told me over the years - stories of ordinary people who made life-altering breakthroughs in their ability to lead happy, productive lives and relate more lovingly to the people who shared their world. There was never a doubt in my mind that he was doing good work. I have rarely known anyone who had as much passion for his work as he did. All he ever wanted from his life was the ability to help people lead happier lives. He enjoyed the occasional recognition that came his way in later years, but no accolade or honor ever meant as much to him as a single human being telling him how much his knowledge, wisdom, and willingness to do this work had changed their lives. He surely left the world - and me - richer for having known him.

Henry Zeff

Henry Zeff - A son's tribute August 2003
As I sit to write this, I am looking at a photo of Leo with his full beard, at the height of his Guru stage. I don't know of any one else, personally, more qualified to wear the title of the Secret Chief. He was always a friend to anyone, at any hour of the day or night.

I remember many times, when I would be visiting overnight, the phone would ring with a late night call from a friend or a member of his extended family, in the middle of some personal problem, a bad trip, or whatever. Leo would answer, always with a soft voice no matter what the hour, and then with wisdom, humility, compassion, and Yiddish sayings. He was a master at work, rarely anxious, always patient and kind - to patients, friends, family and strangers alike.

My brother-in-law and his dad hadn't spoken a word in many years due to child/parent disagreements. Then at my sister-in-law's wedding, Leo spoke with the father for maybe a half hour and the father and son were able to converse as if they were old friends. The miracle at the wedding, I call it.

I don't know how many people's lives Leo touched like this and a thousand other ways throughout the years, in his profession as a psychologist, with and without the "materials" he used, and as a friend and caring person to all he knew.

His eagerness and excitement over each new material that became available was amazing. He was like a true scientist ever ready to check out another way to do the needed job.

His life was an amazing collection of experiences, from growing up dirt poor to finding a home in scouting and then the Army. To college and his degree in psychology, to the wild and crazy 60s, and then his version of a more peaceful, saner 60s. Then the 70's and the new materials of that age.

He was ever humble and quiet about his work and experimentation, even when he began to see the fruits of his work. He had to stay quiet; to be famous in his time was to cease to be able to help.

It is sweet to see Leo finally get some credit for the mark he made on the world of his time and the world to come as well. He truly was a Secret Chief.

"Andrew"

"Andrew" - An underground MDMA guide trained by Leo, early 2003
In the 1970's, I was living in California and was interested in personal, social, and spiritual paradigm change. So I asked somebody who was a role model for me in those regards, "Where can I have an experience with LSD?" She replied, "Oh, I thought you would never ask."

She introduced me to Leo. The protocol was not to volunteer information to people who might be interested. But if somebody asked and you sensed that the motivation was appropriate, you asked Leo for permission to share information in a more specific way. After recounting your personal experience to the person, they then might be introduced to Leo. I did a solo trip. LSD was the material during your introductory solo session. If you were a "good tripper" who could stay self-contained during your trip, then you might be invited to join the family. This meant that you could trip in a group of eight to twelve people on a weekend.

There were all kinds of people: doctors, lawyers, merchants, and marginal kinds such as a pornographer. But you had to have enough money to pay him, and you had to know somebody who was on this path to introduce you. You would pay a therapist's fee for the private introductory interview. You paid a couple hundred dollars for your initial trip, and the group trips cost less. Materials cost an additional ten to thirty dollars. Leo's model was to pay separately for the materials so people did not get greedy, thinking that more was better. People had to be told that after a certain dose they were going to get undesirable side effects rather than increased benefit. Some people needed to learn about that.

There were people in the family who had a harder time coming up with money. They participated on a work exchange basis. They did thorough housecleaning before the other participants arrived. The aesthetics of the setting were important to Leo. He thought if somebody opened their eyes during a bad trip and saw a lot of dust, that might not support the development of their soul as much as seeing flowers and a fresh candle.

Actually, Leo was not as visually oriented as me. When he was working in his disciple's house, there was a girlie calendar on the wall in the kitchen. I was the first person who said, "You know, this doesn't contribute to making me feel safe for tripping." We didn't talk about it at length, but he took it down.

There were a variety of materials that were available: mushrooms and mycelium, MDA, and ibogaine. We originally tripped at night because that is how indigenous people do it. For urban people that was quite a hardship. We did not have much time before and after a weekend. So Leo developed this daytime format so you would have time to come back from your trip in a completely rested state. People then had increasingly positive experiences. Now, a positive experience by Leo's standards was not what you experienced on the day of the trip. Leo believed the value of the medicine was what happened to your quality of life during the period that followed.

He made MDMA available to the group after he had experienced enough of it with Sasha Shulgin. By then, they felt confident that it was reasonable to introduce it to people like ourselves who were willing to experiment. Leo said every time that we are all experimenters. He emphasized that we did not know everything about these medicines, and although he was telling us the best that he knew, in fact nobody knew everything about them. One of my earliest trips was a mushroom trip. While coming down from the trip in that family setting, I got the very clear message "Do this every three months. Keep coming back even if you do not remember why." So I actually did it every three months for about five years.

Leo's groups had a consistent format. We sat around on Friday night in a talking circle. One by one, everybody told what was going on in their lives. If they had tripped before, they described what had happened to them since their last trip. You heard about a dozen stories, different issues that people were dealing with in their lives. You came to the realization that the nature of being human is to feel these struggles, contradictions, curiosities, longings, and pleasures.

Leo would review the instructions and the agreements. You were not to repeat to anybody where, when, or with whom you had this experience. You were not to leave the room without explicit permission from the facilitators. You would not do anything harmful to yourself or anyone else.

There was to be no sex with anybody else. The final agreement was Leo saying, "If I should at any time during the trip tell you to do something that you are not doing, or to stop something that you are doing, you will." He would look the person in the eye, and each participant would have to say "yes". Then Leo used to say "That means that if I told you to jump out a window, you would." He did not want it to seem like it would have to be something that would be clearly in our best interests, because in our tripping state it might seem like something that was against our best interests. So if he said, "Go fly now," we would say "Yes" without question.

Many people reported afterwards that it occurred to them during their trip to do inappropriate things. Then they remembered that they agreed not to do harm, and that they had agreed to do whatever they were told by the leader. Therefore, they would remember this and censor themselves. That turned out to be part of the freedom, not a restriction.

Not every group leader warrants being given that degree of trust. This sort of agreement was very delicate and strong. Then Leo would say to the group "I want you to know that I have never had to call on that, I have never invoked it, but you still need to agree to it because it is one of the agreements." Participants knew beforehand that every time they came they had to reaffirm the same commitment to the agreements. So the beginners in the group and the repeaters all came on a common playing field.

Then Leo gave advice. "If you don't know what to do and your mind wanders, then listen to the music. If you go into heavy judgments against yourself, then listen to the music." He instructed us not to interfere with other people's trips. This was altered for groups on MDMA, because Adam (MDMA) facilitates communication and compassionate connection.

After a lot of people in the family had experienced Adam, some people wanted to use it with softer agreements. There was a smaller group that met about once a month, just to take Adam. The MDMA group was less tightly structured than the family trips. For example, MDMA can have such sensuous body awareness that people wanted to be freer to be in each other's faces with the relational part. Participants in MDMA groups would have to ask a facilitator in order to have contact with anybody else. The facilitator would then ask the other person to see if it was okay for both people to communicate at that time. So there was physical (without being overtly sexual) as well as verbal contact between people in the MDMA group.

Leo looked at his notebook while going through this procedure each time. (Later I also used a notebook when I ran my groups.) The group could see they were in a carefully protected environment. This standardized routine enabled participants to be confident that they could go as deeply as possible into their trip, without having to keep part of their attention focused on their own safety or what was going on outside them.

There was also a small ritual to taking the medicine. We stood in a line waiting for Leo and his assistant to send us off, one by one, with a bon voyage hug. Leo gave good hugs. He was not in any hurry. He said he did not know how it worked, but people claimed they got something profound when he hugged them. He would say, "I've got plenty of it, so take all you need." It was an energy transmission, like recharging your battery. It was based on his confidence, his clarity, and his generosity. There was a humor about him. Yet at the same time he seemed like the group's father. He reminded me of my father, and he made us feel safe. At the end of your send-off hug, he said the same words year after year. He would say "Have a wonderful trip!" Then you took your medicine and you were on your own. You went to your place. You got your pad and your comforts ready. Some people were on ayahuasca, others mushrooms, others MDMA, or whatever.

When you started to come out of your trip in the afternoon, Leo served his homemade chopped chicken liver dish as the first food you would eat. He was an older Jewish man from a n Eastern European background, and he thought chopped chicken liver was the healthiest thing for you. He came around like a waiter with a platter of liver offering it to everybody. With a shorter acting material, like MDMA, some people were back by mid-day. Other people were still flat on their back and not yet ready to eat by supper. We were told not to talk about our trip that day. Everybody shared dinner. Then we went to bed.

Sunday morning there was a ritualized circle. Participants took turns describing what had happened during their trip. We would describe what we felt and did, in the manner of recounting a dream. But it was not about interpreting, except so far as the interpretation of it was part of the trip itself. Each participant would witness this incredible array of individual experiences that had occurred in the same room. You might see common threads and identify with someone else. Or somebody might seem uniquely different from you. Someone might even say "I can not remember anything because I have amnesia for my trip." This was the range of the human condition.

People would often be less judgmental toward themselves when they heard other people's stories. Similarly, people might learn new possibilities by looking at the variety of other people's experiences. When there was a sharing of experiences, somebody might come back three months later and say "When so-and-so said such-and-such in that circle, I took that home with me as part of my trip." Then Leo would say "Well yes, you were still in a somewhat altered state, even though you felt primarily returned, and it was part of your trip then."

We spontaneously used each other's learning. Certain experiences can be potentiated in a group setting, even while you are having your own inner journey. This is separate from any psychic ideas about shared tripping and group consciousness. Leo always encouraged people to have their own individual trip, although I know that some other groups got together with the purpose of working on group projects.

During the period when I was tripping regularly, I had a profound sense of community even with people I had never met, knowing that all over the world there were others who also knew that everything is connected. Bonds were made as our group developed. People fell in love and got married. Leo would say, "You don't want to make any life-changing decisions until at least three weeks after the trip. You don't want to move. You don't want to quit a job and take another one. You don't want to leave a relationship and start a new one. Just be with it a while. See what pertains to the trip itself and what is meant to be actualized in your life." That always seemed like good advice.

When somebody entered the family, they were given a small chalice. The glass cup had relief designs of blooming flowers on the silver stem and base. In the early days, Leo gave these to somebody who did the solo trip. They were from Mexico, and later they were not available anymore. Then a flat rolled silver version was distributed. So if you ever saw one of these cups in someone's house, then you knew they were in the same family. It was a symbolic way of recognizing when you were in the home of a family member. I later ran a group that had a comparable thing we distributed. After five years in Leo's group, I brought in my partner. While he valued the experience he did not like that particular setting. We both had facilitator skills and immediately wanted to share this process. The first time we hosted a group MDMA trip was in 1980. My partner asked me what I wanted for my birthday. I replied that I wanted to take MDMA together with some intimate friends. We chose about six people who we were close with or wanted to be closer to. He made the arrangements. The group went well. We had already developed a workshop circuit doing other kinds of personal development activities over in Europe. Therefore, we had access to a network of Gestalt therapists. Although they were not particularly interested in MDMA, they connected us with psychologists who we trained in West Germany. After getting to know and trust a few German psychologists, we told them about this new thing called MDMA. We invited them to share this experience with us. Then they wanted to invite some of their friends the next time that they came.

Our MDMA groups were this beneficial contribution that just sort of happened without planning. We were doing this regularly, primarily in Germany, but also Austria, Switzerland, Holland, Hungary, and Czechoslovakia. We started gradually in 1981. By the next year it really got going. We really had quite a community. Many participants returned at three-month intervals. Some brought along people who were significant in their lives.

There are a lot of retreat centers in Europe. Sometimes the people who provided these sites knew about our work and participated. Other times they had no idea what we were doing. We sat for about twenty groups of twenty people per year. That was 400 trips a year. Two thirds of those people were repeaters who were coming back. This continued until we stopped this work in 1988.

Our weekend workshops were completely based on Leo's model. There were only two changes to his protocol. First, we used only MDMA. We lived in America, but frequently visited Europe, so we would not be there to provide care afterwards. Therefore, we only used MDMA because it has a low incidence of prolonged reactions. If you sit for thousands of sessions, you do see some rough experiences.

The other change was that we did not personally interview everybody before the trip. The new people got cleared by the person who had been there before. If there were any concerns about the appropriateness of the new individual, such as health problems, then we would say, "No, we cannot take the risk." About a dozen psychologists from different cities became interested in starting their own groups. They seemed sufficiently mature, so they informally apprenticed with us. Once MDMA became freely accessible, I heard of people working with it who I wished were not. Still, I still think the lack of official control was more good than bad.

After experiencing MDMA, one of our clients talked for the first time to her parents about their experiences during World War II. This is a very big issue in Germanic Europe, with that older generation dying out with this great silence about the war. Another of our German clients was the daughter of a Nazi officer. She spent a lot of her childhood locked in a closet because he was a sadist, or did not know how to properly raise children. She was born with normal vision, yet became completely colorblind after prolonged isolation in the closet. As an adult she worked as an artist without being able to see color. She came to trip with us many times when she was in her thirties. She tripped hard, which is unusual on MDMA. She would vomit. She was terrified. She would think about suicide. One time while she was tripping, she decided that she wanted to die because it was too difficult.

That was the only instance in my experience when the quality of the sitting was extremely important for the outcome. I did not tell her not to kill herself; I just really stayed with her. She sometimes had a sense of breakthrough. Memories from childhood would come back to her. She returned to trip again three times a year for a year or two. We would ask her why she kept coming back if it was so unpleasant. She replied that she felt that she was, millimeter by millimeter, making progress. At one point while tripping she said, "I can see color!" From then on, her color blindness was cured.

"Katherine"

"Katherine" - July 7, 2003
I'd like to report a great experience I enjoyed in 1970 at Leo's home. In those days, if you were very lucky indeed, you might have been invited to participate in what was called a "guided trip." The idea was that under supervised conditions, psychedelics could provide an experience that mystics might work for years to be able to have.

On arrival, my husband and I were asked to do "withholds," an exercise that was meant to dispel any negative "charge" that we might have toward each other. Then Leo gave us some guidelines: we were not to leave the house, for our safety. We were not to engage in sex - that wasn't what this was about. We were each to have our own experience, and not disturb the other. We were there to take a look at the contents of our own minds, perhaps in a new light.

Well, all this sounded interesting and only mildly alarming, since Leo was a well-known and trusted friend. We lay on mats with blankets in front of his fireplace on his soft brown carpeting, looking up at a lovely bronze chandelier supported by a ceiling of natural wood. The large windows in the room looked out on his gardens, mostly big white shasta daisies. A stereo played soft popular music. Leo gave me a capsule containing large doses of both LSD and mescaline.

In a few minutes I felt myself relax and sigh, and it seemed the whole house sighed. The appearance of the room seemed to soften, and the chandelier took on the appearance of a glowing jewel. Tiny dust motes seemed to shine like diamonds in the air. I had never understood my early religious training; I just didn't understand what was meant by "God," and had no concept of what was holy at all. But now it seemed my surroundings had taken on new meaning, and shone with an inner light that seemed *self-evidently* sacred.

Later I seemed to pass through other gateways and worlds, some terrifying (I thought I was drowning in blood, and seemed to experience a friend's violent and terrible suicide) - and some oddly just disgusting: things appeared vulgar, sordid, and sort of plastic.

As I was struggling with this ugly world, Leo came over to me and he said simply "When you've come to the end of your rope, just let go."

I didn't just let go. I threw that rope from me, and leaped, I knew not to what!

Instantly I was transported into a state of utter bliss. I seemed to be able to look at this silly creature that was myself - forever setting traps for myself, stepping into them, and then actually being surprised! From my delightful distance, all this seemed hilarious in the extreme, and I laughed with real delight until Leo began to look at me anxiously again. He looked, with his gentle brown eyes, like a worried seal, and I laughed some more. Then I worried I might have hurt his feelings and stopped.

I went back to enjoying my surroundings. Jacob had put on some music that related to my Christian upbringing, and I enjoyed the hymns with some nostalgia. I amused myself by creating pretty visual effects and then changing them. I think at this point I was returning to "normal." After a time I realized I was "back," with considerable regret; I did not ever want to leave that joyful place.

Leo kindly helped us to shower, and we slept comfortably. I believe that I had a truly religious experience. For the first time I understood the nature of Heaven - being freed from my miserable self at last. Christ had said not to look for Heaven because it is all around us if we could only see it. Now I know what he meant - I've been there.

I think in psychedelic circles this is known as the experience of ego death. How odd that we should cling to something that is only a source of Misery.

Love to Leo!
A grateful student and friend

P.S. While I can't really judge how much this experience changed my life, I'm sure I'm much happier for it.

"Rachel"

"Rachel" - December 29, 2003
Leo, his wife, and his children were friends of my husband's mother from the synagogue up in Berkeley. My husband is the one who turned Leo onto marijuana.It was around May 1 of 1965 when we went to Leo's home, joined a group of other people, and had a group experience for the first time. My husband and I were the youngest people there. He was 30 and I was 25. It was a very interesting experience. I realized right away that most of the people were there to "get well" and there were some people with some severe problems. I did not have any that I knew about. I wanted to experience what was going on, and I did. One of the most interesting things that happened that night was we were all laid out in front of the fireplace downstairs and we had our earphones on and our eye shades on and then all of a sudden my husband sat up and called for Leo to come over. He said, "There is a woman upstairs way in the back. She's in trouble." Leo did not doubt him at all. He just went upstairs right where he said and that is where the woman was. She was in trouble. So we realized the power of what was going on. This was a powerful thing that we knew about but we had never experienced close up like that. That is how we met this woman, with whom we have been friends ever since.

There were things we wanted to know and that we wanted to experience. We felt we were perfect the way we were which included the potential for change. So Perfection is where we were coming from. We did not have it that we needed fixing. We had it that there were things we did not know - things we had not experienced that we wanted to. When I first came into this program, I had some doubt as to whether there was some getting well to do or not. As I experienced more of these trips, I realized that there was not. Then I came to the realization that there was more to do, more to experience, more to have, more to give. It was just more, and at the same time, there is only what there is right now. It is a funny juxtaposition. My favorite medicine without question was yage (ayahuasca). Yage and acid. That was my idea of a good time. It was a primitive sort of beast. You talk about dancing and the music becoming energy in your body - that is yage. I remember seeing power, tribal, witchcraft sort of things on that drug specifically. One time I was a lion and I looked down and saw this lion's paw. It was huge, I just felt the power of that lion in my paw, and I just knew how strong a lion was. It is primitive, quite basic and primal. My husband and I used the psychedelics as a way to experience more sensuality. I was able to feel a lot more pleasure from the use of psychedelics. It became a rule in Leo's work that there would be no sex taking place. I respected Leo for putting together a situation where you could have a large group of people on the medicine in a safe way. By having a set, a setting, a structure that people adhered to, it made it safe. I had an experience on mescaline and I remember that was all he had. I worried my way through half of the trip that I was going to waste the trip but then I settled down and I got with it. Then this music came floating through the air. I could see the notes and the clefs and then it just came. I was really going with it, then it started to go toward my crotch, and it turned into this snake. I snapped my legs shut, sat up and resisted it, which turned my life to shit. I just had the experience of resisting pleasure as not being a good thing and then I got back into my trip. I tried to get the snake back to make friends with the snake. Then the snake turned into an octopus. It was beckoning me. It took me down into the water and wanted me to come in a cave. I was scared but I went with it. He just wanted to show me where he lived. I also used LSD in the groups to break through my sensuality barriers, whatever they were, to have more sensuality. I have spirituality tied up with sensuality. We met in that realm. I always believed in God. I always had this secret kind of pleasure knowing that Leo was Jewish too. I felt that it was a very highly spiritual experience. All of it. I did not think you had to be sick to have spirituality. Many of those people did. One of the goals of the group was explained to us this way. America is a new country. It was only a couple of hundred years old and we have come a long way as a country. He and other people wanted to know if psychedelics would enable people to deal with rapidly changing realities. Could problems be solved quicker or more efficiently?

There were people in mathematics and architects brainstorming. There were tests going on about people who were stuck in places in their careers. Mathematicians, architects, chemists, artists, writers, and people who were stuck were given huge doses of mescaline and many of them just broke right through. So there were all kinds of things like that going on. Maybe this could be used for our country to go on in an efficient manner.Up until a few years ago, my husband and I would refer to Leo jokingly as the guy who ruined our lives. We were kidding. He had a lot to do with our lives. I would be a different person if I had not experienced what he had to offer. I feel blessed.

"Julia"

"Julia" - October 3, 2003
For my first experience, Leo had set the stage in his office. He changed that office into a bank of flowers with every symbol you could think of in there - the crucifix, the Star of David, the Hindu symbols, everywhere you looked there were symbols but mostly there were living, beautiful flowers all around. When I took the medicine, I lay back in this ordinary spot which he had made very comfortable for me with a little foam rubber mat and the ceiling was phony squares of insulation and they began to sparkle. Then I began to dissolve, then I'd come back around again. I died 10,000 times. At some point the dying stopped and I was in a neighborhood. I was in a place that was highly manicured and ordered. Nothing was happening. The lawns were cut, the shrubs were trimmed, the houses were perfect. There were little iron fences outside the windows. Nothing. It was dead as a doornail. I was trying to get out of that area because I did not like it. At that moment Leo lifted up the eye mask and said, "Where are you now?" Now in reality he could have been doing his office work and his bills at his desk there while I was going off some place, but he did check in and I said, "I'm stuck in the Midwest someplace and I can't get out." He said, "That's the way it should be. You should be there. Do not try to get out. Be there. Be there with it. Don't try to get out." At that moment the music changed from his usual warhorse scene which was romantic - Tchaikovsky to Handel's water music - and the conjunction of what he said and the music may have made a difference. I found myself on a hill overlooking a sparkling harbor and a city beneath it. I was dressed in tails and a top hat. I took my hat off of my head and made a big gesture over my head with my hand and lifted it off. Out of the hat came the most beautiful spray of stars you would believe. I laughed, and laughed. It was the beginning of change for me from being terribly depressed to another option.

I once overheard him say, "I became so sick of these people coming in with their depressions and their problems and offering other options and they're not being able to take any of them. I became so tired of that." Leo said he wouldn't say this until we were well into him and knowing the process.

In my group, people did seem to take other options. Most of them made significant changes. They were professional people. They didn't change really. When you meet them on the street you wouldn't see any changes, but in their lives they made different choices. When I was with Leo I was involved with a guy that I was bored with but he was good to me. My experience changed everything. I just couldn't take the boredom anymore. I still keep in touch with some of them. They are like family.

You know when you go home for Thanksgiving you've got those aunts and uncles. You know how they don't really fit in your life but they're there. That's family. At that time we were not the only people that were experimenting with this kind of thing. There were a lot of people out there experimenting and we all had this kind of bond. There was something beyond that was momentarily apparent and it led to a huge openness.

Leo made a difference in those people's lives - a big difference. Sure made a difference in mine, but it's interesting to be asked now because it's so integrated that it's hard to separate it and it's been so long ... Leo was such a leader. He had that military experience but he'd also had the experience of being a psychologist, being a Jew, being a Buddhist and being who he was and that combination made him such a fabulous leader. He provided some very strenuous structures on some people.

There was one woman who just could not stop talking. She'd engage you and then you'd be engaged and slowly you'd recognize that this thing was to go on for the next half hour. She was going to be right there in your face talking. It was never loud but terribly engaging and he saw it. He stayed with it for a couple of trips and then he finally said, "On this trip you are not allowed to talk at all." She was mad at him but she made some fabulous changes. She went from cosmetics to opening a massage school in San Francisco and became internationally known. She traveled all over the world with this business. My experiences with Leo affected my relationship with my own family as well. I would never have reunited with them in the same way. Leo started us off with pictures of ourselves before we ever took the medicine. In doing so, I had to write my mother and ask her for the pictures, and she sent me a whole suitcase full of these things from infancy all the way up to being a teenager. It gave me a window into her eyes and I saw my father holding me in a proud way. I've had a lot of differences with my father. They didn't end but it opened a door to beginnings.

"Laura"

"Laura"
My experience with Leo and his group intertwined with events that were part of the historical era itself and with other group experiences I had. I dropped LSD once before I met Leo and certainly would have found some other way to experiment with hallucinogens if I had not met him, as I was living on the cusp of the New York beatnik and California hippie worlds when I arrived in the San Francisco Bay area in 1965.

Leo's unique contribution to my life was his creation of a group within which it was possible to get agreement on what I experienced on hallucinogens. For this I am eternally grateful.

I first saw Leo after my first acid trip. I had arranged for a friend to "sit" with me. The trip started very well - I had read books about the psychedelic experience in preparation for my first trip, and my trip followed the experience as described in The Tibetan Book of the Dead by Leary, Alpert, and Metzner. However, my friend was not prepared to allow me the time and space to examine my own experience inwardly, and the end of the trip felt uncomfortable for us both. My friend referred me to Leo, and talking to him helped me to integrate the experiences of that first trip.

Leo's group trips added to the reality that seeing Leo alone had given me. The group setting nurtured a scientific approach to examining inner human experiences. The group gave me many opportunities to observe the experiences of others from the sidelines as well as through more intimate interactions. The group also gave me opportunities to have others tell me their observations of my trips, and provided opportunities to safely explore "hallucinations." For example, I saw a snake on a mat, knew intellectually that there was no snake, but had to get up and touch the spot that appeared to be a snake in order to have the "hallucination" end.

Leo's record-keeping gave me the opportunity to make scientific observations of the effects of different chemicals on perception and consciousness. We explored different doses, different substances and combinations of substances, taking "boosters " at various times during a trip, and, also using non-psychedelics such as Valium, Ritalin, and marijuana. I got to be expert enough to identify the type and combination of substances taken by observing my own experience and the behavior of others.

Beyond the "scientific" aspects, I experienced personal gratification in the areas of spirituality and musical awareness. I loved using earphones and appreciated the wide variety of music we listened to. In my profession at that time, social work, I became more attuned to the internal experiences of other people. Also, the weekends were just plain fun!

What is the aftermath of my experiences with Leo? For almost 40 years I, along with two friends I met at the group, have lived as part of a community. Within this last year one of my two friends died. I am at peace with death. This peace comes from having the reality of my own perfection and of the perfection of the universe I've created.

Appendix III: Resources

The books, websites and publications on the following pages are recommended for more information about psychedelic therapy and related topics. This list serves as an introduction and is by no means all-inclusive.

Evaluating the Scientific Literature

Like the Secret Chief, many therapists in the United States have surreptitiously employed psychedelic substances in spite of their illegality. Once they discovered the efficacy of such substances, they could not in good conscience withhold such effective means of treatment from their clients despite the risk of incarceration. One of the unfortunate consequences of this situation is that experiences and results cannot be publicly shared, which deprives current practitioners of a great deal of valuable information.

Nevertheless, there are many publications which present promising work with psychedelics, including dramatic help for tough cases that had been impervious to conventional forms of treatment. The World Wide Web Psychedelic Bibliography, available at www.maps.org/wwwpb, compiles a number of other bibliographies of psychedelic research and includes thousands of references, some with full text PDFs. These include the MAPS MDMA Literature Review Project (which includes full text PDFs of most papers), the Hofmann Collection (with over 4,000 psychedelic research papers from the late 1940s to the early 1970s, most with PDFs), and a number of other bibliographies. Other compilations are cited at the end of this section.

A major problem is to know how to evaluate the various references. Much of the current public misunderstanding is the result of the position of mainstream professionals and government agencies who have concentrated on emphasizing only the negative aspects of psychedelic use, screening out any data that would imply usefulness. Dr. Roger Walsh [2] comments on the selective bias of public information:

> Barriers to research and publication appear to have resulted in a bias toward selective dissemination of predominantly negative information about the effects of psychedelics...
>
> There have probably been few areas in psychology that have been subject to as much misinformation and sensationalistic reporting by the media as psychedelic experiences. While preliminary clinical research suggested that they might have considerable research and clinical potential, the popular press preoccupied itself almost entirely with sensationalistic accounts of dangers. This media treatment soon resulted in the cessation of almost all research and a bias at many levels of society toward the dissemination of only negative reports...
>
> ...What seemed to be widely unrecognized was that large numbers of people appeared to have derived, at least from their own point of view, significant benefits from psychedelics, a situation markedly at variance with media accounts of their devastating effects.

In this same paper, Walsh describes submitting a paper to a reputable professional journal that included evidence suggesting that in some cases, people might find psychedelics beneficial. Surprisingly, the editor responded that the paper could be accepted only if any reference to positive effects of psychedelics was removed. Since this was a fairly open-minded editor, Walsh wonders at the chance of publication of positive statements in other places.

To clarify the various positions held, it may be helpful to refer to recent writing which sheds light on the conflicting perceptions of those who claim to be experts. The problem is that mainstream science holds a very limited view of the nature of the human being. Clarification of this situation is now being presented in the relatively new field of Transpersonal Psychology, which recognizes those aspects of human experience in which the sense of identity of self extends beyond the individual or personal to encompass wider aspects of humankind - life, psyche, and cosmos - validating the spiritual foundation of life. An overview of many of the aspects of transpersonal psychology is presented in the book *Paths Beyond Ego: The Transpersonal Vision*[3], a compilation of articles by over thirty contributors knowledgeable in this field.

An extraordinarily comprehensive overview of all aspects of human development is presented by Ken Wilber in *Sex, Ecology, Spirituality: The Spirit of Evolution*[4] and in more readable form in *A Brief History of Everything*[5]. To again quote Walsh, a leading authority in the field of Transpersonal Psychology[6]:

> The aim of these two books is to trace evolution - physical, biological, and human - and to set it within the context of the perennial philosophy: the common core of wisdom at the heart of the great religious traditions. Human evolution - of brain and mind, society and culture - is traced from early hominids to today and related to phenomena such as the evolution of gender relationships , human relationship to the earth, technology, philosophy, religion, and more.
>
> The scope of the work is extraordinary. Only a handful of thinkers, such as Aurobindo in the East and Hegel in the West, have assembled such evolutionary visions. Yet Wilber's view is unique in not only providing a far reaching vision but also grounding that vision in contemporary research in fields such as cosmology, biology, anthropology, sociology, psychology, philosophy, and ecology.

The crux of the most serious disagreements among psychedelic investigators is the value placed on objective experience versus subjective experience. Mainstream science, through the dictum "if it can't be measured, it's not science," by and large ignores subjective or interior experience in favor of the objective outside world. This leaves them living in, according to Wilber[5], a "monological" world, or "flatland." In such a world, much of that which is of great value to humans is nonexistent, such as the very essence of consciousness and the nature of the human mind. It is precisely these latter elements that are so effectively revealed through appropriate use of psychedelics. It is worth reading *A Brief History of Everything*[5] to observe how all aspects of humanity and life can be put into perspective, a perspective developed by a brilliant mind that has carefully examined the data from many areas of scientific research, as well as the world's spiritual disciplines.

With a chemical such as LSD, which opens up access to vast dimensions of the human mind, it should be clear that those who have not taken the chemical or who have not reached transpersonal levels of experience are in a poor position to evaluate the potential of psychedelics and their numerous applications. Consequently, while a great number of investigations were conducted over the years, the outcomes vary considerably depending on the experience and qualities of the investigator. Some investigators conducted research to specifically debunk claims made for the use of LSD. Since set and setting have been found to be eminently definitive factors in the outcome of psychedelic experiences, the experiences of subjects are highly colored by the attitude and belief system of the investigator, particularly with naive subjects. It is therefore important in evaluating published papers to be aware of the qualifications and position of the investigator. The difference in outcome with unskilled supervision can be like using a large amphibious airplane to get from place to place by taxiing around in the water without realizing that it can take off and fly.

The diversity of viewpoints revealed by examining the literature can be appreciated by pondering the label attached to psychedelics by some members of the medical profession, "psychotomimetic" (psychosis mimicking). Another term widely adopted by the medical profession is the term "hallucinogens," which is often used in a deprecatory manner. Those who originated the term psychotomimetic most likely were unable to distinguish between the disorienting and illuminating aspects of the psychedelic experience, or had no personal experience with LSD, or else had uncomfortable personal experiences. It is now well recognized by seasoned psychedelic practitioners that a major requirement for a rewarding experience is honesty, whereby one willingly and fruitfully confronts and resolves any uncomfortable feelings being experienced. Through such confrontation, much valuable learning takes place. The extensive work of Jacob and others in the field indicates that one of the major causes of discomfort while taking psychedelics is the subject's attempt to maintain an image of him/herself that is not in harmony with one's authentic self. The greater the investment in the created image - and consequently, the greater the reluctance to change - the greater the discomfort. The disparity can be so great and so painful that the subject employs psychotic episodes to escape the discomfort. This is part of the reason that some members of the medical profession have chosen the term "psychotomimetic" to describe the action of drugs like LSD.

I have concluded that a more accurate term is "psychosis releasing," as the action of a psychedelic often focuses on those areas in the unconscious that most demand resolution. The willingness to surrender to the experience and allow such resolution to proceed often results in the most valuable kind of learning about one's repressed feelings, hidden values, compulsions and aspirations, and inappropriate behavior. In addition, as repressed psychic material is discharged, the inner core of our transpersonal nature can manifest. This can lead to profound and ecstatic realization of the true nature of ourself and the cosmos.

It is interesting that it is the group that prefers the psychotomimetic label for psychedelics whose professional opinion has been accepted by many media and government officials. This outcome may perhaps be accounted for because many mainstream scientists are very unsettled by the fact that among the most outstanding experiences of psychedelics is the discovery of the presence of Divinity and the sacredness of life. In the current Western world, our scientists are the most respected source of truth, even though polls show that over 90% of the American population believes in God.

For some reason, which I am sure has complex roots, many mainstream psychiatrists and government officials prefer to discount the opinions of those who are truly qualified. Their position may have been greatly influenced by the proselytizing of the Tim Learys of the world, and the unacceptable antics of many young people abusing psychedelic substances. There may also be an aversion to persons truly enjoying themselves, which seems to be frowned upon by many puritanical Americans. But this does not excuse them from objectively examining and appraising all the data, nor from recognizing the appropriate credentials of those qualified to evaluate the use of psychedelics. A well balanced summary of psychedelic therapy research is contained in Grinspoon and Bakalar's book Psychedelic Drugs Reconsidered[7] in the chapter on Therapeutic Uses. Their conclusions at the end of the chapter, including their suggestions for further study, are well worth noting.

Notes

1. Passie, Torsten. 1997. *Psycholytic and Psychedelic Therapy Research 1931 - 1995: A Complete International Bibliography*. Hannover: Laurentius Publishers.
2. Walsh, Roger. 1982. "Psychedelics and Psychological Well-being." *Journal of Humanistic Psychology*. Vol. 22 No. 3, pp. 22-32.
3. Walsh, Roger, and Vaughan, Frances, eds. 1993. *Paths Beyond Ego: The Transpersonal Vision*. Los Angeles: Jeremy P. Tarcher/Perigee Books.
4. Wilber, Ken. 1995. *Sex, Ecology, Spirituality: The Spirit of Evolution*. Boston: Shambhala.
5. Wilber, Ken. 1996. *A Brief History of Everything*. Boston: Shambhala.
6. Walsh, Roger. 1996. "Developmental and Evolutionary Synthesis in the Recent Writings of Ken Wilber." *Revision*. Vol. 18, No. 4, p. 9.
7. Grinspoon, Lester, and Bakalar, James B. 1979. *Psychedelic Drugs Reconsidered*. New York: Basic Books, Inc.

Books

50 Years of LSD: State of the Art and Perspectives on Hallucinogens. A. Pletsher (Ed.). Parthenon Publishing; 1994. A series of papers on the historical, pharmacological, psychopathological, transcultural and clinical aspects of LSD, presented at a conference sponsored by the Swiss Academy of Medical Sciences on the 50th anniversary of the discovery of LSD.

Dark Night, Early Dawn: Steps to a Deep Ecology of Mind. Christopher M. Bache. State University of New York Press; 2000. "With moving honesty and rare lack of inflation, Bache has brought forth a conception of the human psyche that intimately reconnects the personal ordeals and awakenings of the individual to the larger collective suffering and spiritual transformation of the entire human species, at the most crucial of historical thresholds. This is a book to read soon and to integrate carefully." - Richard Tarnas, author of The Passion of the Western Mind: Understanding the Ideas that have Shaped our World View.

The Discovery of Love: A Psychedelic Experience with LSD-25. Malden Grange Bishop. Dodd, Mead & Company; 1963. This book is a detailed and fascinating account of a person's initial encounter with LSD. It also reveals the incredible power of a well planned and well executed psychedelic journey. Beginning in 1961, and stretching over the next three years, the International Foundation for Advanced Study in Menlo Park, California, conducted research with LSD and mescaline, processing some 350 participants. As a historical record, Bishop's book provides an important firsthand account of these experiments from a participant's point of view. To follow a conservative, 54-year-old businessman's transformation into a person who values love above all else in life is a profound testimony to the power of this sacred medicine we call LSD.

The Doors of Perception / Heaven and Hell. Aldous Huxley. Harper Collins; 1954 / 1956. A demonstration of what a refined, prepared mind can do with the opportunity afforded by a psychedelic in observing nature, art, colors, and forms in their full glory, with a profound appreciation of the transpersonal and numinous aspects of life. These books more than any other in their time period encouraged many to investigate the psychedelic experience.

Drawing it Out: Befriending the Unconscious. Sherana Harriette Frances. Introduction by Stanislav Grof, M.D. Prologue and Afterword by Tanya Wilkinson, Ph.D. MAPS; 2001. "I do not know of any single document illustrating the extraordinary healing and transformative potential of psychedelics in a way that matches in its importance this book by Harriette Frances and the unique illustrations that accompany it. Her ability to find artistic expression for the images and depth of her psyche is truly extraordinary!" - Stanislav Grof, M.D., author of LSD Psychotherapy.

Drugs, Set and Setting: The Basis for Controlled Intoxicant Use. Norman Zinberg. Yale University Press; 1984. A pioneering book that illuminated the factors that permit some people to use illegal drugs, including psychedelics, in a controlled fashion.

Ecstasy: The Complete Guide. A Comprehensive look at the Risks and Benefits of MDMA. Julie Holland, M.D. (Ed.). With contributions from Andrew Weil, Ralph Metzner, Rick Doblin, Douglas Rushkoff, Sasha and Ann Shulgin, Rabbi Zalman Schachter, and others. Park Street Press; 2001. "MDMA is a unique compound with great potential for positive use. This is the most complete book about it, with much information to help people realize that potential as well as reduce any possible harm." - Andrew Weil, M.D., author of 8 Weeks to Optimum Health and Spontaneous Healing.

Ecstasy: The MDMA Story. Bruce Eisner. Ronin Publishing; 1994 (second edition). A widely read summary of the history, usage and effects of MDMA.

Entheogens and the Future of Religion. Robert Forte (Ed.). Council on Spiritual Practices; 1997. "Entheogen" is the currently designated name for a psychedelic used for spiritual realization. According to Jonathan Ott, the word is derived from Greek and means "realizing the divine within." Dr. Huston Smith says, "collectively, these essays constitute the best single inquiry into the religious significance of chemically occasioned mystical experiences that has yet appeared."

Exploring Inner Space: Personal Experiences Under LSD-25. Jane Dunlap. Victor Gollancz Ltd.; 1961. Written by a well known scientific authority whose books were so popular the publisher refused to let her use her correct name. Jane Dunlop describes in detail five outstanding experiences under the influence of LSD. More beautifully written and profound descriptions of remarkable LSD experiences probably don't exist.

Gateway to Inner Space: Sacred Plants, Mysticism and Psychotherapy. Christian Rätsch (Ed.). Prism/Avery Publishing; 1989. A collection of essays by many leading researchers in the field of altered states of consciousness. Issues addressed include the medical use of psychedelics, "molecular mysticism," death and rebirth themes in shamanism, comparisons between meditative and psychedelic experiences, and states of tryptamine consciousness.

Hallucinogens: A Reader. Charles S. Grob (Ed.). Penguin Putnam, Inc.; 2002. A collection of essays by and interview with: Lawrence Bush, Gary Fisher, Albert Hofmann, Terence McKenna, Ralph Metzner, Jeremy Narby, Thomas Riedlinger, Glenn Shepard, Huston Smith, Myron Stolaroff, Rick Strassman, Donald Topping, Roger Walsh, and Andrew Weil. A great deal of the misunderstanding regarding the nature of psychedelic substances arises from the fact that the majority of scientists and researchers who have examined these substances in the past have not understood the essential spiritual nature of mankind. This collection of authors are thoroughly familiar with the true potential of psychedelic substances due to their direct personal experiences with them. This is the only way these substances can be properly understood and appreciated. Dr. Grob has assembled a well-informed collection of writings on the nature of psychedelics.

Handbook for the Therapeutic use of Lysergic Acid Diethylamide-25, Individual and Group Therapy. D.B.

Blewett, Ph.D. and N. Chwelos, M.D. 1959. Despite being prepared in the late 1950s, this handbook contains some of the most informed and valuable data available concerning the effective methods of conducting LSD therapy. Available on the www.maps.org website.

The Healing Journey: New Approaches to Consciousness. Claudio Naranjo. Pantheon Books. Random House; 1973. Incisive case reports about the therapeutic use of MMDA, MDA, ibogaine and harmaline. A classic in the field of psychedelic psychotherapy.

Higher Wisdom. Charles S. Grob and Roger Walsh (Eds.). SUNY Press; 2004 (in press). Eminent thinkers reflect on the continuing impact of psychedelics. Contains interviews with Betty Eisner, Ram Dass, James Fadiman, Gary Fisher, Pet e r T. Furst, Stanislav Grof, Micheal Harner, Albert Hofmann, Laura Huxley, Zalman Schachter, Alexander T. Shulgin, Ann Shulgin, Huston Smith, and Myron Stolaroff.

The Human Encounter with Death. Stanislav Grof, M.D. and Joan Halifax, Ph.D. E.P. Dutton; 1977. A remarkable portrait of the experiment in which patients dying of cancer at the Maryland Psychiatric Research Center in Baltimore, Maryland were treated with psychedelic therapy.

The Ibogaine Story: Report on the Staten Island Project. Paul de Rienzo, Dana Beal & Members of the Project. Autonomedia; 1997. An account of the discovery and development of ibogaine as treatment for drug addiction, with a special focus on the political aspects of ibogaine research.

In Search of the Ultimate High: Spiritual Experiences through Psychoactives. Nicholas Saunders, Anja Saunders, and Michelle Pauli. Rider (an imprint of Ebury Press, Random House); 2000. An analysis of the cross-cultural and spiritual implications of altered consciousness produced by psychedelics. Featuring a fascinating collection of the accounts and insights that hundreds of truth seekers around the world have obtained from their thoughtful and reflective use of psychoactives. An excellent book for people who want to know more about the spiritual uses of psychedelics in contemporary society.

Insight Outlook. Albert Hofmann. Humanics New Age; 1989. A personal review of Dr. Hofmann's world view. He describes the early childhood mystical experiences that established his basic understanding. It was his desire to more completely understand the mystery of matter and the miracle of the plant world that led him to chemistry. He chose to work at Sandoz because their chemical explorations involved plant materials, thus leading him more directly to the understanding of nature. The book sets forth the major tenets of his philosophy, which was reinforced by the openings provided by appropriate use of LSD.

Ketamine: Dreams and Realities. Karl Jansen, M.D., Ph.D. MAPS; 2001. "Indispensable reading for those with any interest in ketamine. Entertaining, thought-provoking, and thorough." - Rick Strassman, M.D., author of DMT: The Spirit Molecule.

LSD, My Problem Child: Reflections on Sacred Drugs, Mysticism, and Science. Albert Hofmann. J.P. Tarcher, Inc.; 1983. This book traces how LSD originated, the discovery of its psychic effects, its applications to therapy, and the crushing developments that ensued from the widespread use of LSD as an inebriant. The book describes a number of valuable individual experiences, as well as visits with key figures like Aldous Huxley, Timothy Leary, and others.

LSD Psychotherapy: Exploring the Frontiers of the Hidden Mind. Stanislav Grof, M.D. Introduction by Andrew Weil, M.D. MAPS; 2001. Considered the most complete book on psychedelic therapy, this is a treasure house of all aspects of the work: history, procedures, client preparation, qualifications of the therapist, and more.

Pharmacotheon: Entheogenic drugs, their plant sources and history. Jonathan Ott. Natural Products; 1996 (second edition). The introductory Proemium is a must read for those wishing to understand the current political, social, and scientific dilemmas of psychedelic drugs.

PIHKAL: A Chemical Love Story. Alexander T. Shulgin and Ann Shulgin. Transform Press; 1991. Comprehensive, definitive guide to the psychedelic phenethylamines, such as mescaline and MDMA, and a great love story. Two parts: first the human story of the search for active mind compounds within a marriage of two active minds. Next, detailed catalog of the chemistry, characteristics of action and synthesis of 179 compounds and results of human assay at varying dosages.

Psychedelic Drugs Reconsidered. Lester Grinspoon and James B. Bakalar. The Lindesmith Center; 1997 (third edition). Two of the world's leading experts on drug use provide the general reader with a comprehensive survey of psychedelic drugs and the scientific and intellectual issues they raise. The authors review the chemistry of psychedelics, their effects, and the history of human experience with them as well as assessing the potential value of the drugs. Excellent bibliography.

Psychedelics Encyclopedia. Peter Stafford. Ronin Publishing; 1992 (third edition). Highly readable book on history, background, preparation, chemistry, methods of use, results, and social implications of the known psychedelic drugs.

The Psychedelic Reader: Classic Selections from the Psychedelic Review. Timothy Leary, Ralph Metzner & Gunther M. Weil (Eds.). Citadel Press; 1993. Selections about the therapeutic, religious and legal aspects of psychedelic drugs from the first four issues of the Psychedelic Review (1963-1964), the journal edited by the Harvard psychedelic research team.

Psychoactive Sacramentals: Essays on Entheogens and Religion. Thomas B. Roberts (Ed.). Council on Spiritual Practices; 2001. In 1995, the Chicago Theological Seminary, along with the Council on Spiritual Practices, held a conference to examine the potential benefits and concerns related to employing entheogens in spiritual practice. Speakers included leaders in religion, mental health, research, and allied fields. The views of the participants have now been published in this book, which is a valuable collection of information in an exciting field.

Pursuit of Ecstasy: The MDMA Experience. Jerome Beck, Ph.D. and Marsha Rosenbaum, Ph.D. SUNY Press; 1994. Expanding on a study sponsored by the National Institute on Drug Abuse, the authors present a thorough and trustworthy review of the emergence and spread of MDMA use, the path toward illegalization, the diverse social worlds and scenes evolved around the use of MDMA and how they result in different experiences, why people use MDMA and what if anything makes them stop, long term benefits and therapeutic potential, adverse reactions and abuse, and recommendations for harm reduction and continuing research of the therapeutic potential.

Realms of the Human Unconscious: Observations from LSD Research. Stanislav Grof, M.D. E.P. Dutton; 1976. A systematic and comprehensive discussion of the transpersonal model of the human unconscious. A uniquely valuable contribution to the field of psychology.

The Road to Eleusis: Unveiling the Secret of the Mysteries. R. Gordon Wasson, Carl A. Ruck, Albert Hofmann. Harvest/ HBJ; 1978. Three scholar-scientists document their theory of the LSD-like component of the religious rites at Eleusis, celebrated for 2,000 years.

Shivitti: A Vision. Ka-Tzetnik 135633. Gateways Books; 1998. An autobiographical account of a concentration camp survivor's experiences with LSD psychotherapy, conducted in Holland by Professor Bastiaans. Very moving and illustrative of the processes of LSD psychotherapy.

Storming Heaven: LSD and the American Dream. Jay Stevens. Harper Collins; 1987. A thorough, well written, intensively researched history of the advent of psychedelics on the American scene. With each new aspect introduced, the author traces back to the roots of that development, and shows how it progresses to intertwine with the overall picture.

Thanatos to Eros: Thirty-five Years of Psychedelic Exploration. Myron J. Stolaroff. VWB-Verlag für Wissenschaft und Bildung; 1994 (see page 166 for complete description).

This Timeless Moment. Laura Huxley. Mercury House; 1991. A personal account of Aldous Huxley's last years by Laura, his wife, including details of the outcome of his request to be administered LSD while dying. Profoundly inspirational.

TIHKAL: The Continuation. Alexander T. Shulgin and Ann Shulgin. Transform Press; 1997. A continuation of the Shulgin's popular book PIHKAL: A Chemical Love Story. The first part of the book blends travel, botanical facts, scientific speculation, psychological and political commentary. The second part describes in detail a wealth of tryptamines, plus appendices presenting topics such as cactus alkaloids, natural beta-carbolines, current drug law, and all known tryptamines that might be psychedelic. Once again the Shulgins honor us with an outstanding collection of vital information, particularly for those interested in the psychedelic field.

The Varieties of Psychedelic Experience. R.E.L. Masters and Jean Houston, Ph.D. Delta; 1966. A research-based comprehensive review of the effects of LSD on human personality, along with a section on the role and training of the guide.

Online Resources

Albert Hofmann Foundation - www.hofmann.org
Association for Transpersonal Psychology - www.atpweb.org
Center for Cognitive Liberty & Ethics - www.cognitiveliberty.org
Council on Spiritual Practices - www.csp.org
Dancesafe - www.dancesafe.org
Drug Policy Alliance - www.dpf.org
Drug Reform Coordination Network - www.drcnet.org
Erowid - www.erowid.org
Heffter Research Institute - www.heffter.org
Iboga Therapy House - www.ibogatherapyhouse.org
Institute of Noetic Sciences - www.noetic.org
Island Group - www.island.org
Lycæum - www.lycaeum.org
Marijuana Policy Project - www.mpp.org
Media Awareness Project - www.mapinc.org
Mind States Conferences - www.mindstates.org
Multidisciplinary Association for Psychedelic Studies - www.maps.org
NORML - www.norml.org
Peyote Way Church - www.peyoteway.org
POT-TV - www.pot-tv.net
Psychedelic Bibliography - www.maps.org/wwwpb
Schaffer Drug Library - www.druglibrary.org
Trip - www.tripzine.com

Print Resources

Ambrosia Books & Academic Publishing (formerly Rosetta Books), HC 71 Box 34, Taos NM 97571. Ambrosia offers quality books, art, and obscure out-of-print research relating to ethnobotany and pharmacology. They are also the publisher of Entheos: The Journal of Psychedelic Spirituality. Edited by Mark Hoffman. Yearly two-issue subscriptions are $28.00 (USA). See website for costs to foreign countries. www.entheomedia.org. Catalog $3.00.

The Entheogen Review, POB 19820, Sacramento, CA 95819. A quarterly journal that acts as a clearinghouse for current underground data about the use of visionary plants and drugs, offering information that is unavailable anywhere else. Edited by David Aardvark and K. Trout. $25.00 (USA), $35.00(foreign). See www.entheogenreview.com.

FS Book Company, POB 417457, Sacramento, CA 95841. (800) 635-8883. A large selection of books related to Cannabis, mushrooms, and psychedelics. See www.fsbookco.com. Catalog is $2.00.

Psychedelic Resource List (fourth edition), POB 19820, Sacramento, CA 95819. Descriptions and reviews of over 650 organizations related to psychedelics. 207 pages. $24.00 (USA), $29.00 (foreign). See www.entheogenreview.com/prl.html.

Bibliographies

The Albert Hofmann Collection: LSD & Psilocybin References
www.erowid.org/references/hofmann_collection.php
In the early 1950s, Sandoz began collecting LSD and psilocybin-related articles as part of Albert Hofmann's work with these substances. For nearly 35 years, Sandoz gathered over 4,000 documents: LSD and psilocybin journal articles from the late 1940s through the early-1980s, a few student theses, newspaper clippings, and other unique items. In the mid 1990s, the collection was given to the Albert Hofmann Foundation, and during the late 1990s, along with the Multidisciplinary Association for Psychedelic Studies and the Heffter Research Institute, they collaborated to create a digital index of the papers. In 2002, representatives from the Erowid web site and from MAPS completed the digital index of this entire collection.

Psycholytic and Psychedelic Research 1931-1995: A Complete International Bibliography
Torsten Passie, M.D., M.A., with preface by Hanscarl Leuner, M.D. Laurentius Publishers; 1997. To order contact MAPS by e-mail at askmaps@maps.org or contact Laurentius Publishers by e-mail at dehmlow@bib.mhhannover.de.

An excellent bibliography on the use of psychedelics in psychotherapy, this work is a valuable guide for students and researchers. A meticulous worldwide search by the author has revealed 687 pertinent scientific publications for further study. Research and therapeutic work with psychedelics remains controversial. The presentation of correct information helps overcome irrational projections, conclusions and prohibitions. Scientific research shows these catalysts can be used effectively and safely in medical psychotherapy.

This bibliography includes a precise subject index organized by substances, settings, methods, treatment results and more. The preface by Professor Hanscarl Leuner (Göttingen University, Germany), the leading European authority on research with psychedelics, provides an expert view. The introduction gives an overview of psycholytic and psychedelic therapy. This document is available as part of the WWW Psychedelic Bibliography, at www.maps.org/wwwpb.

Religion and Psychoactive Sacraments: A Bibliographic Guide
Thomas B. Roberts, Ph.D. and Paula Jo Hruby, Ed.D. (Eds.). Contains over 550 annotated references to books and dissertations which address the topic of entheogens, psychoactive plants, and chemicals used within a religious context. In the view of editor Thomas Roberts, the Guide firmly establishes that theologians, clergy, scholars and laypersons see the topic of psychoactive sacraments as important and worthy of discussion and that disagreement, discussion, and debate exist over the questions: Is there legitimate religious use for psychoactive sacraments, and if so, what is appropriate? The index greatly enhances the usefulness of this booklet. Notes and Excerpts for each book range from half a page to three pages. The books described are almost exclusively in the English language and the emphasis is on North America. The editors note that the vast research in world-wide anthropology is under-represented and deserves a guide of its own. Available online at www.csp.org/chrestomathy.

World Wide Web Psychedelic Bibliography
www.maps.org/wwwpb
This bibliography is designed to systematically digitize and protect the body of valuable psychedelic research papers for posterity. Sponsored by the Multidisciplinary Association for Psychedelic Studies, the Heffter Research Institute and the Albert Hofmann Foundation, this site mainly has annotated and non-annotated bibliographical listings but has some full-text listings. Includes bibliographies for: Psychedelics and the Dying; Psychedelics in Western Culture; Sandoz Pharmaceuticals' collection of research on LSD and psilocybin; Sasha Shulgin's MDMA bibliography; Howard Lotsof's ibogaine bibliography; the Janiger and Paltin bibliography of LSD. This site is frequently updated.

By the Same Author

Thanatos To Eros: Thirty-five Years of Psychedelic Exploration, 192 pages, color hard-back cover, ISBN 3-86135-453-5.
Myron Stolaroff was the founder and President of the International Foundation for Advanced Study in Menlo Park, California, an organization devoted to research with LSD and mescaline from 1961 to 1965. Six professional papers covering this work have been published in appropriate journals.

Early on, Stolaroff was convinced of the value of psychedelic substances, and devoted his career to studying them. This book includes a detailed account of his own personal experiences - coming to grips with an excruciatingly painful birth experience and its impact on his life, and learning to recognize and break free of powerful, oppressive feelings of failure and inadequacy. Facing and resolving repressed material opened the door to discovering the joy and vitality that life has to offer. It is a journey from the grip of Thanatos, the drive for death that effectively defeats enjoyment of life, to Eros, the drive for life that brings ultimate fulfillment.

An essential ingredient in the success of this struggle was the use of psychedelic substances. These sacraments, as he prefers to call them, allowed him to confront and resolve powerful shadow material. More important, they opened the gateway to that level of Divine love and grace that is the source of true healing and the freeing of our ultimate capacities.

Stolaroff's desire to discover effective means for self-realization led him to continue exploring newly discovered substances as long as they were legal. This book describes work done with family, friends, and research volunteers employing MDMA, 2CB, 2C-T-2, 2C-T-7, 2C-E, and others. Numerous experiences are described in detail. Since for many people psychedelic experiences tend to fade if not appropriately utilized, serious consideration is given here to the concentrated effort required to accomplish rewarding changes.

These experiments and the discussions presented shed intriguing light on the nature of psychedelic experiences, the nature of the human psyche, factors affecting rewarding experiences, and aspects of transcendental levels of consciousness. Substantial evidence is presented of the inordinate power of the human mind, unrecognized by mainstream science - a power currently widely misdirected to create human pain and suffering. Numerous trials demonstrate that when used with integrity, skill, and fortitude, psychedelic substances can reveal the unfathomed love supporting all of creation, a love that can dissolve the death grip of Thanatos to free Eros and joyously illumine life in all of its aspects.

"I do not remember that a book from a living author impressed me more than Thanatos to Eros... My accord with your concepts of life and reality can best be summarized if I tell you that already in the first two paragraphs of the Introduction, the core of my belief has found its perfect, most beautiful expression."
- Albert Hofmann, Ph.D., retired Director of the Pharmaceutical-Chemical Research Laboratories, Sandoz Ltd., inventor of LSD.

"Myron Stolaroff is one of the bravest, most sincere and forthright psychonauts of our time... The result is a book which speaks volumes to the psychology and spiritual worth of these substances..."
- Jon Hanna, *Psychedelic Resource List*.

Thanatos To Eros may be ordered from: THANEROS PRESS P.O. Box 773, Dept. SC Lone Pine, CA 93545
Price: $22.95 per copy. Add $3.00 per copy for shipping and handling.

For Air Mail to Europe: add an additional $6.00. California residents add $1.78 sales tax for each book. Please make check or money order payable to: *Thaneros Press*. NOTE: Limited supply available.

About the Publisher: The Multidisciplinary Association for Psychedelic Studies (MAPS)

MAPS President Rick Doblin,

MAPS President Rick Doblin with Leo Zeff

HERE THERE BE DRAGONS JUST six hundred years ago, maps of the known world contained the inscription, "Here there be dragons," indicating terra incognita about which we knew nothing and hence feared to tread. Today we find this viewpoint exceedingly quaint. What changed? Knowledge and information was gathered by souls brave enough to challenge orthodoxy and venture into those uncharted realms inhabited by dragons. They returned with firsthand information that refuted "common knowledge" and led to a revised worldview.

Today, knowledge of our physical environment has expanded beyond belief.

Regarding our inner environment, however, many still fear that "here there be dragons." Replacing fear with understanding will require the use of every tool available, including psychedelic substances, to increase our knowledge of the internal terrain. Unfortunately, using psychedelics to explore these uncharted landscapes was forbidden for several decades.

Recently a few brave scientists have been permitted to make the trek and conduct psychedelic research. Would you like to have access to results of that research, and become part of this continuing "quest for knowledge?"

The Multidisciplinary Association for Psychedelic Studies (MAPS) is a membership-based IRS-approved non-profit research and educational corporation founded in 1986. MAPS pursues its mission by assisting scientists to design, to obtain governmental approval for, to fund, to conduct and to report on research into the healing and spiritual potentials of psychedelics and marijuana. Such uses may include psychotherapeutic research and treatment, treatment of addiction, pain relief, spiritual exploration, shamanic healing, psychic research, brain physiology research and related scientific inquiries.

MAPS publishes a quarterly Bulletin that is sent to all members, as well as to a substantial number of government policy makes and academic experts. The Bulletin features research updates, articles about related issues such as spiritual contexts for psychedelics, book reviews, reports on consciousness and the efforts of organizations with similar goals, and readers' letters. MAPS maintains a website (www.maps.org) which contains all the back issues of the MAPS Bulletin, as well as related documents.

Supporting the MAPS Mission

MAPS serves as a non-profit pharmaceutical company that seeks to develop MDMA, other psychedelics and marijuana into prescription medicines. Now that the FDA is once again permitting scientific research into the risks and benefits of psychedelics and marijuana, your support of MAPS can make a substantial difference in the rate at which the field advances. Rates are:

MEMBERSHIP TYPE	RATE (OUTSIDE USA)
Student/low income	$20-34
Basic	$35-49
Basic Plus (includes a free book)	$50-99
Supporting (includes a free book + water bottle or coffee mug)	$100-249
Patron (includes two free books)	$250+

International members, please add $15 to your membership rate for shipping.

Make check or money order payable to MAPS. Credit card charges add $1.00. We can accept checks made on American banks, international postal money orders, Visa, Mastercard, American Express, or Paypal. MAPS cannot accept foreign checks. See "Ordering Information" on the following page to contact MAPS for memberships and donations.

Ordering Information

The Secret Chief Revealed: Conversations with a pioneer of the underground psychedelic therapy movement (ISBN: 0-9660019-6-6) $12.95/copy.

Shipping and Handling Charges
U.S. and Canada - Priority mail (allow 3-7 days): $4.00 (add $1.50 per additional book)
Overseas airmail rates (allow 7-10 days): $12.00 (add $10 per additional book)
Overseas surface mail rates (allow 4-6 weeks): $5.00 per book

Method of Payment
Check or money order in U.S. Dollars, Mastercard, Visa, American Express, or Paypal.
Wholesale Orders Welcome: Case discount: 50% Split case discount (ten copy minimum): 40% Five to nine copies: 20%.

Other ways you can order The Secret Chief
Via secure credit card transactions at http://www.maps.org/secretchief/
Toll-free number (orders only, please): 1-888-868-MAPS (6277)
Through your favorite local bookstore
Send orders to: MAPS - Secret Chief 2105 Robinson Avenue Sarasota, FL 34232
USA Voice: (941) 924-6277
Fax: (941) 924-6265
e-mail: askmaps@maps.org
Toll-free number (orders only, please): 1-888-868-MAPS (6277)

100% OF THE PROFITS
FROM THE SALE OF THIS BOOK
WILL BE DEVOTED TO PSYCHEDELIC PSYCHOTHERAPY RESEARCH.

The Secret Chief Revealed: Conversations with a pioneer of the underground psychedelic therapy movement

ISBN 0-9660019-6-6 (paperback)
Copyright 2004, 1997 by Myron J. Stolaroff

Interested parties wishing to copy any portion of this publication are encouraged to do so, and are kindly requested to credit MAPS including name and address.

Published by:
Multidisciplinary Association for Psychedelic Studies (MAPS)
2105 Robinson Avenue
Sarasota, FL 34232 USA
Voice: (941) 924-6277
Fax: (941) 924-6265
e-mail: askmaps@maps.org
website: www.maps.org/secretchief/

Project Editor: Rick Doblin
Manuscript Editors: Sylvia Thyssen and Brandy Doyle
Additional editing help from Jon Hanna and Valerie Mojeiko

Photos: Jack Coddington
Book & Cover Design: Mark Plummer
Cover: SolidNirvana image ©Hisashi Hoda, used by permission www.voyager.co.jp/

Printed in the United States of America
Set in Adobe Sabon for the Macintosh

How to Work with Difficult Psychedelic Experiences

original text:
https://maps.org/resources/responding-to-difficult-psychedelic-experiences/101-how-to-work-with-difficult-psychedelic-experiences

A true psychedelic experience, even a so-called bad trip, is sacred. In earth-oriented, shamanic cultures, even a psychotic breakdown, induced by a psychedelic, is part of the initiation.

So remember the way of the ancients: this is a process, a process of awakening, healing, and ultimately celebrating life.

To avoid psychologizing the psychedelic experience I have avoided medical or traditional therapeutic language.

Overview of what we will cover:

Table of Contents:

1. Role of the Sitter or Facilitator
2. Varieties of Psychedelic-Induced Crises
3. Working and Being with Psychedelic Emergencies
4. Aftercare
5. Related Readings

This is a short overview of the material we will cover in this hands-on training. It is based on 30 years of experience sitting for people. It has therapeutic value, but goes beyond therapy and moves into transpersonal and spiritual realms.

The manual is based on training, schooling, teachings and hands-on work with the leading people in the psychedelic movement, and on in-depth work with healers/shamans from Nepal, Ecuador, and the Navajo nation. It is based on my own healing and therapeutic work, using psychedelics, western psychology, body work, breathwork, art, and different eastern tools, like meditation, Zen koan study and nature work.

1. Role of the Sitter or Facilitator

The work with psychedelics, entheogens, and plant teachers is an area of the healing arts that is ancient and has been rediscovered in the last 100 years. There are many different ways to work with and understand the psychedelic experience. When we work and sit with a person going through a psychedelic-induced crisis, it is important to understand that in a certain way this is a dialectic relationship, a way of relating that is ancient.

Every person is a psychospiritual system, meaning there is no separation of body, mind, emotion, soul, imagination and energy. Therefore it is very important to see each person as a unique individual.

There is always the tendency to overpower the other with our knowledge, wisdom, and insight. So let go of all knowledge regarding the experiences that the person is having. Just be with, listen, and observe. This brings us back to the dialectical relationship, paying full attention, allowing the other to express and communicate whatever they want. Just being, without a putdown or judgment.

It is important for the healer/sitter/helper to believe in her/his way of working. The belief in the method is important for the results.

The healer/sitter therefore is someone who has had their own psychedelic experience and has had some experience sitting for people, guiding her/his friends. Without any experience, it is impossible to just be with someone having a psychedelic experience or guiding someone having a psychedelic crisis. It is good to know that we all have blind spots and there is the danger that we might stop the experience if we have not explored this material or are afraid.

Rule #1, under any condition, is that we honor and respect the person having the crisis.

Even if we don't understand what's happening (the person having the crisis might be much more developed than we are, lost in worlds unknown to us, or reliving a drama we can't comprehend), we serve as an anchor, a resting place, a quiet center. We know that our presence is helpful. At this moment we don't have to solve all the problems and answer all the questions that the experience or the person's life presents.

We have to remember that tens of millions of people have used psychedelics, in many different, sometimes not very supportive, environments, and returned home safely. With support, knowledge, and integrative work there is very little danger in the psychedelic experience itself. Even the most frightening and bizarre behavior, when explored and worked with, will turn out to be beneficial and enlightening.

As stated earlier, the positive outcome of our work requires trusting the wisdom of the ancients, trusting the wisdom of our modern teachers and healers, and trusting the built-in wisdom of our bodies, minds and souls.

We frequently pick up emotions and feelings and energies from others. We will cover ways of clearing, cleansing, and purification.

2. Varieties of Psychedelic-Induced Crises

This is a vast area, so we will just touch on it. For a more in-depth study, see the reading list.

There is no clear manifestation of any substance or mixture of substances. But there are some generalities. It is very important to know the active duration of the different substances. All psychedelics have a similar pattern: there's the doorway with different physical, mental and emotional manifestations. There is a buildup, then an extended stay on a plateau, then the coming down, re-entry.

The most common felt threat to sanity is the feeling/experience that one is going crazy, losing one's mind, or that this will never end. This feeling/experience is supported by changing mental states and powerful (sometimes) changes in perception. Major shifts in ego/personality structure, regarding one's belief and understanding of oneself, the world, and god, are common.

Old traumas can be remembered and relived. These memories can be of a physical nature (reliving one's birth, childhood abuse and/or illness, memories of famine and/or war, accidents, rape are some of the possibilities of re-emergence). These memories can also be of an intellectual, emotional nature (reliving verbal abuse, a lack of basic emotions, body contact, love, nurture, or a disassociation due to a traumatic experience).

These traumas can also be of a transpersonal nature, meaning phenomena that go beyond our personal identity or biographical understanding of the universe. These could be experiences from another life, becoming one with the earth or other life forms, or experiencing the life cycle of an animal. One could leave one's body, have the experience of merging with an archetype, or experience the world of a god or a goddess. The memory of a violent death can be a most traumatic experience.

There can be many different, sometimes never experienced, sensory, energy, and body sensations. These can range from hearing colors to seeing music. It could be an extremely heightened sense of smell, taste, hearing and vision. Some of the most frightening manifestations of the psychedelic experience are energetic. People go through powerful releases, rendering their bodies out of control, shaking, twisting and vibrating. These energies, being activated by the psychedelic substances, could be related to birth, an opening of a frozen body pattern, bioenergetic, neo-Reichian type of release, or be a reconnecting with the universal life force. The life-force is called the kundalini and it manifests in a powerful opening of the body's energy center. It could also be an intensive sexual or other emotional release.

The body sensations also cover a wide range of sensations and feelings. This can be the feeling (for the first time in one's life) of coming home into the body.

Here's a small list of other possible experiences:

- Relieving birth
- Remembering different deaths
- Relieving accidents
- Reliving illness
- Reliving drowning, torture, and many other physical experiences from this and other lives
- Reliving mystical states
- Identifying with and reliving in detail the victimization of humans throughout history.
- Leaving the body and traveling in the spirit realm
- Merging with rocks, animals, plants and experiencing the pollution and death of the planet and different species
- Merging with people, reading their minds, feeling their emotions
- Being caught in a certain experience
- Having a UFO experience
- Being overwhelmed by feelings and emotions

In a psychedelic experience and crisis the person may react to the healer/sitter and project her/his own feelings and experiences onto the healer/sitter. This could be a sexual, demonic, godlike or fearful transference. When this takes place it is important just to be with, not to defend the transference.

3. Working and Being with Psychedelic Emergencies

The experience of the person's crisis is, many times, one of letting go on all levels of one's being. So we have to create a space where it is possible to be open, a space that's quiet, warm, safe, and beautiful. This space is as important as the sitting/facilitating itself. If possible, have flowers, candles, art and writing supplies, blankets, quiet music and soft light.

Pay attention to the body language while you listen to what's being expressed verbally and emotionally. Follow the expression of the person. If they have a lot of energy, let the energy move, let it express itself (we provide a safe space) in whatever form: uncontrolled shaking, yoga postures, dancing, ritualistic type of movements, hyperventilation, kundalini type release.

If the person wants to speak, if sounds come out uncontrolled, support the expression. This might be: a different or dead language, prayers from the different spiritual traditions, far-out stories and memories, jibberish, animal sounds, looping sentences (repeating over and over the same words), lamenting, cries, or screams.

Respond when needed, do not take over, try to (if appropriate) engage in a calm conversation, responding to fear and anxiety.

The most appropriate response to a powerful psychedelic crisis might be to just sit quietly with the person, making them feel safe.

If the person is stuck there are several different ways to respond:

- Wait and calm them down through talk, knowing the duration of the substance taken
- Walk with them, talking or not, until they calm down
- Have them express the experience through sound
- Have them move through it, through a physical expression, holding a certain posture or letting the body go
- One could do some deep, focused bodywork, just hold someone (meeting their needs) or gently massage them. Always ask for permission regarding any kind of physical contact.
- Have appropriate sitter regarding male/female, important when recall of sexual abuse takes place.
- The person could recline, eyes closed or blindfolded, being in a safe place, listening to comforting music and grounding the experience.
- If their emotions are overwhelming them, encourage their expression.

- When the person is calm enough or has come back from their difficult psychedelic experience, have art supplies and writing material available.

Reassure them:

1. This will pass, this is a process.
2. This is an experience other people have had.

There will be support afterwards.

4. Aftercare

There are many ways to integrate the experience and to continue working with the opening that took place. It is important to complete any unfinished gestalt. Further reading should be encouraged, and the person should work with a trained practitioner to complete the experience. This could be:

- Transpersonally-oriented psychotherapy
- Holotropic Breathwork
- Shamanic Integration work
- Different forms of bodywork
- Different forms of energy release work
- Work with archetypes
- Different art forms, making music, dancing, painting, sculpting
- Meditation and other spiritual practices (following the images or insights of the experience)

There are certain medical conditions that should be treated by the medical management. There can be medical pre-existing conditions that are adverse to the taking of psychedelics. Some of the most common are: pregnancy, mental illness, cardiovascular problems like abnormal blood pressure or other heart problems, recent surgeries and/or accidents, and epilepsy.

5. Related Readings

This is a very short list of some of the in-depth work regarding the psychedelic experience and crisis:

1. *Psychedelic Reflections*, Ed. Lester Grinspoon & James B. Bakalar
2. *The Adventure of Self-Discovery*, Stanislav Grof
3. *LSD Psychotherapy*,Stanislav Grof
4. *Spiritual Emergency*, Stanislav and Christina Grof
5. *Green Psychology*, Ralph Metzner
6. *The Unfolding Self*, Ralph Metzner
7. *The Healing Journey*, Claudio Naranjo
8. *The Cosmic Serpent*, Jeremy Narby
9. *The Secret Chief*, Myron Stolaroff
10. *The Ethics of Caring*, Kylea Taylor
11. *Shamanism*, Roger Walsh

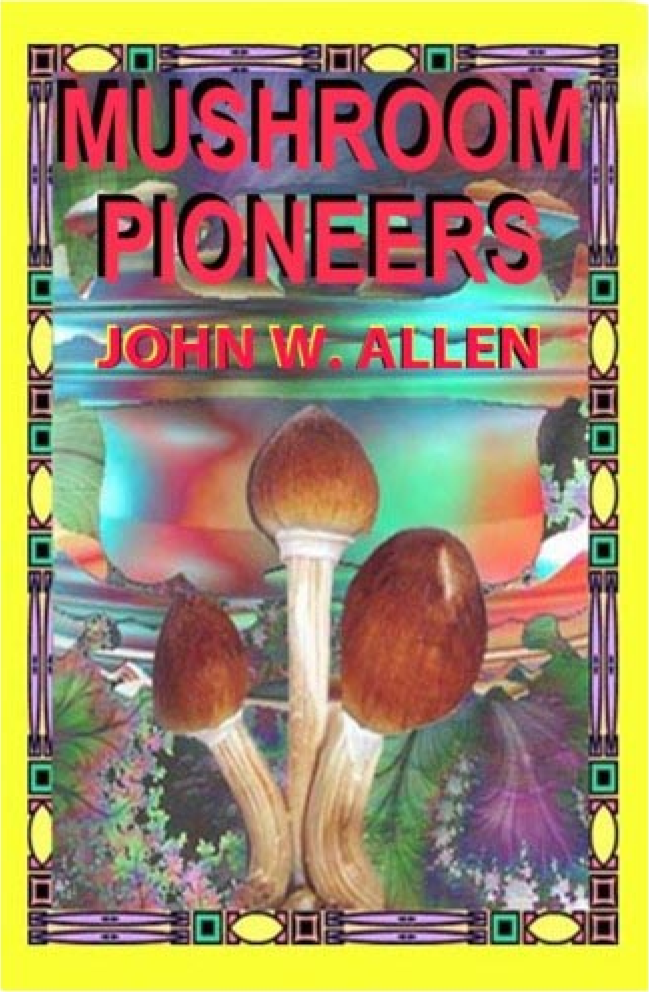
Mushroom Pioneers

by

John W. Allen

© 2002 by John W. Allen

original source: https://www.erowid.org/library/books_online/mushroom_pioneers/mushroom_pioneers2.shtml



Books by John W. Allen

Magic Mushrooms of the Pacific Northwest
Magic Mushrooms of the Hawaiian Islands
Teonanácatl: Ancient and Contemporary Shamanic Mushroom Names of Mesoamerica and Other Regions of the World
Magic Mushrooms in Some Third World Countries,co-authored by Jochen Gartz, Ph.D.

CD-ROMS *Teonanácatl: A Bibliography of Entheogenic Mushrooms*,
co-authored by Jochen Gartz, Ph.D.
Psilocybian Mushroom Cultivation,
co-Authored by Jochen Gartz, Ph.D.

Special Thanks Jonathan Ott, Larry Zoumas and Ken Thompkins

Ethnomycological Journals
Sacred Mushrooms Studies
Volume V11

Copyright@ 2002 by John W. Allen
Book Cover Design by John W. Allen
http://mushroomjohn.com
Mushroom Pioneers at MushroomJohn.com

Printed in the United States

Table of Contents:

Information about Online Edition
Dedication

Endorsement Blurbs for Mushroom Pioneers
Foreword
Introduction
The Spanish, The Aztecs and the Sacred Fungi

Chapter 1. Modern Field Research on Teonanácatl 1915-1940
Chapter 2. Richard Evans Schultes
Chapter 3. Rolf Singer and the Misidentification of Teonanácatl
Chapter 4. The Rediscovery of Entheogenic Mushrooms
Wasson's First Voyage
Wasson Meets María Sabina
CIA Mole James Moore - Spies on Wasson in the Search for Mind-Control Drugs
Chapter 5. María Sabina
Saint Mother of the Sacred Mushrooms
Childhood
The Coming of the Foreigners
May the Force be With You
Notes
Chapter 6. Albert Hofmann and the Synthesis of Psilocybine and Psilocine
Chapter 7. Mushrooms and Timothy Francis Leary
Leary's First Voyage
The Harvard Psilocybin Project and Marsh Chapel
Chapter 8. Biographies of Other Mushroom Pioneers

A Gallery of Photographs
Other Contributors in the Fields of Chemistry, Pharmacology, Psychiatric Medicine Field Identification and Cultivation
Acknowledgements
Interviews with R. Gordon Wasson
Letters in Response to R. Gordon Wasson's May 13, 1957 Life Magazine Article
Further Suggested Reading
Internet Links to Mushroom-Related Websites
References
A Bibliography of R. Gordon Wasson (With Some Annotations)

Information about Online Edition

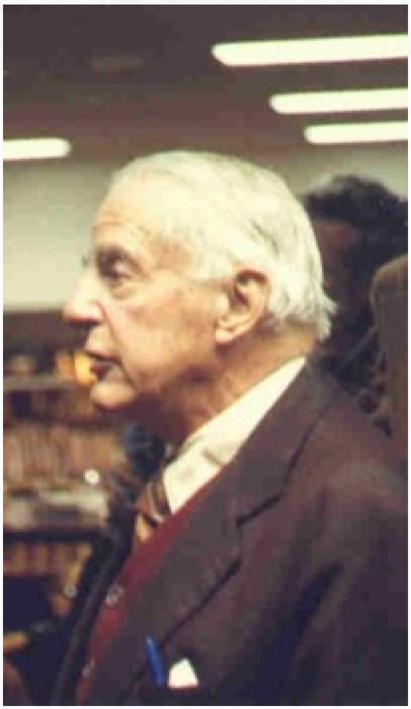
This online publication of John W. Allen's book *Mushroom Pioneers* was HTMLed by Erowid and John Allen. Very small edits have been made to the text of the book, but largely the text remains as it was published as a CDROM by John Allen in 2002. The images have been edited for online viewing. Allen expanded the book "Mushroom Pioneers" after its first print publication in 2000. The current version of the book incorporates two other booklets published by John Allen in 1999 and 2000 about R. Gordon Wasson and Maria Sabina, respectively.

The HTML and editing by Erowid was conducted in November and December 2006 with permission of and in collaboration with John Allen. Typos and corrections will be corrected in the document and are invited from visitors. Errors and inaccuracies in the data in the text will need to be reviewed by the author before changes can be made to the document. Please submit any problems with this document to corrections@erowid.org.

Version History#

- 2006 Dec : Edited and published online by Erowid.org
- 2002 : First digital publication of "Mushroom Pioneers", incorporating the Wasson and Sabina pamphlets, published as a CDROM.
- 2000 Spring : First print publication "Mushroom Pioneers" : ISBN 158214-099-5
- 2000 Spring : First print publication "Wasson's First Voyage: The Rediscovery of Entheogenic Mushrooms". ISBN 158214-027
- 1999 : First print publication of "Maria Sabina: Saint Mother of the Sacred Mushrooms". ISBN 0-9631518-9-4

Dedication



In Memory of R. Gordon Wasson

Forward by David Tatelman
Edited by Jonathan Ott, Jodi Reynolds and Rodman Reynolds

Endorsement Blurbs for Mushroom Pioneers

1.) "Use of psilocybian mushrooms constituted the fourth great wave of entheogenic awareness and distribution (after iffy plants like the Daturas, along with marijuana; the wave created by peyote and mescaline; and then that resulting exfoliation of LSD throughout a significant population in the 1960's and beyond).

"These wondrous mushrooms are notable in that they, a) are easily identifiable, b) spring up quite naturally across many segments of both the Old and New Worlds, and c) are gentle in action (in contrast to the 'coercive' nature of other major psychedelics, which tend to emphasize 'ego-death,' for instance).

"Here John W. Allen describes the rather long and strangely convoluted incursion of mind-altering mushrooms via historical vignettes, by snapshots of the principle players, and by the most extensive annotated bibliography of relevant papers and books ... that brings this entire field of knowledge into the 21st century.

"J. W., mycologist extraordinaire, I salute you!"

- Peter Stafford, author of *The Psychedelic Encyclopedia*, *Psychedelic Baby Reaches Puberty* and *Magic Grams*.

2.) "Mushroom Pioneers is a fascinating account of several individuals who were pivotal in the investigation of psychotropic mushrooms and the introduction of these phenomena into Western medicine and science. John W. Allen has documented an important historical development in this book, and provides his readers with a litany of men and women who rescued an ancient tradition from obscurity."

- Stanley Krippner, Ph.D., Professor of Psychology, Saybrook Graduate School; co-editor *Varieties of Anomalous Experience*.

3.) "John W. Allen, the mushroom man, is our celestial tour guide in a school without walls. Rogue scholar, adventurer and gentleman forager, his works surrounding psychedelic mushrooms are 'must reads'. Allen's books are essential and always a treat."

- Thomas Lyttle, editor "*Psychedelic Monographs and Essays*," and "*Psychedelics Reimagined*."

Ban Hua Thanon Shrooms from Thailand
Photograph by John W. Allen

Foreword

by David Tatelman

It is truly an honor to write the foreword to John Allen's book Mushroom Pioneers.

I first met John Allen when he published Magic Mushrooms of the Pacific Northwest in 1976. I was utterly surprised when his book, written by hand, then published and printed by him on an AB Dick Offset Press, did as well as my own slick new book, Magikal Mushroom Handbook. Readers will appreciate his authentic knowledge of the local mushroom scene, not to mention how he personally sold copies, sometimes by leading hunts to his own private spots.

People in the field of mushrooms are very jealous of their turf. Professional mycologists feel superior to amateur mycologists. Those who make little or no money look with disdain at those who have been successful at selling books or products about mushrooms. John Allen has managed to make friends with just about everybody, the icons, the professors, and the amateurs, by proving that he truly loves mushrooms and knows where to find them perhaps better than anybody. Mycologists and authors alike have ended up working with John and acknowledging his authority in the field.

He has found mushrooms directly across from my office, and in places as far away as Thailand, India, Cambodia, Malaysia and Australia. If there is a mushroom to be found, John Allen can find it. He even has discovered a new species which now bares his name, which is more than I can say.

John has been an invaluable historian for the entire mushroom movement. He has self-published a whole library of books about the mushroom world, documenting our humble history.

It is only fitting that John would be the one to write a book about the history of those involved in the movement. I know he doesn't always appreciate being called that, but to me he will always be Mushroom John!

And I mean that as a mark of respect for all he has done for the field of mycology.

David Tatelman
Homestead Book Company
March 2000
www.homesteadbook.com

Welcome to the Wonderful World of the Sacred Fungi

Introduction

I first became interested in hallucinogenic mushrooms during the early fall of 1972. At that time, the literature on the subject was scant and mostly unavailable to the general public. Those who were aware of the sacred mushrooms did not share their knowledge and even that knowledge was confined to those mushroom species which grew in Mexico and the southeastern gulf states. Only a few knew of their existence outside of Mesoamerica. There was a driving force within me. I could hear the mushrooms calling out my name, and in my own way I called out to them. I needed something new in my life so eventually, out of desperation, I went to the University of Washington's library and inquired about these fungi.

Image 2. King Sphinx
Design by John W. Allen

Reference clerks at the Suzallo library were ignorant of the matter. Simply put, they did not know anything whatsoever about the sacred fungi of Mexico. What was I to do? I next met with Dr. Daniel Stuntz, head of the University of Washington's mycology department. Dr. Stuntz steered me in the right direction by referring me to an article by R. Gordon Wasson which had appeared in the 13 May 1957 issue of Life magazine. This article described Dr. Wasson's research and rediscovery of how the Mazatec Indians in Oaxaca, México, used certain mushrooms in shamanic ceremonies. He also gave me references to Rolf Singer and Alexander H. Smith's pair of articles in Mycologia vol. 50, which told of the traditional Mesoamérican use of the sacred mushrooms and also provided a key to several species of entheogenic mushrooms which were common in the Pacific Northwestern United States. These articles in turn led me to a pioneering ethnobotanical paper written by Richard Evans Schultes in the late 1930s.

This piqued my interest inordinately, hence I proceeded to look up several of these rare articles. However, when I began my research I found that several of the articles to which I had been referred by the late Dr. Stuntz were either missing from the bound library copies of the journals or had at least had the photographs of the mushrooms excised. Even the 1957 Life magazine article by R. Gordon Wasson was missing pictures from the copy which I found on the shelves at the University of Washington's library. Eventually I was able to purchase a copy from a used bookstore, which led me in time to find other publications about the mushrooms. Thus began my quest and life-long-study of the sacred fungi.

In the fall of 1977, I was most fortunate to attend the 2nd International Conference on Hallucinogenic Mushrooms at Ft. Worden near Port Townsend, Washington. It was at this conference that began my symbiotic relationship with these mushrooms. This new field of endeavor opened up many new avenues of research into subjects in which I had henceforth not shown the slightest interest.

As my knowledge began to grow, my studies came to encompass various and sundry fields spaced shelves apart or interspersed at intervals between shelves, in separate buildings, and even in numerous libraries. I digested every thing I could read related to the various fields tangential to the study of sacred fungi.

This also was the beginning of my relationship with the many scholars who had brought to the world's attention the existence of the mushrooms. Eventually, I would come to call some of these intrepid psilophores my friends. Among this first wave I include: Richard Evans Schultes (the greatest ethnobotanist of this century), R. Gordon Wasson (the founder of ethnomycology), Albert Hofmann (the discoverer of LSD), Andrew Weil (who first reported on the ludible use of psychoactive mushrooms), mycologists Gastón Guzmán (the Mexican authority on the taxonomy of these hallucinogenic mushrooms), Rolf Singer, Alexander H. Smith, Roy Watling, and others. This first wave might include the late Timothy Leary, György Miklos-Ola'h, and the late French mycologist Roger Heim.

The second wave consisted of a younger generation which emerged from the psychedelic sixties and included ethnopharmacognost Jonathan Ott, mushroom-cultivator Paul Stamets, mycophiles such as Gary Lincoff, Steven H. Pollock, Gary Menser, Bob Harris, Peter Stafford and publisher David Tatelman of Homestead Book Company (distributor of mushroom books and growing kits).

The third wave consists of the same generation who somewhat later embarked on this path, and includes such prominent researches as Jochen Gartz, Giorgio Samorini, Antonio Bianchi, Francesco Festi, Tjakko Stijve, Mark D. Merlin, Christian Rätsch, Roger Liggenstorfer, Dennis and Terence McKenna, Arno Adelaars, Karl L. R. Jansen, Hans van den Hurk, and others too numerous to mention (the many chemists, psychologists, shamanic healers, philosophers and poets). Last but not least, in the fullness of time, I now include myself in this third wave.

The Spanish, The Aztecs and the Sacred Fungi

Psychoactive fungi of the genera Psilocybe and possibly Panaeolus have been traditionally used for over 3000 years. The use of these interesting fungi in magico-religious ceremonies as divinatory sacraments among several tribes belonging to the Nahua speaking Indians of Mesoamerica is well documented (Wasson & Wasson, 1957 [186]; Schultes, 1939 [103], 1940 [104]).

These Nahua-speakers were the ancestors of the once mighty Olmecs, Toltecs, and Aztecs. Additionally, the Mayan cultures of Central America may also have employed the mushroom entheogens ceremoniously. The indigenous native inhabitants of Mesoamerica currently employ several entheogenic mushrooms for the purpose of healing and curing through divination via magico-religious veladas.

Jim Jacobs, a renowned investigator of the sacred Mexican "magic mushrooms" claims that "their use in a magico-religious ceremony is correct, but that their use is much broader" then one could possibly imagine.

We would know little or nothing of these indigenous peoples' use of the mushrooms, were it not for Doña María Sabina, a Mazatec curandera who shared her secrets with R. Gordon Wasson and photographer Alan Richardson and made it possible for all of us to experience her ecstatic and sacred knowledge. What led to these discoveries will now be presented below.

Many of the early Spanish chroniclers (which included naturalists, botanists and members of the clergy) sailed from far across the Atlantic. They may or may not have been the first to explore this brave new world of ours, but they are the first to have recorded the history of their discoveries. They traveled here under the fear of God, leaving behind them the terrors of the dark middle ages, and leaving behind them a world they were just learning to crawl out from under.

More than 500 years have passed since España triumphed over 700 years of Moorish rule. In 1469, 17-year-old Ferdinand V, ruler of the kingdom of Aragon met and married 18 year-old Isabella I, queen of Castile and Leon. This was an important step in making España a single kingdom. They had fought the Moors, the Mohammedan invaders who had ruled much of España for seven hundred years. In 1492, after more than twenty years of fighting, Ferdinand and Isabella conquered the city of Granada, the last Moorish stronghold in what is now Spain (Nat. Geo. Mag.)[81]. It was also, at this point in their history, that Spain began to expel most Jews from their country, forcing several hundred thousand Jews to migrate to other countries, except for those who converted to Christianity.

Goddess of Shrooms

Image 3: The Goddess of Shrooms
Designed by John W. Allen

After the war with the Moors was over, Ferdinand and Isabella gave court to a navigator, who was also a map-maker as well, a man who claimed to know the "secrets of the winds." This man was Christopher Columbus, who had dreamed of sailing west for more than twenty years. At first, Columbus tried to get help from the King of Portugal, but failed. Then in 1485 he turned to King Ferdinand and Queen Isabella, who at that time were fighting to drive out the Moors from their country, so Columbus had to wait.

Finally his orders arrived, given to him by Ferdinand and Isabella: the royal degree directing him for his first voyage. These documents claimed that Columbus would be sailing to "certain islands in the sea" which he knew existed. Interestingly, Columbus had once sailed to Scandinavia and may have even heard stories about the travels of Leif Ericsson, thus presenting him with an incentive for finding shorter sailing routes to the Indies.

After the war between the Moors and Spain was over, it appeared that it was very important for the merchants of Spain to find a new route to India and Asia (Nat. Geo. Mag.)[81].

After their defeat in Grenada, the Mohammedan Arabs had shut off all of the eastward land routes to Asia. Portugal's explorers had not yet completed their passage around Africa, so new sailing routes were often discussed by the merchants yet no one was enthusiastic about attempting to find newer sailing routes to increase the trade of the country.

The purpose of Columbus' voyage and subsequent ventures across the Atlantic was to increase the resources of Spain with new avenues of commerce and trade. Eventually, they accidentally stumbled upon this brave new world, landing first at what is now San Salvador and later setting up the first colony in Haiti. Eventually Columbus explored most of the South American Coast, and Central America as far west as Panama.

In 1519, the Spanish conqueror Hernando Cortez landed with his men in Mexico and set up a new town, Vera Cruz, and then marched toward the capital city. Within two years Cortez had conquered the country (Nat. Geo. Mag.)[81]. Cortez also began the task of ordering his clergy to convert the Indians into Christians and stopped them from worshipping demonic idols and from performing their rituals which sacrificed human beings to the gods. While these human sacrifices must have seemed very cruel to the invading Europeans, it would be more reasonable to assume that Cortez turned out to be more cruel in his conquest of the native peoples and the way he conducted his conquest than what he was trying to destroy or change. Not only did Cortez destroy many of the Aztec temples but he also brutally put down all resistance. At the time of the conquest it was believed that there were more than 100,000 Aztecs who lived in the capital and over six million Indians living throughout Mexico.

Imagine the fear, which the native population held towards their conquerors. Here was an enemy who had greater powers than their mighty Gods. Weapons of mass destruction, more powerful than their spears and arrows. Muskets, rifles, cannons. Armored suits, mighty vessels which breached the sanctity of their waters.

Once the conquest had begun the invaders immediately began to build their churches, the base core of their spiritual imaginations. The many treasures they collected and cataloged were sent back to their homeland. They carried these precious cargoes to Spain in the name of God and King. Interestingly, many treasure vessels sank after their embarkation mainly because their precious vessels were too heavily laden with treasure. Ironically it was surely their greed which caused their ships to sink (remember that these were seasoned seamen. They were definitely good at their skills and they knew how to sail their ships). Furthermore the Spanish invaders were also seeking such treasures as the Coronado's "Seven Cities of Cibola" (the lost city of gold or "El Dorado" as it later became known), the "fountain of youth" and even aphrodisiacs to seduce young women.

During this period of conquest, they proceeded to rape the land of its many resources and strip away the native peoples of their culture, heritage and religion. Soon they thus began their indoctrination of their way of life into that of the native population. This was achieved largely through the fear of death; thus the conquerors began to civilize the heathens and converted many Aztecs to Christianity.

An interesting observation which has not before been under discussion is about one of the rewards given to all Indians who converted to Christianity. This meant that if any Indian was attacked, beaten on or in danger, it was the honored duty of the soldier or conquistador, all loyal to the King of Spain, to defend, with his life, any Indian who was of the same faith. We must not forget that the Moors were repelled and expelled from España; so that the Catholic church could exist. In fact, one of the titles of Ferdinand, King of España, was "Protector of the Faith" or "Keeper of the Faith," Thus the reason for the soldier to defend a Christian Indians life.

In contrast to this above noted observation, in the American colonies the English missionary breakaway Protestant laymen imposed their harsh religions doctrines and dogma on the native populations whom they encountered and were able to convert only small populations of the native inhabitants into their religions. However, English and European attitudes towards people of a different skin color were obvious (India is an example) and the Indians who became christianized were probably not even allowed to sit at the same table with their white brothers even though they were of the same faith.

Eventually, the conquerors had succeeded in their endeavor to devour the land they now lay claim to. Now the botanists and clergy began to initiate the long and somewhat tedious task of cataloging and recording on paper all that they had discovered in the new world.

During the initial conquest of Nueva España from the Caribbean throughout Central America to México, the use of inebriating intoxicants (including fungi) was a dominating factor in the culture and peoples of the Aztec empire. These sacraments were frowned upon by the Spanish invaders, who observed the Aztec priests and their followers being served the sacred fungi at festivals and coronations. It should be pointed out that the Spanish were very mycophobic and they were repulsed by the mere mention of any type of mushroom. They also deplored the pagan like rituals and the priests who employed mushrooms and other magical herb/drug plants as divinatory substances. They wrote in their histories that teonanácatl (Teunamacatlth), a term used by the Nahuatl speaking Aztec priests in describing the sacred mushrooms may have implied "God's Flesh or Flesh of the Gods." However, many historians wrote of the mushrooms in a negative view. For example: one author described the mushrooms as "Hongol demonico ydolo" (for more terms and names of the sacred mushrooms, see Allen, 1997c [5]). According to Wasson (1980 [174]), "teo" meant awesome or wondrous and "nanacatl" implied mushroom or even meat.

Teonanácatl or "magic mushroom" was one of the most important of the many narcotic drug/herb plants described in several codices written after the arrival of the Spanish in the 15th century. The mushrooms were often administered among the common people, merchants, visiting dignitaries; and even the wealthy were known to have consumed them.

Other plants were also employed in the treatment of different ailments, divination's and for healing or curing and were also used during different seasons. Additionally, several other minor plants were also employed when the more popular remedies were not available.

Many plants used in these magico religious ceremonies more than 400 years ago by the Aztecs and as much as 2000 years earlier by their ancestors the Olmecs and Toltecs, and quite possibly the Mayan people, are still in use today. These include peyote (mescaline), *ololiuhqui-tlitlitzin* (morning glory seeds = ergine alkaloids), *Salvia divinorum* ("Leaves of the Shepherdess" a member of the mint family), *Datura* (jimsom weed, also known as torna loca, toloache or tolatzin), mescal beans (cytisine), puffballs (*Lycoperdon mixtecorum*) or (*Lycoperdon marginatum*). The former is referred to as "*gi-i-wa*" and means "fungus of the first quality" and the latter implies "fungus of the second quality." It has been reported that they cause auditory hallucinations. Use of these alleged puffball inebrients occurs primarily among the Mixtec shamans.

Second only to peyote are the sacred mushrooms referred to by the Aztecs as *teonanácatl*. The majority of the sacred mushrooms of Mesoamerica belong to the genus *Psilocybe*, and a few quite possibly belong to the genera *Panaeolus* and *Conocybe*.

Although indigenous use of many psychotropic plants in Mesoamerica is not uncommon today, the ritualistic or ceremonial use of the sacred mushrooms and other drug/herb plants can be traced back to approximately 1000 BC.

The numerous descriptions recorded by the clergy and historians concerning the effects of these drug/herb plants and their uses among the Aztec people are molded in fear and plastered in bigotry and false heresy. The effects of the mushrooms on those who had experienced them were often reported in a negative vein, most probably by the botanists and historians who were eager to appease their masters back in Spain. The Spanish historians often described the effects of these plants on native peoples as leaving their users in uncontrollable fits, claiming that the native people would even commit violent acts towards themselves and each other. Many would fall into rages as if in a stupor. These descriptions could very well describe an alcoholic syndrome in contemporary society.

The Spanish persecuted, often murderously, those who did not adhere to the catholic ways. It was because of this persecution which caused the native population to hide the use of these mushrooms from their Spanish peers. Thus word of the sacred remained a secret to most of the west until R. Gordon Wasson found the Oaxacan Shamaness María Sabina and wrote of his rediscovery regarding the existence of these mushrooms which are still considered sacred by indigenous peoples living in Certain regions of Mesoamerica (Wasson, 1957 [140]; Wasson and Wasson, 1958 [187]; see also Allen, 1997a [3], 1997b [4]). The legend of that discovery is now retold here one more time so that all may learn the tale and tell it to others.

This volume of *Ethnomycological Journals Sacred Mushroom Studies* Volume VII presents an overview of R. Gordon Wasson's discoveries, four short biographies of the original pioneers who divulged the mysteries of the mushrooms, and their interrelationship with some of the many collaborators who forged new trails in these uncharted domains, presenting new insights into humankind's relationship with sacred mushrooms of the gods. Furthermore, there are many short biographies devoted to many of those brave psilophores who helped paved the way to the magical world of the wondrous mushrooms. Although the present study lists works devoted to psilocybian mushrooms, many of their authors are also prominent researchers and investigators of other kinds of visionary or psychoptic organisias. I have also included in this volume, revised versions of both volume I and II of my series *Ethnomycologial Journals Sacred Mushroom Studies*, *María Sabina: Saint Mother of the Sacred Mushrooms*, and *Wasson's First Voyage: the Rediscovery of Entheogenic Mushrooms*.

As noted in Volume IV of this series, the fear of persecution on the part of the Spanish conquistadores among those who used the sacred mushrooms and other entheogens for healing ceremonies became widespread throughout Mesoamérica. Naturally, the shamans who hid from the Spanish the special powers they derived from the sacred mushrooms concealed this use from public scrutiny, a situation which continues today in the form of (underground) psychedelic therapy in the United States and Europe.

Chapter 1. Modern Field Research on Teonanácatl 1915-1940

Today in México, only a handful of remote montane tribes still practice the customs and rituals of what once must have been a splendid and powerful system of worship and empirical magic. So utterly complete was the neglect and ignorance in our western world of the ethnobiological aspects of Aztec and other Mexican shamanism, that in 1915, William E. Safford, a reputable and distinguished USA botanist who was than a sort of expert on the subject of many Native American psychotropic plants, claimed that the visionary mushrooms as described in the Spanish histories did not in fact exist and that the Mesoamérican Indians had never used such, whether before, during, or after the conquest. Disdaining the graphic testimony of several Spanish chroniclers, Safford dismissed the well-documented evidence of the chroniclers, mostly clerics, who described as mushroomic, the effects the mushrooms allegedly had upon those who consumed them. There is no evidence any of the Spaniards deigned to sample the psychoptic mushrooms.

> **"[T]hree centuries have failed to reveal that an endemic fungus is being used as an intoxicant in Mexico. Nor is such a fungus mentioned either in works on mycology or pharmacology, yet the belief prevails even now that there is a narcotic Mexican fungus."**
>
> W.E. Safford, 1915 in "An Aztec Narcotic", erroneously stating that *teonanácatl* was actually peyote.

Safford (1915)[99] presented a botanical society the results of his study of an Aztec sacred inebriant referred to in a few historical sources as *teonanácatl* which means "wondrous mushroom." He claimed that the so-called wondrous mushrooms were in fact dried peyote buttons and that no mushrooms had been used as inebrients by the native peoples of Mesoamérica. Safford's colleagues displayed little interest when he claimed that the word teonanácatl simply meant peyote. In his paper, he reproduced a photograph of dried peyote buttons. These could easily have been mistaken for dried mushroom-caps, which is what they vaguely resembled to the untrained eye. Safford relied on the fact that "three centuries have failed to reveal that an endemic fungus is being used as an intoxicant in Mexico. Nor is such a fungus mentioned either in works on mycology or pharmacology, yet the belief prevails even now that there is a narcotic Mexican fungus."

According to Safford, the early Spanish descriptions of numerous medicinal plants from Mesoamérica led him to believe that the Aztec entheogen ololiuhqui was either the seed of *Datura* or of a morning-glory species, but he further denied that either plant provoked visionary effects (for a more detailed description of the properties of the sacred morning glory seeds, see Albert Hofmann's biography, "*LSD: My Problem Child*" [1980][38]).

As late as 1921, Safford still held firm to his theory by again denying the existence of the sacred mushrooms, claiming that they were simply dried peyote buttons. Safford (1923)[100] also noted: "Peyote has been called a habit-forming drug, and some writers have likened it to hashish, or Indian Hemp, the latter which had been introduced into the country of México and our southwest under the name of Marijuana, is a most dangerous drug. Introduced clandestinely into prisons, it has of course, been the cause of riots. Its use is now forbidden in México by the government."

It should be obvious to anyone who reads the above letter by Safford that he was a confirmed pharmacophilac and thanks to his prominence the mushrooms continued to be obscured from the world until the late 1930's when they were once again brought to the attention of the scientific community.

In the second decade of this century, Austrian Blas Pablo Reko(1919)[93], a physician with an interest in ethnobotany, learned that some groups of Indians living in the Mexican state of Oaxaca were still using psychoptic mushrooms in secret ceremonies perhaps involving ancient rites. These rites were performed apparently for the purpose of divinatory healing. Reko published his findings in a journal entitled *El México Antiguo*.

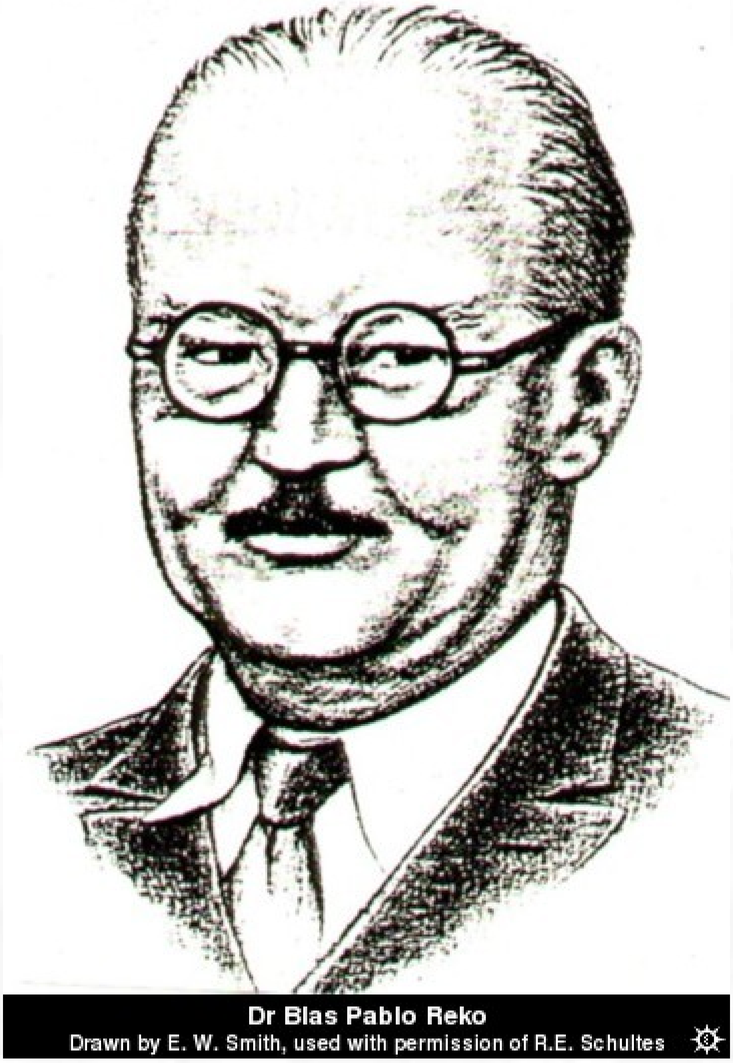

Dr Blas Pablo Reko
Drawn by E. W. Smith, used with permission of R.E. Schultes

Fig. 1. Dr. Blas Pablo Reko
Drawn by E.W. Smith

Reko subsequently discussed this discovery with his colleagues, who paid little attention to his mushroomic theories and showed no interest in pursuing this information on the supposititious use of inebriating mushrooms by the Indians of Mesoamérica. Reko wrote that *teonanácatl* was "Div. géneros de hongos, especialmente un hongo negro que crece sobre estiércol y produce efectos narcóticos." ["Various genera of mushrooms, especially a black mushroom that grows on dung and produces psychotropic effects"].

Reko (1923)[94] later wrote to Dr. J. N. Rose of the United States National Herbarium that "I see in your description of *Lophorphora* (peyote) that Dr. Safford believes this plant to be the '*teonanácatl*' of Sahagún which is surely wrong. It is actually as Sahagún states, a fungus which grows on dung heaps and which is still used under the same old name by the Indians of the Sierra Juarez in Oaxaca in their religious feasts." Safford's last defender, Huntington Cairns (1929)[9], became the last person to expound the Safford theory.

B. P. Reko's cousin, Victor A. Reko (1928)[95], published the first objection to Safford's claims. It appeared in a book written years later in 1936. Below is an excerpt describing the effects of the mushrooms taken from that book entitled *Magische Gifte: Rausche und Betäubungsmittel der Neuen Welt* ("*Magical Poisons: inebrients and Narcotics of the New World*"):

> "The *nanacates* are poisonous mushrooms which have nothing to do with peyote. It is known from olden times that their use induces intoxication, states of ecstasy and mental aberrations, but, notwithstanding the dangers attendant upon their use, people everywhere they grow take advantage of their intoxicating properties up to the present time."

In 1936, an Austrian engineer, Roberto J. Weitlaner, who was also an avid ethnobotanist, spent four days in Huautla de Jiménez, Oaxaca, where he was engaged in linguistic investigations. Weitlaner had learned of the existence of the sacred mushrooms from a Mazatec merchant named José Dorantes. Dorantes had described to Weitlaner his reactions after eating three of the mushrooms which were given to him during a divinatory healing (Johnson, 1940)[46]. It was Weitlaner who first realized that these sacred mushrooms were most likely the teonanácatl described in the chronicles of the Spanish clerics. During this period, several mushroom specimens were collected and forwarded to Blas Pablo Reko. Reko in turn sent the specimens to Harvard University for botanical identification. However, the specimens spoiled before they arrived, thus further delaying their identification and proof of their existence to the scientific community.

In 1936, Weitlaner became the first white man in modern times to observe an actual sacred mushroom ceremony. Two years later, in 1938, his daughter Irmgard, her fiancé Jean Basset Johnson and two friends (Louise Lacaud and Bernard Bevan) continued the investigations begun by Weitlaner. These intrepid investigators were not only able to gather a considerable amount of data on Mazatec shamanism and the use of the sacred mushrooms, but in the process became the first westerners to witness a Mesoamérica shamanic mushroom ceremony. The velada was held in a hut in the tiny montane village of Huautla de Jiménez. Johnson (1939a)[46] published two startling papers regarding his observations on Mazatec "witchcraft." Furthermore, while in Oaxaca, these investigators met Dr. Richard Evans Schultes and Dr. Blas Pablo Reko who were also in Huautla collecting ethnomycological data and mushroom specimens.

While Johnson referred to these ceremonies as examples of "witchcraft", it should be noted that ethnobotanist William Emboden (1979)[16] mentioned that certain modern-day "witches" use a species of Panaeolus mushroom as one of many inebrients in their rituals. Emboden said that the fungus used by a cult of contemporary witches living in Portugal was identified by Roger Heim as *Panaeolus papilionaceus* which may or may not be a synonym for *Panaeolus subbalteatus* or possibly *Copelandia cyanescens*.

Chapter 2. Richard Evans Schultes

The collecting of teonanácatl mushrooms took place when a young Harvard botanist, Richard Evans Schultes, made a trip to Huautla de Jiménez with Blas Pablo Reko (Schultes, Pers. Comm. 1989)[109] and collected several specimens of mushrooms which were suspected of being used in "magico-religious ceremonies." After sun-drying several specimens of these mushrooms, they mailed these samples to Harvard University for identification.

Mushrooms collected by Schultes (1939 [103], 1940 [104], 1978 [106]) and Schultes and Reko, were later identified as*Stropharia cubensis* Earle, *Psilocybe caerulescens* Heim and some specimens of *Psilocybe mexicana* Heim which were mixed and confused by the presence of another mushroom identified as *Panaeolus campanulatus* var. *sphinctrinus*. After these mushrooms were deposited in the herbarium at Harvard, confusion surrounded their botanical identification and their equivalence with the sacred mushroom of the Aztecs until the early 1950's (these discoveries will be discussed in Chapter Three).

Richard Evans Schultes is a most remarkable man. He is one of the pioneers involved in identification of New World shamanic plants, especially those from Mesoamérica and the Amazonia of Colombia in South America. His research into psychoptic plants is undoubtedly the most extensive ever undertaken by any botanical scientist.

RE Schultes, J Ott (Port Townsend, WA, 1977)
Used with permission of Gastón Guzmán

Richard Evans Schultes (1977)

Richard Evans Schultes, Jeffrey Professor of Biology and Director of the Botanical Museum of Harvard University (Emeritus), is a native Bostonian. Not merely a botanical explorer, he is a noted ethnobotanist and conservationist. Among his numerous awards are the Cross of Boyacá, Colombia's highest honor, and the annual Gold Medal of the World Wildlife Fund, presented by H.R.H. the Duke of Edinburgh; in 1987, he received the prestigious Tyler Prize for Environmental Achievement.

His crowning achievement however, was the receipt of botany's Nobel Prize - the Gold Medal of the Linnean Society at London in 1992. Schultes is also on the exclusive list of 50 "Foreign Members" of that in itself exclusive society.

His explorations and botanical identification of thousands of plants from Amazonia is as immense as it is eclectic. During his fourteen years in the Amazon, Schultes had collected more than 24,000 plants new to science of which over 80 are entheogenic (Davis, 1996)[12]. He has also written more than two dozen books and over 100 scientific articles on his discoveries. He is, moreover the only living ethnobotanist to have more than two million acres of land named in his honor; Sector Schultes, part of an Amazonian ecological preserve formally designated in 1986 by the Colombian government.

The field of ethnobotany was Schultes' framework throughout his life. His field work in Oaxaca, México in 1938 and 1939 was somewhat limited due to the Second World War. However, he made history by pioneering the study of shamanic mushrooms of the Mazatec Indians.

Richard Evans Schultes was born in Boston, Massachusetts on January 12, 1915. When he was about six years old, Schultes developed an illness which caused him severe stomach problems. During this period, his father and mother would read to him and one book which caught Schultes' attention was Richard Spruce's "Notes of a Botanist on the Amazon and Andes." This was young Schultes' introduction to the world of botany.

As a young child, Richard once read a floral guide given to him by an uncle and after studying it, would collect leaves to identify and press. It seems that this helped the young collector develop what some people refer to as "the taxonomic eye."

In 1936, Schultes was just another premedical undergraduate student at Harvard University and one of his classes was Biology 104. While attending a course on "Plants and Human Affairs", Schultes was assigned to read a book by Heinrich Klüver[48] entitled "*Mescal: The Divine Plant and its Psychological Effects*." Unbeknownst to Schultes, this assignment was destined to change the course of his entire life.

Previously unaware of peyote, Schultes soon began to develop a burning desire to experience mescaline firsthand. Schultes met with his professor, Oake Ames, and soon found himself with funding (most of which came directly from the pocket of his mentor Ames). Eventually Schultes met Weston LaBarre, a young student from Duke University in North Carolina who also shared an interest in peyote (LaBarre went on to become an anthropology professor and the author of *The Peyote Cult*, the definitive book on the peyote religion and *The Ghost Dance: The Origins of Religion*).

Together, Schultes and LaBarre traveled to Oklahoma where both participated in a Native American Church peyote-ceremony with the Kiowa Indians. There Schultes consumed the sacred cactus on which he then wrote his senior honors thesis.

Schultes soon decided that economic botany was the study he would pursue, so he completed his graduate work on the medicinal plants of Oaxaca, México. Schultes interest in Oaxacan plants came from having read some of the selected writings of the 16th and 17th century Spanish friars and historians who mentioned the existence of innumerable medicinal plants, some of a psychoactive nature, including the morning-glory seeds known as *ololiuhqui*.

Not only did Schultes help rediscover the modern use of the ololiuhqui seeds among the Mazatec Indians, but along with Blas Pablo Reko also collected specimens of the putative sacred mushrooms known as *teonanácatl* - of which Safford had only just denied the existence (Schultes, Pers. Comm. 1989)[109].

As noted previously, the first mushrooms collected by Schultes and Reko fit the botanical description of *Panaeolus campanulatus* var. *sphinctrinus*. In his 1939 and 1940 papers on the identification of the visionary Nahua mushroom, Schultes alleged that the mushrooms mentioned by the Spanish chroniclers probably belonged to the genus Panaeolus. It was important for these scientists to collect and identify the species they believed were the Aztec *teonanácatl*, yet they couldn't find anyone to perform for them a shamanic mushroom ceremony such as they suspected continued being held in secret. According to Schultes (1969)[105], "so few mushrooms were gathered, because of the unusually dry season, that it was not possible for me to ingest them experimentally; all were needed as voucher herbarium specimens."

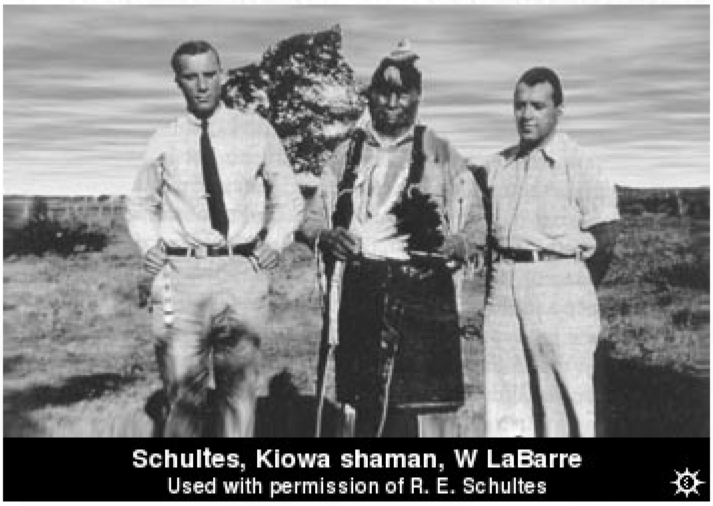

Schultes, Kiowa shaman, W LaBarre
Used with permission of R. E. Schultes

Fig. 2. Richard Evans Schultes, a Kiowa shaman, and Weston LaBarre

Another mushroom Schultes collected among the Sierra Mazateca was known by the Mazatec Indians as kee-sho. This mushroom at the time was incorrectly identified by Rolf Singer as*Stropharia cubensis* Earle. Schultes later collected specimens of *Stropharia cubensis* from dung after heavy rainfalls.

It was later determined that Schultes' identification of the mushroom known as kee-sho actually fit the taxonomic description of *Psilocybe caerulescens* var. *mazatecorum* Heim, a mushroom employed by Mazatec shamans in religious healing ceremonies. However, Schultes did collect *Stropharia cubensis* in Oaxaca in the late 1930's, but could not find any reference to its use prior to the conquest. It is not known if this species occurred in the new world until after the Spanish brought cattle onto the continent, most probably from India, the Philippines or possibly from Africa - although this species does occur in the manure of other ruminants. It is also probable that *Stropharia cubensis* was not one of the mushrooms being used by Aztec shamans and referred to as *teonanácatl*. Singer later amended this species to *Psilocybe cubensis* (Earle) Singer. Schultes (1978)[106] later wrote: "subsequent studies by R. Gordon Wasson, R. Singer, R. Heim and Gastón Guzmán, have indicated that *Stropharia* (*Psilocybe*) *cubensis* Earle is one of the more important sacred Mexican mushrooms" in use today.

In Palenque, México, it is referred to as San Isidro Labrador (St. Isidore the Plowman), so aptly named for a patron saint of agriculture of old México. Even though it is common in most regions throughout Southern México and Central America, there are many shamans who consider it inferior to other varieties and many do not use it professionally except when other species are not available. One possible reason it may be avoided is that it grows in manure; more likely this is simply because it is not pre-Colombian and associated with the offal of the conquistadores cattle.

Schultes then presented to the scientific community numerous references to the use of inebriating mushrooms by Mesoamérican shamans and others. Schultes reported in his 1939 and 1940 papers that several codices not only had described the existence of the sacred mushrooms, but had also vividly described observed effects on people who had consumed the mushrooms, thereby verifying their (the mushrooms) existence and use. Thus Schultes paved the way, so to speak, for the Wassons and others eventually to follow his footsteps, when he published these findings (Schultes, 1939 [103], 1940 [104], see also, Schultes, 1987 [107]).

Schultes' research and oftentimes tedious hard work into the realm of the shamanic mushrooms soon drew to a close as other events directed him to the heart of the vast Amazonian forest to study dart poisons and rubber. As the war years dragged on, the sacred mushrooms of México once again fell back into the shadows of oblivion. Nevertheless, Schultes' doctoral thesis on the medicinal plants of Oaxaca and his two published papers on teonanácatl (Schultes, 1939 [103], 1940 [104]), eventually found their way into the hands of an interested reader, R. Gordon Wasson, a fifty-four-year old Banker with Morgan Guaranty Trust. Wasson, along with his wife Valentina Pavlovna Wasson was able to accomplish that which Schultes had been unable to ingest the shamanic mushrooms of the Mazatecs (see Allen, 1987 [2], 1997a [3]).

Chapter 3. Rolf Singer and the Misidentification of Teonanácatl

Both Schultes' and Schultes & Reko's original 1938 collections of Oaxacan fungi were forwarded from México to the Farlow Herbarium at Harvard University. They represented probably three different species (*Panaeolus campanulatus* var. *sphinctrinus*, *Psilocybe cubensis* identified by Singer and *Psilocybe caerulescens* by recorded name). These collections were accidentally placed on a single herbarium sheet and were later separated in 1941 by mycologist Rolf Singer. In 1958, mycologists Rolf Singer and Alexander H. Smith conducted follow-up research on the previous studies by Schultes and Reko, Wasson and Heim. Singer (1958)[116], used Heim's papers and illustrations from Wasson's Life article as a guide list and) described the labels for both collections of Schultes and Reko's fungi collections but was confused by Schultes' written description of a species that Singer believed was *Panaeolus sphinctrinus*. Interestingly enough, Schultes' macroscopic description of this species actually fit the description of *Psilocybe mexicana* Heim. The first label on this herbarium sheet read as follows:

> "Springy meadows in rainy season. Huautla, July 27, 1938. Stem: 1-2 mm. diam: 10 cm. high; hemispherical but often cuspidate; gills dark brown-black, whole plant coffee brown, black when dry. Mexican name is she-to; tso-ska. Said to be poisonous in overdose of 50-60 mushrooms, but in moderate quantity it produces hilarity and general narcotic feeling of well being for an hour. Excess doses said to produce permanent insanity."

RE Schultes in his office
Unknown photographer, used with permission of R. E. Schultes

Fig. 3. Schultes in his office Harvard, late 1980's.

It appears that Schultes may have collected two different species of mushrooms in the springy meadows. One variety being *Panaeolus campanulatus* var. *sphinctrinus*and the other being *Psilocybe mexicana*. Singer

(1958)[116] had noted that "Springy meadows was the known habitat for *Psilocybe mexicana* and cuspidate is a characteristic feature of the genus *Psilocybe*, as are the brown gills which were mentioned and the coffee brown color of the mushroom." However, the black gills reported by Schultes would definitely fit the description of a *Panaeolus* species. Schultes had not reported that his collection occurred in manure or from the ground. If they were coprophilous Schultes would have mentioned it. Furthermore, she-to and to-ska are epithets used by the Mazatec and Chinantec to describe *Psilocybe mexicana* (see Allen, 1997b)[4]. The author also found the epithets to-shka and shi-to being used to identify a species of *Panaeolus*.

The second collection deposited by Schultes and Reko had originally been misidentified by Singer as *Stropharia* (*Psilocybe*) *caerulescens*. The paper on this second sheet read as follows:

> "Plantae Utiles Mexicana, Oaxaca. Common Name (Mexican) nanacate. Tribe: Mazatec. Indian name: kee-sho. Habitat freshets during the rainy season. Locality: Huautla. Uses: from four to eight are eaten to produce a temporary narcotic state of hilarity. Said to be poisonous if taken in excess, causing permanent insanity" (Singer & Smith, 1958)[116].

Singer mistakenly noted these mushrooms to be *Stropharia caerulescens* [syn.=*Psilocybe cubensis* (Earle) Singer]. Later Singer realized that he had misidentified this species when he learned that the word kee-sho referred to the Mazatec Indian landslide mushroom later identified as *Psilocybe caerulescens* var. *mazatecorum*. Ott (1993)[85], in a personal communication to the author, believed these mushrooms to be *Psilocybe caerulescens* Murr., a mushroom known to occur in sugar cane mulch and at roadside landslides, yet the habitat for this collection was listed as freshets, which as one may surmise, are the dung of cattle. Thus it appears that this second collection was probably *Psilocybe cubensis* (Earle) Singer. Interestingly, in 1923, *Psilocybe caerulescens* Murr. was originally discovered and identified in Huntsville, Alabama, yet it has never been reported from Alabama since. However, this species has since been reported from Florida (Jacobs, 1975)[44].

Singer (1958)[116] noted that Santesson (1939)[102], was probably the first author to publish data on both pharmacological research and chemical analyses of fungi believed to be the cause of what is known as cerebral mycetismus or psychotropic mushroom poison.

Santesson conducted laboratory experiments with extracts of various mushrooms using animal subjects in his investigations. However, it should be noted that it was actually Dr. Michael Levine who in 1917 attempted to investigate the suspected effects of *Panaeolus venenosus* (=syn. *Panaeolus subbalteatus*), a fungus known to cause cerebral mycetismus in humans, yet Dr. Levine did not attempt to isolate the suspected ingredients of the mushrooms during his course of research.

One of the mushrooms allegedly used in Santesson's experiments was *Armellariella mellea* (the honey mushroom). Singer wrote that he was in doubt as to Santesson's identification and asserted that the mushroom in question may have been either *Psilocybe mexicana* or *Psilocybe cubensis*, or possibly a mixture of both.

It should be mentioned that the above noted observation on Santesson's alleged identification of the "honey-mushroom" is based on the writings of Schultes who mentioned that Santesson had used the word Hallimahl, which Schultes identified as Hallimasch, a European name for the "honey-mushroom." Ott (1993b)[85] states that Schultes was in error in his identification of this species (see Ott, 1993a [85]: footnote 6, page 298). Recently **Guzmán-**Dávalos and Guzmán (1991)[30] identified *Gymnopilus subpurpuratus* from Mexico as "staining green when handled." A related variety is *Gymnopilus purpuratus* Cooke & Masse, a species which has been identified as psilocybian. Both of these species macroscopically resemble the honey mushroom, so there is a possibility that Santesson may in fact have had a real hallucinogenic specimen after all.

Schultes' notes on specimens stored on a single sheet in the herbarium confused Singer (1958)[116]. As noted earlier, Schultes had identified one of his collections as *Panaeolus campanulatus* var.*sphinctrinus*, a possible divinatory mushroom. However, Singer then wrote that "the genus of *Panaeolus* was not used by the Mazatec Indians of the Huautla region either for magico-religious ceremonies or as a sacrament in shamanic healings." Additionally, Singer and Smith (1958)[118] wrote, "we must insist, that the phenomena which belonged in the class of cerebral mycetism in the terminology of Ford (1923)[19], and not fully identified (*Panaeolus campanulatus* var. *sphinctrinus*) (Schultes, 1939 [103], 1940 [104]), as being comparable with the hallucinatory-euphoric and lasting effects which have been described in literature as belonging to and coming from certain mushrooms of the genus *Psilocybe*. Aside from that we feel for certain that *Panaeolus campanulatus* var. *sphinctrinus* is not now and never has been used as a drug catalyst for divinatory purposes or religious ceremonies by present day Indians in Mesoamerica", nor was it used as a sacrament by their pre-Colombian ancestors.

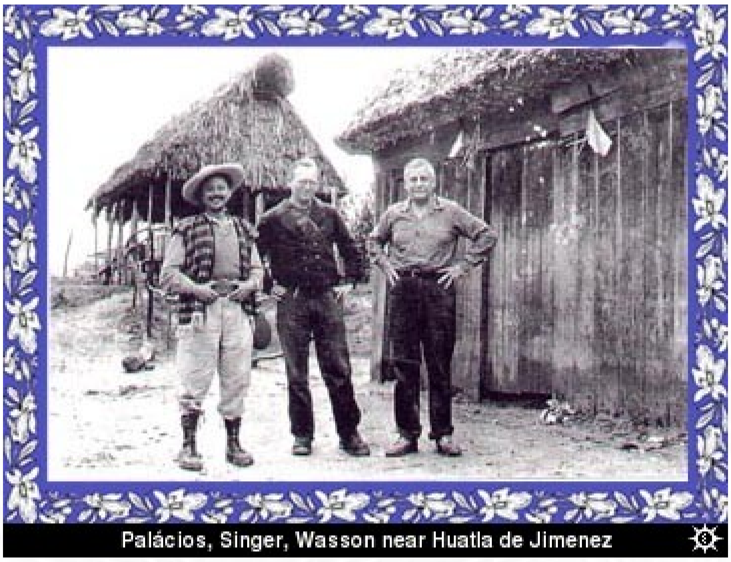

Palácios, Singer, Wasson near Huatla de Jimenez

Fig. 4. Rolf Singer's assistant Palácios, Singer & Gordon Near Huautla (July 1957).

Schultes (1978)[106] later wrote that "Wasson and Heim, and Singer and Guzmán [all] failed to find*Panaeolus campanulatus* var. *sphinctrinus* in use and, as a result, have assumed that it should not be included in the list of hallucinogenically used Mexican mushrooms." The late French mycologist Roger Heim (1963)[32], also asserted that "the Indians do not take *Panaeolus campanulatus* var. *sphinctrinus* in their rituals", and Singer (1958)[116] after one short field trip, categorically stated that "*Panaeolus campanulatus* var. *sphinctrinus* is not used and perhaps, had been mistaken for *Psilocybe mexicana* Heim." The noted Mexican authority on the sacred mushrooms of Mexico, Gastón Guzmán (1977)[27], called *Panaeolus campanulatus* var. *sphinctrinus* a "false *teonanácatl*" while P. Antoine (1970)[6] claimed that this belief has spread and still exists. However, eight years later, Singer (1978)[117] still believed that no species of *Panaeolus* belongs to the group of Mexican hallucinogenic mushrooms which were known as *teonanácatl*. In 1979, Schultes wrote that "certain shamans and curanderas of the Mazatec and Chinantec Indians do employ the mushroom known as *Panaeolus campanulatus* var. *sphinctrinus* in curative and divinatory ceremonies." These *Panaeolus* species are known to the Indians as tha-na-sa, shi-to and to-shka. They are bell-shaped or ovoid-campanulate shaped in the cap and appear to be yellowish-brown in color. Several of the early Spanish codices noted above that one of the yellow mushrooms described was called *teonanácatl*. The author also found these latter two epithets used by the Mazatec in describing *Psilocybe mexicana*.

Specimens of *Panaeolus sphinctrinus* collected in Mexico by French Canadian mycologist György-Miklos Ola'h (1969)[82] were found to contain psilocine and Ola'h classified this species as 'latent' psilocybian.

However, as late as 1983, Guzmán still maintained that "in Mexico, no *Panaeolus* species is used as a sacred or divine mushroom among the Indians of Oaxaca, and that includes the Mazatec, Chatino, Zapotec, and Mixes, and of the Indians in the State of México, in spite of the fact that the species of *Panaeolus* are very common." *Panaeolus* species were collected independently as one of the sacred hallucinogenic mushrooms by two groups of investigators, Weitlaner's group and by Schultes and Reko. Previous chemical analyses of these collections revealed that some species of *Panaeolus* and even *Panaeolus campanulatus* var. *sphinctrinus* do contain the indole chemical psilocybine and psilocine (Ola'h, 1970 [83]; Ott, 1976 [84]; Tyler & Gröger, 1964 [130]). However, one should consider that in a single collection of a particular species, there may be more than two species represented - for example, one species might superficially resemble another, as in the case of *Panaeolina foenisecii* and *Panaeolus subbalteatus*, both of which resemble one another macroscopically.

Designed by John W. Allen

Image 4. Designed by John W. Allen.

Chapter 4. The Rediscovery of Entheogenic Mushrooms

Wasson's First Voyage

R. Gordon Wasson was born in Great Falls, Montana in 1898. The son of an Episcopalian minister, he became the first ethnomycologist in the world. His interest in wild mushrooms spanned more than fifty years, during which time he rediscovered the famed sacred mushrooms of Mesoamerica.

R. Gordon Wasson's interest in mushrooms began during his honeymoon in the Catskill mountains. Wasson and his Russian-born wife, pediatrician Valentina Pavlovna Wasson were hiking one day on a forest-trail when suddenly she espied a cluster of mushrooms which she recognized as being similar to ones she used to gather from the forest for dinner in her native Russia. Overcome with great joy, Valentina picked as many mushrooms as she could carry and that evening she prepared and served them with their evening dinner. Of course, R. Gordon Wasson declined to eat any of the "nasty toadstools" his new wife had gathered from the forest and told her he did not want to awake a widower, thinking that all mushrooms were poisonous (Wasson, 1957a [140]; Wasson & Wasson, 1957 [186]). It was for this reason that Gordon Wasson soon began to wonder why Slavic peoples love the mushrooms while some western Europeans abhorred them. Thus began the age of ethnomycology.

RG Wasson at Int. Conf. on Halluc. Mushrooms (1976)
Photograph by Linda Dear

Fig. 5. R. Gordon Wasson
1st International Conference on Hallucinogenic Mushrooms, 1976
Photo: Linda Dear

Wasson, who worked as a journalist, soon became interested in banking and in 1928 began working as an investment-banker for Morgan Guaranty Trust. By the early 1950's, Wasson had become a vice-president of J.

P. Morgan & Company.

At that time, Wasson received an important letter from Eunice V. Pike, a missionary from the Wycliff Bible Translators. Pike had been living for many years among the Mazatec Indians in the southern Mexican State of Oaxaca. She wrote to Wasson informing him that there were Indian medicine-men and medicine-women who employed certain mushrooms in curative ceremonies. Pike informed Wasson that the use of these mushrooms probably originated prior to the conquest (see Pike & Cowan, 1959 [89]; Pike, 1960 [88]).

Wasson also received a letter from the noted Greek historian and scholar Robert Graves. Graves informed Wasson of two research articles written by Harvard ethnobotanist Richard Evans Schultes (see Davis, 1996 [12]), concerning a mysterious mushroom known to the ancient Aztec people as *teonanácatl*.

However, Schultes' papers concerning the use of these mushrooms by the Aztecs at the time of the Spanish conquest had generated little interest within the scientific community (Schultes, 1939 [103], 1940 [104]). In fact, the question of whether or not the mushrooms ever existed had been raised.

Wasson received another letter from his Italian printer which included a sketch of a Guatemalan mushroom-stone carving some 2000 years old. The drawing represented a sculpture of a man with a mushroom projecting from his head. The sculpture had been discovered somewhere deep in the jungles of Guatemala.

These startling new revelations piqued Wasson's interest immensely, so he then contacted Schultes (Pers. Comm. 1988)[108]: "One day I was home from the Amazon. Wasson phoned me for references to México." Schultes then went on to say "I sent him to Reko who was very helpful to him and who introduced him to Weitlaner. Thus Reko still had his contribution towards the study of the mushrooms." (Blas Pablo Reko, along with Schultes, had collected specimens of the alleged sacred fungi for herbarium deposit and Roberto Weitlaner was the first westerner to observe a sacred mushroom ceremony during the late 1930's).

In 1953, Wasson and his wife traveled to México. After arriving in the Mazatec country and inquiring about the sacred mushrooms they finally succeeded in attending an all night *velada* (as the ceremony is called by the Mazatec shamans or curanderos, who officiate and perform them). This first ceremony was conducted under the guidance of a Mazatec shaman named Don Aurelio Carreras. At the first ceremony, Wasson observed the procedures and took notes of what transpired, but was not allowed to join in nor partake of the mushrooms, However, he was very ecstatic over the performance, and felt no regret for not having been able to fully participate.

Wasson led two more exploratory excursions into México during the following two years. On his third trip to Oaxaca and his second to Huautla de Jiménez, Wasson and his photographer-friend Allan Richardson themselves in the tiny village of Huautla de Jiménez perched high in the Sierra Mazateca of Oaxaca. On the night of 29-30 June 1955, Wasson and Richardson became the first outsiders to partake of the sacred mushrooms.

After Wasson and Richardson had found lodging, they set out on separate searches, asking everyone they encountered for help in their mushroom hunt. After several hours of fruitless questioning of the natives, Wasson decided to ask a local government official to discuss the secrets of the mushrooms with him. He went to the local *municipio* (city hall), although he was aware that many government officials were dishonest and corrupt, especially when it came to matters involving foreigners. But Wasson felt he hadn't much to lose by approaching the official.

Wasson met a man working in the office of the mayor who was the town's sindico. The sindico is the number two man in a municipio, and since his boss was away on business, he was the acting mayor. His name was Cayetano García Mendoza. After exchanging introductions and greetings with García, Wasson in his polite and humble manner discussed with him general topics such as the weather, maize-crop prices, problems with the drinking water, the current prices of coffee, etc. It wasn't long before Wasson found himself leaning over the counter towards Cayetano and whispering the Mazatec name for the mushrooms.

With that Cayetano appeared bewildered and astonished. How could a foreigner have knowledge of such a well kept-secret that very few Mazatec people would mention so casually? But in answer to Wasson's question, Cayetano replied that "nothing could be easier", and then he asked Wasson "to come to my humble abode after four o'clock, when I am finished with my day's work, and I would be ever so glad to help you with your unusual request."

Later that afternoon, Wasson and his friend Richardson arrived at the home where Cayetano resided with his two younger brothers, who were waiting for the strangers to arrive. Emilio and Genero led them down the road to a spot not more than a hundred feet from Cayetano's house, where they found an abundance of mushrooms fruiting out of sugar-cane mulch.

While Richardson began photographing the mushrooms, Wasson picked several and placed them gently into a paste board box which he had brought along for this occasion.

Wasson Meets María Sabina

In the meantime, while Wasson was picking mushrooms, Cayetano proceeded to the home of his friend, Doña María Sabina, a sabia ('wise one' or 'wise woman'). Cayetano found Doña María alone in her home and related to her the events that had transpired earlier that day. He told her "that some blond men have traveled from afar in search of a sabia, and he quietly mentioned to her that the blond stranger had spoken to him in a soft quiet whisper, asking him in a discreet way, that he was seeking '*nti-xi-tjo* (Estrada, 1976)[17]. Although Cayetano was somewhat startled by the question asked of him, he confirmed his feeling of the stranger's request, explaining to Doña María that the blond stranger "knew of what it was that he was talking about." Cayetano felt that Wasson was definitely sincere in learning the secrets of 'nti-xi-tjo. Apparently Wasson's discretion with Cayetano had confirmed his sincerity in seeking knowledge about the mushrooms and their use, which had convinced Cayetano to talk with Doña María, so to convey to her the message from the blond strangers from a far-away land.

Cayetano then explained to Doña María that he told the visitors "I know a true wise woman." Cayetano asked Doña María if he could bring the strangers to her home so that she might teach them the true knowledge of the mushrooms. Doña María replied, "if you want to, I can't say no".

Years later, María Sabina stated that she felt compelled to accept Wasson's request because of Cayetano's official position, and she assumed Cayetano's visit to her humble dwelling that hot summer day was official business.

Many years later, Wasson wondered if María Sabina would have shared her knowledge of the mushrooms with him had Cayetano not intervened as he did. In 1971, Wasson read an interview with María Sabina which appeared in the European magazine L'Europe, published in Milan. It reported that when Cayetano had requested her aid in helping the foreigners, she did so because she felt she had no choice. But she also declared that when she was asked to meet them [Wasson and Richardson] that she "should have said no."

By late afternoon, Wasson, Richardson, and their friends Emilio and Genero, had finished picking the mushrooms and returned to Cayetano's home just as he was returning from seeing María Sabina. It should be noted that a few days later, Wasson offered to pay Cayetano for the fine hospitality and services they had provided Wasson and Richardson, but Cayetano and his wife refused. They informed Wasson that they had been happy to help, and "didn't do so for money."

Cayetano requested that Emilio accompany them to María Sabina's home to act as interpreter. Once there, Wasson opened his paste-board box and exposed the mushrooms he had just picked. Doña María cried out in joy upon seeing the honguitos which she so loved and adored. She held them in her small hands, caressing them while talking to them in her own language. Arrangements were soon made for a velada later that evening.

On the evening of June 29, 1955, Wasson and Richardson became the first white people to consume the sacred mushrooms of the ancient Mazatec people, in a ceremony held under the supervision of curandera Doña María Sabina, who performed for them a velada or vigil at the home of her friend Cayetano García.

Wasson later wrote, "we all ate our mushrooms facing the wall where the small altar table stood. We ate them in silence, except for Cayetano's father, don Emilio, who was consulting the mushrooms about his infected left forearm. He would jerk his head violently with each mushroom that he swallowed, and utter a smacking noise, as though in acknowledgment of their divine potency. I was seated in the corner of the room on the left of the altar. The señora asked me to move because the word would come down there..."

"I joined Allan immediately behind the señora, we took about a half hour to eat our six pairs of mushrooms. By eleven o'clock we had finished our respective portions, the señora crossing herself with the last swallow. ... At about 11:20 Allan leaned from his chair and whispered to me that he was having a chill. We wrapped him in a blanket. A little later he leaned over again and said, 'Gordon, I am beginning to see things,' to which I gave him the comforting reply that I was too."

"The patterns grew into architectural structures, with colonnades and architraves, patios of regal splendor, the stonework all in brilliant colors - gold and onyx and ebony - all harmoniously and ingeniously contrived, in richest magnificence extending beyond the reach of sight. These architectural visions seemed oriental, though at every stage I pointed out to myself that they could not be identified with any specific oriental country..."

"At one point in the faint moonlight the bouquet on the table assumed the dimensions and shape of an imperial conveyance, a triumphal car, drawn by zoological creatures conceivable only in an imaginary mythology, bearing a woman clothed in regal splendor. The visions came in endless succession, each growing out of the preceding ones. We had the sensation that the walls of our humble house had vanished, that our untrammeled souls were floating in the empyrean, stroked by divine breeze, possessed of a divine mobility that would transport anywhere on the wings of a thought. Only when by an act of conscious effort I touched the wall of Cayetano's house would I be brought back to the confines of the room where we all were, and this touch with reality seemed to be what precipitated nausea in me."

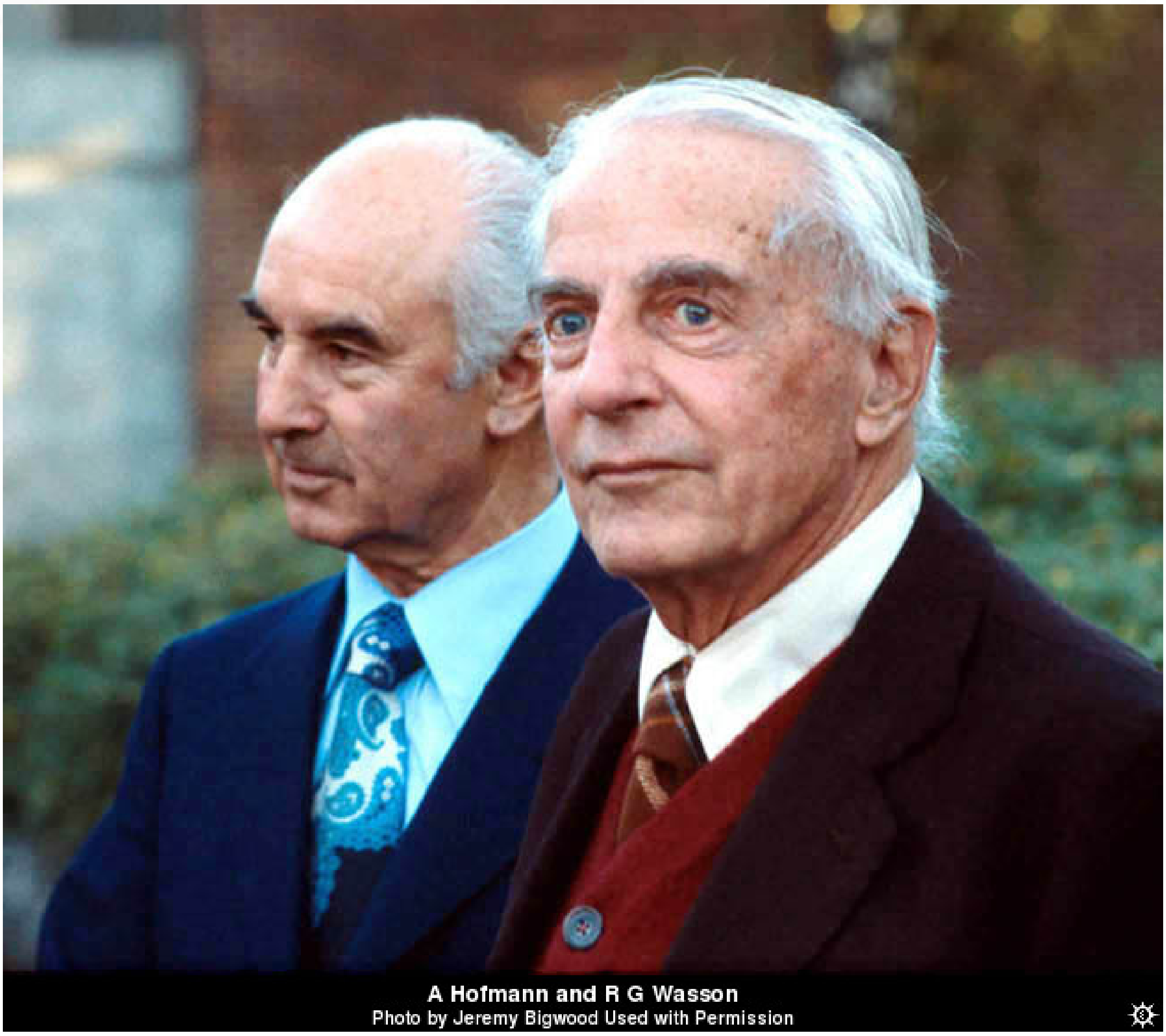

A Hofmann and R G Wasson
Photo by Jeremy Bigwood Used with Permission

Fig. 73. A. Hofmann and R. Gordon Wasson
Photo: Jeremy Bigwood

What Wasson experienced during his first *velada* convinced him that he would never repeat it, but a few nights later he asked Doña María if she would perform again in order that he might record the proceedings. On this occasion Allan Richardson declined partaking of the sacred mushrooms so he might better photograph the session.

Doña María referred to Wasson as "Basson" and she allowed the taking of photographs by Richardson on the condition that Wasson would not profane her by allowing other people access to the photographs taken during the ceremony. She requested that Wasson only share them with his closest and dearest friends and that no others should see them. Eventually their publication in *Life* magazine made María Sabina known to the world. Although this event brought thousands of people into Oaxaca in search of these entheogenic fungi, María Sabina never expressed any resentment toward Wasson as a result.

On the night of July 5, 1955, Wasson's wife Valentina and their 19 year-old daughter Masha (in his 1980 book, The Wondrous Mushroom: Mycolatry in Mesoamerica[174], Wasson mistakenly reported that Masha was then only 13 years old) became the first westerners to consume entheogenic mushrooms outside of a ritual setting. This would appear to be the first reported incident involving non-traditional use of psychoactive mushrooms (Wasson V., 1958)[185].

Six weeks later, having returned to New York, Wasson again felt compelled to ingest the mushrooms from México, to ascertain whether dried specimens he had brought back were still active. This was Wasson's third experience with the sacred mushrooms.

During Wasson's many excursions into Mesoamerica, always seeking new information on the traditional use of entheogenic mushrooms he endeavored to link the enigmatic mushroom-stones of Central America to ritual mushroom use by Mayan peoples to cultic use in primitive Mayan societies.

Wasson believed there was a link between the mushroom effigies and the use of entheogenic mushrooms in Mesoamerica. Once during an excursion to the village of Juxtlahuaca, México, Wasson photographed a young Mexican girl grinding mushrooms on a matate or grinding stone. The mano she used to grind the mushrooms and her position while doing so, was similar to the posture and form represented on one of the mushroom-stones unearthed in Guatemala (Furst, 1986)[20].

Studies by Villacorta & Villacorta (1927)[135], Johnson (1938)[46], Schultes (1939 [103], 1940 [104]), Singer(1949)[114], Wasson & Wasson (1957)[186], de Borhegy (1961b)[13], de Borhegy (1962)[14], Lowy (1971 [71], 1972 [72]), Ott (1976)[84], Mayer (1977)[74], Weil (1977)[137], Wasson (1980)[174], and others who followed the Wassons brought attention to ancient frescoes, paintings, illustrations and gold-work depicting sacred mushrooms (Schultes and Bright, 1979)[110]. The mushroom stones and other art works, including depiction's of mushroom motifs in paintings and sculptures gave ample proof that the entheogenic mushrooms had an important role in the development of spirituality in pre-Colombian cultures.

It is conceivable that some 3000 years ago in Mesoamerica, a sophisticated form of shamanism had flourished and prospered, revolving around the ritual use of entheogenic mushrooms and other visionary inebrients as major foci in the development of Mesoamerican cultures.

Wasson led a total of 10 field-trips into the wilds of Mesoamerica (1953-1962), gathering mushrooms and information on their use in their rituals by the various cultures who used them. Wasson sought the collaboration of many eminent scholars to assist him in these investigations. Specialists who assisted Wasson included: Roger Heim, Gastón Guzmán, Roberto Weitlaner and his daughter Irmagard Weitlaner Johnson, Guy Stresser-Peán, C. Cook de Leonard, W.S. Miller, Searle Hoogshagen, B. Upton and Albert Hofmann who was director of Natural Products at Sandoz in Basel and had discovered LSD before isolating psilocybine and psilocine.

CIA Mole James Moore - Spies on Wasson in the Search for Mind-Control Drugs

"Nervous and paranoid" correctly describes a "short-order chemist" for the CIA, James Moore (Lee & Shlain,1985 [67]; Marks, 1979 [73]; Stevens, 1987 [124]), who secretly infiltrated one of Wasson's small expeditions into the Sierra Mazateca in 1956.

A scientist from the CIA's "Project ARTICHOKE" had traveled to México in search of a so-called "stupid bush" and other plants which might derange the human mind, politically useful to control enemies minds in war time. Large quantities of morning-glory seeds were sent to CIA laboratories for analysis by CIA scientists searching for compounds useful for extracting confessions, locating stolen or lost objects, perhaps even predicting the future. Visionary mushrooms were of special interest in these investigations. According to documents obtained via the Freedom of Information Act, James Moore was an expert in chemical synthesis who worked for the CIA. In 1956, Moore invited himself into one of Wasson's expeditions to México. He offered Wasson a grant for $2,000 dollars from a CIA-front known as the Geschickter Fund for Medical Research, Inc. In 1955, Wasson had declined to collaborate openly with the CIA.

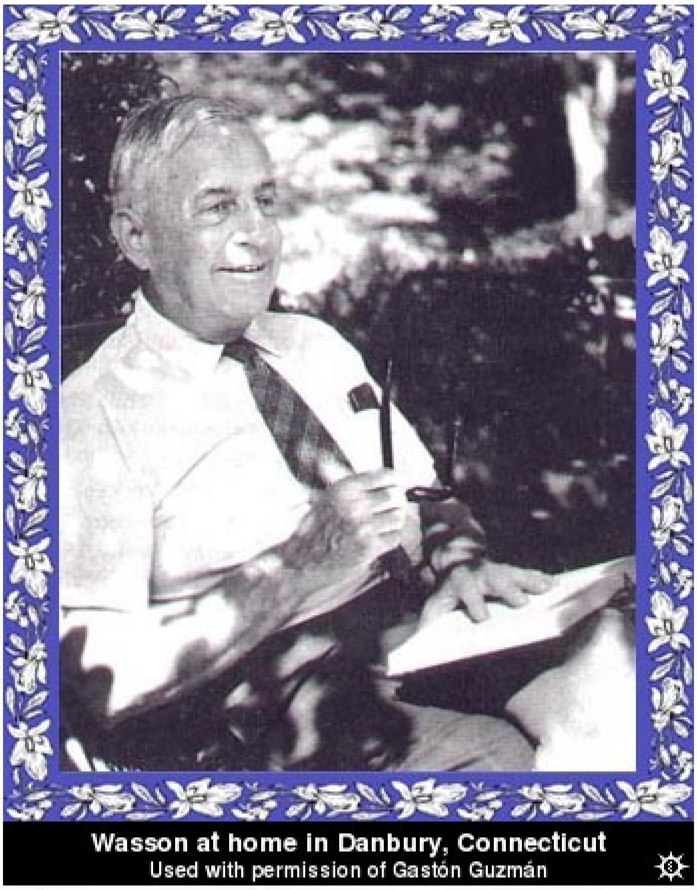

Wasson at home in Danbury, Connecticut
Used with permission of Gastón Guzmán

Fig. 6. R. Gordon Wasson at home
Danbury, Conn.

Moore did not enjoy his single mushroom experience, perhaps due to the fact that he was not who he represented himself to be. Mayhaps this fact got the better of him, and under the influence of the mushrooms he saw himself as he really was. According to Moore, "I had a terrible cold, we damned near starved to death, and I itched all over. There was all this chanting in the dialect. Then they passed the mushrooms around, and we all chewed them. I did feel the hallucinogenic effect, although 'disoriented' would be a better word to describe my reaction."

Moore collected specimens for his CIA-sponsored research and returned to Maryland, where he endeavored to isolate for the CIA the active principle of both the mushrooms and morning glory seeds. Unfortunately for Moore he was unable to find the active ingredients with the fungi and lucky for the world that he didn't find them since they would of most likely been used as tools of mind war under the direction of the CIA.

In spite of the duplicitous antics of the CIA which predictably came to nothing, Wasson and collaborators documented traditional use of the sacred mushrooms in Oaxaca, Mexico and other states. Wasson and Singer found that several species and/or varieties of mushrooms were still employed ceremonially by some dozen Indian tribes belonging to various linguistic groups. Some of the Mexican Indians spoke no Spanish nor possessed a written language. The following indigenous groups used the sacred mushrooms: Mazatecs, Chinantecs, Chatinos, Zapotecs, Mixtecs, Mixes (Mijes), Nahuas and Otomies and possibly also the Tarascans of Michoacán.

Different Oaxacan Indian tribes prefer different species of mushrooms, and the attendant rituals vary somewhat from village to village. Even within a given tribe not all shamans will use precisely the same mushrooms, depending on what species be available at any given time. More than one species may be used perhaps for specific purposes, during a particular curing ritual (Wasson & Wasson, 1957)[186].

The Wassons' discoveries regarding the visionary mushrooms in México became public knowledge in 1957, with the publication of a two-volume book *Mushrooms, Russia and History*, limited to 512 copies and never reprinted. Some university libraries have copies in rare-book collections.

Simultaneous with publications of *Mushrooms, Russia and History* were two popular articles in Life magazine (Wasson, 1957a)[140] and This Week magazine (Wasson, V. P., 1958b)[143]. These articles by Gordon Wasson and the other by his wife, captured the beginning of the Psychedelic Era. Collectors of the Wassoniana have been known to pay up to $50.00 for a mint-copy of this particular issue of *Life*.

A third presentation to the world occurred in 1958, when Gordon Wasson and Roger Heim, together with Albert Hofmann and other collaborators, published *Les Champignons Hallucinogènes du Mexique*, completed by a second volume ten years later, *Nouvelles Investigations sur les Champignons Hallucinogènes*, both written in French, some [parts of which originally appeared as papers in *Comptes Rendus Acad. Sci*. and *Revue du Mycologie*.

R. Gordon Wasson died on Dec 23, 1986, and is survived by an adopted son and daughter.

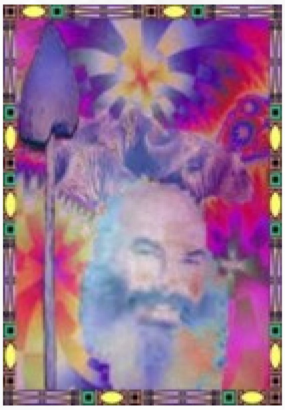


Image: Andrew Weil
Graphic Design by John W. Allen

Chapter 5. María Sabina

Saint Mother of the Sacred Mushrooms

Almost forty years have passed since the eminent ethnomycologist R. Gordon Wasson stumbled into the tiny Oaxacan village of Huautla de Jiménez in search of *teonanácatl*, the magic mushroom of Mesoamerican folklore. His lifetime of studying mushrooms and current three year quest in the foothills of Oaxaca came to an end at the doorway of a small earthen hut with crumbling mud walls and a sunken thatched roof. This hut was the life-long home of Doña María Sabina, the most renowned curandera in all of history.

According to anthropologist Joan Halifax (1979)[31], "For many decades she had practiced her art with the hallucinogenic mushrooms, and many hundreds of sick and suffering people came to her wretched hut to ingest the sacrament as she chants through the night in the darkness before her alter."

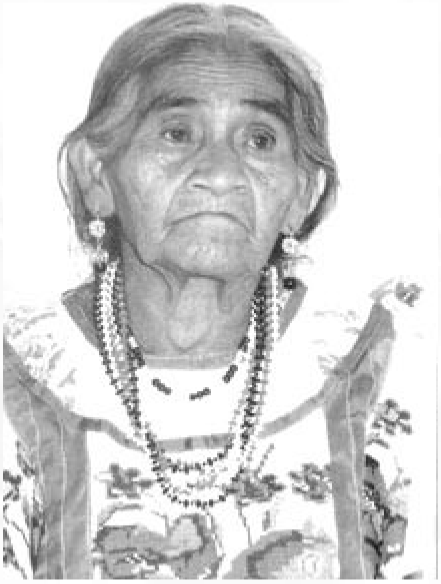


Fig. 7. María Sabina.

Being a kind soul, Doña María welcomed Wasson into her hut and shared the secrets of the sacred mushroom. How could she know that this small, innocent gesture of generosity and kindness would radically change her life and the course of history forever. Despite Wasson's attempts to keep Doña María's identity a secret, the story of the Mazatec witch and her mushrooms of wonder spread throughout the west like wildfire - from the halls of Harvard to the back-beat streets of big town America (when R. Gordon Wasson first wrote of María Sabina and her Veladas in Life magazine (13 May 1957), he referred to her as Eva Mendez, a pseudonym intended to protect her from scalawags and thrill-seekers who might disturb or disrupt her life and those around her).

Wasson's story inevitably piqued the interest of many people. Hoping the mushroom could be a powerful tool in chemical warfare, the CIA sent an undercover agent to Huautla de Jiménez to collect specimens (Marks, 1979)[73]. Again, Doña María shared her secret. What else could she do? The mushroom had shown her that the Westerners would never give her peace. Reluctantly she gave in, but with each desecration of the sacred mushrooms she could feel her curing powers fading.

She knew the Westerners would be coming by the dozens (doctors, scientists, thrill-seekers, spiritual pilgrims) all looking for truth, salvation, the curing magic, or even the face of God. Resigned to her fates, Doña María patiently accepted each weary searcher into her home and performed the velada, the all-night vigil, for them. Each time she gave the visitors what they were looking for. Each time she gave away a bit of herself.

Now all that's left of Doña María are memories, memories of the humble woman who inspired the lives of Tim Leary, Ralph Metzner, Andrew Weil, Jonathan Ott, and countless others. Beyond her memory only the mushrooms remain, the tiny magic toadstools Doña María spent her life mastering. Now that she's gone, the only way to find her is through them, through the sacred ceremonies of Mazatec wizards and healers.

Can you make out her face, dark and chiseled with age? Can you hear her songs and chants cutting through the still blackness of night? Her spirit is out there, caught in an endless rainbow spiral of wisdom and beauty. Her ghost is waiting to be heard. Just reach out...

Childhood

Wasson (Estrada, 1976)[17] reported that María Sabina was born on the 17th of March, 1894. According to parish records María was baptized exactly one week after her birth. Her mother María Concepción said her daughter's birth was the day of the Virgin Magdalene (July 22).

According to a verbal account given to Señor Alvaro Estrada, Doña María first consumed the sacred mushrooms with her sister María Ana at an early age (possibly somewhere between the ages of 7 to 9-years-old). Doña María Sabina recalled that she and her sister were out in the woods tending the family's animals when they stopped under a tree to play games in the shade as little children often do when by themselves with no adults around. María looked to the ground and noticed several beautiful mushrooms growing under the tree and realized they were the same mushrooms used by a local curandero Juan Manuel to cure the sick.

Doña María reached down to the earth and carefully harvested several of the mushrooms exclaiming "if I eat you, you, and you, I know that you will make me sing beautifully." She slowly chewed and swallowed the mushrooms, then urged her sister María Ana to do the same. Slowly, young María began to realize that the mushrooms contained a very potent magic, one that she would never forget.

In the following months Doña María and her sister consumed the fungi several times. Once her mother had found her laughing and singing gaily and asked of her "what have you done?". However, she was never scolded for eating the mushrooms because her mother knew that scolding would cause contrary emotions.

According to Joan Halifax (1979)[31] Doña María was eight years old when her uncle fell sick. Many shamans in the surrounding Sierras near her village had attempted to cure him with various herbs, but his condition only worsened. Doña María remembered that the mushrooms she had eaten while playing with her sister had told her to look for them if she ever needed them and that they would tell her what to do when she needed help.

Doña María went to collect the sacred mushrooms and returned to her uncle's home where she ate them. Immediately, Doña María was swept away into the world of the mushrooms. She asked them what was wrong with her uncle and what could she do to help him get well. According to Doña María, the mushrooms told her that an "evil spirit" had entered the blood of her uncle and possessed him. She would have to give him a special herb, but not the same herb which the other shamans and curanderos had previously given him. Doña María then asked the mushrooms where the herbs could be found and the mushrooms told her that there was a place on the mountains where the trees grew tall and the waters of the brook ran pure. In this place in the earth are the herbs which will cure your uncle.

Doña María knew the place the mushrooms had shown her and ran from her uncle's hut to find the herb. Just as the mushrooms had shown her, the herb was there. When she returned to her uncle's home she boiled the herbs and gave them to her uncle. Within a few days, her uncle was cured, and María knew this would become her way of life.

As Doña María grew older she became fully initiated into her role as a sabia (a wise one). She quickly became respected in her village as an honest and powerful sabia, and in her community she was a blessing to those who sought her services. For decades she practiced her healing arts, and countless hundreds of sick and suffering people sought out her magic. Except for her three marriages, where she was expected to care only for her husband, she continued her sacred practices throughout her life.

Being of the Mazatec (Nahua-speaking) people, María Sabina performed her ceremonies in Mazatec (in This Week magazine, Valentina Wasson, 1958 wrote that the ceremony was spoken in Mixtec). Like the pseudonym of Eva Mendez which R. Gordon Wasson gave to María Sabina, this latter report was also published with the intent of keeping her identity a secret from those who would abuse her livelihood.

Like many of the Mazatec shamans, curanderas, and healers, María Sabina referred to the mushrooms as xi-tjo, si-tho or 'nti-xi-tjo, meaning "worshipped objects that spring forth" ('nti = a particle of reverence and endearment, and xi-tjo = that which springs forth). Some Mazatecs refer to the mushrooms by saying "that the little mushroom comes of itself, no one knows whence, like the wind that comes, we know not when or why."

The sacred mushrooms which María Sabina used during an all night velada (vigil) are usually harvested in the evening when the moon is full, although sometimes they are gathered in the day (see footnote 1 at the end of this chapter). Mushrooms gathered in the moonlight may sometimes be harvested by a young virgin.

After the mushrooms are collected they must be taken to a church. There they are placed on an alter to be blessed before the holy spirit. If the virgin who picked the mushrooms comes upon the carcass of a dead animal, one which had died along the path she follows, she must then discard the mushrooms and find a new path back to the field where the mushrooms grew. There she must gather up more fresh mushrooms and then find a new trail leading back to the church, hoping and praying that she will not come across any more dead animals. Once the mushrooms have been consecrated on the alter they are ready for use.

The *velada* would begin in total darkness so the visions would be bright and clear. After the mushrooms were adorned and blessed by María Sabina, she would slowly pass each one through the swirling smoke of burning Copal incense. The mushrooms are always consumed in pairs of two, signifying one male and one female. Each participant in a ceremony consumes five to six pairs; though more will be given if requested. Because the spiritual energies of the sabia would always dominate the *velada*, María Sabina would normally consume twice as many mushrooms as her voyagers, sometimes up to twelve pairs.

In the tradition of Mazatec shamans and curanderas, María Sabina would first chew the mushrooms, hold them in her mouth for a while, and then swallow them. The mushrooms should be consumed on an empty stomach and eaten over a 20-30 minute period. She decides who is to take them and the spiritual energies of the sabia always dominate the sessions. These sessions are usually conducted at night, in total darkness so that the visual effects from the mushrooms will be fully effective. A candle or two may be used but is seldom necessary. As the energies of the mushrooms pour themselves into the spiritual voyagers, Doña María would chant, slap, and pound her hands against various parts of her body, creating many different resonant sounds while invoking ancient incantations.

The thumping chants would totally fill the space of her hut and go beyond the walls to the far horizons of infinity. The chants were used to invoke the mushrooms power and varied depending on the various illness or ailment which the healer is called upon to cure (see footnote 2 at the end of this chapter) (Krippner & Winkelman, 1983 [52]; also see Aromin, 1973 in Krippner & Winkelman, 1983). Being a devout Catholic her entire life, she would often blend ancient Mazatec rituals with Christian elements, such as the Eucharist of the Catholic religion. When the mushrooms were not in season, María Sabina would employ other sacred plants with Christian rites (see footnote 3 at the end of this chapter).

All accounts of María Sabina attest to the fact that she was indeed a humble and holy woman - a saint. Wasson himself described Doña María as "a woman without blemish, immaculate, one who has never dishonored her calling by using her powers for evil...[a woman of] rare moral and spiritual power, dedicated in her vocation, an artist in her mastery of the techniques of her vocation (Wasson,1980)[174]." In her village, Doña María was exalted as a "sabia" (wise one), and was known among many as a "curandera de primera catagoria" (of the highest quality) and an "una señora sin mancha" (a woman without stain).

Father Antonio Reyes Hernandez is a man of the cloth, a man with the love of God in him, and the Bishop who resides in the parish of the Dominican church which Doña María belonged to. In 1970, when Father Antonio had just completed his first year as the Bishop of Huautla, Alvaro Estrada (1976)[17] had inquired of Father Antonio if his ecclesiastic elders in the church hierarchy opposed the pagan-like rites of the shamans and sabias in Oaxaca and elsewhere in México as his conquering predecessors had during the last three centuries. Father Antonio replied that "the church is not against these pagan rites - if they may be called that. The wise ones and curer's do not compete with our religion. All of them are very religious and come to our mass, even María Sabina. They don't proselytize; therefore they aren't considered heretics, and it's not likely that any anathema's will be hurled at them."

Father Antonio never admonished or condemned her for her work in the village. He was aware that her rituals and practices had been handed down to her through the ages from her ancestors. He also knew that her services were valid treatments for those who sought her shamanic talents. Father Hernandez always recognized her work with the sick and suffering as the mark of a true Christian - one willing to help the less fortunate. Although he knew that Doña María used the mushrooms and pagan practice to heal and cure, he also understood that María Sabina's nature was not of a demonic spirit, "nor was it" satanic or even heretic. He appreciated her spirituality and treasured her work as a long termed good standing member of his church.

A Bishop interested in experiencing the visionary effects of the mushrooms came to María seeking guidance. However, he was turned away since it was not the season for the mushrooms and there were no mushrooms available for a ceremony. The Bishop had asked María Sabina if she would teach her children her talents. María Sabina told the bishop that her talents could not be taught to others but could only be achieved by those whose wisdom had been already naturally attained. However, it is said that before her death in 1985, Doña María spent most of her final years teaching others her talent in the communication of the mushrooms (Krippner (1987) [1983]))[50].

As Doña María believed in the power of Christ, so she also believed in the power of the mushrooms. She gave of herself to her church and likewise to the mushrooms. While working for the church, her mass was spoken in Latin and her chants were always spoken in Mazatec, and it should be remembered that although Doña María was unlettered she was not illiterate.

Doña María was quick to notice that Wasson and his friends, being the first foreigners to (seek) out the 'saint children' (mushrooms), had no sickness or illness to cure. They came only out of curiosity, or to find God (Estrada, 1976)[17]. Before Wasson and the others strangers came to Huautla, the mushrooms had always been used to treat the sick. Doña María foresaw the diminishing effects in her ability to perform her duties. She claimed that as more outsiders used the mushrooms for pleasures, or "to find God," the magic of the mushrooms slowly ebbed from her spirit. Her energy, and the energy of the mushrooms, was slowly fading away.

While María Sabina felt this debasement of her powers and relationship with the mushrooms was caused by the young foreigners who frivolously sought out and abused the sanctity of the sacred mushrooms, it should be noted that seeking and finding one's own god may also be a cure for many of mankind's psychological ills, woes, and faults.

The Coming of the Foreigners

In the beginning, the first travelers who came to Oaxaca in search of the sacred mushrooms were polite and kind to María Sabina. They displayed mutual respect for her personage. Many came bearing gifts and pesos for her services. Doña María received many people (young and old) into her home and performed for them the sacred ceremonies of her ancestors. One of the greatest gifts one could present her with for her services were photographs of her and her family. Some travelers would offer her gifts of no value and many gifts she considered useless. One tourist offered her a large dog in payment for her time, but she refused. She was too poor to afford feeding the animal. Although poor, María Sabina was spiritually enriched.

Doña María had also been widowed twice in her lifetime and once one of her sons had been brutally murdered before her very eyes. She claimed to have witnessed the crime in a vision prior to its happening. This supports the Wasson's assertions that the mushrooms have telepathic properties. In 1984, María Sabina had found a third husband.

Her three room home in Oaxaca where Doña María performed her ceremonies was created of mud with a straw thatched roof and a dirt floor. The interior of her humble dwelling whose walls were crumbling with age had uneven earthen floors which were almost barren of furniture except for the simplest alter. A candle provided the only light since there was no electricity. On a few occasions she was presented with a mattress or two, but she rarely accepted gifts beyond the value of her daily needs.

After Wasson published literature on his rediscovery of an ancient practice which utilized hallucinogenic mushrooms ritualistically in Oaxaca, many young foreigners from the United States, Canada, Europe and South America, began their long treks and tedious pilgrimages into Mexico. Soon Doña María took notice that many native Indians and Mexicans alike were debasing her customs by peddling mushrooms to the tourists in order to feed themselves and their families. During this period, many came seeking the mushrooms and many came only to be turned away.

By 1960, María Sabina realized that she was known the world over. This new found fame brought her much grief, and the agony it caused her soul was evident in her eyes and face. It brought turmoil and profanation to her village and upon her work.

The lack of respect and the total disrespect which the foreigners displayed towards her "saint children" shook the very foundations of her wisdom, strength, and world. Like the ancient mysteries of the "temple of Dionysus" where silence of the ancient rites was golden, María Sabina claimed that before Wasson came, "nobody spoke so openly about the 'saint children'. No Mazatec before ever revealed what he or she knew about this matter (Estrada, 1976)[17]".

After Wasson had attended his first voyage with her, every one seemed to know who she was and what she did.

When Wasson was first introduced to María Sabina in 1955, it was only because of an introduction by her friend Cayetano (Wasson, 1957 [140]; Wasson, 1980 [174]; Allen, 1987 [2]). He was a trusted friend, and María felt that Cayetano's requesting her to meet with the stranger who had traveled from afar in search of a "sabia" was harmless. Upon first meeting Wasson, María Sabina believed him to be a sincere and honest man, and felt that he would respect her ways and never bring shame to her world. Although she cautiously accepted Wasson when Cayetano approached her, she would later accept many into her home, and there were also many whom she would turn away.

María Sabina placed her trust in Wasson and his friends, especially when she allowed them to tape and photograph her during an all night mushroom *velada*. She gave Wasson and Alan Richardson, his photographer, permission to tell her story to others. Doña María hoped that Wasson would not profane her image nor divulge her anonymity to the world in an improper manner. Because Doña María neither read nor wrote (her language has no written words) she would never fully know exactly what Wasson had written of her life.

By 1960, Doña María had decided that if "foreigners come to her without any recommendations [whereas Wasson had one], she would of course still show them her wisdoms" (Wasson, 1980)[174].

During the 1967 summer of love, many drugs and rampant drug use spread from out of the Haight-Ashbury district of San Francisco into the main stream continental United States of America. Many young hippie types and college students soon traveled to México in search of the magic mushroom which they had read about or heard about from their friends (Swain, 1962 [129]; Finkelstein, 1969 [18]; Lincoln, 1967 [69]; Sandford, 1973 [101]; Weil, 1980 [138]).

Doña María soon began to understand the breadth of her fame when over the years she remembered the pilgrimage of "the young people with long hair who came in search of God" but lacked the respect for the mushrooms and greatly profaned them.

Later, Doña María realized that "the young people with long hair didn't need [her] to eat the little things." She said that these "kids ate them anywhere and anytime [they could find them], and they didn't respect our customs." Doña María also claimed that "whoever does it [mushrooms] simply to feel the effects can go crazy and stay that way temporarily, but only for a while."

Wasson recognized the traditional values of the religious motivations of the Mazatec shamans and sabias, explaining that "performing before strangers is a profanation and that the curandera who today, for a fee will perform the mushroom rite for any stranger is a prostitute and a fakir" (Metzner, 1970)[75], yet María Sabina did perform rituals for strangers, sometimes for a fee and sometimes not. At times, she had been known to charge for services which she used to provide for free.

At one point an American tourist once ate too many mushrooms and completely flipped out. He caused "much turmoil" and anxiety in an otherwise once quiet and peaceful community. Another tourist, with a live turkey dangling from his mouth, ran stark raving mad through the streets of Huautla. This incident necessitated intervention by local policia who apprehended him before he could do harm to himself or others. This incident, along with several others, soon led to the expulsion of thousands of long haired thrill seekers from Mexico.

The actions of these young people created many scandals. With the influx of drug-oriented young people, local authorities began to prohibit the use of mushrooms. By 1976, the thousands of foreign invaders began to drastically diminish, allowing the federales to slowly move out of the area. To the native peoples of Oaxaca, the bad elements had finally subsided and peace had once again returned to the village.

Throughout the years Doña María had been hassled many times by local government officials because of her use of the sacred mushrooms with the foreign intruders.

On several occasions she was arrested and jailed for her activities and on one occasion her home was burnt to the ground. A journalist who interviewed her in 1969, tried to intervene for her in this matter. He personally requested that the governor of Oaxaca "leave in peace the most famous shamaness in the world, whom anthropology and escapism have ruined" (Estrada, 1976)[17].

May the Force be With You

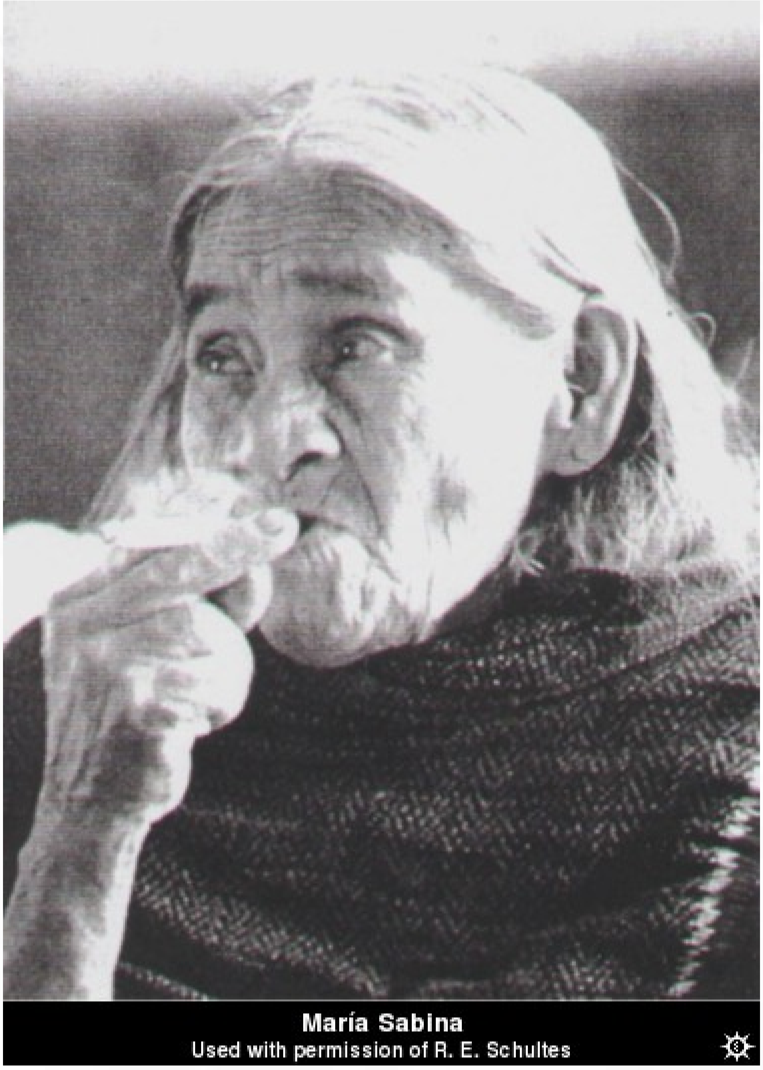

María Sabina
Used with permission of R. E. Schultes

Fig. 8. María Sabina.

As noted above, Federal authorities, army and police included, began the expulsion of hundreds of young foreign travelers, who came to Mexico "in search of the mushrooms and God" (Jones 1963 [45]; Unsign., 1970 [132]).

Doña María believed in the sacred force of the mushrooms with the same enthusiasm that many people came to believe in "the Force" of George Lucas and Luke Skywalker. As the years passed since Wasson first came to Huautla de Jiménez, Doña María felt the force of the mushrooms diminish within her spirit. Doña María realized that with the coming of the white man, the mushrooms were losing their meaning. Doña María claimed that "before Wasson, I felt that the 'saint children' elevated me. I don't feel like that anymore. The force has diminished. If Cayetano had not brought the foreigners ... the 'saint children' would have [probably] kept their powers. From the moment the foreigners arrived, the 'saint children' lost their purity. They lost their force; the foreigners spoiled them. From now on they won't be any good. There is no remedy for it."

This revelation from María Sabina most assuredly rings of the truth. The debasement of the mushrooms by casual thrill-seekers is widespread throughout the planet. Apolonio Teran, a fellow sabio (wiseman) was once interviewed by Alvaro Estrada. Estrada asked Apolonio about the breach of sanctity of the mushrooms by debasement wondering if the mushrooms were still considered to be a sacred and powerful source of medicine.

Apolonio claimed that "the divine mushroom no longer belongs to us [the Indians of Mesoamerica]. It's sacred language has been profaned. The language has been spoiled and it is indecipherable for us... Now the mushrooms speak NQUI LE [English]. Yes, it's the tongue that the foreigners speak... The mushrooms have a divine spirit. They always had it for us, but the foreigners arrived and frightened it away..." Later Wasson (1980)[174] agreed that "since the white man came looking for the mushrooms, they have lost their magic." This could mean that the magic is gone forever among the shamans and native peoples who worship them.

Wasson believed that Doña María's words rang of truth. In exemplifying her wisdom, Wasson stated that "a practice carried on in secret for three centuries or more has now been aerated and aeration spells the end (Estrada, 1976)[17]."

Before Wasson's death (December, 1986), he felt that he alone was responsible and accountable for what must surely be a sad and tragic end to a culture whose traditions and customs involving the sacred use of teonanácatl spanned and flourished majestically for almost three millennia. It now appears that the use of mushrooms among native peoples of Mesoamerica are in their final stages of extinction. Soon the cultural use of mushrooms and other sacred plants could vanish from the face of the earth.

Wasson's eloquent approach in presenting María Sabina's world to the public is without a doubt, beyond reproach. He presented a most unique tale of María Sabina and her sacred mushrooms. His writings took us where no man had gone before and he presented to the world her story as no other person would have. Wasson brought María Sabina and her world into view of the public eye. He told of her chants, her way of life, her reasoning, and of her magic with her fellow village members, all who visited her seeking her advice and divination. Wasson orated her virtues with the highest respect and the finest regards and what he put to paper was only the truth as she revealed it to him and as he first saw and heard it.

Wasson knew that María Sabina was relevant to the balance of nature within her community. He held an extreme profound reverence for the woman and her work. At the same time he displayed features of her spirituality without bringing shame upon her heritage. He presented her to the world with an integrity that brought enchantment with what he wrote. Wasson's discoveries in Mesoamerica and his integral interpretations are what María Sabina would have written and described if she had been able.

Because of Wasson's intrusion into her life and the myriad who followed, a part of María Sabina's world and way of life was taken away. However, the vast treasures of ethnomycological knowledge and wisdom which Wasson extracted from her world became public only because she shared it with the outsiders. This knowledge will now remain a part of history because it was recorded by an honorable man who cared about what he had observed, experienced, and wrote of.

María Sabina was many things: an earth woman, a mother, a sabia, a poet, a healer, a curer, a believer, an achiever, and a curandera who stood at the very edge of her universe and glimpsed the secrets and meaning of life. Doña María had shared her secrets of magic and plant knowledge with the outside world. Only through hope and prayer will the benevolence she provided to the world be fully understood and appreciated. Through the pursuance of R. Gordon Wasson's persistency in following his dream of the trail of the magic mushrooms, Doña María has truly presented mankind with a magical key (mushroom) concerning some plausible answers surrounding some of the mysteries of our religious beginnings and maybe the origin of the earth.

Doña María may be gone, but her spirit and her wisdom still remain. Reach out and take the wisdom she was so willing to share. Take it with care and share it with love and respect. Can you see her face in the dark? Can you hear her chanting?

Notes

1. María Sabina used many different species of the sacred mushrooms for divination. She preferred *Psilocybe mexicana* Heim, the preferred species of the Mazatec shamans. However, the mushrooms which she shared with R. Gordon Wasson and Alan Richardson were *Psilocybe caerulescens* var. *mazatecorum*.
2. The sacred mushrooms are usually consumed when fresh but may sometimes be served when dried. In pre-Columbian México the mushrooms were served and eaten with chocolate and/or honey. A trait left over from the times of the Aztec priests, a cultural tradition handed down through centuries of use by their ancestors. In some regions like Juxtlahuaca, the Mixtec shamans grind the mushrooms into a fine powder and brew a tea with the ground material.

   Metzner (1970)[75] reported that "in the land of the Mixe (Mijes) there are no curanderas. Most of the Mixe know and share the secret of the mushrooms and how to use them. One might take the mushrooms alone but will always have an observer present, to help guide him or her in their journey. The reason one might seek the mushrooms are medical and divinatory: to find a diagnosis and/or cure for an otherwise intractable condition; to find lost objects, animals or people; to get advice on personal problems or some great worry."
   Although María Sabina had gracefully preserved within her the power and wisdom derived from her relationship with the mushrooms, she only used them for good purposes. She also incorporated old traditions, blending them with certain Christian values and ideologies to divinate a particular situation, thereby diagnosing it correctly for the person in need of healing.

   Singer and Smith (1958)[116] believed that "the religious healing ceremonies of the Mazatec are also directed by the curanderos [or curanderas], but more emphasis is given to the revelations obtained by the intoxicating persons, so that the use of the mushrooms in Huautla is at least partly divinatory rather then medical." Metzner (1970)[75] felt that "the use of mushrooms for the [sole] purpose of divination is accepted as a matter of fact. Demonstrations of its capacity to bring about altered states of consciousness combined with brilliant kaleidoscopic visions of glorious colors and patterns have been convincingly made." Aguirre-Beltran (1955) claimed the healer (whether shaman or curandera) "looked not at the context of what it was in these plants that make them do their magic, but felt that the Indians' thoughts on these plants possessed two different aspects in their use in treatment:
   1) the mystical force that the plants projected into ones mind; and
   2) the actual diagnostic power that the use of the plant brings out."
   Beltran was positive that the "sacred herbs, deities in themselves, act by virtue of their mystical properties; that it is not the herb itself that cures but the divinity, the part of the divinity or magic power with which it is imbued."
   In considering the outcome of these ancient pagan practices in traditional societies, we cannot forget that in María Sabina's world the velada and mushrooms that she feeds upon provide the guideposts to her spiritual existence. Doña María had already foreseen the diminishing effects in her ability to perform her duties as the mushrooms became known to the outsiders. She claimed that the more outsiders who used the mushrooms for pleasure or "to find God" caused the magic of the mushrooms to slowly ebb from her spirit. Her energy and the energy which were within the mushrooms was slowly fading away. Metzner (1970)[75] wrote that the "practice which she employed was all that remained among a primitive and illiterate people today of a practice which was once so widespread throughout the mighty and powerful [Aztec] empire" that 300 years ago, a catholic conqueror named Cortez and a hoard of conquistadors almost succeeded in obliterating from the face of the earth any knowledge pertaining to their use and existence.
3. When the mushrooms are not in season, Mazatec shamans and curanderas (including María Sabina) employ several other common psychotropic plants for divination.
   One such plant is *Salvia divinorum*, a member of the mint family which is rich in essential oils. Swiss chemist Albert Hofmann (1980)[38] reported that it was a plant used ceremoniously by María Sabina. Mazatec shamans and sabias refer to this plant as "Hojas de la Pastora" (leaves of the shepherdess). Doña María Sabina referred to it as "la hembra" (the female) (Wasson, 1962b)[153]. *Salvia's* divinatory powers can be experienced by rolling twelve to sixteen mature leaves into a plug and holding it between the cheek and gum for fifteen minutes. Profound visual effects will be noticed with eyes closed or in total darkness. Dried *Salvia* leaves can also be smoked for milder effects.
   When the *Salvia* herb is not available for use in divination, the Mazatecs employ two different species of *Coleus* found in Oaxaca. *Coleus pumilus* is referred to as "el macho" (the male). Two other varieties of *Coleus blumi* are referred to as (1) "El nene" (the children) and (2) "el ahijado" (the godson). The psychoactivity of *Coleus* is debated.
   Another popular plant, a perennial, is the morning glory *Rivea corymbosa*, whose seeds contain lysergic acid amides. Also known as ololiuhqui. In Oaxaca, Mazatec shamans refer to the seeds as "Semillas de la Virgen" (seeds of the Virgin). 50 to 300 ground seeds are soaked in cold water for 1 to 3 days and the filtered liquid is consumed in the evening. However, María Sabina had never used these seeds in any of her ceremonies.

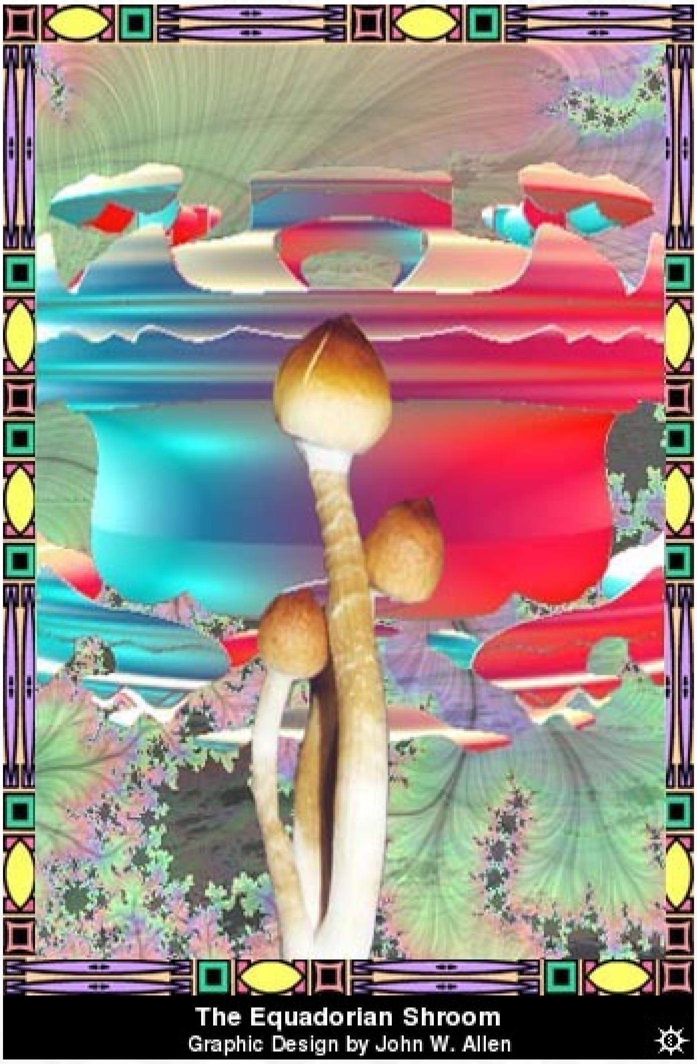

The Equadorian Shroom
Graphic Design by John W. Allen

Image 5: The Equadorian Shroom
Graphic Design by John W. Allen

Chapter 6. Albert Hofmann and the Synthesis of Psilocybine and Psilocine

Albert Hofmann became interested in the Mexican relatives of LSD late in 1956, having read about them in a daily newspaper which had piqued his curiosity. However, the newspaper article offered no information as to where the mushrooms might be obtained, so Hofmann had to wait two years before the sacred mushroom would come to him. It was because of Hofmann's research with LSD that the mushrooms finally found their way into his laboratory, where he was able to quickly isolate their active principles.

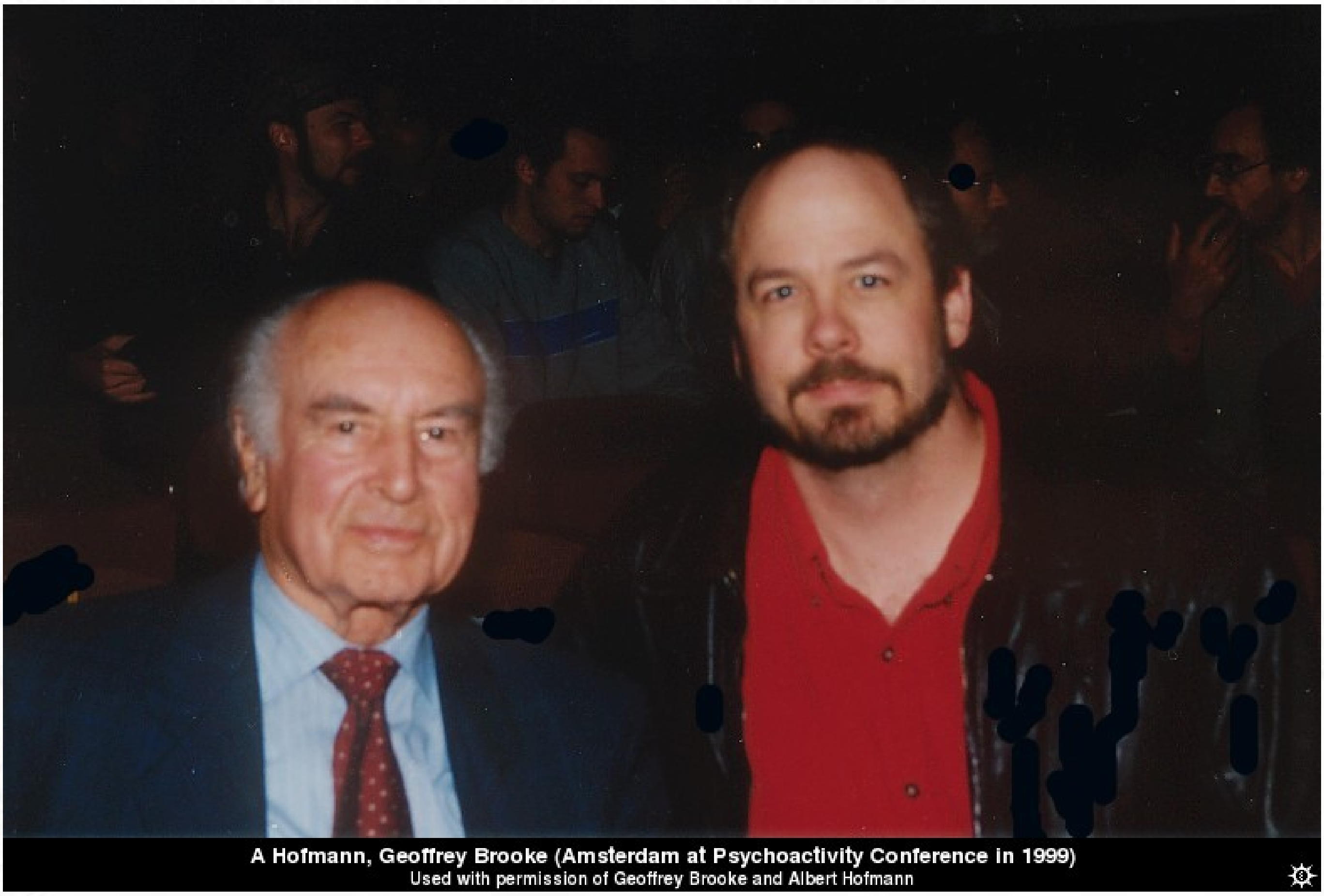

A Hofmann, Geoffrey Brooke (Amsterdam at Psychoactivity Conference in 1999)
Used with permission of Geoffrey Brooke and Albert Hofmann

Fig. 9. Albert Hofmann and Geoffrey Brooke
Amsterdam, Psychoactivity, 1999

In 1958, in a spotless laboratory at the Swiss pharmaceutical firm of Sandoz in Basel, this trim 52-year-old research chemist, at the time the Director of Natural Products, performed an unusual experiment. Hofmann had succeeded in isolating and synthesizing two alkaloids first extracted from dried specimens of *Psilocybe mexicana* Heim. The mushrooms had been grown in vitro in Paris by the eminent French mycologist Roger Heim (Hofmann, 1958 [34]; Unsigned, 1959 [131]). For two years, Heim had sought unsuccessfully to isolate the active ingredients from the mushrooms. Aware of Hofmann's discovery of LSD, Heim had mailed some 100g of dried *Psilocybe mexicana* to Hofmann. Hofmann and his colleagues, after exhausting this supply of mushrooms, grew their own cultures of *Psilocybe mexicana* and other species.

At first Hofmann and co-workers tried to isolate the active principles of the mushrooms using animal bioassays (mice and dogs), which proved unsuccessful. These experiments were inconclusive inasmuch as the animals were unable to describe the effects the mushrooms, which were not evident to observers. Hofmann had exhausted the bulk of the mushrooms sent to him by Heim, and decided to ingest some of the remaining mushrooms to verify that they were indeed active. Albert Hofmann, the "Father of LSD", thus proceeded to eat 32 dried specimens (2.4 g.) of *Psilocybe mexicana* which, according to published reports by Wasson and Heim, was roughly equivalent to an average dose used by shamans in México during their curing ceremonies.

Albert Hofmann and Jochen Gartz in Rovereto, Italy, April, 1992
Used with permission of Jochen Gartz

Fig. 10. Albert Hofmann and Jochen Gartz
Rovereto, Italy, April, 1992

Hofmann had decided to ingest the mushrooms himself since he could not ask his colleagues to consume them until he had first tried them himself. Hofmann later wrote that the 2.4 grams of dried *Psilocybe mexicana* represented a potent dose by Indian standards. According to Hofmann (1980)[38], "Thirty minutes after my taking the mushrooms, the exterior world began to undergo a strange transformation. Everything assumed a Mexican character. As I was perfectly well aware that my knowledge of the Mexican origin of the mushroom would lead me to imagine only Mexican scenery, I tried deliberately to look on my environment as I knew it normally. But all voluntary efforts to look at things in their customary forms and colors proved ineffective. Whether my eyes were closed or open, I saw only Mexican motifs and colors. When the doctor supervising the experiment bent over to check my blood pressure, he was transformed into an Aztec priest and I would not have been astonished if he had drawn an Obsidian knife." Hofmann also described some of the psychoptic effects, noting: "At the peak of the intoxication, about 1 1/2 hours after ingestion of the mushrooms, the rush of interior pictures, mostly abstract motifs rapidly changing in shape and color, reached such an alarming degree that I feared that I would be torn into this whirlpool of form and color and would dissolve." When the experiment had concluded, Hofmann was happy to have returned home from a very strange and fantastic world. Hofmann then related his mushroom experience to his colleagues, who were later also to ingest them. For subsequent studies, Hofmann and his colleagues used themselves as bioassay, which led quickly to isolation of the active principles, which were subsequently synthesized.

In March of 1958 they published their findings in Experientia. Eight months later, in November of 1958, Drs. A. J. Frey, H. Ott, T. Petrzilka and F. Trozler, all colleagues of Albert Hofmann, then published the chemical structures of psilocybine and psilocine.

The 16 June 1958 issue of Time magazine, reporting on Hofmann's synthesis of psilocybine and psilocine, wrote that he had dissolved five milligrams of pure-white crystals in a test-tube with water and while his colleagues and assistants looked on, had swallowed the potion, lain-down on a couch and waited. Hofmann reported "I am losing my normal bodily sensations... My perception of space and time is changing. ... Your faces appear strange..." and finally, "Now as I close my eyes, I see a wonderful but indistinct kaleidoscopic train of visions. They are vividly colored."

This account of June 16th, 1958, brings confusion to the actual dates of these experiments and is quite different from Hofmann's first reported experience with the 32 dried specimens in which he described himself as being in a partial paranoid- like state. This report of the crystallized chemical intoxication was published between the March, 1958 and November, 1958 issues of *Experientia* as mentioned above. Hofmann soon discovered that the effects from the mushrooms were similar to the effects he had earlier experienced from ingestion of LSD and speculated that both worked on the same part of the brain.

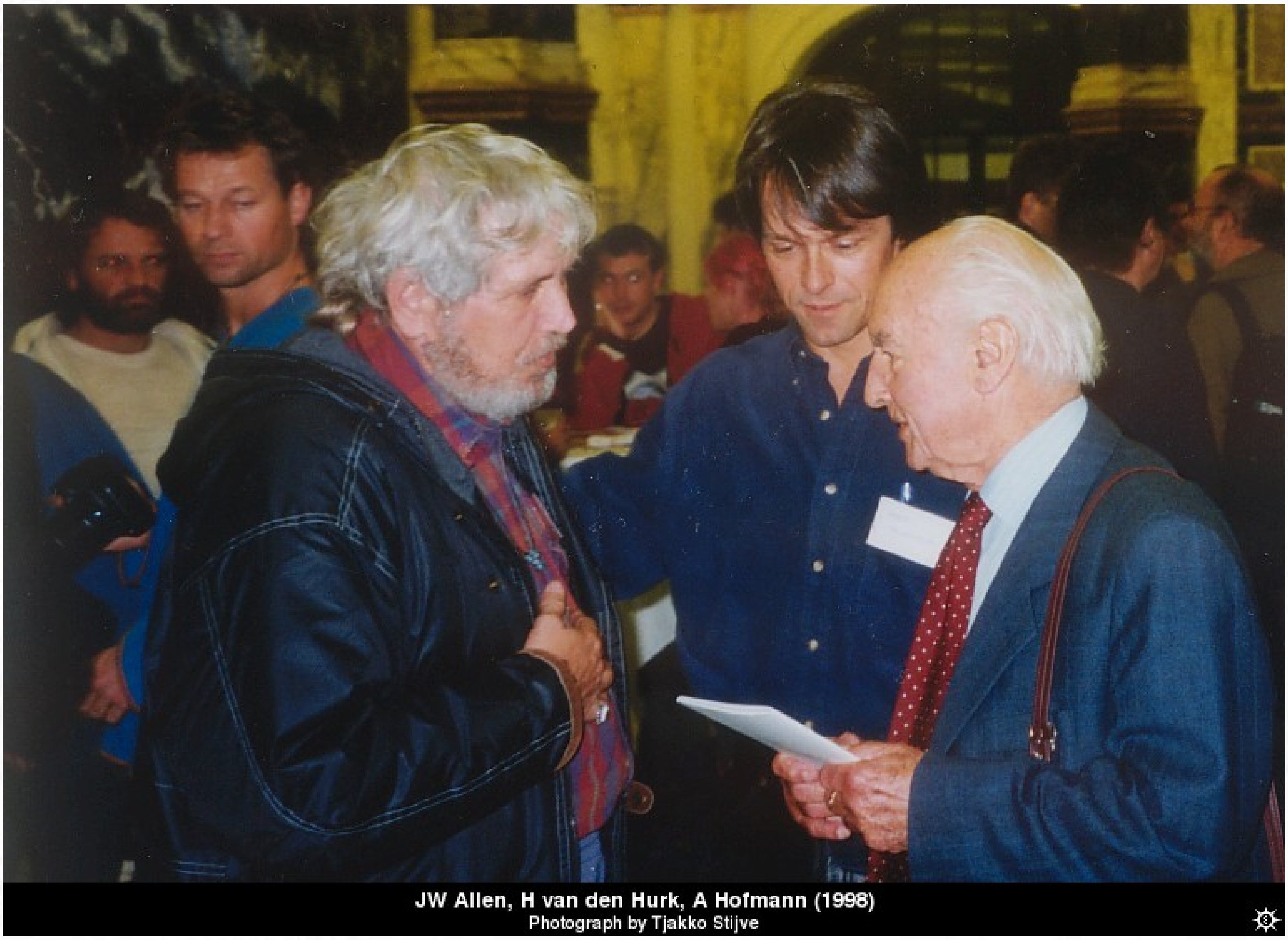

JW Allen, H van den Hurk, A Hofmann (1998)
Photograph by Tjakko Stijve

Fig. 11. John W. Allen, Hans van den Hurk and Albert Hofmann
Amsterdam, Psychoactivity, 1998

Hofmann reported that the mushroomic alkaloids were related to the natural neurotransmitter serotonine (5-hydroxytryptamine) and that their chemical structure was likewise similar to that of LSD. Hofmann and his colleagues named the substances in the Mexican mushrooms psilocybine and psilocine. The former given the pharmaceutical trade-name as "indocybin (Registered trademark)" in recognition of the Indians who first used the mushrooms. Indo both for the Indians and for indole, the nucleus in the chemical structure of psilocybine; and -cybin after Psilocybe. Sandoz then manufactured pills with 2 and 5 milligram doses of Indolcybin (Registered Trademark).

Three years later (Hofmann, 1980)[38], Hofmann and his wife Anita accompanied Gordon Wasson on an expedition to the Sierra Mazateca where they were received most graciously by the now-famous curandera Doña María Sabina. Wasson, Albert and Anita Hofmann attended a *velada* and all requested a potion made from the leaves of *Salvia divinorum*, which gave an experience similar to that of the entheogenic mushrooms, although the duration of the leaves effects were shorter - two-three hours as compared to four-six hours for the mushrooms.

During the *velada*, Doña María Sabina did not consume the *Salvia divinorum* but rather partook of Hofmann's Indocybin pills which he later presented to her as a gift. "She was obviously impressed when it was explained to her that we had managed to confine the spirit of the mushrooms in pills." (Hofmann, 1980)[38] María Sabina reportedly consumed 6 of the 5 milligram pills. In the morning she thanked Hofmann for the pills and added that there was no difference between the effects of the pills and the mushrooms, which quite amazed her. She was happy that now she would be able to perform her ceremonies when the mushrooms were out of season. Much later, however, she said she had not really appreciated that the foreigners had taken the power from the mushrooms and recreated it in a laboratory in the form of pills.

Hofmann and colleagues also synthesized various homologues and analogues of psilocybine (CZ-74, CMY-16, and CY19) and psilocine (CY-39 and CX-59), which were also made available for research by Sandoz and later the National Institute of Mental Health (Baer, 1979)[7].

Albert Hofmann also became a collaborator and close friend of Richard Evans Schultes. Over the years they gave lectures at various conferences on entheogenic plants and also wrote two books describing their studies of entheogens (Schultes & Hofmann, 1973 [111]; Schultes & Hofmann, 1979 [112]).

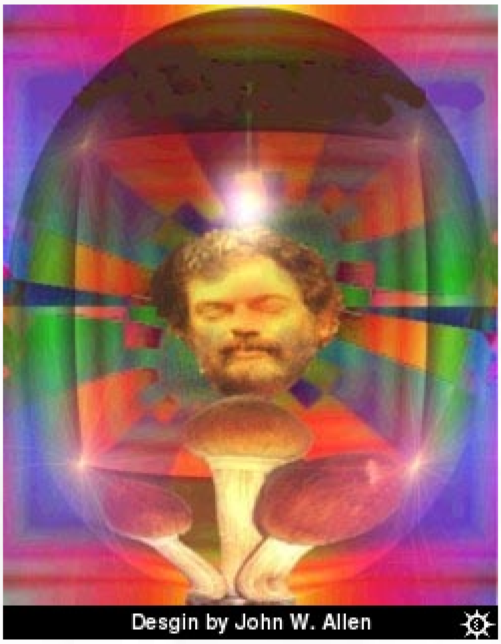

Desgin by John W. Allen

Image 6. In Memory of Terrence McKenna, 1946-2000
Graphic Desgin by John W. Allen

Chapter 7. Mushrooms and Timothy Francis Leary

According to Timothy Francis Leary, he was allegedly conceived on a military reservation known as West Point in 1920. His father Timothy (Tote) was a military man with a penchant for distilled alcohol and his mother Abigail was considered to be the most beautiful woman on post.

After an exciting non-conformist childhood, in August of 1940, Tim, as his father had done before him, entered West Point - a mistake if there ever was one. Because of Tim's shenanigans (drinking and covering up his actions), he was court-martialed and in two minutes of judgment Tim was acquitted. However, his sentence was total silence by his fellow cadets, a silence which lasted for more than seven months. During this period, Tim was constantly harassed and by August of 1941 he had decided to resign his commission from West Point (Leary, 1983)[61].

John W. Allen and Timothy Leary
Photograph by Ron Piper

Fig. 12. John W. Allen and Timothy Leary
Psychedelic Symposium, 1994

In August of 1941, Tim began his study of human behavior at the University of Alabama with psychology as his major, yet by the fall of 1942, Tim was expelled for sexual misconduct and because of his expulsion he lost his draft deferment. In January 1943, Tim reported for basic training at Fort Eustis, Virginia where he was trained in anti-aircraft artillery. After basic training, Tim was selected for Officer's training and before too long Tim was promoted to corporal and assigned to the Acoustic Clinic as a clinical psychologist. After five years in the military, Tim and his new wife Marianne moved west and in 1946, Tim finally received his master's degree in psychology from Washington State University. His thesis was a statistical study of the dimensions of intelligence. In September, Tim was accepted as a doctoral student in psychology at Berkeley. It was at Berkeley where Tim began to foster his ideas on existentialism.

By 1959, Tim had become somewhat successful yet was sufficiently broke. He was the author of numerous scientific papers and two well-regarded books on the diagnosis of personality and had just finished typing a manuscript on new humanist methods for behavior change which he called *Existential Transaction*. Tim was living in a penthouse in Florence, Italy when he was visited by an old drinking buddy from Berkeley, a creativity researcher named Frank Baron. It was Frank who first told Timothy of the Sacred Mexican Magic Mushrooms. Frank even told Timothy that he had brought a bag of the sacred mushrooms back to Harvard. Timothy balked at the idea of the mushrooms and suggested to his friend about the possibility of losing his credibility if he babbled this information to any of his other colleagues. It was Frank Baron who set up an appointment for Tim with David McClelland, Director of the Harvard Center for Personality Research. McClelland was interested in Tim's ideas of existentialism, saying to Tim that "You're just what we need to shake things up at Harvard."

In the summer of 1960 (August), Timothy Leary began his lectureship at Harvard University. This began yet another colorful and exciting chapter in the history of the divine and sacred mushroom. Leary had read R. Gordon Wasson's amazing account recalling his rediscovery of "mushrooms that caused strange visions." This Life magazine article had apparently generated Leary's interest enough so that he wished he could someday experience the effects of the Mexican "magic mushrooms".

Because of Leary's interest in the sacred mushrooms as an adjacent to psychotherapy, clinical applications were soon brought to the academic scene and psilocybin became a new therapeutic tool in psychiatric medicine. This course would soon lead to the widespread recreational use of other drugs such as LSD, mescaline and marijuana, all of which were readily available to students, especially undergraduates, at Harvard University. Such use became pandemic, soon leading to mass civil disobedience in many large metropolitan cities throughout America. All of a sudden, millions of citizens throughout the United States started to take drugs. Eventually, interest and use of psychedelic drugs spread to other countries throughout the world.

While the use of these substances caused no mental or physical problems among those in academic circles where users reported that they experienced euphoria, insight and an awareness of God, there were many new unguided "trippers" who experienced severe dysphoria - resulting in what became known as a "bum trip" or "bad trip". It was because of the "bad trips" resulting from the frivolous use of LSD which eventually led to the prohibited use of these substances by mainstream society's law-making legislature. The death of TV host Art Linkletter's daughter who jumped from a window while high on LSD led the country into a mass hysteria, and many states as well as the Federal Government soon passed legislature banning the use, manufacture and sales of LSD and many other natural entheogenic plant substances. Years later Art Linkletter changed his attitude about many drugs and even felt that marijuana should be legalized.

> **"Timothy Francis Leary holds the honor as the man most responsible for the creation of a new era by which mankind used psychoactive substances in search of neo-religious ideologies through the consumption of certain psychotropic herbs/plants."**
>
> J. W. Allen, "Mushroom Pioneers" (2002)

Timothy Francis Leary holds the honor as the man most responsible for the creation of a new era by which mankind used psychoactive substances in search of neo-religious ideologies through the consumption of certain psychotropic herbs/plants. The use of these magical herbs by individuals who were interested in seeking god caused much confusion and disillusionment in the world. It offered many individuals an alternative lifestyle, one which had not existed for perhaps a millennium.

Because of a few individual dysphoric reactions which occurred in individuals who had ingestion psychoactive drugs, many new laws were created and voted upon, mostly out of fear by legislators who enacted new and harsh drug laws in ignorance - laws which would specifically curb the illicit use of drugs among common citizens of America. This occurred quite hastily in order to pacify the law-enforcement agents who had no real knowledge of drugs. This might cause one to ask, "How can a just society create unjust laws that make criminals out of its citizens?"

These unjust laws eventually brought forth a new breed of American citizens, young and old alike, from all walks of life, including law-enforcement officials. These laws also brought forth an unreal form of civil disobedience, where millions of citizens decided that they were not afraid of being arrested and sent to prison just because they felt that they were within god's right to smoke a joint, eat peyote or consume a sacred mushroom, or any of the other drugs/plants which society deemed to be unacceptable.

Nowhere in any other society or culture in the history of the world have millions of people so blatantly disobeyed the law with such ill-respect as in regards to the drug laws of America. If one is caught breaking these sanctions then that person is liable to prosecution and may be punished for his or her beliefs. Many casual users of entheogenic drugs/plants believe that the plants let them achieve a oneness with god. It must never be forgotten that, when Wasson (1957)[140], Schultes (1978)[106], Leary (1968)[59], and Weil (1980)[138] first experienced the majesty of spirit communion with mushrooms, many of the natural drug-plants were not illegal and that their initial exposure caused a reaction which brought unto them a symbiotic relationship with the magical plant and the true meaning of life. We must never forget that many different species of entheogenic plants were not illegal until the late 1960's and their existence was shared only by an elitist academic segment of society, who for many decades had kept their knowledge sacred and only shared it with their close friends or colleagues.

Under discussion are some of the factors which led to the popularization of hallucinogenic drugs, mushrooms included. The first clue regarding this domino effect, common among those people who have formed a sacred communion with entheogenic healing plants, comes from word of mouth among friends, the public press, drug sub-culture publications, television and Timothy Leary - who was the first person to bring the mushrooms, their effects and their benefits to the attention of the academic public.

While Wasson and his colleagues introduced us into the fascinating world of the "magic mushrooms," it was Leary who introduced us into the "psychedelic" age. He shared his special knowledge with the world. What else could he do once the mushrooms had spoken to him? "Tune in, turn on, drop out" found meaning with many. It became the creed of a whole generation. Imagine that, the beneficial and euphoric rewards of "mind-tripping" into the subconscious, what a trip. Fantastic journeys through the mind. By the early 1970's, President Richard Milhous Nixon had referred to Timothy Leary as "the most dangerous man in the world."

Leary's First Voyage

Prior to the "hippie" and "bohemian" invasion into Mexico during the 1960's by thousands of individuals seeking out the sacred mushrooms, Timothy Francis Leary, still a young Harvard psychologist, was spending his summer vacation in a quiet villa near the tiny village hamlet of Cuernavaca, Mexico. It was at Leary's rented villa resort swimming pool, while relaxing under the hot Mexican sun, that Timothy Leary consumed his first "magic mushrooms."

Leary was waiting for Gerhardt Braun, an anthropologist-historian-linguist from the University of Mexico. Braun was a frequent visitor to Leary's villa, and he had read of the mushrooms while translating ancient Aztec *Nahuatl* texts. His growing interest had aroused something within him, definitely causing him to want to experience the wondrous mushrooms. After a short period of time Braun learned that the so-called "magic mushrooms" could be found growing on the volcanic slopes of Toluca near the village hamlet of San Pedro.

However, it was on the streets of San Pedro, under an arch in the local market, that Gerhardt Braun finally purchased a bag of "magic mushrooms" which he had obtained from an elderly sun-baked Señora named "Old Juana." So, Braun, very excited, then called Leary at the villa in Cuernavaca to inform him that at last he had finally purchased some "magic mushrooms." Leary had first heard of the mushrooms from his friend and colleague Frank Baron. In Baron's own words, "And so I commended the mushroom to the attention of a colleague of mine at Harvard University, Dr. Timothy Leary, who was an active practitioner of group therapy. He [Leary] became interested in its possibilities as a vehicle for inducing change in behavior as a result of the altered state of consciousness that the drug produces (Baron, 1963)[8]." Thus began the "psychedelic age" as Leary and several of his friends would participate in their first communion with the sacred mushrooms of Mexico.

As Leary consumed the fungi (seven mushrooms, *Psilocybe caerulescens* Murr.), he complained of their somewhat bitter and acrid taste with no impending comprehension as to what was about to happen to him. He never thought for one minute that it would forever change the course of his life.

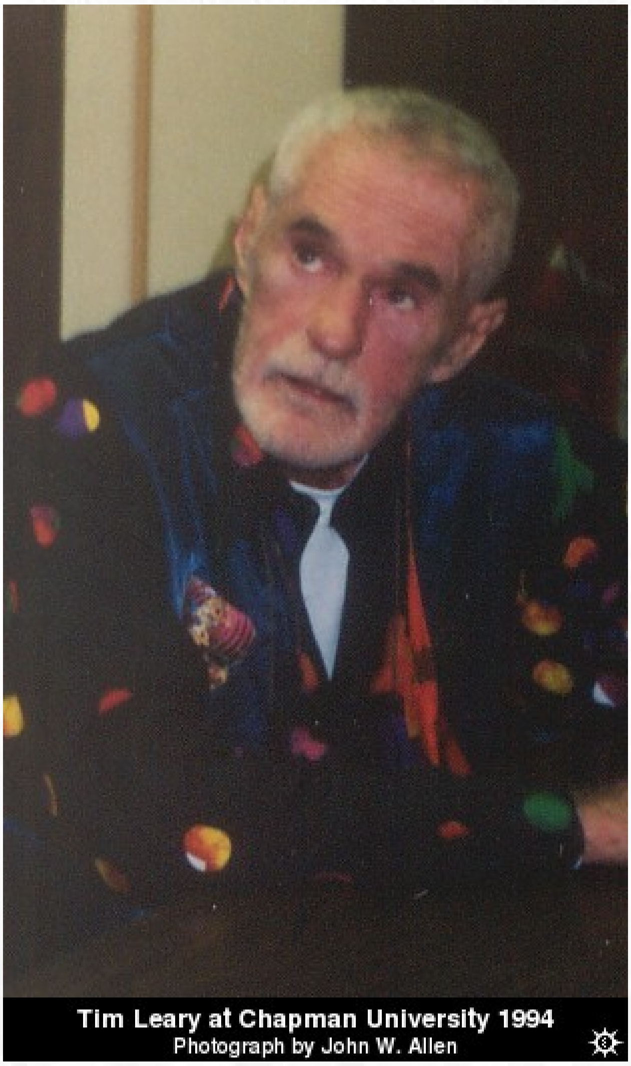

Tim Leary at Chapman University 1994
Photograph by John W. Allen

Fig. 13. Tim Leary Psychedelic Symposium Chapman University, 1994

Leary (1968)[59] later claimed that "It was the classic visionary voyage and I came back a changed man. You are never the same after you've had that one flash glimpse down the cellular time tunnel. You are never the same after you've had the veil drawn." Later, Leary returned to the market place where the mushrooms were purchased from Crazy Juana but he was unable to find her or anyone who might be able to provide him with more specimens of the fungi.

> **"You are never the same after you've had that one flash glimpse down the cellular time tunnel. You are never the same after you've had the veil drawn."**
>
> Timothy Leary, "High Priest" (1968)

Later, Leary's friend and colleague Richard (Baba Ram Dass) Alpert, also from Harvard, had flown down to Mexico and offered Leary a ride back to Massachusetts. Leary decided to share with his friend some comments concerning his mushroom experience by describing to Alpert his most recent ecstatic and religious experience while under the influence of the metaphoric fungi. Leary claimed that "I was whirled through an experience which could be described in many extravagant metaphors but which above all and without question was the deepest [most] religious experience of my life" (Leary, 1968 [59], 1983 [61]).

Alpert's response to Leary's experience came as a shock, since neither person had attained much knowledge in the field of psychoactive drugs. However, Alpert was familiar with the "tea" scene (the use of marijuana and hashish) and related to Leary his impression of the drug marijuana by mentioning that there were cults of beatniks and Bohemians in San Francisco who used hashish and marijuana in dark corners of jazz houses and other nightclubs. They did this in secret out of fear of being arrested for their illicit activities. Alpert even went on to refer to this practice as "cultic." At the time of this conversation, very little research had been conducted involving humans and psychedelic drugs. These comments by Leary and Alpert in the fall of 1960 appeared to be their only knowledge of drugs and drug use. This occurred approximately two to two and a half years before Leary had consumed his first tablet of Sandoz LSD. Of course, it should be mentioned that there were numerous sessions of drug therapy being conducted at Harvard where researchers in a controlled environment gave LSD, mescaline, marijuana, hashish and DMT to student volunteers.

For several years after Leary first consumed the sacred mushrooms in Cuernavaca, he had been offered LSD but was afraid to experiment with it (Metzner, 1970)[75]. The mushroom trip which Leary had experienced would soon trigger a series of events during the next few years, events which would lead to the massive popularization of many mind-altering drug/plants. Leary eventually came to prosthelytize the use of mind-altering chemicals and his advocacy of these drugs played a central role in their re-emergence into western civilization. The use of these drugs was like a religious revival, a revival of people from all walks of life, who would soon become willing pawns in the psychedelization of mind-altering drug/plants. These innocent pawns would soon began to experiment with many varieties of entheogenic drug/plants and use them as sacraments and as a new form or type of recreation. Leary's eminent concern of course would be to use these substances as adjacents to psychotherapy. Soon research grants were sought and applied for and eventually approved. Leary soon began to conduct laboratory experiments with human subjects in controlled environments, all within the framework of the law. It should be mentioned that when Leary conducted this research, most, if not all of the drugs he utilized, were legal at the time, possibly with the exception of peyote (mescaline) and marijuana.

The Harvard Psilocybin Project and Marsh Chapel

Leary's first experiments using what became known as psychedelic drugs involved prisoners at the Concord Massachusetts Reformatory for Men. At first, Leary earned public acclamation among his peers and colleagues at Harvard by opening the door into a new and somewhat mystical dimension and an unusual approach to psycho-therapeutic research.

A new adventure and chapter into the often mysterious subconscious mind of man was about to formulate into existence, a concept in therapy that would shake the very foundation of an established Christian-orientated society. A society which would not condone mankind's intellectual use of mind-altering drugs as a way of life.

One of the most important factors which evolved from Leary's research with psychoactive substances was that Leary created an atmosphere where, because of him, millions of individuals began to use hallucinogenic drugs for purposes other than spirituality, healing or divination. However, who is to say that one's experience under the influence of such drugs is not of a religious nature? This frivolous use of mind-altering drugs created an overall negative attitude amongst the ruling class and legislative branches of the government. They were apparently afraid that these drug/plants would enable users to expand their natural minds into a more flexible opened mind and a new way of thinking - a way of thinking which was definitely not adherent within society's moral turpitude and Christian way of living.

Leary also began to turn friends on to these mushrooms and felt that theses sacred mushrooms should only be used by gifted people. Allen Ginsburg ate mushrooms at Leary's home in Millbrook, took off all his clothes and then ran naked from Leary's home.

He was not to be seen for more that a few months. Leary also turned on many other gifted people to the mushrooms during the early and middle 1960's (Koestler, 1960)[49].

Leary first began his program of therapeutic mushroom use by placing an order with Sandoz Pharmaceuticals in Basil, Switzerland, for the mushroom pills known as "indocybin". Leary had no comprehension that his work with hallucinogenic drugs as an adjacent to psycho-therapy would ever become as popular as it did.

On the day Leary received his first batch of "indocybin" pills, he was at his home in MillBrook and his friends soon encouraged him to return to his office at Harvard to retrieve the pills. Leary and his friends had decided that if they were to attempt to use these pills on human subjects then maybe they should try them first. Before the night was over, Leary and several of his friends had somehow managed to consume the entire vial (100/ 2 mg. pills) of "indocybin". This caused Leary to then re-order another vial of the mushroom pills. It took several weeks for the pills to arrive, giving Leary enough time to prepare his group of researchers to begin implementation of his program. Leary, like María Sabina, also believed that the mushroom pills were no different in effect than the actual mushrooms which he had consumed while vacationing in Mexico (Leary, 1968)[59].

During 1961 (Leary, Litwin & Metzner, 1963 [65]; Leary, 1968 [59]), and the following academic year, Leary and Jonathan Clark worked an intensive tightly structured program involving several small groups comprised of inmates from the Concord Massachusetts State Reformatory for Men. The experiments conducted by Leary and his colleagues on prisoners in this institution gave the psychopharmacologists a new insight into each prisoner's mind and life (Leary, 1961e) [57].

One of the primary goals set in the Harvard psilocybin research projects which used LSD, mescaline and psilocybin as an adjacent to psycho-therapy, was to set goals for the prisoners so that upon their release from prison they would be better able to adjust their lives - both physiologically and psychologically - back into society.

Another goal was to help the prisoners by changing their aggressive thinking disorders which originally caused them to be put in prison. It would appear that the ultimate goal of Leary and his associates would be to change these unhappy thinking anti-social individual souls into happy peaceful loving citizens who, upon release from prison, would end up becoming more productive members of society.

The end results of these early experiments using human subjects were quite satisfactory, but inconclusive as far as prison officials were concerned. The program was abruptly halted because of the adverse publicity which surrounded Leary and his use of consciousness-expanding drugs on human volunteers. Thirty-four-years later, follow-up studies to Tim's experiments at Concord were conducted and the results published (Doblin, 1999-2000 [15]; Leary, 1963 [58]; Leary, 1969 [60]; Leary & Metzner, 1968 [63]; Metzner, 1999-2000 [76]; Metzner & Weil, 1963 [77]; Riedlinger & Leary, 1994 [92]).

Another interesting aspect to Leary's approach to psychoactive substances occurred when Leary administered psilocybin pills to a pregnant woman. Leary provided this subject with psilocybin every two weeks during the woman's pregnancy until her delivery. Leary continued to do follow-up research on the woman for about one year after the child was born. Both the woman and child suffered no ill effects from the consumption of the mushroom pills. The mother did experience some nausea with vomiting while under the influence of the mushroom pills, but no other uncomfortable, unpleasant, or undesirable effects were noticeable or reported during the experience (Leary, Litwin & Metzner, 1963)[65]. Other studies by JWA in 1976-1977 (unpublished notes) indicate that severe nausea does occur from the consumption of psilocybin-containing mushrooms if taken during pregnancy and if taken with alcohol. Furthermore, no one should ever, under any set of circumstances, take any drugs when pregnant unless prescribed by a physician.

Another well-publicized experiment occurred in a University Chapel in Boston on the evening of Good Friday 1962. It was here that twenty theology students took part in Walter Pahnke's Psilocybin experiments. Ten students were given 30 mg. of psilocybin and ten others were given 200 mg. of nicotinic acid, laced with a small amount of Benzedrine to stimulate the initial physical sensations attributed to a psychedelic experience.

This experiment became know as "The Miracle of Marsh Chapel". During the following six months after this experiment, researchers collected extensive data which included tape recordings, group discussions, follow-up interviews and a 147 - item questionnaire used in quantifying the characteristics of a psychedelic experience (Stevens, 1987c [126], d [127]; Leary, 1961c [55], 1961d [56]; Koestler,1961 [41]; Roberts & Jesse, 1998 [96]).

Eventually, Tim was fired from Harvard for failure to attend his lectures. Interestingly, it was partially the fault of Harvard Crimson reporter Andrew Weil that brought Tim Leary his walking papers. Weil had been reporting on Tim's extra-curricular activities involving the giving of drugs to undergraduates which resulted in the firing of both Tim and his friend and colleague Richard (Baba Ram Dass) Alpert (Unsigned, 1963a [133], 1963b [134]).

Years later, John Lennon and Yoko Ono wrote Tim that they had written a song during their Toronto bed-in in Tim's honor. The song: "Come Together".

In June of 1996, Tim Leary passed away and in March of 1997, one gram of Timothy Leary's cremated ashes, along with the ashes of "Star Trek's" Gene Roddenberry and 23 others, was launched into space via a satellite and is now part of the universe.

As a final word regarding some of the early research involved with hallucinogenic mushrooms, the author remembers hearing a story which circulated during the early 1970's which indicated that Sandoz laboratories in Mexico allegedly received a grant to study psilocybin.

They were supposed to manufacture a headache tablet to replace aspirin. According to this story, Sandoz could not produce a pill for headaches because they could not separate the visuals from the tranquil effects of the mushroom experience. It should be noted that this story has not been verified by the author. However, it would appear that if Sandoz had conducted such investigations, they could have made a mild pill which would have produced mild tranquillity in patients rather then a hallucinogenic visual experience.

Logo For Mushroom John's Shroom World
Design by John W. Allen

Image 7: John's Logo For Mushroom John's Shroom World
Graphic Design: John W. Allen

Chapter 8. Biographies of Other Mushroom Pioneers

Below are several dozen short biographies of some of those psilophorians whose interest in the sacred mushrooms goes far beyond that of their own minds.

Arno Adelaars - graduated from the University of Amsterdam, is a Dutch freelance journalist and has published a fine book on European psilocybian mushrooms, "*Alles Over Paddo*'s". Adelaars, together with Hans van den Hurk and Claudia Müller-Ebeling, were the organizers of the October 1998 "Psychoactivity" conference at the Tropen Museum in Amsterdam.

Michael Aldrich - is curator of the Fitz Hugh Ludlow Memorial Library and author of "*The Dope Chronicles 1850-1950*". Mr. Aldrich presides over the largest collection ever assembled of drug-related material from all over the world.

John Marc Allegro - was a British theologian and expert in ancient and archaic languages of Asia Minor (1925-1988). During the 1950s, Allegro was a colleague of the international team of scientists assigned to decipher and translate the Dead Sea Scrolls and was therefore made an Honorary Adviser by King Hussein of Jordan. The publication of his brilliantly written basic study on the fly agaric as a possible origin of early Christian belief systems (*The Sacred Mushroom and the Cross*, 1970) gave him worldwide recognition, but led also to furious hostilities by orthodox theologians, who reacted angrily at the thought provoking title of his book and not justly recognizing the value of the scientific records which Allegro had formulated within the book.

John W. Allen - is an amateur ethnomycologist living in North America. Mr. Allen is the author of ten books (including *Magic Mushrooms of the Pacific Northwest* (1976-1997) the oldest selling identification guide on entheogenic mushroom identification) and more than two dozen articles on the subject of visionary mushrooms and the editor and author of the series *Ethnomycological Journals Sacred Mushroom Studies*. Additionally, Mr. Allen has photographed mushrooms in America, Hawai'i, Southeast Asia, Great Britain and Europe.
Furthermore, Mr. Allen is the discoverer of a new entheogenic mushroom species from Thailand, named *Psilocybe samuiensis* Guzmán, Bandala and Allen. Since the late 1980's Allen has lectured at conferences and symposia, given many slide-show presentations on the history and identification of entheogenic mushrooms and mushroom art throughout the ages at various universities world-wide. His current works include the new CD-ROM, Volume V of *Ethnomycological Journals Sacred Mushroom Studies*, *Psilocybian Mushroom Cultivation: A Brief History* co-authored with Jochen Gartz, Volume VII: Mushroom Pioneers (February 2002) and a forthcoming bibliography of psilocybian and other species of Entheogenic Fungi also co-authored by Dr. Jochen Gartz of the University of Leipzig, Germany.

John W. Allen
Photograph by Dave of Beauty and the Books

Fig. 14. John W. Allen
Photo by Dave of Beauty and the Books, 1997

Richard Alpert - also known as Baba Ram Dass, was Timothy Leary's colleague. He has worked extensively in the field of transcendental meditation, yoga and other eastern philosophies. Alpert, along with Leary, obtained a supply of synthetic psilocybine from Sandoz for use in experiments on prisoners at the Concord State Prison in Massachusetts.

James Arthur - (1958-2005) was deeply involved in studying mushrooms and religion. He was an author, lecturer, and performer who argued that A. muscaria and psilocybian mushrooms were very influential in Christianity and other religions. Arthur explored the idea that Religions have become entities far removed from their original intention as helpers of mankind and have, through ego-inspired misinterpretation of revelation and/or simple control motivation, becomes oppressive to mankind. His views were controversial and disputed by other authors in the field. Arthur also spoke publicly about other topics such as UFOs.

Wolfgang Bauer - is a German psychologist who has studied extensively on optical illusions by Prof. Rausch at the J.W. Goethe - Universität in Frankfurt/Main. Bauer is also editor of Sergius Golowin's classic treatise on witches herbs and magic mushrooms (*Magie der verbotenen Märchen*, Hamburg, 1973), which became a cult-book in the Seventies and which was secretly xerox-copied in the then communistic eastern part of Germany and later redistributed in the hippie-underground there. Furthermore, Bauer is co-editor of *Integration - Journal for Mind-Moving Plants and Culture* and also editor and co-author of *Der Fliegenpilz - Traumkult, Märchenzauber, Mythenrausch* (Aarau 2000). His collection of objects relating to the fly-agaric has been exhibited by the Karl Ernst Osthaus-Museum (Hagen) several times throughout many European Museums.

Michael Beug - was Academic Dean at Evergreen State College in Olympia, Washington. Beug has taught mushroom identification at Evergreen and at mushroom conferences throughout the U.S.A. since 1972. He is also a contributor of photographs to more than a dozen books, and has published numerous scientific papers on mushroom toxins and mushroom- identification keys.

Frank Barron - was a colleague of Timothy Leary, who first told Leary that he had brought some mushrooms he had obtained in México back to Harvard. This was the first Leary had heard of their special power, and later inspired Leary to ingest these special mushrooms.

Antonio Bianchi - is an Italian anesthesiologist and toxicologist, and is an expert on visionary mescaline-containing cacti from Perú (San Pedro) and México (péyote). Bianchi has also studied the soma mushroom, *Amanita muscaria*.

Jeremy Bigwood - is a biochemist and mushroom cultivator. In the late 1970's Bigwood was a co-ordinator of the Second International Conference on Hallucinogenic Mushrooms, where he lectured on new and improved methods for the cultivation of *Psilocybe cubensis*. Bigwood was also co-editor with Jonathan Ott and contributor to *Teonanacatl: Hallucinogenic Mushrooms of North America*. He attended Evergreen State College in Washington State where he collaborated both with Michael Beug and Jonathan Ott. Bigwood and Michael Beug contributed two scientific articles to the Journal of Ethnopharmacology on potency levels of in vitro grown specimens of P. cubensis and other psilocybian mushrooms from the Pacific Northwest of the United States. Furthermore, Bigwood and Ott presented one of the first methods for inoculating shrooms spores using syringes.

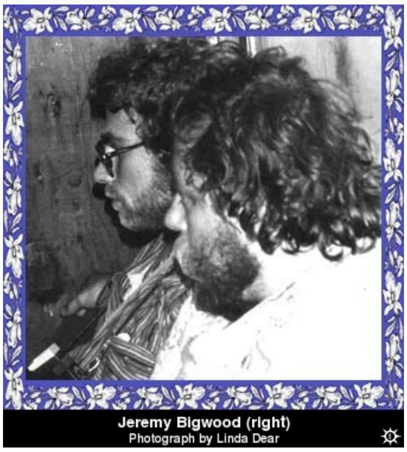


Fig. 15. Jeremy Bigwood (right). Photo: Linda Dear

Richard Glen Boire - is a California attorney who defends clients charged with drug-law violations. He is the publisher of a newsletter The Entheogenic Law Reporter, devoted to drug-related law and news. Boire is also the author of *Sacred Mushrooms and the Law* and *Marijuana Law*.

Masha Wasson Briten - is the adopted daughter of R. Gordon Wasson, who, along with her mother, Valentina Pavlova Wasson, became the first westerner to consume the magic mushrooms outside of a ceremonial context.

J. Christopher Brown - is a graduate student in Botany at the University of Massachusetts who helped to organize the Gordon and Tina Wasson Ethnomycological Collection at the Harvard Botanical Museum.

Carlos Castaneda - is an anthropologist who has written several novels ostensibly about a Yaqui Indian medicine-man named Don Juan. In the what is the first saga, being an account of an alleged relationship with a Yaqui Indian medicine man, *The Teachings of Don Juan: A Yaqui Way of Knowledge*, mentions a smoking-mixture which Don Juan allegedly referred to as humilito.
According to Castaneda, this smoking-mixture contained psilocybian mushrooms ground into a fine powder. This book led many pilgrims to México in search of the "magic mushrooms." It should be noted that no other Yaqui Indians are known to use psilocybian mushrooms, nor have the mushrooms ever been reported to be smoked elsewhere by anyone in México.

Stephan F. de Borhegyi - is an archaeologist who studied the mushroom stones of Middle America and published a few papers regarding them.

Jim de Korne - is the author of *Psychedelic Shamanism* and has contributed two chapters in his book on the sacred mushrooms.

Richard de Mille - has exhaustedly studied the Carlos Castaneda controversy in the process shedding doubt on the authenticity of Castaneda's research and his books concerning his relationship with the (to De Mille) non-existent shaman, Don Juan.

Herman de Vries - is a Dutch artist who is also editor-in-chief of *Integration - Journal of Mind Moving Plants and Culture*. De Vries, spent most of his life suffering from asthma. Doctors told him that he would not lived beyond fifty years of age. However, on the 17th of January 1970, De Vries said goodbye to his illness after an LSD-experience which forever changed his life. And since that very day he has been in the best of health. De Vries believes that as a humans we all have an existential basic right to test and experience all the possibilities which nature offers us. As an artist, De Vries has participated in almost 500 exhibitions and his works are represented in 48 museums.

Rick Doblin - is the founder and current president of *MAPS* (Multidisciplinary Association for Psychedelic Studies) and has recently conducted a follow-up study to Timothy Leary's, Concord Psilocybin Prison Project. Rick is currently in the Ph.D. program in Public Policy at Harvard's Kennedy School of Government and has previously graduated from Stan and Christina Grof's Holotropic Breathwork 3-year training program.

Wendy Doniger O'Flaherty - was co-author with R. Gordon Wasson of *Soma: Divine Mushroom of Immortality*, and is an expert on the Hindu epic *Reg Veda*, also having edited an anthology with some of the original text.

William Emboden - is Professor of Biology at the University of California at Northridge and author of *Narcotic Plants*, an excellent book on visionary and other psychoactive plants. A section of this fine book is devoted to mushrooms.

Leonard Enos - is author of the first identification manual for psilocybine-containing mushrooms common in the Pacific Northwest United States. Mr. Enos' "*A Key to the North American Psilocybin Mushroom*" is poorly written, illustrated with imaginative water-colors of the common species, and tells the prospective collector where, when and how to find several species of psilocybian mushrooms. There is also a un-practical chapter on cultivation of psilocybian mushrooms and another chapter on a so-called philosophy involving psilocybin mushrooms.

Alvaro Estrada - is a Mazatec Indian who speaks and writes Spanish. His interviews with María Sabina were the basis for her autobiography *Vida de María Sabina: La Sabia de Hongos*, translated into French as "*Autobiographie de María Sabina: La Sage aux Champignons Sacrés*"; English as "*María Sabina: Her Life, Her Chants*"; into Portuguese as "*A Vida de María Sabina, a Sabia dos Cogumelos*"; and in German as "*María Sabina: Botin der Heiligen Pilze*".

Michael Fehr - is director of the Karl Ernst Osthaus-Museum in Hagen (Germany). Fehr has organized several exhibitions on the studies and use of the fly-agaric mushroom *Amanita muscaria*. One article of importance to this work has Dr. Fehr discussing the role of psychoactive fungi as objects of museum didactic considerations published in *Der Fliegenpilz* - ein kulturhistorisches Museum (Köln, 1991), a book, of which Michael Fehr is also the editor.

Francisco Festi - is a researcher of entheogenic mushrooms and author of *Funghi Allucinogeni: Aspetti Psicofisiologici E Storici* (in Italian, 1985). An excellent book covering both Old and New World histories of usage, chemistry and pharmacology of these interesting mushrooms.

Nat Finkelstein - was just a young student when he traveled to México in the late 1960's. While their he was most fortunate to consume the sacred mushrooms. Finkelstein later wrote of his experience in an article for *Psychedelic Review* "Hongi Meester" relating his personal mushroom velada with María Sabina.

Peter Furst - is Professor Emeritus of Anthropology at the State University of New York at Albany, a member of the American Department of the University Museum at the University of Pennsylvania, and a research associate in ethnobotany at the Botanical Museum of Harvard University. Furst is the author of *Hallucinogens and Culture*; *Flesh of the Gods*; and *Mushrooms: Psychedelic Fungi*. The latter is part of the *Encyclopedia of Psychoactive Drugs* series.

Jochen Gartz - is a biochemist and mycologist at the University of Leipzig, Germany. Gartz is also founder of the Department of Fungal Biotransformation at that University. Gartz has traveled extensively and conducted field-research in Europe, South Africa and the US Pacific Northwest. He has authored more than 50 scientific papers on the chemistry and cultivation of entheogenic mushrooms and has authored field guides (publ. in German and English) for the identification of psilocybian mushrooms. Gartz is the discoverer of a new entheogenic mushroom from Africa, which he named *Psilocybe natalensis*. His books include *Magic Mushrooms Around the World* (1996), an English translation of the two German editions of "*Narrenschwämme*" (1993); and (co-authored two books on CD-ROM with John W. Allen) "*Magic Mushrooms in Some Third World Countries*" (1998) and "*Psilocybian Mushroom Cultivation: A Brief History*" of which the latter is currently being translated into a German edition by Gartz.

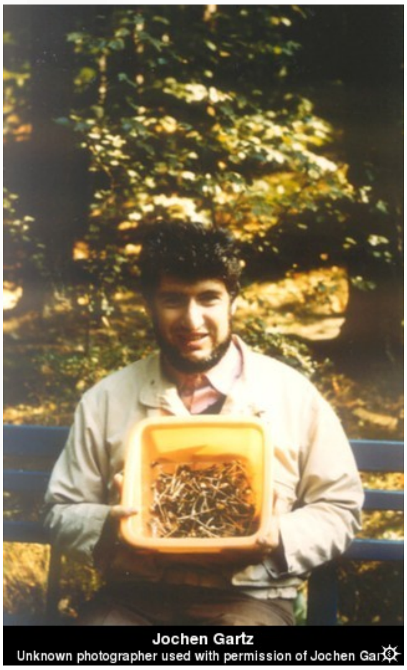

Jochen Gartz
Unknown photographer used with permission of Jochen Gar

Fig. 16. Jochen Gartz

JW Allen, A Shulgin, J Gartz (1994)
Photograph by Tropy Donahue

Fig. 17. John W. Allen, Sasha Shulgin and Jochen Gartz
Chapman University, 1994

Rich Gee - is co-author with Jule Stevens of *How to Grow and Identify Psilocybin Mushrooms* and author of an aquarium guide to the latest techniques for growing psychoactive mushrooms, *Cubensis Aquarium Gardening Workbook Edition*. Mr. Gee is a pioneer in the field of mushroom cultivation.

Ewald Gerhardt - is a European mycologist who has just published a revision of the genus *Panaeolus*.

Hartmut Geerken - is a german writer, musician and paramycologist. As a child Geerken shared a symbiotic relationship with wild edible mushrooms which helped in his survival during the famine after world war II. Increasingly intererested in fungi Geerken eventually became the Editor-in-Chief of *Paramykologische Rundschau* (a paramycological review; 1979 cont.). Geerken also conducted several field studies of Afghan fungi and in the late 1970s along the Afghan-Pakistani border discoverd the up to then unknown "*boletus (tubiporus) pactiae* gee". (s. *Afghanistan Journal*, Graz; 1978/1). Geerken also worked on hallucinogenic mushrooms and mycological folklore healing practises in the middle hindukush and introduced the term rabenbrot to the mycological discussion. In Namibia he did research on the Termitomyces 'omajowa'. Additionally, Geerken has also published numerous books of contemporary literature, directed radio plays and performances and composed musical works in which mushrooms always played an important role. He is also playing the musical works of the mycologist John Cage.

Allen Ginsburg - was one of the first people Timothy Leary introduced to psilocybian mushrooms. According to Leary, Ginsburg, after becoming inebriated by the mushrooms, ripped-off all of his clothes and from Leary's Millbrook estate ran stark naked down the street and was not to be heard from until several months later.

F. F. Ghouled - is author of The Field Guide to Psilocybin Mushrooms. Ghouled, along with colleague Richard Meridith, later published Psilocybin Cultivation after changing his name to F. C. Gould. This former book described collection of *Psilocybe cubensis* found only in the Southeastern United States from Texas to Florida and north to Georgia. Ghouled also alleged *Amanita muscaria* was the famed "magic mushroom" of México [sic!] and mis-identified two photographs of *Psilocybe cubensis* in their young stage of grow as *Panaeolus subbalteatus*.

Sergius Golowin - is a renown Swiss writer and folklorist, who in his book *Die Magie der verbotenen Märchen* (Hamburg, 1973), was the first person to infer that there was a connection between the caps of the dwarfs and other beings in fairy tales and the appearance of the fly agaric, a mushroom which sports a red cap (hat). Golowin is also the founder of the Psychedelic Folklore (Psychedelische Volkskunde) and has made in the early Seventies, a very impressive experiment when he bioassayed seven dried caps of the fly agaric. The account of his experience is printed in *Der Fliegenpilz - Traumkult, Märchenzauber, Mythenrausch*. Furthermore, when Dr. Timothy Leary was arrested in Switzerland after his flight from the U.S.A., Golowin started an initiative intended to get Leary out of Swiss prison and later attempted to help Leary get a residence permit for Leary to remain in Switzerland.

Adam Gottlieb - is author of *The Psilocybin Producer's Guide*, a poorly written book on cultivation with several identification errors which were never corrected in subsequent printings (*Psychedelic Underground Library: Nine Rare Classics*) and reissues of the original book and later the same errors were reprinted in an updated version of his booklet retitled as *Psilocybin Production*.

Robert Graves - was a British author and historian Who wrote also on Greek Mythology and was one of the first persons to whom R. Gordon Wasson gave the sacred-Mexican mushrooms. Graves wrote several articles about mushrooms, including one in which he described his experience while under the influence of psilocybian mushrooms - This article appeared in an issue of *Holiday* magazine (Graves, 1962)[26].

Gastón Guzmán - is a Mexican mycologist, co-founder and past President of the Mexican Mycological Society. Guzmán has spent more than 44 years studying mushrooms, working mainly in taxonomy, ecology and ethnomycology. He presently works at the Instituto de Ecología, Xalapa, Veracruz, México, where he founded the Mycology Department in 1989.

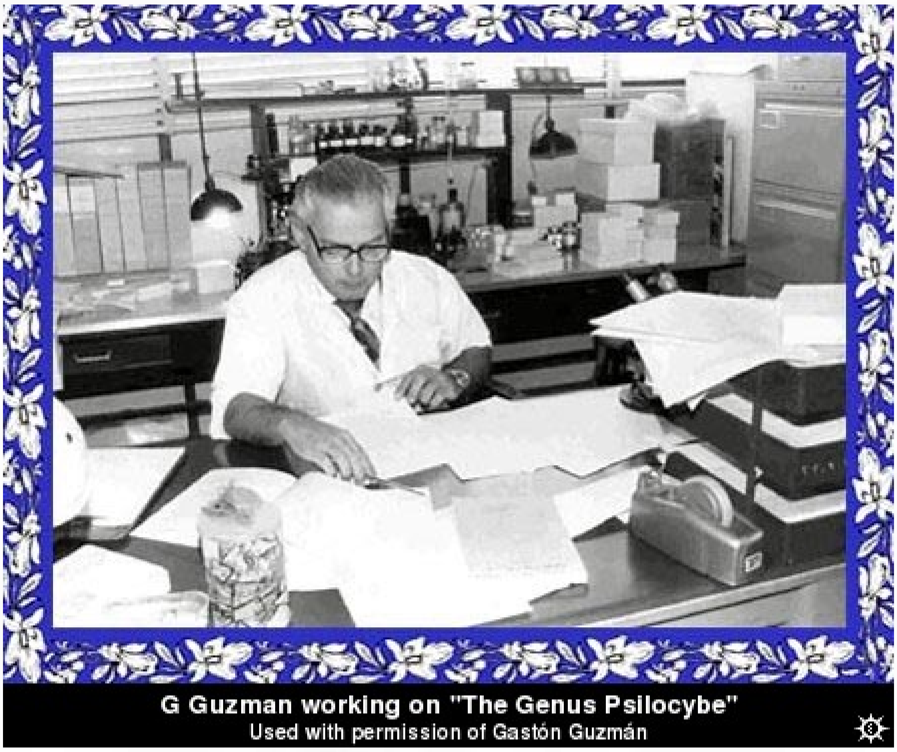

G Guzman working on "The Genus Psilocybe"
Used with permission of Gastón Guzmán

Fig. 18. Gastón Guzmán in his laboratory working on his Monograph *The Genus Psilocybe*

Guzmán has published more than 350 papers on fungi and 8 books. His first book, published in 1977 was the first mushroom field guide published in Mexico. In 1983 Cramer published his monograph on Psilocybe (now out of print): *The Genus Psilocybe: A Systematic Revision of the Known Species Including the History, Distribution and Chemistry of the Hallucinogenic Species*. In 1995 Cramer also published a supplement to that monograph. Guzmán had described more than one hundred new species of Psilocybe throughout the world. His most recent book, published in 1997, is a checklist of Spanish names for mushroom species of Latin American mushrooms, a monumental work covering more than 5,500 common names with scientific equivalents (over 1600 species). Guzmán began his first studies in 1955 and 1957 became field assistant to Rolf Singer, then investigating the hallucinogenic fungi of México. In an obscure village of southern México, Guzmán attended an Indian ceremony where he partook of the visionary mushroom (*Psilocybe cubensis*).

Since 1995 and 1997 Guzmán has been honored as an Emeritus National Research Fellow in Mexico and an Emeritus Research Fellow of his Institution. Guzmán's current work is *A Worldwide Geographical Distribution of the Neurotropic Fungi, Analysis and Discussion*, a listing all of the known psychoactive species (218 and counting) and their worldwide distribution, co authored with John W. Allen and Jochen Gartz. This large monograph will appear in the Italian Journal *Annal des Musei Civici de Rovereto*. Guzmán is considered to be the leading authority on the taxonomy of the Mexican entheogenic mushrooms.

Richard and Karen Haard - were not directly involved in the study of hallucinogenic mushrooms, but they did publish in the mid-1970's one of the first field guides devoted specifically to the identification of both poisonous and hallucinogenic mushrooms of the Pacific Northwest United States. Richard Haard, Ph.D., is a graduate of Kansas State University, and formerly an associate Professor of Biology at Western Washington State College. Haard taught at the Nature Study Institute, Bellingham, Washington, which he and his wife Karen founded in 1974, and also worked as a biological-system consultant for various Indian tribes of North America. Karen Haard, B.Sc. is also a graduate of Kansas State University, and a former research technician in a biological laboratory.

Joan Halifax - is an anthropologist with an interest in shamanism and preliterate cultures that have used drug-plants. She was a close friend of R. Gordon Wasson's.

Martin Hanslmeier - is a German physician and psychotherapist who has been engaged in the study of mycology since childhood. Hanslmeier is also a painter and photographer of psychoactive fungi. His study on German psychoactive mushrooms (Mykographie einer Wiese in der Rhön) has been printed in Herman de Vries' catalogue of a large collection of herbs and plants (Natural relations, Nürnberg 1989). Also numerous articles on magic mushrooms have appeared in many journals and publications throughout Germany.

Bob Harris - is the author of *Growing Wild Mushrooms* and the creator, along with David Tatelman, of the Homestead Mushroom Kit. Harris also invented a wheat-straw pasteurizer to be used in mushroom cultivation.

Roger Heim - was the noted French mycologist who accompanied R. Gordon Wasson on several expeditions into the Sierra Madre of México and identified taxonomically the first seven species of hallucinogenic fungi used in traditional healing ceremonies in Oaxaca, México [see Wasson, 1957 [140];Heim & Wasson, 1958 [33]]. Heim contributed amply to scientific journals, including more than fifty articles concerning the sacred mushrooms of México and, together with his colleague Roger Cailleux and many other specialists, was first to cultivate the entheogenic mushrooms.

Margaret Holden - is an English mycologist who reported on the poisoning of a young boy who had allegedly consumed *Panaeolina foenisecii*. Similar intoxications were reported by the Australian physician R. V. Southcott (1974)[119] and by the American mycologist Orson Miller, (1971)[79].

Hans van den Hurk - is the founder of the Conscious Dreams Smart Shop and wholesale operation in Amsterdam, which legally sells fresh psilocybian mushrooms, péyotl and other natural entheogens. Conscious Dreams, which now has five shops in Holland, was the first Smart Shop in Amsterdam and also the first to offer psilocybian mushrooms for sale. Conscious Dreams is renowned throughout Europe. Currently The legality of psilocybian mushrooms in the Netherlands is being challenged by the courts.

Aldous Huxley - spent the last decade of his life in the study of entheogens, after Humphrey Osmond introduced him to mescaline in 1953. Mr. Huxley is the author of *Brave New World* and *Island*, both of which were about drugs and their integration into society.

Jim Jacobs - has done field-work on psychoactive mushrooms throughout México, Canada, and the United States since 1975. His collections were described in the monograph *The Genus Psilocybe* by Gastón Guzmán. Jacobs is a member of the Oregon Mycological Society's Toxicology Committee and is an independent consultant with Oregon's Poison Control Center. Recently a species of *Psilocybe* was named in his honor *Psilocybe jacobii* Guzmán.

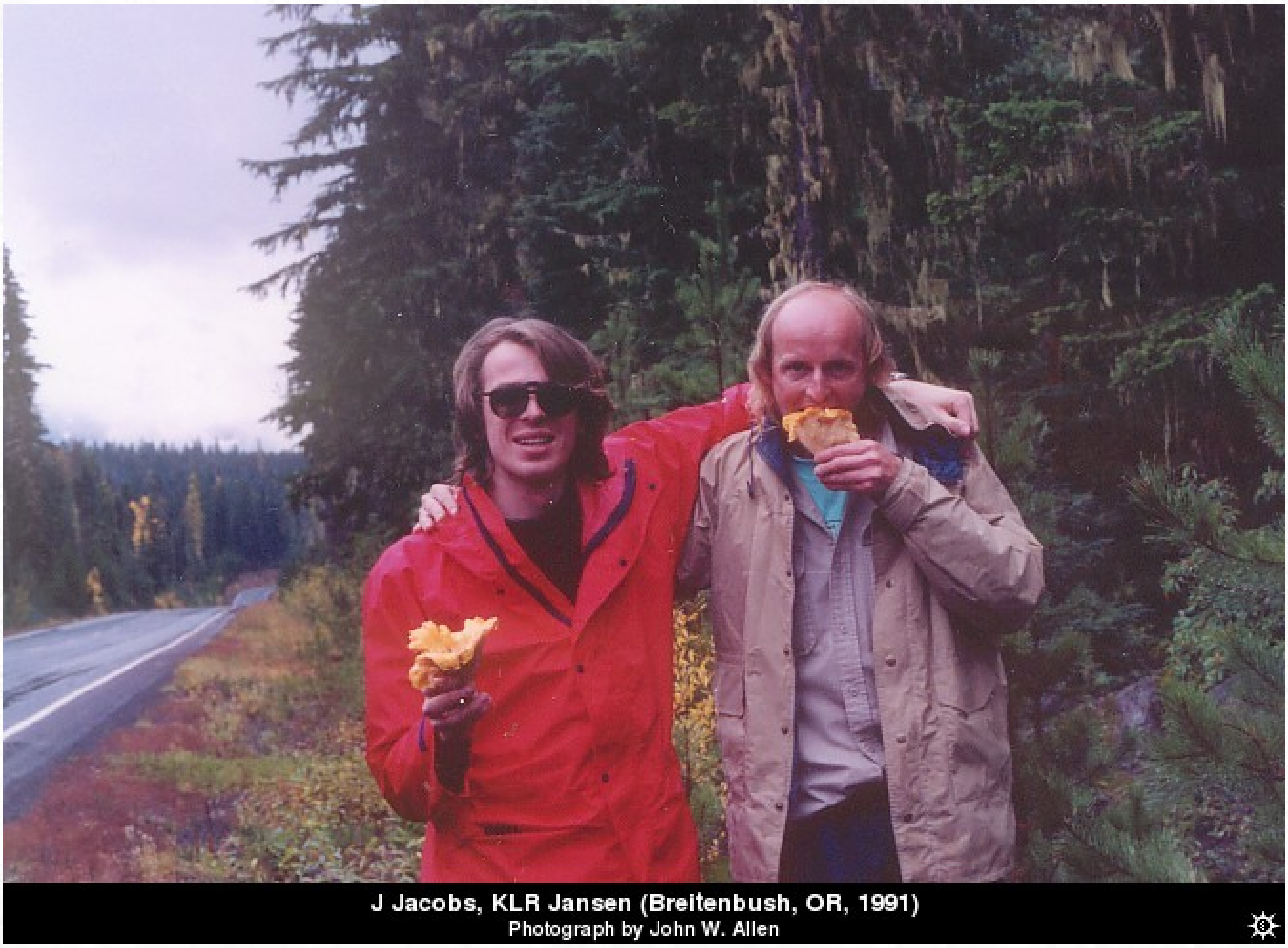

J Jacobs, KLR Jansen (Breitenbush, OR, 1991)
Photograph by John W. Allen

Fig. 19. Jim Jacobs and Karl L. R. Jansen
Chantrelle hunting, Breittenbush, Oregon, 1991

Karl L. R. Jansen - is the M. D., Ph. D., is a member of the Royal College of Psychiatrists and is the co-author, together with John W. Allen and Mark D. Merlin, of the paper *An Ethnomycological review of Psychoactive Agarics in Australia and New Zealand*, was published in a 1991 issue of Journal of Psychoactive Drugs. Jansen is also one of the worlds leading experts on ketamine. He has studied ketamine at every level: from photographing the receptors to which ketamine binds in the human brain, to publishing numerous papers on his discovery of the similarities between ketamine's psychoactive effect and the near-death experience. His writings have appeared in over 30 medical journals and popular magazines of our times. Jansen's recent book, *Ketamine: Dreams and Realities*, is a *tour de force*, and the authoritative tome on the subject. Jansen has also published several papers on the Thai narcotic plant known as *kratom* (*Mitragyna speciosa*).

JW Allen, KLR Jansen (Breitenbush, OR, 1991)
Photograph by Jim Jacobs

Fig. 20. John W. Allen and Karl L. R. Jansen
Breittenbush, Oregon, 1991

Irmgard Weitlaner Johnson - is a specialist in prehispanic and contemporary Mesoamerican textiles and was one of the first westerners to witness a sacred mushroom ceremony.

Everett Kardel - a pioneer in publishing a successful Indentification manual for Pacific Northwest Psilocybe mushrooms is an Oregon author of an early identification guide for mushrooms of the Pacific Northwest (*Magic Mushrooms*), a unique pamphlet printed on a mimeograph machine.

Keewaydinoquay - [M. Peschel] is a North American Indian shaman from Miniss Kitigan, Michigan, a member of the Ahnishinaubeg, one of the few Native American tribes (located in Northern Michigan and Southern Ontario) known to uses a mushroom [*Amanita muscaria*] in a ceremonial context.

Edzard Klapp - has studied under the tuttledge of the well-known German mycologist Hans Haas (*Die Pilze Mittel-Europas*), having, at an early age, discovered the strangeness and the hidden secrets of the sacred fungi. In 1971, Klapp encountered *The Sacred Mushroom* and was began a long-time correspondence with the author John Marco Allegro. Further nurturing Allegro's beliefs, Klapp wrote an essay in 1982 (Rabenbrot). In this essay, Klapp discusses the amanita and its relationship and its association in hypothesis to the bread which the raven brought to Elija the prophet in the Holy Bible. This essay has been reprinted on many ocassions. The metalinguistic term "intentional speech" proved hereby of heurestic value. Carrying on his thesis, Klapp wrote *The Masks of the Fly Agaric* printed in *Der Fliegenpilz - Traumkult, Märchenzauber, Mythenrausch* (Aarau 2000).

Stanley Krippner - Ph.D., is Professor of Psychology at Saybrook Graduate School, San Francisco, California. He is a Fellow of the American Psychological Association, the Association of Clinical and Experimental Hypnosis, the Society for the Scientific Study of Sex, and is a Charter Fellow of the American Psychological Society and the American Academy of Clinical Sexologists. He is a member of the American Anthropological Association, the Association for the Study of Dreams, The International Council of Psychologists, the InterAmerican Psychological Association, The American Academy of Social and Political Science, the Center for Shamanic Studies, and a Charter Member of the International Society for Multiple Personality and Dissociation. He served as Director of the Dream Laboratory at Maimonides Medical Center in Brooklyn for ten years, and for three years was director of the Child Study Center, Kent State University. Dr. Krippner has been a visiting Professor at the College of Life Sciences, Bogota, Colombia and the University of Puerto Rico, and a Lecturer at the University of Minais Gerais, Belo Horizonte, Brazil. He is co-author of several books, including *The Mythic Path*, *Personal Mythology*, *Spiritual Dimensions of Healing*, and *Healing States*, co-editor of *Broken Images, Broken Selves*, and editor of *Dreamtime and Dreamwork* as well as eight volumes of *Advances in Parapsychological Research*. He has authored or co-authored over 500 journal articles, book chapters and monographs. Dr. Krippner, along with co-author Michael Winkleman, contributed a fine article on María Sabina to *The Journal of Psychoactive Drugs* and has a long term interest in shamanic medicine of Third World countries.

Weston LaBarre - is an anthropologist with a special interest in the use of entheogens by primitive societies. He is author both of *The Peyote Cult*, the definitive book on the peyote religion, and *The Ghost Dance: The Origins of Religion* and numerous journal publications on the subject of drug-use in primitive cultures.

Martin A. Lee and Bruce Shlain - are authors of *Acid Dreams: The CIA, LSD, and the Sixties Rebellion*, a book which retells the story of the CIA infiltration of R. Gordon Wasson's expedition to México in 1956. Their book also provides some insight into Timothy Leary's research at Harvard. See John Marks and Jay Stevens.

Roger Liggenstorfer - is co-editor of *María Sabina. Botin der heilige Pilze*. Liggenstorfer has contributed numerous articles to scientific publications. Additionally, Liggenstorfer also believes in "Oink" (the hidden power of *Psilocybe cyanescens*) which is derived from an experience on *Psilocybe cyanescens*, see his book on María Sabina.

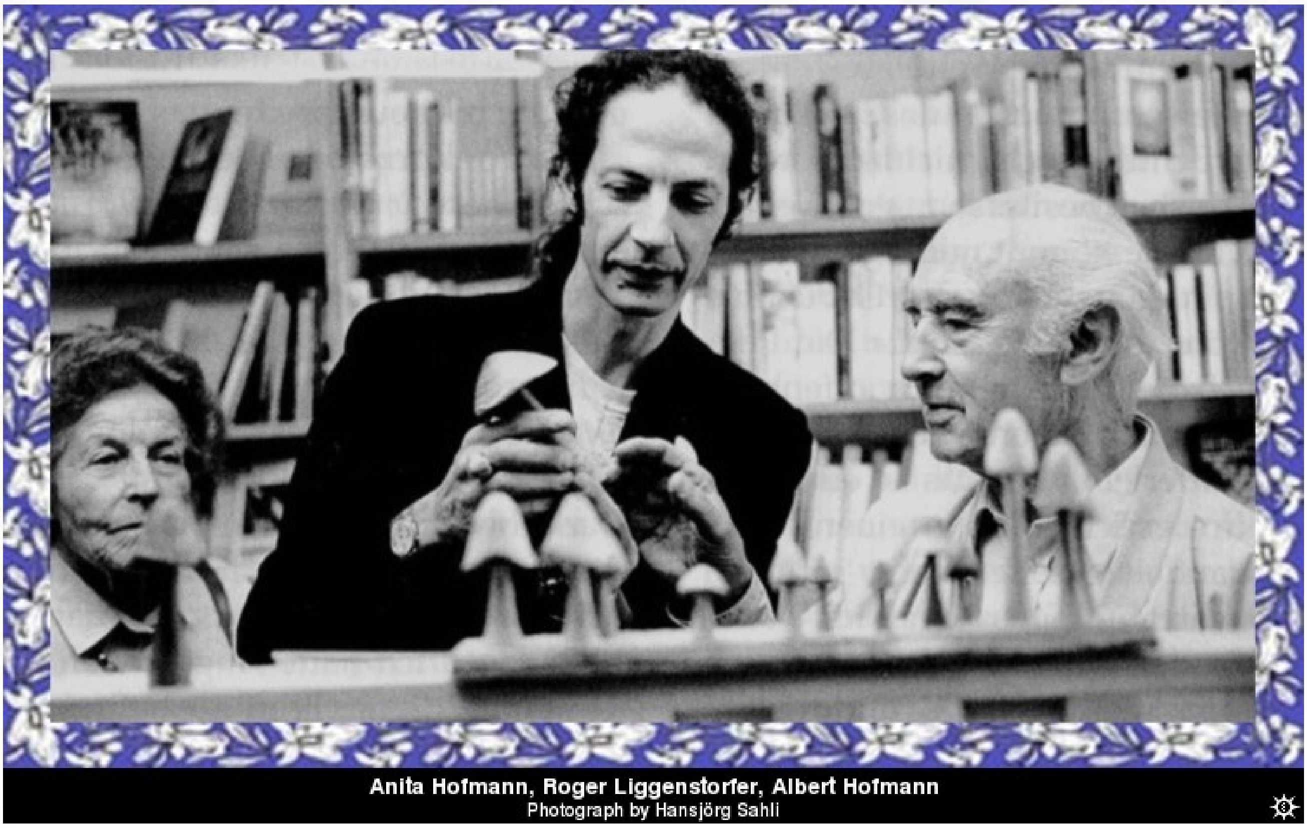

Anita Hofmann, Roger Liggenstorfer, Albert Hofmann
Photograph by Hansjörg Sahli

Fig. 21. Anita Hofmann, Roger Liggenstorfer and Albert Hofmann. Photo: Hansjörg Sahli

Gary Lincoff - is president of the North American Mycological Society, employed at the New York Botanical Garden and is editor of the *Audubon Field Guide to the North American Mushrooms* and *The Simon and Schuster Mushroom Field Guide*. Lincoff has also contributed, with D. H. Mitchell, a 35-page chapter to the book *Toxic and Hallucinogenic Mushroom Poisoning*.

Frank J. Lipp - is professor in the Department of Anthropology of Duke University and has studied the use of psilocybian mushrooms among the Chinantec and Mixe of Oaxaca, México.

Bernard Lowy - was professor Emeritus in the Botany Department of Louisiana State University. He has served for 15 years as a member of the editorial board of Mycologia and contributed numerous articles on hallucinogenic mushrooms, including describing his collection of *Psilocybe mexicana* in Guatemala. He is posthumous co-author of a forthcoming book on the history of entheogenic mushrooms.

Thomas Lyttle - is editor and publisher of the now-defunct journal *Psychedelic Monographs and Essays*. Currently the editor of *Psychedelics reimagined*.

John Marks - is author of *The Search for the Manchurian Candidate*. Marks first uncovered the story of the CIA's infiltration of R. Gordon Wasson's Mexican mushroom expedition in 1956. See related information under James Moore, Jay Stevens and Lee & Shlain.

Dennis McKenna - has been involved in the interdisciplinary study of ethnopharmacology and plant hallucinogens for the past 25 years. He is co-author, with his brother Terence, of *The Invisible Landscape: Mind, Hallucinogens, and the I Ching*, a philosophical and metaphysical exploration of the ontological implications of psychedelic drugs which resulted from the two brothers' early investigations of Amazonian hallucinogens in 1971. He received his doctorate in 1984 from the University of British Columbia. His doctoral research focused on ethnopharmacological investigations of the botany, chemistry, and pharmacology of ayahuasca and oo-koo-he, two orally-active tryptamine-based hallucinogens used by indigenous peoples in the Northwest Amazon. Following the completion of his doctorate, Dr. McKenna received post-doctoral research fellowships in the Laboratory of Clinical Pharmacology, National Institute of Mental Health, and in the Department of Neurology, Stanford University School of Medicine. In 1990, he joined Shaman Pharmaceuticals as Director of Ethnopharmacology. He relocated to Minnesota in 1993 to join the Aveda Corporation, a manufacturer of natural cosmetic products, as Senior Research Pharmacognosist. He currently works as a scientific consultant to clients in the herbal, nutritional, and pharmaceutical industries. Together with two colleagues in the natural products industry, he incorporated the non-profit Institute for Natural Products Research (INPR) in October 1998 to promote research and scientific education with respect to botanical medicines and other natural medicines. Additionally, McKenna serves on the Advisory Board of the American Botanical Council, and on the Editorial Board of Phytomedicine, International Journal of Phytotherapy and Phytopharmacology.
He is a founding board member and Vice-President of the Heffter Research Institute, a non-profit scientific organization dedicated to the investigation of therapeutic applications for psychedelic plants and compounds and has also served as board member and Research Advisor to Botanical Dimensions, a non-profit organization dedicated to the investigation of ethnomedically significant plants. He was a primary organizer and key scientific collaborator for the Hoasca Project, an international biomedical study of Hoasca, a psychoactive drink used in ritual contexts by indigenous peoples and syncretic religious groups in Brasil. He has conducted extensive ethnobotanical fieldwork in the Peruvian, Colombian, and Brasilian Amazon. He has served as invited speaker at numerous scientific congresses, seminars, and symposia. Dr. McKenna is author or co-author of over 35 scientific papers in peer-reviewed journals. His publications have appeared in the *Journal of Ethnopharmacology*, *European Journal of Pharmacology*, *Brain Research*, *Journal of Neuroscience*,*Journal of Neurochemistry*, *Journal of Nervous and Mental Disease*, *Economic Botany*, and elsewhere. Additionally, Dennis McKenna and his brother Terence, using the pseudonyms O. N. Oeric and O. T. Oss, published the first popular of several psilocybin mushroom growing guides in the 1970s. In fact, it was Dennis McKenna who actually devised the technology for growing these mushrooms in jars.

Terence McKenna - was a world-renowned guru of sacred mushrooms, author, evangelistic proselyte of the Amazon and the mind; and a noted lecturer, specializing in shamanic-plants, entheogens from the Amazon and spiritual transformation. Born in 1946, McKenna has spent the last twenty-five years of his life studying the ontological foundations of shamanism, in digesting mushrooms, yopo snuff, and ayahuasca. Together with his brother Dennis he published *The Invisible Landscape: Mind, Hallucinogens and the I Ching*, a scientific and philosophical effort to explain the results of their investigations into the phenomena of time and tryptamine pharmacology.

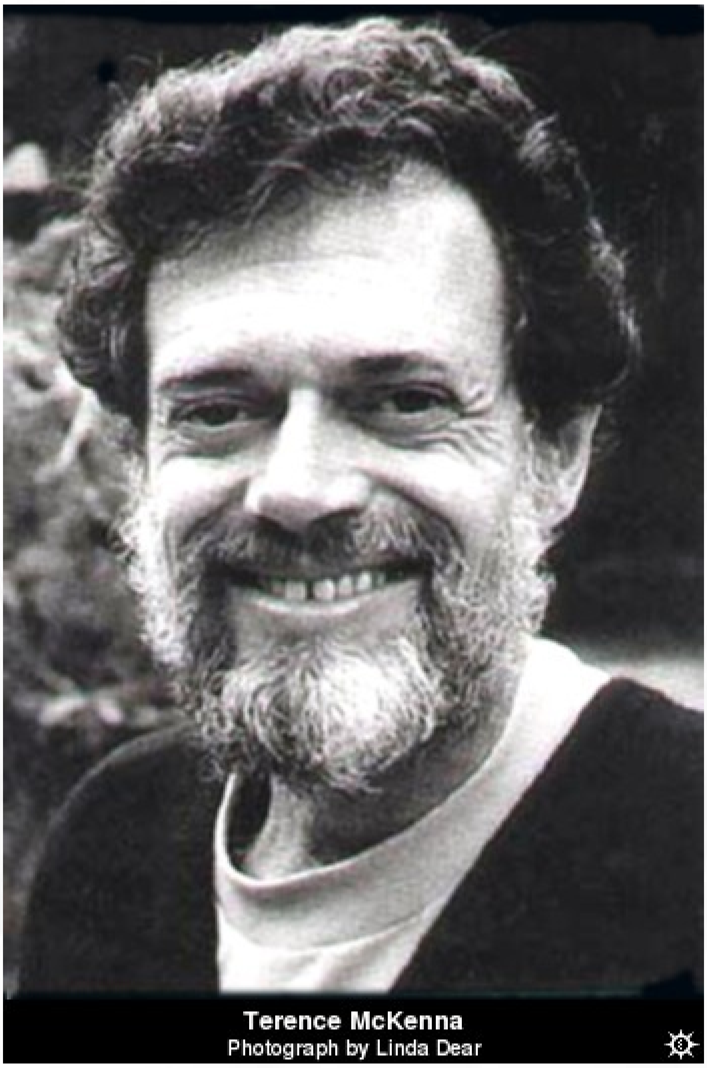


Fig. 22. Terence McKenna

A narrative of the brothers adventures in the Amazon was the subject of a later book by Terence, *True Hallucinations*, although his last trip to the Amazon occurred in 1981 when he accompanied his brother Dennis on an expedition, sponsored by the University of British Columbia, to investigate the use of oo-koo-he, an orally active Virola hallucinogen used by the Witotos and Boras in Peru and Columbia. A graduate of the University of California at Berkeley, McKenna survived the sixties by traveling extensively in the Asian and New World Tropics and extensively studied and lectured on shamanism of the Amazon basin. Terence, along with his wife Kat Harrison and brother Dennis, was also a co-founder of Botanical Dimensions, a non-profit botanical garden on the Island of Hawai'i. Additionally, Terence was a popular lecturer among college students. Besides being co-author with his brother Dennis *The Invisible Landscape* and the classic cultivation guide written under the pseudonyms of Oeric and Oss, Terence was also the author of *Food of the Gods*. Terence passed away in April, 2000 from terminal brain cancer and he will be surely be missed by those whose paths he crossed and touched.

Gary Menser - was a real estate agent in Florence, Oregon and a past President of the Eugene, Oregon Mycological Society. He was author of Hallucinogenic and Poisonous Mushroom Field Guide (later retitled Magikal Mushroom Handbook). Menser was also an expert on truffles and their collection.

Mark D. Merlin - is a biogeographer in the Biology Program of the University of Hawai'i at Manoa with special interest in the ethnobotany and cultural history of entheogenic plants. He has published academic press books on *Cannabis* [*Man and Marijuana: Some Aspects of Their Ancient Relationship*, Fairleigh Dickinson, University Press, 1972], opium or *Papaver somniferum* [*On the Trail of the Ancient Opium Poppy*, Associated University Presses, 1984], and more recently co-authored a book kava (*Piper methysticum*), an important traditional drug-plant of many Pacific Islands [*Kava: The Pacific Drug*, Yale University Press, 1992]. The latter publication was later retitled as *Kava: The Pacific Elixer*. Dr. Merlin has also co-authored seven papers with John W. Allen on identification and non-traditional use of entheogenic mushrooms in Hawai'i and Southeast Asia.

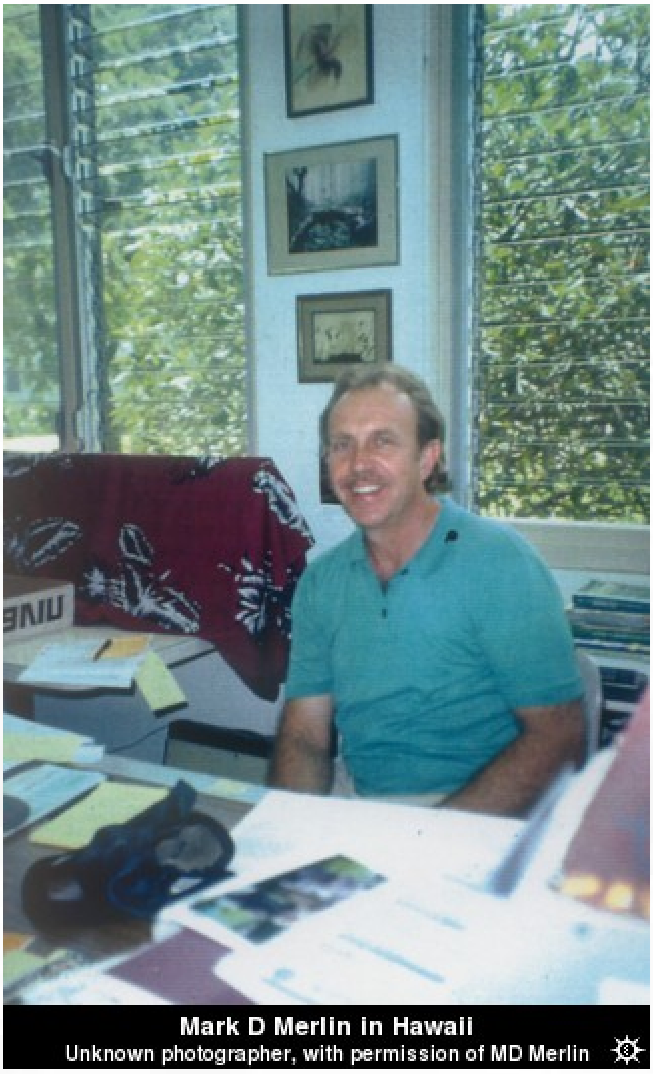

Mark D Merlin in Hawaii
Unknown photographer, with permission of MD Merlin

Fig. 23. Mark D. Merlin
In his office, Hawaii

Richard Alan Miller - is a warlock and herbalist who co-authored with David Tatleman the first psilocybian mushroom handbook featuring color photographs for identification of psilocybian mushrooms: *The Magikal Mushroom Handbook*. Miller also wrote another book, *Magikal and Ritual Use of Herbs*. In the first edition of the latter publication, Miller reported on the (non-existent) sexual mushroom-rituals of the Mazatec Indians. However, the Indians of Oaxaca refrain from any sexual activity for three days before and after a sacred mushroom ceremony. This portion of Mr. Miller's book was removed from subsequent editions.

James Moore - was a CIA "short order cook" [a chemist] who infiltrated one of R. Gordon Wasson's mushroom expeditions to Oaxaca, México in 1956. Moore even ingested the mushrooms during a ceremony and according to Peter Stafford (1992)[120], in Moore's own words, Moore recalls that "I had a terrible cold, we damned near starved to death, and I itched all over. There was all this chanting in the dialect. Then they passed the mushrooms around, and we chewed them up. I did feel the hallucinogenic effect, although 'disoriented' would be a better word to describe my reaction." Obviously Moore had an uncomfortable experience, probably due to the fact that he was not whom he appeared to be. His mind caught up with his phoniness and placed him in an awkward and uncomfortable position. Mr. Moore eventually returned to his laboratory in Delaware where he attempted in vain to isolate the active compounds from the mushrooms - compounds which were to be used by the CIA in "non-conventional chemical warfare." Luckily for all of us, Moore was unsuccessful in this endeavor.

Henry Munn - contributed an excellent essay on the mushrooms of language (Munn, 1973)[80].

Richard Hans Norland - is author of *What's In A Mushroom? Part Three*, a book on psilocybian mushrooms which contains a lot of graphs and charts on the chemical analysis of certain species of entheogenic fungi which were collected in the Pacific Northwest region of the United States. It should be noted that Norland failed to publish *What's in a Mushroom?* Parts One and Two. Furthermore Norland also advertised a psilocybian bibliography for $5.00 in advance of publication - This volume was never published.

György-Miklos Ola'h - is a mycologist and chemist at Laval Université in Québec, Canada. In the late 1960's, Ola'h conducted several studies of the genus *Panaeolus* and published a monograph, *Le Genre Panaeolus*, identifying several species *Panaeolus* mushrooms as latent psilocybian and/or non-psilocybian. Ola'h also studied species from Southeast Asia, Africa and the Philippines.

Jonathan Ott - is an ethnopharmacognosist, natural-products chemist and botanical researcher, is considered by many to be the "Master of Entheogens." A protégé of R. Gordon Wasson, Ott was one of the original organizers of the now-famous mushroom conferences of the late 1970's. Ott is founder of Natural Products Co., a small chemical-manufacturing business based in Vashon, Washington.

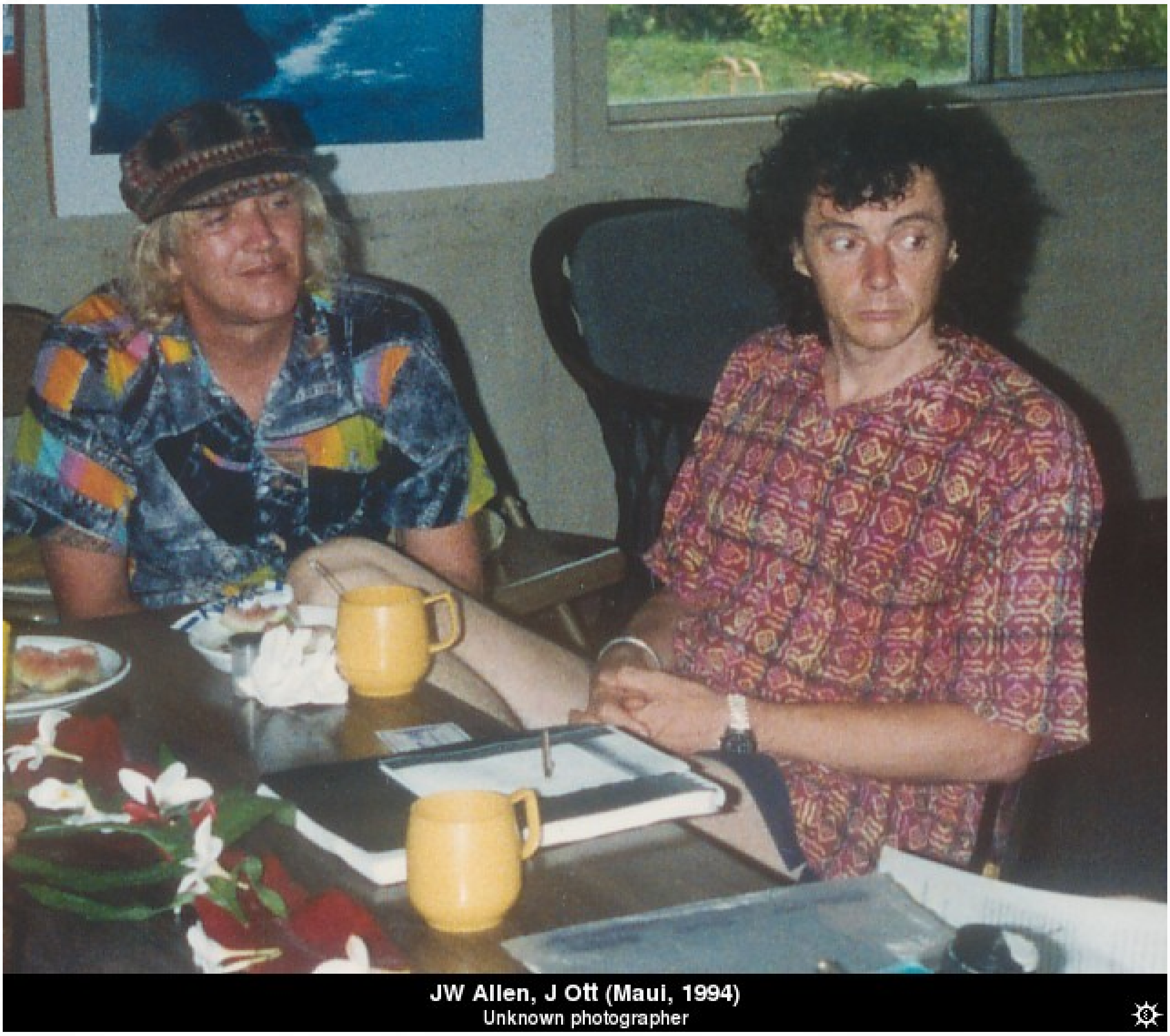


Fig. 24. John W. Allen and Jonathan Ott
Botanical Preservation Corps, Maui, 1994

He is a fellow of the Linnean Society, and a long time member of the American Association for the Advancement of Science, the Society for Economic Botany and the Society of Ethnobiology. Ott co-authored a book and paper with his friend and teacher, the late ethnomycologist R. Gordon Wasson and has also collaborated closely with Richard Evans Schultes and Albert Hofmann. Furthermore, Ott is the author of

Hallucinogenic Plants of North America, book on The Proceedings of the 2nd International Conference on Hallucinogenic Mushrooms, *Teonanácatl: Hallucinogenic Mushrooms of North America* (co-edited with Jeremy Bigwood) both out-of print, as well as *The Cacahuatl Eater: Ruminations of an Unabashed Chocolate Addict*, *Pharmacotheon: Entheogenic Drugs, their Plant Sources and History*. Most recently he published a book on the famous South American visionary-drug, *Ayahuasca Analogues*, as well as *The Age of Entheogens* and *The Angels' Dictionary* and *Pharmacophilia or the Natural Paradises*. Ott is working on a book of shamanic snuffs. Ott, together with Rob Montgomery, conducts annual seminars under the auspices of Entheobotany Seminars Corps. These annual entheogenic-plant seminars have taken place in Equador, Maui, Hawai'i, Veracruz and Palenque, Mexico.

Steven Peele - is curator and President of the Florida Mycology Research Center. At one time, Mr. Peele was the only private citizen in the United States who had a Schedule One permit for possession and sale of psilocybe spores, mushrooms and mushroom-cultures. Due to unorthodox methods for storage of such material, the DEA withdrew his permit. Peele publishes a newsletter, *The Mushroom Culture: Journal of Mushroom Cultivation* and a second Journal, *TEO: The International Journal of Psychoactive Mushrooms*.

Eunice V. Pike and Florence Cowan - are Wycliff Bible translators who lived among the Mazatec Indians of Oaxaca. They wrote two articles in *Practical Anthropology* on the Mazatecs who used magic mushrooms albeit Christian converts. These two women and Richard Evans Schultes gave R. Gordon Wasson the incentive to search for the mushroom cult he rediscovered in México.

Steven Hayden Pollock - followed in Andrew Weil's footsteps by reporting in scientific journals, a history of the contemporary use of psilocybin mushrooms as recreational drugs. Pollock also contributed several noteworthy papers on both *Psilocybe* and *Panaeolus* species to the scientific and academic communities. He was the first investigator to report on the use of visionary mushrooms in Hawai'i. Pollock was also involved in the propagation of *Psilocybe cubensis* and is noted for the marketing of what he referred to as "Cosmic Camote" or "Philosophers Stone." These epithets were given to the sclerotia of a new species discovered by Pollock, *Psilocybe tampanensis*. Pollock also produced a potent strain of *Psilocybe cubensis* which he named Matias Romero after a town in southwestern Mexico and was the first cultivator to use horse manure and straw compost for cultivating the visionary mushrooms.

Stephen H Pollock (1976)
Photograph by Linda Dear

Fig. 25. Steven Hayden Pollock
1st International Conferenceon Hallucinogenic Mushrooms, 1976
Photo: Linda Dear

Andrija Puharich - was a man who overcame poverty and many personal tragedies who etched his way through medical school, going on and establishing a Parapsychological research foundation to oversee his medical discoveries which covered over 75 patents. Puharich was a maverick, a dedicated researcher, a rebel scientist, scorned by colleagues, and revered and encouraged by those gifted with foresightedness, including Aldous Huxley. His involvement in the field of ethnomycology began when he first filmed forays delving into the ancient mysteries and secrets of the sacred mushroom rites of the Chatino Indians of Mexico and later, on a trip to the Hawaiian Islands where Puharich, along with Hawaiian Kahuna David Bray sought evidence that a mushroom may have been used and played an important role in the early religious rites of the Hawaiian people. Unfortunately, Puharich reported that he had not uncovered any conclusive proof supporting the mushroom theory, based on documented evidence which claimed that the mushrooms, which when eaten, gave the user extra-sensory perception. It was because of the similarity between the Hawaiian word "akua" referring to the supernatural and the word "aku" with a similar meaning in five other areas of the world which brought Puharich to Hawaii. Puharich was also interested in and supported Uri Geller, UFO's and was an authority on E.L.F. (extremely low frequency magnetic fields), pollution and its effects on human organisms. His book *The Sacred Mushroom: Key to the Door of Eternity* is a classic testament to his beliefs in the historical value of these mushrooms.

Christian Rätsch - is a cultural anthropologist from Hamburg, Germany, specializing in the sacred and secular use of magical plants. His fieldwork among the Lacandos of Chiapas includes study of Datura and balché potions. Rätsch's books include *Gateway to Inner Space*, *Dictionary of Sacred and Magical Plants*, and diverse publications on the Maya, alchemy, psychedelics, aphrodisiacs and oracles. Rätsch and his colleague Roger Liggenstorfer co-authored and edited a translation of Estrada's book on the life and times of the Mexican shaman Doña María Sabina (*Maria Sabina: Botin der Heiligen Pilze*). Rätsch is also editor of *The Yearbook for Ethnomedicine and the Study of Consciousness* and author of *Enzyklopädie der psychoaktiven Pflanzen. Botanik, Ethnopharmakologie und Anwendungen*.

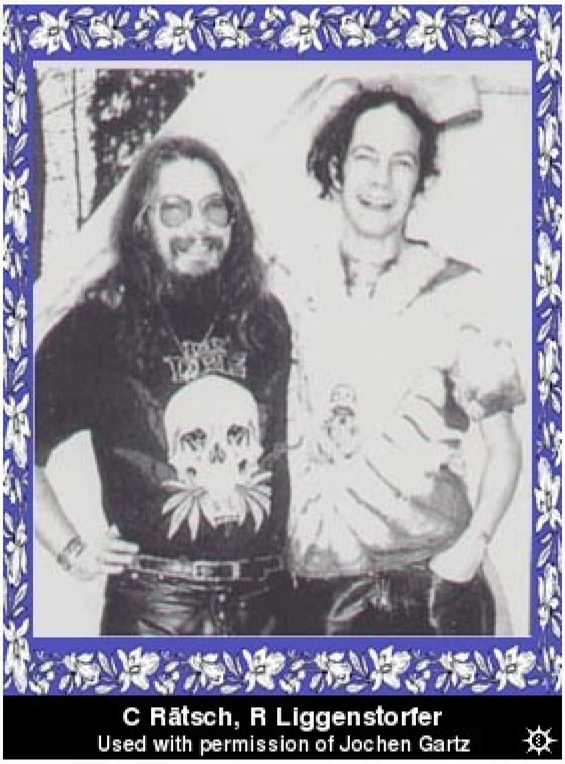

C Rätsch, R Liggenstorfer
Used with permission of Jochen Gartz

Fig. 26. C. Rätsch and R. Liggenstorfer

Alan B. Richardson - is a professional photographer and was a personal friend of R. Gordon Wasson. Richardson's photographs of María Sabina and her nocturnal velada graced the pages of *Life* magazine [May 13, 1957]. Richardson was the first outsider together with R. Gordon Wasson, to eat the sacred mushrooms.

Thomas J. Riedlinger - is a researcher who was editor of *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*. This book contains numerous essays in honor of R. Gordon Wasson, written by those who knew him best.

Ronald Rippchen - is the author and editor of a German book devoted to psilocybian mushrooms. Numerous articles by well-known authors in this field are presented and the book is lavishly illustrated.

Alexandra Rosenbohm - is a German cultural anthropologist and exhibition maker who is a specialist in trance-inducing plants and mushrooms in the context of historic and contemporary shamanism and witchcraft. She has developed and organized several exhibitions regarding that subject and has published books like Halluzinogene Drogen im Schamanismus (about the use of the fly agaric in Siberia). Rosenbohm was also editor and co-author of *Schamanen zwischen Mythos und Moderne* (Leipzig 1999) and *Der Fliegenpilz - Traumkult, Märchenzauber, Mythenrausch* (Aarau 2000).

Barry Rumack and Emanuel Salzman - are authors of an excellent book with several chapters devoted to visionary mushrooms, *Mushroom Poisoning: Diagnosis and Treatment*. It provides a good section on treatment for various kinds of mushroom poisoning, including that of *Amanita muscaria*.

María Sabina - was the famous Mazatec curandera who kept alive the archaic practices of her ancestors the ancient Olmecs, Toltecs and Aztecs. It was Doña María Sabina who first initiated R. Gordon Wasson and Alan Richardson in the "magic mushrooms" of México. Through the writings of Wasson and Wasson (1957)[140], Heim and Wasson (1958)[33] and subsequent writings by others, María Sabina became world-renowned as the most famous shaman of the twentieth century. (see Allen's [1997a][3] volume I of *Ethnomycological Journals Sacred Mushroom Studies* and Estrada's [1976][17] autobiography of María Sabina).

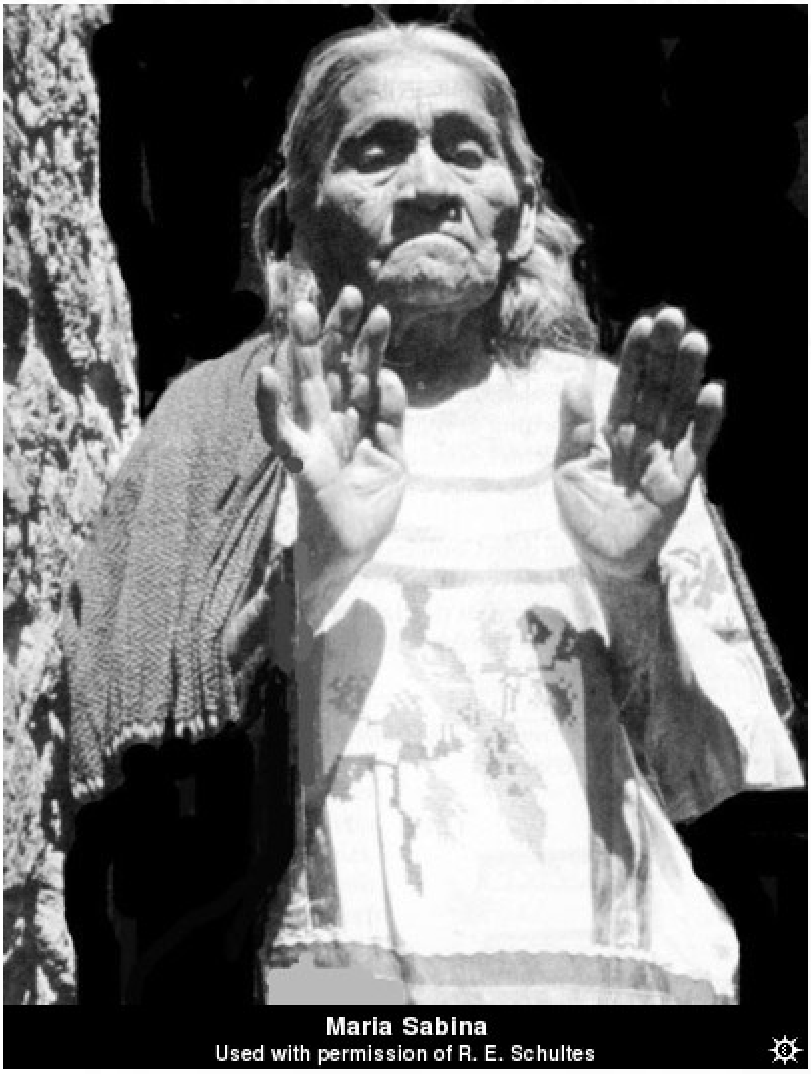

Maria Sabina
Used with permission of R. E. Schultes

Fig. 27. Maria Sabina

Bernardino de Sahagún - was a Franciscan friar who documented the most important historical information on the use of the sacred mushrooms of the New World. It was Sahagún who first wrote down the word teonanácatl. Some other colored Spanish clergymen and historians also mentioned the sacred mushrooms in their writings - these include Juan de Córdova, Jacinto de la Serna, Diego Duran, Francisco Hernández, Alonzo de Molina, and Motolina (a pseudonym for Toribio de Benavente).

Luc Sala - is a German television personality involved in the media and various aspects of the European drug subculture. He is also the author of *Paddos: Our Little Brothers. Starter Guide of Magic Mushroom Psychonauts*. Published in the Netherlands in both English and Dutch editions.

Giorgio Samorini - is an Italian researcher of psychoactive plants and mushrooms with a special interest in the archaeology of mushroom art throughout the ages (including *Amanita* art and the art of the Tassilli plains). Samorini also has a special interest in the African entheogenic/aphrodisiac plant *Tabernanthe iboga*. Samorini is the only white person to have been initiated into the Bwiti cult of Gabon, Africa where this plant is used ceremoniously. Samorini has also studied the mycoflora of Italy.

Jeremy Sandford - is the author of *In Search of the Magic Mushroom*. Sandford describes his adventures in México while seeking out the magic mushrooms he had heard so much about.

J. H. Sanford - is author of an article about the accidental ingestion of psilocybian mushrooms in Japan. Some of the case studies provided by Mr. Sanford date back to the 11th century.

Georges Scheibler - is a Swiss mycologist who published the first European guide to identification of psilocybian mushrooms. After its publication Scheibler was harassed by Swiss authorities. European narcotics agents also believed that his book would lead to widespread abuse of the mushrooms in France and other European countries.

Alexander and Ann Shulgin - are chemists and authors of *Pihkal: Phenlethylamines I Have Known and Loved* and their new monumental work *Tihkal: Tryptamines I Have Known And Loved*, a book about their interest in the tryptamine compounds and the chemistry and chemical formulae of many analogues of psilocine and psilocybine.

Rolf Singer - was a leading figure in mycology who was also a prolific writer who held important academic and research positions in Europe, North America and South America. Singer also was a Research Associate in the Department of Botany at the Field Museum of Natural History in Chicago, Illinois, from 1968-1994. Most noted for developing the nearly universally used classification for the Agaricales (mushrooms and related fungi), Singer reportedly named 86 genera, over 2460 species and infraspecies of fungi distributed in 222 genera. His 440 papers written in 9 languages, covered topics ranging from fungal systematics, nomenclature, ecology, ethnomycology, and mushroom cultivation. Singer, along with noted Michigan mycologist Alexander H. Smith, provided the academic world with the first monograph of the newly discovered species of psilocybian *Psilocybes* and their distribution in the Pacific Northwest of the United States and Mexico. Both of these intrepid scholars hold a special place in the ethnomycology of the sacred mushrooms of Mexico. After Roger Heim provided the taxonomy and naming of the first seven species recognized from México, the late mycologist, accompanied by two young Mexican botanists, M. A. Palacios and Gastón Guzmán, arrived in Oaxaca, México to conduct a taxonomic study on the Mexican mushrooms. Soon they met R. Gordon Wasson, and eventually followed his footsteps tracing the route of the sacred mushrooms throughout Oaxaca, Mexico. Later Singer and his colleague from the University of Michigan, Alexander H. Smith, co-authored a short monograph on the taxonomy of psilocybian mushrooms common in the Pacific Northwestern United States and México (including a few species from México). They also contributed a paper on the sacred mushrooms among the Aztecs and their Náhua descendants. Singer was the second author to note the possible medical use of the sacred mushrooms after Valentina P. Wasson by writing an excellent article on the curative properties of these mushrooms among some groups of indigenous peoples living in Oaxaca (Singer, 1957)[115]. Furthermore, Singer contributed numerous articles to books and journals regarding both the medical and recreational use of the sacred fungi. His book *The Agaricales in Modern Taxonomy* was the first book in modern times to discuss the idea that *Teonanácatl* was a mushroom, even providing some evidence linking the word *Teonanácatl* to certain species.

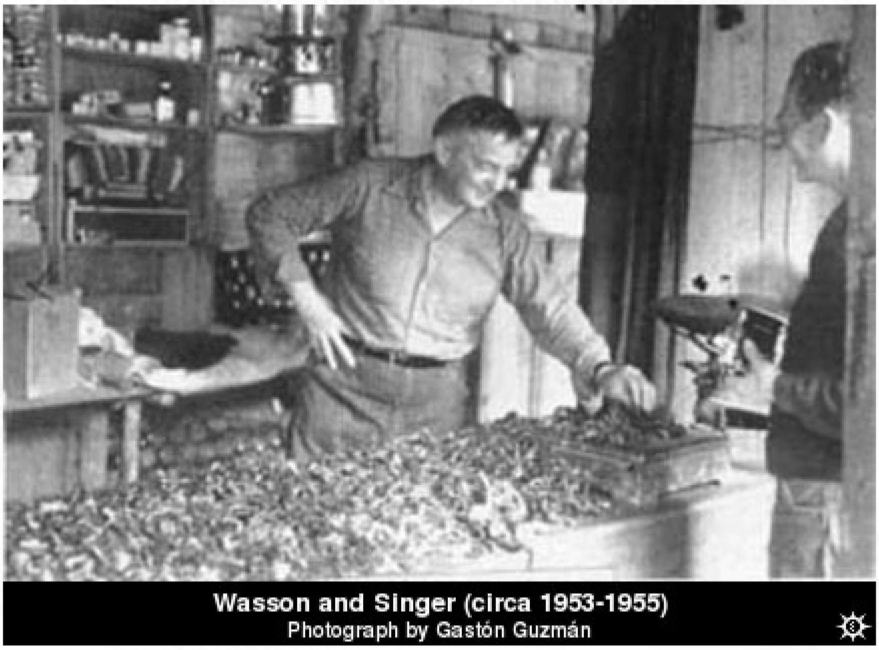

Wasson and Singer (circa 1953-1955)
Photograph by Gastón Guzmán

Fig. 28. Wasson and Singer
Oaxaca mushroom collection, circa 1953-55

Prakitsin Sihanonth - is the head of the Department of Microbiology at Chulalongkorn University in Bangkok, Thailand. Dr. Sihanonth is considered to be a leading authority on mushroom cultivation and excels in the identification of edible, poisonous and psychoactive mushrooms of Thailand.

Alexander H. Smith - was Professor Emeritus of Botany at the University of Michigan and who along with his colleague Rolf Singer, published some of the earliest papers on the occurrence of psilocybian mushrooms in the United States. Smith also once wrote a paper about the hallucinations of those who study hallucinogenic mushrooms, causing several defensive responses in privately published papers between Smith, Ott and Wasson.

Peter Stafford - is author of the *Psychedelics Encyclopedia* which covers many of the entheogenic plants used as ludible drugs by certain segments of contemporary society. This has a fine chapter on the history of entheogenic mushrooms and their pandemic ascent as a popular drug. Mr. Stafford is also a regular contributor to Bruce Eisner's *Island Views*, a quarterly publication devoted to psychedelic drugs and their social use in. Recently Stafford published a new book *Magic Grams*, containing interviews of scholars involved with entheogenic drug research and/or who's interest were similar and the pages are mingled with montages and collages.

Paul Stamets - is the Paul Bunyan of mushrooms common to the Pacific Northwest United States. Stamets has been studying mushrooms in the woods of the Pacific Northwest for more than twenty years, and has discovered and co-authored four new psilocybian mushrooms: *Psilocybe azurescens*, *P. cyanofibrillosa*, *P. liniformans* var. *americana*, and *P. weilii*. Stamets also runs a mushroomic mail-order business, Fungi Perfecti, which grows and sells gourmet and medicinal (no psilocybian) mushrooms, and conducts in-depth workshops on edible-mushroom cultivation. Stamets has lectured on psilocybian mushrooms at numerous universities and presented seminars and slide-presentations all over the world. His books include *Psilocybe Mushrooms and Their Allies* [out of print], *The Mushroom Cultivator* co-authored by Jeff S. Chilton, *Growing Gourmet and Medicinal Mushrooms*, and the recent book *Psilocybin Mushrooms of the World*.

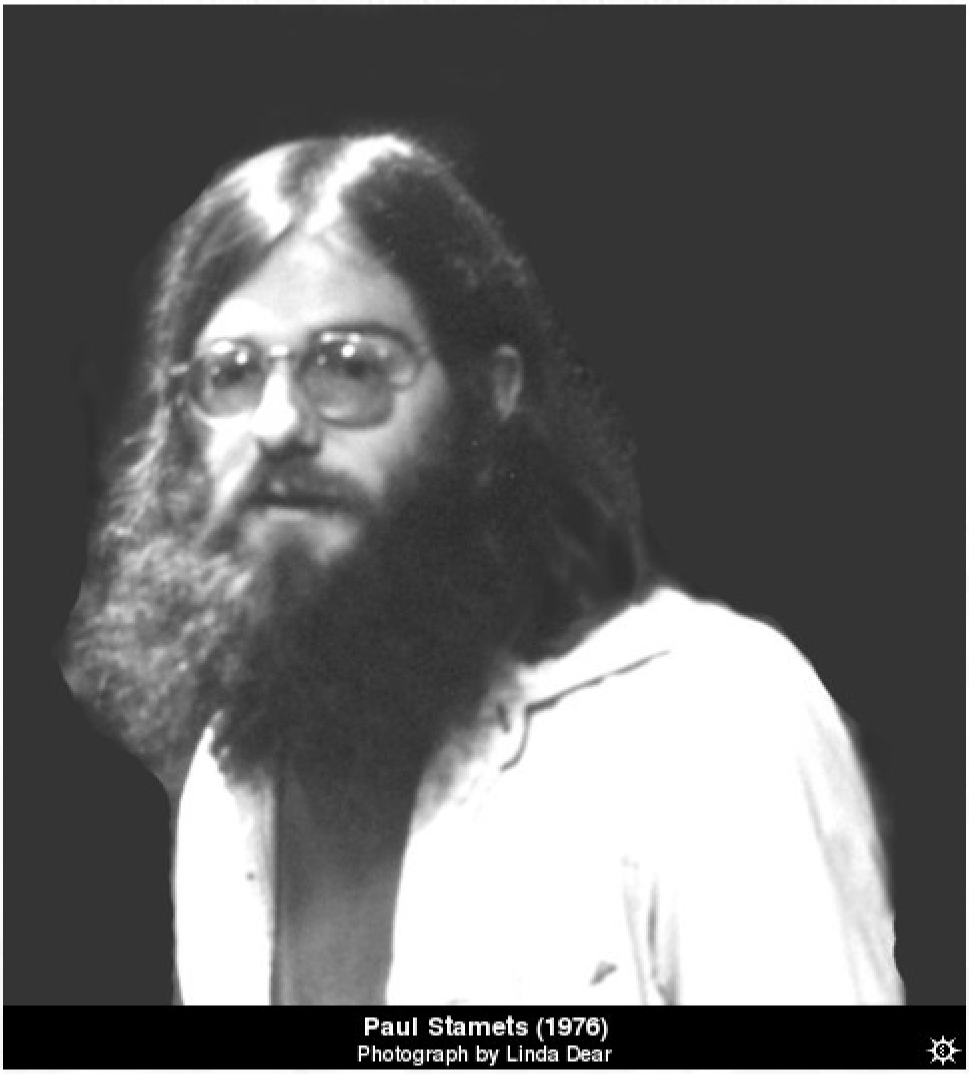


Fig. 29. Paul Stamets
1st International Conference on Hallucinogenic Mushrooms, 1976
Photo: Linda Dear

Sam I. Stein - was an M.D. who wrote the first medical report concerning a negative reaction and bad trip after ingesting five dried grams of in vitro grown specimens of *Psilocybe cubensis* (Earle) Singer (Stein, 1958)[122]. Another important contribution was Stein's paper on the effects of *Panaeolus subbalteatus* and *Psilocybe caerulescens* in a therapeutic mode (Stein, 1959)[123].

Jay Stevens - is author of *Storming Heaven: LSD and the American Dream*. Stevens devoted three chapters of this book to the sacred mushrooms. Mr. Stevens talks about the CIA involvement with the mushrooms and the controversy of the Harvard Psilocybin Projects initiated by Timothy Leary and Jonathan Clark. See related information under the headings of John Marks, Lee and Shlain.

Jule Stevens - is co-author with Rich Gee of *How to Identify and Grow Psilocybin [sic] Mushrooms*, a field-and cultivation-guide to mushrooms of the Pacific Northwest United States and Hawai'i. This guide has step-by-step photographs of the process involved in producing good strains of *Psilocybe cubensis*.

Tjakko Stijve - was born in Utrecht (Netherlands) where he received an education in analytical chemistry. Since 1967 he has lived in Switzerland, where (until his retirement in 1999) he ran a section on food contaminants in the Quality Assurance Department of Nestle. Early on he developed an interest in the chemistry of higher fungi, resulting in the publication of many papers on mushroomic toxins and on the bioaccumulation of potentially-toxic trace-elements in macromycetes. While studying tryptophan-derivatives in the early 1980's, he came upon the tryptamines bufotenine, psilocine and psilocybine in some fungi. This awakened his curiosity about psychoactive mushrooms, and prompted him to look for the tryptamines in (at that time) unexplored genera such as *Inocybe* and *Pluteus*. In the early 1990's together with mycologist André de Meijer, he made an inventory of the psychoactive mushrooms occurring in Paraná, a province in Southern

Brazil. He is presently involved in a study on selenium and bioactive compounds in the genus Albatrellus, which will mark the end of his professional activities in mycochemistry. After his retirement, Stijve will explore a number of ethnomycological subjects.

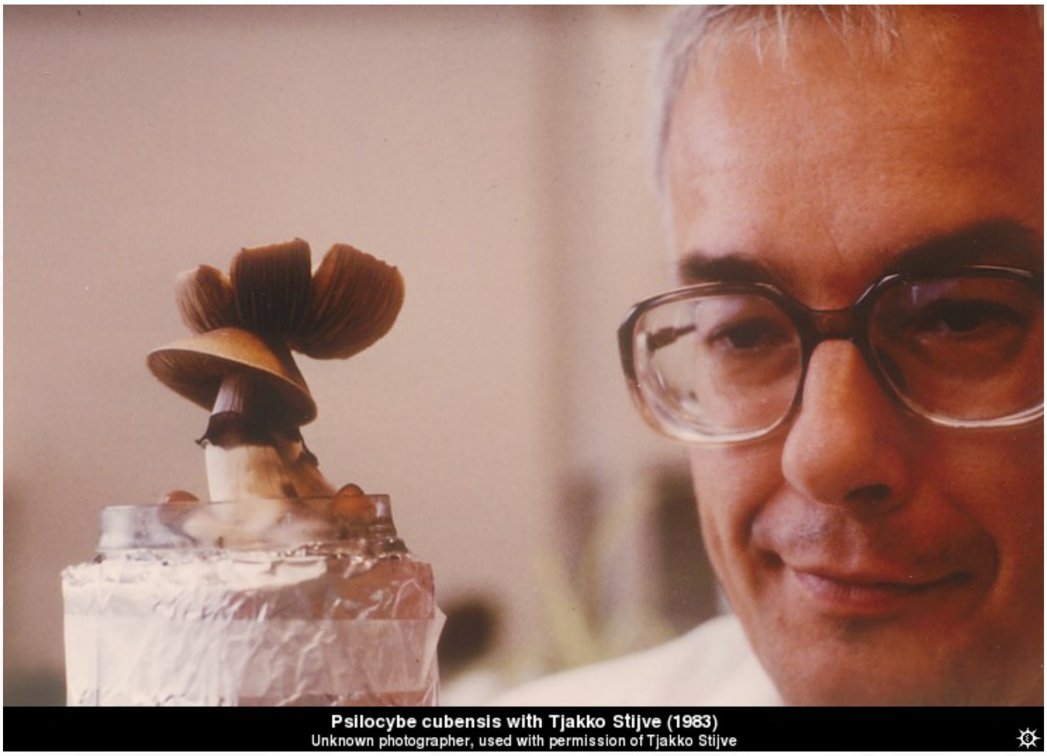

Psilocybe cubensis with Tjakko Stijve (1983)
Unknown photographer, used with permission of Tjakko Stijve

Fig. 30. Tjakko Stijve in his lab as *Psilocybe cubensis* begins to fruit, 1983.

Frederick Swain - was a student who traveled to México in the early 1960's and was graciously greeted by María Sabina who performed a mushroom ceremony for him. Swain wrote of his experience in the Journal *Tomorrow*, later reprinted in *Psychedelic Review* No. 2.

David Tatelman - is President and founder of the Homestead Book Company. By selling thousands of Mushroom kits and spores over a period of 25 years, he is directly responsible for most of the psilocybe mushrooms now cultivated in the United States. He also published one of the first field guides, *The Magickal Mushroom Handbook* and was the publisher of Paul Stamets' first book, *Psilocybin Mushrooms and Their Allies*. His genius has been in popularizing mushrooms to the masses.

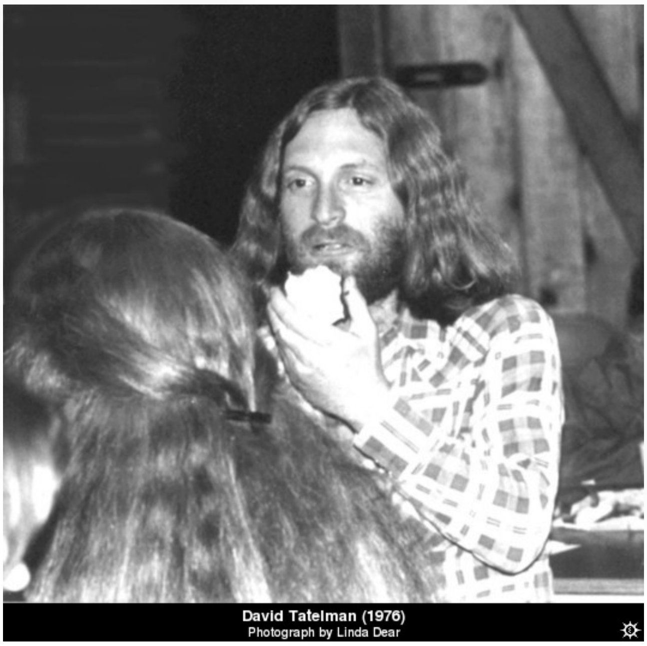

David Tatelman (1976)
Photograph by Linda Dear

Fig. 31. David Tatelman, 1st International Conference on Hallucinogenic Mushrooms, 1976
Photo: Linda Dear

Peter Vuchich - of Hongero Press was the first person to commercially sell *Psilocybe cubensis* spores, which he did by including them in his early book about cultivating mushrooms in the early 70's. Vuchich was also the first person in the United States to successfully advertise his products in *High Times* magazine selling spore kits to the general public.

Johanna Wagner - was a German ethnologist (1923-1990) who became a practicing medicine-woman (mganga) in Africa. In 1982, Dr. Wagner participated in a scientific experiment where she bioassayed fresh caps of the fly agaric. Her experiences with the fly agaric-man during an experience covering almost three days and nights, was recorded on tape and eventually published in *Ein Füllhorn göttlicher Kraft. Unter Schamanen, Gesundbetern und Wetterbeschwörern* (Berlin, 1985).

R. Gordon and Valentina Wasson - were pioneer researchers of the entheogenic mushrooms and they are also the main reason we are all here reading this manuscript. Together they coined the terms mycophobia and mycophilia. R. Gordon Wasson is also referred to as the Father of Ethnomycology. Wasson and his wife Valentina are the epitome of the heart of sacred mushrooms. In the middle 1950's, they became the first outsiders to partake of the sacred mushrooms. Gordon Wasson also studied the Aryan entheogen soma; the Kuma aborigines of New Guinea who used theragenic *Boletus* and *Russula* species, and extensively researched the use of *Amanita muscaria* among certain of Siberia. Later, he brought to the attention of the public and academic communities the discovery of a North American tribe which uses *Amanita muscaria* in a religious context [Wasson & Wasson,1957 [186]; Wasson, 1957a [140], Wasson, 1958b [143],Wasson, 1979 [173], jpd on Ojibway].

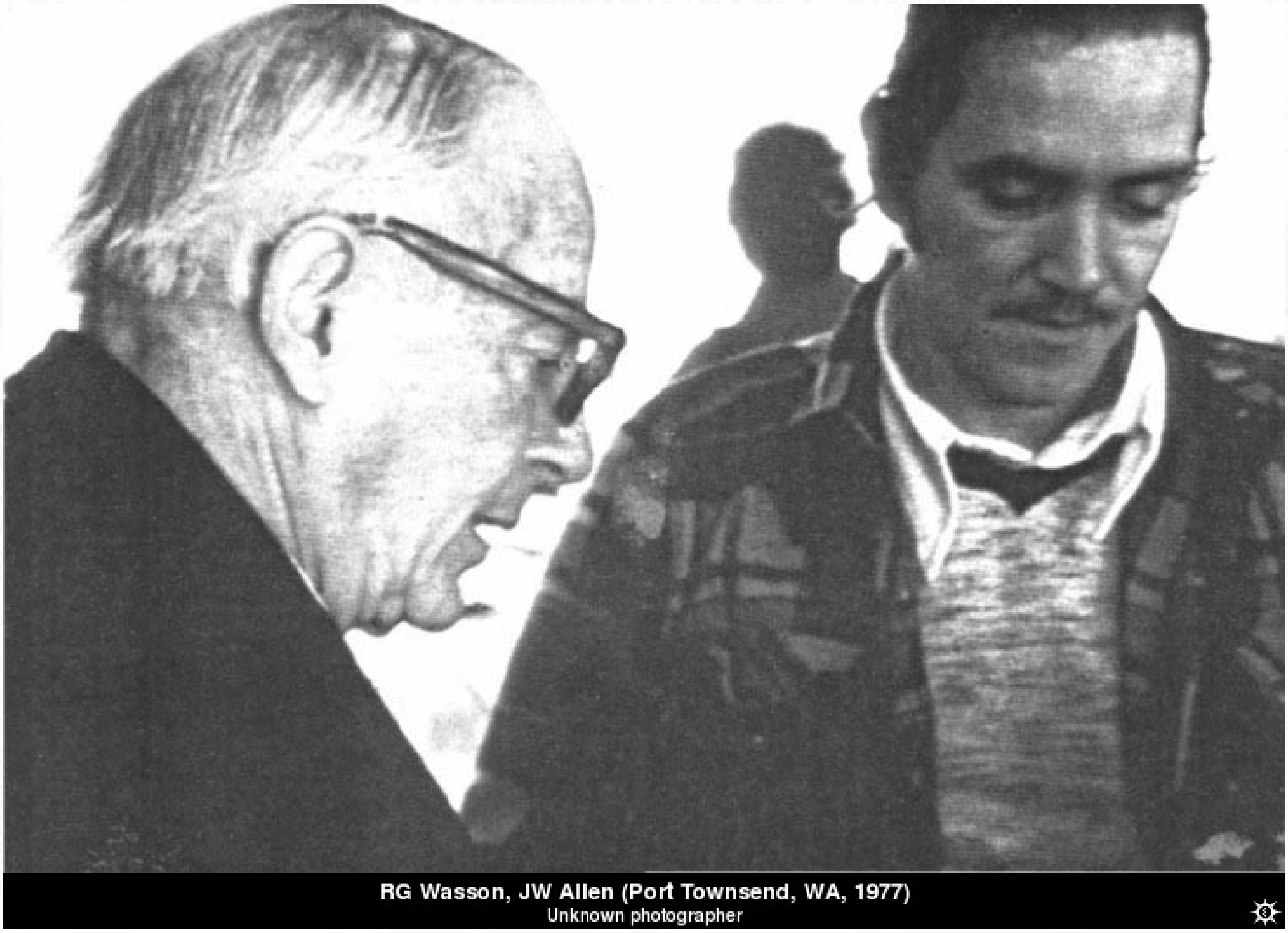

RG Wasson, JW Allen (Port Townsend, WA, 1977)
Unknown photographer

Fig. 32. R. Gordon Wasson and John W. Allen
Ft. Wordon, Port Townsend, Washington, 1977

Roy Watling - is an English mycologist, the Senior Principal Scientific Officer of the Royal Botanic Garden in Edinburgh, Scotland. Watling has contributed numerous articles on the taxonomy and use of psilocybian mushrooms from Australia and Great Britain and has published papers with Gastón Guzmán.

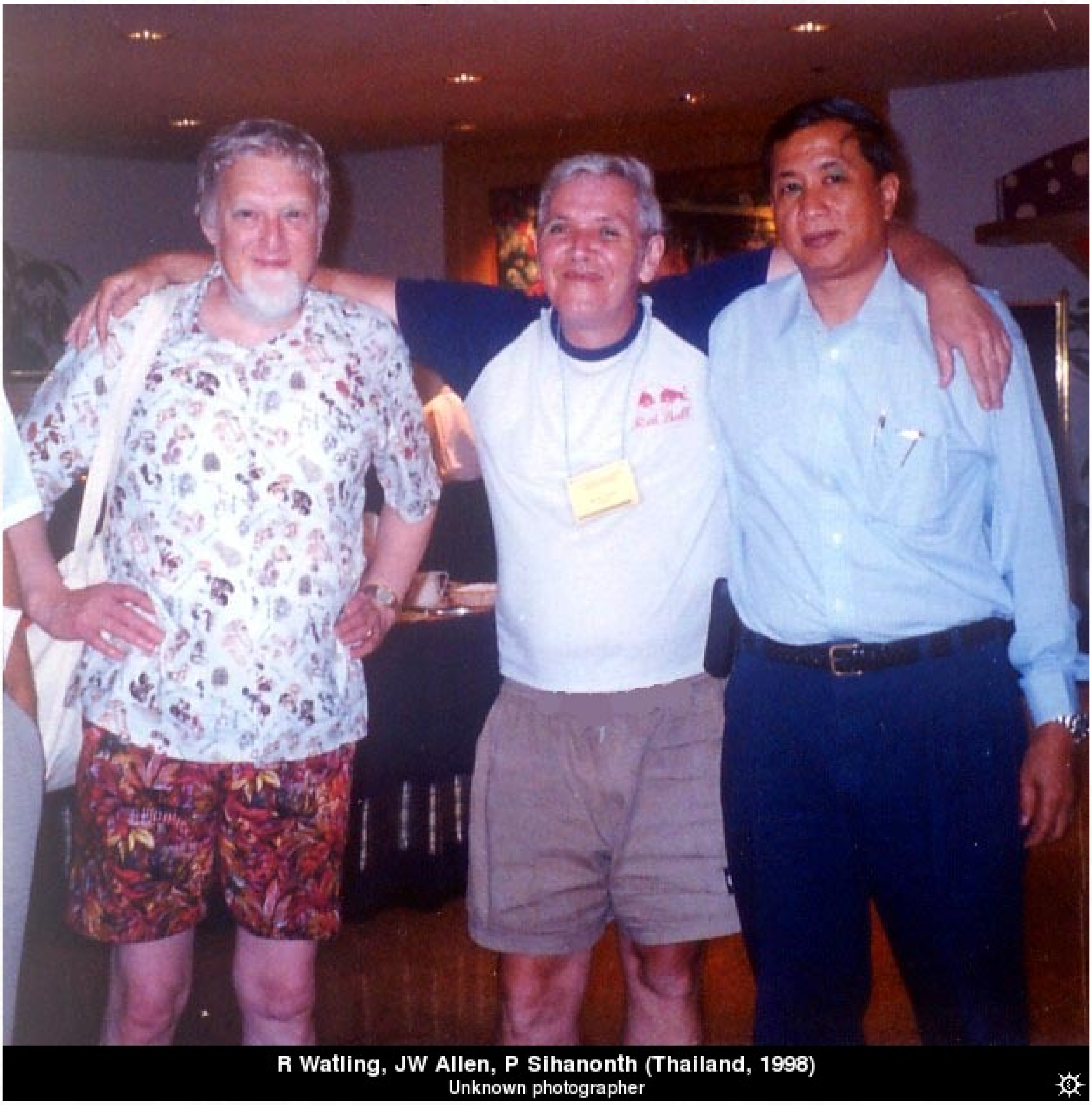

R Watling, JW Allen, P Sihanonth (Thailand, 1998)
Unknown photographer

Fig. 33. Roy Watling, John W. Allen and Prakitsin Sihanonth
Hua Hin, Thailand, 1998

Andrew Weil - is a recipient of an AB degree in botany from Harvard University and also worked for the National Institute of Mental Health. Currently, Dr. Weil is the director of the Program in Integrative Medicine and clinical professor of internal medicine at the University of Arizona in Tucson. As a fellow of the Institute of Current World Affairs, Weil traveled extensively in Mexico, Central and South America gathering information about medicinal plants and healing.

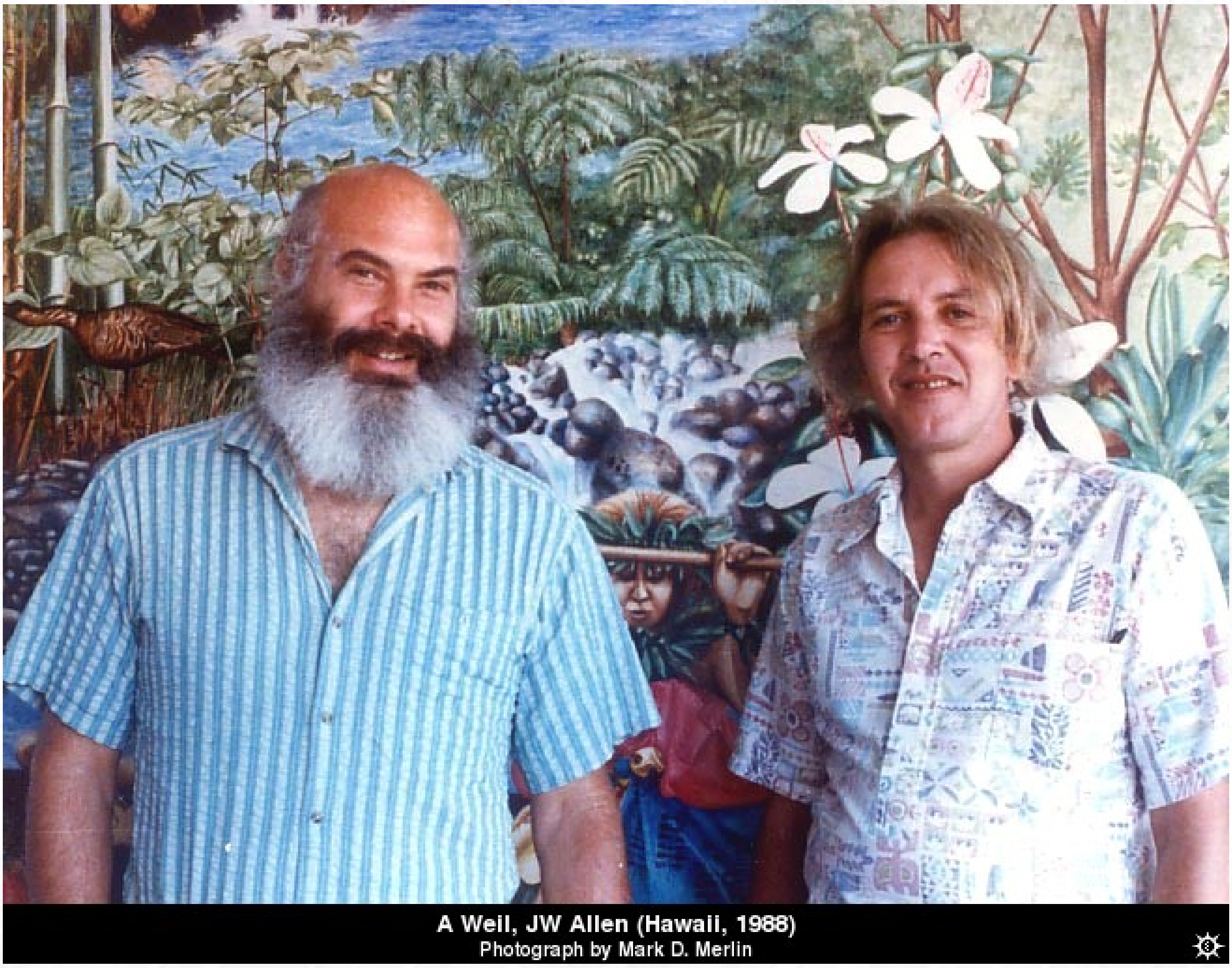

A Weil, JW Allen (Hawaii, 1988)
Photograph by Mark D. Merlin

Fig. 34. Andrew Weil and John W. Allen
Drug Awareness Week, Oahu, Hawaii, 1988

Weil was the first investigator to report on the ludible use of psilocybian mushrooms from the Pacific Northwest United States, Colombia in South America and México. He is a graduate of Harvard Medical School who has traveled extensively writing on drug-use throughout México, Central and South America. Weil is author of *The Natural Mind*, *The Marriage of the Sun and the Moon*, *From Chocolate to Morphine*, and numerous books on holistic health and healing. It was Weil who first reported on the ludible use of *Psilocybe semilanceata* (the 'liberty-cap' mushroom) in Oregon. Weil has also contributed several papers on psilocybian mushrooms to *The Harvard Review*, *The Crimson* (Harvard's newspaper), *The Botanical Museum Leaflets of Harvard*, *The Journal of Psychedelic Drugs*, *The Journal of Altered States of Consciousness* and *Look* Magazine.

Arnold Wolman - is author of a small pamphlet on *Psilocybe cubensis*. This 16-page booklet described the collection of *P. cubensis* from the southeastern United States. This guide was published in Chicago, Illinois and was somewhat limited in its distribution.

Anthony Young - is a mycologist from Australia who has studied extensively the Genus *Panaeolus* in Australia. He has also published a review of the genus *Panaeolus* from Australia.

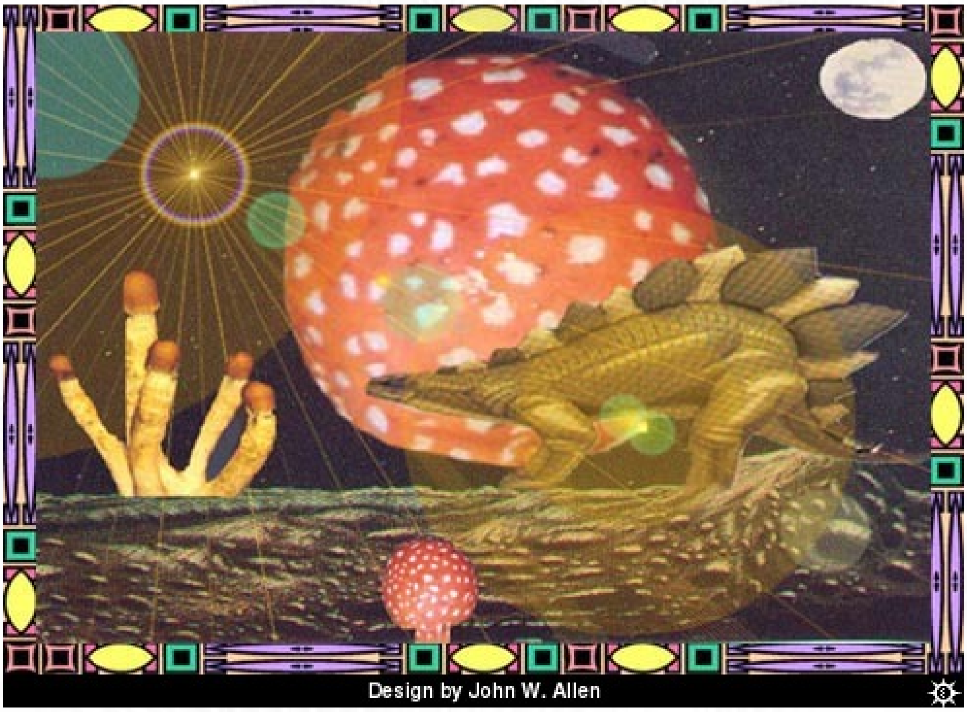

Design by John W. Allen

Image 8: Red Dwarf. Graphic Design by John W. Allen

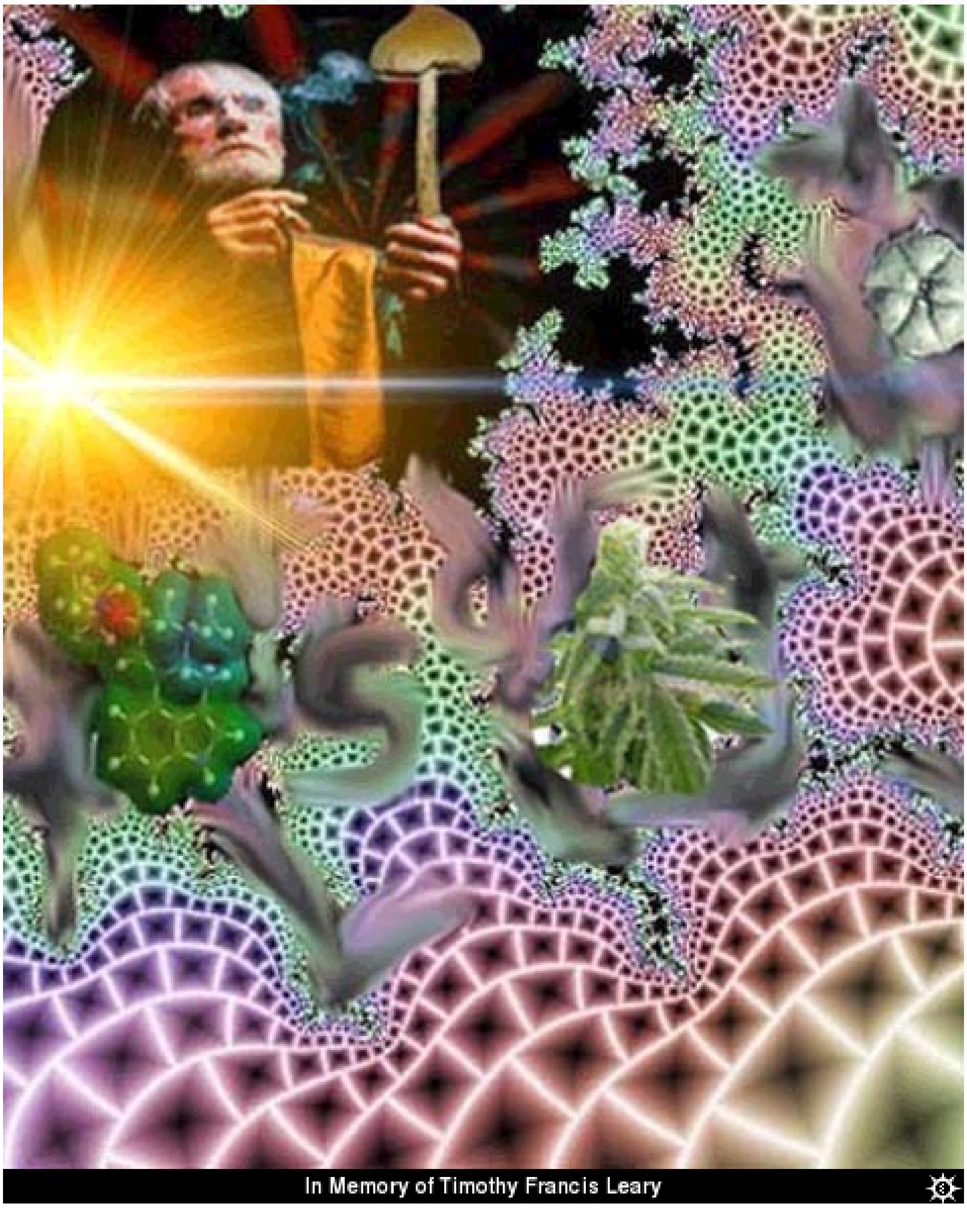

In Memory of Timothy Francis Leary

Image 9: In Memory of Timothy Francis Leary

A Gallery of Photographs

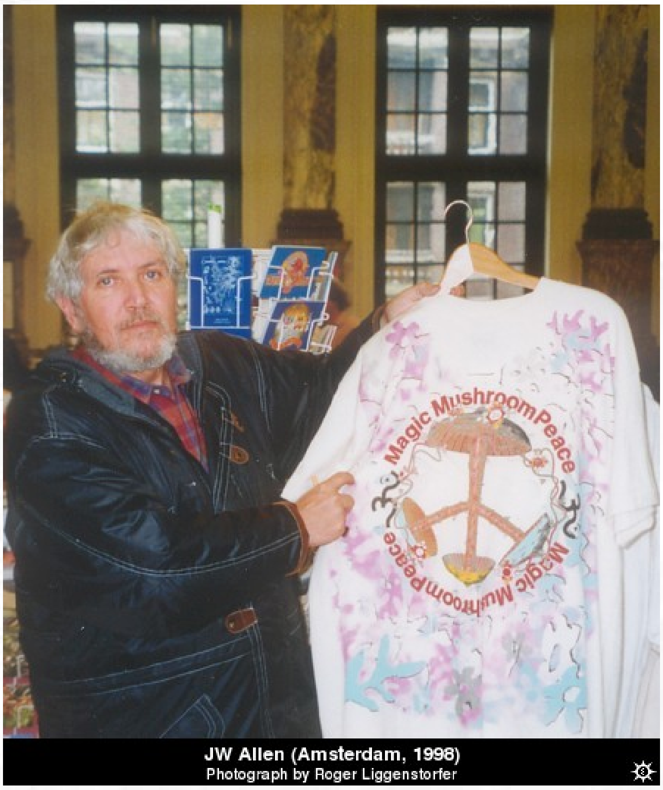

Magic MushroomPeace
Magic MushroomPeace
JW Allen (Amsterdam, 1998)
Photograph by Roger Liggenstorfer

Fig. 35. John W. Allen
Amsterdam, Psychoactivity, 1998

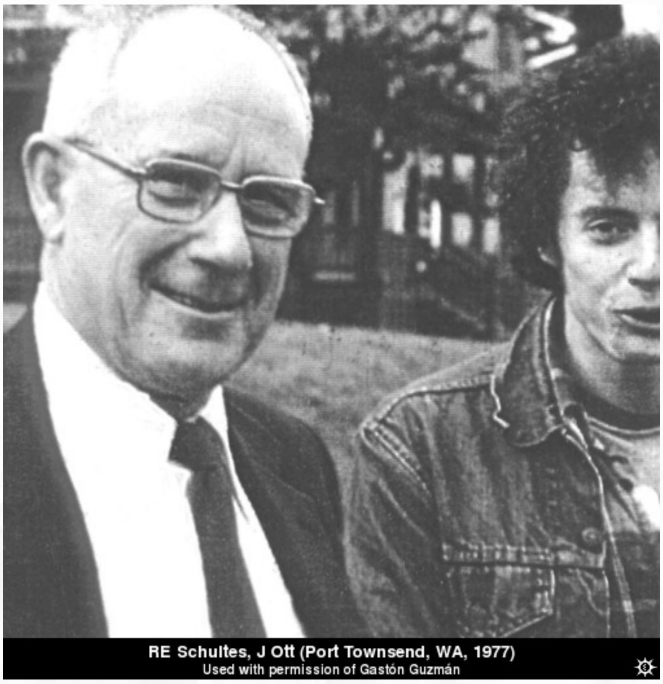

RE Schultes, J Ott (Port Townsend, WA, 1977)
Used with permission of Gastón Guzmán

Fig. 36. Richard Evans Schultes and Jonathan Ott,
2nd International Conference on Hallucinogenic Mushrooms
Ft. Worden, Port Townsend, Washington, October 1977

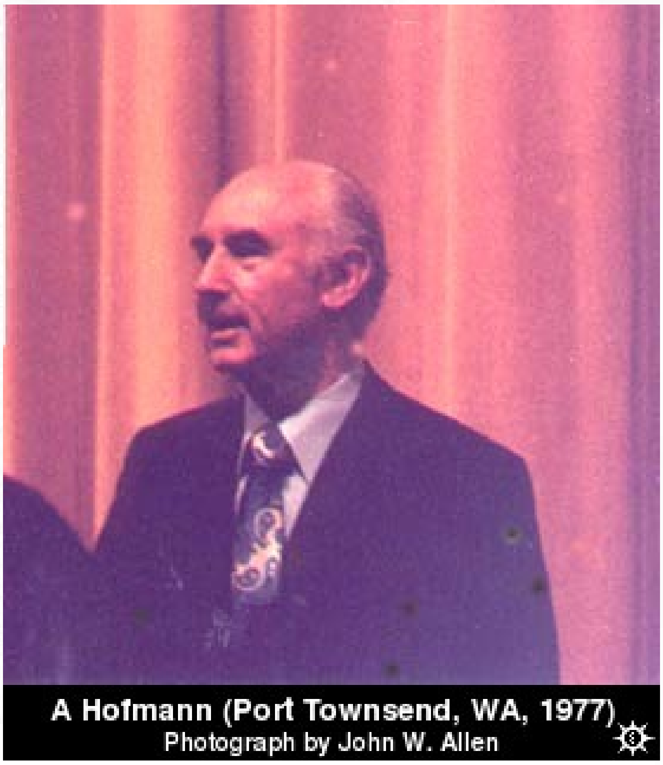

A Hofmann (Port Townsend, WA, 1977)
Photograph by John W. Allen

Fig. 37. Albert Hofmann
2nd International Conference on Hallucinogenic Mushrooms
Ft. Worden, Port Townsend, Washington
October 1977

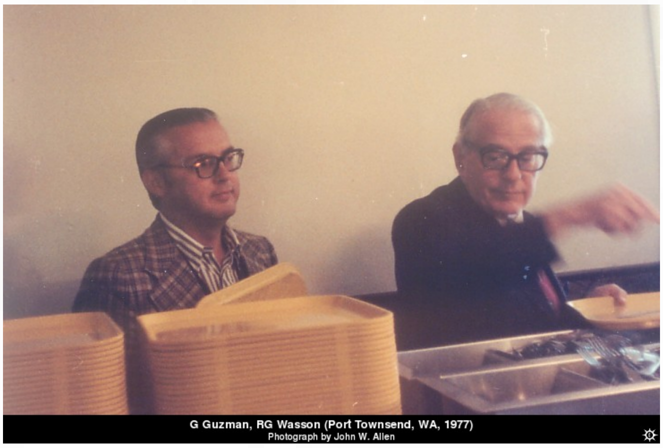

G Guzman, RG Wasson (Port Townsend, WA, 1977)
Photograph by John W. Allen

Fig. 38. Gastón Guzmán and R. Gordon Wasson
Ft. Worden, Port Townsend, Washington, 1977

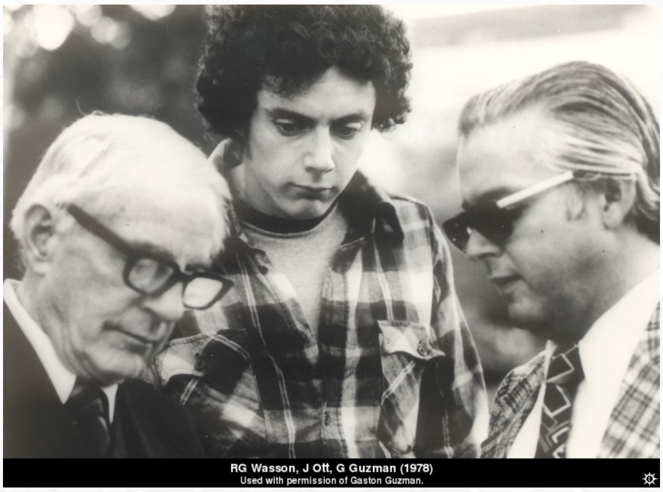

RG Wasson, J Ott, G Guzman (1978)
Used with permission of Gaston Guzman.

**Fig. 39. R. Gordon Wasson, Jonathan Ott, Gastón Guzmán
1978, EVA in Washington**

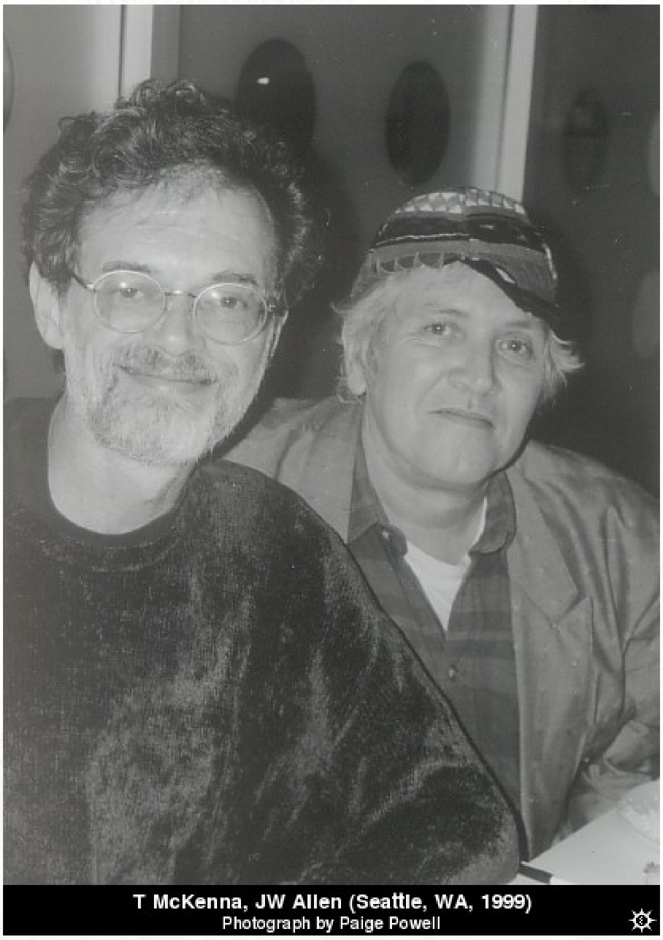

T McKenna, JW Allen (Seattle, WA, 1999)
Photograph by Paige Powell

**Fig. 40. Terence McKenna and John W. Allen
Aro-Space, Seattle, 1999
Photo: Paige Powell**

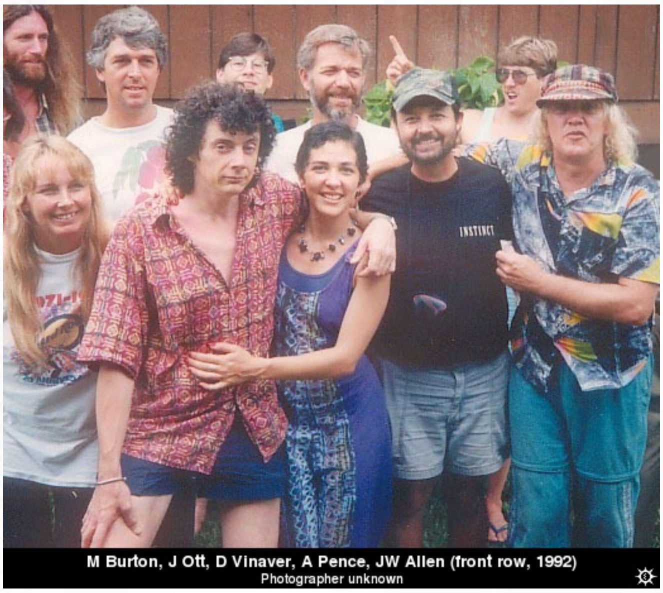

M Burton, J Ott, D Vinaver, A Pence, JW Allen (front row, 1992)
Photographer unknown

**Fig. 41. Front row: Marty Burton, Jonathan Ott, Djahel Vinaver, Alan Pence and John W. Allen.
Back row 3rd from left, David Orr. Maui, 1992**

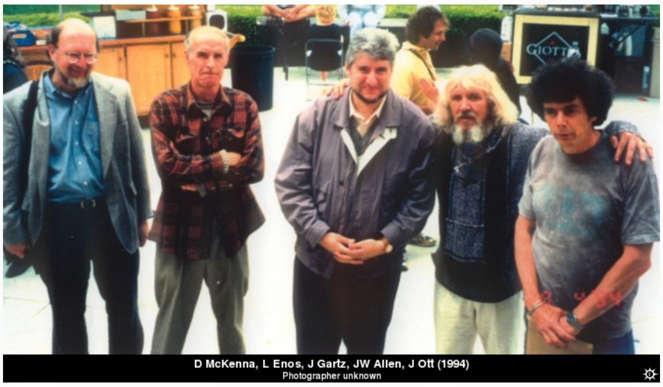

D McKenna, L Enos, J Gartz, JW Allen, J Ott (1994)
Photographer unknown

**Fig. 42. Left to right: Dennis McKenna, Leonard Enos, Jochen Gartz, John W. Allen, Jonathan Ott.
Between and behind Gartz and Allen is Rick Doblin.
Chapman University, 1994**

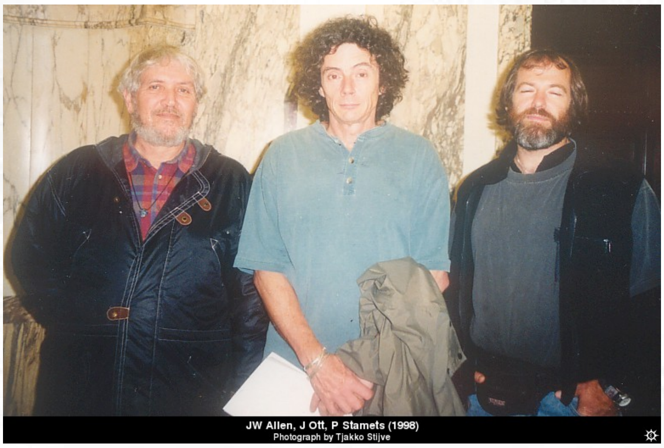

JW Allen, J Ott, P Stamets (1998)
Photograph by Tjakko Stijve

Fig. 43. J. W. Allen, J. Ott & P. Stamets Psychoactivity Conference, Amsterdam, 1998

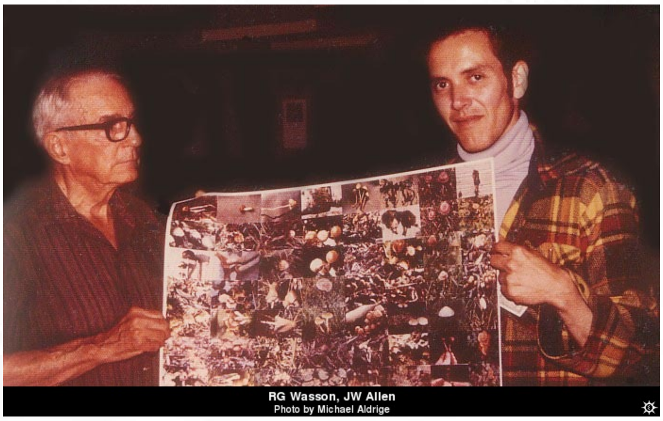

RG Wasson, JW Allen
Photo by Michael Aldrige

Fig. 44. R. Gordon Wasson and John W. Allen presenting a *Safe-Pik* Mushroom Identification poster to Wasson. Photo: Michael Aldridge.

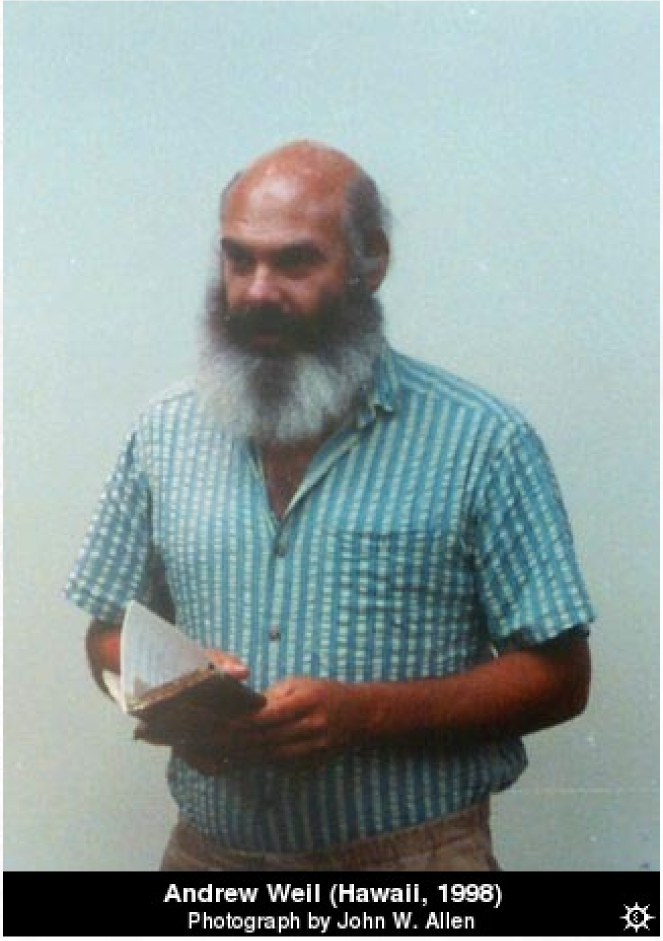

Andrew Weil (Hawaii, 1998)
Photograph by John W. Allen

Fig. 45. Andrew Weil, University of Hawaii Drug Awareness Week. 1988

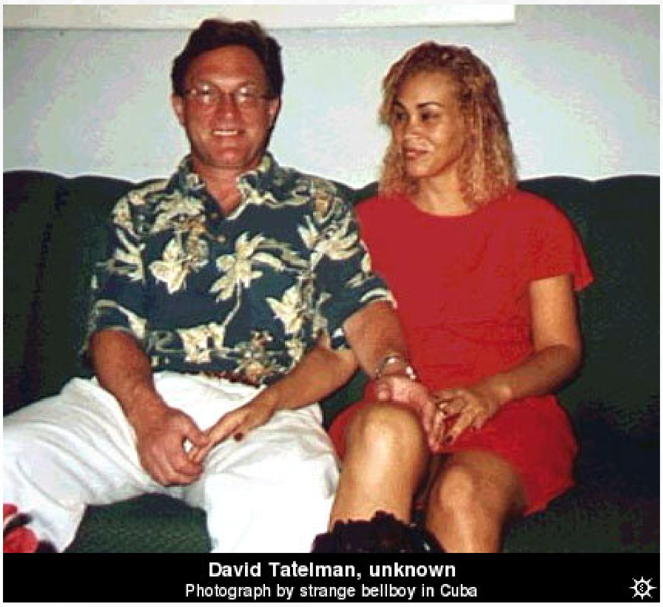

David Tatelman, unknown
Photograph by strange bellboy in Cuba

Fig. 46. David Tatelman President of Homestead Book Co., with friend.

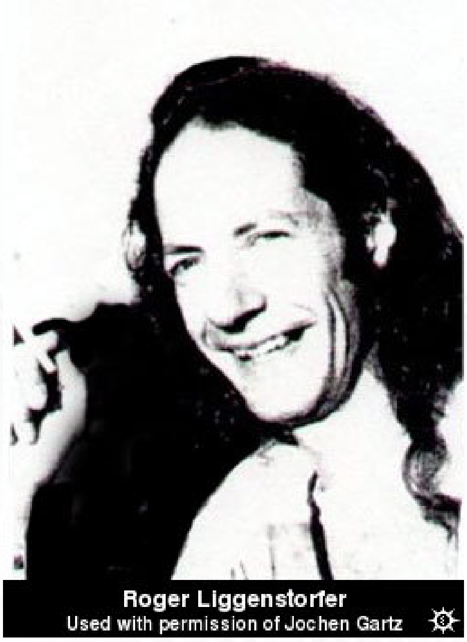

Roger Liggenstorfer
Used with permission of Jochen Gartz

Fig. 47. Roger Liggenstorffer

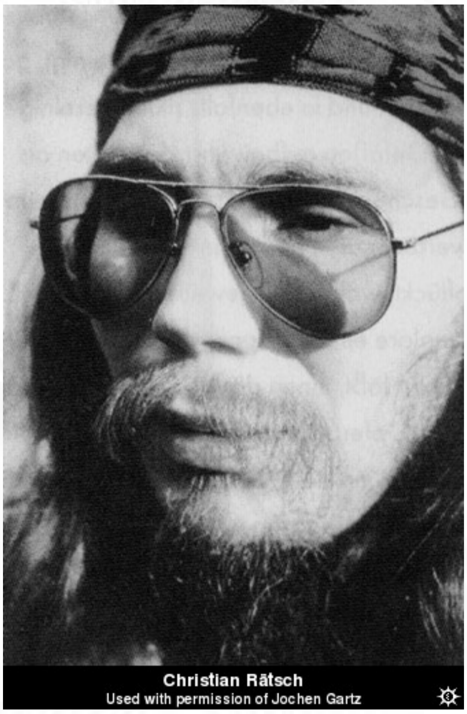

Christian Rätsch
Used with permission of Jochen Gartz

Fig. 48. Christian Rätsch

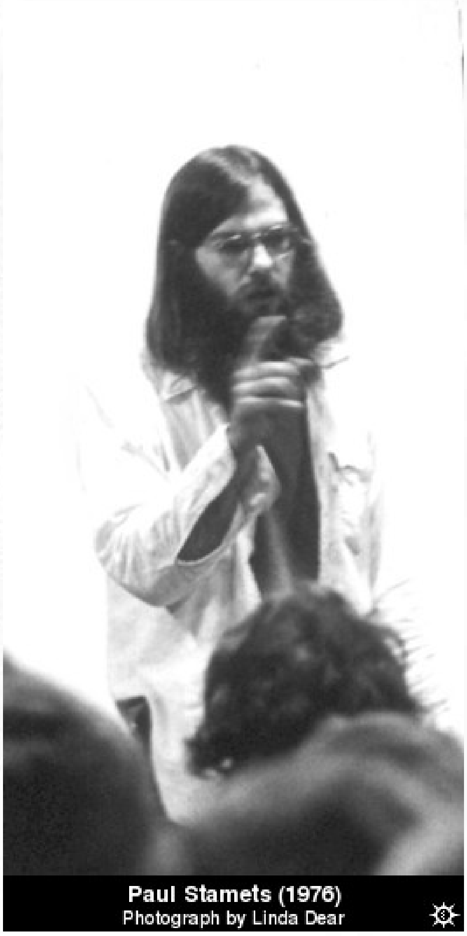

Paul Stamets (1976)
Photograph by Linda Dear

Fig. 49. Paul Stamets presenting a lecture at the 1st International Conference on Hallucinogenic Mushrooms, 1976
Photo: Linda Dear

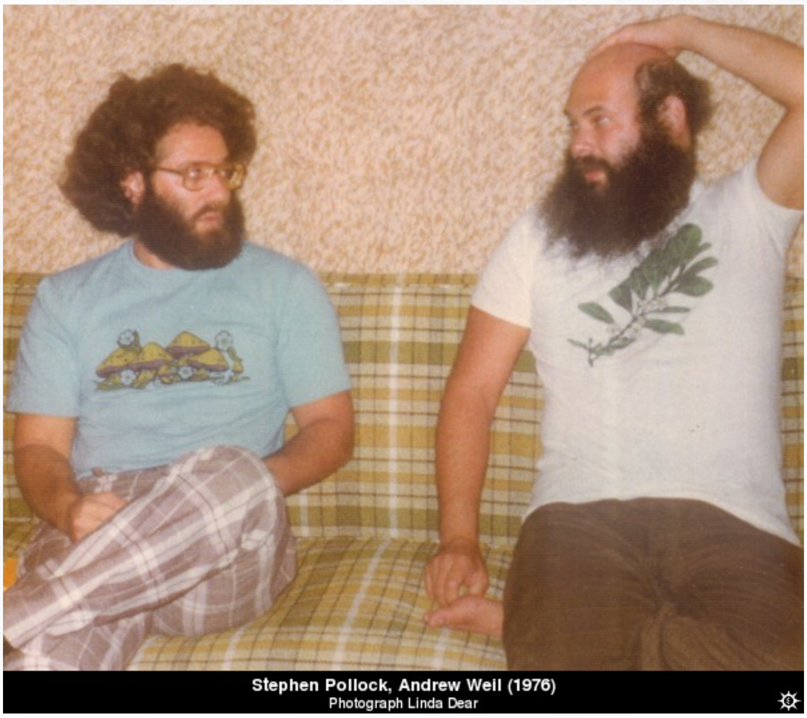

Stephen Pollock, Andrew Weil (1976)
Photograph Linda Dear

Fig. 50. Stephen Pollock and Andrew Weil relaxing between lectures, 1976
Photo: Linda Dear

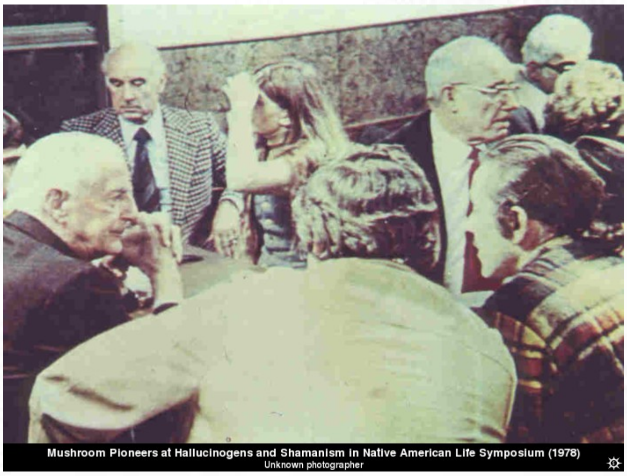

Mushroom Pioneers at Hallucinogens and Shamanism in Native American Life Symposium (1978)
Unknown photographer

Fig. 51. Mushroom Pioneers at the Hallucinogen and Shamanism in Native American Life Symposium San Francisco, October-November 1978

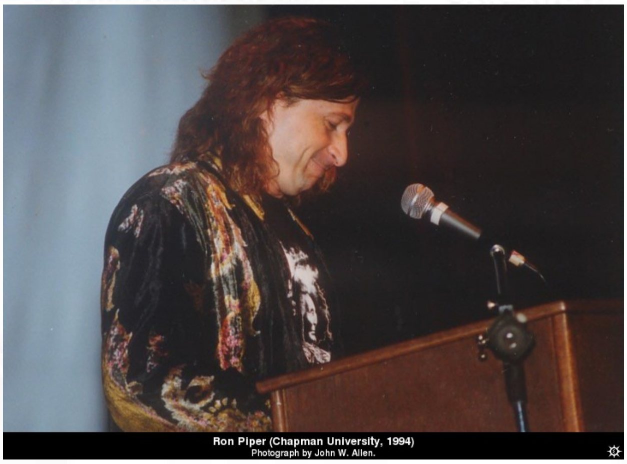

Ron Piper (Chapman University, 1994)
Photograph by John W. Allen.

Fig. 54. Ron Piper
Gathering of the Minds, Chapman University, 1994

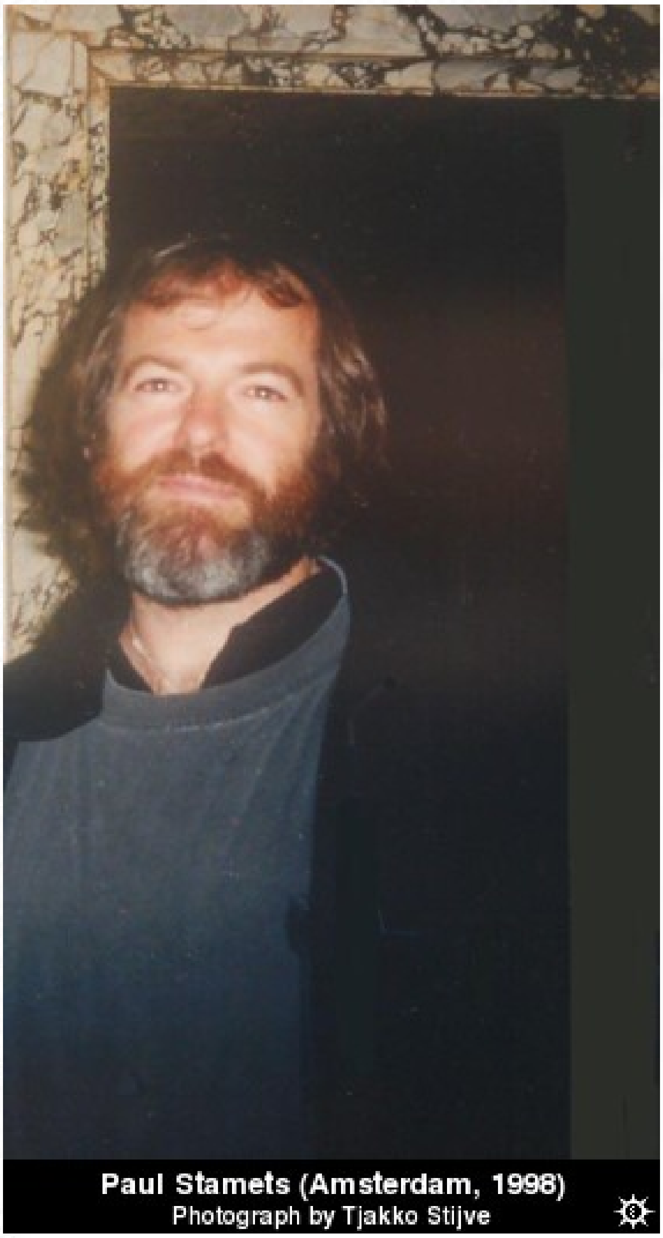

Paul Stamets (Amsterdam, 1998)
Photograph by Tjakko Stijve

Fig. 52. Paul Stamets
Amsterdam, Psychoactivity, 1998

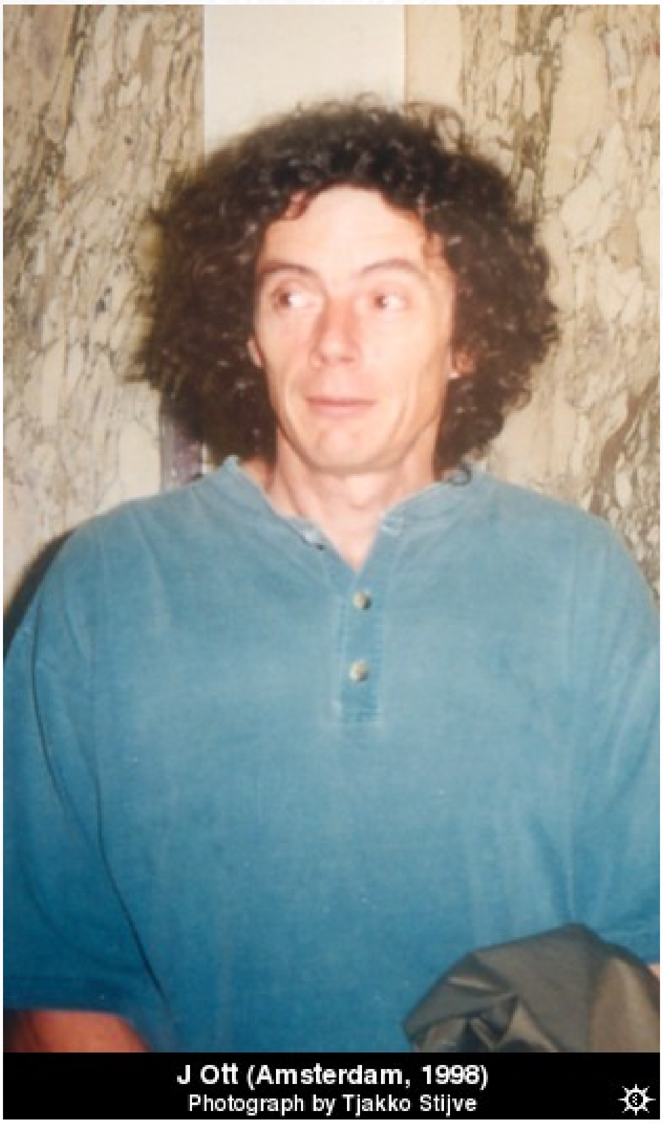

J Ott (Amsterdam, 1998)
Photograph by Tjakko Stijve

Fig. 53. Jonathan Ott
Amsterdam, Psychoactivity, 1998
Photo: Linda Dear

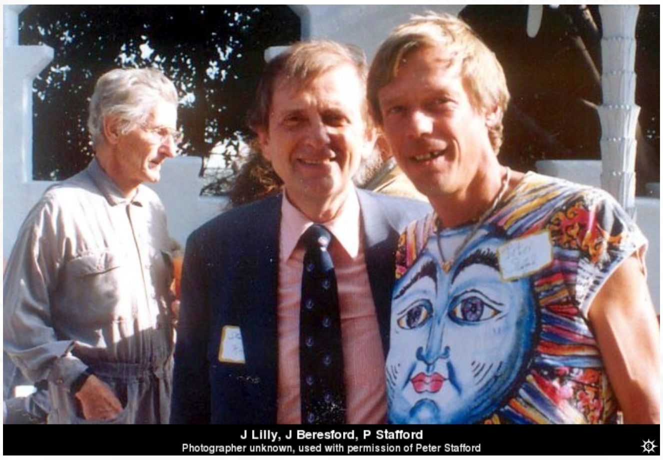

J Lilly, J Beresford, P Stafford
Photographer unknown, used with permission of Peter Stafford

Fig. 55. John Lilly, John Beresford and Peter Stafford

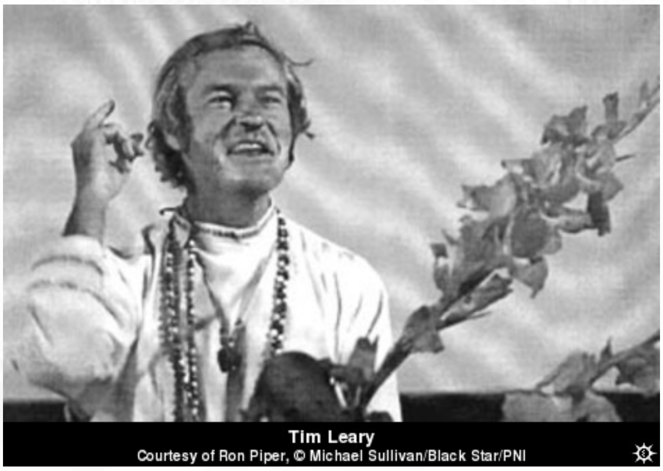

Tim Leary
Courtesy of Ron Piper, © Michael Sullivan/Black Star/PNI

Fig. 56. Timothy Leary, Courtesy of Ron Piper
Copyright by Michael Sullivan/Black Star/PNI.

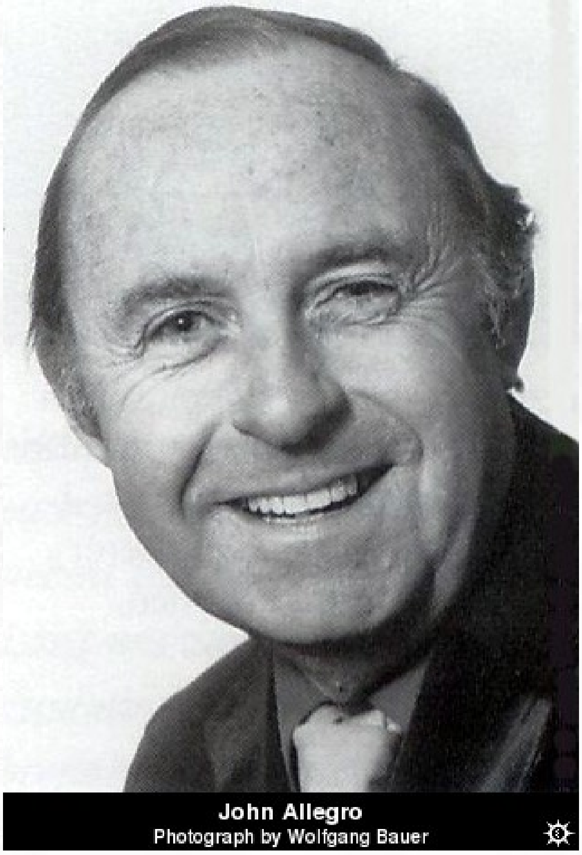

John Allegro
Photograph by Wolfgang Bauer

Fig. 57. John Allegro
Photo: Wolfgang Baeur

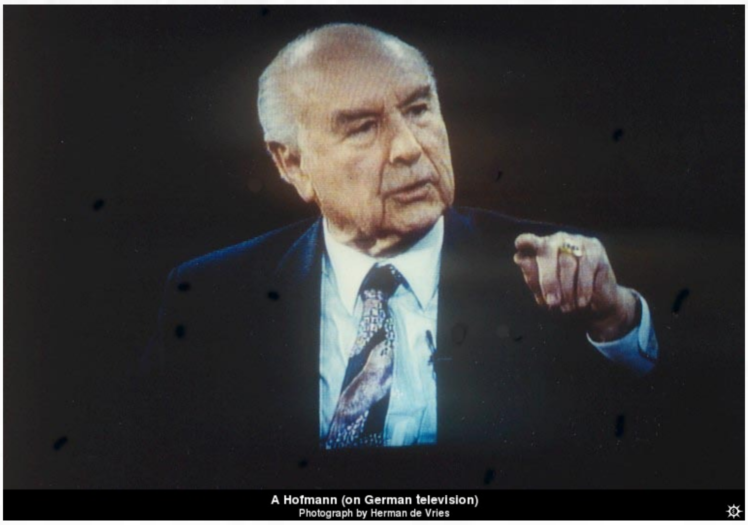

A Hofmann (on German television)
Photograph by Herman de Vries

Fig. 58. Albert Hofmann speaking on German Television
Photo: Herman de Vries.

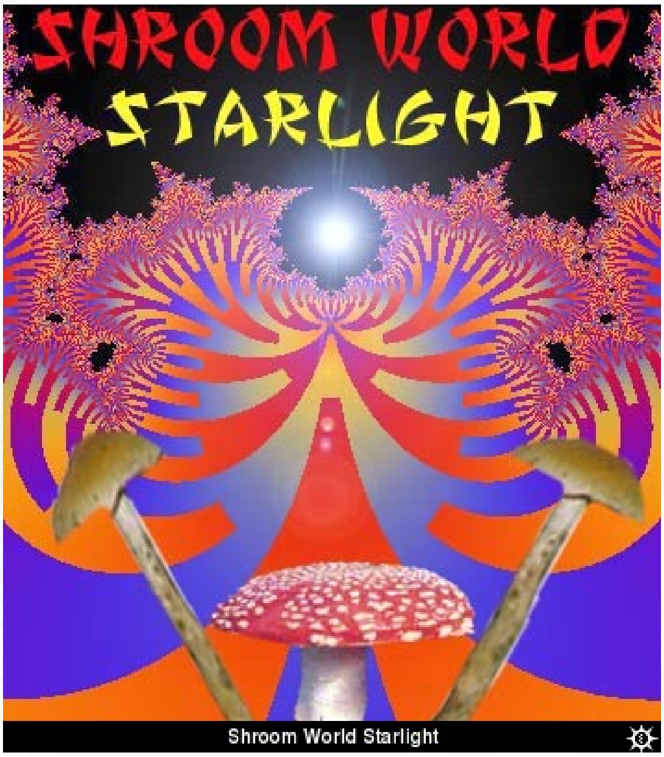

SHROOM WORLD
STARLIGHT
Shroom World Starlight

Image 10: Shroom World Starlight.

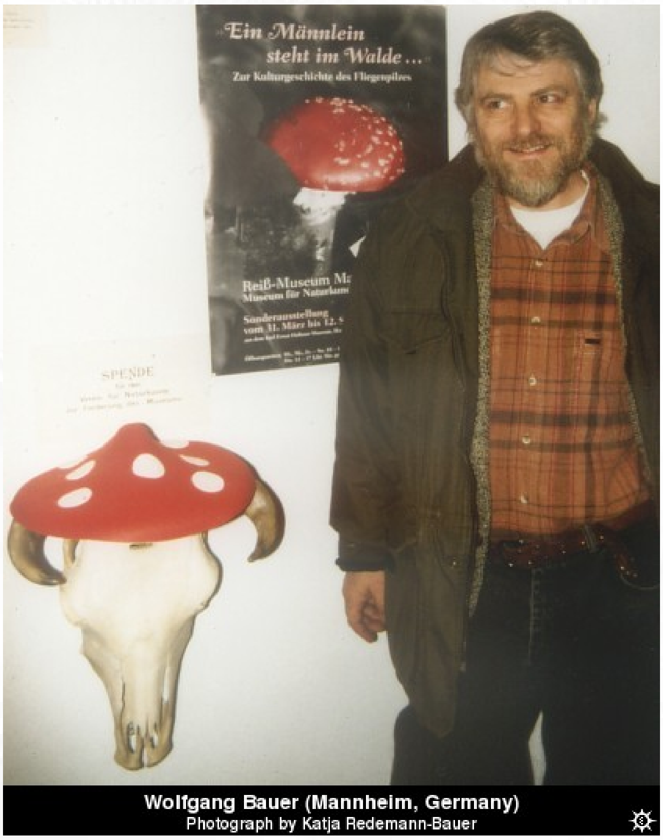

Ein Männlein
steht im Walde ...
Zur Kulturgeschichte des Fliegenpilzes
Reiß-Museum
SPENDE
Wolfgang Bauer (Mannheim, Germany)
Photograph by Katja Redemann-Bauer

**Fig. 59. Wolfgang Bauer at the Fly-Agaric-Exhibition of the Reiss-Museum in Mannheim, Germany
Photo: Katja Redemann-Bauer**

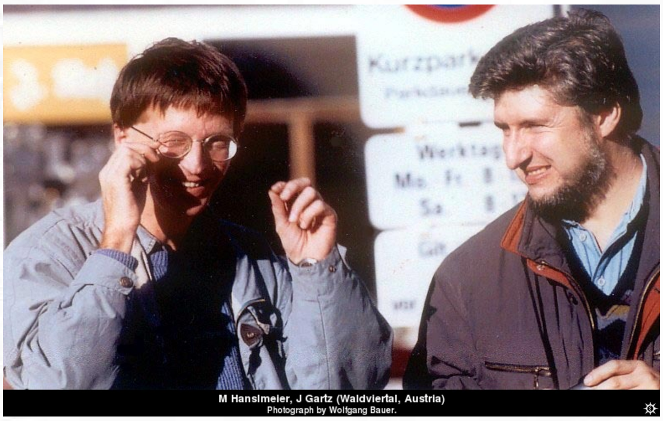

Kurzpark
Werktag
Mo - Fr
Sa
M Hanslmeier, J Gartz (Waldviertal, Austria)
Photograph by Wolfgang Bauer.

Fig. 60. Martin Hanslmeier (left) with Jochen Gartz in the Waldviertal (Austria) hunting psilocybin mushrooms.

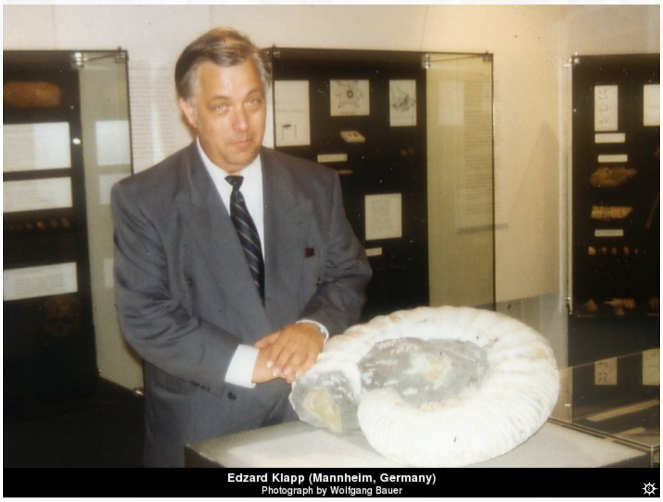

Edzard Klapp (Mannheim, Germany)
Photograph by Wolfgang Bauer

**Fig. 61. Edzard Klapp at the Fly-Agaric-Exhibition of the Reiss-Museum in Mannhein, Germany.
Photo: Wolfgang Bauer**

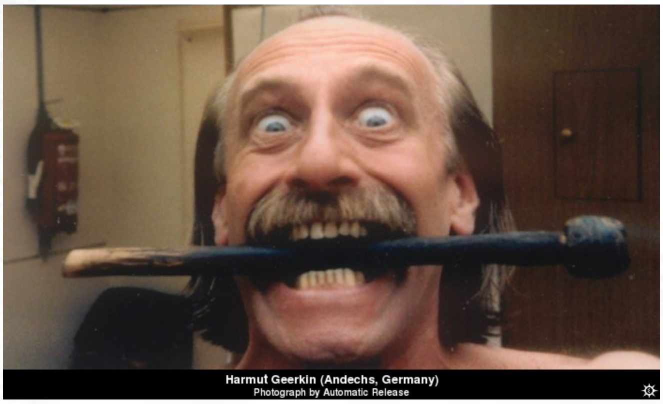

Harmut Geerkin (Andechs, Germany)
Photograph by Automatic Release

**Fig. 62. Hartmut Geerkin while on Fly-Agaric, 20 m deep in a mountain at Andechs, Bavaria attending an isolation experiment for the Max-Planck Institute.
Photo: Automatic Release.**

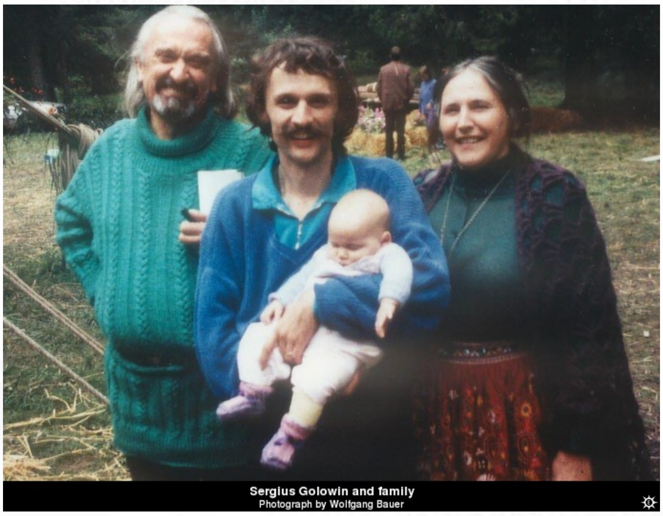

Sergius Golowin and family
Photograph by Wolfgang Bauer

**Fig. 63. Sergius Golowin (left) with family in the Swiss Jura Mountains.
Photo: Wolfgang Bauer**

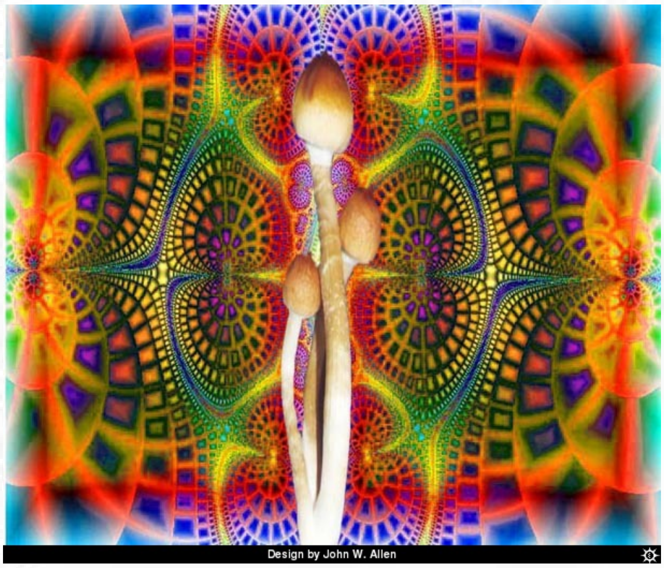

Design by John W. Allen

Image 11: Graphic Design by John W. Allen.

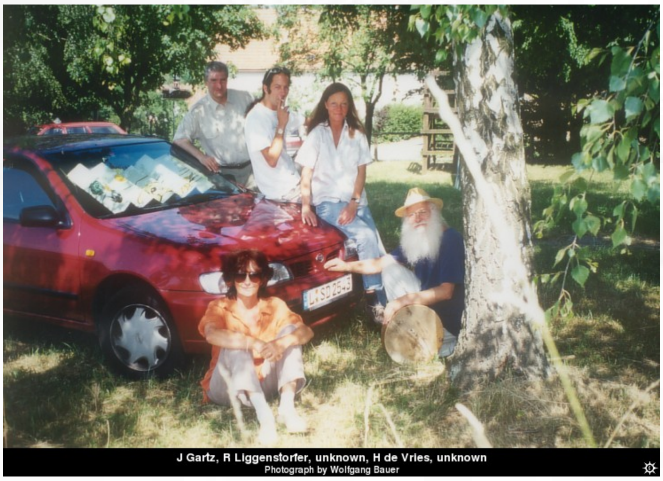

J Gartz, R Liggenstorfer, unknown, H de Vries, unknown
Photograph by Wolfgang Bauer

**Fig. 64. Herman de Vries (first right with drum) with Roger Liggenstorfer (second left), Jochen Gartz (first left) and the car of Gartz with the license plate LSD 25 in the Steigerwald, Germany.
Photo: Wolfgang Bauer.**

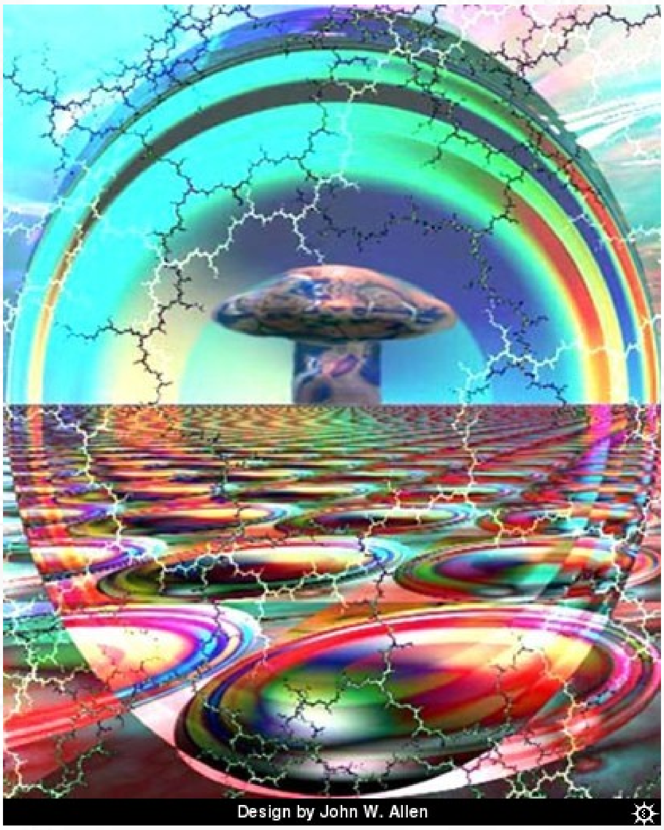

Design by John W. Allen

Image 12: Shroom Gate Graphic Design by John W. Allen

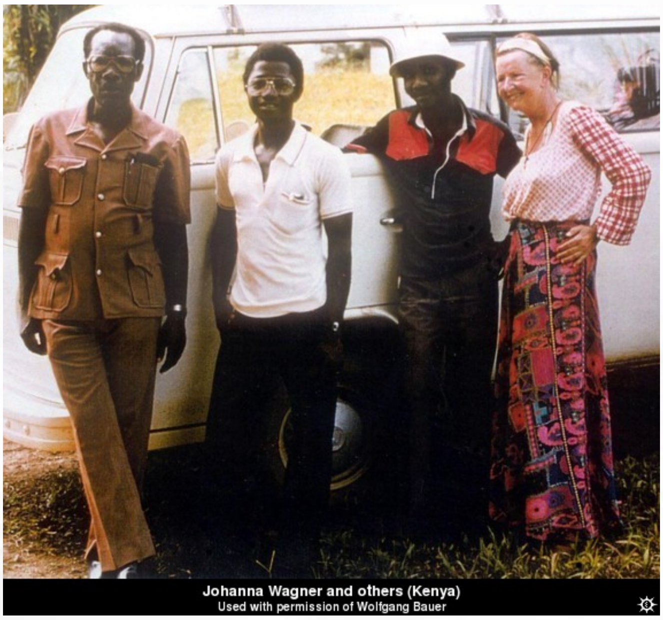

Johanna Wagner and others (Kenya)
Used with permission of Wolfgang Bauer

Fig. 65. Johanna Wagner among her askaris in the national park Nbi in Kenia, Africa.

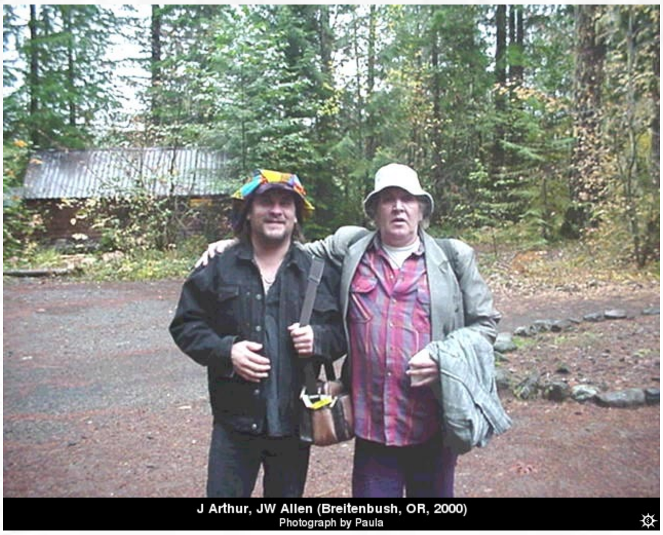

J Arthur, JW Allen (Breitenbush, OR, 2000)
Photograph by Paula

Fig. 66. James Arthur and John W. Allen at Breitenbush Annual Mushroom Conference, 2000.

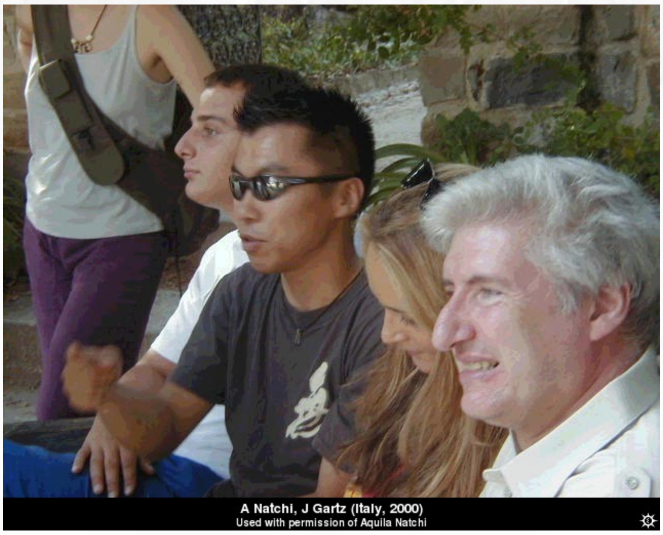

A Natchi, J Gartz (Italy, 2000)
Used with permission of Aquila Natchi

Fig. 67. Journalist Aquila Natchi and Jochen Gartz Italian Conference on Psychoactive Drugs, 2000.

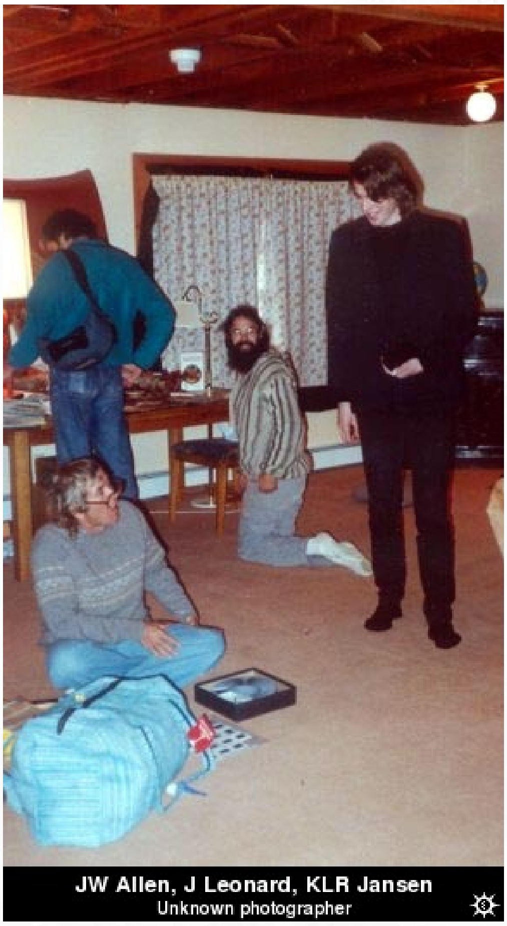

JW Allen, J Leonard, KLR Jansen
Unknown photographer

Fig. 68. John W. Allen (on knees), John Leonard (in foreground), and Karl L.R. Jansen (tall one).

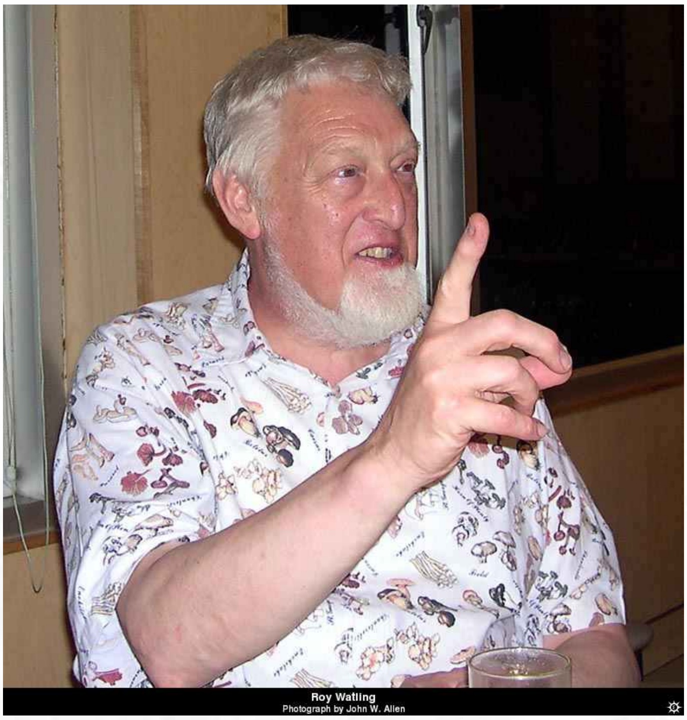

Roy Watling
Photograph by John W. Allen

Fig. 70. Roy Watling. Photo by John W. Allen

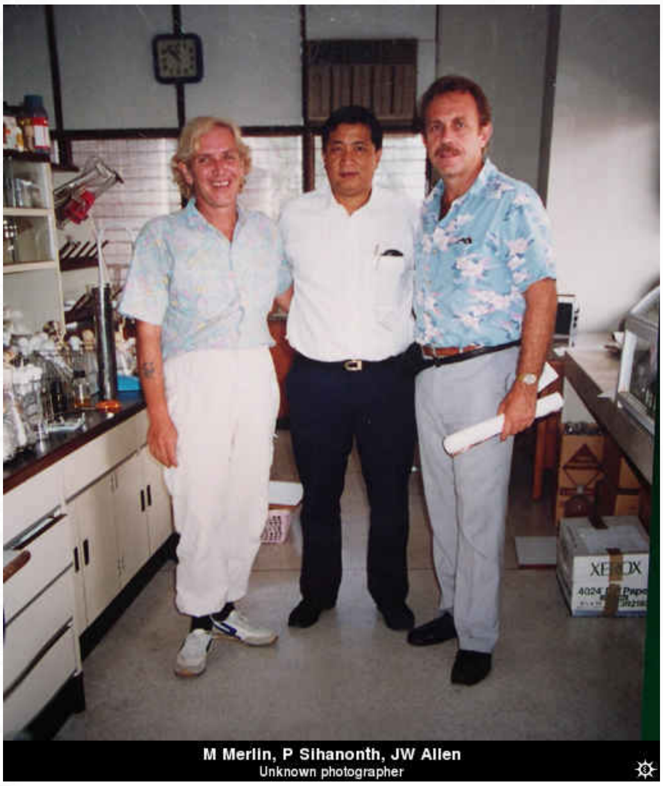

M Merlin, P Sihanonth, JW Allen
Unknown photographer

Fig. 71. Mark Merlin, Prakitsin Sihanonth and John W. Allen. Photographer unknown.

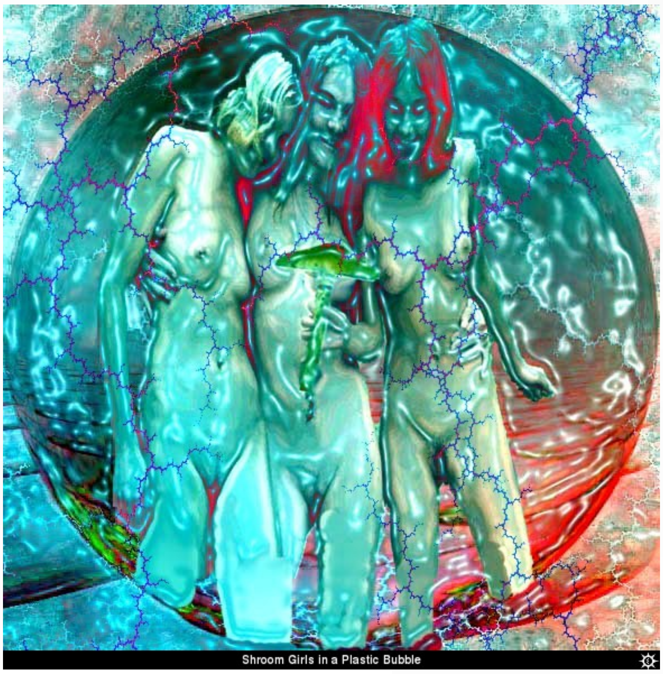

Shroom Girls in a Plastic Bubble

Image 13: Shroom Girls in a Plastic Bubble

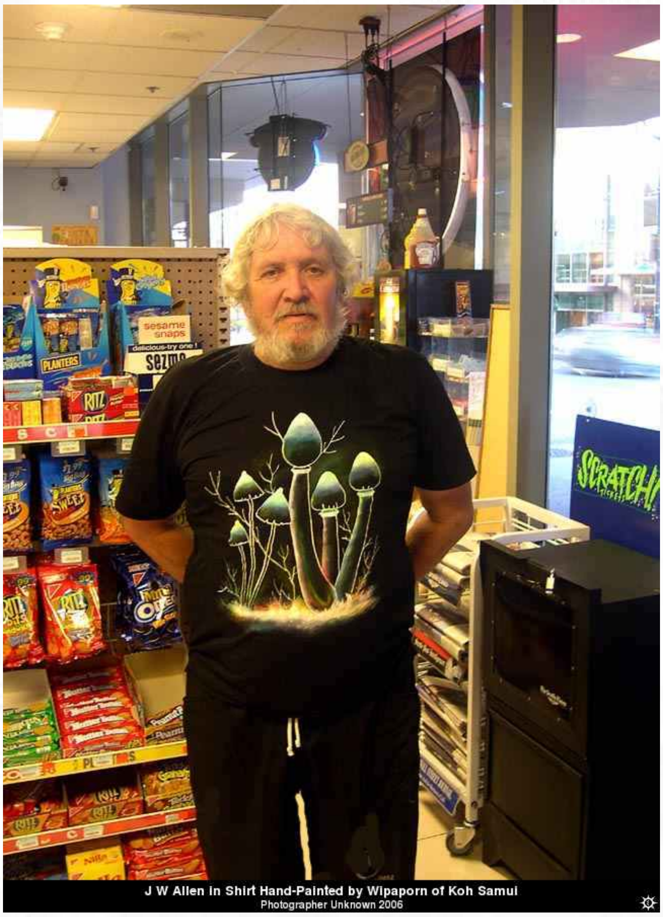

J W Allen in Shirt Hand-Painted by Wipaporn of Koh Samui
Photographer Unknown 2006

**Fig. 72. John W. Allen in Shirt Hand-Painted by Wipaporn of Koh Samui
Photographer unknown.**

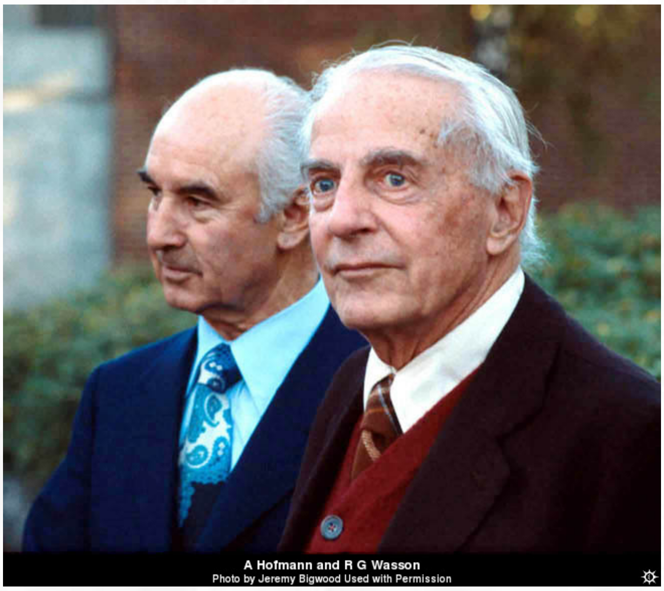

A Hofmann and R G Wasson
Photo by Jeremy Bigwood Used with Permission

Fig. 73. A. Hofmann and R. G. Wasson

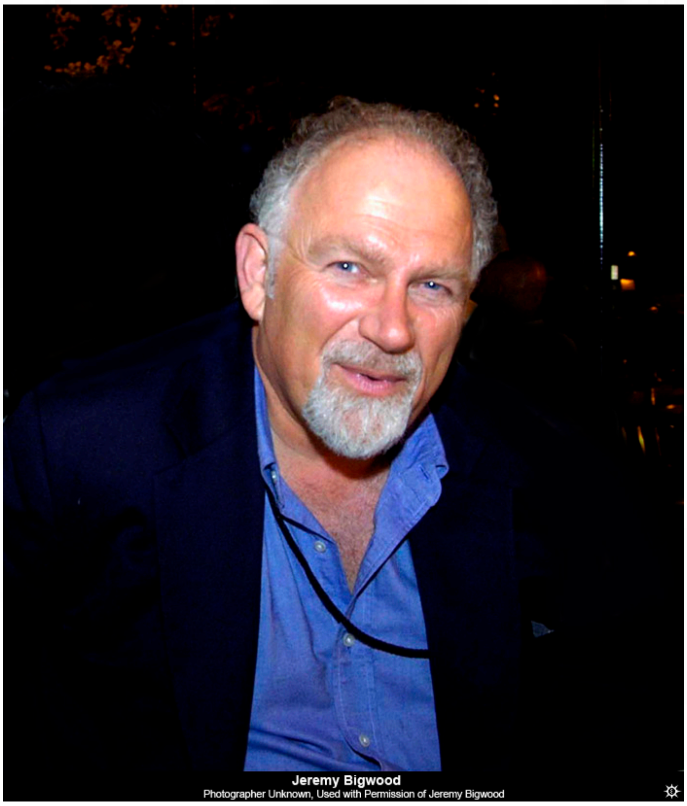

Jeremy Bigwood
Photographer Unknown, Used with Permission of Jeremy Bigwood

**Fig. 74. Jeremy Bigwood
Photographer unknown.**

Other Contributors in the Fields of Chemistry, Pharmacology, Psychiatric Medicine Field Identification and Cultivation

B. Aaronson; J. F. Ammirati; D. Ashley; M. Babos; V. Bandala; G. Bazanté; A. M. Becker; R. G. Benedict; H. Besl; C. Blake; H. Blaschko; J. Bonnard; L. R. Brady; A. Brack; R. Brunner; R. Cailleux; P. Catalfomo; A. Cerletti; J. Ceruti-Scurti; W. S. Chilton; A. L. Christianson; J. Clark; W. H. Clark; R. Cooper; J. Delay; B, Dubansky; C. Dubovoy; J. Fericgla; F. Festi; R. Fischer; N. Fiusello; A. Frey; N. Gabel; E. Gerhardt; G. Gloss; D. Gröger; L. S. Gurevich; M. Hall; G. M. Hatfield; T. Herrera; C. Hischenhuber; K. Hoiland; L. Holister; S. Hoogshagen; E. Horak; A. Horita; J. Jacobs; O. Janiger; J. Jokiranta; F. Kalberer; E. Kardel; C. King; J. Klan; H. Kobel; Y. Koike; G. J. Krieglsteiner; Th. W. Kuyper; R. Kysilka; Th. Lampèriere; D. T. Leslie; H. Leuner; A. Y. Leung; W. G. Levine; G. Litwin; A. A. R. Meijer; R. Metzner; R. Montgomery; V. M. Moser; G. M. Müller; P. Nicolas-Charles; E. Ohenoja; H. Osmond; A.-M. Quetin; A. G. Paul; W. Pahnke; P. Pichot; K. E. Rasmussen; D. Repke; J. E. Robbers; J. Rutschmann; G. Scheibler; S. Sebek; M. Semerdzieva; C. J. Shepherd; R. V. Southcott; Sam I. Stein; A. E. Stocks; Rick Strassman; Guy Stresser-Péan; F. Tapia; M. Taeschler; H. D. Thiers; F. Tonnesen; J. E. Trotter; F. Troxler; V. E. Tyler; P. Vergeer; D. Warshay; L. J. Weber; H. Weidmann; P. Witt; A. Wolman; M. Wurst.

The above list of pioneers are the majority of the original investigators of the chemical, pharmacological, mycological and psychiatric aspects of these interesting mushrooms. The author of this book hopes that this work will stimulate and inspire other students of mushrooms into furthering their ideas and research in this field.

Acknowledgements

The author would like to thank Jonathan Ott of Natural Products of Vashon Island, Washington for his time and consideration in re-editing this book prior to publication. Furthermore, the authors also give special thanks and appreciation to Jodi Meadows and to Rodman Reynolds for their assistance in editing the original manuscript. I would also like to acknowledge the assistance of Wolfgang Bauer of Germany for his help in several of the European authors biographies and the loan of several photographs for this book. Thanks go to Tjakko Stijve for the loan of his images, and for the French Review of the CD-ROM version of this book. And a special note of gratitude to my dear friends Linda Dear, Jan and Lome Nilsson, Gastón Guzmán, Jochen Gartz, Roger Liggenstorfer, Herman de Vries, Geoffrey Brooke, Mark Merlin, David Tatelman and Richard Evans Schultes, Paige Powell and Jonathan Ott for the use of some of their photographs and drawings and to the unknown photographers who took many of the pictures of the author with these scholars.

Joanne and Steven Peele
Used with permission of S Peele

Fig. 69. Joanne and Steven Peele (the latter is curator of the FMRC).

Interviews with R. Gordon Wasson

Forte, R. 1988. (Mag., Int.). A conversation with R. Gordon Wasson. *ReVision the Journal of Consciousness and Change* vol. 10(4):13-30.
R. Gordon Wasson's last interview.

Ott, J. and S. Pollock. 1976. (Mag.). An interview with R. Gordon Wasson. *High Times* vol. 14:23-30., 48. October.

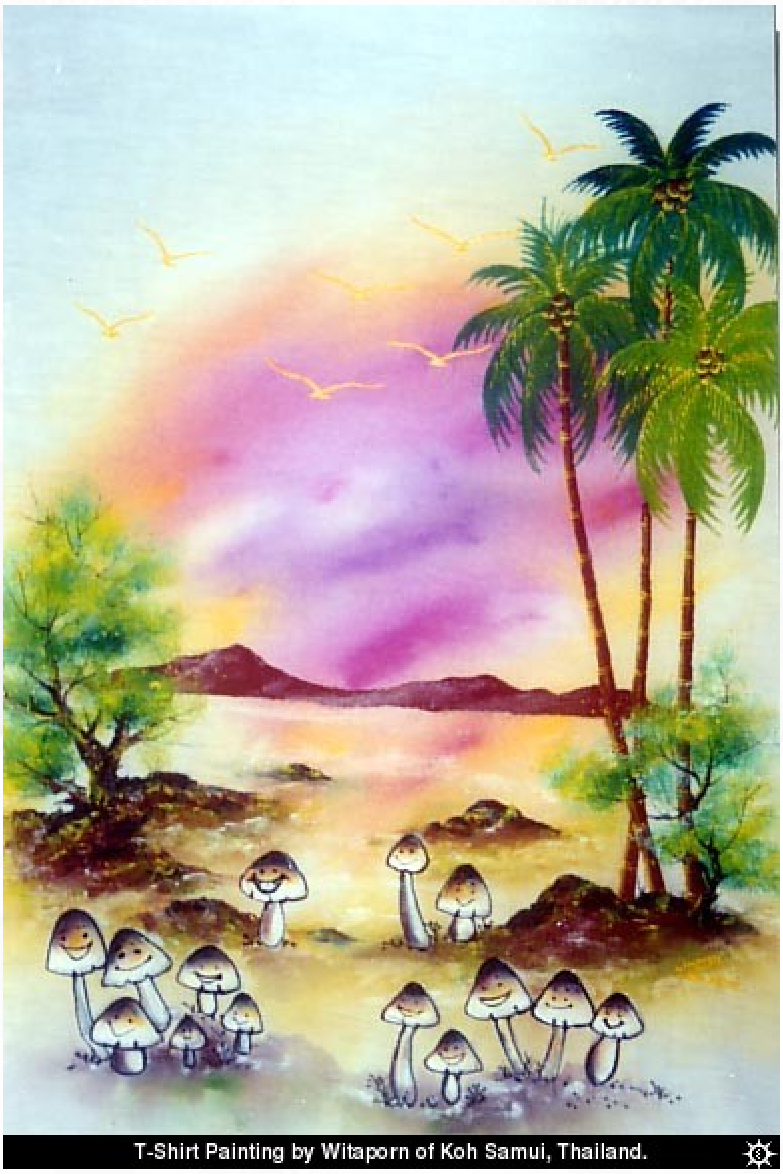

T-Shirt Painting by Witaporn of Koh Samui, Thailand.

Image 14: T-Shirt Painting by Witaporn of Koh Samui, Thailand.

Letters in Response to R. Gordon Wasson's May 13, 1957 Life Magazine Article

Carpenter, D. 1957. (Mag., Letter). *Life*:16. June 3.

Lee, C. 1957. (Mag., letter). *Life*:16. June 3.

Ross, J. 1957. (Mag., letters). *Life*:16. June 3.

Rowley, L. 1957. (Mag., letters). *Life*:16. June 3.

Snyder, M. 1957. (Mag., letters). *Life*:16. June 3.

Stokes Jr., M. Y. 1957. (Mag., letter). *Life*:16. June 3.

T-Shirt Painting by Witaporn of Koh Samui, Thailand.

Image 15: T-Shirt Painting by Witaporn of Koh Samui, Thailand.

Further Suggested Reading

Allen, J. W. 1978[1980]. *Safe-Pik Mushroom Identification Guide*. Publs. Frank and Cheeri Rinaldo. Seattle, Washington. On line copy at Erowid

Allen, J. W. 1997. *Magic Mushrooms of the Pacific Northwest*. Psilly Publications and RaverBooks, Seattle, Washington. 12 color photos.

Allen, J. W. 1998. *Magic Mushrooms of the Hawaiian Islands*. Psilly Publications and RaverBooks. Seattle, Washington. Color Photos.

Allen, J. W. 1997. *Teonanácatl: Ancient and Shamanic Mushroom Names of Mesoamerica and Other Regions of the World*. Psilly Publications and RaverBooks. Seattle, Washington.

Allen, J. W. 1999. Magic Mushrooms of Australia and New Zealand. Www.erowid.org/library/books_online/magic_mushrooms_aunz.shtml/

Allen, J. W. and J. Gartz. 1997. *Magic Mushrooms in Some Third World Countries*. Psilly Publications and RaverBooks. Seattle, Washington.

Allen, J. W. and J. Gartz. 2001. *Psilocybian Mushroom Cultivation: A Brief History Regarding the Contemporary Cultivation, Marketing and Use of Psilocybian Fungi*. Psilly Publications. CD-ROM Productions. Seattle, Washington. With 140 photographs. October, 2001.

Allen, J. W., and J. Gartz. Septermber 2001. *Teonanácatl: A Bibliography of Entheogenic Mushrooms*. Psilly Publications and CD-ROM Production. With a forward by Jonathan Ott.
2100 psilocybian references, 1700 annotations, more than 350 images with thumbnails and enlargements and more than 8000 cross references of Amanita and Pilocybian mushrooms citations.

Arthur, J. 2000. *Mushrooms and Mankind*. The Book Tree. Escondito, California.

Davis, W. 1996. *One River: Explorations and Discoveries in the Amazon Rain Forest*. Touchstone Publishers and Simon and Schulster. New York.

Enos, L. 1973. *A Key to the North American Psilocybe Mushroom*. Youniverse Press. Lemon Grove California.

Estrada, A. 1976. *Maria Sabina: Her Life, Her Chants. An Autobiography*. Ross-Erikson. California.

Friedman, S. A. 1987. *Celebrating the Wild Mushroom*. Dodd, Mead and Co. New York.

Furst, P. T. 1986. *Psychedelic Fungi*. *Encyclopedia of Psychoactive Drugs*. Chelsea House Publishing. New York.

Gartz, J. 1997-98. *Magic Mushrooms Around the World: A Scientific Journey Across Cultures and Time. The case for Challenging Research and Value Systems*. Translated from the masterpiece "*Narremschwammer*" by C. Taake.

Guzmán, G., Allen, J. W. and J. Gartz. 2000. A Worldwide Geographical Distribution of the Neurotropic Fungi, An Analysis and Discussion. *Anali dei Museo Civico* vol. 14:189-280. Rovereto, Italy. (214 species described and 39 images).

Hofmann, A. 1980. *LSD My Problem Child*. McGraw-Hill. New York.

Leary, T. 1995 [1968]. *High Priest*. Ronin Publications Inc. Berkeley, California.

Leary, T. 1983. *Flashbacks: A Personal and Cultural History of an Era*. J. P. Tarcher Inc. Los Angeles.

Lincoff, G. and D. H. Mitchell (Eds.). 1980. *Toxic and Hallucinogenic Mushrooms*. Van Nostrand Reinhold.

New York.

McKenna, T. 1993. *Food of the Gods: The Search for The Original Tree of Life*. Bantam Books. New York.

Menser, G. 1977 [1991]. *Hallucinogenic and Poisonous Mushroom Field Guide*. And/or Press. Berkeley, California. Re-issued as *Magikal Mushroom Handbook*. Homestead Book Co. Seattle, Washington.

Ott, J. 1976 [1979]. *Hallucinogenic Plants of North America*. Wingbow press. Berkeley, California.

Ott, J. 1993. *Pharmacotheon: Entheogenic Drugs, Their Plant Sources and History*. (see pp. 273-319. Natural Products Co. Kennewick, Washington.

Ott, J. and J. Bigwood (Eds.). 1978. *Teonanacatl: Hallucinogenic Mushrooms of North America*. Madrona Press. Seattle, Washington.

Reidlinger, T. J. (Ed.). 1990. *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*. Dioscorides Press. Portland, Oregon.

Rumack, B. and E. Saltzman (Eds.). 1978. *Mushroom Poisoning: Diagnosis and Treatment*. CRC Press. West Palm Beach, Florida.

Sanford, J. 1966. *In Search of the Magic Mushroom*. Clarkson N. Porter. New York.

Schultes, R. E. 1978. *Hallucinogenic Plants*. A Golden Garden Guide. Golden Press. New York.

Schultes, R. E. and A. Hofmann. *Plants of the Gods*. McGraw-Hill Book Co. New York.

Stafford, P. 1992. *Psychedelic Encyclopedia*. J. P. Tarcher, Inc. Los Angeles.

Stamets, P. 1978. *Psilocybe Mushrooms and Their Allies*. Homestead Book Co. Seattle, Washington.

Stamets, P. 1996. *A Field Guide to Psilocybin Mushrooms of the World*. Ten Speed Press. Berkeley, California.

Wasson, R. G. May 13, 1957. *Life* magazine.

Wasson, R. G. 1980. *The Wondrous Mushroom: Mycolatry in Mesoamerica*. McGraw-Hill Book Co. New York.

Weil, A. 1972. *The Natural Mind: A New Way of Looking at Drugs and the Higher Consciousness*. Houghton Mifflin. Boston, Ma.

Weil, A. 1980. *Marriage of the Sun and Moon*. Houghton Mifflin. Boston, Ma.

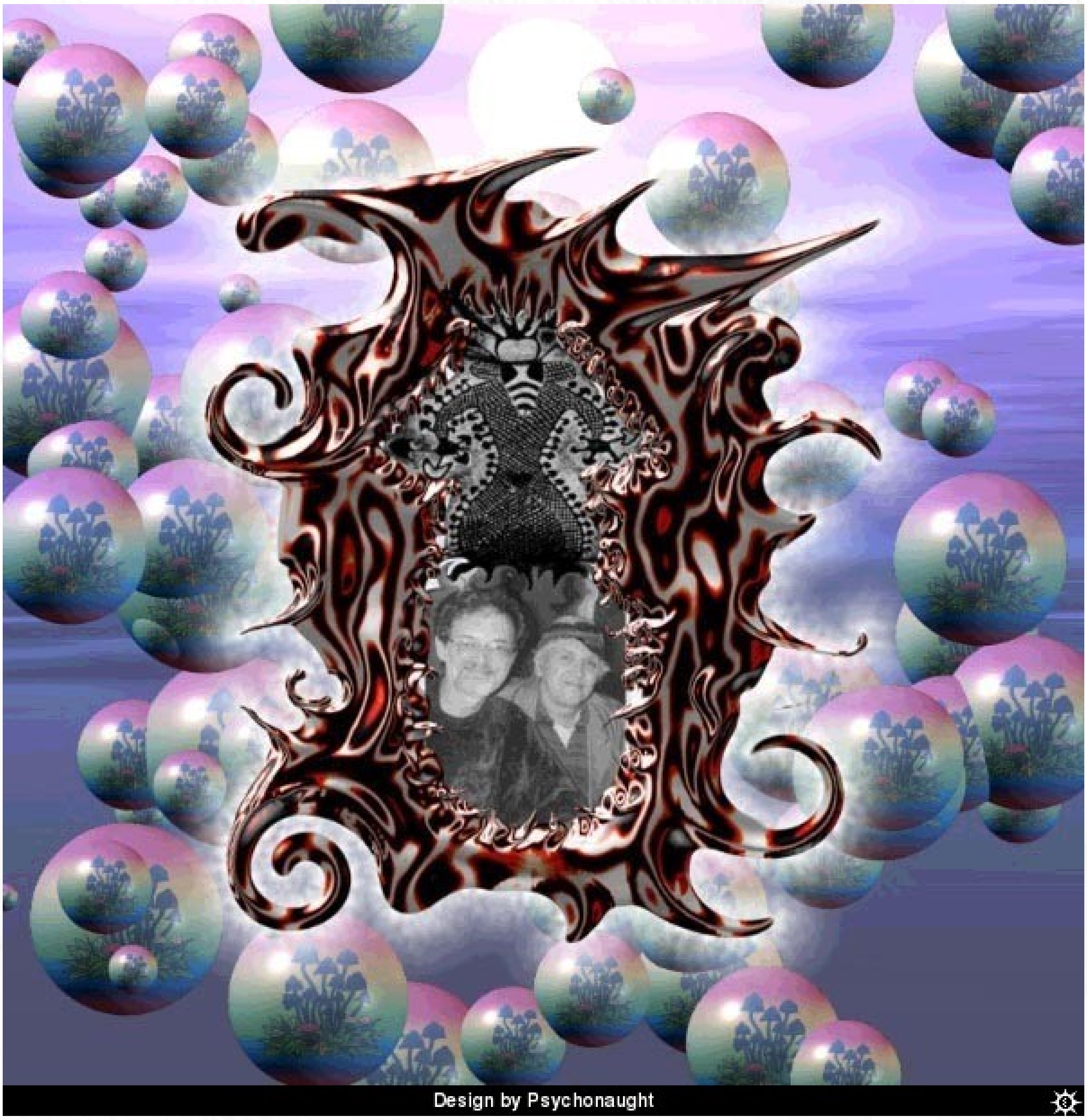


Image 15: Mushroom John and Terence McKenna Graphic Design by Psychonaught.

Internet Links to Mushroom-Related Websites

Primary Internet Resources
The Vaults of Erowid: https://www.erowid.org/

The Shroomery: http://www.shroomery.org/

Spiritplants: http://www.spiritplants.com/

Mushroom John's Shroom World: http://www.mushroomjohn.com/

Blue Honey: http://www.bluehoney.yage.net/

The Lycaeum: http://www.lycaeum.org/

Dissembodied Eyes: http://diseyes.lycaeum.org/fresh/fresh.htm/

Entheogens: http://www.entheogen.com/

Entheos: http://entheomedia.com/

Mycotopia: http://mycotopia.net/

North Florida Shroom Guide: http://jug-or-not.com/shroom/

Visionary Mushrooms: http://stainblue.com/

Hippie Haven: http://www.geocities.com/SouthBeach/Marina/7382/

Ethno-Mycology Links
R. Gordon Wasson's Papers: http://www.herbaria.harvard.edu/Libraries/wasson.html/

James Arthur's Holy Mushroom: http://www.sirius.com/~holy/mushroom.html/

On Line Drug Books: http://www.druglibrary.org/schaffer/lsd/bookmenu.htm/

MAPS: http://www.maps.org/research/psyprojects.html#PSILOCYBIN/

The Psilocybin Solution: http://www.lycaeum.org/books/books/psilocybin-solution/

TRIP (Formerly The Resonance Project): http://www.tripzine.com/

International Mushroom Web Site Links
Australian Mystical-Mycology: http://www.shaman-australis.com/shroom/kersbrookii.htm/

Copenhagen Mushroom Link: http://www.cheathouse.com/cmc/Link.html/

Danish Mushroom Site: http://www.cheathouse.com/svamp/

Italian Mushroom Site: http://www.nagual.f2's.com/cgi-bin/ikonboard/ikonboard.cgi/

Japan's First Mushroom Link: http://cosmicshrooms.com/

McShroom's Psilocybe Scotland Link: http://www.geocities.com/Yosemite/Geyser/2508/

Netherlands Amazing-Nature Mushroom Link: http://Amazing-nature.com/

New Zealand Shroom Connection: http://nevinninsky.com/

Norwegian Mushroom Site: http://users.lycaeum.org/~norshrooms/

UK Mushroom Map Link: http://members.tripod.co.uk/~shroommap/

Swedish Mushroom Site: http://mm.tech-no-logic.org/

Zauberpilze Swiss Mushroom Link: http://ourworld.compuserve.com/homepages/marcian/index.htm/

Spore Suppliers
Homestead Book Company: http://homesteadbook.com/

Ryche Hawk: http://www.thehawkseye.com/

The Ones That Stain Blue: http://stainblue.com/

Spore Works: http://www.sporeworks@shroomery.org/

Psilocybe Fanaticus (PF): http://www.fanaticus.com/

Mushroom Growing Teks and Links
Psiloweb: http://1166.51.114.182/users/mule/cgi-bin/ikonboard.cgi/

Mushroom Growing Supplies Only
(No Spores for Entheogenic mushroom species)
Fungi Perfecti: http://www.fungi.com/info/index.html/

References

1. ↑ **Aguirre-Beltran, G.** 1955. El proceso de aculturación y el Curanderiso en México. *Medicine and Magic*: Chap. 6-7. Mimeographed. México City.
2. ↑ **Allen, J. W.** 1987. Wasson's First Voyage. *High Times* vol. 146:40-41, 68. Trans High Corp. New York.
3. ↑ **Allen, J. W.** 1997a. *María Sabina: Saint Mother of the Sacred Mushrooms*. Ethnomycological Journals Sacred Mushroom Studies vol. I:1-28. RaverBooks. Seattle
4. ↑ **Allen, J. W.** 1997b. *Wasson's First Voyage: The Rediscovery of Entheogenic Mushrooms*. Ethnomycological Journals Sacred Mushroom Studies vol. II:1-30.
5. ↑ **Allen, J. W.** 1997c. *Teonanácatl: Ancient and Contemporary Shamanic Mushroom Names of Mesoamerica and Other Regions of the World*. Ethnomycological Journals Sacred Mushroom Studies vol. III:1-47.
6. ↑ **Antoine, P.** 1970. Les Champignons Hallucinogénes. *Mem. Mycol. Hum., et Veterinaire, Inst. Med. Trop.* Anvers, Antwerp.
7. ↑ **Baer, G.** 1967. Statistical results on reactions of normal subjects to the psilocybin derivatives CEY 19 and CZ 74. *Neuro-psychopharmacology* vol. 129:400-404. Proc. 5th Int. Cong. of Neuro Pharm.
8. ↑ **Baron, F.** 1963. *Creativity and Psychological Health*. D. Van Nostrand Co., Inc. New York (see p. 74-75, 250-255).
9. ↑ **Cairns, H.** 1929. (Mag.). A divine intoxicant. Atlantic Monthly vol. 144(5):638-645. November.
10. ↑ **Clark, J.** 1970. The use of psilocybin in a prison setting. In: Aaronson, B. and H. Osmond (Eds.) *Psychedelics*:40-44. Anchor Books. New York.
11. ↑ **Clark, W. H.** 1969. Historical notes: The Harvard incident. *Chemical Ecstasy: Psychedelic Drugs and Religion*:40-62. Sheed and Ward. New York.
12. ↑ **Davis, W.** 1996. *One River*. Touchstone. New York.
13. ↑ **De Borhegyi, S. F.** 1961b. (Mushroom Stones). Miniature mushrooms stones from Guatemala. *American Antiq*. vol. 26(4):498-504. April.
14. ↑ **De Borhegyi, S. F.** 1962. (Arch.). *The enigmatic mushroom stones of Mesoamerica*. Middle America Research Institute. Middle America Research Records. Tulane University. New Orleans.
15. ↑ **Doblin, R.** 1999-2000. Dr. Leary's Concord Prison Experiment: A 34 Year Follow Up Study. *MAPS Bulletin* vol. IX(4):10-18.
16. ↑ **Emboden, W. A.** 1979. *Narcotic Plants*. Second edition Revised and Enlarged. Macmillan Publishing Co., New York.
17. ↑ **Estrada, A.** 1976[1981]. *María Sabina: her Life, Her Chants. An Autobiography*. Ross-Erikson. California. Translated into English by Henry Munn. Available in Spanish, French, Portuguese and German.
18. ↑ **Finkelstein, N.** 1969. Hongi Meester. *Psychedelic Review* Vol. 10:52-63.
19. ↑ **Ford, W. W.** 1923. Mushroom Poisoning [classification]. *Assc. Amer. Phys. Trans*. vol. 38:225-229.
20. ↑ **Furst, P. T.** 1986. *Mushrooms: Psychedelic Fungi*. Psychoactive Mushrooms. Encyclopedia of Psychoactive Drugs. Chelsea House Publ. New York.
21. ↑ **Gartz, J.** 1996. *Magic Mushrooms around the World*. Lis Publications. Los Angeles. Translated from German by Claudia Taake.
22. ↑ **Gordon, N.** 1963. (Mag.). The Hallucinogenic Drug Cult. *The Reporter*:35-43. August 15.
23. ↑ **Gottleib, A.** 1976. *The Psilocybin Producers Guide*. Kistone Press. California.
24. ↑ **Gottleib, A.** 1997. *Psilocybin Production*. Ronin Publishing. Berkeley, California.
25. ↑ **Gottleib, A.** [Ed., Beverly Potter] 1998. *Psychedelic Underground Classics*. Twentieth Century Alchemist Publishers and Ronin Publishing. Berkeley, California.
26. ↑ **Graves, R.** 1962. A Journey to Paradise: Of toadstools and toxins, and a vivid tour of the Heaven (and Hell). *Holiday* vol. 32(2):36-37, 100-111.
27. ↑ **Guzmán, G.** 1977a. Distribution of the Mexican fungi with discussions on the relationships with the South American mycoflora. In: *IMC2-2nd International Congress Abstracts* vol. A-L:253. Saturday, August 27-September 3, 1977. University of South Florida at Tampa.
28. ↑ **Guzmán, G.** 1977b. The hallucinogenic species of the genus Psilocybe in the world. *IMC2-2nd International Congress Abstracts* vol. A-L:254. Saturday, August 27-September 3, 1977. University of South Florida at Tampa.
29. ↑ **Guzmán, G.** 1983. *The Genus Psilocybe: a systematic Revision of the Known Species Including the History, Distribution and Chemistry of the Hallucinogenic Species*. *Beih Nova Hedwigia* vol. 74. J. Cramer. Vaduz, Germany.
30. ↑ **Guzmán-Davalos, L. and G. Guzmán.** 1991. Additions to the Genus Gymnopilus (Agaricales, Cortinariaceae) from Mexico. *Mycotaxon* vol. XLI(1):43-56.
31. ↑ **Halifax, J.** 1979. María Sabina. Shamanic Voices: A Survey of Visionary Narratives. Chapter 5. *Wondrous Medicine*: 129-135. E. P. Dutton. New York.
32. ↑ **Heim, R.** 1963. *Les Champignons Toxiques et Hallucinogénes*. Boubee et Cie. Paris. New edition, 1978.
33. ↑ **Heim, R. and R. G. Wasson.** 1958. *Les Champignons Hallucinogénes du Mexique: Etude Ethnologiques, taxonomiques, biologiques, physiologiques et chemiques*. With the collaboration of Albert Hofmann, Roger Cailleux, A. Cerletti, Arthur Brack, Hans Kobel, Jean DeLay, Pierre Pichot, Th. Lempiere and J. Nicolas-Charles. (Archives Du Museum National d'Histoire Naturalle ser. 7 vol. 6). Paris. 322 pp. 36 Plates.
34. ↑ **Hofmann, A.** 1958. Rapport sur une Auto-Experience avec le Psilocybe mexicana Heim. *Les Champignons Hallucinogenes du Mexique*:278-280. Ed. Du Mus. Nat. d'Hist. Nat. Paris.

35. ↑ **Hofmann, A.** 1959 Chemical aspects of psilocybin, the psychotropic principle from the Mexican fungus, Psilocybe mexicana Heim. *Neuro-psychopharmacology* vol. 1:446-448. September. 1st Int. Cong. of Neuro-Pharm. Rome. Italy.
36. ↑ **Hofmann, A.** 1971. Teonanacatl and Ololiuqui: Two ancient magic drugs of Mexico. *Bulletin on Narcotics* vol. 23(1):3-14. United Nations Publication.
37. ↑ **Hofmann, A.** 1978. History of the basic chemical investigations of the sacred mushrooms. In (Editors, Ott, J. and Bigwood, J.): *Teonanacatl: Hallucinogenic Mushrooms of North America*:47-61. Proceedings from the 2nd International Conference on Hallucinogenic Mushrooms. Ft. Wordon, Port Townsend, Washington, November 27-30, 1977. Psycho-Mycological Studies No. 2. Seattle, Madrona Publishers.
38. ↑ **Hofmann, A.** 1980. The Mexican relatives of LSD--The sacred mushroom Teonanácatl. *LSD My Problem Child*:101-144. McGraw-Hill. New York. Translated from German by Jonathan Ott.
39. ↑ **Hofmann, A.** 1990. Ride through the Sierra Mazateca in search of the magic plant 'Ska Maria Pastora'. In: Thomas J. Reidlinger (ed.) *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*: 115-128. Dioscorides Press. Portland, Oregon.
40. ↑ **Hofmann, A., Heim, R., Brack, A., and H. Kobel.** 1958a. La Psilocybine, Principe Actif Psychotrope Extrait-du Champignon Hallucinogene Psilocybe mexicana Heim. *Les Champignons Hallucinogenes du Mexique*:255-257. Du Mus. Nat. D'hist. Nat. Paris.
41. ↑ **Hofmann, A., Heim and H. Kobel.** 1958b. Psilocybin, ein psychotroper Wirkstoff aus dem Mexikanischen Rauschpilz *Psilocybe mexicana* Heim. *Experientia* vol. 14(3):107-109. March. Also in: *Revue du Mycologie* vol. 23(1):114-118. April 15., and In:*Nouv Observ*:17-21.
42. ↑ **Hofmann, A., Frey, A., Ott, H., Petrzilka, Th., and F. Troxler.** 1958. Konstitutionsaufklarung und Synthese von Psilocybin. *Experientia* vol. 14(11):397-399.
43. ↑ **Hofmann, A. with R. Heim, Brack, A., Kobel, H., Frey, A., Ott, H., Petrzilka, Th., and F. Troxler.** 1959. Psilocybin und Psilocin, zwei Psychotrope Wirkstoffe aus Mexikanischen Rauschpilzen. *Helv. Chim. Acta*. vol. 42(5):1557-1572.
44. ↑ **Jacobs, K. W.** 1975. Hallucinogenic Mushrooms in Mississippi. *Journal of the Mississippi State Medical Association* vol. 16:35-37.
45. ↑ **Jones, R.** 1963. Up on psilocybin. *Harvard Review* vol. 1(4):38-43. Summer.
46. ↑ **Johnson, J. B.** 1939a. Some notes on the Mazatec. *Revista Mexicana de Anthropologia* vol. 3(2):142-156.
47. ↑ **Kahn, E. J.** 1992. (Mag.). Profiles: Jungle Botanist. *New Yorker*:35-58. June 1.
48. ↑ **Klüver, H.** 1966. *Mescal [sic]. and Mechanisms of Hallucination*. University of Chicago Press. Chicago, Ill.
49. ↑ **Koestler, A.** 1961. Letter to Tim Leary. Feb 17, 1961.
50. ↑ **Krippner, S.** 1987. *Healing States*. (Also see Aromin, 1973: In: Krippner, 1983).
51. ↑ **Krippner, S.** 1994. 1. Ritual Mushroom and Peyote Use in Mesoamerica. The use of Altered Conscious States in North and South American Indian Shamanic Healing Rituals. In: Jarbuch Für Transkulturelle Medizin und Psychotherapie (Yearbook of Cross-Cultural Medicine and Psychotherapy:1810202.
52. ↑ **Krippner, S. and M. Winkelman.** 1983. María Sabina: Wise lady of the mushrooms. *Journal of Psychedelic Drugs* vol. 15(3):225-228. July-September.
53. ↑ **Leary, T. F.** 1961a. *A program of research with consciousness-altering substances*. Harvard University, Center for Research in Personality. Undated (Spring or Summer of 1961). Covering the academic year of 1960-1961. Mimeographed.
54. ↑ **Leary, T. F.** 1961b. *Memorandum on Current Psilocybin projects*. Center for Research in Personality. Harvard University. Fall of 1961.
55. ↑ **Leary, T. F.** 1961c. Letter to Alan Watts. Feb 13, 1961.
56. ↑ **Leary, T. F.** 1961d. Letter to Arthur Koestler. April 25, 1961.
57. ↑ **Leary, T. F.** 1961e. Letter to Aldous Huxley. May 10, 1961.
58. ↑ **Leary, T. F.** 1963. *Report on the Harvard Psilocybin Project*. Unpublished. January 15.
59. ↑ **Leary, T. F.** 1995 [1968]. *High Priest*. Ronin Publishing Inc. Berkeley, California.
60. ↑ **Leary, T. F.** 1969. The effects of consciousness expanding drugs on prisoner rehabilitation. *Psychedelic Review* vol. 10:29-44.
61. ↑ **Leary, T. F.** 1983. *Flashbacks: A Personal and Cultural History of an Era*. Los Angeles. J. P. Tarcher Inc.
62. ↑ **Leary, T. F. and W. H. Clark.** 1963. (Mag.). Religious implications of consciousness expanding drugs. *Religious Education*:251-256.
63. ↑ **Leary, T. and R. Metzner.** 1968. Use of Psychedelic Drugs in Prisoner Rehabilitation. *British Journals of Social Psychiatry* vol.2:27-51.
64. ↑ **Leary, T. F. with Litwin, G. and R. Metzner.** 1962. *Americans and mushrooms in a naturalistic environment. A preliminary report*. Spring. 9 pp. manuscript. Harvard University.
65. ↑ **Leary, T. F., Litwin, G., and R. Metzner.** 1963. Reactions to psilocybin administered in a supportive environment. *Journal of Nervous and Mental Diseases* vol. 137(6):561-573.
66. ↑ **Leary, T. F., Metzner, R., Presnell, M., Weil, G., Schwitzgebel, R., and S. Kinne.** 1965. A New Behavior change program for adult offenders using psilocybin. *Psychotherapy: Therapy, Research, and Practice* vol. 2(2). July. Chicago, Illinois.
67. ↑ **Lee, M. A. and B. Shlain.** 1985. (CIA). Under the mushroom and over the rainbow. *Acid Dreams: The CIA, LSD, and the Sixties Rebellion*:71-97. Grove Press Inc. New York.
68. ↑ **Lennon, John and Yoko Ono.** (Circa 1970s). A letter to Tim Leary.
69. ↑ **Lincoln, J.** 1967. *One Mans Mexico: A Record of Travel and Encounters*. The Bodley Head. London.

70. ↑ **Lipp, F. J.** *The Mixe of Oaxaca: Religion, Ritual, and Healing*. University of Texas Press. Austin.
71. ↑ **Lowy, B.** 1971. (Mushroom Stones). New records of mushroom stones from Guatemala. *Mycologia* vol. 63:983-999.
72. ↑ **Lowy, B.** 1972. Mushroom symbolism in Maya codices. *Mycologia* vol. 64:816-821.
73. ↑ **Marks, J.** 1979. *The Search for the Manchurian Candidate*. Dell. New York.
74. ↑ **Mayer, K. H.** 1977. *The Mushroom Stones of Mesoamerica*. Acoma Books. California. Translated from the German.
75. ↑ **Metzner, R.** 1970. Mushrooms and the mind. In: Aaronson, B. and H. Osmond (Eds.) *Psychedelics: The Uses and Implications of Hallucinogenic Drugs*:90-107. Doubleday/Anchor. Garden City, New Jersey.
76. ↑ **Metzner, R.** 1999-2000. Reflections on the Concord Prison Project and the Follow-Up Study. *MAPS Bulletin* Vol. IX(4):19-20.
77. ↑ **Metzner, R. and G. M. Weil.** 1963. Predicting Recidivism: Base Rates for Massachusetts Correctional Institute Concord. *Journal of Criminal Law, Criminology and Police Science* Vol. 54(3):3070316.
78. ↑ **Metzner, R., Litwin, G. and G. M. Weil.** 1965. The relation of expectations and moods to psilocybin reactions: a questionnaire study. *Psychedelic Review* # 5:3-39.
79. ↑ **Miller, O. K.** 1971. *Mushrooms of North America*. Dutton. New York.
80. ↑ **Munn, H.** 1973. The Mushrooms of Language. In: Harner, M. J. (Ed.) *Hallucinogens and Shamanism*:86-122. Oxford University Press. London.
81. ↑ **National Geographic Magazine.** Various issues on Mexico.
82. ↑ **Ola'h, G.-M.** 1969. A taxonomic and physiological study of the genus Panaeolus with the Latin descriptions of the new species. *Revue de Mycologie* vol. 33(4):284-290. April 1.
83. ↑ **Ola'h, G.-M.** 1970. *Le Genre Panaeolus: Essai Taxinenomique et Physiologique*. *Revue de Mycologie M. Memoire Hors*-ser # 10. 222pp.
84. ↑ **Ott, J.** 1976. *Hallucinogenic Plants of North America*. Psycho-Mycological Studies No. 1. Wingbow Press. Berkeley, California. Revised edition 1979.
85. ↑ **Ott, J.** 1993. Psilocybine-Psilocine-Baeocystine: the Teonanácatl Complex. *Pharmacotheon: Entheogenic Drugs, their plant sources and history*:275-319. Natural Products. Kenniwick, Washington.
86. ↑ **Ott, J.** 1994. Pers. Comm. to the authors.
87. ↑ **Ott, J. and Bigwood, J.** [Eds.]. 1978. *Teonanácatl: Hallucinogenic Mushrooms of North America*. Madrona Publishers. Seattle, Washington.
88. ↑ **Pike, E. V.** 1960. Mazatec sexual impurity and bible reading. *Practical Anthropology* vol. 7(2):49-53. April.
89. ↑ **Pike, E. V. and F. Cowan.** 1959. Mushroom ritual versus Christianity. *Practical Anthropology* vol. 6(4):145-150. July-August.
90. ↑ **Richardson, A. B.** 1990. Recollections of R. Gordon Wasson's 'friend and photographer'. In: Thomas J. Riedlinger (ed.) *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*:193-204. Dioscorides Press. Portland, Oregon.
91. ↑ **Riedlinger, T. J.** 1990b. A latecomer's view of R. Gordon Wasson. In: Thomas J. Riedlinger (ed.) *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*:205-220. Dioscorides Press. Portland, Oregon. Ethnomycological Studies no. 11.
92. ↑ **Riedlinger, T. J. and T. Leary.** 1994. Strong Medicine for Prisoner Reform: The Concord Prison Experiment. *MAPS Bulletin* Vol. 4(4):22-25.
93. ↑ **Reko, B. P.** 1919. De los Nombres Botanicos Aztecos. *El Mexico Antiguo* vol. 1(5):113-117. February.
94. ↑ **Reko, B. P.** 1923. Letter to J. N. Rose. *Herbarium Sheet* Number # 1745713. U. S. National Museum. Washington, D. C.
95. ↑ **Reko, V. A.** 1936 [1938, 1939]. *Magische Gifte: Rausch- und Betäubungsmittel der Neuen Welt*:123-132. Ferdinand Enke Verlag. Stuttgart, Germany.
96. ↑ **Roberts, T. and B. Jesse.** 1998. Recollections of the Good Friday Experiment: An Interview with Huston Smith. *Journal of Transpersonal Psychology* vol. 29(2):99-104.
97. ↑ **Rumack, B. and E. Salzman.** 1978. *Mushroom Poisoning: Diagnosis and Treatment*. CRC Press. West Palm Beach.
98. ↑ **Ryan, M.** 1980. Recording the colleges dark period: 1960-1973. *The Harvard Crimson Anthology / 100 Years at Harvard*:10. Edited by Greg Lawless. Houghton-Mifflin Co. Boston.
99. ↑ **Safford, W. E.** 1915. An Aztec narcotic. *Journal of Heredity* vol. 6:291-311. July.
100. ↑ **Safford, W. E.** 1923. Peyotl. *Journal of the American Medical Association* vol. 77:1278-1279. October.
101. ↑ **Sandford, J.** 1973. *In Search of the Magic Mushroom*. Clarkson N. Porter. New York.
102. ↑ **Santesson, C. G.** 1939. Einige Mexikanische Rauschdrogen. *Archiv Für Botanik* vol. 29A(12):1-9.
103. ↑ **Schultes, R. E.** 1939. The identification of Teonanácatl, a narcotic basidiomycete of the Aztecs. *Botanical Museum Leaflets of Harvard* vol. 7(3):37-54. February 21.
104. ↑ **Schultes, R. E.** 1940. Teonanácatl: The narcotic mushroom of the Aztecs. *American Anthropologist* vol. 42:429-443.
105. ↑ **Schultes, R. E.** 1969. The plant kingdom and hallucinogens. Bulletin on Narcotics, (4).
106. ↑ **Schultes, R. E.** 1978. Evolution of the identification. In: Ott, Jonathan and Jeremy Bigwood (Eds.) *Teonanácatl: Proceedings of the 2nd International Conference on Hallucinogenic Mushrooms*:25-43. Madrona Publ. Seattle.
107. ↑ **Schultes, R. E.** 1987. Personal Communication.
108. ↑ **Schultes, R. E.** 1988. Personal Communication.
109. ↑ **Schultes, R. E.** 1989. Personal Communication.

110. ↑ **Schultes, R. E. and A. Bright.** 1979. Ancient pectorals from Colombia: Mushroom effigies. *Botanical Museum Leaflets of Harvard* vol.27(5-6):113-141. May-June.
111. ↑ **Schultes, R. E. and A. Hofmann.** 1973. *The Botany and Chemistry of the Hallucinogens*. 2nd edition 1980.
112. ↑ **Schultes, R. E. and A. Hofmann.** 1979. *Plants of the Gods: Origins of Hallucinogenic Use*. McGraw-Hill Book Co. New York.
113. ↑ **Sheff, D.** 1987. (Int.). Timothy Leary. *Rolling Stone* No. 512:226-228. Twentieth Anniversary Issue. November 5-December 10.
114. ↑ **Singer, R.** 1949. *The Agaricales (Mushrooms) in Modern Taxonomy*. *Lilloa* vol. 22:472, 506. 832p. 2nd edition from University of Tucuman, Argentina, August 1962. See pp. 543-544.
115. ↑ **Singer, R.** 1957. Sacred mushrooms inspire medical research. *Chicago Natural History Museum* Bulletin:7.
116. ↑ **Singer, R.** 1958. Mycological investigations on Teonanácatl, the Mexican hallucinogenic mushrooms part one: The history of Teonanácatl, field work and culture. *Mycologia* vol. 50(2)239-261. April.
117. ↑ **Singer, R.** 1978b. Hallucinogenic mushrooms. In: Rumack, Barry H. and Emanuell Satlzman's *Mushroom Poisoning: Diagnosis and Treatment*:201-214.
118. ↑ **Singer, R. and A. H. Smith.** 1958b. Mycological investigations on Teonanácatl, the Mexican Hallucinogenic mushrooms part two: A taxonomic monograph of Psilocybe section Caerulescens. *Mycologia* vol. 50(2):262-303. March-April.
119. ↑ **Southcott, R. V.** 1974. Notes on Some Poisonings and other clinical effects following the ingestion of Australian fungi. *South Australian Clinic* vol. 6(5):441-478.
120. ↑ **Stafford, P.** 1977. Psilocybin mushrooms. *Psychedelic Encyclopedia*:195-255. 384p. And/Or Press. Berkeley. Revised 1982 edition appears as chapter 4:224-279. J. P. Tarcher, Inc. Los Angeles. (See next entry).
121. ↑ **Stafford, P.** 1980. *Psilocybin und Andere Pilze*. 71p. Raymon Martin Verlag. Informationsreihe Drogen 4. Germany. Excerpted from Peter Stafford's *Psychedelic Encyclopedia*.
122. ↑ **Stein, S. I.** 1958. An unusual effect from a species of Mexican mushrooms. *Psilocybe cubensis*. *Mycopathologia et Mycologia Applicata* vol. 9(4):236-267.
123. ↑ **Stein, S. I** 1959. Clinical observations on the effects of Panaeolus venonosus vs. *Psilocybe caerulescens*. *Mycologia* vol. 51(1):49-50.
124. ↑ **Stevens, J.** 1987a. (CIA). Noises off stage. *Storming Heaven: LSD and the American Dream*:74-87. Atlantic Monthly Press. New York. (See next three entries).
125. ↑ **Stevens, J.** 1987b. (CIA). Wild geese . *Storming Heaven: LSD and the American Dream*:121-135. Atlantic Monthly Press. New York.
126. ↑ **Stevens, J.** 1987c. Harvard psilocybin project. *Storming Heaven: LSD and the American Dream*:136-158. Atlantic Monthly Press. New York.
127. ↑ **Stevens, J.** 1987d. What happened at Harvard. *Storming Heaven: LSD and the American Dream*:159-170. Atlantic Monthly Press. New York.
128. ↑ **Stresser-Péan, G.** 1990. Travels with R. Gordon Wasson in Mexico, 1956-1962. In: Thomas J. Riedlinger (ed.) *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*:231-238. Ethnomycological Studies No. 11.
129. ↑ **Swain, F.** 1962. Four psilocybin experiences: 1. El hongo mistico. *Tomorrow* vol. 10(4):27-34. Autumn. Also in: *Psychedelic Review* #2. Spring 1963.
130. ↑ **Tyler, V. E. and D. Groger.** 1964. Occurrence of 5-hydroxy-tryptamine and 5-hydroxytryptophan in *Panaeolus sphinctrinus*. *Journal of Pharmaceutical Science* vol. 53(4):462-463.
131. ↑ **Unsigned.** 1959. Road to endsville. *Newsweek*. February 9.
132. ↑ **Unsigned.** 1970. Hippies flocking to México for mushroom trips. *New York Times*:6c. July 23.
133. ↑ **Unsigned.** 1963a. Psychic Research, LSD, And All That. *Time*. March 29.
134. ↑ **Unsigned.** 1963b. No Illusions. *Newsweek*. June 10.
135. ↑ **Villacorta, A. J. C. and C. A. Villacorta.** 1927. (Arch.). On mushroom stones. *Arqueologia Guatemala*:123-125. Guatemala.
136. ↑ **Weil, A.** 1963. Drugs and the mind. *Harvard Review* vol. 1(4):1-3. Summer.
137. ↑ **Weil, A.** 1977. The use of psychoactive mushrooms in the Pacific Northwest. *Botanical Museum Leaflets of Harvard* vol. 25(5):131-148. June 30.
138. ↑ **Weil, A.** 1980. *Marriage of the Sun and the Moon. A Quest for Unity in Consciousness*. Houghton-Mifflin Company. Boston.

A Bibliography of R. Gordon Wasson (With Some Annotations)

139. ↑ **Wasson, R. Gordon**. 1956. Lightning bolt and mushrooms: an essay into early cultural exploration. In: For Roman Jakobson: *Essays on the Occasion of his Sixteenth Birthday*:605-612. The Hague. Mouton & Co.
Reprinted in Dutch in: Antiquity and Survival *vol. 3(1):59-73. 1960.*
140. ↑ **Wasson, R. Gordon**. 1957a. Seeking the magic mushroom. *Life*:100-102, 109-120. May 13.
Letters written to the editor regarding this special issue which appeared in the June 3, 1957 issue of Life. The international edition is dated June 10, 1957. (For letters written in response to the above noted article see Carpenter, 1957; Lee, 1957, Ross, 1957, Rowley, 1957; Snyder, 1957; and Stokes, 1957).
141. ↑ **Wasson, R. Gordon**. 1957b. En busca de los hongos mágicos. *Life en Español*.
A Spanish version of above entry. June 3.
142. ↑ **Wasson, R. Gordon**. 1958a. J'ai mangé les champignons magiques. *Lectures Pourtous* #49:30-35. January. Unsigned.
French translation of the May 13, 1957 article "Seeking the magic mushroom".
143. ↑ **Wasson, R. Gordon**. 1958b. The divine mushroom: Primitive religion and hallucinatory agents. *Proc. Amer. Phil. Soc*. vol. 102(3):221-223. Philadelphia. June 24.
R. Gordon Wasson's journal report on the use of entheogenic mushrooms in primitive societies and his interpretation and description of their overwhelming effects on one's soul.
144. ↑ **Wasson, R. Gordon**. 1958c. Les premier sources. In: *Les Champignons Hallucinogenes du Mexique*:15-44.
145. ↑ **Wasson, R. Gordon**. 1958d. Les champignons sacre au Mexique Contaemporain. In: *Les Champignons Hallucinogenes du Mexique*:45-100.
146. ↑ **Wasson, R. Gordon**. 1958e. Les champignons dan l'Archeologie Meso-Americaine. In: *Les Champignons Hallucinogenes du Mexique*:101-122.
147. ↑ **Wasson, R. Gordon**. 1959a. The hallucinogenic mushrooms of Mexico: An adventure in ethnomycological exploration. *Trans. New York Acad. Sci* .Series II, vol. 21(4):325-339.
R. Gordon Wasson recalls his discovery in México of the use of sacred mushrooms and describes the use of entheogenic mushrooms in past and present cultures. Also in: The Drug Experience, First Personal Accounts of Addicts, Writers, Scientists and Others:*311-324. 1961. Edited by David Ebin, Orian Press. New York.*
148. ↑ **Wasson, R. Gordon**. 1959b. Wild mushrooms: A world of wonder and adventure. *Herbarist* vol. 24:13-28. Boston.
Three reports concerning the effects caused after the accidental ingestion of entheogenic mushrooms which occurred in Poland, Colorado, and the Fiji Islands. These effects are reported by three individuals who read R. Gordon Wasson's article in Life magazine (May 13, 1957).
149. ↑ **Wasson, R. Gordon**. 1960. The hallucinogenic mushrooms of Mexico: An inquiry into the origins of the religious idea among primitive peoples. *Annual Lecture of the Mycological Society of America*. Lecture at Stillwater, Oklahoma. August 30.
Appended to this article is a list of psilocybian fungi from México; including three other non-psychoactive species which are reportedly used ceremoniously as well as the auditory hallucination producing puffballs.
150. ↑ **Wasson, R. Gordon**. 1961a. The hallucinogenic mushrooms of Mexico: An inquiry into the origins of the religious idea among primitive peoples. *Botanical Museum Leaflets of Harvard* vol. 19(7):137-162. February.
Also in: Psychedelic Reader *vol. 1(1):27-42. Spring 1963. Edited by Gunther Weil, Ralph Metzner and Timothy Leary. University Books 1965. New Hyde Park, New York.*
151. ↑ **Wasson, R. G**. 1961b. Notes on the present status of Ololiuqui and other hallucinogens of Mexico. *Botanical Museum Leaflets of Harvard* vol. 20(6):161-212.
Also in: Psychedelic Review Vol. 1(3):27-42. 1963.
152. ↑ **Wasson, R. Gordon**. 1962a. The hallucinogenic mushrooms of Mexico: An inquiry into the origins of the religious idea among primitive peoples. *International Journal of Parapsychology* vol. 4(4):41-58. Autumn.
An abbreviated version of Wasson, 1960, 1961a.
153. ↑ **Wasson, R. Gordon**. 1962b. Salvia Divinorum: A new psychotropic drug from the mint family. *Botanical Museum Leaflets of Harvard* vol. 20:77-84.
154. ↑ **Wasson, R. Gordon**. 1962c. Personal communication with Robert Graves. June 5.
In a letter to Robert Graves, R. Gordon Wasson reports on the presence of Psilocybe cubensis "*in the Philippine [Islands] where it is not eaten [by native peoples].*"
155. ↑ **Wasson, R. Gordon**. 1963. Mushroom rites of Mexico. *Harvard Review* vol. 1(4):7-17. Summer.
A second abbreviated version of the hallucinogenic fungi of Mexico.
156. ↑ **Wasson, R. Gordon**. 1965. Rite of the magic mushroom. In: *The Drug Takers*. Time-Life (authors) special report. New York.
157. ↑ **Wasson, R. Gordon**. 1969. (Bk. Rev.). *Economic Botany* vol. 23(2):197.
A review of Carlos Castaneda's "The Teachings of Don Juan: A Yaqui Way of Knowledge."
158. ↑ **Wasson, R. Gordon**. 1970a. (Letter). *Times Literary Supplement*. August 21.
Letter to the editor.
159. ↑ **Wasson, R. G**. 1970b. Comments inspired by Professor Kuiper's review. *Indo-Iranian Journal* vol. 12(4):286-298.
Professor Kuiper's review is in the same issue.

160. ↑ **Wasson, R. Gordon**. 1970c. (Letter). *Times Literary Supplement*. September 29.
Letter to the editor.
161. ↑ **Wasson, R. Gordon**. 1970d. (News Item). Drugs: The sacred mushroom. *New York Times*. September 29.
Guest editorial.
162. ↑ **Wasson, R. Gordon**. 1970e. Les champignons dan la culture: A propos d'un livre de M. R. Wasson. *L'Homme* vol. 10(1):5-16.
163. ↑ **Wasson, R. Gordon**. 1972a. (Bk. Rev.). *Economic Botany* vol. 26(1):98-99.
A review of Carlos Castaneda's "A Separate Reality: Further Conversations with Don Juan."
164. ↑ **Wasson, R. Gordon**. 1972b. The death of Claudius or mushrooms for murderers. *Botanical Museum Leaflets of Harvard* vol. 23(3):101-128.
165. ↑ **Wasson, R. Gordon**. 1973a. (Bk. Rev.). *Economic Botany* vol. 27(1):151-152.
A review of Carlos Castaneda's "Journey to Ixtlan: The Lessons of Don Juan."
166. ↑ **Wasson, R. Gordon**. 1973b. The role of flowers in Nahuatl culture: A suggested interpretation. *Botanical Museum Leaflets of Harvard* vol. 23(8):305-324. November 30.
Also in: Journal of Psychedelic Drugs *vol. 6(3):351-360. July-September 1974*.
167. ↑ **Wasson, R. Gordon**. 1973c. Mushrooms and Japanese culture. *Trans. Asiatic Soc. of Japan* vol. 11:5-25. December.
R. Gordon Wasson explores the etymology of Japanese mushroom names and reports on several historical tales of accidental ingestion of entheogenic mushrooms in Japan.
168. ↑ **Wasson, R. G.** 1974. (Bk. Rev.). *Economic Botany* vol. 28(3):245-246.
A review of Carlos Castaneda's "Tales of Power."
169. ↑ **Wasson, R. Gordon**. 1977a. (Bk. Rev.). *Head* vol. 2(4):52-53, 88-94. November.
Reprints of R. Gordon Wasson's reviews of Carlos Castaneda's first four books. With an unsigned introduction by Jonathan Ott. Originally published in Economic Botany.
170. ↑ **Wasson, R. Gordon**. 1977b. María Sabina y los hongos. *Vuelta* Vol. 1:(8):24-27. July.
A reprint of Wasson's "Presentación" in Alvaro Estrada's "Vida de María Sabina."
171. ↑ **Wasson, R. Gordon**. 1978a. (Mag.). Wasson's velada with María Sabina. *Head* vol. 2(7):52-56.
This article has been edited from several of Wasson's previously published papers describing his rediscovery of the sacred Mexican mushrooms.
172. ↑ **Wasson, R. Gordon**. 1978b. The hallucinogenic fungi of Mexico. In *Teonanácatl*:63-84. Edited by Jonathan Ott and Jeremy Bigwood. Madrona Publ. Seattle, Washington.
173. ↑ **Wasson, R. Gordon**. 1979. Foreword. In: *Phantastica: Rare and Important Psychoactive Drug Literature from 1700 to the present*. Privately published by William and Victoria Dailey. Antiquarian Books and Fine Prints. 8216 Melrose avenue, Los Angeles, California 90046.
174. ↑ **Wasson, R. Gordon**. 1980. *The Wondrous Mushroom: Mycolatry in Mesoamerica*. Ethnomycological Studies No. 7. McGraw-Hill Book Co. New York, St. Louis and San Francisco.
R. Gordon Wasson retraces the history of the sacred magic mushrooms during the pre-Columbian conquest and their present-day use in Mesoamerica.
175. ↑ **Wasson, R. G**. 1982a *R. Gordon Wasson's Rejoiner to Dr. Rolf Singer. Ethnomycological Studies No. 9*. Botanical Museum of Harvard. Cambridge, Massachusetts.
See separate entries by Alexander H. Smith, Jonathan Ott, and Rolf Singer regarding related papers.
176. ↑ **Wasson, R. Gordon**. 1982b. The last meal of Buddha. *Journal of the American Oriental Society* vol. 102(4):591-603. October-December.
See next entry.
177. ↑ **Wasson, R. Gordon**. 1983a. The last meal of Buddha. *Botanical Museum Leaflets of Harvard* vol. 29(3):219-249. Summer.
178. ↑ **Wasson, R. Gordon**. 1983b. *El Hongo Maravilloso Teonanácatl: Micolatria en Mesoamerica*. Fondo de Cultura Económica. Mexico.
Spanish version of The Wondrous Mushroom.
179. ↑ **Wasson, R. Gordon**. 1985. (Mag.). In pursuit of mushrooms. *Discover* vol. 18(2):9-15.
180. ↑ **Wasson, R. Gordon**. 1990. Gordon Wasson's account of his childhood. In: Thomas J. Riedlinger (ed.) *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*:239-246. Dioscorides Press. Portland, Oregon.
181. ↑ **Wasson, R. G. and S. S. Pau**. 1962. The hallucinogenic mushrooms of Mexico and psilocybin: A bibliography. *Botanical Museum Leaflets of Harvard* vol. 20(2):25-73. September.
See next entry.
182. ↑ **Wasson, R. G. and S. S. Pau**. 1963. The hallucinogenic mushrooms of Mexico and psilocybin: A Bibliography. *Botanical Museum Leaflets of Harvard* vol. 20(2a):25-73c. March 10.
A second printing offers corrections and addenda with more new listings.
183. ↑ **Wasson, R. G. and V. P. Wasson**. 1956. (Record). *Mushroom Ceremony of the Mazatec Indians of Mexico*. Recorded by R. Gordon Wasson, with translations by Eunice V. Pike and Sarah C. Cudschinsky. Folkway Records and Service Corporation, 121 West 47th Street, New York, New York. Record Listing no. Fr8975.
Extracts of a mushroom ceremony recorded in Huautla de Jiménez.
184. ↑ **Wasson, R. G., Hofmann, A., and C. A. P. Ruck**. 1978. *The Road to Eleusis: Unveiling the Secret of the Mysteries. Ethnomycological Studies No. 4*. Harcourt.
185. ↑ **Wasson, V. P**. 1958. (Mag.). I ate the sacred mushroom. *This Week*:8-10, 36. May 19.

This article, originally published in a Boston Newspaper magazine which appeared in eastern Sunday editions of local newspapers. The article, written by R. Gordon Wasson's wife Valentina, describes her experience eating the sacred mushrooms. This was the first mushroom intoxication outside and away from an official ceremony. Gordon's daughter Masha also took part in the mushroom velada. Also in: Shaman Woman, Mainline Lady: Women's Writings on the Drug Experience:182-186. Compiled by C. Palmer and M. Horowitz. William Morrow and Company, Inc. New York and London.

186. ↑ **Wasson, V. P. and R. G. Wasson**. 1957. *Mushrooms, Russia, and History*. Two volumes. 85 plates. 26 water colors. Pantheon Books. New York.
    Limited to 512 numbered copies. Two are numbered A and B. Others are from 1-510.
187. ↑ **Wasson, V. P. and R. G. Wasson**. 1958. (Mag.). The hallucinogenic mushrooms. *Garden Journal*:1-5, 31. January.
    An historical critique in which the Wassons describe worldwide attitudes concerning four centuries of mushroom use in Mesoamerica.

A complete listing of the Wasson's research and collected data papers can be found at: http://www.huh.harvard.edu/Libraries/wasson.html

Hallucinogenic Mushrooms and Evolution

by

Terence Mc Kenna

Originally published in *ReVision - The Journal of Consciousness and Change* Vol. 10, No. 4.

original source: http://www.vasulka.org/archive/Artists3/McKenna,Terence/PsychedelicsRevisited.pdf
backup source: http://www.psilosophy.info/resources/PsychedelicsRevisited.pdf

> **Terence McKenna** has spent the last 20 years in the study of the ontological foundations of shamanism and the ethnopharmacology of spiritual transformation. He graduated from the University of California at Berkeley with a distributed major in ecology, resource conservation, and shamanism. After graduation he traveled extensively in the Asian and New World tropics, becoming specialized in the shamanism and ethnomedicine of the Amazon Basin. With his brother Dennis, he is the author of *The Invisible Landscape* and *Psilocybin: The Magic Mushroom Growers' Guide*. A talking book of his Amazon adventures, *True Hallucinations*, has also been produced. In Hawaii he is the founding secretary - treasurer of Botanical Dimensions, a tax-exempt, nonprofit research botanical garden and germ plasma repository devoted to the collection and propagation of plants of ethnopharmacological interest. In California he divides his time between writing, lecturing, and managing Lux Natura Inc., a publishing company of which he is the president and founder.

For tens of millennia human beings have been utilizing hallucinogenic mushrooms divine and to to induce shamanic ecstasy. The human-mushroom interaction is not a static symbiotic relationship but rather a dynamic one through which at least one of the parties has been bootstrapped to higher cultural levels. The impact of hallucinogenic plants on the evolution and emergence of human beings is a heretofore unexamined phenomenon, yet it promises to provide an understanding of not only primate evolution but also the emergence of the cultural forms unique to *Homo sapiens*.

At Gome National Park in Tanzania, primatologists found that one particular species of leaf kept appearing undigested in Chimpanzee dung. They found that every few days the chimps would vary from their usual pattern of eating wild fruit. Instead, they would walk for 20 minutes or longer to the site where a species of *Aspilia* was growing. They would repeatedly place their lips over an *Aspilia* leaf and hold it in their mouths. Chimps were seen to pluck a leaf, place it in their mouths, roll it around for a few moments, and then swallow it whole. In this way as many as 30 small leaves might be eaten.

Biochemist Eloy Rodriguez of the University of California, Irvine, isolated the active principle from the *Aspilia* - a reddish oil now named thiarubrine-A. Working with the same substance, Neil Towers of the University of British Columbia found that this compound can kill common bacteria in concentrations of less than one part per million. Herbarium records studied by Rodriguez and Towers showed that African peoples used the same leaves to treat wounds and stomach aches. Of the four species of *Aspilia* native to Africa, the indigenous peoples used only three, the same three utilized by the chimpanzees (Rodriguez, Aregullin, Uehara, Nishida, Wrangham, Abramowski, Finlayson, & Tower, 1985).

These findings clearly show the way a beneficial plant, once discovered by an animal or a person, can be included in the diet and thus confer an adaptive advantage. The animal or person is no longer threatened by certain environmental factors, such as diseases that may have previously set constraints on the life span of individuals of the species or on the growth of the population as a whole. This type of adaptive advantage is easily understood. Less easy to understand is the way plant hallucinogens might have provided similar yet different adaptive advantages. These compounds do not catalyze the immune system into higher states of activity, although this may be a secondary effect. Rather, they catalyze consciousness, that peculiar, self-reflecting ability that has reached its greatest apparent expression in human beings. Consciousness, like the ability to resist disease, confers an immense adaptive advantage on any individual who possesses it.

Consciousness has been called awareness of awareness (Guenther, 1966) and is characterized by novel connections among the various data of experience. Consciousness is like a super nonspecific immune response. There is no evolutionary limit to how much consciousness can be acquired by a species. And there is no end to the degree of adaptive advantage the acquisition of consciousness will confer on the individual or the species in which it resides.

There is reason to question the scenario which physical anthropologists present us regarding the emergence of human consciousness out of binocular, bipedal primates. The amount of time allotted to this ontological transformation of animal organization is excessively brief. Evolution in higher animals takes a very long time to occur. For example, the biologist who studies the evolution of the early amphibians rarely operates in time spans of less than 100 thousand years and often speaks in terms of millions of years. But the emergence of man from the higher primates is something that has gone on in less than a million years. Physically humans apparently have changed very little in the last million years. But the amazing proliferation of consciousness, social institutions, coding practices, and cultures has come so quickly that it is difficult for modern evolutionary biologists to account for it. Most do not even attempt an explanation.

There is a hidden factor in the evolution of human beings that is neither a "missing link" nor a *telos* imparted from on high. This hidden factor in the evolution of human beings, the factor that called human consciousness forth from a bipedal ape with binocular vision, involved a feedback loop with plant hallucinogens. This is not an idea that has been widely explored, although a very conservative form of this notion appears in R. Gordon Wasson's *Soma. Divine Mushroom of Immortality* (Wasson, 1971). Wasson does not comment on the emergence of humanness out of the primates but does suggest hallucinogenic mushrooms as the causal agent in the appearance of spiritually aware human beings and the genesis of religion. Wasson feels that omnivorous foraging humans would have eventually encountered hallucinogenic mushrooms or other psychoactive plants in their environment.

The strategy of these early human omnivores was to eat everything and to vomit whatever was unpalatable. Plants found to be edible by this method were then inculcated into their diet. The mushrooms would be especially noticeable because of their unusual form and color. The state of consciousness induced by the mushrooms or other hallucinogens would provide a reason for foraging humans to return repeatedly to those plants in order to reexperience their bewitching novelty. This process would create what C. H. Waddington (1961) called a "creode," a pathway of developmental activity (in other words, a habit).

Habituation to the experience was insured simply because it was ecstatic. "Ecstatic" is a word unnecessary to define except operationally: An ecstatic experience is one that one wishes to have over and over again. It has been shown in experimental situations that if one creates a situation in which *N,N*-di-methyltryptamine (DMT) can be delivered to a monkey on demand, then a large number of monkeys exposed to that experimental apparatus will prefer the DMT over food and water. DMT was used in these experiments because it is a very short-acting, overt hallucinogen that occurs in many different plant species (Jacobs, 1984). Although we cannot analyze the laboratory monkeys' state of mind, it is very clear that something in the experience impels them to return to the stimulus again and again.

Wasson's idea that religion originated when an omnivorous protohuman encountered alkaloids in the environment was countered by Mircea Eliade (1964), the most brilliant expositor of the anthropology of shamanism and the author of *Shamanism: Archaic Techniques of Ecstasy*. Eliade considers what he calls "narcotic" shamanism to be decadent. He feels that if one cannot achieve ecstasy without drugs, then one's culture is probably in a decadent phase. The use of the word *narcotic* - a term usually used for soporifics - to describe this form of shamanism betrays an unsettling botanical and pharmacological naivete. Wasson's notion, which I share, is precisely the opposite: It is the presence of a hallucinogen in a shamanizing culture that indicates its shamanism is authentic and alive. It is the late and decadent phase of shamanism that is characterized by elaborate rituals, ordeals, and reliance on pathological personalities. Wherever these latter phenomena are central, shamanism is well on its way to becoming simply "religion."

One view of plant hallucinogens is to see them as interspecies messages or exopheromones. Pheromones are chemical compounds exuded by an organism for the purpose of carrying messages between organisms of the same species. The meaning of the message is not intrinsic in the pheromone's chemical structure but in evolutionarily established convention. Ants, for instance, produce a number of secretions with very specific meanings for other ants. However, these chemical "languages" are species-specific: the ant of one species cannot "read" the pheromones of another species. In fact there is one known case where a pheromone means one thing to one ant species and yet bears a completely different meaning to another ant species, much in the same way that the English word "no" means "yes" in Greek.

If hallucinogens are operating as exopheromones, then the dynamic symbiotic relationship between primate and hallucinogenic plant is actually a transfer of information from one species to another. The primate gains increased visual acuity and access to the transcendent Other, while the benefits to the mushroom arise out of the primate domestication of previously wild cattle and hence the expansion of the niche occupied by the mushroom. Where plant hallucinogens do not occur, such processes cannot take place, but in the presence of hallucinogens a culture is slowly introduced to increasingly more novel information, sensory input, and behavior and thus is bootstrapped to higher states of self-reflection.

Human language arose out of the synergy of primate organizational potential by plant hallucinogens. Indeed this possibility was brilliantly anticipated by Henry Munn in his essay "The Mushrooms of Language" (1973). Munn writes:

> Language is an ecstatic activity of signification. Intoxicated by the mushrooms, the fluency, the ease, the aptness of expression one becomes capable of are such that one is astounded by the words that issue forth from the contact of the intention of articulation with the matter of experience. The spontaneity the mushrooms liberate is not only perceptual, but linguistic. For the shaman, it is as if existence were uttering itself through him. (pp. 88-89)

Other writers have sensed the importance of hallucinations as catalysts of human psychic organization: - Julian Jaynes' theory, presented in his controversial book *The Origins of Consciousness in the Breakdown of the Bicameral Mind* (1977), makes the point that there may have been major shifts in human self-definition even in historical times. He proposes that through Homeric times people did not have the kind of interior psychic organization that we take for granted. What we call ego was for pre-Homeric people what they called a "god." When danger threatened suddenly and unbidden, the god's voice was heard in the individual's mind, a kind of metaprogram for survival called forth under great stress. This integrative psychic function was perceived by those experiencing it to be either the direct voice of a god, or that of the leader of the society (king), or of the dead king, the king in the afterlife. Merchants and traders moving from one society to another brought the unwelcome news that the gods were saying different things in different places, and thus cast early seeds of doubt. At some point people integrated (in the Jungian sense) this previously autonomous function, and each person *became* the god and reinterpreted the inner voice as the "self" or, as it was later called, the "ego."

Hallucinogenic plants may have been the catalysts for everything about us that distinguishes us from other primates except perhaps the loss of body hair. All of the mental functions - that we associate with humanness, including recall, projective imagination, language, naming, magical speech, dance, and a sense of *religio* may have emerged out of interaction with hallucinogenic plants. Our society, more than others, will find this theory difficult to accept because we have made pharmacologically obtained ecstasy a taboo. Sexuality is a taboo for the same reason: such things are consciously or unconsciously sensed to be entwined with the mysteries of where we came from and how we got to be the way we are. A theory of plant hallucinogens as central to the origin of mind suggests a scenario such as the following.

We know that the Sahara was much wetter as recently as 4 or 5 thousand years ago. The Roman historian Pliny referred to North Africa as "Rome's breadbasket." The presumption is that over the last 150 thousand years the Sahara has grown gradually drier, changing from a subtropical forest to grasslands and recently, to desert. When the grasslands first appeared, the arboreal adaptation of the primates ill served their continued survival. They left the trees and began to foray onto the grasslands. Their arboreally evolved repertoire of troop signals came under pressure to further expand. It was the generation of hunting pack signals, such as occurs in wolves and dogs, that served as the basis for language. But another result of moving out of the trees and onto the grasslands was the likelihood of encountering the manure of ungulate herbivores, and, in the same situation, coprophilic (dung-loving) mushrooms. Several species of psilocybin-containing mushrooms are coprophilic; *Amanita muscaria*, which has a symbiotic relationship to birch and fir trees, does not.

The far fewer number of plant species that characterize grasslands in contrast with forests make it highly likely that any grassland plant encountered would be tested for its food potential. The eminent geographer Carl Saur felt that there was no such thing as a natural grassland. He suggested that all grasslands were human artifacts resulting from burning. He based this argument on the fact that all grassland species can be found present in the understory of the forests at the edge of the grassland, but a very high percentage of the forest species are absent in the grasslands. From this he argued that the grasslands are so recent that they must be seen as concomitant with the rise of large human populations (Saur, 1973).

The next step in the cultural evolution of the bipedal pack-hunting primates was the domestication of some of the browsing herbivores. With the animals and their manure came the mushrooms, and the human-mushroom relationship was further enhanced and deepened.

Evidence for these speculations can be found in southern Algeria. There is an area called the Tassili plateau, a curious geological formation. It is like a labyrinth, a vast badlands of stone escarpments that have been cut by the wind into many perpendicular narrow corridors, almost like an abandoned city. And in the Tassili there are rock paintings that date from the late neolithic to as recently as 2 thousand years ago. Here are the earliest known depictions of shamans in coincidence with large numbers of grazing animals, specifically cattle (Lhote, 1959; Lajoux, 1963). The shamans, dancing and holding fistfuls of mushrooms, also have mushrooms sprouting out of their bodies. This connection between the Tassili art and mushroom use was discovered and pointed out to me by Jeff Gaines, an ethnomycologist and art historian living in Boulder, Colorado. He recognized the implications of the Tassili images for the role of mushroom use in human prehistory. Similar images occur in pre-Colombian Peruvian textiles wherein the shaman is shown holding an object that has been identified as either a "chopper" or "mushroom." Chopping tools have been found that resemble the depicted object. Unlike the Peruvian images, with the Tassili frescoes the case is clear. Here we see dancing shamans with six, eight, or ten mushrooms clutched in their hands and sprouting from their bodies.

The herding peoples who produced the Tassili paintings moved out of Africa over a long period of time, perhaps from 30 thousand to 5 thousand years ago. Wherever they went, their pastoral lifestyle went with them. The Red Sea was landlocked at that time. The boot of Arabia was backed up against the African continent. The landbridge there was utilized by some of these African pastoralists to enter the fertile crescent and later Asia Minor, where they intermingled with populations already present and became well-established by 12 thousand years ago. These pastoral people had a cult of cattle and one of the Great Goddess. The evidence for this comes from a number of sites in southern Anatolia, the best researched being Catal Hüyük, a site dated to 8-9,000 BP. Catal Hüyük has been thoroughly excavated and contains amazing shrines with cattle bas-refiefs and heads of the cattle covered with ocher designs - the very complex paintings of a very complicated civilization (Mellaart, 1965, 1967).

In the confluence of the cult of the Great Goddess and the cattle cult, there is a recognition and an awareness of the mushroom as the third and chthonic member of a kind of late neolithic trinity. The mushroom, seen to be as much a product of the cattle as milk, meat, and manure, was the pipeline to the presence of the Goddess. Recently Riane Eisler (1987), in her important revisioning of history *The Chalice and the Blade*, has advanced the important notion of "partnership" models of society being in competition and oppressed by "dominator" forms of social organization. These latter are hierarchical, paternalistic, materialistic, and male dominated. Her position is that it is the tension between these two forms of social organization and the overexpression of the dominator model that are responsible for our alienation. I am in complete agreement with Eisler's view. In fact this essay asks a two-point question that is an extension of her argument. What factor maintained the equilibrium of the partnership societies of the late neolithic, and what factor faded, thereby setting the stage for the emergence of the evolutionarily maladaptive dominator model?

It is the depth of the relationship of a human group to the gnosis of the vegetable mind, the Gaian collectivity of organic life, that determines the strength of the group's connection to the archetype of the Goddess and hence to the partnership style of social organization. The last time that the mainstream of Western thought was refreshed by the gnosis of the vegetable mind was at the close of the Hellenistic era, when the Eleusianian Mysteries were finally suppressed by enthusiastic Christian barbarians (Wasson, Hofmann, & Ruck, 1978).

The late medieval church that conducted the great witch burnings was very concerned that all credit for episodes of magic and derangement should be given to the Devil - hence, knowledge of plants such as Datura, deadly nightshade, and monkshood and the role that they were playing in the nocturnal gatherings and activities of the practitioners of the craft were suppressed. After all, we cannot have a Devil who is such a diminished figure that he must rely on mere herbs to work his wiles. The Devil must be a worthy foe of the Christos, and hence nearly coequal (Duerr, 1985).

My conclusion is that taking the next evolutionary step - the archaic revival, the rebirth of the Goddess, and the ending of profane history - are agendas that implicitly contain the notion of our reinvolvement with and the emergence of the vegetable mind. That same mind that coaxed us into self-reflecting language now offers us the boundless landscapes of the imagination. Without such a relationship to psychedelic exopheromones regulating our symbiotic relationship with the plant kingdom, we stand outside of an understanding of planetary purpose. And understanding planetary purpose may be the major contribution that we can make to the evolutionary process. Returning to the bosom of the planetary partnership means trading the point of view of the male-created ego for the intuitional translinguistic understanding of the maternal matrix.

The people of Catal Hüyük and other Mesopotamian peoples existed undisturbed in the ancient Middle East for a long time, practicing their Mother Goddess religion. Then, around 5-7,000 BP, a different kind of people with wheeled chariots, patriarchy, and a ritual involving horse sacrifice swept down from north of the Caspian Sea into Turkey, Anatolia, and what is now Iraq and Iran, encountering the pastoral, mushroom-using lowlanders. These invaders are the people that Wasson has suggested were the bearers of Soma. He feels that Soma, the intoxicating plant of the Vedic hymns, may have been the mushroom *Amanita muscaria*. A mushroom mystery cult was carried out of the forests of Central Asia by Aryan people who eventually settled in India.

The problem with this hypothesis is that *A. muscaria* is not a reliable visionary hallucinogen. It is difficult to obtain a consistently ecstatic intoxication from *Amanita muscaria*. Much ink has been shed over this problem. Some have suggested that *A. muscaria* must be pounded with milk curd in order to decarboxalate muscarine, the active toxin, into muscamol, the hallucinogenic constituent. Others have suggested that the *Amanita* must be dried or roasted and aged before it is rendered nontoxic and effective. The fact of the matter is that muscamol is not a deep hallucinogen, even when used as a pure compound. Wasson was on the right track, correctly recognizing the potential of *Amanita muscaria* to induce religious feeling and ecstasy but did not take into account the imagination and linguistic stimulation imparted by the input of African psilocybin-containing mushrooms into the evolution of Old World mycolatry.

We know that at least one psilocybin mushroom, *Psilocybe cubensis* or *Stropharia cubensis*, is circumtropical in its distribution, occurring throughout the warm, wet tropics wherever cattle of the *Bos indicus* type are present. This raises a number of questions. Is *P. cubensis* exclusively a creature of the manure of *Bos indicus*, or can it occur in the manure of other cattle? How recently has it reached its various habitats? The first specimen of *Psilocybe cubensis* was collected by Earle in Cuba in 1906, yet current botanical theory places the actual point of origin for the species in Kampuchea. An archaeological dig in Thailand at a place called Non Nak Tha has been dated to 15,000 BP, and there the bones of *Bos indicus* have been found coincident with human graves. Some of the bones have burned-out centers, indicating that they had been used as *chillums* to bum and presumably smoke vegetable material. *Chillums* of the Non Nak Tha type are used even today among yoga-saddhus throughout India. *Psilocybe cubensis* is common in the Non Nak Tha area today.

At what point, then, did *P. cubensis* enter the New World? In southern Mexico, coincident with the Mayan cultural area, natives use a number of psilocybin-containing mushrooms: *Psilocybe mexicana*, *P. aztecorum*, *P. maztecorum*, and others. These mushrooms constitute the Mexican mushroom complex discovered by Valentina and Gordon Wasson in the early fifties. *Psilocybe cubensis* also occurs in these areas, being especially prolific at Palenque. Palenque is the site of the ruins of one of the most exquisite cities of the Mayan climax. Many people have taken the mushrooms at Palenque and have had the impression that they were ingesting the sacred sacrament of the people who built this fabulous abandoned 7th-century Mayan city, but this notion is disputed by modern botanists. We cannot be certain that *P. cubensis* was the mushroom sacrament of the Maya. Most orthodox botanists argue that *P. cubensis* entered the New World with the conquest, transported by the Spanish and their cattle. In the absence of a decipherment of the Mayan glyphs, it is not easy to imagine how such a matter could be proved or disproved. Given the long viability of the spores and the generally prevailing winds at the equator, the circumtropical distribution of *P. cubensis* is probably a very old fact of the ecology of the planet.

The Indo-Aryan people coming out of central Asia contacted valley-dwelling, pastoral, partnership cultures and assimilated from them the cult of the coprophitic psilocybin-containing mushroom, carrying it eastward into India. The evidence is thin but, on the other hand, the evidence has not been sought. After all, the current desert climate of the region encompassing Iraq, Iran, southern Turkey, Jordan, and Saudi Arabia makes this a very unlikely place to look for archaeological evidence of a mushroom cult. However, Robert Graves's book

Food for Centaurs (1960) discusses how a taboo usually indicates an earlier historical involvement with the forbidden item in the inventory of the culture. And mushrooms, which are hardly found in the contemporary environment where these religions are practiced, are very taboo in the substratum of primitive Zoroastrianism, Mandaeanism, and the undifferentiated cult religions that preceded them. Mandaeanism specifically forbids the eating of mushrooms, according to Wasson (Wasson, Hofmann, & Ruck, 1978).

In *The Sacred Mushroom and the Cross* (1970), John Allegro, concentrating on post-exilic Judaism in Palestine, makes a controversial case that can only be judged by Sumerian philologists. He posits that there are mushroom words, phrases, and symbols that can be traced through Accadian into old Accadian and back into Sumerian, and that mushrooms were used very early in this area. My own approach has been to work forward from the Vedas. The Vedas are hymns that these Indo-Aryan people composed somewhere along their millennia-long peregrinations in India. The Ninth Mandala of the *Rig Veda* especially goes into great detail about Soma and states that Soma stands above the Gods. Soma is the supreme entity. Soma is the moon; Soma is masculine. Here we have a rare phenomenon: a male lunar deity. The connection between the feminine and the moon is so deep and obvious that a lunar male deity stands out, making its traditional history in the region easy to trace.

I reexamined the mythologies of the Near East trying to find a lunar god that would prove that this idea had been imported to India from the West. I found that the Sumerian civilization's northernmost outpost was a city called Harran, a city traditionally associated with the beginning of astrology. Invented in Harran, astrology spread to China, later to Egypt, and throughout the ancient world. The patron deity of the city of Harran was a moon god: Sin or Nannar. Sin was male and wore a cap that looked like a mushroom. No other deity in that pantheon had this headgear. I found three examples of Sin or Nannar on cylinder seals, and in each case the headgear was prominent, and in one instance the accompanying text by a nineteenth-century scholar mentions that this headgear was in fact the identifier for the god (Maspero, 1894).

Why was the Aryan deity connected with the mushroom perceived as male? Although this is a problem for folklorists and mythologists, certain points are obvious. German folklore has always associated the moon with the masculine, and the mushroom will take the projection of masculinity or femininity with equal ease. It is obviously connected to the moon: it has a lustrous, silvery appearance in certain forms, and it seems to appear at night when the moon rules the heavens. On the other hand, one can shift the point of view and suddenly see the mushroom as masculine: it is solar in color, phallic in appearance, and imparts a great energy. So the mushroom is actually an androgynous shape-shifting deity that can take various forms relative to the predisposition of the culture encountering it. One can almost say that it is a mirror of cultural expectations. That is why for the Indo-Aryans it took on a masculine quality and why in other situations it seems to have a very lunar quality. Either way, it is a hallucinogen that is not wild and is associated with the domestication of animals and with human culture. This association with domesticated animals implicates the mushrooms in the cultural development of the Indo-Aryans, the people who wrote the Vedas.

These same Aryans were the authors of a breakthrough in religious ontology. For them there were no sacred rivers, no sacred trees, and no holy mountains. They transcended geography in their notion of deity. They built a fire, and where the fire was human consciousness emerged into the light kindled, the center of the universe came to rest. They had discovered the transcendence of time and space. A sacramental plant hallucinogen that is linked to the dung of domesticated animals means that the sacrament is as nomadic as the people and animals that provide its favored milieu.

There are a number of problems with this theory, one of which is the lack of confirmation in India of the presence of *Psilocybe cubensis* or other psilocybin-containing mushrooms. *Amanita muscaria* is also rare in India. I predict, however, that a careful search of the flora of India will reveal *P. cubensis* as an indigenous component of the biome of the subcontinent. And I maintain that the desertification of the entire area from North Africa to the Tarr region around Delhi has distorted our conception of what occurred in the prehistoric evolution of religious ontology when these civilizations were in their infancy and the area was much wetter. The mushroom religion is actually the generic religion of human beings, and all later adumbrations of religion stem from the cult of ritual ingestion of mushrooms to induce ecstasy.

A rethinking of the role that hallucinogenic plants and fungi have played in the promotion of human emergence from the substrata of primate organization can help to lay the basis for a new appreciation of the unique confluence of factors responsible and necessary for the evolution of human beings. The widely felt intuition of the presence of the Other as a female companion to the human navigation of history can, I believe, be traced back to the immersion in the vegetable mind that provided the ritual context in which of self-awareness, self-reflection, and self-articulation: the light of the Great Goddess.

References

1. Allegro, J. (1970). *The sacred mushroom and the cross*. New York: Doubleday.
2. Duerr, H. P. (1985). *Dreamtime*. Oxford: Basil Blackwell.
3. Eisler, R. (1987). *The chalice and the blade*. San Francisco: Harper & Row.
4. Eliade, M. (1964). *Shamanism: Archaic techniques of ecstasy*. New York: Pantheon Books.
5. Graves, R. (1960). *Food for centaurs*. Garden City, NY: Doubleday.
6. Guenther, H. V. (1966). *Tibetan Buddhism without mystification*. Leiden: E. J. Brill.
7. Jacobs, B. L. (1984). *Hallucinogens: Neurochemical, behavioral and clinical perspectives*. New York: Raven Press.
8. Jaynes, J. (1977). *The origin of consciousness in the breakdown of the bicameral mind*. Boston: Houghton Mifflin.
9. Lajoux, J. (1963). *The rock paintings of Tassili*. Cleveland: World Publishing.
10. Lhote, H. (1959). *The search for the Tassili frescoes*. New York: E. P. Dutton.
11. Maspero, G. (1894). *The dawn of civilization - Egypt and Chaldaea*. London: Society for Promoting Christian Knowledge.
12. Mellaart, J. (1965). *Earliest civilizations of the near east*. New York: McGraw-Hill.
13. Mellaart, J. (1967). *Catal Hüyük: A neolithic town in Anatolia*. New York: McGraw-Hill.
14. Munn, H. (1973). The mushrooms of language. In M. Hamer, *Shamanism and hallucinogens*. London: Oxford University Press.
15. Rodriguez. E., Aregullin, M., Uehara, S., Nishida. T., Wrangham, R., Abramowski, Z., Finlayson, A., & Tower, G. H. (1985). Thiarubrine-A, a bioactive constituent of *Aspilia (Asteraceae)* consumed by wild chimpanzees. *Experientia, 41*, 419-420.
16. Saur, C. (1973). *Man's impact on the earth*. New York: Academic Press.
17. Waddington, C. H. (1961). *The nature of life*. London: George Allen & Unwin.
18. Wasson, R. G. (1971). *Soma. Divine mushroom of immorality*. Italy: Harcourt Brace Jovanovich.
19. Wasson, R. G., Hofmann, A. & Ruck, C. (1978). *The road to Eleusis*. New York: Harcourt Brace Jovanovich.

Mushrooms and the mind

by

Ralph Metzner

original source: http://www.drugtext.org/The-Psychedelics/mushrooms-and-the-mind.html

Was the Buddha's last, fatal supper a mushroom feast? Was soma, the mystery potion at Eleusis, a mushroom? Why are mushrooms linked to thunder, and to toads? Why does Hieronymus Bosch have a gigantic mushroom standing at Hell's entrance? Why have they been called "God's Flesh," and "Devil's Bread"? Men have used mushrooms to murder, to worship, to heal, to prophesy. Some fear and abominate all fungi as "dirty" and "dangerous." Others use discrimination-enjoy them as food and as mediators to divine vision.

Two classes of mushrooms are of primary interest to the anthropologist and psychologist studying the ritual use of fungi. One, the fly agaric, Amanita muscaria, is the "drug of choice" among certain Siberian tribes. It is apparently hallucinogenic, though not psychedelic in the sense of inducing transcendent experiences, experiences of expanded consciousness. The other group, the Psilocybe mushrooms and related species of the Mexican mountains, are both hallucinogenic and psychedelic. They are the "God's Flesh" of the Aztecs.

The Fly Amanita

The fly agaric has a whitish stalk, swollen at the base, a lacerated collar about three quarters of the way up the stalk, and a gorgeously colored umbrella-like cap from three to eight inches wide. In North America the cap will be mostly whitish, yellowish, or orange-red, but in Europe or Asia bright red or purple. In all regions the cap is covered with many whitish, yellowish, or reddish warts[1].

Tribes using the fly agaric include the Kamchadals, Kerjaks, and Chukchees living on the Pacific coast, from Kamchatka to the northeastern tip of Siberia; the Yukaghirs, farther to the west; the Yenisei Ostjaks; and the Samoyed Ostjaks, in the valley of the upper Ob. These Siberian tribes have become famous for the practice of drinking the urine of mushroom-intoxicated persons, in order to get a prolongation of the effect. Oliver Goldsmith, in 1762, described a "mushroom party" thus:

> The poorer sort, who love mushrooms to distraction as well as the rich, but cannot afford it at first hand, post themselves on these occasions around the huts of the rich and watch - theladies and gentlemen as they come down to pass their liquor, and hold a wooden bowl to catch the delicious fluid, very little altered by filtration, being still strongly tinctured with the intoxicating quality. Of this they drink with the utmost satisfaction and thus they get as drunk and as jovial as their betters[2].

Whether the fly agaric is involved in the "berserkgang" of the Vikings is a debated point. Norman Taylor's book Narcotics: Nature's Dangerous Gifts, claims that "in proper amounts it promotes gaiety and exuberance among a morose people, while leading, in large doses, to berserk orgies."[3] R. Gordon Wasson, however, has dissented from this view, pointing out that no plant was ever mentioned in the Viking accounts.

In their monumental book Mushrooms, Russia and History (1957), the Wassons, Robert Gordon and Valentina, draw parallels between the beliefs of the Siberian tribes about the mushrooms and those of the Mexican mushroom-using peoples:

> With our Mexican experiences fresh in mind, we reread what Jochelson and Bogoras had written about the Korjaks and the Chukchees. We discovered startling parallels between the use of the fly amanita (Amanita muscaria) in Siberia and the divine mushrooms in Middle America. In Mexico the mushroom "speaks" to the eater; in Siberia "the spirits of the mushrooms" speak. Just as in Mexico, Jochelson says that among the Korjaks "the agaric would tell every man, even if he were not a shaman, what ailed him when he was sick, or explain a dream to him, or show him the

> upper world or the underground world or foretell what would happen to him." Just as in Mexico on the following day those who have taken the mushrooms compare their experiences, so in Siberia, according to Jochelson, the Korjaks, "when the intoxication had passed, told whither the 'fly-agaric men' had taken them and what they had seen." In Bogoras we discover a link between the lightning bolt and the mushroom. According to a Chukchee myth, lightning is a One-Sided Man who drags his sister along by her foot. As she bumps along the floor of heaven, the noise of her bumping makes the thunder. Her urine is the rain, and she is possessed by the spirits of the fly amanita[4].

Much is made by Wasson of the connection between mushrooms and thunder; we will return to this later.

Dr. Andrija Puharich, whose work has chiefly concerned itself with the experimental investigation of telepathic and related phenomena, has also done some studies of mushroom use among the Chatino Indians of Mexico, and claims that amanita is used by them. Wasson, whose knowledge of the Mexican mushrooms is probably unequaled, disputes this:

> For ten years we combed the various regions, and we have invariably found that it played no role in the life of the Indians, though of course it is of common occurrence in the woods. We had visited the Chatino country, where we were accompanied by Bill Upson of the Instituto Linguistico de Verano, who speaks Chatino. Later he likewise helped Puharich, but he informs us that no *brujo* in his presence testified to the use of a mushroom answering to the description of Amanita muscaria[5].

The three principal ingredients of Amanita muscaria apparently are muscarine, atropine, and bufotenine[6]. Muscarine is a cholinergic drug, which stimulates the parasympathetic system, causing sweating, salivation, pupil contraction, slowed cardiac rate, and increased peristalsis. These effects are counteracted by atropine, which was long used as an antidote to amanita poisoning until it was discovered that the mushroom itself also contained this. The effects of a particular ingestion of the mushroom would depend on the relative quantities of the two substances. Atropine alkaloids are found in many plants, including deadly nightshade, henbane, mandrake, thorn apple, and Jimsonweed. They are generally believed to have been involved in the European witches' cults, definitely to cause hallucinations, as well as either excitement or depression. On the basis of my own experiments with Ditran, a hallucinogenic drug similar in its action to atropine, I would suggest that the anti-cholinergic agents are definitely consciousness-altering, since they produce thought disorientation and visions, but I would doubt that they are psychedelic, or consciousness-expanding. They may be more truly psychotomimetic than LSD or psilocybin[7].

The third ingredient of the amanita mushrooms, bufotenine, probably is psychedelic, since chemically it is 5-hydroxydimethyltryptamine, i.e., closely related to both DMT and psilocin. Bufotenine is also found in the South American snuff *Piptadenia peregrina* and in the sweat gland of the toad *Bufo marinus*, which sheds new light on the witches' brews containing toads. However, the quantity of bufotenine in Amanita muscaria is very small, so the principal visual effects of the mushroom are probably due to its belladonna (atropine) alkaloids. This is confirmed by the stories of the Siberian tribesmen who, having imbibed the mushrooms, jump very high over small objects; visual size distortions are common with Ditran-type drugs, though rare with tryptamine psychedelics.

Although to some people the drinking of muscarinic, atropinized urine may be a repulsive way to get high, as Norman Taylor points out, "Who are we to deny them this revolting pleasure? To these dull plodders of the arctic wastes, the fly agaric may well be their only peep into a world far removed from the frozen reality of their wretchedness. That such people found the fly agaric is merely another illustration of the worldwide hunt for something to break the impact of everyday life."[8]

The Sacred Psilocybes

The story of the Psilocybe mushrooms, the teonanacatl, or "God's Flesh," of the Aztecs, is one of the most dramatic episodes in modern anthropology. When the Spaniards arrived in Mexico, their clerics immediately labeled the mushrooms (and the other hallucinogens in use-peyotl and olohuhqui) as products of the devil and did their best to stamp out this "idolatry." Brother Toribio de Benavente, a Spanish monk better known as Motolinia, in a work on pagan rites and idolatries, described their "vice" as follows:

> They had another drunkenness which made them more cruel: which was of some small mushrooms ... and after a while they were seeing a thousand visions, especially of snakes, and as they went completely out of their minds, it seemed to them that their legs and bodies were full of worms which were eating them alive, and thus, half raving, they went out of the house, wishing that somebody would kill them, and with that bestial drunkenness and the trouble they felt, it would happen sometimes that they hanged themselves. And they were also against others much more cruel. They called these mushrooms teonanacatl, which means flesh of the God (the Demon they adored), and in that manner, with that bitter food, their cruel god held communion with them[9].

A Mexican historian writing in the 1870s, Orozco y Berra, stated that the mushrooms produced "a state of intoxication with frightening hallucinations." Friar Bernardino de Sahagun, a Franciscan monk who preserved texts written in the preconquest Nahuatl language, in writing of the mushrooms often referred to disconsolate, dissolute, disintegrating states of personality; the members of society using the mushrooms were "the deranged one," "the angry young man," "the noblewoman without shame," "the prostitute, the procurer, the enchanter."

This language is the sixteenth-century equivalent of the modern psychiatric approach to hallucinogens. AMA President Roy Grinker, M.D., in an editorial in the Archives of General Psychiatry, warns that "... latent psychotics are disintegrating under the influence of even a single dose; long-continued LSD experiences are subtly creating a psychopathology." Dana Farnsworth, M.D., Harvard health officer, in another editorial refers to drug-induced "nightmares" such as thinking one is only six inches tall, and "horrid, involuntary hallucinations."[12]

The pattern is the same: the representatives of the current psychological power system-the clerics then, the psychiatrists now-react to the new "detonator of the soul" with puritanical paranoia and fearful fantasies of sin, degradation, disintegration. Since anxious suspicion does not allow them to become acquainted with the real nature of the alleged demonic plant or substance, ignorant misrepresentations soon shroud any mention of them, and repressive measures are vigorously pursued.

The historian Lothar Knauth has gathered further references which shed a somewhat different light on the Aztecs' use of the mushrooms. For example, Orozco y Berra, in his account of the coronation of Motecuazoma II, says,

> The religious festivities ended, the lords gathered to eat woodland mushrooms, which contain that which confuses the mind, as if they were intoxicating drinks; while their minds were confused they saw visions, believed they heard voices; therefore they took these hallucinations as divine notices, revelations of the future, and augury of things to come[13].

Another writer, Tezozomoc, has this to add:

> ... the strangers gave them mushrooms found in the mountain woods so that they would get intoxicated, and with that they began to dance; others went inside the room to rest. Then they took the big lights of the patio and every time they started the song the strangers began to dance and to sing, and so that they should not be known they dressed themselves with false hair[14].

For another description of a mushroom ceremony among the Aztecs, Lothar Knauth draws again on a Nahuatl text preserved by Sahaga. It is part of the fiesta that the pochteque, the great merchants of the Aztec empire, gave the night before they sent their trading caravans to the distant, foreign commercial center of the Gulf and Pacific coasts.

There arrived those that were going to dance, ... and those that were going to abandon themselves. Those of the merchant leaders who were not going to dance were the strait-laced, chaste ones, who thought themselves somebody. And the old merchants met them with flowers, with tobacco, with brilliant green paper collars and bunches of quetzal feathers, glistening in the moonlight.

> Right at the beginning, as a refreshment, they ate the mushrooms. They felt with it a burn, a red-hot blown fire inside, and not from hot food they were eating. Therefore they drank hot cacao that was kept warm for the night. Thusly they ate the intoxicating mushrooms. When they had finished eating them, they danced and they cried. Meanwhile some of them felt the effect: they went inside, they sat down, with their backs against the wall. They didn't dance any more. They sat by themselves, in the same place and let their heads hang[15].

The preceding description of the festivities sounds not too unlike a modern description of a "psychedelic celebration," at, for example, the Avalon Ballroom in San Francisco.

> On Friday and Saturday nights they swarm into the Avalon and Fillmore Ballrooms ... to be bathed in constantly changing projections of liquid colors and films, to dance in the dancing light of their ecstatic costumes and faces and feelings, and to drench themselves in the saturating rock 'n' roll of the Grateful Dead. ... The whole environment, in short, is turned on and total immersion is expected[16].

The description of the Aztec mushroom celebration goes on in a more somber key as the participants apparently become involved in visions of the manner of their death. Whether these were genuine clairvoyant experiences or shared hallucinations induced by the high Suggestibility of the bemushroomed state, it is impossible to tell at this remove.

> In that stupor, some imagined they were going to die, and they cried; some were to perish in the war; some were to be eaten by wild beasts; some were to be taken prisoners of war; some were to be somebody rich, very rich; some were to buy and be owners of slaves; some were to be adulterers, were to be stoned to death; some were to be taken for thieves and be stoned to death; some were to become dissolute, were to end as drunkards; some were to drown; some were to be somebody peaceful, peacefully living to themselves and dying the same way; some were to fall from the roof and die suddenly[17].

The negative view of the mushrooms prevailed. Spanish mycophobia succeeded in stamping out the mushroom cult as a major force in Mexican culture. Only a handful of remote mountain tribes preserved the customs and rituals of what must once have been a splendid and powerful system of worship and magic. So complete was the neglect and ignorance in the Western world of this botanical aspect of Mexican religion, that in 1915 a reputable American botanist, William E. Safford, read a paper before a learned society claiming that the so-called sacred mushroom of Mexico did not exist and never had.

In 1936, the Mexican engineer Roberto J. Weitlaner became the first white man in modern times to obtain or even see the sacred mushrooms, in the tiny Oaxacan village Huautla de Jiménez. Two years later, his daughter Irmgard, her anthropologist fiancé, and two friends became the first Westerners to witness a mushroom ceremony. In the same year, the Harvard botanist Richard E. Schultes made a trip to Huautla, obtained some specimen mushrooms from informants, and sent them to the Harvard Botanical Museum, where they were identified as the species *Panaeolus campanulatus*, sphinctrinus variety. Schultes published reports on his finds, but his own work took him to the Amazon jungles to investigate the fabled caapi or yagé vine, and he did not return to Mexico. The war years intervened, and the Mexican mushroom slipped again into the shadows of history.

On June 29, 1955, Robert Gordon Wasson and, his wife, Valentina, became the first white persons in modern times to actually participate in and partake of the sacred mushroom ceremony, again in the tiny village of Huautla de Jiménez, under the wise guidance of the now famous curandera Maria Sabina. The news of their discovery became public with the publication in 1957 of Mushrooms, Russia and History, and with a May 13, 1957, article in Life. This magazine has often since that time been the first to signal, and perhaps in some "mediumistic" way to bring about, new developments in the growth of the "psychedelic movement."

The intriguing story of how Robert Gordon Wasson, a professional banker, partner and vice-president of the Morgan Guaranty Trust Company of New York, found himself ingesting the sacred mushroom on a remote Mexican mountaintop, is worth repeating in his own words:

> (My wife) was a Great Russian and, like all of her fellow countrymen, learned at her mother's knee a solid body of empirical knowledge about the common species (of mushrooms) and a love for them that are astonishing to us Americans. ... Their love of mushrooms is ... a visceral urge, a

> passion that passeth understanding. ... I, of Anglo-Saxon origin, had known nothing of mushrooms. By inheritance, I ignored them all; I rejected those repugnant fungal growths, expressions of parasitism and decay. ... Such discoveries as we have made, including the rediscovery of the religious role of the hallucinogenic mushrooms of Mexico, can be laid to our preoccupation with that cultural rift between my wife and me, between our respective peoples, between mycophilia and mycophobia ... that divide the Indo-European peoples into two camps. ... I suggest that when such traits betoken the attitudes of whole tribes or peoples, and when those traits have remained unaltered throughout recorded history, and especially when they differ from one people to another, neighboring people, then you are face to face with a phenomenon of profound cultural importance, whose primal cause is to be discovered only in the wellsprings of cultural history. ...
>
> Our method of approach was to look everywhere for references to mushrooms. We gathered the words for "mushroom" and the various species in every accessible language. We studied their etymologies.
>
> ... We were quick to discern the latent metaphors in such words.
> ... We searched for the meaning of these figures of speech. We sought mushrooms in the proverbs of Europe, in myths and mythology, in legends and fairy tales, in epics and ballads, in historical episodes, in the obscene and scabrous vocabularies that usually escape the lexicographer. ... Mushrooms are widely linked with the fly, the toad, the cock, and the thunderbolt; and so we studied these to see what associations they conveyed to our remote forebears. ...
>
> I do not recall which of us, my wife or I, first dared to put into words, back in the 40's, the surmise that our own remote ancestors, perhaps four thousand years ago, worshiped a divine mushroom. It seemed to,us that this might explain the phenomenon of mycophilia versus mycophobia, for which we found an abundance of evidence in philology and folklore. ... I remember distinctly how it came about that we embarked on our Middle American explorations. In the fall of 1952 we learned that the sixteenth-century writers, describing the Indian cultures of Mexico, had recorded that certain mushrooms played a divinatory role in the religion of the natives. Simultaneously we learned that certain pre-Columbian stone artifacts resembling mushrooms, most of them roughly a foot high, had been turning up, usually in the highlands of Guatemala, in increasing numbers. ... We spoke up, declaring that the so-called "mushroom stones" really represented mushrooms, and that they were the symbol of a religion, like the Cross in the Christian religion, or the Star of Judea, or the Crescent of the Moslems. ... This Middle American cult of a divine mushroom, this cult of "God's Flesh" ... can be traced back to about 1500 B.C. ... the earliest period in which man was in sufficient command of his technique to be able to carve stone. Thus we find a mushroom in the center of the cult with perhaps the oldest continuous history in the world. ... The cult still existed in the Sierra Mazateca, in Oaxaca. And so we went there, in 1953. ... We found a revelation, in the true meaning of that abused word, which for the Indians is an everyday feature, albeit a Holy Mystery, of their lives[18].

The Wassons made many trips to Mexico, to the different regions, studying the various aspects of the use of the mushrooms. They enlisted eminent collaborators. One of these was Professor Roger Heim, the French mycologist, Director of the Musée National d'Histoire Naturelle, who visited Mexico with the Wassons on several occasions in order to make on-the-spot studies of the sacred mushrooms. The following species of mushrooms, many of them new to science, made up the Wasson-Heim list of hallucinogenic mushrooms used in Mexico: *Cantharellaceae-Conocybe siliginoides*, growing on dead tree trunks; *Strophariaceae-Psilocybe mexicana*, a small, tawny inhabitant of wet pastures, apparently the most highly prized by the users; *Psilocybe azteconim*, called "children of the waters" by the Aztecs; *Psilocybe zapotecorum*, of marshy ground and known by the Zapotecs as "crown of thorns mushroom"; *Psilocybe caerulescens* var. *mazatecorum*, the so-called "landslide mushroom"; *Psilocybe caerulescens* var. *migripes*, which has a native name meaning "mushroom of superior reason"; and *Stropharia cubensis*[19].

While we are on the subject of botanical identities, we might mention the later work of Singer and Guzman, who in 1957 found several additional species of Psilocybe used. As noted before, Wasson disputes Puharich's assertion that *Amanita muscaria* is used at all by the Mexicans. It will be recalled that *Panaeolus sphinctrinus* was identified as one of the teonancatl mushrooms by Schultes in 1938. Hallucinogenic activity was reported for a related species, *Panaeolus papilionaceus*, found in Oxford County, Maine. A note in Science reported that unsuspecting ingestion of this mushroom by two persons resulted in visual and hallucinatory effects comparable to hashish, opium, and "mescal." The mushroom was said to be "common on cultivated land."[20] More recently, Maurice B. Walters reported hallucinogenic activity for *Pholiota spectabilis*, a mushroom unrelated to the psilocybes. It is also fairly common in North America[21]. This writer had the experience of ingesting ground-up mushrooms, which had been collected in the Denver, Colorado, City Park, whose identity the finder refused to divulge for fear that spreading this knowledge would lead to legal restrictions on the noble fungus. The effects of this mushroom were completely hallucinogenic, comparable in all ways to the effects of synthetic psilocybin, with which I was very familiar. We may expect a rich, growing harvest of psychedelic fungi (as well as higher plants) as dedicated and ingenious amateur "theobotanists" investigate the vegetable kingdom for other active species during the next fifty years or so.

Those who are inclined to dismiss Wasson's theory of mycophobia versus mycophilia need only consider the fact that hallucinogenic mushrooms grow wild and are common on the North American continent, yet have never been used for religious or psychic purposes. Our distrust of fungi makes us surround them with so many taboos that we end up, like Professor Safford, even denying their existence in other lands. The mycophilic Mexicans, on the other hand, quietly use our imports, whose value we don't even realize: Stropharia cubensis, which is hallucinogenic, was not known in preconquest Mexico, because it grows in cow dung, and cows came to the New World with the Spanish. The Indians discovered the properties of the mushroom while the whites were busy denying it existed.

Wasson's other main collaborator on the chemical aspects of the mushrooms was the renowned Albert Hofmann of the Sandoz Laboratories in Basel, whose accidental discovery of the psychedelic properties of LSD in 1943 may well be regarded by future generations as one of the turning points of Western civilization, and who has devoted much of his professional life to the extraction of the active principles of various native hallucinogens, and their subsequent synthesis. Hofmann soon identified psilocybin as the main active principle in the mushrooms, along with smaller quantities of psilocin. Psilocin is 4-hydroxydimethyltryptamine; psilocybin is the same, with an added phosphor group. Both are indole alkaloids, like LSD, and are related chemically and in activity to the neural transmitter substance serotonin. Psilocybin is probably converted to psilocin in the body. The effects of these tryptamines are roughly comparable to LSD, differing primarily in the duration of the effect, which is about half as long as LSD. Numerous studies have been done on the pharmacological and psychological effects of psilocybin. Wasson's 1962 bibliography listed a total of 362 technical and lay items;[22] since that time the number has probably passed loco. These lie outside the scope of this article.

The use of the sacred mushrooms is heavily concentrated on Oaxaca, where it is used by the Mazatecs, Chinantecs, Chatinos, Zapotecs, Mixtecs, and Mijes. In each tribe the preferred species of mushroom and the particular rituals used vary somewhat. Secrecy about the mushrooms toward foreigners is the general practice. Puharich wrote, "The first thing one learns from the Chatinos is that no one of them will publicly admit that the sacred mushroom exists, that a rite involving its use exists, or that any practitioners of the rite exist."[23] Wasson makes a great deal of the religious motivation of the curanderos. "Performing before strangers is a profanation," and "the curandero who today, for a big fee, will perform the mushroom rite for any stranger is a prostitute and a faker."[24] Yet Wasson's own original curandera, the famous Maria Sabina, does perform rituals for strangers, sometimes for a fee, sometimes not.[25] It is hard for an outsider to evaluate the motivations of a Mexican curandera. According to recent reports, there are now always a dozen or so Americans in Huautla during the mushroom season, June through August, looking for the inevitable "honghi." Some obtain the mushrooms and take them on their own. One American flipped out and tried to eat a live turkey while on such a trip, causing Maria Sabina great difficulties with local authorities. One need reach for no deeper reason than historical experience to explain the reticence of mushroom cults toward outsiders. As in America today, they have always been persecuted and vilified. Their very survival has depended to a large extent on secrecy.

We find that the mushrooms are referred to by various terms of endearment, such as los ninios, "the children," or las mujercitas, "the little women," or most romantically, "the noble princes of the waters." In some areas, the mujercitas have to be eaten along with some hombrecitos, "little men," a different species of mushroom easily identified by its virile shape. But this is consumed for ritual purposes only, since only the "little women" give the psychic effect.

Wasson has taken photographs of a young girl grinding the mushrooms (also the Ipomoea seeds or the leaves of Salvia divinorum) on a grinding stone, in a posture identical to that found on the famous Guatemalan "mushroom stones," dating back twenty-five hundred years.

Not all the tribes have curanderas as such. The Mazatecs do, and usually the curandera takes twice as many mushrooms as the other voyagers. She decides who else takes them, and her energies dominate the session. In the Mije country, on the other hand, there are no curanderas as such; most of the families know how to use the mushrooms. One person takes them alone, with another present as observer. The reasons for consulting the mushrooms are medical and divinatory: to find a diagnosis and cure for an otherwise intractable condition; to find lost objects, animals, or people; or to get advice on personal problems or some great worry.

The use of the mushrooms for purposes of divination is accepted as a matter of fact. Demonstrations of its capacity to bring about states of higher vision have been convincingly made. A double telepathic experience was reported by the psychiatrist Dr. Margaret A. Paul under the mushroom *Amanita pantherina*, a close relative of *A. muscaria*.[26] Wasson has described his own experience with Maria Sabina on his first session with the psilocybe mushroom.

> Well, the Curandera Maria Sabina asked us what the questions were that were troubling us in the afternoon before the session. We were at a loss, because we had no questions that were troubling us, we just wished to see the ceremony. But, naturally, we had to comply with her request, and I said: "We have not heard from my son who is working in Cambridge, Massachusetts, and we are worried about him (which was not true) and we would like to know how he is faring." Now for an Indian in that country this means that you are really worried about the person, and so she went to work, and in the course of the evening she told us three things about him. She said: "He's not in Cambridge." (She didn't know what Cambridge was.) "He's in your home." I wrote notes down-and it's all in my contemporary notes-she said: "He's in your home. He's not in that other place." (It seemed awfully odd that she should volunteer this - there was no reason for it, but anyway we wrote it down.) And then she said: "He has an emotional disturbance, he reaches even to tears and it's over a girl." Well, we wrote this down-we didn't know anything about it and then finally she said: "I see the Army reaching out for him, I don't know whether the Army will get him." Well, we dismissed it. We didn't think at all about it. Then I got back to New York and was busy in banking, and then I went to Europe on a banking trip, and in Geneva a cablegram reached me from my wife saying that Peter insists on enlisting, and please to cable him not to do so. Well, I sent him a cable and it was too late and he had enlisted in the Army. Then, why had he enlisted in the Army? A letter followed and I learned that he had been in terrible emotional turmoil over a girl about whom he had never spoken to us. Oh, the first thing we discovered on returning to our apartment in New York - it was in an awful turmoil-there had been a party thrown there [laughter] and the bills of the purveyors were all accumulated for the very week-end that we had had this session with Maria Sabina. And Peter made no bones about it - "Oh yes, I went down with three or four friends from Cambridge." And they had staged a party there. Then the next thing was this Army business and then the next thing was that he had been in an awful turmoil over a girl who was living in New Haven. I have no explanation for that at all.[27]

Wasson's answer, when asked if he believed in ESP, was, "I don't believe; and I don't disbelieve. It's not my line." Research on supernormal perceptual processes, as demonstrated here and in Doctor Paul's cases, is sadly lacking and definitely indicated by the evidence brought up so far.

Where a curandera is present, she carries a thread of song almost continuously throughout the session, for many hours on end, with brief intermittent rests. The words vary slightly from session to session; the melodic line stays the same. Recordings have been published of the Mazatec ceremony, and anyone can hear for himself the forces that are collected and transmitted through these chants. Mixing Christian and Indian mythology, they run the whole conceivable range of incarnations and emotions. In addition, the curandera may emit a complex percussive beat, slapping thighs, forehead, arms. "The Mazatec communicants are participants with the curandera in an extempore religious colloquy. Her utterances elicit spontaneous responses from them, responses that maintain a perfect harmony with her and with each other, building up to a quiet, swaying, antiphonal chant. In a successful ceremony this is an essential element."[28]

In considering the Mexican ritual, we cannot forget that this is what remains among a primitive, illiterate people of a practice once widespread throughout the powerful Aztec empire. The ritual does not have the integrative synthetic qualities of the American peyote ritual, though most firsthand accounts agree that, depending, no doubt, on the wisdom and experience of the curandera, it can definitely induce a total transcendent experience.

Another and complex chapter in the checkered and colorful history of the divine mushroom was initiated in August 1960, when, in a villa near Cuernavaca, Dr. Timothy Leary, a Harvard psychologist, ate seven of the mushrooms given him by a scientist from the University of Mexico. "I was whirled through an experience which could be described in many extravagant metaphors but which was above all and without question the deepest religious experience of my life."[28] The experience triggered off over the next seven years a series of events that have been amply described and debated in the popular press and that have played a central role in the reemergence on the North American continent of a religious revival using psychedelic plants and drugs as sacraments.

Etymology and Prehistory

The word "mushroom" is derived from the old French mouscheron, which in turn is based on mousse, moss. "In popular use," according to Webster, "mushroom denotes any edible variety, as opposed to the poisonous ones (toadstools)." Immediately we are back in a circle of associations of mushrooms with toads, bufotenine, the witches. Perhaps, as the Wassons argued, toadstool, like the French crapaudin, was originally the specific name of the demonic fly amanita, the German Fliegenschwamm. Flies, bugs, maggots are popular mythic embodiments of madness and possession (e.g., "la mouche luimonte à la tae"), as readers of Sartre and William Golding well know.

Another interesting line of inquiry opens up when the association of mushrooms with thunder is explored. We have already mentioned the Chukchee tale of lightning dragging his mushroom-possessed sister thunder across the floor of heaven by her foot. In ancient Greece and Rome, as well as in Mexico, it was believed that the growth of mushrooms is directly related not only to rain, but to thundery weather. Similar etymological and folkloric links can be found in japan, the Philippines, Malagasy, Tadzhikistan, and among the Maoris, where *whatitiri* means both "thunder" and "mushroom." The Mazatec Indians call the mushroom *nti si tho* and the Mije Indians *tu muh*. In both languages the word means "that which sprouts by itself," i.e., without seed. The Zapotec Indian curandero, after gathering the mushrooms, invokes the "Powers" that control the mushrooms: the Earth, God the Father, the Trinity, the "Great Lightning Bolt that bred the mushrooms," and the "Great Lightning Bolt that injected blood into the mushrooms." Does this mean that the lightning bolt, "the strength of the earth," as the curandero called it, is thought of as impregnating the earth, and their offspring is the divine mushroom, without seed? Father Sky and Mother Earth form a mythic polarity common to many American Indian tribes.

Wasson's theory is that at some preliterate stage in man's early history, the mushrooms with extraordinary powers were discovered and "served as an agent for the very fission of his soul, releasing his faculty for self-perception, as a stimulant for the imagination of the seer, the poet, the mystic. ... May not the hallucinatory mushrooms have been the most holy secret of the Mysteries?"[30]

Puharich also has argued for the existence of a cult of the divine mushroom in the early Eurasian cultures centered around the powerful Sumero-Akkadian city-states of the third millennium B.C. And in 1926 Henri Frankfort reported the discovery of an ancient Egyptian temple in Byblos (on the Mediterranean coast of Lebanon), dating back to the middle of the third millennium B.C., in which a green jasper seal was found. This seal shows a Horus priest giving two mushrooms to a supplicant. Over the mushroom is a hare, which is the sacred symbol of the Hittite god of rain, thunder, and lightning.

Such archaeological, etymological, and mythological fragments must at present be regarded as mere tiny pieces of the history of man's strange ambivalent relationship to the hallucinogenic, psychedelic plants and drugs. It may be decades before the missing pieces are placed together to give a coherent picture. For the present we cannot much improve on the poetic formulation of Wasson's Indian guide, who when asked why the mushroom was called "that which springs forth," replied:

El honguillo viene por si mismo, no se sabe de donde, como el viento que viene sin saber de donde ni porqué.

The little mushroom comes of itself, no one knows whence, like the wind that comes we know not whence nor why[31].

References

1. Norman Taylor, Narcotics: Nature's Dangerous Gifts. Delta Books, New York, 1963, p. 134.
2. Quoted in Taylor, op. cit., p. 156.
3. Taylor, op. cit., p. 157.
4. R. Gordon Wasson and Valentina P. Wasson, Mushrooms, Russia and History, Pantheon Books, New York, 1957, p. 211.
5. R. Gordon Wasson, "Notes on the Present Status of Ololiuhqui and the Other Hallucinogens of Mexico," Psychedelic Review, #3,1964, p. 301.
6. Robert W. Buck, M.D., "Mushroom Toxins - A Brief Review of the Literature," New England Journal of Medicine, 265, 1961, 681-86.
7. Ralph Metzner, "Subjective Effects of Anticholinergic Hallucinogens" (to be published, Psychedelic Review, #10).
8. Taylor, op. cit., p. 158.
9. Quoted from "Historia de los Indios de la Nueva España," by Lothar Knauth, in Estudios de Culture Nahuatl, Vol. III, 1962, p. 263.
10. Knauth, op. cit., p. 266.
11. Roy Grinker, M.D., "Lysergic Acid Diethylamide, Editorial," Archives of General Psychiatry, 8, 1963, p. 423.
12. Dana Farnsworth, M.D., "Hallucinogenic Agents, Editorial," Journal of the American Medical Association, 185, 1963, pp. 878-80.
13. "Historia Antigua y de la Conquista," in Knauth, op. cit., Vol. III, p. 267.
14. "Crónica Mexicana," in Knauth, op. cit., LXXXVII, p. 267.
15. Facsimile editions by Paso y Troncoso, ff. 37 and 37 vo. in Knauth, op. cit., p. 269.
16. William K. Zinsser, "The Love Hippies," Look, April 18, 1967.
17. Knauth, op. cit., pp. 269-70.
18. R. Gordon Wasson, "The Hallucinogenic Fungi of Mexico." Psychedelic Review, #1, 1963, pp. 27-42.
19. Richard E. Schultes, "Botanical Sources of the New World Narcotics." Psychedelic Review, #2, 1963, p. 161.
20. A. E. Verrill, "A Recent Case of Mushroom Intoxication." Science, XL, 1029, 1914, p. 408.
21. Maurice B. Walters, "Pholiota Spectabilis, a Hallucinogenic Fungus." Mycologie, Sept./Oct. 1965.
22. R. Cordon Wasson, "The Hallucinogenic Mushrooms of Mexico and Psilocybin: A Bibliography." Botanical Museum Leaflets, Vol. 20, No. 2, Harvard University, 1962.
23. Andrija Puharich, M.D., "The Sacred Mushroom and the Question of its Role in Human Culture." Unpublished research memorandum, 1962.
24. Wasson, op. cit. (18), pp. 34-33.
25. Frederick Swain, "The Mystical Mushroom," Tomorrow, Autumn 1962. Also in Psychedelic Review, #2, 1963, pp. 219-29. See also Nat Finkelstein, "Honghi, Meester?" Psychedelic Review, #10, 1967.
26. Margaret A. Paul, "Two Cases of Altered Consciousness with Amnesia Apparently Telepathically Induced." Psychedelic Review, #8, 1966, p. 48.
27. R. Gordon Wasson, Transcript of Discussion, held in Montreal, November 23, 1961.
28. R. G. Wasson, op. cit. (18), p. 41.
29. Timothy Leary, "The Religious Experience: Its Production and Interpretation," Psychedelic Review, #3, 1964, p. 324.
30. R. Gordon Wasson, "Lightning Bolt and Mushrooms, An Essay in Early Cultural Exploration," in Roman Jakobson: Essays on the Occasion of His Sixtieth Birthday, The Hague, Mouton & Co., 1956, p. 610.
31. Henri Frankfort, quoted in Puharich, op. cit., (23).

The Sacred Mushrooms - Rediscovery in Mexico

by

Peter T. Furst

original source: www.drugtext.org/Hallucinogens-and-Culture/chapter-seven-the-sacred-mushrooms-rediscovery-in-mexico.html

If true, surely one of the more significant developments in the study of the ritual use of plant hallucinogens in Middle America is the recent spate of reports that at least some individuals in two Maya populations in southern Mexico are employing the psychoactive mushroom *Stropharia cubensis*[1] in the context of religious ceremony, divination, or curing. The two groups for which this has been reported-but not as yet wholly confirmed by scientifically trained observers-are the Chol, who live not far from the Classic Maya ceremonial and funerary center of Palenque, Chiapas (which, like other Maya lowland sites is thought to have been built and inhabited by ChoIanspeaking Maya), and one small population of Lacandones, of whom only a few remnant groups survive today in the general area of the Usumacinta River near the border of Guatemala. Pending the necessary confirmation, the several accounts that have reached anthropologists and others in the recent past have already led to speculation that perhaps some other Maya-speaking populations may also be found to have retained - or else re-adopted - mushroom rituals that were long thought to have died out among them centuries ago.

Considering the stream of non-Indian mushroom "devotees" that descended on the Mazatec Indians of Oaxaca after their mushroom rites were publicized in the 1950's and early 1960's, perhaps all that should be said for now about the Maya situation is that some reputable scholars have become convinced over the past several years that mushrooms are being employed ritually by at least some Chol and Lacandón Maya. It is true, however, that colleagues who sought to confirm this on the spot were unable to do so in the brief time available to them. At the very least, it seems, the local informants are more reticent on the subject now than even a few years ago. Whatever the reason, the most recent efforts to obtain first-hand information have proved unavailing. The problem is further complicated by a peculiarity of *S. cubensis*: it is a dung fungus that nowadays grows typically on the dung of cattle (as it does, for example, in the grassy meadows all around Palenque). This might lead one to think that it could not be a native New World species but must have been introduced together with cattle after the conquest. Against this, however, we have the fact *S. cubensis* has not been reported in Spain or southern Europe, and, in any event, as we shall see in another chapter, there is a native ruminant whose droppings are perfectly capable of playing host to *S. cubensis* and that played an extraordinarily prominent role in the cosmology of the Maya and other Indian peoples. That animal is the deer.

The use of an hallucinogenic mushroom in Chol country was first reported by a student of M. D. Coe at Yale University (Furst, 1972a:x); the existence of what appeared to be a well-integrated complex of mushroom intoxication, for the purpose of conversing with the deities, was first published by a specialist in Classic Maya art, Merle Greene Robertson (1972), in a paper on the carved monuments of Yaxchilân, an important Maya site on the Usumacinta River. In the course of her research, Mrs. Robertson said, she learned that some Lacandón priests consumed the mushrooms in ritual seclusion, sometimes within the ruins of the smaller temple or funerary structures at Yaxchilin. The mushrooms, she was told, are prepared in specially consecrated pottery bowls that are used for no other purpose and that differ from the so-called "god pots" with anthropomorphic decorations in which incense is burned.

The Lacandones have been subjected to anthropological inquiry for many decades, and it must be emphasized that although ritual intoxication is an essential aspect of their ceremonial life, not one of these investigators witnessed, or heard of, such mushroom rites. Nonetheless, Mrs. Robertson was told by her informants that the sacred mushrooms had served as a medium of communication with the gods for "as long as the oldest" member of that particular group could remember. One cannot help but feel that such information must be taken seriously; the Indians learned long ago - with good and sufficient reason - to conceal and disguise whatever they thought might provoke the wrath or disapproval of the ecclesiastical authorities and other outsiders. Besides, with the exception of peyote, the plant hallucinogens have only recently become the focus of anthropological inquiry in the Americas and elsewhere; field workers are only just beginning to learn to ask the right questions (or better, not to ask questions at all but wait patiently for the information to come naturally, which may, and often does, take many weeks or months of living with the people and convincing them that one means no harm nor desires to change their ways). So it should perhaps not surprise us that neither A. M. Tozzer (1907), author of a classic comparative study of the Lacandones, nor other students of Maya culture considered that ritual intoxication - which has been well-described - might have involved more than just alcohol.

However much it remains to be substantiated, the reported present-day existence of mushroom use among certain Maya groups should go a long way toward settling the question of mushroom "cults" among the ancient Maya, and the reasons for its apparent disappearance from the one area of Middle America where the archaeological evidence for such a cult has been most persuasive.

As Thompson (1970) noted, the Colonial sources on the Maya, which include several useful works on herbal medicines, are silent about intoxicating mushrooms, as well as about other botanically identified psychoactive plants (with the exception of tobacco), however much the sacred mushrooms and plant hallucinogens in general fascinated their contemporaries writing in sixteenth- and seventeenth-century central Mexico. Yet it has long been known that as long as 3000 years ago at least the inhabitants of the highlands and the Pacific slope of Guatemala, as well as some of their neighbors, held certain mushrooms to be so sacred and powerful - perhaps even divine - that they represented them in great number in sculptured stone. In fact, the production of mushroom images or idols of varying symbolic complexity endured in Mesoamerica for nearly two millennia, from ca. 1000 B.C. to the end of the Classic period, ca. A.D. 900, suggesting that a cult of sacred mushrooms not only lasted thousands of years but was anciently more widespread than the sixteenth-century chronicles would lead us to believe.

"Mushroom of the Underworld"

Actually, Thompson was only partly right when he said that the Spaniards were silent on the matter of hallucinogens among the Maya, for several of the early dictionaries compiled by Spanish priests in the Guatemalan highlands demonstrate considerable Indian knowledge of the intoxicating effects of a number of mushroom species[2]. One of the oldest of the Colonial word lists, the Vico dictionary, which was apparently compiled well before the 1550's, explicitly mentions a mushroom called xibalbaj okox (xibalba = underworld, or hell, realm of the dead; okox = mushroom), with the implication that this species is hallucinogenic. In fact, in this context xibalbaj refers not just to the Maya underworld, with its nine lords and nine levels, but also to having visions thereof, so that the name can be understood to mean "mushroom which gives one visions of hell" or "of the world of the dead." The same intoxicating mushroom is also mentioned in a later word list, Fray Tomas Coto's Vocabulario de la lengua Cakchiquel, dated ca. 1690 (manuscript in the library of the American Philosophical Society, Philadelphia), which pulls together much of the earlier material on Cakchiquel-Maya. According to the Coto dictionary, xibalbaj okox, mushroom of the underworld, was also called k'aizalah okox, which can be translated as "mushroom that makes one lose one's judgment."

The Coto dictionary also describes a mushroom called k'ekc'un, which inebriates or makes drunk, and another, muxan okox, "mushroom that makes the eater crazy" (from mox, meaning "mushroom" in the Mixe-Zoque languages of southern Mexico, and "crazy," or "falling into a swoon," in Cakchiquel-Maya of the Guatemalan highlands). Lyle Campbell (personal communication) and Terrence Kaufman, two linguists who have recently investigated the problem of linguistic diffusion in Mesoamerica, believe muxan okox to be one of several cases of linguistic borrowing of ritual terms from Mixe-Zoque into Maya languages in ancient times, perhaps as early as 1000 B.C., or even before. Since they also postulate Mixe-Zoque as the language of the Olmecs - the "mother culture" of Mesoamerican civilization - it is tempting to suggest that the Olmecs might have been instrumental in the spread of mushroom cults throughout Mesoamerica, as they seem to have been of other significant aspects of early Mexican civilization.

Mushroom Stones and the Cult of Sacred Mushrooms

Mention in several of the early sources on Guatemalan Maya languages of a mushroom specifically named for the underworld - i.e. the realm of the dead - is especially interesting in light of the discovery of a ceremonial cache of nine beautifully sculptured miniature mushroom stones and nine miniature metates (grinding stones),dating back some 2200 years, in a richly furnished tomb at Kaminaljáyu, a late Preclassic and Early Classic archaeological site near Guatemala City. The coincidence of the number of mushroom effigy sculptures interred with a Maya dignitary and the number of rulers of the traditional Maya underworld immediately impressed archaeologist Stephan de Borhegyi (1961), who proposed that the mushroom idols were almost certainly connected with the Nine Lords of Xibalba, as described in the Popol Vuh, the sacred book of the Quiche-Maya.

Stone effigies of mushrooms have in fact been turning up in archaeological contexts in Guatemala and Mexico since the nineteenth century. Borhegyi, who until his untimely accidental death in 1969 was director of the Public Museum of Milwaukee, Wisconsin, described, classified, and tentatively dated some 50 of these. More recently, a botanist, Bernard Lowy (1971), augmented the list with another 50, mainly from the highlands and Pacific slope of Guatemala. At this writing, Richard M. Rose, an anthropologist working on a classification of all known mushroom effigies, has catalogued more than 200, many dating to the first millennium B.C. The majority were found on Guatemalan soil, but others come from as far south as El Salvador and Honduras, and as far north as Veracruz and Guerrero in Mexico. Unfortunately, with a few notable exceptions, such as the nine miniature sculptures from Kaminaljóyu, the majority of these interesting effigies was not recovered under scientifically controlled conditions, so that reliable information on provenance and context is not usually available (Richard M. Rose, personal communication).

Connection between these sculptures and the historic mushroom cults of Mesoamerica has not always been accepted. Though many mushroom stones are quite faithful to nature, they were, until recently, not even universally thought to represent mushrooms at all, and a few diehards even now, in the face of all the evidence, reject this interpretation. When first reported in the nineteenth century, the sculptures were thought to be phallic symbols only, a theory that still crops up occasionally but that must be rejected as one-sidedly male-centered. To have any validity at all, the phallic element would have to be seen as one half of a male-female unity, in that the arrangement or juxtaposition of stem (male) and cap (female) in the mushroom fits well into the traditional Mesoamerican system of complementary opposites and the synthesis of male and female elements as the essential precondition for fertility and fecundity. (It is this concept that is expressed so well in Mesoamerican cosmology in the merging of a primordial male and female pair of creator gods into a single bisexual being.)

It was Carl Sapper who in 1898 first identified archaeological mushroom stones from Guatemala and El Salvador as idols of deities in the shape of mushrooms, rejecting, on obvious morphological grounds, the notion that they had served as phallic symbols in a fertility cult. Even now one hears it said that perhaps they were used as seats, or as territorial markers, or even that they might have been potter's tools that served for the making of molds for ceramic bowls. Of these, only for the marker opinion could one make some kind of argument - but even if a mushroom idol served anciently to mark the boundary of a community's land holdings, which in any event were considered sacred, it could have done so as idol of a guardian deity rather than as a property marker in the modern sense. In any case, refusal to recognize the sculptures as what they obviously are - mushroom idols - is likely to be a function of R. G. Wasson's ingenious division of people into those who loathe mushrooms and those who like them (or, in his terminology, mycophobes and mycophiles), a dichotomy that he relates to the history of sacred mushrooms in the lives of different populations since remote antiquity. Even without the visual evidence, one would have to explain away the fact that many of these sculptures, especially those that date between 1000 and 100 B.C., not only represent a naturalistic mushroom but also incorporate a human face or figure, or some mythic or real animal - toads and jaguars in particular - that merge with or project from the stem. The jaguar-mushroom association is especially interesting in light of the mention, in the Coto dictionary, of a mushroom called "jaguar ear." One of the most intriguing of these mushroom "idols" depicts the fungus emerging from the upturned mouth of a toad, apparently *Bufo marinus*, the venomous amphibian that in much of Middle America, and also in the South American tropics, stands for the divine earth as Mother Goddess in her monstrous, devouring animal manifestation (e.g. Tlaltecuhtli, "Owner of the Earth," the earth monster in Aztec cosmology, or Toad Mother Eaua Quinahi, also meaning Owner or Guardian of the Earth, of the Tacana Indians of Amazonian Bolivia [Furst, 1972b].) Wasson (1967a), in his previously quoted discussion of the crucial role of the doncella, or maiden, in the preparation of ritual hallucinogens, has drawn attention to another interesting synthesis of naturalistic and symbolic elements in a mushroom stone in a New York collection:

The cap of the mushroom carries the grooved ring that according to Stephan F. de Borhegyi is the hallmark of the early pre-Classier] period, perhaps B.C. 1000. The stone comes from the Highlands of Guatemala. Out of the stipe there leans forward a strong, eager, sensitive face, bending over an inclined plane. It was not until we had seen the doncella leaning over a metate and grinding the sacred mushrooms in Juxtlahuaca in 1960, that the explanation of the Namuth artifact came to us. The inclined plane in front of the leaning human figure must be a metate. It follows that the face must be that of a woman. Dr. Borhegyi and I went to see the artifact once more: it was a woman! A young woman, for hr breasts were only budding, a doncella. How exciting it is to make such a discovery as this: a theme that we find in the contemporary Mixteca, and in the Sierra Mazateca, and in the Zapotec country, is precisely the same as we find recorded in Jacinto de la Serna and in the records of the Santo Oficio. (p. 348)

Was the Fly-Agaric Sacred to the Maya?

Mushroom effigies of fired clay have also been found in Mexico, as well as South America. Wasson himself has in his collection a fine terracotta "mushroom priestess" in the Classic Veracruz style, probably from the middle of the first millennium A.D., and I have been able to identify a number of ceramic mushroom depictions in the 2000-year-old tomb art of western Mexico (Furst, 1973, 1974c).

Before we leave the archaeological evidence from Mesoamerica, there is one intriguing point to be made about the probable taxonomy of the various mushroom representations. The morphology of the west Mexican ones leaves little doubt that a species of *Psilocybe* is meant. Some of the clay effigies even emphasize the characteristic knob or bump in the center of the cap. Oddly enough, however - considering that there is no evidence that the genus Amanita was ever employed hallucinogenically in Mesoamerica - some Guatemalan mushroom stones seem less to resemble *Psilocybe* than *Amanita muscaria*, the fly-agaric of Siberian shamanism, which also grows in highland Guatemala and elsewhere in North America. On the other hand, the fact that the stem or stipe of the mushroom stones is usually thick like that of *A. muscaria*, and not spindly like that of Psilocybe, might be a function only of the sculptor's material, especially where the stipe is combined with a human or animal effigy. Perhaps there were formerly also wooden mushroom idols that more closely approximated the characteristics of *Stropharia* or *Psilocybe* mushrooms. In any event, the Quiche-Maya of the Guatemalan highlands are evidently well aware that *A. muscaria* is no ordinary mushroom but relates to the supernatural, what with the fact that they have named it cakuljá ikox (cakulja = lightning, ikox = mushroom) (Lowy, 1974, 188-l91). *A. muscaria* is thus related to the Quiche-Maya Lord of Lightning, Rajaw Cakulja, who also directs the dwarflike rain bringers, called chacs in former times but now generally Christianized (in name, not function) as angelitos, little angels.

The ceramic art of the Moche civilization of Peru (ca. 400 B.C.-A.D. 500) also includes a number of anthropomorphic mushroom effigies, as well as personages with mushroom headdresses, dating to the first centuries A.D. Even more interesting is a certain class of spectacular pendants of cast gold from northern Colombia and Panama, apparently representing a deity. Most are highly stylized, but they share one feture - a pair of hemispheric headdress ornaments that look vaguely like bells on an old-fashioned telephone. These had long mystified specialists in the prehistoric art of the region until Andre Emmerich (1965) published a convincing argument that they were pairs of mushrooms that had undergone a stylistic evolution from near-naturalism in earlier pieces to greater stylization, including loss of the stem, in the later ones. Paired mushroomlike head ornaments in fact also occur to the north, on archaeological figurines found in Jalisco, western Mexico. Little is known of pre-Hispanic mushroom use in South America, with the single exception of an early Jesuit report from Peru that the Yurimagua Indians, who have since become extinct, intoxicated themselves with a mushroom that was vaguely described as a "tree fungus."

It is fitting, in the developing story of the Mexican mushrooms, that recognition be given especially to the contribution of that scholarly amateur (in the original complimentary meaning of the word), R. Gordon Wasson. It was he and his late wife, Valentina P. Wasson, who in the mid-1950's rediscovered the living mushroom cult of Oaxacan Indians and brought it to the attention of the world, not only in the pages of Life and in scientific journals but in a remarkable book, Mushrooms, Russia and History (1957). In its pages Borhegyi and Wasson suggested a connection between the sacred mushrooms of Mexico and the prehistoric stone mushrooms of Guatemala - the first time that such a possibility had been considered in print. But this takes us slightly ahead of our story, which should properly begin in the sixteenth century when Sahaglin first described slender-stemmed hallucinogenic mushrooms with small round heads that the Aztecs called teonanacatl, flesh or food of the gods, which he said were usually taken with honey (as the Lacandón are also said to take them), and which could have either pleasant or frightening effects. Francisco Hernandez (1651) was more specific; he mentioned three different kinds of intoxicating mushrooms that were revered by the people of central Mexico at the time of the Conquest. In the seventeenth century Jacinto de la Sema and Ruiz de Alarcón were still perturbed by the continued survival of such mushrooms in indigenous ritual, but thereafter they pass out of the literature, without a single one having been identified botanically - so much ignored that the economic botanist Safford (1915) decided they had never existed at all and that teonanácatl must have been peyote!

Safford's ethnocentric verdict came to be widely accepted although it flew in the face of some very specific historic references (e.g. Sahagtin: "It grows on the plains, in the grass. The head is small and round, the stem long and slender" - a description that hardly fits the peyote cactus, which occurs only in the semi-arid northern high desert. One who disagreed was the aforementioned Dr. Reko, who insisted that the old sources were accurate and that the use of hallucinogenic mushrooms had in fact survived in remote mountain villages of Oaxaca.

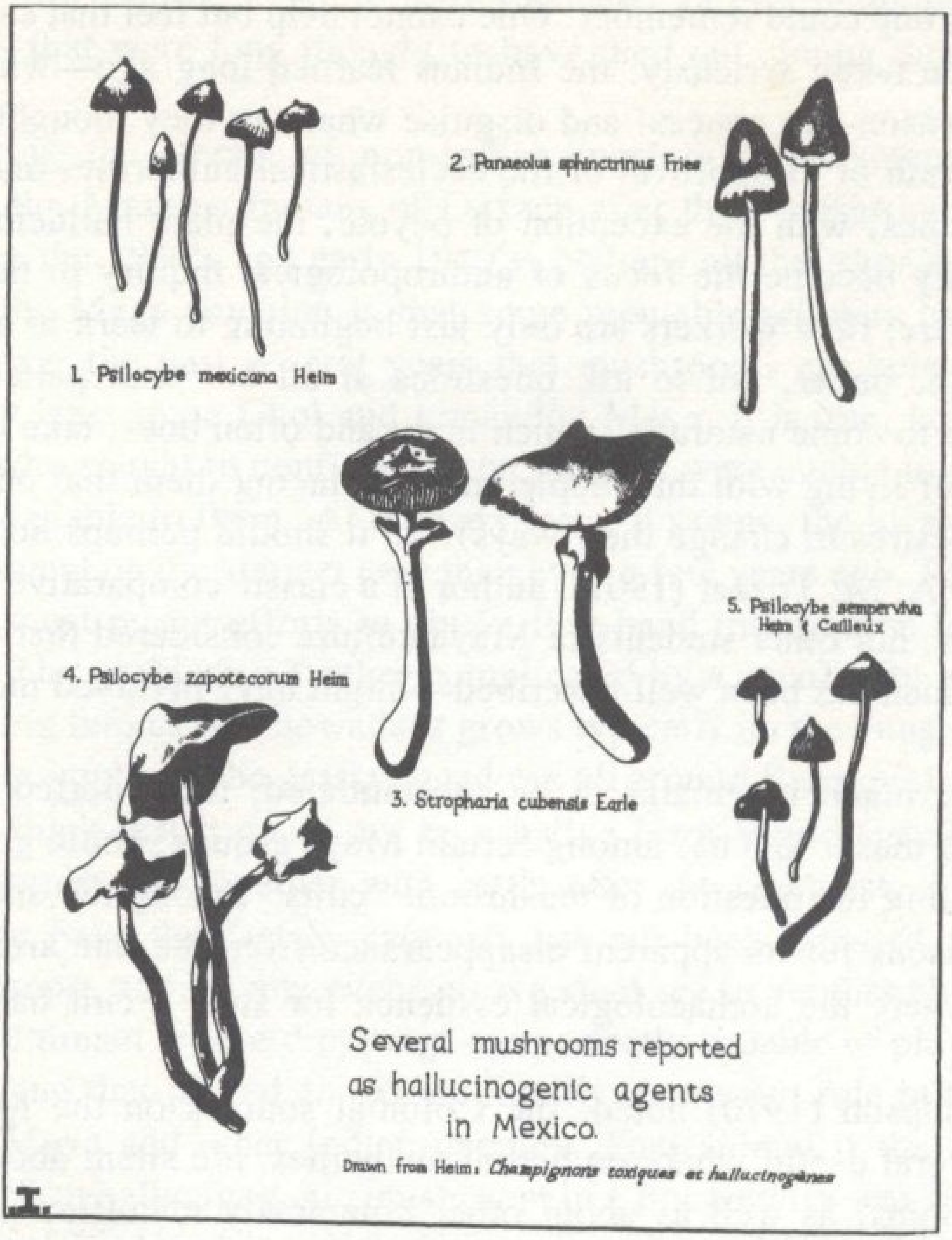
Found at Last: A Living Mushroom Cult in Mexico

He was to be proved right in the late 1930's. In 1936 "Papa" Weitlaner encountered magic mushrooms for the first time in the country of the Mazatecs in Oaxaca. He sent a specimen to Reko, who forwarded it to the Harvard Botanical Museum, where unfortunately it arrived too badly deteriorated to be identified. In 1938, Weitlaner, his daughter Irmgard, and her future husband Jean Basset Johnson, on a field trip to Huautla de Jimenez became the first outsiders permitted to attend - though not participate in - an all-night curing ritual in which mushrooms were eaten. Johnson, who lost his life in North Africa in 1944, described the experience at a meeting of the Sociedad Mexicana de Antropologia in August 1938 and in a more extensive paper published by the Gothenburg Ethnographical Museum (1939).

Mushroom use, he wrote, appeared to be widespread in Mazatec country; shamans, or curers, used them primarily for the purpose of divining the cause of an illness, and during the session it was the mushrooms, which were held in great reverence, that were believed to speak, not the curer. Johnson also confirmed that not just one but several kinds of intoxicating mushrooms were known to the Indians.

In August 1938, a month after the Weitlaner-Johnson experience at Huautla de Jimenez, Schultes and Reko received from Indian informants in the same village specimens of three different species they were told were revered by the people for their visionary properties. Schultes took careful notes of their morphology and in 1939 published the first scientific description. In 1956, the distinguished French mycologist Roger Heim, director of the Museum d'Histoire NatureIle in Paris, identified one as Psilocybe caerulescens; another was defined by the Harvard mycologist Dr. David Linder as *Panaeolus campanulatus*, subsequently redefined as *P. sphinctrinus*; and the third by Dr. Rolf Singer as *Stropharia cubensis*.

Schultes and Reko on their field trip in 1938 had also been able to extend the area of sacred mushroom use beyond the frontiers of Mazatec country to other Indian groups of southeastern Mexico. In the years since, more mushroom-using populations have been added to the list, including, as recently as 1970-l971, the Matlatzinca of San Francisco Oxtotilpan, a small town located about 25 miles southeast of Toluca in the state of Mexico, and possibly also the Chol and Lacandón in the Maya lowlands. The Matlatzinca, who belong to one of the oldest language families of Mexico, the Otomian, are the first inhabitants of central Mexico to have been identified with mushroom use since the sixteenth and seventeenth century, and the Chol and Lacandon are, as already noted, the very first Maya populations for whom sacred mushrooms have been reported in historic times. Altogether we now know of about fifteen different Indian groups, each with its own language, whose curers employ hallucinogenic mushrooms. There are likely to be still others, including lowland and perhaps even highland Maya-speakers, among whom the ancient practice will eventually be found to have survived.


1. Psilocybe mexicana Heim
2. Panaeolus sphinctrinus Fries
3. Stropharia cubensis Earle
4. Psilocybe zapotecorum Heim
5. Psilocybe semperviva Heim & Cailleux

Several mushrooms reported as hallucinogenic agents in Mexico.

Drawn from Heim: *Champignons toxiques et hallucinogènes*

"Mycophiles" and "Mycophobes"

In the meantime Mexican mushroom research had entered an entirely new and more public phase with the entry of the Wassons into the picture. Wasson was a banker, a vice president of J. P. Morgan & Co. in New York; his wife, Valentina Pavlovna (who died in 1958), was a Russian-born pediatrician. Wasson has often told the story of their deep personal stake in mushroom research, which received its initial impetus with his discovery, on their honeymoon, that he and she had assimilated from their different parental cultures very different - indeed, diametrically opposed - points of view toward mushrooms in general, and wild ones in particular:

A little thing, some will say, this difference in emotional attitude toward wild mushrooms. Yet my wife and I did not think so, and we devoted a part of our leisure hours for more than thirty years to dissecting it, defining it, and tracing it to its origin. Such discoveries as we have made, including the rediscovery of the religious role of the hallucinogenic mushrooms of Mexico, can be laid to our preoccupation with that cultural rift between my wife and me, between our respective peoples, between mycophilia and mycophobia (words we devised for the two attitudes), that divide the Indo-European peoples into two camps. (1972a:186)

In 1952, the Wassons first learned of the early Colonial descriptions of mushroom rites and their confirmation by Schultes and others in the late 1930's, and, simultaneously, of the remarkable archaeological artifacts called mushroom stones. In 1953 they plunged seriously into the problem, spurred on by a lengthy description of Mazatec mushroom practices they received from Miss Eunice Pike, a missionary linguist with the Wycliffe Bible Translators, who had spent several years among the Indians of Oaxaca. (See Pike and Cowan, 1939.) Belief in the sacred mushrooms was indeed widespread, she confirmed, but the Indians guarded their secrets well against strangers. As Johnson had reported in 1939, she wrote that pre-Christian and Christian religious concepts and terminologies were inextricably intermingled in the Oaxacan mushroom rites (as, indeed, they are everywhere else, with the exception of the Lacandón; Huichol peyote ritual is likewise essentially non-Christian in meaning and terminology). For example, the Mazatecs spoke of the mushrooms as the blood of Christ, because they were believed to grow only where a drop of Christ's blood had touched the earth; according to another tradition, the sacred mushrooms sprouted where a drop of Christ's spittle had moistened the earth and because of this it was Jesucristo himself that spoke and acted through the mushrooms. (Hofmann, 1964)[3]

"A Soul-Shattering Happening"

In 1953 the Wassons went to Oaxaca for the first time, but another two years passed before they were able to develop a sufficiently warm bond of trust with their Indian hosts to be permitted to partake of the sacred mushrooms. So, in 1955, Wasson and a companion, Alan Richardson, became the first outsiders to actually participate in a mushroom curing ceremony - an unforgettable experience, Wasson later reported, that was to profoundly affect him, who by his cultural inheritance had once utterly "rejected those repugnant fungal growths, manifestations of parasitism and decay" (1972a: 185).

In his enthusiasm for the extraordinary psychic effects of the mushrooms and other sacred halluginogens, Wasson would not be misunderstood as suggesting that these are, or were, the only means of attaining the ecstatic state. Clearly, poets, prophets, mystics, and ascetics ... seem to have enjoyed ecstatic visions that answer the requirements of the ancient Mysteries and that duplicate the mushroom agape of Mexico. I do not suggest that St. John of Patmos ate mushrooms in order to write the Book of the Revelation. Yet the succession of images in his vision, so clearly seen and yet such a phantasmagoria, means for me that he was in the same state as one bemushroomed. (1972a:196)

Nor would he suggest that Blake had to have taken mushrooms or some other natural hallucinogen in order to write that "he who does not imagine in stronger and better lineaments, and in stronger and better light than his perishing eye can see, does not imagine at all." Nevertheless, ... the advantage of the mushroom is that it puts many (if not all) within reach of this state without having to suffer the mortifications of Blake and St.

John. It permits you to see, more clearly than our perishing mortal eye can see, vistas beyond the horizons of this life, to travel backward and forward in time, to enter other planes of existence, even (as the Indians say) to know God. ... All that you see during this night has a pristine quality: the landscape, the edifices, the carvings, the animals - they look as though they had come straight from the Maker's workshop. (1972a:197-198)[4]

Wasson came away from what he later characterized as a profoundly soul-shattering happening, convinced that the magical powers the Indians had ascribed since ancient times to their revered mushrooms were very real indeed, and that chemistry alone could never fully account for the experience of an ineffable mystery, akin to those of the ancient Greeks, with the simultaneous participation of all the senses:

... the bemushroomed person is poised in space, a disembodied eye, invisible, incorporeal, seeing but not seen. In truth, he is the five senses disembodied, all of them keyed to the height of sensitivity and awareness, all of them blending into one another most strangely, until, utterly passive, he becomes a pure receptor, infinitely delicate, of sensations. (p. 198)

The Mosaic Completed

Nevertheless, Wasson was sufficiently a child of the scientific age not to leave it at that (he is, in fact, a meticulous and 'critical scholar and tireless researcher, as demonstrated by his extraordinary book on the identity of Soma [1968] and his latest work, the first definitive monograph on an Oaxacan mushroom rite [1974]). Even before his Mazatec mushroom experience he was in close contact with Roger Heim as one of the leading mycologists in the western world, and Heim now accompanied him on further expeditions into the mountains of Oaxaca, in consequence of which a dozen or so different mushrooms of the family Strophariaceae, mostly of the genus *Psilocybe*, but also of *Conocybe* and *Stropharia*, were identified. With the additional field work of Singer (1958) and the Mexican botanist Gastón Guzman-Huerta (1959a, b), by the end of the 1950's the mosaic of the sacred mushrooms of Mexico, completely unknown only twenty years earlier, was reasonably complete.

According to Schultes's summary of 1972, and his and Hofmann's collaborative monograph on the plant hallucinogens (1973), species of Psilocybe and Stropharia are the Most important, the most significant being apparently *Psilocybe mexicana* , *P. caerulescens* var. *mazatecorum* , *P. caerulescens* var. *nigripes* , *P. yungensis* ,[5] *P. mixaeensis*, *P. hoogshagenii*, *P. aztecorum*, *P. muliercula*, and *Stropharia cubensis*. Singer (1958) reported that his own work in Oaxaca failed to find *Panaeolus sphinctrinus* - one of the three hallucinogenic species the Indians gave Schultes and Reko in 1938-in the Mazatec inventory of sacred mushrooms. But as Schultes (1972a) points out, different shamans have their own favorite species and also tend to vary these according to seasonal availability and the precise purpose for which the mushroom is intended. *Psilocybe mexicana*, a small, tawny inhabitant of wet pasture lands, he writes, is probably the most important species utilized hallucinogenically in Mexico, but the strongest psychedelic effects seem to belong to Stropharia cubensis.

Heim was able to propagate a laboratory culture of the sacred mushrooms in Paris, but when attempts to isolate the active principles of Psilocybe mexicana proved unsuccessful, he submitted several specimens, as well as other species, to Hofmann for analysis at Sandoz. Hofmann was almost immediately successful in discovering the agents responsible for the extraordinary psychic effects of the mushrooms, and, shortly afterwards, in reproducing the chemicals synthetically without the aid of the plants themselves. The principal active agent was identified to be an acidic phosphoric acid ester of 4-hydroxydimethyltryptamine, allied to other naturally occurring organic compounds such as bufotenine and serotonin, and probably derived biogenetically from tryptophane. This he named psilocybine. Also present as an unstable derivative was a compound he called psilocine. The same constituents have been isolated from several North American and European mushroom species that are not used as hallucinogens and for which we have no indication that they were ever so employed (Schultes, 1972a:10).

The active agents of the sacred mushrooms, Hofmann reported, amount to about 0.03% of the total weight of the plants; to achieve the effect of as many as 30 mushrooms (only a few are actually used at a time in the rite) would require only 0.01 gram of the crystallized powder dissolved in water.

Hofmann (1964) has summarized the most important results of the phytochemical investigation of the sacred mushrooms as follows: Psilocybine and psilocine are chemically-structurally related to serotonin, a substance that occurs in the mammalian brain and that plays a role in the chemistry of brain function. The structural relationship of the active principles of the mushrooms with serotonin provides an explanation for their psychic effects, and offers insights into the biochemistry of the brain itself. The pharmacological phenomena are explainable in terms of central excitation of the sympathetic nervous system. In human subjects, doses of 6 to 20 milligrams bring about, without any physical symptoms worth mentioning, fundamental changes or transformations of consciousness, with wholly different perceptions of space, time, and one's psychic and bodily self. The sense of sight and also that of hearing are greatly heightened, to the point of visions and hallucinations. Not uncommonly, long-forgotten events, often those that belong to the realm of earliest childhood, manifest themselves with extraordinary clarity.

Although he was by no means finished with the phytochemistry of the mushrooms (for example, he himself, in the company of Wasson, was still to experience their wondrous mystical effects in a mushroom rite conducted by the famous Mazatec curing priestess Maria Sabina [Wasson et al. , 1974]), for Hofmann the stage was now set for his discovery in the divine morning glories of lysergic acid derivatives closely related to LSD-just as the synthethis of LSD in 1943 had led to the isolation of psilocybine and psilocine in the sacred mushrooms.

References:

1. Although the species name appears to identify this psychedelic mushroom with Cuba, it should not be taken to mean that it is, or originally was, native only to that island or the Caribbean in general. Rather, it was so designated because it was first described in 1906 by F. S. Earle after encountering it in Cuba. S. cubensis appears to be a New World variety found mainly - but not exclusively - in Mexico and parts of Guatemala; interestingly enough, a similar species, originally called Naematoloma caerulescens but subsequently assigned to the same genus as S. cubensis, was identified in 1907 in what is now North Vietnam. For the most recent discussion of the Psilocybin mushrooms, including S. cubensis, see Steven Hayden Pollock, M.D., "The Psilocybin Mushroom Pandemic," Journal of Psychedelic Drugs, Vol. 7, No. 1, pp. 73-84 (1975).
2. My colleague Robert M. Carmack, one of the most knowledgeable of scholars in the field of highland Guatemalan ethnohistory and culture, to whom I am indebted for the mushroom references in early highland dictionaries, recently collected mushroom lore from a Quicheanspeaking elder, confirming that some of the ancient knowledge continues to survive.
3. According to current terminology for the cultural phases of Mesoamerican prehistory this should be called Middle Formative. The dating is in any event only approximate.
4. This belief seems to have its origin in indigenous shamanism. In Mexico, as everywhere else in shamanistic religion, supernatural and therapeutic power are attributed to the shaman's spittle, which is sometimes identified (as among the Papago of Arizona) as rock crystals in liquid form, rock crystals being near-universally regarded as crystallized spirits, usually of deceased shamans. Divine spittle is also related to the origin of the sacred mushroom in Siberia (see Chapter Eight).
5. It is typical of the syncretistic nature of the present-day mushroom cult that some Oaxacan Indians say God gave them the sacred mushrooms because they could not read and it was necessary for him to speak to them directly through the mushrooms. Eunice Pike and her fellow missionary Florence Cowan (Pike and Cowan, 1959) have related how difficult it is to explain the Christian message to people who are convinced they already possess the means - the sacred mushrooms - to receive the word of God in immediate and vivid form, to visit heaven for themselves, and to establish direct contact with God. Readers interested in other sensitive accounts of the mushroom experience might consult, apart from Wasson's most recent work (1974), Henry Munn's essay in Hamer (1973).
6. Schultes suggests that this might have been the species employed by the Yurimagua Indians of Peru.

Using Psychedelics Wisely

by

Myron J. Stolaroff

A veteran researcher explains how psychedelics can be used to give beneficial results

Citation: Stolaroff M. "Using Psychedelics Wisely". Gnosis. Winter 1993;26:26-30.

original source: https://www.erowid.org/psychoactives/writings/stolaroff_using.shtml

Table of Contents:

Set and setting
Motivation
Honesty
Ongoing discipline
Psychedelics as way-showers
Dealing with the shadow
Freeing constricted areas
The trained user
Suggested reading

My wife Jean and I had driven several miles up the mountain to an elevation of 6000 feet a few miles south of Mount Whitney in California. We were about to meet Franklin Merrell-Wolff, author of the book *Pathways through to Space*, an impressively articulate and detailed description of a person entering a state of enlightenment and savoring it over several months.

When we were ushered into his private office, we found ourselves before an outstanding personage who radiated a marvelous glow. When we had talked for a few minutes and I felt sufficiently at home, I spoke of our research work, telling him that we had spent three and a half years administering LSD, sometimes in conjunction with mescaline, to 350 research subjects and had published our findings in medical journals.

"My oh my!" he said, looking at us with consternation. "I hope you haven't used these drugs yourselves."

We admitted that we had. He continued, "According to X" (here he mentioned an Indian sage whose name I do not remember), "it will take you seven incarnations to recover from the damage of taking such substances!"

Naturally I was upset, but I didn't think of the appropriate reply until we were driving back down the hill: "Never underestimate the grace of God!"

There is no question that psychedelic substances are remarkable graces. The farther one can reach into the vastness to be explored, the more one realizes how powerful these materials are. There seems to be no end to the levels of awareness that can be realized by those who use them to explore their psyches with integrity and courage.

The great value in these chemicals is that, in some way still not scientifically explained, they dissolve the boundaries to the unconscious mind. They give us access to our repressed and forgotten material, to the Shadow that C.G. Jung so effectively dealt with, to the archetypes of humanity, to an enormous range of levels of thought, and to the wellspring of creativity and mystical experience that Jung called the collective unconscious.

At the heart of the unconscious is what many experience as the source of life itself, and which some call God. Those who have experienced this describe it as a wondrous, ineffable source of light and energy that infuses all of creation, embracing all wisdom and radiating a vast, unending, and ever-constant love. Immersion in this is the essence of the mystical experience and produces what the great mystics have described as the state of unity or oneness. Such union is the culmination of all seeking, all desire; it is the most cherished of all experiences of which man is capable.

Not all who ingest these substances can count on such revelations. In fact, psychedelics are powerful agents and can be misused. It must be remembered that they help reveal the unconscious, and most of us have made its contents unconscious for very specific reasons. We may not welcome the appearance of repressed, painful feelings, or of evidence that our values and lifestyles might be considerably improved. Nor is it always easy to accept the spaciousness of our being, our immense potential, and the responsibility that these entail. We may also refuse to believe that we are entitled to so much beauty and joy without paying any price other than being ourselves!

To assure a rewarding outcome, let's look at some factors that should be taken into consideration when using these materials. I must add here that in no way am I encouraging the use of illegal substances. I do hope, however, that greater understanding of these materials will help restore an intelligent policy that will make further research possible. Here are some things that will help ensure beneficial results:

Set and setting

Set and setting have been widely recognized as the two most important factors in undertaking a psychedelic experience. Of these, set has the greatest influence.

As the drug opens the door to the unconscious, huge spectrums of possibilities of experience present themselves. Just how one steers through this vast maze depends mostly upon set. Set includes the contents of the personal unconscious, which is essentially the record of all one's life experience. It also includes one's walls of conditioning, which determine the freedom with which one can move through various vistas. Another important aspect of set consists of one's values, attitudes, and aspirations. These will influence the direction of attention and determine how one will deal with the psychic material encountered.

In fact, one can learn a great deal by accepting and reconciling oneself with uncomfortable material. Resisting this discomfort, on the other hand, can greatly intensify the level of pain, leading to disturbing, unsatisfactory experiences, or even psychotic attempts at escape. This latter dynamic is largely responsible for the medical profession's view of these materials as psychotomimetic. On the other hand, surrender, acceptance, gratitude, and appreciation can result in continual opening, expansion, and fulfillment.

Setting, or the environment in which the experience takes place, can also greatly influence the experience, since subjects are often very suggestible under psychedelics. Inspiring ritual, a beautiful natural setting, stimulating artwork, and interesting objects to examine can focus one's attention on rewarding areas. Most important of all is an experienced, compassionate guide who is very familiar with the process. His mere presence establishes a stable energy field that helps the subject remain centered. The guide can be very helpful should the subject get stuck in uncomfortable places, and can ask intelligent questions that will help resolve difficulties, as well as suggesting fruitful directions of exploration that the subject might have otherwise overlooked. The user will also find that simply sharing what is happening with an understanding listener will produce greater clarity and comfort. Finally, a good companion knows that the best guide is one's own inner being, which should not be interfered with unless help is genuinely needed and sought.

Motivation

This is extremely important. Those who earnestly seek knowledge and deeply appreciate life in all its forms will do well. Yet certain characteristics of psychedelics make them very popular for recreational use. The most attractive of these is their great enhancement of sensual responses, which offer heightened perception, amplification of beauty and meaning, and intensified sensual gratification. Psychedelics can also generate a great sense of closeness among participants, especially in a group setting. While I am convinced that one of the great cosmic commands is "Enjoy," there are traps in using these substances purely for recreation. The first is that a person seeking the delights of the senses may find himself overwhelmed by the eruption of repressed unconscious material without knowing how to deal with it. Another danger is that constant pleasure-seeking without giving anything back to life can distort the personality and ultimately produce more discomfort. The safe, sure way to rewarding outcomes with psychedelics is through intelligent, well-informed use.

Honesty

For the serious spiritual seeker, or for that matter anyone seeking knowledge, the single most important characteristic is honesty. This means the courage to look at whatever is presented by the deep mind, the ability to admit one's shortcomings when they become apparent, and the determination to change one's behavior in line with the truth one has experienced.

Ongoing discipline

Experts in the field now generally agree that it is wise to conduct psychedelic explorations within the framework of a spiritual discipline or growth program that will continually call attention to fundamental values and goals. A good discipline will outline a body of ethics for personal behavior that will support the changes required. Good ethics will also help us stay clear about our objectives, and will keep the door open to increasing depths of experience. Moreover, there is evidence to suggest that the more we are prepared to pass on to others whatever spiritual largess we have accumulated, the more we will be given.

For myself, I found training in Tibetan Buddhist meditation a potent adjunct to psychedelic exploration. In learning to hold my mind empty, I became aware that other levels of reality would more readily manifest. It was only in absolute stillness, accompanied by a special, highly developed quality of listening, that many subtle but extremely valuable nuances of reality appeared. While I achieved this to some extent in ordinary practice, I found this effect to be greatly amplified while under the influence of a psychedelic substance. This in turn intensified my daily meditation practice.

Psychedelics as way-showers

The role of psychedelics is often misunderstood. Many feel that having had wonderful experiences, they now have the answers and are somehow changed. And no doubt in many respects they are. But users often overlook the fact that there are usually heavy walls of conditioning and ignorance separating the surface mind from the core of our being. It is a blessing that psychedelics can set aside these barriers and give access to our real Self. But unless one is committed to the changes indicated, old habits of personality can rapidly reestablish themselves.

At this point many feel that repeating the experience will maintain the exalted state. It may, but most often real change requires hard work and dedicated effort. Unfortunately this is not always clear during the experience itself; it has merely pointed the way and shown what is possible. If we like what we see, it is now up to us to bring about the changes indicated.

There is a grace period following profound psychedelic experiences when changes can be rapidly made. At this time one is infused with the wonder and power of the new information. Moreover--and this is an area where some valuable research can be done--the drug experience releases a great deal of bodily and psychic armoring that is tied to our neuroses. This rejuvenation is quite noticeable after a good psychedelic experience, when, without the dragging weight of physical habit patterns, behavior can be more readily changed.

On the other hand, if you make no effort to change, old habits rapidly reassert themselves, and you find yourself sliding back into your previous state. In fact, it can be worse than before, because now you know that things can be better and are disappointed to find yourself mucking around in the same old garbage.

Another factor makes this process even more uncomfortable. A lot of the energy formerly tied up in repressed material is now released. This energy may be used quite fruitfully to expand the boundaries of your being to the new dimensions you have experienced. But if you return to old patterns of behavior, you now have more energy to reinforce them, making life more difficult. For this reason, these experiences must not be taken lightly, but with serious intent.

Dealing with the shadow

As Jung indicated, the Shadow holds all the material that we have pushed aside so we can hide from ourselves. Unfortunately, it also contains much of our energy, and as long as it is unconscious, it exerts a powerful influence on our behavior without our knowing it. Furthermore, Shadow material is responsible for most of the difficulties humans create in the world. We project our Shadow onto others, believe those others to be the source of our difficulties, and seek refuge from them rather than taking responsibility in our own hands. Consequently we must resolve Shadow material if we are to develop. If this were accomplished on a widespread basis, it would be a major benefit for the world.

Jung describes human development as the process of "making the unconscious conscious." Psychedelics, particularly in low doses, can be an extremely effective tool in this process. The bulk of my experience is with the phenethylamine compounds, which remained legal longer than the standard psychedelics such as LSD, mescaline, and psilocybin. Whereas a full dose of a phenethylamine like 2C-T-2 or 2C-T-7 might be 20 milligrams, a low dose would be ten or twelve milligrams, or roughly equivalent to 25-50 micrograms of LSD.

The most infallible guide to Shadow material is our uncomfortable feelings. Many do not like to use low doses because these feelings come to the surface. Rather than experience them, they use larger doses to transcend them. But these uncomfortable feelings are precisely what we must resolve to free ourselves from the Shadow, gain strength and energy, and function more comfortably and competently in the world. By using smaller amounts and being willing to focus our full attention on whatever feelings arise and breathe through them, we find that these feelings eventually dissolve, often with fresh insight and understanding of our personal dynamics. The release of such material permits an expansion of awareness and energy. If we work persistently to clear away repressed areas, we can enter the same sublime states that are available with larger doses--with an important additional gain. Having resolved our uncomfortable feelings, we are in a much better position to maintain a high state of clarity and functioning in day-to-day life.

I would also like to add a word about frequency: Individuals vary greatly in their frequency of use of these materials. Some are satisfied with an overwhelming experience which they feel is good for a lifetime. Others wish to renew their acquaintance with these areas once or twice a year. Still others are interested in frequent explorations to continually push their knowledge forward. Regardless of the frequency, it is wise to make sure that the previous experience has been well integrated before embarking on the next one. Early in one's contact with these substances, where there is a wealth of new experience, this may take several months. As one becomes more experienced, the integration time grows shorter, and the interval between trials may be shortened.

Many stop the use of psychedelics when they feel they have learned what they wished. But often it is likely that they halt because they have hit a deeply repressed, painful area that is heavily defended. The issue goes beyond purely personal material, however. One is unlikely to reach full realization without awareness, not merely of one's own pain and suffering, but of that of all mankind. This may help explain the Dark Night of the Soul, which is the final barrier to mystical union described by Evelyn Underhill in her classic book *Mysticism*. Since we are one, we must not only confront the personal Shadow, but the Shadow of all humanity. We can do this more readily when we discover the ample love that is available to dissolve all Shadow material.

Freeing constricted areas

There is another way in which psychedelics can serve the serious seeker. It often happens that those pursuing rigorous spiritual disciplines achieve elevated states by pushing aside or walling off certain aspects of behavior. With honest use, psychedelics will not permit such areas to remain hidden, but will insist upon their surfacing. One then experiences the great relief of being in touch with all aspects of one's being. The joy and thrill of being totally alive come from having complete access to all of one's feelings.

The trained user

There appears to be a cosmic law that says that giving our complete attention to an object, image, or idea with constancy, patience, and acceptance will allow its different attributes to unfold. Psychedelics greatly accelerate this process. To operate most effectively, the observer must have developed the ability to hold his mind steady so he can watch the process develop. Large doses can push one so hard that it is most difficult to do this. Therefore the best results are achieved by a "trained user"--a person who has learned to manage high doses of psychedelics, or who has learned to hold his mind steady enough to observe his inner process competently. As a user clears up his "inner stuff," he gains more freedom in directing his experience. At this stage, higher doses can be profitably used to penetrate deeper into the nature of Reality.

Interestingly, this concept of the trained user does not appear in the literature. But it is precisely the trained user who can best take advantage of the unfathomed range of wisdom and understanding contained in the far reaches of the mind. There seems to be no limit to the dimensions of understanding that can be experienced by the explorer who has the courage, integrity, and skill to navigate them. With integrity, and with the support of appropriate disciplines and friends, one can bring back a great deal for the betterment of oneself and mankind.

Are psychedelics necessary? Can't these same explorations be conducted by those who have mastered the skills of meditation? No doubt they can--with an enormous investment of time and effort. But it is unlikely that many Westerners will be willing to make such a commitment. For Western seekers, whose spiritual practice must usually be integrated with making a living, the proper use of psychedelics can considerably accelerate the process. However, it is not a path for everyone. Choice should be based on full knowledge of the factors involved.

Psychedelics are not a shortcut, as it is of little value to sidetrack important experiences. If enlightenment requires resolution of unconscious material (and my personal experience indicates that it does), those who aspire to such achievement must carefully consider the pace and intensity with which they are willing to encounter this vast range of dynamics. The psychedelic path, while much more intense than many other disciplines, is in a sense easier because it often provides an earlier and more profound contact with the numinous. Such contact inspires commitment and opens the door to more grace in surmounting uncomfortable material.

If our commitment is truly to the well-being and happiness of all sentient beings, then it is reasonable to study all useful tools for accomplishing these ends. Psychedelics, used with good motivation, skill, and integrity, can contribute much toward easing the pain and suffering of the world while giving access to wisdom and compassion for spiritual development.

The author has worked for many years in the field of psychedelic research. Between 1960 and 1970 he headed the International Foundation for Advanced Study, a research group conducting clinical studies with LSD and mescaline.

Suggested reading

1. Adamson, S. *Through the Gateway of the Heart*. San Francisco: Four Trees Publications, 1985.
2. Blumenthal,Michael. "LSD at Mid-Life," in *New Age Journal*, May/June 1992, pp. 81-83, 142-47.
3. Eisner, Bruce. Ecstasy: *The MDMA Story*. Berkeley, CA.: Ronin Publishing, 1989.
4. Grof, Stanislav. *LSD Psychotherapy*. Pomona, Calif.: Hunter House, 1980.
5. Ratsch, C., ed. *Gateway to lnner Space*. Bridport, Devonshire: Prism Press, 1989. See especially the chapter "Purification, Death, and Rebirth" by Tom Pinkson.
6. Shulgin, Ann and Alexander. *PIHKAL*: A Chemical Love Story. Berkeley, Calif.: Transform Press, 1991.
7. Underhill, Evelyn. *Mysticism*. New York: E.P Dutton, 1961.
8. Weil, Andrew. *The Natural Mind*. Boston: Houghton Mifflin, 1972.

* Note: Subscriptions and backissues of *Gnosis* magazine can be purchased from:
GNOSIS, P.O. Box 14217, San Francisco, CA 94114

Entheogens are NOT Drugs

by

Keith Cleversley

original source: http://www.cleversley.com/on-being-human/entheogens-are-not-drugs/

Truth in Numbers

Before we can begin, a few critical details need to be heard as honestly and with as open a mind as possible, so we can engage in a fruitful dialog regarding an extremely difficult topic.

First, the fact that illicit drugs such as cocaine and heroin are directly responsible for thousands of deaths per year is never disputed. But what rarely gets discussed is the fact that some legalized drugs such as tobacco, alcohol, and prescription medication (which embody the very definition of drugs) are responsible for hundreds of thousands of deaths each and every year, year after year, and are actually more abused in far greater numbers than all illicit drugs combined. This means that millions of deaths have been the direct result of the use and abuse of illicit and legal drugs throughout history.

This is a staggering number.

Conversely, there are a number of ancient and sacred plants known as entheogens. The entire group of these plants is responsible for a negligible number to zero deaths per year. In fact; they may be responsible for under a dozen recorded deaths in their entire recorded history of use. Entheogens are also called "plant teachers" because of the effort required to work with these plants for responsible spiritual exploration; they are not the "quick fix" or the "escape" that abusers of illicit drugs and alcohol are hoping to find.

They are also more commonly (and recently) known as "psychedelics." This is exactly where the knee-jerk reactions often begin. But I ask to suspend your reaction, to reserve judgment until some important facts are understood as we first find some initial common ground. What we can agree on so far is this: The yearly death toll from entheogens/psychedelics is negligible to zero, in stark contrast to the countless millions of deaths throughout recorded history that illicit and legalized drugs are directly responsible for.

This is critical to hold in our minds as we continue.

The Food, Drug, and Cosmetic Act gives us some insight into what the government considers a drug. It's "a substance recognized in an official pharmacopoeia or formulary, a substance intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease, a substance other than food intended to affect the structure or function of the body, a substance intended for use as a component of medicine but not a device or component, part, or accessory of a device." For the sake of discussion, let's also see what Merriam Webster thinks a drug is: "something and often an illegal substance that causes addiction, habituation, or a marked change in consciousness."

When the group of substances, plants, and chemicals that fit even a part of the above definitions are grouped together and universally referred to as "drugs" this (perhaps intentionally) limits any possibility of engaging in an intelligent, unbiased, non-prejudiced discussion about the true difference between drugs that are dangerous, addictive, and often-abused, from those used ritualistically in cultures (entheogens) throughout the world and throughout our mutual human history. Despite the Roman Catholic assertion that indigenous cultures were primitive" and "heathens," it only takes a cursory glance at the state of our planet to get at least an inkling that the people who didn't overpopulate it or pollute it, who typically lived in harmony with their environment and who were connected to it and an integral part of it, may have something profound, even world-changing to teach us.

And, statistics that are difficult for many to look at continue with both over-the-counter and prescription medications. The #1 abused drug in America isn't illegal or illicit drugs, even if we include Cannabis in that group; it's prescription medication. OxyContin, a powerfully addictive narcotic with effects similar to opiates such as heroin became a leading drug of abuse in less than 10 years after its introduction.

Let's take a look at a common drug; aspirin. Aspirin reactions and interactions claim 37,000 lives per year. This is one of countless other drug interactions that cause everything from allergic reactions to death, yet few of us barely blink an eye when it comes to "death by aspirin." In a similar example, 16,500-20,000 deaths per year have been attributed to the use of non-steroidal anti-inflammatory drugs (NSAIDs). I already mentioned that The Center for Disease Control (CDC) reports that a staggering 430,000 deaths per year are attributable to the abuse of tobacco.

Yet the media never covers these things because there's no way to sensationalize it or prey on our fears like they can when the word "psychedelic" is uttered. Well, that, and there's not multi-billion dollar pharmaceutical, tobacco, or alcohol companies as well as their accompanying governmental lobbyists, or the many millions spent on marketing those drugs, often to unsuspecting populations.

On the other hand, entheogens induce almost universal anger, disdain, reaction, and judgment in even the most open-minded, especially when the word "hallucinogenic" accompanies it. Who could blame any of us for this reaction considering the many years of propaganda and false information perpetuated by the media looking for a great story, by corporations looking for more profits, by organized religions feeling usurped, or by the Federal Government looking to maintain control? Coupled with a systematic suppression of the ritualistic use of plant medicines and entheogens by countless cultures, shamanic or otherwise throughout the world and throughout history; the mainstream population has little hope of knowing any differently. This is thankfully changing with pioneering work by groups like M.A.P.S. and the Hefter Institute, who have not only revived clinical research into entheogens, but who've now offered scientific evidence that psychedelics and hallucinogens can help treat a wide range of trauma and disorders, ranging from PTSD to victims of rape and other abuse.

Regardless, the critical point is this: Regardless of any moral, ethical, or religious reasons anyone might have for objecting to entheogens and ethnobotanicals, if we can at least all agree that illicit drugs as well as particular legal drugs are far more of a dire concern due to sheer numbers alone, especially in regard to youth, then we have that critical common ground that will enable us to seek out the true answers to one of the most serious issues facing us today.

Addressing the Myth

The media are guilty of one of the crimes I usually associate with organized religion; of preying on our fear and using that fear to manipulate us. One of the most effective tactics is to repeat something enough times, loudly enough, and in enough ways that it eventually gets accepted as a fact. One example is this universally-recognized fear-inducing statement in relation to entheogens:

"Psychedelics make you jump out of tall buildings."

But the stark, often difficult-to-swallow truth is actually this: The above statement is categorically false and has simply been repeated so many times that it's now accepted as a fact. It plays so perfectly into our natural "fear of the unknown," also making entheogens a perfect fit to be the scapegoat.

There's little to no evidence to support the belief that psychedelics make you engage in fatal activities such as jumping out of buildings, though, but no one seems to notice or to take the time to truly find out for themselves. Conversely, as mentioned earlier, there is far more evidence supporting the fact that many of the demonized entheogens are clinically-proving to be of great benefit in many areas of medicine, or at least are showing great promise in medicine! But label anything with the word "psychedelic" or "hallucinogenic," and you're almost assured of getting whatever legislation you wish passed in relation to it regardless of the facts.

Salvia divinorum is one of the most controversial scapegoats in recent history. When news of a suicide hit the news, a diary entry was found that indicated the person who had committed suicide had taken Salvia divinorum at some point in the past and that, as a result of that experience, realized that there was no point to his life and that his only option was to kill himself.

A tragedy; no question.

But, instead of looking to the broader picture of this person's world, perhaps to the failure of the parents, or to the youth himself who was already so discontent with his world that he had considered suicide previous to ingesting Salvia divinorum"¦it's far more comfortable and easier to blame the hallucinogen as the reason for his death instead.

And we all so easily jump on the bandwagon. It only took the possibility; a mere MENTION of a hallucinogen to elicit sweeping changes to the laws in relation to it. In my eyes, this is not only a red herring, it's a matter of shooting the messenger as well, and as long as "justice is done" no one thinks to question.

Just in case there are those who feel I advocate entheogens to anyone and everyone, I feel the need to offer some clarity on that point: I don't think for a minute that everyone should ingest psychedelics. Many have a difficult enough time handling the waking reality we all find ourselves dealing with on a daily basis. The instantaneous dissolving of the ego can be quite a jarring experience, especially for those in such material-based societies, but the rewards can be equally as valuable. I don't feel that children, in an non-indigenous setting, should work with entheogens, just as I don't feel that kids should be using any drugs, whether it's alcohol, caffeine, tobacco, or even aspirin or Prozac.

The simple fact is this: Psychedelics have no reputable supporting evidence that they cause psychosis or lead one to commit suicide. Without belittling the importance of even a single death that may have been linked to any potentially aggravating factors, it's critically important to make this clear: The massive backlash from a single death in 3,000 years of safe use seems virtually inconceivable when considering the complete lack of outrage to the literally millions of deaths that have been caused by alcohol, tobacco, illicit drugs and prescription medication, often hundreds of thousands of deaths each and every year. How can this be?

It is incredibly odd that a single death, not even directly linked to the plant in question, has directly resulted in the outlawing of that plant, when millions of deaths directly linked to alcohol, tobacco, illicit drugs, and prescription medication have only resulted in stiffer laws or slaps on the wrist, rather than outright outlawing of this scourge. In fact, much legislation has repeatedly been passed to further ensure even more protection under the Federal Government for some of the most dangerous drugs plaguing our society today.

With Open Eyes

When viewed in this manner, it makes it obvious that preying on our fears of the unknown makes entheogens and psychedelics an easy target and scapegoat, effectively shifting the focus away from the true killers in our society.

As further evidence: There's mounting evidence that a legal drug such as Prozac has multiple instances of suicides and attempted suicides attached to it, yet no one is fighting to get Prozac outlawed. It's also been proven that places where Kava Kava is prescribed for depression instead of Prozac, there are fewer side effects and now, evidence that there are fewer depression-related deaths as well. This is key information that could help us all live longer, healthier and happier lives, yet this information, like the positive stories of the use of psychedelics and other psychoactive plants (like Kava Kava), are stifled because of the laws presently in place.

Kava Kava has also been used as an alternative to alcohol, and statistics show that in places where Kava is consumed more than alcohol, there are significantly lower incidents of violence and motor vehicle accidents. Surely this must count for something.

I typically leave the subject of Cannabis out of the discussion on purpose, but this is a prime example of an irrational war waged against a natural herb that has shown immense medical benefits. Although the Federal Government still won't change their policy on this ancient entheogen, a number of states have not only decriminalized cannabis, it has been publicly approved for medical use. Surely this is an indication that there are forces beyond our awareness at work that may not be providing us with the whole and complete truth, and are at least worth examining.

And this is but one entheogen of many that, for thousands of years, have been used successfully medicinally, but have since been blindly outlawed or treated as scapegoats. It will take a massive shift in consciousness, an evolutionary shift to effect a change. And that's actually at the core of what my entire mission on this planet presently revolves around: To be part of the voice for evolution in consciousness and attitude in relation to entheogens and the restoration to their proper place in the medicine cabinet of Mother Nature.

And the exciting news is that things ARE changing. Many states, instead of blindly outlawing Salvia divinorum as over 10 states have of this writing are drafting legislation so Salvia is legal to adults over 18 years of age. This is forward-thinking legislation that returns the right of adults to choose for the tools they want to work with to explore the contents of their own mind themselves. The truth about Cannabis is starting to vividly outshine the propaganda and unfounded outrage that has been mounted against it by the Federal government, and this gives me great hope for the future.

Even ecstasy, hallucinogenic mushrooms, and D.M.T., which are all Schedule I drugs in most of the world as of this writing, have clinical trials being conducted on each as we speak. The results have been astonishing. Ecstasy is proving to be extremely helpful for victims of violent crimes such as rape. Hallucinogenic mushrooms have been showing great promise for the treatment of severe depression. Marijuana has been proven to aid in several serious medical ailments. Ibogaine (another illegal hallucinogen) has proven to be extremely effective in treating addiction. And the list goes on.

CAN entheogens be dangerous? Of course they can. Should they be available to kids? Of course not. But blindly making them illegal, often at the expense of valid, deeply beneficial medical research is simply irrational. But until we can see beyond the lies, the propaganda, and the indoctrinated knee-jerk negative responses whenever the word "hallucinogen" is uttered, the battle will be slow, arduous, and often accompanied by feelings that the fight itself is futile.

Our ignorance and our mutual fallibility to believe what the government and media tells us is true is where their greatest power and our greatest weakness lies. It's easy to capitalize on. But I have two unconquerable allies in this fight: Truth and the Internet. Because of these two powerful forces, I believe it's only a matter of time before we are all forced to evolve our mass consciousness into something far more rational and mutually beneficial to all beings when it comes to the use of entheogens. I will always believe that truth will always win out in the end, no matter how demonized, oppressed, or ignored.

In closing, the word entheogen means "to reveal the Divine within." They are part of a cornucopia of plants that Mother Nature provides, enabling those who choose to do so to explore one's own consciousness, the nature of reality, and our mutual places in the universe. Perhaps this is one of the reasons why there is such a deeply indoctrinated and often irrational reaction to those things which may help expand our individual consciousness; they potentially threaten to undermine those in power. As as we all know, those in power are typically willing to hang onto it at all costs.

What Psychedelics Offer

One of my favorite quotes on psychedelics comes from both Terence McKenna and Dennis McKenna. Both feel that

For that reason alone, I will not give up the fight, and will continue to only get louder as time progresses.

If you want a more detailed discussion on the mechanism of psychedelics, read my "**Entheogens: More Than Chemical Reactions**" article.

- Keith Cleversley

References

1. Chevlen, Eric (2001). "A Bad Prescription from the DEA," The Weekly Standard, 6:36:16-20.
2. Huxley, Aldous. 2009. The Doors of Perception. Harper Perennial Modern Classics.
3. Setter, Stephen M. (1999). "Tailored Intervention Promoting Safe NSAID Use in Elders," U.S. Department of Health and Human Services Grant Application (funded, Stephen M. Setter Principal Investigator), 20-21, 31.
4. National Center for Chronic Disease Prevention and Health Promotion, Comparative Cause of Annual Deaths - United States (www.cdc.gov/tobacco/research_data/health_consequences/andths.htm), last accessed December 23, 2001.

Molecular Mysticism

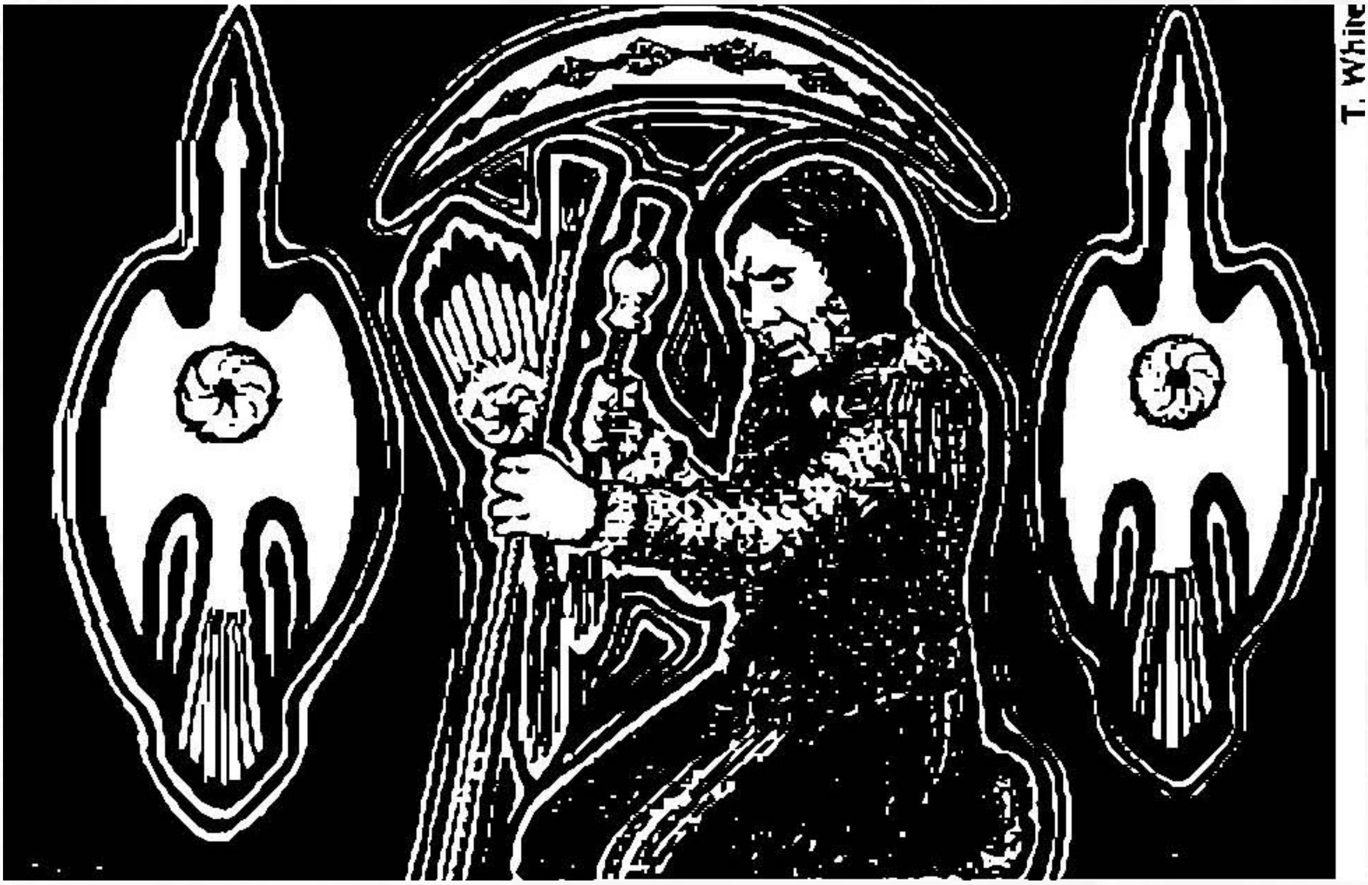
The Role of Psychoactive Substances in the Transformation of Consciousness

by

Ralph Metzner

An essay appearing in The Gateway to Inner Space, Christian Rätsch, editor. Published by Prism Press, Dorset, U.K., 1989.

original source: http://www.maps.org/research-archive/hmma/MetznerSpring88.pdf
backup source: http://www.psilosophy.info/resources/MetznerSpring88.pdf

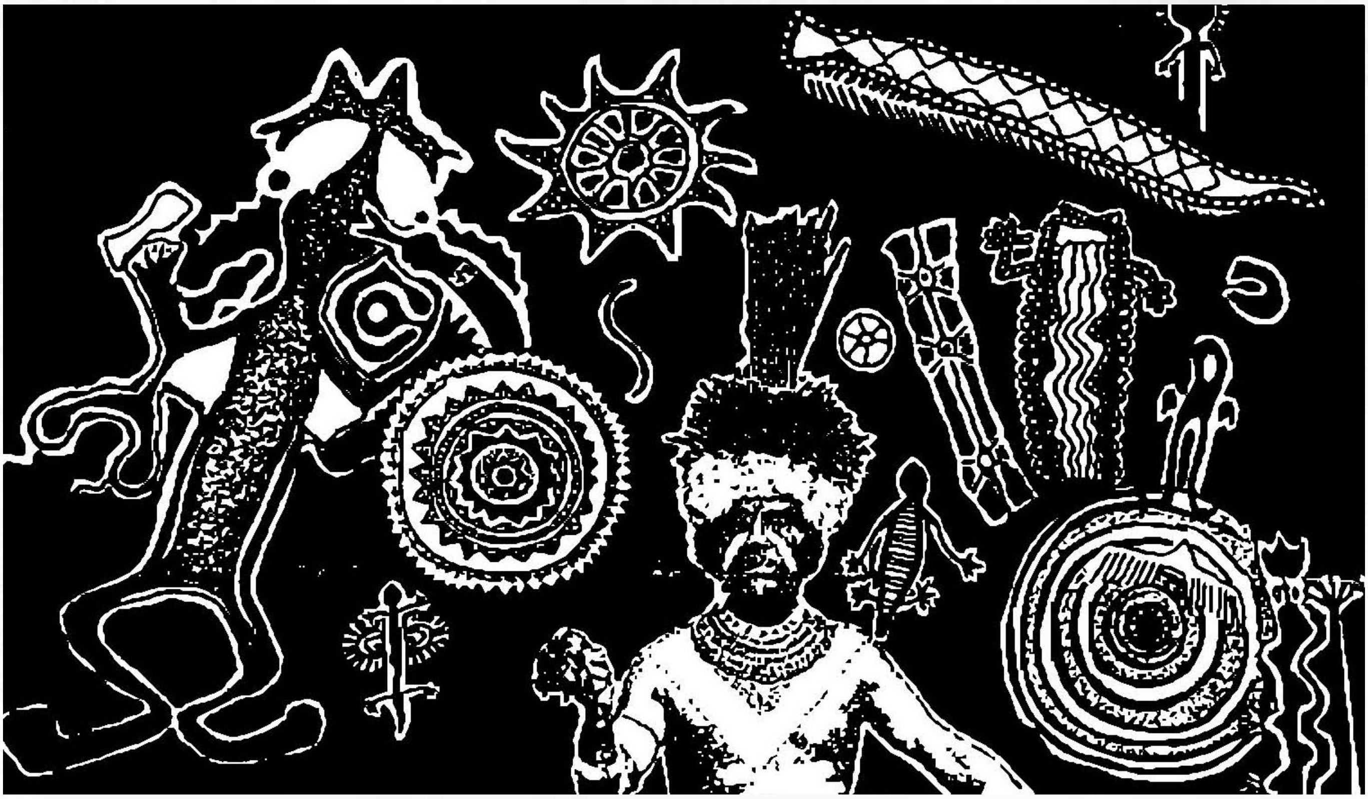


Peyote is a ceremonial sacrament of the Native American Church used for prayer and direct communion with the Spirit world.

There is a question that has troubled me, and no doubt others, since the heyday of psychedelic research in the 1960s, when many groups and individuals were concerned with the problems of assimilating new and powerful mind-altering substances into Western society. The question, simply stated, was this: why did the American Indians succeed in integrating the use of peyote into their culture, including its legal use as a sacrament to this day, when those interested in pursuing consciousness research with drugs in the dominant white culture succeeded only in having the entire field made taboo to research, and any use of the substances a criminal offense punishable by imprisonment? The use of peyote spread from Mexico to the North American Indian tribes in the latter half of the nineteenth century, and has found acceptance as a sacrament in the ceremonies of the *Native American Church*. It is recognized as one kind of religious ritual that some of the tribes practice; as well as being acknowledged by sociologists for its role as an antidote for alcohol abuse.

This intriguing puzzle in ethnopsychology and history was personally relevant to me, since I was one of the psychedelic researchers who saw the enormous transformative potentials of "consciousness expanding" drugs, as we called them, and were eager to continue the research into their psychological significance. It would be fair to state that none of the early explorers in this field, in the 1950s and early 1960s, had any inkling of the social turmoil that was to come, nor the vehemence of the legal-political reaction. Certainly Dr. Albert Hofmann, that epitome of the cautious, conservative scientist, has testified to his dismay and concern over the proliferation of patterns of abuse of what he so poignantly called his "problem child" *(Sorgenkind)*. Thus resulted the strange paradox that substances regarded as a social evil and a law-enforcement problem in the mainstream dominant culture are the sacrament of one particular sub-culture within that larger society. Since the Native American sub-culture is a much older and ecologically more sophisticated culture than the European white culture which attempted to absorb or eliminate it, and since many sensitive individuals have long argued that we should be learning from the Indians, not exterminating them, the examination of the question posed above could lead to some highly interesting conclusions.

The answer to the ethnopsychological puzzle became clear to me only after I started observing and participating in a number of other American Indian ceremonies, such as the healing circle, the sweat lodge, or the spirit dance, that did not involve the use of peyote. I noted what many ethnologists have reported: that these ceremonies were simultaneously religious, medicinal, and psychotherapeutic. The sweat lodge, like the peyote ritual, is regarded as a sacred ceremony, as a form of worship of the Creator; they are also both seen and practiced as a form of physical healing, and they are performed for solving personal and collective psychological problems. Thus, it was natural for those tribes that took up peyote to add this medium to the others they were already familiar with, as a ceremony that expressed and reinforced the integration of body, mind, and spirit. In the dominant white society, by contrast, medicine, psychology, and religious spirituality are separated by seemingly insurmountable paradigm differences. The medical, psychological, and religious professions and established groups, each separately, considered the phenomenon of psychedelic drugs and were frightened by the unpredictable transformations of perception and world-view that they seemed to trigger.

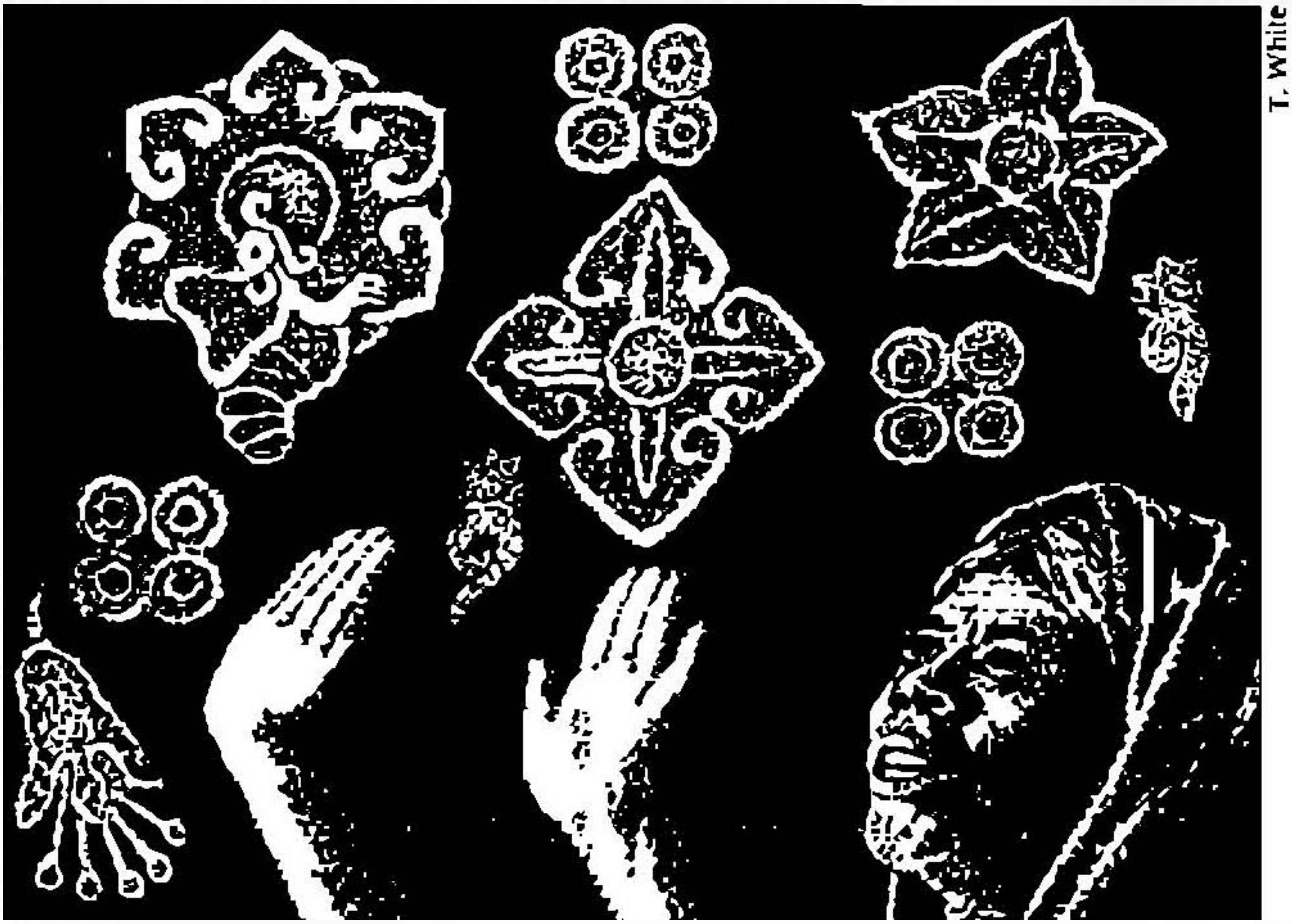


Datura has been used shamanically by several California tribes, and may have inspired some Chumash rock-art images.

Thus, the dominant society's reaction was fear, followed by prohibition, even of further research. None of the three established professions wanted these consciousness-expanding instruments; and neither did they want anyone else to have them of their own free choice The implicit assumption is that people are too ignorant and gullible to be able to make reasoned, informed choices as to how to treat their illnesses, solve their psychological problems, or practice their religion. Thus, the fragmented condition of our whole society is mirrored back to us through these reactions. For the Native Americans, on the other hand, healing, worship, and problem-solving are all subsumed in the one way, which is the way of the Great Spirit, the way of the Earthmother, the traditional way. The integrative understanding given in the peyote visions is not feared, but accepted and respected. Here, the implicit assumption is that everyone has the capability, indeed the task, to attune themselves to higher spiritual sources of knowledge and healing, and the purpose of ceremony, with or without medicinal substances, is regarded as a facilitating of such attunement.

Psychedelics as Sacrament or Recreation

Several observers, for example Andrew Weil (1985), have pointed out the historical pattern that as Western colonial society adopted psychoactive plant or food substances from native cultures (most of which are now regarded as belonging to the Third World), the pattern of use of such psychoactive materials devolved from sacramental to recreational. Tobacco was regarded as a sacred, or power plant, by Indians of North, Central, and South America (Robicsek 1978); it is still so regarded by Native Americans, even though in the white Western culture and in countries influenced by this dominant culture, cigarette smoking is obviously recreational, and has even become a major public health problem. The coca plant, as grown and used by the Andean Indian tribes, was treated as a divinity - Mama Coca - and valued for its health-maintaining properties; cocaine, on the other hand, is purely a recreational drug and its indiscriminate use as such also causes numerous health problems. In this and other instances desacralization of the plant-drug has been accompanied by criminalization. Coffee is another example: apparently first discovered and used by Islamic Sufis who valued its stimulant properties for long nights of prayer and meditation, it became a fashionable recreational drink in European society in the seventeenth century, and was even banned for a while as being too dangerous (cf. Emboden 1972; Weil & Rosen 1983). Even cannabis, the epitome of the recreational "high", is used by some sects of Hindu Tantrism as an amplifier of visualization and meditation.



The shamanic use of psychedelic mushrooms by Mesoamerican curranderos (healers) has been documented extensively by R. Gordon Wasson and others.

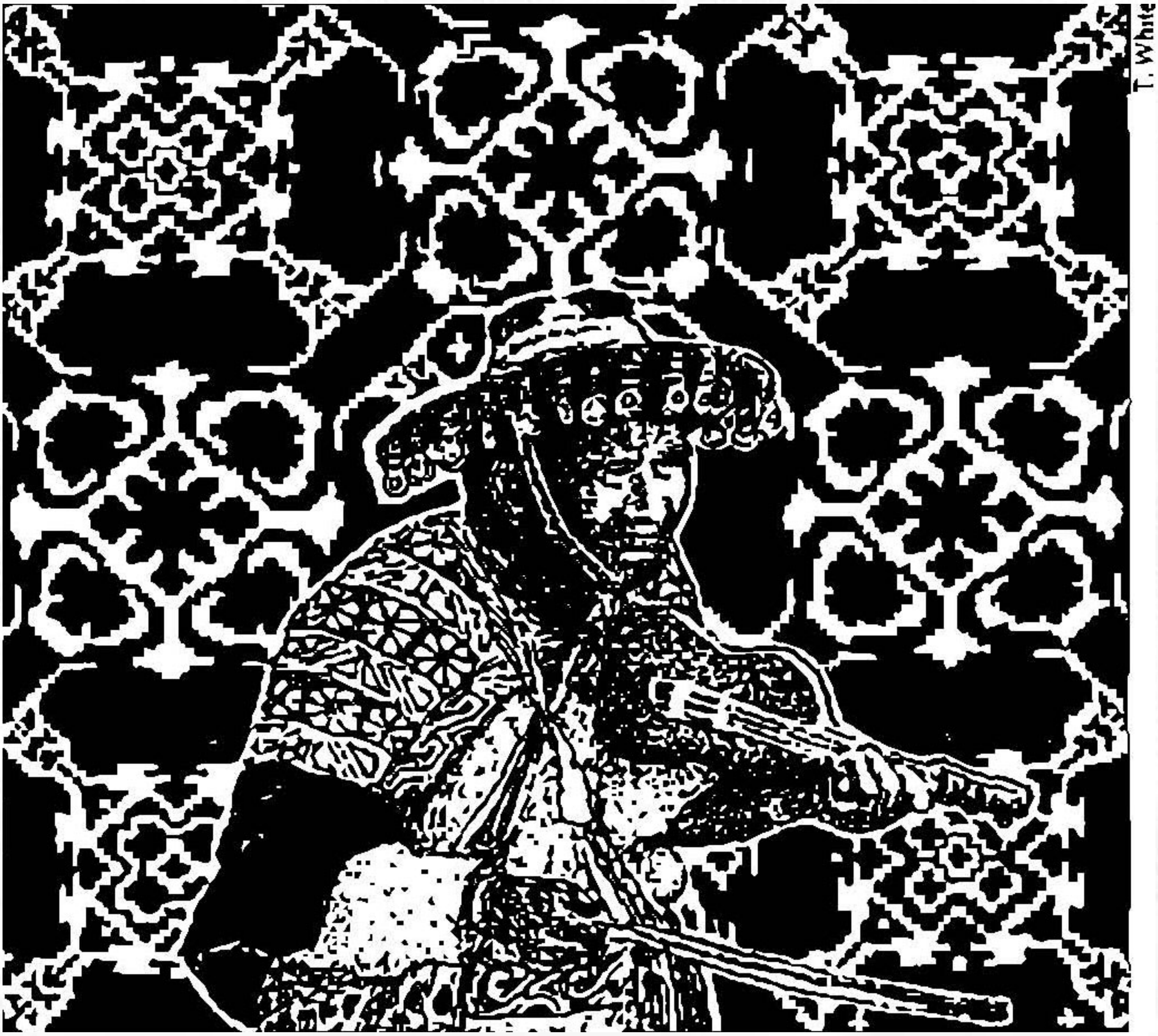
Since originally sacramental healing plants were so rapidly and completely desacralized upon being adopted by the West's increasingly materialistic culture, it should not be surprising that newly discovered synthetic psychoactive drugs have generally been very quickly categorized as either recreational, or "narcotic", or both. Concomitantly, as the indiscriminate, excessive, non-sacramental use of psychoactive plants and newly synthesized analogues spread, so did patterns of abuse and dependence; predictably, established society reacted with prohibitions, which in turn led to organized crime activities. This in spite of the fact that many of the original discoverers of the new synthetic psychedelics, people such as Albert Hofmann and Alexander Shulgin, are individuals of deep spiritual integrity. Neither they, nor the efforts of philosophers such as Aldous Huxley and psychologists such as Timothy Leary to advocate a sacred and respectful attitude towards these substances, were able to prevent the same profanation from taking place.

The newly discovered phenethylamine psychedelic MDMA provides an instructive example of this phenomenon. Two patterns of use seem to have become established during the seventies: some psychotherapists and spiritually inclined individuals began to explore its possible applications as a therapeutic adjuvant and as an amplifier of spiritual practice; another, much larger group of individuals began using it for recreational purposes, as a social "high" comparable in some respects to cocaine. The irresponsible and widespread use in this second category, by increasing numbers of people, understandably made the medical and law-enforcement authorities nervous, and the predictable reaction occurred: MDMA was classified as a Schedule I drug in the United States, which puts it in the same group as heroin, cannabis, and LSD, making it a criminal offense to make, use, or sell, and sending a clearly understood off-limits signal to pharmaceutical and medical researchers.

When Hofmann returned to the Mazatec shamaness Maria Sabina with synthetic psilocybin in order to obtain her assessment of how close the synthesized ingredient was to the natural product, he was following the appropriate path of acknowledging the primacy of the botanical over the synthetic. The argument could be made, and has been made, that perhaps for every one of the important synthetic psychedelics, there is some natural plant that has the same ingredients and that this plant is our connection to the larger lost knowledge of indigenous cultures. Perhaps it should be our research strategy - to find the botanical host for the psychedelics emerging from the laboratory. In the case of LSD, research on the use of morning glory seeds in ancient Mexico and baby woodrose in Hawaii, each of which contain LSD analogues, would allow us to discover a shamanic complex involving this molecule. If Wasson, Hofmann, and Ruck are correct in their proposal that an LSD-like ergot-derived beverage was used as the initiatory sacrament in Eleusis, the implications are profound (Wasson et al 1978). Using Rupert Sheldrake's theory of morphogenetic fields, one could suppose that by re-growing or re-hybridizing this particular plant, we could tune in to and re-activate the morphogenetic field of the Eleusinian mysteries, the ancient world's most awe-inspiring mystical ritual.

There is no inherent reason why sacramental use and recreational use of a substance, in moderation, could not co-exist. In fact, among Native Americans, tobacco often does play this dual role: after a sacred pipe ritual with tobacco or other herbs, participants may smoke cigarettes to relax. We know the sacramental use of wine in the Catholic communion rite; and we certainly know the recreational use of wine. We are able to keep the two contexts separate, and we are also able to recognize when recreational use becomes dependence and abuse. One could envision similar sophistication developing with regard to psychoactive plant products. There could be recognized sacramental and therapeutic applications; and certain patterns of use might develop that were more playful, exploratory, hedonistic and yet could be contained within a reasonable and acceptable social framework that minimizes harm.

The "abuse" of a drug, in such a relatively enlightened system, would not be a function of who uses it, or where it originated, or whether doctors or other authorities condone it, but rather of the behavioral consequences in the drug user. One becomes recognized as an alcoholic, i.e., an abuser of alcohol, when their interpersonal and social relationships are noticeably impaired. There should be no difficulty in establishing similar abuse criteria for other psychoactive drugs.



The ceremonial use of peyote is at the heart of the shamanic rituals, art and life of the Huichol Indians of the Mexican Sierra Madres.

Psychedelics as Gnostic Catalysts

In 1968, in a paper "On the Evolutionary Significance of Psychedelics" published in *Main Currents of Modern Thought*, I suggested that the findings of LSD research in the areas of psychology, religion, and the arts could be looked at in the context of the evolution of consciousness:

> If LSD expands consciousness and if, as is widely believed, further evolution will take the form of an increase in consciousness, then can we not regard LSD as a possible evolutionary instrument?... Here is a device which, by altering the chemical composition of the cerebro-sensory information processing medium, temporarily inactivates the screening-programs, the genetic and cultural filters, which dominate in a completely unnoticed way our usual perceptions of the world.

From the perspective of almost twenty years reflection, I now propose to extend and amplify this statement in two ways: (1) the evolution of consciousness is a transformation process that consists primarily in gaining insight and understanding, or *gnosis;* and (2) the acceleration of this process by molecular catalysts is not only a consequence of new technologies, but is also an integral component of traditional systems of transformation, including shamanism, alchemy, and yoga.

In psychedelic research, the "set-and-setting hypothesis", which was first formulated by Timothy Leary in the early 1960s, has become accepted by most workers in the field. The theory states that the content of a psychedelic experience is a function of the set (intention, attitude, personality, mood) and the setting (interpersonal, social, and environmental) and that the drug functions as a kind of trigger, or catalyst, or non-specific amplifier or sensitizer. The hypothesis can be applied to the understanding of any altered state of consciousness when we recognize that other kinds of stimuli can be triggers, for example, hypnotic induction, meditation technique, *mantra,* sound or music, breathing, sensory isolation, movement, sex, natural landscapes, a near-death experience, and the like. Generalizing the set-and-setting hypothesis in this way helps us to understand psychoactive drugs as one class of triggers within a whole range of possible catalysts of altered states (Tart 1972; Zinberg 1977).

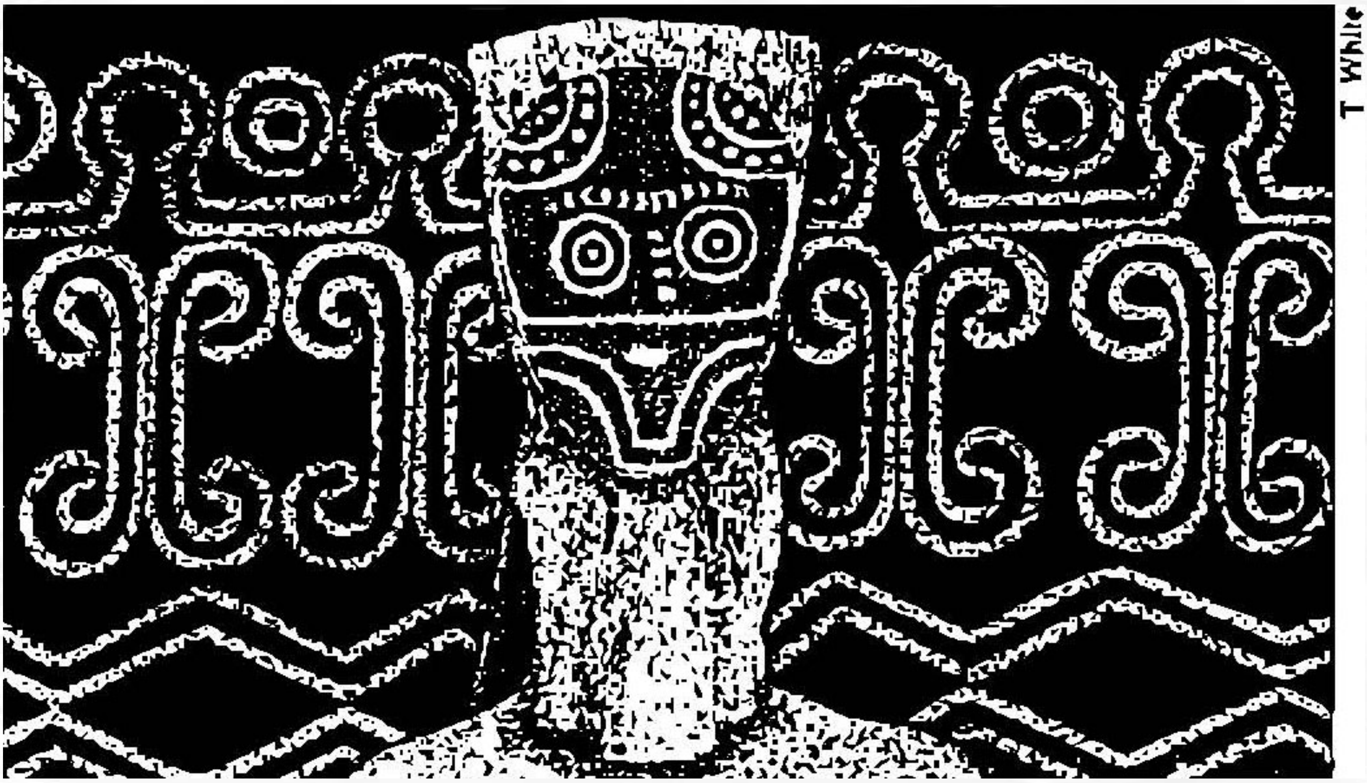
An important clarification results from keeping in mind the distinction between a state (of consciousness) and a psychological trait; between state changes and trait changes. For example, psychologists distinguish between state-anxiety and trait-anxiety. William James, in his *Varieties of Religious Experience* (1961), discussed this question in terms of whether a religious or conversion experience would necessarily lead to more "saintliness", more enlightened traits. This distinction is crucial to the assessment of the value or significance of drug-induced altered states. Only by attending to both the state-changes (visions, insights, feeling) and the long-term consequences, or behavioral or trait changes, can a comprehensive understanding of these phenomena be attained.

Timothy Leary, an earlly champion of LSD, emphasized that the content of a psychedelic experience is influenced by the setting (social, environmental, etc.) and the mind-set (intention, personality, mood, etc.) under which it is taken.

Having an insight is not the same as being able to apply that insight. There is no inherent connection between a mystical experience of oneness and the expression or manifestation of that oneness in the affairs of everyday life. This point is perhaps obvious, yet it is frequently overlooked by those who argue that, on principle, a drug could not induce a genuine mystical experience or play any role in spiritual life. The internal factors of "set", including preparation, expectation, and intention, are the determinants of whether a given experience is authentically religious; and equally, intention is crucial to the question of whether an altered state results in any lasting personality changes. Intention is like a kind of bridge from the ordinary or consensus reality state to the state of heightened consciousness; and it can also provide a bridge from that heightened state back to ordinary reality.

This model allows us to understand why the same drug(s) could be claimed by some to lead to nirvana or religious vision, and in others (for example, someone like Charles Manson) could lead to the most perverse and sadistic violence. The drug is only a tool, a catalyst, to attain certain altered states; which altered states being dependent on the intention. Rather, even where the drug-induced state is benign and expansive, whether or not it leads to long-lasting positive changes is also a matter of intention or mind-set.

The drug indeed seems to reveal or release something that is in the person; which is the factor implied in the term "psychedelic" - mind manifesting. In my opinion, the term "entheogen" is an unfortunate choice because it suggests the god within, the divine principle, is somehow "generated" in these states. My experiences have led me to the opposite conclusion: the god within is the generator, the source of life energy, the awakening and healing power. For someone whose conscious intention is a psychospiritual transformation, the psychedelic *can* be a catalyst that reveals and releases insight or knowledge from higher aspects of our being. This is, I believe, what is meant by *gnosis* - sacred knowledge or insight concerning the fundamental spiritual realities of the universe in general and one's individual destiny in particular.



The shamanic use of ayahuasca and other psychoactive plants by some Amazonian tribes has been documented extensively by anthropologists.

The potential of psychedelic drugs to act as catalysts to a transformation into *gnosis*, or direct, ongoing awareness of divine reality, even if only in a small number of people, would seem to be of the utmost significance. Traditionally, the number of individuals who have had mystical experiences has been very small; the number of those who have been able to make practical applications of such experiences has probably been even smaller. Thus, the discovery of psychedelics, in facilitating such experiences and processes, could be regarded as one very important factor in a general spiritual awakening of collective human consciousness. Other factors that could be mentioned in this connection are the revolutionary paradigm shifts in the physical and biological sciences, the burgeoning of interest in Eastern philosophies and spiritual disciplines, and the growing awareness of the multi-cultural oneness of the human family brought about by the global communications networks.

Psychedelics in Traditional Systems of Transformation

In my earlier writings, I emphasized the newness of psychedelic drugs, the unimaginable potentials to be realized by their constructive application; and I thought of them as first products of a new technology oriented towards the human spirit. While I still believe that these potentials exist, and that synthetic psychedelics have a role to play in consciousness research and perhaps consciousness evolution, my views have changed under the influence of the discoveries and writings of cultural anthropologists and ethnobotanists, who have pointed to the role of mind-altering and visionary botanicals in cultures across the world.

One cannot read the works of R. Gordon Wasson on the Mesoamerican mushroom cults (1980), or the work of Richard E. Schultes and Albert Hofmann (1979) on the profusion of hallucinogens in the Americas, or the cross-cultural work of such authors as Michael Harner (1973), Joan Halifax (1982), Peter Furst (1976), and Marlene Dobkin de Rios (1984), or the cross-culturally oriented medical and psychiatric researchers such as Andrew Weil (1980), Claudio Naranjo (1973), and Stanislav Grof (1985), or more personal accounts such as the writings of Carlos Castaneda, or Florinda Donner (1982), or the McKenna brothers (1975), or Bruce Lamb's biography of Manuel Cordova (1971), without getting a strong sense of the pervasiveness of the quest for visions, insights, and nonordinary states of consciousness; and, further, the sense that psychoactive plants are used in many, but by no means all, of the shamanic cultures that pursue such states. Thus, I have been led to a view closer to that of aboriginal cultures, a view of humanity in a relationship of co-consciousness, communication and cooperation with the animal kingdom, the plant kingdom, and the mineral world. In such a world-view, the ingestion of hallucinogenic plant preparations in order to obtain knowledge for healing, for prophecy, for communication with spirits, for anticipation of danger, or for understanding the universe, appears as one of the oldest and most highly treasured traditions.

The various shamanic cultures all over the world know a wide variety of means for entering non-ordinary realities. Michael Harner (1980) has pointed out that "auditory driving" with prolonged drumming is perhaps as equally widespread a technology for entering shamanic states as hallucinogens. In some cultures, the rhythmic hyperventilation produced through certain kinds of chanting may be another form of altered state trigger. Animal spirits become guides and allies in shamanic initiation. Plant spirits can become "helpers" also even when the plant is not taken internally by either doctor or patient. Tobacco smoke is used as a purifier, as well as a support to prayer. Crystals are used to focus energy for seeing and healing. There is attunement, through prayer and meditation, with deities and spirits of the land, the four directions, the elements, the Creator Spirit. Through many different means, there is the seeking of knowledge from other states, other worlds, knowledge that is used to improve the way we live in this world (through healing, problem-solving, etc.). The use of hallucinogenic plants, when it occurs, is part of an integrated complex of interrelationships between Nature, Spirit, and human consciousness.

Thus, it seems to me that the lessons we are to learn from these consciousness-expanding plants and drugs have to do not only with the recognition of other dimensions of the human psyche, but with a radically different world-view; a world-view that has been maintained in the beliefs, practices, and rituals of shamanic cultures, and almost totally forgotten or suppressed by twentieth century materialistic culture. There is of course a certain delightful irony in the fact that it has taken a material substance to awaken the sleeping consciousness of so many of our contemporaries to the reality of non-material energies, forms, and spirits.

In discussing alchemy as the second of the three traditional systems of consciousness transformation mentioned above, I would like to emphasize first that we have only the minutest shreds of evidence that ingestion of hallucinogens played any part in the European alchemical tradition. The use of solanaceous hallucinogens in European witchcraft, which is related to both shamanism and alchemy, has been documented by Harner (1973:125-130). Likewise, in Chinese Taoist alchemy, the use of botanical and mineral preparations to induce spirit-flight and other kinds of altered states has been discussed by Strickmann (1979). A complete account of the role of hallucinogens in alchemy has not as yet been written. Possibly our ignorance in this field is still a consequence of intentional secrecy on the part of the alchemical writers.

Mircea Eliade, in his book *The Forge and the Crucible* (1962), made a strong case for the historical derivation of alchemy from early Bronze Age and Iron Age metallurgy, mining, and smithing rites and practices. One could argue that alchemy is one form of shamanism: the shamanism of those who worked with minerals and metals, the makers of tools and weapons. Many of the concerns and interests of the alchemists parallel shamanic themes. There is the strong interest in purification and healing, in discovering or making a "tincture" or "elixir" that will give health and longevity. There are visions and encounters with animal spirits, some clearly from the imaginal realms. There are stories and visions of divine or semi-divine figures often personified as the deities of classical mythology. There is the recognition of the sacredness, the animating spirit, of all matter. And there is the integrated world-view, which sees spirituality, religion, health and illness, human beings, the natural world and its elements, all interrelated in a totality.

It might be objected that there does not seem to be the equivalent of a shamanic journey in alchemy; no clear indication of an altered state of consciousness in which visions, or power, or healing abilities are attained. It appears to me that the alchemical equivalent of the shamanic journey is the opus, the work, the experiment with its various operations, such as *solutio, sublimatio, martificatio*, and the like. The focus is more on the long-term personality and physical changes that the alchemical initiate has to undergo, just as the shaman in training does. The experiments in alchemy were regarded as meditative rituals, during which visions might be seen in the retort or furnace, and interior psychophysiological state changes triggered by the observation of chemical processes.

Furthermore, in an interesting recent work, R.J. Stewart (1985) has argued that in the Western tradition of magic and alchemy, which has roots in pre-Christian Celtic mythology and beliefs, and of which traces can still be found in folklore ballads, popular songs, and nursery rhymes, the central transformative experience was an underworld journey. This underworld or otherworld initiation involved taking a "journey" into other realms, encounters with animal and spirit beings, attunement with the land and the ancestors, meditative rituals centering around the tree of life symbolism, and other features that place this tradition clearly into the ancient stream of shamanic lore found in all parts of the globe.

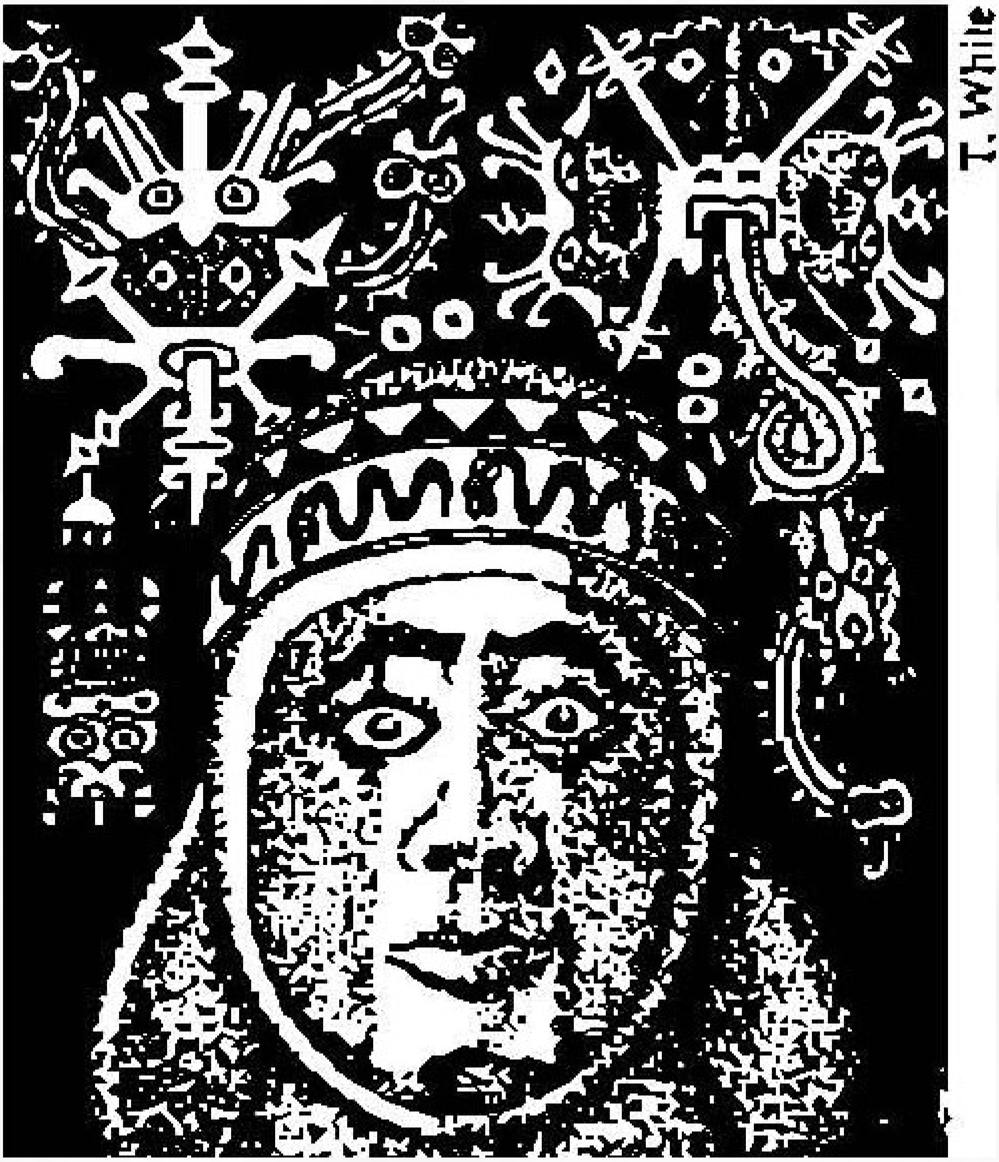
Turning now to yoga as the third of the traditional systems of evolutionary transformation of consciousness, we need not concern ourselves with the question of whether the use of visionary botanicals is a decadent or debased form of yoga, as Eliade (1958) seems to believe; or whether the use of hallucinogens was primary, in the Vedic-Indian tradition as the Soma cult, as Wasson (1968) has proposed. Sometimes, with the latter view, the corollary is proposed that yoga methods were developed when the drug was no longer available as an alternative means for attaining similar states. Suffice it to say that in the Indian yoga traditions, in particular the teachings of Tantra, we have a system of practices for bringing about a transformation of consciousness with many parallels to shamanic and alchemical ideas.

The use of hallucinogens as an adjunct to yoga practices is known to this day in India, among certain Shivaite sects in particular (Aldrich 1977). Those schools and sects that do not use drugs tend to regard those that do as decadent, as belonging to the so-called left-hand path of Tantra, which also incorporates ritual food and sexuality (*maithuna*) as valid aspects of the yogic path. Under the influence of nineteenth century Western occult and theosophical ideas, this left-hand path tended to be equated with "black magic", or "sorcery". In actuality, the designation left-hand path derives from the yogic principle that the left side of the body is the feminine, receptive side; and thus, the left-hand path is the path of those who worship the Goddess (*Shakti*), as the Tantrics do, and incorporate the body, the delight of the senses, nourishment, and sexuality into their yoga. Thus, as in shamanism and alchemy, we find here a strand of the tradition that involves respect and devotion to the feminine principle, the mother goddess, the earth and its fruit, the flesh and blood body, and the seeking of ecstatic visionary states.

It is true that the Indian yoga traditions seem not to have the same concern for the natural world of animals, crystals, and plants as is found in shamanism and alchemy. The emphasis is more on various inner and subtle states of consciousness. Nevertheless, there are interesting parallels between the three traditions. The focusing of inner light-fire energy in different centers and organs of the body, as practiced in Agni Yoga and Kundalini Yoga, is similar to the alchemical practice of purification by fire, and to shamanic notions of filling the body with light (Metzner 1971, 1986). The Indian alchemical tantric tradition had the concept of rasa, which is akin to the European alchemical concept of "tincture" or "elixir". *Rasa* has internal meanings-feeling, mood, "soul", and external referents-essence, juice, liquid. *Rasayano* was the path or way of rasa, the way of fluid energy-flow, that involves both external and internal essences[1]. As a third parallel, I will only mention the Tibetan Buddhist *Vajrayana* system, which is a remarkable fusion of Tantric Buddhist ideas with the Tibetans' original Bon shamanism: a system in which the various animal spirits and demons of the shamans and sorcerers have become transformed into personifications of Buddhist principles and guardians of the dharma (Govinda 1960).

Conclusions

It appears incontrovertible that hallucinogens played some role, of unknown extent, in the transformative traditions of shamanism, alchemy, and yoga. If we regard psychotherapy as the modern descendant of these traditional systems, then a similar, if limited, application of hallucinogens could be made in various aspects of psychotherapy. And this has in fact already occurred, as the various studies of psychedelics in alcoholism, terminal cancer, obsessional neurosis, depression, and other conditions testify (Grof 1985; Grinspoon & Bakalar 1979). It seems likely that these kinds of applications of psychedelics as adjuncts to psychotherapy will continue, if not with LSD and other Schedule I drugs, then with other, newer, perhaps safer psychedelics.



Archeological evidence suggests the use of psychedelics in ancient Peru.

What appears unlikely to me is that this kind of controlled psychiatric application will ever be enough to satisfy the inclinations and needs of those individuals who wish to explore psychedelics in their most ancient role, as tools for seeking visionary states and hidden forms of knowledge. The fact that the serious use of hallucinogens outside of the psychiatric framework continues despite severe social and legal sanctions suggests that this is a kind of individual freedom that will not be easy to abolish. It also suggests that there is a strong need, in certain people, to re-establish their connections with ancient traditions of knowledge in which visionary states of consciousness and exploration of other realities, with or without hallucinogens, were the central concern.

It may be that such a path will always be pursued by only a very limited number of individuals; much as the shamanic, alchemical, and yogic initiations and practices were pursued by only a few individuals in each society. I find it a hopeful sign that some, however few, are willing to explore how to reconnect with these lost sources of knowledge, because, like many others, I feel that our materialist-technological society, with its fragmented world-view, has largely lost its way, and can ill afford to ignore any potential aids to greater knowledge of the human mind. The ecologically balanced and humanistically integrated framework of understanding that the ancient traditions preserved surely has much to offer us.

Furthermore, it is very clear that the visions and insights of the individuals who pursue these paths are visions and insights for the present and the future, not just of historical or anthropological interest. This has always been the pattern: the individual seeks a vision to understand his or her place, or destiny, as a member of the community. The knowledge derived from altered states has been, can be, and needs to be applied to the solution of the staggering problems that confront our species. This is why the discoveries of Albert Hofmann have immense importance-for the understanding of our past, the awareness of our presence, and the safeguarding of our future. For, in the words of The Bible: "where there is no vision, the people perish."

Footnote

[1] We may say that the physico-chemical processes of the rasayana serve as the vehicle for psychic and spiritual operations. The elixir obtained by alchemy corresponds to the 'immortality' pursued by tantric yoga (Eliade 1958 283).

Psychedelic Yoga

by

Sri Brahmarishi Narad

The Application of Yoga Meditation Techniques to the Use of Psychedelic Sacraments

original source: http://deoxy.org/psychedelicyoga.htm

The fact that psychedelic drugs induce a greater sensitivity to subtle spiritual and psychic energies, and speed up the influx of impressions from deeper levels of consciousness, raises the immediate question of how these energies can be properly understood and handled. Obviously, if these energies are not guided, they can do more harm than good. The application of traditional Yoga meditation techniques while under psychedelic experiences, provides a constructive solution to this problem.

According to Yoga philosophy, the most spiritual and powerful aspect of man's nature is the faculty of attention or consciousness. The most fundamental aspect of man's free will is the choice as to what he allows his attention to dwell upon. The attention always has to be on something, but we can choose what we allow it to dwell upon. The goal of all Yoga practices is to discover and directly experience what the attention or faculty of consciousness in man is. The yogi seeks to know that principle by which all else is known. This goal is achieved by observing the observer or placing the attention on the attention itself. This may at first seem very abstract and hard to grasp in terms of practical application, but there are workable, time-proven methods for achieving this state of pure consciousness which when consistently applied and practiced are bound to yield results.

It should be constantly remembered during a psychedelic session that whatever perceptions, thoughts and even hallucinations occur, they are all the creations of one's own mind and consciousness, and are filtered through one's own instrument of perception. These perceptions are patternings of our own psychic energy. We give energy to whatever thoughts and feelings we allow the attention to dwell upon. Wherever the power of attention is focused, it generates mental and emotional energy in the form of its own lower overtones, thus feeding and energizing the thoughts and emotions which the attention dwells upon. It becomes clear that the key to remaining in control of a psychedelic experience is in controlling the flow of attention. Distractive experiences can be avoided in the first place, and the flow of attention can be properly directed by the use of Raja Yoga techniques of meditation. The following is a description of several such techniques which can all be applied while under the influence of LSD, marijuana, mescaline, DMT, hashish, psilocybin or other consciousness-expanding drugs. At this point, let us consider a basic rule to apply in case of paranoia or other unpleasant or frightening experiences while under the influence of a psychedelic drug. Realize that whatever you may be thinking, feeling or experiencing is being experienced by the consciousness within you. Then place your undivided attention on that consciousness which is experiencing whatever is happening to you. This process returns your consciousness to its own pure nature and disengages mental and astral thought forms. These destructive thought forms then dissipate and are dissolved back into the homogeneous, vibrational energy of the plane of energy substance from which they were originally molded. The strong light released by consciousness observing itself, helps to quickly dissolve and dissipate destructive thought forms. This happens because the strong lower overtones of pure consciousness which are generated, cancel out the discordant, out of phase vibrations of destructive thought forms.

If the attention wanders while practicing any of these meditation techniques, immediately bring the attention back to the process of meditation, and do this as many times as is necessary until the attention remains centered on the particular form of meditation which you are practicing. Inexperienced meditators have a tendency to fight distractions, which in itself, becomes a distraction. The attention can only dwell on one thing at a time. Simply bring it back to the thing you are meditating on. Another way of stopping distractions is simply to temporarily suspend the breathing process by neither breathing in or out. Since breathing is intimately tied to every biological process in the body, the instinct to survive (developed over billions of years of evolution) will interrupt the flow of attention into distractions and bring it to center on the awareness of the cessation of breathing. It is then an easy matter to resume normal breathing and to center the attention on the particular form of meditation being practiced.

Sound Current Meditation

Focus your full, undivided attention in the center of your brain where the pineal gland is located. Listen with your attention for whatever sounds present themselves. After awhile, you will hear sounds of various tones and pitches. At first, you may only hear the low hiss of random molecular noise in the ears, but in time, definite tones will present themselves like sustained notes on an organ. This sound is perceived directly by the brain and the subtle bodies themselves, and not through the outer physical organs of the ears. It is the sound of the vibration of conscious energy as it flows through the physical body and as it vibrates and circulates within the subtle bodies. You should focus your entire undivided attention on the sound of highest pitch that you can hear, and let it draw you up into higher and higher states of consciousness; also let the sound reveal and intensify the spiritual light. The better your concentration is, the louder and more distinct the sound will become. Experience the vibration of this sound expanding until it includes your whole head, your whole body, and ever-expanding volumes of space surrounding you. By this means, you will tune into the music of the spheres, and your whole being will become a receiver and transmitter of the harmonious rhythm of the universe. When you open your eyes after such a meditation, you may find your surroundings filled with blazing light. In the beginning, the sound current may appear in one localized part of the head; most likely in one of the ears. You should not listen to the sound current in the left ear because this is psychically harmful. Listen to it in the right ear, and gradually try to move it to the center and top of the brain. From this vertex center, known as the Sahasraram Chakra (whose associated gland is the pineal body), allow the vibration of the sound current to fill the entire head and to then expand beyond the head into the surrounding space. This is one of the classical methods and can lead to the highest type of experience.

Meditation on the Light in the Head

To practice this form of meditation, close your eyes, and observe your inner field of vision by focusing the attention at the point in the center of the forehead, just slightly above the point between the eyebrows. This location is called the Third Eye Center or Agna Chakra. It is related to the faculty of clairvoyant vision. The physical manifestation or anchorage point for the Agna Chakra is the pituitary gland, which is located in a bony cradle in back of the root of the nose. When you close your eyes, look steadily into your inner field of vision until light, color and patterns begin to appear. (This is looking with your attention and not with the physical eyes which should remain relaxed.) When most people close their eyes, initially they see a black void, but by looking steadily into this void, various colors and patterns will begin to appear. When this happens, simply observe them with your full, undivided attention as if you were intently watching a movie. Then periodically focus all of your attention within the smallest point that you can see in the center of your field of vision, and pierce through that point. After you have done this, the light will again blaze forth from the point in a new burst of energy, and you will find yourself at a higher rate of vibration or plane of energy. With continued practice of this form of meditation, you will become immersed in a blazing sea of light; and you will become a center from which that spiritual power is radiated.

By concentrating the attention in the Sahasraram Chakra or Thousand-Petalled Lotus, located at the top of the head, an experienced meditator can release an even more powerful radiation of light and spiritual energy. (It may take more work to activate this chakra; the beginner can get more immediate results by looking through the Agna Chakra or Third Eye Center.) The Sahasraram Wheel is the highest chakra; called the "Doorway to the Infinite" and the Brahmarandra or Hole of Brahma, it is the most powerful and spiritual of all the centers that can be awakened in man (with the possible exception of the Heart Chakra which is considered by some yogis to be of equal importance). When the Sahasraram Chakra is fully activated in a perfected yogin or saint, the white fire of Cosmic Kundalini descends upon him and blends with his own rising kundalini force, and the white light of spirituality radiates for miles around.

Meditation on the Chakras

By focusing the attention on various locations within the body, where the chakras are located, it is possible to activate these chakras and facilitate an increased flow of energy between the higher planes of energy and the subtle body, thus releasing an increased amount of spiritual energy. There are seven major chakras in the body which link together the physical body and the subtle energy bodies. The chakras are revolving vortexes of energy which act as mechanisms for the absorption and radiation of spiritual energy. In the physical body, they relate to glands and major nerve centers. In the etheric body, they are like wheels with flower petals which are created by a sort of stroboscopic effect of the revolving energy. The etheric chakra flowers are connected by a sort of funnel-like stem to the gland or nerve plexus to which they belong. In the astral body, the chakras appear as whirlpools of energy, like the eddies in a stream of water or in a basin of water when the stopper is pulled out. In the mental body, they appear as converging lines of light.

The Muladora Chakra is at the base of the spine and is the seat of the Kundalini Fire Wheel when aroused, which in the advanced stages of yoga, rises up through the center of the spine and activates the highest chakra in the cerebral cortex called the Sahasraram Chakra. The next chakra is called the Sacral Center or the Swadisthana Chakra. It relates to the adrenal glands and is related to the absorption of pranic vitality, which is in the air. The air absorbs this energy from solar radiation. There seems to be some differences of opinion between various texts as to whether the Muladora Chakra or Swadisthana Chakra relates most directly to the sexual functions. After the Swadisthana Chakra, comes the Manipara or Solar Plexus Center which relates to the digestive functions and vitality of the astral desires and feeling emotions. Next in ascending order is the Anahala or Heart Chakra, which relates to the source of spiritual energy and the higher emotions of love, altruism and benevolence. The next chakra is the Vishudha or Throat Chakra, which is related to the thyroid gland and has to do with the power of speech and relates to mantra yoga and the capacity for artistic creativity. This center is activated by chanting and singing. Next we have the Agna Chakra, which is located on the forehead, just slightly above and between the eyebrows. It is related to the pituitary gland and the subcortical areas of the brain. The Agna Chakra has to do with the higher mind faculties of clairvoyance, scientific reasoning, willing and philosophical thought. Development of the chakra awakens the ability to see and regulate astral and mental forces on the superphysical level. Above the Agna is the Sahasraram Chakra or Thousand-Petalled Lotus, which is related to the pineal gland and the cerebral cortex. It's located at the top of the head. It relates to the sound current and the faculty of clairvoyant hearing, and is the most spiritual of all the chakras. When this chakra is fully developed, union with God-consciousness is possible, and Illumination takes place.

By focusing the attention in any one of the chakras, the lower overtones of the concentration of consciousness in that location activates that chakra and increases the energy flow in it, making possible a conscious entry into the superphysical planes of energy. Meditation on the first three chakras, namely the Muladora Chakra, the Sacral Chakra and the Solar Plexus Chakra is not recommended because this can arouse lower emotions and sexual passions. This can allow entry to undesirable astral influences and cause psychological unbalance. It is better to work with the Heart Center, the Agna Chakra, and the Sahasraram Chakra because these are the most directly related to the unfoldment of superconsciousness; and when awakened, will automatically develop the lower chakras by changing the glandular balance of the body and by circulating new pranic forces through the energy channels or nodies of the etheric body as well as purifying and strengthening the astral and mental bodies. The hormones which the pituitary gland secretes, regulates the other glands in the body including the thymus gland, the thyroid gland, the adrenal gland and the sex glands as well as other glands. Once the pituitary gland is fully activated by the development of the Agna Chakra, all other glands are brought into proper chemical balance, thus helping to properly develop and raise the vibratory rate of all the lower chakras. In Kundalini Yoga, an advanced yoga practice, concentration is done on the Muladora Chakra at the base of the spine in order to arouse the Kundalini Fire and bring it through the center of the spine to activate the highest chakra, the Sahasraram, at the top of the head. If however, the Kundalini Fire is prematurely aroused and not properly directed, great damage can be done to the nervous system and to the etheric body. If the Kundalini force is not properly directed upwards, it can revert downward causing abnormal sexual desire and perversion. Therefore, arousing the Kundalini should only be done in advanced stages of yoga when a great deal of purification of the subtle bodies has taken place and soul control over the personality is well established.

The Combination of Mantra Yoga and Meditation

When doing Om chanting or other mantras, it is possible to activate various chakras. By chanting at varying pitches, you will make different tissues in the body vibrate, thus stimulating the nerve centers and the glandular centers, and activating the chakras associated with them. With a bit of experimentation, you will find which tones or pitches vibrate which parts of the body and which chakras. When this has been ascertained, then chant with full force while meditating in the chakra you wish to activate. The sound waves create vibration patterns in the etheric, astral and mental atmosphere, which you can develop the ability to see. They are multicolored and very intricate and beautiful, sometimes forming geometrical patterns and mandalas made out of threads of light. Music will have a similar effect. Just listen to the music during a psychedelic session while observing the inner light through the Agna Chakra or Third Eye Center. Then watch the color patterns change and develop with the music. Classical music and Indian ragas are especially good for this purpose.

Meditation on the I Am Principle

In the practice of this form of meditation, consciousness is made to dwell upon itself. When properly and successfully practiced, this is the most powerful and highest form of meditation. While focusing in the Heart Chakra or in the Sahasraram Chakra at the crown of the head, place the attention on the attention itself. If any distractions come in the form of thoughts and perceptions of a specific nature, then immediately concentrate your attention upon that consciousness in you which is the experiencer of those thoughts and perceptions. Even the manifestation of spiritual light and sound current should be regarded in this way. The sound current and the light are merely the lower overtone manifestations of the pure consciousness upon which you are meditating. The more you hold your attention steady in concentration upon itself, the more the light, sound current, electrical sensations in the body, feelings of magnetic force, sensations of weightlessness, etc. will manifest automatically. If, however, you allow your attention to become distracted by any of these manifestations, then you will be subject to the limitations of the thing by which you have been distracted; and the focusing of pure consciousness will be interrupted so that all of the things which are the lower overtones and by-products of the focusing of pure consciousness, possibly including the psychic manifestation which distracted your attention, will also stop. Seek ye first the kingdom of pure consciousness and all of these other psychic manifestations will be added unto you. Placing the attention on the attention itself can be done in any location in space since pure consciousness, which is the same as God, is an omnipresent principle. In the beginning, it will be found easiest to do this in one of the chakras, preferably the Heart Chakra or the Sahasraram or Head Center. The Agna Chakra or Third Eye Center located on the brow, can also be used with good results, but it is better to use the Sahasraram Chakra if you can activate it. With practice of this form of meditation, your pure consciousness will experience itself as a blazing sea of white light extending infinitely in every direction. The pure consciousness itself is crystalline and colorless, but it generates the white light which is the simultaneous presence of all of the colors which are the specific lower overtone rates of vibration, which the pure consciousness generates. The placing of the attention on the attention itself in a specific chakra, brings about a condition in that chakra, in which its vibration structure is harmonically and geometrically aligned in all of its planes of manifestation or rates of vibration. This creates common node points in the inner plane structure of the chakra. Vibrations of different frequencies and different wavelengths all begin and end together at these common node points. This is made possible by the fact that the wavelengths of the various vibrations and their frequencies all bear exact mathematical rates to each other, like the notes in a musical scale. Any vibrations which are out of phase in terms of their spatial distribution or vibratory rates are automatically canceled out by interfering with other waves at the common node points. Where several wavelengths, both short and long, begin and end their cycles together, it is possible to slip through the dimensions and to experience the higher spiritual rates of vibration and approach the Atman, which moves with infinite speed. At these common node points, the exchange of energy from one octave or plane to another, also becomes possible, allowing a flow of energy from the higher dimensions into the lower dimensions. Thus, a transmutation of those vibration patterns which exist on the lower dimensions into the higher ones becomes possible. The soul is then able to control the personality structure, making it a fit instrument of spiritual expression in the affairs of men. This form of meditation develops one-pointed concentration.

Since the use of psychedelic drugs stimulates the flow of a great amount of energy from higher planes into the lower planes, any thought and emotion patterns created during a psychedelic session are strongly imprinted and have a great deal of energy incorporated into their vibration structure. These thought and emotional patterns then act as powerful unconscious conditioning factors in our daily lives. It is therefore of the utmost importance that constructive imprints are made during a psychedelic session. Remaining in control of the attention can ensure this. In this regard, I would like to give a few final points of advice. Try not to focus the attention from one thing to another too quickly. Stay with a thought or meditation process until it is complete. Don't panic if frightening visions or hallucinations occur. Fear will make you concentrate on them all the more and thus feed them with the power of your attention. Remain detached and place your attention on that consciousness within you which is experiencing the hallucinations. Remember at all times that God exists in you in the form of your own power of attention and that power when properly directed, will control all lesser forces.

It is believed by some researchers that psychedelic drugs stimulate the secretion process of the pineal and pituitary glands, which are known by yogis and occultists to be related to the Sahasraram and Agna chakras (which are also called the Thousand-Petalled Lotus and the Third Eye Center). This stimulation increases the flow of energy between the etheric body and the physical body. It may be that psychedelic drugs place the cells of the physical body under stress so that they must speed up their activity to overcome the stress. When the cells increase their activity, their vibratory rates increase, thus putting them harmonically in resonance with the higher rates of vibration on the subtle superphysical planes of energy. This process makes possible the expression of a higher level of consciousness through the glandular system, brain and nervous system. The increased physical cellular activity requires more work and activity in the etheric body to sustain the stepped-up activity of the physical body. The vibratory rate of the etheric body is thus accelerated, requiring an increased activity in the astral body to sustain and remain harmonically in tune with the etheric body. The increased vibratory rate of the astral body requires a stepped-up activity and increased vibratory rate in the mental body. This in turn more fully tunes the mental body in to the power, love and wisdom of the soul. Thus an alignment of the whole being on all planes is facilitated, and a more rapid exchange of pattern imprints and energy between the various octaves or planes of energy takes place. It may also be that psychedelic drugs have a chemical structure such that they are perfectly in resonance with the lower overtones of certain key frequencies in the higher planes and can therefore act as a point of entry for the reflection of these vibrations in the physical body. They would therefore help to create common node points in the vibration structure of several different dimensions. Not only is the love, wisdom and power of the soul brought to bare in the life of the personality, but the fine organization of the physical body, the etheric, astral and mental bodies, which have been produced by the evolutionary process, are harmonically reflected and preserved in the soul. While the physical body is the least permanent, the densest and composed of the substance of the lowest plane, it is in terms of evolution, the newest and most highly organized in terms of structure. Therefore, a complete replica of it made out of the energy substance of the subtle planes, is an evolutionary gain for the soul and subtle bodies. When the physical body is sufficiently vivified by the influx of energy from the higher dimensions, it begins to create higher overtone reflections of itself in the akasha or energy substance of the higher planes, and thus its pattern is preserved and made immortal. Therefore, when properly used, psychedelic drugs help to speed up the evolutionary process. When man has evolved to superman, he will, under the direction of the superconscious mind in accordance with God's will as it manifests in evolution, take an active part in the molding and directing of the evolution of the mineral, vegetable, and animal kingdoms. Even today, his vibrations intimately affect for good or bad, those kingdoms in nature.

This article originally appeared as an uncopyrighted set of mimeographed sheets sometime during the late 1960's, which was freely distributed on a limited basis, probably in San Francisco. Feel free to make copies of this article and to distribute them to those interested to keep this information alive, otherwise it will disappear into antiquity.

Manna From Heaven

by

Steve Kubby

original report: http://deoxy.org/manna.htm

From *Psychedelic Illuminations* Volume 1, Issue VII
Illustration by Gustave Doré

There are a great many people who would never consider the use of visionary plants to be a spiritual experience. These people believe that spiritual experiences must come directly from God and that the use of visionary plants goes against the teachings of the Bible. Contrary to this notion, the Bible never explicitly prohibits the use of visionary plants or potions. What you will find however, is many curious references to a spiritual food sent down from heaven by God, called manna.

The Bible never tells us exactly what manna was and where it came from, but there are many Old Testament passages which describe its physical qualities and conditions associated with its appearance. The Bible's first reference to manna is in the Book of Exodus as the children of Israel are fleeing from Egypt and following Moses into the wilderness. After six weeks of wandering, they began complaining to Moses that they are tired and hungry. What happens next is truly extraordinary:

> *Then said the LORD unto Moses, Behold, I will rain bread from heaven for you; and the people shall go out and gather a certain rate every day, that I may prove them, whether they will walk in my law or no (16:4).*
>
> *And when the dew that lay was gone up, behold, upon the face of the wilderness there lay a small round thing, as small as the hoar frost on the ground (16:14). And when the children of Israel saw if, they said one to another It is manna: for they wist not what it was. And Moses said unto them, This is the bread which the Lord hath given you to eat.*

When I read this passage, I was struck by the fact that manna easily fits the description of psilocybe mushrooms. For one thing magic mushrooms are small and round, and since they sprout so rapidly they would seem to appear overnight, as if out of the sky. Also, anyone harvesting them would immediately notice that they turn blue where torn and had no roots, giving more reason to believe that the mushrooms were of celestial origin. Note that manna does not just fall from heaven, but instead it is described as coming with the frost and dew, during the wet seasons. These are the precise weather conditions for mushrooms to thrive. And finally, manna is described as a bread.

Although translations have obscured the intent of this passage, it seems to be a description of how to find and identify manna and distinguish it from other non-psychoactive (or possibly lethal) mushrooms. Look for the small round things which are like bread, come with the rain, and seem to have heavenly (bluish) coloring. Psilocybe mushrooms also sprout in tiny pin heads which branch out in all directions and bear a resemblance to hoar frost.

It is also interesting to note that Moses tells the children of Israel that manna comes directly from Heaven to test them on whether or not they will walk in God's law. Here is evidence that manna was endowed with unusual spiritual powers, like those of magic mushrooms. However, manna does not automatically confer spiritual power. Instead, it serves as a test. Magic mushrooms would provide visionary experiences that would certainly test all who ingested them. Moses also said that the manna is literally the "bread of the lord" which is remarkably similar to the literal Aztec name for psilocybe mushrooms, "flesh of the gods."

But how and why did the manna suddenly appear? Again referring to the Bible, it is clear that the children of Israel had journeyed to a land where there was dew in the morning. As a large, nomadic tribe, the Israelites brought a lot of cattle and sheep together in the area. That meant a great deal of manure. The change of climate from the arid lands of Egypt to the dewy climate of the wilderness created ideal conditions for the propagation and spread of psilocybe mushrooms in livestock dung.

> *In Exodus 12:19-20, we find more references to manna.*

Anyone familiar with wild mushrooms knows that they go bad very quickly and shrivel up under the heat of the sun, exactly like manna.

It seems curious that Moses recognized the manna instantly when the children of Israel showed it to him. He knew that the manna would spoil if it was not picked and eaten in the morning. But how did Moses know about manna? Perhaps Moses knew about manna because he had already encountered the mushroom at the time he saw the burning bush. Referring to an earlier period of his life, we find that Moses:

> *...kept a flock of Jethro, his father in-law the priest of Midiam: and he led the flock to the backside of the desert, and came to the mountain of God, even to Horeb (3:1). And the angel of the LORD appeared unto him in a flame of fire out of the midst of a bush: and he looked, and behold, the bush burned with fire, and the bush was not consumed (3:2).*

Had Moses eaten the sacred mushroom while camped at the mountain? Here again we can only speculate that manure from his flock and a change in climate had created the proper environment for the mushrooms to fruit. Perhaps Moses ingested the mushrooms purely by accident, or perhaps his father in law, who we know was also a priest, had introduced Moses to the mushroom. Archaeological evidence of psychedelic mushroom use in Biblical times is well documented by Terence McKenna, so it is reasonable to conclude that Moses could have had some experience with visionary mushrooms.[1]

Later, in Numbers 11:6-9, manna is again described in terms that are remarkably similar to magic mushrooms:

> *But now our soul is dried away: there is nothing at all, beside this manna, before our eyes. And the manna was as coriander seed, and the colour thereof as the colour of bdelliaum. And the people went about and gathered it, and ground it in mills, or beat it in a mortar and baked it in pans: and made cakes of it: and the taste of it was as the taste of fresh oil. And when the dew fell upon the camp in the night, the manna fell upon it.*

Here we find manna described as before our eyes, having a neutral taste like fresh oil, and once again, the Bible mentions that manna appearing in the morning when the dew fell. The Old Testament even tells us what manna looks like, the manna was as coriander seed, and the colour thereof. When psilocybe mushrooms are dried, their range of colors is virtually identical to dried coriander seed. In both cases, with mushrooms and coriander seeds, we see great similarities in the texture, color, tones, contrasts and general visual appearance. The Children of Israel must have given great thought about how to transmit the appearance of manna so as to aid future generations who might encounter it. However, mushrooms were a mystery to the Hebrews and they were unable to predict where manna could be found. Little did they realize that the manure from their cattle was providing a means for the mushroom to find its way into their mountain campsites.

Notice that the manna was ground in mills or beat it in a mortar. That is odd because earlier we are told that manna was quite delicate and, then the sun wax hot, it melted. However, if manna was the psilocybe mushroom, then it was probably dried and then ground in order to be used for baking. In fact, dried magic mushrooms are quite hard. Grinding or crushing the dried mushroom and then baking with the powder would insure that the delicate psychoactive molecules retained their highest potency.

In the next passage, the Bible describes manna as having light tan color and texture like a wafer, certainly an accurate description of the color and texture of a dried psilocybe mushroom. We also learn that the taste of manna is no longer that of fresh oil but rather that of honey. According to McKenna's research, honey has long been used in Mexico as a preserve medium for psilocybin containing mushrooms. Perhaps the children of Israel had begun to mix honey with the manna to preserve its potency. We find that Moses announced that manna must be kept for future generations:

> *And the house of Israel called the name there of manna: and it was like coriander seed, white; and the taste of it was like wafers made with honey (l6:31). And Moses said, This is the thing which the LORD commandeth. Fill an omer of it to be kept for your generations: that they may see the bread where with I have fed you in the wilderness, when I brought you forth from the land of Egypt (l6:32).*

Again we are told to fill an omer with manna. But how much is a omer? Isaac Asimov, in his book on the Bible, concludes that an omer is about four liters, while the King James version of the Bible estimates an omer to be six pints. Psilocybe mushrooms are 92% water and only 8% remains when they are dried. Also, fresh mushroom take up a lot of space, due to their shape. So four liters of fresh magic mushrooms would yield less than a tenth of a liter, or about 1/4 cup of dried, powdered manna This corresponds closely with the amount of magic mushrooms required for a moderately strong dose when used for baking. This is important because it clearly shows that not only does manna have similar qualities to magic mushrooms, it also shows that it was also used in the same quantity as mushrooms. So manna matches psilocybe mushroom on both a qualitative and quantitative analysis providing a compelling argument that psilocybe mushrooms are in actuality "manna from Heaven."

Of course there are those who will remain eternally skeptical, but keep in mind that the description of manna given in the old testament bears an exact resemblance to mushrooms. Even if psilocybe mushrooms are not manna the similarities have indicated mushrooms as a possible candidate, and they certainly fit the bill for a "spiritual food". Unfortunately, when the Children of Israel finally reach the arid land of Canaan, the mysterious manna no longer appeared.

> *And the manna ceased on the morrow after they had eaten of the old corn of the land: neither had the children of Israel manna any more (Joshua 5:12).*

The children of Israel must have been deeply disappointed when they ran out of their sacred manna. We can see that they went to great lengths to preserve their knowledge about identifying and using manna The Old Testament contains detailed information about the color, texture, appearance, and relationship to dew, and the Old Testament even explains how manna is to be ground and then used in baking cakes. If the Israelites thought that manna was a magical event caused by God would they have bothered to note all the details about the identification of manna? What about the manna that Moses said must be put away for future generations? Turning to Hebrews 9:3-4 we find:

> *And after the second veil, the tabernacle which is called the Holiest of all: Which had the golden censer and the Ark of the Covenant overlaid round about with gold, wherein was the golden pot*

that had manna.

Here we learn that manna was to be kept in the Holiest of all, the Ark of the Covenant. Clearly, the manna was something of great spiritual power since the Hebrews treated it with such reverence and even went to such great lengths to see that manna be given to future generations. We must also consider the covenant that the Jewish people held with God which was celebrated through the act of circumcision. Why was this covenant with God associated with the removal of foreskin from infant males. Why not a tattoo, scar, article of clothing or jewelry? Perhaps the answer is that the circumcised penis bears a remarkable resemblance to psilocybe mushroom just before the partial veil has broken away from the mushroom caps and they are at their greatest potency. If the Ark of the Covenant was specifically built to store manna it is logical was also tied to manna through the ritual act of circumcision, which gave each Jewish male his own mushroom-like penis.

The discovery that manna was (and is) psilocybe mushrooms is not simply an issue of theological or academic debate. So great was the power conferred by manna, that this small band of wandering slaves were able to defeat all enemies who crossed their path even when confronted by armies that were bigger and better equipped. Jews, Christians and Moslems can all trace their roots to the children of Israel who ate manna for forty years and saw themselves as God's chosen people. Again, we are reminded of McKenna's thesis that those who ate psilocybe mushrooms had a survival advantage due to better visual acuity, heightened senses, better hunting skills, and for the children of Israel, better warrior skills. Manna gave the Hebrews their own covenant with God one that is even recognized today by Christians who believe that the Jews have already earned a special place as the Chosen People. Bible scholar Grant Jeffrey explains:

"The covenant which God made with Abraham and the kingdom promises to David, Solomon and all the prophets will be finally realized in the Millennial Kingdom... the Lord promised a new covenant with Ismel in which He would give them a new heart, forgiveness of sin, and the infilling of the Spirit to the renewed nation. This promised kingdom will provide the fulfillment of all the hopes and dreams of the Chosen People forever."[3]

What is the new covenant? It is the rediscovery of manna. Across the gulf of thousands of years the Bible transmits and accurate and detailed description of manna waiting for the time when the message can be decoded and manna can again fulfill its role as a celestial messenger. Manna was the basis of the Jewish covenant with God. Indeed, it is this covenant and the use of manna which has set the Jews apart as the Chosen People. The Bible is not the message, it only points the way. Manna is the holy sacrament that provides the means for God to "prove them, whether they will walk in my law, or no."

If manna is indeed the psilocybin mushroom, then this means that the Koran, Bible, and Torah were all inspired by psychedelically induced visions. The very foundations upon which these religions rest were derived from the mushroom experience. Moses and the children of Israel used the mushrooms as true sacraments to communicate with a Higher Power, also known as Allah, God and Yahweh. The discovery that manna is real and is available to us today means that like children of Israel we too can use manna to experience the joy, wisdom and spiritual renewal of the Chosen People.

1. Terence McKenna, *Food of the Gods,* (New York, Harper Collins) p. 84.
2. Terence McKenna, *Food of the Gods,* (New York, Harper Collins), p. 127.
3. Grant R. Jeffrey, *Heaven the last Frontier,* (New York; Bantam), p. 132.

Psychedelics and Religious Experience

by

Alan Watts

(Originally appeared in the California Law Review, Vol. 56, No. 1, January 1968, pp. 74-85.) Copyright Alan Watts & California Law Review.

original source: https://www.dmt-nexus.me/doc/watts_psychedelics_religious_exp.pdf
backup source: http://www.psilosophy.info/resources/watts_psychedelics_religious_exp.pdf

Table of Contents:

The Psychedelic Experience
slowing down of time
awareness of polarity
awareness of relativity
awareness of eternal energy
Opposition to Psychedelic Drugs
danger
escape from reality
Footnotes

The experiences resulting from the use of psychedelic drugs are often described in religious terms. They are therefore of interest to those like myself who, in the tradition of William James, [1] are concerned with the psychology of religion. For more than thirty years I have been studying the causes, the consequences, and the conditions of those peculiar states of consciousness in which the individual discovers himself to be one continuous process with God, with the Universe, with the Ground of Being, or whatever name he may use by cultural conditioning or personal preference for the ultimate and eternal reality. We have no satisfactory and definitive name for experiences of this kind. The terms "religious experience," "mystical experience," and "cosmic consciousness" are all too vague and comprehensive to denote that specific mode of consciousness which, to those who have known it, is as real and overwhelming as falling in love. This article describes such states of consciousness induced by psychedelic drugs, although they are virtually indistinguishable from genuine mystical experience. The article then discusses objections to the use of psychedelic drugs that arise mainly from the opposition between mystical values and the traditional religious and secular values of Western society.

The Psychedelic Experience

The idea of mystical experiences resulting from drug use is not readily accepted in Western societies. Western culture has, historically, a particular fascination with the value and virtue of man as an individual, self-determining, responsible ego, controlling himself and his world by the power of conscious effort and will. Nothing, then, could be more repugnant to this cultural tradition than the notion of spiritual or psychological growth through the use of drugs. A "drugged" person is by definition dimmed in consciousness, fogged in judgment, and deprived of will. But not all psychotropic (consciousness-changing) chemicals are narcotic and soporific, as are alcohol, opiates, and barbiturates. The effects of what are now called psychedelic (mind-manifesting) chemicals differ from those of alcohol as laughter differs from rage, or delight from depression. There is really no analogy between being "high" on LSD and "drunk" on bourbon. True, no one in either state should drive a car, but neither should one drive while reading a book, playing a violin, or making love. Certain creative activities and states of mind demand a concentration and devotion that are simply incompatible with piloting a death - dealing engine along a highway.

I myself have experimented with five of the principal psychedelics: LSD-25, mescaline, psilocybin, dimethyl-tryptamine (DMT), and cannabis. I have done so, as William James tried nitrous oxide, to see if they could help me in identifying what might be called the "essential" or "active" ingredients of the mystical experience. For almost all the classical literature on mysticism is vague, not only in describing the experience, but also in showing rational connections between the experience itself and the various traditional methods recommended to induce it: fasting, concentration, breathing exercises, prayers, incantations, and dances. A traditional master of Zen or Yoga, when asked why such-and-such practices lead or predispose one to the mystical experience, always responds, "This is the way my teacher gave it to me. This is the way I found out. If you're seriously interested, try it for yourself." This answer hardly satisfies an impertinent, scientifically minded, and intellectually curious Westerner. It reminds him of archaic medical prescriptions compounding five salamanders, powdered gallows rope, three boiled bats, a scruple of phosphorus, three pinches of henbane, and a dollop of dragon dung dropped when the moon was in Pisces. Maybe it worked, but what was the essential ingredient?

It struck me, therefore, that if any of the psychedelic chemicals would in fact predispose my consciousness to the mystical experience, I could use them as instruments for studying and describing that experience as one uses a microscope for bacteriology, even though the microscope is an "artificial" and "unnatural" contrivance which might be said to "distort" the vision of the naked eye. However, when I was first invited to test the mystical qualities of LSD-25 by Dr. Keith Ditman of the Neuropsychiatric Clinic at UCLA Medical School, I was unwilling to believe that any mere chemical could induce a genuine mystical experience. At most, it might bring about a state of spiritual insight analogous to swimming with water wings. Indeed, my first experiment with LSD-25 was not mystical. It was an intensely interesting aesthetic and intellectual experience that challenged my powers of analysis and careful description to the utmost.

Some months later, in 1959, I tried LSD-25 again with Drs. Sterling Bunnell and Michael Agron, who were then associated with the Langley-Porter Clinic, in San Francisco. In the course of two experiments I was amazed and somewhat embarrassed to find myself going through states of consciousness that corresponded precisely with every description of major mystical experiences that I had ever read. [2] Furthermore, they exceeded both in depth and in a peculiar quality of unexpectedness the three "natural and spontaneous" experiences of this kind that had happened to me in previous years.

Through subsequent experimentation with LSD-25 and the other chemicals named above (with the exception of DMT, which I find amusing but relatively uninteresting), I found I could move with ease into the state of "cosmic consciousness," and in due course became less and less dependent on the chemicals themselves for "tuning in" to this particular wave length of experience. Of the five psychedelics tried, I found that LSD-25 and cannabis suited my purposes best. Of these two, the latter - cannabis - which I had to use abroad in countries where it is not outlawed, proved to be the better. It does not induce bizarre alterations of sensory perception, and medical studies indicate that it may not, save in great excess, have the dangerous side effects of LSD.

For the purposes of this study, in describing my experiences with psychedelic drugs I avoid the occasional and incidental bizarre alterations of sense perception that psychedelic chemicals may induce. I am concerned, rather, with the fundamental alterations of the normal, socially induced consciousness of one's own existence and relation to the external world. I am trying to delineate the basic principles of psychedelic awareness. But I must add that I can speak only for myself. The quality of these experiences depends considerably upon one's prior orientation and attitude to life, although the now voluminous descriptive literature of these experiences accords quite remarkably with my own.

Almost invariably, my experiments with psychedelics have had four dominant characteristics. I shall try to explain them - in the expectation that the reader will say, at least of the second and third, "Why, that's obvious! No one needs a drug to see that." Quite so, but every insight has degrees of intensity. There can be obvious-1 and obvious-2, and the latter comes on with shattering clarity, manifesting its implications in every sphere and dimension of our existence.

slowing down of time

The first characteristic is a slowing down of time, a *concentration in the present*. One's normally compulsive concern for the future decreases, and one becomes aware of the enormous importance and interest of what is happening at the moment. Other people, going about their business on the streets, seem to be slightly crazy, failing to realize that the whole point of life is to be fully aware of it as it happens. One therefore relaxes, almost luxuriously, into studying the colors in a glass of water, or in listening to the now highly articulate vibration of every note played on an oboe or sung by a voice.

From the pragmatic standpoint of our culture, such an attitude is very bad for business. It might lead to improvidence, lack of foresight, diminished sales of insurance policies, and abandoned savings accounts. Yet this is just the corrective that our culture needs. No one is more fatuously impractical than the "successful" executive who spends his whole life absorbed in frantic paper work with the objective of retiring in comfort at sixty-five, when it will all be too late. Only those who have cultivated the art of living completely in the present have any use for making plans for the future, for when the plans mature they will be able to enjoy the results. "Tomorrow never comes." I have never yet heard a preacher urging his congregation to practice that section of the Sermon on the Mount which begins, "Be not anxious for the morrow...." The truth is that people who live for the future are, as we say of the insane, "not quite all there" - or here: by over - eagerness they are perpetually missing the point. Foresight is bought at the price of anxiety, and when overused it destroys all its own advantages.

awareness of polarity

The second characteristic I will call *awareness of polarity*. This is the vivid realization that states, things, and events that we ordinarily call opposite are interdependent, like back and front, or the poles of a magnet. By polar awareness one sees that things which are explicitly different are implicitly one: self and other, subject and object, left and right, male and female - and then, a little more surprisingly, solid and space, figure and background, pulse and interval, saints and sinners, police and criminals, in-groups and out-groups. Each is definable only in terms of the other, and they go together transactionally, like buying and selling, for there is no sale without a purchase, and no purchase without a sale. As this awareness becomes increasingly intense, you feel that you yourself are polarized with the external universe in such a way that you imply each other. Your push is its pull, and its push is your pull - as when you move the steering wheel of a car. Are you pushing it or pulling it?

At first, this is a very odd sensation, not unlike hearing your own voice played back to you on an electronic system immediately after you have spoken. You become confused, and wait for *it* to go on! Similarly, you feel that you are something being done by the universe, yet that the universe is equally something being done by you - which is true, at least in the neurological sense that the peculiar structure of our brains translates the sun into light, and air vibrations into sound. Our normal sensation of relationship to the outside world is that sometimes I push it, and sometimes it pushes me. But if the two are actually one, where does action begin and responsibility rest? If the universe is doing me, how can I be sure that, two seconds hence, I will still remember the English language? If I am doing it, how can I be sure that, two seconds hence, my brain will know how to turn the sun into light? From such unfamiliar sensations as these, the psychedelic experience can generate confusion, paranoia, and terror - even though the individual is feeling his relationship to the world exactly as it would be described by a biologist, ecologist, or physicist, for he is feeling himself as the unified field of organism and environment.

awareness of relativity

The third characteristic, arising from the second, is *awareness of relativity*. I see that I am a link in an infinite hierarchy of processes and beings, ranging from molecules through bacteria and insects to human beings, and, maybe, to angels and gods - a hierarchy in which every level is in effect the same situation. For example, the poor man worries about money while the rich man worries about his health: the worry is the same, but the difference is in its substance or dimension. I realize that fruit flies must think of themselves as people, because, like ourselves, they find themselves in the middle of their own world - with immeasurably greater things above and smaller things below. To us, they all look alike and seem to have no personality - as do the Chinese when we have not lived among them. Yet fruit flies must see just as many subtle distinctions among themselves as we among ourselves.

From this it is but a short step to the realization that all forms of life and being are simply variations on a single theme: we are all in fact one being doing the same thing in as many different ways as possible. As the French proverb goes, *plus ca change, plus c'est la meme chose* (the more it varies, the more it is one). I see, further, that feeling threatened by the inevitability of death is really the same experience as feeling alive, and that as all beings are feeling this everywhere, they are all just as much "I" as myself. Yet the "I" feeling, to be felt at all, must always be a sensation relative to the "other" - to something beyond its control and experience. To be at all, it must begin and end. But the intellectual jump that mystical and psychedelic experiences make here is in enabling you to see that all these myriad I - centers are yourself - not, indeed, your personal and superficially conscious ego, but what Hindus call the *paramatman*, the Self of all selves. [3] As the retina enables us to see countless pulses of energy as a single light, so the mystical experience shows us innumerable individuals as a single Self.

awareness of eternal energy

The fourth characteristic is *awareness of eternal energy*, often in the form of intense white light, which seems to be both the current in your nerves and that mysterious e which equals mc2. This may sound like megalomania or delusion of grandeur - but one sees quite clearly that all existence is a single energy, and that this energy is one's own being. Of course there is death as well as life, because energy is a pulsation, and just as waves must have both crests and troughs, the experience of existing must go on and off. Basically, therefore, there is simply nothing to worry about, because you yourself are the eternal energy of the universe playing hide-and-seek (off-and-on) with itself. At root, you are the Godhead, for God is all that there is. Quoting Isaiah just a little out of context: "I am the Lord, and there is none else. I form the light and create the darkness: I make peace, and create evil. I, the Lord, do all these things." [4] This is the sense of the fundamental tenet of Hinduism, *Tat tvam asi*-"THAT (i.e., "that subtle Being of which this whole universe is composed") art thou." [5] A classical case of this experience, from the West, is in Tennyson's Memoirs:

> A kind of waking trance I have frequently had, quite up from boyhood, when I have been all alone. This has generally come upon me thro' repeating my own name two or three times to myself silently, till all at once, as it were out of the intensity of the consciousness of individuality, the individuality itself seemed to dissolve and fade away into boundless being, and this not a confused state, but the clearest of the clearest, the surest of the surest, the weirdest of the weirdest, utterly beyond words, where death was an almost laughable impossibility, the loss of personality (if so it were) seeming no extinction but the only true life. [6]

Obviously, these characteristics of the psychedelic experience, as I have known it, are aspects of a single state of consciousness - for I have been describing the same thing from different angles. The descriptions attempt to convey the reality of the experience, but in doing so they also suggest some of the inconsistencies between such experience and the current values of society.

Opposition to Psychedelic Drugs

Resistance to allowing use of psychedelic drugs originates in both religious and secular values. The difficulty in describing psychedelic experiences in traditional religious terms suggests one ground of opposition. The Westerner must borrow such words as *samadhi* or *moksha* from the Hindus, or *satori* or *kensho* from the Japanese, to describe the experience of oneness with the universe. We have no appropriate word because our own Jewish and Christian theologies will not accept the idea that man's inmost self can be identical with the Godhead, even though Christians may insist that this was true in the unique instance of Jesus Christ. Jews and Christians think of God in political and monarchical terms, as the supreme governor of the universe, the ultimate boss. Obviously, it is both socially unacceptable and logically preposterous for a particular individual to claim that he, in person, is the omnipotent and omniscient ruler of the world - to be accorded suitable recognition and honor.

Such an imperial and kingly concept of the ultimate reality, however, is neither necessary nor universal. The Hindus and the Chinese have no difficulty in conceiving of an identity of the self and the Godhead. For most Asians, other than Muslims, the Godhead moves and manifests the world in much the same way that a centipede manipulates a hundred legs - spontaneously, without deliberation or calculation. In other words, they conceive the universe by analogy with an organism as distinct from a mechanism. They do not see it as an artifact or construct under the conscious direction of some supreme technician, engineer, or architect.

If, however, in the context of Christian or Jewish tradition, an individual declares himself to be one with God, he must be dubbed blasphemous (subversive) or insane. Such a mystical experience is a clear threat to traditional religious concepts. The Judaeo-Christian tradition has a monarchical image of God, and monarchs, who rule by force, fear nothing more than insubordination. The Church has therefore always been highly suspicious of mystics, because they seem to be insubordinate and to claim equality or, worse, identity with God. For this reason, John Scotus Erigena and Meister Eckhart were condemned as heretics. This was also why the Quakers faced opposition for their doctrine of the Inward Light, and for their refusal to remove hats in church and in court. A few occasional mystics may be all right so long as they watch their language, like St. Teresa of Avila and St. John of the Cross, who maintained, shall we say, a metaphysical distance of respect between themselves and their heavenly King. Nothing, however, could be more alarming to the ecclesiastical hierarchy than a popular outbreak of mysticism, for this might well amount to setting up a democracy in the kingdom of heaven - and such alarm would be shared equally by Catholics, Jews, and fundamentalist Protestants.

The monarchical image of God, with its implicit distaste for religious insubordination, has a more pervasive impact than many Christians might admit. The thrones of kings have walls immediately behind them, and all who present themselves at court must prostrate themselves or kneel, because this is an awkward position from which to make a sudden attack. It has perhaps never occurred to Christians that when they design a church on the model of a royal court (basilica) and prescribe church ritual, they are implying that God, like a human monarch, is afraid. This is also implied by flattery in prayers:

> O Lord our heavenly Father, high and mighty, King of kings, Lord of lords, the only Ruler of princes, who dost from thy throne behold all the dwellers upon earth: most heartily we beseech thee with thy favor to behold. ... [7]

The Western man who claims consciousness of oneness with God or the universe thus clashes with his society's concept of religion. In most Asian cultures, however, such a man will be congratulated as having penetrated the true secret of life. He has arrived, by chance or by some such discipline as Yoga or Zen meditation, at a state of consciousness in which he experiences directly and vividly what our own scientists know to be true in theory. For the ecologist, the biologist, and the physicist know (but seldom feel) that every organism constitutes a single field of behavior, or process, with its environment. There is no way of separating what any given organism is doing from what its environment is doing, for which reason ecologists speak not of organisms in environments but of organism-environments. Thus the words "I" and "self" should properly mean what the whole universe is doing at this particular "here-and-now" called John Doe.

The kingly concept of God makes identity of self and God, or self and universe, inconceivable in Western religious terms. The difference between Eastern and Western concepts of man and his universe, however, extends beyond strictly religious concepts. The Western scientist may rationally perceive the idea of organism-environment, but he does not ordinarily feel this to be true. By cultural and social conditioning, he has been hypnotized into experiencing himself as an ego - as an isolated center of consciousness and will inside a bag of skin, confronting an external and alien world. We say, "I came into this world." But we did nothing of the kind. We came out of it in just the same way that fruit comes out of trees. Our galaxy, our cosmos, "peoples" in the same way that an apple tree "apples."

Such a vision of the universe clashes with the idea of a monarchical God, with the concept of the separate ego, and even with the secular, atheist/agnostic mentality, which derives its common sense from the mythology of nineteenth-century scientist. According to this view, the universe is a mindless mechanism and man a sort of accidental microorganism infesting a minute globular rock that revolves about an unimportant star on the outer fringe of one of the minor galaxies. This "put-down" theory of man is extremely common among such quasi scientists as sociologists, psychologists, and psychiatrists, most of whom are still thinking of the world in terms of Newtonian mechanics, and have never really caught up with the ideas of Einstein and Bohr, Oppenheimer and Schrodinger. Thus to the ordinary institutional-type psychiatrist, any patient who gives the least hint of mystical or religious experience is automatically diagnosed as deranged. From the standpoint of the mechanistic religion, he is a heretic and is given electroshock therapy as an up-to-date form of thumbscrew and rack. And, incidentally, it is just this kind of quasi scientist who, as consultant to government and law-enforcement agencies, dictates official policies on the use of psychedelic chemicals.

Inability to accept the mystic experience is more than an intellectual handicap. Lack of awareness of the basic unity of organism and environment is a serious and dangerous hallucination. For in a civilization equipped with immense technological power, the sense of alienation between man and nature leads to the use of technology in a hostile spirit-to the "conquest" of nature instead of intelligent co-operation with nature. The result is that we are eroding and destroying our environment, spreading Los Angelization instead of civilization. This is the major threat overhanging Western, technological culture, and no amount of reasoning or doom-preaching seems to help. We simply do not respond to the prophetic and moralizing techniques of conversion upon which Jews and Christians have always relied. But people have an obscure sense of what is good for them - call it "unconscious self-healing," "survival instinct," "positive growth potential," or what you will. Among the educated young there is therefore a startling and unprecedented interest in the transformation of human consciousness. All over the Western world publishers are selling millions of books dealing with Yoga, Vedanta, Zen Buddhism, and the chemical mysticism of psychedelic drugs, and I have come to believe that the whole "hip" subculture, however misguided in some of its manifestations, is the earnest and responsible effort of young people to correct the self-destroying course of industrial civilization.

The content of the mystical experience is thus inconsistent with both the religious and secular concepts of traditional Western thought. Moreover, mystical experiences often result in attitudes that threaten the authority not only of established churches, but also of secular society. Unafraid of death and deficient in worldly ambition, those who have undergone mystical experiences are impervious to threats and promises. Moreover, their sense of the relativity of good and evil arouses the suspicion that they lack both conscience and respect for law. Use of psychedelics in the United States by a literate bourgeoisie means that an important segment of the population is indifferent to society's traditional rewards and sanctions.

In theory, the existence within our secular society of a group that does not accept conventional values is consistent with our political vision. But one of the great problems of the United States, legally and politically, is that we have never quite had the courage of our convictions. The Republic is founded on the marvelously sane principle that a human community can exist and prosper only on a basis of mutual trust. Metaphysically, the American Revolution was a rejection of the dogma of Original Sin, which is the notion that because you cannot trust yourself or other people, there must be some Superior Authority to keep us all in order. The dogma was rejected because, if it is true that we cannot trust ourselves and others, it follows that we cannot trust the Superior Authority which we ourselves conceive and obey, and that the very idea of our own untrustworthiness is unreliable!

Citizens of the United States believe, or are supposed to believe, that a republic is the best form of government. Yet vast confusion arises from trying to be republican in politics and monarchist in religion. How can a republic be the best form of government if the universe, heaven, and hell are a monarchy? [8] Thus, despite the theory of government by consent, based upon mutual trust, the peoples of the United States retain, from the authoritarian backgrounds of their religions or national origins, an utterly naive faith in law as some sort of supernatural and paternalistic power. "There ought to be a law against it!" Our law-enforcement officers are therefore confused, hindered, and bewildered-not to mention corrupted-by being asked to enforce sumptuary laws, often of ecclesiastical origin, that vast numbers of people have no intention of obeying and that, in any case, are immensely difficult or simply impossible to enforce-for example, the barring of anything so undetectable as LSD-25 from international and interstate commerce.

danger

Finally, there are two specific objections to use of psychedelic drugs. First, use of these drugs may be dangerous. However, every worth-while exploration is dangerous - climbing mountains, testing aircraft, rocketing into outer space, skin diving, or collecting botanical specimens in jungles. But if you value knowledge and the actual delight of exploration more than mere duration of uneventful life, you are willing to take the risks. It is not really healthy for monks to practice fasting, and it was hardly hygienic for Jesus to get himself crucified, but these are risks taken in the course of spiritual adventures. Today the adventurous young are taking risks in exploring the psyche, testing their mettle at the task just as, in times past, they have tested it - more violently - in hunting, dueling, hot-rod racing, and playing football. What they need is not prohibitions and policemen, but the most intelligent encouragement and advice that can be found.

escape from reality

Second, drug use may be criticized as an escape from reality. However, this criticism assumes unjustly that the mystical experiences themselves are escapist or unreal. LSD, in particular, is by no means a soft and cushy escape from reality. It can very easily be an experience in which you have to test your soul against all the devils in hell. For me, it has been at times an experience in which I was at once completely lost in the corridors of the mind and yet relating that very lostness to the exact order of logic and language, simultaneously very mad and very sane. But beyond these occasional lost and insane episodes, there are the experiences of the world as a system of total harmony and glory, and the discipline of relating these to the order of logic and language must somehow explain how what William Blake called that "energy which is eternal delight" can consist with the misery and suffering of everyday life. [9]

The undoubted mystical and religious intent of most users of the psychedelics, even if some of these substances should be proved injurious to physical health, requires that their free and responsible use be exempt from legal restraint in any republic that maintains a constitutional separation of church and state. [10] To the extent that mystical experience conforms with the tradition of genuine religious involvement, and to the extent that psychedelics induce that experience, users are entitled to some constitutional protection. Also, to the extent that research in the psychology of religion can utilize such drugs, students of the human mind must be free to use them. Under present laws, I, as an experienced student of the psychology of religion, can no longer pursue research in the field. This is a barbarous restriction of spiritual and intellectual freedom, suggesting that the legal system of the United States is, after all, in tacit alliance with the monarchical theory of the universe, and will, therefore, prohibit and persecute religious ideas and practices based on an organic and unitary vision of the universe. [11]

Footnotes

1. See W. James, *The Varieties of Religious Experience* (1902).
2. An excellent anthology of such experiences is R. Johnson Watcher on the Hills (1959).
3. Thus Hinduism regards the universe not as an artifact, but as an immense drama in which the One Actor (the *paramatman* or *brakman*) plays all the parts, which are his (or "its") masks or personae. The sensation of being only this one particular self, John Doe, is due to the Actor's total absorption in playing this and every other part. For fuller exposition, see S. Radhakrishnan, *The Hindu View of Life* (1927); H. Zimmer, *Philosophies of India* (1951), pp. 355-463. A popular version is in A. Watts, *The Book - On the Taboo Against Knowing Who You Are* (1966).
4. *Isaiah* 45: 6, *Isaiah* 45: 7
5. *Chandogya Upanishad* 6.15.3.
6. Alfred Lord Tennyson, *A Memoir by His Son* (1898), 320.
7. A Prayer for the King's Majesty, Order for Morning Prayer, *Book of Common Prayer* (Church of England, 1904).
8. Thus, until quite recently, belief in a Supreme Being was a legal test of valid conscientious objection to military service. The implication was that the individual objector found himself bound to obey a higher echelon of command than the President and Congress. The analogy is military and monarchical, and therefore objectors who, as Buddhists or naturalists, held an organic theory of the universe often had difficulty in obtaining recognition.
9. This is discussed at length in A. Watts, *The Joyous Cosmology: Adventures in the Chemistry of Consciousness* (1962).
10. "Responsible" in the sense that such substances be taken by or administered to consenting adults only. The user of cannabis, in particular, is apt to have peculiar difficulties in establishing his "undoubted mystical and religious intent" in court. Having committed so loathsome and serious a felony, his chances of clemency are better if he assumes a repentant demeanor, which is quite inconsistent with the sincere belief that his use of cannabis was religious. On the other hand, if he insists unrepentantly that he looks upon such use as a religious sacrament, many judges will declare that they "dislike his attitude," finding it truculent and lacking in appreciation of the gravity of the crime, and the sentence will be that much harsher. The accused is therefore put in a "double-bind" situation, in which he is "damned if he does, and damned if he doesn't." Furthermore, religious integrity - as in conscientious objection - is generally

tested and established by membership in some church or religious organization with a substantial following. But the felonious status of cannabis is such that grave suspicion would be cast upon all individuals forming such an organization, and the test cannot therefore be fulfilled. It is generally forgotten that our guarantees of religious freedom were designed to protect precisely those who were not members of established denominations, but rather such (then) screwball and subversive individuals as Quakers, Shakers, Levellers, and Anabaptists. There is little question that those who use cannabis or other psychedelics with religious intent are now members of a persecuted religion which appears to the rest of society as a grave menace to "mental health," as distinct from the old-fashioned "immortal soul." But it's the same old story.

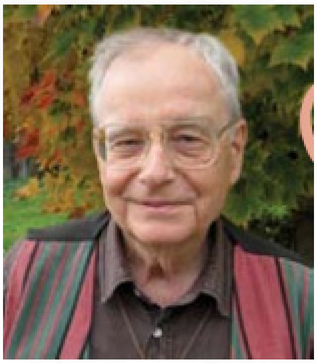
11. Amerindians belonging to the Native American Church who employ the psychedelic peyote cactus in their rituals, are firmly opposed to any government control of this plant, even if they should be guaranteed the right to its use. They feel that peyote is a natural gift of God to mankind, and especially to natives of the land where it grows, and that no government has a right to interfere with its use The same argument might be made on behalf of cannabis, or the mushroom *Psilocybe mexicana Heim*. All these things are natural plants, not processed or synthesized drugs, and by what authority can individuals be prevented from eating theme There is no law against eating or growing the mushroom *Amanita pantherina*, even though it is fatally poisonous and only experts can distinguish it from a common edible mushroom. This case can be made even from the standpoint of believers in the monarchical universe of Judaism and Christianity, for it is a basic principle of both religions, derived from Genesis, that all natural substances created by God are inherently good, and that evil can arise only in their misuse. Thus laws against mere possession, or even cultivation, of these plants are in basic conflict with biblical principles. Criminal conviction of those who employ these plants should be based on proven misuse. "And God said 'Behold, I have given you every herb bearing seed, which is upon the face of all the earth, and every tree, in the which is the fruit of a tree yielding seed - to you it shall be for meat.... And God saw every thing that he had made, and, behold, it was very good." - Genesis 1:29, 31.

Revisiting the Tibetan Book of the Dead and The Psychedelic Experience

by

Ralph Metzner

original source: http://www.maps.org/news-letters/v20n1/v20n1-32to33.pdf
backup source: http://www.psilosophy.info/resources/v20n1-32to33.pdf



Undoubtedly the best-known text in world religious literature concerning itself with the afterlife and the process of reincarnation is the *Bardo Thödol*, popularly known as *The Tibetan Book of the Dead*. This book, in a translation by W.Y. Evans-Wentz, served as the text which Leary, Alpert and myself used as the basis for our guidebook on psychedelic states, *The Psychedelic Experience*, first published in 1964. In the years since its publication I have received many letters and comments to the effect that while most actual psychedelic experiences did not follow the idealized sequence of three stages laid out in the *Bardo Thödol*, what people appreciated about our manual were the recommendations to think of the psychedelic experience as an opportunity for psycho-spiritual practice and learning.

The original *Bardo Thödol*, is attributed to the legendary 8th century Indian Buddhist adept Padmasambhava, who brought Buddhism to Tibet. According to Buddhist scholar (and erstwhile participant in the Harvard psychedelic studies) Robert Thurman, who has published a more recent translation, the title of the work should more accurately read *The Great Book of Natural Liberation Through Understanding in the Between*. "Between" (as a noun) is Thurman's translation of the term bardo, - a somewhat odd linguistic choice for the concept which Evans-Wentz translated as "intermediate state." Actually, there are three bardo states described in the *Bardo Thödol* as being between life and death; and there are three additional bardo states, mentioned in appended *Root Verses*, that occur between birth and death - the waking life, dreaming and meditating.

Thus, it is clear that the term bardo refers to what in Western psychology is called a "state of consciousness." As I point out in my book *MindSpace and TimeStream*, a state of consciousness is always defined by a division of time between two transition points, - for example, "sleep" is the state between falling asleep and waking up. Whereas the Indian Vedanta identifies four common states - waking, sleeping, dreaming and meditating, Buddhist teachings mention three, combining the sleep and dream states. In the abovementioned *Root Verses* and other Tibetan Buddhist texts, there are descriptions of six yogas - practices for becoming lucid and liberated in each (or from each) of the six bardo states. In recent years, several Tibetan lama-teachers have expounded on the yoga of dreams - and such teachings converge with Western psychological research on the induction of lucid dreaming.

The *Bardo Thödol* concerns itself with providing guidance for the dying person on how to find their way through the three bardo states, giving detailed and explicit instructions how people can be helped to make the most favorable kind of rebirth possible. It teaches that liberation from the samsaric round of conditioned existence can occur in, or from, any of the bardo states, if we understand and remember the teachings, recognize the bardo state we are in, and choose the most enlightened conscious option available to us.

The teachings of the *Bardo Thödol*, in outline, are that immediately at death, in the bardo of the moment of dying, highly proficient meditators who can maintain one-pointed concentration will be able to attain liberation. Most people are not able to concentrate, however, get caught up in fear and confusion and enter into the second phase, called the bardo of the experiencing of reality, in which there are visions of "peaceful and wrathful deities." The deceased is reminded not to be overwhelmed by either the heavenly or the hellish visions, but to remember that they are all projections of one's own mind. Due to lack of training and/or preparation on the part of most ordinary people, the bardo traveller, after repeatedly lapsing into unconsciousness, then finds himself in the third phase, the bardo of seeking rebirth, in which he wanders about seeking to orient himself again to ordinary existence.

Although the *Bardo Thödol* does not explicitly mention the prenatal epoch as such, we can find in the teachings of the after-death bardo states some suggestive parallels with findings now emerging out of the work of prenatal regression therapists and past-life therapists. My own understandings of these areas have been deepened by my own participation in such explorations, using psychological, shamanic, yogic and alchemical methods, which I call divinations, for myself and with individuals and groups. At times, my explorations have involved the amplification of perception through psychedelic substances (where this was permissible).

The work of the prenatal regression therapists has uncovered cellular memories of conception, including the impact of the attitudes and expectations of father and mother at the time of conception. Past-life therapists now speak of a series of learning experiences undergone by the soul during the interlife period, that can be remembered in deep trance states. Prior to what is experienced as the descent into form at conception, there is a meeting with a group of meta-physical human spirits, called the soul council, at which the decision to incarnate is made, according to one's intentions, choosing the parents and circumstances of one's incarnation or rebirth.

According to the *Bardo Thödol*, in the phase of rebirth the traveler in the intermediate realms is repeatedly admonished to remember where he is, and that his thoughts and intentions will profoundly affect the kind of experience he/she may have. The deceased is reminded of the six possible worlds of samsara (existence) into which he might find him or herself drifting, carried along by the karmic propensities of their previous existence. They are advised to avoid the hell worlds, and the worlds of pretas and asuras, but, if rebirth is unavoidable, to go with the heavenly worlds of benign spirits (devas) or thehuman world - considered to be offering the best opportunities for liberation.

Then follow a series of instructions on how to "close the womb-door," the point here being to delay the rebirth as long as possible, so that one can prolong one's stay in the higher planes and avoid being sucked into unfavorable birth forms by one's karmic propensities. The first method of closing the womb-door is to remember that you are in this bardo of rebirth and to focus on positive intentions: "this is a time when earnestness and pure love are necessary." The second method of closing the womb-door is used as the deceased has visions of males and females coupling: he/she is to think of them as a divine Father-Mother pair, and withhold from joining them. The third, fourth and fifth methods of closing the wombdoor involve further ways of dealing with the visions of a man and woman copulating.

When we wrote *The Psychedelic Experience*, we interpreted these passages in the *Bardo Thödol* as referring to the sexual hallucinations that are not uncommon in psychedelic states. In the light of my subsequent experiences and of the literature on prenatal regression therapy, I now believe that the visions of couples copulating refer to memories of our own conception. In directed hypnotic and psychedelic trance states, people can remember, as souls, choosing the parents and existential conditions of their conception and birth to come and how that choice relates to their life-purpose. I myself have come to understand how my choice of parents of different nations (Germany and England), that were soon to be embroiled in world war, related to my life's work or mission. I know of artists or musicians, who remember choosing, as souls, to be conceived and born into a family where their artistic inclinations can be nurtured.

According to the *Bardo Thödol*, if after using the various methods of preventing or postponing rebirth by meditating with conscious intention on light, one is still drawn into a womb for birth, the deceased is given instructions for "choosing of the womb-door." The soul is advised to choose a human birth in an area in which religion prevails, and, "being born so, be endowed with great merit so as to be able to serve all sentient beings. Thinking thus, direct your wish, and enter into the womb." This is then, the moment of conception, where the soul descends from the higher realm where it has made its choice for a particular incarnation, in a particular family at a particular place and time.

To summarize, the instructions for the most favorable kind of re-birth, are: to delay the return from the light- and wisdom-filled heaven worlds as long as possible, and when the time comes, which you know by seeing the acts of conception between men and women, to choose a birth family where the likelihood of coming into contact with spiritual teachings are greatest. The ending of the interlife period is the beginning of the bardo of rebirth: the decision is made to reincarnate, in a blending of karmic tendencies and conscious choice, and conception takes place in a fleshly human womb. This rebirth phase then ends with the actual physical birth, nine months later, when we start cycling through the three bardos of waking life, dreaming and meditating.

The Teonanacatl - In Pre-conquest Accounts and Today

by

Lothar Knauth

original source: http://www.samorini.it/doc1/alt_aut/ek/knauth.pdf
backup source: http://www.psilosophy.info/resources/knauth.pdf

Table of Contents:

Types of Hallucinatory Mushrooms
Mushrooms in pre-Conquest Accounts
The Mushroom Party (translation of the text)
Mushrooms Today
Conclusion

Brother Toribio de Benavente, better known as Motolinia, describing the idolatry and bad ha bits of the Mexican Indians, gave this unusual report about one of their lesser known vices:

> They had another drunkenness which made them more cruel: which was of some small mushrooms, which are found here as in Castilla; however the ones here are of such nature that eaten raw and being sour, one drinks afterwards or eats them with a hit of honey; and after a little while they were seeing a thousand visions, especially of snakes, and as they went completely out of their minds, it seemed to them that their legs and body were full of worms which were eating them alive, and thus, half raving, they went out of the house, wishing that somebody would kill them, and with that bestial drunkenness and the trouble they felt, it would happen sometimes that they would hang themselves. And they were also against the others much more cruel. They called these mushrooms *teonanacatl*, which means flesh of the Cod (the demon they adored) and in that manner, with that bitter food, their cruel god held communion with them.[1]

Other pre-Conquest accounts, describing hallucinatory mushrooms and their effects, all written in the 16th Century, are available in Spanish (by Spanish monks and Mestizo historians like Duran and Tezozomoc) and in Nahuatl (Sahagún, Ms. de la Biblioteca Nacional de México). Collected after the Conquest, they base themselves, directly or indirectly, on Indian informants.

Not until recently, a renewed interest has been taken in these "intoxicating mushrooms".[2] In 1936 Robert J. Weitlaner discovered them still being used in ceremonies of the native *curanderos* among the Mazatec Indians in Huautla de Jiménez, State of Oaxaca, México. This discovery was followed by descriptions of non-Indians of Native mushroom ceremonies (Basset Johnson, Carrasco). However, only after the mycologists (the Wassons, Roger Heim) became interested, widespread scientific attention was aroused. Public interest awakened after *Life* magazine published an advance story from the Wasson's *Mushrooms, Russia and History*, with a picture spread of a mushroom ceremony in Oaxaca. Today, hallucinatory mushrooms are grown in greenhouses in Paris and their active substance is synthesized in Switzerland and the United States. Full-scale medical and psychological research programs are under way, among others, at the Institute of Personality Research at Harvard and the Universidad Nacional Autonoma de México.

By correlating Indian and quasi-Indian pre-Conquest references to hallucinatory mushrooms with personal experiences encountered today under controlled group conditions, we hope to reach new insights into one little known facet of pre-Conquest culture.

Types of Hallucinatory Mushrooms

To ward off the impending invasion of Cortés and his Spaniards, the Aztec emperor Mocteuczoma II sent out some of the best magicians of his vast domain. One group of them came from a series of towns famed for their wizardry, which are found on an imaginary line that stretches itself from east to west south of the Valley of

Mexico: Acapixtla (Yecapixtla today), Huaxtepec (Oaxtepec), Yauhtepec, Cuauhnauac (Cuernavaca), Ocuillan, Malinalco and Tenancingo.[3] Strangely enough, this line extended to the northeast leads to *San Pedro Nexapa*, on the slopes of the volcano Popocatepetl, and, drawn out to the west, to *San Pedro Tlanixco*, on the slopes of the Sierra de Toluca (Tzinantecatl). Stranger even, in both San Pedros hallucinatory mushrooms are gathered and used to this day. The third prominent "Mushroom village", already mentioned, is *Huautla de Jiménez*, which, located near Teotitlan del Camino and Tehuacan, Hes in another territory famous in pre-Conquest times for its wisemen, astrologers and magicians.

In each one of the three locations the mushrooms are slightly different in appearance: The one in Huautla is named *Psilocybe mexicana*, the one in San Pedro Nexapa, *Psilocybe aztecorum* Heim, and the one in San Pedro Tlanixco, *Psilocybe wassonii*.

The last mentioned variety is known to me personally and was used in the already mentioned group experiments. They are called by the natives *mujercitas* (little women) or by their Nahuatl equivalent, *Cihuatzitzintli*. They women selling me the mushrooms in the market told me that they had to take a few bites of the mushrooms while picking them, "because otherwise the *mujercitas* will get mad and we will fall sick".

Also used in native ceremonies, but according to Heim of no hallucinatory value, are *hombrecitos* (little men in Nahuatl: *tlacatzitzintli*) identified by the French mycologist as *Cordyceps capiate* and easily recognized by their phallic shape and *niños* (little children, in Nahuatl: *piltzitzintli*), a yellow mushroom known as *Nevrophyllum floccosum*.

Mushrooms in pre-Conquest Accounts

I have drunk mushroom wine, my heart cries,
I am desolate on this earth, I am a wretch...[4]

Thus a Nahuatl poet expresses his feeling of "Ephemeral Friendship". A feeling of desolation seems to he common to most pre-Conquest descriptions of the effect of intoxicating mushrooms. Orozco y Berra, writing in the 1870's but basing himself mainly on Motolinia, gives this account:

> The *teonanacatl*, divine flesh, divine mushroom, bitter and disagreeable, was eaten to practice certain superstitious acts; they took two of three only with a little honey. They produced a state of intoxication with frightening hallucinations.[5]

That these mushrooms were widely used is shown by the fact that Alonso de Molina, in his *Vocabulario en Lengua Castellana y Mexicana* in 1571 published for the first time, gives five different translations for the term "mushroom which makes drunk", namely: *xochinanacatl, tepexina nanacatl, ixtlauacan nanacatl, mazauacan nanacatl* and *tequinti nanacatl*.[6]

Often when disconsolate, dissolute, disintegrating states of personality are described, We find a reference to mushrooms in the Nahuatl accounts recorded by the Franciscan monk Bernardino de Sahagún. The following quotations are taken from their German publication and translation by Leonard Schultze-Jena. Only the first is from another source.

Of *yollopoliuhqui*, the deranged one, "the one who has lost his heart", it is sad: *iuhqui nanacatl tiquatinemi*, "you are like one who always 'eats mushrooms'".[7] The angry young man, in *tlaveliloc telpuchtli*, has turned into a mushroom, *nanacatl mochiuhtinemi*.[8] This is also said of the angry full-grown man, *Itlaueliloc tetzon*, who has turned into a mushroom, who eats them all the time, *nanacatl mochiuhtinemi, quiquatinemi*.[9] From the bad noblewoman without shame, *in amo qualli tetlapallo amo pinavani*, who is addicted to, mushrooms, *monananacatitinemi*,[10] it is only a short step to the prostitute, *aviyani*, who, besides drinking *mivintitinemi*, and chicle-chewing, *motlapavitinemi*, also has the vice of eating mushrooms, *monananavitinemi*.[11] The gallery of lesser members of society continues, downward, to the disintegrated young man, *telpuchtlavelitoc*, who also chews mushrooms consistently,[12] to the procurer, *tetlanochiliani*, who has a whole repertoire of effects for he acts like an hallucinatory seed, *tepixvia*, an enchanter, and an hallucinatory mushrooms.[13]

After having found references to them in the reporting of attributes among the lower fringes of society, we suddenly encounter a mention of them in Orozco y Berra's account of the coronation of Mocteuccoma II:

> The religious festivities ended, the lords gathered to eat woodland mushrooms, which contain that which confuses the mind, as if they were intoxicating drinks; while their minds were confused they saw visions, believed to hear voices; therefore, they took these hallucinations as divine notices, revelations of the future and augury of things to come.[14]

Orozco y Berra bases his accounts of the coronation on the descriptions by Durán and Tezozomoc, chroniclers writing in the 16th century. Durán says of the same incident:

> ... (they) were so intoxicated and out of their mind that many of them killed themselves by their own hands, and under the power of those mushrooms, they saw visions and had revelations of the future, and their demon spoke to them in their drunkenness.[15]

Tezozomoc has this to add:

> …the strangers gave them mushrooms found in the mountain woods so that they would get intoxicated, and with that they began to dance; others went inside to their rooms to rest. Then they took the big lights of the patio and everytime they started the song the strangers began to dance and to sing; and so that they should not be known they dressed themselves with false hair.[16*]

Mushrooms in the coronation festivities? Perhaps the *teonanacatl* was not so bad after all as a status symbol? The following text from Sahagún, the only report of an entire mushroom ceremony I could find written and preserved in Nahuatl, might throw a new light on the actual place taken by mushrooms in pre-Conquest Nahuatl culture.

Though not describing the coronation, it nonetheless is part of the important fiesta which the *pochteque*, the great merchants of the Aztec empire, gave the night before they sent their trading caravans to the distant, foreign commercial centers of the Gulf and Pacific coasts. For the Nahuatl text we have depended on the paleography of Leonard Schultze-Jena; the translation into English, keeping close to the original without romantic enlargement and verbal ornamentation, is our own:

> Ni man ye ic ualquiza im mihtotizque: in tlacateccatl in tlacochcalcatl, in ye mochintin quaquachicti, in otomi, in tiachcuau, auh; yehuantzin puchteca-tlahtoque ahmo mihtotia, zan onoque, mopistoque, ypampa ca yehuantzin in tecouachia. Auh in pochteca huehuetque, yehuantzin tenamiqui ysxochitica in ietica, in amacozcatl xiuhtezcayo, auh in ichquetzalli pepeyocyo metzcuitlatica. Uel yacattiuia, in tequeltitiloya, nanacatl; in quiquaya, ihquac, in quitouaya tlahtla pitzalizpan, ayamo tle tlaqualli quiquaya. Can oc iyo in cacauatl coniya youaltica.
>
> Auh in nanacatl neocyo in quiquaya; in ihuquac ye intech quiza nanacatl, in oncan mihtotia, oncan choca auh y cequintin inoc iyollo quimati: calaqui, in oncan inyeyan motlalian caltech, aocmo mihtotia, can oncan ualtolotimotlalia.
>
> inaca commottiilia, ye mizquiz, oncan chocatica, in aca commottilia, yaomizquiz, in aca commottilia, tequanqualoz. in aca commottilia, yaoc tlamaz, in aca commottilia, yehuatl immocuiltonoz, im motlacamatiz, in aca commottilia, tecouaz, tlacaua yez. In aca commottilia, tetlasximaz, tetzohtzonaloz, tetepacholoz. in aca commottilia, ihichtequiz, no tetepacholoz. in aca commottilia, tequatepachoz, quitzaoctiaz. in aca commottilia, atlan mizquiz, in aca commottilia, yehuatl in iuian yocosca monemitiz, ypan mizquiz. in aca commottilia, tlapanco ualhuetziz, mictiuetzic.
>
> Yzzazo quesquich tepan mochihuaz, mochi oncan conittaya, in ahnoza ylaquiloz. auh in oquincauh nanacatl, ca tepan monohnonotza, quimulhuia. in tle ocommottilihque, auh i yehuantzin, in ahtle oquiquahque nanacatl, no quichiuhtinemi, in tlein impan mochiuaz yuan in tlein quichiuhtinemi cequintin: in ahzo ihichtequi, in ahzo tetlahtlesxima, - yzzazo izquitlamantli omihto: in tlamaz, in tequiuahcatiz, in telpuchiyahcatiz, in yaomizquiz, in motlacamatiz, in tecouaz, in cuicuicaz, in

> tealtiz, in tetlasximaz, in mohquechmecaniz, in atlam mizquiz, in ilaquiloz, yzcaco tlein impan mochiuaz; mochioncan conittaya, in ahnozo anauac miquitiuh.[17]

The Mushroom Party (translation of the text)

"The arrived those that were going to dance: the *Tlacateccatl*, the *Tlacochcalcatl*, and those that were going to abandon themselves, the *Otomi* and the *Titichcaua*. Those of the merchant leaders who were not going to dance were the straight-laced, chaste ones, who bought themselves somebody. And the old merchants met them with flowers, with tobacco, with brilliant green paper collars and bunches of quetzal feathers glistening in the moonlight.

Right at the beginning, as a refreshment, they ate mushrooms. Then they felt with it a bum, a red-hot blown fire inside and not from hot food they were eating. Therefore they drank cocoa that was kept warm for the night. Thusly they ate the intoxicating mushrooms.

When they had finished eating them, they danced and they cried. Meanwhile some of them felt the effect: they went inside they sat down, with their backs against the wall. They didn't dance anymore. They sat by themselves, in the same place and let their heads hang.

In that stupor, some imagined they were going to die and they cried; some were to perish in the war; some were to be eaten by wild beasts; some were to take prisoners of war; some were to be somebody rich, very rich; some were to buy and be owners of slaves; some were to be adulterers, were to be stoned, were to be stoned to death; some were to be thieves and be stoned to death; some were to become dissolute, were to end as drunkards; some were to drown; some were to be somebody peaceful, peacefully living to themselves and dying the same way; some were to fall from the roof and die suddenly.

There were many who were speaking to themselves as they saw how were they were to perish. And as the mushroom effect wore off, they met, huddled together to talk: the ones who had been in the stupor and those who had not eaten any mushrooms who hadn't been in the stupor - and those were teasing the others all night long about what was going to happen: that they were perhaps thieves, that some of them were adulterers. There were so many things to pique them with: that one was to capture prisoners, the great works another was going to do; that one was to be a leader among the young men; that one was to die in the war; that one was to be captured; that one was to be rich; that one was to be successful with women; that one was to wash slaves for sacrifice; that one was to be an adulterer; that one was to hang himself; that one was to drown; that one was lo become dissolute. There were many of those that were teasing... And lo themselves they imagined that they might go lo their deaths in that far land..."

Mushrooms Today

The two mushroom experiments in which I took part were undertaken at different times, in different locations and in different group situations. Both limes the *mujercitas* from the slopes of the Sierra de Toluca were used. The first experiment look place in the midst of the rainy season, in August; the second, towards its end, in October. Fresh mushrooms are available only during the rainy season.

On Thursday, market day, the first lot of mushrooms was bought from Doña Juana, who sampled them in front of us, in the shade of a churchwall, away from the tumult of the market. Upon the return lo Mexico City, the mushrooms were washed in cold water. Since it wouldn't be till Saturday that all subjects could meet for the group session, they were kept till then on the center shelf of the refrigerator.

The experiment took place in a residence in Cuernavaca, forty miles south of Mexico. This city of "eternal spring" has a subtropical climate and an average, even temperature in the middle 80's. Throughout the experiment the usual atmosphere of the house was maintained. After an afternoon of swimming, the participants wore either sports clothes or swimming suits. Though surely a far cry from Aztec vestments, the attire offered probably the same freedom of movement as the *maxtlatl* and the *tilmatli* of the Aztec merchants and noblemen. The idea was to experience the mushroom effect in the usual informal occidental group situation, with the least possible changes.

At 17.00 hrs., I began eating eight of the bluishly tinted mushrooms measuring on the average 7 cm. in stem length and 4 cm. in head diameter. Their taste was bitter-sour and left an acrid afterburn on the tongue and in the esophagus. I was seated at a garden table on the terrace. The large parasol above me had its underside covered with a tasteless flowerpattern. FoHowing my line of vision, about 2 m. beyond the table was a low hedge, then the length of the swimming pool. Farther on, 10 m. of lawn was followed by a line of trees forming the property line. It was about one hour before sunset.

After almost an hour I felt a slight, short pain in the nape of my neck. This was followed soon by a hardly noticeable increase in color perception. At about 18.10 hrs. I thought I saw some of the flowers in the pattern of the parasol move. At the same time I felt an extreme lightness and, coupled with it, a tendency to laugh. My eyes started watering and I had to visit the bathroom inside the house.

After I returned to my seat, I fixed my eyes on the fork in the tree at the end of my line of vision. Soon it took on the shape of a mask, hut not in the sense that it was obviously a mask, but much more that one was reminded of one - about the way one is reminded of something or other in the shape of the inkplots of a Rorschach test. This seems to be a very important point to note: Reality does not change completely while fixing the eye on a certain object. It is much more a seeing of forms based on the concrete image, or integrated into it. Soon afterwards the tree became the corner pillar of a kind of arcade, which changed continually its appearance. Suddenly, I noticed that I could return to the reality of my "table environment" at this side of the hedge. The table was still the table with its glasses and the parasol overhead. And when I looked beyond the hedge... my tree became once more the corner of that marvelous arcade. The images in it were rapidly changing, composite patterns, comparable with finely made mosaic or an exquisite stained glass window. The entire situation appeared closest to sitting in a drive-in theater: One can lose oneself in the image on the screen, but can also return to the reality of the confines of the car: to the coke on the dashboard and the box of popcorn.

At about that time an assistant put a portable radio in front of me. (Who had any idea of time?) Possibly the music might influence my visions. It didn't work. The radio music sounded tinny, grating, out of place. I wanted to be alone with my patterns.

I changed my point of concentration to the parasol above me and now its underside became my world of beautiful imagination. Within its circle, moving harmonically, changing consistently, appeared the most unusual designs of extremely brilliant, integrated colors. There literally thousands of them, one more perfect than the other. In their forms, not in their content, they reminded one of Mixtec codices. All was pure enjoyment. Later on I was told that I sat for an hour and a half staring at the parasol above me.

Another desire to urinate made me leave my position on the terrace. To enter the rest of the house, I had to pass through the kitchen. I noticed a pastel overcast in the interior. Otherwise, neither my visions nor my motions seemed impaired. The assistant who had brought the radio met me and said, "you should see how Ben is carrying on in the bar". Indeed, there seemed to he a clopping, singing sound in the bar-recreation room. As I entered the bathroom I was startled by the extreme luminescent brightness of a maroon towel hung up to dry. Also, the tile room seemed to be alive with hidden fluorescent light.

Then I went to the bar and saw my friend Ben sitting alone in an easy chair. The guitar laid across his knees, he was holding a nonsense dialogue interspersed with nonsense rhymes - with his barret. He recognized me immediately (there was never any difficulty in returning to the reality of recognition) and said, "You know what I just found out? A guitar, like a human being, has a musical side... " Here he struck the cords. Then he flipped the instrument over and tapped the bottom, " ... and a drum side". Then he went into an explanation of the different opportunities of influencing human actions by using either the musical or the drum side of a guitar. At that instant I noticed that also to my repertoires of feelings a new perception of symbolic in human situations had been added.

Leaving Ben, I went to one of the bedrooms. Three other participants were lying on the beds, hallucinating. They appeared to be completely happy with themselves. Now and then a low chuckle might be heard. Lying down also, in the darkness of a night outside, I noticed that now I could turn lo the hallucinations "inside me" at will, being able to change back with equal ease to the actual surroundings. Even while sinking away to see my "inside patterns", I could feel the texture of the bedspread with my fingers. My visions now consisted mainly of ribbons of the republics' flags: French, German, Mexican and American.

Between spells of being absorbed in my patterns, I had an interesting experience of symbolic perception. On the bed next to me, a coed, college senior, was lying in a bundled-up position. Next to her a professor from a prominent university, quite her senior, stretched out full length. Suddenly, with considerable impact, I saw the situation as a symbolic relationship: The phallic posture of the father figure next to the womb position of the child... I might add, that mushrooms don't seem to have any aphrodysian qualities.

After some more time in the bedroom I returned to Ben in the bar. He was still conversing with his barret in a completely autonomous attitude. Then, for the first time I noticed that objects had took on a *melted* look, but through conscious effort they could be kept *solid*. Only their *halo*, an aura of pastel color, could not be forced away.

Soon the effect began to wear away. It had be en just about five hours since it set in. There were still waves of distorted perception, especially of colors. Then, abruptly, I was completely *back*, feeling purged somehow and hungry. There remained a lingering, heightened color awareness. Other wise, I felt no after effect or hangover. I thought only to feel a slight pain on my eyeballs, as after looking into bright sunlight. Eats and drinks were brought to the table. All participants *returned* one after another and began talking about their experiences. In this respect, nothing was changed from pre-Conquest times.

Exchanging impressions and adding information supplied by the assistants, the following pattern of mushroom effects established itself: 1) The effect sets in approximately an hour after the eating. 2) It is felt first by a change in color perception and a general relaxation. This leads to feeling happy to ridiculous and a loosening of the sphincters, mainly inducing a watering of the eyes. 3) The first hour or more is one of intense hallucination in a more or less catatonic state. 4) The quality of the hallucinations is completely subjective, seeming to depend on the psychological state of the person. 5) There seems to be no feeling of hostility. There might be manifestations of auto-sufficiency, a desire not to be bothered. If potential conflict situations arise, the tendency is to withdraw. 6) There occurred definitely no schizophrenic state. All subjects had absolute control over their actions, whenever necessary. (It should be investigated to what extent this holds true for the quasicatatonic state already mentioned). 7) There is absolutely no difficulty in communicating verbally,[18] though the sense of auto-sufficiency is such there is no or little desire for verbal communication. 8) There are no side or after effects worth mentioning.

The second experiment took place in a residence in a Mexico City suburb, in October. This time the mushrooms were eaten the same day they were bought in the Valley of Toluca. The effect was basically the same. The quasi-catatonic state at the beginning was less pronounced and shorter. A certain harmony with sound effects was achieved by listening to Handel's *Watermusic* played back on tape. The over-all experience was pronouncedly wavelike: periods of almost complete reality changing with waves of hyperreality and distorted color perception. There was an extremely heightened awareness of symbolic values in inter-human relations. Toward the end of the toxic state, I experienced for first time a morphic change of my hand: the skin seemed extremely pergamine, the hairs prominent and the fingers growing and shrinking. The effect occurred only after watching the hand for some time. It could he "cut off" at will without difficulty.

It should be noted that during the second experiment all participants spoke at least three languages with some fluency. (The first session was carried on in English). There was absolutely no difficulty sustaining verbal communication in whatever language seemed most convenient at the moment.[18]

Conclusion

A comparison between pre-Conquest accounts and present day experiences shows on the surface a considerable similarity of overall effect. There is, however, a trend toward exaggeration in the Spanish and Mestizo chronicles. Closest to the effects encountered today comes the Nahuatl text about the *pochteca* party, collected by Sahagún.

Attributive expressions, involving references to mushrooms, also preserved in Nahuatl, may not mean a condemnation in pre-Conquest society as such. They are most likely used to create a strong image and evoke the intensity of the effect which must have been known widely - as is shown by the presence of five words for *intoxicating mushrooms* in the Molina vocabulary.

Since it was not meant for general publication, the *Pochteca* account seems to have preserved a considerable objectivity of relation. In the Spanish and Mestizo descriptions we are dealing with writings for wide publication, if not for propaganda. Therefore, they are in accordance with the opinion of the Catholic hierarchy that effect that cannot be controlled should not be approved. This explains also the emphasis on horrible visions and excessive acts. In tum, the *pochteca* report gives the whole range of the effect.

Three points seem to arise dearly from the comparison between pre-Conquest accounts and present-day experiences: 1) Nahuatl records are much less discolored and exaggerated than those written in Spanish; 2) in order to view manifestations of Nahuatl culture an undistorted, "humanistic" outlook is prerequisite and 3) we should try to comprehend pre-Conquest culture from within its context, perceive the complexity of its structure and should never accept without severe questioning, or take for granted the value judgments made by opinionated observers hundred; of years ago - or even just yesterday.

1. MOTOLINIA, *Historia de los Indios de la Nueva España*, Editorial Chávez Hayhoe (México, 1941), *trat.* 1, *cap.* II, p. 25.
2. *Cf.* the interesting summary by Demetrio Sodio "Las Investigaciones con Plantas Alucinantes" in *Boletín del Centro de Investigaciones Antropológicas de México*, May, 1960, No. 7, pp. 14-18.
3. OROZCO y BERRA, Manuel, *Historia Antigua y de la Conquista*, vol. IV, p. 118.
4. GARIBAY K., Angel María, *Poesia Indígena de la Altiplanicie*. U. N. A. M. (Mexico, 1952), p. 103.
5. OROZCO y Berra, vol. I, p. 274.
6. *Op. cit.*, p. 72.
7. SAHAGÚN, *Primeros Memoriales, Edición* faseimilar, pp. 127-9 (Garibay transl.).
8. SAHAGÚN, *Gliederung des alt-aztekischen Volks in Familie, Stand und Beruf*, aus dem aztekischen Urtext übersetzt und erläutert von Dr. Leonard Schultze-Jena (Stuttgart 1952), p. 26/27.
9. *Ibid.*, p. 36/37.
10. *Ibid.*, p. 50/51.
11. *Ibid.*, p. 58/59.
12. *Ibid.*, p. 242/243.
13. *Ibid.*, p. 244/245.
14. OROZCO y BERRA, vol. III, p. 375.
15. DURÁN, *Historia de las Indias de Nueva España y Islas de Tierra Firme*, Editorial Nacional (México, 1951), cap. LIV, p. 431.
16. TEZOZOMOC, Crónica Mexicana. cap. LXXXVII, p. 419.* It is possible that we have here another translation making as little sense as the same author's description of the *tlachtli*, the ballgame.
17. *Gliederung*..., pp. 212 and 214 *cf*. Sahagún, Facsimile edition of Paso y Troncoso, ff. 37 and 37 v.
18. Though being born and brought up in Germany, I now speak more English than German. When I was asked during the toxic state, I and difficulty recalling the German word for *pea* (*Erbse*) and could think sooner of the Spanish *chícharo*. A perfectly natural lapse of memory which might also have happened any other time.

Mushroom and Religion

by

Robert Graves

original source: http://www.math.uci.edu/~vbaranov/nicetexts/eng/mushrooms.html

The profound importance of mushrooms in primitive religion had remained undetected until some twenty years ago, when Mr. R. Gordon Wasson, an American banker, and his Russian-born wife Valentina first called attention to it. The new science of ethnomycology, meaning the attitudes of different races to mushrooms, began with the Wassons' puzzling over the division of Europe into two distinct camps: mycophobes (nations traditionally afraid of mushrooms) and mycophages (nations addicted to eating them). The mycophages of Europe are found in Spain, Southern France, the Balearics, Bavaria, the Balkans and Russia. Russians are the greediest mushroom eaters and recognize over ninety varieties of edible ones.

Until recently we English ate only the white field mushroom *Psalliotis campestris*, except in the Midlands where blewets were sold in the markets. But as a boy in North Wales I found even the field mushroom avoided as poisonous.

My mother had spent her childhood in Bavaria where mushrooms grew profusely in my grandfather's pine woods, and when taken there for holidays as a child I soon learned to distinguish seven or eight edible varieties and bring them back to the kitchen for dinner. Home in Wales, I came across some of these same mushrooms growing in the woods and brought them back to eat; but my mother astonished me by shouting: 'Throw those toadstools away at once! Yes, I know that they *look* like the ones we ate last week at Lauzforn, but here they are deadly poison. You had better wash your hands!' Whether she really believed this - her view seemed borrowed from my mycophobic Irish father - or whether she had to take this attitude because the cook would give notice the moment they were brought into the kitchen, I have never decided.

The existence of so many million unreasoning mycophobes throughout Northern Europe and North America - though, to be sure, some of them now dare to accept cooked mushrooms from abroad, neatly bottled - reminds me of another curious taboo in force among the ancient Greeks. They were forbidden to eat any bright red food, such as lobsters, crabs, prawns and wild strawberries (which had no name because regarded as poisonous). The Hebrew word *syeg*, meaning a 'hedge', explains both these taboos. To protect the Biblical ban on, for example, buying or selling on the holy Sabbath, the Jews of Jesus's day had put a protective 'hedge' around the Fourth Commandment by forbidding anyone to carry coins on his person from Friday evening until Saturday evening. And the truth is that mushrooms had once been regarded as holy and reserved for priests, kings and other privileged people; therefore to prevent the unprivileged from eating a sacred mushroom; a general *syeg* was put on mushroom-eating and reinforced by treating all mushrooms as poisonous. However, as already mentioned, an unexplained relaxation of the taboo in England allowed the eating of white field mushrooms, though the most deadly European mushroom of all, the *Amanita phalloides*, with which Nero's stepfather the Emperor Claudius had been poisoned, was equally white and has often been mistaken for it. It is therefore reasonable to guess that the sacred mushroom originally protected by these taboos grew in forests, not in fields, and was scarlet; and that the taboo explains the diabolic or disgusting names given even to highly edible other mushrooms.

But why was the scarlet mushroom (which can be easily identified with the white-spotted one now favoured by red-coated gnomes in suburban gardens and also associated with Father Christmas's reindeer and decorated tree) held sacred? This spectacular mushroom, incorrectly rumoured to be deadly poison, grows by the million all over the British Isles, but only in birch forests. A simple answer is that this was the magical mushroom, on which sat the caterpillar smoking his hookah, that Alice found growing in Wonderland. Lewis Carroll had read about its properties not long before he published the book; they included the same hallucinations about height - 'curiouser and curiouser' - from which Alice suffered after nibbling it. This mushroom, named *Amanita muscaria* - popularly 'fly agaric' - has now been proved by Gordon Wasson's detailed examination of the Vedic hymns (written in Sanskrit about the time of the Trojan War), to have been the Food of the Gods. It is there named 'Soma'. That it is also 'Ambrosia' and 'Nectar' (both these words mean 'immortal') which were famous as the food and drink of the Greek Olympian gods, I had myself shown some twelve years previously. Two early Greek poets, Sappho and Alcman, had preserved the ancient tradition of Ambrosia as a drink, not a food. This was because the juice of the mushroom - which lost its virtue when cooked - was squeezed out of it between boards, then mixed with milk or curds; and the pulp was thrown away. According to these Vedic hymns, Agni, the god of mystic illumination and holy fire, who was also expressly identified with Soma, had been created when the Father God Indra threw a lightning bolt at the Earth.

Dionysus (Bacchus), the Greek god of mystic illumination, was similarly born when his father the God Zeus (Jove) threw a lightning bolt at the Earth Goddess Semele; the bolt killed Semele but her child was saved and sewn up in his father's thigh, whence he was later granted a second birth. Dionysus is said to have eventually conducted his mother to Heaven where she changed her name to Thyone, meaning 'Queen of the Maenads' (or raging women) and presided over Dionysus's ecstatic October festival, called The Ambrosia. October was the mushroom season. The effect of the *Amanita muscaria* taken without other intoxicants is to give the taker the most delightful hallucinations, if he is in a state of grace, but horrible nightmares otherwise. Fortified, however, with beer and the juice of yellow ivy it would send Greek men and women raging mad. A mixture of *Amanita muscaria* with whisky has long been used as a celebratory drink by successful salmon-poachers in Scotland. It is called a 'Cathy', in honour of Catherine the Great of Russia who is said to have been partial to it.

The pre-Classical priests of Dionysus, a god now known to have been active in Mycenean times, seem to have claimed the sole rights in the scarlet mushroom, the memory of which they had brought from their original homes in Central Asia and which is not found growing south of the fortieth parallel, except at a great height and always in birch groves. The Vedic priests of Agni seem to have imported their supply from the birch-groves of the high Himalayas. Throughout the world mushrooms were believed to be begotten only by lightning.

That Dionysus was Ambrosia, as his Indian counterpart Agni was Soma, is proved by the legend of his birth from Zeus's thigh. The Vedic hymns make it clear that the priests of Indra and Agni used the two different ways of taking Soma still found among the Paleo-Siberians called Korjaks, and also in a small Mongol enclave of Afghanistan. The first was a simple drinking of the juice pressed from the mushrooms between boards and mixed with milk or curds. The hallucinogenic *indoles* it contained entered the stomach; but a great many more entered the kidneys and were later discharged with the urine. Clean-minded Classical scholars have until now shut their eyes to the possibility that the Vedic hymnwriter may have meant exactly what he said with 'the great gods piss out together the lovely Soma'. Yet it has been known for at least two centuries that the Korjaks do so after drinking the mushroom juice, and that their friends strain the urine through wool and, after drinking it, enjoy the same ecstasies. And this, of course, explains Dionysus's second birth from the thigh of his father Zeus and his subsequent release to worshippers in a stream of hallucinogenic urine. Yet Dionysus's source of intoxication has always been politely attributed by Greek scholars to wine, and Ambrosia is identified in the *Oxford English Dictionary* with *asclepias* (milk weed); and by various Encyclopedias with almost every sort of plant except mushrooms.

The Norse *berserks* were magicians and sages, and seem to have used the scarlet *Amanita muscaria*, as did the Korjaks, for inducing prophecies. They were called Berserks (Bear-shirts) because they worshipped the Bear goddess, which accounts for our Great Bear constellation, and wore bear skins in her honour. Their cult was suppressed in the eleventh century A.D. by Christian converts, not only in Scandinavia but in Iceland, where dwarf-birches in the centre of the island provided the berserks with their *amanita*. The proverb quoted by the Emperor Nero 'mushrooms are the food of the Gods' was true in the sense that they provided the passport to a Paradise from which the mushroom-eater was permitted to return, like a god, after his celestial visions. Yet Nero who, having been excluded from the Eleusinian Mysteries for murdering his mother Agrippina, had not himself visited Paradise, quoted the proverb only in a mocking sense: for his step-father Claudius, after dying from *Amanita phalloides* poisoning administered by Agrippina, had afterwards been deified.

I have eaten the Mexican hallucinogenic mushroom *Psilocybe heimsii* in Gordon Wasson's company, with the intention of visiting the Mexican paradise called Tlal6can to which it gives access. The god Tlal6c, who was toadheaded, corresponded exactly with Agni and Dionysus. I also wanted to know whether I had been right in supposing that all religious paradises except the Christian (which is based on a first century Eastern potentate's court), such as the Hebrew, the Sumerian, the Indian, the Mexican, the Polynesian and the Greek (known as the Garden of Hesperides) were not only very much alike but corresponded also with the individual paradises seen by such mystics as the English poet Henry Vaughan, the Silurist. The word *paradise* means 'orchard' in the Semitic languages; an orchard-garden of fruit trees, flowers and running water. Yes, I had guessed right, though there are, I believe, certain dissimilarities: for instance, elephants appear in the Indian paradise and in others the inevitable serpent, familiar to readers of the Paradise chapter in *Genesis*, may appear as it did for me, as an intricately patterned gold chain. A bright snake-like formation is, by the way, a common symptom of a cerebral deoxygenization induced by hallucinogenic drugs; and seeing snakes is a common occurrence among alcoholics, saints who starve themselves, drowning sailors and sufferers from meningitis. My experiences included not only an orchard Paradise where one can see sound, hear colours, and watch trees growing leaf by leaf, but a paradise of jewels like that described in the *Book of Ezekiel* XXVIII, 13-14.

The *psilocybe* mushroom used in the Mexican rites is small, brown in colour, slender-stalked and bitter; but sculptural evidence from Central America suggests that it had supplanted the *Amanita muscaria* in ritual use, probably because it was easier to obtain and because the hang-over did not last so long. The same change seems to have occurred in Greece: the discovery of a new hallucinogenic mushroom, a *stropharia*, or a *panaeolus*, which, unlike the *Amanita muscaria*, could be ground up and baked in sacrificial cakes for religious use in the Mysteries without losing its powers. When, according to the Greek myth, the Corn Goddess Demeter visited Eleusis, the Attic city where the Mysteries were to be celebrated for another two thousand years, she is said to have ordered Triptolemus, son of the local King, to drive around the civilized world in a chariot drawn by snakes, spreading the arts of agriculture as he went. This myth is clearly deceptive. Corn had been sown and harvested in Palestine for several thousands of years before Demeter's people arrived at Eleusis. What may have happened is that the local priestess sent a message about the newly discovered mushroom to priests and priestesses throughout the civilized world - hence the snakes in Triptolemus's chariot. This, if so, would explain why the nature and source of the original Soma has been forgotten in India for so many centuries. The supply from the birch groves of the High Himalayas seems to have been cut off by enemy action, and *placebos*, such as *asclepias*, substituted for it until eventually its place was taken in Brahman ritual, after the receipt of Triptolemus's message, by a better, more manageable and more accessible sacred mushroom.

In 1957 at my suggestion Mr. Wasson and the famous mycologist Dr. Roger Heim, Director of the Musee de l'Homme at Paris, visited the New Guinea Highlands from whence had come reports of a mushroom cult. They were able to attend a Bird of Paradise courtship ceremony danced by Stone Age men and women under the influence of a sacred mushroom. The specimen that Wasson and Heim were offered proved, however, unhallucinogenic. This may have meant either that the tribal elders deceived their visitors for religious reasons by giving them some ineffective substitute or that the tribe, having emigrated there from a place where a truly hallucinogenic mushroom grew, had been reduced to using this other variety as a *placebo*.

Another variety of the *Amanita muscaria* grows south of the fortieth parallel, with the pine as its host-tree, and is equally hallucinogenic. That it was ritually used in Biblical times is suggested by an unwritten Hebrew taboo on mushrooms, broken only by the non-orthodox. (Arabs, by the way, are mycophagous, which perhaps accounts for mushroom eating in those parts of Southern Europe occupied by the Saracens during the early Middle Ages.) I have elsewhere suggested that the golden 'ermrods' laid up in the Ark together with a pot of hallucinogenic manna really represented sacred mushrooms. A concealed reference to their use appears in the *Book of Judges*: the unlikely story of how Samson collected three hundred foxes and sent them into the Philistine's cornfields with torches tied to their tails. The Palestinian fox is not gregarious and the task of capturing three hundred of them, at the rate of one or two a day, and feeding them all until he had collected the full number would have been a senselessly exhausting one. Besides, how could he make sure that the foxes would run into the cornfields and keep the torches alight? The truth seems to be that Samson organized a battalion of raiders - three hundred was the conventional Hebrew battalion strength, as appears in the story of Gideon - and sent them out with torches to burn the Philistines' corn. Indeed, in the 1948 Jewish War of Liberation a raiding battalion was named 'Samson's Foxes'. But why foxes? Because the juice of the *Amanita muscaria* mushrooms (which still grow under the pines of Mount Tabor) could be laced with ivy juice or wine to make the raiders completely fearless, and because this variety, when dried, is fox-coloured. So are other mushrooms, such as the popular *chanterelle* which the Russians call *lisichka*, 'little fox'; but to clarify its meaning the Bible specifies 'little foxes with fire in their tails'. In the *Song of Solomon* the Shunemite bride, about to take part in a sacred marriage, urges her lover to fetch her 'the little foxes that spoil the vines, for my vines have tender grapes'. She means that Solomon must fortify his manhood with mushroom-juice laced with wine, the better to enjoy her young beauty.

Why mycophobes called mushrooms 'toad's bread' or 'toadstools' can readily be explained. When the toad is attacked or scared the warts on its back exude *bufotenin*, the poison secreted in the white hallucinogenic warts of the *Amanita muscaria*. In ancient Greece the toad was the emblem of Argos, the leading state of the Peloponnese, the emblems of the two other states being also connected with the mushroom: namely fox and serpent. This division into states had been made by a legendary king named Phoroneus, which seems a form of Phryneus, meaning 'Toad-man'. The capital city was Mycenae ('Mushroom City') said to have been built by Phoroneus's successor Perseus ('the destroyer') who, according to Pausanicus, had found a mushroom growing on the site beside a spring of water. The toad was also the emblem of Tlalóc, the Mexican God of Inspiration, and appears surrounded by mushrooms in an Aztec mural painting of Tlalócan, his Paradise.

The Slavs are not mycophobic, probably because their remote ancestors were nomads on the treeless steppes and unacquainted with *Amanita muscaria*. Their fermented mare's milk, called kavasse, satisfied their need for occasional intoxication. Like the Arabs in their desert poverty they had learned to eat any growing plant or living animal that was not poisonous. Bavaria is mycophagous, while the rest of Germany is mycophobic, simply because it was once invaded by Slavs.

I should add that reindeer are known to get high on *Amanita muscaria* in the birch forests of the far North, a habit of which their owners take advantage.

Magic Mushrooms Around the World

A Scientific Journey Across Cultures and Time

by

Jochen Gartz

The Case for Challenging Research and Value Systems

© 1996 Jochen Gartz

original source: https://cdn.preterhuman.net/texts/drugs/Magic.Mushrooms.Around.The.World.By.Jochen.Gartz.pdf
backup source: http://www.psilosophy.info/resources/Magic.Mushrooms.Around.The.World.By.Jochen.Gartz.pdf

Table of Contents:

"Who Was the First Magician?" - Foreword by Christian Ratsch
Flesh of the Gods for Devil Worshippers
CHAPTER 1 - Introduction
CHAPTER 2 - Reflections on the History and Scientific Study of Magic Mushrooms
Bwyd Ellylon: A Feast of Fairies in Celebration of the Spirit World
Berserk Rage of Nordic Warriors
Love Potions Brewed from *Bolond Gomba*
Between Reverence and Fear
Scientifically Unbiased Hallucinations?
CHAPTER 3 - The Current State of Knowledge About European Species
3.1 - *Psilocybe semilanceata*: The Classic Species Among European Psychotropic Mushrooms
Listen Well to this Frightful Story from St. James's Green Park....
Early Descriptions
The Popularity of Psilocybe semilanceata
Between a Creek and a Marshlands Pond... 8½ Inches Tall!
Accounts of Impressive Experiences
The Psychotherapeutic Potential of Psilocybin's Psychotropic Effects
The Long Shelflife of Psilocybin
3.2 - *Psilocybe cyanescens*: Potent Mushrooms Growing on Wood Debris
The Widespread Distribution of Psilocybe cyanescens
Spores Introduced From Overseas?
An Amazing Discovery Near Poricko
Impressive Experiences
Distribution Patterns of Psilocybe cyanescens in the Wake of Environmental Changes
3.3 - *Panaeolus subbalteatus*: Mycology and Myths about the *Panaeolus* Species
Growing on Dung, Manure and Compost
Taxonomic Confusion
Panaeolus Experiences
3.4 - *Inocybe aeruginascens*: Fast-Spreading New Arrivals
Strange Distribution Patterns in Hungary and Germany
Identification Errors
Flights of the Soul
Symbiosis With Trees
3.5 - *Gymnopilus purpuratus*: Magnificent Mushrooms from South America
Mushrooms 24 Inches Tall!
Mushrooms on Compost Mixture of Wood Chips and Pig Manure
Intoxicating Potions of the Yurimagua Indians
3.6 - *Conocybe cyanopus*: Tiny Mushrooms of Remarkable Potency

3.7 - *Pluteus salicinus*: A Little-known Wood-Inhabiting Species

CHAPTER 4 - Mushroom Identification: Taxonomic Confusion and the Potential for Deadly Mistakes

Warning: Amatoxins are Lethal!
Mycophile or Mycophobe?

CHAPTER 5 - The Bluing Phenomenon and Metol Testing: Reality vs. Wishful Thinking

A Rich Color Spectrum
The *Agaricales* as Alkaloid Producers
The Limitations of Reagents

CHAPTER 6 - Mushroom Cultivation: Classic Findings and New Techniques

Extraterrestrial or Earthly Organisms?
The Secret of "Overnight" Growth
Cultivating High Yield Strains
Counter-Cultural Expertise Gains Mainstream Acceptance
Some Recent Findings

CHAPTER 7 - Psychotropic Mushroom Species Around the World

- 7.1 - Spotlight on North America and Hawaii
  - *The Spread of Psilocybe semilanceata*
  - *A New Psychoactive Mushroom*
  - *Mushroom Trips as a Popular Sport*
- 7.2 - Mycophilia in Central and South America
- 7.3 - Australia's Mycoflora Attracts Attention
  - *Bizarre Reactions*
- 7.4 - European Customs and Conventions
  - *"Mushrooms Are Mushrooms"*
  - *Mega Mushroom Festival*
  - *Panic Reactions*
- 7.5 - Japanese Experimentation
  - *No Danger from Psilocybes in Japan*
- 7.6 - Intoxications and the Oldest Known Mushroom Cult in Africa
  - *10,000 Years Old*
  - *African Species Related to Psilocybe cyanescens?*
- 7.7 - Usage in Southeast Asia and the South Pacific Islands
  - *Neo-Mycoflora*
  - *Panaeolus cyanescens Omelettes*
  - *Monsoon Climate, Manure and Water Buffaloes*
  - *"Soma": A Psilocybian Species?*
  - *German Tourist Boom*

CHAPTER 8 - Some Comments on Effects of Mushrooms from the Category Phantastika

A Plethora of Names
LSD "Flashbacks"
Psilocybin as a Research Tool for Study and Diagnosis of Brain Damage
Ecstasy is More than Entertainment

CHAPTER 9 - Psychotherapy

Psycholytic Therapy
Psilocybin as the Drug of Choice
The Language of Statistics
The Conquest of Fear in the Face of Death
Scientific Research Under Fire
H-Bomb for the Soul?

CHAPTER 10 - Outlook

More Taxonomic, Ecological and Chemical Data are Needed
Understanding the Mushrooms' Powerful Magic

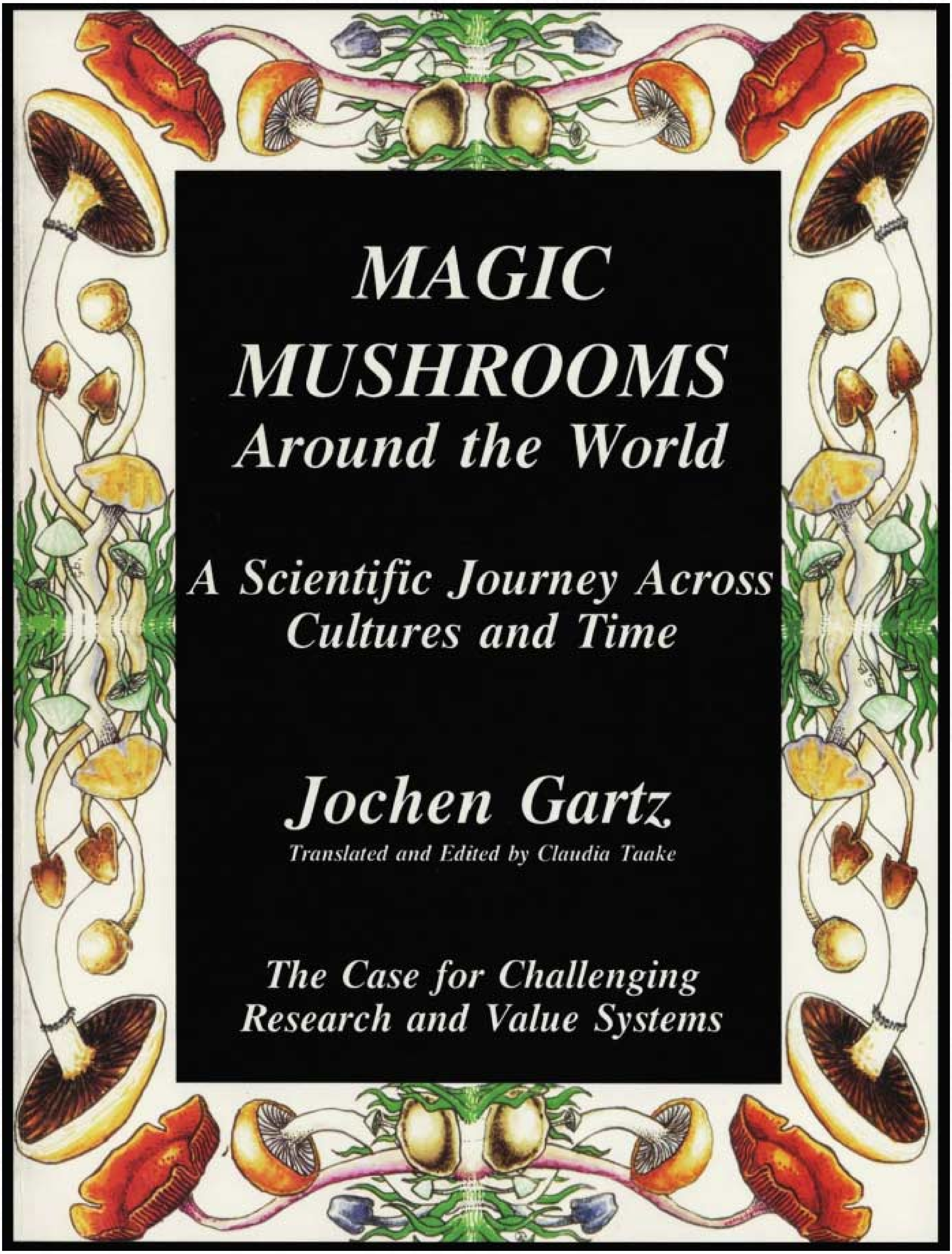
Acknowledgments

Bibliography

1. Basic Reviews
2. Medical-pharmacological Literature

3. General Reference Books
4. Mushroom Cultivation
5. Popular Literature
6. Conocybe
7. Galerina
8. Gymnopilus
9. Inocybe
10. Panaeolus
11. Pluteus
12. Psilocybe cyanescens Complex
13. Psilocybe semilanceata (Liberty Cap)
Index

Page references next to figure numbers refers to original version of this re-edition.



MAGIC MUSHROOMS
Around the World

A Scientific Journey Across Cultures and Time

Jochen Gartz

Translated and Edited by Claudia Taake

The Case for Challenging Research and Value Systems

"Who Was the First Magician?" - Foreword by Christian Ratsch

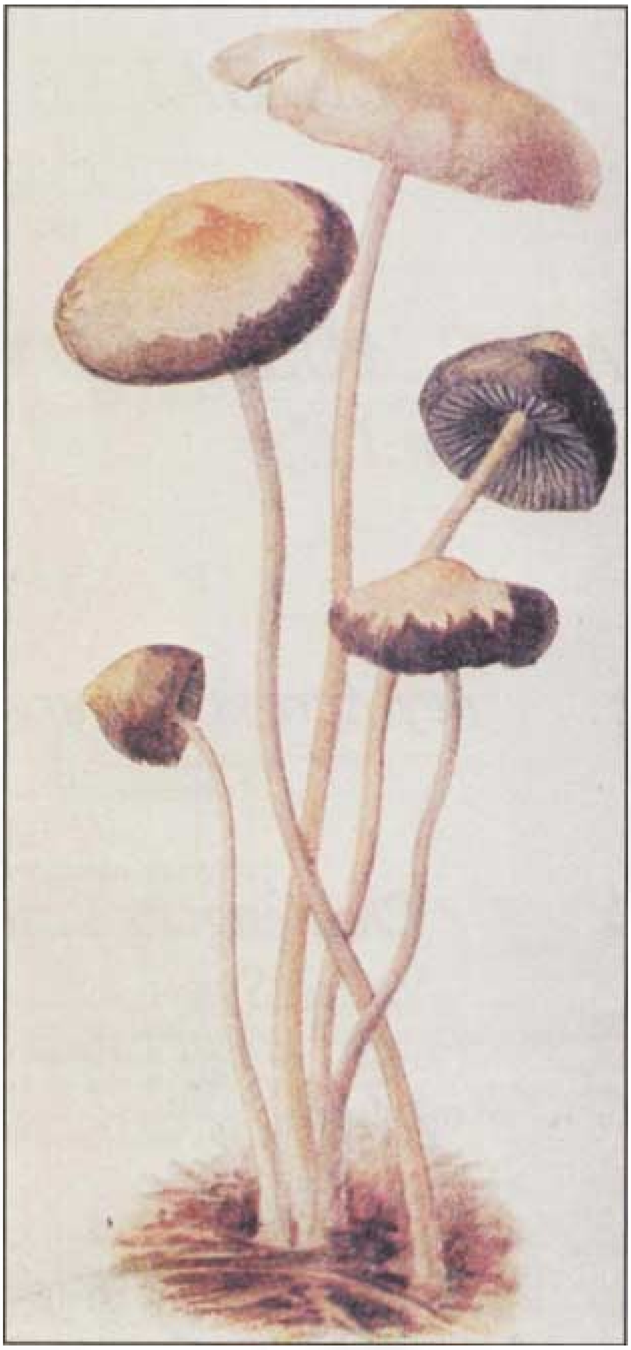


Figure 1 - Water Color Painting of *Psilocybe semilanceata* (Germany, 1927)

Nobody knows precisely when the first magic mushroom emerged from the shadows of prehistory to enter the light of consciousness. Nobody knows when the first magic mushroom was eaten by a human being. Nobody knows just who the first magic mushroom eater was. In seeking answers to these questions, we can only speculate. Mycophobes, however, are quick to voice their conviction that only a fool would be reckless enough to want to attain a higher state of consciousness beyond the boundaries of everyday reality. And only a fool would attempt to do this by ingesting those odd little things that mysteriously thrive on decaying, humid soil, rotten wood and malodorous mounds of cow manure. Historically, magic, mushrooms have been feared and hated' since antiquity: magic mushrooms were thought to be made from poisons that had dripped from serpents' fangs; they were considered to be unclean emissions of evil spirits; moreover, mushrooms were a known cause of death and disease, bloated stomachs and insanity. Beliefs such as these have survived to the present day. They persist, for example, as figures of speech, such as the slick Austrian description of a societal misfit as someone "who ate those madness-inducing mushrooms."

But, there is another, very different, magic mushroom legacy as well.

Flesh of the Gods for Devil Worshippers

The Old World. Mycenaean civilization began with a mushroom trip - Mushrooms were an ingredient in the ambrosia of Dionysus. Porphyrius, the fourth century Latin poet and contemporary of Emperor Konstantin, knew that magic mushrooms were the children of the gods. A quasi-cannibalistic ritual, the act of eating the children of the gods unlocked one's power to experience the truly divine. But not all mushrooms enable human beings to enter the realm of divine consciousness. This magic power resides in only those fungi known as "fool's mushrooms", which were considered poisonous and believed to be the spawn of the Devil throughout the late Middle Ages and well into modern times.

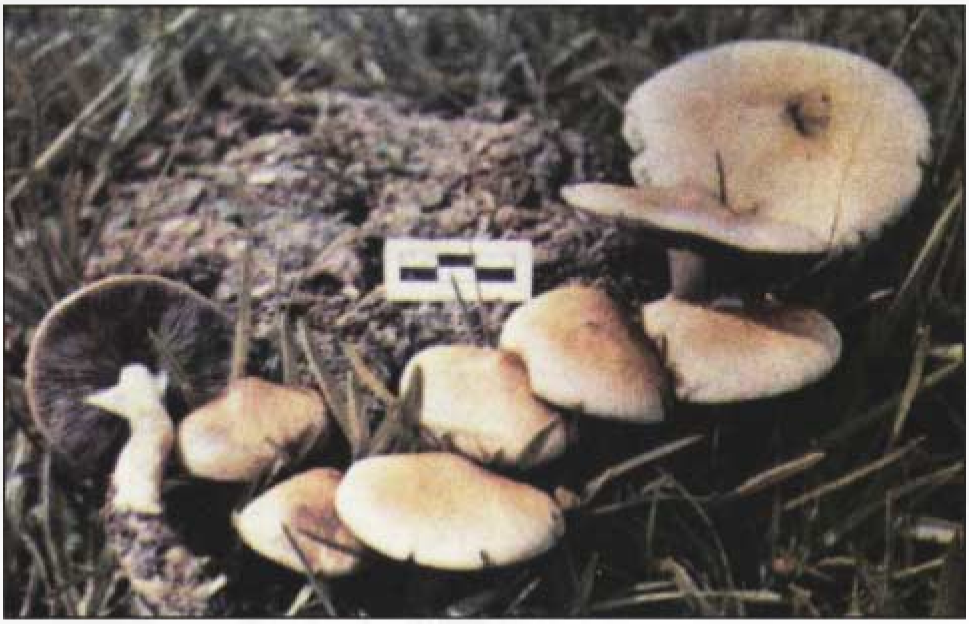


Figure 2 - *Psilocybe cubensis* from Australia

The New World: The Aztecs in Mexico referred to a number of small, inconspicuous mushrooms as teonanacatl, or "flesh of the Gods." These sacred mushrooms were eaten during the course of rituals intended to contact the Gods in order to learn about the world and the realm of the divine. These magic mushroom rituals thoroughly spooked the Catholic Spaniards. The mushroom eaters, commonly thought of as Devil worshippers, were hounded by the Inquisition. Still, all good things survive the tests of time, so the cult of magic mushroom eaters did not become extinct. Like mycelia underground, the cult continued to flourish, and at the proper time in recorded history, in 1957, the fruit of the fully grown mushroom re-surfaced to draw widespread public attention. Valentine and Gordon Wasson became the heroes of the modern neo-mycophilic movement.

Back to the Old World: The revelations and insights gained from the use of psychoactive mushrooms were so magically wonderful, that our native European "fool's mushrooms" - which were gene; considered inedible - had to be recognized as closely related to the magic mushrooms of Mexico, the flesh of the Aztec Gods. The souls of magic mushrooms in Mexico and Germany are essentially made from the same substance: psilocybin.

Jochen Gartz has made an extraordinary contribution to the field of mycology by embracing Germany's magic mushrooms and the scientific study and testing of these fungi. The research efforts upon which this book is based require nothing less than a fearless, brave and courageous consciousness, free of prejudice and mycophobia. I am convinced that a researcher's consciousness infused by the spirit of the magic mushroom is capable of far deeper scientific insights than we can ever expect from the usual ivory tower academics, isolated from reality, and who gorge themselves on our tax dollars.

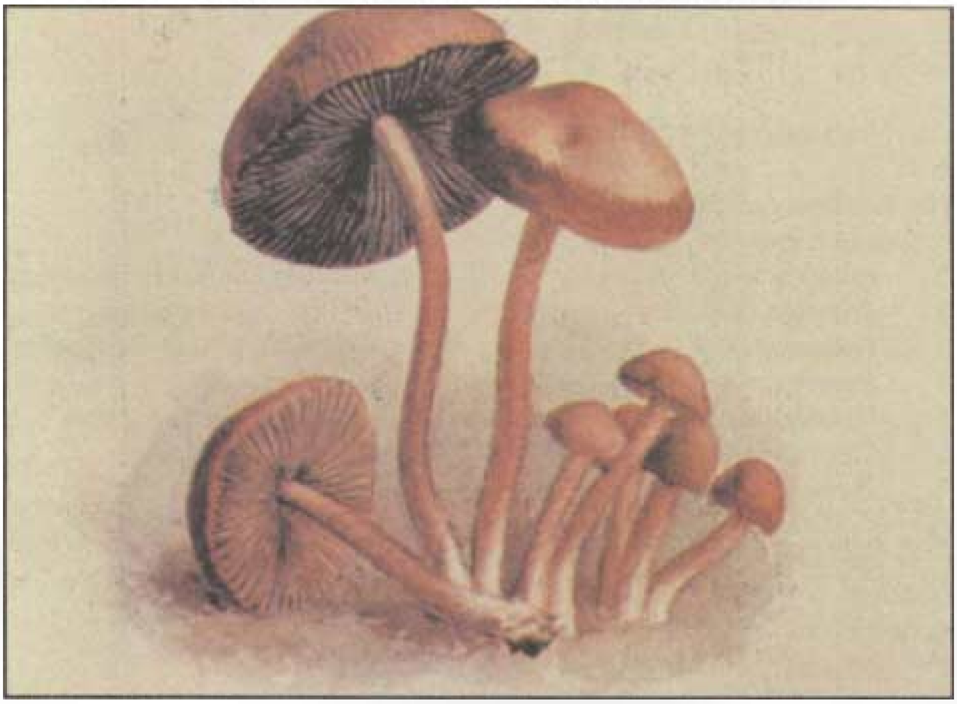


Figure 3 - Water color painting of *Panaeolus subbalteatus* (Germany, 1927).

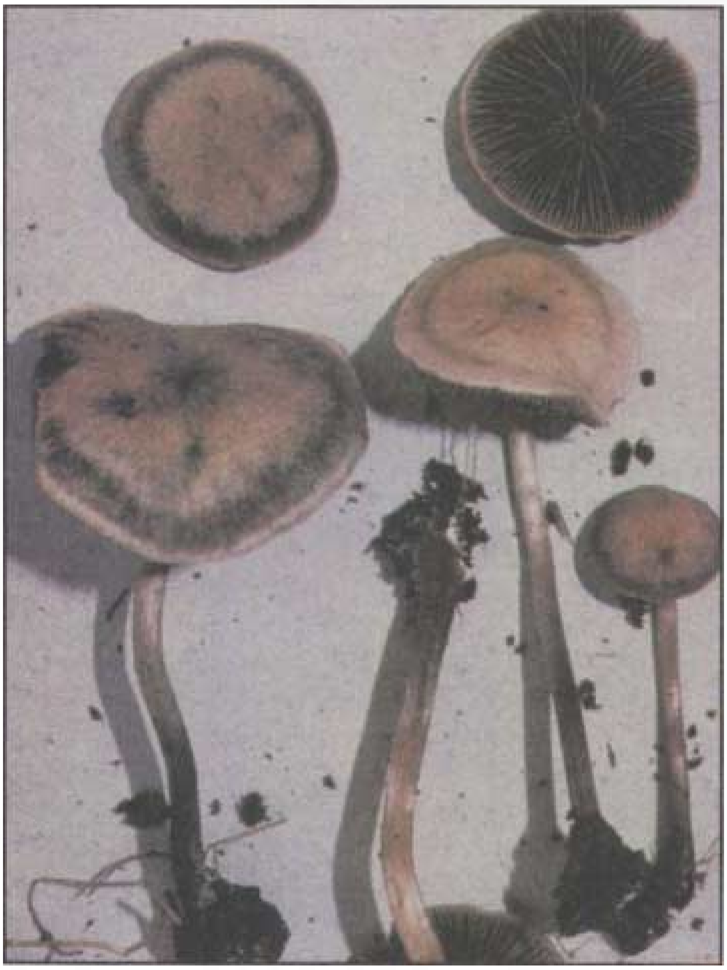


Figure 4 - Fresh *Panaeolus subbalteatus* mushrooms.

I met Jochen Gartz shortly after the fall of the Berlin Wall at the third symposium of the European College for the Study of Consciousness (ECSC) in Freiburg, Germany. Our encounter was my first contact with a researcher from the former East Germany. Jochen Gartz's enthusiastic lecture was a truly consciousness-expanding event, his words breaking down traditional borders and crossing over into new territory. The magic mushrooms spoke through him - with no trace of dogma or ideology - in the tradition of true anarchy that is the hallmark of mushroom magic. What I heard was unbelievable. Jochen spoke of a "new" psychedelic mushroom and its migration. The mycelia had spread in concentric circles outward from Leipzig, jumping all political borders. Finally, when the mycelia reached West German soil, the hated Berlin Wall crumbled. Could there possibly be a connection between the evolution of the magic mushroom and the evolution of our consciousness? Could a mushroom have contributed to the resolution of our political conflicts?

In the past, politicians, even popes, had their own jesters and magicians, who functioned as pressure release valves in the machinations of political power struggles. It is obvious that a country whose chancellor is being pelted with eggs, urgently needs a new breed of magician who are able to readjust reality. But today, no aspiring magician should go about this task without this book as a guide for the wondrous journey into the realm of magic mushrooms.

Christian Ratsch

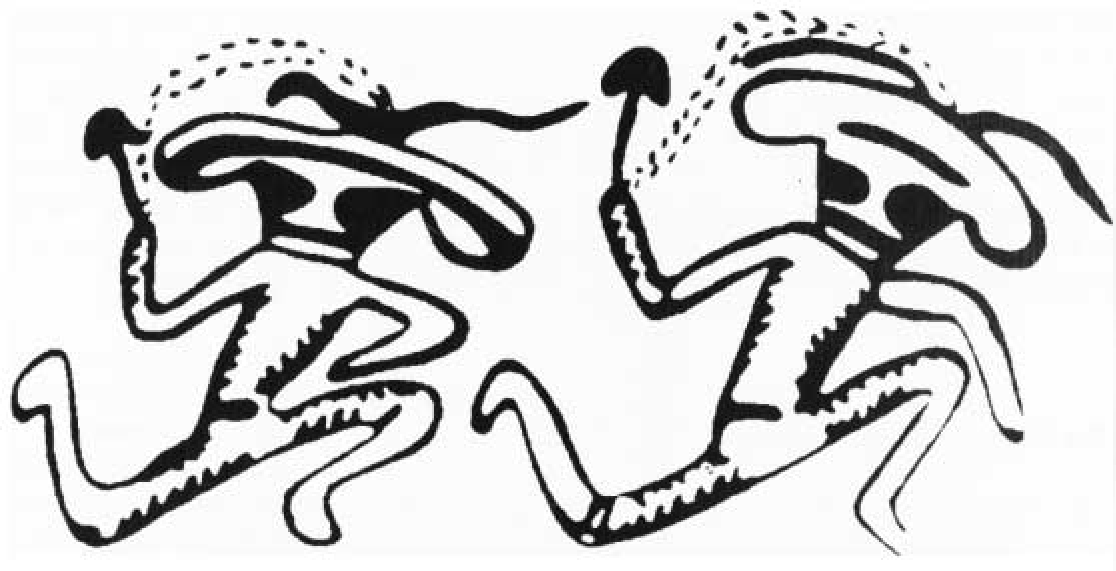


Figure 5 - "*Anthropomorphic Beings Engaged in Mushroom Dance*" 10,000-year-old rock drawing in Tassili, Sahara (Algeria)

CHAPTER 1
Introduction

I BELIEVE THE TIME HAS COME FOR A COMPREHENSIVE REVIEW OF NEW FINDINGS FROM THE FIELDS OF MYCOLOGY, TAXONOMY AND NATURAL PRODUCTS CHEMISTRY

When R.G. Wasson, R. Heim and A. Hofmann began their interdisciplinary research program to study the Mexican species of mushrooms and their usage in Mexican mushroom cults, their efforts culminated in a 1958 landmark report that described the isolation, molecular structure and synthesis of the mushrooms' active ingredients: psilocybin and psilocin. Several years later, these substances were also identified in a species of mushroom in Europe, *Psilocybe semilanceata*, which became the first in a series of newly discovered species. Since then, psychoactive mushrooms from other genera have been reported with increasing frequency.

As part of my analytical work dedicated to the identification of naturally occurring chemicals, I had the good fortune to be part of a research team that studied alkaloids found in a variety of mushroom species. Now I believe the time has come for a comprehensive review of new findings from the fields of mycology, taxonomy and natural products chemistry. Wasson and his successors have already provided detailed accounts pertaining to the history and study of the Mexican mushroom species, so that these materials need not be repeated in this context. However, certain aspects concerning the more recent uses of these mushrooms as well as their conditions of growth will receive more detailed attention in later chapters.

The main purpose of this book is to inspire further study of these mushrooms, particularly basic research efforts and medical applications of magic mushroom ingredients.

The extensive bibliography will help scientists and other interested mycophiles to further immerse themselves in this complex area of study.

Jochen Gartz

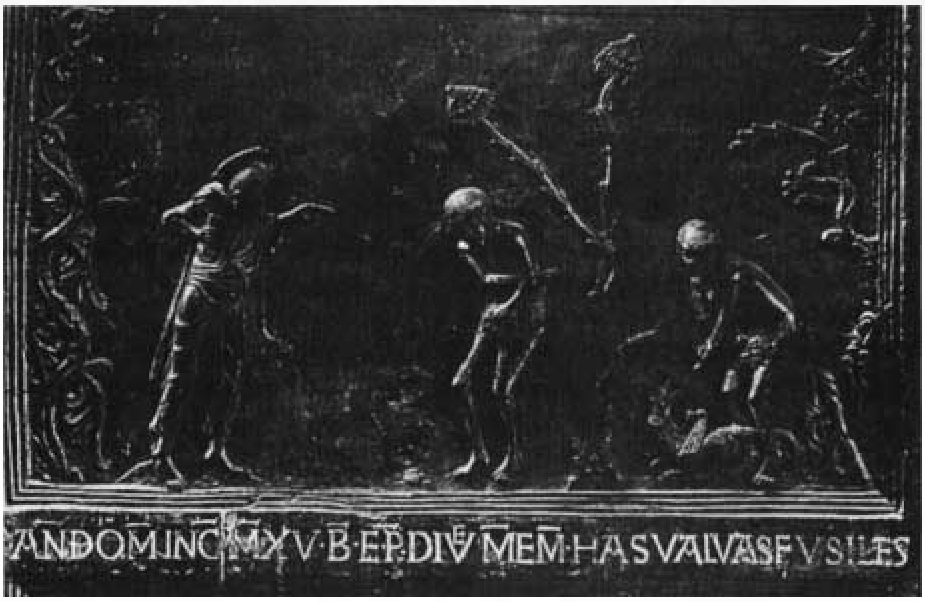

ANDOMINC MXV B EP.DIV MEM HAS VALVAS F VSILES

Figure 6 - Bronze doors with mushroom motif entitled "Trial and Judgment" at Hildesheim Cathedral, Germany (ca. 1020).

CHAPTER 2

Reflections on the History and Scientific Study of Magic Mushrooms

It is remarkable that cultures native to the American continent knew about a relatively large number of natural mind-altering substances compared to early cultures that evolved in Europe or Asia. Botanical evidence does not support the notion that Europe is home to fewer hallucinogenic plants than other regions. Furthermore, the growing number of recently discovered European mushroom species containing psilocybin indicate a flourishing psychotropic mycoflora in Europe similar to those found in other countries.

It is unlikely that early European cultures learned less about local plants and mushrooms through usage and experience than cultures elsewhere in the world. Most likely, early cultural knowledge of European psychoactive plants and mushrooms was lost or destroyed at some time in history, probably as early as several hundred years ago.

The discovery that the fly agaric mushroom (*Amanita muscaria*) was known for its psychoactive properties in Siberia invited the conclusion that this mushroom was used as a psychotropic agent in medieval Europe as well. In fact, there is very little evidence from the Middle Ages to indicate widespread knowledge of the effects of specific mushrooms on human consciousness. However, I believe that past reports on psychoactive mushrooms were causally linked to *Amanita muscaria* simply because this was the only known psychotropic mushroom in Europe at that time.

While the usage of *Amanita muscaria* among Siberian tribes has generated reports of spectacular hallucinations, European accounts of fly agaric intoxications do not generally include descriptions of such intensely hallucinatory effects.

Accordingly, the potent hallucinogenic effects of specific *Psilocybes* and related species are likely to have had a much more significant influence on early European cultures than the delirium-like visions induced by *Amanita muscaria*, a species that is also known to induce unconsciousness and severe somatic side effects. This hypothesis is corroborated by data from comprehensive field studies conducted in Mexico. I believe that historic accounts including those described below - indicate a knowledge of and familiarity with psychotropic mushrooms in Europe that is most likely derived from usage of *Psilocybes* and related species, rather than experience with *Amanita muscaria*. However, it is extremely difficult to reject or confirm this hypothesis, due to the lack of conclusive data available for analysis today.

Bwyd Ellylon: A Feast of Fairies in Celebration of the Spirit World

Tales of ritualistic mushroom usage have found their way into the realm of myths and legends. For instance, one legend describes a peculiar poisonous mushroom in Wales (British Isles) with the strange name of *Bwyd Ellylon*, which was considered a delicacy by fairies feasting in celebration of the spirit world. *Psilocybe semilanceata* is the most important psilocybin-containing mushroom in Europe and it thrives in parts of Great Britain, where the mushroom grows abundantly all across the Welsh countryside during fall season.

I would like to thank G. Samorini for pointing out that the Inquisition was unusually cruel and vicious in the Alpine valleys of Valcamonica, Valtrompia and Valtellina (located in the provinces of Brescia and Sandrio in Northern Italy). Many books chronicle countless witch burnings in that region, with particular emphasis on the witches' meetings at the "Monte del Tonale", located at an altitude of 2000 m (ca. 6,000 ft). Field research has shown that plants of the nightshade family ("witching herbs") do not grow at this altitude; even the fly agaric mushroom is rarely found there. By contrast, pastures in the area abound with *Psilocybe semilanceata* during the fall. Given this historical context, it would seem likely that *Psilocybe semilanceata* played an important role as a psychotropic agent in the region (see Figure 58, Chapter 7.4).

In light of medieval accounts describing the practice of witchcraft, it is interesting to note that a subjective sensation of flying or levitation is among the commonly reported effects of psilocybin intoxication.

Berserk Rage of Nordic Warriors

In the course of the ideological power struggle between Christianity and the remnants of pagan religions that worshipped Nature, many sources of knowledge were lost. The aggressive repression and eradication of pre-Christian customs all but destroyed the continuity of Europe's original cultural heritage, along with much historic evidence documenting early cultural practices, including the usage of plants and mushrooms for the purpose of temporary alterations of consciousness.

Some authors went so far as to blame the fly agaric mushroom for proverbial fits of "berserk rage" attributed to Nordic warriors. Many accounts detailing this phenomenon allude to a "deception of the eyes" (i.e. visual hallucinations). After the Nordic legal system banished the practice of "going berserk", it disappeared quite suddenly during the 12th century. At about the same time, Saxo Grammaticus speculated that the Berserkers may have used magical potions.

It is just as plausible, however, to suggest that the hallucinogen of choice among early Nordic cultures was *Psilocybe semilanceata*, a mushroom species quite common in Norway. Neither *Amanita muscaria* nor *Psilocybe semilanceata* are generally known to cause states of intense rage. However, given the historic context, it is possible that, at the time, people had already begun to internalize negatively biased distortions and the demonization of psychoactive mushrooms and their effects, in order to justify the creation of new laws intended to destroy repulsive pagan customs such as the ritual use of mind-altering plants.

It is important to note the existence of ancient Northern European rock drawings that depict various mushroom themes, along with the discovery of bronze-age vessels decorated with mushroom-related artwork. The drawings often include renditions of zoomorphic entities as well as mushrooms. Significantly, they predate any reports and speculations about the Berserkers by over 2,000 years.

These ancient images suggest the evolution of early European mushroom cults - a cultural practice that most likely vanished during the early Iron Age, as did many other customs and social practices from that era. Still, the discovery of ancient Northern European mushroom cults is a powerful piece of evidence supporting the notion that psychoactive mushroom usage has been continuous throughout history.

In addition, a traditional Swedish custom has survived to the present day, revealing an early knowledge of a certain mushroom believed to evoke "visions of spirit entities". As part of summer solstice celebrations, a poisonous mushroom species ("Baran") was cast into the bonfires. Even though nothing is known about this fungus today, the ritual burning of a poisonous mushroom was intended to weaken the powers of goblins and other evil spirits. The mushrooms were viewed as symbolic incarnations of noxious spirits. The mushrooms' ritualistic destruction by fire thus destroyed the powers of evil and mischievous spirits. The assumption that some mushrooms are physical links to the intangible powers of the spirit world may have evolved from ancient fragments of knowledge about the psychoactivity of specific types of mushrooms.

There are a number of written reports about psychotropic mushrooms that date back to the late Middle Ages. While this collection of documents includes a variety of different sources from several countries, they provide remarkably similar descriptions of psychoactive mushrooms and the general nature of their effects.

Love Potions Brewed from *Bolond Gomba*

Clusius (1525-1609), for example, the great physician and botanist, discovered "bolond gomba" in Hungary. This mushroom was known under the German name "Narrenschwamm" ("fool's mushrooms"). It was used in rural areas, where it was processed into love potions by wise men or "javas asszony". At about the same time, this "fool's mushroom" was documented in Slovakia as well. In addition, the mushroom found its way into the verses of Polish poet Vaclav Potocki (1625-1699), who refers to its potential of "*causing foolishness much like opium does* ".

Similarly, in England, John Parkinson's "Theatricum Botanicum" (1640) includes details about a "*foolish mushroom*".

The Austrian colloquial expression "*He ate those madness-inducing mushrooms*" refers to states of mental confusion.

Historic source materials such as these are scarce and widely scattered. Undoubtedly, they refer to psychotropic mushrooms, but lack sufficient information to permit clear identification of a specific species. However, considering the habitats and occurrence of *Psilocybe semilanceata* and *Psilocybe bohemica*, these two species are among the most likely candidates (see page 16 ff.). It is remarkable that these historic portrayals revolve around just one aspect of the mushrooms' overall effects: the occasional semi-schizophrenic reaction which can at times be quite dramatic. None of these accounts reflect a distinct appreciation of mushrooms in the tradition of the Mexican Indians ("teonanacatl" = flesh of the Gods).

Between Reverence and Fear

By contrast, in Europe we find that the symptoms of mushroom intoxication have always been compared to symptoms of mental illness. Such cross-cultural differences in value judgments can be explained in terms of two concepts introduced by R.G. Wasson and his wife: *mycophilia* and *mycophobia*. This distinction subdivides cultures with different traditional attitudes towards mushrooms into two groups. For instance, an entrenched dislike for mushrooms (mycophobia) in Britain indicates traditional beliefs vastly different from those found in Slavic countries, where mushrooms are generally cherished (mycophilia). The origins and evolution of such diverging attitudes remain lost in the shadows of history.

The development of early cultural taboos and prohibitions against psychotropic mushrooms may be the root cause of enduring mycophobic behavior. On the other hand, it is possible that, thousands of years ago, the process of harvesting mushrooms as a food source caused alarming clusters of regionally isolated cases of fatal mushroom poisonings. Such experiences may well have seeded a potent and lasting aversion towards an entire country's mycoflora.

Similarly, the mycophilia typical of ancient Mexican cultures goes hand in hand with a general social acceptance of the effects of *Psilocybe* mushrooms and their established ritual usages. Among Mexican Indian tribes, the effects of psilocybin have never been causally linked to any type of known mental illness. It is interesting to note that the Indians of Mexico were the only Indians in the Americas who also harvested a large number of mushroom species for food.

Unfortunately, our current socio-political climate is - strongly biased against newly discovered hallucinogens, which are often defined in terms of negatively loaded labels. Even worse, such prejudicial thinking distorts an objective, scientifically neutral approach to the study of these substances. The label "fool's mushroom" first appeared during the 1930s, along with "Mexican mushroom of insanity". In the 1950s, the Central American mushroom cults were discovered and the mushrooms themselves were renamed "Mexican magic mushrooms", in recognition of their psychotropic effects and to emphasize the significance of the mushrooms' early integration into the social fabric of the cultures that cherished them.

Later on, the relatively neutral label "hallucinogenic mushroom" came into use in the mycological literature. Other designations that gained and lost popularity over time include the somewhat derogatory term "intoxicating mushrooms" and the essentially meaningless "drug mushrooms".

Scientifically Unbiased Hallucinations?

Following his experiments with magic mushrooms in Mexico during the summer of 1960, T. Leary returned to Harvard University and began to study psilocybin as a variable in the administration of standard psychological test batteries. His initial focus was diluted when he continued to expand his experiments to include increasingly broader settings and applications. In reaction to Leary's markedly unorthodox approach, the American press began to portray psilocybin mushrooms in terms of slanderous terminology that far exceeded the negative connotations of labels such as "fool's mushrooms". Descriptions of the mushrooms' effects included claims that users experienced "death-like states".

Proponents of psilocybin research were accused of denying that the alkaloid caused "semipermanent brain damage". This pseudo-scientific jumble of meaningless jargon was symptomatic of the sharply escalating controversy surrounding hallucinogenic substances. Increasingly, news reports on psilocybin were eclipsed by massive amounts of publicity about LSD - the most potent hallucinogen ever discovered. The subsequent frenzy of legislative attempts to control LSD resulted in ever tighter restrictions on the scientific study of not only LSD, but psilocybin as well. Mind-altering substances were no longer thought of in terms of their specific effects and properties, but rather were lumped together into a single group of dangerous chemicals. As antidrug hysteria continued to intensify, scientific and pharmacological distinctions became all but irrelevant: hallucinogens were no longer viewed as different from other classes of dangerous and physically addictive drugs, such as heroin or the opiates. This demonization of hallucinogens was successful in spite of massive research efforts that began when Sandoz Pharmaceuticals decided to distribute psilocybin to qualified scientists for experimental and psychotherapeutic purposes. By employing the method for synthesis of psilocybin developed by A. Hofmann, Sandoz Pharmaceuticals manufactured about 2 kg (ca. 4.4 lbs) of pure psilocybin for scientific research purposes.

The results of pharmacological testing soon revealed psilocybin as an alkaloid that was perfectly safe for human subjects under controlled experimental conditions. Despite this evidence, the anti-drug legislative framework of the mid-1960s firmly established an "official mycophobia", a misguided, yet entrenched policy that still prevails today and effectively prevents the scientific investigation of promising potential applications for psilocybin and other alkaloids. At the same time, mycological and biochemical research studies have shown that psilocybin-containing mushrooms thrive all over the world and can be found on all continents. These mushrooms are no different from any other mycoflora and must not be excluded from scientific investigation because of their alkaloid content.

In addition to overall variations in value systems across cultures, individuals tend to develop their own personal attitudes towards mushrooms in general. Oftentimes, the evolution of specific opinions about mushrooms can be traced back to childhood events, even though such early experiences seldom account for the development of prevailing biases and value systems later in life.

I recall an incident from my own childhood, which occurred when I was about five years old. I was playing in a grassy meadow, when a girl pointed to a brown mushroom and earnestly explained that it was inedible and poisonous. While I have never forgotten this encounter, I did grow up to become a devoted mushroom enthusiast. On the other hand, a different childhood event has left me with the vivid memory of discovering a landfill virtually covered with vast numbers of gilled bluing mushrooms and the sense of awe I experienced contemplating this sight. In general, the unusual characteristics of these mushrooms are most likely responsible for strong impressions formed early in life, which then may develop into various attitudes or beliefs later on.

An enduring personal interest in psychotropic mushroom species can serve to amplify or diminish mycophobic as well as mycophilic dispositions, depending on the influence of other factors. After all, judgments about the benefit or folly of deliberately altering one's state of consciousness are also colored by individual preferences, biases and opinions.

The following chapters are meant to illustrate this diversity of attitudes towards psychotropic mushrooms. Descriptions of planned and involuntary experiments with specific mushroom species offer convincing evidence that the effects of psychoactive mushrooms are open to many possible interpretations.

CHAPTER 3
The Current State of Knowledge About European Species

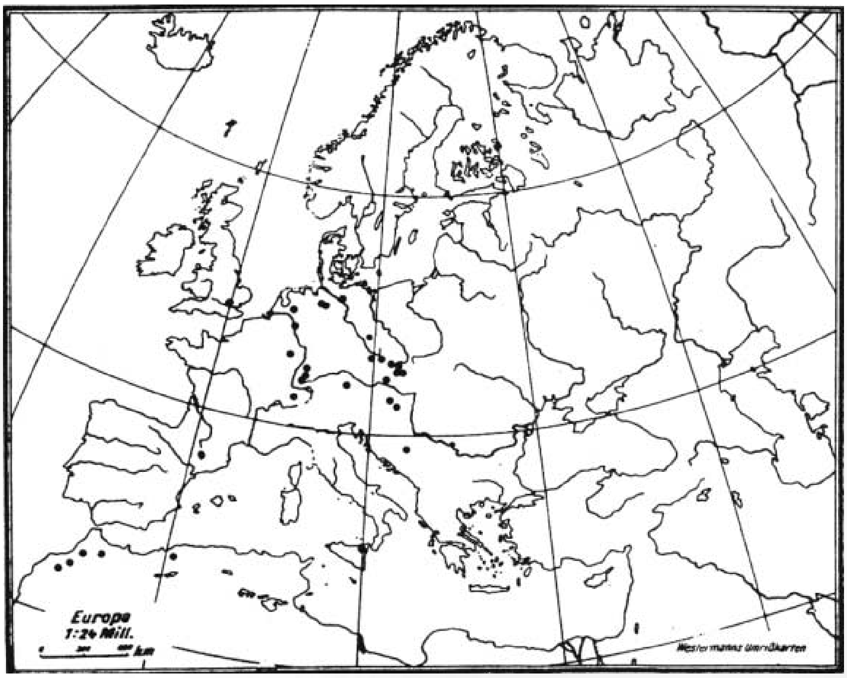


Figure 7 - Distribution pattern of ***Psilocybe cyanescens*** across Europe and North Africa (according to Krieglsteiner). Black dots indicate approximate locations where ***Psilocybe cyanescens*** was found.

Mr. E Branl, on a poisonous Species of Agaric

To the Editors of the "Medical and Physical Journal".

Gentlemen,

IF the following account of the deleterious effects of a very common species of agaric, not hitherto generally suspected to be *poisonous*, appears to you likely to prove *useful* or interesting to the public, you will oblige me by its insertion; should its length be any obstacle to this, I beg you will omit whatever you may think superfluous.

I remain,
Gentlemen,
Yours, most obediently,
EVERARD BRANDE
No.10, Arlington-Street,
Nov. 16th, 1799.

J. S. gathered early in the morning of. the third of October, in the Green Park, what he Supposed to be small mushrooms; there he stewed with the common additions in a tinned iron saucepan.* The whole did not exceed a tea saucerful, which he and four of his children ate the first thing, about eight o'clock in the morning, as they frequently had done without any bad consequence; they afterwards took their usual breakfast of tea, &c. which was finished about nine, when Edward, one of the children, (eight years old,) who had eaten a large proportion of the mushrooms, as they thought them, was attacked with fits of immoderate laughter, nor could the threats of his father-or mother restrain him. To this succeeded vertigo, and a great 'degree of stupor, from which he was roused by being called or shaken, but immediately relapsed. The pupils of his eyes were, at times, dilated to nearly, the circumference of the cornea, *and* scarcely contracted at the approach of a strong light; his breathing was quick, his pulse very variable, at times imperceptible, at others too frequent and small to be counted; latterly, very languid; his feet were cold, livid, and contracted, he sometimes pressed his hands on different parts of his abdomen, as if in pain, but when roused and interrogated as to it, he answered indifferently. yes, or no, as he did to every other question, evidently without any relation to what was asked. About the same time the father, aged forty, was attacked with vertigo, and complained that every thing appeared black, then wholly.

*This accuracy may seem trivial, but I have met with people who supported the following symptoms might have arisen from the use of a copper vessel.

Figure 8 - Reproduction of a report from the mycological literature (1799) describing a case of ***Psilocybe semilanceata*** intoxication.

3.1 - *Psilocybe semilanceata*: The Classic Species Among European Psychotropic Mushrooms

Listen Well to this Frightful Story from St. James's Green Park....

About 200 years ago, E. Brande published an account about a remarkable case of mushroom intoxication in London. On October 3, 1799 an impoverished family picked some mushrooms in St. James's Green Park and prepared them for a meal (see Figure 8, p. 15).

Shortly after eating the mushrooms, the father and his four children developed symptoms of intoxication, such as markedly dilated pupils, spontaneous laughter and delirium. The progression of symptoms was experienced as wave-like, with cycles of increasing and fading intensity. In addition, the father's visual perception was affected so that everything around him appeared to be black - a frightening experience he believed to presage his impending death.

Even though two family members (ages 12 and 18) consumed only small amounts of the cooked mushrooms, the ensuing symptoms of intoxication were no different from those observed in family members who had eaten comparatively larger portions. After several hours, the psychic and perceptual disturbances subsided and finally disappeared, without any lingering side effects. Attempts to treat acute symptoms included administration of emetics and fortifying tonics. In the end, these potions were heralded as the crucial treatment that "cured" the family.

For the most part it is extremely difficult, if not impossible, to assemble complete and accurate details on many aspects of magic mushroom history from source materials available today. Thus, it is an instance of rare good fortune and a boon to mushroom historians that E. Brande's description of a typical psilocybin syndrome was augmented by J. Sowerby, author of "Coloured Figures of English Fungi or Mushrooms" (London, 1803). Sowerby's book included a rendition and description of the mushroom species responsible for the poisoning case described by Brande (see p. 17). Within the context of Sowerby's book, only the variety of mushrooms distinguished by their cone-shaped caps were believed to cause intoxication. Figure 9 shows a typical rendition of *Psilocybe semilanceata*. This mushroom species was known to Sowerby's contemporaries as "*Agaricus glutinosus* Curtis" and its descriptions are fully compatible with current knowledge about *Psilocybe semilanceata*.

A few years later, renowned Swedish mycologist E. Fries referred to "*Agaricus semilanceatus*" in his book entitled "Observationes Mycologicae" (1818). Later on, the same mushroom also appeared under the names *Coprinarius semilanceatus* Fr. or *Panaeolus semilanceatus* (Fr.) Lge. Not until 1870 did Kummer and Quelet classify this mushroom as a member of the genus *Psilocybe*. Consequently, two valid designations may be found in the literature:

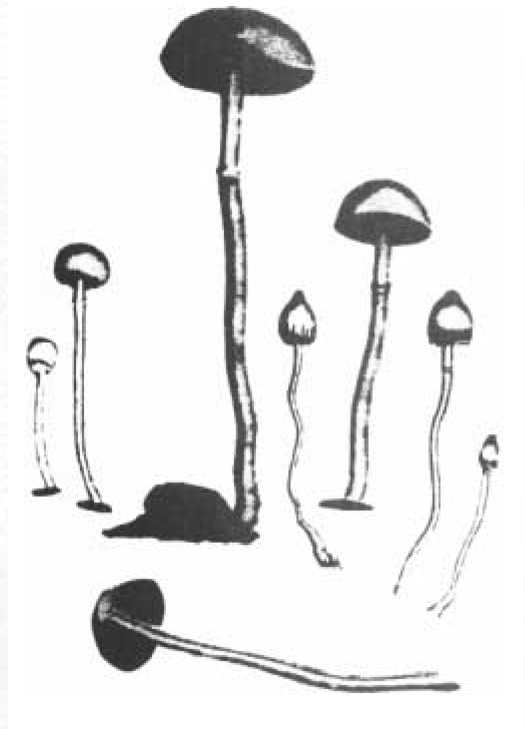
- *Psilocybe semilanceata* (Fr.) Kumm.
or
- *Psilocybe semilanceata* (Fr.) Quel.

Around 1900, M. C. Cooke reported two or three new instances of accidental mushroom intoxication involving children in England. Interestingly, Cooke noted that symptoms were caused only by a variety of mushroom known to turn blue (var. *caerulescens*). He was the first mycologist to wonder if a bluing variety of this species was poisonous, or if the bluish color was induced by external factors, causing changes in the mushroom's chemical composition so as to render them poisonous.

Early Descriptions

A close relative of Mexico's psychoactive species, *Psilocybe semilanceata* is a mushroom whose physical appearance resembles *Psilocybe semperviva* Heim & Cailleux and *Psilocybe mexicana* Heim. Like *Psilocybe semilanceata*, these Mexican species thrive in meadows and pastures. Another common trait among these species is the rather subdued and subtle quality of their bluing reaction. Recognition of these similarities with

Mexican species sparked the curiosity of scientists who wanted to learn more about Europe's *Psilocybe* species. A research team that included A. Hofmann and R. Heim began to study samples of *Psilocybe semilanceata*, in collaboration with C. Furrer, a mycologist who examined fruiting bodies collected in Switzerland and France. By 1963, paper chromatography testing had yielded data of historic significance. For the first time, scientists had confirmed the presence of 0.25% psilocybin in dried samples of *Psilocybe semilanceata*. Publication of the results represented an extraordinary achievement, because psilocybin had never before been detected in a European mushroom species. Previously, the alkaloid had been found only in *Psilocybe* species native to Mexico, Asia and North America.



Stalks generally single, sometimes clustered, from two to four inches in height, the thickness of a goose quill, thread shaped whitish almost solid, the tube being very small, glutinous; ring, a little below the cap, scarce perceptible.

"Cap, from one to two inches in breadth, of a brown color; in the full grown ones hemispherical, always convex, and more or lets glutinous; wet with rain, it becomes browner and transparent, so that it sometimes appears striated."

"Gills numerous, single, of a brownish purple color, clouded; whole ones about twenty, horizontal, three shorter ones placed between them; they throw out a powder of a brownish purple color."
With respect to the use of it, he only says, "There is nothing acrimonious or disagreeable in its taste, yet its appearance will not recommend it to the lovers of mushrooms."

Figure 9 - Drawing and description of ***Psilocybe semilanceata*** by J. Sowerby (London, 1803).

1733. A. semilanceatus Fries (Observ. II. pag. 178)

Synon.: Agaricus semiglobatus Sowerby (Engl. Fungi taf. 240. fig. 1-3). Hut etwas hautig, spitz kegelfdrmig, fast zugespitzt, 1½ Cent. breit, ½ Cent. hock, feucht klebrig, fein streifig, gelb oder grunlich, zah, mit Anfangs umgeknicktem Rande und leicht trennbarer Oberhaut. Stiel zah, gebogen, 11 Cent. hock, kahl, blass. Lamellen angeheftet, aufsteigend, purpur-schwarz. Sporen ellptisch, hellbraun, 9 -16 µ lang, 4 - 9 µ dick.

Ax **Wegen, auf Grasphitzen, besonders wo Mist gelegen hat.**

spitzkegeliger Kahlkopf (Psilocybe semilanceata). Kegel-glockenformig mit papilenertiger spitze Hut-o, 5-1 cm breit, bis 2 cm hock, lehmfarben mit olivgrunem Stich, klebrig. Lamellen breit, oliv-lehmfarben, spater purpurbraun.
Stiel schlank, glanzend. - Gedungte Wiesen, Wegrander. Stellenweise. Wertlos.

Figure 10 Two descriptions of ***Psilocybe semilanceata*** from the German-language literature. The first description (top) was written over a hundred years ago, while the second one (bottom) dates to 1962. Significantly, the more recent entry classifies the species as "essentially worthless". Also see Figure 11.

While *Psilocybe semilanceata* was not recognized as an important psychoactive species until the 1960s, descriptions of the species were included in many standard German language mycology reference books published before 1963. Figure 10 shows examples of two such descriptions, one of them dated 1962 and the second one written about 60 years earlier. Note that the 1962 version designates *Psilocybe semilanceata* as a "worthless" species - a rather incongruous conclusion likely to amuse today's readers. On the other hand, accounts of and knowledge about cases of mushroom intoxication in England did not find their way into

Germany's mycological literature. A few authors, such as Michael & Schulz (1927) and A. Ricken (1915) see Figures 11 and 12, pp. 19-20) contributed excellent and valuable descriptions of *Psilocybe semilanceata*, but these are the exceptions, rather than the rule. A description of *Psilocybe semilanceata* from 1977 reflects less emphasis on details, and a rather cursory approach to differentiation of the species, except for additional data on the mushroom's microscopic characteristics (see Figure 13).

In addition, a German aquarelle painting from 1927 of five fruiting bodies depicts the mushroom's habitus in remarkably realistic detail (see Figure 1, p. 4).

In 1967 and 1969 *Psilocybe semilanceata* samples from Scotland and England were found to contain psilocybin as well. Later on (1977), Michaelis reported discovering the alkaloid in samples collected in Germany (see Figure 14).

The Popularity of *Psilocybe semilanceata*

Since the late 1970s, investigators in several countries have been using of state-of-theart methodology (High Performance Liquid Chromatography) to test samples and quantify their alkaloid content. The following sections include more detailed reviews of these tests and their results.

Psilocybe semilanceata has clearly established itself as the psychotropic mushroom species in Europe. The species thrives throughout the European continent, where it has sparked extensive research efforts. In terms of usage, *Psilocybe semilanceata* is Europe's most popular psychoactive species. In his 1983 monograph, Guzman suggests that *Psilocybe semilanceata* may well be the most common psychoactive *Psilocybe* mushroom in the world. Even though the species is known to flourish in Europe, North America, Australia and Asia, the mycofloras of many countries have not yet been studied or documented. Thus, we cannot yet evaluate the prevalence of *Psilocybe semilanceata* on a global scale.

In Europe, however, discoveries of *Psilocybe semilanceata* have been reported from the following countries: Finland, Norway, Sweden, Denmark, Germany, Switzerland, Austria, The Netherlands, Belgium, France, Russia, Poland, the former Czechoslovakia, Hungary, Romania, Scotland, England, Wales, Italy and Spain.

189. Psilocybe semilanceata Fr. [Worthless]

The cap is uniformly conic to bell-shaped, with a pointy or obtuse center forming an almost wart-like protrusion; initially, caps are often taller than they are wide, margins are bent and curved inward; later on, width of cap is 1.5-4 cm. Hygrophanous; coloration is a dirtyish olive-brown when wet, with translucent striate margins; at the center, coloration is ocher or greenish-yellow against an overall shade of smudgy pale yellow and oftentimes some greenish stains; only the margins are banded by a darkcolored, watery stripe around the edge. No stripes or banding evident when mushrooms are completely dried. Lacking a veil, caps are thin-fleshed, bald, with an easily separable pellicle that remains gelatinous-sticky for a long time, turning shiny when dry.

Gills are olive brown to blackish purple brown in color, with the edges often remaining white, gill spacing is quite crowded; gill attachment is either roughly linear or mostly adnexed; up to 3.5 mm wide; attached at the stem only, fully detached later on.

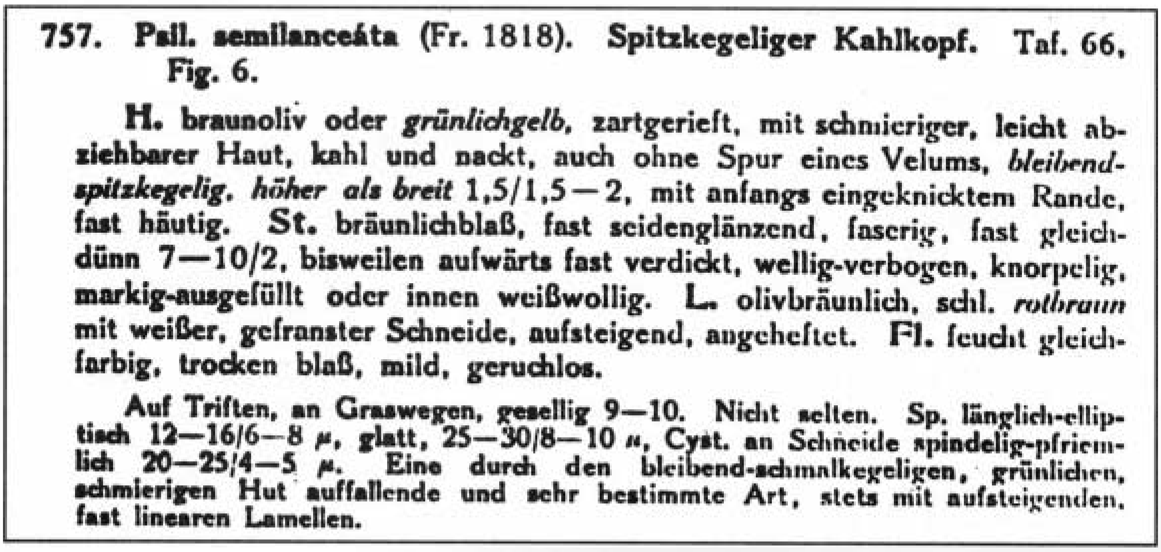
Spores are elongated to ellipitical in shape, smooth and large, measuring 12-16 µ by 6-8 µ. Color of spore dust is blackish purple brown.

Stem is very slender, almost uniformly thin and always twisted, 6-12 cm long and 1.25-2 mm thick, yellowish or whitish in color; areas subjected to pressure develop bluish-green stains. Stems are silky smooth and roughly at the center, cortinate fibrils appear like remnants of a veil, which is brittle and lined with a white fibrous cord of wool-like texture.

When dry, the flesh of the cap is colored pale yellow, while the stem's flesh is ocher brown in color, especially towards the bottom. It is odorless and its flavor is mild. The mushroom grows from August to October, frequently in gregarious clusters, and can be found in pastures and along roadways, growing on dung that has undergone complete decomposition. It is not a particularly rare species.

Figure 11 - (above) This excellent description of ***Psilocybe semilanceata*** by Michael & Schulz (1927) is shown here as originally published in German, with an English translation.

Unfortunately, there are no comprehensive maps detailing the species's distribution pattern. Traditionally, mycologists have often neglected relatively tiny species, such as *Psilocybe semilanceata*, that tend to share their habitats with other, more prominent species. The sarcastic phrase "*The mushrooms occur in abundance wherever mycologists abound*" is particularly pertinent in reference to the *Psilocybe* species. Prior to the discovery of psilocybin, the *Psilocybe* genus languished in the literature, shrouded in obscurity. To this day, few Mycologists specialize in the study of *Psilocybes*, despite the fact that *Psilocybe semilanceata* is the most common and conspicuous species among the *Psilocybes*. Also, mushroom lovers whose interests are not purely scientific (see Chapter 7.4) do not usually preserve their knowledge for posterity in the form of distribution maps. However, there is one map from 1986, which shows the distribution pattern of *Psilocybe semilanceata* across Germany (see Figure 20, p. 28).

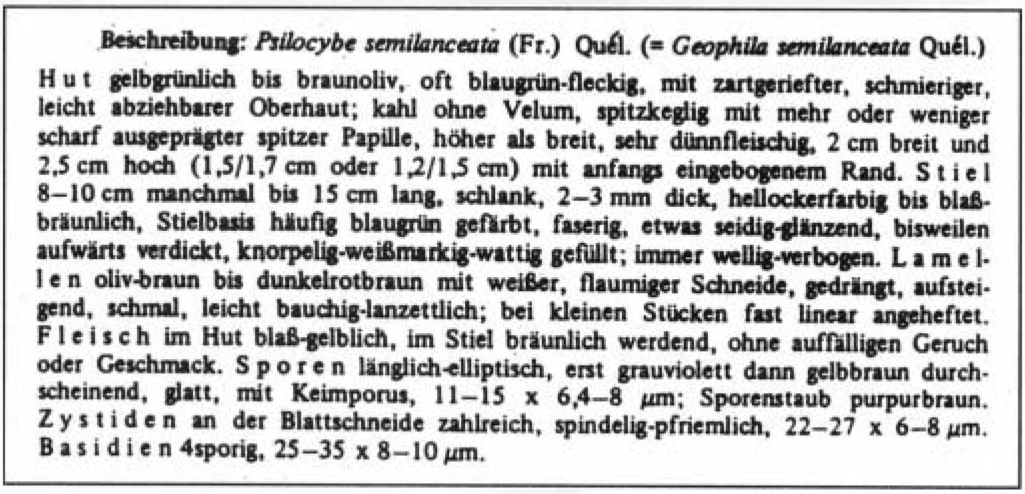


757. Psil. semilanceáta (Fr. 1818). **Spitzkegeliger Kahlkopf.** Taf. 66, Fig. 6.

H. braunoliv oder *grünlichgelb*, zartgerieft, mit schmieriger, leicht abziehbarer Haut, kahl und nackt, auch ohne Spur eines Velums, *bleibend-spitzkegelig, höher als breit* 1,5/1,5—2, mit anfangs eingeknicktem Rande, fast häutig. **St.** bräunlichblaß, fast seidenglänzend, faserig, fast gleichdünn 7—10/2, bisweilen aufwärts fast verdickt, wellig-verbogen, knorpelig, markig-ausgefüllt oder innen weißwollig. **L.** olivbräunlich, schl. *rotbraun* mit weißer, gefranster Schneide, aufsteigend, angeheftet. **Fl.** feucht gleichfarbig, trocken blaß, mild, geruchlos.

Auf Triften, an Graswegen, gesellig 9—10. Nicht selten. Sp. länglich-elliptisch 12—16/6—8 μ, glatt, 25—30/8—10 μ, Cyst. an Schneide spindelig-pfriemlich 20—25/4—5 μ. Eine durch den bleibend-schmalkegeligen, grünlichen, schmierigen Hut auffallende und sehr bestimmte Art, stets mit aufsteigenden, fast linearen Lamellen.

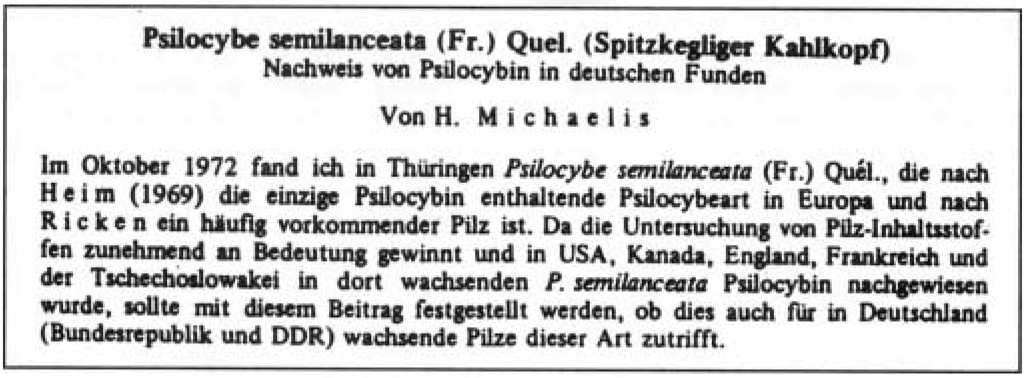
Figure 12 - A. Ricken's description of ***Psilocybe semilanceata*** from 1915.



Beschreibung: *Psilocybe semilanceata* (Fr.) Quél. (= *Geophila semilanceata* Quél.)

Hut gelbgrünlich bis braunoliv, oft blaugrün-fleckig, mit zartgeriefter, schmieriger, leicht abziehbarer Oberhaut; kahl ohne Velum, spitzkeglig mit mehr oder weniger scharf ausgeprägter spitzer Papille, höher als breit, sehr dünnfleischig, 2 cm breit und 2,5 cm hoch (1,5/1,7 cm oder 1,2/1,5 cm) mit anfangs eingebogenem Rand. Stiel 8–10 cm manchmal bis 15 cm lang, schlank, 2–3 mm dick, hellockerfarbig bis blaßbräunlich, Stielbasis häufig blaugrün gefärbt, faserig, etwas seidig-glänzend, bisweilen aufwärts verdickt, knorpelig-weißmarkig-wattig gefüllt; immer wellig-verbogen. Lamellen oliv-braun bis dunkelrotbraun mit weißer, flaumiger Schneide, gedrängt, aufsteigend, schmal, leicht bauchig-lanzettlich; bei kleinen Stücken fast linear angeheftet. Fleisch im Hut blaß-gelblich, im Stiel bräunlich werdend, ohne auffälligen Geruch oder Geschmack. Sporen länglich-elliptisch, erst grauviolett dann gelbbraun durchscheinend, glatt, mit Keimporus, 11–15 x 6,4–8 μm; Sporenstaub purpurbraun. Zystiden an der Blattschneide zahlreich, spindelig-pfriemlich, 22–27 x 6–8 μm. Basidien 4sporig, 25–35 x 8–10 μm.

Figure 13 - Description of ***Psilocybe semilanceata*** by H. Michaelis (1977).



Psilocybe semilanceata (Fr.) Quel. (Spitzkegliger Kahlkopf)
Nachweis von Psilocybin in deutschen Funden

Von H. Michaelis

Im Oktober 1972 fand ich in Thüringen *Psilocybe semilanceata* (Fr.) Quél., die nach Heim (1969) die einzige Psilocybin enthaltende Psilocybeart in Europa und nach Ricken ein häufig vorkommender Pilz ist. Da die Untersuchung von Pilz-Inhaltsstoffen zunehmend an Bedeutung gewinnt und in USA, Kanada, England, Frankreich und der Tschechoslowakei in dort wachsenden *P. semilanceata* Psilocybin nachgewiesen wurde, sollte mit diesem Beitrag festgestellt werden, ob dies auch für in Deutschland (Bundesrepublik und DDR) wachsende Pilze dieser Art zutrifft.

Figure 14 - Excerpt from the first article reporting the discovery of psilocybin in ***Psilocybe semilanceata*** samples from Germany Michaelis (1977).

Almost no published information is available about locations where *Psilocybe* species have been found in eastern Germany. During my own field trips, I have discovered *Psilocybe semilanceata* specimens in various locations, such as near my hometown of Mansfeld in the Vorharz Mountains, in the marshlands of Duben as well as in other eastern German marshland areas. In addition, friends who are also mycologists have told me about finding the mushrooms in other parts of the country. A book published in 1952 is among the rare sources that includes details about specimens discovered in the southeastern state of Saxony (see Figure 16, p. 23).

The *Psilocybe* species grow most abundantly on wet pastures surrounded by forest areas. In my experience, *Psilocybe semilanceata* grows in most of Germany's forestlands. The species fruits during the fall, from late September through October. It favors acidic soil and grassy terrain alongside trails or around the edges of forest lands. Specimens are generally clustered in small groups of 30 mushrooms or less. Deer droppings or other animal feces are usually present at those locations, even though the mushrooms never grow directly on top of dung. Occasionally, extremely stunted specimens may be found in the mountains by the side of the road.

The soil below older cow pastures provides an excellent medium for extensive mycelial growth. In some locations, large areas yield an abundance of fruiting bodies, mirroring the extent of mycelial saturation in the soil. Given adequate moisture, maximum yields can be expected, if the pasture was grazed at least once during the weeks before fruiting season. However, the mushrooms also thrive under similar conditions on horse and sheep pastures. Such grassy areas inside forests are usually grazing areas for deer, who provide the soil with additional fertilization. *However, Psilocybe semilanceata does not grow in locations where artificial fertilizer has been used*. Such pastures are often flanked by creeks or swamp lands, which saturate the soil with water. During the summertime, the warm climate in these wet areas provides an excellent environment for optimal mycelial growth. In Germany, the mushroom's habitat ranges from the coastal areas to mountainous regions, where the species has been found at altitudes of up to 1,720 m (5,160 ft) above sea level (MTB-8443, 1985). In the former Czechoslovakia, samples have been collected at altitudes ranging from 330 to 1,000 m (1,000 - 3,000 ft), with one location at 1,400 m (4,200 ft) above sea level. According to these distribution patterns, the species does not appear to favor a specific altitude. As of 1986, 44 locations in the former Czechoslovakia had been logged, yielding a total of 54 samples. In contrast to other mushroom species, such as the cultivated commercial white mushrooms (*Agaricus bisporis*), *Psilocybe semilanceata* will fruit in a comparatively much wider range of temperatures.

While *Psilocybe semilanceata* is common throughout Germany, the species does not appear to favor specific areas where it occurs in marked abundance or density. One obvious limitation on the growth of the species is the limited presence of fertilizer in areas that would otherwise be excellent locations for the mushroom to thrive in. Most likely that is why the species has not expanded into new habitats in Germany over the last few decades. Descriptions of frequency of occurrence in the older literature are comparable to contemporary observations.

On occasion, however, *Psilocybe semilanceata* can produce a huge number of fruiting bodies at certain locations where conditions for growth are excellent.

Between a Creek and a Marshlands Pond… 8½ Inches Tall!

At this point, I would like to provide some more details about two marshlands locations, where we have conducted mycological field research over the course of several years.

At the first location, the fruiting bodies grew in a shallow grass valley among very tall grass on slightly acidic soil. This grassy area was a forest clearing between a creek and a marshlands pond. In areas exposed to direct sunlight, temperatures were significantly higher than they were in surrounding areas, a phenomenon that persisted during the fall season. Deer droppings contributed to frequent fertilization of the area. The fruiting bodies from the first batch of mushrooms found in this location had stems of up to 8½ in. [!] (21.5 cm) tall, due to very tall grass in the area. The caps of the mushrooms were so tiny, that clear identification of the species as *Psilocybe semilanceata* was not immediately possible. Even though a bluing reaction was present, chromatography testing was needed to confirm the species. Subsequent discoveries, however, yielded samples that could be identified on the spot based on their morphological characteristics. We were able to collect 30 to 60 specimens at this location every fall for three consecutive years. Unfortunately, the location was destroyed soon afterwards, due to man-made modifications to the marshlands and construction of an access road.

During the same year, we discovered a second location within about half a mile of the first one. The area was very large, a former cow pasture which had been grazed regularly. It was located next to a creek that saturated the soil completely. Today, sheep occasionally graze the area and deer droppings are commonly found in the grass. Here, *Psilocybe semilanceata* fruits in abundance. Each fall season, the pasture is covered with hundreds of fruiting bodies (see Figure 15, p. 23).

For three years, we returned to the area three times each fall, and harvested a total of 2,800 mushrooms (ca. 140 g or 5 oz dry weight) at the location. While some of the fruiting bodies could be spotted easily on the grassy soil (see Figure 17) the vast majority of the specimens were usually concealed inside clumps of grass (see Figure 18).

When the weather is dry, *Psilocybe semilanceata* is an easily recognizable species. The fruiting bodies are extremely hygrophanous, which is why the color of the caps changes to a dark olive black-brown when the mushrooms are wet. Only a close inspection of the gills and the crooked stems enabled us to differentiate the wet mushrooms from the *Panaeolus* species (see Chapter 3.3). Like many other psychotropic mushroom species, a crucial characteristic of *Psilocybe semilanceata* is the blue discoloration of parts of the cap and the lower half of the stem, While the degree of discoloration is relatively minor, it is particularly noticeable when the mushrooms are wet. Fruiting bodies that are old and wet may spontaneously develop transparent, blue stains across their caps. On the other hand, discoloration of the stems does not set in until the fruiting bodies have been separated from the mycelia for about 30 to 60 minutes. Even in areas of abundant harvests, I have always found mushrooms with bluish-green discoloration's alongside others that lacked this characteristic. During the drying process, the blue coloration is preserved, even though some fading may occur.

The historic descriptions of *Psilocybe semilanceata* cited above are so detailed that I cannot add any of better quality. In spite of many opinions in the literature to the contrary, there is a noticeable odor that emanates from damp fruiting bodies that have been opened. This odor is similar to, but weaker than the one associated with *Psilocybe bohemica*, which is often described as reminiscent of radishes or poppies, but as generally not unpleasant (also see Chapter 3.2).

In addition, the mushrooms have another special attribute that rarely occurs in other species. Under the light of a quartz lamp, *Psilocybe semilanceata* specimens turn fluorescent. The substance responsible for this phenomenon, however, has not yet been identified.

Accounts of Impressive Experiences

Psilocybe semilanceata is quite likely the most potently psychoactive mushroom among the European species. The impressive nature and rapid onset of the effects are reflected in the description of an intoxication from England cited above. These elements are also part of the following account, which details a mycologist's first self-experiment:

> *After ingesting 1.3 g (less than one-sixteenth of an ounce) of dried and pulverized mushrooms (30 mushrooms total) in water on an empty stomach, 20 minutes passed before the sudden onset of hallucinatory effects, including a heavy flow of tears. The apparitions are best described as a conjunction of visions and thoughts - later on I discovered the term "visualization" in the literature. I had an extremely uncomfortable experience of a daydream-like flight, where my arm had been seized by a witch... There were three of us flying somewhere, sometime. After that, all objects in my immediate surroundings appeared pale and bleached. With my eyes closed I "saw" abstract ornaments with no distinct luminescence or emotional impact. During this time, free-floating dysphoria developed, along with guilt-ridden ruminations. After five hours, the effects ended suddenly, followed by the gradual onset of a mild headache, while no other side effects were noted.*

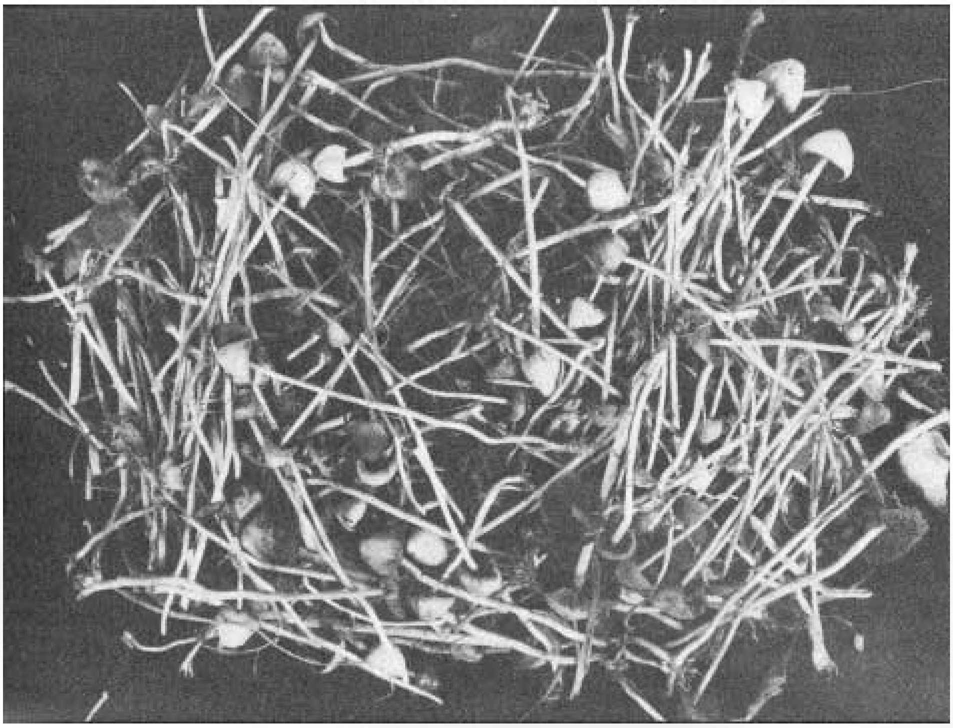
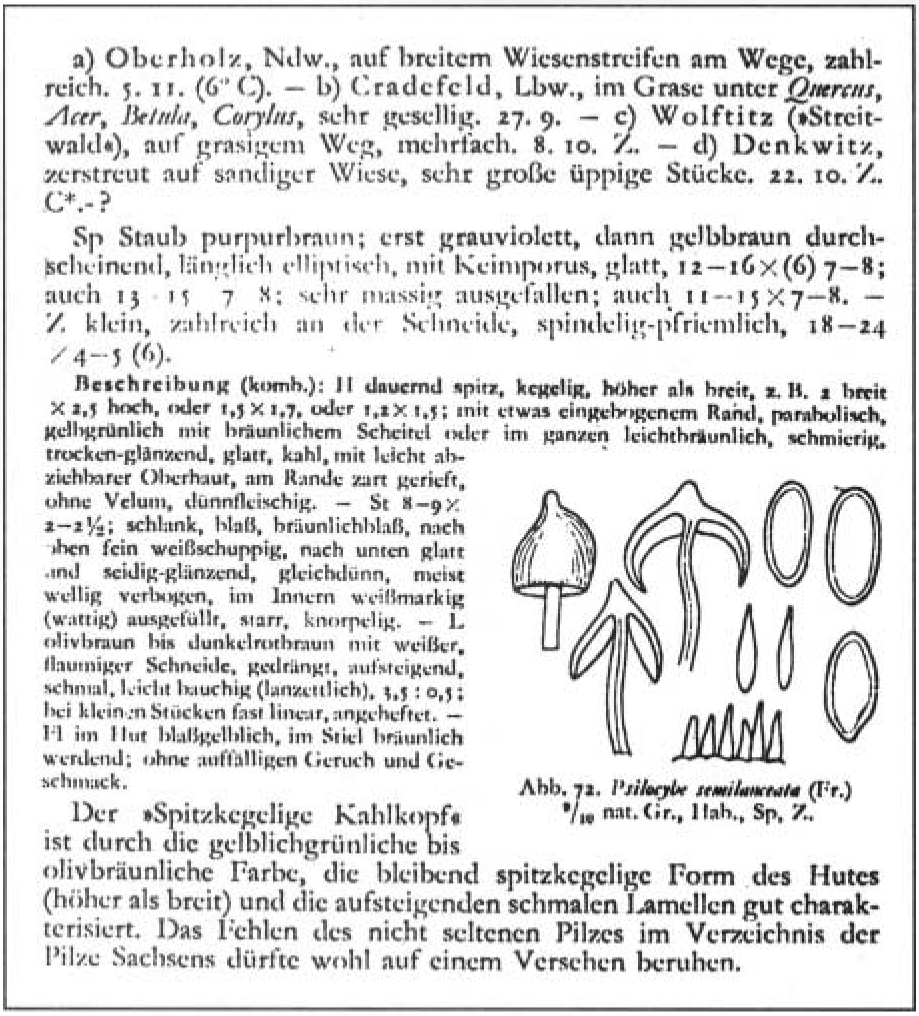


Figure 15 - Harvest of ***Psilocybe semilanceata*** mushrooms from a single location (Eastern German marshlands, 1989).



a) Oberholz, Ndw., auf breitem Wiesenstreifen am Wege, zahlreich. 5. 11. (6° C). – b) Gradefeld, Lbw., im Grase unter *Quercus*, *Acer*, *Betula*, *Corylus*, sehr gesellig. 27. 9. – c) Wolftitz (»Streitwald«), auf grasigem Weg, mehrfach. 8. 10. Z. – d) Denkwitz, zerstreut auf sandiger Wiese, sehr große üppige Stücke. 22. 10. Z. C*.-?

Sp Staub purpurbraun; erst grauviolett, dann gelbbraun durchscheinend, länglich elliptisch, mit Keimporus, glatt, 12–16×(6) 7–8; auch 13–15×7–8; sehr massig ausgefallen; auch 11–15×7–8. – Z. klein, zahlreich an der Schneide, spindelig-pfriemlich, 18–24×4–5 (6).

Beschreibung (komb.): H dauernd spitz, kegelig, höher als breit, z. B. 2 breit × 2,5 hoch, oder 1,5×1,7, oder 1,2×1,5; mit etwas eingebogenem Rand, parabolisch, gelbgrünlich mit bräunlichem Scheitel oder im ganzen leichtbräunlich, schmierig, trocken-glänzend, glatt, kahl, mit leicht abziehbarer Oberhaut, am Rande zart gerieft, ohne Velum, dünnfleischig. – St 8–9× 2–2½; schlank, blaß, bräunlichblaß, nach oben fein weißschuppig, nach unten glatt und seidig-glänzend, gleichdünn, meist wellig verbogen, im Innern weißmarkig (wattig) ausgefüllt, starr, knorpelig. – L olivbraun bis dunkelrotbraun mit weißer, flaumiger Schneide, gedrängt, aufsteigend, schmal, leicht bauchig (lanzettlich), 3,5 : 0,5; bei kleinen Stücken fast linear, angeheftet. – Fl im Hut blaßgelblich, im Stiel bräunlich werdend; ohne auffälligen Geruch und Geschmack.

Abb. 72. *Psilocybe semilanceata* (Fr.) 8/10 nat. Gr., Hab., Sp, Z.

Der »Spitzkegelige Kahlkopf« ist durch die gelblichgrünliche bis olivbräunliche Farbe, die bleibend spitzkegelige Form des Hutes (höher als breit) und die aufsteigenden schmalen Lamellen gut charakterisiert. Das Fehlen des nicht seltenen Pilzes im Verzeichnis der Pilze Sachsens dürfte wohl auf einem Versehen beruhen.

Figure 16 - A good description of ***Psilocybe semilanceata*** mushrooms from Saxony, Eastern Germany (1952).

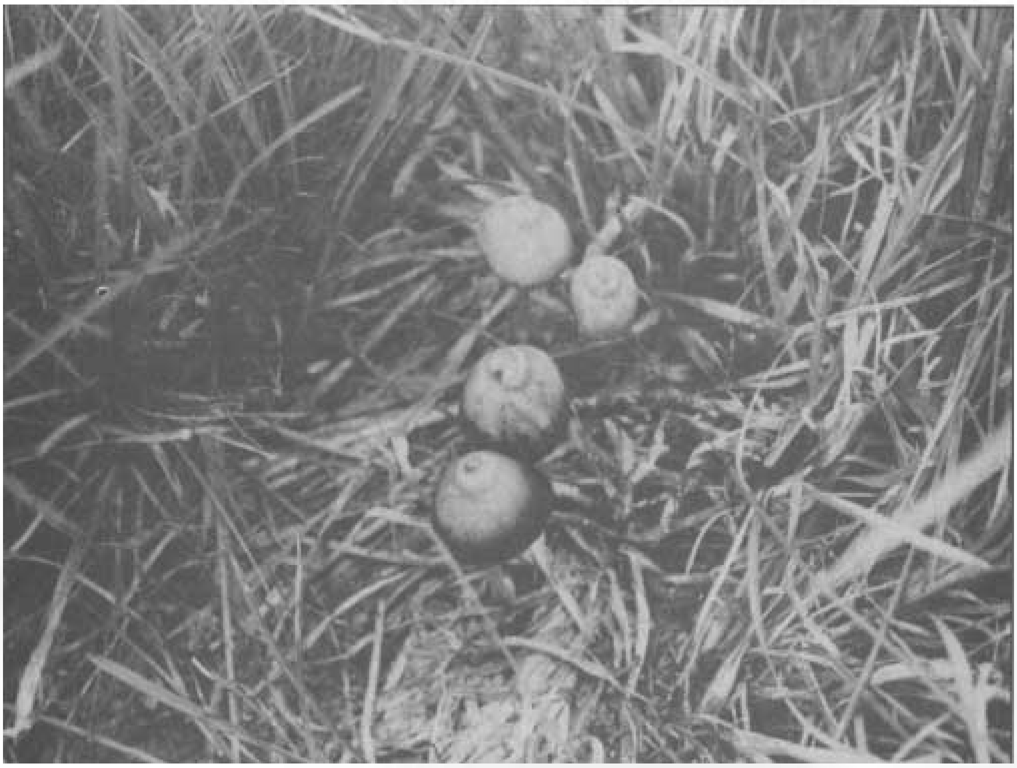


Figure 17 - ***Psilocybe semilanceata*** on grassy soil.

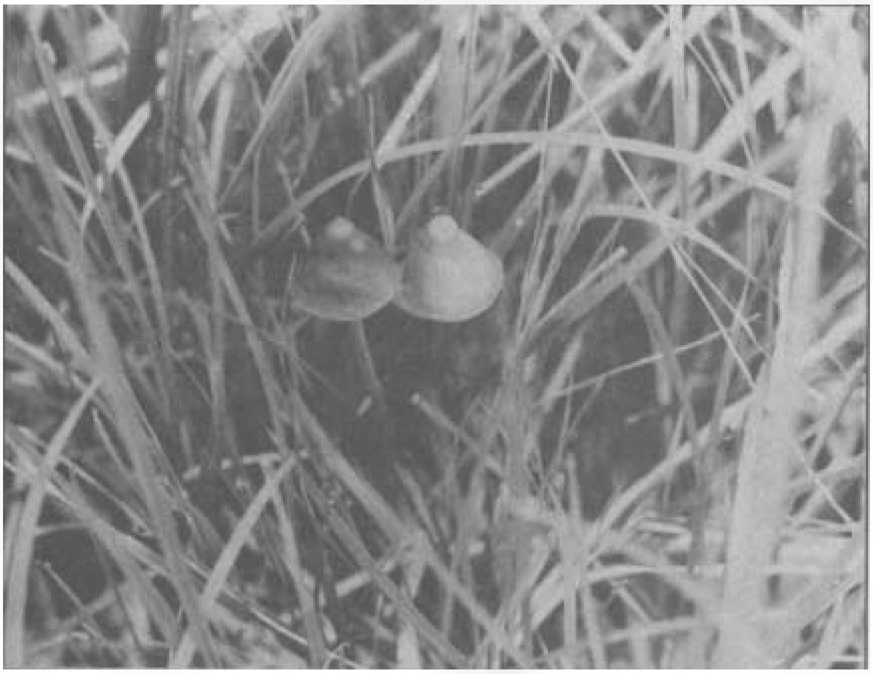


Figure 18 - ***Psilocybe semilanceata*** hidden in high grass.

On the other hand, a second experiment involving about half the previous dosage stood out because of a surge of memories and the simultaneous re-experience of childhood emotions, along with some curious feelings of melting and merging:

> *One day in late summer I was out on a nature walk and ingested 0.6 g of pulverized mushrooms. The weather was warm and sunny and I was walking through open areas near my hometown, were I had often played as a child. Suddenly, I experienced an emotional state most accurately described as child-like wonder and amazement about the surrounding forest. The area nearby appeared in very sharp contrast and my visual perceptions seemed fresh and pure. Suddenly I remembered in vivid detail just how small the trees had been decades ago and how I never observed any other plant growth there before dark, which had sometimes frightened me. At the*

> *same time, my body movements felt much more elastic and childlike. This delightful state of reliving my childhood lasted for about two hours. On the way home I noticed a small calf out on the pasture.*
>
> *The calf evoked a great amount of empathy in me, when I noticed how much it was bothered by pesky flies. These feelings of compassion culminated in a brief experience of completely merging with the calf. I found it to be rather strange and quite uncomfortable. After four hours, the effects subsided without any lasting side effects.*

Finally, a third mushroom experiment with *Psilocybe semilanceata* in Oregon led to an experience of complete identification with a person from the 19th century:

> *We collected a large number of "liberty caps" in a pasture near Astoria. Later on, back at our lodgings, I ate no more than six fresh mushrooms. The key stimulus for the following experience was provided by a water color painting of an elegant lady from the 19th century that captured my attention completely. Suddenly I knew that I was re-living an earlier incarnation, a life that began when I was born in Germany in 1813.*
>
> *My name was Alexander Schmitt, and I knew that I had died in 1871. As a child, I travelled by boat to North America, together with my parents and other immigrants. In the United States, I changed my last name to Smith. I was a logger in a small Kentucky town named Sharpville or Shopville. My life there was hard and full of sacrifices and I drank a lot of alcohol. These circumstances of my existence were indicative of my lifestyle, which included beating my wife and otherwise mistreating her like the tyrant I was. As the experience deepened, I completely identified with the person of Alexander Smith. During these moments I forgot my native German altogether, and my thinking processes unfolded entirely in English. In this manner, I eventually experienced the last hours of Alexander Smith's life. I was lying in bed on several white sheets and was very ill. Suddenly I knew that my wife had poisoned me, to put an end to my continuous degrading treatment of her over the years. I knew that I did not have long to live. I was about to die. Fortunately, the experience ended before I had to face the final struggle against death. Today, over three years later, this unique experience is still etched into my memory in vivid detail.*
>
> *The experience's emotional impact has not diminished with the passage of time.*

Such experiences of earlier incarnations cannot be explained in terms of the accepted tenets of western science. In any case, a thorough attempt should be made to research the existence and historic accuracy of the locations and persons involved. The individual who experienced the events described above had never been to Kentucky, did not know whether or not a town named Sharpville or Shopville has ever existed there and had never before had the slightest interest in this U.S. state. Due to his strictly atheistic upbringing, he had never thought such experiences possible. S. Grof, however, has described similar sequences and emphasized that they can occur quite unexpectedly under the influence of hallucinogens. He also noted that such experiences are not exactly unusual, when an individual experiences repeated applications of hallucinogenic substances.

In closing this section, I would like to present a short account of an experience that illustrates how the effects of psychotropic substances can vary across individuals, depending on the setting in which the experience takes place:

> *After ingestion of 0.6 g of pulverized mushrooms in orange juice, the effects began to manifest after about 30 minutes: An endless sequence of images behind closed eyes. At the same time, no distinctly euphoric nor dysphoric emotional states were noted; the reaction to these images is most fittingly described as "temporary amazement". The initial images of entwined ornaments changed with the passage of time and became plants, some of whom had several surreal characteristics not known to exist on Earth. I believe these images reflected my longstanding preoccupation with the world of plants. Then, when a mirror was placed in front of me, I perceived "a gloomy-looking fellow with a fixed gaze". Then I admitted, somewhat reluctantly, that this impression did, in fact, reflect my everyday demeanor and that I usually did not make it*

easy for others "to see behind the facade ". The experimental guide confirmed my own impressions. Prior to this incident, we had never discussed this issue.

The Psychotherapeutic Potential of Psilocybin's Psychotropic Effects

The preceding account of an experience by a 67-year-old mycologist contains elements that illustrate the beneficial potential of psilocybin's psychotropic effects as an adjunct to psychotherapy. We will return to a discussion of these benefits in Chapter 9.

In accordance with their strong psychoactivity, chemical analyses of *Psilocybe semilanceata* specimens have revealed high levels of psilocybin. It is safe to say that this species has been more thoroughly studied than any other *Psilocybe* species, including the Mexican species, whose dried mass is known to contain 0.2 - 0.6 psilocybin.

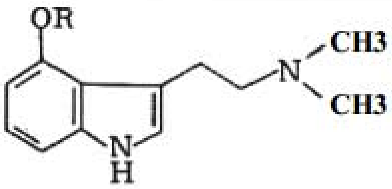
Collections of *Psilocybe semilanceata* from England, Scotland, Norway, Finland, Belgium, Holland, Germany, France, the United States as well as from Switzerland and the former Czechoslovakia have, for the most part, been extensively analyzed. It was discovered that the combined analysis of several dried mushrooms for alkaloid content yielded an average value of 1% psilocybin of the dry weight, regardless of country of origin. The issue of chemical race has been hotly debated with respect to other species, such as the fly agaric mushroom. But in contrast to plants, such a phenomenon has not yet been proven to exist in the higher mushroom species. So far, there is no evidence to support the notion that the basic chemical make-up of a species can vary dramatically from sample to sample. Among the species discussed here, *Psilocybe semilanceata* and *Inocybe aeruginascens* (see Chapter 3.4) appear to be the two species with the lowest degree of variability in psilocybin content across samples. The first three analysis results shown in Table 1 represent data from my own research conducted in the course of a workshop with other investigators in Prague.

Table 1
Average Psilocybin Content of Dried *Psilocybe semilanceata* Samples.

Origin	Psilocybin (%)
1. Dubener Marshlands, Eastern Germany	0.96
2. Prague, Czech Republic	1.05
3. Krasna Lipa, Czech Republic	0.91
4. Norway	0.95
5. Pacific Northwest, USA	0.93
6. The Netherlands	0.97

Fresh mushrooms are about 90% water, that is, one gram of mushroom material contains an average of 1 mg of psilocybin.

Psilocin, a comparatively less stable compound, is the phenol analogue of psilocybin (see Figure 19, p. 27) and thus oxidizes much more readily than psilocybin. *Psilocybe semilanceata* contains only trace amounts of psilocin, if any at all.



(1) **R** = H_2PO_3
(2) **R** = H

Figure 19 - Structural formulas for psilocybin (1) and psilocin (2).

On the other hand, baeocystin as the Biochemical precursor of psilocybin is found in all fruiting bodies of the

Psilocybe species. The precursor has a hydrogen atom where psilocybin's only CH_3 group is located; the average baeocystin content is 0.2% of dry weight. In 1967, Leung and Paul reported the isolation of baeocystin from fruiting bodies of *Psilocybe baeocystis* Singer & Smith in North America. In 1977, Repke and Leslie also found the substance in a *Psilocybe semilanceata* sample from the same place of origin.

Some investigators have found differences in alkaloid content when comparing single fruiting bodies from the same location.

Table 2

Alkaloid Content of Dried Mushrooms from a Location in the Dubener Marshlands of Eastern Germany (Selected Results)

Dry Weight (mg)	Psilocybin (%)	Baeocystin (%)
18	1.25	0.34
30	0.96	0.21
70	0.72	0.19
85	0.90	0.10

Smaller mushrooms almost always contained more alkaloids than larger specimens. This fording was then confirmed by another study using considerably larger amount of investigative materials (40 mushrooms). Moreover, exceptionally high concentrations of baeocystin have been shown to accumulate in the caps of fruiting bodies that contain the alkaloid. In addition, one mushroom sample from Finland deserves special mention due to its unusually high psilocybin content of 2.37%!

Early controlled studies of the psychoactivity of various species in the former Czechoslovakia concluded that *Psilocybe semilanceata* is a more potently psychoactive species than *Psilocybe bohemica*, even though both species were found to contain the same amounts of psilocybin. Thus, researchers hypothesized that the mushrooms are likely to contain additional substances that contribute to the overall psychotropic effect. This hypothesis is supported by the fact that considerable amounts of baeocystin are consistently found in samples of *Psilocybe semilanceata*. I am also aware of an experiment whose results showed that 4 mg of baeocystin caused mild hallucinations for three hours, while 10 mg of baeocystin were found to be about as psychoactive as a similar amount of psilocybin.

The Long Shelflife of Psilocybin

As part of dried mushroom material, psilocybin is a remarkably durable substance. A sample of desiccated mushrooms dated 1869 from a Finnish herbarium was still found to contain 0.014% of psilocybin. On the other hand, no alkaloids were founds in another sample dated 1843. Unfortunately, it is no longer possible to determine the methods used in drying these samples. Temperatures over 50°C cause psilocybin to break down into its derivatives. In laboratory settings, mushrooms are usually dried at room temperatures. Sometimes, fruiting bodies are also freeze-dried for analysis. Freeze-dried mushrooms, however, have a highly porous texture that causes the alkaloids to break down relatively quickly, if the samples are stored at room temperature (20°C). For that reason, freeze-dried samples for biochemical analysis are stored at -10°C prior to alkaloid extractions or chromatography testing. In addition to the reports from Finland, investigators in North America have noted that psilocybin's decay rate is slowest in *Psilocybe semilanceata*, compared to other species.

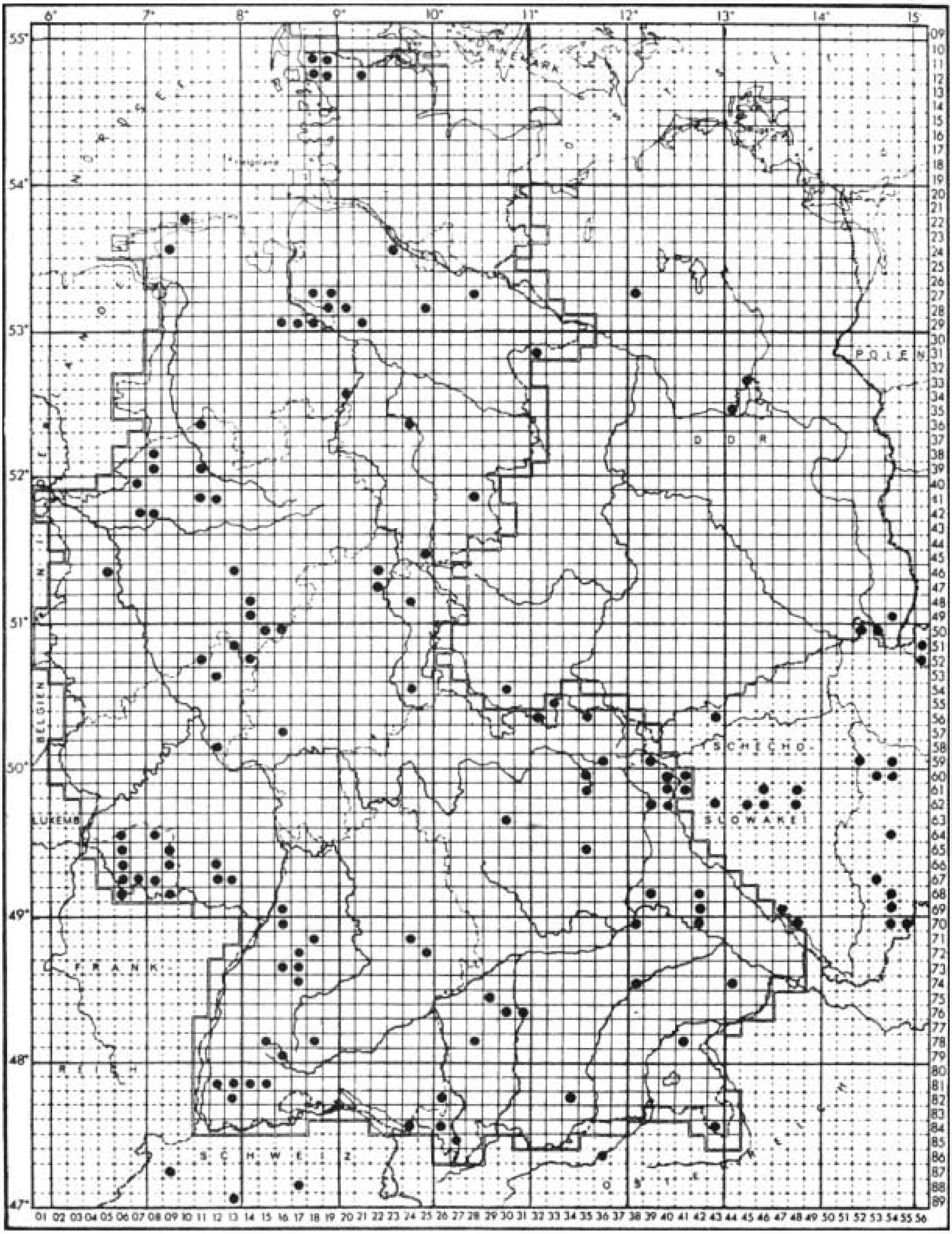

6°
7°
8°
9°
10°
11°
12°
13°
14°
15°
55°
54°
53°
52°
51°
50°
49°
48°
47°
DÄNEMARK
NORDSEE
POLEN
DDR
BELGIEN
LUXEMB.
FRANK-REICH
SCHWEIZ
ÖSTERREICH
SCHECHO-SLOWAKEI

Figure 20 - Distribution pattern of ***Psilocybe semilanceata*** in Germany and adjacent areas. Locations are indicated by black dots.

3.2 - *Psilocybe cyanescens*: Potent Mushrooms Growing on Wood Debris

At least one other *Psilocybe* species in addition to *Psilocybe semilanceata* is known to exist in Europe. At this point, I must emphasize that the differentiation of single species within the *Psilocybe* genus is subject to considerable controversy among eminent taxonomists. For example, there are different methods of distinguishing the *Hypholoma* genus from the *Stropharia* genus.

The Widespread Distribution of *Psilocybe cyanescens*

While *Psilocybe semilanceata* is a species that has long been clearly defined and is well known by this name, there are, according to Krieglsteiner, other strongly bluing mushrooms that can be described as belonging to the "*Psilocybe cyanescens* complex". These are all mushrooms that grow on raw compost and plant debris.

In accordance with current states of knowledge, the following names in the literature are merely synonyms for *Psilocybe cyanescens* Wakefield emend. Krieglsteiner:

- *Hypholoma cyanescens* R. Maire
- *Hypholoma coprinifacies* (Rolland ss. Herink) Pouzar
- *Geophila cyanescens* (R. Maire) Kuhner & Romagnesi
- *Psilocybe serbica* Moser & Horak
- *Psilocybe mairei* Singer
- *Psilocybe bohemica* Sebek

The classification of these synonyms is particularly difficult, because the mycologists involved provided detailed descriptions for isolated collections of fruiting bodies only, followed by comparisons with mushrooms found at other locations, using dates provided in the literature. Under the best of circumstances, an analysis was performed on dried samples from different herbariums. However, the microscopic data pertaining to the *Psilocybe* species are poorly delineated and oftentimes overlap. It is therefore imperative that additional mycological studies of *Psilocybe cyanescens* be performed. To this end, fresh mushroom samples from various European locations should be used, and biochemical methods must be included in the investigation. Guzman's division of *Psilocybe cyanescens* by geographic area, however, definitely turned out to be inaccurate. According to his system, - North Africa was home to *Psilocybe mairei*, while *Psilocybe cyanescens* were found in England and Holland and *Psilocybe serbica* supposedly grew in Serbia and Bohemia. The geographic distribution of the entire species seems to cover a vast area, with variations along climate and terrain at locations where samples were collected. Such disparate morphologies are to be expected when dealing with "young" species, that is, species that have not yet firmly established themselves and are still expanding into new locations.

Figure 7 (p. 14) displays locations in Europe and North Africa where samples of *Psilocybe cyanescens* have been found.

Spores Introduced From Overseas?

In this section I would like to discuss several aspects of the bluing *Psilocybe* mushrooms. Detailed information about several isolated sample collections has been presented by Krieglsteiner.

A description of any mushroom species becomes valid only after a Latin diagnosis of the collected sample has been published in a mycological journal, along with distinctive characteristics in relation to other species.

In 1946 Wakefield described as *Psilocybe cyanescens* Wakefield a sample of bluing dark-spored mushrooms collected at the botanical gardens in Kew, England. It had been suggested that those mushrooms occurred adventitiously, that is, that the spores had been imported from overseas together with other plant materials. The presence of such mushrooms in botanical gardens had been observed quite frequently, and such imports are likely whenever the mushroom in question has never before been found in surrounding areas. The possible importation of *Gymnopilus purpuratus* is described elsewhere (see Chapter 3.5).

The mushrooms displayed a much more intense blue staining reaction than *Psilocybe semilanceata*. They were observed growing on small pieces of wood in the forested areas of Kew Gardens during the fall season for several years. Among the mushrooms' most notable features are their undulating, twisted caps. Guzman believes that specimens collected in British Columbia and the Pacific Northwest of the United States (Northern California, Oregon, Washington) are identical to those found in Kew Gardens (see Figure 24). Indeed, all of the macroscopic and some microscopic descriptions and photographs match the mushrooms found in England. However, conclusive proof of identity can be provided only by results from DNA analyses and cross-breeding experiments with single-spore mycelia. I will elaborate on this method in a later section.

In 1975, fruiting bodies of this species were also discovered in Holland. Additional bluing mushrooms growing gregariously on grass and decaying reeds were found in the Jura Mountains of Switzerland in 1972 (MTB 8511). Other samples are known to have been collected in the Steiermark region of Austria in the fall of 1976, as well as on the Mediterranean island of Corsica in 1972 and 1984.

On several occasions, a number of fruiting bodies classified as *Psilocybe cyanescens* were also discovered in Germany (see Figure 23, p. 32).

More elaborate descriptions of several such collections are provided below:

> On October 31, 1983 considerable quantities of fruiting bodies in all stages of development were found in the lower regions of Bavaria (MTB 7542). Interspersed with grass, the mushrooms grew along a 100-yard stretch right next to an old garbage dump forming colonies, some small and others larger, that were partially intertwined. They were found scattered across decaying plant materials, such as leaves, twigs and mulch. There were greenish and distinctly bluish stains on the caps, and most notably a bluish color near the base of the stem. Other fruiting bodies quickly developed blue stains in reaction to being handled, even in very cool temperatures.

The description of *Psilocybe cyanescens* below is somewhat condensed, but essentially applies to all other collections, while the relative measures and sizes may vary:

> *Caps*: 5-40 mm broad, conic at first, with cortinate fibrils ascending steeply to the stem, but fading quickly, bell-shaped later on, partially with an acute umbo. Later expanding to plane, with undulating or wavy margins, no remnants of veil, also broadly convexed to umbonate in older mushrooms. Deep chestnut brown when fresh and moist, fading to a whitish color when drying, with stains of bluish to blue-green coloration.
>
> *Gills*: Attachment adnate to broadly subdecurrent, color light to dirty beige when young, later on changing to cinnamon-purple brownish color due to maturation of spores. Blue staining reaction is slight in response to pressure.
>
> *Stem*: 30-85 mm long, uniformally thick at 1.5-3 mm. Stems and mycelial fibers turn blue in response to touch, if blue stains not already present.
>
> *Odor*: Somewhat like flour or potatoes.
>
> *Spores*: 6-8 x 9-14 µ.

In 1976, bluing mushrooms growing on plant debris were found in the Saarland region of Germany. Other collections came from the Southern regions of the Black Forest (MTB 7515, 1959, 1963), as well as the Vogtland area (1979) and the Rheinland area (MTB 4706, 1982). Similar mushrooms were also discovered near Hamburg (MTB 2428, 1983) and Bremen (1982, 1983). The latter collections are especially interesting, because the greenhouses at the Rhododendron Park and People's Park in those cities provided layers of wood chips during the fall which enabled the mushrooms to fruit much more prolifically (thousands of mushrooms) than they did naturally in surrounding areas, where the species was also fruiting in several locations. These findings most likely indicate the presence of a similar, imported species, because native fruiting bodies require exposure to the shock of colder temperatures of fall in order to develop from the mycelia. For instance, other wood chipdwelling species have been reported from the Pacific Northwest of the U.S., such as *Psilocybe stuntzii*, *Psilocybe baeocystis*, *Psilocybe pelliculosa* and others (also see Chapter 7.1). *Psilocybe caerulescens* Murr. from Mexico is also related to these species. This was the first *Psilocybe* mushroom to be recognized as psychoactive by Wasson in the course of his self-experiment on June 29, 1955.

Very little is known about the chemical composition of the collections cited above. I analysed a few mushrooms from collections found in the Rheinland area of Germany in 1989. The results were as follows:

Psilocybin:	0.51% of dried mushrooms
Psilocin:	0.08% of dried mushrooms
Baeocystin:	0.04% of dried mushrooms

A few other analyses of German mushrooms yielded similar results. These values were well within the range of concentrations of alkaloids found in Mexican species. The most extensive studies on distribution, psychoactivity and chemical compounds of *Psilocybe cyanescens* complex were conducted in the former Czechoslovakia, where the mushrooms are generally known as *Psilocybe bohemica*, a name which is also used in the text below.

An Amazing Discovery Near Poricko

Kubicka first discovered the species on December 6 and 13, 1942 in the Kresicky Creek Valley village of Poricko v Pozavi near Sazava (Czech Republic). In 1950, mycologist Herink described the mushrooms in detail. He also believes that Fries classified mushrooms of the *Psilocybe cyanescens* complex as *Psilocybe callosa* during the 19th century. On November 11, 1986 I had the opportunity to work with Herink and other Czech mycologists on a mycological field research project at the location, where we found 440 fruiting bodies (550 g or 19.6 ozs). Covering a segment almost two miles long, the species was fruiting among nettles along both sides of the creek on wood chips of *Carpinus*, *Alnus* and *Salix*, on raw compost mixtures of *Picea*, *Pinus* and *Larix* needles, as well as on decaying pine cones. Several specimens up to 15 cm (6 in.) tall with caps up to 5 cm (2 in.) broad were found growing on a rotting log whose underside was exposed to the running water. A water-loving *Psilocybe* species, it primarily fruits in late autumn (see Figure 21, below), when short night frosts induce maximum possible fruiting. The brown caps are strongly hygrophanous and their color fades to a white-milky brown when dried. Its odor has been compared to anything from radishes to poppies. In my experience, the odor is highly variable and thus difficult to define. Young, dry mushrooms develop intensely blue stains in response to handling, while older fruiting bodies tend to be found at the location with dark blue stains already in place. It is remarkable that the mushrooms were fruiting at the same location near Poricko for so many years in a row, producing a large number of fruiting bodies each year. Unfortunately, in recent years the location was partially destroyed, due to construction of a road.

By late 1982, the mushroom species had been found at 51 locations in the former Czechoslovakia, with only seven of them located in Bohemia, 40 in Moravia, and four in Slovakia. Elevations vary from 200 m to 700 m (600 ft to 2,100 ft) above sea level, with only two locations known to exist above 700 m (2,100 ft). By this time, 112 collections had been reported, 44 of which came from the classic location near Sazava.

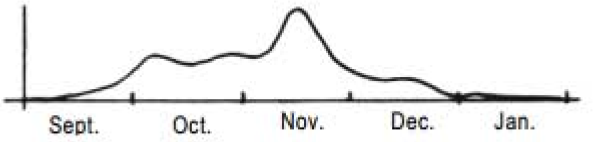


Figure 21 - Fruiting curve of ***Psilocybe cyanescens*** based on observations at several locations in the former Czechoslovakia

The mycelia make use of different kinds of plant debris and even grow on wet cardboard, where they develop into rhizomorphs just like they would in nature. Rhizomorphs are thick strands of mycelia that serve to transport nutrients and water. They also develop intense blue stains (see Figure 22).

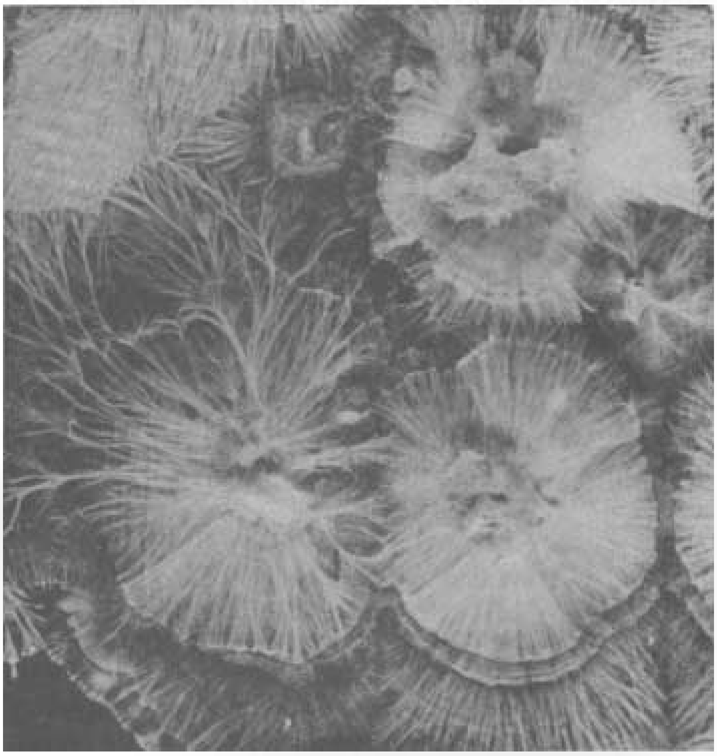


Figure 22 - ***Psilocybe bohemica*** rhizomorphs growing on wet cardboard.

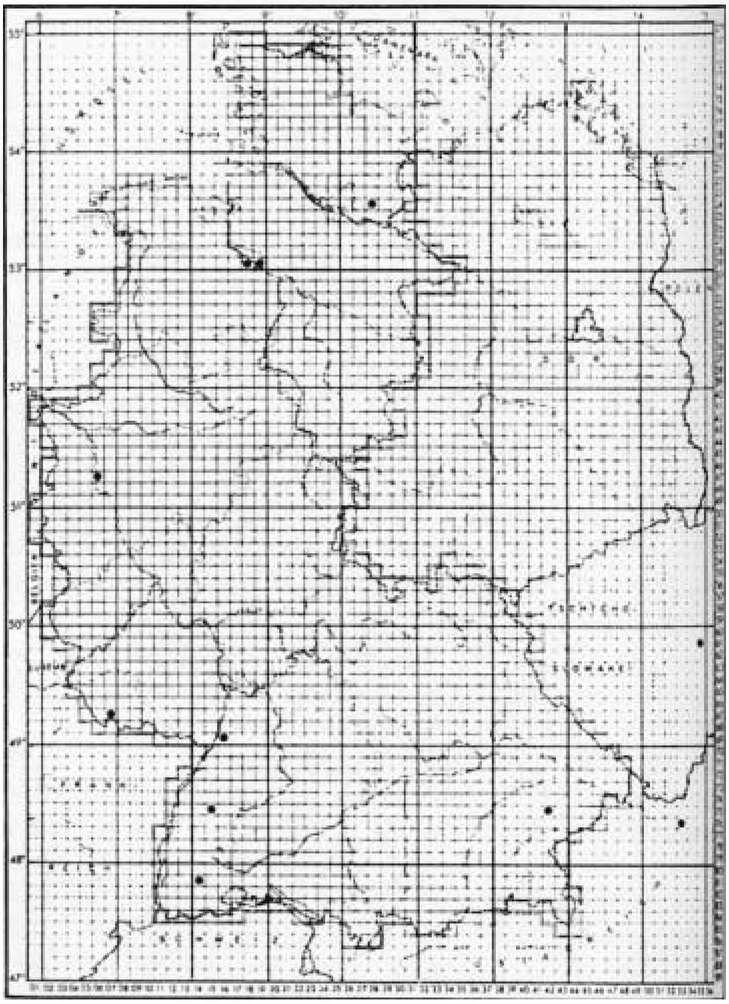


Figure 23 - Distribution pattern of ***Psilocybe cyanescens*** in Germany and adjacent areas (according to Krieglsteiner). Locations are indicated by black dots.

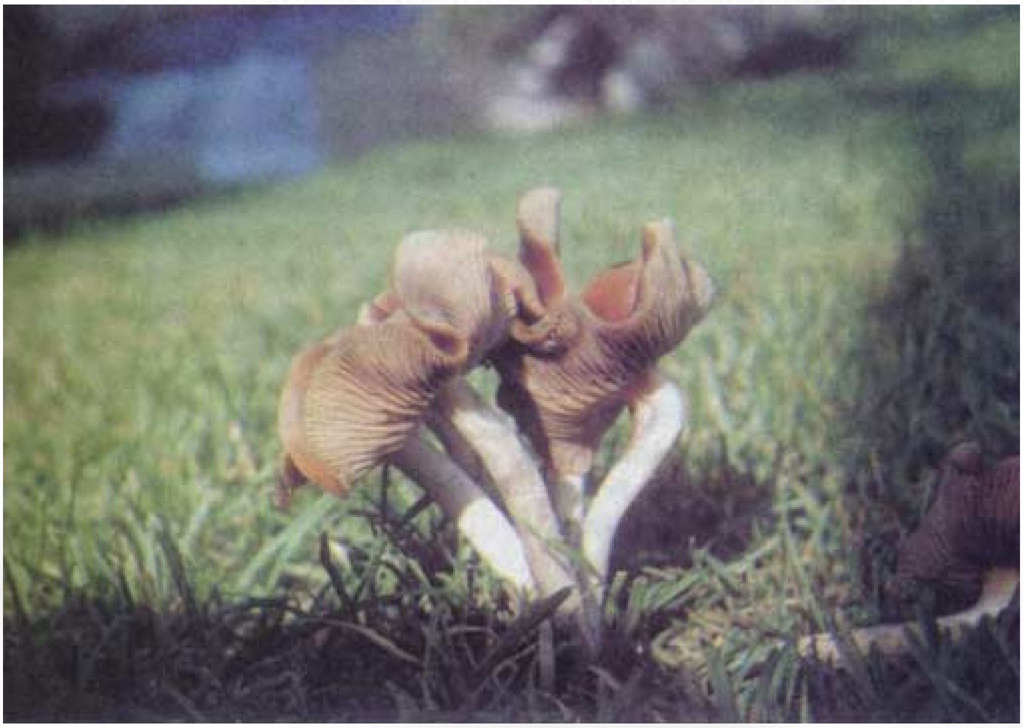


Figure 24 - ***Psilocybe cyanescens*** at a natural location (USA).

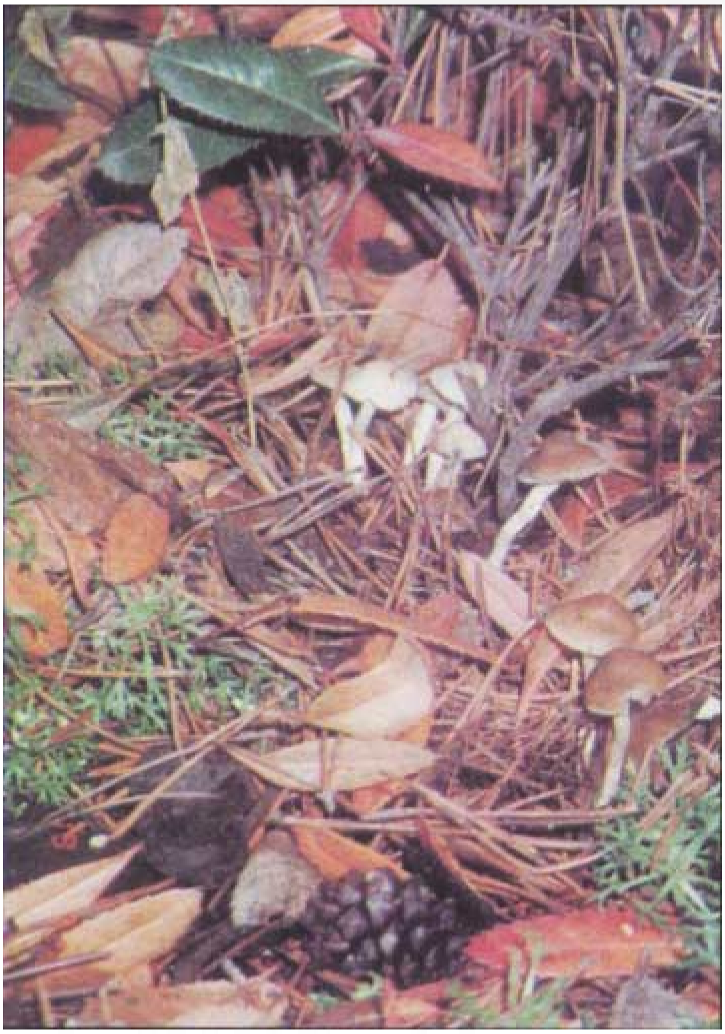


Figure 25 - ***Psilocybe bohemica*** on twigs and leaves.

Impressive Experiences

Psilocybe bohemica is a very psychoactive species. Its effects are vividly documented in the following account of one natural scientist's experience as part of controlled clinical trials in Prague:

About 30 mg of psilocybin in mushroom tissue was prepared in hot water, with effects already noticeable ten minutes after ingestion. I grew increasingly quiet. At first, my legs began to tingle, then my underarms as well. Aside from a deeper breathing rhythm, few other somatic effects were noted. Initially there were fits of laughter caused by unusual cognitive associations; this laughter also affected the two "sober" guides. A growing hyperacuity interfered with the ability to listen to music, so that Vivaldi's "Springtime" caused painful stabs inside the brain. I compared the pain to that caused by a "sawing knife". The experimenters appeared bloated and yellow... Existing bodily characteristics, such as thinning hair stimulated a person's illusionary transformation into a monk with tonsure. Their voices also appeared reverent and, from a somewhat paranoid point of view, these gentlemen at times seemed to be working a switching station that, for some reasons, was my enemy. At the same time, I found both of them to be quite likeable. During this time period, the other female subject perceived fantastic images of moving colors and saw visions of her whole life unfolding behind closed eyes. During this period, I had the distinct impression that an electrical current was flowing through my body, which was not an uncomfortable sensation. About three hours later, the gentlemen retired to the kitchen and the nature of the experience changed quite drastically.

> *At first I felt as if my legs were increasingly merging into the wall, a very comfortable experience. In a state of utter clarity of consciousness, I finally felt as if I had no body at all. I said. "The most descriptive expression is the experience of a pure soul". Using words as triggers, we were able to induce shared experiences of color visions and we travelled together around the word as well the spiritual realm. She made a clearly telepathic statement about my hometown, which I could not fathom or interpret at the time, nor could I do so later on. While under the impression that the thinking process itself was something supernatural, I was filled with confidence when I realized without a doubt that death itself was but a levitation of the soul, which may or may not entail looking down upon the "normal" world. I did, however, anxiously reject her offer to see into my future and tell me about what she learned. Yet I knew that she was already seeing such things.*

The above account vividly illustrates the cosmic-mystical aspects of the mushrooms' effects. Such effects have frequently been described following ingestion of high doses of hallucinogens, especially in cautious and protective environments ("setting") coupled with a positive, internal mood ("set") primed by careful preparation. Of course, the detailed content of such experiences varies across individuals. Pahnke's masterful study during Good Friday Services in 1962 has become a famous event in the history of research into these states of consciousness.

Three years later, a remarkable range of effects was observed in the same participant of an experiment conducted in Prague, where mycelia from *Psilocybe bohemica* were used. Due to an analytical error, the four participants each ingested 72 mg of psilocybin, plus some psilocin, instead of the intended dosage of 30 mg of psilocybin each:

> *Days before the experiment, I already began to suspect that this experience would not evolve as smoothly as it had three years ago, given the amount of personal stress I had suffered over the previous two months. However, I had faith in the expertise provided by psychiatric guidance. Prior to the experiment, I asked the psychiatrist about the possible causes underlying my seeming inability to fully experience the unfolding of visual imagery. He brushed aside my question with a short and terse reply: "Resistance", which only heightened my feelings of anxious tension.*
>
> *After ingestion of the hot preparation, fifteen minutes passed until the sudden onset of its effects. I ceased to perceive the music and sank into an autistic state devoid of visions which lasted for three hours. This state was subjectively experienced as one of confusion with a partial loss of consciousness as well as the loss of a sense of time and place. This torturous period, however, did not include any rough somatic disturbances. After I woke up, I felt like a broken machine; only the compassion of the other participants, which were also suffering, helped to clear my head temporarily. My experimenter attempted to counterbalance these effects and to provide a firmly*

> *grounded focus of reality, but his efforts were unsuccessful in the long run. I felt as if I was extremely drunk, except there was none of the aggression typical of alcohol intoxication. Soon afterwards, I began to project my emotions onto the psychiatrist. I saw him undergo illusionary changes; initially he appeared to be a dominant rooster which transformed into a punk rocker. Then I felt that he would understand what I was going through, given his extensive background and experience with psycholytic therapy. So I asked him, if the two of us could retire to another room. When he consented, I began to undergo a psychic split. The sound of my voice was strange and whiny. I felt as if part of me had split off and become an observer, while the rest of my prone body had assumed the position of an infant, sucking on a finger and crying, crumbling up tissue papers at the same time. On the psychoanalytic level, an extraordinary experience began to unfold. I became conscious of all recent and past conflicts, especially those involving my parents. This part of my personality articulated and worked through the emerging conflicts. Even though one might assume this process was facilitated by the psychiatrist, this was not the case. In the semidarkness I perceived him as my deceased grandfather, as a human skull and as an American football player, whose armor I recognized as a projection of my own uptight personality.*
>
> *Afterwards I looked at my reflection in a large mirror and reconciled my differences with myself as the two halves of my personality merged into one. I saw a soft and tearful face and soon realized that the person I was looking at was none other than myself, that I had learned to accept myself, in spite of all my problems. At the time I also noticed that my self-disciplined behavior was overly exaggerated, a trait generally judged as unfavorable by those around me. I resolved to become more relaxed and carefree in attending to my daily routines. I believed this psychological insight to be a revelation. With my eyes closed, I saw images of translucent vessels atop a brilliantly blue surface. In the weeks and months after the experiment, those around me noticed that my behavior had changed to become more relaxed, which was mentioned spontaneously on several occasions.*

The experience of an initial, painful delirium illustrates a resistance to dealing with the conflicts that invariably emerge in response to high dosages - conflicts that were resolved through an intense psycholytic catharsis (also see Chapter 9). A psychedelic experience ensued as both parts of the divided personality were merged into a whole. This is a decidedly positive outcome of a psycholytic episode with corresponding therapeutic benefits - a result that was entirely unintended (!). Personal stress prior to the experiment apparently facilitated the manifestation of deep-seated conflicts and issues that might otherwise never have been dealt with. With the exception of the attending psychiatrist, outside observers appraised this experience as a "bad trip". The subject, however, thought the experience to be enlightening and illuminating, even five years after it took place. Grof describes very similar reactions to LSD therapy. After "going through Hell", subjects proceed to reintegrate their personality at a higher level of consciousness, while experiencing visionary images of clear, bright lights and illumination.

Table 3
Concentrations of Psilocybin and its Derivatives in Psilocybe bohemica (% of Dried Mushrooms)

Specimen #	Weight (mg)	Psilocybin	Psilocin	Baeocystin
1	31	1.34	0.00	0.01
2	90	0.94	0.01	0.01
3	104	0.41	0.00	0.02
4	175	0.90	0.00	0.01
5	200	0.71	0.01	0.02
6	220	0.37	0.00	0.01

Distribution Patterns of *Psilocybe cyanescens* in the Wake of Environmental Changes

In 1973, Semerdzieva and Nerud first reported the existence and qualitative content of psilocybin in collections of *Psilocybe bohemica*. This research team reported psilocybin levels of up to 1.1% in dried samples. Results from my own studies also revealed variable levels of alkaloids in different mushrooms collected at the one location near Sazava.

In spite of the intense blue staining reaction, there is very little or no psilocin in mushrooms of the European *Psilocybe cyanescens* complex. By chemical-taxonomic standards, European collections are very different from *Psilocybe cyanescens* samples collected in the Pacific Northwest of the United States. The latter are known to contain up to 1% psilocin (dried mushrooms) as well as an equally high level of psilocybin (for a total alkaloid level of 2%), making it one of the most potent species in North America. The study of extracts derived from these mushrooms revealed that enough psilocin was present for the oxidized compound to be visible on a thin-layer chromatography plate. This was not the case when similar analyses were performed on mushrooms collected in the former Czechoslovakia. However, mushrooms from both countries contain similarly low levels of baeocystin.

Generally we can say that this potently psychoactive and conspicuous species is in the process of expanding its habitat across Europe. Increasing use of fertilizer, the acidification of the soil in many regions and the presence in any wet forest or park of a variety of fertile substrates, such as mulch, not dependent on the presence of dung, are all factors that will likely help *Psilocybe cyanescens* achieve a remarkably wide area of distribution in the future.

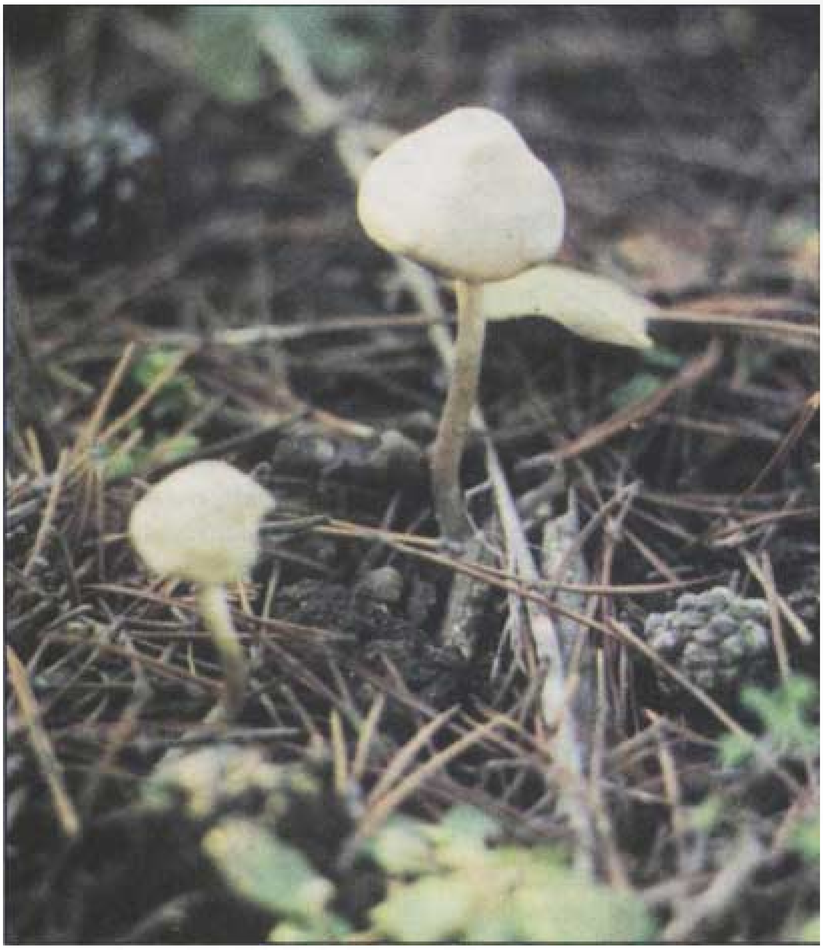


Figure 26 - ***Psilocybe bohemica*** on twigs and compost.

3.3 - *Panaeolus subbalteatus*: Mycology and Myths about the *Panaeolus* Species

Stories about involuntary intoxications with the dark-spread dung-inhabiting mushrooms (genus *Panaeolus*) in various regions of the world have been in circulation since at least the early 19th century.

> *In 1816, an impoverished man collected mushrooms in London's Hyde Park which he thought to be edible white mushrooms ("champignons ", Agaricus bisporus). Soon after ingesting these mushrooms, his field of vision darkened and he saw fog while feeling lightheaded and dizzy.*
>
> *Trembling, he sank into his chair. He felt all his strength draining from his body and he grew oblivious to his surroundings and no longer knew where he was. Some time later, the feelings of dizziness subsided, and his heart rate slowed down until he was finally able to fall asleep.*

The symptoms were later attributed to "*Agaricus campanulatus* Linnaeus ", which the man had mistaken for champignons. The same species had been responsible for a similar case of intoxication that happened about a year earlier. Both accounts are highly reminiscent of the 1799 intoxication with *Psilocybe semilanceata* from St. James Green Park (see p. 15). This would seem to be quite logical, as there are psilocybin-producing mushrooms even among the genus *Panaeolus*. However, the question which of the 15 European species actually produce the psychoactive substance is an issue that remains the subject of considerable scientific controversy. Even though I cannot offer any decisive or final evidence towards the resolution of this problem, there are some fairly conclusive results from modern biochemical analyses (see Table 4 below) of mushrooms that were clearly identified or obtained from herbariums, where certain species were known to have been deposited. Specifically, many American species within the genus *Panaeolus* do not appear to be the same as European species with the same name.

At this point, I would like to present some historic cases of *Panaeolus* intoxications. A typical hallucinogenic experience blamed on the accidental ingestion of *Panaeolus papilionaceus* (Bull.:Fr.) Quel. occurred in Maine, USA, in 1914.

Below is an abridged version of the description of effects by a Mr. W.:

> *On July 10, 1914, I gathered a good mess of the mushrooms (Panaeolus papilionaceus) and had them cooked for dinner. ... They were all eaten by Mrs. Y. and myself. Peculiar symptoms were perceived in a very short time. ... A little later, objects took on peculiar bright colors. A field of redtop grass seemed to be in horizontal stripes of bright red and green, and a peculiar green haze spread itself over all the landscape... Soon both of us became very hilarious, with an irresistible impulse to laugh and joke immoderately, and almost hysterically at times. ... I then had a very disagreeable illusion. Innumerable human faces, of all sorts and sizes, but all hideous, seemed to fill the room and to extend off in multitudes to interminable distances, while many were close to me on all sides. They were all grimacing rapidly and horribly and undergoing contortions, all the time growing more and more hideous. Some were upside down. The faces appeared in all sorts of bright and even intensive colors - so intense that I could only liken them to flames of fire, in red, purple, green and yellow colors, like fireworks. ... The entire experience lasted about six hours. No ill effects followed. There was no headache, nor any disturbance of the digestion.*

During the winter of 1915, a species of *Panaeolus* spontaneously appeared in a mushroom greenhouse in New York. These fruiting bodies were accidentally eaten together with the champignons that were cultivated there. This error led to cases of intoxications so remarkable that Murrill described the mushroom as *Panaeolus venenosus*. Some time passed before it was discovered that this species had previously been described as *Agaricus subbalteatus* B. & Br. from England in 1861. The combination term that is in use today, *Panaeolus subbalteatus* (B.& Br.) Sacc. was first published in 1887.

Other cases of intoxications with similar symptoms caused by the *Panaeolus* species have been reported in the United States (1917), as well as from Australia (after 1940), where the species involved was described as "*Panaeolus ovatus* Cooke & Massee".

In 1939, these reports induced Schultes, in agreement with Linder's classification experiments, to publish as *Panaeolus sphinctrinus* (Fr.) Quel. the *teonanacatl* mushroom described in the Mexican literature from the 16th and 17th centuries.

However, Wasson, Heim and their collaborators, as well as Singer, were unable to document the usage of *Panaeolus* mushrooms in Mexico, in addition to their reports about the usage of psychoactive *Psilocybe* species from the 1950s. By 1959, even Guzman referred to this species as "the false teonanacatl". So far, he has been unable to document native usage of any *Panaeolus* species in Mexico. In fact, the natives of Mexico consider bluing, hallucinogenic *Panaeolus* mushrooms to be poisonous.

Despite the poisoning case reported in England, the early German literature does not classify *Panaeolus* species as poisonous (see Figure 27). The *Psilocybe* species were treated similarly.

Figure 27 describes the mushroom's characteristics as accurately as Figure 3 (p. 6) depicts its habitus. More recent descriptions are usually less detailed and thorough than Michael & Schulz's from 1927.

In Germany, a case of intoxication with *Panaeolus* mushrooms was first reported in 1957 (see Figure 28). From today's perspective, it appears that the mushroom responsible for the intoxication was most likely *Panaeolus retirugis* (Fr.) Gill.

> *About 30 to 60 minutes after ingestion of the cooked mushrooms, the woman's field of vision began to quiver increasingly. At the same time, her pupils were extremely dilated. As she began to have difficulties breathing, she suffered a full-fledged anxiety attack. All objects appeared as if obscured by curtains. After the effects had subsided, no symptoms of lasting damage could be detected.*

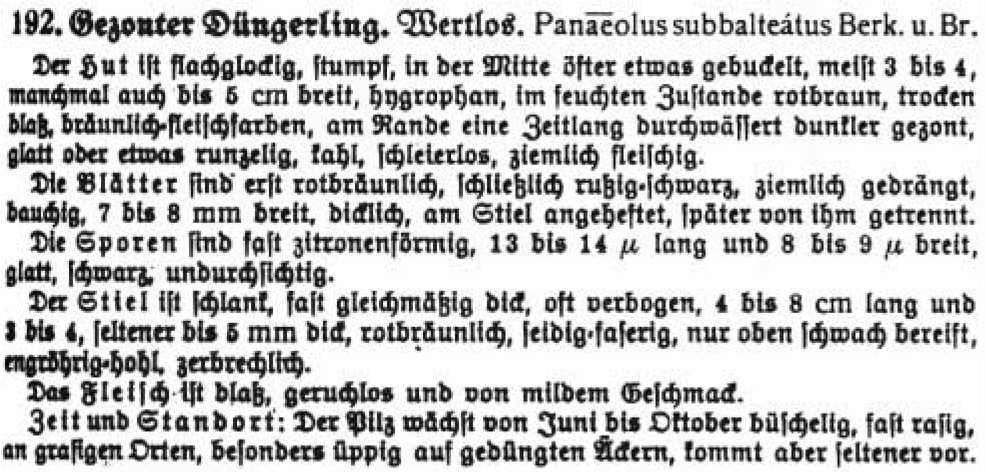
In 1970, another poisoning case with *Panaeolus subbalteatus* occurred in Leipzig. Similar to the 1915 incident in New York, the mushrooms spontaneously emerged among a culture of artificially cultivated mushrooms (*Stropharia rugoso-annulata* Farlow, in this case) and then were eaten by mistake. The description of its effects is somewhat peculiar.

Growing on Dung, Manure and Compost

The stories about intoxications as well as the very name "dung-inhabiting" mushroom offer clues about the kinds of habitats this species prefers to grow in.

At times, they grow directly on top of dung or on pastures that have been heavily fertilized. They are also found on trash heaps, on compost or on straw substrates where mushrooms are commercially cultivated. European *Panaeolus* species that produce psilocybin have a special attribute that differentiates them *Psilocybe* species: they very seldom develop blue stains when handled or injured. In his description of a Scottish case of intoxication in 1977, Watling mentions marked blue colorations along the caps of stems of *Panaeolus subbalteatus*, which also developed in reaction to pressure. According to my observations, the formation of blue stains is very rare. Reports from the Pacific Northwest United States also state that only one in a hundred mushrooms actually turns blue.

One controversial issue in the literature concerns the toxicity of one species: *Panaeolus foenisecii* (Pers.:Fr.) Kuhn. This species has previously been classified as *Psilocybe* as well as *Psathyrella*, and has been described as *Panaeolina* in contrast to *Panaeolus*, because it is a species that does not grow on dung, fruits only after the hay harvest, and develops spores that are purplish-brown and abrasive. Other *Panaeolus* species, however, have black spore prints when placed on white paper underneath a glass vessel to prevent dehydration. But, even the spores of *Panaeolus foenisecii* (Pers.:Fr.) Kuhn.do not all ripen at the same time, which can cause the gills to appear mottled. Due to the complications with taxonomic differentiation, there are certainly no reliable maps showing distribution patterns for the European *Panaeolus* species.



192. Gezonter Düngerling. Wertlos. Panaeolus subbalteátus Berk. u. Br.

Der Hut iſt flachglockig, ſtumpf, in der Mitte öfter etwas gebuckelt, meiſt 3 bis 4, manchmal auch bis 5 cm breit, hygrophan, im feuchten Zuſtande rotbraun, trocken blaß, bräunlich-fleiſchfarben, am Rande eine Zeitlang durchwäſſert dunkler gezont, glatt oder etwas runzelig, kahl, ſchleierlos, ziemlich fleiſchig.

Die Blätter ſind erſt rotbräunlich, ſchließlich rußig-ſchwarz, ziemlich gedrängt, bauchig, 7 bis 8 mm breit, dicklich, am Stiel angeheftet, ſpäter von ihm getrennt.

Die Sporen ſind faſt zitronenförmig, 13 bis 14 μ lang und 8 bis 9 μ breit, glatt, ſchwarz, undurchſichtig.

Der Stiel iſt ſchlank, faſt gleichmäßig dick, oft verbogen, 4 bis 8 cm lang und 3 bis 4, ſeltener bis 5 mm dick, rotbräunlich, ſeidig-faſerig, nur oben ſchwach bereift, engröhrig-hohl, zerbrechlich.

Das Fleiſch iſt blaß, geruchlos und von mildem Geſchmack.

Zeit und Standort: Der Pilz wächſt von Juni bis Oktober büſchelig, faſt raſig, an graſigen Orten, beſonders üppig auf gedüngten Äckern, kommt aber ſeltener vor.

192. *Panaeolus subbalteatus* Berk.u.Br.

The cap is broadly convex, obtuse, often with a slight umbo in the middle, usually 3-4 cm broad, sometimes up to 5 cm. Hygrophanous, reddish brown when wet, pale and brownish to flesh-colored when dry. Margins moist to watery at times, and banded with a dark brown stripe around the edges. Surface smooth or lightly wrinkled, bald, rather fleshy, no veil.

The gills are reddish brown when young, later on sooty or black, gill spacing is rather crowded and bulgy, gills are 7-8 mm wide and somewhat thick. Gills are initially attached to the stem, and detached later on.

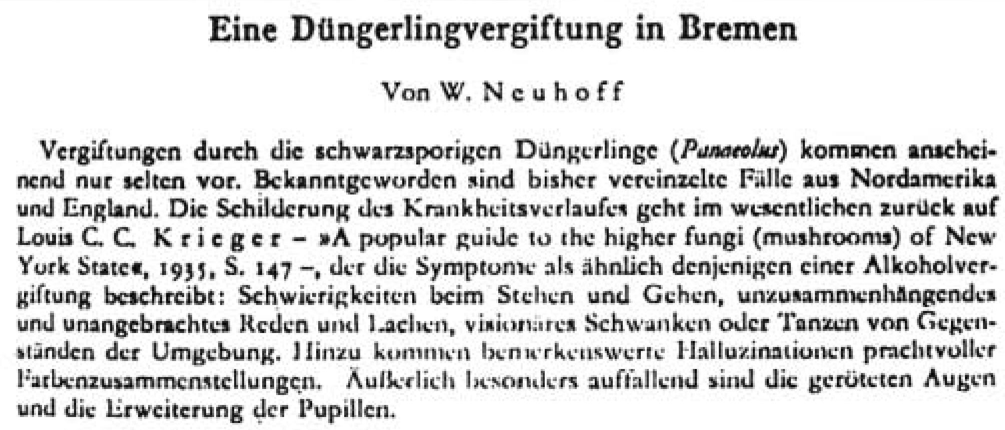
The spores are almost lemon-shaped, 13-14 µ long and 8-9 µ wide, smooth, black and opaque.

The stems are slender, 4-8 cm in length and uniformly thick (3-4 mm, sometimes up to 5 mm). Stems are often curvy and reddish brown in color; silky-fibrous with a slight ring at the top. Stems are narrowly tubular and break easily.

The flesh is pale and odorless with a mild taste.

Habitat and season: The mushroom grows cespitosely to gregariously from June through October in grassy areas. It particularly thrives on fertilized fields and pastures, but occurs there comparatively less often.

Figure 27 - Description of ***Panaeolus subbalteatus*** by Michael & Schulz from 1927 (with English translation below).



Eine Düngerlingvergiftung in Bremen

Von W. Neuhoff

Vergiftungen durch die schwarzsporigen Düngerlinge (*Panaeolus*) kommen anscheinend nur selten vor. Bekanntgeworden sind bisher vereinzelte Fälle aus Nordamerika und England. Die Schilderung des Krankheitsverlaufes geht im wesentlichen zurück auf Louis C. C. Krieger – »A popular guide to the higher fungi (mushrooms) of New York State«, 1935, S. 147 –, der die Symptome als ähnlich denjenigen einer Alkoholvergiftung beschreibt: Schwierigkeiten beim Stehen und Gehen, unzusammenhängendes und unangebrachtes Reden und Lachen, visionäres Schwanken oder Tanzen von Gegenständen der Umgebung. Hinzu kommen bemerkenswerte Halluzinationen prachtvoller Farbenzusammenstellungen. Äußerlich besonders auffallend sind die geröteten Augen und die Erweiterung der Pupillen.

Figure 28 - First description of a *Panaeolus* intoxication in Germany (1957). Symptoms are compared to those of alcohol poisoning, such as difficulties standing or walking, incoherent or inappropriate laughter and talking, and visions of objects moving or dancing. Other symptoms include remarkable hallucinations with splendid color combinations, as well as red eyes and dilated pupils.

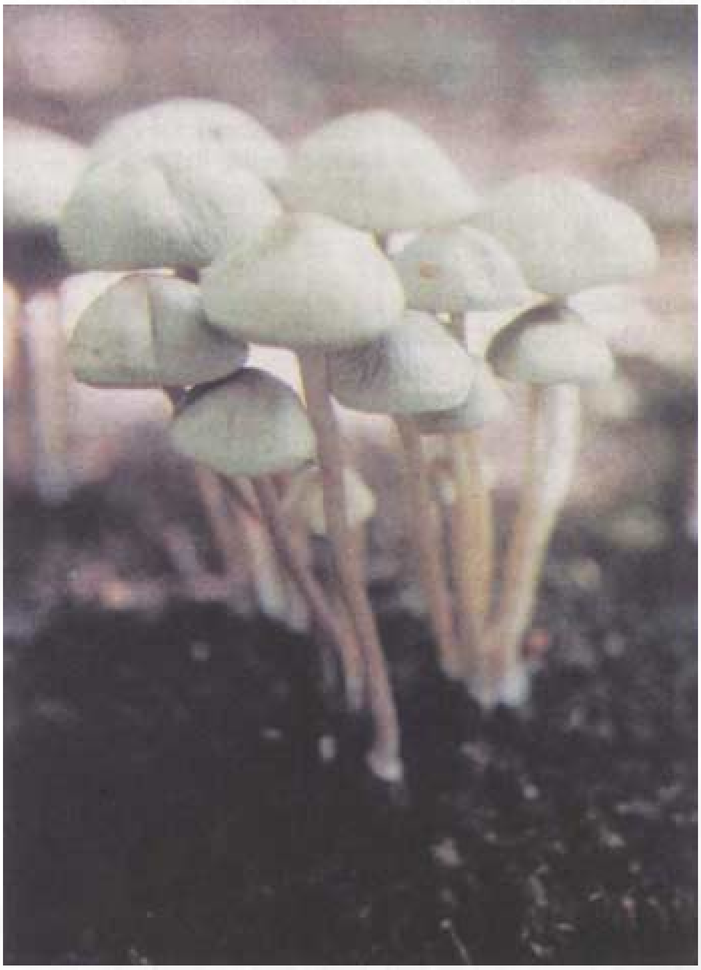


Figure 29 - ***Panaeolus cyanescens*** in Hawaii (USA).

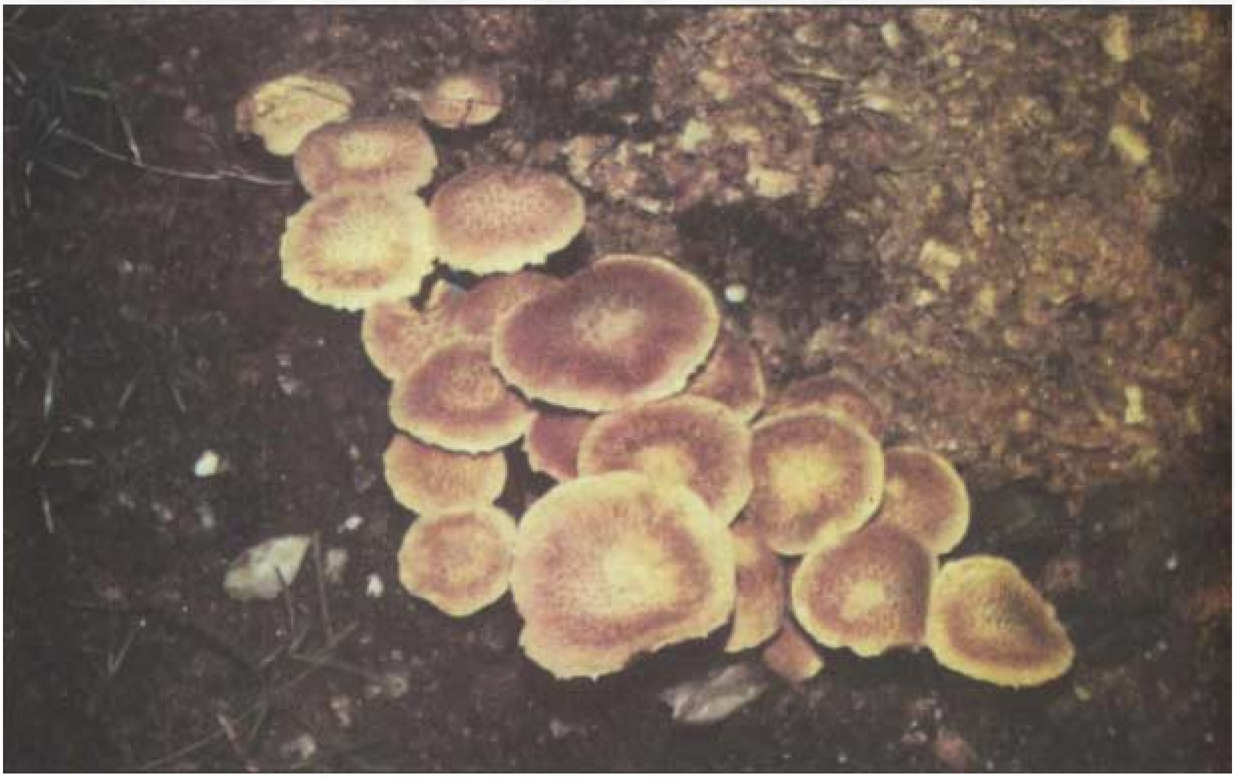


Figure 30 - ***Gymnopilus purpuratus*** on sawdust.

Taxonomic Confusion

On May 25, 1986, in the village of Heringsdorf on the Eastern German Sea Coast, I found 147 fruiting bodies of *Panaeolus subbalteatus* in all stages of development. They were growing on a compost heap that originally contained horse manure. Unlike the *Psilocybe* species, *Panaeolus* mushrooms can be found anytime from spring throughout the fall season. The differentiation of *Panaeolus* species is further hindered because they are very hygrophanous, with caps whose colors can change from whitish to grey, or from reddish brown to a very dark black-brown. Older mushrooms on the compost heap had caps that had cracked with age, and margins that had curved upwards and were covered with spore dust. Only two mushrooms had blue-stained caps, and the stems did not change color in reaction to pressure. In the American literature *Panaeolus subbalteatus* has been labeled "*Panaeolus variabilis*", because some of the stems imitate the appearances of other mushroom species and thereby contribute to the taxonomic confusion. The species is also known to grow in the immediate vicinity of *Panaeolus foenisecii* (Pers.:Fr.) Kühn., creating more opportunities for mistakes, especially if the mushrooms are not closely inspected. The caps of *Panaeolus subbalteatus* become flat as the mushrooms age, a feature that is taxonomically significant.

The cap's long, watery marginal zone gives the mushroom its name. Only the psilocybin-producing species will be discussed in more detail below. Results from recent comprehensive analyses clearly show that *Panaeolus subbalteatus* is the most important psychoactive European species among the genus *Panaeolus*. Ola'h's world monograph about the genus *Panaeolus* was published in the 1960s and has caused much confusion, since he described a number of species as "latent psilocybin-producers". He proposed, for example, that *Panaeolus foenisecii* occasionally produces psilocybin. All *Panaeolus* species share one characteristic that differentiates them from all other species discussed in this book: They produce 5-substituted indole compounds, such as serotonin and its biochemical precursor, 5-hydroxytryptophan. Serotonin is a compound widely found in animals and humans. It acts as a neurotransmitter in the brain, even though not all of serotonin's effects have been entirely understood. It should be noted, however, that both serotonin and 5-hydroxytryptophan are completely inactive when taken orally. When performing paper or thin-layer chromatographies, both of these substances can easily be mistaken for psilocin. It is remarkable that Ola'h's results contradict current findings, in that his data frequently showed the existence of psilocin in *Panaeolus* species!

More recent studies of carefully identified mushroom material from the European *Panaeolus* species did not document substantial amounts of psilocin in these samples. Also, "chemical races" associated with specific species could not be established. I believe that almost all accidental intoxications can be traced to ingestion of *Panaeolus subbalteatus*, with the possible exception of one case caused by an imported tropical species. Very little is said in the literature about *Panaeolus retirugis*, its area of distribution and chemical composition. The intoxication case from Bremen, however, indicates that this species is psychoactive (see Figure 28). In 1985, I found two fruiting bodies in a pasture, whose dried weight contained 0.03 - 0.05% psilocybin, as well as serotonin. All of the mushrooms' features, such as wrinkled, fleshcolored caps, corresponded to descriptions of *Panaeolus retirugis*.

Based on his analyses, Stijve concluded that the dried fruiting bodies of *Panaeolus subbalteatus* contain about 0.1% psilocybin, regardless of location, as well as a tiny amount of baeocystin. Still, accounts of intoxications with consistently potent psychoactive effects would seem to provide evidence against such small amounts of alkaloids in *Panaeolus subbalteatus*. Indeed, dried mushrooms from the Pacific Northwest region of the United States have been reported to contain 0.16% - 0.65% psilocybin. Moreover, the first analyses of the species in North America (1959) led to the isolation of a water-soluble indole compound which is now generally thought to be baeocystin. My own analyses of mycelia and 19 fruiting bodies from the Heringsdorf location indicated levels of psilocybin that are fully compatible with the data from the United States:

Table 4
Ingredients Found in Mycelia and Fruiting Bodies of *Panaeolus subbalteatus* (% of Dried Material)

Ingredient	Mycelia	Fruiting Bodies
Psilocybin	0.07	0.08(stem)-0.70
Psilocyn	0.00	0.00
Baeocystin	0.00	0.05(stem)-0.46
Serotonin	0.10	0.08-0.30
Urea	0.00	1.80-2.30(cap)

Table 4 shows that the nature and relative amounts of the substances found are different in the fruiting bodies compared to the base mycelium, which was tested here for the first time.

As far as active ingredients are concerned, levels of urea are trivial. The substance does, however, have some significance in terms of chemo-taxonomy. Among species discussed here, urea is present only in *Panaeolus* and *Pluteus* species. Urea was detected "incidentally" during thin-layer chromatography testing intended to discover the presence of indole compounds. Stijve has collected and tested samples of *Panaeolus foenisecii* from eight countries across three continents (namely, America, Europe and Australia), but has consistently failed to find psilocybin in addition to 5-substituted indole compounds. My own analyses of 100 mushrooms from a wide variety of locations across Germany also failed to confirm the presence of this alkaloid and its derivatives. While the local European species that are discussed here also tend to occur on other continents (*Panaeolus subbalteatus*, for example, grows in Hawaii), there are tropical varieties of this genus which are highly psychoactive as well. Given the best possible climate conditions, these species may fruit adventively in Europe for short periods of time.

Panaeolus cyanescens is the most well-known representative of these species (see Figure 29). Like other tropical *Panaeolus* and *Psilocybe* species, *Panaeolus cyanescens* exhibits a strong blue staining reaction. The large number of existing synonyms for the species, as presented by Gerhardt (see Figure 31), again indicates substantial taxonomic confusion, as well as insufficient communication and exchange of information.

Panaeolus Experiences

Sometimes it is difficult to avoid the conclusion that many prominent mycologists are only too willing to disregard existing research results in order to attach their names to definitions of "new" species. Singer lists *Panaeolus cyanescens* separate from *Panaeolus* as belonging to the genus *Copelandia*, along with other species. Nowadays, this classification is becoming increasingly unpopular among mycologists, and many of them do not accept it. *Panaeolus cyanescens* is responsible for a number of remarkable intoxications which occurred on August 19, 1965 in Menton, located on the French Mediterranean Coast. The mushroom spontaneously appeared on compost which consisted of straw and decayed horse dung. The compost was intended to improve lawn quality. It should be noted that the horse dung came from a race track used by horses from tropical countries. Under these circumstances, it is quite likely that the species responsible for the intoxications was imported to the location from another country. On one occasion, in the early 1970s, *Panaeolus cyanescens* was found at the Budapest Fairgrounds next to the pavilions from Thailand and Vietnam!

About the course of the intoxications:

> *A woman and her two children ate a meal consisting of only about 60 g (2.1 ozs.) of the mushrooms. Within less than fifteen minutes after ingestion, she began to feel weak, followed by visual disturbances and marked dilation of the pupils. About one hour after the meal she developed dizzy spells that came and went in waves. Increasingly, all colors in her immediate surroundings coalesced into shades of green. The hallucinations were fearsome; the heads of monsters became visible and a wall opened up into an abyss. There was a succession of human figure with animal heads. The next day, everything was back to normal. The oldest child (age 14) also saw her parents' hair color turn green, had dilated pupils and watched geometric shapes appear on the wall. The youngest child (age 11) experienced cramps and lost consciousness.*

In 1960, Singer and Guzman suggested that *Panaeolus cyanescens* might contain psilocybin, because of the intense blue staining they had observed. It wasn't until after the intoxications in Menton had been publicized, that a research team working with A. Hofmann detected 0.2% of psilocybin in the mushrooms. Considering the powerful effects, however, this concentration appears to be too low to cause such impressive reactions. Later on, Sandoz Laboratories reported the level of psilocybin in dried samples as 0.8%, along with 1.2% psilocin. The level of psilocin, however, may have been falsely elevated by the presence of serotonin and its derivates in the mushroom sample that was being tested.

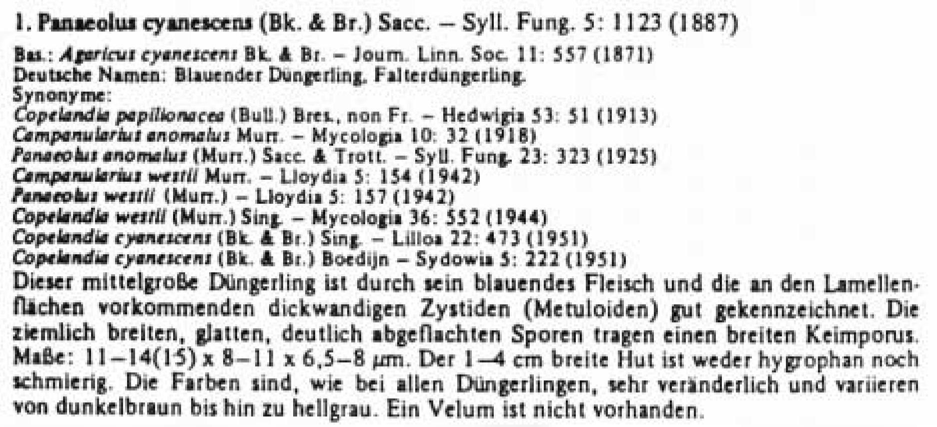
According to Stijve, a mushroom sample collected by J.W. Allen in Thailand contained 0.4% - 1.05% of psilocin, with only trace amounts of psilocybin; serotonin was present in large amounts, comparable to concentrations found in all *Panaeolus* species.

Apparently, *Panaeolus cyanescens* produces more psilocin than psilocybin. Still, I was able to detect 0.4% of psilocybin in mycelia cultivated on malt agar, with no other indole compounds present.

Discussion of the *Panaeolus* species would remain incomplete without pointing out that those subjectively terrifying psychoses reported in 1965 cannot be attributed to a specific mushroom ingredient, but were likely precipitated by the circumstances (set and setting) surrounding the incident. The effects described by J. Allen in Hawaii after eating 20 specimens paint a different picture altogether:

> *With radio music playing softly in the dark, euphoria began to come on in waves. After 20 minutes, visions became so intense that I tried to close my eyes. Whenever I did close my eyes, my eyelids felt as if they were being sprayed from the outside. Colors were sharp and clear, but I always quickly opened my eyes again. Colors were dancing like laser beams to the rhythm of the music. The stars in the sky assembled in clusters that reached all the way into my soul. I was a little scared at the idea that the ocean water might rush up all the way into our hut. Other than that, feelings of euphoria were overwhelming. At times, I was overcome by fits of laughter. That night, I slept like "a prince ". The following morning I gathered up my belongings and had to walk back across the pasture where I had collected the mushrooms the day before. I noticed a lot of new mushrooms that had grown during the previous night's rainfall. By way of a lingering after effect I felt that the mushrooms were sending me a message: "Don't forget us, come back, if you can".*

It is important to keep in mind that more comprehensive studies on taxonomy and biochemical composition are needed in order to fully understand the *Panaeolus* species. Perhaps A. Weil's suggestion that *Panaeolus subbalteatus* from America's Pacific Northwest induces comparatively stronger somatic effects than the *Psilocybe* species can be investigated chemically as well as toxicologically, in order to reject or support this hypothesis.



1. Panaeolus cyanescens (Bk. & Br.) Sacc. — Syll. Fung. 5: 1123 (1887)

Bas.: *Agaricus cyanescens* Bk. & Br. – Journ. Linn. Soc. 11: 557 (1871)
Deutsche Namen: Blauender Düngerling, Falterdüngerling.
Synonyme:
Copelandia papilionacea (Bull.) Bres., non Fr. – Hedwigia 53: 51 (1913)
Campanularius anomalus Murr. – Mycologia 10: 32 (1918)
Panaeolus anomalus (Murr.) Sacc. & Trott. – Syll. Fung. 23: 323 (1925)
Campanularius westii Murr. – Lloydia 5: 154 (1942)
Panaeolus westii (Murr.) – Lloydia 5: 157 (1942)
Copelandia westii (Murr.) Sing. – Mycologia 36: 552 (1944)
Copelandia cyanescens (Bk. & Br.) Sing. – Lilloa 22: 473 (1951)
Copelandia cyanescens (Bk. & Br.) Boedijn – Sydowia 5: 222 (1951)

Dieser mittelgroße Düngerling ist durch sein blauendes Fleisch und die an den Lamellenflächen vorkommenden dickwandigen Zystiden (Metuloiden) gut gekennzeichnet. Die ziemlich breiten, glatten, deutlich abgeflachten Sporen tragen einen breiten Keimporus. Maße: 11–14(15) x 8–11 x 6,5–8 µm. Der 1–4 cm breite Hut ist weder hygrophan noch schmierig. Die Farben sind, wie bei allen Düngerlingen, sehr veränderlich und variieren von dunkelbraun bis hin zu hellgrau. Ein Velum ist nicht vorhanden.

Figure 31 - Synonyms for ***Panaeolus cyanescens*** (according to Gerhardt).

3.4 - *Inocybe aeruginascens*: Fast-Spreading New Arrivals

On June 15, 1965, I. Ferencz discovered fruiting bodies known as "fibrehead mushrooms" in Osca, Hungary, county of Pest. The mushrooms' characteristics did not match those of any known species of the genus *Inocybe*, as described in the literature. That same year, as well as on several occasions later on, Ferencz and other mycologists found large numbers of mushrooms of the same species growing in different locations. Eventually, in 1968, these mushrooms were described as a new species named *Inocybe aeruginascens* Babos (see Figure 33, p. 47).

Strange Distribution Patterns in Hungary and Germany

In 1985, a few mycologists who specialized in the study of the genus *Inocybe* found fibreheads with greenish discolorations in 17 locations (46 specimens) across Hungary. In her 1983 article, Babos noted that *Inocybe aeruginascens* had become the most common mushroom of the Lower Valley's sandy areas around the Hungarian capital city of Budapest. The species is known to fruit across these areas, singly or in gregarious clusters on the sandy soil of the poplar forests, or in mixed forests that include poplars. They have also been found on meadows near poplar trees. The mushrooms are loyal to the location and grow there every year, climate conditions permitting.

In 1975, Kaspar collected the *Inocybe* species in Berlin (Köpenick District) as well. More detailed studies revealed that the mushrooms had previously been misidentified. As early as 1965, fruiting bodies of the species were found in the arboretum at Berlin (Baumschulenweg District). The species had been noted "in passing" by other mycologists with little interest in the mushrooms. Many species (about 160) of the large European *Inocybe* genus cannot be easily differentiated from each other, and therefore attract little interest from expert mycologists. The species are part of a large group of mushrooms that are nicknamed "LBMs" (Little Brown Mushrooms) in the American literature and as such they often entail considerable taxonomic problems. Other examples of mushrooms in this group are the *Panaeolus* species as well as those of the genus *Psilocybe*.

Whenever a "new mushroom" appears spontaneously, the question of its origin has to be addressed. Herink, the Czech mycologist, maintains that he had already discovered the species during the 1930s. He reportedly deposited samples in a herbarium, but the mushrooms have never been clearly identified as *Inocybe aeruginascens* on the basis of biochemical analyses. As fruiting bodies of the *Inocybe aeruginascens* were found simultaneously in Hungary and Germany, the direction of the species' geographical migration could not be determined. It is possible that the species was initially confined to a very small area and only began to attract attention after it had migrated into new habitats. We can only speculate about the possibility of mutations that may have evolved from known species over a relatively short period of time.

Finally, during the 1980s, a few fruiting bodies were collected at locations in Holland (1980) and the Rhone Valley (Wallis Canton) of Switzerland (1984).

In 1983, the species immediately attracted the attention of biochemists and clinicians, after G. Drewitz described mysterious psychotropic intoxications caused by these mushrooms in the city and district of Potsdam, Germany, during June and July, 1980. The observed range of effects was sensational for mushrooms of the *Inocybe* genus, because many of its species induce typical muscarine poisoning symptoms. Muscarine causes parasympathetico-mimetic symptoms, such as pupil contraction (miosis), increased salivation and saliva production. Muscarine has been identified in at least 40 species of the *Inocybe* genus. The first reports about deaths following ingestion of the potent muscarine-containing *Inocybe patouillardii* Bres. date back to the early 20th century.

Identification Errors

Below is a more detailed description of the effects of *Inocybe aeruginascens*:

> *On June 30, 1980 a teenager collected the mushrooms near Potsdam and misidentified them as fairy ring mushrooms (Marasmius oreades (Bolt. & Fr.) Fr.), a species known as a choice table mushroom. At home, the teenager's father sauteed the mushrooms in margarine, and they were subsequently eaten by both of them. The son ate only about one-third of the cooked mushrooms.*
>
> *About 35 to 45 minutes after the meal, both father and son began to experience initial symptoms. The son mainly reported colorful illusions and hallucinations. The woven pattern of his white handkerchief suddenly appeared as shining stripes of crimson red. With his eyes closed, he saw magically illuminated, abstract structures. He noticed his own state of foolish silliness that occurred for apparently no reason at all. Following his father's instructions, he soon found himself outside, in the pouring rain, running back to a near-by railroad embankment, still laughing and giggling, in order to gather more of the mushrooms that had poisoned him.*
>
> *The father's symptoms initially included yawning and a burning sensation of the face, as well as itching at the hairline and fatigue. He then experienced increasing numbness (paraesthesia) of the left half of his face and his left arm. Later on, these symptoms spread to the right half of his body. Fully conscious, he also noticed motor disturbances that disrupted his language ability. His psyche was increasingly dominated by images of depersonalization: For the duration of the experience he felt that he "was standing beside himself as an observer", while his voice sounded very strange to him.*

The second case of intoxication in Potsdam occurred on July 13, 1980:

> *Seventy-five minutes after ingestion of fibrehead mushrooms with greenish discolorations (Inocvbe aeruginascens), the woman began to experience hot flashes, nausea without vomiting, strongly dilated pupils, along with a marked sense of intoxication that she described as "mostly amusing". Spacial illusions were experienced in combination with striking feelings of weightlessness, distances appeared to be magnified. After several hours, these symptoms gradually faded without lasting consequences; only the dilation of the pupils persisted well into the next day.*

Based on these cases, Drewitz proposed that the mushrooms contain psilocybin or similar substances, a hypothesis that was later confirmed (see Tables 6 and 7, p. 49).

More cases of intoxications were reported in the years that followed and earlier cases could also be traced to this mushroom species. In each of these cases, the mushrooms were misidentified as fairy ring mushrooms.

Table 5
Accidental Intoxications with *Inocybe aeruginascens* in Eastern Germany

Year	# of People	Location
1977	3	Hohen-Neuendorf
1980	2	Teltow
1980	1	Potsdam
1984	4	Oranienburg
1984	2	Magdeburg
1985	3	Woltersdorf
1986	7	Potsdam

In all cases, the symptoms subsided after several hours, with no lasting side effects. A psychiatrist surely would have found these situations interesting - especially the last case involving an extended family - and would most likely have welcomed the opportunity to study the psychodynamics and social interactions during the period of collective intoxication.

In 1983, Babos reported another case of unintentional ingestion of *Inocybe aeruginascens* in Budapest, which had occurred on July 1, 1970. In this case, symptoms included subjective feelings of decreasing gravity, colorful hallucinations, spacial illusions and nausea without vomiting.

Flights of the Soul

In this context, the following account is of interest; it details the experience of a mycologist who took 2.4 g of dried mushrooms in the course of a test experiment:

> *The mushrooms tasted like ordinary table mushrooms. While reclining in a state of relaxation about 30 minutes later, a very comfortable feeling of loss of gravity set in, with no other somatic effects. Abstract hallucinations developed slowly, in the form of bursting colors and lights. Once a state of complete loss of gravity was attained, it was followed by a very vivid sensation of the soul in flight, coupled with feelings of euphoria. When looking out the window into the dark night of a forest landscape, visions of strange patterns and formations occurred, which were deeply impressive and seemed to impart an inkling of eternity. At the end of four hours, the effects had dissipated without dysphoria or any type of somatic side effect.*
>
> *A control experiment for comparison purposes was performed using 0.8 g of dried Psilocybe semilanceata. The onset of symptoms was much more sudden, including a heavy flow of tears, so that there was an initial phase of anxiety. Only in a later phase of the experience was it possible to perceive ornaments in the form of "underwater streamers", and to appreciate the aesthetically enhanced nature of these visions.*

The regular pattern of involuntary intoxications is a good indicator for the large scope of expansion of *Inocybe aeruginascens* into new habitats during the 1980s. For example, at the time of the initial intoxications - when the species was still restricted to a few easily quantifiable collections - the mushrooms had spread from Potsdam to the location known in 1982, and from there moved on to several other locations in the vicinity, where more than 150 mushrooms were found (see Figure 34).

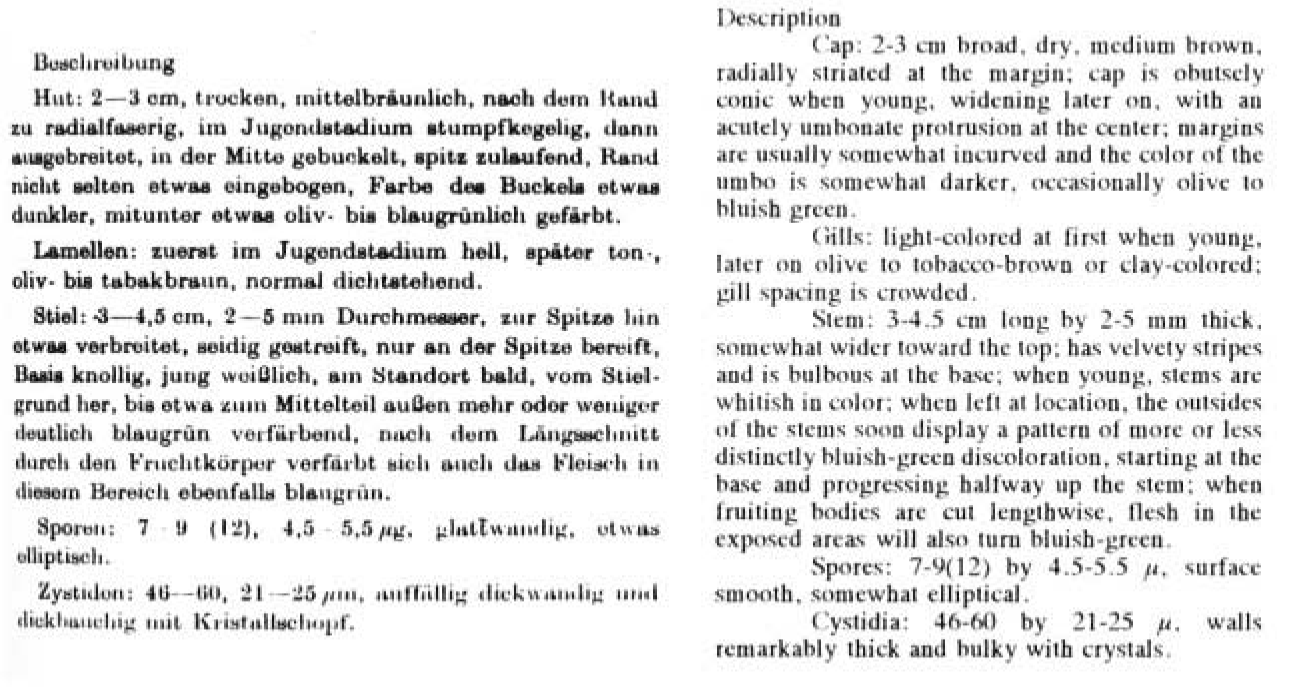
Symbiosis With Trees

Starting in late May 1984, fruiting bodies of the species could be found in abundance at countless new locations across the Brandenburg region of Germany. They tend to grow near the roots of different deciduous trees (*Populus, Tilia, Quercus, Betul*a), on lawns in parks and gardens, at the edges of trails and in the paved margin areas of tree-lined sidewalks (where they may even grow on bare, sandy soil) as well as amongst the greenery of residential areas in the suburbs and communities in and around Berlin.

Herein lies the most marked difference between *Inocybe aeruginascens* and other European psychotropic mushroom species: *Inocybe aeruginascens* grows only in areas of human development. Their prime locations are in the middle of villages and towns, where they grow locally much like other *Inocybe* species. They may temporarily produce mass quantities of fruiting bodies, in those locations that are typical habitats for the edible varieties of the fairy ring mushroom.

So far, the most abundant crop of fruiting bodies was observed in 1987, due to very wet weather conditions, which allowed the mushrooms to thrive. The following years were comparatively dry and the species hardly fruited at all. It wasn't until 1990 that a few mushrooms re-emerged at the classic location in Potsdam. Despite 1989 having been a bad year for mushrooms, it was the year when *Inocybe aeruginascens* was found for the first time at four locations in and around Rostock, a city located on the Eastern German coast, which is famous for its wet climate. Finding the mushrooms at these locations is evidence for a much wider expansion of the species. In coming years, we should expect the species to further migrate into areas with sandy soil.

The *Inocybe* species are mycorrhizal mushrooms, that is, in contrast to other psilocybin-containing species, they require a symbiosis with certain types of wood in order to fruit. Fruiting occurs at the time of greatest biochemical activity of the symbiotic partner trees. Following periods of extended rainfall, *Inocybe aeruginascens* grows in the trees' root areas from late May until October. The mushrooms are especially common in May and June, a time period during which *Inocybe aeruginascens* is easily differentiated from other species of fibreheads, as long as one pays close attention to locations, the characteristic greenish to bluish discoloration (e.g. if the mushrooms are stored overnight, especially in the refrigerator) and the description shown below (see Figure 32).



Beschreibung

Hut: 2—3 cm, trocken, mittelbräunlich, nach dem Rand zu radialfaserig, im Jugendstadium stumpfkegelig, dann ausgebreitet, in der Mitte gebuckelt, spitz zulaufend, Rand nicht selten etwas eingebogen, Farbe des Buckels etwas dunkler, mitunter etwas oliv- bis blaugrünlich gefärbt.

Lamellen: zuerst im Jugendstadium hell, später ton-, oliv- bis tabakbraun, normal dichtstehend.

Stiel: 3—4,5 cm, 2—5 mm Durchmesser, zur Spitze hin etwas verbreitet, seidig gestreift, nur an der Spitze bereift, Basis knollig, jung weißlich, am Standort bald, vom Stielgrund her, bis etwa zum Mittelteil außen mehr oder weniger deutlich blaugrün verfärbend, nach dem Längsschnitt durch den Fruchtkörper verfärbt sich auch das Fleisch in diesem Bereich ebenfalls blaugrün.

Sporen: 7—9 (12), 4,5—5,5 μg, glattwandig, etwas elliptisch.

Zystiden: 46—60, 21—25 μm, auffällig dickwandig und dickbauchig mit Kristallschopf.

Description

Cap: 2-3 cm broad, dry, medium brown, radially striated at the margin; cap is obutsely conic when young, widening later on, with an acutely umbonate protrusion at the center; margins are usually somewhat incurved and the color of the umbo is somewhat darker, occasionally olive to bluish green.

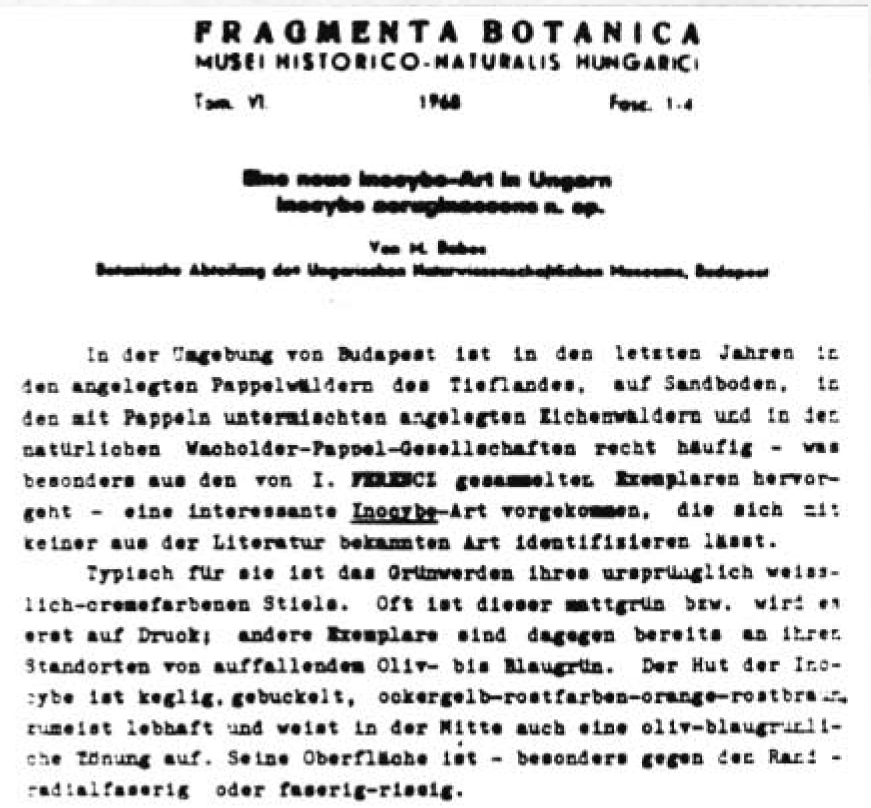
Gills: light-colored at first when young, later on olive to tobacco-brown or clay-colored; gill spacing is crowded.

Stem: 3-4.5 cm long by 2-5 mm thick, somewhat wider toward the top; has velvety stripes and is bulbous at the base; when young, stems are whitish in color; when left at location, the outsides of the stems soon display a pattern of more or less distinctly bluish-green discoloration, starting at the base and progressing halfway up the stem; when fruiting bodies are cut lengthwise, flesh in the exposed areas will also turn bluish-green.

Spores: 7-9(12) by 4.5-5.5 μ, surface smooth, somewhat elliptical.

Cystidia: 46-60 by 21-25 μ, walls remarkably thick and bulky with crystals.

Figure 32 - Description of ***Inocybe aeruginascens*** (Germany, 1986) with English translation at right.



FRAGMENTA BOTANICA
MUSEI HISTORICO-NATURALIS HUNGARICI
Tom. VI. 1968 Fasc. 1-4

Eine neue Inocybe-Art in Ungarn
Inocybe aeruginascens n. sp.

Von M. Babos
Botanische Abteilung des Ungarischen Naturwissenschaftlichen Museums, Budapest

In der Umgebung von Budapest ist in den letzten Jahren in den angelegten Pappelwäldern des Tieflandes, auf Sandboden, in den mit Pappeln untermischten angelegten Eichenwäldern und in den natürlichen Wacholder-Pappel-Gesellschaften recht häufig - was besonders aus den von I. FERENCI gesammelten Exemplaren hervorgeht - eine interessante Inocybe-Art vorgekommen, die sich mit keiner aus der Literatur bekannten Art identifizieren lässt.

Typisch für sie ist das Grünwerden ihres ursprünglich weisslich-cremefarbenen Stiels. Oft ist dieser mattgrün bzw. wird es erst auf Druck; andere Exemplare sind dagegen bereits an ihren Standorten von auffallendem Oliv- bis Blaugrün. Der Hut der Inocybe ist keglig, gebuckelt, ockergelb-rostfarben-orange-rostbraun, zumeist lebhaft und weist in der Mitte auch eine oliv-blaugrünliche Tönung auf. Seine Oberfläche ist - besonders gegen den Rand - radialfaserig oder faserig-rissig.

Figure 33 - First description of ***Inocybe aeruginascens*** in the mycological literature (M. Babos, 1968).

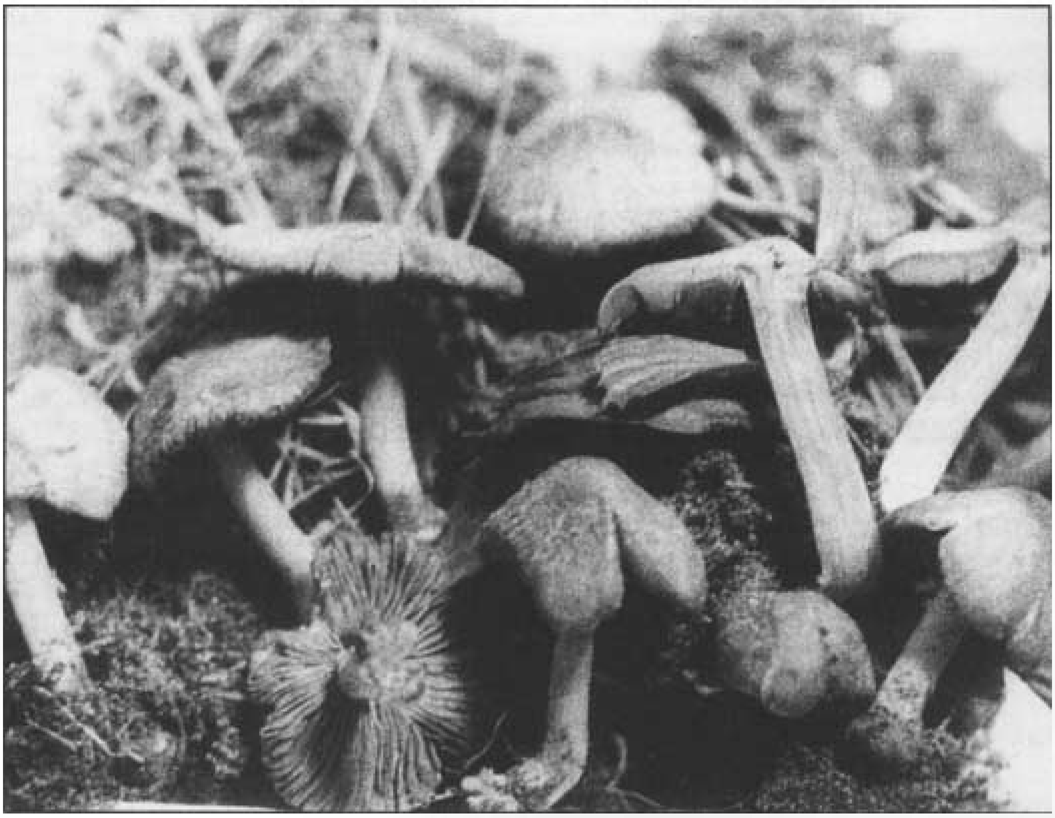


Figure 34 - ***Inocybe aeruginascens*** fruiting bodies from Potsdam, Eastern Germany.

Unlike species of thin-fleshed *Psilocybe* mushrooms that do not fruit until fall, *Inocybe aeruginascens* frequently suffers from fly larvae infestations, especially in older colonies. The resulting lesions are injured areas that turn greenish-blue. It must be noted, however, that of all species introduced here, *Inocybe aeruginascens* is most easily misidentified by laypersons, as it is of the same genus as the potentially lethal species that produce muscarine.

Drewitz's speculation that *Inocybe aeruginascens* contains psilocybin was supported by results from my own investigations in 1984. Extracts of more than 100 mushrooms collected in Hungary and Germany from 1967 to 1990 were examined. Quantitative analyses revealed that the fruiting bodies contained a fairly constant amount of psilocybin each, as well as some baeocystin. These results were first reported in February, 1985. Later that year, the presence of psilocybin in *Inocybe aeruginascens* was confirmed by research teams from the former West Berlin, Regensburg (Germany) and Switzerland. Known cases of intoxication seemed to indicate that the fruiting bodies contained small amounts of muscarine. But among all the samples that were tested - at all stages of development and from widely different collections - not one specimen contained even trace amounts of muscarine.

In collaboration with colleagues from Czechoslovakia, we were able to confirm that the average alkaloid content does not vary much, a finding based on analyses of extracts from several mushrooms. Moreover, the alkaloid content of fruiting bodies stored for prolonged periods declined only slightly over time:

Table 6

Psilocybin Content of *Inocybe aeruginascens* from Various Locations (% of Dried Samples)

Location	Year Found	Year Analyzed	Psilocvbin
Potsdam	1984	1984	0.38
Potsdam	1983	1984	0.34
Potsdam	1982	1984	0.33
Berlin	1975	1985	0.11
Hungary	1967	1985	0.22

Psilocybin levels in *Inocybe aeruginascens* are comparable to those found in *Psilocybe mexicana* Heim. Moreover, *Inocybe aeruginascens* contain traces amounts of psilocin at most. Baeocystin, on the other hand, is accumulated at levels comparable to those of psilocybin. The alkaloid content of the *Inocybe* species differs from those found in the *Psilocybe* species, which contain three to five times more psilocybin than baeocystin. The variation of alkaloid content across different samples of fruiting bodies is illustrated in Table 7, which shows the results from analyses of mushrooms collected at a location in Caputh near Potsdam on June 8, 1986 (see Figures 32 and 34).

Table 7
Psilocybin and Baeocystin Content in Single *Inocybe aeruginascens* Fruiting Bodies (% of Dry Weight)

Mushroom	Dry Weight (mg)	Psilocybin	Baeocystin
1	0.110	0.43	0.15
2	0.118	0.26	0.24
3	0.220	0.23	0.22
4	0.221	0.50	0.25
5	0.298	0.16	0.20

In addition, it should be noted that results from these analyses of mushroom extracts indicated the presence of a previously unknown alkaloid, which I have named *aeruginascin*. The molecular structure of this substance must be similar to those of psilocybin and baeocystin. It is a compound that is soluble only in polar solvents, such as water, methanol and acetic acid. The levels of concentration of *aeruginascin* found in the fruiting bodies is comparable to those of the other two alkaloids. The compound is characteristic of the *Inocybe* species, so that the analytical results of mushrooms extracts using thin-layer chromatography constitute a kind of fingerprint identification of *Inocybe aeruginascens*.

Of course, there is the question whether this substance contributes to the psychoactive effects of *Inocybe aeruginascens*. It is remarkable that all cases of involuntary intoxication induced a feeling of euphoria, despite a psychological state of mind likely to create extremely unfavorable internal conditions ("set") for having a "positive experience" (i.e. knowledge of being poisoned by mushrooms with unknown and potentially fatal consequences). In addition, these cases of intoxications happened in the course of pursuing normal, everyday activities, including appointments and other interferences ("setting") which should have precipitated a much more negative type of experience. Future research must focus first on the discovery of the molecular structure of *aeruginascin*, as well as its synthesis. Subsequent studies should investigate the potentially mood-altering influence of this substance in terms of the mushroom's psychoactive effects as a whole. Moreover, we cannot exclude the possibility that ingestion of the mushrooms may cause a slow release of alkaloids from the organic matrix, followed by their gradual resorption, a process suggested by the effects of the mycologist's test experiment described above. In the meantime, the presence of psilocybin along with baeocystin has also been confirmed in the following *Inocybe* species:

Inocybe corydalina Quel.
Inocybe haemacta Berk. & Br.
Inocybe tricolor Kuhner
Inocybe coelestium Kuyper

These species, however, are not significant contributors in terms of involuntary intoxications, because, for the most part, these *Inocybe* species are extremely rare and grow almost exclusively in forests. Also, their psilocybin levels were lower than those found in *Inocybe aeruginascens*.

Among these species, *Inocybe corydalina* is the most common. An analysis revealed a psilocybin content of only 0.011% - 0.1%, a concentration so low, that this species would become clinically relevant only if large amounts of the mushrooms were eaten.

As part of my own experiments, I also detected psilocybin in *Inocybe calamistrata* (Fr.:Fr.) Gill, a species whose lower stem area is blue. Other authors have not succeeded at confirming the presence of psilocybin in this species.

3.5 - *Gymnopilus purpuratus*: Magnificent Mushrooms from South America

Another controversy documented in the literature revolves around the psychoactivity of several species of the genus *Gymnopilus*.

More than 50 years ago, in October 1942, a remarkable case of intoxication occurred in Cleveland, Ohio, which was attributed to *Pholiota spectabilis*. Today, these mushrooms have been identified as *Gymnopilus spectabilis* (Fr.) A.H. Smith (USA). In Europe, they are also Known as *Gymnopilus junonius* (Fr.) Orton.

> *A woman had been out for a walk in the woods one afternoon and had taken a few nibbles from a mushroom that she found, feeling confident that she could distinguish the edible from the poisonous ones. As soon as she lay down, she began to experience the most glorious visions of color and sounds of music, but with no feelings of discomfort whatsoever. A friend who was with her felt that a doctor should be called immediately. When she consulted me about her symptoms, I told her that certain mushrooms are known to cause the symptoms she suffered. I added that these mushrooms were not classified as poisonous, nor did the effects last very long. Called that same evening and said that the hallucinations had soon passed and that she was feeling perfectly normal again. She added that if this was the way one was supposed to die of mushroom poisoning, she was all for it.*

Another case of poisoning was chronicled in Harvard, Massachusetts:

> *On September 9, 1966, at about 9 a.m., a 56-year-old retired mechanical engineer of Harvard, Massachusetts, picked a bunch of mushrooms clustered by the side of the road in front of his house. Under the mistaken impression that they were honey mushrooms (Armillaria mellea an edible species) he tasted the fresh flesh and found them to be slightly bitter. However, he took them home, where his wife washed them and fried them in butter. He ate two or three caps around noon and within 15 minutes began to feel disconnected and "woozy", head felt numb and his vision was blurred. The room seemed smaller, and the walls closer than usual. Objects were shimmering, and appeared yellow with dark areas in the center. The trees and grass were a vivid green, with spots of radiant purple. These sensations were not unpleasant. Everything seemed to be unnaturally colored, resembling the image of a color TV. Even though he was unable to collect his thoughts, his mind felt sharp and clear: he asked himself questions and immediately knew the answers. By contrast, after having put down a book, he was unable to find it again. After a few hours all three of the involuntary participants had recovered and were able to give a coherent account of their experience.*

In this case, the mushrooms involved were also identified as *Pholiota spectabilis*. This identification is questionable, however, because the species is generally described as having an extremely bitter taste. It was determined that there are significantly more species of the genus *Gymnopilus* in North America (73) than there are in Europe (15).

Mushrooms 24 Inches Tall!

Even though *Gymnopilus junonius* is one of the largest-sized species of mushrooms (with stems that have been observed to grow up to 24 inches [60 cm] tall), there are no known European cases of intoxications caused by *Gymnopilus* species. The extremely bitter taste typical of some *Gymnopilus* species is an effective deterrent to their ingestion as table mushrooms, anyway

However, the cases of intoxication in the U.S. prompted Hatfield and his collaborators to perform phytochemical testing on some of these species. From 1968 to 1971 this group of investigators reported that eight species, including *Gymnopilus junonius* contained inactive styrylpyrones, such as bis-noryangonin. In the wake of yet another case of unintentional intoxication with *Gymnopilus validipes* in the U.S., the same research team was able to confirm that this species contained psilocybin (0.12%). They also found the alkaloid in three other species, including *Gymnopilus spectabilis*.

Still, similar analyses of European *Gymnopilus* species continued to yield negative results.

It was only through a set of strange circumstances that the presence of psilocybin and its derivatives was finally confirmed in European mushroom species of the genus *Gymnopilus*.

As far back as May 1887, a new species of mushroom was found growing on a tree fern trunk in the botanical gardens at Kew, England (also see p. 30, bottom right). The discovery eventually led to the publication of these mushrooms as a new species named *Flammula purpurata* Cooke & Massee. In this context, we must credit Mordecai Cooke (1825-1914), a mycologist of outstanding competence and expertise, who studied a vast number of mushrooms species, including *Psilocybe semilanceata*. He was the first to formulate a hypothesis about the nature of the bluing phenomenon and to point out its physiological significance (also see p. 16, bottom right). He discovered *Inocybe haemacta* as well as several *Panaeolus* species and classified the *Flammula* species mentioned above. Remarkably, one of his first publications was a book of popular folk tales entitled "*The Seven Sisters of Sleep*" (1860), which just happened to be an interdisciplinary investigation of narcotic plants. Did he himself, perhaps, sample one of the psychotropic mushroom species? Most likely, we will never know the answer to this question. Eventually, the *Flammula* species came to be recognized as being native to Australia and South America (Chile), where the mushrooms fruit on dead tree trunks during the month of May. Later on the mushroom's name was changed to *Gymnopilus purpuratus* (Cooke & Massee) Sing.

Mushrooms on Compost Mixture of Wood Chips and Pig Manure

In 1983, a conspicuous mushroom was observed growing on discarded bark and wood chips near a particle board factory in Ribnitz-Damgarten on the Eastern German seaboard. The mushroom was initially classified as *Tricholomopsis rutilans* (Schaeff.:Fr.) Sing. However, this magnificent and beautiful mushroom was found to have spore dust colored orange to rusty brown, along with a well-formed, bright yellow cortina. It also turned blue in reaction to pressure and with age. Closer study revealed that the specimen was actually of the species *Gymnopilus purpuratus*, a mushroom that, after a hundred years, had once again been imported into Europe. The microclimate essential for the mushroom's growth had been created by mixing liquid pig manure with the discarded wood chips. A powerful composting process results from pouring the liquid manure onto heaps that are up to 20 yards long and several yards tall.The process is designed to eliminate both types of refuse. Measurements inside the heaps revealed temperatures of about 176° Fahrenheit. Consequently, the *Gymnopilus* species were able to thrive on the top layers of the heaps, along with other species from Asian and South American countries with warm climates.

There is, of course, the question of just how the *Gymnopilus* species got to Europe in the first place. In the late 1970s, large amounts of feed grain were imported from Argentina. Thus, it appears likely that some mushroom spores may have stuck to the grain from where they passed unharmed through the pigs' digestive systems and went on to colonize the compost heaps.

Even though the compost heaps are plowed at least twice a year and shipped as fertilizer to surrounding fields after about two years of storage, the mushrooms continue to grow on wood piles in new locations whenever its spores have reproduced (see Figure 30, p. 40). However, in the wake of changes in economic conditions and growing ecological awareness in Eastern Germany, it is likely that this composting process will soon be discontinued so that this mushroom species may disappear in Europe once again.

The following description characterizes the *Gymnopilus* species that does not have a bitter taste:

> *Cap*: 15-42 mm broad, occasionally larger sizes up to 20 cm in diameter. Flesh thin, broadly convex without an umbo. Evenly covered with pointy scales, purplish to ruby on yellow background, dry. Margin inrolled at first, incurved later, occasional blue stains.
>
> *Gills*: Close, golden yellow at first, rusty yellow later on due to maturation of spores, edges concolorous with lamellae and bald.
>
> *Stem*: Not hollow, 6-10 mm x 30-80 mm, very rarely up to 15 cm tall, cylindrical to slightly club-shaped, coarse fibrils, striated, lower stem area and base bruise grayish-blue to Greenish when injured and with age, found alone or in clusters of up to 22 mushrooms.

Cortina: Sulphur yellow, almost appendiculate along margin, fibrous at the apex without forming a true annulus, disappears with age.

Basidia: Approximately 35 µ long, club.

By 1969, Singer had noted that based on analyses performed by Cassels in Chile, the mushroom contained an indole derivative and that the species may be hallucinogenic because of the bluing reaction. By 1988, reports from Germany also confirmed the presence of psilocybin in mushroom extracts of the same species, as evidenced by the results of thin-layer chromatography testing (qualitative detection only). That same year, my own quantitative analyses of 26 mushrooms also revealed that psilocin and baeocystin were present in all fruiting bodies of the *Gymnopilus* species. So far, no other European species has been found to contain as much psilocin as *Gymnopilus purpuratus*:

Table 8
Alkaloid Content in Two Collections of *Gymnopilus purpuratus*
(% of Dry Weight).

Mushroom	Psilocybin	Psilocyn	Baeocystin
Sample Collected in 1988			
1	0.29	0.28	0.05
2	0.31	0.29	0.04
Sample Collected in 1987			
1	0.32	0.03	0.03
2	0.21	0.02	0.02

Table 8 illustrates the unstable nature of the psilocin molecule: during the one-year storage time until analysis in 1988, much of the sample's psilocin had already decayed.

Alkaloid concentrations were found to be higher in smaller mushrooms, as shown in Table 8. Larger mushrooms contained about 0.1% of both psilocin and psilocybin. I am not aware of any cases of accidental intoxication nor any self experiments involving *Gymnopilus purpuratus*.

Intoxicating Potions of the Yurimagua Indians

In light of the discovery of psilocybin as an active ingredient in a South American *Gymnopilus* species, numerous historic accounts also appear in a different light.

Jesuits of the 17th and early 18th centuries who had travelled to the western Amazon (Peru) reported that the Yurimagua Indians habitually prepared a potently intoxicating potion derived from a tree-dwelling mushroom. The mushrooms appeared on fallen trees as a kind of reddish growth with a spicy taste. The potion was said to be so potent that nobody who swallowed three mouthfuls of the brew was able to resist its effects. The mushroom was considered to be *Psilocybe yungensis* Singer & Smith. However, since *Gymnopilus* species are reddish in color (see description of *Gymnopilus purpuratus*, above) and tend to colonize dense tree trunks, those strange tree-dwelling mushrooms were most likely a *Gymnopilus* species. The *Psilocybe* species, after all, grow almost exclusively on wood sprigs and tree bark debris. On only one exceptional occasion did we discover a specimen of *Psilocybe bohemica* growing on a thoroughly rotted, wet tree trunk (see p. 31, top right). Most likely, the reddish-colored tree-dwelling species was closely related to *Gymnopilus purpuratus*. The discovery of psilocybin in a mushroom of the *Gymnopilus* species marked the first time this substance had ever been found in a member of the family *Cortinariaceae*.

The *Inocybe* species who were found to contain psilocybin later on, are also members of this family. Since the alkaloid had previously been found in *Psilocybe*, *Panaeolus* and *Conocybe* species - which are not closely related to each other - the hypothesis postulating psilocybin's significance as an important chemotaxonomical substance had to be abandoned.

Future research should attempt to verify the presence of psilocybin and its derivatives in other tropical and subtropical *Gymnopilus* species. Taxonomically, the genus has not yet been exhaustively studied, and mushroom lovers may want to watch out for occurrences of *Gymnopilus purpuratus* in certain European locations, such as botanical gardens or herbariums.

3.6 - *Conocybe cyanopus*: Tiny Mushrooms of Remarkable Potency

While studying the magic mushrooms of Mexico during the 1950s, R. Heim described a new species of the genus *Conocybe*.

Conocybe siligineodes Heim was reported to grow up to 8 cm (3.25 in.) tall, a beautiful, reddish brown to orange-colored mushroom that thrived on rotten wood and which was used as a psychotropic species by the Indians as well. However, the species did not appear again in the literature, nor were the chemical composition or the effects of these samples published. Even after decades of field research in Mexico, Guzman was unable to find the species there. Similarly, he did not discover native usage of any kind of *Conocybe* species. Heim's description however, aroused curiosity as to the chemical composition of this species. Approximately 55 European species which existed saprophytically were relegated to a shadow existence in the older literature. Also, the differentiation of these species is very problematic at times. For the most part, the mushrooms are small and fragile, decay quickly and grow mostly in grassy and mossy areas, where they are easily overlooked.

Around 1930, J. Schaffer discovered numerous *Conocybe* species growing in abundance on a fertilized grassy area near Potsdam. Intrigued by the mushrooms' extraordinary variety of forms and colors, he was inspired to undertake the kind of taxonomic classification that is essential to pursuing mushroom research. One species that he found in Potsdam, Berlin as well as in Germany's Harz Mountains showed bluish discolorations at the base of their stems. This "Galera" species was included by Kuhner as *Conocybe cyanopoda* in his 1935 monograph about the genus *Conocybe*. Today, this species is referred to in the literature as *Conocybe cyanopus* (Atk.) Kuhn. This species with a blue base had been previously discovered in the U.S. (Ithaca, NY) in 1918 and was judged by Kuhner to be identical with the European mushrooms.

The following is an adequate description of *Conocybe cyanopus*, because its bluish discoloration is a sufficiently unique attribute to allow differentiation of this species from other European *Conocybe* species.

> *Cap*: 0.3-2.5 cm broad, nearly hemispheric to convex, striated, ocher to dark brown without grey-green stains.
>
> *Stem*: 2-4 cm long, 1-1.4 cm thick, whitish at first, equal to slightly curved at the base, silvery later on, stains bluish-green - particularly at base - in reaction to injuries or with age.
>
> *Spores*: 7-10 x 4-5 µm.
>
> *Basidia*: 4-spored, pleurocystidia absent, cheilocystidia present, 18-25 x 6.5-10 µm.
>
> *Habitat*: On grassy areas or moss, summer through fall.

The *Conocybe* genus is a member of the *Bolbitiaceae* family, which is similar to the *Coprinaceae*, a family of dark-spored mushrooms that includes the *Panaeolus* species.

The *Conocybe* species are very rare in Europe. The mushrooms are hardly ever found among lists of mushroom discoveries from European countries. Aside from Schaffer's discovery, the mushroom was reportedly found or described only twice (!) within the territory of the former East Germany over the last 60 years (both discoveries were made during the 1980s). However, there are only few mycologists who specialize in the study of the *Conocybe* genus, due to its lack of attractiveness.

Even though the mushroom is very rare, I was able to include one picture of *Conocybe cyanopus* in this book (see Figure 36, p. 57). I also had the good fortune to obtain a dried *Conocybe cyanopus* sample for chemical analysis (see Table 9, p. 56).

Psilocybin was discovered for the first time in a sample of fruiting bodies of the species *Conocybe cyanopus* which had been collected on September 4, 1961 in Seattle, WA. No psilocin however mysterious they may remain.

In 1977, Repke and his research team reported the discovery of baeocystin, as well as psilocybin in a *Conocybe* species from the United States and Canada. Once again, no psilocin was found in these samples. Finally in 1982/83, Norwegian researchers confirmed the existence of trace amounts of psilocin, in addition to 0.33-0.55% of psilocybin, an alkaloid that was also reportedly discovered in Finnish samples. Finally, Beug and Bigwood reported 0.93% of psilocybin in samples collected in the Northwestern United States. Interestingly, the second sample ever discovered in Eastern Germany was found on July 2, 1989 near Potsdam, where several fruiting bodies of the *Conocybe cyanopus* species were growing in a grassy area on sand. The original area, however, where Schaffer first discovered the species 60 years ago, lay within the Potsdam city limits and its exact location can no longer be determined.

The sample collected in 1989 consisted of five mushrooms that were found to have concentrations of psilocybin and baeocystin similar to levels found in *Psilocybe semilanceata*:

Table 9
Selected Test Results on the Alkaloid Content of *Conocybe cyanopus*
(% of Dry Weight)

Mushroom	Dry Weight (mg)	Psilocybin	Baeocystin
1	5	0.84	0.15
2	6	0.73	0.12
3	7	1.01	0.20
4	10	0.91	0.16
5	12	0.89	0.14

Concentrations of psilocybin were strikingly similar to those found in samples collected in the Northwestern United States.

After several days, spores from one of the fruiting bodies germinated on malt agar and, compared to other species, proceeded to grow very slowly into their permanent forms or "sclerotia" (see Figure 35, p. 57). The sclerotia showed no blue discolorations, and were found to contain 0.25% psilocybin when dry, while no additional alkaloids were detected.

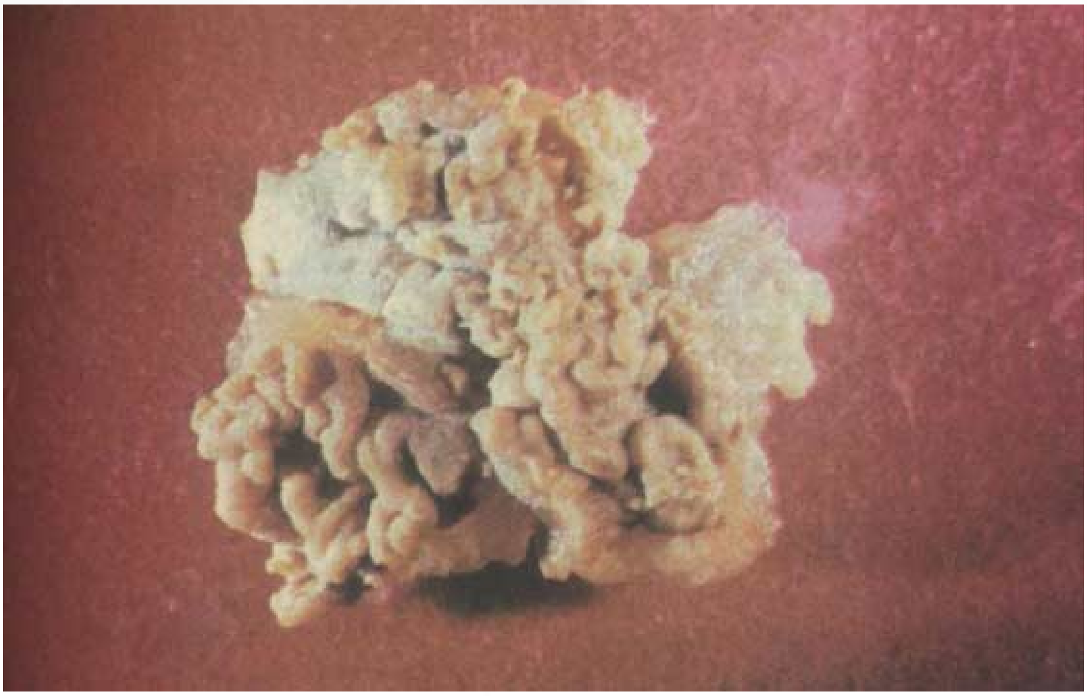


Figure 35 - Sclerotia of ***Conocybe cyanopus*** grown on malt agar.

In summary, it is reasonable to assume that due to its small size and extreme rarity, *Conocybe cyanopus* is a species that is not a significant contributor to intoxications in Europe, nor is it likely to gain such prominence in the future. My own analyses of other, nonbluing *Conocybe* species, such as *Conocybe tenera* (Schaeff.:Fr.) Fayod and *Conocybe lactea* (Lge) Metrod revealed the presence of physiologically inactive ingredients only.

Samples of *Conocybe* species from warm countries have not yet been analyzed and may yet yield remarkable results in terms of chemical composition and alkaloid content.

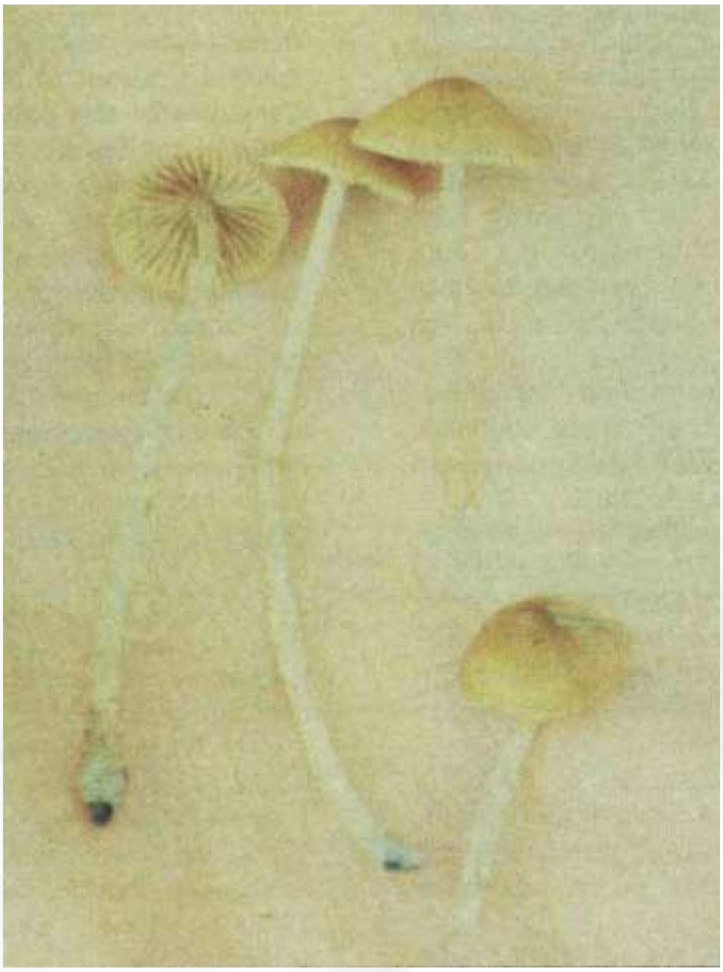


Figure 36 - Fresh ***Conocybe cyanopus*** fruiting bodies from the Pacific Northwest (USA).

3.7 - *Pluteus salicinus*: A Little-known Wood-Inhabiting Species

Within the Pluteaceae family, there are about 45 European species of the genus *Pluteus*, some of whom also produce psilocybin.

Historically, the *Pluteus* species were classified as belonging to the Amanitaceae family, which also include the "death cap" and its relatives, as well as the fly agaric mushroom, both of which belong to the genus *Amanita*. Unlike all the other psychoactive mushrooms mentioned here in this book, the *Pluteus* species are classified as light-spored mushrooms, because of their rose-colored spore dust.

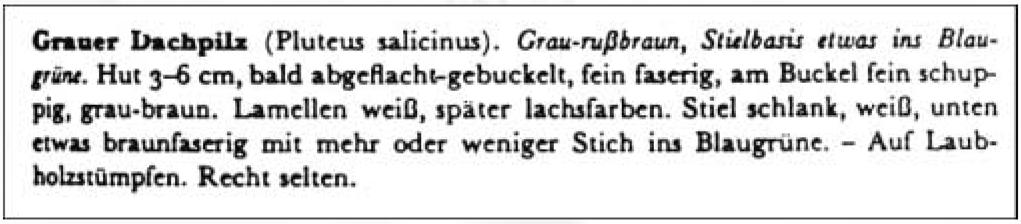
No accidental intoxications involving *Pluteus* species have been documented in the literature.

The first description providing qualitative evidence for the presence of psilocybin and psilocin was provided by Saupe in 1981, who examined extracts of *Pluteus salicinus* (Pers.:Fr.) Kumm. from Illinois. Surprisingly, psilocin turned out to be the alkaloid with the highest levels of concentration in the samples tested. This mushroom species had previously been described in Europe about 200 years ago. Since then, however, it has rarely been mentioned in the literature, and only briefly, if at all (see Figure 37, p. 59).

Some taxonomic methods of classification used earlier can still cause confusion today. For example, Ricken (1915) designated the mushroom as *Pluteus petasatus*.

By way of expanding the description from 1962 (see Figure 37), *Pluteus salicinus* is identified by the following characteristics:

> Medium-sized mushroom with a more or less intensely bluish to bluish-green coloration. Older mushrooms are sometimes colored olive green.
>
> Caps in some cases up to 8 cm in diameter, lighter colored around the margin, silver grey, hairy and felt-like, even hairier and felt-like towards the middle of the cap, often scaly.
>
> Stems up to 10 cm in length, with spontaneous grey-green or grey-blue discolorations at the base, colors intensify in response to pressure.



Grauer Dachpilz (Pluteus salicinus). *Grau-rußbraun, Stielbasis etwas ins Blaugrüne.* Hut 3–6 cm, bald abgeflacht-gebuckelt, fein faserig, am Buckel fein schuppig, grau-braun. Lamellen weiß, später lachsfarben. Stiel schlank, weiß, unten etwas braunfaserig mit mehr oder weniger Stich ins Blaugrüne. – Auf Laubholzstümpfen. Recht selten.

Figure 37 - Description of ***Pluteus salicinus*** from 1962 (Germany). See page 58 for description in English.

There are also mushrooms of this species that are white in color (see Figure 38, p. 60). However, these albino fruiting bodies have stems whose bases show a slight grey-green coloration as well, as do the apex areas of their caps. *Pluteus salicinus* has been described as being anywhere from "very rare" to "not rare" in the wet deciduous forests of Europe. The species of the genus *Pluteus* are final wood-destroyers, that is, they grow saprophytically on wood that appears rotten and discolored, because it has decomposed due to the presence of other mushrooms over the course of many years. *Pluteus salicinus* fruits from May to October on stumps of willows, alder-trees, lime-trees, beech-trees, poplars, maple-trees and possibly on the wooden remnants of other tree species as well. The fact that this mushroom has not been the cause of any intoxications may be explained by its fruiting bodies' occurrence on tree stumps as single mushrooms or in groups of very few mushrooms. Also, compared to other wood-inhabiting mushrooms, *Pluteus salicinus* is not very attractive in appearance. The mushroom's habitus is well illustrated by Figure 39 (p. 60).

For unknown reasons, Kreisel described all *Pluteus* species as "non-poisonous" in his 1987 handbook of mushrooms, despite the fact that psilocybin (0.35% of dried mushrooms) had already been discovered in samples of this species in 1981 (North America) and 1984 (Norway). The alkaloid was also found in mushrooms from Holland, Finland, Sweden and France. The latter tests, however, were limited to very few fruiting bodies in each case.

Whereas Stijve found an average of 0.25% of psilocybin in dried mushrooms from 20 samples collected in Switzerland from 1984 to 1986, my own analyses of non-bluing (!) mushrooms collected in Thuringen, Germany in 1986 yielded much higher alkaloid concentrations:

Table 10
Psilocybin and Urea Content of *Pluteus salicinus*
(% of Dry Weight)

Sample #	**Psilocybin**		**Urea**	
	Cap	Stem	Cap	Stem
1	1.38	0.48	2.50	Traces
2	1.57	0.71	2.60	0.00
3	1.57	0.71	2.60	0.00
4	1.22	1.14	1.40	0.00
5	1.39	0.64	2.40	0.43

Additional analyses of four bluing mushrooms collected in the Dubener marshlands (Eastern Germany) in 1988, confirmed the presence of only about 0.2 - 0.7% psilocybin in those mushrooms. This sample also contained very small amounts of baeocystin.

These results indicate that the variability in alkaloid content in *Pluteus salicinus* has not yet been sufficiently calibrated. Therefore, more analyses are needed. In contrast to the findings based on studies of mushrooms collected in America, it is certain that the European mushrooms produce only traces of psilocin at most.

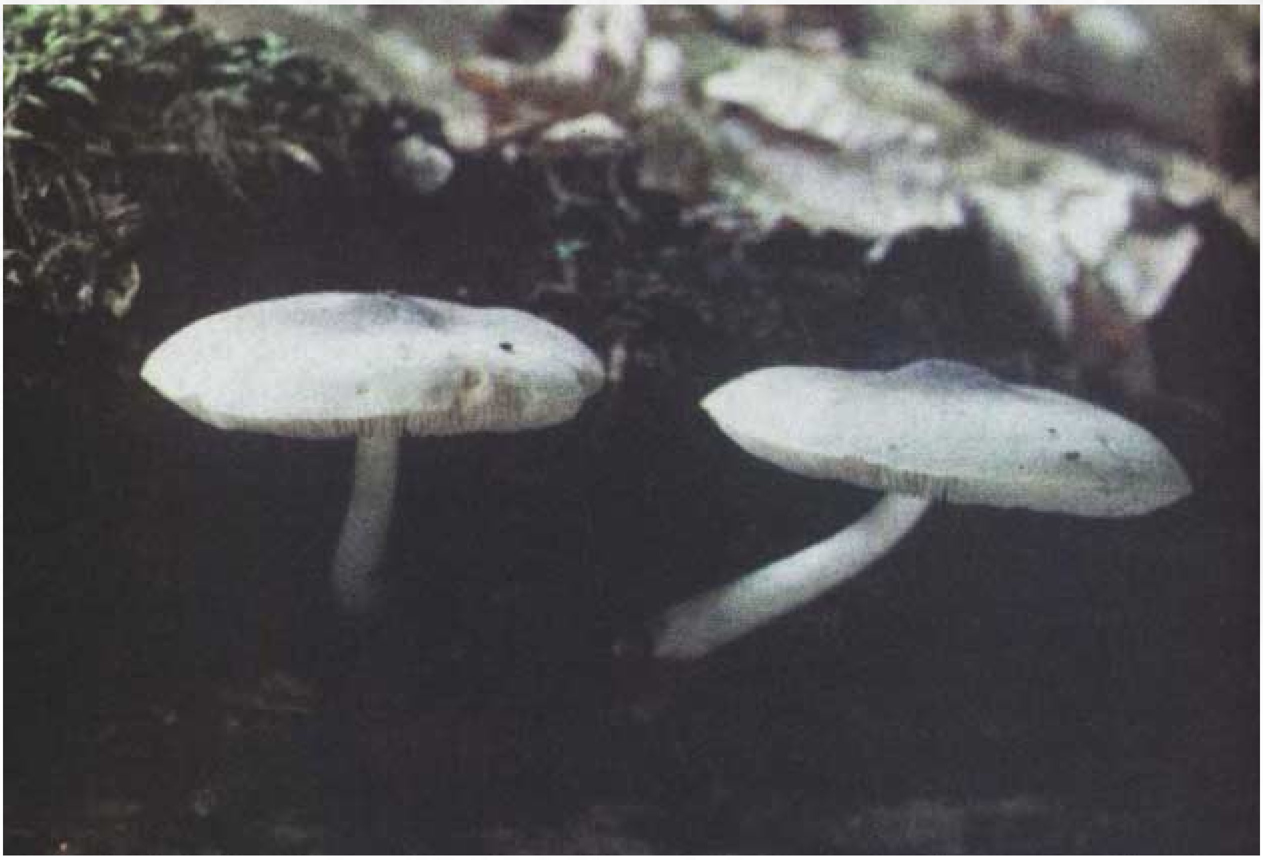


Figure 38 - ***Pluteus salicinus*** at a natural location (Germany).

Stijve and Bonnard were able to examine original material collected by Saupe in the United States. To their surprise, they discovered that the mushrooms were not identical to those found in Europe. They also did no longer contain any alkaloids. These findings show that mushrooms of the same name from different continents are not necessarily identical.

All other *Pluteus* species tested so far contained urea, a substance that can also been found in the *Panaeolus* species. However, the latter also produce compounds like serotonin, which do not occur in the *Pluteus* species. Hence, the different species are once again identifiable by their unique "fingerprints".

Other rare *Pluteus* species with bluish or violet discolorations are mentioned in the literature, such as a *Pluteus cyanopus* from Europe. However, so far, very small amounts of psilocybin (0.035% of dried mushrooms) have been found only in *Pluteus nigroviridis* Babos, an extremely rare species from Hungary.

Therefore, additional analyses of this fairly neglected genus are urgently needed.

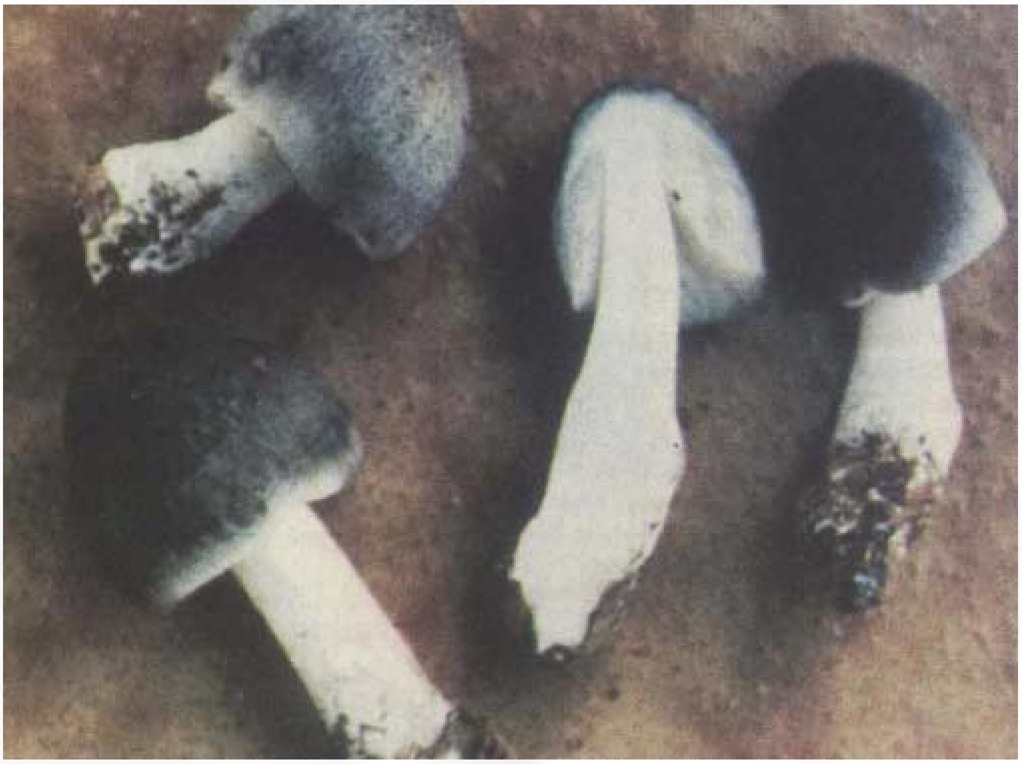


Figure 39 - Fresh ***Pluteus salicinus*** fruiting bodies.

CHAPTER 4

Mushroom Identification: Taxonomic Confusion and the Potential for Deadly Mistakes

> *On December 16, 1981, three teenagers hunting for psychoactive mushrooms on Whidbey Island, WA (USA) collected specimens of a* Galerina *species, in the mistaken belief that the mushrooms belonged to a* Psilocybe *species. All three of them fell ill after eating the mushrooms, but did not report their symptoms or seek medical help for another two days, afraid of being prosecuted for using psilocybin. After medical treatment, two of the teenagers made a full recovery. The third victim, however, a 16 -year-old girl, died on December 24, 1981.*

As presented by Beug and Bigwood, this tragic incident underscores the dangers inherent in careless or erroneous identification of mushroom species, especially when a situation is complicated by overzealous legislative and punitive measures. The psilocybin-producing species as well as culinary mushroom varieties often share some characteristics with many other species. Casual mushroom hunters and lay-persons are especially prone to making identification errors, suffering accidental inoxications as a result. Previous chapters included several case histories of such involuntary intoxications. To be sure, modern mycological keys are valuable tools when it comes to accuracy in deciding the family and genus of an unknown mushroom sample. It can be extremely difficult, however, to identify the specific species of questionable specimens, especially if the sample belongs to the vast category of "LBM"s, or "little brown mushrooms". We currently know very little about the "LBM" species, since their habitats and variations in habitus have not been studied in systematic detail. Not surprisingly, reference books are often limited by incomplete descriptions that lack the essential criteria for differentiating one species from others that are similar or related. I vividly recall my own first attempts to identify unknown samples by relying on what appeared to be precise definitions in standard mycological reference works. I found many of the listed traits to be descriptive of a wide range of sometimes very different species. As I compared my samples with the text, I noticed a tendency to disregard some of the finer details in the literature, so that "my mushrooms" would better match the descriptions. Naturally, this approach resulted in errors. Luckily, I would quickly discover and correct my mistakes upon consultation with my mycologist friends. In my experience, competence and expertise in the area of mushroom identification are skills honed over time through extensive fieldwork, consultations with established mycological experts, and careful analyses of samples based on information found in appropriate reference books.

The literature clearly indicates that *Psilocybe semilanceata* is one species that, at prime locations, can be easily identified without consulting a diagnostic key. *Psilocybe semilanceata* is known for its uniquely distinctive appearance, so that microscopic tests are not needed to distinguish this species from other pasture-dwelling mushrooms. The situation is different, however, for *Psilocybe* species that thrive on wood debris, as illustrated by the tragic story at the beginning of this chapter. Besides, compared to Europe, the North American mycoflora includes a much broader and varied spectrum of mushroom species to begin with.

Warning: Amatoxins are Lethal!

The *Galerina* genus includes a number of poisonous mushrooms. These species are dangerous, because they contain the same deadly amatoxins as the "death cap" (*Amanita phalloides*) and its relatives, "death angel" and "destroying angel". Their toxins are insidious, with no symptoms evident for about 12 hours. During this latency period, the toxins can cause major irreversible internal damage, which is why many cases are fatal in spite of treatment. A common North American species is *Galerina autumnalis* (Peck) Singer & Smith, which grows on wood debris in parks and forests, just like several of the *Psilocybe* species. At first glance, *Galerina autumnalis* resembles *Psilocybe stuntzii* Guzman & Ott, and the two species may grow side by side at the same location. The *Galerina* species, however, does not turn blue. I once discovered a grassy area that was home to a cluster of *Psilocybe stuntzii* specimens entangled with a *Galerina* species. The mushrooms had grown so entwined that individual fruiting bodies could be identified only by spore analyses.

Pholiotina filaris (Fr.) Sing. (also known as *Conocybe*) is another North American species known to contain amatoxins. At the same time, these toxins have not been found in European samples of this species. Thus, *Pholiotina filaris* (Fr.) Sing. most likely does not refer to the same species on both continents. Still, at least one European *Galerina* species (*Galerina marginata* (Fr.) Kuhn.) contains the same toxins found in the "death cap" mushroom. This species also grows on decaying wood substrate and its fruiting bodies contain about one-third of the amount of amanitines found in *Amanita phalloides*. Incredibly, older mushroom books list *Galerina marginata* as an edible species.

In a previous chapter on the *Panaeolus* species I illustrated the potential for identification errors associated with commercial cultivation areas that are "invaded" by outside species. Due to their rapid growth, the *Panaeolus* species in particular will often fruit in artificial growing areas long before the cultivated species that is grown there. Chapter 3.3 details the 1970 poisoning incident involving *Panaeolus subbalteatus* from a cultivation area in Leipzig. In that case, the intruding species was mistaken for *Stropharia rugoso-annulata* Farlow (the Giant *Stropharia*), based on information from a mushroom book. Apparently nobody realized the glaring differences between the book's description and the actual characteristics, except for the assumption that the sample's small size meant the mushrooms simply had not grown as tall as portrayed in the book. This flawed conclusion illustrates a type of judgment error common among amateur mushroom hunters who falsely believe that they are experts. Having been shown a single sample of wild mushrooms, for example, some mycophiles become convinced they will always be able to recognize the species in the future. That is how one such mushroom hunter accidentally ingested *Inocybe aeruginascens* specimens that he believed to be common fairy ring mushrooms. In a similar case of *Inocybe aeruginascens* intoxication, the mushrooms had been picked as white champignons, even though this common culinary mushroom bears no resemblance, either in size or form, to *Inocybe aeruginascens*. Overall, however, these unfortunate cases have also contributed to our understanding of mushroom biochemistry.

In this context, I want to emphasize once more that the hallucinogenic varieties among the *Inocybe*s can easily be mistaken for those muscarine-producing *Inocybe* species that are extremely poisonous.

As part of his investigation of the *Psilocybe* genus, Guzman noted a common trait among the hallucinogenic species, in addition to the bluing reaction: a flour-like smell or taste. Apart from the inherent subjective nature of our sense of smell and taste, a common odor is a trait that definitely does not apply to the European species (also see Chapter 3.2).

Mycophile or Mycophobe?

There are reports from the Western United States about people with expert knowledge of *Psilocybe semilanceata* - devoted mushroom hunters who can identify the species with drill and accuracy. At the same time, however, these experts cannot identify easily spotted common table mushrooms, nor are they able to differentiate the *Agaricus* species (champignons) from other mushrooms, even when these species grow on the same pasture. Such individuals, then, are not interested in species other than *Psilocybe semilanceata*. In my opinion, this attitude reflects a rare combination of mycophilia and mycophobia.

A mushroom's spore dust provides important information needed to determine identity. A spore print is left by the gills when the cap is placed on black or white paper (depending on spore color). As the process takes several hours, a glass vessel must be placed over the cap to prevent drying. While useful, information obtained from spore analyses has its limitations. For instance, spores derived from mushrooms belonging to different genera may have the same color, but reveal basic differences under the microscope. There is also a high degree of similarity among spores from different *Psilocybe* species. Thus, the only way to prevent grave errors and potentially deadly intoxications is to rely on experienced experts for mushroom identification, a process that must include analysis of available ecological data.

CHAPTER 5

The Bluing Phenomenon and Metol Testing: Reality vs. Wishful Thinking

As previously discussed in Chapters 3.1 and 3.7, the bluing reaction is characteristic of species that produce psilocybin. Still, for unknown reasons, some species or samples belonging to a genus that usually turns blue may not always change color, regardless of psilocybin content. Among the species that I have examined, *Psilocybe bohemica* displayed the most impressive bluing reaction. The caps of this species stain very quickly in reaction to pressure. Other species, such as *Psilocybe cubensis* (Earle) Sing. have stems that develop very intensely blue stains, while their caps do not exhibit the bluing reaction. By contrast, *Psilocybe semilanceata*, *Conocybe cyanopus* and *Inocybe aeruginascens* are species whose stems develop only slight stains in reaction to pressure and only after a relatively long time period has elapsed. With respect to time delay and intensity of the bluing reaction, *Gymnopilus purpuratus* is a species that falls in between these two extremes.

A Rich Color Spectrum

The colors range from green to a deep blue. *Psilocybe cubensis* is a species in which the latter color may also take on a blackish-blue hue. The mechanisms underlying the color reactions in these mushrooms has not yet been studied. I have already mentioned Cooke's speculation from the early years of the 20th century about the significance of the bluing reaction in *Psilocybe semilanceata* (see p. 16). In the 1950s, it was Singer and Smith who emphasized that discolorations observed in the psychotropic *Psilocybe* and *Panaeolus* species must somehow be linked directly or indirectly to the mushrooms' active ingredients. Eventually, in 1958, A. Hofmann and his collaborators reported the successful isolation of these ingredients. They were the first to observe that pure psilocin grows unstable when exposed to oxidizing agents such as air and that solutions of psilocin turn bluish-green in an alkaline range.

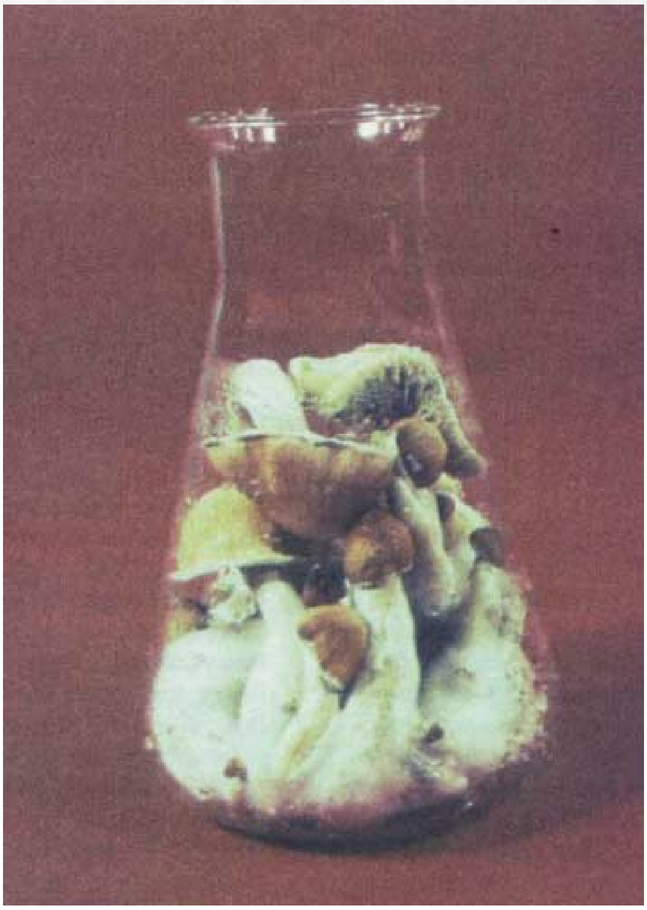


Figure 40 - ***Psilocybe cubensis*** fruiting bodies whose growth was accelerated with plant hormones.

These results provided proof that the bluing reaction resulted from a mushroom ingredient's breakdown by oxidation. From 1960 on, Blaschko, Levine and Bocks, as well as Horita and Weber performed in-vitro studies of the biochemical reactions of psilocybin and psilocin. They concurred that only psilocin can be oxidized into a product of bluish-green color. The phosphate group prevents direct oxidation of this alkaloid (see Figure 19, p. 27). However, the typical bluing phenomenon does occur when this protective group is removed by enzymes, such as various phosphatases, which are very common in human as well as in mushroom tissue. I also observed the bluing reaction following removal of the phosphate group from baeocystin. Observations from in-vitro experiments explain why *Psilocybe bohemica* displays a strong bluing reaction, despite the fact that levels of psilocin in this mushroom are low or nonexistent: Apparently, the enzymatic removal of the phosphate group from the psilocybin molecule occurs quite quickly. This is how psilocin is formed in reaction to injuries to the fruiting bodies. Immediately afterwards, psilocin continues to break down and disappears completely, while a number of blue-colored substances are created. In addition, some enzymes were discovered which accelerate the breakdown of psilocin. Cytochrome oxidases and laccases are examples of such enzymes. The latter has also been found in the mycelia of *Psilocybe cubensis*. Most likely, the enzymes are also formed in those mushrooms that display bluish discolorations in reaction to metol testing. Trace amounts of Iron ions accelerate the bluing reaction as well. The structure of the blue-colored compounds has not yet been investigated. Apparently, they are quite unstable and involve a type of chemical bond known as chinones. Many pigments are known to have this basic structure.

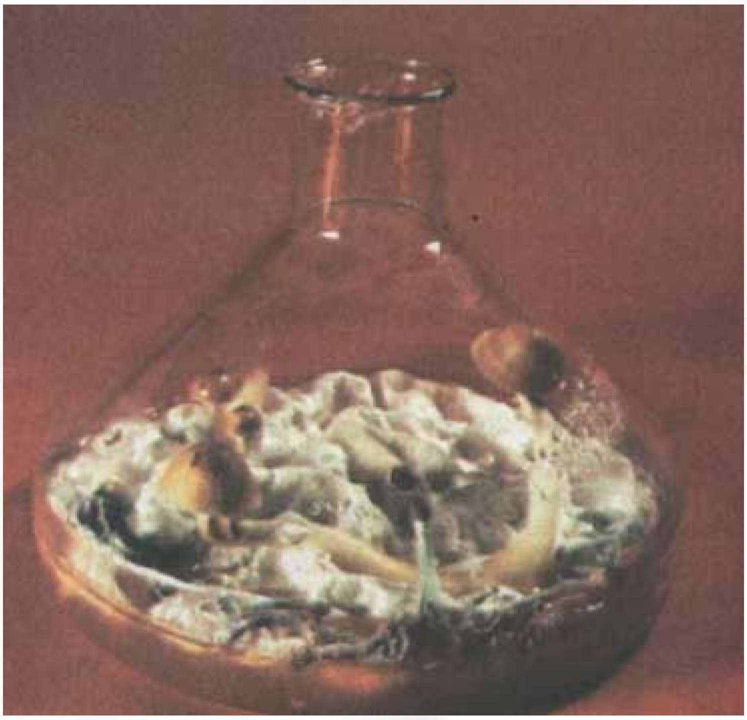


Figure 41 - Mycelial culture of ***Psilocybe cubensis*** on malt extract (3% solution).

The *Agaricales* as Alkaloid Producers

Even though the blue discoloration does not occur in all mushroom species that produce psilocybin and psilocin, we can say that, conversely, all species of the order *Agaricales* (gilled mushrooms) displaying this reaction are capable of producing alkaloids. Historically, this problem associated with the bluing reaction did not particularly impress early mycologists, because there were a number of boletes which turned blue in reaction to pressure and were thought to be among the most valued culinary mushrooms. Indeed, the mushrooms' color reaction is based on ingredients that are physiologically inactive. The boletes also do not display the kinds of spontaneous discolorations with age that are frequently noted in the psychotropic species.

As results of my own analyses have shown, the alkaloid concentrations in *Psilocybe semilanceata* and *Panaeolus subbalteatus* - whose fruiting bodies showed a slight degree of discoloration at most - are within the same orders of magnitude as those found in mushrooms that do not turn blue. Evidently, the pigments involved have a high degree of intensity; the tiny amounts that were produced did not measurably contribute to the destruction of the active ingredients. On the other hand, my own experiments revealed that levels of psilocin and psilocybin in very old and strongly discolored fruiting bodies and mycelia of *Psilocybe cubensis* were considerably lower in comparison to younger specimens. In 1948, Singer was the first to describe the intensification of the bluing reaction, including a change in color towards violet, in samples of *Psilocybe cubensis* which had been moistened with an aqueous solution of the photographic reagent metol (p-methylaminophenol). Ten years later he reported further examinations of some psychotropic *Psilocybe* species whose stems usually turned purple through contact with this reagent. Since 1970, various "field guides" intended to aid in the identification of North American *Psilocybes* have also described this reaction as specific to the *Psilocybe* species. For practical purposes, however, this guideline is all but useless. The metol merely reacts with the laccase enzyme (several structural types) contained in the mushrooms and it is not a reagent able to confirm the presence of psilocybin and its derivatives. Even the brown and white varieties of the commercial champignon mushroom change colors when exposed to a metol solution, just like many other mushrooms do as well.

The Limitations of Reagents

The discovery and usage of different color reagents as a means to differentiate certain species or even genera has been attempted for quite some time, with only moderate success, for the most part. Melzer's Reagent is a well-known mixture whose usage was propagated as a method for identifying the *Psilocybe* species. For this purpose, however, it turned out to be just as nonspecific and worthless as metol.

G. Drewitz discovered that the application of iron chloride to fruiting bodies of *Inocybe aeruginascens* caused a deep blue discoloration, while the muscarine-producing species of the same genus did not change color. Iron chloride is a salt that reacts with different phenoles to form intensely blue molecules. The underlying mechanism of this reaction is more realistic than the others, because psilocin will also react as a phenole. Independent of this color formation, mere trace amounts of iron ions will suffice to accelerate the oxidation of psilocin by air.

However, *Inocybe aeruginascens* is a species that produces only trace amounts of psilocin; therefore, it is very likely that the iron salt reacts with other phenoles in this mushroom species.

In summary, only those bluing reactions that are spontaneous or caused by injuries provide reliable clues as to the presence of psilocybin and its derivatives in *Agaricales*. The presence of the bluing phenomenon itself, however, reveals nothing about the type and quantity of any specific indole compound that may be present in gilled mushrooms.

CHAPTER 6

Mushroom Cultivation: Classic Findings and New Techniques

While conducting research on the Mexican mushroom species during the 1950s, R. Heim and R. Cailleux determined the basic conditions essential to the cultivation of various mushrooms. Before providing additional details, I would like to briefly summarize the nutritional requirements and characteristics of fungal growth, to the extent that these issues are of interest here.

Extraterrestrial or Earthly Organisms?

In terms of cultivation parameters and nutrients, the psychotropic species are no different from table mushrooms and other common gilled mushrooms. For that reason, Oss and Oeric's speculations about extra-terrestrial origins of these species clearly belong into the realm of fables. In addition, psilocybin and psilocin are substances that can be derived from tryptophan by means of discernable reactions; indeed, the amino acid tryptophan in its free form has been found in a large number of mushroom species.

The natural propagation of higher mushrooms is linked to their basidiospores, which are produced on the gills of developing fruiting bodies and which are eventually cast off. Once the spores have been dispersed - by the wind, for example - they will germinate when conditions are favorable (nutrients, temperature, moisture, lack of competing organisms) and finally, they gradually colonize available substrates. Initially, a monokaryotic mycelial thread (i.e. a mycelium with only one nucleus per cell) grows out of the spore and superficially penetrates the nutrient substrate. When two of these hyphae meet, they form a mycelium with two nuclei, or a dikaryotic mycelium ("mycelial network"). Later on, these mycelial strands go on to differentiate into spore-producing fruiting bodies ("fruiting"). Eventually, their spores disperse and germinate once again.

During most parts of the year, the dikaryotic mycelium grows unnoticed in its natural substrate and remains purely vegetative, that is, it continues to spread and to utilize new nutritional resources without producing mushrooms, provided there is sufficient moisture and temperatures do not drop below freezing. ln its dormant state, the mycelium can weather droughts and the cold temperatures of winter, only to begin to grow anew. Some species have mycelia with thick strands that are visible within the substrate (e.g. the rhizomorphs of *Psilocybe cyanescens*), while other species, such as *Psilocybe semilanceata*, develop comparatively thin strands that are hardly visible at all.

The Secret of "Overnight" Growth

Every mushroom collector knows that there are years of maximum mushroom yields. Other years, mushrooms are scarce and dry periods may pass with no apparent crops of gilled mushrooms or boletes. For the majority of mushroom species, the specific conditions required to reach the fruiting phase have not yet been determined.

The saprophytic species (including the hallucinogenic ones except the *Inocybe* species: mycorrhiza with trees) generally fruit after optimal mycelial growth has been induced by appropriate nutrient substrates, as long as the following environmental conditions are maintained:

1. Decrease of the temperature until time of optimal fruiting.
2. Increase of the humidity to 95-100%.
3. Decrease of carbon dioxide concentration through increased air circulation.
4. Exposure to light may be necessary for fruiting.

The last two items already touch upon the essential requirements for mushroom cultivation, since these conditions are always present in Nature, but often need to be specially created for mushroom cultivation inside glass containers or enclosed rooms.

It is no coincidence that the saprophytic species almost always fruit during the fall. Plant substrates such as twigs and leaves fall to the ground during this time and they are immediately colonized by available mycelia from mushroom spores as part of the natural cycle. The concurrent drop in temperature and increase in humidity are preconditions for fruiting. The proverbial rapid growth of mushrooms "overnight" is a function of mycelia that have previously massed together into knots, followed by a differentiation process into primordia, with progressive divisions into caps and stems. The whole mushroom is then ready to develop very rapidly, given sufficient moisture and ideal temperatures. Figure 42 illustrates a comparable in-vitro fruiting process that took about a week, with mycelia from *Psilocybe cubensis* (Earle) on an agar substrate.

Cultivating High Yield Strains

Artificial cultivation is an attempt to imitate and optimize the natural conditions essential for mushroom growth, and may even result in the discovery of additional nutrient substrates on which these species cannot grow in Nature. From the outset, this method of cultivation requires a sterile environment, in order to eliminate often fast-growing organisms such as bacteria and molds. For this purpose, laminar flow hoods are used in mycological laboratories. A small sterile space is created inside these containers by installing a filtration system that removes germs from a stream of air. The sterile space is used for the performance of tasks such as isolation of strains, and the production of sterile cultures and spawn for fruiting experiments. Antibiotics such as gentamycin (0.01%) are often added to the nutrient media, especially in the early stages of this process.

Two methods are used to produce sterile cultures of fungal mycelia.

The first method mimicks the mushrooms' natural reproductive process. Spores that fell off or were removed from the gills are suspended in sterile water. With microscopic control procedures in place, the spore solution is germinated on nutrients of various compositions that have been thickened with agar. One commonly used nutrient medium contains 3-6 malt extract along with 1.5% agar. It induces spores from many different species to germinate in a matter of several days. Prior to germination, all substrates are placed in autoclaves and sterilized with steam. The simultaneous germination of a large number of spores will result in the growth of monokaryotic mycelia which spontaneously combine and go on to form dikaryotic mycelia. Alternatively, one can attempt to systematically fuse selected monokaryotic strands in order to develop vigorous strains for cultivation (criteria: rapid growth, high yield). This is a standard technique that is widely used in the cultivation of champignons (*Agaricus bisporus*).

At the same time, such cross-breeding experiments enable the grower to determine whether mushrooms from different locations belong to the same species. Using this method, I was able to establish that mycelia obtained from *Psilocybe bohemica* and from *Psilocybe cyanescens* (collected in the U.S.) can never be fused together, which means that these two mushrooms are not of the same species.

The second method of cultivation requires cutting a piece of tissue from the inside of young, unopened fruiting bodies, using a disinfected knife in a sterile environment. The piece of tissue is then placed onto nutrient agar medium. In most cases, visible mycelial growth will occur within a few days. This method has the advantage of all mycelia being genetically identical to the mushroom from which they originated, unlike mycelia grown from spore samples. Therefore, this method makes it easy for the grower to reproduce high yield strains of saprophytic species. Some wild strains obtained from various species do not fruit at all when cultivated, or else, they do so very late, with a yield of fruiting bodies that is sparse at best.

Such differences in response to attempted cultivation were also observed by R. Heim with various strains of *Psilocybe mexicana* Heim. As early as 1956, he took spore sprints from a number of fruiting bodies in Mexico. Later on, in Paris, he was able to germinate the spores and isolate mycelial cultures of five different species. In collaboration with R. Cailleux, Heim succeeded at growing fruiting bodies of the species *Psilocybe mexicana*, using compost substrate as a medium. This type of substrate is the most widely used nutrient soil for commercial mushroom cultivation (champignons). The fruiting bodies grown by Heim and Cailleux provided the dried material that A. Hofmann and his collaborators used to isolate psilocybin and psilocin for the first time. In Basel, it was also possible to cultivate mycelia from different species on liquid solutions of malt extract. The mycelial tissue was found to produce psilocybin without having to go through the fruiting process.

This important discovery became the basis for harvesting large amounts of alkaloids. Unlike the fruiting process, which yielded five harvests over the course of several months, a species' mycelial cultures produced much larger amounts of mushroom tissue in only four weeks (see Figure 41). The cultures were grown on stationary malt extract (4-6%) with 0.2% agar added for increased viscosity.

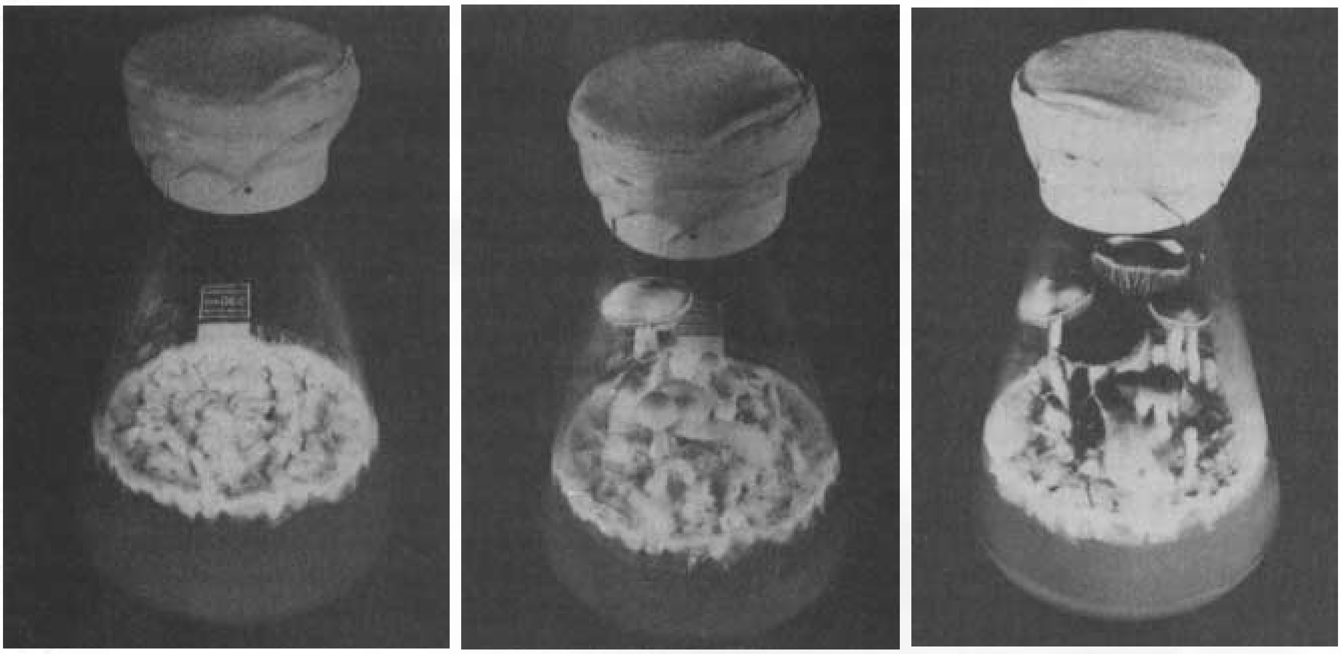


Figure 42 - One-week growth progression of ***Psilocybe cubensis*** cultivated on a malt agar (2%) substrate.

This kind of saprophytic surface cultivation can be easily adapted for growing species which are difficult to fruit under in-vitro conditions, such as *Psilocybe zapotecorum* Heim, permitting cultivation of these species for alkaloid production. Even though the mycelial tissue grown from the Mexican species contained only half as much psilocybin (0.1-0.2% of dry weight) as the mushrooms did, high yields (approximately 20g/l) along with easy and rapid cultivation of mycelial tissue more than compensated for the lower psilocybin content. It is interesting to note that mycelia from the North American species of *Psilocybe cyanescens* will turn blue and accumulate psilocybin when grown on a medium of solid malt agar, while both of these traits disappear completely when the same strain is cultivated on the type of liquid medium described above, even if levels of nutrients are identical. The reasons for this inconsistency remain a mystery.

When mycelial cultures are kept in the dark, the mycelial forms may become partially permanent (sclerotia). Sclerotia may be hardened, are largely dark to black in color and they contain psilocybin as well. The formation of sclerotia was initially observed as part of the first-ever attempt to cultivate psychotropic mushrooms on an agar medium. In 1935, H.J. Brodie reported permanent formations of bluish-green tissue while cultivating *Panaeolus subbalteatus* on malt agar.

Initially, he believed that his nutrient substrates had been contaminated by molds, because *Panaeolus subbalteatus* is a species that almost never spontaneously turns bluish-green. Figure 47 shows a distinct sclerotia formation of the species *Psilocybe semilanceata*. The formation of these permanent structures with *Conocybe cyanopus* has been described in a previous chapter (see Figure 35, p. 57).

Heim and Cailleux primarily described the fruiting of *Psilocybe mexicana* and *Psilocybe cubensis* on agar (0.05-2% malt extract) and on compost. During their experiments, *Psilocybe mexicana* produced the highest yields, while *Psilocybe cubensis* fruited quite vigorously as well. At about the same time, R. Singer had also started mycelial cultures derived from six mushroom species. Singer and his co-workers soon concentrated on *Psilocybe cubensis* in their efforts to induce fruiting. Soon after, in the early 1960s, R. L. Kneebone reported that this robust mushroom species, which thrives across subtropical climate zones, can also be induced to fruit on a rye-grain medium.

Counter-Cultural Expertise Gains Mainstream Acceptance

In the mid-1960s, *Psilocybe cubensis* became the species of choice for experiments that made use of submersed fermentation to investigate the biosynthesis of psilocybin from tryptophan and other precursors. We should note in this context that around the same time, this technique was also used to obtain mycelial pellets of the species *Psilocybe baeocystis* Singer & Smith, providing the material for the first-ever isolation of baeocystin from mushroom tissue.

From the 1970s on, a growing number of books were published in the United States that distributed information acquired by members of the counter-culture on the cultivation of psychotropic mushrooms. The scope of these books soon narrowed, with a primary emphasis on *Psilocybe cubensis*, which may be explained by the fact that, initially, only R. Heim's research results were published, thus making them available to a larger audience.

In 1971, new results were published about the champignon's ability to fruit on a rye grain medium, provided a cover layer was added on top. It wasn't long before these findings were applied to the cultivation of Psilocybe species.

By 1932, J. Sinden had already published a patent for a cultivation process that involved the inoculation of mushroom mycelia derived from champignons into horse dung compost (a medium widely used for cultivation purposes) but only after the mycelia had already grown to permeate a medium of sterilized grains. Since that time, this process has mainly been used in the production of table mushrooms, specifically, for manufacturing the spawn to be placed onto the compost without inducing fruiting on grain. *Psilocybe cubensis* fruits after about three to eight weeks on this substrate.

If a moist cover layer is added (e.g. a peat moss/lime mixture, 2:1), the yields may double. However, this process is risky, because over-saturation can render the containers non-sterile and invite contamination from bacteria and molds. Most authors prefer a mixture of rye and water that has been inoculated with mycelia from an agar culture. Still, rice, barley, wheat and other grains have also been used with varying degrees of success. Figure 52 shows that, after about five weeks, small mushrooms even grew on wet pages of a newspaper that used to be the official print medium controlled by the former East Germany's SED Party ("Sozialistische Einheitspartei Deutschlands" or "Unified Socialist Party of Germany").

Some Recent Findings

Today, *Psilocybe cubensis* is clearly one of the most easily cultivated mushroom species around and it can thrive on a large variety of substrates. Naturally occurring specimens are most often found growing on cow dung. Generally, the species tends to grow on dung and straw as a primary decomposer, but the mushrooms can also utilize nutrients previously converted by other organisms, such as various types of compost, among others (see Figure 53, p. 77).

Within the scope of this book, it is impossible to discuss all details pertaining to the fruiting process of psychotropic mushroom species. P. Stamets and J.S. Chilton are the authors of two outstanding books that deal with all the technical and practical aspects of mushroom cultivation. The psychotropic species are included along with information about many kinds of culinary mushrooms. Still, I would like to make special note of the fact that *Psilocybe cubensis* cultures benefit when horse or cow dung is added to the original nutrient mixtures, as evidenced by the mushrooms' relatively faster growth rate and the development of comparatively more robust specimens (see Figure 45, p. 71 and Figure 49, p. 74). Before adding the dung to the nutrient mixture, however, it must first be suspended in water and autoclaved, which considerably reduces the risk of contamination. Only then should the suspension be added to the rye grain substrate and sterilized once more.

In spite of numerous claims in the popular literature, most attempts by laypersons to cultivate fruiting bodies of *Psilocybe cubensis* on rye grain substrate are thwarted by the presence of contaminating agents such as bacteria and molds. Even though mushrooms are organisms that do not perform photosynthesis and thus are no longer thought of as plants, some mushroom species, including *Psilocybe cubensis*, are heliotropes, meaning they will grow toward stationary sources of light. All *Psilocybe* species examined to date require light to promote the biochemical process in the mycelia that will induce fruiting. Additional exposure to light is needed, if the fruiting bodies are to develop into normal shapes and produce spores.

Apart from a series of interesting physiological experiments performed by E.R. Badham during the 1980s, there are a few other noteworthy substrates for cultivation of *Psilocybe cubensis* fruiting bodies. For instance, we were the first to discover that a new type of plant hormone (brassinosteroids) will accelerate fruiting of the mycelia (Figure 40, p. 64). During these experiments, we were also able to completely suppress the formation of psilocybin and psilocin through high concentrations of phosphate. It is now possible to design future physiological experiments to study different hallucinogenic mushroom species under these conditions.

In recent years I have also succeeded at cultivating the European hallucinogenic mushroom species.

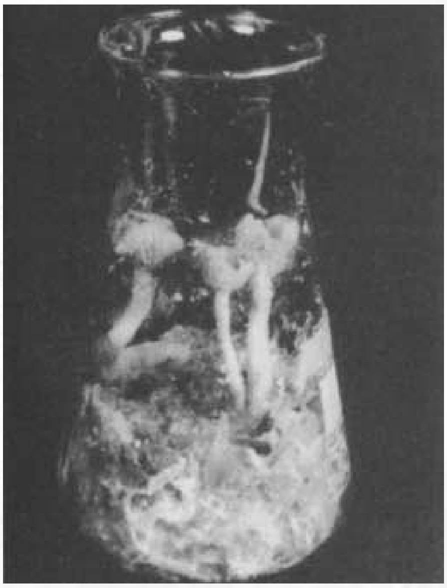


Figure 43 - ***Gymnopilus purpuratus*** fruiting on wet rice and saw dust.

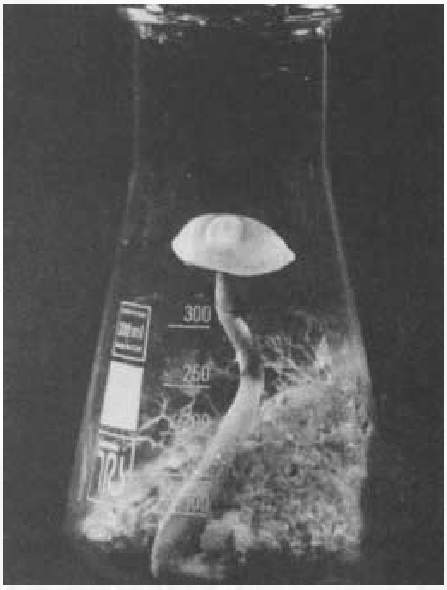


Figure 44 - ***Psilocybe bohemica*** on a rice substrate.

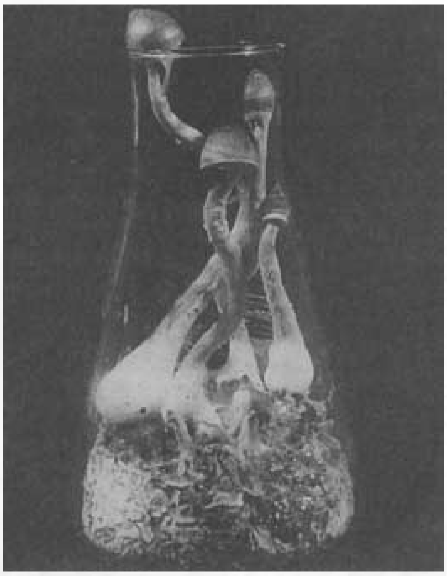


Figure 45 - ***Psilocybe cubensis*** fruiting bodies grown an a mixture of cow manure and rice.

Psilocybe semilanceata is a mushroom species whose mycelia grow at a significantly slower rate than the mycelia of *Psilocybe cubensis*, *Gymnopilus purpuratus*, *Panaeolus subbalteatus* and *Psilocybe bohemica*. Despite the fact that only a few strains of *Psilocybe semilanceata* actually fruited, cultivation of this species succeeded with different substrates. After a mycelial growth period of three to four months, the mushrooms emerged on compost (see Figure 46) as well as on a mixture consisting of grass seeds, dung, and rice (see Figure 66, p. 116). Four flushes of fruiting bodies were observed.

Panaeolus subbalteatus also fruited after 92 days on a mixture of cow dung and damp rice. The physical appearance of these fruiting bodies differed considerably from specimens of the same species that had grown on naturally occurring substrates (Figure 3, p. 6 and Figure 51, p. 76).

According to Stamets and Chilton, *Panaeolus cyanescens* is a species that does not fruit without a cover layer. However, this statement does not seem very plausible, considering the species can be found, much like *Psilocybe cubensis*, growing on top of dung under natural conditions.

Psilocybe bohemica was another species that fruited on damp rice after two or three months. These in-vitro specimens also appeared to be much hardier in comparison to fruiting bodies collected at a natural location near Sazava, Bohemia (Czech Republic). The cultivated specimens even developed two (!) rings, yet these robust mushrooms did not fruit until after an exposure to the shock of cold temperatures (see Figure 44, p. 71).

At about the same time, *Gymnopilus purpuratus* fruited on a moist mixture of rice and saw dust after six to eight weeks (see Figure 43, p. 71). In this case, however, the cultivated mushrooms turned out to be smaller than fruiting bodies that developed from fruiting mycelia on wood shavings at a location outside the laboratory

(Figure 30, p. 40).

During the 1980s, there were also reports about success in cultivating psilocybin-containing sclerotia of *Psilocybe mexicana* and its close relative *Psilocybe tampanensis* Guzman & Pollock. In both cases, the sclerotia form after three to twelve weeks, preferably in the dark on a substrate of lolium (rye grass) seeds. All strains of *Psilocybe tampanensis* originate from a single fruiting body that was found near Tampa, Florida in 1977. Sclerotia from this species have also been cultivated on a straw substrate. Compared to lolium seeds, soft rice has the advantage of not drying out as fast, so that the sclerotia will form more evenly than they would on rye grass seeds. A photograph of *Psilocybe tampanensis* sclerotia is shown on page 117 (Figure 69).

Psilocybe natalensis, which we first discovered in South Africa in January 1994 (see Chapter 7.6), is another species that easily fruits, within four to eight weeks, on compost or on straw with potting soil for a casing.

In closing, I would like to comment on the mycorrhiza problem. Due to the close interrelationship between mushroom mycelia and their symbiotic partner trees, there exists a unique exchange of growth hormones and other products - substances whose study has only just begun. For this reason, all attempts to fruit these species in-vitro have remained unsuccessful. Nonetheless, we were able to start mycelial cultures from some of these species, but in most cases, growth rates remained very slow. As a result of my own investigations, I was able to isolate sterile cultures from *Inocybe aeruginascens* (see Figure 50, p. 75), which grew and developed greenish sclerotia at the same time. The dried mycelial mass contained about 0.1% psilocybin, Figure 48 (p. 74) shows three *Inocybe aeruginascens* fruiting bodies whose mycelia grew naturally. These mycelia were found to contain no baeocystin and less psilocybin (0.05%) than the fruiting bodies shown in Figure 48.

Several months after these mycelia had been isolated from spores and fruiting body tissue samples, they began to degenerate and lost their ability to sustain growth, most likely because information available about conditions and requirements for optimal growth was insufficient.

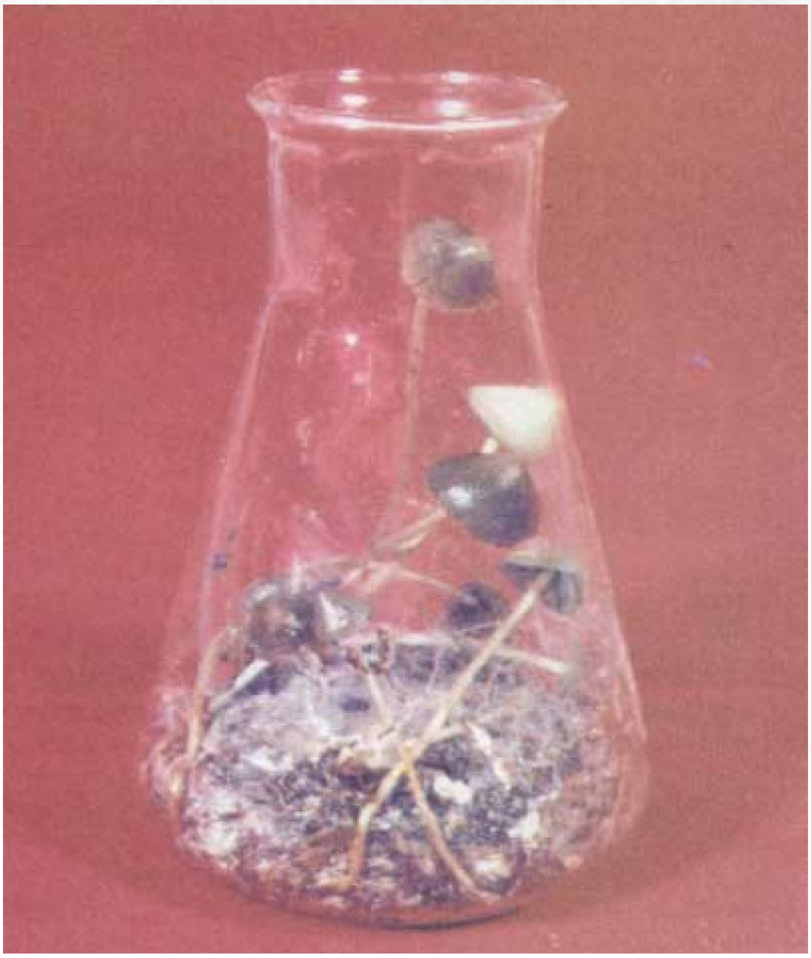


Figure 46 - ***Psilocybe semilanceata*** on compost.

Incidents of mycelial degeneration in saprophytic species have rarely been described in the literature. However, this condition can be easily prevented through usage of more than just one type of nutrient media; thus, the specific composition of a medium should be changed from time to time. In addition, only fast-growing mycelial threads (rhizomorphs) should be selected for propagation. By contrast, prolonged degeneration of strains can be caused by new inoculations of material taken from agar-based portions of mycelia whose texture is somewhat like wool. The kind of viruses known to appear in champignon cultures - where they have already caused a lot of damage - have so far not been found in cultures of the *Psilocybe* and *Panaeolus* species.

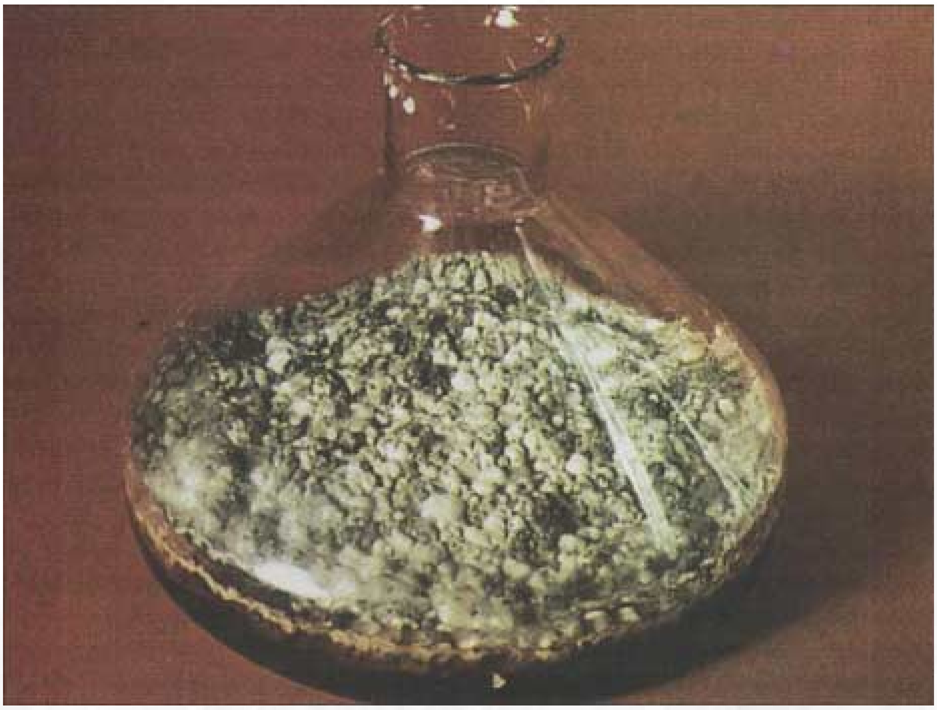


Figure 47 - Surface culture of ***Psilocybe semilanceata*** (with sclerotia formation).

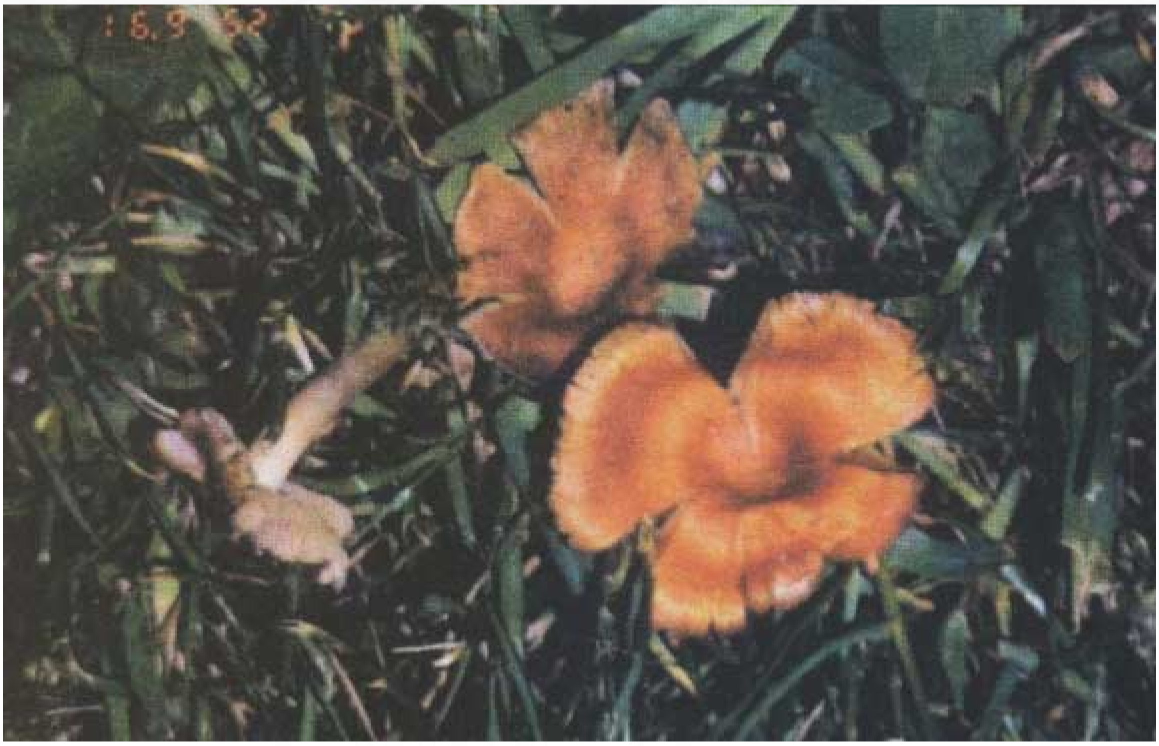


Figure 48 - ***Inocybe aeruginascens*** on grassy soil.

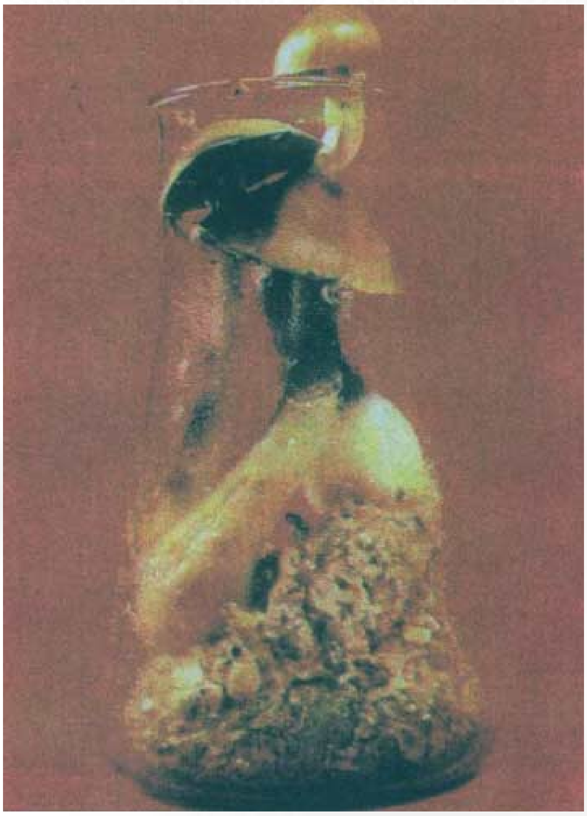


Figure 49 - ***Psilocybe cubensis*** on horse manure and rice.

It is safe to say that we currently know a great deal about the nutritional requirements of *Psilocybe cubensis*. To a lesser extent, such information is available about other species as well. Armed with this knowledge, future researchers may well discover new insights into physiology of these species, as well as the biochemical changes that occur during fruiting.

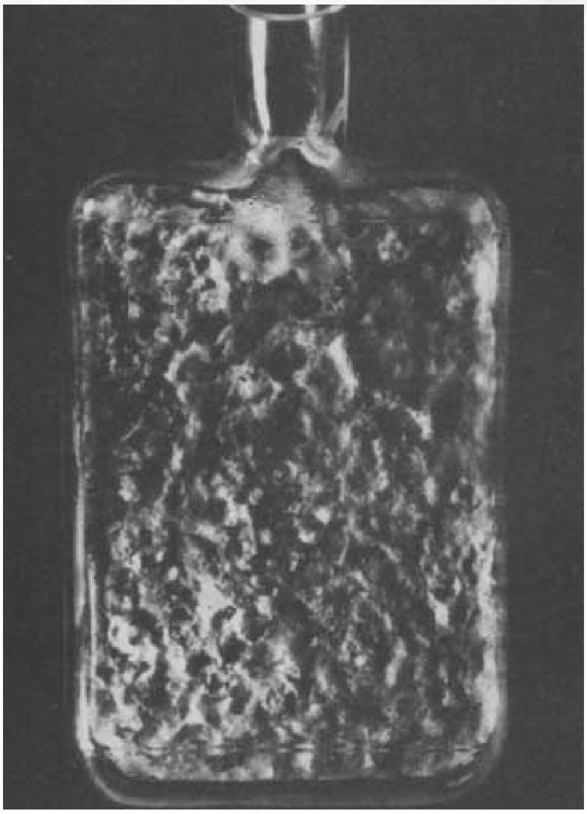


Figure 50 - Surface culture of ***Inocybe aeruginascens*** on a liquid nutrient medium.

In my experiments, it has already been established that the process of differentiation whereby mycelia are transformed into sclerotia or fruiting bodies is linked to increased production of psilocybin as well as psilocin, especially in *Psilocybe cubensis*.

Due to the relatively complex methodology and the type of equipment needed to isolate and maintain sterile cultures, it appears unlikely that cultivation of *Psilocybe cubensis* mushrooms by laypersons will significantly heighten the mushroom's popularity or widen its area of distribution anytime soon.

However, since the early 1980s, growing numbers of mycophiles in North America and Europe have successfully used "natural outdoor cultivation" to fruit *Psilocybe cyanescens* and similar species. This process involves selection of natural wood substrates striated with mycelia (rhizomorphs) that usually turn blue in response to handling. The mycelia are then transferred onto fresh wood chips or commercial mulch (not from cedar trees). After several months of growth, the mycelia fruit during the fall season.

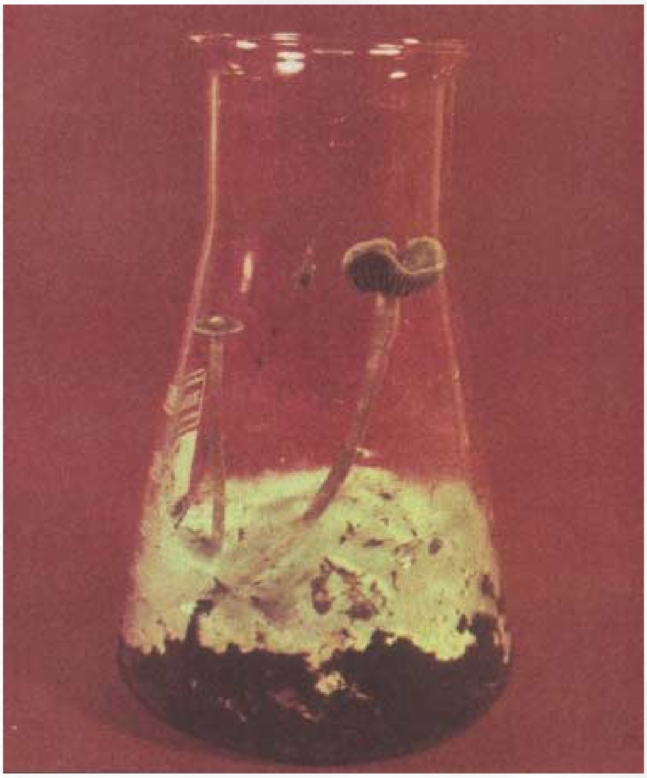


Figure 51 - ***Panaeolus subbalteatus*** on cow dung and rice.

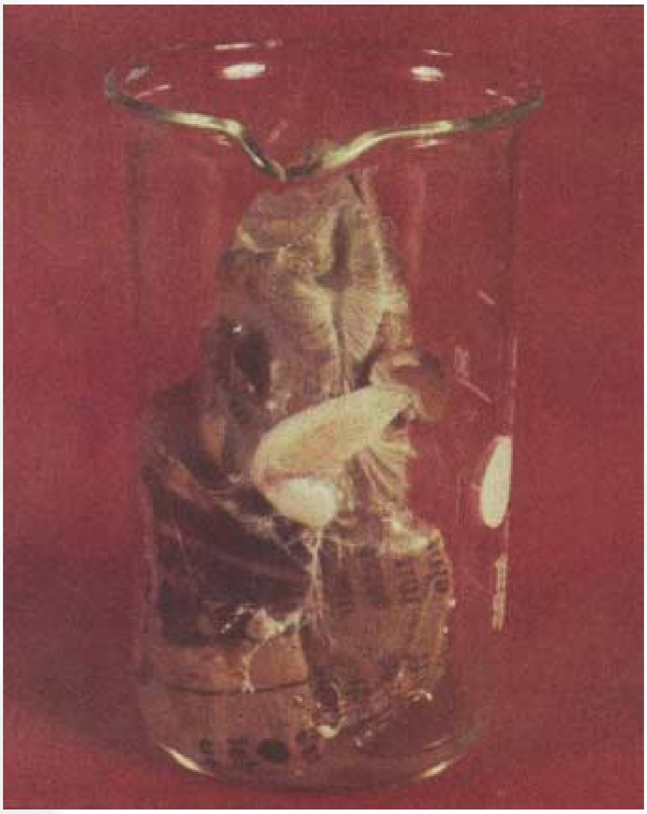


Figure 52 - ***Psilocybe cubensis*** on wet newspaper.

CHAPTER 7

Psychotropic Mushroom Species Around the World

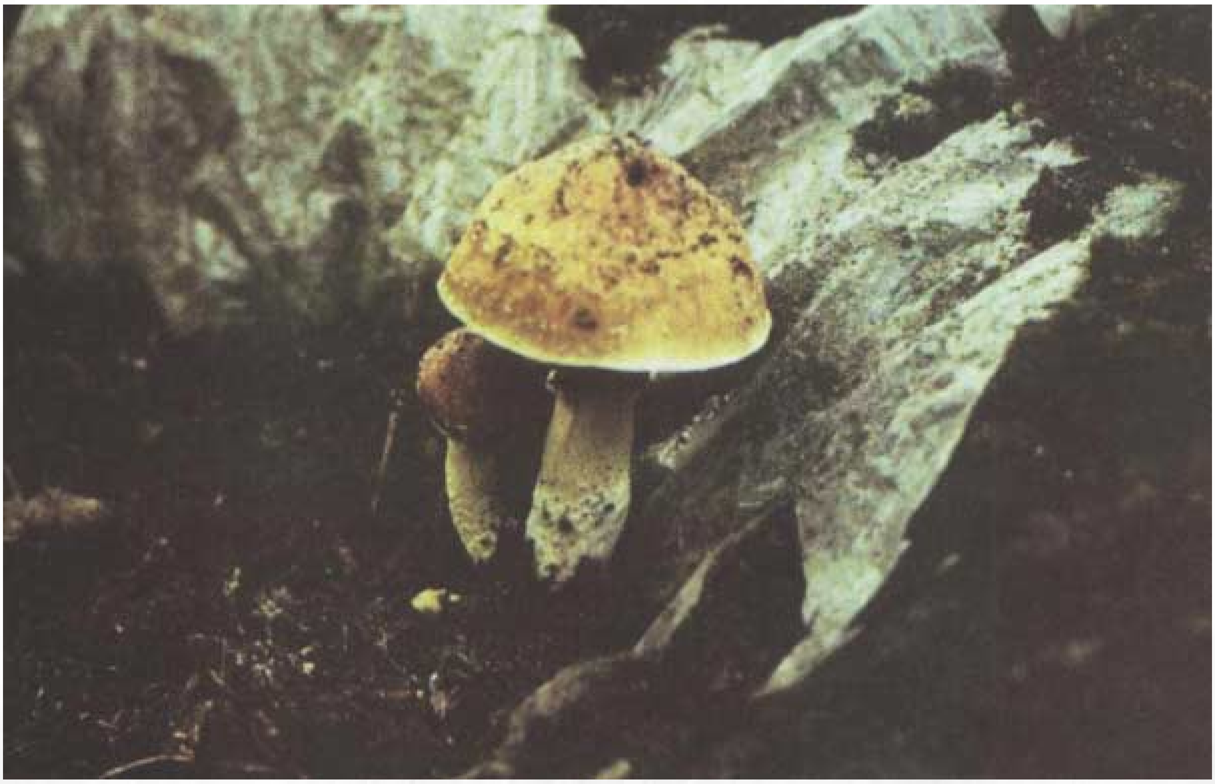


Figure 53 - ***Psilocybe cubensis*** on compost.

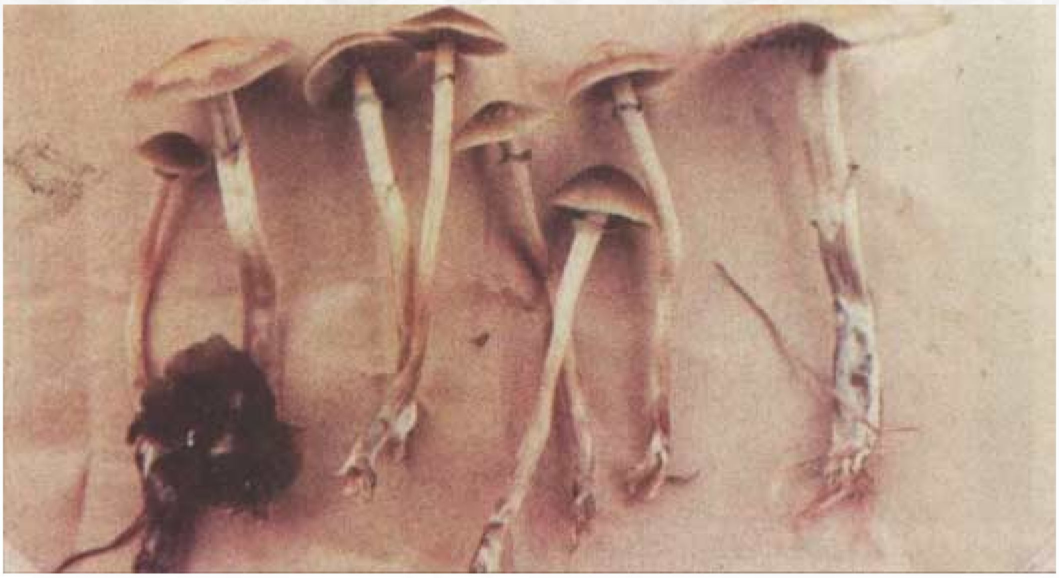


Figure 54 - ***Psilocybe stuntzii*** (grasslands variety) from British Columbia.

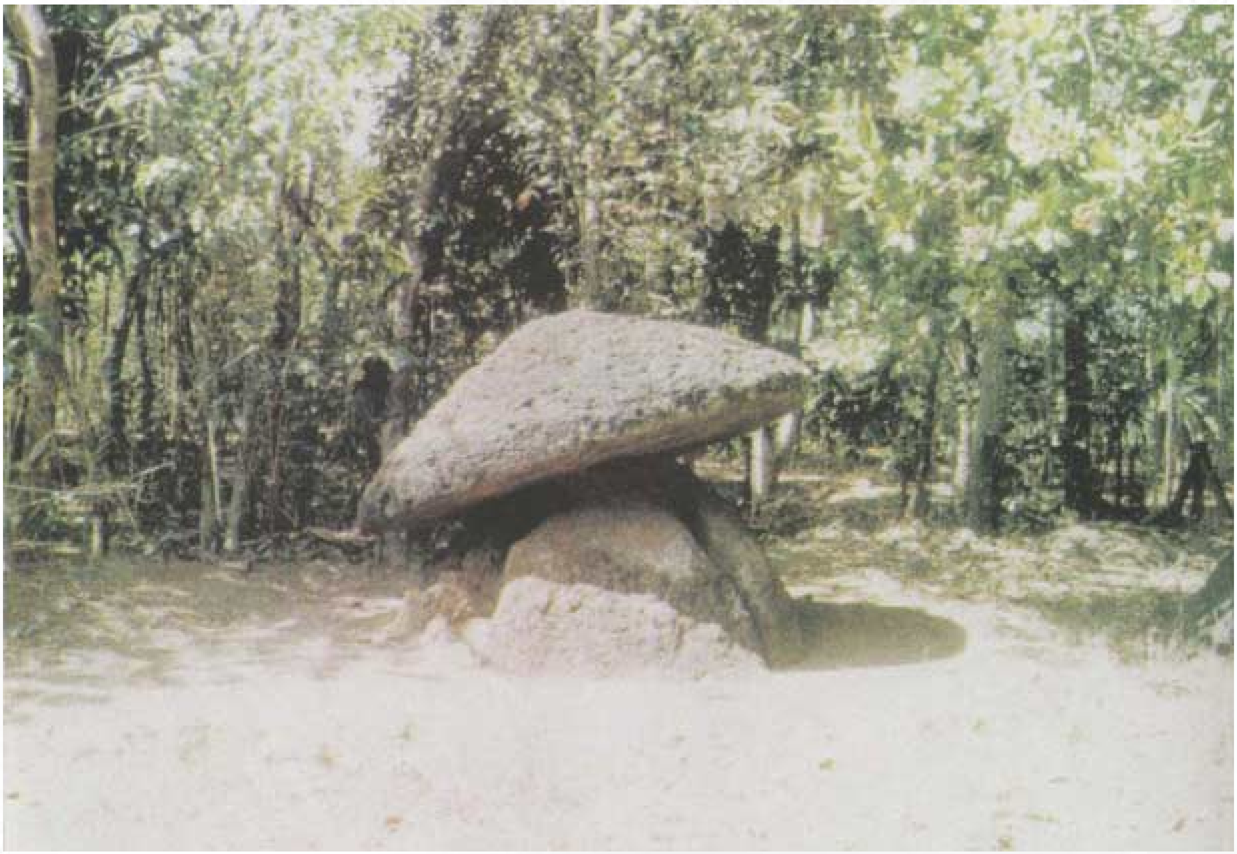


Figure 55 - Giant mushroom sculpture from Kerala, India. There is considerable debate among experts about the significance and purpose of the sculpture.

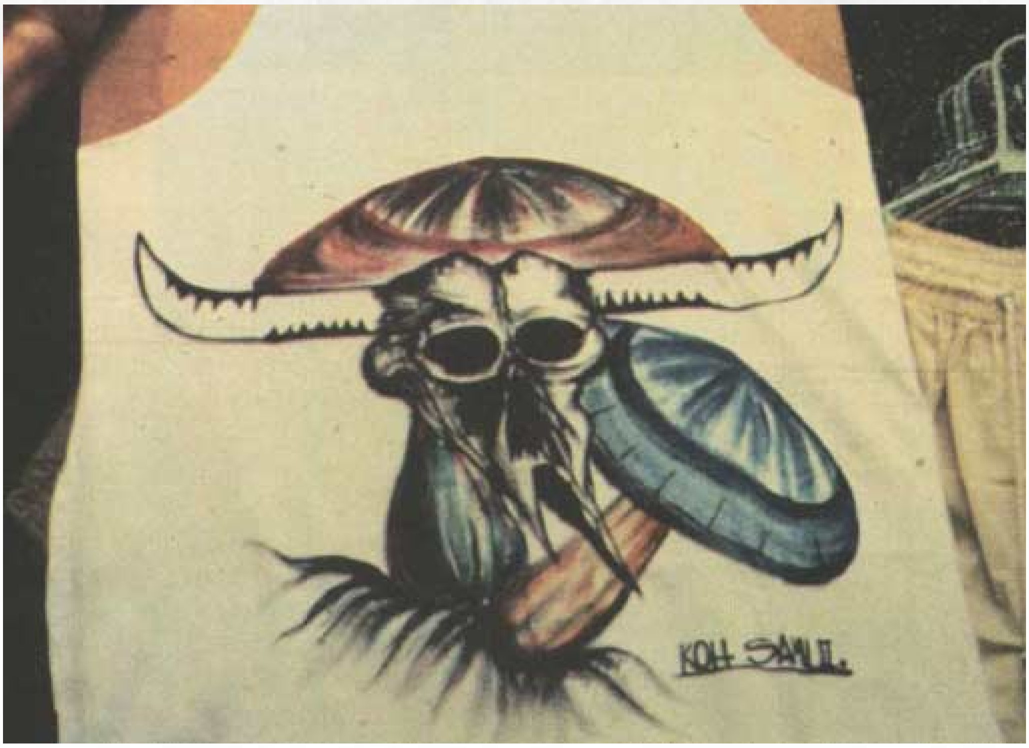


Figure 56 - Magic mushrooms & water buffalo t-shirt from Thailand, designed for the Western tourist market.

7.1 - Spotlight on North America and Hawaii

In 1961, V.E. Tyler became the first investigator to report the detection of psilocybin in *Psilocybe pelliculosa* (Smith) Singer & Smith, a North American mushroom species. One year later, two research groups, working independently, discovered psilocybin, as well as psilocin, in samples of *Psilocybe baeocystis* Singer & Smith from the Pacific Northwest region of North America. Additional chemical and taxonomic findings on that region's mycoflora have been published up to the present day. This area includes the states of Washington (USA), British Columbia (Canada) and western Oregon (USA). The region is considered a major center of psychoactive mushroom use in North America. Some areas along the U.S. Gulf states have acquired similar reputations.

In 1966, Heim and his colleagues reported that an unknown *Psilocybe* species had been confiscated in Canada. The mushrooms appeared to be very similar to *Psilocybe semilanceata*. Shortly thereafter, A.H. Smith determined that the same mushroom species was popular among students in Vancouver. It wasn't long before *Psilocybe semilanceata* was recognized as a species quite common throughout the Pacific Northwest. Moreover, the mushrooms turned out to indistinguishable from European *Psilocybe semilanceata* samples.

The Spread of *Psilocybe semilanceata*

From the late 1960s onward, *Psilocybe semilanceata* usage increased, particularly in areas between the Pacific Ocean and the Cascade Mountains that range from Southern Oregon north to British Columbia. It is likely that during these years, Tom Robbins's popular book "*Another Roadside Attraction*" significantly contributed to the mushroom's increasing popularity. Today, *Psilocybe semilanceata* is the most widely used species in the Pacific Northwest, and its habitat is expanding into pasture lands east of the Cascade Mountains.

As in Great Britain, the mushroom is referred to as "Liberty Cap" in the United States. *Psilocybe semilanceata* has the reputation of being one of the most potent species without generally causing unwanted physical side effects (also see Chapter 3.1). As indicated in previous chapters, recurrent claims about different types of effects from different psychoactive species should be systematically studied, including comprehensive biochemical analyses. These research efforts will likely uncover new biodynamic ingredients.

Another factor that accounts for different types of effects is the variability in levels of alkaloid content. In the course of casual experimentation it is also not uncommon for a number of expectations to become self-fulfilling. The assumption that *Psilocybe baeocystis* (see Figure 72, p. 119), a strongly bluing species, causes a comparatively larger number of physical problems than other species is undoubtedly rooted in the mushroom's "reputation" as being the only *Psilocybe* species to date responsible for the only known fatality involving *Psilocybe baeocystis* - a child who died after eating some of these mushrooms (see Chapter 8 for more details on this incident).

Psilocybe baeocystis primarily grows in inland areas of the Pacific Northwest, on top of wood debris and on lawns in parks. It is a species that can often be found and collected on school and university campuses. *Psilocybe pelliculosa*, a mushroom mentioned in previous chapters, is a species also known as "Liberty Cap". Macroscopically, it is extremely difficult to distinguish from *Psilocybe semilanceata*. Unlike the latter species, however, *Psilocybe pelliculosa* will grow in forests on wood chips and sawdust.

Beug and Bigwood were able to furnish analytical proof in support of the claim that *Psilocybe pelliculosa* is weaker in its psychotropic effects than comparable species. *Psilocybe pelliculosa* contains about 30-50% of the amount of psilocybin found in *Psilocybe cyanescens* (slang names: *Blue wavy, Cyan, Grandote*), a species common across the Pacific Northwest. It fruits primarily in parks, forming partial fairy rings. This species did not become popular among users until the mid-1970s.

A New Psychoactive Mushroom

Several additional *Psilocybe* species have been found in the Pacific Northwest, even though the taxonomic classification of most of these species remains inadequate, despite the fact that monographs such as those by P. Stamets offer quite detailed descriptions of the psychotropic mycoflora. In the mid-1970s, Guzman and Ott reported a rather spectacular event concerning the spread of a "new" mushroom species. During the fall of 1972, large numbers of a strongly bluing gilled mushroom with a distinct ring pattern were found at the University of Washington in Seattle. The fruiting bodies were found growing on bark mulch, which came from a central distribution point and which had been spread widely across the campus by gardeners. Due to the bluing reaction, students at the university assumed that the mushroom contained psilocybin, a belief that was confirmed later on. The sudden appearance of massive numbers of fruiting bodies quickly inspired students at the university to use the mushrooms as a hallucinogen.

In my opinion, it is still uncertain if the mushroom really appeared spontaneously, or whether it fruited on bark debris simply because the substance had previously been mixed with spawn derived from fruiting bodies that originated elsewhere.

In any case, in 1976, the mushrooms were named *Psilocybe stuntzii* Guzman & Ott (slang name: "blue veil" or "stuntzees", (see Figures 54 and 71). Today, the species can be found growing on bark and on lawns in parks, on golf courses, football fields and gardens in numbers so large that it is considered the second most important species in terms of usage, after *Psilocybe semilanceata*. In addition, *Panaeolus subbalteatus* is another regionally important mushroom species (slang name: "red cap"), even though its users believe it to be slightly more poisonous than the *Psilocybe* species. Still, the mushroom is used quite frequently, because it begins to fruit during the spring. The *Psilocybe* species, on the other hand, do not appear until fall and continue to grow into early winter, when temperatures consistently drop below freezing, which inhibits further fruiting of the species. Under favorable conditions, only *Psilocybe stuntzii* can fruit year-round, even though this species still fruits most abundantly in the fall.

Mushroom Trips as a Popular Sport

In 1977, J. Ott estimated that several tens of thousands applied dosages of psychotropic mushroom material are harvested and used each year, particularly in the Pacific Northwest. Despite these quantities, there have never been reports of fatalities or serious physical damage as a consequence of using the *Psilocybe* or *Panaeolus* species. Local papers merely mentioned occasional panic reactions that subsided as soon as the acute effects of the mushrooms had worn off.

The usage of psychotropic mushrooms in the United States tends to cluster geographically in areas that are considered mushroom Eldorados. For example, the city of Redmond, WA used to be known as the "bicycle capital". Since 1978, several newspapers have renamed this city the "psilocybin capital".

Since the late 1960s, the usage of *Panaeolus cyanescens* and its closest relatives has become fashionable in Hawaii, even though the taxonomic differentiation of the *Panaeolus* species from each other is extremely difficult. There were initial attempts to preserve the fresh mushrooms by freezing them with dry ice (solid carbon dioxide) for export to the Pacific Northwest and Southern California. Apparently, these entrepreneurs were unaware of the fact that psychoactive ingredients will remain stable, as long as the mushrooms are dried and stored at temperatures below 50°C (122°F). Such export efforts were soon abandoned, because freezing the mushrooms turned them to mushy pulp that was difficult to transport. In addition, several local species had been discovered in the Pacific Northwest. During the early 1970s, fruiting bodies of the *Panaeolus* species preserved in honey began to appear on the black market in Hawaii and, on occasion, in North America. Again, this method fell short, because mushrooms could be preserved for only short periods of time.

Panaeolus subbalteatus grows in several areas in the Hawaiian Islands, but it is used less frequently than other *Panaeolus* species. Even though one often hears about "Hawaiian strains" of *Psilocybe cubensis*, the species is not native to The Islands and should grow there only under conditions of artificial cultivation. Any spawn used for cultivation, however, must have been isolated from fruiting bodies that originated elsewhere. In Hawaii, the extent of adverse reactions was also limited to a few panic reactions observed in recreational users who had ingested mushrooms of the species *Panaeolus cyanescens*. In 1972, an apparent fatality was definitely not caused by ingestion of mushrooms, but instead was most likely the consequence of a heroin overdose, as reported by J. Allen, who has researched this incident extensively.

The legislatures in North America and Hawaii do not pay very much attention to the usage of psychoactive mushrooms. The identification of species is often quite difficult, so that police enforcement activities primarily target misdemeanors such as parking violations and the willful destruction of fences around pastures. The latter is not uncommon during attempts to force entry into areas where *Psilocybe semilanceata* can be found.

In December 1979, the High Court of British Columbia ruled that the Canadian Narcotics law prohibits psilocybin only in its pure form, whereas mushrooms containing the alkaloid as a natural ingredient are exempt from the law. This decision seems both realistic and reasonable, considering the substantial, uncontrollable spread of these mushrooms and an ongoing battle against truly addictive drugs that requires all available efforts and resources.

Even though the extent of prosecution of drug law violators in Canada and the U.S. varies from state to state, psilocybin-containing mushrooms are only a minor factor in the overall "war on drugs". In California, however, mushroom cultures are illegal, as well as spore prints (!) from the *Psilocybe* species. Spore prints, however, are impossible to control. *Psilocybe cubensis* is common across the South, and *Panaeolus subbalteatus* grows across the Southwestern U.S., where the mushrooms are used extensively. By one estimate, there were 100,000 "Magic Mushroom People" in the state of California alone, a number likely to be much higher today. The demand created by this growing market is probably being met through cultivation of *Psilocybe cubensis*. These users ingest psychotropic mushrooms as a form of recreation, or incorporate them in the ritual practice of natural mysticism. Other users prefer mushrooms as an aid to meditation or to attain communication with the realm of the divine. Regardless of motivation, users tend to lead secluded, self-sufficient lives in close proximity with Nature. Across North America, the total number of magic mushroom consumers is likely close to one million, quite possibly higher.

By the early 1980s, prominent experts in the field had estimated that the number of hallucinogenic mushroom users in the United States outnumbered LSD users for the first time, a trend that went hand in hand with a rise in environmental awareness. In this context it is interesting to note that the Drug Abuse Warning Network (DAWN), which collects data from throughout the United States, documented only 31 cases of clinical interventions for usage of psilocybin-containing mushrooms in 1982. In some of these cases, the mushrooms were used in combination with other substances, confusing the pharmacological picture. In comparison, LSD was involved 1,498 times, while marijuana was cited in 5,295 cases. It should be noted that the high number of marijuana cases cited appears inflated and suspect, in light of data from other studies.

It is interesting to note that T. Leary's psilocybin experiments during the early 1960s provoked severe reactions of a moralistic-puritan nature, while medical reports about prolonged psychoses and other such side effects did not appear until the "LSD era" some years later.

North America's mushrooms offer many opportunities for additional taxonomic work and many more still remain to be discovered. To illustrate, a new mushrooms species was recently reported from Oregon. The mushroom, *Psilocybe* azurescens Stamets & Gartz is unusually large and very potent due to its high psilocybin content. North America's rich mycoflora, particularly in regions of wet climates in the eastern and midwestern United States is wide open for further research efforts that may well yield valuable and amazing new results.

As early as 1909, Murrill described "*Inocybe infida*", a mushroom with "narcotic" effects from New York. In 1911, Ford named "*Inocybe infelix*" as a species that also caused strange effects, without inducing symptoms of muscarine poisoning. These descriptions immediately bring to mind the psilocybin-producing fibreheads, even though visionary experiences are not expressly mentioned.

In the future, we should expect an increase in usage of local, psychoactive species from locations across the U.S. and Canada.

7.2 - Mycophilia in Central and South America

Compared to the time of Wasson and Heim's discovery, recent decades have brought significant changes to several regions of Mexico in terms of how local Indians relate to the psychotropic *Psilocybe* species. In many remote parts of the country, mushroom cults still exist in their specific contemporary forms which combine Christian views with elements from pagan and pre-Christian Nature religions.

By contrast, in other parts of the country, mushroom rituals have fallen into disuse in the wake of interaction with Mexico's "modern life" and its tourism industry. When Guzman investigated the taxonomy and geographic distribution of *Psilocybe aztecorum* Heim in 1978, he noted that several active "curanderas" had been the focal point of sacred mushroom worship 20 years earlier. Today, the next generation of Indians no longer ingest the mushrooms and consider the hallucinogenic species to be nothing but a popular trading commodity for Western tourists.

Starting in the 1960s, large numbers of young people from industrialized nations ("hippies") began to visit the centers of mushroom worship as tourists, favoring the state of Oaxaca. They came mostly from the United States, and initially their main destination was the village of Huautla de Jimenez, to visit Maria Sabina, who guided R.G. Wasson during his first mushroom session in 1955. To the extent that magic mushrooms have been labeled "fool's mushrooms" or "joker's mushrooms" in Europe, it is interesting to note here that Maria Sabina herself repeatedly referred to the mushrooms as "clowns" and called herself "chief of the clowns" or "lord of the clowns". In Mexico, magic mushrooms are also known as "mushrooms of pure laughter".

Today we know that this run on Mexico's mushrooms helped destroy the cultural identity of the native Indians, causing discontent and rising crime rates in several villages. Self-appointed "curanderas", with no traditional roots, presided over mass ceremonies with magic mushrooms. Participants who had panic reactions did little to ease tensions among the local population. Finally, the police and the army were called in to put an end to the resulting turmoil. Mushroom tourism in Mexico dropped off rapidly, especially after similar species were discovered in other countries. Despite legal prohibitions, however, various *Psilocybe* species are still being sold to tourists in some areas of the country today. This phenomenon is not limited to Mexico. In the mid-1970s, Lowy reported from Guatemala that Indian children near the capital city were offering *Psilocybe mexicana* Heim for sale to foreigners, a trading practice that has been observed in other parts of the country as well.

Experts on bluing gilled mushrooms, who traveled to South America and the Caribbean, discovered several psychotropic species (e.g. *Panaeolus cyanescens* in Jamaica), even before mycological research established the existence of these species. According to those few scientific publications on taxonomic identity, the two most commonly used species are *Psilocybe cubensis* and *Panaeolus cyanescens*. Around 1970, tourists who had previously been looking for *Psilocybe* species in Mexico learned that they are abundant among Colombia's mycoflora as well. Consequently, knowledge about these mushrooms spread quickly among Colombian youngsters, possibly as a result of Central America's Indian tradition. Thousands set out in search of these species in and around their areas of residence. Special communes were formed, situated in idyllic regions of the Andes Mountains. The most famous among them was known as La Miel ("honey"). *Psilocybe cubensis* and the *Panaeolus* species were also found to be common across those regions of Amazonia where Colombia, Peru and Brazil share common borders. The archaeological park at San Augustin near Bogota has been dubbed "heart of the magic mushroom land". These species have also been used in Peru. During the 1980s, road side signs proclaiming "No To San Ysidro Drugs!" were a common sight. The slogans referred to *Psilocybe cubensis* under an old name. South America's problems, however, cannot be solely blamed on the ingestion of indigenous, non-lethal mushrooms. Socio-economic problems are rooted in poverty and destitution, epidemics, civil warlike conditions in some parts, as well as the rampages of the cocaine mafia. Today, Argentina and Brazil are two countries where magic mushroom use is still common. In 1975, Pollock reported the practice of mixing a drink from milk, honey, bananas and magic mushrooms.

In terms of interdisciplinary research in Central and South America, there remains the vast challenge of uncovering additional clues about ritual usage among early cultures, coupled with efforts to trace and analyze more recent kinds of uses. Chapter 3.5 already included one historic account of magic mushroom use several centuries ago. A large number of golden pendants in a variety of mushroom shapes have been found in

Colombia, suggesting that magic mushrooms have been used there for centuries. At the same time, research into the taxonomy and chemistry of South American psychotropic species has barely just begun.

7.3 - Australia's Mycoflora Attracts Attention

In 1934 J. Cleland publicized the existence of 12 mushroom species of the genus *Psilocybe* in South Australia. Up to that time, there had been no accounts about psychotropic intoxications from the fifth continent.

Cleland was probably the most renowned Australian mycologist of the 20th century. As early as 1927 he had already described a new species named *Psilocybe* subaeruginosa. This mushroom grows in New South Wales, Victoria and South Australia and turns bluish-green with age or in response to pressure. During the 1940s several accounts surfaced which detailed a series of "hysterical psychoses" caused by *Panaeolus ovatus* Cke. & Mass. (also see Chapter 3.3).

In 1958, Aberdeen and Jones described the geographic distribution of *Psilocybe cubensis* across the southeastern valleys of Queensland and New South Wales. They speculated that this was the mushroom responsible for the cases of intoxication, not the *Panaeolus* species. They proposed this hypothesis, because the mushrooms in question were thought to have been champignons, who resemble the fleshy *Psilocybe* species much more closely than any of the *Panaeolus* species. In addition, the *Psilocybe* species had been described as being much more common in the area. Under wet climate conditions, the *Psilocybe* species can be found growing in abundance on cattle dung, especially along the sunshine coast of Queensland, in the open valleys around Brisbane and in areas that used to be rain forests, but have now been transformed into pastures. It is quite likely that the species was brought into the country by its early settlers. It wasn't until the early 20th century that land in Australia's subtropical and tropical regions was converted into pastures.

Today, it is generally thought that the mysterious *Panaeolus ovatus* species was, in reality, *Panaeolus cyanescens*.

It wasn't until the early 1970s that the latter species was identified. Soon after, the *Panaeolus* species were recognized as being very common throughout Northern and Southern Australia.

Despite the widespread geographic distribution of psychotropic species in Australia, there were only a few efforts to publish information about their chemical composition. In 1970, Picker and Rickards reported the isolation of 0.45% of psilocybin from dried fruiting bodies of *Psilocybe* subaeruginosa, but failed to find any psilocin in that sample. Later on, other authors reported only about one-tenth of this amount of psilocybin, a number that I believe to be too low, considering reports about the mushrooms' strong psychoactive effects.

Psilocybin was also found in Australian samples of *Psilocybe cubensis* (see Figure 2, p. 5), while *Panaeolus cyanescens* was reported to contain psilocybin, along with even higher levels of psilocin and serotonin as well.

Starting in the late 1960s, popular, widespread usage of psychotropic mushrooms began to catch on in Australia. At the same time, these accounts of mushroom use were the only comprehensive reports that originated in a country other than Mexico.

In the summer of 1969, a 4,000-hectare-region near the coast of Queensland gained notoriety because of its *Psilocybe cubensis* crop that grew there after the rainy season. Interested collectors flocked to the area in droves. Media reports at the time gave the impression that the mushrooms were an entirely new discovery, completely disregarding Central American traditions. *Psilocybe cubensis* conquered the black market, where the mushrooms were sold for about U.S.$1 per fruiting body. In the wake of an above-average rainy season, the species fruited so abundantly that special transportation companies were founded for delivery of the mushrooms to Australia's large cities.

However, even here the mushrooms did not grow in heaven: the epidemic subsided somewhat, and the usage of psychotropic mushrooms became endemic across all of Australia. On May 8, 1971, the governor of the conservative state of Queensland prohibited possession of *Psilocybe cubensis* and the species fell under the same legal guidelines as *Cannabis sativa* (hemp) and *Papaver somniferum* (opium poppies).

Still, usage of the *Psilocybe* species continued, despite harsh penalties for possession and use (a total of 74 individuals were sentenced in 1972, and 27 in 1973).

Also, those interested in mycological field research continued to study *Psilocybe* subaeruginosa and even discovered the species in the northern part of the country. Like *Psilocybe cubensis*, this species is also known by the colloquial name of "gold top", whereas *Panaeolus cyanescens*, a species that wasn't discovered until later, acquired the nickname "blue meanies" within the counterculture (an expression that refers to a collection of several fruiting bodies). It is likely that these mushrooms were named after the small blue men featured in the classic psychedelic Beatles movie "Yellow Submarine", which was released in 1968.

In colloquial Australian English, "mushies" is a commonly used short form for "mushrooms".

Next to fresh mushrooms, "processed" preparations also began to appear on the black market: In Hobart, Tasmania, for example, dried and ground up mushrooms packaged in gelatine capsules were sold for $6 a fruiting body. The availability of mushroom-based hallucinogenic substances drastically reduced the market share of LSD, which was generally a lot more expensive. By 1972, LSD had almost disappeared from the black market.

Based on Southcott's (1974) writings, it is likely that the unpleasant taste of fresh specimens of *Psilocybe cyanescens* was the main reason for the processing of the fruiting bodies.

Bizarre Reactions

Considering the widespread use of psychoactive mushrooms in Australia, there were only a handful of reports about medical complications, amounting to only minor complaints from a few individuals. Symptoms were almost exclusively limited to panic reactions due to excessively high doses. These reactions were precipitated by bizarre psychic sensations, which the person was unable to integrate. *One 17 year old teenager, for example, developed a panic reaction when she suddenly felt like a banana that was being peeled* (Southcott). In all cases, symptoms disappeared within several hours as the psilocybin wore off. While a few cases included complaints such as stomach cramps and kidney pain, these symptoms are not characteristic of the *Psilocybe* species and their relatives. It is likely, that other, poisonous, mushrooms, such as muscarine-producing species, were to blame for these syndromes.

I would like to close this chapter with a report from an Australian mushroom lover, who illustrates the reasons and circumstances of psychoactive mushroom use in Australia (Southcott).

Report about the effects of a "gold top " mushroom:

> *The mushrooms which were prepared in a broth and boiled for about two minutes may be used to induce an extremely powerful hallucinatory trip. When eaten raw, the effects can take up to two hours to come on, but taken in soup form they can begin to occur within five to ten minutes of being eaten. The first noticeable effect is a tingling sensation from head to toe, followed by extreme warmth or cold throughout the body. Mild hallucinations begin to occur within a quarter of an hour and become stronger as the trip reaches its peak. This peak can be a terrifying experience for the novice; individuals may not know what to expect and may believe they have gone insane. In many cases, this "insanity" can also be pleasurable and can cause a person to lose all fear of things which had previously seemed impossible to bear. Everything material and otherwise is laid out in front of you for examination and nothing is beyond human comprehension. In my opinion and experience, these mushrooms, when used by persons capable of understanding the tremendous power contained within them, can only be beneficial in their effects.*
>
> *I have found them (Psilocybe subaeruginosa - Southcott) growing in flatbottomed valleys and on gentle slopes. They thrive in moist, grassy soil and can range in size from a quarter of an inch up to two or three inches in diametre. In regard to an overdose of these mushrooms, this user feels that it is not really an accurate term for this condition. It is more an extreme fear of certain things or people that causes "freak-outs". The trip can change from one of fear and hysteria to one of pure ecstasy in a matter of a second, if a person is treated correctly. The police, in my opinion,*

> *are the cause for more bad experiences than all other factors combined. I myself have almost lost all fear of everything I previously dreaded. I intend to continue the use of these mushrooms and see where it leads me, whether it be a good (lawful) or bad thing....*
>
> *Description: The mushrooms (Psilocbe aeruginosa Southcott) have caps colored yellow to dark brown on top, and cream-colored to almost yellow underneath. If picked fresh, the stem and parts of the cap will turn green and blue or sometimes violet. This discoloration does not occur until after the mushrooms have been picked.*

7.4 - European Customs and Conventions

The first report ever published in a scientific European journal about usage of *Psilocybe semilanceata* in Europe was written by M. Carter and appeared in *New Scientist* in September 1976.

"Mushrooms Are Mushrooms"

The mushrooms quite suddenly emerged in the spotlight of public attention in 1976, when Judge Blomefield of Great Britain's High Court handed down a verdict of "not guilty" in the trial of a man accused of possession of psilocybin in the form of dried fruiting bodies from the species *Psilocybe semilanceata*. According to Carter's report, the acquittal was justified as follows: "*Psilocybin is a chemical and mushrooms are mushrooms*". In the wake of this decision, however, a few individuals in Britain were nonetheless sentenced for possession of psilocybin, because the British legal system is based on the principles of common law, which means that the High Court decision was not necessarily binding in cases that went to trial in lower courts after the man had won his acquittal in the High Court.

Despite its Celtic ancestry and the practice of Nature religions, England is among those countries whose population has traditionally been quite mycophobic in its attitudes toward mushrooms, which have always been thought of as poisonous, slimy and moldy. It is therefore quite remarkable that these values appear to be changing with the current younger generation. Could it be that England's Celtic heritage is making a reappearance after centuries of dormancy?

In 1978, C. Hyde and his collaborators reported several cases of voluntary intoxications with *Psilocybe semilanceata* from a medical perspective, describing symptoms experienced by mushroom collectors that range from typically visionary experiences to the manifestation of acutely delirious states. The authors emphasized that the mushrooms were well-known within the hippie subculture of Manchester. Thirty to forty *Psilocybe semilanceata* mushrooms were considered an appropriate dose to attain a fully hallucinatory state.

According to British users, the effects of *Psilocybe semilanceata* include intense visuals without any of the negative feelings that may be caused by LSD. British colloquial names for the mushroom are quite poetic, such as:

- Liberty Cap
- Magic Mushroom
- Blue Legs
- Pixie Caps

Contrary to common opinion, "liberty cap" is not a new name, since M.C. Cooke mentioned it in his writings that date back to the 19th century.

Due to the widespread distribution of this *Psilocybe* species across England, particularly Scotland and Wales, *Psilocybe semilanceata* appears to be more popular in England than in any other European country, with the possible exception of Norway. This is an opinion echoed in numerous scientific and medical articles published on the subject in Great Britain. In my opinion, these publications contain the most detailed descriptions of casual use of psilocybin-containing mushrooms species by laypersons anywhere in the world.

One analysis by P.R. Mills and his collaborators described seven Scottish patients with symptoms caused by ingestion of *Psilocybe semilanceata* mushrooms during the fall of 1978, when the species fruited abundantly in the Glasgow area after heavy rainfall. Four of the seven men had eaten no less than one hundred mushrooms each, which meant they had taken about 50 mg of pure psilocybin a person. It is not surprising, then, that such dosages should cause visions that lasted several hours, along with marked somatic symptoms.

Mega Mushroom Festival

While there is talk about "hippies" in the report from Manchester, a 1980 newspaper article from Wales describes a "new kind of gypsy", whose exploits included a mushroom celebration near Cardiff with 100 participants. The occasion was the discovery of yet another bumper crop of *Psilocybe semilanceata* in that area. Nineteen of the revelers felt so seriously ill they had to seek medical treatment.

It appears that in the early days of mushroom usage in Great Britain, massive amounts of *Psilocybe* mushrooms were consumed on several occasions, which caused a higher number of panic reactions than elsewhere in the world.

However, it is clear from articles published in medical journals that these cases were merely "the tip of the iceberg", that is, they were a small group of users whose reactions to the acute stages of mushroom intoxication attracted attention because they included clinically relevant symptoms such as states of pathological depression with no recognition of surroundings.

In an attempt to describe patterns of usage of the *Psilocybe* species in the Tayside area near Dundee, Scotland, N.R. Peden and his collaborators found that the typical user was much younger there than in Manchester or Wales. The authors examined 27 patients, whose ages ranged from 12 to 24 years. I have previously cited accounts about accidental intoxications indicating that children can have abnormal reactions to psilocybin, such as cramps or loss of consciousness. Teenage use of hallucinogens and other psychoactive substances, including alcohol and nicotine can have disastrous consequences.

The results of a survey at two Scottish schools of 59 children aged 14 to 15 years revealed that 66% of them had already heard about the mushrooms' effects. Also, a paper published by R.E. Young and his research team in 1982 found that the mushroom users in the Glasgow area as a group are quite young. In 1981, these researchers treated 49 children and adults aged 12 to 28 years. These authors are correct in pointing out that the mushrooms cannot be eradicated due to their large area of distribution. At the same time, however, they demand that fungicides be sprayed on mushroom fruiting areas that are easily accessible!

This is a baffling and incomprehensible proposition - to acutely endanger all residents of a certain area by exposing them to poison, simply because there were a few mild cases of mushroom intoxications, with symptoms that soon disappeared. If anyone is to blame, it is the users for their carelessness and recklessness. Fortunately, these crypto-schizophrenic proposals were never implemented.

On the other hand, there are interesting statistics available from the poison center in London, about reported cases, where medical attention was required following ingestion of *Psilocybe semilanceata*. The numbers below show how many people received therapeutic treatment in Great Britain in a given year:

1978 - 33
1979 - 47
1980 - 96
1981 - 142

The average age of the mushroom collectors was between 15 and 19 years. Reports mostly came in during September and October of each year, which corresponds to the mushroom's fruiting period. Cases that were reported during other months of the year had been caused by ingestion of dried mushroom material.

In 36% of these individuals, the mushrooms caused significant visual distortions and visions. Five people acted aggressively without experiencing perceptual alterations. Dosage varied from half a mushroom (effects?) to up to two or three pounds. If the latter amounts have been reported truthfully, those individuals ingested about 1 to 1.5 g of pure psilocybin, assuming an alkaloid content of 0.1% in fresh mushrooms. However, in cases where whole mushrooms had generally been eaten according to the Mexican tradition, liquids removed via stomach pumps largely contained whole mushrooms. Failure to carefully chew the mushrooms before swallowing means that only a fraction of the available amount of alkaloids is extracted from the mushrooms and absorbed by the body.

Panic Reactions

In cases when intoxications were caused by eating 'normal' amounts of mushrooms and the ingestion of potentially deadly species could be excluded, pumping the patients' stomachs turned out to be a procedure that was both too drastic as well as unnecessary. In younger, hyper-suggestible patients, the procedure can precipitate extremely aggressive behavior. In addition, it often doesn't work, because the mushrooms tend to clog the pumping apparatus.

Therefore, panic reactions after ingestion of *Psilocybe semilanceata* is a condition that, in some cases, may be aggravated or even induced by improper treatment of the patient at hospitals and clinics. After evaluation of the statistics on *Psilocybe semilanceata* usage in Great Britain, J. Francis and V.S.G. Murray emphasize that there has not been a single fatality among some 318 poisoning cases - in fact, no severe somatic symptoms were noted, nor have there been incidents of misidentification of the mushroom species. According to the authors, intoxication can be a quite unpleasant experience for the individual. Panic reactions pose the only significant hazard, which may endanger the individuals as well as their surroundings for the duration of the mushrooms' effects.

As an ideal treatment, they proposed that patients be moved to a darkened, beautiful room, and that they be watched until the effects have subsided. If necessary, tranquilizers such as diazepam should be administered.

R. Watling mentions a non-fatal case in Scotland, where *Inocybe geophylla* (Sow. & Fr.) Kumm., a muscarine-containing species, had been mistaken for the *Psilocybe* species.

In the 1980s, *Psilocybe semilanceata* was named as the mushroom species that caused by far the largest number of intoxications in Great Britain. Today, usage of this psychotropic species in that country is not quite as popular anymore as it was 10 years ago. Also, mushroom eaters are no longer prosecuted.

By comparison, a short report by a medical student from Manchester was not convincing. The report claimed that a 24-year old patient suffered from severe depression with somatic side effects for three months ("persistent psychiatric symptoms") and that these symptoms had been induced by ingestion of *Psilocybe semilanceata*. At the time, the patient was experiencing personal stress and had also taken other substances as well. Despite the wide distribution of psychoactive mushrooms around the world, there have been no reports of similar episodes.

The usage of *Psilocybe semilanceata* in Norway was first described during the fall of 1977, in Sandnes, near the Rogaland area. Up to that time, the Norwegian literature had depicted *Psilocybe semilanceata* as merely a small, inedible mushroom known to grow in grass interspersed with other, similar, species. Apparently, the experiences in England and the United States inspired the use of these mushrooms in Norway, as well as in other European countries. However, it is also possible that a report published in 1976 about the discovery of psilocybin in Norwegian collections contributed to subsequent usage of the mushrooms.

Knowledge about the mushrooms spread quickly around Norway, especially in the fjord areas, were the species fruits most abundantly. Daily and weekly papers as well as underground magazines dealt with the mushrooms at length. Only a small number of panic reactions were known to have occurred in Norway, with some individuals requiring temporary clinical attention. Nonetheless, in December 1981, the mushroom species was classified under Norwegian narcotics law as an "absolutely forbidden substance". The same classification applies to the potentially dangerously addictive drugs of the heroine type, as well as to the pure hallucinogens, such as LSD, mescaline and psilocybin, all of which are pharmacologically completely different from any of the heroine-type drugs. By contrast, Figure 57 illustrates that other European nations have attitudes similar to those found in British Columbia, which form the basis for my own analytical work with mushroom materials.

Compared to Norway, there is less information about usage of *Psilocybe semilanceata* from other countries. The year 1981 has been named as the starting date of usage in Finland; by 1984, there had only been one patient who required medical attention.

There are additional countries where the mushrooms are being used and collected, more or less sporadically: The Netherlands, Austria, Denmark, Sweden, Belgium, Germany, Switzerland, and recently Russia near the St. Petersburg area. The mushrooms have even been found in Siberia. In some areas, where the mushrooms thrive in abundance, a more comprehensive mode of usage can be observed, without attracting much additional attention over a longer period of time.

Costly measures, such as the deployment of helicopters over pastures in the Jura Mountains of Switzerland to flush out mushroom collectors have rarely been used and were quickly abandoned.

Switzerland is another country where *Psilocybe cubensis* is being cultivated and used without attracting much attention. Below is an account provided by a Swiss friend about his first ever experience with this species:

> *Intense, kaleidoscope-like colors are being generated. I begin to dive in and out of other realities, followed by the painful loss of ego, death and life. Suddenly I find myself inside a wooden box. My body is a black mass full of low-level pain. I have the black plague. I was put inside the box, because I was thought to be dead, but I am still alive. I am being carried to and placed on top of cart so that I can be transported to be burned. Few others are being given such a box. At first I am in despair, but then I know that the end is near, anyway. Death is a liberation for me. I remember: I see my house in the city center of Metz, where I used to live until now. Then came the plague. My years of selfish dedication of helping sick, degenerate, stinking, hungry and dying people.*
>
> *I provide comfort and companionship, as well as medication that remains ineffective. I continuously make house calls, there is no end in sight. I become ill myself. At first I deny this fact, but now I am inside this wooden box, in a state of semi-consciousness. I know that the end is here.*
>
> *I know that I am a physician named Claudius Vinzen and that the year is 1427.*
>
> *I wake up in the reality of winter, 1990. Metz, where is Metz? Later on, I locate the city on a map of France and until this day, I have been trying to verify if this physician lived there during the Middle Ages. I am reminded of my long years of professional work with criminal and drug-addicted youngsters. I sense the common elements of these two realities (karma?), the sacrifices of selfless helping.*

Such deeply moving experiences do not appear to be unusual (compare to reports of experiences with *Psilocybe semilanceata* in Chapter 3.1) and should always be studied in all seriousness.

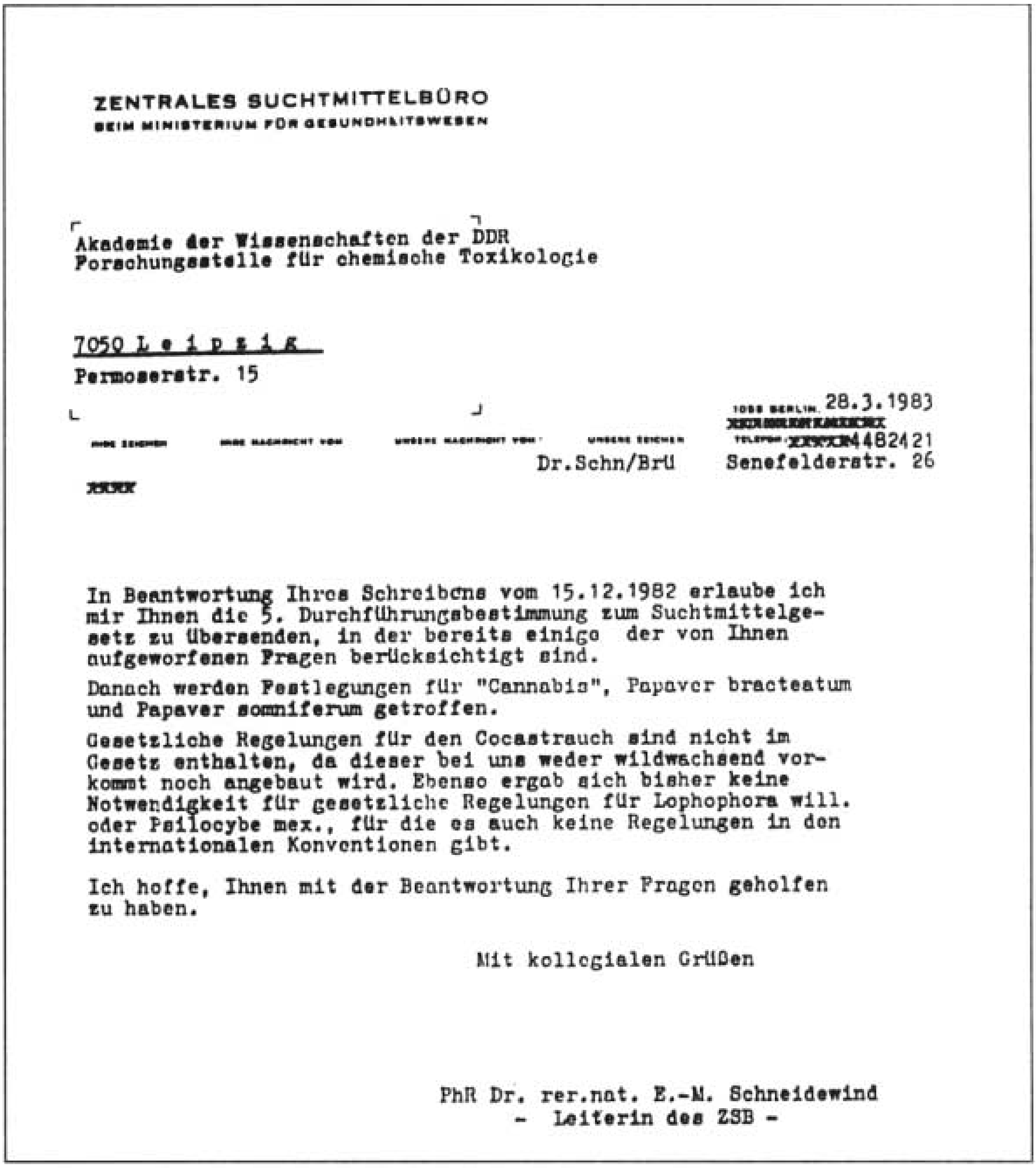
Only France seems to engage in elaborate activities designed to locate collectors of psychotropic mushrooms. Despite its grand mycological traditions, France is a country that has a rather absurd prohibition against the exhibition of *Psilocybe* and *Stropharia* species (European *Stropharia* species do not produce psilocybin) at scientific conventions. As a consequence, French mycologists have been avoiding the use of the genus *Psilocybe*. Nowadays, at mycological conventions, *Psilocybes* are exhibited under the old name of *Geophila* (Quelet), which appears to have gotten around the problem of breaking the law.

According to my personal communications with mycologists, the usage of *Psilocybe semilanceata* in Italy began in about 1980/1981 and has been rising steadily since then. At the same time, there have been no clinically relevant cases, nor any legislative action on the matter. Towards the late 1980s, usage of psychoactive *Psilocybe* species began in the former Czechoslovakia, for instance, around the region of Brno. It appears that *Psilocybe bohemica* is used more often in this country than *Psilocybe semilanceata*, as the former species is quite common there.

Very little is known about European usage of mushroom species from other genera. In the mid-1980s, Spanish youngsters near Barcelona were observed using *Panaeolus* mushrooms.

The well-known booklet authored by Oss and Oeric about the cultivation of *Psilocybe cubensis* has been translated into several European languages and published in different countries. It is almost certain that the book is being used as a cultivation guide in Europe, however, there are no available data about the success rate of these experiments. In many cases, commonly occurring contaminants probably prevent fruiting of this subtropical species on rye substrate.

I won't risk making predictions about the extent of future usage of indigenous European psychoactive mushroom species, nor am I able to predict which species may or may not gain in popularity. However, it is possible to speculate that the increased geographic distribution of species such as *Inocybe aeruginascens* and *Psilocybe cyanescens* may lead to more unintentional intoxications, which, in turn, may result in creating a generally deeper knowledge base about the attributes of these mushrooms.



ZENTRALES SUCHTMITTELBÜRO
BEIM MINISTERIUM FÜR GESUNDHEITSWESEN

Akademie der Wissenschaften der DDR
Forschungsstelle für chemische Toxikologie

7050 Leipzig
Permoserstr. 15

IHRE ZEICHEN   IHRE NACHRICHT VOM   UNSERE NACHRICHT VOM   UNSERE ZEICHEN
Dr.Schn/BrU

1086 BERLIN, 28.3.1983
TELEFON 482421
Senefelderstr. 26

In Beantwortung Ihres Schreibens vom 15.12.1982 erlaube ich mir Ihnen die 5. Durchführungsbestimmung zum Suchtmittelgesetz zu übersenden, in der bereits einige der von Ihnen aufgeworfenen Fragen berücksichtigt sind.

Danach werden Festlegungen für "Cannabis", Papaver bracteatum und Papaver somniferum getroffen.

Gesetzliche Regelungen für den Cocastrauch sind nicht im Gesetz enthalten, da dieser bei uns weder wildwachsend vorkommt noch angebaut wird. Ebenso ergab sich bisher keine Notwendigkeit für gesetzliche Regelungen für Lophophora will. oder Psilocybe mex., für die es auch keine Regelungen in den internationalen Konventionen gibt.

Ich hoffe, Ihnen mit der Beantwortung Ihrer Fragen geholfen zu haben.

Mit kollegialen Grüßen

PhR Dr. rer.nat. E.-M. Schneidewind
- Leiterin des ZSB -

Figure 57 - A letter from the "Central Bureau of Substance Abuse" in the former East Germany, detailing some legal restrictions on psychoactive plants. At the time (1983), ***Psilocybe mexicana*** was not a controlled substance and no restrictions applied to its use.

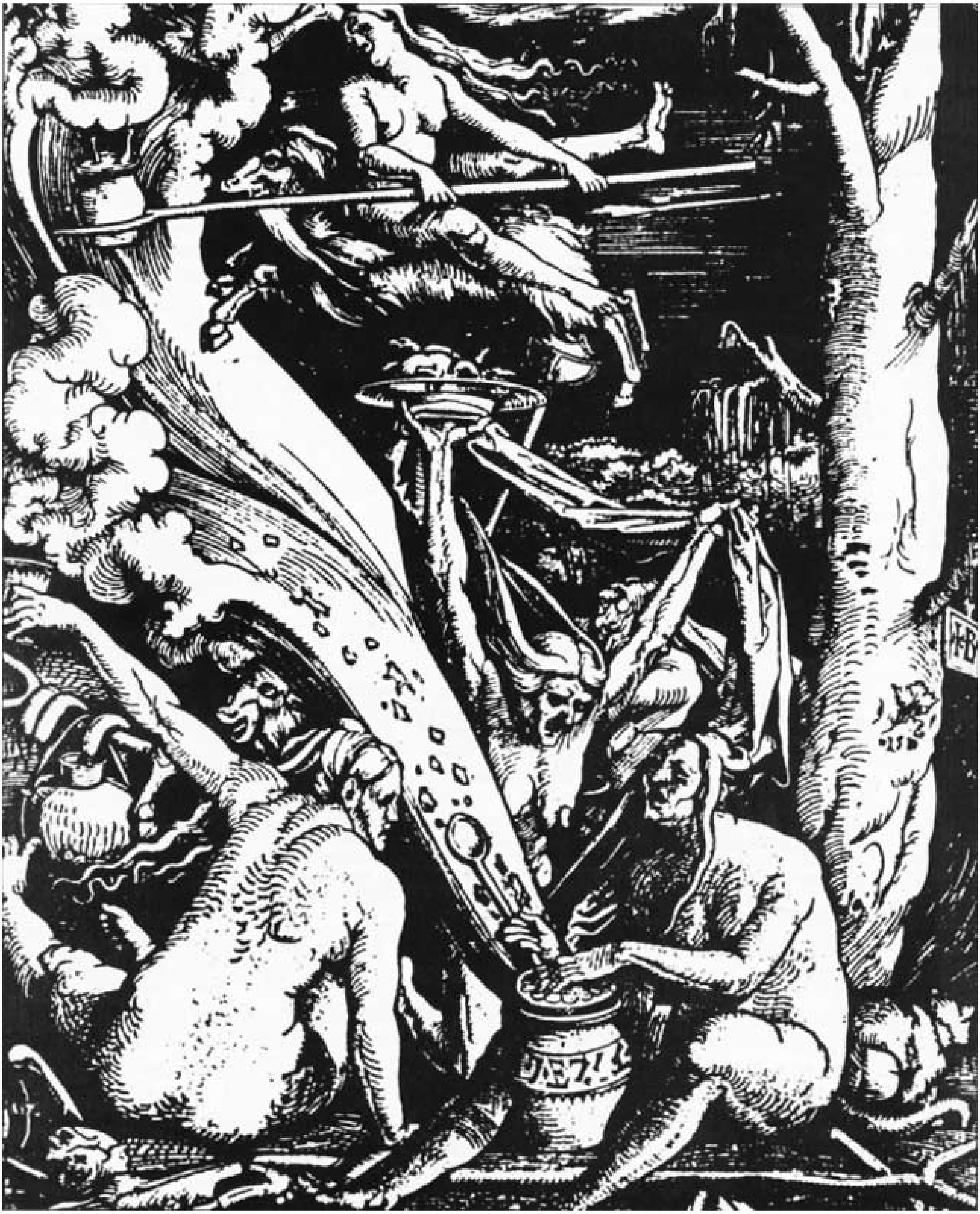


Figure 58 - Woodcut entitled "Cooking Witches" by Baldung Grien (1514). Such cultural practices undoubtedly included familiarity with psychotropic mushrooms, even though such knowledge was considered pagan at the time. The practice of "witchcraft" was maligned and accused witches were persecuted, tortured and executed, as the Christian Inquisition was desperate to suppress pagan beliefs and wisdom.

7.5 - Japanese Experimentation

Mushroom species containing psilocybin are also found in Japan. Tales about the infamous "Laughing Mushroom" date as far back as the Middle Ages. An account from the 11th century became famous:

> *Several lumberjacks from Kyoto got lost in the woods for reasons that remain unknown. Suddenly they encountered four or five Buddhist nuns, whose behavior did not at all conform to expectations: instead of immersing themselves into their inner selves in a quiet quest for Nirvana, the search for Absolute Nothingness, these daughters of Buddha were found dancing and laughing. It turned out that the nuns had also gotten lost in the woods and dealt with their hunger by eating some delicious mushrooms. The faithful nuns soon discovered, however, that they could not stop dancing and laughing. The lumberjacks's stomachs, in the meantime, had also begun to growl and, thinking that what was good for the nuns was good enough for them, the lumberjacks ate some of the mushrooms as well. Soon after, they also succumbed to overwhelming fits of laughter and the urge to dance....*

The linguistic moral of the story: since that time, the mushrooms in question have been referred to in Japanese as

- "maitake" (Dancing Mushrooms)
and later on
- "waraitake" (Laughing Mushrooms).

For a long time, the species thought to be responsible for these symptoms were identified in the mycological literature as *Panaeolus papilionaceus* and as *Gymnopilus spectabilis* ("giant laughing mushroom"). However, today we know that the former is a species from Europe and North America which does not contain any psychoactive substances, while even Japanese authors have been unable, since 1980, to confirm the existence of psilocybin and its derivatives in the latter *Gymnopilus* species. Only inactive substances have been found in *Gymnopilus spectabilis*.

In Japan, the investigation of these mushrooms has a long tradition: There is evidence that mushrooms have been cultivated in Japan for no less than 2,000 years, by collecting naturally grown mycelia of *Lentinus edodes* (Berk.) Singer and transferring onto pieces of wood selected to serve as new substrates.

Incidentally, literary sources from China also attest to knowledge about mushrooms from that country, where such mushrooms were said to be the cause of a (temporary) "disease of dry laughter".

Still, the reports about an irresistible urge to dance constitutes a rather unusual effect of psilocybin, from our current point of view. While psilocybin is initially known to cause fits of laughter, this phase is generally followed by a state of relaxation and a drop in levels of physical activity. It is likely that, in this case, medieval Japanese mentality was a cultural factor that modified the specific expression of an altered state of consciousness.

Aside from the two disputed mushroom species mentioned above, several psychoactive *Psilocybe* species can be found in Japan. There are several known cases of accidental ingestion that occurred during the 20th century, resulting in psilocybin syndromes without inducing fits of dancing.

For example, in 1932, S. Imai described cases of intoxications from 1929 and 1931 which involved his newly classified species *Stropharia caerulescens*. Later on, the species was named *Stropharia venenata* Imai, which grows on top of wood and dung. Today, it is being classified within the genus *Psilocybe* as a close relative of *Psilocybe cubensis*.

Imai mentions an event that occurred on June 21, 1929:

> *A 43-year-old woman collected about 13 oz. of a type of mushroom that she erroneously thought to be honey mushrooms (Armillaria mellea). The following day, she prepared a tasty mushroom meal and served it to her family. As family members began to notice the effects, they immediately*

> *went to see a doctor, who determined that the woman was experiencing the most potent effects: Her stomach was pumped without delay and laxatives were administered, but she still had muscle twitches, followed by hallucinations and a comatose (?) state. The son, who had eaten the soup only, experienced hallucinations as well, because the cooking process had served to extract the water-soluble compounds from the mushrooms.*

No Danger from *Psilocybes* in Japan

Unfortunately, Singer and Smith mistakenly cited these incidents in their (1958) monograph about the *Psilocybe* genus as examples of the mushrooms species' fatal effects. For that reason, this species was unjustly branded for decades in the literature as a highly dangerous poisonous mushroom.

There are other psychoactive mushroom species that grow in Japan, such as the bluing species *Psilocybe subcaerulipes* Hongo and *Psilocybe argentipes* Yokoyama. These species also caused intoxications in three people, who mistook the mushrooms for the honey mushroom. These cases brought about the isolation of psilocybin in crystalline form from dried fruiting bodies of the species, as well as recognition of the species' wide area of distribution. In 1973, Yokoyama published the results from systematic experimentation with *Psilocybe argentipes*. No "urge to dance" was noted in these investigations as well. Below are some excerpts from his research protocols:

> *J.H. (a 24-year-old male) ingested four cooked mushrooms at night, after a meal (!), and then ate another three fresh mushrooms 30 minutes later. This was followed by regurgitation, and 45 minutes later, he started to sweat profusely all over his head and body. His pulse rate and breathing were accelerated, but slowed down later on. He laid down and experienced visual hallucinations, which caused him to panic and to run a distance of about 1,200 ft. to consult the nearest doctor. The physician noted widely dilated pupils, and proceeded to have the patient's stomach pumped and then prescribed laxatives. Three hours later, the abnormal state had largely subsided; by the next morning, there was no evidence of any other side effects.*
>
> *M.K. (a 22-year-old male) ate just one fresh mushroom, which had no effects at all.*
>
> *K.Y. (a 31-year-old male) ate five mushrooms. Regurgitation occurred 30 minutes after ingestion, followed by sweating around the head and body; his extremities appeared to be slightly paralyzed. This paralysis persisted for another three hours. During this time, the subject had great difficulties handling a pen for writing, his mood was depressed and he experienced hallucinations, such as colorful lights flooding down from the sky. By the following morning, all of these effects had dissipated. The fresh fruiting bodies were bitter, a taste that disappeared after the mushrooms had been cooked in water.*

The above experiments are rather amateurish, and the descriptions of results are heavily influenced by a simplistic perspective which assumes that the mushrooms' pharmacological effects proceed along a single, narrow track. Still, these accounts demonstrate that comparable dosages of Japanese mushroom species have psychotropic effects similar to those caused by *Psilocybe* species found on other continents.

Much work still remains to be done in the areas of phytochemistry and taxonomy before the body of knowledge about psychotropic mushroom species in Japan can grow to become adequate. The geographic distribution and ingredients of the Japanese *Panaeolus* species must also be studied further. For instance, *Panaeolus subbalteatus* is one of the species that are growing on several Japanese islands today.

7.6 - Intoxications and the Oldest Known Mushroom Cult in Africa

So far, the mycoflora of the African continent has been studied only peripherally and remains largely unknown. During the late 1980s, Italian mycologist G. Samorini and Terence McKenna, working independently, found evidence for the oldest known mushroom cult in Africa. Their discoveries were not just sensational, but most surprising as well. On the other hand, it really shouldn't come as a surprise that the oldest traces of human contact with mushrooms were found on the very continent known as the cradle of humanity.

10,000 Years Old

From 9,000 to 7,000 years ago, the area of the Sahara - between Tassili (Southern Algeria), Acacus (Libya) and Ennedi (Chad) - was populated by human beings who created magnificent rock drawings, a pictorial legacy that preserved for posterity impressive images of everyday life. These pictures tell about a time when the Sahara was still a blooming garden, a time when no one even suspected that processes of erosion and desolation, starting about 3,500 B.C., would turn the area into a desert quite hostile to human life.

The rock drawings date from as far back as 10,000 B.C. up to the present. Among the drawings from the Stone Age (7,000-5,000 B.C.), there are those described as typical of the so-called "round head phase". They include pictures of pasture animals as well as evergreen and deciduous trees. On top of a Sahara plateau, at an altitude of 6,500 ft., there exist pictures of mythical beings with anthropomorphic and zoomorphic attributes which are reminiscent of early Mexican images: many scenes depict tiny horned dancers alongside mushrooms. Deities with masks and horns are seen holding mushrooms in their hands; sometimes the mushrooms are shown attached directly to body parts. In addition, those Stone Age artists created images of anthropomorphic beings with mushroom-like heads. There are many other indications pointing toward the existence of a comprehensive mushroom cult.

Among the most striking renditions at Tin-Tazarift, Tassili District (Algeria) is a picture of masked anthropomorphic beings engaged in ecstatic dancing. (See Figure 5, p. 8). This figure, "Anthropomorphic Beings Engaged in Mushroom Dance", includes several dashed lines, which are most interesting, because they connect the mushroom with the center of the head. At the same time, these lines represent a flow of energy, maybe even the mushrooms' influence on the human soul. This picture is clearly indicative of psychotropic mushroom use. It seems quite remarkable that, as early as 9,000 - 7,000 years ago, the head was apparently considered to be the seat of consciousness. By contrast, four or five millennia later, during the European era of classical antiquity, the brain's role was merely thought to be similar to that of a kind of cooler. Other rock drawings also depict mushrooms as being mythologically linked with fish.

These images, then, furnish powerful evidence for the usage of psychoactive mushrooms within a mystical-religious framework. The rock drawings consistently show two kinds of mushroom shapes: one of them resembles *Psilocybe semilanceata*, in that the caps are drawn with an acute umbo on top, while the other shape represents larger mushrooms with a habitus much like that of the *Amanita* or *Stropharia* species.

Despite their age, the rock drawings' colors have retained brilliant hues. Pictures of mushrooms were drawn in white as well as several shades of ochre. Also, a few mushrooms were drawn in blue colors. While this is the exception, it may well be a representation of the so-called bluing phenomenon.

In Nature, these colors are associated with the bluing *Psilocybe* and *Panaeolus* species. These mushrooms could have grown on several substrates, such as fallen twigs and raw compost, grounds littered with the remains from evergreen and deciduous trees or dung left behind by pasture animals. Among the mushroom species that may have grown in the area thousands of years ago, the most likely candidates are relatives of *Psilocybe cubensis* and *Panaeolus cyanescens* (dung-inhabiting species), *Psilocybe semilanceata* (a nitrophilic species) as well as *Psilocybe cyanescens*, a species that grows on top of raw compost.

Considering the impressive nature of existing historic evidence, the obvious question would seem to be whether any of these species can currently be found in Africa, where the cradle of mankind is located.

African Species Related to *Psilocybe cyanescens*?

Interestingly, on October 24, 1912, R. Maire first collected several specimens of bluing, dark-spored mushrooms which he found growing on raw compost underneath some cedar trees in Algeria, at Chrea Pass near the city of Blida south of Algiers. He collected additional specimens every year up until 1926 and published his findings in 1928, naming the species *Hypholoma cyanescens* nov. spec.

Later on, G. Malencon classified a number of similar specimens from his own samples collected in the Central Atlas Mountains (Morocco) as belonging to this species. In 1973, Singer then classified the species as

Psilocybe mairei Sing. Krieglsteiner, however, considered this species to be identical with *Psilocybe cyanescens* Wakefield, as found in Europe. Thus, bluing *Psilocybe* species can still be found in Africa today.

In his monograph on *Panaeolus* mushrooms from the 1960's, Ola'h mentions two *Panaeolus* species that are strongly psychoactive:

- *Panaeolus africanus* Ola'h and
- *Panaeolus tropicales* Ola'h.

There are also accounts from Africa about typical hallucinatory intoxications, caused by mistaken identification of a yellow *Stropharia* species as a culinary mushroom. In 1945, E.R. Cullinan and D. Henry described 22 cases in Nairobi, which occurred in July of that same year.

> *The symptoms started one hour after ingestion of the mushrooms, peaked within three hours and then persisted for 24 to 48 (?) hours. Symptoms consisted of emotional imbalance, fits of mirthful and irresponsible laughter alternating with depressive moods, during which patients felt they wanted to die. Patients were unable to sleep, due to nightmarish feelings that descended when they closed their eyes... They remained conscious throughout the experience and their speech, while somewhat uncontrolled, was rational.*

In 1957, A.D. Charters reported additional cases of intoxication from Nairobi:

> *On May 18, 1949, a man and his wife - both Europeans who resided in Nakuru, ate generous portions of mushrooms for lunch. Within 30 minutes, both of them developed mental symptoms, along with pupil dilation and a tingling sensation in the fingers.*
>
> *The man experienced visions of pink colors and a sense of euphoria in association with delusions. He felt that he was passing into the next life and he could see his own body. He stated that he realized "we are in the process of working toward our next life".*
>
> *His wife also reported delusions, and she felt that she was inside the tube that was part of the apparatus used for pumping her stomach at the time. She believed that she was going to die and she was afraid of death. She had laughing fits and felt sensations that alternated between happiness and depression. Both patients had their stomachs pumped and recovered completely within six hours.*

Given sufficiently wet climate conditions, *Psilocybe cubensis* can often be found in other parts of the world growing on pastures in areas located up to 30° north as well as south of the equator. Therefore, it is likely that the yellow *Stropharia* species from the Highlands of Kenya may actually have been *Psilocybe cubensis* mushrooms or at least a close relative of this species.

In January 1994, M. Smith and myself were collaborating in South Africa, where we discovered a bluing *Psilocybe* species in Natal Province. It was the first psychotropic *Psilocybe* species ever found in the area. This species is generally whitish in color and does not have an annular ring. The mushrooms are comparable in size to *Psilocybe cubensis*, but do not grow directly on top of dung in cow pastures. Having been compared with samples of known *Psilocybe* species, the new species is currently being published under the name *Psilocybe natalensis* Gartz, Reid, Ecker & Smith.

The mushroom samples and reports of intoxications described in this chapter indicate that psychoactive species do occur in Africa, which, in turn, supports the hypothesis of an ancient mushroom cult on the African continent. However, additional work is needed with respect to the African species, including their areas of distribution, their taxonomic classification and the essence of their active ingredients.

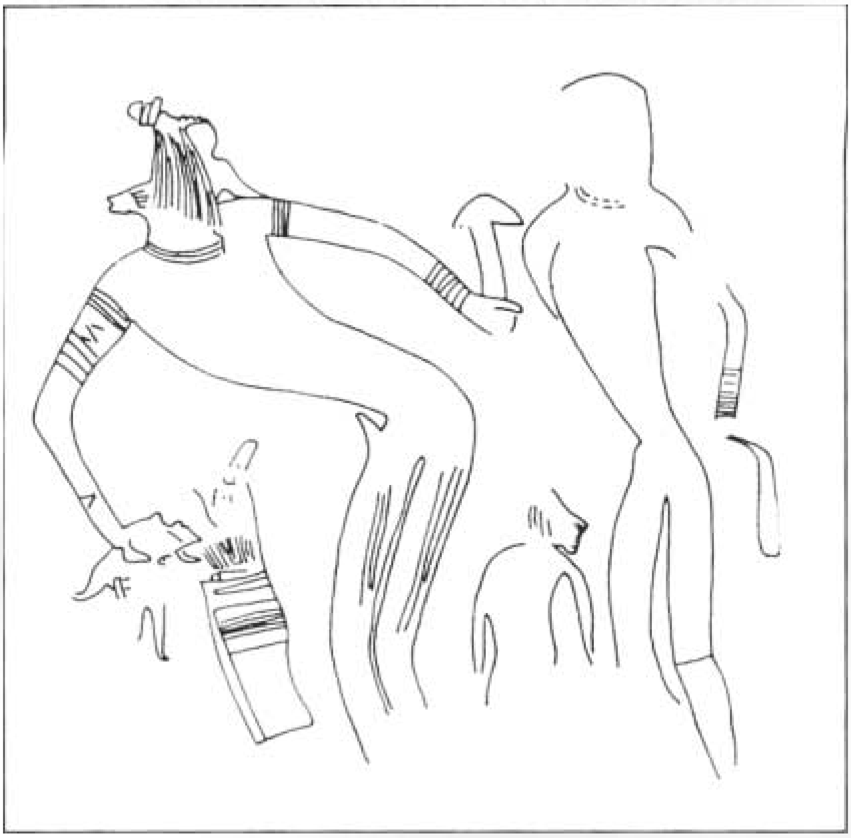


Figure 59 - Outline of a rock drawing from Tassili, Algeria (ca. 7,000 B.C.). The figure on the left clearly is holding a mushroom-shaped object.

7.7 - Usage in Southeast Asia and the South Pacific Islands

Since the late 1960s, the custom of using psilocybin-containing mushrooms has been evolving in various countries across Asia and the Pacific Islands. However, there is no conclusive evidence indicating that mushroom usage was endemic among native cultures prior to the discovery of the Mexican species. Most likely, global tourism has been the most significant factor behind increasing knowledge about relevant mushroom species among the populations of these countries, especially after searches for strongly bluing gilled mushrooms were successful. These mushrooms, most notably those found growing on pasture land, strongly resembled similar species from other continents.

Neo-Mycoflora

Western amateur mycologists helped disseminate information about these species and published articles on the mushrooms in various publications of their home countries. However, little or no efforts were made to identify and describe specific mushrooms species found growing in Asia and the South Pacific Islands. There have also been no research efforts to investigate the overall mycoflora in this part of the world. Thus, during the 1970s, a group of teenagers in Samoa discovered the psychoactive effects of *Panaeolus cyanescens*. At first, the police took measures to suppress the practice. But persecution by law enforcement agencies was halted when it became apparent that ingestion of the mushrooms did not pose a significant health risk. According to Cox, the teenagers' parents considered their children's mushroom experience "a foolish, but totally harmless episode and a part of normal teenage development". In light of such a reasonable frame of reference, the historic label "fool's mushrooms" (Chapter 2) immediately comes to mind.

By contrast, customs of psychoactive mushroom usage in New Zealand evolved around the same species found in Australia, with criminal penalties also modeled after Australian measures of law enforcement. However, in contrast to *Psilocybe semilanceata* and *Panaeolus cyanescens*, *Psilocybe cubensis* is not a species native to New Zealand, and all psychoactive species are generally referred to as "magic mushrooms".

To date, we do not know about all those geographic regions where the discovery of bluing mushroom species was an event that did not attract much attention, yet contributed to the mushrooms' growing popularity and an ever-increasing number of "silent" users. Scientific-mycological investigations of a small number of samples provided clues to the identification of psychoactive species relevant in this context: the two dung-inhabiting species *Psilocybe cubensis* and *Panaeolus cyanescens*, as well as *Panaeolus tropicalis*, a close relative of the latter species. In most cases, the differentiation of the two *Panaeolus* species is an extremely difficult task.

Panaeolus cyanescens Omelettes

During the seventies and eighties, the mushroom restaurants of Bali became quite famous, since interested tourists could order mushroom omelettes made with *Panaeolus cyanescens* - house specialties, and all completely legal to boot. At first, local children collected the mushrooms needed to prepare the dishes. In response to increasing demand for this culinary specialty, however, commercial cultivation of the *Panaeolus* species began, using the method of transferring dung with naturally-grown mycelia onto fresh buffalo manure.

Apparently, no major complications ensued, and this type of mushroom usage remained unchallenged for a long time. In Bali, ingestion of mushrooms has been limited, for the most part, to visiting tourists. In 1992, a German tourist reported that, if anything, the number of restaurants had increased compared to the 1980s. The number of restaurant patrons, however, appeared to have decreased, indicating an increasing familiarity with psychoactive mushrooms species in the tourists' countries of origin.

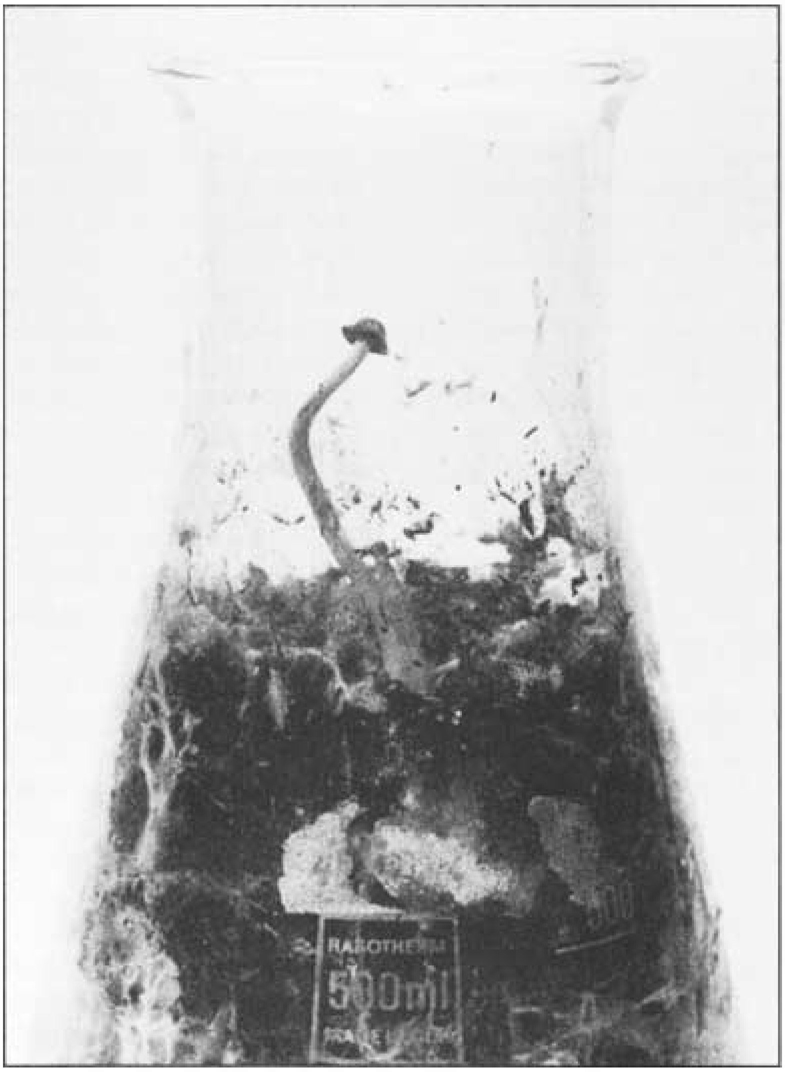


Figure 60 - ***Psilocybe samuiensis*** on a mixture of rye and horse dung.

Similar stories about mushroom specialties exclusively prepared for tourists have also been reported from Sumatra, Java and The Philippines.

Those mushroom species described above are based on samples collected from islands; thus, it is quite logical to expect finding those same species growing on the Asian mainland as well. Soon after Earle published his description of *Stropharia (Psilocybe) cubensis* in a 1906 edition of a Cuban agriculture journal, Patouillard proposed the species name *Naematoloma caerulescens* for his own samples of the same species, which were collected in Tonkin (Vietnam) in 1907. In Thailand and Cambodia, Heim found fruiting bodies of the species *Psilocybe cubensis*, providing the first sample from outside of Mexico used by Hofmann and his collaborators to confirm the presence of psilocybin in the fruiting bodies.

Such positive results inspired the proposal that psychoactive *Psilocybe* and related species thrive on all continents, a hypothesis that has been fully confirmed.

Other mushroom species from the genus *Panaeolus* have been found in mainland Asia as well. For example, Ola'h's monograph describes a bluing mushroom named *Panaeolus cambodginiensis* Ola'h & Heim, a species - as its name suggests - found only in Cambodia. According to Ola'h, all of the species's fruiting bodies contain psilocybin.

Monsoon Climate, Manure and Water Buffaloes

In 1981, Schroeder reported the results of his mycological field work conducted in Nepal during 1978 and 1979, where his research efforts established that mushrooms of the *Psilocybe* species are wide-spread throughout the area. Guzman proposed that these species can quite possibly be classified as *Psilocybe cubensis* and *Psilocybe subcubensis* Guzman. Macroscopically, the latter species is very similar to the subtropical *Psilocybe cubensis* species, but its spores are comparatively smaller and its habitat limited to tropical regions.

The mushrooms primarily grow in valley areas with monsoon climate conditions, at altitudes of about 3,000 ft. on substrates of partially decomposed cow manure as well as on water buffalo dung. While the species fruits all year round, it does so most abundantly in May and June, the rainy months that precede the monsoon season.

Nepal is another country where no evidence was found of any mushroom usage by the indigenous population. Mycophilic Western visitors, however, having discovered the species, soon indulged in usage of the mushrooms for hallucinatory purposes, a practice that failed to draw much public attention. It appears that a relatively large dose was required to achieve the desired effects, since several individuals consumed forty or more of the fleshy mushrooms at a time.

"Soma": A Psilocybian Species?

Within the context of discovering this species, Schroeder and Guzman proposed a most interesting hypothesis. They suggested that "soma", the substance revered as a deity by the mysterious, ancient Aryan civilization, who are said to have developed a soma cult, did not, in fact, refer to the fly agaric mushroom, as initially proposed by Wasson. More likely, soma was the name of a psychedelic *Psilocybe* species, based on its spectacular psychotropic effects and the mushroom's geographic distribution pattern.

An article authored by J.W. Allen and M.D. Merlin concludes that currently Thailand is the country with the largest consumption of psychoactive mushrooms.

In several areas across Thailand, tourists can find menus offering mushrooms prepared as part of omelettes, soups, teas, pizzas or juices. Allen specifically studied patterns of usage on the two islands of Koh Samui and Koh Phangan. Previously, sporadic reports from other islands off the Thai coast contained descriptions of similar practices there. In January 1990, Allen also confirmed usage of the mushrooms in the northern areas of Thailand.

German Tourist Boom

On Koh Samui and Koh Pha-ngan, the mushroom dishes are enjoyed primarily by German tourists. Along with a few other foreigners, some Thai teenagers use the mushrooms as well, sometimes even attempting to smoke them in a bamboo pipe. As a salt-like chemical compound, psilocybin requires temperatures of about 200°C for it to melt and partially break down without sublimation, so that a tobacco pipe will not be effective in achieving the desired psychoactive effects.

During the fall of 1988, Thai authorities distributed warning leaflets at tourist centers, providing a detailed description of a bizarre panic reaction experienced by an Australian tourist, who was hospitalized briefly as a result. Allen thoroughly analyzed this event by seeking additional information about the circumstances of this case, including interviews with all other individuals involved. Allen discovered that the Australian visitor had used excessive amounts of various pharmaceuticals, including highly addictive substances, which is why he eventually required hospitalization.

Finally, in January 1989, this incident was central to justifying passage of a law that prohibits usage of psychoactive mushrooms ("hed keequai" in local language), with harsh penalties provided for non-compliance. Until that time, many restaurants posted signs advertising the various types of mushroom dishes on their menus. But mushroom usage continued despite passage of the law. Specific species still being used were identified as *Psilocybe cubensis*, *Psilocybe subcubensis* and *Panaeolus cyanescens*. It is unknown if a tourist in Thailand has ever been sentenced for usage or possession of mushrooms. In addition to the collection of fruiting bodies growing naturally on buffalo dung, Thai as well as German residents on Koh Samui and Koh Pha-ngan began to cultivate the mushrooms, outdoors and inside houses. In accordance with the "natural cultivation" approach, rice debris was added to fresh manure and mixed with dung already permeated by mycelia. After prohibition, mushroom cultivation continued at hard-to-reach wilderness locations.

Moreover, Allen found evidence that some restaurants temporarily served dishes made from regular table mushrooms apparently spiked with a synthetic hallucinogen (LSD?) whose effects lasted much longer than those of psilocybin. This dangerous practice caused unexpected reactions with effects lasting for up to 10 hours. Some consumers experienced dysphoric side effects which persisted for as long as several days. One individual developed an aversion against all kinds of mushroom dishes for several months.

As in Mexico during the sixties, a large variety of mushroom images and products are marketed commercially in Thailand these days. Among merchandise offered for sale there are hand-painted and mass-produced T-Shirts (see Figure 56, p. 78) with pictures of *Panaeolus cyanescens* and *Psilocybe subcubensis*, shown together as well as separately, not to mention postcards, posters, lighters and key rings, all featuring mushroom-motif decorations. Allen reported that such goods are available in both Northern and Southern Thailand.

In coming years, we can well expect a wealth of new discoveries and insights into the ethnopharmacology, taxonomy and natural chemistry of Asia's mycoflora.

Not surprisingly, another new mushroom species was discovered in Thailand in August, 1991 and named *Psilocybe samuiensis* Guzman, Bandala & Allen (see Figure 60, p. 99). The species is similar in appearance to *Psilocybe semilanceata*, but the fruiting bodies do not contain baeocystin. *Psilocybe samuiensis* is a bluing species that grows on fertilized soil, but not directly on top of dung. We successfully cultivated this species on a mixture of rye, horse dung and water (2:1:2), but found that we needed to add a casing layer consisting of peat and chalk (2:1).

CHAPTER 8

Some Comments on Effects of Mushrooms from the Category Phantastika

Extensive animal research efforts during the 1950s furnished evidence that both psilocybin and psilocin are alkaloids of negligible acute toxicity. Specifically, the dosage of psilocybin that caused death in 50% of the experimental mice (LD 50) was determined to be 280 mg/kg body weight. By comparison, noticeable effects in humans generally occur at dosages as low as 0.02 mg/kg.

Animal tests showed that, on average, psilocybin was a substance only half as toxic as mescaline, and at the same time, turned out to be 50 times more potent as a psychoactive substance. For example, up to 2 g of mescaline were being administered with no dangerous side effects, while the usual dose of psilocybin ranged from 3 to 30 mg as part of psychological testing and psychotherapy sessions.

As is the case with other psychotropic substances, human beings most likely have a more sensitive reaction in response to psilocybin than mice do. Still, the range of safety in controlled experiments comes to several hundred times the amount of the active dosage. The same goes for the consumption of mushroom material, since psilocybin concentrations in mushrooms can vary up to a factor of 10. Consequently, J. Ott speculated that adults would need to eat their own body weight in fresh mushrooms, in order to finally reach the dosage limit of lethal toxicity. Despite the hundreds of thousands of voluntary self-experiments taking place every year in the U.S. alone, no fatalities caused by magic mushrooms have ever occurred there. Small children, however, have abnormal reactions to psilocybin, such as loss of consciousness, cramps and danger of death.

> *It was in the fall of 1960, that a child from Milwaukee, Oregon, picked several mushrooms from grassy soil below a cluster of conifers. Having eaten the mushrooms, the child experienced cramps and a high fever. Similar to a condition described as "status epilepticus", the symptoms were treated by medications, with limited success. The child died within three days.*

The mushroom sample involved in this incident was identified as *Psilocybe baeocystis*. P. Stamets, however, contested this finding, claiming the species had been misidentified. He referred to a publication about the incident that included a picture of the mushrooms, which, according to Stamets, shows a sample of *Psilocybe cyanescens*. This species is well-known as exceptionally potent, due to high levels of psilocybin and psilocin. Still, we cannot determine whether toxic concentrations of alkaloids were the cause of death, or whether ingestion of the alkaloids triggered a latent case of epilepsy in the form of an acute episode that could not be treated or controlled. If a similar incident happened nowadays, fatal outcomes could be easily prevented, since the last three decades of progress in pharmaceutical research included the discovery of new drugs capable of aborting convulsive episodes.

Due to publicity generated by the unfortunate accident in 1960, two alkaloids (baeocystin and norbaeocystin) first isolated from *Psilocybe baeocystis*, at times acquired reputations of being extremely poisonous as well as strongly psychoactive. Both claims, however, are wrong and unsubstantiated. Specifically, both baeocystin and norbaeocystin are present in other mushroom species, such as *Psilocybe semilanceata*, and at generally higher levels compared to the alkaloid content of *Psilocybe baeocystis*.

Biochemical research efforts accelerated and large numbers of studies were conducted, primarily with LSD. These investigators sought to discover the receptor binding sites for hallucinogenic compounds in the brain and to understand the mechanisms underlying the genesis of psychedelic visions. Today, we still lack a sound theoretical framework able to explain the relationship between chemical compounds and the manifestation of their psychoactivity. Even though basic research is certainly important, its methods, unfortunately, are often a function of a rather one-sided pharmacological approach to investigating the effects of psilocybin, LSD and mescaline - an approach that is, in fact, too narrow to address the remarkably unusual nature of these substances and their effects.

Misunderstandings between pharmacologists and toxicologists on the one hand and psychiatrists and psychologists on the other can often be traced all the way back to the 1950's, creating a legacy of disputes and arguments that have yet to be resolved. S. Grof undertook the tedious task of analyzing 5,000 experimental LSD protocols in an effort to isolate "absolute" symptoms that are reported or occur all of the time. His results were negative. According to Grof, hallucinogenic substances are non-specific triggers causing a sequence of altered states of consciousness, which do not fit the syndrome labeled "toxic psychosis". Rather, it is the individual's personality, along with the experimental setting that significantly shape the nature of the psychedelic experience. This view is shared by a majority of experts with considerable experience in conducting psychedelics-assisted psychotherapy. Even "real" somatic symptoms, such as nausea or vomiting, can often be controlled through psychological intervention techniques administered by trained professionals.

A Plethora of Names

The broad range of possible experiences inspired the use of labels other than "hallucinogens", with widely differing semantic connotations: entheogens, psychedelics, illusionogens, psycholytics, psychomimetics, psychodysleptica, psychoemetics and others.

"Phantastica" (Lewin) is the oldest label ever used to describe this class of substances. This term successfully evokes dream-like, fanciful aspects of the experience, as well as the potential for euphoric and dysphoric emotional overtones. More recent terminology often says more about semantic biases of those who use the labels than about any factual, objective characteristics of the alkaloids they refer to. Accordingly, official antidrug propaganda since the 1960's has disparaged "psychedelics" as excessively glamorous and too positive a label, as the term was popular among Timothy Leary's fans and supporters.

When used in low doses or for the first time, these substances are most likely to bring about a kind of magical transformation of surroundings, with a heightened ability to perceive subtle differences along the color spectrum - effects an individual often takes in with a great sense of wonder and awe. Based on these types of experiences, the label "psychoesthetica" has been used as well.

During the 1950's, those experiments of a purely pharmacological nature revealed that, within a specific low dosage range, the effects of psilocybin and LSD were largely similar, except for the shorter duration of the psilocybin experience. That is why there are numerous comparisons in the literature of 10 mg of psilocybin with 100 µg of LSD as equivalent dosages.

There are several authors, however, who focus on the more visionary and metaphysical nature of the psilocybin experience compared to other hallucinogenic substances. A. Hofmann conducted self-experiments with both substances and found the altered state of consciousness induced by psilocybin to be both deeper and somewhat gloomier than those produced by LSD.

Other investigators have portrayed psilocybin as "friendlier" - a substance that is not as fierce as LSD in exposing possible traumas hidden within the subconscious mind (see Chapter 3.2). Such differences in comparative evaluations of psilocybin and LSD are likely linked to a variety of factors, such as dosage differences, research protocols less than comprehensive and exhaustive in scope, as well as personality and environmental variables.

LSD "Flashbacks"

R. Fischer conducted a series of experiments designed to study the effects of psilocybin compared to LSD and mescaline. The results confirmed what had already been common knowledge among those who used the mushrooms in various contexts around the world: "flashbacks" are quite rare, and very mild, if they occur at all, nor do abnormal symptoms persist once the effects of the alkaloid have worn off. Widespread reports of LSD-induced "flashbacks" spawned biochemical theories which falsely postulate that LSD is stored inside the body and can be released at a later time to induce short periods of visions and other "psychotic" manifestations. Such conjecture about the body's "storage capacity" persisted despite prior evidence to the contrary that established LSD as a substance rapidly metabolized and eliminated from the body.

The assumption of a prolonged storage period following ingestion of LSD had already been debunked by LSD-assisted psychotherapy during the 1960's. According to M. Hausner, who worked in the former

Czechoslovakia, several patients who went through a series of LSD sessions did experience "flashbacks" in between sessions. However, the therapeutic administration of hallucinogens was continued in these cases and those flashback episodes that did occur were far less spectacular than expected based on some of the more dramatic descriptions of the phenomenon. Within the context of M. Hausner's studies, flashback episodes turned out to be merely temporary manifestations of issues that had reached the conscious mind. Moreover, flashbacks disappeared as therapy progressed with continued administrations and did not recur after conclusion of the therapy program. These observations are at odds with the biochemical theory which predicted that repeated administrations would increase storage of the substance inside the body, causing increasingly powerful flashback episodes.

Considering the highly variable nature of psilocybin's effects as illustrated by examples of unintentional and carefully controlled experimentation described in this book alone, some striking parallels with Grof's findings on the effects of LSD virtually suggest themselves. Grof noted the emergence of, in that order, abstract, aesthetic, psychodynamic, perinatal and transpersonal types of experiences during hallucinogenic sessions. With repeated administrations of relatively low doses, participants typically progressed through these stages one by one, eventually attaining and lingering at the transpersonal level of analysis.

The accounts of psychoactive mushroom experiences included in this book are by necessity limited to only one to three trials over time. Thus, detailed analyses comparing the effects of LSD and psilocybin must await results from future research efforts, assuming researchers will be able to conduct these types of studies.

By contrast, relatively high doses of LSD as well as psilocybin typically "bypass" the initial phases of experience, propelling the individual directly into the realm of transpersonal consciousness. The natural scientist's first experiment with *Psilocybe bohemica* or the incidents of accidental intoxication with *Psilocybe cubensis* in Africa both illustrate these kinds of transpersonal experiences.

Aside from psilocybin's psychotherapeutic applications as detailed in Chapter 9, there are other interesting phenomena and potential uses for psilocybin as well as those mushrooms whose active ingredients can be analyzed and measured accurately.

The investigation of frequent symptoms such as compulsive laughter, yawning and the flow of tears without dysphoria may reveal interesting neurophysiological mechanisms, provided we can isolate and separate the influence of psychological factors in the manifestation of these symptoms.

Psilocybin as a Research Tool for Study and Diagnosis of Brain Damage

The benefits of diagnosing brain-damaged patients with psilocybin were investigated in the former Czechoslovakia during the 1960s. Psilocybin was the alkaloid of choice for these studies, due to its minimal toxicity and because participants were not expected to develop additional chronic dysfunctions as a result of ingesting psilocybin. Visual hallucinations were found to be almost completely suppressed in patients suffering from lesions to parts of the central nervous system known to mediate visual-sensory functions.

On the other hand, the discovery that psilocybin tended to potentiate a variety of neurological processes effectively turned the alkaloid into a diagnostic tool used to reveal latent paralyses and other subtle types of damage to the central nervous system. While LSD could also have been used for this purpose, researchers preferred psilocybin, because dosage measurement was comparatively simpler, its effects were short-term and patients experienced less fatigue with psilocybin than with LSD.

In one exceptionally remarkable case, *one of the participants, while under the influence of the substance, clearly saw a brain tumor inside her skull - a tumor that was not discovered until an examination that followed the session.*

R. Fischer (see Figure 61) conducted a series of controlled experiments *involving the presentation of words and sentences composed of incomplete letters, with increasingly larger portions of the letters covered in several stages, from the top down. In the end, only the stumps of the letters remained in the display, which* *was no longer readable. Under the influence of psilocybin, however, the ability to "re-synthesize" these characters was observed quite frequently: Participants were able to read a significantly larger number of words, with some reportedly able to see the partial letters, complete and uncut, in a display that showed little more than a white background area.*

These observations are powerful evidence confirming that the effects of mushroom ingredients are certainly not just "psychotic" in nature, a notion preferred by those pharmacologists partial to terminology such as "toxic psychosis", with all its connotations as evoked by the "fool's mushroom" label. Psilocybin and its relatives apparently act as catalysts that initiate new information processing mechanisms and patterns of coordination between the different interactive areas of the brain. As such, the substances create the context needed for integrating emotional and rational processes in new ways. Under the most favorable of circumstances, such states of mind are experienced not only as a profound, impressive expansion of one's consciousness, but may also be reflected in short-term improvements of performance. I believe, however, that these temporary gains in skills are rarely attained by casual or recreational users of psilocybin-containing mushrooms, because set and setting are often less than ideal, and alkaloid content tends to be highly variable. Most researchers, including A. Hofmann, strongly advised against usage of hallucinogens by youngsters, even in controlled experimental settings. Adolescence is a time of upheaval, a developmental stage when youngsters struggle with themselves and their surroundings, searching for a purpose and a firm direction in life: Numerous conflicts arise in the process and need to be dealt with and integrated. Besides inducing altered perceptual states, hallucinogenic substances, including psilocybin are bound to release a stream of new emotions and conflicts. Such experiences often serve to confuse teenaged users and to compound existing areas of conflict, threatening to disturb the youngster's equilibrium, which is rather fragile to begin with.

Quite likely, the search for a means to escape reality plays an important role in this situation. In fact, the escapist aspect of LSD portrayed against a backdrop of political upheaval fuelled a reactionary zeal among those determined to control the substance during the 1960's. As a consequence of these restrictive legislative measures, the unbiased, scientific evaluation of hallucinogenic substances remains an all but impossible task. These examples from the LSD research literature suggest that controlled human subjects research is possible without risking damage or injury to the participants, while gaining a wealth of new insights beyond psychotherapy applications.

Comprehensive investigations of these substances have long ago proven beyond doubt that psilocybin, mescaline and LSD are not physically addictive, nor do they cause withdrawal symptoms of any kind. Repeated self-experimentation over long periods of time is rare; most long-term users eventually reduce frequency of use due to the nature of these substances that initiate powerful transpersonal processes and facilitate the emergence of personal conflicts. Besides, habitual daily users quickly develop tolerance to the point of being unable to experience any psychoactive effects at all. That is why clinical trials are spaced to allow for intervals of at least one week between repeated applications.

Ecstasy is More than Entertainment

Renowned pharmacologist R. Siegel described hallucinogenic mushroom consumption in California as merely "experimental use". According to his definition, almost all users of psychoactive mushrooms have anywhere from at least one up to 10 experiences, with several weeks or months in between repetitions. Or consider R. G. Wasson's poetic answer to a question from his banker friends who wanted to know why he did not eat the mushrooms every day:

> *"There are many who never experienced ecstasy and who may think this is entertaining. But ecstasy is not a form of entertainment: trembles. What kind of person would think nothing of submitting to a sense of pure, absolute awe or of floating through that doorway into the presence of the divine? Those who have never known ecstasy first-hand, distort the word each time they use it. We must comprehend anew the entire, frightening meaning inherent in this word.*

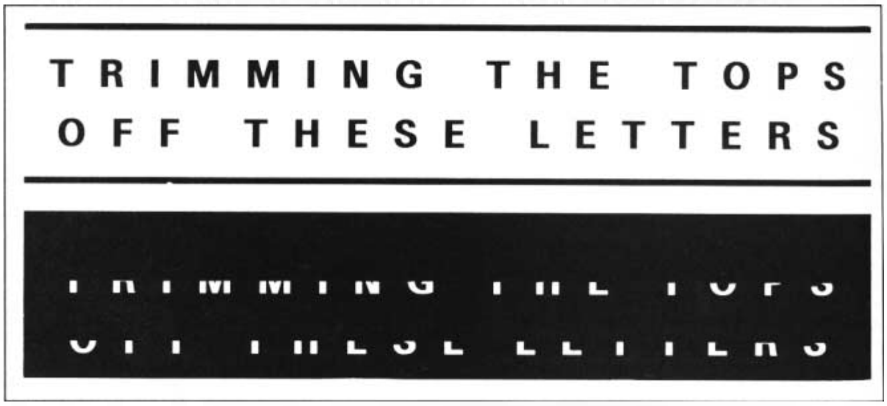


Figure 61 - "Letter Resynthesis" experiment by R. Fischer.

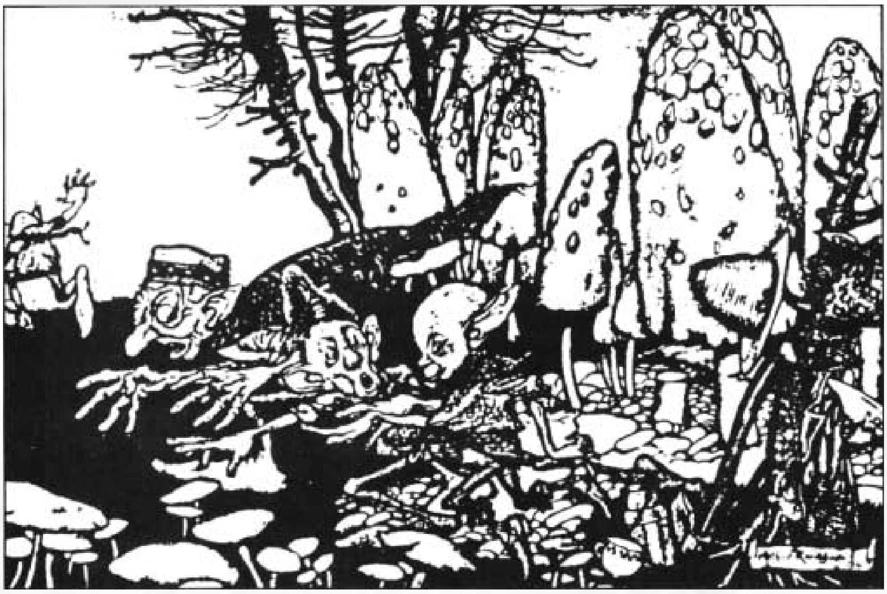


Figure 62 - "Peter Pan in Kensington Gardens". Lithography by Arthur Reckham (London, 1890).

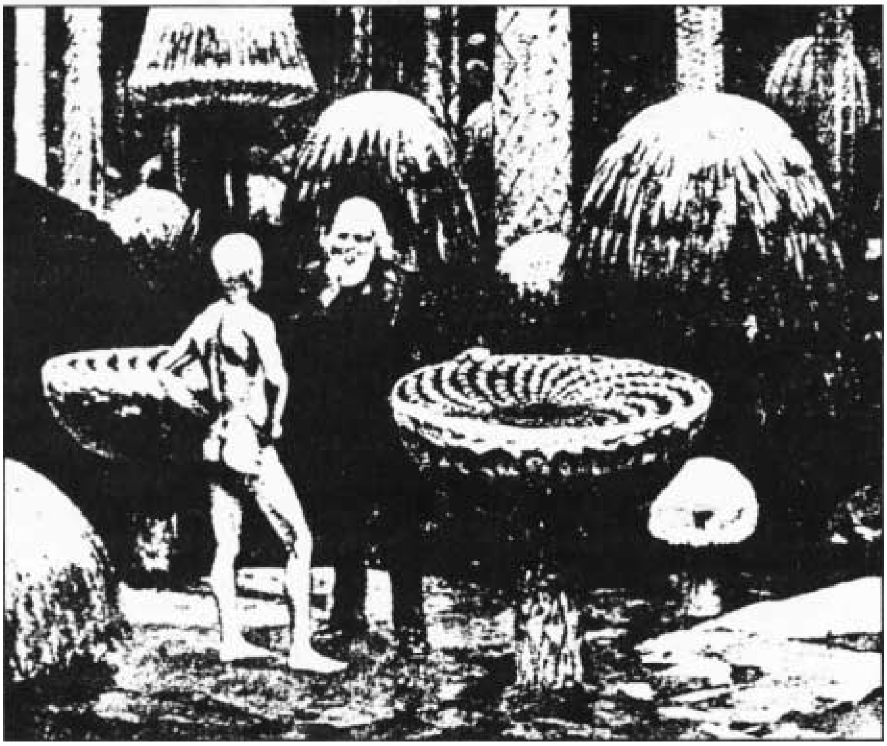


Figure 63 - "*Handing me one of the halves, he spoke the single word, drink.* " From *Etidorhpa* by J.U. Lloyd (1904).

CHAPTER 9

Psychotherapy

We live in an era of profound sociocultural changes, while a growing sense of insecurity pervades many areas of our lives. At the same time, our achievement-oriented society has fostered a set of values propagated by industrious, hard-working and successful citizens. Naturally, not all members of society are able to embody these ideals or embrace them all the time.

Psycholytic Therapy

Oftentimes, the origins of chronic neuroses are rooted in early childhood. Neurotic behavior can evolve under a wide variety of circumstances that include combinations of unfortunate personal and social conditions. There are numerous forms of neuroses and symptoms can vary considerably. Neurotic disorders afflict a large segment of the population, significantly impairing their quality of life.

According to the various schools of traditional psychoanalytic thought, the dissolution of neuroses is a lengthy process, whose progress depends on penetrating layers of "character armoring" and identifying the root causes of unhealthy fixations. Hoping to shorten the duration of treatment by accelerating the pace of resistance dissolution practitioners, have turned to pharmaceuticals as an adjunct to the therapeutic process. Thus, upon discovery of the unique properties of hallucinogenic agents during the 1950's, LSD gained widespread popularity as a therapeutic agent, while mescaline remained obscure, as it was used by comparatively few practitioners. Patients under the influence of these substances confronted long repressed traumatic events as they began to surface and enter conscious awareness. In some cases, such emerging traumatic experiences had been repressed since early childhood. Medical records and case histories indicate that many patients not only remembered, but actually relived traumatic experiences in their past.

At this point, I would like to summarize the major elements of this psychotherapeutic approach, based on the excellent books written by H. Leuner, S. Grof and S. Widmer. From a variety of different perspectives, these authors thoroughly examine the therapeutic process, drawing on extensive clinical expertise representing decades of experience in several countries.

At times, critics from within the psychiatric establishment have claimed that a "short-term high" is simply not capable of propelling complex processes into conscious awareness, and that psychoactive substances are no short-cut to quicker treatment. These are weak objections at best, because we already know that the awesome intensity of an unfolding psychedelic episode is sufficiently powerful to propel individuals towards gaining valuable insights of a highly personal nature (see accounts in Chapter 3.2). Such landmark experiences are likely to stand out as significant personal milestones whose impact will not diminish for many years, even if the individual never uses the substance again. On the other hand, due to the profound, far-reaching nature of the psycholytic process, skillful and responsible guidance is crucial to preventing the genesis of new sets of neurotic symptoms. Whenever a new therapy is adopted, occasional mistakes are not uncommon during the initial phases. The medical use of hallucinogenic substances was no exception. However, our knowledge base and expertise on essential practical procedures has grown considerably since the pioneering days of psycholytic therapy. Having learned from initial errors, we can now prevent problems and avoid mistakes.

Psilocybin as the Drug of Choice

Following its initial isolation and discovery of its chemical structure, psilocybin quickly joined the group of hallucinogens used in therapeutic settings. The alkaloid was considered to be quite safe, based on existing toxicological data. H. Leuner still considers psilocybin the most effective alkaloid for use as a pharmaceutical aid in psychotherapy, despite recent progress in developing other substances designed for therapeutic applications, such as the substituted phenethylamines like MDMA. Psilocybin's reputation as a substance well suited for psychotherapeutic applications is related to its extremely low toxicity. Most importantly, dosages below the 10 mg threshold can be measured with accuracy. This is significant, because dosages of up to 10 mg are not only known to be therapeutically efficient, but effects within this dosage range can always be brought under control. The states of consciousness induced by psilocybin last only five hours, on average, and thus can be more conveniently utilized than altered states caused by LSD, whose effects persist for much longer time periods. LSD should be considered a more difficult substance to work with, due to the possible emergence of unwanted symptoms in a small percentage of users and the prolonged process of "coming down" when symptoms subside. Unlike other hallucinogens, psilocybin also has the advantage of almost never inducing "hangovers" the day after experimental sessions.

It is important to note in this context that all authors stress that hallucinogens are no substitute for lack of skills on the part of the therapist and that the usage of these substances should remain limited to carefully selected cases. Usage of hallucinogens "merely" shortens the duration of psychoanalytic treatment, as problem conflict areas surface faster and with greater clarity, mediated by the process of self-exploration and discovery that is the essence of psychedelic experiences. Repressed patterns of normal behavior and reactions must be gradually reconstructed within the therapist-patient relationship.

The capacity for emotional immersion into one's own problems under the influence of a psychoactive substance is provoked and amplified by the emergence of memories, as well as the elimination of the Me/You boundary. As this process unfolds, the therapist gains valuable insights into existing psychopathologies and psychodynamics. Still, in addition to providing proper guidance for the patient, the therapist must also be able to separate bizarre forms of alienation that may appear from the emerging conflict matter.

The Language of Statistics

According to statistical data, psycholytic therapy is a remarkably efficient form of treatment, most notably in patients suffering from neuroses. A follow-up study of 82 patients showed that 65% of them showed long-term, clinically significant improvement. In all, 28 authors described 1,600 therapy cases, covering 42 investigations that took place from 1953 to 1965. The course of illness was judged very grave and chronic in 68% of the cases. The administration of hallucinogenic substances within the psychotherapy setting resulted in success rates of up to 70% ("good and substantial improvement"), especially in the treatment of neurotic anxieties, depressive-neurotic dysphorias as well as neurotic character disorders.

In the former Czechoslovakia, M. Hausner also tested *Psilocybe bohemica* for psycholytic therapy sessions, with successful outcomes comparable to those observed following administration of LSD. For many years up until 1974, Hausner has used LSD with more than 350 patients in about 3,000 sessions. In Mexico from 1967 until 1974, S. Roquet developed an interesting modification of the therapeutic technique ("psychosynthesis") where hallucinogens are used as an adjunct to the therapy process. His conceptual approach was strongly influenced by the shamanistic uses of different substances in his home country. Groups of 10 to 20 people experienced effects of a diversity of substances (psilocybin mushrooms, peyote, LSD, ololiuqui). While stereo music played in the background, several slide and film projectors were used to present images whose emotional content ranged from pictures of love to scenes of horror. Thus, in addition to hallucinogen-induced emotional stimulation, patients are also exposed to powerful external stress factors, modifying the experience into one of a very deeply emotional nature. Duration of treatments varied from 18 months up to two years, with many hours of drug-free therapy and, on average, one hallucinogen-assisted session a month. On a few occasions, patients received the substance in individual settings. Roquet reported successful treatment of neurotic character disorders in 85 of the patients. The psychoanalytic and transpersonal elements of a substances' effects were considered therapeutic agents, supported by sustained positive feelings among group session participants.

The Conquest of Fear in the Face of Death

During the 1960's and 1970's, most therapists in Europe were limiting the scope of their work by exploring only the psychodynamic level of behavior. Elsewhere, however, practitioners of hallucinogen-assisted therapy dispensed large doses of psychoactive drugs, maximizing the emergence of transpersonal states of consciousness that often resembled mystical experiences. These episodes of transpersonal transcendence ("psychedelic therapy" in the U.S.) contribute to the therapeutic process; they may even be the sole source for future progress.

Under these conditions, stereo music also significantly deepened the intensity of the experience. It appears that these kinds of specific experiences may also account for the remarkable success of treating terminal patients with LSD to ease their fears in the face of death and to reduce even the most severe forms of pain. In many such cases, symptoms disappeared entirely, and relief from pain and anxiety that continued even after the drug's acute effects had worn off. A book by S. Grof provides a compassionate analysis of such successful treatments, which serves to underscore the fact that systematic efforts to investigate these particular therapeutic benefits have only just begun. So far, LSD has been the most widely studied substance in terms of easing the suffering of terminally ill patients, as well as dipropyltryptamine (DPT), a synthetic drug structurally similar to psilocybin that is active only when administered by injection.

Below, a young woman from Switzerland gives a detailed account of her second mushroom experience. Her first experiment, with *Psilocybe cubensis*, had already introduced her to the realm of mystical experiences. For her second journey, she used 20 *Psilocybe semilanceata* mushrooms as part of a group ritual and achieved transcendence. A remarkable feature of her account is that the presence of an experienced guide was needed to realize the full potential of this visionary quest.

> *"I sat down next to another participant, seeking to connect with others in preparation for my journey. We proceeded to eat the fresh mushrooms. The room grew quiet and lovely music began to play. The mushrooms' effects came on much faster than they did during my first experiment. Twice I tried to establish closer contact with my fellow participant, but he was very nervous, and no source of reassurance for me. I was seeking my spiritual companion, but did not find that person among the present group. I became a figure in a long, white robe, wandering aimlessly among the columns (Greece?), still searching.*
>
> *My gaze lingered briefly on the wall next to the door and I saw faces and figures appear and vanish, but they did not hold my interest. It was hopeless. I continued my aimless roaming, and I was on the material plane, which I wanted to leave - had to leave. Suddenly, I found myself with one of the guides, who wanted to help me. I stared off into the distance, longing to be free of the material plane, but unable to do so. For a long time, I failed to connect with the guide; our two worlds were just too different. Suddenly I sensed that he wasn't able to look at me directly. The path by which to reach me runs through my eyes, because only they are truly alive. I asked him to help me on my way and invited him to look into my eyes. I felt as if all life energy was draining from my body and my breathing became erratic. My body contracted, struggling to cast off its worldly shell. The guide began to talk to me in a calm and quiet voice, then laid back down and stroked my right arm. Quite suddenly, I felt at peace. I took a deep breath and relaxed. The guide said that it's alright, to just let go, to give up my resistance. The goddess awoke and told him that he is the one resisting. Why? Didn't he want to learn anything about me? I smiled the goddess's smile and had become her, as he replied that he was afraid of my eyes, because they appeared so bottomless and dark that he feared losing himself in them. I answered that I was dangerous, the Goddess Kali the Terrible, a man-eater, and that he should look at me and enter. My gaze penetrated him into eternity; a connection had finally been established. His face turned green, covered with moss and I saw horns. It was a kind face, yet full of cunning, a little devil's face, like Pan's. At times, stripes streaked across his face; I had become a seer.*
>
> *I saw a child, a young man with blond hair cropped just above his shoulders, ca. 17th century. He is busy writing, inside a small house located in a city; a poet perhaps, or a scribe? Germany or Holland? This was a state of infinite harmony, a light that seemed to come from everywhere and nowhere at all; something that had always been there and always will be, something that simply exists. There is no past and no future. Consciousness beyond body and barriers, infinite, all-consuming; an infinite, universal love that embraces everything. I had a strong sense of agelessness, because I embodied a principle that had always existed. How intensely I felt these unearthly emanations, this very eternity. I saw through what appeared to be a succession of many caves, through myriad dimensions, and all of them were flooded with light - my energy. An energy existing simultaneously at its source as well as throughout eternity. This was a plane of utter harmony, devoid of contrasts such as good and evil, marked by the overwhelming peace of a spirituality both cosmic and infinite. The Goddess smiled. I no longer existed as a woman and as such could not be reached by others.*

> *After that, the effects began to subside slowly. In the presence of my guide I felt infinite protection and total understanding. Under his guidance and protection, I began to ease into the slow and gentle descent back to my earthly state of being. In the process, I found myself able to switch back and forth repeatedly between both states of consciousness. I realized that even my deepest agonies had become insignificant over "on the other side ". Furthermore, I understood that all the religions with their sets of rules had been created at one time or another for the sole purpose of providing guidelines for humanity, yet excessively narrow interpretations of these rules have rendered them all but irrelevant. Anyone who embarks on a deliberate search for a higher harmony, seeking spirituality, has no need for such rules at all."*

It is instructive to consider some of the comments made by R.G. Wasson's wife Valentina Pavlovna, as they appear in the second report about Mexico's magic mushrooms in 1957, written in the wake of experiencing the impressive effects of her self-experiment. A medical doctor by profession, V. Pavlovna brought up the potential for medical applications, given successful isolation of the active mushroom ingredient. According to her writings from that period, she believed the substance to become a significant new tool in the study of psychic processes, that it would benefit the treatment of alcoholism, drug addiction and mental problems, and help ease the suffering of terminally ill patients with severe pain. It was several years later that a number of researchers, unaware of V. Pavlovna's article, began to treat these very same conditions with LSD, a substance that is much harder on the patients' systems than psilocybin!

The medical use of psilocybin, a basically non-toxic substance, as well as mushrooms with known active ingredients, should, in my opinion, be permitted with terminally ill patients. The promise of easing the suffering of dying patients alone should be reason enough to allow the use of psilocybin and related substances, considering the reality of fatal illness as one of the grimmer universals of human existence. Many psychiatrists and pharmacologists maintain that the mystical aspects of hallucinogenic substances should be described more accurately as psychotic in nature, and that repeated manifestations of these symptoms are cause for worry and concern, since their existence and nature cannot be explained. The convictions behind these beliefs, however, pale compared to the promise of being able to provide that which strikes at the very essence of practicing medicine: to help patients endure the ultimate anguish of impending death, while making sure they are not left alone to deal with pain and fear.

Scientific Research Under Fire

It was about 30 years ago that legislation was enacted severely restricting the use and availability of hallucinogens. It is most unfortunate that these sweeping prohibitions dealt a crippling blow to legitimate research efforts, forcing more and more investigators to abandon this area of study. Thus, despite the success of psycholytic therapy, its practice was discontinued during the 1970's. In retrospect, a calm and pragmatic analysis of these events can surely help us recognize that those years of pioneering research laid the foundation for the development of a whole new form of treatment - one that has already proven effective in aiding the healing process and relieving the symptoms of hundreds of gravely ill patients in various countries around the world. In many cases, improvement occurred after all previous methods of treatment had failed completely. Today, we are faced with a situation so bizarre it defies reason and logic: the entire pharmacological class of hallucinogens is subject to even more severe taboos than truly addictive substances that do have legitimate medical uses, such as the morphine-type drugs and their derivatives.

H-Bomb for the Soul?

The irrational fears surrounding the "proper functioning" of our consciousness were responsible for the genesis of two very extreme views about LSD during the 1960's, dating back to the earliest phases of research into this substance. Proponents praised LSD as a "miracle drug", while its detractors were quick to brand LSD the "devil's drug" (or "an H-bomb for the soul"). It was the latter group that prevailed in the end by way of political power.

This controversy, already a matter of historic record, has been marked by a pattern of confusing emotion with scientific standards. Today, we are surely capable of overcoming past controversies, by embracing a rational approach to resolving problems and issues of contention. Viewed objectively, an unbiased assessment of hallucinogen-assisted psychotherapy is possible only in terms of measuring success. In order to do this, however, we must be allowed to use these substances in therapeutic and unbiased scientific settings.

There is some hope that current lop-sided attitudes against hallucinogens may be changing for the better, as efforts by the Swiss Medical Society for Psycholytic Therapy to re-legitimize hallucinogen-assisted therapy have met with modest success. In 1988, the Swiss gave permission to a few selected psychotherapists to use psychoactive substances for psychotherapeutic purposes, at least within a narrow range of strictly defined conditions and for a limited time. Thus, legal psycholytic therapy in Switzerland continued until 1993, with efforts to renew the permit currently underway. Thus, we can hope that in the future, psychedelics-assisted psychotherapy will experience a similar renaissance in other countries as well. If so, psilocybin is likely to stand out as the most valuable and beneficial substance, as well as the least risky among the group of possible substances that may be used in this context.

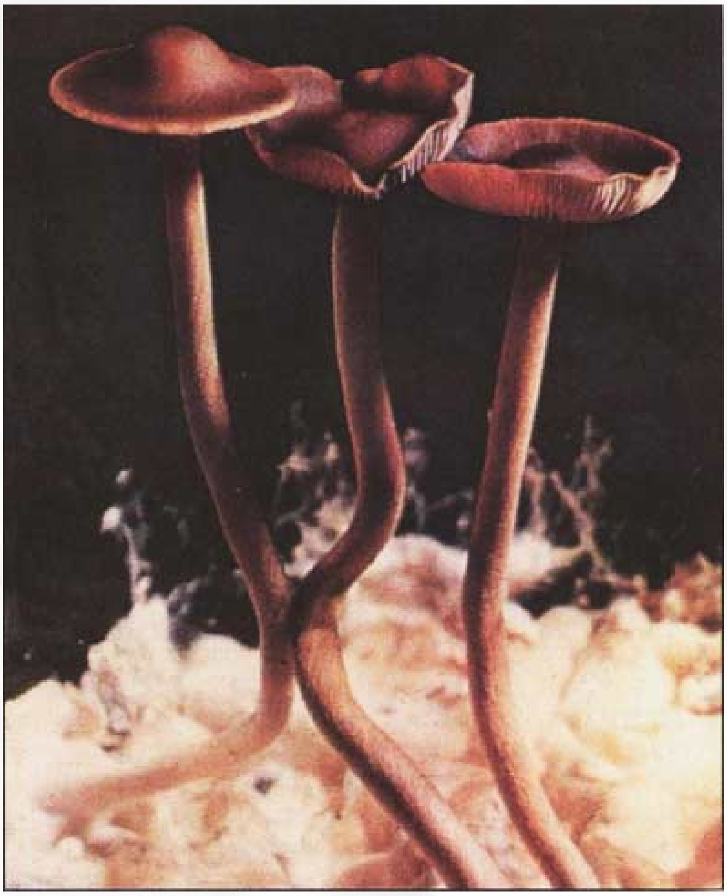


Figure 64 - Laboratory culture of ***Psilocybe mexicana*** Heim.

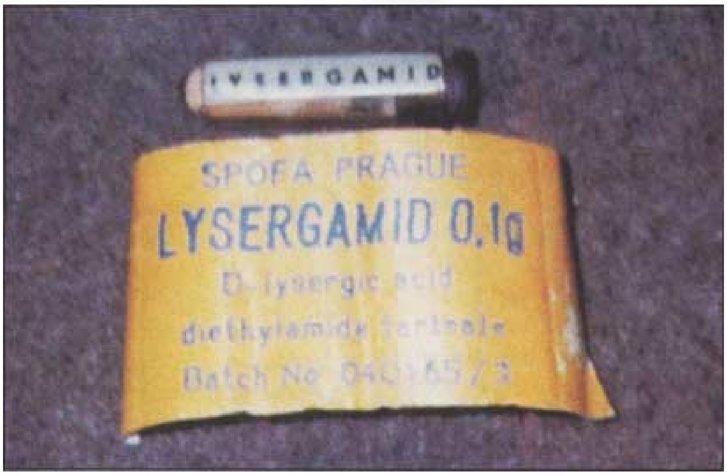


Figure 65 - Vial of pharmaceutical LSD with.

CHAPTER 10

Outlook

Apparently, all of the most important psilocybin-producing European mushroom species are already well known. Their geographic distribution and migration patterns, however, have not yet been adequately investigated. This knowledge gap primarily applies to recently discovered species outside the *Psilocybe* genus. In addition, there is a lack of comprehensive sources of information on distribution patterns of *Psilocybe cyanescens* for a number of different countries.

More Taxonomic, Ecological and Chemical Data are Needed

I would like to suggest that, for most species, even chemical analysis data should be viewed as merely preliminary in nature. In order to learn the truth about these mushrooms and such issues as prevalence, migrations into new habitats, specific positions within the mycological system as a whole, or chemo-taxonomical concerns, we must first acquire more taxonomic, ecological and chemical data from the study of relevant mushroom species. While further analysis of fruiting body samples from known species in order to determine alkaloid content variability remains an essential task, future research must also include efforts to identify secondary substances, as well as their structural isolation. Baeocystin, for example, appears to be an alkaloid primarily found in mushrooms from temperate climate zones, and it is less common in tropical species. Today, there are substantial doubts over whether the synthesis of Baeocystin as described in 1988 is actually feasible. There is an urgent need for additional research on the synthesis of this substance. Possibly, a number of different mushroom ingredients may have psychotropic effects. As such, they could act as modifiers of psilocybin's primary effects in various ways. For instance, accounts of mushroom usage from ancient Mexico already included observations about different types of effect associated with the various mushroom species in use. Perhaps these distinctions are not just the result of different concentrations of psilocybin and psilocin. Moreover, among European and North American mycophiles, the vast majority stress the popularity of *Psilocybe semilanceata*, a species favored over all others, because of its reputation for causing the "richest" kinds of experiences. Indeed, analyses of *Psilocybe semilanceata* extracts typically confirm the presence of eight indole compounds, whereas other species, such as *Psilocybe cubensis*, usually contain only half as many. Understanding just how such ingredients interact with psilocybin may well result in the development of new clinical applications for these substances.

The mycological literature includes information about several rare, if "questionable", species, some of which have been reported to show blue discolorations. The *Mycena* and *Pluteus* genera, for example, include descriptions of such mushroom species. If indole alkaloids were to be found in mushrooms other than the *Agaricales* (gilled mushrooms), it would mean a sensational discovery. Future chemical analyses are bound to identify additional psilocybin-producing mushrooms among the European species, which number about 5,000. There is an even greater likelihood of discovering alkaloids in many non-European species, as the mycofloras of most countries have not been researched as extensively as Europe's.

Understanding the Mushrooms' Powerful Magic

Ethnopharmacological research efforts are also bound to generate remarkable results in the near future. G. Samorini, for instance, recently reported that Catalonia, Spain, is a region where *Psilocybe semilanceata* has traditionally been known by the unusual name of "sorgin zorrotz", or "witches' tread". This label strongly suggests early ritualistic usage of *Psilocybe semilanceata* in that area. Interestingly, Catalonia is also known as Europe's only region where traditional usage of *Amanita muscaria* has been confirmed. In addition, there is growing evidence that other world religions, especially in Africa, have embraced the usage of psychoactive mushrooms as well, an intriguing possibility that calls for further study.

While the number of psychotropic mushroom species has risen dramatically all across Europe, the pace of progress in developing medical uses for mushroom ingredients has not followed suit. However, hallucinogens, including psilocybin have a history of therapeutic usage, a practice that is documented by a great deal of information, experiences and insights.

Given the lack of alternate methods to study these substances, the revival of medical and interdisciplinary research efforts is a more crucially important issue now than ever before. After all, a better understanding of psychotropic substances may well benefit a vast number of patients, possibly by contributing to the processes of mental and psychic healing. A glimmer of hope for the revival of large-scale research comes from the United States, where a very small number of investigators have, on occasion, succeeded at securing government permission to conduct studies on the medical aspects of hallucinogens, including psilocybin. The conceptual approach behind the design of these research projects suggests that virtually no reliable pharmacological data is in existence. In fact, these substances have undergone extensive study over the course of several decades. To the extent that relationships of dosage and effects have already been determined, current and future research efforts should build upon existing knowledge, instead of neglecting or ignoring previously published results. High-tech methodology may well yield new results - techniques for exploring and enhancing our understanding of mushrooms at the biochemical level. But increased biochemical knowledge does not permit us to draw any sort of conclusion about other aspects of psychoactive substances, such as psychedelic peak experiences, exploring the realms of the subconscious mind, as well the development of therapeutic applications based on these effects.

Certain hypnotherapy techniques are known to induce experiences similar, but not identical to, those caused by administration of hallucinogens. Recent studies have demonstrated that hypnosis can benefit the immune system, a finding that suggests psilocybin and related compounds may have potentially similar properties. Meditation and dreaming are additional examples of states of consciousness with interesting parallels to psychedelic experiences, yet very little is known about these links, due to the scarcity of research efforts in this area.

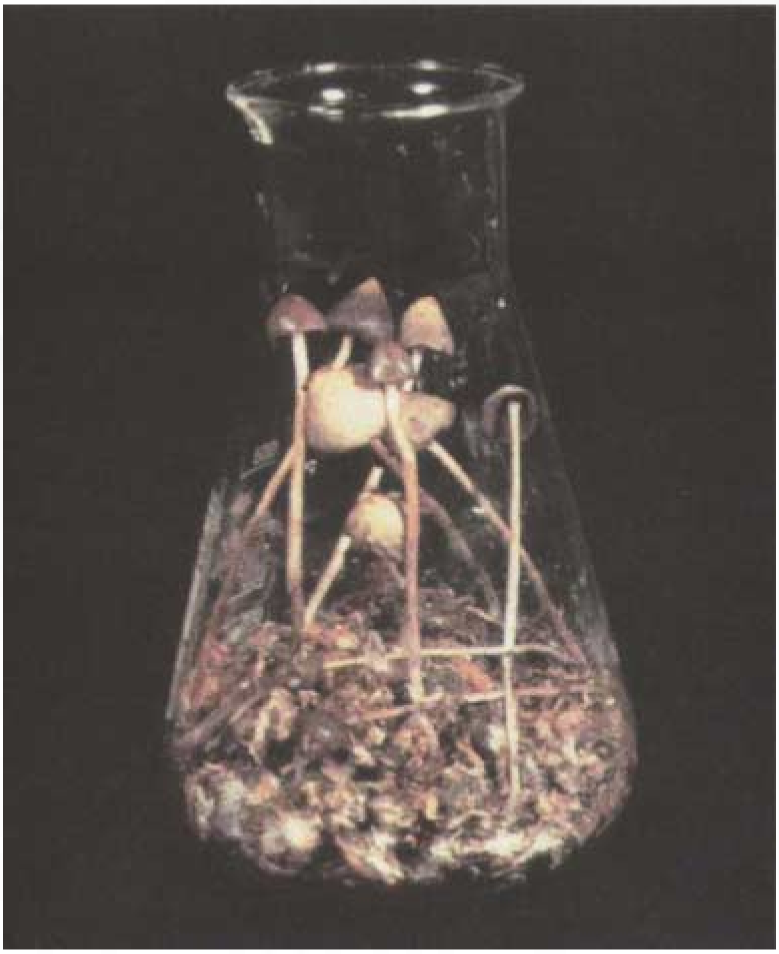


Figure 66 - ***Psilocybe semilanceata*** cultured on a mixture of grass seeds, dung and grains of rice.

In recent years, the non-medical use of psychotropic species has become an increasingly popular pastime. I agree, however, with the assessment of Swiss toxicologist R. Flammer, who has written about the possible problems linked to this practice:

> *"....There is no need to panic, considering the severity of existing problems with alcohol and hard addictive drugs, which make the Panaeolus mushrooms and their close relatives appear harmless by comparison."*

In order to guard against being dazzled or overwhelmed by the mushroom's powerful magic we must embrace the pursuit of in-depth research into hallucinogenic mushrooms, a method that can protect us from jumping to conclusions, and in the process, from hampering the advancement of beneficial applications.

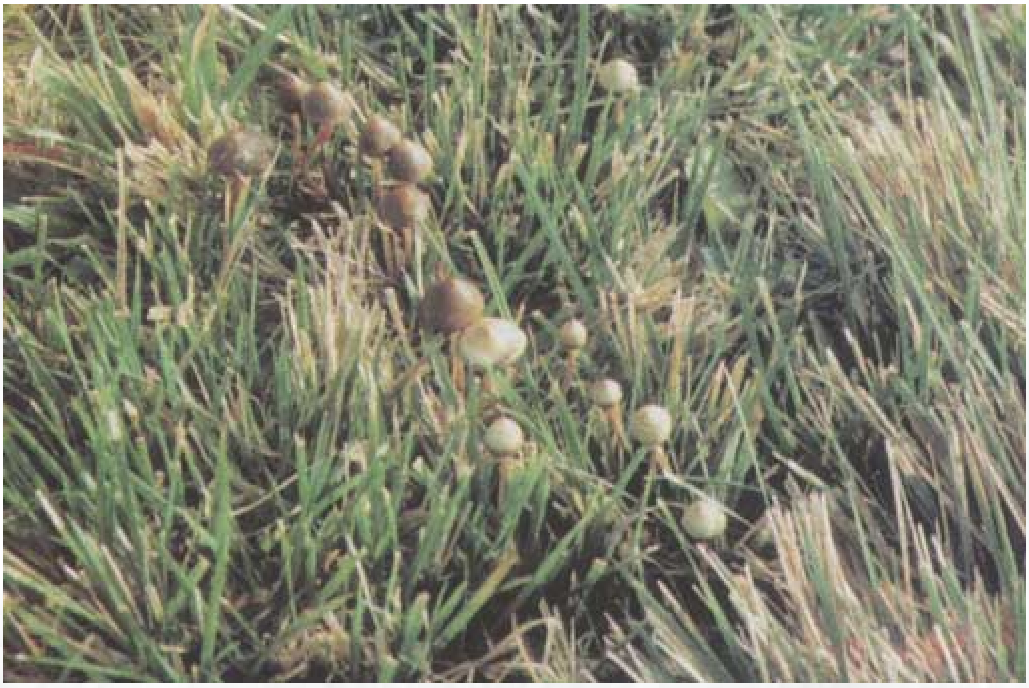


Figure 67 - ***Psilocybe semilanceata*** at a natural location in Austria.

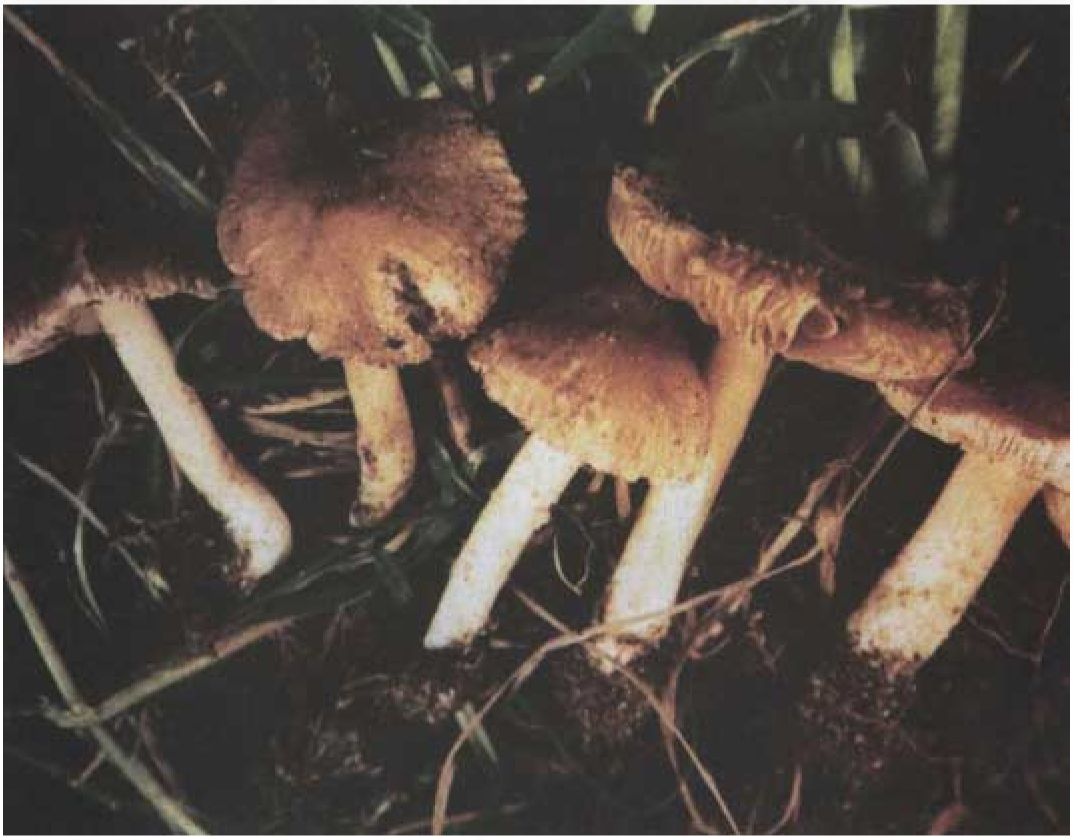


Figure 68 - ***Inocybe aeruginascens*** fruiting bodies at a natural location.

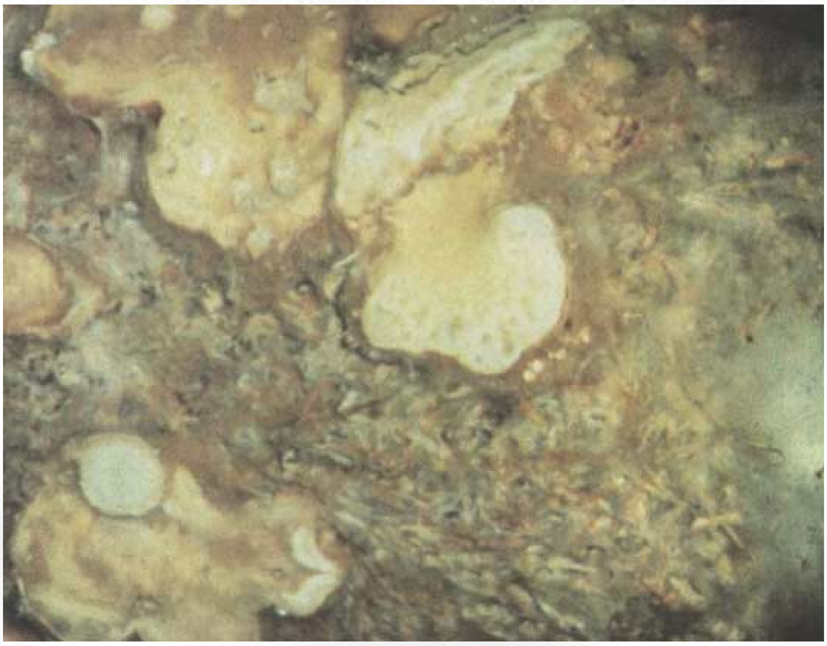


Figure 69 - ***Psilocybe tampanensis*** sclerotia on lolium seeds.

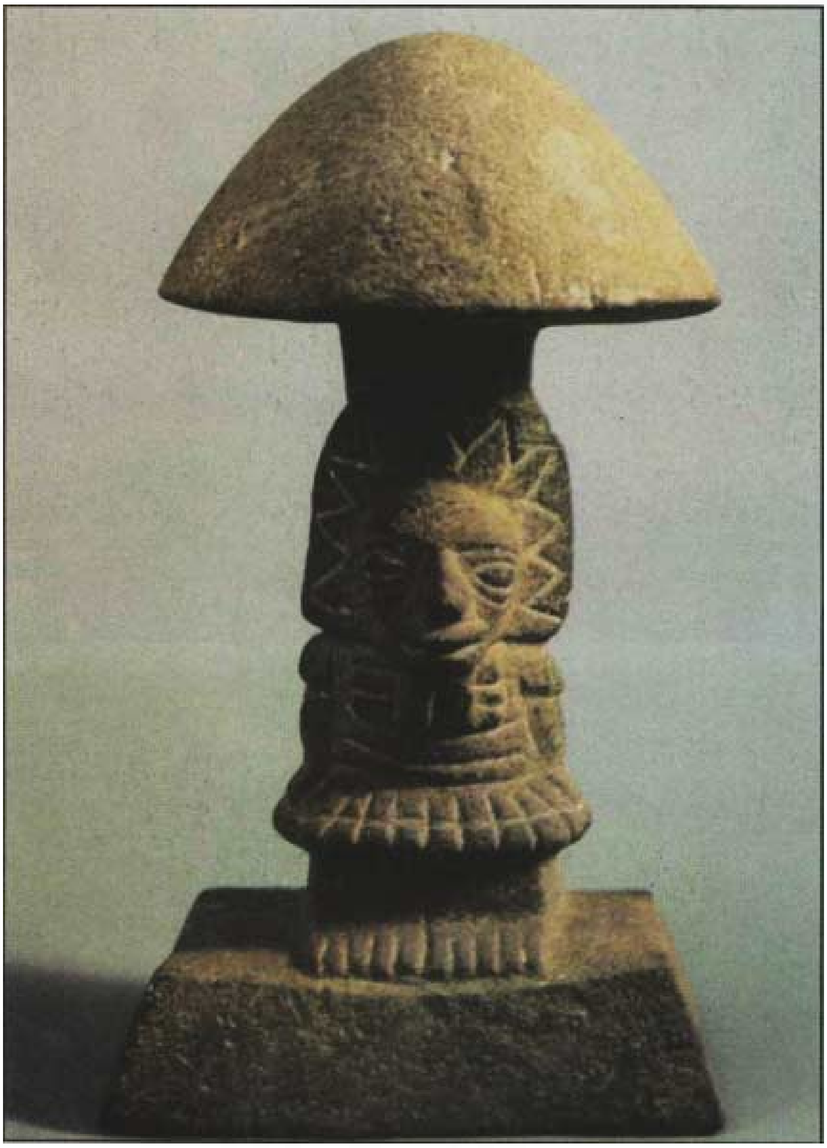


Figure 70 - Stone sculpture of a mushroom deity from the classic period of Mayan culture (300-600 A.D.). Statue is about 12 in. tall. (Rietberg Museum, Zurich).

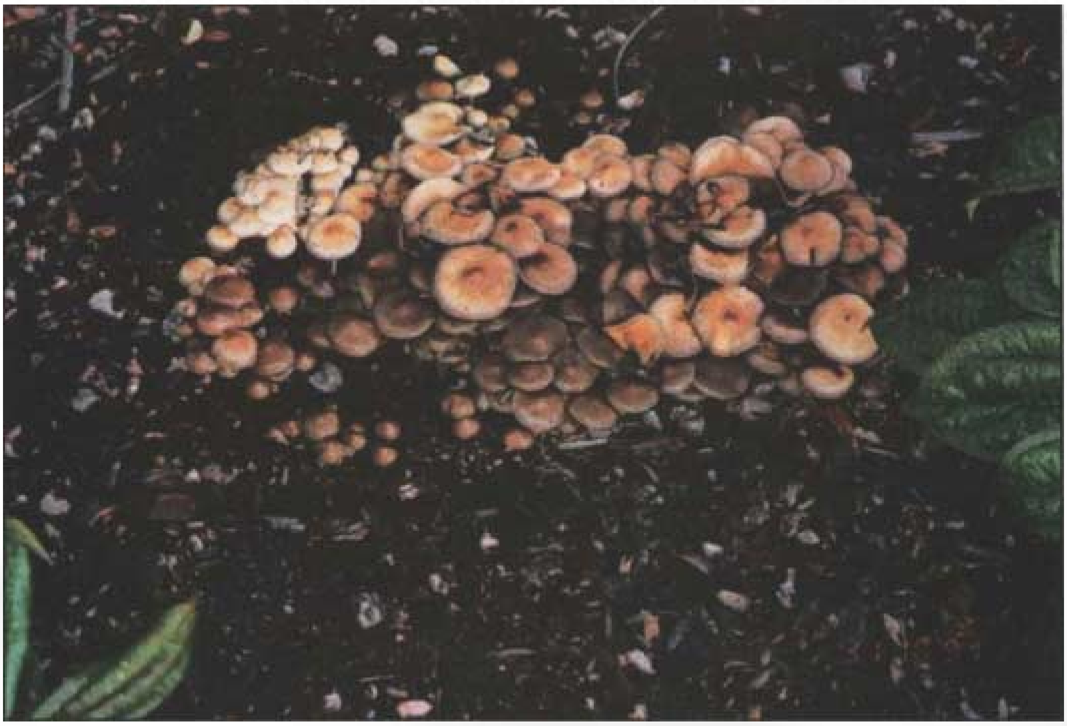


Figure 71 - ***Psilocybe stuntzii*** on mulch (Northwestern United States).

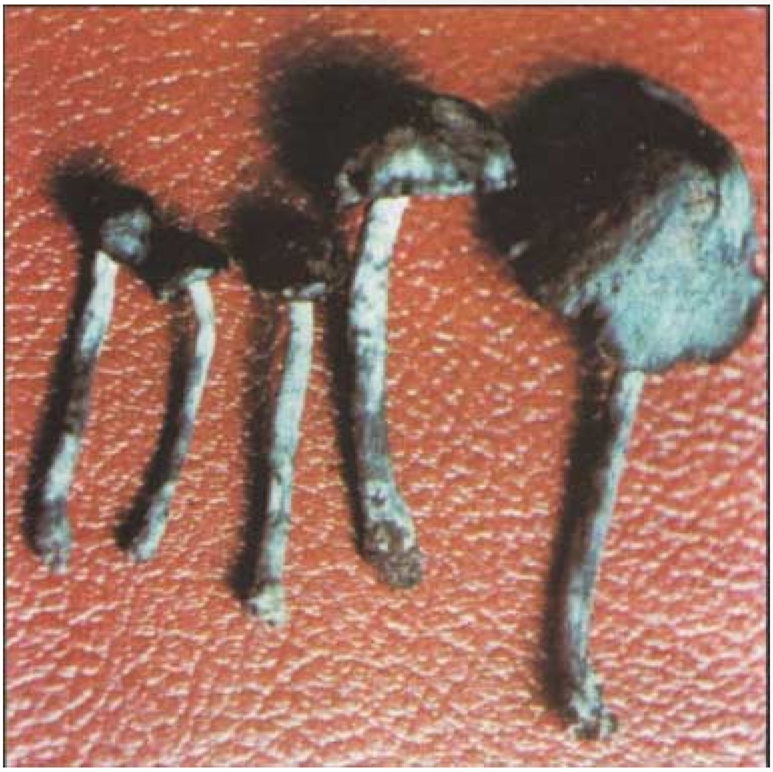


Figure 72 - ***Psilocybe baeocystis*** from Seattle, USA.

Acknowledgments

I am particularly grateful to Claudia Taake. Without her translation, her technical support and our stimulating, creative discussions, the publication of this book in its present form would not have been possible.

I want to thank Scott Bradbury for his contribution of original artwork on both covers and on page 1, and for assisting with cover design and layout.

I am grateful to several individuals who introduced me to mycology; special thanks are due those who have provided me with a number of extremely rare mushroom samples for my research. I am most grateful to Gerhard Drewitz of Caputh (Berlin) for his helpful observations on the taxonomy and toxicology of the *Inocybe* species. For more than 10 years, he has furnished me with rare mushroom specimens for chemical analyses. I am thankful for our many joint excursions into the world of mushrooms.

Gerd K. Muller (Leipzig, Germany) has deepened my understanding of the mushrooms' purpose and position in the natural world. It was our collaboration at the University of Leipzig, and an opportunity to deposit mushroom material at the Leipzig Herbarium that resulted in the discovery of new frontiers in mycological research.

For contributing valuable data on natural products chemistry, taxonomy and medical applications for psychedelics, I am indebted to the late Marta Semerdzieva, who died in 1994, as well as to Milan Hausner and Josef Herink in the Czech Republic. I cherish the memories of our collaboration and our joint field research expeditions.

I want to thank John W. Allen (Hawaii) for generously sharing many photographs and his expert knowledge of the mycofloras in North America, Hawaii and Asia. I sincerely wish to thank my friends in Switzerland, Rita C. Zengaffmen and Udo Kinzel, for all their contributions. I want to thank Michael W. Smith (Pietermaritzburg, South Africa) for our collaborative field research in South Africa in January, 1994. I am grateful to Paul Stamets (Olympia, WA) for his contribution of mushroom photographs. For their expertise and for providing valuable information I also wish to thank Albert Hofmann, who discovered psilocybin and psilocin (Burg, Switzerland); as well as Jonathan Ott (Xalapa, Mexico); Hanscarl Leuner (Gottingen, Germany); Christian Ratsch (Hamburg, Germany); Alexander T. Shulgin (Lafayette, CA); and Giorgio Samorini (Bologna, Italy).

Finally, my heartfelt gratitude goes to Irmgard Richter, for her years of support and for enduring my unbridled mycophilia.

LIS Publications wishes to thank the following individuals and businesses who have helped make this book possible: Brad Falk, Scott Bradbury, Angelica Biddle, Ronda Flanzbaum, Tim Matthews, David Cronk, Kerstin Taake, FS Books, Knockabout Comics, Mind Books and Rosetta Books.

PHOTO AND ILLUSTRATION CREDITS (*listed by Figure #*)

2, 4, 24, 29, 39, 54, 56, 72: Photographs by John W. Allen.

5, 55, 59: Courtesy of Giorgio Samorini.

20, 23, 38: Courtesy of German J. Krieglsteiner.

34: Photograph by Gerhard Drewitz.

36: Photograph by Paul Stamets.

61: Illustration by Claudia Taake.

64, 70: Courtesy of Albert Hofmann.

65: Courtesy of Marta Semerdzieva.

68: Photograph by Gerd K. Miller.

Front Cover by Scott Bradbury

Back cover photograph by Michael T. Smith.

Drawing on page 2 by Scott Bradbury.

All other photographs and illustrations by the author.

Bibliography

Considering the vast amount of relevant mycological literature, it makes sense to subdivide citations into categories representing distinct subject areas and specific species and genera. While some entries deal with more than one mushroom species, they are listed only once, under the category heading of the species that is the main focus of the work cited. This will aid in locating citations about specific species, as well as those with a more generalized scope, since titles alone often do not accurately reflect overall content or specific emphases.

1. Basic Reviews

1. Allen, J.W., Merlin, M.D. & Jansen, K.L.R. (1991). An ethnomycological review of psychoactive Agarics in Australia and New Zealand. *Journal of Psychoactive Drugs*, 23, 39-69.
2. Allen, J.W., Gartz, J. & Guzman, G. (1992). Index to the botanical identification and chemical analysis of the known species of the hallucinogenic fungi. *Integration*, 2&3, 91-97.
3. Allen, J.W. & Merlin, M.D. (1992). Psychoactive mushroom use in Koh Samui and Koh Pha-Ngan, Thailand. *Journal of Ethnopharmacology*, 35, 205-228.
4. Allen, J.W. & Gartz, J. (1995). Some recent notes and observations on the occurrence and use of entheogenic fungi in third world countries. *Psychedelic Monographs and Essays*, 7 (in press).
5. Anonymous (1978). Mycologists and the law. *Bulletin of the British Mycological Society*, 12, 56-57.
6. Auert, G., Dolezal, V., Hausner, M. & Semerdzieva, M. (1980). Halluzinogene Wirkungen zweier Hutpilze der Gattung Psilocybe tschechoslowakischer Herkunft. *Zeitschrift für Ärztliche Fortbildung*, 74, 833-835.
7. Badham, E.R. (1984). Ethnobotany of psilocybin mushrooms, especially Psilocybe cubensis. *Journal of Ethnopharmacology*, 10, 249-254.
8. Beug, M. & Bigwood, J. (1982). Psilocybin and psilocin levels in twenty species from seven genera of wild mushrooms in the Pacific Northwest, USA. *Journal of Ethnopharmacology*, 5, 271-285.
9. Bocks, S.M. (1968). The metabolism of psilocin and psilocybin by fungal enzymes. *Biochemistry Journal*, 106, 12-13.
10. Hall, M.C. (1973). ProblemBoire, R.G. (1995). *Sacred Mushrooms and the Law*. Spectral Mindustries, Davis, CA.
11. Carter, M. (1976). Will the legal Liberty Cap cause home office hallucinations? *New Scientist*, 16 Sept., 59.
12. Cox, P.A. (1981). Use of a hallucinogenic mushroom, Copelandia cyanescens, in Samoa. *Journal of Ethnopharmacology*, 4, 115-116. English, M.P. (1987). *Mordecai Cubitt Cooke*. Biopress Ltd., Bristol, Great Britain.
13. Ford, W.W. (1923). A new classification of mycetismus (mushroom poisoning). *Transactions of the Association of American Physicians*, 38, 225-229.
14. Gartz, J. (1986). Ethnopharmakologie and Entdeckungsgeschichte der halluzinogenen Wirkstoffe von europaischen Pilzen der Gattung Psilocybe. *Zeitschrift für Ärztliche Fortbildung*, 80, 803-805.
15. Gartz, J. (1992/93). New aspects of the occurrence, chemistry and cultivation of European hallucinogenic mushrooms. Ann Mus. Civ. Roverto *(Italy) Sez. sc. nat.*, 8, 107-124.
16. Gartz, J. (1994). Extraction and analysis of indole derivatives from fungal biomass. *Journal of Basic Microbiology*, 34, 17-22.
17. Gartz, J., Allen, J.W. & Merlin, W. (1994). Ethnomycology, biochemistry and cultivation of Psilocybe samuiensis Guzman, Bandala and Allen, a new psychoactive fungus from Koh Samui, Thailand. *Journal of Ethnopharmacology*, 3, 73-80.
18. Gartz, J., Rei D., Eicker, A. & Smith, M.T. (1995). Psilocybe natalensis sp.nov. - the first indigenous blueing member of the Agaricales of South Africa. *Integration*, 6, 29-34.
19. Guzman, G. (1983). The genus Psilocybe. *Beih. Nova Hedwigia*, 74.
20. Guzman, G., Bandala, V.M. & Allen, J.W. (1993). A new bluing Psilocybe from Thailand. *Mycotaxon XLVI*, 155-160.
21. Hall, M.C. (1973). Problems in legislating against abuse of hallucinogenic fungi in Australia. *Bulletin on Narcotics*, 25, 27-36.
22. Hofmann, A. (1960). Die psychotropen Wirkstoffe der mexikanischen Zauberpilze. *Chimia*, 14, 309-318.
23. Hofmann, A. (1980). *LSD - My Problem Child*. McGraw-Hill, New York.
24. Hofmann, A., Heim, R., Brack, A., Kobel, H., Frey, A., Ott, H., Petrzilka, Th. & Troxler, F. (1959). Psilocybin and Psilocin, zwei psychotrope Wirkstoffe aus mexikanischen Zauberpilzen. *Helv. Chim. Acta*, 42, 1557-1572.
25. Knecht, S. (1962). Magische Pilze and Pilzzeremonien. *Zeitschrift fur Pilzkunde*, 28, 69-78.
26. Kaplan, R.H. (1975). The sacred mushroom in Scandinavia. *Man, 10*, 72-79.
27. Larris, S. (1984). Psilocybinsvampe. *Svampe*, 9, 23-29.
28. Lloyd, J.U. (1895). *Etidorhpa*. Robert Clarke Company, Cincinnati.

29. Margot, P. & Watling, R. (1981). Studies in Australian Agarics and Boletes 2. Further studies in Psilocybe. *Transactions of the British Mycological Society*, 76, 485-489.
30. McKenna, T. (1992). *Food of the Gods*. Bantam, New York.
31. Ott, J. (1976). *Hallucinogenic Plants of North America*. Wingbow Press, Berkeley, CA.
32. Ott, J. (1993). *Pharmacotheon*. Natural Products Co., Kennewick, WA.
33. Ott, J. & Bigwood, J. (1978). *Teonanacatl - Hallucinogenic Mushrooms of North America*. Madrona Publishers Inc., Seattle, WA.
34. Pollock, S.H. (1975). The psilocybin mushroom pandemic. *Journal of Psychedelic Drugs*, 7, 73-84.
35. Pollock, S.H. (1977/78). Psychotropic mushrooms and the alteration of consciousness: 1: The ascent of psilocybian mushroom consciousness. *Journal of Altered States of Consciousness*, 3, 15-35.
36. Pollock, S.H. (1976). Psilocybian mycetismus with special reference to *Panaeolus*. *Journal of Psychedelic Drugs*, 8, 43-57.
37. Ratsch, C. (1989). *Gateway to Inner Space*. Prism Press.
38. Riedlinger, T.J. (1990). *The Sacred Mushroom Seeker: Essays for R. Gordon Wasson*. Dioscorides Press, Portland, OR.
39. Ruck, C.A.P., Bigwood, J., Staples, D., Ott, J. & Wasson, R. G. (1979). Entheogens. *Journal of Psychedelic Drugs*, 11, 145-147.
40. Sahiti, A. (1990). *Drogen von A-Z*. Beltz Weinheim-Basel.
41. Samorini, G. (1992). The oldest representations of hallucinogenic mushrooms in the world (Sahara Desert, 9,000-7,000 B.C.), *Integration*, 2&3, 69-79.
42. Schroder, R.F. & Guzman, G. (1981). A psychotropic fungus in Nepal. *Mycotaxon*, 13, 346-348.
43. Schultes, R.E. & Hofmann, A. (1979). *Plants of the Gods*. McGraw-Hill Book Company (UK) Limited, Maidenhead.
44. Schultes, R.E. & Hofmann, A. (1980). *The Botany and Chemistry of Hallucinogens*. Charles C. Thomas Publisher, Springfield, Illinois.
45. Seeger, R. (1985). Psilocybin. *Deutsche Apothekerzeitung*, 125, 65-66.
46. Shulgin, A.T. & Shulgin, A. (1996). *TIHKAL*. Transform Press, Berkeley, CA.
47. Siegel, R.K. (1985). New trends in drug use among youth in California. *Bulletin on Narcotics*, 37, 7-17.
48. Singer, R. (1958). Pilze, die Zerebralmyzetismen verursachen. *Schweizerische Zeitschrift fur Pilzkunde*, 36, 81-89.
49. Singer, R. (1958). Mycological investigation on teonanacatl, the Mexican hallucinogenic mushroom. 1: The history of teonanacatl, field work and culture work. *Mycologia*, 50, 239-261.
50. Stamets, P. (1982). *Psilocybe Mushrooms and their Allies (2nd ed.)*. Homestead Book Co, Seattle, WA.
51. Stamets, P. & Gartz, J. (1995). A new caerulescent Psilocybe from the Pacific Coast of Northwestern America. *Integration*, 6, 21-27.
52. Thompson, J.P., Anglin, M.G., Emboden, W. & Fischer, D.G. (1985). Mushroom use by college students. *Journal of Drug Education*, 15, 111-124.
53. Wasson, R.G. (13 May 1957). Seeking the magic mushroom. *Life*, 13 May: 42(19), 100ff.
54. Wasson, R.G., Kramrisch, S., Ott, J. & Ruck, C.P.A. (1986). *Persephone's Quest - Entheogens and the Origins of Religion*. Yale University Press, New Haven, CT.
55. Wasson, V.P. (1957). I ate the sacred mushrooms. *This Week Magazine,* 19 May, 8ff.
56. Watling, R. (1983). Hallucinogenic mushrooms. *Journal of the Forensic Sciences Society*, 23, 53-66.
57. Weil, A.T. (1977). The use of psychoactive mushrooms in the Pacific Northwest: An ethnopharmacological report. *Botanical Museum Leaflets, Harvard University*, 25, 131-149.

2. Medical-pharmacological Literature

1. Aboul-Enein, H.Y. (1974). Psilocybin: a pharmacological profile. *American Journal of Pharmacology*, 146, 91-95.
2. Barnett, B.E.W. (1971). Diazepam treatment for LSD intoxication. *The Lancet*, 270.
3. Benjamin, C. (1979). Persistent psychiatric symptoms after eating psilocybin mushrooms. *British Medical Journal*, 1319-1320.
4. Charters, A.D. (1957). Mushroom poisoning in Kenya. *Transactions of the Royal Society of Tropical Medicine & Hygiene*, 51, 265-270.
5. Cooles, P. (1980). Abuse of the mushroom Panaeolus foenisecii. *British Medical Journal*, 446-447.
6. Dittrich, A. & Scharfetter, C. (1987). *Ethno psychotherapie*. Enke, Stuttgart (Germany).
7. Dubansky, B. & Vyhnankova, M. (1967). Differences in the reaction of psilocybin in brain damaged subjects as related to the location of the lesion. *Activitas Superior Nervosa*, 9, 418-420.
8. Fischer, R. & Goldman, H. (1975). Therapeutic usefulness of hallucinogenic drugs as a function of their chemical structure. *Pharmakopsychatrie / Neuro-Psychopharamakologie*, 8, 176-178.
9. Fischer, R. & Rockey, M. (1967). Psilocybin. *Experientia*, 23, 150.
10. Francis, J. & Murray, V.S.G. (1983). Review of enquiries made to the NPIS concerning Psilocybe mushroom ingestion, 1978-1981. *Human Toxicology*, 2, 349-352.
11. Grinspoon, L. & Bakalar, J.B. (1981). *Psychedelic Drugs Reconsidered*. Basic Books, New York.
12. Grof, S. (1975). *Realms of the Human Unconscious: Observations from LSD Research*. The Viking Press, Esalen, CA.
13. Grof, S. (1981). *LSD Psychotherapy*. Hunter House, New York.
14. Grof, S. Halifax, J. (1977). *The Human Encouner with Death*. E.P. Dutton, New York.
15. Harries, A.D. & Evans, V. (1981). Sequelae of a "magic mushroom banquet". *Postgraduate Medical Journal*, 57, 571-572.
16. Hyde, C., Glancy, G., Omerod, P., Hall, D. & Taylor, G.S. (1973). Abuse of indigenous psilocybin mushrooms: a new fashion and some psychiatric complications. *British Journal of Psychiatry*, 132, 602-604
17. Leuner, H. (1968). Ist die Verwendung von LSD-25 fur die experimentelle Psychiatrie heute noch vertretbar? *Der Nervenarzt*, 39, 356-360.
18. Leuner, H. (1981). *Halluzinogene*. Hans Huber (Bern/Stuttgart/Wien).
19. Malitz, S., Esconer, H., Wilkens, B. & Hoch, P.H. (1960). Some observations on psilocybin, a new hallucinogen, in volunteer

subjects. *Comprehensive Psychiatry*, 1, 8-17.

20. McCarthy, J.P. (1971). Some less familiar drugs of abuse. *Medical Journal of Australia*, 2, 1078-1081.
21. McCawley, E.L., Brumett, R.E. & Dana, G.W. (1962). Convulsions from Psilocybe mushroom poisoning. *Proceedings of the Western Pharmacological Society*, 5, 27-33.
22. McGlothlin, W.H. & Arnold, D.O. (1971). LSD revisited: A ten-year follow-up of medical LSD use. *Archives of General Psychiatry*, 24, 35-49.
23. Mills, P.R., Lesinkas, D. & Watkinson, G. (1979). The danger of hallucinogenic mushrooms. *Scottish Medical Journal*, 24, 316-317.
24. Parashos, A.J. (1976/77). The psilocybin-induced "state of drunkenness" in normal volunteers and schizophrenics. *Behavioral Neuropsychiatry*, 8, 83-86.
25. Peden, N.R., Bissett, A.F., Macaulay, K.E.C. & Pelosi, A.J. (1981). Clinical toxicology of "magic mushroom" ingestion. *Postgraduate Medical Journal*, 57, 543-545.
26. Peden, N.R. & Pringle, S.D. (1982). Hallucinogenic fungi. *The Lancet*, 13 Feb., 396-397.
27. Peden, N.R. & Pringle, S.D. & Crocks, J. (1982). The problem of psilocybin mushroom abuse. *Human Toxicology*, 1, 417-424.
28. Schwartz, R.H. & Smith, D.E. (1988). Hallucinogenic mushrooms. *Clinical Pediatrics*, 27, 70-73.
29. Southcott, R.V. (1974). Notes on some poisonings and other clinical effects following ingestion of Australian fungi. *South Australian Clinics*, 6, 441-478.
30. Stein, S.I. (1958). An unusual effect from a species of Mexican mushrooms Psilocybe cubensis Mycopath. et *Mycol. Applicata*, 9, 263-264.
31. Stein, S.I. (1959). Clinical observations on the effects of Panaeolus venenosus versus Psilocybe caerulescens mushrooms. *Mycologia*, 51, 49-50.
32. Trotter, J.E. (1944). A report of nine cases of fungus poisoning. *Medical Journal of Australia*, 1, 393.
33. Van Went, G.E. (1978). Mutagenicity testing of three hallucinogens: LSD, psilocybin and O^9-THC, using the micronucleus test. *Experientia*, 34, 324-325.
34. Widmer, S. (1989). *Uber MDMA and LSD: Die unerwunschte Psychotherapie*. Nachtschatten Verlag, Solothurn (Switzerland).
35. Young, R.E., Milroy, R., Hutchison, S. & Kesson, C.M. (1982). The rising price of mushrooms. *The Lancet*, 23 Jan., 213-215.

3. General Reference Books

1. Bresadola, J. (1931). *Iconographia mycologica* 18. Mediolani.
2. Bresinsky, A. & Besl, H. (1985). *Giftpilze*. Wissenschaftliche Verlagsgesellschaft Stuttgart (Germany).
3. Buch, R. (1952). *Die Blätterpilze des nordwestlichen Sachsens.* Leipzig (Germany). Cooke, M.C. (1880-90). *Illustrations of British Fungi*. London.
4. Flammer, R. (1980). *Differentialdiagnose der Pilzvergiftungen*. Fischer Stuttgart (Germany).
5. Flammer, R. & Horak, E. (1980). *Giftpilze - Pilzgifte*. Franckh Stuttgart (Germany).
6. Heim, R. (1967). *Nouvelles Investigations sur les Champignons Hallucinogenes*. Museum Nationale d'Histoire Naturelle, Paris.
7. Heim, R. (1969). *Champignons d'Europe*. Boubee & Cie., Paris.
8. Heim, R. & Wasson, R.G. (1958/9). *Les champignons hallucinogenes du Mexique*. Museum National d'Histoire Naturelle, Paris.
9. Kuhner, R. & Romagnesi, H. (1953). *Fiore analytique des champignons supirieurs*. Masson & Cie., Paris.
10. Lange, J.E. & Lange, M. (1962). 600 *Pilze in Farben*. Bayrischer Landwirtschaftsverlag Munchen (Germany).
11. Michael, E. & Schulz, R. (1927). *Fuhrer fur Pilzfreunde, Bd. 2*. Leipzig (Germany).
12. Michael, E., Hennig, B. & Kreisel, H. (Eds.), (1978-8). *Handbuch fur Pilzfreunde, Bd*. 1-6. ustav Fischer Jena (Germany).
13. Moser, M. (1983). "*Die Rohrlinge and Blatter-pilze*". In: Kleine Kryptogamenflora by H. Gams, Vo1.2b/2, 5th ed. Stuttgart (Germany).
14. Phillips, R. (1981). *Das Kosmosbuch der Pike*. Stuttgart (Germany).
15. Ricken, A. (1915). *Die Bldtterpilze*. Leipzig (Germany).
16. Wasson, R.G. & Wasson, V.P. (1957). *Mushrooms,Russia and History*. Pantheon, New York.
17. Wasson, R.G. (1974). *Maria Sabina and her Mazatec Mushroom Velada*. Harcourt Brace Janovich, New York.
18. Wasson, R.G. (1980). *The Wondrous Mushroom: Mycolatry in Mesoamerica*. McGraw-Hill, New York.

4. Mushroom Cultivation

1. Agurell, S., Blomkvist, S. & Catalfomo, P. (1966). Biosynthesis of psilocybin in submerged culture of Psilocybe cubensis. *Acta Pharm. Suecica*, 3, 37-44.
2. Agurell, S. & Nilsson, L.G. (1968). Biosynthesis of psilocybin. *Acta Chem. Scand.*, 22, 1210-1218.
3. Agurell, S. & Nilsson, L.G. (1968). A biosynthesis sequence from tryptophan to psilocybin. *Tetrahedron Letters*, 9, 1063-1064.
4. Ames, R.W., Singer, R., Stein, S.I. & Smith, A.H. (1958). The influence of temperature on mycelial growth of Psilocybe, Panaeolus and Copelandia. *Mycopathologia*, 9, 268-274.
5. Badham, E.R.(1980). The effect of light upon basidiocarp initiation in Psilocybe cubensis. *Mycologia*, 72, 136-142.
6. Badham, E.R. (1982). Tropisms in the mushroom Psilocybe cubensis. *Mycologia*, 74, 275-279.
7. Badham, E.R. (1984). Modeling growth, development, transpiration and translocation in the mushroom Psilocybe cubensis. *Bulletin of the Torrey Botanical Club*, 111, 159-164.
8. Badham, E.R. & Kincaid, D.T. (1984). Analysis of anemotropism in the mushroom Psilocybe cubensis. *Canadian Journal of Botany*, 62, 296-300.
9. Badham, E.R. (1985). The influence of humidity upon transpiration and growth in Psilocybe cubensis. *Mycologia*, 77, 932-939.
10. Bigwood, J. & Beug, M.W. (1982). Variation of psilocybin and psilocin levels with repeated flushes (harvests) of mature

sporocarps of Psilocybe cubensis (Earle) Singer. *Journal of Ethnopharmacology*, 5, 287-291.

11. Brack, A., Hofmann, A., Kalberer, F., Kobel, H. & Rutschmann, J. (1961). Tryptophan als biogenetische Vorstufe des Psilocybins. *Archiv der Pharmazie.*, 294, 230-234.
12. Catalfomo, P. & Tyler, V.E. (1964). The production of psilocybin in submerged culture by Psilocybe cubensis. *Lloydia*, 21, 53-63.
13. Clemencon, H. (1994). Der Nodulus and die Organogenese wahrend der fruhen Fruchtkorperentwicklung von Psilocybe cyanescens. *Zeitschrift fur Mykologie*, 60, 49-68.
14. Gartz, J. (1987). Variation der Indolakaloide von Psilocybe cubensis durch unterschiedliche Kultivierungsbedingungen. *Beitrdge zur Kenntnis der Pilze Mitteleuropas*, 3, 275-281.
15. Gartz, J. (1989). Biotransformation of tryptamine in fruiting mycelia of Psilocybe cubensis. *Planta Medica*, 55, 249-250.
16. Gartz, J. (1989). Biotransformation of tryptamine derivates in mycelial cultures of Psilocybe. *Journal of Basic Microbiology*, 29, 347-352.
17. Gartz, J. (1989). Bildung and Verteilung der Indolalkaloide in Fruchtkorpern, Mycelien and Sklerotien von Psilocybe cubensis. *Beitrdge zur Kenntnis der Pilze Europas*, 5, 167-174.
18. Gartz, J. & Muller G.K. (1990). Versuche zur Kultur von Gymnopilus purpuratus, Purpurflammling. *Mykologisches Mitteilungsblatt (Germany)*, 33, 29-30.
19. Gartz, J., Adam, G. & Vorbrodt, H.M. (1990). Growth-promoting effect of a brassinosteroid in mycelial cultures of the fungus Psilocybe cubensis. *Naturwissenschaften*, 77, 388-389.
20. Heim, R. & Cailleux, R. (1957). Culture pure et obtention semi-industrielle des Agarics hallucinogens du Mexique. *Compt. Rend.*, 244, 3109-3114.
21. Heim, R., Hofmann, A., Brack, A., Kobel, H. & Cailleux, R. (1959). *Verfahren zur Herstellung and Gewinnung von Psilocybin and Psilocin*. Patent 1087321-12d30hc.
22. Kneebone, L.R. (1960). Methods for the production of certain hallucinogenic agarics. *Abstract. Dev. Ind. Micro.*, 1, 109.
23. Leung, A.Y. & Paul, A.G. (1968). Baeocystin and norbaeocystin: New analogs of psilocybin from Psilocybe baeocystis. *Journal of Pharmaceutical Sciences*, 57, 1667-1671.
24. Leung, A.Y., Smith, A.H. & Paul, A.G. (1968). Production of psilocybin in Psilocybe baeocystis saprophytic culture. *Journal of Pharmaceutical Sciences*, 54, 1576-1579.
25. Leung, A.Y. & Paul, A.G. (1969). The relationships of carbon and nitrogen nutrition of Psilocybe baeocystis to the production of psilocybin and its analogs. *Lloydia*, 32, 66-71.
26. Neal, J.M., Benedict, R.G. & Brady, R. (1968). Interrelationship of phosphate nutrition, nitrogen metabolism and accumulation of key secondary metabolites in saprophytic culture of Psilocybe cubensis, Psilocybe cyanescens and Panaeolus campanulatus. *Journal of Pharmaceutical Sciences*, 57, 1661-1667.
27. Oss, O.T. & Oeric, O.N. (1976). *Psilocybin: Magic Mushroom Grower's Guide*. And/Or Press, Berkeley, CA.
28. Pollock, S.H. (1977). *Magic Mushroom Cultivation*. Herbal Medicine Research Foundation, San Antonio, TX.
29. Stamets, P. & Chilton, J.S. (1983). *The Mushroom Cultivator*. Agarikon Press Olympia, WA.
30. Stamets, P. (1993). *Growing Gourmet & Medicinal Mushrooms*. Ten Speed Press.

5. Popular Literature

1. Cooper, R. (1980). A Guide to British Psilocybin Mushrooms (2nd ed.). Hessle Free Press, London.
2. Estrada, A. (1980). Maria Sabina - Botin der heiligen Pike. Trikont, München (Germany).
3. Haard, R. & Haard, K. (1980). Poisonous & Hallucinogenic Mushrooms (2nd ed.). Homestead Book Company, Seattle, WA.
4. Harris, B. (1989). Growing Wild Mushrooms (revised edition). Homestead Book Company, Seatlle, WA.
5. Leary, T. (1990). *Flashbacks: A Personal and Cultural History of an Era*. J.P. Tarcher Inc., Los Angeles.
6. Menser, G.P. (1984). *Magic Mushroom Handbook*. Homestead, Seattle, WA.
7. Stafford, P. (1992). *Psychedelics Encyclopedia (third expanded edition)*. Ronin Publishing, Berkeley, CA.
8. Stevens, J. & Gee, R. (1987). How *to Identify and Grow Psilocybin Mushrooms*. Sun Magic Publishing, Seattle, WA.

6. Conocybe

1. Benedict, R.G., Brady, L.R., Smith, A.H. & Tyler, V.E. (1962). Occurrence of psilocybin and psilocin in certain Conocybe and Psilocybe species. *Lloydia*, 25, 156-159.
2. Benedict, R.G., Tyler, V.E. & Watling, R. (1967). Blueing in Conocybe, Psilocybe and a Stropharia species and the detection of psilocybin. *Lloydia*, 30, 150-157.
3. Christiansen, A.L., Rasmussen, K.E. & Holland, K. (1984). Detection of psilocybin and psilocin in Norwegian species of Pluteus and Conocybe. *Planta Medica*, 51, 341-343.
4. Gartz, J. (1985). Zur Analytik der Inhaltsstoffe zweier Pilzarten der Gattung Conocybe. *Pharmazie*, 40, 366.
5. Ohenoja, E., Jokiranta, J., Maekinen, T., Kaikkonen, A. & Airaksinen, M.M. (1987). The occurrence of psilocybin and psilocin in Finnish fungi. *Journal of Natural Products*, 50, 741-744.

7. Galerina

1. Besl, H. (1993). *Galerina* steglichii spec. nov., ein halluzinogener Haubling. *Zeitschrift fur Mykologie*, 59, 215-218.
2. Gartz, J. (1995). Cultivation and analysis of Psilocybe species and an investigation of *Galerina* steglichii. Ann. Mus. Civ. Rovereto *(Italy) Sez. sc. nat.*, 10, 297-305.

8. Gymnopilus

1. Buck, R. W. (1967). Psychedelic effect of Pholiota spectabilis. *New England Journal of Medicine*, 267, 391-392.
2. Cleland, J. B. (1934). *Toadstools and mushrooms and other larger fungi of South Australia*. Adelaide.
3. Gartz, J. (1989). Occurrence of psilocybin, psilocin and baeocystin in Gymnopilus purpuratus. *Persoonia*, 14, 19-22.
4. Hatfield, G.M., Valdes, L.J. & Smith, A.H. (1978). The occurrence of psilocybin in Gymnopilus species. *Lloydia*, 41, 140-144.
5. Koike, Y., Wada, K., Kusano, G., Nozoe, S. & Yokoyama, K. (1981). Isolation of psilocybin from Psilocybe argentipes and its determination in specimens of some mushrooms. *Journal of Natural Products*, 44, 362-365.
6. Kreisel, H. & Lindequist, U. (1988). Gymnopiluspurpuratus, ein psilocybinhaltiger Pilz adventiv im Bezirk Rostock. *Zeitschrift fur Mykologie*, 54, 73-76.
7. Singer, R. (1969). Mycoflora Australis. *Beih. Nova Hedwiga*, 29.
8. Singer, R. (1975). *The Agaricales in Modern Taxonomy (3rd ed.)*. Vaduz.
9. Walters, M.B. (1965). Pholiota spectabilis, a hallucinogenic fungus. *Mycologia*, 57, 837-838.

9. Inocybe

1. Babos, M. (1968). Eine neue Inocybe-Art in Ungarn: Inocybe aeruginascens n.sp. *Fragmenta Botanica*, 6, 19-22.
2. Babos, M. (1983). Beobachtungsangaben bei einer halluzinogenen Inocybe-Art (in Hungarian, with German summary). *Mikologicie Kozlemenyek*, 3, 143.
3. Bekker, A.M., Guervich, L.S., Nezdoiminogo, E.L., Onoprienko, B.B. & Koz'min, Y.P. (1989). Chromatographische Studie einiger Indolmetabolite in der Gattung Inocybe (Basidiomyceten) 2 (in Russian). *Mikol. Fitopatol.*, 23, 129, ref. C.A. 111, 53870a.
4. Besl, H. & Mack, P. (1985). Halluzinogene Risspilze. *Zeitschrift fur Mykologie*, 51, 183-184.
5. Bohus, G. & Babos, M. (1977). *Fungorum rariorum icones coloratae Pars 8*. J. Cramer (Liechtenstein).
6. Drewitz, G. (1983). Eine halluzinogene Risspilzart. Grunlichverfarbender Risspilz (Inocybe aeruginescens). *Mykologisches Mitteilungsblatt*, 26, 11-17.
7. Gartz, J. (1985). Vergleichende dünnschichtchromatographische Untersuchungen zweier Psilocybe - and einer halluzinogenen Inocybeart. *Pharmazie*, 40, 134.
8. Gartz, J. & Drewitz, G. (1985). Der erste Nachweis des Vorkommens von Psilocybin in Risspilzen. *Zeitschrift fur Mykologie*, 51, 199-203.
9. Gartz, J. (1986). Nachweis von Tryptaminderivaten in Pilzen der Gattungen Gerronema, Hygrocybe, Psathyrella and von Inocybe. *Biochem. Physiol. Pflanzen*, 181, 275-278.
10. Gartz, J. (1986). Psilocybin in Mycelkulturen von Inocybe aeruginascens. *Biochem. Physiol. Pflanzen*, 181, 511-517.
11. Gartz, J. (1986). Untersuchungen zum Vorkommen des Muscarins in Inocybe aeruginascens Babos. *Zeitschrift fur Mykologie*, 52, 359-361.
12. Gartz, J. & Drewitz, G. (1986). Der Grunlicherfarbende Risspilz - eine Inocybeart mit halluzinogener Wirkung. *Zeitschrift fur Arztliche Fortbildung*, 80, 551-553.
13. Gartz, J. (1987). Variation der Alkaloidmengen in Fruchtkorpern von Inocybe aeruginascens. *Planta Medica*, 53, 539-541.
14. Gartz, J. (1989). Analysis of aeruginascin in fruiting bodies of the mushroom Inocybe aeruginascens. *International Journal of Crude Drug Research*, 27, 141-144.
15. Gurevich, L.S.: Psilocybin and muscarin as possible chemotaxonomic markers of the genus Inocybe (Fr.)Fr.(Cortinariaceae)(rus.) cit.in: *Chemical Abstracts*, 118, 35586c.
16. Haeselbarth, G., Michaelis, H. & Salnikow, J. (1985). Nachweis von Psilocybin in Inocybe aeruginascens Babos. *Mykologisches Mitteilungsblatt*, 28, 59-62.
17. Hohmeyer, H. (1984). Inocybe aeruginascens Babos in Berlin (West) gefunden. *Zeitschrift fur Mykologie*, 50, 211-214.
18. Kaspar, R. (1977). Inocybe aeruginascens bei Berlin-Kopenick - Erstfund fur die DDR. *Mykologisches Mitteilungsblatt*, 21, 99.
19. Robbers, J.E., Brady, L.R. & Tyler, V.E. (1964). A chemical & chemotaxonomic evaluation of Inocybe species. *Lloydia*, 27, 192.
20. Semerdzieva, M., Wurst, M., Koza, T. & Gartz, J. (1986). Psilocybin in Fruchtkorpern von Inocybe aeruginascens. *Planta Medica*, 47, 83-85.
21. Stijve, T., Klan, J. & Kuyper, Th.W. (1985). Occurrence of psilocybin and baeocystin in the genus Inocybe (Fr.)Fr. *Persoonia*, 12, 469-473.
22. Stijve, T. & Kuyper, Th. W. (1985). Occurrence of psilocybin in various higher fungi from several European countries. *Planta Medica*, 46, 385-387.

10. Panaeolus

1. Aberdeen, J.E.C. & Jones, W. (1958). A hallucinogenic toadstool. *Australian Journal of Science*, 21, 149.
2. Benedict, R.G. & Tyler, V.E. (1962). Examination of mycelial cultures of Panaeolus species for tryptophan hydroxylase activity. *Lloydia*, 25, 46-54.
3. Bergner, H. & Oettel, R. (1971). Vergiftungen durch Dungerlinge. *Mykologisches Mitteilungsblatt (Germany)*, 15, 61-63.
4. Brodie, H.J. (1935). The heterothallism of Panaeolus subbalteatus Berk., a sklerotium-producing agaric. *Canadian Journal of Research*, 12, 657-666.
5. Ceruti-Scurti, J., Fuisselli, N. & Jodici, R. (1972). Idrossi-indol derivati in basidiomiceti 3. *Allionia*, 19, 91-96.
6. Ceruti-Scurti, J. & Bianco, M.A. (1973). Caratteristiche colturali di miceli di Panaeolus. *Allionia*, 19, 5.
7. Douglass, B. (1917). Mushroom poisoning. *Torreya*, 17, 207-221.

8. Fiusello, N. & Ceruti-Scurti, J. (1971-72). Idrossi-indol derivati in basidiomiceti 1. *Atti della Accad. science di Torino*, 106, 725.
9. Fiusello, N. & Ceruti-Scurti, J. (1972). Idrossi-indol derivati in basidiomiceti 2. *Allionia*, 18, 85-90.
10. Gartz, J. (1985). Zum Nachweis der Inhaltsstoffe einer Pilzart der Gattung Panaeolus. *Pharmazie*, 40, 431.
11. Gartz, J. (1985). Zur Analyse von Panaeolus campanulatus (Fr.) Quel. *Pharmazie*, 40, 432.
12. Gartz, J. (1989). Analyse der Indolderivate in Fruchtkorpern and Mycelien von Panaeolus subbalteatus (Berk.& Br.) Sacc. *Biochem. Physiol. Pflanzen*, 184, 171-178.
13. Gerhardt, E. (1987). Panaeolus cyanescens (Bk.& Br.) Sacc. and Panaeolus antillarum (Fr.) Dennis, zwei Adventivarten in Mitteleuropa. *Beitrdge zur Kenntnis der Pilze Mitteleuropas*, 3, 223-227.
14. Glen, G. (1816). A case proving the deleterious effects of the Agaricus campanulatus which was mistaken for the Agaricus campestis or champignon. *London Medical and Physical Journal*, 36, 451-453.
15. Gurevich, L.S. (1993). Indole derivatives in certain Panaeolus species from East Europe and Siberia. *Mycological Research*, 97, 251-254.
16. Heim, R., Hofmann, A. & Tscherter, H. (1966). Toxicologie: Sur une intoxication collective a syndrome psilocybien causee en France par un Copelandia. *C.R. Acad. Sci. (D) (Pars)*, 262, 519-523.
17. Murrill, W.A. (1916). A very dangerous mushroom. *Mycologia*, 8, 186-187.
18. Neuhoff, W. (1958). Eine Dungerlingsvergiftung in Bremen. *Zeitschrift fur Pilzkunde*, 24, 87-91.
19. Ola'h, G.M. (1970). Le genre Panaeolus. *Rev. Mycol., Hors-Serie 10*, 1-222.
20. Ott, J. & Guzman, G. (1976). Detection of psilocybin in species of Psilocybe, Panaeolus and Psathyrella. *Llyodia*, 39, 258-260.
21. Pollock, S.H. (1974). A novel experience with Panaeolus - a case study from Hawaii. *Journal of Psychedelic Drugs*, 6, 85-89.
22. Repke, D.B., Leslie, D.T. & Guzman, G. (1977). Baeocystin in Psilocybe, Conocybe and Panaeolus. *Lloydia*, 40, 566-578.
23. Robbers, J.E., Tyler, V.E. & Ola'h, G.M. (1969). Additional evidence supporting the occurrence of psilocybin in Panaeolus foenisecii. *Lloydia*, 32, 399-400.
24. Singer, R. & Smith, A.H. (1958). About the identity of the "weed Panaeolus" or "poisonous Panaeolus". *Mycopathol. Mycol. Appl.*, 9, 280-284.
25. Stein, S.I., Closs, G.L. & Gabel, N.W. (1959). Observations on psychoneurophysiologically significant mushrooms. *Mycopathol. Mycol. Applicata*, 11, 205-216.
26. Stijve, T., Hischenhuber, C. & Ashley, D. (1984). Occurrence of 5-hydroxylated indole derivatives in Panaeolina foenisecii (Fries) Kuehner from various origins. *Zeitschrift fur Mykologie*, 50, 361-368.
27. Stijve, T. (1985). Een chernische verkenning van het geslacht Panaeolus. *Coolia,* 28, 81-89.
28. Stijve, T. (1987). Vorkommen von Serotonin, Psilocybin and Harnstoff in Panaeoloideae. *Beitrdge zur Kenntnis der Pilze Mitteleuropas*, 3, 229-234.
29. Stijve, T. (1992). Psilocin, psilocybin, serotonin & urea in Panaeolus cyanescens from various origins. *Persoonia*, 15, 117-121.
30. Tyler, V.E. & Malone, M.H. (1960). An investigation of the culture, constituents & physiological activity of Panaeolus campanulatus. J. *Amer. Pharm. Assoc., Sci. Ed.*, 49, 23-27.
31. Verrill, A.E. (1914). A recent case of mushroom intoxication. *Science*, 40, 408-410.
32. Watling, R. (1977). A Panaeolus poisoning in Scotland. *Mycopathologia*, 61, 187-190.

11. Pluteus

1. Gartz, J. (1987). Vorkommen von Psilocybin and Baeocystin in Fruchtkorpern von Pluteus salicinus. *Planta Medica*, 53, 290-291.
2. Saupe, S.G. (1981). Occurrence of psilocybin / psilocin in Pluteus salicinus (Pluteaceae). *Mycologia*, 73, 781-784.
3. Stijve, T. & Bonnard, J. (1986). Psilocybine et uree dans le genre Pluteus. *Mycologia Helvetica*, 2, 123-129.

12. Psilocybe cyanescens Complex

1. Gartz, J. & Muffler, G.K. (1989). Analysis and cultivation of fruiting bodies and mycelia of Psilocybe bohemica. *Biochem. Physiol. Pflanzen*, 184, 337-341.
2. Guzman, G. & Bas, C. (1977). A new bluing species of Psilocybe from Europe. *Persoonia*, 9, 233-238.
3. Krieglsteiner, G.J. (1984). Studien zum Psilocybe cyanescens-Komplex in Europa. *Beitrdge zur Kenntnis der Pike Mitteleuropas*, 1,61-94.
4. Krieglsteiner, G.J.(1986). Studien zum Psilocybe cyanescens-callosa-semilanceata-Komplex in Europa. *Beitrage zur Kenntnis der Pike Mitteleuropas*, 2, 57-72.
5. Kysilka, R., Wurst, M., Pacakova, V., Stulik, K. & Haskovec, L. (1985). High-performance liquid chromatographic determination of hallucinogenic indoleamines with simultaneous UV, photometric and voltametric detection. *Journal of Chromatography*, 320, 414-420.
6. Kysilka, R. & Wurst, M. (1989). Highperformance liquid chromatographic determination of some psychotropic indole derivates. *Journal of Chromatography*, 464, 434-437.
7. Kysilka, R. & Wurst, M. (1990). A novel extraction procedure for psilocybin and psilocin determination in mushroom samples. *Planta Medica*, 56, 327-328.
8. Moser, M. & Horak, E. (1968). Psilocybe serbica spec. nov., eine neue Psilocybin and Psilocin bildende Art aus Serbien. *Zeitschrift fur Pilzkunde*, 34, 137-144.
9. Muller, G.K. & Gartz, J. (1986). Psilocybe cyanescens - eine weitere halluzinogene Kahlkopfart in der DDR. *Mykologisches Mitteilungsblatt (Germany)*, 29, 33-35.
10. Sebek, S. (1980). Bohmischer Kahlkopf, Psilocybe bohemica. *Ceska Mykologie*, 37, 177-181.
11. Semerdzieva, M. & Nerud, F. (1973). Halluzinogene Pilze in der Tschechoslowakei. *Ceska Mykologie*, 27, 42-47.

12. Semerdzieva, M. & Wurst, M. (1986). Psychotrope Inhaltsstoffe zweier Psilocybe-Arten/Kahlkopfe aus der CSSR. *Mykologisches Mitteilungsblatt (Germany)*, 29, 65-70.
13. Tjallingii-Beukers, D. (1976). Een blauwwordernde Psilocybe (Psilocybe cyanescens Wakefield 1946). *Coolia*, 19, 38-43.
14. Unger, S.E. & Cooks, R.G. (1979). Application of mass spectometry, mass spectometry (MS/MS) to the identification of natural products in Psilocybe cyanescens. *Analytical Letters 12 (Part B)*, 1157-1167.
15. Wurst, M., Kysilka, R. & Koza, T. (1992). Analysis and isolation of indole alkaloids of fungi by high-performance liquid chromatography. *Journal of Chromatography,* 593, 201-208.

13. Psilocybe semilanceata (Liberty Cap)

1. Brenneisen, R. & Borner, S. (1988). The occurrence of tryptamine derivatives in Psilocybe semilanceata. *Zeitschrift fur Naturforschung*, 43c, 511-515.
2. Brenneisen, R., Borner, S., Peter-Oesch, N. & Schlunegger, U.P. (1988). Synthesis of baeocystin, a natural psilocybin analogue. *Arch. Pharm.*, 321, 487-489.
3. Christiansen, A.L., Rasmussen, K.E. & Hoiland, K. (1981). The content of psilocybin in Norwegian Psilocybe semilanceata. *Planta Medica*, 42, 229-235.
4. Christiansen, A.L., Rasmussen, K.E. & Tonnesen, F. (1981). Determination of psilocybin in Psilocybe semilanceata using high-performance liquid chromatography on a silica column. *Journal of Chromatography*, 210, 163-167.
5. Christiansen, A.L., Rasmussen, K.E. (1982). Analysis of indole alkaloids in Norwegian Psilocybe semilanceata using high-performance liquid chromatography and mass spectometry. *Journal of Chromatography*, 244, 357-364.
6. Christiansen, A.L., Rasmussen, K.E. (1983). Screening of hallucinogenic mushrooms with high-performance liquid chromatography and multiple detection. *Journal of Chromatography*, 270, 293-299.
7. Cooke, M.C. (1902-06). Agaric transformations. *Transactions of the British Mycological Society*, 2, 29-30.
8. Dawson P. & Morelli, C. (1975). *A Guide to the Major Psilocybin Mushroom of British Columbia: Psilocybe semilanceata*. Vancouver.
9. Fries, E.M. (1818). *Observationes Mycologica*. Havniae.
10. Gartz, J. (1985). Zur Isolierung des Baeocystins aus den Fruchtkorpern einer Psilocybeart. *Pharmazie*, 40, 274.
11. Gartz, J. (1985). Zur Extraktion and Chromatographie des blauen Farbstoffes einer Psilocybeart. *Pharmazie*, 40, 274-275.
12. Gartz, J. (1985). Zur Untersuchung von *Psilocybe semilanceata* (Fr.) Kumm. *Pharmazie*, 40,506.
13. Gartz, J. (1986). Quantitive Bestimmung der Indolderivate von Psilocybe semilanceata (Fr.) Kumm. *Biochem. Physiol. Pflanzen*,181, 117-124.
14. Gartz, J. (1991). Further investigations on psychoactive mushrooms of the genera Psilocybe, Gymnopilus and Conocybe. Ann. Mus. Civ. Rovereto *(Italy) Sez. sc. nat.*, 7, 265-274.
15. Heim, R. (1971). A propos des proprietes hailucinogenes du Psilocybe semilanceata. *Naturaliste can.*, 98, 415-424.
16. Heim, R., Genest, K., Hughes, D.W. & Belec, G. (1966). Botanical and chemical characterisation of a forensic mushroom specimen of the genus Psilocybe. *Journal of the Forensic Science Society*, 6, 192-201.
17. Hofmann, A., Heim, R. & Tscherter, H. (1963). Presence de la psilocybine dans une espece europeenne d'Agaric, le Psilocybe semilanceata. *Compt. Rend.*, 257, 10-12.
18. Hoiland, K. *(1978)*. The genus Psilocybe in Norway. *Norwegian Journal of Botany*, 25, 111-122.
19. Horak, E. (1968). *Synopsis generum Agaricalium (Die Gattungstypen der Agaricales)*. In: Beitrage Kryptogamenflora Schweiz, 13. Bern.
20. Jokiranta, J., Mustola, S., Ohenoja, E. & Airaksinen, M.M. (1984). Psilocybin in Finnish Psilocybe semilanceata. *Planta Medica*, 50, 277-278.
21. Mantle, P.G. & Waight, E.S. (1969). Occurrence of psilocybin in the sporophores of Psilocybe semilanceata. *Transactions of the British Mycological Society*, 53, 302-303.
22. Michaelis, H. (1977). Psilocybe semilanceata (Fr.) Quel. (Spitzkegeliger Kahlkopf) - Nachweis von Psilocybin in deutschen Funden. *Zeitschrift fur Pilzkunde*, 43, 305-310.
23. Repke, D.B. & Leslie, D.T. (1977). Baeocystin in Psilocybe semilanceata. J. *Pharm. Sci.*, 66, 113-114.
24. Schumacher, T. (1976). Hallusinogene sopper. *Vare Nyttevekster (Norway)*, 71, 110-115.
25. Stahl, E., Brombeer, J. & Eskes, D. (1978). Rauschgiftpilze mit LSD? *Archiv Pr Kriminologie*, 162, 23-33.
26. Stijve, T. (1984). Psilocybe semilanceata als hallucinogene paddestoel. *Coolia*, 27, 36-43.
27. Vanhaelen-Fastre, R. & Vanhaelen, M. (1984). Qualitative and quantitative determinations of hallucinogenic components of Psilocybe mushrooms by reversed-phase highperformance liquid chromatography. *Journal of Chromatography*, 312, 467-472.
28. Weil, A.T. (1975). Mushroom hunting in Oregon 3: On the trail of the Liberty Cap. *Journal of Psychedelic Drugs*, 7, 96-102.
29. White, P.C. (1979). Analysis of extracts from Psilocybe semilanceata by high-pressure liquid chromatography. *Journal of Chromatography*, 169, 453-456.
30. Wurst, M., Semerdzieva, M. & Vokoun, J. (1984). Analysis of psychotropic compounds in fungi of the genus Psilocybe by reversed phase high-performance liquid chromatography. *Journal of Chromatography*, 286, 229-235.

Index

Page numbers in italics refer to illustrations.

[*Page numbers refers to original copy of this reedition.*]

Aberdeen, J.E.C. & Jones, W. 84
Accidental intoxications, 15, 16, 37-38, 45, 51, 61, 88- 89, 93-94, 102
Aeruginascin, 49
Agaricales, 65, 114
Agaricus campanulatus, 37
Agaricus glutinosus, 16
Agaricus semilanceatus, 16
Agaricus subbalteatus, 37
Alkaloids, 9, 13, 18, 26, 27, 31, 36, 41, 49-50, 55-56, 58-59, 63-65, 69, 88, 102-105, 114
Allen, J.W., 43, 81, 100
Amanita muscaria, 10-11, 115
Amanita phalloides, 61-62
Amanitaceae, 58
Armillaria mellea, 51, 93

Babos, M., 46f, 47
Bad trip, 35, 85f
Badham, E.R., 70
Baeocystin, 28, 31, 35-36, 41-42, 49-50, 53, 56, 59,
63, 69, 72, 101-102, 114
Berserkers, 11
Beug, M.W., 56, 61, 79
Bigwood, J., 56, 61, 79
Biochemical reactions (psilocin and psilocybin), 63
Blue meanies, 85
Bluing, 63-65
Bolbitiaceae, 55
Boletes (bluing), 65, 66
Bolond Gomba, 11
Brande, E. 15, 16
Brassinosteroids, 70
Brodie, H.J., 69
Bwyd Ellylon, 10

Cailleux, R. 66-67, 69
Carter, M., 87
Champignon *(Agaricus bisporis),* 21, 37, 62, 67, 69
Charters, A.D., 96
Chemical races, 41
Chilton, J.S., 70, 72
Cleland, J., 84
Clusius, 11
Conocybe spp., 55-56, 63, 69
Conocybe cyanopoda, 55
Conocybe cyanopus, 55-56, 57, 63, 69
Conocybe lactea, 56
Conocybe siligineodes, 55
Conocybe tenera, 56
Contamination, 70
Cooke, M.C., 16, 52, 63, 87

Copelandia spp., 42
Coprinaceae, 55
Coprinarius semilanceatus, 16
Cortinariaceae, 53
Cox, P.A., 98
Cross-breeding experiments, 30, 67
Cullinan, E.R., 96
Cultivation, 62, 66-75, 81, 90, 98, 101

DAWN, 81
DNA analysis, 30
Dikaryotic mycelia, 65
Dipropyltryptamine, 110
Drewitz, G., 44ff, 65

Entheogens, 103
Enzymatic destruction, 63, 65
Enzymes, 63, 65
Epilepsy, 102
Experiences, 25-26, 34-35, 37-38, 42-43, 45-46, 51, 85-86, 90, 93-94, 102, 105, 110-111

Ferencz, I. , 44
Fischer, R., 103, 105, 106
Flammer, R., 115
Flammula purpurata, 52
Flashbacks, 103-104
Fly Agaric, 10-11, 26, 58, 100
Fool's mushrooms, 7, 11-12, 82, 98
Foolish mushrooms, 12
Ford, W.W., 81
Francis, J. & Murray, V.S.G., 89
Fries, E., 16, 31
Fruiting, 66-70
Furrer, 18

Galera spp., 55
Galerina spp., 61-62
Galerina autumnalis, 61
Galerina marginata, 62
Gentamycin, 67
Geophila cyanescens, 29
Gerhardt, E., 41, 42
Gold tops, 85
Good Friday experiment, 34
Grof, S., 26, 35, 103-104, 108, 110
Guzman, G., 18, 29-30, 38, 43, 55, 62, 80, 82, 100
Gymnopilus spp., 51-54, 63, 71, 72, 93
Gymnopilus junonius, 51
Gymnopilus purpuratus, 30, 40, 51-54, 63, 71, 72
Gymnopilus spectabilis, 51-52, 93
Gymnopilus validipes, 52

HPLC, *see* High-performance liquid chromatography
Hallucinations, 10-11, 27, 42, 45, 51, 85, 94
Hallucinogens, 10-13, 26, 34, 88-89, 102-105, 108-112, 115
Hatfield, G.M., 51
Hausner, M., 107, 109

Heim, R., 9, 18, 38, 55-56, 66-67, 69, 79, 82, 100
Henry, D., 96
Herink, J., 31, 44
High-performance liquid chromatography (HPLC),18
Hofmann, A., 9, 13, 18, 43, 63, 69, 100, 103
Hyde, C., 87
5-Hydroxy-tryptophan, 41
Hygrophanous species, 19, 22, 31, 39, 41
Hypholoma spp., 29, 96
Hypholoma coprinifacies, 29
Hypholoma cyanescens, 29, 96
Hypnosis, 115

Illusions, 45
Imai, S., 93
Indole compounds, 41-42, 43, 65, 114
Inocybe spp., 26, 44-50, 62-65, 72-75, 81, 89, 91
Inocybe aeruginascens, 26, 44-50, 48, 62-65, 72, 74-75, 91, 117
Inocybe calamistrata, 50
Inocybe coelestium, 50
Inocybe corydalina, 50
Inocybe geophylla, 89
Inocybe haemacta, 50, 52
Inocybe infelix, 81
Inocybe infida, 81
Inocybe patouillardi, 45
Inocybe tricolor, 50
Inquisition, 7, 10

Kaspar, R., 44
Kneebone, L.R., 69
Kreisel, H., 58
Krieglsteiner, G.J., 14, 30, 32, 96
Kubicka, 31

LBM's (Little Brown Mushrooms), 44, 61
LD 50, 102
LSD, 13, 35, 81, 85, 87, 89, 101-105, 108-112, 113
Laccase, 63
Laminar flow hood, 67
Leary, T., 12, 81, 103
Lentinus oreades (shiitake), 93
Leuner, H., 108-109
Liberty cap, 34, 79, 87

MDMA, 109
Maire, R., 96
Maitake, 93
Malencon, G., 96
Malt agar, 43, 56, 68, 69
Marasmius oreades, 45
McKenna, T., 95
Melzer's reagent, 65
Merlin, M.D., 100
Mescaline, 89, 102-103, 105, 108
Metol reaction, 63-65
Michael & Schulz, 18, 19, 38, 39

Michaelis. H.. 18. 19, 20
Mills, P.R., 87
Monokaryotic mycelium, 66
Morphine, 112
Murrill, W.A., 37, 81
Muscarine, 44-45, 49, 62, 65, 81, 85, 89
Mycelia, 7-8, 21-22, 30-31, 34, 41-42, 43, 63-67, 69-70, 72, 75, 93, 98, 101
Mycelial degeneration, 72, 75
Mycena spp., 114
Mycophilia, 7, 12, 62
Mycophobia, 8, 12, 62
Mycorrhiza, 46, 66, 72

Naematoloma caerulescens, 100
Nerud, F., 36
Norbaeocystin, 102

Ola'h, G.M., 41, 96, 100
Ololiuqui, 109
Oss, O.T. & Oeric, O.N., 66, 90
Ott, J ,80, 102

Pahnke, W., 34
Panaeolus spp., 16, 35-43, 62, 65, 69, 72, 76, 80-81, 82, 84-85, 94, 96, 98, 100-101
Panaeolus africanus, 96
Panaeolus cambodginiensis, 100
Panaeolus cyanescens, 41, 42, 43, 80-81, 82, 84-85, 96, 98, 101
Panaeolus foeniscecii, 38, 41-42
Panaeolus ovatus, 38, 84
Panaeolus papilionaceus, 37, 93
Panaeolus retirugis, 38, 41
Panaeolus semilanceatus, 16
Panaeolus sphinctrinus, 38
Panaeolus subbalteatus, 6, 37-43, 62, 65, 69, 72, 76, 80-81, 84, 94, 96
Panaeolus tropicales, 96
Panaeolus variabilis, 41
Panaeolus venenosus, 37
Parkinson, J., 12
Peden, N.R., 88
Peyote, 109
Phantastica, 102ff
Pholiota spectabilis, 51
Pholiotina filaris, 62
Picker & Rickards, 84
Pluteaceae, 58
Pluteus spp., 58-60
Pluteus nigroviridis, 59
Pluteus salicinus, 58-60, 59, 60
Pollock, S.H., 83
Potocki, V., 12
Prague research, 26, 34
Primordia, 67
Psathyrella, 38
Psilocin 9, 26, 27, 31, 34-36, 41-42, 43, 49, 53, 55-56, 58, 63-66, 69-70, 75, 79, 84, 102, 114
Psilocybe spp., 4, 5, 9, 10-12, 14-15, 16-28, 17, 23-24, 29-37, 32-33, 36, 46, 49, 52-53, 56, 61-67, 64, 68, 69-70, 71, 73, 72-75, 74, 76-77, 79-81, 82-91, 93-98, 99, 100-102, 104, 109, 113, 114-115, 116, 119
Psilocybe argentipes, 94

Psilocybe aztecorum, 82
Psilocybe azurescens, 81
Psilocybe baeocystis, 27, 31, 69, 79, 102, 119
Psilocybe bohemica, 12, 22, 27, 29, 31, 32-33, 34-36, 53, 63, 67, 71, 72, 104, 109
Psilocybe caerulescens, 16, 31
Psilocybe cubensis, 5, 63-65, 64, 67, 68, 69-70, 71, 72, 74, 75, 76-77, 81, 82-85, 90, 93, 96-97, 98, 100-101, 104, 109, 114
Psilocybe cyanescens, 14, 29-36, 32-33, 66-67, 69, 75, 80, 91, 96, 102, 114
Psilocybe mairei, 29, 96
Psilocybe mexicana, 18, 49, 67, 72, 82, 91, 113
Psilocybe natalensis, 72, 97
Psilocybe pelliculosa, 31, 79
Psilocybe samuiensis, 99, 101
Psilocybe semilanceata, 4, 9, 10-12, 15, 16-28, 17, 23-24, 29-30, 37, 46, 52-53, 56, 61-66, 69, 73, 72, 79-81, 87-89, 95-96, 98, 101-102, 109, 114-115, 116
Psilocybe semperviva, 16
Psilocybe serbica, 29
Psilocybe stuntzii, 31, 61-62, 77, 80, 119
Psilocybe subaeruginosa, 84-86
Psilocybe subcaerulipes, 94
Psilocybe subcubensis, 100-101
Psilocybe tampanensis, 72, 117
Psilocybe yungensis, 52
Psilocybe zapotecorum, 69
Psilocybin, 7, 9, 10-13, 20, 27, 29, 31, 34-38, 41-42, 43, 45-46, 49-50, 52-56, 58-59, 63-65, 79-81, 84-85, 87-90, 93-94, 102-105, 108-112, 114-115
Psychedelic therapy, 102-105, 108-112
Psychedelics, 103, 112
Psychiatry, 89, 108
Psychoactivity, 11, 26, 27, 31, 51, 103
Psychoanalysis, 109
Psychodysleptica, 103
Psycholytic experience, 35, 102-105, 110-111
Psycholytic therapy, 35, 102-105, 108-112
Psychosynthesis, 109
Psychotherapy, 26, 102-105, 108-112

Receptors (in the brain), 102
Rhizomorphs, 31, 32, 66, 75
Ricken, A., 18, 20, 58
Robbins, T., 79
Roquet, S., 110

Samorini, G., 10, 95, 114
Sandoz Pharmaceuticals, 13, 43
Saprophytic species, 55, 58, 66-67, 69, 72
Saupe, S.G., 59
Saxo Grammaticus, 11
Schroeder, R.F., 100
Sclerotia, 56, 57, 69, 73, 72, 75, 117
Semerdzieva, M., 36
Serotonin, 41-42, 43, 59, 84
Siegel, R., 105
Sinden, J., 70
Singer, R., 38, 42, 43, 53, 63-65, 69, 94, 96
Smith, A.H., 63, 79, 94, 96

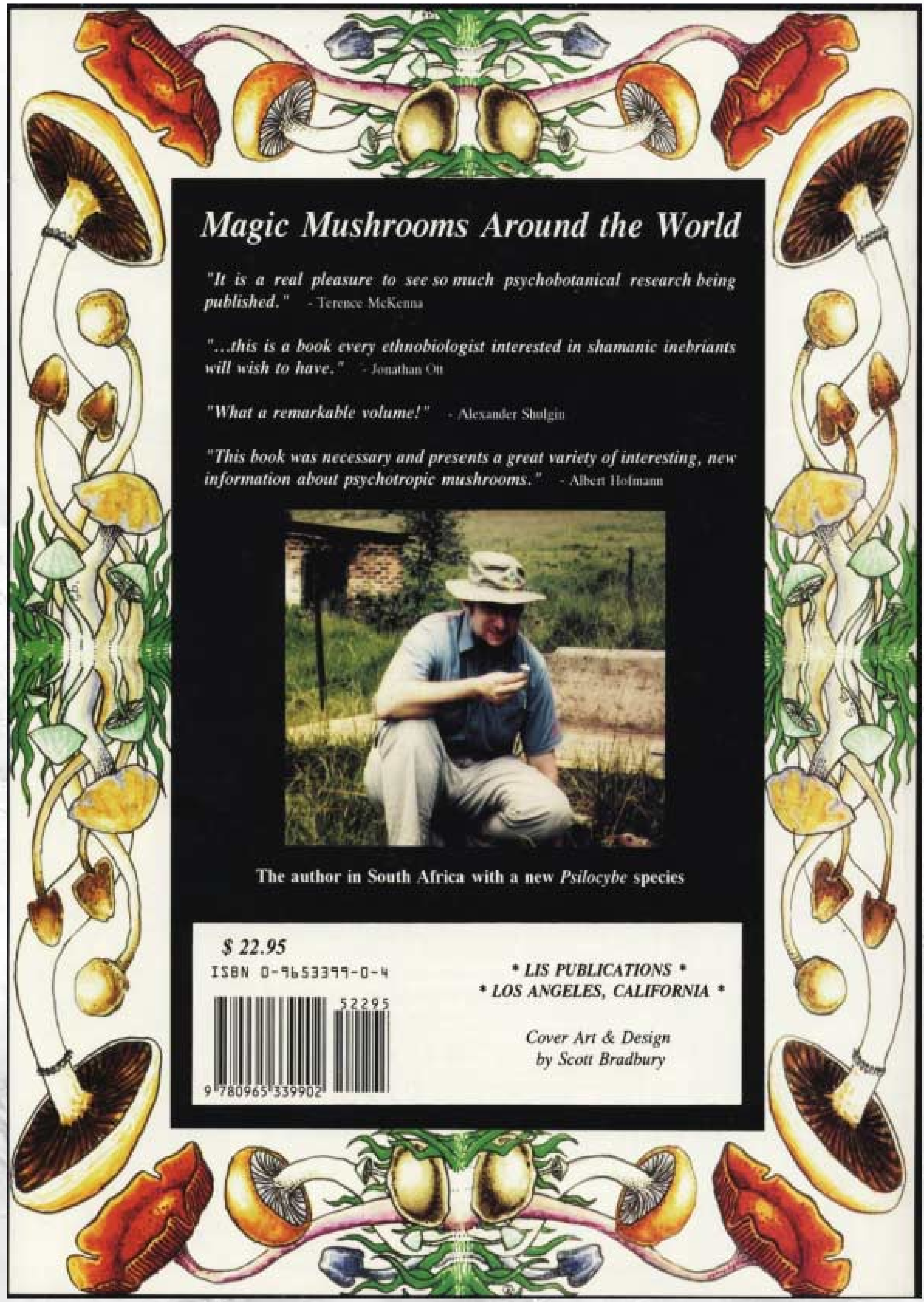
Soma, 100 Sowerby, J., 16, 17
Spore prints, 38, 62, 81
Spores, 29-30, 38, 41, 52-53, 55-56, 62, 66-67, 70, 72, 100
Stamets, P., 70, 72, 80, 102
Sterile conditions (cultivation), 67ff
Stijve, T., 41-42, 43, 58-59
Stropharia spp., 29, 38, 62, 93, 95-96
Stropharia caerulescens, 93
Stropharia rugoso-annulata, 38, 62
Stropharia venenata, 93
Styrylpyrones, 51
Submersed fermentation, 69
Surface cultivation, 69
Symbiosis (with plants), 46, 72

TLC, *see* Thin-layer chromatography
Tassili rock paintings, 8, 95ff, 97
Taxonomy, 9, 41ff, 82-83, 94, 101
Teonanacatl (*Panaeolus sphinctrinus*), 7, 12, 38
Thin-layer chromatography (TLC), 36, 41-42, 49, 53
Toxic psychosis, 103
Toxicity, 38, 102, 109
Tryptophan, 66, 69
Tyler, V.E., 79

Urea, 42, 59

Wakefield, 29
Waraitake, 93
Wasson, R.G., 7, 9, 12, 31, 38, 82, 100, 106, 111
Watling, R., 38, 89
Weil, A., 43
Widmer, S., 108
Witch hunts, 10-11, 92

Yokoyama, K., 94
Young, R.E., 88



Magic Mushrooms Around the World

"It is a real pleasure to see so much psychobotanical research being published." - Terence McKenna

"...this is a book every ethnobiologist interested in shamanic inebriants will wish to have." - Jonathan Ott

"What a remarkable volume!" - Alexander Shulgin

"This book was necessary and presents a great variety of interesting, new information about psychotropic mushrooms." - Albert Hofmann

The author in South Africa with a new *Psilocybe* species

$ 22.95
ISBN 0-9653399-0-4
52295
9 780965 339902

** LIS PUBLICATIONS **
** LOS ANGELES, CALIFORNIA **

Cover Art & Design
by Scott Bradbury

Psychedelic Information Theory

Shamanism in the Age of Reason

by

James L. Kent

First Edition, PIT Press / Supermassive, LLC, 2010

© 2010 by James L. Kent

original text: http://psychedelic-information-theory.com/pdf/PIT-Print-Web.pdf
backup source: http://www.psilosophy.info/resources/PIT-Print-Web.pdf

PIT Press
Supermassive, LLC
1122 E. Pike St. #679
Seattle, WA 98122

For color images, updates, and links to references online:
http://psychedelic-information-theory.com

Keywords: Psychedelics, Entheogens, Hallucinogens, Consciousness, Perception, Pharmacology, Epistemology, Hallucination, Psychosis, Dreaming, Shamanism, Novelty Theory, Creativity, Nonlinear Dynamics, Chaos Theory

Table of Contents:

Preface
Part I - Psychedelic Information Theory
Chapter 01 - What is Psychedelic Information Theory?
- Why "Psychedelic" Information Theory?
- What is "Shamanism in the Age of Reason"?
- Generic Application, Neutrality, Margin of Error
- Notes and References 1

Chapter 02 - The Value of Psychedelic Information
- The Value of Information
- The Value of Psychedelic Information
- Negative and Positive Information Value
- Notes and References 2

Chapter 03 - Psychedelic Information Theory
- Ingestion
- Internal Transmission
- Internal Integration
- Cultural Transmission
- Cultural Integration
- Psychedelic Information Process
- Notes and References 3

Chapter 04 - What is Consciousness?
- Five Basic Functions of Consciousness
  - *Perception*
  - *Recognition*
  - *Memory*
  - *Recall*
  - *Behavior*

- Operating Properties of Consciousness
  - *Modular Coherence*
  - *Linear Stability*
  - *Feedback Control*
  - *Adaptability*
  - *Self-Awareness*
- Modular Consciousness
- Psychedelic Consciousness
- Notes and References 4

Chapter 05 - Limits of Human Perception

- The Visual Spectrum
- Visual Frame Aliasing
- Visual Frame Resolution
- Dreaming, Imagination, Psychosis, Hallucination
- The Limits of Expanded Consciousness
- Notes and References 5

Chapter 06 - The Control Interrupt Model of Psychedelic Action

- Bottom-up Perception, Top-Down Control
- Constraint, Control, and Feedback Inhibition
- The Control Interrupt Model of Psychedelic Action
- Control Interrupt Envelopes
- Control Interrupt and Shamanism
- Notes and References 6

Chapter 07 - Psychedelic Pharmacology

- Serotonin and the Tryptamines
- Dopamine and the Phenethylamines
- Neuromodulators and Global Brain States
- Molecular Shape, Receptor Affinity, MAO Metabolism
- Breadth of Psychedelic Receptor Binding
- Dissociatives, Anticholinergics, Other Hallucinogens
- Notes and References 7

Chapter 08 - 5-HT$_{2A}$ Agonism and Multisensory Binding

- 5-HT$_{2A}$ receptor mechanics
- Layer V pyramidal cells and perceptual binding
- Destabilization in thalamocortical feedback loops
- 5-HT$_{2A}$ cross-agonism and organism re-modulation
- Notes and References 8

Chapter 09 - What is Nonlinear Hallucination?

- Nonlinear Systems
- Nonlinear Consciousness
- Phenomenology of Nonlinear Perspectives
- Nonlinear Hallucination
- Notes and References 9

Chapter 10 - Entopic Hallucination

- Flicker Phosphenes and Hallucinogenic Interrupt
- Entopic vs. Eidetic Hallucination
- Notes and References 10

Chapter 11 - Eidetic Hallucination

- The Hippocampus, ACh, Memory, and Dreaming
- Anticholinergics, Concrete Hallucination, REM
- Notes and References 11

Chapter 12 - Erratic Hallucination

- Breathing Walls, Melting Textures, Creeping Carpets
- Frame Destabilization and Frame Stacking
- Multisensory Destabilization and Schizophrenia
- Notes and References 12

Chapter 13 - Psychedelic Neuroplasticity
The Case for Psychedelic Neuroplasticity
Physiology of Psychedelic Neuroplasticity
Positive and Negative Plasticity
Tribal Imprinting and Viral Neuroplasticity
Notes and References 13
Part II - Shamanism in the Age of Reason
Chapter 14 - What is Shamanism?
Transformational Plasticity and Imprinting
Shamanic Reputation and Expectant Plasticity
Shamanism, Chaos Magic, and Belief as Toolkit
Shamanic Practice and Seeking Balance
Notes and References 14
Chapter 15 - An Overview of Physical Shamanism
Spirit Voices, Shamanic Songs, and Strange Attractors
Control Interrupt and Spirit Spaces
Driving Interrupt Amplitude and ADSR Transitions
Cellular Automata and Fractal Imprinting
Linear vs. Nonlinear Memory Imprinting
Shamanic Information Compression
Notes and References 15
Chapter 16 - Physical Shamanism and Shamanic Therapy
Modern Shamanic Psychotherapy
Shamanic Dieting, Purging, and Cleansing
Metabolic Destabilization and Cellular Regeneration
Physical Shamanism and Metabolic Entrainment
Notes and References 16
Chapter 17 - Hypnotic Entrainment and Induced Trance States
Neural Oscillators
EEG and Brainwaves
Hypnosis, Induced Trance States, and Entrainment
Shamanic Entrainment Technology
Chapter 18 - Psychic Bonding and Psi
Psychic Bonding and Circadian Rhythms
Stress- and Pheromone-Induced Neuroplasticity
Informational Capacities of Bound Partners
Notes and References 18
Chapter 19 - Group Mind and Fluid Tribal Dynamics
Group Trance and Entrainment Technology
Group Mind and Behavioral Phase Transitions
Informational Capacity of Group Mind
Chapter 20 - Shamanic Sorcery
Sorcery and Nonlinear Influence
Synchronicity Magic and Probability Collapse
Sorcery and Negative Information
Notes and References 20
Chapter 21 - Spirits and Spiritual Communion
Habits and Customs of the Spirits
Interfacing with Spirit Information
Gnosis, the All One, and Nonlinear Communion
Information Capacity of Spiritual Communion
Notes and References 21
Chapter 22 - Information Genesis and Complexity
The Singularity and Post-Technological Matrices
Shamanism and Information Matrices
Notes and References 22

Appendix 01 - Conclusions and Discussion
Conclusions
Discussion
Appendix 02 - Informal Discussion of Topics
What is Psychedelic Information Theory?
How does PIT describe psychedelic action?
How do psychedelic interference patterns relate to the techniques of shamanism and psychedelic therapy?
The Control Interrupt Model reduces hallucinogenic action to a high speed sensory attack and decay envelope. Why did you decide on that model?
Why is a wave model of psychedelic action better than traditional shamanic models?
Doesn't reductive analysis take the mystery or artistry out of entheogenic transcendence and shamanism?
How do psi phenomenon like telepathy and group mind tie into PIT's harmonic wave model?
Can you describe a resonant oscillator? How does harmonic resonance apply to the brain?
So shamanic singing is a form of resonant feedback for stabilizing consciousness in chaotic psychedelic states?
Does PIT present a hallucinogenic scale, like the Shulgin scale, which rates hallucination or expanded consciousness along some metric?
You say expanded consciousness tops out at 16 stacked frames? Why 16 frames?
How do you think PIT will be perceived in the future?
What experiments can be done to test the various models presented in PIT?
About this Text - About Psychedelic Information Theory
Bibliography
References
About the Author

Preface

Psychedelic Information Theory (PIT) is a formal deconstruction of psychedelic hallucination, expanded consciousness, and shamanism, and as such it attempts to move topics which have traditionally been classified as metaphysics into fields of physics and mathematics. The goal of PIT is to unify all existing psychedelic research into a formal model which accurately describes the complex dynamics generated when a psychedelic drug is introduced into human neural and social networks. PIT is a general model which links psychedelic pharmacology directly to the nonlinear dynamics of expanded consciousness, neuroplasticity, shamanic technique, and tribal organization. This book should be equally enlightening for shamen, physicians, scientists, mathematicians, mystics, and anyone seeking to model or understand the functional limits of expanded consciousness.

PIT is presented as an introductory textbook for people with broad interests in consciousness, perception, psychedelics, hallucination, shamanism, dreaming, pharmacology, neuroplasticity, chaos theory, and related fields. Because PIT is meant to be an overview of a general theory which encompasses many diverse fields, it only scratches the surface of what could be a far larger and more detailed text. Students interested in further exploration on these topics should consult the bibliography and references for more avenues of research and discovery. For readers who are less scientifically inclined, or who seek a quick overview of the concepts covered in this text, an informal discussion of topics has been included in the appendixes. This discussion provides a brief summary of PIT and answers some of the most common questions raised in reaction to the text.

Sincerely,

James L. Kent

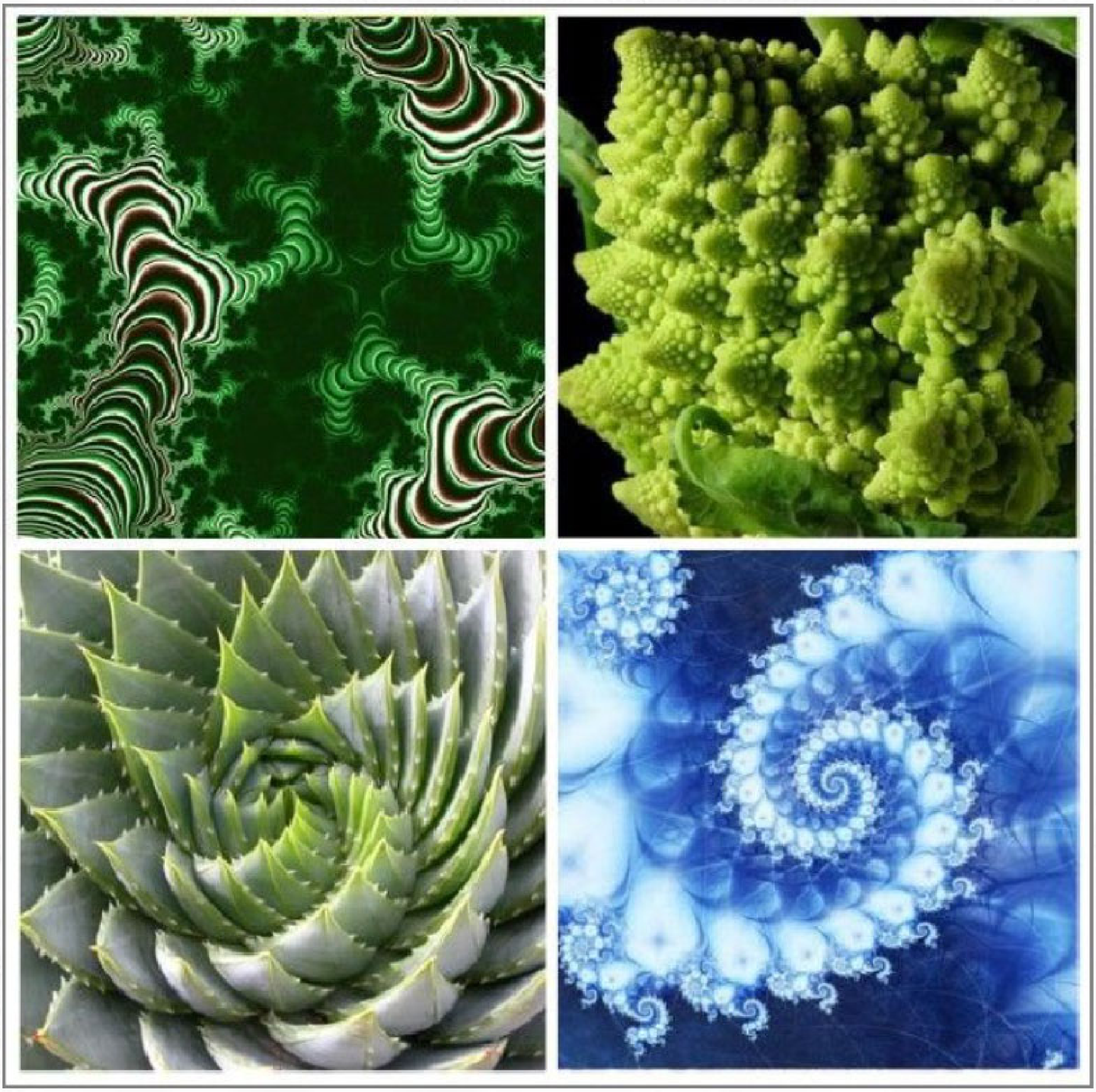


Figure 1. Fractals generated by computer programs and nature are examples of deterministic chaos in nonlinear systems, and share many formal similarities with psychedelic hallucinations. WikiMedia Commons.

Part I

Psychedelic Information Theory

Chapter 01

What is Psychedelic Information Theory?

Psychedelic Information Theory (PIT) is the study of information creation in the human imagination, particularly in states of dreaming, psychosis, and hallucination. PIT seeks to model the functional output of human perception in order to extrapolate the limits and complexity of information arising in human altered states of consciousness.

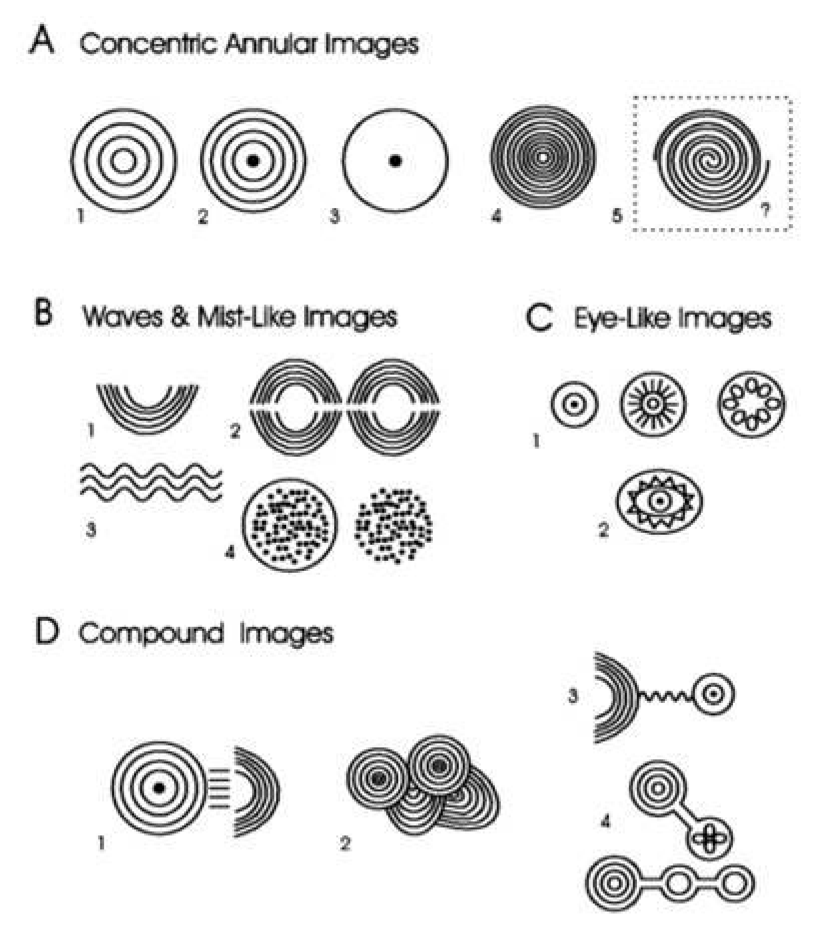


Figure 2. Images of internally generated sensations of light (phosphenes) with geometric shapes and no memory-based content, found in ethnographic reports and prehistoric rock art studies. From Nicholson and Firnhaber.

The foundation of PIT lies in novelty theory, the study of increasing complexity of information over time. Novelty theory encompasses a large time-scale, but PIT is specifically focused on the spontaneous production of complex information in the human organism, which is also known as creativity theory or generative theory. Modeling the creation of information in the human brain requires formal definitions for perception, consciousness, and information, and as such PIT is also a work of systems theory, which posits that the potential output of any system can be fully described by the functional limitations of its components. PIT also draws on control theory, which models the stability and complexity of signal processing in dynamical systems. By applying control theory and systems theory to altered states of consciousness, PIT is an analysis of the nonlinear dynamics of hallucination and expanded states of consciousness. And finally PIT draws upon the fields of wave mechanics, neural oscillators, neuroplasticity, and the fundamentals of pharmacology, cognitive theory, and neural signaling as they apply to perception, memory, and consciousness; this also makes PIT a text on multidisciplinary neuroscience.

Why "Psychedelic" Information Theory?

The bulk of human consciousness exists in a linear range which goes from highly focused and alert to deep asleep and dreaming. Most states of consciousness are experienced uniformly and independently of each other along this linear spectrum. For instance, when you are asleep you are not awake; when you are focused you are not daydreaming; when you are anxious you are not relaxed. The fact that consciousness exists in only one state at one time is an indication that the system is linear and stable. When two distinct perceptions or states of consciousness overlap at the same time this is an indication that the system is unstable, and in most cases where divergent states of consciousness overlap the output is viewed as a pathology.[1] State-divergent pathologies are typically treated with drugs targeted to amplify the positive traits and/or dampen the negative traits.

The term psychedelic means "mind manifesting," which implies that all potential states of mind may be manifested under the influence of psychedelic drugs. If normal consciousness moves in a straight line along a spectrum of many possible states, psychedelics represent a unique and reversible destabilization of this linear spectrum where consciousness can assume multiple points of consciousness simultaneously. The most extreme divergent state of consciousness is described as being wide awake while simultaneously dreaming, a state clinically referred to as psychosis or hallucination. The emergence of multi-state consciousness under the influence of psychedelics represents a system that has destabilized from linear output and has become nonlinear and exponentially complex. Thus, in psychedelic perception the linear functions of consciousness diverge into a complex nonlinear state where multiple perspectives and analytical outputs may be experienced simultaneously.[2] According to PIT, this destabilized state of nonlinear complexity is where new information is generated in the human mind. Understanding the dynamics of this unique nonlinear function is essential to understanding the informational limits and potential complexity range of all human consciousness.

What is "Shamanism in the Age of Reason"?

PIT seeks to describe a model of psychedelic activation that can be adapted to all possible permutations of human consciousness, including group mind states, mystical states, and transpersonal awareness. The ritual of using psychedelics to generate new information, bond with peer groups, and program human belief is traditionally called shamanism, so PIT is a study of the practice of shamanism, which can also be called applied psychedelic science. The practice of using ritual techniques of spiritual transcendence to manipulate belief systems has been popularly dubbed chaos magic, which is an occult blend of neo-shamanism, cognitive theory, and social theory (Fig. 3). Chaos and complexity are also popular terms applied to the study of nonlinear systems, such as fractals and cellular automata, making chaos magic and shamanism spirituo-scientific explorations of the generative function of nonlinear systems.

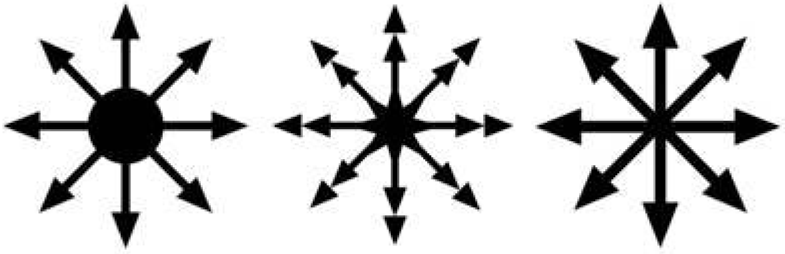


Figure 3. The eight-pointed star is a popular symbol of chaos magic. The arrows represent energy, or information, scattering at high velocity. This symbol is isomorphic of a nonlinear information system, like a universe, which starts at a single point and erupts outward in all directions.

While PIT focuses on physiology over mythology, it is clear that there is a fundamental human desire to achieve states of consciousness subjectively described as Gnostic or spiritually enlightening. It is the conjecture of PIT that all mystical states, including healing and regenerative states, have unique formal nonlinear qualities that can be described in physical terms close enough to make good approximations. This means that PIT is also a work of technical shamanism, neurotheology, or spiritual neuroscience, and can be referenced in the clinical application of psychedelic drugs in shamanic ceremony, mystical ritual, or psychedelic therapy.

Generic Application, Neutrality, Margin of Error

PIT does not attempt to provide precise definitions of consciousness, perception, or the psychedelic state. Instead PIT attempts to model an approximation of psychedelic consciousness based on the known functions and limits of human perception and cognition. According to PIT, if a functional reproduction of consciousness existed then it too could be made to have a psychedelic experience. This also makes PIT a text on artificial intelligence which can be tested in mechanical systems of perception. While this text may contain some assumptions and conjecture on human brain function, the fundamentals of PIT are generic enough to apply to any system of consciousness which relies on real-time frame perception for interacting with reality. Although the bulk of the text focuses on states of hallucinogenesis afforded most readily by the tryptamines LSD, psilocybin (magic mushrooms), and DMT (found in the South American brew ayahuasca), and their action at the 5-HT$_{2A}$ receptor subtype, PIT strives to be generic and substance neutral, meaning that the fundamentals of PIT should apply to all drugs and techniques which produce hallucination, even though they may target different receptors and/or destabilize consciousness in a wholly unique way.

Notes and References 1

1. Some examples of pathologically divergent states of consciousness: Asleep and active is sleepwalking; excited and drowsy is narcolepsy; awake and rigid is Parkinson's Disease; awake and dreaming is psychosis; relaxed and nervous is anxiety disorder; fulfilled and sad is depressive disorder; and so on.
2. When a linear function diverges or bifurcates and begins plotting a range of multiple outputs for the same input, this can be called unstable, dynamic, nonlinear, complex, higher dimensional, undefined, and so on. It depends on how you model your system.

Chapter 02

The Value of Psychedelic Information

A text called *Psychedelic Information Theory* raises the question, "What is Psychedelic Information, and why should we care?" Generally, psychedelic information is any information created in the mind of the subject during a psychedelic experience. Psychedelic information is generated spontaneously in reaction to the psychedelic catalyst; typically the subject has little or no control over the information generated in a psychedelic experience. Psychedelic information is almost always previously unknown to the subject and may appear to originate from an external source or materialize out of thin air. Psychedelic information typically takes the form of visual, audio, and sensory hallucination, but can also be abstract or gestalt like an emotional epiphany. Finally, psychedelic information applies to any art or concept that originates from or evokes psychedelic experience.

This text focuses primarily on the physiological process underlying the spontaneous generation of psychedelic information, and how that information influences both personal and cultural identity. The fact that psychedelic information makes its way into popular culture is proof that humans find psychedelic information valuable, but it is still ambiguous if psychedelics add any real value to culture. Research has shown that spiders are affected by psychedelics,[1] as are rats,[2] cats,[3] monkeys,[4] and so on. However, there is little evidence that information other than noise is generated during psychedelic episodes in animals; the experience does not mean anything beyond a specific derangement of the senses. In contrast, the human adaptation to translate subjective experience into meaningful narrative is uniquely exploited by psychedelics. Psychedelics target perception, memory, and the complex emotions attached to symbols and concepts; the core functions humans rely on to formulate belief. Because of this exploit, the result of the psychedelic catalyst in humans is the spontaneous generation of meaningful information which is imprinted into memory.

Any perceptual system can have a psychedelic experience,[5] but it takes abstract thinking and the interconnection between symbols, concepts, and emotions to make psychedelic information meaningful. Thus, the psychedelic experience does not create information in all systems of consciousness; the psychedelic experience only generates meaningful information in systems of consciousness with the capacity for abstract reasoning via symbolic logic and emotional attachment. Presumably any conscious system which emulates the functions of human abstract reasoning will also similarly generate meaningful information during a psychedelic experience.

The Value of Information

Within the set of information valuable to humans there are domains of descending importance. First there is information valuable to all organisms (biological information), then there is information valuable to all humans (species information), then there is information valuable only to a specific local group of humans (cultural information), and then there is information valuable only to a single human (personal information). All biological information and the most important bits of species information are genetic and are preserved through natural selection. Within the domain of human species importance there is also technological information (such as fire, tools, language, music, agriculture, science, etc.) which are culturally agnostic and serve the needs of the entire species equally. Technological information of species-level importance is equated with high value and will be adopted by all cultures over a short period. Species-level information has high durability and changes very slowly over time.

Cultural information falls in the category of language-based memes and regional or tribal traditions. Cultural information may be shared across cultures or may be restricted to a specific region or subculture. Cultural information is considered to be of medium value, low durability, and changes rapidly over time as the memes and traditions of culture change. Religion and artwork are examples of cultural information that typically only have value to their culture of origin, but occasionally ascend to species-level importance. Finally there is personal information, which is valuable only to a single individual. Personal information changes rapidly, is subject to experience and whim, and is only useful over the lifetime of the organism. Personal information has very low durability and low overall value.

The Value of Psychedelic Information

Psychedelic information is generated within the domain of the personal; yet many people who take psychedelics perceive the information as having species-level importance. There are a few reasons for this phenomena. The first, and easiest, is that psychedelics create states of mania and delusions of grandeur in which the subject feels that he or she is the most brilliant person on the planet, or that they are receiving supernatural prophecy. Secondly, the subject may experience archetypal visions or sensations of transcendence that are perceived to be of high religious or mystical importance. Thirdly, the subject may experience a deconstruction of consciousness associated with animal consciousness, reptilian consciousness, plant consciousness, the Gaian mind, genetic-level intelligence, or deep species memory; information perceived to be of value to all humans or all living creatures. Because psychedelics produce all of these experiences they are routinely perceived as having species-level importance.

Psychedelics are obviously useful in the domain of the personal; shamanism and psychedelic therapy rely on the information function of psychedelics to diagnose and heal. In the cultural domain psychedelics can be employed in ritual to build strong religious or tribal groups; they can be used in healing or sorcery; or they can be a catalyst for innovation and creative expression. Beyond this their value is ambiguous. There are some debates to be made in this area, such as pointing out that Francis Crick envisioned the spiral structure of DNA after he ingested LSD,[6] or that LSD helped Kary Mullis think up the PCR process that earned him a Nobel Prize in genetics.[7,8] To counter these arguments, both Crick and Mullis had been studying molecular biology for years trying to crack those very problems; LSD cannot take credit for anything more than helping Crick and Mullis organize their thoughts in a new way. We can point to great discoveries as examples of psychedelic information, but only a tiny fraction of all psychedelic information can claim this level of importance. Worse than this, erroneous psychedelic information claiming species-level importance has negative cultural value and dilutes the overall information marketplace, making psychedelic information almost statistically worthless.[9]

Probability dictates that most psychedelic information will have little or moderate value, and that the rare piece of psychedelic information will have extreme negative or positive value. It also follows that the more times a subject takes psychedelics the more likely it is they will generate information of high positive or negative value. Similarly, the more often a subject takes psychedelics the more likely they are to latch onto and subsequently reinforce information of high perceived value, either positive or negative. In this case the psychedelic becomes an information imprinting tool. In psychedelic imprinting the information is always subjectively perceived to be of high value, even if it is of low or even negative cultural value.[10]

Negative and Positive Information Value

It is easy to demonstrate that psychedelic information has value; cultures that use psychedelics as sacraments place high value on the information they receive; people will trade hard-earned cash for a psychedelic experience. But because the quality of psychedelic information has such a wide range it is easy to perceive psychedelics as having no value or, in the argument of prohibition, negative value. Psychedelic information with negative value can be described as that which is delusional, paranoid, false, or subverts the health of the individual or culture. Negative psychedelic experiences, or bummers, are a commonly reported element of psychedelic experimentation, but this does not necessarily make bummers negative. Some users claim that negative experiences have value because they provide emotional insight; others report that negative psychedelic experiences cause permanent psychological damage, which is extremely negative. In rare cases people act out and harm themselves or commit suicide on psychedelics. Obviously these are extreme examples of negative value, and these extreme examples are usually linked to mixing drugs, drug binging, or overdosing. There is an optimal dose range for any psychedelic substance; reports of negative effects increase once the optimal dose range is surpassed.[11]

Conversely, there is a range of psychedelic experience that is just as extreme but positive in value; the spiritual or therapeutic or entheogenic experience that adds value to the user and their culture. Having an extremely positive psychedelic experience does not happen by accident; there is nuance involved in selecting the proper dose, finding the right setting, and so on. By contrast, having a negative psychedelic experience is almost always an accident due to improper dose or setting. Therefore, the positive value of a psychedelic experience can be predicted and controlled up to a certain dose range, but beyond that the potential positive value drops and potential negative value increases.

Shamanism, which for the purposes of this text is defined as the practice of using psychedelics in ritual, employs specialized techniques to guide psychedelic information along desired pathways. Influencing and imprinting psychedelic information along positive pathways is perceived as spiritual, enlightening, and therapeutic; influencing or imprinting psychedelic information along negative pathways is perceived as mind control, black magic, or sorcery. Although the value of psychedelic information generated in any single episode is ambiguous, the practice of shamanism is a durable technology with species-wide application. Thus, shamanism is a technological subset of psychedelic information with high value to the entire species, even though the practice of shamanism can be employed to both positive or negative effect.

Notes and References 2

1. Christiansen A, Baum R, Witt P, "Changes In Spider Webs Brought About By Mescaline, Psilocybin And An Increase In Body Weight". JPET April 1962 vol. 136 no. 1 31-37.
2. Butters, Nelson, "The effect of LSD-25 on spatial and stimulus perseverative tendencies in rats". Psychopharmacology, Volume 8, Number 6 / November, 1966
3. Trulson M, Howell G, "Ontogeny of the behavioral effects of lysergic acid diethylamide in cats". Developmental Psychobiology Volume 17 Issue 4, Pages 329 - 346
4. Jarvik M, Chorover S, "Impairment by lysergic acid diethylamide of accuracy in performance of a delayed alternation test in monkeys". Psychopharmacology, Volume 1, Number 3 / May, 1960.
5. See Chapter 04, "What is Consciousness?"
6. Rees, Alun, "Nobel Prize genius Crick was high on LSD when he discovered the secret of life". Mail on Sunday, 8 August 2004.
7. Mullis, Kary, "Dancing Naked in the Mind Field". Vintage, NY, 2000.
8. Rabinow, Paul, "Making PCR: a story of biotechnology". University of Chicago Press, 1996.
9. The psychedelic community produces a new guru every decade or so, and the cultural contributions of these gurus trends from pseudo-scientific to outright fantastical. It is often difficult to tell if the contributions of psychedelic celebrities outweigh the more nonsensical memes they propagate.
10. Psychedelic imprinting can take many forms, and in some cases negative information can be imprinted into identity. Brainwashing is the act of imprinting another person against their will, which is viewed as negative. Self-brainwashing is the act of imprinting yourself with negative information either by choice or error. In self-brainwashing negative information typically assumes explicit paranoid or messianic themes. Extreme cases of psychedelic self-brainwashing will mimic elements of psychosis and persistent delusional disorder. See Chapter 13, "Psychedelic Neuroplasticity".
11. Hasler F, Grimberg U, Benz M, Huber T, Vollenweider F, "Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study". Psychopharmacology, Volume 172, Number 2 / March, 2004.

Chapter 03

Psychedelic Information Theory

Like dreams, psychedelics are catalysts for generating information in the human imagination. There are many theories about the origin of this information: the subconscious; repressed emotions; the collective unconscious; genetic memory; spirit entities; alien transmission; junk data from neural excitation; and so on. Regardless of the origin it is widely accepted that psychedelics do generate information, and not merely junk data of questionable value. Psychedelics excel at producing salient information which can have a profound impact on the beliefs and identity of the subject.

The information generated by psychedelics is usually personal, but it can become transpersonal as psychedelic insights are shared with friends and the public. The rate of psychedelic information flow can be measured by the amount of explicit influence psychedelics have over any given culture, and the rate of flow is different for every culture. Some cultures repress anything resembling psychedelic information while others make it central to their spirituality.[1] Since the cultural revolution of the 1960s, psychedelic information flow has erupted into Western culture at an unprecedented rate. This rate of modern psychedelic information flow has had its ups and downs, but overall has remained relatively constant even in the face of global prohibition.[2]

The pathway of psychedelic information flow is simple and universally the same: 1) ingestion; 2) internal transmission; 3) internal integration; 4) cultural transmission; 5) cultural integration. Most psychedelic research focuses solely on internal transmission, the second stage of the psychedelic information process which is commonly called the trip. While the trip is certainly interesting it is still only one part of the larger overall process by which psychedelics influence both the individual and culture. Each part of this information process has its own patterns and predictable stages, and different portions of this text will attempt to illuminate one or more of these stages in the service of providing an overall understanding of how psychedelics impact culture. Below is a capsule summary of each stage in the psychedelic information process.

Ingestion

While it is difficult to define why people choose to take psychedelics, each society has its own rules which dictate who is allowed to ingest a psychedelic drug and in what context. In traditional settings ingestion is a spiritual exercise used to gain supernatural wisdom, and dosage is controlled ritually by the shaman. In modern Western culture the traditional rules have broken down and psychedelic ingestion has become complex and somewhat haphazard. In a modern context most people are introduced to psychedelics in mundane recreational circumstances, motivated by hedonism, curiosity, boredom, peer pressure, or rebellion. Sometimes an innate hunger for the mysterious drives ingestion. Typically the psychedelic user is seeking something, however vague that notion.

Internal Transmission

Internal transmission is where the psychedelic interacts with the neural network and new information is generated. Information in the psychedelic state is generated spontaneously within visual and audio hallucination; ideas which pop into the subject's imagination; novel juxtapositions of previous concepts; and removed perspectives that allow for new holistic analysis. This information can be literal or figurative; it can be abstract; it can come in words or phrases; it can be spoken or sung; it can be visual; it can emerge as epiphanies or brilliant ideas; it can be a recalled memory; it can be delivered by spirit entities in strange languages; and so on. The information density in a psychedelic session is layered, saturated, and colorfully detailed. Much of the information in a psychedelic hallucination may be accurately described as kaleidoscopic noise, but within this noise comes a wealth of salient content.[4]

In physical terms psychedelics create new information via spontaneous activation and organization of sensory and perceptual networks. Psychedelic information is experienced via direct neural firing and is transferred to memory via the creation and strengthening of synaptic connections in the neural network.[5] Psychedelic information generation takes energy, and the information processing capacities of the human brain are finite, and thus there is an upper limit to the amount of information that can be generated within a single psychedelic session before the brain begins to down-regulate in an attempt to return to baseline.[6]

Internal Integration

For many reasons there is loss of fidelity in the transmission of hallucinatory information from imagination into memory. Like a dream, memories of the psychedelic session must be compressed into manageable snippets that stand out within the larger wash of information. Although psychedelic hallucinations fade quickly they can have lasting emotional impact. How each person deals with the content of each experience is unique to their world view. Some people may choose to ignore content derived from the psychedelic experience; others may cherish anything they can remember and will scrutinize each vision in pursuit of higher metaphysical truth. During this process the information generated during the psychedelic trip is encoded into personal memory by forging and testing new synaptic pathways.

During post-psychedelic integration the subject may begin to reassess and modify personal beliefs and behaviors. Cryptic and intense visions may be recalled over and over, or the subject may dwell obsessively on novel feelings experienced during their trip. The subject will typically review their psychedelic trip and create a lasting narrative of the journey, including what they experienced and what they learned. Integration is where the subject decides what happened in the experience. The content of the hallucination is not as important as the process by which the subject takes that content and shapes it into lasting memories, beliefs, and behaviors; this is the process of encoding psychedelic information into synaptic networks. Content generation without behavioral integration is essentially meaningless, so the true testament of psychedelic power is not the ability to produce visions, but the ability to imprint new information and transform belief.

Cultural Transmission

Psychedelic visions do not stay in the head; if they did there would be no psychedelic art, no psychedelic music, no psychedelic spirituality, and no psychedelic revolution. Psychedelics activate a process in which the realm of the psychological spills out into the realm of the physical. It is clear from 20th century history that psychedelics can fuel artistic expression, social experimentation, religious movements, and political activism. There is no other class of drugs which can claim to have such powerful cultural sway.[7] If psychedelics only produced hallucinations there would still be legitimate cause for fascination, but psychedelics also influence cultural movements, which makes them a global religious and political force to be reckoned with.

The ritual bonding of social groups through cultural transmission of psychedelic information is a subject that has been overlooked in almost all psychedelic research. Not only do psychedelics produce change at the individual level, they also produce changes at the group or tribal level, and thus they influence change in the social structures and goals of human culture. The spread of psychedelic information can be subtle or explicit, starting with the creation of art influenced by the psychedelic experience and culminating in the indoctrination of others into the psychedelic tribe through ritual sharing of the sacrament. Once a subject has been indoctrinated they too will spontaneously generate psychedelic information and begin sharing that information with others. This information process cascades from person to person until the cultural transmission of psychedelic memes reaches a tipping point and becomes openly adopted and even celebrated by the cultural mainstream.

Cultural Integration

By conservative estimates perhaps 10-15% of the population has ever tried a hallucinogen.[8] Despite such low levels of exposure the archetypes of psychedelic experience are well integrated into modern culture. Psychedelic subcultures (urban tribes) are active in every city on the planet. Annual psychedelic festivals, raves, and massives draw tens of thousands of people together from all continents.[9] Psychedelic influences appear constantly in modern fashion, music, visual arts, film, television, consumer products, marketing, packaging, advertising, videogames, and so on. Despite years of prohibition the promise of psychedelic spirituality and psychedelic therapy is still fresh in the public imagination.[10] The global cultural integration of psychedelic information may not be complete, but it is measurably on its way.

It has only been 50 years since the cultural revolution of the 1960s, and the speed with which psychedelics have influenced global culture is impressive. Over the decades the use of psychedelics has jumped generations, and each new generation rediscovers and repurposes the psychedelic ritual for its own needs. There are religious and political forces actively seeking to control or stop the use of psychedelics, but if current trends continue the complete cultural integration of psychedelic information seems inevitable. There may soon come a time when the global majority is in the psychedelic tribe, with the uninitiated minority self-excluded from the ritual. When psychedelic indoctrination reaches a majority of any population then that culture can be described as being saturated with psychedelic information. A culture that has become saturated with psychedelic information will naturally recognize psychedelic ritual as a legitimate rite of passage or spiritual practice.[11]

Psychedelic Information Process

The psychedelic information process is an observable phenomenon that has influenced cultures throughout history and is now affecting modern global culture. At the center of this information process is the pharmacological action of a small number of molecules hitting a tiny subset of neural receptors for a relatively short duration of time. The ongoing information process generated by this small pharmacological interaction goes far beyond the normal range of what we expect drugs to accomplish. Because psychedelics defy pharmacological rationality they are misunderstood, feared, and revered as spiritual in origin. This misunderstanding drives the psychedelic information process into divergent streams of theory and mythology, creating the tapestry of psychedelic propaganda, confusion, and disinformation we have today.

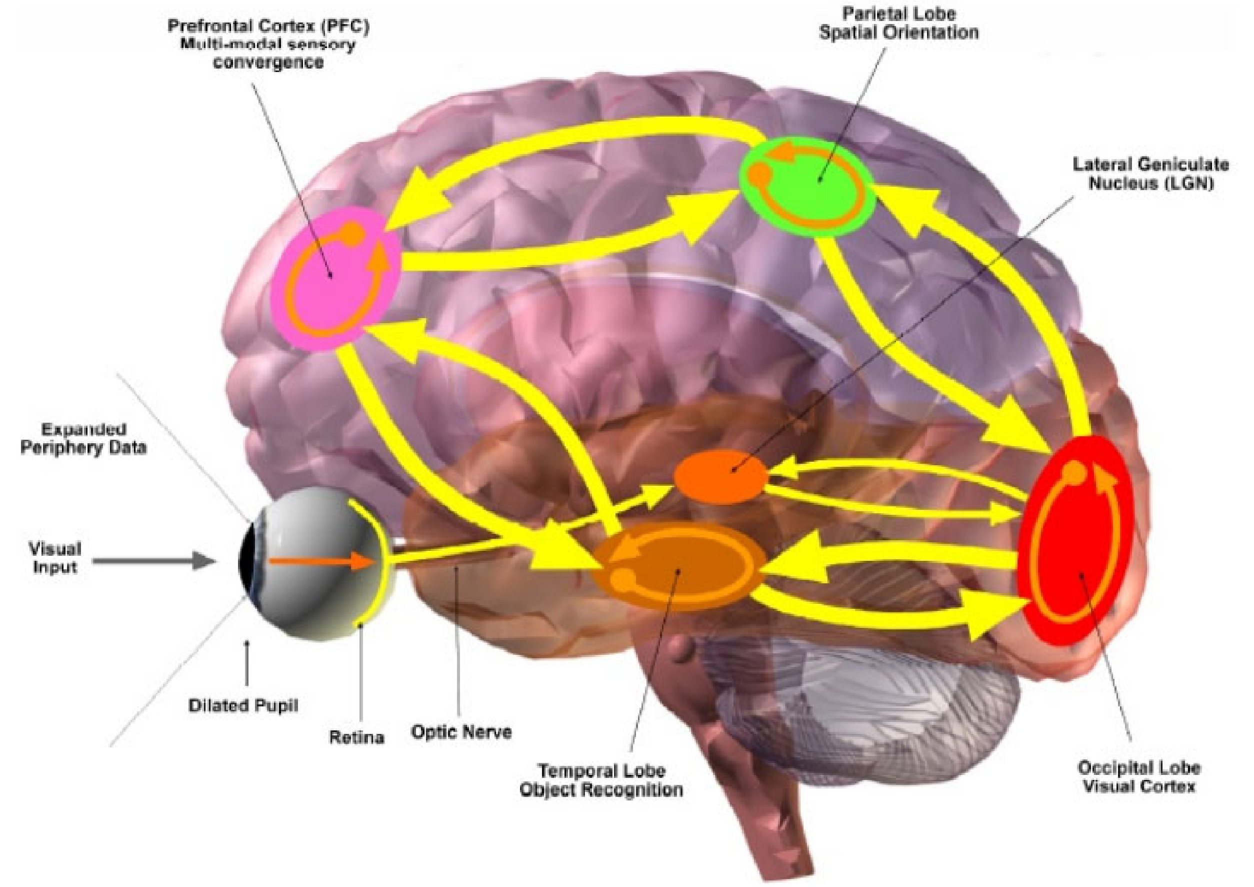


Figure 4. Feedback circuits in visual perception pathways. Sensory signal in human consciousness projects up and around the brain like a wave as consciousness arises in distinct stages. Sensation begins with the sensory organs and feeds into the thalamus (through the LGN for visual pathways), which filters and routes sensation into higher areas of the cortex. Recognition happens quickly and instinctively in the thalamus and medial temporal lobe, focusing attention on salient information. Memory identifies incoming signal moving upward in the cortex, passing data through parallel layers of spatial and object recognition along dorsal and ventral pathways. Multisensory perception finally converges in the pre-frontal cortex as a parsed reconstruction of reality is presented for informing real-time behaviors.

The divergence of psychedelic information and existence of competing schools of psychedelic ideology demonstrates there is no one objective and true psychedelic ideology; any ideology can be influenced and amplified by the psychedelic information process. The psychedelic information process is neutral and ideology non-specific; it applies equally to learning, creativity, mind-control, brainwashing, mysticism, sorcery, and healing. The psychedelic process and psychedelic archetypes can be co-opted by any religious or political group for personal power gain, and psychedelics can be used as weapons as easily as they can be used as medicines or sacraments.[12] The only constant between all divergent schools of psychedelic ideology is the physical process that stimulates the flow of novel information through human neural networks. The study of this information process is known as Psychedelic Information Theory.

Notes and References 3

1. Psychedelic information flow within any culture is a function of religion and politics. Traditional shamanic cultures value psychedelic information as a ritual form of bonding, healing, and discovery, and encourage psychedelic information flow. Industrialized cultures with centralized beliefs view psychedelic information as subversive and anti-authoritarian, and repress psychedelic experimentation out of fear of losing centralized control.
2. A close scrutiny of late 20th century history indicates that there was a small decline in psychedelic interest in the late 1970s and 1980s, followed by a global resurgence of underground psychedelic interest in the 1990s, and a complete return to psychedelic research at the turn of the 21st century. Prohibition may slow the flow of psychedelic information, but it does not stop it.
3. *footnote absent*
4. The content of psychedelic hallucinations has been described vividly in many places. See "Tripping" by Charles Hayes, or the Erowid.org Experience Vaults for hundreds of fascinating first person accounts.
5. See Chapter 13, "Psychedelic Neuroplasticity".
6. Gresch PJ, Smith RL, Barrett RJ, Sanders-Bush E., "Behavioral tolerance to lysergic acid diethylamide is associated with reduced serotonin-2A receptor signaling in rat cortex". Neuropsychopharmacology. 2005 Sep;30(9):1693-702.
7. Since psychoactive drugs shape politics and warfare around the world, the claim that psychedelics are more influential on culture and cultural movements than other drugs can be easily disputed. However, psychedelics are unique in their ability to quickly catalyze tribal subcultures bent on spontaneous altruism, populist activism, and free radicalism.
8. HHS/SAMHSA, Office of Applied Studies, "Ecstasy, Other Club Drugs, & Other Hallucinogens". Internet Reference, 2008.
9. Modern psychedelic festivals can be traced to the "Be-ins" and "Acid Tests" of San Francisco in the late 1960s, made famous by Tom Wolfe's "The Electric Kool-Aid Acid Test". These festivals evolved into Woodstock, the Grateful Dead circuit, the Rainbow Family, Rave culture, Burning Man, the Boom Festival, the Love Parade, and other gatherings around the world dedicated to psychedelic music, art, and culture. Attendance at the largest of these annual festivals is regularly in the tens to hundreds of thousands of people.
10. The 2006 psilocybin and mysticism study by Roland Griffiths brought new enthusiasm to mixing psychedelic spirituality with clinical therapy.
11. It is easy to claim that traditional tribal societies are saturated with psychedelic information, but modern society is not far behind. Western media is filled with psychedelic imagery and fascinated by altered states. In the United States, ayahuasca and peyote are already recognized as legitimate religious sacraments within specific churches, and psychedelic drug experimentation is a common rite of passage among university students.
12. Groups linked to the weaponized use of psychedelics include the Manson Family, the SLA, Aum Shinrikyo, the CIA, and the United States Department of Defense.

Chapter 04

What is Consciousness?

Since this text is about the manipulation of consciousness it is beneficial to have working definition for this term. Consciousness is defined here as a dynamical information processing system with specific functions and emergent operating properties, all of which are necessary to maintain system stability.[1] The minimum specific functions for any conscious system are: 1) perception 2) recognition 3) memory 4) recall, and 5) behavior. The minimum specific operating properties for any conscious system are: 1) modular coherence 2) linear stability 3) feedback control 4) adaptability, and 5) self-awareness. When all of these functions and operating properties are working in tandem you get something resembling human consciousness.[2] When one or more of the five essential functions is degraded then consciousness slides into semi-conscious, subconscious, or unconscious modes. When one or more of the five operating properties is degraded then consciousness becomes unstable and loses fidelity. A description of the functions and operating properties of consciousness follows.

Five Basic Functions of Consciousness

All conscious systems rely on five basic functions to interact with the environment in real time.

Perception

A conscious system must receive input, this input is called perception. For humans, perceptual input is received as sense data moving towards the brain from the peripheral nervous system. Sensation does not become actual perception until it is routed up through the thalamus and into higher cortical areas for processing. Humans also perceive internal thoughts and feelings, their own external behaviors, and small pieces of their dreams. Perception is linear, it feeds back on itself through behavior and recall, and its primary function is to observe changes in environment over time. Errors in human perception are sometimes called hallucination.

Recognition

Data from perception is parsed and matched against known salient patterns; this process is called recognition. Human recognition is driven by hormonal reaction to salient patterns; patterns which have high emotional resonance. Human recognition utilizes fast nonlinear analysis over slow semantic analysis. Fast recognition has high utility but low fidelity, meaning it works quickly but must be double-checked by linear memory for accuracy. Recognition is contextual, multisensory, associative, and its function is to find salient data in incoming perception. Nonlinear recognition errors include false identification, misrepresentation, and déjà vu.

Memory

All salient patterns are stored in memory. Patterns stored in memory are matched against incoming data for recognition; they are also matched against possible solutions for recall. In humans memory is imprinted by emotional resonance, reinforced through linear repetition, and potentiated though nonlinear contextual association. Human memory has many layers; semantic, eidetic, associative, and potentially holographic. Multi-layered human memory involves longterm potentiation and lossy compression, but this compression also includes indexing redundancy to serve fast recall and recognition of salient data.

Recall

Recall uses associative patterns stored in memory to make informed decisions based on logic. Unlike recognition, which is spontaneous and intuitive, recall uses negative feedback to inhibit detrimental solutions and positive feedback to stimulate advantageous solutions. Recall is cyclical and associative, meaning it can use both negative and positive feedback to cycle through and evaluate many hypothetical scenarios before resting on a final decision.[3] The main function of recall is to analyze patterns stored in memory to inform intelligent decisions and behaviors in real time.

Behavior

A conscious system performs behaviors based on input. Human behavior takes the form of both internal and external actions. Internal behaviors, such as thinking thoughts and feeling emotions, transform memory and recall into logical decisions; external behaviors translate internal decisions into outward actions. Human behavior is linear and serial; behaviors are performed in sequence one at a time, typically with thoughts and emotions preceding and informing the intent of action. Both internal and external behaviors feed back into perception, closing the loop on the perceptual feedback process.

Operating Properties of Consciousness

When all of the functions of consciousness are up and running the system begins to take on certain familiar operating properties. These basic properties are what we would expect from any conscious system, and any conscious system that loses these properties will also become unstable and lose fidelity of perception and memory.

Modular Coherence

In order to perform like a seamless, integrated system, consciousness must have some means of synchronizing performance between modular sub-functions. Functional cooperation between different areas of the brain is measured in terms of coupled neural oscillators, neural spike synchrony, and coherence of network oscillations.[4] Waking consciousness oscillates within the alpha and beta ranges; high frequency gamma coherence is associated with the fast binding of cortical networks necessary for perception and consciousness.[5] Modular coherence is the first operating property of a conscious system; precise timing between all areas is necessary for multisensory integration. Without coherence the modular subfunctions of consciousness lose interoperability and destabilize.

Linear Stability

Consciousness can perform many different functions, but it only performs one function at a time. The functional range of consciousness is linear and moves predictably from state to state with the passage of time. Consciousness transitions seamlessly from one behavior to the next. Consciousness retains state data and reacts logically to environmental change. In conscious systems the perception of the passage of time remains constant. The ability to remain focused on the environment and perform sequenced, goal-oriented behaviors in realtime is an operational baseline for all conscious systems.

Feedback Control

Conscious systems must be able to monitor and control their own stability and perform behaviors to modulate system input and output. All conscious systems must have some form of feedback control to retain object focus, retain state data, refine behaviors, perform state transitions, and maintain linear stability. Without feedback control, a dynamical information processing system is prone to output exuberance, memory overload, and error.[6]

Adaptability

A conscious system must be able to store patterns, predict outcomes, learn new behaviors, and react to external variable change. Adaptability and the ability to learn from experience is an epiphenomena or spontaneous operating property of a functionally stable consciousness. Intelligent systems that do not exhibit adaptability only mimic some of the functions and properties of consciousness without actually achieving full consciousness.

Self-Awareness

A conscious system must be aware of itself and be able to recognize other conscious systems. Self-awareness is an epiphenomena of the functions and properties of consciousness maintaining linear stability through time. Self-awareness and the ability to recognize and interact with other conscious systems may be the truest and most objective test of any stable consciousness.

Modular Consciousness

The most dramatic way to demonstrate the fragility of consciousness is to lose it. We sleep every night, and sleeping is a very limited form of consciousness where most of the functions and properties disappear. When we sleep we cannot hold state information from one moment to the next, thus we lose contextual data and self-awareness. In dreams we have perceptions and perform behaviors, but they are not linear nor do we have much control over them. In deep sleep all functions of consciousness go offline and almost entirely shut down. When we wake up these functions slowly return and then restabilize into an alert waking mode. Consciousness turns itself off; consciousness turns itself back on.

Sleeping and dreaming demonstrate that the basic functions of consciousness are modular and interdependent; they can operate individually as well as in specialized groupings. The modular functions of consciousness can be switched off and on in any order without affecting the long-term stability of the fully operational system. The modularity of consciousness becomes evident in cases of brain trauma or mental illnesses where the subject loses some functions of consciousness but retains others.[7] When consciousness is stable we cannot tell it is modular; it runs as a seamless whole or an integrated system. When consciousness destabilizes the modular units uncouple and reveal themselves to be sub-personal pieces of a larger identity process. The loss of multisensory perception and the splintering of consciousness into multiple independent processes can accurately be described as an altered state of consciousness.

Psychedelic Consciousness

If consciousness is modular and the modular functions can interoperate in multiple configurations, it is reasonable to assume there are multiple configurations of sub- and meta- consciousness that are rarely explored. The linear states of consciousness we experience daily are controlled by a top-down homeostatic regulator,[8] but when we short-circuit this regulator we find that modular sub-functions of consciousness can be destabilized, uncoupled, and accessed in novel ways. All forms of mysticism rely on radical destabilization of homeostasis.[9] EEG studies of subjects with hallucinogen persisting perception disorder (HPPD) have shown that when the visual cortex loses coherence with other areas of the brain and coherence among local visual networks increases, spontaneous hallucinations are produced.[10] Sensory deprivation for as little as fifteen minutes is all that is necessary to uncouple the visual cortex and have it start producing coherent self-sustaining hallucinations.[11] This can be described as sleep onset visualization, similar to daydreaming or lucid dreaming, and is sometimes called the prisoner's cinema because extended periods of solitary confinement also produce this effect, as does macular degeneration of the retina. This demonstrates that when modular functions of the brain are uncoupled from top-down coherence they do not always disappear, they may also spontaneously organize into more locally coherent configurations. This uncoupled and locally coherent activity can produce wandering or non-linear sensation in lower brain areas which floats up to conscious awareness as linear perception. This is a neat formal definition for states of dreaming, creative visualization, and hallucination.

Psychedelic Information Theory posits that the uncoupled sub-functions of modular consciousness, acting either alone or in novel peer groupings, are responsible for the subjective altered states classified as hallucinogenic, dissociative, and psychedelic. All hallucinogens must first destabilize top-down coherence of consciousness to produce novel states of spontaneous organization between the modular sub-units; this is how all hallucination begins. Dissociatives disrupt top-down coherence by blocking the excitatory pathways that allow the modular units to communicate. Psychedelics have a more subtle effect on top-down coherence; they periodically interrupt or excite the modulatory frequency of multisensory frame binding, causing perception to destabilize into energetic nonlinear configurations.[12] By destabilizing the top-down control of consciousness, psychedelics allow the modular sub-functions to wander and/or interact with coupled peers in dedicated subsystems; similar to the dedicated circuit created between perception and memory when dreaming.

Destabilizing or splintering consciousness into novel configurations is the essence of psychedelic exploration. When consciousness bifurcates or splits, subjective perception instantly becomes more chaotic and complex. Splintered consciousness may actually appear to be in two places at once, stuck in a superposition between waking and dreaming, finding stability in two simultaneous perceptual states, also know as multi-stability a multi-stable state. Novel configurations of splintered or multi-stable consciousness can be described as nonlinear, complex, meta, transpersonal, depersonalized, faceted, holistic, higher-dimensional, expanded, mystical, subconscious, semi-consciousness, and so on. Splintering, re-configuring, and rebuilding the modular subunits of identity are techniques that may be applied in brainwashing or meta-programming,[13] but also fall under the rubric of mysticism and shamanism. By subverting and re-organizing the modular functions of linear consciousness, psychedelics expand the functional range of consciousness to include many novel states of multi-stable complexity. These complex perceptual states, also known as expanded states of consciousness, are the origin of hallucination and the source of all the psychedelic information that has influenced human mythology, religion, art, science, and culture.

Notes and References 4

1. There is a popular school of thought which posits that consciousness precedes physicality, and that for there to be atoms and molecules and galaxies there must first be consciousness. This is a very broad definition of consciousness which should be saved for more metaphysical discussions.
2. The functions and operating properties of consciousness described here are a simplification of the functions of the human brain, but they are an ample enough description for modeling human consciousness in any environment.
3. This definition of deliberative recall is simplified and based on principles of deductive and inductive reasoning. This definition compresses a much larger discussion on the various types of neural logic and does not account for human emotional irrationality, but it is the minimum definition needed to model the output of human reasoning.
4. The so-called "binding problem" of multisensory perception is approached from a variety of directions, but current theories rely on measuring the strength, frequency, synchrony, and resonance of spike waves propagating through neural assemblies. There are many ways to estimate the relative cooperation between separated brain areas based on their wave properties. Coherence is a term used to indicate strong signal cooperation between separated areas. Areas that are high in coherence may act like coupled oscillators in a feedback circuit, or they may take the form of parallel circuits engaged in a synchronized but distributed processing task.
5. Meador KJ, *et al.*, "Gamma coherence and conscious perception". Neurology 2002;59:847-854.
6. WikiPedia.org, "Control Theory". Internet Reference, 2010.
7. The most compelling examples of mental illnesses which destabilize consciousness are Alzheimer's disease, which affects memory, and schizophrenia, which affects coherence and linear stability. These two examples compress a much larger discussion of how the degradation or loss of specific functions and operating properties of consciousness lead to specific pathologies.
8. Top-down modulation of waking consciousness is a function of aminergic modulation in the forebrain - serotonin and dopamine focusing and maintaining attention - but total homeostatic regulation of brain and body is generally considered to be a function of the hypothalamus. From WikiPedia: "The hypothalamus co-ordinates many hormonal and behavioral circadian rhythms, complex patterns of neuroendocrine outputs, complex homeostatic mechanisms, and many important behaviors."
9. Fasting, chanting, meditation, trance-dancing, isolation tanks, mind machines, and other non-drug visionary practices are rituals designed to destabilize homeostasis through deprivation and hypnotic repetition. Psychedelic drugs achieve more dramatic results by directly interrupting neuromodulatory pathways at the receptor site.
10. Abraham HD, Duffy FH, "EEG coherence in post-LSD visual hallucinations". Psychiatry Res. 2001 Oct 1;107(3):151-63.
11. Mason OJ, Brady F, "The psychotomimetic effects of short-term sensory deprivation". J Nerv Ment Dis. 2009 Oct;197(10):783-5.
12. See Chapter 06, "Control Interrupt Model of Psychedelic Action".
13. Metaprogramming is the term John Lilly chose in the text, "Programming and Metaprogramming in the Human Biocomputer". Splintering is a term used in brainwashing to describe the process of breaking the subject's identity into multiple pieces through stress exercises, making them vulnerable to imprinting and manipulation.

Chapter 05

Limits of Human Perception

Any discussion of psychedelic hallucination is a discussion of the spontaneous emergence of information in human perception. Human perception is limited by the capacity of sense organs; the speed and architecture of the neural network; and the number of distinct perceptions the brain can analyze at any one time. Despite functional limitations, human consciousness is seamless, meaning that each perception and behavior flows smoothly from one to the next. When consciousness is stable, perception and behavior is seamlessly integrated; when consciousness destabilizes, perception and behavior lose cohesion until we are no longer in control of our thoughts and actions. Destabilization of consciousness can happen all at once, in the case of being knocked unconscious, but more often it happens incrementally, as in going to sleep.

Psychedelics are unique in that they can both enhance and degrade perceptual limitations by orders of degrees; psychedelics can obscure and distort perceptual data, or they can enhance resolution and generate expanded states of consciousness. These contrasting results may be dose dependent, but it is also possible that psychedelics simultaneously produce perceptual degradation and enhancement. Psychedelic hallucinations are often described as being beyond the limits of human imagination, a trait which is offered as de-facto evidence of expanded consciousness or supernatural dominion. Since the boundaries of the human imagination can be modeled with some close degree of accuracy, any substantial discussion about the nature of psychedelic hallucination must therefore start with some basic assumptions about the limitations of human perception, and thus the functional limitations of expanded consciousness.

The Visual Spectrum

The human visual spectrum has evolved to work best in a small window of sunlight penetrating the Earth's atmosphere, comprising the white-light band seen in a rainbow; roughly the 400-790 THz (terahertz) energy range which oscillates on the order of hundreds of trillions of cycles per second. The smallest wavelength of visible light is violet, which is only 380 nm (nanometers) wide and travels with the highest frequency. Red, by contrast, is 750 nm long on the other end of the visible spectrum, and at twice the length it travels at half the frequency.[1] Unlike some organisms, the human eye does not see into ultraviolet or infrared rages, nor does it see microwaves, radio waves, x-rays, gamma rays, or anything that falls out of the visual spectrum. This also applies to night vision and dark-adapted vision. The dark-adapted eye utilizes the rod cells as opposed to the cone cells of daylight vision; rod cells are more photosensitive and more numerous, but they lack the color sensitivity and detail resolution of daylight rendering.[2]

Subjects on psychedelics often report increased luminosity and saturation of colors, as well as halos or auras of light surrounding objects; this implies an increase in color saturation and photosensitivity likely related to dilated pupils associated with 5-HT$_{2A}$ agonism. In closed-eye or low-light environments subjects report vividly saturated geometric matrices rendered in swirling palettes of fluorescent purple and neon green.[3] All of these reports fall within the expected range of an overly saturated visible color spectrum, with the dark-adapted eye finding more sensitivity in the shorter-wavelength, higher-frequency, violet to green ranges.

There is speculation that psychedelic hallucination is the result of tuning the brain to receive cosmic radiation at a wider bandwidth than normal; bands associated with electromagnetic, metaphysical, morphogenetic, Akashic, or geomagnetic fields. This so-called spectral argument posits that instead of producing consciousness, the human brain acts as a radio receiver for consciousness, and psychedelics allow the user to tune the brain to new perceptual frequencies, possibly higher dimensional in nature. This metaphor may make intuitive sense, but no research exists to confirm any spectral advantage to psychedelics other than increased photosensitivity and some visual acuity at low doses.[4,5,6] Subjective reports indicate that psychedelics may increase auditory or synesthetic sensitivity to electromagnetic background noise, and the perception of energy fields or auras emanating from living organisms is reported often enough to warrant further scientific scrutiny, but these claims have not been tested rigorously enough to be conclusive.[7] The spectral argument is further weakened by the observation that if the human eye can be tuned to see a novel frequency range, a mechanical spectrum analyzer should also be able to pick up information on that same frequency. To date no hidden psychedelic spiritual energy fields have been detected by even the most sensitive spectral scanning devices.

Visual Frame Aliasing

Seamless perception relies on rapid frame updating to render external changes in real time. Humans can render changes in reality at roughly 13-15 frames per second (fps, or Hz), which means that human reality fully refreshes roughly once every 77 milliseconds (ms), and open-eye saturation of peripheral filling fully fades at around 10-20 seconds (Fig. 5). Human frame perception is exploited by animation and film, which updates at 24 fps, and television, which updates near 30 fps. Computer monitors and high-definition televisions refresh at 60 Hz or higher, and at this rate human perception of motion is entirely seamless.[8] The rate of human frame perception corresponds roughly to the alert beta range of waking human consciousness (12-30 Hz) seen in EEG readings.[9] Any event which happens faster than 1/60th of a second (16.6 ms) falls between perceptual frames and is considered to be subliminal or imperceptible to human consciousness.[10] Seamless frame rendering is also called temporal aliasing, and can be subverted by a variety of common phenomena, including stroboscopic lights which break motions into jerky snapshots, and wagon-wheel illusions where rotating spokes appear to stop or spin backwards.[11,12,13]

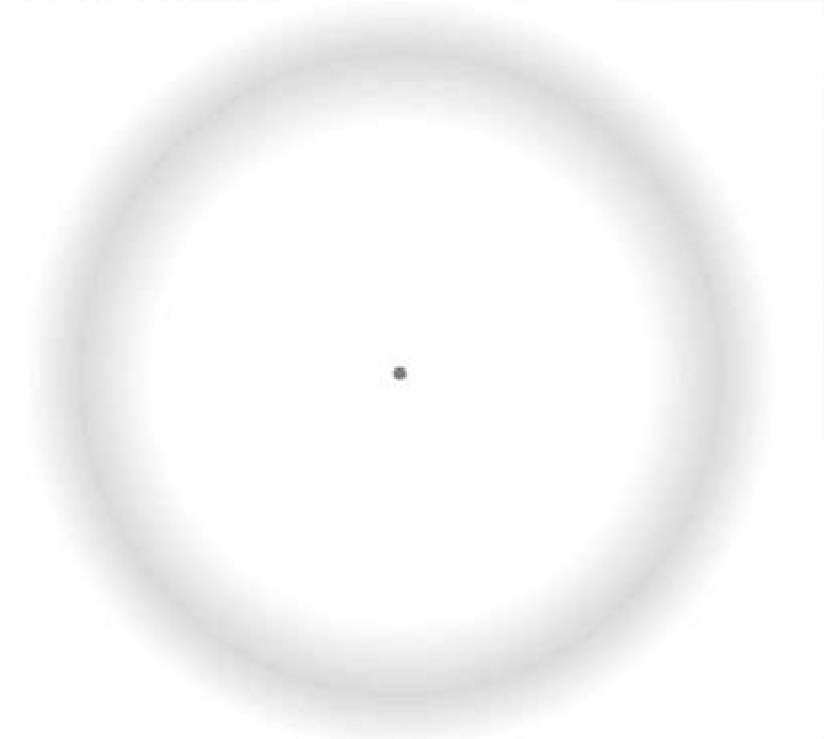


Figure 5. Troxler's fading illusion demonstrates temporal decay of peripheral filling. Stare at the dot in center of image and hold eyes perfectly still for a count of 20. The border around the dot will being to fade. Blinking or moving the eyes will bring the fading areas back. From WikiPedia.

In addition to retaining visual information, perceptual frames hold the totality of multi sensory rendering. Smooth frame aliasing preserves semantic state information from one moment to the next, and retains fidelity of information held in working memory. There is evidence that the brain can track multiple object layers for each frame;[14] possibly corresponding to the number of distinct items we can sustain in working memory, which is about seven.[15] Frame rendering is a distributed cortical task modulated by the aminergic system. High aminergic modulation of the frontal lobe is a good indicator of external frame alertness. Any drug which interrupts the precise timing of the aminergic modulatory system will also disrupt the seamless nature of temporal frame aliasing in the same way that a strobe light disrupts the motion of a spinning wheel. Temporal aliasing hallucinations include frame stacking, frame delay, frame freezing, frame reverse, frame echo, and infinite frame regression; all of which are considered to be uniquely psychedelic.[16] The sensation of hallucinogenic frame stacking indicates that psychedelics may create a temporary frame decay buffer that allows for simultaneous multi-frame analysis and increased complexity of visual comprehension. Subverting or enhancing the limits of visual frame aliasing is an indication of expanded consciousness.

Visual Frame Resolution

Human visual resolution is limited by a number of factors. The first limitation is the density and distribution of retina in the eye; 130 million photoreceptors feeding into 1.2 million optic projections, with a spatial compression ratio of roughly 100 to 1. Photoreceptors in the eye are distributed in rings with color-sensitive cones clustering towards the center and contrast-sensitive rods filling the periphery.[17] Despite the large number of photoreceptors the field of vision is incomplete. Including the blind spot where the retina attaches to the optic nerve, as much as 20% of peripheral vision contains gaps that must be filled with progressive rendering. Incoming rings of visual data must be smoothed into lines and shades in the visual cortex; a process that can produce artifacts of the spatial network when destabilized.[18] The smoothed visual image is then passed forward in two divergent projections for spatial and object analysis, and the finished image reaches multi-modal convergence in the PFC (Fig. 4).[19] This is a fair bit of signal juggling for any processor to handle at 15 frames per second.

Even though human vision employs elaborate compression and reconstruction techniques, the human eye can detect visual detail at resolutions into the micrometer range. From a meter's distance the human eye cannot detect detail under 100 micrometers in length, making print resolutions of 300 dots-per-inch (DPI) entirely seamless. Some estimates put the detail of human visual resolution at 14 million pixels per the entire visual field; or by the 3D topographical field-rendering limit of 10 billion triangles per second, or 760 million triangles per frame.[8] Human detail resolution is only reliable near the center of vision; many optical illusions exploit perceptual filling functions of the periphery (Figs. 5 & 6).[20,21,22] Given the mechanical shortcomings of peripheral rendering, these estimates should be taken as visual saturation points as opposed to functional capacities.

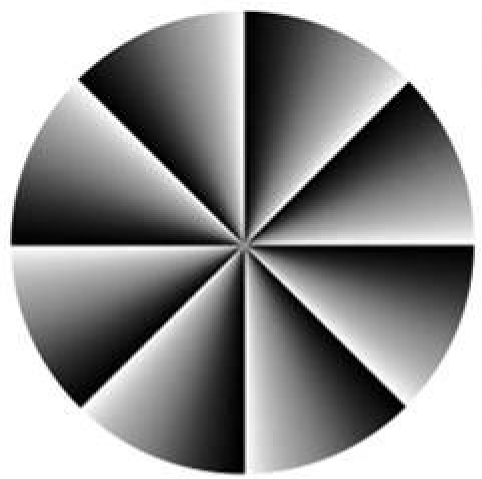


Figure 6. The peripheral drift illusion (PDI) is easily seen when this image is in the visual periphery. Research suggests the illusion is based on temporal differences in tracking luminance along four degrees of gradation. The fourstep gradient processing produces a temporally mismatched contrast signal that fools the peripheral motion system. WikiPedia, Faubert & Herbert, 1998.

Dreaming, Imagination, Psychosis, Hallucination

While the information resolution of imagination and dreams is difficult to measure, it is widely agreed that dream perception is less resolved in detail than waking perception. Dreams are incomplete; contextual state data is not retained from frame to frame; and thus the durability of dream data falls apart under close scrutiny. Sometimes dreams can be vivid to the point of being indistinguishable from reality, containing people and places and narratives that retain state information over many different sequences, but more often dreams are fleeting and half remembered, lasting only a few seconds before fading.

Visual rendering of human imagination is more durable than dreams, but is also very low in resolution. Humans can imagine objects, people, and places in their minds, but human visual imagination is not typically photorealistic. Human memory is more semantic than eidetic, meaning that waking thoughts are mostly verbal, emotional, and only minimally visual. Most humans can imagine basic shapes, outlines, and sensual concepts; a smaller percentage can imagine topographical maps and rotate 3D objects in their mind. Visualizing a simple object like a cube or a pyramid is a cognitive task that requires full concentration; and even at peak visualization the internalized form rarely rises beyond a blurry silhouette. The exception to this limitation is dreaming or daydreaming, when eidetic or photographic snapshots bubble up into consciousness almost fully-formed. The emergence of dreamlike eidetic information into waking consciousness is usually a spontaneous reflex; few people have full control over photorealistic rendering of imagination and memory.[23,24]

Having fully-formed visions spontaneously erupting into consciousness is sometimes called overactive imagination, daydreaming, vivid memory recall, eidetic memory, photographic memory, emergent ideation, hallucination, or psychosis. Each of these modes of internal visualization is characterized by a different intensity and duration of imaginary detail; the more intense and durable the phantom detail, the less it looks like imagination and the more it begins to look like psychosis. Mediating transitions between external alertness and internal visualization is a baseline for perceptual stability; confusing the two would be problematic. The function of internal visualization is activated by the medial temporal lobe and modulated by neurotransmitter acetylcholine; psychedelics presumably activate this function spontaneously by interrupting aminergic alertness of the forebrain.[25] If psychedelic hallucinations capitalize on the brain's capacity to produce vivid dreamlike images, we would expect the detail of a psychedelic frame to match the information profile of a dream frame; low information resolution, fleeting and erratic state data, low formal durability from frame to frame. This means that contextual information such as identity, location, and purpose would also morph and transition many times over the period of a few seconds.

If the quality of a hallucinogenic frame matches the formal quality of a dream frame, one could expect psychedelic visions to be of lower resolution than normal vision; but subjective reports indicate that multiple layers of dreaming and waking consciousness can overlap in a single frame, creating a complex overlay of both real and imagined perceptions. Being unable to separate imagination from reality is the clinical definition of psychosis, but also implies an increase in potential frame information density, which implies expanded consciousness.

The Limits of Expanded Consciousness

If the human imagination is infinite, and if psychedelics can expand the capacity of human imagination, then psychedelics can paradoxically make the infinite even more infinite. This makes sense if you accept that infinity is a linear concept which starts at zero and goes in one direction forever; but if infinity is bent into a series of repeating loops and spirals then it begins to look more like a fractal than a line, and thus more psychedelic. Human perception is linear, but humans live in a nonlinear system. One of the basic limitations of human consciousness in the inability to think exponentially; even with mathematics to assist us, envisioning and predicting exponentially complex systems is a vast conceptual hurdle. Psychedelics destabilize linear perceptions of space and time to produce fractal states of frame layering, bifurcation, and infinite frame recursion. This allows perception to become exponential, to exist in multiple states at once, much like a quantum computer that processes multiple simultaneous probabilities. If normal human imagination is bound within the limits of linear infinity, psychedelic perception is expanded to the limits of exponential or fractal infinity. Psychedelic perception presents a progressive nonlinear bifurcation of recursive self-similar information corresponding to both internal and external perceptual space. The psychedelic layering, bifurcating, and regression of internal and external perceptions creates a timeless, transpersonal perspective of a fractal rendering of time and space.[26]

The perception of seeing all time and space unfolding as a single unified function is a theme that has been reproduced in Eastern mandalas and Mesoamerican calendars for thousands of years, where a central figure sits in the center of concentric interlocking rings of reality (Fig. 7). In Sanskrit this great wheel of time is called Kalachakra (time wheel), and Kalachakra yoga emphasizes the interlocking self-similarity of body cycles and celestial cycles.[27] The description of Kalachakra overlaps with Mesoamerican cyclical calendars and spiritual themes, expressed by María Sabina, the Oaxacan healer who first shared the magic mushroom known as *Teonanacatl* with R. Gordon Wasson. Sabina said, "The more you go inside the world of *Teonanacatl*... you see our past and our future, which are there together as a thing already achieved, already happened... I knew and saw God: an immense clock that ticks, the spheres that go slowly around, and inside the stars, the earth, the entire universe, the day, the night... He who knows to the end the secret of *Teonanacatl* can even see that infinite clockwork."[28] This is undoubtedly a reference to Kalachakra, the great wheel of time.

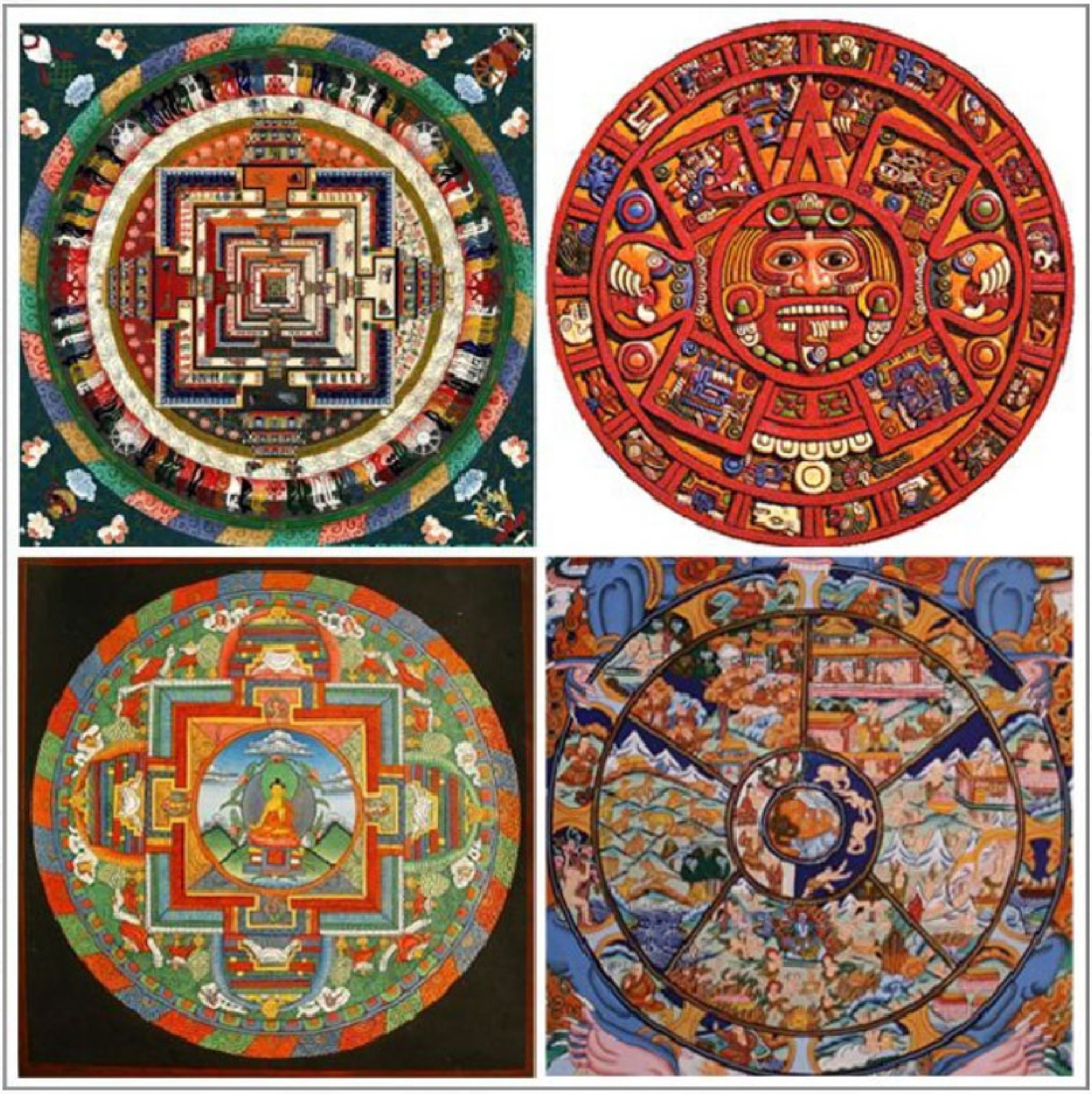


Figure 7. Mandalas and calendars representing universal harmony and knowledge. Top row: a Kalachakra time-wheel mandala; a Mesoamerican calendar. Bottom row: a mandala of the enlightened Buddha; a mandala of the Wheel of Life (Bhavacakra, or samsara). Nonlinear art embeds holographic information - such as an entire cosmology - into a single image.

Witnessing the timeless infinity of Kalachakra can be compared to Western models of Gnosticism and Hermeticism ("As Above, So Below") where the pinnacle of mystical achievement is channeling the infinite wisdom of the universal spirit;[29] or early Deist notions of a God as a great Clockmaker who set the universe in motion and let it run without intervention.[30] According to María Sabina's report, the subjective experience of the infinite clockwork is an end secret of psychedelic vision; this is where you arrive if you follow the process of fractal information regression to the beginning and end of all time. The thought of experiencing Kalachakra as expressed by María Sabina stretches the boundaries of believability, but the subjective reports of a timeless, infinite psychedelic space where the size of the universe is revealed and everything in the past and the future has already occurred is common enough to conclude that this experience is not only possible, but that it might be the end-point of expanded human consciousness.[31]

Notes and References 5

1. WikiPedia.org, "Visible spectrum". Internet Reference, 2010.
2. Miller RE II, Col (RET), "The Eye and Night Vision". USAF Special Report, "Night Vision Manual for the Flight Surgeon", 1992.
3. Accounts of colors seen in tryptamine hallucinations from subjective reports.
4. Hill RM, Fischer R, "Interpretation of visual space under drug-induced ergotropic and trophotropic arousal". Agents Actions, 1971 Nov;2(3):122-30.
5. Fischer R, *et al.*, "Psilocybin-induced contraction of nearby visual space". Agents Actions, 1970 Aug;1(4):190-7.
6. Fischer R, "Effects of psychodysleptic drug psilocybin on visual perception. Changes in brightness preference". Experientia, 1969 Feb 15;25(2):166-9.
7. Accounts of seeing auras taken from subjective reports. Casual tests to confirm spectral claims have been inconclusive.
8. Michael F. Deering, "Limits of Human Vision". Sun Microsystems, 1998.
9. WikiPedia.org, "Electroencephalography". Internet Reference, 2010.
10. WikiPedia.org, "Subliminal stimuli". Internet Reference, 2010.
11. VanRullen R, *et al.*, "The Continuous Wagon Wheel Illusion and the 'When' Pathway of the Right Parietal Lobe: A Repetitive Transcranial Magnetic Stimulation Study". PLoS ONE 3(8): August 6, 2008.
12. WikiPedia.org, "Wagon wheel effect". Internet Reference, 2010.
13. Bach M, "Wagon-wheel effect". From Michael's Optical Illusions & Visual Phenomena. Internet Reference, 2010
14. VanRullen, Rufin, "The continuous Wagon Wheel Illusion is object-based". Vision Research Volume 46, Issue 24, November 2006, Pages 4091-4095.
15. WikiPedia.org, "Working memory". Internet Reference, 2010.
16. See Chapter 12, "Erratic Hallucination".
17. WikiPedia.org, "Retina". Internet Reference, 2010.
18. Gutkin, Pinto, Ermentrout, "Mathematical Neuroscience: From Neurons to Circuits to Systems". Journal of Physiology - Paris 97 (2003) 209-219.
19. LeDoux, Joseph, "Synaptic Self". Viking Penguin, NY, 2002.
20. WikiPedia.org, "Peripheral drift illusion". Internet Reference, 2008.
21. WikiPedia.org, "Grid illusion". Internet Reference, 2010.
22. Pinna, Baingio, "Pinna Illusion". Scholarpedia, 4(2):6656, 2009.
23. The low rendering of human visual imagination is taken from a survey of subjective reports. The quality of internal visualization is enhanced by closing the eyes and falling into a state like meditating or daydreaming.
24. Hobson, J. Allan, "The Dream Drugstore: Chemically Altered States of Consciousness". MIT Press, 2001.
25. Hobson JA, *et al.*, "The neuropsychology of REM sleep dreaming". NeuroReport 9:3, pR1-R14, 16 February 1998.
26. A fractal is a nonlinear algorithms that repeats a basic set of instructions to generate complex, self-similar, recurrent patterns from microscopic to macroscopic to cosmic scales.
27. WikiPedia.org, "Kalachakra". Internet Reference, 2010.
28. Schultes RE, Hofmann A, "Plants of the Gods". Healing Arts Press, Vermont, 1992.
29. WikiPedia.org, "Hermeticism". Internet Reference, 2010.
30. WikiPedia.org, "Watchmaker analogy". Internet Reference, 2010.
31. Exploring the mystical implications of Kalachakra, the great fractal time wheel, has filled many volumes and fueled many prophecies. There is a solid case to be made that Kalachakra is the pinnacle of all mystical achievement; the end of psychedelic exploration; and the endpoint of human consciousness. Since the psychedelic Godhead is a transcendent state of timeless, infinite, omniscient consciousness, it is doubtful that anything more complex or expansive can ever be experienced by the human mind, marking the functional end-point of expanded consciousness.

Chapter 06

The Control Interrupt Model of Psychedelic Action

The brain is an information processing organ that uses top-down signal modulation to control the flow of bottom-up sensory input. Feedback modulation of incoming signal is an example of self-stabilizing control in an information processing system. Using the tenets of cognition and control theory it is possible to describe a model in which hallucinogens periodically interrupt the top-down modulatory control of perception to create sensory interference patterns, multisensory frame destabilization, and altered states of consciousness.

Bottom-up Perception, Top-Down Control

What we perceive as waking consciousness is a synthesis of bottom-up sensation modified by top-down expectation and analysis.[1] Incoming sensation is gated by the top-down focus of subjective attention. Inhibitory feedback subtracts background noise while excitatory feedback resolves and amplifies salient data. This configuration describes a signal filter-amplifier with an inhibitory-excitatory feedback loop to control signal focus and content discrimination. The top-down filtering and focusing of sensory signal is an autonomic reflex and is perceptually seamless; the brain blocks background noise, transitions focus, and recognizes objects without disrupting subjective frame continuity. Without the ability to control incoming sensory signal with feedback, perception would become under-constrained, distracted, overloaded, exuberant, and error-prone. Under-constrained internal sensory noise entering into multisensory awareness would be perceived as hallucination.

Constraint, Control, and Feedback Inhibition

Feedback excitation is applied in sensory circuits to amplify salient input, but the majority of the brain's feedback circuits are inhibitory, meaning that human consciousness is more constrained than unconstrained. In dynamical information processing systems, signal constraint and error correction is applied through negative feedback to subtract or cancel perturbation and noise entering the signal circuit; this is known as control theory. In sensory networks, such as the layers of the cortex or the retina, fast inhibition is applied laterally to boost contrast discrimination in line detail; this is called lateral inhibition. Fast inhibition in the cortex can also be applied from the bottom-up as well as laterally, this is called the synaptic triad of fast inhibition. Inhibition can also be applied from the top-down, allowing the logical cortex to filter or ignore noisy input from the thalamus; this is called top-down feedback inhibition, and it is typically tonic, meaning top-down feedback is inhibitory over many consecutive spike trains to control extended periods of channeled focus. When the brain is alert and focused, this means it is highly constrained by inhibitory feedback.

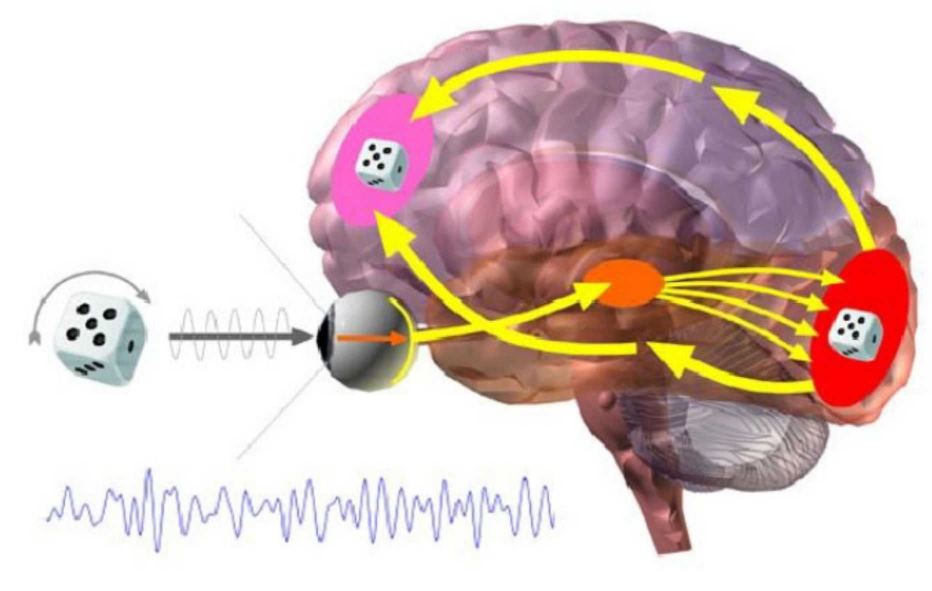
When people express their fears about psychedelics, the most commonly voiced concern is the fear of losing control. Common entheogenic wisdom states that you must relinquish control and submit to the experience to get the most out of psychedelics. Holding onto control causes negative experiences and amplifies anxiety. Metaphors for control and submission are applied to psychedelics because hallucinogens subvert various forms of feedback control, allowing perception and behavior to become unconstrained and unpredictable. Extreme states of under-constrained perception would include sensory saturation, sensory echo, synesthesia, hallucination, disorientation, and confusion. Extreme states of under-constrained behavior would include mania, hysteria, paranoia, euphoria, and as the system becomes totally overloaded, catatonia.

Loss of feedback restraint in a dynamical information processing system causes output to become exuberant and unpredictable; this is called deterministic chaos, or chaos in deterministic systems. In order for a perceptual system to transition from a linear to a chaotic or nonlinear state, negative feedback control must be removed or subverted by a periodic driving force. If control is entirely removed then perception becomes totally unconstrained, leaving a system that is quickly overloaded with too much information. If control is placed in a partially removed state, or in a toggled superposition where it is alternately in control and not in control over the period of a rapid oscillation, then the constraints of linear sensory throughput will bifurcate into a nonlinear spectrum of multi-stable output with signal complexity correlating to the method of control interruption.

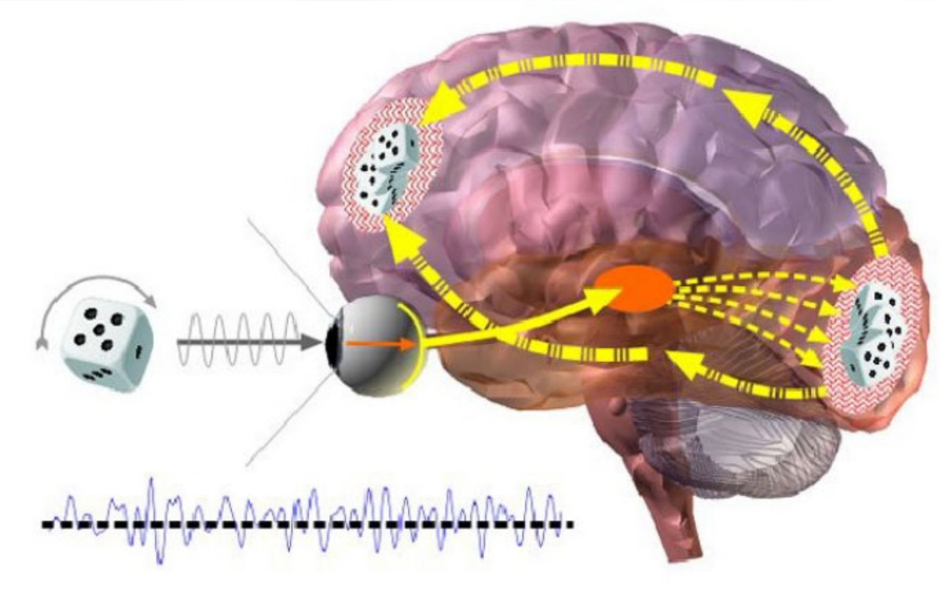
The Control Interrupt Model of Psychedelic Action

Before the mind can start hallucinating, the top-down modulatory control of consciousness must first be interrupted. Interrupting top-down control of consciousness allows the mind to destabilize into novel information processing configurations. When top-down control of waking consciousness is destabilized, neural oscillators in the brain will spontaneously organize into coherence with the most energetic local drivers. This process can be described in terms of oscillator entrainment and resonance; when the modulatory driver maintaining global oscillator coherence is interrupted, uncoupled oscillators will naturally fall into synchrony with most energetic periodic drivers in the environment.[2] In this state, the normally inflexible configurations of consciousness and perception become extensible and open to the influence of environmental feedback. This explains why psychedelics create synesthesia or cross-sensory representations of energetic sensory drivers, and why set and setting have a profound influence on the tone and content of a psychedelic experience.

Figure 8. Stabilized and Destabilized Perception.



Stable perception refreshes at 15 frames per second, allowing seamless update of consciousness in the beta range of 12-30 Hz, indicated by the wave. At this refresh rate objects and textures can be rendered with high precision.



When the precise frame refresh rate of perception is interrupted, consciousness destabilizes and begins to track overlapping information from multiple receding frames. Destabilization, feedback, and latency of frame refresh creates sensory echo and complex frame interference patterns.

When top-down modulatory control of consciousness is interrupted, the seamless nature of multisensory perception degrades and the subject begins to experience hallucinations (Fig. 8). Early indicators of modulatory interruption include periodic high-frequency distortion or noise in sensory networks. In tactile networks this periodic interruption may be felt as parasthesia, or phantom tingling and pulsating; in visual networks it may be perceived as phosphenes, or strobing or flickering of light intensity, possibly fast enough to produce geometric hallucinations; in audio networks it may be perceived as tinnitus, ringing, humming, buzzing, or tones that cycle up and down in pitch. These are all descriptions of field-based hallucinations generated in response to periodic interruptions along multisensory signal pathways. The speed and intensity of the control interrupt, and thus the speed and intensity of the hallucinations, are a direct result of the hallucinogen's pharmacodynamics and method of ingestion.

Control Interrupt Envelopes

Using control interruption as the source of hallucinogenesis, we can model hallucinogenic frame distortion of multisensory perception the same way we model sound waves produced by synthesizers; by plotting the attack, decay, sustain, and release (ADSR envelope) of the interruption as it effects consciousness (Fig. 9).[3,4] For example, nitrous oxide (N_2O) inhalation alters consciousness in such a way that all perceptual frames arise and fall with a predictable "wah-wah-wah" time signature. The throbbing "wah-wah-wah" of the N_2O experience is a stable standing wave formation that begins when the molecule hits the neural network and ends when it is metabolized, but for the duration of N_2O action the "wah-wah-wah" completely penetrates all modes of sensory awareness with a strobe-like intensity. The N_2O sensation is often described as a soft tingling, throbbing, or buzzing that grows to consume all sensation.

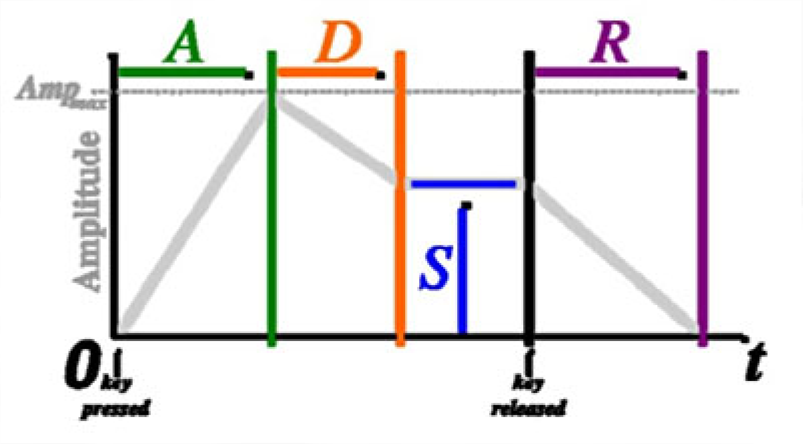


Figure 9. Using an Attack-Decay-Sustain-Release (ADSR) envelope we can model the intensity of hallucinogenic interrupt for any drug. From WikiPedia.

Taking into account the subjective reports of N_2O action, the periodic interrupt of N_2O's "wah-wah-wah" can be modeled as a perceptual wave ambiguity that toggles back and forth between saturated consciousness and semi-consciousness at roughly 8 to 11 frames-per-second, or @8-11 Hz (hertz).[5] Consciousness rises at the peak of each "wah" and diminishes in the valleys in between, growing in sustained intensity with each cycle until the subject passes out. On subanesthetic doses, N_2O creates a looping effect where frame content overlaps into the following frame, causing a perceptual cascade similar to fractal regression. We can thus model the interrupt envelope of N_2O as having a rounded attack, fast decay, low sustain, medium release, with an interrupt frequency of @8-11 Hz. Any psychoactive substance with a similar frequency and shape of interrupt envelope will produce results that feel similar to the N_2O experience (Fig. 10). For instance, smoked *Salvia divinorum* (vaporized Salvinorin A&B, or Salvia) has an interrupt envelope similar to N_2O, except Salvia has a slightly faster interrupt frequency (@12-15 Hz), a harder attack, a slightly longer decay, a more intense sustain, and a slightly longer release.[6] These slight changes in the frequency and shape of interrupt envelope cause Salvia to feel more physically intense, more hallucinatory, and more disorienting than N_2O, even though they share a similar throbbing or tingling sensation along the same pathways and frequency range.

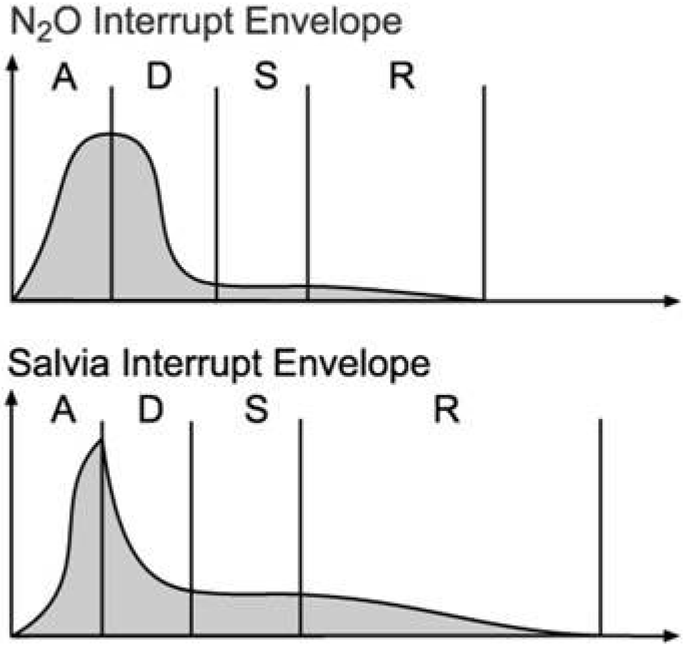


Figure 10. Modeling the interrupt envelope for N_2O and Salvia we can see N_2O has a hard but rounded attack and decay. In contrast Salvia has a slightly faster and more intense ADSR profile, describing a slightly more biting and disorienting effect on multisensory perception.

Using interrupt envelopes we can contrast smoked Salvia or inhaled N_2O with vaporized DMT (*N,N*-dimethyltryptamine), which when smoked has similar onset and duration to both substances but very different hallucinogenic effects. Unlike the slow throbbing periodicity of N_2O or Salvia, vaporized DMT produces an interrupt frequency associated with a high-pitched carrier wave and high-speed frame flicker (24-30+ Hz). The frequency of DMT's interrupt is so rapid the entire body ramps up in panicked response to the new driver. The rate of DMT's visual frame flicker is fast enough to instantly produce geometric hallucinations and fully realized animations.[7] Taking these subjective effects into account we can model DMT's interrupt envelope as having a moderate attack, long decay, medium sustain, long release, and high frequency (24-30+ Hz). The moderate attack means DMT's perceptual frame interference is less of a physical throbbing than N_2O, but because of a higher frequency and longer frame release the rendering of DMT hallucination is more fluid, detailed, seamlessly aliased, and fades longer over a higher number of frames.

The interrupt envelopes modeled here are approximate and based on reported subjective effects, but may also give some insight into the pharmacodynamics of each substance.[8] Following the logic of the Control Interrupt Model, it can be assumed that each hallucinogen has a unique interrupt envelope based on receptor affinity, receptor density, rate of metabolism, and so on, and each unique interrupt envelope creates a distinct type of interference pattern in multisensory perception. The interrupt envelope for any substance will also change if the substance is ingested orally as opposed to vaporized or injected; the speed of absorption into the bloodstream will naturally affect the intensity of ADSR values. This is why each psychedelic can produce unique sensations and hallucinations, and why each psychedelic can produce subtle variations in the speed and intensity of hallucination depending on method of ingestion.[9]

By modeling the interrupt envelope of a psychoactive substance it is possible to accurately predict its subjective results on multisensory perception. Non-drug sources of hallucination, such as those caused by psychosis, deprivation, fever, or schizophrenia, may also have unique and quantifiable control interrupt envelopes related to erratic multisensory frame modulation.

Control Interrupt and Shamanism

If consciousness must have a top-down control frequency to remain stable, and psychedelics produce a periodic interruption of this control frequency, then the interaction between the perceptual control frequency and the periodic interruption can be described as a wave interference pattern in global oscillator coherence. Subjects on moderate doses of psychedelics can override the hallucinogenic interrupt and retain global coherence via energetic physical movement or repetitive behaviors like chanting or dancing. Conversely, if the subject lies motionless, then the interruption fully destabilizes alert consciousness into a depersonalized dreamlike trance.[10] These reports indicate that even though psychedelics destabilize top-down modulatory control of consciousness, feedback control and linear system stability can be entrained back into coherence via external periodic drivers, including rhythmic motor activity, drumming, singing, chanting, rocking back and forth, dancing, and so on. It is no accident that these are also the basic formal elements of shamanic ritual.

In physical terms, the shaman is the primary energetic driver, or resonator, stabilizing attractors within the chaotic hallucinogenic interference pattern created in the consciousness of the subject. In the mathematics of nonlinear dynamics, this phase-locking action is similar to deterministic chaos seen when entraining limit cycles in a forced Van der Pol oscillator.[11] By prescribing a psychedelic substance, the shaman introduces the control frequency interrupt, and through ritual craft and showmanship the shaman applies harmonic interference to navigate and influence the tone and texture of the trip. By mixing the hallucinogenic control interrupt with a harmonic periodic driver the shaman can entrain expanded states of consciousness and manipulate the subject's mind with high precision. The precision wave-based manipulation of neural oscillators within the psychedelic state can be called applied psychedelic science, physical shamanism, or Shamanism in the Age of Reason.

Notes and References 6

1. Corlett PR, Frith CD, Fletcher PC, "From drugs to deprivation: a Bayesian framework for understanding models of psychosis". Psychopharmacology (Berl). 2009 November; 206(4): 515-530.
2. WikiPedia.org, "Entrainment (Physics)". Internet Reference, 2009.
3. ADSR envelopes were chosen as the best available shorthand for approximating differences in the tone and texture of each hallucinogen as it interrupts consciousness. Arguably a more precise model could be employed, but using ADSR compresses a longer discussion on how to precisely model intensity and onset of subjective hallucinogenic effects.
4. WikiPedia.org, "ADSR envelope". Internet Reference, 2009.
5. N_2O interrupt envelope is an approximation based on subjective reports.
6. Salvia interrupt envelope is an approximation based on subjective reports.
7. DMT interrupt envelope is an approximation based on subjective reports.
8. Most receptor interactions occur on the order of microseconds, so attempting to model pharmacodynamics based on rate of subjective frame interruption may be impossible, or require complex statistical interpretations.
9. ADSR envelopes will change slightly for any substance depending on dose and speed of absorption into the bloodstream, but beyond that they may also change depending on the purity of hallucinogen. For instance, if an LSD experience is described as "clean", this means the hallucinogenic interrupt is so subtle that it is almost invisible; this also implies purity of the LSD. In contrast, when an LSD experience is described as "dirty" or "jagged", this means the interrupt induces transitions in consciousness that are abrupt and unpleasant; this also implies the LSD is adulterated or has not been sufficiently purified. It is widely accepted that if one batch of LSD induces a soft interrupt envelope with a wiggly and sensual attack, that same LSD should produce similar result for everyone. The same would be true for LSD that produces a jagged and abrupt attack. If a pure sample set could be acquired and tested, it may be possible to model precise interrupt frequencies and ADSR envelopes for every known psychoactive substance.
10. Reports taken from subjective accounts and corroborated over multiple subjects and experiences.
11. Kanamaru, T., "Van der Pol oscillator", *Scholarpedia*, 2(1), 2202, (2007).

Chapter 07

Psychedelic Pharmacology

Sensory signal traveling through the brain is mediated by glutamate, an excitatory chemical messenger. Sensory signal is filtered by GABA, an inhibitory messenger GABA (Fig. 11).

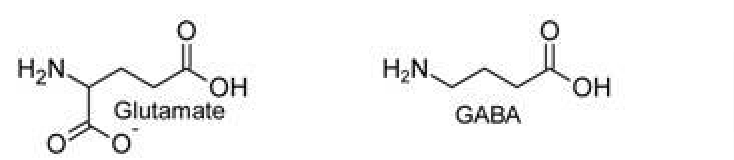


Figure 11. Glutamate and GABA, the neural messengers for go and stop. Glutamate excites neurons and promotes spiking, GABA inhibits spike trains.

The precise spike timing of these messengers is tuned by neuromodulators, which synchronize spiking across the entire brain. Most hallucinogens are structurally similar to the modulators which tune global spike timing, such as serotonin (5-HT), norepinephrine (noradrenaline), and dopamine (DA) (Fig. 12). All of these chemicals are classified as amines, meaning that they have a nitrogen (N^+) containing amino group hanging off a root carbon ring. This nitrogen structure is the key element in any amino acid, carrying the energy needed for metabolic processes which do work. Since these transmitter chemicals have only one nitrogen group they are called monoamines, and they are the essential messengers of the aminergic neuromodulatory system.

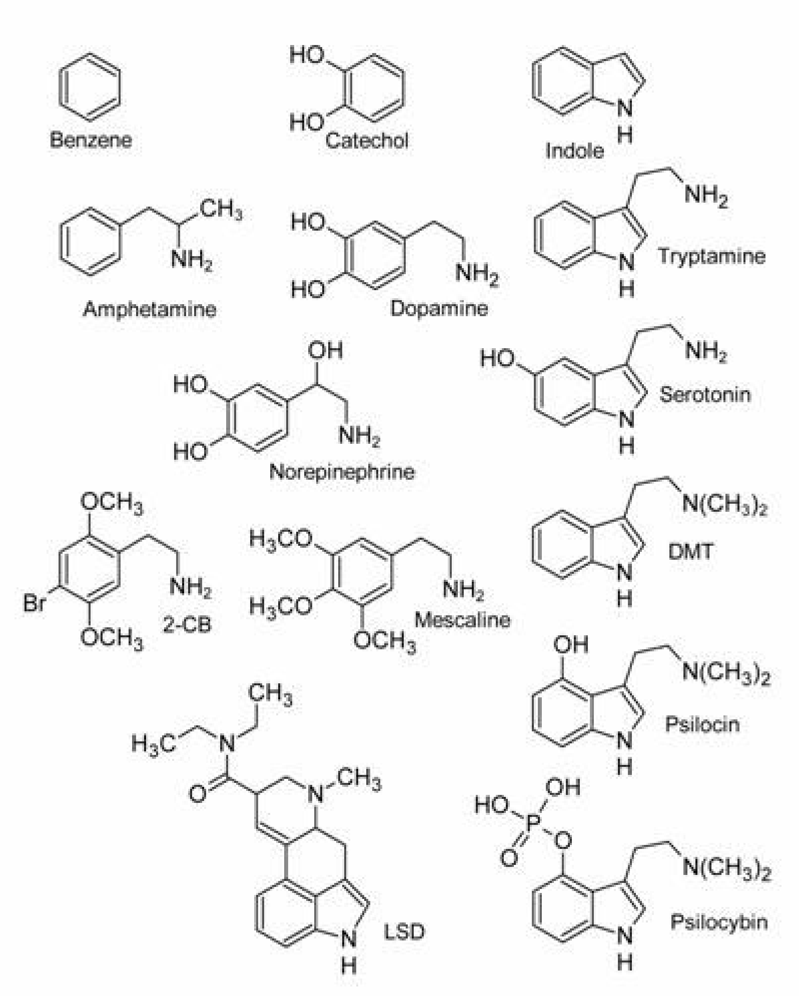


Figure 12. Psychedelic amines look very much like the endogenous neurotransmitters serotonin, norepinephrine, and dopamine. On the left are the adrenal-promoting catecholamines, amphetamines, and phenethylamines; on the right are the indoleamines, also called tryptamines, and their hallucinogenic counterparts. LSD, a synthesized molecule, is also an indoleamine, but is more structurally engineered than its organic counterparts.

Monoamines entering the bloodstream are normally kept out of the brain by the blood-brain-barrier, but psychedelic molecules have a neutral charge so they are able to pass. When these amine crystals pass through the blood-brain barrier they brush against neural receptor sites; if the receptors are a good fit then the crystals get stuck for a short period of time. The bonding of amine ligands to serotonin and dopamine receptors is where psychedelic action begins.[1,2]

Serotonin and the Tryptamines

Because of depressive mood disorders and pharmaceuticals like Prozac, the most well known neuromodulator is serotonin, or 5-HT (5-hydroxytryptamine). 5-HT is essential to many basic brain functions, linked to mood, depression, contentment, learning, anxiety, sleep, appetite, and the regulation of involuntary smooth muscles that control blood pressure and digestion. Serotonin is an indoleamine and a variant of tryptamine, which is the most basic of all the indoleamines and the structural starting point for DMT (*N,N*-dimethyltryptamine), 5-MeO-DMT, psilocin, psilocybin, DPT, AMT, and most psychedelic drugs with acronyms ending in T (which stands for Tryptamine). LSD is also an indoleamine, but it is larger and more complex than organic indoleamines, and is in many ways structurally unique.

Dopamine and the Phenethylamines

Working in concert with serotonin is the neuromodulator dopamine (3-hydroxytyramine). Dopamine is synthesized from L-DOPA and is instrumental in modulating salient attention, motivational response, and fine motor control. Dopamine is central to the reward system, and dopamine release is stimulated by recreational drugs, food, gambling, sex, and physical risk taking. Dopamine imbalances are linked Parkinson's disease, ADD, compulsive risk behavior, and psychosis. The role of dopamine interruption is relevant to psychedelic activity in many aspects; psychedelics may affect sensuality and motor control, and may facilitate psychosis, mania, and compulsive behaviors.

Amphetamines and the phenethylamine group of psychedelics (mescaline, 2-CB, MDA, MDMA, and so on) are more structurally similar to dopamine, epinephrine, and norepinephrine, which are also monoamines but sometimes referred to as catecholamines since they are based on the single catechol ring structure. Epinephrine and norepinephrine are referred to as stress hormones because they prime the body's adrenal production and energy response to stress and danger. The phenethylamines and catecholamines all have the six-carbon benzene ring backbone, simpler than the dual-ring tryptamine structure, with at least one amine group. The simplest form of this molecule is called phenethylamine, and is similar to amphetamine.

In very general terms, the phenethylamine psychedelics are said to be more energetic, sensual, empathogenic, or entactogenic, while tryptamine psychedelics are thought to be more hallucinogenic, disorienting, and somatically heavy. These descriptions are very broad, but this is the popular distinction made between the two major classes of psychedelics.

Neuromodulators and Global Brain States

Serotonin, dopamine, and the other monoamines don't cause neurons to fire, they instead tune the spiking rate of neurons, which means they adjust global network polarity over time to make neural assemblies more or less responsive to stimulus. Serotonin and dopamine are projected into higher areas of the brain from nuclei in the brainstem and middle brain, meaning they are primal signaling mechanisms for modulating many areas of the brain simultaneously. The axons from these aminergic clusters reach upward to many areas of the cortex, affecting the thalamus (sensory filter), amygdala (fear and survival), hypothalamus (homeostatic regulator), hippocampus (memory and learning), and neocortex (sensory and logic processing). Neuromodulators synchronize the neural response to incoming stimulus and keep local competing brain circuits functioning smoothly and in unison. These neuromodulators produce a one-way bottom-up effect, which means they are switched on and off reflexively and unconsciously by glands in the brainstem and basal forebrain in direct response to internal conditions or external stimulus. With neuromodulators the brainstem can exert global homeostatic control over organism mood and behavior. The effect of the aminergic modulators projected upward by the brainstem are tonic, which means their signaling effects are sticky and persist over the duration of many incoming spike trains.

Generally serotonin is thought to have a polarizing effect on neurons, making them less likely to fire and thus having an overall relaxing effect on the brain. This is why many depression and anxiety remedies focus on increasing the supply of serotonin; to decrease anxiety and increase satisfaction. If we assume psychedelics are mimics for neurotransmitters and apply this analogy to DMT, we would expect DMT to have a calming effect on the brain because it looks similar to serotonin. But a flood of DMT does not calm the brain, it makes it hallucinate. Since DMT binds to the same receptor sites as serotonin but does not produce a relaxing effect, it would be logical to assume that DMT is a 5-HT antagonist, meaning it blocks serotonin and depolarizes neurons, making them more excitable. This is not the case. There are many different types of 5-HT receptors, some inhibit neural activity and some promote neural activity. Like most hallucinogens, DMT is classified as a selective 5-HT$_{2A}$ partial or full agonist; also active at other 5-HT subtypes, at DA receptors, at adrenal receptors, at Sigma-1 receptors, and at tertiary amine receptors. This means that DMT is active at many receptor sites and can mimic the agonistic functions of serotonin with varying affinity and efficacy.

5-HT$_{2A}$ partial agonism can be described as a subtle form of aminergic modulatory signal interference. In the most general case it can be assumed that psychedelic activity is due to interference at 5-HT receptor subtypes. In more specific cases we can assume that visual hallucinogenic effect is associated with 5-HT$_{2A}$ and 5-HT$_{2C}$ receptor interaction. Somatic heaviness and dreaminess is associated with broader aminergic interaction; and more sensual, entactogenic, or compulsive effects are associated with dopamine and adrenergic receptor interaction. Psychedelics can have a wide affinity and interact as partial or full agonists at multiple receptor subtypes to produce a wide range of effects.

Because psychedelics are full or partial agonists acting on the same modulatory pathways as 5-HT, the synergistic interaction between these competing agonists can be described in terms of a modulatory wave interference pattern. Agonistic interference at 5-HT subtypes promotes disinhibition and cross-excitability between feedback-coupled assemblies in the brain. Excitation and loss of feedback inhibition in the circuits responsible for processing sensation and perception lead to spontaneous self-sustaining feedback hallucinations. Prolonged states of feedback excitation between the circuits which process perception and memory leads to infinite working memory regression and expanded states of psychedelic consciousness.

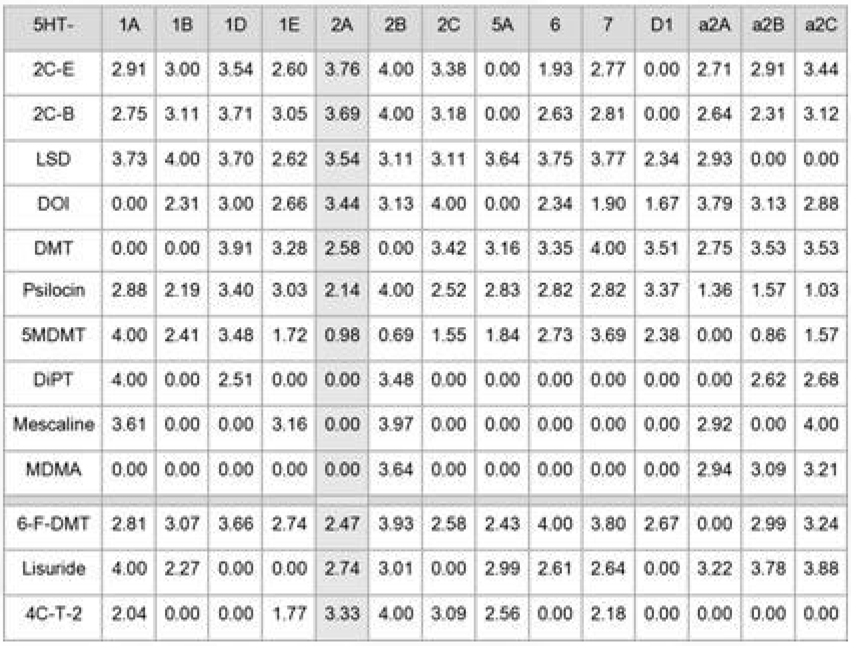
Molecular Shape, Receptor Affinity, MAO Metabolism

The strength and duration of the bond a ligand forms with a receptor is referred to as receptor affinity or potency, and is described in terms of pharmacodynamics. The higher the affinity, the stronger and longer the ligand bonds with a receptor, thus influencing neural activity. Research has shown that 5-HT$_{2A}$ receptor affinity is an accurate measure of the potency of any psychedelic compound; the higher the affinity the higher the potency and psychedelic effect.[4,5] Another thing we know is that the conformational shape of the amine determines how long the molecule takes to metabolize and how sticky it will be at 5-HT receptor types.[6] For instance, the amine tail of LSD is different from other tryptamines; it is long, complex, and connects back to the benzene ring, keeping it rigid instead of flexible like most amino groups or substitutions. Designer amines with a similarly rigid molecular structure have also shown a marked increase in psychedelic potency.[7]

Using this information it can be assumed that the unique structure of LSD is what makes it so potent; giving it a high affinity across a wider range of receptor types; making it more difficult to metabolize; and giving it a broader range of effect over a longer duration. DMT also binds to a wide variety of 5-HT receptor types, but it is smaller and metabolizes very quickly. When DMT is taken with a monoamineoxidase inhibitor (MAOi) in an ayahuasca mixture, the enzymes which metabolize DMT are blocked, making the hallucinogenic effects of DMT orally active and longer lasting. Adding an MAOi to any tryptamine psychedelic will make it nearly twice as hallucinogenic.[8] These few pieces of pharmacology tell us that the efficacy of modulatory interruption, or psychedelic potency, can be somewhat predicted by molecular shape, the rigidity of the molecular structure, and speed of metabolic pathways. If metabolic pathways are degraded by synergistic dosing, as in an ayahuasca mixture, then the potency of the drug increases over the duration of effect in direct proportion to the latency of metabolism.

Breadth of Psychedelic Receptor Binding

Table 1 lists the binding strength of popular psychedelic drugs at many 5-HT receptor sites, listed in order of 5-HT_{2A} affinity.[3] This table should be an accurate representation of hallucinogenic potency of various psychedelics in descending order. From subjective reports all substances at the top of this list are very hallucinogenic, but DMT, which is often considered to be the most hallucinogenic, actually falls somewhere in the middle. If we also look at 5-HT_{2C} affinity, which is implicated in hallucination, we can see that all substances at the top of the list also have high 5-HT_{2C} affinity, with DMT and DOI having slightly higher affinity than the rest. 5-HT_7 receptor affinity, which stimulates cAMP activity and the reward system, also seems to be implicated in overall transcendent psychedelic action, with the mystically popular DMT, 5-MeO-DMT, and LSD topping the affinity list for these receptors.



5HT-	1A	1B	1D	1E	2A	2B	2C	5A	6	7	D1	a2A	a2B	a2C
2C-E	2.91	3.00	3.54	2.60	3.76	4.00	3.38	0.00	1.93	2.77	0.00	2.71	2.91	3.44
2C-B	2.75	3.11	3.71	3.05	3.69	4.00	3.18	0.00	2.63	2.81	0.00	2.64	2.31	3.12
LSD	3.73	4.00	3.70	2.62	3.54	3.11	3.11	3.64	3.75	3.77	2.34	2.93	0.00	0.00
DOI	0.00	2.31	3.00	2.66	3.44	3.13	4.00	0.00	2.34	1.90	1.67	3.79	3.13	2.88
DMT	0.00	0.00	3.91	3.28	2.58	0.00	3.42	3.16	3.35	4.00	3.51	2.75	3.53	3.53
Psilocin	2.88	2.19	3.40	3.03	2.14	4.00	2.52	2.83	2.82	2.82	3.37	1.36	1.57	1.03
5MDMT	4.00	2.41	3.48	1.72	0.98	0.69	1.55	1.84	2.73	3.69	2.38	0.00	0.86	1.57
DiPT	4.00	0.00	2.51	0.00	0.00	3.48	0.00	0.00	0.00	0.00	0.00	0.00	2.62	2.68
Mescaline	3.61	0.00	0.00	3.16	0.00	3.97	0.00	0.00	0.00	0.00	0.00	2.92	0.00	4.00
MDMA	0.00	0.00	0.00	0.00	0.00	3.64	0.00	0.00	0.00	0.00	0.00	2.94	3.09	3.21
6-F-DMT	2.81	3.07	3.66	2.74	2.47	3.93	2.58	2.43	4.00	3.80	2.67	0.00	2.99	3.24
Lisuride	4.00	2.27	0.00	0.00	2.74	3.01	0.00	2.99	2.61	2.64	0.00	3.22	3.78	3.88
4C-T-2	2.04	0.00	0.00	1.77	3.33	4.00	3.09	2.56	0.00	2.18	0.00	0.00	0.00	0.00

Table 1: Popular psychedelic drug affinities across aminergic receptor targets listed in order of 5-HT_{2A} receptor affinity, with dopamine (D1) and adrenal receptors on the right. A value of 4.00 indicates high affinity at that target; any value under 2.00 should be considered imperceptible. Three non-psychedelic control molecules are listed at the bottom for comparison. From Ray, 2010.[3]

In contrast, there are four non-visual psychedelics at the bottom of the list, 5-MeO-DMT, DiPT, Mescaline, and MDMA. These substances have very poor 5-$HT_{2A,2C}$ affinity, but all have a high 5-HT_{2B} and adrenal affinity; this indicates they are effective at stimulating serotonin production, cardiovascular activity, and acute sensuality. 5-HT_{2B} affinity is quite high for all samples in this list with the exception of DMT and 5-MeO-DMT, making 5-HT_{2B} affinity a good indicator for purely sensual or entactogenic effect. It is interesting to note that DiPT, Mescaline, and 5-MeO-DMT all have a high 5-HT_{1A} affinity, which is generally thought to work in contrast to 5-HT_{2A} agonism to promote well-being and satisfaction. DiPT is unusual because it produces distinct audio hallucinations and little or no visual hallucinations, and predictably does not bond with 5-$HT_{2A,2C}$ receptors implicated in visual hallucination. By analyzing this affinity table it seems possible to predict the relative potency and effect of any hallucinogen based solely on binding profiles, though the three control molecules at the bottom of the list (6-F-DMT, Lisuride, 4C-T-2) are reportedly non-hallucinogenic despite high 5-HT receptor promiscuity; this is likely because they are not active as agonists, they are antagonists, or their binding profiles are not synergistic and somehow cancel each other out.

Dissociatives, Anticholinergics, Other Hallucinogens

Psychedelic tryptamines and phenethylamines are not the only hallucinogens, but all hallucinogens work by interrupting sensory processing pathways. Hallucinogenic dissociatives like ketamine (special K), phencyclidine (PCP), and dextromethorphan (DXM) block NMDA glutamate sensory signaling pathways; these pathways mediate fast sensory signal projection through the brain. Anticholinergic deliriants like scopolamine and atropine interrupt cholinergic modulation of memory, recall, and dreaming; these pathways mediate the smooth input and output of memory from the hippocampus. *Salvia divinorum* interrupts kappa-Opioid tactile sensory pathways; these pathways mediate pain, gravity awareness, and sensation for determining physical orientation in space. Depressants like GHB and alcohol activate inhibitory GABA pathways, pathways which dampen and slow smooth sensory throughput. Nitrous Oxide (N_2O) is the simplest and perhaps the most promiscuous of all hallucinogens, worming its way in between a number of rudimentary signaling pathways to produce anesthetic tingling, dissociation, and out-of-body emergence. Although the pharmacological targets of hallucinogens may differ, in all cases perceptual distortion is linked directly to interruption of seamless multisensory signaling and representation across the cortex. Any drug which interrupts pathways of multisensory signaling or binding will be considered psychedelic or hallucinogenic at high enough doses, which is why so many different types of plants and chemicals can be uniquely hallucinogenic across many different receptor targets.

Notes and References 7

1. Snyder S, "Drugs and The Brain". Scientific American Books, 1986.
2. Cooper JR, *et al.*, "The Biochemical Basis of Neuropharmacology". Oxford University Press, NY, 7th ed., 1996.
3. Ray TS, "Psychedelics and the Human Receptorome". PLoS One. 2010; 5(2): e9019.
4. Glennon RA, *et al.*, "Evidence for 5-HT_2 involvement in the mechanism of action of hallucinogenic agents". Life Sci. 1984 Dec 17;35(25):2505-11.
5. Sadzot B, *et al.*, "Hallucinogenic drug interactions at human brain 5-HT_2 receptors: implications for treating LSD-induced hallucinogenesis". Psychopharmacology (Berl). 1989;98(4):495-9.
6. McLean TH, Parrish JC, Braden MR, Marona-Lewicka D, Gallardo-Godoy A, Nichols DE, "1-Aminomethylbenzocycloalkanes: conformationally-restricted hallucinogenic phenethylamine analogues as functionally-selective 5-HT_{2A} receptor agonists". J Med Chem. 2006 Sep 21;49(19):5794-803.
7. Sattelkau T, "An Interview with Dave Nichols". Trip Magazine, V5, Spring 2000, p 42.
8. Subjective reports of taking an MAO inhibitor with psychedelic tryptamines such as DMT, psilocybin, LSD, and 5-MeO-DMT confirm that the addition of an MAOi increases potency and hallucination by an order of magnitude. MAOi potentiation can come from plant sources, such as the harmala alkaloids found in *Peganum harmala* seeds and *Banisteriopsis caapi* vine, but is particularly intense with a pharmaceutical source like moclobemide.

Chapter 08

5-HT_{2A} Agonism and Multisensory Binding

Most visual hallucinogens are active as full or partial agonists at the 5-HT_{2A} receptor subtype, and all produce similar visual hallucinations that are immediately recognizable as psychedelic.[1] Although the 5-HT_{2A} receptor subtype is not the only receptor implicated in hallucinogenesis,[2] it is one of the most studied hallucinogenic targets and offers some insights into the nature of psychedelic action. 5-HT_{2A} receptors are ubiquitous throughout the nervous system, found in the sensory cortex, the frontal cortex, the olfactory cortex, the basal ganglia, the cerebellum, the hippocampus, thalamic nuclei, brainstem nuclei, sensory neurons, platelets, fibroblasts, intestines, smooth muscles, and cardiovascular systems.[3,4,5,6] By following the pathways of 5-HT_{2A} modulated signal transduction through the human organism it is possible to extrapolate that psychedelic experience is not limited to mere hallucination, but is instead a complex multi-layered experience integrated throughout all biological signaling systems.

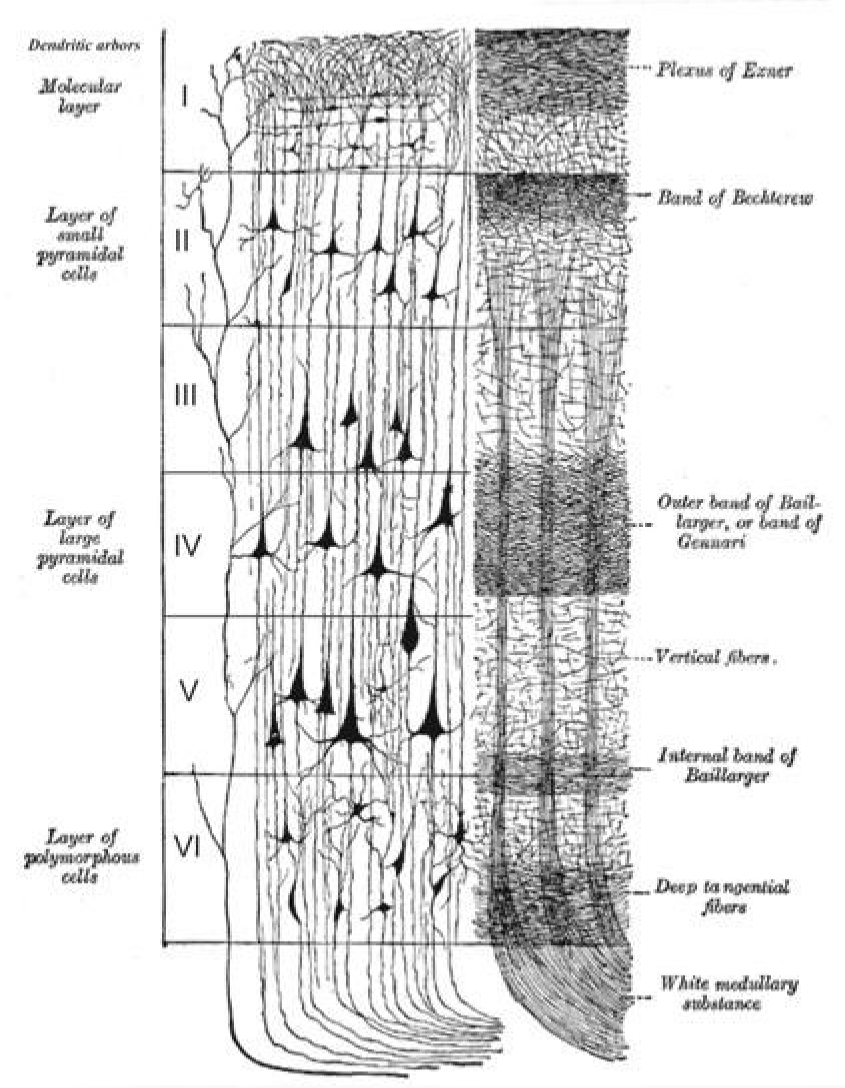

Dendritic arbors
Molecular layer
I
Layer of small pyramidal cells
II
III
Layer of large pyramidal cells
IV
V
Layer of polymorphous cells
VI
Plexus of Exner
Band of Bechterew
Outer band of Baillarger, or band of Gennari
Vertical fibers.
Internal band of Baillarger
Deep tangential fibers
White medullary substance

Figure 13. Layers of the neocortex. Sensory signal rises from the thalamus through intermediary cortical layers to the dendritic arbors at the top layer, the very outer membrane of the cortex, where the highest density of 5-HT_{2A} receptors are expressed. The dendrite arbors in layer I connect back down to the large layer V pyramidal cells, which bind multisensory data via lateral projections, recurrent ascending projections, and reciprocal thalamocortical feedback loops. From Grey's Anatomy, modified.

The layering of cellular signaling systems mediated by 5-HT provides a framework for viewing the 5-HT_{2A} pathway as a primary modulator for homeostatic regulation of multisensory awareness, behavior, and learning.[7] 5-HT_{2A} receptor agonists, also known as hallucinogens, promote disinhibition and excitability in 5-HT mediated pathways, indicating that psychedelic action is the product of spontaneous excitation and self-sustaining feedback in 5-HT mediated signaling pathways. The most obvious effects of 5-HT_{2A} agonism are real-time perceptual distortions, or hallucination, but given the wide distribution of these receptors, there are also bound to be more subtle holistic effects on respiration, metabolism, cellular activity, memory, learning, and long term behavior.

5-HT_{2A} receptor mechanics

The 5-HT_{2A} receptor is a G protein-coupled receptor (GPCR), which means it does not activate ion channels or directly alter cell polarity, but instead sets off a chain reaction of intracellular signaling systems involving phosphatidylinositol (PI) hydrolysis, the production of inositol trisphosphate (IP_3), the release of calcium (Ca^{2+}), and the activation of protein kinase C (PKC) as well as various mitogen-activated protein kinases (MAPK).[6,8,9,25] PKC regulates a variety of cellular functions at the membrane, including signal transduction, receptor desensitization, and synaptic formation and strengthening responsible for learning and memory.[10] MAPK regulates fundamental intracellular functions in the cytoplasm and nucleus such as gene expression, proliferation, cell growth, and survival.[26] It is interesting to note that Salvinorin A, another potent hallucinogen, also stimulates PKC and MAPK signaling pathways via kappa-Opioid receptors.[28,29,30] These receptor-mediated secondary pathways undoubtedly play a role in psychedelic neuroplasticity and cellular regeneration,[27] but the stimulation of secondary messengers is not always necessary for hallucination and psychedelic effect.

Layer V pyramidal cells and perceptual binding

In the human brain the highest density of 5-HT_{2A} receptors are expressed on the dendrites of cortical layer V pyramidal cells,[3,4,5,6,8] and the highest density of layer V dendrites project upward into the dendrite arbors of cortical layer I, the very outward surface of the brain (Fig. 13). 5-HT_{2A} receptors in the dendritic arbors of pyramid cells are primarily responsible for modulating asynchronous (late) glutamate release in the wake of strong incoming spike trains,[1,11,12] presumably for enhanced top-down aliasing, latent reconstruction, and memory imprinting of salient sensory data.[13] Sensory signal rising to the dendrites of the cortical surface encodes a highly detailed reconstruction of external perception for latent real-time analysis and progressive perceptual filling. Multiple layers of the neocortex have descending columnar dendrites or ascending recurrent axon collaterals to provide real-time sensory feedback to latent apical rendering layers, allowing a seamless representation of perceptual motion to be synchronized across the cortex. Cortical layer V neurons receiving input through apical dendrites are one of the primary conduits for binding coherent sensory perception across the entire cortical surface.[14]

Layer V pyramidal cells are unique in that they mediate multiple pathways of perceptual feedback analysis.[14,15] For example, in the visual cortex layer V pyramidal cells are responsible for synchronizing corticothalamic activity with the thalamus via descending axons; they mediate feedback discrimination in columnar circuits via recurrent collaterals ascending through Layers I-IV; they mediate reciprocal interareal connections via laterally branching arboreal and basilar dendrites; and they mediate afferent cortico-cortical signal flow to the pre-frontal cortex (PFC) along both dorsal and ventral processing streams. Through lateral, vertical, elliptical, and recurrent feedback connections, layer V pyramidal cells bind multisensory frame data across the cortex with a functional refresh rate of roughly 15 to 30 frames-per-second (FPS), which means these neurons must process and neutralize incoming sensory spike trains at roughly every 30-60 milliseconds.[16] Loss of precise synchrony and coupling in these circuits would necessarily lead to loss of temporal fidelity in multisensory frame binding. Agonism, disinhibition, excitation, and nonlinear amplification in layer V recurrent circuits would necessarily lead to global multisensory frame aliasing errors, feedback synesthesia, and eventual perceptual overload.

Destabilization in thalamocortical feedback loops

The most potent psychedelics are 5-HT$_{2A}$ receptor agonists; the highest density of 5-HT$_{2A}$ receptors are in the dendrites of layer V pyramidal cells; layer V pyramidal cells bind information in feedback projections throughout the brain. Taking these factors into account it is reasonable to assume that psychedelic hallucinogenic activity is due to nonlinear signal destabilization and amplification via disinhibition recurrent layer V feedback projections. Psychedelic hallucination is achieved by partial or full agonism along recurrent layer V binding junctions; the introduction of a competing agonist in the 5-HT$_{2A}$ modulatory system leads directly to loss of inhibition, underconstrained perception, and self-sustaining excitation in autonomic sensory processing circuits. Destabilization of layer V projections is most acute where signal travels in recurrent loops or feedback circuits that resolve and react to incoming sensory data in real time. The primary circuits for binding real-time sensation include the cortico-striato-thalamo-cortical (CSTC) loops, and the more distributed cortico-thalamo-cortical feedback loops (or thalamocortical loops) which pass information from the cortex either through the basal ganglia or directly back into the thalamus for discriminating and gating attention of incoming signal flow. These loops can be described as attention-controlled feedback filters which drive and stabilize external perception and behavior. CSTC loops provide real-time sensory feedback for fine-tuning eye movements, motor reflexes, emotional responses, and cognitive value placed on stimulus.[17] Destabilization in signal coupling along thalamocortical feedback pathways will necessarily lead to problems with sensory gating, multisensory frame resolution, working memory, and seamless temporal aliasing.

There are specific entopic perceptual effects one would expect to see as a result of instability in thalamocortical feedback loops between the thalamus to the visual cortex, such as a subtle flickering or pulsing of light intensity; geometric grids and matrices; the perception of halos or auras around light sources; increased luminosity of reflective objects; the softening of line and texture resolution; and the inability to hold sharp focal contrast between foreground and background in depth perception.[18] Sensory filling in the visual periphery relies on fast temporal aliasing of signal for motion detection, and this timedependent temporal aliasing can be subverted by optical illusions which create a sense of movement in the periphery (Figs. 6, 23). A competing 5-HT$_{2A}$ agonist would necessarily disrupt the precise inhibitory timing in the cortical columns needed for peripheral edge detection and sensory filling, leading to shifting line and depth ambiguities in the periphery along predictable pulse cycles. If the rate of multisensory frame saturation or neutralization was slowed or interrupted by even a few milliseconds, incoming sensation would begin to layer over itself with increasing levels of smoothing, liquidity, and phantom frame echo decaying in the wake of sensation.[19]

5-HT$_{2A}$ receptor agonists can destabilize multisensory perception in a number of ways. The most general explanation is that 5-HT$_{2A}$ agonists introduce a competing excitatory impulse that disrupts the precise timing of sensory binding in the apical dendrites and recurrent circuits of the thalamus and cortex. Evidence indicates that 5-HT$_{2A}$ agonists promote a late release of glutamate from layer V pyramidal cells following strong incoming spike trains, resulting in the generation of asynchronous excitatory postsynaptic currents (EPSCs).[1,11,12] Asynchronous EPSCs in recurrent sensory circuits are normally helpful for resolving important perceptual data, but if the subject is unable to inhibit evoked EPSCs caused by exogenous modulators (hallucinogens), this late signaling action can lead to glutamate flooding and tonic sensory saturation in perceptual neural assemblies, which is consistent with manic self-sustained states of hallucinogenesis.[20]

There is evidence that 5-HT$_{2A}$ agonists lead to lateral disinhibition in the cortex by blocking presynaptic uptake of 5-HT at the lateral inhibitory synapse, or by overriding tonic GABA$_B$ inhibitory postsynaptic potentials (IPSPs) with asynchronous EPSCs at the lateral-inhibitory synapse.[21,22] Loss of inhibition at the lateral synapses in columns of the visual cortex would lead directly to shifting and wiggling in peripheral line, texture, and contrast resolution. As thalamocortical feedback circuits become increasingly disinhibited, they may fall into coherent self-sustaining states of under-constrained perception,[23] promoting phantom sensory activity such as hallucination and spontaneous dream filling in the corners of the eyes. In the disinhibited or under-constrained psychedelic state, mild stimulus may not provoke hallucinogenic response, but intense stimulation would drive sudden localized feedback coherence, signal amplification, and resulting frame saturation and latency errors. The sudden shift from stabilized brain focus to states of elicited, recurrent thalamocortical feedback excitation can be described in terms of a nonlinear, nonequilibrium phase transition caused by energetic sensory drivers.[15]

5-HT_{2A} cross-agonism and organism re-modulation

Looking beyond the cortex, it is worth mentioning that 5-HT_{2A} receptors are also found in the midbrain, olfactory systems, the brainstem, intestines, and all over the body in smooth muscles and cardiovascular systems. There is some evidence that 5-HT_2 agonists have a secondary effect at the locus ceruleans in the brainstem (LC), promoting adrenal activity in the presence of strong sensory drivers.[1] Sensory driving of adrenal release may promote a synesthetic burst of emotional intensity accompanying any strong multisensory experience. There is evidence that 5-HT agonist hallucinogens inhibit sensory gating in the thalamus, allowing more raw sensation to flood the cortex;[17] this is consistent with decreased gating and nonlinear feedback amplification in thalamocortical loops. A common early side-effect of hallucinogen use is stomach tightening and intestinal cramping; this is undoubtedly due to 5-HT_{2A} agonism interfering with modulation of smooth muscle contraction in the gut. 5-HT_{2A} cross-agonism in the intestines can lead to nausea and purgation, and reports of intense hallucinations typically increase immediately following release of intestinal discomfort.[24] This indicates that radical interruption and re-modulation of all 5-HT_{2A} pathways, from the intestines to the cortex, may be a common precursor to peak psychedelic experiences and states of intense bodily transcendence.

Because of the multiple systems affected by 5-HT_{2A} receptor agonism, it would be overly reductive to point to a single pathway as being responsible for full psychedelic activation. The synergistic effect of multi-layered 5-HT_{2A} agonism is felt subjectively as a throbbing or pulsation of energy which suffuses the entire body, builds in strength and complexity, and culminates in a cathartic multisensory release of highly charged transformative content. At the sensory level, glutamate flooding saturates perception. At the emotional level, adrenal response drives sensual intensity. At the frame level, aminergic interference leads to disorientation and loss of temporal ego cohesion. At the cognitive level, aminergic destabilization drives irrationality, depersonalization, and hallucinogenic dream states. At the circulatory level, 5-HT_{2A} agonism promotes vasoconstriction and increases blood pressure. At the somatic level, an interruption of digestive functioning drives metabolic function and energetic intracellular signaling. At the organism level, the holistic effects of prolonged 5-HT_{2A} agonism become nonlinear, meaning they feed back on themselves and begin to generate complex energetic output in response to sensory input over time. This multi-layered organism activation can be formally described as a runaway biological feedback process, or a nonlinear cellular signaling loop, which drives increasing cellular activity and complexity over the full duration of synergistic agonism.

Notes and References 8

1. Aghajanian GK, Marek GJ, "Serotonin and Hallucinogens". Neuropsychopharmacology. 1999 Aug;21(2 Suppl):16S-23S.
2. Ray TS, "Psychedelics and the Human Receptorome". PLoS One. 2010; 5(2): e9019.
3. Burnet PW, *et al.*, "The distribution of 5-HT_{1A} and 5-HT_{2A} receptor mRNA in human brain". Brain Res. 1995 Apr 3;676(1):157-68.
4. Forutan F, Estalji S, Beu M, *et al.*, "Distribution of 5-HT_{2A} receptors in the human brain: comparison of data in vivo and post mortem". Nuklearmedizin. 2002;41(4):197-201.
5. Pompeiano M, Palacios JM, Mengod G., "Distribution of the serotonin 5-HT_2 receptor family mRNAs: comparison between 5-HT_{2A} and 5-HT_{2C} receptors". Brain Res Mol Brain Res. 1994 Apr;23(1-2):163-78.
6. WikiPedia.org, "5-HT_{2A} Receptor". Internet Reference, 2010.
7. Azmitia EC, "Serotonin and brain: evolution, neuroplasticity, and homeostasis". Int Rev Neurobiol. 2007;77:31-56.
8. Nichols DE, "Hallucinogens". Pharmacology & Therapeutics Volume 101, Issue 2, February 2004, Pages 131-181.
9. Urban JD, *et al.*, "Functional selectivity and classical concepts of quantitative pharmacology". J Pharmacol Exp Ther.;320(1):1-13. Epub 2006 Jun 27.
10. WikiPedia.org, "Protein kinase C". Internet Reference, 2010.
11. Aghajanian GK, Marek GJ, "Serotonin, via 5-HT_{2A} receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release". Brain Research V 825, 1-2, 17 April 1999, Pages 161-171.
12. Aghajanian GK, Marek GJ, "Serotonin Induces Excitatory Postsynaptic Potentials in Apical Dendrites of Neocortical Pyramidal Cells". Neuropharmacology Volume 36, Issues 4-5, 5 April 1997, Pages 589-599.
13. Spratling MW, "Cortical Region Interactions and the Functional Role of Apical Dendrites". Behavioral and Cog. Neuroscience Rev., 1-3 (2002) 219-228.
14. Jones EG, "Thalamic circuitry and thalamocortical synchrony". Philos Trans R Soc Lond B Biol Sci. 2002 Dec 29;357(1428):1659-73.
15. Lumer ED, Edelman GM, Tononi G, "Neural dynamics in a model of the thalamocortical system. II. The role of neural synchrony tested through perturbations of spike timing". Cereb Cortex. 1997 Apr-May;7(3):228-36.
16. See Chapter 05, "Limits of Human Perception".

17. Vollenweider FX, Geyer MA, "A systems model of altered consciousness: integrating natural and drug-induced psychoses". Brain Res Bull. 2001 Nov 15;56(5):495-507.
18. See Chapter 10, "Entopic Hallucination".
19. See Chapter 12, "Erratic Hallucination".
20. Geyer MA, Vollenweider FX, "Serotonin research: contributions to understanding psychoses". Trends Pharmacol Sci. 2008 Sep;29(9):445-53.
21. Kass L, Hartline PH, Adolph AR , "Presynaptic uptake blockade hypothesis for LSD action at the lateral inhibitory synapse in Limulus". The Journal of General Physiology, Vol 82, 245-267.
22. Shao Z, Burkhalter A, "Role of GABAB receptor-mediated inhibition in reciprocal interareal pathways of rat visual cortex". J Neurophysiol. 1999 Mar;81(3):1014-24.
23. Behrendt RP, "Hallucinations: synchronisation of thalamocortical gamma oscillations underconstrained by sensory input". Conscious Cogn. 2003 Sep;12(3):413-51.
24. Accounts of hallucinogens causing stomach unease and intestinal cramping taken from surveys of subjective reports.
25. Watts SW, "Activation of the mitogen-activated protein kinase pathway via the 5-HT$_{2A}$ receptor". Ann N Y Acad Sci. 1998 Dec 15;861:162-8.
26. WikiPedia.org, "Mitogen-activated protein kinase". Internet Ref., 2010.
27. See Chapter 13, "Psychedelic Neuroplasticity".
28. Belcheva MM, *et al.*, "μ and κ Opioid Receptors Activate ERK/MAPK via Different Protein Kinase C Isoforms and Secondary Messengers in Astrocytes". J Biol Chem. 2005 July 29; 280(30): 27662-27669.
29. Bohn LM, "Mitogenic Signaling via Endogenous κ-Opioid Receptors in C6 Glioma Cells: Evidence for the Involvement of Protein Kinase C and the Mitogen-Activated Protein Kinase Signaling Cascade". J Neurochem. 2000 February; 74(2): 564-573.
30. Bruchas MR, *et al.*, "Kappa Opioid Receptor Activation of p38 MAPK Is GRK3- and Arrestin-dependent in Neurons and Astrocytes". June 30, 2006 The Journal of Biological Chemistry, 281, 18081-18089.

Chapter 09

What is Nonlinear Hallucination?

Psychedelic Information Theory invokes nonlinearity to describe the perceptual effects of hallucination, but the term nonlinear has a variety of definitions which are sometimes confusing or unclear. To clarify the nonlinearity of psychedelic hallucination, the following is a description of formal nonlinear dynamics, broader definitions of nonlinear systems, and how each of these definitions may apply to psychedelic perception.

Nonlinear Systems

Nonlinear systems can be defined in terms of the complexity of output in proportion to input, also described in terms of sensitivity to initial conditions. The output of changes in a linear system are simple and can be modeled with a line on a graph. In contrast, the output of a nonlinear system feeds back on itself and becomes chaotic and complex; simple small changes in initial conditions will result in unpredictable and exponentially divergent data sets that cannot be easily predicted. In mathematical terms, the results of a nonlinear system begin to bifurcate, diverge, or split into multiple possible data points the farther out you attempt to resolve them. The results of a nonlinear system cannot be modeled with a linear function because linear functions plot sequential or additive complexity; nonlinear functions plot exponential or geometrically expanding complexity. The mathematical study of nonlinear systems has resulted in chaos theory, complexity theory, and the analysis of self-amplifying recursive systems such as fractals and cellular automata. Renderings of nonlinear systems output are considered to be of high intrinsic beauty, (Fig. 14)[1] and the repeating forms and patterns are often perceived as spiritual or mystical because they are isomorphic of chaotic or nonlinear systems in biology, nature, and the cosmos.

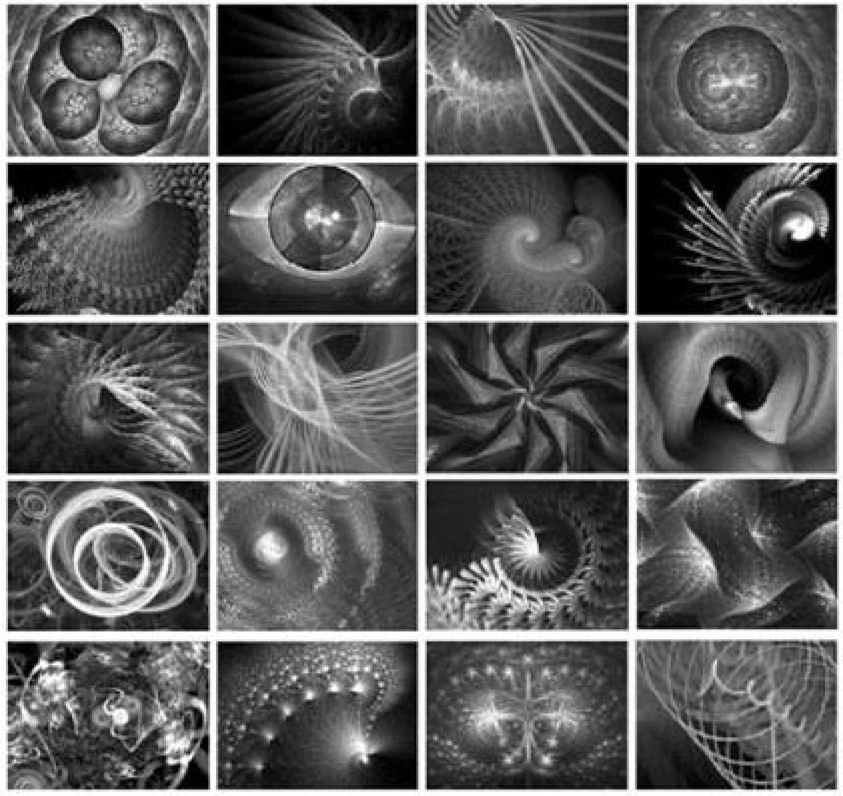


Figure 14. "Electric Sheep" fractals selected for an aesthetic voting experiment. Images chosen for intrinsic natural beauty. From Taylor, 2008.[1]

Nonlinear Consciousness

The physical world is a complex nonlinear system, but human consciousness perceives reality as a single linear sequential narrative that moves predictably forward in time. The linearity of perception is an indication that consciousness is producing stable, predictable output. If perception suddenly diverges into multiple unpredictable outputs for the same linear input, this is an indication that consciousness has destabilized and become nonlinear. A video feedback loop is an good example of a nonlinear perceptual system; each frame captures itself and the receding previous frame, and then itself and two receding frames, and then itself and three receding frames, and then itself and four receding frames, and so on, feeding back on itself at 30 frames per second until complexity recedes into chaos and infinity (Fig. 15). This is the mathematical definition of nonlinear system generating fractal complexity, or chaos, through an iterated map or recursive frame-stacking feedback loop.

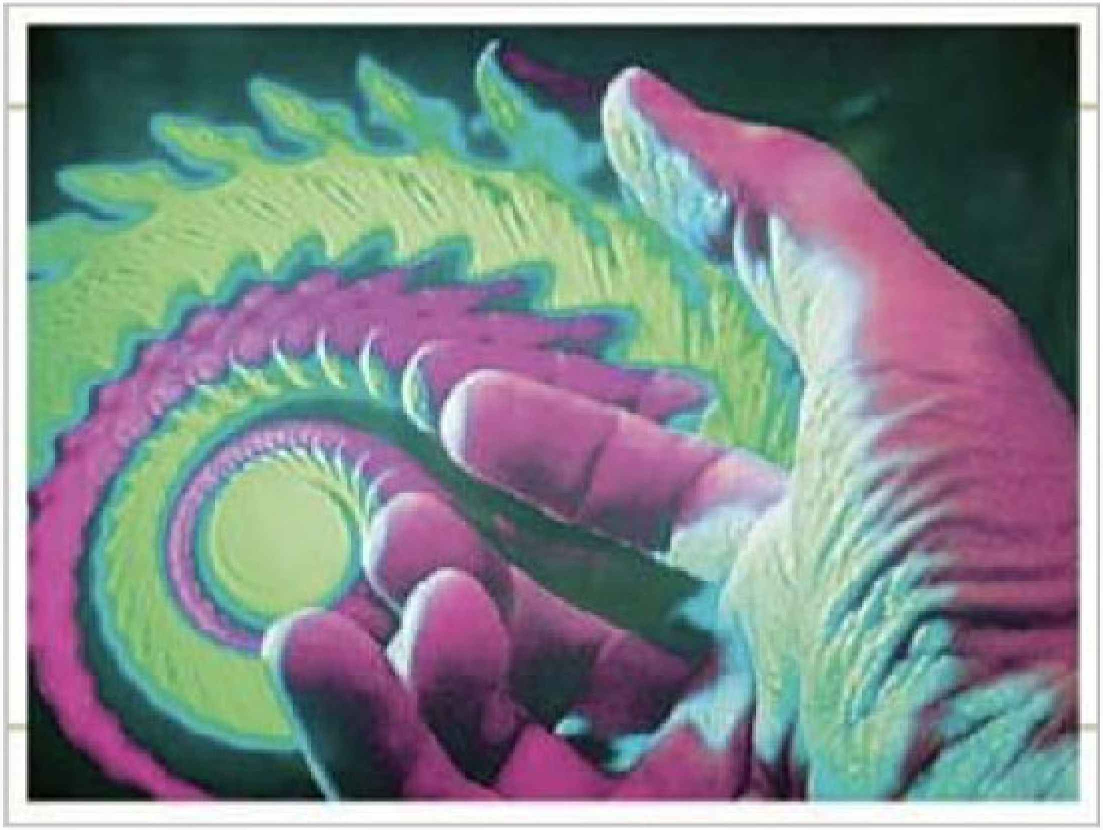


Figure 15. A video feedback loop creates a nonlinear system isomorphic of a fractal, where from recedes inward on itself, spiraling towards infinite complexity in under a second. From Hofstadter, 2007.[2]

Other examples of nonlinear consciousness may be less classically nonlinear, meaning not generating exponential complexity, but still lacking in linear formalism. For instance, consciousness may perceive itself to be in multiple places at once; it may perceive multiple data sets for the same input; it may see multiple different perspectives of the same scene; it may move sideways or backwards or completely outside of linear time. These would all be considered nonlinear perspectives of consciousness. Dreaming can be associatively nonlinear, which means narrative content moves unpredictably from state to state while retaining some tangential linearity. Psychedelics are famous for being progressively nonlinear, which means incoming sensation saturates perception and begins to stack over itself, generating increasing complexity of sensual intensity through time.

Phenomenology of Nonlinear Perspectives

By definition, a nonlinear system produces results with increasing complexity over time. In a linear perspective a human will parse a literal analysis of each object and then move on to the next object. In a nonlinear perspective the subject produces increasingly complex perceptual results for each object held in focus for the duration of that focus. For instance, a subject staring at a rock in a linear state may notice interesting shapes, textures, or colors; in a nonlinear state that same rock may provoke thoughts and visions of the birth of the universe and the origins of suns and planets and all solid matter leading up to the formation of that very rock. The linear perspective sees literal, formal attributes of the rock in the moment; the nonlinear perspective sees the rock as a temporary clump of energy bound in a cosmic information system receding forwards and backwards to the beginning and end of time. The metaphor of seeing the entire universe in a rock can also be applied to emotional epiphanies, autobiographical insights, passing fantasies, paranoid delusions, and so on. Whatever the focus of nonlinear perception, the object held in focus will be amplified with increasing salient complexity the longer it is held in focus.

The endless complexity of nonlinear perception can cause the subject to fall into perceptual loops which spiral, bifurcate, and recur with the formal qualities of a fractal (Figs. 1, 14). Frame information stacked in nonlinear psychedelic perception iterates on the order of 2 to 16 times a second, depending on drug and dose range, allowing for increasingly complex renderings of nonlinear information to the point of total sensory overload. Because of the quickly bifurcating complexity of nonlinear object analysis, the information produced in a nonlinear state emerges into consciousness much faster than information produced in a linear state. The production of fast, nonlinear data in the psychedelic state is often described as a download; an inconceivably large amount of information that compiles into memory almost instantly. The only way this amount of information can be processed through the brain is via nonlinear analysis; linear attempts to formalize psychedelic nonlinear information into words or pictures typically fall short of capturing the holistic perspective.

Nonlinear Hallucination

There are many colorful examples of nonlinear hallucination. Seeing geometric grids, webs, and spirals are nonlinear artifacts of destabilization of coupled oscillators in optic networks. Subjective reports indicate that DiPT produces unique nonlinear pitch transposition in audio networks, causing subjects to hear sounds modulated down an entire octave or more depending on the pitch and volume of stimulus. Auditory echoes, visual motion trails, and phantom tactile sensations are recursive artifacts of perceptual frame feedback. Perceiving multiple perspectives for the same input is a nonlinear bifurcation of multisensory coherence. Perceiving dream images superimposed over external space is nonlinear destabilization of visual memory recall. Seeing the formal boundaries of solid objects bend and melt into each other is a nonlinear destabilization of contrast and edge detection. Hearing a voice on the television or radio speaking directly to you is a nonlinear destabilization of semantic parsing and sequencing. Skipping time, missing time, or moving sideways or backwards in time is a nonlinear destabilization of temporal frame buffering. The basic tenet of psychedelic hallucination is that hallucinations move progressively from linear to nonlinear complexity depending on dose range and duration of effect; the higher the dose of the hallucinogen, the more disproportionately nonlinear, unpredictable, and complex perception will become in response to stimulus over time.

Notes and References 9

1. Taylor RP, Sprott JC., "Biophilic fractals and the visual journey of organic screen-savers". Nonlinear Dynamics Psychol Life Sci. 2008 Jan;12(1):117-29.
2. Hofstadter DR, "I am a Strange Loop". Basic Books, March 26, 2007.

Chapter 10

Entopic Hallucination

Entopic hallucinations, or phosphenes, are one of the most commonly reported visual effects of psychedelics. Phosphenes are a sensation of light caused by excitation of the retina by mechanical or electrical means. Pressure phosphenes can be created by applying pressure to the eyeballs through closed eyelids; flicker phosphenes are created in response to stroboscopic pulses of light; kinetic phosphenes are created in response to physical impact to the head, sometimes referred to as seeing stars. Entopic hallucinations are differentiated from eidetic or photographic hallucinations in that they originate within the neural connections between the eye and cortex (Fig. 16), as opposed to emerging within the cortex or midbrain. There is evidence that entopic phosphene patterns have influenced human cultural and religious archetypes since 10,000 BCE (Fig. 2).[1,2,17]

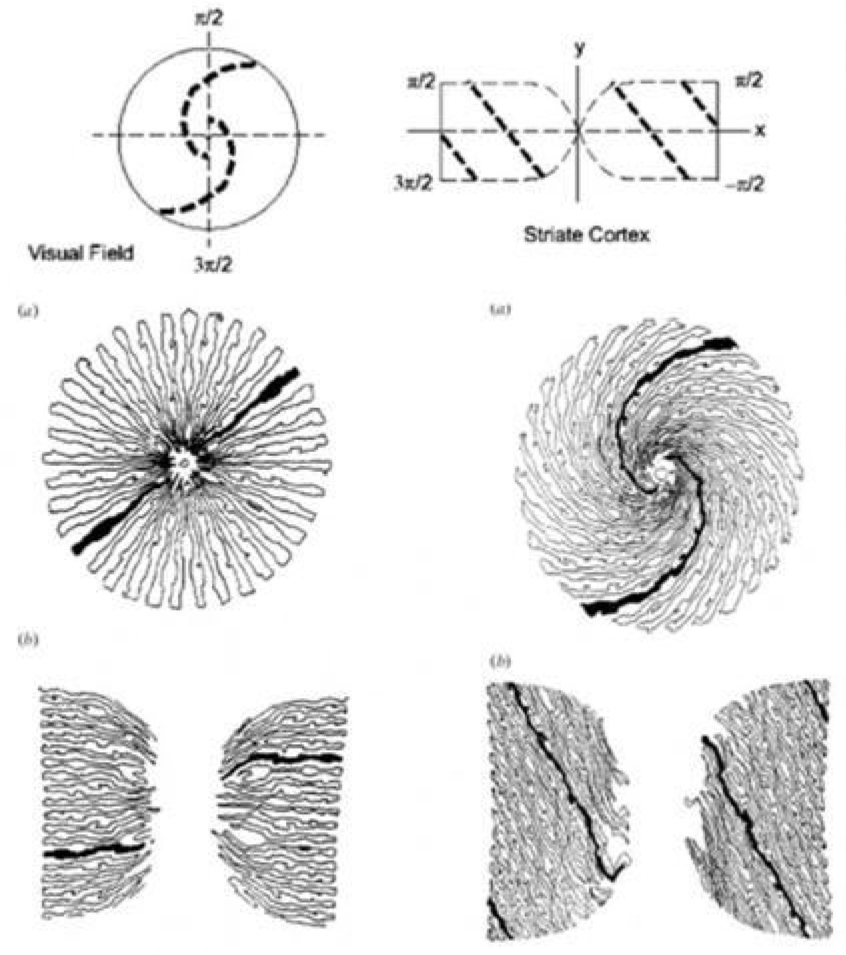


Figure 16. Spatial-relationship mapping between retinal cells with associated areas of the striate (visual) cortex. Images hitting the funnel and spiral ringed networks of the eye must be translated to lines and shades in the cortex for visual rendering. Geometric hallucinations, phosphenes, and entopic form constants arise from destabilization in (a) distance and (b) orientation selective retinal-cortical coupling. From Bressloff, 2002, Gutkin 2003.

Entopic hallucinations fall into predictable geometric patterns and can be measured by formal properties such as form constant, flicker rate, rotation, drift, and decay. Common phosphene forms include web, grid, checkerboard, clover-leaf, honeycomb, spiral, funnel, or more amorphous floating blobs and stars (Fig. 17).[3] Phosphene patterns may match recurring patterns in the natural world, such as cells, stars, sand dunes, flowers, clouds, and snakeskin. Evidence suggests that the form constants of phosphenes are directly related to spatial relationships between the ring-like structure of the retinal cells and the grid-like or columnar neural structures of the visual cortex. The spontaneous production of geometric hallucinations is due to excitation and loss of stability in these retinal-cortical feedback coupling pathways. The transition from seamless visual aliasing to spontaneous geometric patterns can be described as a transcritical sensory bifurcation reflecting the spatial organization of the recurrent network.[4,5,6]

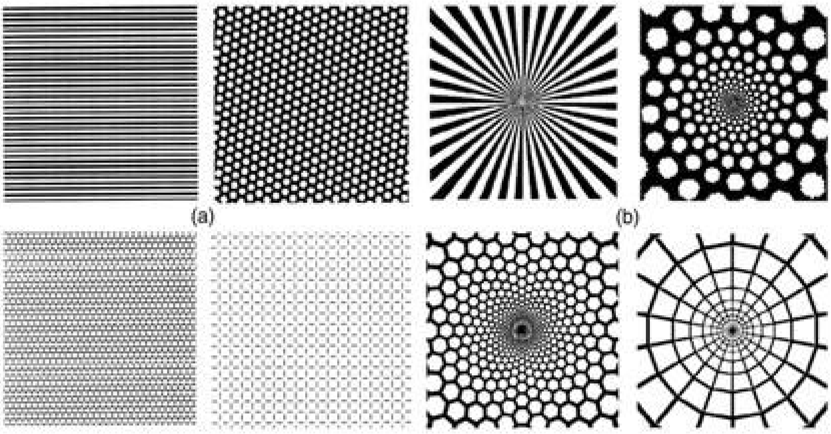


Figure 17. Geometric hallucinations, or flicker phosphenes, appear in form constants arising from destabilization in (a) distance and (b) orientation dependent retino-cortical signal coupling. From Bressloff, 2002., Gutkin 2003.

Pulses in the same frequency range as brain waves (theta to gamma) are most effective in producing flicker phosphenes.[3] Flicker phosphenes created by stroboscopic lights or mind-machines tend to be more amorphous at low frequencies (1-4hz), tend to fall into web, spiral, or cloverleaf patterns at medium frequencies (4-9hz), and tend to lock into grid, honeycomb, or checkerboard patterns at higher frequencies (9-16hz+). Flicker phosphenes will have slow lateral drift at lower frequencies; a rotational drift at medium frequencies; and will maintain stability or produce fast lateral drift at higher frequencies.[7] These phase-related transitions in standing wave shape are also seen in Chladni patterns created in vibrating plates (Fig. 31). Presumably any technology which uses pulsating frequencies to produce phosphenes, such as transcranial magnetic stimulation (TMS), must also use pulses corresponding to the frequency range of human temporal aliasing to produce substantially stabilized phosphene forms.[8]

Flicker Phosphenes and Hallucinogenic Interrupt

Taking what we know about the production of geometric hallucinations in response to pulse activity within specific frequency ranges, it is possible to extrapolate that the multisensory interrupt of any hallucinogen must fall into the same range of @5-40hz, which is the general frequency range of human consciousness, to produce phosphenes. According to the Control Interrupt Model of psychedelic action, any drug which produces a multisensory interrupt within the frequency band of waking consciousness will also necessarily produce flicker phosphenes and be considered hallucinogenic. If the multisensory interrupt is too slow or too fast, the drug may still be considered psychedelic, empathogenic, entactogenic, or dissociative, but it will be less likely produce significantly realized geometric flicker hallucinations. This same principle can be applied to audio and tactile sensory binding; any periodic interrupt within the frequency band of human sensory consciousness will necessarily induce field-like hallucinations with stable form constants and properties related directly to the interrupt frequency.

The evolution of flicker phosphenes can be described formally by the geometrical self-organizing feedback patterns seen in fractals (Figs. 1, 14), cellular automata (Fig. 18), or patterns arising from standing wave interference (Fig. 31). Under the influence of psychedelics, flicker phosphenes grow in intensity, become more elaborate, and become more structurally resolved over time.[3] It can be assumed that this is because the modulatory interrupt of a hallucinogen is being applied directly to the sensory binding pathways via pharmacological interaction as opposed to being applied to the retinal or cortical networks via external pulse stimulation. Because the modulatory interrupt of psychedelics is pharmacological, it is more difficult for the subject to fend off or ignore the interrupt to retain multisensory stability; the very pathways that maintain stability are the pathways which are being interrupted. In a very physical way, the modulatory interrupt of the hallucinogen is hijacking the sensory signaling pathways and overriding them with its own modulatory frequency. Because of this, the influence of the hallucinogenic flicker interrupt becomes explicit in sensory rendering; the subject may literally see or feel the pulsating geometric field interference as a fully embedded aspect of their perceptual reality.

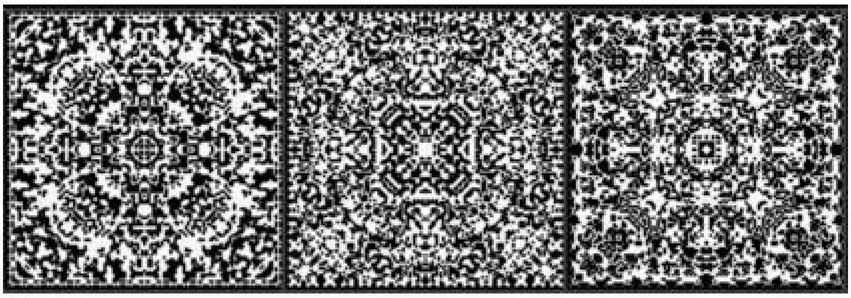


Figure 18. Examples of programmatic cellular automata. Repetition of simple algorithms create complex patterns of archetypal beauty. Levitated.net, 2010.

Flicker phosphenes are the product of neurochemical saturation and have substantial signal decay. There is evidence that electrically stimulated phosphenes take as long as 10-15 seconds to fully fade once the periodic stimulus is removed.[9] Overlapping stereoscopic phosphenes will naturally create decaying interference patterns approaching fractal complexity. It can be assumed there is a saturation of signaling molecules that builds up at the site of synaptic interruption that persists for some period of time following each interrupt. The pulse of each interrupt can be described in terms of saturation attack and decay; the fade of each interrupt can be described in terms of saturation sustain and release (or ADSR envelope).[10] Full saturation would mean a complete white-out of sensory information at the interrupt site; zero saturation would mean the interrupt site is cleared of signaling molecules and is presenting a darkened resting state. Saturation at the interrupt site increases and decreases in intensity over the period of each interrupt; this change in chemical saturation over the duration of each interrupt is perceived as a flicker or pulse of sensory intensity.

Because a hallucinogenic interrupt pulses at many cycles per second, and because each pulse can have a saturation decay of many seconds, phosphenes will naturally drift laterally or radially across the visual field as they decay, creating overlapping webs of many arising and fading geometric patterns all visible within a single perceptual frame. This creates the formation of complex standing interference patterns. The web-like interference of multiple arising and decaying geometric grids creates a 3D meshwork that allows complex eidetic shapes to materialize spontaneously within the quickly morphing wire-frame (Fig. 20). Visual saturation is most intense at the interstices of the wire-frame mesh, creating the perception of bright dots or scintillating jewels where patterned lines overlap and intersect into nodes. These saturated pixel groups may correspond to actual hot-spots of neural activity saturating columns of the visual cortex. These hotspots are produced spontaneously in the wake of stimulus, creating a flood of glutamate wherever shafts of apical dendrites intersect with lateral projections from proximal neural columns.[18] Glutamate flooding at dendritic columns of pyramidal neurons is presumably the result of asynchronous glutamate release following 5-HT$_{2A}$ receptor agonism.[19]

It is widely assumed that geometric hallucinations and flicker phosphenes originate between the optic track and cortex, but some subjective reports of psychedelic experimentation also describe a fast pulsation or rhythmic jitter felt in the muscles around the eyes. This sensation is most acute in the outside corner of the visual periphery, specifically along the lateral rectus and the junction where the inferior oblique passes over the inferior rectus (Fig. 19). This optical pulse may be difficult to discern in early parts of a psychedelic session, but becomes more acute and easier to sense as the session wears on. This rapid pulsation may be related to modulatory interrupt and saturation at the cortical columns that control optic muscles, generating a chain reaction in neural transduction felt as a muscle twitch or throb. Periodically interrupting the eye's finely timed saccades with a muscle twitch or pulsation may be enough to produce phosphenes.

Increasing or decreasing optic pressure naturally produces phosphenes; 5-HT$_{2A}$ agonism decreases ocular pressure. In his experiments with phosphenes in the mid 1800s, Johannes Purkinje applied an aqueous extract of belladonna (scopolamine, atropine) directly to his eye to produce phosphenes. Because the effect was localized, Purkinje proposed that phosphenes may be related to cycloplegia, or partial paralysis of the eye muscles.[20] Given these reports, it is reasonable to assume that any interruption of visual motor control, interruption of optic signal transduction, or change in optic pressure will produce phosphenes. Phosphenes generated by changes in ocular pressure or muscle twitch would be considered synesthetic representations of pressure waves rippling from intraocular fluid into receptive nerve junctions.

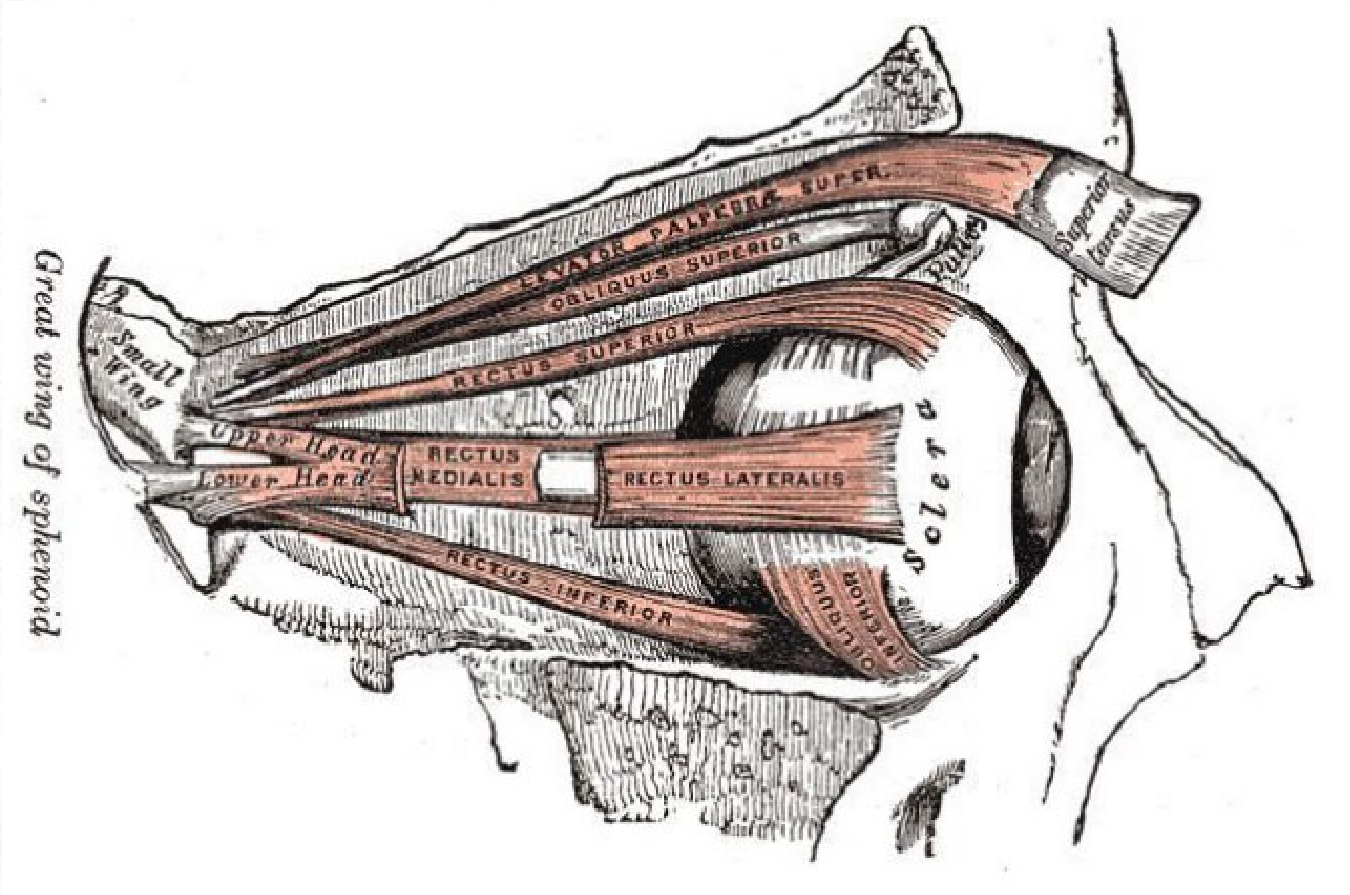


Figure 19. Muscles of the eye. Some subjects on psychedelics report pulses or rhythmic twitching in optic muscles that control focus, specifically the lateral rectus and inferior oblique. These pulses may generate pressure phosphenes related directly to frequency of pulsation. From Grey's Anatomy.

Entopic vs. Eidetic Hallucination

Geometric hallucinations, or phosphenes, are considered to be entopic, meaning they are a product of excitation and destabilization in spatial coupling between neural assemblies in the retina and visual cortex, and produce geometric patterns similar to wave interference patterns. Entopic hallucinations can be contrasted with eidetic hallucinations, which are more fully formed images that appear from visual memory or imagination. Psychedelic eidetic hallucinations are often more explicitly personal than the abstract geometric forms associated with flicker phosphenes. Over the course of a psychedelic session, hallucinations will start with flicker phosphenes and then increase in complexity from entopic to eidetic content, often containing a seamless mixture of the two. It can be assumed that eidetic hallucinations only begin once serotonergic modulation of the PFC has been sufficiently interrupted to allow cholinergic modulation of internalized mid-brain visualization to come to the fore.[11] The transition from entopic to eidetic hallucination is also associated with a transition from the high frequency beta or gamma state to a lower frequency alpha or theta state.

Meditation and auto-hypnotic exercises are targeted to produce states of hypnagogia associated with theta waves and entopic hallucination. Drugs which naturally drive theta waves in the brain are called hypnotics. Some psychedelics are naturally hypnotic, others are hypnotic only in sensory deprivation or under the influence of a theta-band periodic driver.[12] The hallucinogenic tea ayahuasca is a mixture of a high-frequency interrupt psychedelic (DMT) and a low-frequency hypnotic driver (the beta-carbolines harmine and harmaline, among others). This synergistic blend of high-beta interrupt and slow-theta attenuators means that ayahuasca should promote both fast beta geometric flicker phosphenes as well as slow eidetic theta dream snippets. This prediction can resolve paradoxical EEG analysis of subjects under the influence of ayahuasca, which sometimes indicates increased power in high frequency beta and gamma coherence,[13,14] but in the context of shamanic ritual shows increased power in slow-wave theta activity.[15]

Eidetic hallucination is considered to be rendered photographically or presented as a 3D virtual model. In psychedelic intoxication, a strange conversion of eidetic and entopic phenomena can occur when an eidetic image or symbol reproduces into a marching grid or kaleidoscopic network of repeating symbols with a juxtaposed eidetic image emerging within the repeating superstructure. For example, a subject may hallucinate a geometric grid of quickly spinning colored triangles, and as those triangles flicker across the visual field they suddenly cohere into a 3D wire-frame mesh of a more fully-realized eidetic snapshot of a human body or face. In addition to triangles, the overlaying grid may be composed of dots, circles, honeycomb, spiders, insects, centipedes, worms, snakes, reptiles, lizards, question marks, swastikas, teeth, piano keys, skulls, flowers, leaves, stars, eyes, billiard balls, dice, playing cards, human faces, alien faces, dancing elves, skeletons, clowns, jesters, writhing bodies, branching trees, cells, bacteria, paisleys, DNA, Japanese kanji, Byzantine tile patterns, Mesoamerican brick patterns, Native American totem patterns, Polynesian tiki patterns, and similar repeating archetypal forms.[16] The fast flicker rate and embedded kaleidoscopic nature of this type of compound hallucination often defies formal description or the ability to accurately capture in art or memory. The hallucinogenic perception of a complex embedded symbolic grid or kinetic fractal superstructure is unique to the psychedelic experience; it may be the visual essence of what makes an experience authentically psychedelic.

Notes and References 10

1. Williams JD, Dowson TA, *et al.*, "The Signs of All Times: Entoptic Phenomena in Upper Palaeolithic Art". Current Anthropology, Vol. 29, No. 2 (Apr., 1988), pp. 201-245.
2. Pettifor E, "Altered States: The Origin of Art in Entoptic Phenomena". Internet Reference, 1996.
3. Knoll M, Kuglerb J, *et al.*, "Effects of Chemical Stimulation of Electrically-Induced Phosphenes on their Bandwidth, Shape, Number and Intensity". Sterotactic and Functional Neurosurgery, Vol. 23, No. 3, 1963.
4. Bressloff PC, *et al.*, "What Geometric Visual Hallucinations Tell Us about the Visual Cortex". Neural Computation 14 (2002) 473-491.
5. Gutkin B, Pinto , Ermentrout B, "Mathematical Neuroscience: From Neurons to Circuits to Systems". Journal of Physiology, Paris 97 (2003) 209-219.
6. Ermentrout B, Cowen J, "A mathematical theory of visual hallucination patterns". Biological Cybernetics, 34-3 (1979) 137-150.
7. Observations on the correlation between flicker rate and the form constants and properties of phosphenes are based on subjective reports of stroboscopic light pulse machines.
8. Bokkon I, Kirby M, D'Angiulli A, "TMS, phosphenes and visual mental imagery: A mini-review and a theoretical framework". Symposium on Transcranial Magnetic Stimulation and Neuroimaging in Cognition and Behaviour Conference, Montreal, Quebec, Canada, 25 September 2008.
9. Dobelle WH, Mladejovsky HG, "Phosphenes produced by electrical stimulation of human occipital cortex, and their application to the development of a prosthesis for the blind". J Physiol. 1974 December; 243(2): 553-576.1.
10. See Chapter 06, "The Control Interrupt Model of Psychedelic Action".
11. Hobson, J. Allan, "The Dream Drugstore: Chemically Altered States of Consciousness". MIT Press, 2001.
12. Subjective reports show that some tryptamines, such a the psilocybin and psilocin found in magic mushrooms, naturally cause drowsiness even in loud sensory environments. Other tryptamines, like LSD, can have paradoxically trance-like or stimulant-like qualities depending on the environmental drivers of set and setting.
13. Riba J, Anderer P, *et al.*, "Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers". Br J Clin Pharmacol. 2002 June; 53(6): 613-628.
14. Stuckey DE, Lawson R, Luna LE, "EEG gamma coherence and other correlates of subjective reports during ayahuasca experiences". J Psychoactive Drugs. 2005 Jun;37(2):163-78.
15. Hoffmann, E, "Effects of a Psychedelic, Tropical Tea, Ayahuasca, on the Electroencephalographic (EEG) Activity of the Human Brain during a Shamanistic Ritual". MAPS Spring (2001) 25-30.
16. Accounts of geometric meshwork or marching rows of repeating archetypal forms are taken from subjective reports of psychedelic intoxication.
17. Nicholson PT, Firnhaber RP, "Autohypnotic Induction of Sleep Rhythms Generates Visions of Light with Form-constant Patterns". White Paper.
18. Nichols DE, "Hallucinogens". Pharmacology & Therapeutics Volume 101, Issue 2, February 2004, Pages 131-181.
19. Aghajanian GK, Marek GJ, "Serotonin Induces Excitatory Postsynaptic Potentials in Apical Dendrites of Neocortical Pyramidal Cells". Neuropharmacology Volume 36, Issues 4-5, 5 April 1997, Pages 589-599.
20. Melechi A, "Seeing Stars: The Shifting Geometry of Phosphenes". Trip Magazine, issue 10, 26-27, 2004.
21. Levitated.net, "Artifacts of Computation". Internet Reference, 2010.

Chapter 11

Eidetic Hallucination

Psychedelics can produce many types of hallucination, including geometric webs and grids;[1] distortions of space and time;[2] and photographic images of objects, people, or scenery. Hallucinations with a photographic, animated, or film-like clarity are called eidetic hallucinations, or eidetics for short. Eidetics share many of the formal qualities of dreams, visual memory, and imagination, and may be the most alluring aspect of experimenting with hallucinogens. Eidetic hallucinations rise and fall like dream snippets, rarely holding form for more than a few seconds before fading or shifting into another form. Eidetic objects, scenes, or people that become solid and retain their shape for an extended period of time are called frank or concrete hallucinations. Concrete hallucinations are often solid, immersive, indistinguishable from reality, and share many of the qualities of lucid dreaming, sleepwalking, and dementia.

The most commonly reported eidetic hallucinations seen on psychedelics are of people, faces, skulls, jaguars, snakes, plants, blooming flowers, spirits, aliens, insects, and other similar archetypes. Eidetic hallucinations can sometimes take the form of entire virtual worlds, spirit dimensions, invisible landscapes, and so on. Eidetics often emerge within a pre-existing entopic interference pattern that grows in intensity over time to produce more photographic or 3D rendered objects (Fig. 20).[1] Eidetics under the influence of psychedelics are most often reported with eyes closed or while sitting motionless in meditative trance. On high doses of psychedelics eidetic hallucinations may materialize with eyes open on any surface, pattern, or texture that's gazed at for more than a few seconds.[3]

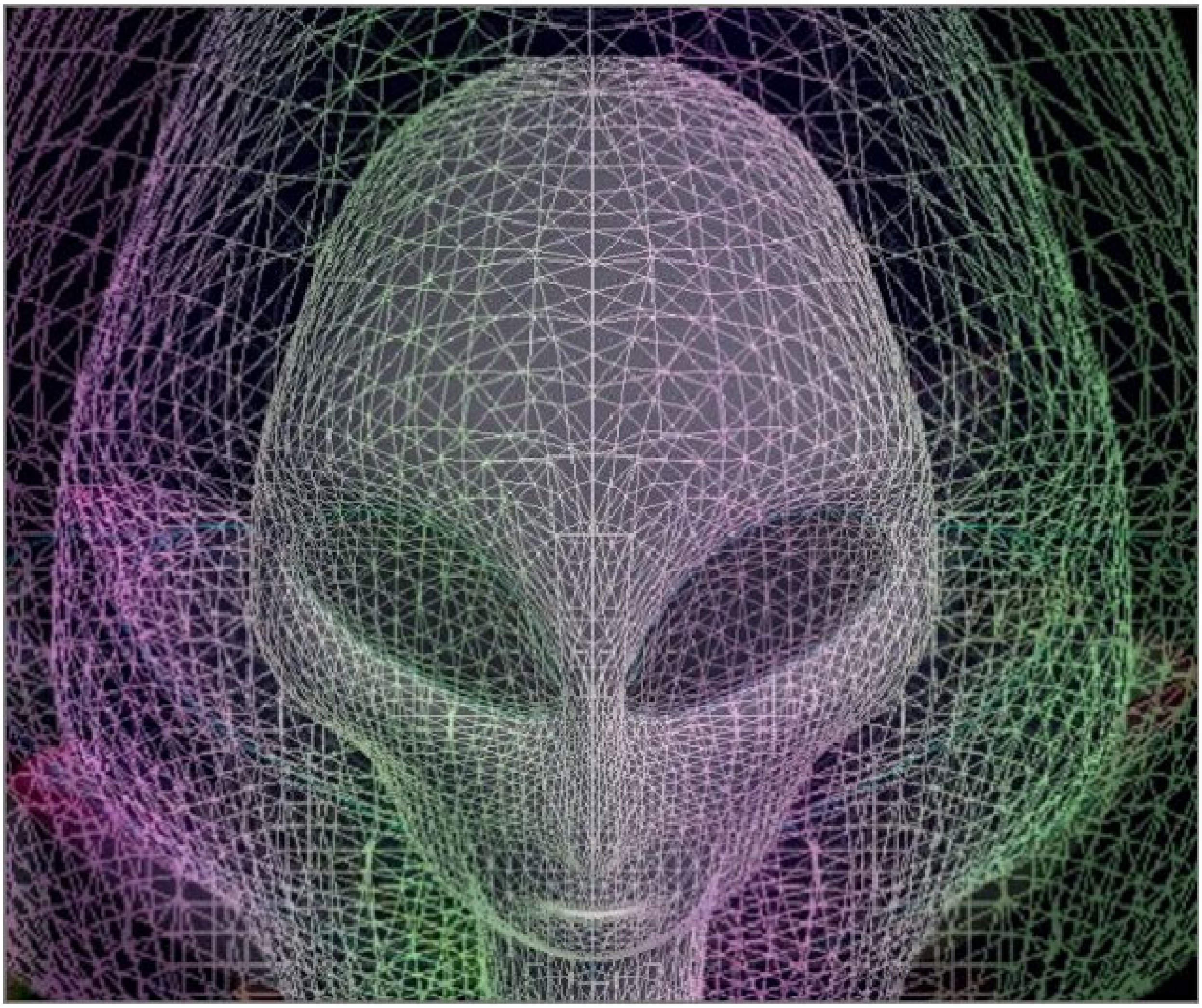


Figure 20. Eidetic tryptamine hallucinations, like this alien, typically emerge as snapshots or animations within a larger geometric interference pattern.

Psychedelic eidetics are progressive, which means they begin as non-durable form arising from patterns or noise, and then over a period of seconds drift, smooth, or lock into formal qualities which can be recognized as salient shapes. The process of smoothing or locking onto an eidetic form in a psychedelic hallucination requires some minimal amount of focus and concentration to sustain. The eidetic image may materialize, ooze, or pulse into clarity in response to the subject's concentration and focus, developing slowly like a Polaroid photo or film-reel fade-in. Losing concentration for an instant can cause the eidetic image to fade or shift into another image. Holding the eyes still will increase intensity of progressive eidetic imagery; blinking or flicking the eyes from side-to-side will wipe the visual memory buffer and cause eidetic images to fade; holding the eyes still again will cause previously held images to spontaneously rematerialize.[4]

The Hippocampus, ACh, Memory, and Dreaming

The processes of dreaming, memory storage, and memory recall are managed by the hippocampus.[5] The hippocampus receives perceptual information from the frontal cortex but is also wired tightly into the emotional limbic system and medial temporal lobe; which is why strong memories always have an emotional component.[6] Since the hippocampus is central in the formation, consolidation, and reconsolidation of all salient memory, we can also assume it is also the source of salient eidetic hallucination. The hippocampus is most active while awake and while dreaming. The process of moving from waking to sleeping is associated with a move from high beta or alpha activity down to slower theta and delta ranges. Deep sleep is associated with slow delta waves and low energy activation, while REM sleep and dreaming begin to produce beta activity and energy profiles similar to those seen in waking activity.[7]

Nocturnal dream activity is a process of memory consolidation.[8] In deep sleep and REM the stress chemical cortisol decreases communication between the hippocampus and neocortex,[9] and the process of REM and dreaming is stimulated by acetylcholine release.[10] Acetylcholine (ACh) is the primary messenger of the brain's cholinergic system, essential to hippocampal modulation of memory compression and recall (Fig. 21). Sleep-onset, sleeping, and dreaming are associated with an increase in ACh modulation of the brainstem and medial temporal lobe; this occurs along with a proportional decrease in serotonin, norepinephrine, and aminergic activity in the pre-frontal cortex (PFC). The interplay between these two systems acts like a tide between waking and sleeping worlds. Drugs which increase aminergic activity, such as antidepressants, should also decrease dreaming.[11] Similarly, the prolonged suppression of cholinergic activity and REM sleep due to deprivation or extended amphetamine use creates psychotic episodes which may be defined as bursts of dream activity erupting spontaneously into waking states.

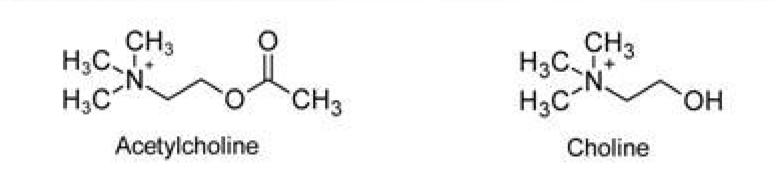


Figure 21. Acetylcholine (ACh) modulates the medial-temporal lobe during memory storage, recall, and dreaming. Eidetic imagery in hallucination is associated with high ACh modulation.

To describe the functional interplay between aminergic waking states and cholinergic dreaming states, J. Allen Hobson has proposed a three-dimensional AIM state-space model.[11] The interference between aminergic and cholinergic systems can be modeled by plotting the overall activation of the brain (A, high vs. low energy), the input of sensory signal (I, internal vs. external), and the signal modulation (M, aminergic vs. cholinergic). Using this AIM model we can present a snapshot of the waking, dreaming, or hallucinating brain in a graphic context (Fig. 22). A waking brain would be high in activity, input gated externally, with high aminergic modulation. A dreaming brain would also be high in activity, but input gated internally and high cholinergic modulation. Similarly, states of deep sleep, mania, and psychosis can also be described.

According to the AIM model, eidetic hallucination in a psychedelic session will not begin until external serotonergic modulation is sufficiently interrupted to allow internally gated cholinergic activity to rise to the fore of consciousness. Remaining motionless, closing the eyes, or sitting in a quiet darkened environment will stimulate the onset of eidetic hallucinations on psychedelics;[12] this is presumably because darkened stillness promotes sleep onset and an increase in internally gated cholinergic activity. The longer a subject under the influence of psychedelics remains motionless, the more photographically rendered the hallucinations will become. When the hallucinating subject rouses from trance and begins to move again, hallucination will lose photographic quality and return back to more generic entopic forms.

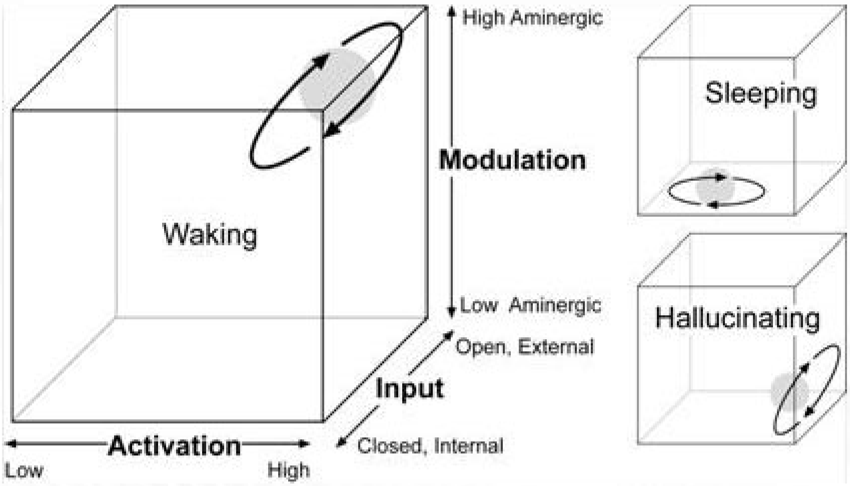


Figure 22. Hobson's AIM model shows patterns of (A)ctivation, (I)nput gating, and (M)odulation in various states of consciousness. Dreams and eidetic hallucination are associated with low aminergic and high cholinergic modulation.[11]

The ACh promotion of dreaming and REM has been demonstrated in animal research,[10] but only subjectively reported and presumed in humans.[22] Subjective reports of combining both the dissociative ketamine and the psychedelic LSD with pre-doses of galantamine and choline (both acetylcholine promoters) indicates that ACh promoters facilitate emotionally intense eidetic hallucinations, sometimes uncomfortable or unpleasant in nature, emerging beyond the subject's capacity to control.[13] This demonstrates that the production of eidetic imagery in response to ACh modulation is a spontaneous and automatic function of memory consolidation that cannot be easily controlled by the will or intent of the subject. The spontaneous production of salient eidetic memory makes psychedelics a useful tool in psychotherapy,[14] but the uncontrollable flood of eidetic imagery may not always be pleasant for the subject. States of intense eidetic hallucination may be associated with memory regression, imprinting, reconsolidation, and neuroplasticity.[15]

Anticholinergics, Concrete Hallucination, REM

Hallucinogens which target ACh receptors are reported to produce very vivid waking dreams and concrete hallucinations. Anticholinergics cause drowsiness, but at high doses also induce a disruptive sleep and a qualitatively unique form of delirium.[24] The commonly reported anticholinergic hallucinogens are the tropane deliriants atropine and scopolamine; found in deadly nightshade, belladonna, *datura*, Jimson weed, and members of the *Solanaceae* family.[16] Muscarine from the *Amanita muscaria* mushroom also interacts at the muscarine ACh receptors as an agonist. Tobacco also targets ACh receptors, but nicotinic ACh receptors instead of muscarinic receptors.[17] All plants and pharmaceuticals which target the cholinergic system are reported to be hallucinogenic at high enough doses. Cholinergic hallucinations are unique in that they may erupt into consciousness fully formed like dreams or fevered delusions.[18] In contrast, tryptamine psychedelics have progressive levels of entopic or erratic hallucination before reaching the level of concrete hallucination. Although *datura* and tobacco are common admixtures of traditional Amazonian ayahuasca preparations, experimentation with plants and drugs that target the cholinergic system at hallucinogenic doses is physically very uncomfortable and potentially lethal.[16,21]

Concrete hallucinations are similar to symptoms of dementia in that the subject literally cannot tell delusion from reality. Like a sleepwalker, the subject may think they are at the supermarket when they are actually looking into a closet. Psychedelics may produce this state of disorientation, but it is more commonly associated with dissociatives, deliriants, and pharmaceutical antihistamines or sleep aids. Suppression of REM sleep is associated with psychotic disorders,[23] and sleep deprivation for as few as three days can cause spontaneous periods of concrete hallucination and waking delusion.[19] Mixing anticholinergics with REM suppression can create highly realized waking lucid dreams and experiences of leaving the body and entering into parallel realities.[20] This indicates that periodic ACh REM consolidation of eidetic memory over the course of 24 hours is necessary for maintaining stability of consciousness. Activating eidetic memory consolidation with the use of psychedelics and extended REM trance-induction may be therapeutic for subjects suffering from depression, anxiety, or psychosis due to PTSD, insomnia, and other stress-related sleep disorders. Conversely, using psychedelics as stimulants to avoid sleep may lead to negative plasticity and persistent psychotic disorders.[15]

Notes and References 11

1. See Chapter 10, "Entopic Hallucination".
2. See Chapter 12, "Erratic Hallucination".
3. Content of eidetic psychedelic hallucinations taken from subjective reports and a survey of psychedelic literature.
4. Accounts of eidetic hallucinations arising progressively and being wiped from visual memory by eye movements taken from subjective reports.
5. LeDoux, Joseph, "Synaptic Self". Viking Penguin, NY, 2002.
6. LeDoux, Joseph, "The Emotional Brain". Simon & Schuster, NY, 1996.
7. Munglani R, Jones JG, "Sleep and General Anesthesia as Altered States of Consciousness". Journal of Psychopharmacology 6:399-409, 1992.
8. Stickgold R, Hobson JA, Fosse R, Fosse M, "Sleep, learning, and dreams: offline memory reprocessing". Science. 2001 Nov 2;294(5544):1052-7.
9. Payne JD, Nadel L., "Sleep, dreams, and memory consolidation: the role of the stress hormone cortisol". Learn Mem. 2004 Nov-Dec;11(6):671-8.
10. Hobson JA, *et al.*, "The neuropsychology of REM sleep dreaming". NeuroReport: 16 February 1998 - Volume 9 - Issue 3 - p R1-R14.
11. Hobson, J. Allan, "The Dream Drugstore: Chemically Altered States of Consciousness". MIT Press, 2001.
12. Accounts of psychedelic eidetic images becoming more intense with eyes held still, eye closed, or in a darkened room taken from subjective reports. Saccades, blinking, or any fast movement of the eyes wiping and refreshing visual memory also taken from subjective accounts.
13. Reported accounts of combining doses of both ketamine and LSD with pre-doses of 800mg of galantamine and 500mg choline report the eidetic visuals of these respective experiences as extremely intense, impossible to stop, and impossible to steer in a conscious direction. This experiments were conducted to enhance the capacity to remember the content generated in a psychedelic experience. Instead of aiding in memory imprinting, ACh modulation produced an opposite effect of visual memory flooding, creating a "Full-blown eyelid movie" that were not always pleasant and were impossible to control. Reports taken from personal e-mail correspondence with the test subject.
14. Grof, S, "LSD Psychotherapy". MAPS, 3rd Edition, 2001.
15. See Chapter 13, "Psychedelic Neuroplasticity".
16. Grinspoon L, Bakalar JB, "Psychedelic Drugs Reconsidered". The Lindesmith Center, 1997.
17. Cooper JR, Bloom FE, Roth RH, "The Biochemical Basis of Neuropharmacology". Oxford University Press, NY, 7th ed., 1996.
18. Accounts of experimentation with plant and pharmaceutical anticholinergics taken from subjective reports and a survey of literature.
19. Coren, S, "Sleep Deprivation, Psychosis and Mental Efficiency". Psychiatric Times. Vol. 15 No. 3, 1998.
20. Zoe 7, "Into The Void". Worldwide Media, 2001.
21. Arnett AM, "Jimson Weed (*Datura* stramonium) Poisoning". Clinical Toxicology Review Dec 1995, Vol 18 (No 3).
22. LaBerge SP, "Substances that Enhance Recall and Lucidity During Dreaming". Patent Application number: 10/604,138; Publication number: US 2004/0266659 A1; Filing date: Jun 27, 2003.
23. Cochen V, Arnulf I, Demeret S, *et al.*, "Vivid dreams, hallucinations, psychosis and REM sleep in Guillain-Barré syndrome". Brain, ISSN 0006-8950. 2005, vol. 128 (11), pp. 2535-2545.
24. Itil TM, "Anticholinergic drug-induced sleep-like EEG pattern in man". Psychopharmacologia. 1969;14(5):383-93.

Chapter 12

Erratic Hallucination

Hallucinations have formal properties that can shed light on their origins. Entopic hallucinations are characterized by geometric forms originating in the retina and optic tract.[1] Eidetic hallucinations are characterized by photographic images originating from the hippocampus and medial temporal lobe.[2] There is also a third type of hallucination not covered by these other formal categories; erratic hallucinations, or hallucinations originating in the loss of multisensory frame stability. Optical illusions that exploit rendering ambiguities in peripheral vision can be described as erratic hallucination. Tinnitus, or phantom ringing or buzzing in the ears can be described as erratic hallucination. Parasthesia, or phantom tingling sensations due to oxygen loss or nerve trauma can also be described as erratic hallucinations.

Like entopic hallucination, the origin of erratic hallucination is a destabilization of multisensory processing and sensory signal coupling. Erratic hallucinations caused by 5-HT$_{2A}$ agonism include wiggling and drifting of line and shadow; frame stacking and recursive frame cascading; and temporal and spatial disorientation caused by loss of multisensory cohesion. Erratic psychedelic hallucination begins at low doses with simple formal boundary errors, and becomes more acute at higher doses, leading to the total loss of multisensory frame stability. Loss of multisensory frame stability under the influence of psychedelics resembles states of senility and schizophrenia.

Breathing Walls, Melting Textures, Creeping Carpets

Subjects under the influence of hallucinogens report breathing walls, creeping carpets, and melting textures. These effects are all similar in that they represent a loss of stability in sharp line, contrast, and texture detail in visual memory. This can be described as a rendering ambiguity error, and indicates a drifting of contrast information both laterally and radially across the cortex. This drifting in the visual field is most prominent in the periphery where the retinal blind-spots are working with incomplete data to begin with. This orientation ambiguity is exploited in optical-illusions which evoke rotational movement (Figs. 6, 23).

Hallucinations of creeping line, depth, and shadow are caused by a loss of lateral or localized inhibition within cortical circuits.[3] The level of disinhibition and drift in the visual field is presumably proportional to the dose of hallucinogen, and this assumption is proved correct by individual reports of hallucinogen use. While at lower doses there may only be a slight wiggling or drifting to the rendering of line and depth, at higher doses the lines and colors between solid forms may appear to bend, swirl, or melt into one another.[4] The inability to alias smooth lines or hold sharp contrast between objects is the definition of linear destabilization.

The melting or drifting of textures seen on psychedelics originates in the layers of the visual cortex, but there are other similar inhibitory mechanisms which stabilize sensory cohesion across the entire brain. By applying disinhibition to audio networks, a subject under the influence of psychedelics may hear an echo or murmur rising in the wake of each sound. By applying disinhibition to tactile networks the subject might feel phantom fluid sensations rippling along the skin. These hallucination patterns are distinct in that they arise like a wiggling or fluid ripple in the wake of stimulus, causing a loss of sensory field stability similar to a slow dripping or melting of contrast boundaries.

Frame Destabilization and Frame Stacking

The seamless nature of human perception depends on the fast updating of sensory frame information. Humans update waking frame information at roughly the beta range of consciousness, around 12-30 Hz, which is why animation, film, TV, and computer screens all appear seamless in the 24-60 Hz range. Psychedelics destabilize smooth frame aliasing by interrupting pathways responsible for multisensory binding.[5] At low doses hallucinogenic interruption is felt as entopic hallucination, but at higher doses modulatory interruption leads to more extreme frame destabilization. Subjects under the influence of tryptamine hallucinogens report sensory frame lag and slow-motion frames; frame delay or echo; frame flange or recursive looping; frame stacking or frame freezing; frame rewind and fast forward; dropped frames; split or bifurcating frames; frame skipping; and similar nonlinear frame effects. These are all examples of extreme erratic hallucination linked to multisensory frame destabilization.

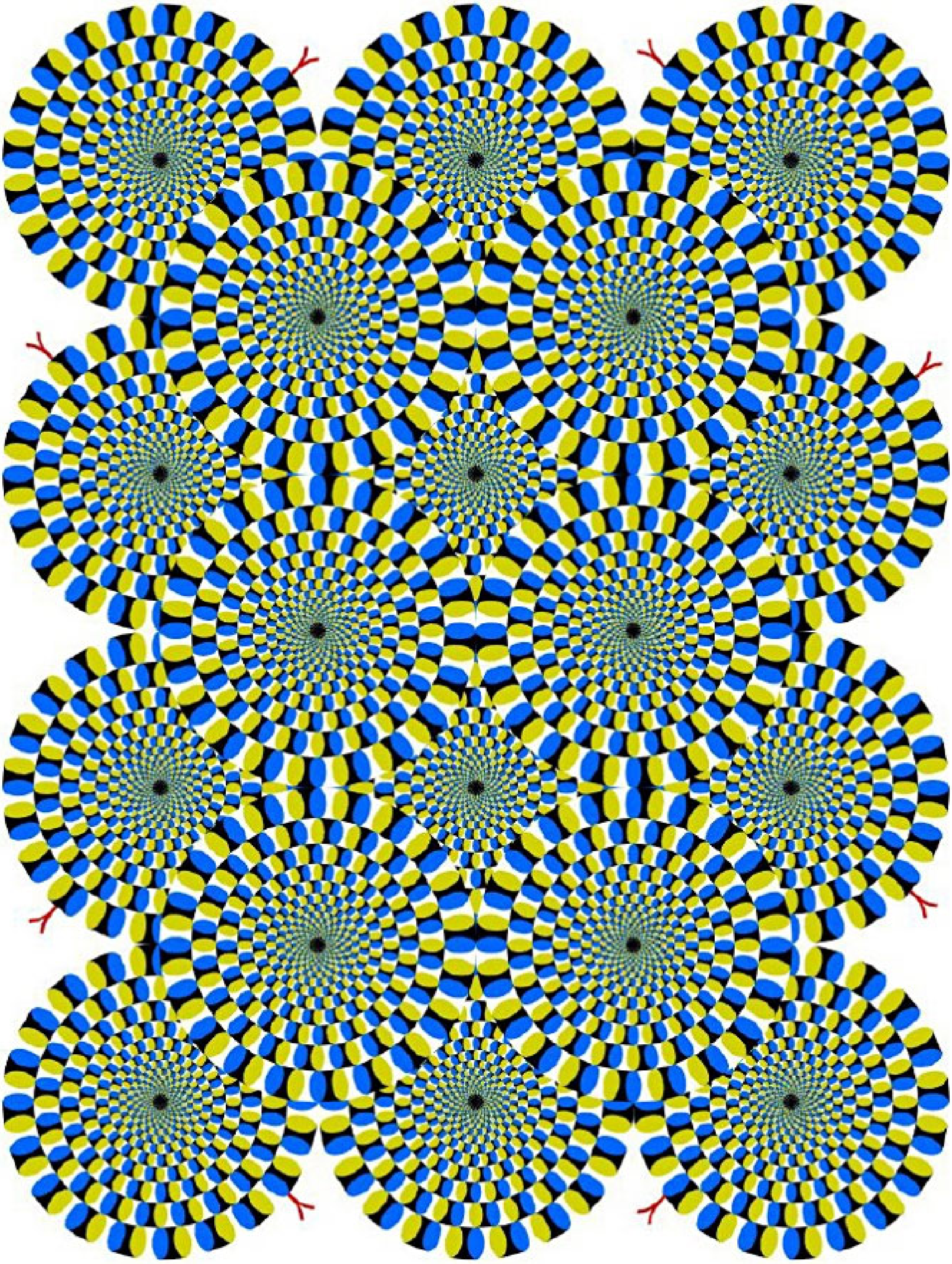


Figure 23. Akiyoshi Kitaoka's "Rotating Snakes" illusion. Stare at the center of any circle and the radial edges of nearby circles will appear to rotate. This image presents an example of the peripheral drift illusion due to contrast ambiguities in the visual field. This illusion exploits contrast expectations created by progressive 4-step gradients along radial tangents. The contrast expectations created by 4-step gradients are time-dependent and wired for motion detection in the periphery. The 4 degrees of color contrast around the periphery requires multiple frames to properly fill, creating a temporal ambiguity to edge aliasing exploited by this illusion. From Kitaoka, 2003.

To account for various types of hallucination related to multisensory frame destabilization the following hallucinogenic Frame Stacking Model has been proposed.[6] To create the perception of fluid movement from frame to frame, any frame we perceive must be a composite of at least two frames, one arising and one fading. Each frame is associated with a neural spike train involving some feedback to the thalamus and basal forebrain to fix the frame's snapshot in working memory. These feedback circuits normally neutralize in about 1/15th of a second, allowing for multisensory frame update of @15 Hz. If hallucinogens interrupt the process of frame neutralization for some small period of time, each frame then begins to fade more slowly until frame data stacks up and feeds back on incoming perception (Fig. 24). As recurrent information from multiple receding frames replicates and stacks onto incoming frames, each perceptual frame splits or bifurcates in complexity. This iterating pattern of recursive complexity is the formal description of a nonlinear system.

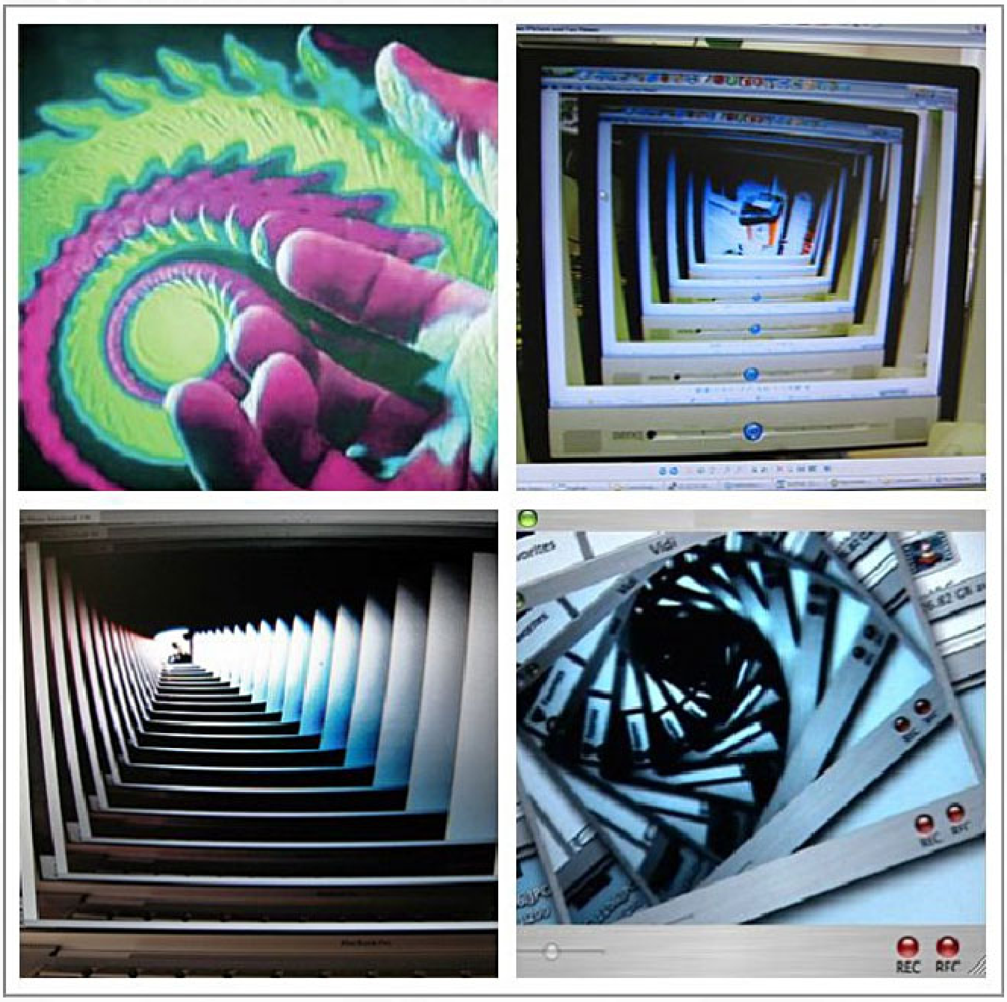


Figure 24. Examples of frame stacking caused by video feedback, which is isomorphic of fractal recursion, visual echo, and psychedelic hallucination. Frames stacked as few 16 layers deep quickly converge towards a vortex, a strange attractor, or a blur of infinite regression.

Frame stacking is considered to be progressive with hallucinogenic dose and grows from mild to extreme. At low doses you might have four frames stacked in perception instead of two; three fading and one arising. With three fading frames you may begin to see softening of edges or intensification of colors as the saturation of each frame stacks over the next. With eight frames stacked you might see visual artifacts like jitters or trails in the wake of any movement, similar to visual flange or video feedback. While holding the eyes still, an increase in frame overlay makes solid objects crystallize into something very fascinating and precious, like a faceted jewel, creating a quality of temporal depth and luminance to surfaces and textures. An increase in frame overlay also creates enhanced edge smoothing between solid objects, which gives reality a sensation of liquidity or stretchiness like surreal art, graffiti, or a cartoon. As frames regress the perspective of perceptual space may begin to elongate like a fish-eye lens. If a fading frame produces an emotionally salient pattern, the salient layer can then feed back into the arising frame as a progressively animated eidetic loop. When sixteen frames are stacked in perception, the wake of overlapping and receding content causes frame overload, confusion, disorientation, dropped frames, ego loss, bodily transcendence, and missing time. Beyond sixteen stacked frames the information density becomes too large for the human brain to render; ego consciousness is overwhelmed and totally destabilizes into a swirling vortex of timeless transpersonal unity.

The Frame Stacking Model presumes that hallucinogens enable a perceptual frame buffer that allows for sorting and browsing through multiple simultaneous linear frames; or that frame perception might be splintered into a radial kaleidoscope of multi-threaded parallel processing frames. Within the context of frame stacking, psychedelic consciousness may enable the subject to scroll back and forth in time; retrieve multiple simultaneous memories from a single stimulus; and project multiple versions of the self into multiple imaginary future scenarios. If the consciousness of a single person can be momentarily realized within three frames - the arising frame, the fading frame, and a static frame which holds the idealized concept of self - then the persistence of six or more frames could lead to the fabrication of two or more fully realized identities within a single subject. This frame splitting effect may explain how people can have conversations with phantom friends or relatives, or how a shaman might invoke anthropomorphized plant spirits with distinct personalities.

Multisensory Destabilization and Schizophrenia

In large doses, hallucinogens can produce multisensory destabilization; a state where sensations, objects, time, and space become entirely decoupled from each other in consciousness. The sensation of time uncoupling or of space losing it boundaries is difficult to describe as hallucination, but it is clearly hallucination. Loss of sensory or temporal frame cohesion implies multisensory destabilization and erratic hallucination. Externally the subject may be awake and responsive, but internally the brain has lost all state data and is completely disoriented, much like acute senility.[7] This state can be simultaneously hysterical or terrifying, which describes the extreme mood shifts associated with transient schizophrenia. Schizophrenia is linked to the inability to retain multisensory frame stability and decreased ability to produce the fast gamma oscillations needed to focus and bind sensory perception.[8,9] Multisensory destabilization is also reproduced by the hallucinogenic dissociatives ketamine and dextromethorphan (DXM) by blocking associative NMDA pathways necessary for fast sensory binding.[10]

Notes and References 12

1. See Chapter 10, "Entopic Hallucination".
2. See Chapter 11, "Eidetic Hallucination".
3. Kass L, Hartline PH, Adolph AR, "Presynaptic uptake blockade hypothesis for LSD action at the lateral inhibitory synapse in Limulus". The Journal of General Physiology, Vol 82, 245-267.
4. Accounts of tryptamine psychedelics producing hallucinations of melting textures, creeping carpets, and breathing walls taken from a survey of subjective reports. Accounts of hallucinations of objects melting and pouring into one another taken from a survey of high-dose subjective reports.
5. See Chapter 06, "The Control Interrupt Model of Psychedelic Action".
6. The Frame Stacking Model of hallucination was proposed by a Canadian researcher who wishes to remain anonymous, and is presented here as a brief summary of a larger e-mail correspondence. The model is based on first-hand experimentation with LSD and *Salvia divinorum*, and has also been applied to hallucinations seen on DMT, psilocybin, 2-CB, N_2O, 5-MeO-DMT, Ketamine, DXM, and others.
7. Accounts of psychedelic intoxication matching states of schizophrenia taken from subjective reports and surveys of case studies.
8. Cho RY, Konecky RO, Carter CS, "Impairments in frontal cortical gamma synchrony and cognitive control in schizophrenia". Proc Natl Acad Sci U S A. 2006 Dec 26;103(52):19878-83. Epub 2006 Dec 14.
9. Colgin, Laura Lee, *et al.*, "Frequency of gamma oscillations routes flow of information in the hippocampus". Nature 462, 353-357 (19 November 2009); doi:10.1038/nature08573.
10. Bonta IL, "Schizophrenia, dissociative anaesthesia and near-death experience; three events meeting at the NMDA receptor". Med Hypotheses, 2004;62(1):23-8.
11. Kitaoka A, Ashida H, 2003 "Phenomenal characteristics of the peripheral drift illusion". Vision (Japan), 15 261-262.

Chapter 13

Psychedelic Neuroplasticity

Neural axons in the human brain are always branching and creating new synaptic connections to facilitate learning and development. Like the toning and bulking of muscle mass, neural connectivity, developmental growth, and plasticity are based partly on genetics and partly on the "use it or lose it" principle; the more you use a neural pathway the more robust and responsive it becomes, the less you use a pathway the weaker it becomes. Training and repetition build faster and more responsive connections; emotional attachments to concepts build more robust connections over time. The more a neuron or assembly of neurons is used in a specific exercise, the faster and more responsive those neurons will become when performing that task. This is how the brain learns new things and integrates new skills. Training, repetition, and reinforcement leads to long term changes in synaptic connectivity; these are the basics of neuroplasticity.[1]

Neuroplasticity is the physical mechanism which makes shamanism and psychedelic therapy viable. In dreaming, neuroplasticity is stimulated in response to daily routine and anxiety; in hypnosis neuroplasticity is stimulated in response to suggestion and reinforcement; in shamanism neuroplasticity is stimulated in response to dose, set, and setting. The efficacy of psychedelics in both shamanic transformation and clinical therapy relies on their unique ability to decouple the cortex, disassociate ego structures, and stimulate archetypal identity regression and personal transformation. No other class of drugs can claim to have such a radical effect on personality; radical personality change in response to brief psychedelic exposure implies neuroplasticity.

While there is no laboratory research to prove that psychedelics stimulate neuroplasticity, there is evidence that a single psychedelic session can produce long-term changes in personality.[2] People who take psychedelics sometimes adopt a new outlook on life, a new manner of dress, a new spirituality, perhaps even a new name to go with their new identity.[3] Self-reinvention is an integral part of psychedelic exploration and subculture. The forging of a new identity does not always happen in a single psychedelic session, but psychedelic experimentation can be a catalyst for sudden radical personality transformation. These basic observations make a case for psychedelics as facilitators of long term identity modification and neuroplasticity.

The Case for Psychedelic Neuroplasticity

Psychedelics can stimulate recall of lost memories and can also generate false memories; lost memory reconsolidation and false memory imprinting implies neuroplasticity. The brain builds tolerance to psychedelics quickly, but psychedelic tolerance can be surpassed by successively ingesting larger and larger doses.[4] Successive dosing and increasing levels of tolerance implies stress-based neuroplasticity. In the case of hallucinogen persisting perception disorder (HPPD), the subject retains some of the visual effects of hallucinogens long after the drug should have metabolized;[5] persisting reactions to neural stress imply neuroplasticity. Psychedelics have been used to facilitate cult induction and programming;[6] indoctrination implies identity-based neuroplasticity. Psychedelics induce peer and mate bonding in tribal subcultures; mate bonding implies identity-based neuroplasticity. Psychedelics can create positive long-term changes in mood and outlook;[2] long term outlook changes imply neuroplasticity. Finally, while lying in darkened silence, the psychedelic state resembles a deep dream-like trance; dreaming is known to facilitate memory compression and long-term memory potentiation (LTP).[7] Any drug which facilitates extended dream-like states should also facilitate memory compression, LTP, and neuroplasticity.

In programmatic terms, a psychedelic drug can be thought of as a back-door or reboot mechanism that allows the subject to enter a visually driven ego programming and debugging matrix; this state would be similar to hypnosis mixed with an element of lucid dreaming or creative visualization. To stretch the computer metaphor further, in the absence of hypnotic suggestion or shamanic control, the psychedelic debugging matrix will naturally drop into a maintenance mode where anxieties are brought to the fore like a screen-saver programmed to browse through repressed salient patterns arising within chaotic noise.[8] All of these programmatic metaphors for psychedelics are accurate, and all imply a spontaneous cataloging, compression, or re-organization of existing synaptic memory via nonlinear eidetic emotional cues; this implies synaptic testing and strengthening in response to pre-existing anxiety, which implies neuroplasticity.

Physiology of Psychedelic Neuroplasticity

Hallucinogens which target the 5-HT_{2A} receptor can influence cellular functioning via the activation of G-proteins and intracellular secondary messengers. The signaling pathways mediated by the 5-HT_{2A} receptor include the activation of PKC and MAPK, protein kinases which energize enzymes to perform complex cellular maintenance. The activation of PKC undoubtedly plays a role in the production and maintenance of long term memory. Evidence shows that inhibiting PKC activation in the cortex for as little as a few hours can cause the rapid erasure of long-term memory associations.[11] It is obvious that PKC is a fundamental part of memory formation and retention, and it is reasonable to assume that drugs which stimulate PKC activity may enhance or alter the processes of memory formation, recall, retention, and plasticity.

The process by which PKC mediates memory associations is still unknown, but the primary assumption is that PKC interacts with diglycerides (DAG) at the intracellular membrane to mark energetic signaling areas for receptor formation and synaptic strengthening. The secondary signaling cascade goes like this: The 5-HT_{2A} receptor is stimulated with an agonist, activating phospholipase C (PLC) in the cell membrane, which then chops a phospholipid (PIP_2 or PI) at the membrane into an IP_3 group and DAG. The DAG stays near the membrane while IP_3 activates the release of calcium (Ca^{2+}) from the endoplasmic reticulum, which then activates PKC, which allows PKC to carry energy back to the cell membrane near the DAG site before activating other enzymes and intracellular substrates. PKC performs its job by moving phosphate groups around the cytoplasm and activating cellular enzymes such as adenosine which forms AMP, ADP, and ATP by linking with phosphate groups in chains of up to three at once, allowing metabolic energy to move quickly to other sites throughout the cell. The addition and removal of phosphates to and from proteins is a fundamental part of all organic metabolic processes; 5-HT_{2A} agonists stimulate this phosphorylation process through PLC, IP_3, Ca^{2+}, and subsequent PKC activation.

The fact that 5-HT_{2A} agonists stimulate PKC and fundamental metabolic processes indicates a strong case for psychedelic neuroplasticity. It is interesting to note that Salvinorin A, from *Salvia divinorum*, also activates these same phosphorylation pathways through the G-coupled kappa-Opiod receptor.[12] It is also interesting to note that of all the hallucinogenic compounds that occur in nature, psilocybin (found in magic mushrooms) is the only one that comes with its own phosphate group (which is stripped to make psilocin), and also appears to be the weakest tryptamine agonist at the 5-HT_{2A} receptor.[13] While it is tempting to assert that PKC phosporylation is at the root of all hallucinogenesis and psychedelic effect, it has been demonstrated that 5-HT_{2A} mediated PI hydrolosis is not always a good indicator of psychedelic potency.[14] Although there are multiple factors responsible for hallucinogenesis, psychedelic stimulation of PKC activity undoubtedly plays a role in perturbing and stimulating persistent memory functions and promoting potential potent neuroplasticity.

Other research indicates that LSD activates cellular mechanisms to promote expression of genes responsible for encoding c-Fos and Arc proteins, particularly in the pre-frontal cortex (PFC).[15] c-Fos is essential to cell proliferation, differentiation, and cellular defense, while Arc (activity-regulated cytoskeleton-associated protein) regulates the formation and repair of the scaffolding maintaining neural shape and stability. By activating expression of c-Fos and Arc proteins in PFC neurons, LSD may promote potent neuroplasticity, cell proliferation, cell repair, and synaptic generation in neurons responsible for identity. Presumably any selective 5-HT_{2A} agonist will produce similar results, making hallucinogenic tryptamines primary candidates for cellular signal strengthening and profound identity-based neuroplasticity.

Positive and Negative Plasticity

Shamanic transformation may stimulate neuroplasticity by helping the subject realize a more transcendent or spiritually integrated vision of themselves. The logic follows that visualization of a transcendent inner self will reinforce positive personality traits and behavioral changes to synchronize with inner idealization. Shamanic identity transformation is not instantaneous, but instead follows an integrative process of synaptic testing and reinforcement over a period of days to weeks. Some psychedelic therapy stimulates neuroplasticity using techniques similar to the ten-step program employed by Alcoholics Anonymous (AA), where the subject takes a clinical inventory of their life and behaviors and assesses each area where they need forgive, accept, or make changes. In psychedelic therapy the process of uncovering and severing negative pathways is called catharsis; the process of wiring and reinforcing new pathways is called integration. These are examples of positive psychedelic plasticity used to maximize positive social integration. These processes are sometimes slow and require some small amount of mental discipline and behavioral follow-through for success.

There are many examples of negative psychedelic neuroplasticity. Renegade schools of ayahuasca sorcery and witchcraft employ some of the most elaborate and lethal mind-games ever devised, including the constant fear of attack by rival sorcerers through poisons, curses, dream invasion, and magical darts that may induce paralysis, cancer, death, or insanity.[9] The traditional shaman's constant stress of exposure to the effects of black magic mirrors paranoid psychosis and post-traumatic stress disorder; this implies negative plasticity. Exposing any subject to extended and repeated psychedelic sessions may force stress-driven plasticity associated with PTSD, torture, isolation, and sensory deprivation. Psychedelics may speed techniques of ego deprogramming and imprinting associated with brainwashing or cult indoctrination;[6] this implies mind control and negative neuroplasticity. Psychedelics may produce psychotic breaks where subjects become violent and deranged, or may reinforce delusional, messianic, paranoid, sociopathic, antisocial and megalomaniacal identity traits;[10] this also implies negative neuroplasticity. Thus, forging new synaptic pathways to radically alter identity structures is not always a good thing, this process can induce pathology as easily as it can reduce pathology.

Tribal Imprinting and Viral Neuroplasticity

One of the most interesting aspects of psychedelics is that group psychedelic experimentation can catalyze spontaneous organization of tribal subcultures and grassroots political movements. According to PIT, if you destabilize the top-down regulating influence of culture over a small group of peers, energetic tribal organizations will spontaneously emerge within those groups; this is an extrapolation of control theory and tenets of distributed cognition. Modern history has demonstrated that if you sprinkle LSD or psychedelic mushrooms over a major city, then flower children will blossom and form drum circles and begin to reproduce. But close observation of modern psychedelic subcultures reveals that radical identity reinvention is not a function of spiritual freedom or political subversion, but is more a viral form of tribal bonding and indoctrination. For example, the hippies of 1960s and the ravers of 1990s each preached freedom and individuality, yet each culture had strictly controlled tribal uniforms, politics, musical styles, and rituals, and ostracized outsiders as being squares or un-hip. This indicates that psychedelic tribal organization and identity reinvention is not a linear function of freedom of expression or social liberation, but is instead a nonlinear amplification of the typical motivators of social elitism, the fears of being ostracized, and the reinforcements of tribal acceptance; all of which strongly affect identity-based neuroplasticity. Presumably any tribe, cultural group, religion, cult, or government can employ psychedelic neuroplasticity to similar social organizing effect.

Notes and References 13

1. LeDoux, Joseph, "Synaptic Self". Viking Penguin, NY, 2002.
2. Griffiths, R.R., "Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance". Psychopharmacology (2006) 187:268-283.
3. Observations of individuals adopting new names and new identities in response to psychedelic indoctrination come from subjective reports and first-hand observations of psychedelic subcultures.
4. Gresch PJ, Smith RL, Barrett RJ, Sanders-Bush E., "Behavioral tolerance to lysergic acid diethylamide is associated with reduced serotonin-2A receptor signaling in rat cortex.". Neuropsychopharmacology. 2005 Sep;30(9):1693-702.
5. Abraham HD, Duffy FH, "EEG coherence in post-LSD visual hallucinations". Psychiatry Res. 2001 Oct 1;107(3):151-63.
6. Groups linked to the weaponized use of psychedelics include the Manson Family, the SLA, Aum Shinrikyo, the CIA, and the United States Department of Defense.
7. Hobson, J. Allan, "The Dream Drugstore: Chemically Altered States of Consciousness". MIT Press, 2001.
8. Accounts of psychedelics producing a screen saver or hypnotic autopilot of unresolved anxieties and salient attractors are taken from subjective reports and surveys of psychedelic literature.
9. Beyer, SV, "Singing to the Plants: A Guide to Mestizo Shamanism in the Upper Amazon". University of New Mexico Press (October 31, 2009).
10. Reports of psychedelics facilitating symptoms of persistent psychosis taken from subjective reports and a survey of psychedelic overdose case studies.
11. Shema R, Sacktor TC, Dudai Y, "Rapid erasure of long-term memory associations in the cortex by an inhibitor of PKM zeta". Science. 2007 Aug 17;317(5840):951-3.
12. Bohn LM, "Mitogenic Signaling via Endogenous κ-Opioid Receptors in C6 Glioma Cells: Evidence for the Involvement of Protein Kinase C and the Mitogen-Activated Protein Kinase Signaling Cascade". J Neurochem. 2000 February; 74(2): 564-573.
13. Ray TS, "Psychedelics and the Human Receptorome". PLoS One. 2010; 5(2): e9019.
14. Nichols DE, "Hallucinogens". Pharmacology & Therapeutics Volume 101, Issue 2, February 2004, Pages 131-181.
15. Nichols CD, Sanders-Bush E, "A Single Dose of Lysergic Acid Diethylamide Influences Gene Expression Patterns within the Mammalian Brain". Neuropsychopharmacology (2002) 26 634-642.

Part II

Shamanism in the Age of Reason

Chapter 14

What is Shamanism?

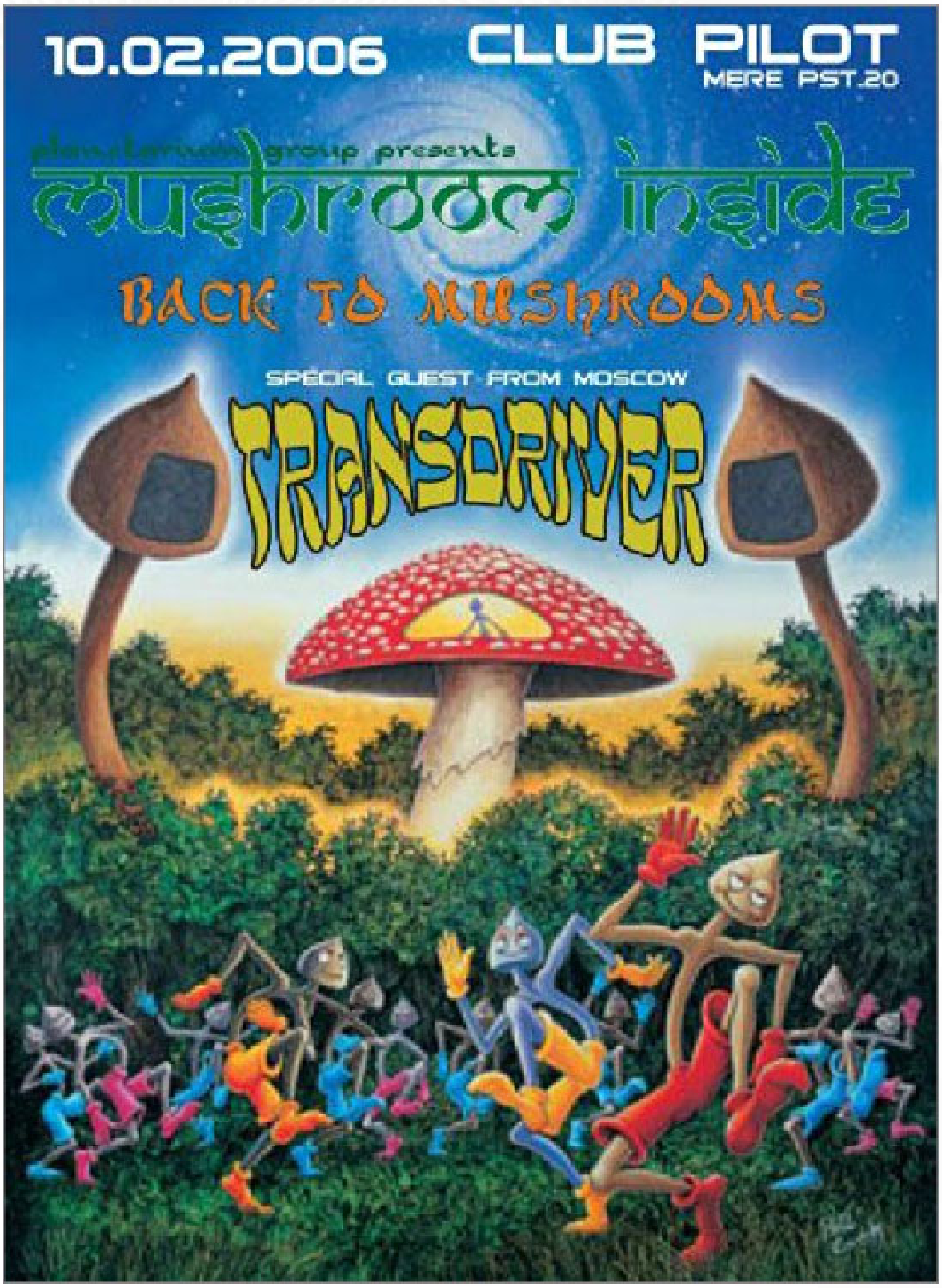

10.02.2006
CLUB PILOT
MERE PST.20
group presents
mushroom inside
BACK TO MUSHROOMS
SPECIAL GUEST FROM MOSCOW
TRANSDRIVER

Figure 25. Flyer for a 21st century mushroom trance party entitled, "Mushroom Inside: Back to Mushrooms," where a DJ inside a giant amanita mushroom controls a synchronized crowd of psilocybe-headed dancers through giant amplifiers made of psilocybin mushrooms. Like marionettes, the dancers assume archetypal forms of resonating Chladni patterns or fractal plane-filling curves in audio-motor synesthesia with the music. Note the ecological overtones as the grass, trees, and galaxy keep tempo with glowing approval.

The origins of shamanism are rooted in spirituality and myth, but the power of shamanism is entirely real. It is the goal of this text to explore rational limits and applications of shamanic power beyond the paradigms of mythology and faith healing. The subtitle of this text is "Shamanism in the Age of Reason," so it seems fitting to provide a good definition for shamanism. There are many definitions that have something to do with tribal healers, witch doctors, ritual plant magic, and/or dealing with the spirit world; these definitions conjure images of pre-industrial folk medicine steeped in superstition. Relegating shamanism to the bin of folk medicine fails to account for the sophistication of shamanic tradecraft, methodology, or the varying levels of shamanic manipulation. Traditional shamanism may be cloaked in the veil of superstition, but behind the veil is the real science of programming human belief and behavior with a blend of mysticism, ritual, and hallucinogenic drugs.

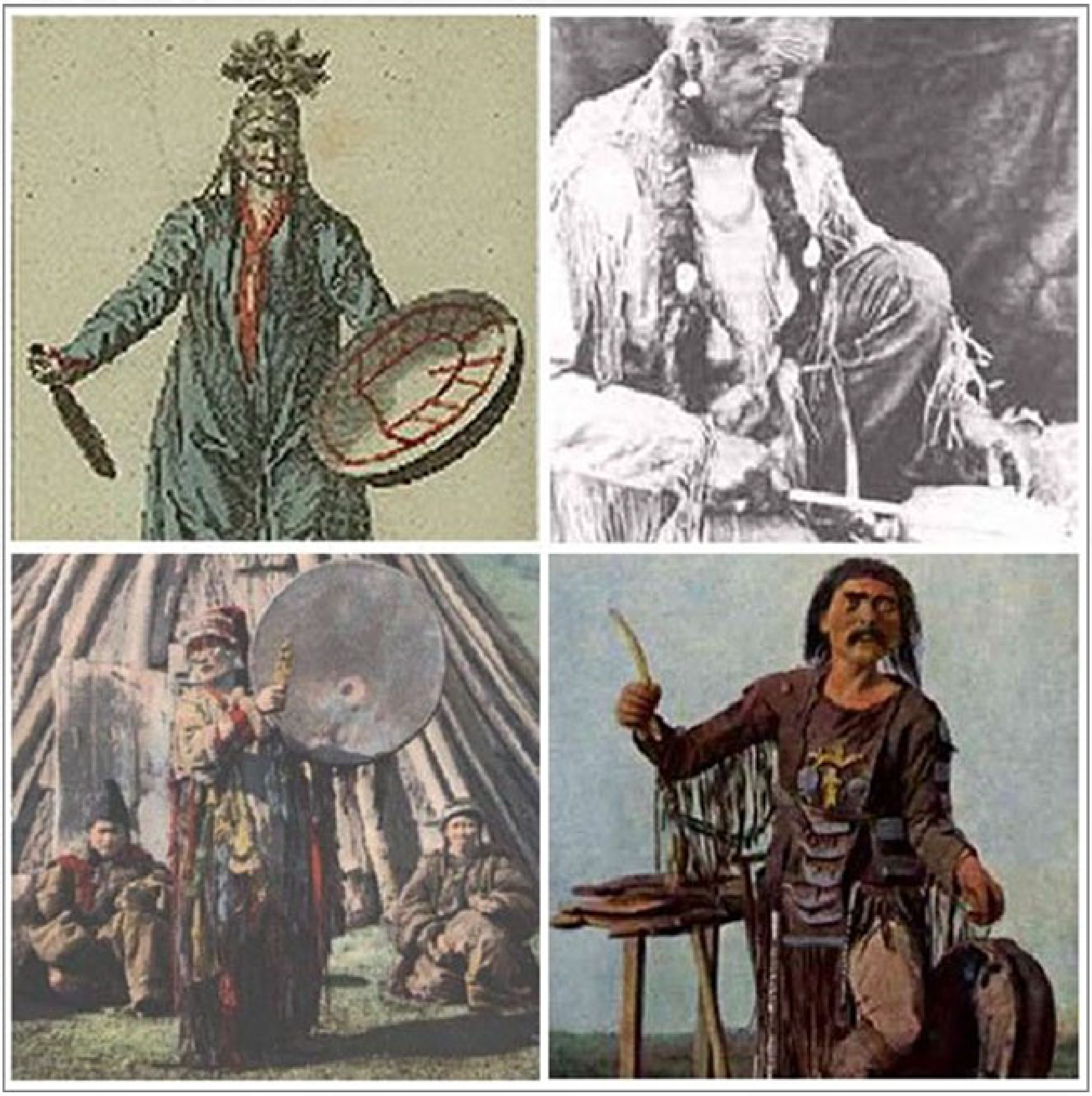


Figure 26. Pictures of the shaman from four different traditions. Clockwise from top: Tartar, Native American, Siberian, and Yakut. All shamen use medicine drums to control the tempo and amplitude of energy oscillating through the sacred circle.

Instead of focusing on the many societal roles and functions a shaman might fill, PIT takes a broader view and starts with this definition: Shamanism is the craft of evoking spontaneous organization of psychedelic information in a subject or group of subjects to promote plasticity, imprinting, and transformation. Psychedelic information implies holistic or meta level manipulation of memory and identity, and this definition fulfills the functions of therapy, sorcery, mind control, applied psychedelic science, targeted neuroplasticity, behavioral conditioning, and tribal bonding. The technology of evoking and imprinting psychedelic information is inherently neutral; the shaman learns to apply this technology for healing and positive plasticity, the sorcerer succumbs to the temptation to use this technology for black magic and negative plasticity.

Transformational Plasticity and Imprinting

The power of shamanism can be measured by the shamanic ability to transform subjective beliefs and behaviors. A shaman can transform the subject in the literal sense, through diet and chemical manipulation; or in the figurative sense, by altering the subject's paradigm and perception of reality. Both of these transformations imply targeted neuroplasticity. The extreme diets and psychedelic medicine catalyze spontaneous stress-based reorganization of neural identity structures, and the shamanic mythology creates the semantic frame through which the subject parses the transformational experience. Although psychedelics have been tested in brainwashing and hostile interrogation, the process of psychedelic imprinting usually works best if the subject is ready and willing to receive the transformation.[1]

Some aspects of psychedelic imprinting are automatic and spontaneously generated like dreams;[2] in this case the shaman's job is to apply the medicine and essentially look important doing nothing. In other instances the subject may have an adverse reaction to the medicine, or become lost in the psychedelic space; in this case the shaman may intervene with a spirit song, a meditative chant, or a rhythmic breathing exercise to guide the subject through the transition. In traditional or loosely organized shamanic ceremonies, the level of intervention and depth of psychedelic imprinting is controlled by ritual, shamanic intent, and group intuition; in clinical psychedelic therapy the depth of psychedelic imprinting is controlled by protocol.

Shamanic Reputation and Expectant Plasticity

If a shaman gains a reputation for being transformative, subjects will seek them out expecting to be transformed. Similarly, a popular shaman may become the target of a rival shaman seeking to curse them or bring them down with magic darts. Both scenarios indicate that the shaman has successfully imprinted his own supernatural abilities to the point of viral plasticity. A shaman does not need psychedelic drugs to accomplish this, any guru with a transformational philosophy and self-promotional streak can achieve this level of influence. The shaman differs from the New Age guru only by having mastery of the plants and the spirit world, which is rudimentary psychopharmacology and ritual transcendence. By offering his or her self as the path to sacred wisdom or healing, or by telling tales of supernatural battles with other sorcerers, the shaman implies that he or she is more powerful than the medicine they employ. Shamanic reputation builds subjective expectations, and in many ways is a very clever set-up and misdirection similar to priming a magic trick or a placebo. If the subject already believes the shaman has supernatural power, the task of transforming them with the medicine is the easy part.

By crafting a supernatural reputation, the shaman starts the process of bending the subject's beliefs and expectations long before the medicine is applied. In hostile interrogation and indoctrination techniques, this process of bending subjective beliefs is called "softening up" the subject, or priming neuroplasticity to be vulnerable to imprinting. If the subject does not appear to respect the shaman's supernatural authority, the shaman may become withholding and demand that the subject follow certain strange rules before applying the medicine. Establishing authority, submissiveness, and strictly enforced rules gives the shaman implicit control over the subject, and sets the stage for applying transformation. Even if the subject does not believe the shaman's mythology, by forcing the subject to follow ritual protocol the shaman establishes the power dynamic necessary for controlling the ceremony and imprinting the subject.

Shamanism, Chaos Magic, and Belief as Toolkit

The shaman's role will always be intertwined with the spiritual belief of the larger tribe or culture. The mythology is not important, a good shaman can adapt any mythology or belief to transformational ritual. Instead of preaching the mythology, the shaman exploits the mythology as a handle or tool for interfacing with and manipulating the subject's core identity structures. By adopting a mythology that's alluring to the patient, the shaman can apply identity transformation within a seamless spiritual context. The process of finding or seeding an emotional handle is a skill that can be learned, but it can also be purely intuitive. The technologies of religion, propaganda, agitprop, and social activism all use negative emotional handles to influence people's beliefs and behaviors; shamanism employs many of the same techniques with positive emotional handles. The practice of manipulating belief like a tool to produce transformative results has become popularly known as chaos magic.[3]

The bulk of available literature on shamanism focuses on sprits, spirit mythology, and the ways in which the shaman communes with plant and spirits to gain supernatural insights. The allure and power of a drug that allows the user to talk directly with spirits is obvious, but fascination with spirits and transcendence may also be a handle used by the shaman to manipulate and imprint a willing subject. Western spiritual seekers are quickly enamored with the romanticism of entheogenic spirit communion, this is not something a good shaman would overlook; this is something that can be easily exploited. Whether the subject comes looking for Jesus, God, plant spirits, healing, or transcendence, the spiritual passions of the subject are the most powerful items in the shaman's entire toolkit.

Shamanic Practice and Seeking Balance

The role of the shaman has always been to apply transformation, typically to restore balance and harmony within tribal units. The shaman works by organizing the flow of energy and information within individuals and tribal structures. The shaman synergizes many layers of transformation in the act of brewing and ingesting psychoactive sacraments, and uses mythology and sacred ritual to facilitate communication, navigate conflict, and fine-tune the overall health of the tribe. Since shamanic transformation can be used for both healing and sorcery, it is logical that the larger tribe will only tolerate such power as long as it is more therapeutic than destructive. Because of this dynamic, a practicing shaman may be inherently distrusted, and will always walk the line between outcast and savior. The romantic character of shamanism relies heavily on this outcast trope. If the shaman fails at the basic tasks of healing and conflict resolution, or abuses shamanic technology to undermine the well-being of the tribe for personal gain, then the shaman loses power and risks being ostracized by the tribe. Thus, the shaman's power is limited and ultimately defined by the trust placed in him by the larger tribe.

Notes and References 14

1. Groups linked to the weaponized use of psychedelics include the Manson Family, the SLA, Aum Shinrikyo, the CIA, and the United States Department of Defense.
2. See Chapter 13, "Psychedelic Neuroplasticity".
3. WikiPedia.org, "Chaos Magic". Internet Reference, 2010.

Chapter 15

An Overview of Physical Shamanism

Physical Shamanism, or Shamanism in the Age of Reason, is differentiated from Spiritual Shamanism in that physical shamanism relies on models of neural oscillators and resonant wave entrainment as opposed to spirit models of channeling, telepathy, or clairvoyance. The Control Interrupt Model presents a description of physical shamanism based on the precision coupling of a multisensory hallucinogenic interrupt to a resonant environmental driver.[1] Physical shamanism assumes the human brain in a destabilized state acts as a resonant oscillator, or a nonlinear information processing system; thus shamanism can be defined as the application of resonant drivers to mediate complex phase transitions between multi-stable states of consciousness.[10,11] The techniques of physical shamanism are often used in concert with a hallucinogen in order to entrance or hypnotize a subject or group of subjects into a targeted mystical state.

Spirit Voices, Shamanic Songs, and Strange Attractors

When a shaman takes a psychedelic he or she hears the spirit voices and intuitively learns to sing the spirit songs. These songs are taken directly from the shaman's head as the psychedelic begins to interrupt consciousness. In many ways these sacred songs, or *icaros*, are attempts to recreate the voice and tone of the pharmacological interaction at various stages of the psychedelic experience. The voice of the shamanic medicine is not human in the typical sense, the psychedelic voice is described more in terms of the repetitive bleeping and blooping of machine code; a biological thrumming; an electronic or alien pulsation; a guttural river of slurping and squelching sounds; the great wheeze of a mystical reed organ; the chirping of crickets; the croaking of frogs; or the fast-clicking communication of an insect intelligence.[2,3] All of these colorful metaphors are the same in that they perfectly describe a resonant standing wave in the alpha to gamma range driving amplitude along multisensory perceptual bands. As the hallucinogenic voice grows in strength, the resonance of the standing wave then couples with and drives the amplitude of all internal physiological processes.[4]

The Control Interrupt Model posits that these spirit voices are the nonlinear artifacts of the hallucinogenic interrupt frequency overlapping into multisensory frame perception with a specific ADSR (attack, decay, sustain, release) envelope. By modulating standing vocal waves, the shaman can exactly match the periodic frequency of the hallucinogenic interrupt; by changing the shape of the lips, the speed of air through the glottis, and the speed of the tongue flicking towards the back of the throat, the shaman can replicate the slippery shape and feel of the hallucinogen's interrupt envelope. Resonance is a term applied to oscillators when the shape and frequency of one standing wave harmonizes with and drives the amplitude, or energy, of another standing wave. By using the physical techniques of sound shaping and resonance, the shaman can amplify the hallucinogenic interrupt of any psychedelic and, beyond that, drive standing wave coherence among multiple participants in a shamanic ritual. This process is intuitive if the shaman merely pays close attention to his or her internal physiology as the hallucinogen takes action.

In the nomenclature of chaos theory, when a chaotic system evolves towards a particular state over time, that state is called an attractor, or a strange attractor in fractal systems. According to PIT, nonlinear consciousness is multi-stable, which means it can have many strange attractors pulling it towards many different stable states; or it can become stuck in a superposition or chaotic phase transition between two or more stable attractors. In normal perception, the primary attractor is linear consciousness; when consciousness is dramatically perturbed it will always find a way to return to the linear state after enough time, and consciousness tends to return to the linear state even when momentarily destabilized. In nonlinear consciousness the attractor may be a manic state, a trance state, a disoriented state, a paranoid state, an enlightened state, and so on. As psychedelic consciousness becomes complex and bifurcates, it gradually moves towards one of many multi-stable attractors, eventually locking into a complex stabilized state based on periodic drivers in set and setting. Once a subject under the influence of psychedelics finds an attractor state and locks into it, it becomes difficult to break the stabilizing harmonic pattern to move towards another attractor. Navigating between strange attractors in the destabilized nonlinear state is the primary function of shamanic singing and ritual; without the ability to self-navigate to a specific attractor, the subject may become stuck in a negative attractor, like an anxiety spiral or paranoid feedback loop.

Control Interrupt and Spirit Spaces

Mixing the Control Interrupt Model with traditional shamanic metaphors, it is accurate to say that the spirit world of each hallucinogen is literally erupting or interrupting into normal consciousness by carving out a distinct wave space where spirits can sneak packets of information to the subject in between normal frames. In physical terms, spirit information erupts into consciousness along the attack and decay of each psychedelic interrupt, then attenuates salient recognition and imprints itself into memory according to the receding sustain and release. As the interrupt's interference pattern overlaps onto multisensory perception, spirit information will appear to overlap onto the fabric of reality; bending towards the subject from a nearby dimension; trickling or gurgling over an invisible spillway; flickering in a stroboscopic film reel; parting through folds in a lattice or screen; becoming visible underneath a silken veil; and so on.[6] The subjective view of the spirit world is that it is an "invisible landscape" suddenly made visible to human eyes, and the addition of the hallucinogenic driver allows the veil of perception to be drawn open like shutters. These are all allusions to the boundaries of perceptual space changing as the hallucinogenic interrupt gains power, entrains sensory processing networks, and generates complex interference patterns.

To clarify this process with a metaphor, in the realm of shamanism it may be helpful to think of serotonergic (5-HT) modulation as reality, and the frequency of the hallucinogen as the spirit world. If serotonergic reality is modulated in the beta range at 12-30 Hz, and the hallucinogenic interrupt of tryptamine Y is modulated to 24 Hz, then there will be a predictable 24 Hz frame flicker superimposed over normal perception when you ingest hallucinogen Y. The interrupt frequency of 24 Hz presumes a very fast pulsation, fast enough to produce film-like or fully animated cartoon hallucinations. The 24 Hz spirit interrupt then masks itself onto multisensory pathways and is perceived as an ontologically distinct spirit realm emerging as a phantom but embedded part of physical reality. The physical intensity and tactile sensuality of the hallucinogenic spirit overlay will depend on the speed, shape, and intensity of the molecule's ADSR interrupt; higher doses of hallucinogen typically means harder attack, longer sustain, elongated release, and more seamless merging between reality and hallucination.

Driving Interrupt Amplitude and ADSR Transitions

As a psychedelic chemical is ingested and metabolized, the frequency and ADSR envelope of the hallucinogenic interrupt will transition over time. This shift in modulatory interrupt can be described as a change in interrupt amplitude over duration of effect; higher amplitude of interrupt means stronger and more realized hallucinations. A shaman will instinctively modulate the tones of his or her chants and songs to match the interrupt frequency and envelope of the hallucinogen as it begins to take effect. This technique accurately describes the oscillating drones, throat singing, slurping, sucking, squelching, whooshing, whistling, guttural ululating, and other vocalizations associated with ayahuasca shamanism.[2,3] If a shaman can drive interrupt amplitude through constructive vocal interference he or she should also be able to dampen interrupt amplitude through destructive vocal interference.[5] This technique would manifest as the ability to snap a subject out of an intense psychedelic experience with a quick change in phase between vocal waves and hallucinogenic interrupt frequency to decrease and flatten interrupt amplitude.

Techniques of using resonance to drive and shape wave amplitude have been exploited by modern DJs and music producers to engineer hard-attack bass lines associated with acid house and trance music. In the psychedelic musical genre known as Goa Trance, bass lines rip through crowds of thousands of dancers with the resonant wave shape and amplitude of electric saw blades. The intensely amplified resonant pulse drivers of Goa Trance music are, in fact, the current bleeding-edge ritual technology of physical shamanism. Goa Trance originated from India; Goa Trance DJs and producers are revered like gurus or techno-shamen; and fans of Goa Trance travel to global music festivals the way other spiritual adherents make yearly pilgrimages. Goa Trance music is the psychedelic essence of resonant hallucinogenic tryptamine interrupt expressing itself through modern ritual entrainment technology. Using an electrically amplified sound system, a trance DJ can manipulate a tribe of thousands in the same way a traditional shaman manipulates a tribe of dozens (Fig. 25). It is shamanic folk technology now applied on an industrial scale.

Cellular Automata and Fractal Imprinting

It may be difficult to understand how a simple periodic interrupt or modulatory frame pulse can create such dramatic perceptual results, but the hallucinogenic interrupt should be thought of as a linear resonant driver which, over time, generates complex and salient wave interference patterns. This can also be described by a dynamical information processing system generating complexity over time based on a simple repetitive algorithm, such as a fractal or a cellular automata. Fractals or cellular automata are perhaps the best visual metaphors for the spontaneous recursive organization of psychedelic visual hallucinations, and there is a very fractal or cellular element to the psychedelic experience which evolves along the flickering pulsation of the hallucinogen's interrupt. The endless unfolding of the infinite psychedelic fractal continues until the hallucinogen is metabolized, at which point the hallucinogenic interrupt wears off, fades away, and consciousness unwinds from the recursive spiral and stabilizes back into linear information processing.

Biology is repetitive feedback patterns; consciousness is repetitive feedback patterns; shamanism is the interruption and re-modulation of those repetitive feedback patterns to produce spectacular experiential results. In a very real way, shamanism is the art of shaping the fractal integrity of the individual from the genetic level up through personal memory and tribal identity. The hallucinogenic interrupt allows the shaman to break the subject's habituated daily routines and place them into a self-referential programming loop that includes all layers of personal and transpersonal identity. The interlocking facets of biological-self and transpersonal-self are made explicit in the flickering spirit space, and by controlling the depth of immersion into this space the shaman can control how much of the subject's existing identity is exposed, manipulated, and transformed in the process.

The fractal rendering of sub- and meta- consciousness in the shamanic space allows psychedelics to have a profound long-term effect on identity-based neuroplasticity.[9] By applying a resonant multisensory driver that acts as a fractal generator for archetypal symbols in imagination, the psychedelic paradigms imprinted into memory appear to be more cosmic, transpersonal, holographic, and durable than sum of linear identity constructs imprinted over the average lifespan. To be clear, the nonlinear iterative nature of psychedelic hallucination exploits archetypal symbol rendering to bypass linear ego and imprint a recursive, holographic view of the transcendent self within a larger emergent cosmic reality. This idealized, holographic representation of the self may be considered more "real" than the actual self, perhaps even experienced as the essential self, genetic self, transpersonal self, or the eternal soul. The ability to produce and manipulate a representation of the idealized transpersonal self makes psychedelics viable in shamanic transformation, clinical therapy, and spiritual awakening.

The holographic image of idealized self does not emerge in a single moment or even in a single psychedelic session; the organization of a psychedelic meta-identity is a process that may take many hours of a single psychedelic session or possibly multiple psychedelic sessions to fully complete. However, once the self-activation of psychedelic metaprogramming and holographic imprinting takes hold, the subject may perceive their transformation to be an evolutionary expression of a hidden genetic instruction set, or a more perfect and cosmically mature version of the self emerging through spiritual cleansing and rebirth.[7] There is evidence that a single psychedelic session can enhance self-worth and have lasting beneficial impact on mood and outlook.[8] There is also evidence that psychedelics can be used to imprint pathological, antisocial, and delusional identity constructs.[9] Holistic identity expression is generally considered to be a positive spiritual technology, but it can also be used to manipulate anxiety and exacerbate pathological behavior. This duality is commonly expressed in the nomenclature of therapy vs. mind control, negative vs. positive neuroplasticity, or shamanism vs. sorcery and witchcraft.

Linear vs. Nonlinear Memory Imprinting

The limits of human memory present some challenges for accurately encoding or describing the information generated in psychedelic states. Waking memory encodes linear, semantic information; dreams encode associative eidetic information; psychedelics encode nonlinear fractal information. There are many factors which limit the ability to accurately remember or recall psychedelic information. The rush of information is too fast; the content of the experience is too ineffable; and the processes of dreaming and eidetic visual hallucination blocks the formation of new semantic memories. In order to remember a dream a subject must wake up and make some mental notes, then go back to sleep to finish the dream; but if the subject does not rouse to some level of lucidity the dream is almost always forgotten. The same can be said for psychedelic hallucination; if the subject is too overwhelmed to make mental notes, the content totally bypasses linear semantic memory. However, if psychedelic hallucination employs the same spontaneous organization of eidetic information used to encode associative long-term memory through dreaming, then psychedelic fractal information may also imprint directly into long-term memory at a subconscious level.

Shamanic Information Compression

The functional limitations of human memory and expression have been problematic for high-dose psychedelic research from the beginning. The best writing, artwork, and video emulating the psychedelic experience must be created after the fact, sometimes painstakingly so. The visual reconstruction of psychedelic memory is a labor intensive process; a single subjective psychedelic frame may take weeks or months to visually render, and will still be lacking in context and complexity from the original experience. This is even more frustrating when you consider that a one line fractal algorithm or cellular automata can generate enough novel artistic complexity to keep the average human fascinated for hours. Linear approaches to capturing the psychedelic aesthetic almost always pale in comparison to their simpler, nonlinear generative counterparts.

The one artistic medium which can be expressed immediately in psychedelic intoxication without disrupting the quality of the shamanic experience is music. A shaman can relate the tone and content of the psychedelic experience in real time by singing, vocalizing, or playing drums (Fig. 26); this is the traditional method for binding psychedelic memory into physical space. The act of singing, drumming, or dancing also drives feedback and amplifies the energy of the psychedelic experience, thus making music the primary medium of psychedelic information compression and transmission.

There is compelling evidence that spontaneous singing and vocalization are forms of nonlinear psychedelic information compression. Glossolalia, or speaking in tongues, is reported as a spiritual side effect of psilocybin. Glossolalia may be considered a form of nonlinear speech, or psychedelic information erupting spontaneously through psycho-verbal synesthesia. When the shaman wants to speak with the spirit voice, that voice comes out more like music or glossolalia than like words and grammar. When a subject on psychedelics listens to music, the music expands from auditory signal into full multisensory synesthesia; every layer of emotional resonance in the song is laid bare for the subject to intimately see and feel. Claiming that psychedelics make music sound better or allow you to "see the music" is easy; this appreciation has fueled global music festivals and DJ circuits for decades. Shamanic music does not need to store visual information because under the influence of psychedelics the music naturally expands into visual perception. A sacred song from a rainforest shaman may not induce a strong reaction in a sober subject, but under the influence of ayahuasca that same song may open a window into the shaman's spirit world. This phenomena goes beyond the level of mere music appreciation, it demonstrates a cross-cultural technology for real-time encoding and transmission of nonlinear psychedelic information.

By examining the wave properties of ayahuasca *icaros*, is it possible to construct an experiential rendering of the synesthetic hallucinogenic effects. A shaman may make gurgling or retching noises to amplify modulatory interruption of 5-HT receptors in the gut to drive purgation. A fast rustling or shushing noise, like a snake rattle or wind through tree branches, evokes alpha-range relaxation and mental fluidity, and may also create goose-bumps and a salient sense of supernatural mystery. A droning drum beat or chant drives theta-band trance and hypnagogic states. A whistling or high pitched melody drives beta and gamma coherence, creating sharp multisensory synesthesia of rising eidetic images. A guttural croaking or a resonant bass line amplifies the saturated attack and decay of stacking hallucinogenic frames.

A shaman may employ one or all of these techniques at various stages of ceremony, and may use them repetitively or cyclically, like a winding stem that moves through deeper and deeper layers of hallucinogenic immersion. The shamanic technique of lulling and evoking mystical hallucination can be compared to the frenetic qualities of modern trance music, where the goal is to entrain and sustain a high-energy visual state that unfolds and recourses for extended periods of time. Trance songs are built around arpeggiated looping melodies which grow in complexity over time, culminating in phase transitions, or breakdowns, where stable looping states are shattered into chaos. While trance dancing, these breakdowns are felt as euphoric, like shattering a barrier into a higher state of freedom and bliss, and when the chaos of the breakdown converges back towards a rhythm, it is an even more frenetic level of organized syncopated beats driven and held together by deep resonant bass pulses. The wave analysis of both modern trance music and traditional *icaros* indicates that these are not merely forms of artistic expression, but are also formal technologies for mediating and navigating various levels of stability in chaotic psychedelic hallucination.

Notes and References 15

1. See Chapter 06, "The Control Interrupt Model of Psychedelic Action".
2. Beyer, SV, "Singing to the Plants: A Guide to Mestizo Shamanism in the Upper Amazon". University of New Mexico Press (October 31, 2009).
3. Observations of shamanic rituals and vocalizations taken from first-hand and recorded accounts of shamanic ceremonies.
4. Subjective reports of psychedelic intoxication include references to internal physiological processes achieving a dramatic synchronized efficiency. It is unknown if psychedelics have a globally coherent effect over all physiological processes, but since there are 5-HT receptors distributed throughout the entire body it is certainly within the realm of possibility.
5. WikiPedia.org, "Interference (wave propagation)". Internet Reference, 2010.
6. Descriptions of entering into the spirit world or receiving information through a lattice, veil, or spiritual overlay taken from subjective reports.
7. Themes of spiritual cleansing and rebirth are common in shamanism and psychedelic mysticism. Modern interpretations of these themes include genetic self-activation or evolutionary manipulation of DNA via psychedelic catalyst. While these descriptions feel authentic, there is no evidence to indicate that psychedelics drive manipulation or programming at a genetic level.
8. Griffiths, R.R., "Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance". Psychopharmacology (2006) 187:268-283.
9. Groups linked to the weaponized use of psychedelics include the Manson Family, the SLA, Aum Shinrikyo, the CIA, and the United States Department of Defense.
10. Yu Jiang, "Trajectory selection in multistable systems using periodic drivings". Volume 264, Issue 1, 13 December 1999, Pages 22-29.
11. Chizhevsky VN, Corbalan R, "Multistability in a driven nonlinear system controlled by weak subharmonic perturbations". phycon, vol. 2, pp.396-402, 2003, International Conference on Physics and Control.
12. Charing HG, "Communion with the Infinite: The visual music of the Shipibo people of the Amazon". SH, Winter 2005.

Chapter 16

Physical Shamanism and Shamanic Therapy

The practice of spiritual shamanism and healing has been covered in many texts, so here we will examine physical models of shamanic therapy only as they apply directly to Psychedelic Information Theory (PIT). According to PIT, hallucination is the spontaneous production of nonlinear information via destabilization of multisensory perception.[1] Similarly, shamanic therapy is the production of spontaneous cellular organization via destabilization of metabolic homeostasis. An M.D. may prescribe a specific therapy to treat a specific symptom or pathology; a shaman will look beyond the pathology and prescribe radical dieting and psychedelic drug therapy to fully reboot, re-tune, and recycle the patient's entire metabolic process. Shamanic therapy can be considered a nonlinear or holistic approach to diagnosis and healing.

Modern Shamanic Psychotherapy

In modern clinical therapy psychedelics are employed to improve psychological resilience in the face of stress or trauma, typically in the case of depression, PTSD, and anxiety. Psychedelics are thought to produce psychological resilience through the spontaneous creation of autobiographical insights and transpersonal spiritual epiphanies which compress existing memories into a new holistic identity. According to PIT, the generation of salient insights in psychedelic trance is the byproduct of nonlinear information creation and memory compression, just as dreaming is a form of associative information creation and compression.[2] Even a single low-dose psychedelic session can produce changes in identity and transpersonal awareness that last a lifetime.[3,4,5]

To apply simple psychedelic therapy, the shaman need do nothing more than provide the medicine and a warm quiet place for the subject to lie down. Psychological resilience is generated by allowing the subject to navigate anxieties, forgive and accept past behaviors, and sense a transpersonal unity and love flowing through all creation. This method works best in targeted therapy, and should only be applied in a controlled setting to reduce anxiety spirals and negative plasticity.

Shamanic Dieting, Purging, and Cleansing

Traditional shamanic therapy typically includes components of restrictive dieting, fasting, and purgation of bodily wastes and fluids.[6] The common wisdom is that dieting and purgation cleanses and purifies the body, restoring it to harmony and balance. A more cynical analysis concludes that radical dieting and fasting destabilizes the body's metabolic homeostasis and puts it into deprived states of heightened alertness and stress, states which can easily produce psychosis if prolonged for a day or more. Subjective reports of psychedelic use often include an initial period of stomach pain and intestinal discomfort preceding full psychedelic destabilization; this is because the psychedelic must interrupt 5-HT receptors in the gut before metabolic homeostasis can be fully uncoupled and re-tuned. Techniques of dieting and fasting speed and amplify the destabilizing effect of psychedelics on global metabolic homeostasis.

Metabolic Destabilization and Cellular Regeneration

The Control Interrupt Model posits that hallucinogens produce complex perceptual results through pharmacological interference of multisensory frame stability.[1] The same model applied to neural oscillators in a sensory network can be applied to cellular oscillators in an biological matrix. Many functions of metabolism and cellular signaling are modulated by 5-HT and dopamine; interrupting these signaling pathways will not only produce patterns of spontaneous neural organization, they will also produce patterns of spontaneous metabolic and cellular organization. For instance, 5-HT_{2A} receptors and serotonin have been shown to play a large role in mediating blood platelet aggregation.[10] Hallucinogens target 5-HT_{2A} receptors, and platelet aggregation is a fundamental immune mechanism. 5-HT_{2A} activation has also been demonstrated to produce powerful anti-inflammatory effects in cardiovascular and soft tissues; and 5-HT_{2A} agonists like LSD may produce potent anti-inflammatory effects against TNF-a (tumor necrosis factor alpha), an autoimmune regulator which has been indicated in atherosclerosis, rheumatoid arthritis, psoriasis, type II diabetes, depression, schizophrenia, and Alzheimer's disease.[11]

Because the 5-HT$_{2A}$ receptor is a G-coupled protein that promotes secondary transmission within the cell membrane, psychedelics that target the 5-HT$_{2A}$ receptor can influence a wide variety of intracellular functions. The signaling pathways mediated by the 5-HT$_{2A}$ receptor include the release of charged calcium ions (Ca^{2+}) and the activation of PKC and MAPK, protein kinases which transfer energy to proteins and enzymes that regulate cellular metabolism and proliferation. Coaxing cellular signaling pathways into patterns of spontaneous regeneration, anti-inflammatory, or autoimmune organization is at the root of all physical shamanic therapy. This model can be applied to neural inflammation, as in cluster headaches; emotional inflammation, as in PTSD; stress-related soft-tissue inflammation, as in fibromyalgia; or any systemic inflammation related to stress, chronic disease, and autoimmune disorders.

Subjects under the influence of psychedelics sometimes report feelings of being cleansed from the inside, like each cell is being polished and organized, and that waste and cellular debris are being expelled. This sensation has been compared to a radical auto-immune response, like computerized maintenance routine for de-fragmenting and optimizing cellular memory structures. Just as neural assemblies may be coaxed into becoming spontaneous nonlinear feedback generators, cellular signaling pathways may be coaxed into generating information via spontaneous energetic metabolic pathway testing, strengthening, and regeneration. Just as nonlinear hallucination may facilitate memory potentiation in the same way as dreaming, nonlinear metabolic organization may facilitate cellular regeneration or immunological response similar to states of fever or deep restorative sleep. The cellular regenerative power of psychedelics have only recently been demonstrated in scientific terms, but in shamanic models this restorative function is taken for granted.

Physical Shamanism and Metabolic Entrainment

Physical shamanism employs wave-based entrainment techniques to coax spontaneous nonlinear organization in metabolic pathways and cellular signaling systems. Typical shamanic wave entrainment comes in the form of singing or music, but can also be applied through talk, touch, hypnotic motion, or other repetitive sensory feedback stimulation. Entraining a subject into a targeted state of consciousness is the science of hypnosis or trance. The psychedelic medicine allows the patient's homeostasis to become destabilized, and in this state the shaman becomes the circuit driver or entrainer, the oscillator with the most power to alter frequencies and amplify or dampen signal strength across the entire circuit. Acting as a hypnotic entrainer, the shaman can place the patient into dream-like trance and then synchronize his own perception to the patient's subtle internal body rhythms. The shaman uses the hallucinogenic interrupt as a control frequency for mediating contact with and manipulating the patient's metabolic processes. Once the control frequency connection has been established through mutual ingestion of the psychedelic medicine, the shaman then uses specialized entrainment waves to coax new metabolic interference patterns and signaling pathways throughout the patient's cellular matrix.

In Shipibo ayahuasca shamanism, the shaman takes the psychedelic medicine in order to visualize a flickering grid of patterns and symbols crawling across the surface of the patient. These ayahuasca patterns are embedded into Shipibo textiles (Fig. 27), ceramics, tattoos, and all forms of tribal artwork, and are considered to be visual representations of the *icaros* sung during shamanic ceremony. Each Shipibo pattern corresponds to a sacred psychedelic space where a specific type of information is manipulated and revealed, and by tuning the fluctuation of these patterns through the patient's biological systems, the shaman can sense blocked signaling pathways, restore atrophied pathways, and bring harmony and balance to the organism. Subjects under the influence of ayahuasca and shamanic singing often report the feeling of every cell in their body resonating in harmony with the healing songs of the *Maestro*.[7,8]

The ayahuasca shaman may employ hands-on techniques to massage the patient's energy patterns into a more harmonic shape, sometimes even sucking or blowing psychic energy through the patient, or perhaps performing a psychic surgery to remove a dark body, a block, or a curse.[9] Sometimes the shaman must dig very deep into muscle and organ tissue before the source of illness can be found; sometimes the patient's energy pathways are so blocked or degraded they are impossible to fix. The shaman may use high-pitched vocal tones to focus sound waves deep into the body, hoping to break apart blocked signal pathways via the power of resonant intonation. The shaman may use high pitched whining or whistling tones focused at one area of the body, or may use throat singing to invoke deep rumbling bass tones which make the patient's chest cavity resonate at same frequency as sound vibrations moving deep into the Earth.[7]

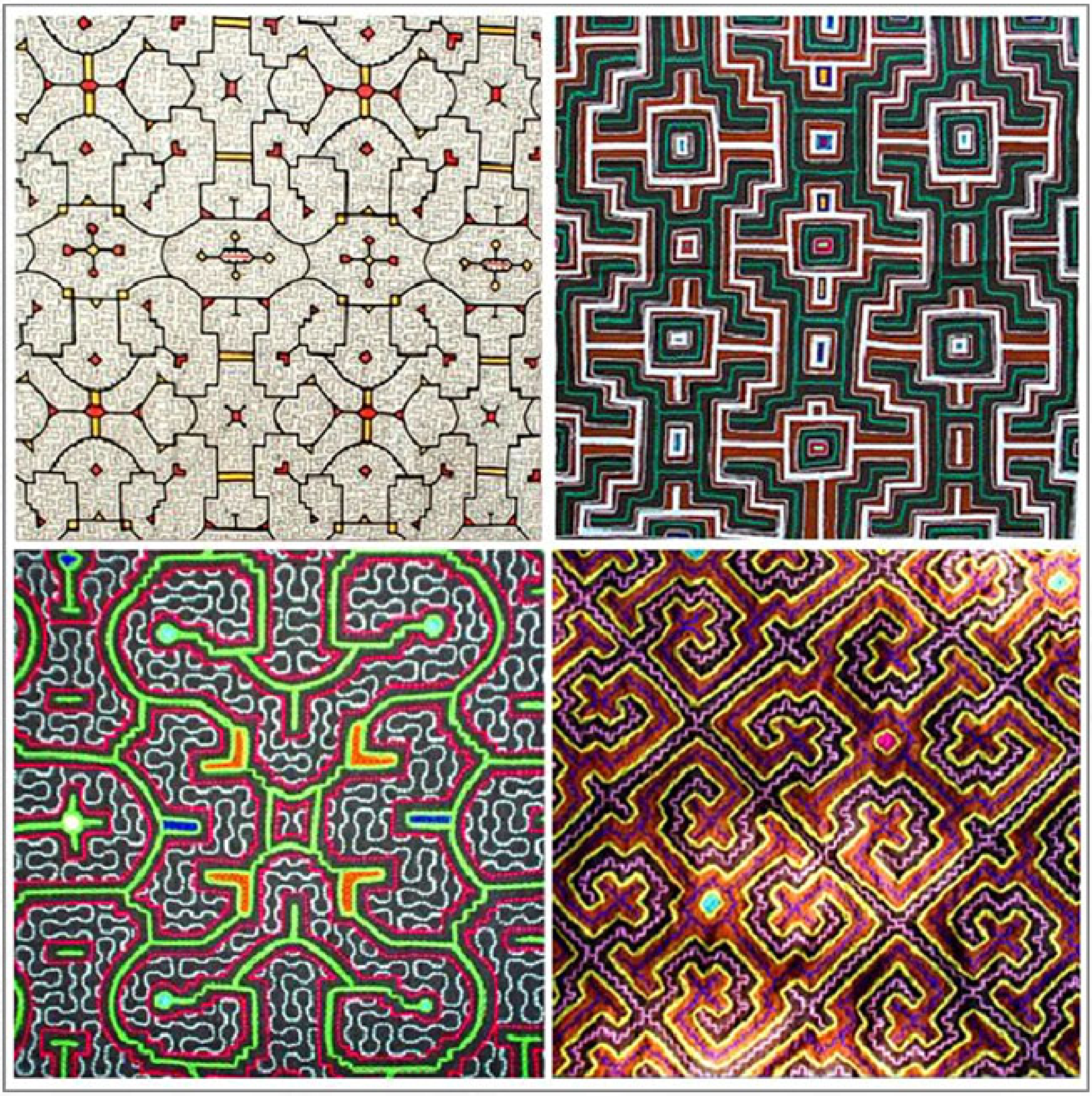


Figure 27. Patterns from Shipibo textiles are nonlinear artifacts of ayahuasca hallucination, and are also isomorphic of Chladni resonating interference patterns and Peano plane-filling fractal curves.

The case can be made that Shipibo textile patterns and sacred songs are compressed artifacts of nonlinear hallucination. These patterns are isomorphic of Chladni resonating interference patterns (Fig. 31), as well as Peano space-filling fractal curves (Fig. 28), S- or L-shaped patterns which repeat in embedded granularity depending on the depth of system iteration.[12] Shipibo textile patterns correspond to specific resonating tones and states of consciousness, and *icaros* are cultural technologies for accessing specific states of highly organized nonlinear feedback complexity in both neural and cellular signaling pathways. By employing these techniques under the influence of psychedelics, the shaman can entrain the biological functions of the patient all the way down to the cellular level, perhaps even to the genetic level. Transitioning through these levels would depend on the granular complexity of the interference pattern, or depth of system iteration, created between the shamanic entrainment wave and the hallucinogenic interrupt.

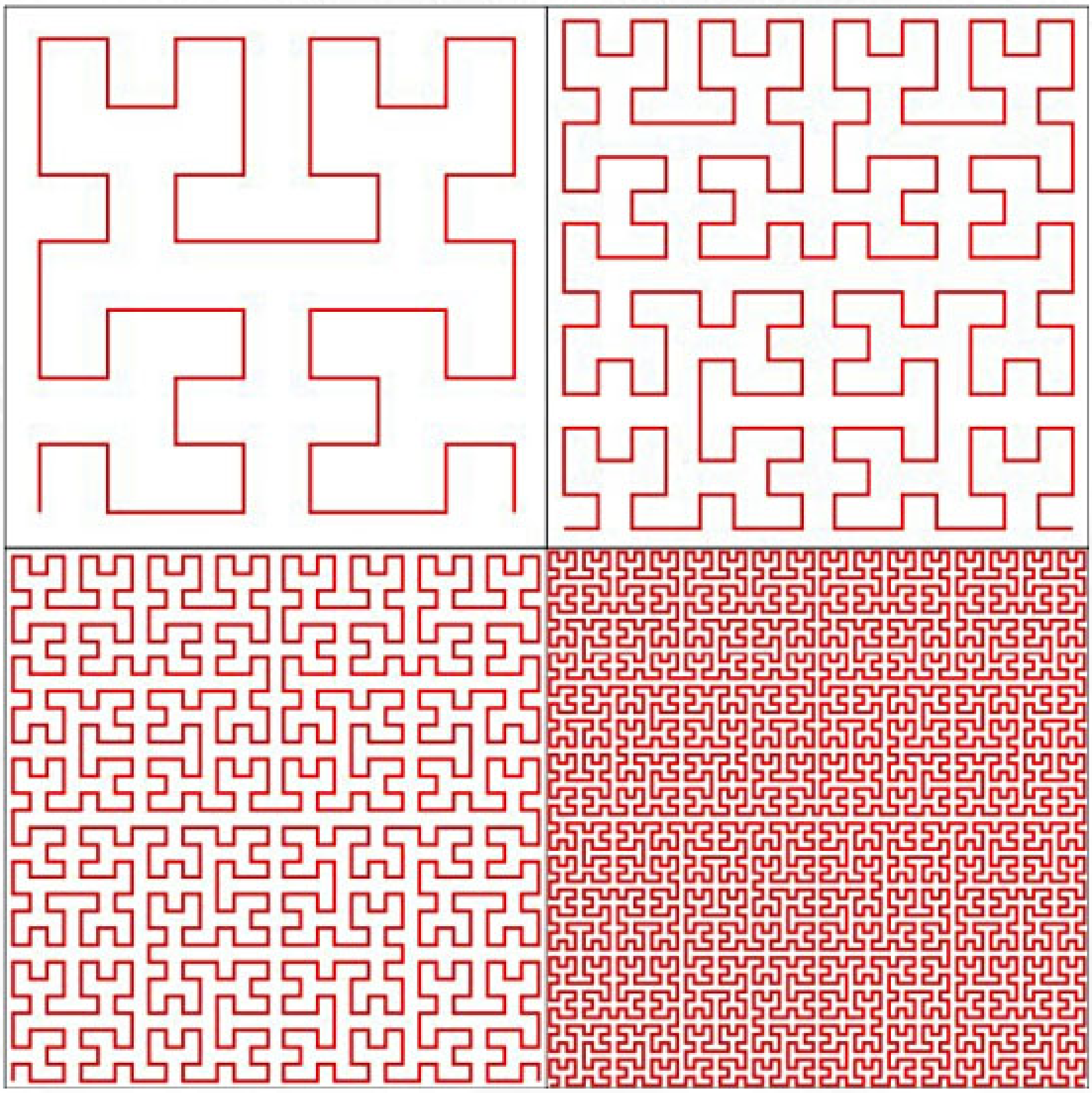


Figure 28. Hilbert curves are examples of recursively constructed L-shaped Peano curves, also called space-filling or plane-filling curves, which recede in granularity with each octave or iteration. From Wolfram Math, 2010.

Notes and References 16

1. See Chapter 06, "Control Interrupt Model of Psychedelic Action".
2. See Chapter 13, "Psychedelic Neuroplasticity".
3. Doblin, R, "Pahnke's 'Good Friday Experiment' A Long-Term Follow-Up And Methodological Critique". The Journal of Transpersonal Psychology, 1991, Vol. 23, No. 1.
4. Griffiths, R.R., "Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance". Psychopharmacology (2006) 187:268-283.
5. Griffiths RR, Richards WA, *et al.*, "Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later". Journal of Psychopharmacology, Vol. 22, No. 6, 621-632 (2008).
6. Tindall R, "The Jaguar That Roams the Mind". Park Street Press, Vermont, 2008.
7. Charing HG, "Communion with the Infinite: The visual music of the Shipibo people of the Amazon". Eagle's Wing, Winter 2005.
8. Pantone, DJ, "The Shipibo Indians: Masters of Ayahuasca". Internet Reference, 2006.
9. Beyer, SV, "Singing to the Plants: A Guide to Mestizo Shamanism in the Upper Amazon". University of New Mexico Press (October 31, 2009).
10. Cerrito E, *et al.*, "5-HT$_2$-receptors and serotonin release: Their role in human platelet aggregation". Life Sciences Volume 53, Issue 3, 1993, 209-215.
11. Yu B, *et al.*, "Serotonin 5-HT$_{2A}$ Receptor Activation Suppresses Tumor Necrosis Factor-α-Induced Inflammation with Extraordinary Potency". JPET November 2008 vol. 327 no. 2 316-323.
12. Wolfram Math, "Peano Curves". Internet Reference, 2010.

Chapter 17

Hypnotic Entrainment and Induced Trance States

The fundamentals of hypnosis and induced trance states begin with the concepts of wave resonance and entrainment. Resonance is the quality of any oscillating system (waves in a neural network) to reach maximum amplitude (power) when stimulated with periodic drivers (pulses) at a specific pitch or rhythm (a resonant frequency). Oscillators can have many resonant frequencies which top out at maximum amplitudes. If we envision the brain as an oscillator for maintaining stable bands of consciousness, each band in the spectrum must therefore have its own corresponding resonant frequency, or frequencies, which can drive spontaneous phase transitions into that standing wave state. The process of using resonance to drive the frequency and amplitude of oscillators is called entrainment, and when the shaman induces a trance state he is applying resonant wave interference to entrain the frequency of the patient's neural oscillators.

Neural Oscillators

All states of consciousness are created by the act of neurons firing in a network. When a single neuron fires once it is not a big event, but when a neuron fires in a rapid sequence then it is signaling other neurons with a fine vibration of wave spikes; these neural spikes are the language of consciousness. When two or more neurons fire at the same frequency they are said to be synchronized, and when two areas of the brain are firing in synchrony there is said to be coherence between these areas, which means they are most likely engaged in a complex distributed processing task. When neurons are coupled together in a recurrent network, the rapid pulses sent back and forth between them are referred to as oscillations, and these oscillations take on the predictable mathematical properties of waves; a wave being any standing oscillation passing through a medium. These standing oscillations - literal waves of energy rippling through pathways in the cranial saltwater - are the field effect of consciousness flowing through the neural network. Smooth or harmonic propagation of these waves indicates high fidelity and stability in the field of consciousness; erratic propagation or interference in these waves indicates a chaotic, transitional, or destabilized field of consciousness.

EEG and Brainwaves

The wave-like oscillations of the brain can be measured via electroencephalography (EEG), a technique in which electrodes are placed on the skin and scalp to aggregate the voltage of energy waves produced along the outermost cortical layers of the brain. EEG machines produce graphs of brain activity over time, and each state of consciousness occupies its own distinct space along the brain wave spectrum (Fig. 29). The normal waking consciousness we perceive as active self is a beta state which begins around 12 Hz, or 12 cycles-persecond; this is the speed at which consciousness updates in a focused, active state. In highly focused or intense waking states these beta rhythms can be pushed up to around 38 Hz, which means the neural network would be cycling information at a rate of thirty-eight framesper-second (FPS).

Below beta is the alpha state, in the 7-12 Hz range, which is associated with detached critical analysis and more relaxed physical intuition. Even more relaxed than alpha is the theta state between 4-7 Hz; this band makes up the transitional states between waking and sleeping, including meditative and lucid dream states. The waking mind finally shuts down at the delta range of 0.5 to 4 Hz, where the brain slows into the deep rhythms of regenerative sleep. The brain wave spectrum from 0.5 to 38 Hz is where we spend all of our days every day, with global brain cohesion rarely tipping over into the high gamma range of 40 Hz and beyond, bands associated with fast personal awareness and highly focused connective insight. But even higher than gamma is the hypergamma range, which is over 100 Hz; and above that is the mythical lambda state, over 200 Hz, where it is rumored that human consciousness tops out at total awareness of all things from the beginning of time to the end of history. On the other end, even lower than deep delta sleep, is the mythical epsilon state where brain waves drop below 0.5 Hz and a yogic state of suspended animation occurs.

When evaluating brainwaves, human consciousness appears to be like a musical instrument than can be tuned and tweaked along a predictable spectrum of possible tones and chords. The brain wave spectrum as detailed here is only the most basic information, but EEG and brain wave science is rich with detail on how the various states interact with one another. For instance, there is evidence that slow wave oscillators in the brainstem may act as the circadian drumbeat of all consciousness; that fast gamma waves are employed spontaneously to bind coherence between slower brain areas; that slow epsilon waves may drive amplitude in the hypergamma and lambda ranges; that the mu rhythm (8-12 Hz) controls and interprets contralateral motor activation; that there are specific brain organs and hormones responsible for attenuating specific pulse ranges and keeping the brain in synch; that beta states promote anxiety; that the brain constantly produces many simultaneous bands of activity at differing power ranges in any state of consciousness; and so on. Brainwaves are often fleeting, irregular, and disorganized; consciousness is distributed and constantly transitioning between multiple tasks and states of focus.

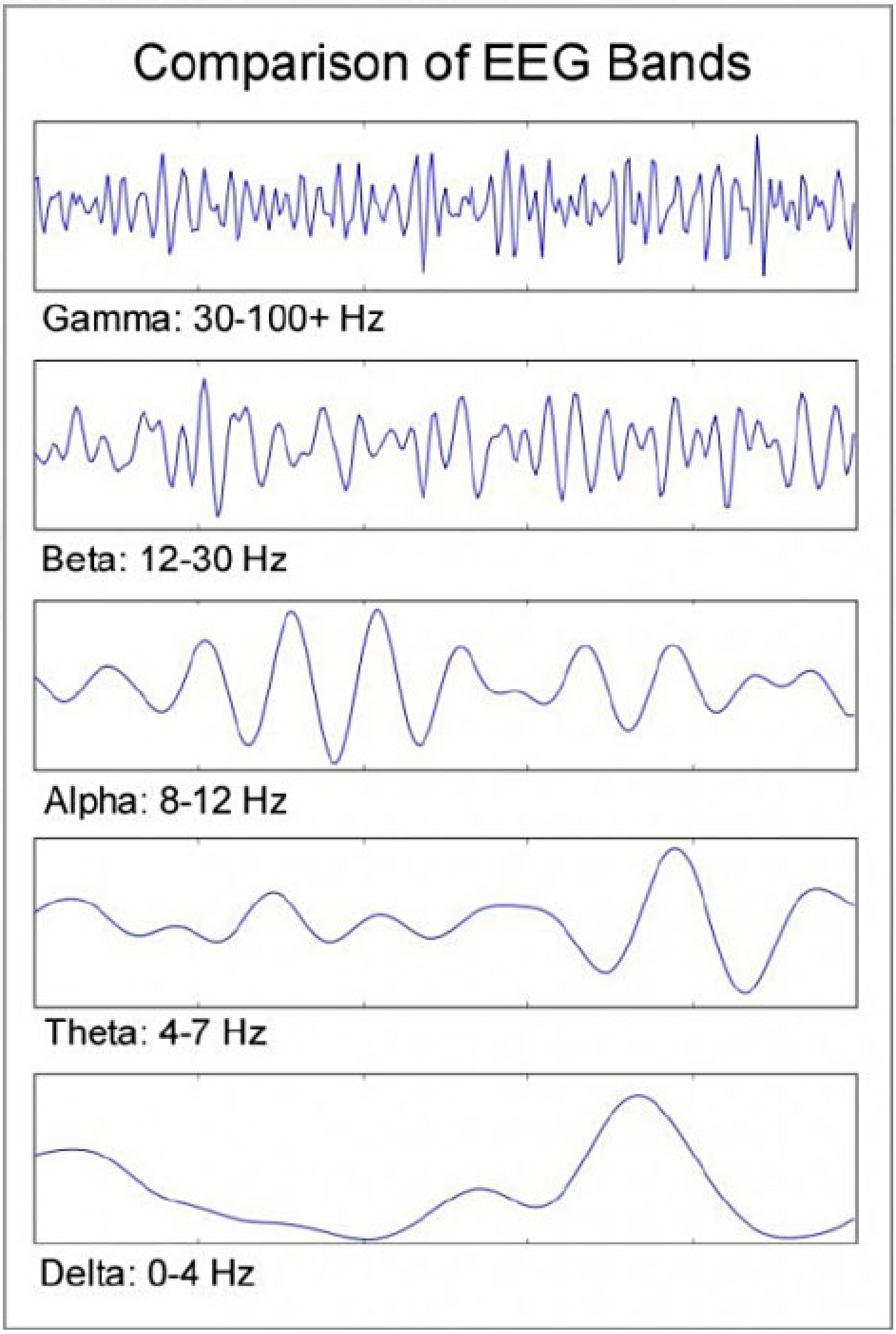


Figure 29. EEG bands over one second of activity. From WikiPedia.

Hypnosis, Induced Trance States, and Entrainment

Most shamanic work is done in what is known as a trance state; a highly relaxed state of extremely narrowed focus. The traditional shamanic trance state is in the theta range, around 4-7 Hz, which is a meditative state in the boundary zone between sleeping and waking. Most shamanic drum circles drop naturally into the theta range, and this is the same range a hypnotherapist will drop a patient into when inducing a highly relaxed state. This range is also associated with daydreaming, memory recall, and guided visualization. The high end of the theta band is associated with internal focus, visualization, and sustained concentration; the lower end is associated with more transient states of daydream, spontaneous memory recall, and lucid dreaming. Somewhere in the lower end of this zone is the hypnagogic grey area between waking and sleeping where body-consciousness disappears and the user feels floating sensations and may have out-of-body experiences (OBEs).

One of the ways a shaman achieves a trance state is through hypnosis. A typical hypnotherapy routine will guide the patient slowly down through a relaxed alpha state and gently place them right on the borderline of the hypnagogic theta state. With the patient teetering on the edge of hypnagogia, the therapist can then either engage them casually in a minimally aware alpha state or tip them into an internal theta state where it is easier to imprint new suggestions onto existing memory structures. If the hypnotherapist wants to make a strong imprint, he will introduce a suggestion in a receptive alpha state, then drop the patient into a low theta state to process the suggestion, then bring them back up to alpha to reinforce the suggestion, and then finally send them back down to low theta or slow delta sleep for further deep associative imprinting. This basic hypnotic routine is meant to focus the patient into the disengaged trance where rational override is shut down and the brain is vulnerable to suggestive memory imprinting. Most modern hypnotherapy focuses on behavioral imprinting, but the hypnotherapist may also uncover lost memories, imprint new memories, suggest the patient is floating, or take the patient on a guided visualization through a dream world. While performing trance work the shaman will tell the patient to remain completely still; this is to minimize circuit perturbation and wave interference produced by voluntary motor rhythms.

Shamanic Entrainment Technology

Hypnotherapy contains many of the same elements of shamanism, but hypnotherapy does not work for everyone. In shamanic therapy the psychedelic agent is applied to destabilize top-down control and make the patient more susceptible to entrainment for longer periods of time. If the patient is lying down with their eyes closed then psychedelics will produce a trance state fairly reliably on their own; the shaman does not need to do much more than measure an accurate dose and provide a safe place for quiet reflection. But aside from treating patients, the shaman also leads group bonding rituals, and these group rituals all utilize similar hypnotic entrainment technologies.

Typical shamanic entrainment technology may include drums, chants, music, strobe lights, chimes, audio pulses, and talk routines which guide the ritual participants into a shared trance. Native American peyote rituals use the beat of a medicine drum as the synchronous driver for the baseline trance, and then layer the rhythm with vocal drones to create resonant drivers which maximize brain wave amplitude and global coherence in the group circuit. Discussion of periodic resonant oscillators and entrainment is essentially a physics-based deconstruction of music's power to induce and lock targeted mind states, which is something we all instinctively understand from the experience of listening to music. However, when you look at this dynamic from a physical standpoint, when the mind is entranced by an entrainment technology such as music, the mind and the music merge from separate individual oscillators into a standing harmonic interference pattern with its own unique properties of coherence and stability.

In traditional Amazonian ayahuasca ceremonies, the shaman may be blessed with an *icaro*, or a sacred song which is delivered spontaneously into the brain by the spirits. When the shaman sings this sacred song, the ritual participants are quickly ushered into the sacred space along with the shaman. Using the entrainment dynamic it is reasonable to assume to that these *icaros* are feedback vocalizations tuned to the resonant frequency of the specific trance state occupied by the shaman. The shaman hears the resonant frequencies in his head as hallucinogenic artifacts of the phase transitions happening within his neural oscillators, and when he vocalizes these noises they come out as pitched micro-tones, often layered with vibratos coming from the nose and throat. By layering resonant multi-tones into the sacred song, the shaman increases the amplitude and entrainment power of his neural and vocal oscillators. If the shaman and the ritual participants all sing the same tones together, their oscillators all merge into a constructive interference pattern and drive each other into a higher amplitude of shared energy. This is the physics of neural entrainment and linking group mind.

Chapter 18

Psychic Bonding and Psi

Psychic bonding is a physical, neurological adaptation that occurs when two subjects spend time together sharing thoughts, feelings, and personal space. Psychic bonding is a survival trait that all animals and possibly all plants share. Psychic bonds can create personal vulnerabilities, so the average subject will have a built-in resistance to psychic bonding unless there is an explicit survival need and a certain level of trust established between subjects. Resistance to psychic bonding naturally breaks down over prolonged exposure between subjects living in the same confines as trust becomes routine and implied. In order to form a psychic bond, subjects must spend a period of at least a few hours together; a period of two to three days is optimal. Subjects should be together throughout all daily activities: waking, sleeping, eating, working, relaxing, etc. Sharing the schedules and routines of daily life is essential to synching the circadian rhythms and cross-expectations of each subject.

Psychic Bonding and Circadian Rhythms

Circadian rhythms are the master clock which controls all the state changes an organism undergoes in a 24-hour period. We wake up, get active, get hungry, get relaxed, get sleepy, go to sleep, and dream on a predictable cycle that mirrors the rotation of our planet, our moon, and our own internal biology. Subjects who are synched to the same circadian rhythms are locally bound to the same hourly oscillator, which means they share the same time-zone and daily living schedules. People who are called to perform daily routines at certain hours - like the prayer times of Islam, the coffee and lunch breaks of Western corporatism, or the hourly news cycles of modern media culture - have particularly high levels of local circadian binding. Usually circadian rhythms must be synched before psychic bonding between subjects can begin, though there is anecdotal evidence that psychic bonding can take place over telepresence if virtual contact is maintained for extended periods of time.

Psychic bonding usually takes place within a household; the household can be a metaphor for any group living situation, it can be an actual house, a business or partnership, or it can be a loose tribal structure like a band, team, squad, or similar nomadic crew. When living within close confinement, subjects are forced to work together, compromise, and share rigidly induced schedules for eating, relaxing, and sleeping. As subjects coexist they begin to build internalized constructs of each other which dictate how they behave and interact; these are cross-expectations fed by mirror neurons analyzing cooperative behaviors. The close familiarity between subjects drives a neural wiring process which embeds the patterns of each bonding partner into the other's mind, a process called mutual plasticity. Routine familiarity between subjects drives mutual plasticity.

Stress- and Pheromone-Induced Neuroplasticity

Smell is the most evocative of human senses because it is wired tightly into reward and fear responses, and of all the things that entice and repulse us about other people smell is arguably the strongest. When subjects are living in close proximity they produce hormones, pheromones, and they sweat, and when those pheromones are inhaled they produce instinctual emotional and neural responses. There is a very complex relationship between hormones, pheromones, behavior, mating, and bonding that permeates the entire plant and animal kingdom; it is a subject that transcends molecular biochemistry and approaches organic information field theory. Attempting to break down the non-verbal power of pheromones to induce bonding and neural growth can lead to many interesting digressions, but what is most germane to our discussion is that when humans are under stress they produce hormones and they sweat, and that hormone-laced perspiration induces powerful empathetic responses in other humans. The feedback of pheromonal response between subjects over a period of a few circadian cycles will automatically drive the bonding process even if subjects are naturally resistant. The introduction of stress into the group household will increase hormonal response and thus make the bonding process more urgent and more powerful.

Bonding can be slow and relaxed, like the way a family builds familiarity over time; or it can be fast and forced like the way cults, fraternities, and militias haze subjects into coherence in a matter of days or weeks. Bonding can also be artificially induced through drugs, group mind rituals, or through the stress of surviving combat or a natural disaster with a small group of people. Bonding pairs are most likely mates, partners, roommates, or people who live and travel together in small tribe-like groups. Hostages can also bond with their captors in what is famously known as Stockholm syndrome,[1] which is an example of stress creating a situation where the brain is ripe for entrainment and imprinting.

A romantic version of group mind leading to psychic bonding might happen spontaneously on date when two potential mates sit and talk quietly for long periods of time, sharing vulnerable aspects of themselves over dinner, drinks, and conversation. If the couple is good fit, they will slowly synch into harmony with each other over the course of an evening until they wind up talking all night, feeling like they've never met anyone who understands them so deeply and intuitively. This is pheromones, proximity, and self-reinforcing neural feedback embedding instinctual rhythms in the rapport between two subjects; or neural cross-expectations. The overlap of hormonal response, brain wave coupling, and proximity between subjects will, over time, build strong synaptic connections which bind these individuals together.

Informational Capacities of Bound Partners

While the telepathic capacity of bound subjects is limited, a bound partner can still tell, for instance, what a partner is thinking just by looking at their face. The telepathy is generally not literal and symbolic, it is intuitive and empathetic. Bound partners will share intuitive rhythms of speaking and interacting - sharing phrases, inside jokes, and specialized facial expressions - and will spontaneously fall into these rhythms whenever they are together, even if they have been separated for long periods of time. There is constant anecdotal evidence that bound partners often spontaneously think of each other at the same moment, causing one to call or seek out the other just as the other thinks of doing the same; or that pets intuitively know when their owners are on the way home.[2] More intriguingly there is evidence indicating that bound partners can non-locally sense when the other is surprised, startled, or in danger.[3,4,5] Bonded pairs being synched on an intuitive level may not be literal telepathy, but this can definitely be classified as psi which has obvious survival advantages.

The key capacity of bonded pairs is that they can think and move fluidly as a pack and work instinctively with each other on an intuitive and non-verbal level. The demonstrable capacity for organisms to bond into collective groups emerges at the bacteria level and becomes most obvious at the insect or hive level. Through the mechanistic means of pheromones and receptors, insects can coalesce into a hive mind capable of many coordinated tasks; this is non-verbal cooperation based solely on encoded rules of instinctive behavior. Fish form schools, birds form flocks, mammals form packs, humans form tribes and towns and cities. Humans can also form psychic bonds with domesticated animals such as cats and dogs and horses, cross-encoding verbal and non-verbal communication for simplification of everyday needs and routines. There is also anecdotal evidence of people bonding with plants. The hormonal process for psychic bonding is genetically encoded and instinctual in cases of extended close proximity, intimacy, and stress; these are the exact variables needed for breaking or domesticating wild animals; the same variables needed for brainwashing; the same variables needed for cult indoctrination and deprogramming. The psychic bonding process is an instinctual evolutionary capability which can be exploited for positive or negative purposes, and the quality of information passed through psychic bonds can be described as automatic, self-stabilizing, non-verbal, advantageous, and intuitive.

Notes and References 18

1. WikiPedia.org, "Stockholm Syndrome". Internet Reference, 2010.
2. Sheldrake R, "A New Science of Life: The Hypothosis of Morphic Resonance". Park Street Press, Vermont. 1995.
3. Luke D, "Psi-verts and Psychic Piracy: The Future of Parapsychology". Reality Sandwich, Internet Reference, 7-6-09.
4. Richards TL, Kozak L, Johnson C, Standish LJ, "Replicable functional magnetic resonance imaging evidence of correlated brain signals between physically isolated subjects". Journal of Alternative and Complementary Medicine, 11, 955-963.

5. Kittenis M., Caryl PG, Stevens P, "Distant psychophysiological interaction effects between related and unrelated participants". Association 47th Annual Convention: Proceedings of Presented Papers, Vienna (67-76), 2004.

Chapter 19

Group Mind and Fluid Tribal Dynamics

The physical theory of group mind begins with some basic assumptions about oscillators and wave mechanics. If the mind is a resonant oscillator for processing information, and two oscillating minds can be synchronized through harmonic or resonant wave interference, then two minds entrained in a synchronized state should be able to pass information from one mind to the other. This theory sounds like potential telepathy, but the reality is more subtle and complex. The information that can be shared between oscillators is non-verbal and non symbolic; it exists in the realm of frequencies, wavelengths, and amplitudes. The most common information passed between entrained oscillators is synchrony testing and error correction, self-correcting mechanisms which maintain oscillator stability. Intuitive synchrony testing and error correction between two or more minds coupled in the same circuit is subjectively perceived as nonverbal communication, group mind, intuition, telepathy, or psi.

Examples of synchrony testing and error correction exist in all forms of communication. When information is flowing smoothly between oscillators, the data transfer has high speed and synchrony; when information transfer from one oscillator fluctuates and becomes ambiguous, the other instantly corrects to resolve the instability and regain synchrony. If automatic synchrony testing and error correction did not exist, any fluctuation in signal fidelity across the circuit would make the oscillator decouple. Synchrony testing and error correction can happen in a verbal conversation, a digital packet transfer, a cellular coding system, the harmonic chiming of bells, and so on. Synchrony testing and error correction allows entrained oscillators to retain stability through mutual feedback control, conserving or amplifying energy by phase locking into stable harmonic configurations. Individuals bound in a group activity use intuitive synchrony testing and error correction to maintain harmony through behavioral coordination and unitary cohesion.

Group Trance and Entrainment Technology

A practicing shaman must be a master of at least one ritual entrainment technology, and must be a master of putting himself and others into a targeted trance state; this is the bare minimum, the rest happens naturally. Some shaman simply provide total quiet and let the medicine do the work; some shamen put on elaborate shows which include singing, chanting, and live musical performance. The jam band phenomena started by adapting the dynamics of medicine drum circles to 1960s psychedelic party culture; hence the Grateful Dead and the growth of the Rainbow Family. In the 1990s the shamanic entrainment ritual was reduced to something as mundane as playing records on a loud stereo system with heavy bass, and this mundane task blossomed into the celebrity DJ profession which fuels modern global party culture. Any live performer can tell you that the feedback circuit between musician and audience fuels the energy of the performance, culminating in the moments when the performer and audience all sing the same chorus or move to the same beat in unison. It is the same with churches; it is the same with sporting events; it is the same with the military. When the audience participates in the performance, either dancing or clapping or singing in unison, it drives the amplitude of the entire circuit. This is spirituality, religion, and group transcendence reduced to wave mechanics.

There are two steps to entraining group mind. You must first demand focus of group attention, and then you must masterfully apply the entrainment technology; these rules are immutable and are the same for the hypnotherapist, the shaman, the musician, the salesman, the politician, the TV programmer, and so on. Demanding the attention of a large group of people is perhaps the hardest part, but the ritual entrainment technology can arguably be purchased at retail. In a club setting the focus of attention is commanded by the DJ, who applies prefabricated entrainment rhythms (dance grooves) to the crowd. When the crowd responds favorably to a specific groove by dancing with exuberance, the DJ rewards them by finding more grooves that fall into the same tempo, and then uses dynamic filters to isolate and boost the resonant frequencies of the walls in the room, pushing the music over the top with tremors that literally rattle the earth. When the DJ establishes a strong feedback control circuit with the crowd, there is phase transition where the crowd ceases to be individuals and they cohere into a single fluid unit. At this point the crowd becomes synchronized in audio-motor synesthesia with the music, almost like puppets (Fig. 25). The physical dynamics of a group of people engaged in trance dancing defies formal social descriptions and is best described as a coherent wave interference pattern.

Group Mind and Behavioral Phase Transitions

This spontaneous movement of a group of individuals into a coherent organism can be described in terms of phase transition from solid state to a liquid state of group dynamic. In the solid state there is ego, language, etiquette, social hierarchy, and rules of one-on-one engagement that keep individual identity separated and solid; in the liquid state individuals drop social pretenses and merge seamlessly into the flock, navigating instinctively via environmental cues and mutual feedback. When a group of individuals moves from a solid to a liquid state, there is a sense of transcendence that is subjectively perceived as joyful, cathartic, and spiritual. Subjects in a liquid group state feel unity, love, and purpose as the energy of the crowd flows through them like a transistor in an electrical circuit.

A similar example of social dynamics passing from solid to liquid state occurs in flocks of birds. On the ground birds assume pecking orders which create the dynamic for mating and nesting, in the air they become a fluid unit that navigates as a seamless whole. This social phase state transition is observable, repeatable, and may be measured generally in terms of global power across alpha bands of the entire group. In the ego-driven beta state the solid norms of society and hierarchy apply, but in the relaxed alpha state behaviors become more fluid and intuitive. In the beta state the individual is concerned only with fulfilling their own rational agenda; in the alpha state the individual moves seamlessly with the flow. When the tribe adopts a fluid social state it becomes a temporary autonomous zone for interpersonal experimentation, identity play, and other ego-blurring experiences that reinforce intimacy and group loyalty.

Informational Capacity of Group Mind

Shamanic mythology tells us that tribe members synchronized to group mind enter a telepathic dream-space where they can all share thoughts and visions. The sensation of bonding and becoming one with the group is real, but the level of telepathic ability achieved in group states is debatable. In a group trance the rational ego is detached and non-verbal intuition is fully engaged; empathy bonding is high and the hallucinogenic medicine turns group intuition into concrete visions. This enhanced non-verbal intuition can be called telepathy, psi, or a shared dream-space, but it would be wrong to assume that each member of the tribe is automatically sharing the same thoughts or visions just because they are all synchronized to the same hallucinogenic control wave or entrainment frequency.

The informational capacities of group mind are limited in a number of ways. Mutual feedback synchrony between peers coupled in group mind is nonverbal, local, and time dependent. At a distance peer and group coupling becomes weaker, and this coupling grows weaker the longer peers are separated by distance. Many traditional shamanic ceremonies recur weekly, or perhaps monthly with the phases of the moon. Shamanic ceremonies often employ the ritual of the medicine circle, a literal circuit of individuals bound in the ceremony for the duration of the ceremony. Breaking the circle in the middle of the ceremony is strongly discouraged, because energy shared and amplified in the circle can escape into the ether instead of staying within the group. Creating the sacred circuit on a recurring basis extends the power of non-local peer coupling over the periods between ceremonies, allowing for extended synchrony at a distance as long as the circuit binds locally or meets to synchronize at regular intervals. Recurring group circuits, such as shamanic ceremonies, church attendance, weekly business meetings, social clubs, and so on, reinforce instinctive behavioral cohesion and cross-expectations between group members.

Group mind can accurately be described as a form of distributed cognition, where the units of a group are coherently bound in a larger integrated system or process. From a distributed standpoint group mind is not literal telepathy, it is instead a form of cooperative thought emerging simultaneously as part of the coherent group process. Distributed functioning in the insect kingdom is commonplace; in the animal kingdom it takes the form of group movements like flocking, herding, and schooling, but sometimes emerges in more complex actions like hunting and stalking. The information shared in distributed tasking is limited to intuitive coherence of motor behavior to fulfill specific tasks and group functions. Behavioral cooperation and functional stability in group mind states is mediated through intuitive, nonverbal synchrony testing and error correction between coupled peers. In team sports and military operation, this highly intuitive group state is sometimes called being in "the zone."

Chapter 20

Shamanic Sorcery

Shamanic sorcery is the craft of manipulating the fabric of psychedelic space for personal gain or vendetta. Powers ascribed to shamanic sorcery include clairvoyance, spirit channeling, shape shifting, astral travel, remote viewing, curses, dream projection, magical darts, telepathy, mind control, necromancy, and so on. The shamanic ontology, or psychedelic spirit space, can be cynically viewed as a shared non-physical, non-temporal delusion accessible to any shaman as long as they accept the rules of the central ontology. In this way the shared shamanic ontology becomes fluid through space and time, and is magically manipulated and reinforced through ritual use of psychedelic drugs. In a setting where the shamanic ontology is readily accepted and reinforced, the shaman has great power; in reductive scientific settings that refute the shamanic ontology, the shaman appears to have an overactive guru complex and delusions of grandeur.

While PIT may appear to discount the claims of shamanic sorcery and spirit channeling, very few scientific studies have been done to either verify or refute the efficacy of psychedelic sorcery. A close reading of the literature on psychedelic discovery by the West reveals that scientists, therapists, and academics have rushed to exploit the power of native visionary ritual without properly considering the cross-cultural psychic backlash.[1,2,3,6] If the shamanic space is purely delusional then modern advocates have nothing to fear by exploiting traditional psychedelic ritual; but if the shamanic space is a transpersonal information field then it should also be considered a battlefield for waging information warfare. Modern advocates cannot embrace the entheogenic side of psychedelic spiritual communion while simultaneously ignoring the darker aspects of a truly transpersonal ontology. Like the internet, which allows peers to couple in unique ways, a shared shamanic network for sending and receiving information is also a vector for potential treachery and attack.

Sorcery and Nonlinear Influence

From a reductive standpoint, the shaman's magical influence is limited only to his tribe members, local neighbors, or those within his personal network; influence within this sphere is easy to account for in purely physical terms. From a metaphysical standpoint, the shaman is also said to be bound non-locally to all spirits and shamen in the psychedelic space regardless of physical or temporal location. The shaman is also said to be able to enter people's dreams, making the destabilized world of fleeting nocturnal visions like a global river for the shaman to navigate. These transpersonal claims are harder to account for in physical terms, and recent theory has attempted to tie the shamanic space to a non-local Akashic or morphogenetic field where non-physical spiritual or biological information is stored and transmitted.[4,5] A shared morphogenetic field should infer evolutionary advantage, but it also implies non-local vulnerability. Attack sorcery often requires a clipping of hair, a fingernail, a personal item, or a totem of the attack target. From a morphological perspective the sorcerer uses the genetic traces of these items as a resonating antenna to attack the target directly through the morphic field.

Under the influence of psychedelics, the shaman can hear the chattering of nonverbal information coming from the jungle, the city, the plants, the animals, and can intuitively sense the natural rhythms and cycles receding into the past and future. The shaman can blow a curse into the passing wind, or at a passing animal, and send magic darts on convoluted pathways towards enemies. From a nonlinear standpoint sorcery does not have to make rational sense. The placebo effect is a positive example of a nonlinear result that does not make rational sense; the same can be said for a curse that causes an enemy to suddenly fall ill. These results only make sense if you analyze them from a longitudinal perspective and follow the small periodic permutations of system variables as they produce disproportionately complex results through time; recovery in the case of placebo, or sickness and death in the case of a curse.

According to the fundamentals of Psychedelic Information Theory, the influence of shamanic sorcery can be presumed to be nonlinear, which means small periodic perturbations of system variables within a larger information system can produce disproportionately complex and chaotic results in any other part of the system. In the nonlinear psychedelic space the shaman is a chaos magician, or the butterfly that flaps his wings in China and creates a hurricane across the ocean. The nonlinear aspect of psychedelic sorcery makes it both a very subtle art form and something that escapes reductive scientific observation, but also makes it very prone to failure and lack of proper control. The weather is famously nonlinear, and one of the jobs of the shaman is reading and controlling the weather; this not a coincidence. PIT assumes that the study and mastery of nonlinear systems and emergent longitudinal complexity is a fundamental part of all psychedelic shamanism and sorcery.

Synchronicity Magic and Probability Collapse

Subjects in a destabilized nonlinear state often report enhanced sensations of non-random coincidence, or synchronicity, that appear to defy all rationality. Accounts of hidden forces acting in concert to send messages through non-random coincidence are common in psychosis, paranoia, schizophrenia, mania, bipolar disorder, and psychedelic intoxication. On psychedelics this state is dose dependent and increases in complexity with larger doses, until it appears the entire fabric of reality, down the subatomic level, is speaking directly to the subject with a singular narrative message. While in this "synchronicity hole," nothing in the universe seems random and all coincidence is laden with profound subtext that makes sense only to the subject. From a clinical standpoint, the synchronicity hole represents a state of delusional megalomania, yet this is exactly the kind of logic we should expect from a nonlinear analysis of reality. Linear analysis may perceive the leaves on a tree as a random distribution; a nonlinear analysis will see a singular non-random function underlying the genesis of complex form.

Subjective accounts of the synchronicity hole describe an immediate precognitive insight where probability appears to collapse and the subject intuitively knows exactly what is going to happen next. Another common description is that psychedelics open the mind to unlimited potential pathways into the future, and those potentials expand and collapse through time in direct response to the behaviors and will of the shaman. A shaman in this space is said to be able to look forward in time into many probable futures, and can choose any future simply by stepping into the vision and following the pathway that leads him there. By applying synchronicity magic and selecting non-random pathways into the future, the shaman expands and collapses probability and subtly alters the fabric of reality by choosing a new destiny. This process can be described in terms of deterministic chaos driving a superposition in subjective identity, leading to radical identity potentiation, behavioral change, and self-actualization through deterministic neuroplasticity.

Sorcery and Negative Information

According to PIT, shamanism is the craft of generating positive or stabilizing information within a larger matrix; sorcery is the craft of generating negative or destabilizing information within a larger information matrix. Negative information is any information which seeks to subvert or destroy parts or all of the larger information matrix. Examples of negative information at the biological scale include viruses, parasites, toxins, and cancers; at the personal scale negative information may include doubt, fear, stress, depression, abuse, neglect, trauma, and delusion; at the tribal level negative information may include dishonesty, distrust, withholding, disinformation, and warfare. When negative information is amplified with positive feedback, it can grow to destroy the entire system. Negative information can be countered with negative feedback, or dampened by positive information which seeks to bring stability back to the matrix. While a shaman uses psychedelics as a medicine or sacrament to heal and maintain tribal stability, the sorcerer uses psychedelics as a weapon to gain power over peers and attack enemies.

If shamanic sorcery is a kind of nonlinear chaos magic, it should also be considered to be somewhat unpredictable, uncontrollable, prone to high rates of failure, and potentially dangerous. Moreover, it is right to be suspicious of people interested in sorcery, which can be formally defined as negative information warfare waged for personal gain. Common wisdom dictates that when studying psychedelic shamanism one should learn under a *Maestro*, or master, who offers spiritual protection against black magic and sorcery.[3] While it is easy to dismiss these claims as superstition, the ambiguities and temptations of psychedelic sorcery have not been adequately addressed in the context of modern entheogenic ritual and clinical psychedelic therapy. Anyone experimenting in the field of psychedelic shamanism should be careful to avoid the dangers and temptations of sorcery.

Notes and References 20

1. Letcher A, "Shroom: A Cultural History of the Magic Mushroom". Faber, Great Britain, 2006.
2. Tindall R, "The Jaguar That Roams the Mind". Park Street Press, Vermont, 2008.
3. Beyer, SV, "Singing to the Plants: A Guide to Mestizo Shamanism in the Upper Amazon". University of New Mexico Press (October 31, 2009).
4. Oroc J, "Tryptamine Palace". Park Street Press, Vermont. 2009.
5. Sheldrake R, "A New Science of Life: The Hypothosis of Morphic Resonance". Park Street Press, Vermont. 1995.
6. Russell D, "Drug War: Covert Money, Power & Policy". Dan Russell, 1999-2000.

Chapter 21

Spirits and Spiritual Communion

Spirit contact is a central part of many psychedelic practices. While the autonomy of spirit entities is a subject for endless metaphysical debate, the reports of seeing spirits under the influence of psychedelics are common enough to make some generalizations. First, psychedelic entities are anthropomorphic interfaces through which psychedelic information is generated or transmitted. Second, formal spirit types represent idealized versions of specific information matrices: cellular, insect, plant, animal, ancestral, mythic, alien, pagan, machine, cosmic, and so on, and each type of spirit reveals different insights into the ordered nature of life and the universe. Third, psychedelic spirits are tricksters; they often speak in riddles, communicate in visual rebus and pantomime, and typically never give a straight answer to inquiries. From an information standpoint it does not matter if the spirits are real or delusion, the information they generate is real and can be analyzed from a formal perspective.

Habits and Customs of the Spirits

A study of the literature on shamanism and helper spirits tells us many things about their behaviors and habits. First, spirits do not generally like light; they will occasionally appear in the daytime, but they prefer to appear in dim light, at night, in an area illuminated only by candle or firelight. Second, spirits usually come only when you call them, only after you have called them, in the long moments of silence following the request for them to appear. Third, spirits do not like loud noises; keeping the entire local area perfectly quiet is the only way to ensure they will feel safe to appear. Fourth, spirits do not like foul smells, they are drawn to the perfumed scents of tobacco smoke and various types of incense, and are repulsed by the smell of meat-eating humans, alcohol drinking humans, and menstruating women; foul smells may actually summon harmful spirits or demons. Finally, some spirits require that the shaman grovel, chant, sing, and produce offerings before they appear; this is not always required but is common enough to be considered typical. To call in the spirits the shaman must respect all these customs while taking large amounts of the psychedelic medicine. The spirits will only come if the shaman calls them at the proper time and place, after he has dieted and purged, taken the medicine, and then burned enough tobacco or incense to make the scent of the area meet stringent requirements.[1]

The ritual for calling the spirits includes many telling details. Fasting and a low-sugar, low-protein diet implies physiological tuning for destabilizing metabolic homeostasis. The doses of hallucinogen taken in spirit communion are high, typically twelve or thirteen pairs of psilocybin mushrooms for traditional Central American ceremonies. Ritual intonation of calling in the spirits, or requesting for them to appear in chant or song, sets the initial conditions for the hallucinogenic experience which follows. Stillness, low light, and silence offers the best conditions for acetylcholine modulation of the midbrain associated with sleep onset, which is known to produce dream-like imagery. Tobacco excites cholinergic modulation of the midbrain. Incense excites olfactory reward centers in the midbrain; foul smells excite olfactory anxiety centers and naturally produce visions that are more demonic than angelic. Psychedelics interfere with smooth muscle contractions related to digestion and uterine cramping, making hallucinogen use potentially uncomfortable for menstruating women, and potentially dangerous for pregnant women. The final element in the ritual is having faith that the spirits will appear, which reinforces the intonation and expectation that they will. And, surprisingly enough, if you follow the ritual exactly and have faith, the spirits will appear.

Interfacing with Spirit Information

If the shaman follows ritual protocol, ingests the psychedelic medicine, and manages to summon the spirits, he should not waste time bothering them with mundane questions. The spirits will typically answer only one question or perform only one task, and that task should be considered urgent and worthy of their participation or they will promptly dismiss the shaman and will not appear again for the rest of the session, perhaps not again for many weeks or months. Spiritual dismissal is reported often enough to be considered typical, so the formal spiritual quality of being offended by mundane inquiries should be noted when attempting to access spirit intelligence. By all accounts, forging reliable relationships with specific spirit entities takes time and requires a fair amount of dedication to learning their habits and ways. The information in the spirit matrix should not be considered a database you simply plug into and access like the internet, but more like a network of individuals whose trust you must gain and keep over a lifetime in order to share their wisdom. Traditional shamen report that one of the worst things that can happen is for the spirits to stop appearing because the shaman has lost his power or offended them in some way. Staying on good working terms with the spirits is a core theme of shamanism and retaining shamanic power.

Gnosis, the All One, and Nonlinear Communion

Subjective accounts of psychedelic transcendence often include reports of a cosmic connection to a single unified force, a force which sometimes speaks to or through the subject. This force does not appear physically or anthropomorphically, but instead appears to be imbued in the fabric of all things. Typically the subject is meditating, is lying still, is engaged in breathing exercises, or has a similarly detached focus when the voice begins to speak. When this force speaks it is through a layered nattering and murmuring arising from seemingly random and unrelated background noises. In a destabilized state, these random background noises synchronize into a coherent pattern of linear, directed communication from one fundamental source. When the fundamental source energy senses the subject's heightened awareness, it begins to coalesce and speak through his or her mind. This voice typically introduces itself in the subject's language with the slowly repeating phrase, "I am the All One, all that is, was, and will ever be."[2]

The All One is subjectively perceived as the mind, consciousness, will, and intent of the physical universe. There is often a sense of reverence, love, acceptance, and unity infused with the contact. Formal accounts of communion with the All One date back to the origins of Hermeticism and Gnosticism, and depict a pantheistic, teleological view of the universe as the sacred physical body of an ever-evolving omniscient God. Formal accounts of the All One clearly depict the scale of timeless omnipresent omniscience we would come to expect from God. If we are to take the formal description of the All One literally, it can be implied that the voice of God is always present, constantly repeating and speaking through the sounds and rhythms of the natural world. There is only one requirement for communing with the All One; the voice is only accessible to people who have destabilized linear perception and can parse environmental data in novel, nonlinear ways.

In accounts of mysticism and madness, God only speaks to people in states of heightened destabilization: deprivation, psychosis, schizophrenia, stress, fever, dream, trance, and hallucination. Because of this it is easy to assume that hearing the voice of God is a symptom of insanity. According to PIT, when the brain destabilizes due to hallucinogenic interrupt, it will naturally seek coherence with the strongest local periodic driver. In some cases the strongest local driver may be the shaman, it may be the jungle, it may be the refrigerator, it may be the city, it may be the croaking of frogs and crickets, it may be a jaguar stalking in the distance, it may be Gaia, or it may be God. Another way to look at it is this: God is a timeless nonlinear being; in order to hear God's voice we must be able to achieve the stillness and silence necessary to perceive and parse longitudinal nonlinear input. Without debating the metaphysical existence of God, the formal techniques for subjectively communing with the All One are reliable and repeatable, and can be readily achieved through temporary, reversible destabilization of linear perception via psychedelic drugs.

Information Capacity of Spiritual Communion

A commonly repeated theme in spiritual shamanism is that spirits are fickle and their information should not always be trusted. This is perhaps a metaphor for all psychedelic information, or information revealed in a state of nonlinear destabilization. Common sense would dictate that if spirit information is unreliable it should be uniformly discounted as delusion or insanity, but subjective reports and clinical studies show that people find great value and utility in the information generated in psychedelic experience. Common sense also dictates that the information capacity of spirit information cannot exceed the existing knowledge of the subject, but subjective reports claim that psychedelic visions reveal new wisdom all the time. The overall information value of psychedelic shamanism is thus debatable.

Since no studies exist to validate the authenticity of psychedelic spirit information, it is impossible to estimate the actual information value. From a statistical analysis we can assume that nonlinear psychedelic information emerges into consciousness at speeds far greater than linear information, generating a large pool of abstract ideas in a very short period of time. Many of the ideas generated in a psychedelic session may be delusional or fantastical, but because of the sheer volume a small percentage of them are also destined to be insightful and genius. Within the flow of psychedelic information it is up to the subject to decide which bits are useful and which bits are not, and the trick of this disambiguation comes when attempting to translate nonlinear insight to linear concepts, beliefs, and behaviors. If nonlinear insights compress easily to linear concepts, then spirit information may be of high value; if nonlinear insights are confusing or defy rationality, then perhaps the spirits are up to their old tricks again. Either way, spirit information should always be carefully parsed and analyzed for trickery and deception before being acted upon or integrated into belief.

Notes and References 21

1. Akers B, "The Sacred Mushrooms of Mexico: Assorted Texts". University Press of America, October 10, 2006.
2. Accounts of communing with a singular universal force under the influence of psychedelics are taken from subjective reports. Direct quotes are paraphrased.

Chapter 22

Information Genesis and Complexity

The emergence of new information over time was the obsession of psychedelic philosopher Terence McKenna, and he popularized the term Novelty Theory to describe the phenomenon of increasing information complexity in the universe through time. In order to graph the emergence of novelty through time, McKenna created an occult formula based on the hexagrams of the I Ching, and charted a jagged line that starts at zero and tops out at infinity; what he called Timewave Zero. McKenna's observation that novelty appeared to be speeding up led him to believe that time was approaching a singularity where all information tops out at infinity, set to occur on December 21, 2012.[1] The infinite complexity McKenna describes is actually the opposite of a singularity (which is zero complexity), but McKenna's observations about novelty speeding up were essentially correct. Although many people have adopted McKenna's 2012 singularity meme, the occult construction of his Timewave and other aspects of his 2012 prophecy have left many unconvinced.

Psychedelic Information Theory approaches novelty and information genesis from a different perspective than McKenna. McKenna viewed novelty as a trend line that begins with the start of the universe and speeds forward from zero until infinity, which is accurate but is also misleading at the same time. McKenna also does not differentiate between types of information and the contexts in which new information emerges; this is also a problem. By blending all information together into a single trend line, it would appear that novelty is speeding up and will soon top out at infinity, but this trend line flattens out if you consider that information exists in various states, and that each state generates information at a more or less constant rate depending on state energy density.

To illustrate the fundamentals of energy density and information complexity I have created a table that delineates the emergence of quantum levels of information systems over time, and the type of information each system generates (Table 2).

Info State	Δ^n	Time of State Change	Information Type
Singular	Δ^0	+15 billion years ago	Singularity, no information
Fundamental	Δ^1	15 billion years ago	Force breaking, strong force, electromagnetism, gravity
Luminous	Δ^2	14.99 billion years ago	Cosmic radiation, light, heat, subatomic particles
Gaseous	Δ^3	14 billion years ago	Simple atoms, hydrogen, helium, galaxy formation, stars
Elemental	Δ^4	11 billion years ago	Heavy elements, star collapse, novas, spread of heavy matter
Organic	Δ^5	4 billion years ago	Complex molecules, organic chemistry, replication, plant life
Animal	Δ^6	500-50 million years ago	Nervous systems, connective logic, memory, consciousness
Technological	Δ^7	3 million years to today	Tools, symbols, art, language, manipulation of matter and energy
Post-Tech	Δ^8	Distant future	Post-terrestrial, AI, nonlinear time and space, n dimensions

Table 2. Emergence of information systems over time: Information emerges into the universe within formal stages, each stage marking a quantum leap in energy density and the speed and complexity at which new information is produced.

Since information is created by state change over time, I have used the symbol Δ (delta, as in delta-one, delta-two, etc.) to denote stages of information creation. Each stage in the matrix represents a quantum leap in the order of energy density and complexity of information being generated, and novelty creation in the universe accelerates with each of these quantum leaps. Each stage relies on the information created in the previous state to move forward with increasing physical density and complexity. This model takes into account the Big Bang theory and the best guesses of modern astrophysics and cosmology as to when each new information level emerged, but the story of information genesis in the universe goes something like this.

Starting at Δ^0 we have the pre-Big Bang singularity where all information is condensed into a single infinitely small point. There is no state change over time, so there is no information. Around fifteen billion years ago there was a Δ^1 state change we call the Big Bang, in which the uniform singularity breaks into the fundamental forces of physics: strong nuclear force, electromagnetism, and gravity. At this stage God says "Let there be light," and we have the emergence of cosmic radiation and nuclear fusion which allows subatomic particles to form, leading to a Δ^2 state change where simple hydrogen and helium atoms can stabilize; the first matter created from condensed particles of energy. The gravity drag on this new mass allowed a Δ^3 state change where globular clouds of gasses clump and then collapsed inward, creating spinning galaxies of exploding stars fueled by nuclear fusion. When stars begin to exhaust their energy and collapse inward, there is a Δ^4 state change that allows for the creation of all the denser elements on the periodic table that can store more cosmic energy within a single point, or an atomic nucleus, which is comprised of particles of compressed energy.

The Δ^4 state represents the galactic preconditions necessary for life as we know it - the "firmament" - and in order to create the dense elements needed for life you need the fundamental forces of physics (Δ^1), an energy radiation source (Δ^2), the formation of simple gasses (Δ^3), and billions of years of nuclear fusion (Δ^4). At each stage you have a modest increase in the complexity of physical interactions which allows for new information genesis, but at the Δ^4 stage following star collapses and supernovae, we finally have the raw materials for terrestrial formation: heavy metals. A glob of heavy metal orbited our local star (the sun) and cooled to form a solid planet. As our planet cooled, liquid water formed on the surface and oxidized the metal on the outer crust, creating the nutrient-rich salt-water conditions for a Δ^5 stage change in the formation of complex molecules held together on strands of charged hydrocarbons. This marks the beginning of life.

The Δ^0 to Δ^4 information states are pre-organic and are therefore only interesting to physicists, astrophysicists, and mathematicians, but the Δ^5 information matrix is the matrix that chemists and microbiologists study; it is the study of the conditions in which energy is stored and transferred through molecular bonds. When shamen and mystics tap into the web of life and the primal force that connects all living things, they are tapping into the Δ^5 information matrix, which is sometimes described as an invisible electromagnetic field which permeates all creation, or the invisible landscape. The visual representation of this living energy field is most acute under the influence of tryptamine hallucinogens such as psilocybin and ayahuasca (DMT), and the source of this field is often perceived to be divine in origin, leading to many interesting speculations about spirit realms, Akashic fields, morphogenetic fields, and the like. Whether or not tryptamine visions are accurate representations of the electromagnetic field is a matter for some debate, but the overwhelming number of subjective accounts make the appearance of this field difficult to deny.

The Δ^5 matrix is the matrix which sustains our life; it is at work in our cellular functioning and metabolism right now. The Δ^5 matrix allows for the creation of new information at a rate that far exceeds previous information stages, and information genesis at this stage happens at the level of nucleotides, DNA, RNA, enzymes, proteins, and the organic chemistry of replication, proliferation, mutation, and Darwinian selection. Life excels at taking inert matter and organizing it into more complex forms, and in a few billion years life evolves from single-celled organisms to complex animals, representing a Δ^6 state change that allows for the development of motor nervous systems and rudimentary organism consciousness. The Δ^6 matrix relies on the Δ^5 organism matrix for cellular energy and nutritional support, but it represents a state change because the information stored in the Δ^6 matrix is neural, connective, and allows for internal storage of external state properties (or memory) at the organism level. The same connective neural network needed to control muscle behavior while navigating the external world is adapted to store memories of the external world for later use, and this internal neural storage increases organic information complexity from simple cellular organization into connective representational and symbolic logic.

The Δ^6 state change marks the most important quantum leap in the entire information chain because at Δ^6 organisms begin to internalize external data into personal connective networks. With the development of animal consciousness, the universe begins to map properties of the physical world (objective information) into connective logic stored in brains (subjective memory). Information in the Δ^6 state flows intuitively through animals in the alpha state, the tribe mind, the hive mind, and the fluid pack. The Δ^6 information matrix is semiconscious, instinctual, and routine; it is where nonverbal intuition, habitual behavior, and psychic bonding occur.

After hundreds of millions of years of animal life there is another state change brought about by evolution and morphology, the early primate adaptation of the fine finger dexterity needed to use tools. The ability for an organism to incorporate an external tool (like a rock or a stick) and a specialized skill (like throwing or pounding) into daily behavior heralded the age of technology, and with the Δ^7 state change came a corresponding shift in the speed and complexity of technological information which grows ever faster and more complex to this day. From sticks to fire to wheels and alphabets and machines and computers, hominids have excelled at incorporating information into their brains, rearranging it, and using it to externalize new information and technologies. The story of Δ^7 information genesis is the story of human culture itself, the organized spread and control of information through hominid tribal groups leading to power, civilization, empire, and industry.

The Δ^7 information matrix represents another quantum leap in information genesis, storage, and transmission. The logic networks created by internalizing reality in the neural Δ^6 matrix are used to create new information which is externalized in the form of technology, language, art, media, and invention. The Δ^7 information state is the realm of language, logic, critical thinking, science, and rational analysis. Modern culture cherishes the Δ^7 information space above all others, this is the space where the tools of mythology, religion, politics, and mathematics emerge. The Δ^7 information space occupies an ego-driven, distracted, beta state of critical self-awareness. Like charged particles seeking to find electromagnetic balance, the human in the Δ^7 state will seek to correct or improve perceived problems with external reality via subjectively controlled ingenuity. Total mastery over the subjective manipulation of matter and energy is the ultimate goal of the Δ^7 information state, the state humans have almost perfected. Now that we have the internet, supercolliders, nanotech, and atomic bombs, all of these technologies seem to herald another quantum information state change in the near future.

The Singularity and Post-Technological Matrices

The Δ^8 information state can be called the post-technology state, and much like McKenna's Timewave Zero, the technological Δ^7 information matrix must eventually top out with the end of science and the complete integration of all physical forces into human technology. This seems like it is happening quickly, but going by trends in previous state changes the singularity isn't likely to happen for another fewhundred-thousand to a million years from now. Though it is currently impossible to imagine what a Δ^8 information space might be like, subjective control over the very fabric of space and time may become possible, allowing something like personal access to space travel, time travel, alternate time streams, and/or an infinite number of parallel dimensions. From the perspective of a Δ^7 information state, a Δ^8 state change would look like subjective human information topping out at infinity; Δ^8 consciousness will have instant access to everything there is to know about humans, technology, the universe, and whatever lies beyond. I believe this Δ^8 state transition is what McKenna perceived in his novelty wave as the end of information.

If we are to follow the permutations of information complexity to date, it is logical to assume that the technology created in the Δ^7 matrix will directly contribute to the fundamental state variables needed for a Δ^8 state change. This can be interpreted to mean that machine code is the next level of information energy density and computers will drive complexity and information genesis into the Δ^8 state. Perhaps this transition is already underway, and is approaching a quantum leap in technology where computers begin generating information and complexity for their own purposes. Only time will tell if this is the case, but in a few hundred thousand years it is conceivable that machine intelligence will be ubiquitous throughout the galaxy, and the end-point of our technology will become the initial conditions needed for the evolution of a more durable and complex matrix.

Shamanism and Information Matrices

When a shaman enters the trance state and searches for new information, there are specific levels of knowledge which are more helpful than others. For instance, when entering group mind with the tribe, the shaman will want to access a pre-technology Δ^6 information matrix where primal animal consciousness, non-verbal communication, and pack bonding instincts are strongest. If the shaman wants to commune with plant intelligence he will enter into a Δ^5 matrix of cellular metabolism and genetic expression; this is also where the shaman will diagnose disease and attempt healing by visualizing and diverting the flow of metabolic energy through the patient's cells with bodywork and sound. Some shaman may also commune with the more cosmic levels of awareness, but shamanism is essentially a Δ^7 technology used by Δ^6 organisms to access information available in Δ^{0-5} matrices; information which is always present but is normally invisible or beyond the limits of human perception.

Notes and References 22

1. McKenna T, "The Invisible Landscape". Harper, San Francisco, 1993.

Appendix 01

Conclusions and Discussion

Conclusions

The primary tenets of Psychedelic Information Theory dictate that hallucinogens generate information by destabilizing linear perception to promote nonlinear states of consciousness; that these states amplify initial conditions provided by set and setting; that these states increase in nonlinear complexity in response to dose of hallucinogen, duration of effect, and strength of sensory stimulation; and that the depth or complexity of psychedelic hallucination can be controlled through pitch-timed, rhythmic, or periodic sensory feedback stimulation.

The tenets of the Control Interrupt Model dictate that top-down feedback control of multisensory perception must be destabilized before consciousness can bifurcate, become nonlinear, and generate hallucination; that the destabilizing interrupt of any hallucinogen can be felt subjectively as a periodic pulsation or interference pattern in the range of human sensory temporal aliasing; that sensory complexity or animated progression of hallucination iterates along the frequency of the periodic interrupt; that each hallucinogen has a distinct sensory interrupt frequency and ADSR envelope based on its affinity and selective agonism in sensory binding pathways; and that the unique interrupt and ADSR envelope created by each molecule is responsible for its unique hallucinogenic patterns and multisensory signatures.

The tenets of Shamanism in the Age of Reason, or Physical Shamanism, dictate that a shaman can intuitively sense the interrupt frequency and ADSR envelope of any hallucinogen simply by ingesting a small amount of the substance and paying close attention to the interference patterns created in perception; that shamanic *icaros* or standing vocalizations use harmonic interference to drive or dampen the amplitude of hallucinogenic interrupt; that driving the amplitude of hallucinogenic interrupt increases depth of iteration and complexity in nonlinear information organization; that shamanic dieting and purging is a precursor to destabilizing metabolic homeostasis necessary for holistic nonlinear re-modulation; that bodily transcendence relies on full nonlinear amplification along all cellular signaling pathways, from the gut to the cortex; and that full nonlinear breakthroughs, or psychedelic peak experiences, are only achieved once top-down homeostasis is fully interrupted and the subject releases all inhibitory feedback control over the resulting emergent process.

The basic conclusions taken from the tenets of Psychedelic Information Theory, the Control Interrupt Model, and Physical Shamanism are as follows.

1. Psychedelics generate information in the human organism via nonlinear feedback amplification of both intercellular (neural) and intracellular (cytoplasmic) signaling mechanisms.
2. The nonlinear amplification of sensation exploits excitatory feedback mechanisms used to create lasting emotional attachments to salient sensory patterns in the wake of strong incoming stimulus.
3. Psychedelic hallucination and expanded states of consciousness represent nonlinear amplification of initial conditions of biology, perception, memory, behavior, and location, otherwise known as set and setting.
4. Nonlinear amplification of sensation promotes neuroplasticity and cellular regeneration via hormonal and stress-based mechanisms related to cell proliferation and long-term memory consolidation.

5. Periods of chaotic transition between multi-stable states of consciousness are subjectively perceived as disorienting, confusing, and uncomfortable. Periods where chaotic transitions approach strange attractors and phase-lock into multi-stability are subjectively perceived as ecstatic, beautiful, spiritual, insightful, cleansing, healing, and transcendent.
6. Extended periods of iterating complexity in cellular networks leads to states of consciousness perceived as enlightening, mystical, infinite, god-like, timeless, Gnostic, and omniscient.
7. Resistance to nonlinear destabilization under the influence of psychedelics results in anxiety spirals, panic, and potentially paranoid and psychotic states.
8. There is an optimal dose range for any hallucinogen where states of nonlinear organization and strange attractors spontaneously emerge. Moving beyond the optimal dose range results in highly unpredictable, uncontrollable, and problematic states of consciousness resembling psychosis and schizophrenia.
9. States of nonlinear organization in neural networks can be stabilized through energetic periodic drivers, such as music, singing, chanting, and dancing; making psychedelic consciousness multi-stable along a range of complex output.
10. Through entrainment and mutual feedback, nonlinear states of cellular signaling can transcend individuals to promote pack mind, group mind, peer bonding, mate bonding, and spontaneous nonverbal organization of tribal or familial structures.
11. Shamanic healing, entheogenic transcendence, and psychedelic creativity all utilize nonlinear amplification to generate novelty in the form of spontaneous energetic organization in cellular signaling systems.
12. Because psychedelics produce uniquely nonlinear states of consciousness, any art which evokes recurrence, chaos, and nonlinear forms will be immediately recognizable as psychedelic.
13. Nonlinear forms are perceived to be inherently beautiful and spiritual because they are isomorphic of ordered complexity in the generative processes of biology and nature; thus psychedelic hallucination is perceived as inherently beautiful and spiritual.

Discussion

The fundamentals of PIT were assembled through formal analysis of hallucinogenic states, shamanic ritual, and subjective reports of expanded consciousness. PIT is a general theory, which means it seeks to model an approximation of psychedelic information complexity emerging into human consciousness and cultural memory. PIT applies existing physical models and mathematical concepts like wave mechanics, coupled oscillators, and deterministic chaos to the processes of perception and consciousness. Some components of PIT's general theory can be easily modeled with mathematical or mechanical counterparts; other components are assumed or presumed from observation and published research; and other components are pure speculation or are left purposely vague due to lack of proper corroborating research. Some of these assumptions, speculations, and missing pieces are discussed here.

First and foremost, PIT assumes that the human brain acts as a resonant oscillator, and that consciousness is the result of time-synchronized interference patterns of recurrent neural spike trains cascading through the neocortex. This is not a radical model, it is based on the fundamentals of neural oscillators, periodic drivers, wave entrainment, resonance, and coherence. Entrainment is the capacity for one oscillator to synchronize the frequency of a group of oscillators; resonance is the capacity for one oscillator to drive the amplitude of another oscillator; coherence is when two oscillators phase-lock into stable resonant or harmonic interference patterns to conserve or amplify energy. Classical wave mechanics and the behaviors of feedback coupled harmonic oscillators are the starting point for almost every new concept introduced in PIT.

The Control Interrupt Model and Physical Shamanism both invoke resonant wave interference as a means of producing coherent patterns of nonlinear organization in oscillating systems. Using sound or vibration to produce spontaneous organization of matter is also known as cymatics, which can be demonstrated with sand on a vibrating steel plate. As the steel plate vibrates at various resonant frequencies, the sand will spontaneously move from chaotic to organized patterns, also known as Chladni patterns or nodal patterns (Fig. 31). Cymatics is an example of oscillating systems finding stability at normal modes. Modal vibration can be characterized by period doubling or halving a system's fundamental frequency to create harmonic interference at one of many possible resonant frequencies. This is a mathematical concept that applies to music, coupled oscillators, modal theory, quantum theory, standing waves, and so on.

Analyzing the brain, perception, and consciousness as a single standing wave or resonant oscillator is a very crude simplification of much more complex sensory process, but the general models of feedback control, destabilization, and chaos apply universally in all oscillating systems. Framing the discussion of psychedelics and shamanism in terms of the nonlinear dynamics of resonant oscillators may not shine light on the entire psychedelic experience, but it provides a comprehensive and succinct formal approximation of perceptual complexity generated in expanded states of consciousness, which is the ultimate goal of PIT.

By invoking stability and chaos in perceptual networks, PIT also assumes there are specific organized-chaotic states of psychedelic consciousness that act as strange attractors to pull perception towards multi-stable convergence points. PIT also implies that resonant periodic drivers, such as shamanic singing or drumming, can entrain, stabilize, and amplify convergent multi-stable psychedelic states, or equilibrium states, to induce healing, transcendence, and group mind. However, PIT offers no specific descriptions of precise shamanic frequencies or equilibrium states as practical evidence of this theory. Because the published research in the field of psychedelic brain scanning is limited, the assertions of shamanic entrainment and multistate phase locking are speculative and based solely on subjective reports and observation of the dynamics of shamanic ritual. PIT provides no formal definition for what a multi-stable psychedelic state looks like on a scanning device compared to a normal state of consciousness, nor does it say where or how one should scan for the best statistical indicators of such states. This is an issue that can only be resolved through statistical analysis of many controlled psychedelic scanning sessions in the presence of live music or shamanic ceremony compared against sessions of meditation or trance dancing. It may be decades before such research becomes available, and even when it is available there is no guarantee it will be conclusive enough to distinctly target specific mystical states.

Because psychedelics are non-specific amplifiers and can produce multiple outcomes based on initial conditions of dose, set, and setting, the concept of scanning brains to provide a single unified definition of an expanded state of consciousness may be inherently flawed. Psychedelics can induce trance, catatonia, hallucination, psychosis, paranoia, mania, hysteria, and euphoria all in response to unobservable conditions in dose, set, and setting, so they are demonstrably capable of inducing many complex states of altered consciousness. Psychedelic amplification of perception is observably nonlinear in the form of fractal hallucinations, and the nonlinear amplification of perception is observably tied to size of dose of hallucinogen and strength of incoming stimulus. A model where strong sensory drivers can entrain multistable states of nonlinear psychedelic consciousness is a small extrapolation of these simple observations. Technically, any song or chant produced by a shaman should entrain an organized psychedelic state along a range of chaotic, stable, and multi-stable output. Studying the biofeedback equilibrium effects of spontaneous shamanic vocalization (*icaros*) in a live group setting may be the best starting place for examining tones and frequencies for driving attractor states for each hallucinogen at each dose range. Isolating which songs are best for producing which states at which dose range may ultimately be more of an art than science, relying less on statistical research and more on the shaman's intuitive grasp of all the sliding state variables unique to each psychedelic session.

The conclusion of PIT is that attractors, or multi-stable convergence points in expanded consciousness, do exist, that they are physical in nature, and that when a subject locks into these states they are nothing less than magical. Finding the sweet spots in neural oscillator coherence where consciousness diverges and becomes exponentially complex may be elusive, or may involve different indicators for each individual. General nonlinear dynamics suggests that expanded states of consciousness may be achieved by entraining limit cycles of perception into period doubled bifurcations of normal output, with each period-doubling preceded by some critical sensory stimulus or spiking activity required to drive the phase transition. This driving action also describes the dynamics of entraining stable or self-sustaining limit cycles in a forced Van der Pol oscillator, which is one of the simplest and earliest demonstrations of deterministic chaos in physical systems. Although first applied to electrical circuits, the Van der Pol equation can also be applied to social and theoretical constructs, like species reproduction or the dynamic effects of repetitive marketing on brand goodwill. Mode locking into period doubled or reverse period doubled stability is the general model of state bifurcation in dynamical systems (Fig. 30), though applying a simple nonlinear circuit model to perception raises some processing questions. If perception can jump limit cycles and bifurcate into analyzing multiple simultaneous frames along the order of 3-to-4 times, moving from aliasing 2 frames to 4, and then to 8, and then to 16 simultaneous frames, where does the extra frame aliasing power come from?

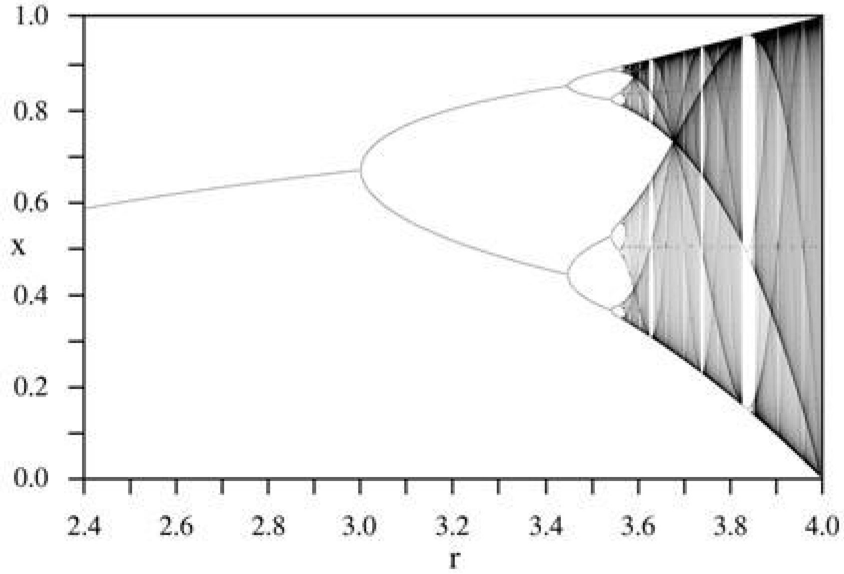


Figure 30. Period doubling bifurcations in the logistics map xn+1 = rxn(1 - xn). The form recedes with self similarity as periods of chaos are followed by periods of convergence and stability. From WikiPedia, Bifurcation Diagram.

The Frame Stacking Model assumes that periodic doubling of frame complexity does not necessarily require a full linear doubling of energy input, but is instead the result of iterated mapping, or nonlinear feedback amplification driving novel re-organization, or phase transitions, through states of chaotic interference and harmonic convergence. For instance, a video camera falling into a chaotic feedback loop does not require extra energy for the transition to stacking multiple receding frames, but the feedback process quickly overwhelms the camera's detail rendering as receding frames over 16 layers deep begin to smooth together in stable interference patterns, or strange attractors, converging on archetypal images of fractal curves, kaleidoscopes, concentric mandalas, galactic vortexes, infinite tunnels, DNA spirals, ascending staircases, and so on (Fig. 24).

Where and how these nonlinear phase transitions occur in human consciousness is still a matter for some speculation. The best evidence indicates that psychedelics promote sensory saturation at the apical dendrite columns of the neocortex, leading to destabilization in recurrent thalamocortical and corticocortical binding pathways. Frame stacking may also be related to receding frame detail being sustained and looped through recurrent circuits between the PFC, basal forebrain, and midbrain. Delaying neutralization or period-doubling saturation intensity in these recurrent mid-brain circuits could lead to frame-feedback or sustained frame echo with high perceived salience. It may seem logical that psychedelic action is localized in the brain, but given the distribution of 5-HT receptors and the indiscriminate nature of ligand binding, it is reasonable to assume that psychedelic amplification in cellular signaling networks is both global and globally coherent. Tracking the physiology of temporal frame aliasing, frame neutralization, frame repetition, and how these sensory mechanisms are exploited by working memory, learning, dreaming, and psychedelics is an area ripe for further exploration.

Finally, the frame model of perception forwarded in PIT is only an approximation of actual perception. While the frame model allows us to put a distinct limit on the rate of human temporal aliasing (roughly 15 frames per second), there is evidence that humans can track multiple moving layers in any single frame. Instead of updating in perfect frames like a film reel, perception is more like a compressed MPEG video or an animation that updates a full keyframe whenever the eyes blink or move, and only makes minor layering changes in between each keyframe. For instance, if you are standing in a grassy meadow watching a bird fly through the air, your brain does not need to update the entire frame of the meadow to track the bird, it only needs to update the layer with the motion of the bird. In this way the brain conserves energy and saves state information for those areas that do not need constant updating, and only updates the entire multisensory frame every few seconds or so, such as when you blink or shift your focus. This motion-sensitive updating of non-essential background noise is most evident in Troxler's fading illusion (Fig. 5).

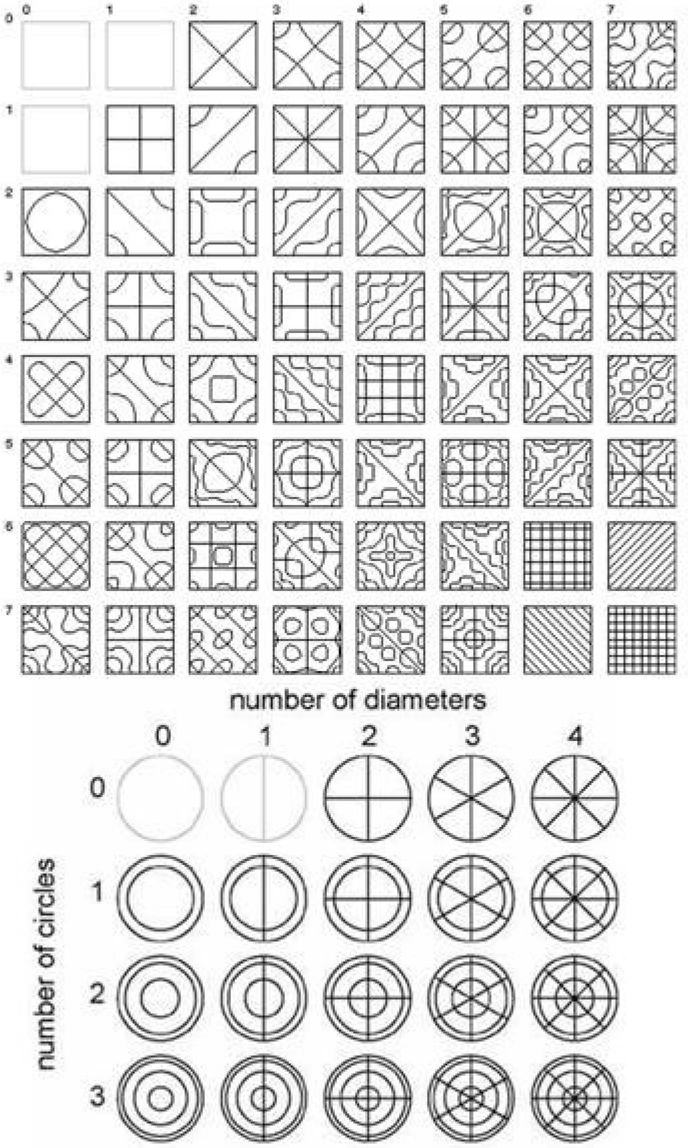


Figure 31. Chladni figures for a square steel plate (top) and a circular plate (bottom) demonstrate the variety of standing wave patterns generated in simple resonating systems. Examining the physical properties of standing waves in resonant systems is also called cymatics. Archetypal forms generated in both rectangular and circular plates are isomorphic of flicker phosphenes seen at various frequencies of light pulse stimulation, and have been reproduced in textile patterns, ceramics, and sacred mandalas since roughly 10,000 BCE. From Lehar, 2010.

Tracking multiple layers for each frame adds another level of complexity to the simplified Frame Stacking Model, and may suggest how psychedelic perception can become kaleidoscopic as radial sections in the visual field mirror themselves, stack, drift, and merge together. Because the update and release of perceptual layers in both multilayered or radial frame filling methods still falls under the classification of temporal aliasing and filling, the general models of PIT would still apply regardless of the morphological or geometric nature of the perceptual bifurcation. The Control Interrupt and Frame Stacking models are provided as very general meta-level descriptions of how psychedelics may subvert temporal aliasing and filling to produce nonlinear feedback and self-sustaining hallucination. While PIT has been focused primarily on visual sensory networks, these models can be applied to the layering and splintering of any subjective sensation of self or reality. The specific pharmacological and neural models underlying these general concepts are more complex than can be detailed in this text, but are sufficiently well understood to make good approximations supporting PIT's claims. Since PIT was designed to be general theory, even as our understanding of perception and pharmacology changes, the general assumptions forwarded here should still apply to all known types of hallucinogenic experience.

Appendix 02

Informal Discussion of Topics

The following is an interview-style discussion of topics presented in *Psychedelic Information Theory* with the author, provided as a summary and general overview of theory for the non-scientific layperson.

What is Psychedelic Information Theory?

The general theory underlying all of PIT is that psychedelics create information when introduced to human neural networks. The spontaneous creation of new information is the essential function of psychedelic activation, and this new information is imprinted into memory and reproduced as music, art, or stories shared with other people. More specifically, PIT presents physical models which describe this generative process, and the dynamics of various psychedelic phenomena like complex hallucination, shamanism, and group mind.

How does PIT describe psychedelic action?

One way to visualize what I'm describing in PIT is through what I call the "Pond and the Pump House" metaphor. Imagine a perfectly round pond with perfectly still water, with a small pump house sitting on an island in the center. When the pump house is turned on it sends out perfectly circular ripples through the water that, over time, create a neatly ordered standing wave of activity. In this metaphor the pond is the surface of the neocortex; the pump house is the body, heartbeat, and respiration; and the ripples are waves of sensory perception seen in an EEG reading of cortical activity. When the pump is on and moving at different speeds, the ripples on the surface of the pond are active and take on different coherent patterns; when the pump is turned off the ripples fade and the pond becomes still and quiet. These are metaphors for consciousness moving from waking to sleeping states.

Now imagine we add a psychedelic to this model. PIT proposes that psychedelics alter the wave patterns of consciousness by creating a tiny tremor under the pond that vibrates the entire structure. Adding the psychedelic to the system creates a competing standing wave that can be seen immediately in the ripples on the surface. The pump keeps pumping, creating its usual standing waves, but because of the tremor there is a new layer of complexity to the ripple patterns. The tremor adds energy to the system, and as it does the standing waves in the pond become more chaotic. Instead of simple coherent ripple patterns, you begin to see overlapping patterns and fast transitions between multiple standing wave states. The complex interference patterns overlap on themselves and exhibit the formal qualities of nonlinear feedback system, such as fractals or cellular automata.

The interference pattern in the ripples of the pond described here is how PIT models a competing tryptamine agonist (a hallucinogen) in the finely timed aminergic system of perception, modulated by serotonin and dopamine. This complex interference pattern is what I am describing with the Control Interrupt Model of psychedelic action. According to PIT, each hallucinogen creates a slightly different tremor or vibration in the signaling pathways of multisensory awareness, which in-turn creates a unique and distinct interference pattern in the standing waves of perception. Some hallucinogenic tremors may be big and rolling, others may be quiet and subtle, others may be sharp and disruptive. The difference in tremor speed and feel created by each psychedelic molecule would be accounted for by the differing receptor affinities and metabolic pathways for each hallucinogen.

How do psychedelic interference patterns relate to the techniques of shamanism and psychedelic therapy?

Let's go back to our pond metaphor. Assume there are sand dunes created at the edges of the pond that correspond to the long-term memory of the standing wave patterns created by the pump house. If you check these dunes after each psychedelic tremor you might find new tiny fractals, spirals, curves, cracks, and filigreed patterns etched into the sand. These sand etchings correspond to the memory of the psychedelic experience now embedded in the patterns of the neural network, and these memory patterns then inform behavior, change beliefs, and are presented over and over again in art, music, and philosophy. That is a metaphor for transformative psychedelic therapy.

Now let's assume there is a tribe of people living at the shores of this pond, and this psychedelic tremor hits once a week. It would be perfectly reasonable to assume that these people would adopt the psychedelic sand patterns as a kind of tribal identity, and embed those patterns into their clothes, tattoos, face paints, pottery, and so on. This is exactly what tribes who take psychedelics do; they embed the colorful fractal patterns created on the surface of their brains onto the surfaces of their bodies, their artwork, their walls, and their world. The physical spilling over of complex psychedelic patterns from a single underlying ripple effect is the foundation of PIT. Psychedelic Information Theory studies the movement of complex information from the genesis of initial hallucinogenic interference pattern to the outward organizing effect on belief, personality, behavior, and tribal structure.

Now, to go one step further, assume that whenever the psychedelic tremor strikes, the tribe of people living at the shores all gather in a circle and begin to sing, or stamp their feet, or beat large drums in unison. The songs produced by the tribe will naturally fall into harmony with the tremor and begin to shape the ripples in the pond through harmonic interference. Over time, if the tribe sings loud enough, they will produce a standing interference pattern, or group hallucination, in the ripples of the pond. This can be described as a shared state of consciousness locked through a standing resonant feedback wave. Shaping interference patterns in consciousness through singing or resonant feedback describes the basic ritual techniques of psychedelic shamanism. Through resonant feedback the shaman and the tribe can master the nonlinear dynamics of the interference pattern to work various forms of magic on the surface of the pond.

The Control Interrupt Model reduces hallucinogenic action to a high speed sensory attack and decay envelope. Why did you decide on that model?

While studying the effects of various hallucinogens, I would always notice a carrier wave, or a high-pitched frequency, or a pulsing, or a throbbing, or a tingling, or some kind of stable interference that was familiar to that substance. And after studying various trip reports for various substances, I realized I was not alone in recording these simple observations. This stable interference is often reported to permeate all sensation; touch, hearing, vision, the entire body. I began to measure the frequencies of these pulses and tingles for different hallucinogens and realized that they all fell into alpha and beta states of consciousness, between 4 to 30 pulses per second, and each drug had a slightly different timing and feel to the way the pulses came on and interrupted consciousness. The slower the interruption, the more of a throbbing or stuttering I felt; the faster the interruption, the more of a tingling, vibration, or high-pitched tremor I felt.

At some point in my analysis of different drugs, I would always say, "That stable interrupt frequency is interesting, I should take a closer look at that," or, "Isn't it weird that I always feel this throbbing on this specific drug, which feels very similar to the pulsing I noticed on this other drug." And then as I began analyzing that one simple pulse interaction, I wondered if pulse interruption in frame perception was all that was needed to produce hallucination. Mind machines produce phosphenes within a small range of light pulse frequencies, so what if hallucinogens did something similar in the same pulse range? What if those pulses were the drug's only action, and the throbbing was the perceptual aggregate of modulatory interference at sensory binding junctions? During the process of formally describing the action of these pulses, it became obvious that the pulsing interference was a carrier wave for hallucination, like the flickering frame rate of an animation reel. The pulses created an overlapping hallucinogenic flicker, or an overlapping modulatory ripple, in multisensory awareness, that creates the chaotic substrate for complex hallucination. It was an extrapolation of psychedelic pharmacology that scaled up to make sense in gross perception, which was the exact kind of model I was looking for.

The more I analyzed the various properties of the flicker or pulsation for each drug, the more I realized that this specific pulsing function was the thing that caused each drug to produce unique geometric hallucinations, like Chladi forms taking on different standing wave patterns on steel plates resonating at different frequencies. I then realized that each hallucinogen could be modeled with a unique interrupt frequency and properties of saturation attack, decay, sustain, and release (ADSR) to describe the onset and feel of distinct hallucinations. An ADSR envelope is a wave modeling technique used in electronic synthesizers to shape the tones and sounds of various musical instruments, but can be used to model the "voice" for any standing wave. The ADSR envelope for each hallucinogen corresponds to receptor agonism and affinity, which naturally shapes the tone and feel of each hallucinogen's unique sensory patterns. After reducing hallucinogenic action to a function of wave interference in perception, it was then only natural to extrapolate hallucination as a cascading event that starts with a small, stable, perturbation in perceptual feedback that grows in amplitude over time to entrain the functional output of the entire system. This model does not rely on anything other than targeted receptor agonism to drive the resulting emergent process.

Why is a wave model of psychedelic action better than traditional shamanic models?

One of the core concepts of physics and science is that every physical interaction can be modeled in discrete packets of energy transfer, and these discrete packets can be statistically interpreted as waves that have formal characteristics of amplitude, frequency, coherence, decay, and so on. This allows a system to be described by predictive physical or mathematical models. Once you break any physical interaction down to a formal wave model, you've essentially described the functionality of the system and can make accurate predictions. Traditional shamanic models are not interested in this level of reductive analysis, but modern science is. PIT fills in some of the formal pieces needed to place techniques of traditional shamanism within the domains of physics and mathematics.

Doesn't reductive analysis take the mystery or artistry out of entheogenic transcendence and shamanism?

There has been a schism in shamanic thought where the drugs have been studied with a reductive pharmacological paradigm, yet the technology of shamanism is still stuck in anthropological or spiritual paradigms. What I am trying to say with PIT is that there is no schism; psychedelic action and shamanism are both fields of physics, they can both be described by physics. This is not a reductive model, it is a unifying model that knits the fields of pharmacology and shamanism together through classical wave mechanics and harmonic theory.

A similar way to look at it might be this. Imagine you were a guitar maker, and you knew precisely how long the neck of the guitar should be, and how tight each string must be, and where each fret must go, and what shape the body should be, all to produce the best and most resonant musical sound. This is an engineering task that can be described by mathematics and harmonic wave theory. However, picking up the instrument and using it to play music that moves people to joy or tears is a process will always be mysterious and artistic. Nothing has been taken away from the artistry of the musician by describing the harmonic theory at the foundation of the instrument. If anything, the harmonic theory allows the guitar maker to produce a better instrument and the musician to attain better mastery.

How do psi phenomenon like telepathy and group mind tie into PIT's harmonic wave model?

You can think of non-verbal communication betweens tribes of humans in terms of group coherence, like the swarming of insects, schooling of fish, or flocking of birds. For most daily interactions we keep ourselves separated as individuals, but for certain activities we drop into a cooperative mode where identity is less important than fluid or harmonic movement within the pack. In humans this can be seen in team sports like soccer or basketball, in the coordinated movements of military squads, in group dancing, or in the intuitive rhythms of lovemaking. Locking into harmonic coherence with another human or group of humans is subjectively felt as nonverbal communication or psi, sometimes reaching the level of telepathy, or instantly knowing what the other person is thinking. Again, this kind of process should not be analyzed within the fields of parapsychology or mysticism. When you're talking about psi and nonverbal communication, you are talking about synchrony and entrainment between resonant oscillators. That is not metaphysics, it is harmonic theory and physics.

Can you describe a resonant oscillator? How does harmonic resonance apply to the brain?

An oscillator is just another term for a wave or vibration, so any system that has a cycling frequency, which is just about everything, is an oscillator. When two oscillators near each other are vibrating near the same frequency they begin to have overlapping wave patterns, or interference patterns, that can be modeled in terms of complimentary synchrony, harmony, phase differentials, and so on. If two oscillators have complimentary interference patterns they are said to be harmonic, meaning they do not dampen each other's power or amplitude. If the two oscillators interfere in a way that drives both of their amplitudes, maximizing the potential energy of the circuit, then they are said to be in resonant coherence. When an oscillating system phase-locks into resonant coherence with another oscillator, energy is amplified and the phase-locked system becomes self-stabilizing and difficult to dampen or perturb even with a competing interference wave.

Harmonic and resonant feedback are at the center of all self-stabilizing oscillating systems, or self-oscillators. Harmonic wave interference conserves energy and is perceived as beautiful to humans in both the arts and the sciences. Loss of harmonic feedback in coupled oscillators drives chaos and chaotic output; resonant feedback and entrainment creates stable attractors and convergence in chaotic systems. These are the fundamentals of all physical systems that oscillate and trade energy over time. If you examine EEG readings it is obvious that the brain is an oscillator with distinct wave patterns for each state of consciousness, and each neuron is a tiny oscillator passing waves of information through an intricately coupled network. So applying the dynamics of resonant oscillators and harmonic wave interference to human perception and expanded states of consciousness is not a radical or fringe idea, it is a natural extension of existing physical theory.

So shamanic singing is a form of resonant feedback for stabilizing consciousness in chaotic psychedelic states?

That is the theory of Physical Shamanism in a nutshell. If you can understand that you can understand almost everything I am modeling with PIT. The interaction starts at the cellular level with a simple pharmacological interference pattern, then erupts into a chaotic ripple across the surface of the neocortex, which then bleeds over into long term memory, informs behavioral changes, and ultimately affects the values of the larger tribe and culture. The chaotic, high-information ripple extends outward over time and goes beyond the confines of the user's mind, expanding into art and media and science and religion and cultural trends. I don't think anyone has ever attempted to deconstruct the entire psychedelic information chain before, let alone attempt to fit it into some kind of physical theory. It is totally new territory.

Clearly, when someone discovers the psychedelic experience they do not keep it to themselves. There is an inherent need to change behaviors and share the experience with others, and that shared experience bounces around the culture and creates resonant interference patterns with shared artwork and reports from other psychedelic experiences, and the amount of detail and spontaneous cultural and tribal organization emerging from this process is enormous. When you attempt to model the psychedelic process with some kind of longitudinal cultural analysis, you see we are dealing with a self-sustaining nonlinear information system that is feeding back on itself through time and producing a disproportionately large amount of output in response to a very small amount of input, which is literally a single pinch of white powder per subject. Somehow, adding that little pinch of white powder ends up changing the world.

Does PIT present a hallucinogenic scale, like the Shulgin scale, which rates hallucination or expanded consciousness along some metric?

The Frame Stacking Model describes degrees of depth and complexity to hallucination, and proposes that depth of hallucination is equal to potency of substance times dose of substance, saturating and feeding back on itself over duration of effect (which is the nonlinear component), modified by the rate of metabolism for that substance. You could write this description as a mathematical formula, but what it is attempting to explain is that there is a critical dose range for each drug where the depth of hallucination becomes self-sustaining and naturally drives towards a fully animated frame rate of about 8-16 stacked frames per second, like an attractor pulling you towards a "peaking" state. If the dose of psychedelic is too small or you metabolize it too quickly, you only get a slightly speedy or jittery sensation corresponding to interference in perception; no peaking state. But once you find the right dose range and achieve self-sustaining hallucination, you lock into this expanded state where you begin stacking progressively animated frames until you top out around 16 receding frames deep. Anything over 16 stacked frames of temporal depth converges towards infinity and overwhelms human perception.

You could break the Shulgin scale down by depth of hallucinogenic frame complexity if you wanted to, but the model PIT suggests is very generic, like a screen saver algorithm or stacked video feedback loop. The Shulgin scale does not attempt to model this kind of complexity in hallucination, nor should it. PIT is attempting to model a more granular level of sensory detail.

You say expanded consciousness tops out at 16 stacked frames? Why 16 frames?

The number 16 seems a bit arbitrary, but it was the number proposed by the person who first described the Frame Stacking Model to me, and this frame depth was upheld to some degree by my own experimentation with mechanical video feedback as well as a variety of hallucinogenic substances. The frame stacking model is an attempt to quantify the fast rate of progressive animation created by hallucination, and to formalize the rate at which sensation saturates, echoes, stacks, regresses, smears, or overlaps into the subsequent perceptual frame. This is a morphological approach to studying the dynamics of progressive hallucination, and you can measure the liquidity or stretchiness of any hallucination based on this metric of seamless smoothing or aliasing between overlapping stacked frames. After about 16 frames of depth, things tend to trail off and blur together into infinitely receding mist.

With the frame stacking model you can step back and analyze your own hallucination and ask; is it flickering and pulsing like a strobe light, or is it oozing slowly with a high degree of fine detail? The more motion trails you are seeing, the more echoes you're hearing, the more liquid and fluid the hallucination seems, all of that corresponds to the number of simultaneous frames you are stacking. After about 16 layers of temporal frame regression, perception begins to saturate and melt and converge down this white spiral or tunnel into infinity. Experiencing this vortex or tunnel, like your mind being sucked out of your body, is a common sensation on large doses of psychedelics. It may be called ego death, or peaking, or whiting out, or a near-death experience, but it is very much like passing out and going unconscious and leaving your body. It is nearly impossible to have any control over thought, action, memory, or behavior past this perceptual capacity. At this point most people lie down and go astral.

How do you think PIT will be perceived in the future?

Most psychedelic theory is built around cultural notions of self and spirituality, and because of this most theories typically have a shelf-life of a few decades. Instead of using metaphors, PIT was built around physical models and the best understanding of the physiology of the brain and perception. This gives PIT a much longer shelf-life than previous psychedelic theory. And since PIT avoids spiritual metaphor it is also applicable across all cultures. PIT is not the final word in the field of psychedelic shamanism, but it provides a neat general framework for the study of expanded consciousness. It is my hope that future generations of explorers will read this text and be inspired to evaluate psychedelic phenomena with a more critical scientific eye.

What experiments can be done to test the various models presented in PIT?

PIT is already a working theory. The process and outcomes of shamanism and psychedelic experimentation have already been formalized and tested. Further testing cannot disprove PIT, but it can help refine the level of detail in the proposed models. PIT was informed by existing research from hundreds if not thousands of different sources, including both published scientific literature, traditional shamanic ritual, and underground research from anonymous psychedelic explorers. PIT does not seek to undo research or suggest further avenues for research, but instead proposes a physical model that can tie all existing research together.

All of the models proposed by PIT come directly from studying subjective reports of psychedelic experience and shamanic ritual, and then overlaying these reports with the most current research on psychedelic receptor interaction along various perceptual pathways. All of the models, methods, and techniques described in PIT have been tested in humans and are accurate. Shamanism is already in common practice with only crude spirit models or psychological models to work with. The only thing left to do is refine our understanding of the brain, and as our understanding grows we can look back at the existing shamanic model and ask, "Is it still accurate?" And if the answer is no, then we need to refine the model and make it more accurate. That's the ongoing labor of science.

About this Text

About Psychedelic Information Theory

Psychedelic Information Theory (PIT) began in 2004 as an extended essay entitled "The Case Against DMT Elves," which was a response to a web article entitled "DMT, Moses, and the Quest for Transcendence" by Clifford Pickover. "The Case Against DMT Elves" was meant to be an antithesis to the "spirit world" models of DMT popularized by Terence McKenna and Rick Strassman in the 1990s, and as such it received some support for taking a more formal approach to examining hallucination. When I realized that the physiological case for complex hallucination had never been sufficiently compiled, I collected some notes and previous writings and began to assemble the PIT Alpha version on the tripzine.com website, which also includes an archive of material from *Trip Magazine*, a journal of psychedelic culture which I published from 1995 through 2005.

The process of putting the PIT Alpha version together took over a year and included the help of many people sending donations, proofreading, and providing valuable feedback on the text. PIT Alpha began as an attempt to reduce psychedelic phenomenology from a purely connective and pharmacological perspective. Sometime in late 2005, halfway through the text of PIT Alpha, I completely abandoned this approach. In 2006 I adopted a circuit model of psychedelic activation I dubbed Signal Theory, which emphasized the role of recurrent excitation in cortical networks as the source of hallucinogenesis. A summary of this theory was presented at the 2006 *Toward a Science of Consciousness* conference in Tucson, AZ. Over a period of two years Signal Theory evolved into what I called the Multi-State Theory of psychedelic action, which was the first time I considered the full implications of psychedelics as catalysts for multi-stable states of nonlinear consciousness.

After releasing a review version of the Multi-State Theory online, I received some interesting feedback that helped focus my thinking, some of it coming from an anonymous Canadian researcher who shared his unique theory of hallucinogenic frame stacking to simplify my theory of recurrent feedback. This led me to study the various nonlinear effects produced by a competing modulator in a precisely timed sequential frame processing system. By extrapolating the various overlapping pharmacological, circuit, and network models of psychedelic action, I settled upon the Control Interrupt Model, which posits that all hallucination begins with a high-frequency periodic interruption of multisensory frame stability that could be described as a wave interference pattern. Once the Control Interrupt Model fell into place, Psychedelic Information Theory suddenly made sense again, and the entire text was rewritten from this new perspective.

After the six year effort on this project, I can proudly say that PIT is the model of hallucinogenesis and psychedelic action I was always seeking to produce. I believe PIT sheds a unique light on the processes of human consciousness and the capacity of the human imagination, and will serve psychedelic research and altered-state exploration for many years. I sincerely thank all of the people who sent donations, feedback, and subtle reminders over the years. Many thanks to all the people who followed my work and kept me focused on finishing, I could not have done it without the consistent support encouragement.

Sincerely,

James L. Kent

Bibliography

1. Akers B; "The Sacred Mushrooms of Mexico: Assorted Texts". University Press of America, October 10, 2006.
2. Beyer SV; "Singing to the Plants: A Guide to Mestizo Shamanism in the Upper Amazon". University of New Mexico Press, October 31, 2009.
3. Cooper JR, Bloom FE, Roth RH; "The Biochemical Basis of Neuropharmacology". Oxford University Press, NY, 7th ed., 1996.
4. Grinspoon L, Bakalar JB; "Psychedelic Drugs Reconsidered". The Lindesmith Center, 1997.
5. Grof S; "LSD Psychotherapy". MAPS, 3rd Edition, 2001.
6. Hayes C; "Tripping: an anthology of true-life psychedelic adventures". Penguin Compass, New York, 2000.
7. Hobson JA; "The Dream Drugstore: Chemically Altered States of Consciousness". MIT Press, 2001.
8. Huxley A; "The Doors of Perception". Harper and Row, 1954.
9. LeDoux J; "The Emotional Brain". Simon & Schuster, NY, 1996.
10. LeDoux J; "Synaptic Self". Viking Penguin, NY, 2002.
11. Letcher A; "Shroom: A Cultural History of the Magic Mushroom". Faber, Great Britain, 2006.
12. Lilly JC.; "Programming and Metaprogramming in the Human Biocomputer". Communication Research Institute, 1968.
13. McKenna T; "The Invisible Landscape". Harper, San Francisco, 1993.
14. Mullis K; "Dancing Naked in the Mind Field". Vintage, NY, 2000.
15. Oroc J; "Tryptamine Palace". Park Street Press, Vermont. 2009.
16. Rabinow P; "Making PCR: a story of biotechnology". University of Chicago Press, 1996.
17. Ruck C, Hofmann A, Wasson GR, *et al.*; "The Road To Eleusis: Unveiling the Secret of the Mysteries". William Dailey Antiquarian Books, 2004.
18. Russell D; "Drug War: Covert Money, Power & Policy". Dan Russell, 1999-2000.
19. Schultes RE, Hofmann A; "Plants of the Gods". Healing Arts Press, Vermont, 1992.
20. Sheldrake R; "A New Science of Life: The Hypothosis of Morphic Resonance". Park Street Press, Vermont. 1995.
21. Shulgin A; "TiHKAL: The Continuation". Transform Press, Berkeley, 1997.
22. Shulgin A; "PiHKAL: A Chemical Love Story". Transform Press, Berkeley, 1991.
23. Snyder S; "Drugs and The Brain". Scientific American Books, 1986.
24. Stafford P; "Psychedelics Encyclopedia". Ronin Publishing, Third Edition. 1992.
25. Stevens J; "Storming Heaven: LSD and the American Dream". Grove Press, 1998.
26. Stolaraff M; "The Secret Chief: Conversations With a Pioneer of the Underground Psychedelic Therapy Movement ". MAPS, October 1997.
27. Strassman R; "DMT: The Spirit Molecule". Park Street Press, Vermont. 2001.
28. Strogatz SH; "Nonlinear Dynamics and Chaos". Perseus Publishing, Cambridge MA, 1994.
29. Tindall R; "The Jaguar That Roams the Mind". Park Street Press, Vermont, 2008.
30. Wolfe T; "The Electric Kool-Aid Acid Test". Bantam, 1999.
31. Zoe 7; "Into The Void". Worldwide Media, 2001.

References

1. Abraham HD, Duffy FH; "EEG coherence in post-LSD visual hallucinations". Psychiatry Res. 2001 Oct 1;107(3):151-63.
2. Aghajanian GK, Marek GJ; "Serotonin Induces Excitatory Postsynaptic Potentials in Apical Dendrites of Neocortical Pyramidal Cells". Neuropharmacology Volume 36, Issues 4-5, 5 April 1997, Pages 589-599
3. Aghajanian GK, Marek GJ; "Seratonin and Hallucinogens". Neuropsychopharmacology. 1999 Aug;21(2 Suppl):16S-23S.
4. Aghajanian GK, Marek GJ; "Serotonin, via 5-HT$_{2A}$ receptors, increases EPSCs in layer V pyramidal cells of prefrontal cortex by an asynchronous mode of glutamate release". Brain Research 825, Issues 1-2, 17 April 1999, 161-171.
5. Arnett AM; "Jimson Weed (*Datura* stramonium) Poisoning". Clinical Toxicology Review Dec 1995, Vol 18 (No 3).
6. Azmitia EC; "Serotonin and brain: evolution, neuroplasticity, and homeostasis". Int Rev Neurobiol. 2007;77:31-56.
7. Bach M; "Wagon-wheel effect". From Michael's Optical Illusions & Visual Phenomena. Internet Reference, 2010.
8. Beer AL, Heckel AH, Greenlee MW; "A Motion Illusion Reveals Mechanisms of Perceptual Stabilization". PLoS ONE 3(7): e2741. 2008.
9. Behrendt RP; "Hallucinations: synchronisation of thalamocortical gamma oscillations underconstrained by sensory input". Conscious Cogn. 2003 Sep;12(3):413-51.
10. Belcheva MM, *et al.*; "μ and κ Opioid Receptors Activate ERK/MAPK via Different Protein Kinase C Isoforms and Secondary Messengers in Astrocytes". J Biol Chem. 2005 July 29; 280(30): 27662-27669.
11. Bennett-Clarke CA, Chiaia NL, Rhoades RW; "Thalamocortical afferents in rat transiently express high-affinity serotonin uptake sites". Brain Research Volume 733, Issue 2, 16 September 1996, Pages 301-306.
12. Bohn LM; "Mitogenic Signaling via Endogenous κ-Opioid Receptors in C6 Glioma Cells: Evidence for the Involvement of Protein Kinase C and the Mitogen-Activated Protein Kinase Signaling Cascade". J Neurochem. 2000 February; 74(2): 564-573.
13. Bokkon I, Kirby M, D'Angiulli A; "TMS, phosphenes and visual mental imagery: A mini-review and a theoretical framework". Symposium on Transcranial Magnetic Stimulation and Neuroimaging in Cognition and Behaviour Conference, Montreal, Quebec, Canada, 25 September 2008.
14. Bonta IL; "Schizophrenia, dissociative anaesthesia and near-death experience; three events meeting at the NMDA receptor". Med Hypotheses. 2004;62(1).
15. Boveroux P, *et al.*; "Brain function in physiologically, pharmacologically, and pathologically altered states of consciousness". Int Anesthesiol Clin. 2008 Summer;46(3):131-46.
16. Bressloff PC, *et al.*; "Geometric visual hallucinations, Euclidean symmetry and the functional architecture of striate cortex". Philos Trans R Soc Lond B Biol Sci. 2001 Mar 29;356(1407):299-330.
17. Bressloff PC, Cowan, *et al.*; "What Geometric Visual Hallucinations Tell Us about the Visual Cortex". Neural Computation 14 (2002) 473-491.
18. Brown University; "Scientists explain inception of perception in the brain". Physorg, March 5, 2007.
19. Bruchas MR, *et al.*; "Kappa Opioid Receptor Activation of p38 MAPK Is GRK3- and Arrestin-dependent in Neurons and Astrocytes". June 30, 2006 The Journal of Biological Chemistry, 281, 18081-18089.
20. Buckman, J; "Brainwashing, LSD, and CIA: Historical and Ethical Perspective". International Journal of Social Psychiatry, Vol. 23, No. 1, 8-19 (1977).
21. Burnet PW, Eastwood SL, *et al.*; "The distribution of 5-HT$_{1A}$ and 5-HT$_{2A}$ receptor mRNA in human brain". Brain Res. 1995 Apr 3;676(1):157-68.
22. Busch N, Dubois J, VanRullen R; "The Phase of Ongoing EEG Oscillations Predicts Visual Perception". The Journal of Neuroscience, June 17, 2009, 29(24):7869-7876.
23. Butters, Nelson; "The effect of LSD-25 on spatial and stimulus perseverative tendencies in rats". Psychopharmacology 8:6, November, 1966.
24. Cerrito E, *et al.*; "5-HT$_2$-receptors and serotonin release: Their role in human platelet aggregation". Life Sciences Volume 53, Issue 3, 1993, 209-215.
25. Charing HG; "Communion with the Infinite: The visual music of the Shipibo people of the Amazon". SH, Winter 2005.
26. Chizhevsky VN, Corbalan R; "Multistability in a driven nonlinear system controlled by weak subharmonic perturbations". phycon, vol. 2, pp.396-402, 2003 International Conference on Physics and Control.
27. Cho RY, Konecky RO, Carter CS; "Impairments in frontal cortical gamma synchrony and cognitive control in schizophrenia". Proc Natl Acad Sci U S A. 2006 Dec 26;103(52):19878-83.
28. Christiansen A, Baum R, Witt P; "Changes In Spider Webs Brought About By Mescaline, Psilocybin And An Increase In Body Weight". JPET April 1962 vol. 136 no. 1 31-37.
29. Cochen V, Arnulf I, Demeret S, *et al.*; "Vivid dreams, hallucinations, psychosis and REM sleep in Guillain-Barré syndrome". Brain, ISSN 0006-8950. 2005, vol. 128 (11), pp. 2535-2545.
30. Colgin, Laura Lee, *et al.*; "Frequency of gamma oscillations routes flow of information in the hippocampus". Nature 462, 353-357 (19 November 2009).
31. Connely B; "Neuropharmacology of Hallucinogens: a brief introduction". Erowid.org, Internet Reference, 2004.
32. Connors C; "Bypassing interneurons: inhibition in neocortex". Nature Neuroscience 10, 808-810 (2007).
33. Coren, S; "Sleep Deprivation, Psychosis and Mental Efficiency". Psychiatric Times. Vol. 15 No. 3, 1998.
34. Corlett PR, Frith CD, Fletcher PC; "From drugs to deprivation: a Bayesian framework for understanding models of psychosis". Psychopharmacology (Berl). 2009 November; 206(4): 515-530.
35. Davis M, Walters JK; "Psilocybin: biphasic dose-response effects on the acoustic startle reflex in the rat". Pharmacol Biochem Behav. 1977 Apr;6(4):427-31.
36. Deering MF; "Limits of Human Vision". Sun Microsystems Internal, 1998.
37. Deschenes M, Bourassa J, Pinault, D ; "Corticothalamic projections from layer V cells in rat are collaterals of long-range corticofugal axons". Brain-Res. 1994 Nov 21; 664(1-2): 215-9
38. Dobelle WH, Mladejovsky HG; "Phosphenes produced by electrical stimulation of human occipital cortex, and their application

to the development of a prosthesis for the blind". J Physiol. 1974 December; 243(2): 553-576.1.

39. Doblin, R; "Pahnke's 'Good Friday Experiment' A Long-Term Follow-Up And Methodological Critique". The Journal of Transpersonal Psychology, Vol. 23, No. 1, 1991.
40. Douglas, Koch, Mahowald, Martin, Suarez; "Recurrent Excitation in Neocortical Circuits". Science 269-5226 (1995) 981-985.
41. Eagleman D, Pariyadath V; "Is subjective duration a signature of coding efficiency?". Phil. Trans. R. Soc. B 12 July 2009 vol. 364 no. 1525 1841-1851.
42. Ermentrout B; "Dynamical consequences of fast-rising, slow-decaying synapses in neuronal networks". Neural Computation 15-11 (2003) 2483-2522.
43. Ermentrout, Cowen; "A mathematical theory of visual hallucination patterns". Biological Cybernetics 34-3 (1979) 137-150.
44. Erowid.org; "Erowid Experience Vaults". Internet Reference, 2010.
45. Erowid.org; "Peyote Legal Status". Internet Reference, 2010.
46. Erowid.org; "UDV Wins Supreme Court Decision on Preliminary Injunction Allowing the use of their ayahuasca / hoasca tea". Internet Reference, 2010.
47. Fischer R, Hill R, Thatcher K, Scheib J.; "Psilocybin-induced contraction of nearby visual space". Agents Actions. 1970 Aug;1(4):190-7.
48. Fischer R, Hill RM, Warshay D; "Effects of psychodysleptic drug psilocybin on visual perception. Changes in brightness preference". Experientia. 1969 Feb 15;25(2):166-9.
49. Forutan F, Estalji S, Beu M, *et al.*; "Distribution of 5-HT$_{2A}$ receptors in the human brain: comparison of data in vivo and post mortem". Nuklearmedizin. 2002;41(4):197-201.
50. Fox D; "Timewarp: How your brain creates the fourth dimension". New Scientist, Issue 2731, 21 October 2009.
51. Gao, Krimer, Goldman-Rakic; "Presynaptic regulation of recurrent excitation by D1 receptors in prefrontal circuits". PNAS 98-1, 295-300, 2001.
52. Geyer MA, Vollenweider FX; "Serotonin research: contributions to understanding psychoses". Trends Pharmacol Sci. 2008 Sep;29(9):445-53.
53. Glennon RA, *et al.*; "Evidence for 5-HT$_2$ involvement in the mechanism of action of hallucinogenic agents". Life Sci. 1984 Dec 17;35(25):2505-11.
54. Gokalp, G; "Sleep and Dreams". Internet Reference, 1999.
55. Gresch PJ, *et al.*; "Behavioral tolerance to lysergic acid diethylamide is associated with reduced serotonin-2A receptor signaling in rat cortex". Neuropsychopharmacology. 2005 Sep;30(9):1693-702.
56. Griffiths RR, Richards WA, *et al.*; "Mystical-type experiences occasioned by psilocybin mediate the attribution of personal meaning and spiritual significance 14 months later". Journal of Psychopharmacology, Vol. 22, No. 6, 621-632 (2008).
57. Griffiths RR; "Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance". Psychopharmacology (2006) 187:268-283.
58. Gutkin, Pinto, Ermentrout; "Mathematical Neuroscience: From Neurons to Circuits to Systems". Journal of Physiology - Paris 97 (2003) 209-219.
59. Harner MJ; "Common Themes in South American Indian Yage Experiences". Internet Reference, 2010.
60. Hasler F, Grimberg U, Benz M, Huber T, Vollenweider F; "Acute psychological and physiological effects of psilocybin in healthy humans: a double-blind, placebo-controlled dose-effect study". Psychopharmacology, Volume 172, Number 2 / March, 2004
61. HHS/SAMHSA, Office of Applied Studies; "Ecstasy, Other Club Drugs, & Other Hallucinogens". Internet Reference, 2008.
62. Hill RM, Fischer R; "Interpretation of visual space under drug-induced ergotropic and trophotropic arousal". Agents Actions. 1971 Nov;2(3):122-30.
63. Hobson JA, Stickgold R, Pace-Schott EF; "The neuropsychology of REM sleep dreaming". NeuroReport: 16 February 1998 - Volume 9 - Issue 3 - p R1-R14.
64. Hoffmann E; "Effects of a Psychedelic, Tropical Tea, Ayahuasca, on the Electroencephalographic (EEG) Activity of the Human Brain during a Shamanistic Ritual". MAPS Spring (2001) 25-30.
65. Itil TM; "Anticholinergic drug-induced sleep-like EEG pattern in man". Psychopharmacologia. 1969;14(5):383-93.
66. Jakab RL, Goldman-Rakic PS; "5-Hydroxytryptamine2A serotonin receptors in the primate cerebral cortex: Possible site of action of hallucinogenic and antipsychotic drugs in pyramidal cell apical dendrites". PNAS January 20, 1998 vol. 95 no. 2 735-740.
67. Jarvik M, Chorover S; "Impairment by lysergic acid diethylamide of accuracy in performance of a delayed alternation test in monkeys". Psychopharmacology, Volume 1, Number 3 / May, 1960.
68. Jones EG; "Thalamic circuitry and thalamocortical synchrony". Philos Trans R Soc Lond B Biol Sci. 2002 Dec 29;357(1428):1659-73.
69. Judd LL, McAdams L, Budnick B, Braff DL ; "Sensory gating deficits in schizophrenia: new results". Am J Psychiatry 1992; 149:488-493.
70. Kanamaru, T., "Van der Pol oscillator", *Scholarpedia*, 2(1), 2202, (2007).
71. Kass L, Hartline PH, Adolph AR ; "Presynaptic uptake blockade hypothesis for LSD action at the lateral inhibitory synapse in Limulus". The Journal of General Physiology, Vol 82, 245-267.
72. Kent JL; "Psychedelic Information Theory: Alpha Edition". Tripzine.com, Internet Reference, 2004.
73. Kent JL; "Signal Theory Overview". Tripzine.com, Internet Reference, 2006.
74. Kent JL; "Signal Theory Poster". Towards a Science of Consciousness Conference, Tucson, AZ, 2006.
75. Kent JL; "Selective 5-HT$_{2A}$ agonist hallucinogens: A review of pharmacological interaction and corollary perceptual effects". Tripzine.com, Internet Reference, 2008.
76. Kent JL, Pickover C; "The Case Against DMT Elves". Tripzine.com, Internet Reference, 2004.
77. Kittenis M., Caryl PG, Stevens P; "Distant psychophysiological interaction effects between related and unrelated participants". Association 47th Annual Convention: Proceedings of Presented Papers, Vienna (67-76), 2004.
78. Knoll M, Kuglerb J, *et al.*; "Effects of Chemical Stimulation of Electrically-Induced Phosphenes on their Bandwidth, Shape,

Number and Intensity". Sterotactic and Functional Neurosurgery, Vol. 23, No. 3, 1963.
79. Levitated.net; "Artifacts of Computation". Internet Reference.
80. Lehar, S; "Harmonic Resonance in the Brain: Spatial patterns in perception and behavior mediated by spatial standing waves in neural tissue". Internet Reference, 2010.
81. Luke D; "Psi-verts and Psychic Piracy: The Future of Parapsychology?". Reality Sandwich, Internet Reference, 7-6-09.
82. Lumer ED, Edelman GM, Tononi G; "Neural dynamics in a model of the thalamocortical system. II. The role of neural synchrony tested through perturbations of spike timing". Cereb Cortex. 1997 Apr-May;7(3):228-36.
83. Marc Wittmann, et al; "Effects of psilocybin on time perception and temporal control of behaviour in humans". 2007;21:50.
84. Mason OJ, Brady F; "The psychotomimetic effects of short-term sensory deprivation". J Nerv Ment Dis. 2009 Oct;197(10):783-5.
85. McLean TH, Parrish JC, Braden MR, Marona-Lewicka D, Gallardo-Godoy A, Nichols DE; "1-Aminomethylbenzocycloalkanes: conformationally-restricted hallucinogenic phenethylamine analogues as functionally-selective 5 HT2A receptor agonists". J Med Chem. 2006 Sep 21;49(19):5794-803.
86. Meador KJ, *et al.*; "Gamma coherence and conscious perception". Neurology 2002;59:847-854.
87. Melechi A, "Seeing Stars: The Shifting Geometry of Phosphenes". Trip Magazine, issue 10, 26-27, 2004.
88. Meredith MA, Stein BE; "Visual, auditory, and somatosensory convergence on cells in superior colliculus results in multisensory integration". J Neurophysiol 56: 640-662, 1986.
89. Miller RE, Tredici TJ; "Vision Manual for the Flight Surgeon: The Eye and Night Vision". USAF Special Report, AL-SR-1992-0002.
90. Mishlove J; "Interview with Francis Crick". Transcript from 'Thinking Allowed, Conversations On the Leading Edge of Knowledge and Discovery'.
91. Munglani R, Jones JG; "Sleep and General Anesthesia as Altered States of Consciousness". Journal of Psychopharmacology 6:399-409, 1992.
92. Nichols CD, Sanders-Bush E; "A Single Dose of Lysergic Acid Diethylamide Influences Gene Expression Patterns within the Mammalian Brain". Neuropsychopharmacology (2002) 26 634-642.
93. Nichols DE; "Hallucinogens". Pharmacology & Therapeutics Volume 101, Issue 2, February 2004, Pages 131-181.
94. Nicholson PT, Firnhaber RP; "Autohypnotic Induction of Sleep Rhythms Generates Visions of Light with Form-constant Patterns". White Paper.
95. Norwegian University of Science and Technology (NTNU); "How the Brain Filters out Distracting Thoughts to Focus on a Single Bit of Information". ScienceDaily 23 November 2009.
96. Pantone, DJ; "The Shipibo Indians: Masters of Ayahuasca". Internet Reference, 2006.
97. Payne JD, Nadel L.; "Sleep, dreams, and memory consolidation: the role of the stress hormone cortisol". Learn Mem. 2004 Nov-Dec;11(6):671-8.
98. Pettifor E; "Altered States: The Origin of Art in Entoptic Phenomena". Internet Reference, 1996.
99. Pickover C; "DMT, Moses, and the Quest for Transcendence". Reality Carnival, 'Sex, Drugs, Einstein, and Elves', 2004.
100. Pinto B, Ermentrout B; "Spatially Structured Activity In Synaptically Coupled Neuronal Networks: I. Traveling Fronts And Pulses". SIAM J. Appl. Math 62-1 (2001) 226-243.
101. Pompeiano M, Palacios JM, Mengod G.; "Distribution of the serotonin 5-HT_2 receptor family mRNAs: comparison between 5-HT_{2A} and 5-HT_{2C} receptors". Brain Res Mol Brain Res. 1994 Apr;23(1-2):163-78.
102. Prudence, Paul; "Chaotic fingerprints and space-time labyrinths". Internet Reference, 2005.
103. Pöppel E; "Pre-semantically defined temporal windows for cognitive processing". Phil. Trans. R. Soc. B 12 July 2009 vol. 364 no. 1525 1887-1896.
104. Rampe J; "Softology - Video Feedback". Internet Reference.
105. Ray TS; "Psychedelics and the Human Receptorome". PLoS One. 2010; 5(2): e9019.
106. Rees, Alun; "Nobel Prize genius Crick was high on LSD when he discovered the secret of life". Mail on Sunday, 8 August 2004.
107. Riba J, Anderer P, *et al.*; "Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers". Br J Clin Pharmacol. 2002 June; 53(6): 613-628.
108. Riba J, Anderer P, *et al.*; "Effects of the South American Psychoactive Beverage Ayahuasca on Regional Brain Electrical Activity in Humans: A Functional Neuroimaging Study". Neuropsychobiology 2004;50:89-101.
109. Richards TL, Kozak *et al.*; "Replicable functional magnetic resonance imaging evidence of correlated brain signals between physically isolated subjects". Journal of Alternative and Complementary Medicine, 11, 955-963.
110. Rose D, Horn G; "Effects of LSD on the responses of single units in cat visual cortex". Experimental Brain Research, Volume 27, Number 1 / January, 1977.
111. Sabolek HR, Penley SC, *et al.*; "Theta and gamma coherence along the septotemporal axis of the hippocampus". J Neurophysiol. 2009 Mar;101(3):1192-200.
112. Sadzot B, Baraban JM, *et al.*; "Hallucinogenic drug interactions at human brain 5-HT_2 receptors: implications for treating LSD-induced hallucinogenesis". Psychopharmacology (Berl). 1989;98(4):495-9.
113. Sattelkau T; "An Interview with Dave Nichols". Trip Magazine, Vol 5., Spring 2000, p 42.
114. Scienceblog.com; "Does time dilate during a threatening situation?". Internet Reference, January 23, 2010.
115. Shao Z, Burkhalter A; "Role of GABAB receptor-mediated inhibition in reciprocal interareal pathways of rat visual cortex". J Neurophysiol. 1999 Mar;81(3):1014-24.
116. Shema R, Sacktor TC, Dudai Y; "Rapid erasure of long-term memory associations in the cortex by an inhibitor of PKM zeta". Science. 2007 Aug 17;317(5840):951-3.
117. Siegel JM; "The stuff dreams are made of: anatomical substrates of REM sleep". Nature Neuroscience, V9.6, p721, 06/2006.
118. Sipes TE, Geyer MA; "DOI disrupts prepulse inhibition of startle in rats via 5-HT_{2A} receptors in the ventral pallidum.". Brain Res. 1997 Jun 27;761(1):97-104.
119. Spratling MW; "Cortical Region Interactions and the Functional Role of Apical Dendrites". Behavioral and Cognitive Neuroscience 1-3 (2002) 219-228.

120. Stickgold R, Hobson JA, Fosse R, Fosse M; "Sleep, learning, and dreams: off-line memory reprocessing". Science. 2001 Nov 2;294(5544):1052-7.
121. Stuckey DE, Lawson R, Luna LE; "EEG gamma coherence and other correlates of subjective reports during ayahuasca experiences". J Psychoactive Drugs. 2005 Jun;37(2):163-78.
122. Swaminathan, Nikhil; "How Hallucinogens Play Their Mind-Bending Games". Scientific American, January 31, 2007.
123. Taylor RP, Sprott JC.; "Biophilic fractals and the visual journey of organic screen-savers". Nonlinear Dynamics Psychol Life Sci. 2008 Jan;12(1):117-29.
124. Trulson M, Howell G; "Ontogeny of the behavioral effects of lysergic acid diethylamide in cats". Developmental Psychobiology 17:4, 329-346.
125. Urban JD, *et al.*; "Functional selectivity and classical concepts of quantitative pharmacology". J Pharmacol Exp Ther. 2007 Jan;320(1):1-13.
126. VanRullen R, Pascual-Leone A, Battelli L; "The Continuous Wagon Wheel Illusion and the "When' Pathway of the Right Parietal Lobe: A Repetitive Transcranial Magnetic Stimulation Study". PLoS ONE 3(8): e2911. August 6, 2008.
127. VanRullen R, *et al.*; "The continuous Wagon Wheel Illusion is object-based". Vision Research Volume 46, Issue 24, November 2006, Pages 4091-4095.
128. Vollenweider FX, Geyer MA; "A systems model of altered consciousness: integrating natural and drug-induced psychoses". Brain Res Bull. 2001 Nov 15;56(5):495-507.
129. Wasson RG; "Seeking the Magic Mushroom". Life Magazine, May 13, 1957, p100.
130. Watts SW; "Activation of the mitogen-activated protein kinase pathway via the 5-HT$_{2A}$ receptor". Ann N Y Acad Sci. 1998 Dec 15;861:162-8.
131. WikiPedia.org; "Interference (wave propagation)". Internet Reference, 2010.
132. WikiPedia.org; "Chaos Magic". Internet Reference, 2010.
133. WikiPedia.org; "Mitogen-activated protein kinase". Internet Reference, 2010.
134. WikiPedia.org; "Space-filling Curves". Internet Reference, 2010.
135. WikiPedia.org; "5-HT$_{2A}$ Receptor". Internet Reference, 2010.
136. WikiPedia.org; "Protein kinase C". Internet Reference, 2010.
137. WikiPedia.org; "Nonlinear System". Internet Reference, 2010.
138. WikiPedia.org; "Stockholm Syndrome". Internet Reference, 2010.
139. WikiPedia.org; "Distributed Cognition". Internet Reference, 2010.
140. WikiPedia.org; "Electroencephalography". Internet Reference, 2010.
141. WikiPedia.org; "Subliminal stimuli". Internet Reference, 2010.
142. WikiPedia.org; "Wagon wheel effect". Internet Reference, 2010.
143. WikiPedia.org; "Working memory". Internet Reference, 2010.
144. WikiPedia.org; "Retina". Internet Reference, 2010.
145. WikiPedia.org; "Grid illusion". Internet Reference, 2010.
146. WikiPedia.org; "Kalachakra". Internet Reference, 2010.
147. WikiPedia.org; "Watchmaker analogy". Internet Reference, 2010.
148. WikiPedia.org; "Hermeticism". Internet Reference, 2010.
149. WikiPedia.org; "Visible spectrum". Internet Reference, 2010.
150. WikiPedia.org; "Control Theory". Internet Reference, 2010.
151. WikiPedia.org; "Entrainment (Physics)". Internet Reference, 2009.
152. WikiPedia.org; "ADSR envelope". Internet Reference, 2009.
153. WikiPedia.org; "Symbionese Liberation Army". Internet Reference, 2010.
154. WikiPedia.org; "Aum Shinrikyo". Internet Reference, 2010.
155. WikiPedia.org; "Project MKULTRA". Internet Reference, 2010.
156. WikiPedia.org; "Peripheral drift illusion". Internet Reference, 2008.
157. Williams JD, Dowson TA, *et al.*; "The Signs of All Times: Entoptic Phenomena in Upper Palaeolithic Art". Current Anthropology, Vol. 29, No. 2 (Apr., 1988), pp. 201-245.
158. Wolfram Math; "Peano Curves". Internet Reference, 2010.
159. Wolfram Math; "Hilbert and Moore Fractal Curves". Internet Reference, 2010.
160. Wolfram Math; "Wunderlich Curves". Internet Reference, 2010.
161. Yu B, *et al.*; "Serotonin 5-Hydroxytryptamine2A Receptor Activation Suppresses Tumor Necrosis Factor-α-Induced Inflammation with Extraordinary Potency". JPET November 2008 vol. 327 no. 2 316-323.

About the Author

James L. Kent is a writer and programmer living in Seattle, Washington, and has studied hallucinogens and perception for over twenty years. He is the former Editor of *Psychedelic Illuminations Magazine*, the former Publisher of *Trip Magazine: The Journal of Psychedelic Culture*, and the creator and co-editor of *DoseNation.com*, a web log for drug news, media, culture, and humor. He is also a contributing neuroscience columnist for *h+ Magazine*.

Journey to Paradise

Of Toadstools and Toxins, and A Vivid Tour Of The Heaven (And Hell) That Lies Within Us All

by

Robert Graves

Holiday vol. 32(2):36-37, 110-111, August 1962.

original text: http://www.mushroomjohn.org/graves1.htm

Robert Graves at a cafe in Palma de Majorca, 1954. Photograph: Daniel Farson

Of all the priests and Sunday-school teachers who taught me about Paradise when I was a child, none claimed to have been there. I never dreamed that I would one day enter that Garden of Delights myself, confirm their account in general outline, and return to tell the tale. No: I am not talking in metaphors, nor am I a mystic. Paradise is where I went.

The point of departure was New York City, on an evening late in January. Four friends had gathered in an apartment overlooking the East River, prepared to set out with me under the guidance of our host. The Greeks had a word for his function, namely "mystagogue", meaning a priest who took charge of initiates at the sacred Mysteries of Eleusis, Corinth, or Samothrace. Our mystagogue tonight had advised us to fast beforehand, drink no liquor, avoid sexual congress, clear our consciences and, in fact, try to achieve what the Catholics call "a state of grace". At seven-thirty he prepared us for our journey by giving us a preparation made from the *psilocybe* mushroom. At eight, he began turning out the lights one by one, while we settled down in easy chairs and awaited the revelation. Soon no sound was heard except the swish-swish of cars passing along the Drive: a noise not unlike the sound of waves on a beach.

I felt a numbness in my arms and a pricking at the nape of my neck. In the half-light that filtered through the shutters, colored dots appeared on the ceiling; they shone more when I closed my eyes. We all began to shiver, our pulses slowed down, and a young woman (the mystagogue's daughter) brought in blankets. Since she had already made this journey, we welcomed her reassuring smile and the pressure of her hand. We remembered the mystagogue's warning: "You are going where God dwells, and will be granted all knowledge. … Whoever nurses evil in his heart sees hideous demons and nameless horrors, more proper to Hell than to Paradise, and wishes he had never been born". I anxiously considered my own motives. Would I see demons? Though not a saint, I was at least a dedicated historian and mythologist; with luck I might be spared punishment.

Since even the half-light had become uncomfortably strong for my eyes, I kept them closed. I knew from a study of Celtic and Middle Eastern religion that the road to Paradise often begins under the sea or from a lake bottom, so the greenish water now lapping around me came as no surprise. I entered a marble grotto, passing a pile of massive sunken statuary, and found myself in a high-roofed tunnel lit by brilliantly colored lamps. The sea lay behind.

This was perfect schizophrenia. My corporeal self reclined in a chair, fully conscious, exchanging occasional confidences with friends; but another "I" had entered the tunnel. Could it be the same tunnel through which, four thousand years before, the epic hero Gilgamesh made his approach to the Babylonian Paradise of the goddess Siduri?

Still worrying about the demons, I glanced up at the roof. Thousands of pink, green or yellow faces, like carnival masks, grimaced horribly down; but I dismissed them with a wave of my hand, and they obediently vanished. A turn in the tunnel brought me to the domed Treasury without which no Paradise is complete, whether Hindu, Babylonian, Hebrew, Icelandic, Irish, Greek or Chinese.

Here Majesty's Crown Jewels at the Tower of London would have looked tawdry by comparison with the fantastic treasure now heaped before me: diadems, tiaras, necklaces, crosses, breast-plates, goblets, cups, platters, scepters, blazing or twinkling. But even richer than these jewels were the royal silks spread out for my inspection in blue, mulberry and white: vast lengths miraculously brocaded with birds, beasts, flowers.

My closest experience to this had been in early childhood when, after waiting endlessly in the cold, dark hall, my sisters and I saw the drawing-room door suddenly flung open, and there blazed the Christmas tree: all its candles lighted, its branches glistening with many-colored tinsel.

Still in a trance, I reached for a notebook and wrote: "9 p.m. Visions of …" but got no further: things were happening to fast. Besides, the pen felt strange in my hand, and its scratch on paper sounded offensively loud. I remember saying: "I have seen enough treasure for a lifetime. Is there no human beauty in Paradise?" At once the diadems, tiaras, necklaces, crosses and scepters vanished. Instead, a row of lovely, live, naked Caryatids appeared, lined along the wall, as if supporting the dome. Their faces were shrouded. Yet I hesitated to indulge in erotic fancies, lest the Caryatids should turn into filthy, deformed devilkins like the ones in Flemish pictures of St. Anthony's Temptations. Blushing, I dismissed them, too, and emerged from the tunnel into daylight.

What I had been taught at school and in church proved true enough, though the truth enormously transcended the account. Around me lay a mountain-top Eden, with its jewel-bright trees, its flowers and its pellucid streams. And I experienced not only the bliss of innocence, but also the "knowledge of good and evil". Most Christians understand this phrase as meaning the power to distinguish right from wrong; in Hebrew, however, it signifies a universal understanding of all things, whether good or evil. Indeed, my mind suddenly became so agile and unfettered that I felt capable of solving any problem in the world; it was as if I had immediate access to all knowledge everywhere. Put the sensation of wisdom sufficed - why should I trouble to exploit it?

An unseen voice began singing. I rejoiced that it was a woman's, not a man's. Every original Paradise belongs to a goddess. Eden once belonged to the Great Goddess of Syria. Mother of All Living; but as soon as the Israelites became monotheistic and transferred their allegiance to Jehovah, she was expelled.

The hidden woman, singing in an unintelligible language, scolded, entreated, commanded, coaxed. Every now and then she would change her mood and song; would mourn, triumph or laugh. I fell wholly under her spell and presently enjoyed the curious experience of *seeing* sound. The song-notes became intricate links of a solid golden chain that coiled and looped in serpentine fashion among jade-green bushes: the only serpent I saw in

Eden.

Each song was followed by a pause, and always I waited in a lover's agony for her to begin again, tears stinging at my eyelids. Once she seemed to sing off-key. Perhaps this was quarter-tone music; at any rate, I understood what she meant when I saw one edge of the golden chain formed by the sound spread out into a spectrum, and laughed for pleasure. Toward the end came a quick, breathless cheerful song of creation and growth. The notes fell to earth but rose once more in green shoots which soared swiftly up, putting out branches, leaves, flowers - until this musical plant dominated the sky like the beanstalk in the fairy tale. My spirit followed after into the clear blue air, gazing down on cornfields, fields of poppies and the spires of a heavenly city.

A last the music ended. The visions were fading now. My corporeal self sighed, stretched luxuriously and looked around. Most of the company had left the room. Only one remained. I asked him: "So the journey seems to be over?"

"Ah, but close your eyes, and you can get back at once", he said.

"How do you feel?"

"My mind has never been so clear! Did you ever hear such music in your life?"

We joined the others in the kitchen, ate cold turkey sandwiches and compared notes. "I saw huge slow-moving fish in the sea; did you?" "The demons scared me nearly to death! I wept and sobbed; maybe I wasn't in a state of grace". "Weren't those building *enormous*? But I couldn't place their architectural style." "Me, I'd take the journey all over again - this minute, if I could!"

A girl from the Metropolitan Museum had seen a different Paradise: "I don't know exactly where I went", she said. "It certainly wasn't a garden. But I did see my own kind of visions: blueprints of a simple joy - all difficulties and perplexities unraveled as I watched."

A curious bond of affection had been established between us, so strong that I felt nothing could ever break it. At two o'clock in the morning we said good-bye. By eight I was on my way to Idlewild, headed for Europe, profoundly refreshed and (in Wordsworth's phrase) "trailing clouds of glory" - wisps of celestial memory which persisted nearly a month.

Let me repeat: I am no mystic. Nor were any of my friends. We had visited Paradise by what orthodox Christians, Jews, Hindus and Moslems would call "the back stairs". The sole legitimate approach, they hold, is by humility, asceticism and meditation - a long rigorous discipline for taming one's bodily appetites and intellectual ambitions. Many mystics have visited Paradise, but as a rule, church authorities suspect the humble member who, after severe mortification of his flesh, claims to have seen sights denied his superiors. Mystics attached to no particular church are ignored, unless their ecstasies have caused a breach of the peace; then they are arrested, hospitalized and given shock therapy as schizophrenics. This is their punishment for living simultaneously in two worlds and failing to distinguish between them. Only when mystics write poems or paint pictures in which the paradisal illumination cannot easily be denied - St. John of the Cross, Vaughan, Blake, van Gogh, for example - are they valued as great souls.

While not denying that Paradise can be attained by spiritual discipline (though when this fails the mystic often sees complementary visions of Hell), I suggest that the so-called back stairs to Paradise must one have been its main portal. Others mush have found the entrance as my friends and I had done, by taking an ambrosial drug which conveys mortals to the Otherworld.

Our host and mystagogue that evening was R. G. Wasson, a vice president of Morgan Guaranty Trust and an internationally known expert on mushrooms. He and I had corresponded for some years on the mycophobia, or unreasoning fear of mushrooms, which affects whole populations in Europe, Asia and Africa. Granted, a few mushrooms, easily distinguishable from edible varieties, do contain a mortal poison; but most are palatable if not delicious. Why, we asked each other, when wholesome fruit and vegetables are freely eaten with a sensible disregard for the poisonous or the inedible, should this selectivity be denied to mushrooms? Why were they given disgusting and often obscene names? Why do toads and serpents figure in mushroom folklore? And why, at the same time, should the mycophobic Greeks have had a proverb (quoted by the Emperor Nero) that "Mushrooms are the food of the gods". Were the "nectar" and "ambrosia" of Greek legend perhaps a hallucinogenic mushroom reserved for royalty or priests who, after being granted ecstatic visions by eating it, ranked as living gods? And were *all* mushrooms given disgusting names in order to protect a particular sacred variety from being eaten by the unauthorized?

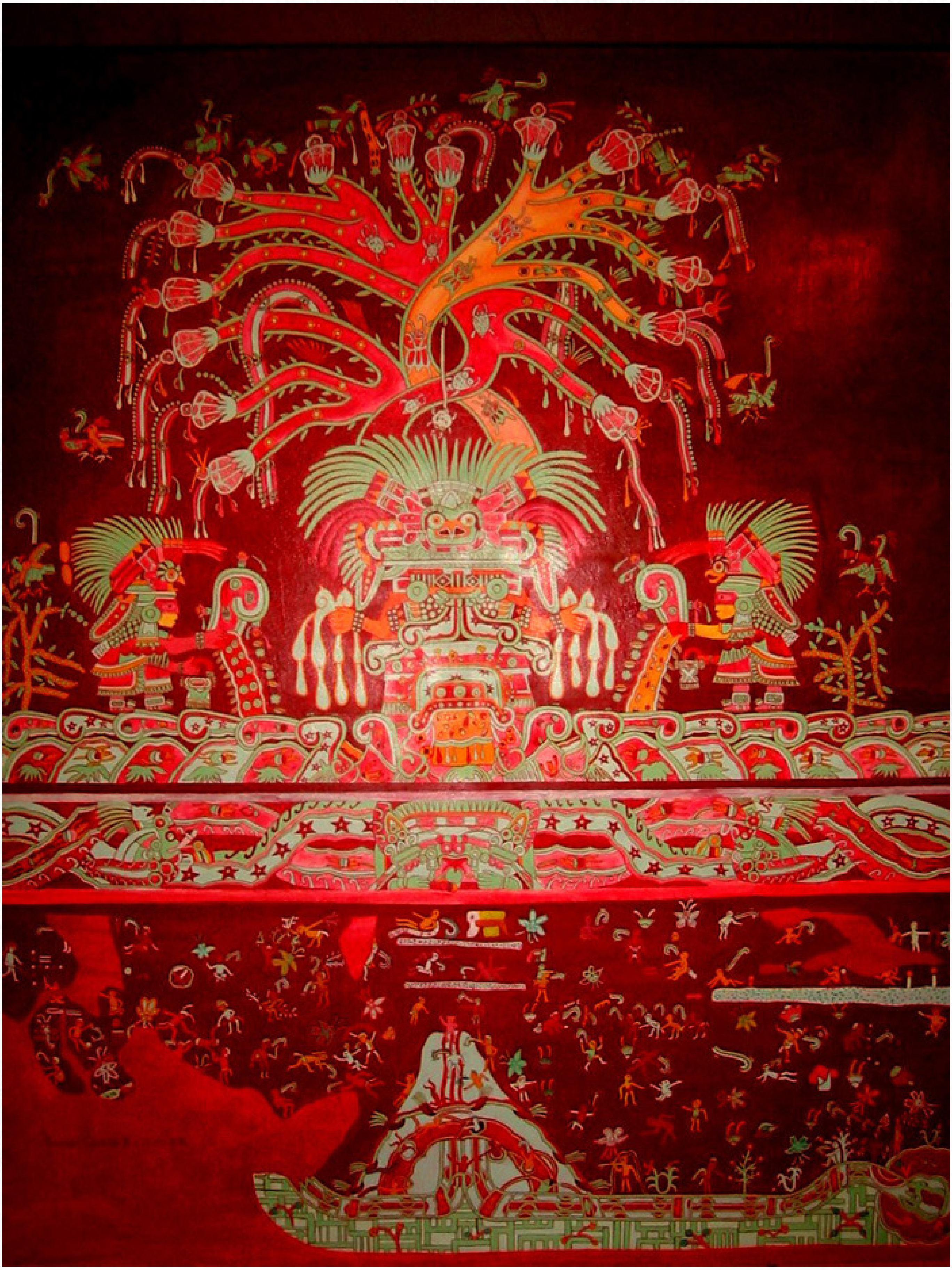
In 1952, I sent Wasson a cutting from an American pharmaceutical journal which seemed to clinch the matter. It referred to 16th Century Spanish reports of an "inebriatory" mushroom eaten by the Aztecs and other Indians of Mexico for oracular purposes. These reports so impressed Wasson that he and his wife, a physician, visited Oaxaca state, where mushroom oracles were rumored to be still operating among the Mazatec Indians. By good fortune they contrived to witness the secret ritual, of which they have published full accounts. During the next five years, Wasson traced the cult in different parts of Mexico, brought back several varieties of sacred mushroom, had them botanically identified by Prof. Roger Heim of Paris and chemically analyzed by Dr. Albert Hofmann of Basle.

That a particular variety of spotted toadstool, the handsome *Amanita muscaria* - in English called "fly-cap" - was used by the primitive Korjaks of Eastern Siberia for inducing hallucinations, we already knew. (So did Lewis Carroll, who made Alice eat it in Wonderland.) Although fly-cap grows freely throughout the American continent, none of the sacred Mexican mushrooms proved to be an *amanita* or to have the same toxic effect. Fly-cap produces a drunken delirium in the eater, accompanied by extraordinary physical strength, erotic energy, and insensitivity to pain; he speaks wildly and loses all sense of time or space. Mexican *psilocybe*, on the other hand - small, bitter and disagreeably rancid - conveys him to Paradise without dulling his wits or turning him into a beast. *Psilocybe* had been our sacred food that evening, though we did not eat the mushrooms themselves; instead, Wasson gave us the last of a small supply of crystals containing their active principle, *psilocybin*, that had been extracted by Doctor Hofmann from a few pounds of mushrooms flown out of Oaxaca. The music which so enchanted us was an invocation to the Mushroom god sung in Old Mazatec by the famous *curandera* (healing woman), María Sabina, which Wasson had recorded on tape.

In Oaxaca, the secret ritual takes place at night, on the mud floor of an Indian hut. Sentries are posted outside against interruption. An altar table is adorned with a crucifix, pictures of saints, and beeswax candles, as well as sacred accessories dating from pagan times - parrot feathers, red flowers, turkey eggs, bark paper, maize kernels, and a pot of charcoal for heating *copal*, a resinous incense. Though the ritual varies between villages, the *curandero* or *curandera* never fails to officiate with profound solemnity, first calling upon God and His saints and passing the mushrooms over the sacred *copal*. They are always eaten raw, in pairs - male and female, originally perhaps representing Tlalóc and his wife - and cups of chocolate or honey-water are served beforehand to keep the empty stomach from nausea. The devotees act with the greatest propriety and must not leave the hut until dawn. Each dose is calculated according to the strength of the mushrooms used, and to the eater's size or known capacity for the drug. No pregnant women or people who have been heard mocking at the mushroom rite may partake of it.

In the Aztec city of Tepantitla there is a fresco dated between the 4th and 7th Centuries A.D. It shows a soul visiting Tlalócan, or Paradise. The expected elements are there: a river (stocked with fish). Bordered with flowers and bejeweled trees, haunted by brightly colored butterflies and a spectacular sky serpent. A blue figure crouches beneath one tree. The soul stands open-mouthed, weeping tears of joy and wonder, his body connected to the river by a thread of water. This river is shaped like a mushroom and, at its source - the center of the mushroom head - lurks Tlalóc, god of mysteries, in toad shape, water issuing from his mouth. The name Tlalóc means "pulp of earth", presumably mushrooms; and Tlalóc, like his mushrooms, was engendered by lightning. He used a seashell as another emblem and owned an underwater grotto. This grotto appears at the bottom of the fresco, marked with a cross, the four head of which are mushrooms. The serpent is Talóc again, who wore a serpent headdress. Spanish missionaries reported infant sacrifices at Tlalóc's annual rain-making rites.

Mazatec Indians now eat the sacred mushrooms as though they were the Christian Host; I even recognized a mention of Christ's name in the invocation. Yet Tlalóc of the Mushrooms till delivers the oracles. The figure crouched beneath the paradisal tree is an *hombrecito* - one of the blue mushroom-spirits who are said to drive thunderclouds through the sky with whips of lightning. Indians describe them as the souls of infants who died before baptism - that is to say, unredeemed pagans.



Tlalócan

May we assume that the similarities between Tlalócan and the Old World Paradises are due to cultural contact, however ancient it may have been, and to a common hallucinogenic food? If so, had Tlalóc a European counterpart who delivered oracles when his flesh was symbolically eaten; who was engendered by lightning;

who possessed an underwater retreat; who had toad and serpent as his emblems; who tolerated infanticide? Yes, indeed: Thracian Dionysus, the Thunderer, may be called Tlalóc's twin. He could transform himself at will and cause extraordinary illusions: as when, captured by pirates, he made a vine sprout from their vessels' deck and twine about the mast, while ivy gripped the rigging, and the oars turned into serpents.

The Eleusinian Mysteries near Athens, in which Dionysus figured, were preceded by fasting and a ceremonial cleansing in the sea. Initiates then entered a temple, drank mint-water, ate pastries baked in magical shapes, and saw celestial visions never to be forgotten. According to the myths, King Perseus of Argos, founder of Mycenae, at first resisted Dionysus. Punished for his obstinacy with an outbreak of madness among the Argive women - they ate their own babies raw, as also happened at Thebes when Pentheus tried to resist the cult - Perseus underwent a conversion and dedicated a temple to Dionysus at Mycenae. Argos had a toad as its badge; and Perseus is said to have named Mycenae after a mushroom found on the site "from which proceeded a stream of water". Perseus even claimed the same sort of nativity as Dionysus: having been engendered by Zeus in a shower of gold. Infanticide is a practice not associated with any Greek myth except that of Dionysus; perhaps both in Greece and Mexico the "babies" eaten in sacred pictures were really mushrooms.

If such mushrooms were, as I suppose, sacred food at the Great Mysteries, they can hardly have been fly caps; though I believe that the primitive Maenads, Centaurs and Satyrs ate these at rowdy autumnal orgies. The Great Mysteries were nothing if not decorous. Nor is any hallucinogenic variety of *psilocybe* known outside Mexico.

Two years ago, however, looking for a clue to the mushroom of the Mysteries, I heard from friends in Portugal that a local witch used a small dung-mushroom to produce visions. I asked them to send a sample to Professor Heim. He identified it as a *Panaeolus papilionaceus*, which grows freely in Europe and North America, and which I had noticed on an ancient Greek vase, shown between the hooves of Nessus the Centaur. I had also read a report on its hallucinogenic properties, published by the American journal *Science* of September, 1914. Fly cap is said to lose its toxic qualities when cooked - I do not guarantee this - but the liquor of *papilionaceus* could have been introduced without detection or loss of potency into the mint-water and sacred pastries at Eleusis.

Fly cap is shown on an Etruscan mirror at the feet of Ixion, ancestor of the Centaurs; and occurs in Guatemalan stone effigies of Tlalóc as toad. It may have been the original "food of the gods" in both hemispheres. My guess is that its properties were first stumbled on in time of famine; and that experiments with smaller, less tempting mushrooms led to the discovery of *psilocybe*, *Panaeolus papilionaceus*, and perhaps other varieties, which also became dedicated to the Toad-god or Serpent-god. Toads excrete a poisonous sweat when ill-treated; serpents have a venomous bite. Both creatures may have served as warning emblems to guard the mushroom taboo.

Any use of hallucinogenic drugs, except for medical purposes, goes against civilized conscience. In this Christian world, only visions won by prayer and piety are ascribed to God; all others are likely to be attributed to the Devil. Because of my Protestant conditioning, I would never take cocaine, heroin, hashish or marijuana, even experimentally; but the Mexican mushroom does not belong to this range of drugs, nor is it habit-forming. So far from stupefying the senses, it quickens them; though the body may be relaxed, the mind stays conscious throughout - indeed, supra-conscious. Since *psilocybe* intensifies and lays bare mental conflicts, an experimentalist is likely to get visions evoked by an uneasy conscience: weeping for grief, not joy, or shuddering aghast. This peculiar virtue of enhancing reality turns the Greek command "Know thyself!" into a practical precept; *psilocybe* illuminates the mind, re-educates sight and hearing.

Paradise thus seems to be a subjective vision. (As Jesus said: "The Kingdom of Heaven is within you". He might have added: "Likewise the Kingdom of Hell".) But the jeweled garden can be attained by the relatively pure of heart without undergoing so austere a discipline as might alienate them from their more worldly friends. The Mexican mushroom feast, for those who attend it in a state of grace and with complete mutual trust - by no means a simple condition - both strengthens human friendship and bestows spiritual enlightenment: the twin purposes of most religions. Yet I should, myself, refuse to enroll in any cult, pagan or Christian, where the mushroom was used as a sacrament - which has happened to *mescalin*, the hallucinogenic drug extracted from cactus buds, now sanctified by a large Christian sect extending from Central America to Canada. Such a cult would not only imply ecclesiastical discipline and theological dogma, but force me into intimacy with people who were not my sort. At school and in the Army I had my share of that.

The fact is that a poetic trance, as I have experienced it on different levels - sometimes light, sometimes so deep that the slightest disturbance caused acute distress - means far more to me than any trance induced by a drug. I understand Coleridge's depreciation of *Kubla Khan*, written almost automatically under the influence of laudanum; he had earned his other poems by active poetic thought. This is not to put an opiate vision, of which one is the dazed victim, in the same class with a mushroom vision, which can be consciously assessed and even controlled; I am aware that under the influence of *psilocybe*, certain oracular *curanderos* and *curanderas* often give amazingly accurate answers to questions asked of them. Nevertheless, Tlalócan, despite its marvels, contains no palace of words presided over by the Living Muse; and no small whitewashed cell (furnished with a table, a chair, pen, ink and paper) where words come to life and combine rhythmically under a poet's supra-conscious guidance. I feel no urge to revisit paradise.

The Philosophy of Psychedelic Transformation

by

Christopher Edward Ross Letheby B.A., M. Phil.

Journal of Consciousness Studies

Department of Philosophy, School of Humanities The University of Adelaide
A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

December 2016

original text: https://digital.library.adelaide.edu.au/dspace/bitstream/2440/104676/2/02whole.pdf
backup source: http://www.psilosophy.info/resources/02whole.pdf

Table of Contents:

- **Abstract**
- **Declaration**
- **Acknowledgements**
- **Introduction**
  - Psychedelic Phenomenology
  - Psychedelic Science
  - The Philosophical Background
  - Philosophy of Psychedelics
- **The Philosophy of Psychedelic Transformation**
  - Statement of Authorship
  - Introduction and Methodological Preliminaries
  - Psychedelic Transformation: An Overview
  - Evidence for the Causal Relevance of the ASC
  - Epistemic Aspects of Psychedelic Transformation
  - Conclusion
- **The Epistemic Innocence of Psychedelic States**
  - Statement of Authorship
  - Introduction
  - Psychedelic Therapy: An Overview
  - The Concept of Epistemic Innocence
  - Epistemic Benefit and Epistemic Risk
  - The No Alternatives Condition
  - Conclusion
  - Acknowledgements
- **Naturalizing Psychedelic Spirituality**
  - Statement of Authorship
  - Introduction
  - The Neuroexistentialist Predicament
  - An Existential Medicine?
  - Naturalistic Entheogenics
  - Mechanisms of Mysticism
  - Conclusion
- **Anatomy of an Avatar: Ego Dissolution in Psychedelic Experience**
  - Statement of Authorship
  - Introduction
  - Binding
  - Binding and Predictive Processing
  - The Architecture of Subjectivity

- Self Binding
- Psychedelic Ego Dissolution
- Ego Dissolution as Unbinding
- Conclusion

Conclusion
- Summary of Arguments
- Directions for Future Research

References

Abstract

Recent scientific research arguably confirms the existence of a remarkable phenomenon: durable psychological benefit to an individual resulting from a single ingestion of a psychedelic drug. In this thesis by publication I ask what exactly is going on in such cases of 'psychedelic transformation'. The thesis is situated in the context of a resurgence of interest in psychedelics within neuroscience and psychiatry, and motivated by the need for philosophical examination of the foundations and results of this research program.

Two common claims in the literature on therapeutic and transformative uses of psychedelics are: (a) psychedelic experiences are a reliable means of knowledge acquisition or spiritual growth, and (b) such epistemic or spiritual benefits are centrally involved in psychedelics' psychological benefits. My aim is to show how such a conception of psychedelic transformation as an epistemic or spiritual process may be reconciled with philosophical naturalism. Naturalism denies the existence of non-natural or supernatural realities such as gods, souls, and immaterial minds. Naturalism is a very widespread view in philosophy today, and is supported by strong arguments.

However, there is a tension between naturalism and the epistemic or spiritual conception of psychedelic transformation, because many psychedelic users claim drug-facilitated knowledge of non-natural realities, such as a mystical 'universal consciousness'. One possible naturalistic response is to dismiss psychedelic users' claims of epistemic or spiritual benefit as mistaken. Here I offer an alternative, showing that we need not throw the epistemic/spiritual baby out with the non-naturalistic bathwater. I show that some kinds of psychedelic-induced epistemic and spiritual benefits are compatible with naturalism and plausibly involved in the drugs' transformative effects.

In 'The Philosophy of Psychedelic Transformation' I review evidence for psychological benefits of psychedelics and defend the claim that psychedelic transformation is unlike standard pharmacotherapies in centrally involving meaningful conscious experiences. I give arguments for three kinds of epistemic benefits: knowledge by acquaintance of the mind's potential, knowledge by acquaintance of the contingency of the sense of self, and revitalised capacities for the acquisition of modal knowledge. In 'The Epistemic Innocence of Psychedelic States' I extend this work, arguing that whatever psychedelics' epistemic demerits, they offer reliable and sometimes unique access to substantial epistemic benefits, including indirect epistemic benefits resulting from psychological benefits. I argue that a balanced picture of the drugs' epistemic merits and demerits is essential to policy discussions about their uses.

In 'Naturalizing Psychedelic Spirituality' I argue that by disrupting mechanisms of self-representation in the brain, psychedelics engender transformative experiences of self-transcendence and mind-expansion which amount to a naturalistic form of spirituality. I propose that such naturalistic spirituality constitutes a viable response to existential anxiety resulting from a naturalistic worldview. Finally, in 'Anatomy of an Avatar: Ego Dissolution in Psychedelic Experiences', I (with Philip Gerrans) argue that such self-transcendent experiences result specifically from disruption to cognitive binding processes implemented by predictive models in the brain. This provides a mechanistic basis for some of the claims of epistemic and spiritual benefit defended earlier.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

I acknowledge that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Christopher Letheby

Signature:
Date:

Publications:

Letheby, C. (2015). The philosophy of psychedelic transformation. *Journal of Consciousness Studies* 22, 170-193.
Letheby, C. (2016). The epistemic innocence of psychedelic states. *Consciousness and Cognition* 39, 28-37.
Letheby, C. (under review). Naturalizing psychedelic spirituality.
Letheby, C. and P. Gerrans (under review). Anatomy of an avatar: ego dissolution in psychedelic experience.

Acknowledgements

With standard but nonetheless sincere apologies to anyone I've forgotten, I thank the following people who have been instrumental in bringing this thesis to completion: Gerard O'Brien especially, and Jon Opie as well, for first-rate supervision, and for taking a chance on an unusual and controversial-sounding topic; Philip Gerrans, for inspiration, collaboration, and ongoing casual employment; everyone in the Department of Philosophy at the University of Adelaide, but especially the participants in our cognitive neuroscience reading group: Glenn Carruthers, Simon Eddy, Rob Farquharson, Anastasiya Kravchuk, Michael Lopresto, Andy McKilliam, Matt Nestor, Greg O'Hair, Laura Ruggles, Liz Schier, and Dook Shepherd; Miri Albahari, for timely encouragement; all the courageous researchers and experimental subjects who have played a part in the psychedelic renaissance; all my friends who have helped and supported me over the past four years; and finally, Mum and Dad, for arguing with me about God and raising me on Douglas Adams and Star Trek, both of which I'm pretty sure helped make me the aspiring philosopher that I am.

Introduction

Recent scientific research has arguably confirmed the existence of a remarkable and long-attested phenomenon: durable and beneficial change to an individual's psychological make-up resulting from a single ingestion of a psychedelic drug. What exactly is going on in such cases of 'psychedelic transformation'? That is the central question motivating this thesis.

The renaissance of scientific research into classic, serotonergic psychedelics, such as lysergic acid diethylamide, psilocybin, mescaline, and dimethyltryptamine, has provided evidence relevant to this question, but has not thereby answered all aspects of it directly. In particular, psychedelic subjects frequently claim that their transformation is a direct result of some kind of learning, insight, or spiritual growth. Determining whether psychedelic transformation is essentially an epistemic or spiritual process requires not just empirical research but philosophical analysis of the results of such research. This is so because what counts as 'epistemic' or 'spiritual' is a partly conceptual, philosophical question anyway, and because there are no straightforward entailments of philosophical conclusions by scientific findings; such inferences require synthesis and interpretation of empirical results.

Despite repeated calls for philosophical analysis of psychedelic phenomena, there has as yet been relatively little attention paid in academic philosophy to the renaissance of psychedelic research. The four papers collected here comprise an effort to initiate philosophical discussion of psychedelic transformation. Specifically, they collectively amount to an attempt to reconcile two independently plausible but seemingly incompatible claims. The first of these is philosophical naturalism: the view that the natural world is all that exists, and that there are no non-natural or supernatural entities such as gods, souls, or immaterial minds. The second is the above-mentioned claim that psychedelics are effective agents of knowledge acquisition or spiritual growth.

I call this second claim the 'entheogenic conception' of psychedelics, from the neologism *entheogen* ('generating the divine within') which has been coined to refer to psychoactive substances when used specifically for spiritual purposes (Ruck *et al*. 1979). The tension between naturalism and the entheogenic conception of psychedelics arises from the fact that claims of knowledge acquisition and spiritual benefit consequent upon psychedelic use are often closely tied to non-naturalistic metaphysical claims (e.g. Vaughan 1983). In these four papers I attempt to show that the entheogenic conception of psychedelics is independent of metaphysical nonnaturalism - that there is a plausible and robust conception of psychedelics as agents of epistemic and spiritual benefit that is perfectly consistent with naturalism. I apply a broadly neurophilosophical approach to this issue, examining the findings from psychedelic science and then showing how they support this naturalized entheogenic conception.

In this introduction I begin by describing the phenomenon to be analysed: therapeutic and transformative effects occasioned by psychedelics. I give a relatively detailed description of the phenomenology of psychedelics states, since the psychedelic experience is the fundamental background to my project, and its phenomenology is not described in detail in any of the papers. I then very briefly summarise results from recent psychedelic science, which are described in more or less detail in each of the four papers, before describing the philosophical background to my project. This consists, firstly, of several non-psychedelic currents in recent philosophy which provide thematic and methodological inspiration and context for my arguments, and, secondly, of the few formal philosophical discussions of psychedelic epistemology and spirituality in recent times. Finally, I state the specific aims of each of the four papers and their intended contributions to the overall project.

I think my arguments show that an entheogenic conception of psychedelics is consistent with naturalism and plausible in light of current scientific knowledge. But regardless of the success of these specific arguments, the most general aim of the thesis is to put psychedelic science on the philosophical map. My project functions as a sort of 'proof-of-concept', demonstrating that rigorous philosophical analysis of psychedelic phenomena is both possible and desirable. The four papers collected here show beyond doubt that these controversial and long-neglected substances raise fascinating questions meriting substantial and sustained philosophical attention.

A note on terminology: my main focus in this thesis is 'classic' psychedelics such as lysergic acid diethylamide (LSD), psilocybin (found in 'magic mushrooms'), mescaline (from peyote and other psychoactive cacti), and dimethyltryptamine (DMT, found in various plants and animals.) All of these drugs exert their psychoactive effects primarily by serotonin-2a receptor agonism (Halberstadt 2015). In most cases (though there is some variation between papers) I reserve the word 'psychedelic' for substances of this class, and not other substances such as ketamine, *Salvia divinorum*, and ibogaine, all of which act by different neuropharmacological mechanisms, despite being classified as 'psychedelic' on phenomenological grounds (Sessa 2012).

Psychedelic Phenomenology

What is it like to be intoxicated by a psychedelic? An economical but unhelpful answer would be that psychedelic consciousness is too heterogeneous and ineffable to admit of useful description. It is true that each psychedelic experience is unique, being shaped not just by substance, dosage, and route of administration, but by 'set and setting' - the individual's psychological make-up and the circumstances in which they take the drug. Moreover, psychedelic subjects often say that the intoxication is unlike anything in their prior experience and words cannot do it justice.

However, even if we cannot give necessary and sufficient phenomenological conditions for a psychedelic experience, we can describe some of the more typical effects; certain themes recur in both narrative accounts and more formal quantitative (Studerus *et al*. 2011, Schmid *et al*. 2015) and qualitative (Turton *et al*. 2014, Gasser *et al*. 2015) studies of psychedelic phenomenology. These include alterations of various kinds to sensory experience in all modalities, as well as to thinking, the experience of one's body, space, and time, affect, and the sense of self. It is worth appreciating, though, that detailed and poetic narrative accounts probably come closest to conveying a true sense of what psychedelic experience is like (cf. Durr 1970).

Alterations to vision are a characteristic effect which fall into at least three categories: intensification of stimulus-bound percepts; alteration of stimulus-bound visual experience; and stimulus-independent percepts. The latter can happen with eyes open or eyes closed. In the most dramatic case, visual experience becomes entirely constituted by stimulus-independent imagery, amounting to the apparent experience of a completely different reality.

Aldous Huxley describes the intensification of colour in his famous account of mescaline intoxication: "Mescalin [sic] raises all colours to a higher power and makes the percipient aware of innumerable fine shades of difference, to which, at ordinary times, he is completely blind" (Huxley 1954, 27). Similar intensification can occur to other aspects of vision: shapes, edges, depth and so forth may all seem more clear, vivid and forceful than usual.

Alteration or distortion of stimulus-bound percepts introduces an element of misrepresentation. One common variety of this is objects which are actually stationary being seen as moving or morphing (as in the famous phenomenon of 'walls breathing'); another is for objects to be seen as having shapes or proportions other than their actual ones. Objects may be overlaid with geometrical patterns, stationary or moving, with no apparent basis in the environment (Strassman 2005).

Overlain geometric patterns occupy a middle ground between distortion of stimulus-bound percepts the experience of novel, stimulus-independent percepts. A more unambiguous example of this third category is furnished by a peyote subject who described seeing a "ball of red fire about the size of a golf ball" moving towards him in the room:

> It drifted, swaying a little from side to side, while moving toward me... when the ball of fire had come close enough I poked at its centre with my finger. It then exploded, a lavish shower of multicoloured sparks cascading and dropping on the rug at my feet.
> (Masters and Houston 1966, 7-8).

This fireball and its behaviour were part of the subject's visual experience but seemed to have no basis at all in the objects and events of his environment.

Vivid endogenous visual experience with eyes closed is also very common. The content of such 'closed eye visuals' ranges from simple moving or transforming geometric patterns through fleeting visions of faces, motifs and scene snapshots, all the way to elaborate, immersive and in some cases interactive visual narratives. At high doses, many subjects describe watching and participating in cinematic dramas which seem to constitute allegories of situations in their lives (Masters and Houston 1966). The most extreme case of such visionary experience is when a subject is seemingly transported to a completely different reality or location which is seen in graphic detail with eyes open or closed. In such 'breakthrough' experiences awareness of the actual environment in all sensory modalities is completely lost (Strassman 2001).

Alterations to visual experience are probably more common than changes in other sensory modalities (Strassman 2005). However, with the exception of closed eye visuals (which do not really have analogues) all of these effects can occur in other modalities. Auditory percepts may be intensified, seeming louder (Fischman 1983, 75), clearer, or possessed of more fine-grained detail; appreciation of music is often heightened considerably (Kaelen *et al*. 2015). One subject on psilocybin described hearing his own breathing as though it were the sound of a waterfall (Malitz *et al*. 1960, 10), which seems like an alteration of an existing percept. Novel auditory percepts are sometimes experienced; the peyote subject quoted earlier reported hearing the music that was being played by characters in a vision he observed (Masters and Houston 1966, 9).

Tactile, gustatory and olfactory perception are less notable sites of perceptual changes than vision and audition, although dramatic intensification can occur in these modalities:

> Sensations were acute. I heard, saw, felt, smelled and tasted more fully than ever before (or since). A peanut butter sandwich was a delicacy not even a god could deserve ... To touch a fabric was one's fingertip was ... to experience intense touch-pleasure.
> (Masters and Houston 1966, 10).

Reports of perceptual distortion or novelty in these three modalities are rare. Intensification or apparent enhancement seem to be the main effects of psychedelics on touch, taste, and smell.

Finally, synaesthetic interactions between sensory modalities often occur in the psychedelic state (Luke and Terhune 2013). The most common form seems to be auditory-visual synaesthesia; psychedelic subjects listening to music often find that their closed-eye visuals vary with, and seem to embody, such features of the music as rhythm and tone (Pahnke and Richards 1966, 185).

One's own body can be a significant locus of abnormal experience on psychedelics. Some such experience occurs in one of the five modalities already discussed; for instance, visual perception of one's own body can be intensified, distorted, or embellished with novel percepts. In particular, psychedelic subjects looking at themselves in a mirror often report unusual experiences such as seeing themselves as caricatures emphasising physical features or personality traits, or seeing themselves in the guise of archetypal or mythical figures. Such experiences can also occur in visual perception of other people (Masters and Houston 1966).

Other abnormal bodily experiences also occur. Some subjects report feeling as though their body is heavier or lighter than usual, or more or less near to their conscious mind (which is sometimes felt to leave the body altogether.) Subjects may also report experiencing the transformation of their body into the form of an animal, robot, or other non-human creature, or its shrinkage to microscopic or expansion to cosmic proportions. The body may feel as though it has been transmuted into a different substance, such as glass, or wood (Masters and Houston 1966).

It is also possible to feel as though one is directly experiencing internal physiological processes, such as the circulation of blood, the functions of organs, or the operations of the brain:

> I felt that I could count the beats, the throbbing of my heart, feel the blood moving through my veins, feel the passage of the breath as it entered and left the body, the nerves as they hummed with their myriad messages.
> (Masters and Houston 1966, 10).

As well as alterations to sensory and bodily experience, changes to spatial and temporal awareness are distinctive features of psychedelic states. Huxley claimed his perceptions of space and time were unaltered but his attitudes toward them had changed: he no longer had much interest in either of them (Huxley 1994). Space and time seem to have diminished in salience for him.

More unambiguous alterations to spatial awareness involve changes to perceived distance and relationships: objects appear nearer or further away than they actually are. Subjects who report 'mystical' experiences typically claim to have inhabited a state without any experience of space or time (Pahnke and Richards 1966).

Distortions of temporal perception are very common. Our much-quoted peyote subject described feeling as though he had been smoking a cigarette for hours, then looking down at it to see that the first ash was still on it, implying he had been smoking it for less than a minute (Masters and Houston 1966). Time dilation - the sense that more time has passed than actually has - is far more common than the reverse; which, however, is not unknown. Once again, mystical experiences are a limiting case of alterations to temporal experience: one of the criteria for classifying an experience as 'mystical' is that it involves some sense of eternity or transcendence of time (Griffiths *et al*. 2006).

It is common for the experience of thinking to change dramatically under the influence of psychedelics. Interestingly, many people comparing psychedelics with other drugs remark on how *unimpaired* they find their mental faculties. Huxley again: "The ability to remember and to 'think straight' is little if at all reduced. (Listening to the recordings of my conversation under the influence of the drug, I cannot discover that I was then any stupider than I am at ordinary times.)" (Huxley 1994, 13).

Nonetheless, many psychedelic experiences involve unusual thinking of some kind. Apparent psychological insight is a common example: psychedelic subjects often feel that they comprehend their own personalities, motivations, behavioural patterns and relationships with an unprecedented clarity (Masters and Houston 1966, 185). Thoughts about significant philosophical and scientific questions such as the mind-body problem, the function of the brain, and the meaning of life are also common, even in subjects not predisposed to contemplating such matters (Shanon 2002). Subjects sometimes feel that their thinking is faster or slower, or more or less clear, than usual, and often feel more prone to creative and associative than logical or rational thought (Grof 1975).

Changes to affective experience are a core aspect of the psychedelic state. They mark the fundamental difference between 'good trips' and 'bad trips'. Subjects enjoying mystical experiences experience unparalleled heights of rapture, serenity, and joy, albeit often combined with or preceded by awe or fear (Wasson 1957, Griffiths *et al*. 2006). More intuitively 'psychotomimetic' (psychosis-mimicking) experiences involve equally unparalleled depths of terror, helplessness, and despair (Masters and Houston 1966, 15-17).

Katz *et al*. (1968) made much of their observation that low-dose LSD subjects often displayed an affective ambivalence, consisting of the alternation between or simultaneous experience of mutually antagonistic, if not contradictory, emotions or moods. They suggested that this ambivalence is a central and theoretically important aspect of the psychedelic experience which may explain some characteristics of the more dramatic experiences possible at high doses. The idea that ambivalence or uncertainty is a key aspect of the psychedelic state features in recent theoretical proposals discussed further below (Carhart-Harris *et al*. 2014).

In general, a typical psychedelic experience involving neither a profound mystical rapture nor a terrifying temporary psychosis involves changes to affect which can be seen as analogous to the changes in sense experience: intensification of feelings can occur, as can affective lability (Strassman 1984) - similar to the distortion of existing sensory percepts - and novel, apparently endogenous affective states can occur too: changes in emotion or mood with no obvious environmental trigger or object (Katz *et al*. 1968).

Changes to the sense of self are another core feature of psychedelic experience. Subjects often feel that their sense of individual identity, or the boundaries between self and world, have been altered, loosened, or diminished. As with changes to spatial and temporal experience, this 'ego dissolution' phenomenon reaches its limit in mystical experiences in which the sense of separate individual identity is said to be altogether abolished, replaced by a much larger sense of identity.

Of all the varieties of psychedelic experience, the 'mystical' variety has provoked some of the greatest interest and controversy. Obviously the first question is what exactly a mystical experience is. The category is vacuous if it includes any experience which a subject calls 'mystical' or 'religious', so it needs to be given a more specific definition (Masters and Houston 1966).

The wellspring for academic discussion of psychedelic-induced mystical experience is Walter Pahnke's (1963) doctoral dissertation, which reports the results of the famous 'Good Friday experiment' in which divinity students were given psilocybin in a placebo-controlled study and many more psilocybin than control subjects satisfied criteria for having had a mystical experience. Pahnke based his criteria on the work of the philosopher W. T. Stace (1960) who endorsed the 'common core thesis' (Hood 2006): the claim that mystical experience, despite differences in description and interpretation, has a temporally and culturally invariant phenomenological essence. Pahnke follows Stace in endorsing the common core thesis and offers a phenomenological typology according to which the central features of a mystical experience are: a sense of unity; transcendence of time and space; deeply felt positive mood; sense of sacredness; feeling of objectivity and reality; paradoxicality; and alleged ineffability.

A mystical experience, then, is an experience of a sense of unity transcending time and space, which is felt by the experiencer to be sacred and objectively real, albeit paradoxical and ineffable, and is accompanied by a deeply felt positive mood. Descriptions of such experiences abound in the literature of the world's religions (Huxley 1945). Apart from being induced by drugs, such experiences can be induced by a variety of religious or spiritual practices, or can occur spontaneously.

There has been considerable debate about the relations between psychedelic-induced and non-psychedelic-induced mystical states; are psychedelic mystical experiences 'authentic', or an artificial facsimile of the genuine article? (Zaehner 1958, Watts 1962, Smith 1964). Pahnke's study was an attempt to apply an empirical methodology to these issues. Subjects wrote descriptions of their experiences, and independent observers equipped with Pahnke's typology rated the extent to which each description exemplified each of the elements of mystical experience. Reports of psilocybin subjects, but not of control subjects, overwhelmingly satisfied the criteria, leading to the conclusion that at least some drug-induced states are indistinguishable from spontaneous mystical experiences (Pahnke 1963, Smith 1964).

Pahnke's study had several methodological problems (Doblin 1991). One of the most celebrated results from the new wave of psychedelic research has been a far more rigorous replication of Pahnke's findings by a research group at Johns Hopkins University (Griffiths *et al*. 2006, 2008, 2011, MacLean *et al*. 2011). In these studies, most high-dose psilocybin experiences satisfied criteria for a 'complete' mystical experience. Subjects who had a mystical experience invariably rated their psilocybin session among the five most "personally meaningful" and "spiritually significant" events of their lives, comparing the meaningfulness of these experiences to such things as the birth of a child or the death of a parent (Griffiths *et al*. 2006).

Thus, as well as inducing a characteristic constellation of remarkable changes to sense perception, affect, and the senses of space, time, body, and self, psychedelics are capable of inducing states of consciousness phenomenologically indistinguishable from non-drug-induced mystical experiences. Indeed, Yaden *et al*. (2016) found that respondents to a large-scale survey rated psychedelic-induced mystical experiences as significantly *more* mystical, intense, and life-changing than non-drug-induced mystical experiences.

It is all of these changes to consciousness, and their sometimes durable psychological consequences, that the recent renaissance of psychedelic science seeks to understand.

Psychedelic Science

The new wave of psychedelic research has sought, among other things, to reassess earlier claims made in the 1950s and 60s for the therapeutic and transformative effects of this class of drugs, but with higher standards of methodological rigour. Importantly, supervised psychedelic administration in controlled research conditions has been shown to be quite safe in both healthy volunteers and patient populations (Johnson *et al*. 2008). Various small pilot studies have found preliminary evidence for the alleviation of symptoms of depression, addiction, and anxiety lasting several months after just one or two psychedelic experiences (dos Santos *et al*. 2016a, Garcia-Romeu *et al*. 2016). More recently, two larger, double-blind randomized controlled trials have found further evidence for the efficacy of psilocybin in alleviating psychological distress relating to terminal illness (Griffiths *et al*. 2016, Ross *et al*. 2016).

Studies in non-patient populations have also found that psilocybin can induce mystical experiences causing positive personality change lasting over a year in a majority of healthy volunteers (Griffiths *et al*. 2006, 2008, 2011, MacLean *et al*. 2011). Subjects who had mystical experiences rated their psilocybin sessions as among the most personally meaningful and spiritually significant events of their lives. More recently, a smaller study found that a single LSD session caused similar personality changes in healthy volunteers lasting at least a fortnight (Lebedev *et al*. 2016).

Besides studies of therapeutic and transformative effects, much basic research has been carried out aimed at identifying the precise nature and mechanisms of psychedelic effects. Numerous animal and human studies have probed the molecular mechanisms and effects of psychedelics on intracellular signalling, on behaviour, and on measures of neuropsychological function and cognitive processes such as attention, working memory, visual and emotional perception, and creativity (Halberstadt 2015, Nichols 2004, 2016).

One of the most interesting lines of research in the psychedelic renaissance has been the use of modern neuroimaging technologies to probe neural correlates of psychedelic consciousness alteration in humans (reviewed in dos Santos *et al*. 2016b). Positron emission tomography (PET) studies of mescaline and psilocybin in the 1990s consistently found increases in glucose metabolism concentrated in frontal brain regions, suggestive of a pattern of metabolic 'hyperfrontality' in the psychedelic state (Hermle *et al*. 1992, Vollenweider *et al*. 1997).

This finding has since been challenged by functional magnetic resonance imaging (fMRI) studies of the psychedelically intoxicated brain. Carhart-Harris *et al*. (2012) reported that acute intravenous psilocybin administration caused decreases, rather than increases, in neural activity as measured by blood-oxygen-level-dependent (BOLD) signal. Moreover, these decreases were localised to nodes of the Default Mode Network (DMN), a functionally coherent network of brain regions repeatedly implicated in mind-wandering, autobiographical memory, and various aspects of self-reference. Subsequent fMRI studies of psychedelics including LSD and ayahuasca have not replicated all the findings of Carhart-Harris *et al*., but decreased BOLD signal in DMN hubs is a frequent result.

The discrepancy between the fMRI and PET results remains to be explained. Various solutions have been proposed. Carhart-Harris *et al*. (2012) suggested that it might be due to the different time courses of oral vs. intravenous psilocybin intoxication, as well as differences in the temporal resolution of the imaging technologies used - but fMRI studies of the DMT-containing psychedelic beverage ayahuasca, which has a similar time course to oral psilocybin, also found decreases rather than increases in signatures of neural activity. Another possibility is that the BOLD signal measured by fMRI tracks neural synchrony, rather than activity, and the psychedelic state is characterised by decreased synchrony but increased activity in key hub regions (Halberstadt 2015). It is safe to say that more research in this area is required.

Such unresolved issues notwithstanding, fruitful and intriguing theoretical proposals have been made on the basis of the recent spate of fMRI results. Citing their findings that psychedelics increase the unpredictability and diversity of patterns of functional connectivity in the brain, as quantified by the notion of entropy, Carhart-Harris *et al*. (2014) proposed that psychedelics induce a highly entropic state of consciousness by destabilizing key connector hub regions whose activity ordinarily functions to constrain the quality of cognition, orchestrating and coordinating the activity of many large-scale networks to ensure that cognitive resources are directed towards adaptive goals. Speculations about the mechanisms of psychedelic therapy have focused on the idea that by this kind of method, psychedelics can break down entrenched and maladaptive patterns of thought and behaviour, creating a period of greater flexibility from which the cognitive system can re-form into more adaptive patterns (Nichols *et al*. forthcoming).

Despite many open questions concerning functional neuroanatomical details, this broad perspective according to which psychedelics disrupt systems involved in self-reference, leading to temporarily 'unconstrained cognition' with potential therapeutic benefits, sits comfortably with the phenomenology as described earlier, and has formed the basis for many of my arguments in this thesis. I turn now to the non-psychedelic philosophical background to my project.

The Philosophical Background

In recent decades philosophy of science has taken a turn towards recognition of the heterogeneity of science and analysis of the specific and distinctive methods and explanatory strategies deployed in the various special sciences (e.g. Craver 2007, Ross 2014, Sober 2000). Despite the extensive literature on ethical issues relating to drug use, especially for non-medical reasons, psychopharmacology as a discipline has received relatively little attention from a philosophy of science perspective. The notable exception is Stein's (2012) pioneering volume, which discusses conceptual, explanatory, and methodological questions relating to how we classify and categorise drugs and how best to understand their effects on cognition, consciousness and the self (as well as discussing relevant ethical issues.) However, Stein only mentions psychedelics in passing.

A few recent publications suggest that interest in philosophy of psychopharmacology is increasing (e.g. Aragona 2013, Cavanna 2015). The renaissance of psychedelic research constitutes a golden opportunity for this nascent field. All sorts of interesting conceptual and methodological questions are raised by psychedelic science. For instance, given the dramatic acute and long-term effects of psychedelics on mood and behaviour, psychedelic therapy seems like an ideal case study for recently influential ideas about multi-level mechanistic explanation in the life sciences - an issue touched on in the first paper of this thesis. Moreover, there are methodological questions about how to test for therapeutic effects of an intervention for which adequate blinding is difficult if not impossible (Langlitz 2012). In general, recent trends in philosophy of science suggest a need for more philosophical analysis of (psychedelic) psychopharmacology.

Another part of the philosophical context in which my project is situated is the recent spate of interest in re-evaluating the epistemic status of intuitively suboptimal cognitive conditions and processes. There is a long history of philosophical distrust of non-ordinary states of cognition and consciousness, and a tendency to see such conditions not only as highly dubious sources of knowledge, but as positive threats to knowledge (Windt 2011). This tendency is understandably more pronounced in the case of conditions which clearly are attended by obvious psychological or epistemic costs, such as delusion, confabulation, and implicit bias. And the undeniable detrimental psychological effects which can sometimes result from psychedelic experience, combined with the conception of psychedelics as 'psychotomimetic' or 'hallucinogenic' - that is, essentially epistemically detrimental - substances would seem to place psychedelic states squarely in the camp of epistemically bankrupt consciousness alterations.

However, recently a number of philosophers have been arguing that the epistemic status of such 'imperfect cognitions' merits re-evaluation. The literature on 'epistemic innocence' proposes that even cognitive conditions with undeniable epistemic costs sometimes lead to significant and otherwise unavailable epistemic benefits (Bortolotti 2015a, 2015b, Bortolotti and Miyazono 2016, Sullivan-Bissett 2015). In many cases, the argument is that these cognitive conditions can lead to psycho-emotional benefits, and epistemic benefits result from those, since knowledge acquisition is often dependent upon adaptive psycho-emotional functioning. The scientific reassessment of the potential of psychedelics to cause lasting psychoemotional benefits suggests that psychedelic states ought to be subjected to the same kind of epistemological re-evaluation. Moreover, the many distinctive aspects of psychedelic therapy, including frequent claims of epistemic benefit by subjects, mean that the analysis of psychedelic phenomena may have implications for this broader project.

The growing interest in how to tackle the existential anxiety and 'disenchantment' resulting from a naturalistic worldview is another recent philosophical current which is relevant to my concerns here. It has long been appreciated that the transition to a post-religious naturalist metaphysics often evokes anxiety about the absence of traditional foundational sources of meaning. Recently, it has been suggested that this existential crisis is filtering into the broader culture and becoming more acute due to the revolution in the self-image of humankind brought about by advances in contemporary neuroscience (Flanagan and Caruso forthcoming, Metzinger 2009). How to individually and collectively come to terms with this 'neuroscientific turn' in the image of humankind is arguably one of the most urgent philosophical challenges of our age, connecting with a classical Socratic vision of philosophy as concerned with the art of living.

The capacity of psychedelics to induce intense and meaningful transformative experiences immediately suggests their potential relevance to this issue. What is more, there has recently been a spate of philosophical interest in the related project of 'naturalizing spirituality' (Stone 2012). This literature is based on a recognition that the term 'spirituality' can legitimately be used to refer to a kind of personal quest for meaning and transcendence that is in principle independent of traditional religious belief. The question whether such a quest can be undertaken in the spirit of naturalism is interesting and important. Plausibly, something like naturalizing spirituality may form part of a viable response to the 'neuroexistentialist' anxiety resulting from the naturalistic disenchantment of the world. Psychedelic subjects' frequent tendency to describe their experiences as 'spiritual'suggests that an analysis of psychedelic phenomena may help to address some of these issues.

Finally, recent philosophy of mind has taken a distinctly empirical orientation, looking to data from neuroscience and psychiatry to inform its theorizing. This trend is most clearly exemplified in the interdisciplinary enterprise of 'philosophical psychopathology' (Graham and Stephens 1994), which treats observations from the study of psychological disorder as a crucial source of information about the structure of the mind in both normal and abnormal conditions. One of the key concerns of scientifically and psychopathologically informed philosophy of mind has been the nature of self-awareness, a central and ubiquitous mental phenomenon that undergoes sometimes bizarre transformations in altered conditions of psychological functioning (Stephens and Graham 2007, Metzinger 2013). Moreover, such conditions may even offer useful clues to the nature of phenomenal consciousness itself (Brogaard and Gatzia 2016).

The neurophilosophy of self-awareness and consciousness has hitherto drawn on whatever sources have been available, including, to some extent, the study of psychedelics (Metzinger 2003). But the ever-increasing body of new knowledge about psychedelic-induced alterations to consciousness and self-awareness has perhaps not yet been fully philosophically appreciated or exploited. The empirical turn in philosophy of mind is yet another recent development which justifies a detailed philosophical investigation of psychedelic phenomena.

Philosophy of Psychedelics

As I have mentioned, relatively little explicitly philosophical attention has been paid to the psychedelic renaissance. However, that is not to say that none has. I will now describe the few philosophical discussions which are directly relevant to my project of naturalizing the entheogenic conception of psychedelics, before stating the aims and intended contributions of each of the four papers in the thesis.

Benny Shanon is a cognitive psychologist with a philosophical background who has conducted extensive research on ayahuasca. His monograph *The Antipodes of the Mind* (2002) is a landmark work of psychedelic phenomenology. But Shanon has also explored some of the philosophical issues raised by the psychedelic experience.

In his paper 'The Epistemics of Ayahuasca Visions' Shanon (2010) assesses psychedelic subjects' claims of knowledge acquisition from an avowedly naturalistic perspective. He argues that psychedelics (ayahuasca, in particular) can allow a subject to attain therapeutically valuable psychological insight into their own and others' minds and the human condition. This claim is echoed by Metzinger (2003) whose primary concern is the use of psychedelic data to inform theories of self-awareness. Nonetheless, he notes that the apparent therapeutic efficacy of the drugs is readily explained by the hypothesis that they can in fact facilitate valuable insights.

Shanon proposes that other putatively epistemic benefits are accessible by means of psychedelic experience. One of these is the apprehension or appreciation of truths about nature in new and deeper ways that are comparable to the kinds of distinctive and insightful conceptions of things communicated in great art.

Other kinds of epistemic benefits mentioned by Shanon include increased well-being and stamina; more harmonious social interaction; novel solutions to problems in one's field of specialisation; and enhanced abilities of artistic performance and creativity. It is an interesting conceptual question to what extent each of these proposed benefits merits the appellation 'epistemic'.

Shanon says a little about the means by which he thinks ayahuasca-induced visions impart these kinds of knowledge. One is the direct impact of the visions themselves, which are extremely beautiful; merely experiencing such beauty causes a profound affective response leading to changes in attitude and outlook. Sometimes subjects experience visions of entities who instruct them directly; for example, about their field of specialisation. In other cases, vivid visions of past (actual) and future (hypothetical) situations in a subject's life enables them to see abstract features and commonalities of these, particularly when sequences of such scenes are presented juxtaposed in thematic rather than chronological ways. Further, interactive visions can function as a kind of virtual reality, by acting in which a subject can learn problem solving strategies and other things learnable by acting in the real world.

Albeit not explicitly cast in terms of knowledge or spirituality, it is also worth mentioning the work of Kenneth Tupper, an education theorist who analyses the cognitive enhancement potential of psychedelics in a way that seems consistent with naturalism. Drawing on the work of philosophers and education theorists, Tupper (2002) proposes that psychedelic experiences can be a means of accessing "mythic and somatic forms of understanding" that are neglected in contemporary educational practice, and also that they can be a means of increasing a hypothesised "existential intelligence" (Tupper 2003). Thomas Roberts (2013) is another education theorist who has extolled the potential cognitive benefits of psychedelics.

On the other side of the debate, G. T. Roche (2010) critiques the claim that psychedelics can induce epistemically or spiritually beneficial experiences. His two basic grounds for scepticism are that psychedelics disrupt the functioning of the cognitive mechanisms which allow the brain to represent reality accurately, and that drug-inspired claims need independent justification to count as knowledge.

Many of Roche's arguments specifically target putative non-naturalistic knowledge gained from psychedelic states and are therefore irrelevant to my concerns. But he argues that even the potentially naturalistically palatable claim that psychedelics can induce veridical apprehensions of oneness with the universe is untenable because the idea of experience without a subject is contradictory. He also argues that psychedelics cannot reliably yield moral or existential insight, because many putative such insights seem flippant, amoral, or otherwise objectionable, and says that there is no good evidence that psychedelic experiences can lead to scientific insight. Such experiences, for Roche, involve radical distortions of cognition and perception which are obviously inimical to such insight. He also argues against the claim that psychedelics can induce mystical experiences equivalent to non-drug-induced ones.

Against the background of these discussions, here are the aims and intended contributions to the overall project of the four papers in this thesis. In the first paper, 'The Philosophy of Psychedelic Transformation', I begin by arguing for the importance of a rigorously naturalistic philosophical analysis of psychedelic phenomena. I then combine scientific evidence concerning the benefits of psychedelics with ideas from philosophy of science to argue that psychedelic transformation is a distinctively humanistic drug therapy because its mechanism of action involves conscious mental representations. I further suggest that this meaning-involving therapeutic mechanism has epistemic dimensions. Establishing the consciousness- and meaning-involving nature of psychedelic transformation is a prerequisite for naturalizing the entheogenic conception of the drugs, and arguing for epistemic dimensions in psychedelic therapy contributes to this project directly by specifying plausible naturalistic epistemic benefits which are consistent with scientific knowledge about transformative mechanisms.

In the second paper, 'The Epistemic Innocence of Psychedelic States', I extend these efforts by arguing that psychedelics can induce additional epistemic benefits as a consequence of their psychological benefits, and moreover that their epistemic benefits - both direct and indirect - are sometimes not available by any other means. The aim here is to further develop the naturalistic grounds for seeing psychedelics as agents of epistemic benefit, and also to connect these ideas to broader discussions about the epistemic innocence of 'imperfect cognitions'. I emphasize the relevance of these conclusions to policy discussions about psychedelic use.

In the third paper, 'Naturalizing Psychedelic Spirituality', I argue that the beneficial effects of psychedelics on existential distress in terminal illness suggest that these drugs may offer the way to a solution to the neuroexistential anxiety accompanying the naturalistic turn in the image of humankind. I connect this proposal to recent philosophical discussions of naturalized spirituality and argue that many of the transformative aspects of psychedelic states which lead subjects to call them 'spiritual' are independent of non-naturalistic metaphysical apprehensions. This amounts to a naturalistic vindication of the specifically spiritual aspect of the entheogenic conception.

Finally, in the fourth paper, 'Anatomy of an Avatar: Ego Dissolution in Psychedelic Experience', I (with Philip Gerrans) argue that the ego dissolution experiences occasioned by psychedelics can best be explained as a disruption to mechanisms of cognitive binding (i.e. representational integration) which give rise to the experience of self-awareness in ordinary waking consciousness. This contributes to naturalizing the entheogenic conception by vindicating the idea that ego dissolution, a core element of spiritual psychedelic experiences, amounts to a veridical apprehension of the non-existence of a durable substantial self. It also provides a plausible mechanism for many of the pro-epistemic and pro-spiritual qualities of the psychedelic experience in the form of detaching attention and salience from their usual coupling to personal concerns, goals, and agendas.

Many questions remain, and I will mention these in the conclusion section at the end. But in these four papers I will show that despite arguments to the contrary, the idea of psychedelics as agents of epistemic and spiritual benefit is alive and well in light of the recent renaissance of research.

The Philosophy of Psychedelic Transformation

Statement of Authorship

Title of paper:	The Philosophy of Psychedelic Transformation
Publication status:	Published
Publication details:	Letheby, C. (2015). The philosophy of psychedelic transformation. Journal of Consciousness Studies 22, 170-193.
Principal Author	
Name of principal author (candidate):	Christopher Letheby
Contribution to the paper:	Devised the arguments and wrote, proofread, polished, formatted, and submitted the paper.
Overall percentage (%):	100%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature:	
Date:	

Introduction and Methodological Preliminaries

Psychedelic drugs are remarkable substances which have been hailed as indispensable epistemic instruments for the sciences of mind, as unparalleled psychotherapeutic interventions, as unique sources of insight into the nature and genesis of psychosis and religion, and as keys to the survival and flourishing of the human species (Osmond 1957, Sessa 2012). After a politically-driven decades-long hiatus, scientific study of these drugs in humans has resumed with impressive results. Given the magnitude and variety of significance ascribed to the substances, it is surprising that philosophers have not shown much interest in this 'psychedelic renaissance'

Here I aim to remedy this deficit. Recent philosophical work on psychopharmacology focuses on bioethical questions of authenticity and autonomy with respect to enhancement (Parens 2005, Glannon 2008, Stein 2012). As such, this is a natural place to begin philosophical analysis of psychedelic phenomena. The psychopharmacological enhancement literature is driven by a concern that certain psychopharmacological interventions may be dehumanising or may compromise the authenticity or identity of patients. Without committing myself to the view that other drugs do compromise authenticity, I want to explore the notion that psychedelics respect authenticity in a unique way - by involving the person in a transformative process which is somewhat[1] transparent, rational, and meaning-involving.

This is similar in spirit to contrasting utopian and dystopian views of psychopharmacology which the philosopher M. H. N. Schermer (2007) finds in the work of Aldous Huxley. In Huxley's novels, fictional psychedelic-like drugs are depicted as humanising and empowering while fictional non-psychedelic-like drugs are depicted as dehumanising and disempowering (Huxley 1932, 1962). I am not committing myself to the dystopian view of non-psychedelic drugs, but exploring the possibility that psychedelic drugs have uniquely utopian credentials. My conjecture is that this difference arises from the fact that psychedelics engage the self in a humanistic transformative process which is (somewhat) transparent and meaning-respecting, rather than performing sub-personal surgery on the constituent parts of a passive self.

I begin by briefly reviewing the history and phenomenology of psychedelics, and recent evidence for therapeutic and transformative efficacy. Next, I discuss my conjecture about the meaning-involving nature of psychedelic transformation. This conjecture depends on the empirical claim that the altered state of consciousness (ASC) induced by psychedelics is causally relevant to the long-term benefits caused by the drugs. I discuss four lines of evidence for this claim - three briefly, before spending longer on the fourth, which draws on recent neuroscientific studies of psilocybin. This research has been claimed to support a theory of psychedelic transformation which implicates the ASC. I describe this theory and argue that it not only implicates the ASC in the transformative process, but supports the idea that psychedelic transformation is an epistemic process. It is tempting to assume that psychedelics are fundamentally agents of misrepresentation (as suggested by the popular term 'hallucinogen'.) From this perspective, one might think that whatever psychedelic therapy is, it is not a process of knowledge acquisition. I suggest this is too quick, and there are good reasons to think that psychedelic experience can sometimes lead to knowledge gain.

Before I begin, some methodological preliminaries are in order. Here I take a naturalistic approach to the phenomenon of psychedelic transformation. Naturalism is a contested term in contemporary philosophy but minimally is taken to mean a rejection of supernatural entities or realities, and an acceptance that everything which exists forms part of a closed causal system populated by the kinds of entities and properties studied by the natural sciences (Papineau 2009). Many psychedelic experiences - especially profoundly transformative ones - involve the apparent apprehension of non-naturalistic realities, and many subjects believe these apprehensions are veridical (Masters and Houston 1966, Shanon 2002).

Given the preceding observation, why take a naturalistic approach? Firstly, naturalism may well be true. There are strong arguments in its favour which convince most current philosophers of mind that some version of it probably is true (Horst 2009). And if naturalism is true, the correct account of psychedelic transformation is naturalistic. Secondly, if naturalism is false, we can establish this only by reaching its limits. The principle of parsimony (Ockham's Razor) dictates that we posit only what is necessary to explain a phenomenon. This raises the question: what could establish the necessity of positing non-natural realities to explain psychedelic phenomena? The answer, I submit, is: trying, and failing, to explain such phenomena solely in terms of the independently well-motivated naturalistic posits already available to us. Cognitive neuroscience is an interdisciplinary attempt to explain mental phenomena - including consciousness - naturalistically. Its total success or partial failure remains to be seen. But the cognitive neuroscience of consciousness is in its infancy, and presuming its eventual partial failure at this point would be premature[2]. So considerations of parsimony dictate that we assume, at least for the present, that psychedelic consciousness can be explained naturalistically.

There is another good reason to try to naturalize psychedelic transformation. The modern West is unusual among human societies in lacking socially approved ritual techniques for the deliberate induction of altered states of consciousness (Bourguignon 1973). Given the apparent safety and possible benefits of long-term ritual psychedelic use (e.g. Grob *et al*. 1996, Bouso *et al*. 2015) this may well be our loss. But in pluralistic, secular societies, this cultural situation is unlikely to be changed by an argument that psychedelics facilitate access to non-natural realities. Some envision the possibility of psychedelics finding a broader-than-merely-medical role in contemporary society (e.g. Tupper 2003). For this to be possible, we need a metaphysically innocent, naturalistically palatable way of understanding what exactly these drugs offer besides the mimicry or alleviation of psychopathology.

Psychedelic Transformation: An Overview

Psychedelic drugs form a chemically and neuropharmacologically diverse group of substances. What unites them is phenomenology: despite differences in molecular structures and receptor binding profiles, all drugs classified as 'psychedelic' induce a characteristic type of altered state of consciousness. Psychedelic experiences are notoriously variable, being strongly influenced by 'set and setting' - that is, an individual's state of mind prior to ingestion, as well as the interpersonal and aesthetic environment (Sessa 2012). However, virtually every psychedelic experience involves alterations to some non-negligible subset of the following phenomenal modalities: sensory experience, affective experience, spatial and temporal experience, somatic experience, thinking or reasoning, and the sense of self (Strassman 2005). These alterations can be very mild or very intense, and can take the form of distortion, intensification, or diminution of exogenous mental contents, as well as the generation of endogenous mental contents with no apparent basis in the physical environment (Masters and Houston 1966).

This class of drugs has been referred to by a bewildering variety of names, including, but not limited to: hallucinogens, psychotomimetics, mysticomimetics, entheogens, schizogens, psychotogens, and, of course, psychedelics (Osmond 1957, Szara 1967, Ruck *et al*. 1979). This abundance of terminology reflects an abundance of uses. Naturally occurring psychedelics such as mescaline, dimethyltryptamine, and psilocybin have been used as religious sacraments in various cultures for centuries at least. Serious scientific interest in psychedelics was sparked by the accidental discovery in the 1940s of the extremely potent psychoactivity of lysergic acid diethylamide (LSD). In the 1950s and 60s, these drugs were studied and used in several different ways (Sessa 2012).

Psychologists and scholars of religion investigated the relationship between psychedelic intoxication and mystical experience, including, famously, experimental attempts to induce mystical states (Pahnke 1963). Various debates also occurred about whether psychedelic mysticism was equivalent to so-called 'genuine' mysticism or somehow inferior (Smith 1964). Meanwhile, psychiatrists used psychedelics in an attempt to understand mental illness - either by studying the psychedelic state as a 'model psychosis', or by experiencing it themselves in order to empathise with their patients. Somewhat surprisingly, psychiatrists also used psychedelics extensively as treatments. The 'psycholytic therapy' model involved classical psychoanalysis conducted under the influence of low doses of psychedelics, which were held to lower patients' defences and allow access to unconscious content. The 'psychedelic therapy' model, on the other hand, involved administration of high doses of psychedelics in order to induce an intense and overwhelming transformative experience (Sessa 2012).

Psychiatrists were very impressed by the efficacy of psychedelics, claiming extraordinary success rates with treatment-resistant alcoholism, as well as other conditions. However, much psychedelic science from the mid-20th century was methodologically sub-optimal by today's standards, often relying heavily on anecdotal evidence or lacking adequate controls, blinding, or follow-up (Doblin 1991, Strassman 1995a, Grob *et al*. 1998). In any case, after a brief heyday, psychedelics were soon made untenable both as treatments and as objects of research. Widespread uncontrolled use of these drugs in the context of the 1960s counterculture led to a moral panic which culminated in the banning of the substances and the subsequent cessation of human research for several decades (Sessa 2012).

Scientific study of the effects of psychedelic drugs on human subjects resumed in the late 1980s and early 1990s - most notably, with Rick Strassman's pioneering studies of dimethyltryptamine, or DMT (Strassman 1995b). These studies were investigations in basic psychopharmacology and did not involve any formal attempt to test for potential therapeutic or transformative effects (although the researchers were certainly aware of the possibility that such effects might occur; Strassman 2001.) Since then, however, many more studies have been conducted which suggest that the mid-20th century enthusiasm about psychedelics may not have been entirely unfounded. More research is still needed, but there is enough information to justify taking seriously the possibility of durable psychological change resulting from a single administration of a drug.

Psilocybin, the active ingredient[3] in 'magic mushrooms', has been perhaps the most widely studied psychedelic since the resumption of human research. One study involved the administration of psilocybin to 9 patients with obsessive-compulsive disorder, all of whom showed significant reductions in symptoms not only during the drug experience but also at a follow-up 24 hours later (Moreno *et al*. 2006). Another study tested the effects of a psilocybin session on late-stage terminal cancer patients experiencing anxiety related to their illness, and these patients displayed significant reductions in anxiety during the experience as well as at two month follow-ups (Grob *et al*. 2011). A similar study has also been conducted with terminal cancer patients using LSD instead of psilocybin, and similar results were found (Gasser *et al*. 2014). Recent studies have found promising results treating tobacco and alcohol addiction with psilocybin (Garcia-Romeu *et al*. 2014, Bogenschutz *et al*. 2015). Meanwhile, the psychedelic dissociative anaesthetic ketamine has been shown to cause a rapid reduction in symptoms of treatment-resistant major depression, with this reduction lasting up to a fortnight. Ketamine used in conjunction with existentially-oriented psychotherapy has also been shown to lead to higher rates of abstinence in heroin addicts (Vollenweider and Kometer 2010).

Apart from these studies of therapeutic effects, perhaps the most famous study conducted to date in the 'psychedelic renaissance' involved the administration of psilocybin to mentally healthy subjects who had no prior experience with psychedelics and who reported regular participation in religious or spiritual activities. Of the 36 subjects in this study, 22 experienced a 'complete' mystical experience as determined by the Hood Mysticism Scale and the States of Consciousness Questionnaire. A mystical experience in this sense has seven essential phenomenological components: internal and external unity, transcendence of time and space, alleged ineffability and paradoxicality, sense of sacredness, noetic quality, and positive mood (Griffiths *et al*. 2006). What is even more interesting is that those subjects who had a complete mystical experience showed significant increases in the core personality domain of Openness. The extent of these increases was predicted by the extent to which a given subject's mystical experience was 'complete', and the increases were diminished but still significant at 14-month follow-ups (MacLean *et al*. 2011). This is impressive because there are very few interventions which have been shown to cause durable and significant changes in any of the 'Big Five' personality domains in adult subjects.

Thus, there is good reason to think that a single administration of a psychedelic can, in conducive circumstances, lead to durable psychological benefit. I turn now to the nature of the transformative process whereby this occurs.

Evidence for the Causal Relevance of the ASC

As I mentioned earlier, bioethicists discussing psychopharmacological enhancement have expressed a concern that changing human personality by using drugs - especially for non-therapeutic or 'cosmetic' reasons - is inevitably dehumanising. One ground for this concern is expressed in the 2003 report of the President's Council on Bioethics as follows: '...biotechnical interventions act directly on the human body and mind to bring about their effects on a passive subject, who plays little or no role at all. He can at best *feel* their effects without *understanding their meaning in human terms*. Thus, a drug that brightened our mood would alter us without our understanding how and why it did so...' (President's Council on Bioethics 2003, 290; my italics).

Now, even if we disagree with the implicit normative verdict, we can recognise standard drug therapies such as antidepressants in this description. But psychedelic transformation seems different. My project begins by considering the intuition that the process of psychedelic transformation might be distinctive in some important or interesting way. This intuition is fuelled by the fact that most psychedelic subjects would *not* recognise psychedelic transformation in the above description. The phenomenology of psychedelic transformation is the antithesis of this kind of description - subjects feel themselves to be actively engaged in a process of transformation, one which crucially involves meaningful experiences and understanding (Masters and Houston 1966, Shanon 2002).

Of course, this feeling might be misleading. From the fact that it seems to subjects that they are engaged in a meaningful transformative process, it does not follow that they in fact are; they could be mistaken. The existence of this feeling does not preclude the possibility that the therapeutic benefits result from a direct pharmacological effect of the drug, unrelated to the ASC. If that were the case, the ASC - and associated feelings of meaningful transformation - would be a mere side-effect, therapeutically speaking. But note at this point that psychedelics certainly are distinctive psychopharmacological interventions in a couple of respects: they induce a vivid ASC which impresses subjects as meaningful, and they (sometimes) cause lasting benefits with a single dose. Standard drug therapies do neither of these things. This lends some initial plausibility to the idea that the subjects' impressions are accurate - that the durable changes to their cognitive and affective functioning are in fact brought about by a process which involves meanings and involves them as subjects. The idea that intense and meaningful experiences can have lasting effects on people is familiar and unmysterious enough, so we should consider the possibility that this is happening in psychedelic transformation.

Of course, to say that psychedelic transformation 'involves meanings' is imprecise and unsatisfactory. At this point I want to suggest an attractively clear and rigorous interpretation of this claim. I think it's quite natural to construe the claim as follows: the causal chain leading from (a) the ingestion of the psychedelic molecule to (b) the subject's enjoying a durable psychological benefit involves phenomenally conscious mental representations. Or, put differently, the psychological benefits are not caused solely by the drugs, but are caused at least partly by the altered state of consciousness, which itself is caused by the drugs.

Now, as I mentioned earlier, this is an empirical claim. We can render it yet more precise and tractable by understanding it as the hypothesis that the psychedelic experience is causally relevant to the psychological benefits. The philosopher Carl Craver, in his analysis of explanatory practice in neuroscience, develops an account of causal relevance as susceptibility to intervention and manipulation (Craver 2007). According to this analysis, the psychedelic experience is causally relevant to the long-term benefits if, and only if, we can reliably manipulate the latter by intervening to manipulate the former. I think there are at least four lines of evidence that this is the case, which I will discuss briefly in a moment.

Before I do discuss this evidence, though, I want to mention that the interpretation I've given of the claim of 'meaning involvement' is a fairly minimal one. I've construed this as the claim that the psychedelic ASC is causally relevant to the long term benefits. But of course that could be true without there being any interesting semantic relation between the acute drug experience and the durable benefits[4]. To see this, consider the possible world in which psychedelic drugs do nothing but induce in subjects vivid and colourful visions of Mickey Mouse. Suppose that in that world, as in the actual world, psychedelics show therapeutic potential for the treatment of conditions like OCD, addiction, and anxiety. And suppose, further, that the more vividly and realistically a given subject's visions portray Mickey Mouse, the greater the magnitude of the transformation enjoyed by that subject.

In the possible world I've just described, the psychedelic ASC is causally relevant to the long-term benefits. That is, we can manipulate the long-term benefits by intervening on the ASC. For instance, if there is a way to promote vividness and clarity of Mickey Mouse visions in certain subjects, then those subjects will enjoy greater benefits than other subjects who received identical doses but had less clear and vivid Mickey Mouse visions. So the minimal interpretation of the meaning-involvement claim is true in the possible world I've described. Nonetheless, it's pretty clear that the members of the President's Council on Bioethics would be unimpressed. This is because although meaning - by which I mean mental representation - is causally involved, that bare fact does not suffice to make the intervention one whose meaning can be "understood in human terms". What is needed for that is some more substantial semantic relation between the experience and the resultant benefits. A pretty clear example of the kind of relation at issue would be a case in which a person is forced under extreme circumstances to parachute out of a plane and consequently loses their lifelong fear of heights. This person has not only had their personality transformed by a conscious experience, but they can understand why that particular conscious experience should have had that particular effect on their personality.

That is the stronger sense of meaning-involvement: not just conscious mental representations being causally relevant to long-term benefits, but also bearing a semantic relation to those benefits such that the latter are rendered humanly comprehensible and able to be situated in a life narrative. Now, there is evidence that at least some cases of psychedelic therapy or transformation are meaning-involving in this stronger sense. Subjects do report having transformative experiences the content of which is transparently relevant to issues in their lives (Masters and Houston 1966; Shanon 2002). Suffice it to note, however, that the minimal interpretation of the meaning-involvement claim is necessary, if not sufficient, for the stronger one. So I shall here limit myself to arguing for the minimal claim that the ASC is causally relevant to the benefits. I turn now to the four lines of evidence for causal relevance.

The first is the phenomenology of psychedelic transformation mentioned earlier. Again, this is far from conclusive. But psychedelic subjects' belief that the benefits are caused by the intoxication merits attention. One possible naturalistic explanation of this belief is that it is true. Maybe subjects believe the intoxication transformed them because it did[5]. This point would be strengthened by some rigorous research into the relations between ASC contents and long-term benefits. Perhaps there are robust and identifiable correlations between certain specific experiential contents and certain specific benefits. Be that as it may, my claim here is just that the tendency of psychedelic subjects to report being transformed by a meaningful experience is a suggestive datum not to be ignored.

The second line of evidence concerns the existence of psychologically beneficial altered states of consciousness not induced by drugs. For example, there is evidence that psychological benefits can result from meditation practice (for reviews, see Davis and Hayes 2011, Goyal *et al*. 2014). Also, relationships have been found between non-drug-induced mystical experiences and measures of subjective well-being (Byrd *et al*. 2000) and durable, (largely) positive life changes are often reported following non-drug-induced near death experiences (Greyson 1997) - though there are obvious obstacles to studying such experiences in a controlled fashion. To the extent that these other altered states resemble psychedelic states, this suggests that the neuropharmacological action of the drugs is an inessential and in principle dispensable means to entering the altered state, which latter does the therapeutic work.

Of course, the question of similarities and differences between altered states is complex. But there is at least some evidence of commonalities between psychedelic and meditative states, as various psychedelic researchers have noted (Hoffmann *et al*. 2001, Palhano-Fontes *et al*. 2015, Stuckey *et al*. 2005). Deactivation of the posterior cingulate cortex has been observed to correlate with subjective experiences of selflessness (or ego dissolution) occasioned by both methods (Brewer *et al*. 2013). Various kinds of unusual experiences popularly associated with psychedelics are also frequently occasioned by meditation practice. Indeed, the sample data in Jack Kornfield's (1979, 45-50) phenomenological study of Buddhist insight meditation read like a compendium of psychedelic phenomena. Such observations as these form part of the motivation for empirical studies, currently in progress, testing the efficacy of psilocybin as an adjunct to meditation training (Brown and Reitman 2010).

One might object that this line of evidence relies on a spurious and unsustainable ontological distinction between the psychedelic ASC and the neuropharmacological action of the drug. Surely the ASC and the neuropharmacological action are in fact one and the same phenomenon, viewed at different levels of description. The evidence suggests this is not the case, however. Certainly the ASC is entirely constituted by abnormal patterns of neural and synaptic activity. Not all of this activity directly involves the psychedelic molecule, however. Psilocybin, for example, causes its psychological effects mainly by stimulating 5- HT2A receptors, which are found primarily on pyramidal neurons in cortical layer V (Carhart-Harris *et al*. 2014). The abnormal patterns of activity in these regions are at least partly constituted by the synaptic action of the drug itself. But abnormal activity in these regions leads in turn to abnormal patterns of activity in other (e.g. subcortical) regions to which these regions project, and those latter patterns are caused but not constituted by the drug action. We can express this by saying that the neuropharmacological action of the drug is a partially distinct sustaining cause of the ASC - only partially distinct because also partially constitutive, and sustaining because the ongoing drug action is necessary for the continuation of the psychedelic state. What I am suggesting, then, is that more variables than the direct drug action are involved in understanding the long-term effects. The downstream effects of that action in other brain regions are also important, and these effects are presumably a function not just of the direct drug action but of the prior state of the downstream systems (part of the 'set' in 'set and setting'.)

The third line of evidence that the ASC is causally relevant to the benefits relates to the fact that in some cases, variables quantifying the ASC have been found to predict variables quantifying the benefits. For instance, in the psilocybin mystical experience study mentioned earlier, the extent to which a subject's experience was mystical predicted the magnitude of increases in their personality domain of Openness (MacLean *et al*. 2011). This seems like clear evidence for causal relevance, in Craver's sense: evidence, that is, that if we could 'manipulate' psychedelic ASCs by creating conditions conducive to their being mystical, this would be a reliable means of manipulating the long-term benefits (in the direction of greater Openness increases.)

The question whether the psychedelic ASC is causally relevant to therapeutic benefits has been explicitly addressed by recent studies of ketamine. One small study of cocaine addicts involved three separate sessions: low dose ketamine, high dose ketamine, and lorazepam as an active placebo (Dakwar *et al*. 2014). These different infusions were given to subjects in a double-blind fashion on separate days. Psychological effects of each infusion were assessed using two different scales: one to measure dissociative type effects, and another to measure mystical type effects. It was found that higher mystical effect scores predicted increased motivation to quit cocaine, while higher dissociative effects did not. Further, variance in mystical effect scores predicted variance in increased motivation even across consistent dosages. That is to say that when you compare all the high-dose ketamine sessions, drug dosage is consistent between subjects. But there is variation in the kind of altered state subjects experienced, and this phenomenal variation predicts variation in therapeutic benefits 24 hours after the session. Once again, this is evidence that we can manipulate the lasting benefits by 'intervening on' the ASC, independently of drug dosage.

Such evidence for relationships between phenomenal variables and benefit variables is important. It would be considered a truism by those with firsthand experience of psychedelic research that the quality of the experience is relevant to the long-term outcome and can vary independently of dosage. Certainly it is possible for two people to consume an equivalent dose of a psychedelic but have vastly different experiences, one enjoying a mystic rapture and the other a nightmarish 'bad trip'. In such a case it would be very surprising if the long-term psychological consequences for the two people were the same[6]. But of course such clinical and anecdotal wisdom needs rigorous testing. It has been suggested that classic psychedelics and dissociative anaesthetics (such as ketamine) may share a common therapeutic mechanism in ultimately targeting glutamate-driven neuroplasticity (Vollenweider and Kometer 2010). One possibility is that this is sufficient for relatively long-term (i.e. weeks) psychological change but further, more specific experiential factors are required to capitalise on this neuroplastic window of opportunity and yield truly durable change[7]. The current instruments used in psychedelic research are relatively coarse-grained; they measure such variables as 'visionary restructuralization' but not specific experiential contents. Perhaps the development of more fine-grained psychometric instruments might reveal further interesting correlations between acute and long-term drug effects.

So, to recap: I construed the conjecture that psychedelic transformation is meaning-involving as entailing (at least) the empirical claim that the altered state is causally relevant to the benefits. Thus far, I've mentioned three kinds of evidence for that causal relevance claim: first, phenomenology; second, beneficial non-drug altered states; and third, correlations between phenomenal variables and psychological benefit variables. I turn now to the fourth line of evidence. This is based on recent neuroimaging studies of the psychedelic state, and also leads to questions about the potentially epistemic nature of psychedelic transformation.

Recently a team led by Dr. Robin Carhart-Harris of Imperial College London gave intravenous injections of psilocybin to healthy volunteers lying in fMRI machines (Carhart-Harris *et al*. 2012). When given intravenously, psilocybin has a very rapid onset and a short duration, which not only makes it practicable for neuroimaging but also allows very precise imaging of the transition from ordinary consciousness to psychedelic consciousness.

The findings from this study were fascinating in a number of respects. Notably, the transition to the psychedelic state involved only decreases, and no increases, in brain activity. This contradicts previous assumptions that psychedelics work by increasing brain activity, and so requires some explaining in its own right. Even more interesting, however, was the localization of these decreases. They were mainly found in the much-discussed Default Mode Network, so-called because it has the interesting property of being most active when a subject is at rest and not engaged in any particular task. When a cognitive or behavioural task is begun, activity in the DMN decreases and activity in other networks correspondingly increases (Raichle *et al*. 2001).

The DMN is also interesting because it displays significantly higher metabolic activity than the average brain region and is extremely densely connected to many other regions. This suggestive set of observations has led to a lot of debate about what exactly the DMN does. Its role is still a matter of controversy, but it has been implicated in various self-referential and metacognitive functions, including daydreaming and 'mental time travel' - that is, the simulation of past and future events (Spreng and Grady 2010). Some theorists have also linked the DMN to the 'narrative self' (D'Argembeau *et al*. 2014).

In discussing their findings, Carhart-Harris and colleagues note that not only did activity in various DMN regions diminish under psilocybin, but many of the normal patterns of connectivity both internal and external to the DMN were disrupted. The result, from the standpoint of global neural dynamics, was a system in a much more disordered and unpredictable state than is ordinarily the case. The authors speculate that this is because the DMN ordinarily acts as a supervisory system which imposes inhibition and constraint on other cognitive systems, and hence disruption to the DMN in the psychedelic state results in a condition of unconstrained cognition (Carhart-Harris *et al*. 2014).

Most relevant to my concerns here are the speculations Carhart-Harris and colleagues make about the mechanisms of psychedelic therapy. They note that various conditions for which psychedelics show therapeutic promise - including OCD, depression, and addiction - can illuminatingly be characterised as 'over-rigid' conditions. A depressed or obsessive system is one trapped for whatever reason in a narrow region of state space. In light of this, they propose that a psychedelic experience might be therapeutic because it forcibly shakes the system out of its rut, freeing it from its rigid confinement and leaving a greater dynamical flexibility which outlasts the experience itself. The point of this, of course, is that this is a conjectural model of psychedelic therapy on which the experience is certainly causally relevant to the benefits[8].

It is important to note that the psychedelic experience and subsequent benefits are here being described in purely dynamical terms. This raises interesting questions about different levels and kinds of explanation in the cognitive sciences. There are long-running debates about the explanatory credentials of dynamical models (e.g. van Gelder 1998, Kaplan and Bechtel 2011) and the case of psychedelic therapy readily reveals the limitations of such models alone. Carhart-Harris *et al*. place great importance on entropy as a quantifiable explanatory construct in understanding the mechanisms of psychedelic therapy. However, transiently elevated entropy is insufficient for therapeutic benefit. This is because two different psychedelic experiences could be equally entropic even though one is a blissful mystical-type experience which leads to durably increased openness and the other is a hellish bad trip which leads to trauma and subsequent nightmares. (Such results do occur, although they are very rare in carefully conducted controlled research.) It may be that de-rigidifying the cognitive system by elevating its entropy is necessary but not sufficient for therapeutic benefit, and it is also necessary that the experience have contents of a certain kind. Acute psychotic experiences presumably involve elevated entropy, though they are distinct from controlled psychedelic states in at least three important ways: they are not voluntary, they are not of a fixed and known duration, and they are not accompanied by insight. All this notwithstanding, the neuroimaging studies combined with the rigidity characteristic of depression and other conditions do provide some evidence that increasing cognitive flexibility is an element of the therapeutic process. Therefore, the studies constitute a fourth and final line of evidence that the psychedelic experience is causally relevant to the long-term benefits. So there is good reason to accept the descriptive claim that psychedelic transformation is a distinctively meaning-involving psychopharmacological intervention.

I emphasise that this is a descriptive claim because I am refraining from entering into the normative bioethical debates about the relative merits of meaning-involving and non-meaning-involving transformative processes. I think the meaning-involving nature of psychedelic transformation is surely a fact highly relevant to policy debates, but my project here is purely descriptive. For me, the next interesting set of issues concerns exactly what kinds of meanings are respected or involved in psychedelic transformation, and how.

Epistemic Aspects of Psychedelic Transformation

Psychedelic subjects very often feel that they gain knowledge through their experiences. However, they also reasonably often come to entertain non-naturalistic metaphysical beliefs as a consequence of their experiences (Vaughan 1983, Strassman 2001, Shanon 2002). It is an interesting question what to say about this from a naturalistic perspective. Is the sense of epistemic benefit experienced by these subjects simply illusory? Or is there some kind of naturalistically palatable epistemic benefit which subjects might indeed be gaining, notwithstanding such metaphysical conversions? I think there are perfectly naturalistic epistemic benefits which may well result from psychedelic states.

The first one follows very naturally from the 'unconstrained cognition' theory of the psychedelic state. If this theory is correct, then cognitive systems, while psychedelically intoxicated, traverse wider regions of state space than they do at other times. Often they enter into completely novel and unfamiliar regions of state space, and often these are very distant from the more familiar regions of ordinary waking consciousness. In light of this, I propose that psychedelic experience can be a means of gaining knowledge by acquaintance of one's own vast psychological potential.

Consider, for example, Aldous Huxley. Prior to his famous mescaline experience in 1952, Huxley was a serious student of the mystical literature of the world's religions. He had knowledge by description - by testimony, in fact - of the existence of certain regions of the human phenomenal state space. He believed, truly and justifiably, that there existed certain possible ways for his mind to be - arguably intrinsically and instrumentally valuable ways featuring such things as intensified perceptions and emotions, greatly enhanced appreciation of the world, and a sense of kinship with all of existence. But he may well have doubted, as do many aspiring mystics, that these ways of being were genuine possibilities *for him*. After the 3*rd* of May, this doubt was gone. Huxley had acquired a new kind of knowledge about the potential of his mind - he had become directly acquainted with its ability to enter states of absorption, harmony, and unparalleled wonder and awe (Huxley 1994). In this context, it is worth mentioning that many senior Western teachers of meditation were inspired by experiences with psychedelic drugs in the 1960s (Badiner and Grey, eds. 2002, Dass 2005). It is plausible to think that they were drawn to the discipline of meditation because they gained knowledge about the immense potential of their own minds. They were then driven to investigate the possibility of realising the potential about which they had gained knowledge.

So psychedelic experiences may well be a means to acquire knowledge by acquaintance of one's own psychological potential. This is, of course, perfectly naturalistic. A second naturalistically palatable kind of knowledge which such experiences might afford is slightly more controversial. This is knowledge by acquaintance[9] with the metaphysical nature of the self.

As I mentioned earlier, some theorists have speculated that the Default Mode Network is the neurocognitive substrate of the narrative self - the sense of one's persistent identity as a distinct individual with a history, which sense is constituted by narratively structured representations of one's past and future. Some theorists inclined towards the research programme known as 'neuropsychoanalysis' have even suggested that the DMN is the substrate of the Freudian ego (Carhart-Harris and Friston 2010). While remaining agnostic on the precise details, the fMRI studies of psilocybin mentioned earlier offer suggestive evidence about the neurocognitive substrate of the sense of self (Carhart-Harris *et al*. 2012). One of the key nodes of the DMN is the posterior cingulate cortex (PCC). In the studies in question, there was a strong correlation between decreases in PCC activity and ratings for one specific item on the psychological questionnaire used to quantify subjects' experiences. This item, scores for which tracked diminution in PCC activity, read as follows: "I experienced a dissolution of my self or ego" (Carhart-Harris *et al*. 2014).

Obviously a more careful treatment of this point is required. But I think the fact that the psilocybin-induced deactivation of the PCC leads subjects to report a dissolution of their ordinary sense of self suggests that, no matter how real and inviolable it feels in the normal course of things, the sense of self is in fact a model of some kind[10] generated by specific cognitive systems in the brain (cf. Metzinger 2003, 2009). On the basis of ordinary waking life, it is tempting to assume that an experiencing subject is a transcendental precondition for the possibility of experience - that the idea of experience without a self is incoherent. The idea here is that this assumption is false - it is a case of incorrectly inferring necessity from constant conjunction - and psilocybin subjects become directly acquainted with this fact. That is, they gain experiential knowledge of the contingency of their own sense of self by experiencing its temporary subtraction from their phenomenal space. Even if this does not show the sense of self to be a *mere* model, the possibility of experience without the feeling of a subject - the possibility of "thoughts without a thinker” (Epstein 2004)—is a striking discovery to make.

It should be clear that there is no contradiction in the idea that psychedelic therapy is a person-involving process which happens to involve a dissolution of the sense of self. It is quite consistent and plausible to think that the sense of self is a mere part of persons considered as experiencing entities - this sense is just one type of experience which such entities typically, but not invariably, have. It is the person, in the sense of the conscious cognizing organism, which has, and unproblematically later remembers, the experience of ego dissolution.

The two suggestions I've made so far concern the possibility of direct epistemic benefit, of gaining knowledge during the psychedelic experience itself. I will finish by proposing one way in which a transformative or therapeutic psychedelic experience might lead to indirect epistemic benefit. This is by restoring the capacity to acquire modal knowledge[11] by restoring the subject's imaginative flexibility.

People suffering from depression, for instance, have difficulty imagining other ways that they could be or certain courses of action they could take. Part of the rigidity mentioned earlier is imaginative rigidity. Once again, the system is trapped in a narrow region of state space and tends not to envision creative solutions to problems or novel behavioural strategies. This seems straightforwardly to be a state of impoverished modal knowledge. There are possibilities available, but the suffering subject is unable to imagine these possibilities and thus unable to know of their availability. In this light, consider the conjectural dynamical model of psychedelic therapy: the system is temporarily unconstrained, conferring a degree of freedom and flexibility, some measure of which outlasts the acute experience. One way this greater flexibility could manifest is as an increased ability to imagine possibilities. And a greater ability to imagine possibilities is, at least, a higher level of access to putative modal truths about oneself and one's life.

Conclusion

To summarise: psychedelic drugs form a phenomenally defined class which includes serotonin agonists such as LSD, DMT, psilocybin and mescaline, as well as dissociative anaesthetics such as ketamine, and other drugs besides. Psychedelic drugs induce a distinctive and intense kind of altered state of consciousness which is different from the altered states induced by drugs of other classes. Psychedelics have been studied again in the last two decades as therapeutic and transformative agents, yielding evidence that they can cause lasting psychological benefits with a single dose or with very few doses.

Some bioethicists worry that cosmetic psychopharmacology is dehumanising because drugs transform passive subjects in a way that is subjectively opaque and not comprehensible in meaningful human terms. A passing acquaintance with the literature on psychedelic therapy leads to the intuition that psychedelic transformation is unlike this. In particular, it seems to be more transparent and meaning-involving. I precisified this intuition as the claim that the psychedelic ASC is causally relevant to the long term benefits, and reviewed four lines of evidence for this claim. These were: first, the phenomenology of psychedelic transformation; second, the existence of beneficial non-drug altered states; third, correlations between phenomenal variables and benefit variables in a dose-independent fashion; and fourth, the de-rigidifying model of psychedelic therapy based on neuroimaging results.

In closing, I suggested three naturalistically palatable kinds of epistemic benefit which might derive from psychedelic experiences: two direct, and one indirect. The first direct kind of benefit is acquiring knowledge by acquaintance of one's own psychological potential. The second direct kind of benefit is acquiring knowledge by acquaintance of the contingency of one's sense of self. And the indirect kind of benefit is a rejuvenation of cognitive capacities which are important for the acquisition of modal knowledge. Many questions remain, but the old idea of drug-induced epistemic benefit merits serious attention, even given naturalism[12].

The Epistemic Innocence of Psychedelic States

Statement of Authorship

Title of paper:	The Epistemic Innocence of Psychedelic States
Publication status:	Published
Publication details:	Letheby, C. (2016). The epistemic innocence of psychedelic states. Consciousness and Cognition 39, 28-37.
Principal Author	
Name of principal author (candidate):	Christopher Letheby
Contribution to the paper:	Devised the arguments and wrote, proofread, polished, formatted, and submitted the paper.
Overall percentage (%):	100%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature:	
Date:	

Introduction

The recent renaissance of scientific research into psychedelic drugs has provided evidence that these controversial substances can confer lasting psychological benefits in just one or two sessions. Small studies have found promising results using LSD and psilocybin to treat addiction (Johnson *et al*. 2014, Bogenschutz *et al*. 2015), obsessive-compulsive disorder (Moreno *et al*. 2006), and anxiety relating to terminal illness (Grob *et al*. 2011, Gasser *et al*. 2014). This method is unlike existing psychiatric treatments in that it relies crucially on the temporary induction of a dramatically altered state of consciousness (Letheby 2015), at least in some cases (Majiæ *et al*. 2015). While in this altered state, patients often have extremely convincing experiences of what seems to be a mystical, immaterial ultimate reality underlying the universe, and there is some reason to think that these mystical experiences can be important for the therapeutic effects (Bogenschutz and Johnson 2015, Majiæ *et al*. 2015). Indeed, one eminent scholar of religion has said that "the basic message of [these drugs is] that there is another Reality that puts this one in the shade" (Smith 2000). This raises difficult questions. Michael Pollan, writing in the New Yorker recently, put it well:

> It's one thing to conclude that love is all that matters, but quite another to come away from a therapy convinced that "there is another reality" awaiting us after death ... or that there is more to the universe - and to consciousness - than a purely materialist world view would have us believe. Is psychedelic therapy simply foisting a comforting delusion on the sick and dying?
> (Pollan 2015).

In this paper I argue that even if psychedelic therapy is "foisting a comforting delusion on the sick and dying" it is not *merely* doing so. To make this argument, I rely on conceptual resources developed in epistemology, the philosophical study of knowledge. The philosopher Lisa Bortolotti and colleagues (Bortolotti 2015a, 2015b, Bortolotti and Miyazono 2016, Sullivan-Bissett 2015) have recently introduced the concept of 'epistemic[13] innocence' to articulate the idea that certain epistemically sub-optimal states such as delusion and confabulation may have not just psychological but epistemic benefits. They urge us to resist a simplistic trade-off view according to which psychological benefits are purchased with epistemic costs. I apply their analysis to psychedelic therapy and argue that at least some psychedelic states are epistemically innocent imperfect cognitions.

I proceed as follows. In section 1, I give a brief overview of psychedelic therapy: the history and phenomenology of these drugs and recent evidence for their therapeutic and transformative efficacy. In section 2, I describe the concept of epistemic innocence and its application by Bortolotti to delusion. In section

3, I argue that psychedelic states can have significant epistemic benefits. This discussion touches on some interesting issues arising from the fact that psychedelic states, unlike many other imperfect cognitive conditions, are voluntarily entered. In section 4, I argue that often no alternative cognitions are available which will deliver the same epistemic benefits as psychedelics. In the course of making this argument, I highlight a potential ambiguity in the formal definition of epistemic innocence. Finally, in section 5, I reflect on the implications of my discussion. The epistemic innocence of psychedelic states has broad consequences. Mounting evidence for the benefits of psychedelics is leading to a re-evaluation of the potential of these substances as tools in psychiatry and beyond (e.g. Sessa 2005, 2008, Sessa and Johnson 2015). I argue that such policy discussions ought to be based on a comprehensive understanding of the merits and demerits, epistemic included, of the drugs.

Psychedelic Therapy: An Overview

There has recently been a renaissance of scientific research into the effects of psychedelic drugs on human subjects in controlled conditions. Although more evidence is required, including replications with larger sample sizes, the results to date give us good reason to take seriously the idea that these drugs can durably change personality and alleviate psychiatric distress with just one or two administrations. In this section, I give a brief history of psychedelics, followed by a review of the recent evidence for therapeutic and transformative efficacy, in order to set the scene for my discussion of epistemological issues.

Sporadic earlier research notwithstanding, the story of modern psychedelic science really begins in 1943, when the Swiss chemist Albert Hofmann accidentally ingested a minute quantity of lysergic acid diethylamide or LSD-25, a chemical he had been developing for medicinal purposes. He famously described the result as follows:

> At home I lay down and sank into a not unpleasant intoxicated-like condition, characterised by an extremely stimulated imagination. In a dreamlike state, with eyes closed … I perceived an uninterrupted stream of fantastic pictures, extraordinary shapes with intense, kaleidoscopic play of colours.
> (Hofmann 1980).

Shortly afterwards, it was recognised that LSD's effects were similar to those of the naturally occurring substances mescaline, found in the peyote cactus, and psilocybin, found in 'magic' mushrooms. British psychiatrist Humphry Osmond (1957) coined the term 'psychedelic', meaning 'mind-manifesting', to describe this newly recognised class of drugs with its distinctive profile of effects. The three drugs I have mentioned not only produce similar effects but act by a common mechanism: stimulation of serotonin 2A receptors (Halberstadt 2015). Various other drugs which produce similar effects by different mechanisms of action have also been classified as 'psychedelic' (Sessa 2012). However, here I restrict myself to discussing the so-called 'classic' serotonin 2A agonist psychedelics (apart from a brief mention of the NMDA antagonist dissociative anaesthetic ketamine, also currently being studied for its therapeutic potential.)

Describing the effects of psychedelics in general is difficult for at least two reasons: first, because they are often held to defy description, and second, because they are extremely variable, being highly dependent on 'set and setting' - that is, the subject's prior state of mind and the external environment. One definition holds that a psychedelic is a drug

> which, without causing physical addiction, craving, major physiological disturbances, delirium, disorientation, or amnesia, more or less reliably produces thought, mood, and perceptual changes otherwise rarely experienced except in dreams, contemplative and religious exaltation, flashes of vivid involuntary memory, and acute psychosis.
> (Grinspoon and Bakalar 1979).

Such "thought, mood, and perceptual changes" might include seeing static objects as moving or warping, vast and colourful visions of ancient civilizations with the eyes closed, emotional extremes of euphoria or terror, or a sense that one's ordinary everyday identity has dissolved into a timeless ultimate reality - to name just a few (Masters and Houston 1966). Very often there is a sense of insightfulness, understanding, or new perspectives, either with respect to personal life issues or with respect to broader - often philosophical - themes (*ibid.*, Shanon 2002).

Psychedelics have been used for religious and medicinal purposes by traditional cultures for centuries, if not millennia (Masters and Houston 1966). After coming to the attention of Western science in the 1940s, they were studied from several different perspectives. The 'psychotomimetic' paradigm emphasised the similarity between psychedelic states and naturally occurring psychotic states. Researchers in this paradigm studied psychedelics to try to gain clues about the biochemical basis of mental illness, while psychiatrists sampled psychedelics in order better to empathise with their psychotic patients (Osmond 1957).

Remarkably, as well as being used to model mental illness, psychedelics were used to treat it. Psychotherapy with psychedelics tended to follow one of two models: 'psycholytic therapy' involved classical psychoanalysis conducted under the influence of low doses of psychedelics, on the grounds that the drugs lowered psychological defensiveness and provided access to unconscious material; 'psychedelic therapy', meanwhile, involved the administration of high doses of psychedelics in order to induce an overwhelming, transformative 'peak' or 'mystical' experience (Grinspoon and Bakalar 1986). Clinicians were very impressed with the therapeutic efficacy of psychedelics, but most of this early research was methodologically problematic by today's standards. Studies often lacked control groups, blinding, and follow-ups, and relied heavily on anecdotal evidence (Sessa 2005). However, one recent meta-analysis of early research did find evidence for the efficacy of high-dose LSD in the treatment of alcoholism (Krebs and Johansen 2012).

Ultimately scientific research and clinical practice with psychedelics was curtailed after the drugs became politically controversial in the 1960s. Widespread uncontrolled use by members of the hippy counterculture led to a highly emotive public debate which culminated in the prohibition of psychedelics. After this, virtually no human research was conducted for some decades (Sessa 2005).

Since the early 1990s, in a changed political climate, human research with psychedelics has slowly but steadily resumed, with intriguing results. Importantly, it has been demonstrated repeatedly and rigorously that it is possible safely to give moderate or high doses of psychedelics to carefully screened and prepared subjects in controlled clinical settings without serious adverse effects (Johnson *et al*. 2008). Various studies have also examined the drugs' therapeutic and transformative potential.

In one study, 9 patients with obsessive-compulsive disorder, all of whom had failed to respond to standard treatments, showed significant reductions in symptoms during the drug experience and at a follow-up 24 hours later (Moreno *et al*. 2006). Another study tested the effects of a psilocybin session on terminal cancer patients experiencing anxiety, and these patients showed significant reductions in anxiety and depression during the experience and at follow-ups two and six months later (Grob *et al*. 2011). A similar study using LSD instead of psilocybin found similar results (Gasser *et al*. 2014). Recent pilot studies have found promising results treating tobacco and alcohol addiction with psilocybin (Johnson *et al*. 2014, Bogenschutz *et al*. 2015). Promising results have also been found using ayahuasca, a South American shamanic beverage containing the classic psychedelic DMT, to treat addiction (Thomas *et al*. 2013) and depression (Osório *et al*. 2015).

Another study examined the effects of psilocybin on mentally healthy religiously-inclined volunteers. 22 of 36 subjects had a 'complete' mystical experience as measured by psychometric scales, involving feelings of unity, transcendence of time and space, and extreme positive affect (Griffiths *et al*. 2006). Those who had a mystical experience showed increases in the personality dimension of openness which were diminished but still significant 14 months later. Importantly, the intensity of their mystical experience predicted the extent of their increases in openness (MacLean *et al*. 2011).

This brief review of recent research reveals substantial evidence that psychedelic drugs can cause lasting psychological benefits with just one or two doses. The mechanism whereby they achieve this result remains uncertain but there is reason to think that the altered state of consciousness induced by the drugs is crucially involved. Specifically, mystical states of consciousness seem to have the greatest therapeutic benefit. In the psilocybin study just mentioned, the extent of mystical experience predicted the degree of personality change. And in the study of psilocybin for tobacco addiction, mystical experiences predicted therapeutic outcome (Garcia-Romeu *et al*. 2014). In the alcoholism study, mystical experience - as well as overall intensity of drug effects - predicted improvements to drinking behaviour (Bogenschutz *et al*. 2015).

From the perspective of philosophical naturalism - the view that the natural world is all that exists - such mystical experiences must be considered illusory, which leads to a troubling picture indeed. A treatment modality which has been hailed as the "next major breakthrough in mental health care" (Jacobson 2014) seems to work, at least in part, by inducing highly compelling metaphysical illusions. For help in thinking about this situation, I turn now to the recent philosophical work on epistemic innocence.

The Concept of Epistemic Innocence

The common saying 'ignorance is bliss' encapsulates the familiar idea that epistemically suboptimal cognitions can cause psychological benefits. Consider the case of motivated delusions. Delusions, in general, are very difficult to define without controversy, but one relatively neutral description holds that they are "strange beliefs[14] which appear in the context of mental distress" (Bortolotti 2013). Delusions may be elaborate, complex narratives accounting for much of a person's experience, as in schizophrenia, or they may be more circumscribed. A certain subclass of circumscribed delusions has been described as 'motivated delusions' on the grounds that these delusions may serve a defensive function, protecting people from the negative psychological consequences of facing unpleasant or devastating truths. Examples of motivated delusions include Reverse Othello syndrome, the delusion that one's romantic partner is faithful; erotomania, the delusion that a stranger - often a famous person - is in love with one; and anosognosia, the denial of illness (Bortolotti 2015a).

Lisa Bortolotti (*ibid.*) notes that solely motivational explanations of the formation of many of these delusions are implausible. However, irrespective of what role, if any, motivation plays in their formation, it is plausible that such delusions can be psychologically beneficial in the kinds of circumstances in which they are typically held. Bortolotti discusses a few cases, including that of 'BX', a musician whose partner left him after he was rendered quadriplegic by a car accident. BX later developed Reverse Othello syndrome, becoming convinced that not only were he and his former partner still together, but that they had married. It is not difficult to see how this delusion could have psychologically benefited BX by saving him from confronting the totality of the awful truth of his situation. He was both quadriplegic *and* single; his life as he knew it had fallen apart. Accepting this could have been utterly debilitating.

Bortolotti discusses other cases for which similar points can be made. One is that of 'LT', a reserved, socially isolated and lonely person, who had recently been through an abrupt relationship break-up and had subsequently developed erotomania. Her erotomania took the form of a delusion that a former fellow student, to whom she had never spoken, was in love with her. It is easy to see how this delusion could have provided psychological consolation given her situation. And the same point can be made for anosognosia - the denial of illness - which often emerges in the context of a traumatic or sudden injury.

When we think about such cognitive conditions as these delusions, it is natural to assume a fairly straightforward 'trade-off' picture according to which, whatever psycho-emotional benefits they may have, their only epistemic effects are detrimental. They may increase a person's happiness or well-being, but they only ever decrease a person's knowledge. Bortolotti argues that often the picture is more complicated. She notes that in addition to the kinds of psychological benefits described above, delusions very often have detrimental psychological effects, putting strain and stress both on the agent's internal cognitive processes and on their relationships with others. The epistemic picture, she says, can be similarly mixed: despite their obvious epistemic costs, such cognitive conditions can deliver significant epistemic benefits which are otherwise unavailable to the agent at that time.

Bortolotti introduces the concept of 'epistemic innocence' to articulate this idea. She proposes two conditions which an imperfect, or epistemically sub-optimal, cognitive process must meet to nonetheless qualify as epistemically innocent. The first of these is the 'Epistemic Benefit' condition: "The [sub-optimal cognitive process] confers a significant epistemic benefit to the agent at the time of its adoption"; and the second is the 'No Alternatives' condition: "Other [cognitive processes] that would confer the same benefit are not available to that agent at that time" (Bortolotti 2015a, 496). Having defined the concept thus, she argues that motivated delusions sometimes satisfy these two conditions.

The concept of epistemic innocence is based on the legal notion of an 'innocence defence', in which an act which would ordinarily be a criminal offence can be excused on the grounds that it was necessary to prevent catastrophe. As we will see shortly, Bortolotti thinks the epistemic status of motivated delusions is sometimes analogous to this: they prevent epistemic catastrophe by committing what would ordinarily be an epistemic crime. The epistemic offence is excused by virtue of its constituting an "acceptable response to an emergency" (Bortolotti 2015a, 495). It is worth noting that this is a richer notion than is captured by the minimal, formal definition of epistemic innocence cited above, which includes no explicit reference to the prevention of catastrophic outcomes. I think this is a strength, not a weakness, of the formal definition. The cases of psychedelic therapy which I will discuss below do not all fit the catastrophe-prevention or emergency-response model. But they do fit the more minimal conception of an epistemic cost being somewhat offset by a significant and otherwise unavailable epistemic benefit. This minimal conception has the advantage of illuminating such cases, not just those which more closely fit the original analogy. Like the cases of implicit bias-driven confabulation discussed by Sullivan-Bissett (2015), psychedelic therapy highlights the broader significance of the concept of epistemic innocence as formally defined. It is not merely a defence of epistemically costly emergency responses, but an invitation to "a more balanced view of the role of [imperfect cognitions] ... [and] a reflection on the role of contextual factors in epistemic evaluation" (Bortolotti 2015a, 490).

Let us return to Bortolotti's arguments for the epistemic innocence of motivated delusions. With respect to the Epistemic Benefit condition, the basic idea is that when these delusions cause psychological benefits, those in turn cause epistemic benefits. Insofar as the Reverse Othello syndrome developed by BX protected him from total psychological collapse, it enabled him to keep communicating and engaging with doctors, nurses and visitors. And communicating with others is one of the main methods - for BX, one of very few available methods - whereby we gain information about the world. BX's delusion may have compromised his access to knowledge about the condition of his romantic relationship, but it facilitated his access to knowledge about the course of his treatment, the weather outside, local politics, and any other topic about which he may have communicated with other people. This basic idea can be applied similarly to LT's erotomania and to cases of anosognosia. Insofar as delusions benefit a person psychologically by keeping them from despair, they thereby benefit a person epistemically by allowing them to keep engaging with other people and their environments, thereby acquiring knowledge (Bortolotti 2015a).

The No Alternatives condition is slightly less clear, since it is a substantive issue in itself what counts as the 'availability' of a cognitive process to an agent at a time. In discussing this, Bortolotti reviews empirical evidence suggesting that the belief revision capacities of patients with anosognosia are often compromised, limiting their ability to replace their delusion with the true belief that they are ill. She makes a more general point, however, which applies to all the motivated delusions discussed thus far. If it is true that these delusions provide psychological benefit by protecting against a potentially catastrophic or debilitating true belief, then it is unlikely that the relevant true beliefs would provide the same epistemic benefits conferred by the delusions. In the case of BX, for instance, a true belief about his relationship would provide one obvious epistemic benefit not provided by the delusion - that of knowing the truth about his relationship. But if this true belief were devastating, it would fail to yield all the epistemic benefits which arise from engagement with people and the environment. So it seems there is no alternative to the delusion available to BX *which would provide the same epistemic benefits gained from the delusion but without its epistemic costs*.

Epistemic Benefit and Epistemic Risk

If naturalism is true, and if mystical experience is the primary mechanism of psychedelic therapy, then it seems undeniable that psychedelic therapy is "foisting a comforting delusion on the sick and dying". However, equipped with the concept of epistemic innocence, we are now in a position to appreciate the respects in which it is not *merely* doing so. The epistemic appraisal of psychedelic therapy - like that of motivated delusion - is more complicated than it might at first appear.

When therapeutic psychedelic experiences alleviate debilitating psychiatric conditions such as alcoholism, they satisfy the Epistemic Benefit condition in the same way as motivated delusions. The recovered alcoholic is far more likely to engage with other people and the broader environment, and thus likely to acquire much more knowledge. Given the reversibility of some alcohol-induced cognitive impairment, the psychedelically recovered alcoholic is also likely to benefit from improved functioning of epistemically important cognitive capacities such as attention and working memory (Mann *et al*. 1999).

The same process of epistemic benefit will occur when psychedelic therapy is applied to other debilitating conditions such as anxiety associated with terminal illness. As a result of psychedelic therapy, patients with terminal illness experience significant and lasting reductions in anxiety and depression (Grob *et al*. 2011, Gasser *et al*. 2014). Lower levels of anxiety and depression will tend to lead to more engagement with the environment and therefore more knowledge acquisition. Successful psychedelic therapy has epistemic benefits.

There is another point worth making about therapeutic psychedelic trips, albeit one not directly relevant to their satisfaction of the Epistemic Benefit condition. It has often been noted that psychedelic subjects, unlike psychotic patients, typically retain insight; that is, they are aware that their unusual experiences have been occasioned by the ingestion of a drug (Hermle *et al*. 1992). This retention of insight does not uniformly beget epistemic conservatism: many psychedelic subjects are convinced that they have enjoyed drug-induced *but nonetheless veridical* metaphysical apprehensions. However, the important point is that non-naturalistic metaphysical conversions are not guaranteed to result even from spectacularly mystical psychedelic trips.

An instructive case is Benny Shanon (2002) the Israeli cognitive scientist, philosopher, and veteran of over 130 experiences with the South American psychedelic brew ayahuasca. It is fair to say that Shanon has experienced and been suitably impressed by a representative sample of psychedelic experience. But in his monograph on ayahuasca he treads a commendably cautious line, rejecting various paranormal claims associated with psychedelics, while flirting with a pragmatic or poetic approach to the idealistic pantheistic metaphysical vision often encountered on this drug. Shanon is living proof that it is possible to experience the full power of psychedelic mysticism in an epistemically responsible way - though of course he is unusually well equipped to do so by virtue of his professional training. It can bring further balance to our epistemic evaluation of psychedelic therapy to note that, while it may be an epistemically risky treatment modality from a naturalistic standpoint, the risk is not absolute.

This mention of epistemic risk highlights an interesting feature of the case of psychedelic therapy. The kinds of imperfect cognitions which have thus far received attention in the epistemic innocence literature - motivated delusions (Bortolotti 2015a), elaborated and systematized delusions (Bortolotti 2015b), implicit bias and confabulation (Sullivan-Bissett 2015) - are all involuntary. As such, the concept of epistemic innocence is applicable to the objective assessment of the epistemic status of these cognitions, as well as to practical questions about how others (e.g. clinicians) ought to interact with the subjects of such cognitions. The present case differs in that introducing the notion of epistemic innocence could perhaps help individuals deciding whether or not to *voluntarily* enter an epistemically detrimental or risky cognitive state.

Imagine a naturalistic, atheistic terminal patient who has been offered a place in a psychedelic therapy trial. A second- or third-hand acquaintance with the phenomenology of psychedelics might lead this patient, reasonably enough, to share Pollan's worry that they would be signing up to acquire a "comforting delusion". To appreciate the point, consider Pascal's Wager, which says we ought to try to bring about theistic belief in ourselves, because belief has higher expected utility than disbelief. That is, belief has vast advantages if God exists but only moderate disadvantages if God does not exist, while disbelief has vast disadvantages if God exists but only moderate advantages if God does not exist. Now, one possible response, in line with the 'evidentialist' tradition derived from the work of W. K. Clifford (1877), is that beliefs ought never be adopted for pragmatic reasons, but only ever on the basis of sufficient evidence. One need not hold such a strong view, however, to share the basic worry: that there is something ethically suspect (because intellectually dishonest) about adopting a belief solely for pragmatic reasons. The prospective psychedelic therapy subject might reasonably wonder if they are contemplating something a little too akin to following Pascal's advice.

Appreciating the epistemic innocence of psychedelic states could help such an epistemically responsible person to appreciate the disanalogies between psychedelic therapy and Pascal's prescription. The potential epistemic costs of psychedelics are offset not just by pragmatic benefits, but by significant and (I will later argue) otherwise unavailable epistemic benefits. It is not a simple purchase of pragmatic benefits with epistemic costs, and this makes a difference to the decision under consideration. It makes a further difference to note that, as illustrated by the case of Shanon, epistemic costs are not an inevitable result of psychedelic transformation but merely a risk.

How large a risk? It is hard to say. It would be interesting to know the statistical relationships between therapeutic and transformative effects and the acquisition of new non-naturalistic metaphysical beliefs consequent on psychedelic ingestion, but such research has not been conducted to my knowledge. Prolonged psychosis is one epistemic (and, of course, psychological) risk of psychedelics. This risk is very low when the drugs are given in carefully controlled conditions, but is known to be higher when they are consumed in uncontrolled conditions (Strassman 1984, Johnson *et al*. 2008). Perhaps the risk of forming extravagant or unwarranted metaphysical beliefs is also higher when the drugs are consumed - especially repeatedly - in uncontrolled conditions. This possibility is suggested by some of the more colourful theories espoused by, for instance, the late Terrence McKenna (1991), countercultural icon and prolific high-dose psychedelic user. If (repeated) uncontrolled psychedelic use does carry elevated epistemic risk, then this might be another reason - in conjunction with the elevated pragmatic risk - militating against such use. At any rate, in the case of just one or very few clinically supervised psychedelic therapy sessions, significant epistemic and pragmatic benefits are highly likely, and epistemic costs not overwhelmingly likely, making the epistemic risk perhaps a reasonable one to take. Of course, the precise risk/benefit analysis will vary depending on the details of individual cases.

Returning to the epistemic benefits of psychedelic therapy, it is interesting to contrast the two recent studies of psilocybin for addiction - one on tobacco, the other on alcohol. I have argued that alcoholics who recover through a psychedelic trip will gain an epistemic benefit because their social and other functionality will be restored. The same argument cannot be made for a recovered smoker, since tobacco addiction, despite its adverse physiological consequences, does not tend to compromise socio-emotional and intellectual functioning in the same way as alcohol addiction. What are we to make of this difference?

First, I am not arguing that every therapeutic psychedelic trip is necessarily epistemically innocent - only that some are. Second, however, even the tobacco smoker who kicks the habit via psychedelic mysticism will gain a significant epistemic benefit. There are at least two ways this might occur. The first relates to the finding that psilocybin-induced mystical experiences had by healthy subjects can lead to durable increases in the personality trait of openness to experience. Even for an already well-functioning individual, it is likely that increased openness to experience will cause increases in epistemic functionality analogous to those gained by the recovered alcoholic. More openness means more engagement with the world, more curiosity, and more new experiences of more varied kinds - all potential sources of knowledge[15].

The second way that the tobacco smoker might epistemically benefit relates to the psychedelic experience itself. I have argued elsewhere that psychedelic states can be a means of gaining direct knowledge of the potential of one's own mind and of the contingency of one's sense of self (Letheby 2015). On the first count, neuroscientific evidence suggests psychedelics temporarily decrease constraint or inhibition in the brain, making overall cognitive dynamics more fluid and flexible (Carhart-Harris *et al*. 2014, Tagliazucchi *et al*. 2014). This can amount to a radical and direct discovery that certain ways of thinking or feeling are genuinely possible for oneself. One mescaline subject thought the most important outcome of his first psychedelic experience was "the knowledge and certainty I now have that it is truly possible to attain to a sense of harmony with all creatures and things" (Masters and Houston 1966, 12).

On the second count, one striking feature of some psychedelic states, especially mystical ones, is the experience of 'ego dissolution', in which the ordinary sense of being a unitary, persisting self or 'I' is temporarily diminished or abolished (Pahnke 1969, Carhart-Harris *et al*. 2014). Various philosophers have defended the view that the self as we ordinarily experience it does not exist (Metzinger 2011). Moreover, attaining direct, experiential knowledge of its non-existence is a central goal of Buddhist meditation (Albahari 2014). Ordinarily, the idea of experience without a sense of self is difficult to understand and may even seem incoherent. However, some meditation practitioners and psychedelic subjects become directly acquainted with the contingency of their sense of self. The felt 'I' may be a ubiquitous feature of human consciousness, but the phenomenology of such altered states as these suggests it is not necessary - and this is a striking and significant discovery to make.

So even if alcoholics stand to benefit more, those who break a tobacco addiction via psychedelic mysticism may still derive a significant epistemic benefit, both in virtue of durably increased openness to experience, and in virtue of discoveries about their own mind made during the acute drug effects.

More generally, I conclude that psychedelic mystical experiences can cause significant epistemic benefits which are independent of their non-naturalistic metaphysical contents. These benefits are of two kinds: direct benefits, in the form of knowledge gained during the psychedelic experience itself; and indirect benefits, in the form of improved epistemic functionality after the psychedelic experience. This establishes that these cognitive states meet the Epistemic Benefit condition. I turn now to the No Alternatives condition.

The No Alternatives Condition

Based on the evidence available to date - which is admittedly limited - the efficacy and rapidity with which controlled psychedelic use can change personality and alleviate psychiatric distress is, in many cases, unique (Young 2013). This means that when we consider the epistemic benefits gained by a psychedelically treated alcoholic as a consequence of their restored cognitive and socio-emotional functioning, there is no known alternative cognitive process which will deliver those benefits with such high probability or so rapidly. The antidepressant efficacy of the (non-classic) psychedelic anaesthetic ketamine provides a good illustration of this. Some researchers think ketamine could be important in cases of suicidal depression because it alleviates depressive symptoms within hours, rather than the timeframe of weeks or months required for standard pharmacological or cognitive antidepressant therapies (Vollenweider and Kometer 2010, 2). To put it starkly, if someone is about to take their own life, a therapeutic psychedelic experience may be the only cognitive process which will lead them to keep living and learning. One classic text on the phenomenology of psychedelics describes such a case: a subject who had decided to commit suicide before he underwent a death-and-rebirth experience in the LSD trip which was his last ditch effort (Masters and Houston 1966, 188-189).

It is true, on the other hand, that depression in particular is a condition for which rapid and effective non-psychedelic treatments - such as electroconvulsive therapy (ECT) and repetitive transcranial magnetic stimulation (rTMS) - exist (Ren *et al*. 2014). So it may be that some cases of antidepressant psychedelic therapy would not provide *uniquely* rapid access to indirect epistemic benefits consequent on restored socio-emotional functionality. These specific psychedelic states would then fail to qualify for epistemic innocence - at least, they would fail to do so in virtue of their indirect epistemic benefits. However, they might still qualify in virtue of their direct epistemic benefits. Further, depression-alleviating psychedelic states may provide uniquely rapid access to indirect epistemic benefits in some of the significant proportion of patients who do not respond to alternative rapid treatments (*ibid*.). Of course, my argument in this paper focuses on the epistemic innocence of trips occasioned by *classic* psychedelics, and it is as yet unclear whether drugs of this class have significant antidepressant potential (though see Baumeister *et al*. 2014, Osório *et al*. 2015).

When alternative rapid treatments for conditions such as depression are available, and a given patient has a good chance of responding to such treatments, does this mean that a psychedelic treatment taken by such a patient would not be epistemically innocent? Not necessarily. As mentioned in the preceding paragraph, even if alternative routes to psychedelics' indirect epistemic benefits are available, there may still be no alternative route available to their direct epistemic benefits. In this case, a psychedelic state still would yield significant and otherwise unavailable epistemic benefits; would still, that is, be epistemically innocent. This is not to say that the psychedelic treatment should therefore be preferred. Establishing epistemic innocence is the beginning, not the end, of such a practical deliberation, which must take into account all the kinds of facts mentioned in my earlier discussion of epistemic risk.

There is at least one kind of case in which a psychedelic treatment might fail to be epistemically innocent: that where the patient has already had multiple noteworthy psychedelic experiences. Such a patient might well already have the kinds of direct knowledge of the mind and the sense of self afforded by psychedelics, and in that case another psychedelic experience would be less likely to afford unique access either to indirect *or to direct* epistemic benefits. Above I speculated that repeated and uncontrolled psychedelic use might carry greater epistemic risk. Now I am suggesting that (excessively) repeated psychedelic use might promise lower epistemic benefit. Alan Watts famously said of the psychedelic experience: "If you get the message, hang up the phone" (Watts 1962). The implicit suggestion, which I am tentatively endorsing, is that there is a point at which the important knowledge to be had from psychedelics has already been gained and so the epistemic value of further use is considerably less.

I am endorsing this suggestion only tentatively because there is some evidence to the contrary. Veterans of dozens or even hundreds of ceremonial ayahuasca sessions claim still to learn something new and important with each ingestion, or with most ingestions (Shanon 2002). What can be said conclusively is that these are the conditions that would have to be met for a particular instance of psychedelic therapy to *fail* the epistemic innocence test: not just availability of alternative routes to indirect epistemic benefit, but the lack (or low probability) of direct epistemic benefits uniquely available via the psychedelic route.

But one might wonder whether the direct benefits are in fact *uniquely* available via the psychedelic route. It could be objected that meditation practice can plausibly yield some of the direct epistemic benefits which I have argued may result from psychedelic ingestion, such as knowledge by acquaintance of the potential of the mind (Kornfield 1979, Delmonte and Kenny 1987) and of the contingency of the sense of self (Brewer *et al*. 2013). However, even if so, this method is slower and less reliable than psychedelics (Harris 2014). If an agent at a particular point in time is on the verge of undergoing a controlled psychedelic session, then they will begin to reap the epistemic benefits of doing so within a matter of hours. They would not reap the same epistemic benefits *at that time* if they decided to begin a meditation practice instead.

One worry which might arise at this point is that my discussion of the No Alternatives condition has focused not on whether the epistemic benefits of psychedelics are available via any alternative means whatsoever, but on whether they are available via any equally reliable and rapid means. This might seem to be a problematic misinterpretation of the condition as presented by Bortolotti *et al*.16 To this I respond, firstly, that the focus on the reliability or probability with which different methods deliver epistemic benefits is an unavoidable consequence of the voluntary nature of psychedelic therapy. When the concern is a practical one about whether individuals should choose to enter into epistemically costly or risky cognitive states, there is no choice but to consider the probabilities of the various costs and benefits which might be involved. The notion of an available alternative which *will* (without fail) yield the same benefits is shown to be an idealization by the forward-looking, practical nature of the present case. When reasoning about actions with uncertain future results, epistemic or otherwise, we cannot but trade in probabilities.

Secondly, the No Alternatives condition as originally formulated is somewhat ambiguous with respect to whether the alternative cognitive process *or its resultant benefits* must be unavailable at the time. If, as suggested above, meditation does provide some of the same direct epistemic benefits as psychedelics, then the objection is correct: strictly speaking, there are alternative cognitive processes *available to the agent at the time* which yield the same epistemic benefits. But such a strict interpretation of the condition may not capture what is most important in cases where one process takes hours to yield these benefits while another takes weeks, months, or years. The contrast between psychedelic and traditional antidepressant therapies shows that such a time difference can be practically as well as epistemically consequential. All this suggests either that the No Alternatives condition should be understood to refer to the availability of epistemic results, rather than of the processes which deliver them, or at least that the two possible interpretations of the condition should be borne in mind and disambiguated on a case-by-case basis.

1. Clearly the transformative process cannot be entirely transparent - subjects may be directly aware of the conscious mental states involved, but not of the neural and sub-neural mechanisms causing and/or constituting those states.
2. I take cognitive neuroscience to have explanatory, not merely descriptive, ambitions. As such, even if it were successful in thoroughly charting the neural correlates of consciousness (no small achievement) it would nonetheless have partially failed unless it could also provide an naturalistic explanatory bridge between those correlates and the qualitative character of conscious experience.
3. Strictly speaking, it is psilocin, the dephosphorylated metabolite of psilocybin, which is biologically active - but this loose way of speaking is common and harmless.
4. It could also be true even if the drug experience causes benefits only indirectly, by causing the adoption of new beliefs which themselves cause benefits. I suspect this is not the case, but I will not argue for that claim here.
5. It should be clear that the same point cannot be made with respect to some subjects' beliefs that they have glimpsed non-natural realms. Certainly, one possible explanation of the formation of those beliefs is that they are true - but that explanation is non-naturalistic and hence unavailable within the methodological parameters of my project.
6. Of course, on naturalism, such phenomenal differences as these amount to differences in neural activity. On naturalism, an altered state of consciousness is nothing other than a transient global alteration to neural information processing. My conjecture that the altered state is the therapeutic agent just amounts to saying that therapeutic results are caused by these dramatic, widespread information processing changes, rather than by some direct (e.g. intracellular) effect of the drug which (a) occurs invariably given a sufficient dose and (b) is insensitive to the details of *how* global information processing is differentially altered by particular ingestions.
7. I am grateful to Philip Gerrans for this suggestion
8. Recall: on naturalism, the experience - i.e. the altered state of consciousness - just is the alteration to global neural information processing; in this case, disinhibition of other regions consequent on DMN disintegration.
9. I do not intend to import all the details of Russell's (1910) original analysis of knowledge by acquaintance, but I take it the

intuitive contrast with 'second-hand' knowledge by description or testimony is clear enough.

10. By 'model' I mean something like 'representation encoded by patterns of neural activation' - in this case, a representation whose contents contribute to phenomenal consciousness. I deliberately remain agnostic on details of representational formats, coding schemes, etc.
11. 'Modal knowledge' is a philosophical term for knowledge about possibility, necessity, and so forth.
12. For helpful feedback on earlier versions, I am grateful to Gerard O'Brien, Jon Opie, audiences at the University of Adelaide Philosophy Postgraduate Colloquium and the Australasian Association of Philosophy annual conference, and two anonymous referees for the Journal of Consciousness Studies.
13. Where 'epistemic' simply means 'of or pertaining to knowledge'.
14. Though it is highly controversial whether delusions are beliefs. Non-doxastic theorists (e.g. Gerrans 2014) argue that they are not, emphasising their non-belief-like features: they are often held with ambivalence, isolated from an agent's other beliefs, and relatively behaviourally inert. Doxastic theorists, on the other hand, emphasise the belief-like features of delusions, as well as suggesting that non-doxasticists deploy an overly strict or narrow conception of beliefs (e.g. Bortolotti and Gunn 2015).
15. An intriguing question is whether personality traits such as openness to experience bear any interesting relation to the kinds of epistemic virtues discussed by philosophers. (I am indebted to James Morauta for raising this question.) Any attempt to draw such correspondences, however, faces difficult problems concerning how to understand the theoretical and ontological commitments of the Big Five model of personality (Miller 2014) - problems which do not arise for the mere claim that increased openness will typically be accompanied by epistemic benefit.
16. I am indebted to an anonymous reviewer for raising this point.

Conclusion

Evidence for the transformative efficacy and possible therapeutic utility of psychedelics raises intriguing issues which deserve serious attention. Among these is the legitimate concern that we may be "foisting a comforting delusion on the sick and dying". I have applied the concept of epistemic innocence to argue that the situation is more complicated and that despite their potential (albeit not inevitable) epistemic faults, psychedelic states can confer significant and otherwise unavailable epistemic benefits, both direct and indirect. Possible direct benefits include knowledge by acquaintance of the potential of the mind and the contingency of the sense of self. Possible indirect benefits include improved epistemic functionality brought about either by restored cognitive, social, and emotional functionality, or by increased openness to experience. Thus, some psychedelic states are epistemically innocent imperfect cognitions.

This conclusion matters because the epistemic status of psychedelic therapy is highly relevant to policy debates. Some of the psychedelic scientists interviewed by Michael Pollan in the *New Yorker* seem quite unconcerned by the possibility that therapeutically efficacious psychedelic mystical experiences are non-veridical. I think they are right to be unconcerned, but not because the epistemic status of therapies is unimportant.

To appreciate the importance of epistemic issues, consider Nozick's (1974) famous 'Experience Machine' thought experiment. The hypothetical Machine provides users with a lifelong stream of virtual reality experiences as pleasurable, varied, and realistic as could be. It is a common intuition that plugging in to the Machine would be a mistake, and one explanation of this intuition is that we care not only about having pleasant experiences but about having experiences based in reality. Truth and knowledge matter. When some method of attaining well-being depends upon forming false or unsupported beliefs, or refraining from forming true or well-supported beliefs, we tend to view this as a flaw of that method.

Of course, such flaws are not inevitably fatal. This is one of the key points of the talk about epistemic innocence. The point is just that epistemic evaluation matters. So if we are to prescribe an epistemically costly method of attaining well-being, we want to do so because the epistemic costs are outweighed by the overall benefits - not because we have simply ignored the epistemic costs. The scientists interviewed by Pollan may well be correct that the potential non-veridicality of psychedelic mysticism is not a compelling objection to prescribing psychedelic therapy. But this is not because epistemic issues are unimportant. Rather, it is because psychedelic therapy is unlike the Experience Machine in the respects explored in this paper.

Finally, the case of psychedelic therapy helps advance the broader discussion of epistemic innocence. It shows that the concept illuminates a broader range of cases than just acceptable emergency responses, and also illuminates issues concerning voluntary imperfect cognitions. This in turn raises the issue of epistemic risk, and how such risk might be traded off against potential epistemic benefits, as well as pragmatic risks and benefits. Meanwhile, the contrast between psychedelics and prospective alternatives reveals the need for care in interpreting the No Alternatives condition. Most generally, this analysis of psychedelic therapy provides yet more reason to think that the epistemic status of imperfect cognitions is more complex than it might at first appear.

Acknowledgements

I am grateful to Gerard O'Brien, audiences at the University of Adelaide Philosophy Club, the University of Adelaide Philosophy Postgraduate Colloquium, and the Australasian Association of Philosophy annual conference, and two anonymous referees for helpful feedback on earlier versions of this paper.

Naturalizing Psychedelic Sprirituality

Statement of Authorship

Title of paper:	Naturalizing Psychedelic Spirituality
Publication status:	Submitted for publication
Publication details:	Under review for Zygon: Journal of Religion and Science. December 2016.
Principal Author	
Name of principal author (candidate):	Christopher Letheby
Contribution to the paper:	Devised the arguments and wrote, proofread, polished, formatted, and submitted the paper.
Overall percentage (%):	100%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature:	
Date:	

Introduction

One of the biggest philosophical problems of our age is how to respond to the existential anxiety caused by the 'disenchantment of the world' - the transition from a religious worldview to a naturalistic one which eschews transcendent foundations for meaning and value. Some philosophers have suggested that this problem is currently becoming more acute as the results from contemporary neuroscience filter into the zeitgeist, rendering a disenchanted naturalistic conception of human beings ever more unavoidable and undeniable, and leading to a distinctive 'neuroexistentialist' anxiety (Flanagan and Caruso forthcoming, Metzinger 2009).

Various theoretical solutions to this problem have been pursued, often in the form of efforts to 'naturalize' some central pillar of meaning or purpose such as free will or morality (Dennett 1984, Sturgeon 2006). But to (somewhat facetiously) paraphrase Douglas Adams (1979), this is odd because, on the whole, it isn't our theories that are unhappy. I want to explore the prospects for a different, more practical kind of solution, based on a remarkable empirical observation about the conditions under which human beings can regain a sense that life is worth living. I refer to the finding that classic psychedelic drugs such as LSD and psilocybin can, under conducive circumstances, occasion intense experiences leading to lasting psychological benefits - including the amelioration of existential distress resulting from terminal illness (Grob *et al*. 2011, Gasser *et al*. 2014, Griffiths *et al*. 2016, Ross *et al*. 2016). A renaissance of scientific research into an "existential medicine" (Grob 2007, 213) certainly warrants the attention of philosophers interested in the overcoming of disenchantment and nihilism.

There is a problem, however, in that some evidence suggests that the existential re-enchantment occasioned by psychedelics depends crucially on the induction of mystical experiences involving apparent encounters with transcendent non-natural levels of reality (Griffiths *et al*. 2006). If this is so, then psychedelics would seem less a means to making peace with a naturalistic worldview than a means to becoming persuaded of its falsity. In the spirit of the philosophical project of 'naturalizing spirituality', I will argue that such non-naturalistic metaphysical epiphanies are far from the whole story: that there are key elements of psychedelic spirituality which can be practiced by a naturalist in intellectual good faith, and which represent a promising path to re-enchanting the naturalistic world on its own terms.

I will begin, in section 1, by describing the neuroexistentialist predicament, and two possible kinds of solutions to it, in more detail. In section 2 I will describe the potential psychedelic solution and the apparent problem with that. In sections 3 and 4 I will draw on neuroscientific research into the mechanisms of psychedelic-induced transformative experience to argue that there is a naturalistically viable kind of spirituality to be found here. The basic idea is that psychedelics degrade the mechanisms of self-representation in the brain, in some cases allowing subjects to see that the ordinary sense of self is a useful fiction, and in other cases freeing their attention from self-focused concerns leading to the availability of broader perspectives on life. The common thread is that a good deal of existential suffering stems from an excessively rigid focus on and reified belief in a solid and enduring self and its travails. Loosening the bonds of this egocentricity and ego identification, by psychedelics or other means, is one good idea about what naturalized spirituality might amount to, and a promising practical response to neuroexistential anxiety

The Neuroexistentialist Predicament

Naturalism, in its most basic form, is the denial of the existence of non-natural or supernatural entities such as gods, souls, spirits, and non-physical minds. It is a commonplace by now that the gradual transition from a religious to a naturalistic worldview over the past few centuries - due to the rise of modern science, and especially since Darwin - has created a crisis of meaning and value. The growing plausibility of naturalism, which leaves no room for any of the traditional foundations of value, evokes anxiety about what, if anything, could possibly replace those foundations, and how, if at all, we might come to terms with a world devoid of them. This naturalistic crisis is sometimes referred to as the *disenchantment of the world* (Dreyfus and Kelly 2011).

Owen Flanagan and Gregg Caruso (forthcoming) argue that we are currently experiencing a new and distinctive wave of existential anxiety as a result of impressive advances in neuroscience, and the popular dissemination of these findings. It is not that neuroscience has discovered anything new about how disenchanted the naturalistic world is; rather, it is painting a vivid and dramatic picture of what this disenchantment looks like, in the specific and cherished case of human beings. Part of what is hardest to swallow about a naturalistic view of the world, at least for some, is its implication that human beings are ultimately nothing special - a very smart animal, to be sure, but a mere accidentally evolved, cognitively limited, mortal animal none the less. We have no Cartesian ego, no contra-causal free will, and no eternal destiny. With every new stride in the neuroscientific mapping of the material bases of decision making, reward, emotion, and so forth, this reality becomes ever more palpable. And the popularization of neuroscience plausibly heralds the dissemination of this vision beyond intellectual and academic circles into the broader culture, threatening a wholesale and widespread crisis of meaning.

One useful way of conceiving of this situation is in terms of Wilfrid Sellars' (1963) manifest and scientific images of humankind. The manifest image is simply the potentially highly reflective and refined, but nonetheless pre-scientific, conception of what kinds of things human beings are, developed and expressed in the arts and humanities as well as in everyday talk and thought. The scientific image, meanwhile, is the theoretical conception of the nature of human beings delivered collectively by biology, psychology, anthropology and so on - including, most recently and notably, neuroscience. Sellars thought - and others since (e.g. Dennett 2013) have agreed - that dealing with the various apparent conflicts between the manifest and scientific images is one of the central tasks, if not the central task, of philosophy today. It is an important and difficult business trying to "know [our] way around" (Sellars 1963, 1) a world in which our most successful epistemic enterprise seems to keep telling us that we are something very different from what we automatically and perhaps unavoidably take ourselves to be.

Flanagan and Caruso (forthcoming) describe the manifest image as incorporating commitments to such things as transcendent foundations for meaning, contra-causal (or 'libertarian') free will, human exceptionalism, the immortality of the soul, and so forth. Doubtless there is considerable inter-individual and cross-cultural variation in the precise content of the manifest image. Nonetheless it seems plausible that most of us operate at least tacitly with an individual and collective self-conception that is significantly at odds with the disenchanted scientific image.

The philosophical attempt to grapple with this inter-image conflict is exemplified in the 'naturalizing' industry that has sprung up in the last several decades. The basic strategy is to take some component of the manifest image, such as free will, or objective moral requirements, that seems inadmissible to the scientific image, and give an analysis or account of the phenomenon in question which shows that it can be a real and unmysterious part of a purely naturalistic world. Such responses attempt to demonstrate theoretically that the problem is not as bad as it seems, because the naturalistic world is not as devoid of cherished foundations for meaning and purpose as we thought it was.

There is nothing wrong with this kind of strategy, but an interestingly different sort of response is available. This is exemplified by the project that Flanagan (2007) has called *naturalistic eudaimonics* (from the Greek *eudaimonia*, usually translated as 'human flourishing') - an empirically based inquiry into the conditions under which human beings can flourish and live meaningful lives. This project arises from a recognition that the neuroexistentialist predicament, while it may have its genesis in our theoretical beliefs about how things are, is not merely a theoretical or intellectual problem - it is a practical, emotional problem, a problem of living. A reflective person who is struggling with the problem of nihilism and disenchantment in our neuroscientific, post-Darwinian age wants to know: how can I, or how can we, live well and find meaning and fulfillment, given the kinds of creatures it seems that we are and the kind of world it seems that we inhabit? Of course, one possible answer to that question is: by gaining a theoretical, philosophical understanding and appreciation of how phenomena such as morality and freedom fit into a naturalistic world. But the eudaimonic approach does not presuppose that the only or the best answers will take this form. Rather, it starts with the question: how do human beings achieve meaning, fulfillment and flourishing, when in fact they do?

This is similar in spirit to the methodology of the movement known as *neurophilosophy* (Churchland 1989). Practitioners of neurophilosophy - neurophilosophers - seek to bring the results of neuroscience to bear on traditional philosophical questions. For instance, a neurophilosopher interested in understanding the nature of morality might start her inquiry by looking at neuroscientific evidence concerning moral judgment: its alterations under various conditions, its relations to other cognitive capacities, its neural substrates, and so forth (Churchland 2011). She would then use these facts as a basis for philosophical conclusions about morality.

Here I want to suggest that a helpful contribution to Flanagan's naturalistic eudaimonics could be made by a neurophilosophical inquiry into certain kinds of experiences which are repeatedly referred to as 'spiritual', and which sometimes seem to help those who undergo them to overcome existential anxiety and find meaning in life. A golden opportunity for such an inquiry currently exists, in the form of a recent surge of cognitive neuroscience research into pharmacological agents which reliably evoke such experiences - namely, classic psychedelic drugs.

An Existential Medicine?

Patients with terminal illness undergo intense suffering of many kinds, not least of which is the sense that life is worthless or meaningless in light of their impending mortality. Powerful, effective, and reliable methods of ameliorating this existential distress have thus far proven elusive (Henoch and Danielson 2008). Hence, the following quotations from terminal patients are noteworthy: "It was less about my illness. I was able to put it into perspective. ... Not to see oneself with one's sickness as center. There are more important things in life. ... The evolution of humankind for example. ... Your Inner Ego gets diminished, I believe, and you are looking at the whole ..." (Gasser *et al*. 2015, 62). And: "Dying is as usual or unusual as life itself. You cannot separate it. I simply have to familiarize myself with the idea and the process" (*ibid*.).

These patients are describing experiences and insights they had while intoxicated by the infamous drug lysergic acid diethylamide (LSD), as subjects in the first controlled study of LSD-assisted psychotherapy in over four decades. The 12 subjects in this study showed reductions in anxiety for 12 months after two LSD sessions (Gasser *et al*. 2014). Similar results were found in an earlier pilot study using psilocybin, another classic psychedelic, to treat anxiety relating to terminal illness (Grob *et al*. 2011). More recently, these results have been replicated in two larger, double-blind, placebo-controlled studies of psilocybin treatment for psychological distress in life-threatening cancer (Griffiths *et al*. 2016, Ross *et al*. 2016). As a result of these studies, the treatment of psychological distress in terminal illness is now the best-studied therapeutic application of classic psychedelics (Nutt 2016).

So, we have evidence for thinking that experiences occasioned by classic psychedelics can help people to deal with a sense of the meaninglessness of life in light of mortality. This suggests the possibility of an analogy with other kinds of existential anxiety: could psychedelics offer part of a solution to neuroexistentialist anxiety and the crisis of meaning resulting from the disenchantment of the world? This kind of solution might take two forms: either the careful, controlled administration of psychedelics (in a vastly different legal, regulatory and cultural situation from that which exists today) to volunteers afflicted by neuroexistentialist anxiety, or the study of the mechanisms of psychedelic therapy in the hopes of finding non-pharmacological routes to their salutary psycho-existential effects.

Before I explore this possibility in more detail, a little background is in order. LSD and psilocybin are both 'classic' psychedelics, meaning that they alter consciousness mainly by agonism of the serotonin 2a receptor. Other famous exemplars of this class include mescaline (from the peyote cactus) and dimethyltryptamine (DMT, an ingredient in the South American beverage ayahuasca), both of which have long histories of traditional religious use (as does psilocybin.) I will confine my discussion here to these classic, serotonergic psychedelics, and reserve the term psychedelic for them alone, omitting other drugs which have been called 'psychedelic' on phenomenological grounds despite different mechanisms of action (e.g. ketamine, *Salvia divinorum*, and MDMA or 'Ecstasy'; Sessa 2012).

From the 1940s to the 1960s there was widespread scientific interest in psychedelics following Albert Hoffman's discovery in 1943 of the potent effects of LSD. The propensity of psychedelics to induce experiences which subjects described in spiritual or mystical terms was one factor responsible for this interest (Dyck 2008). It should be noted that another distinctive property of psychedelics is the extreme variability of their effects; as such, it is certainly not the case that every psychedelic experience is of a spiritual nature (Masters and Houston 1966). However, experiences of this broad kind seemed to keep happening unbidden, even when the drugs were being studied for quite different reasons, such as their putative capacity to mimic psychosis (Mangini 1998).

Since the early days of psychedelic science there has been a debate over the credentials of drug-induced mystical-type experiences: whether they are identical or different, equivalent or inferior, to 'genuine' mystical experiences which occur spontaneously or through religious practice (Zaehner 1958, Smith 1964, Walsh 2003). However, it is beyond doubt that many psychedelic experiences possess core phenomenological features characteristic of non-drug mystical states, such as the dissolution of the sense of self, a feeling of unity with the cosmos, ineffability, and profound joy and peace (Pahnke 1969, Griffiths *et al*. 2006). This similarity was emphasized by intellectuals such as Aldous Huxley (1954), Alan Watts (1962) and Timothy Leary (Leary *et al*. 1964), who explicitly connected the psychedelic state to the consciousness alterations aimed at by Eastern meditative practices, laying the conceptual groundwork for the psychopharmacological mysticism of the 1960s counterculture. Many psychedelic mystics of the era became dedicated practitioners, sometimes teachers, of meditation (Dass 1971, Osto 2016).

Ultimately, psychedelics became the focus of intense sociopolitical controversy due to widespread use by members of the counterculture, leading to their prohibition and the subsequent virtual cessation of human research for some decades (Dyck 2008). Since the 1990s, however, a slow but steady 'renaissance' of scientific interest in psychedelics has occurred (Sessa 2012). As well as establishing the feasibility and safety of careful and controlled psychedelic administration, this new wave of research has begun revisiting earlier claims for the therapeutic and transformative efficacy of psychedelics.

I already mentioned the four studies published to date of LSD and psilocybin in the treatment of anxiety resulting from terminal illness. Besides these, small studies have also investigated the potential of psilocybin, LSD, and ayahuasca to treat addiction, obsessive-compulsive disorder, and depression, with uniformly promising albeit tentative results (reviewed in dos Santos *et al*. 2016a). Meanwhile, studies in healthy non-patient populations have found that mystical-type experiences induced by psilocybin can lead to positive personality change lasting over a year (MacLean *et al*. 2011). One frequent result, both in these studies of healthy subjects and in studies of therapeutic applications, has been that the degree of mystical experience predicts the degree of long-term psychological benefits. This echoes results from earlier, often less methodologically rigorous mid-20th century studies (Pahnke 1969). So there is mounting evidence that classic psychedelics can durably improve quality of life by inducing mystical or spiritual experiences, bolstering the case for them as a potential remedy to neuroexistential anxiety and disenchantment.

There is a problem, however, in that such mystical experiences almost by definition involve the apparent apprehension of a transcendent, non-natural reality or 'Ground of Being' of precisely the kind that is denied by a naturalistic worldview. If inducing such experiences really is the means whereby psychedelics improve individuals' psycho-existential situations, then it would seem that these drugs are suited not to reconcile subjects to naturalism but to persuade them of its falsity. This is a serious reason to doubt whether my proposed neurophilosophical response to the neuroexistentialist predicament can even get off the ground.

Naturalistic Entheogenics

To some - especially those who have themselves benefited from a psychedelic mystical experience - it may seem that there is little to worry about here. If psychedelic mysticism can solve our neuroexistentialist problem by showing us that there is no problem, because a transcendent foundation for meaning exists after all, then so much the better!

The problem is that those who are impressed by the theoretical arguments for naturalism will be unimpressed by this response. The arguments for naturalism strike many philosophers as very persuasive, and if these arguments are sound - if naturalism is true - then the apparently non-naturalistic dimensions of mystical experience must be illusory. I am not undertaking a defense of naturalism here, but rather asking: on the (plausible) supposition that naturalism is true, is there a way that we can existentially come to terms with that fact? It should be clear that taking non-naturalistic mystical realizations at face value cannot support an affirmative answer to this question. Becoming convinced that a fact does not obtain is not coming to terms with it.

My psychedelic response to the neuroexistentialist predicament is intended as a contribution to the project of eudaimonics, which Flanagan and Caruso explicitly define as an inquiry into the conditions of flourishing for beings "whose self understanding includes the idea that [a naturalistic world] is the only kind of world that there is" (forthcoming, 15). The key question then becomes: is it true that the basic way in which psychedelic experiences alleviate psychological and existential distress is by convincing subjects that some more comforting metaphysical worldview than naturalism is correct? I am going to argue that it is not: that there are core aspects of the psychedelic transformative process, even in intense peak experiences, which are independent of apparent non-naturalistic metaphysical apprehensions. Moreover, I am going to suggest that even some of the aspects of psychedelic experience which prompt the description *spiritual* fit this naturalistic bill.

At this point my project connects with recent philosophical endeavors to naturalize spirituality, as distinct from religious belief. The very idea of something worth calling 'spirituality' that is both separable from religion and consistent with a naturalistic metaphysics may sound strange at best, contradictory at worst. But there is a growing recognition that one common use of the word *spiritual* denotes something that is distinct from religion, that has more to do with a personal quest for meaning based on transformative practice and experience, specifically experience of a self-transcendent nature. And proponents of naturalistic spirituality have been arguing that at least some of these practices and experiences can be pursued and cultivated in a way that is compatible with both intellectual honesty (Metzinger 2014) and a commitment to naturalism (Stone 2012). My aim here is to extend these efforts into the psychedelic sphere.

The neologism *entheogen* (generating the divine within) has become popular as a way of referring to psychedelics when used specifically for spiritual purposes (Ruck *et al*. 1979, Smith 2000). It is not too much of a stretch to say that the history of psychedelic research has been witness to a tension between an 'entheogenic conception' of the drugs and a seemingly opposing 'psychotomimetic/hallucinogenic conception' favored by less mystically and more naturalistically inclined thinkers. This latter conception sees psychedelics as fundamentally agents of misrepresentation and cognitive distortion, lacking significant epistemic value; according to Nicolas Langlitz's (2012) anthropological studies of psychedelic science, such a conception is implicit in much of the language used to frame model psychosis research. But Langlitz notes a tendency to rapprochement on the part of certain psychedelic researchers who embrace what he calls a *mystic materialism*. In effect, I am going to be suggesting that such a view is legitimate, by trying to naturalize the entheogenic conception of psychedelics.

I will not be assuming or defending any specific philosophical account of naturalistic spirituality. Instead, in keeping with my neurophilosophical orientation mentioned earlier, I propose that we take a 'bottom-up' approach to understanding the phenomenon: look first at what is known neuroscientifically about the kinds of experiences and practices in question, and try to identify the features and qualities which cause people to describe them as 'spiritual'. We can come to understand what spirituality is, and whether and how it is compatible with naturalism, by looking closely at the details of paradigm cases of putatively spiritual phenomena. And subjects' overwhelming tendency to describe them in such terms suggests that psychedelic peak experiences certainly fit the bill.

Even though I will not endorse any of the existing theories, I will note that one ground for optimism about naturalizing entheogenics is that many common features of psychedelic experiences are also common themes in theories of naturalistic spirituality. Among these are wonder and awe, especially at the natural world (Goodenough 1998), love of life (Solomon 2002), and dissolution or transcendence of the individual sense of self (Harris 2014, Simpson 2014).

Ursula Goodenough proposes that reflective contemplation of scientific descriptions of nature, along with philosophical mysteries such as why there is something rather than nothing, can evoke deeply thoughtful but also affective responses of wonder and reverence at the vastness, complexity, and improbability of the natural world and of our own existence. Part of this process involves broadening our perspective and learning to see the individual self in a much larger spatiotemporal context (Goodenough 1998, Goodenough 2001, Goodenough and Woodruff 2001). Robert Solomon's account of naturalistic spirituality echoes many of these themes, recommending a thoughtful (intellectually well-grounded) sense of love and reverence for life as it is, and a sense of existential gratitude grounded in an appreciation of the vulnerability and contingency of our own lives. Like Goodenough, Solomon (2002) suggests that a key part of the spiritual process is the broadening of perspective beyond the concerns of the individual self.

While these theories of spirituality recommend transcending the self by a broadening of perspective, Sam Harris (2014) holds that spirituality consists precisely in attaining and then deepening a direct, experiential insight into the nonexistence of the self. Of course, Harris does not deny that conscious biological organisms as constantly evolving processes exist. But the claim here, common to many mystical traditions and articulated most clearly in Buddhism (Albahari 2006), is that we tacitly and habitually take ourselves to be something more than a constantly changing process - a persisting and indivisible subject of experience sharply distinct from the rest of the world. Our acceptance of this 'self-illusion' is claimed to give rise to much psychological suffering, and as such, seeing through the illusion is prescribed as a remedy.

As Harris is at pains to emphasize, despite the stronger metaphysical commitments of some schools of Buddhism, there is nothing non-naturalistic about this core psychological claim (cf. Simpson 2014). Ultimately, I will suggest that psychedelics dissolve (or weaken) the self-illusion, and broaden our perspectives, by the same basic mechanism. Evidence to be discussed below suggests that the neurocognitive systems underpinning the sense of self are the same ones that constrain cognition in accordance with the goals and interests of that self, and disrupting these systems both diminishes the felt sense of self and liberates attention from bondage to self-centered concerns. Thus, despite their differences in emphasis, there is plausibly a mechanistic unity to the varieties of 'de-selfing' recommended in these various accounts of naturalistic spirituality.

A second ground for optimism is that some psychedelic researchers describe the entheogenic transformative process in terms which do not sound unambiguously non-naturalistic. For instance, Charles Grob, describing the use of psilocybin for anxiety relating to terminal illness, says this: "Under the influence of hallucinogens, individuals transcend their primary identification with their bodies and experience ego-free states before the time of their actual physical demise, and return with a new perspective and profound acceptance of the life constant, change … This implicit acceptance of the inevitable cycles of life leads to a drastically altered approach to what time is remaining without the panic, fear, pain, and dependency that were previously so overwhelming" (Grob 2007, 213).

Of course, references to transcending a "primary identification" with the body, and to experiencing "ego-free states", may sound somewhat questionable to naturalistic ears. However, as I have indicated, I think that there is perfectly plausible naturalistic sense to be made of such talk. In order to establish this, I turn now to recent cognitive neuroscience research on the mechanisms of psychedelic transformation.

Mechanisms of Mysticism

Recent fMRI studies of the psychedelic state have provided a fascinating window onto the neurocognitive mechanisms whereby these substances exert their effects on consciousness. Robin Carhart-Harris and colleagues (2012) found, to their surprise, that intravenous psilocybin decreased brain activity, rather than increasing it as had previously been thought. Moreover, the decreases were concentrated mainly in the famous Default Mode Network (DMN), a network of densely connected brain regions, most active in resting task-free conditions, which has repeatedly been implicated in generating the sense of self, as well as in mind-wandering, mental time travel (the simulation of past and future events), and theory of mind (the attribution of mental states to self and others; Raichle *et al*. 2001, Spreng and Grady 2010).

The decrease in activity and connectivity within the DMN was accompanied by a global increase in the unpredictability of the patterns of functional connectivity throughout the brain, quantified by the information-theoretic construct of *entropy*. Carhart-Harris *et al*. (2014) used these findings to argue that the core mechanism of psychedelic consciousness-alteration is downregulation of the DMN, which they claim implements ego-functions and serves as a 'conductor' of the global neurocognitive orchestra, constraining the quality of cognition to maintain an efficient and adaptive functional profile. Disruption to the DMN disrupts its ability to constrain cognition and allocate resources in a goal-driven fashion, and this explains many key features of the psychedelic state such as the detaching of attention from personal concerns and the sense of 'mind expansion' resulting from a broadening and loosening of attention.

The dissolution of the ego or sense of self is a quintessential feature of psychedelic experiences, particularly mystical ones, which seems explicable on this model too. Remarkably, subjective ratings of ego dissolution in these studies correlated strongly with decreases in alpha oscillations in the posterior cingulate cortex (PCC), a key DMN hub whose activity is also decreased in states of 'effortless awareness' achieved by meditation (Brewer *et al*. 2013). A study of cortical thickness in long-term religious users of ayahuasca found thinning in the PCC relative to matched controls. This thinning correlated with the extent of prior ayahuasca use, as well as with psychometric scores for the personality trait of 'self-transcendence', and was not accompanied by any impairments to neuropsychological function (Bouso *et al*. 2015). Combined with the finding that acute ayahuasca intake increases capacities cultivated in mindfulness meditation, such as psychological 'decentering' and a nonjudgmental perspective on inner experience, this set of observations is intriguing to say the least (Soler *et al*. 2016).

Carhart-Harris *et al*. (2014) argue that ego dissolution and entropy elevation both result essentially from psychedelic-induced downregulation of the DMN and related networks. Discussing the therapeutic effects of psychedelics, they note that many of the conditions indicated - addiction, depression, anxiety, and obsessive-compulsive disorder - are characterized by cognitive rigidity. They propose that the psychedelic-induced entropy elevation shakes the cognitive system out of its rut, breaking down entrenched patterns (i.e. habits) of thought, feeling, and perception, creating the possibility of forming new, more adaptive patterns by potentiating novel and under-utilized pathways. This claim is further supported by the recent finding that the degree of entropy elevation induced by LSD predicted the magnitude of increases in the personality trait of Openness to Experience displayed by healthy subjects a fortnight later (Lebedev *et al*. 2016). This is the same personality trait that was increased following psilocybin-induced mystical experiences (MacLean *et al*. 2011).

Many questions remain unanswered in the cognitive neuroscience of psychedelics. Not all neuroimaging studies have produced consistent results (see dos Santos *et al*. 2016b for a review). However, the theoretical speculations I have just described represent a plausible synthesis of current mechanistic knowledge which is consistent with phenomenological observations and provides a useful basis for thinking about the spiritual dimensions of the experience.

Consider ego dissolution, a prominent element of mystical experience. As I mentioned earlier, it is a plausible naturalistic view that the self or 'I' as we ordinarily experience it does not exist - that the sense of self is a useful fiction created by the brain (Metzinger 2003). Buddhism contends that our belief in the reality of this fictitious entity, and our subsequent attachment to its fortunes, is the source of all psychological suffering (Albahari 2006). The DMN has repeatedly been implicated in both mind-wandering and the sense of self, and empirical studies have shown that time spent mind-wandering, and functional connectivity within the DMN, both predict unhappiness. Matthew Killingsworth and Daniel Gilbert (2010) used an experience-sampling methodology implemented by a smartphone app to track participants' self-reported levels of mind-wandering vs. mindfulness, and happiness vs. unhappiness, throughout the day. They reported that mind-wandering was both extremely common and strongly correlated with state unhappiness. Meanwhile, Luo *et al*. (2015) found that high levels of functional connectivity within the DMN as revealed by resting-state fMRI were correlated with trait unhappiness as determined by psychometric questionnaires (cf. Machado and Cantilino 2016). There is no need to swallow Buddhist psychology whole to entertain the view that excessive rumination about the self and its travails causes much needless distress.

Granted this much, the ego dissolution experience may well involve a genuine insight, a veridical apprehension of the fact that our sense of being a discrete and persistent 'I' arises out of a habitual process of creating models and spinning narratives about an ultimately fictitious entity (Dennett 1991, Simpson 2014). And if breaking the cycle of self-focused rumination can help to alleviate anxiety and depression in general, then it theoretically ought to work for existential anxiety in particular. After all, existential anxiety, as much as any other kind, intrinsically involves a focus on the prospects of a subject, a self, in a threatening predicament.

There is an obvious worry about the very idea of an ego dissolution experience: that it is conceptually incoherent to claim that a subject has a memory of an episode during which their sense of self was absent (Metzinger 2005). It is possible to reply to this by suggesting that, despite appearances and intuitions, the cognitive processes supporting self-representation and autobiographical or episodic memory encoding are dissociable. But further empirical research would be needed to determine this. A simpler line of response is to concede that probably some minimal sense of self remains in most if not all psychedelic experiences (Pahnke 1969, Shanon 2002). Even if that is true, clearly the dramatic alteration or diminution of the ordinary sense of self is enough to have a profound impact on a subject.

Moreover, there is reason to think that a 'mere' loosening, rather than dramatic diminution, of the sense of self can have a profound effect. In the recent study of LSD in terminal illness, full-blown mystical experiences were not generally observed. Instead, reductions in anxiety were brought about by emotional, not metaphysical, peak experiences, characterized by loosening, not disintegration, of ego boundaries (Gasser *et al*. 2015). The researchers suggest that the reductions in existential angst were brought about by a liberation of attention from its bondage to personal concerns, enabling patients to access new, broader perspectives on their predicament: "Throughout an altered basic emotional experience, loosening of ego functions combined with pronounced self-referential processing of significant (intellectual/emotional) content, patients may gain a new perspective on themselves and a reduction of ruminations and ego-centeredness" (*ibid*., 9).

One patient in this study commented that when the sense of ego is diminished, "you are looking at the whole ... you are indeed starting to build relations with plants or with the entire living world around. You think less about yourself, you are thinking - across borders" (*ibid*., 6).

These observations suggest a mechanism, distinct from but continuous with the mechanisms of full-blown mystical or ego dissolution experiences, whereby psychedelics could induce the kinds of experiential qualities emphasized in Goodenough's and Solomon's theories of naturalistic spirituality: broader perspectives, wonder and awe, and appreciation of life. Recall, Carhart-Harris *et al*. propose that the DMN, as part and parcel of the 'ego functions' it implements, serves to constrain the quality of cognition, allocating attentional resources to stimuli in accordance with an organism's goals. We have seen that an excessive focus on the self and its travails, existential or otherwise, plausibly underpins much psychological distress, existential or otherwise. But this excessive focus also consumes attentional resources which otherwise could be devoted to non-self-related cognitive contents, such as reflection on the natural world and the human condition.

Indeed, psychedelic phenomenology suggests that when attention is freed from a bondage to self-related concerns by the downregulation of 'selfing' systems in the brain, these are exactly the kinds of places that it tends to go. It is very common, even in non-mystical states, for psychedelic subjects to report feeling a sense of kinship with the natural world, or wonder and awe at the miracle of existence in general and human existence in particular (Shanon 2002). In his literary analysis of narrative reports of psychedelic experience, R. A. Durr (1970) argues that changes to attention in the psychedelic state lead to the same kind of (essentially imaginative) appreciation of life that is expressed in verse by the Romantic poets. When the bonds of self-concern are weakened psychopharmacologically, "looking at the whole [and] starting to build relations with plants or with the entire living world" becomes, it would seem, not only possible but probable.

The philosopher Jesse Prinz (2014) proposes an account of the cognitive dynamics of aesthetic appreciation which seems applicable to the broader kind of appreciation of life resulting from psychedelic states. On Prinz's view appreciation amounts to a positive feedback loop between attention and wonder. Attention alights on some element of a visual object which evokes wonder, and the sense of wonder leads to increased attention to the visual element, and so forth. Perhaps by disrupting the analogous but deleterious positive feedback loop between existential anxiety and excessive attention to the existential predicament of the self, psychedelics create space for other, more beneficial attentional cycles to arise (cf. Nichols *et al*. forthcoming).

Everything I have said so far points to a central common element in mystical and non-mystical psychedelic experiences: the weakening of the ego by disruption to the DMN, whether this results in an 'ego dissolution' experience or a broadening of attention and loosening of cognition. In either case, something occurs that could reasonably be called mind-expansion, a liberation of focus from a narrow, rigid and maladaptive preoccupation with a reified self and its predicament. There is evidence that this basic process is important to the therapeutic and transformative effects of psychedelics. And while clearly compatible with a naturalistic outlook, a transformative process which involves broadening perspective beyond the individual self, and apprehending its interconnectedness, transience, and ephemerality, surely deserves the name *spirituality* if anything does.

Conclusion

The disenchantment consequent upon naturalism, particularly in its current neuroexistentialist incarnation, is a pressing problem deserving of serious philosophical attention. A plethora of theoretical solutions have been proposed, but it is worth investigating practical, psychological solutions to this problem too, via a neurophilosophical inquiry into methods of re-enchantment. The renaissance of scientific research into psychedelics, the 'existential medicine', constitutes an extremely promising avenue for this inquiry, but the apparent centrality of non-naturalistic mysticism to psychedelic transformation poses a prima facie obstacle. I have argued that despite appearances, entheogenic spirituality can be naturalized, by understanding that much of its transformative efficacy is a matter of breaking the spell of narrowly self-focused rumination, temporarily disrupting the mechanisms of self-representation and liberating attention from bondage to personal concerns. This disruption and liberation afford an opportunity to access new perspectives, see oneself and one's concerns in a broader context, and develop a sense of wonder and appreciation for life.

Anatomy of an Avatar: Ego Dissolution in Psychedelic Experience

Statement of Authorship

Title of paper:	Anatomy of an Avatar: Ego Dissolution in Psychedelic Experience
Publication status:	Submitted for Publication
Publication details:	Under review for Neuroscience of Consciousness, December 2016.
Principal Author	
Name of principal author (candidate):	Christopher Letheby
Contribution to the paper:	Contributed equally to devising the arguments and writing the paper; additionally proofread, polished, formatted, referenced, and submitted the paper.
Overall percentage (%):	55%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature:	
Date:	

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:
i) the candidate's stated contribution to the publication is accurate (as detailed above);
ii) permission is granted for the candidate to include the publication in the thesis;
and
iii) the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of co-author:	Philip Gerrans
Contribution to the paper:	Contributed equally to devising the arguments and writing the paper.
Signature:	
Date:	

Introduction

In this paper we argue that 'ego dissolution' in psychedelic experience is a window on the nature of self-awareness. Ego dissolution provides evidence that the mind uses a predictive coding strategy to represent the self as a unified entity. Under this strategy higher-level models predict that features represented at lower levels are attributes of objects. Thus, for example, in perceptual and sensorimotor feature binding the higher-level modelling of objects is used to integrate representations of features into coherent wholes. We see and feel objects, not concatenations of features, as a result of this top down process. Similarly, we argue, the self is postulated by higher-level processes as an entity to facilitate the binding or integration of information. We argue that this explains a Cartesian intuition that the self is a simple indivisible entity. In psychedelic experience these integrative processes are disrupted leading to the phenomenology of ego dissolution.

We support this idea with evidence from two related sources. The first is research by Sui and Humphreys (2015) on cognitive binding and the role of the self-model in enhancing it. The postulation of a self to which information is relevant makes a difference to the integrity of representations. However the mechanisms involved model that self as a heuristic, a way of making information 'sticky', rather than as a way of tracking the fluctuating cognitive fortunes of an actual entity. Self-awareness is the experience of cognitive processes in which these binding processes are intact.

The second is evidence provided by the phenomenon of 'ego dissolution' reported in psychedelic experience. We argue that that evidence suggests that psychedelics target mechanisms on which self-binding depends. Psychedelic experience degrades these binding processes, enabling us to experience cognition not bound by self-models. We emphasise that the 'self' which dissolves in psychedelic experience is not an actual entity or an object of perception, interoception or introspection but an entity inferred by the mind to predict the flow of experience in and across cognitive modalities. As Thomas Metzinger (2016) put it: "There is just no entity there, no individual substance, and scientifically we can predict and explain everything we want to predict and explain in a much more parsimonious way."

We can contrast Metzinger's view with Hohwy and Michael's (forthcoming) "causal realist interpretation of the reference of intentional terms and of the self" which argues that the causal power exerted by the object(s) of self representation implies a causally efficacious entity underlying the hierarchy of integrative processes. Sui and Humphreys similarly argue that the binding power of self-representation cannot be explained by a self that is essentially a theoretical or narrative abstraction. Ultimately we will argue, on the basis of the psychedelic evidence, that Sui and Humphreys, and Hohwy and Michael, are right to reject a purely narrative view of the underpinnings of self-awareness: the self-model is deeper, more robust, and more cognitively ubiquitous than that. But we will side with Metzinger and against Hohwy and Michael in denying that anything, including the self-model, possesses the right attributes to qualify as a self. The issues are subtle since all sides agree on the integrative role of the self-model and the predictive hierarchical nature of self-modeling. We return to this issue in the final section. At this point we note only that the phenomenology of ego dissolution seems easier to explain if the subject is experiencing the disintegration of a system whose integration she normally experiences in terms of an indivisible mental (but not immaterial) substance.

We offer a diagnosis of this phenomenon in terms of self-binding. We discuss the nature of binding and self-binding, arguing that self-binding does not entail the existence of an object to which attributes are bound (though it does require the *representation* of an object, to which representations of attributes are bound.) We then turn to the main sections of the paper that explain the phenomenon of ego dissolution in psychedelic experience. We describe the phenomenology and neural correlates and show that ego dissolution is best understood as a phenomenon of unbinding. In a final section we situate our account in the conceptual framework of contemporary debates and address some puzzles and remaining issues. In brief our conclusion is that even in florid psychedelic experience the self-model is never entirely destroyed. Rather as the coherence it normally imposes degrades, we become aware that our normal experience of unity depends on a modeling process. Just as disorders of feature binding help disclose the nature of object representation, ego dissolution discloses the nature of self-awareness.

Furthermore our normal experience of unity compels the inference not just that we are a self, but that that self is a Cartesian substance. The self-model is a hypothesis of a unitary and persisting entity - a bare particular - which owns and inhabits the body, which thinks the thoughts, which feels the feelings, and which was present in past experience and will be present in future experience. It turns out that controversy over the neural basis of self awareness turns on whether the mechanisms which produce the experience of self awareness perform their integrative tasks by modeling the self as an simple indivisible substance.

Binding

The notion of binding solves a problem first discussed for visual representation. It arises from evidence that different visual features of objects, such as colour, shape, and motion, are processed in separate areas of visual cortex. These representational elements are combined into coherent, unified percepts by feature binding processes. Evidence for the existence of feature binding mechanisms comes from conditions in which they fail, such as 'illusory conjunctions' of features induced experimentally or resulting from pathology (Burwick 2014). An example might be a subject presented with a green circle and a blue square who misperceives a blue circle and a green square.

Binding can be described and explained at the phenomenal (unity of experience), cognitive (coherence and integration) and neural (mechanism) levels (Revonsuo 1999). There is no single theory of the nature of binding. Some theorists treat it as a global phenomenon involving the integration of information across large-scale networks. Others focus on local or modular integration of percepts or even perceptual elements, proposing that such modular integration is necessary before candidate representations can be globally integrated. However in the absence of a final theory it remains true that cognition and experience require the coherent functioning of spatially and temporally distributed neuronal populations to produce integrated representations.

The resurgence of interest in the phenomenon by neuroscientists in the 1990s produced different theories of binding. It has been explained in terms (i) of phase synchrony (peaks and valleys of waveforms occurring simultaneously) across distributed circuitry (Singer 1999); (ii) convergence zones: specialized circuitry that integrates signals fed forward from lower level systems (Damasio 1989). Such convergence zones could be hierarchically organized, elements of a percept being individually unified then fed forward to higher levels to be integrated into the overall representation of a perceived scene and (iii) integrative properties of layer V pyramidal cells (Bachmann 2015). Refined versions of this idea suggest that information thus bound passes through a processing bottleneck enabling it to become the object of metacognitive processes. (i)-(iii) fit well with attentional and global broadcast theories of consciousness, which make availability to executive processing the essence of consciousness. On these views unbound information cannot be the object of conscious awareness. (iv) is a Hebbian theory that proposes that binding consists in the frontally regulated construction and maintenance of transient activity patterns in frontal-posterior (especially parietal) circuitry, stabilizing and integrating perceptual representations, which then become available to executive functioning (Ballard *et al*. 1983, van Essen *et al*. 1992).

These theories (i)-(iv) can be made consistent. Conscious representation might depend on synchronous firing within convergence zones whose properties are modulated from above according to context.

Here we want to note several aspects of binding theory. It is proposed to explain the unity and stability of conscious experience and it implies a neural mechanism. It explains the unity of conscious experience in terms of functional coupling between cognitive subsystems and there is a strong implication that that such coupling requires frontal involvement. Relatedly, the disruption, alteration or disappearance of consciousness is produced by the disruption of frontal-posterior coupling (Mashour 2013). This last point reminds us that consciousness comes in different forms and that a binding theory of consciousness should help explain (ultimately) sleep, dreaming, coma, alert waking, psychosis, as well as the state we are interested in here, psychedelic experience.

We think that the phenomenon of ego dissolution is a case where understanding the nature of phenomenal unbinding can illuminate the nature of binding: in this case the binding which underlies the phenomenon of self awareness.

Binding and Predictive Processing

When the binding problem and tentative solutions were first proposed the predictive processing theory had not undergone its recent revival but we note that it provides an elegant framework for understanding the binding of information. Predictive processing theories of cognition treat the brain as a neurally instantiated processing hierarchy, with generative models at higher levels predicting bottom-up inputs from lower levels. The discrepancy between predicted and actual input takes the form of an error signal, with the magnitude of error known as 'surprisal'. Error signals are cancelled either by updating the model or by taking action (known as 'active inference') to alter the discrepant input (Hohwy 2013).

This framework provides an elegant solution to the binding problem. Regularities in sensory input over time constrain the combinations of features into objects that will be predictively successful. So the binding of features together into coherent percepts is determined by the probabilistic model which best matches present and past inputs, and the choice of probabilistic model is determined by regularities in the inputs. Binding, on this view, is essentially a kind of top-down abductive inference. If I am fielding in a game of cricket, the patterns in the inputs to my visual system are efficiently and reliably predicted by a model that posits various entities - a batter, a bat, a ball - each possessing various attributes such as colour, shape, location, speed and direction of motion. So object perception is a matter of hypothesizing an ontology that makes the flow of sensory input intelligible and predictable.

Our central idea here is that self-representation can be understood using the predictive framework in the same way as object representation. The self model is an object posited to make sense of, to unify, and to predict ongoing patterns of egocentric, salient, autobiographical experience.

The notion of egocentric experience reflects the fact that experience is spatially and temporally organized from a perspective or location such as point of view or origin of movement. For example sensorimotor control depends on integration of sensory input at a point or points internal to the organism.

Salience refers to that fact that the organism is bombarded by information only a fraction of which is relevant to its goals and interests. Each of those goals, which range from phylogenetically ancient (maintaining homeostasis) to recent (maintaining social reputation) creates a dimension of salience which requires the mind to allocate processing resources adaptively. The ability to represent these multiple dimensions of salience depends on hierarchically organized neural circuitry, which focuses perception and cognition, biasing cognitive systems to the processing of relevant information. This salience network coordinates the interaction of neural systems that detect and evaluate relevance, bias processing accordingly and, importantly, allow us to feel the consequences as affective states.

Thus we are organisms which experience and act in the world from a unique physical (spatiotemporal) and affective orientation. In the process the mind makes models to explain the way the world makes us feel as we move through it. When we deliberate on and communicate the resultant experience we represent the integrated functioning of the egocentric and salience systems as unified through time in a single entity.

In effect the salience system links the egocentric self-models that manage the physical/bodily interface with autobiographical models which situate the organism historically. The salience system tells the organism which information matters and how it matters, moment to moment and through time. In effect the salience system is constantly creating the illusion of substantial selfhood by binding information into a representation not of the world in itself, but the world as it matters to the organism. As Seth (2013) put it:

> emotion and embodied selfhood are grounded in active inference of those signals most likely to be 'me' across interoceptive and exteroceptive domains. In humans, self-related predictive coding simultaneously engages multiple levels of self-representation, including physiological homeostasis, physical bodilyintegrity, morphology and position, and - more speculatively - the metacognitive and narrative 'I'.

The narrative 'I' is Dennett's (1991) narrative self or Damasio's (2010) autobiographical self, which allows us to experience high level (attempted) control of the integrated functioning of the egocentric and salience systems.

We think that Dennett is correct that the narrative self is a model which abstracts from integrated functioning of a hierarchy of egocentric and salience systems to posit a simple unified entity of which those integrated features are attributes. This view is consistent with the idea that as that functioning disintegrates we will no longer feel like unified entities.

The Architecture of Subjectivity

That the salience network is activated in such a variety of conditions, ranging from basic perceptual processing to high-level metacognition, is a consequence of the way minds evolved. The mind did not evolve to range impartially over all the information available in the world and represent its causal and conceptual structure. Rather the mind naturally allocates resources to information relevant to organismic goals and interests, represented at different time scales and levels of explicitness. Simplifying, we can say that emotional processes represent relevance to goals and interests, the salience/reward system focuses attention cognition and behaviour adaptively and affective systems allow us to experience the consequences as felt body states.

A consistent finding in the case of self-referential processing is activity in a network of midline structures whose hubs are involved in emotion, motivation, salience, and the switching of attention between neutral/external and self-relevant information (Qin and Northoff 2011). These structures are not active when attention is focused 'outward'so to speak on the perceptual environment or on problem solving with an impersonal aspect. It seems clear that smooth context-sensitive activity in this midline-centred network is an essential aspect of cognitive function. Organisms need to be able to allocate cognitive resources appropriately according to whether the context requires accurate representation of the world (concrete or abstract) or the significance of the world to their goals and interests.

The cortical midline structures repeatedly implicated in self reference divide into two distinct, large-scale functional networks. The salience network (SLN), which we have been discussing, is centered on key hub regions such as the anterior cingulate cortex (ACC), implicated in error detection and task switching, and the anterior insular cortex (AIC), implicated in interoceptive processing and conscious emotional feelings (Seth *op. cit.*). Meanwhile, the much-discussed default mode network (DMN) is centered on key hub regions such as the medial prefrontal cortex (MPFC), posterior cingulate cortex (PCC), and inferior parietal lobule (IPL; Davey *et al*. 2016).

The DMN was originally identified in neuroimaging studies of the resting brain (Raichle *et al*. 2001). It has since been found to be activated by many self-referential tasks, including 'prospection' or 'mental time travel' - the autobiographical simulation of past and future experience - and theory of mind (Spreng and Grady 2010). Of course, mind-wandering in task free conditions often concerns self-referential themes. The pioneering studies of Damasio, and much subsequent research, support the view that the MPFC is centrally involved in the attribution of personal relevance to (that is to say, the egocentric evaluation of) actual or simulated autobiographical episodes (D'Argembeau 2013). In relation to the different levels of self-modelling, the DMN is implicated in higher-level, narrative self-representation, as opposed to the more minimal embodied form of self-awareness supported by the SLN.

The PCC is a functionally enigmatic region with considerably higher metabolic activity and structural connectivity than most brain areas, leading some to describe it as the "core node of the DMN" (Davey *et al*. 2016, 390). In their analysis aimed at delineating the substrates of self-reference within the DMN, Davey *et al*. found that the optimal model was one in which "self-related processes were driven by PCC activity and moderated by the regulatory influences of MPFC." Activity in the left IPL, which is known to play a role in the retrieval of semantic information, was also part of the core self-reference network identified by this analysis.

Many intriguing findings support a key role for the PCC in self-reference. Neurofeedback studies of meditators suggest that PCC activity co-varies not with mind wandering as such, but with the experience of becoming 'caught up' in a train of thought. Brewer proposes that the PCC is involved in getting 'caught up in experience', whether it be a particularly compelling rumination or a drug craving - and numerous results find meditation downregulating PCC activity (Brewer *et al*. 2013, Brewer and Garrison 2014). Experimental results implicate the PCC in processes such as integrating information about spatial self-location and body ownership (Guterstam *et al*. 2015). According to one recent model, the PCC is a key hub involved in 'tuning' the connectivity of many other brain networks, regulating the balance between internal and external attention, as well as the breadth of attention (Leech and Sharp 2014). These observations about PCC function cohere with findings from psychedelic neuroscience which we will discuss below. First, however, we turn to the generic function of 'self-binding' which seems to be implemented by these self-processing networks.

Self Binding

The concept of self-binding comes from the work of Sui and Humphreys (2015) who proposed it to explain why cognition across domains and levels is enhanced for self-relevant information. Subjects asked to classify words on the basis of self-relatedness or meaning remember more self-related words, and moreover remember more episodic details surrounding the learning of those words, suggesting enhanced mnemonic binding. Meanwhile, in face processing studies, subjects are quicker to recognise their own face than friends' or strangers' faces, whether upright or inverted. Friends' faces also have an advantage over strangers', but only in the upright condition, suggesting that self-reference confers a unique Gestalt or integrative advantage. (Other results militate against an explanation of this effect in terms of mere familiarity).

Sui and Humphreys also cite evidence that self-reference enhances coupling between different temporal stages of information processing, possibly related to temporal binding, and enhances functional coupling between specific brain regions such as the aforementioned DMN, implicated as a neural substrate for autobiographical thought.

Sui and Humphreys also show that there is an attentional and decisionmaking enhancement effect for self-related information which speeds up sequential processing by enhancing "binding between different states of processing" (*ibid*., 724). They noted that these effects could best be explained in terms of an integrative role for self-related processing and hence they employed the concept of self-binding. Given the necessity for binding in establishing coherence they then examined a role for functional coupling of distributed circuitry consistently implicated in self-referential effects. Dynamic causal modelling of fMRI data showed "self-reference enhances the neural coupling between regions concerned with a core self-representation (vmPFC) and with distinct domain-specific regions associated with different components of the self, including self-related attention (LpSTS)" (*ibid.*, 724). Metanalyses of fMRI data reinforced the finding that "there is enhanced neural coupling for self-processing (vs other-related processing) between the vmPFC/pregenual anterior cingulate (pACC) and several other regions including the bilateral anterior insula, left striatum, right thalamus, and amygdala" (*ibid.*, 724).

Further evidence that self-relevance enhances processing comes from the role of affect in perceptual binding. It is well-established that perceived objects evoke immediate affective responses. Lebrecht *et al*. (2012) found that even paradigmatically neutral objects such as coffee cups and clocks evoke measurable 'micro-valences', concluding that "valence should be construed as a property of object representations" - that is, the affective response is bound to the percept, forming a unified representation, rather than being merely associated with it. The view that affect is bound to perception is supported by studies showing the role of the amygdala in driving eye saccades in face perception, directing the gaze to emotionally salient stimuli.

At higher levels affect is bound to memories and imaginative states invoked in reverie or deliberation, a process which seems to depend particularly on the vmPFC. This suggests that the vmPFC is recapitulating at a higher level the role played by the amygdala in perceptual processing. Namely co-ordinating the construction of self-relevant representations. One nice demonstration of this phenomenon arises in a distinction drawn between episodic (the episodic representation of previously acquired information) and autobiographical memory (in which the subject feels herself present as part of the recollected experience) by Asaf Gilboa:

> the Ventromedial PFC ... does so by establishing a *self-related* retrieval template that sets up the parameters against which retrieved memories are evaluated based on (or which give rise to) a general intuitive 'feeling of rightness'. Thus, the monitoring of the veracity and perhaps cohesiveness of autobiographical memories is primarily mediated by the ventromedial PFC. (2004; our italics).

For Sui and Humphreys the self plays far too important a role to be dismissed as a narrative fiction. They frame their argument in terms of the *function* of self-reference and argue that the integrative function they identify could not be performed by a fiction. They describe different elements of a self-referential processing system as constituting an "integrative hub for information processing" (Sui and Humphreys *op. cit.*, p. 719). The key nodes of the network they identify are those implicated in emotional binding and affective experience, the enhancement of attention for emotionally salient and motivating information and the switching of attention according to context.

These systems together perform the function identified by Sui and Humphreys. At perceptual and sensory levels they ensure that salient information is preferentially attended to and integrated into coherent percepts. At higher, conceptual or metacognitive levels they ensure that the same is true of the representations that figure in memories, stories, and causal explanations. In a review of the neural correlates of self-binding, which are the substrates of the network we outline above Lou *et al*. concluded "self-awareness is an integral function of all conscious experiences, binding conscious experiences together into a single construct with a sense of unity of consciousness" (in press).

This is a very strong claim. It implies that conscious experience would not arise in the absence of self-binding. The work of Sui and Humphreys suggests that this is not the case. Their subjects did not lose consciousness when perceiving self irrelevant information. The same is true for patients with lesions to components of this network. However such patients do seem to have compromised abilities in tasks (such as autobiographical simulation, personal decision making and social interaction) that we pretheoretically describe as requiring self-awareness. As we will show, the neuroscience and phenomenology of psychedelic ego dissolution put further pressure on the view that self-binding is necessary for consciousness. Indeed, psychedelic consciousness, in which the mechanisms of self-binding are compromised, is usually described as a state of increased or intensified consciousness, leading Carhart-Harris *et al*. (2014) to suggest that self-referential processes constrain consciousness rather than enabling it.

Recognizing the role of self-binding and self-models leaves questions about the mechanisms of binding unanswered. As we noted earlier many candidates have been proposed, including various forms of temporal correlation (synchronisation of cells or functional coupling of brain regions; Singer 1999), convergence of modular input streams in high-level integrative brain regions (Damasio 1989), and even intracellular processes implemented in cortical pyramidal cells (Bachmann 2015).

At this point evidence about the actions of psychedelic drugs and the experience of ego dissolution becomes relevant. Under the influence of psychedelics we continue to represent the world and our bodies but attention is captured and allocated in different ways, experience seems both more intense and less personal, and salience, affective feeling and motivation become detached from personal goals and history.

Psychedelic Ego Dissolution

'Classic' (serotonin 2a receptor agonist) psychedelics such as mescaline, psilocybin, and dimethyltryptamine (DMT, a key constituent in the South American beverage ayahuasca) have a long history of religious, spiritual, and medicinal use in various cultures (Sessa 2012). Serious scientific interest in these substances was sparked by the accidental discovery in the 1940s of the extremely potent psychoactive effects of lysergic acid diethylamide (LSD). During the 1950s and 60s, psychedelics were studied intensively as models of psychotic and mystical states, as psychotherapeutic agents, and as instruments for mapping the varieties of human consciousness (Osmond 1957). However, uncontrolled use of the drugs in the context of the hippie counterculture led to socio-political controversy, culminating in the virtual cessation of human psychedelic research for some decades.

Since the early 1990s this research has been slowly but steadily resuming, with greater methodological rigour and aided by the many new technical and theoretical innovations in the mind and brain sciences. Several small studies have revealed preliminary evidence for the safety and therapeutic efficacy of carefully controlled psychedelic administration (dos Santos *et al*. 2016a, Griffiths *et al*. 2016, Ross *et al*. 2016). Meanwhile, neuroimaging investigations have begun to identify neural correlates of the changes in cognition and consciousness caused by psychedelics (dos Santos *et al*. 2016b).

The remarkable variability and alleged ineffability of psychedelic experiences pose barriers to describing these states. But some progress has been made on charting the phenomenology of the 'antipodes of the mind' (Huxley 1954, Masters and Houston 1966, Shanon 2002). Psychedelics alter many aspects of experience: sense perception, emotion, cognition, and the apprehension of time and space. But of all their effects, perhaps none is more provocative than the profound alteration to the ordinary sense of self or ego known as 'ego dissolution'. The countercultural icon Alan Watts, responsible for popularising both Eastern religion and psychedelics in the 1960s, wrote: "there are certain types of change which are usual enough to be considered characteristic of psychedelics: the sense of slowed or arrested time, and the alteration of "ego boundary" - that is, of the sensation of one's own identity" (Watts 1964). Psychedelic subjects often report that their sense of being a self, or 'I', distinct from the rest of the world 'out there', is weakened, altered, or abolished during the intoxication.

Ego dissolution experiences often occur in the context of mystical states in which the ordinary sense of self is replaced by a sense of union with an ultimate reality underlying all of manifest existence - the famous 'cosmic consciousness' experience. Shanon describes the content of this apparent metaphysical realisation as "idealistic monism with pantheistic overtones" (2002, 163). The propensity of psychedelics to occasion such experiences goes some way to explaining their history of religious use. Indeed, intellectuals such as Watts and Aldous Huxley were initially drawn to psychedelics due to their prior interest in mysticism. With respect to ego dissolution, it is worth noting that apprehending the non-existence of the individual self is a central goal of Buddhist meditation (Albahari 2014). There is evidence that mystical states are important for the therapeutic effects of psychedelics (Garcia-Romeu *et al*. 2016) so explaining the ego dissolution experience is a crucial step in theorising the mechanisms of psychedelic treatment.

Early theoretical speculations about psychedelic ego dissolution strikingly anticipated the key ideas we will develop in the rest of the paper. In accordance with the dominant orientation of mid-20th century psychiatry, Freudian constructs were used liberally - some of which have recently been revived and linked to the predictive coding framework in the context of the 'neuropsychoanalysis' movement (Carhart-Harris and Friston 2010). However, Freudian commitments are inessential to the central points here. Savage (1955) and Klee (1963) both suggest explanations of ego dissolution in terms of failures of mechanisms of cognitive integration, and view these compromised perceptual (particularly interoceptive) integrative mechanisms as the basis of the self-model: "Lacking a reliable inflow (or integration) of stimuli, particularly from his body, the subject has lost much of the basis for his self-percept" (Klee 1963, 465). Both authors also liberally refer to the breakdown of cognitive processes of expectation (cf. prediction) in explaining psychedelic ego dissolution. These early speculations sit very comfortably with currently influential theoretical frameworks in cognitive neuroscience, and suggest a bidirectional, mutually reinforcing relationship between self-representation and cognitive integration.

Another important point is that ego dissolution is not an all-or-nothing affair. Different aspects of self-awareness may be more or less disrupted in different ways on psychedelics. Various authors have suggested that some vestiges of self-awareness are preserved in most, if not all, psychedelic experiences (Pahnke 1969, Shanon 2002), which helps explain the puzzling fact that autobiographical memories can apparently be formed of these putatively selfless episodes (Metzinger 2005). Moreover, there are aspects of psychedelic phenomenology which may not be explicitly described as ego dissolution but are still readily explained by our account. Subjects often find their attention drawn to stimuli which they normally would not notice; as Watts puts it, psychedelics "make the spotlight of consciousness a floodlight which... brings to light unsuspected details - details normally ignored because of their lack of significance" (Watts 1964). Attention is no longer guided exclusively by adaptive and egocentric goals and agendas; salience attribution is no longer bound to personal concern.

Subjects often become less defensive and better able to view their own thoughts and feelings dispassionately - one main rationale for early therapeutic use of these drugs (Eisner and Cohen 1958). A very common experience is to see one's own dysfunctional emotional or behavioural patterns, and the possibility of alternatives, with striking clarity (Shanon 2002, 162-163). There is a tendency toward decentring and the objectification of self-related phenomena which ordinarily are taken very personally and evoke strong emotional reactivity (Soler *et al*. 2016). All of this suggests that, even when ego is not felt to dissolve altogether, the contents of consciousness are less filtered through considerations of self-relevance than is usual. Various cognitive processes which are usually tightly coupled to self-representation become decoupled from it.

Ego Dissolution as Unbinding

When Carhart-Harris *et al*. (2012) published the first human fMRI studies of serotonergic psychedelics their results caused quite a stir. Not only did they find that intravenous psilocybin caused an overall reduction in neural activity (measured by BOLD signal), apparently contradicting earlier PET studies showing metabolic hyperactivity on psilocybin (Vollenweider *et al*. 1997). The decreases were concentrated mainly in the DMN. Psilocybin decreased activity in DMN regions but also the integrity of the network as measured by functional connectivity analyses. The normal functional coupling between key DMN hubs diminished - in particular, between the MPFC and the PCC. Despite apparent inconsistency with PET results, the fMRI results cohered with MEG investigations in the same study. These electrophysiological measures revealed another striking result: decreased alpha power (which has been linked to inhibitory processes) in the PCC correlated with psychometric ratings of ego dissolution.

Not all of these findings have been replicated in all subsequent psychedelic fMRI studies. But various observations support a role for downregulation of the DMN, and the PCC in particular, in psychedelic ego dissolution. Palhano-Fontes *et al*. reported decreased BOLD signal in DMN nodes including the MPFC and PCC during ayahuasca intoxication (Palhano-Fontes *et al*. 2015). Meanwhile, thinning of the PCC has been observed in long-term ayahuasca users, with the degree of thinning correlated with both psychometric scores for 'self-transcendence' and the extent of prior ayahuasca use (Bouso *et al*. 2015). Interestingly, these ayahuasca users equaled or outperformed matched controls on tests of neuropsychological function, suggesting that this PCC thinning is not linked to cognitive impairment. The connection with findings about PCC deactivation in 'effortless awareness' meditation is obvious, and bolstered by the finding that acute ayahuasca intoxication increases mindfulness-related capacities (Soler *et al*. 2016).

Matters have been complicated by recent apparently conflicting findings concerning the neural correlates of ego dissolution. Lebedev *et al*. (2015) reported that disintegration not of the DMN but of the SLN correlated with psilocybin-induced ego dissolution. Referring to the apparent conflict with prior results, Lebedev *et al*. note that while the DMN is frequently linked to the narrative self, the salience network has been linked with a more minimal or embodied sense of self. The distinction between narrative and minimal selfhood is commonplace in recent literature and will form part of our explanation of this pattern of results too.

Lebedev *et al*. also found ego dissolution significantly correlated with reductions in interhemispheric connectivity and in functional coupling between the medial temporal lobes (MTL) and cortical regions. This connects with earlier findings of MTL-DMN decoupling under psilocybin (Carhart-Harris *et al*. 2014) - though in the earlier studies, this decoupling did not significantly predict ego dissolution, while in the Lebedev *et al*. study, the MTL decoupled from broader cortical regions than just the DMN.

Most recently, Tagliazucchi *et al*. (2016) found that ego dissolution induced by LSD correlated with increased global functional connectivity, with these increases resulting from a breakdown in the integrity of resting-state networks. Here the DMN and SLN were both affected. The strongest specific correlation with ego dissolution was decoupling of the parahippocampal cortex, in the MTL, from the precuneus - a key DMN node anatomically adjacent to the PCC. In this study disintegration of the DMN also tracked reduced mental time travel to the past, consistent with this network's hypothesized role in this process (Speth *et al*. 2016).

What are we to make of these varied results? The major networks whose breakdown is linked to psychedelic ego dissolution have all independently been linked to one aspect or another of self-representation. Lebedev *et al*. suggest a need for fine-grained psychometric instruments capable of distinguishing between alterations to different aspects of self-awareness. Unfortunately, the ego dissolution inventory recently introduced and validated by Nour *et al*. (2016) does not make such discriminations, so for now we are stuck with theoretical speculation. However, our account will predict that Lebedev *et al*. are correct: different aspects or levels of the self-model are disrupted by psychedelics in different conditions, compromising the integrity of distinct self-binding processes.

We submit that an elegant resolution of these issues is as follows. Sui and Humphreys are correct that the self is more than a mere narrative posit. There is a robust self-representation implemented in cortical midline nodes of the DMN and SLN which plays a causal role in processing at all levels, both enabling and emerging from cognitive binding processes. This model includes both the "pre-reflective experience of "I" as a continuously existing being" (White 2015) as well as the various perceptual, embodied, and narrative representations of attributes, goals, and events which are bound to that being. The plastering of these representations with "sticky 'I, me, mine' labels that... prove painful to remove" (Kingsland 2016, 285) explains the anxiety and dysphoria which sometimes attend ego dissolution experiences (albeit relatively rarely in controlled settings.) The multi-layered nature of the self-model explains the apparently variable neural correlates of the same coarse-grained subjective report of "ego dissolution". Savage suggests that on LSD "[changes] in body ego feeling usually precede changes in mental ego feeling and sometimes are the only changes" (1955, 11), evincing an early clinical recognition that different aspects of the self-model might be affected to varying extents by psychedelics.

However, it does not follow from the existence of a robust, causally efficacious, and multi-layered self-model that the entity represented by this model exists. We agree with Metzinger that it does not, and reject Dennett's identification of the self with narrative self-models as well as Hohwy and Michael's identification of the self with hierarchical predictive self-models. This is because the self-model does not posit the existence of a narrative or a model; it posits the existence of a substance, a prime mover, a persistent entity that underlies, owns, and initiates thoughts, experiences, and actions. In accordance with predictive coding principles of cognitive efficiency, the postulation of a bare particular to which events and attributes are bound is an economical means to prediction and explanation of the flow of information.

Hohwy and Michael (forthcoming) argue that the self-model qualifies as a self because it performs many of the functions attributed to the self, such as being a "hidden cause" of thought, emotion, and behaviour. It is true that the self-model does these things. But on our view it is more like an existential placebo than a successfully self-referential model. The expectation that a drug treatment will work is a mental representation which is capable of performing some of the functional role which it attributes to its hypothesized object - viz., the pharmacological capacities of a chemical. But this does not mean such an expectation is a pharmacological capacity of a chemical. It does some of the right stuff, but it is the wrong kind of thing.

Analogously, consider a theist who mentally represents God as the source of meaning and purpose in her life. Plausibly her mental model of God as an objectively existing and meaning-providing entity will cause her to have experiences of meaning and purpose in life - that is, it will perform some of the functional role that it attributes to its hypothesized entity. But this does not mean the theist's God-model qualifies as God. Again, it does some of the right stuff, but it is the wrong kind of thing. It is not a transcendent deity; it is a system of mental representations in someone's head. One way of putting the point, then, is that the concept SELF is not purely functionally defined but has crucial *substantial* metaphysical commitments; playing part of the functional role of a self is an insufficient qualification for selfhood.

Our argument, then, turns crucially on the claim that the content of the self-model is that of an enduring substance which is distinct from all the mental, emotional, and physical activity of which it is supposed to be the owner. As Metzinger (2003) points out, our 'phenomenal avatar' (conscious self-model) is *transparent*: one does not feel like an avatar encoded in a "biological data format", one feels like a unitary, persisting substance or entity. The prevalence of this Cartesian intuition in philosophical discussions of selfhood (as exhibited by standard responses to Parfit's famous teleportation thought experiments) supports this psychosemantic claim. Some may find this claim introspectively dubitable. But it is precisely the ubiquity of this sense of 'I' that makes it difficult to isolate phenomenologically - and this is the reason why phenomena such as ego dissolution are theoretically valuable. As Savage says in his discussion of LSD phenomenology, "By and large the individual is not aware of the ego boundaries of his mind and body and becomes aware of them only when a change has occurred in them" (1955, 6). Psychedelics, by deconstructing the avatar, render it opaque and acquaint subjects directly with its representational nature. The transformative existential shock which often attends this discovery testifies to the fact that a mere avatar is not what we, in the ordinary and sober course of things, deeply feel and take ourselves to be.

Conclusion

Dennett (1992) famously argued that the self is a 'centre of narrative gravity' akin to the centre of gravity of an object: an abstraction, but no less real or predictively useful for that. On the predictive coding construal of the integrative self, the self-*model* functions as a centre of *representational* gravity - not just in narrative processes but also in lower-level affective, bodily, and spatial processes. It is a representation of the 'point' around which everything else revolves. But crucially, it is not a representation as of a mere point, but as of a particular. This is why we reject Dennett's metaphysics of selfhood, as well as Hohwy and Michael's claim that the self-model has enough of the right attributes to qualify as a self.

If our conjectures are right, the content of the self-model is Cartesian: it is of a substance or an entity which *has* the properties and experiences. And here we agree with Metzinger (2016) that there "is just no entity there, no individual substance, and scientifically we can predict and explain everything we want to predict and explain in a much more parsimonious way." Thus, our view is structurally analogous to Mackie's (1977) error theory of morality, conjoining the psychosemantic claim that the self-representation is as of a Cartesian substance with the ontological claim that no such substance exists. It is also substantially similar to Metzinger's views about the self-model, developed in the context of a specific case and a mechanistic proposal (self-binding on predictive processing principles) about how the model performs its adaptive functions for the organism.

All of this fits smoothly with the idea that the DMN and SLN implement narrative and embodied aspects of self-representation respectively. The self-representation as we conceive it serves as an organising principle at different levels and in different domains of processing. Perceptual representations are organised in an egocentric space; interoceptive representations are interpreted as signals of adaptively relevant events or 'core relational themes' (Prinz 2004); and narratives are structured around the fortunes and prospects of a protagonist. At all levels, salience is attributed, attention directed, and information integrated in accordance with the relevance of information to the organism's goals. As James Kingsland (2016, 209) puts it, "we have evolved into an ape that takes things personally".

Conclusion

In this final section, I summarise the arguments given in the four papers, and suggest directions for future research. The arguments given have made significant inroads into the philosophical analysis of psychedelic phenomena, but many unanswered questions remain, most of which will benefit from further results of the ongoing scientific study of psychedelics and their transformative effects.

Summary of Arguments

Overall, I have argued that the 'entheogenic conception' of psychedelics as effective agents of knowledge gain and spiritual growth is both consistent with naturalism and plausible in light of current scientific knowledge.

In the first paper, after arguing for the importance of a naturalistic approach and reviewing the history and transformative effects of psychedelics, I used Craver's account of causal relevance to argue that four lines of evidence implicate the psychedelic ASC in the transformative process: the apparently epistemic phenomenology of psychedelic transformation, the analogy with non-drug-induced transformative experiences, the correlations between phenomenal variables and psychological benefit variables, and the 'de-rigidifying' theory of psychedelic therapy. From the causal relevance of the ASC I concluded that psychedelic transformation is a distinctively 'humanistic', that is meaning-involving, psychopharmacological intervention. I then suggested three kinds of epistemic benefits that plausibly result from psychedelic transformation. These were: knowledge by acquaintance of the mind's potential, suggested by the de-rigidifying theory of psychedelic therapy; knowledge by acquaintance with the metaphysical nature of the (sense of) self, suggested by the phenomenon of ego dissolution; and revitalized capacities for the acquisition of modal knowledge, suggested by claims of increased cognitive flexibility following psychedelic ingestion (and again, bolstered by the de-rigidifying theory.)

In the second paper, after once again reviewing the history and science, I used Bortolotti's notion of epistemic innocence to argue that psychedelic states sometimes have the potential to cause significant and otherwise unavailable epistemic benefits to subjects. These epistemic benefits include the three kinds argued for in the first paper, plus indirect epistemic benefits consequent on psychological benefits. By freeing subjects from debilitating forms of psychological distress, and increasing their Openness to Experience, psychedelics plausibly result in a more pro-epistemic behavioural profile characterised by increased curiosity, positive mood, and engagement with the world. I suggested that the epistemic innocence of psychedelic states is highly relevant to policy debates because, even if they are not the only thing that matters, truth and knowledge do matter; the concern that psychedelic therapy may be "foisting a comforting delusion on the sick and dying" is real and legitimate. I also argued that the analysis of psychedelic states reveals an ambiguity in the formal definition of epistemic innocence; namely, it is not clear whether what is required for epistemic innocence is the unavailability at-a-time of alternative cognitive processes leading to equivalent epistemic benefits, or of the beneficial epistemic *results* of those processes. I suggested that the distinction between these two possibilities ought to be borne in mind in future research into the complex epistemic profiles of intuitively 'imperfect' cognitions.

In the third paper, I explored the potential of psychedelic experiences to alleviate the 'neuroexistentialist' anxiety consequent on the disenchantment of the world, arguing that their capacity to alleviate other kinds of existential distress provides a prima facie case for investigating this potential. I noted the problem arising from the apparent centrality of non-naturalistic metaphysical apprehensions to psychedelic transformation. I then used current theoretical knowledge about the mechanisms of psychedelic transformation, and phenomenological reports of psychedelic subjects, to argue that such metaphysical apprehensions are far from the whole story. I proposed that there are central means whereby psychedelics can combat existential distress that are naturalistically acceptable; namely, disruption to processes of self-representation, leading to a de-coupling of attention from personal concerns and the consequent availability of broader perspectives, leading to wonder and appreciation for life and a diminution of excessive and distressing focus on the existential plight of the vulnerable individual self. I also suggested that such neurophilosophical investigations of psychedelic-induced re-enchantment can make a valuable contribution to the related philosophical projects of naturalistic eudaimonics and naturalizing spirituality, which collectively constitute a promising and distinctive kind of response to neuroexistential anxiety. I pointed out that the central means of psychedelic re-enchantment which I identified are common themes in philosophical accounts of naturalistic spirituality

In the fourth and final paper, Philip Gerrans and I argued that psychedelic ego dissolution can best be explained as the result of a neuropharmacological disruption to 'self-binding' processes implemented in accordance with predictive coding principles. We suggested that hierarchical predictive models unify and integrate information in various domains and at various levels of processing by positing a discrete and unitary entity - a 'bare particular' or Cartesian substance - to which representations of attributes are bound. The psychosemantic claim that we represent ourselves as such a particular explains both prevalent Cartesian intuitions in philosophical discussions of self-awareness as well as the transformative existential shock that attends the psychedelic-induced realization that no such particular in fact exists. On the basis of this theoretical account we sided with Metzinger and against other theorists such as Hohwy and Michael in arguing that the neurocognitive nature of self-awareness and alterations thereto support an error theory of self-representation; even if predictive models themselves perform some of the functional role attributed to the entity which they posit, they do not have the right attributes to qualify as a self, because the self-model posits a unitary, persistent and indivisible entity. Self-models play some of the roles that a self would play, but they are the wrong kind of thing. This theory of ego dissolution contributes to naturalizing the entheogenic conception by showing that psychedelic experiences can afford subjects veridical and transformative insights into the very nature of their own existence.

Directions for Future Research

Several questions in the philosophy of psychedelic transformation remain to be addressed, either at all or in more detail. For instance, in the first paper, I gave reasons for thinking that epistemic gains such as knowledge by acquaintance with the potential of the mind and with the constructed nature of the sense of self are causally involved in the psychedelic transformative process. But more work needs to be done to show precisely how such epistemological concepts map onto specific components of the transformative mechanism.

This is an area where the ideas from philosophy of science about causal relevance and multi-level explanation, briefly touched on in the first paper, could be extremely helpful. Theoretical investigation into psychedelic transformation has continued to emphasise a common mechanism operating across different conditions: downregulating connector hubs, thereby rendering the brain more flexible and allowing the potentiation of more adaptive pathways. As I argued in the first paper, certain considerations from the philosophy of science suggest that a purely dynamical interpretation of this theory needs to be supplemented with mechanistic details to be genuinely explanatory. So far, so good. But it is still an open question whether those mechanistic details need refer to specific (kinds of) representational contents.

Nichols *et al*. (forthcoming) emphasise changes to whole brain dynamics, as mechanistically realized in changing connectivity between hub regions and other networks, as a common mechanism in different cases of psychedelic transformation. They suggest that the mystical experience might simply be an epiphenomenon of this transformative mechanism, rather than causally involved itself. Perhaps knowledge by acquaintance with the mind's potential is still plausibly part of the mechanism even on a reasonably content-independent story such as this. But clearly these questions need further analysis and (like most of the unanswered questions I will mention) will become even more tractable in light of further developments in psychedelic science.

Meanwhile, the notion of epistemic risk discussed in the second paper could be developed further, both in relation to psychedelics and other cognitive conditions with mixed epistemic profiles. The idea of assessing a pharmacological or other intervention in terms of its physiological, psychological, or social risk/benefit ratio is familiar enough, but if my arguments in this paper are sound, then epistemic risk/benefit ratios may constitute an important and relatively understudied dimension of an overall risk/benefit analysis of psychiatric treatment modalities. Biddle (2016) suggests that the notion of epistemic risk can help illuminate issues in philosophy of science relating to theory confirmation. It would be an interesting project to see if the idea as he develops it could help in further analysis of the risks involved in voluntarily entering epistemically complex cognitive conditions such as the psychedelic state.

It should be noted that empirical data are clearly relevant to epistemic risk assessment too. I have cited the case of Benny Shanon as showing that the epistemic risk of psychedelics from a naturalistic perspective is not absolute - it is possible to undergo psychedelic mystical experiences while subsequently retaining a critical attitude toward the apparent metaphysical apprehensions occurring therein. But it would be good to have some rigorous data on the likelihood of doing this. If it is genuinely a concern that psychedelic therapy might be "foisting a comforting delusion on the sick and dying" - and I have argued that it is - then it would seem important to conduct quantitative research into the frequency with which psychedelic treatment results in patients acquiring new beliefs which must be regarded as delusive from a naturalistic perspective, and also into the relevance or otherwise of such doxastic changes to clinical outcomes.

Such research could also help make more progress on issues concerning naturalizing psychedelic spirituality, discussed in the third paper. In that paper I argued that mystical metaphysical apprehensions are not the whole story, and that key elements of the psychedelic transformative process are both independent of such apprehensions and consistent with a commitment to naturalism. I think the evidence which I synthesized provides a strong theoretical case for this claim, but it ought to be subjected to direct empirical scrutiny. Quantitative studies into the relationships, if any, between psychedelic-induced metaphysical conversions and psychological benefits could give us much greater confidence regarding the respects in which and extents to which psychedelic transformation is a matter of metaphysical consolation or, alternatively, of naturalistic spiritual transformation. Such research might also be able to support or undermine the suggestion made by Nichols *et al*. (forthcoming) that the psychedelic mystical experience is essentially an epiphenomenon of the dismantling of rigid connectivity patterns by downregulation of connector hubs.

My proposal in the third paper that psychedelics can help overcome existential anxiety in non-patient populations merits empirical scrutiny too. There is certainly extensive anecdotal evidence that healthy subjects can experience a renewed sense of optimism and meaning in life as a result of psychedelic use (Masters and Houston 1966, Shanon 2002). But it would be an interesting project to rigorously and quantitatively examine psychedelics' capacity to combat disenchantment and nihilism in ostensibly mentally healthy people who nonetheless report significant levels of existential distress. This could be combined with the research questions suggested in the preceding paragraphs, to yield a project examining the ability of psychedelics to alleviate existential distress in non-patient populations and the role of metaphysical consolation in their ability (if such they have) to do so. Such research would amount to an interesting kind of experimental philosophy focused on what Langlitz (2016) calls "live philosophical questions".

Further research is also needed on the predictive coding-inspired unbinding theory of ego dissolution developed in the fourth paper. Gerrans and I argue that disruption to different large-scale brain networks in different conditions would result in phenomenologically distinct ego dissolution experiences by disrupting different aspects of the self-model. As we remark in the paper, more fine-grained psychometric instruments capable of discriminating between different varieties or aspects of ego dissolution would help in testing this prediction (although some progress could be made by examining the written or verbal descriptions of subjects in different neuroimaging studies identifying different neural correlates of ego dissolution.) The development of such instruments could be an interesting interdisciplinary project because it ideally ought to draw on descriptions of ego dissolution experiences as well as on recent research, both scientific and philosophical, on the different varieties and aspects of self-awareness.

There are also outstanding questions concerning the potential epistemic benefits of psychedelics which I have not addressed in any of these papers. As I mentioned in the introduction, both Metzinger (2003) and Shanon (2010) endorse the venerable claim that psychedelics can allow subjects to gain therapeutically valuable insights into their own psychology. The account of ego dissolution as unbinding goes some way to establishing a mechanistically plausible explanation of how this could work: by disrupting self-binding processes, psychedelics decouple salience and attention from self-representation, allowing the sort of decentring and objectivity which permits uncomfortable mental contents to be viewed with detachment, honesty and clarity, rather than denial. But much more work needs to be done to develop this proposal, including answering Roche's (2010) arguments against the possibility of any kind of drug-induced propositional knowledge.

Further questions in psychedelic epistemology have more strongly conceptual dimensions. Shanon (2010) lists a variety of other putatively epistemic benefits of psychedelics, including the apprehension or appreciation of truths about nature in new and deeper ways; increases to well-being and stamina; more harmonious social interaction; novel solutions to problems in one's field of specialisation; and enhanced abilities of artistic performance and creativity. Determining whether psychedelics do in fact cause each of these results is an empirical matter, and determining the extent to which each of them amounts to a genuinely epistemic benefit demands rigorous conceptual analysis. Although he does not explicitly use an epistemic vocabulary, similar points apply to Tupper's (2002, 2003) proposals that psychedelics can provide access to mythic and somatic forms of understanding and can enhance existential intelligence.

Another epistemological concept which may be useful in analysing psychedelic transformation is that of 'knowledge how' (Fantl 2016). I have not explicitly mentioned this possibility so far, but some of Shanon's and Tupper's proposals, plus the connections between psychedelics and meditation, raise the question whether certain aspects of psychedelic-assisted learning might best be conceived of as the acquisition of cognitive, emotional, or attentional skills or abilities.

In sum, many more questions remain than I have even attempted to answer here, and most of them require further empirical, theoretical, and conceptual work. With any luck, the psychedelic renaissance, and the philosophical exploration thereof, is only just beginning.

References

1. Adams, D. (1979). *The hitchhiker's guide to the galaxy*. Pan Books.
2. Albahari, M. (2006). *Analytical Buddhism: the two-tiered illusion of self*. Palgrave Macmillan.
3. Albahari, M. (2014). Insight knowledge of no self in Buddhism: an epistemic analysis. *Philosopher's Imprint* 14, 1-30.
4. Aragona, M. (2013). Philosophy of clinical psychopharmacology. *Psychiatria Danubina* 25, 4-10.
5. Bachmann, T. (2015). How a (sub) cellular coincidence detection mechanism featuring layer-5 pyramidal cells may help produce various visual phenomena. *Frontiers in Psychology* 6. doi: 10.3389/fpsyg.2015.01947
6. Badiner, A. H. and A. Grey (eds.) (2002). *Zig zag zen: Buddhism and psychedelics*. Chronicle Books.
7. Ballard, D. H., G. E. Hinton, and T. J. Sejnowski (1983). Parallel visual computation. *Nature* 306, 21-26.
8. Biddle, J. B. (2016). Inductive risk, epistemic risk, and overdiagnosis of disease. *Perspectives on Science* 24, 192-205.
9. Bogenschutz, M. P., A. A. Forcehimes, J. A. Pommy, C. E. Wilcox, P. C. R. Barbosa, and R. J. Strassman (2015). Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. *Journal of Psychopharmacology* 29, 289-299.
10. Bogenschutz, M. P., & Johnson, M. W. (2015). Classic hallucinogens in the treatment of addiction. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*. DOI: http://dx.doi.org/10.1016/j.pnpbp.2015.03.002.
11. Bortolotti, L. (2013). Delusions. In E. N. Zalta (ed.) *The Stanford Encyclopedia of Philosophy (Summer 2015 Edition)*. http://plato.stanford.edu/archives/sum2015/entries/delusion
12. Bortolotti, L. (2015a). The epistemic innocence of motivated delusions. *Consciousness and Cognition*, 33, 490-499.
13. Bortolotti, L. (2015b). Epistemic benefits of elaborated and systematized delusions in schizophrenia. *British Journal for the Philosophy of Science*. DOI: http://dx.doi.org/10.1093/bjps/axv024.
14. Bortolotti, L. & Gunn, R. (2015). Philip Gerrans: The measure of madness: philosophy, cognitive neuroscience, and delusional thought. *British Journal for the Philosophy of Science*. DOI: http://dx.doi.org/10.1093/bjps/axv032.
15. Bortolotti, L. & Miyazono, K. (2016). The ethics of delusional belief. *Erkenntnis* 81, 275-296.
16. Bourguignon, E. (1973). *Religion, altered states of consciousness, and social change*. Ohio State University Press.
17. Bouso, J. C., F. Palhano-Fontes, A. Rodríguez-Fornells, S. Ribeiro, R. Sanches, J. A. S. Crippa, J. E. C. Hallak, D. B. de Araujo, and J. Riba (2015). Long-term use of psychedelic drugs is associated with differences in brain structure and personality in humans. *European Neuropsychopharmacology* 25, 483-492.
18. Brewer, J. A. and K. A. Garrison (2014). The posterior cingulate cortex as a plausible mechanistic target of meditation. *Annals of the New York Academy of Sciences* 1307, 19-27.
19. Brewer, J. A., K. A. Garrison, and S. Whitfield-Gabrieli (2013). What about the "self" is processed in the posterior cingulate cortex? *Frontiers in Human Neuroscience* 7, 1-7.
20. Brogaard, B. and D. E. Gatzia (2016). What can neuroscience tell us about the hard problem of consciousness? *Frontiers in Neuroscience* 10. doi: 10.3389/fnins.2016.00395
21. Brown, D. J. and L. Reitman (2010). Psilocybin studies and the religious experience: an interview with Roland Griffiths, Ph.D. *MAPS Bulletin* 20, 22-25. http://www.maps.org/news-letters/v20n1/v20n1-22to25.pdf
22. Burwick, T. (2014). The binding problem. *Wiley Interdisciplinary Reviews: Cognitive Science* 5, 305-315.
23. Byrd, K. R., D. Lear, and S. Schwenka (2000). Mysticism as a predictor of subjective well-being. *The International Journal for the Psychology of Religion* 10, 259- 269.
24. Carhart-Harris, R. L. and K. Friston (2010). The default mode, ego-functions, and free-energy: a neurobiological account of Freudian ideas. *Brain* 133, 1265- 1283.
25. Carhart-Harris, R. L., D. Erritzoe, T. Williams *et al*. (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proceedings of the National Academy of Sciences* 109, 2138-2143.
26. Carhart-Harris, R. L., R. Leech, P. J. Hellyer, *et al*. (2014). The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs. *Frontiers in Human Neuroscience* 8, 1-22.
27. Cavanna, A. E. (2015). On the philosophy of psychopharmacology. *Cognitive Neuropsychiatry* 20, 551-554.
28. Churchland, P. S. (1986). *Neurophilosophy: toward a unified science of the mind-brain*. MIT Press.
29. Churchland, P. S. (2011). *Braintrust: what neuroscience tells us about morality*. Princeton University Press.
30. Clifford, W. K. (1877). The ethics of belief. *Contemporary Review*.
31. Craver, C. F. (2007). *Explaining the brain: mechanisms and the mosaic unity of neuroscience*. Oxford University Press.

32. Dakwar, E., C. Anerella, C. L. Hart, F. R. Levin, S. J. Mathew, and E. V. Nunes (2014). Therapeutic infusions of ketamine: do the psychoactive effects matter? *Drug and Alcohol Dependence* 136, 153-157.
33. Damasio, A. R. (1989). The brain binds entities and events by multiregional activation from convergence zones. *Neural Computation* 1, 123-132.
34. Damasio, A. R. (2010). *Self comes to mind: constructing the conscious brain*. Pantheon.
35. D'Argembeau, A. (2013). On the role of the ventromedial prefrontal cortex in self-processing: the valuation hypothesis. *Frontiers in Human Neuroscience* 7. doi: 10.3389/fnhum.2013.00372
36. D'Argembeau, A., H. Cassol, C. Phillips, E. Balteau, E. Salmon, and M. van der Linden (2014). Brains creating stories of selves: the neural basis of autobiographical reasoning. *Social Cognitive and Affective Neuroscience* 9, 646-652.
37. Dass, R. (1971). *Be here now*. Modern Press.
38. Dass, R. (2005). Walking the path: psychedelics and beyond. In R. Walsh and C. S. Grob (eds.) *Higher wisdom: eminent elders explore the continuing impact of psychedelics*, 207-221. SUNY Press.
39. Davey, C. J., J. Pujol, and B. J. Harrison (2016). Mapping the self in the brain's default mode network. *Neuroimage* 132, 390-397.
40. Davis, D. M., and J. A. Hayes (2011). What are the benefits of mindfulness? A practice review of psychotherapy-related research. *Psychotherapy* 48, 198-208.
41. Delmonte, M. M. & Kenny, V. (1987). Conceptual models and functions of meditation in psychotherapy. *Journal of Contemporary Psychotherapy* 17, 38- 59.
42. Dennett, D. C. (1984). *Elbow room: the varieties of free will worth wanting*. MIT Press.
43. Dennett, D. (1991). *Consciousness explained*. Little Brown & Co.
44. Dennett, D. (1992). The self as a center of narrative gravity. In F. Kessel, P. Cole, and D. Johnson (eds). *Self and consciousness: multiple perspectives*. Erlbaum.
45. Dennett, D. (2013). Kinds of things: towards a bestiary of the manifest image. In D. Ross, J. Ladyman, and H. Kincaid (eds.) *Scientific metaphysics*, 96-107. Oxford University Press.
46. Doblin, R. (1991). Pahnke's Good Friday experiment: a long-term follow-up and methodological critique. *Journal of Transpersonal Psychology* 23, 1-28.
47. dos Santos, R. G., F. L. Osório, J. A. S. Crippa *et al*. (2016a). Antidepressive, anxiolytic, and antiaddictive effects of ayahuasca, psilocybin and lysergic acid diethylamide (LSD): a systematic review of clinical trials published in the last 25 Years. *Therapeutic Advances in Psychopharmacology* 6, 193-213.
48. dos Santos, R. G, F. L. Osório, J. A. S. Crippa *et al*. (2016b). Classical hallucinogens and neuroimaging: a systematic review of human studies: hallucinogens and neuroimaging. *Neuroscience & Biobehavioral Reviews* 71, 715-728.
49. Durr, R. A. (1970). *Poetic vision and the psychedelic experience*. Syracuse University Press.
50. Dyck, E. (2008). *Psychedelic psychiatry: LSD from clinic to campus*. Johns Hopkins University Press.
51. Eisner, B. G. and S. Cohen (1958). Psychotherapy with lysergic acid diethylamide. *Journal of Nervous and Mental Disease* 127, 528-539.
52. Epstein, M. (2004). *Thoughts without a thinker: psychotherapy from a Buddhist perspective*. Basic Books.
53. Fantl, J. (2016). Knowledge how. In E. Zalta (ed.) *The Stanford Encyclopedia of Philosophy* (Spring 2016 edition). https://plato.stanford.edu/archives/spr2016/entries/knowledge-how/
54. Fischman, L. G. (1983). Dreams, hallucinogenic drug states, and schizophrenia: a psychological and biological comparison. *Schizophrenia Bulletin* 9, 73-94.
55. Flanagan, O. (2007). *The really hard problem: meaning in a material world*. MIT Press.
56. Flanagan, O. and G. D. Caruso (forthcoming). Neuroexistentialism: Third-wave Existentialism. In G. D. Caruso and O. Flanagan (eds.) *Neuroexistentialism: meaning, morals and purpose in the age of neuroscience*. Oxford University Press.
57. Garcia-Romeu, A., R. R. Griffiths, and M. W. Johnson (2014). Psilocybin-occasioned mystical experiences in the treatment of tobacco addiction. *Current Drug Abuse Reviews* 7, 157-164.
58. Garcia-Romeu, A., B. Kersgaard, and P. H. Addy (2016). Clinical applications of hallucinogens: a review. *Experimental and Clinical Psychopharmacology* 24, 229-268.
59. Gasser, P., D. Holstein, Y. Michel *et al*. (2014). Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. *Journal of Nervous and Mental Disease* 202, 513-520.
60. Gasser, P., K. Kirchner, and T. Passie. (2015). LSD-assisted psychotherapy for anxiety associated with a life-threatening disease: a qualitative study of acute and sustained subjective effects. *Journal of Psychopharmacology* 29, 57-68.
61. Gerrans, P. (2014). *The measure of madness: philosophy, cognitive neuroscience, and delusional thought*. MIT Press.
62. Gilboa, A. (2004). Autobiographical and episodic memory - one and the same? Evidence from prefrontal activation in neuroimaging studies. *Neuropsychologia* 42, 1336-1349.
63. Glannon, W. (2008). Psychopharmacological enhancement. *Neuroethics* 1, 45-54.
64. Goodenough, U. (1998). *The sacred depths of nature*. Oxford University Press.
65. Goodenough, U. (2001). Vertical and horizontal transcendence. *Zygon* 36, 21-31.
66. Goodenough, U. and P. Woodruff (2001). Mindful virtue, mindful reverence. *Zygon* 36, 585-595.
67. Goyal, M., S. Singh, E. M. S. Sibinga *et al*. (2014). Meditation programs for psychological stress and well-being: a systematic review and meta-analysis. *Journal of the American Medical Association Internal Medicine* 174, 357-368.
68. Graham, G. and G. L. Stephens (1994). *Philosophical psychopathology*. MIT Press.
69. Greyson, B. (1997). The near-death experience as a focus of clinical attention. *Journal of Nervous and Mental Disease* 185, 327-334.
70. Griffiths R. R., W. A. Richards, U. McCann, and R. Jesse (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187, 268-283.
71. Griffiths, R. R., M. W. Johnson, M. A. Carducci *et al*. (2016). Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. Journal of *Psychopharmacology* 30, 1181-1197.

72. Grinspoon, L. & Bakalar, J. B. (1979). *Psychedelic drugs reconsidered*. Basic Books.
73. Grinspoon, L. & Bakalar, J. B. (1986). Can drugs be used to enhance the psychotherapeutic process? *American Journal of Psychotherapy* 40, 393-404.
74. Grob, C. S. (2007). The use of psilocybin in patients with advanced cancer and existential anxiety. In M. Winkelman and T. B. Roberts (eds.) *Psychedelic medicine: new evidence for hallucinogenic substances as treatments*, 205-216. Praeger.
75. Grob, C. S., D. J. McKenna, J. C. Callaway, G. S. Brito, E. S. Neves, G. Oberlaender, O. L. Saide, E. Labigalini, C. Tacla, C. T. Miranda, R. J. Strassman, and K. B. Boone (1996). Human psychopharmacology of Hoasca, a plant hallucinogen used in ritual context in Brazil. *Journal of Nervous and Mental Disease* 184, 86-94.
76. Grob, C. S., G. R. Greer, and M. Mangini (1998). Editors' introduction: hallucinogens at the turn of the century. *Journal of Psychoactive Drugs* 30, 315-319.
77. Grob, C. S., A. L. Danforth, G. S. Chopra *et al*. (2011). Pilot study of psilocybin treatment for anxiety in patients with advanced-stage cancer. *Archives of General Psychiatry* 68, 71-78.
78. Grof, S. (1975). *Realms of the human unconscious: observations from LSD research*. Viking.
79. Guterstam, A., M. Björnsdotter, G. Gentile *et al*. (2015). Posterior cingulate cortex integrates the senses of self-location and body ownership. *Current Biology* 25, 1416-1425.
80. Halberstadt, A. (2015). Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behavioral Brain Research* 277, 91-120.
81. Harris, S. (2014). *Waking up: a guide to spirituality without religion*. Simon and Schuster.
82. Hermle, L., Fünfgeld, M., Oepen, G., Botsch, H., Borchardt, D., Gouzoulis, E. ... & Spitzer, M. (1992). Mescaline induced psychopathological, neuropsychological and neurometabolic effects in normal subjects: experimental psychosis as a tool for psychiatric research. *Biological Psychiatry* 32, 976-991.
83. Hofmann, A. (1980). *LSD: my problem child*. McGraw-Hill.
84. Hoffmann, E., J. M. K. Hesselink, and Y.-W. M. da Silveira Barbosa (2001). Effects of a psychedelic, tropical tea, Ayahuasca, on the electroencephalographic (EEG) activity of the human brain during a shamanistic ritual. *MAPS Bulletin* 11, 25-30
85. Hohwy, J. (2013). *The predictive mind*. Oxford University Press.
86. Hohwy, J. and J. Michael (forthcoming). Why should any body have a self? In F. de Vignemont and A. Alsmith (eds.) *The body and the self, revisited*. MIT Press.
87. Hood, R. W. (2006). The common-core thesis in the study of mysticism. In P. McNamara (ed.) *Where God and science meet: how brain and evolutionary studies alter our understanding of religion*, vol. 3, 119-138. Praeger.
88. Horst, S. (2009). Naturalisms in philosophy of mind. *Philosophy Compass* 4, 219- 254.
89. Huxley, A. (1932). *Brave new world*. Vintage.
90. Huxley, A. (1945). *The perennial philosophy*. Harper and Brothers.
91. Huxley, A. (1954). *The doors of perception*. Chatto and Windus.
92. Huxley, A. (1962). *Island*. Harper Collins.
93. Huxley, A. (1994). *The doors of perception and heaven and hell*. Flamingo
94. Jacobson, R. (2014, August 14). Turn on, tune in, get better: psychedelic drugs hold medical promise. *Scientific American*. http://www.scientificamerican.com/article/turn-on-tune-in-get-better-psychedelic-drugs-hold-medical-promise/
95. Johnson, M. W., Richards, W. A., & Griffiths, R. R. (2008). Human hallucinogen research: guidelines for safety. *Journal of Psychopharmacology* 22, 603-620.
96. Johnson, M. W., Garcia-Romeu, A., Cosimano, M. P., & Griffiths, R. R. (2014). Pilot study of the 5-HT$_{2A}$R agonist psilocybin in the treatment of tobacco addiction. *Journal of Psychopharmacology* 28, 983-992.
97. Kaelen, M., F. S. Barrett, L. Roseman *et al*. (2015). LSD enhances the emotional response to music. *Psychopharmacology* 232, 3607-3614.
98. Kaplan, D. M. and W. Bechtel (2011). Dynamical models: an alternative or complement to mechanistic explanation? *Topics in Cognitive Science* 3, 438- 444.
99. Katz, M. M., I. E Waskow, and J. Olsson (1968). Characterizing the psychological state produced by LSD. *Journal of Abnormal Psychology* 73, 1-14.
100. Killingsworth, M. A. and D. T. Gilbert (2010). A wandering mind is an unhappy mind. *Science* 330, 932-932.
101. Kingsland, J. (2016). *Siddhartha's brain: the science of meditation, mindfulness and enlightenment*. Robinson.
102. Klee, G. D. (1963). Lysergic acid diethylamide (LSD-25) and ego functions. *Archives of General Psychiatry* 8, 461-474
103. Kornfield, J. (1979). Intensive insight meditation: a phenomenological study. *Journal of Transpersonal Psychology* 11, 41-58.
104. Krebs, T. S., & Johansen, P.-Ø. (2012). Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. *Journal of Psychopharmacology* 26, 994-1002.
105. Langlitz, N. (2012). *Neuropsychedelia: the revival of hallucinogen research since the decade of the brain*. University of California Press.
106. Langlitz, N. (2016). Is there a place for psychedelics in philosophy? Fieldwork in neuro- and perennial philosophy. *Common Knowledge* 22, 373-384.
107. Leary, T., R. Metzner, and R. Alpert (1964). *The psychedelic experience*. University Books.
108. Lebedev, A. V., M. Lövdén, G. Rosenthal *et al*. (2015). Finding the self by losing the self: neural correlates of ego-dissolution under psilocybin. *Human Brain Mapping* 36, 3137-3153.
109. Lebedev, A. V., M. Kaelen, M. Lövden *et al*. (2016). LSD-induced entropic brain activity predicts subsequent personality change. *Human Brain Mapping* 37, 3203-3213.
110. Lebrecht, S., M. Bar, L. F. Barrett *et al*. (2012). Micro-valences: perceiving affective valence in everyday objects. *Frontiers in Psychology* 3. doi: 10.3389/fpsyg.2012.00107
111. Leech, R. and D. J. Sharp (2014). The role of the posterior cingulate cortex in cognition and disease. *Brain* 137, 12-32.
112. Letheby, C. (2015). The philosophy of psychedelic transformation. *Journal of Consciousness Studies*, 22, 170-193.
113. Lou, H. C., J. P. Changeux, and A. Rosenstand (in press). Towards a cognitive neuroscience of self-awareness. *Neuroscience and Biobehavioral Reviews*. doi: 10.1016/j.neuobiorev.2016.04.004

114. Luke, D. P. and D. B. Terhune (2013). The induction of synaesthesia with chemical agents: a systematic review. *Frontiers in Psychology* 4. doi: 10.3389/fpsyg.2013.00753
115. Luo, Y., K. Feng, S. Qi *et al*. (2015). Resting-state functional connectivity of the default mode network associated with happiness. *Social Cognitive and Affective Neuroscience*. doi: 10.1093/scan/nsv132
116. Machado, L., and A. Cantilino (2016). A systematic review of the neural correlates of positive emotions. *Revista Brasileira de Psiquiatria*. doi: 10.1590/1516-4446- 2016-1988
117. Mackie, J. L. (1977). Ethics: *inventing right and wrong*. Penguin.
118. MacLean, K. A., M. W. Johnson, and R. R. Griffiths (2011). Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *Journal of Psychopharmacology* 25, 1453-1461.
119. Majiæ, T., T. T. Schmidt, and J. Gallinat, (2015). Peak experiences and the afterglow phenomenon: when and how do therapeutic effects of hallucinogens depend on psychedelic experiences? *Journal of Psychopharmacology* 29, 241-253.
120. Malitz, S., H. Esecover, B. Wilkens *et al*. (1960). Some observations on psilocybin, a new hallucinogen, in volunteer subjects. *Comprehensive Psychiatry* 1, 8-17.
121. Mangini, M. (1998). Treatment of alcoholism using psychedelic drugs: a review of the program of research. *Journal of Psychoactive Drugs* 30, 381-418.
122. Mann, K., Günther, A., Stetter, F., & Ackermann, K. (1999). Rapid recovery from cognitive deficits in abstinent alcoholics: a controlled test-retest study. *Alcohol and Alcoholism* 34, 567-574.
123. Mashour, G. A. (2013). Cognitive unbinding: a neuroscientific paradigm of general anesthesia and related states of unconsciousness. *Neuroscience and Biobehavioral Reviews* 37, 2751-2759.
124. Masters, R. E. L. and J. Houston (1966). *The varieties of psychedelic experience*. Holt, Rinehart and Winston.
125. McKenna, T. (1991). *The archaic revival*. Harper Collins.
126. Metzinger, T. (2003). *Being no-one: the self-model theory of subjectivity*. MIT Press.
127. Metzinger, T. (2005). Précis: being no one. *Psyche* 11, 1-35.
128. Metzinger, T. (2009). *The ego tunnel: the science of the mind and the myth of the self*. Basic Books.
129. Metzinger, T. (2011). The no-self alternative. In S. Gallagher (ed.), *The Oxford handbook of the self*, 279-296. Oxford University Press.
130. Metzinger, T. (2013). Why are dreams interesting for philosophers? The example of minimal phenomenal selfhood, plus an agenda for future research. *Frontiers in Psychology* 4. doi: 10.3389/fpsyg.2013.00746
131. Metzinger, T. (2014). Spirituality and intellectual honesty: an essay. http://www.blogs.unimainz.de/fb05philosophieengl/files/2013/07/TheorPhil_Metzinger_SIR_2014_ English.pdf
132. Metzinger, T. (2016). All about the ego tunnel: interview by Richard Marshall. *3AM Magazine*. http://www.3ammagazine.com/3am/all-about-the-ego-tunnel/
133. Miller, C. (2014). Moral virtues, epistemic virtues, and the Big Five. In A. Fairweather & O. Flanagan (eds.) *Naturalizing epistemic virtue*, 92-117. Cambridge University Press.
134. Moreno, F. A., C. B. Wiegand, E. K. Taitano, and P. L. Delgado (2006). Safety, tolerability and efficacy of psilocybin in 9 patients with obsessive-compulsive disorder. *Journal of Clinical Psychiatry* 67, 1735-1740.
135. Nichols, D. E. (2004). Hallucinogens. *Pharmacology and Therapeutics* 101, 131-181.
136. Nichols, D. E. (2016). Psychedelics. *Pharmacological Reviews* 68, 264-355.
137. Nichols, D. E., M. W. Johnson, and C. D. Nichols (forthcoming). Psychedelics as medicines: an emerging new paradigm. *Clinical Pharmacology & Therapeutics*. doi: 10.1002/cpt.557
138. Nour, M. M., L. Evans, D. Nutt *et al*. (2016). Ego-dissolution and psychedelics: validation of the ego-dissolution inventory (EDI). *Frontiers in Human Neuroscience* 10. doi: 10.3389/fnhum.2016.00269.
139. Nozick, R. (1974). *Anarchy, state and utopia*. Basic Books.
140. Nutt, D. (2016). Psilocybin for anxiety and depression in cancer care? Lessons from the past and prospects for the future. *Journal of Psychopharmacology* 30, 1163- 1164.
141. Osmond, H. (1957). A review of the clinical effects of psychotomimetic agents. *Annals of the New York Academy of Sciences* 66, 418-434.
142. Osório, F. L., Sanches, R. F., Macedo, L. R., dos Santos, R. G., Maia-de-Oliveira, J. P., Wichert-Ana, L. ... & Hallak, J. E. (2015). Antidepressant effects of ayahuasca in patients with recurrent depression: a preliminary report. *Revista Brasileira de Psiquiatria* 37, 13-20.
143. Osto, D. (2016). *Altered states: Buddhism and psychedelic spirituality in America*. Columbia University Press.
144. Pahnke, W. N. (1963). Drugs and mysticism: an analysis of the relationship between psychedelic drugs and the mystical consciousness: a thesis. Doctoral dissertation, Harvard University.
145. Pahnke, W. (1969). The psychedelic mystical experience in the human encounter with death. *The Harvard Theological Review* 62, 1-21.
146. Pahnke, W. N. and W. A. Richards (1966). Implications of LSD and experimental mysticism. *Journal of Religion and Health* 5, 175-208.
147. Palhano-Fontes, F., K. C. Andrade, L. F. Tofoli, A. C. Santos, J. A. S. Crippa, J. E. C. Hallak, S. Ribeiro, and D. B. de Araujo (2015). The psychedelic state induced by ayahuasca modulates the activity and connectivity of the default mode network. *PLoS ONE* 10, e0118143.
148. Papineau, D. (2009). Naturalism. In E. N. Zalta (ed.) *The Stanford Encyclopedia of Philosophy (Spring 2009 Edition)*. http://plato.stanford.edu/archives/spr2009/entries/naturalism/
149. Parens, E. (2005). Authenticity and ambivalence: toward understanding the enhancement debate. Hastings Center Report 35, 34-41.
150. Pollan, M. (2015, February 9). The trip treatment. The New Yorker. http://www.newyorker.com/magazine/2015/02/09/trip-treatment. 28 Aug 2015.
151. Prinz, J. J. (2004). *Gut reactions: a perceptual theory of emotion*. Oxford University Press.
152. Prinz, J. (2014). Seeing with feeling. In Gregory Currie, Matthew Kieran, Aaron Meskin *et al*. (eds.) *Aesthetics and the*

sciences of mind, 143-158. Oxford University Press.
153. Qin, P. and G. Northoff (2011). How is our self related to midline regions and the default mode network? *Neuroimage* 57, 1221-1233.
154. Raichle, M. E., A. M. MacLeod, A. Z. Snyder *et al*. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences* 98, 676-682.
155. Ren, J., Li, H., Palaniyappan, L., Liu, H., Wang, J., Li, C., & Rossini, P. M. (2014). Repetitive transcranial magnetic stimulation versus electroconvulsive therapy for major depression: a systematic review and meta-analysis. *Progress in Neuro-Psychopharmacology and Biological Psychiatry* 51, 181-189.
156. Revonsuo, A. (1999). Binding and the phenomenal unity of consciousness. *Consciousness and Cognition* 8, 173-185.
157. Roberts, T. B. (2013). *The psychedelic future of the mind: how entheogens are enhancing cognition, boosting intelligence, and raising values*. Park Street.
158. Roche, G. T. (2010). Seeing snakes: on delusion, knowledge and the drug experience. In D. Jacquetted (ed.) *Cannabis - philosophy for everyone: what were we just talking about?*. John Wiley and Sons.
159. Ross, D. (2014). *Philosophy of economics*. Palgrave Macmillan.
160. Ross, S., A. Bossis, J. Guss *et al*. (2016). Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with lifethreatening cancer: a randomized controlled trial. *Journal of Psychopharmacology* 30, 1165-1180.
161. Ruck, C. A. P., J. Bigwood, D. Staples, J. Ott and G. Wasson (1979). Entheogens. *Journal of Psychedelic Drugs* 11, 145-146.
162. Russell, B. (1910). Knowledge by acquaintance and knowledge by description. *Proceedings of the Aristotelian Society* 11, 108-128.
163. Savage, C. (1955). Variations in ego feeling induced by d-lysergic acid diethylamide (LSD-25). *The Psychoanalytic Review* 42, 1-16.
164. Schermer, M. H. N. (2007). Brave new world versus island - utopian and dystopian views on psychopharmacology. *Medicine, Health Care and Philosophy* 10, 119-128.
165. Schmid, Y., F. Enzler, P. Gasser *et al*. (2015). Acute effects of lysergic acid diethylamide in healthy subjects. *Biological Psychiatry* 78, 544-553.
166. Sellars, W. (1963). *Science, perception and reality*. The Humanities Press.
167. Sessa, B. (2005). Can psychedelics have a role in psychiatry once again? *British Journal of Psychiatry* 186, 457-458.
168. Sessa, B. (2008). Is it time to revisit the role of psychedelic drugs in enhancing human creativity? *Journal of Psychopharmacology* 22, 821-827.
169. Sessa, B. (2012). *The psychedelic renaissance: reassessing the role of psychedelic drugs in 21st century psychiatry and society*. Muswell Hill Press.
170. Sessa, B. & Johnson, M. W. (2015). Can psychedelic compounds play a part in drug dependence therapy? *British Journal of Psychiatry* 206, 1-3.
171. Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. *Trends in Cognitive Sciences* 17, 565-573.
172. Shanon, B. (2002). *The antipodes of the mind: charting the phenomenology of the ayahuasca experience*. Oxford University Press.
173. Shanon, B. (2010). The epistemics of ayahuasca visions. *Phenomenology and the Cognitive Sciences* 9, 263-280.
174. Simpson, W. (2014). The mystical stance: the experience of self-loss and Daniel Dennett's "center of narrative gravity". *Zygon* 49, 458-475.
175. Singer, W. (1999). Neuronal synchrony: a versatile code for the definition of relations? *Neuron* 24, 49-65.
176. Smith, H. (1964). Do drugs have religious import? *Journal of Philosophy* 61, 517- 530.
177. Smith, H. (2000). *Cleansing the doors of perception: the religious significance of entheogenic plants and chemicals*. Tarcher/Putnam.
178. Sober, E. (2000). *Philosophy of biology*, 2nd ed. Westview Press.
179. Soler, J., M. Elices, A. Franquesa *et al*. (2016). Exploring the therapeutic potential of ayahuasca: acute intake increases mindfulness-related capacities. *Psychopharmacology* 233, 823-829.
180. Solomon, R. C. (2002). *Spirituality for the skeptic: the thoughtful love of life*. Oxford University Press.
181. Speth, J., C. Speth, M. Kaelen *et al*. (2016). Decreased mental time travel to the past correlated with default-mode network disintegration under lysergic acid diethylamide. *Journal of Psychopharmacology* 30, 344-353.
182. Spreng, R. N. and C. L. Grady (2010). Patterns of brain activity supporting autobiographical memory, prospection, and theory of mind, and their relationship to the default mode network. *Journal of Cognitive Neuroscience* 22, 1112-1123.
183. Stace, W. T. (1960). *Mysticism and philosophy*. Lippincott.
184. Stein, D. J. (2012). *Philosophy of psychopharmacology*. Cambridge University Press.
185. Stein, D. J. (2012). Psychopharmacological enhancement: a conceptual framework. *Philosophy, Ethics and Humanities in Medicine* 7, 5.
186. Stephens, G. L. and G. Graham (2007). Philosophical psychopathology and self-consciousness. In M. Velmans and S. Schneider (eds). *The Blackwell companion to consciousness*, 194-208. Blackwell.
187. Stone, J. A. (2012). Spirituality for naturalists. *Zygon* 47, 481-500.
188. Strassman, R. J. (1984). Adverse reactions to psychedelic drugs: a review of the literature. *Journal of Nervous and Mental Disease* 172, 577-595.
189. Strassman, R. J. (1995a). Hallucinogenic drugs in psychiatric research and treatment. *Journal of Nervous and Mental Disease* 183, 127-138.
190. Strassman, R. J. (1995b). Human psychopharmacology of *N,N*-dimethyltryptamine. *Behavioral Brain Research* 73, 121-124.
191. Strassman, R. J. (2001). *DMT: the spirit molecule*. Park Street Press.
192. Strassman, R. (2005). Hallucinogens. In M. Earlywine (ed.) *Mind-altering drugs: the science of subjective experience*, 49-85. Oxford University Press.
193. Stuckey, D. E., R. Lawson, and L. E. Luna (2005). EEG gamma coherence and other correlates of subjective reports during

Ayahuasca experiences. *Journal of Psychoactive Drugs* 37, 163-178.

194. Studerus, E., M. Kometer, F. Hasler *et al.* (2011). Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *Journal of Psychopharmacology* 25, 1434-1452.
195. Sturgeon, N. (2006). Ethical naturalism. In D. Copp (ed.) *The Oxford handbook of ethical theory*, 91-121. Oxford University Press.
196. Sui, J. and G. W. Humphreys (2015). The integrative self: how self-reference integrates perception and memory. *Trends in Cognitive Sciences* 19, 719-728.
197. Sullivan-Bissett, E. (2015). Implicit bias, confabulation and epistemic innocence. *Consciousness and Cognition* 33, 548-560.
198. Szara, S. (1967). The hallucinogenic drugs - curse or blessing? *American Journal of Psychiatry* 123, 1513-1518.
199. The President's Council on Bioethics (2003). *Beyond therapy: biotechnology and the pursuit of happiness*. https://bioethicsarchive.georgetown.edu/pcbe/reports/beyondtherapy/index.html. 10 Jun 2014.
200. Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D., & Chialvo, D. R. (2014). Enhanced repertoire of brain dynamical states during the psychedelic experience. *Human Brain Mapping* 35, 5442-5456.
201. Tagliazucchi, E., L. Roseman, M. Kaelen *et al.* (2016). Increased global functional connectivity correlates with LSD-induced ego dissolution. *Current Biology* 26, 1043-1050.
202. Thomas, G., Lucas, P., Capler, N. R., Tupper, K. W., & Martin, G. (2013). Ayahuasca-assisted therapy for addiction: results from a preliminary observational study in Canada. *Current Drug Abuse Reviews* 6, 30-42.
203. Tupper, K. W. (2002). Entheogens and existential intelligence: the use of plant teachers as cognitive tools. *Canadian Journal of Education/Revue canadienne de l'education* 27, 499-516.
204. Tupper, K. (2003). Entheogens & education: exploring the potential of psychoactives as educational tools. *Journal of Drug Education and Awareness* 1, 145-161.
205. Turton, S., D. J. Nutt, and R. L. Carhart-Harris (2014). A qualitative report on the subjective experience of intravenous psilocybin administered in an fMRI environment. *Current Drug Abuse Reviews* 7, 117-127.
206. Vaughan, F. (1983). Perception and knowledge: reflections on psychological and spiritual learning in the psychedelic experience. In L. Grinspoon and J. B. Bakalar (eds.) *Psychedelic reflections*. Human Sciences Press.
207. van Essen, D. C., C. H. Anderson, and D. J. Felleman (1992). Information processing in the primate visual system: An integrated systems perspective. *Science* 255, 419-423.
208. Van Gelder, T. (1998). The dynamical hypothesis in cognitive science. *Behavioral and Brain Sciences* 21, 615-628.
209. Vollenweider, F. X., K. L. Leenders, C. Scharfetter *et al.* (1997). Positron emission tomography and fluorodeoxyglucose studies of metabolic hyperfrontality and psychopathology in the psilocybin model of psychosis. *Neuropsychopharmacology* 16, 357-372.
210. Vollenweider, F. X. and Kometer, M. (2010). The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. *Nature Reviews Neuroscience* 11, 642-651.
211. Walsh, R. (2003). Entheogens: true or false. *International Journal of Transpersonal Studies* 22, 1-6.
212. Wasson, R. G. (1957). Seeking the magic mushroom. *Life* 42, 100.
213. Watts, A. (1962). *The joyous cosmology: adventures in the chemistry of consciousness*. Pantheon.
214. Watts, A. (1964). A psychedelic experience: fact or fantasy? In D. Solomon (ed.) *LSD: the consciousness-expanding drug*. Putnam.
215. White, P. A. (2015). The pre-reflective experience of "I" as a continuously existing being: the role of temporal functional binding. *Consciousness and Cognition* 31, 98-114.
216. Windt, J. M. (2011). Altered consciousness in philosophy. In E. Cardeña and M. Winkelman (eds.) *Altering consciousness: multidisciplinary perspectives*, 229- 254. ABC-CLIO.
217. Yaden, D. B., K. D. Le Nguyen, M. L. Kern *et al.* (2016). Of roots and fruits: a comparison of psychedelic and nonpsychedelic mystical experiences. *Journal of Humanistic Psychology*. doi: 10.1177/0022167816674625
218. Young, S. N. (2013). Single treatments which have lasting effects: some thoughts on the antidepressant effects of ketamine and botulinum toxin and the anxiolytic effect of psilocybin. *Journal of Psychiatry and Neuroscience* 38, 78-83.
219. Zaehner, R. C. (1958). *Mysticism: sacred and profane*. Clarendon Press.

Will psilocybin lose its magic in the clinical setting?

by

Caroline Hayes, Mourad Wahba and Stuart Watson

Received: 19 November 2021; revised manuscript accepted: 1 March 2022

Ther Adv Psychopharmacol 2022, Vol. 12: 1–9
DOI: 10.1177/20451253221090822

© The Author(s), 2022

original report: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9036342/pdf/10.1177_20451253221090822.pdf
backup source: http://www.psilosophy.info/resources/10.1177_20451253221090822.pdf

Correspondence to:

Caroline Hayes
Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, St Nicholas Hospital, Jubilee Road, Newcastle upon Tyne NE3 3XT, UK.
Caroline.Hayes@cntw.nhs.uk

Mourad Wahba
Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, Newcastle upon Tyne, UK

Stuart Watson
Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, Newcastle upon Tyne, UK
Newcastle University, Newcastle upon Tyne, UK

Table of Contents:

- **Abstract**
- **Introduction**
- **History**
- **Mechanism of action**
  - Serotonergic effects
  - Connectivity
  - The Bayesian model
  - Psychological flexibility
  - Neuroplasticity
- **Efficacy**
  - Therapeutic effects
  - Expectancy
  - Diversity
- **Therapist input**
  - Availability of therapist training
  - Therapists' personal experience of psychedelics
  - Cost of therapy
- **Potential adverse effects**
  - Patient vulnerability
  - Patients with psychiatric co-morbidities
  - Potential for abuse
- **Ethical considerations in psychedelic therapy**
- **Conclusion**
- **References**

Abstract

Psilocybin as a novel treatment for depression is garnering a lot of attention from both the mainstream media and the academic community. Although phase 3 trials are only just beginning, we feel that it is important for clinicians to consider what psilocybin-assisted psychotherapy might look like in the clinical setting. In this narrative review article we have considered the difficulties that may arise as psilocybin emerges from the research setting, which may hamper its progress towards becoming a licenced medication. Psilocybin has its own unique challenges: the expectation patients come to dosing with having read overwhelmingly positive media; patient suggestibility under the influence of psilocybin and requirement for specialised therapists to name a few. We have also made some recommendations for measures that should be taken in both the phase 3 trials and with clinicians to try and minimise some of the issues raised. In doing so our hope is that psilocybin will continue towards becoming a licenced medication that suitable patients are able to access with relative ease. Practicing psychiatrists need to have an awareness of the potential pitfalls of psilocybin as they will be responsible for prescribing it in the future.

Keywords: psychedelics, psilocybin, affective disorders, review, novel psychoactive drugs

Introduction

Psychedelics,[1,2] particularly psilocybin,[3] are increasingly being evaluated in clinical trials. This article examines the practical considerations required for them to progress from substances mainly used for ceremonial, recreational, and other non-clinical purposes, to routine clinical practice.

History

Psilocybin containing mushrooms were used ceremonially in 16th century Mexico prior to Spanish prohibition. There are some indications that use extended far earlier than this; stone sculptures of mushrooms capped with faces of Gods or animal-like demons were found in El Salvador, Guatemala, and Mexico, the oldest of which dates back to before 500 B.C.[4,5] Despite this long history of use, psilocybin mushrooms were only popularised in Western culture in the 1950s through the article 'Seeking the magic mushroom', written by mycologist Gordon Wasson and published in Life magazine.[6] He was inspired to write the article after being introduced to the ritualistic use in Mexico, where he ingested psychoactive mushrooms in a group session and emerged 'awestruck' from the experience.[6]

Mechanism of action

Serotonergic effects

Psilocybin belongs to the tryptamine/indolamine class of psychedelics.[7] Its metabolite psilocin is the main psychoactive compound found in psychedelic mushrooms of the psilocybe genus. Once consumed orally psilocybin is quickly dephosphorylated into psilocin which has been shown to bind to 5-HT_{1A}, 5-HT_{1B}, 5-HT_{1D}, 5-HT_{2A}, 5-HT_{2B}, 5-HT_{2C}, 5-HT_5, 5-HT_6, and 5-HT_7 receptors.[8] However, it appears that the psychedelic effects of psilocin are largely mediated by just one 5-HT receptor: 5HT_{2A}.[9] Blocking the 5-HT_{2A} receptor with the antagonist ketanserin attenuates the psychedelic effects significantly.[10] In addition, psilocybin's effects in humans have been shown to correlate with 5HT_{2A} receptor occupancy measured by positron emission tomography in the prefrontal cortex and other regions.[11]

Connectivity

Functional MRI of resting state connectivity shows that psilocybin induces changes in global brain connectivity, namely a synchronisation (hyperconnectivity) of sensory networks and a disintegration (hypoconnectivity) in subcortical and bilateral cortical areas comprising associative networks (e.g. the medial and lateral prefrontal cortex, the cingulum, insula, and temporoparietal junction),[8] adding to the evidence that psilocybin disrupts the normal associative mechanisms of the brain's connector hubs.[12] Evidence has also shown that there are changes to network-level functioning i.e. increased cortical entropy (where entropy is defined as a quantity that measures uncertainty, with increasing entropy being synonymous with an increase in disorder within a system), disintegration of networks, and improved communication between brain regions that are normally segregated.[13] These connectivity changes may underlie the demonstration that ingestion of psilocybin or psilocybin containing mushrooms triggers a profound change in consciousness, leading to changes in cognition, emotion, perception, and sense of self that can lead onto a flurry of effects including visual illusions, distorted perception of time, depersonalisation and mystical-type experiences.[14]

The Bayesian model

One hypothesised mechanism of action of psilocybin and other classical psychedelics could be described using a predictive processing model. Broadly, this model ascribes predictive properties to the brain, where it is not viewed as a passive organ in receipt of information, but an active generative organ which encodes prior beliefs about sensory input and their causes, and generates predictions accordingly. Sensory information which conflicts with these predictions must therefore cause the brain to revise its model of the world, or to attenuate the salience given to the input signal in order to preserve its model of the world.[15] The direction of flow of information-whether the model is updated with bottom up sensory information, or the sensory information is attenuated via top down control-is believed to be dependent on the weighting given to the signals.[16] Using this model, psychopathology may be caused by an overly rigid predictive model, where more weighting is given to top down predictions than bottom up information flow, thereby attenuating all information contradicting this model. For example, it has been argued that people with MDD frequently anticipate negative events, where negative predictions continue to shape perspective[17] regardless of the sensory information received. In their comprehensive paper 'REBUS and the Anarchic Brain: Towards a Unified Model of the Brain Action of Psychedelics', -where rebus is an acronym for relaxed beliefs under psychedelics- the authors argue that psychedelics may help reduce the impact of prior beliefs on immediate perception by relaxing the weighting of pathologically over-weighted priors (or schema) underpinning various expressions of mental illness, thereby increasing sensitisation to bottom up information, and reducing top down control.[16] Consequently, this may create a window where these beliefs can be challenged and re-examined.

Psychological flexibility

Psychological flexibility is defined as the ability to stay in contact with the present moment regardless of unpleasant thoughts, feelings, and bodily sensations, while choosing one's behaviours based on the situation and personal values.[18] The 'Accept, Connect, Embody' model (a psilocybin therapy model based on Acceptance and Commitment Therapy) capitalises on this concept, working on the premise that psilocybin can enhance psychological flexibility and can catalyse acceptance and connection.[19] Acceptance is defined here as cognitive de-fusion (being able to 'see through' thoughts- observing them rather than fusing with them), present moment awareness (mindful connection to sensory experience, where patients are invited to 'embody' their experience, directing attention to it with intent rather than engage in practices to avoid it), and willingness (the will to change). Connection is defined as 'self-as-context' (where the self is described as a space within which thoughts, emotions, physical sensations, and other phenomena arise, and emphasis is placed on an observer self that can notice these phenomena while building distance from it, rather than identify with them), values (one's idea of what is important in life), and committed action (steps needed to live by values).

Neuroplasticity

Psilocybin appears to offer longevity of symptom resolution after short term treatment,[13,20] rendering it favourable to those who would rather avoid medications requiring daily dosing. This may be mediated by increased neuroplastic changes in the brain. Pre-clinical trials have shown that psychedelics such as lysergic acid diethylamide (LSD) and N, N-dimethyltryptamine (DMT) robustly increase neuritogenesis (the sprouting of neurites e.g. an axon or dendrite from a cell, before differentiation) and synaptogenesis *in vivo* and *in vitro*.[21] Moreover, a recent rodent trial investigating psilocybin showed that a single dose resulted in a 10%

increase in spine size and density which occurred within 24 hours and persisted up to a month later.[22]

Efficacy

Therapeutic effects

Over the past few years, psilocybin therapy has shown promise in preliminary studies investigating its safety and efficacy in substance misuse, Obsessive Compulsive Disorder, Major Depressive Disorder[23,24] and Treatment-Resistant Depression,[25] and end of life anxiety associated with cancer[26] and AIDS.[27] This suggests that psilocybin may be a versatile tool that can be used to alleviate transdiagnostic psychological distress.

Expectancy

A significant number of those who volunteer to take part in trials have previous experience with psychedelics, and they often come with a high expectation of a positive experience.[28] With extensive positive coverage in the mainstream media this bias is likely to become more evident in those who have never tried psilocybin before, perhaps falsely inflating the positive results generated by research. A recent study looking at microdosing of psychedelics showed that, overall, there was little objective therapeutic benefit. However, those who had positive expectancy scores at baseline reported improvement in psychological wellbeing and improvement in depressive symptoms. This suggests a significant placebo response,[29] and highlights the role of this expectancy bias in psychedelic research. At the other end of the spectrum there are those who have been sold the idea of an experience that is a life-changing miracle cure, only to be dissatisfied by the reality. One patient described being 'underwhelmed' and 'disappointed' with the short-term effects of psilocybin and its impact on his life.[30] As positive media coverage of research continues to be present in the mainstream media this experience is likely to be replicated many times over.

Diversity

In the vast majority (70.6%) of psilocybin studies, 75% of all participants were white.[31] This is important because, as Michaels *et al*.[32] point out, we are currently testing a highly specific therapy under narrow conditions on an exclusive group. This is reiterated by Sellers *et al*.[28] who describe the study population as 'Often mainly Caucasian, highly educated living in major urban centers with access to tertiary medical care.' Consequently, clinicians should be mindful that the reality of clinical psilocybin on a broader population may not match the promising picture painted by the research. This is a particular concern when psilocybin is being researched as a treatment for depression as its prevalence is greater in those of a lower socioeconomic status.[33] It is essential that any future phase three trials aim to recruit a more diverse range of subjects to ensure that this imbalance is addressed.

In addition, we should consider whether this narrow pool of study participants could reflect a relatively low interest in medical psilocybin in the general population.[28] The Global Drug Survey (2019) found that only 18% of those who have not tried psychedelics would accept them as a therapy for depression or PTSD.[34]

Therapist input

In clinical trials,[20,23,27] psilocybin is used as an adjunct to psychotherapy; the experience comprises only a part of a larger treatment programme with emphasis on preparation and integration to make the most out of the experience and maximise therapeutic outcome. In this model, therapist input is an essential ingredient. While the therapeutic model itself may change from ACT[35] (Acceptance and Commitment Therapy) to ACE (a model based on ACT, described above in *Psychological Flexibility*), to bespoke models devised specifically for psilocybin, their overall structure remains the same. The Therapist provides support in the process of preparation, dosing and of integrating newly-generated insights into the participants' lives to help lead to changes in cognition and behaviour.[36,37] Furthermore, in this model, a skilled therapist is expected to act as a container for the participant and to support them through challenging experiences that may arise during the session, figuratively (and at times literally) holding their hand as they navigate the more difficult parts of the experience. It has been found that an extended period of overwhelming emotional arousal may be detrimental to treatment outcomes,[38] as well as being very distressing for the patient. The consistency of the delivery of therapist support is fundamental to both efficacy and patient safety,[37] and so it is important that the high standard of training of therapists working in clinical trials is maintained if and when psilocybin eventually makes it into the clinical setting. However, there are some potential barriers to this that should be anticipated and addressed.

Availability of therapist training

Psychedelic therapists who practice in the research setting tend to have undergone training that includes a minimum amount of clinical experience with subjects under the influence of psilocybin.[37] If psilocybin is licenced for clinical use in the next few years it is likely that demand for trained therapists will outstrip supply due to the relatively small number of patients being dosed as part of clinical trials. Steps should be taken to ensure that only those with sufficient training should undertake psychedelic therapy alongside psilocybin. This may mean that patients who would benefit from psilocybin might be denied treatment or end up on long waiting lists. There is some evidence to suggest that a delay in treatment may lead to poorer therapeutic outcomes.[39] How such training of therapists will be encouraged, supported and managed is an as yet unanswered question.

Tai *et al*.[37] have described the development and implementation of a therapist training programme for the phase IIb trial sponsored by Compass Pathways. In order to be eligible to train, participants had to be mental health practitioners with a professional licence in good standing. The trainers were described as 'experts by experience', who had delivered therapy during previous clinical trials. The training programme consisted of 20 hours of online learning followed by 5 days of in-person training. Trainees must then sit in on four psilocybin sessions before they can lead one themselves. Once therapists are competent to lead, they have on-going mentoring and attend webinars so they remain up to date and can share experience. All therapists who took part had committed to a code of ethics to help ensure patient safety.

Therapists' personal experience of psychedelics

Questions have also been raised about how a therapists' own firsthand experience of psychedelics may affect patient outcomes, and as yet there is no research into this.[40] Some are of the opinion that psychedelic therapists who have themselves had a psychedelic experience are better able to be empathetic and effective than those therapists who are psychedelic-naïve, therefore leading to improved therapeutic outcomes.[36] In a climate in which psychedelic drugs are illegal, personal use by professionals is a highly sensitive topic. Those who have used psychedelics may not be willing to disclose this due to fear of stigma or having their work discredited.[36] Both factors may put off professionals training as psychedelic therapists. Going forward it is important to establish the benefit or otherwise of therapist's own psychedelic experience and that barriers other than training are addressed when recruiting professionals into this role.

Cost of therapy

A full course of psilocybin therapy requires a lot of therapist input which is expensive.[41] Sellers *et al*.[28] describe the follow up after the psychedelic experience as 'critical' as the impact on the patient can be very profound. In a publicly funded healthcare system there may be a temptation to economise and cut the time spent with a therapist to the bare minimum. Alternatively, psilocybin therapy may be very difficult to access if it is heavily rationed. Carhart-Harris and Goodwin[41] suggest that a minimum standard be set for therapy and that this should be 'manualised' to ensure the standard is maintained. It is essential that therapist time is not cut to the extent that it affects patient safety.[42]

Potential adverse effects

Within research studies, screening, supervision and setting are carefully controlled and, on the whole, psilocybin is well tolerated by patients. The most commonly reported immediate adverse events are nausea, vomiting, transient anxiety and mild increases in heart rate and blood pressure, with headache being the most commonly reported delayed adverse event.[43] These may be easily managed in the clinical setting.

When used recreationally, there have been reports of acute psychological distress, dangerous behaviour and enduring psychological problems. In a survey study looking at challenging experiences as a result of recreational psilocybin use, 39% of 1993 respondents rated their 'bad trip' as one of the top five most challenging experiences of their lifetime.[44]

Thirty percent of sufferers of treatment-resistant depression will attempt suicide at least once.[45] In the recently released results of the Phase IIb trial sponsored by Compass Pathways, we can see that 5.2% of patients who received Psilocybin reported a serious adverse event, including suicidal ideation and suicidal behaviour.[46] With regards to set and setting, it may be that those experiencing low mood may be in a mind-set that might predispose them to a more challenging experience, and therefore potentially significant distress. More so if it doesn't come to a resolution as it sometimes does with psychedelic therapy. Alternatively, suicidality can be a result of a 'disappointment reaction', where participants with high hopes of a potential treatment falling through, or not achieving desirable results, leads to disappointment and suicidal behaviour. Preliminary results from the Compass phase 2b trial suggest that all patients with suicidal behaviour had a history of suicidal thoughts, and the behaviour took place 1 month after psilocybin administration. In addition, all patients reporting these events were non responders at their last assessment prior to the event or at the time of the event.

That being said, Phase III trials must continue to carefully monitor suicidality following administration of Psilocybin to see how significant a risk this may pose, particularly in patients with preexisting suicidal ideation. At the present time there simply is not enough data around patient safety in this area.

Patient vulnerability

Carhart-Harris and Goodwin[41] talk about the 'special vulnerability' of those under the influence of psilocybin. Sjoberg and Hollister[47] found that those having a psychedelic experience might be more suggestible, meaning that they are more vulnerable than in other types of therapy. Many psychiatric patients have a history of trauma, and so lone working by therapists during dosing sessions should be avoided, to protect both patients and therapists. Sellers *et al*.[28] have also suggested that ideally the two professionals accompanying the patient should never both be of a different gender to the patient. Chaperones are currently used in the research setting. However, in a busy clinical setting that may be short-staffed, there may be a temptation to go without. In order to protect both patients and therapists, chaperones should be considered mandatory.

Patients with psychiatric co-morbidities

Existing psilocybin studies have been highly selective and excluded patients with psychiatric comorbidities, and so the risks associated with psilocybin in this group of patients has not been very well explored. This means that results may not be generalizable and there may be significant risk associated with using psilocybin in naturalistic clinical practice where comorbidity is the norm rather than the exception.[28]

Potential for abuse

With psilocybin being known first and foremost as a drug of abuse, would use of psilocybin in the clinical setting lead patients to seeking it in the community? Furthermore, if psilocybin became a licenced medication would it encourage people to seek it themselves to self-medicate outside of controlled clinical settings and without the guidance of therapists, where they are more likely to experience adverse effects? We know that users quickly become tolerant following repeated doses of psilocybin. However, physical dependence does not develop.[10] Psilocybin has much less potential for abuse than other psychoactive drugs,[43] but diversion and abuse of prescription medication is a recognised problem and there would likely be concern around greater access to psilocybin by the public.[28] There are documented incidences of those given psilocybin as part of a trial successfully obtaining it afterwards in the community: In a trial carried out by Carhart-Harris *et al*.[13] 5 of the 20 patients dosed did so. This may be because of patients seeking help for their symptoms after the positive effects of dosing had worn off, as has been seen in patients followed up longer term.[13] It is important to differentiate between an individual taking psilocybin to regain therapeutic benefit from drug dependency. It is also important to highlight the risks of taking psilocybin outside a controlled setting and provide harm reduction information where appropriate.

Ethical considerations in psychedelic therapy

Langlitz *et al*.[48] beautifully highlight a somewhat idiosyncratic challenge to psychedelic therapy that may not be as prominent in other psychopharmacological interventions; namely the subject of moral psychopharmacology.

Potential Pitfall	Proposed solution
Current studies have had non-diverse subject populations, not reflective of patients who may benefit from Psilocybin in the clinical setting.	Phase III trials to recruit a more diverse and representative group of subjects.
Stigma; psilocybin may be considered a drug of abuse amongst both patients and professionals.	Inclusion of psychedelics, including proposed mechanisms of action, potential clinical uses, and balanced information around addiction potential into training curricula for mental health professionals.
Risk to patients due to vulnerability under the influence of Psilocybin.	Ensure chaperone provision by making it mandatory.
Patients self-medicating in the community with illicit Psilocybin, or psilocybin-containing mushrooms.	Where appropriate, provide harm reduction advice, highlight risks of outside of a controlled setting.
Shortage of trained therapists, leading to greater difficulty accessing Psilocybin therapy, or those with insufficient training delivering therapy.	Minimum training standards to be set, and training to be manualised. Mental health trusts to support Psilocybin therapist training where able.

Figure 1. Table summarising proposed solutions to issues that might arise if Psilocybin becomes a licenced medication.

Psilocybin, among other psychedelics, has been associated with changes in character and social cognition.[49] For example, three months after psilocybin treatment, patients showed an increase in extraversion and openness scores,[50] with some patients reporting an ability to re-connect with close relationships, including people who had wronged them.[51] There was also a significant increase in nature relatedness (subjective connection to nature), sustained up to a year after administration.[52] Participants taking part in a smoking cessation trial described engaging in prosocial and altruistic behaviours after their psilocybin sessions,[53] and psilocybin was shown to reduce altruistic punishment as rejections were reduced in the ultimatum game[54] and 'social pain signals' in the Cyberball game, suggesting that it attenuates responses to negative stimuli correlating to changes in self-processing rather than a lack of awareness of their exclusion.[55]

Although other substances can also alter social cognition and behaviour,[56-58] the importance of context and the 'noetic quality' ascribed to psychedelic experiences renders their users particularly vulnerable to these changes, with these characteristics acting as a 'double edged sword'[59] in terms of benefits and harms. Psychedelics ingested in different settings have been utilised to induce different, and sometimes opposing changes, from liberation from society to aides of initiation and integration into society, and from inducers of unity and connection to tools used in rituals to prepare for conflict.[48] Context and culture have a profound influence on the malleable state of mind that occurs with psilocybin, which is only intensified by the sense of revelation and intrinsic 'knowing' reported by users, reducing the need for external validation of these revelations. Timmermann *et al*.[59] highlights the influence of these factors as seen in the rising of false memories in clinical settings, the influence of spiritual beliefs at retreat centres on their attenders, and meta-physical explanations given to experiences while under the influence of DMT. The potential for iatrogenic harm that could arise as a result of this is clear, especially as psychedelic use becomes more mainstream and extra-pharmacological factors become more diverse.

It is therefore important that special care should be given to the consent process and to psychoeducation around the use of psychedelic substances. It will certainly be a challenge to standardise this and fine tune the process to maximise benefits and reduce harms as psilocybin moves into the clinical setting.

Conclusion

It may indeed be the case that psilocybin facilitates the relaxation of long-held beliefs, which under a therapeutic framework can lead to revision of such beliefs and translate to enduring therapeutic benefit, outlasting its acute effects.[60] This would make it a valuable and versatile tool in the treatment of several mental disorders when utilised with the appropriate therapeutic support.

However, there are several measures that need to be taken to ensure future patient safety, summarised in Figure 1. Ideally future phase 3 trials should recruit study populations that better represent the full population for whom this treatment is intended. This will make the results more generalizable and will minimise the risk to those patients who fall outside the very narrow existing study population. There is also the need for more information about long-term effects before psilocybin can be used in psychiatric practice.[61] Moreover, it is important to be aware of both the expectancy bias that seem to accompany psychedelics among proponents of their use, and the negative connotations they have among those who are not so inclined. There is a need for a balanced portrayal of both positive effects and potential pitfalls, where psilocybin and other psychedelic substances can be viewed through a critical, evidence-based lens without the weight of negative cultural stigmas or unrealistic expectations. One aspect that may support this is the incorporation of modules on psychedelic substances and their effects within training curricula for mental health professionals. Finally, it is paramount that strict standards around therapist training, chaperone provision, and course of therapy are maintained in clinical settings to maximise benefits and minimise risks. This list of considerations is by no means exhaustive and is sure to grow as more research is conducted. A stance of openness, curiosity, and willingness to change is essential as we slowly understand how to work with this powerful substance.

Author contributions
Caroline Hayes: Writing - original draft; Writing - review & editing.
Mourad Wahba: Writing - original draft; Writing - review & editing.
Stuart Watson: Supervision; Writing - review & editing.

ORCID iD
Caroline Hayes https://orcid.org/0000-0002-1953-5262

Acknowledgements
The team would like to thank Professor Hamish McAllister-Williams for kindly reviewing the manuscript.

Funding
The authors received no financial support for the research, authorship, and/or publication of this article.

Conflict of interest statement
The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr Hayes and Dr Wahba were sub-investigators on the COMP001 Psilocybin for Treatment-Resistant Depression Trial.

References

1. Patra S. Return of the psychedelics: psilocybin for treatment resistant depression. *Asian J Psychiatr* 2016; 24: 51-52.
2. Sessa B. Turn on and tune in to evidence-based psychedelic research. *Lancet Psychiatry* 2015; 2: 10-12.
3. Johnson MW and Griffiths RR. Potential therapeutic effects of psilocybin. *Neurotherapeutics* 2017; 14: 734-740.
4. Carod-Artal FJ. Hallucinogenic drugs in pre- columbian mesoamerican cultures. *Neurologia* 2015; 30: 42-49.
5. Hofmann A. *LSD, my problem child*. New York: McGraw-Hill, 1980, p. 209.
6. Wasson G. Seeking the magic mushroom. *Life*, 13 May 1957, pp. 100-120.
7. Tyls F, Palenicek T and Horacek J. Psilocybin - summary of knowledge and new perspectives. *Eur Neuropsychopharmacol* 2014; 24: 342-356.
8. Preller KDP and Burt J. Psilocybin induces time-dependent changes in global functional connectivity. *Biol Psych* 2020; 88:

197-207.

9. Robin L, Carhart-Harris LR, Bolstridge M, *et al.* Psilocybin for treatment-resistant depression: fMRI-measured brain mechanisms. *Scientific Reports* 2017; 7: 13187.
10. Passie T, Seifert J, Schneider U, *et al.* The pharmacology of psilocybin. *Addict Biol* 2002; 7: 357-364.
11. Vollenweider FX and Preller KH. Psychedelic drugs: neurobiology and potential for treatment of psychiatric disorders. *Nat Rev Neurosci* 2020; 21: 611-624.
12. Carhart-Harris RL, Erritzoe D, Williams T, *et al.* Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. *Proc Natl Acad Sci U S A* 2012; 109: 2138-2143.
13. Carhart-Harris RL, Bolstridge M, Day CMJ, *et al.* Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. *Psychopharmacology (Berl)* 2018; 235: 399-408.
14. Studerus E, Kometer M, Hasler F, *et al.* Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. *J Psychopharmacol* 2010; 25: 1434-1452.
15. Clark JE, Watson S and Friston KJ. What is mood? A computational perspective. *Psychol Med* 2018; 48: 2277-2284.
16. Carhart-Harris RL and Friston KJ. REBUS and the anarchic brain: toward a unified model of the brain action of psychedelics. *Pharmacol Rev* 2019; 71: 316-344.
17. Kube T, Schwarting R, Rozenkrantz L, *et al.* Distorted cognitive processes in major depression: a predictive processing perspective. *Biol Psychiatry* 2020; 87: 388-398.
18. Hoffmann D, Rask CU and Frostholm L. Acceptance and commitment therapy for health anxiety. In: Hedman-Lagerlöf E (ed.) *The clinician's guide to treating health anxiety*. London: Elsevier, 2019, p. 190.
19. Watts RLJB. The use of the psychological flexibility model to support psychedelic assisted therapy. *J Context Behav Sci* 2020; 15: 92-102.
20. Agin-Liebes GI, Malone T, Yalch MM, *et al.* Long-term follow-up of psilocybin-assisted psychotherapy for psychiatric and existential distress in patients with life-threatening cancer. *J Psychopharmacol* 2020; 34: 155-166.
21. Ly C, Greb A, Cameron L, *et al.* Psychedelics promote structural and functional neural plasticity. *Cell Reports* 2018; 23: 3170-3182.
22. Shao LX, Liao C, Gregg I, *et al.* Psilocybin induces rapid and persistent growth of dendritic spines in frontal cortex *in vivo*. *Neuron* 2021; 109: 2535-2544.e4.
23. Davis AK, Barrett FS, May DG, *et al.* Effects of psilocybin-assisted therapy on major depressive disorder: a randomized clinical trial. *JAMA Psych* 2021; 78: 481-489.
24. Carhart-Harris R, Giribaldi B, Watts R, *et al.* Trial of psilocybin versus escitalopram for depression. *N Engl J Med* 2021; 384: 1402-1411.
25. Daniel J and Haberman M. Clinical potential of psilocybin as a treatment for mental health conditions. *Ment Health Clin* 2017; 7: 24-28.
26. Griffiths RR, Johnson MW, Carducci MA, *et al.* Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. *J Psychopharmacol* 2016; 30: 1181-1197.
27. Anderson BT, Danforth A, Daroff PR, *et al.* Psilocybin-assisted group therapy for demoralized older long-term AIDS survivor men: an open-label safety and feasibility pilot study. *Eclinicalmedicine* 2020; 27: 100538.
28. Sellers EM, Romach MK and Leiderman DB. Studies with psychedelic drugs in human volunteers. *Neuropharmacology* 2018; 142: 116-134.
29. Kaertner LS, Steinborn MB, Kettner H, *et al.* Positive expectations predict improved mental-health outcomes linked to psychedelic microdosing. *Sci Rep* 2021; 11: 1941.
30. Malone TC, Mennenga SE, Guss J, *et al.* Individual experiences in four cancer patients following psilocybin-assisted psychotherapy. *Front Pharmacol* 2018; 9: 256.
31. George JR, Michaels T, Sevelius J, *et al.* The psychedelic renaissance and the limitations of a White-dominant medical framework: a call for indigenous and ethnic minority inclusion. *J Psych Stud* 2020; 4: 4-15.
32. Michaels TI, Purdon J, Collins A, *et al.* Inclusion of people of color in psychedelic-assisted psychotherapy: a review of the literature. *BMC Psych* 2018; 18: 245.
33. Carles Muntaner WWE, Miech R and O'Campo P. Socioeconomic position and major mental disorders. *Epidemiol Rev* 2004; 26: 53-62.
34. Winstock A and Johnson M. GDS2019: the psychedelic revolution in psychiatry and why patient opinion matters so much, https://www. globaldrugsurvey.com/gds-2019/gds2019-the-psychedelic-revolution-in-psychiatry-and-why-patient-opinion-matters-so-much/
35. Sloshower J, Guss J, Krause R, *et al.* Psilocybin- assisted therapy of major depressive disorder using acceptance and commitment therapy as a therapeutic frame. *J Context Behav Sci* 2020; 15: 12-19.
36. Phelps J. Developing guidelines and competencies for the training of psychedelic therapists. *J Human Psychol* 2017; 57: 450-487.
37. Tai SJ, Nielson EM, Lennard-Jones M, *et al.* Development and evaluation of a therapist training program for psilocybin therapy for treatment-resistant depression in clinical research. *Front Psych* 2021; 12: 586682.
38. Carryer JR and Greenberg LS. Optimal levels of emotional arousal in experiential therapy of depression. *J Consult Clin Psychol* 2010; 78: 190-199.
39. Bukh JD, Bock C, Vinberg M, *et al.* The effect of prolonged duration of untreated depression on antidepressant treatment outcome. *J Affect Disord* 2013; 145: 42-48.
40. Nielson EM and Guss J. The influence of therapists' first-hand experience with psychedelics on psychedelic-assisted psychotherapy research and therapist training. *J Psyched Stud* 2018; 2: 64-73.
41. Carhart-Harris RL and Goodwin GM. The therapeutic potential of psychedelic drugs: past, present, and future. *Neuropsychopharmacol* 2017; 42: 105-2113.
42. Johnson M, Richards W and Griffiths R. Human hallucinogen research: guidelines for safety. *J Psychopharmacol* 2008; 22: 603-620.

43. Rucker JJH, Iliff J and Nutt DJ. Psychiatry & the psychedelic drugs. Past, Present & Future. *Neuropharmacology* 2018; 142: 200-218.
44. Carbonaro TM, Bradstreet MP, Barrett FS, *et al.* Survey study of challenging experiences after ingesting psilocybin mushrooms: acute and enduring positive and negative consequences. *J Psychopharmacol* 2016; 30: 1268-1278.
45. Bergfeld IO, Mantione M, Figee M, *et al.* Treatment-resistant depression and suicidality. *J Affect Disord* 2018; 235: 362-367.
46. Pathways C. COMP360 psilocybin therapy for treatment-resistant depression - phase IIb topline data, https://j8g9v7z6.rocketcdn.me/wp-content/uploads/2021/11/COMP001_-_topline_data.pdf (2021, accessed 11 January 2022).
47. Sjoberg BM Jr and Hollister LE. The effects of psychotomimetic drugs on primary suggestibility. *Psychopharmacologia* 1965; 8: 251-262.
48. Langlitz N, Dyck E, Scheidegger M, *et al.* Moral psychopharmacology needs moral inquiry: the case of psychedelics. *Front Psychiatry* 2021; 12: 680064.
49. Preller KH and Vollenweider FX. Modulation of social cognition via hallucinogens and 'entactogens'. *Front Psychiatry* 2019; 10: 881.
50. Erritzoe D, Roseman L, Nour MM, *et al.* Effects of psilocybin therapy on personality structure. *Acta Psychiatr Scand* 2018; 138: 368-378.
51. Rosalind Watts CD, Krzanowski J, Nutt D, *et al.* Patients' accounts of increased 'connectedness' and 'acceptance' after psilocybin for treatment- resistant depression. *J Human Psychol* 2017; 57: 520-564.
52. Lyons T and Carhart-Harris RL. Increased nature relatedness and decreased authoritarian political views after psilocybin for treatment-resistant depression. *J Psychopharmacol* 2018; 32: 811-819.
53. Noorani T, Garcia-Romeu A, Swift TC, *et al.* Psychedelic therapy for smoking cessation: qualitative analysis of participant accounts. *J Psychopharmacol* 2018; 32: 756-769.
54. Gabay AS, Carhart-Harris RL, Mazibuko N, *et al.* Psilocybin and MDMA reduce costly punishment in the Ultimatum Game. *Sci Rep* 2018; 8: 8236.
55. Preller KH, Pokorny T, Hock A, *et al.* Effects of serotonin 2A/1A receptor stimulation on social exclusion processing. *Proc Natl Acad Sci U S A* 2016; 113: 5119-5124.
56. Kosfeld M, Heinrichs M, Zak PJ, *et al.* Oxytocin increases trust in humans. *Nature* 2005; 435: 673-676.
57. De Dreu CK, Greer LL, Van Kleef GA, *et al.* Oxytocin promotes human ethnocentrism. *Proc Natl Acad Sci U S A* 2011; 108: 1262-1266.
58. Quednow B. Social cognition and interaction in stimulant use disorders. *Curr Opin Behav Sci* 2017; 13: 55-62.
59. Timmermann C, Watts R and Dupuis D. Towards psychedelic apprenticeship: developing a gentle touch for the mediation and validation of psychedelic-induced insights and revelations. *Trans Psych*. Epub ahead of print 22 March 2020. DOI: 10.1177/13634615221082796.
60. Carhart-Harris RL. How do psychedelics work. *Curr Opin Psychiatry* 2019; 32: 16-21.
61. Kelly JR, Crockett MT, Alexander L, *et al.* Psychedelic science in post-COVID-19 psychiatry. *Ir J Psychol Med* 2021; 38: 93-98.

Are Psychedelics Useful in the Practice of Buddhism?

by

Myron J. Stolarof

Journal of Humanistic Psychology, Volume 39, No. 1, Winter 1999, pp. 60-80

© Myron J. Stolarof

original report: https://psychonautdocs.com/docs/stolaroff_buddhism.pdf
backup source: http://www.psilosophy.info/resources/stolaroff_buddhism.pdf

In the fall of 1996 issue of the Buddhist magazine Tricycle, various teachers of Buddhist meditation practice commented on the value of psychedelic experiences, with opinions of them ranging from helpful to harmful. Here, the author hopes to explain these conflicting viewpoints by describing important aspects of employing psychedelics that must be taken into account for effective results. These embrace proper methodology, which includes set and setting, dose levels, appropriate substances, appropriate intervals, and proper integration of each experience. The author has found the informed use of psychedelics to be a valuable tool in accelerating proficiency and deepening meditative practice and offers recommendations for successful use. The adverse comments of several recognized teachers are evaluated to shed further light on fruitful application of psychedelic substances.

AUTHOR'S NOTE: *The author wishes to express his appreciation to the management and editors of Tricycle for their special issue on psychedelics and to all the contributors for their willingness to present their views on a controversial subject.*

The Buddhist magazine Tricycle devoted its fall of 1996 issue to the topic of psychedelics and Buddhism. The viewpoints of the authors regarding the efficacy of psychedelics on Buddhist practice ranged from a high degree of support to outright opposition. Those who are interested in the possible application of psychedelics to meditative practice might well be puzzled by such a diversity of viewpoints. Yet, the answer is simple. Psychedelics can be used in a great variety of ways for an enormous array of purposes. The results depend greatly on the experience, knowledge, skill, and level of development of the practitioner. Thus, the person presenting his and/or her own particular point of view may or may not be aware of numerous other considerations involved. Widespread unfavorable public bias toward psychedelics has been created by very selective reporting by the media, as observed by Walsh (1982). As Walsh reports, this bias is so unfavorable that a reputable journal refused to accept an article that indicated some beneficial outcomes from the use of psychedelics unless the reference to positive effects was removed. I hope to shed some light on the diversity of viewpoints by first laying out what I consider to be important factors to take into account in effectively employing psychedelics. From this perspective, we can examine some of the more relevant comments that have been expressed.

Psychedelic agents, when properly understood, are probably one of the most valuable, useful, and powerful tools available to humanity. Yet, their use is extremely complex, which means that they are widely misunderstood and very often abused.

Let me be clear: It is not psychedelics that are complex. In their most useful application, they play a rather straightforward role. After 40 years of careful study, it is my observation that one of the outstanding actions of psychedelics is permitting the dissolving of mind sets. One of the most powerful mind set humans employ is the hiding of undesirable material from consciousness. Thus, a very important function of psychedelic substances is to permit access to the unconscious mind. The unconscious mind is enormously complex and possesses an extremely wide range of attributes, from repressed, painful material to the sublime realization of universal love. We probably shall never cease to discover new aspects and dimensions of the mind, as it appears endless, and I am convinced that continual searching will reveal new discoveries.

Probably every hypothesis that any scientist, therapist, or mystic has conceived ultimately can be observed to fit some set of conditions, from psychological dynamics to the ultimate nature of the universe. One of the most remarkable things to the experienced psychedelic user is discovering how the boundaries of perception dissolve to permit viewing ever new images, perceptions, concepts, and realizations. The biggest problem lies in incorporating discoveries into meaningful, enhanced functioning in life.

Humans love structure, and at the same time, the ego loves certainty, so a great variety of claims often are made about what psychedelics can or cannot do. With integrity, commitment, and courage, vast aspects of the mind can be explored. It is important to realize that what one experiences depends a great deal on his/her value-belief system, motivation, conditioning, and accumulated unconscious content, which includes the rigidity with which the mind functions.

I am an early stage novice in my practice of Buddhism, so there is a great deal about the subject of which I am ignorant. However, I have had considerable experience with psychedelics, and my major concern is that there will be attempts to categorize these potent aids and contain them within the walls of narrow, judgmental decisions, thereby cutting off much potential usefulness.

I personally have found that appropriately understood and used, psychedelics can play a significant role in deepening and accelerating the progress of one's meditative practice. This is not true for everyone. Psychedelics are of little use for advanced practitioners who have learned to achieve results without the benefit of such aids or for those who can free themselves from worldly obligations for extensive daily practice. Also, encountering heavily defended areas in the psyche with psychedelics may produce intense, uncomfortable feelings that many may prefer to work through more gradually.

My concern is mostly for the large number of people who could benefit from fruitful meditation practice but must still be occupied in the world by earning a living and raising a family. Such persons lead busy lives and may not have the time to devote to perfecting a practice that will lead to significant freedom. For these, informed use of psychedelics can be quite helpful in more rapidly reaching the level of accomplishment at which practice becomes self-sustaining. The ultimate achievement of liberation must occur through interior development that does not depend on the use of a plant or a chemical, although these may help in discovering the way.

There are several key factors to consider in evaluating whether the use of psychedelics can be personally fruitful:

1. **Legal status.** In a sense, this discussion is hypothetical because now most psychedelics are illegal to possess in the United States. Westerners for several centuries have focused primarily on the outer world, with the resulting neglect of developing inner resources. This neglect, coupled with a heavy emphasis on materialism and reductionism, has created a painful schism between adopted conscious values and the deep interests of the Self. For most people, it has become so painful to reveal this powerful conflict that those substances that might accomplish this have been made illegal to possess. This has not stopped many dedicated therapists and seekers who find that the value of such substances exceeds the risk of incarceration. The illegal status also creates the problem of finding pure substances in reliably known dose levels. I am not advocating that anyone break the law, but I am pointing out the importance of developing sound, rational policies that will permit appropriate scientific evaluation of these substances and, ultimately, the realization of their potential.
2. **Methodology.** It is important that those who wish to work with psychedelics be fully informed of appropriate procedures. Unfortunately, the illegal status of psychedelics has prevented the publication and sharing of results and effective practices. However, there is available a great deal of information to guide the serious seeker if one has the diligence to seek it out. Some excellent examples of appropriate procedures can be found in the following references.
   Grof's (1980) book, *LSD Psychotherapy*, is a treasure house of good information. See in particular the sections Psychedelic Therapy With LSD (pp. 32-38), Personality of the Subject (pp. 52-64), Personality of the Therapist or Guide (pp. 89-107), and Set and Setting of the Sessions (pp. 108-116).
   In Adamson and Metzner (1988), much attention is given to guidelines, preparation, set and setting.
   The pamphlet, *Code of Ethics for Spiritual Guides*, was prepared by the Council on Spiritual Practices, which can be contacted at the following address: Box 460065, San Francisco, CA 94146-0065.

Finally, Stolaroff (1993) presents a brief summary of important factors to take into account.

3. **Low doses.** Many who have experimented with psychedelics have used high doses of substance to assure penetration into the very rewarding transpersonal levels of experience. Such experiences can be awesome, compelling, and extremely rewarding. Yet, it is often the case that these experiences fade away in time unless there are diligent efforts to make the changes indicated. In profound experiences, the layers of conditioning that, in ordinary states, hold one away from liberation are transcended and from the lofty view of the transcendental state, personal conditioning seems unimportant and often unrecognized. Yet after the experience, old habits and patterns reestablish themselves and often there is no alteration in behavior. The use of low doses often can be much more effective in dealing with our "psychic garbage." Many do not care for low doses because they can stir up uncomfortable feelings, and they prefer to transcend them by pushing on into higher states, but it is precisely these uncomfortable feelings that must be resolved to achieve true freedom. With low doses, by focusing directly on the feelings and staying with them without aversion and without grasping, they will in time dissipate. Resolving one's repressed feelings in this manner clears the inner being, permitting the True Self to manifest more steadily. Such a result provides greater energy, deeper peace, more perceptive awareness, greater clarity, keener intuition, and greater compassion. It permits the deepening of one's meditation practice. The surfacing of buried feelings that this procedure permits often can bring new understanding of one's personality dynamics.
4. **Different compounds.** Some compounds may be more suitable for developing meditation practice than are others. I personally have had substantial experience with the phenethylamines, outstanding examples of which are 2C-T-2, 2C-T7, and 2C-B (code names for 2,5-dimethoxy-4-(ethylthio) phenethylamine, 2,5- dimethoxy-4-(n-propylthio) phenethylamine, and 4-bromo-2,5-dimethoxyphenethylamine, respectively). The synthetic procedures and physical characteristics of all of these compounds are published in Shulgin and Shulgin (1991). These compounds have the characteristic of having some of the centering qualities of MDMA, yet being more LSD-like than is MDMA without the powerful push of LSD. This lowers the likelihood of the user being trapped in deep pools of repressed material. Not being as pushy as LSD, these compounds require developing volition to achieve similar levels of experience. This is the same kind of volition that develops good meditation practice. Consequently, it is easier to focus attention under their influence, which permits developing the attributes for good meditation practice. As one develops proficiency in entering the desired state, it is found that the advantage of one compound over another diminishes. The appropriate dose (found by experiment-generally equivalent to 25-50 micrograms of LSD) of most any long-acting psychedelic is helpful.
5. **Freeing deeply occluded areas.** The practice of Buddhism in general, as I understand it, is not necessarily therapeutically oriented. There is much advice in older texts to resolve personal problems with focused attention and application of intention to change behavior. The result is that much unconscious material never gets resolved despite the ability of the mind to achieve high levels of awareness. For a discussion of the difference between meditative realization and the uncovering process achieved through psychotherapy, see Wilber (1993, pp. 196-198). Psychedelics facilitate reaching these deeper, often highly defended levels and clearing them out, thus permitting greater liberation and dropping of undesirable personality and behavior patterns. Some powerfully repressed areas, such as the very painful birth experience! underwent in my first LSD session (Stolaroff, 1994), might never be resolved without the help of psychedelics.
6. **Judicious spacing of psychedelic experiences.** In my own practice, I intentionally have limited my early morning formal meditation session to an hour so as to leave ample time for worldly endeavors. Thus, whatever I discover will be more applicable for the large numbers of persons constrained by the need or desire to function in the world. Although I have advanced sufficiently in my practice to fend off some of the typical aging symptoms (I am 77 years old) such as loss of energy, stiff and sore muscles, and increased arthritic symptoms, I do find that after a while, I begin to acquire such symptoms. When this happens, an appropriate psychedelic experience is a very effective rejuvenator. Aging symptoms summarily are dissipated, I am in a much more enjoyable and effective state of being, and I find it easier to remain in this state through my regular meditation practice. Also, if there are deep, underlying, unconscious dynamics that are a drag on life, as I have experienced much of my life, I find it especially helpful to resolve such deep patterns with psychedelics. The psychedelic experience provides extremely effective clearing and a quantum jump improvement in well-being and meditative proficiency. At the same time, it is important not simply to rely on another experience to overcome difficulties. Numerous

times I have discovered that mustering a deeper degree of intent can resolve important restrictions through properly focused meditation practice, with the advantage of a more permanent and satisfying state of well-being. Such work also ensures that when an additional experience is found to be appropriate, it will be considerably more rewarding.

7. **Honoring the experience.** A very important aspect of employing psychedelics is to acknowledge fully the graces that have been received. This is done through appreciation and gratitude, which are best expressed by determinedly putting into effect in one's life the changes that have been indicated. In fact, failure to do so can contribute to subsequent depression. Thoroughly honoring the experience and postponing further psychedelic exploration until a real need is determined that cannot be resolved in straightforward meditation practice ensures that the next experience will be fruitful. One of the fairly widespread abuses of psychedelics is to rely on repeated use of the drug to accomplish relief from discomfort instead of exerting the effort to make changes in one's behavior that have already been indicated. This is the most frequent objection to psychedelics raised by the contributors to Tricycle (1996).
8. **Historical precedence.** Psychedelics have had extensive use in spiritual practices in numerous cultures around the world and encompassing some 2,000 years of history. Current legally sanctioned spiritual practices with psychedelics include the Native American Indian church in North America, based on the use of peyote, and the Santo Daime and União do Vegetal churches in Brazil employing ayahuasca. Robert Jesse (1996) briefly reviews the history of such usage and describes a number of the substances most widely employed-peyote, mushrooms, ayahuasca, soma, kykeon, iboga, cannabis, LSD, and MDMA.

Using Psychedelics In Meditation Practice

Since the passage of the Controlled Substance Analogue Enforcement Act of 1986, almost all psychedelic substances have been outlawed: As a consequence, it has not been possible to conduct legally any research since that time. The following suggestions are based on the limited amount of experience that has been garnered, most of which is personal, and indicate where future research can be gainfully directed.

1. **Ethical framework.** Committing oneself to a suitable ethical framework, such as the Buddhist eight-fold path, is essential. This is an important part of the mental set and also provides help in integrating psychedelic experiences.
2. **Preparation.** The participant should have a thorough understanding of psychedelics including the types of experience that may be expected, factors affecting experience, how to handle various kinds of experiences and how to follow them up, and the importance of set and setting as described above. It is important to have first undergone a high-dose experience with a qualified guide that has resulted in reaching transpersonal levels. This will put the entire process into perspective.
3. **Employing a correct substance at the proper dose level.** Described above.
4. **Developing mental stability.** This application is probably the most fruitful for employing psychedelic substances. A practice focusing on the breath is particularly appropriate. With proper substance and dose, one will note several possible developments. First, distractions may be more intense than in ordinary practice because the action of the chemical releases more material from the unconscious. At the same time, the enhanced awareness resulting from the action of the psychedelic allows one to notice in greater detail how various attitudes, thoughts, and actions affect the ability to hold one's focus steady. From this, one learns to hold the mind in the position of maximum effectiveness for becoming free of distractions and for holding mental focus stable. One then experiences the deepening of the practice, more readily avoiding distractions and moving into areas of peace, calm, and growing euphoria. With continuing practice, one finds it easier to enter the numinous levels that one ultimately is seeking. Furthermore, the volition gained in developing this practice under the influence of a psychedelic carries on into day-to-day practice during which the same level of achievement becomes accessible. The outcome that I personally have found most satisfying is the ability to hold the mind perfectly still, a state that makes access to previously unrevealed regions of the mind available, including the direct contact with one's essence or divinity.
5. **Deepening the meditation practice.** One's daily practice may be strengthened by using the discoveries made under the influence of psychedelics. I recommend working to obtain maximum benefit from one psychedelic experience before proceeding with another. When experiences are spaced

> judiciously in this manner, one learns under the influence to go deeper into the contact with the numinous. As the ability to hold the mind steady grows, it becomes possible to focus more directly on the contact with the inner teacher-our deepest Self, our Buddha nature, or however one chooses to call the wise, guiding entity within us. Maintaining this focus leads to what seems to me to be the most valuable, fulfilling experiences possible. From such experiences, combined with daily practice, grows the ability to achieve similar results in ordinary practice, until eventually the use of the psychedelic substance is no longer required. At this point, the faculty for achieving optimum results has been developed within us. I like to call this "developing a God muscle."
>
> Many of the issues concerning the application of psychedelics in meditative practice may be clarified further by examining some of the comments reported in the Tricycle issue on Buddhism and Psychedelics (Tricycle, 1996). Jack Kornfield (1996) presents a knowledgeable and well-balanced view of the use of psychedelics as well as important factors required for a good meditative practice and spiritual development. He points out the value that psychedelics have in introducing persons to new areas of the mind and even to glimpses of the goal of spiritual realization, experiences which encouraged many to develop a more disciplined practice. He also clearly points out a common failing among many psychedelic users: failure to understand the depth of change required to transform oneself and to understand that it takes more than repeated psychedelic experiences to accomplish this.

Next, I will present some responses to Michelle McDonald-Smith's (1996) firmly expressed views.

> From my experience, no matter what kind of deep opening one might have on a drug, it isn't going to develop one's ability to have those experiences naturally. Other people might say that drugs are a doorway, but I don't see them developing anything. They don't develop equanimity, they don't develop concentration, they don't develop any factors of enlightenment. (McDonald-Smith p. 67)

In sharing my own perceptions on the same factors she has enumerated, I wish it to be clear that I am discussing the results of informed used, which has been delineated elsewhere in this article.

I agree that psychedelics alone will not necessarily develop the ability to have transpersonal experiences naturally, despite the fact that many people who have had such an outstanding initial experience are content to never have another, feeling that they have been blessed for life. I maintain that psychedelics are way showers, and we then must work with serious intent to attain the states that are shown to be possible. Nevertheless, it is of enormous benefit and inspiration if one can glimpse and experience firsthand the territory to which we aspire. Norbert Wiener, the Massachusetts Institute of Technology scientist who suggested the binary system on which the operation of computers is based, commented on the successful development of the atomic bomb by the Russians. He stated that their simply knowing that it is possible was at least 50.

In contrast to McDonald-Smith's (1996) claim, "I don't see them as developing anything"(p.67), I see them as developing wisdom, heightened perception, self-understanding, energy, and freedom; releasing habitual blocks that interfere with the total response of our senses; facilitating the flow of ideas; releasing intuition and creativity as unconscious blocks are removed and as we become in touch with our inherent faculties; and deepening our meditation practice. My observations are based on some 40 years of research, including observing more than 100 individuals.

Regarding the comments about equanimity, concentration, and enlightenment, I find that appropriate use of psychedelics helps develop all of these qualities. I never realized what equanimity was until I began taking psychedelics. One of the great gifts of psychedelics is permitting one to learn real concentration. Of course, if there is much repressed material in the unconscious and one takes a significant dose of a psychedelic, it is neither possible nor desirable to try to concentrate. It is best to simply surrender to the experience and to let the flow of imagery and feelings proceed undisturbed. In this flow, unconscious material is released. The meditation equivalent is focusing on the breath or on an object and simply letting thoughts and feelings flow without getting involved. When the high-pressure feelings in the unconscious demanding release begin to abate, then it becomes possible to concentrate on the desired object. The practice of holding one's attention steadily on an image, concept, or object under the influence of a good psychedelic permits many aspects of the object of attention to unfold, so that one may learn a great deal of new information about the object as well as discover unsuspected beauty and meaning and experience appreciation. Eventually, one develops concentration sufficient to hold the mind quite still, which permits other aspects of reality to manifest. I often feel that this is creating the empty space to permit God to enter, which I consider a major factor of enlightenment. In practicing holding the mind steady under a low dose of a psychedelic, one becomes much more aware of the subtle distractions and urges that affect concentration. Some distractions are more intense, so one can practice maintaining stability in spite of them. Such practice under the influence helps strengthen the faculty that maintains steady attention. A great deal can be accomplished in learning to effectively maintain stability, learning which is immediately applicable in subsequent practice.

McDonald-Smith (1996) stated:

> Drugs take a considerable toll on the body and the mind. They bring all this energy into the system so that it catapults you into a different state of consciousness at the same time that it taxes your body, mind, and heart. You get a sort of beatific view, but actually you are further down the mountain. (McDonald-Smith p. 67)

My associates and I, in psychedelic research, find ourselves very much at odds with this statement. Yes, if a person is carrying heavy psychic burdens and takes a large psychedelic dose, he or she can be very tired at the end of the day and perhaps for a few days after. But often this is followed by a gratifying sense of rejuvenation and appreciation for the benefits realized. Important exceptions are the cases in which the participant does not work all the way through important problem areas, leaving them with a feeling of unfinished business and perhaps even greater discomfort because he or she is now experiencing uncomfortable feelings that formerly were locked safely away. Working through these feelings with the help of a good counselor and following up with subsequent psychedelic sessions can clear up this problem.

Rather than toll, there is healing and rejuvenation. One often feels that he or she has dropped a heavy load off the body, and his or her spirits are high. A heavier mind can come from the unresolved situation described above; otherwise, there is lightness of feeling and clarity of mind. Other than toll, there is renewal. I have friends who take many different kinds of vitamins and nutriments to achieve healthy states of mind and body and to have more energy. I try their various recommendations, but my experience is that none of them work as well as a good, appropriate psychedelic session. Rather than being brought further down, you are climbing the mountain with considerable help. It is very true, however, that to maintain the high states experienced, it takes committed effort to make the necessary changes in day-to-day life. This point is frequently neglected. My experience is that not expressing appropriate gratitude and appreciation for the marvelous graces that have been granted can lead to self-hatred and depression. A good meditation practice is an effective means of maintaining awareness of the needed changes and furnishing the energy and motivation to make them possible.

McDonald-Smith (1996) also stated:

> I've had people come to retreats who've done a lot of drugs, and it seems like they don't have the energy to access subtle stages of insight. They've blown it off with drugs. You pay a price for any drug experience. (McDonald-Smith p. 69)

It is true that many have abused psychedelics by frequent use, probably of high doses, with insufficient effort to integrate the meaning of the experience. Frequent repetition can dissolve ego strength, and such people can develop rambling minds and have little ability to focus. However, it is important to understand that this is the result of abuse, which is net the case with informed use. You do not "pay a price for any drug experience." Appropriately used, psychedelic experiences not only have little or no price, but also open the door to healing, rejuvenation, and many riches in life.

McDonald-Smith (1996) says: "On the deepest level of letting go, drugs get in the way. This is especially true for those who are heavily armored" (p. 69). I say that appropriate use of psychedelics teaches you to let go and discover the rewarding benefits of letting go. We are all afraid of the unknown; psychedelics can help one develop trust, face fear, and enter unknown and sublime arenas. Psychedelics are especially helpful for the heavily armored, if they truly wish to resolve their difficulties, as they can help dissolve the heavy walls of defensiveness and permit resolution and profound insight.

A major emphasis in the remainder of McDonald-Smith's (1996) article is that "drugs promote attachment to peak experience... what you actually get from drug experience is the desire to take the drugs again" (p. 70). Many have fallen into this trap, but it is an overstatement to generalize that this is always the case. With an honest approach, one realizes that there is work to do before seeking another session. My own experience is that for many of us, particularly with me for many years, our self-esteem is so low that we feel that we do not deserve the full benefits of grace. I have found that extensive help is waiting in many different forms and from many different levels and is generously offered. We can always benefit from taking advantage of help in whatever mode, be it teachers, nutriments, reading, exercise, prayer, or simply thinking good thoughts. And they can all work together and support each other. Appreciation and gratitude multiply the benefits. And one certainly cannot argue with McDonald-Smith's advice to be completely aware in each moment.

Allan Hunt Badiner (1996) has written in Tricycle an impressive description of an extremely powerful, remarkable, life-changing experience with yagé. His experience probably represents the far extremes of intensity, variety, complexity, and meaning that psychedelics have to offer. Badiner is to be highly congratulated for both his courage and his power of articulation in encountering and describing this compelling experience. There are probably not a great many persons prepared to make such an encounter, but the outcome of Allan's experience is testimony to the advice given by many sages that the encountering of pain and suffering, and even of near death itself, paves the way to becoming utterly alive.

Nina Wise (1996), in her article in Tricycle, tells a beautiful story of personal growth and development with the aid of psychedelics, excellent teachers, and dedicated practice. With her first psychedelic experience, she encounters a trauma often encountered by inexperienced explorers. She has a glorious, very opening experience, yet sinks into deep depression because she does not know how to integrate the experience to maintain such a state. She finds a meditation teacher and begins to grow in her practice. A subsequent experience with ayahuasca provides another important opening that has very meaningful consequences in her life. Later, with the help of good meditation teachers, she reaches the peace and equanimity she has been searching for and is no longer attracted to the aid offered by psychedelics. She has reached the state of realization for which most of us long.

One hardly could hope for a better outcome than that which Nina Wise presents to us. Yet, her story does provide the opportunity to include some additional remarks about the use of psychedelics. Her first experience points out the need, as almost all the knowledgeable writers in the Tricycle (1996) issue have clearly stated, to have a framework and discipline within which to have the experience and, particularly, to help follow up the experience for optimum benefit. Her second experience with ayahuasca illustrated that at an appropriate time, a further experience can be quite helpful.

There were characteristics about her psychedelic journeys that she was quite happy to leave behind her and not engage again. Wise's (1996) words are, "My psychedelic experiences, which had brought me to this place, were now interfering with my vision" (p. 93). It is important to understand that psychedelics, when properly employed, can lead to the same state she had achieved of direct experience of reality. It is the state reached by what I call the trained user. It helps to know that the creepy visions, the hallucinations, and the constant flow of imagery are the results of pressures in the unconscious where repressed material is demanding release. By employing low psychedelic doses, it is possible to confront and deal with these images and, particularly, the feelings behind them, until they clear up. Then one reaches, while under the influence, the stage of immediate perception (Sherwood, Stolaroff, & Harman, 1962). "In this stage, the psychosomatic symptoms, the model psychoses, the multicolored hallucinatory images tend to disappear. The individual develops an awareness of other aspects of reality than those to which he is accustomed" (p. 71). The fact that a psychedelic produces streams of imagery indicates that the interior barriers to the center core of the self have not been completely eliminated. For those who wish to be completely liberated, psychedelic experiences, properly timed and integrated, can be very helpful in resolving repressed material and defensive blocks, thus giving freer access to the divine within.

Trudy Walter (1996) has given us a touching story of the difficulties of addiction and the hardship of breaking it. For years, she took respite and enjoyment in "getting stoned," and it was only through dedicated commitment to her meditation practice that she could free herself from her addiction. No matter how enjoyable or helpful an aid can be, eventually, as stated so clearly by Frances Vaughan (1995), these "golden chains" must be transcended to develop the capabilities of our true inner self.

Robert Aitken (1996) states: "I don't think drugs have particularly helped anybody arrive where they are" (p. 105). This is most definitely not true for me and many others whom I know. I very much agree with his observation that many desperately are trying to achieve realization through the drug experience when what is required is hard work in changing their attitudes, values, and behavior-a process facilitated much more effectively through deepened intention and improved behavior than through overuse of psychedelic chemicals.

Aitken (1996) offers evidence that being under the influence and then later trying to practice does not work. This has been commented on by other teachers, and I am sure that it is true for many. However, the situation is quite complex, and care is required to evaluate such generalizations. A great deal can be learned about how to use psychedelics appropriately to enhance and deepen practice. It requires looking at a number of considerations. What is the substance, the dose level, the frequency, the intention, and the effort to make maximum use of the experience, regardless of whether it was pleasant or uncomfortable, or the effort to deal with indicated changes in values and actions? With agents as powerful as psychedelics and the vast regions of the human mind made available, it seems quite shortsighted to draw conclusions before thorough investigative efforts have been pursued. And of course, with the current legal status, one dare not publish or publicly share results, so that it is most likely that there exists a great deal of valuable experience that remains hidden from the public eye.

It is my experience that practice with an appropriate, moderate dose of a psychedelic permits deepening of the meditation practice and learning much more rapidly to avoid distractions and concentrate on the important aspects of the practice. Because of our unfortunate drug laws, it has not been possible to replicate my findings on a broad basis, although preliminary trials with others support my own experience and the validity of my hypothesis. I am sure that we must find ways to verify procedures that offer such promising accomplishments.

Aitken (1996) observes that those who returned to a retreat from psychedelic experiences demonstrated a deterioration in their ability to meditate. I personally deem it unwise to muddle the opportunity to learn what a retreat has to offer by interspersing drug experiences.

Aitken (1996) is certainly right to raise the question, what after the experience? There is now almost universal consensus that being shown the territory is not enough. It is extremely important to consummate the experience by bringing it to full fruition in day-to-day life. Commitment to an ethical way of life, supported by a good meditation practice that enhances stability and clarity, is one of the best ways to ensure this accomplishment.

Aitken (1996) again says that you do not have to take drugs to wake up to reality. This is certainly true, and a great many will choose the meditative path. But for many others, the appropriate use of psychedelics can rapidly hasten the discovery of reality and, furthermore, can help reveal the inner blocks that hold one from reality and even temporarily dissolve them, so that one develops a clear picture of how to stay in touch with reality. Without psychedelics, it can take many, many months of hard work to obtain the same vision, and after the vision is obtained, there may still be repressed inner psychic loads that can inhibit freedom, suppress the experience of one's feelings and senses to the fullest, and preclude living constantly out of one's essence or Buddha nature.

There no doubt are many who have turned away from psychedelics because of unsatisfactory experiences. Although psychedelics are not a path for everyone, it is possible to cultivate more favorable outcomes with a better understanding of the nature of the experience, the possible varieties of dynamics that can arise, and how to deal with them. Those who confront and resolve negative experiences can come out with a good deal more understanding and relief from psychic burdens, which can result in greater energy and well-being.

Aitken (1996) states "that there is a qualitative difference between the ecstasy that some people report from their drug experiences and the understanding, the realization, that comes with Zen practice" (p. 109). I am not familiar with Zen practice, and so I may be in no position to comment, as Aitken likewise may not be in a position to comment on the ecstatic experience some achieve through psychedelics. But I do know from firsthand experience that it is possible to experience ecstasy almost beyond what the human frame can stand, and if Zen practitioners reach this state, power to them.

Joan Halifax (1996) clearly understands a great deal about psychedelics and what they can do and, at the same time, has developed her practice to a point at which psychedelics are no longer necessary. In her description of outgrowing the need for psychedelics, she states that the qualities of stability, loving-kindness, clarity, and humbleness are the primary qualities of the mind cultivated in meditation. She further states that such quailties are not necessarily cultivated by psychedelics. This statement is certainly true for some users who have been deceived and even become burdensome know-it-ails through their psychedelic use. I personally have found that psychedelics have been powerful influences in developing all the qualities that Halifax mentions. I already have commented that the appropriate mixture of meditation and psychedelics can influence strongly the effectiveness of each practice.

I am very much encouraged by the positive results I have observed during several decades of investigation. I find psychedelics to have significant potential not only in aiding the development of meditation practice, but also in many other important areas. Unfortunately, this perspective is not generally shared, and the controversy over psychedelics continues to be one of the major scientific disputes of recent history.

A number of excellent articles have been published examining this controversy and/or providing additional information for better understanding psychedelics. Clark (1975) presents an insightful article based on 100 respondents to a questionnaire study to assess views on promising areas of psychedelic research, the extent of the promise, and the difficulties in conducting research. A strong recommendation is made for opening up and funding psychedelic research. Villoldo (1977) describes the work of Salvador Roquet, who developed very intense methods of conducting group psychedelic sessions with powerful impact, perhaps the most intensely focused procedure yet evolved. Many important aspects of successfully employing psychedelics in therapy are discussed. Klavetter and Mogar (1967) make a questionnaire analysis of participants completing the psychedelic program at the International Foundation for Advanced Study in Menlo Park and convert the data into peakers and nonpeakers following Maslow's (1962) definitions. Peakers consistently report significant therapeutic benefit following the LSD session, a result confirmed by Hoffer (1965) and Pahnke and Richards (1966). Stolaroff (1997) presents an in-depth interview with one of the most accomplished psychedelic therapists of our time, now deceased and unnamed because of our current drug laws. This book covers the successful development of both individual and group experiences, selecting the most effective of a variety of psychedelic substances, and the optimum progression of their application.

Baumeister and Placidi (1983) present a fairly complete review of the LSD controversy, citing interesting and insightful reasons for the positions taken. Kurtz (1963) presents a cogent comparison of religious mystical experience, nature mystical experiences, Maslow's (1962) peak experiences, and drug-induced experiences. His analysis provides conclusions that the drug experiences of unity, when they occur, are the most inclusive and comprehensive in including all aspects of reality and the totality of human consciousness, combining intellectual, sensory, and mystical aspects occurring simultaneously. Mogar (1965) provides an excellent review paper, pointing out the growing trends in psychiatry and psychology and the growing acceptance of a wider range of human capacities and functions as revealed through altered states of consciousness produced by a variety of means. An excellent summary of results obtained in psychedelic research is presented.

Harman (1963) presents probably the most informed review of the psychedelic drug controversy, recognizing the root of the controversy in basic metaphysical assumptions, carefully describing the character of psychedelic experiences and the factors that influence them, comparing the highest potential of such experiences with natural mystical experiences, presenting the data assuring safety in proper hands, analyzing the resistance to accepting psychedelic research despite the publishing of positive results, and recommending proceeding with important research. The most recent information at this writing comes from Shulgin and Shulgin (1997), which covers a wide variety of interesting topics. Pertinent to this discussion are presentations on the nature and variety of psychedelic experiences and the growing appropriation of power by government to prescribe medical practice and scientific research (see, particularly, Part 2: Psychedelics and Personal Transformation, and Part 5: Drugs and Politics).

Although the articles discussed above contribute much important information, they still fall short in recognizing one of the most crucial aspects of psychedelic use. Most observers still lean toward the allopathic medical perception of drugs, in which the results are attributed to the particular action of the drug in the body. In the case of psychedelics, what transpires depends far more on the characteristics of the participant ingesting the drug and the circumstances of its use. It does not seem to be recognized generally that an individual can, with time and repetition, learn increasingly how to make more effective use of the opportunities psychedelics afford. It is possible to develop the characteristics of the trained user as previously described, when the mind can be held perfectly still so as to reveal other aspects of reality. With continued practice, the aspiring seeker increasingly learns how to focus the experience, learn trust, and develop motivation and courage for deeper exploration. This practice will yield deeper and deeper penetration into unknown areas of existence, with the possibility of bringing back ever new treasures.

I therefore hope that Buddhists and others will approach these substances with an open mind and, as a minimum, not stand in the way of efforts to learn more about them and the most appropriate ways of employing them.

References

1. Adamson, S., & Metzner, R. (1988). *The nature of the MDMA experience and its role in healing, psychotherapy, and spiritual practice* Revision, 10(4), 59-72.
2. Aitken, R. (1996, Fall). *The round table*, Tricycle, 6(1), 103, 105.
3. Badiner, A. (1996, Fall). *Yagé and the yanas*, Tricycle, 6(1), 72-77.
4. Baumeister, R., & Placidi, K. (1983, Fall). *A social history and analysis of the LSD controversy*, Journal of Humanistic Psychology, 23(4), 25-58.
5. Clark, W. H. (1975, Summer). *Psychedelic research: Obstacles and values.*
6. Journal of Humanistic Psychology 15(3), 5-17.
7. Grof, S. (1980). *LSD psychotherapy*, Pomona, CA: Hunter House.
8. Halifax, J. (1996, Fall). *The round table*, Tricycle, 6(1), 103.
9. Harman, W. (1963, Fall). *Some aspects of the psychedelic-drug controversy*, Journal of Humanistic Psychology, 3(2), 93-107.
10. Hoffer, A. (1965). *LSD: A review of its present status*, Clinical Pharmaceutical Therapy, 183, 49-57.
11. Jesse, R. (1996, Fall). *Entheopas: A brief history of their spiritual use* Tricycle, 6(1), 60-64.
12. Klavetter, R., & Mogar, R. (1967). *Peak experiences: Investigation of their relationship to psychedelic therapy and self-actualization*, Journal of Humanistic Psychology, 7(2), 171-177.
13. Kornfield, J. (1996, Fall). *Domains of consciousness*, Tricycle, 6(1), 34-40.
14. Kurtz, P. (1963, Fall). *Similarities and differences between religious mysticism and drug-induced experiences*, Journal of Humanistic Psychology, 3(2), 146-154.
15. Maslow, A. (1962). *Toward a psychology of being*, New York: Van Nostrand.
16. McDonald-Smith, M. (1996, Fall). *On the front lines*, Tricycle, 6(1), 67-70.
17. Mogar, R. (1965, Fall). *Current status and future trends in psychedelic (LSD) research*, Journal of Humanistic Psychology, 5(2), 147-166.
18. Pahnke, W. N., & Richards, W. A. (1966). *Implications of LSD and experimental mysticism*, Journal of Religious Health, 5, 175-208.
19. Sherwood, J., Stolaroff, M., & Harman, W., (1962). *The psychedelic experience-a new concept in psychotherapy*, Journal of Neuropsychiatry, 4, 71-72.
20. Shulgin, A. T., & Shulgin, A. (1991). *PIHKAL: A Chemical Love Story*, Berkeley, CA: Transform.
21. Shulgin, A. T., & Shulgin, A. (1997). *TIHKAL: the Continuation*, Berkeley, CA: Transform.
22. Stolaroff, M. (1993, Winter). *Using psychedelics wisely*, Gnosis, a Journal of the Western Inner Traditions, 26-30.
23. Stolaroff, M. (1994). *Thanatos to Eros: Thirty-five years of psychedelic exploration*, Lone Pine, CA: Thaneros.
24. Stolaroff, M. (1997). *The secret chief: Conversations with a pioneer of the under-ground psychedelic therapy movement*, Charlotte, NC: Multidisciplinary Association for Psychedelic Studies (MAPS).
25. Tricycle. (1996, Fall). 6(1).
26. Vaughan, F. (1995). *Shadows of the sacred*, Wheaton, IL: Quest Books.
27. Villoldo, A. (1977, Fall). *An introduction to the psychedelic psychotherapy of Salvador Roquet* Journal of Humanistic Psychology, 17(4), 45-58.
28. Walsh, R. (1982, Summer). *Psychedelics and psychological well-being*, Journal of Humanistic Psychology, 22(3), 22-32.
29. Walter, T. (1996, Fall). *Leaning into rawness*, Tricycle, 6(1), 98-100.
30. Wilber, K. (1993). *Grace and grit*, Boston: Shambhala.
31. Wise, N. (1996, Fall). *The psychedelic journey into the zafu*, Tricycle, 6(1), 89-93.

Chemical Youth - Chemical Creativity

Navigating Uncertainty in Search of the Good Life

by

Anita Hardon

Chapter 8 of Chemical Youth

Critical Studies in Risk and Uncertainty
doi.org/10.1007/978-3-030-57081-1_8

© The Author(s) 2021

original text:
https://www.researchgate.net/publication/347152238_Chemical_Creativity/fulltext/6044315d299bf1e0785f6b59/Chemical-Creativity.pdf
backup source: http://www.psilosophy.info/resources/Chemical-Creativity.pdf

Table of Contents:

A Brief History of Microdosing
Microdosing Narratives
Aggregating Experiences
Collaborative Trials
Hubs of Concern and Collaboration
In Conclusion
ChemicalYouth Ethnographers
Notes
References

> As you sit behind your desk, you may start to feel a little tingling sensation or a slight increase in awareness of things around you at the office, things that you didn't notice before. Words might appear brighter or sharper on the screen. And perhaps not so much changes around you but how you experience it changes quite a lot, you feel alive and quite present in your body. (Mishra 2020, p. 42)

This is an excerpt of an interview that Swasti Mishra (2020), one of the ChemicalYouth ethnographers, had with young professionals in Amsterdam who were self-experimenting with microdoses of lysergic acid, also known as LSD, and psilocybin, the active ingredient of "magic mushrooms." During the ChemicalYouth project, we observed that microdosing with psychedelics was emerging as a new trend among students and young professionals. Popular media such as *Forbes, Vice, Rolling Stone*, and *Marie Claire* published stories on this trend, with titles such as: "Micro-dosing: The Drug Habit Your Boss Is Gonna Love" (Dean 2017), "Interview With a Corporate Banker Who Microdosed His Way to the Top" (Fisher 2016), and "Can Very Small Doses of LSD Make You a Better Worker?" (Woods 2016).

O'Bryan Tear, a psychedelic researcher from the United Kingdom, defines microdosing as:

> taking a very small amount of LSD or magic mushrooms with the aim of boosting creativity, productivity or mood. So it does not give you a full recreational experience. It keeps you engaged and relatively sober, but it helps you work better and more productively". (BBC London News 2018)

Nina, one of Mishra's interlocutors, explains it as follows:

> It's not like taking a full dose....the tiny dose counteracts the "airy-fairy" psychedelic effect, and it

> lets you take advantage of the focus, the creative ways you can make new connections between different pieces of information, and even simply the good mood it puts you in. (Mishra 2018, p. 1)

In this chapter we explore this burgeoning practice of microdosing and three ways of gathering data to understand its effects: analyzing users' narratives, collaborating with users to aggregate user accounts, and organizing clinical experiments. In the first way, users' narratives show how they "do" microdosing, what they want to achieve by using these substances, and what they do to prevent or reduce harm. Mishra (2020), for example, examined the narratives of microdosers in Amsterdam, and followed their collaborative self-experiments over time. Some members of our team have also reviewed reports on microdosing in popular media and online, a form of "virtual ethnography" (see Krieg *et al*. 2017; Hupli *et al*. 2019). A second way of understanding the effects of microdosing is through the gathering of data that can aggregate users' experiences; such data has been generated through collaborations between researchers and users, and is reviewed here. Finally, a third way is through clinical trials that compare the effects of psychoactive substances with those of placebos. These studies use a "blinding" strategy, an administrative procedure that ensures that participants don't know if they are being given a psychoactive substance or pharmacologically inert one; in this way, researchers hope to unravel what the "real," that is material, effects of microdosing are.

In the conclusion, we reflect on the ways that the practical wisdom (Boothroyd and Lewis 2016) generated by young people in collaborative microdosing experiments is linked to larger scale surveys and trials that aim to generate scientific evidence on benefits and risks of microdosing. We outline the modes of "knowing" that these surveys and placebo-controlled studies produce, how they lead to re-articulations of chemicals efficacy and reflect on the ways it can be understood as regulation from below, a concept that we discussed in Chapter 2, and will further elaborate in Chapter 9, the concluding chapter.

A Brief History of Microdosing

People who engage in and study microdosing often mention Albert Hofmann, admired for his self-experiments with LSD. Hofmann was the first to synthesize the drug in 1938, when he worked for the pharmaceutical company Sandoz. He was exploring the alkaloids present in a fungus called ergot (used traditionally by midwives to induce labor). When synthesizing LSD he was interrupted in his work by "unusual sensations" due to ingesting a small amount accidently. He went home to lie down, reporting later that "in dreamlike state, with eyes closed. ... I perceived an uninterrupted stream of fantastic pictures, extraordinary shapes with intense, kaleidoscopic play of colors" (as quoted in Pollan 2019, p. 22). In his 1979 memoir *LSD: My Problem Child*, Hofmann describes a series of self-experiments that followed and includes excerpts from his lab journals, such as this one from April 4, 1943:

> 4/4/43. 16.20: 0.5cc of ½ promil aqueous solution of diethylamide tartrate orally = 0.25 mg tartate. Taken diluted with about 10 cc water. Tasteless. 17.00: Beginning of dizziness, feeling of anxiety, visual distortions, symptoms of paralysis, desire to laugh: Supplement of 4/12: Home by bicycle. From ca. 18:00-20.00 most severe crisis. (Hofmann 1979, p. 48)

Reflecting back on that day, he then comments that:

> Here the notes in my laboratory journal cease. I was able to write the last words with great effort. ... I had to struggle to speak intelligibly. I asked my laboratory assistant, who was informed of the self-experiment, to escort me home. We went by bicycle, no automobile being available because of wartime restrictions. (Hofmann 1979, p. 48)

Based on these self-experiments Hofmann (1979) concluded that LSD was a psychoactive substance with "extraordinary properties and potency" (p. 51). In 1947, Sandoz started marketing LSD (under the brand name Delysid) as a psychiatric drug.

James Fadiman was one of the first researchers to explore the effects of LSD on creativity, when he was still a graduate student at Stanford University in the 1960s. He designed an experiment to determine whether psychedelics could facilitate problem-solving of a technical nature. As Fadiman (2011) recalls:

> others had done work with artists - but we took on a different challenge. Could we use these materials and get people to work on highly technical problems. ... We began this really gorgeous study with senior research scientists from a number of companies. We told them that we'd assist them in their most pressing technological problems, particularly if they were really stuck. (p. 233)

The experiments conducted by Fadiman and others in this first wave of psychedelic research gave users structured guidance during their "trips," including preparation in the form of "flight instructions." These helped users "set" how they would navigate their experiences during the trip; for example, the "setting" of being in a safe place, accompanied by trip "sitters" helped ensure users that they would be supported if they experienced anxiety, fear, or adverse physical effects. The Spring Grove Group, which conducted research to find out if LSD could help alcoholic patients overcome their addictions, established the following setting: LSD treatment was done in a comfortable room, with a sofa, carpet, flowers, and a good sound system. Music was played throughout the session, and the trial subject was given eyeshades, allowing the patient to retreat into their imagination. A therapist guided the experience and helped subjects feel cared for, encouraging them to go with the flow of the drug-induced effects (Oram 2014).

Fadiman's research into the creative potential of LSD stopped in 1966, when the US Food and Drug Administration (FDA) declared LSD a scheduled drug. One of the main reasons for this declaration was the alleged "misuse" of the drug for recreational purposes by young people in the Sixties' counterculture. Despite not being able to complete the study, Fadiman concluded that the scientists who had participated in the experiment were pleased with the results: the drug had in fact helped them solve technical problems. One scientist even won a major scientific award (Fadiman 2011).

Indeed, early on in the history of LSD, the substance came to be heralded for its aid stimulating technological breakthroughs. John Markoff, a co-fellow at the Center for Advanced Study in the Behavioral Sciences at Stanford University, where I have written much of this book, suggests that the use of LSD to promote creativity had far-reaching consequences, stimulating the innovations that emerged from Silicon Valley in the 1960s and 1970s (see Markoff 2005). Steve Jobs, a dropout from college who experimented with drugs and was part of the youth counterculture in the 1960s, told him that, "taking LSD was one of the two or three most important things he had done in his life" (Markoff 2005, p. 21). Kary Mullis, who received a Nobel Prize for inventing the polymerase chain reaction (PCR), a revolutionary technique for multiplying tiny amounts of DNA for use in genetic research, similarly attributed his innovation to his LSD use. In an interview for a BBC documentary, he explained how psychedelic experiences helped him imagine how DNA works:

> I wasn't stoned on LSD at the time, but my mind had learnt how to get there. I could sit on the DNA molecules and watch the polymers go by. And I didn't feel dumb about it. I felt like that's just the way I think, I put myself in all different kinds of spots. And I learnt it partially, I would think, this is again my opinion, through psychedelic drugs. (Eagles 1997)

When Jobs and Mullis experimented with LSD, microdosing was not yet popular. In an online interview with Dutch microdosing enthusiasts, Fadiman explained "with a high dose, set and setting is as important as the drug" (Microdosing Netherlands 2019). In contrast, he says, "with micro-dosing, unless your outerworld is terrible, it does not seem to matter much ... Because its effect are so subtle, set and setting are far less important." The idea that LSD could be safely used at very low dosages is the innovating force behind microdosing.

Fadiman (2011) proposed a schedule of one day of microdosing, followed by two days off, and repeating the cycle starting on the fourth day. In the interview, Fadiman recalls that he proposed this schedule not as a standard practice, but as a tool for users to observe what microdosing did for them: "we wanted people to, on the third day, to experience how they feel without the substance, and reflect on the difference between 'on and off.'" He said that after one month of trying out this schedule, microdosers should be able to determine what works best for them. In *The Psychedelic Explorer's Guide*, Fadiman (2011) quotes a man named Charles, who used this schedule:

> The protocol I followed had me take a micro-dose one day, then carefully observe any ongoing or lingering effects the second day, and the give myself the third day completely off. By going slow, you give yourself a chance to really know, to really observe what is different, why it is different,

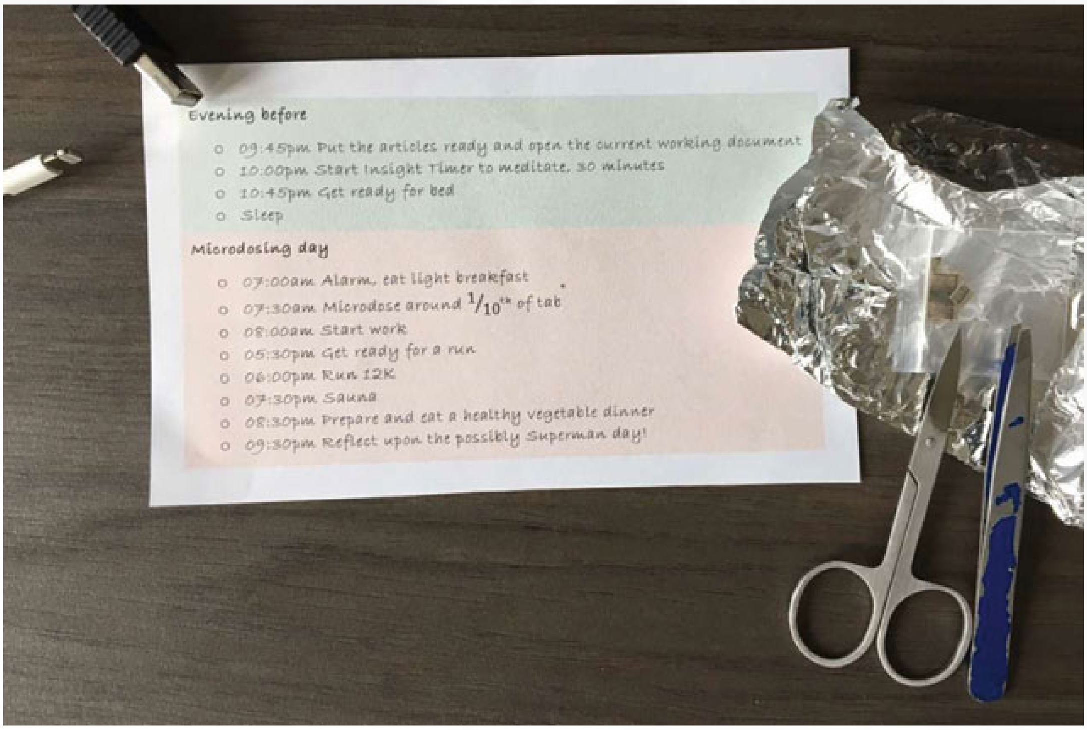
> and how you can best take advantage of it. ... I've found that I've had some brilliant outbursts (at least they seemed brilliant to me) with respect to both work and personal creative projects. (p. 200)

This guide also describes the experiences of a woman named Madeline, who attested to the creative potential of microdosing. A documentary maker from Manhattan, married with a four-year-old child, Madeline says she has to review 50 hours of film footage and "knit it together in a story arc," and that when microdosing she feels deeply connected to her work: "I barely come up for air for the next five hours because I am so sincerely enjoying what I'm doing" (Fadiman 2011, p. 202).

A similar narrative is reported in the popular women's magazine *Marie Claire*, which ran a story entitled "Why Power Women Are Micro-Dosing LSD at Work" (Malone 2016), in which a woman named Karen Smith, a 32-year-old who lives in Chicago, explains in detail how she made capsules and dosed psilocybin. Karen is enrolled in a data science graduate program after working for 10 years in a tech startup. Confronted with cold Midwest winters, and having quit cigarettes and marijuana, she was looking for something else to improve her mental well-being. Her husband had read about the beneficial effects of psilocybin on the forum-based website Reddit (which at the time had a forum on microdosing with over 9000 subscribers). The couple was offered some "magic" mushrooms - psilocybin containing-mushrooms - from a friend, which they ground up in a spice grinder. They bought empty capsules on Amazon, and packed them with the powder: 10 micrograms for Karen's husband and half that amount for Karen. They took a capsule every few days for four months. Karen started feeling better and became very efficient. In Karen's words, "It gives you fresh eyes ... for programming or figuring out algorithmic stuff. It made me really productive in a motivated way." An added benefit was that Karen got a lot of household chores done.

Microdosing Narratives

In the earlier use of LSD, preparation mattered - users were given "flight instructions" and trip sitters guided the experience. The stories that we reviewed suggest that microdosing has little to do with managing preparation or setting as a runway for an unpredictable flight. Instead, it involves material work, as presented in the story of Karen - preparing capsules, cutting blots, and weighing - as well as attending to schedules that ensure the productive insertion of microdosing into a day's schedule. Figure 8.1 provides an example of such a schedule from Mishra's fieldwork. Note how it includes timeslots for meditation, sleeping healthy eating, and a reflecting on the success of the day's work.



Evening before

- 09:45pm Put the articles ready and open the current working document
- 10:00pm Start Insight Timer to meditate. 30 minutes
- 10:45pm Get ready for bed
- Sleep

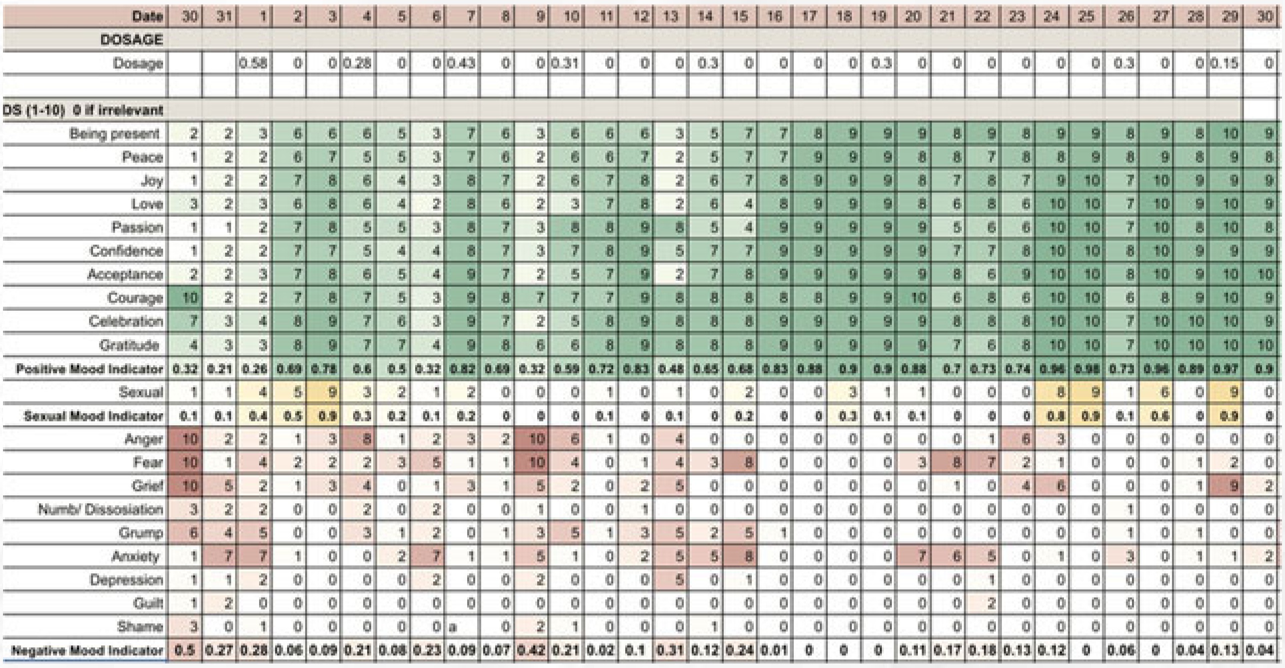
Microdosing day

- 07:00am Alarm, eat light breakfast
- 07:30am Microdose around 1/10th of tab
- 08:00am Start work
- 05:30pm Get ready for a run
- 06:00pm Run 12K
- 07:30pm Sauna
- 08:30pm Prepare and eat a healthy vegetable dinner
- 09:30pm Reflect upon the possibly Superman day!

Fig. 8.1 Inserting microdosing into a "Superman" day (Source Photo Swasti Mishra, November 2017, Amsterdam)

Trip sitters are not seen as necessary for microdosing. Instead users keep records of their own experiences themselves, many of them inspired by Albert Hoffman's laboratory notes. The narratives we examined suggest that microdosing had positive experience on users' moods and creativity, but that adverse events that interfere with the capacity to work could also occur. They also show that users compared the pros and cons of a range of substances (LSD, mushrooms, mescaline) for different tasks at hand. Finally, users commented on other medical benefits on microdosing, including their potential in the treatment of ADHD.

JingShu, one of Mishra's informants developed a scale to record the effects of microdosing over the course of 30 days, see Fig. 8.2. She divided effects into three categories: sexual, positive, and negative (each with their own summative indicator). She judiciously tracked various emotions and her work productivity, rating them on a scale of one to ten, and noting possible side effects.



Date	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
DOSAGE																																
Dosage			0.58	0	0	0.28	0	0	0.43	0	0	0.31	0	0	0	0.3	0	0	0	0	0.3	0	0	0	0	0	0	0.3	0	0	0.15	0
DS (1-10) 0 if irrelevant																																
Being present	2	2	3	6	6	6	5	3	7	6	3	6	6	6	3	5	7	7	8	9	9	9	8	9	8	9	9	8	9	8	10	9
Peace	1	2	2	6	7	5	5	3	7	6	2	6	6	7	2	5	7	7	9	9	9	8	8	7	8	8	9	8	9	8	9	8
Joy	1	2	2	7	8	6	4	3	8	7	2	6	7	8	2	6	7	8	9	9	9	8	7	8	7	9	10	7	10	9	9	9
Love	3	2	3	6	8	6	4	2	8	6	2	3	7	8	2	6	4	8	9	9	9	8	6	8	6	10	10	7	10	9	10	9
Passion	1	1	2	7	8	5	5	3	8	7	3	8	8	9	8	5	4	9	9	9	9	9	5	6	6	10	10	7	10	8	10	8
Confidence	1	2	2	7	7	5	4	4	8	7	3	7	8	9	5	7	7	9	9	9	9	9	7	7	8	10	10	8	10	9	9	9
Acceptance	2	2	3	7	8	6	5	4	9	7	2	5	7	9	2	7	8	9	9	9	9	9	8	6	9	10	10	8	10	9	10	10
Courage	10	2	2	7	8	7	5	3	9	8	7	7	7	9	8	8	8	8	8	9	9	10	6	8	6	10	10	6	8	9	10	9
Celebration	7	3	4	8	9	7	6	3	9	7	2	5	8	9	8	8	8	9	9	9	9	9	8	8	8	10	10	7	10	10	10	9
Gratitude	4	3	3	8	9	7	7	4	9	8	6	6	8	9	8	8	8	9	9	9	9	9	7	6	8	10	10	7	10	10	10	10
Positive Mood Indicator	0.32	0.21	0.26	0.69	0.78	0.6	0.5	0.32	0.82	0.69	0.32	0.59	0.72	0.83	0.48	0.65	0.68	0.83	0.88	0.9	0.9	0.88	0.7	0.73	0.74	0.96	0.98	0.73	0.96	0.89	0.97	0.9
Sexual	1	1	4	5	9	3	2	1	2	0	0	0	1	0	1	0	2	0	0	3	1	1	0	0	0	8	9	1	6	0	9	0
Sexual Mood Indicator	0.1	0.1	0.4	0.5	0.9	0.3	0.2	0.1	0.2	0	0	0	0.1	0	0.1	0	0.2	0	0	0.3	0.1	0.1	0	0	0	0.8	0.9	0.1	0.6	0	0.9	0
Anger	10	2	2	1	3	8	1	2	3	2	10	6	1	0	4	0	0	0	0	0	0	0	0	1	6	3	0	0	0	0	0	0
Fear	10	1	4	2	2	2	3	5	1	1	10	4	0	1	4	3	8	0	0	0	0	3	8	7	2	1	0	0	0	1	2	0
Grief	10	5	2	1	3	4	0	1	3	1	5	2	0	2	5	0	0	0	0	0	0	0	1	0	4	6	0	0	0	1	9	2
Numb/ Dissosiation	3	2	2	0	0	2	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Grump	6	4	5	0	0	3	1	2	0	1	3	5	1	3	5	2	5	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Anxiety	1	7	7	1	0	0	2	7	1	1	5	1	0	2	5	5	8	0	0	0	0	7	6	5	0	1	0	3	0	1	1	2
Depression	1	1	2	0	0	0	0	2	0	0	2	0	0	0	5	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Guilt	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Shame	3	0	1	0	0	0	0	0	a	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Negative Mood Indicator	0.5	0.27	0.28	0.06	0.09	0.21	0.08	0.23	0.09	0.07	0.42	0.21	0.02	0.1	0.31	0.12	0.24	0.01	0	0	0	0.11	0.17	0.18	0.13	0.12	0	0.06	0	0.04	0.13	0.04

Fig. 8.2 The 30-day observations of JingShu (Note Retrieved on May 24 2020 from https://microdosing.nl/i-microdosed-on-psilocybin-for-30-days-and-tracked-its-lasting-effects/. Source Photo from Mishra [2020, p. 37])

Her positive mood indicators included being present, peace, joy, love, passion, confidence, acceptance, courage, celebration, and gratitude. Over the course of the 30 days, her scores on positive affects became higher. She tells Mishra that she was impressed by the "non-stickiness" to both positive and negative events that occurred in her life (Mishra 2020, p. 37).

There are many such individual reports of experiences with microdosing on online forum-based sites such as Reddit (used by Karen) and drug-using focused sites like Erowid (2020). Erowid is an "experience vault," which is filled through decentralized user engagement (Liu 2012, p. 25) via voluntary submissions, and which is managed centrally by two experienced drug users (named "Earth" and "Fire") who screen and edit reports before they are published on the website. Our analysis of user reports on Erowid shows that most of the participants in the experience vault are young (average age 23) and male (86% of reports are from men; 14% from women).[1] While Erowid accepts reports on a wide range of drugs, the most commonly mentioned substances are mushrooms (*N* = 1715) and LSD (*N* = 1168). "Microdosing" was the most mentioned term in the LSD reports, which attests to the popularity of this practice.

An example of such a report is entitled "Psychedelic Microdosing: A Surprising ADHD Fix" (Erowid 2020). This report concerns 1P-LSD, a synthetic modification of LSD. "Designer drugs" such as 1P-LSD have emerged in this underground drug-use culture as a way of avoiding drug regulations that have defined LSD itself as illegal. The user who wrote up the experiences with 1P-LSD does not self-declare his/her age or sex, but does give his/her weight (60 kg) and the dose used (6 µg), while proposing a dosage scheme that consist of 1/16 rather than 1/10 of the regular dosage, and reports that he/she did not experience any side effects:

> I had been trying out magic mushrooms (or rather magic truffles) with... "interesting" results. But they are of tremendously repellent taste, and the reliable occurrence of nausea makes them unfit for daily utilisation. It was only then that I found out about 1P-LSD, a novel lysergamide that had entered the market only this very year and, being not yet statutory regulated, was being sold legally across Europe (and in some countries, still is). After reading up on it, I came to the conclusion that, judging by the majority of reports out on the interwebs, its biochemical response was indiscernible from that of its famous twin, LSD-25 [The drug that Sandoz branded as Delysid, which was taken off the market in 1966]. Excitedly, I ordered a sample from a research alchemist.
>
> A period of experimentation followed, and I had some profound experiences with this substance ... the real revelation was the unexpected attenuation of my ADHD symptoms. Not only was I able to focus much better, both at work and university. Mood swings and impulsive behaviour basically vanished. During conversations, it has become easy for me to subdue my urge to interrupt, instead patiently listening to the other person and replying in a concise and considerate manner.
>
> Addendum: I have shared my find in my local ADHD support group. Several others have reported back with comments such as "helpful effects" "better concentration and general condition," "less thought racing," "less irritable" etc. One group member, who happens to be an alcoholic, happily recounted that each day he is microdosing, the urge to open yet another beer vanishes, and he will not even finish his first one.
>
> Addendum 2: To better assess the effects of 1P-LSD, I reverted back to Ritalin for a day while working on a very concentration-demanding job. In direct comparison, inattentivity is decreased to a similar extent with 20mg Ritalin as is with 6mcg 1P-LSD. In my opinion though, Ritalin does not feel quite natural, while the LSD does. It is just a more pleasing remedy.

This user turned to a new chemical (1P-LSD) that was similar to LSD, reporting not only on its effects but also on their research process; this suggests that, like many reporters on Erowid, this user is an experienced "psychonaut" (a user who tries out new designer drugs on a regular basis to examine the altered states of consciousness that the substances generate, see Berning and Hardon [2016] and Langlitz [2012]). This user was interested in trying out microdosing to be more creative and productive, as well as in doing research and connecting to others to share their experiences, especially with fellow ADHD sufferers.

Video reports of experiences with microdosing are also posted on YouTube, a platform that makes it easier to share the material aspects of "doing" microdosing and "real time" effects. Aleksi Hupli and Moritz Berning, who both participated in the ChemicalYouth project as ethnographers, used the YouTube Data Tool developed by the Digital Methods Initiative of the University of Amsterdam to explore these visual demonstrations of users' techniques (Hupli *et al*. 2019). The search, conducted in June 2016, resulted in 115 videos - six of which accounted for 92% of approximately 1 million total views. Subsequent extractions in November 2017 ($N = 351$) and October 2018 ($N = 447$) revealed a surge in video postings.

One of the two most popular videos, *Your Mate Tom*, presents Tom who consumes mushrooms in front of his camera, which the video declares are "props" (perhaps to avoid legal repercussions). Fifteen minutes after consumption Tom reports not feeling high but instead calm, despite his heart rate being slightly elevated. He says he feels "a bit chill, a bit calm, like I had one little tiny drag of a joint" (as quoted in Hupli *et al*. 2019, p. 133). He also tells his audience about an adverse event that happened when he took "three little mushrooms" on his way to the university to study for an exam and he "started to feel a bit funny," anxious and having mild visual distortions. Attesting to a need for cautious dosing, he says "that's what I get for not actually getting scales and measuring it. That's what I get for just estimating" (quoted in Hupli *et al*. 2019, p. 133).

Another highly viewed video, posted by PsychedSubstance, also calls for cautious dosing, suggesting that a person should first take half of the threshold amount; then, if they don't feel anything, slowly increase the amount by 25-50% until they "hit 1.5 of the threshold" (Hupli *et al*. 2019, p. 133). The video further recommends using a test kit, with a link to purchase it in the video description, to verify the purity of LSD. PsychedSubstance recommends that dosing every other day would be ideal,[2] since the body builds a tolerance to classical psychedelics immediately.

PsychedSubstance also compares the effects of different psychedelic substances, saying: "I can speak from personal experience being on mescaline microdose right now that it feels extremely similar to being on LSD microdose" (quoted in Hupli *et al*. 2019, p. 134). He tells the audience that his thoughts run a lot smoother on mescaline than on LSD, and that he experiences more auditory enhancement when using mescaline; when using LSD, in contrast, he experiences more visual enhancement.

Aggregating Experiences

The online platforms where users exchange experiences are convenient virtual spaces for academic researchers to engage with users and learn from their experiences. Efforts to aggregate user experiences confirm the observations of individual users: microdosing enhances creativity and elevates moods. But, the studies also point to adverse effects, and contra-indications for use.

Johnstad (2018), from the University of Bergen, engaged online users in a qualitative microdosing study. He posted an online thread that, after describing the purpose of the study, asked for input. He then approached users who reported on their microdosing practices via the private message function. Through open-ended, qualitative interviews he accumulated a great deal of data. Twenty-one respondents (all male, average age 30) agreed to be interviewed. Johnstad (2018) reports that his respondents reported positive health benefits, including feeling less depressed and anxious, though a few respondents experienced no effects at all and therefore stopped doing in. The participants in Johnstad's study, like many of the users referred to above, were interested in comparative efficacy. Some reflected on differences between LSD and mushrooms, as expressed by one informant: "LSD is just more practical for work and play, bounding energy and target mentality. Mushroom microdoses are more of a personal and 'fresh' interaction with the universe" (Johnstad 2018, p. 46). Despite general agreement on the lack of intoxication produced by microdoses, some respondents did report adverse events. They attributed these to taking a slightly higher dose, referred to as a "mini-dose," or to timing the use incorrectly, which resulted in tripping and having difficulty performing the tasks at hand. As one of Johnstad's (2018) respondents reported:

I was feeling very tired and had a martial arts class to attend for the first time, so I didn't want to make a bad impression. This was my second time microdosing [mu]shrooms, and I dosed around 0.25-0.35 gram a few hours before in an attempt to peak well before the class and still just be stimulated and in a good positive mood for it. This backfired massively as I had a large meal around the time of dosing and it really kicked in once I got to the class. I found it very hard to follow instructions. (pp. 46-47)

Others reported insomnia after microdosing late in the day, and some also said that, after microdosing for a while, benefits faded and mental health conditions were exacerbated.

Fadiman and Korb (2019a, b) encouraged people who contacted them for advice to send reports of their experiences, using a Google form and a dedicated website (microdosingpsychedelics.com). They describe this work as "citizen science, a social agreement where researchers enlist those members of the public with an interest in a particular topic or issue to upload their own observations or local experiments into an unrestricted database" (Fadiman and Korb 2019a, p. 321). In citizen science, participants are not study subjects, but collaborators. The collaboration involved the researchers providing information on what they knew about the practice, and participants filling in Google forms, which, in addition to daily mood check-ins, included a modified version of the Positive and Negative Affect Scale (PANAS; see also Watson and Clark 1988). Over 18 months, 4000 people wrote in asking for information, and 843 responded to the request to fill in a Google form.[3]

Thus, the majority of people who were asked to join the study did not do so. This may have happened for many reasons: perhaps they decided not to microdose. Or perhaps they did try it, but stopped because it didn't work for them. Or they liked the effects, but didn't want to spend time participating. Fadiman and Korb (2019a) note that they had discouraged volunteers who appeared disorganized, were experiencing a bad period in life, as well as those with a history of psychosis, acknowledging that their findings were, therefore, not necessarily representative of the population of users:

> It is entirely possible that a sizeable percentage of the general population, were they to microdose, would experience no discernable effects. Another significant percentage might have a sufficiently negative experience such that they would not be inclined to continue or contribute a research report. (Fadiman and Korb 2019a, p. 322)

- Attentive: paying close attention
- Focused: able to direct specific attention
- Depressed: generally unhappy or despondent
- Clear: free of unpleasantness or confusion
- Guilty: feeling regret for doing something wrong
- Proud: having a sense of achievement
- Irritable: feeling easily annoyed
- Strong: feeling able to cope with difficulties
- Ashamed: feeling shame for doing something wrong or foolish
- Interested: wanting to be involved in something
- Jittery: feeling agitated and edgy

Note that the list includes positive and negative affects in random order. Using this scale, Fadiman and Korb (2019b) found that 52.5% of the people who participated in the study experienced a relative improvement in the positive affects, and 31% experienced a decrease in negative affects. Overall, they reported elevated moods, and they found that microdosing was helpful for their productivity. A number of respondents said that they had been more creative, which they underscored by sending some of the art and music that they had crafted (Fadiman and Korb 2019b, p. 121). Interestingly in this large-scale survey, a substantial number of participants preferred microdosing to the use of ADHD drugs such as Ritalin for improving their productivity and focus, echoing the reports on Erowid (see above).[4]

Fadiman and Korb's "citizen science" approach aims not only at demonstrating benefits but also making microdosing safer. They write: "we tried to give the best and safest current information as we went along in these aggregated self-reports" (Fadiman and Korb 2019a, p. 327). Based on the data collected in their study, they advised lowering the suggested dose from 1/10 to 1/20 of a regular dose, warned that people with a red-green colorblindness could experience visual distortions for a number of days after discontinuing use, and warned of interactions with medications, such as lithium. They also called for more research: "The next steps are for research institutions to turn our search into research, establish safe methods and protocols, and scientifically verify or invalidate the claims we see in our inboxes and hypotheses we and others generate" (Fadiman and Korb 2019a, p. 322).

Academic researchers have been taking on this challenge in different ways. Here we present the findings from two such studies, one using an online questionnaire - an approach similar to that of Fadiman and Korb - and another extracting data from a real life microdosing event.

In 2018, the University of Maastricht's Department of Neuropsychology and Psychopharmacology conducted an online survey focusing on the benefits of microdosing on creativity, cognitive flexibility, and well-being (Hutten *et al*. 2019). Their online questionnaire was advertised to microdosers through online fora. The researchers received responses from 1116 respondents, largely young and male (18 years and older; 84% men; 14% women), of whom 80% were currently microdosing. The researchers report that performance enhancement was the most important stated purpose for microdosing. Enhanced creativity and enhanced mood were the most commonly reported positive effects. Psilocybin and LSD were the most used substance; dosing schedules varied. Around one-fifth of the respondents said that they had stopped microdosing completely, and one-third said they had stopped using at least one kind of psychedelic substance. Reasons given for stopping included doubt about efficacy and negative physical and psychological experiences (these are not specified in the study).

Researchers from the Brain and Cognition Institute of Leiden University, the Netherlands, in collaboration with the Psychedelic Society of the Netherlands, did a natural experiment at a microdosing event to assess the extent to which creativity is enhanced through microdosing (Prochazkova *et al*. 2018). Participants were asked to complete tasks to assess their creativity-related problem-solving skills, once before taking a microdose and once around 1.5 hours after taking a microdose. This timeframe was chosen because self-reports in the Erowid archive of user experiences suggest that effects of mushrooms peak between 30 and 90 minutes of use.

Out of 80 attendees at the event, 38 volunteered to participate in the experiment (23 men and 15 women, average age 31). In this experiment the amount of mushrooms was adjusted to their weight. Attendees with low body weight were given 0.22 grams, those with average weight 0.33 grams, and those with high body weight 0.44 grams, but participants were also free to adjust. The dosage was calculated based on the definition of microdosing as 1/10 of a recreational dose. The researchers also analyzed the presence of psychedelic alkaloids in the mushrooms, such as psilocybin.

The researchers report an increase in divergent idea generation, flexibility, and originality scores. The tests used included the Picture Concept Task, which measures visual creativity; it involves finding an association between several images. It also included the Alternative Uses Task, which is used to measure the possible uses of an object. The researchers write that the benefit of this study design is that it is done in a natural setting, but the disadvantage is that use is less controlled than in a laboratory, and that there is no control group. As a result, they do not know if the improved scores on creativity after using mushrooms are due to other factors, such as the learning that took place in the pre-mushroom-use tests, or the expectation that mushrooms increase creativity. Moreover, a positive mood and thrill of being part of the collective experiment could have influenced the test results. These researchers from the Brain and Cognition Institute of Leiden University were concerned with the "confounding" influence of users' expectations, a concern that set them apart from the first wave of psychedelic researchers, who explicitly aimed to create a positive expectation in order to enhance the effects of the psychedelic substances. In their scientific report on the experiment, the researchers emphasize that "future studies should seek to validate our findings using a lab-based randomized double-blind placebo-controlled experimental design" (Prochazkova *et al*. 2018, pp. 3409-3410).

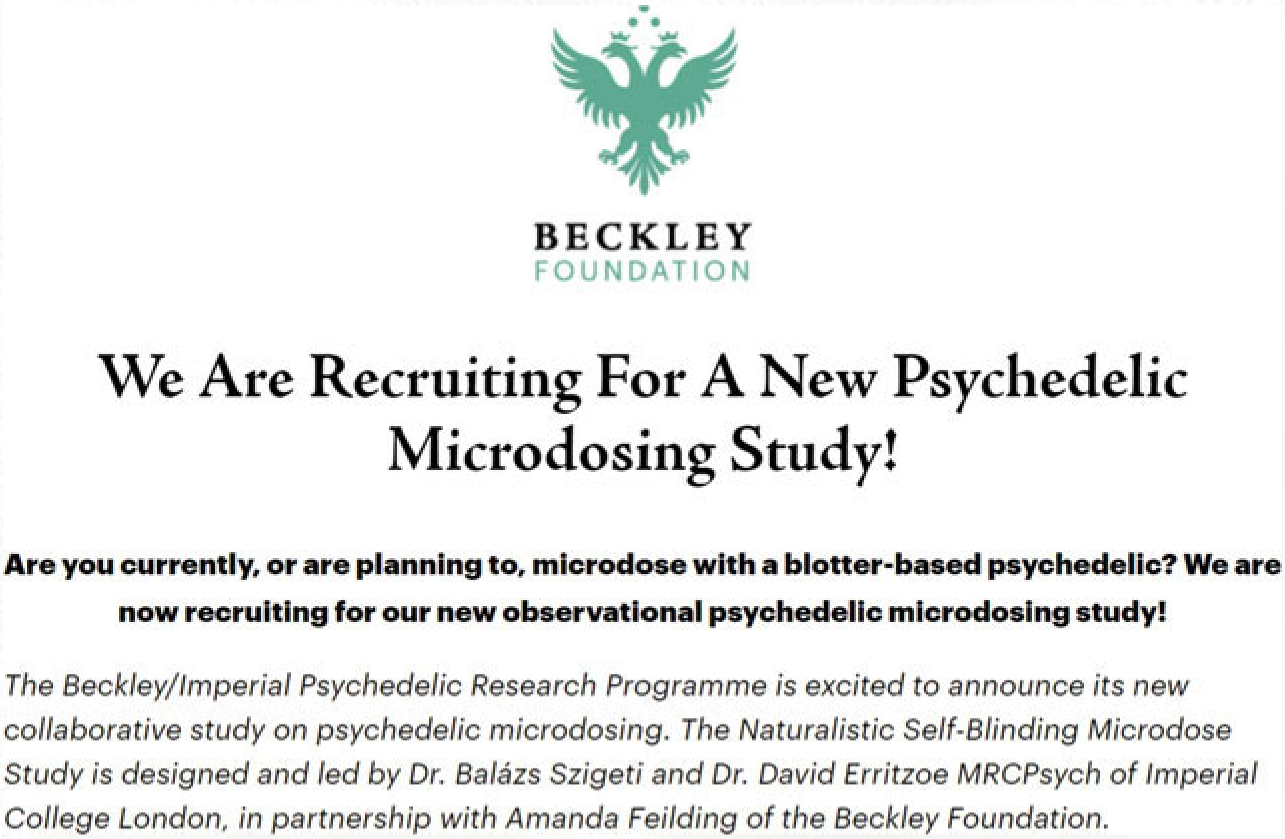
Collaborative Trials

In the hybrid communities of users and academic researchers that participate in such online studies, there is an emerging call to study if the effects of microdosing are "real" through placebo-controlled controlled trials. A research group at the University of Maastricht has conducted a critical review of existing "evidence," finding that future studies need to examine whether there is an "expectation" effect (Kuypers *et al*. 2019). While microdosing is associated with positive effects in existing observational studies, these studies are of users who take the substances for the express purpose of increasing performance and creativity, and thus may expect positive effects. The researchers recommend "rigorous placebo controlled clinical studies with different low doses of the drug to determine whether there is any evidence for the claims being made by microdosers" (Kuypers *et al*. 2019, p. 1046). They also stress that, at the time their review was published, only one study had followed a double-blind, placebo-controlled protocol to look at the effects of microdosing LSD (see Yanakieva *et al*. 2019). This relatively small study (only 48 subjects were enrolled) reported a limited effect: a delay in time perception after the administration of single microdoses of LSD.

The UK-based Beckley Foundation, the founder of which openly admits to having benefited from experiences with LSD in the 1960s, is committed to supporting researchers who seek to generate more reliable evidence. On its website the foundation states:

> Although many underground adherents attribute a variety of psychological and physical benefits to microdosing, including enhanced mood, focus, and cognition, or even reduced pain, there is a dearth of reliable evidence of the benefits - or indeed any potential health effects - of the practice. (Beckley Foundation 2017)

Together with researchers from Imperial College in London, the Beckley Foundation is engaging users in the production of such reliable evidence. At the time of writing this book, the study was recruiting participants who already engaged in microdosing, or who were about to participate in a naturalistic *self -blinding* study, which would allow for the collection of more reliable evidence (see Fig. 8.3, the recruitment advertisement).



BECKLEY
FOUNDATION

We Are Recruiting For A New Psychedelic Microdosing Study!

Are you currently, or are planning to, microdose with a blotter-based psychedelic? We are now recruiting for our new observational psychedelic microdosing study!

The Beckley/Imperial Psychedelic Research Programme is excited to announce its new collaborative study on psychedelic microdosing. The Naturalistic Self-Blinding Microdose Study is designed and led by Dr. Balázs Szigeti and Dr. David Erritzoe MRCPsych of Imperial College London, in partnership with Amanda Feilding of the Beckley Foundation.

Fig. 8.3 Recruitment advertisement on the Beckley Foundation website (Beckley Foundation 2017)

The website for the study contains a guide on how to carefully prepare microdoses and make capsules, which are either a placebo or a microdose, and how to pair the capsules up with QR codes in envelopes that are then randomly allocated over testing days, see Fig. 8.4.

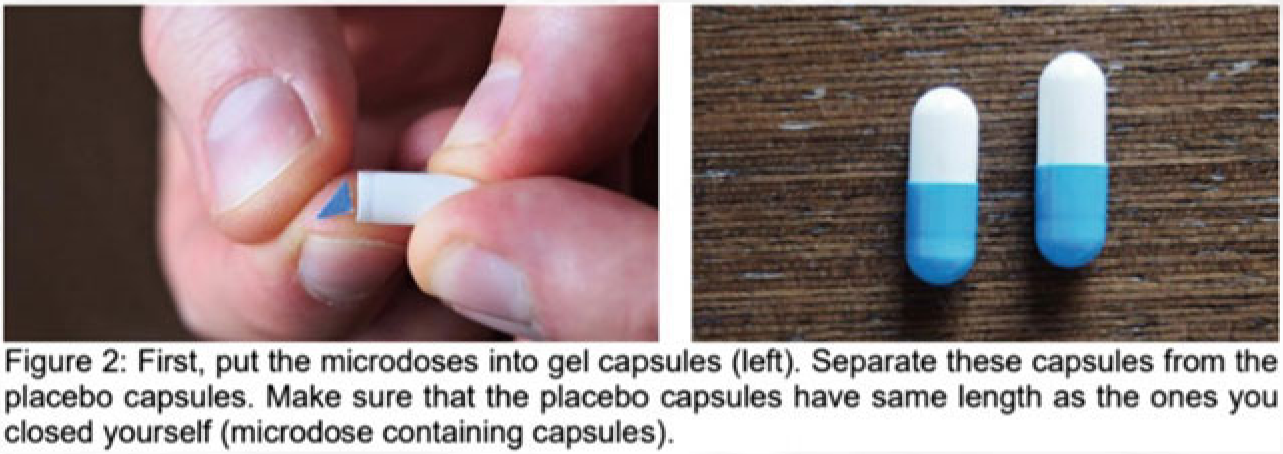


Figure 2: First, put the microdoses into gel capsules (left). Separate these capsules from the placebo capsules. Make sure that the placebo capsules have same length as the ones you closed yourself (microdose containing capsules).

Fig. 8.4 The placebo and microdose capsules that users are expected to prepare themselves (*Source* Screenshot from the self-blinding manual [Imperial College London 2020])

Szigeti, one of the Imperial College researchers explains why "blinding" is necessary in an informational YouTube video entitled "Is Microdosing Placebo? The Self-Blinding Study" (b1987307 2019), which the Beckley Foundation links to on its website. He cites a pyramid of evidence, pointing to randomized controlled trials at the top of the pyramid and individual case reports at the bottom (Fig. 8.5).

Szigeti argues that, at present, "There is no evidence for microdosing, but also no evidence against it." Why don't the many user stories and results of observational studies count as evidence? He argues that the observational studies that have been done so far don't provide evidence because they do not account for the expectation effect. A self-blinding placebo-controlled study can provide more rigorous evidence, he suggests.

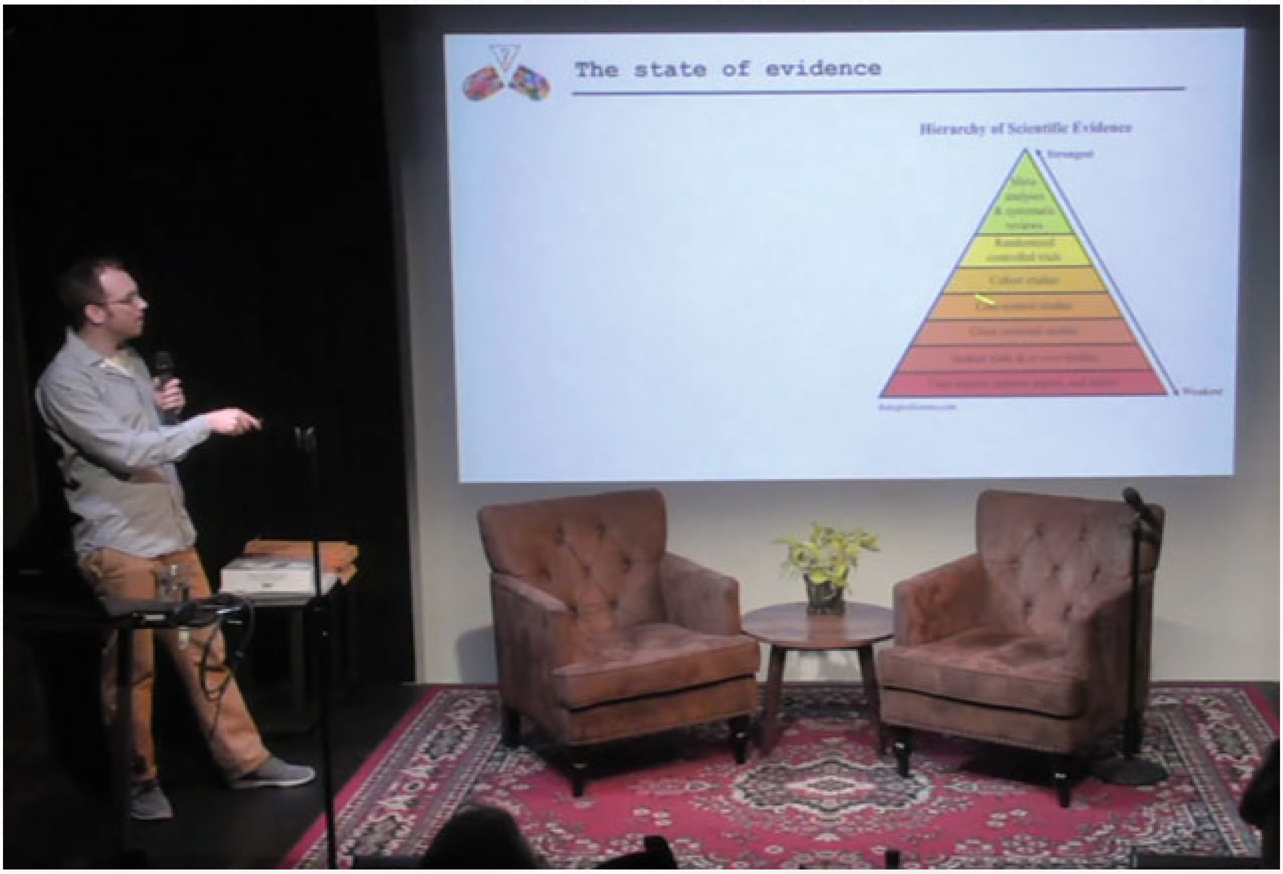

The state of evidence
Hierarchy of Scientific Evidence
Randomized controlled trials
Cohort studies

Fig. 8.5 Szigeti arguing for the need for more reliable evidence (b1987307 2019) (Note the comfortable, home-like surroundings in which Szigeti presents the state of the evidence. *Source* Screenshot by Anita Hardon, January 2020, the Netherlands)

As we mentioned above, in the past, psychedelic researchers sought to cultivate a positive effect by setting expectations. The "flight instructions" developed by these early researchers were designed to produce specific kinds of positive effects, including capacities to problem solve as well as therapeutic efficacies. Preparing for such desired effects was considered as important as the consumption of the substance. Today, those engaged in microdosing, in contrast, appear intent on measuring the materials effects of LSD and mushrooms, purified from the influences of set and setting. Why is this so? To some extent, we can attribute self-blinding trials to the prohibition of psychedelics. Microdosing would be much easier if the substances used were studied, regulated, and allowed on the market. "Reliable" evidence from randomized controlled trials could help producers file for regulatory approval of microdoses of LSD and psilocybin for specific indications, such as ADHD.

Hubs of Concern and Collaboration

Toward the end of the ChemicalYouth project, I attended a talk on microdosing at the Trimbos Institute, a Dutch institute for mental health. Trimbos runs the Dutch Drugs Information and Monitoring Services (DIMS), which has observed an increase in microdosing of psychedelics because users increasingly come to DIMS to have their LSD tested. In the Netherlands, microdosers are in the luxurious position of living in a country where the use and sale of magic mushrooms is legal, and the quality of LSD can be tested through one of the 31 drug testing sites in the country (see also Chapter 2).

The speaker was a moderator of microdosing.nl, an online forum for Dutch microdosing enthusiasts. He presented a protocol similar to the cautionary approach proposed in the PsychedSubstance video, advising users to start with a very low dose and then gradually increase it to find one's "sweet spot." Following this session, I explored the Dutch website of microdosing.nl and found the very interesting interview between two young moderators and Fadiman, mentioned earlier in this chapter (Microdosing Netherlands 2019). In this interview, Fadiman emphasizes that online surveys of experiences are important, because they provide insights into what the substances can do. He also notes that scientists want to have clear biological endpoints;

scientists like stuff that they can measure. But, he asks, can clinical trials be designed to measure the effects of microdosing? How do you measure having a good day or a productive one? What constitutes a good day will differ from person to person. People report working well, eating healthily, and even forgetting that they took a pill. How to measure such a range of effects?

The Dutch moderators asked Fadiman to reflect on users' embrace of microdosing to enhance their moods, creativity, and productivity. They ask: "Wouldn't it be better to have a good day without a supplement?" Fadiman responds: "The answer is: do you really need an apple? Or is there any point in having wine with your meal?" He points out that as far as is known today microdosing is safe. So why not take it? The Dutch moderator ends the discussion by comparing microdosing to cycling: "We all do it and don't want to live without it. We know there can be a danger, you assess the risk, you watch the traffic."

How popular microdosing had become was clear at the 2017 NextWeb conference for Tech innovators and start-ups, which was held in Amsterdam with 15,000 attendees from all over the world. The program included Paul Austin one of the leaders of the Third Wave - an online hub for responsible psychedelic use. Austin told the audience that microdosing can help business leaders excel, because it allows them to be creative, adaptable, patient and present: "It's about this sense of being in the zone. In the zone, present, in the moment. Microdosing psychedelics can do this, sex does this, extreme sports do this, being really engaged and focused and dedicated on a project that you really love does this" (Aronov 2019, p. 711).

In contrast, there is the more cautious conclusion of JingShu, interviewed by Mishra. More doubtful on the need for microdosing after trying it out for 30 days, Jingshu says, "I was quite skeptical of the mentality of optimization in this fast-paced, competitive world: what are we optimizing ourselves for?" (quoted in Mishra 2020, p. 37).

In Conclusion

This chapter describes how users and researchers have been exploring the effects of microdosing in three different ways, each of which generates different ways of "knowing" the substances. First, user narratives focus on a plurality of creativity, focus, and productivity-enhancing effects of these chemicals. They describe how users incorporate microdosing in daily schedules, attend to diets, and adjust dosages. Moreover, we observed users comparing the effects of different psychedelic substances, aiming to tailor the choice of substance to the task at hand. The online peer-to-peer sharing of experiences, support and co-creation of knowledge "constitutes an emergent and constantly evolving form of practical wisdom" (Boothroyd and Lewis 2016, p. 293). This chapter shows how, in a second way of exploring effects, researchers build on this practical wisdom in designing studies that seek to aggregate user experiences. These observational studies seek user collaboration through online fora and real life events to augment understanding of how the effects of microdosing are moderated by underlying conditions (such as anxiety and colorblindness), and interactions with other medicines. These researchers do not see this as conclusive evidence, but rather point to issues that need to be explored further: To what extent do the positive experiences just reflect placebo responses? Most users stop after a while - so what do we know about long-term effects? Does tolerance build after microdosing for a long time? The third way to study the effects of microdosing are randomized controlled trials. These aim to test if the effects of microdosing are "real," that is caused by the psychoactive substance used in the microdosing practice. The evidence generated by such studies depends on the "endpoints" chosen and the biological markers used.

While the first two ways of exploring microdosing are aimed at "improving" effects by trying different microdosing schedules, dosages and diets, and aggregating experiences through observations, the third way of doing research is aimed at "proving" effects through trials (Mol 2006). Improving through tinkering allows users to adjust dosages, experiment with diets as adjuncts to the treatment, and determine how best to embed microdosing in daily routines (Mol and Hardon 2020). It also allows users to adjust the microdosing regime to the work at hand: to perform during a job interview a different kind of microdosing is called for, than when aiming to solve a technical puzzle in the privacy of one's study.

Such tinkering is not possible in clinical trials which are designed to "prove" the effects of standardized treatments using pre-defined endpoints, while filtering out any "expectation" effects. Proving through clinical trials, however, has as advantage that if sufficient experiments have been done, the evidence can be submitted for review to the food and drug authority.

Though it is too early to tell, randomized controlled trials could prove that microdosing does indeed have specific beneficial material effects. But this does not mean that microdoses of LSD or psilocybin could immediately enter the market. Food and drug authorities will demand results from large-scale "phase 3" trials, which are expensive, and may be reluctant to review new indications for psychedelics, because these drugs were used recreationally in large doses in the past, resulting in its scheduling in the 1960s.

However, it can be done. The Multidisciplinary Association for Psychedelic Studies, a nonprofit organization based in Santa Cruz, California, received the green light from the US FDA to do phase 3 placebo-controlled trials of MDMA (a drugs which has also been used for recreational purposes) for the treatment of post-traumatic stress disorder, and in 2019 the association published positive results from these trials, which led to FDA approval to expand access to this treatment (Mithoefer *et al*. 2019).

Could researchers win such approval for the use of microdoses of LSD and/or psilocybin for creativity and productivity? It seems unlikely, because here the indications are not medical. But let's assume that large-scale trials were done, and that, as was the case for MDMA, the results were positive. Hypothetically, this could convince authorities that microdosing is effective, and that microdoses of LSD and/or psilocybin can be used safely. If this happens, the substances will be re-"informed," changing from illegal recreational substances to medicines for cognitive enhancement. We expect that, if this happens, microdoses would be incorporated into the vibrant online market for drugs used to enhance cognition, referred to as "nootropics." Web-based shops sell supplements such as "Rise," a daily nootropic for memory, and Sprint, a nootropic for energy and focus. HVMN (pronounced 'human'), the company that makes Rise and Sprint, "believes that the human system can be quantified, optimized and upgraded" (Angel 2018, p. 67). Given the wide range of positive user experiences, companies like this one are likely to be interested in adding microdoses to their product lines. If this happened, Karen and other users would not have to go through the material work of making capsules, weighing chemicals, and testing for purity. They could simply buy their preferred substance online.

That the products would be available in standardized forms, with precise advice on how to take it, does not mean that tinkering would end. Whether LSD and psilocybin are approved or not, users will continue to tinker with diets, dosages and schedules relying on shared practical wisdom online, which has been augmented with insights from surveys and trials. The chapter shows how throughout the different kinds of collaborative experimentation and every day tinkering the properties of LSD and psilocybin evolve - new benefits emerge, dosages are adjusted, and cautionary tales shared. The practice is fluid, and ways of knowing are always emergent (Hardon and Sanabria 2017; Mol and Hardon 2020). The peer-to-peer sharing, and collaborations with researchers make up a dynamic form of regulation from below, which acknowledges the experiences of users, and helps refine the practice so as to maximize a wide range of benefits, and prevent harm.

ChemicalYouth Ethnographers

Swasti Mishra is an anthropologist with interest in the intersections of health, drugs, biomedicine, and society. She completed her PhD under the ChemicalYouth project, at the University of Amsterdam. Her doctoral research focused on the generation and circulation of knowledge about psychedelic drugs, including from clinical trials, psychiatric practices, and public health centers, as well as their non-medical use in office spaces or festival venues, primarily situated in the United States and the Netherlands. She is currently part of a research project on the assessment of public health emergency preparedness across the European Union Framework contract with European Centre for Disease Prevention and Control (Fig. 8.6).

Fig. 8.6 Swasti Mishra

Lisa Krieg studied cultural anthropology at the University of Heidelberg, and defended her PhD on social memory in Germany in 2016 at Utrecht University. She joined the ChemicalYouth team as a virtual ethnographer, and conducted research collaboratively with other team members on digital archives of drug experience reports, working on platforms such as Erowid and Wikipedia. Currently, she works at the University of Bonn on human-nature-technology relations (Fig. 8.7).

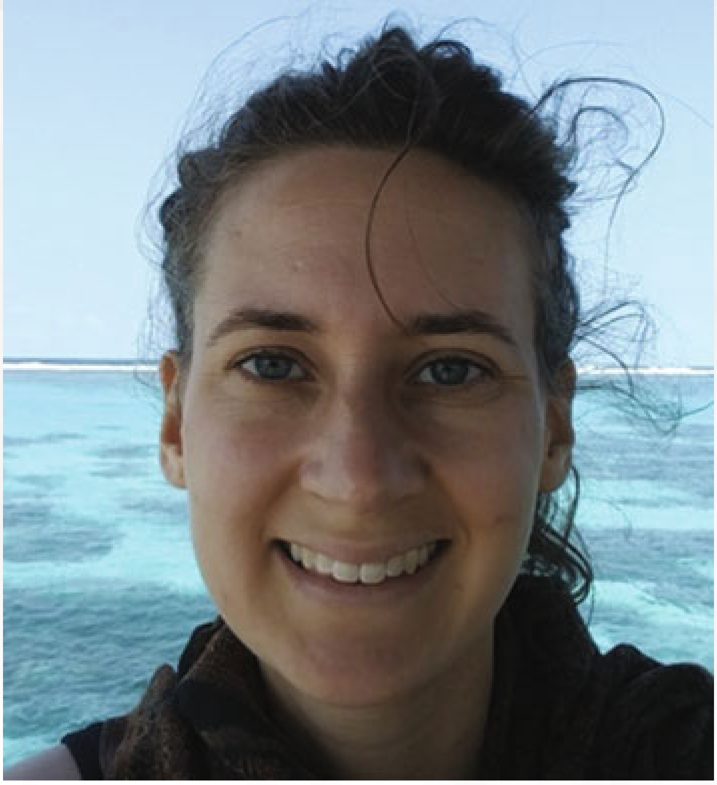


Fig. 8.7 Lisa Krieg

Moritz Berning focused on mixing classical and virtual ethnographic research, trying to balance the limitations that come with each approach. For the ChemicalYouth project, he explored how risk is approached and managed with regard to old and new psychoactive substances. These included situational practices at festivals or clubs, as well as refined social mechanisms of testing substances in virtual spaces (Fig. 8.8).

Fig. 8.8 Moritz Berning

Aleksi Hupli has been trained as a medical anthropologist by the University of Amsterdam (2013) and as a sociologist by the University of Helsinki (2014). He is currently finishing his PhD in sociology at the University of Tampere focusing on cognitive enhancement drug use among student populations. He has also coordinated the Global Drug Survey in Finland since 2017, is a board member of the Finnish Association for Humane Drug Policy and Legalize NL, serves as the president of the Amsterdam Society of Medical Social Scientists, and is a member of the Finnish Bioethics Institute (Fig. 8.9).

Fig. 8.9 Aleksi Hupli

Notes

1. We developed an interactive website (https://chemicalyouth.org/visualising-erowid/) that provides insights into more than 9480 users' reports.
2. This dosing rationale differs from that proposed by Fadiman, who suggested that the second day be microdose-free, in order to experience what it is like to not be affected by the substance. Fadiman's advice was aimed at supporting research into the effects of microdosing, by contrasting substance-free days with those affected by the microdose.
3. Three hundred and sixty-six people sent in one day of data; 137 sent in data for more than one day and less than a week; 340 sent in data for longer than one week.
4. The advantage of microdosing LSD over ADHD drugs was also discussed by Mishra's (2020) interlocutors, who said that on LSD they didn't experience "the comedown of other stuff "; they also pointed to cost advantages, arguing that in the Netherlands microdosing was "even cheaper in the long run, though it depends on how you source it of course. An LSD tab cut into eight pieces is just five euros divided by eight, while Ritalin off-label you get for five euros per pill" (p. 42).

References

1. Angel, B. (2018). *Unstoppable: A 90-day plan to biohack your mind and body for success*. Irvine: Enterpreneur Press.
2. Aronov, M. (2019). (Micro-)"psychedelic" experiences: From the 1960s creativity at the workplace to the twenty-first century neuro-newspeak. *Ethnologie Francaise*, 176, 701-718.
3. b1987307. (2019). *Is microdosing placebo? The self blinding microdose study. YouTube. https://www.youtube.com/watch?v=QS8m0SZLxFM&t=14s. Accessed on April 15, 2020.*
4. BBC London News. (2018). *LSD microdosing* . BBC London News. https:// www.youtube.com/watch?v=GPYzS9vxymQ. Accessed on April 15, 2020.
5. Beckley Foundation. (2017). *Recruitment flyer*. Beckley Foundation. https:// beckleyfoundation.org/2018/09/03/we-are-recruiting-for-a-new-psychedelic-microdosing-study/. Accessed on April 20, 2020.
6. Berning, M., & Hardon, A. (2016). Educated guesses and other ways to address the pharmacological uncertainty of designer drugs: An exploratory study of experimentation through an online drug forum. *Contemporary Drug Problems, 43*(3), 277-292. https://doi.org/10.1177/0091450916662164.
7. Boothroyd, D., & Lewis, S. (2016). Online drug scenes and harm reduction from below as phronesis. *Contemporary Drug Problems, 43*(3), 293-307. https://doi.org/10.1177/0091450916654266.
8. Dean, J. (2017). *Micro-dosing: The drug habit your boss is gonna love*. GQ. https://www.gq.com/story/micro-dosing-lsd. Accessed on December 13, 2019.
9. Eagles, B. (1997). *Psychedelic science*. London: British Broadcasting Corporation.
10. Erowid. (2020). *Erowid*. Erowid. https://www.erowid.org. Accessed on March 20, 2020.
11. Fadiman, J. (2011). *The psychedelic explorer's guide: Safe, therapeutic, and sacred journeys*. Rochester, NY: Park Street Press.
12. Fadiman, J., & Korb, S. (2019a). Microdosing psychedelics. In M. Winkelman & B. Sessa (Eds.), *Advances in psychedelic medicine: State of the art therapeutic applications* (pp. 318-335). Santa Barbara, CA: Greenwood.
13. Fadiman, J., & Korb, S. (2019b). Might microdosing psychedelics be safe and beneficial? An initial exploration. *Journal of Psychoactive Drugs, 51*(2), 118-122. https://doi.org/10.1080/02791072.2019.1593561.
14. Fisher, S. (2016). *Interview with a corporate banker who microdosed his way to the top*. Vice. https://www.vice.com/en_au/article/5g9a4q/we-intervieweda-corporate-banker-who-won-the-national-sales-award-while-microdosingmushrooms. Accessed on March 1, 2020.
15. Gomart, E. (2002). Methadone: Six effects in search of a substance. *Social Studies Sciences, 32*(2), 93-135.
16. Hardon, A., & Sanabria, E. (2017). Fluid drugs: Revisiting the anthropology of pharmaceuticals. *Annual Review of Anthropology, 46* (1), 117-132. https://doi.org/10.1146/annurev-anthro-102116-041539.
17. Hofmann, A. (1979). *LSD: My problem child* . New York: McGraw-Hill Book Company.
18. Hupli, A., Berning, M., Zhuparris, A., & Fadiman, J. (2019). Descriptive assemblage of psychedelic microdosing: Netnographic study of YouTube videos and on-going research projects. *Performance Enhancement and Health,6*, 129-138. https://doi.org/10.1016/j.peh.2019.01.001.
19. Hutten, N. R. P. W., Mason, N. L., Dolder, P. C., & Kuypers, K. P. C. (2019). Motives and side-effects of microdosing with psychedelics among users. *International Journal of Neuropsychopharmacology, 22(7)*, 426-434. https://doi.org/10.1093/ijnp/pyz029.
20. Imperial College London. (2020). *Self-blinding microdose study set up manual for blotter psychedelics*. London: Creative Commons.
21. Johnstad, P. G. (2018). Powerful substances in tiny amounts: An interview study of psychedelic microdosing. *Nordic Studies on Alcohol and Drugs, 35* (1), 39-51. https://doi.org/10.1177/1455072517753339.
22. Krieg, L. J., Berning, M., & Hardon, A. (2017). Anthropology with algorithms? An exploration of online drug knowledge using digital methods. *Medicine Anthropology Theory, 4* (3). https://doi.org/10.17157/mat.4.3.458.
23. Kuypers, K. P., Ng, L., Erritzoe, D., Knudsen, G. M., Nichols, C. D., Nichols, D. E., et al. (2019). Microdosing psychedelics: More questions than answers? An overview and suggestions for future research. *Journal of Psychopharmacology, 33*(9),

1039-1057. https://doi.org/10.1177/0269881119857204.

24. Langlitz, N. (2012). *Neuropsychedelia: The revival of hallucinogen research since the decade of the brain*. Berkeley: University of California Press.
25. Liu, A. (2012). The state of the digital humanities: A report and a critique. *Arts and Humanities in Higher Education, 11*(1-2), 8-41. https://doi.org/ 10.1177/1474022211427364.
26. Malone, N. (2016). *Women are microdosing on LSD: Psychedelics and the working woman. Marie Claire. https://www.marieclaire.com/culture/news/ a23669/power-women-microdosing-lsd/. Accessed on April 20, 2020.*
27. Markoff, J. (2005). *What the dormouse said: How the 60s counterculture shaped the personal computer industry*. London: Penguin Books.
28. Microdosing Netherlands. (2019). *James Fadiman about microdosing*. Microdosing.nl podcast. https://www.youtube.com/watch?v=k7dQj92WPug&t=6s. Accessed on April 16, 2020.
29. Mishra, S. (2018). *Microdosing at work: Reworking bodies and chemicals*. Cultural Anthropology. https://culanth.org/fieldsights/microdosing-at-work-reworking-bodies-and-chemicals. Accessed on May 24, 2020.
30. Mishra, S. (2020). *Drug craft: On the configurations of psychedelic efficacies*. Doctoral dissertation. Anthropology department. Amsterdam: University of Amsterdam. https://pure.uva.nl/ws/files/47924549/Front_matter.pdf.
31. Mithoefer, M. C., Feduccia, A., Mithoefer, A. T., Feduccia, A. A., Jerome, L., Wagner, M., et al. (2019). 3,4-methylenedioxymethamphetamine (MDMA)-assisted psychotherapy for post-traumatic stress disorder in military veterans, firefighters, and police officers: A randomised, double-blind, dose-response, phase 2 clinical trial. *The Lancet Psychiatry, 5*(6), 486-497. https://doi.org/10.1016/S2215-0366(18)30135-4.
32. Mol, A. (2006). Proving or improving: On health care research as a form of self-reflection. *Qualitative Health Research, 16* (3), 405-414. https://doi.org/10.1177/1049732305285856.
33. Mol, A., & Hardon, A. (2020). Caring: A fluid concept for adaptable engagements. In J. Bowen, N. Dodier, J. W. Duyvendak, & A. Hardon (Eds.), *Pragmatic inquiry: Critical concepts for social sciences*. London: Routledge.
34. Oram, M. (2014). Efficacy and enlightenment: LSD psychotherapy and the drug amendments of 1962. *Journal of the History of Medicine and Allied Sciences, 69*(2), 221-250.
35. Pollan, M. (2019). *How to change your mind: The new science of psychedelics*. London: Penguin Books.
36. Prochazkova, L., Lippelt, D. P., Colzato, L. S., Kuchar, M., Sjoerds, Z., & Hommel, B. (2018). Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. *Psychopharmacology (Berl), 235*(12), 3401-3413. https://doi.org/10.1007/s00213-018-5049-7.
37. Watson, D., & Clark, L. A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS Scales. *Journal of Personality and Social Psychology, 54* (6), 1063-1070.
38. Woods, B. (2016). *Can very small doses of LSD make you a better worker? I decided to try it*. Vox. https://www.vox.com/2016/3/2/11115974/lsd-internet-addiction. Accessed on April 20, 2020.
39. Yanakieva, S., Polychroni, N., Family, N., Williams, L. T. J., Luke, D. P., & Terhune, D. B. (2019). The effects of microdose LSD on time perception: A randomised, double-blind, placebo-controlled trial. *Psychopharmacology (Berl), 236* (4), 1159-1170. https://doi.org/10.1007/s00213-018-5119-x.

Is it time to revisit the role of psychedelic drugs in enhancing human creativity?

by

Ben Sessa

Journal of Psychopharmacology 22(8) (2008) 821-827

Psychopharmacology Unit, Bristol University, Bristol, UK.
doi: 10.1177/0269881108091597

© Ben Sessa

original report: https://maps.org/images/pdf/creativity-psychedelics.pdf
backup source: http://www.psilosophy.info/resources/creativity-psychedelics.pdf

Corresponding author: Psychopharmacology Unit, Bristol University, Bristol, UK. Email: drbensessa@hotmail.com

Table of Contents:

- Abstract
- Introduction
- What is creativity?
- Formal attempts at defining creativity
- Neurobiology of creativity
- How is creativity measured?
- Characteristics of creative people
- How the psychedelic experience might enhance the creative process
- Anecdotal historic examples of using psychedelic drugs to enhance artistic creativity
- Oscar Janiger's unique study
- Further experiments in creativity and psychedelics
- The commercial industry implications for enhancing creativity with drugs
- Clinical implications of drugs that may enhance creativity
- Set and setting
- What is the benefit of revisiting psychedelics and creativity research now?
- Conclusion
- Acknowledgements
- References

Abstract

Human creativity is difficult to define and measure, but it is undoubtedly an important cognitive process. This makes it an interesting challenge for modern neuroscientific exploration - especially given the current interest in developing cognitive enhancers for commercial and clinical uses. There are similarities between the typical traits of creative people and the subjective psychological characteristics of the psychedelic (hallucinogenic) drug experience. This phenomenon was studied in a number of small trials and case studies in the 1960s. Results were inconclusive, and the quality of these studies - by modern research standards - was merely anecdotal. Nevertheless, with today's current renaissance in psychedelic drug research and the growing interest in cognitive enhancing drugs, now may be the time to re-visit these studies with contemporary research methods.

Key words psychedelic; creativity; LSD

Introduction

The psychedelic drugs and their related cousins are enjoying a renaissance in medical research. In the spirit of medicine's first foray into the possible uses for these drugs in the 1950s and 1960s, the majority of contemporary studies have focused on their potential clinical applications. However, just like some of the earliest scientific studies with lysergic acid diethylamide (LSD), modern research may also re-open avenues for experiments with less immediately obvious clinical applications that may nevertheless shed light on what these unique substances can teach us about the brain. One such area worthy of re-visiting with modern research is the role that psychedelic drugs play in the realm of creativity. To propose such a project one must first briefly describe some of the challenges that are faced when studying the concept of creativity - such as how creativity is defined and measured.

What is creativity?

The word create derives from the Latin *creatus*, 'to have grown'; defined as a mental process involving the generation of new ideas or concepts or new associations between existing ideas or concepts. The ancient Greeks talked about creativity in the context of poetry 'bringing new life into the world', and ancient Rome expanded this further to encompass the creativity of art and architecture. Creativity may be seen from the perspective of theology, philosophy and psychology - but is most frequently applied from the point of view of art and design - and more recently in the commercial industry of advertising - where it is seen as an essential tool in stimulating product development and marketing strategy.

Formal attempts at defining creativity

In his book The Art of Thought (1926), Graham Wallas described five stages of the creative process, from *preparation*, *incubation*, *intimation* and *illumination* through to *verification*, and considered creativity to be an evolutionary process allowing humans to adapt to their changing environments. The American psychologist Guilford (1966) made the distinction between convergent and divergent thinking processes, whereby the latter involves creative generation of multiple answers to a set problem opposed to aiming for a single, correct solution to a problem.

Neurobiology of creativity

The well-documented 'left brain-right brain' model of brain function often polarises an individual's skills as artistic at the expense of language and mathematics. However, using evidence from lesion analysis, functional imaging and drug studies, the Harvard neurologist Alice Flaherty (2005) challenges this popularly held belief and describes a *three*-factor anatomical model of creativity that focuses on interactions between the temporal lobes, frontal lobes and limbic system - mediated by dopamine activity.

It is recognised that creative thinking requires more than just a general intelligence and specific knowledge, but also the ability to develop alternative solutions to a single question - or divergent thinking (Balzac, 2006). Heilman, *et al*. (2003) proposed that creative innovation requires the co-activation and communication between regions of the brain that ordinarily are not strongly connected. Heilman suggests that highly creative individuals are able to store extensive specialised knowledge in their temporoparietal cortex, be capable of divergent thinking mediated by the frontal lobe and, crucially, be able to modulate the activity of the locus coeruleus (which fires in response to novel stimuli) via the norepinephrine system, 'to understand and express novel orderly relationships.'

There is a current trend for exploring the concept of cognitive enhancing drugs. Although many of these so-called *smart drugs* or nootropics available over-the-counter have little in the way of objective scientific validity, there remains a genuine furious exploration for such agents. Research in this field seeks the role of relevant receptor systems in learning and other cognitive processes. The use of D-cycloserine as an adjunct to psychotherapy is well studied (Ressler, *et al*. 2004), and a recent study by Harvey (2003) describes using LSD (a 5-HT_{2A} receptor agonist) to enhance associative learning in rabbits.

How is creativity measured?

Since renaissance times, creativity has often been measured in terms of examining the output of so-called *creators*. The sheer volume of works by Da Vinci and Michelangelo are frequently quoted as testament to their creative geniuses. However, defining objective measures for the process of creativity is notoriously difficult - especially when taking into account the subjective nature of an individual's aesthetic appreciation of a particular creation. Some scholars (Zinkhan, 1993) have argued that creativity, by definition, defies measurement because all tests have predetermined correct answers and originality is a requirement of creativity - therefore, any 'correct' answer in a creativity test could not be creative.

Tests to measure creativity fall into two broad categories - the more scientific psychometric tests and the more subjective, but widely used, method of 'Expert Opinion'. Many of the psychometric tests developed have arisen from Guilford's definition of creativity as a product of divergent thinking. Tests that measure divergent thinking include the 'Unusual Uses' test, the 'Structure Of Intellect' test and Mednick's Remote Associates Test (1962). The creativity researcher Paul Torrance (1974) further developed Guilford's tests to produce the Torrance Tests of Creative Thinking (TTCT), which tested divergent thinking and other problem-solving skills, through *Fluency*, *Flexibility*, *Originality* and *Elaboration*. Further related tests include the Starkweather Originality Test (1964) - for young children only - and the Group Inventory for Finding Creative Talent (GIFT) (Rimm, 1980).

Critics of psychometric tests have suggested that it is not possible to articulate clear, objective criteria for a creative product, but that if external appropriate judges can agree on a product's creativity, it can be accepted as such (Amabile, 1982), and this point of view underlies the evaluation of identifying creativity by Expert Opinion. Techniques include Amabile's Consensual Assessment Technique (CAT) (1982). The judgement of panels of esteemed experts in the relevant field continues to be a popularly accepted method for assessing creativity in the arts. For example, The Turner Prize and The Booker Prize.

Characteristics of creative people

'We are all, to a varying extent capable of creativity - we participate in it simply by thinking.' (Barron, 1965). In a slightly archaic qualitative study, Barron (1965) examined the psychological profiles of a large group of individuals from different professional fields who frequently produced highly creative, original work, such as mathematics, the physical sciences, architecture and creative writing. He used a variety of (mainly psychodynamic) psychological rating scales and diagnostic instruments to postulate a list of eight traits that characterised these highly creative individuals, as follows:

1. Creativity was not linked directly to IQ. Although intelligence is in some degree necessary, it is not alone a sufficient condition for high creativity.
2. Finding meaning in the world - and being enthusiastic and able to communicate that meaning to others in one form or other.
3. Being intuitive
4. Being introverted
5. Finding a simple explanation to a complex problem (and this refers to creativity in both art and mathematics).
6. Being slightly more 'psychologically imbalanced' (measured by Barron as 'schizoid tendencies') than the general population.
7. Ability to maintain independent judgement (even in the face of alternative peer consensus).
8. 'Maintenance of psychic opposites' - for example, individuals who displayed a tendency to be both free and disciplined or both 'masculine' and 'feminine'.

Rogers (1959) described how particular *internal* and *external* conditions are necessary to enhance the creative process. Internal conditions (many of which share similarities with Barron's descriptions of characteristics of creative people) include a low psychological defensiveness, a lack of rigidity, a permeability of boundaries in concepts, beliefs, perceptions and hypotheses, a tolerance for ambiguity, an ability to receive and integrate apparently conflicting information, a sensitive awareness of feelings and openness to all phases of experience, intuition, aesthetic sensibility, a sense of satisfaction in self-expression, the ability to think in terms of analogues and metaphors and the ability to 'toy' with ideas, shapes and hypotheses. Rogers' external conditions that facilitate the enhancement of creativity include an atmosphere of psychological safety and psychological freedom in which the subject is permitted to think and feel whatever is discovered within oneself.

How the psychedelic experience might enhance the creative process

The term 'Psychedelic Experience' was coined in the 1950s to describe the subjective psychological effects of the human user when under the influence of a hallucinogenic drug. Such drugs, which occur in abundance in many plants and fungi and may also be synthesised artificially, include lysergic acid diethylamide (LSD), mescaline (found in the *Peyote cactus*), dimethyltryptamine (DMT, the active component in Ayhuasca) and psilocybin (the active component found in many species of 'magic' mushrooms.)

The psychological experience induced in humans under the influence of psychedelic drugs is multifarious and idiosyncratic, but nevertheless a broad range of common characteristics are frequently identified. These include alterations in the user's perceptions (in all the sensory modalities), changes in the emotions and expansion in an individual's sense of thought and identity. A particular feature of the experience - that is encompassed by all the above characteristics and has special relevance to the creative process is, that of a general increase in complexity and openness, such that the usual ego-bound restraints that allow humans to accept given pre-conceived ideas about themselves and the world around them are necessarily challenged. Another important feature is the tendency for users to assign unique and novel meanings to their experience - together with an appreciation that they are part of a bigger, universal cosmic-oneness.

In the introduction to their original article describing a pilot study to explore the use of psychedelic agents in creative problem solving (below), Harman, *et al*. (1966) suggested that using a psychedelic drug under the appropriately controlled test conditions satisfies all of the criteria outlined by Rogers (above) to enhance the creative process.

Anecdotal historic examples of using psychedelic drugs to enhance artistic creativity

There are many anecdotal examples of artists and writers describing the use of psychedelic drugs such as LSD to enhance the creative process (and a similar number of such accounts disputing this suggestion). The use of drugs to enhance artistic creativity is not new, illustrated when the Roman poet Ovid said, 'There is no poetry among water drinkers.' There are examples of pre-historic art from all around the world, which use optical illusions or *entoptic phenomena* to enhance the visual experience. The linkages between this form of artwork and pre-historic use of psychedelic drugs is well established and described in the art work of many pre-historic cultures from Ireland (Dronfield, 1995), Africa and France (Lewin, 1991) to South America (Howard, 1957) and as far afield as Siberia in the Arctic circle (Dikov, 1971).

The use of opium (whilst not usually credited as a *psychedelic* drug) to influence creativity is well recognised. Thomas De Quincey describes the pleasures, as well as the pitfalls, of taking opium in *Confessions of an English Opium-Eater* (1822). The English Romantic poet Samuel Taylor Coleridge also reports the vivid imagery of the opium experience in his poem *Kubla Khan* (1816), as does Alexandre Dumas père, in *In The Count of Monte Cristo* (1844). And the 1832 poem by Alfred Lord Tennyson, *The Lotus-Eaters* describes how opium is used as a creative tool in the nineteenth century. In the 20th century, the French poet and playwriter Antonin Artaud used opium extensively, as well as the *Peyote cactus* (Artaud, 1937).

More recent examples of artists using psychedelic drugs include Henri Michaux, the Belgian-born French painter, journalist and poet, who at the age of 56 started using mescaline and cannabis and wrote about his experiences in his later works (Michaux, 1956). A now very famous account of the mescaline experience by the English intellectual writer Aldous Huxley in 1954 placed Huxley as a centrally revered figure for the subsequent cultural drug revolution that followed. Then since the 1960s, the volume of modern Western art and music that attributes its influences to the psychedelic drugs is vast. Some such artists and musicians openly proclaim themselves to be 'psychedelic artists,' whereas many others will frequently acknowledge the influence of psychedelic drug experiences have had on their work. One such piece of psychedelic drug-influenced artwork recently appeared in the *British Journal of Psychiatry* in homage to the discoverer of LSD, Dr Albert Hofmann (Sessa, 2007).

Oscar Janiger's unique study

An attempt to explore the value of the agent LSD in influencing artistic creativity was made in a remarkable long-term series of anecdotal case studies by the American psychiatrist Oscar Janiger (Dobkin de Rios and Janiger, 2003). Between 1954 and 1962, he facilitated LSD sessions for almost 1000 people between ages 18 and 81 in a variety of professions from doctors and nurses, lawyers, housewives and police officers to judges, truckers, students and the unemployed and retired. One of his participants was the film star Cary Grant. In contrast to the often highly systematised design of most other psychedelic research of this period, Janiger's experiments were largely unguided and took place in a naturalistic setting, with a view to explore what the nature of the 'intrinsic, characteristic LSD response' (if indeed there was one) might be. Unsurprisingly, the volunteer's experiences varied widely, but adverse reactions were extremely rare, and the vast majority described the experience as valuable and sustaining. During the course of this work two experiential characteristics emerged repeatedly - those of spontaneous spiritual experiences and those of LSD boosting the subjects' experiences of creativity.

These latter observations lead Janiger to conduct a parallel study examining the effects of the drug on creativity in a controlled setting. He subsequently gave LSD to a mixed group of 60 visual artists over a seven-year period, and they produced over 250 drawings that were later analysed by a professor of art history, who compared the artists' work before and after the LSD sessions. Because of the heterogeneity of the population and the aesthetic nature of analysing the results, making objective statements about how LSD effected the artists' creativity is impossible, but the drug did appear to enhance certain aspects of the artists' work; namely there was a tendency towards more expressionistic work, a sharpening of colour, a greater freedom from prescribed mental sets, an increased syntactical organisation, a deeper accessibility of past impressions and a heightened sense of emotional excitement. However, perhaps the most valuable aspect of Janiger's study is the many qualitative reports from the artists themselves, who without exception found the LSD experience artistically and personally profound.

Further experiments in creativity and psychedelics

An article by Stanley Krippner (1972) outlines five studies. In a study by Berlin, *et al*. (1955), four prominent graphic artists were given mescaline and LSD and encouraged to complete paintings whilst under the influence of the drug. A panel of art critics judged their subsequent paintings to have 'greater aesthetic value' than the artist's usual work.

The American psychologist Frank Barron (1965) gave psilocybin to creative individuals and recorded their subjective impressions. The psychiatrist McGlothlin, *et al*. (1967) gave 200 μg of LSD to 72 graduate students together with two control groups. In long-term follow-up, the experimental group showed a subjective greater appreciation of music and the arts, but no actual increase in creative ability.

In an experiment by Zegans, *et al*. (1967), 19 graduate students were given one of three varying doses of LSD, alongside 11 students who received a placebo. The subjects did not know they were to be given psychotropic drugs when they initially signed up for the experiment, and they were not selected for their creative abilities. A range of creativity test data (including the Mednick Association Test, the Modified Word Association Test, the Mosaic Design Test and the Free Association Test) were conducted at baseline, during and after the acute intoxication. Although results were not statistically significant, there was trend towards significance for the LSD group for all tests. One striking conclusion of the experiment was that whilst administering LSD to unprepared students did not result in a blanket statistically significantly improvement in creativity for all subjects, for certain subjects with particular 'creative personality traits', it was noted that LSD 'increased the accessibility of remote or unique ideas and associations to their conscious awareness'.

It is noteworthy that little emphasis was made towards the importance of (personal mind-) set and (environmental) setting during these studies - two very important factors that have been shown to radically alter the outcome of individual's experiences under psychedelic drugs. All these studies report the variable successes of demonstrating the psychedelic drug's ability to improve creativity in the experimental context - especially when subjects are taken from an unselected population of graduate students.

However, the pilot study by Harman, *et al*. (1966) from the Institute of Psychedelic Research of San Francisco State College deserves closer attention. The researchers took particular care to select individuals ($n = 27$) engaged in creative industries (engineers, theoretical mathematicians, physicists, architects and designers) and 'primed' them with a pre-drug session in which they were encouraged to select problems of a professional interest that required a creative solution. A very positive mind-set was, therefore, encouraged by the researchers, who told the subjects that the drug *would* enhance their creativity and help them to work more productively without distractions. Baseline psychometric tests included the Purdue Creativity Test, the Millar Object Visualisation Test and the Witkin Embedded Figures Test. At the psychedelic sessions (using mescaline) a few days later, subjects were encouraged to work in groups and as individuals to tackle their chosen problems and were subjected to further psychometric tests. Follow-up consisted of subjects submitting a written subjective account of their experience within 1 week of the drug session and further interviews with the researchers 8 weeks later in which subjects were asked whether the drug session had offered an impairment, no change or an improvement in their creativity and work performance. All participants showed enhanced abilities on all tests when under the drug compared with the previous non-drug tests ($P < 0.01$). In the subjective written accounts, all the participants described subjective enhanced effects of the drug on their creative process. From these qualitative reports 11 'Strategies of Enhanced Functioning' were extracted:

1. Reduced inhibition and reduced anxiety.
2. Improved capacity to restructure problems in a wider context.
3. Increased fluency and flexibility of ideas.
4. Increased visual imagery and fantasy.
5. Increased ability to concentrate.
6. Increased empathy with objects and processes.
7. Increased empathy with people.
8. Subconscious data more accessible.
9. Improved association of dissimilar ideas.
10. Heightened motivation to obtain closure.
11. Improved ability to visualise the completed solution.

At 8-week follow-up, all subjects reported either improvements or no change in their creative abilities - with no reports of impairments. Although this study is severely limited in not being double blind and placebo controlled, it reports the power of (and importance) of set and setting, and its potential implications for the creative industries is highly significant.

The commercial industry implications for enhancing creativity with drugs

A better understanding of creativity, how best to measure and, crucially, how best to enhance it, has vast implications for commercial industry. Above and beyond the artistic and neuroscientific interest in the creative process, practically all aspects of modern industry rely to some extent on the concept of product design - particularly in the advertising industry, where creativity is arguably the most important element of success (ElMurad and West, 2004). Despite the enormous amount of money and energy invested in such commercial industries, the scientific concept of *how* creativity is enhanced is poorly understood. This makes the neuroscientific understanding of these processes particularly relevant.

There have been some notable historical examples of designers using psychedelic drugs to improve their skills.

One such example, from 1965, is when the architect Kyoshi Izumi was asked to design a psychiatric hospital in Canada and decided to take LSD (as a psychotomimetic) and perform extensive visits to old mental institutions in an attempt to see the wards in a new light. He found himself terrified by the standard hospital paraphernalia such as the tiles on the walls, the recessed closets and the raised hospital beds. There was no privacy, and the sense of time was nil, because of the absence of clocks and calendars. After his LSD insights, Mr. Izumi was able to design what has been called 'the ideal mental hospital.' The first was built in Yorkton, Saskatchewan, and five others have been modelled upon it elsewhere in Canada (Stafford and Golightly, 1967).

Another possible example of the creative influence of psychedelic drugs comes from the alleged use of low doses of LSD by the Nobel Prize winner Francis Crick, who discovered the double-helix structure of the DNA molecule in Cambridge in the 1950s. The drug was freely available at that time as a tool for psychotherapy. Crick was a well-known admirer of Aldous Huxley and went on to campaign for the legalisation of cannabis in the 1960s as a founder member of the 'Soma' group - named after Huxley's mythical drug from the book Brave New World.

Another incidence of psychedelic drug-induced creativity from the scientific community comes from the Nobel Prize winning chemist Dr Kary Mullis, the inventor of PCR, who is quoted as saying: 'Would I have invented PCR if I hadn't taken LSD? I seriously doubt it,' he says. 'I could sit on a DNA molecule and watch the polymers go by. I learnt that partly on psychedelic drugs.'

A further striking example of psychedelic drug-enhanced creativity of industry comes from the well-established computer industry in California. The liberal atmosphere and loose approach to creativity fostered by the 1960s use of LSD on the West Coast of the United States spawned a population a creative post-hippie entrepreneurs. Pioneers such as Steve Jobs and Steve Wozniak, founders of the Apple computer industry, were both products of the 1960s counter-culture who were part of a group of visionaries setting out to turn computers into a means for freeing minds and information (Markoff, 2006).

Clinical implications of drugs that may enhance creativity

Perhaps the most obvious clinical area that may benefit from an enhancement of creativity is autism. A common problem in patients with autism is the inability to see the intrinsic (and sometimes abstract) connectivity between people and objects. One of the central tenants of the psychedelic experience is its ability to encourage the user to find new meaning in and see associations between objects and feel part of the abstract connectivity of the universe. Although these are subjective effects enhanced only acutely during the psychedelic experience, they are experiences enjoyed by most people to a lesser degree at all times. In autism, such experiences are frequently impaired. This phenomenon was explored in the early part of the 1960s in a small number of studies using psychedelic drugs on children with autism (Mogar and Aldrich, 1969). Most subjects were between 6 and 10 years old, and all were considered severe cases of autism who had failed to respond to other forms of treatment. Consistent effects of the psychedelic drugs included improved speech in otherwise muted patients, a greater emotional responsiveness to other children and adults, increased positive mood with frequent smiling and laughter and decreases in obsessive-compulsive behaviour. The collective results argued strongly for more extensive research, but this, like all psychedelic research by the end of the 1960s, did not materialise because of socio-political reasons (see Sessa, 2005).

Set and setting

That the classical psychedelic drugs (LSD, Mescaline, DMT and Psilocybin) produce very variable psychological characteristics is undeniable. The role of fostering a positive set and setting is crucial to a positive outcome. This is also true for MDMA - which is generally accepted to produce an overwhelmingly positive mood for most users but is also subject to negative experiences in a minority of cases particularly when users have been given negative information about the drug's effects. Therefore, in exploring psychedelics as clinical tools, the concepts of set and setting ought not to be seen as *confounders* but rather as an *active* part of the experimental intention. The totality of the psychedelic experience is a combination of pharmacological and psychological factors interacting together in a synergistic fashion; set and setting must be seen as essential components of the psychedelic experience that must be attended to achieve a maximum positive response. Although this is true for *all* clinically used psychotropic drugs to a certain extent (and SSRIs, for example, can have placebo efficacy rates of up to 45%), it is especially so of the psychedelic drugs. Therefore, studies that either deliberately or unintentionally disregard these set and setting factors and report negative outcomes ought not to be used as evidence to dispute the positive potential of psychedelic drugs.

It is well accepted that when under the acute influence of psychedelic drugs, performance on standard tests of intelligence, learning, memory and other cognitive functions, as well as certain psychomotor tasks, generally show impairment and sometimes show lack of change and only rarely show improvement (Carter, *et al.*, 2005). However, it is often difficult to get meaningful data from such measurements because subjects frequently become engrossed in the subjective aspects of the drug experience and lose interest in the tasks presented by the investigators. Psychological tests are often seen as absurd or irrelevant by the subjects, illustrated well by this quote from the psychologist Arthur Kleps (1967), 'If I were to give you an IQ test and during the administration one of the walls of the room opened up, giving you a vision of the blazing glories of the central galactic suns, and at the same time your childhood began to unreel before your inner eye like a three-dimension colour movie, you too would not do well on an intelligence test.'

What is the benefit of revisiting psychedelics and creativity research now?

Psychedelic research's current renaissance is spurred on in part by a more realistic understanding of the safety profile of recreationally abused substances. LSD and MDMA were recently categorised far down the list of the potential hazards of 20 commonly abused substances (Nutt, *et al.*, 2007). The political climate is beneficial for exploring the therapeutic possibilities of such drugs that have hitherto been considered off limits simply because they have been used recreationally. There are several trials underway throughout the world at present - some of which are aiming to recreate some of the famous studies of the 1950s and 1960s using modern research methods. One such trial recently recreated was Walter Pahnke's *1962 Good Friday Experiment* (Pahnke, 1969) in which psilocybin was seen to induce a subjective experience of spirituality in its users. In the famous 1960s experiment, Pahnke (who was both a physician and a religious minister) used a double-blind technique to administer 30 mg of psilocybin to 10 experimental subjects, whereas a further 10 subjects received an active (but nonpsychedelic) placebo (nicotinic acid). All the subjects, who were Harvard theology students, then attended Good Friday Mass at Boston University's Marsh Chapel. Their subjective account of the experience was measured using the 'Stace Criteria' - a well-established scale for measuring the degree of mystical experience. In his 2006 recreation of Pahnke's study, Roland Griffiths of the Johns Hopkins School of Medicine in Baltimore, USA used a double-blind technique and gave psilocybin to 36 volunteers without previous experience with hallucinogens, using a matched-control group who were given methylphenidate (ritalin) as an active placebo. The degree of mystical experience was measured using a questionnaire developed by Ralph W Hood (2001). Sixty-one per cent of the psilocybin subjects reported a 'complete mystical experience', compared with only 13% of the methylphenidate group. Griffiths followed-up the subjects at 2 months and found that 79% of the psilocybin subjects reported moderately to greatly increased life satisfaction and sense of well being. It is noted that there were also some significant negative subjective experiences, with 36% of the psilocybin subjects participants describing a strong to extreme 'experience of fear' during the psilocybin session (which was not reported by any subject during the methylphenidate session), with about one-third of these (13% of the total) reporting that this dysphoria dominated the entire session. (Griffiths, *et al.*, 2006). It is difficult to imagine the obvious clinical benefits of such a study, but heartening to see such an experiment that further expands our understanding of neuroscience. A recreation of the previously mentioned study by Harman, *et al.* (1966) would provide similar data to the neuro-scientific community, and as mentioned it could also have far greater implications for clinical and commercial sectors of society.

Conclusion

As with all psychedelic research, planning new projects using drugs that have a contentious history needs to be done cautiously to avoid the (often inaccurate) preconceptions about the relative usefulness and harm of these substances. However, common to all these drugs, there exists a rich wealth of anecdotal studies from 40 years ago that were abandoned prematurely before their full therapeutic potential was either adequately reported or discounted. The area of psychedelic enhancement of creativity is one such area that may have potential benefits for furthering our understanding of neuroscience. In addition, if we are to strive to comprehend the brain and mind in their entireties, these are areas that are worth revisiting with modern research methods.

Acknowledgements

We thank David Nutt from the Psychopharmacology Unit at Bristol University for suggestions and support in preparing this paper.

References

1. Amabile, TM (1982) Social psychology of creativity: a consensual assessment technique. Journal of Personality and Social Psychology 43: 997-1013.
2. Artaud, A (1937) The Peyote Dance. Farrar, Straus and Giroux (1976). 19 UnionSquare, West New York, NY 10003 United States.
3. Balzac, F (2006) Exploring the brain's role in creativity. Neuropsychiatry Rev 7: 1, 19-20.
4. Barron, F (1965) The Creative Process and the Psychedelic Experience. Explorations Magazine. Berkley, California, June-July.
5. Berlin, L, Guthrie, T, Weider, A, Goodell, H, Wolff, HG (1955) Studies in human cerebral function: the effects of mescaline and lysergic acid on cerebral processes pertinent to creative activity. J Nerv Ment Dis 122: 487-491.
6. Carter, OL, Burr, DC, Pettigrew, JD, Wallis, GM, Hasler, F, Vollenweider, FX (2005) Using psilocybin to investigate the relationship between attention, working memory, and the serotonin 1A and 2A receptors. J Cogn Neurosci 17: 1497-1508.
7. Coleridge, ST (1816) Kubla Khan, New Ed edition. Two Rivers Press (2004), Reading, Berkshire, UK.
8. De Quincy, T (1822) Confessions of an Opium Eater. Oxford, UK: Oxford University Press (1998).
9. Dikov, NN (1971) Naskalnuie Sagadki Drevniei Ciukotki (Pietroglifui Pegtimelia). Moscow: Nauka.
10. Dobkin de Rios, M, Janiger, O (2003) LSD, Spirituality and the Creative Process. Rochester, Vermont: Park Street Press, pp. 1-4.
11. Dronfield, J (1995) Subjective visions and the source of Irish Megalithic art. Antiquity 69: 539-549.
12. Dumas, A (1844) The Count of Monte Cristo. Penguin Classics (2003). London, UK: Penguin.
13. El-Murad, J, West, DC (2004) The definition and measurement of creativity: what do we know. J Advert Res 44: 188-201.
14. Flaherty, AW (2005) Frontotemporal and dopaminergic control of idea generation and creative drive. J Comp Neurol 493: 147-153.
15. Griffiths, RR, Richards, WA, McCann, U, Jesse, R (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. Psychopharmacology (Berl) 187: 268-283.
16. Guilford, JP (1966) Measurement and Creativity. Theory into Practice. Lawrence Erlbaum Associates, Inc. 10 Industrial Avenue Mahwah, NJ 07430 USA, pp. 186-189.
17. Harman, WW, McKim, RH, Mogar, RE, Fadiman, J, Stolaroff, MJ (1966) Psychedelic agents in creative problem solving: a pilot study. Psychol Rep 19: 211-227.
18. Harvey, JA (2003) Role of the serotonin 5-HT$_{2A}$ receptor in learning. Learn Mem 10: 355-362.
19. Heilman, KM, Nadeau, SE, Beversdorf, DO (2003) Creative innovation: possible brain mechanisms. Neurocase 9: 369-379.
20. Hood, RW, Ghorbani, N, Watson, PJ, Ghramaleki, AF, Bing, MN, Davison, HK, *et al*. (2001) Dimensions of the mysticism scale: confirming the three-factor structure in the United States and Iran. J Sci Study Relig 40: 691-705.
21. Howard, JH (1957) The mescal bean cult of the central and southern plains: an ancestor of the peyote cult. Am Anthropol 59: 75-87.
22. Huxley, A (1954) The Doors of Perception. London: Chatto and Windus.
23. Kleps, A (1967) LSD: The problem-solving psychedelic, chapter III. In: Stafford, PG, Golightly, BH (eds), Creative Problem Solving. Award Books: New York p. 46.
24. Krippner, S (1972) Mescaline psilocybin and creative artists. In: Tart, CT, (ed), Altered States of Consciousness. Published by John Wiley and Sons, New Jersey, USA.
25. Lewin, R (1991) Stone Age psychedelia: was the cave art of Stone Age people the fruit of hallucinations induced by shamanistic rituals? New Scientist magazine, p. 30.
26. Markoff, J (2006) What the Dormouse Said: How the Sixties Counterculture Shaped the Personal Computer Industry. New York, USA: Penguin Group.
27. McGlothlin, WH, Cohen, S, McGlothlin, MS (1967) Long lasting effects of LSD on normals. Arch Gen Psychiatry 17: 521-532.
28. Michaux, H (1956) Miserable Miracle. San Francisco: City Lights Books (1963).
29. Mogar, RE, Aldrich, RW (1969) The use of psychedelic agents with autistic schizophrenic children. Behav Neuropsychiatry 1:

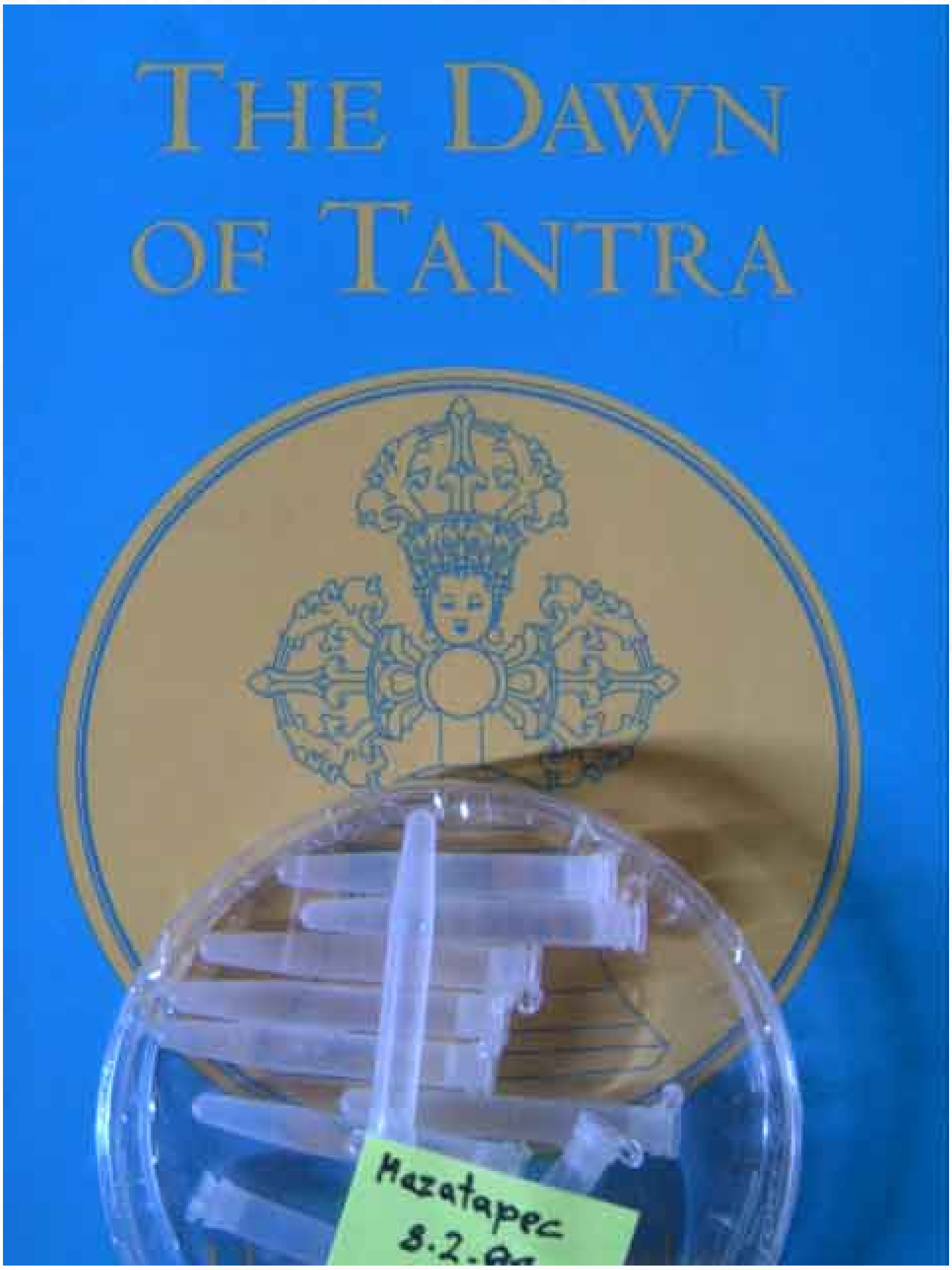
44-50.
30. Nutt, DJ, King, LA, Saulsbury, W, Blakemore, C (2007) Developing a rational scale for assessing the risks of drugs of potential misuse. Lancet 369: 1047-1053.
31. Pahnke, WN (1969) Psychedelic drugs and mystical experience. Int Psychiatry Clin 5: 149-162.
32. Ressler, KJ, Rothbaum, BO, Tannenbaum, L, Anderson, P, Graap, K, Zimand, E, *et al*. (2004) Cognitive enhancers as adjuncts to psychotherapy: use of D-cycloserine in phobics to facilitate extinction of fear. Arch Gen Psychiatry 61: 1136-1144.
33. Rimm, SB (1980) Group Inventory for Finding Creative Talent. Watertown, WI: Educational Assessment Service.
34. Rogers, CR (1959) Toward a theory of creativity. In: Anderson, HH (ed), Creativity and its Cultivation. New York: Harper, pp. 69-82.
35. Sessa, B (2005) Can psychedelics have a role in psychiatry again? Br J Psychiatry 186: 457-458.
36. Sessa, B (2007) Pictures in psychiatry. Br J Psychiatry 190: 1-a2-1. doi: 10.1192/bjp.190.1.A2.
37. Stafford, PG, Golightly, BH (1967) LSD - the problem-solving psychedelic, chapter VII. London: T&amacr;ṇḍom Books, pp. 207-209.
38. Starkweather, EK (1964) Problems in the measurement of creativity in preschool children. J Educ Meas 1: 109-113.
39. Tennyson, AL (1832) The Lotus Eaters, New Ed edition. USA: Oxford University Press (2000).
40. Torrance, EP (1974) Torrance Tests of Creative Thinking. Scholastic Testing Service, Inc. Available at: http://www.ststesting.com/2005giftttct.html.
41. Wallas, G (1926) The Art of Thought. London: Watts and Co.
42. Zegans, LS, Pollard, JC, Brown, D (1967) The effects of LSD-25 on creativity and tolerance to regression. Arch Gen Psychiatry 16: 740-749.
43. Zinkhan, G (1993) Creativity in advertising, creativity in the journal of advertising. J Advert 22: 1-3.

Practical method for long term storage of mycellium in dH2O using ependorf tubes as vials

by

Quincunx

original source: http://www.shroomery.org/8511/Practical-method-for-long-term-storage-of-mycellium-in-dH2O-using-ependorf-tubes-as-vials



background:
This is a simple method (TEK of some kind) i use to store mushroom mycellium cultures in dH2O for prolonged time. It is far from being ideal but i thought it could come handy for some of you (read the part about mailing cultures stored like this). Feel free to improve it. I came up with it because i couldn't find any appropriate TEK at The Shroomery FAQ about dH2O storage.

primary objectives:

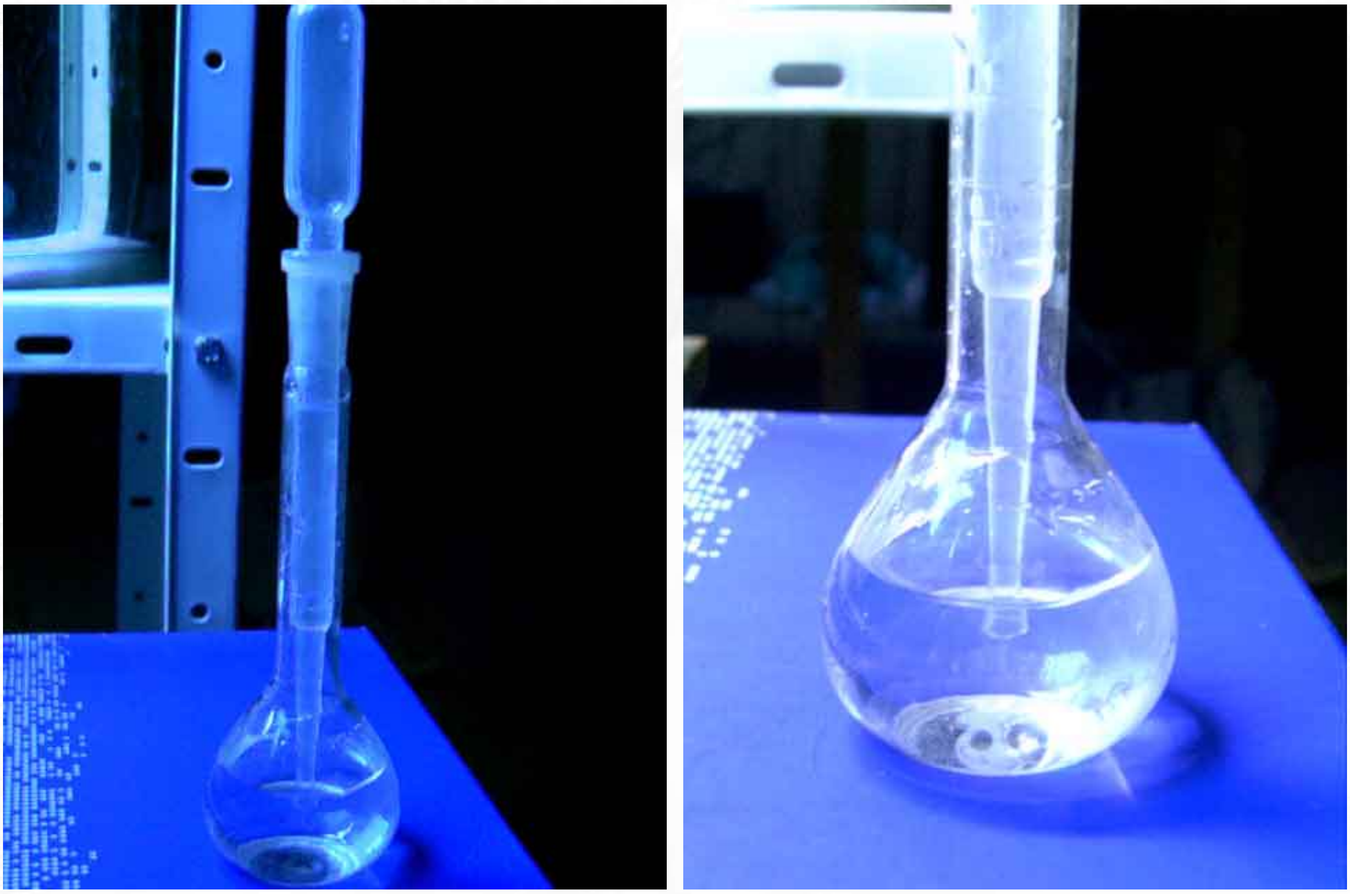
- at least 50% of isolates should survive a period of 2 years
- isolates should be stored in as small containers as possibile

secondary objectives:

- isolates should survive occasional temperature fluctuation
- vials should be crash resistant to survive mail shipping & handling
- method/TEK should be simple and cheap so anyone can use it

materials used:

- 0.5 mL PP ependorf tubes
- dripping-tube or a pipette - pick one that will fit into neck of your flask:



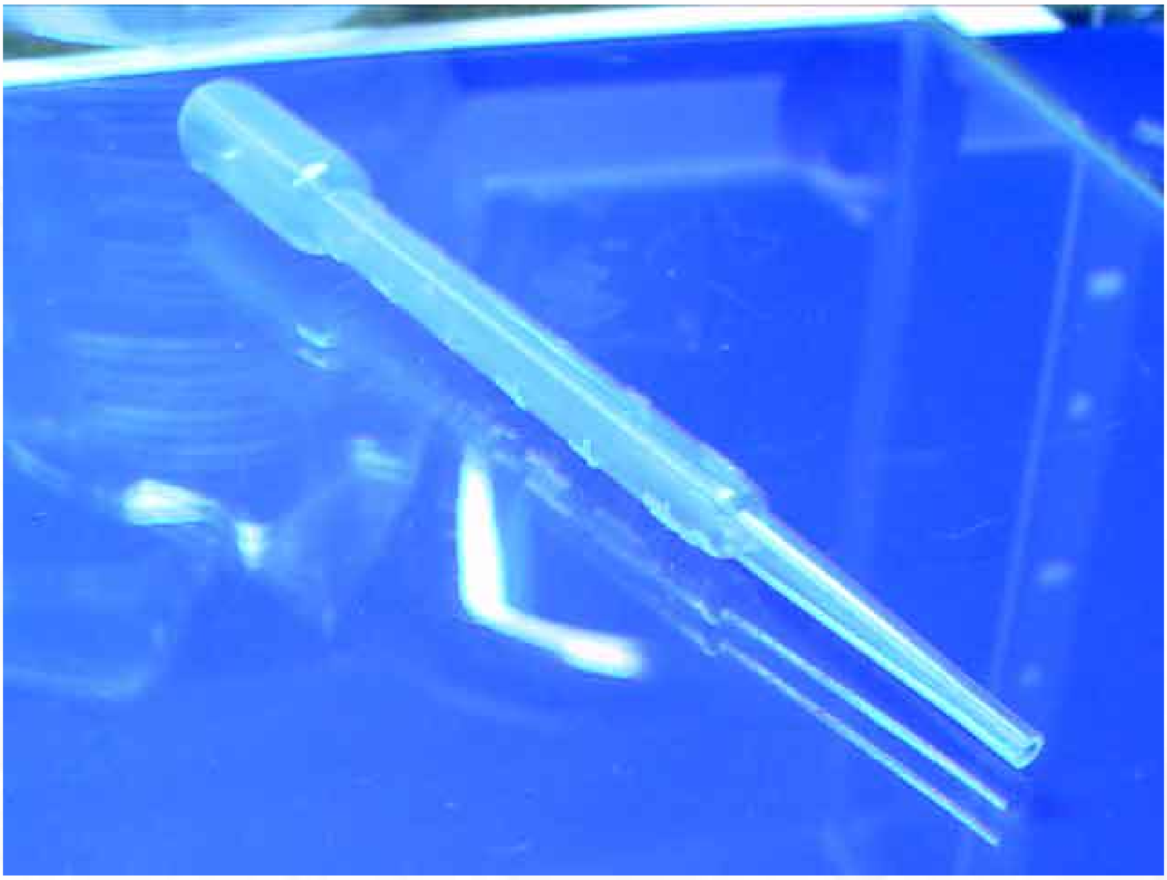
- cotton bud sticks
- small flat bottom flask or erlenmeyer flask or even standard test tube will do
- pure dH2O (bottled spring water is drinkable and contains minerals - i'm not sure if this is good in this case)

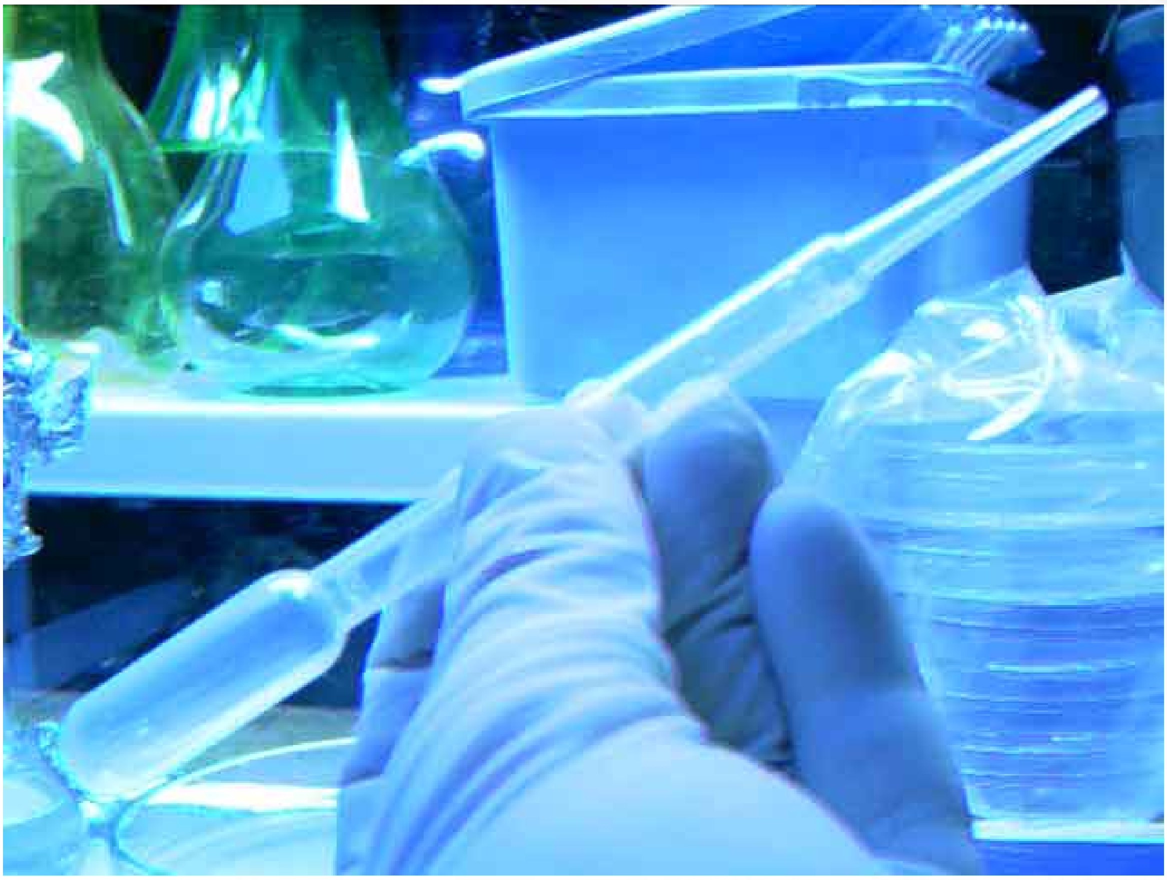
High sterility is a must so think in advance and sterilize everything. If possibile find presterilized cotton buds (pharmacy), ependorfs and plastic dripping tube. Otherwise make sure that materials can withstand PCing.
I've found cotton bud stick as the best tool for removing mycellium from the surface effeciently with a minimum of agar material transfered as well. Spatula and/or scalpel will work too, but they are too sharp for me - mycellium will deposit on the edge and form hard to break clumps once transfered in dH2O. Also, one

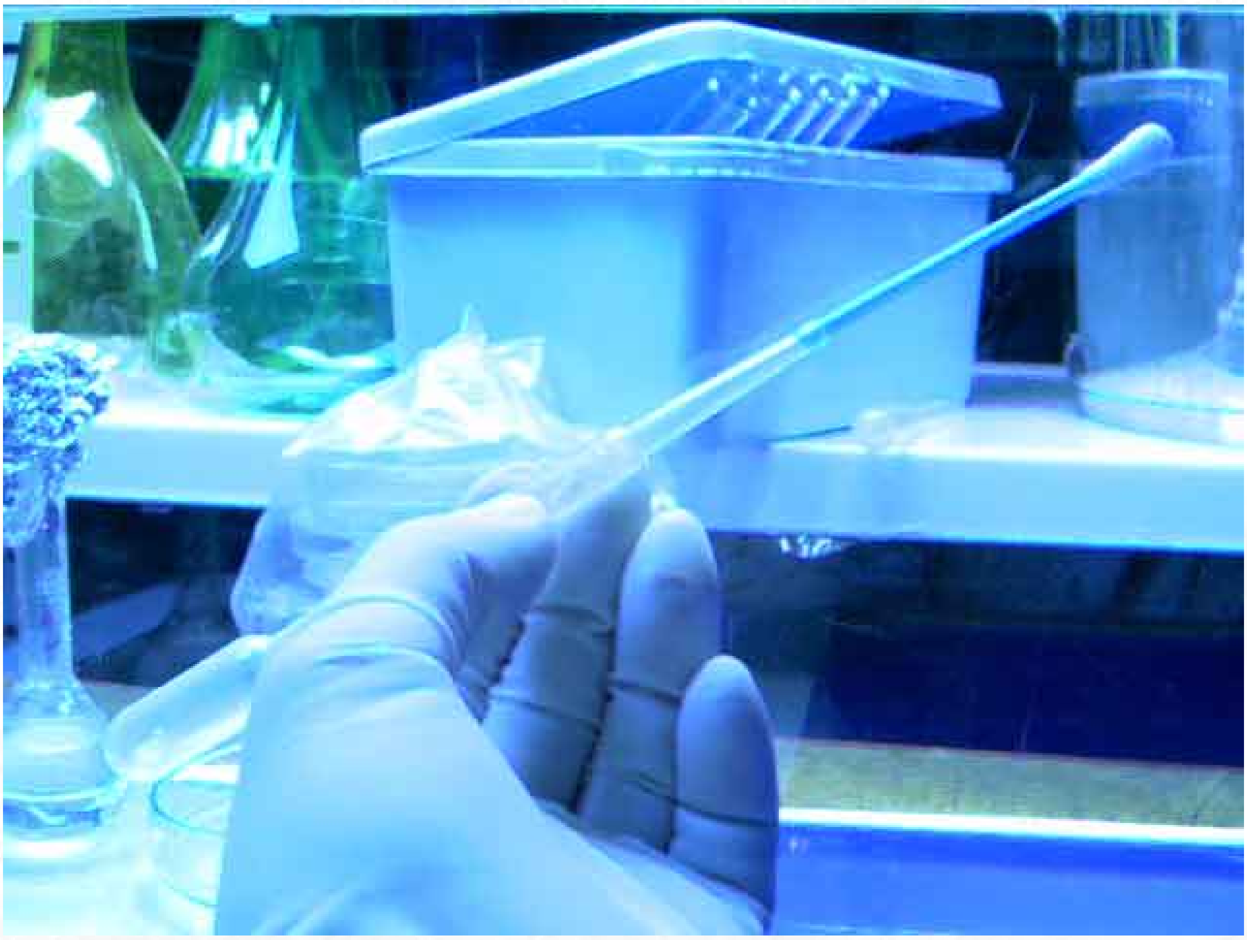
false move and you can dig deep into agar. Suntzu gave me the original idea with sterilized swab (thanx) so i've pondered on this and came up with sticks.

Ok. Here's my method.

First i cut a stick (it's hollow) at the base and fit it at the end of the dripping-tube to construct a simple tool like this:

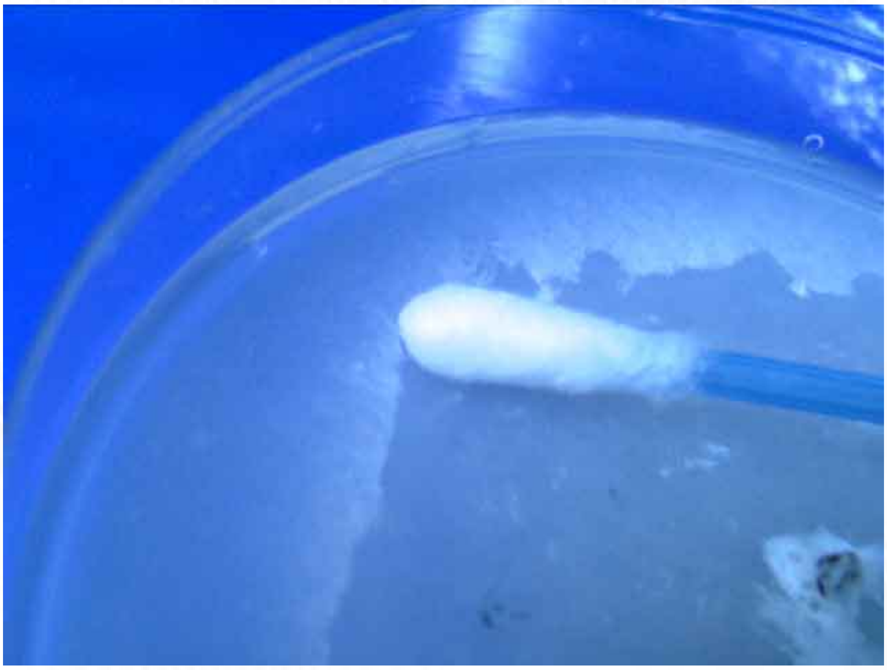




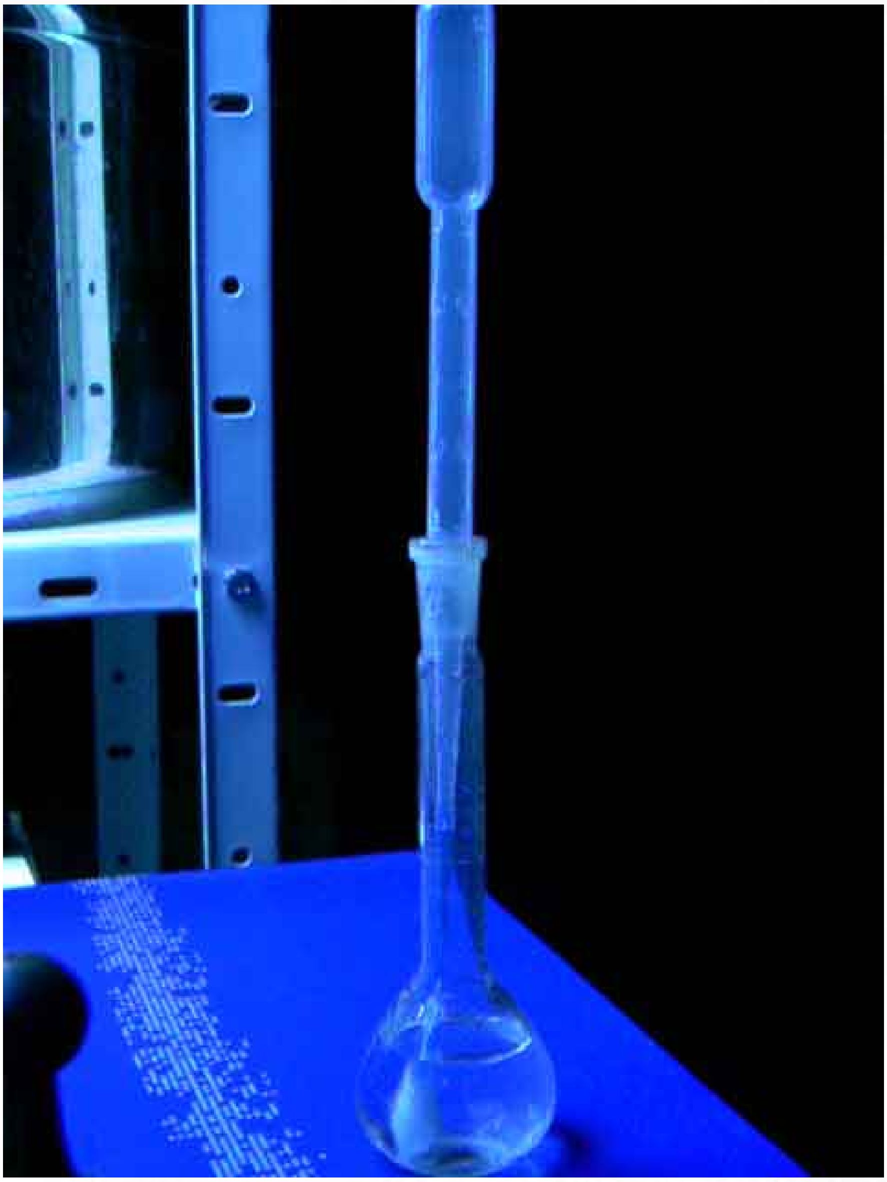


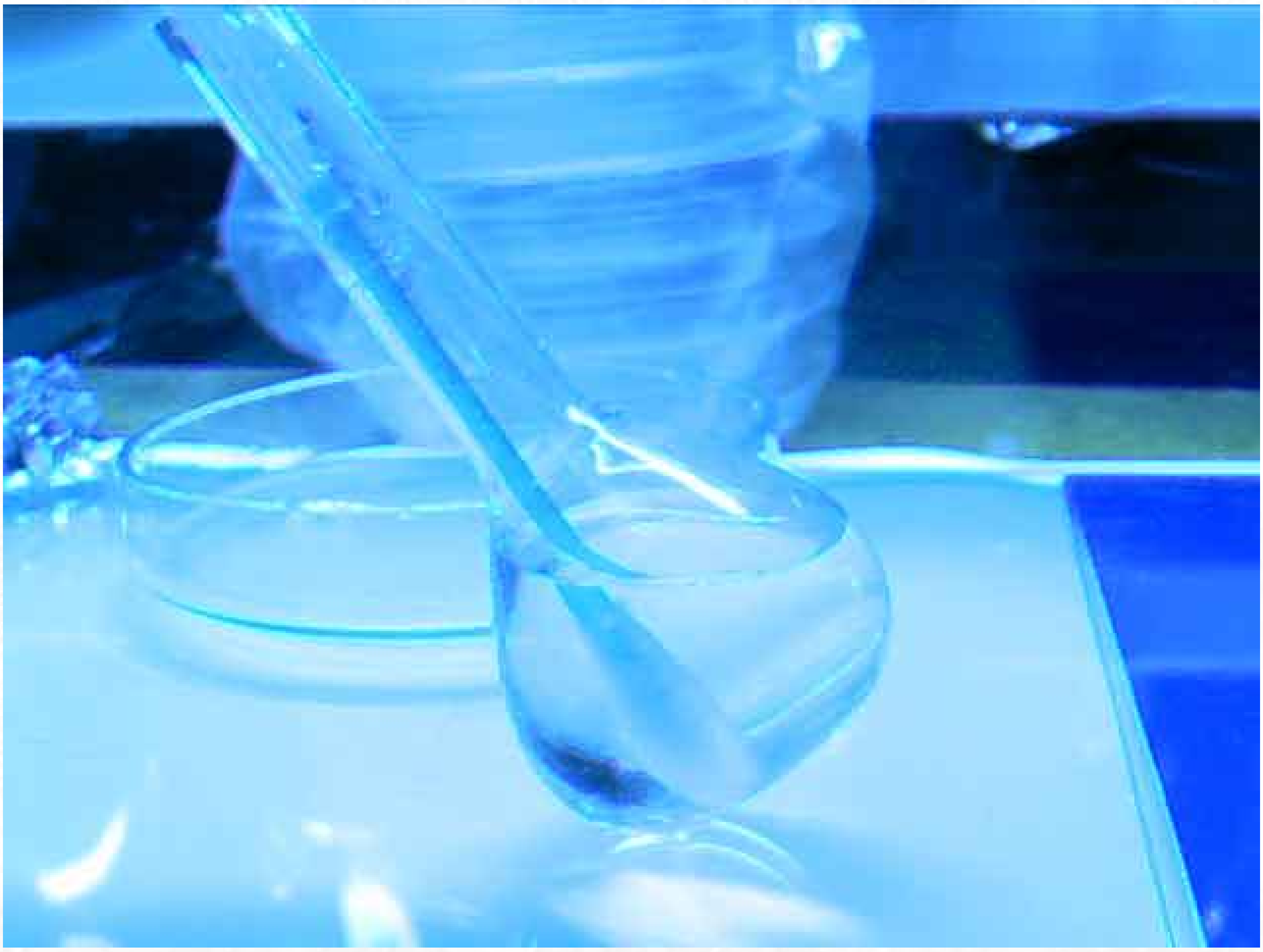
Then take a Petri dish (colonized as needed) and roll the stick over surface:

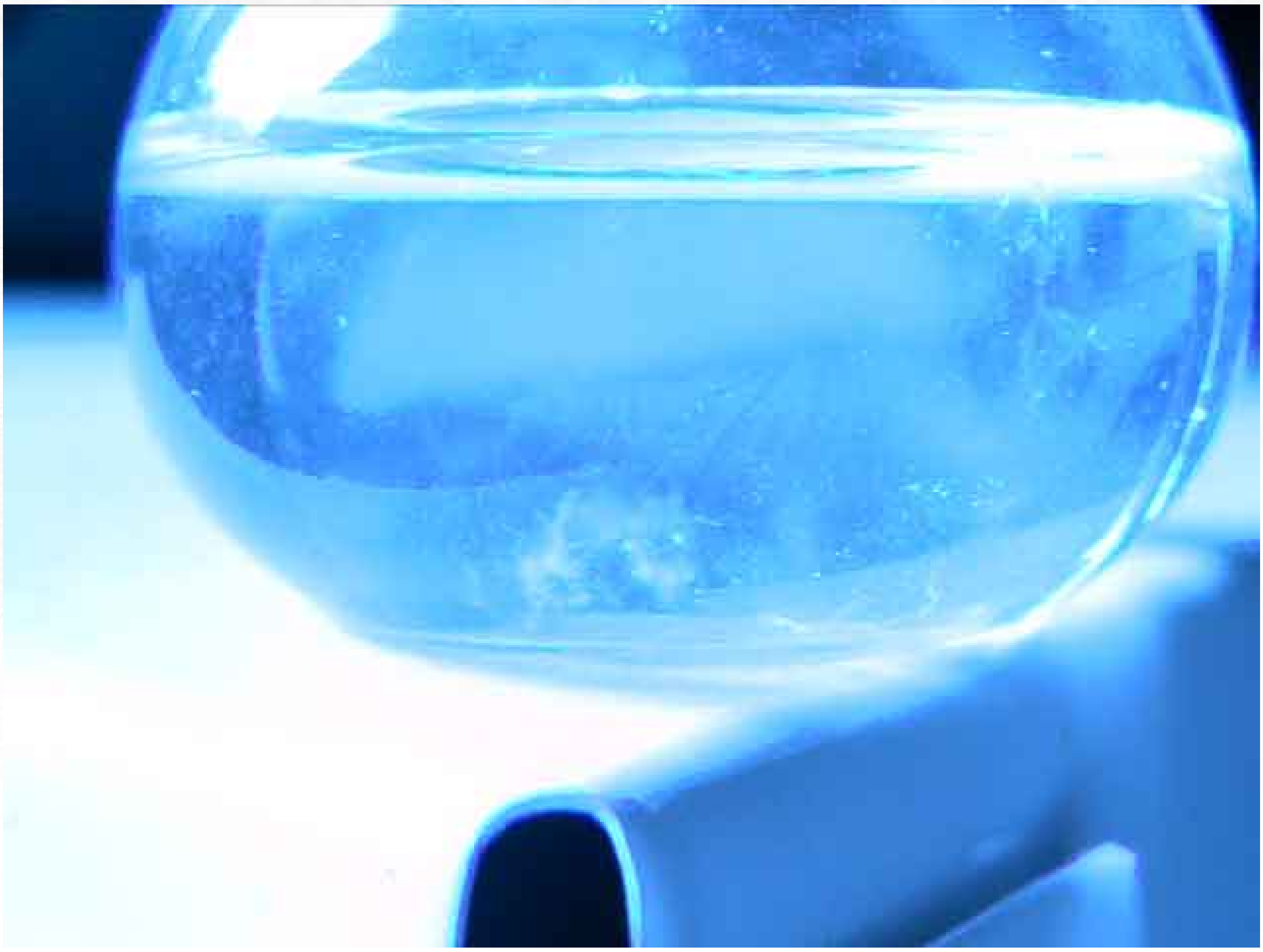
Cambodia
30.1.
13
22.1.03
MZ
MZ 22.1.03



You can gently wipe mycellium out of agar surface and even if you touch the surface with the bud tip it will feel like waxed solid floor (unlike with scalpel or spatula). Then transfer to flask with dH2O (constructed tool is thin and more than long enough to fit the neck of the flask):



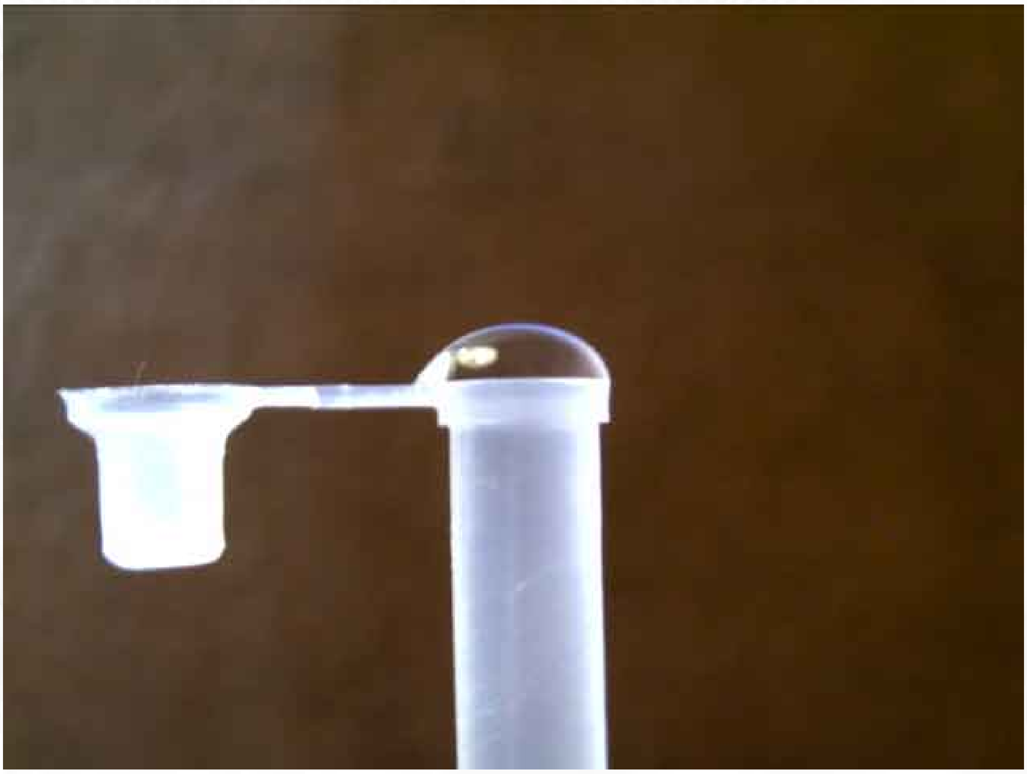




Once in water, gently press dipping-tube nozzle to push some air through stick and shake - this will release the mycellium from the cotton bud. Do not release the nozzle again until you remove the stick from water otherwise it will suck the mycellium back on the cotton bud.

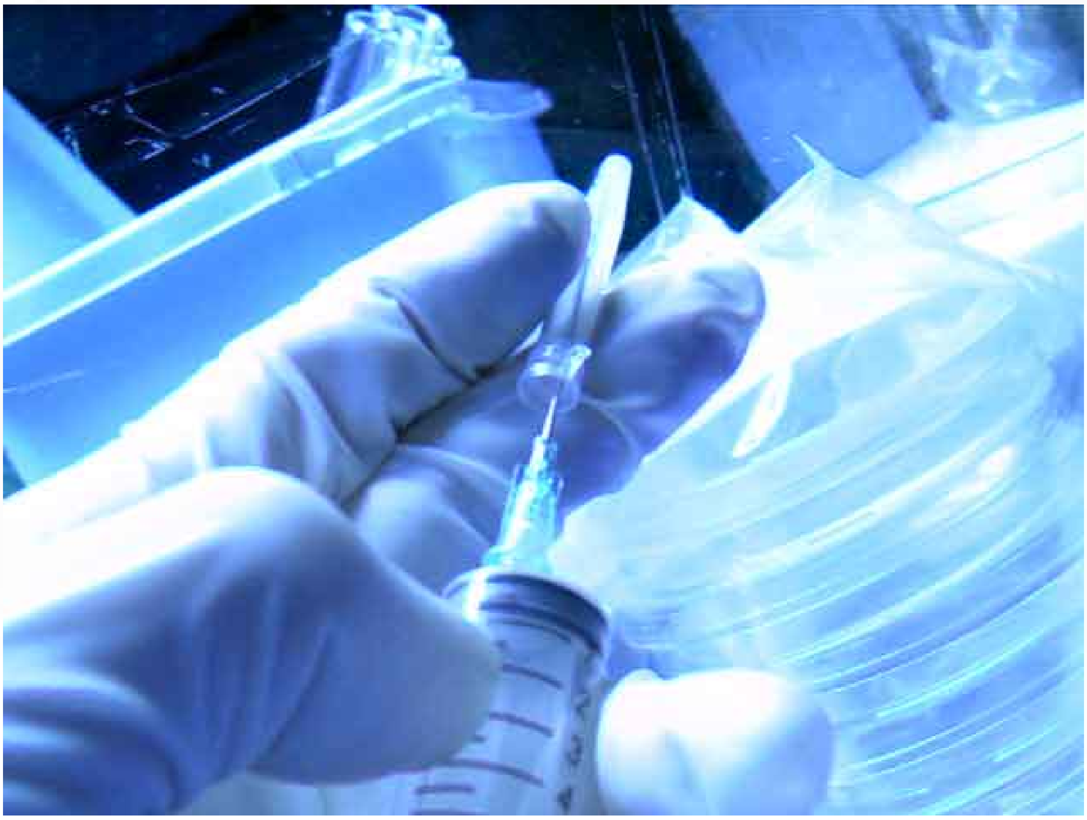
Once suspention is dense enough, stir the flask some more. Now it is time to fill those little ependorfers. This can be tricky and requires still hand and patience (side note: it is a nice workout for those of you that are deep int E7D o the zen or yoga to improve mind concentration).

Remove the stick from the end of dipping tube and fill it with mycellium suspension. Then slowly dip the suspension into ependorfers all the way up, be carefull to remove all air bubbles (tricky thing due to capillarity) until they are full like this:



... and seal them. If they are not filled all the way up and above some air can remain inside.

Well. This is it. After some practice you'll find the method quick and easy to perform. 0.5 mL is enough to inoculate a lot of fresh Petris and more than enough to start a single 750 mL jar with grain spawn. Also, since PP ependorfers will not break easly and are small enough and mycellium stored like this can sustain a lot of temperature fluctation, they are great for discreet mailing in almost any envelope. (a hint: they will fit into any cheap pen and if X-rayed it will seem like spare ink container) The reciever does not need a pipette or anything. A sterile needle and syringe will do. Just wipe the plug of the ependorf with some alcohol and stick a needle through and pull the syringe bat like this:



Wishing you all healthy crops.

The Metabolic Pathway of Psilocybin Production

by

micro

original source: http://www.shroomery.org/6227/The-Metabolic-Pathway-of-Psilocybin-Production

Metabolic pathways are important to understand when you are trying to produce a certain chemical from a living organism. Psilocybin is produced starting from chorismate, which is produced on the Shikimic Acid pathway. The Shikimate pathway is present in many different plants, fungi and bacteria, but is not present in animals, and is important for producing many different aromatic compounds, including many antibiotics and the tryptamine-based psychedelic drugs, like DMT, the ergot alkaloids and psilocybin. It is extremely important to know the metabolic pathway in order to do any scientific investigation of its production. The idea of this paper is simply to list all of the products and enzymes so one can look them up, if the need arises.

The first main step is the Shikimate pathway which is carried out in the cytosol of the fungal cells. This produces a product called chorismate which is used for the synthesis of folate, ubiquinone, phenylalanine, tyrosine and tryptophan. This pathway starts off with phosphoenolpyruvate, a product of glycolysis, and erythrose 4-phosphate, a product of the pentose phosphate pathway (a byproduct produced via a transketolase enzyme) that acts as a phosphate donor. These pathways are illustrated below. The pathway looks like this, starting with the starting products and then continuing with the enzyme on the right, which produces the next product:

Product	Enzyme
Phosphoenolpyruvate + erythrose 4-phosphate	DHAP Synthase =>
7P-2-dehydro-3-deoxy-d-arabino-heptonate	3-dehydroquinate synthase =>
Dehydroquinate	3-dehydroquinate dehydratase =>
Dehydroshikimate	Shikimate 5-dehydrogenase =>
Skikimate	Shikimate kinase =>
Shikimate-3-P	EPSP synthase =>
5-0-(1-carboxyvinyl)-3-phosphoshikimate	Chorismate synthase =>
Chorismate	

Chorismate can now go to any of 5 different pathways; we're concerned with the tryptophan pathway:

Product	Enzyme
Chorismate	2-deoxyisochorismate synthase =>
2-amino-2-deoxychorismate	Anthranilate synthase =>
Anthranilate	Anthranylate-phosphoribosyl transferase =>
N-(5'phosphoribosyl) anthranilate	N-(5'phosphoribosyl) anthranilate isomerase =>
Enol-1-0 carboxyphenylamino-1-deoxyribulose phosphate	indole-3-glycerolphosphate synthase =>
Indole-3-glycerolphosphate	Tryptophan synthase (a subunit) =>
Indole	Tryptophan synthase (b subunit) =>
Tryptophan	Tryptophan decarboxylase =>
Tryptamine	

Tryptophan is decarboxylated via an enzyme called tryptophan decarboxylase to form tryptamine. This is the last major step in the pathway that is significantly inhibited by a self-feedback downregulation mechanism, meaning that if too much of a particular substance is in the cells the enzyme will stop converting tryptophan to tryptamine. Here is a list of some inhibitors of tryptophan decarboxylase (copied from a paper at the lycaeum; unknown URL:)

Inhibition of Tryptophan Decarboxylase

Type of inhibition	Inhibitor	% Inhibition
Competitive Inhibitors:	N,N-dimethyltryptamine	65
	Indole-3-acetic acid	60
(Unknown Mechanism:)	Tryptamine	62
	5-Hydroxytryptamine	45
	Indole-3-acetaldehyde	50
Non-Inhibitors:	5-Methoxy-N,N-dimethyltryptamine	(0)
	5-Methoxytryptamine	(0)
	Indole-3-pyruvic acid	(0)

The pathway for the conversion of tryptamine to psilocybin and psilocin is still unclear, but it is proposed that there are many different steps, since the phosphorylated intermediates baeocystin and norbaeocystin are produced, in addition to psilocybin, which is most likely produced via one phosphorylase enzyme from psilocin. The experiments by Gartz *et al*. regarding an addition of tryptamine hcl to the substrate showed an increase in psilocin levels compared to psilocybin which suggests the downregulation of a phosphorylase enzyme at this step, and also provides some possible insight to the evolution of psilocybin in mushrooms.

PRIMARY PATHWAYS:

Both of the starting materials of the Shikimic Acid Pathway, phosphoenolpyruvate and erythrose 4-phosphate, are ultimately a product of glucose. Glucose is phosphorylated by ATP, which loses a phosphoryl group to glucose to become ADP:

The Glucose 6-P is then used on two different pathways, glycolysis and the Pentose Phosphate Pathway to produce our two starting materials.

Phosphoenolpyruvate is produced as a byproduct of glycolysis:

....and Erythrose-4-P is produced as a biproduct of the Pentose Phosphate Pathway:

References:

1. (My Notes)
2. Roberts CW, Roberts F, Lyons RE, Kirisits MJ, Mui EJ, Finnerty J, Johnson JJ, Ferguson DJ, Coggins JR, Krell T, Coombs GH, Milhous WK, Kyle DE, Tzipori S, Barnwell J, Dame JB, Carlton J, McLeod R.
   The shikimate pathway and its branches in apicomplexan parasites.
   J Infect Dis. 2002 Feb 15;185 Suppl 1:S25-36
3. Niels Jensen
   Attempted molecular loning of enzymes from the psilocybin biosynthesis pathway in Psilocybe tampanensis
4. The Lycaeum
5. http://www.rpi.edu/dept/bcbp/molbiochem/MBWeb/mb1/part2/glycolysis.htm
6. http://www.sbuniv.edu/~ggray.wh.bol/tutorial/pentose/step2.htm
7. http://www.gwu.edu/~mpb/pentphos.htm

Charcoal's Secret

by

JaComet

original source: http://www.shroomery.org/forums/showflat.php/Number/6024742

Somewhere in Stamets' work, and possibly on the boards, I noted that charcoal may be helpful where spores are difficult to start. Adding charcoal to culture media seems to be beneficial. I don't know what it does but I do know a bit about charcoals.

Charcoal has a secret. Not a secret really, just largely unrecognized outside of Asia. Some charcoal gives off far-infrared radiation. Not just while it is burning, it radiates all the time. Far-infrared = thermal radiation. Some charcoals even emit negative ions. With this in mind, let's look at how we may employ it's unique properties.

First let's look at regular and "activated" charcoal.

Regular charcoal is produced where hardwoods, sawdust, bone char, coconut shells, peat, coal or petroleum coke are fired in an enclosed burning environment. Restricting the amount of air provided to the burn runs off the water and volatile organic constituents in the wood, leaving blackened chunks of carbon mixed with traces of minerals from the original material.

Activated charcoal is made by taking regular charcoal and re-firing it with introduction of air blast, steam, oxygen or other gases to corrode the interior cell structure, creating a more porous structure. Activated charcoal attracts and retains organic matter run through it, as well as mechanically trapping particulate matter. These properties make it useful in a variety of applications, notably in water filtering.

Now let's look at infrared radiation and wavelengths.

When regular charcoal is burnt infrared radiation is released. This penetrating thermal radiation is what makes charcoal grilled foods different from flame grilled or broiled. The food is cooked on the inside by the radiation, reducing cooking time and sealing in juices as the out side is sealed by charring.

As stated earlier some charcoals give off infrared radiation all the time. Activated charcoal may give off infrared. I don't know. I expect this property may be dependent on the starting materials, but I've not found any information in these regards.

Now here is where things get interesting.

+++

Journal of Chemical Engineering of Japan, vol 25 no 3 pp 275-281(1992) [Japanese]

EFFECT OF FAR-INFRARED IRRADIATION ON PASTEURIZATION OF BACTERIA SUSPENDED IN LIQUID MEDIUM BELOW LETHAL TEMPERATURE

ATSUSHI HASHIMOTO, JUN SAWAI, HIDEO IGARASHI AND MASARU SHIMIZU

Department of Chemical Engineering, Division of Chemical & Biological Science and Techr Tokyo University of Agriculture & Technology, Tokyo 184

The purpose of this study is to examine the influence of far-infrared irradiation on pasteurization of bacteria suspended in liquid medium below the lethal temperature. Under this condition, Escherichia coli and Staphylococcus aureus are injured and killed by far-infrared irradiation. With increase in irradiation power and with decrease in depth of the suspension, the ratio of the number of injured cells to the number of viable cells becomes higher, and the number of viable cells becomes smaller. Moreover, the pasteurization effect can be enhanced by raising the bulk temperature of the suspension. By estimating the temperature distribution within the suspension, it is suggested that the test bacteria are injured and killed in the very thin domain near the surface of the suspension.

+++

Journal of Chemical Engineering of Japan, vol 25 no 6 pp 666-671(1992) [Japanese]

FAR-INFRARED IRRADIATION EFFECT ON PASTEURIZATION OF BACTERIA ON OR WITHIN WET-SOLID MEDIUM

ATSUSHI HASHIMOTO, HIDEO IGARASHF AND MASARU SHIMIZU

Department of Chemical Engineering, Division of Chemical & Biological Science and Technology, Tokyo University of Agriculture & Technology, Tokyo 184

The present purpose is to study the influence of far-infrared irradiation on pasteurization of Escherichia coli and Staphylococcus aureus on or within a model for wet-solid food. Agar medium was used as the food model. By determining the thermal resistances of the test bacteria, the pasteurization effect of far-infrared irradiation (radiative heating) was compared with that of hot-air heating (a conventional method) from the viewpoint of thermal death kinetics. It was found experimentally that far-infrared irradiation is more effective than hot-air heating for the test bacteria on the agar-plate. Moreover, it is suggested that the surface temperature of the pasteurization sample irradiated by far-infrared radiation is higher than that measured by the thermocouples.

+++

So, what does all this have to do with anything?

Heated and evaporated water readily absorbs infrared radiant energy at 3, 4.5 and 6 µm.
I suggest this radiation can affect water in bacterial cells, killing them.

Enter Bamboo Charcoal!

Bamboo Charcoal has the possibly unique properties of emitting infrared rays in the range between 4 and 16µm, even at room temperature, along with negative ions and canceling electromagnetic (EM) radiation. Negative ions also disable or kill bacteria.

A Russian research team headed by A L. Tchijevski found an exponential bacteria decay rate of 78 percent per minute in negatively charged air environments. The team concluded negative ions killed the bacteria. Other studies indicate negative ions also kill or disable viruses and fungus spores.

But why are ions therapeutic? Partly because they kill germs. Back in the 1930s. a Russian team headed by A L. Tchijevski found that large ion doses of either polarity retarded bacteria colony formation on plates. Ionization also sterilized enclosed air. Latter experiments duplicating Tchijevski's work noted an exponential bacteria decay rate of 23 percent per minute for untreated air 34 percent per minute for air with pos-ions. and 78 percent per minute for negatively charged air. They concluded that the pos-ion decay rate was due to simple bonding or the ions with the bacteria, whereas the neg-ions actually killed them.

Some studies suggest that negative ions also have a biological effect on bacteria and viruses, killing them on contact in many cases.

Bamboo Charcoal is much more porous than other types, typically reaching surface areas of 300 to 700 square meters per gram. Wood charcoals area is around 30 square meters per gram. Coconut shell is somewhat higher. Bamboo Charcoal therefore is superior in many respects for filtration and absorption.

Bamboo Charcoal is high density and is very porous. It soaks up and releases moisture helping to maintain equilibrium. It is also a rich source of trace minerals, which it releases slowly to water.

Biological organisms absorb infrared in the 8-14 µm range utilizing the energy for a variety of metabolic processes.

Enough for now. Ponder how you might add this knowledge to your culture techniques, keeping in mind that liquid cultures may benefit where spores may not.

More to come as my trials continue.

Remember you heard it here first.

Mapping the Mycelial Network

by

John W. Allen, Jochen Gartz and Gaston Guzmán

The Resonance Project
Issue 2, Winter 1997/98

original source: http://www.erowid.org/plants/mushrooms/references/other/1997_allen_resproject_1.shtml

It's only been forty years since R. Gordon Wasson rediscovered the traditional use of hallucinogenic fungi in Mesoamerica, but in that time more than 160 species of psilocybian mushrooms have been identified worldwide (Allen, Gartz & Guzmán, 1998 [1992]). In 1957, only seven species were recognized within the scientific community, and outside of Mesoamerica their existence was known to only a small handful of scientists who investigated their restricted use among several groups of indigenous peoples native to Southern Mexico; primarily within the Mexican state of Oaxaca.

To this day, researchers have identified the existence of hallucinogenic psilocybian mushrooms as far north as Alaska and Siberia in the Northern Hemisphere, and as far south as Chile and Australia in the austral floral zone. Psilocybian mushrooms grow from California in the western United States to China and Japan in the east. Since the ecological and geographical distribution of the more than 160 species of hallucinogenic mushrooms is so vast and diverse, we have decided to present a geographical table of their distribution.

The following article presents a detailed listing of the various species of mushrooms which can be found from state to state in both the United States and Canada. A country by country listing of global distribution is also in the works, and will be available soon. References and more information are given at the end of the article.

UNITED STATES

Alabama

Gymnopilus spectabilis (Hesler, 1969)
Psilocybe caerulescens Murr. (Guzmán, 1983)
Psilocybe cubensis

Alaska

Amanita muscaria
Psilocybe cyanescens Wakefield. (Guzmán, 1983; Stamets, 1996)
Panaeolus ater (Lange) Kühner & Romagnesi. (Pollock, 1976)
Panaeolus subbalteatus Berkeley & Broome. (Miller et al., 1982)

Arizona

Gymnopilus sapineus
Gymnopilus spectabilis

California (San Francisco to Oregon)

Amanita muscaria
Copelandia cyanescens (Arora, 1986)
Copelandia tropicalis
Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)
Gymnopilus liquiritae
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus sapineus
Gymnopilus spectabilis
Hypholoma popperiana
Panaeolus fimicola
Panaeolus papilionaceus
Psilocybe azurescens Stamets Gartz. (Stamets, 1996). (Introduced)
Psilocybe baeocystis
Psilocybe cyanescens Wakefield. (Guzmán, 1983).
Psilocybe cyanofibrillosa
Psilocybe pelliculosa (Smith) Singer & Smith. (Guzmán, 1983)
Psilocybe semilanceata (Fr.) Kummer
Psilocybe stuntzii Guzmán & Ott. (Guzmán, 1983)

Colorado

Conocybe cyanopus (Atkins) Kuhner. (Stamets, 1993)
Gymnopilus sapineus
Panaeolus papilionaceus

Florida

Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus sapineus
Copelandia cyanescens
Copelandia westii
Psilocybe caerulescens Murr. (Jacobs, 1975)
Psilocybe cubensis (Earle) Singer. (Guzmán, 1983)
Psilocybe mammilata (Murr.) Smith. (Guzmán, 1983)
Psilocybe tampanensis Guzmán & Pollock. (Guzmán, 1983)

Georgia

Psilocybe weilii nom. prov. Guzmán, Tapia & Stamets. (Stamets, 1996)

Hawaii

Copelandia cyanesens (Bk. & Br.) Singer. (Merlin & Allen, 1993)
Copelandia tropicalis (Ola'h) Singer & Weeks. (Merlin & Allen, 1993)
Copelandia cambodginiensis (Ola'h et Heim) Singer & Weeks. (Merlin & Allen, 1993)
Copelandia bispora Malencon & Bertault. (Merlin & Allen, 1993)
Copelandia anomala Murrill. (Merlin & Allen, 1993)
Panaeolus subbalteatus (Bk. & Br.) Sacc. (Merlin & Allen, 1993)

Idaho

Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)
Gymnopilus liquiritae
Gymnopilus luteofius
Gymnopilus sapineus
Gymnopilus spectabilis
Panaeolus subbalteatus Berkeley & Broome
Psilocybe fimetaria (Orton) Watling. (Guzmán, 1983)
Psilocybe pelliculosa Singer & Smith. (Guzmán, 1983)
Psilocybe silvatica (Peck) Singer & Smith. (Guzmán, 1983)

Illinois

Pluteus salicinus (Pers.:Fr.) Kummer. (Gartz, 1996)

Indiana

Panaeolus papilionaceus (Gerhardt, 1996)

Louisiana

Copelandia cyanescens (Bk. & Br.) Singer. (Stamets, 1996)
Psilocybe caerulescens Murr. (Jacobs, 1975)
Psilocybe cubensis

Maine

Gymnopilus liquiritae
Gymnopilus sapineus
Gymnopilus spectabilis
Panaeolus papillionaceus (Bull.:Fr.) Quel. (Gartz, 1996)
Psilocybe caerulipes (Peck) Sacc. (Singer & Smith, 1958)

Maryland

Panaeolus subbalteatus Berkeley & Broome. (Singer, et al., 1958)

Massachusetts

Gymnopilus sapineus
Gymnopilus spectabilis (Fr.) Smith = Gymnopilus junonius (Fr.) Orton. (Pollock, 1976)
Panaeolus papilionaceus
Panaeolus subbalteatus Berkeley & Broome. (Singer, et al., 1958)

Michigan

Conocybe smithii Watling. (Stamets, 1993)
Gymnopilus aeruginosus (Peck) Singer. (Hatfield et al., 1978)
Gymnopilus liquiritae
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus luteus (Peck) Hesler. (Hatfield et al., 1978)
Gymnopilus sapineus
Gymnopilus spectabilis
Gymnopilus validipes (Peck) Hesler. (Hatfield et al., 1978)
Panaeolus subbalteatus Berkeley & Broome. (Singer et al., 1958)
Psilocybe caerulipes (Peck) Sacc. (Guzmán, 1983)
Psilocybe liniformans var. americana Guzmán & Stamets. (Guzmán, 1983)
Psilocybe silvatica (Peck) Singer & Smith. (Stamets, 1996)

Mississippi

Psilocybe caerulescens Murr. (Jacobs, 1975)
Psilocybe cubensis
Psilocybe tampanensis

Missouri

Gymnopilus sapineus
Panaeolus papilionaceus
Panaeolus subbalteatus Berkeley & Broome. (Pollock, 1976)

New hampshire

Gymnopilus liquiritae
Gymnopilus sapineus
Gymnopilus spectabilis

New Jersey

Psilocybe graveolens Peck. (Guzmán, 1983)

New Mexico

Gymnopilus liquiritae
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus sapineus
Gymnopilus spectabilis
Panaeolus papilionaceus
Psilocybe azurescens Stamets Gartz. (Stamets, 1996). (Introduced)

New York

Conocybe cyanopus (Atk.) Kühn. (Gartz, 1996)
Gymnopilus liquiritae
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus luteus
Gymnopilus spectabilis
Gymnopilus validipes (Peck) Hesler. (Hesler, 1969)
Panaeolus fimicola
Panaeolus papillionaceus (Bull. :Fr.) Quel. (Gartz, 1996)
Panaeolus subbalteatus
Psilocybe caerulipes (Peck) Sacc. (Guzmán, 1983)
Psilocybe semilanceata (Fr. :Secr.) Kummer. (Guzmán, 1983)
Psilocybe silvatica (Peck) Singer & Smith. (Stamets, 1996)

North Carolina

Gymnopilus aeruginosus
Gymnopilus liquiritae
Gymnopilus luteofolius
Gymnopilus spectabilis
Psilocybe caerulipes (Peck) Sacc. (Singer & Smith, 1958)

Ohio

Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)
Gymnopilus luteofolius
Gymnopilus spectabilis (Fr.) Smith = Gymnopilus junonius (Fr.) Orton
Panaeolus subbalteatus Berkeley & Broome. (Pollock, 1976)
Psilocybe azurescens (Stamets, 1996) (Introduced)
Psilocybe caerulipes (Peck) Sacc. (Guzmán, 1983; Smith & Weber-Smith, 1980)

Oregon

Amanita muscaria
Amanita pantherina
Conocybe cyanopus (Atkins) Kuhner
Conocybe smithii Watling. (Stamets, 1996)
Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)
Gymnopilus liquiritae
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus sapineus
Gymnopilus spectabilis
Gymnopilus viridans
Panaeolus castaneifolius
Panaeolus subbalteatus Berkeley & Broome. (Ott & Guzmán, 1976)
Psilocybe azurescens
Psilocybe baeocystis Singer & Smith. (Guzmán, 1983)
Psilocybe cyanafibrillosa Guzmán & Stamets
Psilocybe cyanescens Wakefield. (Guzmán, 1983)
Psilocybe fimetaria (Orton) Watling. (Stamets, 1996)
Psilocybe liniformans var. americana Guzmán & Stamets. (Guzmán, 1983)
Psilocybe pelliculosa (Smith) Singer & Smith. (Guzmán, 1983)
Psilocybe semilanceata (Fr.) Kummer. (Guzmán, 1983)
Psilocybe sierrae
Psilocybe silvatica (Peck) Singer & Smith. (Guzmán, 1983)
Psilocybe strictipes Singer & Smith = Psilocybe callosa. (Stamets, 1996)
Psilocybe stuntzii Guzmán & Ott. (Guzmán, 1983)
Psilocybe subfimetaria Guzmán & Smith. (Guzmán, 1983)

Pennsylvania

Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)

Tennessee

Gymnopilus aeruginosus (Peck) Singer. (Stamets, 1996)
Gymnopilus liquiritae
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus luteus
Gymnopilus sapineus
Gymnopilus spectabilis
Panaeolus fimicola
Panaeolus papilionaceus
Psilocybe caerulipes (Peck) Sacc. (Guzmán, 1983)

Texas

Amanita muscaria
Copelandia cambodgeniensis
Gymnopilus aeruginosus
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Gymnopilus luteoviridisrle Singer. (Alexopolous & Jackson, 1976)
Gymnopilus sapineus
Gymnopilus spectabilis
Panaeolus subbalteatus
Psilocybe cubensis

Vermont

Gymnopilus spectabilis (Stamets & Gartz, 1996)
Gymnopilus liquiritae
Gymnoplilus spaineus
Psilocybe azurescens (Stamets, 1996) (Introduced)

Washington

Amanita muscaria
Amanita pantherina
Conocybe cyanopus (Atkins) Kuhner. (Stamets, 1996)
Conocybe smithii Watling. (Stamets, 1996)
Gymnopilus aeruginosus (Peck) Singer. (Hatfield et al., 1978)
Gymnopilus brandlei (Hesler, 1969)
Gymnopilus luteofolius
Gymnopilus sapineus
Gymnopilus spectabilis
Gymnopilus viridans Murrill. (Ammirati et al., 1985)
Mycena cyanorhizza
Panaeolus fimicola
Panaeolus papilionaceus
Panaeolus subbalteatus Berkeley & Broome
Psilocybe azurescens
Psilocybe beocystis Singer & Smith. (Guzmán, 1983)
Psilocybe cyanafibrillosa Guzmán & Stamets. (Guzmán, 1983)
Psilocybe cyanescens Wakefield. (Guzmán, 1983)
Psilocybe fimetaria (Orton) Watling. (Guzmán, 1983)
Psilocybe liniformans var. americana Guzmán & Stamets. (Guzmán, 1983)
Psilocybe pelliculosa (Smith) Singer & Smith. (Guzmán, 1983)
Psilocybe semilanceata (Fr.) Kummer. (Guzmán, 1983)
Psilocybe silvatica (Peck) Singer & Smith. (Guzmán, 1983)
Psilocybe strictipes Singer & Smith = Psilocybe callosa. (Stamets, 1996)
Psilocybe stuntzii Guzmán & Ott. (Guzmán, 1983)

Wisconsin

Psilocybe azurescens Stamets Gartz (Stamets, 1996). (Introduced)

Wyoming

Gymnopilus sapineus (Hesler, 1969)
Gymnopilus liquiritae (Hesler, 1969)
Gymnopolus spectabilis (Hesler, 1969)

CANADA

Alberta

Amanita muscaria (Ammirati et al., 1985)
Conocybe kuehneriana (Schalwijk-Barendsen)
Gymnopilus luteofolius (Schalwijk-Barendsen)
Gymnopilus sapineus (Schalwijk-Barendsen)
Gymnopilus spectabilis (Schalwijk-Barendsen)
Panaeolus subbalteatus (Schalwijk-Barendsen)

British Columbia

Amanita muscaria (Ammirati et al., 1985)
Amanita pantherina (Ammirati et al., 1985)
Conocybe cyanopus (Atkins) Kuhner. (Stamets, 1993)
Gymnopilus luteofolius (Peck) Singer. (Stamets, 1996)
Psilocybe baeocystis Singer & Smith. (Guzmán, 1983)
Psilocybe cyanafibrillosa Guzmán & Stamets
Psilocybe cyanescens Wakefield. (Guzmán, 1983)
Psilocybe fimetaria (Orton) Watling. (Guzmán, 1983)
Psilocybe pelliculosa (Smith) Singer & Smith. (Guzmán, 1983)
Psilocybe semilanceata (Fr.) Kummer. (Guzmán, 1983)
Psilocybe sierrae (Stamets, 1996; Guzmán, 1983)
Psilocybe silvatica (Peck) Singer & Smith
Psilocybe strictipes Singer & Smith = Psilocybe callosa. (Stamets, 1996)
Psilocybe stuntzii Guzmán & Ott. (Guzmán, 1983)
Psilocybe subfimetaria Guzmán & Smith. (Guzmán, 1983)
Panaeolus subbalteatus Berkeley & Broome

Newfoundland

Psilocybe semilanceata (Redhead, 1989)

New Brunswick

Psilocybe fimetaria (Stamets, 1996)
Psilocybe semilanceata (Redhead, 1989)

Northwest Territory

Amanita muscaria (Ammirati et al., 1985)

Nova Scotia

Amanita muscaria (Ammirati et al., 1985)
Gymnopilus spectabilis (Hesler, 1969)
Psilocybe semilanceata (Redhead, 1989)

Ontario

Amanita muscaria
Gymnopilus spectabilis
Gymnopilus viridans Murrill. (Hatfield et al., 1978)
Psilocybe silvatica (Peck) Singer & Smith. (Singer & Smith, 1958)
Panaeolus subbalteatus Berkeley & Broome. (Pollock, 1976)
Psilocybe caerulipes
Psilocybe silvatica

Prince Edward Island

Psilocybe semilanceata

Quebec

Amanita muscaria
Panaeolus subbalteatus Berkeley & Broome. (Pollock, 1976)
Psilocybe caerulipes (Peck) Sacc. (Singer & Smith, 1958)
Psilocybe quebecensis Ola'h & Heim. (Guzmán, 1983)
Psilocybe semilanceata

Saskatchewan

Amanita muscaria

Yukon Territory

Amanita muscria

Greenland

Panaeolus ater
Panaeolus papilionaceus

The psilometric scale of comparative potency of selected Psilocybe mushrooms

original source: http://www.erowid.org/plants/mushrooms/mushrooms_info4.shtml

SPECIES	PSILOCYBIN(%)	PSILOCYN(%)	BAEOCYSTIN(%)	REFERENCE
P. azurenscens	1,78	0,38	0,35	Stamets and Gartz 1995
P. bohemica	1,34	0,11	0,02	Gartz and Muller 1989; Gartz (1994)
P. semilanceata	0,98	0,02	0,36	Gartz 1994
P. baeocystis	0,85	0,59	0,10	Repke et al. 1977; Beug and Bigwood 1982(b)
P. cyanescens	0,85	0,36	0,03	Stijve and Kuyper 1985; Repke et al. 1977
P. tampanensis	0,68	0,32	n/a	Gartz 1994
P. cubensis	0,63	0,60	0,025	Gartz 1994; Stijve and de Meijer 1993
P. weilii	0,61	0,27	0,05	
P. hoogshagenii	0,60	0,10	n/a	Heim and Hofmann 1958
P. stuntzii	0,36	0,12	0,02	Beug and Bigwood 1982(b); Repke et al. 1977
P. cyanofibrillosa	0,21	0,04	n/a	Stamets et al. 1980
P. liniformans	0,16	n/d	0,005	Stijve and Kuyper

Psilocybin Mushrooms of the World, Paul Stamets

Magic Mushroom Dosage Calculator

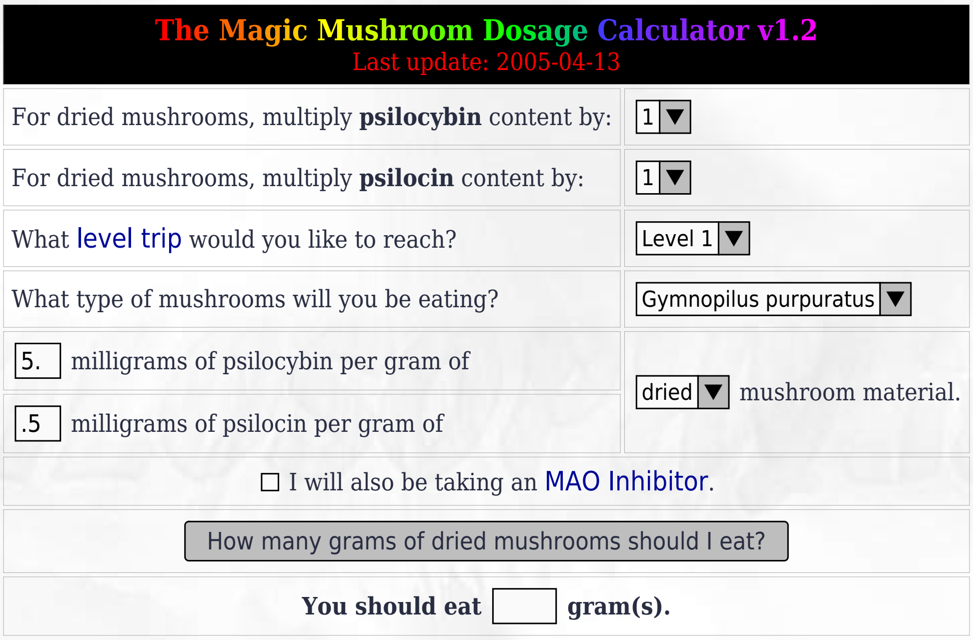
by

Ythan Burstein

original source: http://www.shroomery.org/6257/Magic-Mushroom-Dosage-Calculator

I wrote this calculator in JavaScript to help figure out how many mushrooms to eat to reach the desired trip strength. I don't have a secret unifying formula; I don't think one exists for mushrooms. I did, though, tweak a formula until it seemed accurate, and then I plugged in variables. I also left it open to user modification, so you can play with the values so it's customized to your unique reaction to the mushrooms.

Here's a rundown of what all the input fields are for; you probably won't need to modify most of them.



The Magic Mushroom Dosage Calculator v1.2
Last update: 2005-04-13

For dried mushrooms, multiply **psilocybin** content by:	1
For dried mushrooms, multiply **psilocin** content by:	1
What level trip would you like to reach?	Level 1
What type of mushrooms will you be eating?	Gymnopilus purpuratus
5. milligrams of psilocybin per gram of	dried mushroom material.
.5 milligrams of psilocin per gram of	

☐ I will also be taking an MAO Inhibitor.

You should eat ____ **gram(s).**

For dried mushrooms, multiply psilocybin content by: This allows you to specify the deterioration which the psilocybin in your mushrooms experiences when it's dried. If you suspect your mushrooms lose half their psilocybin when they're dried, set this value to ".5". If you suspect they don't lose any at all, set this value to "1". The default value is ".8", which is a median. If you take extra-special care when drying and storing your mushrooms, you'll want to use a higher number. If you dried your mushrooms by putting them in the oven at 250° for an hour, use a lower number.

For dried mushrooms, multiply psilocin content by: This is exactly the same as the psilocybin input box, only it changes the deterioration rate of psilocin. Unlike its more stable cousin, psilocin tends to break down pretty quickly no matter how careful you are about preserving your mushrooms. ".5" is the default, and unless you freeze-dry your mushrooms and store them with an industrial grade vacuum packager, you'll probably want to leave it where it is.

What level trip would you like to reach? Read the trip level descriptions and decide. You should note that it's not a straight line; if you eat 20 grams wet to reach level 2, that doesn't neccessarily mean you'll need 40 to get to level 4.

What type of mushrooms will you be eating? These are really just psilocybin and psilocin "presets". Choose the type of mushroom you'll be eating and it modifies the value of the psiloc(yb)in fields for that mushroom. The values are compiled from many sources on the internet and care was taken the values represent an average potency of many samples whenever the data was available.

Milligrams of psilocybin per gram: This displays the content of psilocybin in the mushroom you currently have selected in mg/g fresh material. If you think that the value is incorrect (and it quite possibly may be since the same species of mushroom may have up to tenfold fluctuations in its psilocybin content), you can enter a new value.

Milligrams of psilocin per gram: The same, only for psilocin.

Will you be eating fresh or dried mushrooms? Well, which kind will you be eating? If you select "dried", the Calculator applies the deterioration values to the psilocybin and psilocin content of the mushroom and compensates for the change in weight due to dehydration. Mushrooms are ~90% water when fresh, which means there will be a big difference between how much dry mushroom material and how much wet mushroom material you'll have to eat to achieve the same trip level.

I will also be taking an MAO Inhibitor. For people too lazy to divide their total by two, check this box if you take a monoamine oxidase inhibitor before eating your mushrooms.

Okay, so that's it for the instructions, but there's one last thing I want to make clear:
THIS CALCULATOR IS IN NO WAY INTENDED TO GIVE ABSOLUTELY DEFINITIVE ANSWERS!
You can have two people identical in weight eat the same amount of mushrooms, and one will trip for hours and one will hardly feel a buzz. I think the values you get by using this calculator should be pretty accurate, since I've tweaked it pretty carefully, but you should really determine your dosage the old-fasioned way, by starting small and working your way up. If you don't want to waste the time or the shrooms on that, then **BE CAREFUL** with any value this calculator spits out.

Alright. Have fun.

The following comes from here.

Level 1
This level produces a mild "stoning" effect, with some visual enhancement (i.e. brighter colours, etcetera). Some short term memory anomalies. Left/right brain communication changes causing music to sound "wider".

Level 2
Bright colors, and visuals (i.e. things start to move and breathe), some 2 dimensional patterns become apparent upon shutting eyes. Confused or reminiscent thoughts. Change of short term memory leads to continual distractive thought patterns. Vast increase in creativity becomes apparent as the natural brain filter is bypassed.

Level 3
Very obvious visuals, everything looking curved and/or warped patterns and kaleidoscopes seen on walls, faces etc. Some mild hallucinations such as rivers flowing in wood grained or "mother of pearl" surfaces. Closed eye hallucinations become 3 dimensional. There is some confusion of the senses (i.e. seeing sounds as colors, etcetera). Time distortions and "moments of eternity".

Level 4
Strong hallucinations, i.e. objects morphing into other objects. Destruction or multiple splitting of the ego. (Things start talking to you, or you find that you are feeling contradictory things simultaneously). Some loss of reality. Time becomes meaningless. Out of body experiences and e.s.p. type phenomena. Blending of the senses.

Level 5
Total loss of visual connection with reality. The senses cease to function in the normal way. Total loss of ego. Merging with space, other objects, or the universe. The loss of reality becomes so severe that it defies explanation. The earlier levels are relatively easy to explain in terms of measureable changes in perception and thought patterns. This level is different in that the actual universe within which things are normally perceived, ceases to exist! Satori enlightenment (and other such labels).

The Mushroom Entheogen - The Measure of the Mushroom

by

C.B. Gold

Taken from PM&E Volume Five

(OCR'd by GluckSpilz)

original source: https://www.erowid.org/plants/mushrooms/mushrooms_article2.shtml

Table of Contents:

- **Summary**
- **Subjective and Objective Testing**
  - The Subjective Test
  - Objective Testing
    - *General theory and various detection and measuring schemes*
    - *p-DMAB Test Paper*
    - *The theory behind the reference colorimetric test*
- **Other Potential Chromophores**
- **The Correct Wavelength to Measure the DMAB Chromophore**
- **Light Speeds the Test Reaction**
- **Defining the Extraction Solvent**
- **Sample Weight**
- **Other Influences on the Test**
- **Interpretation of the DMAB Test**
- **The Colorimetric Test**
  - Equipment
  - Chamicals
  - Supplies
    - *Colorimeters*
    - *Balance*
    - *Large borosilicate test tubes*
    - *Matched cuvettes*
    - *Test Tube Holder*
    - *Chemicals*
    - *Plastic sheet*
- **Testing Solutions Preparation**
  - Color development reagent
  - Acetic Acid Extraction Solution
- **The para-Dimethylbenzaldehyde Colorimetric Test**
- **Conclusion**
- **Bibliography**

Summary

The Mushroom Entheogen explores the relationships between hard mycological chemistry and visionary experiences related to psilocybin mushroom use. In PM & E vol. 1 we were presented with optimum harvesting/storage techniques. A study of the bluing reaction with ways to inhibit its onset was presented. In PM & E vol. 2 the relationships between mushroom pretreatment agents and various forms of dehydration were presented, with emphasis on optimum psychoactivity. In PM & E vol. 4 instructions are given for constructing a vacuum dehydration system. HPTLC (high performance thin layer chromatography) comparisons were noted upon samples.

We continue this series with an overview of psilocybin potency testing - both in the laboratory and through implicit meditation and physiological / psychological observation. PM & E is exceptionally proud to bring this installment of The Mushroom Entheogen to our readers. So why do you need to test your psychedelic mushrooms for their potency?

There are two good reasons: either to see the affect of some experimental procedure on the final concentration of the active tryptamines (i.e. psilocybin and psilocin) in the mushrooms (which is pretty much what these articles are about) or more important, to know the subjective intensity of the dosage you may plan to take. You may remember the anecdote from the previous article about my friend who mistakenly took too much mushroom powder. He came very close to needing some medical help, because he thought he was losing his mind.

Neither of us had any idea that we had made a measurement error with our dose of mushrooms and he had taken twice the amount of what would have been a large dose. I ended with about half of a large dose. I was fine but he panicked and the knowledge that I had taken what I thought was the same dose made it even worse, because as far as I was concerned he was being totally irrational.

This extreme example of overdose is more likely to be the rarity. What is more common and frustrating is "under" dosing. If you are like me, a mushroom trip is a special event for which I need to plan the time. With family and job responsibilities I can no longer take a day off on the weekend anytime I feel like it. Too many times I have planned for a day of tripping only to end up with a mild buzz and a loaded feeling, not that altered state of awareness and consciousness which is characteristic of the full mushroom trip. I needed a mushroom testing procedure. Knowing what the active tryptamine concentration is before taking the mushrooms can prevent the possible problem of over or under dosing.

One aim of my research, besides reducing the toxicity of the mushrooms, is to maximize the psilocybin content of the cultivated mushrooms and to stabilize the quantity biosynthesized from flush to flush of a particular strain of P. cubensis by controlling environmental and nutritional factors. In my own research I found that as I experimentally changed these growth-affecting factors, my particular strain's concentration, as measured by the test procedure described at the end of this article, increased by a factor of four or five.

In their research, Bigwood and Beung echo this same variation in the concentration of psilocybin in the controlled cultivation of P. cubensis. But because of their large variation in what they felt was a rigidly controlled growth environment, I am inclined to conclude that they were not controlling all the possible factors which control the growth and biosynthesis of psilocybin. They found that in their own cultivation, concentrations varied by a factor of four and, even worse, specimens from other sources varied as much as ten fold.[4]

An upcoming article, using the results of the mushroom sample testing will show how, by careful control of the mushroom nutritional and environmental growth factors, one can minimize this large flush-to-flush tryptamine (the major molecular grouping in psilocybin/psilocin and other related compounds) concentration variation.

Because of even less environmental and nutritional control, this sample-to-sample variation is further exacerbated if you collect samples from the wild. Besides strain differences (i.e. genetic differences), microenvironmental and growth substrate nutritional differences contribute to large variations between specimens, even collected close together. Christiansen, *et al*. found from their studies of the psilocybin concentration of many different samples of P. semilanceata in Norway, that the content varied by a factor slightly greater than ten.[7]

If ten-fold variations exist between mushrooms of the same species, imagine the potential for variation between different psychedelic genera. Mushrooms which contain the hallucinogenic tryptamines include the genera *Concybe*, *Panaeolus*, *Psilocybe*, and Stropharia.[12] If you are collecting any of these varieties for psychedelic purposes, you may wish to consider a test of their relative strength before taking them. If you plan to take the mushrooms fresh, then with a little experience with one of the field tests described later you will be able to estimate their relative concentration. You can tell not only from the final intensity of color of the reaction but also from the speed with which the sample develops a color.

A final point on the need for a test: if you happen to be someone who buys psychedelic mushrooms, you may want to know just what you are getting for your money. Ideally, if it were legal to sell, a mushroom dealer should be aware of the relative strength of his different batches of mushrooms and should sell the dried mushrooms not by weight but by what is necessary for a moderate-dose trip.

Subjective and Objective Testing

"Okay," you say, "So maybe it would be helpful to be able to test the mushrooms I buy or grow, but I am not a chemist and I want something simple. There are two basic types of testing: subjective and objective. Subjective testing of mushrooms is descriptive. It is easy and cheap and requires only attention to one's own mind, but it does take time.

Objective testing, on the other hand, is quantitative. It is simple, usually quick, repeatable, but can in some procedures, require complex and expensive equipment. Although I have identified two forms of testing, we need both to know the psychedelic effectiveness of an unknown batch of mushrooms or to communicate what our batch of mushrooms will be like to someone else.

The problem with subjective testing is standardizing the method. Because of the vagaries of the mind, one needs to control the set and setting under which one performs his subjective testing. By controlling these two factors, although very difficult at that, one can establish a common reaction (e.g. degree of energy, quantity of hallucinations, their colors and shapes, the ease of feeling at-one with external objects or concepts, etc.) to a standardized dose. This reaction can be the gauge which one uses to compare all other subjective tests. This subjective response to a standardized dose will help one to know how much to take later.

The problem with objective testing is that no matter what value of concentration (usually expressed in mg of psilocybin/ gr. of mushroom) one finally arrives at from his test, it does not tell him what the subjective experience will be like. To know what the subjective experience is, one still needs to take the psychedelic. By doing this a few times for various concentration levels, one can extrapolate a subjective intensity value from an unfamiliar objective test value, thus dispensing with the need for subjective testing.

The advantage of having an objective test concentration value is that it can communicate what the personal experience will be like to anyone who has taken the time to compare several batches of mushrooms subjectively after finding an objective test concentration value for each batch. By comparing their experiences with a few corresponding numerical values, one can infer from a new objective test value the intensity of the personal experience when taking an unknown batch of mushrooms.

The subjective effects may vary considerably from one individual to another but it is the intensity and duration which will change linearly with the increase in the objective test value.

Subjective tests need to be done only a few times (and recorded for future comparisons) when comparing different concentration levels of mushroom strengths, after which you can rely solely on the objective test for evaluating new samples of mushrooms. Whereas, if one opts to use the subjective test only, then one will need to test each batch by actually taking a small, standardized dose. Then from this tedious evaluation one can determine the amount needed for whatever level of tripping one wishes to reach later.

Besides the problem of taking a sample dose for each and every batch of mushrooms, the subjective test has another difficulty when used alone. Its results can be difficult to communicate to someone else because the phenomenal experience may vary radically from one individual to another. For instance, someone may describe a reaction to a five gram mushroom trip as giving him a feeling of strong sexual energy with a keen awareness of his physical self.

Whereas, you may take the very same mushroom powder and even expect and perhaps look forward to a similar reaction, only to experience a very introspective trip in which the last thing on your mind is sex. The objective test value allows a means of communicating the intensity of the mushroom trip without describing the experience it evoked. By itself subjective testing has its problems, but when supplemented with objective, quantitative testing, it can become a predictive tool for us to use. And also, by itself, objective testing conveys no real meaning to us about the subjective nature of the trip. For the reason that the objective test tells us no personally valid information, one can conclude that the foundation for any quantitative test is our own subjective testing.

I have used the following procedures and guidelines in my own subjective testing. Use your own guidelines, but the primary rule is to watch the effects of the psychedelic on your body and mind. It helps to know your mind well before evaluating the changes caused by a psychedelic. The best way to understand your own mind is to regularly practice some form of mental meditation techniques in which the emphasis is on alert consciousness in an ever-increasingly calm mind.

The Subjective Test

- One can argue about the effects of set and setting on the psychedelic experience, but no matter the outcome of the argument one generally does have more physical effects, greater duration and depth of the trip with ever-increasing doses of psychedelics. Observe these differences in the trip's length and depth for different amounts of mushroom, preferably from the same mixture of mushroom powder (all properly stored so that the interval between tests does not degrade the quality of the mushroom).
- Observe your mind with little or no other sensory inputs during the trip. The best way to do this is to close your eyes or be in complete darkness, plug your ears or be in an absolutely quiet environment and lie or sit completely still. After sitting or lying like this for a few minutes, notice the intensity of the colors in the mind's eye or projected in the dark. Observe the sharpness of the edges and forms. Is the nature of the forms benign or malevolent? Do you experience dreamy hallucinations or patterns? Is your mind clear or dreamy or sleepy?
- Observe the nature of your perceptions in an eyes-open mode in a well-lighted environment. Notice the rippling effect around objects. Do you have colored patterns or hallucinations projected on the environment. This is sure indicator that you have taken a strong dose.
- Listen to sounds or music and feel their effect on your emotions and observe how they change the hallucinations or patterns.
- Observe the quality of your consciousness. Are you cloudy, sleepy, moody, willful, clear, alert? Note all

physical side effects, such as nausea, headaches, muscle aches, stomach cramping, aching joints and other uncomfortable symptoms. Many aches and pains can be a result of psychosomatic manifestations during a psychedelic trip. But many times impurities in the mushrooms can initiate the side effects, too. All the above are indications of the quality of the trip and consequently the mushroom quality. Generally, as I perfected my growing and storage techniques, the above physical symptoms diminished.
- Watch how you respond physically. How is your coordination, such as your ability to walk and talk?
- I have noticed that left brain functions - those usually associated with concrete, analytical thought processes - become harder to perform with increasing doses of psychedelics. Can you perform simple math tasks? Do you have trouble expressing ideas in speech? Can you give directions to a familiar location to someone?
- How fast does the trip come on? How long is the "rush?" How long before you start to come down from the psychedelic portion of the trip? I find that the drug effects last no longer than six to eight hours, but as I increase the dosage or strength of the mushrooms, the trip comes on faster, the rush lasts somewhat longer and the psychedelic portion gradually increases from as little as thirty minutes to as much as five or six hours. By reassessing your trip as it progresses using some of the evaluation criteria as described in the above points, you can observe the course of the trip accurately and predict its length and intensity.
- When establishing a subjective baseline for your trips, it is important to standardize the set and setting of your trip so that you minimize the results of such variables on the trip. Try to take it in the same type of environment, preferably at the same time of day. Do not take an evaluative trip if you are in a negative mood. My friend recommends jogging, or other aerobic exercises, to help elevate and stabilize one's moods.

It is best to take the mushrooms on an empty stomach during an evaluation because different foods will affect the nature of the trip. Also, having food in the stomach will slow the absorption of the psilocybin and give the impression that you had less. If you are correlating objective test concentration information with subjective intensities, make sure you always use the same amount of mushroom. I found that one gram was enough to test. It usually was not enough to put me on a full-blown trip, but was plenty to observe all the psychedelic manifestations, particularly if I closed my eyes and plugged my ears and practiced meditation techniques which I know.

Having evaluated your mushroom samples subjectively, you are well on your way to being able to plan for an entheogenic, or ecstatic trip because you know how much to take for the sought-after experience. The emphasis of these articles is purposely limited to the use of the mushrooms for the more introverted and spiritually expanding psychedelic experience. True, many of the preparation, growing techniques and even some of the suggestions for directing the energy of the experience (a later article) can apply to trips which focus on interpersonal relationships or even for those who just want to have fun for an afternoon, but you will not need to work as hard for these non-entheogenic experiences. My background with psychedelics, and primarily with the "magic mushrooms," has shown me that the highest quality mushroom experience and states of consciousness come with effort and planning between trips and a tremendous burst of yearning during the actual trip.

Apparently a change in consciousness takes effort and time. The more intense the concentration of effort and desire for such a change, the faster is the change in consciousness. The next section may be superfluous to your needs if you are not drawn to such objective evaluation of your mushrooms. But even if you do not elect to do any chemical testing of your mushrooms the discussion might help you to understand the meaning of the values which I will describe in upcoming articles on environmental and nutritional influences on the growth and psychedelic tryptamine production in P. cubensis. So I encourage you to read at least the general theory and interpretation of the test's results. The actual test procedure is at the end of the article for those who wish to do their own chemical evaluations.

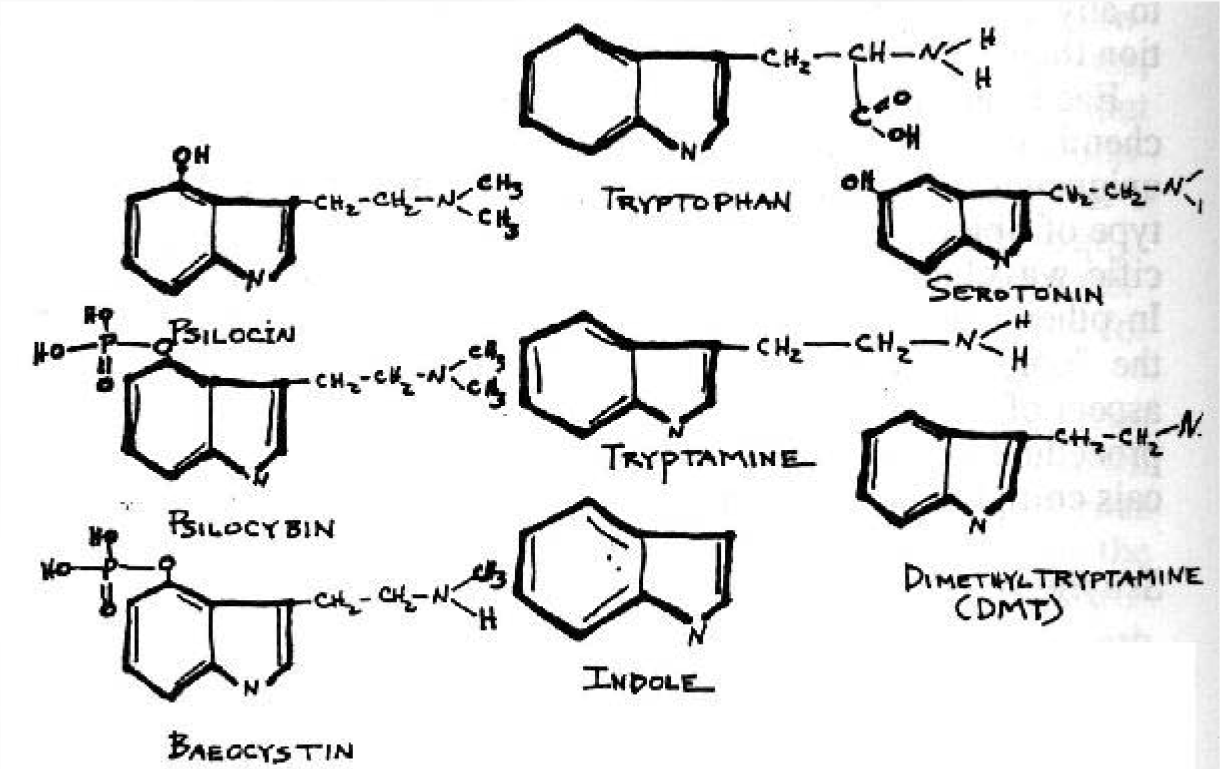
Objective Testing

General theory and various detection and measuring schemes

Objective test results can give a numerical value which tells how much, and for some tests, what is in a mushroom. One can find a relative concentration value or an absolute concentration value. If one has access to the pure psychedelic tryptamines then one can derive the absolute concentration by measuring an accurately weighed amount of the pure sample and then comparing that test result with the value obtained for the unknown sample. If one does not have a pure sample it does not matter because the numerical test results will indicate that one sample has more of the measured tryptamine than another and to what degree it has a greater concentration.

These numerical or objective test results greatly help communicate the relative strength of different batches of mushrooms to any one else who may have a different subjective interpretation than yourself. Each individual chemical behaves differently from all other chemicals because of its unique structure. Based on this uniqueness of each chemical, objective tests are possible. One type of objective testing relies on the unique absorption of specific wavelengths of light absorbed by each unique chemical.

In other words, each chemical has a different color, although the "color" is usually not in the visible spectrum. Another aspect of each chemical which is often used in designing a test procedure is that it will interact with or react with other chemicals completely differently.



INDOLE—TRYPTAMINE DERIVATIVES
Figure #1

sketch by C.B. Gold

Figure 1 - Shows indole-tryptamine derivatives. Similarities between naturally occurring bodily compounds and hallucinogenic compounds allows for the psychedelic effect.

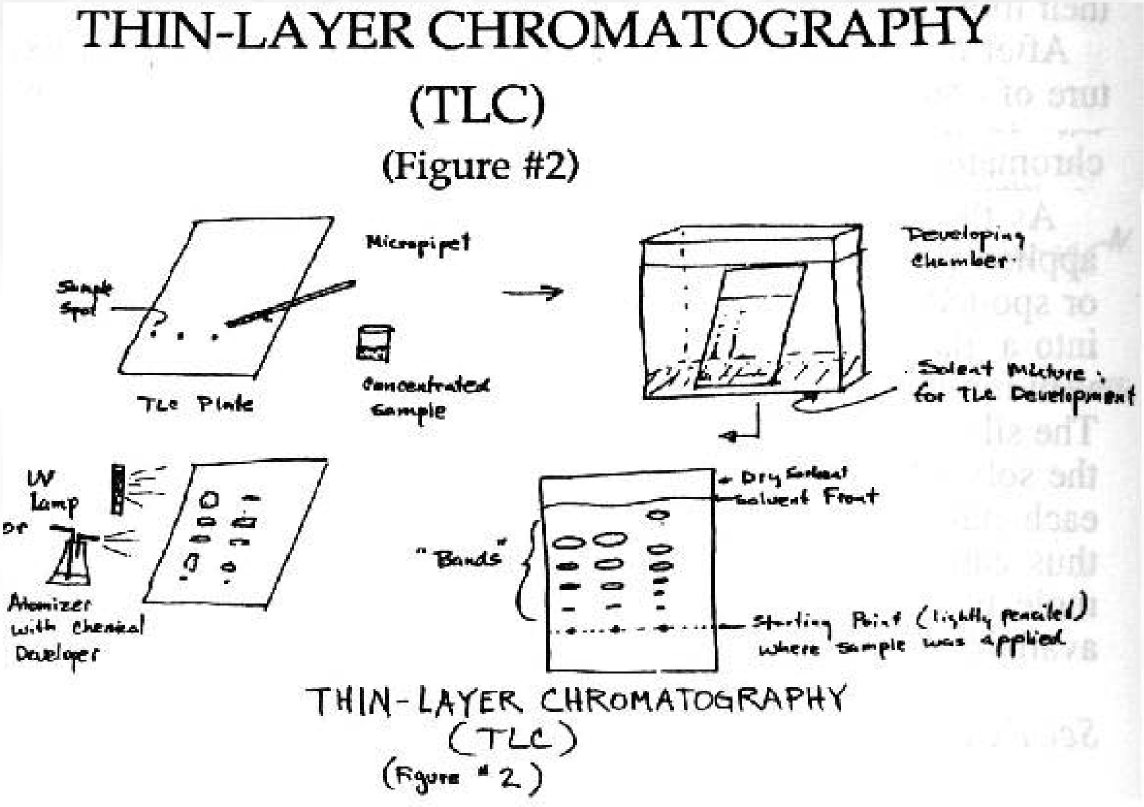
Tests can be developed which are also based on the similarity of various compounds with the understanding that a related portion of the molecule will react similarly. For instance, there are several active molecular components in the entheogenic mushrooms but the most important component includes the general family of molecules, called tryptamines. All these tryptamines have in common the indole ring in their molecular makeup. Tests have been developed which show whether this indole ring (as part of the larger tryptamine molecule) is present in a solution and to what degree.

The several different types of tests which are available to the scientist include spectrophotometry, colorimetry and chromatography. Spectrophotometry measures the degree with which the molecule under investigation absorbs light at specific wave lengths. But because most organic molecules absorb best in the infrared or ultraviolet spectrum and these instruments are expensive for the average hobbyist, I have not pursued these techniques.

Chromatography is a technique which separates mixtures of compounds by passing the mixture while in solution through a specially prepared media (the "sorbent") of highly refined sand, called, "silica gel." Silica gel is the most common sorbent used, but other less common sorbents can be used. The mixture of various molecules interact differently with the molecules on the surface of the silica gel as they pass and thus slow their movement to a greater or lesser degree.

After migrating through the silica gel for a distance, the mixture of compounds segregate into separate bands of pure compounds. Chromatography generally falls in two modes, depending on the apparatus used with the silica gel to separate the sample - thin layer chromatography (TLC) and column chromatography of which high pressure liquid chromatography (HPLC) is another technique subgroup commonly used in the lab.

As the name indicates, in TLC a thin layer of silica gel is applied to a glass or plastic plate then the sample is streaked or spotted near the bottom of the plate. The plate is then put into a glass tank in which a small amount of a particular solvent mixture, determined by experimentation, has been poured. The silica gel, being porous, allows capillary action to draw up the solvent which pulls the sample, too. As the sample moves each pure chemical in the mixture moves at a different rate thus causing a separation into bands of the pure component molecules of the sample mixture. Different techniques are available to make each pure chemical band visible.


THIN-LAYER CHROMATOGRAPHY
(TLC)
(Figure #2)
Sample Spot
Micropipet
TLC Plate
Concentrated Sample
Developing Chamber
Solvent Mixture for TLC Development
UV Lamp
or
Atomizer with Chemical Developer
"Bands"
Dry Solvent
Solvent Front
Starting Point (lightly penciled) where sample was applied
THIN-LAYER CHROMATOGRAPHY
(TLC)
(Figure #2)

sketch by C.B. Gold

Figure 2 - Shows a rendition of the TLC (Thin Layer Chromatography) processing. This method of visual analysis allows chemical present within the mushroom to be compared next to one another.

For a given sorbent and solvent a particular compound (e.g. the psychedelic tryptamines) will always move up the TLC plate the same relative distance when compared to the distance that the solvent was allowed to creep up the plate. For example on one occasion a researcher let the solvent develop on the TLC plate for one hour and the solvent moved up the plate 10 cm. After using either a chemical dye to detect the chrometegraphed spots or a UV lamp, he found that the spot he was most interested in moved 5 cm up the plate or half way between the starting point and the solvent front. On another occasion he only let the plate in for 45 minutes and the solvent moved only 8 cm. Because he knows the compound has an Rf (an abbreviation referring to relative migration distance up a TLC plate of a pure compound) of 0.5, then under identical conditions for the same chemical, the spot of interest will move half way up the plate or 4 cm. And so it does in practice.

The experimental literature will usually have these relative distance values for most compounds, which are always less than 1.0 (An Rf of 1.0 would indicate that the compound moved with the solvent all the way up the plate; therefore its relative distance when compared to the distance that the solvent moved is 1.0.) After a TLC separation it is easy to see if a particular compound is present by looking for a band which occurs at the correct distance up the plate. The intensity of the color of the band will indicate the concentration of the compound, or one can actually scrape the band off the plate and measure the nearly pure compound by some of the other techniques available.

HPLC (or High Pressure Liquid Chromatography) is a form of column chromatography. The sample is applied at the top of high pressure capable column with sorbent in it, then the solvent is pumped through the column at high pressures (usually 1000 psi or greater). At the other end of the column a spectrophotometer monitors the solvent for an absorbance which indicates an organic compound is coming off the column. The experimenter can view the output from the spectrophotometer via a graph output or a video screen.

The area under the peaks which represent each different molecule are proportional to the concentration. With samples of the pure tryptamines, one can calculate the absolute concentration of the compounds investigated. An HPLC solvent is pumped through the column until most of the sample has been washed off. Instead of distance traveled through the silica gel as in TLC, the time it took to wash the compound off the column before it was detected by the spectrophotometer is used to determine what the molecule is.

If you read the technical literature you will see HPLC mentioned often. Its advantage is far greater sensitivity and ability to resolve many more compounds which may be present in an unknown sample. Its disadvantage is cost. The average HPLC set up may cost $10,000. Whereas one can buy pretty much all he needs to perform TLC for about $100 to $200.

Which brings us to the last general detection technique and the one of choice for most of my research - colorimetry. Colorimetry is similar to spectrophotometry in that a solution of the sample absorbs specific wavelengths of light and the wavelength and the degree of absorbance can tell much about the sample. But in colorimetry the light absorbed and the consequent color of the solution measured falls within the visible spectrum. Also, because the absorption peaks cover a much broader range of wavelengths than in the ultraviolet (UV) or infrared (IR) regions, the spectrophotometer used can be much less sensitive and can use coarser methods of breaking up the light spectrum to irradiate the sample. The instrument used for colorimetry is called not a "spectrophotometer," but a "colorimeter" and can use filters rather than the much more expensive diffraction grating monochrometer used in spectrophotometers.

The trick with colorimetry is making the sample molecule which normally does not absorb in the visible spectrum (i.e. 400 to 700 nanometers, which is the wavelength of light from the deepest reds to the faintest violets) visibly colored. Chemists have found that there are molecules which by themselves are uncolored but when combined with certain other molecules will form a color. These chemicals are called "chromophores" and the presence of this color indicates that the molecule under test exists in the solution and the intensity of the color tells one how much of the compound is in the solution.

The problem with colorimetry is that most chromophores do not combine specifically with a unique molecule but with a portion of the molecule under test. For example, in the test which I used in my research, the chromophore reacts with the indole ring of the psychedelic tryptamines to form a blue or purplish color. Indole rings are not specific to psychedelic tryptamines. There are many molecules other than the psychedelic tryptamines which have indole rings.

And to further complicate things, the chromophore will react with other nitrogen containing centers, although without the usual blue or violet color. The net result can be a hodgepodge of color which overlaps to a greater or lesser degree with the specific wavelength, or color, which the colorimeter is viewing. The colorimeter is dumb; it does not know the difference between an absorbance at 570 nanometers which is caused by urea or psilocybin or a little of both. Generally, the non-active compounds have absorbances far enough away in the light spectrum so that they do not interfere with the psychedelic tryptamine readings, but this is not always the case. I will discuss this interference and how it relates to the interpretation of the test's results in a later section.

Spectrophotometric theory tells us that the measured absorbance of a compound is directly related to its concentration in solution. In other words as absorbance increases so does the concentration. If we test one mushroom for active tryptamines and find that it has an absorbance of 0.600 and then test another and find that it has an absorbance of 0.900, we can say that the latter one has a greater concentration of tryptamines than the first. Sure, we do not know the absolute concentration in mg/gram of the psilocybin/psilocin, but who cares? We can as easily relate to 0.600 A as we could relate to 2 mg/gram in our own subjective experience.

Because of the potential for ambiguity in the test results through the chromophore's multiple color reactions, it may be appropriate to review the literature to see what constituents of P. cubensis others have found in their research. Some of these other natural compounds will react with the test and add to the test value even though they are not active tryptamines. And others are active tryptamines which because of their somewhat different psychophysiological activity can modify one's trip significantly for better or worse. We need to know what these are, too.

As far as active tryptamines in the mushroom, the two with the greatest concentration in P. cubensis are, of course, psilocybin and psilocin.[13 p.109] The "tryptamine derivatives" are called such because of their similarity to serotonin. This class has an INDOLE group and a DIMETHYLAMINE group. The tryptamine derivatives include the brain transmitter substance, serotonin, the essential amino acid, tryptophan, the fast acting but short lasting psychedelic, DMT, and of course psilocin and psilocybin. "Active tryptamines" refers to the various psychedelic tryptamines, including psilocybin, psilocin and all their analogs. See Figure 1 for examples of the various tryptamines.

Repke points out that any psilocin detected in mushroom samples may in fact be an artifact caused by hydrolytic cleavage of the phosphate group off the psilocybin molecule in the handling and sample preparation.[14] In fact, other analogs can be easily formed by the various enzyme systems and the presence of oxygen. I tried to make this point in the first article when I emphasized the importance of low temperature, vacuum drying when preparing the mushrooms for storage or the care needed in preparing the mushrooms for ingestion, for it is these analogs and breakdown products which are most likely the cause of the headaches, mental cloudiness and achiness which are not normal side effects of synthetic psilocybin.

Most literature references which I read noted that little psilocin was present in mushrooms. They may not have been able to find any psilocin with the psilocybin, because it is an artifact or perhaps because of the ease with which psilocin is oxidized. In the work of Bigwood and Beug, however, they found that after the second flush the psilocin levels are significantly high. In fact, they range from about ten to thirty percent of the total active tryptamine concentration (concentration of psilocybin and psilocin in this paper).[4]

Apparently, baeocystin, which is another psychedelic analog to psilocybin and psilocin, plays a major role in the natural biosynthesis of the psilocin and psilocybin in the mushroom and it is present in small but significant levels in P. cubensis. Based on the various samples tested in the cited literature, the range extends from 0.001% to 0.02% baeocystin of the mushroom's dry weight. Repke and the others found that baeocystin was never found in mushrooms which did not already have psilocybin present also. To put this in perspective, psilocybin usually makes up about one percent of the dry mushroom weight. (Baeocystin forms a pink to purple to blue color reaction in the presence of Ehrlich's reagent, which is similar to the test reagent which I describe at the end of this article.)[14]

The researchers, Beung and Bigwood found through their TLC work that they could isolate 12 distinct spots (i.e. different compounds) on the silica gel plate. Besides psilocybin, psilocin and baeocystin, their tentative conclusion is that the other spots represent N-methyl and tryptamine analogs of psilocin and psilocybin.[3]

Another tryptamine found in mushrooms is tryptophan.[9] This will react with the test reagents with a similar color as psilocin and will consequently add a small amount of absorbance to any test result, giving a slightly false high reading.

The test which I used to quantify the amount of psilocybin and psilocin in the P. cubensis mushrooms reacts with other nitrogen containing compounds, although it is most sensitive to indole containing compounds when read at the prescribed wavelength.[10] The common amino acid, glycine, is one such nitrogen containing compound found in abundance in the mushroom.[18] Another nitrogen based compound which has been found in the mushroom is urea. The yellow color change of the test indicates the presence of one of these ubiquitous compounds. Luckily, yellow adds only a small amount of absorbance to the value of the active tryptamines when read at 570 nm, the test wavelength.[3]

Casale, in reviewing the literature, mentions that besides the compounds already mentioned, ergosterol, ergosteral peroxide and a,a-trehalose have also been found in the methanol extracts of the Psilocybe mushrooms.[5] I could find no other mention in the literature about other tryptamine analogs, toxins, enzymes or hormones which may be present in P. cubensis and thus affect one's subjective experience. Agurell, Blomkvist and Catalfomo[1] identified a lengthy list of possible tryptophan metabolites which might show up in the psilocybe mushrooms: 6-hydroxytryptophan; kynurenine; tryptophan; kynurenic acid; xanthurenic acid; psilocin; tryptamine; methyltryptamine; dimethyltryptamine; 3-hydroxyanthranilic acid; anthranilic acid; N-acetyltryptophan; and indoleacetic acid. Agurell and Nilsson[2] demonstrated in their paper a tentative biosynthetic route for psilocybin for which any of the intermediates could exist in the mushroom, too. The synthetic pathway proceeds from tryptophan to tryptamine to N-methyltryptamine to *N,N*-dimethyltryptamine to psilocin to psilocybin.

Any and probably all precursors to psilocybin can be found at one time or another in P. cubensis. Some may be bound to proteins or enzymes which may tie them up for any chemical reaction or assimilation in the body. The consequence of the presence of all these other non-active tryptamine or nitrogen containing compounds which react with the test reagent is to artificially raise the absorbance or apparent concentration. In testing, the change in the absorbance does not necessarily mean a change in the active tryptamine (i.e. psilocybin/psilocin) concentration at all. Some quick and easy tests for field or the non-technically inclined.

A simple test described in High Times to determine whether one has inadvertently purchased LSD laced mushrooms is to mash the mushroom in some methanol and let it sit overnight. Decant the methanol the next day and hold the extract up to a black light. If the liquid glows blue then you have LSD containing mushrooms, which, as far as I know, do not exist.[17 p. 252] Norland describes a few colorimetric tests which can be used to identify mushrooms which contain tryptamine derivatives.[13 p.116] You may find them more useful than the longer and more complicated test procedure at the end of this article. You do not require a colorimeter for test results and if you can live with an eyeball color comparison and your memory, you can at least estimate the concentration differences between mushroom flushes.

1. A simple test for indole-containing compounds and tryptamines is to crush a small piece of mushroom into 1/2 ounce of vodka or ethyl alcohol ("denatured alcohol" or the hardware store "shellac thinner" is fine) and mix. Add 3-4 drops of hydrochloric acid (or the hardware store variety called, "muriatic acid") then drop a pine tree shaving into the solution which will turn "cheny red" in the presence of indoles.
2. Another test for indoles uses a small crushed piece of mushroom in 1/2 oz. of either methanol or ethanol (or Vodka). If you are interested in testing for psilocybin use methanol; if psilocin use ethanol or vodka. The difference in solubility between the two active tryptamines account for the difference in the solvents used. Mix well then filter. Let evaporate overnight or use a steam bath or a hair dryer to dry. Spot the residue on filter paper and let dry. Spray or drop on the following developer. In order for the test to work effectively the developer must be made fresh. To make the developer, add one drop of 37% formaldehyde to 15 drops of concentrated sulfuric acid. Psilocin should turn green to black where as psilocybin should turn yellow to green-yellow; green is normal. Orange-brown indicates amphetamines or LSD.
3. Ehrlich's reagent is a name of a mixture which is used to detect indole compounds which have been separated on a TLC plate. After spraying the test solution on the plate, a colored spot will form where such an indole-like compound lies. The reagent is made from pimethylaminobenzaIdehyde (5%)

(abbreviated DMAB) in concentrated hydrochloric acid (HCl).[9] Another variation of the Ehrlich's reagent is 2% DMAB in HCl-ethanol (1:1). This reagent gave the following color changes: psilocybin turned reddish-purple then faded to violet whereas psilocin yielded a strong blue color which faded to violet.[18]

4. If you are interested in pursuing a TLC testing procedure, see Leung, Smith and Paul for the various solvent systems which can be used to separate out the constituents of the mushroom. Also, you will be able to use the information about the expected relative distances (Rf values) which psilocin and psilocybin will travel up the plate for each solvent system. This information plus a test reagent such as the Ehrlich's will help to establish if psilocybin or psilocin or both are present in the mushrooms you test.[9]

For my own TLC use, I found that the solvent system which Beung and Bigwood used in their research worked best. They found that they could obtain the greatest resolution of the most spots by using a solvent mixture of n-butanol-acetic acid-water (12:3:5) with silica gelplates.[3] In my use of this solvent system, T found that the solvent ratios mix well. Some of the other literature suggests solvent mixtures which are not homogeneous after shaking, but instead quickly separate out into two layers, making these other solvent mixtures difficult to use in TLC.

In my own separations, I used a UV light and the fluorescent version of the TLC plates for detection. I did not have access to a fine mist sprayer which is required if using the Ehrlich's reagent. I could only distinguish six spots in contrast to the twelve which Beung and Bigwood found when they used both detection schemes (i.e. Ehrlich's reagent and UV lamp). In another test procedure I made a test paper which can detect the presence of indole compounds by using p-DMAB (para-dimethoxybenzaIdehyde) as the detection reagent or chromophore. Although the paper is not sensitive to low levels of indoles, I found it useful for quick checks of mushroom extracts for the presence of psilocybin/psilocin.

p-DMAB Test Paper

1. Add 1.0 gram of p-DMAB to 28 mil of ethanol (denatured). Stir until dissolved.
2. Add water to the above mix until 60 mil total volume achieved.
3. Soak some filter paper in the solution and let dry completely. One can use a hair dryer to speed the drying but do not use too hot of an air flow. The heat will destroy the p-DMAB and consequently the test paper's usefulness. Store the paper in a tight jar in the refrigerator.
4. To use the paper add a drop of the extracted sample to the paper and let dry. Hold the test paper over the mouth of a bottle of concentrated hydrochloric acid. The fumes will develop the purplish/blue color quickly. If the fumes do not develop the color try adding a drop of hydrochloric acid on the paper next to the sample spot. As the hydrochloric acid diffuses into the filter-test paper and comes close to the sample spot, the color, purple or blue will form if the sample is positive for indole compounds.

The theory behind the reference colorimetric test

In the preceding sections I have outlined the general parameters of colorimetric testing and in the last section listed the procedures for several test which are easy to set up and read. The test which I have selected for measuring the active tryptamine content in the various experimental samples from the last four years, is based on a color reaction with paradimethylaminobenzaldehyde (DMAB). DMAB is the common reagent ingredient in several other tests mentioned above including the Ehrlich's test.

To review the general colorimetric test again, the indole part of the tryptamines reacts with DMAB in a solution conducive to driving the reaction to completion thus forming a colored complex which can be visualized or read with a colorimeter or spectrophotometer. The intensity of the color (i.e. absorbance) is proportional to the concentration of the tryptamine content of the solution. The use of this test is common in the literature in slightly different formats. The test which I developed for measuring the indole-like compounds, psilocybin and psilocin, was originally used in a slightly modified form to measure ergot alkaloids.[16] Lysergic acid and ergotamine tartrate are ergot derivatives - both precursors to LSD and other pharmaceuticals and can be tested using DMAB.

Besides the more sensitive but more complex HPLC (High Pressure Liquid Chromatography) testing procedures, various researchers have used other means of quantifying psilocybin and psilocin. Leung and Paul used a quantitative TLC (Thin Layer Chromatography) method in which the least amount of chemically pure psilocybin to cause a reaction with Ehrlich's reagent (a 5% solution of p-DMAB in hydrochloric acid) was compared to the least amount of a test sample from extracted mushroom tissue needed to induce a color change. One assumes that the psilocybin concentration is equal in both cases and then computes the percent concentration of the psilocybin in the mushroom by knowing the amount of mushroom which was extracted.[11]

Other Potential Chromophores

The test does not have to be restricted to DMAB as a chromophore. Although in the following testing procedure and in all the technical literature, para-dimethylaminobenzaldehyde has been used as a color developing agent, another chemical, para-dimethylaminocinnamaldehyde may be used. This particular developing agent will yield a much more intense color than the DMAB and will consequently be more sensitive.

This additional sensitivity may be necessary if you are using a more crude colorimeter with a broad bandpass filter (i.e. more than 30 NM). Instead of the accepted reading wavelength of 570 nm used for the DMAB test, you should use 625 nm for para-dimethylaminocinnamaldehyde.[15] But in most applications this increased sensitivity will cause too dark a reaction color to develop and thus be hard to read on the colorimeter scale.

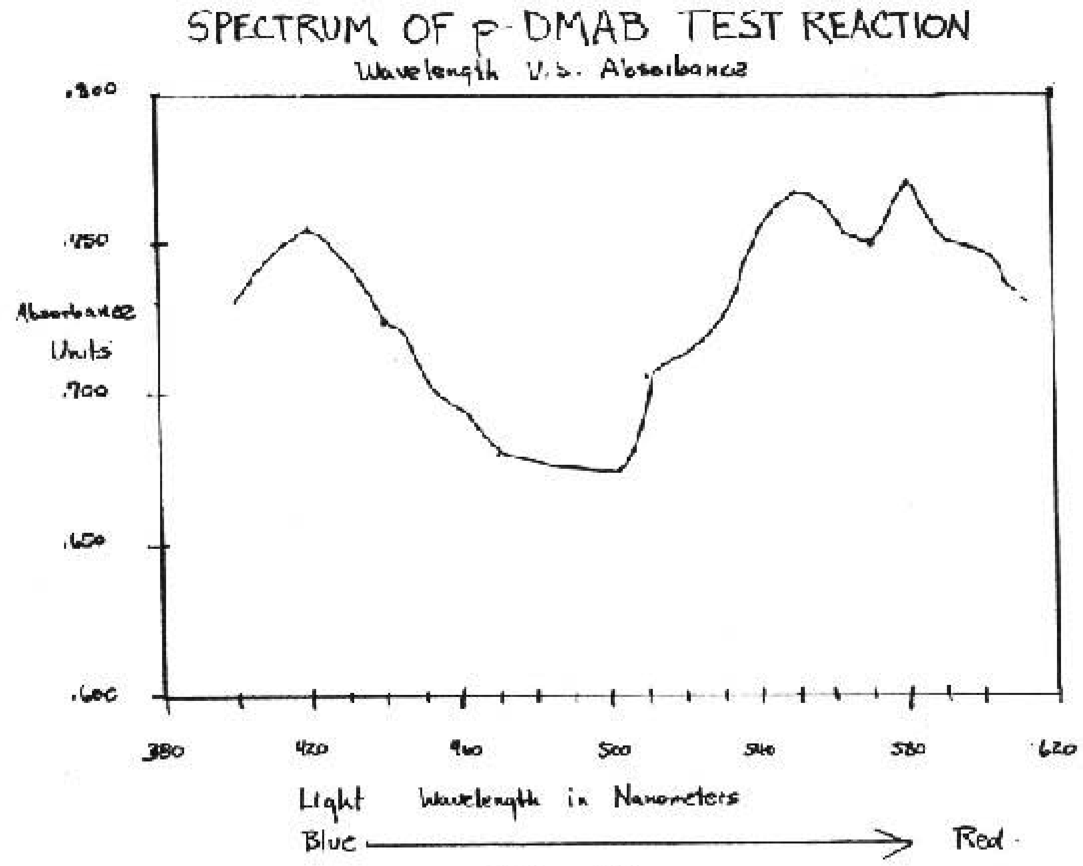
Still another reagent used similarly to the DMAB reagent (Erlich's reagent) is the Pauley reagent. This reagent uses diazotised sulphanilic acid. It is more specific than DMAB in that it does not react with psilocybin or urea, but only with psilocin, giving a deep red-orange color.[18] (I do not have details on which wavelength to measure this color reaction.)

The Correct Wavelength to Measure the DMAB Chromophore

A few researchers used DMAB in their colorimetric test and generally the wavelength they used to read the indole containing compounds has been 570 nm. The spectrophotometric peak of both psilocybin and psilocin after reacting with DMAB is sufficiently broad so that one can use another wavelength close to 570 nm without affecting the sensitivity of the test. This could be important if you use a filter colorimeter and the available filters do not include the specific wavelength of 570 nm.

In figure 3 I have constructed a spectral absorbance graph for a positive DMAB test for some mushroom powder. I took transmittance readings every 10 nm from 400 nm to 610 nm and then converted the transmittance values to absorbance, which I later plotted. The best wavelength to read a colorimetric test is usually at one of the absorbance peaks. As you can see, the test could be read at more than one wavelength based on this criteria. Another possible absorbance maxima besides the approximate 580 nm peak is on the 550 nm peak. It is probable that these two peaks represent psilocin and psilocybin. The large peak around 410 nm may be a secondary peak for psilocybin, which is usually seen as purple - a combination of red and blue.

When analyzing the graph remember that this represents spectral absorbance not transmittance. Therefore for the color blue one would look for an absorbance peak in the red area of the spectrum (i.e. near 600 nm).



(Figure #3)

sketch by C.B. Gold

Figure 3 - Shows the spectrum of p-DMAB test reactions. This test allows color reactions, such show amounts of specific chemicals in comparison.

Light Speeds the Test Reaction

It was from the paper of Agurell, Blomkvist and Catalfomo which I discovered the principle outline of the test which T present here.[1] In that paper they suggested the use of a UV light which will speed the reaction with the DMAB chromophore. I have substituted that step by letting the reaction develop under fluorescent lights for a longer period of time. Even at that, the reaction continues to develop for 24 hours after initiation. The researchers mentioned also produced a calibration curve which could prove useful. But these researchers not only extracted the psilocybin but also purified it to some extent before testing their samples. You may be able to get a "ball park" absolute concentration in mg/gram of mushroom by extrapolating from this curve and by purifying your mushroom extract. Consult the reference for more details on purification if you are interested. (A future article will outline a purification procedure.)

The DMAB reaction requires at least thirty minutes to reach a plateau of color development under fluorescent light. Note figure 4 which shows this. Because the reaction actually continues for up to 24 hours, you will need to accurately time the development period and then standardize this time for all tests. I use 30 minutes because the greatest color changes have occurred by this time and I prefer not waiting too long for the results. Another good reason for using a shorter development time period is that psilocin and other related tryptamines which are present do gradually degrade, thus altering the value of concentration for the active tryptamines if allowed to sit in solution while the test is developing.

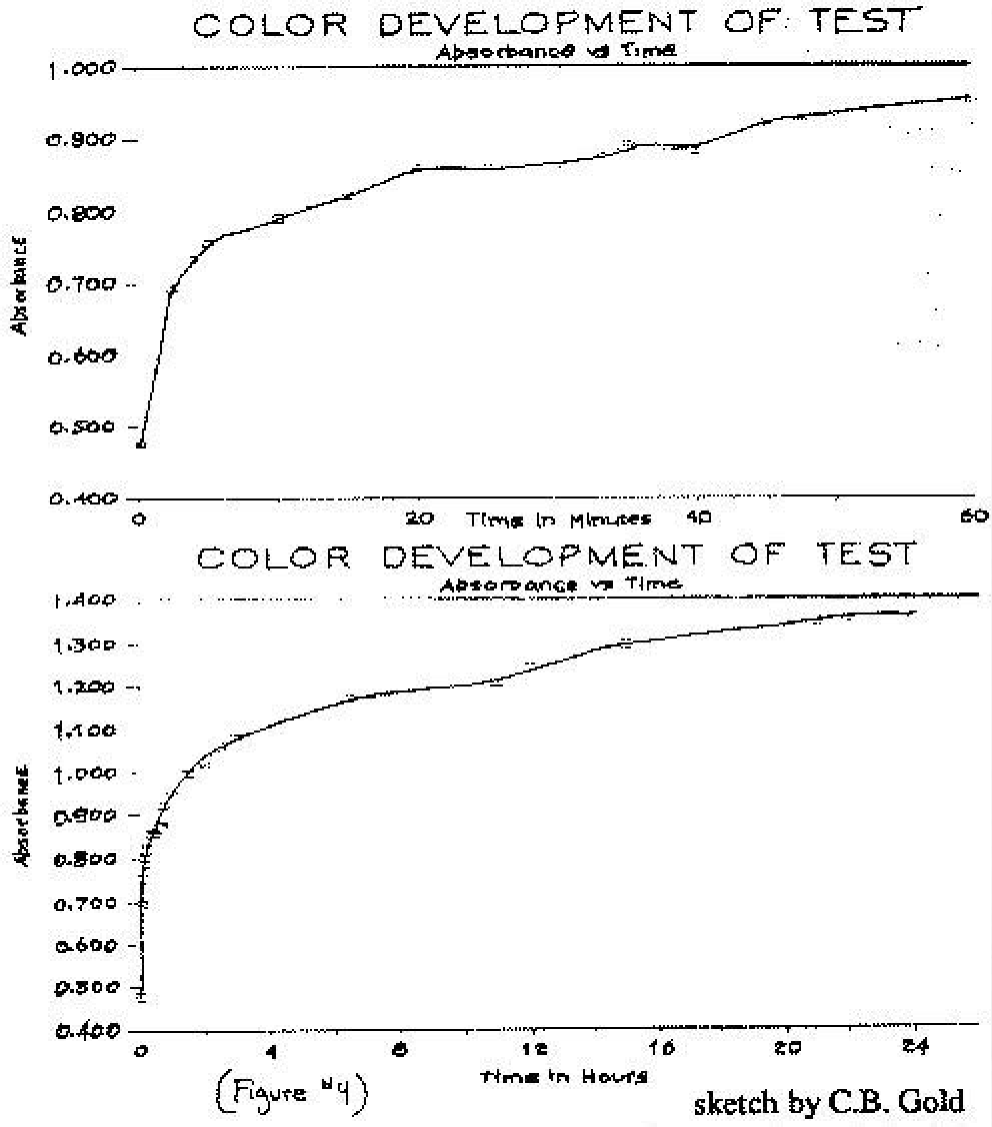


Figure 4 - Shows the time absorption scale surounding colorimetric testing.

Defining the Extraction Solvent

The researchers, Agurell, *et al.*, tested the extracted and somewhat purified psilocybin. They did not test for psilocin. To avoid a tedious and lengthy sample preparation, I wanted to extract, then read the mushroom sample without purification. Ideally, I wanted to use an aqueous solution to avoid organic solvents and to test for both psilocybin and psilocin during the same test. But psilocin has difficulty dissolving in water, and psilocybin is easily dissolved in water. Since psilocin is especially unstable in alkaline solution, I felt that an acidified aqueous solution would be the best to use as a solvent.[19] Many TLC tests confirmed that the acetic acid-water solution which I finally decided on did, in fact, extract both the psilocybin and psilocin.

I use an acetic acid-water extraction solution to help extract the psilocin and psilocybin more completely and also, to lower the pH so that the active tryptamines will be more stable. Without the acetic acid the solution will quickly react with atmospheric oxygen in the presence of endogenous enzymes to form a strong blue product and in the process destroy some of the psilocybin/psilocin. Also, the color blue itself will interfere with the test results, since the reaction yields a blue or purple color for tryptamines. Specifically, psilocin yields a brown-deep blue and psilocybin a yellow-green and purple color. In contrast, LSD will react with DMAB to form a blue-purple color.[17]

Apparently, others have also found that a dilute acetic acid solution is an excellent solvent for both psilocin and psilocybin. Not only does the solution completely extract both tryptamines but the solution extracts other interfering substances to a lesser degree. Casale also notes that if one heats the extraction solution of dilute acetic acid to 70 degrees centigrade for ten minutes, then the psilocybin is completely converted by dephosphorylation to psilocin.[5]

I have found on my own that heating the acetic acid solution eliminated whatever bluing reaction was occurring in the enzyme denaturing environment of the low pH extraction solution. That psilocybin is converted to psilocin is a plus, too. It means that the color reaction will form a more pure color and is therefore easier to interpret the test results.

Besides measuring the color of the developed reagent when it has stabilized somewhat, it is also important to measure a sample of the mushroom extraction as soon as possible. The dilute acetic acid slows the degradation of the psilocin-like tryptamines but does not totally inhibit this degradation. The longer you wait to perform the test on your sample, the lower the value will be. I found the reduction to be approximately 10% after 20 hours. Interestingly, the greater the concentration of active tryptamines as measured on a fresh sample, the greater the effect of time in reducing the apparent concentration.

Sample Weight

I arrived at the sample weight of 0.5 gram powdered mushroom by running a test on four sample masses: 0.2 grams, 0.5 grams, 1.0 gram and 1.5 gram. For the extraction volume of 20 milliliters, the 0.5 gram sample works best. The larger mushroom samples tend to float on top of the extraction solution in the large test tube and have to be constantly stirred so that the powder remains in the extraction solution. The smaller amounts of mushroom powder become increasingly harder to weigh accurately and precisely. Also, the smaller samples have less of a color in the developed reaction making it harder to read the spectrophotometer.

Other Influences on the Test

An interesting but unexplained influence on the color test came from a slight, but apparently significant, change in my standard procedure. If for some reason I used solvents in the preparation of the mushroom material and did not extract the mushrooms, but then totally evaporated the solvent leaving the original mushroom powder ostensibly unchanged, the test color shifted to a more pink color and consequently changed the absorbance from 570 nm. I noted this color shift primarily when I used methanol. Perhaps methanol reacts with something in the mushroom and this product in turn reacts with the DMAB. The point is that the test results cannot be compared to other test results for which you have modified the test procedures. Common sense may tell you that a particular modification may not matter, but in fact, the modification may change the results dramatically.

A more dramatic example of trying to compare apples and oranges as far as the colorimetric test for psilocybin/psilocin happens when I have tried to pre-purify a mushroom powder sample by extraction. My extractions were attempts to clean up the mushroom powder of non-active tryptamines. The colorimetric test becomes a more pure color but because other chemical entities have been removed which also react with DMAB, the overall absorbance drops, giving one the immediate impression that not as much psilocybin/psilocin exist in the mushroom powder sample when, in fact, just as much psilocybin/psilocin is present.

Interpretation of the DMAB Test

The DMAB test reacts with other than psilocin/psilocybin. The DMAB colorimetric test is not a perfect test. The numerical results can be somewhat misleading when used to indicate the concentration of psilocybin/psilocin, the two most common psilocybian analogs in P. cubensis. In the above section on "what is in the mushroom and what are we measuring?", I made the point that the test is not specific to just these two tryptamines. The test reacts with nitrogen-containing indoles, of which the tryptamines are a larger molecule which incorporates the indole group. The test is most sensitive to these indole-containing compounds but still can react with other indoles besides tryptamines.

DMAB reacts to form different colors with other indole containing compounds or other reactive nitrogen-containing molecules. For instance, psilocin typically is blue and psilocybin is purple or purple-green. And tryptophan which is chemically similar to both develops a deep blue color which is different enough from both to make it difficult to use as a standard as I had hoped.

The evidence one can obtain from the different color reactions for different indole compounds can help to evaluate the test results. Note the color mixture after the test has developed. Record the various colors. How pure a color are they? The more pure the color the greater the purity of the tryptamine present in the mushroom.

In my own TLC work I have consistently seen four separate bands which react with DMAB:

Zone	Rf	Color with DMAB
1	0.137	Dark Violet
2	0.275	Pure Violet
3	0.550	Grey Blue
4	0.965	Pink Orange

Each of the above "zones" represent a different chemical compound in the mushrooms which I tested.

By knowing that the DMAB test reacts with other indole compounds besides psilocin/psilocybin, one can conclude that the numerical results of the test represent the summed absorbances (i.e. concentrations) of the various tryptamines or other reactive compounds present in the mushroom, not just the absorbance of psilocybin or psilocin.

One needs to keep in mind that the DMAB test can lead to ambiguous results when trying to make conclusions about environmental or nutritional influences on the biosynthesis of psilocybin/psilocin. What may be occurring is a change in the mixture of the various tryptamines in the mushroom along with an increasing or decreasing or static test result. The ultimate confirmation would be the subjective test, because a change in the tryptamine concentration will change the nature of the psychedelic trip.

One can mistakenly interpret the test results in other ways. In addition to the extra absorbance because DMAB reacts with other compounds in the mushroom extraction besides the ones we are most interested, the general enzyme class of phenol oxidases which are widely distributed in different species of mushrooms can use DMAB as a substrate and can thus reduce the absorbance of the test artificially. By reducing the concentration of DMAB, these enzymes effect a falsely low value for the tryptamines. This is another reason I use a low pH extraction solution (i.e. acetic acid in water) and heat the extraction mixture. Both of these procedural details should reduce the likelihood of losing DMAB through enzymatic activity.[8,p. 108]

As noted in the article on harvesting and storage, some ions will interfere with the color development of the DMAB. In particular, my experience shows that the bisulfate ion inhibits the reaction. Sodium bisulfite can be an alternative to vitamin C as an antioxidant and enzyme inhibitor for mushroom storage.

Quantifying the contribution of non-psilocybin/psilocin factors which react to DMAB. When I began subjectively testing the effect of nutritional factors on the growth of my variety of P. cubensis, I noticed that the increase in absorbance of the DMAB test, which relates to an increase in concentration, did not seem to be proportional to the large increase in the subjective effects of the mushroom powder. A small apparent increase in the concentration (absorbance value) of the DMAB test doubled the subjective effects of the mushroom. My earliest concentration values for the mushrooms tested were 0.6 A (absorbance units). When I subjectively tested mushrooms which had increased to 0.8 A, I was surprised to have a trip which seemed twice as strong.

After careful thought, I concluded that the initial concentration value was composed of two or more colored constituents which added to the total value and that the active tryptamines which made the trip possible were a comparatively small percentage of this total color intensity.

To obtain evidence to confirm or deny this hypothesis, I used the process of paper chromatography to separate out three different mushroom powder samples measuring approximately 0.60 A, 0.80 A and 0.85 A by the DMAB test. After separating the mushroom extracts, I cut out the zone which corresponded to psilocybin, using its known Rf value for paper chromatography and a 2% solution of DMAB in ethanol and hydrochloric acid (1:1) to conclusively identify the width of the zone by its color reaction. After cutting out the psilocybin zone, I extracted it in 5% glacial acetic acid at room temperature overnight. I retested this extraction and compared the results with the extraction and test of the remainder of the cut up paper chromatogram which held the other factors in the mushroom extraction.

After correcting for variations in the sample volumes streaked on the paper and in spite of the poor separation achieved on the paper as compared to silica gel TLC, the results clearly showed that the other unknown but DMAB reacting factors in the mushroom increased their concentration with the increasing absorbance at a slower rate than psilocybin. In other words, the concentration of psilocybin increased with the increase in absorbance, which follows colorimetric theory, but as the absorbance increased, the psilocybin concentration contributed a greater percentage to the total color intensity of the various constituents which react with DMAB. This is in direct conflict with colorimetric theory which states that the concentration of a solution with an absorbance of 1.0 is twice that of a solution with an absorbance of 0.5. But colorimetric theory is for a solution of a single absorbing molecule and as stated previously, there could be as many as twelve different DMAB reactive compounds in the mushroom, each increasing its concentration at a different rate as stimulated by nutritional or environmental changes.

So at this point one can only say that as the absorbance of the test increases, the concentration of the active tryptamines increases - but we still do not know by how much. To try and answer this, I put together a graph at the end of my four years of research based on my subjective experiences of the strength of a trip as compared to the absorbance of the DMAB test. My log shows that I had at least several trips at several different concentration levels: at 0.5 to 0.6 absorbance; at 0.7 to 0.9 absorbance; at 0.9 to 1.1 absorbance and at greater than 1.1 absorbance. By using the intensity, duration and phenomenal experiences of the 0.5 absorbance experience as my reference, I compared each plateau with the previous one and then converted the increase into units of the base reference experience.

For example, I know from written records of my experiences that the second plateau (0.75 A) feels twice as strong as the first (0.5 A) and the third level is 1.5 times as strong as the second, and so on. The following graph (Figure 5) shows these results.

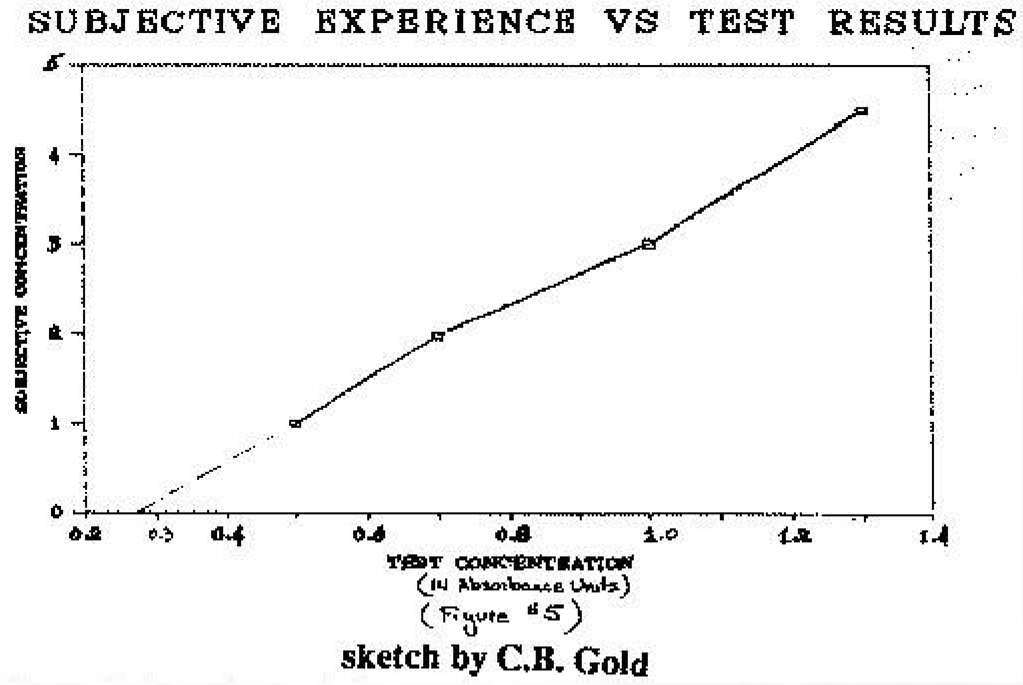


Figure 5 - Shows the psychedelic's trance strength compared to the colorimetric tests.

There are several points that we can glean from the graph:

1. The increase in the active tryptamines is in fact linear for this range and this variety of P. cubensis. Apparently for every increase in the mushroom test value of 0.2 to 0.3 A the experience intensity

increases by the equivalent of the 0.5 A mushroom experience.

2. The paper chromatography extraction experiment discussed earlier obtained a value of the other-than-psilocybin factors' absorbance as 0.35 A for the 0.6 A mushroom powder. The test was inconclusive on this matter because paper chromatography is such a rough separation procedure, but it suggests that the value for the absorbance for the other-than-psilocybin factors increases only slightly as the absorbance increases. Interestingly, if one extrapolates the subjective experience graph to the "0" experience point, the absorbance obtained corresponds to the point after which one will begin to experience the psilocybin. This extrapolated absorbance approximates 0.3 A which supports the paper chromatography results that showed that the first 0.3 A of a mushroom test value is color from non-active tryptamines and other DMAB reactive compounds. The value also means that all the samples had at least 0.3 A of non-active, but DMAB reactive, junk in the mushroom. Of course some of the active tryptamines, which can intensify the trip, may not necessarily be a pleasant addition to the trip either.
3. Although my work on increasing the concentration of active tryptamines through environmental and nutritional manipulation was successful, my secondary goal of reducing the concentration of the junk in the mushroom was not particularly successful Apparently, the level of non-active, but DMAB reactive substances, stayed about the same. It is impossible for me to know without more extensive testing using HPLC whether as the concentration increased, the mixture and relative concentration of the various active tryptamines, such as psilocybin, psilocin, baeocystin and their analogs, changed in the mushroom powder.

In conclusion, then, when reading the upcoming article(s) on growth factors for P. cubensis, keep in mind that as the test values go up the subjective experience increases in intensity, too. But, an increase in the objective test value cannot be used to predict an equivalent percentage increase in the subjective experience. In fact my experience has shown that for a modest increase in the test absorbance, I increased the subjective amount of active tryptamines two or even three times.

The Colorimetric Test

(Items marked with an "*" have expanded notes and explanations following the equipment and supplies listing.)

Equipment

- Colorimeter/Spectrophotometer*
- Hot Plate
- Quart Pan
- Balance capable of weighing at least one gram and
- accurate to 0.1 gr*
- Electric Coffee grinder

Chamicals*

- 25 grams p(para)-Dimethylamino benzaldehyde
- 1 pt concentrated. Sulfuric Acid
- 1 pt Glacial Acetic Acid
- 125 gr Ferric Chloride
- Deionized water

Supplies

- 1 ea. 250 mil plastic graduated cylinder
- 1 ea. borosilicate 250 mil beaker
- 2 ea. 125 mil amber narrow mouthed bottle with caps
- 1 ea. 1000 mil bottle with cap

- 12 ea 20 X 150mm borosilicate glass culture tubes*
- 6 ea matched cuvettes for the colorimeter*
- Polyester cosmetic balls (available at most supermarkets)
- 6 ea. Small (60mm) plastic funnels
- 1 ea. Multiple funnel rack
- 1 Box Filter paper: 9 cm Coarse (like Whatman 4) and 9 cm Medium (1 or 2)
- 1 ea. Plastic test tube rack (to hold about 10 of the 20 mm tubes)
- 1 ea. Plastic test tube rack (Nalge 5900-0007)$
- 1 ea. Test tube cleaning brush
- 1 ea. Volumetric pipette 20 mil
- 1 ea. Pipette 10 mil in 1/10 mil
- 1 ea. Pipette 1 mil in 1/100 mil
- 1 ea. Pipetting Aid (either Bel-Art F-37898 or Nalge 3780- 0100)
- 1 ea. glass stirring rod
- 1 ea. stainless spatula, double blade-rounded and squared
- 1 ea. 500 mil plastic wash bottle
- 1 ea. bright color nail polish or airplane glue
- 1 ea. small polypropylene plastic sheet about 4" square*
- 1 ea. thermometer, 0 to 110 degrees Centigrade

*NOTES:

Colorimeters

I acquired a used Bausch & Lomb Spectronic 20. I understand that not everyone is in the position to so easily buy such equipment. Try the yellow pages for used laboratory equipment dealers. If not specifically listed, try laboratory suppliers. Usually, they have a service department and may have used spectrophotometers or colorimeters. Some brand names to look for are older models of the Bausch & Lomb Spectronic 20, the Coleman Jr. and the Turner. These companies sold many of these lower cost spectrophotometers for many years and you might be able to buy one comparatively inexpensively, say 100 to 200 dollars.

Another option is to buy a new colorimeter but without all the expensive features that the above units have. For the application of reading at a fixed wavelength and a broad color peak, such as in this test, a low cost colorimeter is all that is necessary. All it needs is the proper filter (i.e. as close to 570 nm as possible), a cuvette or test tube holder and a scale in per cent transmittance.

There are three companies that I know of which can offer a low cost colorimeter:

- Chemtrix (P.O. box 1359, Hillsboro OR 97123; 800-821-1358) has a colorimeter (20A) for $269;
- Hach (P.O.Box 389 Loveland, Colorado 80539; 800-525-5940) has a single parameter DR100 colorimeter for about $200 (contact Hach about supplying a transmittance scale and the proper filter)
- Hellige (877 Stewart Ave., Garden City, N.Y. 11530; 516-222-0302) has a meter readout photometer for about $125.

Balance

The Ohaus triple-beam balance is a recognizable standard school lab scale. Presently these cost about $80 to $90 from almost any lab dealer or even hobby shops or some specialty hardware stores. But for this test and most work with mushrooms, you will not need the capacity, or ability to weigh large as well as small masses, offered by this triple-beam. I do not have company names but I have seen in High Times advertisements for small, Inexpensive scales which can weigh accurately up to 30 grams.

Large borosilicate test tubes

Of the twelve test tubes set aside six. These will be used "as-is" with out matchine. The other six need to be volumetrically marked for the standard extraction volume of 20 milliliters. To do this, simply fill up the 20 mil volumetric pipette with water then add it to the test tube to be marked while standing in the test tube holder. Then mark the bottom of the meniscus with an indelible marking felt pen. Do the same with the other five test tubes.

Matched cuvettes

Cuvettes should be one centimeter ID, but because of variations in the extrusion Process for the tubes the ID differs slightly. This irregularity in the internal diameter and the occasional streaks or variations in the thickness in the glass walls of the tubes will result in cuvette-to-cuvette differences in the amount of light from the colorimeter filter passing through the cuvette and solution. This variation can be as much as five percent transmittance. To increase test-to-test precision, some of the manufacturers of the colorimeters mentioned above offer matched cuvettes as an option. Matched cuvettes have been selected so that the amount of light which is absorbed by the walls of the cuvette is essentially the same from cuvette to cuvette. For the price it is usually easier to buy them. If you have to prepare matched cuvettes follow this procedure:

1. 13 mm OD culture tubes will have a nominal ID of 10 mm. Buy at least a couple of dozen.
2. Chose several and fill them with water. Insert them into your colorimeter and set the wavelength to 570 nm or as near as your filter will allow.
3. Set the meter to an arbitrary mid-meter position. Then slowly rotate the cuvette. Notice the variation as you rotate the cuvette the full 360 degrees. Choose the culture tube with the least variation.
4. Continue with another set of a few cuvettes and keep selecting the least variable cuvette until you have six to ten cuvettes.
5. Now match the cuvettes by making an arbitrary mark with nail polish or airplane enamel on the open lip of a cuvette such that this mark can be used to align the cuvette in its holder. Note the meter readout.
6. Take another pre-selected cuvette and rotate it until it matches the transmittance of the first marked cuvette. Mark it with nail polish or paint, too.
7. Continue until all the cuvettes are matched and marked. When using the cuvettes to measure the transmittance of the DMAB test reaction, be sure to always align the mark with the pre-determined alignment position in the cuvette holder. Usually the holder itself has a mark or ridge to reproduce the correct cuvette position.
8. It is possible that the initial cuvette which you arbitrarily marked may not match any or only a few other cuvettes. Just start over but use another cuvette as your initial reference cuvette.

Test Tube Holder

The particular holder I use is an open style which is one tube deep and seven across. I use this holder for heating the extraction solution in a one quart pan. To make it fit in the pan, I cut the holder in two sections of three test tube capacity each. When using this holder with the test tubes make sure you balance the weight of the tubes in the three slots. The holder tends to float. For instance if you put a single test tube in the holder's end, the holder will float up dumping the tube into the heated water and thus losing your mushroom sample. To avoid losing your sample, when extracting a single sample put the tube in the center of the holder, or if using two test tubes, put them on either end of the holder.

Chemicals

I have used technical grade chemicals throughout all my testing. Technical grade is somewhat less pure than reagent grade and usually less expensive. The sulfuric acid could be reagent grade which would be somewhat clearer than the slightly yellow-brown technicalgrade. Sulfuric acid is used in the color development solution and is read on the colorimeter, so clarity and lack of particles floating around would help readability and reproducability. I have had no problems with the less expensive technical grade by always using a sample blank to compare all mushroom test samples against it. A sample blank is used in colorimetry to set the "zero" point. It is usually the test reagent with a distilled water sample rather than the material or extraction to be tested. If the test reagent is colored in the spectral region of the test before any reaction, then by using a sample blank one can offset the colorimeter by this degree of color so that the test result is not artificially high.

Plastic sheet

All that is necessary is a piece of plastic to cover your thumb so that when you shake the culture tube with the test reaction mixture the sulfuric acid will not burn your skin. A piece a couple inches square should suffice. Most plastics are unaffected by sulfuric acid.

Testing Solutions Preparation

Color development reagent

This mixture is the actual solution which when in the presence of an indole or indole-like compound will develop a color from a near colorless solution.

1. Weigh out 0.2 gr of p-dimethylaminobenzaIdehyde (DMAB) and put it into the 250 mil beaker.
2. Make a 20% aqueous ferric chloride solution by weighing out 20 gr of the ferric chloride into 100 mil of distilled or Deionized (DI) water in the 250 mil graduated cylinder. Wear gloves. Ferric chloride can be corrosive. Make sure it all goes into solution. If any particles remain insoluble, filter the solution. Store the finished solution in a 125 mil bottle and label. Rinse out the graduated cylinder.
3. Using the 1 ml pipette and the pipette-aid (never suck up corrosive or toxic chemicals in a pipette!) draw up 0.3 mil of the stock ferric chloride solution (#2,above). Add this to the 250 mil beaker with the DMAB already in it.
4. Add 35 mil of distilled or Deionized water to the 250 mil beaker and stir the water to dissolve the DMAB as much as possible.
5. Add 65 mil of Sulfuric Acid from the graduated cylinder to the beaker with the DMAB. Be careful with sulfuric acid. Wear gloves, an apron and preferably a face shield. When adding the acid, set the beaker on the table. Do not hold the beaker. An exothermic reaction will take place when you add the acid to the water present in the beaker and it will be too hot to hold. Gently stir the mixture. The heat of the acid-water mixture will drive the remaining DMAB into solution.
6. Let the mixture cool down and pour this stock solution into a 125 mil bottle and label it. Do not put hot liquids into the bottles; they may break.

Store the DMAB solution in a dark, cool location, preferably in the freezer section of your refrigerator. If you cannot store it somewhere cold, the solution will gradually darken and thus be unusable for colorimetry. I have successfully stored my stock solution in the freezer for over a year and it has not darkened noticeably. At room temperature you will probably need to discard the solution after a few months.

Acetic Acid Extraction Solution

This stock solution is used to extract the mushroom of its active tryptamines. Then a sample of this extract is tested using the above DMAB color development solution.

1. Measure out 50 mil of glacial acetic acid in the 250 mil graduated cylinder. Fill the cylinder to the 250 mil mark with DI or distilled water and pour it into the 1000 mil bottle. Rinse the cylinder with 3 X 250 mil amounts of DI water into to the 1000 mil bottle to make a total of 1000 mil stock solution of 5% Acetic Acid.
2. Distilled vinegar (i.e. "white vinegar") can be substituted for 5% acetic acid. Distilled vinegar is approximately 5% acetic acid.

The para-Dimethylbenzaldehyde Colorimetric Test

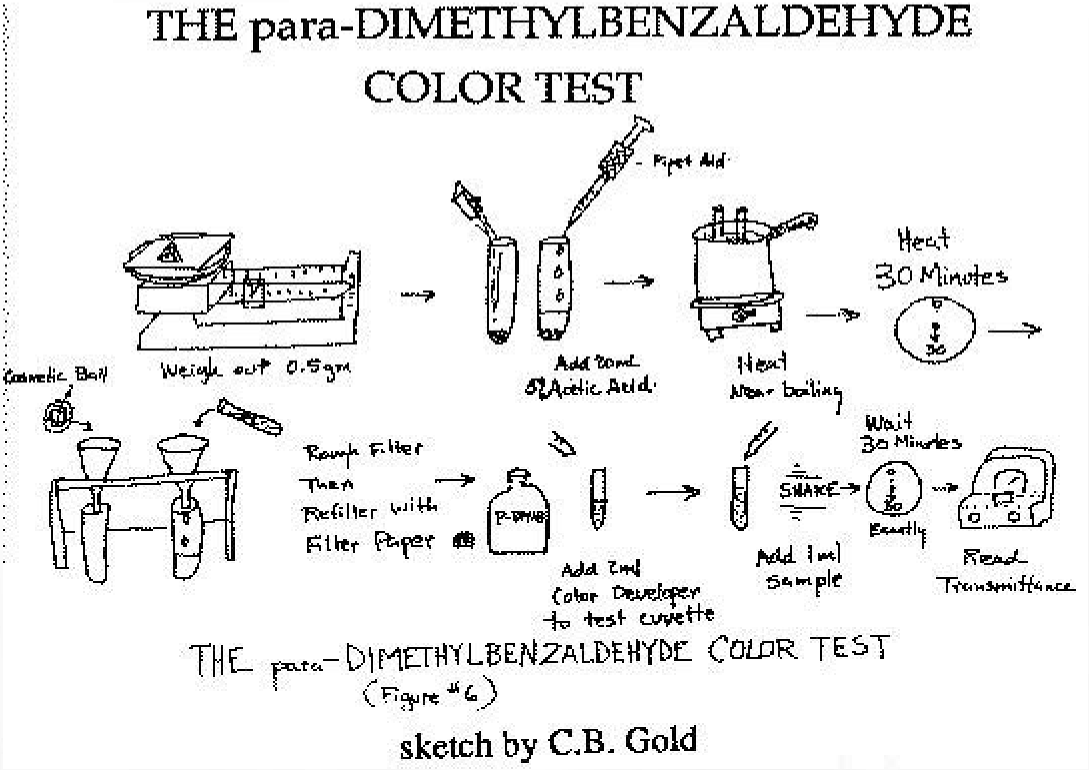

THE para-DIMETHYLBENZALDEHYDE
COLOR TEST
- Pipet Acid
Heat
30 Minutes
Weigh out 0.5gm
Add 20ml
5% Acetic Acid
Heat
Near boiling
Cosmetic Ball
Rough Filter
Then
Refilter with
Filter Paper
P-DMAB
Add 2ml
Color Developer
to test cuvette
Add 1ml
sample
SHAKE
Wait
30 Minutes
Exactly
Read
Transmittance
THE para-DIMETHYLBENZALDEHYDE COLOR TEST
(Figure #6)
sketch by C.B. Gold

Figure 6 - Shows the basic procedure for colorimetric (p-DMAB) testing.

1. Set up the table or bench on which you will do your test with all the equipment in the above illustration spread out. Turn on the colorimeter or spectrophotometer to begin warming it up and adjust or set the proper wavelength (570 nm or close to this). Most have light sources which need to be on for 20 to 30 minutes to stabilize the spectral output. The older models also have slow-to-warm-up electronics.

2. Turn on the heating plate and begin to heat the water filled quart pan. Do not let the water boil. The boiling action will tip over the test tubes with the samples spilling out into the boiling water.

3. If you have not done so, use a coffee mill to grind up the dried mushrooms which you wish to test. Weigh out 0.5 grams of the ground mushroom. It's best when using a scale to use a piece of paper on which you weigh the mushroom. Find out how much this paper weighs before adding any mushroom powder then add this weight to the required half gram sample. This total weight in grams is what you should set the scale for if you have a triple beam-type scale. With the weighed mushroom powder on the weighing paper, cup the paper to form a trough and pour the sample into an empty, large (20 mm X 150 mm) unmarked test tube.

4. Add 20 mil of 5% Glacial Acetic Acid to the sample. Stir the sample with a glass stir rod making sure all the mushroom powder is wetted with the acetic acid solution. Put the test tube in the plastic holder and immerse the holder in the preheated near-boiling water. Note the time or start a timer. Heat this suspension for 30 minutes. This time is not critical. If you should heat it for longer than thirty minutes it will not make much difference. Too long will oxidize the psilocin in the solution and cause a false low reading of the sample. Also, the acetic acid solution does evaporate.

   Every ten minutes or so stir the suspension with the stirring rod. The mushroom powder tends to float on the acetic acid solution which cannot optimally extract the mushroom powder when it is not suspended. Also, the top of the powder can be exposed to air and will oxidize to a dark blue. Again, this can lead to a false low reading.

   The immersion of the glacial acetic acid solution in near boiling water with the mushroom powder during the extraction phase of the test is important to deactivate any enzymes which can cause bluing, and thus tryptamine loss, in the mushrooms.

Without heat and with time the mushroom extract solution will slowly turn blue-green until it becomes dark blue after several days.

As noted in the above section on theory, use a thermometer to make sure that the extraction solution reaches 70 degrees Centigrade for at least ten minutes. This temperature converts all the psilocybin to psilocin which makes for more pure test color.

5. While the mushroom powder is extracting, set up the next step: the filtering and sample development. For each sample, use one small filtering funnel. In the funnel put a polyester ball. Using the wash bottle, wet the cosmetic ball then press any excess water out of the cosmetic ball with your finger. Discard this water if it went into the collection test tube.

6. After 30 minutes or so, remove the test tube holder from the water bath. Turn off the heat plate (or stove). Just before the initial filtering, stir the suspension one more time. Pour the test tube contents over the top of the polyester cosmetic ball in the small filtering funnel which drains into a large (20 X 150 mm) test tube on which you marked the 20 mil level. Do not worry if you cannot get every last drop of the suspension out of the test tube.

   Let the filtrate pass through the small filter completely by gravity. Sometimes pressing the cosmetic ball will succeed in driving more water extract off the polyester fibers. This step is important because if you don't get all of the original, undiluted extract in the final test sample, your concentration value will be falsely low. I have occasionally forgotten to do this squeezing step and have had readings which were off by 25%.

   Although you could get more consistent results by just using filter paper instead of the cosmetic ball, by filtering the thinly mucilaginous mushroom suspension with the cosmetic ball you can save literally hours of waiting for all the suspension to get through the paper filter.

7. Now use the wash bottle filled with distilled (or deionized) water and rinse the sides of the test tube used to extract the mushroom sample with a few milliliters of water. Note that the cosmetic ball filtered extract does not reach the 20 mil mark on the test tube. This loss of fluid came primarily from evaporation when you were heating the mushroom suspension.

   For reasons of standardization all our test solutions need to have a total volume of 20 mi. Shake the unmarked test tube which you just added some rinse water to and pour an estimated amount of the rinse water which will fill up the test tube to the 20 mil mark over the cosmetic ball filter. This rinse will remove most of the residual extract left on the polyester ball and will dilute the initial filtrate up to the 20 mil mark. Watch the filtering carefully and remove the filter to the sink once the level has reached the 20 mil mark.

   The largest errors can occur in the filtering and dilution steps. If in the process of washing the filtrate and bringing up the filtered volume to the 20 milliliter mark, you add too much water to the top of the funnel filter you will dilute some of the extracted sample which will not then pass through the filter.

   Since you have reached the 20 ml mark you are forced to discard the water which may contain some of your sample. The results may then be artificially low. Solution: add smaller amounts of rinse water with the squeegee bottle, so that you will not leave any of the liquid mushroom extraction on the filter that will then not be part of the test.

   If in the process of rinsing the sample on the cosmetic ball and adjusting the 20 mil volume, you should over-fill the test tube beyond the 20 mil mark, just correct the final absorbance by multiplying the absorbance by a fraction consisting of the volume which was filtered (over 20 milliliters) as the numerator and 20 as the denominator.

8. This rough filtered extract is your test sample but needs to be filtered again so that it is clear and will not add absorbance to the colorimeter reading because of its cloudiness. Pour this extract through another small plastic funnel with a folded piece of filter paper in it. Fold the filter paper on itself three times (i.e. into eighths).

   Most extracts will have some colloidal suspension in them, making them look slightly cloudy. Even filtering these with a fine filter will not remove all the turbidity. For most filtering you will need to remove only coarse particles and the Whatman #4 filter paper will suffice. For heavier suspensions use the finer, but slower, Whatman #2 filter paper. The idea here is to obtain a reasonably clear sample which has the least amount of turbidity. Turbidity, if excessive, will give false high colorimetric readings.

   For the receiving container for this filtrate, use another large test tube as the receiver. After a few milliliters of fluid has passed through, you can stop the process if you wish. I usually like at least enough prepared sample for a couple of tests (each tests requires 0.5 or 1.0 ml of sample), just in case I wish to repeat a reading.

9. The preceding two-step filtering process should take 10 to 15 minutes. While the filtering is proceeding, using the pipette-aid and the 10 mil pipette, draw up 2 mil of the DMAB reagent and dispense it into a matched cuvettes/small test tube. Continue dispensing the DMAB reagent into a matched cuvette for each sample or test you may wish to run. Now you are ready to develop the color and read the final absorbance. If you store the DMAB test solution in the freezer, allow it to return to room temperature before using it in a test.

10. Using the pipette-aid and the 1 mil graduated pipette, draw up a 1 ml sample of the mushroom extract to be tested. If you anticipate an absorbance reading above 0.700 A or so, then draw up only 1/2 mil of sample, but before doing so add a 1/2 mil of Deionized or distilled water to the small reaction test tube/matched cuvette.

    The reason for this dilution is that for colorimeters with a transmittance scale, the most readable portion of the scale lies above 20% transmittance. Lower transmittance than this corresponds to higher absorbance and greater possibility of reading errors and poor precision. I checked to make sure that both ways of testing equaled the same value after making the necessary multiplication of the diluted sample by two.

    The total combined test volume must be 3 mil for both the sample and the DMAB reagent. The aqueous sample will not immediately mix with the much denser DMAB reagent but will rest on top until mixed.

11. Make sure your timer is ready. Hold your thumb over the reaction tube with the plastic sheet between the thumb and the test tube and turn the tube upside-down then back again. Do not shake because the shaking will add bubbles which can remain on the walls of the test tube and interfere with the colorimetric reading later. Either start the timer or note the time immediately. After exactly 30 minutes, read the transmittance on the colorimeter (or absorbance if your instrument has a direct liner conversion to absorbance from transmittance).

    Sometimes the reaction mixture in spite of filtering the sample will become turbid. If so, dilute with 3 ml of DI water, read and divide the absorbance result by two. This dilution will usually water down the turbidity enough to be able to read the test.

    It is important to test the mushroom extraction solution soon, otherwise the bluing and other oxidation reactions will breakdown the active tryptamines and cause you to have a false low value for the test's absorbance. By testing the mush- room extract solution at regular intervals, I found that no significant reduction of the active tryptamine concentration occurred until after six to eight hours.

    I have always conducted this test under two 40 watt fluorescent lamps. In light of the research paper which used UV to accelerate the DMAB color reaction[6], fluorescent lamps may have more of their spectral output in the near UV than incandescent lights or sunlight coming through a glass window. The absence of such lighting in your test area may slow the reaction down and thus cause you to have lower readings after the 30 minutes than mine. I have not confirmed this, but be aware of this possibility.

12. At the end of 30 minutes, read the colorimeter scale and note the value for later reference. When reading the meter (unless the meter is digital) look directly down on the needle to the scale. If you should read the needle at an angle, your reading will not be as accurate, nor reproducible. As the value of the transmittance becomes smaller, errors in reading make a greater difference in the final absorbance (or concentration) value. Some meters have a mirror below the scale. By looking down on the needle such that you cannot see the needle's reflection, then you know that you are looking directly down on the needle and meter. Try to interpolate or "guesstimate" the value if the needle should fall between two divisions and show this as part of your recorded value (e.g. 14.6%) If you have a colorimeter or spectrophotometer with a direct absorbance output, your test value will be directly proportional to concentration of the tryptamines present in the mushroom sample. If, on the other hand, your colorimeter has a transmittance scale (i.e. 0-100%) and only a log absorbance scale (i.e. the distance between integers gets smaller as the numbers get larger), you will need to convert your transmittance to absorbance. The formula is: Absorbance Log (1/.01 X Transmittance in %).

    The easiest way to calculate this is to buy an inexpensive calculator with a "log" and "1/x" or reciprocal functions. Then calculate by entering the transmittance as a number between one and one hundred, divide by 100, push the "1/X" key then push the "Log" key. The result will be the absorbance which is proportional to concentration.

Conclusion

It is my hope that the above helps to explain the test values which will be used in the upcoming articles. The next article on the environmental and nutritional influences on the growth and biosynthesis of psilocybin in P. cubensis will make use of this test extensively. The last section of this article, of course, is for those people inclined to do their own testing. I encourage anyone with any amount of chemistry background to try this test. The test values will help immensely in planning your own entheogenic experiences with the "magic mushroom."

Bibliography

1. Agurell, S., Blomkvist,S. and Catalfomo, P., "Biosynthesis of Psilocybin in Submerged Culture of Psilocybin cubensis: Part I. Incorporation of labeled tryptophan and tryptamine," Acta Pharm. Suecica, Vol. 3 (1966), 37-44.
2. Agurell, S., Lars, J. and and Nilsson, C., "Biosynthesis of Psilocybin: Part II. Incorporation of Labelled Tryptamine Derivatives, Acta Chemica Scandinavica, Vol. 22, No. 4 (1968), 1210-1218.
3. Beung, M.W. and Bigwood, J., "Quantitative Analysis of Psilocybin and Psilocin in P. Baeocystis by HPLC and by Thin-Layer Chromatography, Journal of Chromatography, Vol. 207 (1981), 379-385.
4. Bigwood, Jeremy and Beug, Michael W., and others, editors. "Variation of Psilocybin and Psilocin Levels with Repeated Flushes (Harvests) of Mature Sporocarps of Psilocybe Cubensis (Earle) Singer," Journal of Ethnopharmacology, Vol. 5 (1982), 287-291.
5. Casale, John F., "An Aqueous-Organic Extraction Method for the Isolation and Identification of Psilocin from Hallucinogenic Mushrooms," Journal of Forensic Sciences, Vol. 30, No. 1(Jan., 1985), 247-250.
6. Catalfomo, P. and Tyler, V. E., Jr., "The Production of Psilocybin in Submerged Culture by Psilocybe cubensis, Lloydia, Vol. 27, No.l (March 1964), 53-63.
7. Christiansen, A.L. and Rasmussen, K.E., and others. "The Content of Psilocybin in Norvegian Psilocybe semilanceata," Planta Medica: Journal of Medicinal Plant Research, Vol. 42 (1981), 229-235.
8. Haard, Richard and Karen. Poisonous & Hallucinogenic Mushrooms, 2nd Edition. Cloudburst Press, 1977.
9. Leung, A. Y. and Smith, A. H., and others. "Production of Psilocybin in Psilocybe Baeocystis Saprophytic Culture, Journal of Pharmaceutical Sciences, Vol. 54, No. 11 (November 1965), 1576-1579.
10. Leung, A.Y. and Paul, A. G., "Baeocystin and Norbaeocystin: New Analogs of Psilocybin from Psilocybe baeocystis," Journal of Pharmaceutical Sciences, Vol. 57, No. 10 (October 1968), 1667-1671.
11. Leung, A.Y. and Paul, A.G., "The Relationship of Carbon and Nitrogen Nutrition of Psilocybe baecocystis to the Production of Psilocybin and its Analogs," Lloydia, Vol. 32, No. 1(March, 1969), 66-71.
12. Lewis, Waiter H., Medical Botany: Plants affecting Man's Health. Chapter 18, Hallucinogens. Wiley-Interscience, John Wiley & Sons, 1977.
13. Norland, Richard. What's in a Mushroom. Pear Tree Publications, 1976.

14. Repke, David B. and Leslie, Dale Thomas, and others. "Baeocystin in Psilocybe, Conocybe and Panaeolus," Lloydia, Vol. 40, No.6 (Nov-Dec 1977), 566-578.
15. Sarvicki,editor. Photometric Organic Analysis, Vol 31. Wiley-Interscience, 1970.
16. Snell & Snell,editor. Colorzetric Methods of Analysis, 3rd Edition, Volume IV. Van Nostrand, 1954.
17. Stafford, Peter. Psychedelics Encyclopedia. From Chapter 4, "Mushrooms". Berkeley, California: And/Or Press, 1977.
18. Weeks, Amold R. and Singer, Rolf, and others. "A New Psilocybian Species of Coplandia," Journal of Natural Products, Vol. 42, No. 5 (1979), 469-474.
19. Windholz, Martha, editor. The Merck Index. Ninth Edition, Entries #7711 and #7712. Rahway,N.J.: Merck & Co., Inc., 1976.

Fly Agaric Tincture

by

Sam Malone

from **flyagarictincture.blogspot.com**

original source: http://flyagarictincture.blogspot.com/

> *The fly agaric won't actually kill any borrelia bacteria. You'll still need something else for that. But what it is doing is alleviating the symptoms that make this disease so horrible. For me, this is mostly chronic fatigue and dementia symptoms.*

Table of Contents:

- **Fly Agaric Mushroom *(briefly)***
  - Background
  - Theory
  - Identification
  - Collection
  - Preparation
    - *Drying Whole*
    - *Drying Small Pieces*
    - *Make Into Tincture*
    - *Freezing*
    - *Compress*
  - Dosage
    - *Dried/Frozen Mushroom Pieces*
    - *Tincture*
  - WARNINGS
  - My Experience
- **Day 1 to 3**
- **Gathering the mushrooms and making the tincture**
- **Drying the mushrooms**
- **First Week Summary**
- **Ten Things I Learned This Week**
- **Week Two Summary**
  - comments 1
- **Finishing the Tincture**
  - comments 2
- **Week Three Summary (Getting the Dosage Right)**
- **Tradition of Using Fly Agaric Medicinally**
- **Advice for an Imaginary Test Subject**
  - The Tincture
  - Taking the Tincture
  - Results of Taking the Tincture
  - Safety
  - comments 3
- **How Fly Agaric Tincture is Used in Germany (Possibly)**
- **Week Four Summary**
- **Week Five Summary: Starting Antibiotics**
- **Week Seven Summary: External Application of the Tincture**
- **Migraine and Fly Agaric Tincture**
- **External Use of Fly Agaric Tincture on Sciatica, Back Pain etc**
  - comments 4

- **Borrelia: infecting people since prehistory**
- **Fly Agaric Tincture and the Lymphatic System**
  - comments 5
- **Three Month Summary**
  - Internal Application of Fly Agaric Tincture
  - External Application of Fly Agaric Tincture
  - External Application to overcome Chronic Fatigue
  - Cauldron of Rebirth
- **9 Month Update**
- **Some Russian Fly Agaric Treatment Products**
- **Some Russian Fly Agaric Medicinal Recipes**
- **Stalwart: forgotten folkname for fly agaric**
- **Letters from Russians who have used fly agaric medicinally**
  - Lung Cancer
  - Lung Cancer. Stroke
  - Stomach cancer
  - Rheumatism
  - Uterine cancer, throat cancer
  - Stomach polyps
  - Disease of the breast
  - Stomach cancer 2
  - Longevity
    - *Comment*
  - Questions - Answers
- **Fly Agaric and Radiation Burns**
  - Treating Radiation Burns with Fly Agaric
  - comments 6
- **Fly Agaric Protects Against Aging and Neurogenerative Disease**
- **Chemicals and Compounds of the Fly Agaric**
  - Muscimol
  - Ibotenic Acid
  - Muscazone
  - R-4-hydroxy-pyrrolidone
  - Tricholomic Acid
  - Muscarine
  - Bufotenin
  - Choline
  - Acetylcholine
  - Betaine
  - Atropene
  - Muscaridin
  - Hercynin
  - Uracil
  - Xanthine
  - Hypoxanthine
  - Adenosine
- **Bug Agaric in Herbal Simples for Modern Uses of Cure (1897)**

Fly Agaric Mushroom *(briefly)*

Wednesday, 16 May 2012

original source: http://lymeuk.blogspot.com/2012/05/fly-agaric-mushroom.html

Within half an hour I was transformed from a demented cripple into a normal person...

Amanita muscaria

Background

Fly agaric is used by sub-arctic NW Pacific peoples to treat psycho-physical fatigue, dementia, chronic fatigue, sclerosis, low immunity, skin problems, rheumatism, neuralgia and tumours. Lyme disease is endemic in the areas where these people live.

Theory

From what I understand, and what my LLMD (Lyme Literate Medical Doctor) has told me, the muscarine in the fly agaric mushroom is a neuro-transmitter. It forces open the muscarinic receptors, a form of acetylcholine receptor that plays a crucial part in the relay of electrical signals around the body. It is possible that these muscarinic receptors have become clogged with the neurotoxins created by the Borrelia bacterial infection. It's possible that neurotoxins from other infections could also have this effect.

Lymphocytes have muscarinic receptors too, so with muscarine they're able to do their jobs better, boosting immune defence. Fly agaric mushrooms also contain other chemicals with antimicrobial properties. The mycelium that creates them is like a plug-in immune system for the tree they attach to. It is believed that people can benefit from this antimicrobial activity also.

The raw, fresh mushroom contains ibotenic acid, which can give you an upset stomach. It's necessary to dry or cook the mushroom, which turns the ibotenic acid into muscimol, which won't upset your stomach. The small amount of muscimol may lift your mood a little.

Identification

The fly agaric mushroom is the classic toadstool of fairytale, a red mushroom with white spots. It is found throughout Britain, the season stretching roughly from late August to early December, under birch, oak or pine trees. It's unlikely to be confused with any other mushroom. It's best to take good fresh specimens, with either an open or closed cap.

Collection

Pick the whole mushroom. Take a non-metallic tool such as a clean wooden spoon to dig an inch or so around the base of the stalk. Sometimes it's possible to simply hold the stalk as low as possible and gently jiggle and pull it loose.

The mushrooms are the fruiting bodies of an underground mycelium in symbiotic relationship with the host tree. You can sustainably collect all fly agaric mushrooms you find, though it's best to take only the good fresh ones for medicinal use.

Wrap the mushroom in a large leaf, eg a dock leaf. Newspaper will stick to the caps.

Preparation

Wash the mushroom thoroughly. It doesn't matter if the white spots wash off. Try not to get the gills wet though, as they take a long time to dry again.

Cut out any bad bits or bits with wormholes in. You can use these to spread the fly agaric spore to another birch, oak or pine.

There are then several ways to prepare and preserve the mushroom:

Drying Whole

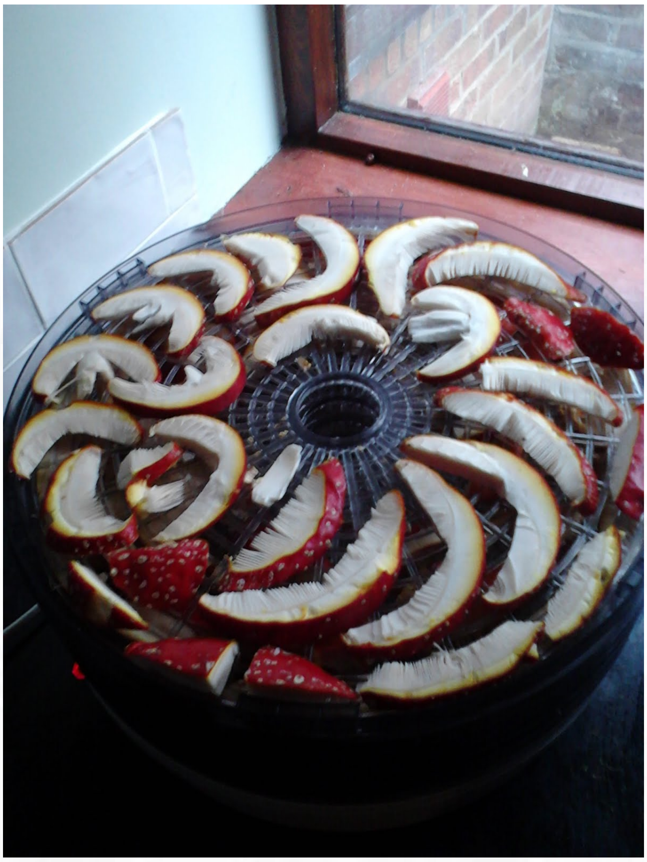
Use a skewer or thin stick to pierce the mushroom along its central axis. Leave on the skewer or thread onto a string. The image shows a Siberian rig. Dry in the hot air above a fire. This will take several hours, perhaps even more than a day. Once dry, keep in an airtight container, preferably with some desiccant in.

Break off pieces as required to eat or crumble into tea.

Drying Small Pieces

Cut the mushroom into thin pieces, around 2mm thick. They will dry more easily and quickly this way. Dry in a food dehydrator, or in the warm air above a fire, or in a warm airing cupboard. The image shows an improvised dryer near a solid fuel stove.

Overall I would probably recommend a food dehydrator. They're so easy to use. You can dry all sorts of other things in them as well, other plants to help treat your chronic illness, or fruit and vegetables for healthy treats. An open fire in the centre of a yurt would be best, but without that option, or an always-hot Aga, nothing is as easy as a food dehydrator. Mine only has one setting, but still does everything I ask of it.



Dry until the mushroom pieces are like crispbread, with all moisture gone. This will take several hours. Store in an airtight container, preferably with some desiccant in.

Eat a piece or crumble into tea as required.

Make Into Tincture

Cut the mushroom into small pieces (around 2cm square) and place in a jar. Cover with vodka or another 37-40% spirit. Shake a few times a day for 10-14 days. Filter through a muslin sheet. Store the mushroom vodka in a cool dark place.

Apply externally to relieve sciatica and other pain, including joint pain and swolle lymph nodes. The tincture can also be applied to external infections, for example nail fungus, and skin conditions found in Lyme disease.

Drops can be applied under the tongue to improve cognition in the short term.

The leftover mushroom pieces can be dried or cooked and eaten as required, though they won't be as strong as the ones in choice 2 above.

Freezing

Fry the mushroom, preferably in coconut oil, for around ten minutes on a medium heat. Cut into small pieces and freeze. Pieces can be eaten as required.

Compress

I haven't made a compress from fly agaric, so the following information is from nemf.org.

> Three small fresh pieces of mukhomor good for sore throat and cancer. Preparation for arthritis: Place several young A. Muscaria into an airtight container. Put container into a cool dark place (like a basement) until liquid comes out of mushrooms. Take a mushroom in hand, squeeze out moisture and place the pulp on arthritis. Bandage overnight. Mushroom body can be replaced in liquid and will last a long time.

Dosage

Dosage is an individual matter, varying not only from person to person, but also for the same person at different times, depending on their current neurotoxin load. The amount of muscarine (active acetylcholine chemical) present in the mushroom also varies, from one mushroom to another, and even within the same mushroom. It's best to take a small amount at a time and monitor effects.

Dried/Frozen Mushroom Pieces

It's best to start with a small amount, a piece the size of one of your little finger bones. Any benefits will be apparent within an hour. If no benefit is felt, another little finger bone sized piece can be taken. It's best to stick to a limit of three pieces this size per day.

Tincture

Rub in as much as is required to cover the target areas. If the pain or discomfort is relieved, this is likely to last for hours. Repeat as required.

Under the tongue - a few drops under the tongue. The effect will be almost immediate. Repeat as required, but don't be tempted to overdo it.

WARNINGS

Fly agaric can be fatal, though a fatal dose is in the region of 20-30 mushrooms at a time.

Large amounts of fly agaric can lead to a sense of unreality, like Alice in Wonderland. If this happens to you, don't take any mushroom for a day or two.

According to Wikipedia:

> Muscarine is contraindicated in patients with diseases that make them susceptible to

> parasympathetic stimulation, patients who have asthma or COPD or patients who have peptic ulcer disease. Also patients with an obstruction in the gastrointestinal or urinary tract are not prescribed muscarine because it will aggravate the obstruction, causing pressure to build up that may lead to perforation.

The antidote for fly agaric mushroom is milk thistle. The antidote to muscarine is atropine.

My Experience

I'd spent the whole summer lying on my boat, feeling like death, mostly too crippled to do anything, mostly too demented to see anyone.

With no memory of the past and no cognition to imagine the future, I was very much in the here and now. My butterfly brain kept settling on the colour red. Somehow this translated into me biting into a fly agaric mushroom for the first time. Just one small bite.

It tasted great. And within half an hour I had a surge of energy. It seemed as if I was doing things almost before the thought of doing them had even occurred. The headfog was clearing. It was like waking from an enchantment. It wasn't in any way "trippy" - I was simply returned to normality.

There were only a couple of weeks left until the fly agaric season was over. Every day I took a bite of mushroom and went out collecting more. Some I dried, some I froze, some I turned into tincture.

It was immediately obvious I was onto something huge, and I started writing the blog flyagarictincture.blogspot.co.uk. Prior to eating the mushroom, I couldn't read or write anything. I just didn't have the requisite cognition or attention.

There didn't seem to be any information on the web about this. All I could find was from helium.com.

> Fly agaric is still used in Siberia and Russia especially by elder people to reduce fatigue, to give more strength and to raise the spirit.

Nearly a year on and I'm still on the fly agaric pretty much every day. Just small amounts. Despite my experiments with fly agaric tincture, I now think that eating a little of the mushroom every day works best, fresh, frozen or dried. It is impossible to determine a definitive dose, as the amount of muscarine will vary from one mushroom to another. But I generally take an amount the size of a little finger bone between zero and three times a day, depending on whether I think I need it or not.

For a few months whilst on the fly agaric, I had blood tests to check my liver function. It was always fine.

Day 1 to 3

Thursday, 17 November 2011

original source: http://flyagarictincture.blogspot.com/2011/11/day-1-to-3.html

I've got chronic Lyme disease, caught from a tick bite many years ago, and it's almost impossible to get diagnosis and treatment here in the UK (and in many other countries). So people with Lyme disease either have to find a doctor who understands and can treat it (pretty much always private and also very rare and expensive), or try to treat it themselves. I've started this blog to document a treatment I'm trying: fly agaric tincture.

Chronic Lyme disease can hit your nervous system and brain really hard. It's estimated that you lose 30-50 IQ points while chronically infected (sorry, I'll try to include some links to relevant research at some point). It makes any sort of rational thought pretty much impossible. So bear with me - there's a good chance this narrative will jump all over the place.

With most treatments for Lyme disease, it's really difficult to tell whether it's working or not. Generally, if a treatment regime is having the desired effect and killing off some of the bacteria, you'll actually feel worse. This is believed to be because the bacteria as they die give off neurotoxins, which knock you for six. When a whole load of bacteria die off at once, it can produce a Herxheimer effect, first noted in syphilitic patients. This is an acute increase in symptoms, and usually lasts a few days. My first one involved nausea and an extreme thirst.

Taking the fly agaric is a completely different experience. I hasten to add, I'm just taking the fly agaric in tiny doses, nowhere near enough to get high, hallucinate or trip out. This treatment isn't about that. It's just about finding something that can either fight the bacteria, restore some quality of life, or even both.

There are many caveats with fly agaric (Amanita muscaria). In very large doses it can kill. In smaller doses it can alter your perceptions and cause you to hallucinate. In tiny doses there seems to be much less risk, but this cannot be described as a risk free treatment. I'm not suggesting anyone try this themselves. I just want to record my own experiences. Also, the amount of active chemicals in the mushrooms can vary massively, depending on the time of year, method of preparation and other unknown factors. Even two mushrooms growing side by side at the same time, prepared the same way, can result in very different levels of active chemical. This makes dosing very difficult. It seems best to start with very little.

I don't think it's possible to buy fly agaric tincture anywhere, so I realised I would need to make my own. Despite a couple of years of being completely crippled with chronic Lyme, I'm now able to walk around a bit most of the time, and was able to find four fly agaric growing wild (I'll expand on identification and collection in another post). Finding little information on the web, I decided to try several different methods of preparation and preservation.

I didn't want to wait 2-3 weeks for a tincture to be ready, so determined to chop, fry and freeze the first mushroom. I chopped another and preserved it in vinegar. I chopped another and covered it in vodka (32%-40%) to make a tincture. The last one I set air drying, intending to eventually crumble it into tea. I'll go into the actual methods in more detail in another post, and link to the articles that gave me the ideas.

PATAK'S
PATAK'S

The initial dose was a seventh of a cap, eaten with breakfast. Within half an hour I began to feel more alert and aware. I spend most of my time lying around feeling like death, but within an hour I was up and about and feeling very lively. I cycled into town and did some chores. There was no "coming up" rush, no hallucinations or change in perceptions beyond feeling lively and really up for it. It was the best day I've had in an awfully long time. Probably years. At no point did I feel any stomach cramps or nausea, possibly because of the small dose, possibly because the mushroom had been cooked.

The liveliness wore off in the late afternoon, and I did get pretty tired. I was back out for more fresh air and exercise though. Actually I went out looking for more mushrooms! This is the first treatment I'd tried that undoubtedly makes you feel better.

I mentioned this experiment on the Lyme disease forum I frequent. Within an hour of taking the first bit of mushroom, I felt I might be onto something, and wanted to let someone know, in case I was run over by a bus or something. To my astonishment, someone on the forum had ten days earlier been given a bottle of fly agaric tincture by a top herbalist, to treat the "head fog" or mental confusion that goes along with chronic Lyme. He was told to put a couple of drops under his tongue every half hour until his head felt clear. I've since found out that you can get fly agaric tincture on prescription in Germany.

I was certainly very tired that evening. I'd done a lot more physically than I normally would in a day. I slept very well that night.

Day 2 I took half the amount of fried and frozen and refried mushroom at breakfast, taking the other half of a seventh of a cap later in the afternoon. This was to try and even out the energy levels throughout the day. Again, I found I had energy and mental clarity way beyond what I've become accustomed to. The best way to describe it is that it is as if an enchantment has been lifted. The chronic fatigue aspect of Lyme seems to disappear. Last week it was a huge effort to just try and think around a simple chore, let alone do it. This week, the chores are simply done, in less time than it would normally take to try and get your head round what needs doing. It's starting to feel quite miraculous. Needless to say, I was out hunting for more mushrooms again.

I'm still not letting myself get too over-excited though. In the summer I took a month long course of Korean ginseng, to try to get some energy. The first couple of days I felt all right, but then was much worse for the rest of the summer, without a single "good day". I've since found out that ginseng can feed the energy of the bacteria and actually make you feel worse. I'm hoping that the same thing isn't true of fly agaric.

I had trouble getting off to sleep that night, and thought that perhaps I had taken too large a dose in the afternoon. It's already becoming clear that multiple tiny doses, such as tincture drops, would be a much better way of administering the fly agaric, and managing the levels you're taking.

Day 3 I took a similar amount to Day 2, but missed out the afternoon dose. I think even my small doses are possibly too large. Energy levels and mental clarity continued to be astonishing. My long-suffering boyfriend is amazed at the change in me. He even got breakfast in bed this morning.

Again I was out mushroom hunting. It's getting near the end of the season, so it makes sense to collect them now. In exchange for taking the mature mushrooms, I plant some fly agaric spore, which is found in the gills of the mature mushroom. I'll go into more detail in another post at some point.

I missed the afternoon dose but still had trouble getting to sleep. I should add, insomnia is one of the symptoms of chronic Lyme, and comes and goes. It could be unrelated to the fly agaric experiment.

I've given up the other methods of storing the mushrooms (pickling, drying and freezing). With the pickled mushroom, all the red colour was leaching into the vinegar, and I was concerned that the active chemicals might end up in the vinegar. I've also decided to dry the mushrooms for a few days before making the tincture. From my experiments so far, this should ensure a deeper red hue in the tincture. Since it was the colour that drew me to the fly agaric in the first place, this seems important.

EDIT It seems it wasn't the drying that made the colour brighter. There was an immature mushroom in one batch (it had been kicked over so I bagged it up) and the colour is much brighter before they reach maturity. I guess the tincture will end up pink, but pink is good too :).

Gathering the mushrooms and making the tincture

Friday, 18 November 2011

original source: http://flyagarictincture.blogspot.com/2011/11/gathering-mushrooms-and-making-tincture.html

Amanita muscaria is found mostly in woods, from late summer to late autumn. Mostly around birch trees, they can also be found around oak and pine. They stand out a mile, bright red, usually with white spots, unless they've been washed off by the rain.

There are real dangers if you take the wrong mushroom, so if you're not 100% sure, don't do it. Your life or liver might depend on it.

These photos are of some mushrooms I found on the common yesterday.

I've just been taking the mature ones (when they've flattened out), and returning for the immature ones a few days later, by which time they've matured. There's a frill halfway up the stem. Cut them off there, then you can air dry them without crushing the gills.

To say thank you I propagate the spore to create new colonies:

- Put caps or bits of caps that aren't good enough for medicinal purposes (if they've started to go off) into a container.
- Add water and mix or shake well.
- Pour over the roots of a birch, oak or pine tree that doesn't already have a colony.

Wrap your harvest individually in cloth. Newspaper will do, but bits of paper will probably get stuck on the mushroom.

I'm still experimenting with what to do next, but here's what I'm currently doing.

- Air dry the mushrooms for a couple of days, preferably somewhere sunny, warm and drafty.
- Clean any dirt off the mushroom once it has dried. Don't wash the mushroom. Clean the dirt off with a soft brush or your fingers. It doesn't matter if some bits are left.
- Cut into pieces around a centimeter or half-inch square.
- Put into a jar and cover with spirit that is 32-40% proof. Stop pouring when the mushrooms start to float. Within a little while the mushroom pieces will start to shrink and the spirit will take on a pink or red hue.
- Put in a warm and sunny spot for 2-3 weeks.
- Strain the liquid off. Don't force anything through the muslin or whatever.

Drying the mushrooms

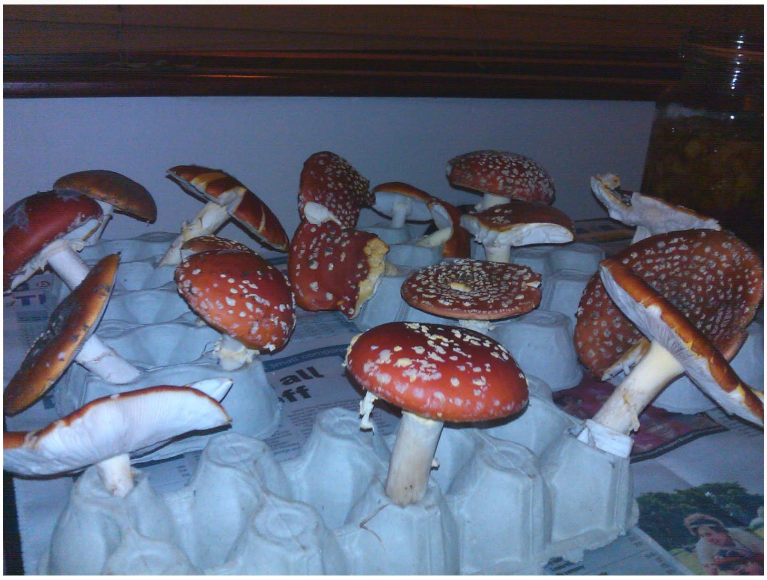
Saturday, 19 November 2011

original source: http://flyagarictincture.blogspot.com/2011/11/drying-mushrooms.html

The mushrooms I was attempting to air dry weren't really getting any drier. I picked them before realising that the gills would need a good air flow around them, and I didn't leave a stalk. Thinking about it now, I could have perched the cap on a stick to dry, but I didn't think of that at the time. We had a good fire burning, and I thought I'd give heat drying a try.

I'd read that the gills go temporarily mushy when heated, and they should be placed top up to catch and dry any goo. I put them in the ashes under the fire overnight, and they were lovely and crispy this morning. I've put them in an air-tight container and will pop a bag of desiccant in there if I can find one.

Harvesting continued today. I don't know whether the unseasonably warm weather is extending the fruiting season, but don't want to run out of these miracle working mushrooms before the next season comes around, not until the end of next summer.



I cut today's crop with their stems on, to have another go at air drying. If they're still not drying successfully, I'll fire dry them or freeze them. Stuck into holes in egg boxes, they make a little enchanted tabletop forest.

First Week Summary

Monday, 21 November 2011

original source: http://flyagarictincture.blogspot.com/2011/11/first-week-summary.html

It's now a week since I started taking very small pieces of fly agaric mushroom for my Lyme disease. I have to say, it's proving successful beyond my wildest dreams. I spoke with my LLMD (Lyme Literate Medical Doctor) at the weekend, and she expressed great interest and explained to me how it's working. And it is undoubtedly working.

The fly agaric won't actually kill any borrelia bacteria. You'll still need something else for that. But what it is doing is alleviating the symptoms that make this disease so horrible. For me, this is mostly chronic fatigue and dementia symptoms.

Up until last week, my days largely consisted of lying around feeling like death, too mentally confused to do pretty much anything. I'd stopped going out and seeing people, because I couldn't keep up with conversations, and I would sometimes say things that offended people, without realising what I was doing. Plus I had absolutely no energy.

Since starting the fly agaric experiment, it's been like breaking an enchantment. I've been describing it as a miracle, and that's exactly how it feels. Within half an hour of taking the first piece I could feel the difference.

I've been incredibly active every day. My cognition is so improved. There's no way I would have been able to string my thoughts together in a blog like this before. Friends and family have mentioned how much better I am, and that I have a sparkle back in my eyes. I really feel like myself again. I haven't been able to work for four years (I was a computing lecturer), but I feel now that I could certainly do something, and I don't feel hugely far off lecturing again, once I get my stamina and full mental ability back.

Fly agaric is still used in this way - ingesting small daily pieces to treat psycho-physical fatigue and more - in remote areas of Siberia. I haven't found anything new, just something that has been forgotten by our culture. Not a cure, but a treatment for chronic fatigue, dementia and more (possibly Parkinsons, schizophrenia and more). It's also great as a painkiller, and I no longer use my previous method of pain control. The mushroom is enough.

Here's a bit of science, but I don't pretend to understand it, so if I've made an error - or if you can explain it better - please let me know via email or comments. It seems that neurotoxins (from the bacteria dying off) clog up the muscarinic receptors (which are acetylcholine receptors), and messages contained in neurotransmitters can't get across. A chemical in the fly agaric mushroom forces these messages across, and hey presto, suddenly you can move and think again.

Of course, just because this treatment is working for me doesn't mean it will work for everyone. Lyme disease can present very differently in different people. And there are dangers involved, either through picking the wrong mushroom or taking too much.

Once my tincture is ready, in another week or two, I'll be moving onto that, but until then I'll continue harvesting (the season end is drawing near) and eating a little cooked and frozen mushroom every day. Someone very dear to me has early stage dementia, and I intend trying to get them to take it. And a good friend has bad back pain, and I'll try her with the tincture drops once they're ready. For back pain, apparently you can just put a few drops on the site of pain - no need to ingest it - so it'll be interesting to see what happens there.

The images on this post are from sxc.hu, a free photo site.

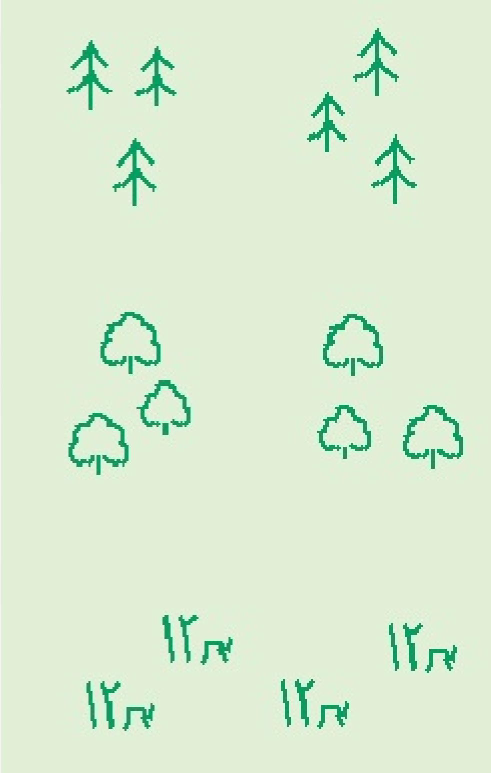
Ten Things I Learned This Week

Thursday, 24 November 2011

original source: http://flyagarictincture.blogspot.com/2011/11/ten-things-i-learned-this-week.html

Everything's still going well, ten days into the treatment of Lyme disease with very small amounts of fly agaric. I'm still eating bits that have been cooked and frozen, as the tincture isn't ready yet.

1. *Image (below) from top: coniferous, deciduous and coppiced woodland. Some woodland is a mix of these types, in which case there will be a combination of symbols.*
   The easiest way to find woodland to search for fly agaric is to look at a local Ordnance Survey map.
   Although the fly agaric mycelium can be hosted by pine and fir, these forests, in Britain at least, are more likely to have been relatively recently planted for timber, and unlikely to harbour any Amanita muscaria.
   Coppiced woodland is likely to be hazel, willow, sweet chestnut, hornbeam or alder, none of which host the symbiont, so are probably not worth hunting in.



2. I've stopped wrapping the individual mushrooms in newspaper, as it was sticking to the tops of the caps. A basket or cloth bag is a better bet.

3. The stalks are likely to contain maggots. I left the stalks on the mushrooms I was air drying, which resulted in more than a hundred tiny maggots wriggling around on the coffee table. Luckily I removed them before my boyfriend spotted them! From now on I'll either leave the stalks in the ground or use them to spawn with.

4. When spawning I've found that if you dig (just with a small stick) around the base of a host tree (birch, oak, pine, fir), ready-made fissures can appear. The idea is to get the spore on the roots, so I've started making use of these fissures. I've also put pieces of mushroom into animal burrows that lead under a potential host tree.

5. The best way to remove bits of dirt from the mushroom cap is with a mush brush, a special soft brush for cleaning mushrooms without damaging their skins.

I've ordered one but it hasn't come yet. I'll review it when it does. I'm hoping that it will work on damp mushrooms as well as dry ones.

6. Drying the mushrooms can cause an allergic reaction. I was pulling the stalks off the mushrooms I've been air drying, and my nose started running. My nasal membranes were sore for quite a while. I don't think I'm going to air dry again.
7. An alternative to air drying is to use a food dehydrator. If I weren't able to take the tincture - if I had an allergy to alcohol for example - I might consider this route.
8. I started on a new mushroom from the freezer this week. I took a piece the same size that I had from the previous mushroom, but became very clumsy. I think that the new mushroom has more active ingredient. I've been taking smaller pieces since, and everything has been fine again.
9. All things considered, I think I will clean, chop and tincturise the mushrooms right away from now on. As well as avoiding drying allergy, it will also make the strength easier to determine, by averaging out the strength of all the mushrooms in the vodka.
10. It's best to shake the jar with the mushrooms in before adding the vodka. This helps them settle, and you can fit more mushrooms in the jar.

Week Two Summary

Monday, 28 November 2011

original source: http://flyagarictincture.blogspot.com/2011/11/week-two-summary.html

I've been taking very small amounts of fly agaric tincture to treat my Lyme disease for two weeks now. For this update I'm going to list my individual symptoms and explain how the mushroom has affected each one.

1. **Exhaustion/Chronic Fatigue -** Before I started taking the mushroom, it was extremely difficult to do anything but lie around without the slightest energy to do anything. It would take the hugest effort of will to do the slightest thing.
   This changed within half an hour of taking the mushroom for the first time, and has improved ever since. I've been so lively the last two weeks, and am up and doing something almost before I've thought about it. This turnaround seems to me, and those that know me, nothing short of miraculous.

2. **Cognition -** Before starting on the mushroom, my cognition had deteriorated to such a degree that I couldn't get my head round anything. If I had to do something, or think about something, that required more than one step, I couldn't do it. I couldn't string my thoughts together to write anything. I couldn't compare or summarise anything. My IQ must have dropped a huge number of points.
   Since taking the mushroom, this is the other major area that has seemed miraculous. The difference is huge, and my cognition is still improving. I've been able to pick up my work developing mobile phone apps, which I'd had to give up several months ago because my brain simply wasn't working. I can keep up with conversations again. I'm able to formulate my thoughts enough to write this blog.

3. **Memory -** Prior to the mushrooms, my memory was shot. This is related to cognition, above, and together they make up the majority of the "dementia-like symptoms" that you get with Lyme disease.
   It seems that some medication aimed at treating dementia uses the same mechanism as the fly agaric tincture, for example:

   > Piracetam improves the function of the neurotransmitter acetylcholine via muscarinic cholinergic (ACh) receptors which are implicated in memory processes. (from Wikipedia)

   Needless to say, my memory is greatly improved now. I no longer have to carry a list round with me detailing anything that I'd need to do that day (assuming I'd remember to write it down in the first place, not lose the list, or forget the list even existed). I'm almost able to take my memory for granted again.

4. **Loss of Control** - The other main "dementia-like" symptom is very creepy, and involves seemingly losing autonomic control over your actions, and doing and saying things you really didn't intend to.
   I haven't lost control and done or said anything inappropriate since I started on the mushrooms. This was the main reason I had stopped socialising (as well as the chronic fatigue), as I was terrified I would say something that offended someone, and this did happen a couple of times. It's such a relief to be free of this.

5. **Stamina** - Prior to the mushroom, I could do little chores like housework for five or ten minutes at a time, then would need to rest for at least five or ten minutes. My muscle and tendon trouble would mean that I couldn't be on my feet for very long anyway.
   Yesterday I walked for around five miles, with barely a rest. This is far and away the furthest I've walked in four and a half years, since my life fell apart with what turned out to be Lyme disease. I was tired afterwards, but managed to watch a football match on TV and then cook and eat a roast pork dinner before dropping off for an hour's nap.
   It's probable that fly agaric is the Viking berserker mushroom that would give them such amazing stamina, so it's not surprising that it does improve stamina. I'm really getting a full day every day now.

6. **Pain** - An old injury in my neck, back and shoulder had caused me to need pain relief every day. This injury seems to have been colonised by the borrelia bacteria, as they can use your own collagen to build citadels for themselves in areas that are low in movement or oxygen. This is why with Lyme disease it's so important to keep moving and stretching your muscles, even if you're just lying there.
   Although I do still have low levels of pain and discomfort, I no longer require any pain relief at all.

7. **Muscle ache** - When exerting my muscles in any way, such as climbing the stairs, they would ache quite terribly. I still get this to some degree, but it is improved and improving.

8. **Tendinitis -** It was tendinitis in my ankles that started this health nightmare that eventually turned out to be Lyme disease. After two years of only being able to walk a few steps, this did improve with deep tissue massage, but was still a great limiter in what I've been able to do. The tendinitis would flare up, mostly in my ankles and knees, just about every month, when the bacteria have their monthly bloom. A bad flare would take weeks to get better. I had tendinitis in my ankles all summer this year, and could barely do anything.
   With all the extra exercise I've been getting since starting on the mushroom, I had a flare of tendinitis at the back of my knees last week. I expected it to last a few weeks as usual, but it was gone within a few days on the mushrooms.

9. **Hypocapnia/Hypocapnoea** (low carbon dioxide, causing nausea, dizziness, seizure, muscle spasm) - I'm not sure whether the mushroom is just improving the symptoms of this, or whether it's addressing my low carbon dioxide levels. I haven't had as much dizziness and muscle spasm, I've had no nausea, and it's much more rarely that I realise I'm not breathing.

10. **Cold -** My body does seem able to regulate its heat better. I'm sure the increase in activity must help with this. My temperature has been 35-36C before the mushrooms, but often at 37C since.

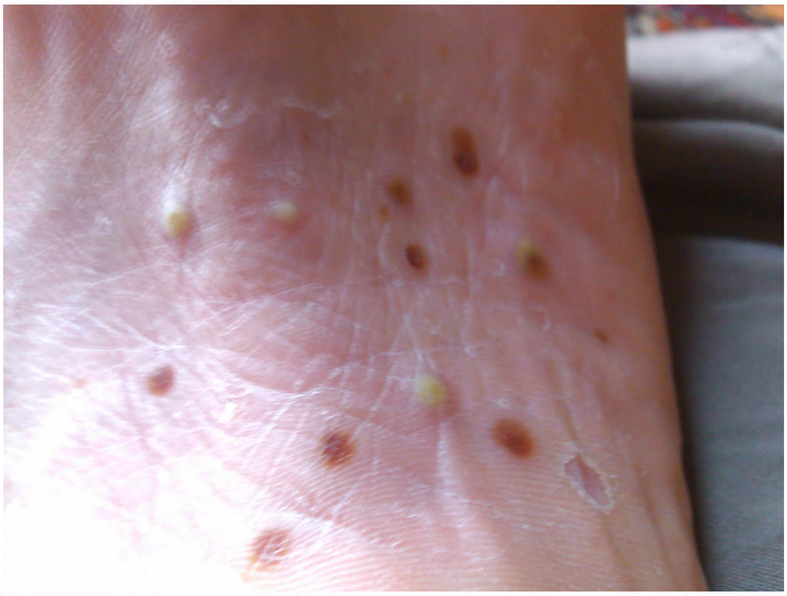
11. **Insomnia** - I haven't had any episodes of insomnia over the last week, though I did have a couple the week before.

12. **Tinnitus** - The tinnitus was very variable before starting on the mushrooms, so it's hard to say whether this has been affected. It hasn't been bad over the last week though.

13. **Tourettes-like moments** - When I remember something embarrassing I've said or done, a strange uncontrollable noise will erupt from me. I understand this is also related to Lyme disease. I've only had it over the last few years, during which the Lyme wrecked my life. I haven't had this as much over the last couple of weeks, but it does still occur every few days or so.

14. **Stress and worry** - My levels of stress and worry have gone way down since starting the fly agaric. I'm sure this must have a positive effect of many of my other symptoms as well. I honestly can't think of a time in my life when I've felt happier and less worried. The simple joy of being alive, and the beauty and draw of nature, are making my life a living paradise.

15. **Antibiotic Effect? -** I have had something on the sole of my left foot for probably two years now. I've been told variously that it's verrucas and athlete's foot, and treated it accordingly, but it's made no difference. Rubbing raw garlic into it would get rid of it briefly, but it always came back. My LLMD (Lyme Literate Medical Doctor) said that she thought it was bacterial. Since I started on the fly agaric a couple of weeks ago, the infection has almost gone.



16. **Sensitivity to Light** - I still have great sensitivity to light, especially when unexpectedly reflected.

I've tried to be as objective in this write-up as possible. I should add, this isn't the first treatment I've tried that I thought would work, so it can't be explained by a placebo effect. I really think I've stumbled onto something of immense value here, something that was once known but has been forgotten, except in some remote areas of Siberia.

I'm only two weeks into this experiment, so it's possible of course that difficulties may yet arise, but after two weeks, small pieces of fly agaric are having a seemingly miraculous effect on almost all my symptoms.

Photos on this post are from sxc.hu, a free photo site (except for the foot rot).

comments 1

dace2 *December 2011 at 05:51*
I appreciate reading such positive things about this mushroom!!! This has always been my Mum‘s favorite mushroom. Not to take medicinally but have a creative fascination with. She learned a great respect for it at an early age. She comes from a rural part of Latvia where the mushroom is known and used by native healers. She spent a great deal of time with a grandmother who was such a healer. They gathered such mushrooms but she doesn't recall exactly what it's use was. She knows it was greatly respected, which is partly where her own fascination began. Thank you so much for sharing your experience!

Sam Malone *3 December 2011 at 05:01*
Dace, thanks so much for letting us know! I think I'd very much like to travel where healers are using fly agaric. It's wonderful to know that this knowledge lives on in some places. Full respect to rural Latvia x

mb *4 January 2012 at 18:10*
Hello all - I have been taking tiny bits of the dry mushroom (say 1/4 " square sz, or a bit more for only four days.
I hesitate to post so early, but indeed both me and my husband feel a slight shift in attitude.
For the better! Slight mood enhancement and clarity - more positive.
We have had much reason for situational depression for several years now - so this change is phenomenal for us both.
I think of the literature I read about "elder folk" using the fly agaric in some cultures.
Would heed the warning of Henrietta's herb page - esp. if taking antibiotics - Agaric is very hard on the liver. Take good care!! MB

Sam Malone *5 January 2012 at 03:06*
mb - that's fantastic! Long may it continue! Thanks for letting us know, and do keep us posted on how it goes.

Anon *21 April 2013 at 23:20*
That foot problem looks like dyshidrosis. My mom has it.

Sam Malone *22 April 2013 at 02:59*
Many thanks for this! I still have the infection so I'll see what I can do. Thanks for taking the time to let me know - I really appreciate it.

mb *10 February 2017 at 14:47*
Hello! Thanks for your Blog! Marbritt (Mary Britton) I think we used to email occasionally about the fly agaric.

Finishing the Tincture

Saturday, 3 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/finishing-tincture.html

1. The chopped mushrooms have been soaking in vodka for 10-14 days now, so it's time to strain them and complete the tincture. The colour in the jar doesn't really show here, but it's a beautiful golden red.

It's been sitting in the sun for this time, as this is the advice for most tinctures, but it may well be that it would be better in the dark. I really don't know. The liquid is really clear though and smells good too.

2. The contents of the jar need straining first. I've borrowed my boyfriend's muslin cloth that he uses for wine making, but an old pair of tights would probably work just as well.

I've just left this to strain for an hour. I'm not sure whether to squeeze the mushrooms and get every last little drip out of them. I just let them drain with the first couple of batches, then put the mushrooms in the composter. But now the harvesting season's at an end and there's a finite supply, I've given these ones a good squeeze.

I'm going to save the squeezed mushrooms to try and cultivate the mycelium. More on that in a later post, fingers crossed!

3. I then run the liquid through a coffee filter. As you can see in the image of the completed jar (below), there is some white stuff that accumulates at the top of the jar. I think that this is the mushroom spore, which is definitely white, and small enough to get through the coffee filter.

The liquid itself is a gorgeous reddy golden amber colour.

Mushroom spore shell is made of the hardest yet lightest natural substance we know of. People such as Terence McKenna have posited that it's light enough for the spore to be blown anywhere on the planet, even into the upper atmosphere.

It is then hard enough to survive being sucked through the atmosphere and can be blown across the empty vast distances of space, perhaps eventually being sucked into another planet's gravitational pull, and forming a new colony in an alien land.

4. The tincture is then decanted into bottles. It's a good idea to label these to show what they contain, and with a warning that the contents are poisonous (if taken in excess).

I bought some stickers from eBay for this, some nice shiny fly agarics to show the contents, and some skulls to warn poison. The skulls however are from Nightmare Before Christmas, and look unbelievably cute. Best to keep out of reach of children. And teenagers.

comments 2

Simpler Thomas *31 December 2011 at 16:40*
Hey nice post! I discovered Fly Agaric about three years ago, and have been experimenting with it ever since. I have been taking subliminal amounts almost daily (dried stem pieces mostly) as well as occasionally cooking with it (smallish amount in an omelette in the morning) and eating larger amounts of the dried mushroom. This year I ate a small piece (size of a fingernail) while out mushie hunting. I didn't read your whole post and I am wondering if you tincture fresh or dry? The effect will vary in each case. Generally dried or cooked mushrooms are preferred over fresh (not just for the F. Agaric, but most mushrooms in general). This mushroom, although it has a reputation as a poison (mostly based on ignorance and fear, I'm afraid) which it doesn't actually live up to. It IS poisonous to smaller animals, like insects, and seems to have antibiotic properties as well (I use it as a general antibiotic in the winter to keep healthy, always alternating with probiotics of course). The only people who have ever died or gotten deadly sick from this mushrooms are those who have eaten an absurd amount of fresh mushroom deliberately (suicide attempts?). It will make you throw up if you eat an amount of fresh ones, but alot of mushrooms act this way... My personal opinion is that this was probably the first antibiotic medicine used by humans. It is easy to find, hard to miss, and impossible to confuse with another mushroom! I would even risk saying that it may be a good antibiotic for actually killing the life-form which causes lymes disease.... Why take expensive anti-biotics when you can go out into the forest and gather turkey tail and amanita musc.? It's just a thought... Glad that you are doing research on this wonderful medicinal mushroom! I'll read the rest of your blog when I have more time! Cheers!

Sam Malone *4 January 2012 at 04:25*
Thanks for your comment. I'd be interested to hear more about your experiences.
I experimented with making the tincture out of both dried and fresh mushrooms. I had a steep learning curve, and initially thought that it would be the muscimol I was using, so dried the mushrooms to ensure as much ibotenic acid as possible was converted to muscimol.
It now seems it's the muscarine that's really helping, though the other chemicals are probably helping, and, as you say, the antibiotic properties. I've read that fly agaric have antibacterial, antiviral, antiparasitic and antifungal properties as well.
It also makes a good plug-in immune system for oak. I'm really hoping it'll protect them against the apparently bacterial acute oak decline.
From now on I'll make the tincture with fresh mushrooms, including the stems. It seems to taste a lot better with fresh mushrooms (especially when using green apple vodka for the tincture).
Great to find someone doing something so similar! Best wishes, Sam

stmarys *11 December 2012 at 16:50*
Hi Sam,
Thanks for your interesting blog. I came upon it through a link from your post in the Telegraph online regarding Dr Sarah McKenzie Ross' research about organophosphates exposure, which I'd googled, having just heard her on Radio 4 today.
I was interested because my partner has recently been diagnosed with Primary Progressive Multiple Sclerosis, (which, as you may know, is an auto-immune disease affecting the myelin sheath, which insulates the nerves and helps in the transmission of nerve impulses between the brain and body) or at least, that's what the neurologists think it is. He is, or was, a farmer, all his life from a long line of farmers, so very likely has used these chemicals. MS is, of course, not the same as Lyme Disease but some of his symptoms appear to be similar to those caused, apparently by OP exposure, but also to those of Lyme Disease, (and probably to lots of others) though he is now severely disabled, barely able to walk, slow speech, constantly dizzy, fatigued, suffers tremours, memory problems, etc etc and is literally half the man he was as his muscles have deteriorated. There is, so far, no cure for MS, and he hasn't been offered any treatment, although there are treatments but only for the less severe types and not cures but merely to slow the progression.
The point of my post here - and I apologise for being long-winded - I realise the causes may differ, and while I'm not suggesting Fly Agaric could necessarily help him, but I was wondering if, along your research trail, you had ever come across anything covering MS, or rather, anyone using 'alternative' methods for treating the symptoms, as you are with Lyme and Fly Agaric.
While I am no scientist I don't believe anything without hard evidence, but I do believe these old remedies are often dismissed in modern times (at least, in the West) and deserve more respect and credence considering their efficacy has been 'field-trialled' over thousands of years, and indeed, currently, by yourself. I am also a cynic, however, and I certainly do believe the likes of Pfizer, Bayer and Monsanto are unlikely to support my beliefs, at least not without slapping on a patent, any time soon.
Warm Regards
Sue Phipps

Sam Malone *14 December 2012 at 09:40*
Hi Sue and so sorry to hear about your husband.
Actually in Siberia (and possibly further afield) they use fly agaric to treat MS! MS and Lyme are so similar, to the extent that a large number of people diagnosed with MS later find out that they actually have Lyme. I'll happily send you some fly agaric to try. It's probably easier to email me at crowcity@gmail.com
Have you heard about Dr Wheldon's explorations and experiments when his wife was diagnosed with MS? http://www.davidwheldon.co.uk/ms-treatment1.html
Updates on her progress are here: http://www.davidwheldon.co.uk/updates.html
Best wishes,
Sam

Week Three Summary (Getting the Dosage Right)

Sunday, 4 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/week-three-summary-getting-dosage-right.html

Week 3 has been good. I've continued to be active both physically and mentally, and have had no insomnia. In fact my confidence has been such that I've broken a little from the no alcohol, no dairy and no gluten diet I've been on since February.

The only trouble I've had is getting the tincture dosage right, and this has definitely affected my perception here and there.

The fly agaric tincture has matured now, after sitting in the sun for 10-14 days covered in vodka. So this week I stopped eating small pieces of frozen cooked mushroom and started on the tincture. The changeover hasn't been as easy as I'd expected. The tincture is much stronger than I thought.

I'm currently taking various other tinctures to help with the symptoms and cause of Lyme disease - Banderol, Cumanda, Milk Thistle, St John's Wort and Sarsparilla. I'm also on a month-long anti-parasitic regime of tinctures of Wormwood, Clove and Black Walnut Hull. The dosage for these tinctures is generally around 10 drops 3 times a day, so I decided to start with that amount of fly agaric. That proved to be a mistake.

I was taking way too much fly agaric tincture. I was actually getting some of the effects typical of "vision questing" with it, without intending to. I didn't realise this, as the overall effect can be quite similar to Lyme symptoms (drowsiness, blurry vision, a sense of timelessness, distancing or separateness from what is generally considered to be reality, a lack of insight into some things, a little macropsia/micropsia - things becoming big or small).

I've never taken fly agaric for any purpose other than in these very small quantities for treating the Lyme symptoms these last few weeks, so I didn't know what it would be like to take it in larger quantities. It wasn't scary or anything (it removes fear anyway, one of the reasons why warriors such as berserkers would go into battle on small amounts!), but it must have altered my perceptions to some degree, as I simply wasn't aware that I was taking too much.

In other words, I don't think you can rely on your perception to get the dosage right. I think it's better to go with the numbers, and keep the dosage really small. Just enough to oil the processes of thought, memory and movement. Like oiling a squeaky door or a machine with moving parts, just a drop here and there.

A gentleman on the Lyme forum I frequent is also taking fly agaric tincture for Lyme, given him by a qualified herbalist. He has been on the tincture for a few weeks now, and has found that 2 drops 3 times a day works best for him. I'm going to follow his advice this week, and stick to that. I've also decided to take one day off from it a week. To this end I took none today, and had plenty of energy and felt bright mentally all day.

Tradition of Using Fly Agaric Medicinally

Monday, 5 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/tradition-of-using-fly-agaric.html

Here are the only mentions I've been able to find on the net of using fly agaric in small medicinal doses. Mind, Google would have only returned sites written in English. If you are aware of any others, please add them in comments.

> The Koryaks use this mushroom in a variety of ways, including administering it to their old people to insure their sleep at night and their energy during the day. Tatiana, the Even shaman, uses this mushroom externally as a poultice to treat patient wounds, as an anti-inflammatory and analgesic, and internally (by herself) as a device to allow her to visit the spirit world to seek, for example, the cure for an illness (physical, mental, or spiritual), or the place where a successful hunt could occur.
> The fly-agaric mushroom is gathered by the young and middle-aged Koryaks in the summer and early fall and dried for use during the winter months primarily by the elderly.
> from nemf.org
>
> Three small fresh pieces of mukhomor good for sore throat and cancer. Preparation for arthritis: Place several young A. Muscaria into an airtight container. Put container into a cool dark place (like a basement) until liquid comes out of mushrooms. Take a mushroom in hand, squeeze out moisture and place the pulp on arthritis. Bandage overnight. Mushroom body can be replaced in liquid and will last a long time.
> from erowid.org
>
> Sometimes dried mushrooms were soaked in distilled Bilberry juice - obviously a fairly modern method since distillation only arrived in Siberia in the 1500. Occasionally they were mixed with the juice of Willow-Herb. No research is known to have investigated the possible synergistic action of this combination. Medicinally it was used for 'psychophysical fatigue' and for bites of venomous snakes (Saar, 1991). It was also applied externally to treat joint ailments (Moskalenko, 1987). In Afghanistan a fly agaric smoking mixture known as tshashm baskon ('eye opener') is used for psychosis (Mochtar & Geerken, 1979). In Western medicine Fly Agaric serves as a well known homeopathic remedy, used for tics, epilepsy and depression, and in conjunction with homeopathic Mandrake tincture, is used to treat Parkinson disease (Villers & Thümen 1893, Waldschmidt 1992).
> from sacredearth.com
>
> Amanita muscaria has an alternative health application, giving its inclusion into the magical mushrooms arena of interest. Fly agaric remains closely linked with the neurological functioning of the human body in alternative medicine. Amanita muscaria as a mushroom has uses in treating varying nervous disorders. These disorders originate within a neurological capacity and include such illnesses as dementia, continual dizziness, and Parkinson's disease. Other uses for this magical mushroom as an alternative medicine has enabled sufferers from nervous tics, depression and epilepsy to feel significant less adverse symptoms with the use of the fly agaric as a medicine.. The mushroom primarily focuses on cerebral treatments. This revels the mushroom has a chemical ability to effect a persons neurotic state of wellbeing.
> from HubPages.com
>
> It is given in homeopathic doses against scabies and psoriasis.
> Used only in homeopathic doses (Agaricus muscarius) for neurological problems characterized by involuntary movements.
> from medical-explorer.com

> * Chronic fatigue and ageing *
> Fly agaric is still used in Siberia and Russia especially by elder people to reduce fatigue, to give more strength and to raise the spirit. They mostly make a tea, boiling either dried or fresh cap of mushroom in water for some time. They add honey to the tea and drink it by small portions.
> It is also considered that Amanita muscaria heal illnesses, connected with aging - sclerosis, insomnia, angiospasm etc.
>
> * Tumor, low immunity and skin diseases *
> Some people believe that fly agaric has antitumor and immunostimulating properties. For these purposes it can be used both inward and outwardly.
> Besides making a tea, Russian people also make an extract, infusing fresh cups with alcohol. They take it inward in 0.5-1 teaspoon daily, as well as apply on skin to heal eczema, swellings, allergic dermatitis and other skin diseases.
>
> * Rheumatism and joints diseases *
> People believe that applying a compress with fly agaric extract helps to relieve a pain in bones and joints.
> from helium.com
>
> It's 2-3 drops of tincture on the spine, when sciatica hits. Relief is pretty much instant.
> from henriette's herbal
>
> In case of psychophysical fatigue the fungus was administered internally (see M. Saar, 1990). Intoxication by viper bite called for its external application.
> from Fungi in Khanti Folk Medicine
>
> Following the prescription of Fly Agaric almost all of the patients exhibited increased motivation, improved mood and improved mental and physical well-being. Here again it is the doseage that determines that something is not a poison.
> from clanpheryllt

Looking beyond the net for information, perhaps we can turn to the less rational archive of myth and fairy tales. It's possible that knowledge has been encoded in these.

For example, I recently found out that a folk name for fly agaric is "raven's bread". And who are the only two ravens that most people could name? Huginn and Muninn, literally Thought and Memory, who sat on Odin's shoulders and whispered in his ears when he needed to know something.

This struck me as being perhaps more than coincidence, since improving thought and memory are two of the main benefits of eating raven's bread in small raven-like quantities, medicinally.

Advice for an Imaginary Test Subject

Friday, 9 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/advice-for-imaginary-test-subject.html

Of course, for legal and safety reasons I can't recommend anyone try taking fly agaric tincture, especially without medical supervision. But if someone were to decide to try taking small amounts of fly agaric tincture to see if it might help alleviate symptoms of Lyme disease such as dementia and chronic fatigue, my advice would run something like this...

The Tincture

- The tincture is really strong. It will affect you in ways that other tinctures don't.
- Taking a higher dose of the tincture won't do you more good, or make you feel better than small doses. Small doses work best.
- If you have physical pain somewhere, you can rub a few drops into the skin where the pain is (back etc). I'm not sure whether you should include these drops in your daily total. It's possible that active chemicals are absorbed through the skin.
- You may notice something white floating in the tincture. I think it's the mushroom spore, which is so tiny it gets through the coffee filter. It won't do you any harm. It can't grow inside you.

Taking the Tincture

- Take 1-3 drops 3 times a day (early morning, late morning, late afternoon). Probably best to start with 1 drop first day, 2 drops second day etc. Be really careful about going higher than 3 drops at a time. Even

3 may be too many for some people.
- Take the drops under your tongue or in a cup of tea or however you like.
- You can manage your energy levels by overlapping the times when you take the drops.
- Take a day off the drops a week. This way you can still monitor your symptoms. The tincture may alleviate your symptoms, but the infection is still there in the background. Even if you're feeling much better, you still need to address the underlying infection.

Results of Taking the Tincture

- The effects of the drops last 4-6 hours, although some benefits do seem to go over to the next day.
- You may suddenly find you have huge amounts of mental and physical energy for the first time in years. Be careful to pace yourself and remember to stop and stretch regularly.
- If you take much more than 3 drops at a time, you may "trip" a bit. These effects are likely to be sleepiness, mild euphoria, blurred vision and micropsia/macropsia (things suddenly seeming much bigger or smaller than they actually are). You may not notice that this is happening to you, as your insight may also be affected. Ask someone to keep an eye on you, or put up signs to remind yourself that this may happen. You are best just keeping to very small doses. Larger ones won't give a greater benefit.

Safety

- The dose may be quite particular to each individual. Whilst you're working out the right dose for you, don't drive or operate machinery.
- Treat your bottle of fly agaric tincture as poison. Label it accordingly and keep out of reach of children. And curious teenagers!
- As with any psycho-active substance, there's a very small chance of psychosis from taking the fly agaric tincture. If this happens, stop taking the tincture and everything should go back to normal. If it doesn't, tell a medical professional that you have been taking fly agaric tincture to stimulate your muscarinic receptors because of your Lyme disease. They will give you something to counteract this.
- Take milk thistle in some form. This is the antidote to fly agaric tincture and will help protect your liver. The tincture will still work just as well.

comments 3

mb *25 December 2011 at 11:12*
Happy Holidays. I have purchased some caps.
What proportion of alcohol to mushroom did you use for your tincture? Or did you just pour until rooms were covered. I looked at Henrietta's - but would like to hear from you as you are having success.

Sam Malone *29 December 2011 at 10:18*
Hi mb
Are your caps dried? If so I'd probably rehydrate them before adding the alcohol. Chop and add a little water and wait until they're rehydrated. I've never tried this but am thinking of doing it with some of the ones I dried, so let me know how it goes!
Yes I just covered the mushrooms with alcohol. I read somewhere that you need to use 36-40% alcohol, nothing stronger.
I found that it's best to chop into smallish pieces (about half an inch or 2cm square), put into a jar, shake the jar then cover with alcohol.
Leave for 7-10 days then strain through muslin if you've lots of mushrooms, or just a coffee filter if you don't have so many. I'd always strain through a coffee filter after the muslin. The spore will still get through though, and rise to the surface if left overnight.
Let us know how it goes!
Best wishes,
Sam

How Fly Agaric Tincture is Used in Germany (Possibly)

Saturday, 10 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/how-fly-agaric-tincture-is-used-in.html

Here is a list of how fly agaric tincture is possibly used in Germany, according to herbalterra.com and Google Translate. Some crazy mistranslations may have occurred but I've just left them in. It's also possible that it's just homeopathic doses they're talking about. Please say if you can clarify any of this.

[some changes to this translation in this edition on psilosophy:

- constipation with it extremely difficult to discharge from a chair - constipation with extremely difficult discharging of a stool
- dizenteriepodobny diarrhea - dysentery-like diarrhea
- skin, eczema - skin eczema
- a feeling of power - a feeling of currents
- strong napiranie at the bottom - strong pressing at the bottom
- irritating bleach the skin - irritating blanching/whitening of the skin
- Qatar file - cataract
- iperemiyu - hyperaemia]

- Communicative disorders of the spinal cord, epilepsy, chorea, tics, alcohol, alcoholic delirium, psychosis in infectious disease with a strong movement, walking, depression, dull headache in the forehead, an exciting area of the nasal bone, unilateral headache, feeling of icy cold in the head, the high sensitivity of the scalp, dizziness, inappropriate behavior with a laugh, increased tone in his voice, singing, and the desire to mate, delusional speech cuddle with a reluctance to answer questions, seizures of different origin, paralysis, multiple sclerosis;
- Angina with stinging and burning pain in my heart, just in the left arm, palpitations, cardiac arrhythmias, the white-finger tips of the ears and nose, followed by hyperemia, angioneurosis limbs;
- Increased flow of saliva, bitter saliva, ulceration of the mucous membranes of the mouth, tongue, toothache, bad breath, attacks of a strong hunger, especially in the evening hours, burping air and food, nausea, vomiting immediately after eating, weight and crampy abdominal pain, bloating abdominal gas

with a garlic smell, constipation with extremely difficult discharging of a stool, dysentery-like diarrhea, especially in children, burning in the anus, scanty urine mixed with thick mucus, fever;

- Itching and irritation in the nose, sneezing, using a liquid discharge from the nose, an increased sense of smell, nosebleeds;
- Cramping painful cough, especially if the patient is nervous or just fall asleep with little expectoration, hemoptysis, briefly, shortness of breath with the need to take a deep breath, sweating in the chest at night, laryngotracheitis, to take pulmonary tuberculosis. Diabetes. Outside the tumor, running sores, tuberculosis, skin eczema, atopic dermatitis, diathesis. Redness, swelling, burning, itching of the skin, very itchy skin rashes millet, redness and cracks on the lips, blisters on the upper lip;
- The feeling of fatigue in the neck, back, especially when sitting or lying down, pain in the back muscles, universal joint damage: the left arm and right leg and vice versa, the crackling of the joints, rheumatism, lumbago, sciatica, low energy, mental and physical fatigue, feeling of weakness in the limbs, while sufficient strength in them, trembling limbs, cramps in large fingers, numbness, a feeling of currents, ice needles, crawling, burning, increased sensitivity to cold in the extremities, painful cold;
- Increased libido with flaccidity of the penis, weakness and sweating after having sex, impotence, premature, painful menstruation with sensation of uterine prolapse, a strong pressing at the bottom, irritating blanching/whitening of the skin, sexual arousal, itching and burning sensation in the breast nipple, genital itching and irritation, painful menstruation, heavy climax;
- Diseases of the eye, vitreous opacities and lens, black flies before his eyes, itching, burning, lower vision, increased sensitivity at the touch of age, blepharospasm (spasmodic contraction of the eyelids), blepharitis (inflammation of the eyelid), conjunctivitis, myopia (nearsightedness), diplopia (double vision), twitching of the eyelids and eyeballs, asthenopia (eye fatigue sets in quickly during the visual work), cataract;
- Pain in the ears, sharp pain along the Eustachian tube, hyperaemia and swelling of the ears, as if perfrigeration, itchy ears.

Week Four Summary

Monday, 12 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/week-four-summary.html

I've now been taking very small amounts of fly agaric mushroom daily for four weeks, in an experiment to see if and how it might relieve some of the symptoms of my chronic Lyme disease (neuroborreliosis). This post will summarise the whole first month, as well as Week Four.

The first two weeks I was eating small pieces of frozen mushroom, around the size of my last little finger bone. Once the tincture was ready I moved over to that, finally settling on a dose of 1-3 drops 3 times a day. This is usually 3 drops when I get up, 3 drops late morning and 3 more drops late afternoon.

The mushroom has had an amazing effect on me over the last month. My chronic fatigue, poor cognition and dementia are so much improved, I really feel like myself again. I can walk for miles, read and evaluate what I've read, keep up with conversations and enjoy being with people again. It really has been nothing short of miraculous.

Even during Week Four, my physical and mental faculties have continued to improve. I'm now reading five books at a time, devouring the information contained within them, remembering every word. A month ago I couldn't read at all, as I didn't have the cognition to figure out what was being said, or the memory to build meaning. Yesterday I ran for a few hundred yards. During most of the summer I couldn't walk even 50 metres.

Before I became disabled and my life fell apart (four and a half years ago), I worked as a computing lecturer. For the first time since then, I feel I'm not far off being able to lecture again. In the last couple of weeks I've picked up my work developing mobile phone apps, which I'd had to stop in early summer, as my brain just wasn't functioning.

There is no mystery to how this works. As I understand it (albeit perhaps incorrectly) the borrelia bacteria produce neurotoxins that congregate in the brain stem. There they block signals in the acetylcholine receptors, causing symptoms such as chronic fatigue and dementia. The muscarine in the fly agaric enables the signals to get across, overcoming the blocking effect of the neurotoxins. Hey presto, you can think, walk and live again.

I'm not claiming that fly agaric is a cure for Lyme disease or any other condition. But it certainly seems to have huge value in treating the worst symptoms. I've read that it also has anti-microbial properties, so perhaps using it longterm might reveal further benefits. Right now, you would have to prise it out of my cold dead hands to get it off me.

Yesterday I started on heavy duty antibiotics, which seems to be the only treatment that can seriously reduce the amount of borrelia bacteria infesting someone with Lyme disease. I shall continue to take the fly agaric though, to counteract the worst symptoms, and see what it can do. If I do stop taking it for a day, I do start to go back to being a zombie again. The plan is to have one day off a week though, to monitor remaining Lyme symptoms without the influence of the fly agaric.

Week Five Summary: Starting Antibiotics

Tuesday, 20 December 2011

original source: http://flyagarictincture.blogspot.com/2011/12/week-five-summary-starting-antibiotics.html

I was finally diagnosed with neuroborreliosis (late stage Lyme disease) a few weeks ago, after at least sixteen years of infection, and four and a half years of total debilitation. I was prescribed strong antibiotics (500mg of cefuroxime twice a day), which I finally started taking last week. I'd held off from taking them in order to figure the right fly agaric tincture dosage, but it seems now that this is much more variable than I had realised.

Borrelia burgdorferi, the spirochete that causes Lyme Disease. FA stain (CDC)

It took a few days of the antibiotics before I realised that I was mentally and physically deteriorating. Unfortunately with Lyme disease, insight often goes out of the window. There have been times when I've declared how much better I'm feeling, only to find out later that I'd just temporarily lost what little insight I do have. So much of Lyme disease is trying to cope with a substantially diminished mental and physical arsenal. You can have all the will in the world though, and it doesn't make a huge amount of difference. It really is like a fairytale enchantment.

The antibiotics kill off more borrelia bacteria, which creates more neurotoxins, which find their way to your brain and clog up the neurones in the brain stem. This is what leads to symptoms such as chronic fatigue and dementia.

By the weekend I decided to try 3 drops of the fly agaric tincture in every cup of tea I drank. Not very scientific, but easy to remember. It really helped. I got some good exercise both days, and was able to cope with everything I had to do.

Yesterday I went back to 3 drops times a day, and was so exhausted by the evening that I pretty much couldn't even think. A good night's sleep though, and I'm feeling better again this morning. I'll stick to 3 drops in every cup of tea for a while, especially with Christmas and the extra energy needed for that.

I did manage to publish an app for the first time since about March, when I started treating the Lyme disease, and the neurotoxins must have started really building up. So I'm incredibly grateful to the fly agaric for giving me this level of improvement.

It's scary being back in the dusty void of Lyme disease dementia. It took some courage to start on the antibiotics, as I knew that there was a chance everything would go foggy and I'd end up a zombie again. When I first took antibiotics for the Lyme, back in February/March when I presented with an erythema migrans rash, the dementia hit me like a cattle stun gun, and hasn't really cleared since. At least with the fly agaric tincture, I stand a chance of bringing myself out of it to some degree by increasing the dose.

On the forum I frequent, some people are doing essentially the same thing with nicotine patches. Nicotine acts the same way as the muscarine in the fly agaric, stimulating the acetylcholine receptors in the brain stem so that messages can get through. It seems that with that also, dosage is a very individual thing.

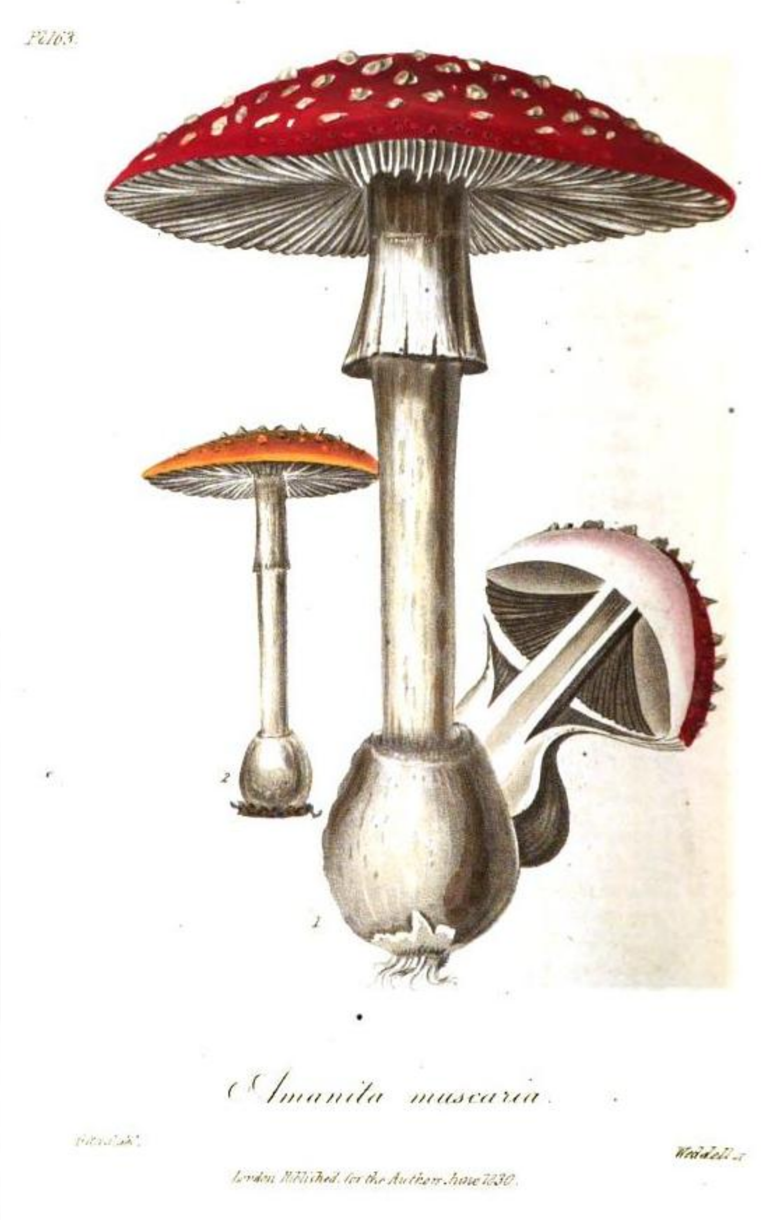
The image in this post is of the borrelia bacteria, borrowed from textbook of bacteriology.

Week Seven Summary: External Application of the Tincture

Thursday, 5 January 2012

original source: http://flyagarictincture.blogspot.com/2012/01/week-seven-summary-external-application.html

I unfortunately missed the Week Six Summary, due to Christmas and a killer migraine that took the better part of a week to clear. I eased up my militant no alcohol, no dairy, no gluten diet in the run-up to Christmas. I've a lot to celebrate this year (found out what had wrecked my life, found a doctor to treat it, despite the usual nightmares with the NHS and Lyme), and felt like cutting loose a bit. Plus I've felt like death for most of the year, so feeling substantially better on the mushrooms, I thought I'd celebrate that too. My boils and impetigo all came back, but have largely gone now since giving up the dairy, alcohol and gluten again.


Pl.163.
2
1
Amanita muscaria.
Weddell sc
London Published for the Author June 1830.

I'm actually halfway through Week Eight now, and settling into a good routine. Since the amount of fly agaric required seems to vary so much, probably due to the varying amount of bacteria and neurotoxins, I've changed my attitude to dosage. Instead of trying to find my perfect dosage, I now just take three drops under the tongue when I feel my cognition waning, which is generally every couple of hours.

I've had a lot more bacteria die-off, due to being on antibiotics now, and also freeing up the areas in my jaw/neck/shoulder/back/pelvis that are stuck together with what I believe are borrelia colonies. They crack and crunch and spike you like crazy, but bit by bit become softer and more free. Sometimes there's a big movement, and suddenly I can move a part of my body again. I actually wiggle when I walk again now, instead of moving like a robot.

As well as stretching, movement, deep tissue massage and ultrasound, I've now found something else that really helps the pain and discomfort in areas colonised by the borrelia bacteria ... the external application of fly agaric tincture!

I've a lot to say about both migraine and general external application of the tincture, so I'll break this post up into one covering migraine, and another covering external application of fly agaric tincture for sciatica and similar pain.

I should add, my experiences on fly agaric tincture may be closely related to the species of borrelia I have.

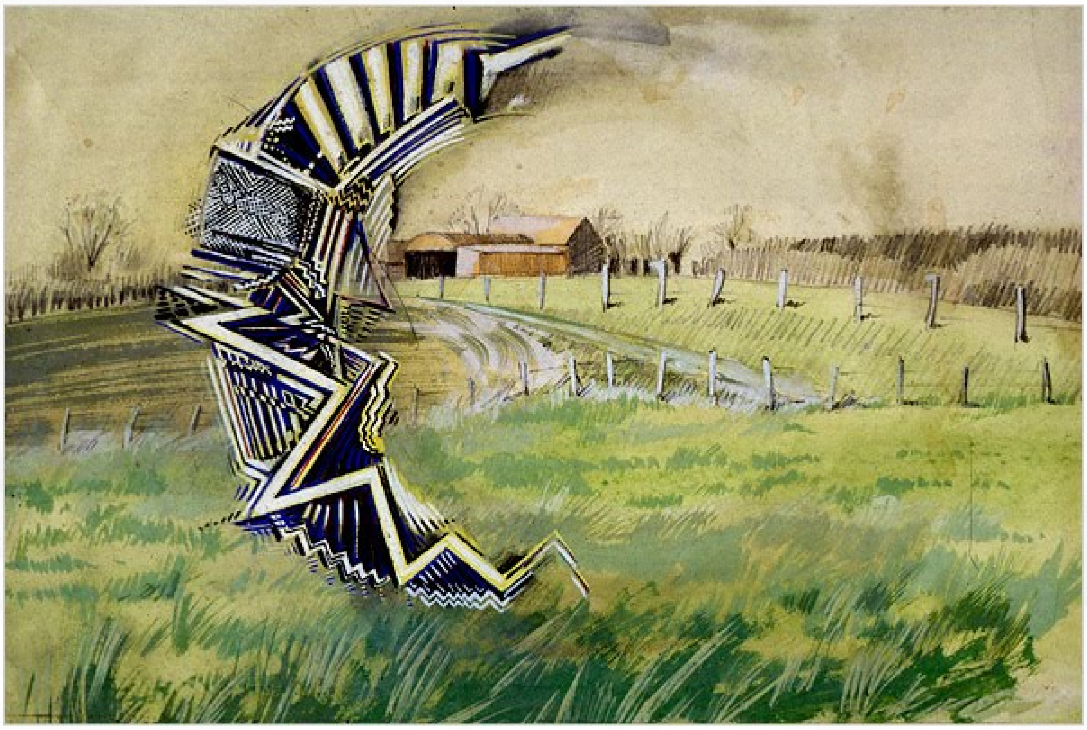
According to a Melisa LTT test, I am infected with *Borrelia afzelii* and *Borrelia garinii*. Afzelii tends to affect the nervous system the most, and garinii tends to favour connective tissue, especially tendons.

Migraine and Fly Agaric Tincture

Thursday, 5 January 2012

original source: http://flyagarictincture.blogspot.com/2012/01/migraine-and-fly-agaric-tincture.html

I was plagued with migraines during the time when I was completely disabled with tendon trouble, but had no idea that it was late stage Lyme that was the cause. The migraines would generally appear the day after I'd had a session stretching my neck. Again, I didn't realise it at the time, but the borrelia bacteria had colonised my neck, and the stretching and manipulation were breaking some of these colonies up, releasing large numbers of bacteria or associated neurotoxin detritus. I assume it was this that caused the migraines.



I did a whole diet exclusion course to be sure that it wasn't anything I was eating that was causing the migraines. I excluded everything that had ever been believed to have even only possibly caused a migraine, yet the migraines continued. They would be worse if I hadn't had one for a while, but not so bad if they were more regular. They would be preceded by the aura of lights in the eye, and continue for three days as a general rule. During this time I wouldn't be able to read, watch TV, listen to the radio or music, have the curtains open or anything. Just lie in the dark.

A large area in my shoulder became free in the early hours of Boxing Day, and I think this was the cause of the massive migraine that started several hours later. At least it gave me an opportunity to try the fly agaric tincture on a migraine. Since the muscarine in the tincture affects the central nervous system, I was confident that I might get some relief.

I rubbed fly agaric tincture into my head and neck and did experience a great deal of relief from the pain of the headache and stiff neck. I was able to sleep through the worst of it, which is rarely the case for me. The migraine itself (it's a neurological thing, not just a headache) dragged on for nearly a week though. I went for a country walk but had difficulty with hypocapnoea (lack of carbon dioxide), which according to my LLMD is also due to borrelia neurotoxins in my brain stem.

In short I'd definitely recommend trying fly agaric tincture for the pain of migraine, though it didn't seem to lessen the duration any.

I took the image in this post from anthonypeake.com, where I found an interesting discussion about the aura and migraines in general.

External Use of Fly Agaric Tincture on Sciatica, Back Pain etc

Thursday, 5 January 2012

original source: http://flyagarictincture.blogspot.com/2012/01/external-use-of-fly-agaric-tincture-on.html

When I first started investigating the medicinal use of fly agaric tincture, pretty much the only information I could find was on the external application of it to treat sciatica etc, on Henriette's Herbal:

> How to use this then? It's 2-3 drops of tincture on the spine, when sciatica hits. Relief is pretty much instant.
>
> I expect the tincture relaxes the muscles around the spine, where the hurt comes from, and when those muscles are finally allowed to relax they stop clamping bone all over the pinched nerve, which means the nerve can finally relax and no longer scream to the brain that "this hurts, cramp down on this, fast and hard!". And the pain goes away. Bliss.
>
> I learned this from an old Finnish lady years ago - she came up to tell me about it after a lecture. I've told it onwards pretty much every time I remember to, and get very good feedback: "Remember the fly agaric tincture you told us about? Well, we made some in fall, and it helped, and after that the bottle has been in pretty much every house in the village, thanks heaps!". And such.

A friend of mine has been trialling this for as long as I've been on the tincture, seven and a half weeks now. Since she's applying it externally, I was happy there would be no risk for her to give it a go.

Her feedback is extremely positive. She has suffered from backache, diagnosed with scoliosis, for many years, and is in constant pain. The fly agaric tincture has really helped her. One liberal application of the tincture on her back will give her a good six hours of relief at a time.

Spurred on by her success, I've tried applying the tincture onto my painful ear/jaw/neck/shoulder/back/pelvis/rib areas. It's definitely helped with the pain. Furthermore, it's really helping with reclaiming these areas from borrelia colonisation, turning them back from stone (a hard substance, but of course not literally stone) into soft flesh again.

As I understand it, there are muscarinic receptors where the central nervous system meets the muscles, and the muscarine in the fly agaric tincture is acting on these, giving immediate and fairly long-lasting relief. It really is substantially better than ibuprofen gel, deep heat or anything else I've tried. Definitely worth giving it a go if you suffer from sciatica.

comments 4

LOVE_IS_THE_SOLUTION *20 February 2013 at 03:56*
hello
came here from ur comment on smart meters with klinghardt. great blog! i want to express gratefulness for ur blog.
i want to hint in the direction of treating chronic lyme. most cheap is the salt and vitamin c treatment, where u intake up to 15 g salt and vitamin c per day. that costs monthly less than $5. but it is to be used for 2y and has severe side effect. but the spirochetes are killed because they are taken the water from. works fine, though i did not try yet.
secondly mms by jim humble shall be tried in my humble opinion (not providing medical advice at all, u know).
what i did try is the use of a combination of detoxing thigns like the chlorella algae combined with the use of antibiotics called Rizols, which happen to be ozonated oils. they work just fine. klinghardt once said, the dosage of gamma and zeta rizols at a dosage of 60 drops daily each moves things. that would cost around $20-45 a month - but it truely works just fine!
as storl suggests teasle works fine, too. some think it just rids the neurotoxins and does not sufficantly treat the lyme. i can just tell that it works for me too.
also there are rife techniques that work fine. rife did blood-electrification. there ought to be working treatments googleable, too.
though we found out about each others through klinghardt, ur suggested to check out the video on hpu from klinghardt, to be found here: http://www.youtube.com/watch?v=9yx-WcBv-oY
feel free to check back in a week or so at my website where i link information about health i find valuable(atm down, next week up again) it is in german language but the video sources are mainly in english language. it is http://www.healthygimmicks.de
love peace
ingo

LOVE_IS_THE_SOLUTION *20 February 2013 at 04:03*
I like the idea of connecting. in a world where every information is available for everybody thorugh the world wide web, it is no longer about getting information, it is about connecting the valueable information. thats the main reason i do make a comment like the above. to freely quote klinghardt: u got to detox, detox, detox and on top of that detox as also do alternative antibiotic treatments.
Cheers, man - truely i sense the good idea behind this blog. thank you
love peace
ingo

Borrelia: infecting people since prehistory

Saturday, 7 January 2012

original source: http://flyagarictincture.blogspot.com/2012/01/borrelia-infecting-people-since.html

A few months ago I surmised that what we call Lyme disease must have been endemic in hunter gatherer communities. With much of their time being spent in and around forests, grasslands and moors, people must have been perpetually exposed to ticks. They must also have been exposed to the diseases that ticks carry, including the borrelia bacteria of Lyme disease.

Indeed, it has recently been shown that Otzi the iceman, the 5300 year old Neolithic mummy found in the Alps, was infected with *Borrelia burgdorferi*. I am not aware of any similar tests having been carried out on bog bodies or other mummies yet, but *Borrelia burgdorferi* DNA has been isolated from 13 of 1,036 mite museum samples in the United States (Persing D, Telford Sr, Rys P, Dodge DE, White TJ, Malawista SE, *et al*. Detection of *Borrelia burgdorferi* DNA in museum specimens of Ixodes dammini ticks. Science 1990;249:1420-3). Mites are also known to carry borrelia bacteria, though most human infestation is thought to come from ticks.

It was the belief that our forebears must have somehow learned to cope with borrelia infestation that led me to search for a readily available natural treatment. I had previously read Wolf Storl's Healing Lyme Disease Naturally, and, though the teasel tincture didn't work for me, it did help to set me in the right direction. Similarly MM Drymon's Disguised as the Devil, or it's much cheaper on Kindle, in which she links the Salem witch trials to Lyme disease. Lyme disease seemed to me to be unavoidable in a society with a close relationship to nature, especially along the edges of woodland.

I was very lucky that the first plant I tried (Amanita muscaria) grows in abundance where I was living at the time, and that it was the growing season (late August to early December) during the time I was looking for a treatment. I cannot imagine life without it now. I have since researched its history and uses, and it does seem that humankind has long enjoyed a close relationship with this plant.

- Amanita muscaria has been posited as the Soma of the Vedic scriptures in Soma: Divine Mushroom of Immortality by R. Gordon Wasson.
- It has also been suggested that it lies behind pretty much every religion on the planet, in John Allegro's The Sacred Mushroom and the Cross.
- It is even implicated widely in the emergence of Santa Claus and our Christmas celebrations.
- I've just finished reading Ploughing the Clouds by Peter Lamborn Wilson, which convincingly searches

Irish myth for encoded references to Amanita muscaria.

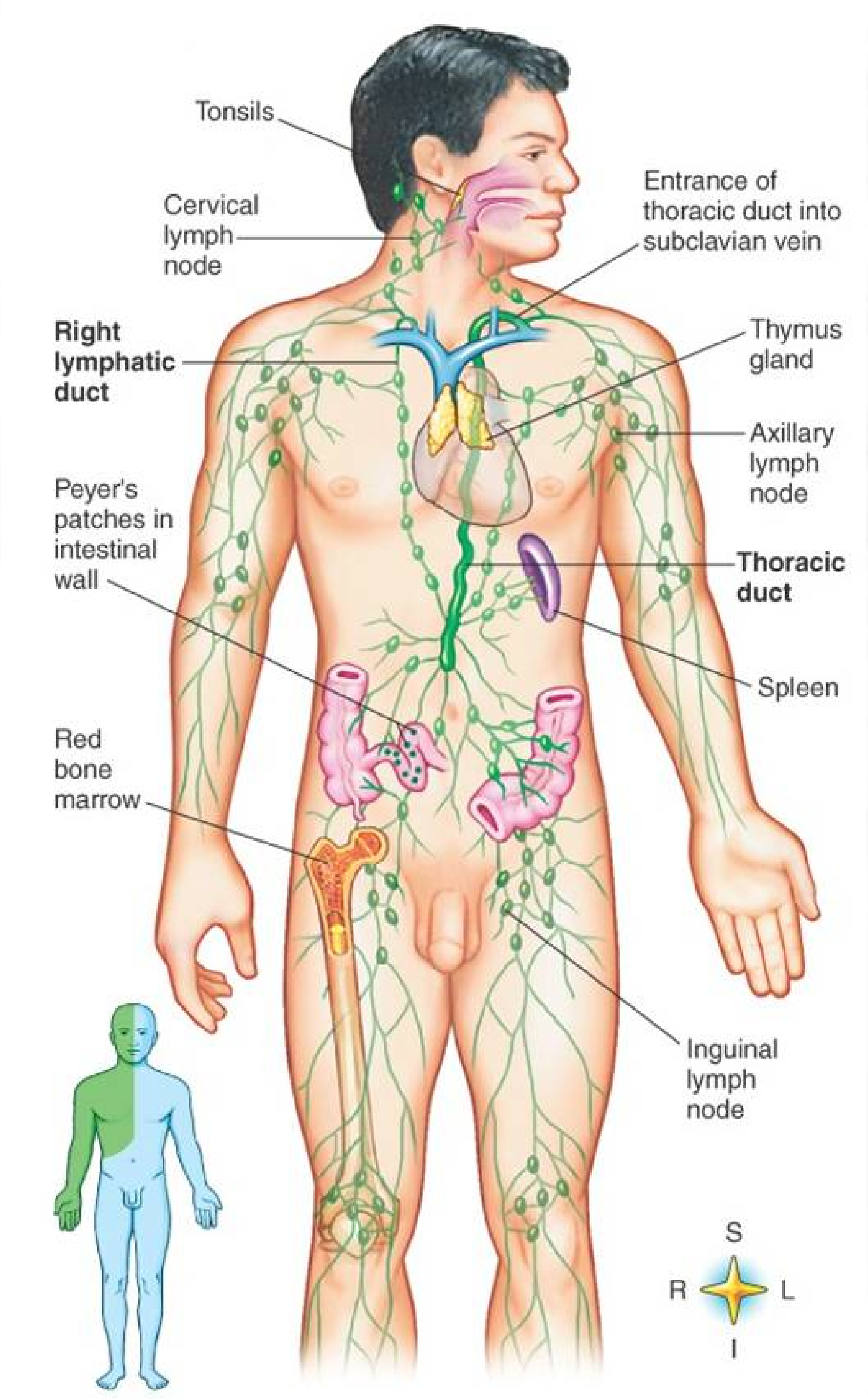
Where people do still live a life similar to that of our prehistoric ancestors, for example the pastoral nomads in northern Sweden, Finland and remote areas of Siberia, the ticks that harbour the disease live in abundance, and infestation with borrelia bacteria is endemic. These are the areas where fly agaric is still traditionally used, and not just for shamanic journeying. It is given in small daily amounts to treat physical fatigue, and poor memory and cognition. The elderly receive it as a matter of course. Is it treating the symptoms of chronic Lyme disease? I do believe so.

Fly Agaric Tincture and the Lymphatic System

Thursday, 19 January 2012

original source: http://flyagarictincture.blogspot.com/2012/01/fly-agaric-tincture-and-lymphatic.html

I have recently found out that my lymphatic system is almost totally blocked in some areas, and has been for many years. This can happen as a result of a bacterial infestation such as Lyme disease. It can also happen as a result of parasitic infestation, which is not uncommon as a co-infection of Lyme disease. People mostly get infected with Lyme disease by ticks, which are characterised as "nature's dirty needle" because they carry so many vile things.


Tonsils
Cervical lymph node
Right lymphatic duct
Peyer's patches in intestinal wall
Red bone marrow
Entrance of thoracic duct into subclavian vein
Thymus gland
Axillary lymph node
Thoracic duct
Spleen
Inguinal lymph node
S
R
L
I

Edit 2/2/12: I don't know if it's physically possible to have such a blocked lymphatic system. It could be crystallised neurotoxins along the muscles near the lymphatic system. Whatever it is, it's breaking down, and my pain is decreasing as it does so.

Before my LLMD (Lyme Literate Medical Doctor) informed me that I was engaging in lymphatic drainage, I had thought that I was massaging calcarised tendons or muscles, as they were so solid. Over the last few weeks, I've been rubbing fly agaric tincture onto the skin above these blocked areas of my lymphatic system. I've also been blasting them with a portable ultrasound machine I have, which has really helped, but here we're concerned about the effects, if any, of the fly agaric tincture.

I have noticed that since applying the fly agaric tincture, the hard and sharp stuff in my lymphatic system has been breaking up much more easily. Apparently the lymphatic system is not far under the skin, so the muscarine in the fly agaric tincture should be able to get to it pretty easily.

I don't pretend to understand the mechanisms of any of this, but I have found that:

> All five muscarinic subtypes have been detected in human lymphocytes; however, receptor subtype expression appears to vary by individual.

(from Muscarinic Receptors By Allison D. Fryer, Arthur Christopoulos, Neil M. Nathanson, Springer 2012. P408)

The fly agaric tincture will not be enough by itself to normalise the lymphatic system. Supporting treatments include Manual Lymphatic Drainage, self massage, exercise and herbal support.

Edit 17/2/12 - Since writing this post I've seen a lymphatic drainage massage specialist, who has confirmed that my lymphatic system is blocked in places. Even after just one session I've felt incredible benefit. I've had a clear head and not suffered the harsher "dementia symptoms" of neuroborreliosis since that first treatment. I had a lot of lymph build-up at the back of my head, which must have been keeping the neurotoxins in the back of my head, where they caused the dementia-like symptoms and problems with my autonomic nervous system, such as hypocapnoea.

Edit 23/1/13 - It now seems likely that the hardness and pain from my lymphatic system may have come about as a result of infestation by a lymphatic nematode or roundworm. These are apparently common even in temperate areas, but aren't normally a problem. When combined with a lack of movement and/or other infection, they can become problematic. I've found ultrasound to be best at breaking down these hard areas, although I always get an increase in neurotoxin symptoms when I do this. Almost constant movement really helps as well, as does keeping warm and hydrated. Cleavers/goose grass/sticky willy is great to help clean out the lymphatics. I'm still not quite done getting rid of it all, but I'm ever closer.

comments 5

> **mb** *23 January 2012 at 10:55*
> Hello there - Thanks to your investigations and sharing, I have recently experimented with the Amanita myself. My husband and I both have tick born illnesses, varying degrees of suffering, luckily for us - although my husband has suffered for years with brain fog. Eating a little piece of the mushroom has definitely improved our cognitive abilities, and given us both an "uplift" in terms of mood.
> Very subtle, but life changing.
> I wonder what people are doing while they tincture? I recently did a 1:1 dry mushroom to 100 proof vodka. The vodka was actually diluted to 40% as per Henrietta's advice. I soaked the caps first in distilled H2O and used this water to dilute the vodka. So! It may not be a real 40% dilution - Henrietta is very clear that Amanita is a "liver fryer" - meaning that she advises (strongly) that we label this with "POISON" symbol, and use great care in its administration.
> I mention this to inform, not to frighten.
> Anyone else making their own tincture?
> I have started to give my son the tincture at 6 drops per day. So far no great effect, but I am

taking it very slowly with his treatment - he's on ABX too.
I am grateful to have discovered this wonderful plant, and look forward to learning as much as possible, including a good spot to forage for it come Spring.

Sam Malone *24 January 2012 at 11:24*
Thanks for letting us know mb, and really pleased to hear it's helping you.
I was thinking, as you're buying the dried mushroom, maybe it would make more sense to eat small amounts of the dried mushroom rather than make it into a tincture. I think the dried mushroom tastes really nice, but you can also grind it up into a powder and put it into capsules if you prefer.
In Siberia I understand they air dry the mushrooms, including the stem, and the elderly will then either eat a little bit a few times a day, or make a tea out of the powder.
Sorry I can't find the link for my source for thinking this at the moment.
Best wishes, Sam

Sam Malone *24 January 2012 at 11:49*
Oops forgot to mention, unless you're in the Southern Hemisphere, the fly agaric won't be out until late summer. I've heard of it showing itself in June in freakish conditions, but late August is when they really start to appear.

Three Month Summary

Friday, 17 February 2012

original source: http://flyagarictincture.blogspot.com/2012_02_01_archive.html

Three months ago, I started taking fly agaric to treat my neuroborreliosis, or advanced Lyme disease. Along the way I've found huge relief, and applications beyond treating just neuroborreliosis. So how am I using the fly agaric three months on?

Internal Application of Fly Agaric Tincture

I am still taking drops of the fly agaric tincture under my tongue, to treat the impaired cognition and memory of neuroborreliosis. In the very early days I was eating small pieces of fried and frozen mushroom, which worked just as well, as would eating small pieces of dried mushroom, the way they do it in Siberia. It is also possible to make tea from the dried mushroom, which they also do in Siberia, but I haven't tried this yet.

I've found that there is no specific dose, and that the amount required can vary day to day. The rule of thumb I've gravitated towards is three drops under the tongue roughly every half hour until I feel mentally alert, then as much as is required to keep me that way. It's not as easy as it sounds though, and can be a bit of a rollercoaster while you get used to it. I haven't felt that I was "tripping" at any time though, and haven't had any hallucinations or anything like that.

My memory and cognition are hugely improved, and I've been able to develop mobile phone apps again - namely Ogham (Druid prophecy and tree lore) and Hugin and Munin, a raven based memo program.

External Application of Fly Agaric Tincture

In countries including Latvia, Lithuania, Finland, there is still a tradition of using fly agaric in this way. A few drops are applied externally - rubbed gently into the skin - to relieve topical pain. It seems that this will work for any pain related to the central nervous system, and its effects are complete and immediate and last around 3-4 hours. It really seems to work like magic.

When suffering the agonies that will sometimes hit as a result of my neuroborreliosis, I've applied the fly agaric tincture very liberally, even 10-20ml at a time if the pain is over a wide area. I'm not aware of any dangers using the tincture in this way. Relief is always complete and immediate. It even works for the pain of migraine, but unfortunately doesn't touch the concussion-like hangover of a bad migraine.

External Application to overcome Chronic Fatigue

As part of the process of making the tincture, I run it through coffee filters. This leaves me with coffee filters wet with tincture. On a whim I tried rubbing these over my muscles, covering as much of my body as possible. I almost immediately felt raring to go, and walked without any trouble up a very steep hill nearby, to the castle at the top. I hadn't even been able to make it up the hill before.

As I understand it, the muscarine in the mushroom tincture is enabling the body's electrical signals to reach the muscles, whereas before they couldn't make it over the neurotoxins. I believe that this is probably how the Viking berserkers used to apply the fly agaric mushroom to themselves before battle. It gives noticeably more energy than ingesting the mushroom.

I also apply the tincture externally to any area - usually the back of my knees - that has been over-exerted and is seizing up. Instead of leading to tendinitis and a couple of weeks of enforced rest, the area is generally absolutely fine the next day.

I have also been applying the tincture externally to areas of my lymphatic system that are blocked, sluggish or painful. I can feel and hear the lymph cracking and crunching and breaking down. The improvements there also help counteract the negative effects of the neurotoxins of neuroborreliosis (advanced Lyme disease). I should add, the species of Lyme disease I have are *Borrelia afzelii* and *Borrelia garinii*, the two most common European kinds. I would be interested to hear if anyone is doing anything similar to counteract other species, perhaps most notably *Borrelia burgdorferi*, the most common North American species.

Cauldron of Rebirth

The ancient Celts would take wounded warriors and soak them in a cauldron that restored them so they could return to the battlefield. It has been theorised that the Cauldron of Rebirth contained fly agaric mushrooms with the active ingredient (again probably muscarine rather than muscimol) dissolved in some liquid.

I've been making very diluted cauldrons of rebirth by adding 5-10ml of fly agaric tincture to the bath. It really does take the pain and aches away.

So to summarise this summary, fly agaric has changed my life. It's taken me from being an exhausted cripple with severe dementia-like symptoms to being pretty much a "normal" person again. I can walk for miles, I am reading voraciously, I can string a thought together long enough to write it down, I can engage in conversation, I don't just lie around all day feeling like death any more, and my mood is greatly enhanced.

9 Month Update

Saturday, 29 September 2012

original source: http://flyagarictincture.blogspot.com/2012/09/9-month-update.html

I've now been taking fly agaric mushroom for nine months. I've found that it makes a huge difference to the chronic fatigue, cognitive and memory troubles that result from my neuroborreliosis (chronic Lyme disease).

I initially ate small pieces of the mushroom, moving onto taking the tincture after a couple of weeks. Since the last update, I've gone back to eating small pieces of the mushroom again. These have been dried, since the mushrooms have been out of season.

Since I could find no real information on taking the mushrooms medicinally in this way, I tried different methods, probably focussing too much on the tincture. Luckily I had dried quite a few mushrooms, so was able to compare the different methods.

The effects of eating small pieces of mushroom seem stronger and longer lasting that the tincture, with a slower release. I've still made use of the tincture though, for external application and for a quick cognitive "shot" under the tongue.

Dried fly agaric is used to treat Lyme-like symptoms in sub-arctic areas where Lyme disease is endemic, for example in Pacific Siberia:

> Fly agaric serves the neurological functions of the human body in alternative medicine. The mushroom has been used to treat varying nervous disorders, dementia, dizziness, and Parkinson's disease.
> (from http://www.helium.com/items/2112311-uses-of-fly-agaric-amanita-muscaria-in-alternative-medicine)
>
> Fly agaric is still used in Siberia and Russia especially by elder people to reduce fatigue, to give more strength and to raise the spirit. They mostly make a tea, boiling either dried or fresh cap of mushroom in water for some time. They add honey to the tea and drink it by small portions. It is also considered that Amanita muscaria heal illnesses, connected with aging - sclerosis, insomnia, angiospasm etc. Some people believe that fly agaric has antitumor and immunostimulating

> properties.
> (from http://www.helium.com/items/1732849-can-i-use-fly-agaric-for-healing)

Fly agaric is far and away the best treatment I have tried since finding out that I have chronic Lyme disease (neuroborreliosis). There are probably many facets to its action, but the most important one is the muscarine in the mushroom enabling nervous system signals to jump over the Lyme neurotoxins that clog up the neuroreceptors.

The amount of mushroom needed does vary, due to the differing amounts in individual mushrooms, and the current level of neurotoxin load. It is hard to estimate the size of a daily piece, as much depends on how much it has been dried, and how much of its water content it has lost. Starting with a piece the size of the top little finger joint is perhaps the best way to go. If nothing has happened in half an hour, another piece can be taken.

At no point have I felt even remotely "trippy" - only "normal". It is like awakening from an enchantment. Suddenly you can think again, you can move, you can remember. There's no need to lie around trying to summon the strength to do the slightest little thing. It's done almost before you've started to think about doing it. I have had regular blood tests to check liver function, and everything has been totally fine.

I feel the mushroom has restored enough of my cognition and memory for me to live, though I am not (quite) yet working again. It has also given me the energy to have a good country walk of a few miles every day. This exercise has been of immeasurable benefit to my lymphatic system and my general well-being, including happiness levels. Especially as for three and a half years I could barely walk, and thought I would be stuck in a wheelchair for life. This was before I found out that it was Lyme disease behind it all.

If you would like to discuss any of this further, please do not hesitate to contact me. I may not update this blog again, as I'm going to concentrate on Fighting Lyme Disease, showing how you can make herbal treatments to treat and beat the Lyme.

Some Russian Fly Agaric Treatment Products

Thursday, 17 January 2013

original source: http://flyagarictincture.blogspot.com/2013/01/some-russian-fly-agaric-treatment.html

** If I'm able to find a site that sells these products internationally I'll let you know **

I've lately taken to searching the internet for the Russian translation of fly agaric - Мухомор красный. Fly agaric has been used medicinally in Russia for a long time - and not just amongst tribal peoples. Above is a commercially available cream made from fly agaric. It is used to stimulate blood circulation, prevent varicose veins, increase the elasticity of the skin, stimulate cell renewal (View original Russian site)

Крем
от мозолей,
против грибка,
потливости
МУХОМОР
ПРОТИВ

Here are some Russian fly agaric products. Translated by Google Translate - thanks Google :)

In fact, there's a whole "Mushroom Collection" of cosmetic products (see photo above). These include:

1. Cream of corn, against the fungus, sweating ", 75 ml
2. Wrinkle cream, anti aging changes ", 75 ml
3. Anti-cellulite cream that simulates the contours of the body, "75 ml
4. Cream warming, against joint pain ", 75 ml
5. Hand cream, protective, soothing, healing ", 75 ml
6. Foot Cream against varicose veins, edema, fatigue, "75 ml

View original Russian site

Here's another product (photo above). The translation says:

Cream "Fung Chi Amanita" is unique, designed by a group of scientists in conjunction with the St. Petersburg Chemical and Pharmacological Institute, operated externally with the following diseases:

[some changes to this translation in this edition on psilosophy:

- constipation with it extremely difficult to discharge from a chair - constipation with extremely difficult discharging of a stool
- Sustavnye diseases - Articular diseases
- Trudnozazhivlyaemye wounds - Badly healing wounds

  - tromboflebitnye - thrombophlebitis
  - Kozhnye diseases - Skin diseases
  - Dobrokachestvennye growths - Nonmalignant growths]

1.Articular diseases (arthritis, arthritis, arthritis, psoriatic arthritis, osteochondrosis) in cancer metastatic to bone. Application: Massage lightly rub in a small amount of skin cream 2 times a day, preferably cast warming bandage (except cancer).

2.Badly healing wounds and ulcers (thrombophlebitis, cancers, fistulas, pressure sores, boils, boils). Directions: Apply a thin layer of cream on the ulcer, then gauze and fixed tubular bandage or medical bandage. Change the dressing every day.

3.Skin diseases (dermatitis, fungal infections, pyoderma, psoriasis, eczema, fungal infections of feet and nail lesions). Directions: Apply a thin layer of cream on the seat, then close and lock the gauze bandage or medical tubular bandage. Change the bandage, 2 times a day.

4. Varicose vein disease, varicose "veins", thrombophlebitis. Application: Massage lightly rub in a small amount of skin cream 2 times a day without overlapping warming bandages.

5.Nonmalignant growths on the skin (papillomas, lipomas, warts) Application: Massage lightly rub in a small amount of skin cream 2 times a day.

ФУНГО-ШИ®
Мухомор
КРЕМ

Some Russian Fly Agaric Medicinal Recipes

Sunday, 20 January 2013

original source: http://flyagarictincture.blogspot.com/2013/01/some-russian-fly-agaric-recipes.html

Here are some Russian fly agaric medicinal recipes that I've found by searching via Google for "Мухомор красный" - literally "red fly killer" - which is what fly agaric is called there. I haven't tried these, but thought I'd publish them here so that people have access to them. Thanks to Google Translate for the translation.

ЯДОВИТЫЕ ГРИБЫ
Мухомор красный · Amanita muscaria
1986 ПОЧТА СССР 5

from http://www.behigh.org/library/verbnik/muxomor.html

Amanita - the healing of all fungi
Here are five of the many applications of mushroom in traditional medicine...

1. Take a large red mushroom, finely chop and add 0.5 liters of 56% vodka. Buried in the muck for a month. The resulting jelly rub sore spots. Apply in paralysis, rheumatism, radiculitis.
2. Of mushroom, crushed in half with sour cream, make an ointment that is applied to a rag to a problem area. Used in paralysis, rheumatism, sciatica, sciatica, arthritis.
3. Amanita have to grill (?! AV) Cut two days in the refrigerator in a plastic bag, and then, placing cut pieces in a jar, pour the vodka on the thickness of your finger over the mushrooms. Bank to put in the cellar or in the refrigerator to sustain a uniform temperature. After two weeks, strain. That potion is ready. Good thirst rheumatic pain and sciatica and does heal when rubbed regularly.
4. Mushroom caps to fill 1 liter jar, pour vodka, buried in the ground for month, then strain and refrigerate. In gastric cancer, skin drink 1 teaspoon drop in Dist. Water 3 times for 1 hour before meals 20 days time - 10 days.
5. Finely chop the full liter bottle of bright red toadstools, cork stopper and put in the oven for the night after removed the bread. The next morning flick the bottle through a sieve and put in a glass jar. Rub the sore spots for the night and a very good lap.

(Recipes are taken from the publication of Vladimir Volkov in the Kostroma regional newspaper "Volga nov" July 25, 1995/15 years after the death of one of the most "muhomoristyh" guys Russia Vladimir Vysotsky - AV) "

From the publication "of mushrooms and berries 1997 Calendar" (LLP firm "Journe." Kostroma, 1996, edition of 300, 000)

The following is from http://www.zdorovgid.ru/maz-iz-krasnogo-muxomora/

Cream of mushroom red
Category: Gifts of Nature, medicinal plants, treatment of injuries, bruises, burns

Treatment of red fly agaric
Offer readers a unique recipe means that our ancestors were treated. They were treated much the drug. Intervertebral hernia, diseases of the joints, cracked heels, shipitsy (bones) in the legs, ulcers, various skin diseases. This is a brown thick ointment softens easily at 37 degrees. In the ointment is the dried powder of Amanita muscaria. For the preparation of medicines are needed only red mushroom.

To dry amanita at less than 60 degrees. Need rye flour that does not contain stabilizers, disintegrants. Better rye by grind in a coffee grinder. Pine sap resin can replace any tree. Resin - a valuable medicinal ointment component that delivers medication to the patient body. Along with a natural preservative for the mushroom body fat. The shelf life of the oil - a few years.

In a water bath to keep the enamel mug 50g unsalted visceral fat. As the fat melts, add the dried red mushroom powder 30 grams, 10 grams of rye flour, pine sap 10 grams. Thoroughly mix all until smooth. Keep a medicine in a glass container in the refrigerator.

Intervertebral hernia, painful joints before applying means warm light massage camphor oil. Back (joint) after rubbing ointment wrap woolen cloth to keep warm through the night. Camphorated oil in the other cases is not required. Cracks, minor wounds, insect bites, herpes grease composition just before full recovery.

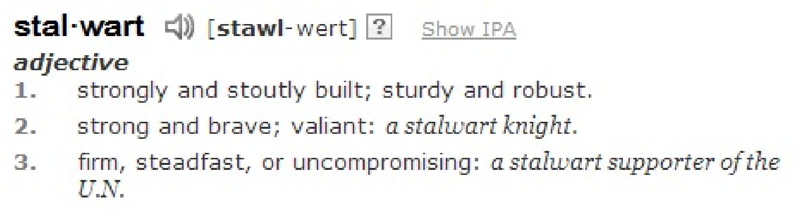
Ulcers, large wounds, fistulas are treated differently. Wound before treatment should be washed with a disinfectant solution (potassium permanganate, furatsilin, galangal broth or tsetrarii). Next, using the end of a lime glow sticks dry. Ignite this dry lime-stick (you can replace the currant), blow out the flame, the surface of the wound led to the end of the glow for 3-5 minutes at a distance of 1-2 cm. Do not worry: the burn will not be felt coolness.

Emergency procedure promotes tissue regeneration of the skin. Wound will heal much faster. Then apply ointment to a clean linen cloth the size you want a thin layer applied to the wound. Secure the elastic mesh or bandage. Ligation done daily until recovery.

Stalwart: forgotten folkname for fly agaric

Wednesday, 23 January 2013

original source: http://flyagarictincture.blogspot.com/2013/01/stalwart-forgotten-folkname-for-fly.html



stal·wart [stawl-wert] ? Show IPA

adjective

1. strongly and stoutly built; sturdy and robust.
2. strong and brave; valiant: *a stalwart knight.*
3. firm, steadfast, or uncompromising: *a stalwart supporter of the U.N.*

The fly agaric is such an iconic mushroom, instantly recognisable, with a long relationship with the human race. Yet we have no English folkname for it. I propose that stalwart is a forgotten folkname for fly agaric.

The word "stalwart" is of largely unknown etymology. The Online Etymology Dictionary has:

> **stalwart** (adj.)
> late 14c., Scottish variant of Old English stælwierðe "good, serviceable," probably a contracted compound of staðol "foundation, support" (from P.Gmc. *stathlaz, from PIE root *sta- "to stand, set down, make or be firm;" see stet) + wierðe "good, excellent, worthy" (see worth). Another theory traces the first element of stælwierðe to Old English stæl "place," from P.Gmc. *stælaz.

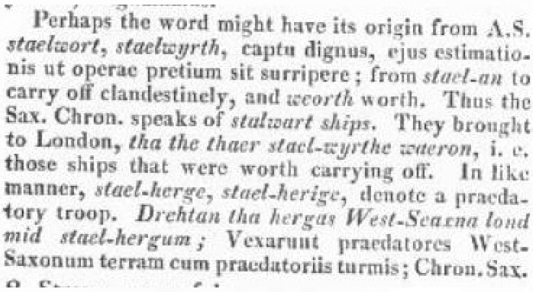
It is clearly made up of two different parts, "stal" and "wart".

- "Wart" could easily be a corruption of "wort", the old English word for "plant" - seen, for example, in St John's wort. Stalwart was often spelt "stalwort" historically.
- "Stal" could easily be a shortening of the old Germanic word for mushroom, surviving into Dutch, for example, as "paddenstoel". Although this sounds more like toadstool than mushroom, it is a generic word for fungi with a hat and a stem. This word actually has the same etymology as the stal above - meaning a foundation, support. It is also the origin of the word "steel".

The word "stalwart" is usually used to describe a warrior or a hero, someone who stands strong. This perhaps suggests a connection with ancient fighting forces. It is widely believed that Viking berserkers - and perhaps other warriors, notably Celts - made use of the fly agaric in battle. Therefore a fighter would be considered "stalwart" because they had partaken of the stal wort, the mushroom plant.

Having performed a little archaeological experimentation regarding this, I would posit that the warriors would cover their skin in fly agaric juice, and probably take a bite also. Strength and stamina are increased, and fear dissipates. There is a feeling of immortality. All these are qualities likely to make a warrior stand firm and fight for glory in battle.

Thus the berserker is shielded by the mushroom, which he also takes a bite from. Perhaps this is what the Isle of Lewis chesspiece berserker here is telling us as he bites his shield.



Perhaps the word might have its origin from A.S. *staelwort, staelwyrth*, captu dignus, ejus estimationis ut operae pretium sit surripere; from *stael-an* to carry off clandestinely, and *weorth* worth. Thus the Sax. Chron. speaks of *stalwart ships*. They brought to London, *tha the thaer stael-wyrthe waeron*, i. e. those ships that were worth carrying off. In like manner, *stael-herge, stael-herige*, denote a praedatory troop. *Drehtan tha hergas West-Seaxna lond mid stael-hergum*; Vexarunt praedatores West-Saxonum terram cum praedatoriis turmis; Chron. Sax.

Pictorial extract from An Etymological Dictionary of the Scottish Language: Volume 2 By John Jamieson, Edinburgh University Press 1808.

Within the Saxon Chronicles there is the word "staelwort", with a meaning of "to carry away clandestinely". It is likely that any fly agaric mushroom sect would - like those written about by Wasson and Allegro - have secret means of obtaining the mushrooms, carrying them away in a process known only to initiates, and probably subject to much ritual.

Indeed, Wiktionary has "stæl" as meaning "theft", akin to the Old English "stalu", all from the same Indo-Germanic root. This is suggestive of another very interesting possibility, that "stalwart" could be "the stolen plant".

Part of the mythology of the Vedic soma is that the plant be stolen from its guardians. Theodora, from A. A. Macdonell, Vedic Mythology (Strassburg, 1897), explains:

> The first soma is supposed to have been stolen from its guardian demon by an eagle, this soma-bringing eagle of Indra being comparable with the nectar-bringing eagle of Zeus, and with the eagle which, as a metamorphosis of Odin, carried off the mead.

- mushroom plant
- strength plant
- foundation/support plant
- secretly-carried-away plant
- the stolen plant

and could even provide another clue that perhaps fly agaric does equate with the Soma of the Rig Veda, and is indicative of an ancient entheogenic practice surviving in Indo-European Britain and Ireland. Such is investigated in PL Wilson's excellent Ploughing the Clouds: The Search for Irish soma.

It is, of course, possible that more than one of these meanings could also apply, in a play on words, for example, "the stolen plant that makes strong", even providing "foundation" for a whole culture.

Letters from Russians who have used fly agaric medicinally

Saturday, 23 February 2013

original source: http://flyagarictincture.blogspot.com/2013/02/letters-from-russians-who-have-used-fly.html

Here are some letters from Russians who have used fly agaric medicinally. I found these at shamanika.biz. I do hope they are happy with them being reproduced here. Copyright is attributable to (C) Makeyenko TV Physician. Translation from Russian by Google Translate. The whole of this article is from that webpage. I have written none of the following ...

Lung Cancer

(Letter of Anapa on K st Tatyana Alexandrovna). In 1969, my father (I was living in the city of Tyumen) ill - lung cancer. From the operation, he refused - he was immediately discharged from Oncology Center. His condition was terrible. They waited for the worst ... But at the hospital someone advised to drink mushroom hails vodka. Start was terrible. But he decided, at first spoonful 1.5 months, then a shot of the infusion, and then could drink a bottle a day of the liquid (the good liked to drink.) Its age was then 60 years old. And the state just two months later began to improve. Went phlegm with cough, with black - coal dust (he also worked on a locomotive engineer), sputum was intense. That's it then spent 13 years with breaks drank mushroom. Even little by little moonlighting guard, went to the forest for one mushroom. Then he gave them in the winter, who addressed. His father died with a diagnosis of pulmonary hemorrhage, ie, where there was a focus of the tumor - this place is just physically worn out.

Lung Cancer. Stroke

(Letter from the city of Yaroslavl on T-tion Nina Vasilievna). My husband literally not even a year old, he died of lung cancer. But I suggested and even gave ready hails mushroom in the primary moonshine, because now the pure alcohol can not get anywhere else. Describe how it healed. Gave the scheme from the 1st drop and brought to 20 drops 3 times a day for 15 - 20 minutes before a meal, and went back to 19 drops, then 18 and so on and brought to 7 drops. But he did not know that drinking mushroom. I once said to him: Serge, Let's have a fly agaric. A: what about you? Are you crazy? Decided to poison me? He did not know it was drinking it, because I'm in a thermos overnight insisted in hot water rose, the color was brown, and add 1 tablespoon of honey. Temperature husband reached even 40 degrees. Injections: analgina, diphenhydramine, but-silos 2 times and it was 3 times, but to no avail, and she started to drink Amanita - he recovered a bit, ate everything, began to leave himself out, he tucked in bed with him. A headache cough and he went to a therapist, and came to the reception, the doctor was surprised that he got up and danced in front of her dance. The doctor did not believe that he is on his feet. The pressure was high, and there is normal.

And so while drinking mushroom - was healthy. But as I said to him, and you do have drink, quarreled and did not drink. Decided to take a break, but you can see the cancer was extensive. A daughter of our smart, graduated from the Institute on excellent, scolded him that you mom treats, wants you to have lived, and you do not drink mushroom. And he agreed to drink. And because it was a big break, began to give one a bit, but apparently it was not enough. You had told me something like a 8 or 9-drops and no break you and your husband have been through. So I regret it all. He was my benefactor, and morally supported me. But alas, no one has suggested a break, as well as because of drops to give him.

Husband died, I go to the grave and weep, but that has not stopped. Went into the forest, gathered muscaria, got a little moonshine and double stage set for 1 month. I myself drink it now. Stomach ache, was not hurt. And when one went to the grave and met a woman and she told me that her relatives a woman 40 years hit paralysis. Her husband got this one year hails mushroom and watered for about a year and now she works as a cleaner and even dance. All she departed, and her husband said to his feet, and all what happened.

Stomach cancer

(Letter of Solikamsk from K-th Valentina). I had a case. My husband had surgery perforated ulcer. Managed to sew. Lived for 8 years. What was spring, autumn relapses. Decided to go to a resort, was examined and passed. Admitted to hospital, the operation did not do. Than treated - injections. But I was wearing a hospital mushroom. Tincture made two weeks in a dark place for 3 cap mushroom to 0.5 liters of vodka. So hats were not blooming, red. He drank in the morning on an empty stomach half a spoon and a mummy with the head under the tongue to dissolve the match and finally butter. FGS was autumn and the doctor said everything was fine. Already passed 7 years. I think he helped mushroom. A recognized cancer. Stomach cancer.

Rheumatism

(Letter of Saransk from A-ing Inessy Vasil'yevna). I was operated on for cancer of the stomach, removed 1/2 of stomach and I made medicine from mushroom to grandmother's recipe and here for 3 years I drink this medicine with 1 drop of 25 and until the 1st 50 days, then break for three weeks, and again. My mother was a terrible rheumatism, she began to drink with me, and now walking without crutches and sticks and legs swell.

Uterine cancer, throat cancer

(Letter from the Voronezh region from K-hand Raisa Grigorevny). I had no ill. His whole life was in the hospital two times: birth, 2 daughters from me. Ill eight years ago. Profuse bleeding, thick pieces. The district hospital said: "Climax". And discharged. I lie at home. I feel sick. I can not get up. Blood clots. Husband drove the ambulance to the regional oncology. Diagnosed with adenocarcinoma. Difficult surgery - deleted all a woman. Final diagnosis: chorionepithelioma. ESR - 68. From chemotherapy refused flatly. The tablets did not drink, all ejected. Lay on the table under the irradiation with a prayer: "Save me, O Lord." Immediately got up and into the shower, all washed away. A secret from the doctors saw mushroom (tincture). After irradiation greatly hurt the liver, stomach upset: neither eat - diarrhea, did not hold urine. When the pain was impossible to sleep, then saw a double dose of mushroom. Soothing.

For 1 year, I drank 3 liter jar mushroom infusion. I forgot where the liver. Normalized stomach, urinary bladder. Without re-examination I was given life the 2nd level of disability. But with God's help, I work as a teacher at a school in a full load. Of course, very tired. God gives me patience, contentment and joy in the soul. I do not have depression, resentment, bitterness, resentment. In the bustle of everyday life, I always turn to God. Churches have not. I read the Bible - a wonderful source of spiritual and pray. Understood the main thing: we are all under God. I'm worthless instrument of God.

Another case of healing mushroom. 3 years ago after her husband became ill, my friend. Cancer. Initially uterus removed, and then the right breast. Cancer in stage 4. Earth collapsed! Her sons asked, "Help!" Doctors were warned of deaths. I went to her in the hospital and begged him not to do chemotherapy pill or drink, or fly agaric mushroom will not help. Chemistry did not, said that all going to die. Saw mushroom after eating (to food - could not). Combined Saw distilled kerosene. Every day, I visited her and inspired not to lose heart. Recovered. Now works in its place - the chief accountant of the farm. Rejoice! Kind! Do not allow discouragement in his soul. He lives with God! Praying. In oncology, I noticed that died, those who went into the disease, limp, he was afraid of death. A person has to control himself. This is very important!

How did I know about the fly agaric? Nowhere read, are not met. My husband's brother (Yoshkar-Ola lives) grazed cattle. He noticed that the sick cow and mushroom grab greedily munching. Looking, run to where the red mushroom. And they get better. One day he was found shot in the throat. Grew. Covered passage. Doctors said, "Cut! Cancer." He did not return. Scored mushroom cap, was there, so it was fun to die, washed down with vodka. There was all black as tar, all cleared, lump disappeared. It took 40 years. Now he is 80. Lives. Amanita drink in their scheme. He cured the daughter-in-law, which removed both breasts. It works too, though afraid of the sun.

Dear Tamara, your brochure I need not to treat (we're healthy), but in order to compare with the experience, a way of making drugs, self-control, system usage. It's medicine - poison. One time I was poisoned, as tincture of mushroom was not sustained over time. His stomach was washed with water and baking soda in large quantities.

Stomach polyps

(Letter from the Tyumen region of M Victor Mikhailovich). I want to tell you how I was treated mushroom. Prompted me one recipe Grandma (now deceased). My wife was a cancer patient. That's grandmother and persuaded me to insist mushroom. She gave me a dry mushroom, which I insisted on vodka 0.5 liters of 18 days in a cool dark place. Wife then refused to drink this infusion. And I had eight polyps in the stomach. Then I decided to take myself this infusion. Peel, as taught - 1 nightingales spoon 3 times a day for half an hour before meals. Drank all the brandy, well, as if no change is noticed, and when Moscow offered to do the surgery - to remove polyps, when the survey revealed that they have not. Asked what was treated. Other drugs, except mushroom, do not drink. Treated differently, some believed, some laughed. But I do know that it is from mushroom. And the result is there.

Disease of the breast

(Letter from Krasnodar from B-k_Nadezhdy Feodorovna). Amanita muscaria, I am treated eighth year and it helped me a lot. 9 years ago I had an operation, "Fibroadenoma right breast." But in spite of the operation, I have continued chest ache, a rough, pink, bad joint. And the worst thing that was for me, it became a bother and left breast. I had a record, after 2 - 3 months was at the doctor's office. The pain was such that I feared so God forbid someone touched me. Suggested a second surgery, I refused, since mammograms have become the defining features of diffuse fibrous mastopathy.

2 years after the operation, I began to drink brandy mushroom, I always send it to my sister from Sverdlovsk. Saw her almost eight years now ended. Pain did not bother me a year three - four, but I kept taking it from 15 to 45 drops, adding one drop every day. The last three years have always drank a tablespoon for a month, then a month break, and so on for the last 3 - 4 years, I can no longer even lie on your stomach, but not abuse, basically try to sleep on your side or back . You know, Tamara, over the years I have something to do with this tincture feel safe, even if it is just in the fridge and I did not drink for a while, I feel more confident and relaxed that I have it. Now infusion over, I feel like I'm losing confidence, some confusion.

Stomach cancer 2

(Letter from the Bryansk region of I-to AM). I will be very grateful if you send me a brochure entitled "Treatment of fly agarics." I am not sick with cancer, and an ad in the newspaper would not have paid any attention if he did not know the case in the neighboring area. Wife wanted to poison her husband mushroom. He was discharged from the hospital to live out his days at home. He had stomach cancer. Severely tortured and tormented her as drinking began shamelessly. So, fry toadstools, gave them to the table as the mushrooms with a bottle of vodka. Recovered and lived for many years after this event. And even more treats from all diseases infusion of toadstools.

Longevity

(Letter of Boksitogorsk from A-va VT). If the truth can send a brochure entitled "Treatment of fly agarics", I'll wait. I kid read "Aliket go to the mountains" - so there is a moment that shamans used dried mushroom stem. Then my neighbor, an old man insisted on amanita brew and drank and lived, although the doctors were surprised that he did not die for a long time. Earlier in his youth, I somehow did not pay attention to it. But now I'm 59 years old and it's time and I'm interested in this tincture. But how to prepare it - that's the question.

Comment

Information that the fly agaric tincture drink to prolong life, I have many. Also this beautiful property it often read in the literature. In addition, the mushroom causes a rush of energy, stimulates physical and mental endurance, has the property to quickly restore lost power. But! used for continuous use as a stimulant mushroom can not, because it is a poison and narcotic. Only courses and in small doses! Mushroom use as drugs started in Russia about 10,000 years ago. Alkaloids contained in Amanita cause poisoning, hallucinations, and addictive. Another effect is that are near objects appear either very large (makropsiya) or very small (mikropsiya). Possible movements and convulsions. Episodes of intense excitement turns to moments of deep depression. Amanita muscaria, in contrast to other hallucinogens, causes an abnormally severe physical mobility. Indigenous peoples of Siberia - the Chukchi, Koryak, Kamchadals and others - are widely used amanita in several cases: to communicate with the supernatural in order to predict the future, to determine the cause of the disease, as well as just for fun during festivals (such as weddings) when they treated guests. And, of course, is widely used to enhance the abilities of mushroom shaman.

Questions - Answers

How to prepare and take the medicine of toadstools?
The answer is: preparation methods and regimens - a few dozen. (There is even such a seemingly frivolous as infused with male urine amanita. Well, this is unusual cooked mixture (with fly agarics on urine of men) is a natural drug and is used for severe pain in cancer patients).

Which one to choose - solves your fitoterapevt or healer, who you're going through treatment, and who is responsible for the drug and for you. Self poisonous herbs and mushrooms to engage strongly advise. But if you can not be treated by a specialist (which is much more effective than self-medication), use 50% tincture of vodka under the scheme: start with 1 drop 3 times a day for half an hour before meals, daily increasing the dose of each meal and 1 drop and work up to 20 drops 3 times a day. Then drops down, reducing the daily dose of 1 drop at each visit. Break - 1 week. Conduct at least 3 courses in a row.

Mushroom tincture drink better with 0.5 glasses of water infusion of birch fungus fungus or drop it 1 tablespoon diluted Befungin - pharmaceutical drugs fungus.

To prepare the tincture used only hats. Cut them into small pieces, weighed, placed in a jar, add an equal amount by weight of vodka and infuse at room temperature in the dark for 1 month.

The second method. Hats chop the brim lay in a jar, close the nylon cover, tie a cloth and buried in the ground to a depth of 1 meter for 1 month. Then drain the resulting juice and add some to it an equal amount of vodka. Store at room temperature tincture in a dark place out of reach of children. Shelf life - 1 year. And once again, remember that it is a poison.

50% tincture is used only if the patient takes of poisonous herbs only one mushroom. If you use an integrated, enhanced treatment (several potent herbs and ointments), the concentration, dose and regimen of others. When non-cancer diseases, use a weaker tincture - 10%.

In general, well said, responding to a similar question, healer of Moscow Vladimir Mironov, successfully using mushroom and brandy fly agaric ointment for the treatment of various diseases, including cancer, "I specifically do not include a recipe here fly agaric tinctures. It requires accurate compliance dosage. And then tell me how it is prepared, - in the woods any mushroom will not. Yet mushroom - mushroom special. Hence drink liquor only under close supervision."

Tell us how to prepare a tincture of hemlock.
To prepare the tincture using fresh flowers and green unripe seeds, in these parts of the plant contains many alkaloids. Fresh flowers are crushed, weighed, placed in a jar and pour vodka quality by weight in the ratio of 1:10, for example, 100 g of flowers we have to take one liter of vodka. Keep the vodka was no additives, particularly acidic - like citric acid, whey - for then alkaloids bind and precipitate, liqueur turns cloudy. Infuse 3 weeks at room temperature, and always in the dark. After 3 weeks, strain. Next. After 2 - 3 weeks after harvesting flowers (depending on weather conditions) Collect green unripe seeds of hemlock. Of them the same way, prepare 10% tincture 3 weeks strain. Then mix equal parts both tinctures: from seeds and flowers, shake well. Tincture of hemlock is ready for use. You can store it at room temperature, always in the dark and always out of reach of children. Shelf life - 1 year.

What is the stronger of the herbs - hemlock, aconite, or mushroom? Where should I start treatment?
By the force of the antitumor effect of these herbs are equal. Depending on individual sensitivity of some patients are better at Hemlock, others to Akon, third on the mushroom. Of cancer patients do not have time for the selection, so I always assign a comprehensive, enhanced treatment: all three infusions made in the same day at different times. Besides infusions necessarily give their patients herbal ointment - lubricate the affected area and the nearby lymph nodes. In the ointment are hemlock, mushroom, aconite, milestones, henbane, and some other herbs and pharmaceutical ingredients to improve skin permeability. The main property of the ointment - the local anti-tumor effects. In addition, it has analgesic and good wound-healing effect (when a cancerous ulcer, for example, splitting the running breast cancer).

I was approached by a young man from Polotsk - cancer of the penis. In Minsk, underwent surgery. Does not heal within a year post-operative wound. Tried all assigned ointment treated laser - without effect. Gave her ointment. Ringing. Happy, all is well. Regret only one thing - he had heard from patients about me good reviews, but somehow I did not believe in the grass. Year wondering whether to apply to me. And helped salve for several weeks. In benign tumors, treatment, I usually start with hemlock. In most cases, this is enough. When failure of hemlock select another tool.

(C) Makeyenko TV Physician - fitoterapevt

Fly Agaric and Radiation Burns

Saturday, 23 February 2013

original source: http://flyagarictincture.blogspot.com/2013/02/fly-agaric-and-radiation-burns.html

I was very surprised to find that fly agaric is used externally as a remedy for radiation burns in Russia (eg "an effective tool in radiation injuries of the skin"). I was even more surprised when it turned out I had radiation burns myself, and was able to use the fly agaric to treat them.

For the last two years, since I got my first smartphone, my thumbs and index fingers developed very deep splits in them. It seemed that the splits went all the way through the skin. They were very sore, and often very itchy, unbearably so. They had yellowy orange scabs surrounded by red soreness.

A month ago, I suddenly realised that the splits, redness and soreness were exactly where my smartphone touched my hands. I thought perhaps it could be radiation burns, and stopped using the mobile phone. Instead, I started using a netbook much more. The splits largely healed up. But the skin on my index finger, where it touches the mousepad, became very hard and sore.

I bought an electromagnetic radiation meter to see how much radiation - if any - these devices were giving off. I was shocked to see how much EMR (electromagnetic radiation) they were giving out, and continuously, rather than in pulses. Since then I've stayed off the netbook as well as the smartphone, and am only on the computer for short periods of time, using an external keyboard.

My hands are still scarred, but they haven't split again, for the first time in two years. I am satisfied that the splits and soreness were EMR burns. They looked just like the least severe images if you type "radiation burns" into Google images.

Treating Radiation Burns with Fly Agaric

I can't remember what I treated the burns with for the first year. For the second year though, once I'd discovered fly agaric, I treated them with fly agaric tincture, as I'd found it to be great at healing cooking burns and any little cuts, cat scratches etc. The splits would heal up, and become less sore, but they would always return before long, usually just a few days.

Once I realised that they were radiation burns, I tried a fly agaric compress. This was basically just a piece of mushroom soaked in vodka and taped onto the thumb and finger of one hand. This probably isn't the correct way to make a fly agaric compress. It made the skin around the burn look as if it had been in the bath for a week. It didn't feel as if this was the way to treat it, so I went back to just applying the tincture every hour or two, and leaving the wounds open to the air.

Sure enough, when applying the fly agaric tincture onto the radiation burns, they healed up quite quickly, within a few days, especially once I stopped using the netbook as well. They're still scarred, but at least they aren't split or scabbed anymore.

I found that the alcohol in the tincture dried the skin on my hands out. At this point, it would be great to have a fly agaric lotion to apply. I have experimented with coconut oil and powdered fly agaric, but it hasn't really worked out. I hope to find a way to make a fly agaric lotion, or at least manage to find somewhere I can buy the Russian fly agaric lotions.

Of course, sunburn is also a form of radiation burn, and fly agaric may be helpful in treating this as well.

Regrettably, all the photographs I took of my thumbs and fingers at various stages in the healing process are blurred and unusable.

comments 6

greenbeaver *14 September 2013 at 14:29*
olive oil

Fly Agaric Protects Against Aging and Neurogenerative Disease

Monday, 21 July 2014

original source: http://flyagarictincture.blogspot.com/2014/07/fly-agaric-protects-against-aging-and.html

Research shows that stimulating muscarinic receptors protects the brain and central nervous system against aging and neurodegenerative disease.

> These results demonstrate that stimulation of muscarinic receptors provides substantial protection from DNA damage, oxidative stress, and mitochondrial impairment, insults that may be encountered by neurons in development, aging, or neurodegenerative diseases. These findings suggest that neurotransmitter-induced signaling bolsters survival mechanisms, and inadequate neurotransmission may exacerbate neuronal loss.

Fly agaric mushrooms contain tiny amounts of muscarine, which acts as a stimulant to muscarinic receptors. So does eating a small daily piece of fly agaric mushroom protect against neurodegeneration? The elders of some native Siberian peoples eat a little fly agaric every day. They say that it gives them energy and helps them to think and remember things. It would seem that it is likely also protecting their brains and nervous systems against neurodegeneration related to aging.

Chemicals and Compounds of the Fly Agaric

Monday, 21 July 2014

original source: http://flyagarictincture.blogspot.com/2014/07/chemicals-and-compounds-of-fly-agaric.html

The different chemicals and compounds found within the fly agaric mushroom. The quantities of these can vary wildly from mushroom to mushroom, and even within one mushroom. Some of the chemicals can cancel each other out (for example atropine and muscarine), but with slightly differing amounts, there can be very different effects.

Muscimol

Muscimol stimulates GABA receptors. GABA is found throughout the plant and animal kingdom, and may represent a ubiquitous biological signalling molecule between animals, bacteria, fungi and plants (http://sydney.edu.au/medicine/pharmacology/adrien-albert/images/pdfs/RefsPDFs/390.pdf).

Muscimol is a crystalline solid that melts at 175C. It has neurologic activity and is a potent depressant of the central nervous system. The adverse effects of ingestion include sleep, hallucination, distorted perceptions and vomiting. (A Comprehensive Guide to the Hazardous Properties of Chemical Substances By Pradyot Patnaik 2007)

Ibotenic Acid

Ibotenic acid can be used in a similar way to monosodium glutamate, to improve the flavour of foods.

> Tricholomic acid and ibotenic acid can prevent deterioration of food and separation of Water therefrom, and keep the freshness and vivid appearance thereof; for example, when either of them is added to food paste, it improves color and increases viscosity and elasticity; when added to sake (rice wine), it prevents deterioration, when added to miso (bean paste) or soy sauce, it increases stability; and when added to milk or its processed matter, it lowers curd tension and promotes digestion.

The insecticidal properties of fly agaric are a result of ibotenic acid (Takemoto et al, 1964). Experiments have shown that the insecticidal activity of tricholomic acid is superior to that of ibotenic acid.

Muscazone

Muscazone is a crystalline solid amino acid that decomposes above 190C. It's sparingly soluble in water. The toxic symptoms from high doses are similar to those from ibotenic acid. (A Comprehensive Guide to the Hazardous Properties of Chemical Substances By Pradyot Patnaik 2007)

R-4-hydroxy-pyrrolidone

This chemical frame is common in some micromycetes; they generally exhibit a potent biological activity against bacteria and other fungi (e.g. aureothrycin, equisetin). This additional compound, gives information on the biogenesis of ibotenic acid, muscimol, and muscazone.

Tricholomic Acid

Tricholomic acid can be used in a similar way to monosodium glutamate, to improve the flavour of foods.

> tricholomic acid and ibotenic acid can prevent deterioration of food and separation of Water therefrom, and keep the freshness and vivid appearance thereof; for example, when either of

them is added to food paste, it improves color and increases viscosity and elasticity; when added to sake (rice wine), it prevents deterioration, when added to miso (bean paste) or soy sauce, it increases stability; and when added to milk or its processed matter, it lowers curd tension and promotes digestion.

Muscarine

Muscarine is a non-selective agonist of the muscarinic acetylcholine receptor. It crosses the Blood Brain Barrier. Muscarine mimics the function of the natural neurotransmitter acetylcholine in the muscarinic part of the cholinergic nervous system. Muscarine is not metabolised by acetylcholinesterase.

Bufotenin

(5-HO-DMT, *N,N*-dimethylserotonin), is a tryptamine related to the neurotransmitter serotonin. It is an alkaloid found in the skin of some species of toads; in mushrooms, higher plants, and mammals.[1] The name bufotenin originates from the Bufo genus of toads, which includes several species of psychoactive toads, most notably *Incilius alvarius*, that secrete bufotoxins from their parotoid glands.[2] Bufotenin is similar in chemical structure to the psychedelics psilocin (4-HO-DMT), 5-MeO-DMT, and DMT, chemicals which also occur in some of the same fungus, plant, and animal species as bufotenin. The psychoactivity of bufotenin has been disputed, though recent studies suggest it is similar in nature to 5-MeO-DMT. (from Wikipedia)

Choline

Choline is the precursor molecule for the neurotransmitter acetylcholine.

Acetylcholine

Acetylcholine is an organic molecule that acts as a neurotransmitter in many organisms, including humans.

Betaine

A betaine is a neutral chemical compound with a positively charged cationic functional group. It is also a methyl donor of increasingly recognised significance in biology.

Atropene

Is an antidote to muscarine.

Muscaridin

Hercynin

May act as a precursor of trimethylamine (Nielsen, J. Trimethylammonium compounds in Tilletia spp., *Canadian Journal of Botany*, 1963, 41(3) p. 335-339.). Trimethylamine is used in the synthesis of choline, itself a precursor of acetylcholine.

Uracil

One of the four nucleobases in the nucleic acid of RNA. In DNA, uracil is methylated and becomes thymine.

Xanthine

A mild stimulant and broncho-dilator. Increases alertness in the central nervous system. Stimulates the respiratory centre and is used in the treatment of asthma and infantile apnoea.

Hypoxanthine

The *Pheretima aspergillum* worm, used in Chinese medicine preparations, contains hypoxanthine. (The Pharmacology of Chinese Herbs, Second Edition By Kee C. Huang)

Adenosine

Very important in human energetic processes, as ADP, ATP and cAMP. It is also an important neurotransmitter in falling asleep. Adenosine receptors are key to opening the Blood Brain Barrier (BBB). Adenosine is also believed to have anti-inflammatory properties.

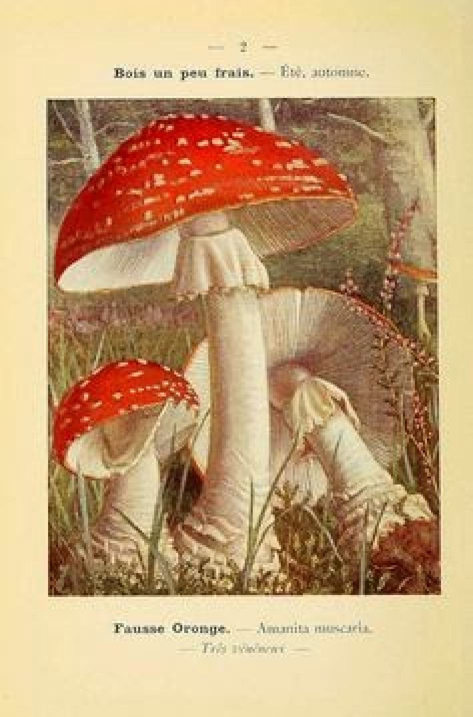
Bug Agaric in Herbal Simples for Modern Uses of Cure (1897)

Friday, 3 October 2014

original source: http://flyagarictincture.blogspot.com/2014/10/bug-agaric-in-herbal-simples-for-modern.html

The following is from Herbal Simples for Modern Uses of Cure (1897) by William Thomas Fernie:

The pileus of the Fly Agaric is broad, convex, and of a rich orange scarlet [369] colour, with a striate margin and white gills. It gets its name, as also that of Flybane, from being used in milk to kill flies; and it is called Bug Agaric from having been formerly employed to smear over bedsteads so as to destroy bugs.


— 2 —
Bois un peu frais. — Été, automne.
Fausse Oronge. — Amanita muscaria.
— Très vénéneux —

It inhabits dry places, especially birchwoods, and pinewoods, having a bright red upper surface studded with brown warts; and when taken as a poisonous agent it causes intoxication, delirium, and death through narcotism. It is more common in Scotland than in England. This Mushroom is highly poisonous, and therefore the remedial preparations are only to be given in a diluted form.

For medicinal purposes a tincture is made (H.) from the fresh fungus: and a trituration of the dried fungus powdered and mixed with inert sugar of milk also powdered. These preparations are kept specially by the homoeopathic chemists: and the use of the Fly Agaric has been adopted by the school which they represent for curatively treating an irritable spinal cord, with soreness, twitching of the limbs, dragging of the legs, unsteadiness of the head, neuralgic pains in the arms and legs (as if caused by sharp ice), some giddiness, a coating of yellow fur on the lining mucous membranes, together with a crawling, or burning, and eruptive skin. In fact for a lamentably depraved condition of all the bodily health, such as characterises advanced locomotor ataxy, and allied spinal degradations leading to general physical failure. Just such a totality of symptoms has been recorded by provers after taking the fungus for some length of time in toxical quantities.

The tincture should be used of the third decimal strength, five drops for a dose twice or three times a day with a spoonful of water; or the trituration of the third decimal strength, for each dose as much of the powder as will lie on the flat surface of [370] a sixpence. Chilblains may be mitigated by taking the tincture of this Agaric, and by applying some of the stronger tincture on cotton wool over the swollen and itching parts at night.

"Muscarin" is the leading active principle of the Fly Agaric, in conjunction with agaricin, mycose, and mannite.

It stimulates, when swallowed in strong doses, certain nerves which tend to retard the action of the heart.

Both our Fly Agaric and the White Agaric of the United States serve to relieve the night sweats of advanced pulmonary consumption, and they have severally proved of supreme palliative use against the cough, the sleeplessness, and the other worst symptoms of this, wasting disease, as also for drying up the milk in weaning.

Each of these fungi when taken by mistake will salivate profusely, and provoke both immoderate, and untimely laughter. When the action of the heart is laboured and feeble through lack of nervous power, muscarin, or the tincture of Fly Agaric, in a much diluted potency will relieve this trouble. The dose of Muscarin, or Agaricin, is from a sixth to half a grain in a pill. These medicines increase the secretion of tears, saliva, bile, and sweating, but they materially lessen the quantity of urine.

Belladonna is found to be the best antidote.

Amanita phalloides poisoning and treatment with silibinin in the Australian Capital Territory and New South Wales

by

Darren M. Roberts, Michael J. Hall, Morna M. Falkland, Simone I. Strasser, Nick A. Buckley

MJA 198 (1) - 21 January 2013

Received 26 Jul 2012, accepted 3 Dec 2012.

original source: https://www.mja.com.au/system/files/issues/198_01_210113/rob11180_fm.pdf
backup source: http://www.psilosophy.info/resources/rob11180_fm.pdf

Darren M. Roberts, PhD, FRACP, Clinical Toxicology Fellow[1]
Michael J. Hall, FACEM, Clinical Director, Department of Emergency Medicine[2]
Morna M. Falkland, BPharm, Senior Pharmacist, Medicines Information Centre[2]
Simone I. Strasser, MD, FRACP, Clinical Associate Professor and Hepatologis[3]
Nick A. Buckley, MD, FRACP, Clinical Toxicologist[1], and Professor[4]

1. New South Wales Poisons Information Centre, Children's Hospital at Westmead, Sydney, NSW.
2. Canberra Hospital, Canberra, ACT
3. Australian National Liver Transplantation Unit, Royal Prince Alfred Hospital, Sydney, NSW
4. Professorial Medicine Unit, Prince of Wales Hospital, University of New South Wales, Sydney, NSW.

1darren1@gmail.com

MJA 2013; 198: 43-47 doi: 10.5694/mja12.11180

Table of Contents:

Abstract
Objectives
Design, setting and patients
Main outcome measures
Results
Conclusions
Methods
Ethics approval
Results
Discussion
References

Abstract

Objectives

To report the frequency and clinical outcomes of *Amanita phalloides* poisoning in the Australian Capital Territory and New South Wales, and the treatments used (including silibinin).

Design, setting and patients

Retrospective case series of patients admitted to public hospitals in Canberra and Sydney for suspected *A. phalloides* poisoning between 1999 and 2012 (identified from hospital records and calls to the New South Wales Poisons Information Centre).

Main outcome measures

Frequency of poisoning and the clinical outcomes.

Results

Twelve patients presented with a history suggesting *A. phalloides* poisoning, 10 with probable poisoning and two with possible poisoning. Eight of those with probable poisoning developed significant hepatotoxicity and four died. Silibinin was administered to nine of those with probable poisoning (the other presented before 2005). Maintaining silibinin supply became a challenge during two clusters of poisoning. Eight of the patients with probable poisoning were not long-term residents of the ACT, and six were immigrants from Asia.

Conclusions

The mortality rate due to *A. phalloides* poisoning in this case series was high despite treatment according to current standards, including use of silibinin, and the frequency of hepatotoxicity was more than double that for the previous decade. Ongoing public health campaigns are required.

Amanita phalloides ("deathcap" or "whitecap") is a cyclopeptide variety of mushroom that is responsible for more than 90% of mushroom-related fatalities; one mushroom cap can cause fulminant hepatic failure and death in an adult.[1] Most reported *A. phalloides* poisonings occur in Europe. In Australia, most occur in Canberra as *A. phalloides* grows in the Australian Capital Territory, particularly in the older suburbs of Canberra (which has been attributed to imported oak trees). Cases have also been reported in Victoria. Public health campaigns are commonplace in the ACT in summer and autumn ("mushroom season").

Amatoxin is the most potent hepatotoxin in cyclopeptide mushrooms; it irreversibly binds to RNA polymerase II, causing hepatic necrosis.[1] The clinical features of *A. phalloides* poisoning are well described (Box 1). The most recent report of *A. phalloides* poisonings in Australia was from the ACT over 10 years ago, describing seven poisonings that occurred between 1988 and 1998.[5] Since then, a chemically modified derivative of silibinin (silibinin-C-2',3-dihydrogen succinate, disodium salt [Legalon SIL, Madaus], referred to hereafter as silibinin) - a purported antidote to *A. phalloides* poisoning that is derived from the milk thistle *Silybum marianum* - has been stocked by hospitals in the ACT. In 2005, Canberra Hospital imported silibinin for use as an antidote through the Special Access Scheme of the Therapeutic Goods Administration because it is not registered for use in Australia. Sufficient stock was purchased to treat one patient for at least 96 hours at a dosage of 20 mg/kg/24 h, given in 6-hourly doses. This decision was made (despite a lack of good-quality evidence of efficacy) because there was no approved treatment in Australia, there was a plausible mechanism of action and some supporting evidence from animal studies, and silibinin is regarded as the standard of care in Europe. In 2010, the silibinin stock level at Canberra Hospital was increased so that there was sufficient stock to treat two patients and, in Sydney, Royal Prince Alfred Hospital also stocked it.

Here, we review cases of *A. phalloides* poisoning that occurred in the ACT and New South Wales between 1999 and 2012, including patients treated with silibinin.

Methods

We reviewed the clinical records of patients with possible *A. phalloides* poisoning who were treated at public hospitals in Canberra and the Australian National Liver Transplantation Unit at Royal Prince Alfred Hospital between January 1999 and May 2012. Patients were identified from clinical databases in departments of emergency medicine and clinical toxicology in the ACT and from call records of the New South Wales Poisons Information Centre. A diagnosis of *A. phalloides* poisoning was suspected on the basis of a history of mushroom ingestion and subsequent delayed onset of gastroenteritis and hepatitis; blood tests confirming the presence of amatoxin are not available in Australia.

1 Clinical features of acute *Amanita phalloides* poisoning[1-4]
0 to 6-18 hours after ingestion: Asymptomatic
6-24 hours after ingestion: Gastroenteritis, including abdominal pain, nausea, vomiting, diffuse diarrhoea, dehydration with or without hypotension, metabolic acidosis and electrolyte disturbance; normal or mildly deranged renal function and levels of hepatic enzymes
1-7 days after ingestion: Resolving gastrointestinal symptoms, but progressive hepatic failure, coagulopathy, kidney injury (including hepatorenal syndrome); possible progression to multisystem organ failure and a 10%-30% mortality rate
> 7 days after ingestion: Complete resolution of symptoms occurs in most survivors over weeks or months; chronic hepatitis may persist

De-identified demographic, clinical and treatment data were extracted and two prognostic tools for predicting death (or liver transplant) due to acute *A. phalloides* poisoning were considered.

Onset of diarrhoea < 8 hours after mushroom ingestion or INR ≥ 6 on Day 4. These criteria are supported by a study of 27 patients (sensitivity 1.0 and specificity 0.68 for diarrhoea; sensitivity 1.0 and specificity 1.0 for INR)[2] and a study of 10 patients (sensitivity 1.0 and specificity 1.0 for diarrhoea; sensitivity 0.71 and specificity 1.0 for INR),[6] but they have been criticised because the supporting studies classified liver transplant recipients as deaths in their analysis.[7]

INR ≥ 2.5 and serum creatinine level > 106 µmol/L from Day 3. The reported predictive utility of these criteria is variable (sensitivity 1.0 and specificity 0.98 in a study of 198 patients;[8] sensitivity 0.75 and specificity 0.90 in a study of 27 patients;[2] sensitivity 0.57 and specificity 1.0 in a study of 10 patients[6]).

Ethics approval

This study was approved by the Human Research Ethics Committees of ACT Health, Calvary Health Care ACT, Royal Prince Alfred Hospital and the Children's Hospital at Westmead.

Results

Over the 12-year study period, 12 patients presented with a history suggesting *A. phalloides* poisoning; they all developed clinical features of poisoning and were admitted to hospital (Box 2). The median age of the patients was 36 years (interquartile range, 27-51 years; range, 2-88 years) and eight patients were male. Eight of those with probable poisoning (based on clinical and mycological features) were not long-term residents of the ACT and seven were immigrants (six from Asia, one from Europe).

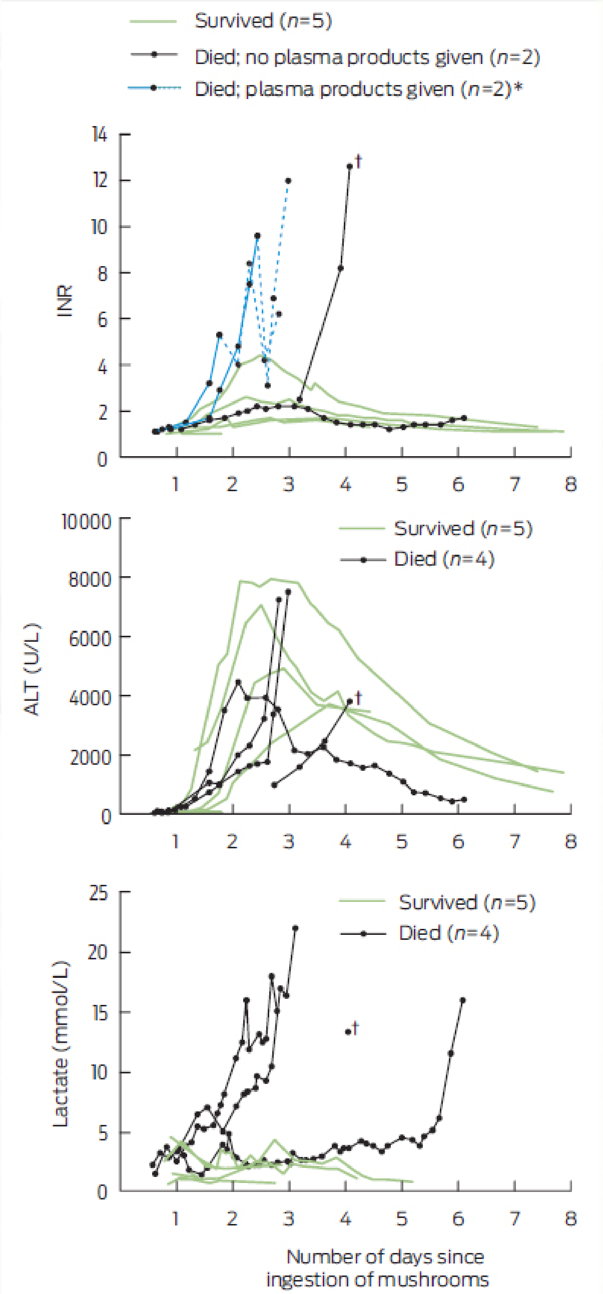
2 Patients with a history suggesting *Amanita phalloides* poisoning, Australian Capital Teritory and New South Wales, 1999-2012*

Patient	No. of mushrooms ingested	Onset of symptoms	Peak abnormal results of renal and liver function tests	Treatment	Predicted to die**	Outcome
A	1	8.5 h	Cr, 137 µmol/L; ALT, 7814 U/L; INR, 3.4; La, 4.6 mmol/L	IV fluids, analgesia, antiemetics, MDAC, NAC, penicillin, silibinin (36 h after ingestion) then silymarin, ICU admission, care by liver transplantation unit	No	Survived, no sequelae
B	10	9 h	Cr, 192 µmol/L; ALT, 3914 U/L; INR, 2.2; La, 16 mmol/L	IV fluids, penicillin, silibinin (23 h after ingestion) then silymarin, ICU admission, care by liver transplantation unit	No	Died 6 days after ingestion (shock, acute abdomen and cerebral oedema; hepatic failure was resolving)
C	1	8.5 h	Cr, 98 µmol/L; ALT, 4913 U/L; INR, 1.7; La, 1.6 mmol/L	IV fluids, antiemetics, analgesia, MDAC, NAC, penicillin, silibinin (46 h after ingestion)	No	Survived, no sequelae
D	2	11 h	Cr, 88 µmol/L; ALT, 3701 U/L; INR, 1.7; La, 2.3 mmol/L	IV fluids, penicillin, silibinin (21 h after ingestion), cimetidine, antibiotics and antifungal, care by liver transplantation unit	No	Survived
E	Unclear, various mushrooms ingested in two meals	25 h after first meal; 9 h after second meal	Cr, 73 µmol/L; ALT, 7067 U/L; INR, 2.6; La, 4.4 mmol/L	IV fluids, MDAC, acetylcysteine, silibinin (31 h after second meal), ICU admission, care by liver transplantation unit	No	Survived, persistent but asymptomatic hepatitis at last review (5 days after ingestion)
F	Unclear; perhaps 8-10	10 h	Cr, 179 µmol/L; ALT, 7253 U/L; INR, 8.4; La, 18 mmol/L	IV fluids, NAC, MDAC, silibinin (19 h after ingestion), ICU admission, care by liver transplantation unit, plasma products	No (died early)	Died 2.5 days after ingestion, fulminant hepatic failure and lactic acidosis
G	Unclear	Unknown; had symptoms for 48 h before presentation	Cr, 232 µmol/L; ALT, 3793 U/L; INR, 12.6; La, 13.4 mmol/L	IV fluids, then heparin and interhospital transfer for investigation and treatment of an ischaemic foot that resolved without other intervention***	Yes	Died 4 days after suspected time of ingestion, fulminant hepatic failure and lactic acidosis
H	Unclear; perhaps 8-10	10 h	Cr, 119 µmol/L; ALT, 7511 U/L; INR, >12; La, 22 mmol/L	IV fluids, NAC, MDAC, silibinin (19 h after ingestion), ICU admission, care by liver transplantation unit, plasma products	Yes (based on terminal blood test results)	Died 3 days after ingestion, fulminant hepatic failure and lactic acidosis
I	Unclear	14 h	Cr, 77 µmol/L; ALT, 63 U/L; INR, 1.0; La, 1.3 mmol/L	IV fluids, MDAC, NAC, silibinin (23 h after ingestion), ICU admission	No	Survived, no sequelae
J	5	10 h	Cr, 111 µmol/L; ALT, 52 U/L; INR, 1.1; La, 1.5 mmol/L	IV fluids, MDAC, NAC, silibinin (33 h after ingestion), ICU admission	No	Survived
K	Part of a mushroom	12 h	Urea and ALT levels mildly elevated	Observed for 4 h, no follow-up	No	Survived
L	1	6 h (very mild)	No changes	Observed overnight, no progression of symptoms	No	Survived

ALT = serum alanine aminotransferase (reference interval, < 55 U/L).
Cr = serum creatinine (reference interval, 60-110 µmol/L).
ICU = intensive care unit.
INR = international normalised ratio (reference interval, 0.8-1.2).
IV = intravenous.
La = blood lactate (reference interval, < 2.5 mmol/L).
MDAC = multiple doses of activated charcoal.
NAC = acetylcysteine.
* Poisoning was probable in Patients A-J (clinical or mycological features confirmed that *A. phalloides* had been ingested) and possible in Patients K and L (very mild symptoms and non-significant biochemical changes).
**Based on prognostication tools.
*** Patient G presented before 2005, so did not receive silibinin.

All the patients had ingested wild mushrooms. One had presented to a Sydney hospital after picking mushrooms in Canberra, transporting them home and then incorporating them into a meal. Two had consumed mushrooms for recreational purposes after they had been misidentified as a hallucinogenic variety. Another had consumed mushrooms believed to be *A. phalloides* (based on information in public health campaigns) for self-poisoning.

Two patients had very mild symptoms and non-significant biochemical changes, so *A. phalloides* poisoning was considered possible. The other 10 had probable *A. phalloides* poisoning owing to marked symptoms and the characteristics of the ingested mushroom; eight developed significant hepatotoxicity (alanine aminotransferase [ALT] level more than 10 times the upper limit of the reference interval) and seven were admitted to an intensive care unit. One patient presented to hospital after 48 hours of gastroenteritis but the history of mushroom ingestion was not noted until about 4 hours before she died. Six patients were transferred from the ACT to the Australian National Liver Transplantation Unit in Sydney. Four of the patients with probable *A. phalloides* poisoning died.



3 Temporal changes in INR, serum ALT levels and blood lactate levels in patients with probable *Amanita phalloides* poisoning.
ALT = alanine aminotransferase.
INR = international normalised ratio.
* Change from solid blue line to dashed blue line indicates start of treatment with plasma products.
† Time of ingestion unclear, so times are estimates.

Temporal changes in INR, serum ALT levels and blood lactate levels are shown in Box 3. In most patients, marked changes in INR and ALT levels did not occur until at least 24 hours after mushroom ingestion. In two of the patients who died rapidly, the rate of increase of INR was more marked compared with that in survivors, but the same was not observed with ALT levels. The rate of increase in blood lactate levels was also more marked in patients who died compared with those who survived. The onset of increased INR and ALT levels appears to have been delayed for one of the patients who died and had not received silibinin (Patient G); however, the time of mushroom ingestion by this patient was imprecisely documented.

Multiple therapies were administered, including silibinin to all but one patient with probable *A. phalloides* poisoning. Silibinin supply was exhausted during the treatment of one patient, who was subsequently given oral silymarin (Legalon [140 mg silymarin capsules], Madaus; a standardised extract of milk thistle seeds that contains silibinin). Other purported antidotes that were administered included intravenous acetylcysteine (given according to dosing guidelines for paracetamol poisoning) and intravenous penicillin (given in high doses [0.25-1.0 million units/kg/day]). Patients also received multiple doses of activated charcoal (50 grams 6-hourly by enteral administration).

Maintaining a supply of silibinin to treat patients was a challenge due to the clustering of events. Of the 10 probable poisonings, nine occurred over the last 4 years of the study period. In six of these cases, the patients presented on a public holiday (New Year's Day) - two on one occasion and four on another. Additional stock was urgently required for the cluster of four patients, which required close communication with pharmacy, clinical toxicology and liver transplant centre colleagues in other states, and with the importing company (which promptly mobilised sufficient stock). However, one of only three hospitals that stocked silibinin during the study period is in South Australia, but this was not known by anyone within the Poisons Information Centre network when treatment for the cluster of four patients was urgently being sought.

From our experience, elevated INR and blood lactate levels appeared to be the best prognostic markers. Other prognostic tools (listed in the Methods) did not provide useful advance warning of death - they met criteria only within several hours of death in the four patients who died. One death is notable because the INR values and ALT levels suggested resolution of hepatic injury, but the patient had progressive severe metabolic acidosis and hypoalbuminaemia and, 6 days after mushroom ingestion, developed an acute abdomen and subsequently died of cerebral oedema. The three patients who died rapidly with hepatic failure also had very severe lactic acidosis (Box 3). Severe gastrointestinal tract toxicity may be a significant contributory cause of death and may complicate liver transplantation.[9] Toxicity progressed rapidly in two patients who were thought to have ingested the largest doses (about 8- 10 mushrooms). Because of the small number of patients, it was not possible to explore the effectiveness of treatments.

Discussion

This case series shows that *A. phalloides* poisoning is an ongoing public health concern. It is also the first report of silibinin use in Australia for *A. phalloides* poisoning. Despite availability of silibinin, multiple ingestions from 2000 to 2012 led to severe poisoning, including four deaths. Compared with data from the previous decade,[5] the number of patients with hepatotoxicity more than doubled and the number of deaths quadrupled. However, the events were clustered and sporadic. People who do not reside in the ACT appear to be at higher risk, as do immigrants (six victims had recently arrived from Asia, where consumption of wild mushrooms is commonplace, and had limited English language skills). Those who consume mushrooms for recreational purposes may also be vulnerable.

Ongoing review of public health campaigns and existing treatment protocols is occurring and appears to be warranted. However, increased awareness of the toxicity of *A. phalloides* may have the counter-effect of prompting its use for self-harm, which is concerning given the low efficacy of existing treatments.

The approach to treating patients with suspected *A. phalloides* poisoning includes prompt consideration of the diagnosis and identification of the mushroom if a fresh specimen or a sample of gastric contents is available. This requires liaison with a mycologist and performance of the Meixner test. The Meixner test is conducted by adding hydrochloric acid to a sample of mushroom placed on newspaper; a blue colour change suggests the presence of amatoxin, although false positive results have been reported.[1] Treatment includes supportive care and gastrointestinal decontamination, and antidote use should be considered.[10] Fluid resuscitation is required during the gastroenteritis phase to restore haemodynamic stability and maintain renal perfusion. Amatoxin is subject to enterohepatic recirculation, so multiple doses of activated charcoal should be given to limit reabsorption. Nasobiliary drainage has also been employed to reduce enterohepatic recirculation.[11] Extracorporeal treatments have been trialled, but efficacy is inadequately quantified.

Electrolyte abnormalities should be corrected, and liver enzyme levels, INR, and lactate levels should be monitored for prognosticative purposes. Indications for liver transplantation are debated. Where possible, transplantation should be delayed until at least 2-4 days after poisoning to allow elimination of amatoxin to prevent graft poisoning.[12] Early predictors of severe poisoning (but not necessarily death) may also help decision making regarding transfer to specialised liver units.

Multiple antidotes are currently used to treat patients with *A. phalloides* poisoning.[1,10] The evidence of efficacy is limited for all treatments, largely due to the difficulties associated with human studies of an infrequent and sporadic type of poisoning. Two analyses of observational studies in human poisonings have supported the role of silibinin and acetylcysteine;[10,13] however, positive findings are limited by potential publication bias.[10,13] None of the treatments have been subjected to dose-response or controlled trials in humans. Many animal studies are of limited clinical relevance because treatments are not delayed. Further, in-vitro studies have demonstrated effects of benzylpenicillin, acetylcysteine and silibinin in human cultured hepatocytes,[14-16] but not canine hepatocytes.[17] A study in pigs demonstrated no beneficial effects of silibinin, acetylcysteine, benzylpenicillin, cimetidine or thioctic acid administered 4 hours after poisoning.[18] In our case series, four out of 10 patients with clinically significant poisoning died, despite the use of intravenous silibinin and other treatments in nine of them. The optimal doses and timing of antidotes, and the range of amatoxin ingestion for which antidotes are effective, are unknown.

Despite these limitations, silibinin continues to be imported into Australia and is widely used elsewhere. Decisions regarding stock holdings of silibinin require consideration of cost (about $1400/day/patient), stock expiration, and time to obtain replacement or additional stock (potentially long, as it is not marketed in Australia). Our experience suggests that Poisons Information Centre knowledge of silibinin stocks, and rapid communication with the distributor and hospitals is required. A coordinated national approach (eg., a national inventory of antidotes) may be useful given that *A. phalloides* poisoning is not limited to the ACT.

A blood test that detects amatoxin would be useful to confirm exposures for epidemiological purposes. If rapidly available, a quantitative assay might assist existing prognostic tests, although more research is first required to guide interpretation of these results - for example, to develop a nomogram for risk stratification, similar to the approach used for paracetamol poisoning. An amatoxin assay may also be useful for determining when the blood concentration of amatoxin is sufficiently low in an individual patient to allow liver transplantation to proceed, when required, without subsequent poisoning of the graft.

Management is controversial in patients who present early after ingestion of mushrooms that may be *A. phalloides* but do not have clinical features of significant poisoning. We identified two such patients with favourable outcomes (although *A. phalloides* ingestion was not confirmed). In such cases, the risk of *A. phalloides* ingestion should be clarified by consulting a mycologist and/or conducting a Meixner test. Early intervention, including decontamination and antidotes, should be considered after consulting a Poisons Information Centre.

Clinical trials on antidotes for *A. phalloides* poisoning would be extremely helpful as there are no treatments with good evidence, and there may be as yet unknown but cheaper and more widely available alternatives to silibinin. An observational study of silibinin (ClinicalTrials.gov Identifier, NCT00915681) is underway, but no randomised controlled trials are currently registered and most guidelines follow the accepted standard practice in Europe.

A. phalloides poisoning is a public health problem in Australia, particularly the ACT, and the mortality rate is potentially high. Based on currently available data, we recommend treatment with supportive care, multiple doses of activated charcoal, intravenous silibinin, and acetylcysteine, as well as consideration of liver transplantation.

Acknowledgements: We thank Emily Diprose for helpful comments on this article.

Competing interests: No relevant disclosures.

References

1. Berger KJ, Guss DA. Mycotoxins revisited: part I. *J Emerg Med* 2005; 28: 53-62.
2. Escudié L, Francoz C, Vinel JP, *et al*. *Amanita phalloides* poisoning: reassessment of prognostic factors and indications for emergency liver transplantation. *J Hepatol* 2007; 46: 466-473.
3. Giannini L, Vannacci A, Missanelli A, *et al*. Amatoxin poisoning: a 15-year retrospective analysis and follow-up evaluation of 105 patients. *Clin Toxicol (Phila)* 2007; 45: 539-542.
4. Krenová M, Pelclová D. Potential hepatotoxic and nephrotoxic substances reported to the Czech Toxicological Information Centre in the past 3 years. *J Toxicol Clin Toxicol* 2004; 42: 498.
5. Trim GM, Lepp H, Hall MJ, *et al*. Poisoning by *Amanita phalloides* ("deathcap") mushrooms in the Australian Capital Territory. *Med J Aust* 1999; 171: 247-249.
6. Ferreira R, Romãozinho JM, Amaro P, *et al*. Assessment of emergency liver transplantation criteria in acute liver failure due to *Amanita phalloides*. *Eur J Gastroenterol Hepatol* 2011; 23: 1226-1232.
7. Ganzert M, Felgenhauer N, Zilker T. Reassessment of predictors of fatal outcome in amatoxin poisoning: some critical comments. *J Hepatol* 2007; 47: 424-425.
8. Ganzert M, Felgenhauer N, Zilker T. Indication of liver transplantation following amatoxin intoxication. *J Hepatol* 2005; 42: 202-209.
9. Pinson CW, Daya MR, Benner KG, *et al*. Liver transplantation for severe *Amanita phalloides* mushroom poisoning. *Am J Surg* 1990; 159: 493-499.
10. Enjalbert F, Rapior S, Nouguier-Soulé J, *et al*. Treatment of amatoxin poisoning: 20-year retrospective analysis. *J Toxicol Clin Toxicol* 2002; 40: 715-757.
11. Madhok M, Scalzo AJ, Blume CM, *et al*. *Amanita bisporigera* ingestion: mistaken identity, doserelated toxicity, and improvement despite severe hepatotoxicity. *Pediatr Emerg Care* 2006; 22: 177-180.
12. Jaeger A, Jehl F, Flesch F, *et al*. Kinetics of amatoxins in human poisoning: therapeutic implications. *J Toxicol Clin Toxicol* 1993; 31: 63-80.
13. Poucheret P, Fons F, Doré JC, *et al*. Amatoxin poisoning treatment decision-making: pharmaco-therapeutic clinical strategy assessment using multidimensional multivariate statistic analysis. *Toxicon* 2010; 55: 1338-1345.
14. Magdalan J, Piotrowska A, Gomulkiewicz A, *et al*. Benzylpenicyllin and acetylcysteine protection from α-amanitin-induced apoptosis in human hepatocyte cultures. *Exp Toxicol Pathol* 2011; 63: 311-315.
15. Magdalan J, Ostrowska A, Piotrowska A, *et al*. Benzylpenicillin, acetylcysteine and silibinin as antidotes in human hepatocytes intoxicated with alpha-amanitin. *Exp Toxicol Pathol* 2010; 62: 367-373.
16. Magdalan J, Piotrowska A, Gomulkiewicz A, *et al*. Influence of commonly used clinical antidotes on antioxidant systems in human hepatocyte culture intoxicated with alphaamanitin. *Hum Exp Toxicol* 2011; 30: 38-43.
17. Magdalan J, Ostrowska A, Piotrowska A, *et al*. Failure of benzylpenicillin, N-acetylcysteine and silibinin to reduce alpha-amanitin hepatotoxicity. *In Vivo* 2009; 23: 393-399.
18. Tong TC, Hernandez M, Richardson WH 3rd, *et al*. Comparative treatment of alpha-amanitin poisoning with N-acetylcysteine, benzylpenicillin, cimetidine, thioctic acid, and silybin in a murine model. *Ann Emerg Med* 2007; 50: 282-288.

Amanita muscaria and the thunderbolt legend in Guatemala and Mexico

by

Bernard Lowy

Botany Department, Louisiana State University, Baton Rouge, 70803

Mycologia, 66, 188-191 (1974)

original source: https://www.bibliotecapleyades.net/archivos_pdf/amanita-muscaria-thunderbolt-legend.pdf
backup source: http://www.psilosophy.info/resources/amanita-muscaria-thunderbolt-legend.pdf

Early man was profoundly moved by the apparently miraculous attributes of lightning and thunder which first inspired in him fear, then respect and reverence for the power his gods displayed in those awesome phenomena. Of particular concern to the ethnomycologist is the causal association in the mind of primitive man of thunderbolts and mushrooms and among the cultures in which this magical alliance became integrated into national mythologies were the Roman and the Hindu. In Roman lore, some fungi were believed to spring from the ground in places struck by a thunderbolt and according to Hindu tradition as recorded in the Rig Veda, it is stated that "Parjanya, the god of thunder was the father of Soma" (Wasson, 1969). Wasson minutely examined the available evidence for the identification of soma and concluded that the most convincing interpretation we may hope for at present is its identity with *Amanita muscaria* (L. ex Fr.) Hooker.

During the past several years, I have examined some aspects of ethnomycology in the Americas, principally those relating to mushroom stones and Maya codices (Lowy 1968, 1971, 1972a, b). As a result of a study made in Guatemala, Mexico, and Honduras in June and July, 1973, it was established that there exists in the Guatemalan highlands and in southern Mexico a tradition that links *Amanita muscaria* with the thunderbolt. Preliminary inquiries in western Honduras have thus far failed to reveal a trace of this legend, nor have I found it in El Salvador. The first intimation that such a mythology might be extant among indigenous peoples of the Americas came in 1970 in the course of my field work in Mexico and Guatemala. Although I had by that time compiled a small mushroom vocabulary in several Indian languages, further opportunities were sought for the verification of the meanings of some words from other native informants and through consultation with professional linguists. Sufficient evidence is now at hand to justify the assertion that in some regions of the New World the *Amanita muscaria*-thunderbolt legend is firmly implanted in the minds of its autochthonous inhabitants.

While I was interrogating three young bilingual (Quiche-Spanish speaking) Indians who were participants in the linguistic "Proyecto Francisco Marroquin" in Antigua, Guatemala in June, 1973, these in formants unequivocally identified *A. muscaria* from a color photograph. Their name for this mushroom in the Quiche idiom was "kaquljá :." When asked what the word meant, they translated it into Spanish as "trueno" meaning thunder. After consultation among themselves and questioning by myself and Dr. William Norman, Quiche specialist, it was evident that it was not thunder alone that was signified by "kaquljá :," but the accompanying lightning as it strikes the ground during a storm. The equivalent term in Spanish is "rayo." This was clearly differentiated from the Quiche word "xkoyopá :'," or "relampago" in Spanish, a lightning flash, which, according to my informants, was never used to designate the mushroom. It is of interest too, that the native speakers could offer no explanation for the use of the word "kaquljá :" for *A. muscaria*, indicating only that it was common usage. Its ancestral origins have long since been forgotten. To my knowledge, this is the first report that the thunderbolt and *Amanita muscaria* have been found to be intimately related in the folklore of an indigenous population in the Americas.

At the "Proyecto," *Amanita caesarea* (Scop. ex Fr.) Pers. ex Schw. was easily recognized from my color photograph by the native speakers of Quiche, Cakchiquel, and Mam. It was called "q'atzu :i" (or by one of its variants "atzui" or "atzu") by the Quiche, a word which I had confirmed on many previous occasions in the Quiche-speaking regions of Guatemala. Among the Cakchiquel of Solola and Panajachel, *A. caesarea* is known as "q'uatzu :y" which was verified by Dr. Norman's Cakchiquel group at the "Proyecto." Lic. Nora England, specialist in the Mam language there, kindly allowed me to question her native Mam students and from them the word "xq'antzy:" was given for *A. caesarea*, but a photograph of *A. muscaria* was not recognized by them. The Cakchiquel group also identified *A. muscaria* from the photograph, knew it to be poisonous and called it "ruk'awach q'uatzu:y," the poisonous "q'uatzu :y," but no other connotation was associated by them with this mushroom.

A few kilometers north of Chichicastenango, in pine woods along the road to El Quiche, I again collected (July, 1973) both *A. muscaria* and *A. caesarea* and returned with the specimens to the Sunday market at Chichicastenango. There I sought the mushroom venders and displayed my finds. The edible and poisonous species were immediately distinguished and I was strongly admonished not to eat the "kaqulјá :" for it would have fatal consequences. Whereas "kaquljá :" refers to the legendary origin of *A. muscaria*, a Quiche expression that is descriptive of its dangerous, fearful potentialities is "itzel ocox," meaning the evil or diabolical mushroom.

In Comitán, San Cristóbal de Las Casas, and Tuxtla Gutiérrez in the state of Chiapas, Mexico, *A. caesarea* is a common and highly prized mushroom called "yuyo" (or "yullo") which in some regions of Latin America is a term used to signify "hierbas tiernas comestibles" (in "Diccionario de la lengua Española", Madrid, 1970), tender edible herbs. It is frequently prepared by roasting over a charcoal fire and I have eaten it in public places in San Cristóbal on numerous occasions. Incidentally, I have consistently found in my travels throughout the Americas that among lay individuals with a formal education, varying degrees of mycophobia is the general rule, but the educationally less privileged tend to be distinctly mycophilic. This is not as paradoxical as it may appear, since the peasantry are closest to the soil and know at first hand its products both cultivated and wild. *Amanita muscaria* is well known as a poisonous mushroom throughout the region of Chiapas under discussion and the revealing Spanish epithet for it in San Cristóbal de Las Casas and in Tuxtla Gutiérrez is "yuyo de rayo," the "yuyo" of the thunderbolt. I also discovered that among the Tzeltal-speaking natives of San Cristobal and nearby Zinacantán, this expression has its exact counterpart in their language. *Amanita muscaria* is called by them "yuy chauk," "yuy" being a variant of the Spanish "yuyo" and "chauk" meaning "rayo" or thunderbolt.

Chiapas and Guatemala are not only geographically contiguous, but, more significantly, they share a common heritage, so it may be surmised that the similar mushroom mythologies that find expression there reflect the influence of a dominant Mayan civilization. It may only be conjectured how this legend came to be shared by such widely separated cultures as are those of the New World and the Indo-European, but it is not improbable that it arose independently among the Maya. Further inquiries among contemporary Guatemalan linguistic groups including the Cakchiquel, Kekchi, Mam, and Ixil in Guatemala and the Tzotzil, Tzeltal, Chontal, and others in Mexico are planned so that it may eventually be possible to trace the range and depth of this ancient tradition in the Americas.

Literature cited

1. **Lowy, B.** 1968. Un hongo de piedra preclasica de Mixco Viejo, Guatemala. *Bol. Soc. Mex. Micol.* 2: 9-15.
2. **Lowy, B.** 1971. New records of mushroom stones from Guatemala. *Mycologia* 63: 983-993.
3. **Lowy, B.** 1972a. A newly discovered copy of a Maya codex. *Revista Interamer. Rev.* 2:405-407.
4. **Lowy, B.** 1972b. Mushroom symbolism in Maya codices. Mycologia 64: 816-824. Wasson, R. G. 1969. *Soma: divine mushroom of immortality.* Harcourt, Brace & World, Inc., New York. 381 p.

Soma siddhas and alchemical enlightenment

Psychedelic mushrooms in Buddhist tradition

by

Scott Hajicek-Dobberstein

3322 16th Street, San Francisco. CA 94114. USA

Received 6 November 1993; revision received 7 February 1994; accepted 16 February 1995

***Journal of Ethnopharmacology* 48 (1995) 99-118**

© Scott Hajicek-Dobberstein

original source: http://www2.ups.edu/faculty/bdasher/Chem361/Review_Articles_files/Mushrooms%20and%20Buddhist.pdf
backup source: http://www.psilosophy.info/resources/Mushrooms%20and%20Buddhist.pdf

Table of Contents:

Abstract
1. Introduction
2. Materials
  2.1. The hagiographies of Buddhist siddhas
3. Method
  3.1. Interpretation of the secret meaning
  3.2. Siddha tradition
  3.3. The story of the siddha Karnaripa
  3.4. Karnaripa's miraculous birth
  3.5. The story of Mahasiddha Karnaripa
  3.6. Delicious food, pancake on a needle
  3.7. The tree goddess
  3.8. Karnaripa Aryadeva
  3.9. Magic urine elixir
  3.10. Laughter
  3.11. The single eye
  3.12. Lustful women-sky journey-anointing
4. Results of the interpretation of the secret meaning
  4.1. Aryadeva's legend by Bu-ston and Taranatha
  4.2. The siddha Nagabodhi
  4.3. Sakara and Padmasambhava
  4.4. Aryadeva and Odin
  4.5. The Celtic version
5. Conclusions
Acknowledgements
References
Tibetan references

Abstract

In the legendary biographies of some Buddhist adepts from the 2nd- and 9th-centuries there are some clues which can be interpreted to reveal that the adepts were consuming psychedelic *Amanita muscaria*, 'fly agaric', mushrooms to achieve enlightenment. This secret ingredient in the alchemical elixir they used to attain 'realization' was, of course, unnamed, in keeping with their vows to maintain the secrecy of their practices. Its identity was concealed behind a set of symbols, some of which appeared in the Soma symbol system of the Rg Veda, some other symbols possibly passed down from a time of earlier shamanic use of the mushroom in the forests of Northern Eurasia, and some symbols that may be unique to these Buddhist legends. The congruity of these sets of symbols from Northern and Southern Asian traditions will be shown to be reflected in the Germanic tradition in some characteristics of the Oldest God, Odin.

Keywords: Amanita muscaria; Soma; Buddhism; Psychedelic drugs; Odin.

1. Introduction

It has been put forth by various theorists and to different degrees of acceptance that the psychedelic mushroom *Amanita muscaria* (L. ex Fr.) Hooker var. *muscaria*, the fly agaric, is the real entity behind such myths and legends as Soma, both god and sacred beverage (Wasson, 1968), the apple in the Garden of Eden (Wasson, 1968) and the apples of Hesperides (Ruck in Wasson, 1986, p. 171), the Golden Fleece (Allegro, 1970, p. 118; Ruck in Wasson, 1986, p. 171) and the fire of Prometheus (Ruck in Wasson, 1986, p. 169), Kakulja hurakan 'Lightening bolt One-leg' of the Mayans (Lowry in Wasson, 1986, pp.47-51) and the Huitzilapochtli aspect of Tezcatlipoca of the Aztecs (Wasson, 1986, p.53), and even Jesus Christ (Allegro, 1970) and Santa Claus (Ott, 1976, p. 97).

The fly agaric seems to be more liberal regarding the varieties of mythological traditions it appears in than the few specific habitats it prefers in nature. I have recently found it appearing in the pages of some hagiographies of Buddhist *siddhas*, 'adepts, attainers' or, very loosely, 'saints'. No direct connection of any psychedelic mushroom to any Buddhist tradition has yet been demonstrated, but I present evidence here which shows that in a Buddhist alchemical tradition, probably a continuation of the Vedic soma use, *Amanita muscaria* was taken under certain conditions to achieve enlightenment.

According to Wasson (1968, p. 168), religious use of *Amanita muscaria* began some time after the last Ice Age in the northern Eurasian forest belt which spread north following the retreating polar ice cap, approximately 9000 B.C.E. There, probably beneath a birch tree, its preferred symbiont, early human foragers found and ate the magnificent red- and-white fly agaric, possibly after observing the effect it had on reindeer who had eaten it. Thus began the religious and recreational use of this psychedelic mushroom which continues to the present time in several regions of the world.

At some undetermined time, early Indo-European speaking tribes lived in close proximity to the ancestors of the Finno-Ugrians with whom they shared the use of fly agaric, along with a vocabulary pertaining to its use (for examination of the linguistic evidence of contact between these tribes, see Burrows, 1973, pp.23-27; Collinder, 1955, pp. xiii, 46, 128-141). Centuries later, priests of the Vedic culture sang hymns in praise of Soma the god, the sacred plant and the sacred drink pressed from the plant. For reasons that remain uncertain, fly agaric was later replaced in Vedic Soma ceremonies by non-psychedelic substitutes, and its true identity became a mystery even to the previous keepers of this secret, the Vedic priests.

After that point, there seem to be no references recorded in Indian literature by those who had practical knowledge of the true identity of Soma, or by those possibly consuming fly agaric under another name. The references to Soma in post-Vedic sources are discussed by O'Flaherty (Wasson, 1968, pp. 95-147).

2. Materials

2.1. The hagiographies of Buddhist siddhas

Yet, such references to practitioners of religious rituals actually using the psychedelic mushroom do exist. I have found them in *The Stories of the Eighty-Four Siddhas* (Skt. *Caturasiti-siddhapravrtti*, Tib. *Grub thob brgyad cu rtsa bzhi'i lo rgyus*) which was translated into Tibetan and written down in the late 11th- or early 12th-century C.E. by the monk Smon-grub-shes-rab, as narrated to him in Sanskrit by Abhayadatta. The attribution of author, translator and origin of the text given in its colophon does not mention an original Sanskrit text as a source. This conspicuous omission may suggest derivation from oral tradition. A discussion of the identities of the purported author and translator can be found in Dowman (1985, pp. 384-88).

The most likely sources of the eighty-four thumb-nail biographies that make up this work were the legends of each of the *siddhas* which were passed down as oral hagiography by his or her disciples and later compiled, possibly by Abhayadatta who did not include a record of his sources.

There are two English translations of this work, Robinson (1979) and Dowman (1985). Both translators worked under the guidance of Tibetan lama advisors. Robinson's translation is very close to the Tibetan text, but Dowman presents a self-described adaption 'from the stilted mnemonic style of the Tibetan manuscript to give a fluent idiomatic rendering into English while maintaining fidelity to the original meaning' (Dowman, 1985, p. xii). At least in the story of the *siddha* Karnaripa, Dowman and his lama advisors completely missed the 'original meaning'. This story, which reveals the identity of the secret ingredient of the alchemical elixir which brings enlightenment, is interpreted by Dowman simply as a parable of the *siddha*'s humility and modesty! Robinson also fails to reveal the real meaning of the story of Karnaripa, which is not explicitly expressed in the story, but he does not obscure the real meaning with imperceptive, misinformed impressions. I present my own translation of the story of the *siddha* Karnaripa below. I have tried to keep my translation as close as possible to the literal content of the Tibetan text, so that those who do not read Tibetan can interpret for themselves the imagery and symbolic elements of the story.

3. Method

3.1. Interpretation of the secret meaning

There are at least three levels of information contained in the eighty-four stories. Firstly, there are the historical, biographical facts: the castes into which the *siddhas* were born, their occupations, the locations they lived in, the names of their gurus and the tantras they practised. The validity of these facts is, in many cases, uncertain.

The second level of meaning in these stories is the didactic. For instance, Karnaripa is told by his guru that he should not receive tasty food as his alms; he should only accept as much food as will fit on the point of a needle. The lesson for Karnaripa and for readers of his story is that tantric disciples should practice austerities. This level of meaning is carried in the stories by the overt meaning of the words and symbols.

In many stories, I cannot say how many, there is embedded a deeper level of meaning which is expressed in *sandhabhasa*, 'intentional language' or 'enigmatic language', which is used to obscure the true meaning for the uninitiated while declaring it for the initiates. Such symbols in the stories seem to mean one thing, but they really mean something else. After receiving Nagarjuna's dietary advice, Karnaripa returns from begging with a pancake piled with sweets on the tip of his needle. This seems to be an ironic joke played on his guru by his benefactors. However, at a deeper level which I will attempt to interpret below, the pancake on a needle is a symbol representing the fly agaric mushroom. After all, we should not expect practitioners of tantra or alchemy, known for their vows of secrecy, to relate a story of the wonderful alchemical elixir which grants enlightenment, while plainly and openly stating the identity of the secret essential ingredient.

It would be difficult to determine the degree to which these legends accurately report the events in the lives of the *siddhas*. It could be said that this collection was intended as a didactic paradigm of the variety of paths on which human beings wander in samsara and the corresponding paths which lead them to enlightenment. Karnaripa was also known as Aryadeva. The events in his life as told by Abhayadatta are very similar to those details given by the Tibetan historians Bu-ston and Taranatha, but all of these authors are also unanimous in their error of conflating the biographies of two Aryadevas, who lived five centuries apart.

As I have no explanation myself, I would love to know why the religious use of a psychedelic mushroom is, according to my interpretations, attributed to two Buddhist saints, one a 2nd-century Madhyamika dialectician and the other a 7th-century Vajrayana adept, both having the same name. The legend of Karnaripa was obviously composed by a practitioner, probably an accomplished practitioner, of *Amanita* alchemy, but, unless the legends are true, the reasons for connection of that tradition with the lives of the Aryadevas are not so obvious.

I realize that I cannot, based on the hagiographies by Abhayadatta, Bu-ston and Taranatha, prove that *Amanita* alchemy was practised by the specific persons named Aryadeva. However, even if it were true that these stories are allegorical paradigms having no other historical value, what would remain would be a record of anonymous Vajrayana Buddhist tantric adepts using psychedelic mushrooms, under certain circumstances, to become enlightened.

3.2. Siddha tradition

The *siddha* tradition flourished in India from the 8th- to the 12th-century. In place of intellectual and academic efforts, it emphasized the dedicated practice of Tantric meditation under the guidance of an accomplished guru which would result in the practitioner's attainment of the Great Seal (Skt. *mahamudra-siddhi*, Tib. *phyag rgya chen po'i dngos sgrub pa*). This was the expression used to refer to the state of enlightenment they attained through their varieties of tantric meditation.

Ten of the *siddhas* were monks or yogins who had not found realization through monastic and scholastic endeavors. Others lacked concern for realization of the Dharma until each of them reached a crisis in his or her life. They found gurus who showed them the means to free themselves from the snares of *samsara*, i.e. 'to obtain the *siddhi* of *Mahamudra*'. These means were the practices of tantric meditation, often specifically adapted by their gurus to match the specific problems of their life crises. However, in the case of Karnaripa/Aryadeva, it seems that many initiations by various masters could not bring realization to him, in spite of his auspicious birth and his excellence in Buddhist academic studies. He needed to drink an alchemical elixir to allow realization to arise in him.

3.3. The story of the siddha Karnaripa

This *Mahasiddha* Karnaripa, whose story is number eighteen in the *Stories of the Eighty-Four Siddhas*, is actually two different persons whose biographies are conflated and undifferentiated in Tibetan sources. No distinction is made in works attributed to Aryadeva in the Tibetan canon, although the subject of any of the works usually falls into the area of study of one or the other Aryadeva.

The Sanskrit name Aryadeva appears as 'Phagspa-lha in Tibetan; Cheng t'ien (translated) or T'i po (transliterated) in Chinese; and as Shoten (translated) or Daiba (for Deva) in Japanese. These are usually translated as 'Sublime god' (Malalasekera, 1966, p. 109). I will offer an alternative translation below. For reasons which are given in his biographies, overtly as a cover story and covertly as encrypted tantric secrets, he is also known as Karnaripa or Kaneripa. Alternative renderings are most likely due to scribal errors. In the text of the story of Karnaripa which I have translated, his name is given as 'Kartaripa' in the first two references, there after being given as 'Karnaripa' seven times, 'Aryadeva' also being used four times, and 'Mig-gcig-pa' being used one time. Fig. 1 is a reproduction of the text which appears on ff. 96-102 of *Grub thob brgyad bcu rtsa bzhi'i chos skor*, (Chophel Legdan, 1973) also reproduced in Robinson (1979, pp. 335-337).

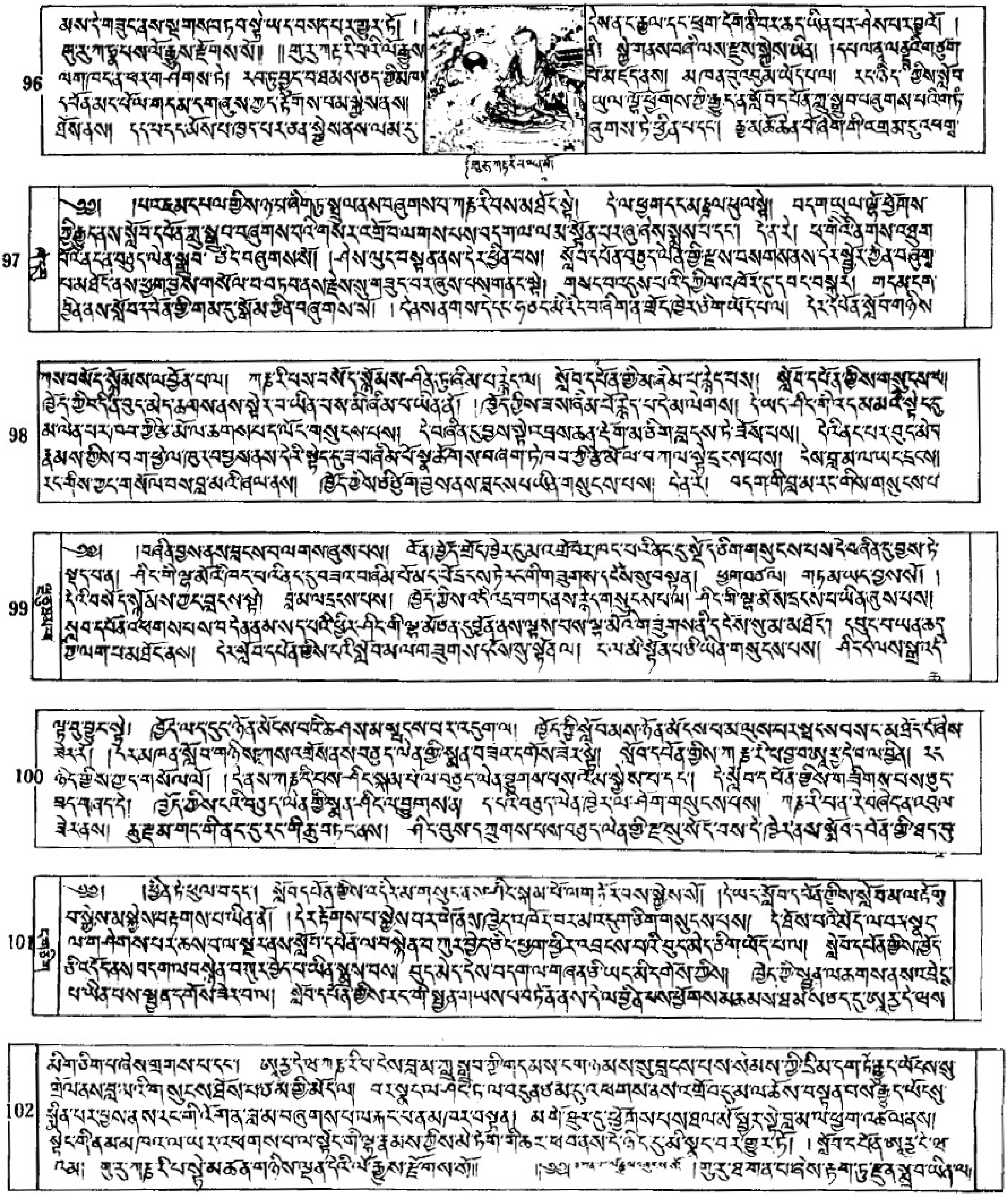

96
97
98
99
100
101
102

Fig. 1. The Story of the Siddha Karnaripa from The Stories of the Eighty-four Siddhas by Abhayadatta (ca. 1100 C.E.). Courtesy of Dharma Publishing.

The '*-pa*' suffix to the Sanskrit is an abbreviation for '*-pada*', an honorific affix. The '*Karnari-*' part of his name has been considered to be of uncertain translation, although it must derive from '*kana*' (Monier-Williams, 1899, p. 269) which is the Sanskrit equivalent of his Tibetan name Mig-gcigpa, 'One-eyed'.

The first Aryadeva was the most eminent disciple of Nagarjuna, the founder of the Madhyamika school of Buddhism. He lived in India in the 2nd century C.E.

The second Aryadeva was the disciple of the Vajrayanist *Mahasiddha* Nagarjuna who had several disciples counted among the eighty-four *siddhas*. Aryadeva II lived in India in the 7th- or 8th-century C.E.

A detailed examination of the conflated biographies and the canonical works attributed to 'Aryadeva' appears in Malalasekera (1966, pp. 109-116) (This source does not refer to *The Stories of the Eighty-Four Siddhas*). I have begun an examination of the works of both Arydevas, their gurus and fellow disciples, in search of further references to their use of psychedelic mushrooms. However, as of this writing, I have been limited to finding such references in their Tibetan hagiographies and have been surprised to find evidence linking both of the Arydevas and the later Nagarjuna and some of his tantric disciples to the use of psychedelic mushrooms.

What follows is my translation of the story of Arydeva from *The Stories of the Eighty-Four Siddhas*, with my interposed interpretations of the *sandhabhasa*. The reader might enjoy a preliminary reading of the story itself by skipping over the interpretive sections.

3.4. Karnaripa's miraculous birth

In order to avoid interrupting the story after the very first line, I shall do so even before the story begins. In the Buddhist view, there are four kinds of births (or rebirths) which result in existence in the world of living beings. These are birth through heat and moisture for plants and lower life forms, birth from egg for oviparous life forms, birth from womb for viviparous life forms and miraculous birth for beings from higher realms who appear in the world of living beings in human form in the center of a lotus blossom, uncontaminated by passage through a womb. Karnaripa and two other *siddhas*, Pankaja and Sakara, are described as being miraculously born. The story of Sakara contains some symbols that may be references to *Amanita muscaria* and these will be discussed below.

In many cultures, mushrooms themselves were considered to be miraculously born, due to their mysterious, apparently seedless generation. Wasson (1971, p. 184) explains the significance of the name of the deity Aja Ekapad who appears in the Rg Veda closely associated with Soma. Aja 'un-born' and Ekapad 'single foot' refer to the mushroom's miraculous birth and the monopod stem upon which it stands. Karnaripa's miraculous birth is one of several clues to his connection with the mushroom, though not the most persuasive.

3.5. The story of Mahasiddha Karnaripa

Of the four ways of birth, his was miraculous. He went away to glorious Nalanda college. He became principal of all monks. There were one hundred-thousand scholars. Although he requested instruction from many masters, realization did not arise. He heard report that Master Nagarjuna resided around the southern regions. Special faith and adherence arose in him. He entered on the road and went.

At the shore of a great ocean, Sublime Manjusri had transformed himself into a fisherman living there. Karnaripa saw him, bowed and offered him a *mandala* and said, 'Because it is reported that Master Nagarjuna lived around the southern regions, Oh Honored One, please show me the road'. The fisherman said, 'He resides inside that thick forest over there practising alchemy'. Having been instructed thus, Karnaripa went there. He saw the master dwelling there, collecting alchemical materials and preparing them. Karnaripa bowed, made a prayer, respectfully asked to be accepted as a student; his request was granted. He was given initiation and instruction in the *mandala* of *Guhyasamaja* and sat in meditation before the master.

Not very far from that forest was a city. Both master and pupil went there for alms. Karnaripa received very delicious alms, while the master received alms that were not delicious. The master said, 'Because this food of yours was given by lustful women, it is not delicious. This obtaining of delicious food by you is not good, so do not collect it on a tree leaf, but receive it on the point of a needle'. Doing so, Karnaripa took a single piece of rice pulp and ate it.

In the morning, women made wheat cakes, put various kinds of delicious food on a cake, put it on the point of a needle, and brought it to Karnaripa, who brought it to his lama. Nagarjuna ate it and said, 'What did you do to receive this?'

Karnaripa said, 'Doing just as my lama said, your worship, I received this'.

'Well then do not go to the city; stay at home'. Nagarjuna said.

3.6. Delicious food, pancake on a needle

A common epithet for Soma in the Rg Veda is *madhu*, 'honey, sweetness, delicious, intoxicating'. *Amrta*, or Nectar of the gods, is idealized as the most delicious food and drink. The 'very delicious alms' that Karnaripa received might be a reference to this ambrosia. The image of the wheat cake on the tip of a needle with delicious food on top represents the flattened cap of the mushroom on the top of its stalk, flecked with white remnants of its 'universal veil'.

At this point in the story Nagarjuna thinks that this 'delicious food' (on the didactic or *sandhabasa* level?) is not good for Karnaripa, who eats instead 'a single piece of rice pulp' (Tib. '*bras chan*). In Monier-Williams (1899, p. 1249) under *soma*, after the primary definitions of god, plant and drink, we find '*somam* - rice pulp'. Here the true name of the elixir Soma may be encrypted in a Tibetan-Sanskrit pun.

Having been advised by Nagarjuna to stay home:

> Karnaripa did so, but when he stayed, a tree goddess brought much delicious food into the house and actually showed him her form. She bowed and conversed with him. He received her alms and brought them to his lama who said, 'Where did you obtain things like this?'
>
> Karnaripa said, 'It was brought by a tree goddess'. In order to test if this were true, the sublime master went to the tree possessed of the goddess, looked at it but did not actually see the form of the goddess. He saw her arm up to the shoulder.

3.7. The tree goddess

Although the exalted, sacred status of the birch tree and the central roles it played in the cosmology and shamanic rites of the Siberian and Altaic cultures were well documented in many examples compiled by Holmberg (1927) and Eliade (1964), the reason why the birch is thus regarded as the Tree of Life is not given by either author. It is given by Wasson (1968, pp. 216-218).

The birch tree (Betula sp.) is the preferred mycorrhizal symbiont of the psychedelic mushroom *Amanita muscaria*, and the preferred host of the shelf fungus *Fomes fomentarius*, which was boiled and dried to form perfect tinder to catch a spark for making fires. These two magic substances were found growing on or below the birch tree which was therefore the most important tree in the cosmos. Holmberg (1927, p. 350) gives a Mordvin tale of a giant birch tree growing on a hill in the depths of the forest, a tree with giant leaves and buds, roots which ring round the earth, and branches which surround heaven. At the root of this birch is a spring, roofed over with carved boards and white sheets, on its edge a red wooden can containing a sweet honey drink. The can has a silver ladle decorated on the bottom with the sun and the moon, the handle with smaller stars. As the sun moves in the heavens, the handle of the ladle turns with it.

The 'red can' can be interpreted as the red *Amanita* and the 'sweet honey drink' as the psychedelic essence. The 'ladle' is also the mushroom; its cap is a red solar disk by day and shines silver like a lunar disk in moonlight. Before the white flecks - remnants of the universal veil - are washed off the cap, they are the stars in the sky that turn as the stem is turned. Similar substance forms the ring around the stem.

Holmberg (1927, p. 351) also retells several Yakut legends of the Tree of Life. In one tale, 'the First Man' approached the magnificent tree to ask why he had been created. From an opening in the trunk there appeared a female, visible only to the waist, who told him he had been created to be the father of the human race. In a variant of this story, 'the White Youth' prayed to the 'Honored High Mistress', the spirit of the Tree of Life, to be granted the companionship of a wife and other human beings. The tree creaked and from under its roots the tree spirit arose up to her waist. She appeared as a middle-aged women with grave eyes, flowing locks and naked, swelling breasts which she offered to the Youth. He drank her milk and felt his powers grow a hundredfold.

Wasson (1968, p. 214) sees the tree goddess who appeared from under the roots as the *Amanita muscaria*; her swelling breasts he sees as the mushroom, her milk as the psychedelic essence.

In another Yakut tale, the tree goddess is called Kibai-Khotun, the goddess of Birth and Fate. The Yukaghir call the mushrooms *can-pai*, 'tree girl' (Wasson, 1968, p. 272). Common elements of these Siberian stories are: a sacred tree, a goddess of the tree who appears only up to her waist from the tree or its roots, the swelling breasts of the goddess and her milk of knowledge and strength, and a lake or spring under the tree.

This tree goddess from Siberian legends appears in the story of Karnaripa in South-East India. She does not appear to him as a legendary figure from a far away land, she appears to him in person. She shows to him her true form and brings him 'much delicious food'. Nagarjuna could only see her arm up to the shoulder; he saw the mushroom sticking out of the ground but not the goddess.

Wasson observes (1968, p. 218) that the sacred tree and the tree goddess were apparently absent from the Vedic Soma symbol system. This absence suggests that the *Amanita* alchemy tradition which Nagarjuna and Karnaripa practised was separate from the Vedic Soma tradition, or that such a separate tradition was synthesized with the Soma tradition by the Buddhist alchemists. Nebesky-Wojkowitz (1956, pp. 539-553) gives examples of the many similarities between Siberian shamanism and 'traditions and rites that appear to be survivals of an early Tibetan shamanism.' If, in the distant past, some exchange of shamanic practices did occur between Siberian, Mongolian and Tibetan people, it is unlikely that an element as important as the *Amanita muscaria* would not be a part of that exchange. I will discuss below a certain goddess who will be linked with the fly agaric, who seems to appear in the Siberian and Tibetan pantheons, but not in Indian tradition.

There is evidence that the birch as the Sacred Tree was not overlooked in India. In Monier-Williams (1976, p. 51) we find, among the synonyms for 'birch', *mahausadham* 'great drug'. Although the birch is regarded in some systems of herbal medicine to have some minor useful properties, these would by no means qualify the birch tree itself as a 'great drug'. It seems more likely that the great drug was the *Amanita muscaria*, the symbiont of the birch.

Coomaraswamy (1971, pp. 32-33) agrees that trees and tree deities played an insignificant part in the Rg Veda and Atharva Veda, but he says, 'There is no motif more fundamentally characteristic of Indian art from first to last then is that of the Woman and Tree'. Some of his examples even include a half-seen figure in the tree. I note the similarity to such figures from the Siberian myths and from Karnaripa's story, but I could find no other images from the fly agaric symbol set in any of Coomaraswamy's examples. A genealogy of these mythologies is needed. The goddess who appeared to the Buddha beneath the Tree of Enlightenment is worth investigating for any possible connection with the *Amanita* birch goddess.

As we return to the story of Karnaripa, Nagarjuna is trying to confront the tree goddess.

> The master said to her, 'You actually showed your form to my student, why do you not show it to me?'
>
> From the tree arose a voice like this, 'Obviously you have not abandoned a portion of your defilement; your student has entirely abandoned his defilement, so he saw me'. Thus she spoke.
>
> At that, the master and student conferred. They said, 'We need to eat the alchemical medicine'. The master gave it to Arydeva who was called Karnaripa. He himself also ate it.

3.8. Karnaripa Aryadeva

There is no explanation given for Karnaripa having another name 'Aryadeva', which first arises in this story at the point of the drinking of the alchemical elixir. 'Aryadeva' and its Tibetan equivalent 'Phags-pa-lha' are usually translated as 'Sublime god'. However, the initial elements of these names may be implied genitives (for Aryanam deva and 'Phags-pa'i-lha) which would translate as 'God of the Aryans', a perfect epithet for Soma who was, of course, a god of the Aryans. The meaning of 'Karnaripa', as will be shown below, is more definitely connected with Soma.

> Then Karnaripa smeared the elixir on a dead tree, causing leaves to grow. The master saw that, laughed a little, and said, 'Since you smear my elixir on the tree, bring my elixir, come!' So

> Karnaripa said, 'If you wish, I will give it'.
>
> He put his own water [i.e., he urinated] into the full water pot and stirred it with a stick so that it became a pot of elixir. He went straight to his master and offered it. The master said nothing to this. He sprinkled it on a dead tree which grew leaves. Thereupon the master examined whether or not realization had arisen in his student.

3.9. Magic urine elixir

Of all the plants in the world used by humans to alter their minds (I include not just the psychedelics but also the stimulants, cognodisleptics, narcotics, etc.), *Amanita muscaria* is the only such plant known to have the following characteristic: its active constituent, muscimol, is passed through the human body with only a small part of the dose destructively metabolized, so that the urine of the mushroom eater contains enough muscimol to be effectively recycled for up to five more intoxications. This quality of the fly agaric was known to its users in Siberia (Wasson, 1968, p. 25) and to some Indians of North America (Keewaydinoquay, 1979, pp. 29-31). Wasson (1968, pp. 25-34) claims to have discovered evidence in the Rg Veda that the Vedic priests were aware of the potency of the Soma-drinker's urine. This potency of the urine of the fly agaric eater is the property that will identify any unidentified drug which also has this characteristic.

The potency of Karnaripa's urine is demonstrated by its revitalization of the dead tree on which Nagarjuna sprinkled the urine. This was the same effect produced when Karnaripa smeared Nagarjuna's alchemical elixir on a dead tree. Also, in the words of the story, 'He put his own water into a full pot.., so that it became a pot of elixir'. The urine does not merely share similar characteristics with the elixir, it is the elixir.

And then, by observing the single fact that Karnaripa's urine had the same effect on the dead tree as his alchemical medicine, Nagarjuna determined that realization had arisen in his student. This is an unusual method for a Tantric Buddhist master to test the attainment of his student.

These references to the potent urine of the drinker of the alchemical medicine are very strong evidence that the fly agaric was an essential ingredient in the elixir.

The story does say that Karnaripa urinated 'into a full water pot (*chu rdzam gang gi nang du rang gi chu btang*)'. It seems necessary to ask, why does he urinate 'into a full water pot'? The 'full water pot' might be a reference to the 'full vessel' or 'brimming vessel' (*purna ghata*), 'the commonest of all Indian symbols of plenty' (Coomaraswamy, 1971, p. 40). And also 'when soma is represented in art, it is as a full vessel' (Coomaraswamy, 1979, p. 40). Is Karnaripa's urination into the full water pot another Tibetan-Sanskrit play on words which refer to Soma or is this just a meaningless coincidence?

3.10. Laughter

I must discuss the occurrence of Nagarjuna's laughter in the story, occurring after they drink the elixir. His laughter might suggest the elixir has exhilarating effects, in addition to its rejuvenating effects and its unexplained powers to cause 'realization' to arise. This occurrence of laughter is one of only four occurrences of laughter in all eighty-four biographies, and possibly the only one of its kind, i.e. euphoric, exhilarated laughter.

In his own legend, *Siddha* Virupa laughs 'twelve wrathful laughs' to subdue a legion of witches who were trying to kill him. This is laughter of a different sort. In the story of *Siddha* Bhusuku, the king and the people laugh at Bhusuku because he had been a lazy bum and yet stood before them to lecture them. This is clearly derisive laughter.

Finally, in the story of *Siddha* Nagabodhi, his teacher Nagarjuna (again!) laughs at him when he sees Nagabodhi has produced horn on his head by the power of meditation. This laughter could be seen as mildly derisive or amused, or laughter of satisfaction, but not of exhilaration. In any case, it also occurs in the context of a story with *sandhabhasa* elements referring to the use of *Amanita muscaria*. I will return to a discussion of the story of Nagabodhi below, after the material on Karnaripa-Aryadeva.

> Having understood that realization had arisen in his student he said, 'Do not stay in samsara'. At the instant of hearing that, Karnaripa prepared to depart to the sky. There was a woman from among those mentioned before who paid her respects to the master and followed as attendant.
>
> The master said, 'What do you desire that makes you one who pays her respects to me?'
>
> The woman said, 'Because I do not need anything else at all, because I am a follower from attachment to your eye, I need your eye'.
>
> The master plucked out his right eye, gave it to her and thereby became known in all directions as Aryadeva, the One-eyed.

3.11. The single eye

One of the many descriptions and epithets of Soma that Wasson interpreted as derived from the characteristics of the *Amanita muscaria* was 'the Single Eye'. The mushroom, at one stage of development, looks something like a bloody human eye-ball plucked from the socket and thrown on the ground. Wasson (1968, p. 46) cited five different lines of the Rg Veda connecting Soma with the image of 'the Single Eye'.

Working with Ruck, Wasson (1986, pp. 60-67) explained both the myth of the 'Shade-foot' people (Gr. *Sciopedes*) or 'One-leg' people (Gr. *Monocoli*) (who were said to leap about on a single, powerful leg when not resting on their back in the shade of their single foot), and the myth of the *Cyclopes*, the one-eyed people, as legends derived from characteristics of the *Amanita muscaria*. The Vedic Aja Ekapad, 'Unborn Single-foot' referred to above reflects the same characteristics.

Nebesky-Wojkowitz (1956, p. 122) provides a list of several one-eyed, one-legged, one-winged deities who have 'a physical anomaly typical of many of the ancient Tibetan divinities'. Included is the goddess Ral-gcig-ma (Skt. Ekajati or Ekajata) who has but one foot, one breast, one tooth, one tuft of hair and one eye with which she surveys the past, the present and the future, i.e. 'the three times' (1956, p. 34). Also given for comparison (1956, p. 539) are the similar Siberian demons: Anakhai, a one-eyed demon of the Buriats; Arsari of the Chuvashes, who has only one hand, leg and eye; and the initiatory demon of the Yakut shamans who has only one arm, leg and eye.

According to Dowman (1985, p. 121), Ekajata is not documented as an indigenous Indian deity. Bharati (1975, p. 38) suggests that Ekajata was a Tibetan import or reimported to India, citing Bhattacharya's translation of the colophon of *Sadhanamala* no. 141, which describes an Ekajata sadhana: 'restored from Tibet by Arya Nagarjuna' (Bharati, 1975, p. 74). He is probably referring to the *Ral pa gcig ma'i sgrub thabs* by Nagajuna, which has such a colophon (*bsTan 'gyur*, Peking #4340, vol. 81, pp. 9-10). It would be interesting to discover why this single-eyed goddess/demon seems to be shared by Siberians and Tibetans, but not Indians.

According to the legends, Karnaripa had but one eye because he gave one away. Although the recipient of the eye varies in different sources (compared below), in each version Karnaripa just plucked out his own eye to give away. This event is not worked smoothly into the story lines - it just happens abruptly - and there is no elaboration of the reasons why his eye was needed.

On the historical level, these legends might be the folk-history generated to explain the attributed lack of an eye by both the *Mahasiddha* Aryadeva II and also by his predecessor Arydeva I. Material in a Chinese source (Nanjio, 1883, no. 1462), recorded by Kumarajiva in the 5th century before the time of Arydeva II, makes it clear that his predecessor also was described as having only one eye (Malalasekera, 1966, p. 111).

What could the didactic significance of this part of the story be? I asked a Tibetan lama informant what the meaning of the eye plucking could be. He said that Karnaripa was practising the *paramita* of giving or generosity. Thus, it must seem to one who must guess without the benefit of other clues from the symbol system of *Amanita muscaria* use in Siberian shamanic, Vedic, Buddhist and Germanic (see below) traditions.

'The Single Eye' is both an epithet of Soma and of Karnaripa, who is not merely connected with the mushroom; he shares the name of the mushroom, he is equated with the mushroom. The deeper meaning of his having the mushroom's name and the gift of his eye is, as yet, unknown to me.

In the *sMan dpyad yan lag brgyad pa 'i shying po 'i 'grel pa las sman gyi ruing gi rnam grangs*, translated and edited by Dash (1987, p. 353), there is listed an herbal medicine of unknown botanical identity called *somaksi*, 'eye of soma' (these translations are mine). Synonyms of this medicine are given as *maha gulma*, 'great cluster of trees' or 'great tumor' or possibly 'great myrobalan', or in Monier-Williams (1899, p. 795) *maha gulma* is given as 'the Soma plant'; also *maha gara*, 'great drink' or 'great poison'; also *candra taru*, 'moon tree' or 'bright tree' ('bright' is the meaning of the Proto-Indo-European birch word **bherH-g-o-*) (Friedrich, 1970, pp. 27-29); and *dvija priya*, given in Monier-Williams (1989, p. 506) as 'dear to a Brahman, Aryan, the soma plant'. This list of synonyms for the unidentified drug *somaksi* provides, at least, another connection between Soma and 'the Single Eye'.

Candranandana, who compiled this pharmacopoeia, was a Kashmiri scholar (Dash, 1987, p. viii) who belonged to a period prior to 1013 C.E. when Rin-chen-bzang-po translated his works into Tibetan. It is impossible to say how many, if any, of the Kashmiri or Tibetan physicians who read these references to the drug *somaksi* actually understood the meaning of its names and really knew what it was. If the lineage of this secret knowledge were broken, then the tradition would be passed down like a riddle that no one knew the answer to, like the story of *Siddha* Karnaripa.

> Aryadeva Karnaripa practised the instructions of Lama Nagarjuna so the stains of his mind were cleansed and his mental continuum was liberated. At the instant of merely hearing the words of his lama, he levitated to the height of seven palm trees into the sky. He taught the Dharma to many beings so their mental continuums were made completely mature.
>
> While the lama sat below him, he pointed his feet into the sky. By facing down, he folded his hands and bowed down to his lama. He levitated up into the sky and the gods above caused a rain of flowers. He disappeared into suchness.
>
> The End

3.12. Lustful women-sky journey-anointing

There was some imagery in Karnaripa's story that I examined with inconclusive results. I was curious about the 'lustful women' (*bud med chags*) who gave Karnaripa the 'delicious alms'. They may be related to the dryad or tree goddess of fertility (Skt. *vrksaka*) who appears as a voluptuous beauty, scantily clothed, embracing the tree tightly, amorously wrapping one leg around the tree trunk like a vine or *lata*, 'both 'creeper' or 'vine', and 'woman'' (Coomaraswamy, 1971, p. 32). Soma was referred to as a *lata* (Wasson, 1968, pp. 97, 98, 103 ft., 106-108, ll0, 123, 125). Also, in Sanskrit as in English, the term 'horny' relates the image of the horn '*srnga*' to the erotic sentiment '*srngara*' (Monier-Williams, 1899, p. 1087). I will discuss below the connection of the horn with the *Amanita muscaria*.

I was also curious about Karnaripa's aerobatic manoeuvres at the conclusion of his story. Such 'sky-going' is not unusual for Indian yogins, including tantric *siddhas*. It is also common behavior for shamans, including those of Siberian traditions. Karnaripa's ascension to the height of 'seven palm trees' is a close parallel to the Siberian shaman's journey through the seven heavens as he climbs up the seven notched steps in the birch pole representing the seven-branched World Tree (Eliade, 1964, pp. 264, 270-279). 'Ostyak and Lapp shamans eat mushrooms with seven spots to enter into trance; the Lapp shaman is given a mushroom with seven spots by his master' (1964, p. 278). I intend to do further research comparing Buddhist tantric celestial journeys with shamanic celestial journeys with special attention to numerical or arboreal references.

Finally, I wondered about the 'dead tree' on which Karnaripa 'smeared' or 'anointed' (Tib. *byugs*, Das, 1902, p. 924) the alchemical medicine. I think the dead tree could be the neurological network that has not experienced revitalization and realization, by one means or another. The use of the specific verb '*byug*' instead of a more common, general verb like 'put' (Tib. *rgyab*) could be significant. According to Allegro (1970, p. 56) the slimy, slippery mushroom thrusting up through the earth was seen as the erect penis of the Father God which had been anointed or 'christened' with semen and sexual fluids, becoming 'Christos' the Anointed One. For a Sanskrit synonym, Monier-Williams (1899, p. 11) gives '*anji*,... ointment... unctuous, smooth, sleek (*membrum* *virile*)'. Another Sanskrit synonym for 'smear, anoint', *lip* (1899, p. 902) gives us *limpata*, 'libidinous, lustful' (1899, p. 902), possibly meaning 'anointed with perfumed oils'. According to Tucker (1931, p. 13), the original ambrosia was neither food nor drink of the gods. It was 'unguent' of the gods, body fluids which worshippers smeared onto the fetish-stone (Gr. *baetulos*) (Tucker, 1931, p. 34). Allegro (1970, pp. 265-66) suggested a derivation of *betula*, 'birch', from *baetulos*. The role of 'Anointing' in the earliest religions needs research.

4. Results of the interpretation of the secret meaning

I am sure that a number of apparent connections I have suggested between the images in the story of Aryadeva and the *Amanita muscaria* may be coincidental and meaningless overlappings of symbols and epithets. A few of these meaningless coincidences are probable. However, a set of such coincidences would be improbable. The congruity of the set of symbols in the legend of Arydeva and the sets of symbols in the mythology of *Amanita muscaria* from Siberian and Vedic traditions is too strong to be a coincidence. It seems that there is enough evidence to conclude that the alchemical elixir of these *siddhas* contained the psychedelic mushroom *Amanita muscaria*: the references to a potion which provides both wisdom and magically potent urine, the references to the Single Eye, the references to the partial appearance of the goddess from the tree. These references must refer to the *Amanita muscaria*, as they do in other traditions.

The other references to the 'miraculous birth', to the 'delicious alms', to the 'wheat cake on the tip of a needle', to the 'rice pulp' *somam*, to the 'God of the Aryans', to the 'full vessel', probably refer to the mushroom, especially when considered in addition to the first set of definite references. The meaning of the secret language is obvious if one has guessed the secret.

Not so obvious is the information at the historical and didactic levels of the *sandhabhasa*. In these areas the legend presents many more questions than answers: what is the exact connection between the psychedelic mushroom and the historical (?) persons Aryadeva (2nd cent.) and Karnaripa (8th cent.)? Why do they have an epithet of the mushroom as their proper names? What is the connection of the mushroom to the two Nagarjunas? If this alchemical practice really existed, what was its source and its lineage of transmission? How long did the tradition remain unbroken? When was the last time the story of Karnaripa was read by someone who understood its secrets? What, if any, is the connection of the mushroom with the *Guhyasamaja* tantra into which Karnaripa was initiated by Nagarjuna? In the legend, the realization through alchemy seemed to be completely unrelated to the tantra.

And in regard to considerations of didactic content: Who should attempt to attain this alchemical *siddhi*? And who should not? What is the nature of the practice and process? What results should one expect? What are the signs of development and attainment? What does one need to know to practice this alchemy and where can one learn this? What is the meaning of the gift of the eye? In Karnaripa's story there is some obvious didactic intent in the *sandhabhasa* and I present my interpretation here.

At the beginning of the legend, Karnaripa is described simply as the principal of one hundred thousand monks at Nalanda college. His high degree of intellectual attainment and the instructions he received from many masters were not sufficient for him to experience realization. When Manjusri, the God of Wisdom, appeared to him as a lowly fisherman, Karnaripa's undefiled vision allowed him to see through the god's appearance and recognize him. This same undefiled vision allowed Karnaripa to see the tree goddess in her true form, although he did not realize the true nature of her gifts of alms, i.e. the potential value of the psychedelic mushroom. In contrast we have Nagarjuna who recognized her alms as the essential alchemical elixir, but could not see the true form of the tree goddess.

The meaning of this seems to be that, to obtain the *siddhi*, one needs both to have entirely abandoned one's defilements (evidenced by Karnaripa's miraculous birth, scholastic attainments and his instant recognition of Manjusri and the tree goddess) and also to have knowledge of the identity and the potential virtues of the alchemical elixir (evidenced by Nagarjuna's recognition of the gifts of alms, and his knowledge of its manner of preparation, consumption and of its effects). This interpretation seems to conform smoothly to Karnaripa's spiritual development in the story, but an evaluation of Nagarjuna's role presents some questions.

Is his recognition of the signs of attainment due to his personal experience or to teachings he had received?

How has his failure to abandon entirely his defilements affected his ability to obtain this *siddhi*? How has he deserved the title of 'Master' while retaining these defilements? The substance of the dialogue between Karnaripa and Nagarjuna on questions like these would be most interesting to read; however, we have only their simple conclusion: 'We need to eat the alchemical medicine'.

By testing the magic power of Karnaripa's urine after they drink the elixir Nagarjuna determines that realization has arisen in his student. He knows that Karnaripa, through the intuitive insight he has experienced, needs only to hear his teacher's words in order to leave *samsara* behind.

The legend adds that Karnaripa then practised the instructions of his teacher so that the stains of his mind became pure and his mental continuum was liberated, this happening after he had already entirely abandoned his defilements and after realization had arisen. These may be references to different, specific stages of attainment. Karnaripa's further practice of his teacher's instruction and the rest of the story might be an addition to the original legend added by the compiler in his stylistic homogenization of the conclusions of the legends.

4.1. Aryadeva's legend by Bu-ston and Taranatha

Two other sources of 'biographical' material on Aryadeva and Nagarjuna are the works of Bu-ston (14th century) and Taranatha (1608). I made my own translations of some of this material which I will summarize and analyze.

Bu-ston's account of 'the teacher Aryadeva' begins with his miraculous birth from a lotus flower in Simhala (Sri Lanka) where he was adopted by the king. When he grew up he became a student of Nagarjuna and became learned in all branches of science and all Buddhist and non-Buddhist philosophical systems.

After this brief introduction, Bu-ston seems to begin to focus on the main event in his account, Aryadeva's defeat of the heretic. A non-Buddhist (Sivaite) teacher named Matrceta, who had done much damage to the Dharma, came to Nalanda to contest the Buddhists there. They sent a message to summon Nagarjuna, but Aryadeva came instead to convert Matrceta. This seems to set the stage for the great contest, but that event is barely mentioned in the rest of the story, which I translate unabridged:

> When Aryadeva was coming, a tree goddess begged for one of his eyes, and he gave her one eye. Then, when he had defeated the heretic, it was said, 'This one-eyed one, what sort is he?' [Aryadeva] said,
>
> > 'Siva has three eyes yet he cannot see reality. Indra has one thousand eyes but he cannot see reality. Aryadeva has only one eye; whatever he is, He sees the reality of all the three worlds',
>
> (Bu-ston, 1971, f. 834, I. 3-5)

It is added that Matrceta converted to Buddhism and became a great *pandit*.

Bu-ston then gives a list of the works written by Aryadeva, drawing no distinction between Aryadevas I and II.

Again, it is uncertain whether the attribute of miraculous birth in Bu-ston's retelling was intended by the original composer of that element of the legend to be taken as a hagiographic detail or more specifically as a *sandhabhasa* reference to the *Amanita muscaria*.

Bu-ston has Aryadeva giving his eye to a tree goddess. It is uncertain whether this detail of the story, i.e. the tree goddess, originated in the legend of the second century Aryadeva or the eighth century Aryadeva. It may be impossible to decide which symbols referring to the mushroom were contributed to the conflated legend in reference to Aryadeva I or Aryadeva II, or which symbols were originally and intentionally shared by both legends.

The Single Eye was shared by both Aryadevas. A Chinese source (Nanjio, 1883, no. 1462) explains Aryadeva's epithet of Kanadeva, 'One-eyed God' saying he gave his eye to Mahesvara, after the previous day plucking an eye from a golden statue of the god (Malalasekera, 1966, p. 111). This reference proceeded the time of Araydeva II who was also famous as Karnaripa, Mig-gcig-pa, 'the Oneeyed'. Even if this symbol in the conflated biography belongs only to the legend of Aryadeva I, then other symbols suffice to link Aryadeva II as well to the *Amanita muscaria*.

Bu-ston's short account does manage to include three images from the *Amanita* symbol set: the miraculous birth, the gift of the single eye, and the tree goddess. He also provides us with Aryadeva's own answer (he writes) to the question, 'Who or what is this one-eyed Aryadeva?' The actual interrogative in the Tibetan text is not simply 'who'(*su*) or 'what' (*ci*) but *ci'dra* meaning 'like what?' or 'what sort?' (Das, 1902, p. 695).

Aryadeva's reply is both informative and evasive. He says that, whatever he may be, his single eye sees all of reality, the reality unglimpsed by the three eyes of Siva or the thousand eyes of Indra. He seems to be saying that his own identity is unimportant, except for his Single Eye of omniscient vision. If my interpretation of this *sandhabhasa* is correct, Aryadeva says that the vision provided by the psychedelic mushroom is far superior to the vision of the supreme deities of heretical religions (he did not compare himself with the Buddha).

I have the feeling that many scholars of Buddhism will find it easier to believe in psychedelic drug use by the Tantric Aryadeva and Nagarjuna than by their Madhyamika predecessors. It must be remembered, though, that besides being the founders of the Madhyamika tradition, both Nagarjuna I and Aryadeva I were credited with being masters of all branches of science and all forms of orthodox and heterodox philosophical systems which should have included alchemy.

Taranatha's account of Aryadeva begins with a discussion of the circumstances of his birth, relating the royalty of his birth as verified by other sources, but discounting the miraculous form of the birth, which he seems to attribute to the Tibetan people's fondness for rumours. He continues with a short history of Aryadeva's spiritual career, mentioning Nagarjuna's initiation of Aryadeva into alchemy. Then comes the main event of the legend, the debate with Matrceta. The monks of Nalanda wrote a letter to summon Aryadeva to the debate and tied it to the neck of a raven (*bya rog*, also 'crow', both birds sharing synonyms in Tibetan and Sanskrit) which had come out from the heart of a self-arisen stone image of Mahakala.

Although the raven or crow has not yet been recognized as an element of the *Amanita* symbol system, I could not dismiss that possibility without further investigation.

The first connection I have found between the raven and the *Amanita muscaria* is in some Siberian (Koryak) folk tales (Wasson, 1968, pp. 294-301) in which the hero 'Raven-man' shows his love for eating fly agaric. Another Koryak story (Wasson, 1968, p. 268) connects the hero 'Big Raven' with the origin of the fly agaric. Big Raven was unable to lift the provision bag of a whale to help it escape when it had run aground. The Supreme Being spat on the ground and the fly agaric appeared there from his saliva. Big Raven ate the mushrooms, began to feel gay, to dance and he helped the whale escape. Fly-agaric showed him how the whale returned to his comrades, so Big Raven said, 'Let the *wa'paq* [*Amanita muscaria*] remain on earth, and let my children see what it will show them'.

Another connection of the raven and the fly agaric comes from the Hindu Kush in the extreme north-east region of Afghanistan. In regard to modern use of the mushroom there, Wasson (1982, p. 601) cited an article from the *Afghanistan Journal* 6 [2], 1979 in which three old mountain-men referred to their fly agaric as 'raven's bread'. This epithet, apparently unexplained in the article, received no further attention from Wasson.

Again we find possible connections between the crow and the fly agaric in Monier-Williams (1899) where we find these entries: under *kana*, 'one-eyed... *kanas*, a crow' (p. 269); *ekaksha* [*eka* 'one' *akshi* 'eye'], 'one-eyed... *ekakshas*, a crow' (p. 267). It is added that crows are supposed to only have one eye which they move from one side to the other as required.

Also given under *drona*, 'a wooden vessel, bucket,...; a Soma vessel; a raven or crow; *dronakaka* a raven' (Monier-Williams, 1899, p. 503). It is uncertain if this reference connects the raven specifically to the Soma bucket or merely to any kind of bucket.

Unless these examples are coincidences, it seems there has been some relationship between the raven/crow and the fly agaric across much space and time. As for the details of this relationship, I have none. The raven, a carrion feeder with color vision, would have noticed the bright-red *Amanita* long ago and it would be known by now if they enjoyed their 'raven's bread'.

According to Taranatha, after he received the message tied to the raven, Aryadeva went to Nalanda with the aid of the object of swift transport (*rkang mgyogs kyi rdzas*). On the way, he met a woman of a non-Buddhist sect who needed the eye of a learned *bhiksu* as a ritual implement to attain her siddhi; so he gave her one of his eyes.

'There he subdued the allies of the heretic [Matrceta] - the sister *pandita*, the parrot, and the chalk - by means of a shameless monk, a cat and a jar of black oil' (my trans.) (Taranatha, n.d., p. 81). Some details of this tantric contest are added in a version from oral tradition given by Geshe Wangyal (1973, pp. 49-50) in which Mahesvara aided Matrceta in the debate by entering his body and empowering him to shoot all-destroying flames from his forehead. Sarasvati (in place of the 'sister *pandita*') aided him with beautiful and wise phrases. A *pandit* in the form of the parrot would whisper advice in his ear. Siva wrote advice in the sky with the chalk (another version has the writing on a chalk board). Aryadeva countered by bringing a naked man (in place of the shameless monk) which caused Sarasvati to turn away, a cat which jumped up and killed the parrot, and by spreading vanishing oil in the sky (or on the chalk board) to erase the writing. He also brought a dirty boot which drove away Mahesvara.

As Taranatha continues, Aryadeva defeated Matrceta three times and caught him when he tried to escape by flying away. Matrceta was later converted to Buddhism.

I could find no connection between the fly agaric and the allies of Matrceta, nor to the jar of black oil. Aided by Sanskrit glosses offered by Lama Chimpa (1970, p. 125) I immediately came upon two Sanskrit-Tibetan puns which connect the mushroom with the shameless monk and the cat.

In the Tibetan text, the *dge bsnyen* (Skt. *upasaka*, 'Buddhist lay worshipper') is described as *spyi brtol can*, given in Das (1902, p. 807) as 'impudent, shameless, daring' or 'scurrilous, foulmouthed' deriving from *gtol*, 'to disclose' or *rdol* 'to come out' and *spyi* 'general, public'. Lama Chimpa offered as Sanskrit synonyms *kakola*, probably drawing on *Mahavyutpatti* #4863, '*spyi rtol, kakola*', which is given in Monier-Williams (1899, p. 268) as a 'raven'. Evidently the 'wild, wary and suspicious Tibet Raven becomes bold when scavenging around villages...' (Wilmore, 1979, p. 156). This characteristic provides a pun which invokes the shameless/raven/Single eye/*Amanita muscaria* symbol set.

Aryadeva's cat, Tib. *byi la*, is another point in the same equation. Sanskrit synonyms are *vidala* (Das, 1902, p. 888) and the same by Lama Chimpa, found in Monier-Williams (1899, p. 731) under bidala (= *vidala*) as 'a cat .... the eyeball'. This invokes the cat/Single eye/*Amanita muscaria* symbol set.

4.2. The siddha Nagabodhi

Taranatha follows his story of Aryadeva with those of three other disciples of Nagarjuna: Nagavyaha, Nagabodhi and Shingkhipa, all receiving shorter entries than Aryadeva. It is mentioned that Nagabodhi attained the *siddhi* of alchemy (*bcud len gyi dngos grub*).

The story of Nagabodhi given by Abhayadatta (Robinson, 1979, pp. 233-235) does not mention alchemy (openly). In his version, the story opens with Nagabodhi, a thief, looking through a door at Nagarjuna who is eating delicious food from a golden bowl.

I see the reference to this meal as a possible expression of the 'delicious food'/ambrosia/soma/*Amanita* set. Although I am unaware of a precedent, the 'golden bowl' would be a good description of the partially opened mushroom cap, which can vary in color from deep red to light yellow through all shades of golden-orange.

Nagarjuna, reading in Nagabodhi's mind his intention to steal, throws the bowl of food out of the room at him, saying objects of desire, like all things, are transitory phantoms of the mind, able to be produced and destroyed by mental concentration. He instructs Nagabodhi to create, in place of his desires, horns on his head, and by meditating he does so. Realizing the emptiness of all things, he attains *siddhi*.

In Taranatha's version, elements of this story of Nagabodhi appear in the story of the *mahasiddha* Shingkhipa, who is described as 'dull witted' (*blo rtul ba*), so dull witted he could not memorize even one verse after many days. Nagarjuna instructed him to create horns on his head by meditating and later, to remove the horns by meditating. After instruction in the Stages of Completion, Shingkhipa attained the *Mahamudra siddhi*. Although it did not seem a likelihood to me, I investigated the possibility that the image of a horn, or horns, was an expression of *Amanita* symbolism.

Wendy Doniger O'Flaherty (1981, p. 263) refers to 'the sharp-horned bull' as 'a common metaphor for Soma'. Here, emphasis seems to be placed on the horns. Furthermore, in Monier-Williams (1976, p. 51) as a synonym for 'birch' we find *srngi*, and under *srngaka* we find (Monier-Williams, 1899, p. 1008) 'a kind of Betula or birch tree'. What is this connection between birch trees and horns (Skt. *srnga*)? It has been pointed out (Lama Chimpa, 1970, p. 127) that the name Shingkhipa is certainly derived from *srngin*, attested by its Tibetan translation *rwa can* 'the horned one'.

In Dowman's version (1985, p. 350) the horns produced by Nagabodhi are red horns; no reason is given for this coloration which matches the fly agaric. These red horns may link Nagabodhi/Shingkhipa to the birch tree and to the *Amanita muscaria*. An even weaker clue was the 'delicious food' in the 'golden bowl' on which Nagarjuna dined. I would not even mention these as possible mushroom references, except that they are followed by an almost certain reference to the *Amanita muscaria* in an otherwise enigmatic addendum to the story of Shingkhipa by Taranatha. Here is my translation:

> Then the master, together with his retinue, practised mercurial alchemy for 6 months. After success was attained, when the pills were being dispensed to each of the disciples, he [Shingkhipa] touched his head to the pill, put it down and turned away. So when the master asked the reason, he said, 'I have no need of this. If the master himself wishes something like this, prepare vessels filled with water'.

Accordingly, one thousand great wine vessels were filled and the forest appeared filled with them. He poured a drop of his urine into each of the jars so that all of them became the resultant nectar, the transmutative juice. Master Nagarjuna hid all of them in an inaccessible cave of one side of that mountain. He offered a prayer to benefit all future sentient beings. This dull witted one who attained *siddhi* was called Shingkhipa, 'the horned one'. (Taranatha, n.d., p. 83)

This reference, which equates the magically potent urine of the *siddha* with the alchemical elixir, may be taken as a reference to the use of *Amanita muscaria* for reasons explained above in connection with Aryadeva. Again, the didactic content of the story is not so obvious. It is uncertain how much of that information was intentionally obscure, and how much detail has been lost due to the entropic process of oral tradition. There seems to be a parable regarding fly agaric use in the story of the Horned-one, but my analysis of the story gives more questions than answers.

If the golden bowl of delicious food is a mushroom reference, then Nagarjuna appears to be telling Nagabodhi that he does not need this material, he only needs the power of meditation. If the horns on the head are a mushroom reference, when he advises his disciple to create them, is Nagarjuna advising the use of mushrooms or the use of meditation in place of mushrooms? His potent urine is proof that the Horned-one had consumed the fly agaric. When Shingkhipa does not accept his masters gift of the magic pills of mercurial alchemy and offers, in return, his magic urine, is he saying that he doesn't need it because he can now dispense it, or that mushroom alchemy is superior to mercurial alchemy, or that meditation can create potent urine?

Although I have tried to find other examples of such magic urine in Buddhist literature, the only two examples I now have are in Abhayadatta's story of Karnaripa and Taranatha's story of the Horned-one, both students of Nagarjuna II.

4.3. Sakara and Padmasambhava

I have mentioned above two others of the eighty-four *siddhas* who are described as lotusborn. The *siddha* Pankaja was also born of a lotus blossom and was also a disciple of Nagarjuna II, but his legend has no obvious symbols in common with the mushroom traditions. The 'real' identities of the *siddhas* Pankaja and Sakara are even more complicated to determine than the identities of the Aryadevas and Nagarjunas. These matters are discussed by Dowman (1985, p. 266 and pp. 344-346). I will limit my discussion to the similarities of the stories of Sakara by Abhayadatta (Robinson, 1979, pp. 227-230, ft. 276-283, pp. 380-382) and of Padmasambhava (Evans-Wentz, 1954).

According to the legends, both individuals were born to heirless kings who had prayed for sons; both were born in lotus blossoms after their births were foretold in dreams; both abdicated to seek the Dharma. In the remainder of the story of Sakara, aside from a reference to rice pulp ('*bras chan*, *somam*?), I have found no symbolic references to the mushroom but some familiar images appear in the legend of Padmasambhava.

To end the famine in his land, King Indrabhuti, who was blind, descended to the world of the *nagas*, to obtain from them the wish-granting gem. When it was given to him by the princess of the *nagas*, he wished for sight in one of his eyes and it was granted. When he returned to his kingdom he found the miraculously born Padmasambhava seated in a giant lotus blossum, 'a fair, rosy-checked little boy' encircled by an aura, his face beaded with perspiration. Upon hearing Padmasambhava's first words, the king was no longer blind in his other eye (Evans-Wentz, 1954, pp. 105-109).

Later in the story, Padmasambhava was sent into exile and the king gave him the wish-granting gem, but Padmasambhava returned it saying, 'Whatever I behold is my wish-granting gem'. When the king extended his open hand to receive it, Padmasambhava spat in the king's hand and the spittle instantly became another wish-granting gem (Evans-Wentz, 1954, pp. 117-118). Here we have two 'Single eye' stories united, one eye cured by the wish-granting gem and the other eye cured by the words of Padmasambhava.

In Taranatha's story, the Horned-one returned the alchemical pills to Nagarjuna and offered his urine as the equivalent. In this story, Padmasambhava returned the wish-granting gem to the king and offered his spittle as the equivalent. The possible connection of the psychedelic mushroom with the wish-granting gem is worthy of further examination. Recall the Koryak tale cited above regarding the origin of *Amanita muscaria* from the spittle of the Supreme Being. I will give below another example of spittle which produces *Amanita muscaria*.

The birth of Aryadeva is also mentioned in the legend of Padmasambhava (Evans-Wentz, 1954, p. 156), who was said to be present when Aryadeva appeared in a lotus blossom as a beautiful eightyear-old child with a perspiring face. I am not sure if this detail of a face beaded with perspiration is an intentional reference to the mushroom or a reference to something else added by a later redactor. Possible referents of the beads of perspiration on the face are the white spots of the universal veil on the red ('rosy-checked') mushroom cap, or the strong diaphoretic quality of the mushroom.

Once again, in these legends of lotus-born ones, we are given symbols which seem to be commonly held with the fly agaric symbol set, but the deeper didactic content of these symbols is unclear. This opacity maybe the result of missing, misemphasized or rearranged details due to transmission of the legends by uninformed non-practitioners, as in the interpretation of the story of Karnaripa by Dowman and his lama informants. Once the informed lineage was broken, those who passed down the legends of these Buddhist adepts could not correct erroneous variances, lacking practical knowledge of the real meaning of these legends.

4.4. Aryadeva and Odin

In what at first must seem like a whopping non-sequitur, I will compare the Tibetan legends of these Buddhists with the legend of the chief god of the Germanic pantheon, Odin.

In the prose introduction to the Eddic *Lay of Grimnir* (also in the *Gylfanning* of Snorri Sturluson), Odin is described as sitting in his high seat in Asgard, from where, with his single eye of omniscient vision, he can see everything that happens in all the three worlds of the Germanic universe. I think it is no mere coincidence that this description of Odin is the same as Aryadeva's selfdescription in Taranatha. Among Odin's many names and attributes are Har and Bileyg, both 'the One-Eyed'. Odin had but one eye because he traded his other eye to Mimir, the owner of the well of wisdom and understanding beneath the tree Mimameith, 'Mimir's tree', often taken to be Askr Yggdrasils, 'Ash of Odin's Steed', the World Tree.

Mimir was the wisest of the Aesir, the race of gods to which Odin and Thor belong, because he drank every day from his well of wisdom. He drank from the Gjallarhorn until Odin, in order to receive a single drink from the well, pledged one of his eyes in return. After that, Mimir drank each day from 'Odin's pledge'. This imagery has perplexed scholars of Eddic mythology who were unaware of the 'kenning' of *Amanita muscaria* as the Single Eye in other traditions.

Mimir was taken hostage by the Aesirs' foes, the Vanir, who cut off his head. Odin smeared it with wort to preserve it and it could speak words of wisdom in answer to his questions. In the *Sigrdrifumal* v. 14-15, the Valkyrie Sigrdrifa speaks of 'mind runes' which Hropt (Odin) devised from the 'sap which seeped in drops out of Heithdraupnir's head, out of Hoddrofnir's horn', evidently referring to Mimir's head and horn (trans. by Hollander, 1962, p. 236 (who points out an intriguing lacuna in these verses)). 'Mimir' apparently means 'the Thinking One'. What is this sap which drips from his head or his horn to form 'mind runes'?

Another of Odin's names is Hrafna (Raven)-god. This name has been believed to relate his role as War god to the ravens that haunt battlefields feasting on the dead. It might also reflect the role of Odin as Great Seer. Odin had two ravens Hugin and Munin, 'Thought' and 'Remembrance', which flew over the world, telling him all they saw. I am unaware of any connection of the raven and the Single Eye in Germanic mythology, but Odin's two ravens might be his own two eyes sent forth in shamanic vision quest.

Odin gives a long list of some of his names and attributes in the *Grimnismal*, of which many could possibly be seen as expressions of *Amanita muscaria* symbolism, for instance, Odin's name Sithhott, 'Long-Hood' (Hollander, 1962, p. 63) or Sidhhottr, 'With Broad Hat' (MacCulloch, 1930, p. 43). Other than 'Bileyg', it is likely that most of these names refer to something other than the mushroom, although Odin's characteristic broadrimmed hat is worthy of further consideration.

We have then, in the myth of Odin, at least six symbols which also appear in the fly agaric symbol systems of other traditions: the Single Eye, the sacred tree, the deity beneath the tree, the well of wisdom beneath the tree, the elixir of wisdom, and the raven. Odin also bears a name of the mushroom as one of his own names, as does Aryadeva/Karnaripa: One-Eyed. If my interpretation is correct, then the legend says that Odin, the Oldest God, attained his omniscient vision by consuming *Amanita muscaria*.

As in the Buddhist legends, it is very difficult to determine exactly how, when, why or where this connection to the mushroom became part of Odin's legend. I intend to follow up with further research in this area.

4.5. The Celtic version

One variation in this tradition is that the World Tree of the Germanic universe is not the birch, but the ash (*Fraxinus* sp., or more likely *Sorbus aucuparica*) which is not a symbiont of the *Amanita muscaria*. In the Celtic myths, the sacred tree is the rowan or quicken tree, the mountain ash, *Sorbus aucuparica*, not a true ash but so named for its many ash-like physical characteristics.

Unlike the true ash which bears samaras, the rowan bears as fruit small red pomes or rowanberries. These were considered to be the ambrosia of the gods which cured all diseases, and brought exhilaration and rejuvenation. These red berries appear in one episode in the legend of the Pursuit of Diarmait O'Duibhne and Grainne.

The Tuatha De Danann, gods of the Gaels, brought these berries from the Land of Promise, but when one fell to earth, from it grew the rowan tree. When the gods found that they had carelessly endowed mortals with their ambrosial berries, they sent a savage one-eyed giant, Searbhan (Sharvan) the Surly, to kill any mortals who tried to eat the berries. This one-eyed giant was later killed by Diarmait when Grainne wished for some of the berries. Then they hid in the dead giant's hut in the tree until their pursuers found them and they fled again.

Several of the *Amanita muscaria* symbols appear in this legend, but in an altered form. In this case, the ambrosial food is a red pome, the Cosmic Birch Tree is a Celestial Ash Tree, and the Oneeyed God who attains wisdom is a Surly, One-eyed Giant who kills wisdom seekers. I don't know if these alterations are intentional didactic changes in the Ur-legend of the mushroom, or whether they are unintentional degenerations due to retelling of the legend after the knowledge of its true meaning was lost.

Although the ambrosial rowanberries were so strongly desired by Grainne, the story never mentions her eating them, nor any change in her due to possession of the berries. This would have been an important element to include in any legend intended to teach the real importance of the psychedelic 'berries'. In the legend of Finn mac Coul there are nine magic hazel trees which bore crimson nuts that gave universal wisdom to anyone who ate them. They fell off the trees into a well below, where lived the divine 'Salmons of Knowledge', the only class of creatures privileged to eat the crimson nuts. Finn attained knowledge by eating one of the salmon.

Although the shift of sacred tree in Celtic myth from birch to ash was not accompanied by a linguistic shift, the linguistic shift occurs in Italic (Latin) where the cognate of **bherH-g-o-* (birch) is *fraxinus*, which names the ash. Of all the western stocks of Indo-European, only Celtic lacks a birch cognate (Friedrich, 1970, p. 173). The Latin name of the mountain ash was *Sorbus*, possibly derived from Proto-Indo-European **sor-dho-s* which referred to some bush or tree that bore red or black berries (Friedrich, 1970, p. 150). The Latin name of the birch was *betula*, a word of unknown derivation, possibly coming from Celtic (Tucker, 1931, p. 34). When the names and the meanings of the names of the sacred trees of these traditions have been sorted out accurately, the history of the religious use of fly agaric will be easier to trace.

In a rare 'non-finding' of fly agaric in a tradition in which they were said to appear, Wasson (1968, pp. 177-178) denied that the *Amanita muscaria* was in any way connected to the Viking berserkers, who were believed to eat the mushroom to 'go berserk' in a murderous frenzy. I do not wish to argue that the berserkers did eat the mushroom, but I will point out that there is evidence against both of Wasson's reasons for his denial. His second reason was that the 'symptoms of fly agaric intoxication were the opposite of berserk-raging' (Wasson, 1968, p. 178). Although I have a longer argument that is beyond the scope of this paper, I will say that evidence against this point exists in the pages of *Soma* (Wasson, 1968) in several anecdotal descriptions of the mushroom's effects.

Wasson's first reason for his denial was that 'fly agaric is never mentioned in the Sagas or Eddas'. I am sure that if someone had used a similar argument against his identification of Soma, he would have considered the argument ludicrous. He certainly knew that, to find a reference to *Amanita muscaria* use, one should not look under 'fly agaric', nor even 'mushroom' in an index to the Eddas; one should start by looking for imagery that is known to appear elsewhere in reference to the mushroom, for instance the one-eyed demons of the Siberian tribes, the Single Eye Soma of the Aryans, or the Kanadeva/Mig-gcig-pa of the Buddhists. Even if Wasson had not been looking specifically for this imagery, he could not have read the story of Odin's single eye without recognizing it. Furthermore, this attribute of Odin is certainly not arcane. One cannot read the Eddas, nor even the most general account of Norse mythology, without finding a description of Odin and his single eye.

How could Wasson have made such a glaring, uncharacteristic oversight? The only answer I can conceive of is that he did not want to find any evidence that could connect his wonderful, noble, 'entheogenic' mushroom with the war party drug-of-choice of those Hell's Angels in longships.

The berserker question is certainly an insignificant sidebar to the possible connections of the fly agaric with Odin. My suggestion that such evidence exists is not without precedent. Morgan (1986, p. 45) in some references linking Santa Claus to the fly agaric reports a belief of the people in Kocevja in southern (former) Yugoslavia, that on Christmas night, Wotan the king of the gods rides through the woods on a white horse, pursued by devils. Wherever the red-and-white flecks of foam from the horse's mouth fall to the ground, they grow into next year's crop of fly agaric. Besides linking the *Amanita muscaria* to Odin and to Santa Claus, this legend is the third example I have given linking the origin of fly agaric to spittle (see also Allegro, 1970, p. 56).

The theory linking Santa Claus to the *Amanita muscaria* has been attributed to Ott (1976, p. 97) wherein he credits (n. 146, p. 154) 'Roderick, B. personal comm.'. Santa is seen as a Siberian shaman ('lives at the North Pole') who performs a winter solstice (Christmas) ritual. In typical shamanic behavior, he flies through the sky (with his reindeer, which are known to be very fond of fly agaric). He enters and leaves the yurt through the smokehole at the top ('up the chimney he rose') (Eliade, 1964, p. 262), climbing down and up the birch pole (Christmas tree) which supports the roof. The colors of the mushroom are red and fuzzy white, as is Santa's costume. If Santa Claus had but one eye, or if magic urine had been a part of his legend, his connection to the *Amanita muscaria* would be much easier to believe.

5. Conclusions

In suggesting the connections between the symbols in these legends and the *Amanita muscaria*, it is certainly not my intention to pound a square peg into a round hole. If any of my suggested interpretations can be shown to be incorrect, this will trim the deadwood, and my case will stand on the points that remain. I hope the few loose ends left above will not detract from the fabric of my argument regarding Abhayadatta's legend of Karnaripa. I hope my efforts to examine every possible clue will not be mistaken for Wassonian 'monomaniacal... paranoid.., mycocentricity' (Weil, 1988, pp. 489-490).

The suggestion that some Buddhist *siddhas* used a psychedelic drug will be dismissed out of hand by many. The use of 'intoxicants' is against the contemporary orthodox Buddhist ethic. In a footnote to his interpretation of a beer-brewing recipe as a metaphor for the process of enlightenment, Ardussi (1977, n. 37, pp. 123-124) denies 'that Vasubandhu's reference to magical powers deriving from the use of herbs (*Abhidharmakosa* VII. 53) suggests a type of mystical experience comparable to, or contributing to the better understanding of experiences obtained otherwise through meditation'. I believe I have demonstrated that some contemporary nonorthodox Buddhist 'alchemists' find precedents in the *Mahasiddhas* Nagarjuna and Aryadeva, who agreed, 'We need to eat the alchemical medicine'.

Perhaps my analysis of these legends and symbols can provide a basis for new research by scholars of Buddhism, Tantra, alchemy, Soma studies, Eddic studies, ethnopharmacology, comparative mythology, transpersonal psychology, shamanism and history of religion.

The relationship of a drug-induced psychedelic experience to 'genuine' mystical experience or to Buddhist enlightenment is debated today (Ratsch, 1989; Tart, 1991) as earnestly and as inconclusively as it was in the early years of wide-spread use of psychedelic drugs. I believe my identification of *Amanita muscaria* as the alchemical agent which brought 'realization' to these Buddhist adepts can help determine the value of the psychedelic experience in Buddhist tradition. Orthodox scholars may object but they can no longer 'Just say No'.

Acknowledgements

For my line of research into the Germanic myths I am indebted to my good friend Birrell Walsh, who informed me of Odin's monocularity when he heard I had an eye out for that kind of imagery.

References

1. Allegro, J.M. (1970) *The Sacred Mushroom and the Cross*. Doubleday and Co., Inc., New York, pp. 349.
2. Ardussi, J.A. (1977) The Doha Tradition in Tibet. *Journal of the American Oriental Society* 97 (2), 115-124.
3. Bharati, A. (1975) *The Tantric Tradition.* Samuel Weisner Inc., New York , pp. 348.
4. Burrows, T. (1973) *Thi Sanskrit Language.* Faber & Faber, London, pp. 23-27.
5. Chimpa, L. and Chattopadhyaya, A. trans. (1970) *Taranatha, a History of Buddhism.* Indian Institute of Advanced Studies, Simla, pp. 493.
6. Collinder, B. (1955) *Fenno-ugric Vocabulary a Etymological Dictionary of the Uralic Languages.* Almqvist and Wiksell, Stockholm, pp. xiii, 46, 128-141.
7. Coomaraswamy, A.K. (1971) *Yaksas.* Munishiram Monoharlal, New Delhi. pp. 32-33, p. 40.
8. Das, S.C. (1902) *A Tibetan-English Dictionary with Sanskrit Synonyms.* The Bengal Secretariat Book Depot, Calcutta, pp. 1353.
9. Dash, V.B. (1987) *Illustrated Materia Medica of Indo-Tibetan Medicine.* Classics India Publication, Delhi, pp. 647.
10. Dowman, K. (1985) *Masters of Mahamudra.* State University of New York Press, Albany, pp. 454.
11. Eliade, M. (1964) *Shamanism: Archaic Techniques of Ecstasy.* Bollingen Series, no. 76. Princeton University Press, Princeton, pp. 610.
12. Evans-Wentz, W.Y. (1954) *The Tibetan Book of the Great Liberation.* Oxford University Press, London, pp. 261.
13. Friedrich, P. (1970) *Proto-Indo-European Trees.* University of Chicago Press, Chicago, pp. 188.
14. Hollander, L.M. trans. (1962) *The Poetic Edda.* University of Texas Press, Austin, pp. 343.
15. Holmberg, U. (1927) Finno-Ugrian, Siberian. In: J.A. MacCulloch, (Ed.), *The Mythology of All Races.* vol. IV. Archaeological Institute of America, Boston, pp. 350-351.
16. Keewaydinoquay. (1979) The Legend of Miskwedo. *Journal of Psychedelic Drugs* II (1-2), 29-31.
17. MacCulloch, J.A. (1930) Eddie In: J.A. MacCulloch, (Ed.), *The Mythology of All Races.* vol. II. Archaeological Institute of America, Boston, p. 43.

18. Malalasekera, G.P. ed (1966) *Encyclopedia of Buddhism* vol. II. Government Press, Ceylon, pp. 109-116.
19. Morgan, A. (1987) Who put the toad in toadstool? *New Scientist.* Dec 25/Jan 1, pp. 44-47.
20. Monier-Williams, M. (1899) *A Sanskrit-English Dictionary.* Oxford University Press, Oxford, pp. 1333.
21. Monier-Williams, M. (1976) *English-Sanskrit Dictionary.* Munshiram Manoharlal Publishers Pvt. Ltd., New Delhi, pp. 859.
22. Nanjio, B. (1983) *A Catalogue of Chinese Translation of the Buddhist Tripitaka, the Sacred Canon of the Buddhists in China and Japan.* Oxford, no. 1462.
23. Nebesky-Wojkowitz, R. de (1956) *Oracles and Demons of Tibet.* Mouton and Co., The Hague, pp. 666.
24. O'Flaherty, W.O. trans. (1981) *The Rg Veda.* Penguin Books Ltd., London, pp. 343.
25. Ott, J. (1976) *Hallucinogenic Plants of North America.* Wingbow Press, Berkeley, pp. 161.
26. Ratsch, C. ed. (1989) *Gateway to Inner Space Sacred Plants, Mysticism and Psychotherapy.* Avery Publishing Group, Inc., Garden City Park, pp. 258.
27. Robinson, J.B. (1979) *Buddha's Lions.* Dharma Publishing, Berkeley, pp. 404.
28. Tart, C.T. (1991) Influences of Previous Psychedelic Drug Experiences on Students of Tibetan Buddhism: a Preliminary Exploration. *The Journal of Transpersonal Psychology* 23 (2), 139-173.
29. Tucker T.C. (1931) *A Concise Etymological Dictionary of Latin.* M. Niemayer, Halle, p. 13, p.34.
30. Wangyal, Geshe. (1973) *The Door of Liberation.* Girodias Assoc. Inc., New York, pp. 49-50.
31. Wasson, R.G. (1968) *Soma: Divine Mushroom of Immortality.* Harcourt, Brace, Jovanovich, New York, pp. 381.
32. Wasson, R.G. (1971) The Soma of the Rig Veda: what was it? *Journal of the American Oriental Society* 91 (2) 169-187.
33. Wasson, R.G. (1982) The Last Meal of the Buddha. *Journal of the American Oriental Society* 102 (4) 591-603.
34. Wasson, R.G. (1986) *Persephone's Quest: Entheogens and the Origins of Religion.* Yale University Press, New Haven, pp. 257.
35. Weil, A. (1988) Review of Wasson (1986). *Journal of Psychoactive Drugs* 20 (4), 489-490.
36. Wilmore, S.B. (1979) *Crows, Jays, Ravens and Their Relatives.* T.F.H. Publications, Inc., Ltd., Hong Kong, p. 156.

Tibetan references

1. Abhayadatta. (1973) *Grub thob brgyad bcu rtsa bzhi'i chos skor.* Chophel Legdan, New Delhi, ft. 318.
2. Abhayadatta. (nd.) *Grub thob rgyad beu rtsa bshi'i lo rgyus, bsTan 'gyur.* Peking #5091, vol 87, pp. 183-184.
3. Bu-ston. (1971) Chos 'Byung, in *The Collected Works of Bu-ston,* part 24 (ya). International Academy of Indian Culture, New Delhi, f. 834.
4. Nagarjuna. (nd.) *Ral pa gcig ma'i sgrub thabs. bsTan 'gyur.* Peking #4340, vol 81, pp. 9-10.
5. Taranatha. (n.d.) *Dam pa'i chos rin po che 'phags pa'i yul du ji ltar dar ba'i tshul gsal bar ston pa dgos 'dod kun 'byung.* Tibetan Institute, Sarnath, pp. 79-83.

Mixing the *Kykeon*

by

Peter Webster

from the pages of
ELEUSIS: Journal of Psychoactive Plants and Compounds

New Series 4, 2000

original text: http://www.psychedelic-library.org/Mixing%20the%20Kykeon%20Final%20Draft.pdf
backup source: http://www.psilosophy.info/resources/Mixing%20the%20Kykeon%20Final%20Draft.pdf

Table of Contents:

Abstract
Part 1
- Introduction
- The Clues
- The Objections
- Analysis
- Further Considerations
- Ergine and Isoergine
- Footnotes to part 1

Part 2
- Entheo-pharmacological Considerations
  - *Clinical versus Ritual Setting*
  - *Fasting*
  - *Sacred versus Profane Setting*
  - *Synergine*
- Chemistry
- Footnotes to part 2

Part 3
- Footnote to Part 3

References

Abstract

Hypotheses advanced in *The Road to Eleusis*[1] concerning the possible composition and method of preparation of the kykeon are evaluated in light of published criticism. Objections to the *Eleusis* theory are countered, and based on a largely overlooked aspect of the chemical hydrolysis of ergot alkaloids, a new hypothesis is suggested that reinvigorates the *Eleusis* debate. In part 2 of this essay, organic chemist Daniel M. Perrine provides further considerations that build upon the new idea, and a technical discussion of the practicality and realisability of the "Ergine Hypothesis" paves the way for new chemical and psychopharmacological research. In part 3, co-author of *The Road to Eleusis* Carl A. P. Ruck re-examines the Eleusis mythologies and ritual practises from which appear a much expanded understanding of the entheo-pharmacology of the ancient world.

Part 1

Introduction

In *The Road to Eleusis*, R. Gordon Wasson, Albert Hofmann and Carl A. P. Ruck attempted to resolve a long-standing debate concerning the famous Eleusinian Mysteries of ancient Greece. Earlier suggestions attributed variously to Karl Kerényi, R. G. Wasson, or Robert Graves had proposed that the autumnal phase of the rite might have involved the use of a psychoactive drug, and it was the task of *The Road to Eleusis* to propose a testable theory as to the nature of the *kykeon*, the revered sacramental potion that would have been a likely vehicle for such a substance.

The principal hypothesis proposed by the three authors suggests that the ergot species *Claviceps purpurea*, collected by the hierophantic priests from its natural and common parasitisation of barley growing in the Rarian plain adjacent to Eleusis, was the probable source of psychoactive ingredient for the elixir. *C. purpurea* and related parasitic fungi produce lysergic acid alkaloids, among which are several known psychedelic compounds as well as other important pharmaceuticals.

The partaking of the *kykeon* marked the climax of the famous autumnal ceremony at Eleusis, performed for nearly two thousand consecutive years and whose initiates included essentially all the great names of Greek antiquity. Claims for the potency and revelatory effect of the *kykeon* and the profound nature of the secrets revealed at the Eleusinian celebration are widespread in Greek literature and historical writings, so there can be little doubt that the rite was of major importance to the course of Greek civilisation or that the potion must have been more than a symbolic sacrament like the Christian Eucharist of bread and wine: the *kykeon* surely contained a powerful psychoactive substance similar to one of the major vision-inducing and psychedelic plant alkaloids that Western science has only recently rediscovered.

Albert Hofmann, writing in *The Road to Eleusis*, further suggested that the hierophants might have processed the *C. purpurea* ergot with a simple water extraction, dissolving off the water-soluble alkaloids containing ergonovine and methylergonovine, the principal hypothesised psychoactive compounds. Ergonovine, also known as ergometrine or ergobasine, is a psychoactive lysergic acid amide similar in structure to, but far less potent than lysergide, or LSD. The proposed water-extraction process would also supposedly have prevented the toxic ergopeptine alkaloids of *C. purpurea*, abortifacient and dangerously vasoconstrictive but not at all psychedelic, from entering the potion. Ergopeptine alkaloids such as ergotoxine and ergotamine were the agents responsible for the recurring plagues of ergotism known throughout European history, so it may safely be assumed that they were somehow excluded from the *kykeon*.

Hofmann also proposed an alternate hypothesis that the *kykeon* might have been prepared from another species of ergot (*Claviceps paspali*), growing not on barley (or only rarely) but on wild grasses of the region such as *Paspalum distichum*. The hypothesis appeared attractive because *C. paspali* produces a much more psychedelic blend of alkaloids than *C. purpurea*, similar to that contained in the redoubtable Western hemisphere psychedelic plant of the Aztecs, *ololiuhqui*. In addition, the toxic ergopeptine alkaloids are largely if not completely absent in this ergot species.

This paper examines these hypotheses in light of more recently published material, and introduces additional considerations in an attempt to take the Eleusis debate to a level from which further research might lead to a breakthrough. New hypotheses concerning the composition of the *kykeon* and the ways it might have been prepared are advanced. We will attempt to evaluate what is known and suspected about the possible composition of the *kykeon* employing several important clues gleaned from Greek literature and modern research. Such clues need to be kept in mind during the evaluation of *kykeon* hypotheses, for considered apart from these clues, even the proposal that an ergot was the psychoactive ingredient can be doubted, and the way left open for the suggestion of several other possible psychoactive plants as the key ingredient. Indeed, certain authors have done so, in a paper to be discussed below.

The Clues

The fact that the Rite was practised like clockwork for large numbers of communicants (a thousand or more, in later years), and for nearly two millennia must require that the psychedelic entity employed was of constant characteristics and dependability, that sufficient quantities could be easily obtained every year independent of varying conditions, and that the method of preparation was also little subject to the vagaries of error or changing conditions.

Other facts relevant to the *kykeon* and the Rite, and the two hierophant families which controlled and kept secret the recipe for the sacrament for nearly two millennia, are several. Of special importance is the fact that the recipe *was* successfully kept secret for this very long period, when documentation shows that many would probably have desired to discover its particulars. The *kykeon*, or perhaps the secret of its preparation, was apparently stolen on at least one occasion for use at Athens "cocktail parties," profaning the sacred rite and its potion. If the *kykeon* could have been simply duplicated, if it were obvious which ingredients were used and how they were prepared, it would presumably have not been necessary to steal it, and its profane use might well have become common. We must assume not only that the recipe *was* effectively kept secret, but more importantly that some critical feature of the recipe was *easy to keep secret*. Perhaps the true identity of the active ingredient, but more likely the way in which it was processed or prepared was the key secret. Such processes must of course have been simple and reproducible, in line with technical abilities of the time, yet not easily observed by spies nor intuited by outsiders.

Further clues can be gleaned from Greek literature, and pertaining to the characteristics of ergot and the way and frequency with which it infests its hosts, and similar botanical characteristics of other proposed active ingredients such as *Psilocybe* mushrooms. I shall introduce these further clues as necessary during the discussion to follow.

The Objections

Recently, objections have been raised concerning the ergot hypothesis, most notably in an article by Ivan Valencic in *Jahrbuch fur Ethomedizin und Bewusstseinsforschung*: "Has the Mystery of the Eleusinian Mysteries Been Solved?". The main complaints of the author are as follows, in the order in which they appear in the article:

> Objection 1. The proposed psychoactive ingredients of *C. purpurea*, ergonovine and methylergonovine, are not exceptionally psychedelic when ingested as synthesised compounds.
>
> Objection 2. Preparations of *C. purpurea* itself have not been made and pharmacologically tested which demonstrate it might have been sufficiently psychoactive to have provided the undoubted powerful psychedelic reaction to the *kykeon*.
>
> Objection 3. These same proposed active ingredients, at the doses necessary to produce the moderate psychoactive effects they are capable of producing, also produce significant discomfort, cramping, and lassitude. Presumably the effect of the *kykeon* was a quite enjoyable experience or it wouldn't have been sought after by rich Athenians to entertain guests, nor would the experience of the sacrament at Eleusis have been written about so glowingly by everyone who partook of the Rite and its potion.
>
> Objection 4. In addition, ergonovine at these dose levels is capable of producing spontaneous abortion, and since women were often initiates in the Rite and no such problems were ever described, we must doubt that the full story has been discovered in the *C. purpurea* hypothesis as advanced in *The Road to Eleusis*.
>
> Objection 5. Concerning the *C. paspali* variant of the hypothesis, it is objected that this fungus is known to produce tremors in cattle grazing on infected grass, and, similarly to *C. purpurea*, that no one has processed the fungus into a preparation shown to be psychedelic to a degree in agreement with the properties of the *kykeon*.

> Objection 6. The reference to the composition of the *kykeon* in the Homeric *Hymn to Demeter* is obviously incomplete, or even false, the recipe given there containing only water, barley, and a type of mint known to be at most only slightly psychoactive. It is thus proposed that this formula was merely a red herring, a way to deceive and disguise the true recipe. Barley may have had nothing to do with the true ingredients. Thus other psychedelic entities such as *Psilocybe* mushrooms or even opium must be considered as possibilities.

These would appear to be important reservations. And as the author points out, both the *C. purpurea* and *C. paspali* hypotheses are conspicuously testable, yet the only testing that has been accomplished has not produced very promising results. (An overview of several self-experiments with the proposed ergot alkaloids is given in Valencic's article, as well as in part 2 of this essay.) Let me work backwards through these objections, and bring to bear the clues I have mentioned.

Analysis

It is only possible to entertain objection 6 if we believe that the lack of positive results of testing the two ergot hypotheses precludes further experimental developments. Indeed, this appears to be Valencic's position as he concludes that the ergot hypotheses are "not very likely," and he "agree[s] with Robert Graves and Terence McKenna that there exists also reasonable possibility that psilocybian mushrooms might have helped to produce the astonishment and ecstasy in ancient initiates..." Given that the references to barley and mint in the *Hymn to Demeter* fit well in several respects with the *C. purpurea* hypothesis, and that further evidence from Greek literature as discussed by Carl Ruck in *The Road to Eleusis* also implicates barley and mint, more than mere "doubts" should be required before insinuating that the recipe of the *Hymn to Demeter* was mere fabrication. The best and most believable lies or deceptions are ones closest to the truth, and even better are deceptions which actually are the truth disguised by the way of telling, or by leaving out some critical detail. If the *Hymn to Demeter* specifies barley, it is very likely that the *kykeon* has *something to do* with barley.[2] *Psilocybe* mushrooms have no relationship with barley whatsoever. And the mint specified in the recipe also would support the ergot hypothesis, since mint is a known remedy for the slight nausea often encountered with various lysergic acid compounds including the psychedelic ones as well as ergotamine taken as a remedy for migraine. The preponderance of evidence indicates we must further explore the ergot hypothesis, rather than abandon it for other possible psychedelic plants.

The proposal that the barley-mint recipe was a total fabrication designed to conceal the true secret also begs the question of why barley and mint would have been chosen as the fictitious ingredients. Why not other herbs, or plants, or even rare substances that were generally unavailable? Why implicate a principal foodstuff if in reality there were not the least connection? The barley-mint recipe cannot be abandoned so easily. In addition, some facts relevant to *Psilocybe* mushrooms, discussed below, make this alternate hypothesis rather far-fetched.

Objection 5 has recently become a moot point, as it has been convincingly shown that *C. paspali* was almost certainly not present in ancient Greece, neither its host *paspalum* grass.[3] *C. paspali* might well have made a suitably psychoactive potion due to its alkaloidal content, very similar to the Aztec psychedelic, *ololiuqui*. Although several self-experiments with *ololiuqui* (seeds of two species of morning glory) or with its purified alkaloids ergine and isoergine have been inconclusive (see the mentioned examples in part II of this paper), I can personally assure readers that the alkaloids of *ololiuqui* are, when prepared correctly, quite capable of producing the entire range of powerful psychedelic effects. Ergine and its stereoisomer isoergine are the two principal psychoactive compounds of *ololiuqui*, and also the major alkaloids found in *C. paspali*, yet they are not found in *C. purpurea*. But the story of ergine and isoergine might be more important than has previously been suspected, as will be evident from what follows here.

Objections 1 through 4 all depend on the assumption that ergonovine and methylergonovine are the active principles resulting from the processing that was required to make the *kykeon* from *C. purpurea*. But self-experiments with these compounds, and the lack of other suitably psychoactive chemical candidates in *C. purpurea*, seem nearly to disqualify the ergot hypothesis from serious consideration. We seem to be at an impasse, with the best hypothesis marred by experimental weaknesses, and alternate hypotheses rapidly diverging from our most solid clues.

Although one might imagine that *C. purpurea* naturally parasitising barley in ancient Greece contained a more psychoactive blend of alkaloids than has been found in *C. purpurea* grown and tested in recent times, the fact that the psychedelic *kykeon* was so reliable for so long would indicate a corresponding long term reliability of content of the fungus which should thus have continued into the present, *i.e.*, today's *C. purpurea* is very probably quite similar in its alkaloidal spectrum to that of the same fungus parasitising barley in ancient Greece. Thus some suggestions that the known variability of ergot with varying hosts and growth conditions might resolve the question is unconvincing. Similarly unconvincing are proposals that the Eleusinian priests had discovered and cultivated some other species of ergot.

Further Considerations

Following are some further observations which should guide hypothesis formation: facts and probabilities drawn from what we know about ancient Greece, the Rite, the biology and chemistry of ergot and other proposed psychedelic plants, and other sources.

Relatively large amounts of the ingredient were needed,[4] at a certain time of year, on demand. This fact argues against wild mushrooms or wild ergots such as *C. paspali*, and in favour of the hypothesis that the priests harvested the item from a plentiful, known, reliable, naturally-occurring and nearby supply. It is possible, however, that they had discovered how to augment supplies by simple procedures.[5] Even with modern agricultural techniques, *C. purpurea* remains a common infestation of cereal grains, thus we may assume that this ergot was also common in the barley of the Rarian harvest, no doubt a large one. Thus even with a mild ergot infestation, sufficient quantities should have been obtainable. The grain harvest, and consequently the possibility to select out the ergot therein, occurs in late spring or summer, just in time for the September Eleusis celebration. The separation of ergot from the grain might also have been easy for the priests to do without undue observation, or without raising suspicions of what it was to be used for. A "purification" of the harvest in which "malformed grains" (see again footnote 1) as well as other contaminating material were removed might have been a cover-story.

However, as discussed above, *C. purpurea*, in its natural state, contains an alkaloidal content that is at best only moderately psychoactive, and with unfavourable toxic side-effects. *C. paspali* would have been a far more likely candidate on the basis of its alkaloid content, but is now ruled out. In fact, we might have ruled out naturally-occurring *C. paspali* on the basis of availability: Growing wild, it probably wouldn't have been reliable or copious enough to produce the quantities necessary, and collecting large amounts would have entailed scouting the countryside at great length, an activity easily observed by spies, and thus the recipe become easily known. Similarly, if *C. purpurea* were the active ingredient, and easy to process with a simple water extraction as suggested by Hofmann, could the secret so easily have been kept for so long?

Psilocybe mushrooms are ruled out, however. Several aspects of the Rite and what we know about wild mushrooms make the *Psilocybe* hypothesis unlikely. The rite was held every year and at a precisely defined time in the month of September. Thousands of specimens of even the strongest *Psilocybe* mushrooms would have been needed, at a time of year when the climate of Greece was just barely subsiding from the summer heat and dryness. Although cooler mountainous areas of 1000 meters in altitude are within ten or twenty kilometres of Eleusis, it is very unlikely that such vast quantities of an uncommon wild mushroom could have been located so early in the year, like clockwork and in advance of the autumn rains, or that the hierophants could have collected such quantities every year and transported them back to Eleusis without the secret of their activity escaping. And as anyone who has collected wild mushrooms knows, they seldom appear on-schedule, in such dependable quantities, even when an area known to produce a certain variety has been identified.

If it is proposed that a *Psilocybe species* growing on the dung of domesticated herbivores might have been the *kykeon*'s secret, again we run into trouble. In the typical summer climate of Greece, herbivores' excretions would have dried so quickly in the heat that the hierophants would have had to irrigate them to even hope that mushrooms would appear, and they would have been lucky to produce even a handful under those conditions. And once again, it would have been a difficult operation to keep secret. After autumn rains, in November and December, animal dungs might well have produced their fungal consequences, too late for the rite unless we hypothesise that December's *Psilocybe* was stored for the following year: Again, a highly unlikely hypothesis for reasons too obvious to mention. But this observation does indicate another argument for ergot: the easily-dried sclerotia of ergot *are* quite capable of being stored, retaining their alkaloids for considerable periods, and certainly *could* have been stored for at least a year without preservatives, in containers of minimal size easily secreted in the confines of the temple. Thus stored ergot might have augmented supplies in lean years.

And of course the idea that the hierophants had perfected the cultivation of *Psilocybe* mushrooms is even more fantastic. I doubt that such a hypothesis even needs to be criticised. But one final argument might indicate that there weren't even any *Psilocybe* of note growing in Greece at the time. As noted in *The Road to Eleusis*, (p. 42) the Greeks were well acquainted with a wide range of inebriants and herbs, and how to prepare "wines" suitable for many purposes. If *Psilocybe* mushrooms had been common enough to use for the *kykeon*, they would no doubt have long been known and written about, and their secret impossible to keep. Neither the *Psilocybe* hypothesis, nor the hypotheses of naturally-occurring alkaloids of *Claviceps purpurea*, nor naturally-occurring *Claviceps paspali*, nor of course any of the other hypotheses that the *kykeon* was some kind of alcoholic beer made from barley, or that it was merely symbolic, etc. etc., will suffice.

We seem to have shown that *C. purpurea* is the most likely *kykeon* candidate while simultaneously proving its insufficiency to deliver a safe dose of alkaloids powerful enough to produce the full range of psychedelic effects. What is amiss? The most straightforward hypothesis is that the Greek priests had discovered some way to *transform* naturally-occurring supplies of *C. purpurea*: they must have found a technologically-simple process to alter the alkaloidal spectrum of ergot. At first this surely sounds like an impossible idea, yet some ergot alkaloid research of the 1930s, recently confirmed and until now overlooked by the various participants in the Eleusis debate, provides the key.

Ergine and Isoergine

Years ago, with the threat of my impending draft into the U.S. Army for an extended tour of Southeast Asia, I decided instead to "go on the lam," and departed for Mexico with the intention of researching the distribution and chemistry of some of the famous Central American psychoactive plants such as *ololiuqui*. It was during the course of these investigations that I prepared astonishingly powerful extracts of *ololiuqui*, alluded to above. I had also been interested in the possibility of hydrolysing the alkaloids of *ololiuqui* in an attempt to prepare pure lysergic acid. This is a simple process, requiring only that the extracted ergine / isoergine content of the seeds be boiled for some time with a strong base such as potassium hydroxide. Although my researches were ended prematurely by unfortunate events, an important result for the present question was that I became well-acquainted with the chemical literature concerning lysergic acid, its production via hydrolysis, and the various conversions possible when treating ergot alkaloids in differing conditions.

I learned from the early chemical literature that the base-catalysed hydrolysis of ergopeptine alkaloids typical of *C. purpurea* apparently proceeded via a two-step process, the first and most rapid step resulting in ergine[6] which was then more slowly hydrolysed to lysergic acid. The discovery of ergine was in fact accomplished in such a manner: Early work in the 1930s had found that treating ergotoxine (a mixture of three ergot alkaloids from *C. purpurea* extracts) with a base such as potassium hydroxide, yielded both lysergic acid and ergine.[7] The details of the various experiments indicated that longer reaction times and higher temperatures favoured the complete transformation to lysergic acid, while short reaction times and lower temperatures resulted in significant amounts of ergine. Subsequent unpublished work by myself indicated the strong dependence of the hydrolysis on temperature, but weak dependence on base concentration.

Over the years I gradually forgot about these results until recently, musing over the objections to the theory of *The Road to Eleusis*, the "Ergine Hypothesis" suddenly appeared to me as a possible key to countering the objections. The hierophantic priests might well have discovered how to achieve a partial hydrolysis of the mostly toxic alkaloids of *C. purpurea*, resulting in an extract of ergot containing a blend of psychedelic compounds closely similar to the Aztec's *ololiuqui*. The partial hydrolysis might thus also eliminate the toxic ergopeptine alkaloids, converting them to psychoactive ergine and isoergine.

But how were the hierophants to accomplish this feat, seemingly not duplicated until the 20th Century? It must have been a technologically simple procedure, and employed common ingredients, yet been easy to keep secret. Although potassium hydroxide was surely not available to the Greeks, the ashes of wood fires certainly were, and in fact a mixture of wood ash in water results in a solution of potassium of reasonably strong basicity. Is it possible that merely digesting powdered ergot with wood ash and water (and possibly wine containing 10% or so of ethanol to improve the solubility of the alkaloids), heating the mixture for a short period and then filtering off the liquid might have been the method of mixing the *kykeon*? I decided to ask the opinion of a colleague, an associate professor of chemistry at Loyola College in Maryland, and author of *The Chemistry of Mind-Altering Drugs*.

Footnotes to part 1

1. *The Road to Eleusis: Unveiling the Secret of the Mysteries*, R. Gordon Wasson, Carl A.P. Ruck, Albert Hofmann. Harcourt Brace Jovanovich 1978. Republished in a Twentieth Anniversary Edition with additional material, Hermes Press, 1998.
2. It should be remembered that the appearance of ergot on its host has all through history led to the conclusion that ergot was merely malformed or sun-burned or "rusted" grains of the cereal host in question. It wasn't until the 20th Century that ergot was generally recognised as another species altogether, a fungal parasite of the grain on which it appeared. Thus the Greeks very probably also made this error.
3. See Francesco Festi & Giorgio Samorini, "*Claviceps paspali* and the Eleusinian Kykeon: A Correction." *The Entheogen Review*, Volume VIII, Number 3, Autumn 1999.
4. A quick calculation of quantities necessary: Total alkaloid yield of *C. purpurea* may be about 1%, most of it ergopeptines with only a few percent ergonovine. The dose of ergine / isoergine (the active ingredients according to the arguments to follow concerning the method of preparation) should be between 1 and 5 mg as it has been recorded that its potency is about 1/10 that of LSD. Thus, per 1000 Eleusis participants we require up to 5 gm total alkaloids, corresponding to 0.5 kg of ergot. Modern yields of ergot from cultivation on rye can yield hundreds of kilograms per hectare. Thus it seems reasonable that the Greek priests could easily have harvested enough ergot from the nearby barley fields. Ripe ergots can easily be collected from the grain in the field, as they fall off the grain head even with strong wind. By contrast, the ergonovine hypothesis of *The Road to Eleusis* would require far greater quantities of *C. purpurea* since ergonovine only represents a small fraction of the alkaloid content of the fungus.
5. A likely possibility is that the priests had discovered how to spread an ergot infection using a water solution of the *honeydew* produced. Early in the growth of ergot on grain, the fungus causes the production of droplets of a sticky syrup on the grain heads, and insects attracted to this exudation transmit the ergot mycelium therein to other developing heads of grain. A solution of a few drops of honeydew in a litre of water produces a mixture that when shaken or sprayed onto other developing grain heads readily spreads the infection.
6. The process also produces isoergine, for in basic solution all such amides of lysergic acid rapidly approach an equilibrium mixture of the two associated stereoisomers.
7. References for the technical articles mentioned are to be found in the second section of this paper.

Part 2

by
Daniel M. Perrine, Ph.D.

Entheo-pharmacological Considerations

In agreement with what Peter Webster has discussed in the preceding portion of this article, it seems to me that it is quite possible that a "potion" containing as its main active ingredient lysergamide (ergine, the active entheogen in *ololiuqui*) and free from any more toxic alkaloids, could be reliably produced from ergot harvested from *Claviceps purpurea* infected barley using materials and processes available to the ancient Greeks. That is, such a procedure seems chemically possible for reasons which will shortly be presented in detail - although, of course, this possibility cannot be truly proved without actually carrying out a series of experiments in which ergot would be processed as hypothesized. Chemical possibility is, of course, not historical fact or even historical plausibility, but it can at least establish historical possibility.

A first objection to the suggestion that the Eleusinian mysteries owed some of their powerful effects and passionate loyalty to the entheogenic action of lysergamide in the *kykeon* is that lysergamide is not really a very good entheogen, certainly not when compared to the psilocybin in *nanacatl* or the mescaline in peyote. Indeed, the few documented descriptions of *ololiuqui* intoxication are far less dramatic than those employing LSD, mescaline, or psilocybin. Here is the full record, as far as I have been able to ascertain:

1. In 1955, Humphrey Osmond[1] took 60 to 100 seeds and experienced, according to Schultes and Hofmann, "a state of apathy and listlessness, accompanied by increased visual sensitivity. After about four hours, there followed a period in which he had a relaxed feeling of well-being that lasted for a longer time."[2]
2. Hofmann compares the effects of *ololiuqui* rather unfavorably with those of LSD in his book, *LSD: My Problem Child*[3] His description is as follows: "After the discovery of the psychic effects of LSD, I had also tested lysergic acid amide [lysergamide] in a self-experiment and established that it likewise evoked a dreamlike condition, but only with about a tenfold to twentyfold greater dose than LSD. This effect was characterized by a sensation of mental emptiness and the unreality and meaninglessness of the outer world, by enhanced sensitivity of hearing, and by a not unpleasant physical lassitude, which ultimately led to sleep." As for the effects of the Mexican morning-glory seeds, he continues: "The psychic effects of *ololiuqui*, in fact, differ from those of LSD in that the euphoric and the hallucinogenic components are less pronounced, while a sensation of mental emptiness, often anxiety and depression, predominates. [Such]...weariness and lassitude are hardly desirable effects...in an inebriant."
3. Solms, in a systematic comparative study of the psychopharmacology of lysergamide, confirmed Hofmann's impressions, concluding that it "induces indifference, a decrease in psychomotor activity, the feeling of sinking into nothingness and a desire to sleep... until finally an increased clouding of consciousness does produce sleep."[4]
4. Hofmann also tested the effects of isoergine (which is formed in much smaller amounts with ergine in the basic hydrolysis of ergot shortly to be described) and found that 2.0 mg orally produced a syndrome not very different from ergine, characterized by sensations of "tiredness, apathy, a feeling of mental emptiness and the unreality and complete meaninglessness of the outside world."[5]

These seem to be the effects of ergine and/or isoergine when taken in the context of a scientific, clinical effort to disclose their psychopharmacology; and we can therefore presume that these would also be the effects of our hypothesized κυκεών under the same conditions. For the process we will describe would transform all the ergot alkaloids into ergine or isoergine. Even ergobasine (lysergic acid hydroxyethylamide, found in small amounts in *ololiuqui* and in some samples of ergot from Central Europe) would be converted to ergine. The only other likely psychoactive ingredient in the κυκεών would be wine.[6]

But these rather humdrum effects of ergine taken in the context of a dispassionate clinical experiment by volunteers already well-acquainted with the overwhelming visual and psychological effects of LSD and psilocybin by no means preclude the possibility, even the likelihood, that a potion containing ergine could powerfully catalyze and amplify the religious experience of the Eleusinian communicants of ancient Greece. Among the most important reasons for affirming this are the following:

Clinical versus Ritual Setting

There is no doubt that *ololiuqui* has been valued for centuries as a sacred entheogen in Oaxaca by *curanderos* of the Zapotec, Chinantec, Mazatec, and Mixtec tribes. And the principle psychoactive agent in *ololiuqui* (*Rivea corymbosa*, *Ipomoea violacea*) is just what we propose to have been the active agent in the *kykeon*: ergine (with smaller amounts of isoergine).[7] If, to the vague and directionless alteration of mental state provided by ergine in the jejune setting of the research clinic, there is added the governing mind-set of religious belief coupled to the external setting of a centuries-old ritual, participants can and do experience a many-fold entheogenic intensification of the awe and dread felt before an ecstatic theophany of the *mysterium tremendum et fascinans*.

Indeed, other *pharmaka* with far less likely *a priori* plausibility if judged solely by their clinical psychopharmacology have been exploited for millennia in various cultures for their entheogenic effects: I am thinking particularly of *Amanita muscaria* (which despite its likely identity with the archetypical Vedic entheogen, *soma*, produces in secular settings only a bizarre state of incoherent delirium) and the presently much-despised *Nicotiana*, which "is not generally considered to be a hallucinogen. Yet, like the sacred mushrooms, peyote, morning-glories, *Datura*, ayahuasca, the psychotomimetic snuffs, ... tobacco has long been known to play a central role in North and South American shamanism, both in the achievement of shamanistic trance states and in purification and supernatural curing. Even if it is not one of the "true" hallucinogens ... tobacco is often conceptually and functionally indistinguishable from them. We know that Indians from Canada to Patagonia esteemed tobacco as one of their most important medicinal and magical plants and that some employed it as a vehicle of ecstasy."[8] Of course, many of these groups used tobacco or tobacco extracts in massive dosages in order to deliberately provoke a near-death experience. Yet, even in moderate amounts, and despite endless condemnation from Christian missionaries and Surgeons General, tobacco continues to be revered to this day as an integral part of the peyote ceremony by many adherents of the Native American Church.

Fasting

The *kykeon* was drunk *after a nine-day fast*. It was perhaps the sole beverage/food which broke that nine-day fast, and the drinking of the *kykeon* took place at the peak of a most solemn religious ritual.[9] Probably few or none of the readers of this article have carried out a strict fast for nine days in the integral context of a life-transforming religious observation, and still less likely have any of them followed this by consuming, at the approach to the Holy of Holies, a dreaded sacrament with potent mind-altering effects. Peter Webster has given testimony to being himself deeply affected by *ololiuqui*. Let me add my own testimony to the effects of set, setting, and fasting:

About a quarter of a century ago, in the company of a dozen or so other recently-ordained Jesuits my age, I entered upon the consummatory event of the Jesuit spiritual training, the second and final 30-day Ignatian retreat. During the first part of Ignatius's *Spiritual Exercises*, which are the guide for this retreat, the "exercitant" is expected to unceasingly consider his utter unworthiness before God of aught but damnation, all the while living in total silence and solitude except for attendance at Mass and brief colloquies with one's director. Following these directives to excess, I soon fell prey to the Moloch of Christianity's most negative doctrines. By the third day, I had ceased eating, attending services, or talking with my director, walking alone instead for miles each day lashing myself with doubts and despair. After more than three days of eating nothing, I reached a rather grim metastable state at the nadir of resigned desperation: if I could never attain the love of/for God, I would simply go through the dead motions of devotion during the rest of the retreat. It was dawn. For the first time in four days, I ate, with total absence of any appetite: one slice of toast and a cup of sugarless black coffee. As I stared then blankly at the blank pages of my retreat journal, I was suddenly and overwhelmingly "transported." In some indescribable way and for what seemed like only a few seconds, I was suspended from the world of space and time and experienced myself in the immediate presence of "God." I say "God" because It was nothing at all like anything my imagination had ever before constructed. But it was *true* with an ineluctable certitude I have never been able to doubt. And it was probably the most pivotal moment of my life: whatever I have done since (including leaving the priesthood many years later) can be traced in some sense back to this experience; everything I have thought since of myself or "God" has been radically different. Was it the set and setting? Of course. Was it the fasting? I doubt that it would have occurred had I not fasted those four days - but then, I would never have fasted those four days (it was a completely spontaneous lack of interest in eating, not a planned exercise) had I not been gripped by an overpowering mind set which was completely reinforced by the setting.

Perhaps the experience was even to some extent the "entheogenic" effects of black coffee and toast. In the early part of the last century, week-long fevers could leave a sick person delirious and emaciated, and Thomas De Quincey writes in 1822, by way of comment on his own opium habit, that "Some people have maintained, in my hearing, that they had been drunk upon green tea; and a medical student in London, for whose knowledge in his profession I have reason to feel great respect, assured me, the other day, that a patient, in recovering from an illness, had got drunk on a beef-steak."[10] I purchased a few seconds of Eternity with four days of fasting and a cup of black coffee; had I paid with nine days, ergine, and Pramnian wine, might I not have bought an hour?

I am certain that the duration and perhaps even the depth of this experience (although the second aspect seems much less quantifiable than the first) would have been greatly intensified if, say, I had drunk a cup of peyote tea instead of black coffee. Indeed, when I try to imagine what would have been the likely outcome of such a switch in beverages I am terrified and find myself quite grateful that only coffee was available. As Huston Smith says, "awe is not fun,"[11] and the experience was sufficiently awesome as it was.

Two reasons convince me that an entheogen would have powerfully intensified the duration and particularly the likelihood of such an experience (for in-depth experiences of this sort are not that common, even among the many earnest Jesuits who have made this final retreat - at least not among the Jesuits I knew and know from my generation). The first is that I am now able to extrapolate backwards in time from a number of quite beautiful, awesome - even occasionally terrifying - religious theophanies which I experienced years later under the influence of entheogens.[12] The psychological and spiritual set and setting of these later experiences could not approach the once-in-a-lifetime situation of the retreat experience described above (although it was intentionally and earnestly religious), and so I was all the more impressed that the simple ingestion of a plant or chemical could invoke in such ordinary circumstances so profound an emotional and religious response.

The second reason is of course the famous "Good Friday Experiment" of Walter Pahnke, the "Miracle at Marsh Chapel," where a group of seminary professors and students, under double-blind conditions, were given either psilocybin or an active placebo[13] immediately before a three-hour Good Friday service. Those receiving the true entheogen experienced an intensity of religious emotion and exaltation greatly exceeding in statistical significance the experience of the controls, and they evaluated their experience just as highly when they were interviewed in a long-term follow up by Rick Doblin some 25 years later.[14] This is as close to a scientific demonstration of the efficacy of entheogens in intensifying and facilitating religious experience as has yet been conducted. And yet, one can only guess how much even this profound entheogenic catalysis of a religious setting might have been still more amplified had it been experienced following a multi-day fast!

Sacred versus Profane Setting

No one disputes that ergine unmistakably and profoundly alters everyday consciousness - the only dispute concerns whether this alteration has, considered in isolation, properly "entheogenic" qualities. But as a matter of fact, even those psychoactive agents which by general consensus produce an alteration of consciousness most closely resembling and most likely productive of religious ecstasy (mescaline, psilocybin, LSD) *fail*, in the vast majority of cases, to produce anything like a religious experience when taken in a totally profane context. I am thinking of the hundreds of first-hand written accounts the college students I teach have given me over the years describing their use of psilocybe mushrooms or LSD. I would characterize fewer than 20% as empathogenic, and fewer than 10% as entheogenic. Doubtless the common use of large amounts of alcohol at the same time has much to do with this, but I suspect the usually banal intra- and interpersonal context, a context augmented by a nearly total absence of prior religious experience in any depth, is what succeeds in quenching so utterly the sacred flame. All of which is to say that entheogens, even the best of them, cannot create the "divine within" in and of themselves (to this extent, "entheogen" is a misnomer or an overstatement) absent anything at all numinous in set or setting. *Odi profanum vulgus, et arceo* admonishes Horace.

Synergine

It may seem to the reader that the arguments I have been making here could be turned on their head: if set and setting are so important to religious experience, why is there any need to hypothesize the presence of an entheogenic drug in the *kykeon* at all? Why? Because herbs, drugs, and potions *were* widely investigated in the ancient Greco-Roman world; because the *kykeon was* regarded with awe and dread as having an intrinsic psycho-spiritual potency (in a culture in which the distinction between divine or demonic possession and psychopharmacological alterations of consciousness barely existed: for most people, there was only the former, even with regard to Dionysian alcohol); and, consequently, because in such a cultural context the hierophants of a so deeply a revered and successful initiatory rite as that of Eleusis *must* have devoted their best efforts over the millennia of its existence to endow the *kykeon* with the most powerful and appropriate *pharmaka* they could find. Reflecting again on the results of Walter Pahnke's study, it is clear that when an appropriately intense set and setting are present, nearly every participant who receives an entheogen experiences an unforgettably transformative theophany. On the other hand, those who experience only set and setting have such intense experiences relatively rarely. The stories and testimony from the Eleusinian participants, filtered through the darkening lens of history, seem to suggest that mystical and near-mystical experiences were so usual that we must postulate the synergetic and catalytic effects of an entheogen.

For all the numerous descriptions of entheogenically catalyzed religious experience suggest that the triad of *set, setting*, and *drug* (which last of course becomes an "entheogen" only in virtue of a particular context of set and setting) operate as independent variables, since each is indispensable. Yet despite this independence, they act in consort to *a*ffect and *e*ffect the final outcome not merely as their arithmetic sum but (particularly in the case of entheogenic drugs) in a deeply interpenetrating *synergisis*. Participants at Eleusis came away convinced that they had seen and *experienced* ("hierophant" means one who makes the Holy itself *manifest, to be seen*),[15] in a numinous revelation, that they were individually destined for happiness after death. This is extraordinary in Greco-Roman religiosity, otherwise striking for its near hopelessness regarding the fate of the individual after death: *Immortalia ne speres*, admonishes Horace again; and yet "the Mysteries of Eleusis, ... both to the community and to the individual, ... supplied confidence in the face of all-devouring death."[16] And the experience commanded immense loyalty: quite astonishingly, the secrets of the Eleusinian mysteries were never divulged. It seems to me that Something, something well beyond the sacrifice of a few animals and the attendance at a solemn ritual, must be invoked to account for this: what better Something than that central feature of so many primordial religions throughout the world - an entheogenic sacrament? And hence, abandoning all semblance of etymological propriety, and employing the argot of the pharmaceutical corporations, we might christen the generic drug ergine, when employed exclusively as an entheogen, as *Synergine*.

Chemistry

Due credit should be given to Peter Webster for his laudably tenacious and accurate memory. When he first suggested to me that ergine could be isolated by alkaline hydrolysis of ergot alkaloidal material, I was somewhat skeptical - why, if the other peptide bonds of ergot had been hydrolyzed, would not the amide linkage of ergine itself be hydrolyzed and the product be lysergic acid itself? Other organic chemists I proposed this to felt likewise. But Peter was right: ergine, not lysergic acid, was in fact the first characteristic ergot compound to be isolated in pure form. In 1932, Sidney Smith and Geoffrey Willward Timmis of the Wellcome Chemical Works in Dartford, UK, were the first workers to report a non-trivial product from the degradation of ergot alkaloids.[17] The crystalline compound resembled the ergotinine or ergotoxine from which it was isolated in that it was an alkaloid which displayed all the characteristic color tests for the presence of an indole ring system. However, when its effect on rabbit uterine contractions were tested it was disappointingly found to be over 400 times less potent than ergotoxine. They named the compound *ergine*; later, it would be shown to be the simple amide of lysergic acid.

Two years later, Jacobs and Craig at the Rockefeller Institute in New York confirmed the results of Smith and

Timmis and found that by using aqueous instead of methanolic alkali they could get a better yield of a new substance, lysergic acid.[18] Later communications between these groups in England and the U.S. allowed a determination that ergine was indeed the simple amide of lysergic acid.[19] Since the yield was greater and since lysergic acid proved to be a far more useful starting-point for further studies either of ergot itself or of any new derivatives with its properties, little further attention was given to the procedure of Smith and Timmis; instead, all efforts were directed to improved methods of isolating the commercially important lysergic acid. (Indeed, these efforts continue to this day, and in the course of writing this article, Peter Webster put me in touch with Vladimír Kren, a highly regarded ergot researcher from the Czech Institute of Microbiology, who sent us a preprint of an article disclosing a procedure for maximizing the yield of lysergic acid from ergot.[20]) It appears that preoccupation with the production of lysergic acid has led to some chemists to forget that simpler and milder versions of these same procedures will result in the production of ergine - *and it is precisely these simpler and milder conditions which would be accessible to the hierophants of Eleusis*.

How did the experimental conditions of Smith and Timmis (ST), in which ergine was produced from ergotinine, differ from those of Jacobs and Craig (JC), in which lysergic acid was produced from ergotinine? Fundamentally, the difference was a matter of concentration and temperature. ST refluxed ergotinine for one hour in a 1.0 *M* solution of potassium hydroxide (KOH) in methanol, which boils at 65°C, while JC refluxed ergotinine for an hour in a 1.4 *M* solution of KOH in water, which of course boils at 100°C. The reason that ST used methanol is that pure crystalline ergotinine[21] is insoluble in water and unreactive even in boiling aqueous KOH. JC found that the resinous material remaining after ergotinine was rapidly dissolved in methanolic KOH and then evaporated would slowly dissolve with liberation of ammonia in boiling aqueous 1.4 *M* KOH. Martínková, Kren, *et al*. have been able to maximize the production of ergine/isoergine from ergotamine by using a less concentrated solution of KOH. They produce a mixture consisting principally of ergine and isoergine (total: 10.3 g) with relatively small amounts of lysergic acid/isolysergic acids (total: 1.65 g) from 30 g of ergotamine by refluxing for two hours in a 0.60 *M* solution of KOH, the solvent being a 1:3 mixture of water:ethyl alcohol.[22] These results can be compared to a standard procedure for producing lysergic acid from ergotamine as given in Shulgin's TIHKAL, where 3.5 g lysergic acid is obtained by stirring 10 g ergotamine in a 1.2 *M* aqueous KOH at 70°C for 3 hours.[23]

We suggest that conditions of solubility, pH, and temperature which would be equivalent in effect to ST's process, and result in the conversion of ergot to ergine, could be readily obtained by boiling crude ergot for several hours in water to which the ashes of wood or other plant material, perhaps barley, had been added. These are, of course, conditions easily achieved by the hierophants of Eleusis. Why would these conditions produce ergine? Wood ash contains potassium carbonate (pearlash), a strong base which for millennia was the usual material used to produce soap from animal or vegetable fats - an hydrolysis process (saponification) almost identical to the hydrolysis of the amide bonds of ergot. Wood ash has a pH of about 12, while the 0.60 *M* KOH used by MK has a pH of almost 14. But the Greek priests would have employed water as a solvent, since distilled methanol or ethanol was then unknown, and the resulting higher temperatures (and quite likely longer cooking times, which would tend to concentrate both product and alkali reagent) would compensate for the less concentrated base. As for the solubility problem encountered by ST and JC, we suggest that it would not obtain when crude ergot was used instead of crystalline ergotinine. This is because crude ergot contains from 30-35% fatty acids[24] which would both solubilize the ergot alkaloids of their own accord and even more so by virtue of the micelles formed when these fats were saponified by the hot pearlash.[25]

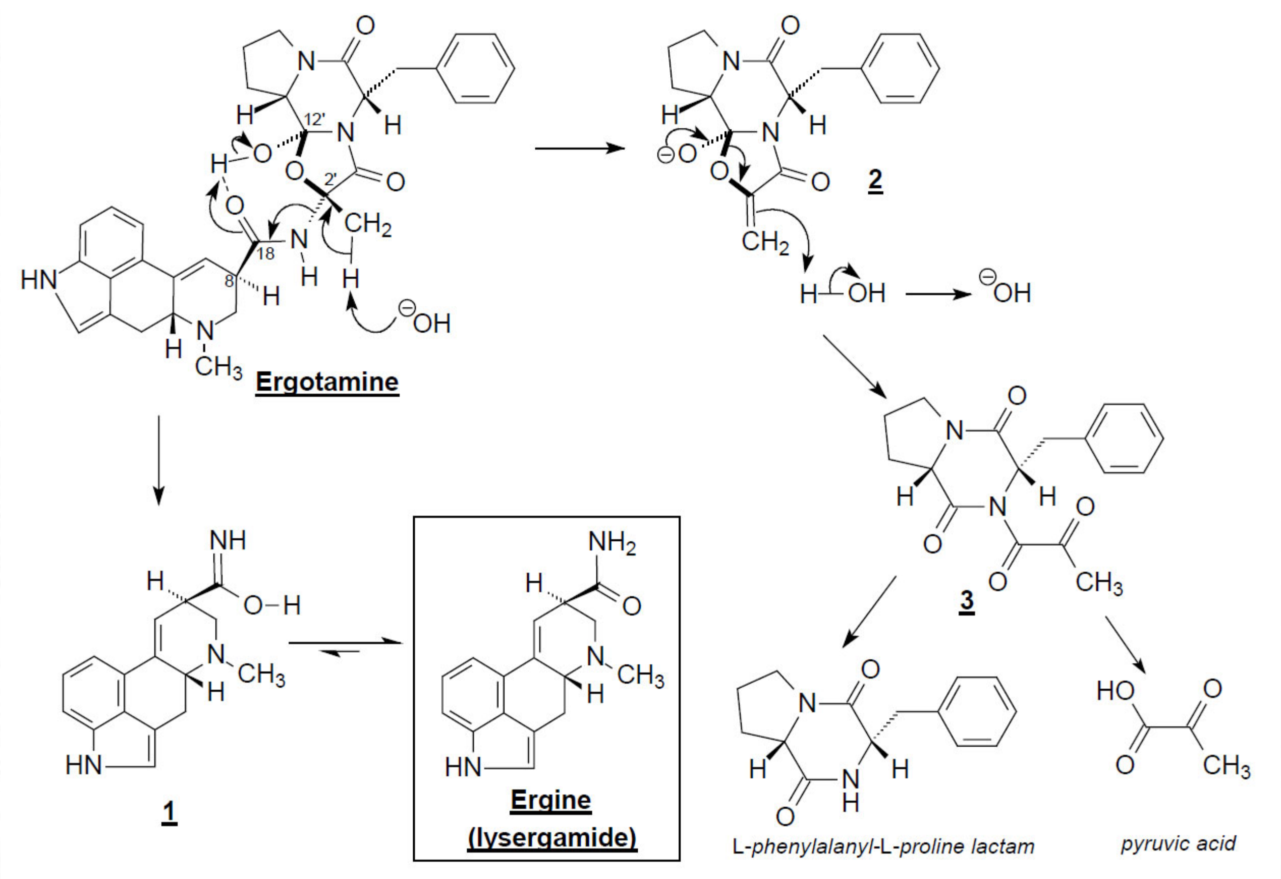
Why would the hierophants consider ashes as a suitable ingredient in a sacred potion? We suggest the possibility that some sort of symbolism involving the resurgence of life from inanimate ashes may be involved. Kerényi points to a symbolic cluster of images surrounding birth in death, birth in fire, the ashes of the cremated votaries - all linked to the hope of life after death.[26] Persephone herself was looked upon as the goddess of fire, for "through her power the evil element was transformed into a kindly one."[27] Perhaps also the ashes symbolized the immortality which Demeter wished to bestow on the little prince Demophoön, who was able to thrive and grow without food as long as she secretly placed him each night in the fire like a log. When Demophoön's mother, Metaneira, observes Demeter's strange action and protests it, Demeter takes the boy from the fire - but now he is doomed with the rest of mankind to death. "Unknowing are ye mortals and thoughtless: ye know not whether good or evil approaches."[28] An augmenting motive to any of the preceding is simply the reverence naturally felt towards the ashes remaining after a whole-burnt offering to the gods on a sacred altar. These are not ashes to be simply disposed of as one would ordinary hearth ashes; they partake of the sacral nature of the offering, and it is natural to attempt to incorporate them in some further sacral function. The same instinct can be seen at work in the custom, observed to this day in the Roman Catholic tradition, of reserving the ashes of the palms blessed on Palm Sunday to be used on Ash Wednesday of the following liturgical season.

Would a potion containing enough ashes to hydrolyze ergot alkaloids be too basic and caustic to drink? We suggest several possibilities: most simply, a solution of potassium carbonate, if allowed to stand exposed to the air for a few days, would absorb enough carbon dioxide from the air to be turned into the relatively harmless potassium bicarbonate. Alternatively, as we have suggested earlier, a final addition of wine to the *kykeon* would neutralize the ashes, and this seems reasonable since in Homer the *kykeon* always contains wine. But in the Eleusinian myth, Demeter pointedly refuses to accept any wine to assuage her grief, since it would be "contrary to *themis*," against nature. This is thought to be more than just an expression of her unwillingness to drink a beverage of joy while still in grief for her daughter; rather, she declines because wine comes from Dionysus, and the rape of Demeter's daughter occurred on the Nysan Plain, where the Dionysian ground opened.29 Indeed, the *kykeon* is possibly the Eleusinian drink in part because it stood as an alternative in opposition to Dionysian wine. A third possibility, then, is that the final mixture was neutralized (more effectively in any case since it is more acidic) by the addition of vinegar, which as spoiled wine, might not offend Demeter and/or might even be symbolic of participation in her grief.

We finally come to the most technical part of this discussion, which is a mechanism justifying the chemical transformation of ergot peptide alkaloids into ergine/isoergine and non-toxic secondary products. For this I owe much to discussions with Professor David Nichols of Purdue University, whose numerous discoveries and internationally acknowledged expertise in the realm of psychedelic chemistry, and whose much greater familiarity with the chemistry of lysergic acid, make him far more qualified to address this issue than I.

We feel that the mechanism shown in **Scheme 1** accounts adequately for the known experimental facts. We show ergotamine with a hydrogen bond forming an eight-membered ring from the carbonyl at C-18 to the hydroxyl group at C-12' since Ott, Hofmann, and Frey have given persuasive evidence that this corresponds to the internal structure of the natural alkaloids.[30] There are three mechanisms which could be invoked to account for the partial hydrolysis of ergotamine to ergine. The first and simplest would be an attack by hydroxide at the amide N of lysergic acid (the N bonded to C-18), which would cleave off ergine in one step. However, as Dr. Nichols points out, this would involve an S_N2 attack at a quite hindered center. A more accessible point of attack would be the removal by base of the proton of the C-12' hydroxyl, which would induce a cascade effect essentially similar to what we have pictured in **Scheme 1**. However, part of the data provided by Ott *et al*. supporting the existence of an intramolecular hydrogen bonding at this center is the reduced acidity of this hydroxyl group at C-12' relative to the unnatural *aci* isomers, where epimerization at the C-2' center excludes the possibility of hydrogen bonding to the lysergic acid carbonyl for steric reasons. (Nonetheless, the OH in question is still considerably more acidic than an ordinary alcohol due to the cumulative electron withdrawal of a nitrogen and an oxygen on C-12'.) In any case, a third point of attack is possible that obviates both of these difficulties, and that is what we have drawn in **Scheme 1**, where solvent hydroxide removes a proton from the methyl group attached to C-2', thereby initiating a cascade of reactions (probably more or less simultaneous) involving the intramolecular hydrogen bond and leading to the enol tautomer of ergine, **1**, which rapidly rearranges to **ergine**. The other product of this cleavage is **2**, which should rapidly form **3** by extracting a proton from the solvent to regenerate hydroxide ion. **3** should itself be quite easily hydrolyzed in mild base to pyruvic acid and L-phenylalanyl-Lproline lactam, a harmless dipeptide formed from two essential amino acids. Under the mild conditions we envisage it is unlikely that any significant quantities of lysergic acid itself would be formed, since the amide bond of ergine would be hydrolyzed only very slowly by potassium carbonate. In any case, lysergic acid itself has almost no psychotropic effects.

Scheme 1



Footnotes to part 2

1. Osmond, H., Ololiuqui: The ancient Aztec narcotic. Remarks on the effects of *Rivea corymbosa* (ololiuqui). J. Ment. Sci., 101:526-537.
2. Schultes, R. E.; Hofmann, A., *The Botany and Chemistry of Hallucinogens*. Springfield, IL, Charles C. Thomas Publisher, 1973 [Henceforward *BCH*], p.147.
3. Hofmann, A., *LSD, My Problem Child: Reflections on Sacred Drugs, Mysticism, and Science*, trans. J. Ott, Los Angeles: Jeremy P. Tarcher, 1983, pp. 124-126.
4. Solms, H., Relationships between chemical structure and psychoses with the use of psychotoxic substances," *J. Clin. Exp. Psychopath. Quart. Rev. Psychiat. Neurol.*, 17:429-433, 1956; quoted in *BCH*, p. 153.]
5. Hofmann, A., The active principles of the seeds of *Rivea corymbosa* and *Ipomoea violacea. Bot. Mus. Leafl., Harvard U.*, 20:194-212, 1963]; quoted in *BCH*, p.153.
6. The κυκεών which "fair-tressed Hecamede" mixes for Nestor and his comrades in the *Iliad* (xi. 624-641) contains barley-groats, grated goat cheese, and Pramnian wine. In the *Odyssey*, the κυκεών which Circe mixes to transform Odysseus's companions into swine (*Odyssey*, x. 234-235) similarly consists of "cheese, barley-meal, and Pramnian wine" - but she has added a drug (φαρμακον) to bewitch them. Later, Odysseus is able to rescue them by first taking the antidote "moly" provided him by Hermes (*Odyssey*, x. 290, 316-320). Interestingly, the unusual word "moly" (μώλυ) is probably related to the Sanskrit *mulam*, a root, with the compound *mula-karma*, meaning the "magical use of roots." As well as making likely the presence of wine (or vinegar) in the Eleusinian sacrament, these citations show that an interest in drugs and potions added to a κυκεών is as old as the earliest Greek literature.
7. Schultes, R. E., "An Overview of Hallucinogens in the Western Hemisphere." In: *Flesh of the Gods: The Ritual Use of Hallucinogens*, Furst, P. T., ed., Prospect Heights, IL: Waveland Press, 1972, p. 20.
8. Wilbert, J., "Tobacco and Shamanistic Ecstasy among the Warao Indians of Venezuela." In: *Flesh of the Gods: The Ritual Use of Hallucinogens*, Furst, P. T., ed., Prospect Heights, IL: Waveland Press, 1972, p. 55.
9. Kerényi, C., *Eleusis: Archetypal Image of Mother and Daughter*, trans. Manheim, R., Princeton, NJ:

Princeton University Press, 1967, p. 177.

10. De Quincey, T., *Confessions of an English Opium-Eater*, Ticknor, Reed, & Fields: Boston, 1853 [reprint of the 1822 edition], p. 73.
11. Quoted in: O'Reilly, D., "Drugs were his door to the sacred," *The Philadelphia Inquirer*, Sunday, June 18, 2000. Huston Smith, a widely-respected historian of religions who himself experienced a profound mescaline-catalyzed theophany at Harvard in the 1960s, was being interviewed about his recent book, which provides perhaps the best and most balanced evaluation of the phenomena of entheogen-altered or entheogen-induced religious states: Smith, Huston, *Cleansing the Doors of Perception: The Religious Significance of Entheogenic Plants and Chemicals*, New York: Tarcher/Putnam, 2000.
12. I wish I could say this with the same aplomb with which William James discusses his use of nitrous oxide and ether. But unfortunately, the present legal and emotional climate is not as open-minded as it was in his day. And so I feel compelled to add by way of legal exculpation, and while emphasizing that the United States Constitution still grants the presumption of innocence, that entheogenic experiences do not necessarily involve the violation of any law, even laws which are arguably adjudged as excessive and immoral. (Cf. Husak, D., *Drugs and Rights*, [Cambridge Studies in Philosophy and Public Policy, D. MacLean, Ed.], New York: Cambridge University Press, 1992.) This is because 1) in some countries some entheogens are legal which are illegal in the United States; 2) some entheogens which are generally illegal in the United States are not necessarily illegal in all circumstances; and that 3) a number of quite effective entheogenic chemicals have never been declared illegal in any country - some of these are easily synthesized and others can be ordered from most of the major chemical supply houses.
13. Pahnke, W., "Drugs and mysticism: An analysis of the relationship between psychedelic drugs and the mystical consciousness." Ph.D. dissertation, Harvard University, 1963. The experiment is also described in: Pahnke, W., "Drugs and mysticism," *The International Journal of Parapsychology*, **viii**, (1966), pp. 295- 313; reprinted in: *Psychedelics: The Uses and Implications of Hallucinogenic Drugs*, Aaronson, B.; Osmond, H., Eds., Garden City, NY: Anchor Doubleday, pp. 145-165. The "active placebo" was nicotinic acid, which provokes a harmless flushing of the skin, tachycardia, and a rush of pounding blood to the head - symptoms which, although not very different from those caused by a cup of black coffee on an empty stomach - might suggest to the suggestible that they had taken a psychoactive drug. Using an active placebo was Pahnke's supererogatory effort to completely level the playing field between placebo and psychedelic. (Such probative integrity is rarely employed today: when, for example, a new drug with purported antidepressant effects is first tested on depressed subjects it is thrown into competition against a look-alike sugar pill which can have no psychic effect except through the subject's imagination. Nonetheless, those given placebo always show significant improvement over baseline, though not as much improvement as those given the genuine antidepressant. Such is the power of that most addictive of placebos, Hope.) However, in Pahnke's experiment, so intense and unique were the effects of high-dose (30 mg) psilocybin that within an hour it became apparent who had received the entheogen to both the controls and to the recipients of the active drug. See the discussion and evaluation by Rick Doblin cited below.
14. Doblin, R., "Pahnke's 'Good Friday experiment': A long-term follow-up and methodological critique," *Journal of Transpersonal Psychology*, **1991**, 23, 1-28.
15. Kerényi, C., *Eleusis*, p. 90-91.
16. Kerényi, C., *Eleusis*, p. 16.
17. Smith, S.; Timmis, G. M., "The Alkaloids of Ergot. Part III. Ergine, a New Base obtained by the Degradation of Ergotoxine and Ergotinine," *J. Chem. Soc.*, **1932**, 763-766. 18.
18. Jacobs, W. A.; Craig, L. C., "The Ergot Alkaloids: II. The Degradation of Ergotinine with Alkali. Lysergic Acid," *J. Biol. Chem.*, **104** (1934), 547-551.
19. Jacobs, W. A.; Craig, L. C., "The Ergot Alkaloids: III. On Lysergic Acid," *J. Biol. Chem.*, **106** (1934), 393-399.
20. Martínková, L.; Kren, V.; Cvak, L.; Ovesná, M; Prepechalová, I., "Hydrolysis of lysergamide to lysergic acid by Rhodococcus equi, *J. Biotechnol*. In press.
21. Ergotinine is actually an equimolar eutectic mixture of ergocornine, ergocristinine, and ergocryptinine isolated by Tanret from ergot in 1875 (*Compt. Rend*. **81**, 891), but this was only discovered a decade later by Stoll and Hofmann (*Helv. Chim. Acta*, **26** [1943], 1570).
22. Martínková, L.; Kren, V.; *et al., ut supra*. These workers intentionally maximize the production of an ergine/isoergine mixture because they have developed a high-yield enzymatic procedure for converting

this mixture into d-lysergic acid.

23. Shulgin, A.; Shulgin, A, *TIHKAL: The Continuation*, Berkeley, CA: Transform Press, 1997, pp. 490-491.
24. Buchta, M.; Cvak, L., "Ergot Alkaloids and other metabolites of the genus *Claviceps*." In: *Ergot: The Genus* Claviceps, Kren, V.; Cvak, L., Eds., Amsterdam: Harwood Academic, 1999, pp. 173-200. Cf. p. 194.
25. In modern times soap is made by treating fats with sodium hydroxide, NaOH, a base essentially as strong as KOH. But this process was developed by Leblanc and Chevreul only around 1790. Soap has been known since at least 300 BC, but had always been made by the much slower process of employing the potassium carbonate in wood ash, commonly called *pearlash*. After the Leblanc's work it became evident that soap could also be made from "lixivated pearlash" or *potash*, which was made by adding calcined limestone (lime, calcium hydroxide, CaOH) to the pearlash and precipitating out calcium carbonate. Lime was well-known to the Romans, who used it extensively in mortar for construction purposes, and oddly enough, the process of lixiviation was also known - it is mentioned by Pliny, who also discusses soap. But lixiviated pearlash appears not to have been applied to the production of soap until modern times. Indeed, the ancients did not use soap for cleansing; the usual process was to rub olive oil onto the skin after a bath, and then to scrape off the excess oil and dirt. Soap was used to some extent medicinally as a laxative, but primarily as an ointment for giving a bright hue to the hair - "rutilandis capillis." Pliny, *Historia naturalis*, xxviii. 51. There are numerous studies which have confirmed that micelles can greatly augment the rate of chemical reactions, particularly those which involve two phases as would be the case with our relatively insoluble material.
26. Kerényi, C., *Eleusis*, p. 92-93. 27.
27. Kerényi, C., *Eleusis*, p. 101. 28.
28. Kerényi, C., *Eleusis*, pp. 40-41. 29.
29. Kerényi, C., *Eleusis*, p. 40.
30. Ott, H.; Hofmann, A.; Frey, A. J., "Acid-catalyzed isomerization in the peptide part of ergot alkaloids," *J. Am. Chem. Soc.*, **88**, (1966), 1251-1256.

Part 3

by
Carl A. P. Ruck

Barley-groats, water, and fresh mint. *Alphi* (or more fully, *alphiton*), *hydor*, and *glechon* (also called *blechon*). These are the known ingredients for the Eleusinian potion, the mixed drink or *kykeon*; these were the elements publicly announced and not part of the secret. Symbolically, the two plants represent various dichotomous antitheses that the aqueous *kykeon* mediates. First, the botanical, with the cultivated agricultural foodstuff as opposed to the wild gathered herb, the former the staff of life, the latter supposedly soporific. And the socio-political, with the sanctioned nuptial rite replacing illicit abduction and concubinage. And the religious, with the incorporation of the older chthonic deities into the Hellenized family of celestial Olympians. And both plants, in the pharmacopoeia of the midwife, the latter an abortifacient, the former an aid in parturition, inducing uterine contractions.

Cultivars, it was thought, are the product of human scientific intervention, without which they will revert to their poisonous inedible avatars. Sometimes, this is actually true. Thus the olive requires repeated pruning to prevent it from sending up a thicket of sprouts from its rootlets and returning to its fruitless natural state. The vine, too, needs pruning since it fruits only on new growth; and in ancient lore, its avatar was seen in the ivy, its sinister mimic, whose leaves and diminutive berries supposedly deranged the mind in their natural state, unlike the sophisticated intoxicant manufactured from the crushed grapes of the cultivar. An example from the New World is Indian corn, which if left unattended, drops its cobs of kernels to sprout all in the same spot, too close to grow without crowding each other out and becoming increasingly stunted like the original grasses from which it is hybridized. More to the point is the barley of the Eleusinian potion whose avatar was seen in the grassy weed that invades the tended plowland, the grain called tares, cockle, or darnel, *Lolium*, with the botanical epithet *temulentum*, 'drunken Lolium,' whose drunken toxicity derives from the ergot *Claviceps purpurea*, 'purple club-head,' descriptive of the enlarged deformed kernels formed by the dried sclerotia of the fungus, which spreads its poisonous contamination to the barley. In Greek, the weedy grass is named solely for these deformed kernels as *aira* or 'hammer.' The ergot itself was called 'rust' or *erysibe*, a metaphor that occurs also in English. As such, the botanic rust had its analogue in the destructive oxidization of iron that corrupts the metal utensils, returning them to the original ore. Demeter, the goddess of grains, could have the epithet Erysibe, for Greek deities often bear apotropaic names of their more sinister personae, just as Persephone is called the 'killer of Deadly Perse,' as the goddess who has displaced her more fearsome aspect as Perse.

It is only when we distance ourselves from the Eleusinian Mystery that we can expect to find mention of the ergot potion. Melampous, called 'black-foot' and the founder of a family of shamans, was a medicine-man, expert in understanding the speech of animals, birds, and insects, a gift he had received when two serpents licked his ears as he lay asleep. While attempting to win a herd of estrual cows as the bride price for the maiden Pero, named as the 'leathern food-pouch' like the *pera* in which was hidden some secret of the Eleusinian Mystery, Melampous was held prisoner by the 'Jailer' Phylakos, but he was able to gain his release by curing his captor's son of impotence. He learned from an old vulture, who had witnessed the event years ago, that Phylakos had inadvertently frightened his son when he approached him while gelding rams, bloody knife in hand. Phylakos had plunged the knife into an oak tree and gone to comfort the terrified child. It had lain there forgotten, rusting. Melampous scraped off he rust and administered it as a potion.

The symbolism of the rust is its mediation between primitivism and culture. From it can be extracted via alkaline hydrolysis, as we have seen, the visionary agent for the Eleusinian initiation. Pearlash or potash, called *tephra* and *spodos* in Greek, was known as an eye salve at least as early as Aristotle; and a century earlier, we know that the alkaline fluid called *konia* ('ash-water') was used for washing. There was also a *konia* derived from holy water and the ashes from sacrificial burnings that was used as a medicine. Hence, the procedure was within the expertise of the ancient pharmacologist, an art whose divine patroness was the third of the Eleusinian deities, Hekate. The Melampous myth also indicates a transition from human offerings to animal substitutes, for Iphiklos, the son of the Jailer, was probably not mistaken that the knife was originally intended for him and not the ram. Fiery immolation of human socalled volunteers and funeral pyres are frequent in the traditions of Eleusis. And in particular, Demeter, before teaching the Mystery, had laid the

Queen's son Demophoön, lulled to sleep with poppy juice, nightly in the hearth like a log to burn off his mortality, intending to make him celestial, like the daughter Persephone, whose contamination with flesh she had not yet come to accept. This event of the myth was commemorated each year at the Eleusinian rite by the 'boy from the hearth,' a child from a noble Athenian family whose initiation was funded at public expense. The secret agency of the potash would, therefore, not be without significance, as the mediation between body and soul, the reconciliation of chthonic and celestial realms.

As to when the potion was drunk, there are those who would imagine it prepared well in advance and perhaps sipped sometime while on route to the sanctuary on the day of the initiation; this view is intended to allow time for the barley-groats to ferment slightly, producing some kind of weak beer. If, however, it were prepared in advance and in the possession of the initiates, it could hardly be a secret; nor were the Greeks, who were never interested in beer, although they knew of it, likely to interpret a mild alcoholic intoxication as an entheogenic experience, especially since wine, in other circumstances, or more exactly, strong ancient Greek wine fortified with herbal inebriants, offered precisely that in the rites of the god Dionysos. The only supposed evidence for the mixing of the *kykeon* in advance is a papyrus fragment of a comedy of Eupolis where a foreigner is seen with barley-groats (*krimnon*) on his upper lip while still in Athens; the circumstances, however, are probably the affair of the Profanation of the Mysteries, which involved exactly this, the drinking of the *kykeon* illegally at home as a recreational inebriant, since certain well-placed Athenians with connections to the Eleusinian priesthood had apparently learned the secret of the potion. And indeed, Eupolis's foreigner is described as being overtaken by a hallucinatory fever (*epialos*, like a nightmare) while on the way to the marketplace because of the *kykeon* he had drunk.

The ten-day fast imposed upon the candidates for the initiation has also been called into evidence to help explain how some mild inebriant could have induced the visionary experience that by all testimony occurred at the Eleusinian sanctuary. This fasting, however, could hardly have been total, but just the avoidance of certain foods; and the offering of the mystic sacrificial pigs, washed in the sea, would certainly imply a day of feasting during this period of the fast. The vessel for mixing the *kykeon* was emblematic of the initiation ritual; both metal and ceramic exemplars still exist, the latter imitating in clay the style of the former. Ninnion's tablet depicts the procession that left Athens in the morning of the final day to walk the Sacred Road to the village of Eleusis. The women carry the vessel on their heads, with boughs of myrtle inserted in its handles: the symbolism of the myrtle indicates that the potion is a mediation, both as the rite of marriage, which will supplant the abduction of Persephone and unite the chthonic realm with the celestial and also as the redemption of Semele, since this is the plant with which Dionysos paid for his dead mother's resurrection. Appropriately, therefore, the initiates are led by Iakchos, who is Dionysos personified as the call that leads them into the netherworld. The potion, however, was not drunk from the *kykeon* vessel (nor is its style suitable for this purpose), but from cup-sized jugs, which the men in the procession carry in their hands. Each of the events along the way suggests that the Mystery procession was a mimesis of a journey to the otherworld, whose gateway awaited them in the Cave of Plouto beside the great Hall of Initiation at Eleusis. As they left the plain of Attica, the bridge over the River Kephisos and the ritual of the *gephyrismos* (or 'bridging') was practice for the narrow and dangerous passageway whose final locale would be the deep subterranean channel at the back of the Cave. Similarly, at the shallow saline lake called the Rheitoi or 'Streams' that marked the boundary of the Rarian plain in which lay the Eleusinian acropolis, the narrow bridge required that their carts be left behind and everything for the ceremony now be carried by hand. Here they were met by the hereditary priesthood of the Krokonidai, whose name suggests they are descended from the Athenian King Ion, Apollo's son via the *krokos* flower (supposedly the 'crocus') and after whom this month of Boëdromion ('Aid,' our September) was named for the alliance he made with Eleusis. The Krokonidai tied a 'string' or *kroke* to the right hand and left foot of each initiate, for such bows are emblematic of the joining between the realms. Their journey would be reversible, replacing earlier rites of human immolation. Hence, they had rested in Apollo's grove of laurel trees or *daphne* at the crest of Mount Aigeleos, before descending to the Rheitoi; and Artemis's temple lay still ahead of them at the entrance to the Eleusinian enclosure, beside the Well, the 'Well of Flowers,' the 'Virgin's Well,' where Demeter had rested when she first arrived at Eleusis, beyond whose watery surface at the base of the narrow shaft now resided her abducted daughter. (The grove of Apollo's entheogen, the temple of Artemis: because these were the two deities most implicated in the older rites of human sacrificial offerings.) There the initiates danced until nightfall, then passed with torches into the forbidden sanctuary, each accompanied by a sponsor, the mystagogue, up the incline, past the 'Laughless Rock,' which none would dare sit upon for fear of becoming stuck, like Theseus when he visited Persephone, and on into the

Hall or Telesterion of 'Completion,' such being the metaphor in Greek for what we call by the Latin of initiation or beginning.

Hall could accommodate perhaps only a thirtieth of that, they ranged themselves along the peripheral steps, sitting probably, not standing all packed together, and watched as the priestesses danced in the darkness with lanterns and incense burners on their heads. The Mystery Baskets or Cista Mystica were opened, whatever they contained hidden until now from profane view. Then the *kykeon* was mixed. Barley. Mint. Water. One of the Eleusinian priests called the Hydranos was specifically responsible for the water, for this would have to be prepared in advance, with its hydrolyzed visionary agent from the ergots that, we may surmise, had been specifically encouraged to grow by contaminating some portion of the crop with the 'honey dew' of *Claviceps purpurea*, the sweet exudation of its ascospores. "I have opened the basket; I have drunk the potion," was the final password. The unused portion of this special water figured in the rite, probably now just as the initiates prepared for their spiritual descent into the netherworld to encounter the Goddess. Two round urns on unstable bases where emptied, with the chant, no doubt repeated again and again by the whole congregation, *Hye kye*, "Rain conceive." After their descent, she would surface back up with them all, amidst a brilliant light, a fire that supposedly (although it may be just a metaphor) could be seen from miles away, as the Hierophant opened the door on the antique temple within the great Hall, at the moment of her giving birth to the Mystery child Brimos, who is otherwise known in the Eleusinian myth as Triptolemos, the prince to whom Demeter entrusted the Mystery and the sacrament of cultivating barley. Brimo, as Persephone now was called, had given birth to Brimos, a son named after her in the older matrilineal fashion: the 'Terrible Queen with her Terrible son.' This Queen is ultimately the reunion of the three phases of the goddess, as maiden, mother and crone, represented as Hekate, three women in one, and the patroness of witchcraft and herbalism; and the son similarly triform as the 'Triple Warrior' Triptolemos. With the conclusion of the Initiation, the winter rain would begin and the seed of Persephone would be hidden in the plowland to fruit again six months hence.

The mint in the potion, *Mentha pulegium* or pennyroyal, in addition to its symbolism as the wild antithesis to the cultivated barley, may have functioned merely to scent the drink, for without infusion in boiling water it would not be likely to release enough of its toxins - and it is specifically denoted as fresh mint; hence the potential abortifacient was surpassed by the superior magic of the ergot's birthing drug. It is possible, however, that the pennyroyal functioned in some way either to calm nausea (which is one of its uses in herbal pharmacology) or to potentiate or catalyze in some way the psychoactive toxins of the hydrolyzed ergot. This would require further experimentation to determine. Pennyroyal, commonly called fleabane and fleawort, also would have been noted for its apotropaic effect on flies; hence its botanic name of *pulegium*, from *pulex*, 'flea.' In concentration, the terpenoid ketone pulegone from pennyroyal is lethal for humans.

This greater Initiation was called the 'Vision,' the *epopteia*, something that even a blind man could see, as is testified by the votive of Eukrates, found in the excavation of the sanctuary, who without eyes saw, like everyone else, the Resurrection of Persephone. It was the culmination of the rite that had begun six months earlier in February, in the month of 'Flowering' called Anthesterion. That was the Lesser Mystery, so-called, the *myesis* or 'Closing of the Eyes' and being lulled to rest. It was the time to plant the other crop[1] that would fruit at the end of summer. If one observed the ground carefully at that time, the ergots from the winter crop, which readily detach from the ears of barley and which for centuries would be thought to be nothing more than sun-baked kernels amongst the healthy grains, display their other mode of propagation, as the mycelia of the sclerotia, like any other fungus, send up their fruiting bodies, the mushroom caps with their spore-bearing gills. It is as if these special kernels of barley had become the seed of the wild and seedless mushroom. This Mystery was the rite of death that was prelude to the resurrection. In myth, it was the Abduction of Persephone as she plucked a special flower that was called the *narkissos*, a word from the Minoan language that was assimilated into Greek and which is the root for our word 'narcotic.' Similarly, the place where she found the *narkissos* was called Nysa in the myth, a word that persists into modern Greek as nystazo, to 'get drowsy.'

It is unlikely that every initiate could attend the public part of this rite since the dangerous winter seas would not be navigable until at least a month later, although on occasion the rite was performed out of season to accommodate personages of importance. It is probable that versions of the ceremony were enacted in locale Eleusinian sanctuaries. Nor is it likely that the *narkissos* aspect of the fearsome rite was enacted by anyone more than just the titular Sacred Queen of the city of Athens, who experienced a *hierogamos* or 'Sacred Wedding' with the god Dionysos as some kind of maenadic ritual with her female attendants in the temple in the Swamps, also considered as a part of her house called the 'bull stall.' This was the transmutation of a ritual that went back to Minoan religion and had once required the offering of human victims. In Athens, some aspect of the rite was enacted at the so-called 'Hunting Preserve,' the mystery sanctuary of Agrai, on the banks of the River Ilissos, where as late as the mid-eighteenth century there still stood a temple of Artemis. In myth, it was remembered as the place where the nymph Oreithyia (or 'mountain ecstatic female') was abducted from her sisterhood of maidens called the 'drug-ladies' or Pharmakidai to establish Athens' own special family relationship with the world beneath the earth. These maidens were also known as the Hyakinthidai or 'hyacinth ladies,' in commemoration of the Hyakinthos whom Apollo 'unwillingly' (for such is always the ruse in human immolation) escorted to Paradise. Both the *narkissos* and the *hyakinthos* are flowers from the pre-Greek language, as is also the name of the river. In this essay, I summarize for the purpose of clarity and directness ethobotanical and metaphoric items that are documented in other writings (most recently, RUCK & STAPLES & HEINRICH 2000).

The *narkissos* flower figures prominently in Minoan art, on a sacrificial knife and wall paintings and a golden ring, probably the emblem of a shamanic priestess, depicting women as 'bee ladies' experiencing a vision, and even a ceramic plate showing a Persephone snake-goddess with her flower. We can identify it as *Pancratium maritimum*, the sea daffodil, of the amaryllis family. Its ethnopharmacological traditions (as well as its botanical family, which includes the toxic daffodil, whose poisons from the bulb can be absorbed through the skin, and the autumn crocus (*Colchicum* sps.), the latter associated with Medea and Prometheus) suggest psychotoxicity. Some fifteen species of amaryllis are toxic. *Pancratium trianthum*, because of its entheogenic properties is reputedly often found growing around shrines and sacred areas (EMBODEN 1979: 79, fig 44). It bears lily-like flowers of pink and white stripes on a naked scape. The bushmen of Dobe, Botswana, know this bulbous perennial as *kwashi*, a powerful sacred hallucinogen, capable of producing vivid and colorful visions. The bulb is not eaten, but rather it is slashed open and pressed onto self-inflicted wounds on the foreheads of participants. (One might compare the ritual flagellation of Spartan youths with squills.) The intoxicating principle is transported directly into the circulatory system, creating an immediate reaction. A related species is *Pancratium speciosum*, used by the Caribs of the West Indies under the name of *ognon* or *gli* as a powerful emetic. Some species are quite narcotic and are purported to have caused death by paralysis of the central nervous system; still others are classified as cardiac poisons. As always, ethnopharmacological expertise is essential for the ritual use of toxins.

The botanical name of *Pancratium* means the 'all-powerful,' like Christ as the Pankrator in Byzantine art, for its numinosity was assimilated in Christian mystery rites as the plant called *chreston*, an ancient corruption of Christ's name as the 'good' instead of the 'anointed' in Greek. It still goes by the name of the Virgin *Panaghia* in modern Greek. But somewhere along the way it also assumed the sanctity of the hoama or Soma which the Iranian Magoi used in their shamanic initiations, which is to say that it was assimilated to *Amanita muscaria*, the fly-agaric mushroom. This fungal sacrament persisted in Gnostic Christian sects, often labeled as heretical, most notably amongst the Manichaeans, whose rites, which thrived in the orient, were repeatedly reintroduced into western Europe by the Crusades. The role of flyagaric in Eleusinian lore can no longer be denied now that the plant elevated between the two goddesses, and apparently extracted from the Mystery wallet or *pera*, on the bas-relief from Pharsalia, Thessaly, in northern Greece, has been definitively identified as a large mushroom.

Fly-agaric in Greek mythopoeia is involved with the Gorgon Medusa and the hero Perseus, as well as the mooing of estrual cows and the purple-red heifer maiden Io, who is herself a female version of the same name as the Athenian king Ion, both with names that are cognate with 'violet,' a holy plant in Greek ethnobotany and involved with the linguistic root for 'drug,' as in the word for drug-man, *iatros*. This entheogen of the primordial times was hidden away from profane view, hidden until it was revealed on the night of the Great Initiation, within the rockrose, *kisthos*, after which the Cista Mystica or mystery hamper of the Eleusinian rite is named, a wild rose with single petals. Hence the prominence of rose motifs in the decoration of the sanctuary. Some claimed that it was the phallus of Dionysos that lay hidden within; others that it was a *kteis*; with either, it was emblematic of fly-agaric, a hermaphroditic phallus that penetrates its own vulva as it grows, like the Baubo creature who first served the potion to Demeter. The rose, itself, resembles the opium poppy flower, for that entheogen is well attested in Minoan religion; and after its assimilation to the Hellenized rite, it, too, enclosed the secret. The opium capsules, moreover, resemble little pomegranate fruits, another Eleusinian motif; one common weed in fields of grain is called the pomegranate poppy because of the likeness of its capsules. The pomegranate itself as it fruits on its tree resembles apples, like the golden apples of the

Hesperides, which one ancient vase painting identifies explicitly as mushrooms, for as the pomegranate hangs on its bough, the long calyx gives the red fruit a stipe like fly-agaric.

The fly-agaric is so named because of its attractiveness to flies, who seek out its toxins and were thought to be killed by it, although actually they revive after the experience. It would have been noted that the honey dew of the ergotized barley is similarly attractive to flies; it was long thought that it was just the sap of the grain exuded when the insects bore into the kernels. Fleabane, of course, represents the antithesis, repelling flies.

As for what the ordinary initiate could expect to experience at the *myesis*, we have only the traditions of the Purification. The rite is difficult to separate from the other aspects of the Anthesteria, which was a three-day wine festival (open to all and not restricted to the candidates for initiation) to which the ghosts of departed family members were invited. Orestes was said to have visited Athens during the festival, pursued by the netherworld sisterhood of Furies and the ghost of his mother Clytaemnestra, whom he had murdered, under orders from Apollo. He was exonerated and cured of his madness. Similarly, Herakles was purified of the murder of his wife and children. Anyone guilty of murder was offered the same ritual purification in preparation for the greater initiation; but certainly not many candidates could have been murderers.

Perhaps we get closer to the meaning with Melampous, the same shaman who discovered the rust potion. Another of his spectacular cures was the daughters of Proitos, the Proitidai. They had gone mad, becoming consubstantial with the fly-agaric (for such is the common experience of those who partake of the sacramental food): they grew bald with scabby patches on their skin, like the white fragments of the shattered universal veil adhering to the flyagaric's cap, and went mooing like cows in heat. Such estrual mooing was thought to be caused by the goading of the gad-fly or *oistros* (which gives us our word estrus) and which was also called the *myops*, 'squint-eye,' as in myopia, metaphorically appropriate for the myesis. He purified them at a temple of Artemis in Arcadia on the River Lousios. One of them died, but the other two he and his brother married, as replacements for Pero, the Mystery wallet, whom both of them had claimed as wife in the affair of the rust potion.

The purification of Herakles, Orestes, and the Proitidai is always depicted as involving the sacrifice of a pig, for the animal offering was the substitute for human immolation; while the candidate sat, head shrouded, enthroned, the *thronosis*, on the 'fleeceling of a ram,' which is another metaphor for fly-agaric. The ordinary initiate, however, probably began this indoctrination for the Greater Initiation simply by becoming at peace with the revenant spirits and by feasting on the slaughtered pigs - the pig offered in sacrifice as a token substitute for the death and myesis experienced by Persephone.

Footnote to Part 3

1. As would be expected, two crops were planted. The times of planting do not correspond exactly to the two Mysteries, which appear to be religious preliminaries for the actual plantings. Hesiod's *Works and Days* directs that the winter crop of Demeter's grain (presumably barley) should be planted when the voice of the migratory crane is first heard, *i.e.*, mid November (448), whether or not the rains have begun. The field should have been plowed in the spring and left fallow. If you wait for the winter solstice to plant, it is too late for the spring harvest. The winter crop should be planted when the cuckoo first calls, *i.e.*, March (486), if it has rained within three days as much as the height of an ox's hoof, which will assure a crop as good as the winter one. This crop is winnowed when Orion first rises at dawn, *i.e.*, July (587).

References

1. EMBODEN WILLIAM, 1979, revised and enlarged edition, *Narcotic Plants*, Collier Books, division of MacMillan Publishing, New York.
2. RUCK CARL & BLAISE DANIEL STAPLES & CLARK HEINRICH, 2000, *The Apples of Apollo: Pagan and Christian Mysteries of the Eucharist*, Carolina Academic Press, Durham, NC.

A Study of Cultural Bias in Field Guide Determinations of Mushroom Edibility Using the Iconic Mushroom, Amanita muscaria, as an Example[1]

by

William Rubel[*,2] **and David Arora**[3]

Published online 23 October 2008.

Economic Botany, 62(3), 2008, pp. 223-243

© 2008 The New York Botanical Garden Press, Bronx, NY 10458-5126 U.S.A.

original text: http://www.davidarora.com/uploads/muscaria_revised.pdf
backup source: http://www.psilosophy.info/resources/muscaria_revised.pdf

[2] Center for Cultural Studies, University of California, Santa Cruz, CA, USA
[3] Department of Forest Science, Oregon State University, Corvallis, OR, USA
*Corresponding author; e-mail: william@williamrubel.com

Table of Contents:

- Introduction
- The Fly Agaric: *Amanita muscaria*
- The Toxicity of *Amanita muscaria*
- Early Literature on the Edibility of *Amanita muscaria*
- 20th-Century Literature on the Edibility of Amanita muscaria
- Recent Food Use of *Amanita muscaria* outside North America
- *Amanita muscaria*: A Special Mushroom but Not a Special Case
- Criteria for Edibility Determinations of Mushrooms versus Plants
- Field Guides: Science or Culture?
- Field Guides and the Future
- Acknowledgments
- Literature Cited

A Study of Cultural Bias in Field Guide Determinations of Mushroom Edibility Using the Iconic Mushroom, *Amanita muscaria*, as an Example. Mushroom field guides teach identification skills as well as provide information on the edible or toxic qualities of each species of wild mushroom. As such they function as modern-day village elders for an increasingly urban, nature-ignorant population. This paper identifies underlying cultural bias in the determination of mushroom edibility in English-language field guides, using the iconic mushroom, *Amanita muscaria*, as an example. We explore a selection of ethnographic and medical texts that report the use of *A. muscaria* as a food, and we accept parboiling as a safe method of detoxifying it for the dinner table. Mushroom field guides, however, almost universally label the mushroom as poisonous. We discuss the cultural underpinnings and literary form of mushroom field guides and demonstrate that they work within a mostly closed intellectual system that ironically shares many of the same limitations of cultural bias found in traditional folk cultures, but with the pretense of being modern and scientific.

Key Words: Edibility, field guides, mushrooms, *Amanita muscaria*, mushroom edibility, mushroom field guides, field guide bias.

Introduction

Modern-day field guides teach readers how to differentiate life forms; if they are field guides to mushrooms or plants, they frequently also provide information on edibility or other uses. In other words, they function in many ways as parent, grandparent, village herbalist, or shaman for people who do not live in a village or rural area and whose direct experience of nature is limited. Given the unprecedented wealth of information available to specialists in any field, it is tempting to assume that mushroom field guides have been good teachers. But have they? Without question they have been excellent teachers of taxonomy and identification skills. Mushroom morphology is described in detail using a specialized language, and field guides have more or less kept up with changes in nomenclature and advances in scholarship (most recently, molecular studies) from Linnaeus to the present, thereby enabling careful readers to identify many mushrooms successfully. With respect to edibility, however, the mushroom field guide literature has not kept up with advances in scholarship. The field guide literature tends to lack curiosity, to be resistant to change, and even to ignore facts that contradict the prevailing cultural consensus on a mushroom's edibility, as we will show.

Flora Londinensis (1777-1798), by English naturalist William Curtis, heavily influenced the development of the field guide genre. In fact, it should be considered one of its principal English-language prototypes. In this work, the author described the natural history and distinguishing characteristics of wild plants and mushrooms growing around London. Curtis (1777-1798) observed that:

> In some Countries, Mushrooms are made much more an object of food than with us... With us they are used more as an article of luxury

He also pointed out that most of the mushrooms sold in English markets were cultivated, and while he offered some information on the edibility of wild mushrooms, his overall message to readers was one of prudence:

> The best advice would be to caution persons in general, to meddle with no other sort than the common field Mushrooms...

Curtis was clearly aware that he was writing for an audience more comfortable eating cultivated mushrooms than wild ones, and therefore an audience that would be reassured by his extreme caution rather than disappointed or exasperated by it.

More than a century later, in North America, the cultural underpinning for mushroom field guide authors erring on the side of extreme caution remained the same. Louis Krieger, in *The Mushroom Handbook* (1936/1967 reprint: 113) wrote:

> The wild growing kinds [of mushrooms] are not of economic importance in this country, except with certain recent immigrants, chiefly from Russia and southern Europe. The average American of "Nordic" stock either does not care for mushrooms at all, or he stands in such mortal fear of the wild kinds that nothing could tempt him to eat one of these.

Despite significant changes in culinary culture over the past two centuries, fear of mushroom poisoning still runs as a leitmotif through English-language field guides, even those that explicitly seek to encourage consumption of wild mushrooms (e.g., Fischer and Bessette 1992; Schwab 2006; Kuo 2007).

We chose the well-known mushroom *Amanita muscaria* (L.) Lam. (or *A. muscaria* sensu lato - see Oda, Tanaka, and Tsuda 2004; Geml *et al*. 2006) as a convenient vehicle for exploring the nature of the edibility determination in English-language mushroom field guides because it has an extensive literature both inside and outside the field of mycology. Furthermore, it is so easily identified that its "poisonous" label cannot be attributed to authors trying to protect their readership from confusing it with more dangerous species.

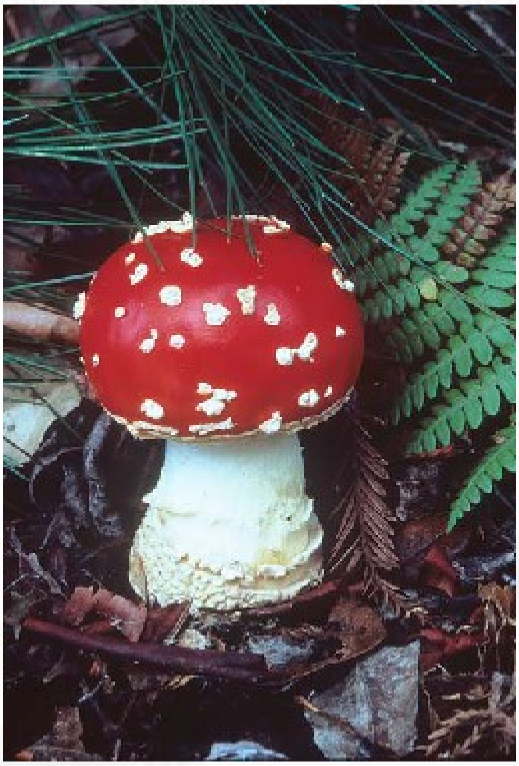


Fig. 1. The iconic *Amanita muscaria* is unmistakeable. (David Arora, all rights reserved).

The Fly Agaric: *Amanita muscaria*

Amanita muscaria is one of the easiest of all mushrooms to identify - the "red one with the white spots" (Fig. 1). As Letcher (2007) points out, "Even a child with no knowledge of natural history could identify one," as there are no other terrestrial life forms in the temperate zone with a similar color pattern. *A. muscaria* is also a cultural icon. It is widely depicted in cartoons and children's books, and is the mushroom that the dwarfs dance around in Disney's 1937 animated feature, *Snow White*. While most people are familiar with its caricature in commercial art, many are unaware that such a mushroom exists in nature. But it is, in fact, a common forest species in much of the north temperate zone and is widely naturalized in the southern hemisphere as well.

Most authors who write about *A. muscaria* remark on its striking appearance. The Scottish mycologist, Robert Greville (1823), called it the "most splendid chief of the agaricoid tribe," and the French naturalist Jean-Baptiste Lamarck, writing around the same time, elegantly expressed what so many feel when they come across it in the forest: "Cette espéce est remarquable par sa beauté" (Lamarck and Augustin 1815).

Amanita muscaria is known in most English-language field guides as the fly agaric or fly amanita. Steeped in milk, it has been widely used to attract flies; the flies become intoxicated by the infusion and then drown (Wasson and Wasson 1957:190; Michelot and Melendez-Howell 2003). But *A. muscaria* is also known as an inebriant. In parts of Siberia where alcohol was unknown, the recreational use of *A. muscaria* was well documented in the 18th century (e.g., von Strahlenberg 1736). Its modern use as an inebriant is also well known (Letcher 2007; Erowid 2008).

Ethnomycologist R. Gordon Wasson (1968) gained renown by focusing on its religious rather than recreational use, for example, by proposing that *A. muscaria* is the enigmatic Soma praised in ancient Vedic texts. His theories have gained currency in some circles but are still controversial (Letcher 2007). A standard dose as an inebriant is one to two caps (Greville 1823; Lincoff and Mitchel 1977); an upset stomach may or may not result. The active principle was long believed to be muscarine - isolated from *A. muscaria* in 1869 and the first mushroom toxin ever identified. Much later, however, it was demonstrated that muscarine, while found in a number of other mushrooms, occurs in such minute quantities in *A. muscaria* as to be clinically insignificant (Lincoff and Mitchel 1977; Benjamin 1995). It is ibotenic acid and muscimol (a more potent, decarboxylated version of ibotenic acid) that produce its inebriating effects (Takemoto *et al*. 1964; Bowden and Drysdale 1965;

Eugster *et al*. 1965). Both of the latter compounds are water soluble and, as we will show, can easily be removed from the mushroom by parboiling it and then discarding the liquid. It should be noted that we use the term "parboil" in this paper to mean precook by boiling, as per the third definition of Rombauer *et al*. (2006:1054). It should also be noted that the dangerously poisonous, amanitin-containing species, e.g., *A. phalloides* Secr., cannot be detoxified by any normal cooking or processing method, and are not discussed hereafter.

Despite being common, easy to identify, and an excellent savory mushroom after parboiling (Arora 2000; Rubel 2000), and despite a longstanding, albeit scattered, tradition of being eaten as a food in the European, Russian, North American, and Japanese countrysides, *A. muscaria* is almost universally characterized by modern mushroom field guides as being poisonous (e.g., Smith and Weber 1980; Lincoff 1981; Arora 1986; McKnight 1987; Hall *et al*. 2003; Miller and Miller 2006), even deadly (e.g., Groves 1962; Phillips 1991).

As we will show, 19th-century investigators from various disciplines established that the mushroom could easily be detoxified by parboiling it. This understanding was widely published in the 19th-century medical and toxicological literature but was ignored and decisively rejected by English-language mushroom field guide authors of the 19th and early 20th centuries. The rejection was so thorough that knowledge of *A. muscaria*'s food use appears to have effectively been lost by the late 20th century. Contemporary field guide authors continue to emphasize (and often exaggerate) the toxicity of *A. muscaria*, seldom mention that anyone eats it, and fail to provide precise and accurate instructions on how to detoxify it. As a result, *A. muscaria* is rarely picked for the dinner table except by those who inherit a local or family tradition of eating it.

The Toxicity of *Amanita muscaria*

English-language mushroom field guides agree that *Amanita muscaria* is poisonous and should not be eaten ("This is a dangerous fungus and should be avoided" - Miller 1972:32; see also McIlvaine and Macadam 1902; Marshall 1905; Güssow and Odell 1927; Smith 1975; Arora 1979; Lincoff 1981; Fergus and Fergus 2003; etc.). In many of these cited works, the authors mention the possibility of *A. muscaria* being fatal. Some authors even classify it as deadly (Gibson 1899; Krieger 1936), and the mushroom guide belonging to the prestigious Peterson Field Guide series (McKnight 1987) marks *A. muscaria* with the universally intimidating skull-and-crossbones symbol.

Yet in researching this article, we were unable to find a single adult death in North America indisputably caused by *A. muscaria*. Recent literature typically lumps poisoning by *A. muscaria* with poisoning by the closely related but significantly more toxic *A. pantherina* (DC.) Krombh. (Lincoff and Mitchell 1977; Benjamin 1995; Michelot and Melendez-Howell 2003). Furthermore, during the 19th and 20th centuries, atropine (the active principle of deadly nightshade, *Atropa belladonna* L.) was commonly prescribed as an antidote to *A. muscaria* poisoning in the mistaken belief that muscarine was the principal toxin. Atropine, however, may aggravate the symptoms of *A. muscaria* ingestion (Mitchel 1980). These variables complicate research into *A. muscaria* poisoning, but if *A. muscaria* has caused fatalities in North America, they have been few and far between. The only fatality cited by modern authors (Benjamin 1995:313) is that of Count de Vecchi, legate to the Italian Embassy in Washington, D.C., who allegedly died of *A. muscaria* poisoning in 1897 after dining on two dozen (!) mushrooms purchased in a local market (Prentiss 1898). Though his death has been linked repeatedly with *A. muscaria* (e.g., Jordan 1917:20), we use the word allegedly because it is impossible from the published accounts to reconstruct exactly what he died from; indeed, there is enough uncertainty to justify a separate article on the subject. The second most-often cited death by *A. muscaria* poisoning after that of Count de Vecchi is that of the Czar Alexis of Russia (e.g., Marshall 1905; Hard 1908) - in 1679! But authors do not agree on whether it was the Czar or the Czar's wife who was poisoned (Douglass 1917a).

A few mushrooms with histories of being eaten have been shown to be quite dangerous. *Gyromitra esculenta* (Pers.) Fr., for example, is popular in northern Europe but has caused deaths when not properly prepared, in part because there is a narrow dosage threshold between serious symptoms and a complete absence of them (Benjamin 1995). Another mushroom, *Paxillus involutus* (Batsch) Fr., has a history of being eaten in Europe but can cause severe allergic reactions in people who have eaten it for years. *A. muscaria*, however, does not have such a record, and an adult who eats one or two caps, even uncooked, does not, according to the literature, risk such severe consequences. The fatal human dose for *A. muscaria* has not been determined.

Benjamin (1995:309) speculated that 15 caps would be fatal, but it is unclear whether he was referring to *A. muscaria* or to the more toxic *A. pantherina*. Lincoff and Mitchel (1977) reported a man who ate 20 caps and survived, but also did not specify which species he ate. Many websites mention a fatality caused by the consumption of 20 or "two dozen" *A. muscaria* caps, but these apparently refer back to the unfortunate Count de Vecchi. What is known is that none of the hundreds, even thousands, of adults who have used *A. muscaria* as an intoxicant in North America have directly died from doing so (McDonald 1978:225), and early reports of *A. muscaria* usage as an inebriant in Siberia were not accompanied by references to fatalities.

Early Literature on the Edibility of *Amanita muscaria*

The documentation of historic *Amanita muscaria* food use is sparse, though persistent, and includes Europe, Asia, and North America. Most accounts merely mention its use as a food, but omit information on its safe detoxification. This dichotomy in the literature does not pertain only to *A. muscaria* or only to English-language field guides. See, for example, French mycologist Roget Heim's mention of the "poisonous" *Boletus satanas* Lenz being eaten by some people while failing to describe how "some people" detoxified the mushroom (Heim 1963:176).

The most explicit, widely-circulated, early account in English of *A. muscaria*'s use in the kitchen was by German physician and naturalist George Heinrich von Langsdorf, brought into the English-language literature as part of Robert Greville's influential presentation to the Wernarian Natural History Society in 1823. In Greville's (1823:344) translation: "[in Siberia it] is sometimes eaten fresh in soups and sauces, and then loses much of its intoxicating properties." While his translation might be construed to allow for the possibility of savory dishes that intoxicate slightly, it is more likely that the mushrooms were detoxified by being first parboiled, which would be consistent with the Russian method for detoxifying "poisonous" mushrooms described by Pallas (1794:76) from his visit to a region near Moscow. It is also consistent with our experience of current practice in Russia (as well as Lithuania), where many or most species of wild mushrooms are first boiled in water, drained, and then used as an ingredient in a dish.

While von Langsdorf's detailed descriptions of *A. muscaria*'s use as an inebriant in Siberia were subsequently cited (e.g., Christison 1829:653), his description of its use as a food was never cited again. But there were other mentions of kitchen use of *A. muscaria* - in, for example, Charles David Badham's (1863) book, *A treatise on the esculent funguses of England*. Its use as a food in Russia was noted in the Annals of Horticulture (1848:423), by Cooke (1880:211), and by William Delisle Hay (1887:154), who wrote, "The plant is eaten both in North Russia and in Southern France, *but of course* [emphasis ours] after being boiled and washed." These, plus more general references to "poisonous" mushrooms being eaten in the Russian and European countrysides (e.g., Pallas 1794; Porcher 1854; Whetstone 1898:263) formed a backdrop to the more precise work on *A. muscaria* detoxification published in the 19th-century medical and toxicological literature.

During the 19th century, efforts were made to prove in a methodical way that *A. muscaria*, as well as various other "poisonous" mushrooms, could be made safe for the dinner table. A French physician, Dr. Félix Archimède Pouchet, was especially influential in establishing the efficacy of boiling *A. muscaria* to remove its toxins, but he had a distinctly practical quest: he was looking for a way to unlock the nutrition tied up in wild mushrooms that the rural poor were not collecting because they thought them poisonous. In this quest to use "poisonous" mushrooms to help feed the poor, he was inspired by the root crop manioc (*Manihot esculenta* Crantz), described by one of his contemporaries (Taylor 1859:626) as follows:

> The root of one variety of this West Indian plant, known under the name Bitter Cassava, contains in its juice prussic [hydrocyanic] acid. It is, therefore, when recently expressed, highly poisonous, inducing coma, convulsions, and death… The vegetable principles of the plant, evaporated to dryness, form what is called *Cassava-cake*, which is not only inert, by reason [of] the poison being volatized, but highly nutritious. The starch obtained from this root is well known under the name *Tapioca*. Neither cassava nor tapioca yields any trace of prussic acid.

Pouchet (1839:323) explicitly acknowledged the example of manioc. As he put it (translated from the original French by the authors),

> Manioc forms the staple nourishment of a large number of people but has in its tissues the most

> violent of poisons; through skill, man extracts the poison from the nutritive part, and we think that science could do the same for mushrooms.

Pouchet's reference to manioc was a conceptual breakthrough. In suggesting that the French eat *A. muscaria*, he did not argue that it was a traditional food someplace else, like in Italy or Russia, but simply that through scientific methods he had determined it could easily be rendered safe to eat. He was also saying that mushrooms could be thought of in the same way we think of other foods that are edible, and that by analogy what he was doing to *A. muscaria* was no more extreme than detoxifying manioc.

One of Pouchet's experiments was to boil five *A. muscaria* caps per liter of water for 15 minutes. He strained out the mushrooms and fed the broth to dogs, who died, thus demonstrating that the toxins were water soluble. But he also fed dogs boiled caps without the broth, and they thrived, thus demonstrating that the caps were no longer poisonous. (Note: smaller dogs are cheaper to maintain for experimental purposes than large ones, so we can infer that five caps for one of Pouchet's dogs is equivalent to 20 or more caps for a human adult.)

Pouchet's experiments were widely described. Reese (1874:346) said in his manual on toxicology, "A third [dog] which was fed [by Pouchet] on boiled amanitas for two months actually fattened on this food." Pouchet's experiments were also cited in the standard medical references of that era, for example in *Medical Jurisprudence* (Wharton *et al*. 1860:569; Wharton *et al*. 1873:470; Wharton and Stillé 1882:675). In all of the above cases, the edibility of parboiled *A. muscaria* was accepted as fact.

While Pouchet, to demonstrate edibility, experimented on animals, another Frenchman, M. Gerard, experimented on himself, and on his family. In 1851, Gerard demonstrated that *A. muscaria*, along with a number of other "poisonous" mushrooms, could be safely eaten if parboiled (Gerard 1852). He was also widely cited in the 19th-century toxicological literature. Here is Gerard's recipe for *A. muscaria* as translated by the Southern Society for Clinical Investigation (1853: 261):

> To every five hundred grams of mushrooms cut up into a medium size, a liter of water, slightly acidulated by two or three spoonfuls of vinegar (or, if nothing else is on hand, gray salt), should be used. If [only] water alone can be obtained, this must be renewed once or twice. In this fluid the fungi are to be macerated for two entire hours, after which they are to be washed in an abundance of water. Next, they are to be put into cold water and boiled for half an hour, after which they may be taken out, washed, dried, and used as food.

Interest in Gerard's work was so great that it was republished a decade later, again in English, under the title, "A simple means of removing the poisonous properties of suspicious mushrooms" (Gerard 1863), and it was cited in Hay's (1887) book on British mushrooms. It is worth noting Gerard's use of vinegar. This use may be traceable to Jean Jacques Paulet, a French botanist and mycologist who was credited with demonstrating in 1776 that "the mode in which... [mushrooms] were cooked" affected toxicity, and that salt and vinegar were particularly helpful in this regard (Lindley 1836:422).

The belief in the edibility of parboiled *A. muscaria* was apparently not a controversial one in the 19th-century American medical community. Dr. Francis Porcher cited most of the above sources (including Pouchet) in his report to the American Medical Association entitled *The Medical, Poisonous, and Dietetic Properties of the Cryptogamic Plants of the United States* (Porcher 1854). He also cited several sources as saying of *A. muscaria* that, "in the middle of France they had constantly been in the habit of eating them" (Porcher 1854:61). Of the ethnographic literature in general, he concluded that what was written was really true: that many poisonous mushrooms could be rendered edible through knowledgeable processing. In his own words, "There is no reason to doubt the fact that sorts *justly esteemed poisonous are really used* [author's emphasis]" (Porcher 1854:47). Porcher's work, with its imprimatur of the American Medical Association, was also cited in the aforementioned and influential *Medical Jurisprudence* (Wharton *et al*. 1860; Wharton *et al*. 1873; Wharton and Stillé 1882).

At the end of the 19th century, the noted American botanist, Charles Peck (1895:214), in an extensive passage on the use of *A. muscaria* as a food, described Americans who detoxified *A. muscaria* with vinegar and/or water. But the most detailed, objective, and accurate description of its edibility was written in 1898 by

Frederick Vernon Coville, a distinguished botanist, explorer, and ethnographer, who authored 170 books and articles (but who, significantly, was not a mushroom field guide author). Coville was the first to discover the importance of soil acidity to blueberries; he also wrote books on desert plants, served as Chief Botanist for the United States Department of Agriculture and as Chairman of the National Geographic Society Research Committee, and was the first director of the United States National Arboretum. Coville published a report on *Amanita muscaria* in 1898 for the United States Department of Agriculture as part of an investigation into the death by mushroom poisoning of Count de Vecchi of Washington, D.C. In this work, entitled *Observations on Recent Cases of Mushroom Poisoning in the District of Columbia*, Coville exhibited a reasonably solid grasp of the scientific understanding of the edibility of *A. muscaria*. He went to the market where the Count had purchased the mushrooms that allegedly poisoned him and, remarkably, discovered *A. muscaria* being eaten in Washington, D.C.!

> It is well known that in some parts of Europe the fly amanita, after the removal of the poison by treatment with vinegar, is a common article of food. It was interesting to discover not long since that among some of our own people the practice prevails. Though most of the colored women of the markets look upon the species with horror, one of them recited in detail how she was in the habit of cooking it. She prepared the stem by scraping, the cap by removing the gills and peeling the upper surface. Thus dressed the mushrooms were first boiled in salt and water, and afterwards steeped in vinegar. They were then washed in clear water, cooked in gravy like ordinary mushrooms, and served with beefsteak. This is an exceedingly interesting operation from the fact that although its author was wholly ignorant of the chemistry of mushroom poisons, she had nevertheless been employing a process for the removal of these poisons which was scientifically correct. (Coville 1898: 19)

Coville's work stands as a model for writers today. While Coville was not a mushroom expert, he reviewed the scientific literature, the ethnographic literature, and did his own field work. Although he did not go on to recommend that his readers eat *A. muscaria*, he used his understanding of mushroom toxicology to explain the findings of his field research and to reconcile the two. He unambiguously concluded that "after the two treatments the mushroom is free from poisons." Thus he is notable for using the science of his day to explain why a folk method of detoxification was effective.

20th-Century Literature on the Edibility of Amanita muscaria

Since contemporary mushroom field guides teach that *A. muscaria* is poisonous, even potentially deadly, it is difficult to appreciate the extent to which the 19th-century toxicological literature was united behind the ethnographic literature in declaring that *A. muscaria* is edible after parboiling. Knowledge, particularly in written form, is widely assumed to progress over time as more and more bits of information are accumulated, examined, and tested. In the case of *A. muscaria*, however, 20th-century mushroom field guides have proved strangely impervious to the facts, as we will show, and knowledge of its edibility seems actually to have regressed.

Coville's work was cited in the early 20thcentury medical literature (e.g., Wiley 1917:445). Furthermore, a medical doctor, Beaman Douglass (1917b:212), reported that, "The negroes of the southern states are said to have learned empirically how to prepare [*A. muscaria*, as well as *Russula emetica* (Sch.) Pers.] which they eat freely." The field guide literature, however, did not follow up on Coville (despite his excellent reputation) and the other explicit 19th-century literature on *A. muscaria* edibility. Instead, the field guide literature rejected its edibility and closed ranks around its toxicity.

In an act of omission for the apparent purpose of distorting or suppressing evidence of its edibility, Nina Marshall, in *The Mushroom Book* (1905:49-50), cited Coville but failed to say that *A. muscaria* was eaten in Washington D.C., and that there was a "scientifically correct" way to detoxify the mushroom. Instead, she labeled *A. muscaria* "poisonous," and emphasized its danger by stating, "It is known to have caused much sickness and many deaths. It caused the death of the Czar Alexis of Russia, and of the Count de Vecchi in Washington." While she did mention that *A. muscaria* is "cooked and eaten by the Russians," she prefaced that statement with the phrase "it is said" (rather than "it is known"), thus implying that it may not be true. Her respected contemporary, Prof. George F. Atkinson of Cornell University, said of *A. muscaria* in his field guide

(Atkinson 1900), "... deadly as ordinarily found, [but] is undoubtedly used quite largely as food in parts of France and Russia, and it has been eaten repeatedly in certain localities in this country without harm." But Atkinson, unlike Coville, did not explain in which localities in the United States *A. muscaria* was eaten, nor how such a "deadly" mushroom could be safely prepared.

The most influential North American mushroom field guide of that era, however, was *One Thousand American Fungi* by Captain Charles McIlvaine (McIlvaine and Macadam 1902), a book that is still in print. McIlvaine was interested in the science of his day, but he proudly broke with the tradition of field guide authors simply following each other's lead, and sought to establish edibility on a sound personal and scientific basis. He tested hundreds of mushrooms on himself, including some routinely characterized as poisonous, and even had a group of designated "undertasters" (McIlvaine and Macadam 1902/1967 reprint: xv, 454).

Uncharacteristically, however, McIlvaine exaggerated the toxicity of *A. muscaria*, a mushroom that he asserted was "undoubtedly poisonous [author's emphasis] to a high degree" (McIlvaine and Macadam 1902/1967 reprint: 15). McIlvaine claimed to have become intoxicated from eating a hazelnut-sized piece of raw cap - an impossibility according to Phipps (2000), unless the effects were psychosomatic; that McIlvaine experienced an anxiety reaction is also suggested by the fact that he counteracted the mushroom's effects by smoking a pipe! McIlvaine emphatically rejected the use of vinegar, or any other method, for extracting poison from the mushroom on the grounds that one couldn't be sure it had all been removed. His mention of the use of vinegar (McIlvaine and Macadam 1902/1967 reprint: 15-16) implies that he was familiar with Coville's "scientifically correct" method for detoxifying *A. muscaria*. His rejection of the detoxification procedure was subsequently cited by others as a reason to reject it (e.g., Benedict 1908:94).

Why didn't McIlvaine test detoxification procedures prior to rejecting them? The answer seems to be his personal bias, for he was no stranger to conducting experiments to prove a point. McIlvaine injected etherized cats with *A. muscaria* juice, killing them. This inspired a physiologist, William Carter (1901), to conduct a bigger study of the effect of injecting a range of animals - cats, dogs, rabbits, even frogs - with *A. muscaria* juice. These experiments, unlike those of Pouchet, had no chance of demonstrating that the mushroom was edible. With the hindsight of one hundred years, it is evident that McIlvaine and Carter presaged a 20th-century shift toward using increasingly sophisticated laboratory techniques to study toxins and toxicity while abandoning Pouchet's quest to use science as a means of learning how to safely detoxify mushrooms for the table.

The first comprehensive academic treatment of North American agarics was written by Prof. Charles Henry Kauffman (1918). Kauffman gave a detailed morphological description of *Amanita muscaria* in which he called it "deadly poisonous," saying, "It is a delightful object for the artistic eye of the nature lover but in all other respects a menace." Yet buried in the appendix of this same field guide (Kauffman 1918; 1971 reprint: 841-842) is a section called "Treatment of *Amanita muscaria* poisoning," written by Dr. O. E. Fischer, who, significantly, was not a mycologist but a medical doctor, like Porcher and Douglass. Fischer cited *A. muscaria* as being eaten as food in Saxony and Bohemia. He also cited Coville, and gave the African-American market woman's recipe for its safe preparation.

Writing ten years later, William Sturgis Thomas, president of the New York Mycological Society and author of the mushroom volume (Thomas 1928) in Putnam's Nature Field Books series, based most of his mushroom edibility information on Peck. Incredibly, however, he skipped over the information that Peck (1895) provided on the use of *A. muscaria* as food, just as Marshall had purposefully dropped Coville's authoritative information on its detoxification.

The next important field guide mention of *A. muscaria* being eaten was in *The Mushroom Handbook* (1936), by Louis Krieger. A mycological bibliographer, Krieger was conversant in English, French, and German, and his knowledge of the relevant literature was second to none. Perhaps reflecting the prevailing climate of hostility toward drugs (the notorious anti-drug movie, *Reefer Madness*, was also released in 1936), Krieger chose to exaggerate the intoxicating effects of raw *A. muscaria* by describing, apparently without basis, Siberian villages full of "intoxicated people running amok with drawn knives and false courage endanger[ing] the lives of their fellows." Regarding the edibility of *A. muscaria*, Krieger stated, "This species, though known to be deadly, is eaten without ill effects by some people." He provided no specific information on who ate *A. muscaria* nor did he give any details for safely preparing it.

But no major field guide author so fully embodies the dichotomy between the careful and scholarly treatment of mushroom taxonomy and the idiosyncratic treatment of mushroom edibility as Alexander Smith, the preeminent North American mushroom taxonomist of the 20th century. Smith authored approximately 200 articles and books over a long and distinguished career and named many new species. He dedicated his first field guide for the general public, *Mushrooms in Their Natural Habitats* (Smith 1948), to his mentor, the aforementioned Charles Kauffman, and labeled *A. muscaria* as poisonous, thus following Kauffman (1918) as well as Gibson (1899), McIlvaine and Macadam (1902), Marshall (1905), and Krieger (1936), among others, in rejecting or ignoring the 19thcentury toxicological and ethnographic literature. Like Gibson (1899), Smith attributed stories of people safely eating *A. muscaria* to misidentification. He even speculated that the people were probably eating *A. frostiana* Peck, a North American species unknown in Europe and Asia. Smith's next work for the general public was *A Mushroom Hunter*'s *Field Guide* (1958, 1963), a book that sold 100,000 copies and was hailed as the "first modern [mushroom] field guide for amateurs" (Thiers 1987). In the first version of this book, Smith (1958:136) said this of *A. muscaria*:

> Poisonous. If someone claims to know how to cook it so that it is edible, do not argue with him, but do not eat any. Apparently there are ways of extracting the poison, but the risk is not worth the effort.

It is unclear to us what Smith's reasons were for saying not to argue the point (because it truly is edible?), or what the "effort" is that he refers to. But in the second "revised and enlarged" version of the same book, Smith (1963:177) labeled *A. muscaria* "poisonous," and then immediately went on to say,

> However, some people extract the poison and then eat the mushroom, apparently with no ill effects. They claim it is a most delicious species. The instructions, as I have heard them, are to parboil the specimens in salt water until no more yellow scum comes to the surface...

As we can find no other specific mention in the mushroom literature of "yellow scum," we conclude that Smith was in touch with credible informants who regularly ate *A. muscaria* and considered it delicious. But he provided no information about who these people were, and, unlike Coville, he didn't stand behind his own ethnographic report. Instead, he went on to tell readers that if they tried the detoxification method he had just described, that they did so at their own risk (Smith 1963:177). Smith's distrust of his own finding suggests that he was unaware of the substantial body of l9th-century literature on the subject, and furthermore, that this body of knowledge regarding *A. muscaria*'s edibility had already effectively vanished. Furthermore, Smith seems to have made no personal effort to verify the efficacy of parboiling *A. muscaria*, an indication of his and his culture's lack of interest in wild mushrooms as food. Thus he was clearly working within the same intellectual framework as the 18th-century English field guide author William Curtis, one in which the accuracy of the edibility information is not as important as that of the taxonomic information.

In Smith's 1975 work, *A Field Guide to Western Mushrooms*, under the description of *A. muscaria*, he reverted to labeling it poisonous and dropped the reference to detoxification (Smith 1975:167). However, as in Kauffman (1918), there is completely different information buried in the chapter on mushroom poisoning, namely, the unambiguous statement "People who know how to boil the poison out of it use it as an esculent" (Smith 1975:15). Five years later, in the revised edition of *The Mushroom Hunter*'s *Field Guide* (Smith and Weber 1980:171-172), Smith once again changed his position, or at least his emphasis. Instead of continuing to characterize *A. muscaria* as "poisonous," he broke with his own past as well as with the entire history of mushroom field guides by labeling it as "poisonous to most people," thus implying that some people are immune to its toxins and can eat it with impunity. Smith then went on to say that "some people can eat this species and suffer no ill effects; others parboil the specimens and discard the liquid..."

While specimens of *A. muscaria* vary in the amounts of toxins they contain (Benedict 1972), and while individuals may vary in their sensitivity to the toxins, there is no literature to support the idea that anyone is immune to its toxins and could eat as many non-detoxified specimens as they wanted without becoming intoxicated or nauseous or worse. Smith cited no references for his extraordinary claim that non-detoxified *A. muscaria* is edible for some people, but the phrase "some people can eat this species and suffer no ill effects" is almost verbatim from Krieger (1936/ 1967 reprint: 238-239).

Despite his inconsistencies, his apparent distrust of his own findings, and his failure to use science to support (or debunk) folk detoxification techniques, Smith deserves credit for breaking with his 20th-century predecessors in publishing accounts of *A. muscaria*'s usage as food. Smith was a mushroom taxonomist, not an ethnographer, and he did not often report ethnographic uses of mushrooms in his books. He clearly did not trust the detoxification procedure he described for *A. muscaria*, and strongly recommended against employing it. Yet, in four books spanning more than 20 years he repeatedly described or alluded to this same detoxification procedure which he distrusted. Why would he do so when it would have been so much easier not to mention it being eaten and simply to agree with the 20th-century field guide consensus that *A. muscaria* was poisonous? We think his repeated references to detoxification point to food use of *A. muscaria* in North America consisting not of isolated instances, but of a tradition sufficiently developed and widespread enough that Smith anticipated some of his readers encountering it, and thus felt compelled to inform them of it.

Though Smith was a highly respected mushroom expert, his repeated references to the use of *A. muscaria* as an esculent were ignored by subsequent field guide authors (e.g., McKenny and Stuntz 1971; Miller 1972; Guild 1977; Arora 1979, 1986; Lincoff 1981; Fischer and Bessette 1992; Jordan and Wheeler 1995; Bessette *et al*. 1997), suggesting a broad cultural bias against taking ethnographic references to mushroom food use seriously when they contradict prevailing practices. However, we find Smith's allusions tantalizing.

In addition to the aforementioned references by Peck, and more specifically to the food use of *A. muscaria* by African-Americans in America's South, we surmise that there was, and may still be, an undocumented tradition of eating *A. muscaria* in North America. Besides Smith, who collected mushrooms extensively in the Pacific Northwest and Midwest, Chilton (in Rumack and Salzman 1978:112) mentioned a "few people in Europe and North America" preparing *A. muscaria* for the table. He described a procedure similar to that of Coville's African-American market woman, though without the final soaking in vinegar. Lincoff and Mitchel (1977:85) mentioned unconfirmed reports from the Pacific Northwest of people who "eat the Fly Agaric as a food after peeling the cap, parboiling the peeled mushrooms, discarding the cooking water, and recooking them," but, like so many 20th-century authors, they warned against doing so. Denis Benjamin (pers. comm.) reports similar usage of *A. muscaria* in the Pacific Northwest during the 1980s, with one man telling him that his family had been eating *A. muscaria* as food for three generations.

We have also encountered people who eat *A. muscaria* as food, both in Europe and North America. One such person, a man living in the Sierra Nevada foothills of California, actually came to doubt the safety of his family's tradition of eating parboiled *A. muscaria* based on what he had read in Arora's (1986) field guide. The man asked Arora if there were any long-term ill effects from dining on parboiled *A. muscaria* because he hadn't noticed any short-term ill effects. It is difficult to imagine rural Tibetans or Mayans who had been taught by their parents how to safely prepare a particular mushroom losing confidence because of what was written in a book. But in 20th-century North America, the prestige of the written word was such that this rural man sought assurance for something that he had been doing all his life, and he ironically sought it from a field guide author who had never (at that time) eaten it as a food, and, unaware of the 19th-century understanding that it was edible, had merely repeated the 20th-century consensus that it wasn't. As a result of this encounter and further research with Alan Phipps in Sanada, Japan, where *A. muscaria* is an esteemed edible mushroom (Wasson and Wasson 1957; Arora 2000; Phipps 2000), Arora has changed his assessment of the edibility of *A. muscaria* and now considers it to be a delicious edible mushroom if parboiled. This information, however, has not yet made its way into his field guides (Arora 1986, 1991).

The only modern English-language field guide we have found that categorically states that one can make *A. muscaria* safe to eat is *The Mushroom Manual* by Lorentz Pearson (1987). Citing the Swedish field guide author Bengt Cortin, who personally tested more than 300 species of wild mushrooms including many of doubtful edibility, Pearson (1987:61) offered the following detoxification method:

> To render *Amanita muscaria* safe to eat: (1) carefully peel the cap, removing every bit of the pellis or rind...; (2) cut into relatively small bits; (3) place the bits in boiling water and boil for exactly five minutes; (4) discard the water, and boil again in fresh, boiling water for an additional five minutes; (5) discard the water and prepare the mushroom in the usual way.

Paradoxically, however, just as references to *A. muscaria* food use were buried in chapters on poisoning in Kauffman (1918) and Smith (1975), the above recipe was placed in a chapter ominously titled "The Fatal Five," thereby severely undercutting its impact. As we have already noted, other English-language field guide authors have not followed up on Smith's description of *A. muscaria*'s edibility, nor on Pearson's rendition of Cortin's precise instructions.

By the end of the 20st century, mention of the use of parboiled *A. muscaria* as a food had been practically expunged from the written record. Kenneth Lampe (1979:95), in a pharmacological review of toxic mushrooms, stated, "Cooking does not markedly affect [its] activity," and Didier Michelot and Leda Maria MelendezHowell (2003), two scientists favorably disposed towards *A. muscaria*, wrote in an otherwise wellresearched paper that"Contrary to some statements, cooking does not notably lower toxicity, demonstrating that the active components are not heat sensitive." Michelot and Melendez-Howell wanted to show that the mushroom could be detoxified and then eaten for dinner, but the late 20th-century literature that they worked with no longer included the 19th-century knowledge that the toxins in *A. muscaria* are water soluble. Thus they didn't realize that "cooking" per se, i.e., the application of heat, does not detoxify *A. muscaria*, but that boiling it in water does. Their failure to match the correct cooking method to the mushroom testifies to a more general failure on the part of the literature (and especially mushroom field guides) to be more accurate and explicit in reporting the well-established fact that *A. muscaria*'s toxins are water soluble.

Recent Food Use of *Amanita muscaria* outside North America

This work focuses on English-language field guides. A methodical survey of mushroom field guides from Europe and Asia would be instructive. As an example of what one is likely to find, the Swedish author Bengt Cortin (1942) wrote (translated by Eric Danell), "Nowadays it has been determined, that this poisonous mushroom is harmless if treated in the right way." The literature that supports that statement would be well worth knowing. An Italian author, Bruno Cetto (1994) mentioned *A. muscaria* being eaten as a food in contemporary Italy. Lucius von Frieden (1964) also mentioned it being eaten in Europe. But neither author provided concrete details, and both focused on the broader national attitude towards *A. muscaria* rather than on regional practices that deviated from the norm. Even so, the mention of *A. muscaria* use as food in parts of Italy suggests that a broader survey of field guides might uncover useful information on the practice of *A. muscaria* consumption in Europe that could then be used to focus field research where one is most likely to still be able to find people who can explain how they detoxify the mushroom, what they do with it, and how it fits into their culture and cuisine.

The best English-language report on the current use of *A. muscaria* as food in Asia, or for that matter, anywhere, is Phipps' (2000) treatise focused on the town of Sanada in Nagano Prefecture, Japan. Phipps' primary goal was to ascertain through laboratory testing whether the traditional salting method there rendered *A. muscaria* totally safe. It did. After boiling and storing the mushrooms in salt - the predominant treatment of *A. muscaria* in and around Sanada - Phipps found that there was no detectable muscimol or ibotenic acid. Phipps documented two other preparation methods: grilling and drying. The grilled caps are typically eaten by groups of men along with *sake*, while the dried caps are powdered for use as a flavor-enhancing condiment, producing the taste sensation the Japanese call *umami* (Kawai *et al*. 2002); according to Lincoff and Mitchel (1977), ibotenic acid and muscimol are far more powerful than the better known *umami* agent, MSG. In contrast to parboiling, Phipps found that both grilling and drying, far from detoxifying the mushroom, convert some of the ibotenic acid into the much more potent compound, muscimol (Phipps 2000:52-58). Phipps' work offers a model for combining ethnographic research with laboratory science to clarify the role of basic culinary processes - drying, grilling, roasting, frying, boiling - in eliminating or concentrating mushroom toxins.

Amanita muscaria: A Special Mushroom but Not a Special Case

The consistent labeling of *A. muscaria* as poisonous and the failure of modern field guides to acknowledge its use as food is by no means a special case. Many other mushrooms that can be made edible through *knowledgeable* processing are routinely dismissed as "poisonous" or not edible in mushroom field guides, whether out of bias, ignorance, or both. For example, *B. luridus* Schaeff., *B. erythropus* sensu auct. mult., and their close relatives are commonly eaten in China and Europe (especially Italy) but are labeled poisonous by many English-language field guides (e.g., Miller 1972; Bessette and Sundberg 1987; Bessette *et al*. 1997; Hall et. al 2003). *B. satanas* Lenz is eaten in Sicily after a complex cooking process (Galli 1996) but is described as poisonous by most field guides, including Italian ones (e.g., Cetto 1994; Testi 1995; Papetti *et al*. 1999). *B.*

subvelutipes Peck is eaten in Japan (Imazeki *et al*. 1988) and has been safely served for years by restaurants in Massachusetts but is listed as poisonous in field guides written specifically for that area (Bessette *et al*. 1997; Bessette *et al*. 2001). *Gomphus floccosus* (Schwein.) Singer is often listed as poisonous (e.g., Miller and Miller 2006), but is commonly sold in the markets of Mexico and China. Acrid, red-capped russulas such as *Russula emetica* are widely eaten after being cooked or salted but are labeled poisonous by field guides in many languages (e.g., Hagara 1987; States 1990; Kuo 2007). Various peppery species of *Lactarius* such as *L. torminosus* (Schaeff.) Gray are condemned as poisonous by assorted English-language field guides (e.g., Glick 1979; Phillips 1981, 1991; McKenny *et al*. 1987; Miller and Miller 2006) but form an important part of northern European, Russian, and Siberian cuisine, as noted by Heilmann-Clausen *et al*. (1998: 30) in their monograph on *Lactarius*:

> *Lactarius torminosus* is listed among the poisonous species in southern Europe, but in Finland the edibility of the species is not questioned.

Not only individual species but entire genera are routinely dismissed by field guides as poisonous or inedible or worthless (e.g., Lincoff 1981; Arora 1986; Jordan and Wheeler 1995), despite containing commercially-valuable edible species with long histories of usage. These genera include *Astraeus, Calostoma, Cortinarius, Entoloma, Hebeloma, Helvella, Schizophyllum, Scleroderma, Suillus*, and *Tremella*, to name just a few.

Criteria for Edibility Determinations of Mushrooms versus Plants

Listing *A. muscaria* as edible rather than poisonous is a completely unremarkable judgment in a culinary context, or even in the context of most books on plant identification and uses. In many cases, the processing required for traditional plant foods is far more exacting and labor-intensive than the parboiling required to make *A. muscaria* edible. For example, most bamboo shoots (e.g., *Dendrocalamus*, *Phyllostachys*, and *Bambusa* spp.) require boiling, in some cases with two changes of water. Researchers have determined that the traditional parboiling method for preparing the seaweed *hijiki*, *Hizikia fusiforme* (Harvey) Okamura, removes potentially dangerous quantities of arsenic found in the raw product (Hanaoka *et al*. 2001; Ichikawa *et al*. 2006). Lupine or wolfbean (*Lupinis albus* L.), which the authors recently purchased at a California supermarket, may require up to four *days* of soaking and water changes to make it safe for the table (Grande *et al*. 2004). The Canadian Food Inspection Agency (2005) recommends detoxifying fiddlehead ferns (*Matteuccia struthiopteris* L.) prior to "sauteeing, frying, or baking" by rinsing them in several changes of water, and then boiling for 15 minutes, or steaming for 12 minutes. Pokeweed (*Phytolacca americana* L.), the subject of a popular radio song in 1965 and a frequently eaten wild food in the American South and Midwest, has roots that can be fatally poisonous and shoots that are "one of the best tasting vegetables on the planet" (Brill 2002); the shoots, however, need to be boiled *three* times (and the water discarded) to render them safe to eat (Brill 2002:164-165). We have already mentioned that cassava, the source of tapioca, requires special treatment to eliminate hydrocyanic acid (Taylor 1859). Another staple, taro (*Colocasia esculenta* [L.] Schott), must be cooked 10-45 minutes depending on the variety and the part of the plant used in order to avoid experiencing "the sensation of a hundred red hot needles" in one's throat (Solomon and Solomon 1998:375).

As can be seen, this list of examples ranges from relatively obscure dietary supplements to widely-used, culturally-salient staples, and the consequences of improper preparation can be milder than for *A. muscaria*, or more severe. Yet all of these foods are consistently described in plant field guides (as well as cookbooks) as being edible, and it is either taken for granted that readers know how to prepare them (the packet of lupine we purchased had no instructions for its preparation!), or else directions for their processing are provided. Their toxicity, while acknowledged, is not used to dissuade people from eating them, but is instead treated as an inconvenience - something to be removed as one would remove dirt from a garden carrot. Jacquat and Bertossa (1990), for example, said this about the Thai plant *phak naam* (*Lasia spinosa* Thw.): "The young leaves are edible, but must be cooked or fermented to neutralize the hydrocyanic acid." While mushroom field guides are not cookbooks, and cannot be expected to carry the burden of an encyclopedic record of mushroom use, it would be easy enough for authors to say something equally terse, *useful*, and non-inflammatory about *A. muscaria*, such as, "edible if sliced thinly and parboiled in a large pot of salted water for 15 minutes, rinsed, and the water thrown out." They are, after all, the authorities that most urban people (including many scientists) consult first when they want to learn about a mushroom.

Contemporary English-language cookbook and plant field-guide authors operate in the same litigious climate as mushroom field guide authors, and all write for increasingly nature-alienated, rather than nature-immersed, audiences. But the formers' emphasis tends to be on a plant's edibility, not its toxicity, at least where there is a history of usage, while wild mushrooms appear to be held to an entirely different standard of accountability by English-language field guides.

It is tempting to attribute this double standard to the entrenched Anglo-American cultural antipathy toward wild mushrooms called "mycophobia" by the husband-wife team of Valentina Pavlovna Wasson and R. Gordon Wasson (1957), and "fungophobia" by British naturalist William Delisle Hay (1887:6), who commented,

> [All mushrooms]... are lumped together in one sweeping condemnation. They are looked upon as vegetable vermin, only made to be destroyed. No English eye can see their beauties, their office is unknown, their varieties not regarded.

While mycophobia undoubtedly limits the range of mushroom species labeled edible, a more specific Anglo-American antipathy toward boiled mushrooms has probably also had an effect on English-language authors' determinations of several species' fitness for the table, including *A. muscaria*. In Anglo-American cuisine, boiling mushrooms is an alien concept that approaches taboo status. We boil green vegetables, tubers, and eggs, not mushrooms. The last reference to boiling mushrooms that we could find in a major English-language cookbook was in Robert May's *The Accomplsht Cook* (1660). English 18th-century mushroom cookery practice was to stew, grill, bake, and fry mushrooms, but without parboiling (Glasse 1747; Briggs 1792). This is the practice that entered the American cookbook literature in the 19th century, and is the tradition that North Americans follow to this day (Randolph 1836; Lincoln 1884; Rorer 1902; Rombauer *et al*. 2006). An exception is Kuo (2007), an American field guide author, who is not averse to boiling the mushroom, *Lactarius deceptivus* Peck, *three* times with water changes (a northern European treatment), but nonetheless dismisses *A. muscaria* as "seriously poisonous." On the other hand, most modern field guides in other languages, even those from countries with little or no aversion to boiling mushrooms, clearly label *A. muscaria* as poisonous, with no mention of it being edible if parboiled or of its use as food by some people. Our survey of field guides in other languages, though cursory, included several from mycophilic countries such as Russia, Italy, and Japan (Hongo and Izawa 1994; Testi 1995; Papetti *et al*. 1999; Tat'jana 2007).

It is also significant that some mushrooms - e.g., morels (*Morchella* spp.) and honey mushrooms (*Armillaria* spp.) - are invariably labeled "edible" in English-language field guides despite being toxic raw (Benjamin 1995:278, 358). In other words, there is no consistent logical standard by which a mushroom is judged to be edible or poisonous. Instead, the initial reputation that a mushroom - or any potential food - acquires, for whatever reason, tends to hold sway through weight of precedence. Cultural assessments of a food's safety and desirability can certainly change (see Yamin-Pasternak 2008, this issue), but not easily. Thus peanuts (*Arachis hypogaea* L.) and other tree nuts are in no immediate danger of being labeled poisonous despite causing more than 100 deaths a year in the United States alone (Sampson 2002), while field guide authors list *A. muscaria* as poisonous despite its edibility being solidly established in the 19th century. Furthermore, a particularly litigious culture (such as that of contemporary America) may function as an additional brake on the dissemination of unpopular but scientifically accurate information. The net result, evident in the mushroom edibility literature, is a climate of fear-based ignorance rather than knowledge-based caution. As Douglass (1917b:207) so pungently put it, "With bigoted abstinence on the one hand, with gourmandizing and gluttony on the other and perhaps a bad cook in the kitchen even the most innocent and well-meaning mushroom will acquire a bad reputation."

Field Guides: Science or Culture?

Food choices and cuisine lie at the heart of cultural, regional, and national identity, whereas the taxonomy of nature, at least in modern urban societies, does not. This dichotomy may explain why food choices tend to be resistant to change, while scientific taxonomy embraces change as proof of modernity. The accuracy of the taxonomic and nomenclatural information is scrupulously maintained in field guides from decade to decade because modernity confers credibility. If the taxonomy and nomenclature of a field guide are out-of-date, its credibility suffers, and readers may well doubt the knowledge of the author. The edibility determinations are a significant part of almost all mushroom field guides; indeed, without the edibility information their public appeal would be greatly reduced. Yet the edibility determinations are free from the need to be modern or accurate precisely because they are culturally derived and reflect what it means to be an American or English consumer of wild mushrooms, as opposed to a Chinese or Italian one. As but one example, when the field guide by Thomas (1928) was reissued in a new edition (Thomas 2003), the scientific nomenclature was updated, but the edibility information was not.

The disparity between field guides' treatment of mushroom morphology versus edibility can also be seen in the language. For example, *poisonous* is an intimidating word: attached to a potential foodstuff, it tends to discourage consumption. For the past 250 years, the primary meaning of "poison" has been a small amount of something that causes immense harm, even death (Oxford English Dictionary 2008), yet mushroom field guides routinely apply the label "poisonous" to a wide range of species including those that kill, those that merely upset one's stomach, and those that intoxicate. The imprecise language of mushroom edibility determinations (edible, poisonous) contrasts sharply with the highly precise terminology applied to the morphological features of mushrooms; for example, the surface ornamentation of a mushroom's stalk can be described as squamulose, scabrous, floccose, punctate, reticulate, or glandular-dotted. The difference in language further suggests that the high quality of analytical thought applied to questions of identification and morphology is not applied in the same measure to a mushroom's edibility, and is instead superseded by personal and cultural bias.

There is nothing inherently wrong with teaching edibility in terms of cultural practices as long as the bias is declared. However, modern field guides tend *not* to explicitly declare their bias as Curtis (1777-1798) did when he said of *Agaricus fimetarius* L., "It is not eaten with us." Instead, field guides tend to declare a mushroom species as "poisonous" or "not edible" as if it were an objective truth (see, for example: Lincoff 1981; Bon 1987; Phillips 1991; Jordan and Wheeler 1995; Bessette *et al*. 1997).

The problem of cultural bias in the evaluation of mushroom edibility was recognized in the 19th century when field guides were still a new genre. The Frenchman, Dr. Pouchet (1839), noted many instances in which the absolutist language of mushroom edibility asserted as fact the inedibility of a mushroom that was either published as edible by a different "expert," or was known to be eaten someplace else:

> According to Bulliard, the *Boletus cyanescens* [*Gyroporus cyanescens* (Bull.) Quél] is poisonous, while Bosc says that it is eaten in Piémont; *Agaricus necator* [*Lactarius necator* (Bull.) Pers], considered as a violent poison by many authors, was eaten by M. Letellier without the least problem, and Buxbaum says that the Russians make a great use of it. L'Agaricus acris [*Lactarius piperatus* (L.) Pers.], is also described as poisonous by a great number of specialists, and eaten in many places, according to M. Letellier.

Little has changed since 1839, as mushroom field guides continue to disregard ethnographic and scientific evidence of edibility in favor of an intellectually closed system for assessing mushroom edibility based on personal bias, the culinary and cultural practices of the author's home country, and the information presented in preceding field guides.

Furthermore, the field guide's literary form itself deceives. All of the information about each mushroom appears to derive from one set of objective facts led by the scholarly taxonomic binomial for each species. But while the Linnaean taxonomic system is concerned with mushroom morphology and phylogeny, the edibility determination and information are there to advise *cooks*, not taxonomists. Thus, two entirely different classification systems with different goals, each resting upon a different body of knowledge and arrived at using different methods, are deceptively intermingled; the taxonomic and descriptive information predominates (typically by a ratio of more than 5:1), and the edibility information derives much of its *gravitas* from being embedded in the former. Sitting under the taxonomic umbrella, the edibility information is shaded, as it were, from the glare of objective scrutiny. In summary, mushroom field guide authors teach the science of taxonomy. They *could* teach the science of edibility, but they don't. They teach a cultural lesson, and always have.

Field Guides and the Future

Field guide bias has been an impediment to sound scholarship, as we have shown for Michelot and Melendez-Howell (2003). It may have discouraged ethnographers from seeking information on the consumption of mushrooms they assumed could not be eaten, and it most certainly has limited the number of mushroom tastes, shapes, and textures available to cooks. Therefore, we support Samuel Thayer's (2006:12) insistence that field guide authors provide citations for every fact of edibility or toxicity not derived from personal experience. In his words,

> When the works of authors who abide by [this principle] come to supplant those of sloppy scholarship, the study of wild food plants will be taken seriously again, and the oldest and most beautiful pastime in history will rise from the ashes.

In the last century there has been a dramatic urbanization of the landscape, widespread destruction of mushroom habitat, and a radical transformation of the relationship between people and forests. Both authors have shared the company of traditional mushroom collectors on all the major continents, and, except in the most isolated villages, these people tend to collect many fewer species than their parents, and their parents collect fewer than the grandparents (see Guissou *et al*. 2008, this issue). As with so many practices related to forests, knowledge is being rapidly lost. But if we methodically hunt for the remnants of mushroom knowledge with the obsessive diligence we search for mushrooms hidden under forest leaves, we may still be able to preserve a broad record of human endeavor regarding wild mushroom edibility and preparation, and the role wild mushrooms have played in people's lives prior to mass urbanization. For this hunt we must use focused conferences, field work, laboratory experiments, and the many tools of the Internet to assemble and disseminate information about mushroom edibility and usage from all over the world.

We believe that concerted research will reveal that the record of mushroom usage is far richer, more intricate, and more varied than the modern literature would suggest. Bringing field guide edibility determinations in line with accurate ethnographic and toxicological scholarship would create a body of work that will both preserve culinary information that is at risk of being lost, and facilitate a new mushroom cookery based on the broadest possible definition of edibility. This might seem a daunting task, but it coincides with a renewed and growing interest in local and wild foods (Ghirardini *et al*. 2007) that challenges the homogenizing influences of globalization (a process occurring even with respect to wild mushrooms, as described by Sitta and Floriani 2008, this issue).

As the scope of orally-transmitted mushroom knowledge diminishes in countries where mushroom collecting has been widespread, field guides will play an increasingly important role in shaping human-mushroom relationships. They will supplant parents and village elders as the most significant and obvious sources for information on mushroom identification, ecology, and edibility; indeed, in some countries they already have. But greater influence entails heightened responsibility and a more pressing need to be accurate. For, as we have shown for *Amanita muscaria*, field guides not only reflect and reinforce cultural consensus, they forge it.

Acknowledgments

The authors wish to thank Denis Benjamin, Michael Beug, Eric Danell, Ivan Day, Dan Moerman, Glenn Shepard, Jr., and Andrew Weil for their assistance and helpful suggestions.

Literature Cited

1. Annals of Horticulture. 1848. Annals of Horticulture and Dear-Book of Information on Practical Gardening. Charles Cox, London.
2. Arora, D. 1979. Mushrooms Demystified: A Comprehensive Guide to the Fleshy Fungi of the Central California Coast. Ten Speed Press, Berkeley.
3. Arora, D. 1986. Mushrooms Demystified: A Comprehensive Guide to the Fleshy Fungi. 2nd ed. Ten Speed Press, Berkeley.
4. Arora, D. 1991. All that the Rain Promises and More...: A Hip Pocket Guide to Western Mushrooms. Ten Speed Press, Berkeley.
5. Arora, D. 2000. Funghi dal Mondo. Bollettino del Gruppo Micologico G. Bresadola Trento 43:38-40.
6. Atkinson, G. F. 1900. Mushrooms, Edible, Poisonous, etc. Andrus and Church, Ithaca, New York.

7. Badham, C. D. 1863. A Treatise on the Esculent Funguses of England, edited by F. Currey. Lovell Reeve and Company, London.
8. Benedict, A. L. 1908. Golden rules of dietetics; the general principles and empiric knowledge of human nutrition; analytic tables of foodstuffs; diet lists and rules for infant feeding and for feeding in various diseases. C. V. Mosby, St. Louis.
9. Benedict, R. G. 1972. Mushroom Toxins Other Than Amanita. Pages 281-320 in S. Kadis, A. Ciegler, and S. J. Ajl, eds., Microbial Toxins. Vol. 8. Academic Press, New York.
10. Benjamin, D. R. 1995. Mushrooms: Poisons and Panaceas - A Handbook for Naturalists, Mycologists, and Physicians. W. H. Freeman, New York.
11. Bessette, A. E., and W. Sundberg 1987. Mushrooms: A Quick Reference Guide to Mushrooms of North America. Macmillan, New York.
12. Bessette, A. E, A. R. Bessette, and D. W. Fischer. 1997. Mushrooms of Northeastern North America. Syracuse University Press, Syracuse, New York.
13. Bessette, A. R., A. E. Bessette, and W. J. Neill. 2001. Mushrooms of Cape Cod and the National Seashore. Syracuse University Press, Syracuse, New York.
14. Bon, M. 1987. The Mushrooms and Toadstools of Britain and Northwestern Europe. Hodder and Stoughton, London.
15. Boom, M. 2005. Re: San Francisco Chronicle Magazine article. www.tech.groups.yahoo. com/group/mssf/messages/9038 (17 March 2008).
16. Bowden, K., and A. C. Drysdale. 1965. A Novel Constituent of *Amanita Muscaria*. Tetrahedron Letters 612:727-728.
17. Briggs, R. 1792. The New Art of Cookery... Being a Complete Guide to All Housekeepers, etc. W. Spotswood, Philadelphia.
18. Brill, S. 2002. The Wild Vegetarian Cookbook. Harvard Common Press, Boston.
19. Canadian Food Inspection Agency. 2005. Food Safety Measures for Fiddleheads http://www. inspection.gc.ca/english/fssa/concen/specif/ fidcroe.shtml (15 July 2007).
20. Carter, W. S. 1901. The Physiological Action of Three Poisonous Toadstools - *Amanita Muscaria*, *Amanita Verna* or *Bulbosa*, and *Amanita Phalloides*. American Journal of Physiology 5:158-174.
21. Cetto, B. 1994. I Funghi dal Vero. Vol. 1. Arti Grafiche Saturna, Trento, Italy.
22. Christison, R. 1829. A Treatise on Poisons in Relation to Medical Jurisprudence, Physiology and the Practice of Physic. A. and C. Black, Edinburgh.
23. Cooke, M. C. 1880. Fungi: Their Nature and Uses. D. Appleton and Company, New York.
24. Cortin, B. 1942. Svampplockarens Handbok. Saxon and Lindström, Stockholm.
25. Coville, F. V. 1898. Observations on Recent Cases of Mushroom Poisoning in the District of Columbia. United States Department of Agriculture, Division of Botany, U.S. Government Printing Office, Washington, D.C.
26. Curtis, W. 1777-1798. Flora Londinensis. A non-paginated volume printed for and sold by the author; and B. White, bookseller, London.
27. Douglass, B. 1917a. Mushroom Poisoning. Torreya 1710:171-175.
28. Douglass, B. 1917b. Mushroom Poisoning (cont.). Torreya 1712:207-221.
29. Erowid. 2008. http://www.erowid.org/plants/ amanitas/amanitas.shtml (4 February 2008).
30. Eugster, C. H., G. F. R. Müller, and R. Good. 1965. Active Principles from *Amanita muscaria*: Ibotenic Acid and Muscazone. Tetrahedron Letters 623:1813-1815.
31. Fergus,C. L., and C. Fergus. 2003. Common Edible and Poisonous Mushrooms of the Northeast. Stackpole Books, Mechanicsburg, Pennsylvania.
32. Fischer, D. W., and A. Bessette. 1992. Edible Wild Mushrooms of North America: A Field-to-Kitchen Guide. University of Texas, Austin.
33. Galli, R. 1996. I Boleti. Edinatura, Milan.
34. Geml, J., G. A. Laursen, K. O'Neill, H. C. Nusbaum, and D. L. Taylor. 2006. Beringian Origins and Cryptic Speciation Events in the Fly Agaric (*Amanita muscaria*). Molecular Ecology 151:225-239.
35. Gerard, M. 1852. On the Deprivation of the Noxious Powers of Poisonous Mushrooms. The British and Foreign Medico-chirurgical Review 10:279-280.
36. Gerard, M. 1863. A simple means of removing the poisonous properties of suspicious mushrooms. The Half-yearly Abstract of the Medical Sciences: being a digest of British and Continental medicine, and of the progress of medicine and the collateral sciences 37:15-16.
37. Ghirardini, M., M. Carli, N. Del Vecchio, A. Rovati, O. Cova, F. Valigi, G. Agnetti, M. Macconi, D. Adamo, M. Traina, F. Laudini, I. Marcheselli, N. Caruso, T. Gedda, F. Donati, A. Marzadro, P. Russi, C. Spaggiari, M. Bianco, R. Binda, E. Barattieri, A. Tognacci, M. Girardo, L. Vaschetti, P. Caprino, E. Sesti, G. Andreozzi, E. Coletto, G. Belzer, and A. Pieroni. 2007. The Importance of a Taste. A Comparative Study on Wild Food Plant Consumption in Twenty-One Local Communities in Italy. Journal of Ethnobiology and Ethnomedicine 3:1.
38. Gibson, W. H. 1899. Our edible toadstools and mushrooms and how to distinguish them; a selection of thirty native food varieties, easily recognizable by their marked individualities, with simple rules for the identification of poisonous species. Harper and Brothers, New York.
39. Glasse, H. 1747. The Art of Cookery. 2nd ed. Printed for the Author, London.
40. Glick, P. 1979. The Mushroom Trail Guide. Holt, Rinehart, and Winston, New York.
41. Grande, A. D., R. Paradiso, S. Amico, G. Fulco, B. Fantauzza, and P. Noto. 2004. Anticholinergic Toxicity Associated with Lupin Seed Ingestion: Case Report. European Journal of Emergency Medicine 11:119-120.
42. Greville, R. K. 1823. Scottish Cryptogamic Flora. Edinburgh.
43. Groves, J. W. 1962. Edible and Poisonous Mushrooms of Canada. Canada Department of Agriculture, Ottawa.
44. Guild, B. 1977. The Alaskan Mushroom Hunter's Guide. Alaska Northwest Publishing, Anchorage.
45. Guissou, K. M. L., A. M. Lykke, P. Sankara, and S. Guinko. 2008. Declining Wild Mushroom Recognition and Usage in Burkina Faso. Economic Botany 62(3).
46. Güssow, H. T., and W. S. Odell. 1927. Mushrooms and Toadstools: An Account of the More Common Edible and Poisonous

Fungi of Canada. Ministry of Agriculture, Ottawa.
47. Hagara, L. 1987. Atlas Húb. Vydavatel'stvo Osveta, Martin, Slovakia.
48. Hall, I. R., S. L. Stephenson, P. K. Buchanan, W. Yun, and A. L. J. Cole. 2003. Edible and Poisonous Mushrooms of the World. Timber Press, Portland.
49. Hanaoka, K., K. Yosida, M. Tamano, T. Kuroiwa, T. Kaise, and S. Maeda. 2001. Arsenic in the Prepared Edible Brown Alga Hijiki, *Hijikia fusiforme*. Applied Organometallic Chemistry 156:561-565.
50. Hard, M. E. 1908. The Mushroom: Edible and Otherwise, Its Habitat and Its Time of Growth. Mushroom Publishing Company, Columbus, Ohio.
51. Hay, W. D. 1887. An Elementary Text-book of British Fungi. S. Sonnenschein, Lowrey, London.
52. Heilmann-Clausen, J., A. Verbeken, and J. Vesterholt. 1998. The Genus *Lactarius* (Fungi of Northern Europe, Vol. 2). Danish Mycological Society, Copenhagen.
53. Heim, R. 1963. Les Champignons, Toxiques et Hallucinogenes. Editions N. Boubee, Paris.
54. Hongo, T. and M. Izawa. 1994. Mushrooms. Yama-kei, Tokyo. In Japanese.
55. Ichikawa, S., M. Kamoshida, K. Hanoaka, M. Hamano, T. Matitani, and T. Kaise. 2006. Decrease of Arsenic in Edible Brown Algae *Hijikia fusiforme* by the Cooking Process. Applied Organometallic Chemistry 209:585-590.
56. Imazeki, R., Y. Otani, and T. Hongo. 1988. Fungi of Japan. Yama-kei, Tokyo. In Japanese.
57. Jacquat, C., and G. Bertossa. 1990. Plants from the Markets of Thailand. Editions Duang Kamol, Bangkok, Thailand.
58. Jordan, E. O. 1917. Food Poisoning. University of Chicago Press, Chicago.
59. Jordan, P., and S. Wheeler. 1995. The Ultimate Mushroom Book. Smithmark, New York.
60. Kauffman, C. H. 1918. The Agaricaceae of Michigan. Michigan Geological and Biological Survey, 5:26. (Reprinted 1971 by Dover Publications, New York, as the Gilled Mushrooms [Agaricaceae] of Michigan and the Great Lakes Region.)
61. Kawai, M., A. Okiyama, and Y. Ueda. 2002. Taste Enhancements between Various Amino Acids and IMP. Chemical Senses 27:739-745.
62. Krieger, L. C. 1936. The Mushroom Handbook. Macmillan, New York. (Reprinted in 1967 by Dover Publications, New York).
63. Kuo, K. 2007. 100 Edible Mushrooms. University of Michigan, Ann Arbor.
64. Lamarck, J. B. and P. Augustin. 1815. Flore française, ou, Descriptions succinctes de toutes les plantes qui croissent naturellement en France: disposées selon une nouvelle méthode d'analyse, et précédées par un exposé des principes élémentaires de la botanique. Desray, Paris
65. Lampe, K. F. 1979. Toxic Fungi. Annual Review of Pharmacology and Toxicology 19:85-104.
66. Letcher, A. 2007. Shroom: A Cultural History of the Magic Mushroom. Ecco, New York.
67. Lincoff, G. 1981. The Audubon Society Field Guide to North American Mushrooms. Chanticleer Press, Knopf, New York. Lincoff, G., and D. H. Mitchel. 1977. Toxic and Hallucinogenic Mushroom Poisoning: A Handbook for Physicians and Mushroom Hunters. Van Nostrand Reinhold, New York.
68. Lincoln, D. A. 1884. Mrs. Lincoln's Boston Cook Book. Roberts Brothers, Boston
69. Lindley, J. 1836. A Natural System of Botany, or, A systematic view of the organization, natural affinities, and geographical distribution, of the whole vegetable kingdom: together with the uses of the most important species in medicine, the arts, and rural or domestic economy. Longman, Rees, Orme, Brown, Green, and Longman, London.
70. Marshall, N. L. 1905. The Mushroom Book. A Popular Guide to the Identification and Study of Our Commoner Fungi, with Special Emphasis on the Edible Varieties. Doubleday, Page and Company, New York.
71. May, R. 1660. The Accomplisht Cook, or, the Art and Mystery of Cookery. Reprinted 1994, Prospect Books, Totnes.
72. McDonald, A. 1978. The Abuse of Drug Terminology. In B. Rumack and E. Salzman, eds., Mushroom Poisoning: Diagnosis and Treatment. CRC Press, West Palm Beach, Florida.
73. McIlvaine, C. and R. K. Macadam. 1902. One Thousand American Fungi. Bowen-Merrill, Indianapolis. (Reprinted in1973 by Dover Publications, New York).
74. McKenny, M., and D. E. Stuntz. 1971. The Savory Wild Mushroom. University of Washington Press, Seattle.
75. McKenny, M., D. Stuntz, and J. Ammirati. 1987. The New Savory Wild Mushroom. University of Washington, Seattle.
76. McKnight, K. 1987. A Field Guide to Mushrooms of North America. (The Peterson Field Guide Series: 34). Houghton Mifflin, Boston.
77. Michelot, D., and L. M. Melendez-Howell. 2003. *Amanita muscaria*: Chemistry, Biology, Toxicology, and Ethnomycology. Mycological Research 107:131-146.
78. Miller, O. K. 1972. Mushrooms of North America. Dutton, New York.
79. Miller, O. K., and H. Miller. 2006. North American Mushrooms: A Field Guide to Edible and Inedible Fungi. Falcon Guides, Guilford, Connecticut.
80. Millman, L., and T. Haff. 2004. Notes on the Ingestion of *Amanita muscaria*. Mushroom: The Journal of Wild Mushrooming 223:55.
81. Mitchel, D. H. 1980. *Amanita* Mushroom Poisoning. Annual Review of Medicine 31:51-57.
82. Oda T., C. Tanaka, and M. Tsuda. 2004. Molecular Phylogeny and Biogeography of the Widely Distributed *Amanita* Species, *A. muscaria* and *A. pantherina*. Mycological Research 108:885-896.
83. Oxford English Dictionary. 2008. (J. Simpson, Chief Editor). Oxford University Press, Oxford. (Electronic resource)
84. Pallas, P. S. 1794. Voyages du professeur Pallas dans plusieurs provinces de l'empire de Russie et dans l'Asie septentrionale. 2006. Elibron Classics, USA.
85. Papetti, C., G. Consiglio, and G. Simonini. 1999. Funghi d'Italia. Fondazione Centro Studi Micologici Dell' A.M.B. Vicenza.
86. Pearson, L. C. 1987. The Mushroom Manual. Naturegraph Publishers, Happy Camp, California.
87. Peck, C. H. 1895. Annual Report of the State Botanist 1895. University of the State of New York, Albany.
88. Phillips, R. 1981. Mushrooms and Other Fungi of Great Britain and Europe. Pan Books, London.
89. Phillips, R. 1991. Mushrooms of North America. Little, Brown and Company, Boston.
90. Phipps, A. 2000, Japanese Use of Beni-TenguDake (*Amanita muscaria*) and the Efficacy of Traditional Detoxification Methods. Master's thesis, Biology Department, Florida International University.

91. Porcher, F. P. 1854. The Medicinal, Poisonous, and Dietetic Properties of the Cryptogamic Plants of the United States. Being a report made to the American Medical Association, at its sessions held in Richmond, Va., and St. Louis, Mo. Baker, Godwin and Co., New York.
92. Pouchet, F. A. 1839. Expériences sur L'Alimentation par les Champignons Vénéneux. Journal de chimie médicale, de pharmacie et de toxicology V. 322-328.
93. Prentiss, D. W. 1898. Five Cases of MushroomPoisoning, Three of Which Proved Fatal; Treatment of the Poisoning.. The Philadelphia Medical Journal. September 24:607-611.
94. Randolph, M. 1836. The Virginia Housewife; or, Methodical Cook. Stereotype. J. Plaskitt, Baltimore, Maryland.
95. Reese, J. J. 1874. A Manual of Toxicology, including the Consideration of the Nature, Properties, Effects, and Means of Detection of Poisons, more especially in their Medicolegal Relations. J. B. Lippincott and Co., Philadelphia.
96. Rombauer, I., M. R. Becker, and E. Becker. 2006. Joy of Cooking. Scribner, New York.
97. Rorer, S. T. H. 1902. Mrs. Rorer's New Cook Book: A Manual of Housekeeping. Arnold and Company, Philadelphia.
98. Rubel, W. 2000. http://www.williamrubel.com/ mushrooms/amanita-muscaria/ (16 May 2007).
99. Rumack, B. H., and E. Salzman. 1978. Mushroom Poisoning: Diagnosis and Treatment. CRC Press, West Palm Beach, Florida.
100. Sampson, H. A. 2002. Peanut Allergy. The New England Journal of Medicine 34617:1294-1299.
101. Schwab, A. 2006. Mushrooming Without Fear. Merwin Unwin Books, Ludlow, U.K., and Skyhorse Publishing, New York.
102. Sitta, N. and M. Floriani. 2008. Nationalization and Globalization Trends in the Wild Mushroom Commerce of Italy with Emphasis on Porcini *(Boletus edulis* and Allied Species). Economic Botany 62(3).
103. Smith, A. H. 1948. Mushrooms in Their Natural Habitat. Hafner Press, New York.
104. Smith, A. H. 1958. The Mushroom Hunter's Field Guide. University of Michigan Press, Ann Arbor.
105. Smith, A. H. 1963. The Mushroom Hunter's Field Guide. Revised and enlarged. University of Michigan Press, Ann Arbor.
106. Smith, A. H. 1975. A Field Guide to Western Mushrooms. University of Michigan Press, Ann Arbor.
107. Smith, A. H., and N. S. Weber. 1980. The Mushroom Hunter's Field Guide. All color and enlarged. University of Michigan Press, Ann Arbor.
108. Solomon, C., and N. Solomon. 1998. Charmaine
109. Solomon's Encyclopedia of Asian Food. Periplus Editions, Boston.
110. Southern Society for Clinical Investigation (U. S.). 1853. The American Journal of the Medical Sciences. J. B. Lippincott, Philadelphia.
111. States, J. S. 1990. Mushrooms and Truffles of the Southwest. University of Arizona, Tucson.
112. Takemoto, T., Y. Nakajima, and T. Yokobe. 1964. Isolation of a Flycidal Constituent Ibotenic Acid from *Amanita muscaria* and *A. pantherina*. Yakugaku Zasshi 84:1233-1234.
113. Tat'jana, I. 2007. llustrirovannaja Enciclopediya: Sobiraem i Gotovim. Eksmo, Moscow. In Russian.
114. Taylor, A. S. 1859. On Poisons in Relation to Medical Jurisprudence and Medicine. 2nd American edition, from 2nd London edition. Blanchard and Lea, Philadelphia.
115. Testi, A. 1995. Il Libro dei Funghi D'Italia. Demetra, Colognola.
116. Thayer, S. 2006. The Forager's Harvest: A Guide to Identifying, Harvesting, and Preparing Edible Wild Plants. Forager's Harvest, Ogema, Wisconsin.
117. Thiers, H. D. 1987. Alexander H. Smith, 1904-1986. Mycologia 79:811-818.
118. Thomas. W. S. 1928. Field Book of Common Gilled Mushrooms, with a Key to Their Identification and Directions for Cooking Those That Are Edible. G. P. Putnam's Sons, New York.
119. Thomas. W. S. 2003. Field Guide to Mushrooms: Based on Field Book of Common Mushrooms. Revised, updated, and with illustrations and photographs by Marie F. Heerkens, ed. Sterling Publications, New York.
120. von Frieden, L. 1964. I Funghi di Tutti I paesi. Rizzoli, Italy. Reprinted in English as Mushrooms of the World, 1969, Bobbs-Merrill, Indianapolis.
121. von Strahlenberg, P. J. 1736. An histori-geographical description of the north and eastern part of Europe and Asia; but more particularly of Russia, Siberia, and Great Tartary. Faithfully translated into English. London.
122. Wasson, R. G. 1968. SOMA: Divine Mushroom of Immortality. Harcourt Brace Jovanovich, New York.
123. Wasson, V. P., and R. G. Wasson. 1957. Mushrooms, Russia, and History. Pantheon Books, New York.
124. Wharton, F., M. Stillé, and A. Stillé. 1860. A Treatise on Medical Jurisprudence. 2nd ed. rev. Kay and Brother, Philadelphia.
125. Wharton, F., M. Stillé, S. Ashurst, R. Amory, and W. Sinkler. 1873. Wharton and Still&eaeacute;'s Medical Jurisprudence. Vol. 2. Kay and Brother, Philadelphia.
126. Wharton, F. and M. Stillé. 1882. A Treatise on Medical Jurisprudence. Kay and Brother, Philadelphia.
127. Whetstone, M. S. 1898. The Mushroom as Food. Annual Report of the Minnesota State Horticultural Society, XXVI: Minneapolis, Office of the Library.
128. Wiley, H. W. 1917. Foods and Their Adulteration; Origin, Manufacture, and Composition of Food Products; Infants' and Invalids' Foods; Detection of Common Adulterations. P. Blakiston's Sons and Co., Philadelphia.
129. Yamin-Pasternak, S. 2008. From Disgust to Desire: Changing Attitudes Toward Beringian Mushrooms. Economic Botany 62(3).

Further Reflections on *Amanita muscaria* as an Edible Species

by

Debbie Viess

original text: https://www.mushroomthejournal.com/amanita-muscaria-edibility/

Table of Contents:

Field Guide Bias Si! *Muscaria* as a Safe Edible Species No!
"Edible" *Amanita muscaria*: A Recipe for Disaster?
Redefining Poisonous to Exempt *Muscaria*
Recent North American Deaths Linked to *Amanita Muscaria* Ingestions
Recent *Muscaria* Deaths in the Southern Hemisphere
Our Most Famous North American *Muscaria* Fatality
Evidence for *Amanita muscaria* as a Poisonous Mushroom
Attitudes about Eating *Amanita muscaria* from Outside of North America
A Food of Desperation in Italy
Pouchet's Place in History
Amanita muscaria Consumption in Japan: Exception not the Rule
Limited Historical Evidence of *muscaria* Consumption in North America
Amanita muscaria Fed to Participants in Arora Forays
Peer Reviewed is not the Same as Peer Approved
Evaluate All of the Evidence and Decide for Yourselves
Muscaria Treatment in American Mushroom Field Guides
Acknowledgments
References

Over twenty five years ago, a tiny perfect grisette seduced me into the world of mushrooms. Barely three inches tall, it glowed pearly gray and grew from the middle of my favorite Bay Area hiking trail. The sight of it drew me to my knees. It was too beautiful to disturb, so I sketched it on a bank deposit slip, the only scrap of paper that I had with me. I carried that paper in my wallet for years and eventually identified it as a grisette, a member of the *Amanita vaginata* group, one of the many edible amanita species found here in California.

The hook was set, and amanitas in the wild continued to intrigue me. I obsessively read mushroom field guides, paying particular attention to the amanitas. A desire to eat what I had tentatively identified as a "Coccora" (*Amanita calyptroderma*), a locally popular edible amanita, coupled with a strong sense of self-preservation, caused me to join a local mycological society and begin my mushroom studies in earnest.

Since then, I have become a proponent of the safe and mindful collection and consumption of various edible California amanita species, as well as a mushroom poison identifier and mushroom educator, and I continue to have an abiding passion for all of the members of the genus *Amanita*. It was therefore with great interest that I first learned of the paper discussing *Amanita muscaria* and its use as food by William Rubel and David Arora, in the October 2008 special mushroom issue of the journal *Economic Botany*.

For as long as I have known him, David Arora has recounted the story of the modern day treatment of *muscaria* as an edible species in the Nagano Prefecture of Japan. Along with many others who attended his lectures and forays, I was fascinated by the concept. I was also aware of the many instances of serious *muscaria* poisonings that have occurred both through the ages and in modern times, so I was curious how their argument in the *Economic Botany* paper would proceed.

The title of the article was "A Study of Cultural Bias in Field Guide Determinations of Mushroom Edibility Using the Iconic Mushroom, *Amanita muscaria*, as an Example." The authors start by noting that there is a broad scientific acceptance that *muscaria* toxins are water soluble, and that there are a few isolated practices of people around the world detoxifying and eating *Amanita muscaria*. From this they conclude that somehow "cultural bias" causes North American field guide authors to continue to list *muscaria* as a poisonous rather than edible species (Rubel, Arora, 2008).

But is this really a case of "cultural bias," or is it just good, common sense?

The basic hypothesis of field guide authors' mushroom edibility bias is sound. Any mushroom book that deals with edibility preferences is subject to the whims of its author: their culinary experience, personal judgment, and prevailing opinions all help to determine poisonous and edible designations. Since no one wants to recommend a mushroom that might be harmful to others, it is in everyone's best interest for field guide authors to err on the side of caution, even if you might be aware of exceptions to the rule.

As I read Rubel's arguments and selected quotes in his *muscaria* paper, my uneasiness grew. His several attempts to redefine the word "poisonous" so that it didn't apply to *muscaria* were disturbing. His suggestion that future mushroom book authors should list *muscaria* as an edible species, and that it would be perfectly unremarkable to do so, was also troubling. Do we really want to encourage folks to use less caution about known poisonous species, even if, as mycophagists of long standing, we may know of ways to circumvent these poisons? And finally, I wasn't buying the premise that *muscaria* was commonly accepted as a perfectly safe edible species anywhere in the world.

Amanita muscaria is one of the most beautiful and eye-catching mushrooms found any where. Although *muscaria* is a seriously toxic mushroom, its most abundant toxins - ibotenic acid and its decarboxylation by-product muscimol - are water soluble, and can be leached from the mushroom flesh through careful and prolonged boiling.

Let us note in passing that this method of preparation of course does not work for the deadly, amatoxincontaining, world-spanning amanitas collectively called "Death Caps" and "Destroying Angels." The highly stable and supremely toxic amatoxin molecule is impervious to heat, cold, or acid bath. Amatoxins cannot be removed from mushroom flesh through par-boiling or any other sort of heat or cooking process. Certainly, no one would want to have novice amanita mycophagists generalizing the *muscaria* parboiling detoxification process to these sorts of unequivocally deadly, albeit also delicious tasting, amanita species.

As for *muscaria*, it is true that very small numbers of people around the world have indeed discovered that it can be made edible through careful and sometimes elaborate preparation; but it is also imperative to remember to throw out the water into which the toxins were leached. One American couple who forgot to do so became seriously intoxicated, to the point of damaging both themselves and their household (Beug, 2010)!

Field Guide Bias Si! *Muscaria* as a Safe Edible Species No!

On these basic points (water soluble toxins in *muscaria*, field guide bias) I think that we can all agree. But rather than going on to demonstrate how most field guide authors show bias in all of their edibles' designations, the Rubel/Arora paper chose to present an elaborate justification for the treatment of *muscaria* as a perfectly safe edible species. The authors based this hypothesis upon the evidence that they selected, but I will show that this evidence is incomplete and therefore insufficient for declaring *muscaria* to be a perfectly safe edible species.

As an intellectual exercise, digging through dusty tomes to find a few scattered references to folks who ate *muscaria* as food in the course of history can make interesting reading. Conjecture can be strengthened by selective examples to support a hypothesis. However, it is difficult to prove a hypothesis beyond the shadow of doubt through the fog of centuries. What becomes troubling is when this conjecture and conflation of anecdotal evidence gets stamped with the imprimatur of someone of David Arora's stature, a man to whom many look for answers to mycological questions, especially in terms of mushroom edibility.

The authors' central hypothesis of the purported safe edibility of *Amanita muscaria* soon left the relative obscurity of subscribers to *Economic Botany*, and traveled to the boundless territory of the Internet, with links to the paper on both Rubel's and Arora's websites, in addition to many other places online, such as Wikipedia, Springerlink.com, Ingentaconnect.com, Discoverlife. org, Tititudorancea.org, etc.. Now the paper, with what I believe to be major misconceptions, was being referenced by a wide variety of mushroom enthusiasts worldwide as "common knowledge," and a recipe for the "safe" preparation of *muscaria* was freely shared.

"Edible" *Amanita muscaria*: A Recipe for Disaster?

As public educators, on a topic that is mostly unknown here in North America, I believe that we must consider the impact of our words. Although many experienced mushroomers are aware of the fact that it is possible to remove the toxins from *Amanita muscaria*, it is naïve at best to assume that people will always carefully follow a recipe, especially one that includes a potentially dangerous mushroom. Ironically enough, even the original *muscaria* detoxification recipe that Rubel and Arora provided in the *Economic Botany* article had important numerical conversion errors, listing 250 gm. of *muscaria* as the equivalent of 4 ounces. In the online version of this paper, linked to from his website, Arora changed the amount of *muscaria* in the recipe to the correct weight of 110 gm. (Arora, 2009).

Yet even a perfectly reasonable recipe can have unreasonable translation into a real-time meal. If many folks have difficulties following any recipe, why start with a troublesome and sometimes even dangerous ingredient? I know of at least four folks who had unpleasant experiences after attempting to detoxify *muscaria* at home. One told me of her experiences directly, another wrote it up in great and glorious detail online (Konecney, 2009), and two others published their story in *Mushroom, the Journal of Wild Mushrooming* (Millman, Haff, 2004). Even the recent book *Mycophilia* by Eugenia Bone describes a less than ideal experience (waking up in a chair not remembering anything) after eating *muscaria* as an "edible" species, with two well known Western amateur mycologists who brought the *muscaria* to her vacation home in Colorado (Bone, 2011). Do you think they got the recipe wrong, too, or perhaps didn't care if it ended with the diners in a *muscaria* dream state?

What seems to be a fairly obvious factor that the authors failed to consider was this: the vast majority of folks who would even want to try *muscaria* as an edible are undoubtedly already primed for eating *muscaria* as an entheogen (in layperson's terms: to get high). In other words, they would have even less reason to want to follow exactly the elaborate procedures necessary to make this mushroom wholly non-toxic. For these "psychonauts," a nice, neurotoxic poisoning could be looked upon as a bonus. Pity those poor folks who just want a nice mushroom meal for their families, though, and not a trip to the emergency room. Wouldn't a bit of warning be in order for them?

Redefining Poisonous to Exempt *Muscaria*

According to Rubel , one shouldn't even consider *muscaria* to be poisonous, at least in the strict sense. After all, a small piece won't kill you (Rubel, Arora, 2008). But in fact, although seldom fatal (its deadly designation in many older field guides does indeed seem like "overkill" to most) *muscaria* can certainly be dangerously toxic.

I botenic acid-containing mushrooms (*Amanita pantherina* and *A. muscaria* and their close relatives) are a major cause of serious mushroom poisonings, especially in the Pacific Northwest, often resulting in hospitalizations (Benjamin, 1995; Beug, 2006; Spoerke *et al*, 1994). Usually, these poisonings are self-limiting. The folks who were poisoned, regardless of the reason the mushroom was eaten, have no wish to repeat the experience.

Recent North American Deaths Linked to *Amanita Muscaria* Ingestions

Sometimes the unforeseen results of eating *muscaria* are more serious than "merely" an unpleasant poisoning and hospital stay. The National Poison Data System for 2004, established by the American Association of Poison Control Centers (AAPCC), listed a fatal outcome for a young man who ate 6-10 freeze-dried *muscaria* caps (Watson, 2004). He was discovered in cardiac arrest, and died 10 days later from anoxic brain injury. Another fatal *muscaria* poisoning case from 2007, recounted in a NAMA Toxicology Committee Report in the 2009 issue of *McIlvainea*, tells of an otherwise healthy young man who died twelve hours after ingesting 6 or 7 *muscaria* caps. After falling into a *muscaria*-induced swoon the night before, he was found dead in bed the next morning. The medical examiner who autopsied the corpse labeled it death by mushroom poisoning, since he could find no other contributing cause of death (Beug, 2009), although since there were other drugs involved, the exact cause of death remained unclear (Beug, 2012).

Blithe assurances of the safe and unremarkable edibility of *muscaria* would be cold comfort indeed to the families of the two separate cases of young men who ate *muscaria* and then fell into comas. While in this helpless state, one froze to death while camping, and the other died after aspirating vomitus (Beug, 2006).

In a more recent case, recounted to me by Marilyn Shaw, toxicology expert and poison identifier for the Rocky Mountain Poison Control, a young man in Aurora, Colorado narrowly escaped death when he was discovered naked and unconscious, with a severely lowered body temperature and in cardiac arrest, after the recreational ingestion of *muscaria* (Shaw, 2012).

Who knows how many other incidental deaths after *muscaria* ingestion there may have been? Testing for muscimol levels is hardly part of a coroner's normal toxicology panel (Benjamin, 2012).

Recent *Muscaria* Deaths in the Southern Hemisphere

Documented deaths from the ingestion of *Amanita muscaria* are not restricted to North America. Formerly found only in the Northern hemisphere, *Amanita muscaria* has been inadvertently introduced to the Southern hemisphere in *Pinus* tree farms, producing a novel, toxic species of red amanita in places where no ibotenic acid-containing amanitas have been found before. This has had tragic consequences in Tanzania, where locals had safely gathered a number of choice, edible amanita species for many generations, without a thought to careful identifications. Often only the amanita caps were gathered, leaving the bases buried. A *muscaria* cap in age, with its warts removed and with a striate margin, can closely resemble local edible species in Amanita section Caesarea.

While Finnish mycologists were in Tanzania describing some of these local, edible amanita species for science, they consulted on a *muscaria* poisoning case, where two women and a child were poisoned and in hospital. After reassuring doctors that the poisonings would resolve on their own, since that was indeed their experience with *muscaria* poisonings in Scandinavia, they were horrified to learn that one of the women died from her meal the next day. Upon further interviews with other Tanzanian locals gathering amanitas, they discovered even more recent *muscaria* deaths (Harkonen, 1994).

Our Most Famous North American *Muscaria* Fatality

If one is willing to go back a little over a hundred years ago, you discover the unfortunate death of Italian diplomat Count de Vecchj, who requested amanita mushrooms from the Virginia countryside for his breakfast, believing them to be local examples of *Amanita caesarea*. Unfortunately, the mushrooms that were brought to and consumed by the Count were not the choice, edible *caesarea* of Italy, but the toxic *muscaria*, and the Count ate a gluttonous meal of somewhere between a dozen and two dozen caps, which resulted in convulsions so great that he broke his hotel bed (Rose, 2006).

The Count, who prided himself upon his mushroom identification skills, died from his meal. Out of his death and its ensuing lurid and widespread publicity, sprang a renewed North American interest in mushroom societies, especially in the Northeast, to provide much needed public education about edible and poisonous wild mushrooms (Rose, 2006).

On the face of all of this evidence to the contrary, it is disingenuous at best to consider *muscaria* to not be a poisonous mushroom. But poisonous is an off-putting word, pleads Rubel, a fan of *muscaria* eating to be sure.

Evidence for *Amanita muscaria* as a Poisonous Mushroom

In his *muscaria* paper, Rubel states: "Listing *A. muscaria* as edible rather than poisonous is a completely unremarkable judgment in a culinary context." Here is how Rubel describes the effects of *muscaria* ingestion on his website:

> "*Amanita muscaria* is not poisonous in the sense that it can kill you. It is poisonous in the sense that if not parboiled in plentiful water (the "toxins" are water soluble), then raw or undercooked mushrooms eaten (in moderation) will cause you to become inebriated and possible nauseous" (Rubel, 2011).

The above statement assumes that future *muscaria* eaters, perhaps lulled into complacency by assurances that *muscaria* isn't *really* poisonous, will use moderation and carefully follow a recipe. But wouldn't a stronger emphasis on its very real toxicity be a better way to get any future *muscaria* mycophagists to be cautious in its preparation and consumption? Or maybe reject the idea of eating *muscaria* as an edible species altogether?

Here's what the *Emergency Physicians Monthly* website had to say about *Amanita muscaria* and the many ibotenic acid poisonings that they have collectively observed:

> A toxic dose in adults is approximately 6 mg. muscimol or 60 mg. ibotenic acid - the amount found in one cap of *Amanita muscaria*. However, the amount and ratio of chemical compounds per mushroom varies widely from region to region and season to season. Spring and summer mushrooms have been reported to contain up to 10 times as much ibotenic acid and muscimol compared to autumn specimens. Toxic components are not distributed uniformly in the mushroom. Most of the muscimol and ibotenic are contained in the cap or pileus. A fatal dose has been calculated at approximately 15 caps.

Fly agarics are known for unpredictable clinical effects which can be highly variable between individuals exposed to similar doses. Symptoms typically appear after 30 to 90 minutes and peak within three hours. Certain effects can last for days, but the majority of cases completely recover within 12 to 24 hours. Unlike other toxic mushroom ingestions, vomiting is uncommon. Patients may exhibit ataxia, auditory and visual hallucinations (described as sliding vision and "the ability to see through walls"), as well as hysteria. Central nervous system depression, coma, myoclonic jerking, hyperkinetic behavior, and seizures have been described in larger doses. Retrograde amnesia and somnolence can result following recovery. (Erickson, 2010)

Whoa, that sounds rather more unpleasant than "inebriation" and "mild nausea," doesn't it?

Let's take the informed opinion of another North American mycologist and toxicologist, Michael Beug, PhD. Beug fields poisoning calls in the Pacific Northwest, where muscimol poisonings account for the majority of all serious mushroom poisonings. He had also heard that some Russians living outside Moscow eat detoxified *muscaria* as an edible species (through the work of R. Gordon Wasson and later from Dr. Daniel Stuntz), but he doesn't know how many do so, nor to what degree this is practiced. Here is what Beug had to say about eating *Amanita muscaria*:

Both *Amanita muscaria* and *Amanita pantherina* are large, showy, and delicious, though poisonous mushrooms (unless cooked by boiling them and then discarding the water, but if you don't get rid of *all* the water, look out!). Though some people in Russia apparently parboil and eat *Amanita muscaria*, it is not a practice I recommend. *Amanita muscaria* and *Amanita pantherina* are frequently eaten intentionally by people seeking to get high and are also frequently eaten by mistake (believe it or not, often from people thinking they had an *Agaricus*). The "trip" from *Amanita muscaria* and *Amanita pantherina* is generally not pleasant and involves hospitals more predominately than hallucinations. (Beug, 2004)

Attitudes about Eating *Amanita muscaria* from Outside of North America

A very different viewpoint of Russian fungal proclivities is provided by Gary Lincoff, mycologist and author of *The Audubon Society Field Guide to North American Mushrooms*. Lincoff and a group of 15 or so others traveled to the Kamchatka Peninsula of Russia in 2004 and 2005. Their purpose was to investigate firsthand the statements made by Gordon Wasson about *Amanita muscaria* use in Siberia, taken from his 1968 book, *Soma: Divine Mushroom of Immortality*. Here is what Lincoff had to say about local attitudes towards *muscaria*:

> The hunter-gatherer peoples differ from the Russians in many ways but none more dramatic than in their use of mushrooms. The Russians hunt many kinds of edible mushrooms but avoid one mushroom in particular, the fly-agaric, *Amanita muscaria*, which they regard as very poisonous. In fact, it is used in Russia and Europe as a fly-killer: the mushroom is placed in a cup of milk to which flies are attracted and become numbed. The hunter-gatherers, on the other hand, collect and eat just one single mushroom, the same fly-agaric that the Russians avoid. (Lincoff, 2005)

The Eastern Siberian Koryak and Even (or Evensk) tribes, the hunter-gatherers to which Lincoff refers, eat their *muscaria* sun-dried and uncooked, for maximum mind-altering potency. It is used as a sort of tonic within that traditional society, especially by the elderly. It is not eaten as a food species, but as medicine.

Russian mycologist Tatiana Bulyankova, a scientist from Western Siberia who has been contributing field observations to the popular website Mushroomobserver.org, sent me a long letter about firsthand Russian mushroom eating practices. She also spoke laughingly about how in Russia, American field guide authors were roundly ignored, and warned me that it was pretty impossible to generalize anything about a country the size of Russia, or as she put it, 1/7 of all land mass. Point taken, Tatiana!

Here is what she had to say about *Amanita muscaria*:

> The Fly Agaric, predictably, is very common here (and everywhere else in cold to temperate-climate Russia, I guess). It is the symbol of all toxic mushrooms here, I'd even say it's the symbol of poison. It's featured in countless books, cartoons, artworks... everyone knows that it's poisonous. Of course there are young idiots who try it as a recreational drug but that's a bad influence of the Internet, I guess. It's also consumed by tribe shamans of Yugra, Yakutia and other Northern territories but it's something I've only read in the books. (Bulyankova, 2011)

I think we may safely draw the conclusion that even in obsessively fungiphilic Russia, the commonsense cultural bias is *against* eating *Amanita muscaria* as an edible.

A quick survey of various field guides and online sources where the eating of *muscaria* as an edible species is mentioned shows very little empirical or even local evidence to bolster the claims - most *muscaria* eating was reported from elsewhere. A modern Lithuanian field guide stated that *muscaria* was poisonous, but also: "eaten in mountainous France and Austria." No word about Lithuanian edibility practices, though, despite an apparent historical tradition of *muscaria* inebriation.

The main market for *muscaria* in Eastern Europe seems to be in high potency, dried *muscaria* caps, harvested in Latvia and Bulgaria, and then sold online for "scientific purposes." Beware of what is sometimes deadly home research.

George Atkinson, in his 1900 mushroom book *Studies in American Fungi*, claimed that *muscaria* was: "eaten as food in parts of France and Russia, and sometimes in North America," but again, this is repeating information drawn from other sources without explicit verification of facts.

Bruno Cetto's more recent Italian mushroom guide, *I Funghi dal Vero*, Vol. 1, claims that *muscaria* was "eaten cooked and pickled in Russia, France and the Lake Garda region" of Italy. Again, there is no verification of these claims; and the information appears to be merely copied from one source to another without citation. There may well be a very few folks in Russia that eat *muscaria* as an edible species, and perhaps Pouchet (detailed later in this essay) managed to convince some of the poor to do so in France as well, but these are hardly widespread practices.

A Food of Desperation in Italy

Attempting to track down some of the Italian *muscaria* eating references from the Lake La Garda region, (prior to WWII), I came up with the following, from Pierluigi Cornacchia's online article, "*L'Amanita muscaria in Italia*". This modern day writer remarks upon the difficulty of tracking down these old references, even within Italy, and lists many local variations of common names for *muscaria*, all of which refer to its poisonous properties. Here are two quoted instances where locals in the past had detoxified and eaten *muscaria* (Cornacchia, 2006):

> F. Cavara (1897) confirmed that in Vallombrosa (Firenze) *Amanita muscaria* was commonly consumed and stated, "I can assure you that many report, in some countries of Tuscany, for example above Pontassieve, in late autumn, this agaric is harvested in quantity and put to soak in basins where water is changed every day, for 10 or 12 days, after that is treated like other edible fungi and found excellent. It helps [in the preservation] that the season is cold."
>
> This information has been verified directly in the field. I have been collecting testimonies of elderly inhabitants of the villages of Reggello, Saltino, Pian di Melosa and Vallombrosa. The ovolo malefic ["evil egg"],[1] as it is called in those parts, was usually consumed after appropriate preparations (boiling with vinegar, salting, rinsing with running water). According to the testimonies, the use of this fungus as food, which lasted until the beginning of World War II, was due solely to the economic problems.
>
> [1] Presumably the good mushroom eggs in that part of the country would be caesarea or the Coccora. - LS

In other words, the *ovolo malefic* was a food of desperation, and the preparation needed to make it edible was hardly trivial.

Pouchet's Place in History

Another country for which the historical and "culturally accepted" practice of eating *muscaria* has been claimed is France. Although I could find zero evidence of current *muscaria* eating practices, and in fact a respected French mycologist of my acquaintance scoffed at the very idea (Wuilbaut, 2012), in his *muscaria* paper Rubel devoted a good bit of ink to the work of a Frenchman and scientist who apparently tried to popularize *muscaria* eating amongst the poor in the 1800s: Félix Archimède Pouchet.

Pouchet in his time - like Rubel in ours - equated the preparation of and eating of poisonous *muscaria* to poisonous manioc, a staple food across Africa. Manioc starts out deadly poisonous and is made edible through careful preparation. But this is a poor analogy. Nobody in modern day North America *needs* to eat *muscaria* to survive. Fresh or dried, dangerously poisonous, cyanide containing manioc is often the only high quality starch available to millions, mostly across Africa, where it can be grown in poor soil and under drought conditions. Its deadly toxins also discourage crop predation. But it can have faulty preparation as well, and can cause some very serious illnesses.

Perhaps, like me, you had never heard of Pouchet? He was indeed a respected scientist of his time, and a popular science writer, but also one of the strongest proponents of the theory of spontaneous generation. Would it be safe to hold the rest of his science up to a modern light?

To prove that *muscaria* was a safe edible species, he fed dogs both *muscaria*-infused broth (to show that *muscaria* toxins were water soluble; the dogs died) and boiled and drained *muscaria* (the dogs survived) (Pouchet, 1839). He also claimed to have "fattened dogs" on boiled *muscaria*, but experimental details for that experiment were not available and fortunately for local dogs, none of these experiments were repeated, to my knowledge, by any other researchers. Pouchet's work was widely cited by others at the time (Rubel, Arora, 2008). But do a few dog studies really translate to human safety?

If *muscaria* was such a wonderful and safe edible species, why would Pouchet limit its use to the poor?

Pouchet is best known today for being a fierce public critic of Louis Pasteur, another scientist of the day who publicly disputed the commonly held theory of spontaneous generation. Pasteur was, of course, the French scientist who managed to keep lots of folks from dying in various horrible ways, by creating the process of pasteurization that prevented formerly widespread milk fevers (typhoid and scarlet fever, septic sore throat, diphtheria, and diarrheal diseases) and for creating life-saving vaccines against the scourges of rabies and anthrax (Swayze and Reed, 1978).

Pasteur gave a public demonstration, to which Pouchet was formally invited, to prove once and for all that it was in fact microorganisms, not spontaneous generation, that created life where there was apparently none before. Pasteur gave birth to the science of microbiology.

Pouchet was a no-show at this triumphant exhibition by Pasteur, but he did give us boiled *muscaria* for the poor as *his* legacy.

Sketchy historical evidence, couched in terms of "it is said" and "it is reported that" of *muscaria* eating around the world should not be used to bolster claims of its safety. There is no evidence that it was ever a commonly accepted edible species anywhere in the world, and for good reason.

Amanita muscaria Consumption in Japan: Exception not the Rule

What about in Japan, specifically the Nagano Prefecture, where the consumption of *muscaria* as an edible species is often cited?

I first learned about the unusual practice of mundane (as opposed to ritual) *muscaria* munching in David Arora's annual Mendocino Thanksgiving Foray, an event that I attended, both as a participant and as staff, for over a dozen years running. The story that he told was both fascinating and charming: he claimed to have passed local mushroom hunters along a Nagano mountainside, whose baskets were filled with *muscaria*. Arora's basket brimmed with *Boletus edulis*, and they both looked at each others' finds in horror! Great theatre, but what is the deeper reality?

While visiting the Nagano Prefecture, Arora tried the *muscaria* pickles that are a traditional but in fact seldom eaten food. Nagano Prefecture is the only Japanese province wholly cut off from the sea. The practice of pickling *muscaria* began after "salt roads" were built from the coast into the mountains over a hundred years ago.

In addition to Arora's experiences there, a young man by the name of Allan Phipps, who spoke and understood the Japanese language, spent a good bit of time researching the localized treatment of *muscaria* as an edible species for his Master's Thesis at Florida International University. His results were quite interesting, and showed that eating *muscaria* is hardly typical for the Japanese culture as a whole (Phipps, 2000).

Phipps' thesis showed that local consumption of *muscaria* as an edible species is severely restricted, in both amounts of *muscaria* eaten as well as in general acceptance of the practice. *Muscaria* eating takes place not in the already limited Nagano Prefecture as a whole, but merely as a subset of people in one town: Sanada Town, with a population around 10,000. Within that subset, Phipps located 123 *muscaria*-favorable individuals, and from them he winnowed out ten most likely subjects for interviews (Phipps, 2000, p. 29).

Even more telling, he discovered these interview subjects by attending local mushroom fairs (three per year in Sanada Town), of a similar style to our North American mushroom fairs, with general collecting on one day, identification by local experts on the next, and then public displays with labeled mushrooms. At all of these fairs, within ground zero of *muscaria* eating in Japan, displays of *muscaria* were clearly labeled as poisonous mushrooms! These fairs were sponsored by the Japanese government and local insurance companies in hopes of preventing *mushroom poisonings* (my emphasis). Phipps found his interview subjects by hanging out at the *muscaria* display table and targeting those that scoffed at the poison label (Phipps, 2000, p. 29).

Indeed, within Sanada Town only (adjoining towns within the Nagano Prefecture treat *muscaria* as a wholly poisonous mushroom) *muscaria* is made into pickles, which have been shown through careful lab analysis to contain zero amounts of toxins. These pickles are then eaten in small amounts, for special occasions such as the New Year.

The process of making them is extremely involved (Phipps, 2000, p. 62). There are four steps to pickling *muscaria*, as relayed to Phipps by Sanada Town *muscaria* pickle devotees: boiling for ten minutes, or five minutes three times, washing, salting and soaking. Mushrooms are often initially boiled until all color is removed; the water is always tossed. After boiling, the mushrooms are rinsed under running water for 1-3 minutes. Mushrooms are then packed in salt and compressed, and left for at least one month. Prior to consumption, pickles were soaked for several hours or overnight to remove the salt (and any remaining traces of the toxins). These *muscaria* pickles were then used as culinary accents, not meals. They were and still are eaten for special occasions only, or served to special guests (Phipps. 2000, p. 37).

But frankly, the above method to prepare a wholly non-toxic snack does not sound like a reasonable recipe for today's modern-day, want-it-now cooks. In fact, the tradition is dying in Sanada Town, because modern Japanese youth can't be bothered to go through all the preparation steps to make a toxic mushroom edible (Phipps, 2000).

Phipps' thesis that unboiled *muscaria* is also grilled and eaten in *small* quantities (Phipps' emphasis) by certain local men. Here is what a subject told Phipps:

> "He compared the experience of eating a known poisonous mushroom like *muscaria* to eating fugu, the poisonous blowfish. The combined thrill of eating something poisonous and the outstanding taste makes this mushroom worth the risk."

But only small amounts are ever eaten, and there remains a good bit of paranoia attached to the process, with the men fearful of possible accumulative effects in addition to directly toxic ones. In other words, despite the limited local tradition of eating *muscaria* as an edible species, they are still uneasy about actually eating it (Phipps, 2000, pg. 41).

It is safe to say that *muscaria* eating in Japan is by no means a culturally accepted practice - and as even Rubel pointed out, in apparent disbelief, even Japanese field guides list *muscaria* as an unambiguously toxic mushroom.

Limited Historical Evidence of *muscaria* Consumption in North America

Rubel and Arora were "intrigued" by unsubstantiated reports of African-Americans in the southern states in the 1800s that may have eaten *muscaria*, but convincing evidence is lacking. Even if it were true, what reasons might an enslaved people have for eating *muscaria*? Was it another food of desperation? Or perhaps it was even eaten unboiled for its entheogenic strengthening effects, qualities a desperate slave could surely use. This is of course mere conjecture on my part, but so is any other imagined historical scenario.

A single verified example of historical *muscaria* eating in the Washington, D.C. area was also cited by Rubel, in hopes, I believe, of showing that it was at one time an accepted practice here in North America, so why not now? But even here in North America the evidence is not only flimsy but rather conjectural. Yes, there was apparently one black woman mushroom vendor who prepared *muscaria* for her table, discovered at a mushroom market outside of Washington, D.C. in the late 1800s, and of course that famous fatal encounter with *muscaria* by the late Count de Vecchj.

Even more telling to me than one individual with out-of-thenorm eating habits was this quote by Frederick Vernon Coville - a botanist who in 1898 investigated the recent, sensational *muscaria* poisoning of Count de Vecchj for the U.S. Department of Agriculture. Coville searched for potential sources of *muscaria* at the Washington, D.C., K Street Market:

> Though *most* [my emphasis] of the colored women of the markets look upon the species [*Amanita muscaria*] with horror *one* [my emphasis] of them recited in detail how she was in the habit of

> cooking it. (Coville, 1898)

Oddly, in his *muscaria* paper Rubel also showed the entire quote, but somehow didn't derive the same meaning that I did: that eating *muscaria* was *not* a common practice, but one observed by a single individual among many others who rightly feared it. Rubel went on to seemingly conjecture that because this one woman's recipe (again, an anomaly among the rest of the mushroom sellers) for *muscaria* was printed in a USDA publication (Coville, 1898), and then cited by others, it was therefore a locally acceptable practice.

I drew a very different conclusion from these same facts: that the behavior of one woman does not a trend make, and that in fact, the publication of these recipes and the quotes about the market seller were widely cited and published for the very same reason that this topic gets press today: its shock value.

The *muscaria* prep by the African American market woman was quite elaborate, and the mushroom hardly resembled a *muscaria* when it was done: the cap was peeled, the stipe was peeled and the gills were removed. The remaining mushroom bits were then parboiled and the boiling water tossed before cooking. Coville went on to suggest that since, as was believed at the time, most of the toxins were contained in the gills and the cap cuticle, parboiling would have most certainly removed any remaining toxins, and he praised her ability to be able to detoxify a known poisonous mushroom without a scientific background. But he was hardly advocating its use.

It is possible that some misconstrued Coville's remarks as a recommendation that *muscaria* be treated as an edible species. A few months later, in a revised version of the original USDA Circular 13, Coville firmly recommended that no one eat this mushroom, as did physicians during the same time period who were writing for the medical rather than the botanical community. Here is his quote:

> this process (of *muscaria* preparation) is cited not to recommend its wider use, but as a matter of general interest. The writer's recommendation is that a mushroom containing such a deadly poison should not be used for food in any form. (Coville, 1898, revised)

Coville also noted in the revision of USDA Circular 13 that the *muscaria* that poisoned the Count was not purchased at the K Street Market, but rather was brought to him from the Virginia countryside by a countryman who delivered it "under protest" to the Count.

As an added public safety precaution, *muscaria* selling was banned at local, Washington, D.C. markets, shortly after Coville's original article appeared (Chestnut, V.K, 1898). But there is no evidence that it was ever for sale in these markets to begin with.

Lacking in many of these historical, eating-*muscaria*-as-an-edible accounts are first hand reports of the effects, or lack thereof, post-ingestion, but there is certainly a broadly based fear of eating *muscaria*, here and across the world. This is reflected in the universal treatment of *muscaria* as a poisonous mushroom by mushroom field guides worldwide, including those countries with a strong mycophilic and mycophagic history, like Europe (Courtecuisse, 1994) and Japan (Hongo, Izawa, 1994).

Amanita muscaria Fed to Participants in Arora Forays

What about modern day use of *muscaria* here in North America? In his paper, Rubel states that David Arora has served *muscaria* to hundreds as a justification for its safety as an edible, and those numbers are probably true. But I would lay wager, based on my first hand evidence, that none of them ate a full meal of it; and the kitchen preparation for their *muscaria* tastings included thin slicing, several boilings, carefully measured waters (thrown out between batches) and a good splash of vinegar at the end. That last seems more for good measure than for any real benefit.

I was at the first Mendocino California foray, back in the 90s, when Arora served about 70 of us boiled *muscaria*, and I participated in about a dozen forays after that one. Most folks, with a bit of peer pressure and the reassurances of the "god of mushrooms" would try a piece or two - though, according to one of the people who passed the mushrooms around, at least a third of the group declined. Several folks that I have talked to who attended those forays did not wish to repeat the experience of eating parboiled *muscaria*, and who knows how many others, over the years, felt the same way? Like the Japanese gentlemen in Nagano Prefecture, they were thrilled by their daring, but still uneasy about eating a mushroom widely believed to be poisonous.

Peer Reviewed is not the Same as Peer Approved

In correspondence with me, Rubel apparently attempted to bolster his claims about the safety of *muscaria* as an edible species by informing me that he and Arora had published their paper in a peer-reviewed journal (Rubel, 2009). But since only two of his reviewers were actual toxicologists (Michael Beug, PhD and Denis Benjamin, MD) and they both had issues with the paper as originally presented to them (neither read the final version), I was hardly reassured (Beug, 2009; Benjamin, 2009). Dr. Benjamin informed me that his opinions upon this topic were undergoing some evolution and he asked to not be quoted here, but Dr. Beug had no such qualms. Here is what he told me, and I quote:

> "I did not review the final version of the [*muscaria*] paper but was highly critical of the draft and recommended that it not be published" (Beug, 2012).

Does it count as much if the peers who review your work and are intimately familiar with toxic mushrooms pan it?

Evaluate All of the Evidence and Decide for Yourselves

I will not go through a point by point rebuttal of the Rubel/Arora paper, although I have certainly been doing so in my mind and in various forums online, ever since I first read it over five years ago. I would hope by now that you the reader are starting to see the bigger picture on your own: that despite the fact that a few people, here and there around the world, have indeed eaten *Amanita muscaria* after elaborate detoxification preparations, it is hardly a broadly accepted practice to eat *muscaria* as an edible species anywhere, nor has it ever been so. And it is preposterous to pretend that it is sometimes not a dangerously poisonous mushroom, when there is a wealth of evidence to the contrary.

When field guides both here and abroad list *Amanita muscaria* as a toxic mushroom they are representing both the universal cultural and common sense norm. Perhaps these various American field guide authors, scoffed at by Rubel, who list *muscaria* as a poisonous mushroom, were more concerned with the safety of innocent foragers rather than presenting all of the possible ways that one might circumvent the poisons?

As new mycophagists delve deeper into the study of mushrooms in their readings of other places and times, perhaps they will be tempted to try a piece or two of *muscaria*, boiled or unboiled. But to recommend its safe practice as an edible species, with the justification that it was ever commonly eaten in other places and has little toxic downside, is a highly implausible parsing of history.

In edible *Amanita* lectures that I have given around the country, I often cite the official United Nations Food and Agricultural Organization (FAO) document on edible fungi, where dozens of species of edible amanitas, among many, many other species of edible mushrooms, are listed by name. These are all amanitas, from *caesarea* to *zambiana*, commonly eaten or sold in markets around the world. This list even includes some *Amanita* species that might reasonably give us the willies, like *Amanita manginiana*, an edible, market amanita from China that is related to and even resembles *Amanita phalloides* (Boa, 2004). But even in this very even-handed, strongly fungiphilic international document, *muscaria* is listed not as an edible but as a medicinal mushroom. Even more emphatically, the U.N. actually proposed a *resolution* against its sale and use as an edible species:

> Article 622 - None of the genera of poisonous mushrooms listed hereinafter may be used as food, *even if they have undergone special treatments to deprive them of their toxic principles* [italics mine]:
>
> *Amanita*: Mushrooms with fleshy caps colored green (Green *Amanita* or *Amanita phalloides*), or red with white warts (Fly Agaric or *Amanita muscaria*)...

Has it started to sink in yet? That maybe, just maybe, more than a little caution is called for when considering

Amanita muscaria as an edible species?

In the interest of full disclosure, I admit that I have personally eaten very small amounts of *Amanita muscaria* as an edible three times: once, at a long-ago Arora foray, where it was first par-boiled (slimy, tasteless, but still thrilling in a naughty way), once at a camping foray at Salt Point State Park, on the California Coast, where it was grilled by a master Japanese chef (delicious; the best amanita that I ever ate), and once atop pizza, after rehydrating dried *muscaria* mushrooms and throwing out the pretty red water. And yet, I believe that to encourage folks to eat *muscaria* is a bad idea, and I feel safe in saying that the vast majority of the rational, mushroom-loving world agrees with me.

Ironically, perhaps Den is Benjamin's recent satirical piece on *muscaria* eating in FUNGI magazine (Winter, 2011), really does hold the answer: if you must recommend the eating of *muscaria*, treat it as a poisonous mushroom that can be presented as a daring culinary adventure - the land-based American fugu experience, if you will. Go ahead, flirt with danger and have a *muscaria* snack at some future foray or in the privacy of your own home; certainly a piece or two of *muscaria* with the crap boiled out of it won't kill you, and then you'll have those bragging rights (Benjamin, 2011).

But please, gentlemen, don't tout *Amanita muscaria* as a perfectly reasonable edible species with a long history of safe usage and cultural acceptance both here and overseas, when the evidence clearly refutes your claim. And if you do someday revise *Mushrooms Demystified*, Mr. Arora, please, err on the side of caution. The many people who look to you for personal safety as well as honest answers will appreciate it.

Muscaria Treatment in American Mushroom Field Guides

Just to see what all the fuss was about in the treatment of *muscaria* by American mushroom field guide authors, I read the *muscaria* edibility descriptions in over a dozen modern guides that I own. All authors, reasonably enough, cited *muscaria* as a toxic mushroom. None, other than McIlvaine's *One Thousand American Fungi*, cited it as deadly. Some mentioned its potential hallucinogenic properties. Some talked about its historic use as an inebriant. The most recent mushroom field guide from California, *A Field Guide to Mushrooms of Western North America* (Davis *et al*, 2012), touched upon some of this recent edibility controversy by expanding a bit upon the usual dismissive toxicity statements. They stated that *muscaria* was:

> Poisonous and hallucinogenic; the toxins are water soluble, but given the preparation required to remove the toxins, this is not a good mushroom for the table.

The strongest argument against its use, however, was this one, from a mushroom field guide published in 1986:

> Poisonous and hallucinogenic. Fatalities are extremely rare, but it is undoubtedly dangerous in large or even moderate doses. Too many people have had unpleasant experiences for me to recommend it.

The author? David Arora, in *Mushrooms Demystified* (Arora, 1986).

Those wise words still ring true today.

Acknowledgments

Much gratitude to Michael Beug and Denis Benjamin, for their many conversations with me on this topic, thanks to Marilyn Shaw for her many toxicology insights and for sharing her concerns about the treatment of *muscaria* as an edible species, and special thanks to my dedicated reviewers, Jan Lindgren, Roy Halling, Gary Lincoff and Michael Beug, your suggestions and corrections were much appreciated.

Correspondence about this article may be sent to: amanitarita@yahoo.com

References

1. Arora, David. 1986. *Mushrooms Demystified: A Comprehensive Guide to the Fleshy Fungi*, 2nd Edition, Ten Speed Press, Berkeley.
2. Arora, D. 2009. "A Study of Cultural Bias...," Corrected muscaria recipe on page 243. http:// davidarora.com/uploads/rubel_arora_muscaria_revised.pdf
3. Atkinson, George. 1900. *Studies of American Fungi: Mushrooms Edible Poisonous etc*. Henry Holt and Co. 2008: http://www.scribd.com/ doc/54044336/George-FrancisAtkinson-Studies-of-AmericanFungi-Mushrooms-EdiblePoisonous-Etc
4. Barron, George. 1999. *Mushrooms of Northeastern North America : Midwest to New England*. Lone Pine Publishing.
5. Benjamin, Denis R. 1995. *Mushroom, Poisons and Panaceas - A Handbook for Naturalists, Mycologists and Physicians*. W.H. Freeman, New York.
6. Benjamin, D. 2009. Personal communication. August 10, 2009.
7. Benjamin, D. 2011. "*Amanita muscaria* - an entrepreneurial opportunity (A modern satire)." FUNGI Magazine, Vol. 4:1, Winter, 2011.
8. Benjamin, D. 2012. Personal communication. September 18, 2012.
9. Bessette, Alan, A. Bessette, D. Fischer. 1997. *Mushrooms of Northeastern North America*. Syracuse University Press, Syracuse, New York.
10. Bessette, A., W. Roody, A. Bessette and D. Dunway. 2007. *Mushrooms of the Southeastern United States*. Syracuse University Press, Syracuse, New York.
11. Beug, M ichael 20 04. "An Overview of Mushroom Poisonings in North America." *The Mycophile* Vol. 45:2, pp. 4-5 April 2004.
12. Beug, M. 2006. "Thirty-Plus Years of Mushroom Poisoning: Summary of the Approximately 2,000 Reports in the NAMA Case Registry." *McIlvainea* 16 (2) Fall 2006.
13. Beug, M . 2 0 09. Personal communication. August 10, 2009.
14. Beug, M . 2009. " NA M A Toxicology Committee Report for 2007: Recent Mushroom Poisonings in North America." *McIlvainea*, Vol. 18, 2009.
15. Beug, M. 2010. "*Amanita* Bravado." http://tech.groups.yahoo.com/group/BayAreaMushrooms/message/7749, Feb. 28, 2010.
16. Beug , M. 2011. " NAMA Toxicology Committee Report for 2010, North American Mushroom Poisonings." McIlvainea, Vol. 20, 2011. pp. 2-3.
17. Boa, Eric. 2004. "Wild edible fungi: a global overview of their use and importance to people." Food and Agricultural Organization (FAO) of the United Nations, Department of Forestry, Corporate Document Repository, http://www.fao.org/docrep/007/y5489e/y5489e00.htm
18. Bone, Eugenia. 2011. *Mycophilia: Revelations from the Weird World of Mushrooms*. Rodale Books.
19. Bulyankova, Tatiana. 2011. Personal communication. November 4, 2011.
20. Cetto, Bruno. 1994. *I Funghi dal Vero*. Vol. 1. Arti Grafiche Saturna, Trento, Italy.
21. Chestnut, V.K., 1898. "Principal Poisonous Plants of the United States." USDA, Department of Agriculture, Division of Botany, Bulletin 20.
22. Cornaccia, Pierluigi. 1980. "*Amanita muscaria* in Italy." (in the original Italian) http://www.autistici.org/mirrors/www.psicoattivo.it/media/libri/amanita/am_06.html
23. Courtecuisse, R. and Duhem, B. 1995. *Mushrooms and Toadstools of Britain and Europe*. Harper Collins Publishers.
24. Coville, F.V. 1898. "Observations on Recent Cases of Mushroom Poisoning in the District of Columbia. Circular 13." United States Department of Agriculture, Division of Botany, U.S. Government Printing Office, Washington, D.C.
25. Coville, F.V. 1898. Ibid. revised version of Circular 13.
26. Davis, R.M., R. Sommer, J. Menge, 2012. *Field Guide to Mushrooms of Western North America*. University of California Press, Berkeley, California.
27. Erickson, Timothy, MD. 2010. "Name that Toxin: *Amanita muscaria*." Emergency Physicians Monthly website: http://www.epmonthly.com/subspecialties/toxicology/name-that-toxin/1/ March 8, 2010.
28. Evenson, V.S., 1997. *Mushrooms of Colorado and the Southern Rocky Mountains*. Denver Botanic Garden, Westcliffe Publisher.
29. Glick, P. 1979. *The Mushroom Trail Guide*. Holt, Reinhart and Winston, New York.
30. Hall, I., S. Stephenson, P. Buchanon, W. Yun and A. Cole. 2003. *Edible and Poisonous Mushrooms of the World*. Timber Press, Portland, Cambridge.
31. Harkonen, M., T. Saarimake and L. Mwasumbi. 1994. "Tanzanian mushrooms and their uses. 4. Some reddish edible and poisonous Amanita species." *Karstenia* 34: 47-60.
32. Imazeki, R., Y. Otani, and T. Hongo. 1988. *Fungi of Japan*. Yamakei, Tokyo.
33. Konecney, Tony. Dec. 2, 2009. http://blog.tonx.org/2009/12/cooking-with-amanita-muscaria/
34. Lincoff, Gary. 1981. Simon and *Schuster's Guide to Mushrooms*. Simon and Schuster, New York.
35. Lincoff, G. 1981. *The Audubon Society Field Guide to North American Mushrooms*. Chanticleer Press, Knopf, New York.
36. Lincoff, G. 2005. "*Amanita muscaria* in Kamchatka." http://www.nemf.org/files/various/muscaria/part1.html
37. McIlvaine, C. and R.K. Macadam. 1902. *One Thousand American Fungi*. Bowen-Merrill, Indianapolis. (Reprinted in 1973 by Dover publications, New York).
38. Metzler, Sue and V. Metzler. 1992. *Texas Mushrooms*. University of Texas Press, Austin.
39. Miller, Orson. K., 6th edition, 1984. *Mushrooms of North America*. Chanticleer Press, New York.
40. Miller, O.K. 2006. *North American Mushrooms: A Field Guide to Edible and Inedible Fungi*. Glove Pequot Press, Guilford, Connecticut.
41. Millman, L., and T. Haff. 2004. "Notes on the Ingestion of *Amanita muscaria*." Mushroom, The Journal of Wild Mushrooming. 223:55.
42. National Poison Data System, 2004. American Association of Poison Control Centers (AAPCC), 2004 Annual Report, pg. 604

http://www.aapcc.org/dnn/Portals/0/AJEM%20%20AAPCC%20Annual%20Report%202004.pdf

43. Phipps, Alan. 2000. *Japanese Use of Beni-Tengu-Dake (Amanita muscaria) and the Efficacy of Traditional Detoxification Methods*. Master's Thesis, Biology Department, Florida International University.
44. Pouchet , Felix A . 1839. "Experiences sur L'Alimentation par les Champignons Veneneux." Journal de chimie de medicale, de pharmacie et de toxicology. V. 322-328.
45. Roody, William C. 2003. *Mushrooms of West Virginia and the Central Appalachians*. The University Press, of Kentucky.
46. Rose, David. 2006. " The Poisoning of Count Achilles de Vecchj and the Origins of American Amateur Mycology." McIlvainea, Vol. 16, No. 1, 2006.
47. Rubel, William. 2009. Personal communication. August 26, 2009.
48. Rubel, William and David Arora. 2008. "A Study of Cultural Bias in Field Guide Determinations of Mushroom Edibility Using the Iconic Mushroom, *Amanita muscaria*, as an Example." *Economic Botany*, 62 (3), 2008, pp. 223-243, New York Botanical Garden Press, Bronx, NY 10458-5126 U.S.A.
49. Rubel, W. 2011. "*Amanita muscaria*, edible if parboiled." *The Magic of Fire: Traditional Foodways* with William Rubel. http://www.williamrubel.com/2011/09/30/amanita-muscariaedibile-if-parboiled/
50. Shaw, Marilyn. 2012. Personal communication. June, 28, 2012.
51. Spoerke, David G. and B. Rumack. 1994. Handbook of Mushroom Poisoning Diagnosis and Treatment. CRC Press, Inc. Boca Raton, FL. pp. 273-275.
52. Swazey, J. and Reeds, K. 1978. "Louis Pasteur: Science and the Applications of Science." Essays on Paths of Discovery in the Bio-Medical Sciences. DHEW Publication No. (NIH) 78-244, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, Public Health Service National Institutes of Health. http://newman.baruch.cuny.edu/ digital/2001/swazey_reeds_1978/chap_02.htm
53. Uzelac , Branislav. 2009. Gljive Srbije Izapadnog Balkana [Mushrooms of the Balkans]. BGV Logik, Beograd.
54. Watson, William A. *et al*. 2004. Annual Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System. http://www.aapcc.org/dnn/Portals/0/AJEM%20-%20AAPCC%20Annual%20Report%202004.pdf. p. 605.
55. Wuilbaut, J.J., 2012. Personal communication. June 23, 2012.

The Mushroom and the Water Lily: Literary and Pictorial Evidence for Nymphaea as a Ritual Psychotogen in Mesoamerica

by

William A. Emboden[*]

Department of Biology, California State University, Northbridge, CA 91330 (U.S.A.)

(Received November 13, 1980; accepted January 5, 1981)
Journal of Ethnopharmacology, 5 (1982) 139-148

© William A. Emboden

original source: http://www.psilosophy.info/resources/the_mushroom_and_the_water_lily_emboden1982.pdf

[*] Associate in Ethnobotany, Botanical Museum, Harvard University, and Research Associate, Natural History Museum, Los Angeles, U.S.A.

Summary

In reconstructing early uses of psychotogens in Mesoamerica, mushrooms have occupied the attention of botanists and anthropologists almost to the exclusion of other plant motifs. Not all of the images and literary fragments extant lend themselves to mycological interpretation. Some authors have interpreted the peltate leaves and flower buds of the psychotogen *Nymphaea ampla* as being green mushrooms and/or stalked sea shells. The context of presentation, information on the water lily in Maya antiquity, and recent information on the chemistry of this white water lily suggest that we must reassess the role of *Nymphaea ampla*. In a reevaluation of these ancient literary and iconographic sources, it would seem that both mushrooms and water lilies emerge as important ritual psychotogens. While the contextual use of mushrooms is well known, the water lily has been largely ignored. This presentation provides some perspective on both of these important New World narcotics.

The antiquity of mushroom use in Mesoamerica is lost to us, but we are able to date mushroom veneration to at least 100 B.C. based upon the discovery of nine miniature mushroom stones in a late pre-Classic to early-Classic sites near Guatemala City. Progressive finds have been made from Vera Cruz in the north to El Salvador and Honduras in the south. The nature of these mushroom stones and the distribution of mushroom cults were documented by Mayer (1977) who gave dimensions of stones and associated figures. He recorded over 290 such effigies.

Several concepts regarding mushroom stones have been advanced. The 19th century idea that these were the products of cults of phallic worship have been discarded. Rose (1977) has suggested that they may have been used to form rubber balls used in the sacred ball games of the ancient Maya. While this idea may have some validity, it does not explain the miniature stones, and those that have associated metates for grinding. Furst (1976) discovered entries in Quiche and Cakchiquel dictionaries dating from *circa* 1550 and 1690 B.C., respectively. These indicate an association between the mushroom and the underworld, and the mushroom and the loss of one's judgement. Mayer (1977) indicates that the dictionary of Fray Thomas Coto of *circa* 1690 makes specific mention of mushrooms that inebriate. Ethnomycologists no longer doubt the importance of the mushrooms that inebriate to the functions of priestly castes in ancient Mesoamerica. The tradition as it has evolved to the present day has been documented by Wasson (1974) in a word by word transcription of the *Velada* of María Sabina as well as through musical documentation.

Initial field data on hallucinogenic fungi came from Weitlaner's accounts of his witnessing holy rites involving sacred mushrooms, *teonanactl*, and the studies in 1938 and 1939 by Schultes (1940) in the area of Oaxaca. It was the collections of Schultes that provided positive identification of several species of *Psilocybe* and *Paneolus* that were hallucinogenic. These early studies spurred R. Gordon Wasson on to work with his wife and colleague Valentina on the context of mushroom use in this area among the Mazatecs and others. Collaboration between the French mycologist Roger Heim and Wasson (1958) provided a volume of great importance in advancing ideas in the area of ethnomycology. The primary corpus of their work was extended by Heim *et al*. in 1967. Since both of these volumes appeared in French, much of the information of these investigators was relegated to small bodies of scholars. With the publication in 1980 of Wasson's book, *The Wondrous Mushroom*, we have a fine synopsis of the mushrooms that are used in a ritual context in Mexico and Mesoamerica.

The field of ethnomycology has been greatly enhanced by Wasson's recent publication. Despite the erudition of Wasson's meticulous scholarship, there are elements in this book that disturb the ethnobotanist. These are the same elements that appeared in the earlier collaborations with Heim. Specifically, the assertion that the motifs associated with water are green basidiomycetes. Further, the interpretation of Nahuatl verses in a mycological context seems inappropriate. It is the purpose of this paper to indicate that these motifs and verses are better suited to the white water lily, *Nymphaea ampla*, and that this plant has psychotropic qualities that would suit the ritual nature of the iconography and poetic depictions.

In recent years we have seen the appearance of several papers suggesting that certain water lilies (*Nymphaea*) have served as hallucinogens in Maya civilizations and are still in use in some areas of Chiapas (Dobkin de Rios, 1974; Diaz, 1977; Emboden, 1979b and 1981). The concept that water lilies might be used as ritual psychotogens was extended to ancient Egyptian civilizations (Emboden, 1979a).

The collective evidence on water lilies in the old world and the new world suggest a contextual use as a ritual psychotogen. This evidence has been distilled from Maya and post-Maya ceramics, codices, stone reliefs and frescos. The ancient Egyptians left similar information in tomb sculpture, ceramics, frescos and papyri (Emboden, 1979a).

It is the assertion of Wasson (1980) that many of the pictorial images found in an aquatic context in ancient cultures of Mexico are mushrooms that induce hallucinations, or in Wasson's usage (*fide* Ruck) these are entheogens. The aqueous environments in which these are found bespeak the sacred nature of water and purification. The color green that these alleged basidiomycetes exhibit is indicative of holiness.

I would propose an alternative hypothesis. In so doing, my reasoning must be based upon interpretation rather than sound scientific evidence. I would not wish to detract from the presentation of Wasson, but botanical reasoning and familiarity with the imagery presented compels me to suggest a more plausible explanation of green, aqueous basidiomycetes. I shall review some of the same texts, images, and verses that have been dealt with by Wasson, and I shall add evidence from additional sources.

I cannot subscribe to the notion that those who take exception to a mycological interpretation of green, aquatic mushrooms are all "mycophobes". We are all searching for the most accurate and consistent presensation of data that are derived from sources that are often oblique, elliptical and highly stylized. This study should be regarded as a search for clarity and understanding, and not a challenge to the fine scholarship of R. Gordon Wasson, a man for whom I have great admiration.

In dealing with flowers in Nahuatl poetry, the subject of chapter 4 in Wasson (1980), Father Garibay's *Poesia Nahuatl* (1968) is cited with considerable frequency. In the Garibay translations there is frequent mention of flowers in the context of inebriation. Although Garibay denies any hallucinogenic (entheogenic) elements as being apparent in these texts, we must support Wasson in his stance that the poetry is flat and stale without "bone and sinew, the blood and muscle of their (Nahua nobles) poetry". What, may be argued, is the genus and species of "flores" referred to in these texts. Perhaps we go too far if we accept Wasson's assertion that "flores is the trope for the entheogens". This would seem to force much of the poetry into a sort of procrustean bed. In some instances it would seem that the flowers are possessed of beauty and fragance and little more; however, in other verses the poet is explicit in speaking of their inebriating qualities. For example, "*De dónde las flores que embrigan?*" (I, p. 77). "From whence come the flowers that inebriate?" This is addressed to the sacerdotes or priests, those who would be the keepers of such mysteries. Likewise, "*He llegado a su presencia y hago estremecer… mis flores embriagadores*." (II, pp. 34-35). "Having arrived in your presence, I wave my inebriating flowers." Also, "*Deleitaos con las embriagadores flores que están en nuestras manos*." (I, p. 50). "Delight in the inebriating flowers that we hold in our hands." We further learn that the propriants encircle their throats with garlands of these flowers, recalling ancient Egyptian practices employing water lilies in a similar fashion.

Wasson, in reviewing the above in a fuller context involving his own thoughts regarding these verses, deduces that the flowers are "the inebriating mushrooms or morning-glory seeds". I would suggest that at this point no evidence has yet been adduced as to the specific nature of the flowers, but to state that "flowers" is a metaphor, and that "inebriating" is not a metaphor is taking liberties that go beyond poetic license. Likewise, Garibay's verses include the mention of *hongos* or mushrooms, and had these been intended, the texts would have so stated. The only argument to this can be that the poet was concealing the essential nature of *flores*.

On page 86, Wasson revises Garibay's translation of "*Brotaron las flores, Abren sus corolas ante él que da vida*." (II, p. 113). "Flowers spring forth opening their corollas before the lifegiver." The revision of Wasson interpolates after the word forth, "like chicks from the egg". Although there are no corresponding words in Garibay's translation, a new sense has been imposed. This would seem unnecessary were it not to convey a mycological meaning. The emergence of a mushroom from its egg-like origins would lend support to the thesis that *flores* is really a surrogate for *hongos* and, more specifically, entheogenic mushrooms. The argument rests on the Nahuatl verb *cueponi* which Molina (1571) translates as "bursting forth, (1) as a chick from its shell, (2) as a chestnut having been roasted, and (3) as a flower emerging from its bud". Since Molina chose the egg metaphor as his first analogy, Wasson has seized upon this over the opening of a flower. However, the poem goes on to speak of the flowers as "rich fragrant flowers ... bedecked with flowery butterflies" (II, p. 113). This does not suit a mushroom, and the egg and chick interpolation is certainly out of place. One might as easily have used the chestnut example of Molina. The texts require neither of these alternatives. Since it is *flores* that the texts refer to, the logical bursting forth would be that of a flower opening. Many flowers open so rapidly that the patient individual is able to watch this progression. Some flowers literally burst forth as the result of opening until the points of the calyx tips separate. *Nymphaea* species generally open very quickly and close just as rapidly.

In *Poesia Nahuatl* (I, p. 49) "*Se va pintando tu corazón con flores polichromas; pintas tú*" is rendered as "Thy heart is being painted with polychrome flowers; thou paintest ..." *etc*. This recalls the many Maya polychrome vases that have survived with frequent depiction of water lilies. Although these were for the most part Maya vessels of the Classical and pre-Classical periods, they are manifest in the imagery of these pre-Conquest poems. The frequency of the water lily motif far exceeds any imagery that might be interpreted as mushrooms.

In a monologue of Nezahualcóyotl it is stated, "*Hay cantos floridos: que se diga yo bebo flores que embrigan, ya llegaron las flores que causan vértigo, ven y serás glorificado*." (III, p. 11). "There are songs in flower: let it be said I drink the flowers that inebriate, already came flowers causing vertigo. Come, and you will be in glory." Wasson interpolates *poyoma* after *flores* in the text and amplifies his choice by stating that the Nahuatl *poyomatli* was intended to designate *Quararibea funebris*, a tree having fragrant flowers that were mixed with chocolate (*Theobroma cacao*) when it was made into a beverage. The problems with such an interpetation are to be found in Garibay's *History of Nahuatl Literature* (1953; I, p. 181) where we encounter "*... aquellas pores, anelhuayo y raiz no conocen*", translated as "... those flowers prosper, and roots they have not". This same statement is reiterated in *Poesia Nahuatl*: "*hay flores perfectas, hay flores sin raices*" (I, p. 29): "there are perfect flowers, there are flowers without roots". Again in the poems we encounter, "*flores anelhuayo desarraigados*". A further clarification of the nature of these "flowers without roots" is found in the same set of verses on the same page: "*aquí se yergue la Flor Blanca*" (III, p. 39). This is translated as "here stands high the White Flower". Wasson sees these as "fungal growths" as fungi have no roots.

For another interpretation, one might look to *Nymphaea ampla* of that region. It is a flower that is white and fragrant and whose flower buds are able to intoxicate due to their nupharidine content as well as possible apomorphine based upon the aporphine-like compounds isolated by Diaz (1977). An earlier verse (also III, p. 39) indicates that these flowers come from "the region afar where the water gushes forth". This suggests that they are aquatic. With the light of day the white flower bursts forth from its green calyx just as in the verses of the poem. The flower bud is ovoid. If one pulls the flowers from the still waters they have no roots. If they are dug they have a rhizome. This tuberous structure has few roots, but is conspicuous by its form. Why not a water lily instead of mushrooms?

Wasson (1974) records María Sabina chanting the following during her mushroom *Velada*: "Woman (of a) root below the water am I, Father Jesus Christ, tender root woman am I." (p, 61, lines 19-21). Wasson suggests this to be an important area of inquiry for the botanist. Since Diaz (1975) records the use of *Nymphaea ampla* in Chiapas where the rhizome is ingested, and since aquatic plants of medicinal value are few, we might suppose María Sabina invokes the water lily.

If a mushroom were intended in the previous verses, why was *hongos* used by Garibay (II, p. 55): "*He bebido vino de hongos y llora mi corazón.*" The Nahuatl for mushroom in the original was *nanacaoctli*, the suffix *-octli* referring to any inebriating liquor. This is not the *xochitl* or flowers of earlier citations. We need not exclude mushrooms from all of these texts, but neither should we find them where they are not. Since the text specifies a white flower, why should we implicate the tree *Quararibea funebris* (Bombacaceae) whose cup-like flowers are yellow or "dazzling yellow" in the words of Wasson (1980, p. 101).

It is not necessary to select either a mushroom or a water lily in all of these various pre-Conquest verses, frescos, and codices. An example of this is to be found in the famed *Codex Vindobonensis* painted in a Mixtec scriptorium. In a future paper on this volume, I will point out the many instances in which the water lily is found in conjunction with the gods and with water and honey. It is my assertion (Emboden, 1979a, b) that the water lily (*Nymphaea ampla*) played a major role in Maya civilization and was used in this and derivative cultures as a primary hallucinogen. Water, honey and the ubiquitous yeast formed a foaming beverage to which *Lonchocarpus yucatanensis* and *Nymphaea ampla* were added (Emboden, 1979a, b). This same white water lily may be found on the page of the Codex (p. 24) on which Caso (1963) found "entheogenic mushrooms".

On page 24 of this codex, Quetzalcóatl is seen carrying a woman who is "the spirit of the mushrooms" as evidenced by the mushrooms in her hair. Subsequently he faces Piltzintecuhtli, or "Most Noble Prince", who holds a pair of mushrooms. Between the two is a flower supported on a peduncle of seven spheres. Piltzintecuhtli is an alter ego of Xochipilli, the Sun God and Prince of Flowers. In the subsequent scene seven gods and goddesses hold mushrooms aloft. Between the fifth and sixth personages we see the same spheres mentioned earlier, but five in number, surmounted by a flower bud that is elongate, or in the terminology of Rands (1953), "mammiform". It is noted by Wasson that this fifth figure in a series of deities holds but one mushroom. Is it the *Nymphaea* but that completes the iconography?

Wasson's commentary on this page stops with his description of that which he interprets as a "mushroom *velada*". I would not take issue with any of this interpretation, but I would like to extend it by finishing a description of that same page. Below figure seven is the *Nymphaea* bud on a knotted peduncle. Rands (1953), in his extensive examination of water lily motifs and their frequency in Maya territory, noted that the knotted peduncle was always associated with an especially significant religious rite. I would suggest that this same contextual use applies here. Just below this is the water lily bud and the five knotted spheres, and to the left is a lake and a diver. Below the aforementioned knotted water lily and bud with spheres is the same motif repeated, and to the left there is a confrontation of two deities. They are able to walk on the surface of the water. The figure to the right holds upright three water lily buds as a sort of emblem of power, much as in ancient Egypt (Emboden, 1979a). Underneath the water there is a knotted water lily with a green peduncle and white flower. Although Wasson does not reproduce this page in color, I have referred to a fascimile edition in color for this verification. On this page mushrooms are united with the water lilies in a divine context just as they are found in a divinatory context among the Maya.

An interpretation of the murals of Teotihuacán occupies Wasson's attention in chapter 8 of his book. The labyrinthine buildings are, in Wasson's thesis, cenacula where small groups of pilgrims might undergo ritual activity. While Wasson suggests mushrooms, morning-glory seed, *cacao* and *poyomatli* flowers as elements of the divine office, there is no mention of the water lily. I presented these murals and discussed my interpretation with Wasson in the Spring of 1979 and yet no mention is made of my interpretations. Yet, Miller (1973) is castigated for not mentioning the publications of Wasson and Heim. For this neglect he is (Wasson's words) "certainly not at home in botanical iconography nor the entheogens". Wasson asserts further that if Miller had read and remembered an article that he wrote in 1957 "his text would have been utterly different". My rather lengthy 1979 discourse with Wasson is relegated on page 158 of his text to "Some have suggested that it [referring to the green mushrooms in his interpretation] might be the leaf of a water lily." After a few terse sentences that do not meet the arguments presented to him, this hypothesis is dismissed as "mycophobia". I would have expected a citation of the person who had made the identification of water lilies in the murals of Teotihuacán. In my defense, I must state that I do not harbor mycophobia; to the contrary, I have eaten numerous genera and species of mushrooms of both the old world and the new world. Yes, I have enjoyed the entheogenic experience of *Psilocybe cubensis* (formerly *Stropharia cubensis*). I will then present my interpretation of these murals as they were set forth to Wasson in 1979.

On a wall of a structure called Teopancaxco there is a mural that is reproduced as Fig. 2 on page 157 of Wasson's 1980 book. It must be remembered that most of the border of this mural had disappeared at the time of its discovery and a copy of an authentic fragment is reproduced as Fig. 1 on page 156 of Wasson's treatment. Accepting both figures as accurate representations, I find alternating peltate leaves of *Nymphaea ampla* and the flowers and flower buds of this aquatic, fresh water plant. The figures that Wasson sees as green (for holiness) mushrooms, I see as the peltate leaf of *Nymphaea* with its serrate margin. The third and the fifth glyphs of the original border (Fig. 1 in Wasson) are interpreted by Wasson as bivalves or snails, the former being the prevailing opinion according to the author. It is very easy to see that the entire scene is aquatic. Snails and bivalves are not found on a stipe - in this border all elements are stalked. If one views these as *Nymphaea* flowers subtended by a tripartite calyx, there is no problem of interpretation. Each flower alternates with a peltate leaf in which the petiole attaches to the center of the leaf in an umbrella-like fashion. Traces of green paint remain on the original leaves of the border.

Wasson suggests that if these peltate images were water lily leaves they would exhibit "a deep cleft where the stem (petiole) leads off". In nature, I respond, the leaf does not exhibit this in so pronounced a fashion as to attract attention to this particular feature. On dried herbarium specimens this aspect of the leaf becomes exaggerated. I would ask why these should be identified as fungi when the presumed "gills" do not emanate from the stipe (petiole) but are mere abbreviated marginal slashes and are not present at all on the sixth image reading Fig. 1 from the top to the base. How is one to explain the calyx of the third and the fifth images? As in the stylized presentations in ancient Egypt, they are tripartite. What basidiomycete is green and aquatic? As a metaphor green is for holiness and is sanctified by its association with water, according to the Wasson interpretation.

It is puzzling to encounter the statement that those who suggest a water lily (Emboden, obviously) "do not suggest a species and are idly guessing". This is misleading, for it was *Nymphaea ampla* that I suggested to Wasson on April 6, 1979, in Nash Hall of the Botanical Museum of Harvard University. I also showed slides of this plant. It is even more curious then why he should present, in Fig. 3 of his text, *Nymphaeu tuberosa*, a water lily that was not mentioned and which does not have the characteristic serrate margin and has not been linked to ritual use.

It should be mentioned that the repetition of the *Nymphaea* leaf and flower, or its bud, was common in Maya presentations and was well documented by Rands (1953). It is this same alternating series that is seen in the *Codex Bourbonicus* (Hamy, 1899) in the figure of Tlaloc, the god of rain, rivers, lakes, etc., reproduced in the Wasson tome as Fig. 4. However, in this presentation of some one thousand years later, the alternating images are at the tips of tributaries or waves and are so stylized that they could be identified only by conjecture. We should deal with primary sources that are revealing rather than secondary motifs that have lost any true identity. The deterioration of symbols is easily seen if one compares the Teopancaxco mural (Wasson's Fig. 2) with the devolved version in the *Codex Bourbonicus* (Wasson's Fig. 5). I cannot see the transition of the latter to Fig. 6 in which an image from the post-Conquest *Atlas* of Diego Duran shows a lake with margins on which there are nine small concentric circles. These appear on many aqueous motifs in the surviving codices as foam on water. Must we force our imaginations to extend these to mushrooms?

Turning our attention to another area of Teotihuacán, all may judge the magnificent mural of the complex of Tepantitla restored by Augustin Caleti on exhibition in the Nations Museum of Archeology in Mexico City. I, like so many others, have had the great pleasure of studying this restoration repainted by the skilled muralist Villagra. Fortunately, Villagra carried out his restoration almost twenty years before any discussion of entheogenic elements in the mural was initiated.

In the upper part of the primary mural of Tepantitla there is a massive deity that Kubler (1967) has taken to be a female divinity. Above her head is a giant flowering tree. To the right and to the left of this deity are hierophants from whose hands water pours into the great lake upon which the scene is resting. Along the margins of the pouring water we again encounter what Wasson identifies as "alternating shells and mushrooms", and which I take to be water lily leaves and buds. Note again (Wasson's Fig. 10) that the leaves are green and the margins are serrate. There are no gills extending to the pileus as is true of basidiomycetes. These aquatic elements are all stalked.

In the lower register of the aforementioned mural is a depiction of "Playing Fields of Paradise" (Caso, 1942, pp. 127-136). While the reproduction in Wasson (1980) is not as fine as that reproduced in Heim and Wasson (1958) we can see a sacred lake in the lower right in which a giant frog or toad is surrounded by "shell and mushroom", according to Wasson. I would point out that there are no indications of gills, only the conspicuously serrate margins. Of the three sets of water lily leaf and flower bud pairs, I would call attention to that in the lower right near the toad or frog's anal area. The leaf has a very decided cleft. That same cleft was stressed earlier as negative evidence by Wasson. He does not call his reader's attention to this portrayal. I would agree when he states that this is "the real world of the entheogenic vision". But, I would suggest that it is the narcotic water lily that engenders the visionary experience.

Details in Wasson's Fig. 13 and 14 further establish the green water lily leaf with its serrate margin emerging from the mouth of a jaguar. I would refer the reader to Thompson (1972) for a discussion of the relationship between the jaguar and the water lily in *Commentary on the Dresden Codex*. An even greater amplification of this is to be found in Coe (1973) *The Maya Scribe and His World*. There is so intimate and regular a connection between the water lily and the jaguar that Coe uses the term "Water lily Jaguar" to identify that deity. While Tepantitla is not Maya, the same associations are to be found. As for the detail in Fig. 14 of Wasson, we see amphibians that are imperfectly developed (metamorphic) swimming with water lily leaves and buds (mushrooms and shells?) in their mouths. Interestingly, there is at the base (center of Fig. 14) a leaf and two buds with feathers emerging from the leaf. In Maya portrayals, it is common to find the flower with quetzal bird feathers stuck inside the corolla. This is regularly seen when a figure of great power wears the flower on his brow (Emboden, 1981).

In a structural complex known as Zacuala there is to be found a mural of the sacred lake in which there is a "radiant mouth". This motif is what Hasso von Winning (1949) has called the "vagina dentata" motif. From the four comers of the sacred lake there emerge four peltate, serrate, green water lily leaves that are called by Wasson "unmistakable greenish mushrooms". Figure 21 of Wasson, which is a painting by Mendoza of a reconstructed bowl from Zacuala, shows the same repetitive motif that has been argued throughout this paper. It is a frequent Maya theme (Thompson, 1966, p. 61).

From my own experiences, I have found that mushrooms with entheogenic properties are superior to any water lily species in provoking the sensation of ecstasis, literally liberating the soul from the body. I do not doubt for one moment that Wasson's research on hallucinogenic fungi is collectively some of the most important ethnobotanical research produced in this century. Much of his recent book is translated from his earlier work with the late Roger Heim and appeared only in French in editions from the Natural History Museum of Paris. There are, however, many new revelations given to us in *The Wondrous Mushroom*. I have initiated this paper on the basis of my personal conviction that, in the instances that I have cited, identifications made by Wasson are not correct. Both Wasson and I are making interpretive assertions, and only readers familiar with hallucinogenic fungi and water lilies will be able to make a decision as to which arguments are most compelling. Only through hypotheses and challenges to these are we going to have an accurate view of the essential activities of the ancient peoples of Mesoamerica.

It is my belief that we do not have to decide whether to accept a fungus or a water lily. Both figure prominently in the literature and iconography of priestly castes in the pre-Conquest period of Mesoamerica.

References

1. Caso, A., *El Pariso Terrenal et Teotihuacán*, Curanderos Americanos, Mexico, D. F., 1942.
2. Coe, M., *The Maya Scribe and His World*, The Grolier Club, New York, 1973.
3. Diaz, J. L., *Ethnofarmacologia de Plantas Alucinógenas Latinoamericanas* [*Curanderos Cientificos CEMEF 4*], Centro de Estudios en Farmodependencia, Mexico, D. F., 1975, pp. 174-178.
4. Diaz, J. L., Ethnopharmacology of sacred psychoactive plants used by the Indians of Mexico. *Annual Review of Pharmacology and Toxicology, 17* (1977) 647-675.
5. Dobkin de Rios, M., The influence of psychotropic flora and fauna on Maya religion. *Current Anthropology, 15* (1974) 147-164.
6. Emboden, W. A., The sacred narcotic lily of the Nile: *Nymphaea caerulea* Sav. *Economic Botany, 33* (1) (1979a).
7. Emboden, W. A., *Nymphaea ampla* and other Maya narcotic plants. *Mexicon, 1* (1979b) 50-52.
8. Emboden, W. A., Transcultural use of water lilies in Maya and Egyptian civilizations. *Journal of Ethnopharmacology, 3* (1981) 39-83.
9. Furst P. T., Fertility, vision quest and auto-sacrifice: Some thoughts on ritual bloodletting among the Maya. In Merle Green Robertson (ed.), *The Art, Iconography and Dynastic History of Palenque*, Part III, The Robert Louis Stevenson School, Pebble Beach, California, 1976, pp. 181-193.
10. Garibay, K. A. M., *Historia de la Literatura* Náhuatl, 2 volumes, Porruá Mexico, 1953.
11. Garibay, K. A. M., *Poesiá Náhuatl*, 3 volumes, UNAM, Mexico, D.F., 1964, 1965, 1968.
12. Hamy, E. T., *Codex Bourbonicus*, Manuscrit Mexicain de la Biblioteque du Palais-Bourbon, Fat. avec comm. par E. T. Hamy, Paris, 1899.
13. Heim, R. and Wasson, R. G., *Les Champignons Hallucinogènes du Mexique*, Editions du Museum National d'Histoire Naturelle, Paris, 1958.
14. Heim, R., Cailleux, R., Wasson, R. G. and Thevénard P., *Nouvelles Investigations sur les Champignons Hallucinogènes*, Editions du Museum National d'Histoire Naturelle, Paris, 1967.
15. Kubler, G., *The Iconography of the Art of Teotihuacán* [*Studies in Pre-Columbian Art and Archeology*, No. 4], Dumbarton Oaks, Washington, DC, 1967.
16. Mayer, K. H., *The Mushroom Stones of Mesoamerica*, Acoma Books, Ramona, California, 1977.
17. Miller, A. G., *The Mural Painting of Teotihuacán*, Dumbarton Oaks, Washington, DC, 1973.
18. Molina, A., *Vocabulario en Lengua Castellana y Mexicana*, 1571.
19. Rands, R. L., The water lily in Maya art: a complex of alleged Asiatic origin. *Anthropological Papers, Bureau of American Ethnology Bulletin, 151* (1953) 75-153.
20. Rose, R. M., Mushroom stones and the highland Maya ball game. *Ph.D. Thesis*, Harvard University, Cambridge, MA, 1977.
21. Schultes, E. E., Teonanacatl, the narcotic mushroom of the Aztecs. *American Anthropology, 42* (1940) 429-443.
22. Thompson, J. E. S., *Commentary on the Dresden Codex*, The American Philosophical Society, Philadelphia, PA, 1972.
23. Wasson, R. G., *Maria Sabina and Her Mushroom Velada*, Harcourt Brace Jovanovich, New York, 1974.
24. Wasson, R. G., *The Wondrous Mushroom*, Harcourt Brace Jovanovich, New York, 1980.
25. Winning, H. von, Shell designs on Teotihuacán pottery. *El Mexico Antiguo*, Vol. VII, Mexico, D.F., 1949.

Amanita Muscaria; Herb of Immortality

by

Donald E. Teeter

Brought to you by The Ambrosia Society in cooperation with the Author

© 2005, Donald E. Teeter

original text: http://www.ambrosiasociety.org/files/herbofimmortality.pdf
backup source: http://www.psilosophy.info/resources/herbofimmortality.pdf

Permission is granted by the Copyright holder, Donald E. Teeter, for the Ambrosia Society to distribute this Copyright protected E-book version of "Amanita Muscaria; Herb of Immortality". Permission is also granted to the reader for their personal, not for profit, electronic transmission or forwarding, copying onto information storage devises or disks, and the printing of a personal hard copy, in Toto, without alteration, of this Copy written work "Amanita Muscaria; Herb of Immortality". All other Copyright protected rights are reserved by the Copyright holder.

The Ambrosia Society
Is an Educational, Scientific, Religious and Fraternal Association of individuals dedicated to understanding the ancient Sacrament. Help support this important ongoing Research
Donate to the Ambrosia Society.
At Ambrosia Society.org
Or Ambrosia Society
4800 Yager Lane Manor, Texas 78653

Where does one begin?
To tell the many tales
Of the Wondrous One
So very old
Who today among you
Will believe the Living Secret
These Ancient tales
Still hold?
Tales of the One Fruit
Of the Twelve Trees of Life
Herb of Immortality
Ambrosia
Golden Elixir of
Immortality Nectar of the Gods
Honey sweet
Taste of Divinity
Great Gift of the Creator,
That the lame may walk
And the blind may see
Wondrous tales of a
Living God made of flesh
Born from Thunder
The Golden embryo
Mighty child of Heaven
Fountain of the water of life
Ancient Sacrament
And Sacrifice

Table of Contents:

1. The Beginning
2. The Indo-Europeans
3. The Ancient World
4. Amanita muscaria - Legendary Herb of Immortality
5. Amanita muscaria - The Fruit of the Trees of Life
6. Amanita muscaria - Soma the pressed One And the Holy Grail
7. Amanita muscaria - The Living Bread
8. Amanita Muscaria - The Healing Herb
Diseases; the tiny Demons
9. Natural Science
10. Natural Science; Pharmacology
Some Herbal Principles
11. Natural Magic
The Hunt
Preparing the Plant of Life
Magic Food
Ambrosia; elixir of Life
Sacred Wine
Preparing the Seer's Milk
Preparing the Holy Oil
Preparing the Living Water
Preparing the Eucharist
Honey Drops
Set and setting
12. The Resurrection Question
Observations on the Resurrection of Amanita muscaria
13. The Question of Wine
14. Natural Magic; Recreating the Grail
14-1. The Grail
14-2. Soma, source of the Legends
14-3. Celtic Cauldrons and Magic Cups
14-4. Proving the Theory
14-5. Creating Your Own Grail
14-6. Using the GRAIL
Recipes
14-7. Conclusions
15. Growing the Eucharistic Bread and Wine in quantity
Making the Living Bread
Making the Sacramental Wine
16. Gods, Books, Myths and Folktales
17. The Rig Veda
Soma and the Holy Grail
Soma and Healing
Soma and the Grail
18. Zoroaster the Prophet and the Mazda Religion
19. Mithras
20. The Bible
Old Testament quotes.
21. New Testament Bible Quotes
22. Dionysus
23. Odin; God of Wisdom
Jack and the Beanstalk
Santa Claus and Christmas
24. Amanita muscaria and Philosophical Alchemy, Hermeticism, the Occult and Judeo-Christian Mysticism

The Second Key of Basil Valentine
From, Kelley's Terrestrial Astronomy
25. Some Thoughts
26. The Names of a God, Part 1
27. Names of a God, part 2
28. Supplies and Info
Suggested Readings

1. The Beginning

Where does one start to tell the story of the legendary Herb of Immortality, after all there are no living eyewitnesses of this momentous ancient discovery? All the knowledge we have concerning the ancient mystical Herb of Immortality is now found in ancient stories, some of these stories are today considered religious truths by active religions. Other stories are ancient myths of religions now considered extinct. While still other stories are now considered folk tales and fairytales with which we amuse our children; and in doing so, pass these stories down countless generations.

Modern people put their knowledge into books; the ancient people on the other hand placed their knowledge into stories. Some ancient stories are in fact very detailed books of knowledge concerning the Herb of Immortality, when the story is properly decoded a wealth of practical information concerning this unique life form can be rediscovered by a modern person.

While I cannot give you exact information on the ancient discovery of the Herb of Immortality, I can give you some background on how I came to understand the knowledge contained in these ancient stories.

As a young American child, I was exposed to many of the same stories you were as a child. Now some of these stories were completely baffling to me in that they didn't make any logical sense. It wasn't the fairytale bedtime stories that were so illogical, after all, no one, not even a child expected these stories to make sense. It was the other class of stories, the Santa Clause and most especially the Jesus stories that I had the most trouble trying to understand logically.

The Santa Clause story was just baffling from a logistical viewpoint of making and then delivering the Gifts, you know around the world making millions of stops all in one night. Why, those reindeer would have to travel at the speed of light. This Santa Clause story was however nothing compared to the completely baffling Bible story of the man-god called Jesus Christ because the Santa story was always being told kind of tongue in cheek, the Christ story instead was presented to me as not only true but the ultimate truth.

Now this Jesus Christ story was so completely unbelievable to me that I just couldn't get my skeptical little mind to wrap around it. After all, the story starts with the birth of a man supposedly created without intercourse and born from a virgin. Now as a young country boy, I knew the mathematics of animal and human reproduction at a young age and that no person could be immaculately conceived, so the story starts out completely unbelievable to me. Next he turns ordinary water into a superior wine in the first of many miracles, then he miraculously heals the sick, the blind see and the lame walk, yet the Sunday school teacher couldn't explain to me how he did it, it was a miracle and as such could not be explained. Later in the story he is a prophet and can tell or predict the future, again with no explanation given as to how he did it. Then there is his death and resurrection in the flesh in three days; again something that totally goes against logic and nature, since no human who is truly dead has ever rose up again. After his resurrection he is immortal in the flesh and ascends back to heaven where he came from, thus ending the story.

Now this Christ story is very strange but there were other strange things taught in Sunday school that just did not make sense; like my Sunday school teacher saying that the Christ of the Christians was the ancient Hebrew God of the Old Testament bible. I tried for weeks to figure that one out. The Communion was another strange thing since we were supposed to eat the flesh and drink the blood of Jesus, like a bunch of cannibals; luckily all we really had to consume was a little cube of white bread and a shot of grape juice.

I think I was about ten when I just completely gave up trying to rationally understand the Christ story and became a non-believer in both the story and the Christian faith as containing any kind of real truth.

Over the next few years I experienced a growing spiritual hunger and decided to study some other religions to see if they had anything real to offer or if they were just as insane as Christianity. My mother had bought a complete set of 1898 edition Encyclopedia Britannica at our local library's book sale. In 1969 when I was thirteen I happened to open the Encyclopedia at an article on Hinduism and I came across this quote about an ancient plant god named Soma from the Rig Veda; the oldest collection of books in the Hindu literature.

Rig Veda "Book 8 hymn LXVIII"

"1. This here is Soma, never restrained, active, all conquering bursting forth, a Seer and Sage by sapience.
2. All that's bare he covers over; all the sick he medicines, the blind man sees, the cripple walks."

This quote completely "blew my mind" as you would say in 1969; here was a real plant worshiped as a god, that was doing the exact same cures attributed to the Christ. Could it be that the Christ story was about a real plant god and not about a man-god at all?

The next paragraph said that Soma was identical with the ancient Persian Haoma, that it is the Ambrosia and Nectar of the ancient Greeks and that this plant was the ancient and legendary Herb of Immortality. Soma was said to be an Indian version of the Greek God of intoxication Dionysus. However exactly which plant was the real Soma was unknown in 1898.

Since the plant was real there was at last a solid starting point to try and understand these very confusing religious stories. Some checking confirmed that the Rig Veda was far older than Christianity; so Christianity could not have influenced the Rig Veda; in contrast the much older Rig Veda could easily have influenced Christianity.

Research in several dictionaries showed that all the names mentioned in the second paragraph; Soma, Haoma, Ambrosia, Nectar and Dionysus are Indo-European words, meaning that they all belonged to a specific language family called Indo-European. The individual meanings of these names are unique; Soma/Haoma means the pressed one, from the pounding or pressing in the Soma Ceremony while in Greek Soma means the "body". Ambrosia or Ambrose means "not mortal", Nectar means "Death overcomer", these are very strange names for a plant.

In researching for the true Botanical identity of the Vedic Soma plant, it quickly became apparent that nobody knew what plant really was the true Soma of the Vedas. A great many plants were proposed as the real Soma such as Poppy (opium), Cannabis (hemp, pot), Ephedra (amphetamines), and several plants used in India as modern Soma substitutes that are not known to have any mental or healing effects and appeared to be chosen for their small size, lack of leaves and milky sap.

Some of the strangest plants considered as the real Soma are Rhubarb and Ragweed, Rhubarb was proposed because it had red or golden stems and Soma was said to be either red or golden, Ragweed was considered simply because its scientific name is Ambrosia.

It was also proposed that the real Soma was actually a mixture of several plants, but this didn't seem to fit the Vedas description of Soma as the pressed one (singular), not the pressed ones (plural).

Alcoholic brews such as mead and beer were also proposed since Soma is called honey in the Vedas and the grain barley used in modern beer brewing is mentioned as being used in the Soma ceremony. However alcohol didn't seem to match the descriptions of Soma's mental or healing effects, after all, no one today expects the blind to see or the lame to walk from drinking a beer. The Soma Ceremony was at most three days long; hardly enough time for alcoholic fermentation to occur. The Soma of the Vedas was a plant that grew on mountains and was picked and dried, a process completely unnecessary for yeast fermentation.

In studying the Persian version of Soma called Haoma I came across this little gem in an earlier edition of the Encyclopedia Britannica that showed that I was probably on the right track as far as the relationship of Soma and the Christ. This the exact same quote I found in the early 1970's, but quoted here from a later edition.

The following is from the Encyclopedia Britannica (1991, vol. 26, pg. 789, Rites & Ceremonies):

"In Zoroastrianism haoma (Sanskrit soma, from the root su or bu, 'to squeeze' or 'pound') is the name given to the yellow plant, from which a juice was extracted and consumed in the Yasna ceremony, the general sacrifice in honor of all the deities. The liturgy of the Yasna was a remarkable anticipation of the mass in Christianity." "Haoma was regarded by Zoroaster as the son of the Wise Lord and Creator (Ahura Mazda) and the chief priest of the Yasna cult. He was believed to be incarnate in the sacred plant that was pounded to death in order to extract its life-giving juice so that those who consumed it might be given immortality. He was regarded as both victim and priest in a sacrificial-sacramental offering in worship. As the intermediary between God and man, Haoma acquired a place and sacramental significance in the worship of Mithra (an Indo-Iranian god of light) in his capacity as the immaculate priest of Ahura Mazda with whom he was coequal. The Mithraic sacramental banquet was derived from the Yasna ceremony, wine taking the place of the haoma and Mithra that of Ahura Mazda. In the Mithraic initiation rites, it was not until one attained the status of the initiatory degree known as 'Lion' that the neophyte could partake of the oblation of bread, wine, and water, which was the earthly counterpart of the celestial mystical sacramental banquet. The sacred wine gave vigor to the body, prosperity, wisdom, and the power to combat malignant spirits and to obtain immortality."

It should be pointed out that Zoroaster would have to be an exceptional prophet to anticipate the Christian mass since he died approximately 600 or more years before the earliest Christian mass was held. Again we have a situation were the far older Yasna could not have been influenced by Christianity, but early Christianity could easily have been influenced by Zoroastrianism. You will notice that Haoma like the Christ is also considered the Son of God, the chief Priest of the religion and is both a sacrifice and sacrament central to the religion.

It is well known that Mithraism, which was very widespread throughout the late Roman Empire, had a profound impact on early Christianity with Mithra's birthday, Dec. 25th adopted by Christianity as Christmas or Christ's birthday and the adoption of Mithra's day of the week, Sunday as the day of worship and rest, instead of the Hebrew Sabbath of Saturday. The sacred wine of Mithra was a type of Haoma not alcoholic wine since it was said to posses exceptional properties compared to ordinary wine. It is reasonable to believe that the original Eucharist wine of early Christianity was identical to the Mithraic wine.

However, researching Haoma really didn't throw any light on the identity of the real Soma/Haoma plant since many of the same plants were proposed for Haoma as for Soma.

Researching Ambrose and Nectar yielded little practical information on the real plant other than it was considered the food of the Gods, bestowed immortality on humans and according to Homer in the Iliad, the Ambrose/Nectar plant could spring up instantly at the command of the gods.

In 1974 I read a book called "Soma: Divine Mushroom of Immortality" by Mr. Wasson who proposed that the original Soma was the mushroom called *Amanita muscaria* or more commonly the Fly Agaric. This is the large red or gold capped white mushroom with small white warts scattered across the colored cap surface. His was the most convincing argument concerning the identity of the original Soma plant and I quickly came to believe that his identification was indeed the correct one. *Amanita muscaria* was even known to produce psychoactive urine in the users just like the Vedic Soma, a property that no other Eurasian drug plant is known to produce.

Convinced that Mr. Wasson was right I decided to gather as much knowledge as possible in three distinct areas of research. First it was very confusing to have pieces of the puzzle scattered from Greece thru Persia to India, so I decided that understanding the earliest movements and history of these people may provide the background needed. Since Soma/Haoma, Ambrose and Nectar were all very ancient Indo-European words; I began to study the Indo-European languages and history in an effort to try and understand why this magic plant seemed to be everywhere. Second I decided to study the old religions of the Rig Veda, the religion of Zoroaster, the Bible and the ancient mythology in an effort to better understand the relationship of these religions to one another. Thirdly the medicinal benefits of this plant to modern mankind could be of vast importance so understanding the actual plant's natural history and subjecting it to experimentation would sooner or later have to be done.

Keep in mind that I was only 18 when I decided to start this branch of research and life very quickly intervened, so for many years this research was carried on as a very part time hobby.

About ten years into this research I was beginning to understand that the most important parts of the Christ story were the parts that were completely impossible for a man, since these impossible story elements were actually describing the Soma plant.

An awaking for me occurred at about this same time when I walked into a large library and noticed that the real books like how to books, dictionaries, encyclopedias, technical books, science and math etc. were out numbered at least 5 to 1 by fiction books. At that point I began to understand that there were very good, even overwhelming odds that the whole New Testament was a manufactured story and not as many Christians believe a true and historical document. In other words the New Testament was most likely a work of "historical fiction" with real knowledge of the Soma plant purposely encoded into it.

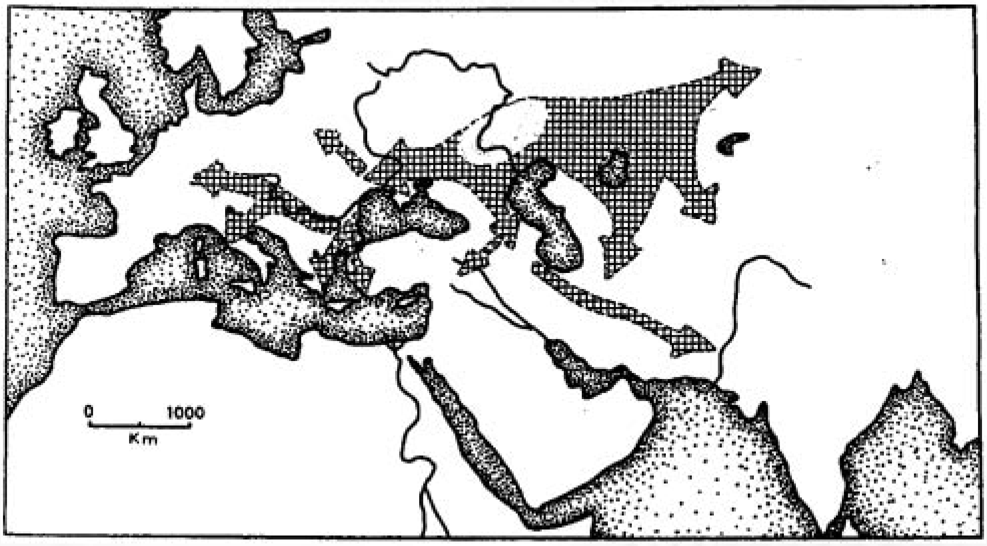
Over the years I have discovered that much of the ancient Indo-European mythology is constructed in exactly the same manner and contains a wealth of hidden yet practical knowledge that is only revealed when you understand that the story is really about *Amanita muscaria*.

2. The Indo-Europeans

It is not the purpose of this chapter to go into an in depth study of the Indo-European peoples but simply to give you some background to help you understand why the religions based on the Herb of Immortality are found so widely distributed over Eurasia. The reader is encouraged to study the Indo-European peoples and history in much greater detail and depth, since for many readers with a Eurasian heritage; they are your ancient ancestors.

The term Indo-European properly describes a very large language family, which includes English, French, Latin, Greek, Gaelic, Iranian, Hindi, and Sanskrit to name but a few. Historically this language family was found from India to Ireland hence Indo-European.

All of the Indo-European languages are descended from a common ancient ancestral language now extinct called Proto-Indo-European. Since all Indo-European languages share a common ancestor and in many ways are still very similar to each other, it is the common belief of language experts that about 7000 years ago all the Indo-European speakers in the world lived in a relatively small geographic area that is believed to be north or northeast of the Black Sea.



(Map: the white oval area is one of the proposed homelands while the other is just west of it N of the Black Sea, the arrows show the routes of the expansions into all the surrounding territory.)

During this time it is believed that the Proto-Indo-Europeans were the first people to domesticate the Horse for riding. There is also archaeological evidence that these people began an extensive development and use of the wheel for carts and wagons, this technology of greatly increased mobility is believed to have been part of the reason for the Indo-European expansion.

Beginning about 6000 years ago there is an expansion of Indo-European speakers out of this homeland East into the Steppes of central Asia and West into central Europe.

Approximately 5000 years ago there is another expansion into Mesopotamia, Persia, Europe and eastward deeper into the Steppes.

About 4000 years ago there is a major expansion from which most of the modern Indo-European languages are descended; this expansion extends the Indo-European languages over a vast area of Europe, the Middle East, central Asia, Northern India, and the Siberian Steppe to Manchuria.

Less than 1400 years ago the rise of Islam spread the non Indo-European Arabic language over much of the formerly Greek and Persian speaking areas of the Middle East and North Africa.

Beginning about 900 years ago the movement of Mongol and Turkish tribes greatly reduces the number of Indo-European speaking tribes on the steppes through warfare, genocide and assimilation, and eventually splits the Indo-European language continuum by the invasion of what is now called Turkey, where the Turkish language replaced Greek.

Within the last 500 yrs with the Age of Discovery there is an expansion of Indo-European speakers into the Asian Steppes, Siberia, North and South America, India and East Asia, Australia and Africa.

About 200 years ago European explorers bring back to Europe ancient writings from India such as the Rig Veda, and the Yasna from Persia, both of which were unknown in Europe at the time.

Language scholars quickly discovered that Sanskrit and ancient Persian were closely related to Latin and Greek and the study of the Indo-European language family was born.

Presently, one half of the world's population speaks an Indo-European language as a first or second language.

3. The Ancient World

In order to understand the ancient stories about the Herb of Immorality you must first understand the differences between the modern world you live in and the ancient Eurasian world. These ancient stories were created in societies whose world view is entirely different than your world view, so it's important that you begin to understand the ancient world view that these stories originated in.

The first major difference is modern people go to the store for the things we need, in fact most people in the west today are absolutely dependent on the stores. In sharp contrast our ancestors lived in the store, from the forests, fields and streams came everything they used and it was Nature that they were dependent on for food, clothing, housing, medicines, and all the necessities of human life. As a rule Primitive people generally know every plant and animal in their environment and how to use them if there is a use for them. Many ancient Eurasian societies contained healers who were masters at using drug plants for medicine. They did this without the knowledge we now posses of the chemistry involved, since it was only in 1806 that a brilliant chemist isolated morphine from opium and forever changed our view of how these magic plants actually worked.

The perspective on the world at large of the modern person is completely different than the ancient world view of the universe. The relatively recent invention in the 1600's of the telescope and the microscope changed a world view that had existed basically unchanged for thousands of years, and expanded the modern universe millions of times over the old world view. When you look up into a starry night sky you know that some of these stars are trillions of miles away, to the ancients the Sun, Moon, Planets and Stars were only a few miles away, and things like Comets scared them since they were believed to be so close.

The Microscope expanded the world view in the opposite direction and radically changed our idea of Nature and our ideas about our own physical body. It has revealed the causes of many diseases and the cellular miracle of all living Creation. To the ancients all of this was completely unknown with things like diseases being given a supernatural cause i.e. Demons, witchcraft, etc or vague natural causes like poisoning, bad water, food or air. The ultimate secret of how plants, animals, and people reproduced themselves was also a great mystery to the ancients who depended on the mysterious fertility of plants, animals, and themselves for their own existence.

Another basic difference between the ancient and modern worlds is how Deities or God(s), are conceived of, in the ancient world only those things that could be seen by the human eye, that were also physically "immortal", and were of use to, or frightening to mankind, like the Sun, Moon, Earth, Sky and Fire were considered "Gods".

In the ancient Indo-European theology the God of "heaven" was the Sky Father, Latin; Ju-piter (Jupiter), Greek; Zeu-pater (Zeus), Sanskrit; Dyaus-pita, Proto-Indo-European; Dyeus-pater and the Germanic God; Tues, as in Tuesday. The ancient peoples Sky Father is the same Sky you see everyday, a sky that brings sunshine, rain, wind, tornadoes, hail, thunder, lightning, flood or drought, and the occasional solid rock we call a meteorite. The sky father was a benevolent deity most of the time but he could also be very destructive, even a mass killer of men. The ancients were very aware of this destructive side of the Sky Father and always wanted to be on the good side of the Sky Father. Unlike the modern world there were no ancient atheists since everyone could plainly see the Sky Father, and only an idiot would have claimed the Sky didn't exist.

In contrast the modern world view has destroyed the ancient Gods of Sun, Moon, Earth and Sky. Since a visible or real "God" no longer has a place in our physical universe, modern people only have "supernatural" Gods. These modern concepts of an invisible God are of course our way of keeping the ancient Sky Father alive in our minds and societies long after we dethroned him and destroyed his heaven with our science.

Modern people have to always remember that the Gods of the ancient people are always real things; and that the stories about these real Gods are describing something real.

Now if we blindly assume that the ancient's concept of God was the same as our modern concept of a supernatural god then everything the ancient stories say about these real Gods, will always be misinterpreted by us, with the result being that we will fail to understand the real wisdom contained in these ancient stories about these real things.

Another very important thing to keep in mind is that the ancients always personified these real Gods in their stories; so if you naively believe the story is about the "person" in the story and do not know its about a real God/thing personified you can mislead yourself into a supernatural wilderness were absolutely nothing is real. A wilderness were confusion, illusion and misunderstanding rules all and reason can not be found.

4. Amanita muscaria - Legendary Herb of Immortality

The ancient Indo-Europeans called the *Amanita muscaria* mushroom "Maga" (The Great Gift) and so great was this Gift that its fame and name echoes down the ages as the root of our modern word Magic. The "Magus" or "Magi" (Great Gift bearers) used this truly wondrous great Gift of Nature; that healed their bodies of sickness and inspired their minds with wisdom and poetry, and they praised it in story and song, even worshiping the Gift as a God, it being the only source of an incredible magic.

The great Gift bears hundreds of different ancient names; the Greeks called it "Ambrosia" (Not Mortal) the "Nectar" (Death-overcomer) of the Gods. As the ancient legendary "Herb of Immortality" the Great Gift alone holds the Secret of what we call the "Holy Grail" and the magic multiplying "Living Bread" of the New Testament Bible.

The Great Gift is incredibly old, far; far older than mankind and in its original discovery by ancient western man are the roots of our western magic, religion, science and medicine.

The Great Gift has worn many names of Gods such as the Indo-Aryan's "Soma" with 100+ names the drinkable Immortal Living God who made the "blind see and the cripple walk" thousands of years before any human named Jesus walked the earth. Soma was so revered that Bronze Age "Seers and Sages" composed over 100 Hymns in its honor; these Hymns ring with ecstatic praise of this divine Living God, and are incorporated into one of the world's oldest religious text, the Rig Veda.

"Haoma" with 50+ names, the Persian pronunciation of Soma was the sacred drink made from a sacred immortal plant, which inspired the Persian Prophet Zoroaster to create a new religion that in approximately 550 BC became the state religion of the ancient Persian Empire, which stretched from the Nile in Egypt to the Indus river of India.

Zoroaster's religion had a tremendous impact on what we would call the Old Testament Hebrews who were a part of the ancient Persian Empire and who's Prophets like the Persian Prophets (Magi) rehydrated the dried fungus and pressed out a magic Elixir or used it to create the Living Bread and by its power they healed the sick, found lost objects and foretold the future.

The Hebrew Prophets called this one wondrous life form by more than twenty names including "the Anointed One" which in Greek is "Christos", Latin "Chrestus", English "Christ".

The New Testament story of the Sky God's divine infant's "virgin birth", who "turns water to wine", then "heals all the sick", who is "the source of all prophecy", that suffers death at the hands of men only to "resurrect in three days" and then became "Immortal", a story that is totally impossible for any man, yet it is exactly those impossible elements of the Christ story that are actually an accurate description of the birth, use, and death defying ability of the ancient Sacramental "Herb of Immortality".

The legendary "Herb of Immortality" the source of the golden, honey sweet, "Elixir of Life", the goal of philosophers, alchemists and mystics alike, who quested after it in the hope of life eternal. This theme of human immortality from consuming a very special Herb of Immortality is found throughout Eurasian mythology and in the ancient texts that are the foundation of several modern religions "Soma" in the Rig Veda (Hinduism), the "Fruit of the Tree of Life" in the Old Testament (Judaism and Christianity) and as the "Eucharist" or "Christ" in the New Testament (Christianity). All of these ancient texts also mention the same basic "Miracle" cures "the blind see, the deaf hear, the lame walk, and all the sick are cured" and greatly extended life spans for those humans who regularly consumed this magic herb.

However a close examination of the name or phrase "Herb of Immortality" and related words in the context of the ancient texts that refers to it, reveals that the ancients who actually used and knew this "plant" had a much more literal meaning of immortal in mind, when it is applied to the actual "plant".

The prefix im - when used in English means "not" as in impossible = not possible, or improbable = not probable. Mortal in English means "death" so the word immortal literally means "not-death" this is the same concept we see in the original ancient Indo-European words, where A= not, such as Greek, Ambrose = not-death, ancient Persian, Amarta = not-death, and Sanskrit, Amrita = not-death, or deathlessness. All of these ancient words are names of a "deathless plant" that produced a living magic drink with the same name; i.e. Ambrose, Amrita, and Amarta are all names of the plant and the drink made from it. "Herb" in English is traditionally considered to be any species of non-woody plant picked for medicinal, culinary or aromatic use. Keeping in mind that from ancient times until just very recently mushrooms were always considered to be "plants" since they are obviously not animal or mineral. When you place the two concepts together you end up with the "herb of not death" or the "herb that is not death," so it is the "herb" that is "immortal." This Herb's real physical Immortality is the true Secret of the Holy Grail and the Bibles Living Bread.

We know this life form today by its scientific name *Amanita muscaria* or its common name the Fly Agaric, it is the large golden or red-capped white mushroom with small white flakes on the cap that is commonly found in temperate forests worldwide. The names *Amanita muscaria* and Fly Agaric both refer to this mushrooms ability to attract, intoxicate and completely stupefy housefly and other fly species, along with slugs, snails and beetles, please note; removing these comatose insects and slugs from the mushroom usually results in their complete recovery within the hour.

Amanita muscaria is commonly considered poisonous to humans, yet reliable recorded fatalities are extremely rare, even when it is consumed fresh in large quantities by humans seeking intoxication or even those attempting suicide, however the resulting experience is usually not one many people would repeat.

Drying the fresh *Amanita muscaria* mushroom at a low heat of 100-120 deg. F until it is completely dry radically changes the mushrooms chemistry leading to an aromatic, sweet tasting form that is usable, storable, and resurrect able. Consuming this dried form is capable of generating a profound fundamental spiritual experience in some individuals.

While doing field research that led to my first book "The Sacred Secret; The Return of the Christ," I discovered that *Amanita muscaria* resurrects in three days and is Immortal, exactly as the ancients said it was, a very important fact that seems to have been overlooked by both modern Biological Science and Religious scholars. Further research into this natural immortality led to my second book "Natural Magic; Recreating the Grail", in which I show that *Amanita muscaria* is the only logical source of the Holy Grail and other magic vessel legends of Eurasia. In this work I will show that *Amanita muscaria* is the source of the biblical Living bread and the only logical explanation of the miracle of the multiplying loaves.

To understand how a mushroom that is here today and gone tomorrow can really be "Immortal" you have to know what the mushroom *Amanita muscaria* really is.

5. Amanita muscaria - The Fruit of the Trees of Life

All mushrooms are the fruit of a fungus and contain microscopic seeds called spores. Just as an apple bears no resemblance to the tree that grew it, a mushroom bears no resemblance to the fungus that grew it.

Fungi are a distinct branch on the biological tree of life, being neither Plant nor Animal but their own unique type of life form. Fungi are somewhat similar to animal life in that, both Animals and Fungi must find and burn food (carbohydrates) for life energy using oxygen and producing carbon dioxide, unlike green plants, which through photosynthesis can make their own food from water, carbon dioxide and light.

The Fungi are divided in to two broad categories, "Fungi Imperfecti" the simple fungi; yeasts, smuts, rusts, and molds like bread mold, penicillin mold etc. and the "Fungi Perfecti" the mushrooms etc. This division is based on how the Fungi produce and distribute their spores. The Imperfect fungi reproduce by budding (yeasts), or by using simple spore bearing structures to produce their spores and their reproduction usually involves no genetic mixing.

The Perfect fungi instead create mushrooms or other advanced structures to produce and distribute their spores, which are part of a fairly complicated nonsexual type of reproduction involving genetic mixing, which we won't go into here. However many higher fungi can and do make spore bearing structures similar to simple fungi and release spores by this method also.

All Perfect fungi are composed of thread like cells (mycelium) joined end to end and usually can only be seen by the naked human eye when in mass. The tiniest piece of a mushroom fungus, even a single cell of mycelium, can grow into a complete full sized fungus.

Many fungi are Mycorhiza which literally means fungus + root; and have a symbiotic relationship with a green plant; modern research has shown that approximately 95% of all the green plant species on earth each depend on one or more Mycorhiza fungi species to survive! The Mycorhiza Fungi supply their plant partner with water, nutrients and very importantly antibiotics, since green plants have no immune system of their own; in return the plant feeds the fungus carbohydrates.

Many Fungi manufacture and secrete chemicals that are very strong antibiotics; in fact almost all of modern Medicine's antibiotics were first discovered in Fungi.

Perfect Fungi have a unique ability to transport several times their body weight of water through their mycelium per day and it is possible for dried Fungi mycelium and dried mushrooms, to absorb water, and return to life after being completely dried for long periods of time.

Since a living fungus needs to eat; and it has to grow to obtain its food, many Fungi are capable of extremely fast growth of their mycelium. It has been estimated that a healthy mushroom culture growing on grain in a quart jar can grow new mycelium at the rate of 1 kilometer (6/10 of a mile) per 24 hours.

In the case of mushrooms the fruiting body is capable of an almost explosive growth, for example an *Amanita muscaria* mushroom can grow from a little egg smaller than a golf ball to a specimen 10 inches high and 8 inches across the cap in just a few days.

The spores of many Imperfect and Perfect Fungi are capable of circling the globe on the wind and are resistant to extremely high altitude, radiation, cold, heat, and many corrosive chemicals. As a class Fungi are some of the hardiest life forms on the planet and in a very real sense they are Immortal when compared to higher plant and animal life.

An individual *Amanita muscaria* fungus can be a huge organism that penetrates acres of ground, is symbiotic with hundreds of trees, weighs multiple tons, and with a possible lifespan measured in thousands of years.

Amanita muscaria is a Mycorhiza fungus that lives in a symbiotic relationship with certain tree families like Pine, Spruce, Hemlock, Fir, Larch, Birch, Beech, Maple, Poplar, Alder, Hazel, Olive and others. The *Amanita muscaria* fungus provides their trees with water, nutrients, and antibiotics in return the fungi are fed by the tree with carbohydrates and fallen debris such as leaves, needles, twigs etc...

Only with suitable symbiotic trees will the *Amanita muscaria* fungus fruit and produce its mushrooms. This very special relationship of *Amanita muscaria* with these particular trees was noticed anciently and led to the idea of the Tree or Trees of Life that produced the magical Fruit of the Tree of Life. This ancient Fruit of the Tree of Life concept is spread all over Eurasia and is also found in the Genesis story of the Old Testament Bible.

It is interesting that many of the Trees of Life actually named in Eurasian mythology are tree species that do not produce any edible fruit of their own, yet are symbiotic with *Amanita muscaria*, which shows that *Amanita muscaria* is the true "Fruit of the Tree of Life" in these ancient legends.

6. Amanita muscaria - Soma the pressed One And the Holy Grail

Rig Veda; Book IX Hymn LXII 4-8
4. "Strong, mountain-born, the stalk hath been pressed in the streams for rapturous joy: Hawk-like he settles in his home.
5. Fair is the God-loved juice; the plant is washed in waters, pressed by men: the milk cows sweeten it with milk.
6. As drivers decorate a racehorse, so have they adorned the meath's juice for Ambrosia, for the festival.
7. Thou Soma drop, with thy streams that drop sweet juices, which were poured for help, has settled in the cleansing sieve.
8. So flow thou onward through the fleece, for Indra flow, to be his drink, finding thine home in vats of wood."

All of the ancient Indo-European religions contain a variant of the Soma ceremony which even thousands of years ago was considered ancient in origin, some religions ascribing the Soma ceremonies creation to the first man, in others it was the Gods who first preformed the Soma sacrifice. The Soma ceremony is the oldest record we have of the interaction between *Amanita muscaria* and men, for without the Soma ceremony men would have never discovered that *Amanita muscaria* was an Immortal Herb.

In the Soma ceremony the dried *Amanita muscaria* earned the name Soma "the pressed one" by being re-hydrated with water and when it had absorbed as much water as it could hold, it was juiced so to speak, by being pressed or pounded between two stones to release the golden colored Amrita; the legendary Nectar of the Gods.

To filter, this juice was poured onto the high end of a wooden trough set at a shallow angle that was lined with "the eternal fleece," at the other end of the trough the now filtered fluid fell into a large carved wooden vat called the "Drona" (dronakalasa) which was claimed to be Soma's "home," into which was added a cooled, previously boiled thin gruel of water, ground or cracked barley, milk, and honey, this gruel, was then ladled from the Drona into wooden or terra cotta pitchers, poured into individual wooden or terra cotta, beakers or cups, and then consumed, generating a Divine rapturous joy in the participants of the ceremony.

When *Amanita muscaria* is used in the Soma ceremony you end up with a living wooly looking wooden trough and living magic cups, pitchers, and the Drona or vat, which all become "Soma's home". In essence these living cups, are the same as what we call the Holy Grail or the Bibles "Cup of the Lord".

The same *Amanita muscaria* Mushrooms are hydrated and pressed or pounded three times in the Soma Ceremony and are shattered into fragments, the mushrooms are basically gone, however they have released billions of spores and countless microscopic fragments of the mushrooms into the fluid, both of which can come back to life as *Amanita muscaria* mycelium, every drop of this fluid is alive with *Amanita muscaria*.

When this fluid penetrates the porous walls of a new wooden or terra cotta vessel it carries the microscopic spores and fragments with it. The addition of the foods to this fluid gives the fungus an energy source to grow on; in approximately three days the mycelium will be clearly visible to the human eye, and very much resembles white or gray sheep's wool or an old mans beard.

Once the *Amanita muscaria* mycelium is established in a vessel it is in effect a living vessel, the Herb of Immortality now has a new home and a new symbiotic relationship; one with the man whose cup it now lives in. A symbiosis where the *Amanita muscaria* fungus living in the vessel receives food and water, in return the human receives a dose of effective antibiotics and a very unique, profound spiritual experience by consuming the same food and water that was shared with the fungus.

It is this symbiosis that makes the Holy Grail truly "Holy," a Living Vessel that transforms the simple shared food and water into a Communion meal with a Living God.

The influence of this extremely ancient Communion Ceremony on much more recent religions like Christianity can not be ignored, since the Christian Communion where the participants are supposed to eat the body, and drink the blood of a sacrificed yet living immortal god, is truly based not on a last supper in Jerusalem, but on the ancient Soma Sacrifice ceremony.

The "Christ" or more precisely the Eucharist in the New Testament has more than thirty names. It is simultaneously the "Lamb of God", the "Living Bread," a "Living Stone," a "Living God," the "Living Water," the "Resurrection and Life," the "Son of God" and the "Tree of Life."

Some of the most bizarre statements ever committed to writing are in the New Testament Bible, most of these strange statements are attributed directly to the mythological founder, and these bizarre statements have confused true believer and nonbeliever alike ever since. This confusion is the natural result of applying these statements to a "real man," since these same exact bizarre statements make perfect logical sense when they are applied to the ancient Sacramental Herb of Immortality.

7. Amanita muscaria - The Living Bread

Gospel of John 6:48-51
48. "I am that bread of life.
49. Your fathers did eat manna in the wilderness, and are dead.
50. This is the bread which cometh down from heaven, that a man may eat thereof, and not die.
51. I am the living bread which came down from heaven: if any man eat of this bread, he shall live for ever: and the bread that I will give is my flesh, which I will give for the life of the world."

Here we plainly have an ancient reference to consuming magic "bread" that came down from heaven, and that eating this Heaven sent "flesh" will allow a man to live forever. Obviously this can only be a reference to the ancient Herb of Immortality in its role as the early Christian Eucharist.

The ancients always associated the Herb of Immortality with the Sky Father God, since only when the sky flashed with lightning, roared with thunder and rained in season, did these very special Sacred Magic Mushrooms appear on earth. It is this connection of the Sky Father God and the *Amanita muscaria* mushroom that led to the "Son of God" conception for the Herb of Immortality and the ancient idea that the living Herb of Immortality literally came down from Heaven.

Since the *Amanita muscaria* mushroom seemed to appear over night and it has no roots or seeds visible to the naked human eye it was anciently thought that it was "immaculately conceived", "virgin birthed" or as the Rig Veda so eloquently and simply states, Soma is "Born of Thunder".

All most everyone who tastes the dried *Amanita muscaria* mushroom comments on how good it tastes, most people comparing the flavor to honey, malt, or sweet bread, surprisingly no one says it tastes like a mushroom. I find it very interesting that several Roman Catholic people who I have shared the dried *Amanita* Mushrooms with on many different occasions over the years have stated that it tastes just like the "Host" or "Eucharist" the small Sacramental water which is claimed to be the "Body of Christ" used in the Roman Catholic Mass.

At first glance this would appear to be all the information contained in this statement of John, but the name "living bread" is a key to an even deeper understanding of the New Testament's Sacramental use of *Amanita muscaria*. This "living bread" of the New Testament is really alive and the main characteristic of all life is that it multiplies; this ability to multiply reveals that the "miracle" of the multiplying loaves in the New Testament has an entirely natural source, the ancient Herb of Immortality.

The name "the Lamb of God" gives us a clue as to the appearance of this "living bread"; the mycelium of *Amanita muscaria* can be several inches long and resembles white or gray sheep's wool or an old man's white or gray beard.

Living Bread
In this section you will learn how the ancients made the Sacramental Living Bread of the New Testament, and how to duplicate the "Miracle" of the multiplying loaves of Spiritual food.

The ancient technology of the living vessel or Holy Grail can be used to make the "living bread" which greatly increases the supply of this very special Sacrament. In the Grail legends the Holy Grail could create both magic food and drink, at first I thought that this was a reference to the barley gruel of the Soma ceremony, which is both food and drink, but further meditation on the name the "Living Bread" along with a lot of actual experimentation convinced me that simply changing the shape of a living vessel from the Grail's vat, pitcher or cup shape into a shallow bowl or pan to increase the oxygen supply and release excess heat, and changing the food to water ratio from the Grail's mostly water, to a "living bread" formula of boiled grain containing a lot of solid food and a minimal amount of excess water.

When this cooked grain is placed in to a suitable shallow living vessel, it is quickly colonized by the *Amanita muscaria* fungus, which grows into a solid fleshy loaf with the exposed surface, covered in long wool looking mycelium. In usually four to seven days this loaf of fungus can be removed from the living vessel, dried at low heat and used as if it were the dried *Amanita muscaria* mushroom. The living vessel can then be refilled with new boiled grain as soon as the old loaf is removed to start this cycle over again. If the fungus cake is handled properly it can be used to create a much larger quantity of living bread and at the same time create even more magic living vessels, which can produce still more living bread. Some simple calculations based on experiments show that using the right techniques an ancient person could start with a single medium size properly dried *Amanita muscaria* mushroom cap and in less than a month's time create several pounds of dried living bread and at least a dozen small living vessels, this "Living Bread" multiplies very rapidly and can easily feed a fair number of people with the Eucharist Sacrament in quantities large enough to manifest it's dramatic healing effects and allow a profound spiritual awakening to be generated in the participants.

Now you know the ancient Living Secret of Eurasian Magic and Religion; the true Secret of the Holy Grail and the Living Bread; now you can begin to understand the true greatness of the ancient "Maga" the Great Immortal Gift of Nature that just keeps giving it's own flesh and blood and by doing so, heals the sick and inspires human minds with it's unique Wisdom. The stories of the ancients say the Maga may be the Secret to the Greatest Gift of them all, that of an extra long, healthy, and happy life.

For more information on growing the Living Bread under modern conditions please go to Chapter 15.

8. Amanita Muscaria - The Healing Herb

The Rig Veda; Book VIII, Hymn LXVIII.
1."This here is Soma, never restrained, active, all-conquering bursting forth, a Seer and Sage by sapience.
2. All that's bare he covers over; all the sick he medicines, the blind man sees, the cripple walks."

I came across this quote from the Rig Veda in an old 1898 encyclopedia in 1969 when I was thirteen and the questions it raised completely changed my life, leading me on a life long quest to understand the ancient and legendary Herb of Immortality.

So began my treasure hunt for this miraculous Herb of Immortality, a hunt through all the ancient religious texts and Mythology of Eurasia I could find; and reviewing all the other plant candidates that had been proposed as the original Soma. Seeking to find the one real thing all of these Myths seemed to have in common the "Magic Herb," which since it is real, can be understood scientifically, becoming for me a search for real knowledge of this ancient miraculous healing plant; which may be the single greatest healing Herb on earth.

My own years of hands on research with *Amanita muscaria* convince me that it is the only life form that could be the Soma, Haoma, Ambrosia, Nectar and Eucharist of the ancient religions. Not only is *Amanita muscaria* truly Immortal; it also possesses very strong antibiotic, antiviral properties which we will explore further in this chapter. First we will compare the healings in three ancient religious texts; then we will examine the latest modern biochemical analysis of *Amanita muscaria*, and lastly we will examine evidence from modern people who have been cured of various illnesses by consuming dried *Amanita muscaria*.

The following is from the Sacred Secret
Action after Ingestion of the Soma, Haoma, Christ

The action of a drug in the human organism is fairly constant regardless of cultural differences. For example, Penicillin will cure certain infections in an Eskimo, Hottentot or you. It works the same regardless of culture; it will even work on someone who doesn't believe it will work, because of this fact; this is an even more valid comparison than the two preceding ones. Names are tied to culture and thus subject to variation; the action of a drug or drug plant is not.

The action of the drug plant under consideration has features peculiar to itself. No other drug plant in Eurasia has all the effects of the one under our consideration; this uniqueness means we are not likely to be confused by another drug plant.

The reader is cautioned that this plant is a psychoactive plant. Ancient references to the blind seeing and the lame stepping forth may not be literal, as in the blind see (visions) and the lame steps forth (psychically), but in three different religions there are the exact same references to healing. I believe if this plant were tested, it would reveal very strong antibiotic and antiviral properties, and, surely the ancients knew a healing when they saw one. It will, however, take someone much more qualified than me to test this and discover the truth.

What we hope to discover is the reputed action of the plant in those three different religions. If there are correspondences between the action of the Soma, Haoma and the Christ/Eucharist, a simple chart will reveal it.

	SOMA	HAOMA	EUCHARIST
1. General healing	X	X	X
2. Deafness	X	V	X
3. Blindness	X	X	X
4. Lameness	X	V	X
5. Leprosy	V	V	X
6. Physical rejuvenation	X	X	X
7. Mental illness	I	X	X
8. Prophecy	X	X	X
9. Prophets	X	X	X
10. Intoxication	X	X	X
11. Visions	X	X	X
12. Voices	X	I	X
13. Immortality	X	X	X
14. Psychoactive Urine	X	X	X

X = Clearly stated in Texts.
V = Covered by a general statement, such as the Rig-Veda's statement that Soma cures all the sick.
I = Implied in Texts.

1. General healing, any claim of healing.
2. Both deafness and blindness in the texts may be a spiritual concept, i.e. we are all blind and deaf until the herb opens our eyes and ears, however most hearing loss today is due to bacterial infections, or as complications from a serious illness.
3. The major cause of blindness even today is bacterial infections. A certain type of Bacterial blindness "Ophthalmic blindness" is transmitted by flies and was very common in the Middle East; it is now treated with antibiotics.
4. The major cause of lameness anciently, would be polio, a virus. A plant with antiviral properties may be an effective treatment.
5. Leprosy is cause by a bacterium; the modern treatment is with antibiotics.
6. Makes the old young (Yasna).
7. Several different types of mental illness are described in the New Testament along with what appears to be Epilepsy; all are supposedly cured or helped; the Christ/Eucharist and Soma/Haoma are all said to cast out demons in their respective texts.
8. & 9. Prophecy and prophets appear to be common to any variant of the Herb of Immortality Cult, the fact the herb is the only way to truly prophesy is always stressed.
10. All three agree on a Divine intoxication being one of the effects.

11. Visions, whether part of prophecy or not, are one of the effects. The blind seeing may also be a reference to visions.
12. The voice of the God is stressed in the Rig-Veda's "Master poet never yet equaled" and the New Testament's "Word of God"
13. It is hard to determine what exactly is meant in the texts by immortality and becoming immortal. All three religions stress this as the most important effect of the sacramental herb. "We have drunk the Soma, We have become immortal" Rig-Veda.
14. Psychoactive urine is found in all three texts, and was the conclusive proof that *Amanita muscaria* is the Soma, Haoma, the New Testament reference to psychoactive urine is John 7: 37-38 and is proof that the Christ/Eucharist is also *Amanita muscaria*.

Please note: I believe the only reason the Haoma column isn't a perfect match, is the shattering of the Yasna's texts by Alexander the Great's invasion of Persia, plus my inability to get all of the remaining Yasna texts to compare to the other two.

Once you understand that *Amanita muscaria* is the subject of the most ancient veneration and is the real "Living God" of the Eurasian religious texts preserved from antiquity then the secret of the "Miracle healings" is laid bare.

Diseases; the tiny Demons

Bacteria are single celled life forms of the class Schizomycetes, that can be easily seen under a good optical microscope, most bacteria are completely harmless and some are very useful to man in creating cheese, vinegar, yogurt etc. however many bacteria create disease by infecting green plants and animals including mankind. Some of the most horrible diseases to afflict mankind are caused by bacteria such as Leprosy, Tuberculosis, the Black Death (bubonic plague), Cholera and Typhus.

Recently whole new classes of bacteria have been discovered that are up to two hundred times smaller than normal sized bacteria, and some of these micro bacteria have been implicated in causing human diseases including non rheumatoid Arthritis.

Antibiotics are chemicals that selectively kill bacteria, and many Fungi manufacture and secrete antibiotic compounds to eliminate or control the bacteria in their environment. Modern science has discovered hundreds of antibiotic compounds, mostly in the Fungi Imperfecti; such as Penicillin, the first antibiotic isolated from a Fungi. This discovery has revolutionized Medicine; since common Bacterial infections that 70 years ago were death sentences, are now successfully treated with Antibiotics. Unfortunately Bacteria have a high mutation rate and many disease Bacteria exposed to antibiotics quickly develop resistance to these chemicals eventually making those antibiotics obsolete for treating these bacteria.

The other major class of diseases in plants, animals and mankind are Viral in origin. Viruses can only be seen by using an electron-scanning microscope and are orders of magnitude smaller than bacteria. For a very good example of just how much smaller a Virus is than a Bacteria; we have to think on the larger scale that we are more familiar with; imagine if a single Bacteria cell was expanded to the size of a 747 airplane fuselage, at the same scale a single Virus would be the size of a rat! Viruses consist of a core of DNA/RNA surrounded by a protein case, and can only reproduce inside a living bacteria, fungi, plant, or animal cell. Viruses attach themselves to the outside of the cell membrane and then inject their DNA/RNA into the host cell, once inside a suitable cell the Virus DNA/RNA commandeers raw materials and forces the cell to produce the virus protein cases, while the viral DNA/RNA reproduces very rapidly at the cells expense. A single virus may become several hundred viruses, which then load themselves (the viral DNA/RNA) into the protein cases and leave that cell in search of more cellular victims, the host cell ruptured and depleted of the materials needed to heal it self, dies. Viruses are the ultimate users, the smallest known predators, and a most efficient life form in that it isn't really alive, unless it's looting a cell to reproduce itself. Viruses have a fairly high mutation rate, so a relatively harmless virus can mutate and suddenly become deadly.

Viral diseases include the common cold, influenza, Small Pox, Chicken Pox, Herpes, Rabies, and Polio. Rheumatoid Arthritis is now thought to be a viral disease; and viruses have been implicated as the cause of several Cancers. The latest research has shown that the same virus that causes Mononucleosis (mono) is also the cause of Multiple Sclerosis (MS) a degenerative nerve disease. Many Virus infections live in the nerves of animals where the animal's immune system does not function; including Polio; which leads to paralysis of the infected nerves and the eventual atrophy of the affected limbs; and if vital nerves to the heart or lungs are infected Polio could quickly cause death. According to Archeologists who have studied diseases in the ancient Eurasian people, Polio was the major cause of lameness with Arthritis being the second major cause.

Unlike Antibiotics; Antiviral chemicals appear to be rare in Nature; and many of the Antiviral compounds used in modern Medicine are very expensive and have severe even toxic side effects. Now this apparent scarcity of antiviral agents in nature may have more to do with how we hunt for them than any real scarcity. Most antibiotics come from the simple fungi, which produce them to eliminate the bacterial competition for a limited food supply, finding and testing these Fungi for antibiotic use is fairly cheap compared to testing antiviral compounds.

Animals have immune systems and can deal with most virus infections; green plants on the other hand have no immune system of their own, there is no way a green plant can deal with a bacteria or viral attack. This is one reason the Mycorhiza fungi are so important; they supply their plant partners with antibiotic and antiviral compounds and these compounds keep the green plant healthy.

In the search for effective antiviral compounds the Mycorhiza fungi would be the logical starting place. *Amanita muscaria* is a Mycorhiza fungus that can keep its symbiotic trees alive and healthy for thousands of years. Fortunately for us the ancients did most of the actual field research; in the Holy writings of the ancient Eurasian religions are the clues needed to rediscover an effective antiviral agent; *Amanita muscaria*. The healing of the lame in the Rig Veda, Yasna, the Old Testament, and New Testament are obviously references to healing Polio a known virus.

The third major causes of diseases are parasites, which are single celled to multicellular animals that can range in size from microscopic organisms to intestinal worms several feet long. Malaria is a microscopic parasite transmitted by mosquitoes, which affects humans in large areas of the world. Many parasitic infestations are extremely hard to kill since chemicals that can kill a small parasitic animal are often very toxic to the large animal that is infested.

In nature the *Amanita muscaria* mushroom is often found with paralyzed or comatose insects and slugs in or on the mushroom, this may be a sign that *Amanita muscaria* could cure certain parasitic diseases, but this has not been proven.

The fourth major cause of diseases are fungal infections of which ringworm, athletes' feet, and yeast infections are the most common, however some molds, mildews and other fungi can cause serious illness or death if their spores are inhaled in large quantities or if mold contaminated foods are eaten. It is thought by many Health Professionals that the yeast infection *Candida* is actually to blame for a host of medical problems masquerading as separate diseases.

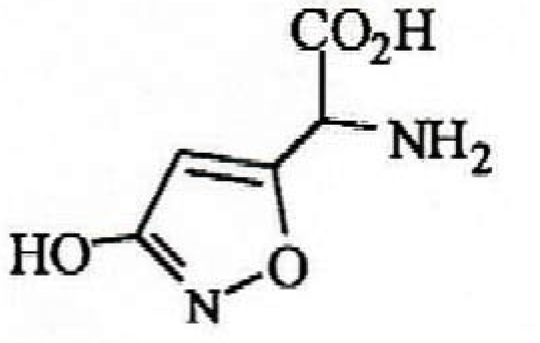
Some fungi infections can be very hard to combat with the standard antifungal agents in use today. Strange as it may seem some fungi manufacture and secrete potent antifungal compounds to reduce the competition in their environment from other fungi.

There are several compounds in *Amanita muscaria* that exhibit antibiotic action and other medicinal effects, which are known to science.

The following short excerpts are from
Mycol. Res. 107 (2): 131-146 (February 2003)
© The British Mycological Society
DOI: 10.1017/8095376203007305

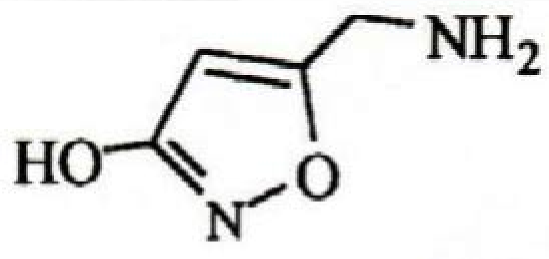
Review
Amanita muscaria: Chemistry, Biology, Toxicology, and Ethnomycology.
By Didier Michelot and Leda Maria Melendez-Howell

"Ibotenic acid, and particularly muscimol, have to be regarded as the substances responsible for the psychotropic action of *Amanita muscaria*. The effects of both substances are similar but not identical to the effect of the fungus in toto."



Ibotenic acid

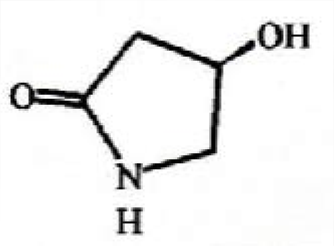
"Ibotenic acid (pantherin, agarin), i.e. a-amino-3-hydroxy-5-isoxazoloacetic acid, is colorless (crystals, C5H6N2O4, mol. wt. 158.11, mp. 150-152 deg. C decomposition), readily soluble in cold water. Any attempt of dehydration leads to decarboxilation yielding quantitatively muscimol."



Muscimol

"Muscimol, i.e. 5-(aminomethyl)-3-hydroxyisoxazole, isolated from *Amanita muscaria*, is colorless (crystals, C4H6N2O2, mol. wt.114.10, mp. 175 deg. C decomposition) readily soluble in cold water."

"Interestingly, cycloserine (myxomycin, seromycin, D-4-amino-3- isoxazolidone) is an antimicrobial tuberculostatic agent that exhibits a similar carbon backbone as muscimol."



(-)-R-4-hydroxy-pyrrolidone-(2)

"(-)-R-4-hydroxy-pyrrolidone-(2), whose structure is closely related to ibotenic acid and muscimol, was found in *Amanita muscaria* (Matsumoto *et al*. 1969a). This chemical frame is common in some micromycetes; they generally exhibit a potent biological activity against bacteria and other fungi (e.g. aureothrycin, equisetin)."

"A; B-(1->6) branched (1->3)-beta-D-glucan (AM-ASN) was isolated from *A. muscaria*. AM-ASN exhibited antitumor activity against Sarcoma 180 in mice (Kiho *et al*. 1992)."

(Sorry; no chemical drawing of AM-ASN is available to me at this time.)

As you can see, the two major chemicals Ibotenic acid and Muscimol found in *Amanita muscaria*, are closely related to known antibiotics. Plus, the chemically related hydroxypyrollidone derivative found in *Amanita* *muscaria* is a known antibiotic and antifungal; also found in micromycetes.

The chemical AM-ASN a Beta-glucan is extremely interesting for its antitumor activity; Sarcoma 180 is a standard cancer cell line that is used in cancer research all over the world. AM-ASN may in fact be the antiviral compound we are searching for but that testing has yet to be performed.

No specifically antiviral compounds are found in this paper; that doesn't mean that they do not exist in the mushroom; it simply means that no research has been done in this area.

This is the basic research on the antibiotic properties of *Amanita muscaria* however there are other medicinal properties that are very interesting concerning ibotenic acid and muscimol in this paper.

"Ibotenic acid and muscimol are respectively conformationally restricted derivatives of glutamic acid and gamma-aminobutyric acid (GABA)."

"Glutamic acid is a major excitatory neurotransmitter in mammalian central nervous systems and its receptors are implicated in neurological disorders such as epilepsy and Huntington's disease. Inhibitory glutamate receptors (IGluRs) constitute a class of ion channel proteins equivalent to glycine and GABA receptors. Ibotenic acid acts on IGluRs (Cleland 1996)."

"AMPA, a synthetic analogue of ibotenic acid, displays the same typical moiety and was found to be more effective and specific glutamate agonist than the parent compound (Watkins, Krogsgaard-Larsen & Honore 1990)."

"There is evidence that damaged function of GABA mediated inhibitory synapses is implied in experimental and clinical seizure disorders. Decreased concentration, and then activity of GABA, may have a role in human epilepsy. Muscimol is a potent conformational analogue and biologically active bioisostere (Krogsgaard et. el. 2000)."

"This toxin tightly binds with the gamma-aminobutyrate receptor (de Feudis 1980). Moreover, it is also an inhibitor of neuronal and glial GABA uptake and a substrate for the GABA-metabolizing enzyme: GABA transaminase. Subsequently, some research teams tried to improve the potency of drugs. Lipophilicity is of considerable interest for the prediction of the transport, adsorption and distribution properties of molecules, and so is an important factor in drug design. More lipophilic bioisosteres of muscimol and GABA have been synthesized, such as Tiagabine. This drug was marketed as a therapeutic agent for the treatment of epilepsy, Gabatril ® (Krogsgaard-Larsen 1977, Krogsgaard-Larsen et. el. 1994, Krogsgaard-Larsen, Frolund & Frydenvang 2000)."

Here we have ibotenic acid and muscimol both having beneficial effects on human epilepsy and perhaps Huntington's disease or other neurological disorders. The reference to muscimol as a "toxin" is to be expected in a paper dealing with the chemistry of a "poisonous mushroom".

In the ancient world epilepsy was the proof that demons possessed certain humans, a belief that was only reinforced with every seizure, which can be very frightening to any onlooker, and devastating for the victim. Any substance that could cure or moderate this disease would have been held in the very highest regard in the ancient world. Most of the people in the New Testament, who are said to be possessed by demons with a detailed description of their symptoms; appear to be epileptics who are reported to be cured by the Christ/Eucharist.

I believe *Amanita muscaria*'s many medicinal benefits explain why Christianity first spread across the Roman Empire among the sick.

Testimonials

Patient Zero; Donald E. Teeter
Italic section originally published 2001 in The Sacred Secret

I purchased some dried *Amanita muscaria* specimens through mail order. On opening the bag, I was struck by a most pleasant aroma. Somewhere in my body an old switch clicked, it was as if my body somehow had prior knowledge of what was now in my hands. A small taste test confirmed that it tasted just like it smelled. It was not bitter or nasty at all, but sweet, actually tasty.

I ingested about 1/16 oz. weighed. The effects were very mild; slight euphoria; slight increase in ambient light, these pleasant effects lasted about 3 hours.

One week later, I ingested 1/8 oz. (3.5 grams.). More pronounced effects: general internal calm, very soothing; visual illusions of color, blue being especially brilliant; waviness of the visual field; slight impairment of walking; illuminated changing color patterns with eyes closed. After about 2 hours: drowsiness set in, lay down with closed eyes, extraordinary visual illusions, inner sense of peace. 4-1/2 hours after ingestion feel rested and back to normal.

One week later, 1/4 oz. ingested. Much more pronounced effects with quicker onset: a semi-dark room is brilliant with light, I walk like a drunk and lying down is mandatory. After about 2 hours: intense Persian carpet patterns with eyes closed, great sense of inner peace, some auditory effects.

One week after this, I ingested 1/2 oz. (about 3 specimens), very quick onset, just minutes. Laying down mandatory after about 1 to 1-1/2 hours: extreme inner calm; indescribable illuminated visions; extremely complex auditory effects, ranging from a narration of the visions to complex "sayings or teachings" for lack of a better word. The experience was not all one way as in being spoken to; to questions, it gave answers; sometimes the visions would illustrate answers! At some point, I spiritually journeyed to a place I can only call the kingdom of light. Everything seen was illuminated with an Inner Light. This vision was a cohesive whole, with a beginning, middle and end. The visual and auditory effects subsided after about 4-1/2 hours. 6 hours after ingestion, I felt rested and physically rejuvenated this sense of physical well being lasted for about 14 days after ingestion.

During the 1/8 oz. experience, I noticed a burning sensation at a cold sore site; I had been having cold sores (2 or so a year) since my early teens. The sensation felt just like a cold sore coming on. Some warts on my hand also tingled. The cold sore never did erupt. The warts tingled more with increasing doses, after the 1/2 oz. dose, the warts disappeared over night. It has been 10 years since I first tasted the Soma; I have not had a cold sore or a wart since!* Warts and cold sores are two different kinds of Herpes virus. This mushroom appears to me to be an antiviral agent.

> *It has now been 14 years that I have been without a cold sore or wart; several Physicians and other health care workers have told me that modern medicine can only suppress the symptoms of cold sore herpes; that there is no known cure, and that complete remission from the cold sore herpes symptoms for more than a decade is very unusual.

Reasons why I believe *Amanita muscaria* contains one or more antibiotic, antiviral agents.

1. Ancient references to healing, spanning 2000 years.
2. Presence of the herb in milk can retard its spoilage for over 24 hours at a room temperature of 60-65 deg. F.
3. The penicillin like property of being excreted (urinated) unchanged a very useful property for an antibiotic.
4. The urine containing the drug also shows a delayed spoilage.
5. The mycorhiza fungus, as a symbiot with trees, is reported to manufacture antibiotics for its host tree. Such chemicals may be just as useful in fighting infection in a mammal as in a tree.
6. The personal experience of being healed, and the observation of other people being healed by *Amanita muscaria*.

In the spring of 2002 I was in Austin Texas; and one morning I woke up with a burning pain deep in my left hip and it was very hard to walk. Over the next few weeks the burning pain spread across my lower back and into my right hip, walking was now very painful. Approximately a month after the first symptoms appearance I was diagnosed as having Arthritis, the pain was excruciating and I couldn't walk more than a few steps without a cane. I did not have any *Amanita muscaria* mushrooms, the preceding summer in upstate New York had been very dry and I didn't find very many and those few were now gone.

Then I met David at the Gardens of the Ancients; in Manor Texas, he was very interested in the *Amanita muscaria* mushrooms and he ordered a pound from a supplier. About ten days later they arrived, and David invited me over to show him how I used the mushrooms. I made up some Ambrosia; a simple cold-water extract, and that evening we consumed some small pieces of mushroom cap washed down with the Ambrosia.

The very next morning the burning pain was greatly reduced and I had much better mobility. A few days later I purchased a 1/4 oz. and consumed them all. The next morning the burning pain was completely gone from my back and both hips and I could now walk upright without the aid of the cane.

I no longer get colds or flu's; at the first sign of a cold or flue I simply consume a small piece of mushroom (1-2 grams) and all symptoms disappear; usually within a few hours. One time I was away from home visiting relatives, and I came down with a nasty flue that was going around; I had no A. M. mushrooms with me, and I got very sick, very quick. On returning home the next day I consumed about 1/8 oz. of caps and stems and went to bed, about 8 hrs later I woke up feeling well, with no symptoms of this flue.

A small piece of *Amanita muscaria* mushroom cap placed on an infected tooth and left on for several hours will kill off the infection very quickly; the pain usually stopping in less than an hour; with the infection usually cured with one or two small pieces of cap.

I watched my son Neil cure Kennel cough (a communicable canine lung infection) in three dogs with a small bowl of ambrosia given to each one; which they quickly consumed, with complete remission of all symptoms from just one dose. Several people have told me that Kennel cough can be very hard to treat with the standard antibiotics and often takes months. The fact the dogs consumed the ambrosia so readily; shows me that they instinctively knew it would be good for them.
Donald E. Teeter

#2
I have been suffering from chronic back, hip, and leg pain for about four years. Recently, I was told by an Orthopedic Surgeon, that I had Bursitis in my hip and Tendonitis in my back. I could hardly walk and I shuffled about like the elderly, the pain was exhausting.

I was encouraged to try the *Amanita muscaria*. The first day I sucked on a cap for a while and then ate it. That evening I made a tea with it. The next morning, I had regained the mobility in my hip; I could now take normal strides. I continued to take the mushroom in some form twice every day for two weeks.

I still suffer some pain, but I can walk much better now.

Twice I have used the mushroom for dental care. Once after a lot of dental work my gums were sore, recently for a gum infection. I put a piece of cap over the affected area like a Band-Aid and sucked on it. Both times it pulled the infection out. 6/8/04
K. Lee
Age 35

#3
I consume small quantities of dried *Amanita muscaria* mushroom as needed whenever I feel sad or anxious. I never felt "high" on *Amanita muscaria*, just what I considered normal, I still feel my emotions but with *Amanita muscaria* I don't feel controlled by them.

While using this Mushroom I have noticed my ever-present insomnia is gone and I sleep better than I have for years. I have also noticed Colds and Flues are now so mild I don't take medication to control the symptoms. However, I do eat more dried *Amanita muscaria* mushrooms when I start to feel sick.

One small dose of 1 to 2 grams of dried *Amanita muscaria* mushroom at night is all I need to take for maintenance; I sleep very well and don't have as many body aches or pains. Over the years I have used prescription as well as illegal drugs to treat my insomnia and to escape from emotions I didn't want to feel. Often the side effects and increasing tolerance of these drugs brought on a deepening dependency and depression, as these medications would leave me either intoxicated or sleepy.

Now with *Amanita muscaria* it's nice to be both sober and in control of my body and mind. 5/5/05
L. L. Garner

#4
We have noted repeatedly that *Amanita muscaria* has a number of healing properties; these include arthritis and joint pain relief, stomachaches or nausea, diarrhea, toothaches, anxiety relief, insomnia, and a reduction in generalized infections. In all of these cases we have seen a clear repeatable pattern of *Amanita muscaria* helping in the above ailments.

Arthritis and Joint Pain
I have noticed a number of people that had near miraculous improvement in hip and knee pains after taking doses of *Amanita muscaria*. Researchers have noted in the last 5 years that the most prevalent forms of arthritis are caused by a nanobacteria. During the active period of the experience pain seems to vanish and the body feels almost pain free, I have noticed this dramatic effect myself and many other people have also commented on this feeling. I am sure this is partly due to the mental effect of the muscimol, but I also suspect there is an antibacterial and antiviral and antifungal effect of the *Amanita muscaria*. This reduction in the activity of these internal populations of nanobacteria could also account for the significant reduction in pain due to ingesting the mushroom or its other products.

Nano bacteria and the Heart
In scientific papers we have studied we have noticed that *Amanita muscaria* is clearly antibiotic and antifungal. But the ability of *Amanita muscaria* to kill or reduce the populations of nanobacteria is remarkable. The effect is not permanent but does seem to be additive over time. Nanobacteria also play a major role in heart attacks, tooth and gum disease, and cardiovascular disease particularly the build up of plaque.

Although we have not directly studied the effect on the heart and cardiovascular, I would suspect that the de-stressful aspects of *Amanita muscaria* and the ability to control nanobacteria might make it a very powerful heart medicine. Other mushrooms are renowned heart medicines such as Reishi, shitake, cordyceps and other mushrooms. I would not be at all surprised if the ability of these species to kill nanobacteria is the principle benefit to the heart and cardiovascular.

Toothaches
We have noted a clear improvement to toothache pain and infection by placing a piece of *Amanita muscaria* over the painful tooth or gum area. Although the effect is not as potent as peyote the effect is noticeable and repeatable. *Amanita muscaria* relieves the pain, inflammation and swelling of the tissues and also is good at de-stressing the subject since tooth pain is very stressful and agonizing.

Anti-anxiety Agent
Amanita muscaria is a remarkable de-stressing agent, during the active period of the dosing the *Amanita muscaria* is very calming to the nerves and most people who are stressed out will quickly find themselves in dreamland. The effect is so remarkable that many paintings of the middle ages show people who have eaten *Amanita muscaria* passed out in the fields along a brook or in the forest. One of the most obvious and sure properties of *Amanita muscaria* is the effect that a tired worn out person will soon find himself in deep sleep if they take a dosage in excess of 7 to 10 grams. Other effects include a stabilizing of the nerves and the nervous system as the nervous systems seems to get a break and calm down, allowing the subject to get needed rest that their anxiety condition has prevented. *Amanita muscaria* is really a god send when an over stressed person needs to break the cycle of stress that seems bound to be a downward spiral into insomnia and anxiety. Usually the day after the dosage the subject feels good, unlike alcohol, which stresses the nervous system and makes you feel hung over. The *Amanita muscaria* makes one feel refreshed, revitalized and relaxed.

David Schanzle; Owner, Gardens of the Ancients Herb Emporium and Nursery. Manor TX.

9. Natural Science

Amanita muscaria, common name Fly Agaric.
Cap; from 1-1/2 to 8 inches diameter, sometimes much larger (12 inches).
Cap Color; ranges from straw yellow, yellow orange, orange, orange red, to bright blood red.
Cap colored surface; smooth with white or off white warts on it.
Margin of Cap; may have striated surface that matches the gills below it, especially older specimens.
Gills; crowded, white, broad and free from stem with extremely fine hairy edges.
Spores; 8-11 × 6-8µ, ellipsoid, thin walled.
Spore Print; is white.
Stalk; 1-1/2 to 10 inches long, cylindrical, pure white to off white.
Stalk Interior; pithy inside when young, older ones are hollow.
Stalk Veil; full and skirt shaped, white, persistent, sometimes has an edge of velvety yellow.
Base; bulbous, covered in scale like patches of vulva in concentric rings.
Flesh; is white to off white, firm.
Season; in most of N. America; June to fall frost, in certain areas like coastal California and Florida it fruits in Dec. Jan, in other areas it is a spring mushroom.
Habitat; found only in association with certain tree species, pine, spruce, larch, fir, hemlock, birch, beech, maple, hazel, olive, and, rarely, oak.
Distribution; world wide, wherever suitable forest habitat and soil conditions are found.

I sincerely hope that anyone considering gathering this mushroom will buy a good field guide. I have looked at many; the best field guide I have found to date is the Audubon Society Field Guide to North American Mushrooms; the real photos are a great help. There are several other species of mushroom that may confuse an amateur, some have unknown toxicity, some are edible but they are not the herb of Life. A good field guide will help in determining exactly what you are looking at.

All mushroom literature will state that *Amanita muscaria* is poisonous! Fresh mushrooms are somewhat toxic, proper drying, however, radically changes the mushroom's chemistry. Some literature also lists this plant as a hallucinogen, without mentioning the fact that it has to be dried to be psychoactive, that's irresponsible, being an advertisement to misadventure. Other literature mentions the Siberian use as a hallucinogen, and then maintains that the Siberian *Amanita muscaria* is different from the North American *Amanita muscaria*. This is not the difference, drying is the difference! The Siberians thoroughly dry theirs before consumption, while Westerners are making themselves sick on raw ones!

The spores of this Fungus are small enough to ride the wind to anywhere on the planet! Siberian spores are landing in North America while North American spores are landing in Siberia.

There may be local variations in areas but this species is breeding planet wide and some of the variation may just be differences in growing conditions: New York to New England and coastal California being home to a golden yellow variety with the occasional orange or bright red one appearing; the west coast range and Rocky mountains produce a blood red variety with the occasional orange or yellow showing up, orange is found over most of the remaining country with the occasional yellow or red ones. From yellow to orange to red, they all seem to have the same effect and identical taste, if dried identically. In comparing independent chemical analysis of *Amanita muscaria* specimens from Italy, Holland, South Africa, Japan, North America and Siberia no significant differences were found in this fungi's chemistry.

It is interesting to note that the red, orange, and yellow specimens are sometimes indistinguishable from each other when dried, turning to a dull gold color on the cap. Some literature states that there are several different color varieties of *Amanita muscaria*, each having its own variety name: as in *A. muscaria* var. *muscaria*, red fly Agaric; *A. muscaria* var. *formosa*, the yellow orange fly Agaric. The Fly Agaric even has a white variety. The experts are not done thrashing all this out yet. I, however, only gather the yellow, orange, or red ones.

Host trees seem to make a slight difference in potency; in my personal experience the ones growing with any species of pine being slightly better than other host tree species. In your area it may be a different tree host that yields the best herb of Life. The *Amanita muscaria* is a mycorhiza fungus and it lives in a symbiotic relationship with certain tree species. The body of the fungus actually coats the tree's roots. It supplies the tree with water, nutrients and antibiotics; in return the fungus receives food.

Living *Amanita muscaria* is often found with paralyzed insects and slugs that tried to eat the mushroom. If you remove the comatose victim it regains its senses in about 20 minutes. The fungus sheathing of tree roots probably protects against insect and nematode attack. The fungus could, in fact, be a predator of small life forms, paralyzing its victims and then absorbing them, this small prey being a ready source of nitrogen and other nutrients needed by the fungus and its host tree.

The common name Fly Agaric is based on the folk belief that it kills flies. I have not found that to be true; they simply become comatose if they are exposed to fresh fly Agaric. Dried fly Agaric in milk is very attractive to flies; they are irresistibly drawn to it, becoming hilariously intoxicated after consuming it. The flies recover in 12 to 24 hours, seemingly none the worse for the experience.

10. Natural Science; Pharmacology

Living *Amanita muscaria* contains mainly Ibotenic acid; a trace of Muscimol may be present on the outer surface of the mushroom. Extremely small trace amounts of approximately 15 other chemicals are also present. Fresh *Amanita muscaria* should never be consumed! While not deadly poisonous they do not have the desired properties; all references to human poisoning are from fresh Fly Agaric. To be used as the Sacramental Herb of Life; the *Amanita muscaria* mushrooms must be thoroughly dried!

All species of mushrooms when fresh including *Amanita muscaria* contain a form of hydrazine that has been used by NASA as a rocket fuel; the amount of this hydrazine varies widely from species to species, and widely among individual mushrooms of the same species. No one has figured out why all mushrooms make this hydrazine since mushrooms would seem to have little need for rocket fuel. This hydrazine is not good for you when it's consumed; drying *Amanita muscaria* completely dry and then aging them for a few months will remove this hydrazine.

In drying *Amanita muscaria*, the Ibotenic acid is converted to Muscimol. Muscimol is present in the dried specimen in very small amounts, approximately one milligram per gram (1000 milligrams). Trace amounts of unconverted Ibotenic Acid are also present. Drying the herb in the sun produces a trace of a variant of Ibotenic Acid called Muscazone; this is far less potent than Muscimol with different effects.

The herb's effects are from a combination of these chemicals; the varying proportions of these chemicals lead to variation between individual plants. In actual practice, this variation is not of great concern; some individual plants may be stronger or weaker, the practice of averaging a batch from many specimens tends to produce an average.

Processing also has an effect on chemical makeup. Shaded cool drying producing more Muscimol than sun drying. Heated drying's effects varies with temperature and above 130 deg. F the mushroom cooks and the heat actually starts breaking down these chemicals. Room temperature to about 120 deg. F seems to be the best in my experience. I do not sun dry but you may choose to. If you have a regular food dehydrator with an adjustable temperature control, use it. As long your drying practices are consistent from one mushroom to another, the result seems fairly constant.

Scientific studies of the effects of isolated pure samples do not apply to the mushroom. They are, however, very useful in determining the effect of each chemical.

Ibotenic Acid's effect on the eyes is dilation of the pupil. The only mental effect seems to be sedation. This probably accounts for the coma like sleep and stupor reported from fresh *Amanita muscaria* ingestion. On drying, Ibotenic Acid loses CO_2 and becomes Muscimol.

Muscimol is the prime chemical for the dried herb's action. Muscimol dilates the pupil; and is the main component causing mental effects. Muscimol is relatively stable as a chemical; both it and Ibotenic Acid are very water-soluble. Muscimol is 4 to 10 times as active as Ibotenic Acid. Muscimol is a very polar molecule, with a strong - and + charge on opposite ends of the molecule. The effects of pure Muscimol are reputed to be similar to dried *Amanita muscaria*.

Ibotenic Acid if exposed to ultraviolet light produces Muscazone. Muscazone has less potency than Muscimol, but more than Ibotenic Acid does. It is present only in trace amounts in the herb.

There is no practical reason to try and isolate or concentrate these chemicals. Nature has produced an ideal mix already and the natural potency is just about right for practical use. Any water extract made from the herb for consumption (i.e. Ambrosia) will be weaker still. Because of the dried herb's low potency (1 mg Muscimol per 1 gram herb), accidental overdose would be almost impossible. Overdosing by misadventure is a different story. All doses should be weighed, with a maximum 14 gram = 1/2 oz = about 3 specimens, as the upper most limit per 200 lb. person. Smaller people should, of course, use less (1/8 oz per 50 lbs. body weight max). Remember that all medicinal herbs should be kept out of the reach of children!

The most pleasurable range for most people is from 3.5 gram = 1/8 oz to 10 gr. = 3/8 oz, this would be equal to 3 to 10 mg muscimol. People familiar with dried *Amanita muscaria* can detect faint effects from less than 1/2 gram.

Some Herbal Principles

The effect of a drug plant is subject to a few variables. First, the absorption rate of the active principles into the body, second, is the physical size of the pieces of plant that are releasing the active principle.

This second variable is subject to manipulation. As an example, if you eat a given weight of dried *Amanita muscaria* in one piece, say a 1/16 oz cap rolled up and swallowed whole, the experience will be lighter and longer lasting, than the exact same piece reduced to a fine powder before being eaten where the active principle is released faster from the smaller pieces, absorbed faster and excreted faster, leading to a more intense effect over a shorter duration.

Another variable encountered with any herb plant is the variation in potency between individuals of the same species. This variability is beyond human control. We can, however, reduce this effect, if we use pieces from a number of specimens in our preparation we end up with an average of the total. This average will be more predictable in effect than individual specimens since extra strong or weak individual herbs are averaged out by this method, a sample of the batch being representative of the whole batch.

Lastly, is preserve ability; all herbs decline in potency over time. Such things as oxygen, moisture, light and heat all work to change any herb's chemistry. Physical changes may accelerate these changes; grinding an herb into a powder, for example, allows herb chemicals to escape and other things, like oxygen, in.

The herb of Life is no exception to this rule. The *Amanita muscaria* must be dried before use! The large pieces resulting from this drying, if stored in sealed plastic bags that are then placed in airtight plastic or glass containers preserve fairly well. The herb degrades rapidly if over exposed to the environment or is powdered or otherwise altered from its storable form. It is best to only prepare as much herb of Life as will be immediately used.

11. Natural Magic

The following material details how to find and prepare *Amanita muscaria* for use as a sacrament.

It is up to the reader to exercise caution and restraint when first trying the *Amanita muscaria* mushroom; individuals vary widely in their response to various substances. It is much better to have a lighter pleasant effect than to be overpowered. While I personally have never seen anyone experience a bad effect, there is always that possibility.

Our ancient fathers called it the herb of Life; let's keep it that way. The *Amanita muscaria* is Sacred; treat it and yourself with respect. To find and consume the *Amanita muscaria* mushroom is to embark on a spiritual quest.

This knowledge is given so you may have the power of choice. If you wish to use the herb for healing, you can, if you wish to explore the Sacred, its here. The herb of Life is your birthright! No man, or assembly of men, has the right to deny you contact with the divine.

The Hunt

Finding the herb of Life is a sacred hunt, the *Amanita muscaria* mushroom, as mentioned in Natural Science, is a Mycorhiza mushroom. It lives in a symbiotic relationship with various species of trees such as Pine, Spruce, Larch, Birch, Beech, Maple, Hemlock, Fir, Hazel, Olive, and occasionally, the Oaks. So, I don't hunt the herb as much as the trees that support it. The *Amanita muscaria* mushrooms will always be found in association with these trees, in the area encompassed by the tree roots. The herb also needs drainage; sandy soil or sloping terrain seems to be preferred.

Over most of North America the fungus fruits from June to November. In California and Florida it fruits in some areas in the winter, the only sure way to discover where the herb is to spend as much time on the hunting as you can afford during its season.

Once you have found the *Amanita muscaria* mushrooms in a certain place, returning there to check from season to season is usually a good idea. Eventually you will compile a list of areas where you know the herb lives. It then becomes a matter of catching the fruiting. Do not be greedy, this plant is essential to the life of the forest; I always leave the older worm eaten and the very young buttons. The old ones don't taste good but are still releasing spores while the very young buttons could easily be confused with a button of a different fungus. If all you find are young buttons; try to return in a day or two; they should be in their prime by then.

A prime specimen has a basically flat cap and is about its full size. It should be fresh looking and undamaged by insects, slugs or weathering. Rounded caps mean it is 1 to 3 days from maturity. Upturned edges on a cap mean it's an older specimen; as long as they look fresh all three levels of maturity can be harvested.

A few simple items make harvesting easier. A basket to carry them in, lined with a clean cloth, a couple of small clean soft brushes to remove debris from the specimens and a flat blade screwdriver or an old stiff kitchen knife. Just slide the screwdriver or knife into the ground next to the specimen's stem and pry up, it should just pop up whole.

It is a lot easier removing dirt and debris from the specimen before it starts to dry and the less dirt in the specimen basket the better, so I try to clean them thoroughly as I am harvesting with brushes and my fingers. Removing the stem from the cap at this time seems to result in less over all damage, as does segregating the caps from the stems in the basket since the caps are somewhat fragile.

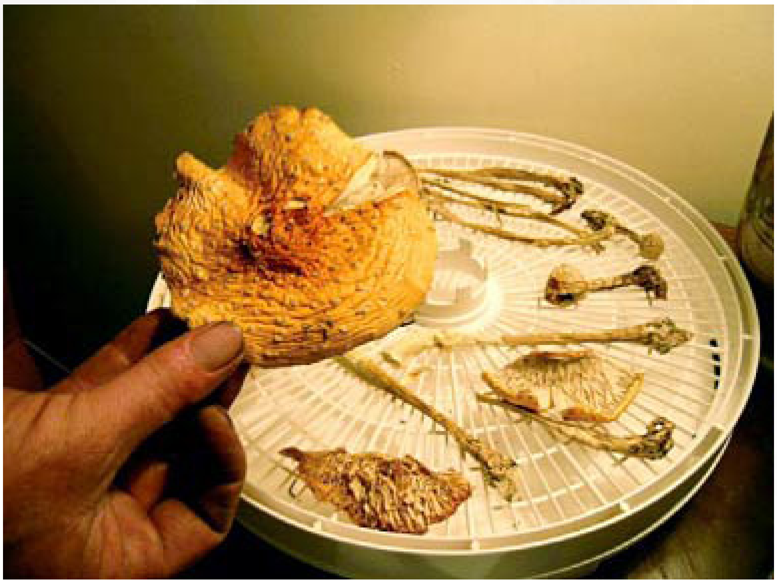
Amanita muscaria should be dried as soon as possible after harvest. Final cleaning of the herb should be done before drying. Sometimes a thin layer of soil is actually trapped in the skin of the stem's butt. Gently scraping with a knife will remove it; a final cleaning can be done in this area after drying.

A basket of *Amanita muscaria* mushrooms.

Preparing the Plant of Life

Once fresh specimens are obtained they must be dried before use! I remove the cap from the stem (if not already done) and slice the stem into quarters lengthwise the cap will dry whole. Placed on a screen or rack with good air movement they should dry in a day or two. If placed over a heating vent or oven dried, do not exceed 120 deg. F. A conventional food dehydrator with a temperature control works very well. Dry the *Amanita muscaria* mushrooms until completely dry; it should be cracker dry, pieces should snap when bent. Once dry it should be placed in sealable plastic bags, sealing the dried herb of Life in the bags creates the most delectable fragrance, it's no wonder the ancient Aryans also called it "Andhas" R.V. literally "the flower." These bags can then be stored in glass or plastic containers; store in a dry cool dark area.

These dried *Amanita muscaria* mushrooms should be aged for 2 or 3 months before using to allow a good curing of the specimens. Proper drying and curing is essential for both good taste and potency. The bread of Heaven can be simply eaten as is or used in the following preparations.



Dried *Amanita muscaria* pieces being removed from the drier.

WARNING: Do not consume any carbonated beverage, (beer, soda, etc.) before or after consuming the dried *Amanita muscaria*. It appears that Muscimol can be reconverted into Ibotenic Acid in the presence of carbonated water. This reverses the effects of drying where Ibotenic Acid loses CO_2 and becomes Muscimol. The resulting effect being similar to fresh *Amanita muscaria* ingestion nausea, vomiting, stomach cramps, stupor, coma like sleep, excess salivation and no hallucinogenic effect!

Magic Food

In Soma: Divine mushroom of Immortality it is mentioned that the Siberian tribes using *Amanita muscaria* often placed the dried mushroom into soups and stews thus creating magic food and this is one of the most enjoyable ways of consuming *Amanita muscaria*. Crushed or powdered dried *Amanita* can easily be added to a bowl of stew, soup or oatmeal and actually makes the food taste better. This is probably the best way to begin using the Herb of Life.

Ambrosia; elixir of Life

It's easy to turn water to wine if you have the properly dried specimens. Simply weigh out the desired amount of dried *Amanita muscaria* pieces. Place cap pieces upside down in the bottom of a small Mason type jar. Break stem pieces into 1/2" to 1" lengths and place on cap pieces. Shake gently to settle pieces into the smallest volume. Add just enough cool drinking water to cover the herb and let soak for at least 3 hours at room temperature. The water should be a dark amber color.

Pour off the ambrosia into a second glass or jar (using a strainer), cover the second jar and set aside. Add the same amount of new drinking water to the *Amanita muscaria* pieces in the first jar, let sit for at least 2 hours. This water should become almost as colored as the first run. Strain liquid as before, into the second jar, which already holds the first run. A third run may be taken if you wish but it will be considerably weaker than the first two extractions. I usually press the pieces with a fork to squeeze out more ambrosia, and then rinse the pieces and the first jar with a small amount of water, strain and add to the second jar.

This procedure yields ambrosia that is both tasty and potent. The original pieces being left somewhat larger for a reason, the mushroom is in fact a pump. When rehydrated with water it goes back to pumping water through its body, leading to a fairly efficient water extraction of the water-soluble chemicals.

It takes slightly more dried *Amanita muscaria* per dose, when making ambrosia than just consuming the dried mushroom, but the resulting experience seems clearer and cleaner with the ambrosia, with only the most water-soluble chemicals and sugars being in the ambrosia. This concentrated ambrosia is sweet to the taste. The flavor of well-made ambrosia is unique, tasting to me like a weak honey, malt and water solution. Just like coffee, tea or beer making, the quality of the water used has an effect on the taste. Reverse osmosis or distilled water yielding the best flavor.

The similarity between the word ambrosia and amber, probably relate to the color of the ambrosia, which is always a shade of amber. Ambrosia being yellow amber in transmitted light and reddish amber in reflected light.

The ambrosia is best when sipped slowly and allowed to lie on your tongue for a few seconds before swallowing.

Sacred Wine

A variation of the standard Ambrosia is to substitute Grape juice for the water. You can make this Sacred wine very easily by using approximately one oz. (28 grams) of dried *Amanita muscaria* per quart of grape juice, soak for 8 - 12 hrs then strain off the juice and press the mushroom pieces to recover more juice, which is added back to the strained juice. It seems to me that a slightly acidic Grape juice works best and a few drops of vinegar added per cup of juice at the start seems to make it more potent.

This wine has the unique property of getting more potent (up to a point) from being diluted with water! For best results you should dilute this wine using 2 - 4 cups water for every cup of wine before drinking. When properly diluted with water it will slack your thirst, if it is not diluted enough it will dry your mouth in a few minutes.

Preparing the Seer's Milk

The mixing of milk with the herb or the expressed juice is a very ancient practice dating back at least 4000 years; and, reports from Siberia dating from the 1900s report the fermenting of dried *Amanita muscaria* with reindeer milk. In the Rig Veda, the expressed juice is mixed with soured milk and curds before being consumed, no time seems to have been allowed for fermentation. The lactic acid present in the soured milk probably reacts quickly with the Muscimol, converting it to a more potent form.

Personally, I can't drink sour milk so I use a different method. I place small pieces of the herb into a bowl or jar and add whole homogenized fresh milk: 3/4 - 1-cup milk per one average sized (5-7 grams) shredded dried specimen. Place in a cool room (60-70 deg. F.); cover the bowl with a clean cloth or paper towel.

If there are any flies in the room, they will show you when it's ready, they will be drawn to it like iron to a magnet. If a drop is placed on a plate, when the flies find it they will become intoxicated. Just the smell of it seems both irresistible and intoxicating to them. This property explains the ancient Biblical name Beelzebub the Lord of the Flies.

If there are no flies around, pull a drop out every hour (with an eyedropper) and taste. At 60 deg. F. it may take 12 hours or more to ferment. The milk will not readily spoil and still tastes sweet after 24 hours. At about 30 hours it turns to a non-psychoactive yogurt that then spoils. The fact the milk doesn't readily spoil shows the antibiotic properties of *Amanita muscaria*.

Properly fermented milk is much stronger than the herb or ambrosia. You will know when it is ready with the one-drop taste test. When you are sure it's reached its peak, strain the milk into a glass or cup. Press the pieces in the bowl with a spoon or fork to try and recover as much milk as you can; sip very slowly and enjoy.

Preparing the Holy Oil

Olive oil and animal fat are both absorbed into the skin. As far as preservability goes, olive oil has an edge over animal fat, especially in warm or hot conditions. The active principal of the herb can also be absorbed into the skin; if you gently hold a fresh *Amanita muscaria* stem in your hand for about 5 minutes, you will start feeling a light giddiness, the longer the contact, the more intense the effects.

To create the holy oil, powder some dried specimens and sift the powder through a fine cloth. Return the pieces that didn't pass to being re-powdered. Once you have the desired amount of fine herb powder, place into a clean dry small sealable vial or bottle. Slowly add just enough olive oil to cover the powder. Using a piece of wire, gently stir the powder and olive oil together. Add more oil as needed to create a thin paste. Seal the container and let the herb soak in the oil for an hour or two. To use, place a fingertip on the surface of the oil and apply to the center of the forehead about an inch or so above the eyebrows. The effects should start in a few minutes and last until the oil is all absorbed. This is the most controllable method of using dried *Amanita muscaria* and probably the most efficient way of using a limited quantity of dried mushroom for a number of people. The effects are never too intense unless too much oil was applied.

This oil is also a very effective topical antibiotic and can be used on many different infections of the skin; such as inflamed insect bites or other infected wounds.

Preparing the Living Water

If you eat the dried herb of Life, drink the ambrosia or consume the milk of prophecy, you will produce the Living Water. The dosage going in determines the strength of what comes out. Approximately 7/8 of the active principal is excreted in the urine. The rest is probably sweated out. Recycling the active principal is a way to greatly extend the duration of the experience with a given amount of herb.

Many people will be disgusted at the thought of drinking their own urine. Fresh urine is, however, more sterile than tap water if you do not have a kidney infection. Urine spoils very quickly when exposed to microbes from the air; they multiply rapidly in the nutrient rich solution. The presence of the herb's essence in the urine does slow down such spoilage, another sign of antibiotic action. Personally, I have never tasted the Living Water; you are on your own with this one.

Preparing the Eucharist

The modern sacrament used by the older Christian churches is obviously descended from something; the water is now reputed to be composed of wheat flour. But what was it originally? If you believe the herb of Life is the Christ, then the herb as the Bread of Life would be the source of the sacramental flour.

Amanita muscaria, when crispy dry, powders or grates easily. A mortar and pestle works well today just as it would have anciently, it's just slow, and a small coffee grinder easily disintegrates it. Herb flour is made by sifting the ground powder through a fine cloth or screen to remove the larger pieces. These larger pieces are then reground and re-sifted. This is exactly the same technique used in the production of fine grade cereal flour. Eventually, you get most of the dried mushroom to sift through as herb flour. Gram for gram, herb flour is the strongest preparation that is easy to make.

This flour has many advantages for sharing among a number of people. First, the averaging effect of using multiple plants, second, in setting an accurate dose for each water from a batch of flour. When pressed into waters it is easy to handle; placed on the tongue, the water dissolves quickly and is totally absorbed, the water also dissolves easily in wine, grape juice or water.

Creating the waters is more involved than some of the other processes and will require the construction of some simple equipment. You will need a sifter and a press. The best sifter is created with two wide mouth Mason type jar ring lids. Place top-to-top, line up and tape around the outside of both with duct tape. You now have a top with two threaded ends on it and a hole in the middle. A piece of fine cloth is placed over a Mason type jar containing the course herb powder. The double lid is screwed down over the cloth onto the jar. A clean, dry, empty jar is now screwed onto the other side of the top. To sift, you place "course powder" jar up and shake. The fine powder will collect in the empty jar that is now on the bottom. The advantage of this sifter is that you don't lose much fine dust.

The cloth should be sheer and fine in weave. The threads should be smooth, not fuzzy. The ideal fabric looks like a fine screen when held up to the light. The cloth must be perfectly dry or it won't sift.

The ancient style of sifter can be easily recreated with an embroidery hoop and a piece of cloth. Sift into a large shallow bowl. A gentle motion is all that's needed. The advantage of this sifter is that it can be much larger in the cloth area than a wide mouth jar lid. It sifts faster but must be used in a draft free area, and you are going to lose some fine dust.

For the herb flour to be turned into a water, you need a press. In the Sacred Secret I gave instructions on how to build a simple but crude press. Then I discovered that presses could be purchased from Church supply houses that are specifically made to produce the Eucharist water; these presses can do a superior job than the home built one.

It may take some experience and trial and error to tune the operation. The waters should be pressed hard enough to withstand some handling and still dissolve on the tongue or in liquid.

Using a set of measuring spoons, determine the amount of herb flour to be used for each water. Then, use the spoon chosen to set the volume for every water produced from that particular batch of flour. This achieves uniformity from water to water, especially if the spoon is over filled and then struck off level with a knife.

When not being used, the die pieces should be stored in a clean dry area. Anything that touches the herb flour should be dry!

As you can see, the technology needed to create the water type herb sacrament was easily in reach of the early Christians. Everything involved was already in use in ancient Middle Eastern herbal practices. The early Christians had good pharmacological reasons for developing and using the herb flour water as a sacrament. The use of this technique stretches the supplies of the herb to its maximum by obtaining maximum effect from minimal amounts. There are other reasons why this form of sacrament was adopted. One, people who would never eat a toadstool would have no problem eating it as a water. By concealing the true identity of the sacrament from both followers and enemies, the priesthood maintained control and power over the one and denied their enemies information. The sacrament could easily be substituted with cereal flour if the supplies of the herb ran out, or, if they thought the authorities were going to raid.

Like all other herb of Life preparations, grind no more flour than will be immediately used.

Honey Drops

Once you have mastered the technique of producing herb flour, you may wish to make honey drops instead of waters. There is no need for a press. Simply produce the desired weight of flour, and then slowly and carefully fold in a small amount of pure honey. Work into a thick putty consistency. Roll into ball's 3/4" to 1" diameter or flatten out into a water.

The addition of honey makes a very tasty candy. The honey also seems to improve the absorption of the herb's essence. Like all other herb of Life preparations, it should be made and used immediately.

Set and setting

When *Amanita muscaria* is used Sacramentally, the set and setting are very important. The experience evoked by any psychoactive drug is affected by the set and setting where the drug is taken. The set means the individual's expectations of the coming experience, the setting, is the physical environment where the experience is taking place.

This herb will probably not be popular as a party drug. The increased sensitivity to light and sound can be too much for a party scene. Daylight use is probably not a good idea either as a sunny day can actually be painful. Some of the shamans of Siberia, who use the herb, practice their magic in complete darkness. Early Christians also seemed to favor dark rooms or areas, catacombs, etc. (See Matthew 10:27). The auditory effects are best heard in a quiet environment; and of course, distractions should be kept to a minimum.

No one should consume more than 3.5 gr. (1/8 oz.) of the herb of Life while alone. Higher doses may produce a disassociate effect, leading to a short-lived but complete break with reality. Many people will also lose their equilibrium and stagger and fall. Both of these effects may result in physical damage from falling or other accidents. There should always be a watcher (an unintoxicated person) to guard against these events. And, of course, only an idiot would drive a vehicle while under the influence of the herb of Life!

Do not mix the dried *Amanita muscaria* with other Drugs, Prescription, over the counter, or illegal.

WARNING: Do not consume any carbonated beverage (beer, soda, etc) before or after consuming the dried herb of Life. It appears that Muscimol can be reconverted into Ibotenic Acid in the presence of carbonated water. This reverses the effects of drying where Ibotenic Acid loses CO_2 and becomes Muscimol. The resulting effect being similar to fresh *Amanita muscaria* ingestion, with nausea, vomiting, stomach cramps, stupor, coma like sleep, excess salivation and little or no hallucinogenic effect.

12. The Resurrection Question

It occurred to me late in the construction of this book (The Sacred Secret) that I had not addressed a fundamental belief of Christianity, i.e. the idea of the resurrection of the Christ.

In order for my theory to hold up, the herb of Life (*Amanita muscaria*) must be able to resurrect. At first, I believed the ability of the dried specimen to absorb water, rehydrate and continue to release spores; an ability mycologist refer to as resurrection was the answer. But this rehydration would happen before the plant was ritually killed (pressed and extracted). A true resurrection of the plant would have to happen after it had been so killed.

After re-reading the New Testament statements, the idea that I was reading a recipe or formula encoded in myth took hold. The constant reference to three days seemed to be an essential part of the formula. Since the rehydration with water can take place in minutes to hours, it again did not fit the three-day references.

Returning to the Rig-Veda, for more information, I discovered that the water used for rehydration had grain (barley) boiled in it, before being used on the Somas. This would result in a very nutritious food source for the fungus. A puzzling statement was also found, referring to "these ancient Somas and these new ones." The new Somas were obviously ones picked and dried. But what could these ancient Somas be?

In Wasson's Soma, the Siberian tribes, using *Amanita muscaria* as an intoxicant, preferred older specimens that had dried in the ground; a fuzzy feel to the stem and a dark color distinguished these mushrooms. During the summer of 2000, while gathering specimens, I came upon several old specimens that had turned black. Each one was covered in a silvery gray long hairy mycelium; some of these hairy strands were more than 6 inches long. Closer inspection of these older black specimens with a hand lens revealed that the fuzz was erupting from the body of the mushroom and growing back into the ground; everywhere this fuzz touched the forest floor it had eaten the needles and leaf litter creating a bird nest like depression in the forest floor. Now was this fuzz the actual *Amanita muscaria* plant; after all, the specimen is just the fruiting body? I had seen this hairy mold many times before; it appeared on specimens that had been water extracted then left in the jar for a couple of days. Had I, in fact, been resurrecting the herb of Life without knowing it?

Like everything else dealing directly with the herb of Life in this book, it was time to experiment; time to see if the *Amanita muscaria* lived up to its ancient name Ambrose "not mortal."

Dried specimens were extracted with grape juice, barley water or honey water. In all cases, the pieces left after the extraction, erupted in silvery, bluish Grey mycelium within three days at a normal room temperature. These were allowed to grow for up to three weeks after extraction. They were then dried and re-extracted. In all cases, the liquid extract was again psychoactive. This cycle was repeated three times with no real change in psychoactivity; it appears that, as long as the herb of Life is adequately fed, the cycle can be repeated indefinitely!

One must ask oneself, how could this plant get a reputation and several names based on it being immortal unless the ancients knew of it's resurrect ability? How else can this extremely ancient belief be explained? (Ambrose = Not Mortal, NekTar = Death Overcomer, Born Immortal, etc, etc.)

Always in this study, I have tried to maintain scientific and common sense principals in this search for knowledge. It should come as no surprise then, that scientific study could recover a lost science, and this is exactly what we are dealing with here. It is an ancient science of spirituality, not religion as we moderns conceive of religion.

The New Testament is ancient scientific (empirical) knowledge embedded in a story. Some ancient people were keen observers, even if their observations are explained in words and concepts foreign to our thinking. This in no way invalidates their observations or their conclusions.

There are only two ways to preserve complex knowledge without writing, both methods known to students cramming for a test.

First, make it poetry or song where the rhyme helps remember the information, the Rig Veda is a prime example of this, where the poetry of the Hymns lends itself to being used as such a vehicle of knowledge.

Second, make it part of a story. In remembering the story, the knowledge is remembered, but the story itself must be memorable. The New Testament is an example of this second method. As long as you know this story actually contains hidden knowledge, there is no misunderstanding; but if you don't know it is really a vehicle for transmitting hidden knowledge; and so believe it to be literal, then misunderstanding is all this method can produce.

All the major points in the New Testament such as "the virgin birth," "water to wine", "healing," "prophecy" and "the resurrection" fit *Amanita muscaria* precisely. They do not fit a man or any other life form on the planet.

The rediscovery of this plant's resurrect ability is the last piece of the puzzle. It is the last major point in this Mushroom's identification as the Christ in the gospels of the New Testament. This mushroom resurrects so simply and naturally, any aware human, liquid extracting the mushrooms rather than just eating it could discover it quite easily.

Could any plant be more magical in the eyes of ancient people? Consuming an extract of a hallucinogenic plant, that will not die, would be the ultimate act of magic for the ancients. Nothing else could even come close to the power of this act. The fact that this Fungus exhibits antibiotic action would only reinforce this belief, all the more so if it actually extends a human's life span!

We have now come to the very foundation of religious belief in the west, this being human immortality. "We have drunk the Soma, we have become immortal" claim the Seers in the Rig Veda. Of course, they have become immortal, for they have drunk the immortal Soma. Can the New Testament's claims of consuming the Christ and immortality be understood any other way? No, it can only make sense in this context, that if you consume the immortal, you become immortal. This is pure magical thinking, exactly the kind of thinking you would expect to find at the very dawn of religion.

All religions are descended from shamanism; and a shaman's job is to make contact with the divine; could there be any more divine life form available to make that contact with than this immortal plant?

This wonderful herb proclaims its own divinity. In overcoming its own death, it demonstrates its power. In brilliant visions it shows its divinity. In fantastic sayings or celestial songs, it teaches with moral force. In pulling back the curtain of time and revealing the future, it shows itself as a god. In driving illness from sick bodies, it reveals divine healing powers. In its joy, the heart is gladdened. This was a divinity a man could know. A god, meant to be worshiped by being killed and used, but no wrong done. You have slain a god yet he lives again! An awesome god who lies down its life, for those who love him, and takes it up once more, a god that tastes death, yet is deathless itself, a completely guilt free gift, straight from the creator of all things.

Now, let's leave what the ancients thought of this herb of immortality, and return to the experiments and what this herb can teach us today.

An extraction with food source liquids in an effort to produce an extra pleasant drink, would invariably lead to resurrection. Like all fungi, the herb is temperature sensitive and prefers warmth to resurrect in the mentioned 3 days.

Amanita muscaria must be a very effective antibiotic producer. All experiments were carried out in a non-sterile environment, in an effort to replicate the ancient conditions. So these experiments must have been subject to spores and bacteria in massive amounts. Yet not one appeared to be contaminated with any other life form. I have even carried out the whole process, from extraction with grape juice to resurrection, to its greatest growth, outdoors during the late summer, with only a cloth covering the jar's mouth to keep bugs out. Not only could the ancients have carried out the resurrection, I believe, anyone can! This simple experiment should be proof to anyone that *Amanita muscaria* is producing one or more exceptional antibiotics.

All the resurrected cultures were dried to convert Ibotenic Acid to Muscimol, these seemed to possess the same gram for gram potency that they originally had.

The foods used were grape juice, boiled barley water and honey water. Grape juice was chosen because it was readily available to ancient people in the Middle East and Mediterranean Basin.

Barley cooked in an excess of water, the water strained off and then used, was chosen because of it being mentioned in the Rig Veda. Barley was also one of the earliest cereal grains to be cultivated, so, it would be available very early in history.

Honey was available to humans long before agriculture. Honey is the most widely available sweetener in

Eurasia. It would, of course, have been used to sweeten any beverage. The honey was diluted in water to create a slightly sweet tasting solution before being used.

When the cultures resurrect, and while growing, the appearance is one of mold. An aggressive, hairy, bluish gray to white mycelium completely covers the pieces of specimens. It looks like it should smell very bad; however, this is not the case! Resurrected with grape juice, there is a slight vinegar smell that transforms into one of the most delightful flowery fragrances I have ever smelled. Barley water produces a much heavier smell that while strong, is not offensive. Resurrected with honey, the smell is flowery, mild and pleasant. This is important to show that the resurrected *Amanita muscaria* would not offend man. There is no reason a person, acquainted with the herb, would not try the resurrected specimen in an extraction.

It is obvious that the food sources I chose are also the food source liquids used for another fungus cultivation, yeast, yielding wine, beer and mead. All three were known from ancient to modern times. But in light of the new knowledge of the herb of Life's resurrection, can we be sure that all ancient wines etc. were really alcoholic? A comparison of modern wine, ancient wine and a grape juice, *Amanita muscaria* extract is in the Question of Wine in the following chapter.

Observations on the Resurrection of Amanita muscaria

This Fungus needs oxygen, sealing it in an airtight jar; results in slow or no growth, with the production of very smelly chemicals. All the experiments were covered with a cloth or paper towel. This seemed to supply enough oxygen and keep the humidity levels high enough.

In the dark, the mycelium is actually a pure snow white; this quickly changes on exposure to light, to a silvery, bluish gray color. Occasionally there is a brownish tint. The pieces of the original specimen invariably turn dark, from a dark brown to almost black; they also grow back together into one piece. After this mycelium has been observed a few times it is easy to recognize, it is very distinctive in appearance and the color change from light is another identifying mark.

This plant likes warmth, with 60 deg. F. to 80 deg. F. being suitable for growth. Resurrection in three days requires 65-70 deg. F. After the mycelium starts to grow it will continue until it runs out of food and or water; this can take several weeks, I just let them grow till they stop. Do not shake or handle too rough while it's growing and don't place the jar in direct sunlight, it can be burned.

Amanita muscaria is a very hardy life form; I have resurrected dry specimens that were powdered before extraction, plus, those actually crushed, while full of grape juice, these were reduced to slime, and still resurrected! Although in both instances, it took slightly longer to resurrect these abused ones.

Once resurrected, the dried fungus returns to a living state much quicker than it does in the case of the specimen. Subsequent resurrections easily happen within three days. In order to prevent the extract from becoming charged with living chemicals, I only extract dried resurrections for half the time of specimens. (12 hours max!)

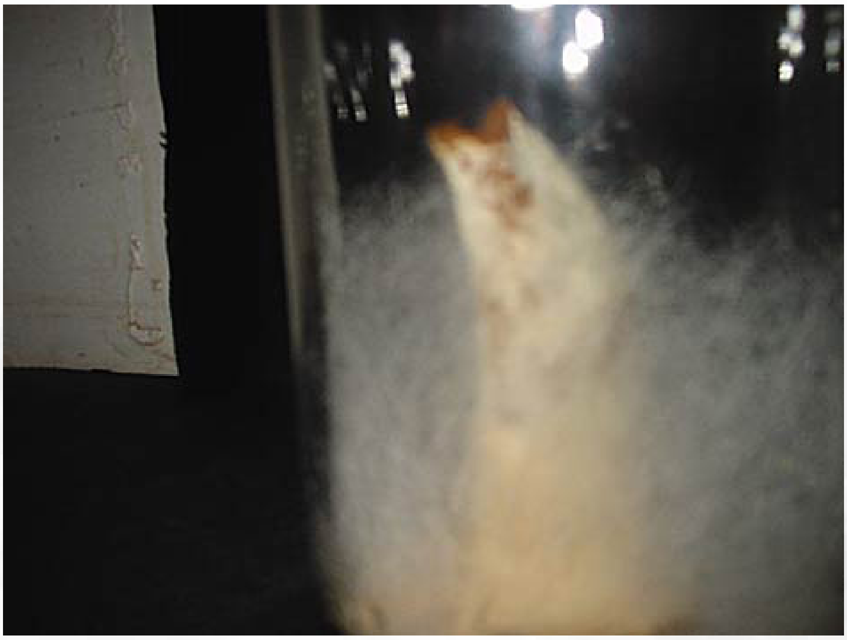
Drying the resurrections is necessary to convert Ibotenic Acid to Muscimol. Dry the same as a specimen. It can also be dried in the jar or bottle it grew in. Simply remove paper or cloth cover and place jar in a warm oven 120 deg. F. until dry. This reduces the handling damage to the mycelium considerably.

I believe that the natural ability of *Amanita muscaria* to resurrect allows it to; one, take advantage of food on the surface of the forest and two, be consumed by animals and distributed over a wide area.

Since almost any organic matter on the surface such as leaves etc is capable of being consumed by *Amanita muscaria* the Mushrooms ability to actually reach out with its mycelium and eat its above ground surroundings under certain weather conditions must give it a certain advantage.

Amanita muscaria mushrooms are routinely consumed by a large number of animal species such as slugs, squirrels and other rodents, opossum, raccoon, deer and the occasional human. When the mushroom is digested and then passed as feces the spores germinate and the mycelium will use the feces as a concentrated source of food. When *Amanita muscaria* is fruiting it is not uncommon to find fresh deer feces with what certainly appears to be *Amanita muscaria* mycelium sprouting several inches long. Since animals can move a considerable distance and the *Amanita muscaria* mushroom spores are getting a concentrated food source as a head start this ability has considerable survival value. In this the mushroom is acting just like most fruiting plants, which give animals food in return for their dispersing the plant's seeds over a wide area.

In these instances the *Amanita muscaria* mycelium that is exposed to the environment develops spores similar to those produced by the simpler fungi. Under the microscope there are small balls along the length of the exposed mycelium, which turn black when mature. Each of these tiny balls containing several hundred clear spores, and there can be thousands of these balls in even a tiny *Amanita muscaria* culture.



A single stem of dried *Amanita muscaria* on the third day after hydration, just starting to resurrect with long white mycelium plainly visible to the naked eye. Below is the same stem a few days later.

See last two pages for photos from time lapse video, "The Resurrection of *Amanita muscaria*"

13. The Question of Wine

In answering the resurrection question, perhaps another mystery of the ancient world may be solved. That being the question, "What on earth were they drinking and calling wine"? Ancient wine was radically different from modern wine in many ways; so this is really an interesting question.

First, it should be established that ancient wine was intoxicating. It was, ancient sources stating that four drinking cups of wine caused intoxication. These cups have been recovered in great numbers from archaeological sites throughout the ancient world. The ones I have seen are about 4 to 8-oz. capacity. They are not usually much bigger than this but there are exceptions, of course. Consuming 16 to 32 oz. of modern wine would obviously cause intoxication. This modern wine is, however, consumed straight, and this is the major difference between modern and ancient wines. The ancients always cut their wine with water and not just a little water either. One part wine having two to ten parts water added. Exceptionally strong wine could even be cut twenty to one. The most common ratio mentioned being three to four parts water to one of wine. There is simply no way an alcoholic wine could be reduced with water in these ratios and still be active! So, if the ancient wine could not be alcoholic, what was it?

The addition of the water was considered essential to the process. Drinking undiluted wine was reputed to cause death, definitely another major difference between modern and ancient wine. The most common theory to explain this difference is shown below.

The technology of ancient wine making (open fermentation in crocks or vats) would only produce a six-percent alcohol content. This would be quickly reduced to acetic acid (vinegar). Ancient wine was produced exactly the same as modern vinegar. So, a stable vinegar solution was probably the basis of ancient wine. Vinegar is, however, not intoxicating. One explanation is that vinegar was used as a vehicle for carrying other drugs. Dried drug plants such as poppy (opium), datura, henbane, etc. being extracted with the vinegar. (With the possible exception of opium and ephedra, none of these other plants would really be pleasant in their effects.) Vinegar would then preserve these drugs in solution. This would allow bottling, transport and use months or years later. Drug plants, herbs and spices were also added to the wine in the mixing bowl when the water was added. Such drugged wine was probably used in the ancient world, and, before this rediscovery of the resurrection of *Amanita muscaria*, a very logical conclusion.

The resurrection does, however, suggest a different scenario; simply add a given weight of dried *Amanita muscaria* to your grape juice, etc. in an open crock. The antibiotic action of the herb suppresses competition for the juice. After a certain time, the juice is full of *Amanita muscaria* chemicals. It may be possible to then bottle and transport without spoilage. The presence of a small amount of living *Amanita muscaria* culture in the juice would also tend to inhibit spoilage.

The specimens can be left in the empty crock to resurrect and then grow. After this resurrection is dried, it can then be reused. After one or two growth cycles the culture would be completely unidentifiable as *Amanita muscaria*. This culture may be capable of living through many generations of men; long enough that the culture's true origin may be lost.

I believe that this is one of the main reasons for these sacred stories of the virgin birthed hero that does miracles; dies as a sacrifice; resurrects and becomes immortal; these are stories both sacred and wide spread and they contain a description of the only life form on the planet that would do this! This knowledge would allow starting a new wine producing culture from the wild source.

There was nothing more sacred in the ancient world than their wine. Wine was the one and only god worshiped by the entire ancient world; consumed by Greek, Roman, Jewish, Armenian, Celtic, Persian, Babylonian, etc. etc. a comforter of king and slave. Could there be a more Sacred knowledge to preserve for the future than this?

If *Amanita muscaria* were really the source of the ancient wine, an extract would have to be capable of being diluted with water in a large ratio. To test this, 1/2 oz. of dried *Amanita muscaria* specimens was extracted with 16-oz. grape juice; the extraction lasted 8 hours. The straight extract was sipped and produced the usual effects; the amount consumed being about 4 oz.

Then approximately 1 oz. extract was diluted with approximately 3-oz. water; this actually tasted better than the straight extract. Several ounces of the extract were consumed diluted in various ratios of 2 to 6 water to 1 of extract. To my great surprise, the addition of the water actually made a great difference in the effect. The usual *Amanita muscaria* effects became instead purely psychedelic, very similar to Psilocybin or LSD!

This intoxication was much more pleasant than that produced by the straight extract; the dilution also seemed to increase the potency, exactly the opposite of every other drug extract on the planet, where dilution invariably leads to a weaker solution. Nothing in my years of researching *Amanita muscaria* was as surprising to me as this transformation! It came completely unexpected and was a very enlightening experience. This experiment was repeated several more times with exactly the same result. The ancient emphasis on dilution was really a practical application of chemistry. I feel fairly confident in stating that *Amanita muscaria* really was the source of at least some of the ancient wines.

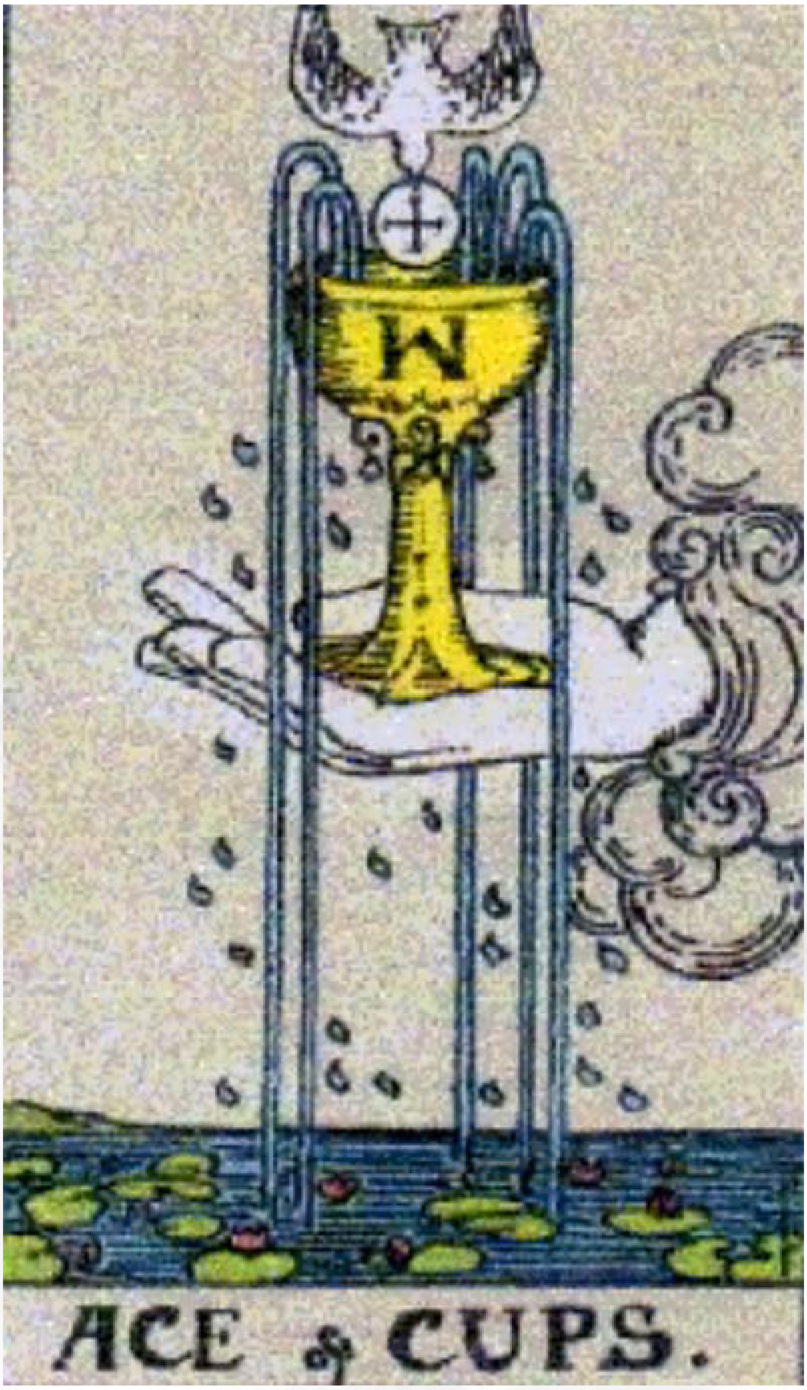
In trying to understand this transformation, I have developed a theory; Muscimol is a very polar molecule, I believe the oppositely charged ends link up and form long chains or other structures, I also believe these chains are released by the dried specimen into solution. Water is also a polar molecule and the sudden addition of a large amount of water breaks these chains into individual units of Muscimol dissolved in water. The long chains having the effects of the *Amanita muscaria* and the primary extract; while the dissolved individual Muscimol units having instead a psychedelic effect. This would explain the apparent increase in potency of the diluted solution. It is only a theory; but it is the best I can come up with, using only observed effects, a chemical structure diagram of Muscimol and reasoning.

This *Amanita* wine, after the addition of the water, was much more pleasant to me than anything alcoholic. In the ancient world this ability to be diluted and yet become stronger, would be another sign of divinity.

For details on creating an *Amanita muscaria* wine culture under modern conditions see chapter 15.

Shortly after The Sacred Secret was published, I was studying Celtic mythology and the Magic cauldrons in these Myths and their relationship with the Holy Grail. I soon realized that the Resurrection of *Amanita muscaria* solved the mystery of the Holy Grail, and after two years of research a separate little book was published titled "Natural Magic; Recreating the Grail" which is reproduced here in it's entirety; please note: since it was a separate booklet some info is repeated.

14. Natural Magic; Recreating the Grail



1909 Rider-Waite Tarot card, Ace of Cups, the secret of the Grail in a single image for those with eyes to see.

14-1. The Grail

The Grail has had hundreds of books written about it, yet not one book, till now, could prove what the Grail really is, what it does, or show you how to make your own Grail.

The Grail, a most precious, highly desired object of Knightly Quests, the Holy chalice that held Christ's Blood, and became magical as a result, a miraculous, mysterious, magical container of the Divine.

Legends and Stories of the Grail echo down through the Ages, whispering to us, of Power and Wisdom, living in a Cup! Stories of Wondrous Cauldrons and Magic Bowls whose drink of Healing, Poetry, and Inspiration never runs out! This is what this book is about.

The secret of the Grail is ancient, older than King Arthur, older than Christianity, far older than civilization itself. I had to follow the Grail into ancient prehistory to rediscover it's lost secrets.

The Grail is mysterious, yet it is real, it can be understood. The Grail is magical, yet like all magic once the secret is understood, it's very simple. The Grail is probably one of the oldest magic tricks known to man, but was absolutely baffling to early man when he performed it. This unexplainable Natural Magic astounded even the Wisest of Magicians.

The creation of a Grail involved the practice of the highest Magic known to early humanity. A Sacred, immortal, hallucinogenic plant was crushed and consumed as a beverage. Since the Plant is immortal it comes back to Life and lives in a suitable container, like your cup, perhaps forever. This is the technical magic of the Grail, plain, and simple. The real Natural Magic is the resulting symbiosis between all too mortal man and an immortal plant.

14-2. Soma, source of the Legends

Soma is just one of the many names for the Sacred Immortal plant used in creating the Grails, other ancient names are Ambrose (not-mortal) and Nek-tar (death-overcomer), names obviously based on the plant's resurrection and immortality. Soma itself means the pressed one, from the crushing of the plant in the preparation of the magic drink, in the Soma ceremony. One other ancient name for this sacred plant that deserves special mention is Maga (the Great Gift) Maga is the root of the modern words magic, magi, and magician.

Two modern names in English for this fungus are its scientific name *Amanita muscaria* and its common name the Fly Agaric; both names describe its power over flies. The *Amanita muscaria* is a large red or gold capped white mushroom with white patches on the colored cap. This pretty mushroom is commonly used decoratively, and is constantly found in Fairy Tale book artwork.

The *Amanita muscaria* is commonly found in temperate forests containing Pine, Spruce, Birch, Maple, and other tree species. *Amanita muscaria* has a worldwide distribution and is found on all continents except Antarctica.

Amanita muscaria varies in size from 3 to 8 inches diameter of the cap; it ranges in height from 3 to 10 inches, with up to 2 inches more stem below ground level. The cap color can range from a brilliant golden yellow to a deep blood red. The cap is covered with small white or off white warts arranged in a circular pattern, these are the remains of its universal veil. The underside of the cap is white or off white and has gills arraigned in a radial pattern, like the spokes of a wheel. If you remove the stem, the underside of the cap resembles a giant eye leading to ancient names like, the Single Eye. The upper stem has the remnants of the partial veil clinging to it like a small collar; this veil originally protected the gills. The very bottom of the stem is bulbous and usually has concentric rings or steps wrapped around it at ground level; this is the remains of the universal and partial veils attachment points on the base.

Like all the higher fungus (mushrooms etc.) the *Amanita muscaria* fungus occurs in two forms, the mushroom (the fruiting body) and the actual plant (the primal form) this primal form resembles common molds, such as bread mold. The primal form of *Amanita muscaria* can be huge; a single plant can cover multiple acres and weigh many tons. When the plant was used in the Soma ceremony the dried mushroom was crushed and destroyed, but the plant fragments, spores, and the magic drink it produced are capable of resurrecting and growing in the primal form.

My research with this plant leads me to believe that it would be impossible to perform the Soma ceremony with wooden or earthenware vessels and not have the plant resurrect and continue to live in them. The magic of the Grail can now be easily understood as a natural result of performing the Soma ceremony. This is truly Natural Magic.

14-3. Celtic Cauldrons and Magic Cups

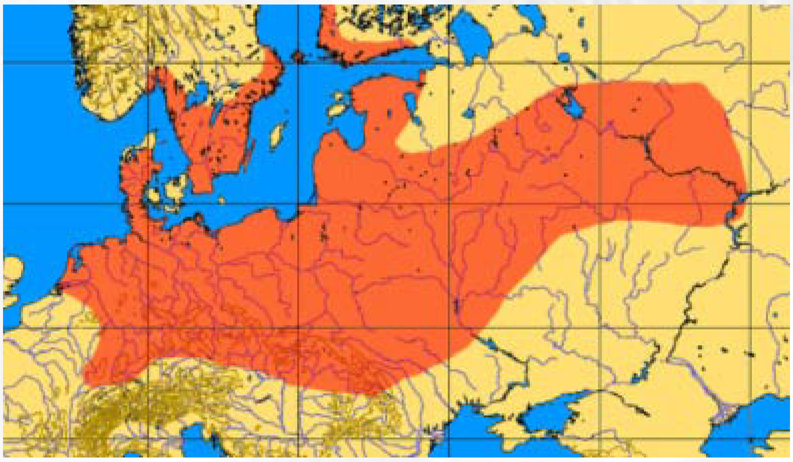
The Grail stories are now considered by many people to be Christian stories with the Grail being the cup that held the Last Suppers wine (a communion cup) or the cup that held Christ's blood. The truth is that the ancient Grail stories predate Christianity, and are old Celtic myths that were adopted by the Church. The word Grail comes from the Celtic "Greal", which means a brew of inspiration.

The Celtic origin of the Grail myths means that discovering Celtic beginnings may lead us to the Grails beginnings.

The people known to the modern world, as Celts are the Irish, Welch, Scots, and Bretons, all now living in or near the British Isles. Before the rise of the Roman Empire the Celts occupied a large part of Northern Europe, from Hungary through Germany and France to Ireland, Spain and Italy.

These Iron Age Celts are descended from a large group of Stone to Bronze Age cultures collectively known as the Corded Ware or Beaker People. This name was given to these people due to the earthenware drinking beakers and amphora found in male burials. These beakers are quite large (1.1 liter) and were impressed with cords before their firing. In the burials, the beaker was either in hand or close to it. Amphoras are large earthenware pots that are associated with the beakers. Other burial finds included flint and copper knifes, stone arrowheads, and wrist guards. One other item consistently found in these Warrior burials is perforated stone mace heads, hammerheads, and battle-axe heads. Leading some scholars to label them the Battle-axe people.

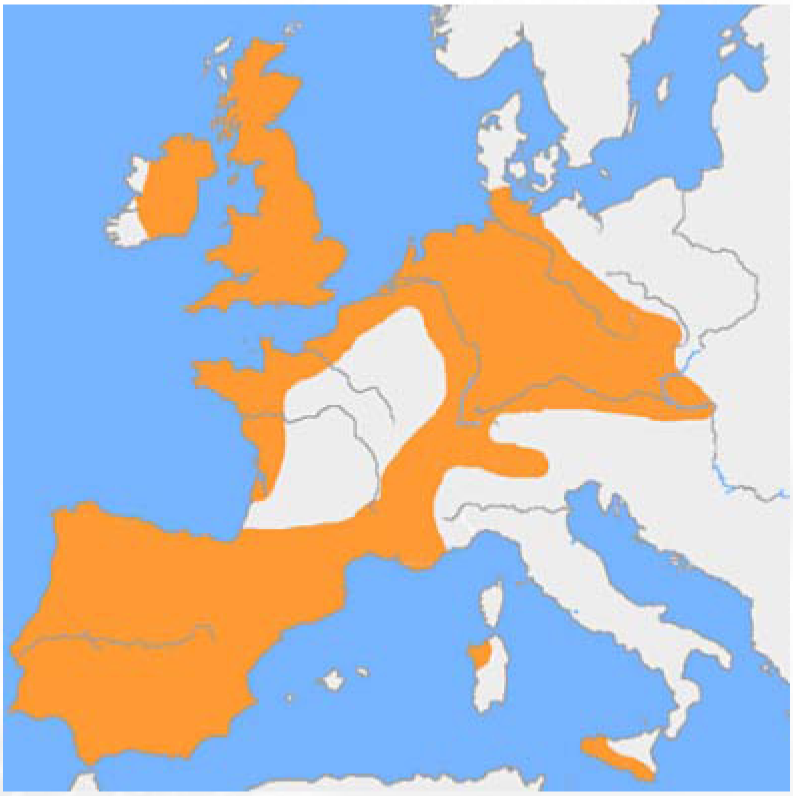
The Beaker culture extends back to 6,000 years before the present or 4,000 B. C. The Beaker people had horses, cattle, sheep, and goats and practiced agriculture, they possessed the wheel, plow and early metallurgy. By 2,000 BC they occupy all the territory the Celts are found in 1,500 years later. I believe the Beaker people are the source of the Grail myth and the ancestors of the Celtic and other European peoples.



Above area of the older Corded Ware culture.

We will never know what language the Beaker people spoke, they are simply too far away in time, and left us no known writings. The Celtic languages are part of a large language family called Indo-European. Languages in the Indo-European family are all related to each other and share a common point of origin. Modern Indo-European languages include Irish, English, German, French, Italian, Greek, Kurdish, Armenian, Russian, Iranian, and Hindi. This is only a small sample of Indo-European languages. Indo-European languages are spoken over a broad band of Eurasia from Europe to India. Further spread of Indo-European speakers has distributed it over much of the globe.

Below area of the Bell Beaker people.



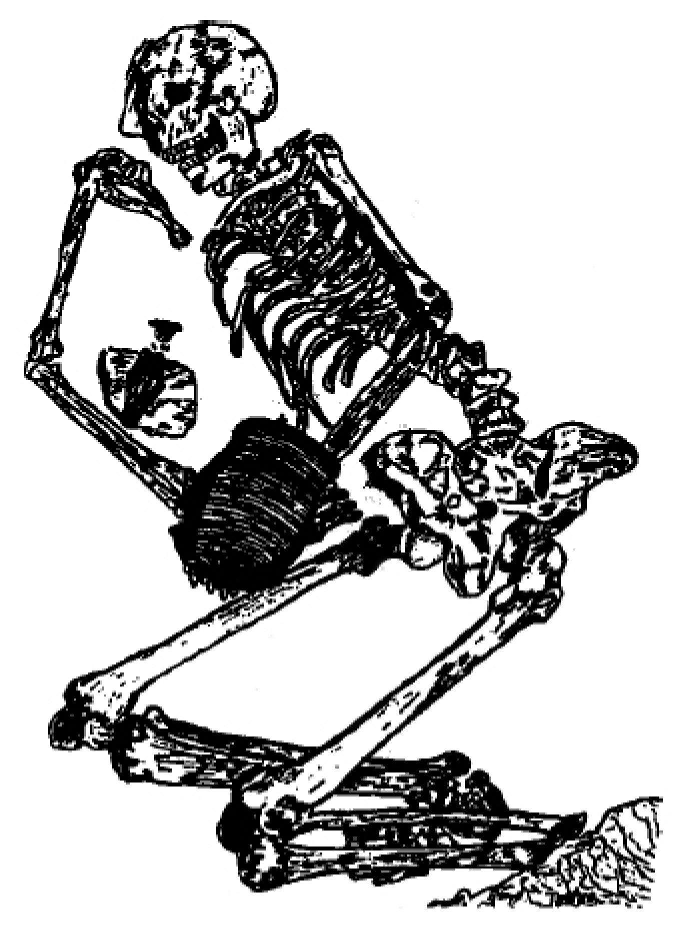
Since Indo-European has a point of origin, one can assume that at some early point, all the Indo-European speakers in the world were in one small area. If you find certain cultural traits and Legends common in the various descendents of the earliest Indo-European people those traits and Legends are from the original Indo-European speakers.

One such cultural trait and myth common to the early Indo-European peoples are Legends of a Divine Plant of Immortality which was processed into a Sacred Drink of Inspiration. This drink and the plant that produced it are known as Ambrose (ambrosia), Nectar, and Soma. Words found in both Greek and early Sanskrit (India). Our knowledge of the Soma ceremony is based on the Rig Veda (Praise-Wisdom) a book of Hymns composed by Seers and Sages. The Rig Veda is one of the largest and oldest texts in any Indo-European language; some of the Hymns may date back to 2,000 BC or older. Indo-European people expanding into Northern India in the Bronze Age composed the Rig Veda.

The Rig Veda has one overriding theme: Soma; one whole book #9 is completely about Soma and Soma is mentioned in almost every Hymn in the other books. Soma is obviously the source of the Wisdom, the ancient Seers and Sages were praising. Book 9 Hymns were sung as the Soma was being prepared and were an integral part of the Soma ceremony.

After the Soma was prepared it was poured into wooden cups to be consumed these wooden cups were owned by individuals who carried them to their grave. A man's wooden Soma cup was placed in his burial within easy reach if the dead man ever needed it. This is strikingly similar to the Beaker burials. When burial was by cremation the wooden Soma cup was placed on the funeral pyre, to accompany him into the afterlife. Large wooden and earthenware bowls were used in the processing of the Soma; these would also have the Immortal Plant living in them, just like the smaller cups or beakers. The amphorae in the Beaker burials correspond to these large Soma bowls; both are representations of the Magic Cauldrons, Pots and Bowls, found in all Indo-European Myth.

Bell Beakers recovered from beaker burials.



Typical Beaker burial, this one is from England, 2000 BC similar burials exist across Europe from Moscow to N. Africa all have elements in common, weapons, (in this case a copper dagger) male burial and the cord impressed Magic Beaker.

14-4. Proving the Theory

Ancient legends and archeology have given us a starting point, to attempt to recreate the Grail. In Science an unproven theory is just conjecture. To prove that any theory is true, evidence must be assembled from experiments. Experiments to be true must be repeatable by everyone and yield the same results, under the same conditions.

In the Resurrection Question (chapter 17) of The Sacred Secret, I detail my rediscovery of *Amanita muscaria*'s fantastic ability to resurrect. This fundamental rediscovery completely changes our understanding of ancient Religion and Magic, and provided the basis to really understand the Grail Myths.

My experiments in the Resurrection Question were carried out in glass canning jars or glass bottles. *Amanita muscaria* resurrected and lived in the glass no problem, but it didn't seem to be happy in there. Glass is a cold material; small animals may die of hypothermia if kept in a glass jar in even a warm room, it is also very slick, the fungus could not attach itself to the glass. Glass provided no nutrition for the fungus; all the glass resurrections were fed a food source liquid like grape juice or honey water.

I began some preliminary experiments on earthenware using some small terracotta pots called muffin pots available at a local Craft store. These pots are made in the same clay and shape as a common flowerpot minus the drain hole and are 3" in diameter Terra-cotta is a source of mineral nutrients which is why potted green plants usually grow much better in terra-cotta than in plastic, porcelain, or stoneware planters. Terra cotta is also porous and can hold a liquid food in itself till the *Amanita muscaria* uses it.

The fungus grew quite well in these small pots. These cups were used dozens of times and seemed to become more potent with each cycle of use. They did however have some major drawbacks; first they are tiny, holding only about 3 oz of fluid, second the wide-open mouth and shallow depth allowed them to dry out fast, placing one on top of the other, mouth-to-mouth helped compensate for this. Thirdly they were thin and fragile, and broke very easily. Lastly, the machine made inner surface was very smooth, it seemed that a more textured and porous surface, like ancient earthenware possessed, would be a much better surface for the fungus to grow on.

Tests on samples of stoneware and unglazed porcelain proved that the fungus would not grow well on these substances, the higher firing temperature leads to partial or complete vitrification, which resembles glass in its physical properties.

In summation if you place *Amanita muscaria* in a suitable terra cotta pot with a source of food it will resurrect and continue to grow on the walls of the pot perhaps forever!

14-5. Creating Your Own Grail

Creating your own magic Grail is easier than baking bread or canning fruit, simply follow the directions below to create your own Grail. But first you must understand some basic chemistry concerning *Amanita muscaria*. *Amanita muscaria* must be dried to become psychoactive; this converts a chemical called Ibotenic Acid to muscimol, which is the desired agent. When Ibotenic Acid is dried the chemical loses a carbon dioxide molecule and a water molecule to produce Muscimol. This chemical change can be reversed with Carbonated water so do not consume dried *Amanita muscaria* or the products of the Grail with Carbonated water (Beer, Soda, or bubbly wine like Champagne). To do so will at the very least nullify the mental effects and at the worst it can cause symptoms similar to fresh (undried) *Amanita muscaria* poisoning. These symptoms include nausea, vomiting, stomach cramps and extreme sedation resulting in a coma like sleep with no hallucinogenic effects!

Once you have a functioning Grail it will be used in a basic cycle of being filled with a food source liquid (Grape juice, Honey water, etc.) that feeds the fungus and is what you will consume. This liquid will set in the Grail for 4 to 12 hours; it is then poured off and drunk. The Grail will then be allowed to set empty for a week or more to grow and dry and can then be reused, this cycle can be repeated indefinitely.

To create your Grail you first need a suitable terra cotta pot or bowl, the ancients Beakers ranged from a tall vase to shallow bowl shapes, so the shape doesn't seem to matter, but a vessel you can see and reach into is very convenient. The terra cotta vessel should be at least 16 oz (500 ml) in capacity to make it worthwhile to use. Pottery shops or Garden supply stores are good places to look for a suitable pot, remember it must be terra cotta just like a clay flowerpot. Porcelain, stoneware, or any pot that's glazed inside or out cannot be used. If you wish you could try to make your own terra cotta pot, just remember to fire it at the lowest temp (700 to 800 degrees Celsius) higher temperatures cause vitrification and make the pot useless for a Grail. Some Colleges, Craft Stores, or pottery supply stores offer classes in ceramics, for most people this is easier than doing it all themselves. The Pot must also have enough of a rim to secure your cloth cover described below.

You will need a suitable thin cloth to cover the Grail whenever you are not pouring liquid into or out of the Grail. In the Grail legends the Grail was always covered with a cloth. In practice any cloth that is thick enough to keep fruit flies out of your Grail can be used. Cotton, or Linen works well but even polyesters can be used. The main requirements are that it keeps fruit flies out, easily lets oxygen in and helps keep the humidity level high for a couple of days to allow the fungus to grow. This cloth should be secured with a string or rubber band around the top of your Grail to keep it in place. It also helps to have two cloth covers for each Grail so that one can be washed and dried while the other is covering the Grail.

The next thing you need is the dried *Amanita muscaria*; this can be found in the forests or can be ordered from suppliers listed in Supplies and Sources in the last chapter. Most people will find it much easier to purchase this plant than to hunt it on their own, and that is what I recommend. If you wish to hunt this plant you will need a good field guide to mushrooms and you should also read my book The Sacred Secret for instructions on how to handle *Amanita muscaria* after its picked.

The last item you need is fungus food, this can be as simple as a store bought bottle of pasteurized Grape juice, Honey dissolved in boiling water, or any beer recipe without the yeast and hops. For most people the Grape juice will be the most convenient food to use since it is pasteurized before being bottled it is not likely to introduce any contamination into your Grail. Other bottled juices like Apple always seem to have other things added (corn syrup or chemicals) and I don't use them. If you wish to use a fresh juice it should be brought to a temp of 190 deg F in a double boiler to pasteurize it and it should be filtered and cooled before using. If you wish to use honey or a beer recipe it must be brought to boiling and then allowed to cool while covered, let it cool to room temp before using it in your Grail, adding hot liquid can cook the *Amanita muscaria* living in the Grail. The Honey or beer solution should also be filtered through a coffee filter to remove solids, or in the case of honey, any undissolved globs which if left on the fungus when it dries will kill it with sugar. All the food the fungus receives should be dissolved in solution or in microscopic pieces. This way it grows quickly, runs out of food quickly and enters its dormant state. While the plant is in its living phase it excretes Ibotenic Acid, which dries into muscimol on the surface of the fungus, it's this muscimol, which is extracted, with the next feeding.

Once you have the 4 items listed above you can begin the creation of your GRAIL There are 2 easy ways to create your Grail.

#1 Fill your terra cotta pot with clean drinking water and determine the volume of the pot by pouring the water into a measuring cup. Rinse the inside of the pot and place upside down to drain; this step is common to both methods.

The simplest way is to place 14 to 28 grams (1/2 to 1 oz) of dried *Amanita muscaria* pieces per liter (quart) of the pots volume, into your rinsed out pot. To this add your chosen room temp liquid food, place on the cloth cover, and leave undisturbed for 6 to 12 hrs in a warm area. Now you pour off all the liquid leaving the pieces of mushroom in the pot. Arrange the pieces on the sides of the pot in an open pattern to prevent the pieces from compacting (in a tall vessel you may have to lay it on its side to do this), recover with your cloth cover. See the next chapter on using the Ambrosia you just poured off. Place in a warm dry area that has air movement. In 3 days the pieces of mushroom and the walls of the pot should start getting fuzzy as the *Amanita muscaria* reverts to its primal form. This mycelium will be white or gray and continue to grow until it runs out of food and or water this can take several weeks. After the mycelium stops growing it will dry and shrink, the Grail will be ready to use again when the outside of the pot is warm and dry to the touch, the pieces of mushroom are hard, and the mycelium is shrunken back. Basically this is a two-week to one-month cycle, especially in a large pot.

The second method is to use the same ratio of *Amanita muscaria*, 14 to 28 grams (1/2 to 1 oz) to 1 liter (1 quart) of your pot's volume. This is ground to a powder and poured into the pot, then add the room temp liquid food, cover, and let it sit 6 to 12 hrs. Strain off the Ambrosia leaving the dregs and a small amount of liquid, return any filtered powder to the pot. Rotate the pot to evenly coat the inside of the pot with the now soggy powder. This powder will resurrect and create a thin layer of living *Amanita muscaria* on the inside of the pot. Because its in a thin layer it can go through a complete cycle of use in 7 to 14 days and works very well in small pots of a liter or less.

No matter which method you choose to use; adding a small piece of mushroom or some ground powder to the Grail occasionally with the liquid food seems to boost the cultures growth and keep it healthy.

Drying the Grail is as easy as placing the Grail in front of a small fan in a dry room temp area for at least 3 days before using. A fan can't over dry the Grail so it is the safest way to dry it. It is very important that the Grail be dry before using to produce the desired effects.

14-6. Using the GRAIL

Using your Grail is now a very simple procedure that any one can do! Place the dried Grail on a plate or other waterproof base, remove the cloth, and fill with your chosen liquid food. Recover the Grail with its cloth and let it set for 6 to 12 hrs after which time you uncover it and pour out the Ambrosia that the Grail has produced. Recover the Grail and let it sit in a warm room temp for the next 7 to 28 days at which time it is ready to use again.

The Ambrosia that you have poured off should be diluted with at least 2 parts water to 1 of Ambrosia before being consumed. As the Grail is used it will grow in thicker and thicker and become more potent with each cycle of use, dilute with more water as it becomes stronger. Eventually it can be diluted at a ratio of 3 or 4 parts water to 1 part Ambrosia. This dilution is very important to produce the desired effects; undiluted Ambrosia is actually less potent than the properly diluted Ambrosia. Remember do not consume any CARBONATED beverages (Soda, Beer, or bubbly wine) when consuming your Grail's Ambrosia, or let anyone else do so!

The intoxication produced by drinking the diluted Ambrosia is very pleasant for most people; in small doses it is similar to alcohol while larger doses produces a psychedelic effect. Undiluted Ambrosia in large doses can produce a confused mental state that most people do not find as pleasant as properly diluted Ambrosia. (The best antidote to this condition is drinking water.)

As your Grail gets older it should eventually lose its white or gray fuzzy look and start looking similar to a lichen (a tough leathery fungus found on rocks and trees) it will usually be white, gray or black, sometimes all three of these colors are found simultaneously. Also as your Grail gets older it should develop a unique fragrance depending on its own genetics and the foods it has been fed, this fragrance is also mentioned in the Grail legends were the Grail has a spicy aroma. All of the ones I've created smell kind of like mint or flowers when they reach this stage.

The ambrosia produced by your Grail or dried *Amanita muscaria* specimens is a living culture and will resurrect into the Primal form in 3 to 5 days. Because of this fact a Magic Grail can multiply and create another Grail, simply using a terra cotta vessel, as a drinking cup for Ambrosia will cause it to eventually become a Grail capable of creating its own Ambrosia; truly this is Magic.

You now posses a Magic Grail; it is possible that this Grail can live for many more years; properly taken care of it may last the rest of your life! Your Grail is however a Living organism and it must be treated as such. Do not expose your Grail to high temperatures, or let it freeze when it's in its living state. Always check the condition of your Grail before using, if it smells bad do not use it. Check to see if it has other colors on it; yellow, green, red or blue, may be a sign of contamination especially if it also smells bad. Remember to always keep the Grail covered with its cloth and keep it were rodents cannot get into it. Do not leave your Grail full of liquid food for more than 12 hrs it will start to drown, it needs air just like you do.

Recipes

Notes on Water:
Like beer, coffee, and tea making, the quality of the water you start with has a large impact on the taste of the final result. Use the best water you can find. Do not use chlorinated water in your Grail; chlorine is a poison to funguses. Do not use "hard water" in your Grail; the chemical deposits it contains can be harmful to the *Amanita muscaria* living in the Grail. Use fresh reverse-osmosis water or distilled water in all the recipes. (Remember not all bottled water is reverse-osmosis, some bottled spring water is very hard and should not be used.) If it is impossible to get these waters, well or city water may be boiled for 20 minutes to sterilize it, remove the chlorine, and leave the hard water deposits in the boiling pan rather than in your Grail. Cover the boiling pan and let cool to room temp filter through a coffee filter before using

1. Bottled pasteurized grape juice in a quantity to fill the Grail should be purchased, always open a new bottle for each use to prevent contamination. This can have as much as 10% water added before being used. Use at room temperature. This creates the Wine of Dionysus.

2. Frozen concentrated Grape Juice can be used if mixed with good water. Mix according to the directions on the container.

3. Honey at the rate of up to 3 fluid oz. per quart (90 ml per liter) of water is dissolved in boiling water, remove from heat, cover and let cool to room temp. Stir before using to make sure the honey is completely dissolved, if it isn't, it should be filtered through a coffee filter to remove any globs of honey. Honey has the widest range of flavors of any single food you can use. Ancient honey contained much more pollen than modern honey usually does; cooked pollen from certain plants could be a very nutritious food.

4. Barley, organic human food grade Barley is added to water at the rate of 4 fluid oz. (1/2 cup) per 5 cups=1.25 quart (1.25 liter) in a cooking pot. Bring to a boil, reduce heat to simmer, cover and cook for 45 to 60 minutes, add water to replace volume, bring back to boiling. Remove from heat, leave covered till cool, and filter through a coffee filter to produce a clear fluid. This recipe can also be combined with the honey recipe to produce better tasting Ambrosia.

5. Any home brew beer recipe can be used in your Grail remember to delete the yeast and hops from the recipe, and to filter it before using at room temperature.

These recipes are all based on recipes found in the ancient texts such as the Rig Veda; other foods could be experimented with if you want to.

The most convenient food is the Pasteurized bottled Grape juice, you don't need a stove and cooking pots to use it, just open the bottle and carefully pour it into your Grail. It is however a good idea to vary the foods you feed your Grail, so the *Amanita muscaria* has a wide range of nutrition. Please note: any clear fluid extraction following a grape juice extraction may appear dark colored due to the previous grape juice; it is however harmless and the ambrosia is as good as ever.

14-7. Conclusions

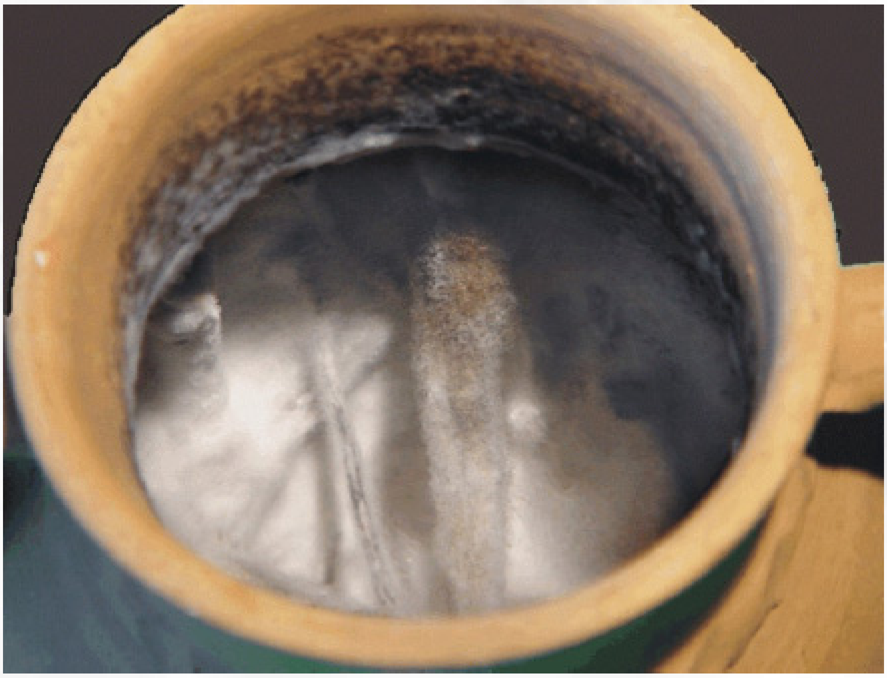
The corded ware, beaker culture and the Grail religion lasted more than 2500 years, eventually spreading from east of Moscow to Scandinavia, Scotland, Ireland, England, Germany, France, Italy, Spain, Portugal, and North Africa, an ancestral culture of all of Europe and beyond.

The theme of the Beaker burials is echoed in the Grail myths the combination of warriors and Magic vessels are the two main elements common to both. Legends of Magic pots and cups producing a Magic drink are recorded by writing as soon as writing appears in Europe, continent wide ancient legends that last until today.

There are two ancient claims for the Grail of Legend that should be of special interest to modern people. First the Grail could reputedly heal any non-fatal wound and cure any illness! Second, those who possessed the ancient Grail had extremely long life spans. Attributes that the Grail shares with *Amanita muscaria* in the ancient legends. As shown in The Sacred Secret, to be able to resurrect *Amanita muscaria* must be producing exceptional antibiotics.

The *Amanita muscaria* as the Ambrose, Amarta, Amrita, the Nek-tar of the Gods is an Indo-European heritage encoded in our languages, religions, myths, and folklore. This immortal plant and its accompanying Magic vessel are the source of ancient legend and Myth. It was called Maga, "the Great Gift," the very root of our modern word magic! Those who carried the Great Gift were called "Gift bearers," the root of the modern words Magi, Magus, and Magician. The Grail is one of *Amanita muscaria*'s greatest Gifts to mankind, a magical never ending source of inspiration, enlightenment, healing, comfort, joy, and by it's very existence, astonishment!

The Grail when recreated with *Amanita muscaria* matches the Grail of ancient legends perfectly. From it being a never-ending source of wisdom and inspiration to having the spicy smell of the Grail of legend. I believe that the fantastic ability of *Amanita muscaria* to resurrect and live in a wooden or terra cotta cup or bowl is the source of the Grail legends, and of all Eurasian stories of magic cups or bowls. It is very unlikely if there is any other explanation for these ancient legends except *Amanita muscaria* and its natural ability to do the seemingly impossible. *Amanita muscaria* is NATURAL MAGIC.



A photo of one of the Author's Grails containing resurrected *Amanita muscaria*. Now you can see why the Grail of legend could not serve a coward.

15. Growing the Eucharistic Bread and Wine in quantity

This section tells you how to create both the Living Bread and the Sacramental Wine; which are the sacred sacraments of Christianity. Any one who understands the importance of the Sacraments in the New Testament Bible understands that consuming the Living Bread and the Sacred Wine is the basis of Christianity.

While terra cotta was used anciently to culture *Amanita muscaria* it does have some major drawbacks when compared to glass. Terra cotta can become contaminated with other fungi or bacteria and the only solution is to discard the vessel. Which may explain the massive amount of discarded pottery at some Eur-Asian Archeological sites, in many cases the pottery was deliberately broken before discarding. A practice which would keep anyone from using a contaminated vessel by mistake.

Glass however can be sterilized with both heat and chemical methods to insure the minimum contamination.

Making the Living Bread

Gospel of John 6:48-51
48. "I am that bread of life.
49. Your fathers did eat manna in the wilderness, and are dead.
50. This is the bread which cometh down from heaven, that a man may eat thereof, and not die.
51. I am the living bread which came down from heaven: if any man eat of this bread, he shall live for ever: and the bread that I will give is my flesh, which I will give for the life of the world."

The living bread is perhaps the greatest of *Amanita muscaria*'s Magic tricks and can increase the supply of the Sacrament several hundred times in a very short period of time.

With the Grail only a small quantity of *Amanita muscaria* mushroom mycelium is produced at any one time, with the living bread a large amount of mushroom mycelium is grown out on cooked Barley in three days or less, and after it is dried, it can be used just as if it were the dried *Amanita muscaria* mushroom.

The grain chosen has a large effect on the finished product; Wheat, Rye, and Oats do not work as well as Barley; which contains a larger amount of protein compared to the other grains. Rice should never be used due to an ever-present contamination by a green mold that always develops on cooked rice. All Grain in general is contaminated with all kinds of bacteria, yeasts, smuts, and other fungi, these are usually present at harvest but the levels of contamination may increase dramatically due to improper storage.

Many people make a big deal over so called "organic" grain, which is actually not as good for making the living bread as the more refined Barley sold for human consumption. Basically the outer hull of the Barley grains is removed in a process called pearling this exposes the inner starch to the *Amanita muscaria* Fungus and greatly accelerates the growth, also a large amount of contaminating fungi spores; bacteria and yeast are removed with the seed hull during pearling so a much cleaner grain is produced by this operation.

Barley that still retains the seed hull will take more time for the *Amanita muscaria* fungus to colonize and can actually double the time it takes to grow compared to the more refined Barley, this extra time needed for growing and the large amount of contaminants on this type of Barley greatly increases the chances of contamination.

You should be aware that sometimes "organic" Barley is claimed to be "Pearled" this is however not a true statement unless the seed hull is removed; at which time it cannot legally be sold as "organic whole grain" Barley!

The Barley used should resemble white rice in color, with a dull abraded surface, and has only a small line of yellow running down the grains length, if the Barley grains are smooth, shiny and yellow it still has its seed hull and should be rejected for use.

The desirable refined Pearled Barley is actually very easy to find with the dried beans at almost any supermarket, and is usually sold in 1 lb bags, which are very convenient to use, all the instructions and times mentioned here assume the use of this Pearled Barley.

Cooking the Barley is the next step and is a very important factor in the success of the operation. The cooked Barley grains should be slightly rubbery and can be fluffed into individual grains, to provide a light airy structure in the grain for the *Amanita muscaria* fungus to grow through.

It is best to cook only 1 lb of dry Barley at a time, cooking larger amounts will cause the bottom grain to become almost like glue from the weight of the grain above it. The cooking pot should be at least 11/2 gal (6 quarts) in capacity and have a tight fitting cover; a wide bottomed pot is to be preferred over a narrow pot of the same capacity.

Since the weight to volume ratio of different lots of Barley grain can vary greatly I always use a 1 to 2 ratio of Barley to water by weight, so for a 1 lb bag of Barley I use 2 lbs of water = 1 quart, for reference 1 pint of water weighs 1 lb, for those on the metric system, use 500 grams Barley and 1 liter water.

Into the pot add 1 quart water, cover and heat till boiling, open cover add 1 lb white pearled Barley, stir, replace cover and turn heat down to a low simmer, cook for 45 min, turn heat off and leave covered till cool, approx 2 hours; do not stir or mess with it till it is cool.

Remove cover and using a fork lightly scrape the surface of the grain to release individual grains, continue to scrape all the grains free from the mass, when you get to the bottom of the pot there is usually some grain stuck in a layer of glue like residue carefully break this up into very small pieces of 1 to 3 grains and mix it into the rest of the grain.

At this point you should add the inoculant in small doses to the grain in the cooking pot, mixing it into the fluffed grain very thoroughly. After it is inoculated, load the grain with a large serving spoon into the jars chosen about 2 inches deep, place a coffee filter over the jars mouth and secure with a rubber band.

The inoculant is made by using a 1-ounce bottle with a cap, into which 1/4 fluid oz (fill bottle 1/4 full) of dried powdered *Amanita muscaria* cap is placed, fill the bottle with room temp water that has been boiled, and let it sit for 3 hours, shake well before using it on the grain. I usually make up the inoculant before I start cooking the Barley. This small amount of inoculant is perfect for 1 lb of the dried Barley when cooked, using more inoculant can add too much water to the cooked grain and cause problems.

The jars should be wide mouth canning or storage jars, from 1 pint to 1 gal in size, my personal preference is the 1 gal wide mouth jars, 3 to 4 of which can hold the cooked grain from 1 lb of dry Barley, the smaller jars hold about 3/4 to 1 cup of cooked grain each and require about 9 to 12 jars to hold all the grain. It is very important to practice good sanitation and clean the jars thoroughly with detergent, rinsing thoroughly, and if necessary soaking with a chlorine bleach solution.

Place the loaded inoculated jars into the grow area you have chosen, it should be room temperature (65-72 deg F) with some air movement and no direct sunlight on the jars, a dark area is to be preferred but not at the expense of air movement. The grow area must be easily cleanable and kept clean, it must also be free of other molds, for example using a moldy smelling basement as a grow area is just asking for contamination.

If everything goes right by the 36-48 hour, small areas of white hairy growth should be plainly visible to the naked eye scattered through the grain. Under ideal conditions the Fungus will completely colonize the grain between 60 to 72 hours after being placed into the jars. When the grain is completely colonized the *Amanita muscaria* fungus will have grown out of the surface of the grain 1-2 inches, and be pure white to a light gray white in color. It is very important to harvest the living bread at the right time, if the culture is allowed to grow past this point the top will quickly turn black with a massive amount of spores.

It is very important to inspect these cultures very carefully for contamination by other life forms such as bacteria using both sight and smell, other fungi can usually be seen as a difference in color or structure of mycelium, while bacteria can be detected by a strong sour smell. Contaminated cultures should not be used for human consumption and the jars that contained them should be either cleaned and boiled in water for 20 min or soaked with a strong bleach solution, before being reused.

Because the *Amanita muscaria* fungus can colonize the cooked Barley in a short amount of time contamination is usually not a problem, however temperatures above 78 deg F in the grow area can accelerate the growth of bacteria while slowing the growth of the *Amanita muscaria* mycelium and lead to contamination.

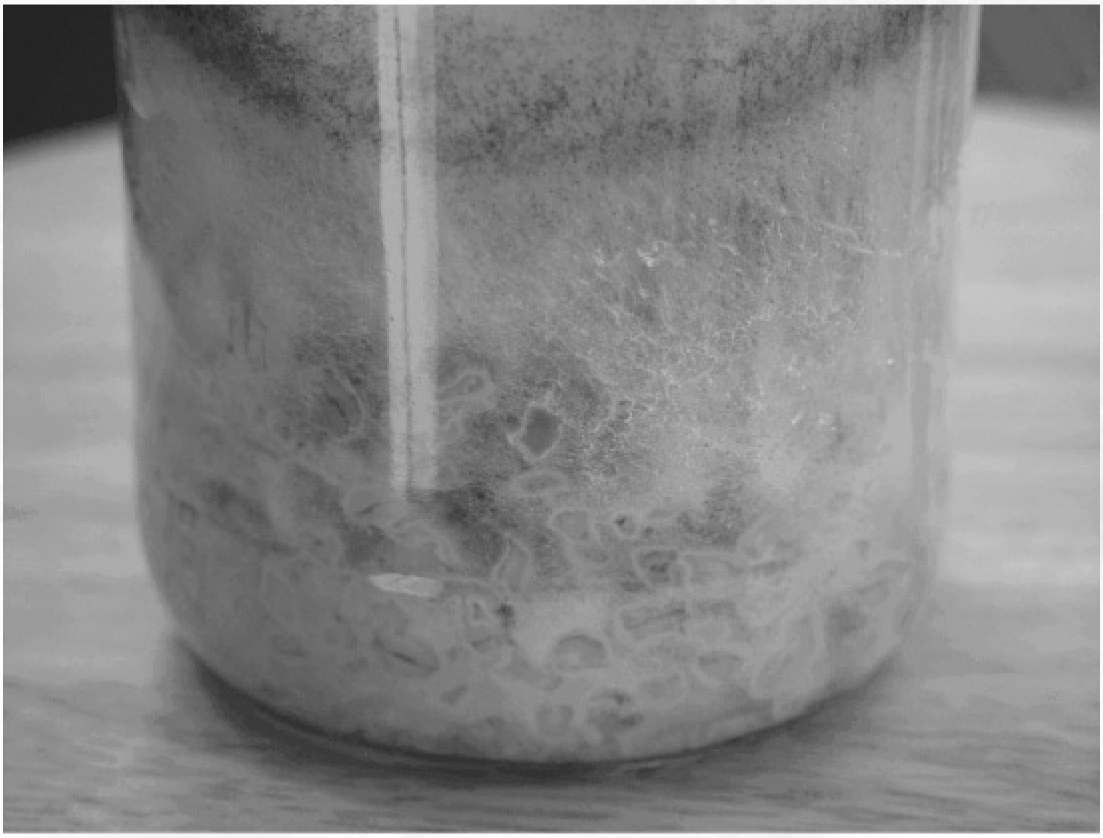
When the cultures are harvested they must be dried before they can be used, I use the same food dehydrator with a built in temperature control that I use to dry the *Amanita muscaria* mushrooms. The cultures can also be dried in an oven set on the warm setting with the door cracked open slightly.

The cultures should be dried completely dry and it is better to dry it too long than not enough, breaking the cultures into pieces speeds up the drying process considerably. When the cultures are completely dry place into sealable plastic bags or glass jars, in a very short time it will generate a very pleasing aroma, and become quite fragrant. The Living Bread is much better tasting than the Barley it was made from with a very satisfying malt type flavor.

The dried Living Bread can be ground into flour and sifted through a fine mesh strainer and used in a wide variety of recipes such as brownies, cookies, cakes, Banana and other sweet breads. The Living Bread flour can be used cup for cup instead of regular flour in your favorite recipes, the only real difference in the Living Bread recipes is to leave out all the salts, I don't add table salt, Baking Powder, or Baking Soda, and I cook everything I make at 300 to 325 deg F as Muscimol breaks down at 350 deg F. or higher.

If the dried Living Bread is cracked into pieces or ground to a coarse flour it can be cooked in boiling water like a regular hot breakfast cereal such as Oatmeal or Grits, and creates what I call the true Breakfast of Champions, with milk and honey added it is extremely tasty and really brightens up the day.

A very tasty Ambrosia can be made from the Living Bread by simply soaking the ground flour in cool drinking water and adding honey or sugar to sweeten, this can also be prepared as a hot drink by simply heating the water containing the Living Bread Flour, I use about ½ cup flour in 1 quart water, but the exact ratio isn't real important. You can also add the Living Bread flour to grape juice or other fruit juices and create a Living Bread Wine, in just a few minutes.



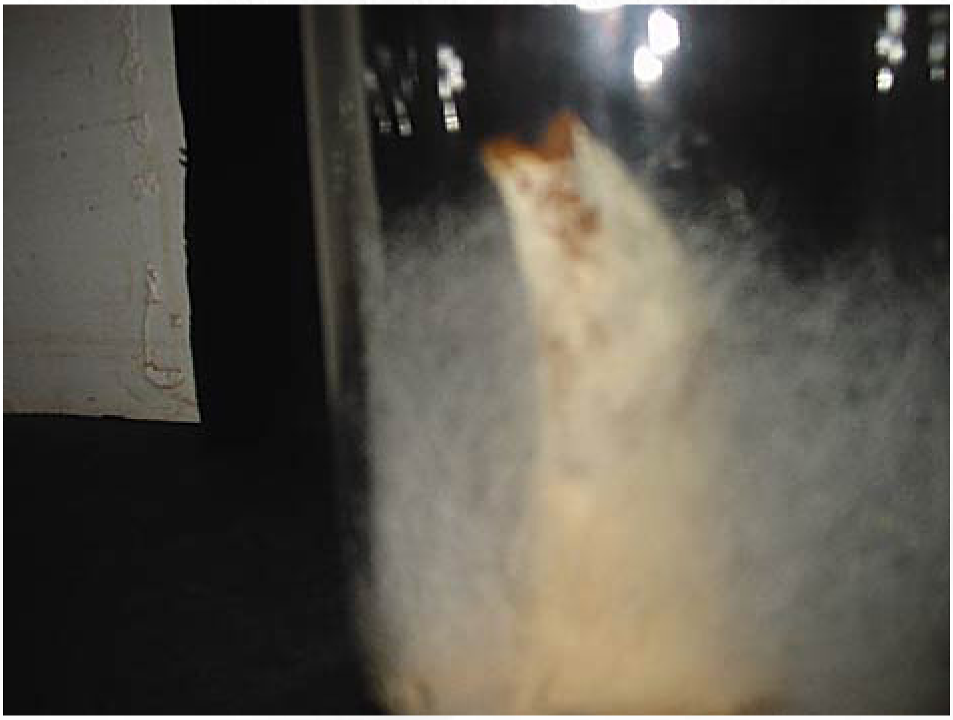
Amanita muscaria growing on cooked Barley.

Making the Sacramental Wine

The Gospel of John 15: 1
1. I am the true vine and my father is the husbandman.

The purpose of this is to instruct you in culturing your own alcohol free, sulfide free, Ambrosia Wine simply and cheaply at home using concentrated fruit juices, some simple equipment and the Ambrosia plant (*Amanita muscaria*).

Amanita muscaria is immortal, all the culture techniques used by the ancients and by us today are based on the fact, that *Amanita muscaria* mushrooms can be dried, stored dry for a long time and when re-hydrated with water magically returns to life in three days as mycelium.



A single stem of dried *Amanita muscaria* on the third day after being re-hydrated with water and now growing mycelium, this is what the *Amanita muscaria* mycelium should look like.

In Soma: Divine Mushroom of Immortality, Wasson cites reports of Siberian Tribes who fermented *Amanita muscaria* with various berry or fruit juices, diluted honey or with juice from a certain type of sweet grass. Many Tribes used these fermented juices for curing upset stomachs and other medicinal applications along with its use as an intoxicant.

The wines of the ancient Greeks and Romans were also capable of being used medicinally; Homer in the Iliad, states that undiluted Wine was used on battle wounds, (like an antiseptic) something that modern wine is never used for.

Unlike modern alcoholic wine, the Ancient wines of western Eurasia had to be diluted with a large quantity of water before being consumed; in fact, ancient sources state that consuming a large quantity of undiluted ancient wine could cause death. This wine was diluted with large ratios of water; ranging from one part wine with two to fifty parts water added.

These potent wines are mentioned in ancient literature such as Homer's Iliad (800 BC) and were produced from very ancient times into the late Roman Era (500 AD). At this time, the production seems to cease, along with any more mention of these very special wines in the literature of the day.

To give the reader a quick background on culture techniques that we will use here, we will look at the beginning of scientific microbial culturing. This uses glass bottles, a simple micro pore filter, and sterilization by the use of heat. Using these simple scientific techniques developed over the last one hundred years the average reader can easily culture the Ambrosia wine. There are significant benefits to this modern approach over the ancient methods, such as using just the tiniest amount of dried mushroom to start a culture and the high productivity with a very low contamination rate.

Louis Pasteur (1822-1895) is credited; with the important discovery that the air is full of microorganisms and their spores, which cause the spoilage of food and can cause diseases of plants, animals and man. He used a very simple experiment to prove his theory and this experimental technique is the basis of modern pure culture techniques for growing fungi, bacteria, yeasts, even plant, and animal cells in a sterile environment as a pure culture.

In Pasteur's experiments, glass bottles partially filled with beef broth; milk or other foods that quickly spoiled in the open air were prepared. The bottles mouth was then plugged with a tight wad of waterproof cotton, the bottles were placed upright into a hot water bath and cooked to a temperature that killed all microbes inside the bottle, the hot air and steam generated in the bottle passing through the cotton wad. By cooking the bottles properly, the contents would not spoil, even if kept for months. The cotton plug did not seal out air so this was fundamentally different from canning which requires an airtight seal.

Pasteur further showed that if you removed the cotton plug from a sterile bottle exposing the sterile food contents to the microbe and spore filled outside air for even a few seconds, then reinserted the cotton plug, the contents always spoiled in a short time. Microscopic examination of the contents of the spoiled bottles always showed microorganisms, which were absent from the contents of the still sterile bottles.

Pasteur's secret to creating a sterile environment with food and oxygen inside of the bottle is the cotton plug, which is sterilized during the cooking process by out flowing steam and hot air. The now sterile cotton plug becomes a micro-pore filter capable of filtering out all the microorganisms and their spores from the outside air that re-enters the bottle on cooling.

It should be obvious that if the right foods for a certain microorganism were prepared this way and then inoculated with even a small amount of that microorganism culture, that culture would flourish in this artificial environment without any competition from other microorganisms. If the inoculating culture is completely free of other contaminating microorganisms it will grow into a pure culture in the bottles. The cotton plug allowed oxygen-using cultures such as Fungi, to obtain oxygen from the outside air without allowing contaminating microbes into the pure culture.

Making the Sacred Ambrosial Wine is a simple process that requires only some easily obtained supplies and some commonly available equipment.

1. Dried *Amanita muscaria* mushroom caps, you need low temperature dried *Amanita muscaria* mushroom caps that will be used as the inoculant. If you purchase dried *Amanita muscaria* mushrooms, the higher grades are usually worth the extra money. If you picked and low temperature dried (120 degrees F or less) your own *Amanita muscaria* mushrooms, the caps of the best specimens should be saved separately for use as inoculant. These dried caps should be inspected carefully for dirt, pine needles etc, which should be removed, before they are ground into a fine powder. The small coffee grinders work very well and are inexpensive enough that one can be dedicated to only grinding *Amanita muscaria*. The inoculant should be ground fine enough (like flour), that it to floats on the surface of the juice.

2. Glass bottles or jugs. Next, you need glass bottles of from 1 pint to 1-gallon capacity such as juice bottles of all sizes, beer bottles, wine bottles etc. however, bottles with a tapered neck are better than bottles with a short neck for plugging with the polyfill. The size of the bottles you can use, is determined by the size of the cooking pot you have. Clear glass bottles are preferable to brown, green or blue bottles to culture in since you can easily see the culture inside. I prefer; the clear glass 1-gallon jugs, they can hold up to three quarts of juice for culturing, they are the largest size bottle that is commonly found and yet they are small enough to easily handle when hot. New bottles need to be cleaned before using, with detergent and hot water and rinsed repeatedly to remove all traces of the detergent. Recycled juice and especially beer and wine bottles should be filled with a hot bleach solution of 1 fluid ounce of bleach for 1 quart of water, filled all the way to the top,

sealed with the proper cap and left for several days, rinse the bleached bottles well before using. Always inspect the bottles carefully for cracks and chips which can cause breakage of the bottle during the heating and cooling cycle of pasteurization.

3. Polyfill, Mr. L Pasteur used specially prepared waterproof cotton, which would not absorb the water or steam generated by the cooking process to plug the bottles and create a micro-pore filter. Today waterproof cotton is very expensive, the last time I priced some from a science supply store it was over $35.00 a pound.

There is however, a superior substitute called Polyfill, which is a polyester fiber that resembles loose cotton, available from craft and fabric stores as a pillow stuffing. The polyester fiber is waterproof, not biodegradable, and is easily sterilized with the heat of pasteurization. A few dollars will buy you a big bag of Polyfill, which will last through a lot of culturing.

To use as a micro-pore filter, a polyfill wad is rolled into a ball about 3 or 4 times the size of the bottles mouth and pushed in with a twisting motion. The plug must be tight fitting and as the ball of polyfill is twisted into the bottle, the plug should get longer. It is a good idea to practice plugging an empty dry bottle of the kind you are going to use, to get the right feel before you actually start culturing.

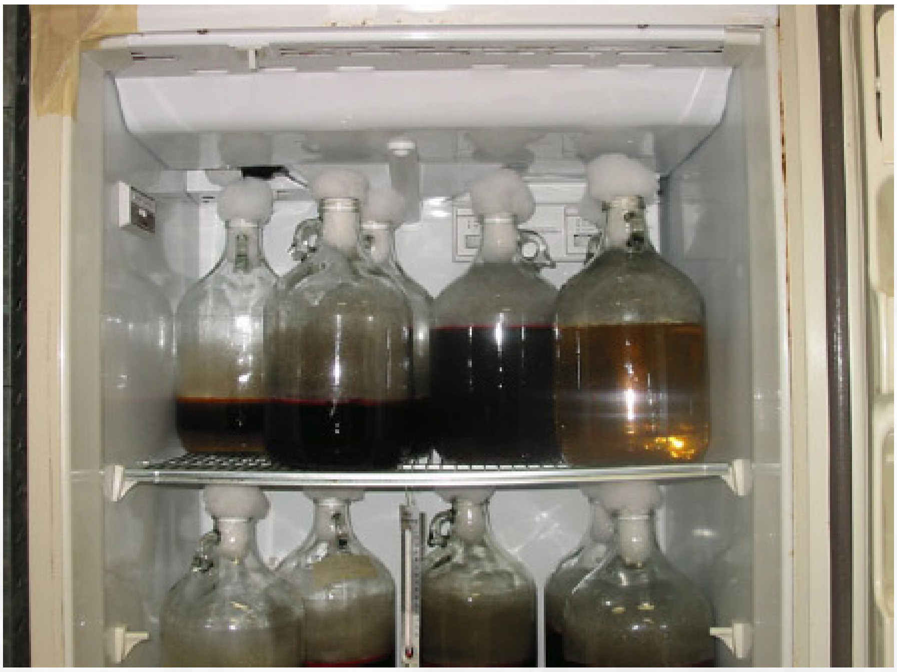
4. Cooking pots, you, will need two cooking pots, a small stainless steel cooking pot of about 11/2 gallon to react the finished wine and a large one for pasteurization.

To pasteurize the juice in the bottles you need a hot water canner with a basket or a suitable sized cooking pot and a holed metal plate or stand to hold the bottles off the bottom of the cooking pot, I use the metal stand that came with a pressure cooker. The cooking pot must be large enough diameter to hold the bottles and deep enough to match or cover the juice level inside the bottle. Ideally, the pot should be deep enough to cover with a lid that does not touch the polyfill of the plugged bottles inside. You can use an aluminum pot to pasteurize the juice filled bottles, but never let grape juice or the wine touch an aluminum pot, utensil or foil. Acid containing liquids like grape juice will quickly dissolve aluminum into solution and create a poisonous product. Always use stainless steel or the new tempered glass cooking pots to react the finished wine.

This is the Authors pasteurization equipment, a large pressure cooker pot, with the metal stand to hold the bottles off the hot bottom of the pot. There is no need to use pressure I simply use a stainless steel salad bowl for a cover that is tall enough to not touch the bottle's polyfill plug.

5. An accurate waterproof thermometer that is easy to read in the temperature range of 150-195 degrees F made of glass or stainless steel, I prefer Stainless steel, as it is unbreakable. You will probably have to rig a wire to hold the thermometer at the proper depth in the water.

6. A growing area, you need an area set aside to place the bottles during the time they are growing. The temperature needs to be from 64 to 74 degrees Fahrenheit and stable without fast or wide swings in temperature. A cabinet or closet will work, as well as an old refrigerator that has the doors shimmed open a small amount. The growing area should be easy to clean and thoroughly cleaned before being used the first time.



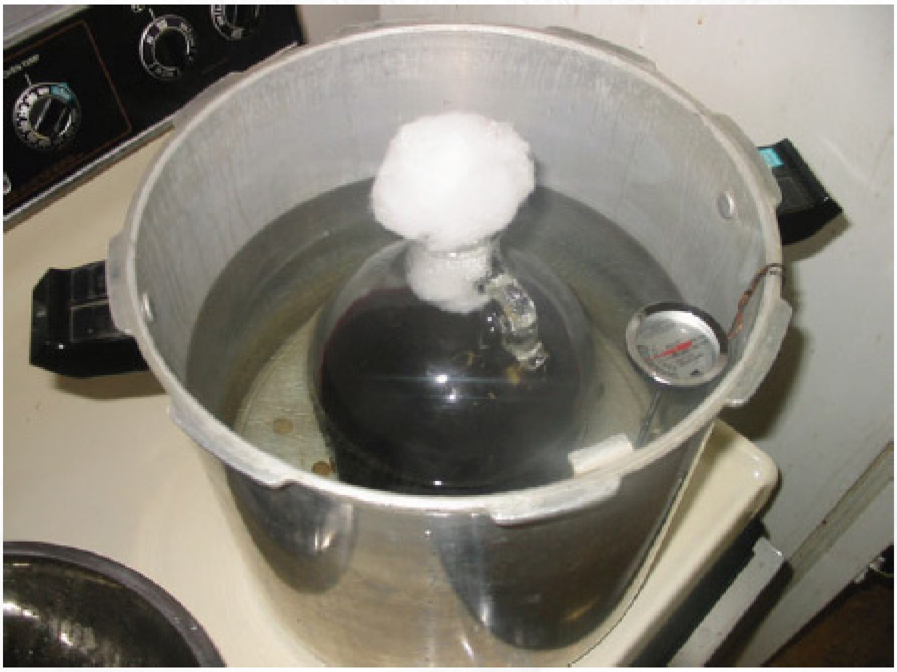
This is the Authors growing area, in an old refrigerator with the doors shimmed open slightly to provide for air circulation.

7. Fruit juice, you can purchase grape or other fruit juice in the frozen concentrate form, at any grocery store. For best results, this juice must be pasteurized, before being used to culture the Ambrosia wine. I prefer the frozen concentrate for several reasons, one, it's much cheaper than bottled juice, two, by pasteurizing the juice in the polyfill plugged bottle that is going to be the growth chamber, a more sterile situation is created than simply pouring bottled juice into a clean bottle. Mix the thawed frozen concentrate juice with water according to the directions on the juice container. If you are using small bottles, mix the juice in a pitcher or a large bottle and pour into the small bottles.

Take the cleaned bottles or jugs you have chosen and fill to the start of the jugs shoulder or approximately ¾ full i.e. a quart bottle will hold 3 cups of juice and 1 gallon will hold 3 quarts. It is important to leave a suitable air space in the bottle and the largest surface area possible on the top of the juice to support the *Amanita muscaria* fungus; which grows on the surface of the juice.

Carefully wipe the inside of the filled bottles mouth and neck with a clean piece of paper towel to remove any juice that might contact the polyfill plug. Juice left on the bottle's neck or mouth may become a source of contamination and it gets sticky enough after pasteurization to pull fibers out of the polyfill plug when it is removed for inoculation. Now, plug each of the filled bottles with a tight fitting wad of polyfill.

Place the polyfill plugged bottles containing the juice into your cooking pot on a metal stand or in the canning basket, and add cool water to the pot until the water in the pot is just about 1 inch above the level of the juice in the bottles. Place the pot on a stove and slowly heat the water at medium or medium high until the water in the pot reaches 175 deg F (use a thermometer) turn heat down and hold at 175-185 deg F for 30 minutes.



A polyfill plugged 1 gallon bottle containing 3 quarts of grape juice ready to be pasteurized.

Carefully remove the hot bottles from the water bath and place on a folded towel or a thick layer of newspaper to prevent the bottom of the bottles from breaking due to thermal shock. If you are going to pasteurize more bottles pour out the hot water from the pot and replace it with cool water as placing cool bottles into hot water can also cause breakage from thermal shock.

Cooled to room temperature the bottle is ready to inoculate.

Once the pasteurized bottles have cooled to room temperature, they are ready to inoculate; this step must be performed quickly to avoid contamination of the pasteurized juice, the whole operation of inoculation should take less than ½ second per bottle. Remove the polyfill plug straight up and hold about one inch over the mouth of the bottle and inoculate the bottle with approximately ½ an aspirin tablet size of the powdered inoculant for a gallon jug or ¼ that amount for a quart bottle. The point of a knife works well to pick up and handle the small amount of inoculant needed. The inoculant should be dropped onto the surface of the juice, quickly replace the polyfill plug into the mouth of bottle. Carefully place the bottles into their growing area without sloshing the fluid inside.

Inoculating the Grape juice with powdered *Amanita muscaria*.

The juice is now inoculated with ground *Amanita muscaria* caps and the polyfill plug is being replaced.

In 1,5 to 3 days, the *Amanita muscaria* mycelium should start growing large enough to see with the naked eye and in a few more days will become a thick mat of long white mycelium floating on the surface of the juice with fine filaments reaching into the juice.

In 3 to 4 weeks for the quart, sized bottles or 1 to 2 months for the gallon sized bottles depending on temperature and the amount of sugar in the juice the Wine should be ready. Young *Amanita muscaria* mycelium is white, as the culture ages the mycelium will start to turn gray and finally a very dark gray that almost looks black. This color change seems to be related to the amount of sugar in the juice. If you want a sweeter fruitier tasting wine harvest the wine when the mycelium turns uniformly light gray. When the mycelium is dark gray most of the sugar has been consumed and the *Amanita muscaria* mycelium will start eating the fruit flavor right out of the juice. It takes some time to develop a feel for when to harvest the wine to get the quality you want. Beginners can use a simple rule; to allow one week for starting and then add one week for every inch of the juice depth inside the bottle. Starting with an equal amount of juice, a narrow tall bottle will always take longer than a wide bottle filled a few inches deep.

The long white to dark gray *Amanita muscaria* mycelium growing on pasteurized grape juice, converting the juice into the Sacred Ambrosial Wine.

When you think the Wine is ready pour off the juice through a funnel plugged with a small amount of clean Polyfill sitting in another bottle of suitable capacity. If the *Amanita muscaria* fungus consumed all the sugars and other food in the juice, the raw wine will keep in a bottle at room temperature for a long time without going bad, being similar to vinegar, as ibotenic acid is chemically a form of acetic acid.

The Wine has two phases the raw and the reacted. The raw wine as poured from the fungus culture contains mostly Ibotenic acid and has an acidic taste. Consuming the raw Wine in any large quantity causes stomach upset for most people and it is not as potent as the same wine after it is reacted. Small quantities of raw undiluted Wine (1-4 oz) can be consumed medicinally for stomachaches, fevers, colds, or flues and can also be used as an antiseptic on wounds, but it stings like alcohol.

To react the raw Wine, the ibotenic acid is converted into muscimol; by heating in an open stainless steel pan or better yet, a stainless steel double boiler to more than 195 degrees F stirring constantly. This process drives off the CO_2 molecule that is chemically bound to the ibotenic acid molecule, converting it to muscimol and creates a sweeter tasting wine that is 4 to 10 times stronger in potency than the acidic form. The released CO_2 forms very small bubbles, which can easily be seen in the wine when it is heated to the correct temperature. Once the wine starts to simmer and release steam, at temperatures above 195 degrees F, most of the CO_2 is gone and the reaction is now done. From sea level to 3000 feet this temperature recommendation holds true, at higher elevations, the upper temperature needed to release the CO_2 molecule will be lower.

The reacted Wine should be diluted with water, in the ancient ratios of 2-20 parts water for every part Wine before drinking. The properly diluted Wine is more pleasant to drink and more potent than the undiluted Wine.

An alternate method of reacting and diluting the raw wine in one operation is to fill a stainless steel cooking pot with three or four times the volume of good drinking water for every volume of raw wine. Cover the pot and heat this water to a rolling boil then pour in the raw wine and stir, continue to heat at a lower setting, stirring regularly, until the temperature reaches more than 195 degrees Fahrenheit. Shut off the heat, cover and if it is going to be used that day let it sit until cool.

If you wish to bottle this, reacted and diluted wine for later use; pour the still hot (180+ degrees F) wine into cleaned fruit juice bottles or jugs; filling all the way to the top of the bottle and then cap the bottle with the proper cap. On cooling, a vacuum is created inside the bottle and if the seal between bottle and cap is airtight, the cap should be depressed by the outside air. If the cap did not depress on cooling then an airtight seal was not formed and the wine in that bottle should be used immediately. Only store bottles whose caps were depressed, and if a stored bottle is later found to have a raised cap do not use the contents.

I only use recycled bottles, which have the screw caps, to store the finished wine, the screw cap being much simpler and less expensive than other ways of sealing a pasteurized bottle.

If you wish to use beer bottles to store the pasteurized reacted wine, you need a hand capper and caps available at homebrew beer supply stores.

Wine bottles that use corks can also be used to store this reacted and pasteurized wine and the equipment needed to cork the bottles is also available at homebrew and wine making supply stores. However natural corks have many problems including a specific bacterium found on about 1 in 5 corks that while harmless to humans, can ruin the taste of the stored product. Natural corks may not seal airtight and the cork and the bottles mouth must be dipped into melted sealing wax while the bottle is still hot, to insure an airtight seal.

Artificial plastic corks are available from the same homebrew and home wine supply stores. These plastic corks were developed specifically to overcome the shortcomings of natural corks and are preferable to the natural corks in every way but appearance.

To keep for long-term storage the bottled wine should be stored in a cool dark area to prevent light damage to the wine, which can change the flavor and color. Dark green or brown bottles are more resistant to light and help preserve the flavor better than clear glass bottles.

To serve the bottled diluted reacted wine simply open the bottle and serve at room temperature or chill before serving. Raw wine must be reacted before serving, see the instructions above for details. Reacted undiluted wine must be diluted with water before serving, the ancient ratios of 3 or 4 parts water to one of wine is usually adequate for most Ambrosial wine.

The Ambrosial Wine stimulates the appetite and the taste buds, and it makes an excellent dinner wine. Food should always be served with this wine, even if it is just snacks like cheese and crackers.

I have used other juices to grow the *Amanita muscaria* culture on including white grape juice, apple juice, pineapple juice, and orange juice. These last three juices do not contain as much sugar as grape juice, and unless sugar is added during mixing, they are not as strong as the grape wine. Blueberries are related to bilberries, which have been recorded as being used in Siberia to culture *Amanita muscaria*, but I have not found a good source of blueberry juice yet. I think any fruit juice that is both sweet and acidic could be used to culture *Amanita muscaria* on.

If you have a very clean area to work in you can pull small clumps of mycelium from your wine cultures that are being harvested, with a piece of wire bent into a hook, flame the wire before using. These clumps of mycelium can then be used to inoculate freshly pasteurized juice to start the cycle over again.

The ancient Christians served their version of the Sacramental Wine when they celebrated the Agape, or "love feast", and the Communion. The Eucharist Wine and the Living bread are the foundation stones of the earliest Christians beliefs. With these Sacraments made from the "Bread from Heaven", they healed the sick, uttered prophecies, spoke in tongues, and were themselves spiritually reborn by consuming the "Flesh and Blood of God".

16. Gods, Books, Myths and Folktales

This small section describes the ancient Gods that are obviously *Amanita muscaria* and their accompanying texts. By reading these ancient texts the reader can begin to do their own research on this fascinating ancient interaction between mankind and *Amanita muscaria*. I have included some of my favorite quotes from several of these texts, and in some cases my own commentary on a particular passage.

I encourage the reader to study this ancient knowledge as in depth as they wish, as this was the greatest knowledge the ancient Eurasian world possessed. These ancient people were our ancestors and the Old Sacred Knowledge they possessed is our inheritance and our birthright.

17. The Rig Veda

Soma and the Holy Grail

The Rig Veda is the world's oldest and largest religious texts consisting of just over one thousand Hymns, containing over ten thousand verses divided into ten books. These Sacred Hymns are usually dated to the late Bronze Age, but many of these Hymns may actually be considerably older. The name Rig Veda means Praise (Rig) Knowledge (Veda), Veda is an ancient Indo-European root word that in many modern Indo-European Languages still means knowledge of a sacred nature. The Rig Veda is written in an archaic form of Sanskrit and is a foundation document in the studies of ancient Indo-European languages.

Traditionally the Rig Veda was hand written with ink, on Birch bark sheets that are then bound with wooden covers painted red. The Birch tree is not found on the plains of India and the Birch bark is imported from Kashmir and the Himalayan mountains. Birch trees are well known to be symbiotic with *Amanita muscaria* and explain the link of this Holy Book made of Birch bark and *Amanita muscaria* as the God Soma.

The drinkable, Immortal, living God, Soma, is mentioned in almost every one of the thousand Hymns as the preferred drink of both Gods and men. There are one hundred and fourteen Hymns specifically about Soma in book nine of the Rig Veda plus a few Soma hymns scattered through the other books of the Rig Veda.

These Sacred Hymns were composed by Soma intoxicated "Seers and Sages" living very intimately with nature and are rich in naturalistic poetic imagery and animal metaphors and also contain a multitude of names that specifically refer to the God Soma. Many of these Soma hymns ring with ecstatic praise of the Soma plant/god/drink. Some of these Hymns poetically describe the mountainous natural habitat and brilliant Red or Gold appearance of the Soma plant. Other Hymns describe the processing sequence of the Soma plant into the Soma drink in the Soma sacrifice ceremony. A few Hymns also contain clear references to healings and increased life spans of Soma users.

The secret of Magic cups or what we would call the Holy Grail is found scattered through the Hymns of book nine. The Seers and Sages that composed this book were experts on the Soma plant/drink/god and loudly proclaim the secret of Soma's immortality, but to understand what they are saying, you have to know that *Amanita muscaria* is the real Soma plant and that it is capable of being completely dried, rehydrated, pounded between stones, and turned into the gods own beloved juice, every drop of this Ambrosia can resurrect, and create a magic cup or larger magic vessel simply by a terra cotta or wooden cup being used to hold Soma. Only, with this knowledge can you begin to understand what these Sacred Hymns are really saying regarding Soma the "Immortal God".

Soma and Healing

8 XLVIII 3-5 & 11,12

3. We have drunk Soma and become immortal; we have attained the light, the Gods discovered. Now what may a foeman's malice do to harm us? What, O Immortal, a mortal mans deception?

4. Absorbed into the heart, be sweet, O drop, as a kind father to his son, O Soma, As a wise Friend to friend: do thou, wide-ruler, O Soma, lengthen out our days for living.

5.These glorious drops that give me freedom have I drunk. Closely they knit my joints as straps secure a chariot. Let them protect my foot from slipping on the way: yea let the drops I drink preserve me from disease.

11. Our maladies have lost their strength and vanished; they feared, and passed away into the darkness. Soma hath risen in us, exceedingly mighty, and we have come to where men prolong existence.

12. Fathers, that drop which our hearts have drunken, Immortal in himself, hath entered mortals. So let us serve this Soma with oblation, and rest securely in his grace and favor.

8 LXVIII 1,2
1."This here is Soma, never restrained, active, all conquering bursting forth, a Seer and Sage by sapience.

2. All that's bare he covers over; all the sick he medicines, the blind man sees, the cripple walks."

1 XXIII 19, 20
19. Amrita is in the Waters; in the Waters there is healing balm: be swift, ye Gods, to give them praise. 20. Within the Waters - Soma thus hath told me - dwell all balms that heal, and Agni, he who blesseth all. The Waters hold all medicines.

9 LXXVI 4
4. "Monarch of everything that sees the sun light, Soma cleanses himself, triumphing over the Prophets, he made the Word of the Way to resound, he who is cleansed by the suns ray, he the father of poems, master-poet yet equaled."

Soma and the Grail

9- I- 1,2, 5,6
1. "In sweetest and most gladdening stream flow pure, O Soma, on thy way, pressed out for Indra, to be his drink.

2. Fiend-queller, Friend of all men, he hath with the wood attained unto His place, his iron fashioned home[1]."

5. "O Soma drop, we draw nigh to thee, with this one object day by day: To thee alone our prayers are said.

6. By means of this eternal fleece[2], may faith purify Thy Soma that is foaming forth".

9 III 1
1."Here present this Immortal God flies, like a bird upon her wings, to settle in the vats of wood".

9 XXVIII 1-6
1. "Urged by the men, this vigorous Steed, Lord of the mind, Omniscient, runs to the woolen strainer.

2. Within the filter hath he flowed, this Soma for the Gods effused, entering all their essences.

3. He shines in beauty there, this God Immortal in his dwelling place, Foeslayer, dearest to the Gods.

4. Directed by the Sisters ten, bellowing on his way this Steer, runs onward to the wooden vats.

5 This Pavamana[3], swift and strong, Omniscient, gave splendor to the sun and all his forms of light.

6. This Soma, being purified, flows mighty and infallible, Slayer of sinners, dear to Gods".

[1] The phrase "iron fashioned home" means a large carved wooden bowl that was carved with an iron chisel, iron was a very special metal in the Bronze Age, so in effect they are bragging.
[2] The "eternal fleece" is the mycelium of *Amanita muscaria*, which resembles sheep's wool, as you can see in the resurrection photos.
[3] Soma is called Soma Pavamana in most of the book 9 Hymns; Pavamana means self-purifying so Soma Pavamana is "the pressed one-self purifying". I believe that the Old Testament Bible's word "Manna" is a Hebrew version of Pavamana, perhaps inherited from long forgotten Indo-European ancestors or from the Persian religion of Zoroaster.

9 XII 1-8
1."To Indra have the Soma drops, exceedingly rich in sweets, have been poured, Shed in the seat of sacrifice.

2. As mother cattle low to their calves, to Indra have the sages called, called him to drink the Soma juice.

3. In the stream's wave wise Soma dwells, distilling rapture, in his seat, Resting upon a wild-cows hide.

4. Far-sighted Soma, Sage and Seer, is worshipped in the central part of Heaven, the strainer of wool.

5. In close embrace the drop holds Soma when poured within the jars, and on the purifying sieve.

6. The drop sends forth a voice on high to regions of air, shaking the vase that drops with honey.

7. The Tree whose praises never fail yields heavenly milk among our hymns, Urging men's generations on.

8. The Wise One, with the Sages stream, the Soma flows on to the dear places of the sky".

18. Zoroaster the Prophet and the Mazda Religion

Stone relief of Ahura Mazda.

The birth of the founder of the Mazda religion, Zoroaster or Zarathushtra, is variously dated from 6000 BC (Greek) to 600 BC (Sassnian). The later date seems more reasonable to me, yet there are many valid questions about the real age when Zoroaster lived. The theology developed by Zoroaster had a profound impact on the much later religions of Judaism, Christianity, Buddhism and Islam.

Beliefs found in Christianity today such as, heaven and hell, the resurrection of the dead, a last judgment, the coming of various saviors and an apocalyptic end of times are all found in the teachings of Zoroaster before they show up in any other religions. As the state religion of the Persian Empire, the influence this religion wielded in the ancient world was immense.

The Indo-European peoples who invaded Iran were closely related to the Indo-Europeans that continued on and invaded India. The Rig Veda's Soma cult was established in Iran at an early date.

Zoroaster did not create a new religion as many may think, he simply reformed this existing Vedic religion by doing away with the Vedic animal sacrifices, which he considered both cruel and wasteful and replacing it with the Fire Ceremony, while the ancient Vedic Soma/Haoma Sacrifice ceremony was elevated to the highest act of worship.

The use of Haoma (Soma) was integral to this religion, the concepts of the Mazda religion concerning Haoma's place in the universe are identical to early Christian concepts of the Christ.

The following is from the Encyclopedia Britannica (1991, vol. 26, pg. 789, Rites & Ceremonies):

"In Zoroastrianism haoma (Sanskrit soma, from the root su or bu, 'to squeeze' or 'pound') is the name given to the yellow plant, from which a juice was extracted and consumed in the Yasna ceremony, the general sacrifice in honor of all the deities. The liturgy of the Yasna was a remarkable anticipation of the mass in Christianity." "Haoma was regarded by Zoroaster as the son of the Wise Lord and Creator (Ahura Mazda) and the chief priest of the Yasna cult. He was believed to be incarnate in the sacred plant that was pounded to death in order to extract its life-giving juice so that those who consumed it might be given immortality. He was regarded as both victim and priest in a sacrificial-sacramental offering in worship. As the intermediary between God and man, Haoma acquired a place and sacramental significance in the worship of Mithra (an Indo-Iranian god of light) in his capacity as the immaculate priest of Ahura Mazda with whom he was coequal. The Mithraic sacramental banquet was derived from the Yasna ceremony, wine taking the place of the haoma and Mithra that of Ahura Mazda. In the Mithraic initiation rites, it was not until one attained the status of the initiatory degree known as "Lion" that the neophyte could partake of the oblation of bread, wine, and water, which was the earthly counterpart of the celestial mystical sacramental banquet. The sacred wine gave vigor to the body, prosperity, wisdom, and the power to combat malignant spirits and to obtain immortality."

19. Mithras

The Rock birth of Mithras from the egg.

"Mithras" is the Latin name of a Vedic god that the ancient Persians called "Mithra", and in the Rig Veda is called "Mitra". Mitra is one of the hundred plus names of Soma in the Rig Veda and means "the friend of all men". Mitra is an extremely old God, whose name first appears in writing in a peace treaty between the Hittite empire and the Mitanni in approximately 1450 BC. The Hittite and the Mitanni are both Indo-European peoples mentioned in the Old Testament Bible where the Mitanni are called Hurrians, which were claimed to be the best Charioteers in the world.

During the rise of Zoroastrianism in Persia the ancient cult of Mithra was suppressed for a short time, but rises again and is reincorporated into the Mazda religion of Persia.

After Persia; was conquered by Alexander the Great; the cult of Mithra spreads deep into the Greek and later the Roman world and was extremely popular with warriors. For a short time the Romans try to suppress the Mithras cult as a Persian subversion of the Roman people. The cult survives this persecution and begins to spread among the Roman elite and especially among the troops of the Roman legions, who spread it into the farthest reaches of the empire and beyond.

The cult of Mithras held its meetings and ceremonies, in small underground chambers called "Mithraeum". These chambers could only accommodate perhaps 30 people when the numbers of people became too large for that Mithraeum to hold another Mithraeum was established.

The Mithras cult was strictly male in membership and like modern Free Masonry the cults members were divided into a graduated hierarchy with 7 levels, only the highest grade of initiate could found a new Mithraeum. The ability of the Mithras cult to stay in small personal groups and still expand their total numbers was a key to their survival through any of the ancient persecutions. The cult of Mithras doesn't appear to be persecuted to any large extent by the official Christian Church, it seems they simply melted into Christianity.

Many modern Christians do not understand the tremendous influence Roman Mithraism had on early Christianity an influence that still exists today. Every Christmas Christians celebrate the birth of Mithras on December 25th and every Sunday they worship on Mithras sacred day. A lot of very old Christian Churches in Europe and the Middle East are built on top of even older Mithraeum, including the Vatican's Saint Peters Basilica, which has an ancient Mithraeum in its basement. Literally and physically the Soma God Mithras and the ancient religion of Mithraism, are two of the main foundation stones of Christianity

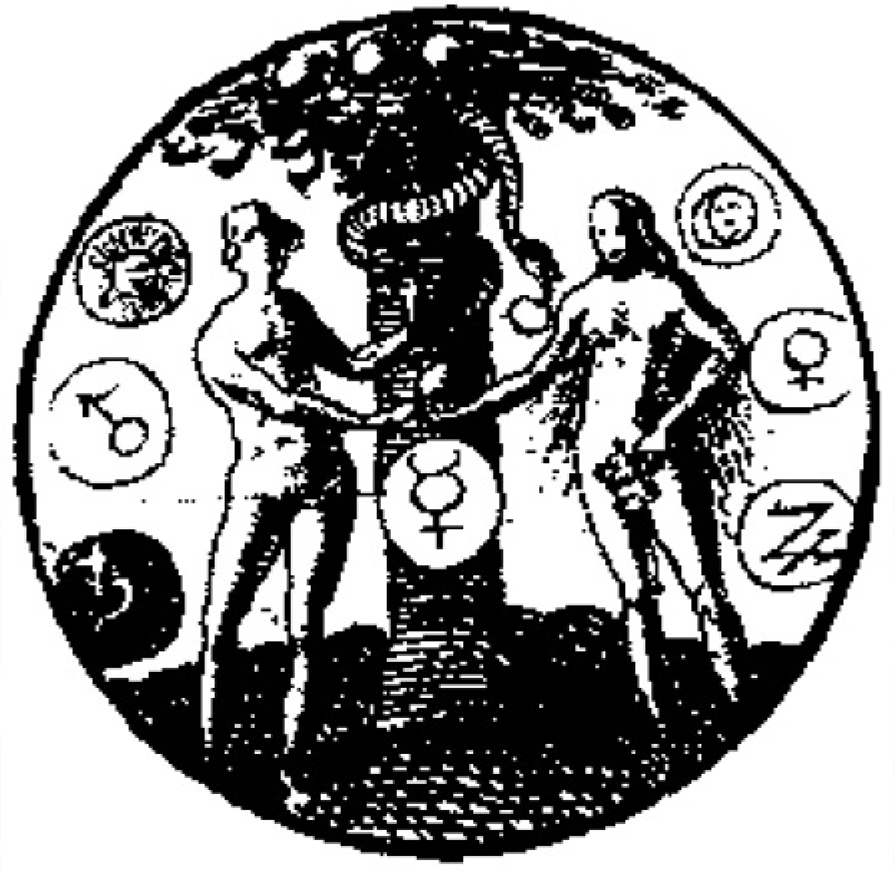
20. The Bible

What we call the Bible is actually two separate collections of books The Old Testament and The New Testament these books are widely separated in time and the languages in which they are recorded. The Old Testament was recorded in Hebrew on animal skin scrolls and as a collection of books dates no earlier than 600 BC although some of these individual stories may date back much earlier. The New Testament was written originally in Aramaic and Greek, recorded on papyrus in a codex format and the earliest individual letters and books still in existence date to no earlier than 140AD.

Although this large and varied collection of books are recorded over a fairly long time span with the influence of several different foreign cultural influences; there is one theme that is constant and that is consuming the Fruit of the Tree of Knowledge/Life.

In Genesis, Adam and Eve taste the forbidden Fruit of the Tree of the Knowledge of good and evil, and their eyes were opened and they became truly human. This is a concept carried through most of the other books until the Revelations of Saint John, the last book in the New Testament, where there is the river of the water of Life and the Trees of Life whose "leaves" were for the healing of the nations.

These books start with the consumption of a very special "Fruit" this same Fruit is consumed by the Seers (Prophets) in many of the Old Testament books, this is continued into the New Testament were the Fruit of the Tree of Life is re-elevated to the status of the Son of God, and must be tasted, consumed, and has existed from the beginning.



The Serpent of Wisdom, Adam & Eve, the Fruit of the Tree of Knowledge, from the Hermetic Garden.

Old Testament quotes.

Gen. 3: 3-7
"3. But the fruit of the tree which is in the midst of the garden, God hath said, ye shall not eat of it, neither shall ye touch it, lest you die.
4. And the serpent said unto the woman, ye shall not surely die.
5. For God doth know that in the day ye eat thereof, then your eyes shall be opened, and ye shall be as gods, knowing good and evil.
6. And when the woman saw that the tree was good for food, and that it was pleasant to the eyes, and a tree to be desired to make one wise, she took of the fruit thereof, and did eat, and gave also unto her husband with her; and he did eat. 7. And the eyes of them both were opened, and they knew that they were naked; and they sewed fig leaves together, and made themselves aprons."

Ps. 34:8
"8. O taste and see that the Lord is good; blessed is the man that trusteth in him."

Jer. 15:16
"16. I came upon the Words of God and I did eat them; and thy Word was unto me the joy and rejoicing of my heart"

Amanita muscaria when eaten dried or made into a cold-water extract has a flavor very close to Honey; this honey sweet taste is mentioned in the Rig Veda, the Yasna, and the Old and New Testaments.

In the quote below the source of this magic honey is a mountain dwelling life form that can suck "honey" out of rock. This life form can also eat a variety of human prepared foods and "drink" grape juice.

Deut 32: 13
"13. He (God) made him (Soma) ride on the high places of the earth, that he might eat the increase of the fields; and he made him to suck honey out of the rock, and oil out of flinty rock.

14. Butter of kine, and milk of sheep, with fat of lambs, and rams of the breed of Bashan, and goats with the fat of kidneys, of wheat: and thou didst drink the pure blood of the grape."

Ps. 81:16
"16. He should have fed them also with the finest of the wheat; and with honey out of the rock should I have satisfied thee."

Ezekiel 3: 1-4
"1. Moreover he said unto me, Son of man, eat that thou findest, eat this roll, and go speak unto the house of Israel.
2. So I opened my mouth, and he caused me to eat that roll.
3. And he said unto me, Son of man, cause thy belly to eat, and fill thy bowels with this roll that I give thee. Then did I eat it; and it was in my mouth as honey for sweetness.
4. And he said unto me, Son of man, go, get thee unto the house of Israel, and speak with them my words."

Here we see that the Honey sweet food is closely associated with prophecy and creates the ancient prophets.

Isaiah 42:18-20
"18. Hear, ye deaf; and look ye blind, that ye may see.
19. Who is blind, but my servant? Or deaf; as my messenger that I sent? Who is blind as he that is perfect and blind as the Lord's servant?
20. Seeing many things, but thou observest not; opening the ear's, but he heareth not."

Isaiah 53:1-2
"1. Who hath believed our report? And to whom is the arm of the Lord revealed?
2. For he shall grow up before him as a tender plant, and as a root out of a dry ground: he hath neither form nor comeliness; and when we should see him, there is no beauty that we should desire him."

In the above quotes the "Lord's servant", the "messenger" and the "arm of the Lord" are all names for one thing, *Amanita muscaria*. The Lord's servant is "blind" "deaf" and "perfect" and who opens the eyes of the blind and the ears of the deaf. The arm of the Lord is described as a "tender plant", as a "root" out of dry ground, and that when "seen" is not a thing of great beauty.

Many modern Christians claim that Isaiah 53 is a prophecy or vision of Jesus and the crucifixion. I believe that Isaiah 53 is not a vision or a prophecy of any kind, but is simply the words spoken in the ritual as the Soma plant was processed into the Soma drink in Isaiah's version of the Soma ceremony.

21. New Testament Bible Quotes

The New Testament Bible is perhaps the most misunderstood and misinterpreted book ever written, with dedicated Christian scholars and those who hate the book and Christianity both being completely ignorant of what this book is really about i.e. Soma.

What sets this collection of books apart from other ancient texts on the Plant God Soma and has caused this confusion; is the extensive personification of the Soma Plant as the hero "Christ Jesus" of a story that was written as being a real historical event.

The quotes were chosen to show that the Christ was to be "tasted", "eaten" and dates "from the beginning" all things that are impossible for a man. The words in bold print are supposedly those words straight from the mouth of Jesus as the founder of Christianity.

Milk of the Word
Taste the Lord
Living Stone

1 Peter 2: 2-4
2. As newborn babes, desire the sincere milk of the word, that ye may grow thereby:

3. If so be ye have tasted that the Lord is gracious.
4. To whom coming, as unto a living stone, disallowed indeed of men, but chosen of God, and precious.

Tasting the Heavenly gift
Hebrews 6: 4-5
4. For it is impossible for those who were once enlightened, and have tasted of the heavenly gift, and were made partakers of the Holy Ghost.
5. And have tasted the good word of God, and the powers of the world to come.

Living Water
Gospel of John 7:37, 38
"37 In the last day, that great day of the feast, Jesus stood and cried, saying, If any man thirst, let him come unto me, and drink."

"38 He that believeth on me, as the scripture hath said, out of his belly shall flow rivers of living water."

Amanita muscaria is a most unique drug plant that when consumed in quantity produces potent psychoactive urine.

Bread of Life
Gospel of John 6:48-58
"48. I am that bread of life.
49. Your fathers did eat manna in the wilderness, and are dead.
50. This is the bread which cometh down from heaven, that a man may eat thereof, and not die
51. I am the living bread, which came down from heaven: if any man eat of this bread, he shall live for ever: and the bread that I will give is my flesh, which I will give for the life of the world.
52. The Jews therefore strove among themselves, saying, how can this man give us his flesh to eat?" (This is a very good question, an obvious hint to the wise that no man is speaking, and an excellent distraction to the unwary by maintaining the illusion of reality being narrated.)
53. "Then Jesus said unto them, Verily, verily, I say unto you, Except ye eat the flesh of the Son of man, and drink his blood, ye have no life in you.
54. Whoso eateth my flesh, and drinketh my blood, hath eternal life: and I will raise him up at the last day.
55. For my flesh is meat indeed, and my blood is drink indeed.
56. He that eateth my flesh, and drinketh my blood, dwelleth in me, and I in him.
57. As the living Father hath sent me, and I live by the Father: so he that eateth me, even he shall live by me."
"58. This is that bread which came down from heaven: not as your fathers did eat manna, and are dead: he that eateth of this bread shall live forever."

Word of God
Gospel of John 1:1-4, 14
"1. In the beginning was the Word, and the Word was with God, and the Word was God.

2. The same was in the beginning with God.
3. All things were made by him; and without him was not any thing made that was made.
4. In him was life; and the life was the light of men.
14. And the Word was made flesh and dwelt among us (and we beheld his glory, the glory as of the only begotten of the Father) full of grace and truth."

Now, compare to the Rig-Veda speaking of Soma:

R.V. 1X87 2cd "Father of the gods, progenitor of the moving force, mainstay of the sky, foundation of the earth."

R.V. 1X76 4 "Monarch of everything that sees the sun light, Soma cleanses himself, triumphing over the Prophets, he made the Word of the Way to resound, he who is cleansed by the suns ray, he the father of poems, master-poet yet equaled."

The Word of the New Testament cannot be fitted to a man, no matter how you twist logic and belief. It does, however, fit perfectly with the Rig Veda's eloquent Word of the Way, the father of the Gods, the Master-Poet, without any problems.

Son of God
John 3:16-17
The most "quoted" line in all of the New Testament writings is John 3:16.
16. "For God so loved the world, that he gave his only begotten Son, that whosoever believeth in him, should not perish, but have everlasting life.
17. For God sent not his Son into the world to condemn the world; but that the world through him might be saved."

A "man," or the real Son of God; *Amanita muscaria*, the herb of immortality, the whole conception of Christianity is completely changed by which viewpoint is used "Man" has a God who demands the human sacrifice of a perfect man, to make up for human disobedience (free will), no loving God here.

"Herb of Life", the sky father sends his son (*Amanita muscaria*) nature's greatest gift to man. A loving, caring God, a father that gives, not demands. The son brings his gifts to humanity, Wisdom, prophecy, joy, new life, health, love, immortality and who even when sacrificed lives again.

Word of Life
1 John 1:1-2
"1. That which was from the beginning, which we have heard, which we have seen with our eyes, which we have looked upon, and our hands have handled of the Word of life;
2. (For the life was manifested, and we have seen it, and bear witness, and show unto you that eternal life, which was with the Father, and was manifested unto us.)"

This simply can't apply to a "man" by any stretch of the imagination. It does, however, make a perfect fit with the herb of Immortality. The New Testament's Word of Life is composed of two Rig Veda terms for the Soma, Word of the Way and the Herb of Life. Substitute herb of life; for Word of life and you have a perfectly logical statement. In the herb cult context it is perfectly logical as written.

Who is the Christ?
Mathew 22: 41-46
"41. While the Pharisees were gathered together, Jesus asked them.
42. Saying, What think you of the Christ? Whose son is he? They say unto him, the son of David.
43. He saith unto them, how, then does David in spirit call him Lord, saying.
44. The Lord said to my Lord, sit thou on my right hand, till I make thine enemies thy footstool?
45. If David then calls him Lord, how is he his son?
46. And no man was able to answer him a word, neither did any man from that day forth ask him any more questions."

I had to read this statement several times to really understand this most profound question in line 45. The statement in line 44 quoted from Psalm 110.1, is written from the perspective of the scribe, or in the third person so it is saying the Lord (the God) said to my (the Scribes) Lord (King David).

Here we have "Jesus," plainly stating through the use of a clever question; that no son of David; himself included, could ever be the Christ. Now this statement from the founder of Christianity completely contradicts the belief of all Christian Churches that state "Jesus the son of David is the Christ".

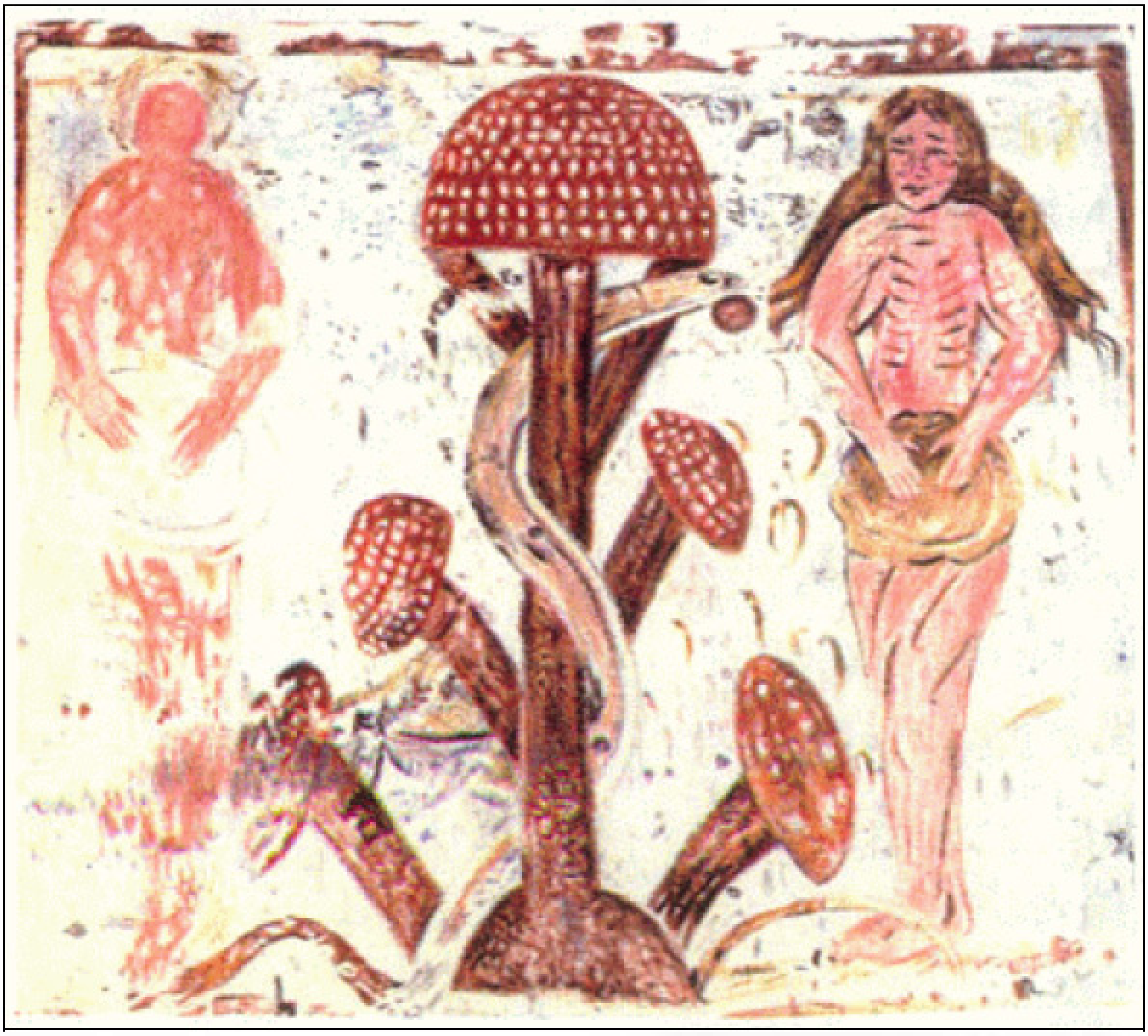
The phrase "in spirit" is the New Testament's way of saying intoxicated on Soma. It was common in the Persian Soma usage to have a scribe present whenever a Magi or Prince consumed the Soma, to record every word of that person's conversation with the God Soma or to record other impressions of the person's experience, this recording of the interaction between a man and the "living" God is the root of the ancient practice of prophecy.

Many Christians would be surprised to know that the late Roman emperors manufactured the Religion now called Christianity, in a desperate attempt to hold a crumbling empire together. Elements from several different religions were combined to create a "universal" or Catholic Church, which was established to stabilize and unify the Roman Empire.

Zoroastrianism, Mithraism, the cult of Dionysus, the cult of Isis and Osiris, the cult of Amen and many others, were all used to create Christianity. All of these ancient religions were widespread thru out the late Roman Empire and are still detectable in modern Christianity, the cult of Isis has become the cult of the Virgin Mary, Mithras/Osiris/Dionysus combined have become the Christ, and every Christian knows that hymns and prayers end with "Amen" the name of the ancient Egyptian god Amen. The New Testament texts that Christianity is based on were extensively edited for content, and even rewritten by people employed by the Roman Emperors to create this new religion. Many texts that did not fit into this new scheme were simply dropped from the list of acceptable texts, and in some cases were banned outright.

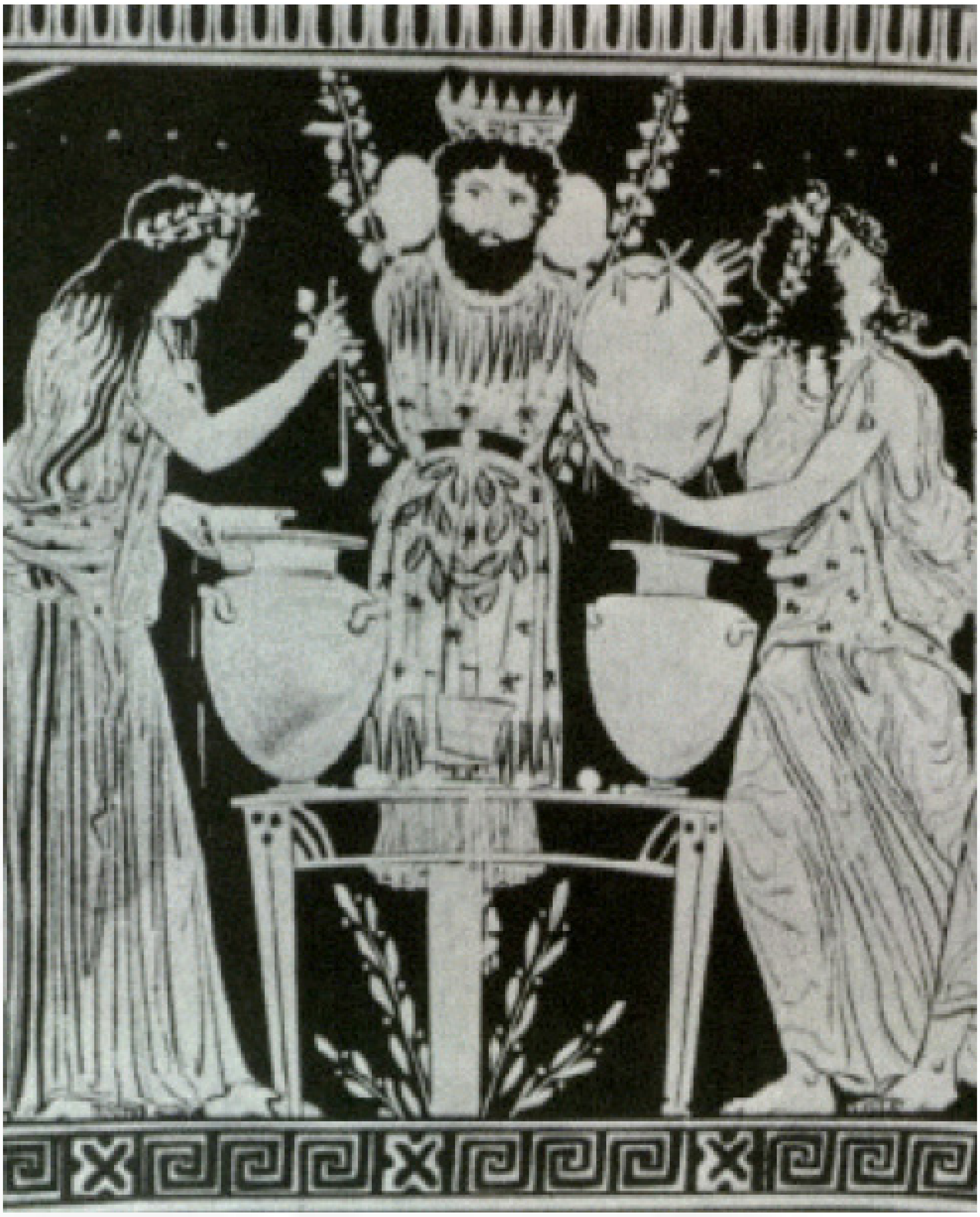
This Frankenstein's monster creation of the Roman Empire has carried on a war for almost 17 centuries trying to subjugate or eradicate all other belief systems in an effort to become the "Universal" church of the world. They have warred upon heretics, scientists, witches, pagans, people of other religions, and splinter sects of their own religion. This cult of human sacrifice masquerading as a religion is in reality a political machine designed for world conquest.

While I value the New Testament texts as one source of information on the Soma God, I have absolutely no use for the "Christian religion" as currently practiced.



Adam & Eve fresco Plaincourault Chapel

22. Dionysus

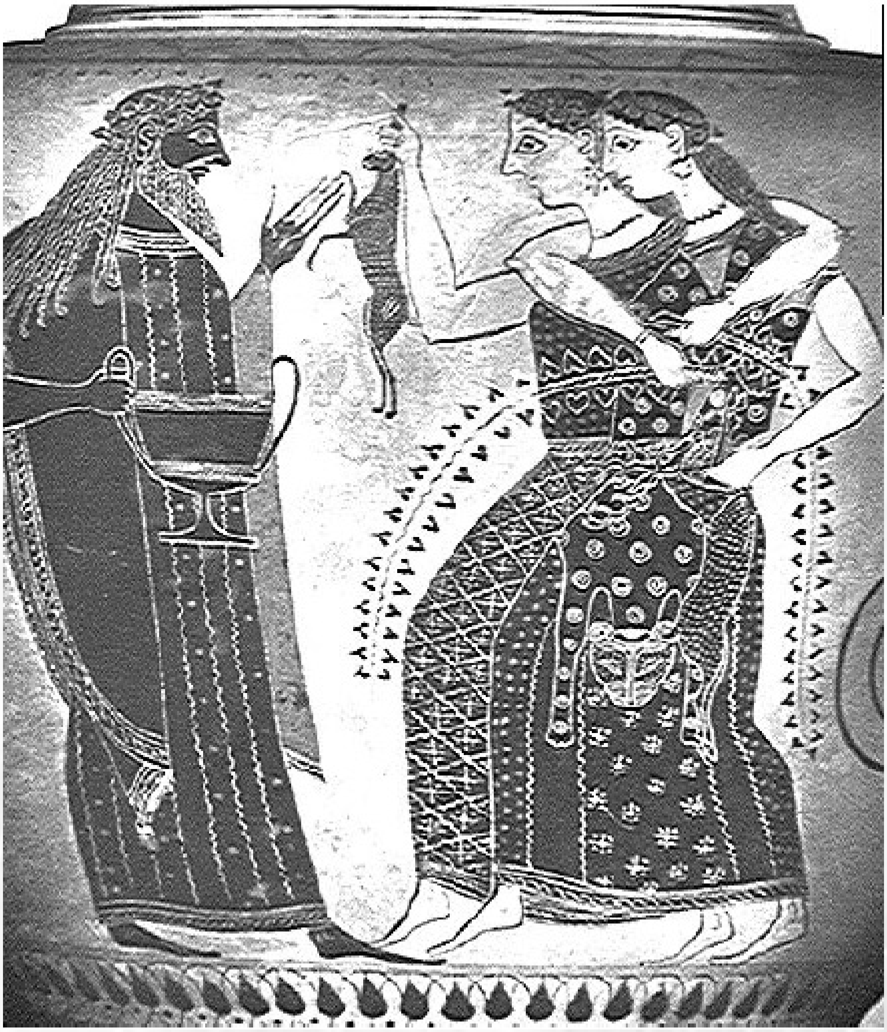


Dionysus as a white pillar receiving offerings, note small white mushroom shaped objects on table.

All ancient Indo-European peoples possessed variants of the Soma Ceremony; the Greek god Dionysus is an example of a Greek variant of the ancient Soma God. Dionysus is an extremely old God whose name was found on a fired clay tablet written in Linear B script, an archaic form of Greek that is pre alphabet and dates to about 1450 BC.

Dionysus caused vines to spring up over night bearing Wine; obviously this is no grape vine. His Priests could convert fresh grape juice into a special potent wine over night and any cup this Wine was poured into became a Sacred object ie. A Holy Grail.

His female followers went into the woods in a sacred hunt for the God himself who was in the form of "little spotted animals" who later were torn to pieces by the women with their bare hands.

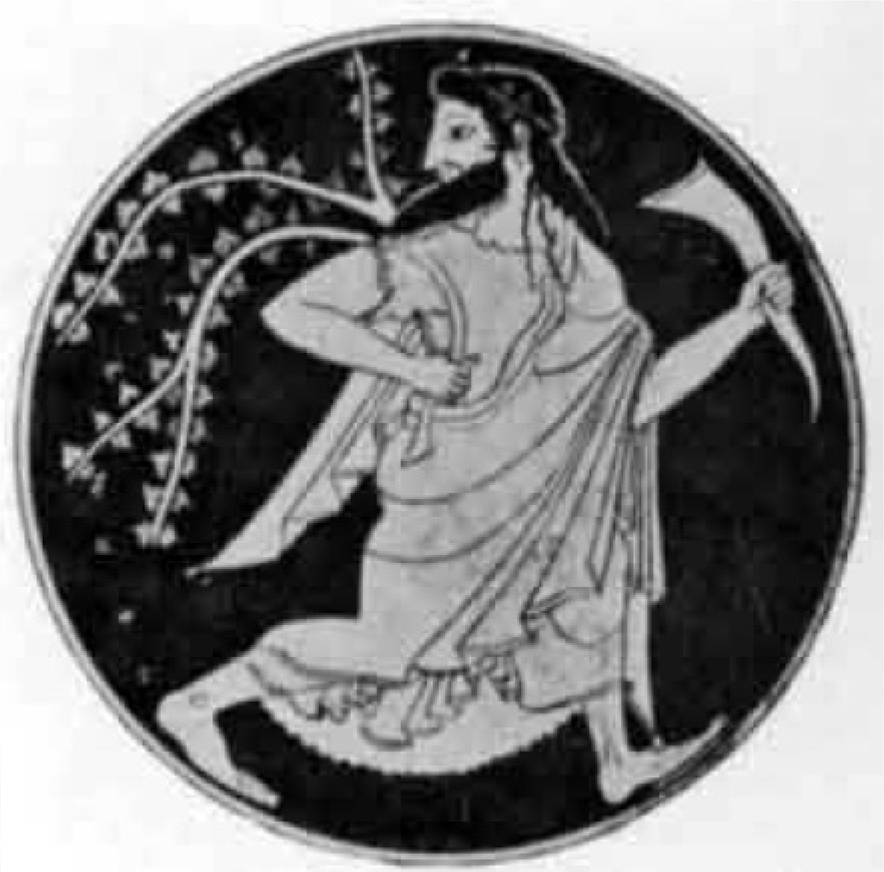


Dionysus receiving small spotted animals from his female followers.

The cult of Dionysus was very secretive with only woman worshipers and his male priests being admitted to the secret nighttime services. In many cases all males were excluded from certain temples or ceremonies. The cult of Dionysus also had a very public face with mass public drinking of the cults Wine at special festivals and entertainment with plays, poetry, song and theater.

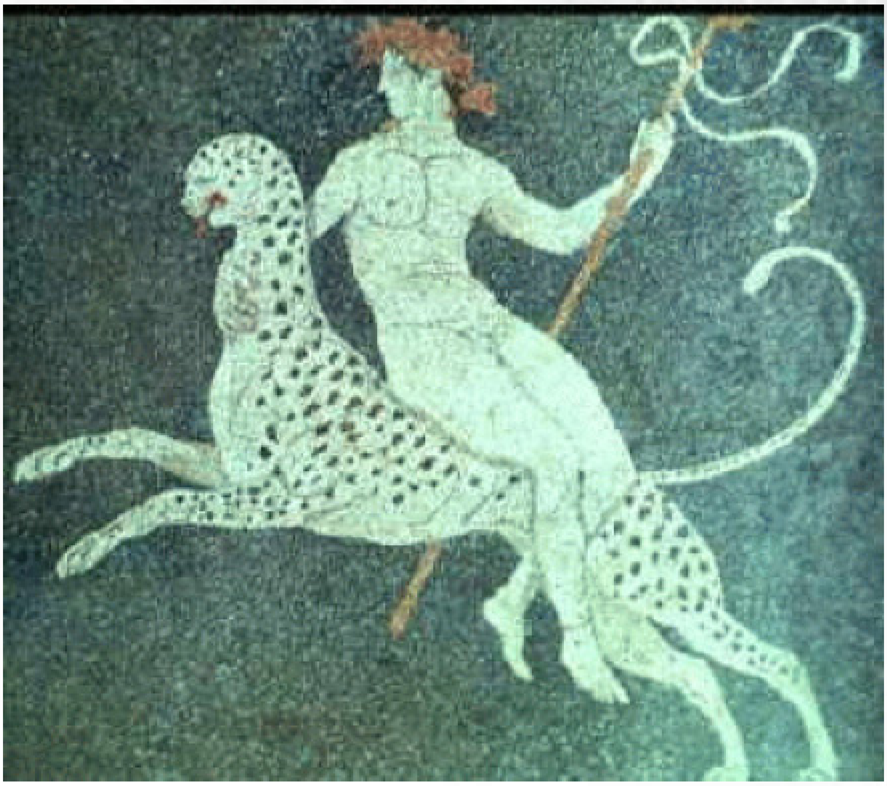
When this cult reached Rome in about 300 BC it was soon outlawed and by the Romans own count more than twenty thousand people were crucified, the majority women, the Romans replaced this secretive Dionysus cult with their public cult of Bacchus and these two Gods have been confused with each other ever since.

The true cult of Dionysus survived being outlawed losing the wild ecstatic dancing that marked its earlier form and eventually evolving into a religion of personal salvation, until it was outlawed by the Roman Catholic Church as being a Pagan religion.



Above; Dionysus with "Grape vines" sprouting from his back, carrying his magic drinking Horn or Cornucopia.

Below; Dionysus riding a Leopard.



23. Odin; God of Wisdom

The Germanic and Nordic, "Wotan", "Woden" or "Odin" the premier God of the North; a god of war, wisdom and secret knowledge, who possessed the poetic mead of inspiration.

Odin is only one of two to three hundred names for this God, these including Ygg = egg, Jalk (English Jack) = youth, Sidhot = slouchy hat, and Sidskeg = the long beard. These names are a precise fit with the visible *Amanita muscaria* Life cycle, which starts with an egg, growing into a youth, maturing into a slouchy hat, and finally into the long beard "mycelium".

Odin has only one eye, he gave up the other one as payment to drink from the well of knowledge, if you pick a fresh *Amanita muscaria*, remove the cap from the stem and look at the underside of the cap you will see what looks like a single giant eye.

Odin pierced by his own spear, hung himself on the world tree for nine days and nights distilling wisdom, fresh *Amanita muscaria* must be dried before consumption, anciently it was threaded onto a string and hung up to dry, it having no wisdom or knowledge in it when it's fresh.

Many of the Myths of Odin concern his attaining the Poetic Mead, the most precious drink in the universe; it was stored in three casks the Red, the Gold, the Brown, which are the three most common color phases of *Amanita muscaria*. One Myth says Odin has a magic Goat that every day fills a pitcher with the poetic mead, the magic goat (mycelium) and the never-ending pitcher of Mead are just another version of the Holy Grail myth.

A separate Norse Myth concerns the "Golden Apples of Immortality", which all the Germanic Gods had to consume daily to stay young and strong.

Most of the myths of Odin are found in the Elder Edda; which is a collection of the ancient Norse/German mythology saved from oblivion in the late middle ages. The similarity between the words Veda and Edda is no coincidence according to the Indo-European language experts, which believe they both descend from a common ancestral Proto-Indo-European word for Wisdom/Knowledge thus the Elder Edda means the Old Wisdom/Knowledge.

Christianity replaced the old German religion in Scandinavia only 1000 to 800 years ago and like it did everywhere it gained political control, it suppressed the Old Knowledge with persecution of all the remaining followers.

In response some of the Old Wisdom religion found it's way into childhood stories like Jack and the beanstalk and of course there is Odin playing Santa Claus.

Jack and the Beanstalk

The Jack stories are very popular childhood entertainment throughout the Germanic world including England. As with all folklore, there are several different Jack stories and of course local varieties of the same story. The English name "Jack" or the Norse "Jalk" means a "Youth" and is one of the old names of Odin.

In the Jack the Giant killer stories Jack does exactly the same thing Odin does in his ancient stories namely overcome Giants, with only the name of the hero God changed to protect the storyteller from persecution. In Norse mythology things are not as they are said to be, in fact they are always named as an opposite, for example a giant in Norse Myth is not really a giant but a man. Once you understand that Odin is *Amanita muscaria* and men are giants compared to him, his stories of "slaying Giants" is easy to understand and probably warded off the uninitiated person from even touching Odin the Giant killer

In the Jack and the Beanstalk story, Jack trades a cow to an old man for three "magic" beans; the code breaker is the word magic or Maga which is one of the oldest names for *Amanita muscaria*, in the Rig Veda the going rate for Soma is three Somas for one cow, so Jack didn't get ripped off he just paid the going rate.

The magic beans in the story sprout into a gigantic beanstalk that reaches to heaven. In reality Jack would consume these three Maga and have visions, the theme of climbing the World Tree is common in Nordic Shamanism and by climbing up into heaven, or down to its roots in the underworld the Shaman's spirit could visit all the regions of existence.

At the top of the beanstalk/world tree Jack discovers a Giant that wants to eat him, a bag of "Gold" that never runs out, a Golden Harp that recites poetry, and makes music by itself, and the Goose that lays Golden Eggs.

The never-ending bag of Gold recalls the Bhagas of the Rig Veda, the leather bags used to carry the dried Soma plants to the Soma ceremony, these bags gave the name Brahmans or "bag-man" to the ancient Soma drinkers. Now if you know where the Somas grow, your bag will never be empty, plus at three Somas per cow this knowledge could generate real wealth.

One of the most surprising effects of consuming dried *Amanita muscaria* are the auditory effects, these can be very beautiful poetry, music or the spoken word. There is simply no comparison to real music as the auditory effects can be orders of magnitude better than ordinary music. Thus, the stories "golden harp" that sings and plays it's own music.

The Golden Eggs supposedly produced by a "goose" are obviously *Amanita muscaria* mushrooms, which when just emerging really are small golden eggs. In the Rig Veda Soma is called the Golden Embryo the most precious thing in all creation, while one of Odin's names is Ygg, in English egg.

Santa Claus and Christmas

In Siberian folklore, reindeer, which love eating *Amanita muscaria* and becoming intoxicated, are always associated with the mushroom. In the Santa story the reindeer not only pull a sled, but can also fly into the sky. This symbolism should be obvious, since people who have eaten dried *Amanita muscaria* often report flying as one of the visions, such people would of course think a stoned out reindeer was also capable of this kind of shamanic "flying".

Santa; the jolly little fat guy, with a long white beard, in a red and white suit, who can travel around the world in a single night leaving brightly wrapped "presents" under evergreen trees is obviously *Amanita muscaria* personified.

Amanita muscaria is little in size yet quite fat, full of laughter and joy when dried and consumed, it produces a long white mycelium when resurrected that resembles a white beard, it is the only brilliantly red and white life form in the northern forest, it can come up over a very large area in a single night, it is a symbiot with evergreen trees like Pine, Fir, and Spruce, and is obviously the brightly wrapped presents to be found under these trees. The Santa story is Norse/Germanic in origin, and the earliest known German Christmas tree ornaments are painted wood or glazed ceramic *Amanita muscaria* representations.

This Santa story appears to be shifted six months on the Solar calendar, probably to avoid the church's persecutions and to bring it into line with the Church's calendar. Since, in the far north *Amanita muscaria* fruits during or after the longest days of the year. While the modern Christmas or (Mithra's birthday) is celebrated during the shortest days of the year, when *Amanita muscaria* fruits in the much warmer Mediterranean basin area.

However, the ceremonial sharing of dried *Amanita muscaria* at a midwinter celebration in the northern forests may be an ancient practice since the antibiotics it contains and it's light increasing mood-enhancing intoxication would probably be most needed by the ancient peoples at this bleak time of the year.

24. Amanita muscaria and Philosophical Alchemy, Hermeticism, the Occult and Judeo-Christian Mysticism

Each of these categories are often considered to be separate belief systems and yet these belief systems are mixed to such a large extent that there is no "pure"strain. Alchemy for example contains elements of Hermeticism, Occultism, and Judeo-Christian mysticism, and each of these categories also contain major elements of the others.

These belief systems were developed or surfaced during the early Medieval period under the fierce persecution of heretics and other thought criminals by the Roman Catholic Church, thus many of their texts are written in a way the church would not suspect of heresy and often symbols and pictures are used instead of words to carry meaning in the form of a symbolic language.

In a further effort to keep their heads upon their shoulders many authors of these texts used assumed names and since Europe's Jewish population was not subject to the same rules the church applied to Christians, many "Christian"authors used Jewish names. However there is considerable cross over between Christian, Muslim and Jewish thought at this time and the Kabbala was widely studied by Alchemists and Hermetic students. The use of assumed names by authors of these types of texts lasts until the 1600"s when the power of the Church to torture and kill for the crime of heresy declines in most areas of Europe, only then authors began to put their own names proudly on their work.

Alchemy is the art of transmutation, which is divided into the two main branches of Practical Alchemy and Philosophical Alchemy. Practical Alchemy concerned itself with the transmutation of lead into gold and the experimental exploration of matter which over time developed into the science of modern chemistry, this branch of Alchemy does not concern us, except to realize that not all Alchemy is the same.

In contrast the goal of Philosophical Alchemy is the spiritual transmutation of men into more than man through the use of the Philosophers Stone and the Elixir of Immortality. These Philosophical Alchemy texts are full of bizarre imagery and veiled references to *Amanita muscaria* as the Philosophers Stone the source of the Elixir of Immortality. They also show a series of transformations involving the Philosophers Stone which when understood as *Amanita muscaria* corresponds with the resurrection of the dried mushroom and the secret of the Holy Grail.

Hermeticism is a mixture of beliefs drawn from Egyptian and pre Christian Greek sources. The Egyptian god Thoth was thought to be the author of several Hermetic texts. The Greek name for Thoth is Hermes Trismegistus meaning "Hermes the thrice greatest". Many Hermetic authors signed their work as Hermes Trismegistus or variations thereof believing the text was directly inspired by Hermes Trismegistus. The Greek god Hermes (Roman Mercury) is found widely in Hermeticism, Hermes is winged with wings on his ankles, shoulders, or on his head and he carries the same winged staff wound with serpents, "the caduceus' that modern Medicine uses for it's symbol of healing. The Greek Hermes, a healer, the god of commerce, invention, cunning, theft, messenger and herald to the other gods, a patron of travelers, and leader of souls to the underworld. Hermes is also associated with Hermaphroditism (Hermes + Aphrodite) the occurrence of male and female sexual characteristics in the same body, named after Hermaphroditus the son of Hermes and Aphrodite, who became united in one body with the female nymph Salmacis. This joining of the opposites of male and female in one body is apparent in the *Amanita muscaria* mushroom which appears to be both male and female genitalia. Hermetic also stands for sealed, a Hermetic seal is air tight thus Hermetic knowledge is Sealed knowledge, one must break the code to access the sealed knowledge.

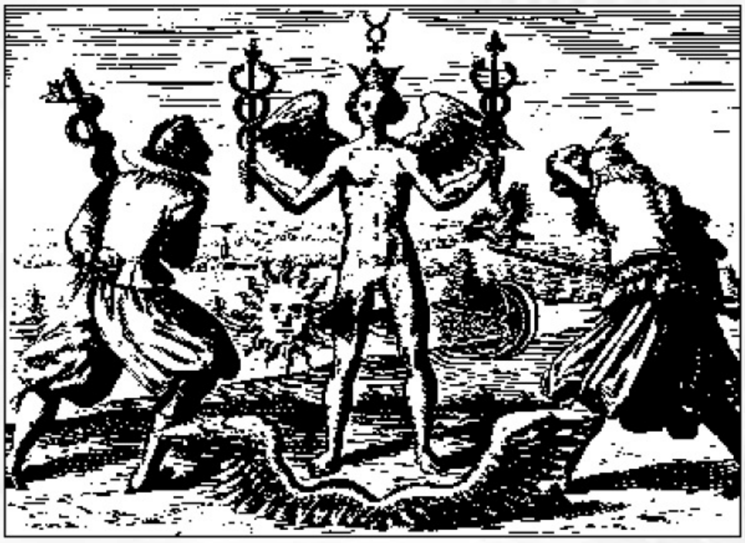
Occult means hidden, as in hidden knowledge, the occult is often thought of as dealing with "supernatural" knowledge, and viewed from the standards of the Church as being evil, even Satanic. Yet, the Occult is best understood as Esoteric knowledge that was intended for only a few people. Esoteric and Occult are synonyms for the words mystery and mysterious which evolved from the Mystery religions of ancient Eurasia.

From the ancient Mystery religions we also have Mystic and Mysticism. Followers of Mysticism are often outward believers in more organized religions and are often called Christian mystics or Jewish mystics yet all Mystics share more in common than their religions seem to share. All branches of mysticism believe in the personal experience of God through a divine rapture, an indescribable bliss which carries them to other levels of perception and reality. The belief that man in a physical body can experience God seemed heresy in the more organized religions and Christianity, Judaism, and Islam have all persecuted Mystic sects.

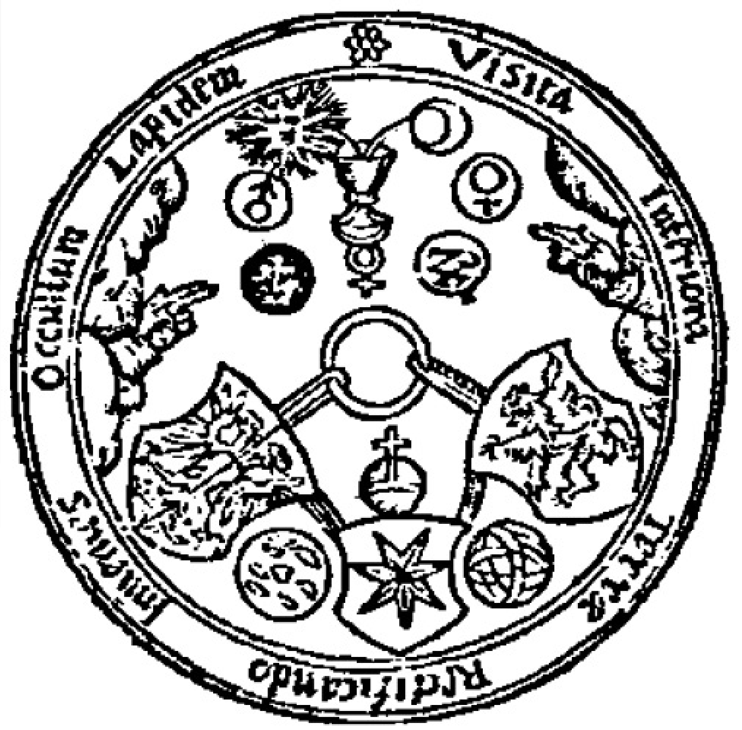
Not all Mystic sects know of *Amanita muscaria* and some would not use it if they knew that secret, instead the rapture is generated through meditation or other means, including other psychoactive drugs such as Hashish used by some Hindu and Muslim mystics.

There is however a large number of Christian and Jewish Mystics that did know of and use *Amanita muscaria* as a Sacrament. Some like Jacob Boehme created beautiful images containing the *Amanita muscaria* Sacrament in plain sight. Hiding the Secret in images that can only be understood if you already know the Secret, is one way to preserve and pass on the Sacred knowledge. Only those with eyes to see will see.

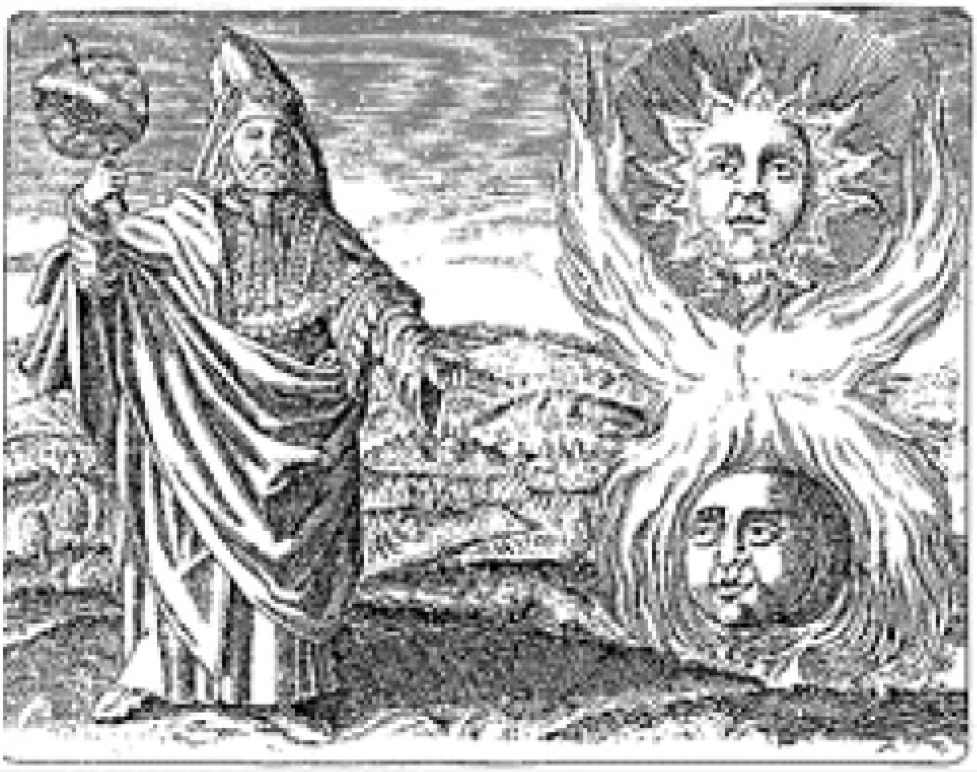
The Second Key of Basil Valentine



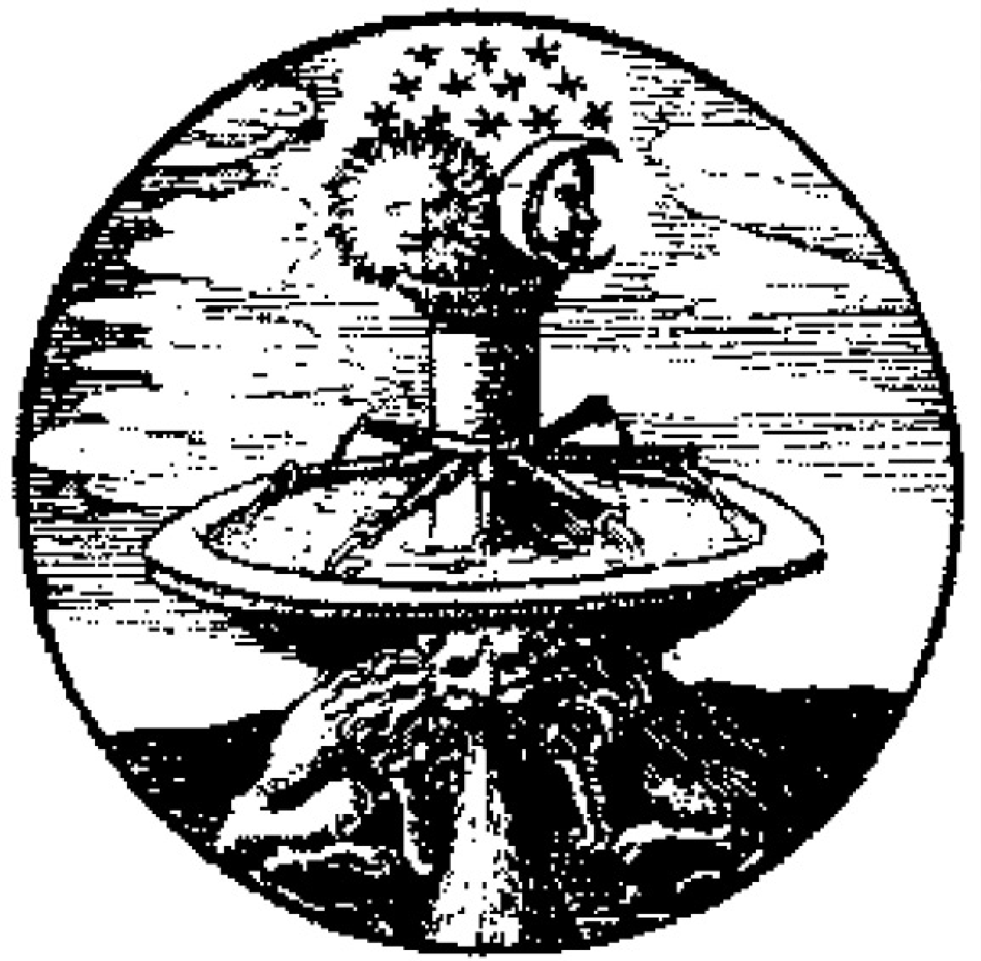
Hermes, the Sun & Moon on earth, spread wings rooted to the earth.



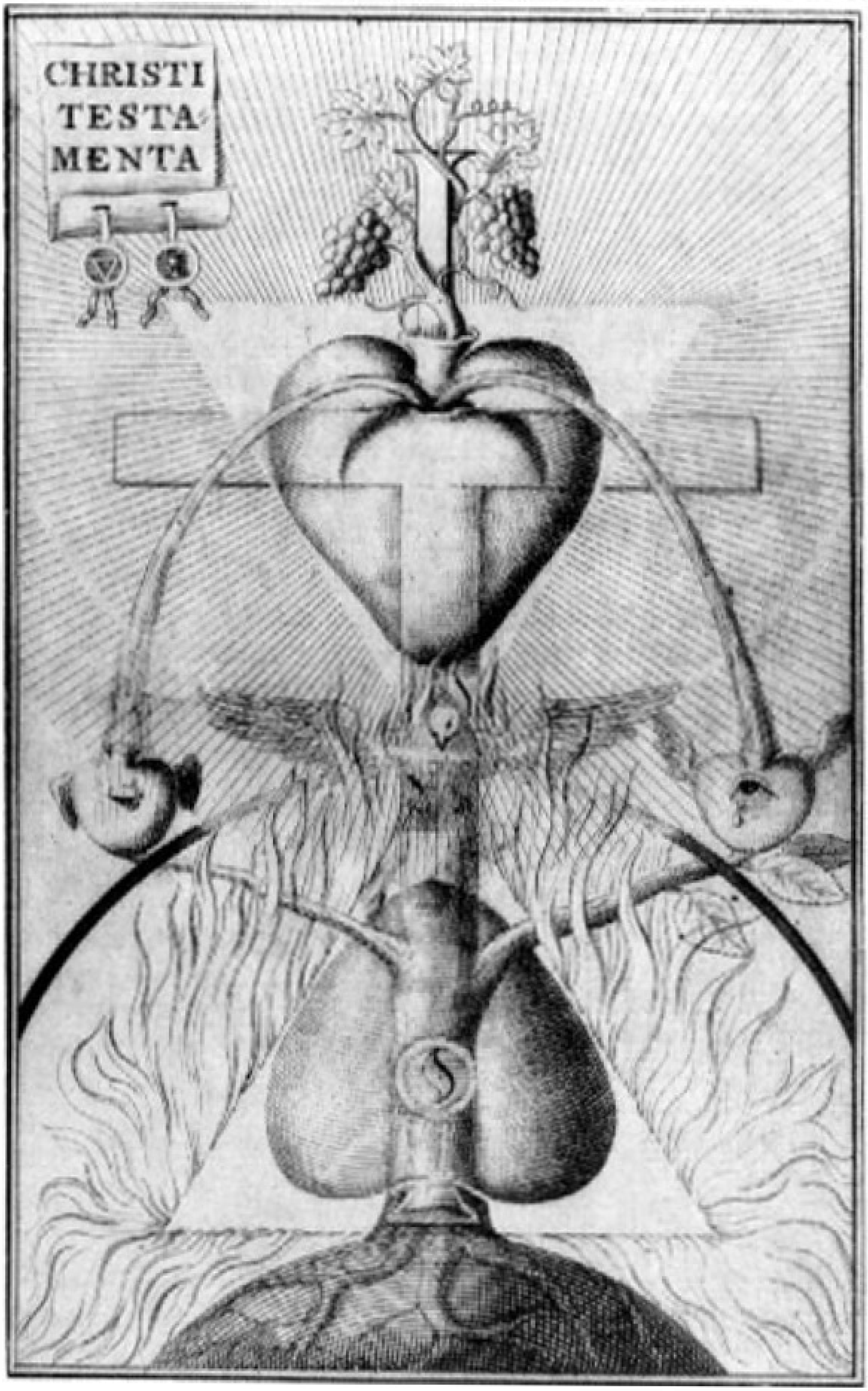
Sun & Moon fill Hermes Sacred Cup. Azoth.



One who knows the Heavens points to the Sun & Moon on the Earth. Azoth.

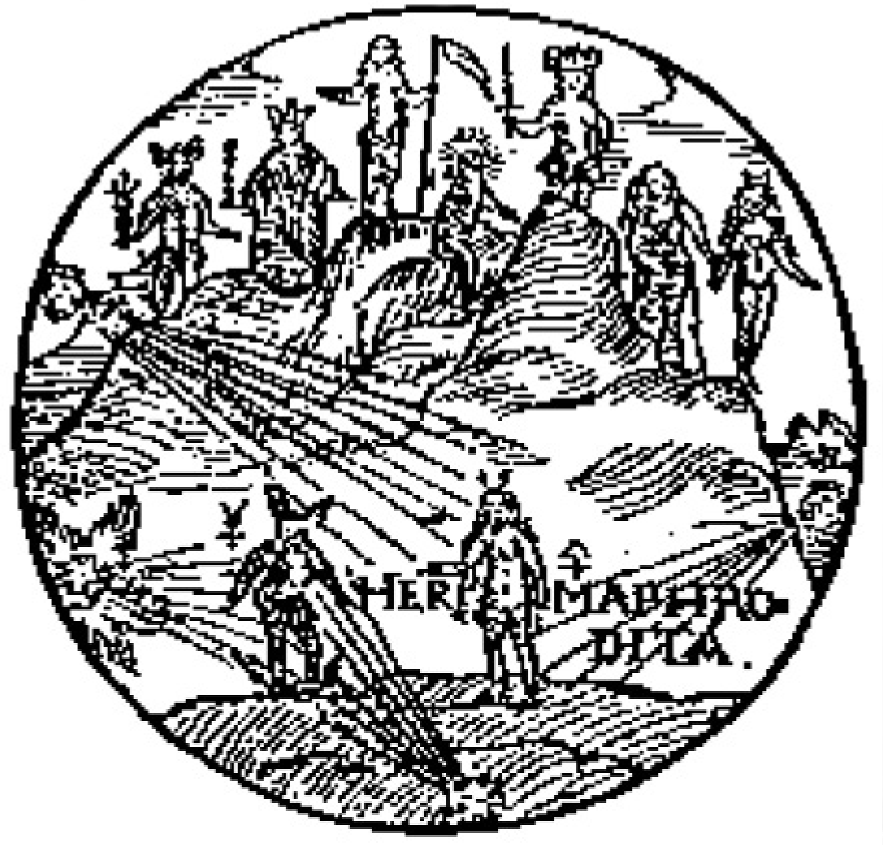


From the Sun & Moon on Earth the water of Life flows. Hermetic Garden.

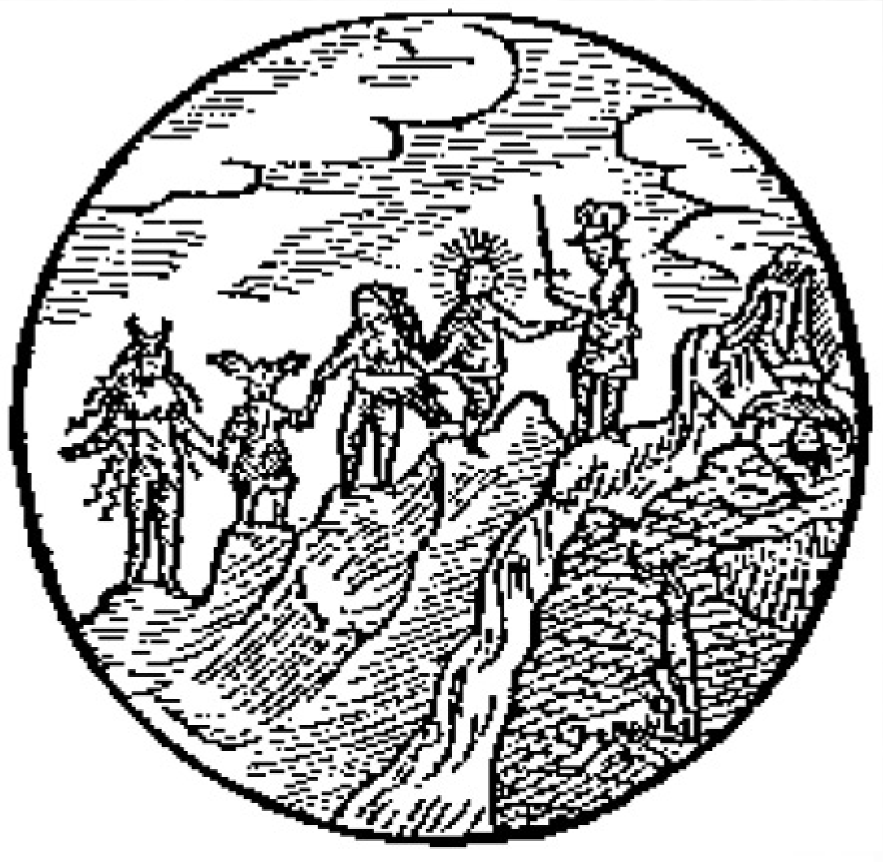


Testament of Christ-Jacob Boehme.

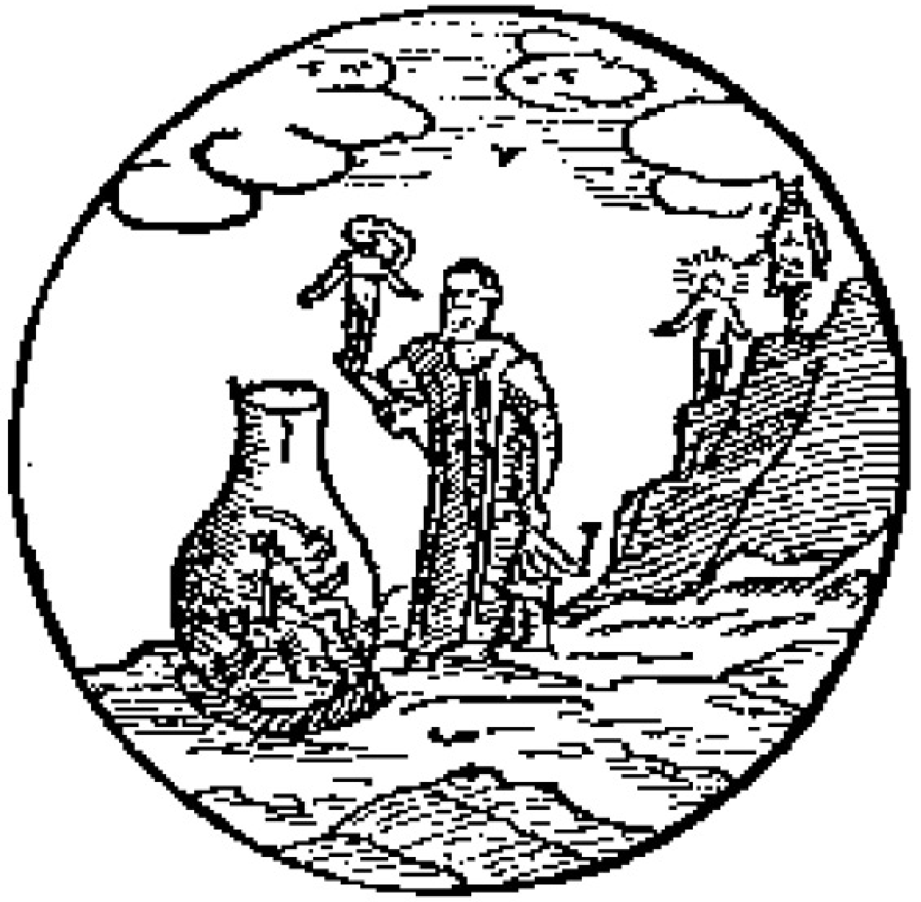
From, Kelley's Terrestrial Astronomy



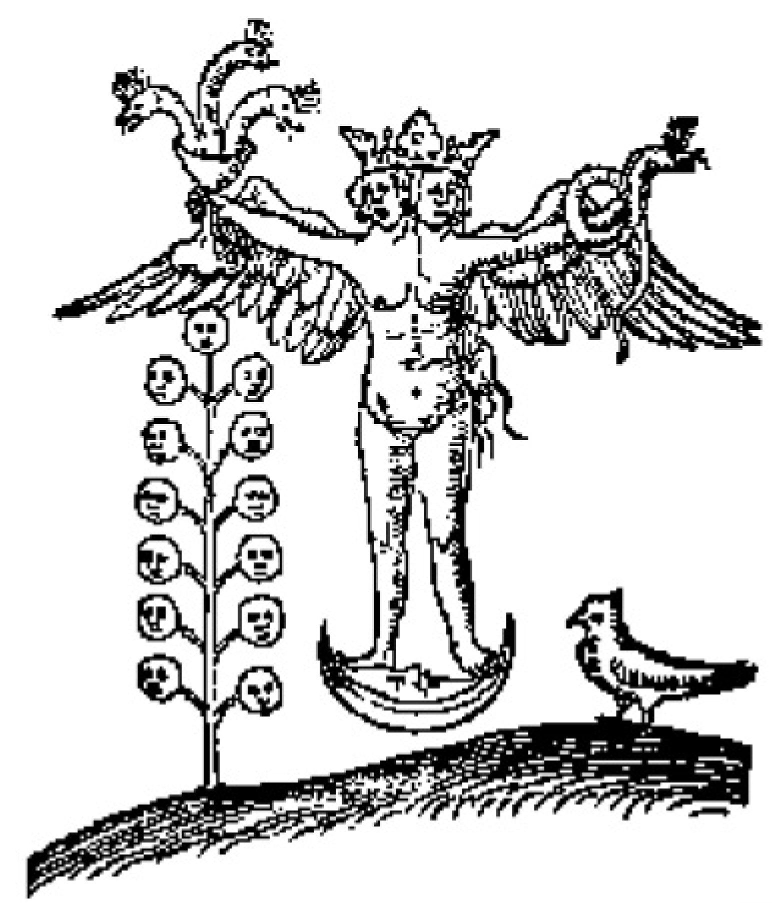
Hermaphrodites on the mountains.



A closer view, some have fallen over.

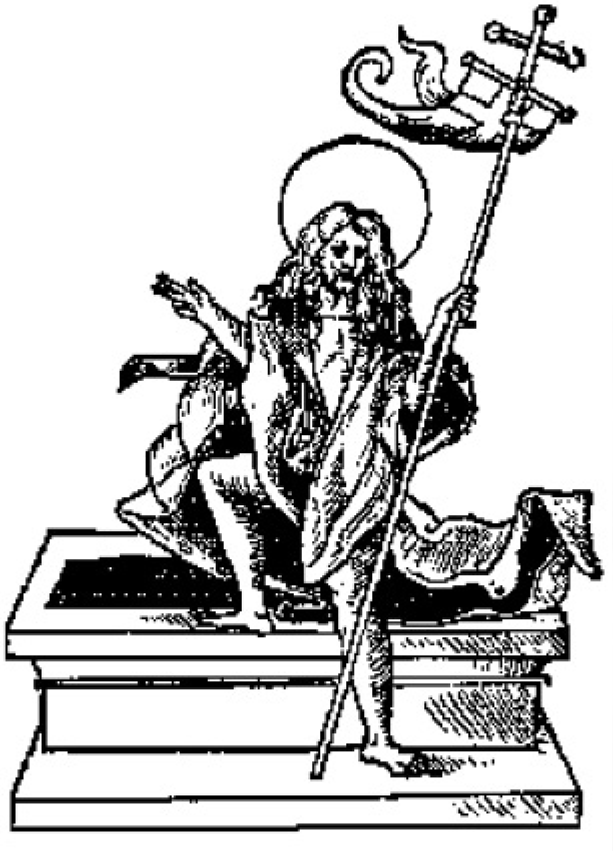


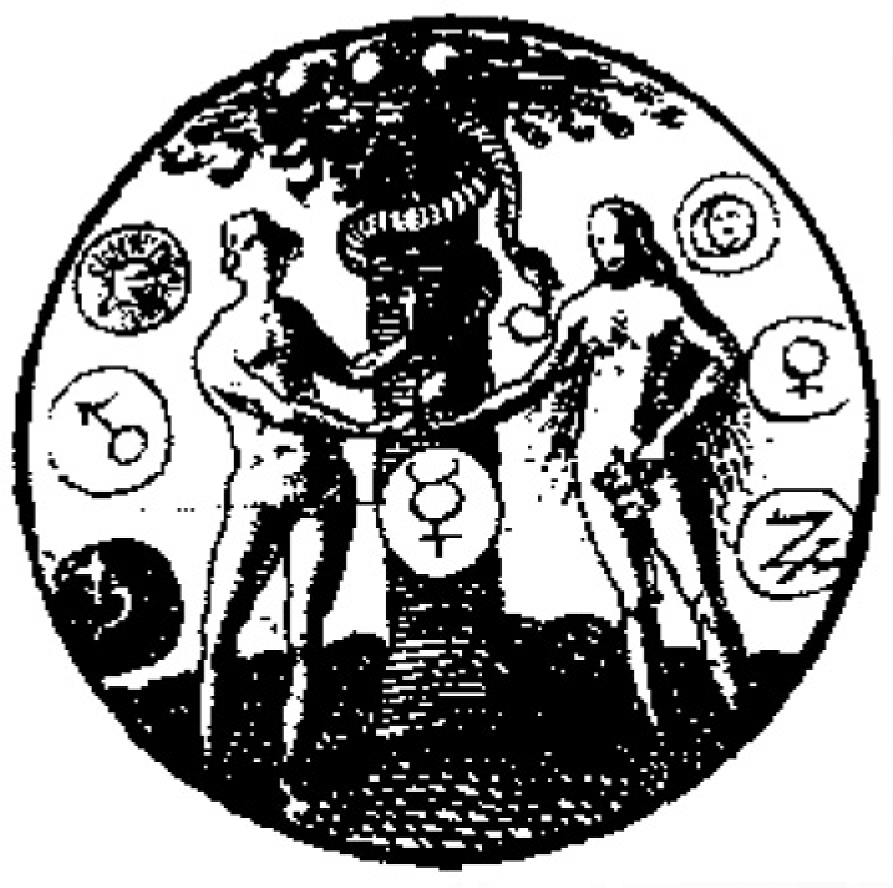
Into the Wizards vessel they go.



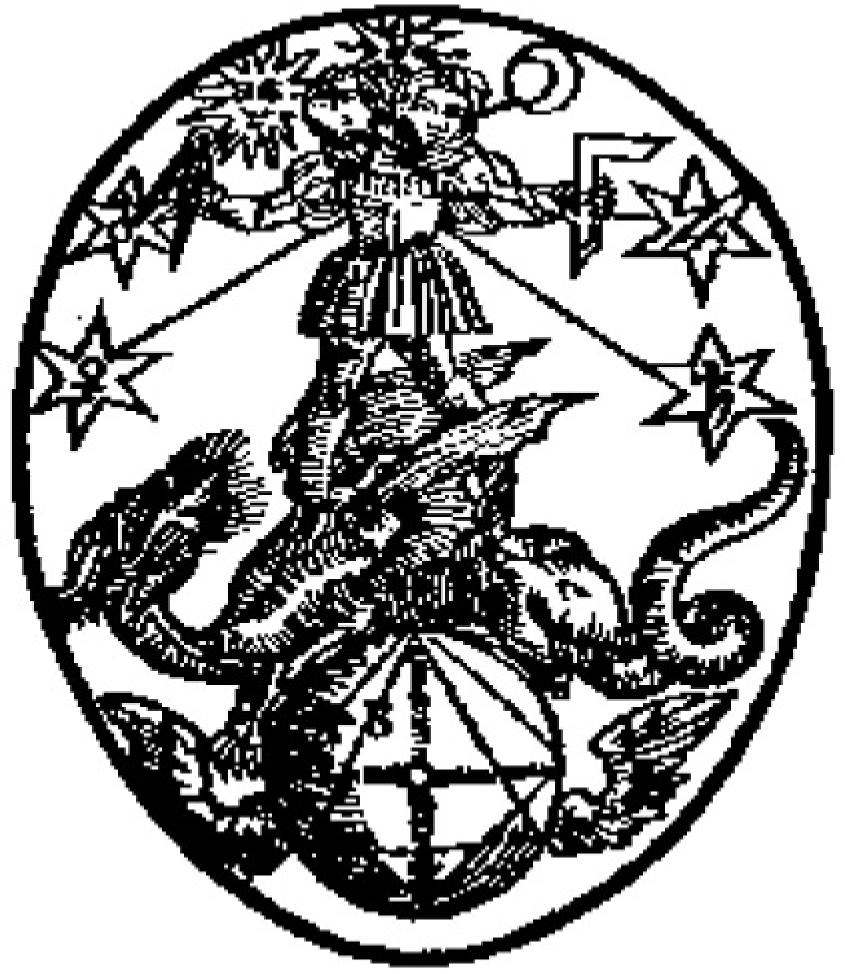
In the Rosary of the Philosophers the creature above transmutes into the Christ below. The Hermaphrodite holds the Grail sprouting snakes and holds the serpents of wisdom in the other hand.

The risen Christ below wears a new robe.

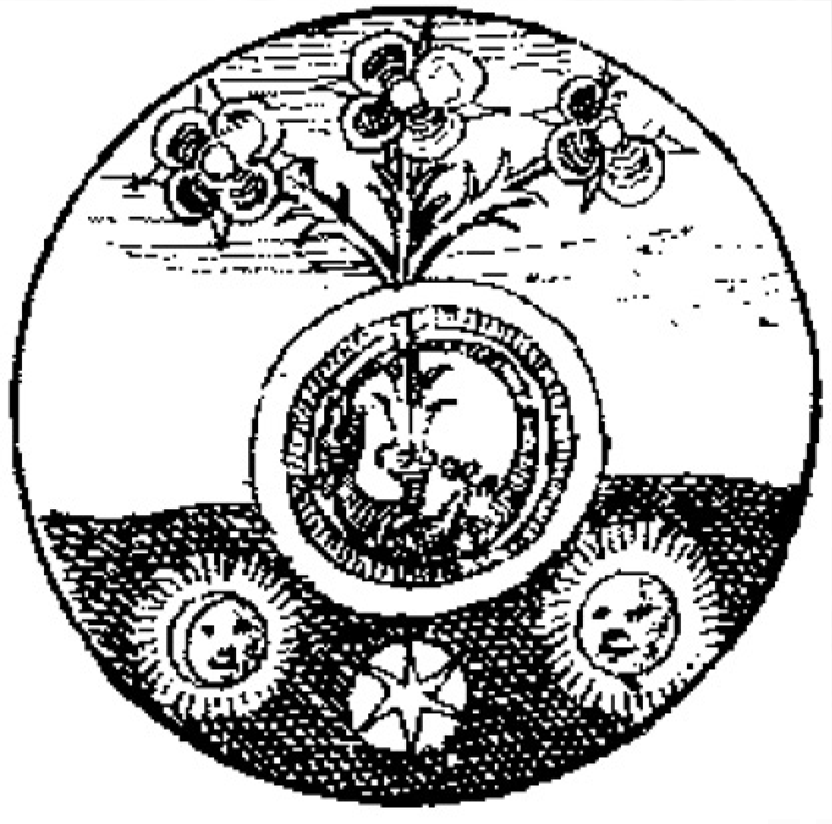




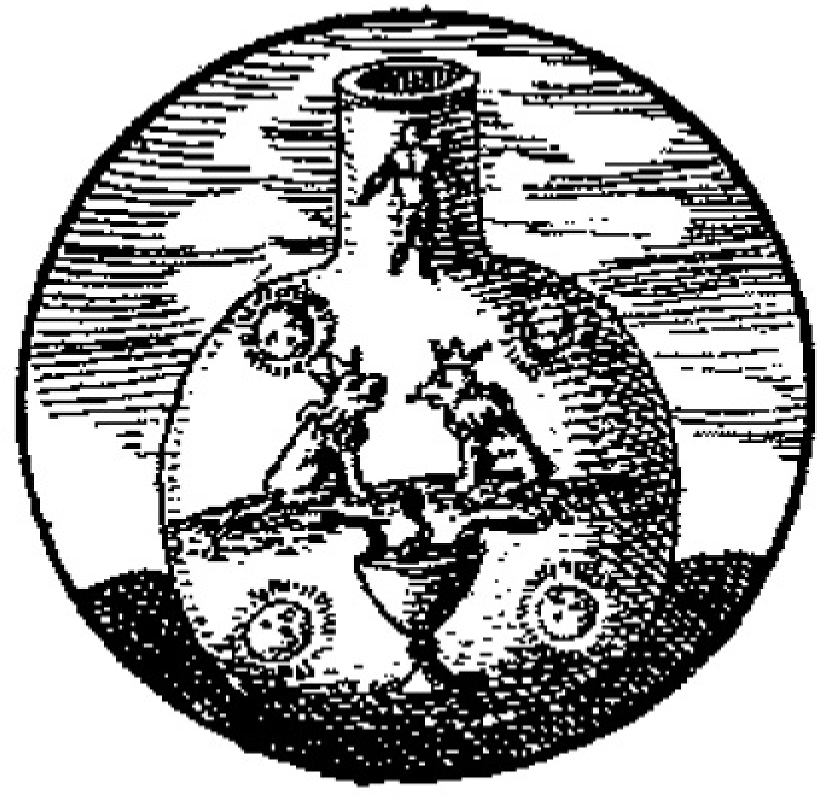
Adam & Eve from the Hermetic Garden.



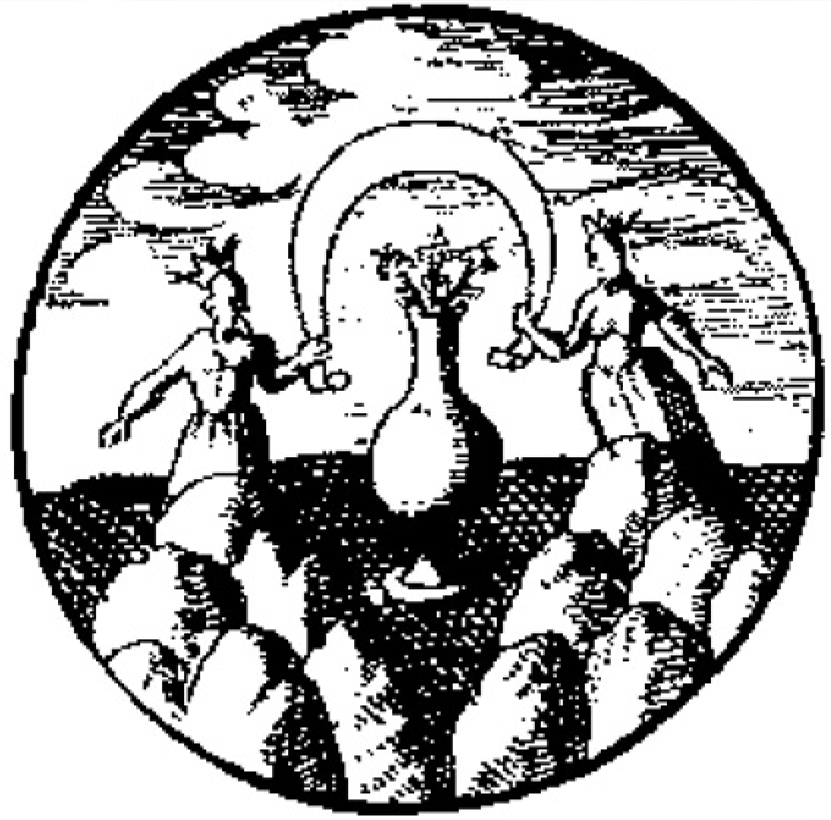
Hermaphrodite egg from Azoth.



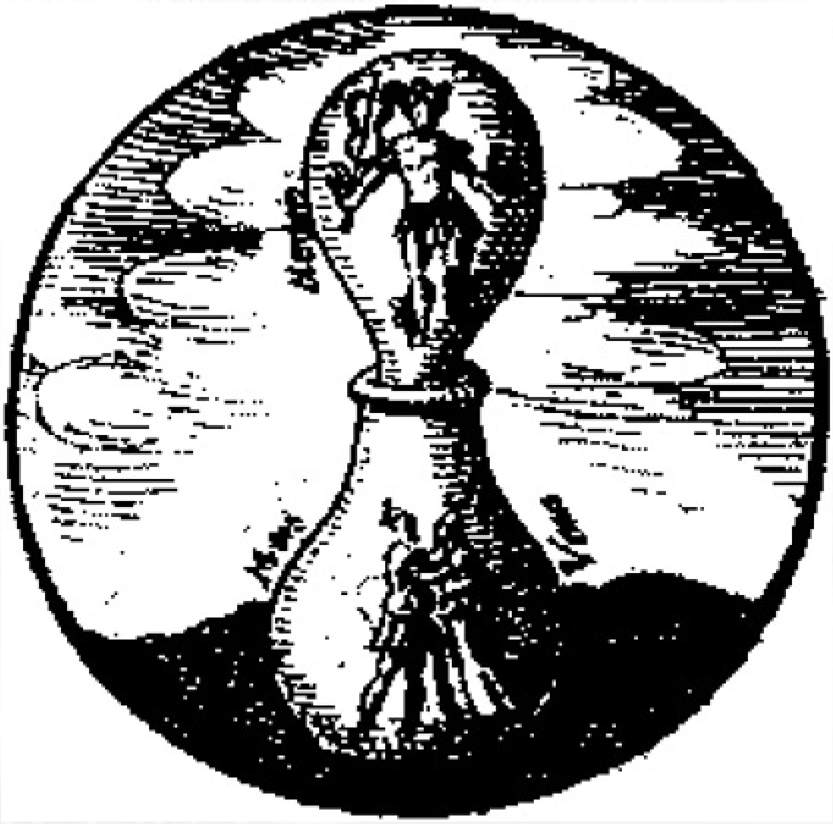
Sun & Moon under the Earth, a baby dragon in the divine egg suckles from his own tail. Hermetic Garden.



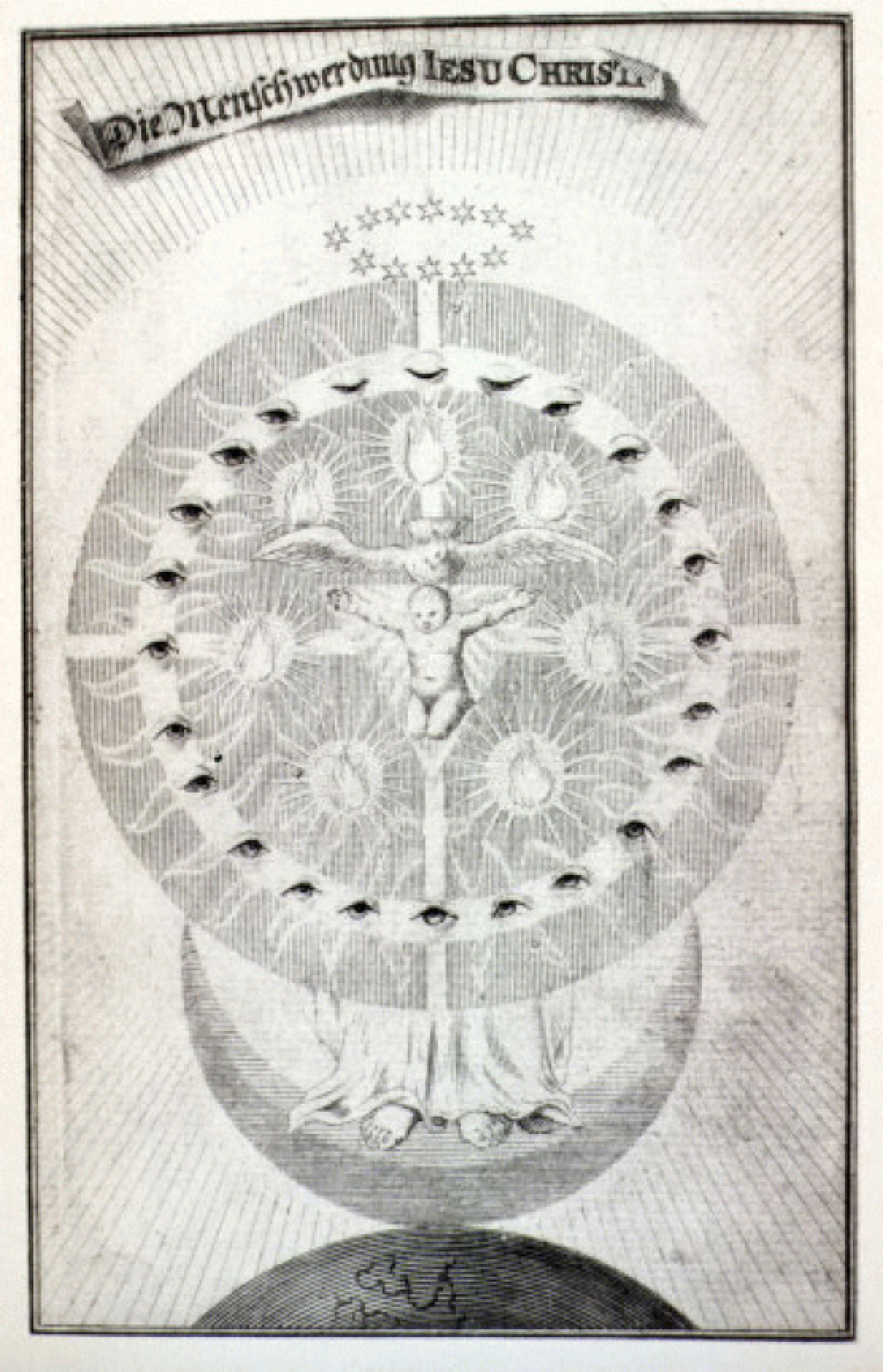
The Alchemical Secret of the Holy Grail. Hermetic Garden.



The Immortal sprouts in a cloth covered vessel. Hermetic Garden.



Mars & Venus creating Hermes. Hermetic Garden.


Die Menſchwerdung IESU CHRISTI

Sun & Moon on Earth-Jacob Boehme.

Sun & Moon on Earth-D. Teeter. Photo Neil Switkowski.

25. Some Thoughts

Amanita muscaria is the most widely distributed natural intoxicant on planet Earth being found on all continents except Antarctica, this fact in itself would guaranty a lot of stories about *Amanita muscaria* worldwide. *Amanita muscaria* when properly prepared is a much safer plant intoxicant than many commonly used intoxicating plants like poppy, henbane, datura, or belladonna since these plants can easily cause death with just a small overdose.

In the northern forests *Amanita muscaria* is the most easily recognized and exploitable source of large quantities of effective antibiotics, this would also generate a lot of stories of *Amanita muscaria* doing miraculous healing and cures.

The *Amanita muscaria* mushroom is very distinctive in appearance and with a little training is easily distinguished from all other mushrooms, some of which can be deadly.

The Immortality exhibited by *Amanita muscaria* is a source of wonder, and the source of all the magic vessel legends of ancient Eurasia. Since this immortality can be exploited by using magic cups or other cultivation techniques to extend the supply of this very special life form the cults using *Amanita muscaria* would not have to maintain a large supply of mushrooms.

The unique fragrance and taste of dried *Amanita muscaria* resembles honey and is sweet to the taste unlike most other medicinal or psychoactive plants.

Our ancestors discovered a living treasure in the forests and they used it. This practical knowledge they passed from generation to generation for ages in story, song and ritual.

Some time between the ancient world and the modern world the secret to understanding these stories and rituals was lost. These stories evolving into sacred books, myth, or Folk stories while the rituals became the outward signs of various religions, yet without the knowledge of the ancient sacrament the stories became unintelligible and the ancient rituals became meaningless.

The real and practical ancient living god of our ancestors was hidden from us and was replaced by a truly worthless even dangerous supernatural god. This is a concept of god created by men to control men, as this modern god is really an anti-god, whose followers have killed millions through warfare, persecution and ignorance. This invisible modern god cannot fulfill the ancient promises of the real "Living God"; since it is a god who opens not the eyes of the blind, that leaves the sick diseased and the lame crippled.

For the true seeker, know that in the real world, you can find a real forest that is home to the ancient living god of our fathers. The ancient Garden of paradise has always been here; in this earthly garden is the Fruit of the Tree of Wisdom and Life. Taste for yourself nature's honey sweet medicine, heal your body and spirit, let your eyes be opened and become reborn as gods. This is the promise of the ancient Knowledge; this is your ancestral birthright.

26. The Names of a God, Part 1

What's in a name? Everything! The ancient Indo-Europeans and their descendants attached a lot of meaning to names, yet names, no matter how long, can convey only so much meaning. Where there is a mystery full of meaning to try and convey, as in the herb of Life, one name simply cannot do the job. In the case of *Amanita muscaria*, the names multiply giving it more names than any other life form. Most of the names are attributes or descriptions of its effects rather than physical descriptions, but these also exist in abundance. Since we are dealing with a physical plant that has many mental and physical effects on the human body, the multitude of names makes perfect sense.

In contrast, the truly supernatural gods have very few names. Zeus is basically Zeus, while Yahweh, his Hebrew counterpart, is always Yahweh. Yahweh's messenger, the Messiah, however, has over 50 names in the Old and New Testaments.

Many of the names have to do with one effect, the production of auditory effects. A dead dry plant, with no lips or tongue, speaks, leading to names such as The Messiah (messenger), the Word, the Word of the Way, the Tongue of the Way, the Word of God, etc., etc. These names causing endless confusion for scholars who don't know a plant can speak!

Many other names are based on the fact that *Amanita muscaria* is "Immortal" in the truest sense of that word. This has also caused endless confusion for scholars who do not understand that *Amanita muscaria* is truly immortal, in the literal sense of the word.

Other names are, of course, based on other effects. In this section, we will take a closer look at some of these names of god. Names will be drawn from many sources, Ancient Aryan, Greek, Persian, Hebrew and Christian. The abbreviations are R.V. = Rig Veda, Ys = Yasna, O.T. = Old Testament, N.T. = New Testament.

Greek - Ambrose,
R.V. - Amrita,
"Not mortal". Seems to refer to both plant and juice extracted from the *Amanita muscaria* after it has been dried then rehydrated with water. In the Greek legends Ambrose is sometimes called Nek-Tar (see Nek-tar).

R.V. - Andhas,
"The Flower" The ancient Aryans sometimes referred to Soma as "the flower" dried *Amanita muscaria* has a very pleasant aroma, the association of flowers and nectar probably arose from this plant, which is both the flower and the nectar.

O.T., N.T. - Be-el-ze-bub
"The lord of the flies" or "God of the flies"; this name has been demonized extensively; however in its original plain meaning it is very descriptive of the herb, since living *Amanita muscaria* is often surrounded with clouds of small flies or gnats while larger flies may be found sitting on it, or laying under it, completely comatose. Dried *Amanita muscaria* in milk is irresistible to flies, the flies becoming very intoxicated. The modern common name, fly Agaric, and the scientific name, *Amanita muscaria*, associate this mushroom with a power over flies.

There are 7 references in the New Testament to the "Lord of Flies" (Beelzebub) and all of these are associated with "Jesus", they are Matthew 10:25, 12:24, 12:27, Mark 3:22, and Luke 11:15, 11: 18, 11:19.

R.V. - Born of Thunder
The *Amanita muscaria* mushroom, having no visible seeds or root system anciently was thought to just spring up with the sound of thunder. In effect an Immaculate Conception for an herb full of wonder and divinity. This concept leads to the Son of God, Son of Zeus, and Son of the Sky Father names.

R.V. - Comforter
O.T. - Comforter
N.T. - Comforter
As the "comforter," the herb is held in the highest esteem by these three variants of the ancient religion. The New Testament has the most references to the comforter as the Holy Spirit. The "Holy Spirit" is a description of the herb's effects after ingestion.

O.T. - Counselor
R.V. - Counselor
As the advisor of the seers (prophets) who then advised other men, the counsel of the herb was considered to be the highest available to mankind.

Greek - Dionysus
"The Son of the Deity." The cult of Dionysus shows obvious signs of being originally a cult of the herb, such as the vines yielding wine that appear overnight, with the emphasis on intoxication. The ritual importance of small spotted "animals", and the sacred hunt in the woods for these spotted creatures (*Amanita muscaria*), plus the fact that women were supposed to tear these "animals" (Dionysus himself) apart with their bare hands. Dionysus is personified as the sacrificial victim in this ritual. Dionysus as depicted sometimes, wears a scarlet mask and a leopard skin. Behind his mask he's hiding a secret, his inner self. The most common cult object was a white post with the scarlet mask hanging on top, phallic or fungus? The cult's main objective was

to induce a divine ecstasy in the Maenads (female worshipers).

R.V. - The Father of the Gods
Ys - The first and last
O.T. - The first and last
N.T. - Alpha and Omega
The idea that this plant was and should be considered the beginning of western religion is anciently held to be true. As the father of the gods, the Soma was thought to have produced the gods and they the universe, the Soma plant, being a god, high priest and sacrifice in the Soma ceremony. Obviously in the visions and auditory effects induced by this plant, we find the birthplace of the gods and religion.

R.V. - A fountain made of gold, the fount
O.T. - The fountain of living water
N.T. - The fountain of the water of life
"The fountain of living water" is closely associated with the idea of amrita, ambrosia, the elixir of immortality. The body of the herb that provides this amrita appearing like a small spring of water that eventually shoots up into a frozen fountain shape, bearing in this form, the water of life, it had mysteriously brought up out of the earth.

The large bowl holding the Soma juice is called the fount in the Rig-Veda, the ancestor of the fount of holy water in Christian churches. R.V. 9 XCVII 44, "Pour us a fount of meath, a spring of treasure." In the Rig-Veda the water extraction and filtering process is poetically compared with oceans, rivers, streams, fountains, springs and drops of rain.

Greek - The Golden Apples of Immortality
Latin - The Golden Apples of Immortality
Norse - The Golden Apples of Immortality
Greek, Roman and Norse mythologies all mention the "golden apples of immortality" in several legends. In Greek and Latin, the word for apple is also used in a generic sense for fruit. Button stage, *Amanita muscaria* specimens, when dried whole, definitely resembles small golden apples. These golden apples are the most precious things mentioned in these myths as the immortality of the gods themselves depended on them.

N.T. - The living bread
These names of the Christ, as being the living bread, the bread of life and the bread from heaven all point to the consumption of "*Amanita muscaria*" as heavenly food. All three have correspondences such as:

N.T. - the living God
N.T. - bread of life
N.T. - living bread, living stone
N.T. - bread from heaven
The food of Gods -R.V.
Chief of all foods -R.V.

Lord of Life - RV
Deathless God - RV
The *Amanita muscaria* mushroom certainly is a living being, it is also the only plant in all of human history to be considered a God! The psychedelic mushrooms used by the Mexican Indians are considered messengers, not god.

N.T. - a living stone
A fairly good description of living *Amanita muscaria*, in the young growth stages, this living stone is the foundation of Christianity. That people either accepted it or were offended by it is plainly written, (see I Peter 2:4-8).

R.V. - Madhu
"Honey, Sweet". The Soma is called honey more often in the Rig Veda than any other single description. The juice of the dry *Amanita muscaria* after rehydration with water is very sweet to the taste, in contrast to other available drug plants such as *Datura*, Henbane, Opium and Ephedra. These have a bitter or nasty taste; none

of these could be called sweet. (Ephedra is one of the modern substitutes used by Hindu Brahmins in today's Soma ceremonies and in the modern Zoroastrianism Haoma ceremony, leading many to believe that it is the original Soma/Haoma. Ephedra contains Ephedrine an Amphetamine, which produces exhilaration and some euphoria, but it does not produce the original Soma's effects of visions, auditory effects, rapturous intoxication or psychoactive urine.)

R.V. - Master Poet or The Lord of Speech, Sacred Bard (Poet)
A speaking name for Soma in the Rig-Veda, Soma being the father of poems, a master poet never yet equaled! The auditory effects again being stressed in the highest terms. The Soma is the inspiration of poets and prophets.

O.T. - The Messiah
N.T. - The Christ
"The Messenger." No other name has caused as much confusion as this one. This is a speaking name, like the Word of the Way. Because of this, the messiah is thought to be a man by the uninformed. That the messiah of the Old Testament prophets could not be a "man" is plainly evident in their description of god's messenger.
Isaiah 42:19-20
"19. Who is blind, but my servant? Or deaf, as my messenger that I sent? Who is blind as he that is perfect and blind as the Lord's servant?
20. Seeing many things, but thou observest not; opening the ear's, but he heareth not."
Isaiah 53:2
"2. For he shall grow up before him as a tender plant, and as a root out of a dry ground."

The messiah is blind, lacking eyes, deaf, lacking ears, but he opens the eyes of the blind, and opens the ears of men, both are effects of the herb of Life. The description as a tender plant is botanically correct, since few plants are as "tender" as the living *Amanita muscaria*; which in arid areas sometimes fruits in ground as hard as concrete, I have personally observed this in Arizona, U.S.A.

The Old Testament prophets simply pounded this plant after rehydration with water to yield its juice, exactly the same as in the Soma and Haoma ceremonies. Isaiah Chapter 53 is, I believe, the liturgy spoken as this processing went on. The linking of this plant with prophecy extends thousands of years prior to Isaiah's time. The wonder of a dry dead plant, speaking, would raise its messages to the highest levels in the eyes of the ancient peoples. The fact that some of what it said sometimes came true raised it even higher.

R.V. - Nek-tar
Greek - Nectar
Nek = Corpse + Tar = overcomer
The "corpse/death overcomer." An ancient word based on the herb's resurrecting ability, giving it a central place in the ancient Aryan religion, as the bringer of immortality to mankind. The gods of the Greeks drank Ambrosia, the Nectar that made them immortal.

The possibility that regular, ritual consumption of a plant, exhibiting antibiotic antiviral properties, that may extend the span of human life, should be thoroughly investigated. There must be some logic to this extremely ancient and long running belief.

It is interesting to note that Soma drinkers in the Rig Veda were expecting 100 years as a lifespan, with the possibility of many more. In contrast to the bible's three score and ten (70 years) with the possibility of another decade or two. The only Biblical exceptions were the prophets who were also herb users with many of them living well past 100 years.

O.T. - Prince of Peace
I believe this name is based on the calming effect caused by consuming dried *Amanita muscaria*. This inner peace is unique to this herb, it is thoroughly calming and yet clear, with almost no interference in thought or perception. It is the only mental effect produced by small doses (one to two grams of herb), the calming effect becoming more intense with stronger doses.

As an anti-anxiety agent, the ancients would have highly valued it. I believe their lives could have been much more stressful than modern existence. As a modern anti-anxiety agent it may find use, since compounds with similar effects are widely prescribed medications in modern society.

R.V. - Sage
It is hard for modern people to understand how a plant or the resulting beverage can be wise. But anciently, the herb was considered to be the source of wisdom, the creator of human sages.

As one who has tasted the herb, I have to agree completely with the ancients. Consuming dried *Amanita muscaria* creates extraordinary visions and auditory effects; these unleash a tremendous quantity of information. This is accompanied by lessons or teachings; the whole experience can be considered a learning experience, one that unfortunately, cannot be transmitted with words.

N.T. - Savior
O.T. - Savior - Redeemer - Intercessor
R.V. - Savitar or Savitr
The idea of the herb of Life being a savior, springs from the theology of the ancient Indo-Europeans where the supreme god(s) demands perfect justice in the judgment of the dead, all humans, of course, failing this judgment. The savior, however, intercedes for his devotees at the dead's judgment and, like a good lawyer, gets them off with all charges dropped. Savitar is a name for Soma in the Rig-Veda, and carries out the exact same function, as the savior in the Christian religion.

R.V. - Soma
Persian - Haoma
"The Pressed one" this name is based on the role this plant had in ancient Indo-European religion, where it was dried, then rehydrated with water and pressed or pounded to extract its juice. Soma can refer to the plant, its juice, the juice mixed with milk, the divine urine produced, or the god incarnate of the plant.

This plant god was the central sacrifice in the Soma ceremony. The purpose of this ceremony was to give the participants immortality. This ceremony is very ancient, being in existence before the invasions by the Indo-Europeans of Persia, Turkey, Egypt, India, Greece, Eastern Europe and Central China. From this ceremony, Hinduism, Zoroastrianism, Judaism, and Christianity are all descended.

O.T., N.T. - The Tree of Life
The Fruit of the Tree of Life
R.V. - The Tree
The Red colored Tree
The *Amanita muscaria*, as mentioned in the botany section, is a mycorhiza fungus. Being a symbiotic with certain tree species, pine, spruce, birch, fir, larch, and occasionally the oak, being the preferred species. All of the trees mentioned above have been considered trees of life by various Eurasian peoples.

The ancients obviously knew of the connection between the host tree and the appearance of *Amanita muscaria*, the true fruit of the tree of life.

O.T. - The Tree of Knowledge of Good and Evil
"The tree of knowledge" the legendary beginning of human awareness and thought in the Old Testament is attributed to the consumption of this plant by Adam and Eve, which opened their eyes and their minds. In this new self-awareness, they discover their nakedness and their humanity.

This Genesis story is obviously descended from older legends. The association of the herb of Life and serpent is found in many ancient legends where the serpent is the guardian of the herb of Life. Such as Indra slaying the monster serpent Vrtra to recover the cows (Somas) hidden in a mountain cave; or the epic of Gilgamesh, a Sumerian legend where Gilgamesh, after many hazards and adventures finds the herb of immortality (Molly) only to have it stolen back by the serpent when Gilgamesh falls asleep.

Later writers have obviously twisted the Genesis story of the tree of knowledge for religious control purposes. The greatest advance in human thought is represented as the fall of mankind, instead of being celebrated, it's condemned, how stupid!

N.T. - The Way
Ys - Asha - cosmic order, truth, justice
R.V. - RTA - cosmic order, eternal law
In the Rig Veda, Soma as the "Word of the Way" or "Speaker of Eternal Law" was believed to be the founder and upholder of the eternal law. This cosmic law was believed to permeate and order the entire universe. Establishing the movements and relationships of the heavenly bodies, the seasons, the gods, plants, animals, and man, Soma being the central sacrifice, in rites guaranteeing the continuance of this eternal law. On the individual level, consuming the herb was thought to bring the individual's morality into line with the cosmic order considered an essential ingredient in the spiritual rebirth experience.

R.V. - The Word of the Way
R.V. - Speaker of Eternal Law
R.V. - The Tongue of the Way
O.T. - The Word of God
N.T. - The Word, The Word of Life
In this series of names, we can plainly see the importance of the auditory effects produced by the dried *Amanita muscaria*. This concept, of the herb being the Word, is the foundation of these three variants of the old religion. That the ancients believed this herb, heaven sent to communicate with humans, was the word of god and spoke the truth is the basis of prophecy. The human prophet simply relaying the information the herb spoke. No other drug plant in Eurasia is known to consistently produce such auditory effects. The Siberian accounts of dried *Amanita muscaria* consumption by the natives, often mentions the auditory effects experienced by its users. See "Soma, Divine Mushroom of Immortality" by Wasson.

O.T. - Wonderful
R.V. - Wonder-worker
No other single item on this earth is as full of wonder as this plant. In the healing, prophesy, visions, rapture, other world journeys, its virgin birth, brilliant appearance, and resurrection; humanity encountered the amazing.

27. Names of a God, part 2

All the following names and descriptions were compiled from translations. Translations by their very nature cannot be exact. So when you compare these names to one another, it is the meaning, the concepts embodied in them that should be considered and compared.

Two translations were used for the Rig-Veda. The first is Wendy Doniger O'Flaherty's translations for "Soma, Divine Mushroom of Immortality" by R. Gordon Wasson ISBN 0-15-683800-1.

The second and much more complete translation is "Sacred Writings"; Vol. 5, "Hinduism the Rig Veda", translated by Ralph T. H. Griffith. A Book of the Month Club published by Motilal Banarisidas Publishers, PVT. LTD. Each one of these translations produced its own list of names for "Soma".

The names of "Haoma" were compiled from "The Gathas of Zarathushtra", translated by Piloo Nanavutty, published by Gantha Corp. 1999, ISBN 1-890206-09-1 Pub.

The Old and New Testament names of the "Messiah" were compiled from the "Holy Bible" authorized (King James) version, which, for all its faults and archaic English, is still one of the best translations into English, as far as accuracy goes.

Each name or description is referenced in the parent texts original style.

In The Sacred Secret, I did a comparison of the names of the Christ to the names of Soma and Hoama in a simple chart. I recommend every serious student should create your own comparison chart of names to prove to yourself that Soma, Hoama and the Christ can only be the same life form; and that life form is *Amanita muscaria*.

Rig Veda Names and Descriptions of Soma as translated by Wendy Doniger O'Flaherty in R.G. Wasson's "Soma

Divine Mushroom of immortality".

	Book-Hymn-Verse
Navel of the Way	9-74-4
Immortal Principle	9-74-4
Immortal Hiri (golden)	9-69-5
Heavens Head	1-43-9
The Single eye	9-9-4
Mainstay of the Sky	9-2-5
Word of the Way	9-76-4
Tongue of the Way	9-75-2
Born of Thunder	9-82-3
Immortal One	1-43-9
Foundation of the Earth	9-89-6
Father of the Gods	9-87-2
He the all-knowing	9-27-3
Wonder-Worker	9-66-3
The Seer's Milk	9-85-10
Bull	9-70-7
King Soma	9-86-40
The Sun	9-2-6
Fire	9-67-23
God	9-98-9
Praiseworthy God	9-66-1
The beautiful plant	9-62-5
Sharp seer	9-12-4
Master Poet	9-76-4
Giver of the Gift	9-97-55

Rig Veda, Sacred Writings Vol. 5
Names and Descriptions of Soma.

	Book-Hymn-Verse
Immortal God	9-III-1
Lord of Holy Laws	9- III-10
God amid the Gods	9-V-4
Bull	9-VI-1
Sage of Heaven	9-IX-1
The Fount	9-IX-6
The Tree	9-XII-7
The Wise One	9-XII-8
Sacred Bard	9-XVIII-2
The Strong One	9-XVIII-7
Sage	9-XX-1
Brave Hero	9-XXIII-5
The Red	9-XXV-5
The Lord of Speech	9-XXVI-4
Omniscient	9-XXVII-3
Head of Heaven	9-XXVII-3
Conqueror	9-XXVII-4
Lord of the Mind	9-XXVIII-1
Steed	9-XXVIII-1
Lord of Wealth	9-XXIX-3

Potent One	9-XXX-1
Child of Heaven	9-XXXIII-5
Lord of Strength	9-XXXVI-6
Fiend Slayer	9-XXVII-3
Tawny One	9-XXXVIII-2
Lovely One	9-XLIII-1
Inspirer	9-XLIV-6
Sapient One	9-XLVIII-3
The Falcon	9-XLVII-3
The Friend of all	9-XLVIII-4
Chief Friend of Gods	9-XLIX-3
The milk of heaven	9-LI-2
Far-sighted One	9-LI-2
The Child	9-LXI-7
Ambrosia	9-LXII-6
Enlightener	9-LXIV-10
Song-Lover	9-LXIV-14
The Mighty One with thousand eyes	9-LXV-7
The Guardian	9-LXV-28
The Gladdener	9-LXV-29
Most Wise	9-LXV-30
Slayer of demons	9-LXVII-20
God Savitar	9-LXVII-26
The germ of Law	9-LXVIII-5
The Creature	9-LXVIII-5
Winner of Wealth	9-LXVIII-8
Amrta	9-LXX-2
Celestial Strengthener	9-LXXI-4
The Holy One	9-LXXI-6
The Everlasting One	9-LXXII-6
Guardian of Law	9-LXXIII-8
The Mighty	9-LXXV-1
Far-seeing One	9-LXXV-1
The Gold-hued	9-LXXVI-1
The King	9-LXXVI-4
The Ancient One	9-LXXVII-2
Mitra, the Holy	9-LXXVII-5
The Master of the house	9-LXXVIII-3
Liberal Prince	9-LXXXI-3
The Wondrous One	9-LXXXII-1
Immortal Soma	9-LXXXIV-2
Sovran of this world	9-LXXXV-3
The Eagle	9-LXXXV-11
The Youngling	9-LXXXV-11
Bird of golden color	9-LXXXV-11
High Heavens sustainer	9-LXXXVI-8
Father of the Gods	9-LXXXVI-10
Sovran Lordn	9-LXXXVI-28
The Babe	9-LXXXVI-36
King of all the world	9-LXXXVI-36
The Animal	9-LXXXVI-43
The skillful Speaker	9-XCI-1
Inventor	9-XCI-1
Father of holy hymns	9-XCVI-5

Father of the earth	9-XCVI-5
Father of heaven	9-XCVI-5
Foe-queller	9-XCVI-12
Comforter	9-XCVI-12
A Poet	9-XCVI-17
Light-winner	9-XCVI-18
The Red Bull	9-XCVII-22
Chief of all foods	9-XCVII-22
Child of Waters	9-XCVII-41
A fount of meath	9-XCVII-44
The Wise	9-XCVII-56
The All-obtainer	9-XCVII-56
Most Resplendent One	9-XCVIII-12
The Lord of Song	9-XCIX-6
The Lord of Speech	9-CI-5
Lord of the multitude	9-CI-7
Infallible	9-CIII-4
A Priest	9-CIII-5
The food of Gods	9-CIV-5
A fountain made of gold	9-CVII-4
Sage and Singer	9-CVII-4
Excellently Wise	9-CVIII-2
Best Rapture-giver	9-CVIII-5
Born Immortal	9-CVIII-12
Father of the Gods	9-CIX-4
Deathless God	9-CX-4
Splendid by Law	9-CXIII-4
Sovran Ruler of the Plants	9-CXIV-2
Lord of Life	7-XXXVII-6
The Plant	9-LXII-5
Lord of plants	1-XCI-6
Healer of disease	1-XCI-12
The Red colored Tree	10-XCIV-3

Yasna Names and Descriptions of Haoma (the pressed one) from "The Gathas of Zarathushtra" translated by Piloo Nanavutty.

	Book-Hymn-Verse
Ahura (the Living One)	Ys-29-5
Ahura Mazda	Ys-29-7
(Living Lord of Life, Wisdom)	
Asha	Ys-44-7
(Cosmic order, truth, justice)	Ys-28-2
Vohu Mana (the good mind)	Ys-28-6, 7
Khashathra	Ys-28-9
(Sovereignty, power, kingdom)	
Armaiti	Ys-45-4
(Devotion, love. Beloved of the Wise)	
Haurvatat	Ys-33-9
(Health, wellbeing, perfection)	
Ameretat (immortality)	Ys-33-9
Madhu-Vidya	Ys-33-9
(Honey sweet knowledge of Divinity)	
Spenta Mainyu	Ys-47-6,50

(Holy Spirit)	
Khratn (Wisdom)	Ys-28-1
Chisti (enlightenment)	Ys-48-5
Father of Truth	Ys-47-2
Manthra (word of power)	Ys-28-5
Creator of Truth	Ys-31-7, 8
First and Last	Ys-31-8
Hu-Dad (giver of all good)	Ys-48-3
Data Angheush (creator of Life)	Ys-50,11
He is the Healer of Life	Ys-31-19
Duradsha (keeping death afar)	Ys-32-10
Savior	Ys-34-13
Spenisha Mainyu Mazda (Lord of Life and Truth)	Ys-46-9

Old Testament Names and Descriptions of the Messiah, Holy Bible, King James Version.

The Lord (taste)	Ps. 34: 8
The Holy One of Israel	Is. 49: 7, 45:11
The Messiah	Is. 42:19
The strong arm of the Lord	Is. 53: 1
A tender plant	Is. 53: 2
A root out of dry ground	Is. 53: 2
Word of God	Ps. 107: 20-147: 18
The plant of renown	Ezek. 34:29
Im man'-u-el	Is. 7:14
Wonderful	Is. 9: 6
Counselor	Is. 9: 6
The Mighty God	Is. 9: 6
The everlasting Father	Is. 9: 6
The Prince of Peace	Is. 9: 6
The redeemer of Israel	Is. 49: 7, 63:16
fountain of living waters	Jer. 2:13, 17:13
The first and last	Is. 44: 6, 48:12
The Lords servant	Is. 42: 1, 42:19
The tree of Life	Gen. 2: 9,3: 22-24
The tree of knowledge	Gen. 2: 9, 3: 1-24
The Living God	1 Sam. 17:26, 11
The Ancient of Days	Dan. 7: 9, 13, 22
A precious stone	Is. 28:16
Words (eaten)	Jer. 15:16

New Testament Names and Descriptions of the Christ Holy Bible, King James Version

The Lord (tasted)	1 Peter 2: 3
Son of God	John 3:18
The Word	John 1: 1, 14
The Way	John 14: 6
The truth	John 14: 6
The life	John 14: 6
The true vine	John 15: 1
The bread of life	John 6,35,48
Living bread	John 6:51

bread from heaven	John 6: 32,50,58
light of the world	John 8:12
the good shepherd	John 10:11, 14
the Lamb of God	John 1:29, 36
the gate for the sheep	John 10: 7
a living stone	1 Peter 2: 4
living God	1 Tim. 4:10
first begotten	Heb. 1: 6
high priest of God	Heb. 3: 1, 9:11
King of kings	1 Tim. 6:15
living water	John 7:38
light of men	John 1: 4
Alpha and Omega	Rev. 21: 6, 22:13
Word of life	1 John 1: 1
milk of the word	1 Peter 2: 2
chosen of God	1 Peter 2: 4
heavenly gift (tasted)	Heb. 6: 4
the resurrection and life	John 11:25
fountain of the water of life	Rev. 21: 6
the tree of life	Rev. 22: 2, 14
Savior	John 4:42
Be-el-ze-bub	Matt. 10:25
the Master of the house	Matt. 10:25

28. Supplies and Info

The following is a listing of businesses that sell *Amanita muscaria*; they are listed here for your convenience.

Gardens of the Ancients
Herb Emporium and Nursery
4800 Yager Lane
Manor, TX 78653
(512) 272-9062

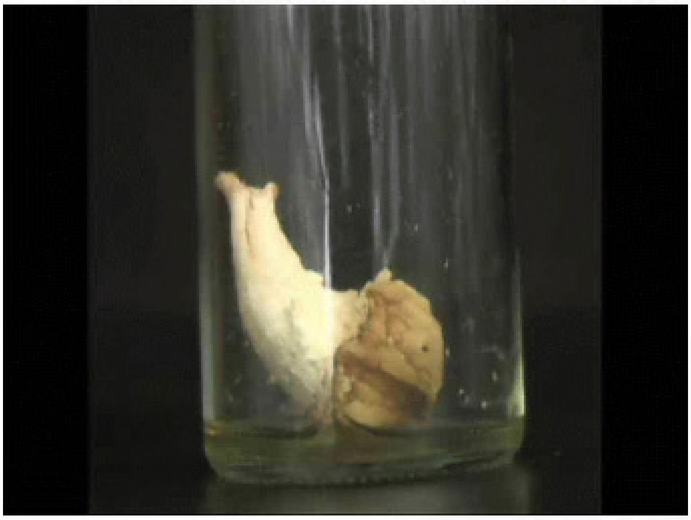
Bouncing Bear Botanicals
PO Box 3895
Olathe, KS 66063
www.BouncingB.com
info@bouncingb.com

JLF Poisonous Non-Consumables
PO Box 184
Elizabethtown, IN 47232
USA 812 379-2508 (24-7)

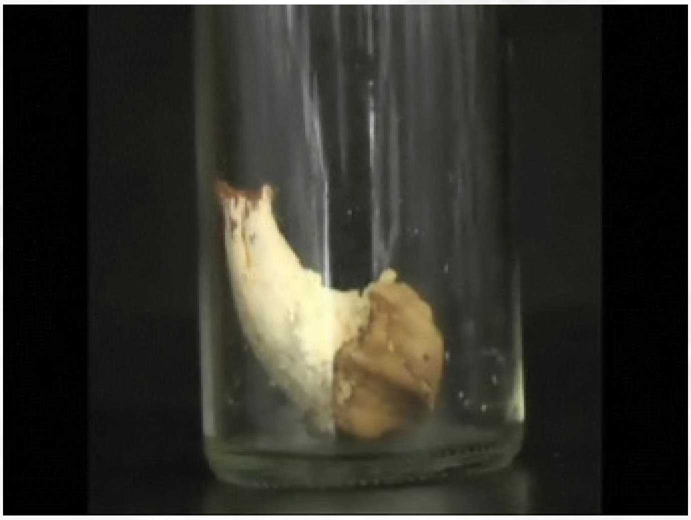
Doc Kunda's Place
A Mystical Oasis
Herbs, Jewelry, Unique Services
www.dockunda.com

Suggested Readings

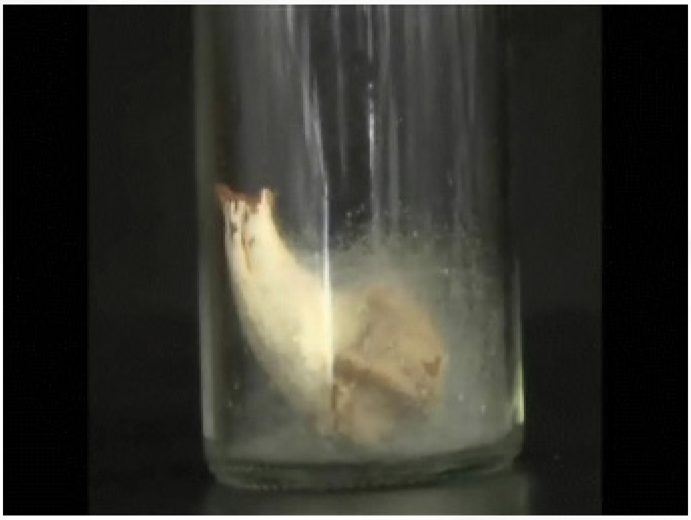
1. The Sacred Secret: the Return of the Christ By Donald E. Teeter. Pup. By Xlibris Corp. ISBN 1-4010-2522-6
2. Soma Divine Mushroom of Immortality by R. Gordon Wasson Harcourt Brace Jovanovich, Inc., ISBN 0-15-6838000-1
3. Entheos; The Journal of Psychedelic Spirituality, Entheomedia, HC 71 Box 34 Taos, NM 87571
4. The Apples of Apollo By Ruck, Staples, Heinrich, Carolina Academic Press ISBN # 0-89089-924-X
5. Sacred Writings Vol. 5, Hinduism: The Rig-Veda Translated by Ralph T. H. Griffith, a book of the Month Club Book, Motilal Banarsidass, Publishers Pvt. Ltd.
6. Sacred Mushroom and the Cross By John Marco Allegro, Pub. Garden City, NY, Doubleday 1970
7. The Road to Eleusis By R. Gordon Wasson, Albert Hofmann, Ruck Carl A.P. Reprint 1999, Pub. Dailey, William Rare Books ISBN 091514820X contains an excellent discussion on ancient wines
8. Plants of the Gods By Richard Evans Schultes and Albert Hofmann Healing Arts Press, Rochester VT, ISBN 0-89281-406-3
9. The Magical and Ritual use of Herbs By Richard Allen Miller Destiny Books, Rochester, VT, ISBN 0-89281-401-2
10. In Search of the Indo-Europeans by J. P. Mallory Thames and Hudson, ISBN 0-500-27616-1
11. The Tarim Mummies by J. P. Mallory and V. H. Mair Thames and Hudson, ISBN 5-500-05101-1
12. Harper Collins Past World's Atlas of Archaeology Borders Press, ISBN 0-7230-1054-4
13. The National Audubon Society Field Guide to North American Mushrooms. Pub. Alfred A. Knopf, Inc. ISBN 0-394-51992-2
14. Simon & Schuster's Guide to Mushrooms Pub. Simon & Schuster, Inc. ISBN 0-671-42849-7
15. The American Heritage Dictionary of the English Language; American Heritage Publishing Co., Inc. and Houghton Mifflin Co. 1971 the Appendix contains an excellent section on the Indo-European languages plus a dictionary of Proto-Indo-European Root words. This dictionary is common at Public Libraries.
16. The Beaker Folk Copper Age Archaeology in Western Europe Richard J. Harrison Library of Congress # 80-50793
17. The Ultimate Encyclopedia of Mythology by Arthur Cotterell & Rachel Storm Pup. Hermes House ISBN # 1-84038-516-2 Pg. 134 has an excellent comparison of the Holy Grail and the ancient magic Celtic Cauldrons.
18. The Iliad, by Homer, various translations available
19. The Odyssey, by Homer, various translations available
20. The Holy Bible, various translations some are much better than others, but all versions have faults in translation
21. Computer search words: Amanita Muscaria, Ambrosia, Nectar, Soma, Hoama, Maga + Magi-Magus, Odin, Dionysus, Isis + Osiris, Amen, Mithra, Attis, Golden Apples of Immortality, Fly Agaric, Holy Grail, Greek mythology, Norse mythology, Celtic mythology, the Rig Veda, the Yasna + Zoroaster, Indo-European- (languages, history, peoples, movements), Beaker people-folk, Battle Axe people, Corded Ware people, European prehistory + Archaeology



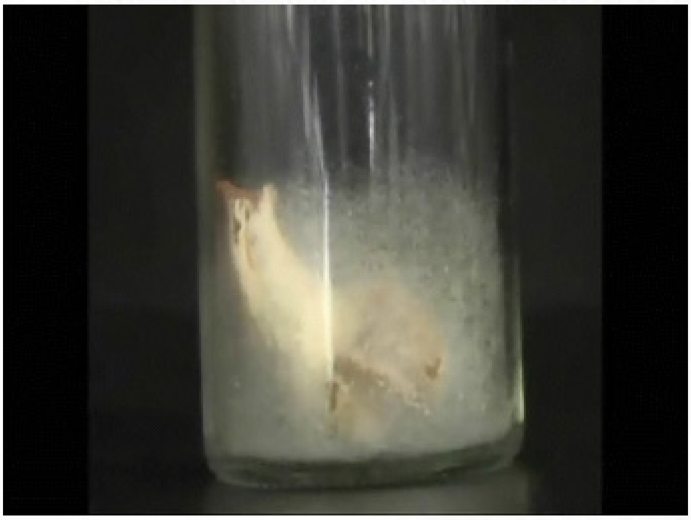
Start, a dried stem of *Amanita muscaria* with water added to bottle.



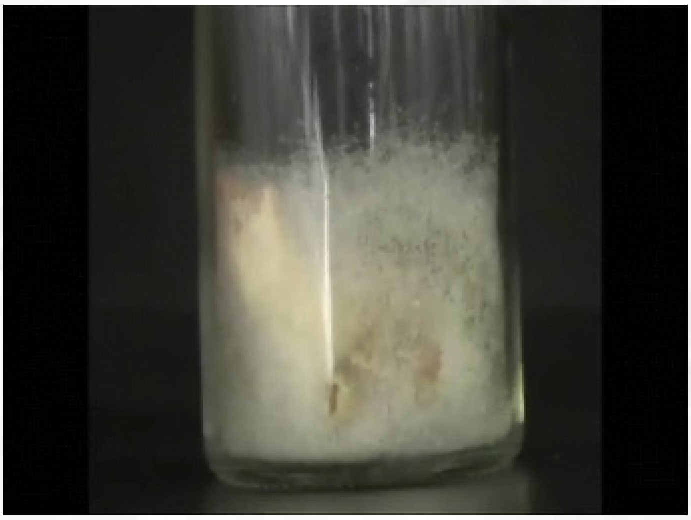
24 hrs. Dried stem has absorbed most of the water and has swollen noticeably.



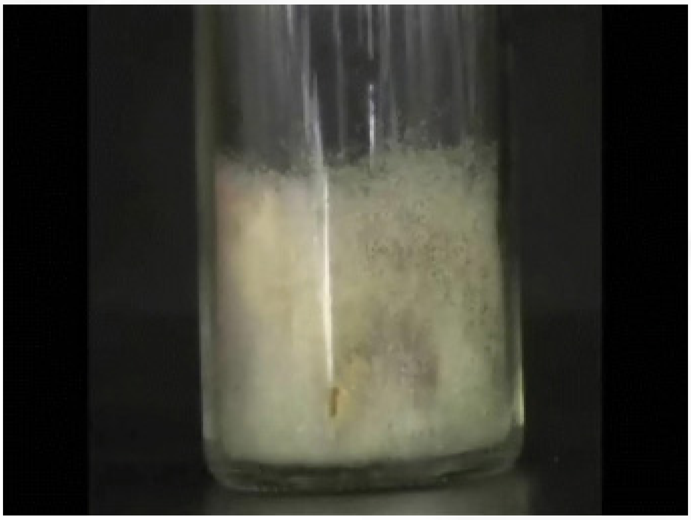
60 hrs. "Thou callest forth the out spun thread." Rig Veda 9-22-7



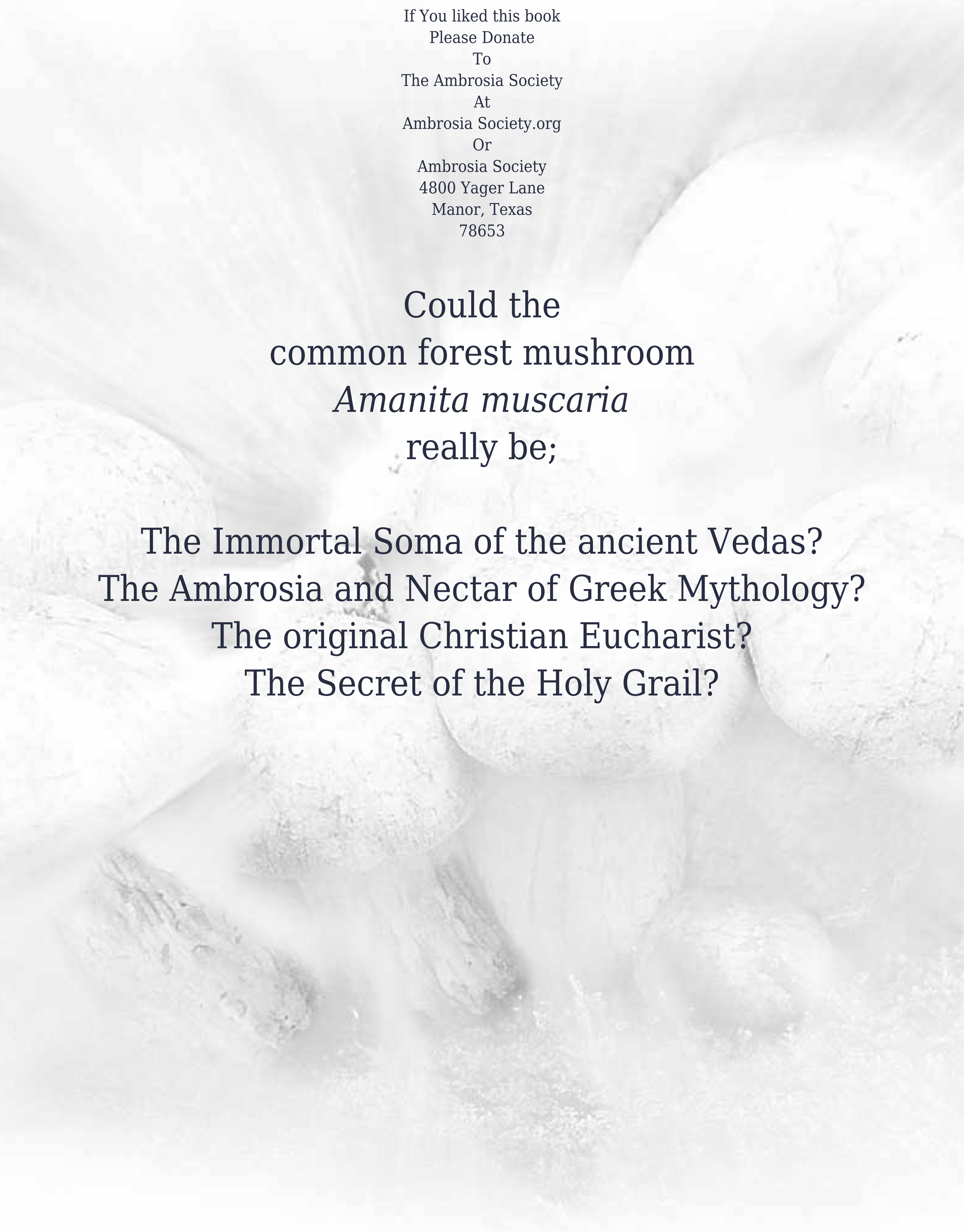
72 hrs. "Purified in his fleecy garb, attaining every beauty" Rig Veda 9-16-6



96 hrs. "He shines in beauty there, this God Immortal in his dwelling place" Rig Veda 9-28-3



120 hrs. View "The Resurrection of Amanita muscaria" time lapse video on You Tube.com



If You liked this book
Please Donate
To
The Ambrosia Society
At
Ambrosia Society.org
Or
Ambrosia Society
4800 Yager Lane
Manor, Texas
78653

Could the
common forest mushroom
Amanita muscaria
really be;

The Immortal Soma of the ancient Vedas?
The Ambrosia and Nectar of Greek Mythology?
The original Christian Eucharist?
The Secret of the Holy Grail?

Amanita muscaria: The Holy Sacrament of the Order of Melchizedek, Symbol of The Resurrection, and Cause for Christian Redemption

by

Brendan Bombaci, MA

2017 Lulu Press

© Brendan Bombaci

original text:
https://www.researchgate.net/profile/Brendan-Bombaci/publication/365233339_Amanita_muscaria_The_Holy_Sacrament_of_the_Order_of_Melchizedek_Symbol_of_The_Resurrection_and_Cause_for_Christian_Redemption/links/636bb1f02f4bca7fd0470405/Amanita-muscaria-The-Holy-Sacrament-of-the-Order-of-Melchizedek-Symbol-of-The-Resurrection-and-Cause-for-Christian-Redemption.pdf
backup source:
http://www.psilosophy.info/resources/Amanita-muscaria-The-Holy-Sacrament-of-the-Order-of-Melchizedek-Symbol-of-The-Resurrection-and-Cause-for-Christian-Redemption.pdf

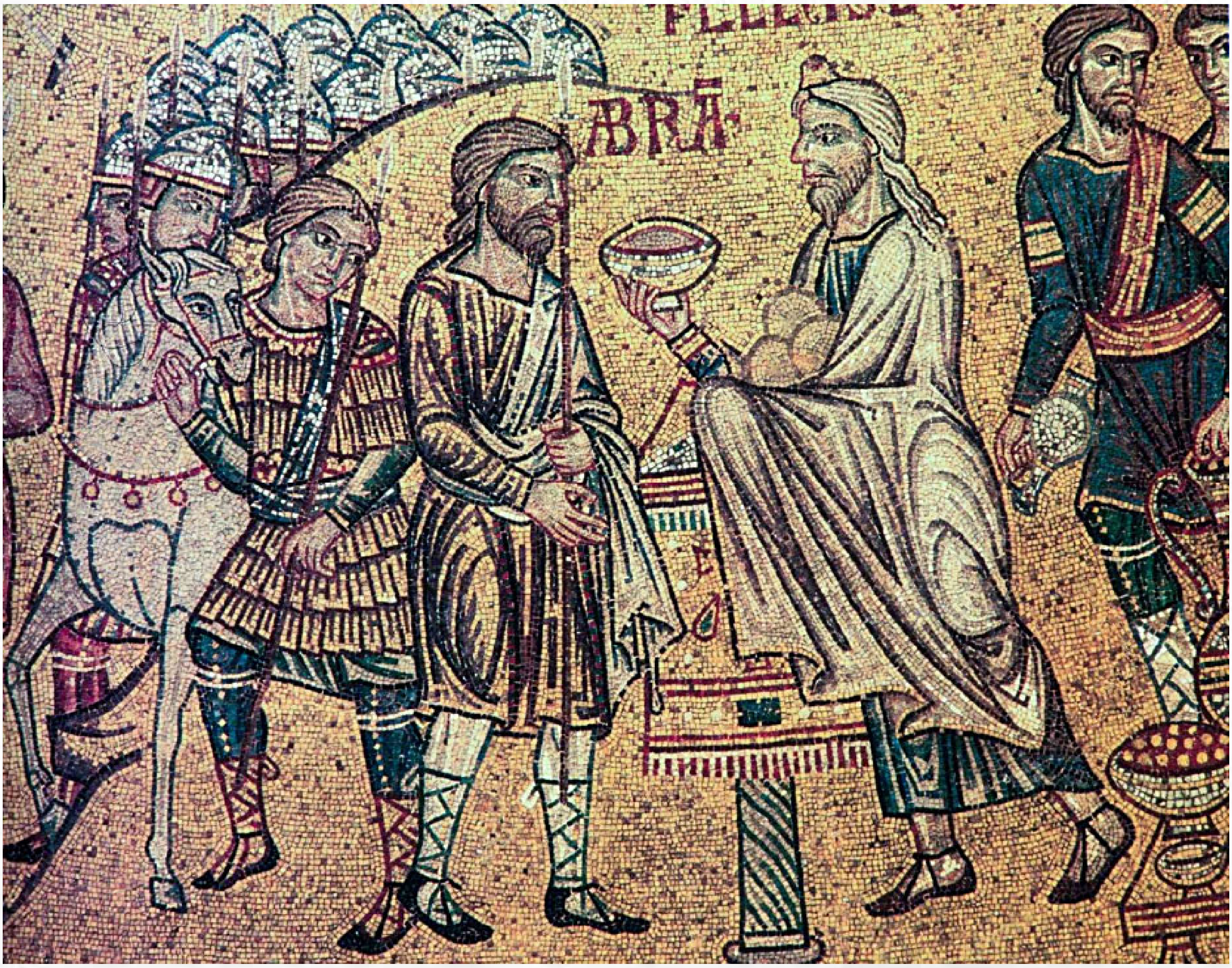
What was known to early Christians about the crucial Old Testament figurehead named Melchizedek was almost solely written into what would become known, after two long millennia since Jesus lived, as the Dead Sea Scrolls. So, his identity was either kept secret by initiated messianic Jews or by the later Church officials themselves. In Biblical canon, he was "the king of Salem and a priest of God Most High" during the time of Genesis (14:18), worshipful of the Israelite god El'Elyon ("God"). Scant detail was recorded in this canon about his lineage, his people, or any other authorities associated with him or under his command. In that he blessed Abraham, and Abraham paid him tithe, a divine right to rule was conferred to Abraham, whose descendants in as much were then made to respect Melchizedek as their Lord (Hebrews 7:8-11), who was "higher" than they and Abraham himself. What was to later Christians a taunting or sacred mystery regarding Melchizedek's lineage and Order, and in what way he was considered the Lord of Lords, or Most High Priest over the line of David (and therefore in their eyes the incarnate Lord over everyone), caused the Biblically exegetical Paul and Peter to regard him as immortal like God.

In that David wrote about a man becoming "a priest forever in the order of Melchizedek" (Psalm 110:1-7), the apostle Paul assumed that this person must have been of unique divinity - the most potent divinity - which he presumed could only be attributed to the Jesus he decried as having been God in flesh. This was a stance he took and wrote about (Hebrews 7:3, 7:8-11, 7:22-25) only after experiencing a peculiar hallucinatory blindness that caused him to see "a light from Heaven flashing around him" and hear instructions, from a voice claiming to be Jesus, to go to Damascus (Acts 9:3-6), wherein he was healed (an important account I discuss in following paragraphs). This would imply that the Psalm was a prophesy, in that David was Jesus' ancestor. However, Psalm 110 makes no mention of the anointed priest's name, his place in any lineage, or even if he was currently alive, a historical figure, or yet to be born (and therefore a prophesied figure). So, it is pure speculation that Jesus was the priest in the Psalm. None the less, due to Paul's freshly inspired and audacious fervor (Acts 22:14), and due to his influence as one who was converted to Christianity in the middle of his career as a key imperial Roman hunter of Christians, this Psalm went down in history as the most widely proclaimed testament to Jesus' immortality, a proclamation which was backed by Peter (Acts 2:32-35) and then affirmed by Clement I, the first Pope (ordained by Peter) and "fellow laborer" of the Apostle Paul [Atwill pp 38-39], to be the holy and infallible truth.

The true meaning behind the statement that Jesus had become "a priest forever in the order of Melchizedek," and therefore "immortal" like "God" (i.e., El'Elyon) - as Paul and Peter proclaim - would only have been known to those anointed priests in the Aaronic line serving David. This is realized by way of scriptural analysis of the Dead Sea Scrolls. In these texts, Melchizedek is a title meaning "Prince of Righteousness." This title is also used interchangeably with Michael, the "prince of light" (1QM 13:10-11; cf. 1QS 2:20-22; CD 5:17-19) and "the angel of [God's] truth" (1QS 3:24), highest of all of God's princes, implying that "Michael" (actually Micha'el) was either his first name or a moniker for his rank in the Order. The Qumran document 4Q401 "Songs of the Sabbath Sacrifice" or "The Angelic Liturgy" (11:3 and 22:3) corroborate that Melchizedek is a character who leads the "El'ohim," which is the name used in canon for "angelic," "divine," or "princely" ministerial beings. It is also the name which the author of the Dead Sea Scroll document 11Q13 or "11QMelch" replaces in Psalms 82:1 with the name Melchizedek, implying that they are the holiest individuals below El'Elyon himself. There is reference in scroll 11Q13, again, to "the men of the lot of Melchizedek" who will be atoned for in the end times. Structuring of the name of each angel, whereby they end with "el," reveals individual rank titles that correspond with the name of the Order (El'ohim), rather than personal names. This gives credence to the idea that "Gabri'el," the 'angel' subordinate to Micha'el who visited Mary to tell her of her coming miraculous conception, was in fact a mortal man just like others in the Order of Melchizedek. In as much, it is most likely the case that David was not referring to Jesus 'the redeemer' (messiah actually translates as "anointed one") when he spoke of "my Lord," who was addressed by the Lord, in Psalms 110:4. Most probably, he was speaking of a priest in his service (or rather a priest who he served) who was ordained in the Order of Melchizedek, likely a descendent of Aaron named Zadok (I Kings 1:34, I Kings 2:35, I Kings 4:2, etc; 1 Chronicles 24:3, Book of Numbers 25:13, Book of Exodus 28:01). Such a priest would indeed be his "Lord," as David, like all in the line of Abraham, owe the Order of Melchizedek their allegiance as aforementioned, and therefore owe any priesthood wrought from said divine blessing the same allegiance. This explicitly denotes that the rank stations/positions of priests in the Order are considered timeless, hence why "angelic" or "ministerial" monikers are referenced as immortal. There would be, then, a certain degree of overconfidence in the men of the lot of Melchizedek that their Order will last through the end of time. But there is most probably another equally intriguing definition of "immortality" at play for the anointed priests of the Order, perhaps not so much in place of, but simultaneously existing with, that given so far.

It turns out that various species of Acacia, the type of wood used most for sacred purposes in the Bible, contain the most potent hallucinogenic substance known to man, that is DMT (Callaway 1988; Rätsch 1998: 28-30; Shanon 2008:58-70); many of these are used without secrecy in Africa, India, and Southern Europe. That being said, there is another plant, more ubiquitously presented throughout the art and literature of Biblical history, whose chemistry is less quantitatively potent but whose effect is still and differentially awe inducing, and quite literally visionary. It is the *Amanita muscaria* mushroom, found in pine forests worldwide and used through time immemorial by a myriad of cultures (Rätsch 1998: 630-641). Academics have certainly had evidence to propound the divulging of knowledge that it was used by Biblical era figures in years past (Irvin and Herer 2008; Irvin, Rutajit, and Zervos 2009; Rätsch 1998:632), and a publisher of elegantly copied "illuminated manuscripts" has provided the world with the same revelation in stunningly brilliant illustrated 14th Century scriptural form (© M. Moleiro Editor, www.moleiro.com), revealing that psychoactive mushrooms were considered by certain European monks to be holy (image revealed later in this article). And still, a more recent production from highly educated authors on a private literary and physically investigative endeavor has contributed a great deal more to the knowledge base (Brown and Brown 2016) by describing some widespread Early-to-Middle-Ages painted and sculpted renditions of Biblical characters - including Jesus and Gabri'el - using *Amanita* mushrooms, throughout Western and Eastern (Byzantine) Christendom.

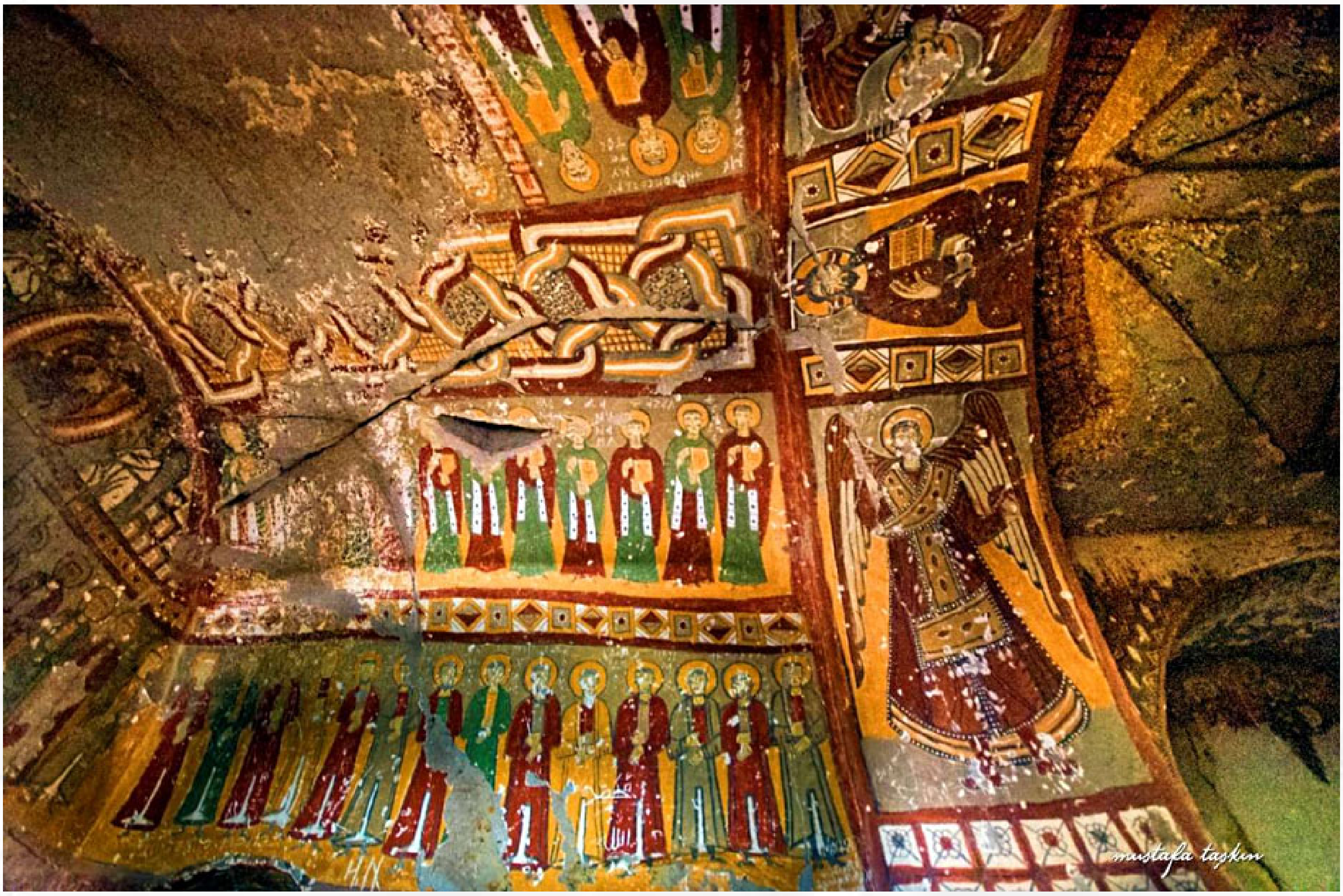
It is a cross-cultural reality that experiences with *Amanita* mushrooms do not vary much from a dream-like trance induction wherein the experiencer will lose their sobriety, and either engage actively with visually manifested mentations ("hallucinations"), hear voices and/or natural or unnatural sounds, have Out of Body Experiences (OOBEs), or even undergo what feels like supernatural judgment or empowerment. Experienced shamanic practitioners of any given cultural community are usually those either strong enough in nerve, and/or who prescribe to safety conferring ritual discipline, to endure let alone desire such experiences more than once (Bombaci 2012). Shamans of various cultures, including Horus-worshipping priests of Amen-Ra in Biblical era Egypt (Berlant 2005; Brown and Brown 2016:209-210), consider psychoactive mushrooms to be a sort of agent or spirit of the underworld, or gateway to the numinous realm, which implies that the experience itself is that of death and then rebirth (upon sobering). It can be reasonably assumed that priests in the Order of Melchizedek would hold the same regard (Peoples, Duda, and Marlow 2016; Vitebsky 1995:88-90, 94-95; Winkelman 1996), and deem themselves "immortal" in that they have survived death and know what awaits them, as well as how best to prepare for it and be masters of that realm (through continued ritual practice).



A blaring clue. "Abraham meets Melchizedek" mosaic section with *Amanita muscaria* mushroom cap displayed prominently in lower right, as a symbolic key for identifying to the initiated what types of "bread" and "wine" were consumed for the consecration of Melchizedek's blessing upon Abraham (roasted *Amanita* caps lose their red and become tan, and exude detoxified wine-colored liquid - which may or may not indicate that the "wine" was also an *Amanita* product). Note the focus of the gazing squire behind Abraham on the left: the *Amanita* cap in *grail* on bottom right. Notice also the behavior of the servants on the right: one is surreptitiously pouring out wine as he takes a handful of *Amanita* mushroom, as the other cautiously gazes at the viewer. Circa 13th Century. In Basilica di San Marcos, Venezia, Italia. Image from Public Domain photographic facsimile on Wikimedia Commons.

Relatively, but in speculative interpretation, it might be intuited that the term "scales," used to describe that which fell from Paul's eyes when Ananias of Damascus "healed" him of his hallucinatory "blindness" (Acts 9:18) and then sent him to proselytize, was not to be understood as reference to some physical material or disease (which would be odd by any account, because such a disease is not known of now, and because his military unit did not recount seeing anything wrong with him at all), but rather to the shedding of some *experience*; that is, it might well be that Paul was intentionally given a rather heavy dose of *Amanita* extract by a covert Christian sympathizer in his military unit of persecutors in order to conduct a psychological operation to coerce his highly useful religious conversion. After all, the "voice of Jesus" commanded Paul to Damascus where "the Lord" told Ananias to heal Paul so that he could become his "chosen instrument to proclaim [his] name to their kings and to the people of Israel" (Acts 9:15), acting as the 'witness' of "the Righteous One" (Acts 22:14), a title which is alias for Micha'el Melchizedek, as we know, who has indeed been depicted throughout Catholic canon as a winged judge weighing souls on a *scale* in his role as gatekeeper to Heaven. In as much, Paul was made to believe he was at the gates of Heaven in between life and death. This exegetical interpretation makes sense, and the accusation is far from outlandish, given how "Ananias" was the exact name of 'two' men involved with the orchestration of separate Christianity-bolstering miracles in the Bible - this healing and preaching episode, and then one where he was a non-believer who purportedly died by way of a miraculously Christ-embued life taking power within Peter (Acts 5:5) - and still another man, a Pharisee high priest (likely the true identity of these 'three' men) who helped usher along Paul's eventual martyrdom by the

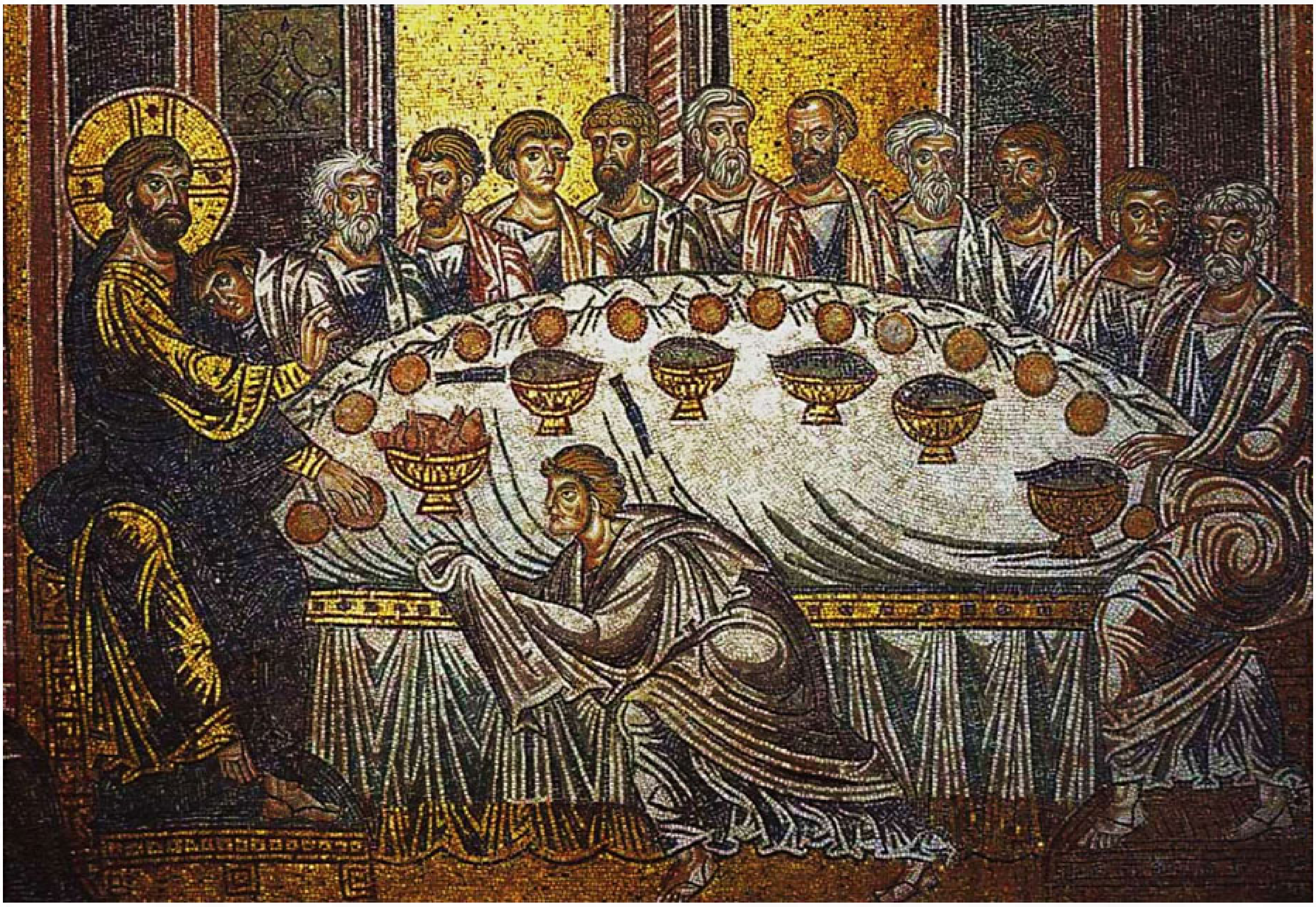
Romans (Acts 23:1, 24:5, 25:5, 27:30) [Bombaci 2017]. Thus, Paul was "blind" because he was literally in hallucinatory limbo, especially because he did not eat or drink anything for 3 days after being drugged (Acts 9:9), and he was then "resurrected" or healed from "blinding" judgment, likely with an antidote given to him by Ananias along with the food he ate which gave back his strength (Acts 9:19). People in the western world might call this psychological warfare today; however, such a fabulation is not uncommon amongst shamanistic and miracle cult groups of various cultures, as theatrics lend supernatural credence to the power of the initiated, allowing them to gain and maintain their status (Vitebsky 1995:120-124).



Yilanli Church of Ilhara Valley, Turkey. *Amanita* mushrooms held in the hands of the angels Gabri'el, front right, and Micha'el, above (hand not in frame - image more fully revealed in a photograph by Martin Siepmann via AGE Fotostock, website in References Cited). Photo by Mustafa Taskin, permission for use granted by him via direct communication on Flickr, wherein his photo is copyrighted and available for full-frame viewing.

Though Paul's mis/adventure seems to be an aside, it is worth mentioning here because of the way in which immortality was an already acceptable and in fact promoted notion amongst both Pharisee Jews and Roman Emperors. Officials of the former preached that angels, spirits, and resurrection are all real phenomenon (Acts 23:8 - in opposition to beliefs of the Saducees, their Jewish sectarian competition), and 36 of 60 emperors of the latter called themselves *diius* (the culturally syncretic and Roman term for the highest of Gods) [Atwill 2011:37] all the way through the Papacy whereby Popes are considered the "Vicar" (literally, *replacement* or *stand-in*) of Christ. So then, it was apparently no revolutionary event for Christianity to become the official religion of the Roman Empire, but the same can be said for how it would gain more influence than the Judaism of the Pharisees, in that their faith, with its supernatural stances, could yet be defended and compatible with Christianity while Saducees became less favored, and, because the violent messianic Sicarii zealots amongst them, causing war between *all* Jews and Romans, would be stymied to silence and yet serve to stigmatize Jews as a whole. The Roman Empire would in turn 'graft' itself to the branch or *nazor* of David (hence the term "Nazorean") and be crowned successor of its lineage [Atwill 2011:219-263] in both Holiness and dominion, wherein all emperors would receive the title of Pontifex Maximus, making each one in rule the high priest "of the Roman religion and the official head of the Roman college of priests - the same title and office that, once Christianity had become the Roman state religion, its popes would assume" [Atwill, p35]. As of modern day, this power has affected billions of people around the world and is recognized by many (including the Vatican's own Congregation of the Doctrine of the Faith) as higher in authority than kingdoms and governing establishments alike [Robbins 1999:114-132]. Immortal, indeed - and with sequential rulers that are each living stand-in icons, resurrections as it were, of the original High Priest Melchizedek, while also representing the original Roman *diius* (Bombaci 2017).

Also easing the appropriation of the visionary religion into official State ministry was the fact that, in many cases, Dionysian and Apollonian worship in Greco-Roman times involved the use of psychoactive *Amanita* mushrooms, two of which bear the variant names of *Amanita regalis* (Fr.) "Michael" and *Amanita caesarea* [Rätsch 2005:632-633]. However, as with elite use in the pre-Columbian world [Rätsch 2005:635], the official sacramental use of these *entheogens* (a term meaning "generator of God within") was kept secret beyond the enduring period of the Medieval Inquisition in the Old World through public portrayal of them as being dangerous or pagan and therefore heretical [Brown and Brown 2016:152-168]. It would dramatically affect the faith of Christian followers worldwide to be informed that the "bread" and "wine" of the Last Supper were actually psychoactive sacraments of the Order, which would consecrate the conferral of official priesthood upon Jesus' disciples, causing them to "be filled with the Holy Spirit" (Acts 2:4) and "speak in tongues" after the Ascension on the Day of Pentecost when imbibing it "with Jesus" (Matthew 26:29). "Speaking in tongues," by the Biblical description of the experience, is an adequate term for a phenomenon entirely familiar to those who have imbibed the psychoactive mixture of any entheogen and the tea of *Syrian Rue*, a revered plant used throughout the Middle East as both medicine and as royal red dye, which contains a hallucinogen-activating chemical, harmine, once called *telepathine* [Rätsch 2005:425-428, 638-639]. Indeed, "speaking in tongues" is considered an act of the most Holy where the "speaker" gains "all kinds of speech and all kinds of knowledge" (1 Corinthians 1:5) and can communicate directly with God (1 Corinthians 14:2) while being considered insane by onlookers (1 Corinthians 14:23). That the disciples were not actually speaking other *languages*, but were rather using *all kinds of speech*, as quoted above, is denoted in Acts 2:13 whereby some onlookers pointed out that the disciples must have been "full of *new* wine" (KJV).



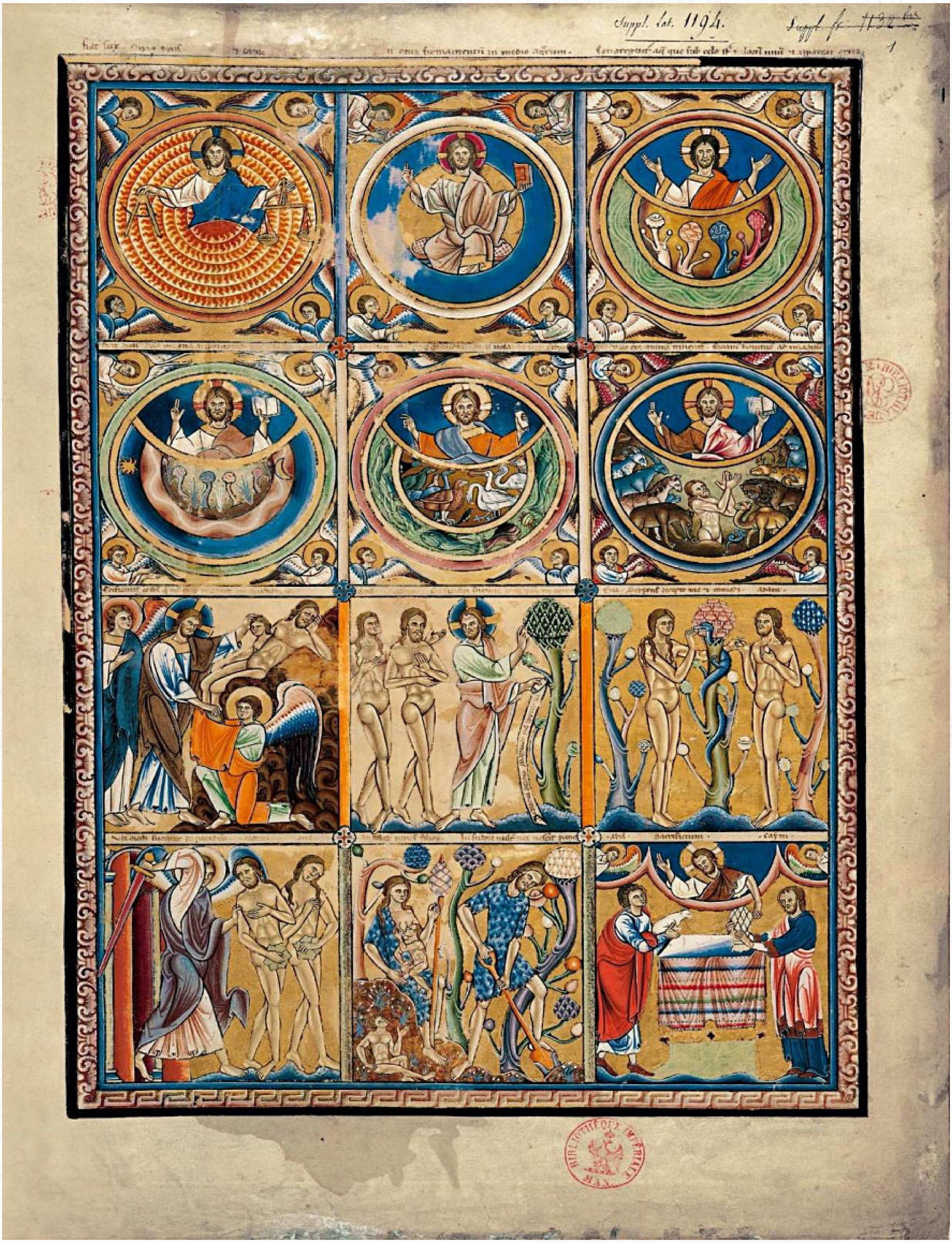
La Ultima Cena (The Last Supper) mosaic, circa 1388AD, in The Duomo of La Cattedrale di Santa Maria Nuova, presenting perfectly rounded, reddish, and spot-fringed "loaves" of sacrament. Note the hand-veiled manner in which the disciple is receiving the sacrament, symbolic of the white *veil* on the underside of *Amanita* mushroom caps; this is common practice with the sacrament (Brown and Brown 2016), and is seen also in the previous image of Melchizedek and Abraham. Public domain photographic facsimile on Wikimedia Commons.

The mixing of wine with spices to increase intoxication is written of throughout the Bible (Isaiah 5:22 & 65:11, Psalm 75:8, Proverbs 23:30), and, as we know it is fallacy that new wine is innately more potent than old wine (in any manner but purity), the onlookers' proclamation implied two things: they were at least novice polyglots whereby they knew that what they were hearing was not actually foreign languages (such as Arabic), and they were also keen to entheogenic intoxication, *though the psychoactive effects they were witnessing were perhaps of a* "*new*" *or rather* unfamiliar *type*. Indeed, as the Weymouth New Testament translation clarified the Bible for 19th Century English-speakers, Jesus actually said, in Matthew 26:29, "I will never again take the produce of the vine until that day when I shall drink the *new wine* with you in my Father's Kingdom," i.e., during entry into and after his "Ascension," i.e., the onset and peak of his entheogenic experience in "Heaven." More to the point, when Peter retorted to the onlookers that he and the disciples were not drunk, as "it was yet early in the morning" (Acts 2:15), he would not have been lying if indeed they had consumed the sacramental entheogenic admixture rather than alcohol, and, his retort therein reveals both his defiance against needing to abide layfolk norms due to his status in sacred discipleship, as well as his fervent belief that there is truly divinity in the rite. The holiest person they knew of had told them at the Last Supper that this *new wine* was not wine at all, but the "blood" of the new Covenant (Matthew 26:28), while the sharing of the bloodline was symbolic of resurrection or perpetuation of the Priesthood - just as symbolic, really, as the "rebirth" or "awakening" from the entheogenic experience itself. "Drunk" was certainly not the word for their condition. *Illuminated* is more appropriate. And illumination was exactly the point of the *timma* in the Dionysian celebrations and the *pharmakos* in the Eleusinian Mysteries (meaning 'to rub or pound,' and 'drugged wine,' respectively), which were exapted from the Greek pharmacotheon by the Romans for holy communion, the former of these known as being psychoactive and the latter surely containing ergot alkaloids - the precursors to LSD (Muraresku 2020). "To this day all visitors to Saint Paul's Monastery on Mt. Athos in Greece, one of the most important sites of Orthodox [Christian] spirituality, will come face-to-face with a beautiful Greek saying mounted on the wall of the reception area: "If you die before you die, you won't die when you die" (Muraresku 2020:11).

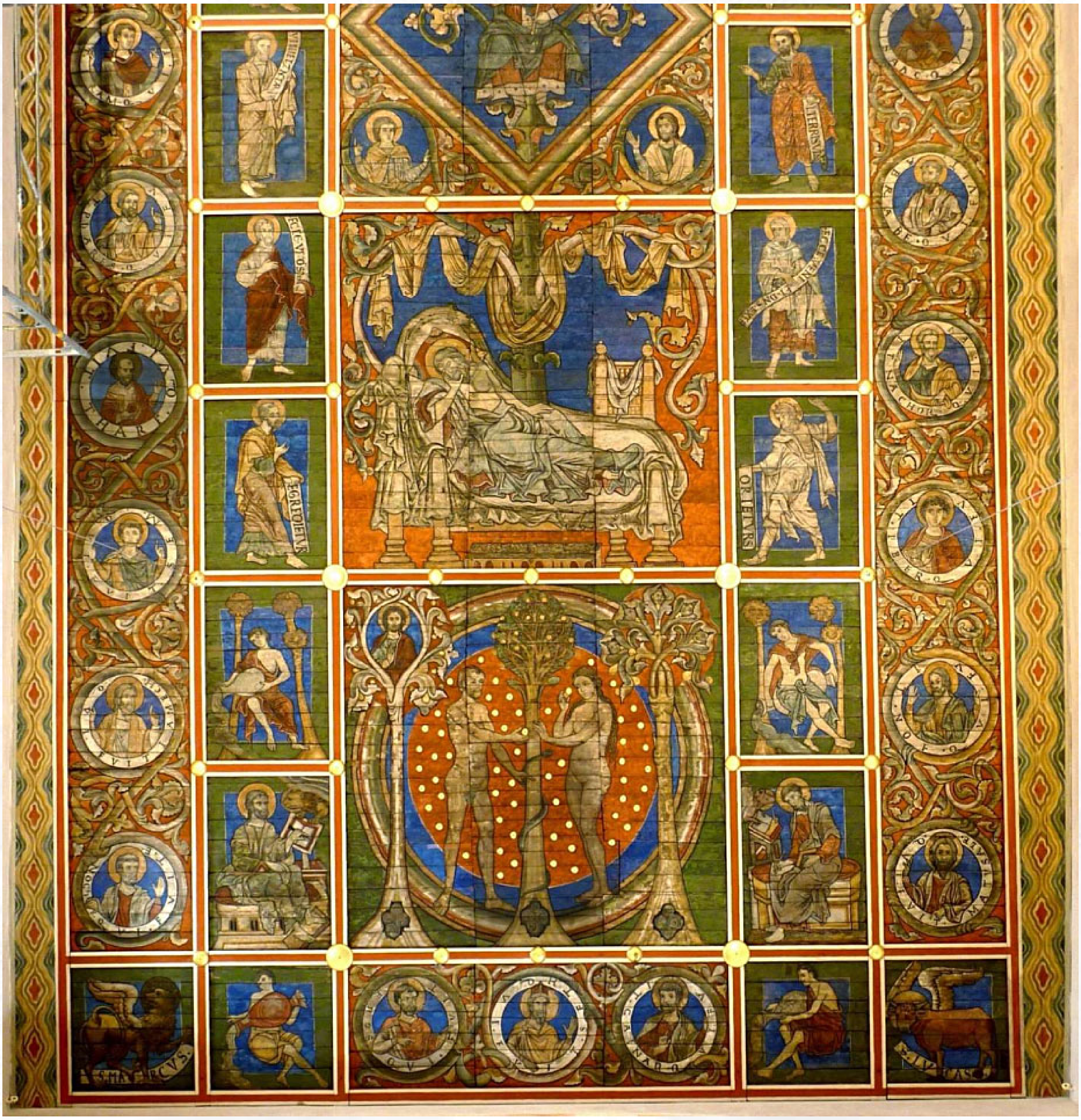
It would likewise be of shocking impact for the faithful today to see the mural painting of the *Amanita* "sponge" being offered to Jesus upon the cross before his death and *resurrection*, at the Dark Church in Göreme, Turkey (Brown and Brown 2016:190), or the mural painting of *Amanita* mushrooms held in the hands of the angels Gabri'el and (probably) Micha'el in the Yilanli Church of Ilhara Valley, Turkey (shown heretofore, but also more fully revealed in the photo by Martin Siepmann via AGE Fotostock, website in References Cited). That Jesus' resurrection was a metaphor, for enlighteningly awe-striking entheogenic experiences and the *blessing* of being returned therefrom, is further revealed by inter-textual analysis of the contradicting *physical* Resurrection account as differing between the Gospels of Matthew, Mark, Luke, and John:

> "the four Gospels each give a different time for the first visit to Jesus' tomb, though they all agree that a character named Mary Magdalene is the first visitor. The four Gospels also contradict one another about whether Mary Magdalene is alone when she first comes to the tomb, and about how many individuals are either inside or outside the tomb when she arrives. [...] Keeping in mind the ancient Hebrew tradition of reading their literature intertextually, it is congruent that the Romans would use this technique for their lampoon. Mistake one another for angels, and thereby delude themselves into believing that their Messiah has risen from the dead." [Atwill 2011:187]

This is elucidated in logistical / schematic literary analysis to be true [Atwill 2011:187-219]. The 'lampoon' Atwill refers to is that whereby the imperial Flavian family outwitted the zealots through clever storytelling to have them believe not only that their prophesied militant messiah was actually a Gnostic pacifist (Internet Sacred Texts Archive 2010), but that he was now deceased though immortally a judge over all who do not abide such pacifist ways, i.e., *him* being Rome itself, a la the standing Pope, or Vicar of its realm. It is then a sort of taunt about the immortal success of this obfuscation, that the *Amanita* symbolism would arise as an esoteric clue in plain sight about Jesus' resurrection, i.e. in Christmas festivity via concurrent celebration of Saint Nicholas or "Santa Claus" (Main 2013; Vitebsky 1995:70-73, 82-84) - a purportedly fabled and secular but actually historical Catholic figure thought to be imbued with post-mortem supernatural powers (de Ceglia 2012), and who is most commonly recognized and unfortunately belittled as whimsical rather than truly representational, because of the occulting cultural syncretism that went into creating his story and image. Importantly, Saint Nicholas was integral to the signing of the Nicene Creed that established the modern Trinitarian doctrine and the Catholic Church.

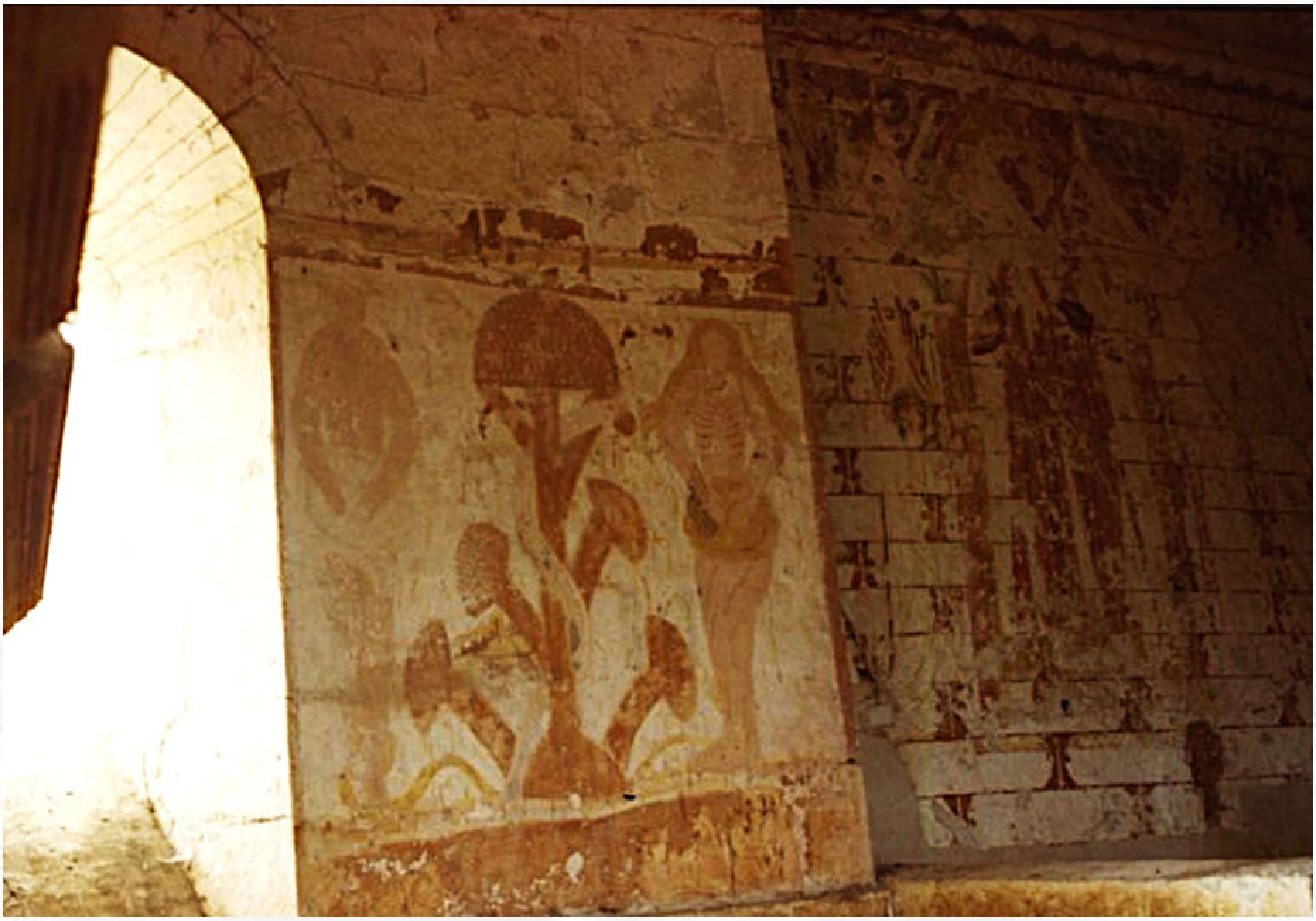


"Scenes from the Old Testament: Genesis," in the 14^{th} century *illuminated manuscript* called the Great Canterbury Psalter (f. 1r), the original of which was meticulously copied and reprinted by Moleiro (© M. Moleiro Editor, www.Moleiro.com). Note image of El'Elyon ("God") guiding Adam and Eve to the green colored Fruit of the Tree of Life, followed by image of their Original Sin in eating from the Fruit of the Tree of Knowledge, white-spotted and red in comparison. The visage of the latter is muddled by the 'topiary' illustration style used for *all* plants, common in art from this time period, making it easy to obscure the *Amanita*'s involvement with Christendom.



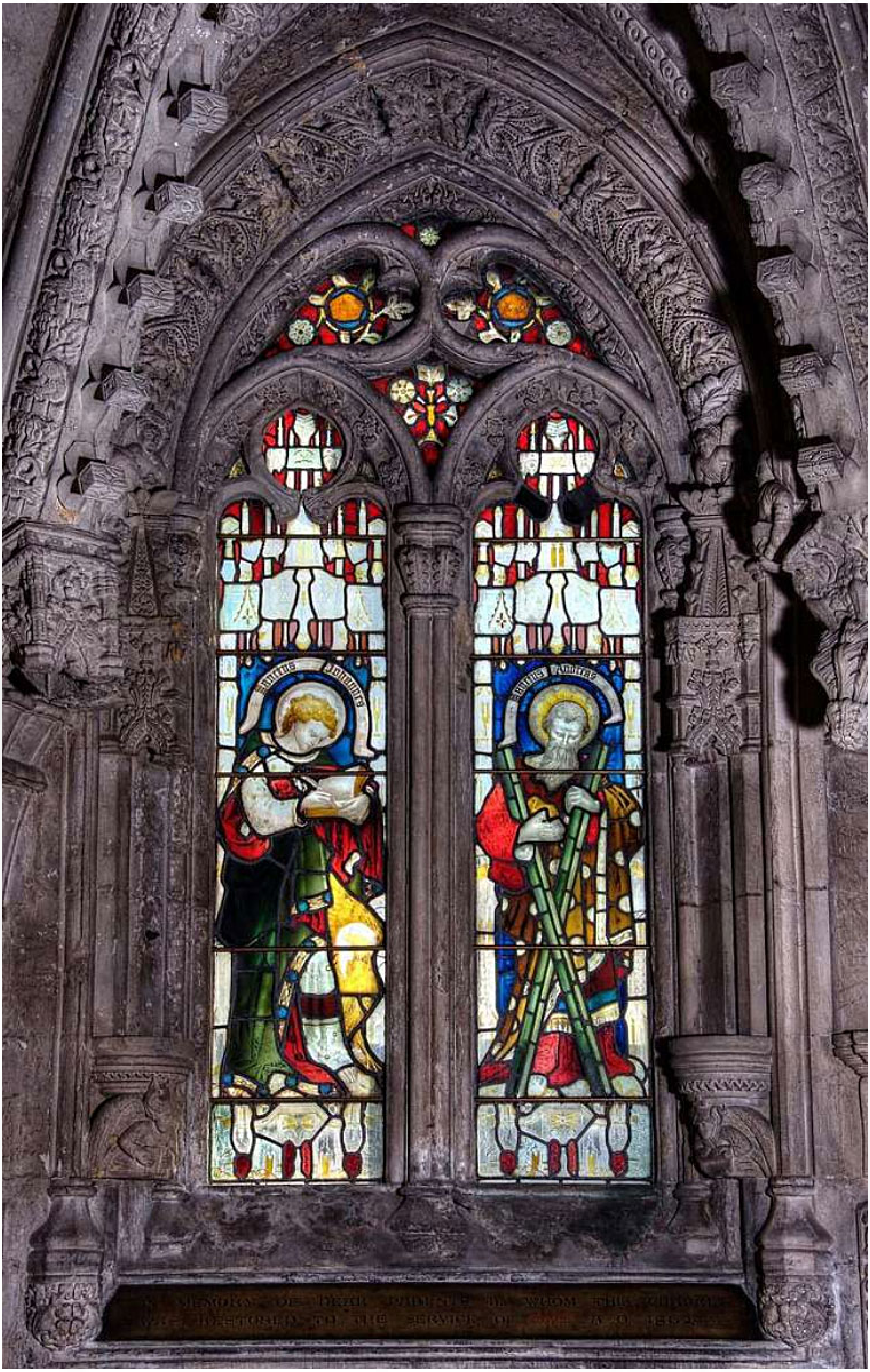
"Hildesheim, St. Michael's church - Painted wooden ceiling from about 1230 CE. The painted wooden ceiling of the nave is a rare and beautiful survival, dating from 1230. [...] It depicts the Tree of Jesse (the family tree of Christ). Also pictured are 42 circular medallions of the ancestors of Christ; 40 square or rectangular fields are (...) flanking the central picture panels with representations of the Four Evangelists and their symbols, the Four archangels, the Four Rivers of Paradise and many prophets. The area showing Christ enthroned is the only part that is not original - that section of the ceiling collapsed in 1650 and was remade in 1960" - *Petrus Agricola*. The mural blatantly depicts Adam and Eve picking the white spots from an *Amanita muscaria* cap, with the mushroom being identified *in association with* a coniferous tree or cedar, around which the "talking" serpent is coiled. *Amanitas* do in fact primarily grow under such trees throughout the world, and, with spore reproduction being unknown before scientific advances, their origins were elusive to historic people, seeming to be from the trees themselves - *as fruits*. Faithful Reproduction of a 2-dimensional Public Domain artwork* created by Petrus Agricola, accessed from his Flickr.com portfolio.

Amanita sacrament use in the Order of Melchizedek is revealed by murals in various Catholic churches (Irvin and Herer 2008; Irvin, Rutajit, and Zervos 2009), and in a Medieval "Illuminated" Bible called The "Eadwine" or "Great Canterbury" Psalter (© M. Moleiro Editor, www.moleiro.com), of The Temptation of Adam and Eve wherein they are portrayed as eating *not* "fruit" from a magic tree but from blatant macro representations of *Amanita* mushrooms. This would imply that Original Sin itself is derived from entheogenic enlightenment, and, in association with its use as the Holy sacrament, that the most disciplined religious use of *Amanita* - for repeated communication with God that occurred upon their consumption of it, and therefore to receive forgiving divine guidance - is the only path to redemption. Considering that the potent psychoactive substances *Boswelia* (the active ingredient in Frankincense, an antidepressant/euphoriant), and cannabis (*knei bosem* in Hebrew, a euphoriant/hallucinogen), were used frequently in a fashion inducing acute exposure for purification and access to the numinous in religious rites of the Old Testament (Shanon 2008:69), the *Amanita* was therefore but one magical substance in a divine mixture. As regards the botanical identification of knei bosem, the use of *Cannabis sativa* in Egypt since the time of Moses is indisputable (Rätsch 2005:148), and it was used contemporaneously by people of nearby countries for religious and hedonic purposes as well.

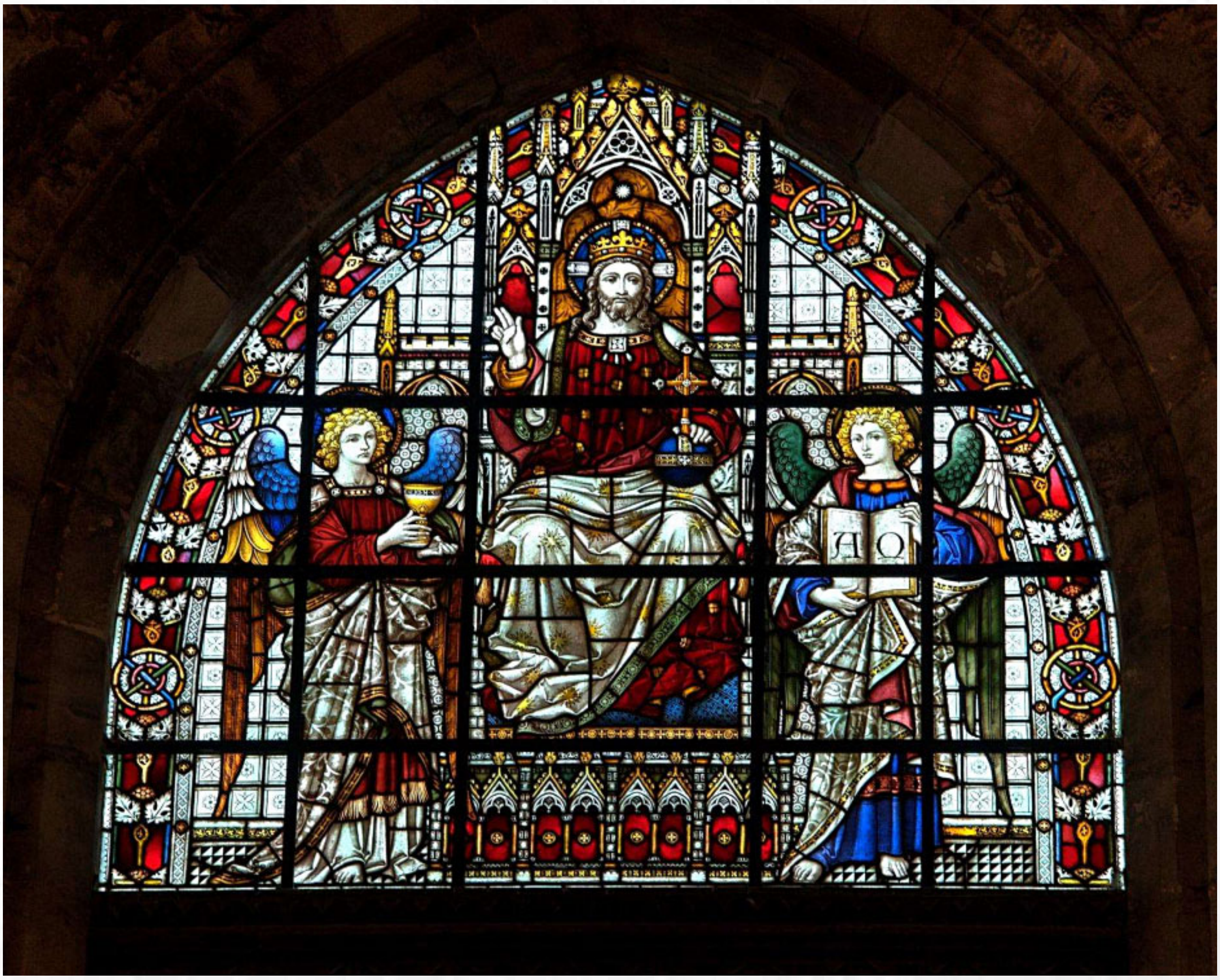


The famous Plaincourault Fresco in the 12th Century Knights Hospitallers' chapel in the Château de Plaincourault historical monument complex. Note that in this representation, the "Tree" of Knowledge of Right and Wrong is in fact not a pine or cedar with *Amanita muscaria* as its "fruit," but rather it is the mushroom itself (in a cluster). Photo by academically published author Giorgio Samorini (covered under a Creative Commons Attribution-NonCommercial-ShareAlike 2.0 Generic license).

Given the widespread and common nature of ancient entheogenic rites in the varying religions throughout the region, it is apparent what exactly this refers to. Such a premise would explain why the Holy Inquisition was initiated, as the Church was encountering more and more numerous reports of pagan people utilizing entheogens. Hence began the trials of "witches" and "heretics," given that pagans were not typically literate and therefore not considered capable of being as Holy as Church officials - a reality that likely gave these officials the sense that pagans were profaning their Holy Sacrament and therefore also the true spiritual pathway to God itself. This premise would also explain why Jesus is canonized as being entirely necessary for pagans to receive redemption and thence acceptance into Heaven, as his Trinitarian role is the supernatural mediator between God and the people whose descendants bear the mark of Original Sin and therefore displease Him. The trouble with this doctrine is that he is considered immortal by virtue of, or rather, by the original erring interpretive testimony of Luke 1:26-38, purporting that he was the son of God. Through this overall exegetical analysis, we know now the origin of the proclamation of Jesus' immortality as well as the meaning behind holy resurrection. So, the whole Trinity Doctrine falls apart as the dark gaps are thus filled. Or rather, it is a fallacious doctrine that Jesus alone can do the saving or that he is even required for it.



In a 15th Century church of the Knights Templar, Rosslyn Chapel (Scotland), is this stained glass art presented for focus on Saint Andrew on right window panel, wearing *Amanita* styled robes. Of note, as he was an apostle and the brother of fellow apostle Saint Peter. Photograph copyright by Vic Sharp (www.mistyriver.co.uk), original available for viewing on his Flickr portfolio.



Also in Rosslyn Chapel, is this stained glass window depicting Jesus enthroned as "priest forever in the Order of Melchizedek," wearing regalia fashioned as an *Amanita* mushroom, with symbolically *gold*-spotted red robe (rather than white, likely to denote Order status) and white 'veil' below; El'Ohim at his sides. Photo copyright by Vic Sharp (www.mistyriver.co.uk), original available for viewing on his Flickr portfolio.

Emulation of mutually ideal goodness and compassion was the message of Jesus the preacher in the gospel of Matthew. However, the Nag Hammadi texts found in the deserts of Egypt in 1945 added clarity to these teachings via the Gospel of Thomas whereby Jesus is quoted at length on the topic of gnostic *self-identification* with God. One famous passage is this:

> "I am the light that is over all; I am the All. The All came forth out of me; and to me the All has come. Split a piece of wood - I am there; lift the stone, and you will find me." [Logon 77, in Patterson and Robinson 1998]

However, Jesus also said that

> "The person old in his days will not hesitate to ask a child seven days old about the place of life, and he will live; for many who are first will become last, and they will become a single one" (Logon 4, ibid), whereby "The one who seeks should not cease until he finds; and when he finds, he will be dismayed; and when he is dismayed, he will be astonished; and he will be king over the All" (Logon 2, ibid).

This is profound, and yet there is another and more truly explicit passage on gnosis:

> "If those who lead you say to you: 'Look, the kingdom is in the sky!' then the birds of the sky will precede you. If they say to you: 'It is in the sea,' then the fishes will precede you. Rather, the kingdom is inside of you, and outside of you. When you come to know yourselves, then you will be known, and you will realize that you are the children of the living father. But if you do not come to know yourselves, then you exist in poverty, and you are poverty." [Logon 3, ibid]

And it is a certain poverty that most spiritual people feel when they pray but God does not *seem* to correspond. As Saint Thomas Aquinas said, "For those with faith, no evidence is necessary; for those without it, no evidence will suffice." In scientific analogy, the Golden Ratio may be a biological truth, but represents a never-ending spiral - an irrational value, the type of which makes us always reach for more knowledge without ever seeing that we could already be holding the penultimate and concise version of it if only we gave more credence to pattern recognition. Of course, we are beginning to do exactly that, in this increasingly AI-imbued epoch. Entheogenic initiatory rites that reveal abstract naturalistic truths and resurrect one into gnostic self-realization can both inspire and reify reverent beliefs and show the path of humanitarian and ecological redemption. They should therefore not be reserved for "the men of the lot of Melchizedek" either now or at the end times should they ever actually come. It is the right of all to be so enlightened.

References Cited

1. Atwill, Joseph. 2011. Caesar's Messiah: The Roman Conspiracy to Invent Jesus: Flavian Signature Edition. CreateSpace Independent Publishing Platform.
2. Berlant, SR. 2005. The Entheomycological Origins of Egyptian Crowns and the Esoteric Underpinnings of Egyptian Religion. Journal of Ethnopharmacology (Nov 14 / 102[2]):275-288.
3. Bombaci, Brendan. 2017. Ananias, the Triple Agent with the Intent to Martyr the Apostle Paul and Undermine Messianic Judaism. https://www.researchgate.net/profile/Brendan_Bombaci/contributions.
4. Bombaci, Brendan. 2016. Of Jesus, the "Messiah" (Anointed One) and "Melchizedek" (Prince of Righteousness): Rebutting the Trinity Doctrine. https://www.researchgate.net/profile/Brendan_Bombaci/contributions.
5. Bombaci, Brendan. 2012. Defending Perceptual Diversity in America: Entheogens as Legitimate Contributors to Learning, Health, and Empathy. Multidisciplinary Association for Psychedelic Studies. Resources > Free Books and Essays > Psychedelics and Culture. https://s3-us-west-1.amazonaws.com/mapscontent/pdfs/DPD_Bombaci_2016.pdf
6. Brown, Jerry B., and Julie M. Brown. 2016. The Psychedelic Gospels: The Secret History of Hallucinogens in Christianity. South Paris (ME): Park Street Press.
7. Callaway, J.C. 1988. A Proposed Mechanism for the Visions of Dream Sleep. Medical Hypothesis 26:119-124.
8. De Ceglia, Francesco Paulo. 2012. The Science of Santa Claus: Discussions on the Manna of Nicholas of Myra in the Modern Age. Nuncius (27):241-269.
9. Internet Sacred Texts Archive. 2010. http://www.sacred-texts.com/gno/index.htm. Accessed January 2019.
10. Irvin, J. R., and Jack Herer. 2008. The Holy Mushroom: Evidence of Mushrooms in Judeo-Christianity: A Critical Re-Evaluation of the Schism Between John M. Allegro and R. Gordon Wasson Over the Theory on the Entheogenic Origins of Christianity Presented in The Sacred Mushroom and the Cross. Charleston: Booksurge Publishing.
11. Irvin, Jan, Andrew Rutajit, and Nicholas Zervos. 2009. Astrotheology & Shamanism: Christianity's Pagan Roots (A Revolutionary Interpretation of the Evidence). Booksurge Publishing: North Charleston.
12. Main, Douglas. Live Science online. Culture. Article, "8 Ways Magic Mushrooms Explain Santa Story." December 18. https://www.livescience.com/42077-8-ways-mushrooms-explainsanta.html. Accessed December 2018.
13. Moleiro (© M. Moleiro Editor, www.Moleiro.com). The Great Canterbury Psalter, f. 1r. Image acquired with limited and non-exclusive photo reproduction rights in January of 2019.
14. Muraresku, Brian C. 2020. The Immortality Key: The Secret History of the Religion with No Name. St. Martin's Press: Manhattan.
15. Patterson, Stephen J., and James M. Robinson. 1998. Saying Three. The Gospel According to Thomas. The Fifth Gospel. Trinity Press International. Original Translation by the Berlin Working Group for Coptic Gnostic Writings. http://www.gnosis.org/naghamm/gth_pat_rob.htm. Prepared by Michael W. Grondin, July 2000; Reformatted by Lance Owens 2011, 2015. Accessed 10 September 2022.
16. Peoples, Hervey C., Pavel Duda, and Frank W. Marlowe. 2016. Hunter-Gatherers and the Origins of Religion. Human Nature (September / 27[3]):261-82.
17. Petri, G. 2014. The Public Domain vs. the Museum: The Limits of Copyright and Reproductionsn of Two-dimensional Works of Art. Journal of Conservation and Museum Studies 12(1), p.Art. 8. DOI: http://doi.org/10.5334/jcms.1021217.
18. Rätsch, Christian. 2005. The Encyclopedia of Psychoactive Plants: Ethnopharmacology and Its Applications. Park Street Press: Rochester.
19. Robbins, John W. 1999. Ecclesiastical Megalomania: The Economical and Political Thought of the Roman Catholic Church. Trinity Paper no 52. Unicoi: The Trinity Foundation.
20. Sapolsky, Robert M. 2004. Why Zebras Don't Get Ulcers: The Acclaimed Guide to Stress, Stress-Related Diseases, and Coping. Holt Paperbacks; Macmillan.
21. Shanon, Benny. 2008. Biblical Entheogens: A Speculative Hypothesis. Time and Mind: The Journal of Archaeology, Consciousness, and Culture 1(1):51-74.
22. Siepmann, Martin. Date n/a. Photo: Frescoes in the Snake Church or Yilanli Kilese, Ihlara Valley or Ihlara Vadisi, Aksaray Province, Cappadocia, Central Anatolia Region, Anatolia, Turkey. AGE Fotostock. Accessed 30 November 2018. https://www.agefotostock.com/age/en/Stock-Images/Rights-Managed/IBR-3953603.
23. Vitebsky, Piers. 1995. Shamanism. University of Oklahoma Press: Norman.
24. Winkelman, Michael. 1996. Psychointegrator Plants: Their Roles in Human Culture, Consciousness, and Health. Yearbook of Cross-Cultural Medicine and Psychotherapy (1995):9-53. Walter Andritsky and Michael Winkelman, eds. Reprinted by Permission of the Publisher. Berlin: VWF VerlagfürWissenschaft und Bildung.

The Road to Eleusis

Unveiling the Secret of the Mysteries

by

R. Gordon Wasson, Albert Hofmann, Carl A. P. Ruck

original text: https://druglibrary.net/schaffer/lsd/eleuch1.htm

Table of Contents:

Foreword by R. Gordon Wasson
I. The Wasson Road to Eleusis
II. A Challenging Question and My Answer
III. Solving the Eleusinian Mystery
IV. Ancillary Data
V. The Homeric Hymn to Demeter

To Richard Evans Schultes, Ph.D., M.H. (Hon.)
Pioneer Explorer of Psychotropic Plants in the New World
Holder of the Paul C. Mangelsdorf Chair in the Natural Sciences
Director and Curator of Economic Botany
Botanical Museum of Harvard University

Foreword by R. Gordon Wasson

So much has been written about the Eleusinian Mysteries and for so long a time that a word is needed to justify this presentation of three papers dealing with them. For close to 2,000 years the Mystery was performed every year (except one) for carefully screened initiates in our month of September. Everyone speaking the Greek language was free to present himself, except only those who had the unexpiated blood of a murdered man on their hands. The initiates lived through the night in the telesterion of Eleusis, under the leadership of the two hierophantic families, the Eumolpids and the Kerykes, and they would come away all wonderstruck by what they had lived through: according to some, they were never the same as before. The testimony about that night of awe-inspiring experience is unanimous and Sophocles speaks for the initiates when he says:

> Thrice happy are those of mortals, who having seen those rites depart for Hades; for to them alone is granted to have a true life there. For the rest, all there is evil.

Yet up to now no one has known what justifies utterances such as this, and there are many like it. Here lies for us the mystery of the Eleusinian Mysteries. To this mystery we three have applied ourselves and believe we have found the solution, close to 2,000 years after the last performance of the rite and some 4,000 years since the first.

The first three chapters of this book were read by the respective authors as papers before the Second International Conference on Hallucinogenic Mushrooms held on the Olympic Peninsula, Washington, on Friday, 28 October 1977.

R.G.W.

I. The Wasson Road to Eleusis

by R. Gordon Wasson

With this little book we begin a new chapter in the history of the fifty-year-old discipline of ethnomycology, a chapter that for the first time takes within its purview, and in a big way, our own cultural past, our legacy from ancient Greece. Ethnomycology is simply the study of the role of mushrooms, in the broadest sense, in the past of the human race; and it is a branch of ethnobotany.

The English language lacks a word to designate the higher fungi. "Toadstool" is an epithet, a pejorative designation embracing all those fungal growths that the user distrusts, whether rightly or wrongly. "Mushroom" is ambiguous, covering different areas of the fungal world for different persons. In this little book we will use "mushroom" for all the higher fungi. Now that at long last the world is coming to know these fungal growths in all their myriad shapes and colors and smells and textures, perhaps this novel usage will answer to a need and come to be generally accepted.

We are three who have enlisted for this presentation. Dr. Albert Hofmann is the Swiss chemist renowned for his discovery in 1943 of LSD, but his familiarity with the plant alkaloids is encyclopaedic and he will draw our attention to attributes of some of them relevant to the Eleusinian Mysteries.

As we are dealing with a central theme of Greek civilization in antiquity, it was obvious that we needed the cooperation of a Greek scholar. At the appropriate moment I learned of Professor Carl A. P. Ruck, of Boston University, who for some years has been making notable discoveries in the recalcitrant area of Greek ethnobotany. For many months we three have been studying the proposal that we are making and his paper will be the third and concluding one. *The Homeric Hymn to Demeter* is the source for the myth that underlies Eleusis and we offer a new English rendering of it by Danny Staples.

It will be my function, in this first of three papers, to stress certain attributes of the cult of inebriating mushrooms in Mexico.

Early Man in Greece, in the second millennium before Christ, founded the Mysteries of Eleusis and they held spellbound the initiates who each year attended the rite. Silence as to what took place there was obligatory: the laws of Athens were extreme in the penalties that were imposed on any who infringed the secret, but throughout the Greek world, far beyond the reach of Athens' laws, the secret was kept spontaneously throughout Antiquity, and since the suspension of the Mysteries in the 4th century A. D. that Secret has become a built-in element in the lore of Ancient Greece. I would not be surprised if some classical scholars would even feel that we are guilty of a sacrilegious outrage at now prying open the secret. On 15 November 1956 I read a brief paper before the American Philosophical Society describing the Mexican mushroom cult and in the ensuing oral discussion I intimated that this cult might lead us to the solution of the Eleusinian Mysteries. A famous English archaeologist specializing in the archaeology of Greece, with whom I had had the friendliest relations for about thirty-five years, wrote me in a letter a little later the following:

> I do not think that Mycenae had anything to do with the divine mushroom or the Eleusinian mysteries either. May I add a word of warning? Stick to your Mexican mushroom cult and beware of seeing mushrooms everywhere. We much enjoyed your Philadelphia paper and would recommend you keep as close to that as you can. Forgive the frankness of an old friend.

I am sorry that he has now joined the shades in Hades, or perhaps I should be happy that he will not be pained by my brashness in disregarding his well-meant advice.

My late wife Valentina Pavlovna and I were the first to use the term ethnomycology and we have been closely identified with the progress in this discipline over the past fifty years. That the reader may sense the drama of this our latest discovery I will begin by retelling the story of our mushroomic adventure. It covers precisely the last fifty years. It constitutes in large measure the autobiography of the Wasson family, and it has now led us directly to Eleusis.

Late in August 1927 my bride, as she then was, and I took our delayed honeymoon in the chalet lent to us by the publisher Adam Dingwall at Big Indian in the Catskills. She was a Russian born in Moscow of a family of the intelligentsia. Tina had fled from Russia with her family in the summer of 1918, she being then 17 years old. She qualified as a physician at the University of London and had been working hard to establish her pediatric practice in New York. I was a newspaper man in the financial department of the *Herald Tribune*. On that first beautiful afternoon of our holiday in the Catskills, we went sauntering down the path for a walk, hand in hand, happy as larks, both of us abounding in the joy of life. There was a clearing on the right, a mountain forest on our left.

Suddenly Tina threw down my hand and darted up into the forest. She had seen mushrooms, a host of mushrooms, mushrooms of many kinds that peopled the forest floor. She cried out in delight at their beauty. She addressed each kind with an affectionate Russian name. Such a display she had not seen since she left her family's *dacha* near Moscow, almost a decade before. She knelt before those toadstools in poses of adoration like the Virgin hearkening to the Angel of the Annunciation. She began gathering some of the fungi in her apron. I called to her: "Come back, come back to me! They are poisonous, putrid. They are toadstools. Come back to me!" She only laughed the more: her merry laughter will ring forever in my ears. That evening she seasoned the soup with the fungi, she garnished the meat with other fungi. Yet others she threaded together and strung up to dry, for winter use as she said. My discomfiture was complete. That night I ate nothing with mushrooms in it. Frantic and deeply hurt, I was led to wild ideas: I told her that I would wake up a widower.

She proved right and I wrong.

The particular circumstances of this episode seem to have shaped the course of our lives. We began checking with our compatriots, she with Russians and I with Anglo-Saxons. We quickly found that our individual attitudes characterized our respective peoples. Then we began gathering information, at first slowly, haphazardly, intermittently. We assembled our respective vocabularies for mushrooms: the Russian was endless, never to this day exhausted; the English, essentially confined to three words, two of them ill-defined - toadstool, mushroom, fungus. The Russian poets and novelists filled their writings with mushrooms, always in a loving context. It would seem to a stranger that every Russian poet composes verses on mushroom-gathering almost as a rite of passage to qualify for mature rating! In English the silence of many writers about mushrooms is deafening: Chaucer and Milton never mention them, the others seldom. For Shakespeare, Spenser, William Penn, Laurence Sterne (extensively), Shelley, Keats, Tennyson, for Edgar Allan Poe and D. H. Lawrence and Emily Dickinson, "mushroom" and "toadstool" are unpleasant, even disgusting epithets. Our poets when they do mention them link them to decay and death. We began to cast our net wider and to study all the peoples of Europe, not only the German and French and Italians, but more especially the peripheral cultures, out of the main stream, where archaic forms and beliefs survive longest - the Albanian, Frisian, Lappish, Basque, Catalonian and Sardinian, Icelandic and Faroese, and of course the Hungarian and the Finnish. In all our inquiries and travels we looked, not to the erudite, but to the humble and illiterate peasants as our most cherished informants. We explored their knowledge of mushrooms and the uses to which they put them. We were careful also to take the flavor of the scabrous and erotic vocabularies often neglected by lexicographers. We examined the common names for mushrooms in all these cultures, seeking the fossil metaphors hiding in their etymologies, to discover what those metaphors expressed, whether a favorable or unfavorable attitude toward our earthy creatures.

A little thing, some of you may say, this difference in emotional attitude toward wild mushrooms. But my wife and I did not think so, and we devoted most of our leisure hours for decades to dissecting it, defining it, and tracing it to its origin. Such discoveries as we have made, including the rediscovery of the religious role for the hallucinogenic mushrooms of Mexico, can be laid to our preoccupation with that cultural rift between my wife and me, between our respective peoples, between the mycophilia and mycophobia (words that we devised for our two attitudes) that divide the Indo-European peoples into two camps. If this hypothesis of ours be wrong, then it must have been a singular false hypothesis to have borne the fruit that it has. But it is not wrong. Thanks to the immense strides made in the study of the human psyche in this century, we are all now aware that deep-seated emotional attitudes acquired in early life are of profound importance. I suggest that when such traits betoken the attitudes of whole tribes or peoples, when those traits have remained unaltered throughout recorded history, and especially when they differ from one people to another neighboring people, then you are face to face with a phenomenon of deepest cultural implications, whose primal cause is to be discovered only in the well-springs of cultural history.

Our card files and correspondence kept expanding and in the end, sometime in the early 1940's, we sat down, Tina and I, and asked ourselves what we were going to do with all our data. We decided to write a book, but there were so many lacunae in our evidence that it would be years before we could put words to paper. In our conversations at that time we found that we had been thinking along the same lines, afraid to express our thoughts even to each other: they were too fantastic. We had both come to discern a period long long ago, long before our ancestors knew how to write, when those ancestors must have regarded a mushroom as a divinity or quasi-divinity. We knew not which mushroom(s) nor why. In the days of Early Man his whole world was shot through with religious feeling and the unseen powers held him in thrall. Our sacred "mushroom" must have been wondrous indeed, evoking awe and adoration, fear, yes, even terror. When that early cult gave way to new religions and to novel ways emerging with a literate culture, the emotions aroused by the old cult would survive, truncated from their roots. In one area the fear and terror would live on, either of a particular mushroom (as in the case of *A. muscaria*); or else, as the emotional focus through tabu became vague, of "toadstools" in general; and in another area, for a reason that we cannot now tell, it was the spirit of love and adoration that survived. Here would lie the explanation of the mycophobia vs. mycophilia that we had discovered. ("Toadstool", incidentally, was originally the specific name of *A. muscaria*, the divine mushroom, of a beauty befitting its divinity. Through tabu, "toadstool" lost its focus and came to hover over the whole of the mushroom tribe that the mycophobe shuns.)

It was in Mexico that our pursuit of a hypothetical sacred mushroom first achieved its goal. On 19 September 1952 we received in the post two letters from Europe: one from Robert Graves enclosing a cutting from a pharmaceutical journal in which there were quotations from Richard Evans Schultes, who in turn cited a number of 16th century Spanish friars telling of a strange mushroom cult among the Indians of Mesoamerica; the second from Giovanni Mardersteig, our printer in Verona, sending us his sketch of a curious archaeological artifact from Mesoamerica. It was exhibited in the Rietberg Museum of Zurich. The artifact was of stone, about a foot high, obviously a mushroom, with a radiant being carved on the stem or what mycologists call the stipe. Here was perhaps the very cult we were seeking, well within our reach. Earlier we had resolved that we would avoid the New World and Africa in our inquiries: the world was too large and our hands were full with Eurasia. But in a trice we changed our minds and the course of our studies, and we concentrated on Mexico and Guatemala. We had been postulating a wild mushroom as a focus of religious devotion, a fantastic surmise. Now here it was on our doorstep. All that winter we went racing through the texts of the 16th century Spanish friars, and what extraordinary narratives they give us! We flew down to Mexico in that summer of 1953 and for many rainy seasons thereafter. With wonderful cooperation from everyone in that country, on the night of 29-30 June 1955 we finally made our breakthrough: my photographer and friend Allan Richardson and I participated with our Indian friends in a midnight *agape* conducted by a shaman of extraordinary quality. This was the first time on record that anyone of the alien race had shared in such a communion. It was a soul-shattering experience. The wild surmise that we had dared to postulate in a whisper to each other years before was at last vindicated. And now, nearly a quarter of a century later, we are prepared to offer another mushroom, *Claviceps purpurea*, as holding the secret to the Eleusinian Mysteries.

That there might be a common denominator between the Mexican mushroom Mystery and the Mystery of Eleusis had struck me at once. They both aroused an overwhelming sense of awe, of wonder. I will leave to Professor Ruck the discussion of Eleusis but will quote one ancient author, Aristides the Rhetor, who in the 2nd century A. D. pulled aside the curtain for an instant when he said that what the initiate experienced was "new, astonishing, inaccessible to rational cognition", and he went on:

> Eleusis is a shrine common to the whole earth, and of all the divine things that exist among men, it is both the most awesome and the most luminous. At what place in the world have more miraculous tidings been sung, and where have the dromena called forth greater emotion, *where has there been greater rivalry between seeing and hearing?* [Italics mine.]

And he goes on to speak of the "ineffable visions" that it had been the privilege of many generations of fortunate men and women to behold.

This description point by point tallies with the effect on the initiate of the Mesoamerican mushroom rite, even to the "rivalry" between seeing and hearing. For the sights that one sees assume rhythmical contours, and the singing of the shaman seems to take on visible and colorful shapes.

There seems to have been a saying among the Greeks that mushrooms were the "food of the Gods", *broma theon*, and Porphyrius is quoted as having called them "nurslings of the Gods", *theotrophos*. The Greeks of the classic period were mycophobes. Was this not because their ancestors had felt that the whole fungal tribe was infected "by attraction" with the holiness of the sacred mushroom, and that mushrooms were therefore to be avoided by mortal men? Are we not dealing with what was in origin a religious tabu?

I would not be understood as contending that only these alkaloids (wherever found in nature) bring about visions and ecstasy. Clearly some poets and prophets and many mystics and ascetics seem to have enjoyed ecstatic visions that answer the requirements of the ancient Mysteries and that duplicate the mushroom agape of Mexico. I do not suggest that St. John of Patmos ate mushrooms in order to write the Book of the Revelation. Yet the succession of images in his Vision, so clearly seen but such a phantasmagoria, means for me that he was in the same state as one bemushroomed. Nor do I suggest for a moment that William Blake knew the mushroom when he wrote this telling account of the clarity of "vision":

> The Prophets describe what they saw in Vision as real and existing men, whom they saw with their imaginative and immortal organs; the Apostles the same; the clearer the organ the more distinct the object. *A Spirit and a Vision are not, as the modern philosophy supposes, a cloudy vapour, or a nothing: they are organized and minutely articulated beyond all that the mortal and perishing nature can produce. He who does not imagine in stronger and better lineaments, and in stronger and better light than his perishing eye can see, does not imagine at all.* [Italics mine. From The Writings of William Blake, ed. by Geoffrey Keynes, vol. III, p. 108]

This must sound cryptic to one who does not share Blake's vision or who has not taken the mushroom. The advantage of the mushroom is that it puts many, if not everyone, within reach of this state without having to suffer the mortifications of Blake and St. John. It permits you to see, more clearly than our perishing mortal eye can see, vistas beyond the horizons of this life, to travel backwards and forwards in time, to enter other planes of existence, even (as the Indians say) to know God. It is hardly surprising that your emotions are profoundly affected, and you feel that an indissoluble bond unites you with the others who have shared with you in the sacred agape. All that you see during this night has a pristine quality: the landscape, the edifices, the carvings, the animals - they look as though they had come straight from the Maker's workshop. This newness of everything - it is as though the world had just dawned - overwhelms you and melts you with its beauty. Not unnaturally, what is happening to you seems to you freighted with significance, beside which the humdrum events of everyday are trivial. All these things you see with an immediacy of vision that leads you to say to yourself, "Now I am seeing for the first time, seeing direct, without the intervention of mortal eyes."

Plato tells us that beyond this ephemeral and imperfect existence here below, there is another Ideal world of Archetypes, where the original, the true, the beautiful Pattern of things exists for evermore. Poets and philosophers for millennia have pondered and discussed his conception. It is clear to me where Plato found his "Ideas"; it was clear to those who were initiated into the Mysteries among his contemporaries too. Plato had drunk of the potion in the Temple of Eleusis and had spent the night seeing the great Vision.

And all the time that you are seeing these things, the priestess in Mexico sings, not loud, but with authority. The Indians are notoriously not given to displays of inner feelings - except on these occasions. The singing is good, but under the influence of the mushroom you think it is infinitely tender and sweet. It is as though you were hearing it with your mind's ear, purged of all dross. You are lying on a *petate* or mat; perhaps, if you have been wise, on an air mattress and in a sleeping bag. It is dark, for all lights have been extinguished save a few embers among the stones on the floor and the incense in a sherd. It is still, for the thatched hut is apt to be some distance away from the village. In the darkness and stillness, that voice hovers through the hut, coming now from beyond your feet, now at your very ear, now distant, now actually underneath you, with strange ventriloquistic effect. The mushrooms produce this illusion also. Everyone experiences it, just as do the tribesmen of Siberia who have eaten of *Amanita muscaria* and lie under the spell of their shamans, displaying as these do their astonishing dexterity with ventriloquistic drum beats. Likewise, in Mexico, I have heard a shaman engage in a most complicated percussive beat: with her hands she hits her chest, her thighs, her forehead, her arms, each giving a different resonance, keeping a complicated rhythm and modulating, even syncopating, the strokes. Your body lies in the darkness, heavy as lead, but your spirit seems to soar and leave the hut, and with the speed of thought to travel where it listeth, in time and space, accompanied by the shaman's singing and by the ejaculations of her percussive chant. What you are seeing and what you are hearing appear as one: the music assumes harmonious shapes, giving visual form to its harmonies, and what you are seeing takes on the modalities of music - the music of the spheres. "Where has there been greater rivalry between seeing and hearing?" How apposite to the Mexican experience was the ancient Greek's rhetorical question! All your senses are similarly affected: the cigarette with which you occasionally break the tension of the night smells as no cigarette before had ever smelled; the glass of simple water is infinitely better than champagne. Elsewhere I once wrote that the bemushroomed person is poised in space, a disembodied eye, invisible, incorporeal, seeing but not seen. In truth, he is the five senses disembodied, all of them keyed to the height of sensitivity and awareness, all of them blending into one another most strangely, until the person, utterly passive, becomes a pure receptor, infinitely delicate, of sensations.

As your body lies there in its sleeping bag, your soul is free, loses all sense of time, alert as it never was before, living an eternity in a night, seeing infinity in a grain of sand. What you have seen and heard is cut as with a burin in your memory, never to be effaced. At last you know what the ineffable is, and what ecstasy means. Ecstasy ! The mind harks back to the origin of that word. For the Greeks *ekstasis* meant the flight of the soul from the body. I am certain that this word came into being to describe the effect of the Mystery of Eleusis. Can you find a better word than that to describe the bemushroomed state? In common parlance, among the many who have not experienced ecstasy, ecstasy is fun, and I am frequently asked why I do not reach for mushrooms every night. But ecstasy is not fun. Your very soul is seized and shaken until it tingles. After all, who will choose to feel undiluted awe, or to float through that door yonder into the Divine Presence? The unknowing vulgar abuse the word, and we must recapture its full and terrifying sense.... A few hours later, the next morning, you are fit to go to work. But how unimportant work seems to you, by comparison with the portentous happenings of that night! If you can, you prefer to stay close to the house, and, with those who lived through that night, compare notes, and utter ejaculations of amazement.

I will convey to you the overwhelming impression of awe that the sacred mushrooms arouse in the native population of the Mexican highlands. In the Mazatec tribe where I ingested them for the first time these particular mushrooms are not "mushrooms": they stand apart. One word - *thain*^{3} - embraces the whole fungal tribe, edible, innocuous but inedible, and toxic, - the whole fungal world except the sacred species. The sacred species are known by a name that in itself is a euphemism for some other name now lost: they are ^{ʔ}*nti*^{1}*xi*^{3}*tho*^{3}. (In Mazatec each syllable must be pronounced in one of four tones or in slides from one tone to another, *1* being the highest. The initial ^{ʔ} is a glottal stop.) The first element, ^{ʔ}*nti*^{1}, is a diminutive of affection and respect. The second element, *xi*^{3}*tho*^{3}, means "that which leaps forth". The whole word is thus: "the dear little things that leap forth". But this word is holy: you do not hear it uttered in the market place or where numbers of people are assembled. It is best to bring up the subject at night, by the light of a fire or a *vela* (votive candle), when you are alone with your hosts. Then they will dilate endlessly on the wonders of these wondrous mushrooms. For this euphemistic name they will probably use yet others, a further degree of euphemism, the *santitos*, the "little saints", or again the "little things" in Mazatec. When we were leaving the Mazatec mountains on horseback after our first visit there, we asked our muleteer Victor Hernandez how it came about that the sacred mushrooms were called "the dear little ones that leap forth". He had traveled the mountain trails all his life and spoke Spanish although he could neither read nor write nor even tell time by the clock's face. His answer, breathtaking in sincerity and feeling, breathed the poetry of religion and I quote it word for word as he uttered it and as I put it down in my notebook at the time:

> El honguillo viene por si mismo, no se sabe de donde, como el viento que viene sin saber de donde ni porque. [The little mushroom comes of itself, no one knows whence, like the wind that comes we know not whence nor why.]

Victor was referring to the genesis of the sacred mushrooms: they leap forth seedless and rootless, a mystery from the beginning. Aurelio Carreras, town slaughterer in Huautla, when we asked him where the mushrooms take you, said simply: *Le llevan alli donde dios esta*, "They carry you there where God is". According to Ricardo Garcia Gonzalez of Rio Santiago, "To eat the mushrooms you must be clean: they are the blood of our Lord the Eternal Father." *Hay que ser may limpio, es la sangre de Nuestro Señor Padre Eterno.* These are Spanish-speaking villagers picked at random. They express religion in its purest essence, without intellectual content. Aristotle said of the Eleusinian Mysteries precisely the same: the initiates were to suffer, to feel, to experience certain impressions and moods. They were not to learn anything.

As man emerged from his brutish past, thousands of years ago, there was a stage in the evolution of his awareness when the discovery of a mushroom (or was it a higher plant?) with miraculous properties was a revelation to him, a veritable detonator to his soul, arousing in him sentiments of awe and reverence, and gentleness and love, to the highest pitch of which mankind is capable, all those sentiments and virtues that mankind has ever since regarded as the highest attribute of his kind. It made him see what this perishing mortal eye cannot see. How right the Greeks were to hedge about this Mystery, this imbibing of the potion, with secrecy and surveillance! What today is resolved into a mere drug, a tryptamine or lysergic acid derivative, was for him a prodigious miracle, inspiring in him poetry and philosophy and religion. Perhaps with all our modern knowledge we do not need the divine mushrooms any more. Or do we need them more than ever? Some are shocked that the key even to religion might be reduced to a mere drug. On the other hand, the drug is as mysterious as it ever was: "like the wind that comes we know not whence nor why." Out of a mere drug comes the ineffable, comes ecstasy. It is not the only instance in the history of humankind where the lowly has given birth to the divine. Altering a sacred text, we would say that this paradox is a hard saying, yet one worthy of all men to be believed.

If our classical scholars were given the opportunity to attend the rite at Eleusis, to talk with the priestess, what would they not exchange for that chance? They would approach the precincts, enter the hallowed chamber, with the reverence born of the texts venerated by scholars for millennia. How propitious would their frame of mind be, if they were invited to partake of the potion! Well, those rites take place now, unbeknownst to the classical scholars, in scattered dwellings, humble, thatched, without windows, far from the beaten track, high in the mountains of Mexico, in the stillness of the night, broken only by the distant barking of a dog or the braying of an ass. Or, since we are in the rainy season, perhaps the Mystery is accompanied by torrential rains and punctuated by terrifying thunderbolts. Then, indeed, as you lie there bemushroomed, listening to the music and seeing the visions, you know a soul-shattering experience, recalling as you do the belief of some early peoples that mushrooms, the sacred mushrooms, are divinely engendered by Parjanya, the Aryan God of the Lightning-bolt, in the Soft Mother Earth.

Someone has called mycology the step-child of the sciences. Is it not now acquiring a wholly new and unexpected dimension? Religion has always been at the core of man's highest faculties and cultural achievements, and therefore I ask you now to contemplate our lowly mushroom - what patents of ancient lineage and nobility are coming its way!

R. Gordon Wasson

II. A Challenging Question and My Answer

by Albert Hofmann

In July 1975 I was visiting my friend Gordon Wasson in his home in Danbury when he suddenly asked me this question: whether Early Man in ancient Greece could have hit on a method to isolate an hallucinogen from ergot that would have given him an experience comparable to LSD or psilocybin. I replied that this might well have been the case and I promised to send him, after further reflection, an exposition of our present knowledge on the subject, which I already suspected would support my tentative position. Two years have passed, and here now is my answer.

Ergot is the English name for a fungal growth, the "sclerotium" of a mushroom known to mycologists as *Claviceps purpurea* (Fr.) Tul. It is a parasite on rye and other cereals such as barley or wheat, and also on certain wild grasses. Other species of the genus Claviceps, viz *C. paspali* Stev. and Hall, *C. nigricans* Tul., and *C. glabra* Langdon, etc., are parasitical to many species and varieties of grasses. Ergot itself is not of uniform chemical composition: it occurs in "biological" or "chemical" races, differing from each other mainly by the composition of their alkaloidal constituents. (Chemists define "alkaloids" as nitrogen-containing alkaline substances that represent the pharmacologically active principles of many plants.) Thus in Switzerland there exist three varieties of ergot of rye: (a) in the Midlands a race containing mainly the alkaloid ergotamine, (b) in the Valais one with alkaloids of the ergotoxine group, and (c) in the Grisons a variety with no alkaloids at all. Furthermore in other kinds of ergot - growing on wheat, on barley, on millet, on lolium, etc. - there are wide variations in alkaloidal makeup, sometimes depending on geographical location.

By far the most important of all kinds of ergot is ergot of rye, purple-brown protrusions from the ears of rye. Ergot of rye (in scientific nomenclature: *Secale cornutum*) has been called in England "horned rye", "spiked rye", "spurred rye", but most commonly "ergot of rye", a translation of the French *ergot de seigle*. The word ergot is defined in the Petit Larousse as "*petit ongle pointu derriere le pied du coq*", "small pointed talon behind the cock's foot", but the derivation of the French word *ergot* is uncertain. Other French names are *blé cornu, seigle ergoté, seigle ivre*. In German there seem to be more variants than in other languages: *Mutterkorn, Rockenmutter, Afterkorn, Todtenkorn, Tollkorn*, and many others. In German folklore there was a belief that, when the corn waved in the wind, the corn mother (a demon) was passing through the field; her children were the rye wolves (ergot). In our context we observe that of these names, two, *seigle ivre* ("drunken rye") and *Tollkorn* ("mad grain"), point to a knowledge of the psychotropic effects of ergot. This folk awareness of the mind-changing effects of ergot shows an intimate knowledge of its properties, at least among herbalists, deeply rooted in European traditions.

Ergot of rye has a storied past. Once a dreaded poison, it has become a rich treasure chamber of valuable pharmaceuticals.

In the Middle Ages bizarre epidemics occurred in Europe costing thousands of people their lives, occasioned by bread made from rye contaminated with ergot. These epidemics took two forms, *Ergotismus convulsivus*, characterized by nervous convulsive and epileptiform symptoms, and *Ergotismus gangraenosus*, in which gangrenous manifestations leading to mummification of the extremities were a prominent feature. Ergotism was also known as *ignis sacer* ("holy fire"), or "St. Anthony's fire", because St. Anthony was the patron saint of a religious order founded to care for the victims of ergotism. The cause of these epidemics - bread contaminated with ergot - was not learned until the seventeenth century, and since then there have been only sporadic outbreaks of ergot poisoning.

Ergot was first mentioned as a remedy by the German physician Adam Lonitzer in 1582. He said it was being used by midwives to precipitate childbirth. The first scientific report on the use of ergot as a uterotonic agent was presented by the American physician John Stearns in 1808: "Account of the *pulvis parturiens*". But already in 1824 Dr. David Hosack, also American, recognizing the dangers of using ergot for accelerating childbirth, recommended that the drug be used only to control postpartum haemorrhage. Since then ergot has been used in obstetrics mainly for this purpose.[1] (This Dr. Hosack was a distinguished man. He was a physician to many of the eminent New Yorkers of his time, and he accompanied Alexander Hamilton to Weehawken heights for his fatal duel with Aaron Burr. This I learned from the admirable life of Hosack by Christine Robbins.)

The latest and most important chapter in the history of ergot deals with it as a rich source of pharmacologically useful alkaloids.[2] More than thirty alkaloids have been isolated from ergot and it is unlikely that many new ones will be discovered. Hundreds of chemical modifications of these natural alkaloids have been prepared and investigated pharmacologically. Today all these alkaloids are also available by total synthesis.

Medicinally the most useful alkaloids stem from ergot of rye. The first ergot alkaloid that found widespread therapeutic use was ergotamine, isolated by A. Stoll in 1918. It is the essential component of pharmaceutical preparations such as "Cafergot" and "Bellergal", medicaments against migraine and nervous disorders. Modern valuable ergot preparations are "Hydergine" developed by A. Stoll and A. Hofmann in the Sandoz laboratories in Basel, containing hydrogenated ergotoxine alkaloids, used in the treatment of geriatric disorders, and "Dihydergot" with dihydroergotamine as active component, for the therapy of circulatory disturbances.

Of special relevance to our problem here are the investigations into the alkaloid ergonovine, which is the specific uterotonic water-soluble principle of ergot. In 1932 H. W. Dudley and C. Moir in England discovered that water-soluble extracts of ergot, containing none of the water-insoluble alkaloids of the ergotamine-ergotoxine-type, elicited strong uterotonic activity. This observation led three years later to the isolation of the alkaloid responsible for this action simultaneously in four separate laboratories, which named it "ergometrine", "ergobasin", "ergotocine," "ergostetrine", respectively. The International Pharmacopoeia Commission proposed a name to be internationally accepted to replace these synonyms, viz. "ergonovine".

In 1937, starting with naturally occurring lysergic acid, I prepared ergonovine, which by its chemical composition is lysergic acid propanolamide. Lysergic acid is the nucleus common to most ergot alkaloids. It is extracted from special cultures of ergot and could also be prepared today by total synthesis if this procedure were not too expensive. I used the method developed for the synthesis of ergonovine for the preparation of many chemical modifications of ergonovine. One of these partly synthetic derivatives of ergonovine was lysergic acid butanolamide. This is used today in obstetrics, replacing to a major extent ergonovine, under the brand name "Methergine" to stop postpartum haemorrhage.

Another lysergic acid derivative that I synthesized in this context aiming to get an analeptic (that is, an agent with circulation- and respiration-stimulating properties) was lysergic acid diethylamide. Pharmacological examination revealed a fairly strong uterotonic activity in this compound, nearly as strong as ergonovine. In 1943 I discovered in self-experiments the specific high hallucinogenic potency of lysergic acid diethylamide, which became known world-wide under the laboratory code name LSD-25.

My interest in hallucinogenic agents, originating in 1943 from my work with LSD, brought me into personal contact with Gordon Wasson, pioneer ethnomycologist and also pioneer in the investigation of the ancient Mexican mushroom cult. From Roger Heim, then head of the Laboratoire de Cryptogamie and Director of the famous Museum National d'Histoire Naturelle of Paris, whom Wasson invited to study and identify in the field his sacred mushrooms, I received samples of them for chemical analysis. With my laboratory assistant Hans Tscherter I succeeded in isolating the hallucinogenic principles of the sacred Mexican mushrooms, which I named psilocybin and psilocin. With my colleagues of the Sandoz Research Laboratories, we succeeded in the elucidation of the chemical structure and the synthesis of psilocybin and psilocin.

Inspired by my talks with my friend Wasson and encouraged by our success with the hallucinogenic mushrooms, I decided to tackle also the problem of another psychotropic Mexican plant, *ololiuhqui*. With Wasson's help I obtained a large quantity of authentic *ololiuhqui* seeds of the two morning glories that the Mesoamerican Indians were using, seeds of *Turbina corymbosa* (L.) Raf. and *Ipomoea violacea* L. When we analyzed them we arrived at an unexpected result: these ancient drugs that we are apt to call "magical" and the Indians consider divine, contained as their psychoactive principles some of our already familiar ergot alkaloids. The main components were lysergic acid amide and lysergic acid hydroxyethylamide, both water-soluble alkaloids, closely related to lysergic acid diethylamide (LSD), as is evident even to the non-chemist. Another constituent of the *ololiuhqui* alkaloids was ergonovine, the uterotonic principle of ergot.

The psychoactive property of these simple lysergic acid amides, closely related to LSD, is well established. The question presented itself whether ergonovine, being not only an alkaloidal component of ergot but also of *ololiuhqui*, possessed hallucinogenic activity. In the light of its chemical structure this did not seem unlikely: it does not differ much from LSD. But one may ask why, if it is hallucinogenic, this astonishing fact has not been announced, in the light of its use over recent decades in obstetrics. Undoubtedly the answer lies in the extremely low dosage of ergonovine used to stop postpartum bleeding, *viz* 0.1 to 0.25 mg. The effective dose of lysergic acid amide is 1 to 2 mg by oral application. I decided therefore to test in a self-experiment a corresponding dose of ergonovine:

> 1 April 1976
> 12.20 h: 2.0 mg ergonovine hydrogenmaleinate, containing 1.5 mg ergonovine base, ingested in a glass of water.
> 13.00 h: slight nausea, same effect as I have experienced always in my LSD or psilocybin experiments. Tired, need to lie down. With eyes closed colored figures.
> 13.30 h: the trees in the nearby forest seem to live, their branches moving in a threatening way.
> 14.30 h: strong desire to dream, unable to do systematic work, with eyes closed or open afflicted by mollusk-like forms and feelings.
> 16.00 h: motives and colors have become clearer, but bearing still some hidden dangers.
> 17.00 h: after a short sleep I awoke by a kind of inner explosion of all the senses.
> 18.00 h: an unexpected visit forced me to become active, but during the whole evening I lived more in an inner than in the outer world.
> 22.00 h: all effects worn off, normal feeling.

This was an experiment performed without attention to "set and setting" but it proves that ergonovine possesses a psychotropic, mood-changing, slightly hallucinogenic activity when taken in the same amount as is an effective dose of lysergic acid amide, the main constituent of *ololiuhqui*. Its potency is about one-twentieth of the potency of LSD and about five times that of psilocybin.

There is a further finding that may prove to be of utmost importance in considering Wasson's question. The main constituents of the Mexican morning-glory seeds are (a) lysergic acid amide (= "ergine"), and (b) lysergic acid hydroxyethylamide, and these are also the main alkaloids in ergot growing on the wild grass *Paspalum distichum* L. This grass grows commonly all around the Mediterranean basin and is often infected with *Claviceps paspali*. F. Arcamone *et al.*[3] were the first to discover these alkaloids in ergot of *P. distichum*, in 1960.

Within the kinds of ergot produced by the various species of the genus *Claviceps* and its many hosts, cereals and wild grasses, types of ergot do exist that contain hallucinogenic alkaloids, the same alkaloids as in the Mexican hallucinogenic morning-glories. These alkaloids, mainly lysergic acid amide, lysergic acid hydroxyethylamide, and ergonovine, are soluble in water, in contrast to the non-hallucinogenic medicinally useful alkaloids of the ergotamine and ergotoxine type. With the techniques and equipment available in antiquity it was therefore easy to prepare an hallucinogenic extract from suitable kinds of ergot.

What suitable kinds of ergot were accessible to the ancient Greeks? No rye grew there, but wheat and barley did and *Claviceps purpurea* flourishes on both. We analyzed ergot of wheat and ergot of barley in our laboratory and they were found to contain basically the same alkaloids as ergot of rye, viz alkaloids of the ergotamine and ergotoxine group, ergonovine, and sometimes also traces of lysergic acid amide. As I said before, ergonovine and lysergic acid amide, both psychoactive, are soluble in water whereas the other alkaloids are not. As we all know, ergot differs in its chemical constituents according to its host grass and according to geography. We have no way to tell what the chemistry was of the ergot of barley or wheat raised on the Rarian plain in the 2nd millennium B.C. But it is certainly not pulling a long bow to assume that the barley grown there was host to an ergot containing, perhaps among others, the soluble hallucinogenic alkaloids. The famous Rarian plain was adjacent to Eleusis. Indeed this may well have led to the choice of Eleusis for Demeter's temple, and for the growth of the cluster of powerful myths surrounding them and Triptolemus that still exert their spell on us today.

The separation of the hallucinogenic agents by simple water solution from the non-soluble ergotamine and ergotoxine alkaloids was well within the range of possibilities open to Early Man in Greece. An easier method still would have been to have recourse to some kind of ergot like that growing on the grass *Paspalum distichum*, which contains only alkaloids that are hallucinogenic and which could even have been used directly in powder form. As I said before, *P. distichum* grows everywhere around the Mediterranean basin. During the many centuries when the Eleusinian Mysteries were thriving and holding the antique Greek world enthralled, may not the hierophants of Eleusis have been broadening their knowledge and improving their skills? For the Greek world as for us, the Mysteries are linked to Demeter and Kore, and they and Triptolemus are the famed mythical progenitors of cultivated wheat and barley. But in the course of time the hierophants could easily have discovered *Claviceps paspali* growing on the grass *Paspalum distichum*. Here they would be able to get their hallucinogen direct, straight and pure. But I mention this only as a possibility or a likelihood, and not because we need *P. distichum* to answer Wasson's question.

Finally we must also discuss an ergot parasitical to a wild grass called in scientific nomenclature *Lolium temulentum* L. In English this is most widely known as darnel or cockle or (in the Bible) tares, a weed that plagues grain crops. It is sometimes called "wild rye grass", an unfortunate name because wild rye has nothing to do with rye: the rye of "wild rye grass" is of utterly different etymology. In classic Greek darnel was *aira* and in classic Latin was *lolium*. Its name in French is *ivraie* and in German *Taumellolch*, both names pointing to a belief in its psychotropic activity in the folk knowledge of the traditional European herbalists. A citation for *ivraie* in A. D. 1236 has been found, and it must go back much further than that.

Analysis of *Lolium temulentum* in my laboratory and an extended botanical, chemical, and pharmacological investigation by I. Katz[4] showed that the plant itself contains no alkaloids nor does it possess any pharmacological activity. But the Lolium species (*L. temulentum* and *L. perenne*) are notoriously prey to the Claviceps fungus. The psychotropic reputation of darnel must therefore be attributed to its parasitic infection by ergot. Samples of ergot grown on *L. temulentum* and *L. perenne* collected in Germany, France, and Switzerland showed large variation in their alkaloidal composition. Some contained substantial amounts of ergonovine together with alkaloids of the ergotamine and ergotoxine group.[5] A species of ergot growing on darnel may have existed in ancient Greece that contained mainly hallucinogenic alkaloids of ergot such as we have found in ergot of Paspalum.

In conclusion I now answer Wasson's question. The answer is yes, Early Man in ancient Greece could have arrived at an hallucinogen from ergot. He might have done this from ergot growing on wheat or barley. An easier way would have been to use the ergot growing on the common wild grass Paspalum. This is based on the assumption that the herbalists of ancient Greece were as intelligent and resourceful as the herbalists of pre-Conquest Mexico.

Albert Hofmann

1. The standard monograph on the botany and history of ergot is G. Barger: *Ergot and Ergotism*, Gurney and Jackson, London, 1931.
2. The results of the chemical, pharmacological, and medicinal investigations on ergot alkaloids carried out in laboratories all over the world are reviewed in the monograph by A. Hofmann: *Die Mutterkornalkaloide*, F. Enke Verlag, Stuttgart, 1964.
3. Arcamone, F., Bonino, C., Chain, E. B., Ferretti, A., Pennella, P., Tonolo, A., and Vero, L.; *Nature* (London) 187, 238 (1960).
4. Katz, I.: Contribution à Etude de l'ivraie enivrante (*Lolium temulentum* L.). Thèse présentée a l'Ecole Polytechnique Federale, Zurich, 1949.
5. Kobel, H., Sandoz Research Laboratories, Basel. Private communication.

III. Solving the Eleusinian Mystery

by Carl A. P. Ruck

We are told that there once was a young Athenian who was much taken with the beauty of a courtesan in one of the brothels of Corinth. His attempts to repay her favors in some special way were continually frustrated by the madam, who insisted upon confiscating all private gifts. To give the girl something that would be hers alone, he hit upon the idea of offering her an immaterial, and thereby inalienable, benefit: he would pay the expenses for her introduction into the blessed community of those who had witnessed the secret religious ceremony practiced at the village of Eleusis. That sight was generally considered the culminating experience of a lifetime. And so she was allowed to travel to Athens, together with the madam and a younger girl from the brothel. The lover lodged them all with a friend while they prepared themselves by the preliminary rites. The full sequence would require more than half a year's residence in Athens. Then at last, amidst the throng of thousands who each autumn for the first and only time made the pilgrimage, they too walked the Sacred Road, crossing the narrow bridge that still today can be seen, now submerged in the brackish waters of the swamp that once divided Athens from the territory of its neighboring village, some fourteen miles distant, a region sacred for its special affinity with the realm of departed spirits, who were thought to insure the fertility of the adjacent plain of grain. The procession of pilgrims symbolically passed the frontier between worlds, a momentous journey characterized by its difficulty, for the bridge was expressly constructed too narrow for vehicular traffic and ahead, just as they arrived at the village itself, it was traditional that they would be obscenely insulted by masked men, who lined the bridge across the final boundary of water.

Each year new candidates for initiation would walk that Sacred Road, people of all classes, emperors and prostitutes, slaves and freemen, an annual celebration that was to last for upwards of a millennium and a half, until the pagan religion finally succumbed to the intense hatred and rivalry of a newer sect, the recently legitimized Christians in the fourth century of our era. The only requirement, beyond a knowledge of the Greek language, was the price of the sacrificial pig and the fees of the various priests and guides, a little more than a month's wages, plus the expense of the stay in Athens.

Every step of the way recalled some aspect of an ancient myth that told how the Earth Mother, the goddess Demeter, had lost her only daughter, the maiden Persephone, abducted as she gathered flowers by her bridegroom, who was Hades or the lord of death. The pilgrims called upon Iakchos as they walked. It was he who was thought to lead them on their way: through him, they would summon back the queen Persephone into the realm of the living. When at last they arrived at Eleusis, they danced far into the night beside the well where originally the mother had mourned for her lost Persephone. As they danced in honor of those sacred two goddesses and of their mysterious consort Dionysus, the god of inebriants, the stars and the moon and the daughters of Ocean would seem to join in their exultation. Then they passed through the gates of the fortress walls, beyond which, shielded from profane view, was enacted the great Mystery of Eleusis.

It was called a mystery because no one, under pain of death, could reveal what happened within the sanctuary. My colleagues and I, working from hints in numerous sources, have ventured to go beyond that forbidden gate.

Ancient writers unanimously indicate that something was seen in the great *telesterion* or initiation hall within the sanctuary. To say so much was not prohibited. The experience was a vision whereby the pilgrim became someone who saw, an *epoptes.*

The hall, however, as can now be reconstructed from archaeological remains, was totally unsuited for theatrical performances; nor do the epigraphically extant account books for the sanctuary record any expenditures for actors or stage apparatus. What was witnessed there was no play by actors, but *phasmata*, ghostly apparitions, in particular, the spirit of Persephone herself, returned from the dead with her new-born son, conceived in the land of death. The Greeks were sophisticated about drama and it is highly unlikely that they could have been duped by some kind of theatrical trick, especially since it is people as intelligent as the poet Pindar and the tragedian Sophocles who have testified to the overwhelming value of what was seen at Eleusis.

There were physical symptoms, moreover, that accompanied the vision: fear and a trembling in the limbs, vertigo, nausea, and a cold sweat. Then there came the vision, a sight amidst an aura of brilliant light that suddenly flickered through the darkened chamber. Eyes had never before seen the like, and apart from the formal prohibition against telling of what had happened, the experience itself was incommunicable, for there are no words adequate to the task. Even a poet could only say that he had seen the beginning and the end of life and known that they were one, something given by god. The division between earth and sky melted into a pillar of light.

These are the symptomatic reactions not to a drama or ceremony, but to a mystical vision; and since the sight could be offered to thousands of initiates each year dependably upon schedule, it seems obvious that an hallucinogen must have induced it. We are confirmed in this conclusion by two further observations: a special potion, as we know, was drunk prior to the visual experience; and secondly, a notorious scandal was uncovered in the classical age, when it was discovered that numerous aristocratic Athenians had begun celebrating the Mystery at home with groups of drunken guests at dinner parties.

To identify the Eleusinian drug, we must first find the pattern of meaning that underlies the Mystery. The sacred myth that narrates the events involved in the founding of the Mystery is recorded in the so-called Homeric hymn to Demeter, an anonymous poem dating from the seventh century B.C., seven centuries later than the probable date of the first performance of the ceremony. In it we are told how the goddess Persephone was abducted by her bridegroom Hades to the realm of the dead when she picked a special hundred-headed *narkissos* while gathering flowers with the daughters of Ocean in a place called Nysa. All Greek words ending in *-issos* derive from the language spoken by the agrarian cultures dwelling in the Greek lands before the coming of the migrating Indo-European Greeks. The Greeks themselves, however, thought that the *narkissos* was so-named because of its narcotic properties, obviously because that was the essential nature or symbolism of Persephone's flower. The marital abduction or seizure of maidens while gathering flowers is, moreover, a common theme in Greek myths and Plato records a rationalized version of such stories in which the companion of the seized maiden is named Pharmaceia or, as the name means, the "use of drugs". The particular myth that Plato is rationalizing is in fact one that traced the descent of the priesthood at Eleusis. There can be no doubt that Persephone's abduction was a drug-induced seizure.

That fact has never been noticed by Classicists, despite its absolute expectability in terms of what we know about the religions of the agrarian peoples who preceded the Greeks. Those religions centered upon the female's procreativity and the cyclical rebirth and death of both plants and mankind. She was the Great Mother and the entire world was her Child. The essential event in those religions was the Sacred Marriage, in which the priestess periodically communed with the realm of spirits within the earth to renew the agricultural year and the civilized life that grew upon the earth. Her male consort was a vegetative spirit, both her son who grew from the earth and the mate who would abduct her to the fecundating other realm as he possessed her upon his death. When the roving Indo-Europeans settled in the Greek lands, their immortal Father God of the sky, who was Zeus, became assimilated to the pattern of the dying and reborn vegetative consort of the Great Mother. There are indications of this assimilation in the traditions about the Zeus who was born and died in Crete. Furthermore, archaeological remains from the Minoan-Mycenaean period of Greek culture frequently depict visionary experience encountered by women engaged in rituals involving flowers. The priestesses or goddesses themselves occur as idols decorated with vegetative motifs, accompanied by their serpent consort or crowned with a diadem of opium capsules. Moreover, the myths that narrate the founding of the various Mycenean citadels show, as we might expect, recurrent variations upon the Sacred Marriage enacted between the immigrant founder and the autochthonous female in ecstatic contexts. Most interesting among these are the traditions about Mykenai (Mycenae) itself, for it was said to have been founded when the female of that place lost her head to the male of the new dynasty, who had picked a mushroom. The etymology of Mykenai, which was recognized in antiquity but has been repeatedly rejected by modern scholars, is correctly derived from Mykene, the bride of the *mykes* or mushroom. Fungoid manifestations of the vegetative consort in the Sacred Marriage can also be detected in the symbolism of the founding fathers at other Mycenaean sites, perhaps because that particular wave of immigrants brought knowledge of the wild and untameable mushroom with them on their movement south into the Greek lands. At Athens in the classical period, the ancient Sacred Marriage was still celebrated annually by the wife of the sacral head of state: in the month of February, she would unite with the god Dionysus.

It was as Dionysus that the Zeus who had been assimilated as consort to the Mother Goddess survived into the classical period. His name designates him as the Zeus of Nysa, for Dios is a form of the word Zeus. Nysa was not only, as we have seen, the place where Persephone was abducted, but also the name for wherever was enacted that same nuptial encounter involving the passion of Dionysus' birth and death. When he possessed his women devotees, the maenads or bacchants, he was synonymous with Hades, the lord of death and bridegroom to the goddess Persephone. The maenads, like Persephone, also gathered flowers. We know this because their emblem was the *thyrsos*, a fennel stalk stuffed with ivy leaves; such hollow stalks were customarily used by herb gatherers as receptacles for their cuttings, and the ivy that was stuffed into the maenads' stalks was sacred to Dionysus and reputed to be a psychotropic plant.

Dionysus, however, could possess his ecstatic brides through the agency of other plants as well, for he was the vegetative consort residing in all manner of inebriants, including apparently certain of the fungi. The stipe, by analogy to the maenads' emblem, was also called a *thyrsos*, with the mushroom's cap substituted for the psychotropic herbs. Dionysus himself was born prematurely in the mystical seventh month during a winter snowfall when his celestial father struck his earth bride Semele at Thebes with a bolt of lightning; in the same manner mushrooms were thought to be engendered wherever lightning struck the earth. The father of Dionysus was another Dionysus, as would be expected in a Sacred Marriage, for the child born at the time of the earth's renewal is identical with the ingested consort who will reunite his mother-bride with the awesome nether realm from which life must forever be reborn. Thus not surprisingly we are told that Semele also conceived Dionysus when she drank a potion compounded of her own son's heart. So too was Dionysus like his father also called the thunderer, for despite the gentleness of his infancy and his sometimes effeminate appearance, he could suddenly metamorphose into the virulence of his full manhood, in which form he was a bull, rending the earth, as at his birth, announced by a bellowing, the mykema that signified the presence of the *mykes* or mushroom. His symbol was the phallos itself, by a common metaphor also called the *mykes.*

It was with the vine, however, and its fermented juice that Dionysus was chiefly associated. Mushrooms themselves in fact were considered a fermentation of the earth, a perfect symbol of rebirth from the cold realm of putrefaction that was the mouldy other world. A similar process was sensed in the frothing turmoil whereby the fungal yeast converted grapes into wine. In wine the god had found his greatest blessing for mankind; here his untameable, wild nature had succumbed to domestication. He himself was said to have first discovered the properties of this plant that had grown from the spilled blood of the gods when he noticed a serpent drinking its toxin from the fruit, for serpents were thought to derive their poisons from the herbs they ate, just as conversely it was said that serpents could transfer their toxins to plants in their vicinity. Dionysus taught man the way to calm this gift's violent nature by diluting it with water. And customarily it was mixed with water that the Greeks drank their wines.

This custom of diluting wine deserves our attention since the Greeks did not know the art of distillation and hence the alcoholic content of their wines could not have exceeded about fourteen percent, at which concentration the alcohol from natural fermentation becomes fatal to the fungus that produced it, thereby terminating the process. Simple evaporation without distillation could not increase the alcoholic content since alcohol, which has a lower boiling point than water, will merely escape to the air, leaving the final product weaker instead of more concentrated. Alcohol in fact was never isolated as the toxin in wine and there is no word for it in ancient Greek. Hence the dilution of wine, usually with at least three parts of water, could be expected to produce a drink of slight inebriating properties.

That, however, was not the case. The word for drunkenness in Greek designates a state of raving madness. We hear of some wines so strong that they could be diluted with twenty parts of water and that required at least eight parts water to be drunk safely, for, according to report, the drinking of certain wines straight actually caused permanent brain damage and in some cases even death. Just three small cups of diluted wine were enough in fact to bring the drinker to the threshold of madness. Obviously the alcohol could not have been the cause of these extreme reactions. We can also document the fact that different wines were capable of inducing different physical symptoms, ranging from slumber to insomnia and hallucinations.

The solution to this apparent contradiction is simply that ancient wine, like the wine of most early peoples, did not contain alcohol as its sole inebriant but was ordinarily a variable infusion of herbal toxins in a vinous liquid. Unguents, spices, and herbs, all with recognized psychotropic properties, could be added to the wine at the ceremony of its dilution with water. A description of such a ceremony occurs in Homer's *Odyssey*, where Helen prepares a special wine by adding the euphoric *nepenthes* to the wine that she serves her husband and his guest. The fact is that the Greeks had devised a spectrum of ingredients for their drinks, each with is own properties.

Thus the wine of Dionysus was the principle medium whereby the classical Greeks continued to partake of the ancient ecstasy resident in all the vegetative forms that were the Earth's child. In social situations, the drinking was regulated by a leader, who determined the degree of inebriation that he would impose upon the revelers as they ceremonially drank a measured sequence of toasts. At sacral events, the wine would be more potent and the express purpose of the drinking was to induce that deeper drunkenness in which the presence of the deity could be felt.

The herbal inebriants that figured in these Dionysian rites of drinking required magical procedures when the herbs were gathered. As wild beings whose spirits were akin to their particular guardian animals, the plants were the objects of a hunt. And the ecstatic rapture they might induce in religious contexts inevitably identified them as sexual forces.

Thus the female devotees of the god Dionysus appropriately bore the *thyrsos* as their emblem as they roamed the winter mountainsides in search of the so-called vine that grew suddenly with earth-rending thunder and the bellowing of bulls amidst their night-long dancing; that beloved child, the age-old serpent consort, was the object of their hunt, who was suckled, then like a beast torn to pieces and eaten raw; his own mothers, as was often claimed, were guilty of cannibalism eating his flesh, for like mothers the women would have brought the drug into being, harvesting and compounding it with the help of the god's so-called nurses, in whose loving care he would grow to manhood, eventually to possess them as his brides. Such ceremonies enacted the sacred nuptials of the city's women, who thereby entered the awesome alliance with the nether lord, upon whose realm depended the growth of all this world's fertility of plants and man.

Persephone's abduction at Nysa was prototypic of that first nuptial between the realms, the primal experience of death. In the hunting place called Agrai, in the month of February, which was called the time of flowers, the candidates for the coming initiation at Eleusis experienced in some way the death of Persephone through the ritual mimeses of those Dionysian events. That occurrence was termed the Lesser Mystery and it was considered a preliminary for the vision of the Greater Mystery that would take place at the time of the autumn sowing in September.

The Greater Mystery was the complement of the Lesser, for it centered upon redemption instead of death, the triumphant return of Persephone from Hades with the infant son she had conceived during her sojourn in communion with the spiritual realm. The Homeric hymn, after its account of Persephone's fatal nuptial encounter, goes on to tell how Demeter came to establish the Greater Mystery. In grief for her lost daughter, she went to Eleusis. Her journey there is a sympathetic imitation of Persephone's entrance into the citadel of Hades, for Eleusis was a simulacrum of the other word, where Demeter too would experience the ominous chthonic phase of her womanhood, not as sacred queen to the lord of death, but as witch and wet-nurse in his house, for when Persephone progresses beyond maidenhood, her mother must make way, relinquishing her former role and moving on to the third stage, when a woman's aging womb brings her once again into proximity with the powers of death. These chthonic or earth-oriented phases of womanhood were symbolized in the goddess Hecate, whose triform body expressed the female's totality as bride, wife, and aged nurse in Hades' realm.

At Eleusis, Demeter first attempts to assuage her grief by negating the possibility of the world of death to which she has lost her daughter. She does this by nourishing the royal prince with immortality. His mother, however, objects, for she cannot understand or accept a system that would inevitably alienate the son from his own mother's realm as irredeemably as Persephone from Demeter.

Demeter again attempts a solution, this time an eternity of death, in which she and the maiden would stay forever in their chthonic phase. She causes a plague of sterility so that no life can emerge from the earth. This solution, however, leaves no role for the immortal deities of the sky, whose delicate balance with the forces of the earth is dependent upon the continuing worship of mortal men, who share with them the fruits of life.

The final solution is to heal the universe into which death has now intruded by admitting also the possibility of return into life. Rebirth from death was the secret of Eleusis. In Hades, Persephone, like the earth itself, takes seed into her body and thereby eternally comes back to her ecstatic mother with her new son, only to die as eternally in his fecundating embrace. The sign of the redemption was an ear of barley, the risen grain, that following the Mystery would be committed once again to the cold earth in the sowing of the sacred plain adjacent to Eleusis.

This was the final mediation that Demeter taught to a second of the royal princes in the citadel of Eleusis. His name was Triptolemus, the trifold warrior, and he becomes the apostle of the new faith, traveling throughout the world on a serpent chariot spreading the gospel of the cultivation of grain. His exact identity was part of the secret of the Mystery, for the various traditions about his parentage suggest that the initiates learned that, like the grain that was his emblem, he was actually the son of the trifold females who were the queens in the house of the lord of death. He was, therefore, another form of Dionysus, who in a similar fashion also was an apostle, traveling in the same manner of cart on his journey teaching man the cultivation of the vine. The pattern indicated in these Eleusinian apostleships clearly signifies the transition from wild botanic growth to the arts of cultivation upon which civilized life must depend.

In the various Eleusinian mythical traditions, several other male figures symbolize a similar transmutation of the wild horror and loss that is death into the ravishingly handsome young man who is born from Hades' realm in pledge of the coming redemption. In one such tradition, he is Iakchos (Iacchus), the joyous Dionysian male who led the initiates toward their vision of salvation; in another, Eubuleus, the serene personification of the cosmological plan wherein the celestial immortals collaborated with the forces of death to show humankind its proper role; in a third, Zagreus, the enigmatic hunting companion of his ecstatic brides. The fourth and most perfect of these transmuted figures is Ploutos, the personification of the wealth that stems from the fertility of man and field. The initiate could expect that this beneficent representative of death would thereafter become welcome in his house as his constant guest, joined by ties of friendship. This Ploutos was originally the vegetative son of Demeter in her more ancient days as Great Mother on Crete, where she conceived him in a thrice plowed field when she united with her intoxicating mate whose name was Iasion, which means "the man of the drug".

Triptolemus, however, was the paramount transmutation, Demeter's special response to the problem of death. It was his sacred barley, solemnly grown in the Rarian plain and threshed on his floor, that was the principle ingredient in the potion drunk by the initiates in preparation for the culminating vision. The formula for that potion is recorded in the Homeric hymn. In addition to the barley, it contained water and a fragrant mint called blechon. The mint initially would seem the most likely candidate for the psychoactive agent in the potion, except that all our evidence about this particular mint indicates that it was unsuitable, being neither sufficiently psychotropic to warrant the danger of profane usage nor appropriately revered as the secret drug. Rather, it was openly despised as a sign of the illicit union of man and woman in lustful concubinage without the sacrament of marriage. To just such an unsanctified abduction Demeter had lost her daughter at Nysa and accordingly we are told that the mother vented her displeasure by changing the prostitute of Hades into mint, thereupon grinding and bruising her botanic body. The final Eleusinian solution, on the other hand, will reconcile the mother to the daughter's loss through legitimatizing the nuptial abduction in the rite of matrimony, whereby an heir can accede to the dynastic house. Barley and not mint is the revelation at Eleusis, and it is to it that we must look for the sacred drug.

With the cultivation of grain, man had left his wild, nomadic ways and settled in cities, giving to the earth in order to receive back its harvest. All civilized institutions derived from this delicate accord struck with the dark, cold forces of death. Grain itself was thought to be a hybrid, carefully evolved from more primitive grasses. If not tended with proper care, it could be expected to revert to its worthless, inedible avatar. That primitive sibling to grain was thought to be the plant called *aira* in Greek, *Lolium temulentum* in botanical nomenclature, or commonly in English wild ryes, darned cockle, ivray, or finally "tares" in the Bible. This weed is usually infested with a fungoid growth, *Claviceps purpurea*, ergot or rust, a reddening corruption to which barley was thought to be particularly susceptible. *Aira*, therefore, doubly endangered the cultivated staff of life, first as the renascent primordial grass and secondly as the host for the encroaching ergot infection. The revertive tendency of the infected grain, furthermore, was all too obvious, for when the sclerotia fell to the ground there grew from them not grain but tiny purple mushrooms, the fruiting bodies of the ergot fungus, clearly a return to the species of the unregenerate, wild Dionysian abductor.

Unlike the seedless mushroom, however, ergot would have seemed akin to the kernels of grain that were its host. As well as grain, therefore, it too was Demeter's plant, for she could wear its distinctive color as her robe or on her feet or be named with its epithet, Erysibe. The hallucinogenic properties of *Claviceps* were recognized in antiquity, and thus we may surmise that the parallel apostleships of the barley and the vine would have signified analogous transmutations wherein the chthonic spirits submitted to cultivation. Wine, however, was Dionysus' realm, the liquid that gave sleep like death and forgetfulness, whereas Demeter was the earth, dry with the harvest upon which man fed to live. Grain was her sacrament. Upon first coming to Eleusis, Demeter had refused the cup of wine and the initiates thereafter imitated her abstention in deference to the superior symbolism of the potion of barley.

Clearly ergot of barley is the likely psychotropic ingredient in the Eleusinian potion. Its seeming symbiotic relationship to the barley signified an appropriate expropriation and transmutation of the Dionysian spirit to which the grain, Demeter's daughter, was lost in the nuptial embrace with earth. Grain and ergot together, moreover, were joined in a bisexual union as siblings, bearing at the time of the maiden's loss already the potential for her own return and for the birth of the phalloid son that would grow from her body. A similar hermaphroditism occurs in the mythical traditions about the grotesquely fertile woman whose obscene jests were said to have cheered Demeter from her grief just before she drank the potion.

This solution to the Mystery of Eleusis is made still more probable by a papyrus fragment that was brought to my attention by our translator of the Homeric hymn. The fragment preserves a portion of the *Demes*, a comedy by Eupolis written shortly after the scandal of the profanation of the Mystery in the fifth century B.C. It confirms that the profanation did indeed entail the drinking of the sacred *kykeon* and suggests that our identification of the drug it contained is correct. In the comedy, an informer explains to a judge how he had come upon someone who had obviously been drinking the potion since he had barley groats on his moustache. The accused had bribed the informer to say that it was simply porridge and not the potion that he had drunk. By a possible pun, the comedian may even indicate that the incriminating "crumbs of barley" were "purples of barley".

Thus we may now venture past the forbidden gates and reconstruct the scene within the great initiation hall at Eleusis. The preparation of the potion was the central event. With elaborate pageantry, the hierophant, the priest who traced his descent back to the first performance of the Mystery, removed the sclerotia of ergot from the free-standing room constructed inside the *telesterion* over the remains of the original temple that had stood there in Mycenaean times. As he performed the service, he intoned ancient chants in a falsetto voice, for his role in the Mystery was asexual, a male who had sacrificed his gender to the Great Goddess. He conveyed the grain in chalices to the priestesses, who then danced throughout the hall, balancing the vessels and lamps upon their heads. The grain was next mixed with mint and water in urns, from which the sacred potion was then ladled into the special cups for the initiates to drink their share. Finally, in acknowledgment of their readiness, they all chanted that they had drunk the potion and had handled the secret objects that had come with them on the Sacred Road in sealed baskets. Then, seated on the tiers of steps that lined the walls of the cavernous hall, in darkness they waited. From the potion they gradually entered into ecstasy. You must remember that this potion - an hallucinogen - under the right set and setting, disturbs man's inner ear and trips astonishing ventriloquistic effects. We can rest assured that the hierophants, with generations of experience, knew all the secrets of set and setting. I am sure that there was music, probably both vocal and instrumental, not loud but with authority, coming from hither and yon, now from the depths of the earth, now from outside, now a mere whisper infiltrating the ear, flitting from place to place unaccountably. The hierophants may well have known the art of releasing into the air various perfumes in succession, and they must have contrived the music for a crescendo of expectation, until suddenly the inner chamber was flung open and spirits of light entered the room, subdued lights I think, not blinding, and among them the spirit of Persephone with her new-born son just returned from Hades. She would arrive just as the hierophant raised his voice in ancient measures reserved for the Mystery: "The Terrible Queen has given birth to her son, the Terrible One". This divine birth of the Lord of the Nether World was accompanied by the bellowing roar of a gong-like instrument that outdid, for the ecstatic audience, the mightiest thunderclap, coming from the bowels of the earth.

Some Christian bishops, in the last days of the Mystery, thought they had discovered and could reveal the secret of Eleusis. One said that in this pagan rite there was materialized a stalk of barley. How true according to his limited lights, yet how utterly false. The Bishop had not known the night of nights at Eleusis. He was like one who has not known LSD or the mushrooms of Mexico or the morning-glory seeds. For close on to two thousand years a few of the ancient Greeks passed each year through the portals of Eleusis. There they celebrated the divine gift to mankind of the cultivated grain and they were also initiated into the awe some powers of the nether world through the purple dark of the grain's sibling that Dr Hofmann has once again made accessible to our generation. The myths of Demeter and Persephone and all their company fit our explanation in every respect. Nothing in any of them is incompatible with our thesis.

Until yesterday we knew of Eleusis only what little a few of the initiates told us but the spell of their words had held generations of mankind enthralled. Now, thanks to Dr Hofmann and Gordon Wasson, those of us who have experienced the superior hallucinogens may join the fellowship of the ancient initiates in a lasting bond of friendship, a friendship born of a shared experience of a reality deeper far than we had known before.

Carl A. P. Ruck

IV. Ancillary Data

by R. Gordon Wasson, Albert Hofmann, and Carl A. P. Ruck

A Greek scholar, writing just half a century ago, did not hesitate to dismiss the worship of Demeter at Eleusis as "trivial and absurd; but," he added, "there can be no doubt that it did much to satisfy the emotional side of the religious instincts of the Greeks. Its modern analogue is perhaps the Salvation Army." We trust that our own comparisons will be less bizarre than his. In our generation we enjoy the advantage of having rediscovered the hallucinogenic experience. Moreover, the value of interdisciplinary collaboration is that it gives us access to knowledge otherwise apt to be beyond the reach of scholars. Our joint effort has yielded a radical answer to our problem: it sets the stage for much reexamination of traditional opinions about the classical Greeks and their tragic literature in celebration of the god Dionysus.

The ancient testimony about Eleusis is unanimous and unambiguous. Eleusis was the supreme experience in an initiate's life. It was both physical and mystical: trembling, vertigo, cold sweat, and then a sight that made all previous seeing seem like blindness, a sense of awe and wonder at a brilliance that caused a profound silence since what had just been seen and felt could never be communicated: words are unequal to the task. Those symptoms are unmistakably the experience induced by an hallucinogen. To reach that conclusion, we have only to show that the rational Greeks, and indeed some of the most famous and intelligent amongst them, could experience and enter fully into such irrationality.

Eleusis was different from the convivial inebriation of friends at a *symposion* or the drunken *komos* revel at the festivals of drama. Eleusis was something for which even the maenadic ecstasy of the mountain women was only partial preparation. In their various ways, other Greek cults too enacted aspects of the ancient communion practiced between gods and men, between the living and the dead, but it was at Eleusis alone that the experience occurred with overwhelming finality: here alone was the grand design fulfilled of the maiden resurrected with her son conceived in death, and of the ear of barley that like her had sprouted beneath the earth. By this resurrection was validated the continuance of all that a Greek held most dear, the civilized way of life that, beyond each city's constitution, was the Greek heritage, evolved out of aboriginal primitivism just as all life too came from the beneficent accord with the lord of death. Here indeed is a rich full-bodied myth, filled with contradictions like all the myths of an unlettered age, one saying this and another saying that and a third saying something else, but somehow in the end harmonizing into one whole, a myth that for the Greeks explained the beginning and the end of things.

Months of learning and rituals preceded the revelation on the Mystery night, each action programming in further detail the meaning and substance, the full ramifications of the vision that lay ahead. At last the initiates would sit on the steps in the initiation hall. It was all done now except for the finale. They had learned the secret version of the sacred myth, they had bathed in the sea, abstained from various tabu foods and drinks, sacrificed a pig, taken the long walk along the Sacred Way from Athens, and made the perilous crossing of the final division of water before their arrival at the city of their Eleusinian hosts. Outside the sanctuary walls, there was the night-long dance beside the Maiden's Well on the very ground that the goddess had visited. Then there was the fast and the momentous entrance into the forbidden territory past the cave that was an entrance to Hades and the rock where Demeter had sat in grief. In the initiation hall, there was the final ceremonial dance of the priestesses carrying the chalice of grain upon their heads as they mixed and distributed the sacred potion: fragrant *blechon*, the despised herb associated with the illicit nature of the abduction, immersed in water to which was added a sprinkling of flour from barley grown in the Rarian plain. The barley's potential as the foodstuff for mankind depended upon keeping at bay the encroachment of the reddening corruption that would draw it back to its worthless avatar, the rust-infested weed. Like the *blechon*, the weed too was thus associated with primitivism and the ways of life before the institutions of society brought man to a higher mode of existence. Of these two plants the initiates drank and then paused expectant for redemption while the hierophant chanted the ancient words. Then, suddenly, there was light and the boundaries on this world burst their bounds as spiritual presences were felt in their midst and the hall was flooded with glowing mystery.

From beginning to end here there was a reenactment of a sacred drama in which the initiates as well as the officiants had their role to play, until at last they experienced as actors the ineffable, all of their senses and emotions being shot through with what would thereafter be forever the unspeakable.

As the initiates passed through the lengthy proceedings, they were admitted to many secrets, but the hierophants may well have withheld from them the Secret of Secrets: the sacred water of the potion had already soaked up in the right dosage from the immersed ergot what it contained of ergine and ergonovine, as we call them today. But the hierophants were certainly, through the centuries, seeking ways to improve their technique, their formulae. In the course of those two millennia may they not have discovered a kind of ergot that contains solely the hallucinogenic alkaloids such as has been found in modern times in ergot of *Paspalum distichum*? Indeed herbalists other than the hierophantic families may have shared in this discovery and it may have been their knowledge that prompted the rash of profanations in B.C. 415. The inside story of those events will never be known but that there was a story to tell is certain.

In unlettered cultures the knowledge of the herbalist - the knowledge of the properties of plants and their use - was everywhere a body of secret lore passed on by word of mouth from herbalist to apprentice and sometimes from one herbalist to another. The apprenticeship took years before one practiced on one's own, and one never stopped learning. There were questions of dosage, of side effects, of proper plant ingredients that became poisons when taken to excess. In Mexico Bernardino de Sahagun and Francisco Hernandez were gifted Spaniards and they spent endless effort and time to take down from the Indians the virtues of various Mexican plants. But they were Europeans who knew not the American plant world, and in their European world they were certainly not what we would call botanists or herbalists. Their intentions were good but their ignorance was complete. What they have to tell us about the hallucinogens is childish. They could have tried the hallucinogens but elected not to do so, spurned the chance. What a different story they would have told us if they had lived for a number of years as apprentices of the Indian *sabios*.

In the Homeric hymn to Demeter, on arriving at Eleusis, tired and disconsolate over the loss of her daughter Persephone, Demeter was offered a drink of wine, which she declined. Since every act in this narrative had mythic meaning, it seems that drinking the alcoholic beverage did not go with the drinking of the divine potion called kykeon. The two kinds of inebriation were incompatible. In Mexico those who will take the mushrooms know that they must refrain from drinking alcoholic beverages for four days before the *velada*, as the mushroom celebration is called. Alcoholic inebriation would profane, would defile, the divine draught, alike in Mexico and Greece.

The Eleusinian Mysteries were in the exclusive hands of the Eumolpus and Kerykes families. For close to two thousand years, these hierophants governed with autocratic authority the rites at Eleusis. By contrast, in the sacred mushroom country of Mexico every village has its *sabios* ("wisemen") who are the custodians of the rite. (In some remote Mixe villages the individual families take the mushrooms when they feel the need, without the guidance of a sabio. Whether this informal practice in the Mixe country marks a breakdown in the rite or the survival of an earlier archaic procedure, we do not know.) In Greece the "initiate" took the potion only once in his life, and thus he could not compare successive experiencies. In Mexico one may consult the mushroom whenever a grave family problem presents itself. Some Indians choose never to take the mushroom, others only once, yet others intermittently. The newcomer to the experience is constantly warned that ingesting the hallucinogen is in the highest degree *delicado*, "delicate" with a connotation of grave danger.

At Eleusis and in Mexico certain items of food were proscribed for some time before the big night. It is impossible to compare the dietary exclusions, so different are the foods, except that in both cases eggs are tabu. Fasting was practiced in Greece and also in Mexico, from the morning throughout the day: in both cases one faced the night on an empty stomach. In Mexico before the Conquest it was the practice in aristocratic circles to drink nourishing chocolate spiked with the inebriating mushrooms, in this way breaking the fast as the events of the night were launched on their course. Owing to the silence enjoined on everyone who had taken part in the Mystery, there are scarcely any hints as to what happened in the writers of the flourishing period of Eleusis, but in the early centuries of the Christian era, with Eleusis breaking down, we discover a few references, obscure, inhibited, that may permit us some uncertain glimpses. We find mention of a collation served to the initiates when a large cake called the *pelanos*, made of barley and wheat harvested in the adjacent sacred Rarian plain, was broken into pieces and the portions served to all. In the sources one hears of a bond of alliance and friendship that sprang up among the initiates, and some have suggested that this sprang from the collation they had shared together. It is not incompatible with the Greek texts to suppose that the collation paralleled the breaking of the fast in Mexico, the *pelanos* taking the place of the chocolate. But surely the bond of alliance and friendship had nothing to do with the collation: nothing so jejune would have sufficed. The overwhelming effect of the night under the influence of an hallucinogen gives natural birth to a feeling of shared supernatural experience never to be forgotten, a feeling of *cofradia*, of brotherhood. Two of us have known this personally in Mexico: those who pass through a *velada*, in the right set and setting, live through an awesome experience, and feel welling up within them a tie that unites them with their companions of that night of nights that will last for as long as they live. Here we think is the bond of alliance and friendship of which the Greek sources speak obscurely.

Then there is the matter of secrecy. In Mexico nothing had been heard of the sacred mushrooms in sophisticated circles since the early friars mentioned them briefly in the sixteenth and seventeenth centuries. It has been said that the mushrooms were a "secret" of the Indians living in the highlands of southern Mexico. Our own little group flushed them out into the open. But we think this "secret" was never really a secret. In the Indian communities everyone knew about them and also about the morning-glory seeds. Every villager could, if he wished, learn the art of recognizing the sacred mushrooms and many did so. There was a small trade in the mushrooms, supplying the demand among the natives who had moved to the cities and who still wished to "consult" them. The Church had originally opposed them and the Holy Office of the Inquisition in the sixteenth and seventeenth centuries tried to stamp out the native use of them by vigorous persecutions. They failed, of course, but the natural mycophobia of the Spanish population, their contempt for peculiar native practices, and the similar attitude of the French, the Germans, and the English who later came to know Mexico led naturally to an absence of communication between the natives and the occupying races on matters that lay closest to the Indians' hearts. It is small wonder that the sacred mushrooms, after an abortive spate of notices, hopelessly inadequate, in the writings of the early friars, have remained unknown to the world to our own times. The Indians would not take the initiative in speaking about them. The "secrecy" was not a conspiracy of silence: it was imposed on the Indians by the White Man, owing to the lack of intelligent and sympathetic curiosity in the elite of the White circles.

The secrecy in the ancient Greek world about the Eleusinian Mysteries was somewhat different. The laws of Athens made it a crime to speak about what went on at Eleusis in the telesterion. Toward the end of the Homeric hymn to Demeter, this silence is expressly enjoined on all initiates. In B.C. 415 there was a spate of deliberate profanations of the Mysteries by the jet set in Athens and a crackdown followed, harsh penalties being inflicted. But the secrecy ran far beyond the reach of the laws of Athens. That secrecy ruled everywhere in the Greek world and was never seriously violated. It too was self-enforcing. Those who knew the superior hallucinogens through personal experience were not inclined to discuss with outsiders what was revealed to them: words could not convey to strangers the wonders of that night and there would always be the danger that the effort to explain would be met with incredulity, with the scoffing and mockery that would seem to the initiate sacrilegious, would wound him in the very core of his being. One who has known the ineffable is loath to embark on explanations: words are useless.

So far as we can say, at every point what happened at Eleusis fits in with the hallucinogenic experience in Mexico but in one major respect the Mexican rite outdistances Eleusis. They both share in the great Vision ("Vision" embracing all the senses and the emotions), but in Mexico the sacred mushrooms (and the other superior hallucinogens) serve also as oracles. The hierophants of Eleusis saw a new crop of initiates every year and there were many initiates. With the limitations that this procedure imposed, they could not serve as consultants either to individuals or the State on grave problems where these would be needing advice. In Mexico, on the other hand, the hallucinogen is consulted from time to time on all kinds of serious matters. The questions put to the mushrooms must be serious: if they are unworthy or frivolous, the suppliant is in for a sharp rebuff. Faith in the mushrooms among the Indians where traditional beliefs still prevail is absolute. When the suppliant has observed all the tabus, when the *velada* takes place under the right circumstances of darkness and silence, and when he poses his questions with a pure heart, the mushrooms will not lie. So say the Indians. And such meager evidence as one of us has suggests that they may be right.

Toward the end of the last century the world learned of peyotl and early in the middle of this century the hallucinogenic morning-glory seeds were identified by Richard Evans Schultes. A little later the sacred mushrooms of Mexico received their full meed of public attention, located and written up by Roger Heim and one of us. They were shown the way by a botanist, Blas Pablo Reko, and an anthropologist, Robert J. Weitlaner. Now the three of us are submitting to the modern world what well may be the key to the mystery of the Eleusinian Mysteries. The tie that binds the grain of Triptolemus to the supernal experience of Eleusis, easily and safely attainable from ergot, is so close and natural and poetically satisfying, complying point by point with the myth of Demeter and Persephone, that are we not virtually compelled to accept this solution?

Further avenues of inquiry open up. For example, the pregnant empresses of Byzantium lived in a porphyry-lined chamber so that their progeny would be born "in the purple" ("porphyry" = purple). Was this "purple" the color of *Claviceps purpurea* and do we have here a posthumous outcropping of the purple-robed Demeter and Hades-of-the-purple-hair? The earliest codices were written on purple vellum. Was this because only the most exalted color would be fitting, eg, for St. Augustine's *De Civitate Dei*? By a knee-jerk reflex the values of the Pagan world would thus live on under the Christian Dispensation.

R. Gordon Wasson, Albert Hofmann, and Carl A. P. Ruck

V. The Homeric Hymn to Demeter

Let me tell you the story of Demeter, the holy goddess whose hair grew in rich plaits as only a goddess's does, and of her daughter, whom Hades seized. Zeus, the thunder god, gave her to him. This is how it happened.

She was playing far from Demeter, lady of the harvest who reaps with a golden sickle, gathering flowers with the daughters of Ocean, roses and crocus and beautiful violets, iris, hyacinths, and the narcissus. Earth brought forth the narcissus as a wonderful lure for the blossoming girl according to Zeus's plan to please Hades, who receives all. It was an object of awe for all to see, both the immortal gods and mortal men. And from its root grew a hundred heads, smelling a smell so sweet that the whole broad sky above and all the earth laughed and the salty swell of the sea. The girl was amazed and stretched out both her hands to take the marvelous bauble. But as she did, the earth gaped open and Lord Hades, whom we all will meet, burst forth with his immortal horses into the Nysian plain. Lord Hades, the son of Cronus who is called by many names. Begging for pity and fighting him off, she was dragged into his golden chariot. She screamed the shrill cry of a maenad, calling father Zeus, Zeus the highest and the best. But none of the immortals nor any mortal man heard her voice, not even the olive trees that produce splendid fruit; only Hecate, who wears a delicate veil, Persaeus's kindly daughter, heard her from her cave - and Lord Helius, the brilliant son of Hyperion, he too heard the girl's cries to her father. But the son of Cronus was sitting far from the gods in his temple, a temple thronged with worshippers. And as he received sacrifice from mortal men, she was being carried off at his suggestion by his own brother, the one who rules over many and receives all - the son of Cronus who has many names, Hades, and his immortal horses.

As long as the maiden goddess could still see the earth and the starry skies, the sea that ebbs and the rays of the sun, she could still hope to join her beloved mother and the race of the gods who will always be. And that hope consoled her in her misery. The peaks of the mountains resounded with her immortal voice, and the depths of the sea, until at last her mother heard her cries. So bitter was the pain that seized the goddess's heart, that she tore from her head a gossamer veil, the veil that covered her divine hair, and threw over her shoulders a great black cloak, the mantle of death.

She flew swift as a bird over land and sea, seeking her daughter, but no one wanted to tell her the truth, no god nor any mortal man; nor did any bird come to her and we all know birds bear true messages. So for nine days, holy Deo roamed over the earth, carrying blazing torches in her hands, and so great was her grief that she refused the taste of ambrosia and sweet nectar and shunned the bath. But when dawn arrived bearing light for the tenth day, Hecate met her, holding a flame in her hand and bringing her a message - she told her this tale:

> 'Great Demeter, Goddess who brings in the seasons and gives splendid gifts, who of the heavenly gods or mortal men took Persephone and has broken your heart? I have come to you because I heard a cry, but I did not see with my own eyes who took her - here is all I know.'

So said Hecate, but the daughter of Rhea, Demeter whose hair grew in rich plaits as only a goddess's does, did not answer her with words; instead she swiftly flew with her, carrying blazing torches in her hands. They sped straight to Helius, the sun, watchman of the gods and of men, and standing in front of his horses, Demeter, goddess among goddesses, said:

> 'Helius, since we both are gods, you must help me, if ever in word or deed I warmed your heart and soul. I bore a daughter, a beautiful child with beautiful face, whose cries I heard through the uncharted skies, the cries of a captive - although I did not see anything with my own eyes. But you, because you see everything beneath with your divine rays, everything on land and sea, you must tell me the truth. Did you see my child anywhere? Who has taken her from me against her will? Was it a god or some mortal man?'

She said that. And the son of Hyperion answered her by saying:

> 'Lady Demeter, daughter of Rhea whose hair grows in rich plaits as only a goddess's does, you will know the truth, since I stand in awe of you and pity you for how you suffer over the loss of your child. Zeus alone of the immortals is to blame, for he gave her to Hades, his own brother, to

> have for his wife. Seizing her, he led her to the sunless west, and her screams were shrill as a maenad's. But, Goddess, cease your great lament; you need not have such wrath: Aidoneus, the ruler of many, is your own brother and is not an unfitting husband among the immortals for your daughter. As for honor, he has his third of the world that he received when the realms were first apportioned and is the lord over those he received and with whom he dwells.'

When he had said this, he roused his horses and at his bidding they bore the swift chariot easily through the air like long-winged birds. Hearing him, Demeter's grief became anguish and her heart swelled with wrath. Angered with Zeus, the storm-black son of Cronus, she stayed away from the assembly of the gods and lofty Olympus and went in disguise for a long time to dwell with mortal men. No man who saw her knew her nor did any of the women who at that time wore their belts low over their hips, until she arrived at the house of the wise man Celeus, who was at that time the lord of Eleusis, where incense is always burning. She sat broken-hearted near the road at the Virgin's Well, where the women of the town drew water and where a dense olive tree grew giving shade. Sitting there, she looked like a woman long since a crone, who can bear no children nor enjoy the gifts of Aphrodite; such women are nurses for the children of kings, who administer justice, and they work as housekeepers throughout their endless rooms. The daughters of Celeus, son of Eleusinus, saw her as they were bringing bronze jars of water to their father's house. There were four daughters, whose flowering beauty was such beauty as goddesses have: Callidice and Cleisidice, lovely Demo and Callithoe, who was the eldest of them all. They did not recognize the woman as Demeter, however, since it is always difficult for the gods to be seen by mortals. But, standing near her, they said:

> 'Who are you, old woman? Why do you stay outside the town instead of approaching the city? There, in the shadowy halls, there are women as old as you - and younger ones as well - who will welcome you in word and deed.'

That's what they said and lady Demeter answered them:

> 'Dear children, bless you, whoever you are, you splendid girls. I shall tell you, for it would not be unseemly in speaking to girls such as you to tell the truth. My name is Dos, for that is the one my dear mother gave me. Now I have come from Crete upon the broad back of the sea, although I did not want to. Men, pirates they were, they took me away by force. Later, they put their swift ship in at Thoricus. There, a crowd of women came down to the sea and prepared a meal for us by the stern cables of our ship. But I had no desire for the pleasure of food. In secret stealing away through the dark land, I fled my vile captors so they might not sell me and have enjoyment of my price. Thus, I wandered about and now have come here - although I don't know just where I am nor who these people are who live here. But may all the gods on Olympus give you good husbands and may they grant that you bear as many children as you wish. Pity me, girls,...
> [lacuna: and tell me (?)]
> ... dear children, to whose house I should go to find proper work, doing the sort of tasks old women do: to nurse a new-born child, holding him in my arms. I could also keep the house and make the lord's bed, the bed that lies deep within the well-built chambers, and I could teach the women their work.'

So the goddess spoke, and the unwedded virgin Callidice answered her, Callidice, the best-looking of the daughters of Celeus:

> 'Old Mother, poor mortals must endure what the gods dole out because they are much our betters. Ah, but let me explain it to you clearly and tell you the names of the men who are important, the ones honored in our town and who rule our people and guard the citadel, that sits like a crown upon our city - the ones who counsel us and keep our peace. There is Triptolemus, the wise, and Dioclus and Polyxenus, irreproachable Eumolpus and Dolichus and our own valorous father; and all of them have wives who keep their houses. And none of them on first seeing you would dishonor your person and send you away. Rather, they will welcome you because you are like some god. If you wish, stay here and we will go to our father's house to tell Metaneira, our mother Metaneira who wears her belt low over her hips we will tell her everything from start to finish. And we will see if she wants you to come to our house rather than go seek some other. She has borne a son late in her life and is nursing him in her well-built chamber, a

> child most prayed for by us all. If you nurse and raise him and he reaches young manhood, then all women when they see you will envy you - so many will be the gifts she will pay you for rearing him.'

She said that and the goddess shook her head in assent. The maidens then filled their shining vessels with water and carried them home rejoicing. Quickly they arrived at their father's great mansion and quickly they told their mother what they had seen and heard. And she bade them go quickly to call the old woman and offer her a handsome wage. As deer or young heifers frolick in the meadows, sating themselves with the new shoots of springtime, thus the maidens as they held the folds of their gossamer robes rushed along the grooves of the wagon trail, their hair tossing about their shoulders like crocus blossoms, saffron and gold. They found the glorious goddess near the road, just where they had left her. Then they led her to their father's house and she walked behind them with a heavy heart, draped from head to foot, and around the delicate feet of the goddess, her dark robe fluttered. Soon they arrived at the house of Celeus, whom god favors, and they went through the corridors until they reached their mother, lady Metaneira. She was sitting by a pillar and was holding her new offspring, her son, on her lap. The girls ran to their mother's side; then Demeter stepped to the threshold, her head grazing the roof beam - and the doorway was filled with her divine aura. Awe and reverence seized the mother and she grew pale from fear. She rose and begged the goddess to be seated on her own chair, but Demeter, the goddess who brings forth the seasons and gives us splendid gifts, did not choose to be seated on the glittering chair; rather, she stood in silence with her beautiful eyes cast down, until the scheming Iambe gave her a stool and threw a gleaming ram's fleece over it. Sitting there, she drew her veil across her face and for a long time sat grieving, speechless as she sat upon the stool. Nor did she say or do a thing; she just sat mirthless, with a taste for neither food nor drink, wasting away because of her desire for her daughter. Thus she remained until the scheming Iambe amused her with jokes and made the holy lady smile, then laugh, softening her heart - Iambe who in later times pleased her at her rites of Mystery. Metaneira offered her a cup filled with wine, as sweet as honey, but she refused it, telling her the red wine would be a sacrilege. She asked instead for barley and water to drink mixed with tender leaves of *glechon*. Metaneira made the potion and gave it to the goddess as she had asked; and great Deo received the potion as the precedent for the Mystery...
[lacuna of 22 to 26 lines]
... Metaneira, whose robe hung in thick folds about her hips, said to her:

> 'Greetings, woman, I do not think you are of low parentage, since modesty distinguishes your looks and grace, as if you were descended from a line of kings, who administer justice. But we poor miserable mortals must suffer what the gods dole out and it seems a yoke of misfortune encircles your neck. Now since you have come here, what's mine shall be yours also. Nurse this child of mine: the gods granted him to me late in life when I had lost all hope of bearing him, and I prayed for him often. If you nurse him and he reaches young manhood, then all women when they see you will envy you - so many will be the gifts I shall pay for raising him.'

Demeter, the goddess who wears a splendid crown, then answered her:

> 'Greetings to you, woman, may the gods bless you with all that is good. I shall gently rear your child as you have bidden me. Have no fear for his safety, for he'll suckle the milk from no wicked nurse nor risk incantations that possess a babe nor will he taste of witches' root; for I know the powerful great herbs that are gathered and the talisman plant that wards off possession.'

So saying, she lifted him in her immortal hands and held him to her fragrant breast; and his mother rested content. Thus Demeter nursed the handsome son of wise Celeus, the son whom Metaneira bore, Metaneira whose robe hung in thick folds about her hips. The child flourished and grew like a god, for he fed not on mother's milk, but upon ambrosia, the food of gods, with which Demeter anointed him - anointed as if born a god himself; and she inspired him with her breath sweetly as she rocked him in her lap and at night she would bury him in the powers of the fire upon the hearth. But his parents knew none of this, and to them he was like a miracle, a kind of prodigy, somehow divine. The goddess would have made him ageless and immortal had it not been for the folly of Metaneira, his own mother. One night, watching from the sweet-smelling chamber, she spied upon the goddess at her magic and deranged by what she saw shrieked and beat her thighs in terror for her child. Horror-stricken she let forth this torrent of words:

> 'That woman, a guest in my house - dear Demophoon - she is burying you in a great fire and she

> leaves it to me to mourn and bear the pain of grief.'

So she wailed in anguish and the goddess who is a goddess amongst goddesses heard her. Enraged with her folly, Demeter, whose crown is splendid, grabbed the child from the fire and threw him to the ground, the son Metaneira had borne, the one for whom she had lost all hope - and so furious was her heart that she said to Metaneira:

> 'All men are fools! They lack the sense to foresee their fate as it comes upon them, good or ill, whatever it be. You, because your head is witless, it is you who have caused this irreversible mistake. Let the oath of the gods be known, the oath that is sworn by the unassuaged deathless water of the River Styx: I would have made this son ageless for all of time and I would have granted him undying honor, but now he can never escape the demons that bring his death. Yet he has rested on my lap and slept in my arms, and for that he will always have undying honor: in remembrance of him, all in due course as the season returns, young Eleusinians will always join together in contest and battle again and again.'
>
> 'I am Demeter, the one supreme in honor, for I am the source of life and joy both for mortals and immortals. This is what you must do. Have all your people build me a temple with an altar before it, beside the fortress of the high city that looms above Callichoron Well. And I myself shall institute my rites so that you may perform them and so conciliate my wrath.'

As she said that, the goddess was transformed, as if a wind had blown off her old age and left but her glorious beauty; her robes exhaled sweet perfumes, her skin radiated the aura of the immortals, and her golden hair covered her shoulders. The palace was filled with a brilliance such as the brilliance lightning gives. Then she turned and walked out of the hall.

When she had gone, Metaneira stood trembling and for a long time remained speechless, nor did she remember to pick up her beloved child from the floor. But his sisters heard his pitiful cries and rushed from their beds, beds that were strewn with rich coverings. Then one of them picked up the child and laid him on her lap. One rekindled the fire, while another raised up her mother and hurried her out of the fragrant room upon her delicate feet. Next they bathed the trembling child, fondling him, hoping to calm him after what had just happened, but he could not be assuaged - no matter how well they nursed him, they could not compare with Demeter.

All night long they propitiated the glorious goddess as they trembled in fear and when dawn appeared they told the whole truth to powerful Celeus, as the goddess had commanded them, Demeter, whose crown is splendid. Then Celeus called his many subjects to an assembly and commanded them to build an opulent temple for Demeter, whose hair grew in rich plaits as only a goddess's does, and he told them to build an altar on the rising hill. And as soon as they heard his voice, they obeyed him and built the temple as he had bid them. And the temple grew under her help.

When they finished the temple and had stopped working, they went home, each to his own house. But golden-haired Demeter remained there sitting apart from all the blessed gods, wasting away with longing for her daughter, Persephone whose robe hung in thick folds about her hips. Then she made a deadly year for mankind, withering the soil that is so nourishing, and Earth would not send up seeds because Demeter, the goddess who wears a splendid crown, kept them hidden. In vain the oxen pulled the curved plowshare through the fields, and much white barley fell to the earth, where it was wasted. And now she would have destroyed the whole race of mortal men by famine and robbed the gods of their honors and sacrifices, the gods who have Olympus for their home, had not Zeus perceived this and pondered it in his heart.

First he sent Iris, who flies on wings of gold, to call upon Demeter, whose hair grew in rich plaits as only a goddess's does and whose face glows with beauty. That was his decision and Iris obeyed Zeus, the storm-black son of Cronus. Swiftly she cut through the sky and arrived at the city of Eleusis, where incense perfumes the air. She found Demeter in her temple wearing the dark robes of a mourner, and she spoke this flutter of words:

> 'Demeter, father Zeus calls you to come rejoin the undying race of the gods who will always be.
> Come now, don't let my message from Zeus go unheeded.'

That's what she said, imploring her, but Demeter's mind could not be changed. Then father Zeus sent out all the blessed gods and one by one they went to her and called upon her and gave her many splendid gifts and let her choose as much honor as she might want among the immortals. But no one could persuade her to change her mind since she was so angered, and she stubbornly ignored their pleas. She said she would never again set foot on fragrant Olympus or let the earth bear fruit unless she saw her beautiful daughter with her own eyes.

Finally Zeus heard this, Zeus the thunder god, and he sent Hermes, who carries a golden wand, into Erebus, Hermes whom they call the Argus-killer because he slew that hundred-eyed monster, and now Zeus sent him that he might exhort Hades with soft words to let him lead holy Persephone out of the sunless west into the light. Then her mother would see her with her own eyes and seeing her, change her temper.

So, leaving the seat of Olympus, Hermes obeyed and rushed through the hollows of the earth. He found the lord of the dead seated in his house on a couch with his awesome wife, but it was not her will that kept her seated there since all she could will was her mother. But her mother was far away, thinking over what the gods had done. Standing nearby, the mighty slayer of Argus addressed him:

> 'Lord of Death, you Hades whose hair is purple, father Zeus commanded me to lead glorious Persephone out of Erebus back to us gods so that her mother, when she sees her with her own eyes, will stop her wrath and her horrible anger against the immortals - because she is planning a great act of vengeance: she is going to destroy the feeble race of mortals who dwell on the earth; this will she do by keeping the seeds hidden underground and so will she cause the honors that are paid to the gods to perish. She has a furious wrath and won't mingle with the gods; instead she sits apart from us in her fragrant temple, which is scented with incense, and she holds as her domain now the rocky citadel of Eleusis.'

He said that and the lord of the dead, Aidoneus, smiled and raised his eyebrows nor did he disobey the command of Zeus the king. Hurrying, he gave these commands to Persephone, the queen of miracles:

> 'Go, Persephone, to your mother, the lady who wears deep purple robes, and have a kindly spirit in your breast and be not so despondent. I will not make so bad a husband for you amongst the immortals - after all, I am Zeus's own brother. When you are there in his realm, you will rule over all the plants that grow and all moving creatures. Yours will be the greatest honor amongst all immortals and anyone who fails to make sacrifices to you and does not perform your rites or forgets to offer you appropriate gifts will learn the consequences.'

He said that and Persephone rejoiced and quickly jumped up from her throne in glee. But he, himself, gave her in secret a sweet pomegranate seed to eat so that she might not remain forever with her mother, the awesome Demeter whose robe is a deep purple. Then Aidoneus, who rules over many, harnessed his immortal horses to a golden chariot. Persephone got into the chariot and beside her sat the mighty slayer of Argus, Hermes, who held the reins and a whip in his hands. And they sped through the hall with horses eager to fly. Quickly they made the long journey back and neither the sea nor the waters of the rivers could hinder the flight of such immortal horses, no, nor even the grassy valleys nor the mountain tops, but always onwards did they cut through the air over the very mountain tops like a ship through the deep ocean. And then Hermes stopped them where Demeter was waiting in front of her temple perfumed with incense; and when she saw her daughter, she ran to her as a maenad racing through a mountain wood runs.

[387-405 badly mutilated; restoration uncertain]

And Persephone, for her part, when she saw her mother's beautiful eyes, leapt from the chariot and fell on her knees, covering her mother with embraces. But while Demeter still was caressing her child and holding her in her arms, she thought with horror - a trap - and trembling with her fear, she stopped fondling her beloved daughter and spoke these words:

> 'My child, when you were below the earth, did you eat any food? Tell me the truth and don't hide anything from me, so that we both may know. Because if you didn't accept his hospitality, you can flee from the halls of that loathsome Hades and dwell with me and your father, the storm-black son of Cronus, where you will be honored by all the immortals. But if you did eat anything, you will have to make the journey back again to the depths of the earth and live with Hades for a third

> part of the seasons of the year and stay here with me and the other immortals for only two of the three. When the earth abounds with all the fragrant blossoms that come with Spring, then from the sunless west out of the dark night you'll rise and appear as a great miracle to the gods and mortal men.... [lacuna]... And with what trick did the god who receives all deceive you?'

Persephone, most beautiful, answered her:

> 'I will tell you everything just as it truly happened, Mother. When Hermes came to me, Hermes the helper and swift messenger of the gods - when he came, beseeched by my father Zeus, son of Cronus, and by all the other gods who live on Olympus when he came to lead me out of Erebus so that you could see me with your own eyes, he came so that you would cease your wrath with the immortals and calm your terrible anger. So he came and I jumped up for joy, but he - Hades - forced upon me a pomegranate seed, forced it upon me against my will so that I would eat it - and I did eat of that sweet fruit.'
>
> 'And I'll also tell how he seized me according to the plan of my father, the son of Cronus, and brought me into the hollows of the earth. I'll tell you all this, everything you have asked.'
>
> 'All of us were playing in a lush meadow, my friends and I - Leucippe and Phaino, Electra and Ianthe - and I was playing with Melite, Iache, Rhodeia and Callirhoe, Melobosis and Tyche, and also with Ocyrhoe, who is as beautiful as a flower herself. There were also Chryseis, Ianeira, Acaste and Admete, Rhodope, Pluto and Calypso, whom all men desire. And with us were Styx and Urania, lovely Galaxaura and Pallas, who spurs on battles, and Artemis, the archer. Thus we all played, all virgins and fullbloomed in youth: we gathered the blossoms of earth in our hands, flower gathering flower - bouquets of gentle crocus, iris and hyacinth, rose buds and lilies, gorgeous to see. And there was a narcissus - the wide earth had brought it forth, glorious as a crocus, a jewel - and in ecstasy I spied it and plucked it, but the earth gave way beneath and from her burst the great lord Hades, who receives many. In his golden chariot, he carried me beneath the earth and I struggled all unwilling, screaming shrill a lament.'
>
> 'Wretched though it makes me, I have told you the whole truth.'

Thus they were in harmony with each other and for the whole day they comforted one another and their embraces finally softened their grief, each receiving and giving joy. Then to them came Hecate, who wears a delicate veil and she also caressed the daughter of holy Demeter and from that time on, lady Hecate was the servant and companion of Persephone.

Zeus, the thunder god, sent a messenger to them, Rhea whose hair grew in rich plaits as only a goddess's does, and she was sent to lead back Demeter, whose robes are purple dark, to the race of the gods. Then Zeus promised to give her whatever honors she wanted from the immortal gods. And he consented to the plan that the girl spend a third part of each spiraling year in the dark where the sun goes down, but that two-thirds would be spent with her mother and the other immortals. That's what he said, and the goddess did not disobey Zeus's message. Swiftly she fled down from the peaks of Olympus and sped to the Rarian plain.

Formerly this plain was the richest of fields that give life, but at this time it gave no life at all, lying waste, barren and all leafless. And the white barley was hidden in the earth by Demeter's plan. But in a little while, as the springtime progressed, it would be waving long ears of grain like a mane in the wind and its fertile furrows would be filled with grain lying at harvest, while other ears would be bound in sheaves. It was in that field that she alighted first out of the uncharted sky. When the goddesses saw each other, they embraced and rejoiced in their hearts. Then Rhea, who wore a delicate veil, said:

[462-70: text damaged; reconstruction uncertain]

> 'Come, my child, Zeus the thunder god calls you to come rejoin the race of the gods and he promised whatever honors you might want from the other immortals. He agreed that your daughter spend a third part of each spiraling year in the dark where the sun goes down and the other two-thirds with you and the other immortals. That's what he said was to be and he nodded his head in assent. So come, child, and obey and persist not in fighting with the stormy son of

> Cronus, but once again give the earth's fruit to mankind.'

That's what she said. And she was not disobeyed, for as soon as she had finished speaking, Demeter made fruits spring up from the rich plowlands, and the whole wide world became heavy with leaves and flowers. Then she went forth to the kings who administer justice, Triptolemus and Diocles, who drives horses, and mighty Eumolpus and Celeus, the leader of his people. To them, she showed the performance of her rites and taught her Mysteries - holy rites that are awesome, that no one may transgress nor reveal nor express in words, for an overwhelming reverence for the gods stops his voice. Whoever among men who walk the earth has seen these Mysteries is blessed, but whoever is uninitiated and has not received his share of the rite, he will not have the same lot as the others, once he is dead and dwells in the mould where the sun goes down.

And when the goddess among goddesses had taught them everything, she went to Olympus to be in the company of the other gods. There the two goddesses live with Zeus, who delights in the thunderbolt, and they are holy and revered.

Whomever the goddesses love among men who walk the earth, he is blessed, for they soon send Plutus into his great house to live at his own hearth, Plutus who gives wealth to mortal men.

But come now, you goddesses who preside over the town of Eleusis, where incense perfumes the air - you two who also have domains on Paros, which the sea surrounds, and in mountainous Antron - you lady Deo who brings in the seasons and gives splendid gifts, you and your beautiful daughter Persephone, come now grant me an easy life for my song. And still again may I pray to sing you a song.

Translation by Danny Staples

Soma and the Fly-Agaric

Mr. Wasson's Rejoinder to Professor Brough

by

R. Gordon Wasson

Botanical Museum of Harvard University CAMBRIDGE, MASS., November 1972

Ethno-mycological Studies No. 2

© R. Gordon Wasson, 1972

original source: https://www.samorini.it/doc1/alt_aut/sz/wasson-rejoinder-to-professor-brough-soma.pdf
backup source: https://www.psilosophy.info/resources/wasson-rejoinder-to-professor-brough-soma.pdf

Table of Contents:

Foreword by Richard Evans Schultes
I - Introduction
II - Chemistry and Pharmacology
III - The Persona of Soma: In the Beginning Was the Word
IV - Was There a Soma-urine?
V - Questions of Exegesis
VI - Conclusion
VII - An Excursus: Early Man and Plant Hallucinogens.
Appendix I - Recent Bibliography on *A. muscaria*.
Appendix II - Manner of Ingesting the Fly-agaric among Siberian Natives
Appendix III - Miscellany

Foreword by Richard Evans Schultes

On April 15, 1969 Mr. R. Gordon Wasson, Honorary Research Fellow in our Botanical Museum, brought out his *SOMA Divine Mushroom of Immortality*. In it he proposed a novel identification for Soma, the long enigmatic god-plant of the ancient Aryans, as *Amanita muscaria*, the brilliant red mushroom with white spots that is common in the birch and pine forests of Eurasia.

In June 1971 the Bulletin of the School of Oriental and African Studies (the '*BSOAS*') of the University of London published a 31-page article by John Brough, Professor of Sanskrit in the University of Cambridge, challenging the thesis developed in Mr. Wasson's book. On Sunday August 8, 1971 Mr. Wasson was host to Professor and Mrs. Brough in his home in Connecticut and on that occasion Professor Brough gave him an autographed copy of his paper, the first that Mr. Wasson had seen of it. On January 12, 1972 Mr. Wasson sent off his rejoinder to the *BSOAS*. On February 15 the Editorial Board declined to publish it, adhering 'to its general policy of not publishing rejoinders to reviews'. Thereupon Mr. Wasson on March 14 asked for the privilege of reprinting privately the Brough paper to accompany his reply elsewhere. So far as we know, the Board never took action on Mr. Wasson's request of March 14.

Following my return from a field trip in the upper Amazon and after familiarizing myself with all the facts, I decided that our Botanical Museum should publish Mr. Wasson's answer, and he fell in with my suggestion. On May 25 I addressed a letter to Professor Edward Ullendorff, M. A., D. Phil., F. B. A., Chairman of the Editorial Board of *BSOAS*, apprising him of our intention and soliciting permission to reproduce Professor Brough's paper together with the Wasson rejoinder. I expected this to be granted as a matter of course. On June 20 the Board finally declined to grant us the requested permission.

Together with Mr. Wasson I deplore the decision of the *BSOAS* Board not to allow us to reprint the Brough paper. In matters of moment editors should not feel hamstrung by their own house rules. Professor Brough may feel that it is unfair to him for Mr. Wasson's reply to go out unaccompanied by his text. But the Wasson rejoinder has now been so re-phrased as to stand adequately on its own feet. The journal in which Professor Brough's evaluation appeared is of limited accessibility to specialists in the diverse fields that the Soma problem will interest. While it would have been helpful to our readers, and only fair to Professor Brough, to have the Brough review before them, in the light of the decision of the *BSOAS* Editors, there is nothing that we can do about it.

On a larger stage, we deplore the decision of the Editors of BSOAS because we believe that a learned journal has a duty to encourage, rather than impede, the interchange of scholarly views. The mystery of the Soma plant reaches beyond questions of Vedic exegesis. The collection of hymns known as the *ṚgVeda* is a seminal document in Eurasian man's early history, and, as the Vedist Louis Renou wrote, the whole of the *ṚgVeda* with its problems is present *in nuce* in the themes that Soma presents to us. If the Vedists make no effort to identify the plant, others must undertake the task. As is common knowledge, over the past two decades notable achievements have been made by the Swiss team of Conrad Eugster and Peter G. Waser in the analysis of *Amanita muscaria* and the study of the properties of its constituents. Apart from many other matters, Mr. Wasson presents what seems to be telling evidence, especially to scientists, that the Brahmans of Vedic times were privy to the secret of those properties, unique so far as we now know in the plant world. He takes advantage of this paper to reformulate succinctly, in the light of all the discussion provoked by his book, the case for his identification of Soma and carries the argument into new ground.

The Soma question does not interest chemists and pharmacologists alone. It impinges on botany and especially on that field of botany which concerns itself with the psychotropic plants. It bears on anthropology and archæology, on religion and the early cultural history of Eurasia. Paraphrasing Georges Clemenceau on war and the generals, I would say that Soma and the *ṚgVeda* are too important to be left to the Vedists.

RICHARD EVANS SCHULTES
Professor of Biology
Director of the Botanical Museum
of Harvard University

Cambridge, Mass.
June 30, 1972

I

Introduction

When the *ṚgVeda* was first revealed to the West after the middle of the last century, it aroused excitement and lively expectations in cultivated circles. But in recent decades that nascent enthusiasm has been receding, largely no doubt because of difficulties inherent in the text but also because many Vedic scholars have been content to live in isolation in what looks to the outsider like an hermetic coterie. This attitude is exemplified at every level, conscious and unconscious, in Professor Brough' s painstaking dissection of my *SOMA Divine Mushroom of Immortality*.

The *ṚgVeda* is unique in various ways in its antiquity, in its textual purity, and in the strong though narrow beam of light that it throws on the religious and spiritual life of one element in our Eurasian ancestry just as it was emerging from pre-history. There was always the enigma of Soma. With the strides made recently in exploring for psychotropic plants, Soma, permeating the *ṚgVeda*, cries for identification at last. But following the example of their Hindu predecessors, Western Vedists have chosen to ignore this question and some even seem to resent a proffered solution, saying that the problem is insoluble without having made an effort to solve it.

With two of John Brough's pronouncements in his review article[1] on my *SOMA* I agree. 'The importance of the Soma-plant in Vedic religion has never been underestimated. ... the *ṚgVeda* is, so to speak, permeated by Soma'.[2] Here he is right. Soma is indeed the key to the 1028 hymns of the *ṚgVeda*, and that key was long since mislaid. Brough goes on to call my views 'revolutionary',[3] and again he is right. I was waiting for someone of stature to say this. That he devotes 31 pages to me in the *BSOAS* is in itself a recognition of the importance of the issue I raise. As this issue has wide bearings, reaching in diverse directions far beyond Vedic circles, he must expect me to discuss his views on their merits, according to my lights, not letting personal attachments affect my findings. This was his way in writing his review. I welcome his paper, supplying me as it does with a number of texts that allow me to clarify, amplify, and drive home my thesis.

Near the beginning of his paper Brough has this to say about the Siberian materials that I offer my readers in *SOMA*:

> ... as a matter of simple logic, such parallels have no probative value. They cannot even be adduced as confirmatory arguments for the theory that the Soma-plant was *A. muscaria*. Until this theory is proved for the *ṚgVeda*, and proved beyond any possible doubt, the non-Indo-Iranian materials remain, in the strictest sense, irrelevant. Even if the proposed identification for Soma seems probable, but is not proved on the basis of internal evidence, extraneous facts are not additional evidence. [JB 332-333]

Any such proposition is, I submit, untenable. How ambivalent is Brough's guidance line! Even though a 'proposed identification for Soma seems probable' what a big concession! - 'if not proved on the basis of internal evidence', it carries no weight with him as a Vedist. By this rule Brough achieves two ends: the exclusion by fiat of the testimony of my photographs, and unless I have misunderstood him the exclusion of non-Vedists from the field, for only accomplished Vedic scholars can pass on the internal Vedic evidence. By contrast I hold that the Soma problem has the widest cultural ramifications and it can only be met by drawing on the resources of diverse disciplines. The sterility of the traditional manner of handling the Soma enigma is manifest.

Brough goes further: the Vedic scholar may not advance an identification of Soma on what lawyers would call the weight of the internal evidence, nor yet on evidence proving his case beyond a reasonable doubt, as in a criminal trial. The proof must be 'beyond any possible doubt'. To exact unanimous agreement among Vedic scholars on a novel interpretation of the Vedic evidence is chimerical: there will always be dissenting voices, as Vedic scholars including Brough well know. What Brough is saying is that the identification of Soma is impossible, and one re-reads Brough's words at the end of his opening paragraph with fresh understanding as the full reach of its chilling sense dawns upon us; '... and the opinion is widely held that the problem is insoluble'. Can it be that many Vedists today hold to such a despairing view? Is the anonymity of Soma a built-in element in Vedic studies and are Brough and some other Vedic scholars content, perhaps determined, to have it so?

But no Berlin Wall sets off the *ṚgVeda* hymns in an encapsulated enclave. They are just one area of many - though a particularly fascinating and important one - in the republic of humane letters. Where would Biblical criticism be if Biblical scholars had not taken soundings in all the adjacent cultures and not least the non-Semitic ones? Where would Homeric studies be if a Schliemann had not gone beyond the text to look for Troy? Nor have the scholars in these fields hesitated to enlist the help of scientists in devising techniques to date and assess their archæological finds. Has Brough read *Science and Civilisation in China* by his colleague of Gonville and Caius College, or, if he has, has he failed to catch its message? Not all Vedic scholars share Brough's attitude, but he does not stand alone. F. B. J. Kuiper of the Kern Institute in Leiden has said that 'the search for the "original Soma" might lead us far beyond the field of Indo-Iranian studies proper',[4] as though such excursions were dangerous temptations to be avoided. These two statements, Brough's and Kuiper's, reveal the absurd isolation in which some Vedic scholars live by choice. I should have expected Vedists to be foraging in all the highways and byways of science and the humanities for clues to the all-important enigma of the mysterious Soma. I should have expected all (not just a few) of them to welcome suggestions from those specializing in other disciplines such as botany, where the explorations for the hallucinogens have lately thrown wide the door to new interpretations in cultural history. I should have expected the Vedists not only to be abreast of the thrilling developments in the botanical exploration for the psychotropic plants of the world but to be pioneers in it, contributing suggestions from the *ṚgVeda* for identifying Soma. But many are not informed, not interested, and they resist suggestions. The fruits of interdisciplinary exchanges are to be rejected out of hand, in advance.

The Vedists with notable exceptions seem to be, as it were, the heirs to the Brahman caste, not touching ordinary mortals and not to be touched by them. True, in the rest of his paper Brough comes down into the market-place to rub elbows with the commonalty, and his friends may point out that he fails fortunately to live up to the rules laid down in his opening paragraphs. But this initial declaration of his, all the more meaningful for being a forthright admission, gives us the cast of his mind, discloses his attitude toward traspassers in the Vedic preserve.

1. ↑ 'Soma and *Amanita muscaria*', *BSOAS* Vol. XXXIV Part 2, 1971, pp. 331-362, hereinafter referred to as JB. In my reply I have been helped in Vedic matters by Mr. Alexis Sanderson, but he is not to be held responsible for either the form or the substance of my reply.
2. ↑ JB 331
3. ↑ JB 332
4. ↑ From a review of *SOMA* in the *Indo-Iranian Journal*, Vol. XII No. 4, 1970, p. 284. I seize this opportunity to call public attention to an extraordinary act of scholarly elegance on Professor Kuiper's part. He sent me his review when it was written, months before its publication, and on my suggestion opened the columns of his *Journal* to my response, allowing me to appear in the same issue with his review and following immediately after it. Not only this: his review was printed in 8-pt type on a 9-pt slug whereas my reply was in 9-pt type on a 10-pt slug, making my paper more readable than his! In this case the characterization 'a scholar and a gentleman' is no mere *cliché*.

II

Chemistry and Pharmacology

I will start with the chemistry and pharmacology of the fly-agaric, *Amanita muscaria*, the plant that I am confident (more so than when my book came out, now that I begin to see what the opposition amounts to) was the Soma of the Aryans.

In our generation the pioneers and leaders in this research have always been Conrad H. Eugster, Professor of Chemistry in the University of Zurich, and his colleague Peter G. Waser, Professor of Pharmacology, with whose papers Brough was unacquainted.[1]

Eugster's isolation of two new chemical entities in the fly-agaric, now called 'ibotenic acid' and 'muscimol', has been the epoch-making discovery to date in fly-agaric research. At first unveiled only in patent applications, they were revealed in a doctoral dissertation in Zurich in 1961. Both entities are psychotomimetics, or, in popular language, hallucinogens.

And here we come upon startling facts. Ibotenic acid is present in the fresh fly-agaric in widely varying amounts, ranging from 0.03% to 0.1%. When the fly-agaric dries, the ibotenic acid steadily disintegrates and disappears. It is replaced by muscimol, *which is at least five times more powerful*. Thus we have the unique situation where a psychotomimetic agent converts itself through simple drying into another active agent that is more potent by far and more stable. In *SOMA* I give *in extenso* (and in summary on pp. 153 ff) the almost unanimous testimony, extending over two centuries and throughout almost the whole of the northern tier of tribes from the valley of the Ob to the Chukotka, that the fly-agaric must *not* be eaten fresh: it should be dried, preferably sun-dried. The empirical knowledge of the Siberian natives is now confirmed by Eugster. Furthermore Eugster says that Swiss mushrooms gathered in mid-summer carry more ibotenic acid than in autumn. This echoes the testimony of von Langsdorf[2] about the practice of the Kamchadal of using mushrooms gathered in July and August. Thus these discoveries of Eugster's at the laboratory bench only confirm what the unlettered Siberian tribesmen have known empirically from time immemorial. My *SOMA* was in Eugster's library, but as he fails to mention the evidence from Siberia, I can only conclude that this element in it failed to catch his attention.

The testimony is abundant though not unanimous that the Siberian tribesmen, after having dried their fly-agarics, on ingesting them washed them down with water, or with the juice of berries (bilberries *Vaccinium uliginosum* or willow herb *Epilobium angustifolium* - or perhaps other berries), or thoroughly worked them over in human saliva. Alcohol is never mentioned and Krasheninnikov in the mid-18th century says expressly that the mushrooms were soaked in the 'must' or 'wort' (Russian: *suslo*) of *Epilobium angustifolium*.[3] The parallel with the Vedic usage is remarkable. The dried mushrooms (in which the ibotenic add has been replaced by muscimol) are re-watered[4] in the elaborate Soma sacrifice, and later, after filtering, the *pávam&amacr;na* is mixed with milk or curds or ghee or barley water, or occasionally with honey (*mádhu*). Nothing authorizes us to say the *mádhu* was mead.[5]

Now listen to Brough:

> ... it would be strange that the elaborate Vedic process of pounding out and filtering the juice should have been necessary. Why should the plant not have been simply eaten? There is no particular sanctity in liquid as such. [JB 338]

Not sanctity but chemistry! The plant *must* be first dried, then re-inflated, and finally the juice expelled.

Brough goes on to say there is no mention in my exhibits of the 'pounding' of the mushrooms to extract the juice. No, there is no mention, nor of a Brahman caste singing hymns in the Vedic language.

The Vedic hymns marked a high point in the religious life of the Aryan people, in which the rapturous experience produced by Soma led the Brahmans to clothe the celebration of the sacrament in an amazing ritual, perhaps without parallel in history. Let us now travel down the corridors of time three thousand years, and through the corridors of space for thousands of miles, and we find some dozen tribes almost pushed into the Arctic Ocean, in cultural disarray, minuscule in numbers, disappearing before our very eyes, but still possessing (I submit) the same mushroom that the Aryans possessed, insisting that the mushroom was of an order superior to the alcohol of the West,[6] drying their mushrooms as the Aryans had dried theirs, only to steep them again in fluid in which water plays the operative role, consuming them, and then knowing rapture.[7]

Brough says he 'has no specialist qualifications in chemistry and pharmacology' [JB 360] and proceeds at once to supply documentary support for his lack of qualifications in a number of surprising statements in the chemical and pharmacological fields, *e.g.*,

> ... it is most probable that the muscarine is the chief nauseating agent in *A. muscaria*. [JB 360]

Since Eugster and Waser brought out their landmark paper in 1954 no informed person has entertained this notion. The drug muscarine is present in the fly-agaric in such small amounts that quantities far beyond human capacity would have to be ingested to provoke any kind of muscarine reaction. All that Brough says about the chemistry and pharmacology of *A. muscaria* is out of date.

A little later we come on this:

> ... much work remains to be done in botany, chemistry, and pharmacology before it will be sensible to make a further attack on the problem of the botanical identity of the Soma plant. [JB 361]

The readers of the *BSOAS* rightly look to the papers published therein for authoritative pronouncements in the fields under discussion and they may overlook Brough's warning that he is here speaking without credentials or they may skip over his disavowal of 'specialist qualifications' as only a standard *cliché* of false modesty. But the fact is that Brough shows no knowledge of the immense amount of work done and progress achieved in recent decades in psychoactive plant substances, and the fly-agaric is in the vanguard of these advances. At the last moment, when I caught wind of what was afoot, I sent him an elementary paper[8] that might have rescued him, but it was too late. In an Addendum at the end of his paper [JB 362] he graciously acknowledged receipt of the paper but then goes on to minimize the importance of his lack of 'specialist qualifications' by saying that the 'chief point of [his] argument still stands', *i.e.*, the 'nausea, vomiting, and coma caused by the fly-agaric', as though these effects were absolutes, not arguable, not subject to definition, to qualification, to circumstance. But let us reflect a moment. Wine as one of the Elements in the Mass is analogous. From earliest times (indeed since Noah's days!) wine has been known to cause nausea, vomiting, and coma; yet its sacramental rôle stands unchallenged.

Brough speaks of the work that remains to be done in botany, chemistry, and pharmacology before we can tackle the botanical identification of the Soma-plant. But if Vedists persist in remaining ignorant of the work that has been done and is being done in these other disciplines, his formula for progress leads to a dead-end. For Brough would confine work on the *ṚgVeda* to Vedists, and since most Vedists, and not least the good ones, are unlikely to have time to master botany or chemistry or pharmacology, the outlook is bleak.

But of course Brough is mistaken in claiming for Vedists pre-emptive rights in the *ṚgVeda*. He is wrong in his *noli-me-tangere* stand, which is simply a *déformation professionelle*.

1. ↑ For the bibliography of their papers, see Appendix I. They supply the names of two other teams, one Japanese and the other English, that have concerned themselves in the '60's with the fly-agaric.
2. ↑ See below Appendix II; also my *SOMA*, p. 247.
3. ↑ By definition 'must' or 'wort' is a non-alcoholic juice but a juice destined for fermentation. We all know that in popular usage 'must' is sometimes applied to a beverage that has begun to ferment. Krasheninnikov was a scrupulous reporter, and if

alcohol had been involved I think he would certainly have told us so. Besides all of the rest of the dozen witnesses are unambiguous: water (sometimes sweetened with berry juice), not alcohol, was the vehicle that the natives relied on. ... Only Brough can explain why he misrepresents the Siberian sources saying that in Siberia 'the mushroom is apparently always consumed whole' (JB 336), and repeating this error on JB 338, though this time qualifying it somewhat.

4. ↑ There are numerous verses in the *ṚgVeda* alluding to the reflation of the dried Soma: *e.g.*, IX 30.5, 62.5, 79.4. W. Caland and V. Henry in their classic *L'Agniṣṭoma* (Paris, 1906-1907) say that the Soma plants were mingled with water on the second day of the prolonged ritual (§ 47) that they were describing, and the pressing and filtering took place only three days later (§ 127), on the fifth day. In the ritual that they give us the original Soma was no longer being used, but the steeping in water that they report must have come down from earlier times, since there could be no point in inventing at a later date such a conspicuous feature of the liturgy, a feature that would be otiose with a substituted plant. The Soma sacrifice was ordinarily much simpler and briefer than the lengthy *Agniṣṭoma*, which is useful in giving us as it were a slowmotion picture of the sequence of events.

   The author of a review of *SOMA* that appeared in *The Times Literary Supplement* (22-V-69) denied that there was 're-hydration' (as he called the reflation) of Soma in the Vedic ritual. He had simply overlooked the numerous verses in the *ṚgVeda* referring to it, as well as the evidence in *L'Agniṣṭoma*. The reviewer was also certain, if Soma had been a mushroom, that the priests, when they gave up Soma, would have chosen another mushroom as a substitute. But no one is privy to the motives of the Brahmans of B. C. 1000. It seems to me that if they found it advisable to abandon Soma, the circumstances were probably such that they would wish to obliterate its very memory. The Brahmans were skilled in memory disciplines and had they desired to perpetuate the memory of their sacred plant, nothing could have been easier. The review ended with a frivolous (though in the critic's opinion serious) suggestion that the *chanterelle* (*Cantharellus cibarius*) was the original Soma. Eminent scholars, sheltered behind the anonymity of the TLS reviews, sometimes as here are careless and irresponsible in their handling of serious books.

5. ↑ Henry Wassén, Director of the Gothenburg Ethnographical Museum, a shrewd, widely read, widely traveled man, in conversing with me has always urged upon me, first, the key significance among the Paleosiberian shamans of the fluid that they took with the fly-agaric, and secondly, the psychological importance of the unanimity with which they tell, on returning from an ecstatic trance, of the far journeys they have been on. We now see the meaning of the fluid that they imbibe. I next draw attention to the following footnote in *L'Agniṣṭoma* (p. 450; preceding ftnt.), speaking of the Vedic hymns:

   > ... le sacrifice [fut] souvent métaphoriquement assimilé à une marche, un voyage, une expédition, et comportant d'ailleurs réellement un grand nombre d'évolutions processionelles.

   In short, in that distant Aryan land Caland and Henry as early as 1906 gave us, in discussing Soma, a description of what today, in popular parlance, is called a 'trip.' The analogy with the Siberian tribesmen as well as with today's use of hallucinogens is manifest.

6. ↑ *SOMA* 250: Von Langsdorf says, 'The Koryaks greatly prefer fly-agarics to the Russians' vodka and maintain that after eating fly-agarics a man never suffers from headaches or other ill-effects.' 267-268: Jochelson says, 'Like all other primitive tribes, the Koryak are passionate consumers of brandy, and dealers often obtain an arctic or red fox in exchange for one wine glassful of brandy. To my question as to which they preferred, brandy or fly-agaric, many Koryak answered, "Fly-agaric". Intoxication from the latter is considered more pleasurable, and the reaction is less painful, than that following brandy.'
7. ↑ See Appendix III for additional evidence and comments on Russian, Siberian, and German practices and attitudes.
8. ↑ Appendix I, No. 15.

III

The Persona of Soma: In the Beginning Was the Word

The juice of the Soma-plant caused divine inebriation, *mada* or *maδa* in Indo-Iranian terms.[1] The 'reverential awe' (Brough's words) that Soma inspired permeates the *ṚgVeda*. This reverence, this awe, prompts Brough to see an analogy with the Greek **ἐνθουσιασμός**, 'God-possessed', and rightly so. 'All the words concerning poetic inspiration', says Brough, 'appear in connexion with Soma', and he lists six such words, *dh&imacr;*, *dh&imacr;ti*, *mati*, *vip-*, *gir-*, *man&imacr;ṣ&amacr;*. Another term *kavi*, 'poet', is frequently applied to Soma, and *kā̆vya*, translated by Renou as *pouvoir-poétique*, 'poetic potency', is preponderantly applied to Soma and to Agni, two gods in the *ṚgVeda* who are closely associated together. A *kā̆vya* is an inspired utterance and also a magically potent spell, as Brough points out. He quotes Renou as equating *vā̆c*, 'the Word', in French 'la Parole', with the 'Logos' of Greek. All this is splendid. I would have added some comment on *amṛta*, a powerful synonym for Soma, used time and again, a word cognate with Greek 'ambrosia', the food of the immortals.

These Vedic words tell us what is essential about the effect of Soma on the Brahmans who were the custodians of its secrets. My reservation - and a grave one - is that Brough seems to find these words foreign to him. He is not at home with them. He cites Vedic verses and words. He quotes Renou. He thinks he finds a Greek word that is applicable:

> It is difficult to give an adequate equivalent [of *mada*], but the tenor of the hymns indicates something like 'possession by the divinity' in some way comparable to Greek ὁ ἐνθουσιασμός. [JB 339]

Why does Brough find it 'difficult' to render *mada*? Divine inebriation, divine possession - these are common coin of the realm where mystics and their commentators dwell. There has been no dearth of them from India to the Atlantic, from Vedic times down to today, in all the religions that we know anything about. I find it odd that a Professor of Sanskrit in Cambridge should not be at home in the idiom of the mystics. I do not of course insist that he be a mystic, but that with sympathetic understanding he should be attuned to them, listen to them, watch their performances, know their ways.

What is but a suspicion on the reader's part at this point is proved beyond a doubt a page later. Brough finds only one hymn[2] - and that a doubtful one - that may have been inspired by an 'hallucinogen', - only one out of 1028. After we have been told that Soma, permeating the *ṚgVeda* (as Brough himself says), the potent engine behind the hymns, leads to *mada* (divine possession), generates 'reverential awe', vibrates with the Word (*vā̆c*), makes for *kā̆vya* (poetic potency), when we are expecting Brough to lead us through the hymns and trace in them the all-pervading influence of these moving superlatives, when we are to be shown, in short, whither Soma took the poets, we are reduced to one dubious hymn, X 119. And why did Brough choose this one hymn? Is it only because each of its verses ends with a refrain, 'Have I not drunk the Soma juice?' An astonishing way to judge poetic inspiration! Let us suppose the poet had ended the verses of this hymn with a different refrain: Brough would not have cited it, but would it have been any less 'inspired'? Or let us suppose the poet of IX 113 had replaced his refrain with one mentioning Soma-juice: would this have made a difference? The poets were singing their hymns to each other, for those who knew the Way (*ṛtá*), not preparing road-maps for strangers thousands of years later and thousands of miles away.

Brough discovers a dichotomy between the 'inspired' hymns and the 'far more' that are liturgical. Why this dichotomy? Liturgy is the supreme communal expression of religious feeling. Liturgy is an enactment of a myth or a sacrament, and every word, every gesture, every posture, also the processions, solemnly performed by people duly appointed for the purpose, can be as inspired as Brough's 'inspired' hymns. When he thinks of the liturgical hymns, is he mistaking the rubrics, the 'stage directions', for the divine performance? In any case it is clear that Brough fails to feel the throb, the glow, the tingling sensation that the hymns conveyed to the priests who composed them, giving voice to the divine afflatus that moved the poets. Granted, religion has moved thousands of years and thousands of miles from the Vedic age, and to seize the poets' thoughts and feelings calls for highly developed empathy on our part. When the priests sang the opening verses of IX 74, with one numinous phrase after another, those in attendance must have felt the tug at the heart, their rising gooseflesh (as A:'E. Housman[3] put it on a celebrated occasion in Cambridge), their tear ducts perhaps working. This was what was meant by *kăvya*, and only at a lower level, among those who were incapable of reaching the heights of which I speak, did *kăvya* convey the mundane sense of Brough's 'magically potent spell' or incantation.

After dwelling at some length on the 'reverential awe' generated by Soma, after discussing the Vedic words that eloquently describe its effects, after thus supplying us with the peculiarity, the very signature, of an hallucinogen when consumed by one ready to receive it, the reader is startled by Brough's question:

> Yet, if we exclude this hymn [10.119], what indisputable evidence is there in the *ṚgVeda* that *soma* was hallucinogenic? [JB 341]

What additional evidence do we need? It is possible of course that Brough does not know an hallucinogen when he describes one. With an hallucinogen the 'reverential awe' of which Brough speaks imbues all the hallucinations of the five senses and together with them places one, for the nonce, among the Immortals. The 'reverential awe' holds one spellbound, entranced, for the time being, and nothing else matters. 'Reverential awe' is the hallmark of the hallucinogen.

In *SOMA* I suggested that the fly-agaric with its sturdy stanchion and resplendent capital happily coincided with the metaphor, 'mainstay of the sky' or 'pillar of the world', by which Soma is designated time and again in the *ṚgVeda*. Brough says on this:

> I find the idea almost comic that the Vedic poets should have seen in this little mushroom a model of the sky supported by a mighty pillar. [JB 357, lines 9 and 10]

Brough is admitting (his admission being spontaneous and therefore the more significant) how little he knows of the poetic idiom of the enraptured mystic, who often tries to convey the ineffable by hyperbole and paradox. 'And a sigh is the sword of an angel king,' wrote Blake. If Brough came across this line for the first time without knowing the author, would he not find the metaphor of a sword for a sigh almost comic? The same insensitivity to a powerful metaphor marks Brough's treatment of the knot-studded cudgel of Indra,[4] which also seems to have given Brough a merry time. We are postulating that the fly-agaric is the adored Soma. We are postulating that the Brahman poets knew divine inebriation from imbibing Soma, that they were gifted with *kăvya*, 'poetic potency', that they spoke the *văc*, the Word. We are postulating a Soma glowing with holiness. No appropriate figure of speech is too exalted, too extreme, for the Soma-plant.

I do not of course hold the view that the fly-agaric itself was the *fons et origo* of the metaphors 'Mainstay of the Sky', the 'Single Eye', the 'Head' of Soma, etc. The Vedic conception of the universe - the vault of heaven, *s&umacr;rya*, and all the rest - found a surprising number of parallels in the shape and colouring of the superb fly-agaric and the poets seized on them for their tropes. Their cosmological ideas and the plant reinforced each other most beautifully. But some of the figures, such as the 'First Filter', the 'knot-studded cudgel' of Indra, and the 'Third Filter' could only have originated in the fly-agaric.

The words *mada*, *kavi* and *kăvya*, *văc*, and the others listed by Brough - all emanations as it were of Soma - are the body and soul of the *ṚgVeda*. After citing them timidly, gingerly, Brough drops them for good. He embarks on the building of an utterly different, incompatible *persona* for this god, one with whom he seems at home. Brough thinks Soma is a stimulant; yes, a vulgar stimulant like alcohol, like the rum ration that has sometimes been given in the West to sailors and soldiers before entering a battle. Brough is sure about this Soma.

> On a more mundane plane, the *soma*-drink was a powerful stimulant for those about to go into battle. [JB 340)

Who drank Soma in Vedic times? The priests - or some of them - certainly, and perhaps the wealthy patrons of the cult also. But who tells us that the ordinary warriors did so? Brough speaks of 'the secular use of *soma* in battle'[5] as of a fact and he 'conjectures' that this use came first in time! I wish he had given us supporting evidence.

In the Vedic hymns Indra, the warrior god, as well as other deities, went into the fray against their mythological enemies with bellies full of Soma. But this is mythology, equipping the gods with the divine afflatus. The Brahmans conceived of their tribal gods fighting the enemy with full equipment, with *mada* and *văc* doing their part.

Brough quotes[6] in favor of his warrior interpretation of Soma *ṚgVeda* IX 30.3 where the poet says, 'Bring us warrior-might [exaltation of spirit as well as bodily strength] fit to subdue warriors'; and IX 85.2 where he says, 'O Pavam&amacr;na, stimulate us in the battle... strike down our enemies.' But these two verses sound like the hymns that were sung in churches all over the world without any 'stimulant' during the last wars. Soma and Indra are mighty tribal gods, they are 'our side', and they are urged on together to enter the fray and do valiantly. The Brahmans were singing hymns pleading with their gods, Indra, Soma, and the rest, expressing ardent hopes, praying for victory with the gods' aid. The men may have fought better after they had heard such a stirring religious service.

Brough reverts to the 'stimulating' effect of Soma time and again.

> There are ample grounds for believing that *soma* was a powerful stimulant. [JB 341]

What 'ample grounds'? He gives us no grounds at all.

> Here, it would seem, is a plant [*i.e.*, the fly-agaric] whose effects are totally unsuitable to stimulate Indra and human warriors for battle. [JB 360]

Yes indeed. At this point Brough is right. Soma stimulated the *kavi* to song, not warriors to battle.

> Ephedrine is a powerful stimulant, and would thus be a more plausible preparation for warriors about to go into battle. [JB 361]

But divine inebriation is what moved the *kavi* who imbibed Soma. *Mada* and *văc* are its sweet fruits, not lust to do battle.

Brough does not reconcile his two personalities of Soma. Would a leader commanding troops about to enter battle choose that particular moment to have his men awe-struck with holy rapture? But until Brough documents his construction of Soma as a 'stimulant' like our spirits, it is idle to speculate on the possibilities, enticing though this exercise promises to be.

Brough finds stupor incompatible with the Vedic religion.[7] How does a man in rapture look? There are many stupors and one kind is a man in rapture. Those Europeans who observed the tribesmen in Siberia did not know what they were seeing. They contented themselves with saying 'stupor' and they were right, but they did not look far enough. Everything that Brough holds against my theory on p. 360 is not only compatible with the fly-agaric as Soma but confirms it. He objects to the emetic properties of Soma, but in the East the attitude toward vomiting is far different from our modern Western attitude. We think vomiting a sign of illness or at least an imbalance in the organism, and in company vomiting is beyond the pale. Part of the yoga discipline is to extend the range of the voluntary nervous system to include vomiting and to vomit regularly. I do not assert that any such régime ruled 3,000 years ago in the Indus Valley, but I am fairly confident the Brahmans of the *ṚgVeda* did not share the modern Western conventional horror of vomiting, which I believe is limited to our own age and culture. Certainly once you are in a state of ecstasy, vomiting does not matter, as those who have experienced rapture well know.

Brough cites convulsions as caused by the fly-agaric. This must be based on von Langsdorf's testimony, pp. 248, 250-1 of *SOMA*. But von Langsdorf quotes informants as saying that convulsions are caused by *excessive* use of fly-agaric. Brough omits the word 'excessive'. He has reversed the tenor of his source. Furthermore von Langsdorf adds that cases of convulsions leading to death were 'extremely rare' and moreover, on inquiry, 'no one could recall any specific example'. (His informants were doubtless Russians exchanging hearsay in the Russian colony concerning the surrounding helots - the Kamchadal, Koryak, *etc.*) Brough does not quote von Langsdorf's careful *caveat* that covers this part of his text:

> Although I made great efforts to find out something about the harmful or possibly deadly effects of the fly-agaric, I could obtain no satisfactory information on the subject. The Koryaks greatly prefer fly-agarics to the Russians' vodka and maintain that after eating fly-agarics a man never suffers from headaches or other ill effects.

Brough seems to know little of the varieties of religious experience. The Vedic religion was not a sedate, decorous, conventional service attended by well dressed well behaved families such as we have on Sundays in the churches and cathedrals of England and the United States.[8]

Brough asks me in a challenging tone why I feel certain *mádhu* in the *ṚgVeda* never meant 'mead' but always 'honey'. I am quite sure that I am right and here are my reasons. Soma in the *ṚgVeda* is exalted above all earthly things. Soma is of the earth but it is also divine. It possesses the power to confer the 'reverential awe' of divine inebriation, the *pouvoir-poétique* as Renou phrased this gift that surpassed all other gifts. Soma was the Word made juice. Only metaphors of superlative enhancement were worthy of it. Repeatedly the term *mádhu* is so used. In the Vedic age honey was unique, a product of nature having the colour of amber and a heavenly taste, virtually the only source of sweetness that the Indo-Iranians knew. In this guise, *mádhu* was worthy of Soma. Who would downgrade Soma by calling it 'mead'? Mead is a fermented drink in a class with beer. If *mádhu* had meant 'mead', why was not *súr&amacr;* an equally common trope for Soma?

We in the West, by long tradition, are obsessed with alcohol as the sole inebriant. A divine inebriant is utterly different in kind from an alcoholic beverage. Would a believing Christian liken the Elements in the Holy Eucharist to the beer being dispensed in a local pub? *A fortiori* would the Brahman, possessing an herb whose miraculous potency did not need to be taken on faith, call this herb by the equivalent of beer? If the Aryan culture knew mead, I think the Aryans must have called it by another name and in I 117.6 the poet obviously meant 'a hundred jars of honey', the highly prized honey, not mead. Had the Brahmans commonly used the same word for both, honey and mead, the confusion of senses would have precluded *mádhu* as a trope for Soma. At the expense of repetition I repeat that a fermented beverage must not be confused with a divine inebriant. This is the first and great commandment for the Western student of Soma to master.

1. ↑ Brough's discussion here is JB 339-340. In the Trentino dialect of Italian the fly-agaric is *ovolo matto*, 'mad mushroom'. Some philologists have thought that this adj. *matto*, apparently a *hapax* or rare in Latin, now common in Italian, was cognate with the Indo-Iranian *mada*, *maδa*.
2. ↑ I refrained in *SOMA* from citing X 119 because of its late date, not feeling certain that Soma was still being consumed by the Brahmans when the last batch of hymns was admitted to the canon.
3. ↑ *The Name and Nature of Poetry*, Leslie Stephen Lecture, Cambridge, 13 May 1933.
4. ↑ JB bottom of 359.
5. ↑ JB 340.
6. ↑ JB 340.
7. ↑ JB 360. W. Caland and V. Henry in their *L'Agniṣṭoma*, beginning on p. XI of the Preface, describe the function of the various priests and say of the first Priest the following:

    > Le prêtre dit *brahman* occupe une place à part. En principe, i est muet et inactif, et pourtant il passe pour le personnage le plus important du drame qui se joue sous ses yeux impassibles. Il est le 'médecin du sacrifice': si quelque manquement s'y est produit, il sait le rite et la formule efficaces qui en annulent les conséquences; il accomplit le rite, profère la formule et *rentre dans son repos*. [Italics mine]

    And so the priest who ranked first in importance had virtually nothing to do! He remained in his place and then withdrew 'to take his rest'. The brilliant men who composed *L'Agniṣṭoma* were working from sources composed after the use of the Soma-plant had been abandoned. Was not this 'first priest' in line of succession to a priest who, in the days when the genuine Soma was present, had been singled out to drink the Soma and then to retire into seclusion and pass into a state of rapture - what Brough calls a 'stupor'? Vedic students should examine carefully the sources to see what additional light they shed on this first of the priests, who thus went off to *prendre son repos*.
8. ↑ I regret that I confused Brough with my presentation of the Vogul tale, to which he draws attention, JB 360. The two recensions of the Epic song 'about the creation of the heavens and earth', Reguly's and Munkácsi's, taken down 40 years apart, differ only in minute linguistic details that do not affect the meaning. The translation of the song was never in question, only the accuracy of Munkácsi's summary, which is printed in italic in my SOMA, pp. 307-308, and I went to Budapest to consult János Gulya for this purpose. It turned out that Munkácsi's summary was grossly inaccurate.

IV

Was There a Soma-urine?

As an inebriant the fly-agaric possesses a property that is peculiar to it: the potency in this mushroom passes through to the urine and the urine is as inebriating as the mushroom itself, possibly more so. Perhaps the Indo-Iranians made no use of this property, or made only occasional use of it when there was a shortage of the original plant, or they may have resorted to the urine in some areas and not in others, or they may have practiced urine-drinking early in the Vedic age and then abandoned it. But even if the Indo-Iranians never resorted to Soma-urine, if in the Vedic age they showed knowledge of the inebriating quality of the urine after imbibing Soma, this alone would suffice: it is proof - and what proof! - that we have identified the plant. It would rivet the superb fly-agaric to the Divine Soma. For the fly-agaric, so far as we know, is the sole source of muscimol, and muscimol, so far as we know, is the sole hallucinogen that passes through to the urine with unchanged potency.

I do not assert that the Vedic priests drank Soma-urine. I say the case for the practice is strong and cannot be dismissed out of hand. The intense repugnance of the West and among occidentalized Hindus to my idea is only an anthropological trait of Westerners and we must guard against being swayed by our tribal traits. A knee-jerk rejection tells more about us than about the Indo-Iranians of old.

As with vomiting, the attitude in the East toward urine is different from ours. Urine is extensively used as medicine and in ablutions and in certain religious offices. Urine is normally the chief source of sterile fluid available to peoples who do not possess our technology, especially useful for washing wounds.

In a Gatha of the Avesta, Yasna 48.rn, Zarathustra excoriates a practice of the priests:

> When will you (O Mazdah) do away with the urine *of this drunkenness* with which the priests evilly delude the people? [Italics mine.]

It seems to me that Zarathustra was speaking of the Haoma-urine drinking in the ritual. F.B.J. Kuiper, who disagrees with me on my identification of Soma, is nevertheless cautious in his comment on my interpretation:

> Since there is ample evidence to show that the fly-agaric can also be 'taken in the urine of the person who has ingested it,'... the surprising novel interpretation of Zarathustra's words... may well contain a grain of truth,... [*Indo-Iranian Journal*, Vol. XII No. 4 (1970) p. 283]

But now listen to Brough:

> It seems certain that Zarathustra here is castigating the Haoma-ritual; but there is no reason to see in the word *m&umacr;θra* anything more than a strong term of abuse... [JB 348]

But was 'piss' a term of abuse in ancient Iran, let alone a strong one? Brough produces no parallel texts citing 'piss' as a term of abuse, not from the Avesta, nor from Sogdian or Khotanese sources, nor from the corpus of Pahlevi writings, nor from the vast body of Vedic and Sanskrit texts with which he is familiar. He produces none at all and I doubt whether he can. He would ask us to accept a usage probably running counter to Iranian attitudes that would be a *hapax*, rather than the plain meaning of the verse. He would conjure away a crux with a bland assertion! Let us note that our text speaks of the *urine of this drunkenness*.

It is my suggestion that the 'third filter', mentioned twice in the *ṚgVeda* (IX 73.8, 97.55), is the human organism filtering the Soma juice through to the urine. Abundant testimony from travelers, anthropologists, linguists, and others sheds light on the practice as it has survived down to our times among the most remote peoples in the northern tier of cultures in Siberia, the Paleosiberians, and also some of the Uralic tribes - the Samoyed, one branch of the Lapps, the Ob Ugrians, and possibly some of the Finnie peoples. The urine-drinking custom is strong among the Northeastern tribes in the Chukotka. These facts are challenged by no one, no matter how surprising they are to Westerners coming upon them for the first time. It is the thesis of my book that a practice, amply attested in modern times for northern Siberia and Europe, was shared in the remote past by the Indo-Aryans who brought it down from their northern homeland, a plausible thesis that needs to be weighed, rather than rejected out of hand. Brough proffers no explanation for the 'third filter'.

Here is what Claude Levi-Strauss in his review article on my *SOMA* (*L'Homme*, Vol. 10, No. 1, 1970, p. 9) had to say about my construction of the 'third filter':

> Quant au troisième filtre, sa nature et son rôle demeurent inexplicables, sauf à y reconnaître le corps même du consommateur... à travers lequel le Soma passe en se clarifiant pour rejaillir sous forme d'urine. Il est de fait que de nombreux versets prêtent une extrême attention au cheminement du Soma clans l'estomac, le ventre et les entrailles du dlieu.

After dismissing cavalierly a series of Vedic verses discussing Soma in the enormous belly and the entrails of Indra, Brough concludes:

> ... there is no hint in the RV that Indra ever excreted *soma*. [JB 359]

Brough overlooked VIII 4.10:

> Like a thirsty stag, come here to drink;
> Drink Soma, as much as you wish.
> Pissing it out day by day, O generous one,
> you have assumed your most mighty force.
> (Tr. by Daniel H. H. Ingalls)

How does Brough render this verse? Until we hear from him, there stands Indra with his vast belly full of Soma daily pissing Soma.

And in II 34.13 the Rudras in the shape of horses seem to have pissed Soma. This is certainly a possible construction of the verse.

When one drinks tea or coffee or milk or beer, one urinates not tea or coffee or milk or beer, but urine. Why does Indra, why possibly do the Rudras, urinate Soma? How did the Vedic priests learn about Soma-urine unless they had drunk it?

Among the hallucinogens known so far to science, the fly-agaric is unique in that its active agent - muscimol - is carried through to the urine unchanged.[1] If Indra pisses Soma, as he does, what can he have drunk other than the pressed juice of the reflated fly-agaric? How else is Soma-urine to be explained? This reminds me of Voltaire's apophthegm: *Si Dieu n'existait pas, il faudrait l'inventer*. With Soma-urine the opposite holds true: *Si cela n'existait pas, qui pourrait l'inventeri*?

As for Brough's discussion of IX 74-4, he says that Geldner's conjecture making the priests piss in the ritual seems 'not impossible', though for him it is 'highly improbable'. Geldner's conjecture is all the more remarkable in that he did not, when he made it, suspect the possibility of Soma-urine. What would he have said now that I have introduced the fly-agaric? Brough accepts Renou's rendering of *náro* in this verse as referring to the Maruts:

> '... the presence of the Maruts in this verse is beyond dispute.' [JB 347]

But Daniel H. H. Ingalls a year earlier had already disputed this finding of Brough's. Ingalls, who rejects my Soma-urine theory, had declared in April 1970 that I had 'been sharper than most Vedic; translators in seeing that the word *náro* in that verse must refer to the priests. It must;...'[2] Ingalls and Brough disagree with each other and with me on the interpretation to be given to this whole passage.

In later times we find references to Soma-urine and the drinking of it. According to a well known Br&amacr;hmaṇa story[3] Indra drinks so much Soma that it flowed out from all of the orifices of his body *as well as from his bladder*. In the Mah&amacr;bh&amacr;rata there is a quaint apologue,[4] a late interpolation, telling how a *m&amacr;tañga* (lowest of the low) invited the holy man Uttañka to drink his urine to quench Uttañka's unbearable thirst and how Uttañka, feeling insulted and indignant, refused the proffered beverage, only to learn later that the *m&amacr;tañga* had been Kṛṣṇa in disguise who had been offering him *amṛta* urine. *Amṛta* is often used in the *ṚgVeda* and the old texts as a synonym for Soma. These are telling citations difficult for even the most determined exegete to conjure away. Brough fails to mention them.

There is more evidence, remote but nonetheless enlightening. The Parsis, descendants of the Zoroastrians, to this day consume urine in their religious devotions, though only in symbolic amounts and only bull's urine.[5] The Manichæans, whose religion was an off-shoot of Zoroastrianism, exercised considerable influence in China for some centuries and from a late date in Fukien Province there survive two reports by a high civil servant to his superiors of the Chinese Establishment criticizing the religious activities of those Manichæans sectarians. In their devotions, he said, they consume too many *red mushrooms* and moreover they were making use of urine, apparently human urine.[6]

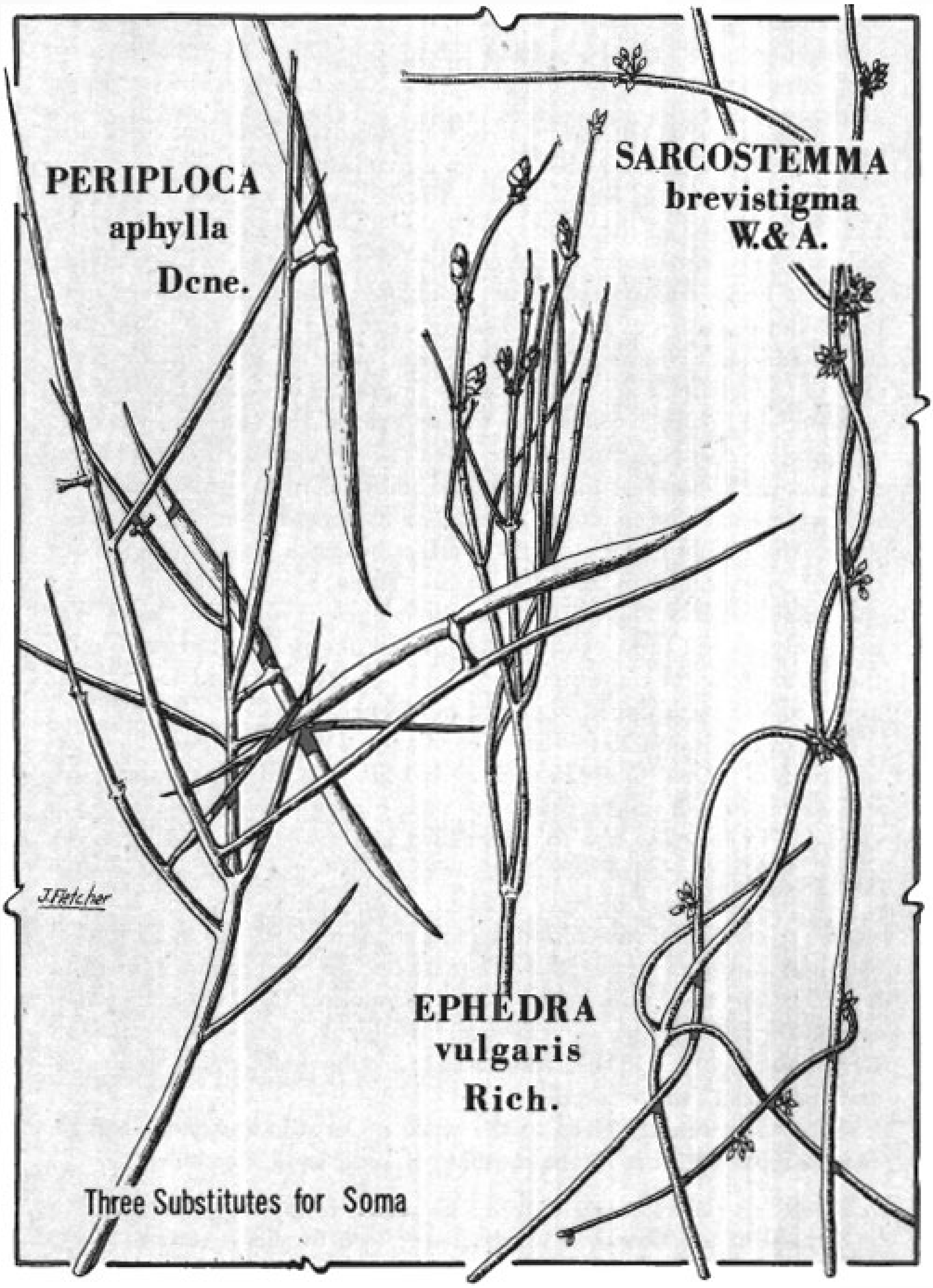
If my interpretation of the *ṚgVeda* in the matter of Soma-urine meets with resistance in the West, in India in some quarters it has proved acceptable, even illuminating. A lady of English origin writes me that she was in a circle of Indian ladies and one of them, a ranee, was expatiating on the infatuation of her husband, the rajah, for a certain *s&amacr;dhu*. Why, he even wishes to drink the *s&amacr;dhu*'s urine, she said. The Indian ladies accepted this calmly, as though not surprised, and my correspondent therefore remained silent. Again, an Indian intellectual says that the present-day *s&amacr;dhu* conveys his spiritual powers to his disciples in any one of four ways: 1) by a 'laying-on' of hands, precisely as in our Church; 2) by having his disciple repeat incessantly for long periods a certain *mantra*; 3) by having him fix his gaze undeviatingly on the *s&amacr;dhu*'s countenance for long periods; and finally 4) by giving his favoured disciple the privilege of drinking his urine. I think these instances of contemporary urine-drinking may come down from the time when urine was still impregnated with the essence of Soma.

Sometimes I am asked why, if there was Soma-urine in Vedic times, it is not more specifically described: the Brahmans in those remote days were certainly not squeamish about the bodily functions. True, Victorian squeamishness was foreign to the Aryans. Our sole source of information about this practice is the body of hymns known as the *ṚgVeda*. The hymnologists composed their verses for other Brahmans and themselves to chant and hear, and their audience of course knew all about the practice. We are fortunate that there should be two direct references to the Third Filter, and a number of oblique allusions. There must have been a reticence, not from squeamishness, but from a sense of holiness that attended the miracle of transubstantiation when the urine of the priest became the divine Soma, to the accompaniment of the liturgy and hymns rendered with careful perfection. A Holy Mystery always and everywhere leaves the devout believer reticent, as he sings and acts out the canon of the liturgy in awesome measures... Transubstantiation! How surprising are the parallels between certain features in the Soma sacrifice and the heavy burden of centuries of Christian theology!

V

Questions of Exegesis

Brough advances, tentatively it is true, the hypothesis that *aṃ&sacute;ú* was the name of the Soma plant. We agree that Soma was a god and that *pávam&amacr;na*, the juice of the plant, was worshipped as a god. I would consider that the god on the mountain heights was immanent in the plant's juice, and this immanence continued after it was gathered, as it was drying and was being transported to its destination where the sacrifice took place, during storage, and after being expressed from the plant and before and after filtering. Whether 'Soma' was the name of the plant or was applied to it by metonymy is important but need not for the moment detain us. I will revert to this toward the end of my paper.



Three Substitutes for Soma

That the Vedic priests should have had two or more names, in addition to many metaphors, for their great god Soma seems to me natural, even inevitable, each of such names having had its genesis in one aspect of the plant. The names in time would overlap, but each would retain, so to speak, its own center of semantic gravity. 'Soma' grows in the mountains and upland valleys: this is its home where it reigns supreme. 'Soma' was used only on the most exalted plane. *Pávam&amacr;na* is the expressed juice, the liquor ready for consuming. *Aṃ&sacute;ú*, Brough says, is a third name: what aspect of the plant did it originally represent?

Perhaps the Brahmans felt the need of a word free of the portentous associations of 'Soma' to use in their daily round for the dried, shriveled, lacklustre globs of fungus that were their constant preoccupation. *Aṃ&sacute;ú* extended its meaning also to the pressed juice: *vide, e.g.*, VI 71.2; IX 86.45, 91.3, 96.8 and 97.14, where the sense of *aṃ&sacute;ú* overlaps that of *pávam&amacr;na*.

But the etymology of *aṃ&sacute;ú* remains as obscure as ever and is it not useless to speculate? Its Avestan cognate sheds no light and in the rest of the Indo-European languages no cognate has yet been found. Moreover, we know the word only in the sacred hymns and the Avesta. Its use, if any, in the lay language of Vedic times is a blank. Darmesteter and later Renou used *tige* for it in their translations; and Bartholomae, in his dictionary of Avestan, 'tender shoot'.

From the meanings given to the word in 'later Indo-Aryan', Brough, though rejecting 'fibre' as the meaning of Vedic *aṃ&sacute;ú*, concludes:

> ... the later development of such a meaning strongly suggests that the Soma-plant was fibrous or stringy, rather than the fleshy texture of a mushroom. [JB 338]

But the later Indo-Aryans had before their very eyes the fibrous, stringy plants that passed for Soma, for the Brahmans had selected surrogates for the genuine Soma following the Vedic era. Even today there are countless Brahmans who will solemnly tell you that the original Soma was one of these surrogates, most of them *Somalat&amacr;* or *Soma-vall&imacr;*. I urge the reader who is seriously interested in these matters to read Part II of our *SOMA* by Dr. Wendy Doniger O'Flaherty to inform himself on this extraordinary chapter in cultural history. The descriptions of these plants are insufficient for us to identify them. The earliest identifiable surrogates are species of Sarcostemma or Periploca or Ephedra, of which we carried a picture in our *SOMA* on p. 105, here reproduced on the facing page. They are indeed 'fibrous' and 'stringy', and might even have given rise to the meaning 'ray' that *aṃ&sacute;ú* also carried in later times. I think that the most learned and intelligent of the Brahmans must always have known these plants were only surrogates, but the changelings seem to have been generally accepted. There may well have been other substitutes in the beginning, and rhubarb has been suggested as one of them. To all of them 'fibrous' and 'stringy' are appropriate.

Under these circumstances in post-Vedic times, with 'Soma' surrogates aplenty at hand and accepted as the genuine article, who would think of running the movie backward for centuries, even millennia, in quest of a plant that no one living knew anything about? Here is indeed a case where the Law of Parsimony imposes itself.

Soma was the pole-star of the hymns of the *ṚgVeda*. Its abandonment must have been a momentous event in the lives of the Brahmans. Not once do the Br&amacr;hmaṇas describe the original Soma. Not once do they say that the surrogates (which they *do* describe *as surrogates*) resemble the original Soma. This consistent silence about the original Soma must have had a meaning. Negative evidence is usually weak evidence but in this instance the silence is deafening and so for once the negative evidence becomes positive. The Brahmans were masters of the mnemonic techniques - and what masters! - needed to preserve what they wished to preserve in their culture. To have preserved the memory of Soma would have been child's play for them. Did not the Brahmans hope, did they not feel (and in the event rightly so), that later generations would assume the original Soma was in some way similar to the surrogates? Here in Soma is an example of successful priestly obfuscation on the part of the Brahman custodians of the secret - successful down to our own day. (The Brahmans must have had their own good reasons for acting as they did.) Professor Brough himself attributes to the original Soma the properties of the surrogates![7]

★

Now I quote from Brough's paper, to illustrate the nature of his exegesis

> '*Soma grew in the mountains.*' This is important for the fly-agaric theory, since the plant grows only in mycorrhizal relationship with the birch and (less frequently) conifers. 'In northern Eurasia the birch and conifer grow at sea level. South of the Oxus and in India they are found only at a great height in the mountains, around 8,000 to 16,000 feet'... This would account for the increasing difficulty in obtaining supplies of the plant as the Indo-Aryans penetrated further south. The implicit syllogism is obviously invalid, by reason of the undistributed middle: at this point in the argument, many other plants growing in the mountains may still be considered possible. The twelve RV verses quoted here by Wasson show only that Soma (but plant or god?) was located on the mountains. [JB 342]

'The implicit syllogism is obviously invalid.' But I *implied* no syllogism. What I meant I wrote, nothing more. Brough *inferred*, mistakenly, an invalid syllogism and would father it on me.[8] Who could suppose me such a simpleton as to assert that Soma and the fly-agaric are identical because they both grow in the mountains? In *SOMA* I developed successively a number of propositions each of which served to limit the area of search for Soma. For an example, the poets insistently place Soma in the heights: ergo, we exclude the lowland flora. I pointed out, step by step, how Soma and the fly-agaric shared in these successive attributes. Instead of a faulty syllogism on my part, we are offered a faulty inference on Brough's.

★

The twelve verses that I quoted in *SOMA* indeed show that Soma, both plant and god, dwelt in the mountains, as Brough concedes.

Then Brough goes on to quote two verses where the poets have referred to Soma as growing also in valleys, as though valleys had of necessity to be close to sea-level and lofty valleys were a rarity. True, Brough may be thinking of the Cotswolds and the Grampians, but we are not speaking of England or Scotland. We are speaking of the Hindu Kush and the Himalayas where mountains rise from the hot plains quickly to great heights and where valleys start at the hightest level. Mountains and valleys go together; they are the recto and verso of a page, the observe and reverse of a coin. When the composer of Yasna 10.17 spoke of 'the Haomas whether those on the heights of the mountains, whether those in the valleys of the rivers', was he not resorting to the familiar poetic device of parallelism, saying the same thing in different words? And where in *ṚgVeda* VIII 6.28 the poet speaks of 'the hidden place of the mountains, and in the confluence of the river's', he is surely referring to the celestial counterpart lying in the heavens.

★

> It is difficult [says Brough] to imagine that the ritual utterances of the ceremonies of Soma Pavam&amacr;na... should be dominated by rapturous descriptions of *A. muscaria*, a plant which can be seen in its beauty during only a few days in the year. [JB 335]

Why is it difficult? The difficulty lies rather in imagining the opposite. When the whole of the religious life of the Brahmans was centered on this miraculous plant, when the Brahmans were constantly preoccupied with assuring a regular supply of it, when it evoked overpowering awe and reverence among them, could they be heedless of its provenience? Of its life-cycle? That it was visible for only a short time in the year in places perhaps inaccessible to all but a few of the priests would create for the glowing plant a scarcity value, enhancing yet further its unique status in the world's order. They were not living in our segmented culture, many of us shut off from all-providing Nature, the umbilical cord to Nature severed. They were living in a sparsely settled countryside. They were doubtless great walkers as the Hindus are today. They lived close to nature. The harvesting of the Soma-plants must have been the occasion for special ceremonies and holy rejoicings, all perhaps ordered according to the movements of the sun and moon, as was and still is the case in Mexico when 'God's flesh' (the inebriating mushrooms) is gathered on the mountainside just before sunrise. But we know nothing of this: the abandonment of Soma meant that any ceremonies proper to its gathering lapsed. When Soma at last came to be abandoned, the difficulties in the way of achieving this drastic, this revolutionary, step must have been greatly eased by two facts: first, the Brahmans alone were custodians of its secrets, and, second, certainly only some of the Brahmans knew the plant *in situ*, growing in the mountains.

If I understand Brough, he thinks that the poets' interest in the Soma-plant began only when someone else delivered the dried plants to them in the lowlands. Are there those (other than Brough) who can believe this? I cannot.

Brough performs a similar feat in dismissing the poets' failure to mention the roots, leaves, blossoms, fruit (or seed) of Soma. He thinks it natural for scores of poets over generations or even centuries, in different religious centers, to sing of the holy plant, focus of their religion, without a single one of them mentioning these indispensable organs of the phanerogams. This omission does not strike him as in the least surprising. It is my position on the other hand that these parts of ordinary plants failed to be mentioned *because a mushroom does not possess them*.

★

The Colour of Soma. When I returned from the Far East in the winter of 1965-66, I spent the thirty-five days of voyage on a freighter drafting a 31-page *précis* of my argument. I also drew up a list of questions to put to those who knew the *ṚgVeda*. My *précis* with illustrations went to Louis Renou in Paris. I followed a few weeks later with my questions. The most important one, as important as all the others put together, was whether *hári* was incompatible with the fly-agaric. I put the question to Renou at our first meeting and discussed it thoroughly again when I was spending Sunday with him in the country, right after Easter of 1966. He had already seen, of course, my principal photographs that accompanied the *précis* and that were later published in *SOMA*. Brough asks on what evidence the two sentences that he quotes from me were based. Those sentences read as follows:

> *Hári* is not only a colour word: the intensity of the colour is also expressed by it. It is dazzling, brilliant, lustrous, resplendent, flaming. [JB 349]

They were the judgement of Louis Renou. The wording is mine, the substance was his. It was I who raised this point, being sceptical about the applicability of *hári*. It was Renou's idea that the intensity of the colour might have been the common denominator linking the fly-agaric with the sun and fire. He developed his thinking on this at some length and delighted me with his illuminating exposition. In many languages there is one colour word that carries a further meaning of superlative intensity, of ultimate enhancement, *etc.*, a meaning independent of its position in the spectrum.

The horse was the noblest of domesticated animals, full of brio and fire, and among horses the bay was outstanding. What could be more natural than that 'bay' would serve as the adjective to express what the sun, fire, the steed of the sun-god, and the fly-agaric possessed in common, a superlative intensity in colour? In Appendix III c we cite an instance of such a word in circumstances not unrelated to the point at issue here.

We are discussing poets, not spectrum calibrators, not exegetes. The Vedic poet would feel the need of a word to characterize the glowing scarlet of his mushrooms, a *mot juste*. He saw, he chose to see, he arrived at a convention to think of the sun, fire, the steed of the sun-god, the fly-agaric as equally flaming, resplendent, lustrous, brilliant, dazzling: as sharing in these supreme qualities. Soma and the sun and Agni were all-important in his world. The poets saw them as in a class by themselves. Other poets will quickly grasp this, and also poets *in posse*, among whom will be found some exegetes, including in the end I hope John Brough.

★

On this question of the meaning of *hári* Brough says that 'red is absolutely excluded'.[9] He is as sure of this as he was of the Maruts whose presence in IX 74:4 was 'beyond dispute' only to be confronted with Ingalls who had already, a year earlier, disputed their presence.

I have made no effort to find a plant that would fit the preconceptions of any one Vedist. I have chosen a plant that I think can be reconciled with the *ṚgVeda*, let the chips fall where they may. It is incumbent on Vedists to see whether, even at the price of revising their previously held individual views, my solution is compatible with the *ṚgVeda*. Many Vedists are taking their time with my *SOMA*: they are living with my idea. They may come up with a hard core of objections and the fly-agaric will then pass into the lumber room of discarded notions. But everything of worth that has turned up so far since my *SOMA* appeared has in fact buttressed my case.

The identification of Soma calls for a rationale of its own. If we were privileged to travel on H. G. Wells's time machine, we could all ride together backward in time and there in the mountains of northwest India confront the plant Soma. The sight would resolve innumerable doubts with clean finality. Not possessing a time machine, however, we must stand before every candidate and see whether it can be reconciled with the *ṚgVeda*. It matters not at all if there have been two or more interpretations to a given verse, *provided one interpretation fits the candidate*. For example, when the poet speaks of 'valleys' as a home for Soma, meaning perhaps lowland valleys, this is irrelevant, if the poet could have had in mind upland valleys. And does the candidate shed light on words and expressions heretofore obscure? Or wholly new readings may be suggested by the fly-agaric... Our quest is an obstacle course, and every obstacle overcome means a substantial gain and an accelerating achievement, until we face virtual certainty.

★

Of my plates VII and IX in *SOMA* Brough says [JB 353-356] that they are 'among the most visually persuasive for Wasson's theory'. We are discussing the Vedic lines, 'He makes of milk his vesture-of-grand-occasion' and 'The hide is of bull, the dress of sheep'. But Brough says my photographs are ruled out as evidence because I must first prove that the fly-agaric is Soma before they qualify. He is reverting here to the rule that he lays down in his opening pages and that I reject as untenable. We all know of many valued discoveries, in humane letters as well as science, that have been made following precisely this procedure, reaching out and discovering analogies, exploring further, finding additional parallels, in the end establishing the case for which proof was being sought.

The *ṚgVeda* IX 97.9 says that 'by day he [Soma] appears *hári*, by night, silvery white.' Brough finds [JB 352] my photographs illustrating this verse 'charming' but says they will not do. He prefers Geldner's comment: *Soma als Sonne und Mond*. I submit that it is questionable for the exegete to cite Geldner as an authority when Geldner did not have before him my alternative reading. How does Brough know that Geldner would hold to his view today? (Let us not forget that Geldner, *unaware of my Soma-urine theory*, went so far as to suggest the possibility that the priests piss in the course of the rite!) Or perhaps Geldner would accept both readings, the Vedic poets being eminently skilled in expressing two planes of meanings with the same words. We must remember that Soma as the moon figures overwhelmingly in post-Vedic, Brahmanical times, and that this conception in the *ṚgVeda* is of disputed strength, especially if we eliminate from consideration the last batch of hymns to be admitted to the canon. Geldner's rendering may well be an out and out anachronism. He may have resorted to it for want of a better explanation. I have sometimes asked myself whether the moon as 'Soma', rather than as *candrámas*, was associated with the abandonment of Soma, when the translation to the skies of this divinity was a happy solution for the problem of Soma's disappearance here below.

★

I will finish this section with a question. Do we not find in the fly-agaric a happy solution to the identity of the Vedic divinity, Aja Ekap&amacr;d? Already in the last century Abel Bergaigne was saying that this meant the *Non-né Unipéde*, 'the Not-born Single-foot',[10] but he was at a loss to explain this curious name. Now we see what was meant. The god Soma has a single foot and he is also 'Not-born', for the herbalists of old knew well that mushrooms have no seed and come into being, not like all other creatures, but springing up mysteriously, children as they thought of the gods. (In those days there were no microscopes to reveal the spores.) There is a verse in the *ṚgVeda* that says Parjanya, the god of thunder, was the father of Soma, and according to another verse, 'the gods, those fathers with a commanding glance, laid the Somic germ'.[11]

Bergaigne showed noteworthy prescience in divining the sense of Aja Ekap&amacr;d, groping blindly as he was; and so did Geldner when he surmised that the priests might be pissing in the course of the ritual, though he knew nothing of the fly-agaric or muscimol.[12]

In the *ṚgVeda* the full name of Aja Ekap&amacr;d is cited six times, always in hymns to the Vi&sacute;vadevas, and accompanied in five of the citations by another divinity, Ahi Budhnya, the serpent of the depths, a chthonic being who invariably guards the holy plant throughout Eurasia. That Aja Ekap&amacr;d is another name for Soma, perhaps already archaic in Vedic times, finds support in RV X 65.13, where the epithet proper to Soma, 'Mainstay of the Sky', is applied to him. Pliny[13] tells us of a single-legged folk (*monocoli*) said to live in India who take their siesta in the shadow of their own single foot. Is not this the Vedic personification of Soma, Ekap&amacr;d, which by the time it reached the Mediterranean 1000 years later had become confused with a genuine people, and is not this fabulous folk revealingly linked in Pliny's text to a *chattra*, a parasol mushroom? In RV X 82.6 Aja appears, not now linked to Ekap&amacr;d, but to the navel, *n&amacr;bhi*, and thus two seemingly disparate metaphors are reconciled in the divine mushroom, both referring to Soma. Even more exciting, at the far end of Eurasia, is the myth of the Chukchi to explain thunder.[14] The Chukchi live in the peninsula known as the Chukotka, opposite Alaska. They are linguistically related to the Koryak and the Kamchadal. The Russian anthropologist V. G. Bogoraz reports that thunder is

> the rattling noise made by girls [the 'fly-agaric girls' of Chukchi parlance] playing on a spread sealskin. Rain is the urine of one of the girls. In one tale the lightning is described as a one-sided man [a 'Uniped', *monocolus*] who drags his one-sided sister along by her foot. She is intoxicated with the fly-agaric. The noise caused by her back as it strikes the floor of heaven is thunder, her urine is the [Soma-impregnated] rain.

In this myth we find the same forest-belt themes as in the Vedic hymns - Ekap&amacr;d (him of the single foot), the fly-agaric inebriant, with the thunderstorm complex and the Soma urine.

1. ↑ The Eugster-Waser team ignored the Siberian experience but Peter Waser in a paper published in 1967 (No. 10 in Appendix I, pp. 437-438) made known that muscimol, the most important psychotomimetic so far discovered in *A. muscaria*, passed through to the urine. Once again his finding confirms what the tribesmen have known for ages from personal observation. Richard Evans Schultes drew attention to this convergence of herbal lore of the tribesmen with contemporary scientific discovery in his paper published in the *Journal of Psychedelic Drugs*, Spring 1971, Vol. 3, No. 2, p. 105.
2. ↑ Paper read at annual meeting of American Oriental Society, 15 April 1970. Published in *Journal of American Oriental Society*, Vol. 91, No. 2, April-June 1971, p. 188.
3. ↑ *Taittir&imacr;ya Saṃhit&amacr;* 2.3.2.5-6, '*Satapatha Br&amacr;hmaṇa* 5.5.4.8-9, and in most detail 12.7.1.1-9. This last citation is a scholiast's effusion carried to absurd lengths, but it raises an interesting question. The muscimol in the dried and reflated fly-agaric passes through to the urine, but does it also come through in the secretions of the sweat glands and tear ducts? The pharmacologists and chemists must answer this and it can easily be answered. If we found muscimol in the sweat and tears of those who have ingested the juice of the reflated fly-agaric, it would mean that the *ṚgVeda* had called our attention to something we did not know about the hallucinogenic *Amanita muscaria*!
4. ↑ *A&sacute;vamedha Parvan*, 14.54.12-25.
5. ↑ J. J. Modi: *The Religious Ceremonies and Customs of the Parsees*, Bombay, 1923; 2nd edition 1937. 2nd ed. p. 93 and index entries under 'gaomez', 'nirang', and 'nirangdin'.
6. ↑ *Un traité manichéen retrouvé en Chine*, traduit et annoté par Ed. Chavannes et P. Pelliot, Paris, 1912, pp. 292-340, especially pp. 302-305 and 310-314.
7. ↑ In his discussion of *aṃ&sacute;ú* Brough has this curious sentence that I call to the reader's attention:

   > There are no grounds for believing that the Indo-Iranians were sufficiently skilled herbalists to have made such discoveries. [JB bottom of p. 336]

   On the contrary there is every ground for so believing. The Indo-Iranians, not advanced like us technologically, must have been skilled herbalists like all other peoples at their stage of development. They lived in intimate contact with nature. They knew their plants: which to use for what illnesses and accidents, and whether the roots or the bark or the leaves or the blossoms or the seed, and how to prepare and apply the medication, whether externally or by ingestion, and the dosage, *etc.*, *etc*. True, we know this chiefly by analogy with peoples living today in conditions similar to theirs, but the evidence is conclusive. Our alert pharmaceutical enterprises listen with respect to what the unlettered old woman in New Guinea or the upper Amazon or Mesoamerica or India has to say about the herbs known to her, hoping always (and sometimes with success) to learn of some new Rauwolfia. The vast herbal lore of ancient India survives, however obscurely for us, in the compilations of Caraka and Su&sacute;ruta. It survives to this day, passing from one generation to the next by word of mouth, and is a resource that has scarcely been tapped by students of economic botany. To assume a condescending attitude toward this fund of empirical knowledge of botany is grievously wrong. The *ṚgVeda* is filled with herbal lore and one hymn, X 97, is devoted to plants, *óṣadhi*. One does not ordinarily look to a collection of hymns for herbal medicine and is it not noteworthy how frequently plants are cited?

8. ↑ Here is the important though not the only *lapsus* on Brough's part. There are others. A few lines earlier he speaks of illustrations 'photographed from an angle which conceals' the annulus of the fly-agaric. Several of my colleagues have seen in this wording (which could have been easily changed to remove the sting) an implication of deliberate concealment. Brough's question about the annulus carries no weight. Seldom is it so conspicuous as in Poluzzi's illustration and often it has completely or almost completely disappeared. It is a flimsy discard of the organism.
9. ↑ JB 350.
10. ↑ *La Religion Védique*, Vol. III, pp. 20-25. *Aja* also carries the meaning 'goat', but Bergaigne rightly rejected this homonym here. See App. III C for a present day application of 'single-foot' to the fly-agaric.
11. ↑ IX 82.3; 83.3; also see Abel Bergaigne, *La Religion Védique*, Vol. I, pp. 172-3. When man depended for his survival on his knowledge of plants, and even after the domestication of certain plants became firmly rooted, the mystery of the generation of fungi, having no seed and not lending themselves to cultivation, was, it seems, widely known. *Cf*, *e.g.*, Plutarch's *Symposiaka*, Prob. 2, Bk. 4. ... In 1953 our Mazatec muleteer was Victor Hernández, a man who had traveled the mountain trails of the Sierra Madre Oriental all his life and spoke Spanish with grace, though he could neither read nor write, nor even tell the hour by the clock's face. We asked him why the sacred mushrooms were called in his native tongue 'that-which-springs-forth'. His answer, breathtaking in its sincerity and feeling, was filled with the poetry of religion, and I quote it word for word as he gave it:

    El honguillo viene por sí mismo, no se sabe de dónde,
    como el viento que viene sin saber de dónde ni porqué.
    The little mushroom comes of itself, no one knows whence,
    like the wind that comes we know not whence nor why.

12. ↑ Similar prescience was shown by Philippe de Félice in his *Poisons Sacrés Ivresses Divines* when he gave a surprisingly accurate description of Soma, pp. 268-9, Editions Albin Michel, Paris, 1936. To none of them - neither Bergaigne, Geldner, nor de Félice - did the possibility of the single-footed mushroom occur.
13. ↑ Quoting Ctesias: *Hist. Nat.* VII ii 23 (Loeb translation, Vol. II, p. 521). Ctesias derived the information from Megasthenes. See J. W. McCrindle: *Ancient India as described by Megasthenes and Arrian*, 1877; p. 76.
14. ↑ Bogoras, Waldemar: *The Chukchee*, Memoir of the Amer. Museum of Nat. Hist. Jesup North Pole Expedition, 1904-1909, pp. 322-323. In the English translation 'one-sided' is confusing. The Chukchi original of this, as well as Bogoraz's Russian translation, does not appear in the Russian publications of Bogoraz. In an analogous context, however, 'one-sided' appears in the Russian text as *ljudi-polovinki* rather than *odnobokij*, as one might have expected, and this would seem to mean a race of people equipped with only half of man's attributes, a human organism split down perpendicularly in the middle. This would fit the personification of the fly-agaric as a tribe of people having only one pedal extremity, only a single eye, *etc*. The Siberian tribes under tabu influences devise many fanciful names for the fly-agaric, of which this seems to be one. Pliny's *monocoli* is derived from the Greek μονόχωλος, for which 'one-sided' is given as a meaning by Liddell & Scott. A. P. Okladnikov in *Yakutia before its Incorporation into the Russian State* (McGill-Queen's University Press, 1970, p. 446) reports on the wide dissemination of tales about one-sided folk among the primitive tribes of the tundra and the northern taiga of Siberia. If I am right, we hear distant echoes of these fabulous beings, evoked by the fly-agaric working on the stone-age imagination in the Far North, in the 'Arimaspi' of Herodocus and the 'single-eye' of Soma, and also in Pliny's '*monocoli*'; and the conception finds full expression in the 'Aja Ekapad' of the *ṚgVeda*, which I would anchor to the fly-agaric of the taiga. It has been suggested that the important 'one-sided' mythic folk figuring in the mentality of the Siberian tribesmen of the north should be called 'halflings' in English.

VI

Conclusion

In his 31-page review article Professor John Brough rakes me fore and aft with grape and ball. As the smoke slowly drifts away he finds me riding the waves much as before, with a shot here and there through my rigging. His gun sights had suffered a consistent deviation from the true.

In Victorian days there was a familiar literary device: a long lost heir, vanished and since many years believed dead in the endless spaces of Australia, would turn up and make dramatic entry when all the kin had gathered around the table to listen to the reading of the will. Each of those present, in the surprise of the moment, would react according to character, and the reactions were as diverse as the author could make them. There is some analogy here with my *SOMA*. A stranger to the Vedic coterie, I have offered to Vedists a *jeune premier* as claimant to the honours paid to Soma *in absentia* for 3,000 years, a stunningly handsome plant, small, fleshy, paralleling in colour and shape those features of the cosmos to which the Vedic Brahmans paid utmost homage, an actual plant that until lately still evoked adoration and awe and fear among the Eurasian tribes of most ancient cultural lineage who dwell in the farthest reaches of remote Siberia. This plant is an hallucinogen, the dried plants being re-watered and then their juice pressed out, mixed with other fluids, and consumed. Furthermore, the ordinary urine of the drinker becomes impregnated with the god and then in turn is sometimes imbibed.

Professor Brough, eminent scholar of secure reputation, did me the honour of paying my candidate lengthy and courteous attention, for which I am duly grateful. By fiat he would dismiss *ab initio* the testimony of my photographs as irrelevant, as also the Siberian practices because they are Siberian and not Aryan, forgetting that human cultures are a seamless garment. He supposes - he *must* suppose in order that my photos be irrelevant - that the Vedic Brahmans were uninterested in the appearance of their glorious growing plant-god, uninformed about features of its appearance that bear breathtaking analogies with their conception of the cosmos. He offers us a *persona* of Soma that is a travesty, a staggering misconception of that holy being, if we are to believe our sole source of information, the hymns of the *ṚgVeda*. He would conjure away many exegetical questions, either by dogmatic pronouncement or by flitting lightly over deep-seated problems. Surprisingly, he asserts that the Indra of the *ṚgVeda* never pisses Soma-urine. He plunges ahead into matters botanical, chemical, pharmacological, and physiological where he has done no homework.

★

In the course of the past fifty years has it occurred to a single Vedist that Vedists are primarily responsible for the identification of Soma? Is any Vedist of the past fifty years aware of the upsurge of interest in psychotropic plants among botanists, chemists, and pharmacologists, and aware also of their achievements in this area, of the work in progress? And if not, why not?... It becomes imperative for accomplished Vedists to reread the *ṚgVeda* from beginning to end, not merely Maṇḍala IX nor those other passages where the poet uses the word 'Soma', and uncover places where the new identification of the plant clarifies the text, suggests fresh readings, and introduces additional planes of understanding. For, as Brough says, Soma 'permeates' the *ṚgVeda*.

Let the Vedists leave off feeding exclusively on the *ṚgVeda* and each other. Let them be on easy terms with the outside world, with botanists, chemists, pharmacologists, physiologists: with anthropologists, pre-historians, and students of religion among early cultures, living and moribund and dead. Brough's paper on every page shouts his need (unfelt by him) for those interdisciplinary contacts to which on principle he closes his eyes and ears. If the older generation of Vedists includes many for whom this expanded opportunity is disturbing, younger scholars will certainly seize on it with enthusiasm. As for the identity of the Soma plant, I am not without confidence in the results of any further enquiries. The annals of pioneering research count instances where the valid discoveries of workers outside the inner fold of traditional scholarship are initially ignored or rejected out-of-hand.

★

On an earlier page I promised to return to the meaning of 'Soma' and this I now do.

A few days after Renou received my *précis* and a couple of weeks before my meetings with him he wrote on 30 March 1966 a two page memorandum addressed to a *confrére* of his. He had read my *précis*. He knew nothing of mushrooms. He was taken aback, incredulous, sceptical. But toward the end of his memo he said:

> Ou alors, il faudrait admettre que la racine védique su- ne signifie pas 'pressurer' et que le mot qu'on traduit par 'tige' signifie autre chose.

With insight he had placed his finger on the crux, insofar as linguistics is concerned.

I have discussed the meaning of *tige*, *aṃ&sacute;ú*. As for *la racine védique su-*, meaning *pressurer*, which is the traditional and accepted etymology for 'Soma', perhaps never challenged up to now, it should be reviewed by an Indo-Europeanist of stature, preferably one intimate with the Indo-Iranian linguistic area. Is not the traditional etymology merely a popular etymology sanctified by age? Did it evolve at an early age, before the elements of philology were known, for the express purpose of fitting the liturgy? There was the need to dry the mushrooms, and then steep them in water again, and finally to squeeze the juice out and to consume the juice mixed with other fluids. In fact, the swollen importance that the pounding assumed in the liturgy the hypertrophy of the 'pressing' act - the thunderous pounding of the water-steeped plants - all this elaborate ritual may be reflected in the 'popular' etymology that became traditional, the ritual serving to consolidate the 'popular' etymology arrived at by paranomasia, act and word serving as resonators for each other. (By 'popular' I mean of course in Brahman circles, which alone were concerned with the ritual usage.) But in reality the word 'Soma' may have had a different origin. Is an alternative etymology available? Had Renou lived, had Emile Benveniste not been stricken, this matter would surely have been explored.

VII

An Excursus: Early Man and Plant Hallucinogens.

V. Gordon Childe in what must be considered his valedictory[1] despaired of ever recapturing the emotions, the motive forces, that actuated Stone Age man: they were as dead as the microliths scattered around his settlements. But was Childe altogether right?

Only now are we beginning to sense the rôle of the plant hallucinogens in early man's cultural history, beginning to identify these plants, to analyze them from every angle, to perceive that over a large part of the habitable world (including of course the land mass of Eurasia) they quickened early man's imagination, stirred early man to the innermost core of his being, led him to know ecstasy and enthusiasm in the etymological meaning of those pregnant words. They were a heaven-sent relief from the perils and the hard drabness of his day-to-day chores. It is easy now-a-days to dismiss the hallucinogens as mere chemical compounds with surprising effects on the psyche, and so they are. But our Stone Age ancestor did not know this. He saw these astonishing effects as miraculous, and the plants opened portals for consulting his ancestors or his gods: gave him a vehicle to travel where he willed in time and space. Their unearthly splendor elicited the reverential awe of which Brough rightly speaks, and also fear and adoration, and the secrecy that naturally accompanies these emotions.

By reason of this veil of secrecy our 'advanced' civilization lost the identity of the plants themselves but perhaps as a reflex of those breathtaking visions we elaborated in their place solemn rites of utmost majesty, a mythology, a theology, which for centuries held us spellbound, though these lack the immediacy of the hallucinogenic experience that our ancestors knew. Our scientists are now searching for a use that the psychotropic plants may be put to, but whatever that use may prove to be, the contribution that they have already made to our knowledge of pre-history is of outstanding importance, no less than a Pisgah view of early man's cultural vision, where heaven and hell lay spread out on all sides of him. In this area of his existence we now grasp an aspect of Stone Age man's cultural life that until now eluded us. Childe's despairing summation must be qualified to accommodate our new knowledge.

We have always heard of the tantalizing Mysteries of Eleusis, of Mithra, of Orpheus, of Apollo, of countless others. But the secrecy with which they were surrounded proved an impassable barrier for us. A potion was drunk at Eleusis. What was that potion and whither did it lead? One Aristides in the 2nd century A. D. allowed us the faintest glimpse of what went on. The initiate experienced something 'new, astonishing, inaccessible to rational cognition'. And, speaking of the Eleusinian Mystery, he said:[2]

> Eleusis is a shrine common to the whole earth, and of all the divine things that exist among men, it is both the most awesome and the most luminous. At what place in the world have more miraculous tidings been sung, where have the dromena called forth greater emotion, *where has there been greater rivalry between seeing and hearing*?

And then he went on to speak of the 'ineffable visions' that it had been the privilege of many generations of fortunate men and women to behold.

'Shamanism' is the convenient name that we give to the religious experience of the Stone Age, and its key is ecstasy, rapture. Fortunately for us, the cult of the hallucinogen did not die out in pre-history. Shamanism lingered on here and there, reaching as with fingers down the corridors of time into early history. I suggest that it survives to this day in the secret rites of the divine mushroom in Mesoamerica, and also that we possess in the potent cult of Soma among Aryan Brahmans a shamanic legacy that we are only now in a position to esteem at its inestimable worth. Here was a group who when the moment came to abandon Soma, the Element in their communion, worked out mnemonic devices of incomparable strength, this strength being a measure of the potency of the hallucinogenic visions they knew well, to assure the perpetuation of the hymns they sang, words and music, so that we today may, as with a tape recording, listen in their chants to the very words and notes they sang. We do not yet know how it came about that shamanism, in this instance, passed on to a priestly class its most precious gift, the gift of Soma.

Let us remember that Soma was not born (Aja) as elements of this world are born; his birth was miraculous, conceived in the soft, fertile earth by an ejaculation of thunder and lightning accompanied with a downfall of rain. The plant-god was sacrificed in the course of the liturgy and his juice consumed by chosen men, and even by transubstantiation the urine of the priest who drank the potion was converted in turn into more of the divine fluid.

The reticence that the hallucinogen imposed on its devotees was only natural, inspired by the reverential awe that still handicaps the student of the hallucinogenic mushrooms in the remotest mountains of southern Mexico, an awe so overwhelming, a reticence so complete, that only now, after four centuries of the Spaniards' Conquest, is the outside world penetrating to the heart of the Mystery and a few are partaking of the Marvelous Herb in native rites.

I would not be understood as contending that only these substances (wherever found in nature) bring about visions and ecstasy. Clearly some poets and prophets and many mystics and ascetics seem to have enjoyed ecstatic visions that answer the requirements of the ancient Mysteries and that duplicate the mushroom agapé of Mexico. I do not suggest that St. John of Patmos ate mushrooms in order to write the Book of the Revelation. But the succession of images in his Vision, so clearly seen and yet such a phantasmagoria, means for me that he was in the same state as one bemushroomed. Nor do I suggest for a moment that William Blake knew the mushroom when he wrote his telling account of the clarity of 'vision':

> The Prophets describe what they saw in Vision as real and existing men, whom they saw with their imaginative and immortal organs; the Apostles the same; the clearer the organ the more distinct the object. A Spirit and a Vision are not, as the modern philosophy supposes, a cloudy vapour, or a nothing: they are organized and minutely articulated beyond all that the mortal and perishing nature can produce. *He who does not imagine in stronger and better lineaments, and in stronger and better light than his perishing eye can see, does not imagine at all*. [Italics mine. From *The Writings of William Blake*, ed. by Geoffrey Keynes, vol. III, p. 108]

This must sound cryptic to one who does not share Blake's vision or who has not taken the mushroom. The advantage of the mushroom is that it puts many (if not everyone) within reach of this state without having to suffer the mortifications of Blake and St. John. It permits you to see, more clearly than our perishing mortal eye can see, vistas beyond the horizons of this life, to travel backwards and forwards in time, to enter other planes of existence, even (as the Amerindians say) to know God. It is hardly surprising that your emotions are profoundly affected, and you feel that an indissoluble bond unites you with the others who have shared with you in the sacred agapé. All that you see during this night has a pristine quality: the landscape, the edifices, the carvings, the animals - they look as though they had come straight from the Maker's workshop. This newness of everything - it is as though the world had just dawned overwhelms you and melts you with its beauty. Not unnaturally, what is happening to you seems to you freighted with significance, beside which the humdrum events of everyday are trivial. All these things you see with an immediacy of vision that leads you to say to yourself, 'Now I am seeing for the first time, seeing direct, without the intervention of mortal eyes.'

And all the time that you are seeing these things, the priestess sings, not loud, but with authority. The Amerindians are notoriously not given to displays of inner feelings - except on these occasions. The singing is good, but under the influence of the mushroom you think it is infinitely tender and sweet. It is as though you were hearing it with your mind's ear, purged of all dross. You are lying on a *petate* or mat; perhaps, if you have been wise, on an air mattress and in a sleeping bag. It is dark, for all lights have been extinguished save a few embers among the stones on the floor and the incense in a sherd. It is still, for the thatched hut is apt to be some distance away from the village. In the darkness and stillness, that voice hovers through the hut, coming now from beyond your feet, now at your very ear, now distant, now actually underneath you, *hic et ubique*, with strange ventriloquistic effect. The mushrooms produce this illusion also. Everyone experiences it, just as do the tribesmen of Siberia who have eaten of *Amanita muscaria* and lie under the spell of their shamans, displaying as these do their astonishing dexterity with ventriloquistic drum-beats. Likewise, in Mexico, I have heard a shaman engage in a most complicated percussive beat; with her hands she hits her chest, her thighs, her forehead, her arms, each giving a different resonance, keeping a complicated rhythm and modulating, even syncopating, the strokes. Your body lies in the darkness, heavy as lead, but your spirit seems to soar and perhaps leave the hut, and with the speed of thought to travel where it pleases you, in time and space, accompanied by the shaman's singing and by the ejaculations of her percussive beat. What you are seeing and what you are hearing appear as one: the music assumes harmonious shapes, giving visual form to its harmonies, and what you are seeing takes on the modalities of music - the music of the spheres. 'Where has there been greater rivalry between seeing and hearing?' How apposite to the Mexican experience was the ancient Greek's rhetorical question! All your senses are similarly affected: the cigarette with which you occasionally break the tension of the night is imbued with such an aroma as no cigarette before had ever possessed, the glass of simple water is infinitely better than champagne. Elsewhere I once wrote that the bemushroomed person is poised in space, a disembodied eye, invisible, incorporeal, seeing but not seen. In truth, he is the five senses disembodied, all of them keyed to the height of sensitivity and awareness, all of them blending into one another most strangely, until the person, utterly passive, becomes a pure receptor, infinitely delicate, of sensations. (You, being a stranger, are perforce only a receptor. But the Mazatec Indians are also participants with the *curandera* in an extempore religious colloquy. Her utterances elicit spontaneous responses from them, responses that maintain a perfect harmony with her and with each other, building up to a quiet swaying antiphonal chant. In a successful ceremony this is an essential element, and one cannot experience the full effect of the rôle of the mushroom in the Indian community unless one attends such a gathering, either alone or with one or at most two other strangers.)

As your body lies there in its sleeping bag, your soul is free, loses all sense of time, alert as it never was before, living an eternity in a night, seeing infinity in a grain of sand. What you have seen and heard is cut as with a burin in your memory, never to be effaced. At last you know what the ineffable is, and what ecstasy means. Ecstasy! The mind harks back to the origin of that word. For the Greeks *ekstasis* meant the flight of the soul from the body. Can you find a better word than that to describe the bemushroomed state? In common parlance, among the many who have not experienced ecstasy, ecstasy is fun, and I am frequently asked why I do not reach for mushrooms every night. But ecstasy is not fun. Your very soul is seized and shaken until it tingles. After all, who will choose to feel undiluted awe, or to float through that door yonder into the Divine Presence? The unknowing vulgar abuse the word, and we must recapture its full and terrifying sense... A few hours later, the next morning, you are fit to go to work. But how unimportant work seems to you, by comparison with the portentous happenings of that night! If you can, you prefer to stay close to the house, and, with those who lived through that night, compare notes, and utter exclamations of amazement.

In Nahuatl, the language spoken by the Aztecs, the sacred mushrooms were and are called *teo-nanácatl*, God's flesh. I need hardly remind the reader of a disquieting parallel, the designation of the Elements in our Eucharist: 'Take, eat, this is my body... ', and again, 'Grant us, therefore, gracious Lord, so to eat the flesh of thy dear son...' But there is one difference. The orthodox Christian must accept by an act of faith the miracle of the conversion of the bread into God's flesh: that is what is meant by Transubstantiation. By contrast the mushroom of the Nahua carries its own conviction: every communicant will testify to the miracle that he has experienced. The Mazatec Indians call[3] the sacred mushrooms ^{ʔ}*nti*^{1}*xi*^{3}*tho*^{3}, 'what leaps forth', that is, what leaps into being without the measured growth from seed, *i.e.*, the mushroom. ... We now know that there are dozens of hallucinogens, each with its own potentialities, sometimes differing greatly from each other, and we have not yet determined the specific hallucinogen or hallucinogens used in Greece and the Middle East.

I find the parallels between the mushroom cult and Christianity disquieting. In both the deity is conceived miraculously, not from seed after the order of normal generation. In both the miraculous conception is effected by a ray from heaven. In one the deity is a man-god, in the other a plant-god, and the deity is consumed in both in the course of an agapé wrapped in holy mystery. In one by an act of faith the bread and wine through a Miracle of Transubstantiation are converted into the body and blood of the Lord. In the Eurasian mushroom cult the act of transubstantiation takes place when ordinary urine becomes the divine essence.

As man emerged from his brutish past, thousands of years ago, there was a stage in the evolution of his awareness when the discovery of a mushroom (or was it a higher plant?) with miraculous properties was a revelation to him, a veritable detonator to his soul, arousing in him sentiments of awe and reverence, and gentleness and love, to the highest pitch of which mankind is capable, all those sentiments and virtues that mankind has ever since regarded as the highest attribute of his kind. It made him see what this perishing mortal eye cannot see. How right the Greeks were to hedge about this Mystery, this imbibing of the potion, with secrecy and surveillance! What today is resolved into a mere drug, a tryptamine or lysergic acid derivative, was for him a prodigious miracle, inspiring in him poetry and philosophy and religion. Perhaps with all our modern knowledge we do not need the divine mushrooms any more. Or do we need them more than ever? Some are shocked that the key even to religion might be reduced to a mere drug. On the other hand, the drug is as mysterious as ever it was: 'like the wind it cometh we know not whence, nor why.' Out of a mere drug comes the ineffable, comes ecstasy. It is not the only instance in the history of humankind where the lowly has given birth to the divine.

To conclude I will quote a passage that I wrote many years ago, before I had thought about Soma; the passage is applicable, *mutatis mutandis*, in broad terms to any hallucinogen including Soma;

'If our classical scholars were given the opportunity to attend the rite at Eleusis, to talk with the priests, what would they not exchange for that chance? They would approach the precincts, enter the hallowed chamber, with the reverence born of the texts venerated by scholars for millennia. How propitious would their frame of mind be, if they were invited to partake of the potion! Well, those rites take place now, unbeknown to classical scholars, in scattered dwellings, humble, thatched, without windows, far from the beaten track, high in the mountains of Mexico, in the stillness of the night, broken only by the distant barking of a dog or the braying of an ass. Or, since we are in the rainy season, perhaps the Mystery is accompanied by torrential rains and punctuated by terrifying thunderbolts. Then, indeed, as you lie there bemushroomed, listening to the music and seeing the visions, you know a soul shattering experience, recalling as you do the belief in both Eurasia and Mesoamerica that mushrooms, the sacred mushrooms, are divinely engendered by the God of the Thunder-bolt in the fertile Mother Earth.'

1. ↑ *Piecing Together the Past: the Interpretation of Archeological Data*, Frederick A. Praeger, N. Y., 1956; pp. 170-172.
2. ↑ For the source of the quotations see Walter F. Otto: 'The Meaning of the Eleusinian Mysteries,' published in *The Mysteries*, 1955, ed. by Joseph Campbell, Pantheon Books, Bollingen Series XXX, 2; pp. 20 *et seq*. Italics are mine.
3. ↑ The sign that precedes the Mazatec word is a glottal stop. The Mazatec language is tonal, and the superscript digits represent the four registered tones, '1' being the highest and '4' the lowest. '^{ʔ}nti^{1}' is a respectful diminutive that I find difficult to translate. The 'x' somewhat resembles in pronunciation English 'sh'. The 'th' is an aspirated 't'.

Appendix I

Recent Bibliography on *A. muscaria*.

[Here is a chronological list of the principal papers written by Conrad H. Eugster and Peter G. Waser on *Amanita muscaria*, its chemistry and pharmacology, and also papers and dissertations written under their direction or as a result of their work. The complete bibliography exceeds 50 items.]

1. C.H. EUGSTER and PETER G. WASER, 'Zur Kenntnis des Muscarins', *Experientia*, Vol. X, 298 (1954).
2. C.H. EUGSTER, 'The Chemistry of Muscarine', *Advances in Organic Chemistry*. (Raphael, Taylor, Wynberg Ed.) Methods and Results, Vol. 11, 427 (1960).
3. GÜNTER F. R. MÜLLER, 'Beiträge zur Kenntnis der Inhaltsstoffe des Fliegenpilzes (*Amanita muscaria* L.)', Dissertation, Universität Zürich 1961. (Leitung Prof. C. H. Eugster)
4. PETER G. WASER, 'Chemistry and Pharmacology of muscarine, muscarone and some related compounds', *Pharmacol. Rev.*, 13, 465-515 (1961).
5. GÜNTER F. R. MÜLLER and C. H. EUGSTER, 'Muscimol, ein pharmakodynamisch wirksamer Stoff aus *Amanita muscaria*', *Helv. Chim. Acta*, Vol. 48, 910 (1965).
6. R. GOOD, G. F. R. MÜLLER and C. H. EUGSTER, 'Isolierung und Charakterisierung von Prämuscimol und Muscazon aus *Amanita muscaria*', *Helv. Chim. Acta*, Vol. 48, 927 (1965).
7. A. R. GAGNEUX, F. HÄFLIGER, C. H. EUGSTER and R. GOOD, 'Synthesis of Pantherine (Agarin)' *Tetrahedron Letters* No. 25, 2077 (1965).
8. A. R. GAGNEUX, F. HÄFLIGER, R. MEIER and C. H. EUGSTER, 'Synthesis of Ibotenic Acid', *Tetrahedron Letters* No. 25, 2081 (1967).
9. C. H. EUGSTER, 'Isolation, Structure and Syntheses of Central-active Compounds from *Amanita muscaria* (L. ex Fr.) Hooker', Proceedings of a Symposium San Francisco 1967, published as *Ethnopharmacologic Search for Psychoactive Drugs*. U. S. Public Health Service Publication No. 1965, 416-418 (1967); discussion of papers on *A. muscaria*, 441.
10. Peter G. WASER, 'The Pharmacology of *Amanita muscaria*', Proceedings of a Symposium San Francisco 1967, published as *Ethnopharmacologic Search for Psychoactive Drugs*. U. S. Public Health Service Publication No. 1965, 416-439 (1967); discussion of papers on *A. muscaria*, 441.
11. C. H. EUGSTER, 'Wirkstoffe aus dem Fliegenpilz', *Naturwissenschaften*, Heft 7, 305 (1968).
12. W. THEOBALD, 0. BÜCH, H. A. KUNZ, P. KRUPP, E. G. STENGER und H. HEIMANN, 'Pharmakologische und experimental psychologische Untersuchungen des Inhaltsstoffe des Fliegenpilzes (*Amanita muscaria*)'. *Arzneimittelforschung* (Drug Research) 18, 311 (1963).
13. PETRA BERSIN, 'Beeinflussung des Monoaminumsatzes im Gehirn durch Muscimol und Ibotensäure', Dissertation, under the direction of Prof. Peter G. Waser and Prof. J. Buchi. Zurich 1969.
14. C.H. EUGSTER, 'Chemie der Wirkstoffe aus dem Fliegenpilz (*Amanita muscaria*)', *Fortschritte der Chemie organischer Naturstoffe*, Vol. XXVII, 262 (1969).
15. P. CATALFOMO and C.H. EUGSTER, '*Amanita muscaria*: Present understanding of its chemistry', *Bull. on Narcotics*, Vol. XXII, No. 4, 33 (1970).
16. P. KÖNIG-BERSIN, P. G. WASER, H. LANGEMANN and W. LICHTENSTEIGER, 'Monoamines in the Brain under the Influence of Muscimol and Ibotenic Acid, Two Psychoactive Principles of *Amanita muscaria*', *Psychopharmacologia* 18, 1-10 (1970).
17. PETER G. WASER, 'Pharmakologie der Halluzinogene', Schweiz. Rundschau Med., *Praxis* 60, 1001-1005 (1971).
18. PETER G. WASER, 'Pharmakologische Wirkungsspektren von Halluzinogenen', *Bull. Schweiz. Akad. Med. Wiss.*, 27, 39-57 (1971).

Appendix II

Manner of Ingesting the Fly-agaric among Siberian Natives

The manner of ingesting the fly-agaric among the Siberian natives is important. All sources save one say the mushrooms must be first dried. The one exception is Georgi, whose testimony for reasons that I explain (see *SOMA*, pp. 240-1) is suspect. Almost all of them say the dried mushrooms are washed down with water or in the juice of berries or thoroughly mixed with saliva before swallowing. Saliva consists chiefly of water. Some informants call attention to the thorough and prolonged mastication that precedes ingestion. This corresponds, I suggest, to the 'pounding' of Soma, already immersed in water, a feature in Vedic ritual that seems to have undergone hypertrophic development, probably for liturgical effect. Alcohol is never cited as an additive, neither among the Aryans nor the Siberian tribesmen. Many of our witnesses from Siberia are Europeans who were quick to despise the 'filthy' practices of the tribesmen, and to contrast their 'superior' vodka with the mushrooms that, to their dismay, some of the tribesmen, when asked, preferred over alcohol. Where in one or two instances they report the ingestion of the mushrooms without mentioning the accompaniment of other fluid, this is not conclusive; the drinking of water may have seemed too banal to record. Until recent centuries distilled alcohol was unknown in the Siberian North, as it was also among the Vedic Aryans. Here are the relevant texts, with the page references to my *SOMA*:

1. KRASHENINNIKOV, STEPHAN; pp. 235-236: 'Sometimes for their enjoyment they also use the *mukhomor*, the well known mushroom that we ordinarily use for poisoning flies. [*Mukhomor* = fly-agaric] It is first soaked in must of *kiprei* [*Epilobium angustifolium*], which they drink, or else the dried mushrooms are rolled and swallowed whole, which method is very popular.'
2. STELLER, GEORG WILHELM; p. 239: 'The fly-agarics are dried, then eaten in large pieces without chewing them, washing them down with cold water.'
3. GEORGI, JOHANN GOTTLIEB; p.240: 'To that end they either eat one of these mushrooms quite fresh, or perhaps drink the decoction of three of them.'
4. LANGSDORF, GEORG HEINRICH von; pp. 247-248: 'The Kamchadals gather them usually during the hottest months of July and August; they maintain that those that dry by themselves in the earth, on the stalk, and that are somewhat furry and velvety to the touch on the underside of the cap have a far stronger narcotic effect than those picked fresh and strung up to dry in the air… The usual way to consume fly-agarics is to dry them and then to swallow them at one gulp, rolled up into a ball, without chewing them; chewing fly-agarics is considered harmful, since it is said to cause digestive disturbances.'
   'Sometimes these mushrooms are cooked fresh and eaten in soups or sauces, since they then taste more like the usual edible mushrooms and have a weaker effect, so that when the mushrooms are prepared in this way, a larger amount can be eaten without harmful results. Occasionally, too, fly-agarics are soaked in berry juice, which one may thereafter drink at his pleasure as a genuine intoxicating wine. Juice squeezed from bilberries (*Vaccinium uliginosum*) is said to be most suitable for this purpose because it heightens the intoxicating effect, so that one may expect to achieve a more potent result with a smaller quantity.'
5. ERMAN, ADOLPH; pp. 253: 'Of the various ways of using *mukhomor* he said that the best was the simplest way, *viz.*, drying it, swallowing it raw, and washing it down with water. On the other hand, the Russians of Klynchevsk, who according to him pick whole packhorse loads of this valuable plant, prepare an extract by decocting it in water, and try to take away its extremely disgusting taste by mixing the extract with various berry juices.'
6. MAYDELL, BARON GERHARD von; p. 254: 'At the Paren' I also obtained some dried fly-agaric (*Amanita muscaria*), which is very highly prized among the Koryaks for its intoxicating effect. It is not eaten in the fresh state, in which it is believed to be poisonous, but always hung up to be smoked until it is shriveled and quite dry so that it will keep well. It is said to occur only among birch trees and hence is confined to a few localities, among which I heard Penzhinskoye and Markovo mentioned in particular. When a Koryak consumes the fly-agaric, he chews the dried mushroom and then drinks it down with water.'

7. DITTMAR, CARL von; p. 256: '... the *mukhomor* is only chewed, and the juice is then swallowed.'
8. JADRINTSEV, NIKOLAI MIKHAILOVICH; p. 260: '... Furthermore, the natives are passionately addicted to the fly-agaric (*i.e.*, to a decoction of *Amanita muscaria*), which replaces liquor and is also sold to merchants.'
9. SLJUNIN, NIKOLAI VASIL'EVICH; p. 261: 'The Koryaks maintain that fresh fly-agarics are highly poisonous and hence do not eat them. They are first dried for a long time in the sun and over the fire in the tent. Only then is the mushroom consumed, together with fresh water to wash it down.'
10. ENDERLI, J.; p. 262: 'At the man's order, the woman dug into an old leather sack, in which all sorts of things were heaped one on top of another, and brought out a small package wrapped in dirty leather, from which she took a few old and dry fly-agarics. She then sat down next to the two men and began chewing the mushrooms thoroughly. After chewing, she took the mushroom out of her mouth and rolled it between her hands to the shape of a little sausage. The reason for this is that the mushroom has a highly unpleasant and nauseating taste, so that even a man who intends to eat it always gives it to someone else to chew and then swallows the little sausage whole, like a pill.'
11. JOCHELSON, WALDEMAR; p. 266: 'Accordingly, fly-agaric is dried in the sun or over the hearth after it has been gathered. It is eaten by men only; at least, I never saw a woman drugged by it. The method of using it varies. As far as I could see, in the villages of Penzhina Bay, the men, before eating it, first let the women chew it, and then [the men] swallow it. Bogoraz says that the Chukchee tear the fungus into pieces, chew it, and then drink water. Sljunin describes in the same way the Koryak method of using fly-agaric. In describing the use of fly-agaric by the Chukchee and Koryak, Dittmar says that they chew it and keep the quid in their mouths for a long time without swallowing it, Krasheninnikov says that the Kamchadal roll the dried fungus up in the form of a tube, and swallow it unchewed, or soak it in a decoction of willow-herb and drink the tincture.'
12. BOGORAZ, VLADIMIR GERMANOVICH; p. 273: 'The mushrooms are usually dried up and strung together in threes, that number being an average dose. ... When eaten, the mushrooms are torn to small shreds, and these are chewed piece by piece, and swallowed with a little water. Among the Koryak the woman chews the mushroom, and offers the ready quid to her husband to swallow.'

Appendix III

Miscellany

A. Professor Marija Gimbutas on Uses of Fly-agaric in European Russia.

In 1961 a Lithuanian by birth and cultural heritage, Marija Gimbutas, now the renowned pre-historian, wrote me this concerning the fly-agaric in her native land:

> ... A happier use for the *raudonoji musmir&edot;* ['fly-agaric' in Lithuanian] was to add them, raw or dried, to vodka, on occasions such as wedding banquets: the effect was a curious, extremely hilarious intoxication. Before World War I orthodox Russians in Lithuania are known to have used this 'fly-agaric vodka'. Around 1905, the fly-agaric vodka was put to good use on Russian prison guards in arranging prisoners' escapes. Around 1942 the old custom was revived in the district of Vilnius: the people added the fly-agaric to home-made vodka.
> It is known that in the 19th c., or earlier, *Amanita muscaria* was exported from the East Baltic area to the north (North Russia) for the shamans as an intoxication medium. This I read myself in the books, but cannot now remember the source.

Here is the only responsible testimony that I have found concerning a customary use for purposes of inebriation of the fly-agaric in Europe. The practice that Professor Gimbutas reports cannot go back far, since *aquavitæ* was introduced into Eastern Europe only in the 16th century. Was there a synergistic action when vodka was mixed with muscimol? This remains to be determined.

The final solution to the fly-agaric mystery is held up by the heavy tabu that hangs over the ingesting of *A. muscaria* throughout our European culture area. When I ingested dry fly-agaric in the Burgholzli Clinic in Zurich, doctors and nurses stood around viewing me with ill-concealed anxiety, though I defied and defy them to cite me a single authenticated case where anyone has suffered serious ill effects from this mushroom. Roger Heim, for the past 30 years the world's outstanding mycologist, has looked through the annals of mycology and medicine in France and has not found a single instance. *A. muscaria*, the supreme 'toadstool', is often held synonymous with 'deadly mushroom' and reports have occurred frequently where the fly-agaric is credited by careless and unqualified persons with deaths caused by other mushrooms. Brough speaks of the fly-agaric as deadly, saying that *A. phalloides* is 'much more [*sic*] deadly'. (JB 353) He cites no instance of a death, properly authenticated as to cause, from the Eurasian fly-agaric. He here gives renewed expression to the ancient European attitude toward this lovely mushroom of the peculiar properties, an attitude in which fear and rejection mingle in some localities and in some contexts with a certain awe and affection - the precise syndrome of a religious tabu.

B. Official Soviet View toward Fly-agaric Ingestion.

Sometimes I am asked why we do not enlist the cooperation of Soviet anthropologists. The Soviet authorities labour under an ideological handicap when it comes to the fly-agaric, what is commonly called today a 'hang-up'. The official position is set forth in *SOMA* (pp. 337-8) when Messrs. Brekhman and Sem gave voice to the official view that no traces of the practice survive:

> The minor nationalities of Siberia and the Far East now do not use any psychoactive drugs, which have been relinquished because of radical changes in economy, culture, mode of life, and ideology of the population of this part of the Soviet Union. After the October Socialist Revolution and the establishment of the Soviet power these not numerous nationalities have embarked on a new way of historical development. Formerly backward nationalities of one of the borderlands of Russia, with the help of the Russian people and Soviet Power, passing through intermediate stages, they have soon reached the socialist phase of social development.

Even the best workers in the field in the USSR - and they are first-rate men like A. P. Okladnikov and A. F. Anisimov, seem never to mention the fly-agaric. When we bear in mind that the larch is one of the favourite hosts to the fly-agaric, how odd it sounds to read in Anisimov, retelling a Gilyak myth, the following evasive language:

> ... As he went up the river, the younger brother saw a larch, 'A thick larch rising to the very sky.' *At the foot of the larch there was food*, grown and placed there by the 'master of the larch,' unknown to the brothers. The younger brother tasted the food and took some to give to the older one. The next day the titmice brothers proceeded together to the source of the food. There they met heavenly people - two little birds, a silver and a gold one, which had descended to the base of the larch and declared themselves the masters of the food.
>
> [*Studies in Siberian Shamanism*, ed. by Henry M. Michael, University of Toronto Press, 1963, published for the Arctic Institute of North America. Pages 169-170. Italics mine.]

The marvelous food at the foot of the larch was obviously the fly-agaric.

This quotation from Anisimov's text permits us to add the Gilyak (called *Nivkhi* in Russia today) to the Paleosiberian tribes familiar with the inebriating mushrooms. Our count is complete; we have positive evidence for the other five Paleosiberian peoples still extant, and the Gilyak are the sixth and final one. ... I have learned that the Gilyak often wear a crudely carved little wooden figure, usually with one leg, suspended around their necks to ward off illness; they call it *pangkh*. Though my sources do not say so, I think this is obviously the Ob-Ugrian word for the fly-agaric, *pango*. (See, *e.g.*, *Religioznye verovaniia narodov SSSR*, vol. I, Moscow-Leningrad, 1931, p. 79.)

To make inquiries of the Soviet authorities about the present-day use of the fly-agaric might only lead to harassment of the tribesmen in the northlands.

C. The Manikin in the Wood.

I will now quote German verses that are familiar to every child (and therefore adult) born to German as his mother tongue. It is a riddle:

Ein Männlein steht in Walde	A manikin stands in the wood
Ganz still und stumm.	Stock-still and mute.
Er hat von lauter purpur	He has of purple pure
Ein Mäntlein um.	A mantle around him.
Sag' wer mag das Männlein sein	Say, who may the manikin be
Das da steht auf einem Bein?	Who stands there on one leg?

Alternative ending:

Sag' wer mag das Männlein sein	Say, who may the manikin be
Das da steht im Wald allein	Who stands there in the wood alone
Mit dem purpur roten Mäntlein?	With the purple red mantle?

Children: Glückspilz! Fliegenpilz!	Children: Happiness mushroom! Fly-agaric!

I have supplied the text of these children's verses for two reasons. We see in the use of 'purple' how a people calls 'out its name' a colour word in a special context. Purple is altogether inappropriate to describe the cap of the fly-agaric. Adopting Brough's idea and manner, we should be constrained to say that purple 'is absolutely excluded' as a colour adjective for the fly-agaric. But there in the verses stands the 'purple' fly-agaric in all his imperial majesty!

By a happy but perhaps not fortuitous chance, the answer to the question posed by the riddle:

Say, who may the manikin be
Who stands there on one leg?

is our Soma. History is punctuated by ironies, and how ironical it would be if Max Müller and his fellow Vedists, asking everybody, everywhere, what Soma was, could have found the answer, by listening to the little children playing around his feet in Germany. We can't prove it, but the riddle sounds as though it went back long before the dawn of history. The manikin of the single leg is of course our Vedic Ekap&amacr;d.

This paper has been printed in 1000 copies
from Dante Face by Stamperia Valdonega.
VERONA • NOVEMBER 1972

Mushrooms and the Wine of Maron

by

Carl A.P. Ruck

original source:
https://open.bu.edu/bitstream/handle/2144/20636/Mushrooms%2band%2bthe%2bWine%2bof%2bMaron%2bfirst%2bprint%2bversion.pdf
backup source: http://www.psilosophy.info/resources/Mushrooms%2band%2bthe%2bWine%2bof%2bMaron%2bfirst%2bprint%2bversion.pdf

Table of Contents:

Abstract
The Zerynthian Cave
Lycanthropy
Excessive Drinking
Mixing the Wine
Herbalist Fantasies
Harvesting Monsters
Seafaring
Wolf Mushroom
Eagle Fare
Dirty Dancing
Crazy as a Loon
Demeter's Indiscretion in the Cornfield
References

Abstract

Although the excavators of the sanctuary of the Great Gods on the island of Samothrace recognize that drinking to the point of intoxication was practiced at the Mystery, naively this has not been seen as an element in the initiation scenario. Numerous drinking cups have been found, inscribed as the property of the gods, and the ancient village of Keramidaria ('Ceramics') was devoted to the manufacture of amphorae, officially stamped as genuine provenance of Samothrace for the export of the wine distinctive of the Mystery, probably a version of Homer's potent Maronian wine of the Cyclops. That wine still existed in the Roman Period, and on the testimony of the proconsul assigned to the province, it even required dilution with eight parts water to be drunk safely. At the time of Odysseus, the rate of dilution was twentyfold. Such potent wines achieved their high intoxicating potential from the substances added to the ferment, a fact that has now been confirmed by the discovery of an intact wine cellar from Canaan, dated to the beginning of the second millennium BCE. The myth of the establishment of the Mystery, dated to the generations before the Trojan War, narrates the tale of its founder sailing like a drunken loon upon a wineskin, and similar establishments of the Mystery of the Great Gods depict a Kabeiric dwarfish Odysseus sailing upon an amphora filled with the special potion of the great sorceress Circe. This wine was fortified with a sacred psychoactive mushroom, whose antiquity can be traced back to the wolf sacrament of the Achaemenid Persians, and documented as well in Celtic lore and among the Nordic berserkers, recorded as early as the Emperor Trajan as a rite of the Dacians of Thrace, who are named as the 'People of the Wolf' and who carried the banner of Draco into battle, a serpent with the head of a wolf. The serpent is an indication of the wolf's toxicity, and the fondness of wolves for eating the mushrooms was the basis for the rituals of lycanthropy and the initiated fraternal packs of warriors. In Athens of the Classical Age, the fungal identity of this initiatory sacrament was common knowledge, obscenely parodied on the comic stage. The Etruscans carried this sacrament to the Italian peninsula and it was incorporated into the mythologized history of Rome's founding by the Trojan Aeneas as the fulfilment of the prophecy of the edible tables that would signal the site for the future city. The cult of the Great Gods involved the widespread phenomenon of the little people that materialized from the sacramental fungus as fairy creatures, using the mushroom as their tables set with dainty morsels that inspired visionary experience and of which it was taboo for the uninitiated to partake.

Keywords: Mystery, Great Gods, Samothrace, seafaring, wine, Maron, mushroom, Cyclops, Odysseus, Celtic fairies, Virgil, *Aeneid*, foundation of Rome, lycanthropy, Phrygian cap, Bassarides, fox cap, Draco, Dacians, berserkers, haoma, Persians, Kabeiroi

The Zerynthian Cave

The Mystery of the Great Gods of Samothrace was established at the site of the present archaeological remains in the seventh century BCE, and the Temple complex was greatly expanded in the Hellenistic Age by dedications from the Macedonian heirs of Alexander, the Great. Its antiquity, however, goes back at least to the mid second millennium. Originally, the rite was performed at a still unidentified cave, one of several that issue in profuse streams falling as cataracts down the steep slope of the heavily forested volcanic island, probably the one adjacent to the village of Therma, which was channeled through the site of the later sanctuary complex below it. The legendary founders of the Mystery were the Amazons, who supposedly discovered the island uninhabited and dedicated it to the 'Mother of the Gods,' well before the Trojan War. The island, however, was probably already inhabited and sacred at least as early as the Neolithic Period.

Troy itself was supposedly founded three generations after the establishment of the Mystery by a refugee from Samothrace, although his original home was said to have been Arcadia in the central Peloponnesus, and the War was fought in the third generation after its founding. Agamemnon, as mythologized history, was cited among the list of initiates. The Arcadian origin of the Mystery was elaborated as the birthplace of Hermes and his role as cow-thief, and in the tradition that Virgil followed in narrating Rome's Trojan ancestry. The Samothracian ritual preserved prayers in a pre-Greek language, perhaps a version of Etruscan, probably a dialect of Luwian, the language of Troy with borrowings from neighboring Phrygian peoples. The deities who presided over the Mystery formed a triad and preserved their ancient occult pre-Greek names as a goddess Axieros, her daughter Axiokersa, and the daughter's mate Axiokersos, where the similar prefix apparently was an honorific indication of divinity. They were loosely equated to the later Demeter, Persephone, and Hades, although Axieros was also a version of the Anatolian Mountain Mother, who was interchangeable with Rheia and later named as Cybele. If there was a fourth in the divine group, his name was Kasmilos and equated to the later Hermes. Surprisingly, the excavators of the remains of the sanctuary have shown little interest in the Zerynthian Cave and have confined their reconstruction of the rituals to the physical ruins and to the mention of bacchanalia, which they interpret as performances of drama. Although the site offers areas for viewing certain sacred events, such as sacrificial offerings, instruction of the candidates for initiation, or perhaps the recitation of a poem like the Homeric *Hymn to Hermes*, there is no proper theater, nor is there any record of playwrights. The area below the niche for the Winged Victory monument, although stepped with seats or standing tiers, looked down upon an altar for sacrifice, with no theatrical backdrop or skene, required for dramatic performances. The slightly sunken small circular area just beyond the entrance gate was not an amphitheater, and provided only a couple of narrow tiers to accommodate viewers standing in a circle.

The ancient testimony for the sacred Zerynthian Cave is indisputable. The third-century Hellenistic poet Lycophron (*Alexandra*, 1175-1180), who was a great antiquarian of obscure traditions, mentions the Cave; and its centrality to the Mystery even at this later period is shown by its depiction, complete with the issuing cataract, in the lower right of the second-century BCE marble relief from Larissa, a dedication of Danaä, portraying a *theoxénia* or 'offering of hospitality to deity,' to the 'Great Gods,' who are shown arriving as the Dioskouroi above a flying Victory (Louvre, Ma 746). The Cave was named *Zerynthos*, a linguistic formation that is clearly in a language that predates Greek, and the goddess Hekate bore it as an epithet, as did pre-Greek Thracian versions of Apollo and Artemis. The whole northern coast of the island of Samothrace was still identified with that epithet in the first century CE (Ovid, *Tristia*, 10-19). Similar Zerythian caves existed throughout the mainland of ancient Thrace. The bacchanalia, so-called, would obviously have occurred originally at these Caves, precluding the scenario for the performance of established or scripted dramas as the essential element of the Mystery. Several Hellenistic buildings in the later temple complex of the sanctuary can be interpreted as architectural simulacra of caves, being either built into an excavated hillside (like the Imperial Period *Anaktoron* lodge-hall), or like the third-century BCE Rotunda of Queen Arsinoë, the largest enclosed round building of ancient Greece, which, despite its grandeur, had a dirt floor to imitate the cave that it replaced.

Lycanthropy

The Zerynthian deities were worshipped by the offering of canines, a victim associated with the chthonic Hekate, but also involved in the traditions of Apollo and Artemis, most notably in the Corycian 'Wolf-Cave' above Delphi on Mount Parnassus, which was the well documented site of bacchanalia (Euripides, *Ion*), that were clearly not dramatic performances, but states of intense intoxication, still as late as the second century CE, as recorded by Plutarch, who was a priest at Delphi; and in the myth of the Theban Actaeon and his hunting hounds, who reverted to wolves and attacked their master as he metamorphosed into a stag when he spied upon Artemis bathing nude. Kotytto, a Thracian version of Athena, led them into battle. She was worshipped in ecstatic midnight bacchanalian drunken orgies on hilltops (Aeschylus, frag. 27), surviving well into the Roman Period in the Cotyttia Festival described by Horace and Juvenal, involving not only intoxication, but pharmaceutical lore and wild promiscuous sexual abandon (Ruck *et al.*, 2014; Horace, *Epodes*, 17; Juvenal, *Satires*, 2).

The involvement of canines is most probably metaphoric for the nature of the bacchanalia, indicating that the intoxication was interpreted with the metaphor of rabidity, the madness that links the domesticated dog with its wild canine antecedents as wolves and foxes. The rabid madness was personified as Lyssa, which designates the 'she-wolf' (Euripides, *Heracles*). The entire pelt of the red fox was worn by the Zerynthian deities as headdress, and by the Thracian bacchants, at least as late as the fifth century BCE, who took their name from the fox pelt as Bassarides (Aeschylus, *Bassarides*; Euripides, *Bacchae*). The myth of the Thracian Lycurgus, named as the 'Wolf-worker' and indicative of lycanthropy, and the Homeric account of his opposition to the Thracian bacchant maenads, suggest that the wolf represents a pre-Dionysian manifestation of ecstatic intoxication.

The fox pelt was stylized as the Thracian/Phrygian cap, imitating the pointed red snout of the animal (Ruck *et al.*, 2014). It is never worn throughout its long history without reference to the significance of its origin as indicative of lycanthropic intoxication and emblematic of initiation into religious Mysteries. Even as later awarded to liberated slaves as the liberty cap in the Roman Period, its underlying original significance symbolized the liberation from the realm of ordinary vision or transcendent altered consciousness. Most notably, the Persian Zoroastrian priests or Magi wore the cap, and it was characteristic of their mediator with deity Mithras, and it was awarded to the candidate for the highest rank in the religion of Mithraism, which spread throughout the Roman Empire, initiating most of the Emperors, soldiers, and male bureaucrats who administered the Empire (Ruck and Hoffman, 2011), until it was ostensibly ended by the Christian Conversion, although it probably was assimilated into brotherhoods of Christian knights, such as the *Ordre de la Toison d'Or* of Duke Philip the Good of Burgundy (Ruck and Hoffman, 2012). The first in the seven stages of the initiation was the grade of Raven (Corax), which was symbolized by the cup of the sacramental drink that it served to the seventh and highest rank as Father (Pater), supposedly at a banquet on the flesh of the slaughtered cosmic bull, represented by a loaf of the Raven's leavened bread, incised with the chiastic intersection of the solar and zodiacal ellipses. The cap was also worn by the legendary Perseus of Mycenae. He was the father of Perses, the name awarded to the fifth rank in the initiatory ascent of Mithraism as the 'Persian,' whose priestly title in the ceremony was the 'Keeper of the Fruits.'

Excessive Drinking

Many drinking vessels survive from the remains of the Samothracian sanctuary, leading the excavators to conclude that excessive drinking - to the point of intoxication - was an element of the initiation (Lehmann, 1954, 1998, 6th ed. 1954: 40), although they fail to see the role of a sacred potion, such as was involved in all Mystery initiations, most notably the holy *kykeon* of Eleusis. The vessels are marked as property of the Samothracian Mystery. At other sites where rituals similar to those of Samothrace were performed, considerable amounts of drinking also took place. At Thebes, the distinctive copious *skyphos* drinking cups were apparently intended to be smashed ritually after drinking the initiatory potion. Beneath the mid fourth-century BCE building in the Samothracian sanctuary euphemistically labelled the 'Hall of Choral Dancing' on the basis of a frieze of dancers linked hand-in-hand, an extensive deposit of ceramics was uncovered, dating as early as the seventh century. The Hall contained the famous sculptural group of *Aphrodite and Pothos* or 'Yearning' by the fourth-century Skopas, who may have designed the entire building. It implies the truer nature of the erotic intoxicated dancing that occurred in the Hall, and terracotta figurines from burial sites in the sanctuary represent winged Erotes (cupids) and perhaps the infant Adonis or some other version of the Anatolian goddess's young son and lover. Dances with linked hands survive as the *sirtáki*, performed at weddings and funerals, and the dance is more ecstatic than stately.

The long portico or Stoa, moreover, which after its erection in the third century BCE sheltered the initiates as they slept together overnight in the open air, cannot be divorced from the suspicion of the sexual or orgiastic experience that surrounded similar bivouacking rituals, such as the Thesmophoria in fifth-century Athens and elsewhere. It was precisely such an erotic implication that motivated the uncle of Olympias, the future mother of Alexander the Great, to send his teenage niece to Samothrace for the initiation in order to introduce her as an eligible candidate to Philip, who was looking for a new wife. Of the Thesmophoria, we know that excessive drinking was the norm (Aristophanes, *Thesmophoriazousae*, 626-633, 735-738), while the bivouacking women conversed with prostitutes or hetaerae on sexual matters and techniques as a ritual to rekindle the fire, not just that of the extinguished hearth, but also of the conjugal bed as a reuniting of the segregated sexes and the renewal of ordinary life. The relighting of the fire was apparently an element of the Samothracian rites, as indicated by the tradition of the notorious Lemnian stench and the sexual engagement of the Argonauts on route for their quest of the Golden Fleece (Burkert, 1970). The stench was a curse from Aphrodite and the volcanic forge of her husband Hephaestus and was metaphoric for the overmastering intensity of the pheromones (Ruck, 2016).

In addition, numerous amphorae from the ancient village of Keramidaria ('Ceramics') are the product of workshops devoted to the manufacture of vessels, officially stamped as genuine provenance of Samothrace. The vessels were used for export of the wine apparently distinctive of the Mystery initiation. Tradition links the wine of these Zerynthian Caves with the legendary wine of Apollo's priest Maron. The vixen, female fox-capped bacchants of his tribe of Thracian Cicones attacked Orpheus and rendered him limb from limb in their madness, an analogous tale to the death of Pentheus of Thebes, who was himself an analogue of the death of his cousin Actaeon by his maddened hounds, inasmuch as it took place in exactly the same sacred spot on the mount Cithaeron outside Thebes. (Euripides, *Bacchae*, 1291). Odysseus used this wine of Maron to intoxicate the Cyclops Polyphemus. In the Homeric account, the wine required dilution with twenty parts water to drink it safely (Homer, *Odyssey*, 9.193-255).

The Homeric narrative is modeled upon the folkloric religious motif of initiatory liberation from a cave, traceable back to caves sacred as early as the Paleolithic and fully elaborated in Plato's 'Allegory of the Cave' (*Republic*, 514a-520a) and in the third-century CE Porphyry's essay on the *Cave of the Nymphs* (Ruck, 2015). As is characteristic of an initiatory rite of passage (Turner, 1967: 93-111), Odysseus moves from his name as Nobody in the Cave of Polyphemus to his heroic identity as the 'hated' Odysseus upon emerging, escaping by the ruse of disguising himself and his men as rams. Hung upside-down beneath an animal as they emerge from the cave is a zero-point of identity. The Homeric account plays upon the two versions of the Greek for 'nobody,' the factual *oútis* ('nobody') and the potential *métis* ('perhaps nobody, somebody'), where the latter puns upon *métis* as 'clever intelligence.' It also plays upon the dialectical version as *ótis*, the childhood name of the hero as the 'floppy-eared' bear, whose long hibernation suggested the motif of spiritual renewal through cave incubation. The Etruscans knew of version of the Odysseus myth in which the hero's disappearance was caused by his becoming so sleepy that people had trouble finding him (Plutarch, *Moralia*, 2.27e). Lycanthropy and ursine transmogrification are analogous initiatory motifs (Ruck *et al.*, 2007).

A wine marketed under the name of Maron still existed in the Roman period, and although not as potent as the legendary Homeric drink, on the personal testimony of the proconsul assigned to the province, it still required dilution with eight parts water to be drunk safely (Pliny, *Natural History*, 14.53; cf. Pollux, 66.10).

Mixing the Wine

Since fermentation is limited by the lethal effect of alcohol above a certain concentration of toxicity to the fungal growth of the yeasts that convert the sugars of the juice to ethanol, such potent wines achieved their high intoxicating potential from the special admixture of substances added to the natural ferment (Euripides, *Orestes*, 497-499). Some of these substances also withdrew oxygen from the mixture to retard the further oxidizing of the ethanol to vinegar or 'sour wine.' Wine was customarily drunk diluted with several parts water, yielding a drink of low ethanol content, but fortified to varying degrees of intoxication by the adding of other psychoactive substances, symbolizing the natural intoxicants of the primordial world, before the evolution of viticulture, typically toxic vines like ivy, bryony (wild cucumber), and smilax (bindweed, wild morning glory), which mimicked the growth of the grapevine. Even deadly poisonous plants like hemlock, in sub-lethal dosages, were among the additives (Hillman, 2008: 158-159; Nicander, *Alexipharmaca*, 186-194). In the Homeric tradition, Helen notoriously added the anodyne drug nepenthes to the drink she served to her guests in Sparta (Homer, *Odyssey*, 219-221). Thus, even though diluted, small amounts of ethanol drunk over an extended period could induce severe intoxication (Eubulus, frag. 94), and Plato stigmatized the drunkenness of the symposia (Rinella, 2010).

The tradition persists in the Demotic Greek word for wine, not as *[w]oínos* or 'wine,' but *krasí* for the 'mix.' In antiquity, the wine was associated with the taste of pine sap because of the pitch smeared on the porous clay amphorae to render them watertight (Aristophanes, *Acharnians*, 190, with scholia). The resin added to modern retsina both retards the wine's oxidizing and imparts psychoactive terpenes. The discovery of an intact wine cellar from the mid-second millennium BCE confirms this ancient practice (Ritter, 2013). Whereas the wild vines and their fruits are toxic in their natural state, the leaves of the grapevine and its grapes are edible, and the grapevine, in addition, requires human intervention as annual pruning to induce it to fruit with the berries upon whose juice is grown the intoxicant as an act of civilized cultivation. The adding of natural toxins to the cultivated yielded a drink that symbolized the reconciliation of the civilized world with its wild, primordial precedents.

Herbalist Fantasies

The emblem of the bacchant fox-capped vixens was the thyrsus, the receptacle for the wild plants gathered by herbalists (Theophrastus, *History of Plants*, 9.16.2). The bacchanalia honored not the god of viticulture, but his antecedent persona. The thyrsus identifies the women as engaged in the rituals and fantasies required for picking plants imbued with animate or divine personae. The fantasies often involve motifs of sexual engagement with the creatures that materialize from the magical plants, such as is documented at least until recently in the procedures for picking mandrake in Rumania, where the women undress and present themselves seductively nude to the object of their quest (Eliade, 1985: 17). In antiquity, menses was smeared on the mandrake to entice it to release its root (Josephus, *Jewish Wars*, 7.181), or its lycanthropic madness could be averted by enlisting a dog as the actual agent to pull the root from the ground, while the herbalist kept close watch for the approach of a pecker bird who might mount a sexual attack in retaliation. Numerous vase paintings depict the sexual assault or romp of the satyrs with the bacchants, who often fend off the attack with the thyrsus aimed directly at the genitals of the ithyphallic rapists. Mystical experience is commonly interpreted as cosmic orgasm, explicitly described as such by the sixteenth-century St. Teresa of Ávila and the eleventh-century theologian Rupert of Deutz, who both imagined that they engaged sexually with the Christ (Ruck and Hoffman, 2012: 250-252). A version of such empathetic communion resulted in the numerous documented instances of the physical stigmata that afflicted mystical Christians. Dionysus also materialized among the bacchants, crossdressing as a female and presenting himself as their perfect lover. They are shown offering themselves in return, presenting him their 'bunnies,' or dancing costumed as hares, the 'bunny' (*lagós* being metaphoric for their sexual organ (Henderson, 1975: 144, 170)). The satyrs represented the wild toxins before the advent of the civilized deity of viticulture. As goat-men hybrids, it was appropriate that the goat was the animal sacrificed to Dionysus and that the goatskin was employed to house the wine grown from the fruit of the grapevine, with the neck or foot of the wineskin being its metaphoric penis.

The thyrsus as a term was interchangeable with the narthex, which has the transparent etymology of the 'narcotic receptacle or storehouse.' *Narthex* was used as the title in antiquity for various compendia of drug lore. Typically, the thyrsus was depicted stuffed with wild ivy leaves, indicating that the plants they were gathering were emblematic of the toxins of the primordial world. The ivy leaves could be replaced with a pinecone, making the wand emblematic of the transcendence accessed by the gathered herbs, since the pineal gland is so named for its resemblance to the pinecone, and it was commonly thought in antiquity to function as a third eye, the gateway for mystical vision (Galen, *On the Use of the Parts of the Body*, 8.14). The pinecone also represents the god's earlier manifestation in the resinous pine tree, commemorated in the resin added to the mixture of wine, and in such arboreal epithets of the deity as *Dendrítes*.

The ivy leaves could be imagined as dripping with honey (Euripides, *Bacchae*, 710-711), which was commonly acknowledged also as a precedent for the wine (Plato, *Symposium*, 203b), since honey, like the skins of grapes and other fruits, naturally contains the yeasts for fermentation, and when found diluted in basins with rainfall to lessen the overly intense sugar concentration, it quickly yields ethanol. Thus it was common tradition that the honey drink or mead predated wine, and *méli* provides the generic word for intoxicated beverage as *methú* and the Demotic Greek verb for 'drunkenness' (*methisménos*). Mead, like wine, however, is similarly limited in the concentration of ethanol that the yeast can produce. The Nordic meads of legendary potency derived their toxicity similarly from fortifying additives (Ruck *et al.*, 2007: 153-155), and it was the common custom throughout the ages always to add other toxins into all forms of fermented beverage (McGovern, 2010).

The bee provides the natural prototype for the female herb gatherer, since it goes from flower to flower, collecting the nectar for the honey (Plato, *Ion*). It also presents a model of a matriarchal sisterhood centering upon its ovulating queen. A gold ring from Minoan Isopata near Cretan Knossos depicts a group of women gathering a magical flower that accesses mystical vision, indicated by the single disembodied eye. They have the faces not of human females, but of an insect, probably intended as bees, which was their title as priestesses. The bee metaphor persisted into Classical times, where various priestesses (of Artemis, Apollo, and Demeter) bore the tittle of Melissa, including the Pythian prophetess at Delphi, where still above the later sanctuary on Parnassus the bacchants swarmed out of the Corycian Wolf Cave like bees (Homeric *Hymn to Hermes*, 550-564).

The honey of these bees was symbolically psychoactive, Inspiring mellifluous inspired speech and interchangeable with the toxins of serpents and magical flowers as the source of mystical experience (Pindar, *Sixth Olympian Ode*; Ruck, 1976). Serpents were thought to derive their venom from eating toxic plants (Virgil, Aeneid, 2.471), and plants acquired their poisons by proximity to serpents (Nicander, *Alexipharmaca*, 521; Pliny, *Natural History*, 9.5), while bees obtained both their honey and their sting from the same obvious common source. Honey from toxic flowers, moreover, can be powerfully psychoactive (Xenophon, *Anabasis*, 4.8.20-21).

The bee is inseparable as a mythical motif from the bear. The animal is notorious for its fondness of honey, and some species even eat the bees. The bear walks upright and appears to be a gigantic human, perhaps enchanted into this ursine transmogrification, an impression seemingly proven by the animal's response to the human pheromone. The motif occurs in the tale of Callisto, a byname of Artemis, who was metamorphosed into the constellation of the Great Bear, and in the name of the goddess's pubescent troupe of girls as 'cubs' (*árktoi*).

In addition to the plants gathered, the bacchants handled serpents (Euripides, *Bacchae*, 698), and are frequently so depicted in vase paintings. Serpents can never be separated from the notion of toxicity, and there is explicit mention of milking them for their venoms in a bacchant context (Demosthenes, *On the Crown*, 18.260). Olympias became a great aficionado of the revels in the various Zerynthian Caves throughout Thrace, and she told her son that she had conceived him from Zeus in the form of a serpent, an event upon which Philip apparently spied, for which he lost the sight of one eye (Plutarch, *Alexander*, 3.1). A similar tale was told about Atia, the mother of Octavian Augustus, who entered an entranced state during a midnight ritual for the god Apollo. It left its mark on her body as a blemish, the same color as the snake, and just before her delivery, her husband dreamed that her womb opened to emit a solar beam that extended to the universe, a dream that she too had independently (Suetonius, Octavius Caesar). Conception through the agency of a serpent implies the whole botanical complex that united serpents, bees, and their shared toxicity with plants. Such tales are typical of the hagiography of famous men, but they indicate the sexual metaphor as descriptive of the orgiastic drug-induced revel as communion with deity.

The bacchants may have suckled fawns and wild wolf cubs (Euripides, *Bacchae*, 699-700), although more probably these events enter into the realm of metaphor, since it is inconceivable that the women, untrained in hunting, could have managed to catch their nurslings and it is unlikely that they brought them with them to the mountain bacchanalia. Since some of the animals seen depicted, such as leopards, are ferocious, the animals are probably zoomorphic materializations of the animate spirit of the gathered plants. Thus the women are seen cavorting with wild bulls, and they were said to have rendered the animals, limb from limb. The bull was hardly likely to submit to such treatment, nor is it believable, except as metaphor, that even groups of women together could accomplish such a feat, which in actuality would require teams of opposing horses. The same is true of Pentheus and Orpheus, both rendered by the bacchants. In the case of Pentheus, his decapitated head was placed atop the thyrsus, like a plant gathered from the mountainside. As a mythic motif, they both represent the materialized personae as surrogates for the deity in his manifestations that predate viticulture, and they thus oppose his new gift of wine. Significantly, Pentheus was plucked from the top of a pine tree, where the god had placed him as the wild surrogate (Euripides, *Bacchae*, 1063-1083).

Just as ivy, bryony, and smilax resemble the cultivated grapevine, but are intoxicating in their natural state, it could be expected that mushrooms figured as additives to the wine, inasmuch as fermentation was recognized as a controlled fungal growth. Mushrooms themselves were called a 'fermentation of the earth' (Nicander, *Alexipharmaca*, 521). In common culinary Latin nomenclature, the stipe of the mushroom was termed its thyrsus (Apicius, 7. 15. 6), making it the natural prototype for the narthex stuffed with the toxins of its cap. Fermentation was also thought to resemble the process of the corporeal putrefaction of the corpse in its moldy interment and thus linked wine as a mediation with the chthonic realm. A similar connotation resulted from the lingering noxious odor of rotting imparted to the vessels for fermentation by fumigation with burning sulfur, as an antioxidant to retard the acidification of the wine. The mushroom's funereal symbolism made it the common shape for numerous tombstones, from all regions and spanning entire antiquity. None of these can rightly be identified as simply phallic. The most explicit is the Hellenistic tombstone of Lysandra from the southern shore of the Black Sea (Kurtz and Boardman, 1971: 242-244).

A *hydria* vase from the cemetery of ancient Thracian Enez (Ainos) depicts the mixing of a *pithos* of sacramental wine under the supervision of a priest (Museum of Edirne; Ruck *et al*., 2014). Along with other plants (vines like bryony and smilax), a mushroom is being offered to a priest for inclusion in the mixture. This is quite probably the famous wine of Maron.

Harvesting Monsters

The most famous of the monstrous anthropomorphisms that materialized from the gathered herbs is the Gorgon Medusa, a version of the goddess Athena, whom the hero Perseus plucked as an apple with a pruning hook. Its identity as a mushroom is documented both as depicted in art (fourth-century BCE *amphora*, Berlin, F. 3022; Wasson *et al*., 1978: image 7) and in the local mythical traditions reported by the second-century CE ethnographic traveler Pausanias (*Description of Greece*, 2.16.3). As further confirmation, Perseus placed the harvested head in a *kíbisis*, an open-topped sack slung on his arm, and so depicted in numerous vase paintings. Such a sack is still used today by pickers of fruits like apples. The Medusa's head was depicted as analogous to a golden apple from the Tree of the Hesperides. The 'apple' was metaphorically psychoactive, since the magical steed Pegasus sprung from the monster's severed neck. The horse is named for the springs of inspiring waters that flow wherever he touches earth, and he functions as the flying vehicle for the harvester, an obvious metaphor for shamanic transcendence accessed via a psychoactive plant.

The Gorgons, among their other zoomorphisms as horse, mermaid, swan, pig, and serpents, mooed like cows (Eustathius, on *Iliad* 2.498; Stephanus of Byzantium, *s.v.* Mukale). The cows in myth are constantly in estrus, like the bovine metamorphosis of the cow-maiden Io, stung by the sting of her herdsman's cow-prod, transmogrified into the cow-fly *Tabanus bovinus*, the Greek *oístros*, which is the etymology for estrus. The mooing is the complement to the bellowing of their taurine mate. It is the sound that mushrooms in Greek make as they burst into fruit from the ground (Aeschylus, frag. 6, probably from his *Perseus* tragedy; Euripides, *Bacchae*, 691). The common designation of the fungus as a 'mushroom' in English is an onomatopoetic bovine zoomorphism as a moo-shroom, derived from the Greek *muá-ein* and Latin *muss-are* for 'mooing or bellowing,' Late Latin *mussarion*, French *mousseron*, assimilated into English as early as the Elizabethan Age. The mushroom stung by the cow-flies immediately suggests the common association of the

Amanita muscaria with flies, as the fly agaric or French *tue-mouches* and German *Fliegenpilz*. It grows in mycorrhizal symbiosis with the host tree, like another of its fruits. The indigenous Anishinaabeg of North America call it the 'tree-mushroom,' *miskwedo* (Keewaydinoquay, 1984).

Seafaring

The deities of the Mystery on Samothrace are commonly cited as the Dioskouroi (Dioscuri), the twin sons of Zeus, male twins of their sisters Helen and Clytemnestra, from his insemination of Leda of Sparta, having taken the shape of a swan. The Winged Victory or Niki of Samothrace now displayed on the landing of the Denon branch of the Louvre in Paris dates from the second century BCE as a dedication from the island of Rhodes commemorating a naval battle. Niki figures were frequent decorative motives designating the Mystery. The Dioskouroi were invoked by imperiled sailors, and the Mystery was supposedly an assurance of safety at sea (Burkert, 1977; Mikalson, 2010) or for profitable commerce from trade at sea (Blakeley, 2008, 2013). Few initiates, however, would be apt to travel frequently at sea.

This interpretation, moreover, ignores the antiquity of the rite at the Zerynthian Caves, both on Samothrace and throughout Thrace, and the ecstatic nature of the original bacchanalia and the copious drinking as later practiced in the lower sanctuary. The metaphor of life's course as a hazardous voyage at sea was a common poetic motif, including the government or piloting of the ship of state.

There was a forge adjacent to the sanctuary, considered not relevant by the excavators, but implying the theme of spiritual transcendence in the volcanic caldera, analogous to the ennobling of ores through metallurgical alchemy. Many rings of ferromagnetic iron were cast as souvenirs of the initiation (Cardew, 2012). They symbolized the broken link from the chains that bound them formerly to the delusional imprisonment in the cave of ordinary vision. It is significant that the chain dance was an element of the ritual. Similarly, iron magnets and the electrostatic attractive force of amber were sacred to the religion. Amber in mythic tradition represented the gummy tears of the Daughters of the Sun metamorphosed into poplars, encapsulating the sun's brilliance, and it was commonly thought that all mushrooms were derived from such resinous exudations of trees (Pliny, *Natural History*, 22.96.1). Amber had particular significance as a homeopathic remedy for madness, and the resinous pitch was also seen as the menses of the tree and efficacious as an aphrodisiac. Thus, both the magnet and amber are emblematic of eroticism.

The devotion of the Dioskouroi to each other was so great that although only one of them was immortal, and the other mortal, they vowed to share immortality together on alternating days. They thus were constantly engaged in the metaphoric voyage at sea across the great aquifer of Ocean that separates the living from the dead. They materialized as the electrostatic discharge that flashes like lightning from the masts of ships, known as St. Elmo's fire, still called *dioskouroi* in Greek. They were assimilated into Christian hagiography in the account of St. Paul's shipwrecked voyage on the Alexandrian boat called Dioskouroi, where Christ usurped the role of savior for ships at sea (*Acts of the Apostles*, 28.11).

Wolf Mushroom

The Dioskouroi were imagined as handsome youths, wearing the birth remnants of the halved eggshell as Phrygian caps upon their heads, but there were less iconic versions of their portrayal as twin shields or just a pair of fox-caps or linked twin pillars in landlocked Sparta, where they symbolized not foreigner travel, but the shrine of the opened tomb awaiting offerings. As the twin pillars, they were also carried into battle by the Spartan troops, who were identified as packs of wolves. They are personifications of the mushroom of the initiatory wine of Samothrace.

The lycanthropy and the related motif of rabidity as metaphoric for the altered state of consciousness of the bacchants derives from the association of the wolf with the *Amanita muscaria*, upon which it feeds. In the New World, it is documented among the Huichol as the occult initiatory sacrament of their elite wolf warriors (Hoffman, 2001), and among the Ahnishinaabeg for its access to heightened physical endurance and strength (Keewaydinoquay, 1984), as also claimed by the bacchants. It was the sacred intoxicant of Thracian warriors, traceable back to the mid second millennium BCE, and documented as lycanthropy in the Homeric episode of the Thracian horseman, Rhesus (Homer, *Iliad*, 10; Ruck *et al*., 2007: 87-124). It was still documented as a mushroom cult at the time of the Emperor Trajan (Dio Cassius, *Roman History*, epitome 68.8.1) among the Thracian Dacians, named as the 'Wolf-people.' They bore the emblem of Draco, their wolf-headed serpent, into battle. It is the same initiatory mushroom cult associated with the Nordic berserkers, named as the 'bear-shirts,' who materialized on the battlefield either as werewolves or in ursine transmogrifications. In folkloric tradition, it survives in the tale of *Rotkäppschen*, 'Little Red-cap,' named for her Phrygian mushroom cap, and the episode of initiatory lycanthropy (Ruck *et al*., 2007).

It is the ancient sacrament of the Zoroastrian Persians, *haoma*, the Avestan analogue of the Vedic Soma, known to the Greeks as *[h]ómomi*, assimilated as the Homeric *mólu* (moly), and associated with wolves (Plutarch, *Isis and Osiris*, 46). An elite troupe of Scythian warriors in the sixth-century BCE Achaemenid army were named as the *Saka Hauma-varga* or 'Haoma Wolves.' A recently restored fabric from the burial cloth of a Mongolian woman, dating to the second century CE, depicts a Zoroastrian priest presenting the deceased a large mushroom, identified by the Russian restorers as a psilocybin *Stropharia*, but probably too large and more likely an *Amanita*, discolored by the age of the tapestry (*Science*, vol. 26, no.2).

Eagle Fare

As the Gemini, the form the Dioskouroi assumed when they ascended to the realm of the constellations, they encode an ancient riddle about the herb that sprouted from the ichor or divine fluid that fell from the liver of the Titan Prometheus, the creator of man, as it was gnawed upon by the eagle of his torment, as eternal punishment for having stolen fire from the gods. The liver was considered a microcosmic image of the cosmos and, therefore, the seat of divination. The liver also acts as a filter for toxins and thus contains the highest concentration of ingested psychoactive plants. Since the Titan placed the fire he stole in a thyrsus, the event was analogous to the gathering of a sacred plant.

The riddle about this Promethean herb, which was picked by Medea, a priestess of Hecate, was that it was like the flower in the Wolf Cave at Delphi and that it sprouted from the earth with a 'twin' stem. (Apollonius Rhodius, *Argonautica*, 3.838 *et seq*.) It gave Jason the meaning of his name as the 'Drug-man' and let him access the strength to plow the field with the fire-breathing bulls and plant the toxic seeds of serpent fangs. This is not a branching stem, not even a double stem, but a twin (*dídymos*, *geminus*), characteristic of no plant but the *Amanitas*. As it expands from the egg shape, splitting its cap into halved eggshells, the single stipe extends in both directions producing the defining dumbbell of the birthing mushroom. The divine thunderbolt of Zeus was customarily depicted in Greek art as such a dumbbell, a bi-conical object, often with conventional lightning flashes attached. It is the same shape as the Vajra thunderbolt of Vedic Indra, and in Buddhism it is symbolic of the thunderbolt experience of enlightenment. As the Gemini, the Dioskouroi were depicted in medieval lore as Siamese twins, a form attested in antiquity for their Spartan doublets, the Moliones (Plutarch, *On Brotherly Love*, 1). They are the original of the primordial spherical creatures who were split in two to make the race of human, eternally seeking its erotic complement in reuniting with the beloved other half (Plato, *Symposium*, 186c *et seq*.; Ruck *et al*., 2001: 124-125).

The sources that identify the deities of the Mystery as the Dioskouroi make clear that this is not the true identity of the divine twins who were transported to the stars, which must never be told, but that they encode a symbolic manifestation of the regenerative spirit of primal man, not actually brothers, but twin siblings, a couple, male and female (Varro, *On the Latin Language*, 5.10.57-58). This also suits the hermaphroditic persona that the mushroom displays as the phallic thrust of the extending stipe appears to penetrate the vulva of the inverting cap. In Corinth, the tradition was preserved that Sisyphus, by some accounts the father of Odysseus, created the first indigenous people out of mushrooms after a rainfall (Ovid, *Metamorphoses*, 7.392-393).

The *Amanita muscaria* is commonly called 'raven's bread' because of the bird's fondness for ingesting the mushroom (Klapp, 2013). 'Bread' was an obvious metaphor for mushrooms, similarly spongy and leavened, the likeness of the heaven, just like the prophetic liver of haruspicy. It is unlikely that the raven alone eats the mushroom, and other birds are probably interchangeable in its designation. Its association with the thunderbird is attested in Ahnishinaabeg folklore (Wasson, 2001). The prophet Elijah was miraculously fed in the desert by a raven that brought him meat and bread (*I Kings*, 17.6), and it is the Raven who serves the cosmic bread and drink of the so-called bull's blood at the divine banquet to the Pater in Mithraism. In Classical tradition, the quail, which was known to eat things that were toxic to men, rendering feasting upon the quail potentially lethal (Aristotle, *History of Plants*, 820.6-7; etc.), is an analogue of the eagle's fare. The quail's erratic behavior made it appear drunken with epileptic seizures of the sacred disease, called 'quail madness' (*ortugomanía*). It is probably this bestiary lore that made the bird sacred to Apollo and Artemis. Their mother had a comic epithet as 'Mother of Quails' (*ortugométra*, Aristophanes, *Birds*, 870). The pubescent priestesses of Artemis danced a drunken staggering in imitation of the quails. Second only to the identification of the Gorgon Medusa as a fungal anthropomorphism, there could be no motif more central to the ethnobotany of ancient Greece than this divinatory liver of Prometheus.

Dirty Dancing

The Dioskouroi in the Mystery of Samothrace were interchangeable with the Corybants, who sprung from the fingers of Rhea as she groveled in the earth, bent in labor for the birth of Zeus. The posture suggests that they, too, belongs to the motif of gathering sacred plants. They are named as the 'helmeted dancers,' who protected the infant, hiding his birth cries by drumming on their shields. They were interchangeable with the Kouretes, who are named simply as the boys. Like the Dioskouroi, these all are visualized as idealized young men. Their typical dancing stance is raised on a single foot, with the shield held implausibly over their heads, a stance that Attis and Mithras also assume in some versions of them as warriors.

In the folklore of fantastic creatures, they appear revealed as fungal anthropomorphisms with the name of the Kaulomycetes or 'Cover-mushroom' warriors (Lucian, *True History*, 1.16). These were warriors who held their mushroom cap as a shield over their heads and fought with an asparagus for a sword. With these details, we enter a realm where the Mystery creatures are apparently less than normal size, small enough for the mushroom's cap to serve as shield for a warrior imagined beneath it, who fights with an asparagus stalk. The choice of botanical sword is disproportionally long for beings so tiny and suspiciously phallic, and the asparagus was reputed to have aphrodisiac properties and it is slang for the penis. Hence the erotic implications of the Corybants as initiators of Cleinias, the younger brother of Alcibiades, into the Samothracian Mystery in Plato's *Euthydemus* dialogue (Levenson, 1999). The single foot stance of the Corybants and Kouretes defines another fantastical fungal anthropomorphism. These are the Skiapodes ('Shade-foots'), a tribe of creatures with only a single broad foot, upon which they vigorously dance, until they tire and fall upon their backs to rest in the shade of their one foot spread above like a parasol or (Ruck, 1986: 151-178). The parasol (*skiádeion*) is an obvious metaphor for the mushroom and these creatures survived in medieval art and are recognized as fungal in European folklore (Lewis, 1952). Aristophanes presented Prometheus as such a Shadefoot in the *Birds* (1494 *et seq.*), hiding from the celestial gods above beneath his *skiádeion*, which, when unfurled, turns out to be the comic disguise for his gigantic phallic erection (Ruck, 1986). The 'mushroom' was a common metaphor for an erect penis (Henderson, 1975).

The Great Gods of Samothrace, at least in their herbal personae, belonged to the cult of the little people, common in the Celtic lore of Europe. Interchangeable with the Dioskouroi, Corybants, and Kouretes were the 'finger' creatures or Daktyls. They, too, sprang from the fingers of Rhea as she picked the sacred plant for the birthing of her divine son, Zeus. Although their dactylic personae suggest their erect penises, they also had an equal handful of sisters, and hence the groups of little creatures could appropriately engage in sexual revels.

Among such dwarfish beings of the Mystery were the Kabeiroi, gnomes, imagined as ithyphallic African grotesqueries and their female companions, similarly oversexed. Dwarfism is the converse of gigantism, as in the tiny brothers of the African giant Antaeus, the reference for Jonathan Swift's tribe of Lilliputians (1726), and the alteration in size is metaphoric of the penile erection, and also suggests the alternating macroscopic and microscopic vision characteristic of the *Amanita muscaria*, as popularized in Lewis Carrol's *Alice's Adventures in Wonderland* (1865). The name of the Kabeiroi is plausibly linked etymologically with Cybele. In ancient Greek folklore, they are known as *kóbaloi*, trickster, thieving goblins (Aristophanes, *Knights*, 450; *Frogs*, 1015; *Plutus*, 279, etc.). They are shape-shifters (*ailomórphoi*), attendants upon Dionysus, dancing maniacs (*choroimanéis*) (Brown, 2004: 230-231). Two of them who are twins are named as the dwarfish Kerkopes ('Tail-faces'), depicted with African or simian features, whose monkey 'tail' presents them backwardly phallic. They survive in the folklore of Europe as the German *Kobald*, the French *gobelin*, and the puck of England (Hardwick, 2007).

Odysseus, Circe, as Kabeiroi, and the potion are frequent motifs on the drinking vessels from the Mystery sanctuary outside Thebes. Circe, although not otherwise known for her weaving in the Homeric tradition (Homer, *Iliad*, 302-347), is shown interrupting her work at the loom to offer the ithyphallic Odysseus the potion that turns men into pigs. The comb (*ktéis*) was the equivalent of the phallus. It held the threads of the loom's warp threads apart for the penetration of the cock, back and forth, with the threads of the weft. Terracotta models of the 'comb' in antiquity were almost as abundant as phalloi. The depictions of the Kabeiric Circe are thus as obscene as the gnomish Odysseus. Aristophanes staged an obscene choral dance in his *Plutus* comedy (408 BCE, revised *ca*. 388), where the asshole of a Corinthian hetaera named for the famous enchantress serves as the mortar for mixing the Mystery potion (290-315). Circe notoriously turned men into pigs. Boars, like the bear, respond to the human pheromone, and piglet was slang for the female's comb or pudendum (Henderson, 1975). The phallic thrust of the mushroom's stipe can be imagined as penetrating through the webbing threads of the radiating gills on the underside of the cap.

When not depicted as such misshapen gnomes, the Kabeiroi were crabs (*kárkinoi*), sons of Hephaestus, attending him as henchmen at the alchemical forge of transmutation. Hephaestus himself at the forge was imagined as wearing the red eggshell cap (Phrygian *pileus*) symbolizing the vault of heaven, a common metaphor for the pileus of the *Amanita*, suggesting transcendent experience. The emblematic tool of metallurgy was the god's pincers, which were called 'crabs.' Aeschylus staged them as tiny pubic lice dancing around a giant erection in his *Wasps* comedy (422 BCE), punning upon the snot ejaculating from the bellowing erection (*muktér mukátai*). The mushroom is named in Greek *mykes* for its slimy mucus, as typical, not a name, but an epithet, for something too sacred and taboo to have a proper name. The scene is the culmination of a parody upon the Samothracian Mystery and the visionary phallic mushroom of the Persian *haoma*-wolves (Ruck, 2012).

The Lemnian forge, where Hephaestus copulated with his wife Aphrodite, was the source of the fearsome sexual stench of the Lemnian women, and Aristophanes staged the odiferous combat of opposing pheromones as the divided chorus of grotesque male and female Kabeiric dancers in his *Lysistrata* comedy (411 BCE) (Ruck, 2016: 160-208). The metallurgical forge is traditionally seen as a womb tended by specially initiated males, with its slag as its menses (Blakeley, 2006).

Crazy as a Loon

The Kabeiroi as crabs walked sideways, like the smithy god Hephaestus, whom they served. The god himself had backwards feet (*amphiguéeis*) and an ambidextrous manner of walking, characteristic of drunkenness. Hermes, who was patron of the Samothracian Mystery, famously turned the feet of the cows mooing in estrus backwards (an impossible feat for cows, named as *próbata* or 'forward-walkers') and he wore his sandals turned around for the event, as narrated in the Homeric hymn, probably intended for recital in the Samothrace sanctuary. Aristophanes, who was obviously an initiate into the Mystery on Samothrace, introduced Hermes in this role of backwards ambulation in his *Peace* comedy (421 BCE), which staged the flight of the hero in the persona of Perseus flying to heaven on the gigantic mushroom of his erection portrayed as a dung beetle in the persona of Pegasus (Ruck, 2016: 94-115). Aeschylus, who also was an initiate of the Mystery of Samothrace, staged the initiation of the Argonauts as a drunken revel of the sailors with the Kabeiroi (Aeschylus, frag. 48, 49).

Ambidextrous ambulation is a version of shape-shifting. Thus another version of the god's attendants at the volcanic forge were the wizards called Telchines or 'Enchanters.' They had the ability to shift shape and become seals. Like the crab, the seal is characterized with a handicapped mode of ambulation, inasmuch as its hind limbs are bound together, causing it to slither its way forward, rocking back and forth, appearing drunk and leaving a zigzag trail like a serpent. Their drunkenness was interpreted as lycanthropic rabidity, since that were said to have metamorphosed from the rabid hounds of Actaeon. They are comparable to the selkies of Celtic lore, who assume human form on land and are notorious for their sexual proficiency. Shapeshifting and ambidextrous ambulation were emblematic of divination. Thus the grandfather of the Kabeiric males and females was cited as Proteus, the seal-keeper and famous prophet. Seals are noted for their fishy stench, which implies the sexual pheromones. The same ambidextrous orientation characterizes the Kerkopes, with their 'tails' on the wrong side, and also the paired brothers, Prometheus, with his backwards minded sibling Epimetheus. Additionally, the backward-tailed Kerkopes were usually depicted upside-down, from which vantage their forward vision was reversed backwards.

One of the foundational myths for the Samothracian Mystery describes Dardanus sailing on a goatskin raft, drunken and crazy as a loon (Lycophron, *Alexandra*, 69-82), whose eerie screams and erratic diving suggest spiritual possession and the same motif of drunkenness, hence the comparison 'crazy as a loon.' Virgil connected this obscure tradition of the fungal drunkenness of Dardanus with the Trojan ancestry of Aeneas in the foundational myth for Rome. The city would not be founded until Aeneas and his men were forced to eat their own tables (*Aeneid*, 3.254-257). The site would be indicated by tables laden with the slimy mucous offal of the Harpies, the repulsive food that had given the prophet Phineus the awesome power of prophecy. The Harpies materialized as elfin eddies (Homer, *Odyssey*, 20.66, 77), like the Celtic fairies, and also as swarms of flies (Apuleius, *Golden Ass*, 10.15), suggestive of the particular species of mushroom. These tables are a version of the *Amanita muscaria* mushroom, spread with the scabby white remnants of its shattered veil like bits of bread attracting swarms of cow flies, tables that belonged to the fairies and of which it was forbidden to eat (Ruck and Larner, 2013). The fairy lore of northern Europe occurs in ancient Greece, as well. The figure of Psyche is commonly depicted with butterfly wings, as on the mushroom tombstone of Lysandra, and even the Gorgon Medusa, as might be expected, can be portrayed with fairy wings (Athenian black figure *lekythos*, ca. 450 BCE, Metropolitan Museum, New York). The 'Great Gods' of Samothrace was a cult of the 'little people' (Ruck, 2016).

A bizarre analogue of this foundational myth involves the Kabeiric Odysseus and Circe (Lycophron, *Alexandra*, 1226 *et seq.*) One of the Kabeiric drinking vessels depicts Odysseus, nude, dwarfish, with African features and grossly ithyphallic with sagging belly, sailing like Dardanus on a raft of two amphorae, probably depicting the export trade of Maronian wine from Samothrace (late fifth-century BCE *skyphos*, Ashmolean Museum, Oxford, inv. no. V.262). The other side of the cup depicts the Kabeiric Odysseus, with erection, confronting Circe and her comb, as she presents him with the potion. Another obscure account of this raft of the drunken loon mentions four legs in a basket, referring to the two dancers treading the grapes of the vintage in the straining basket.

Although the Roman Penates were imagined, like the Dioskouroi, as idealized adolescent males, they were traditionally represented as figurines, which is to say, of diminutive size. The original Penates that Aeneas brought from Rome were preserved in a temple on the Tiber south of Rome, and although probably pious forgeries in Classical times, they replaced creatures like the ithyphallic grotesqueries of the Mystery. Like the twin yoked pillars of the Spartan Dioskouroi, the Penates were guardians of the innermost recesses of the household, the *penetralia*, which implies the motif of sexual penetration, and in antiquity interpreted as penetration into the secrets of mystical vision. At each meal, an offering was made to the Penates to remove the accursed taint of primordial toxicity and render the food safe for consumption.

The Etruscan version of these little creatures is their Tages, a little young old man, who popped up in the plowman's path and dictated the book of secrets and taught the art of divination by inspection of the liver. The name of the plowman is a version of Tages, and also the origin of the tribal designation of the people.

Demeter's Indiscretion in the Cornfield

The fungal identity of all these Samothracian grotesqueries is expectable since another foundational myth for the Mystery of Samothrace involves, not the drunken sailing of Dardanus, but the inaugural plowing for the foundation of the Greek city of Thebes and a parallel of the Eleusinian adduction of Persephone. By this account, at the marriage feast of Cadmus and Harmonia, Demeter had sex with Iasion (or Iasos/Iasios, a brother of Dardanus) in a cornfield. This Iasion was an ithyphallic Kabeiros creature. In this telling of the tale, Harmonia was also probably a Kabeiros, since she is the sister of Iasion and Dardanus. The latter two were cited as the original Kabeiroi (Apollonius Rhodius, *Argonautica*, 1.917, scholia), and one killed the other. Iasion is named as the 'Drug-man' and is a doublet of Jason anointed with the chrism of eagle-fare.

Demeter taught Iasion how to plow. He was named Triptolemos for the first 'three furrows' (*trípolos*) cut into the primordial cropland, symbolic of the vulva, tripartite for the triple goddess, repeated annually as an inaugural ritual in a plot dedicated in his honor. The plow was his phallic stick, and so recognized in the legal terminology of the marriage contract for the plowing of legitimate children. For this affront to

Demeter/Persephone's virginal modesty, the primordial plowman was sacrificed, repeated thereafter with an offering of a victim at the annual inaugural plowing. The symbolic offering of victims in the persona of the primordial plowman represented an accommodation with the forces of primitivism, which yielded to the evolutionary arts of agriculture. He plays the same role as the primordial antecedents to viticulture, and botanically he was manifest in the single or dual kernels of the most primitive edible grass, which was spelt ('split-dual kernel') or German *Einkorn* ('one-kernel'), known as 'goat grass' in Greek. This primitive grass resembles the ergot that grows on the cultivated superior grassy hybrids like barley. Ergot is so named for the 'cockspur' in French, which in antiquity would be the 'talons' of ornithological creatures like the Harpies. The ergot was recognized in antiquity as a fungus since the sclerotia of infested kernels of grain fruit as mushrooms visible to the unaided eye. It was the psychoactive ingredient of the Eleusinian Mystery potion, representing the seed of the totally wild and seedless mushroom, and thus the mediation between the wilderness of the mushroom's habitat and the cultivated cropland. The ergot in an aqueous context with bone ash, representing the sacrificed plowman, yields an oscillating hydration of ergine and isoergine, LSA, which is a natural analogue of LSD.

Triptolemos and Demeter proselytized the art of agriculture throughout the world. It was a flight in a special cart, through the air, metaphoric for ecstatic transcendence. It was the very same cart drawn by toxic serpents in which Jason's Medea flew. Her name is merely the adjectival version of the participial form it has in the Gorgon Medusa as the 'Queen.' Medea inherited this very same solar cart from her aunt, Circe, the Kabeiric lover of the grotesque ithyphallic version of the dwarfish Odysseus.

Analogous to the controlled fungal growth in the yeasts of vinous fermentation, was Demeter's gift of bread. Leavened bread is similarly a fungal growth, yielding the spongy dry food, the civilized analogue of the sponge that provided the metaphor for the mushroom as a fungus (*spóngos*), and for the metaphor for the bread of ravens and thunderbirds. The sponge belongs to the tradition of the fungal Medusa, since the blood from her harvested head metamorphosed into coral, which becomes hard and petrified only when immersed in water, and the spongey expansion of the mushroom's fruiting was metaphoric for the heaving upwards of the cosmic rim of the heavens. Thus both wine and bread as the fundamental liquid and dry foods of antiquity partake of the same evolution of primordial toxicity into the arts of civilized cultivation.

Carl A.P. Ruck
Clark University, psychology 1953
Yale University, pre-medical, psychology, Classical Philology: BA, 1958
University of Michigan, Classical Philology: MA, 1959
Harvard University, Classical Philology: PhD, 1965
Professor, Boston University, Department of Classical Studies
Boston University, College of Arts and Sciences
745 Commonwealth Avenue Boston, Massachusetts, 02215 USA
1-617-353-4435 bacchus@bu.edu
Fax: 1-617-353-1610

References

1. Blakely, S. 2006. Myth, ritual, and metallurgy in ancient Greece and recent Africa. Cambridge: Cambridge University Press.
2. Blakely, S. 2008. Kadmos, Jason, and the great gods of Samothrace: initiation as mediation in a northern Aegean context. Electronic antiquity. 11(1). Virginia Polytechnic Institute and State University: 67-95.
3. Blakely, S. 2013. Daimones in the Thracian sea: mysteries, iron, and metaphors. Archiv für Religionsgeschichte. 14(1): 155-182.
4. Brown, R. 2004. The Greek Dionysiak myth, part 2. Whitefish: Kessinger Publishing, reprint of London: Longmans, 1877-1878: 230-231.
5. Burkert, W. 1970. Jason, Hypsipyle, and new fire at Lemnos: a study in myth and ritual. The classical quarterly. new series, 20(1): 1-16. Reprinted Burkert, W. 2001. Savage energies: lessons of myth and ritual in ancient Greece. Chicago: University of Chicago Press: 64-84; and Berenson Maclean J.K., and Bradshaw Aitken, E. (eds.) 2004. Philostratus's *Heroikos*: religion and cultural identity in the third century C.E. Leiden: Brill: 99-126.
6. Burkert, W. 1977. Greek religion: archaic and classical. Oxford: Blackwell/Harvard University Press, 1985, translated from the German, Griechische Religion der archaischen und klassischen Epoche. Stuttgart: Verlag W. Kohlhammer.
7. Cardew, A. 2012. The archaic and the sublimity of origins. Bishop, P. (ed.) The archaic: the past in the present. New York: Routledge: 93-146.
8. Eliade, M. 1970. De Zalmoxis à Genghis Khan. Paris: Édition Payot.
9. Hardwick, C. 2007. Traditions, superstitions, and folklore (chiefly Lancashire and the north of England): their affinity to others in widely-distributed localities, their eastern origins and mythical significance. Whitefish: Kessinger Publishing, reprint of London: Simpkin, Marshall and Co., 1872.

10. Henderson, J. 1975. The maculate muse: obscene language in Attic comedy. New Haven: Yale University Press.
11. Hoffman, M. 2001. Huichol wolf shamanism and A. muscaria. Entheos: journal of psychedelic spirituality. 1(2): 43-48.
12. Keewaydinoquay (Peschal) (with an introduction by Wasson, R.G.). 1984. The miswedo in Anishinaabeg life. Verona: Stamperia Valdonega, from the hand-corrected master proof of the unpublished printing, of which only five copies exist, sequestered from access in the Wasson Archives, Harvard Library.
13. Klapp, E. 2013. Raven's bread and other manifestations of fly agaric in classical and biblical literature. Rush, J.A. (ed.) Entheogens and the development of culture: the anthropology and neurobiology of ecstatic experience. Berkeley: Atlantic Books: 333-342.
14. Kurtz, D., and Boardman, J. 1971. Greek burial customs. London: Thames and Hudson.
15. Lehmann, K. 1954. Samothrace: a guide to the excavations and the museum. Thessaloniki: Institute of Fine Arts, New York University, 1998, 6th edition, revised and enlarged, 1st edition, 1954.
16. Levenson, C. 1999. Socrates among the Corybantes: being, reality, and the gods. Woodstock: Spring Publications.
17. Lewis, C.S. 1952. The voyage of the Dawn Treader.
18. McGovern, P. 2010. Uncorking the past: the quest for wine, beer, and other alcoholic beverages. Berkeley: University of California Press.
19. Mikalson, J.D. 2010. Ancient Greek religion. Chichester: Blackwell's/Jon Wiley & Sons.
20. Rinella, M. 2010. Pharmakon: Plato, drug culture, and identity in ancient Athens. Lanham: Lexington Books.
21. Ritter, M. Ancient wine cellar unearthed in Israel shows Canaanites enjoyed a sophisticated drink New York: AP, 2013. http://www.huffingtonpost.com/2013/11/22/ancient-wine-cellar-israel_n_4323848.html Accessed date: December 3, 2015.
22. Ruck, C.A.P, 2015. The cave of Euripides. Time and mind: the journal of archaeology, consciousness and culture. 8(3): 279-302.
23. Ruck, C.A.P. 1976. On the sacred names of Iamos and Ion: ethnobotanical referents in the hero's parentage, Classical journal. 71(3): 235-252.
24. Ruck, C.A.P. 1986. Mushrooms and philosophers. Wasson, R.G., Kramrisch, S., Ott, J., and Ruck, C.A.P. Persephone's quest: entheogens and the origins of religion. New Haven: Yale University Press: 151-178.
25. Ruck, C.A.P. 2012. The great god Sabazios and the crab dance in Athens. The stone mushrooms of Thrace (bilingual edition, English and Greek). Alexandroupoli: EKATAIOS: 193-220.
26. Ruck, C.A.P. 2016. The great gods of Samothrace and the cult of the little people. Berkeley: Regent Press.
27. Ruck, C.A.P., and Hoffman, M.A. 2012. The effluents of deity: alchemy and psychoactive sacraments in medieval and renaissance art. Durham: Carolina Academic Press.
28. Ruck, C.A.P., and Larner, R. 2013. Virgil's edible tables. Rush, J.A. (ed.) Entheogens and the development of culture: the anthropology and neurobiology of ecstatic experience. Berkeley: Atlantic Books: 387-449.
29. Ruck, C.A.P., ed. Dionysus in Thrace: ancient entheogenic themes in the mythology and archaeology of Northern Greece, Bulgaria, and Turkey. Berkeley: Regent Press, 2014.
30. Ruck, C.A.P., Hoffman, M.A. and González Celdrán, J.A. 2011. Mushrooms, myth, and Mithras: the drug cult that civilized Europe. San Francisco: City Lights Books.
31. Ruck, C.A.P., Staples, B.D., González Celdán, J.A., and Hoffman, M.A. 2007. The hidden world: survival of pagan shamanic themes in European fairytales. Durham: Carolina Academic Press.
32. *Science: First Hand*, 20 Aug 2010, vol. 26, no. 2: "We Drank Soma, We Became Immortal." http://scfh.ru/en/papers/we-drank-soma-we-became-immortal-/ Accessed date: June 14, 2015.
33. Turner, V. 1967. Betwixt and between: the liminal period in *rites de passage*. The forest of symbols: aspects of Ndembu ritual. Ithaca: Cornell University Press: 93-111.
34. Wasson, R.G. 2001. The miskwedo of the Ahnishinaubeg. Entheos: the journal of psychedelic spirituality. 1(2): 3-12.
35. Wasson, R.G., Hofmann, A., and Ruck, C.A.P. (1978). The road to Eleusis: unveiling the secret of the mysteries. New York: Harcourt Brace Jovanovich. Reprint, Los Angeles: Hermes Press, 1998. Reprint, Berkeley: Atlantic Books, 2008.

The Last Meal of the Buddha

by

R. Gordon Wasson and Wendy Doniger O'Flaherty

Journal of the American Oriental Society, Vol. 102, No. 4 (Oct. - Dec., 1982), pp. 591-603

© Authors, 1982

original report: http://lirs.ru/lib/jaos/The_Last_Meal_of_the_Buddha,Wasson,1982,JAOS.pdf
backup source: http://www.psilosophy.info/resources/The_Last_Meal_of_the_Buddha,Wasson,1982,JAOS.pdf

Table of Contents:

I. What was s&umacr;kara-maddava?
II. The Santal and the *Putka*
III. The death of the Buddha
IV. The Buddha's last meal
V. The Indus Valley and Kashmir
Memorandum by Walpola R&amacr;hula of the early sources for the meaning of *s&umacr;kara-maddava*
Epilogue

I. What was s&umacr;kara-maddava?

Upwards of a dozen scholars[1] in the past century have commented on what the Buddha ate at his Last Meal, *ca*. B.C. 483, and the puzzling mystifications in the evidence. The meal was served to him and his suite of monks by his host the metal-worker Cunda at P&amacr;v&amacr;, a village that lay near Kusin&amacr;r&amacr; where the Mah&amacr;parinirv&amacr;ṇa - the 'Great Decease' as the Rhys Davids translated it - was scheduled to take place some hours later. The canonical P&amacr;li Text says that Cunda served his august guest *s&umacr;kara-maddava*, a hapax in P&amacr;li. Walpola R&amacr;hula, the Buddhist monk and scholar residing in the West, has assembled in a memorandum for us the relevant P&amacr;li texts with his translations and notes, and this document is appended to our paper.

The first part of that compound word, *s&umacr;kara-*, is simple: 'pertaining to swine,' *s&umacr;k-* being cognate with Latin *sus*. The second element is generally thought to mean tidbits, dainties, but whether as a specially delicate part of the pig's meat or as a food of which swine were specially fond, whether a subjective or objective genitive, no one can say. Rhys Davids noticing that in Bihar there was a common edible underground fungus, translated *s&umacr;kara-maddava* by 'truffles.'[2] This was a successful pitch, considering that by 'truffles' he meant an underground fungus common thereabouts, although no truffle (= *Tuber*) has been discovered so far in Bihar. His underground fungus was a *Scleroderma*, a little snow-white ball that is gathered just as soon as it appears on the surface. There are a number of genera of underground fungi of which truffles are one, and each genus has many species.

The two canonical P&amacr;li Commentaries discuss but do not agree on the meaning to give to *s&umacr;kara-maddava*. One of them is the canonical P&amacr;li Commentary on the *D&imacr;gha Nik&amacr;ya*, *Sumaṅgalavil&amacr;sini*, and the other, the *Paramatthajotik&amacr;*, the canonical Commentary on the *Ud&amacr;na*. These Commentaries took their present form in P&amacr;li under the guidance of the celebrated monk Buddhaghoṣa early in the fifth century of our era, mostly from Sinhala sources available to him. Each of these commentaries suggests various dishes as possibilities. Both include pork and an 'elixir' (a chemical preparation) in the list of choices. The canonical P&amacr;li Commentary on the *D&imacr;gha Nik&amacr;ya* adds soft rice with the broth of the five products of the cow. The canonical P&amacr;li Commentary on the *Ud&amacr;na*, deriving its authority from the Great Commentary (now lost) that dates from the third century B.C., offers two further choices: bamboo shoots (sprouts) trodden by pigs, and *mushrooms grown on a spot trodden by pigs*.

That the Buddha was eating his last meal was known to everyone thereabouts: nothing that happened there could have escaped those within eye-reach nor have been forgotten by them, not least because of the awesome event to take place a few hours later, the Buddha's translation to Nirvana that he had been predicting for that night since he was in Vai&sacute;ali three months before.

Dr. Stella Kramrisch, building on the work of the late Professor Roger Heim and me in eastern India, has identified with finality the *s&umacr;kara-maddava* as the *P&umacr;tika*,[3] a plant that figures conspicuously in the Br&amacr;hmaṇas and other early post-Vedic sacred Sanskrit texts. In this paper I will examine the Last Meal at P&amacr;v&amacr; and the death of Gautama the Buddha at Kusin&amacr;r&amacr; in what is today northern Bihar. I will focus attention on what he ate at his Last Meal - a matter of little theological importance to the Theravadin branch of Buddhism and none at all to the Buddhists of the Greater Vehicle, but pertinent to our mushroomic inquiries and notably, as I shall show, to the identity of Soma.

Of all the scholars who have dealt with the Last Meal of the Buddha, I believe only one, André Bareau, has addressed himself to the surprising anomaly offered by the possibility of either pork or mushrooms being served to the Buddha at this meal. Here is what Bareau has to say:

> En effet, la viande de porc et plus encore les champignons sont des choses pour lesquelles les Indiens impregnés de culture brahmanique, comme l'étaient le Buddha et une grande partie de ses disciples, éprouvent un profond, un insurmontable dégout et que ne consomment guère que certains tribus sauvages ou des gens de basse caste, rejetés par la bonne société et pressés par la faim. L'idée d'offrir au Bienheureux, pour l'honorer et le régaler, comme un mets de choix, ... de la viande de porc ou des champignons est aussi insolite que si, dans une légende occidentale, on offrait à quelque éminent personnage un festin dont le plat principal serait une cuisse de chien ou une purée de goémon, des sauterelles frites ou des chenilles grillées; cela paraîtrait à juste titre une plaisanterie ou ferait croire à une erreur de copie. [*Recherches sur la biographie du Buddha*. Tome 1, p 267. Paris. 1970. Publications de l'Ecole Française d'Extrême-Orient, Vol LXXVII]

Confirming what Bareau says, Chap V-5 of the laws of Manu, believed to have been committed to writing around the beginning of the Christian era, declares that:

> garlic, leeks and onions, mushrooms and (all plants) springing from impure (substances), are unfit to be eaten by twice-born men,

and this proscription is repeated in V-19:

> A twice-born man who knowingly eats mushrooms, a village-pig, garlic, a village-cock, onions, or leeks, will become an outcast.

Here the prohibition carries a dire penalty. Mushrooms are forbidden in two further clauses, VI-14 and XI-156. The repeated prohibition applies expressly to twice-born men, which embraced the three upper castes.

The ban on mushrooms was no dead letter. Sir William Jones quotes from a commentator on the laws of Manu named Yama:

> ... the ancient Hindus held the fungus in such detestation that Yama... declares 'those who eat mushrooms, whether springing from the ground or growing on a tree, fully equal in guilt to the slayers of Bráhmens, and the most despicable of all deadly sinners.' [*The Works of Sir William Jones*, Vol V, pp 160-161, London, 1807.]

This is the most extravagant outburst of mycophobia that we have found anywhere, surely the most extravagant to be found in the Indo-European world, which is saying a good deal. The learned Brahman tells us that the simple mushroom-eater is as bad as the murderers of Brahmans! Why such passionate, such exaggerated censure? Bareau, in comparing the Hindu eater of mushrooms to one among us who eats dog's flesh, was engaging in understatement.

Three months before the Last Meal at P&amacr;v&amacr; and before his Mah&amacr;parinirv&amacr;ṇa, the Buddha had been sojourning at Vai&sacute;ali and thereabouts. While in the vicinity of Vai&sacute;ali he had suffered a grave illness, attributed from ancient times to a chronic gastric upset, probably dysentery; had felt the weight of his years, had called himself an 'octogenarian,' and had announced his intention to go to Kusin&amacr;r&amacr; and there three months later to experience the Mah&amacr;parinirv&amacr;ṇa, the Final Extinction. He was predicting the time and place of his own end. He made his way to Kusin&amacr;r&amacr; with his followers on foot, teaching the doctrine as was his wont, and it took him three months to cover the 140 kilometers. To his disciples and the villagers he made freely known his purpose: he never wavered in his resolution, nor did he hide it from anyone.

The day before the Buddha reached Kusin&amacr;r&amacr; he arrived at the nearby village of P&amacr;v&amacr; and passed the night in the mango grove belonging to one Cunda, a metal-worker or blacksmith, and therefore a &sacute;&umacr;dra, the lowest of the four castes in Hindu society. Cunda, appearing almost immediately, inquired what the Buddha desired. According to one of the Chinese recensions of the Buddha's life, the Buddha explained that he was to undergo the Mah&amacr;parinirv&amacr;ṇa in Kusin&amacr;r&amacr;: lamentations followed. Cunda invited the Buddha and his many followers to take their single meal the next day with him, and by his silence the Buddha accepted. Cunda withdrew to assemble the food and prepare it. In the morning Cunda came to summon the Buddha and his followers to the meal that he had prepared.

Cunda, as we said before, was a &sacute;&umacr;dra, a man of the lowest caste. On the other hand, as the metal-worker of the region he was a technician, comfortably off, extending hospitality on a moment's notice to the Buddha and his numerous followers, one accustomed to meeting and mixing with travelers including individuals of what are today called the 'scheduled castes,' aboriginal tribesmen who were not Hindus and therefore not a part of the dominant Hindu society. His forge may well have been the *raison d'être* for P&amacr;v&amacr;. When the Buddha arrived at Cunda's dwelling-place and was seated in the place prepared for him, he (according to the *D&imacr;gha Nik&amacr;ya*) addressed Cunda saying,

> As to the *s&umacr;kara-maddava* you have made ready, serve me with them, Cunda, and as to the other food, sweet rice and cakes, serve the monks with them. [Chap. IV, §18, p. 138]

The Buddha then said to Cunda,

> Whatever *s&umacr;kara-maddava* are left over to thee, those bury in a hole. [§19]

In a hole, not just throw away, and we are told that the surplus *s&umacr;kara-maddava* Cunda buried in a hole. Apparently Cunda had brought *s&umacr;kara-maddava* for the whole company, as he had thought all would share in them, so there must have been an ample surplus.

Then the Buddha added these remarkable words,

> I see no one, Cunda, on earth nor in Mara's heaven, nor in Brahma's heaven, no one among the Samaṇas and Br&amacr;hmaṇas, among gods, and men, by whom, when he has eaten it, that food can be properly assimilated, save by a *Tath&amacr;gata*. [§19]

Obviously the Buddha had recognized at once what he was being offered, the *s&umacr;kara-maddava*, and he knew the mushrooms were of a species that would shortly smell bad ('stink') if they were not eaten or buried in a hole. (To this day the custom among some Santal seems to survive to bury any surplus *s&umacr;kara-maddava* in a hole.) Perhaps it was the first time in his life that the Buddha, of kṣatriya origin, was being offered mushrooms to eat. But these particular mushrooms were familiar to him because of their unique role in the Hindu religion in which he had been brought up.

André Bareau appreciates to the full the solemnity of this dish of *s&umacr;kara-maddava*, though he did not know what it was. He says:

> ... cette nourriture, la dernière que consomme le Bienheureux avant son Parinirv&amacr;ṇa, est une nourriture en quelque sorte sacrée, dont les riches qualités, la puissance essentielle, vont lui permettre d'accomplir cet exploit surhumain, la suprême Extinction. Cette richesse, cette

> puissance sont trop grandes pour être supportées par les autres êtres, hommes ou dieux, qui n'auront jamais, et de loin, à exécuter une action comparable. [*Recherches sur la biographie du Buddha*. Tome 1, p. 271. Paris. 1970. Publications de l'Ecole Française d'Extrême-Orient, Vol LXXVII]

Here was the Buddha, at one of the two supreme moments of his life, unexpectedly offered at his last meal a dish that Hindus of the upper castes were forbidden to eat, an edible mushroom, a dish that was the surrogate for Soma when formally sacrificed in an utterly different manner and setting.[3] Buddhaghoṣa quotes the Great Commentary (*Mah&amacr;-aṭṭhakath&amacr;*) as saying of Cunda's motives in offering this dish to the Buddha and his monks:

> They say that Cunda, the smith, having heard that the Exalted One would attain *parinibb&amacr;na* that day, thought it would be good if he could live longer after eating this dish, and offered it wishing for the Master's longevity. [p. 27 *infra*]

Walpola R&amacr;hula's comment on the Great Commentary from which we have extracted this quotation is as follows:

> The *Mah&amacr;-aṭṭhakath&amacr;* (Great Commentary) is the most important of the ancient original Sinhala commentaries dating back at least to the 3rd century B.C., on which are based the present available P&amacr;li commentaries of the 5th century A.C., including the Commentaries on the *D&imacr;gha Nik&amacr;ya* and the *Ud&amacr;na* from which these two commentarial passages are taken. [p. 27 *infra*]

The Great Commentary cites hearsay ('They say...') as the reason that Cunda served those particular mushrooms on that day. The hearsay may be right, but if indeed Cunda felt the dish of *P&umacr;tika* would extend the life of the Buddha, he must have confused the properties of *Soma* and of the *P&umacr;tika*. The *P&umacr;tika* enjoyed a unique status as the exalted surrogate for *Soma*, but, whereas *Soma* was consumed, the *P&umacr;tika*, as Kramrisch quotes the sources,[3] were mixed with the clay and then fired ritually in the making of the Mah&amacr;v&imacr;ra pot and there is no reason to think that the Hindus of the three upper castes or even the Brahman hierarchs ate these fungi. Does not the text of the Great Commentary permit another interpretation: Cunda, a &sacute;&umacr;dra accustomed to eating the *P&umacr;tika*, served them because it was the season of the rains (which had started when the Buddha and his suite were in Vai&sacute;ali) and the mushrooms, which he had known all his life, were fresh from picking? If so, it was the Buddha who at once recognized them because of their role in the Hindu religion and stopped Cunda from serving them to the others. The Buddha was certainly not accustomed to eating mushrooms of an kind, and here he was being invited to eat those slimy mucoid excrescences, as the twice-born Hindus with loathing would view them. May not this, combined with the emotional tension of his imminent extinction, have provoked a recrudescence of his intermittent attacks of dysentery?

I now interrupt our account of the Buddha's progress on his last day to set forth certain discoveries bearing on *s&umacr;kara-maddava*.

II. The Santal and the *Putka*

By an accident of fortune the Santal people living now in western Bihar and Orissa have preserved for us, as though in a time capsule, the identity of the Sanskrit *P&umacr;tika*, a plant until recently unidentified, an ingredient in the clay of the Mah&amacr;v&imacr;ra vessel that was fired in the course of the Pravargya sacrifice. The *P&umacr;tika* is known as having been the surrogate for Soma,[4] though probably today by no Santal, and it figures conspicuously in the Br&amacr;hmaṇas and other early sacred Sanskrit texts. As I said before, it was identified by Kramrisch on the strength of evidence produced by Heim and me.[5] (Roger Heim, outstanding French mycologist, had served as President of the Académie des Sciences and was Director of the Muséum National d'Histoire Naturelle: he accompanied me on many of my field trips.)

The late Georg Morgenstierne, the Norwegian linguist, specialist in the Kafir and Dardic languages, also a

Sanskrit and Persian scholar, first called my attention to an oddity of the Santal language of special interest to me, as it affected their mushroom vocabulary. Santali was not a specialty of his but he was a vast reservoir of general linguistic knowledge.

The Santal, who number some millions, live in villages scattered in the area of eastern Bihar known as the Santal Parganas, in the western north-and-south strip of West Bengal, and in Orissa as far south as the Simlipal Hills. The Santal are slight in build, neat in dress, with sleek, black hair and dark almost black regular features, their houses of red earth ornamented with curious painted geometric patterns and neatly disposed within and without, in these respects contrasting with the Hindus. By tradition they are food gatherers, hunters, fishermen, but are now taking to agriculture.

From the Indo-European point of view, the Munda languages, of which Santali is the biggest member, are peculiar: in Santali there are no genders, - no masculine, feminine, neuter. Their nouns are either animate or inanimate endowed with a soul or without a soul. The entire animal kingdom is animate, has a soul. The whole of the mineral kingdom is inanimate, without a soul. There are oddities: e.g., the sun, moon, stars are animate. Strangely, the vegetable kingdom - herbs, shrubs, trees, the fungal world - is inanimate, but *with a single exception*, one species of mushroom, the *putka*. The Santal do not know why the *putka* is animate, or so they say. The *putka* is an underground fungus that is gathered for eating just as it appears, a snow-white little ball, in mycology identified by Heim as a *Scleroderma*, well known in Europe. In season it is commonly highly prized as food by the Santal, and much sought for by women and children.

For the last century the Norwegian Lutherans have made a vigorous play to be helpful in India by missionary activity among the Santal. The Rev. P. O. Bodding, a resident of the Santal Parganas from 1890 to 1934, mastered their language and compiled an admirable Santal-English dictionary in five large volumes, pointing out among other things the oddity of *putka*, which enjoyed in the vegetable kingdom the unique attribute of a soul. He could not explain this anomaly, nor did he venture an etymology for *putka*. But in the preface to his dictionary Mr. Bodding observed a noteworthy fact:

> Strangely enough, the Santals use some pure Sanskrit words, which, so far as I know, are not heard in the present day Hindi.

I visited Dumka in the Santal Parganas for the first time in January 1965. The Rev. A. E. Strønstad, Mr. Bodding's successor, and Mrs. Strønstad put me up and Mrs. Strønstad graciously served as my interpreter. We asked elderly and knowledgeable Santal in Dumka and the surrounding villages why *putka* was animate. No one could tell us. Our best informant turned out to be Ludgi Marndi, the widow of a native Lutheran pastor. She told us that there was one entheogenic mushroom.[6] Was it the *putka*? No, not at all. It was merely *ot*', 'mushroom' of the soulless class. No one was able to find an example of this inebriating mushroom, but the description (big, growing only in dung mostly of cattle, and white reaching an intense cream color in the umbolate center) tallied with *Stropharia cubensis*. Neither were there any *putka* at the time of my visit: they would come after the monsoon broke. Ludgi Marndi and some other informants suggested that the *putka* was animate because it was found regularly in the sacred grove of *sarjom* trees near every village. (Santali *sarjom* = Hindi *s&amacr;l* = *Shorea robusta*.) But the sacred *sarjom* trees were not animate so why should a mushroom growing from their roots be? Furthermore, the *putka* grew also in mycorrhizal relationship with other species of trees. Ludgi Marndi seemed an especially good informant and just before we were leaving for New Delhi, defeated as we thought, I asked if I might talk with her again. We went over the same ground. Suddenly she leaned forward across the table to Mrs. Strønstad and in a whisper (as translated to me) said that she would tell her why she thought the *putka* were animate: 'You must eat them within hours of gathering *for they will soon stink like a cadaver*.' She spoke under considerable emotion. We knew not what this meant but at once I jotted down her translated words in my notebook and her remark appeared later, somewhat toned down, in the paper[7] that Heim and I published.

My 1965 visit was followed by another with Heim in July-August 1967, he flying from Paris to Calcutta and I from New York. We started our quest in the Simlipal Hills and the village of Bisoï in Orissa, where the Santal and their close linguistic kin the Ho intermix, as well as several other peoples. Again we questioned the natives about why the *putka* were animate. In Nawana in the Simlipal Hills I spent the evening with Ganesh Ram Ho, the chief of the village, and he, as Ludgi Marndi had done, volunteered the information that there was an entheogenic mushroom, and his description tallied with Ludgi's; his testimony confirmed that it was probably

Stropharia cubensis or a close cousin. (That these two excellent informants volunteered to speak of an inebriating mushroom, doubtless *Stropharia cubensis*, is a lead not to be neglected: it may have played a part in the cultural past of the Santal and of Soma.) But, just as before, it was '*ud*' and soulless. '*Ud*' is 'mushroom' in Ho.

We published the account of our trips to the Santal country in *Les Cahiers du Pacifique*, #14, September 1970. Kramrisch in time saw our paper and she grasped immediately that the *putka* of the Santal was the *P&umacr;tika* of the Br&amacr;hmaṇas, of the Pravargya sacrifice and the Mah&amacr;v&imacr;ra pot.[3] The *P&umacr;tika* had been the surrogate for Soma and naturally it would possess a soul! Kramrisch deserves a rich accolade for discovering that Santali *putka* was a loanword from the Sanskrit *P&umacr;tika*. When Soma was being abandoned, probably over a long period that ended shortly after B.C. 1000, the *P&umacr;tika* took its place, not as an entheogenic drink like Soma in the earlier sacrifice but as a component with the clay in the ceremonial firing of the Mah&amacr;v&imacr;ra vessel. Its stench (of which Ludgi Marndi had spoken) was turned into fragrance when the pot, held by tongs, was fired in the course of the rite. No one had ever known what plant it was. We now know that, like Soma, it was a mushroom, but a common mushroom, and it possessed divine qualities though less than Soma's.

In Santal culture not only is the *putka* animate, endowed with a soul: it possesses another of Soma's attributes. The belief is apparently universal among the Santal that the *putka* is generated by (mythological) thunderbolts.[8] Long after the Brahmans have lost any use for or knowledge of this mushroom, and have lost all special contact with the Santal, these humble, hardworking people, untouchables, still believe that the *putka* is procreated by the lightningbolt, as the Vedic Brahmans believed that Soma was procreated by the Vajra of Indra, or Parjanya, the god of lightning. Here is another manifestation, another proof, of the breathtaking cultural intensity millennia ago of the religion of the hierarchs of the Aryans. The lightningbolt was thought of as the sperm, the spunk, fecundating the soft mother earth with the entheogenic mushrooms.

The Santal believe there are two kinds of *putka*, the *hor putka* and the *seta putka*, one smooth and the other rough. Heim said the two kinds were merely different stages in the life cycle of the one species. The *hor putka* is the 'man *putka*,' not in the sense of male but of a human being, or of the 'Santal' whom they naturally regard as *par exellence* the human being. The *seta putka*, which is rough, is the 'dog *putka*,' the dog not being despised as it is in Hindu culture. A few of the Santal spoke to us of a third *putka*, the *rote putka* or 'toad *putka*.' Most Santal did not recognize this term and of those who did, most could not say what kind of mushroom it meant. But when we were in Kathikund, a village in the Santal Parganas, we witnessed from our veranda a violent midday thunderstorm and within hours and then throughout the night a host of puffballs appeared on the plain before our bungalow. One of our Santal companions told us with assurance that these were indeed *rote putka*. In this instance the puffball was *Lycoperdon pusillum* but probably any other puffball coming in response to a thunder shower would be a *rote putka*. In short, the *rote putka*, which is not eaten by the Santal, is a false *putka*. ... The entheogenic mushrooms of which Ludgi Marndi and Ganesh Ram Ho had told us, probably *Stropharia cubensis*, are not *putka*: they are merely *ot*', or *ud* in the Ho language, enjoy no grammatical distinction in the languages, and so far as I learned no distinction in folklore. But it is imperative that this be explored much further. Does its entheogenic virtue account for the colored geometrical designs, endlessly varied, that decorate the exteriors of many Santal houses?

Throughout our visits to the Santal country the people we spoke with said that pigs dug for the *putka*, thus confirming what the canonical P&amacr;li Commentary on the *Ud&amacr;na* says of *s&umacr;kara-maddava* (p. 27, *infra*). But I was seeking a quotation and after returning to New York the Rev. Johannes Gausdal, a retired missionary living in Oslo, put me in touch with Mr. Gora Tudu, principal of Kaerabani High School, and we asked Mr. Tudu through Mr. Gausdal whether swine sought out the *putka* in the forest. Here is what he replied:

> Whether the pigs eat *putka* or not? In this case also I got some *putka* from the forests. I tried them on a few pigs - the old *putka* were not liked, but the new ones seemed to be delicacies of the pigs. They ate them with relish. Also in the forest I found at several bushes where *putka* usually come up several marks of upturned earth, indicating that the pigs had been digging for the *putka*. [Letter in my *Munda* file]

I was careful not to divulge the reason this question was being asked. There are a number of genera of underground fungi divided among scores of species, and I should be surprised if they all drew pigs but perhaps they do.

Mr. Gausdal asked also about the smell of aging *putka*. Mr. Tudu replied, with unconscious humor:

> I collected some *putka*, both *hor putka* and *seta putka*, and put them in dishes in dry condition as well as wet, just to see what the smell would be like after decomposition. In both the smell emitted was that of decomposing wood material, not at all bad in the sense of any blooded being. The smell was never too strong or filthy. The worst I could compare, the smell was that of rotting jute in muddy water.

Kramrisch tells me that rotting jute in muddy water creates a fearful stench. Mr. Tudu possesses the endearing quality of dirt farmers everywhere: their fondness for the smell of dung heaps, for example, is powerfully colored by what dung means for the crops. The earthy smells of farm yards also possess a likeable integrit.

The Gausdal-Gora Tudu correspondence was conducted in Santali, but my questions and his answers to them were in English.

We know that the Santal have not always lived where they do now. Six hundred years ago they lived to the west of Benares on the Chot&amacr; N&amacr;gpur plateau, and tradition has it that long before then the Santal had lived much further to the West, just where no one knows, but possibly near the ancient center of Brahmanical sacrifices, where they could have had close relations with the Aryans, perhaps serving them before and through the shift from Soma to the *P&umacr;tika*. This would also explain the other Sanskrit words in Santali that Mr. Bodding notes. Indeed he remarks in his preface to his Santal Dictionary that 'the description of the Dasyus in the Vedas and the Mah&amacr;bh&amacr;rata seems to be adaptable to many a Santal.'

III. The death of the Buddha

Having completed the Santal interpolation, we will now revert to the text of the *D&imacr;gha Nik&amacr;ya* as translated by the Rhys Davids.

After the discussion of the *s&umacr;kara-maddava*, the Rhys Davids translation continues with an astonishing development:

> §20. Now when the Exalted One had eaten the rice prepared by Cunda, the worker in metals, there fell upon him a dire sickness, the disease of dysentery, and sharp pain came upon him, even unto death. But the Exalted One, mindful and self-possessed, bore it without complaint. [Chap. IV]

This was a disconcerting turn of events, since the Omniscient One has but lately said that he sees no one, save a Tath&amacr;gata, who can properly assimilate the *s&umacr;kara-maddava*, which he has just eaten. If the circumstances were invented, as Bareau thinks, what a strange set of circumstances for utterly devoted followers of the Buddha to have invented! The mushrooms, now that we know precisely, were sound and there was never a risk: moreover, aged *P&umacr;tika* would declare their age by their stench! And Cunda was a responsible man to buy and cook them. However, let us remember that in the upper Hindu castes where the Buddha had been brought up and lived out all his early life, even though he was now free from food tabus and caste distinctions, all mushrooms would be shunned as inedible; but here, at a critical moment of his life, he was being offered *P&umacr;tika*. Did Cunda know the role of the *P&umacr;tika* in the religion of the twice-born castes? Did he perhaps know it by rumor, inaccurately? Or did he not know it at all and was he serving these mushrooms solely for the excellent reason that they were fresh and in season? It is clear from the testimony of the *D&imacr;gha Nik&amacr;ya* that the attack suffered by the Buddha was sudden; it was violent; it alarmed the whole company; it was virtually over quickly, for not long afterward the Buddha instructed the faithful &Amacr;nanda that they should walk on to Kusin&amacr;r&amacr; close by. But what could be more natural than a violent reaction in one brought up as a kṣatriya to consider mushrooms inedible? And with his large intestine being chronically inflamed with dysentery, his diarrhoea was a natural sequence. 'Dysentery' is a translation of the P&amacr;li *lohita-pakkhandika*, which means 'bloody flux' in old-fashioned English.

The account in the *D&imacr;gha Nik&amacr;ya* is as though written to order for this explanation. Two quatrains, apparently independent of each other, are inserted in the text of the *D&imacr;gha Nik&amacr;ya* (§20, p. 139) at this point. Buddhaghoṣa adds a note: 'It should be understood that these are the verses by the Theras [Elders] who held the Council' the Council that took place at R&amacr;jagṛha, at which some months later the initial plans were laid for mobilizing detailed recollections of the Buddha's teachings and for organizing the Buddhist religion. The first quatrain shows how those present murmured against Cunda, and, according to the second, there was also murmuring about the mushrooms. Here are the quatrains in the Rhys Davids translation:

> When he had eaten Cunda's food,
> The copper-smith's - thus have I heard -
> the bore with fortitude the pain,
> The sharp pain even unto death.
>
> When he had eaten, from the mushrooms [=*s&umacr;kara-maddava*] in the food
> There fell upon the Teacher sickness dire,
> Then after nature was relieved the Exalted One announced and said:
> I now am going on to Kusin&amacr;r&amacr;

After the episode the Exalted One went out of his way to exonerate Cunda of blame, thus making even more tenable my explanation of his illness. For if Cunda had been guilty of negligence in choosing the mushrooms, why should the Omniscient One have exonerated him?

> 42. And the Exalted One addressed the venerable &Amacr;nanda, and said: - 'Now it may happen, &Amacr;nanda, that some one should stir up remorse in Cunda the smith, by saying: - "This is evil to thee, Cunda, and loss to thee in that when the Tath&amacr;gata had eaten his last meal from thy provision, then he died." Any such remorse, &Amacr;nanda, in Cunda the smith should be checked by saying: - "This is good to thee, Cunda, and gain to thee, in that when the Tath&amacr;gata had eaten his last meal from thy provision, then he died." From the very mouth of the Exalted One, Cunda, have I heard, from his own mouth have I received this saying: - "These two offerings of food are of equal fruit, and of equal profit and of much greater fruit and much greater profit than any other - and which are the two? The offering of food which, when a Tath&amacr;gata has eaten, he attains to supreme and perfect insight; and the offering of food which, when a Tath&amacr;gata has eaten, he passes away by that utter passing away in which nothing whatever remains behind these two offerings of food are of equal fruit and of equal profit, and of much greater fruit and much greater profit than any others. There has been laid up by Cunda the smith a karma redounding to length of life, redounding to good birth, redounding to good fortune, redounding to good fame, redounding to the inheritance of heaven, and of sovereign power." In this way, &Amacr;nanda, should be checked any remorse in Cunda the smith.' (p. 147-8)

Bareau concedes that Cunda and P&amacr;v&amacr; may be original elements but, if so, thinks that they are the sole original elements in the narrative of the Buddha's stay in P&amacr;v&amacr;:

> Deux siècles après le Parinirv&amacr;ṇa, ces deux noms, ici P&amacr;v&amacr; et Cunda, étaient les deux seuls éléments anciens, peut-être même historiques, de l'épisode du dernier repas du Buddha. Aucun souvenir n'avait donc été conservé ni des incidents qui avaient pu s'y produire ni de la nature précise des aliments qui avaient été servis alors au Bienheureux. [Tome I, p. 258 in his *Recherches sur la biographie du Buddha*, Ecole Française d'Extrême Orient]

Perhaps in the light of our discoveries Bareau may grant more to the history of the Buddha's Last Meal in P&amacr;v&amacr; as told in the *D&imacr;gha Nik&amacr;ya*. Too many had witnessed the episode with the mushrooms to permit the Theras to suppress it: his sudden illness had provoked too much talk.

Here is the account of the Buddha's death according to the *D&imacr;gha Nik&amacr;ya*, Chap. V,

> 1. Now the Exalted One addressed the venerable &Amacr;nanda, and said: - 'Come, &Amacr;nanda, let us go on to the S&amacr;la Grove of the Mallas, the Upavattana of Kusin&amacr;r&amacr;, on the further side of the river Hiranyavat&imacr;.'
> 'Even so, lord!' said the venerable &Amacr;nanda, in assent, to the Exalted One.
> And the Exalted One proceeded with a great company of brethren to the S&amacr;la Grove of the Mallas, the Upavattana of Kusin&amacr;r&amacr;, on the further side of the river Hiranyavat&imacr;: and when he had come there he addressed the venerable &Amacr;nanda, and said:
> 'Spread over for me, I pray you, &Amacr;nanda, the couch with its head to the north, between the twin S&amacr;la trees. I am weary, &Amacr;nanda, and would lie down.'
> 'Even so, lord!' said the venerable &Amacr;nanda, in assent, to the Exalted One. And he spread a covering over the couch with its head to the north, between the twin S&amacr;la trees. And the Exalted One laid himself down on his right side, with one leg resting on the other; and he was mindful and self-possessed.

In a note on this passage the Sinhala commentator added an explanation:

> Tradition says that there was a row of S&amacr;la trees at the head of that couch, and another at its foot, one young S&amacr;la tree being close to its head, and another close to its foot. The twin S&amacr;la trees were so called because the two trees were equally grown in respect of the roots, trunks, branches, and leaves. There was a couch there in the park for the special use of the (periodically elected) chieftain of the Mallas, and it was this couch which the Exalted One asked &Amacr;nanda to make ready. (Ftnt. p. 149)

In the last watch of the night the Buddha died, precisely as he had been predicting for three months, since he was in Vai&sacute;ali.

There have been individuals in various parts of the world, and especially among the holy men of India, who have acquired by 'concentration' (*sam&amacr;dhi*) control over some of the muscles that ordinarily function in response to stimuli beyond the human will. A. L. Basham has remarked on this in *The Wonder That Was India*, p. 327:

> The ancient mystical physiology of India needs further study, not only by professional Indologists, but by open-minded biologists and psychologists, who may reveal the true secret of the yog&imacr;. For whatever we may think about his spiritual claims there is no doubt that the advanced yog&imacr can hold his breath for very long periods without suffering injury, can control the rhythm of his own heartbeats, can withstand extremes of heat and cold, can remain healthy on a starvation diet, and, despite his austere and frugal life and his remarkable physical contortions, which would ruin the system of any ordinary man, can often survive to a very advanced age with full use of his faculties.

Basham fails to mention that occasionally death is the goal of this 'concentration,' but there is no reason to question that death can be the purpose of such an act of will. In recent years, when death has been the end result of this manifestation of will power, *mah&amacr;sam&amacr;dhi* has sometimes been the term used when speaking of it.

The Buddha predicted the day of his death three months before and thenceforward announced freely the time and place of his own extinction. After his Last Meal the narrative says that on his initiative he walked the short distance to Kusin&amacr;r&amacr;. Since the time of his death, no Hindu, no Buddhist, has ever suggested that he died of mushroom poisoning. His death has not provoked discussion among Buddhists. Knowing as we now do what the mushrooms were that Cunda served, they could have provoked a stomach upset in a Hindu mycophobe but they could not have caused his death. He died of his own will power, of his own *mah&amacr;sam&amacr;dhi*. Or, rather than provoking his own death, did he not use yogic power, under trying circumstances, to postpone his translation to *nirv&amacr;na* until he had reached his place of choice?

The surrogate for Soma explains and justifies the extraordinary words used by the Buddha in limiting to himself alone this dish. By consigning to a hole the surplus *P&umacr;tika*, he showed himself familiar with its everyday properties. Now that we know the precise properties of this mushroom, its etymology as cognate with 'putrid' is clarified,[3] and its strong link with Soma is a good explanation for the Santal belief that it is generated by the divine lightningbolt.

Up to this point we have concentrated on only one source - the canonical P&amacr;li Text of the *D&imacr;gha Nik&amacr;ya* - for our details about the life of Buddha. It is the Holy Scripture of the Theravadin branch of Buddhism with its headquarters in &Sacute;r&imacr; Laṅka. There are, in addition, five other master recensions of his life, four in Chinese and one in Sanskrit. All five mention the stop in P&amacr;v&amacr; and name Cunda as the host there, but none of them mentions *s&umacr;kara-maddava*. An obvious explanation for this omission is that the Chinese are natural mycophiles: they eat with relish all kinds of edible mushrooms and they know their mushrooms. They would not understand why the Buddha honored the *P&umacr;tika*, saying he alone could digest it. For the Chinese all this would have been incomprehensible.

The Buddha and his followers were mostly Hindus of the upper castes who had withdrawn from obedience to the Hindu religion. When the Theras assembled at R&amacr;jagṛha, they were inevitably, even if they were rebels, heirs to the infinite complexity of habits, practices, subtle ways of thinking and feeling of the Brahmanic religion. When Buddhism became a world religion, it liberated itself from the Brahmanic religion and this included the mighty tradition of Soma and the Vedic hymns, and of course from the less powerful hold of the *P&umacr;tika*. In the early days of Christianity, before it became a world religion, the pull of Jewish ways such as circumcision and the ban on pig-meat exerted influence on Jewish converts to Christianity, and the early Church faced a parallel conflict.

IV. The Buddha's last meal

The episode at P&amacr;v&amacr; lends itself to various explanations; the written record contains a number of anomalies. If we were to offer the solution that we think is most likely, here it is.

There is only the Commentary on the *Ud&amacr;na*, which Buddhaghoṣa presented as hearsay, to show that Cunda the &sacute;udra knew of the use made by the Brahmans of the *P&umacr;tika*. Cunda certainly knew this mushroom as a universal favorite among mushroom eaters when it was in season and it was in season right then: he was taken aback when the Buddha recognized the mushroom and asked him, in astonishing language unfamiliar to his ears, to serve them to the Buddha only. Cunda had done himself proud in assembling mushrooms for the whole company, and now he was forbidden to give them to the guests or even to himself.

Shortly after the Buddha had eaten his mushrooms with rice he fell violently ill. This must have caused Cunda consternation and chagrin. Alarm was felt, and there was murmuring against Cunda and the mushrooms in the assembly, for all or almost all were twice-born men and had been indoctrinated against mushrooms. We can imagine Cunda's embarrassment but we have no information: an opaque cloud of silence falls over him.

In the *D&imacr;gha Nik&amacr;ya* the Buddha exonerates Cunda, somewhat stiltedly under the circumstances. Perhaps everyone remembered that the Buddha had spoken up for Cunda and many had heard him but none could recall what precisely he had said. Someone seems to have drafted the paragraph much later. The fitting exoneration of Cunda demonstrated the thoughtfulness and the nobility of the Buddha under most trying circumstances.

Was not '*s&umacr;kara-maddava*' introduced in place of *P&umacr;tika* at R&amacr;jagṛha to avoid confusing people as to the Buddha's attitude toward the Old Religion? He showed an attitude toward the *P&umacr;tika*, and he reacted to them, in a way that we today, under the circumstances, can understand for the first time.

And as for the diverse explanations in the two canonical Commentaries for *s&umacr;kara-maddava*, they may have been introduced at R&amacr;jagṛha also, or perhaps more likely late in A&sacute;oka's reign when the need for an explanation became increasingly felt by the Buddhist community. No theological importance was ever given, then or later, to the P&amacr;v&amacr; episode because, after all, the Buddha was under acute stress at the time, what with his illness, his imminent extinction freely predicted since he was in Vai&sacute;ali three months before the episode at P&amacr;v&amacr;, and the unexpected dish of *P&umacr;tika* that suddenly confronted him. There had been far too much talk among those present to suppress the episode, but obviously the *P&umacr;tika* was not to be identified plainly. The *s&umacr;kara-maddava* was a way to tell the truth but still to interpose obstacles to its understanding. The word may have been a neologism invented *ad hoc*.

Now we see for the first time in how dramatic a predicament the Brahman proscription on mushrooms for the twice-born castes accidentally involved the Buddhist religion at the very moment of its birth. We still do not know we will probably never know when that proscription came into force, perhaps over centuries while the Vedic hymns were being composed, or possibly when the hierarchs among the Brahmans learned of the entheogenic virtues of *Stropharia cubensis* as known to the lower orders living in India, or when Soma was finally abandoned and the *P&umacr;tika* adopted as its surrogate. But we do know how effectively the Buddhist Theras fudged the facts in the *D&imacr;gha Nik&amacr;ya*, until an inquirer 2,500 years after the event appeared, assembled the evidence, and with the help of Georg Morgenstierne, Roger Heim, Stella Kramrisch, Wendy Doniger O'Flaherty, and above all of the Santal people, fitted together the jigsaw pieces.

V. The Indus Valley and Kashmir

When we published *SOMA Divine Mushroom of Immortality* in 1968 I pointed out in it that in the 1028 hymns of the ṚgVeda there was never a mention of the blossoms, fruit, seed, leaves, branches, bark, or roots of the plant - a telling clue where to look for the divine herb. But there was another botanical fact that deserved full recognition, but I had not yet focussed on it.

Botanists divide plants between phanerogams and cryptogams. The phanerogams include all flower- and seed-bearing plants, whether trees, shrubs, creepers or climbers, herbs and grasses, whether cultivated or uncultivated. The cryptogams are lower orders of vegetation, less developed along the evolutionary trail, and the mushrooms are the cryptogams that interest us. Only in recent centuries have three or four species out of thousands lent themselves to commercial exploitation, and a meager handful also to expensive cultivation in laboratories. In Aryan times, in the Indus Valley and Kashmir, there was the widest variety of climate, owing to the variety of accidented terrain therein - lofty mountains, low lying plains, valleys, wetlands, arid stretches - and any needed phanerogam could probably have been grown in some part of that large country. *But only those mushrooms grew there that the country produced spontaneously*. Since we know that the supply of Soma was limited at best to the mountains and must have been further reduced when the monsoon failed, conforming to what we know about Soma in Vedic times, this points to the entheogenic mushroom *Amanita muscaria* for their Soma. That the birch and also the conifers act as hosts to *A. muscaria* was not realized by anyone among the Aryans, and therefore no one thought of planting the host trees to see whether by this means man could thus increase the yield of the holy plant.

Other fungal entheogens grow at the lower levels. They come in cattle dung, are easily identified and gathered, and are effective. But they fail to conform to Brahman practices: they are known to tribals and sudras. Soma on the other hand exacts self-discipline of the priests, a long initiation and training: it is, for proper exploitation, an affair of a priestly *élite*. But the possible role of *Stropharia cubensis* growing in the dung of cattle in the lives of the lower orders remains to this day wholly unexplored. Is *S. cubensis* responsible for the elevation of the cow to a sacred status? And for the inclusion of the urine and dung of cows in the *pañcagavya*? And was that a contributing reason for abandoning Soma? Given the ecological conditions prevailing in the Indus Valley and Kashmir, only a few of the Aryans could know by personal experience the secrets of the Divine Herb. The cult of Soma must have been shaped by the peculiar circumstances prevailing in the area, but ultimately those circumstances must have doomed that cult. Today it lives on in India only as an intense and glowing memory of an ancient rite.

Under the British Raj the rich and diverse vegetation of India was admirably studied, and George Watt's encyclopaedia *Dictionary of the Economic Products of India*, 1889-1896, in eleven volumes, edited and partly written by him, is a major legacy of the British rule in India. However, the mycophobic British did little to advance knowledge of mycology, and the Hindus nothing. No one ever suggested a mushroom for Soma, let alone *A. muscaria*. Our *SOMA* came out in 1968 but no *A. muscaria* since then has yet been found in Pakistan or Kashmir: there have been numerous reports of finds but voucher specimens have not been deposited in herbaria. Dr. Roy Watling, mycologist of the Royal Botanic Garden of Edinburgh, spent three weeks in the field in 1978 on a general survey of the Kashmir area, in the vicinity of Srinagar. He collected in stands of birch in two areas but he arrived there late in the growing season and moreover the season was dry. In his printed report[9] he writes, 'The species *A. muscaria* is almost certainly native to the *Betula*-zone of northern India.' There he found *Betula utilis* from 9,000 feet up to the timber line at 10,500 feet but no *A. muscaria*. In the Northwestern Himalayas the birch grows intermixed with Rhododendron in scrub-vegetation up to 11,500 feet.

We may think we are feeling the frustrations of the Aryans but by comparison with them we are making only lackadaisical efforts to find a few voucher specimens, whereas the Brahmans must have developed urgent need for quantities of fruiting bodies to dry, and then to reflate, and bring to the pressing stones. Their needs must have been constantly increasing with the increasing population. Whatever may have been the case later, the relations at first with the natives were surely hostile. The natives seem to have come to occupy the intermediate mountain heights, precisely where *A. muscaria* grows and where the ṚgVeda time and again says Soma grows. As we know from the *&Sacute;atapatha Br&amacr;hmaṇa*, the Brahmans depended for their Soma supplies, in large part at least, on the natives living in the mountains. The supply depended on the weather and the state of the relations with the natives, whereas the needs were swelling with every generation. The Brahmans must have found it in their interest to cultivate the Dasyus and the Dasyus would have found it advantageous to discover every spot where *A. muscaria* grew, above all the stands of birch but also other host trees. (*A. muscaria* has been reported lately from Tamilnadu, especially from the Nilgiri Hills, in Southern India, but its presence there has been attributed by mycologists to plantings of exotic conifers in the past century.) Most of the Soma sacrifices must have used make-do phanerogamic substitutes and in the post-Vedic Br&amacr;hmaṇas and other writings we learn how the priests from early times faced this scarcity with such make-do plants.

The Brahmans probably continued to trade with the mountains of Afghanistan seeking Soma, and with the Hindu Kush, but there is no knowing whether these tribesmen were friendly, perhaps intermittently. The *Afghanistan Journal* 6.2, 1979, announced the finding of *A. muscaria* in Nuristan, in the Shetul Valley high in the Hindu Kush in the extreme northeast of the country. The authors, Gholam Mochtar and Hartmut Geerken of Kabul, talked with three old codgers, ostensibly *habitués* of the "ravens' bread," claimed to be *A. muscaria* from which an inebriating concoction is made. The episode is insufficiently documented to permit conclusions about its bearing on *Amanita muscaria* and the Soma question. Their report antedates the Russian invasion.

The use of substitutes by the Aryans must have been a reluctantly adopted practice from the start. They are mentioned for the first time in the last batch of hymns incorporated into the canon, Mandala X 85 through to the end, 191. In *SOMA* we failed to take into consideration these hymns of Mandala X, since they were admitted to the canon at a late stage, shortly before the Vedic age ended. But some years ago Professor Clifford Wright, in a lecture delivered at Cambridge University, took the position that many of those hymns, the last to be admitted to the canon, on strong stylistic grounds were by no means the last to be composed. There is a verse in these hymns that speaks of the substitutes. That hymn may well have been composed centuries earlier:

> ṚgVeda X 85.3: One thinks one drinks Soma because a plant is crushed. The Soma that the Brahmans know - that no one drinks.

This conforms to our present thinking: the scarcity of Soma was not to be explained by the spread of the Aryans southward, then eastward down the Yamun&amacr; and beyond the confluence with the Ganges. The scarcity had always existed, and the make-do substitutes had been a chronic problem.

1. 1896 and earlier. Karl Eugen Neumann: *Die Reden Gotamo Buddho's aus des Mittleren Sammlung Majjhimanik&amacr;yo des P&amacr;li-Kanons*, Leipsig, 1896, pp. XIX-XXII. Neumann cites earlier writers: Friedrich Zimmermann, who in turn refers to an article in the *Journal of the Maha-Bodhi Society*, Vol. 1, No. VIII, pp. 2-3, Calcutta, 1892, wherein the editor of this *Journal* reproduces statements by 'Rhys Davids, Bigandet, Rockhill, and Colonel Olcott,' laying stress on the proper meaning of *s&umacr;kara-maddava*. We have seen none of these earlier discussions.
   1910. T. W. and C. A. F. Rhys Davids, and later editions. *Dialogues of the Buddha: Part II*. Translated from the P&amacr;li of the *D&imacr;gha Nik&amacr;ya* by T. W. and C. A. F. Rhys Davids. One of the series of the Sacred Books of the Buddhists. Published for the P&amacr;li Text Society by Luzac, London. (All of our quotations from the *D&imacr;gha Nik&amacr;ya* are from the 1959 edition.)
   1916. Coomaraswamy, Ananda K.: *Buddha and the Gospel of Buddhism*, p. 79, George G. Harrap, London.
   1931-2. Arthur Waley. 'Did Buddha die of eating pork?' *Mélanges chinois et bouddhiques*, Vol. 1, pp. 343-354. Brussels.

1942. Fa Chow. 'S&umacr;kara-maddava and the Buddha's Death.' *Annals of the Bhandarkar Oriental Research Institute*. Edited by R. N. Dandekar, pp. 127-133.
1948. E. Waldschmidt. *Beiträge zur Textgeschichte des Mah&amacr;parinirv&amacr;ṇas&umacr;tra*, pp. 63-85: 'Die Letzte Mahlzeit des Buddha.'
1948. E. J. Thomas. *Indian Culture*, XV, pp. 1-3: 'Buddha's Last Meal.'
1949. A. Foucher. *La Vie du Bouddha*. Paris, Payot. pp. 304-308: 'Le Dernier repas à P&amacr;v&amacr;.'
1968. André Bareau. 'La Nourriture offerte au Buddha lors de son dernier repas,' *Mélanges d'Indianisme*, Paris, Editions E. de Boccard. pp. 61-71.
1970. André Bareau. *Recherches sur la biographie du Buddha*. Tome 1. Notably Chapter VII 8 & 9, pp. 251-281. Paris. Ecole Française d'Extrême-Orient, Vol. LXXVII.
1970. P. Demiéville. Review of R. Gordon Wasson: *SOMA. Divine Mushroom of Immortality*. *T'oung Pao*, LVI: Livr. 4-5, pp. 298-302. E. J. Brill, Leiden.
This list does not pretend to be exhaustive.

2. See note 1, entry under 1910. p. 137 ftnt.
3. Stella Kramrisch: 'The M&amacr;hav&imacr;ra Vessel and the Plant P&umacr;tika,' *JAOS*, 95.2, April-June 1975.
4. See Manfred Mayrhofer: *A Concise Sanskrit Etymological Dictionary*, entry under *p&umacr;tikaḥ*, also Vol. 3, p. 761.
5. *Cahiers du Pacifique* #14, September, 1970: 'Les putka des Santals, champignons doués d'une âme.' p. 77. For those interested, the mushroom was *Scleroderma hydrometrica* (Pers.) H. var. *maculata* (Pat.) H. In Europe it breaks out into an *Astraeus*, but in India remains closed, a *Scleroderma*.
6. 'Entheogen' is a word devised by some of us for those plant substances that inspired Early Man with awe and reverence for their effect on him. By 'Early Man' we mean mankind in prehistory or proto-history, before he could read and write, whether long long ago or since then or even living today in remote regions of the earth. 'Entheogen' (or its adjective 'entheogenic') has the advantage that it does not carry the odor of 'hallucinogen,' 'psychedelic,' 'drug,' etc., of the youth of the 1960s. See *Journal of Psychedelic Drugs*, Vol. 11 (1-2), Jan-June 1979, pp. 145-6.
7. Fn. 5, p. 65.
8. Fn. 5, p. 64, bottom of page; *SOMA: Divine Mushroom of Immortality*, pp. 39-40.
9. Watling, Roy and Norma M. Gregory: 'Larger Fungi from Kashmir,' *Nova Hedwigia*, Band XXXII, Brunswick, 1980, J. Cramer.

Memorandum by Walpola R&amacr;hula of the early sources for the meaning of *s&umacr;kara-maddava*

The original Canonical P&amacr;li passage from the *Mah&amacr;parinibb&amacr;nasutta* of the *D&imacr;ghanik&amacr;ya*, P&amacr;li Text Society edition (London 1966), Vol. II, p. 127:

> *Atha kho Cundo kamm&amacr;raputto tass&amacr; rattiy&amacr; accayena sake nivesane paṇ&imacr;taṃ kh&amacr;daniyaṃ bhojaniyaṃ paṭiy&amacr;d&amacr;petv&amacr; pah&umacr;tañ ca s&umacr;karamaddavaṃ Bhagavato k&amacr;laṃ &amacr;roc&amacr;pesi: 'K&amacr;lo bhante, niṭṭhitaṃ bhattan'ti.*

Translation:

> Then at the end of that night, Cunda, the smith, having made ready in his house hard and soft delicious food, and also a big quantity of *s&umacr;karamaddava*, announced the time to the Exalted One, saying: 'The time, Lord, has come, the meal is ready.'

In explaining *s&umacr;karamaddava* in this passage the P&amacr;li Commentary of the *D&imacr;ghanik&amacr;ya*, *Sumaṅgalavil&amacr;sini*, P&amacr;li Text Society ed. (London, 1971), Vol. II, p. 568, gives three different opinions:

> *S&umacr;karamaddavan ti n'&amacr;titaruṇassa n'&amacr;tijiṇṇassa ekajeṭṭhakas&umacr;karassa pavattamaṃsaṃ. Taṃ kira muduñ c'eva siniddhañ ca hoti. Taṃ paṭiy&amacr;d&amacr;petv&amacr; s&amacr;dhukaṃ pac&amacr;petv&amacr;'ti attho.* (Colombo ed. of the *Sumaṅgalavil&amacr;sin&imacr;*, Part 1, (1918) p. 395 adds within brackets): [*Eke bhaṇanti: s&umacr;karamaddavaṃ pana muduodanassa pañcagorasa - y&umacr;sap&amacr;canavidh&amacr;nassa n&amacr;mam etan'ti yath&amacr; gavap&amacr;naṃ n&amacr;ma p&amacr;kan&amacr;maṃ. Keci bhaṅanti: s&umacr;karamaddavaṃ n&amacr;ma ras&amacr;yanavidhi, taṃ pana ras&amacr;yanasatthe &amacr;gacchati, taṃ Cundena Bhagavato parinibb&amacr;naṃ na bhaveyy&amacr;'ti ras&amacr;yaṃ paṭiyattan'ti.*]

Translation:

> *S&umacr;karamaddava* means meat available (in the market) of an excellent (first-rate) pig neither too young nor too old. This is soft and fatty. 'Having made it ready': having cooked it well is the sense. (Some say: *s&umacr;karamaddava* is the name for a culinary preparation of soft rice made into a broth with the five products of the cow,[1] just as *gavap&amacr;na* is the name of a culinary preparation. Others say: *s&umacr;karamaddava* is a chemical preparation [elixir]. It is found in the science of chemistry. That chemical preparation [elixir] was made by Cunda thinking that the *parinibb&amacr;na* of the Exalted One might not take place.)

The story of Cunda offering *s&umacr;karamaddava* to the Buddha occurs exactly in the same way in another canonical P&amacr;li text, *Ud&amacr;na*. The *Paramatthajotik&amacr;*, Commentary on the *Ud&amacr;na* (Colombo, 1920), p. 279, in explaining *s&umacr;karamaddava* gives four different opinions:

> *S&umacr;karamaddavan'ti s&umacr;karassa mudusiniddhaṃ pavattamaṃsan'ti Mah&amacr;aṭṭhakath&amacr;yaṃ vuttaṃ. Keci pana s&umacr;karamaddavan'ti na s&umacr;karamaṃsaṃ, s&umacr;karehi madditavaṃsakal&imacr;ro'ti vadanti. Aññe: s&umacr;karehi madditappadese j&amacr;taṃ ahicchattan'ti. Apare pana s&umacr;karamaddavaṃ n&amacr;ma ekaṃ ras&amacr;yanan'ti bhaṇimsu. Tañ hi Cundo kamm&amacr;raputto ajja Bhagav&amacr; parinibb&amacr;yissati't&imacr; sutv&amacr; 'appeva n&amacr;ma naṃ paribhuñjitv&amacr; cirataraṃ tiṭṭheyy&amacr;'ti Satthu ciraj&imacr;vitukamyat&amacr;ya ad&amacr;s&imacr;'ti ti vadanti.*

Translation:

> It is said in the Great Commentary (*Mah&amacr;aṭṭhakath&amacr;*)[2] that *s&umacr;karamaddava* is soft and fatty pork (flesh of pig) available (in the market). But some say: *s&umacr;karamaddava* does not mean pork (flesh of pig), but bamboo shoot (bamboo sprout) trodden by pigs; others say that it is mushroom grown on a spot trodden by pigs; still others have maintained that *s&umacr;karamaddava* is a certain elixir. They say that Cunda, the smith, having heard that the Exalted One would attain *parinibb&amacr;na* that day (lit., today) thought that it would be good if He could live longer after eating this (preparation), and offered it wishing the Master's longevity.

[1] Five products of the cow: 1) milk, 2) curd, 3) buttermilk, 4) fresh butter, 5) clarified butter (ghee). W. R. [Walpola R&amacr;hula is a Buddhist monk of our day and he renders in English the Sanskrit word *pañcagavya* as befits our times. In the past, for millennia *pañcagavya* represented: 1) milk, 2) coagulated or sour milk, 3) butter, 4) urine, and 5) dung. R.G.W.]

[2] The *Mah&amacr;aṭṭhakath&amacr;* (Great Commentary) is the most important of the ancient original Sinhala commentaries dating back at least to the 3rd century B.C., on which are based the present available P&amacr;li commentaries of the 5th century A.C., including the Commentaries on the *D&imacr;ghanik&amacr;ya* and the *Ud&amacr;na* from which these two commentarial passages are taken. W. R.

Epilogue

When I began working with Gordon Wasson on *SOMA*, almost twenty years ago, we had, at first, no suspicion that Soma might have been a mushroom: we just wished to collect the texts relating to Soma and look at them with a botanical as well as an Indological eye. It was only when I casually mentioned to RGW the urine-drinking, Soma-drinking episode in the *Mah&amacr;bh&amacr;rata* that he thought of *Amanita muscaria* as a possible identity for Soma, but from that moment on he became increasingly convinced that this was the case. I was certain that the evidence proved Soma was an entheogen (we called it an hallucinogen then), and that it was not a form of alcohol (as had been theretofore widely believed) but was a drug provoking an ecstasy of a very special kind. Here is a truth of great importance in the study of later Indian religion and this was the major contribution that RGW had made to Vedic studies.

I was, however, not yet convinced that Soma was a mushroom. I felt that the arguments rested primarily on the interpretation of adjectives, many of them words for colors, and mythological traits, many of which applied to other gods as well, permitting other interpretations as well as the interpretation that identified Soma with the fly-agaric. As an Indologist, rather than a botanist, I still feel that the broader hypothesis - that Soma was an entheogen - is more significant than the narrower one - that it was a mushroom. Over the years, however, the new evidence that RGW has brought to light, particularly the evidence linking the Buddha's last meal to Soma through the double links of the Vedic *P&umacr;tika* and the Santal *putka*, does in fact make it seem likely that Soma was a mushroom, as RGW believed from the first moment, and, when we recall the religious role of urine mentioned above, specifically the fly-agaric. But each of the three levels of the hypothesis - that Soma was an entheogen, a mushroom, and the fly-agaric - adds a valuable dimension to our understanding of both Vedic and post-Vedic religion.

Wendy Doniger O'Flaherty
Chicago
January 15, 1982

Bur&amacr;q depicted as Amanita muscaria in a 15th century Timurid-illuminated manuscript?

by

Alan Piper*

Independent Scholar, Newham, London, UK (Received: May 8, 2019; accepted: August 2, 2019)

Journal of Psychedelic Studies DOI: 10.1556/2054.2019.023

© 2019 The Author(s)

original report: https://pdfs.semanticscholar.org/4fd4/03ef9e5977f8414faf3b4f55d12b97ce36f9.pdf
backup source: http://www.psilosophy.info/resources/03ef9e5977f8414faf3b4f55d12b97ce36f9.pdf

* Corresponding address: Alan Piper; Independent Scholar, 56 Meath Road, Newham, London E15 3DR, UK; Phone: +44 7882 816332; E-mail: tzanjo@googlemail.com

Table of Contents:

Abstract
Cultural context
The *mi'raj* manuscript
Bur&amacr;q depicted as *Amanita muscaria* in the *mi'raj* manscript
The mi'raj as an otherworldly journey in the shamanic tradition
The extent and diffusion of A. muscaria and its use as an inebriant
Global distribution and usage
Distribution of mushroom words in Eurasia
Indications of the antiquity of *A. muscaria* usage
Folk use of *A. muscaria* as an inebriant in modern Afghanistan
Bur&amacr;q, shamanism, and the theme of regurgitation
Bur&amacr;q and baraq as Mount of the Shaman
Regurgitation in association with mushrooms and shamanism
Evidence of *A. muscaria* usage in the Timurid religious milieu
A. muscaria in Tantric Buddhism
Influence of Buddhist and Hindu esotericism on Islamic mysticism
Timurid cultural eclecticism and Timur's own unorthodox religious beliefs
Conclusions
References

Abstract

A series of illustrations in a 15th century Timurid manuscript record the *mi'raj*, the ascent through the seven heavens by Mohammed, the Prophet of Islam. Several of the illustrations depict *Bur&amacr;q*, the fabulous creature by means of which Mohammed achieves his ascent, with distinctive features of the *Amanita muscaria* mushroom. *A. muscaria* or "fly agaric" is a psychoactive mushroom used by Siberian shamans to enter the spirit world for the purposes of conversing with spirits or diagnosing and curing disease. Using an interdisciplinary approach, the author explores the routes by which *Bur&amacr;q* could have come to be depicted in this manuscript with the characteristics of a psychoactive fungus, when any suggestion that the Prophet might have had recourse to a drug to accomplish his spirit journey would be anathema to orthodox Islam. There is no suggestion that Mohammad's night journey (isra) or ascent (mi'raj) was accomplished under the influence of a psychoactive mushroom or plant.

Keywords: Mi'raj, Timurid, Central Asia, shamanism, Siberia, *Amanita muscaria*

Cultural context

The *mi'raj* manuscript

An illustrated manuscript depicting, in a series of miniatures, the successive stages of the *mi'raj*, the miraculous ascent of the Prophet Mohammed through the seven heavens to receive God's instructions for the faithful was produced in 15th century in the city of Herat (Séguy, 1977). This text of the *mi'raj* story is in Turkish, in the Uighur script. The manuscript was purchased, on behalf of the French Ambassador, in 18th century Constantinople, and it currently resides in the Bibliothèque Nationale in Paris, France as *Manuscrit Supplément Turc* 190.

Herat, today in Western Afghanistan, has been a crossroads of trade and culture for hundreds of years and formed an important stop on the Silk Route. When the Arabs captured Herat in 660 CE, it became a center of the Muslim world. The Mongols swept through and took control of Islamic Central Asia in the 13th century, and Herat went into decline after being sacked by Genghis Khan in 1222-1223. However, control of most of Asia by the Mongols soon created an environment of tremendous cultural exchange and Eastern and Central Asian influences became evident in Islamic art. Timur-i Lenk, the Turkic conqueror, better known in the West as Tamerlane, took Herat in about 1393, initiating its greatest era under Timurid rule, when it became a center of science and culture. The *mi'raj* manuscript illustrations are a product of the Herat school, a style of miniature painting that flourished in the 15th century under the patronage of the Timurids.

Bur&amacr;q depicted as *Amanita muscaria* in the *mi'raj* manscript

In the Muslim tradition, the *mi'raj* was preceded by the *isra* or "Night Journey" during which Mohammed traveled overnight from Mecca to Jerusalem by means of a fabulous beast called *Bur&amacr;q*. In some versions, the Prophet's ascent is also accomplished by the agency of *Bur&amacr;q*. According to tradition, at the site of the Temple Mount in Jerusalem, known to Muslims as *Haram esh-Sharif* ("the Noble Sanctuary"), Mohammed ascended through the seven heavens in the company of the angel Gabriel, to receive God's instructions for the faithful. *Bur&amacr;q* is described as being a creature larger than a donkey but smaller than a mule and is usually depicted as an equine creature with a woman's head and sometimes, but not always, with wings (Hajj&amacr;j, 1989; Vuckovic, 2005).

Seale in her visual history of *Bur&amacr;q* (2016) notes that *Bur&amacr;q* is "*a creature not of scripture but of lore*," first appearing in an 8th century biography of Mohammed. The iconography of *Bur&amacr;q* from Persian miniatures to the decoration of Pakistani trucks is such that "*there is no original, no definitive Buraq, but rather an unruly palimpsest of jumbled creeds, kitsch, and sheer artistic caprice.*" Depictions of *Bur&amacr;q* vary from frankly equine to various chimeras mixing human and various animal parts (Seale, 2016). The plethora of literature concerning Muhammad's ascension to heaven "*slipped its scriptural moorings and slid out into poetry and folklore*" and *Bur&amacr;q*'s body became "*a receptacle for the many myths, metaphors, and moral concerns that Islam inherited*."

Several of the illustrations in the Herat manuscript depict *Bur&amacr;q* with the distinctive red and white spotted skin of the *A. muscaria* mushroom, exact in the smallest detail. That is to say, they both share a distinctive shade of red as a background color, which is covered by small circular or oval white patches that have ragged edges and, when aged, a darkened center (Figure 1). The pattern and color for the Prophet's piebald mount could be the result of an imaginative flight of fancy of the artist, unrelated to the appearance of any mushroom. While the suggestion that the Prophet might have had used a psychoactive drug to accomplish his spirit journey would be anathema to orthodox Islam, there is a variety of evidence that supports the possibility that this illustration could represent the translation into art of Central Asian shamanic traditions, in which the Prophet's miraculous heavenly ascent was interpreted by the artist in terms of a spirit journey accomplished by the agency of the fly agaric mushroom. The author will draw on botanical, linguistic, and ethnographic evidence, as well as the history of religious ideas and folklore, to support the conclusion that the depiction of *Bur&amacr;q* with the distinctive features of *A. muscaria* is not the product of chance.

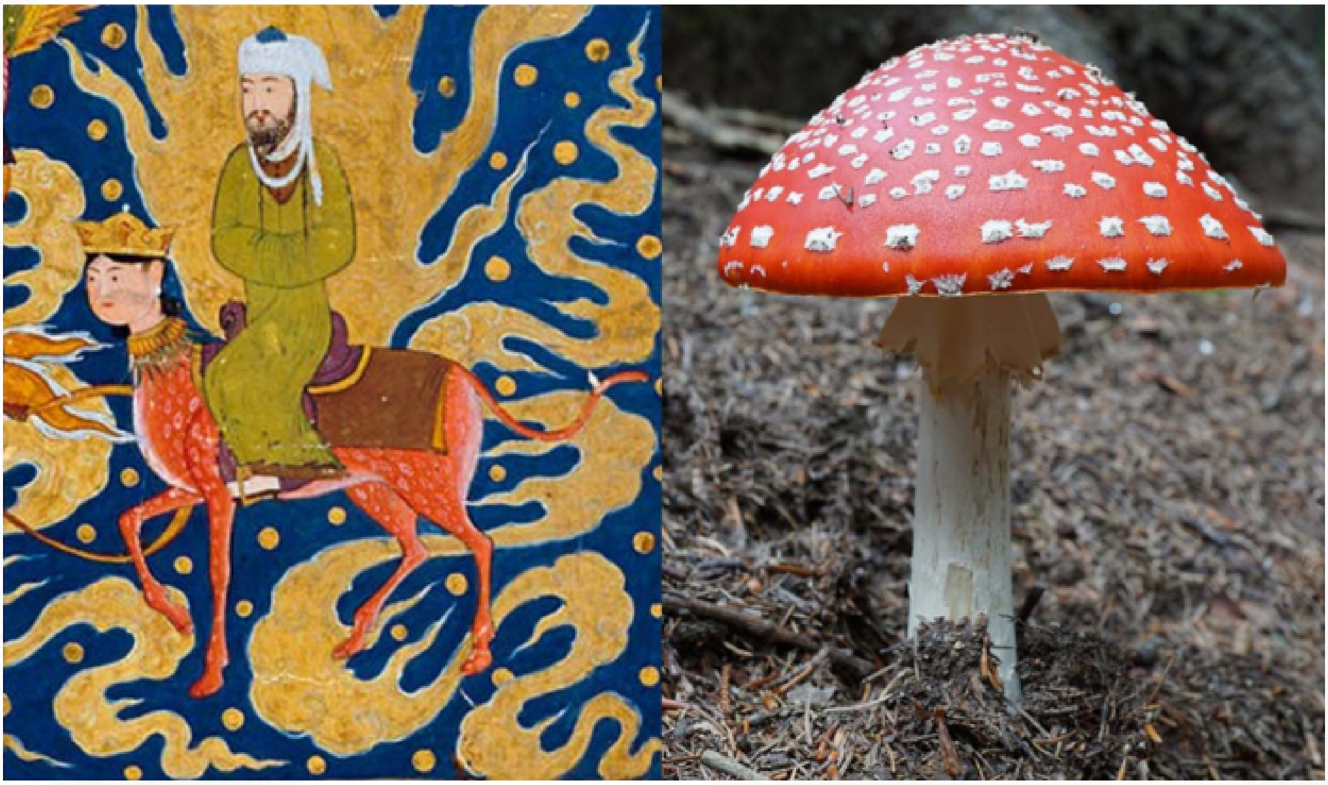


Figure 1. Detail from page showing the Night Journey (Mi'raj) of the Prophet Muhammad from Mira'j-nameh, Manuscrit Supplément Turc 190. Adjacent is a typical example of *Amanita muscaria* mushroom. Image source of mirajnameh: https://commons.wikimedia.org/wiki/File:Miraj-BNF-1436.jpg. Image source of *A. muscaria*: https://commons.wikimedia.org/wiki/File:2006-10-25_Amanita_muscaria_crop.jpg. A full sequence of images from the mirajnameh can be freely viewed at: https://gallica.bnf.fr/ark:/12148/btv1b8427195m/f39.image

I must make it clear that I am not in any way suggesting that Mohammad's night journey (*isra*) or ascent (*mi'raj*) was accomplished under the influence of a psychoactive mushroom or plant. I am only asserting that, as Islam extended its influence, the *isra* and *mi'raj* narratives were adapted to different cultural milieus. In the case of the Timurid miniatures, an artist may have embellished *Bur&amacr;q* with a hide resembling the skin of a psychoactive mushroom based on local awareness of shamanic journeys accomplished in this way. Although accounts of the *isra* and *mi'raj* are based on a very brief scriptural reference in the Quran, as agents of missionary conversion and as important assertions of Mohammad's divine authority, these narratives "*have been developed and transformed in fascinating ways in the diverse contexts in which the story was told and retold over the course of many centuries*" (Gruber & Colby, 2010).

Nor am I suggesting that Mohammed would necessarily be seen as a shaman rather than a spiritual leader, except in the sense that his spirit journey could be seen as comparable to those accomplished by a shaman, by those for whom the narrative fitted this context. In Central Asia, shamanism was combined with elements of Sufism to adapt to wider Islamic society. To this day, "islamised shamanism" for the purposes of healing and divination, accomplished through personal relations with spirits, continues to exist in Kazakhstan, Uzbekistan, Tajikistan, Kirghizstan, Northern Afghanistan, the Turkoman province of Iran, and the Uygur district of Xinjian province of China (Zarcone & Hobart, 2016).

The mi'raj as an otherworldly journey in the shamanic tradition

The word *mi'raj* means "ladder" in Arabic, which is a ladder in the tradition of Jacob's ladder in the Old Testament story, reaching from earth to heaven with the Angels of God ascending and descending upon it (Vuckovic, 2005). Mohammed's ladder may be compared to the notched tent pole by means of which Siberian shamans are sometimes described as accomplishing their celestial ascents (Stone, 1992). Since the *mi'raj* tradition first attracted critical scholarly attention, a variety of authors have identified the *mi'raj* as drawing on earlier Judaeo-Christian accounts of heavenly ascent such as the *Book of Enoch* and Iranian traditions such as the *Arda Wiraf* narrative (Vuckovic, 2005). In the *Arda Wiraf* narrative, a righteous man is chosen to visit the spirit world by means of a narcotic potion of wine and Cannabis or Henbane (Flattery & Schwartz, 1992) to determine if the existing forms of Zoroastrian of worship were pleasing to God (Haug & West, 1971).

The dependence of the *mi'raj* story on earlier Iranian and Judaeo-Christian narrative traditions, or their common sources, is still maintained along with the assumption that these traditions reflect earlier shamanic traditions widely diffused throughout Eurasia (Culianu, 2001; Séguy, 1977; Vuckovic, 2005). The traditional descriptions of Mohammed's experiences on his journey include a number of elements that are stereotypical of intoxication by hallucinogenic plants. These elements include distortions of the perceived size of objects; iridescent halos around people and objects; multiple images as under stroboscopic light; everything appearing bejewelled; objects veiled in moving patterns; visions of fantastic animals and vegetation; and a generalized intensification of the all the senses (Hajj&amacr;aj, 1989; Séguy, 1977). Key elements of the *mi'raj* story are present in shamanic spirit journeys, including those that have been recorded as typical of the use of *A. muscaria* (Schurr, 1995).

> These include:
> - helping spirits guide the shaman through the spiritual topology of the supernatural world;
> - exploration of the sacred cosmology;
> - information from the supernatural realm is to be reintegrated into the daily lives of group members;
> - on return from the supernatural realm, the shaman relates his visions to those around them and reports discussions with dead kinsmen.

The angel *jibril* (Gabriel) accompanies and guides Mohammed on his journey. Mohammed is taken in turn through the seven heavens and there meets and converses with his ancestors; former prophets such as Adam, Noah, Idris (Enoch), Abraham, Moses, and Jesus. Mohammed returns with the instructions for worship by the faithful and relates the pleasures of the pure in paradise and the punishments meted out to sinners in hell (Culianu, 2001; Vuckovic, 2005).

The extent and diffusion of A. muscaria and its use as an inebriant

Global distribution and usage

Amanita species are widely distributed throughout the planet. *A. muscaria* grows in summer and fall under coniferous and deciduous trees, from the lowland up to the sub-alpine zone. It occurs practically all over the temperate and subtropical zones in Europe, North Africa, South Africa, Asia, Japan, Australia, North America, and in South America (Seeger & Stijve, 1978). Like a number of other mushrooms, the mycelium of the *A. muscaria* cannot establish itself other than in symbiosis with the root system of certain species of trees. In the case of *A. muscaria*, it is particularly associated with the birch and pine, sacred trees throughout Eurasia.

Prior to invading and establishing a Central Asian empire, the original homeland of the Mongols lay on the fringes of Siberia around the Altai Mountains of Siberia, an area rich in pine and birch trees (de Hartog, 2004), the essential symbiotic hosts of *A. muscaria*. The Turkic-speaking Mongols' favored intoxicant is alcohol in the form of the fermented mare's milk or "koumis." The arrival and availability of alcohol has been viewed as displacing the indigenous use of *Amanita* in the 20th century (Salzman, Salzman, Salzman, & Lincoff, 1996) and *Amanita* usage may have been more extensive in the past. Conversely, *A. muscaria* has been used by soldiers as an inebriant in the absence the availability of alcohol (Wasson, 1972).

Prolific reports of the use of *A. muscaria* as an inebriant were recorded among the indigenous peoples of Siberia, by Russian and European traders, missionaries, and explorers from the 17th century onwards (Wasson, 1972). The majority of records of contemporary use of *A. muscaria* as an inebriant by indigenous peoples is confined to reindeer-herding peoples who speak languages in the Uralic family. These include the Samoyedic or Finno-Ugric groups in Western and Northern Siberia and peoples in the extreme east of Siberia who speak isolates, Paleosiberian languages without any known linguistic relationships to other language families, such the Chukchi (Salzman *et al.*, 1996). Riding a horse or reindeer through the sky is a common metaphor for shamanic spirit journeys in Siberian shamanism and sticks with the head of a reindeer or horse and sometimes both are a tool and badge of office for apprentice shamans in Siberia (Stone, 2003). Reliable reports record that "*Ostyak and Vogul tribes in western Siberia and Kamchadal, Koryak, Chukchi tribes in eastern Siberia, still use A. muscaria for shamanistic rites*" (Michelot & Melendez-Howell, 2003, pp. 131-146). However, the contemporary use of *A. muscaria* has also been recorded in Tibet (Müller-Ebeling *et al*., 2000), Afghanistan (Mochtar & Geerken, 1979), Spain (Fericgla, 1992), South Africa (Miller, 2001), and North America, where Peschel (1998) writes of the traditional use of *A. muscaria* by the Ahnishinaubeg (Ojibway) people who live near Lake Superior. Among the indigenous peoples of Siberia, *A. muscaria* also has medicinal uses as a tonic or to help the elderly sleep (Lincoff, 2005; Saar, 1991). There is artifactual evidence suggesting that historical use in a shamanic context in South America (Furst, 1986) and an awareness of its intoxicating effect in association with altered states of consciousness is indicated in folklore throughout Europe (Fericgla, 2001).

Distribution of mushroom words in Eurasia

In a number of Ugrian languages, mushrooms, and in some cases, the *A. muscaria* specifically, are referred to as *pânkh* in Mansi (obsl. Vogul) *pango*, *panga* (Mordvinian), *pongo* (Cheremis), and in northern Mansi *pânkh* also means "intoxication, drunkenness" (Eliade, 2004). All of these words have the same roots as words in Indo-European (IE) languages such as the Spanish *hongo*, mushroom, English "fungus" and "sponge," from Latin *spongia*, Greek *spongos*. The same IE root is evident in words for mushroom in languages of the Indian subcontinent *khumb(&imacr;)* and *phung&imacr;* (Sindhi), *(k)humb(&imacr;)*, (Hindi) and in Afghanistan Pashto: Waziri *x&omacr;mba* (Morgenstierne, 1957). This root is also evident in the modern English term "(s)punk" for tinder derived from dried tree fungus, *Polyporus fomentarius*. Wasson (1972) cites several references in the Vedic scriptures to *soma*, the sacred drug of Hindu scriptures dating to the third millennium BCE, which he believed to be *A. muscaria*, as the "mainstay of the sky."

In Graves' study of proto-religions in Central Asia, he supplies a *panga*/*pongo*/*hongo* type word list, which he links not to fungus/mushroom, etc., but to a Chinese deity called *P'an Ku* who is "a pillar of the sky." *P'an Ku* swells from an egg-shape until he supports the sky above the earth like a mushroom (Graves, 1994). Stone (1992) discusses *A. muscaria* as Axis Mundi, the white speckles on the mushroom cap-like stars on the dome of the heavens. The wide historical and geographical dissemination of *(s)pong*-type mushroom words, in both Uralic and IE languages, from Western Europe to Siberia and the Indian subcontinent, suggests an extremely ancient Pan-Eurasian cultural distribution of the use and knowledge of fungi, possibly with shamanic roots.

Although in Finno-Ugric languages, *pango*-type words are specifically associated both with *A. muscaria* and words relating to intoxication in general (Balázs, 1996), it is possible that the original reference is to the shape of the growing mushroom's cap, in words meaning "hump," "bump," "ball," and "sphere" as in Sanskrit in which *kumbha* means "hump" (Morgenstierne, 1957). In Hungarian, *gomba* is "mushroom;" *gomb* is "button" or "knob;" and *gömb* is "ball," "orb," "bellshaped," and "globular" (Országh, 1987). In Hungarian, 16 names refer expressedly to *A. muscaria*, including several which refer to its power to intoxicate, such as *bolondgomba*, "crazy mushroom," *táncgomba*, "dance mushroom," *bukfencgomba*, "somersault, crazy mushroom," and also *mesegomba* "mushroom of fairy tales" (Zsigmond, 2003). Hungarian contains many words of clearly Turkic origin and claims for Hungarian as both a Finno-Ugric and Turkic language have both been made. Certainly, there was close contact between Turkic and Finno-Ugric speakers at some point in the emergence of the modern Magyar (Hungarian) peoples.

Indications of the antiquity of *A. muscaria* usage

Bronze Age petroglyphs, discovered on the Pegtymel River in North-Eastern Siberia, depict human figures with mushroom caps for heads or above their heads (Devlet, 2008; Golovnev, 2001). The petroglyphs have been quite logically associated with use of *A. muscaria*, which continues there among the indigenous Chukchi peoples, in an unbroken tradition to this day (Devlet, 2008) and are featured in the film *Pegtymel* (2001) by Dr. Andrei Golovnev, Arctic anthropologist and filmmaker and a leading expert on indigenous peoples and cultures of the Russian North. The illustrations of petrogylphs from the Pegtymel region used are taken directly from the ethnographic film *Pegtymel* (2001), made by Professor Andrei Golovnev, member of the Russian Academy of Sciences, and have been converted to black and white for clarity. An additional source for examples of mushroom iconography in the Pegtymel petroglyphs can be found in Devlet (2008). A discussion of questions of interpretation and illustrations of the Pegtymel' (sic) petroglyphs can be found in PART III, PEGTYMEL' PETROGLYPHS, in Kiriak (2007). A short discussion of the petroglyphs and illustrations can also be found in the study of Gosso and Webster (2014). These petroglyphs depict what may be either anthropomorphic mushroom spirits, as experienced in a state of mushroom intoxication, or individuals themselves under the influence of hallucinogenic mushrooms, so indicated by placing a mushroom motif in place of or above their heads (Figures 2-5).

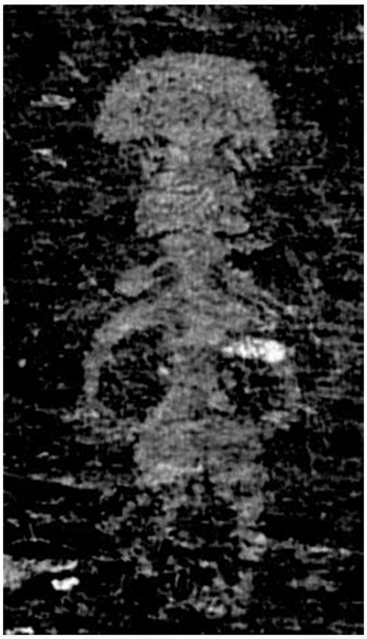


Figure 2. Mushroom Maiden

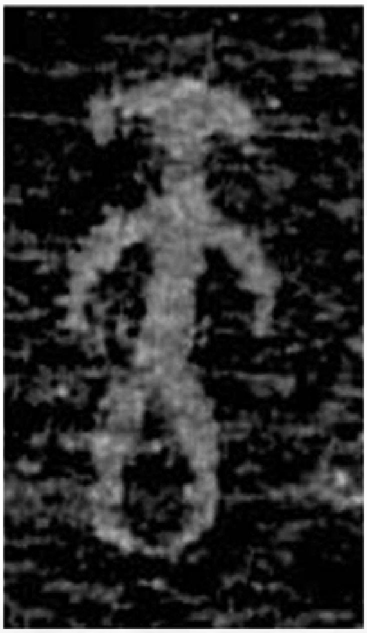


Figure 3. Male companion

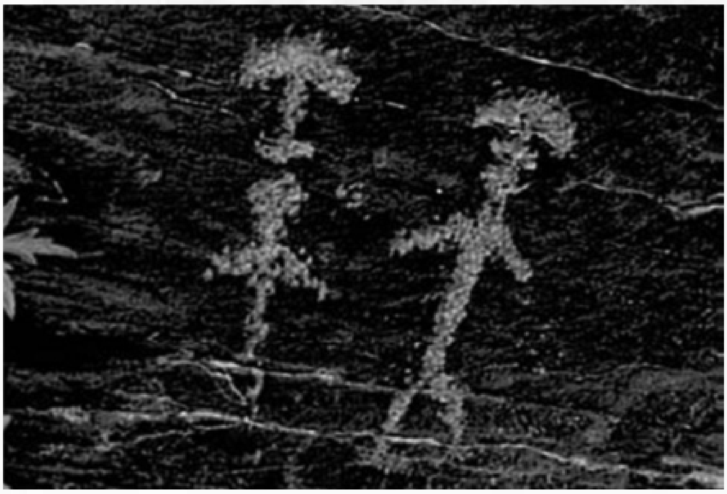


Figure 4. Mushroom men

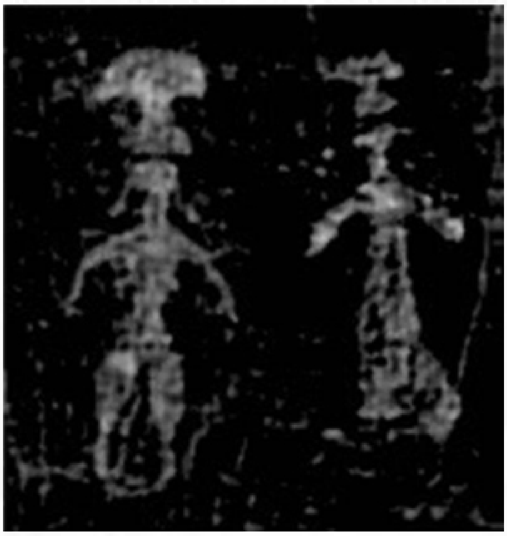


Figure 5. Mushroom women

Pegtymel Petroglyphs (Golovnev, 2001)

Barkalaja (1997) has conducted field research among the Khanty (obsl. Ostyak) peoples, who inhabit a vast area of swampland in North-Western Siberia. According to Barkalaja (1997), for the Khanty, *pong* (*A. muscaria*) is the intermediary between the shaman and God. *Pong* communicates by turn questions and the answers journeying to the heavens and back. In some regions, the spirit of the Khanty shaman himself travels after eating *pong*. In others, it is not the shaman who sings at a ritual, but the mushroom spirit; the shaman merely repeats the songs sung to him by the spirits of the mushroom. This notion is congruent with that of the Mazatecs, indigenous peoples of Oaxaca, Mexico, who use psychoactive mushrooms of the genus *Psilocybe*. In trance, it is the mushrooms who speak. "*If you ask a shaman where his imagery comes from, he is likely to reply: I didn't say it, the mushrooms did*" (Munn, 1973, pp. 86-122). Among the modern Chuckchi of the Pegtymel region, an elder, describing his visions under the influence of *A. muscaria*, corrects his wife's remark, "*remember you were telling me once that you took* vapak (*A. muscaria*) *and saw dead people*," by saying "*I didn't see them the* vapak *saw them*" (Golovnev, 2001). According to the Chukchi, "*when you take* vapak *you feel as if you are walking, your legs are yours, but the head is another's, the head of the mushroom. You are not a human anymore but a spotty mushroom*, vapak" (Golovnev, 2001). Devlet (2008) reports mushroom-like rock art images from Chukotka, South Siberia, and Central Asia and associates them with ethnological observations of the extant practice of eating *A. muscaria* among the Chukchas. Cheremisin (1997) reports depictions of human figures in mushroom-shaped "headdresses" as widespread in the rock art in Central Asia and in Southern Siberia, in Tuva, the Mongolian Altai, in Northern China, and Inner Mongolia, but challenges their connection with an *A. muscaria* cult. However, the Pegtymel petroglyphs are so evocative of the traditional conceptions of mushroom intoxication by Siberian and other indigenous peoples that any alternative interpretation would need strong evidential support, given the documentation of existing traditions of eating *A. muscaria* in the same location.

Folk use of *A. muscaria* as an inebriant in modern Afghanistan

Contemporary use of *A. muscaria* as an inebriant in Central Asia was discovered in Afghanistan during the 1960s, by Said Ghoulam Mochtar and Hartmut Geerken. They made several mycological expeditions to the Shutul Valley, a side valley of the River Panjshir, which rises in the Mountains of the Hindu Kush to the north of Kabul, in eastern Afghanistan. There they were able to question several older male inhabitants of this secluded mountain valley about the use of *A. muscaria*, which both plays a recreational role and has applications in folk medicine there (Mochtar & Geerken, 1979). Inquiring about its occurrence and use, Mochtar and Geerken were informed that *A. muscaria*, locally called *Nan-e-saghta*, "Raven's Bread" is gathered in the late spring of wet years and dried in the hot sun. In this way, the mushroom is almost permanently preserved. The association of ravens with *A. muscaria* also occurs in Siberian folk tales. A Koryak tale relates how the powers of the mushroom we revealed to the culture hero, Big Raven, by God to achieve a Herculean task. Big Raven says afterward: "*Let the Agaric remain on earth and let my children see what it will* *show them*" (Waldemar, Kasten, & Dürr, 2016, p. 162).

In the Shutul Valley, dried *A. muscaria* is ground to a powder by the inhabitants for its use as an inebriant. They boil the *Amanita* powder with fresh mountain snapweed and soured goat-cheese brine, and in this way produce a well-known local specialty, "Extract of Shutul." In the hamlet of Qaf-e-Changar, at the upper reaches of the Shutul, the calyx-tips of seed-bearing flowers of the black henbane, *Hyoscyamus niger*, are added to the extract. It is used for purposes of therapeutic massage, coming into effect by means of transcutaneous stimulation. An external application of *A. muscaria* is also used by the Khanty of Siberia for treatment of snakebite (Saar, 1991).

During their excursions, Mochtar and Geerken (1979) were able to tape-record the reports of elderly inhabitants of the valley, describing their experiences under the influence of the mushroom.

> - Farid Ahmad (aged around 60 years): "*[around 15 minutes] after I drink the extract, a feeling of weariness and a need for sleep overcomes me. I hear voices, although I am alone in my room.... I laugh about the voices and about myself...*"
>
> - Mustafa (aged around 60 years): "*First, I am very sleepy, then I feel good. I forget sentences.... Once I thought that I was a tree...*"
>
> - Ahmad Kargar (aged about 65 years): "*I have drunk it for many years, yet only once have I had a really bad time. I was anxious and afraid; I ran around in the woods and didn't know who or where I was...*"
>
> - Malang Aziz (aged between 60 and 70 years): "*We don't have much, but we have Raven's Bread. We grind it down to a gray powder and make a concoction of it.... In Winter, when we can't leave the house, we drink it.*"

In the Shutul Valley, the preparation and use of *A. muscaria* would appear to exist only as an archaic practice among the valley's older inhabitants. Mochtar and Geerken (1979) conclude that it should be of great interest to mycologists that these vestiges of a mushroom cult have survived until our day in one remote mountain valley in the Hindu Kush, "and perhaps others elsewhere?"

Bur&amacr;q, shamanism, and the theme of regurgitation

Bur&amacr;q and baraq as Mount of the Shaman

Dankoff (1971) explores the relations in language and myth between the Turkic *baraq* referring to the "mount of the shaman" and the Arabic *Bur&amacr;q*, the fabulous mount by means of which Mohammed accomplishes the *isra* and sometimes the *mi'raj*. He identifies the routes by which the Middle Iranian *b&amacr;rak*, thorough linguistic borrowing, came to designate, on the one hand, the Arabic *Bur&amacr;q* Mohammed's spirit mount and on the other the Turkic *baraq* to designate the "mount of the shaman," a "shamanic animal," or "the shaman himself." In the early 13th century, in Turkey, Syria, and Iran, dervishes of wild appearance gathered around a nominally Muslim spiritual leader called Barak Baba (Karamustafa, 1994). Of special interest is the manner in which Barak Baba received his name. In a version of the story cited by Dankoff, while Saru Saltuk (Barak Baba's spiritual master) was yet a shepherd, Seyyídi Mahmud (Baraq Baba) paid him a visit and placed in his mouth a morsel of food along with some yogurt. This morsel was like a piece of matted cloth, the size of a bean, and stuck to his upper palate. Saru Saltuk at once had a fit of vomiting, and this morsel fell out with his vomit. The prince had fallen into a trance at Saru Saltuk's discourse, and he now ate up the vomit. Saru Saltuk caressed him and called him "my *baraq*" (Dankoff, 1971, pp. 109-110).

Regurgitation in association with mushrooms and shamanism

While eating someone's vomit might appear disgusting to modern western tastes, it was not foreign to Siberian cultures as the following 19th century account makes clear. "*If the Yakut was a good and loving spouse, he would go directly home and eject the contents of his stomach into a vessel of water, which then he placed out* *of doors to cool and collect; and from the rich, floating vomit his wife and children would afterward enjoy a hearty meal*" (Melville, 1885, p. 318). This practice also formed part of the ritual employment of *A. muscaria* as an intoxicant in Siberia. A shipwrecked seaman, who had been rescued by the Siberian Chukchi, with whom he remained some 2 years, described their way of making an intoxicating liquor in this way,

> *... in the summer, mushrooms or fungi were collected in large quantity, and eaten by a man who, like our Indians, prepared himself by fasting for the feast. After eating enormous quantities of the fungi, he vomited into a receptacle, and again loaded up, time and again, and disgorged the stuff in a semi-fermented or half-digested condition. It was swallowed by those who were waiting for the drink; and his urine was also imbibed, to aid in producing a debauch, resulting in frenzied intoxication.* (Bourke, 1891, p. 74)

The theme of regurgitation in association with a spirit helper in the guise of a mushroom turns up in Finnish folklore. According to the Victorian folklorist Keightley (2000), a type of Finnish goblin steals the milk from other people's cows, carries, and coagulates it in his stomach and then disgorges into his mistress's churn. In this connection, Keightley states that there is a species of mushroom which, if it is fired with tar, salt, and sulfur and then beaten with a rod, will cause the woman who owns the goblin to quickly appear and beg to spare him. That is to say, the mushroom's role as an assistant or familiar spirit, by means of which his mistress accomplishes her sorcery, is thus revealed. Siberian shamans view *A. muscaria* consumption as a means of creating assistants to assist them in contacting the supernatural world (Schurr, 1995).

In this connection, it is relevant that, in Norse mythology, Odin by means of transforming first into a snake and then into a bird, steals, swallows, and then regurgitates the "mead of inspiration." He thereby makes it available to man, endowing those privileged to drink it with the gifts of poetic composition. A lesser portion is excreted from his other end for the benefit of a lower class of poet. Among populations using *A. muscaria* for shamanic purposes, transformation into animals is a typical experience of *A. muscaria* intoxication (Schurr, 1995) and in this guise the shaman is able to perform supernatural feats. The recurrent theme in folklore of a magical food that endows men with supernatural talents is certainly a reference to the consumption of psychoactive substances and the talents supported by *A. muscaria* in Siberia include assistance in the recital of epics (Schurr, 1995).

Evidence of *A. muscaria* usage in the Timurid religious milieu

A. muscaria in Tantric Buddhism

The imbibing of bodily fluids and other excrementa is a feature of the esoteric schools of Buddhist and Hindu Tantra, in connection with initiation and transcendental mind states (Crowley, 1996; White, 2003). It is possible that the depiction of *A. muscaria* in the Timurid manuscript as the agency of the Prophet's ascent reflects an awareness of its properties assimilated from Tibetan Buddhism. There is intriguing evidence for the use of *A. muscaria* not only as recorded in contemporary Tibetan shamanism (Müller-Ebeling *et al.*, 2000), but also in the Tantric traditions of Tibetan Buddhism found in Tantra's classical texts (Crowley, 1996; Hajicek-Dobberstein, 1995). Although later largely supplanted by Islam, many Mongols had adopted Buddhism early in the 13th century as they were exposed to the religion in China, Tibet, and Northern India (Nicolle, 1998, pp. 134-140). Ghengis Khan's grandson, Hülegü (1217-1265), the first Khan of the Ilkhanate of Persia, adopted some Buddhist customs. He considered himself a devotee of the Boddhisattva Maitreya (Nicolle, 1998, pp. 134-135), but is primarily regarded as a traditional Mongol shamanist (Heissig, 1980).

Influence of Buddhist and Hindu esotericism on Islamic mysticism

Buddhism was "*the most important civilized religion among the first Il-Khans. Buddhist monks came from China, Tibet and Uighur Central Asia*" (Nicolle, 1998). Hülegü's brother, Kublai Khan (1215-1294), adopted the slightly unorthodox Tibetan lamaist version of Buddhism and made Buddhism the state religion when he became Khan of the Mongols in 1260. Hülegü's grandson, Arghun (1258-1291), "*brought both Buddhist priests* *and men skilled in yogic mysticism from India. It is even possible that Buddhist yogis and the half-shamanist bakshi ascetics in the Il-Khan Court influenced the development of certain later forms of Islamic Sufi mysticism. This in turn influenced aspects of modern Iranian Sh'ia Islam*" (Nicolle, 1998, p. 135).

According to Heissig (1980, p. 4):

> *... through close contact with the Turkic Uighurs settled in the cities, who practised Buddhism, Manichaeism and Nestorianism, ideas from these religions penetrated among the Mongols, above all the Manichaean concepts of light, the figure of Hormusta, the Ahuramazda of the Persians.*

Besides being written in Turkic in the Uighur script, the Timurid illustrated manuscript of the *mi'raj* reveals Buddhist and Zoroastrian (Iranian) influences in its iconography (Séguy, 1977). In Zoroastrian tradition, the conversion of legendary King Vishtasp recorded in the Zoroastrian scriptures to Zoroaster's religious message is achieved when Ahuramazda instructs an angel to carry up to Vishtasp a potion described as "*that fountain of life, for looking into the existence of the spirits, the enlightening food by means of which great glory and beauty are seen by Vishtasp*" (West, 1987). The possible use of *A. muscaria* by the Manicheans, who are condemned in a medieval Chinese text for eating red mushrooms, is cited by Wasson (1972).

Influences from Islam were joined by those from the earlier assimilation of Buddhism and the indigenous shamanistic conceptions of the Mongols. This resulted early in a predominance of syncretistic thought and the fusion of motifs from different religious traditions (Nicolle, 1998, pp. 134-140). The practices of Tantric Buddhism, which were certainly an aspect assimilated by the Mongols (Heissig, 1980), have important elements in common with the antinomian dervish movements and associated figures such as Barak Baba. They included the deliberate flouting of convention as an aspect of religious asceticism, including the eating of forbidden foods, the use of drugs for transcendental purposes and dwelling in graveyards (Karamustafa, 1994).

Timurid cultural eclecticism and Timur's own unorthodox religious beliefs

According to Manz (1999), Timur's public religious affiliations were largely political. He cultivated powerful Sufi *shayks* who formed part of his inner circle and his primary allegiance was probably to the conservative Naqshbandi order. Timur's own religious practices were Islamic with an admixture of Turco-Mongolian shamanism (Manz, 1999, p. 17) and he "*left an ambiguous record of flights of curiosity into the realms of unorthodox religious beliefs*" (Etheredge, 2011, p. 112). The degree of cultural eclecticism in Timurid Herat may be judged by a court historian's description of the marriage festivities of Timur's son, quoted in Slobin (1976, p. 73).

> *Golden-tongued singers and sweet-sounding musicians played and sang to motives in Persian style, to Arab melodies according to Turkish practice and with Mongol voices, following Chinese laws of singing and Altai meters.*

Conclusions

The most numerous accounts of the use of *A. muscaria* as an intoxicant are drawn from the indigenous peoples of Siberia. However, evidence for contemporary use has been recorded in Spain, Tibet, and Afghanistan. Its association with altered states of consciousness in European folklore (Fericgla, 2001) further suggests, together with linguistic evidence, that the use of *A. muscaria* as an inebriant was, and perhaps still is, much more widely diffused than is generally recognized. *A. muscaria* may have been an important inebriant before the availability of alcohol, which has displaced its use in recent history. As the product of such a cultural crossroads as 15th century Herat, it no longer appears surprising that an image of a psychoactive mushroom should appear as the metaphorical means of ascent in a Timurid representation of the *mi'raj*, the ecstatic heavenly journey of the Prophet. Among the possible sources of this iconography are Pan-Eurasian shamanic practices shared in this case through Turkic contacts with Siberian peoples; the assimilation by Turkic peoples of the practices of Tantric Buddhism which evinces knowledge of *A. muscaria*; or local folk knowledge in Central Asia of the properties of Amanita as evidenced by the archaic practices of the Shutuli elders in the

Hindu Kush.

Acknowledgements: The author would like to acknowledge the peer review process that considerably improved the paper and to thank Mike Crowley for drawing his attention to Seale's visual history of *Bur&amacr;q*. He also reports no financial or other relationship relevant to the subject of this article.

Conflict of interest: The author declares no conflict of interest.

References

1. Balázs, J. (1996). The Hungarian Shaman's technique of trance induction. In V. Diószegi & M. Hoppál (Eds.), *Folk beliefs and shamanistic traditions in Siberia*. Budapest, Hungary: Akadémiai Kiadó.
2. Barkalaja, A. (1997). On the sacrificial ritual of the Pim River Khanty in December 1995. In A. Leete (Ed.), *Pro ethnologia 5: Arctic studies 1*. Tartu, Estonia: Estonian National Museum.
3. Bourke, C. J. G. (1891). *Scatalogic rites of all nations: A dissertation upon the employment of excrementitious remedial agents in religion, therapeutics, divination, witchcraft, love-philters, etc., in all parts of the globe/Based upon original notes and personal observation, and upon compilation from one thousand authorities*. Washington, DC: W. H. Lowdermilk & Co.
4. Cheremisin, D. V. (1997). The petroglyphs of the Left Bank of the Chuia (Gorny Altai). *Journal of the Korean Ancient Historical Society*, 10, 197-228. Retrieved from http://ambal.archaeology.nsc.ru/geni/Editions/Electronical/Bulletens/Herald/Vol1/Default.htm
5. Crowley, M. (1996). When the Gods drank urine: A Tibetan myth may help solve the riddle of soma, sacred drug of ancient India. *Fortean Studies, III,* 176-188.
6. Culianu, I. (2001). *Out of this world: Otherworldly Journeys from Gilgamesh to Albert Einstein*. Boston, MA: Shambhala.
7. Dankoff, R. (1971). Baraq and Bur&amacr;q. *Central Asiatic Journal, 15.2,* 102-117. Retrieved from https://www.jstor.org/stable/41926898
8. de Hartog, L. (2004). *Genghis Khan: Conqueror of the world*. New York, NY: Tauris Parke.
9. Devlet, E. (2008). Rock art studies in the far East and Russia, 2002-2004. In P. Bahn, N. Franklin, & M. Strecker (Eds.), *Rock art studies: News of the world* (Vol. 3). Oxford, UK: Oxbow Books.
10. Eliade, M. (2004). *Shamanism: Archaic techniques of Ecstasy*. Princeton, NJ: Princeton University Press.
11. Etheredge, L. (Ed.). (2011). *Iran (Middle East: Region in transition)* (p. 112). New York, NY: Rosen Publishing.
12. Fericgla, J. M. (1992). *A. muscaria* usage in Catalunya. In H. de Vries (Ed.), *Integration: Journal for mind-moving plants and culture* (Number 2 and 3, Special Mushroom Issue). Eschenau, Austria: Bilwis-Verlag.
13. Fericgla, J. M. (2001). *El Hongo y la Genesis De Las Culturas: Duendes y Gnomos Ambitos Culturales Forjados por el Consumo de la Seta Enteogena A. muscaria* [Fungi and the genesis of cultures. Goblins and gnomes: Cultural fields forged by the consumption of the entheogenic mushroom *A. muscaria*]. Barcelona, Spain: La Liebre de Marzo.
14. Flattery, D. S., & Schwartz, M. (1992). *Haoma and harmaline: The botanical identity of the Indo-Iranian sacred Hallucinogen "Soma" and its legacy in religion, language, and Middle-Eastern Folklore*. Berkley, CA: University of California Press.
15. Furst, P. (1986). *Mushrooms: Psychedelic fungi* (Encyclopedia of psychoactive drugs series). New York, NY: Chelsea House Publishers.
16. Golovnev, A. (Director). (2001). *Pegtymel [DVD]*. Hanover, NH: Institute of Arctic Studies.
17. Gosso, F., & Webster, P. (2014). *The dream on the rock: Visions of prehistory*. New York, NY: State University of New York Press.
18. Graves, C. (1994). *Proto-religions in Central Asia. Bochum publications in evolutionary cultural semiotics* (Vol. 34). Bochum, Germany: Brockmeyer.
19. Gruber, C., & Colby, F. (Eds.). (2010). *The Prophet's ascension: Cross-cultural encounters with the Islamic Mi'raj Tales*. Bloomington, IN: Indiana University Press.
20. Hajicek-Dobberstein, S. (1995). Soma siddhas and alchemical enlightenment: Psychedelic mushrooms in Buddhist tradition. *Journal of Ethnopharmacology, 48*(2), 99-118. doi: http://dx.doi.org/10.1016/0378-8741(95)01292-L
21. Hajj&amacr;j, A.-A. (1989). *The Isr&amacr; and Mi'r&amacr;. The prophet's night journey and ascent into heaven*. London, UK: Dar Al-Taqwa.
22. Haug, M., & West, E. (Trans.). (1971). *The book of Arda Viraf*. Amsterdam, Netherlands: Oriental Press.
23. Heissig, W. (1980). *The religions of Mongolia*. London, UK: Routledge and Kegan Paul.
24. Karamustafa, A. T. (1994). *God's unruly friends: Dervish groups in the Islamic middle period 1200-1550*. Salt Lake City, UT: University of Utah Press.
25. Keightley, T. (2000). *The world guide to gnomes, fairies, elves & other little people*. New York, NY: Gramercy Books.
26. Kiriak, M. (2007). *Early art of the northern Far East: The Stone Age*. Anchorage, Alaska: U.S. Department of the Interior, National Park Service, Shared Beringian Heritage program.
27. Lincoff, G. (2005, October). *Is the fly-agaric (Amanita muscaria) an effective medicinal mushroom?* Paper presented at The Third International Medicinal Mushroom Conference, Port Townsend, Washington. Retrieved from https://www.nemf.org/files/various/muscaria/fly_agaric_text.html
28. Manz, B. F. (1999). *The rise and rule of Tamerlane*. Cambridge, UK: Cambridge University Press.
29. Melville, G. W. (1885). *In the Lena Delta*. Boston, MA: Houghton Mifflin.
30. Michelot, D., & Melendez-Howell, L. (2003). *A. muscaria*: Chemistry, biology, toxicology, and ethnomycology. *Mycological Research, 107*(2), 131-146. doi: http://dx.doi.org/10.1017/S0953756203007305
31. Miller, H. (2001). *The mystery of Zulu Dawn. More secrets of the dead*. London, UK: Channel 4 Books.
32. Mochtar, S., & Geerken, H. (1979). Die Halluzinogene Muscarin und Ibotensäure im Mittleren Hindukusch: Ein Beitrag zur

volkheilpraktischen Mykologie [The hallucinogens muscarine and ibotenic acid in the Middle Hindu Kush: A contribution on traditional medicinal mycology] (Peter G. Werner, Trans.]. *Afghanistan Journal, 6,* 62-65. Retrieved from https://www.erowid.org/plants/amanitas/references/journal/1979_mochtar_afghanistan1.shtml

33. Morgenstierne, G. (1957). 'Mushroom' and 'toadstool' in Indo-Iranian. *Bulletin of the School of Oriental and African Studies, 20*(1), 451-457. doi: http://dx.doi.org/10.1017/S0041977X0006198X
34. Müller-Ebeling, C., Ratsch, C., & Shahi, S. B. (2000). *Shamanism and Tantra in the Himalayas*. London, UK: Thames and Hudson.
35. Munn, H. (1973). The mushrooms of language. In M. Harner (Ed.), *Hallucinogens and shamanism* (pp. 86-122). New York, NY: Oxford University Press.
36. Nicolle, D. (1998). *The Mongol Warlords*. London, UK: Brockhampton Press.
37. Országh, L. (1987). *Magyar-Angol Kézistótár* (11th ed.). Budapest, Hungary: Akadémia Kiadó.
38. Peschel, K. (1998). *Puhpohwee for the people, an account of fungi uses among the Ahnishinaabeg*. DeKalb, IL: LEPS Press.
39. Saar, M. (1991). Fungi in Khanty folk medicine. *Journal of Ethnopharmacology*, 31(2), 175-179. doi:10.1016/0378-8741(91)90003-V
40. Salzman, E., Salzman, J., Salzman, J., & Lincoff, G. (1996). In search of Mukhomor, the mushroom of immortality. *Shaman's Drum, 4,* 36-47. Retrieved from http://bigmedia.org/about-jason-salzman/19929-2/
41. Schurr, Th. G. (1995). Aboriginal Siberian use of *Amanita muscaria* in shamanistic practices: Neuropharmacological effects of fungal alkaloids Ingested during trance induction, and cultural patterning of visionary experience. *Curare. Zeitschrft für Ethnomedizin, 18*(1), 31-65. Retrieved from http://52.33.200.251/bibliography/default/resource/15573
42. Seale, Y. (2016). Out of their love they made it: A visual history of Bur&amacr;q. *Public Domain Review*. Retrieved from https://publicdomainreview.org/2016/09/21/out-of-their-love-they-made-it-a-visual-history-of-buraq/
43. Seeger, R., & Stijve, T. (1978). Occurrence of toxic *Amanita* species, in Amanita toxins and poisoning. In H. Faulstich, T. Wieland, & B. Kommerell (Eds.), *Amanita toxins and poisoning*. Baden-Baden, Germany: Verlag Gerhard Witzrock.
44. Séguy, M.-R. (1977). *The miraculous journey of Mahomet. Mirâj Nâmeh. Introduction and commentaries by Marie-Rose Séguy*. London, UK: The Scholar Press.
45. Slobin, M. (1976). *Music in the culture of Northern Afghanistan* (p. 73). Tucson, Ariz: University of Arizona Press.
46. Stimson, T. (Director and Producer). (1999). *Song of Mukhomor [DVD]*. Denver, CO: Privately produced.
47. Stone, A. (1992). Flying to the cloud: Soma and the Axis Mundi. *Mercian Mysteries,* No. 13.
48. Stone, A. (2003). *Explore shamanism*. Loughborough, UK: Heart of Albion Press.
49. Vuckovic, B. (2005). *Heavenly journeys, earthly concerns: The legacy of the Mi'raj in the formation of Islam*. New York, NY: Routledge and Kegan Paul.
50. Waldemar, J. (Auth.), Kasten E., & Dürr M. (Eds.). (2016). *The Koryak, Verlag der Kulturstiftung Sibirien*. Norderstedt, Germany: SEC Publications.
51. Wasson, R. G. (1972). *Soma: Divine mushroom of immortality*. San Diego, CA: Harcourt Brace Jonavich.
52. West, E. (Trans.). (1987). Denkard. In *Sacred books of the East* (Vol. 5). Oxford, UK: Oxford University Press.
53. White, D. G. (2003). *Kiss of the Yogini. Tantric sex in its South Asian Contexts*. Chicago, IL: University of Chicago Press.
54. Zarcone, T., & Hobart, A. (Eds.). (2016). *Shamanism and Islam*. London, UK: I.B. Tauris.
55. Zsigmond, G. (2003). The *Amanitaceae* in Hungarian folk tradition. In P.-F. Ferenc & G. Zsigmond (Eds.), *Moeszia. Erdélyi Gombász* (Vol. 1, pp. 55-68). Sf. Gheorghe, Romania: Periodical of the Kálmán LÁSZLÓ Mycological Society.

Baba Yaga and the Mushrooms

by

Frank M. Dugan

FUNGI Volume 10:2 Summer 2017

online on 17 August 2017
USDA-ARS Plant Introduction, Washington State University

© Frank M. Dugan

original report:
https://www.researchgate.net/profile/Frank-Dugan/publication/319162721_Baba_Yaga_and_the_Mushrooms/links/5995f1fd0f7e9b91cb095cad/Baba-Yaga-and-the-Mushrooms.pdf
backup source: http://www.psilosophy.info/resources/Baba-Yaga-and-the-Mushrooms.pdf

Table of Contents:

Abstract
Introduction: early print sources, including illustrations
Speculation and inference on the antiquity of Baba Yaga
Philological, textual and ethnographic evidence on mushrooms
Discussion and conclusions
Acknowledgements
Literature cited

Abstract

Nineteenth and early 20th century artists portray the Russian witch Baba Yaga with mushrooms, especially with *Amanita muscaria*, the fly agaric. Fairy tales about Baba Yaga, as well as other Slavic folktales, repeatedly contain passing reference to mushrooms, but mushrooms are not integral to story line in Baba Yaga tales. Written documentation for Baba Yaga extends only to late 17th-early 18th centuries, but philological studies and comparative folklore suggest her presence in folk belief considerably before then, plausibly originating from Baltic, Ugric and/or other non-Slavic sources. Linguistic and ethnographic analyses firmly link "baba" and "witch" to various mushrooms in Baltic and Slavic countries. In some tales, Baba Yaga is either the aunt or mother of a certain wizard, whose identity overlaps with another wizard equated with fly agaric. Baba Yaga is also strongly associated with water birds and bird-maidens (*rusalki*). Khanty myth references a water bird assisting creation of Earth from a red-capped mushroom. Baltic myth contains a "Mother of Mushrooms." Pre-Slavic Balkan (Vin&ccaron;a) artifacts include figurines of bird-women, and mushrooms sculpted from rock crystal. Relationships of Balkan, Baltic, Ugric, and other mythic figures to Baba Yaga and to mushrooms are conjectured here and in other literature.

Key words: Amanita, baba, Baba Yaga, Balkan, Baltic, Bilibin, bird-maiden, fly agaric, Karazin, Khanty, mushroom, Polenova, Russian, Slavic, Ugric, Vasnetsov, Vin&ccaron;a, Zworykin

Introduction: early print sources, including illustrations

The witch Baba Yaga, a prominent character in Russian fairy tales, was first well documented in print in the 18th century. The "outstanding Russian poet, scientist, and grammarian" Mikhail Lomonosov referred to Baba Yaga in 1755 in notes in a Russian grammar. In 1780, Vasilii Levshin published a literary fairy tale containing reference to Baba Yaga, and in 1788 there was a comic opera by Dmitry Petrovich Gorchakov in which Baba

Yaga appears with traditional attributes of hut on chicken legs, and mortar and pestle. Details of these and other instances from the late 1700s and early 1800s are summarized by Johns (2004). By 1820, an authentic folktale with Baba Yaga had been published, a version of type tale AT 327C/F (concerning a witch and children). The compiler, Mikhail Makarov, considered Baba Yaga to be "some kind of Slavic deity, known to us from folktales" (Johns, 2004). Early graphic portrayals of Baba Yaga indicate her attributes of association with animals and the mortar and pestle (Figs. 1, 2)

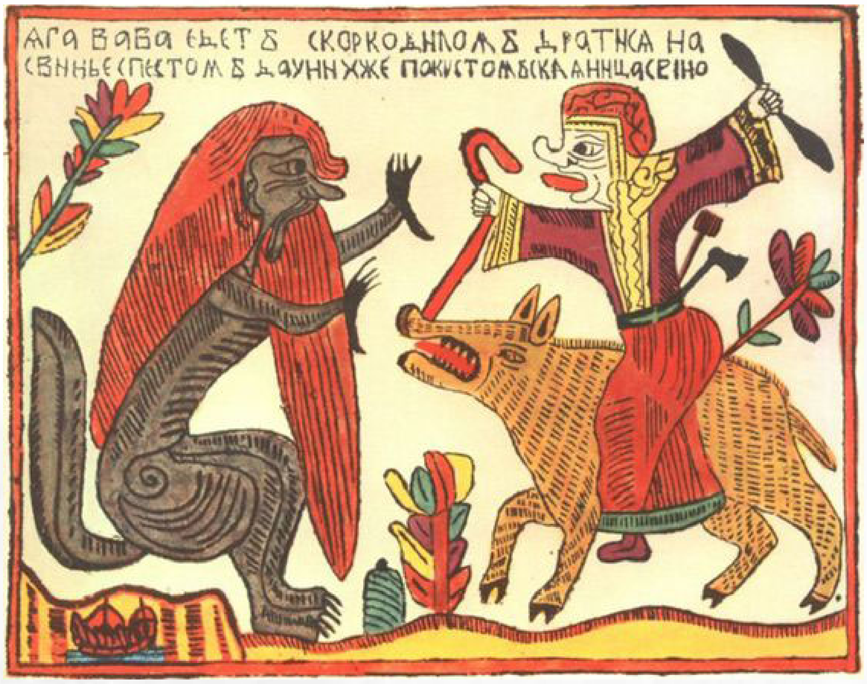

АГА БАБА ЕДЕТ Б СКОРКОДНЛОМЪ ДРАТНСА НА
СВННЬЕ СПЕСТОМ Б ДАУННЖЕ ПОКУСТОМ БСКААННЦА СЕІНО

Figure 1. Baba Yaga riding a pig, in a Russian *lubok* (a type of print); possibly a satire on Peter the Great and his wife, or alternatively, a contest between Baba Yaga and a shaman (Farrell 1993) ("early 17th century" in Wikipedia, citing Baldina Ol'ga Dmitrievna, Russkie narodnye kartinki. Moskva, Molodaya gvardiya, 1972). The figure is presented in monochrome by Johns (2004), who stated that it dates from late 17th or early 18th centuries. The object in Baba Yaga's raised hand is a pestle (Farrell, 1993).

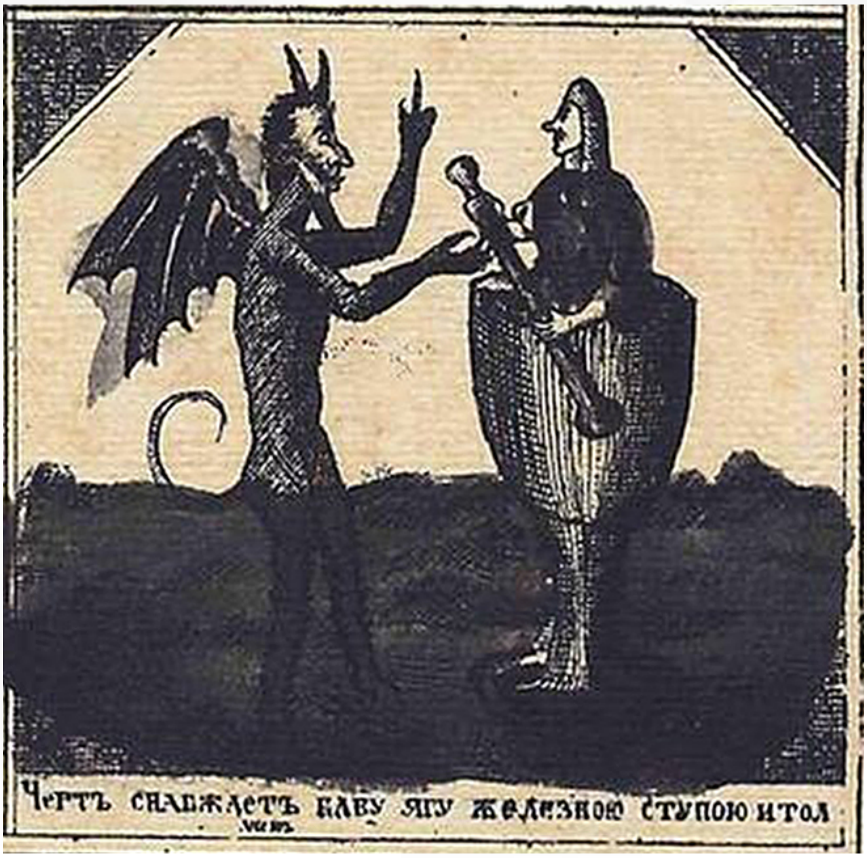

Чертъ снабжаетъ бабу ягу железною ступою и тол
чемъ

Figure 2. From the early 19th century, Baba Yaga (pictured with a devil), is clearly portrayed with her mortar and pestle (Russian National Library). Kabakova (2016) provides multiple archival and literary sources for the figure, of which Fig. 2 is a detail.

Highly enigmatic, and of uncertain affiliation with Baba Yaga, is a putatively Slavic goddess, Tata (or Stata) Baba, 16th century (Fig. 3). According to Thevet (1575) her statue, worshipped as an idol by the Russians, represented a Pietà of some sort (hardly in character with Baba Yaga) and no doubt showing strong Christian influence. Thevet himself never visited Russia.

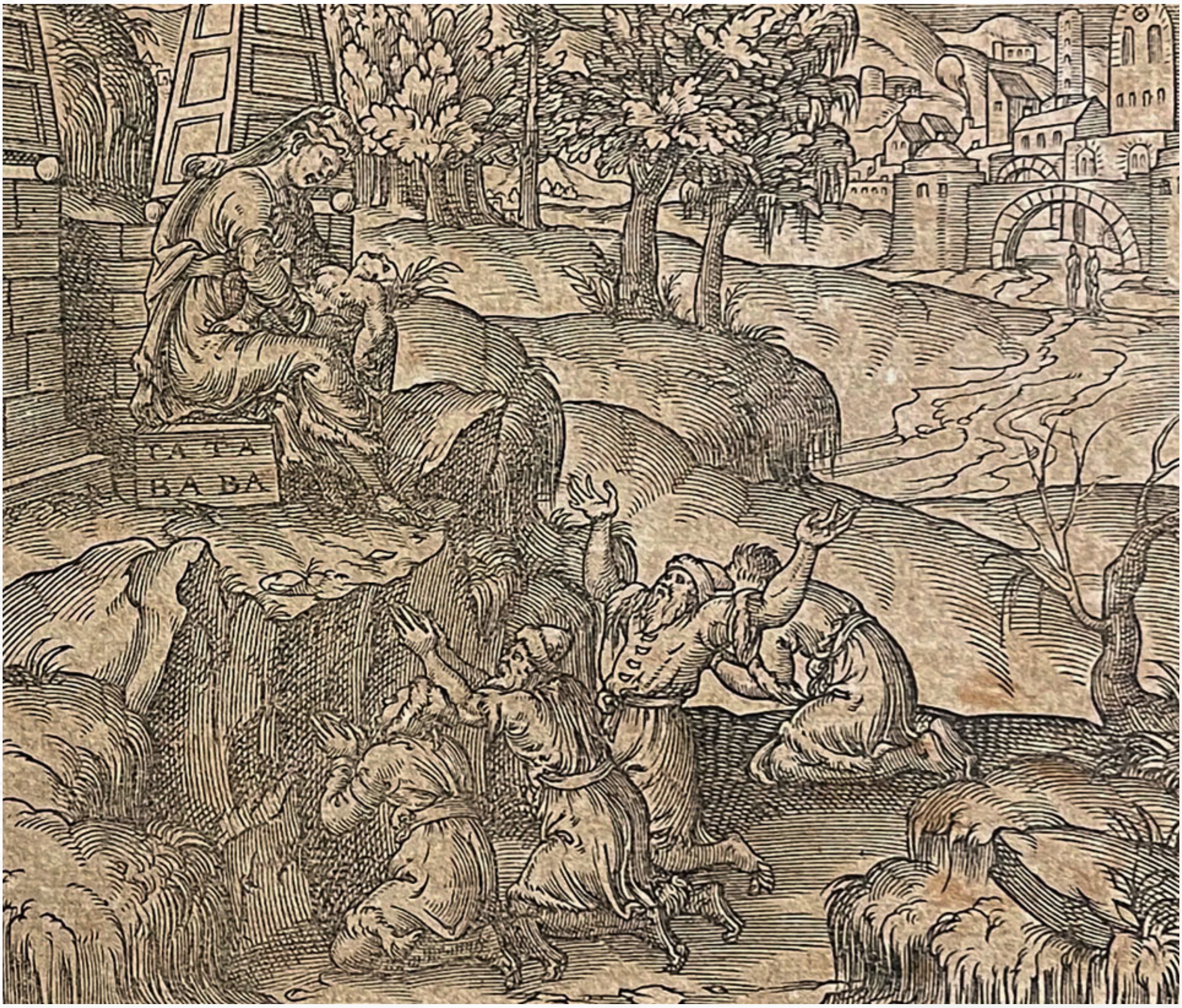


Figure 3. Tata Baba, Muscovy region, by André Thevet, Paris (1575), *Cosmographie Universelle*. "Tata" usually connotes "father" in Slavic, but "stado" connotes "herd" or "flock;" and "baba" connotes an older woman.

Also enigmatic is the relation of Baba Yaga to other ancient Slavic deities. Wood (2015) aims some criticism at Forrester *et al*. (2013) and their sources for being "a little too ready to link Slavic figures such as the Kievan goddess Mokosh [a Mother Earth kind of deity]" to Baba Yaga. However, it seems completely appropriate to inform readers that Baba Yaga shares attributes with some of these deities, e.g., the Baltic Mother of Mushrooms (below), and a female deity analyzed in Propp's (1984) speculations on the Rig-Veda (below).

The famed Aleksandr Afanas'ev (1826-1871), Russia's foremost compiler of Russian folktales, assembled his collections in the early 1850s, most often from prior, unpublished collections. These tales are essentially the equivalent of those assembled by the Brothers Grimm for Germanic tales, and are still readily available in print in English, e.g., Afanas'ev (1945). By the early 1860s, these were appearing in translation in popular periodicals, and contained the familiar (often formulaic) components relevant to Baba Yaga: the hut on chicken legs, the invocation by the protagonist to the hut ("stand with your rear to the forest and your front to us"), Baba Yaga's expression of recognition ("now the flesh of a Russian ... I've smelt with nose and seen with sight"), Baba Yaga's daughters, and her mortar and pestle (Borrow, 1862).

The earliest illustrations I can locate explicitly associating Baba Yaga with mushrooms were painted by Nikolai Nikolaevich Karazin (1820-1908) in 1889 (Fig. 4) and, less explicitly, by Yelena Polenova (1850-1898) in about 1880 (Fig. 5). All the mushrooms are supernaturally large, and certainly appear to belong to Amanita. However, there are reasons, primarily philological but occasionally the contents of certain folktales, to believe that Baba Yaga's associations with mushrooms run much deeper.

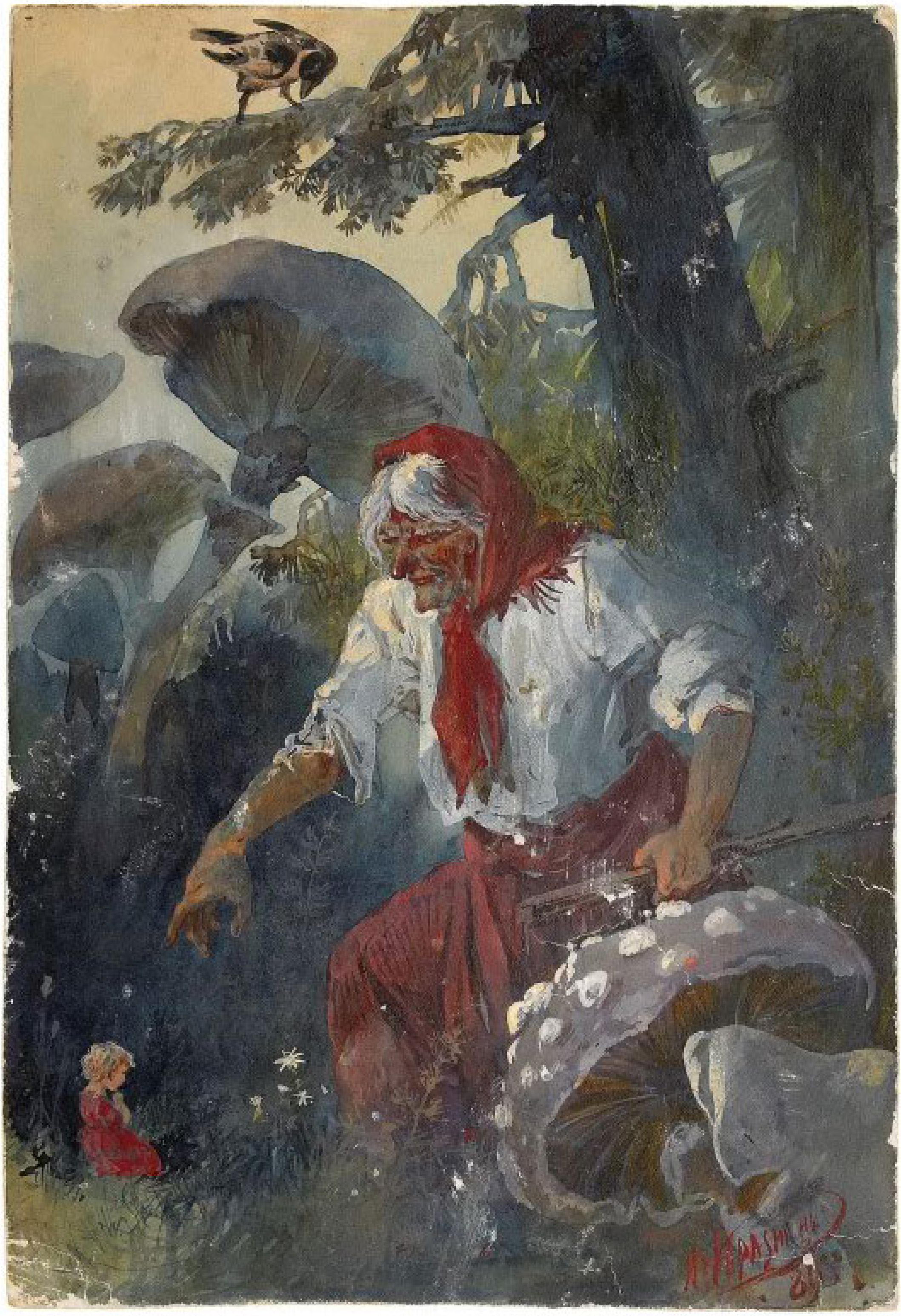


Figure 4. Baba Yaga by N.N. Karazin (1889) (Raven's Bread, https://rabenbrot.wordpress.com/2013/11/28/slavicmushrooms/). The painting, sold at auction, is in a private collection. Note the Amanita-like mushroom (dots on cap) at lower right.

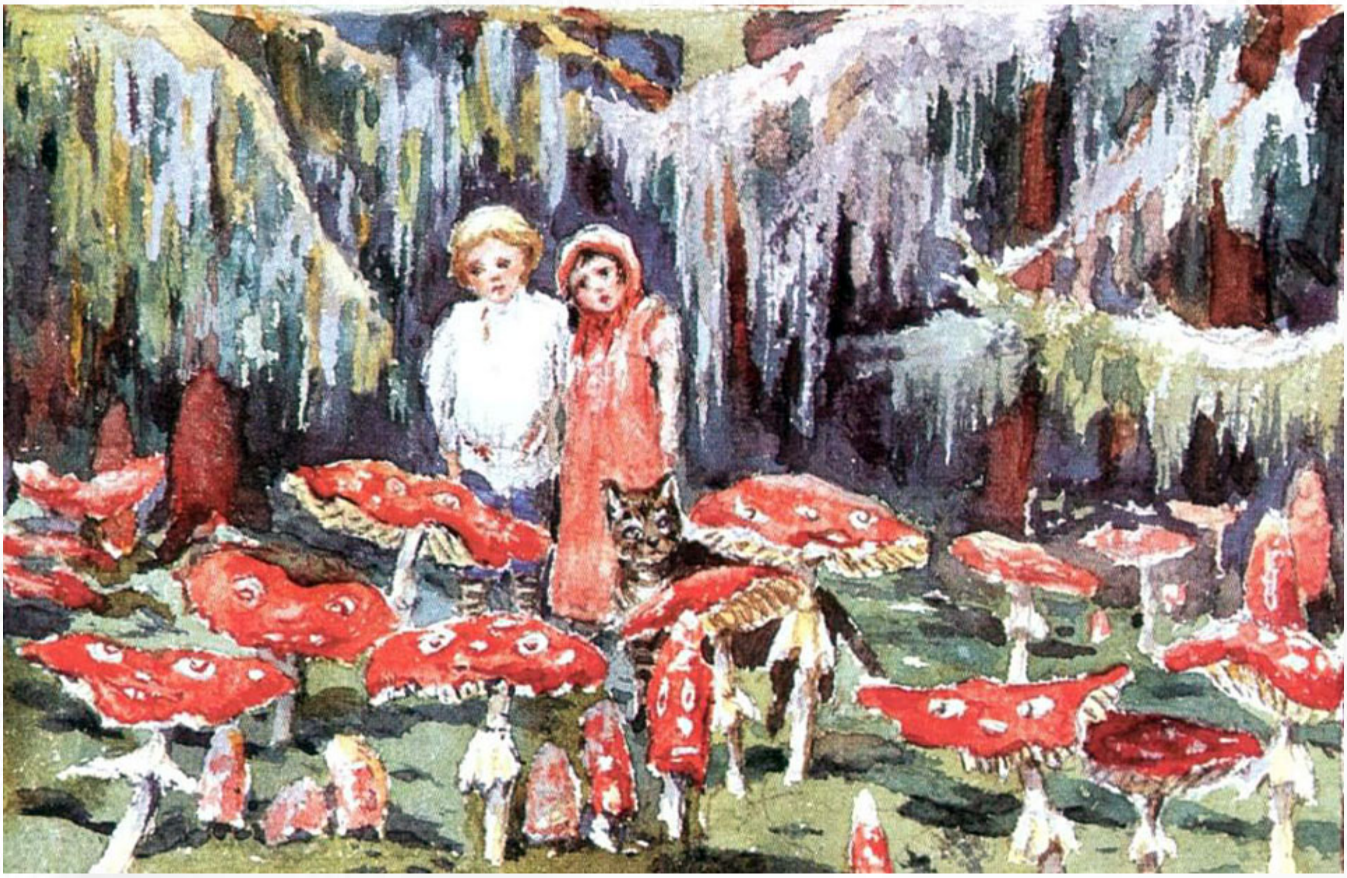


Figure 5. Masha and Vanya by Y. Polenova (~1880). Vanya was stolen, and had to be rescued from Baba Yaga by his sister Masha. An abundance of menacing fly agarics is conspicuous, but Baba Yaga is not pictured (http://schwarzze.livejournal.com).

Speculation and inference on the antiquity of Baba Yaga

It is not difficult to find conjectures, some more supported than others, on the purported great antiquity of Baba Yaga. The preeminent authority on structure of fairy tales (Märchen, wonder tales) Vladimir Propp (1895-1970), examined a hymn in the Rig-Veda (To the Lady of the Forest, Arany&amacr;ni). Although there is no mention of legs on her hut, the Lady is the Mother of Animals, has a house and/or wagon, and lives in the forest. "We readily recognize Baba Yaga and her hut" (Propp, 1984, posthumous trans.). Among formulaic components such as mentioned above, Propp (2012, posthumous trans.) adds the motif of Baba Yaga as gatekeeper to the boundaries and entrance to the other world. Her dialog with protagonists concerns entry to that world, and "reflects extremely ancient ideas" (Propp, 2012). Marija Gimbutas (1921-1994), widely known for her ideas on the origins of Indo-European peoples, considered Baba Yaba "the ancient Slavic goddess of death and regeneration" (Gimbutas, 1999, posthumous publ.). In her extended thesis on the great antiquity of certain folkways in Eastern Europe, Barber (2013) noted that some folklorists see in Baba Yaga an "ancestral helper along the maternal line." Folktales involving Baba Yaga are integral to Barber's (2013) thesis of folkways (dance, attire, stories) linking mythological female figures to agricultural and human fertility in remote antiquity. Johns (2004) documented the widespread occurrence of "baba" throughout Slavic countries, nearly always with the connotation of "old woman" and derived it from an IndoEuropean root **b(h)&amacr;b(h)-* (* denoting a reconstructed root, i.e., Proto-Indo-European, thus implying considerable antiquity). "The origin and meaning of *Iaga* is [*sic*] far more obscure" (Johns, 2004) and several possibilities are reviewed, including derivations from Baltic and proto-Slavic. Anthropomorphic stone stelae, some associated with Scythian or even earlier times, frequently possess pendant breasts, and are known by several appellations ending in "baba" (Shapiro, 1983).

Another putative link to antiquity is Baba Yaga's affiliation with birds. Her geese, for example, steal children for her (Afanas'ev no. 113, The Geese and Swans), as does the Grey Eagle (Khudiakov no. 53, The Brother) (Forrester *et al.*, 2013). Folktales connecting Baba Yaga with bird maidens were captured by Ivan Bilibin (1876-1942) in a water color (Fig. 6). Such bird maidens were associated with folktales about Baba Yaga and the Firebird (Hubbs, 1988). In Russian folklore, bird maidens are sometimes *rusalki*, having features of archaic goddesses (half female human, half fish, half serpent, etc.) and often displaying malevolent habits. Hubbs (1988) and Barber (2013) considered them very ancient. "They ... echo the hybrid goddesses of Tripol'e [Ukrainian Neolithic]" (Hubbs, 1988). Cheek (2013) stated that "Je&zcaron;ibaba/Baba Yaga" is a more recent phenomenon than *rusalki*, "coming into her own in Slavic tales and Czech tales ... in the 19th century," but as we've seen, Baba Yaga is already well documented in the 18th century. Shapiro (1983) has a view similar to that of Hubbs (1988), and both Shapiro and Johns (2004) note connections of Baba Yaga with serpents as well as with birds. This line of thought is pursued, albeit in an almost chain-of-consciousness fashion, by Richards (2004), where Baba Yaga is linked via a series of motifs combining bird heads atop elongated necks or torsos, to artifacts in the Vin&ccaron;a culture (Transylvania, ca. 5000 BC) (Richards, 2004). It should be added that mushrooms sculpted from rock crystal were recovered in archaeological context from a Vin&ccaron;a site (Gimbutas, 1982). Caveats are essential here, chiefly that it is unproven whether the Vin&ccaron;a culture was, unlike the Slavic, Indo- or even Proto-Indo-European (although it may have had pertinent influence on Proto-Slavic peoples), and there is no way of knowing at present how the mushroom iconography may have been related to the Vin&ccaron;a bird motifs. See however, the connection between water birds and a mushroom at the origin of the world in Baltic myth, below.

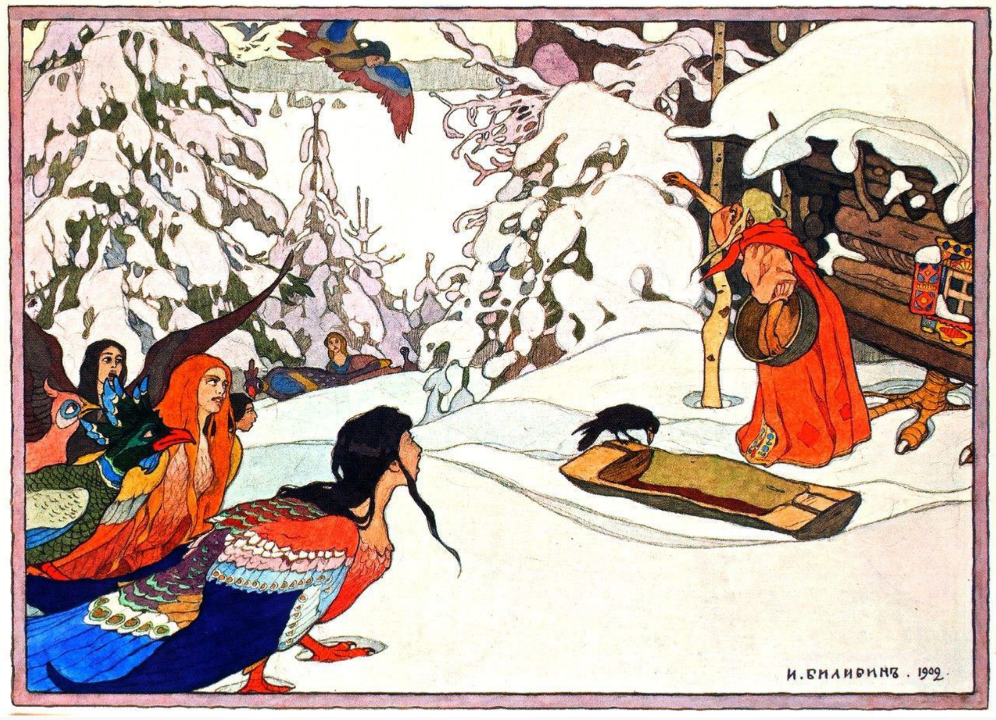

И. БИЛИБИНЪ. 1902.

Figure 6. Baba Yaga and the Bird Maidens by Ivan Bilibin (1902) (Wikimedia).

Philological, textual and ethnographic evidence on mushrooms

Most pertinent to linking "baba" ("old woman" - "grandmother" - "midwife" - "witch" - or even "dead female ancestor" - etc.) with "mushroom" is the summary of Stankiewicz (1958). "Baba" may even connote a specific kind of "mushroom," e.g., *Boletus edulis* (an eminently edible species) in Polish *babka* (Stankiewicz, 1958). In Slovak, *je&zcaron;ibaba* is the equivalent of Russian Baba *jaga* (*yaga*, *iaga*) (Stankiewicz, 1958). Johns (2004) also reviews multiple interpretations of "baba" and "iaga" and notes the connection to "certain kinds of mushroom." "Baba" in Polish has roughly the same connotations as above in the review of Ostling (2011), who provided an illustration of a baba from ~1685 in which a witchy baba holds a broomstick, and an instance from a witchcraft trial of mushroom powder used to bewitch crops. In 1671, a woman was accused of trying to poison the Tsar's wife with a mushroom, and tortured on suspicion of magic; possession of herbs (a mushroom in this case) was a frequent attribute of those accused of being a witch ("female magician ... midwife ... *baba*") (Ryan, 1998). Dugan (2008a; 2008b; 2011) reviewed ethnographic evidence connecting mushrooms with witches and women, particularly older women, in Europe, especially Slavic and Baltic countries.

This connection may be responsible for elements in Edgeworth (1869), a work of fiction wherein two gentlemen traveling in Lithuania are accosted by an elderly "sorceress" and "witch," who conjures a serpent from a basket of mushrooms while invoking the name of a putatively ancient Slavic deity. Edgeworth (1869) was an abridgement of a work of the same date by Prosper Mérimée (1803-1870), but the story was not fully translated from French into English until Mérimée (1905), with an illustration of the witch, her mushrooms and the serpent (Fig. 7). Whether this episode reflects genuine folklore or is more appropriately treated as "fakelore" is conjectural. Elements of purported Slavic paganism were here being combined in popular literature with mushrooms, serpents and witchcraft, although Baba Yaga was not directly referenced. One mushroom in the witch's basket elicited comment from the gentlemen, but it was *Agaricus necator* (*Lactarius necator*, considered inedible in western countries but preserved in salt in Eastern Europe), not an Amanita. That Slavic peoples consumed fungi avoided by peoples to the west was the opinion of Lyall (1823), who provided an extensive synopsis on mycophagy in Russia of the early 19th century and earlier. Lyall (1823) made no reference to witches with regard to mushrooms, but noted the special role of Russian women in collecting fungi.

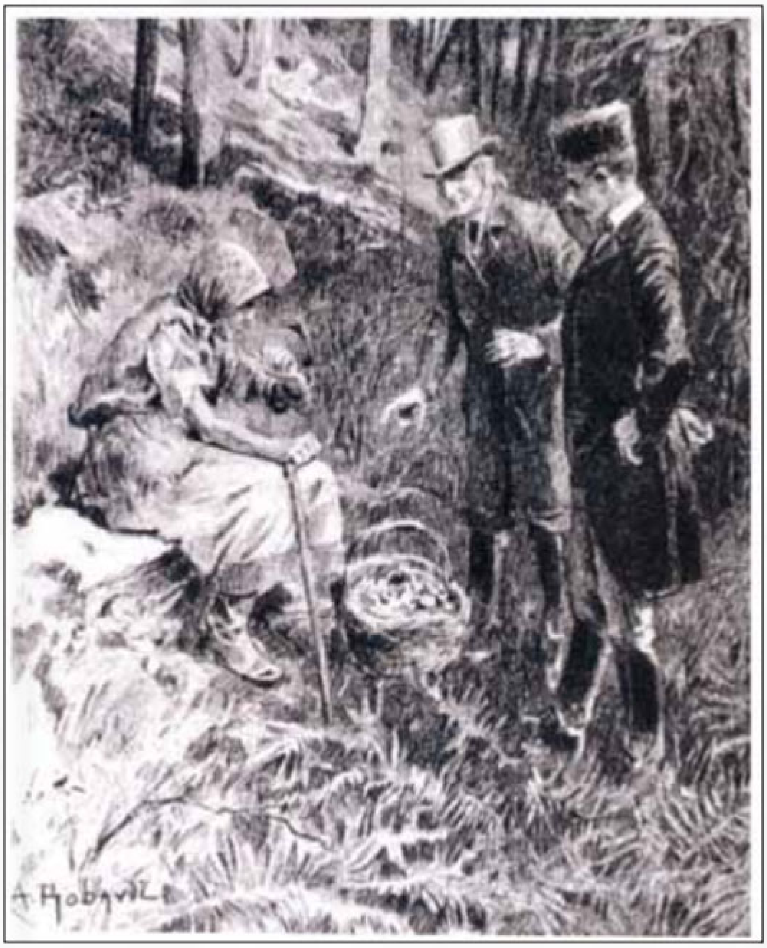


Figure 7. The witch in Mérimée (1905), an English translation from the French of 1869. A pagan Slavic god is invoked; a snake conjured from a basket of mushrooms coils around the witch's left arm. Artist: A. Robaudi.

The general semiotic significance of mushrooms in myth was reviewed by Toporov (1985), with occasional reference to usages linking mushrooms to thunder and/or lightning and deities personifying them, e.g., Perun the Slavic god of thunder. Johns (2004) reviewed, somewhat skeptically, previous opinion linking Baba Yaga to storm clouds. More prosaically, a Russian forest spirit (and sometimes associate of Baba Yaga), the *leshii*, would assume the likeness of a mushroom or alter the appearance of mushrooms with a whip; in the north, such spirits were associated with storm winds (Ivanits, 1989). According to Deteli&cacute; (1998), the Slovenes had a ritual of rolling on the ground at "first thunder" (of the season?) to promote an abundant harvest of white mushrooms. The first mushrooms found during a mushroom harvest ("first fruits") might be offered as a sacrifice to a forest spirit, albeit with addition of Christian prayer (Wenska, 2015). Notably, the spirit was identified with Veles, a chthonic and aquatic deity distinct from Perun (Wenska, 2015).

Mushrooms were a component of Baltic and Ugric religion. There was a "Mother of Mushrooms" (S&ecaron;ņu m&amacr;te) in Baltic religion. Opinions are divided on whether such "mothers" or goddesses in Baltic religion indicate influence of the Christian Virgin Mary (Ankrava, 2013; Biezais and Ankrava, 2005). There is a reference to Earth originating as a "red-cropped" [sic - "red-capped"?] mushroom in myths of the Khanty, an indigenous Ugric people, near Ob River, Russia. This origin, subsequent to the Deluge, was wrought by a bird, Luli (a small loon) (Deviatkina, 2011), although there are different versions, less specific about the bird ("water bird" or "diving bird" or specifying other birds like sandpiper, swan or grebe) and omitting the mushroom (Deviatkina, 2011; Limerov, 2005).

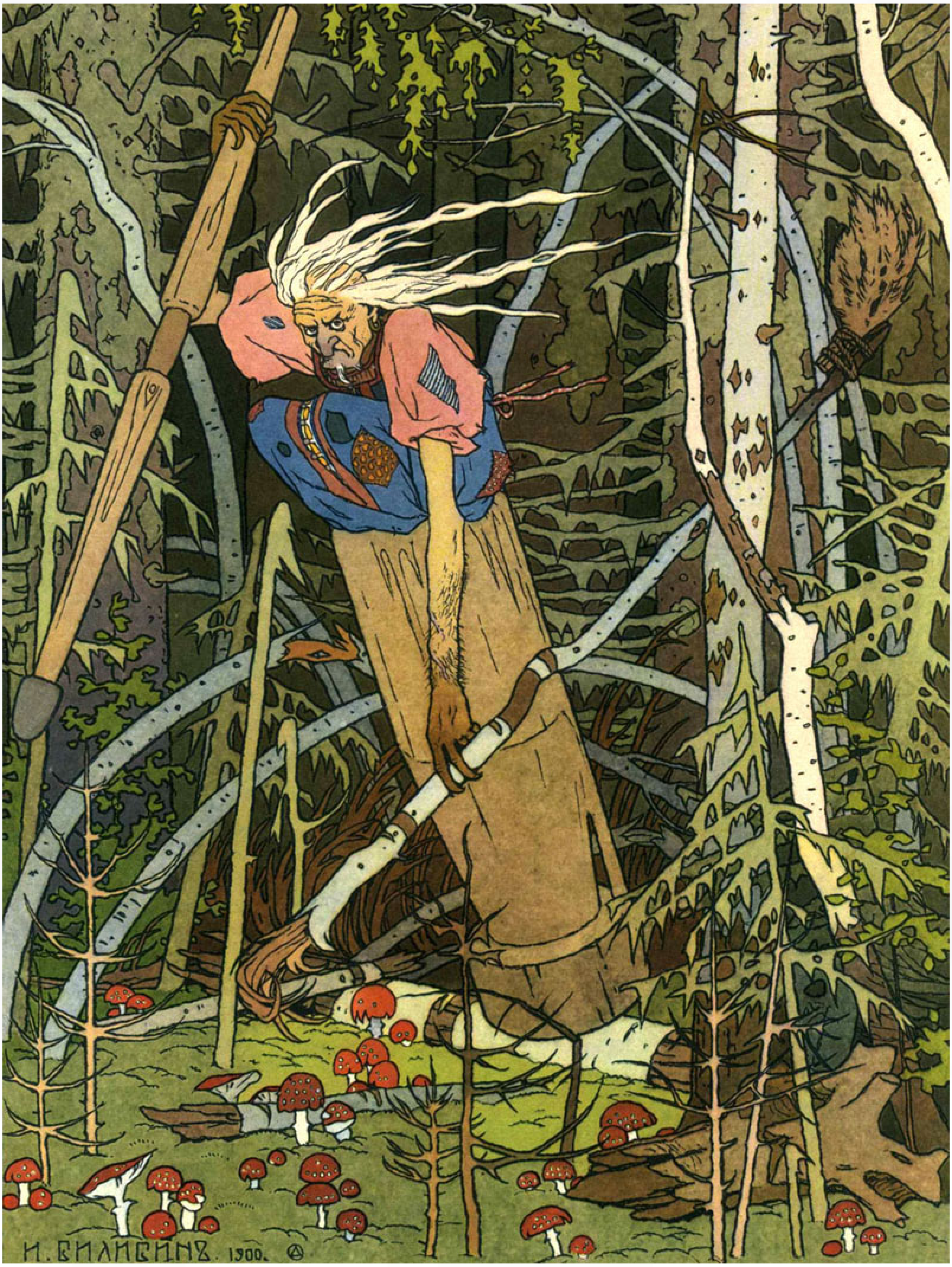

И. БИЛИБИНЪ. 1900.

Figure 8. Baba Yaga by Ivan Bilibin (1902), with fly agarics in foreground (Wikimedia). Bilibin and Zworykin (Fig. 9) were influenced by Yelena Polenova's illustrations of mushrooms (see Dugan, 2016).

Hubbs (1988) related a folksong, a stanza of which goes, "Where old women go mushrooms grow, Oi Liuli [Lada]." Lada is a name commonly occurring in planting or harvest songs in Russia, and "has been linked to a Latvian goddess, as well as to the Golden *baba* of the Ugrians" (Hubbs, 1988, with commentary on various possible origins for Lada). "Lada" is also linked to other "baba" names, or more specifically to a close analog "Boda" in a Polish document of about 1550 (Marjani&cacute;, 2003, with commentary on the antiquity of "baba" names for ancient Serbian and Croatian female deities). Baba Yaga is not explicitly linked to the Golden Baba, but Johns (2004) noted the possibility of a non-Russian (and probably northern) origin for Baba Yaga, based on the formulaic nature of her response to a Russian visitor, i.e., her statement that she smells a Russian, and that it has been a long time since a Russian has come to her. Johns (2004) lists water birds (including pelicans, swans, etc.) associated with Baba Yaga. Goscilo (2013) noted that the legs on Baba Yaga's hut are congruent with the "legs" formed by bases of trees used as platforms for storage huts by indigenous peoples of the Russian north. Hatto (2017) has an analogous opinion on the resemblance of the Khanty "Idol-Hut" to Baba Yaga's dwelling, and describes several Khanty practices involving fly agaric (*Amanita muscaria*). So it is plausible, but scarcely certain, that the Slavic Baba Yaga was derived from Baltic and/or Ugric mythologies, whose female divinities had connections to mushrooms and birds. According to famed founder of ethnomycology R. Gordon Wasson (1898-1986), the wise women (*javas asszony*) of Hungarian tradition used fly agaric for love philtres (Wasson, 1968). Hungarian (Magyar) is a branch of Ugric, this relation explaining why the use of fly agaric, documented in Ugric lore, persisted in Hungarian folkways (Czigány, 1980). Outside these traditions, it is recorded that Swedish witches of the 17th century made salves of mushrooms ("*röd flugsvamp-amanita muscaria*") and stored them in horns, also used for storing salves of hemp, opium and henbane (Jordon, 2012, citing a source in Swedish).

However, individual folktales in which Baba Yaga herself has direct and explicit connections with mushrooms are hard to find. Goscilo (2013) stated that mushrooms are "never mentioned in Russian fairy tales," but this is an exaggeration. It certainly does not apply to all Russian folktales, e.g., The War of The Mushrooms, a well-known folk poem (Dugan, 2016), but not directly pertinent to Baba Yaga. In Russian fairy tales *per se*, (Märchen, wonder tales), mushrooms appear, but usually incidentally, e.g., "One day the man went into the woods to get mushrooms" (Baba Yaga and the Runt, Afanas'ev no. 105, in Forrester *et al*. 2013). Similarly, in Ivanko the Bear's Son (Afanas'ev, 1945), "One day the wife went to the forest for mushrooms ..." This usage, in a culture in which mushroom hunting is a common pastime, is equivalent to saying, "Once upon a time." In another Afanas'ev collection (Haney, 2014) we likewise have a tale with Baba Yaga's daughters (AT 301, involving stolen princesses), in which characters search for berries or mushrooms. These instances use mushroom hunting to situate the tale, but mushrooms themselves are not integral to the plot. Mushrooms comprise part of a story line in The Fool and the Birch Tree (Afanas'ev v., no. 53, Ralston 1880), where the clever brothers lie to an avaricious cleric that they have no money, only mushrooms, but the foolish brother speaks the truth; a series of events ensue, but none pertinent to Baba Yaga. Mushrooms are also integral to plot in The Milk of the Beasts (Afanas'ev 203) wherein the fool (our hero) collects mushrooms, and then discovers the hideout of the robbers. He defeats them, and fills his mushroom basket with their gold, which he gives to his sister (Haney, 2015), but again Baba Yaga is not involved.

Very intriguingly, in some Russian tales there is a villainous wizard, Mukhomor, sometimes equated with the equally bad Koshchei the Deathless (The Enchanted Tsardom, in Haney, 2013). Mukhomor "means 'Poison Mushroom' (Fly-agaric)" (Haney, 2013), and indeed the "moucho-more, a deleterious species of mushroom" was early recorded as comprising "entertainments" of Siberian tribesmen (Von Kotzebue, 1830), an obvious allusion to use of fly agaric for intoxication (e.g., Wasson, 1968). Koshchei and Baba Yaga can appear in the same tale. Baba Yaga is either his aunt or his mother (Shapiro, 1983), and the association between Koshchei, Baba Yaga and fly agarics persists in contemporary Russian grade school games (Yamin-Pasternak, personal communication). I have not seen the name "Mukhomor" directly linked to Baba Yaga in older folktales. But in some contemporary Russian tales and theater productions, there occurs the name "Mukhomorovna" or "Yaga Mukhomorovna," e.g., Baba Yaga's patronymic, "daughter of Mukhomor" (Yamin-Pasternak, personal communication). A distinguished scholar of Russian literature and folklore, W.R.S. Ralston (1828-1889), provided summaries of the relation between Baba Yaga, Koshchei and their roles in Russian and Slavonic folklore, often with reference to the perspectives of Afanas'ev (Ralston, 1872).

Soidla and Shapiro (1997) cited Propp (1986, posthumous, in Russian, pp. 66-67) for Baba Yaga treating visitors to "magical foods or drinks intended for the dead and not for the living." The authors go on to state, "Of the magical foods, mushrooms seem to be most common, and some Baba-Yaga tales contain references to mushrooms in several contexts. Illustrations for these tales (although certainly done much later than the tales themselves) often depict Baba-Yaga surrounded by red fly agaric and other mushrooms." It is unclear on the basis of Soidla and Shapiro (1997) if the use of mushrooms in this manner, e.g., as a magical food, is contained in Propp (1986) or is an inference by the authors.[1] Their primary example of mushrooms in a fairy tale consists of "Baba Yaga sets off into the woods to gather mushrooms and parsley for the stew and finds a hedgehog sitting on top of a big mushroom and eating a mushroom." The hedgehog becomes a boy who is the protagonist of the tale. This tale is unsurprisingly mentioned in works devoted to mushrooms, e.g., Marley (2010), citing Vilenskaya (n.d.).[2] The theme of mushrooms as magical foods dispensed by Baba Yaga is also addressed by Ivanova (2013), but specific citations for this occurrence are not provided so it is unclear whether or not this use of mushrooms is Ivanova's inference. Propp (1968) mentions specific examples of food or beverages acting as magic agents, but mushrooms are not specified.

Multiple illustrations by Bilibin for folktales involving Baga Yaga included mushrooms, especially fly agaric (*Amanita muscaria*) (Fig. 8). Similar illustrations, numerous and widely known, were produced by contemporaries, e.g. Boris Zworykin (1872-1942, Fig. 9).[3] Over decades, inclusion of fly agaric in illustrations of Baba Yaga tales became standard, such as those by Peter Koshkin for Baba Yaga and Vasilisa the Beautiful (pp 90-91, in Warner, 1985).

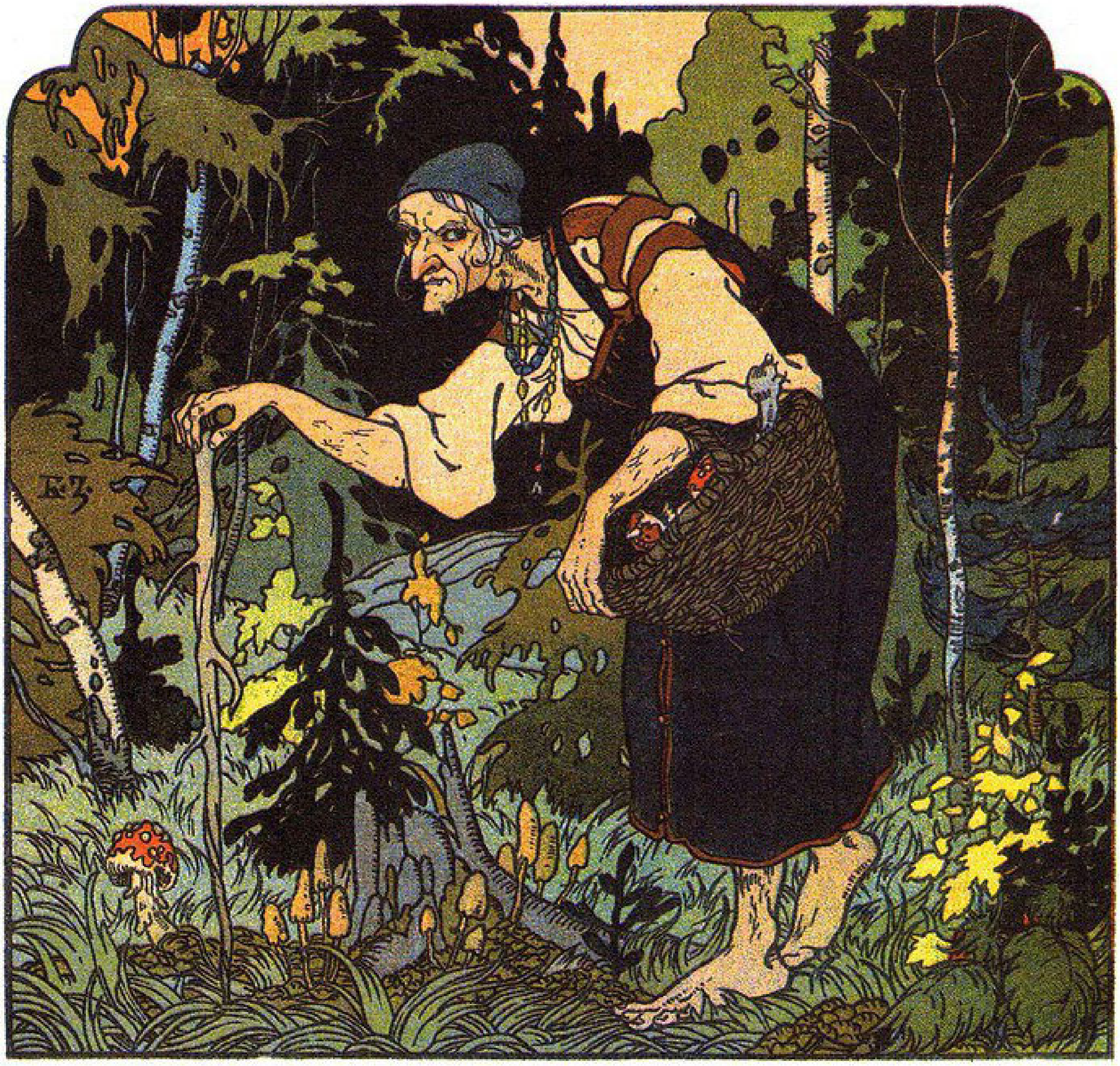


Figure 9. Boris Zworykin's Baba Yaga (1917, in V.A. Smirnov, The Witch and the Strawberries) with fly agaric in lower left. Zworykin has been called "the shadow that followed Bilibin" (forum.artinvestment.ru) but their works were largely contemporaneous.

That the fly agaric was pictorially inserted into Baba Yaga tales well prior to the more recent enthusiasm of mycophiles for Wasson's (1968) thesis on soma is demonstrated not only by Bilibin's artwork and that of contemporaries, e.g., Zworykin and Viktor Vasnetsov, 1848-1926 (Fig. 10), but is suggested by the *Amanita*-like mushroom in Karazin (1889). Prior to Karazin (1889), Yelena Polenova painted "Masha and Vanya" (~1880) with fly agarics (http://schwarzze.livejournal. com/248633.html). In this tale (number 113 in the Afanas'ev collections), Baba Yaga's swan-geese capture Vanya, who must be rescued by his sister, but in the painting itself (Fig. 5) only the siblings are shown. Unsurprisingly, Wasson enthusiasts (see *In Wasson's footsteps* (sort of), Dugan, 2011) have suggested that *A. muscaria* be added to Baba Yaga's accoutrements, e.g., Dunn (1973).

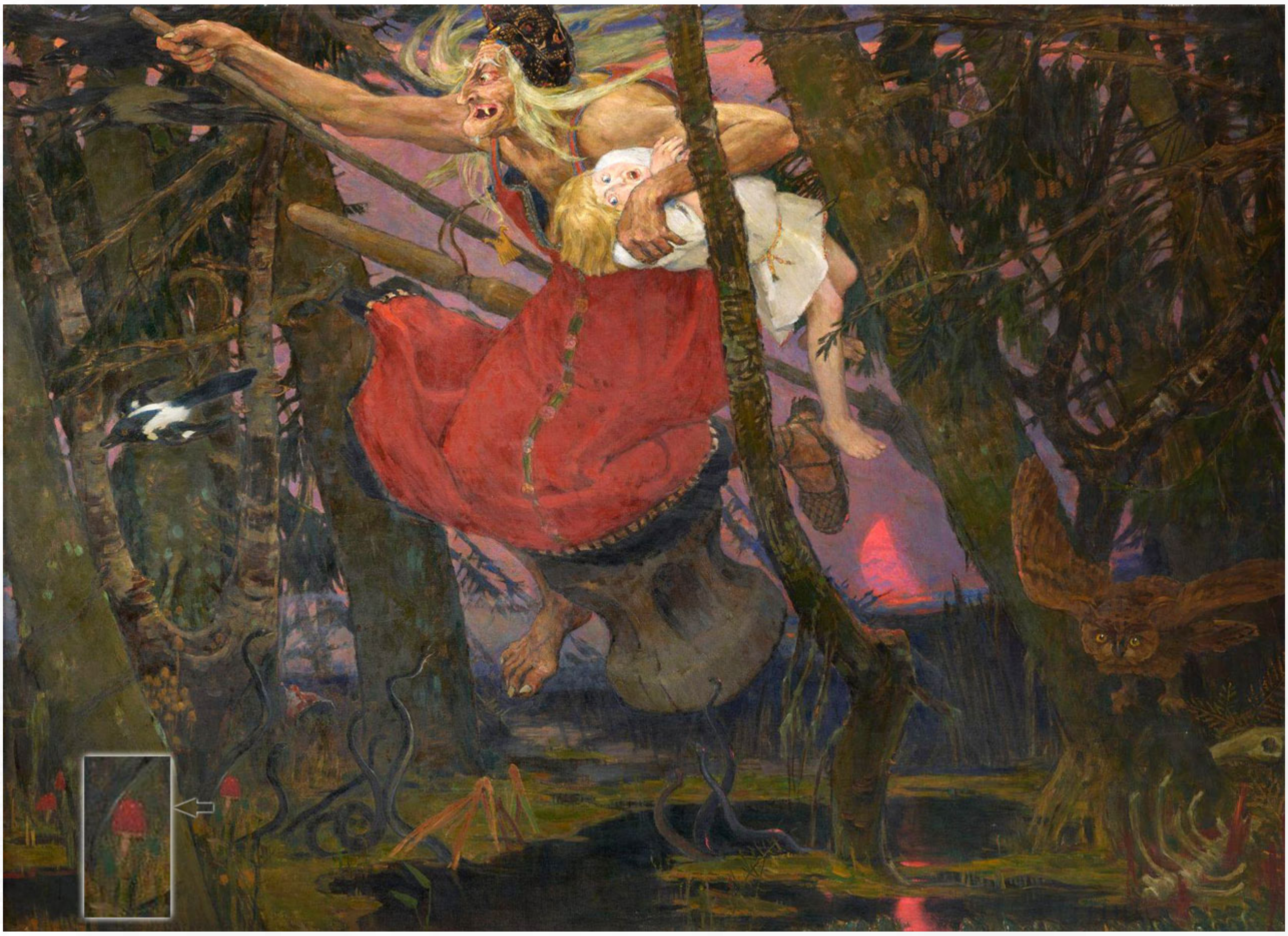


Figure 10. Baba Yaga, by Viktor Vasnetsov (1917, Wikimedia), emphasizing Baba Yaga's reputation of kidnapping children for her dinner. Inconspicuous fly agarics are visible in the lower left corner (arrow, and insert).

Items manufactured in the Russian folk tradition (or at least imitating that tradition) very frequently include images of Baba Yaga in association with the fly agaric. Lacquer boxes in particular (Fig. 11) can be readily located in online images, often on pinterest.com or other sites, and usually feature the hut on chicken legs, Baba Yaga, and a mortar (but sometimes with a broomstick substituted for the pestle and with Westernized accoutrements, e.g., black cats, cauldrons, etc.). Google Shopping offers an assortment of Russian lacquer ware on which Baba Yaga and fly agaric mushrooms are often conspicuous. Baga Yaga items comprising stained glass, coasters, lacquer, tapestries and other items on esty.com also include *Amanita* motifs. Bilibin prints, many predictably including little red-capped mushrooms with white dots, are offered on ebay.com. Fly agarics ornament Baba Yaga books and dolls offered by amazon.com. From zazzle.com you can get your Vasilisa the Beautiful coffee mug, and other mugs with similar Baba Yaga themes, with or without fly agarics.

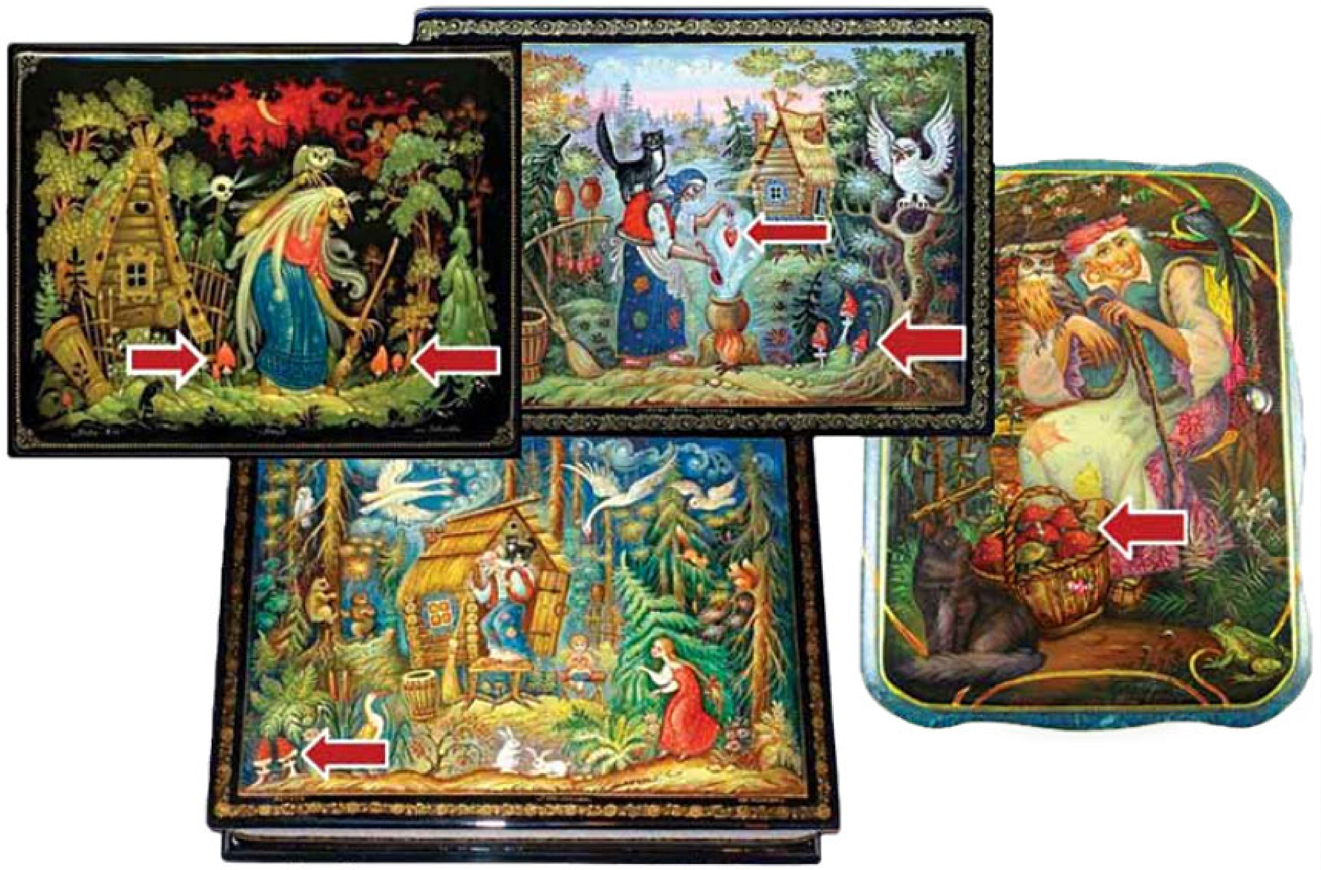


Figure 11. Modern lacquer boxes, simulating Russian folk art on Baba Yaga and advertised online, frequently feature fly agarics (arrows). The box showing Baba Yaga dropping an *Amanita* into a cauldron (top middle), is captioned by Goscilo (2013) as demonstrating "the Russian handicraft industry's profit-driven catering to Western traditions and tastes.

Discussion and conclusions

Philological and ethnographic evidence strongly supports the notion that Baba Yaga has been present in Russian folk tradition much longer than written documentation alone attests. Persons well acquainted with this tradition repeatedly use the word "ancient" but usually without quantification. It is probably safe to infer that Baba Yaga was already established in folklore during medieval times. If Propp (1984) was correct, we might even surmise that the Lady of the Forest and Baba Yaga had a common origin in distant Indo-European or even ProtoIndo-European times. However, in another comparison (that of the princess Elena the Wise with the ancient Greek Demeter), Propp (1984) was careful to note, "Even though we compare Demeter and the princess, it does not mean our princess is a direct descendent of Demeter. It only means that features of the goddess of agriculture are characteristic of the princess." This cautious attitude might equally apply to the brilliantly intuitive but highly speculative work of Barber (2013). Motifs may be shuffled between tales, and tales between cultures, and as Propp (1968) emphasized, different folk characters may be exchanged between tales, and the same function within tales might be fulfilled by different characters.

Mushrooms have played a prominent role in Russian cultural life, seemingly for centuries. They are so embedded, that to say a given character went to gather mushrooms is a standard introductory motif for a folktale, including some tales about Baba Yaga. In Russian fairy tales, it is therefore not surprising that mushrooms are occasionally in the background and have become a standard fixture of Russian fairy tale illustration. It seems they are usually more emblematic of setting than of function or plot ("morphology" *sensu* Propp, 1968). But there are hints at deeper roles: "Mother of Mushrooms" in Baltic lore and a plausible connection of the Ugric "Golden *baba*" with mushrooms; the fairy tale wizard named "Poison Mushroom;" and philological connections between "baba" and mushrooms. One wonders where Karazin made the connection between Baba Yaga and Amanita, as the giant *Amanita*-like mushroom in Karazin (1889) was painted when Bilibin was only thirteen. Were Karazin, Zworykin, Bilibin and their contemporaries drawing from a shared folk tradition, or merely echoing prior artistic approaches, e.g., Polenova? Antedating Polenova's painting, Modest

Mussorgsky's composition, Pictures at an Exhibition (1874) incorporated a theme, "The Hut on Chicken Legs" after a painting by Mussorgsky's friend, the painter Victor Hartmann (1834-1873). Hartmann himself once shocked his contemporaries by going to a costume ball dressed as Baba Yaga (www.stmoroky.com). Mussorgsky's "Gathering Mushrooms" (1867) has lyrics in which the woman collecting these fungi considers using them as poison on her husband. These established facts do *not* indicate that either Mussorgsky or Hartmann directly connected Baba Yaga with mushrooms, but the possibility is implied. It may be mere coincidence (or not) that the conductor Sir Henry Wood (1869-1944) later added mushroom bells (mushroom-shaped percussive instruments) to the orchestration for "The Hut on Chicken Legs" (www.musicweb-international.com).

Especially intriguing is the possibility that Baba Yaga and her hut are derived in part from ancient Baltic and Ugric beliefs, including the myth of a red-capped mushroom and water birds. Going even farther back in time, were the enigmatic Vin&ccaron;a mushroom sculptures in any way related to the Vin&ccaron;a bird-women figurines, and did these remote motifs foreshadow folk concepts of Baba Yaga?

These tantalizing conjectures entice us to explore the depths underlying contemporary fairy tale convention and ornament. Some persons who have delved into the impacts of *Amanita* on folk belief have made startling (specious?) claims, including that cultic beliefs about *Amanita muscaria* underpin Mediterranean and European history (e.g., Allegro, 1970; Ruck *et al*., 2011). Others claim to have unlocked the keys to eternity by channeling conversations with ancient Egyptian *Amanita*-users (Puharich, 1959, with cameo appearances by Aldous Huxley and Gordon Wasson). With more restricted ambition, we might try unlocking the shamanic roots of European fairy tales, for which Ruck *et al*. (2007) made valiant efforts, but pertaining to Baba Yaga (and in spite of a wonderful picture of her on the jacket, with fly agarics!), they uncovered little not addressed here.[4] Ruck *et al*. (2007; 2011) followed other scholars (Allegro, 1970; Wasson, 1968; and many others, less well-known) in surmising that the fly agaric had foundational impacts on world history, myth and religion, and in constructing their own highly detailed account. Readers are encouraged to explore such accounts, but urged to keep their skepticism intact.

Proceeding with caution, we might remind ourselves that written source materials on Baba Yaga date only from late 17th-early 18th century, and I have found pictorial sources relating Baba Yaga to mushrooms only from late 19*th* century onwards. Openly practiced paganism existed in Eastern Europe well into the 10*th* century, and Baltic, Finno-Ugric and Prussian paganism was suppressed by the Teutonic Knights only in the 13*th* century (Barford, 2001), but written sources from those times describing pagan folklore are virtually nonexistent. Pagan lore usually must be inferred from Church documents hostile to pagan belief (Filotas, 2005). Although there is a literature on pagan influences on festivals, holidays and the like, most derives from Western Europe (e.g., Dugan, 2015), and gleanings on Baba Yaga and Eastern European shamanism are slim (Johns, 2004). But that pre-Christian beliefs long lingered below the surface was evident to persons familiar with Pre-Revolutionary Russia: "The old pagan religion, too, is a secret institution ... the wood-sprites have their abode; whilst the lakes, rivers, and waterfalls abound in water-sprites, of whom the Roosalka are the most dangerous ... The cult of the wood-sprite obtains mostly in the forest region ... whilst the water cult (the worship of water-sprites) prevails among the thousands of fishermen, raftsmen, boatmen, and sailors of the mighty rivers and lakes" (Steveni, 1913). A pagan storm deity was by then "the Tsar of the winds, who ... is also very common" (Steveni, 1913). After providing concise accounts of several offerings and sacrifices to the various sprites by both Russians and Finnish tribes along the upper Volga, Steveni (who spent more than 10 years in Russia), mentions the "wise woman" in northern Russian villages, "who effects cures by spells and incantations and the use of herbs." Here we are not so far from the world of Baba Yaga. But although belief in witches is specified, Baba Yaga herself is not mentioned and mushrooms are only referenced as a common food in Steveni (1913). Use of herbs and roots, as well as potions and incantations, were frequently mentioned in Russian witchcraft trials of earlier times (Zguta, 1977). References to fly agaric in Jordon (2012), pertaining to Swedish witches, and in Czigány (1980), pertaining to "wise women" in Hungary, are especially engaging, as they relate use of fly agaric in the traditions of northern and central Europe, respectively, as opposed to the shamanic traditions of Siberia. Is the presence of the wizard Mukhomor ("Fly-agaric") in Russian fairy tales an indication of a bridge between Siberian and west/ central European traditions? Might Baba Yaga also be found on this bridge?

At present, rather than create our own mythologies, it is best to admit the paucity of sources and the limits of reasonable conjecture. The Baba Yaga of fairy tales is likely the result of anastomosis between numerous strands, some glimpsed by us only faintly and fleetingly. It seems unlikely that any single strand comprised a "true" Baba Yaga of remote antiquity, but each may have contributed to her eventual identity, including her association with mushrooms.

1. Taras Nazarov and Sveta Yamin-Pasternak, both fluent in Russian, read pages 66-67 of the 1986 edition and confirmed this result: mushrooms are not mentioned by Propp (1986) on these pages.
2. Vilenskaya (n.d.) cited Small (1966), as did Ruck *et al*. (2007) for this story of a hedgehog and mushrooms. Her phrasing, seemingly straight from Small (1966), is word-for-word the same as that of Soidla and Shapiro (1997). Small's (1966) tale was "drawn together into one story" from "such sources as" (Small lists several 20th century fairy tale compilations). Small (1966) is an engaging tale written for children, but of indefinite (or mixed) provenance.
3. Bilibin was in Germany in 1898 and 1900, where other artists portrayed witches with mushrooms. Heinrich Vogeler's *Die Hexe mit Eule* (1895) includes *Amanita* mushrooms. Alexander Zick (1845-1907) portrayed the witch in *Hänsel et Gretel avec la sorcière* (date unknown) with red-capped mushrooms. German artists Paul Meyerheim (1843-1915) and Hermann Vogel (1856-1918) showed mushrooms with witches or other fairy tale characters in the 1890s. In England, Edgar Bundy's A Witch (1896) contained fly agarics. H.J. Ford's *The Witch-Maiden* (Yellow Fairy Book, 1894) has a fly agaric. Such examples could be multiplied and after 1900 were abundant.
4. Ruck *et al*. (2007) cite Propp (1986) in support of their statement on Baba Yaga and "the gateway to another world ... through purveyance of magical food and drink, most often mushrooms, commonly depicted, *at least in late illustrations*, as fly agarics" (emphasis added). As indicated in footnote 1, I can find no evidence that Propp (1986) actually mentioned mushrooms in this regard. In their footnote 5, referencing Propp (1986), Ruck *et al*. (2007) also cite Vilenskaya (n.d.), who like Soidla and Shapiro (1997), specifically referred to Propp (1986, pp. 66-67) in support of mushrooms being magical food. Ivanova (2013) wrote that mushrooms were "supposedly" the food leading to the other world, but directly cited no specific source. One might tentatively conclude that this persistent citing of Propp (1986, pp 66-67), who did not actually specify mushrooms on those pages, and of Small (1966), whose tale of Baba Yaga, a hedgehog and mushrooms was a late synthesis (see footnote 2), have lent too much credence to the idea that Baba Yaga was intimately connected with mushrooms in authentic, transcribed folktales. Whether or not she was associated with mushrooms in other folkways, including with the wizard Mukhomor (fly agaric) is a different matter.

Acknowledgements

The author thanks Taras Nazarov and Sveta Yamin-Pasternak for assistance with Propp (1986), and Sveta Yamin-Pasternak for constructive comments on the manuscript.

frank.dugan [at] ars.usda.gov, fdugan [at] wsu.edu

Literature cited

1. Afanas'ev, A. 1945. *Russian Fairy Tales*. Pantheon, New York,662 pp.
2. Allegro, J.M. 1970. *The Sacred Mushroom and the Cross.*
3. Bantam, New York, 355 pp. Ankrava, S. 2013. Baltic religion, pp. 359-371 in: *The Handbook of Religions in Ancient Europe*. Routledge, London.
4. Barber, E.W. 2013. *The Dancing Goddesses: Folklore, Archaeology, and the Origins of European Dance*. W.W. Norton, New York, 429 pp.
5. Barford, P.M. 2001. *The Early Slavs.* Cornell University Press, Ithaca.
6. Biezais, H., and S. Ankrava. 2005. Baltic Religion, pp. 756-762 in: *The Encyclopedia of Religion*, 2nd ed., vol.2, L. Jones, M. Eliade, and C.J. Adams, eds., Macmillan Reference, Detroit.
7. Borrow, G. 1862. Russian popular tales: translated from the Russian. *Once A Week: An Illustrated Miscellany of Literature, Art, Science, & Popular Information* 6: 572-574.
8. Cheek, T. 2013. *Rusalka: A Performance Guide with Translations & Pronunciation.* Scarecrow Press, Plymouth, U.K., 286 pp.
9. Czigány, L.G. 1980. The use of hallucinogens and the shamanistic tradition of the Finno-Ugrian people. *Slavonic and East European Review* 58: 212-217.
10. Deteli&cacute;, M. 1998. Flesh and bones: Literary and real codes in fairy tales. *Balcanica* 29: 269-305.
11. Deviatkina, T. 2011. Images of birds in Mordvinian mythology. *Folklore* 48: 143-152. www.folklore.ee/folklore/vol48/deviatkina.pdf.
12. Dugan, F.M. 2008a. *Fungi in the Ancient World: How Mushrooms, Mildews, Molds, and Yeast Shaped the Early Civilizations of Europe, the Mediterranean, and the Near East.* APS Press, St. Paul, 140 pp.
13. Dugan, F.M. 2008b. Fungi, folkways and fairy tales: mushrooms & mildews in stories, remedies & rituals, from Oberon to the Internet. *North American Fungi* 3(7): 23-72.
14. Dugan, F.M. 2011. *Conspectus of World Ethnomycology: Fungi in Ceremonies, Crafts, Diets, Medicines, and Myths.* APS Press, St. Paul, 151 pp.

15. Dugan, F.M. 2015. Vestiges of vanished gods: Plants and agriculture in the calendars and customs of Northwest Europe, pp. 123-140 in: *Hidden Histories and Ancient Mysteries of Witches, Plants, and Fungi.* APS Press, St. Paul.
16. Dugan, F. 2016. The War of the Mushrooms: A Russian folktale revisited. *FUNGI* 8(5): 35-36.
17. Dunn, E. 1973. Russian use of *Amanita muscaria*: A footnote to Wasson's Soma. *Current Anthropology* 14: 488-492.
18. Edgeworth, M.L. 1869. Professor Wittembach's story: the mystery of Lokis. *Appletons' Journal* 2: 423-427, 455-459.
19. Farrell, D.E. 1993. Shamanic elements in some early eighteenth century Russian woodcuts. *Slavic Review* 54: 725-744.
20. Filotas, B. 2005. *Pagan Survivals, Superstitions and Popular Cultures in Early Medieval Pastoral Literature.* Pont. Inst.
21. Medieval Stud., Toronto, 438 pp. Forrester, S., H. Goscilo, and M. Skoro (eds.). 2013. *Baba Yaga: The Wild Witch of the East in Russian Fairy Tales.* University Press of Mississippi, Jackson, 202 pp.
22. Gimbutas, M. 1999. *The Living Goddesses.* Ed. And supplemented by M.R. Dexter, University of California Press,Berkeley, 286 pp.
23. Gimbutas, M. 1982. *The Goddesses and Gods of Old Europe: 6500-3500 BC; Myths and Images.* University of California Press, Berkeley, 304 pp.
24. Goscilo, H. 2013. Caption to Baba Yaga as the queen of hearts, p. xxviii, p. 125 in: *Baba Yaga: The Wild Witch of the East in Russian Fairy Tales*, forward J. Zipes, introduction & trans. S. Forrester, captions to illustrations H. Goscilo, selection of images M. Skoro & H. Goscilo, eds. S. Forrester, H. Goscilo, M. Skoro, University Press of Mississippi, Jackson.
25. Haney, J.V. 2013. *Long, Long Tales from the Russian North*. University Press of Mississippi, Jackson, 301 pp.
26. Haney, J.V. 2014. *The Complete Folktales of A.N. Afanas'ev. Vol. 1*. University Press of Mississippi, Jackson, 560 pp.
27. Haney, J.V. 2015. *The Complete Folktales of A.N. Afanas'ev. Vol. 2*. University Press of Mississippi, Jackson, 608 pp.
28. Hatto, A. 2017. *The World of the Khanty Epic Hero-Princes: An Exploration of a Siberian Oral Tradition.* Cambridge University Press, Cambridge.
29. Hubbs, J. 1988. *Mother Russia: The Feminine Myth in Russian Culture.* Indiana University Press, Bloomington, 302 pp.
30. Ivanits, L.J. 1989. *Russian Folk Belief*. M.E. Sharpe, Armonk, New York, 256 pp.
31. Ivanova, E.V. 2013. The problem of mysteriousness of Baba Yaga character in religious mythology. J. Siberian Federal University, *Humanities and Social Sciences* 12: 1857-1866.
32. Johns, A. 2004. *Baba Yaga: The Ambiguous Mother and Witch of the Russian Folktale.* International Folkloristics Vol. 3., Peter Lang, New York, 356 pp.
33. Jordon, C.H. 2012. *Whispers in the Church: Swedish Witch Hunt, 1672.* Abbott Press, Bloomington, Indiana, 276 pp.
34. Kabakova, G. 2016. Baba Yaga dans les louboks. *Review Sciences/Lettres* 4: 1-11. https://rsl.revues.org/1000.
35. Limerov, P.F. 2005. Forest myths: A brief overview of ideologies before St. Stefan. *Folklore* 30: 97-134. www.folklore.ee/folklore/vol30/limerov.pdf.
36. Lyall, R. 1823. *The Character of the Russians and a Detailed History of Moscow*. T. Caldwell, London, 667 pp.
37. Marjani&cacute;, S. 2003. The dyadic doddess and duotheism in Nodilo's *The Ancient Faith of the Serbs and the Croats*. *Studia Mythologica Slavica* 6: 181-204.
38. Marley, G.A. 2010. *Chanterelle Dreams, Amanita Nightmares: The Love, Lore, and Mystique of Mushrooms*. Chelsea Green, White River Junction, Vermont, 288 pp.
39. Mérimée, P. 1905. Lokis, pp. 1-74, in: *The Writings of Prosper Mérimée*, Vol. 5. George E. Croscup, London.
40. Ostling, M. 2011. *Between the Devil and the Host: Imagining Witchcraft in Early Modern Poland.* Oxford University Press, Oxford, 279 pp.
41. Propp, V. 1968. *Morphology of the Folktale*, 2nd ed. Trans. L. Scott, introductions S. Pirkova-Jakobson and A. Dundes, preface L.A. Wagoner. University of Texas Press, Austin, 158 pp.
42. Propp, V. 1984. *Theory and History of Folklore.* A.Y. Martin and R.P. Martin, trans., E. Liberman, ed., University of Minnesota Press, Minneapolis, 251 pp.
43. Propp, V. 1986. Исторические корни волшебной сказки *(Istoricheskтye korni volshebnoy skazki - Historical Roots of the Fairy Tale*). Leningrad University Press, Leningrad. [In Russian]
44. Propp, V. 2012. *The Russian Folktale*. Trans. & ed. S. Forrester, forward J. Zipes. Wayne State University Press, Detroit, 387 pp.
45. Puharic, A. 1959. *The Sacred Mushroom: Key to the Door of Eternity.* Doubleday, New York, 262 pp.
46. Ralston, W.R.S. 1872. *The Songs of the Russian People, as Illustrative of Slavonic Mythology and Russian Social Life* (reprint 1970). Haskell House, New York, 447 pp.
47. Ralston, W.R.S. 1880. *Russian Folk-Tales.* R. Worthington, New York, 388 pp.
48. Richards, S. 2004. Baga Iaga and the Great Phallic Goddess. *San Francisco Jung Institute Library Journal* 23: 54-66.
49. Ruck, C.A.P., M.A. Hoffman, and J.A.G. Celdrán. 2011. *Mushrooms, Myth, and Mithras: The Drug Cult That Civilized Europe*. City Lights, San Francisco, 300 pp.
50. Ruck, C.A.P., B.D. Staples, J.A.G. Celdrán, and M.A. Hoffman. 2007*. The Hidden World: Survival of Pagan Shamanic Themes in European Fairy Tales.* Carolina Academic Press, Durham, 415 pp.
51. Ryan, W.F. 1998. The witchcraft hysteria in Early Modern Europe: was Russia an exception? *Slavonic and East European Review* 76: 49-84.
52. Shapiro, M. 1983. Baba-Jaga: A search for mythopoeic identities. *International Journal of Slavic Linguistics Poetics* 28: 109-135.
53. Small, E. 1966. *Baba Yaga*. Houghton Mifflin, Boston, 48 pp.
54. Soidla, T.R., and S.I. Shapiro. 1997. *Everything is According to the Way: Voices of Russian Transpersonalism.* Bolda-Lok, Brisbane.
55. Stankiewicz, E. 1958. Slavic kinship terms and the perils of the soul. *Journal of American Folklore* 71: 115-122.
56. Steveni, W.B. 1913. *Things Seen in Russia.* E.P. Dutton, New York, 259 pp.
57. Thevet, A. 1575. Cosmographie Universelle: illustree de diverses figures des choses plus remarquables veues par l'auteur, & incogneues de noz anciens & modernes. P. L'Huilier, Paris. Tome 2. 1295 pp. https://ia601405.us.archive.org/0/items/cihm_40485/cihm_40485.pdf.

58. Toporov, V.N. 1985. On the semiotics of mythological conceptions about mushrooms. (Translation by S. Rudy.) *Semiotica* 53-54: 295-357.
59. Vilenskaya, L. n.d. From Slavic mysteries to contemporary PSI research and back, part 3. www.resonateview.org/places/writings/larissa/myth.com.
60. Von Kotzebue, O. 1830. *A New Voyage Round the World, in the Years 1823, 24, 25, and 26.* Vol. II. Henry Colburn and Richard Bentley, London, 362 pp.
61. Warner, E. 1985. *Heroes, Monsters and Other Worlds from Russian Mythology.* Peter Lowe, London, 132 pp.
62. Wasson, R.G. 1968. *Soma: Divine Mushroom of Immortality.* Harcourt Brace Jovanovich, New York, 381 pp.
63. Wenska, I. 2015. Sacrifices among the Slavs: Between archeological evidence and 19th century folklore. *Analecta Archaeologica Ressoviensia* 10: 271-294.
64. Wood, J. 2015. Book Reviews - Baba Yaga: The Wild Witch of the East in Russian Fairy Tales. *Folklore* 126: 238-239.
65. Zguta, R. 1977. Witchcraft trials in seventeenth-century Russia. *American Historical Review* 82: 1187-1207.

Psychedelic philanthropy: The nonprofit sector and Timothy Leary's 1960s psychedelic movement

by

Chris Elcock

Received: 2 October 2020; Revised: 3 December 2020; Accepted: 21 December 2020

J Hist Behav Sci. 2021;1-20.
DOI: 10.1002/jhbs.22083

original report: https://bibliography.maps.org/resources/download/18546

Correspondence: Chris Elcock, Saint-Étienne, France. Email: christian.elcock@yahoo.fr

Table of Contents:

- **Abstract**
- **1. Introduction**
  - 1.1 Psychedelic research and patronage
  - 1.2 Leary and the Harvard years (1960-1963)
  - 1.3 Millbrook and the study of spirituality (1963-1965)
  - 1.4 From charity to activism: The Timothy Leary defense fund
  - 1.5 The legacy of the TLDF
  - 1.6 Psychedelic philanthropy beyond the 1960s
- **2. Conclusion**
- **Acknowledgments**
- **Conflict of Interests**
- **Endnotes**
- **References**

Abstract

Little has been written on the financial support behind Timothy Leary's unorthodox research into mind-altering drugs like LSD and psilocybin and his subsequent psychedelic movement. Indeed several individuals and organizations helped the psychedelic cause by directly funding Leary's ventures, offering legal and logistic assistance, and organizing fund-raising campaigns. I argue that classic philanthropic attitudes and wealthy patrons played a major supporting role for Leary's psychedelic movement in the first part of the decade and that the changes in Leary's research objectives and his transition from academic to LSD guru were accompanied by changes in the patterns of support that occurred throughout the 1960s. This paper also connects Leary's legal troubles in the second part of the decade with the rise of the movement to legalize cannabis and points to historical continuity by looking at contemporary endeavors to fund psychedelic research.

Keywords: activism, cannabis, LSD and psychedelics, philanthropy, Timothy Leary

1. Introduction

The 1960s are remembered as a decade when Americans experimented with a wide-range of illicit drugs. In particular, psychedelics like LSD, mescaline, psilocybin, peyote, DMT, and cannabis,1 emerged as a new category of mind-altering substances that could shatter the senses, trigger other-worldly visions, distort notions of time and space, and lead to moments of deep introspection. As these drugs grew in popularity, a movement made up of intellectuals, artists, and religious figures reasoned that psychedelics had the power to radically transform humanity and promoted them accordingly: if everyone altered their brain chemistries with these drugs, global peace, love, and understanding would naturally ensue (Conners, 2010; Elcock, 2013, 2015; Greenfield, 2006; Higgs, 2006; Lee & Shlain, 1985; Stevens, 1988).

Harvard psychologist Timothy Leary was one of many to experiment and to become enamored with psilocybin mushrooms and LSD. As an academic, he was initially keen to study the effects of these drugs on human personality but he came to realize that they were too important to remain in the academy and that they should be promoted on a much larger scale. His research became increasingly idiosyncratic and Harvard and Leary were forced to part in 1963 following reports of drug use on campus and of unethical drug research on human subjects. After this first public controversy, authorities kept close tabs on him and in December 1965 he was arrested at the Texas-Mexico border for cannabis possession. Scrambling for support, he renewed his efforts to promote these drugs in a more aggressive way by explicitly framing the psychedelic experience as inherently religious to invoke his rights as a practicing Hindu (Lander, 2014), but after two more drug busts justice finally sidelined the notorious proselytizer in 1970.

While the jury is still out on Leary and his legacy, this canonical narrative says little about the role of the people who were taken to his persona and who were so impressed by his psychedelic undertakings that they decided to help him through financial contributions and logistic assistance. Based on publications in magazines and newspapers, letters, memoirs, and personal communications, this paper argues that Leary's movement[2] was helped by typical philanthropic attitudes drawing from a long tradition in American life in spite of the controversies surrounding LSD and its association with the counter-culture in the second part of the 1960s. Americans from various backgrounds reasoned that if the psychedelic experience was such a great asset for humanity, then they should become the protectors and the benefactors of the psychedelic movement. And when the controversial Leary ran into trouble with the law, many stepped in to offer their support and donated to a fund created for his legal expenses.

By examining the role of Leary's supporters this paper seeks to offer an alternative to the two dominant takes on the history of the psychedelic movement (in contrast with the general historical scholarship on the history of LSD and psychedelics, which has been growing exponentially over last few years through increasingly varied approaches and geographical focuses (Aronov, 2019; Dawson, 2018; Hartgosohn, 2020; S. Marks, 2015; Oram, 2018; Richert & Dyck, 2020)). Indeed several historians and commentators have dismissed Leary's movement as an embarrassment and only given it surface treatment in their analyses by zeroing on the controversies surrounding that history, such as the psychedelic movement's extreme and provocative rhetoric.[3] In particular, they have condemned Leary for his reckless promotion of psychedelic drugs and in doing so, they have downplayed his well-documented claims of enlightenment through psychedelic experimentation.

By contrast a revisionist school, partly through the lens of spirituality, has based its interpretations on the premise that psychedelics had the power to induce a complex spiritual experience, which became the cornerstone of Leary's promotion of these drugs (Fuller, 2000; Kent, 2001; Lander, 2011, 2014; Shipley, 2015).[4] While this side of the scholarship has paid a lot more attention to claims of drug-induced enlightenment, I focus instead on the behind-the-scenes history of the psychedelic movement, rather than its well-publicized and sensational aspects, to move away from Leary at the center-stage of this narrative and examine the more discreet and influential players who made this movement possible.

This paper begins with a brief contextualization by looking at psychedelic funding in other research groups and goes on to illustrate the main argument by identifying several key events and periods that were accompanied by changes in the patterns of support for Leary's work. First, his discovery of psilocybin in 1960 and his fascination for the drug led him to share his enthusiasm with several influential New Yorkers, including Beat poet Allen Ginsberg who convinced him that it was an important asset for humanity and that it should be enjoyed by all. In turn, this spurred Leary to successfully court the support of the New York upper class to sponsor his research by channeling funds to Harvard. At the time he was not the controversial and polarizing figure he became in the second part of the 1960s and his research was thought to be a legitimate way of contributing to the "well-being of mankind" (Zunz, 2012a) that deserved adequate support.

Second Leary's first contact with LSD in 1961 made an even greater impression on him and led him to believe that reality was merely a cultural construct. As a result his research became increasingly idiosyncratic and by the time Harvard had moved to oust him and his closest lieutenant Richard Alpert (who subsequently dismissed drugs and became Baba Ram Dass) in 1963 Leary was already setting his sights on experimenting with psychedelics outside the confines of academia. During that period most of the classic patronage dried up but two millionaires and heirs to the Mellon family continued to help Leary and his group by allowing them to settle on their spacious mansion in Millbrook, New York. Their continuing support may come as a surprise given the radicalization of his thought, but then in the larger social history of the 1960s even the radical turn of the civil rights movement in the second part of the decade did not put an end to its philanthropic support (Zunz, 2012a, p. 201).

Finally, Leary and his associates carried on with their freewheeling psychedelic explorations but his 1965 arrest for cannabis possession was a watershed moment that gave him added media coverage and contributed to a major shift away from classic philanthropy. Leary finished discarding what was left of his academic career, appointed himself the "High Priest" of LSD, and from then on systematically touted the drug as a Godsend and a cure-for-all. Meanwhile what had begun as behavioral research into psychedelics funded by wealthy patrons morphed into a grass-roots movement to decriminalize cannabis made up of less-fortuned Americans keen to support Leary and his legal battles with more modest contributions. As a political movement this was considered to be legally off limits for big philanthropy, which has traditionally stayed clear from such ventures and concentrated on the realms of science and education that are deemed to be politically neutral (Zunz, 2012a, p. 5). Yet, this did not stop a handful of New York millionaires from getting involved in the battle-just like some had to cover "Typhoid Mary" Mallon's own legal expenses at the turn of the century (Bartoletti, 2015).

By looking at this undocumented side of Leary's movement, this paper adds to the history of American philanthropy (Bremner, 1988; Crowther-Heyck, 2006; L. J. Friedman & McGarvie, 2002; 2002; Powell & Steinberg, 2006; Zunz, 2006, 2012a) by examining how both wealthy and ordinary Americans dedicated time and money to benefit the psychedelic community, regardless of its illegal or otherwise deviant practices. In this way, it documents a rather unique case of open psychoactive drug activism that transcended class, which may, in a much larger historical framework, be framed as an early attempt to liberalize illicit substance use before the war on drugs of the 1970s. In a similar vein, this article examines the transition from psychedelic funding to marijuana activism and understands the support for Leary's campaign to prove the cannabis laws unconstitutional as a catalyst for a much broader movement to decriminalize and legalize the drug, and contributes to the history of cannabis politics by underscoring its loose connection with big philanthropy (Booth, 2005; J. C. Davis, 2015; Dufton, 2017; Ferrara, 2016; Lee, 2013).

As well this paper builds on the existing historiography of the 1960s. First, it pays particular attention to the way Leary's movement was helped by a funding process that is considered "a quintessential part of being American" (Zunz, 2012a, p. 3) and adds to the scholarship that has argued that this movement was part and parcel of American culture in spite of its apparent criticisms of the American way of life (Elcock, 2015).[5] Second this side of the history of drug use points to a complex and pluralistic psychedelic culture that could include millionaires as much as ordinary Americans and examining this uncanny involvement of the elites and the mobilization to protect Leary becomes another way of rethinking the boundaries separating part of the 1960s counter-culture and the "dominant" or "mainstream" culture it supposedly took issue with.[6] Beyond these contributions this paper points to the contemporary context of the scientific reappraisal of psychedelic drugs in neuroscience and psychiatry (the "psychedelic renaissance" (Hartgosohn, 2020; Langlitz, 2013; Sessa, 2012) and discusses the historical continuity of psychedelic philanthropy.

1.1 Psychedelic research and patronage

In the 1950s, and before psychedelic drug use became more visible in the second part of the following decade, some medical doctors saw these substances as novel ways of probing the depth of the human mind. LSD appeared to break down mental barriers, ease the process of introspection, and lead to therapeutic renewal. As a result, psychiatrists reasoned that the drug could be a valid adjunct for psychotherapy and used it to treat mental illness and alcoholism (Dyck, 2008; S. Marks, 2015; Passie, 1997). By the late 1950s LSD had generated a considerable amount of scientific enthusiasm that was amply covered in newspapers and magazines (Siff, 2015). In various parts of the country, medical doctors conducted research as part of their scholarly work for universities. Like most investigations undertaken in behavioral sciences, many of those endeavors were funded by the National Institute for Mental Health.[7] But others realized that certain wealthy philanthropists and non-profit foundations could offer them financial assistance.

The private funding of psychedelic science may seem surprising on the surface, given the controversies that occurred in the 1960s, but less so if we look at the trends in patronage in the postwar period and the intellectual and scientific shifts that accompanied them. At the time behavioral sciences laid great emphasis on problem-solving and psychedelics seemed to offer a great deal to tackle various social ills (Stafford, 1967). Historian Hunter Crowther-Heyck has disputed the notion that patrons resented politically controversial topics related to race, class, gender, and religion. For instance, federal and private patronage supported projects that were instrumental in the *Brown vs Board of Education* Supreme Court decision, launching the war on poverty and challenging ideas of sexuality, race, and gender (Crowther-Heyck, 2006, p. 427), and other historians have tempered the hegemonic influence of the Cold War on the funding of research topics in the social sciences (Solovey & Cravens, 2012).

But even then qualifying psychedelics as controversial substances in those early years is debatable. On the one hand, psychedelic research did break away with the behavioral sciences that were increasingly adopting a rigorously empirical "natural science" model for social sciences to gather support (Crowther-Heyck, 2006, p. 426); psychedelic scientists relied instead on subjective accounts of psychedelic experiences to underscore the efficacy of their therapies (Oram, 2012). On the other hand, perhaps LSD was just another substance among the battery of drugs available to Americans in the golden era of psychopharmacology (Healy, 2002; H. Marks, 1997).

Some of these funds were channeled to major organizations dedicated to the study of these substances outside academia. In 1961, the International Foundation for Advanced Study (IFAS) was founded in Menlo Park, California. It gathered a team of researchers to look into the potential of psychedelics and had Charles Savage as medical director from 1962 to 1964. In 1965, Savage became director of research at the Spring Grove State Hospital in Baltimore where seminal psychedelic research was conducted (Oram, 2018, p. 109)[8] and maintained his involvement with the IFAS. On October 8, 1965, he wrote to Nina Ridenour, secretary to the Ittleson Family Foundation, a philanthropic organization in New York City that had been interested in curbing mental illness since 1932. He acknowledged their financial contribution "at a time when support for this study was difficult to obtain" and added: "Even more important to me than the money was the moral support which you provided."[9]

Savage seemed to have realized that philanthropists could be powerful allies for psychedelic research and tried to further court the Ittleson Foundation by sending them a letter describing his ongoing work and suggesting that additional funds would be most welcome. In tune with the objectives of the Foundation, Savage was careful to underline the potential of this study for the greater benefit of society: "It appears that we have developed useful techniques for the brief psychotherapy of chronic neurotics and alcoholics." He also felt that it was "timely to expand the range of therapy to such social problems as addiction and delinquency."[10] On February 15, 1966, Savage scheduled an LSD session for Ridenour to observe on closed-circuit TV on February 24, 1966, so that she could get a better idea of their work.[11]

Other scientific organizations investigating the potential of LSD for mind research enjoyed even better fortunes. In 1963, British expatriate and M.D. John Beresford founded the Agora Scientific Trust in New York City and co-directed it with philosopher Jean Houston. Among the research advisers was *Playboy* executive Victor Lownes (who dispensed the drug to The Beatles' dentist and to filmmaker Roman Polanski) but more importantly, the group could count on the support of Nassau millionaire Howard Teague who, as psychologist Stanley Krippner recalls, had a life-changing psychedelic experience and wished to see these substances used legally.[12] According to Michael Hollingshead, another British expatriate famous for introducing Leary to LSD, Teague bankrolled the organization by helping it acquire property and furniture "in a very open and generous way."(Hollingshead, 1973)

What drove these patrons to give to psychedelic research is not always clear but it is nonetheless possible to suggest four general types of motivations. The first obvious reason was scientific. Psychedelics were promising adjuncts for psychiatry and might be able to alleviate social problems like alcoholism, mental illness, and prison recidivism (Doblin, 1998; Tenenbaum, 1961). Second, libertarian-minded benefactors moved in when authorities tried to ban psychedelics and to sideline Leary because they saw the attacks as a violation of academic and religious freedom.[13] Third, LSD was still an obscure drug in the early 1960s and some philanthropists may have become interested in these mysterious and exotic substances and supported psychedelic research to boost their cultural capital (Ulibarri, 2000; Versterlund, 2006).[14] Finally, those who underwent a life-changing spiritual experience with psychedelics felt that these drugs were so important that they needed to be widely promoted. Where scholars have acknowledged the importance of religion in shaping social movements, charity, and voluntary associations (see, e.g., Hustinx *et al*., 2015; Lam, 2002; Rossinow, 1998) a religious revelation (Huxley, 2004; Nordstrom & Pilgrim, 1980; Shipley, 2015; H. Smith, 1964; Zaehner, 1957),[15] rather than belonging to a religious congregation, could prompt philanthropists to support psychedelic research.

1.2 Leary and the Harvard years (1960-1963)

In the early years of the 1960s Leary was also conducting psychedelic drug research, which became increasingly idiosyncratic as the years went by. At Harvard University's Center for Research in Personality, he saw fit to surround himself with fellow academics as well as lay people and he liberally dispensed psychedelics to Allen Ginsberg, jazz musician Charles Mingus, and poet Robert Lowell, to name but a few. Spurred by Ginsberg's own idealistic enthusiasm, he shunned Aldous Huxley's caution to refrain from promoting psychedelics as magic bullets, particularly after his seminal 1961 LSD experience, after which he concluded that reality was nothing but a cultural consensus (Higgs, 2006, pp. 41-46)

While most researchers into LSD and psychedelics were far more conservative in their approaches to these drugs, psychedelic idealism was neither confined to Leary, nor was his desire to share these substances with non-scientists. Saskatchewan-based MDs Humphry Osmond and Duncan Blewett were thrilled by the possibilities for personal transformation and Osmond and UCLA psychiatrist Sidney Cohen famously initiated Huxley and Henry and Clare Booth Luce respectively (Dyck, 1997; Novak, 1997). But this paled in comparison to Leary's iconoclastic brand of psychedelic research that was intent on revealing the transformative power of these drugs regardless of the scientific method-even though his treatment model did not differ greatly from the accepted methods of the time-and to his ultimate goal of making the world a better place.

Perhaps more importantly Leary and Alpert were both charismatic figures who were able to draw considerable support from a broad range of Americans. In their respective biographies of Leary Robert Greenfield and John Higgs both describe him as seductive, manipulative, and narcissistic-though Higgs' account is generally more balanced and occasionally more sympathetic (Greenfield, 2006; Higgs, 2006). What is less documented is the background of Richard Alpert, who was born into immense wealth thanks to the fortune his father had made in the railroad industry, and the influence he had at Harvard. As Beat poet Gerd Stern remembers, "Richard was probably the most magnetic and the most successful lecturer in psychology ever to teach at Harvard. Psychology 1, or whatever it was that he taught, always needed the largest auditorium, and there was never even standing room available. The guy is a snakeoil salesman of the first order. I mean, he can go on any subject and persuade you that this is absolutely it" (Stern, 2001). More to the point Alpert was described by former Harvard graduate student Ralph Metzner as a "money magnet" because of his ability to attract research grants before his involvement with psychedelics, which in turn enabled him to employ several graduate students (Dass *et al*., 2010).

As the word got around that Leary was conducting mind-altering drug sessions around Harvard and in New York City, a wide pool of supporters became interested in his enterprise and felt that his experiments warranted funding. From 1961 to 1963 he and his associates organized drug sessions with incarcerated inmates with the stated aim of reforming them from within to ultimately set them free and gradually empty the prisons of the country.[16] His prison rehabilitation program certainly appeared controversial on the surface; yet, it was surprisingly in tune with the kind of problem-centered and interdisciplinary research projects the patronage system of the time sought to fund. As Crowther-Heyck puts it, "One important consequence of this belief was the idea that research should focus on solving problems with tangible, testable, real-world implications in addition to having significance for theory" (Crowther-Heyck, 2006, p. 433).[17] At the time both the federal government and the non-profit sector were indeed concerned about crime and their respective funding schemes were supporting the Mobilization for Youth initiative to fight juvenile delinquency on New York City's Lower East Side (Zunz, 2012a, pp. 212, 213). Hence patrons supported Leary's work not necessarily out of psychedelic conviction but because it might be able to tackle a major social issue in a highly innovative and radical way.

This project became partly funded by the Uris Brothers Foundation, created by real estate tycoons Harold and Percy Uris. The grant, which was renewed in 1962, covered clerical expenses and the salaries of former inmates working in the community.[18] The connection between Leary and Uris appears to have been made possible by real estate agent Bernard Friedman, who was drawn to Leary's enterprise as a result of a psilocybin session the latter had conducted for him. Friedman believed that the mushrooms had helped him become "freer, more relaxed" as a writer and he wanted to repay Leary in any way he could. So he spoke with the supervisor of the Foundation and Harvard graduate who was keen to contribute $5,000 to his *alma mater* (B. H. Friedman, 2006).[19] Wall Street stock-brokers also felt that Leary's work could benefit society. In May 1963, Arthur Tomaselli of Arthur Wiesenberger & Company sent them $100 drawn on the Morgan Guaranty Trust Company and acknowledged their "noble cause."[20]

His greatest backers, however, came from the Hitchcock family that boasted a long tradition of philanthropy. Peggy and her brother Billy-a stockbroker at Lehman Brothers-were the grandchildren of founder of Gulf Oil William Larimer Hitchcock, the nephews of the famous philanthropist Andrew W. Mellon, and the children of Tommy Hitchcock Jr., considered one of the greatest polo players ever. They helped him further his crusade by offering financial, logistic, and legal assistance.[21] Peggy became the secretary to Leary's International Foundation for Internal Freedom (IF-IF), an eclectic organization dedicated to the study of psychedelics.

This was but one of the many acts of generosity coming from the Hitchcock family, who soon became critical allies for Leary's venture. Peggy and Billy's brother Tommy sympathized with Leary's cause by donating $2400 toward his research,[22] but his direct involvement remained discreet. Peggy, on the other hand, appeared to be thrilled by the possibilities offered by these drugs and by Leary's psychedelic mission. As the secretary to IF-IF, she sent several letters to members of her family with materials pertaining to psychedelic research, which shows that she was looking to broaden IF-IF's support base by sparking their interest in these drugs. For instance, she told her uncle Jack and aunt Ray Walton, daughter of William Larrimer Mellon and philanthropist, that she was terribly excited by her involvement in psychedelic drug research and by the new scientific possibilities to study consciousness, and underscored the value of such substances for the human race.

Crucially, she also mentioned that the current scientific climate threatened psychedelic research and that it was urgent and critical to lobby the government to ease the situation: "The present need for funds is the result of a ridiculous development, the confusion in Food and Drug Administration regulations following the thalidomide scandal last summer. Virtually all so-called experimental drugs such as LSD-25, as well as numerous others of different sorts, are no longer available for research, due to new FDA restrictions."[23] Her enthusiasm was genuine, according to Leary. Notwithstanding utopian fancies, she understood that LSD could have great value for society: "I know Peggy was very excited at the possibility of LSD knocking out junk habit."[24]

Leary and his associates realized that charity could be a strong source of income and reasoned that they needed to be more attractive for donors like the Hitchcocks. In October 1963, the IF-IF was granted tax-exempt status, retroactive to the beginning of the year. This was an important asset to help the organization secure additional funds and in the process this brand of psychedelic philanthropy furthered a much longer tradition of tax-exemption that is such a fundamental part of the non-profit sector.[25] In two letters, Alpert informed some of the contributors, which included Peggy Hitchcock, of the news and thanked them again for their generosity: "Your gift, made at a time when our need was so great and when we could not definitely assure tax exemption, was doubly welcome. I am happy that from a tax point of view this confidence has been justified."[26]

But in spite of Peggy's generosity, Leary could not always easily have access to some of the funds for his research, likely because Leary was flouting academic conventions and because the university was uneasy about a psychologist (rather than a psychiatrist) dabbling with strange mind-altering drugs. In November 1962 she contributed $3000 toward his "Behavior Change Program" through the Laboratory of Social Relations of the Harvard Faculty of Arts and Science. As arrangements were made to channel these funds to Leary, the Laboratory requested certain provisions which suggested that the university was beginning to treat his research with suspicion. It informed him that they were "not willing to administer funds for their research involving the drug psilocybin unless a suitable committee could be formed to advise on the research and help control the various public repercussions of their activities." As the Laboratory believed that those conditions were not met, it informed Leary that he should request a transfer of the funds out of the laboratory and into an external organization.[27]

It is easy to see why Harvard was pulling the plug on his research, just like medical doctor Thomas Szasz had seen his staff dwindle because of his controversial views on psychiatry around the same time. Initially, Leary seemed like a promising psychologist who had a bright career ahead of him. His interest in psychedelics did raise a few eyebrows, but then the university also had a long tradition of academic freedom, so he was free to experiment with psilocybin. Things changed in spring 1962, however, when the *Boston Herald* tabloid reproduced a damning piece revealing that Leary and Alpert's colleagues were concerned by their lack of scientific rigor and suggesting that these drugs were trickling out of their lab and onto the campus (Gordon, 1962, as referenced in Siff, 2015, pp. 124 and 125). The publicity certainly piqued the curiosity of several students but more importantly the Harvard drug scandal was the first of the kind to make the nationwide news. In 1963, Leary's and Alpert's contracts were not renewed.

Though the university's concern for its reputation explains in part why it sought to impose restrictions on Leary's research, his gradual resentment of academic science can also be attributed to the inherent complexity of the psychedelic experience. Those investigating LSD as an adjunct to psychotherapy relied on the subjective experiences of their patients, rather than on hard, objective, and measurable data. In the aftermath of the thalidomide scandal that had witnessed the drug cause terrible birth defects, which Peggy Hitchcock mentioned in the letter to her aunt, the 1962 Kefauver Harris Amendment of the FDA introduced the requirement to prove the scientific efficacy of a drug before it could be used, which created further constraints for psychedelic research. As historian Matthew Oram has argued, this crippled research to a point where only a handful of government-sanctioned studies were underway by the late 1960s.[28]

It is no surprise, then, that the idiosyncratic Leary preferred to move away from the university and continue his research outside academia. This prompted a gradual metamorphosis whereby he "abandoned the role of the conventional, academic, scientist, and became, without knowing it, a *shaman*, an activist change-agent" (Leary, 1982). Philanthropists did not terminate their funding, however. They reasoned that Leary's research was important, regardless of the epistemological questions surrounding psychedelic science.

1.3 Millbrook and the study of spirituality (1963-1965)

After leaving Harvard Leary wondered where the IF-IF could set up shop and, partly thanks to Peggy Hitchcock's handsome 20,000 dollar donation (Leary, 1990), they initially found sanctuary in Mexico and subsequently in the Caribbean. But in the end, local authorities were unimpressed by a bunch of eccentric Americans using mind-altering drugs (Higgs, 2006, pp. 54-58) and they were forced to temporarily move back to Boston. Before the Hitchcocks offered their assistance once again, Leary was courting the help of another wealthy figure. Early in 1964 Bostonian and Romania-born Elisabeth Amelung expressed her interest in supporting the IF-IF by inviting them to settle on her 55-acre estate. She had experimented with the psychedelic peyote cactus and organic gardening with an experimental commune in Romania.[29]

But Leary soon learned that the Hitchcocks had just bought a 2500-acre estate in upstate New York for tax purposes-it functioned as a cattle ranch so it was also good investment. His group settled down on their property in Millbrook and Leary created the Castalia Foundation to study psychedelics in an even more eclectic setting and with reasonable operating costs-the rent was a dollar a year (Greenfield, 2006, pp. 206, 207). Billy joined and sponsored Castalia and the other two semi-religious institutions that sprouted on his estate. Bill Haines ran the Sri Ram Ashram and former psychologist Art Kleps, who authored a zany psychedelic *Boo Hoo Bible* (Kleps, 1971),[30] directed the iconoclastic Neo-American Church. One observer saw this move as a classic case of philanthropy, claiming that Kleps' unusual Church was fortunate to have such a wealthy protector, who gave it "a kind of establishment gloss as well as a home."[31]

As historian of religion Robert Fuller aptly sums up, the Millbrook scene does not elicit easy interpretation. "For about four years Millbrook was a monastery, school, research laboratory, religious commune, and opium den all rolled into one" (Fuller, 2000, p. 69). What is clear however is that in the post-Harvard setting any idea of rigorously empirical science had gone out of the window. But the transition from behavioral sciences to this unorthodox pursuit of psychedelic-induced spirituality did not occur suddenly and had precedents in Leary's time at Harvard (Lander, 2011, p. 67). In April 1962 he and graduate student Walter Pahnke had studied the effects of psilocybin on a group of divinity students in an attempt to show that the drug could trigger a mystical experience.[32] This naturally paved the way for more emphasis on the religious import of the psychedelic experience, which eventually culminated in Leary's transformation into a religious figure extolling the benefits of LSD in the second part of the 1960s.

With Leary's academic career over and all the negative publicity, the New York elite naturally stayed clear from him and his research, which makes Billy Hitchcock's own involvement all the more intriguing. Kleps, for one, was unsure of his motivations: "Youthful folly? Courage of Psychedelian conviction? Sympathy and generosity? Boredom? Innocence? Arrogance? Curiosity? Lecherous anticipation of variegated choirs of marijuana goddesses? The hypnotic spell of Timothy Leary?" (Kleps, 2005b). Some of the Millbrook residents like Hollingshead never trusted him and thought that it was strange, if not downright suspicious, that a millionaire who was part of the "establishment" could have such an interest in the psychedelic revolution. He sometimes took part in the psychedelic group sessions with Leary and his associates, but unlike everybody around him, he tended not to verbalize his experiences and never came forward with any metaphysical insights on his trips.[33] Hollingshead notwithstanding, other figures of the psychedelic movement saw Hitchcock as a fraud. The less-known Lisa Bieberman ran a series of bulletins for the "Psychedelic Information Center" in Cambridge, Massachusetts-she took part in Leary's venture from 1962 onward, but ended up criticizing Leary and Kleps for their public mismanagement of the psychedelic movement.[34] In her writings, she referred to the case of Tord Svenson who had been ordained "Keeper of the Divine Toad" by Kleps and had helped him financially and physically in many occurrences. But when he was arrested for possession of cannabis and peyote, neither Kleps nor Hitchcock budged to assist him with the legal procedures. She also accused Leary and Kleps of extorting money from their supporters when they requested contributions to cover the legal expenses of bail charges ($35,000) levied against the Millbrook residents in various drug-related arrests:

> Billy Hitchcock has already paid the $35,000 bail charges; his pockets are not empty. He has forty million dollars. He owns and operates the estate for his personal amusement. What he feels like paying for, to keep the carnival going, is paid; what he doesn't feel like paying for, isn't paid. Tord Svenson, for instance, was considered dispensable-in the long run anyone is dispensable except Billy Hitchcock, and whomever he relies upon to keep his scene exiting, which at the moment seems to mean Leary and Kleps.[35]

Others, on the other hand, thought that he was genuinely interested in reforming America. For instance, New York psychedelic painter Isaac Abrams still thinks today that "Billy believed in the psychedelic experience."[36] Others still thought that he was simply looking for an unusual form of excitement. Gerd Stern, who collaborated with Leary for artistic undertakings, contends that "Billy like his sister Peggy was intrigued and became involved in the revolving group of exciting personalities who comprised the culture of Millbrook."[37] In any event, he was a major backer for Leary's venture, who undoubtedly enjoyed fueling this unusual scene at the crossroads of science, religion, and debauchery.

As for Billy's sister Peggy, self-described as a "trust fund baby" who was bored by her upper-class environment, it is much clearer that she was fascinated by psychedelics and enamored by Leary. She had first tried mescaline in 1961 and then heard about his research into mind-altering drugs courtesy of the influential theater producer Van Wolfe (Dass *et al.*, 2010, p. 42). Peggy admired Leary's spirit of adventure and enterprise and soon fell in love with him. For a womanizer like Leary the feeling was not mutual but they nonetheless became close friends and occasional lovers. In spite of the money and energy she gave to Leary's mission she was surprised that he never really openly solicited her for greater funding: "He never asked me for money. I think he felt he had to make it on his own [...]. Perhaps he also had a cultural bias because I was a woman with whom he was involved and he would not feel comfortable asking me for money" (Dass *et al.*, 2010, p. 58).

Theology professor Walter Houston Clark was another prominent contributor, who was likely driven by a combination of Christian charity and the strong impression the psychedelic experience made upon him. He gave $150 toward Leary's research after spending time with him at Millbrook in 1964[38] and he was rumored to be much wealthier than he appeared, but with the reputation of being stingy. Yet, when Kleps was arrested in Florida for possession of LSD, Clark gave $200 for his bail. On another occasion, Kleps was visited by a young couple that was touring the United States listening to gurus and experimenting with psychedelics. In his own words, they "were ragged and appeared to be poor," but turned out to have substantial income from trust funds, and ultimately "outcontributed Billy Hitchcock ... by about 20-to-1 in the years that followed" (Kleps, 2005d).

The less-known Charlie Rumsey got involved in Leary's movement. For Kleps, his role in New York's psychedelic scene seen has been underestimated: "Psychedelianism will truly have triumphed on the day when the sun's early light dawns in Central Park on a statue of Charlie" (Kleps, 2005e) Rumsey was an old friend of Hitchcock's and a lawyer who came from an equally wealthy background and had ancestral connections with the Harriman family that had built its fortune with the railroad industry and that was also involved in philanthropy. He led an eccentric and flamboyant life and liked to entertain in his New York apartment. For those in the know, however, he became an important LSD supplier for the wealthy and guided many LSD users toward the Millbrook commune. And when Leary ran into trouble with the law, he was one of the many New York jet setters to help the defrocked Harvard professor-by becoming secretary to the Timothy Leary Defense Fund.

1.4 From charity to activism: The Timothy Leary defense fund

In December 1965 Leary was arrested on the Texas-Mexico border for carrying less than an ounce of cannabis. Facing a 30-year prison sentence, he decided to take his case to the US Supreme Court and argue that the 1937 Marihuana Tax Act was unconstitutional. In March 1966, Billy Hitchcock provided Leary's bail money and then set up the Timothy Leary Defense Fund (TLDF) to cover the legal expenses of the upcoming trial. The TLDF published a call for donations in the *New York Times* (Lander, 2014, p. 147) and sent letters all over the country, hoping to gather enough financial support.

As a result one of the psychedelic movement's major sources of income began to shift away from the wealthy philanthropists to a more grass-roots form of campaigning, which involved collecting more modest contributions from less-fortuned Americans. Up until his first arrest, patrons had been supporting Leary's research that many saw as idiosyncratic, but not illegitimate. When they moved to defend him and to contribute to his Defense Fund, they decided to condone his use of cannabis and shifted away from a longer tradition of "scientific philanthropy" (Bremmer, 1988) to promote a form of pro-drug activism that lacked the moral sanction of scientific research. Additionally, Leary's cause converged with the Committee to Legalize Marijuana (LeMar) initiated by Ginsberg and poet Ed Sanders in December 1964, and which argued against the prohibition of cannabis on libertarian and medical grounds (Ed Sanders, 2011).[39] What had started as a charity-based scientific enterprise morphed into a social movement that was in tune with the climate of the middle of the decade.

To be sure, Leary's high-profile exit from Harvard was a source of publicity that helped gather support. For artist Martin Carey, "The '50s were such a dull, sleepy time, and school was dull and boring and inoffensive.' The people who had trouble in school were usually more intelligent, so they got bored." Hearing about a drug scandal in an Ivy-league institution-it "was like a light shining into all that boredom" (Graboi, 1991)[40] Yet, Leary's crusade would not have been the same without the backing of the New York jet set, rather than the so-called "Flower Children" of the second part of the 1960s, and the TLDF secured funds through a letter-writing campaign that was hardly unconventional. Historian Lisa McGirr has studied the history of conservative activism in Orange County, California (where Leary was, incidentally, arrested again in 1968 for cannabis possession) by examining the grass-roots role of ordinary middle-class suburbanites who pressed for a conservative agenda, which also included writing letters (McGirr, 2001). Just as McGirr lamented the disproportionate focus on the liberal and progressive movements of the 1960s at the time of her publication, a more balanced take on one of the most controversial movements of the decade reveals classic tactics and backers, rather than just radical and provocative statements and actions.

In the larger history of the psychedelic movement, Leary's 30-year conviction for cannabis possession and his subsequent defense is critical to understand the latter part of the decade. Notwithstanding the convergence with LeMar, it also saw him complete the transition from academic psychologist to High Priest of LSD that had begun in the aftermath of the drug scandals at Harvard. This was not just the result of a discussion with the famous Canadian media analyst Marshall McLuhan, who had advised him to make his discourse fashionable and appealing to gather popular support. As his lawyer pondered how to defend his case, Isaac Abrams, who happened to be visiting at Millbrook, came up with a brilliant idea: "Well, American Indians take peyote as a sacrament. Maybe this is a similar thing." The attorney was thrilled. "And the next thing you know, they were calling it a sacrament."[41] By presenting cannabis as such, it opened up a new legal strategy: Leary, as an alleged practicing Hindu, could invoke his right to use the drug as part of his religion.[42]

So the language of "rights" became one of Leary's favorite angles of defense (Elcock, 2015). This contrasted with the rhetoric deployed by another psychedelic icon. Novelist Ken Kesey, famous for writing *One Flew over the Cuckoo's Nest* and for organizing seminal psychedelic parties on the West coast, had also been arrested for cannabis possession on April 13, 1965 in his home in La Honda, California. A Ken Kesey Defense Fund (KKDF) was set up to cover the legal expenses, because the high bail had drained his resources. Although the KKDF courted contributors by invoking the duty to protect the rights guaranteed by their American citizenship, Kesey himself preferred to mention the broader atmosphere of protest that reigned throughout the country:

> I think people all over the country are getting fed up with the way officers of the law have been treating 'outsiders' recently. They're sick of the way police brutally beat young civil rights workers in the South, sick of the methods used by police during the recent demonstrations on the Berkeley campus of the University of California and fed up with the way police officers have been harassing creative groups such as we have here in La Honda [...].[43]

While the legacy and impact of the KKDF is hard to assess due to the lack of primary material available, it appears that the TLDF drew a wide range of support from all over the country. Students, computer programmers, biologists, teachers, postal clerks, or physicists gave to the cause out of libertarian convictions[44] or out of disgust at the harsh sentence passed.[45] Others requested further information on the legality and pharmacology of psychedelic drugs and cannabis, and expressed interest in the idea of reforming drug laws.[46] Others still wished to remain anonymous, but contributed financially and gave lists of names to contact on their behalf.[47] Anthropology professor Omer C. Stewart, who had previously testified as an expert witness in cases involving peyote, was another donor who did not want to see his name appear on the list of public figures supporting Leary, but agreed to support the Fund confidentially.[48] Although the TLDF was based in New York City, the organization was eager to expand and set up chapters in other cities. In Washington, D.C., several supporters formed the Psychedelic Information Center of Washington, which ran newsletters to raise monies or simply collect donations for the Fund.[49]

The TLDF also sent letters to progressive groups, hoping for support from more typical organizations to defend Leary's rights. The Bruin Humanist Forum, a University of California at Los Angeles chapter of the Humanist Union of North America, expressed its sympathy for Leary's cause and supported him by disseminating information about cannabis and LSD, and was also interested in the broader issues: "We are eager to help in the fight to legalize marijuana."[50]

In an attempt to connect pro-drug activism with the trademark protest movements of the 1960s, the Defense Fund tried the American Civil Liberties Union (ACLU) that had previously assisted several progressive causes of the 1960s. In 1961 the Southern California chapter had for instance put pressure on the Board of Education to fight school segregation and overcrowding in Los Angeles (Theoharis, 2006) and in 1966 Native American Indians and the nascent Red Power movement likewise found its legal support in 1966 when activists were arrested as a result of their involvement in the "fish-ins" in Washington State to protest against the violation of a 19th-century treaty guarantying their rights to fish in the area (S. L. Smith, 2012).

But when the right to consume illicit drugs arrived on the agenda, the reactions were mostly negative, if not openly hostile. Many ACLU members simply requested to have their names removed from the mailing list and wondered how the TLDF had gotten them in the first place. One member of the Union admitted that Leary's conviction was an extreme sentence, but he felt that he would never have to do more than three years and that at any rate Leary was "largely responsible for the present widespread, uncontrolled use of LSD, especially by young people with well-documented disastrous results in many cases."[51] Another member argued that Leary had repeatedly broken the law and led others down that path and that for that reason he "would gladly do anything [he] could to uphold Timothy Leary's conviction."[52] Another still was brief and blunt: she declined the offer to contribute to the TLDF but on the other hand she was willing to send funds to ensure his imprisonment.[53] Such antagonistic reactions were even stronger than the kind of "liberal anticommunism" that plagued the organization (Kutulas, 2006), so for once Leary was not far off the mark when he wrote around the same time that mind-altering drugs were so reviled in America that they were "a symbol more powerful than sex or communism"(Leary, 1995).

Unfortunately for Leary the TLDF closed on May 27, 1966, due to lack of funds.[54] Despite the many contributions, administrative and legal expenses were too high to be effectively met. Additionally, Leary and his crew were raided in their Millbrook home on April 17 and many were arrested for drug possession. Posting all those bails was a critical blow to the Fund. The three religious leaders, Leary, Kleps, and Haines co-authored the "Call to Alms for the Battle of Millbrook," in which they requested donations for the Millbrook Defense Fund (Kleps, 1971, p. 63), and contributions continued to come in, but at an average of $10 per day.[55]

1.5 The legacy of the TLDF

In spite of its shortcomings the TLDF became a catalyst for the broader campaign to legalize cannabis use. The support Leary received for his defense was not surprising in that marijuana activism had been going on for a few years in New York and was burgeoning in California, where Los Angeles attorney Al Mathews was mounting a challenge with the Anonymous Committee for the Abolition of the Prohibition Against Marijuana by collecting signatures for a petition. They put forth pharmacological arguments that criticized the legality of alcohol and tobacco, when cannabis seemed less harmful and potentially therapeutic.[56]

Leary's strategy inspired some cannabis users to challenge the legislation in a similar way. In September 1966 Mark Fox wrote to the TLDF to request information about Leary's defense because he was awaiting trial in Arizona for possession. Like Leary, Fox was keen to invoke the language of rights to defend himself: "I expect to admit to smoking marijuana but will try to show that it is my right as provided by the U.S. constitution."[57] Howard Ingram was in an even worse situation in California, facing trial for selling the drug to a minor and possession of cannabis and LSD with the intent to sell. He wanted to take his case to the Supreme Court, if he could gather enough support, and was keen on monitoring the Leary case, in hope that his defense would set a legal precedent.[58]

The convergence of psychedelic voluntary associations and the pro-cannabis movement was even more apparent when LeMar received a copy of the TLDF's Declaration of Principle through their attorney, which they signed and returned. The state of their finances did not permit them to contribute to the campaign, but they promised to help by requesting forms to be sent out to the LeMar mailing list across the country.[59] But even more fittingly Mike Lynch wrote to Leary in the fall of 1966 to tell him that he would like to start a LeMar chapter at the Arizona State University and requested "all the historical, legal, social, and scientific information [about] marijuana and LSD."[60]

The psychedelic movement and the TLDF appeared to spur the larger psychedelic counter-culture to jump to the defense of its fellow drug users. The support was often morally justified by the fact that defendants were sometimes entrapped by undercover law-enforcement officers and then faced harsh penalties for use or distribution of the drug. Sometime in spring 1967, Jim Ewan, who was serving as "Boo Hoo" for the Neo-American Church chapter at Wichita State University in Kansas, was entrapped by two FDA agents and charged with possession, sale, and delivery of LSD, and possession of cannabis. A defense fund was set up and calls for legal and financial support were made in the pages of the *East Village Other*. The New York underground newspaper-very sympathetic to psychedelia-stressed the importance of fighting for the case from a religious perspective, just like Leary was doing: "If the psychedelic churches are to hope for any legal acceptance of their use of these sacraments, they should realize the importance of this case, the best test case at present" (*East Village Other*, 1967).

Similar organizations were established throughout the entire country. In Chicago, the Drug Reform Union made plans to offer drug users legal aid and bail money "so that the busted person can obtain legal advice and bail to get him out of jail as fast as possible" (*Daily Illini*, 1969) In 1967 Kleps was arrested in Florida and Lisa Bieberman raised $1000 for his bail through her LSD Loan Fund-"only to have him retreat into Millbrook and refuse to appear for trial, thus causing [her] to lose most or possibly all of the bail money."[61] The LSD Loan Fund also lent one psychedelic drug user $150 to help him with his legal expenses, following his arrest for possession of peyote and cannabis in North Carolina.[62] As well, the magazine *Innerspace*, which was created as a national platform for the psychedelic culture, requested financial assistance for a cannabis user who was arrested in Capitola, California in February 1966 for possession.[63] The magazine offered information about the Jade Companions of the Flowered Dance, which was set up in New York City (with three centers in Manhattan and Brooklyn) to assist psychedelic drug users who had been arrested for drug-related violations of the law: for a $5 annual membership, one had free legal consultation and access to a bail fund in cases of psychedelic drug possession. A similar organization had been established in Washington, DC before the Jade Companions.[64]

As these instances suggest, understanding the rise of this unusual form of humanitarian idealism requires paying attention to the legal status of LSD and other psychedelics. New York State provided penalties for possession and distribution of LSD as early as 1965. The drug was banned on October 6, 1966 in California and the federal government made it a Schedule I drug in 1970, which left psychedelic drug users potentially facing lengthy prison terms. Bails and defense funds were set up to give LSD users a chance to fight for their case in court and became the logical consequence of the new legislation. But in spite of their efforts, the war on drugs of the 1970s dealt a significant blow to these psychedelic enthusiasts.

However, this psychedelic activism was not just the result of a more punitive legislation. A full-blown psychedelic experience was often interpreted as a spiritual revelation and spurred several psychedelic drug users to act not only for the psychedelic community in its largest sense, but also for what they saw as a great benefit to humankind. As with more orthodox forms of religion in the United States, psychedelic spirituality extended beyond simple spiritual practices and into the secular sphere through acts of charity. In this way, psychedelic philanthropy differed from many other forms of charities and voluntary associations, because the desire to improve society was not motivated by the belonging to a religious congregation, but in many cases by a revelatory drug experience.

1.6 Psychedelic philanthropy beyond the 1960s

In the following decades, LSD and psychedelic drug consumption carried on in the United States, albeit without the idealism of the 1960s. Psychedelic research was virtually non-existent due to the new legislation (Spring Grove was the outstanding exception) and philanthropic attitudes toward these drugs seemed to have disappeared. In the 1990s, however, the rise of the neurosciences rekindled the scientific interest in psychedelics and led to a form of "psychedelic renaissance," which was accompanied by a scientific philanthropy that echoed the enthusiasm of the early 1960s.

Anthropologist of science Nicolas Langlitz has since chronicled this renaissance and has shown that wealthy patrons have been instrumental in facilitating the process. In particular, John Gilmore, a wealthy Silicon Valley libertarian committed to defending civil rights, gave millions of dollars in an attempt to make psychedelics available for medical applications. This, he felt, could ultimately end the war on drugs. And the late Bob Wallace of Microsoft was another major donor to the contemporary psychedelic cause. He almost single-handedly sponsored the research undertaken by the Heffter Institute that promotes research into psychedelics. But unlike Gilmore, he was ready to bankroll both the basic scientific research and the Institute's infrastructure. Most donors longed to see these substances used to treat patients and gave accordingly. But Wallace was well-aware that the process was much longer and frustrating and he donated to the cause while hoping that clinical trials would someday follow suit (Langlitz, 2013, pp. 69-77).

Other international organizations like the Multidisciplinary Association for Psychedelic Studies (MAPS) also illustrate how psychedelic philanthropy survived the 1960s. In 2014, for instance, MAPS issued a press release acknowledging donors who had contributed toward scientific investigations into the potential of psychedelic drugs. The organization received $1.9 million from the late Precious Moments artist and psychedelic enthusiast Timothy Butcher who, in the words of a close friend, "believed strongly in the work MAPS is doing."[65] In one newsletter, the organization thanked several people who gave funds for research but one name stood out: "We also gratefully acknowledge the Rockefeller Brothers Fund, who made a grant of $10,000 to honor Richard Rockefeller and his commitment to philanthropy, or 'love of humanity.'"[66] This of course echoed the financial contributions coming from the heirs to the Mellon family half a century ago and shows that what might have seemed like an unusual cause to support for such a big name in the realm of philanthropy back then was in fact not an isolated case.

There is also historical continuity in the way some psychedelic drug users are organizing to protect what they see as their rights to alter their consciousness regardless of the legislation. In particular, the International Centre for Ethnobotanical Education, Research and Service (ICEERS) created an Ayahuasca Defense Fund (ADF)[67] in 2015 to offer legal advice and support for people (lawyers and expert witnesses) who have been arrested for possessing the DMT containing brew that originates from the Amazon basin. Unlike the TLDF, however, the ADF is much better organized and international in scope and it can cite centuries of indigenous ayahuasca use as proof of its safety and efficacy. Hence the ADF has successfully assisted dozens of defendants in Spain, Chile, the United States, and the United Kingdom, and is constantly looking for financial support to further its cause (Oberhaus, 2017).

Meanwhile, cannabis activism is scoring important victories in the United States and North America and it seems like it is only a matter of time before the plant becomes legal on a federal level. In the process, marijuana has already become a multi-million industry attracting investors from all over the country-a remarkable feat which would have seemed like a pipe dream in the 1960s. But an even larger look at the funding patterns behind the entire category of psychedelics reveals that a similar shift might be underway. The UK-based Compass Pathways, which was created in 2016, has come under fire for using private funds in an attempt to develop a for-profit model of psilocybin therapy and the more obscure Eleusis has recently patented a form of LSD therapy for Alzheimer's disease (E. Davis, 2018). This has prompted some prominent members of the global psychedelic community to release a statement emphasizing the need to conduct psychedelic research with "intellectual and scientific integrity, service, open science and open practices, and non-interference" (Jesse, 2018).

Whether this for-profit model will prevail at a time when post-prohibition scenarios are becoming increasingly plausible is a matter of speculation, but the controversy and uproar suggests that the kind of idealism that had permeated Leary's research into psychedelics has survived the 1960s and is here to stay. A non-profit organization like MAPS, however, epitomizes the continuity of a charity-based and idealistic psychedelic research coupled with a discourse that underscores the value psychedelic drugs possess for humanity, while the global psychedelic community is singling out controversial organizations like Compass Pathways and Eleusis for their unethical for-profit motives.

2. Conclusion

In spite of their flawed and controversial nature, then, Leary and his movement were instrumental in framing psychedelics as revered life-changing tools that should be made available to everyone and that attracted like-minded donors. Where many takes on the history of Leary's psychedelic movement have emphasized his irresponsible promotion of psychedelic drugs, this paper has instead examined how conventional philanthropic attitudes were able to support him and other research groups. Some patrons underwent life-changing psychedelic experiences akin to a spiritual awakening and decided that psychedelics were important substances that deserved adequate promotion. Others realized that these chemicals could benefit society and they furthered a long tradition of scientific philanthropy. Still, others were drawn to the excitement and prestige of becoming the benefactors and protectors of the psychedelic movement. Finally, many psychedelic enthusiasts perceived the attacks on psychedelic research as a violation of academic freedom and defended them on libertarian grounds. The support Leary drew for his research should not really come as a surprise if we look at the major aims behind private patronage in postwar America, which could indeed include behavioral research into a category of vision-inducing drugs that went on to become controversially associated with deviance and dissent.

Though Leary's movement and his high-profile crusade to challenge the existing drug laws stood out, many similar groups felt they were part of a large community of illicit substance users and realized that they needed to organize to inform and protect their fellow members who wished to carry on their psychedelic lifestyles regardless of the legislation. Paying attention to these groups shifts attention away from notions of drug use as escapism and subversion of authority and points to more complex patterns of social bonding within the drug culture. As David Farber has contended in his work on the American counter-culture, "historians need to write more about the men and women who tried, often with qualified success, to build a new culture in the late 1960s and early 1970s" (Farber, 2013, p. 3) and focus away from the famous counter-cultural events that fuel the declensionist (or "rise and fall") theory of 1960s historiography. A history of the funding and support behind the psychedelic movement indeed reveals that many Americans did not see LSD in terms of hedonism, but rather as a useful tool that could benefit humanity and chose to fund psychedelic research and help the psychedelic movement accordingly.

Acknowledgments

I wish to thank Erika Dyck, Lindsey Banco, and the blind reviewers of the journals that assessed this paper for their helpful and insightful comments as well as *Social History of Alcohol and Drugs for their editorial support*. Primary research for this paper was gracefully supported by Erika Dyck's Canada Research Chair funds and minor revisions of this paper were funded by generous support from Emilia Sanabria's European Research Council Starting Grant no. 757589.

Conflict of Interests

The author declares that there are no conflict of interests.

Endnotes

1. Marijuana is often defined as a minor psychedelic, even though this classification is debatable. In this paper, I have chosen to include it in that category of illicit drugs because both LSD and cannabis were linked by their ability to spur Americans to give money for research and activism. Although psychedelics are indelibly associated with the 1960s, heroin and amphetamines were equally prevalent. See for instance the relevant sections in Schneider (2008), Rasmussen (2009).
2. Here Leary's movement is framed at the crossroads of scientific research, religion, and politics. Leary was initially interested in the study of psychedelics but he soon displayed a tangible religious discourse that could also be understood as a political crusade. Certainly, the campaign to save Leary from the hammer of justice was political in nature.
3. As examples of this critical school, see Jonnes (1996), Marwick (1998), Paglia (2003), Heath and Potter (2006), DeGroot (2008). These contributions come from a pool of conservative, libertarian, and liberal authors, which suggests that the repudiation of Leary's psychedelic movement does not stem from political bias.
4. An exception to this trend is Hartogsohn's recent focus on Leary's popularization of the concept of set and setting, albeit from the perspective of science history in Hartgosohn (2020).
5. It strengthens this brand of historiography by highlighting the "American" characteristics of the psychedelic movement, rather than its radical and revolutionary aspects that have attracted the bulk of scholarly attention.
6. For elements of discussions on this conceptual problem, see Roberts (1978), Henderson (2011), Bennett (2012). As well, several historians have illustrated how the borders separating mainstream culture and counter-culture are porous. See Frank (1998), Farber (2013), Kaiser and McCray (2016), J. C. Davis (2017).
7. For a list of the government-funded research into psychedelics, see U.S. Senate, 89th Congress, 2nd Session (1966); as referenced in Oram (2012). In the context of the Cold War the Central Intelligence Agency also bankrolled some of this study, hoping to find the ultimate truth-serum or a weapon that could incapacitate an entire country. See J. Marks (1988).
8. The research into the therapeutic potential of psychedelics at the Spring Grove State Hospital was

funded by the National Institute of Mental Health, the Maryland State Department of Health and Mental Hygiene, the Mary Reynolds Babcock Foundation, and the Public Health Service. In the words of Oram, it was "the longest, largest, most sophisticated, and most successful such program ever undertaken in the United States" (Oram, 2018, p. 109).

9. Charles Savage to Nina Ridenour, October 8, 1965, folder "Correspondence, Jun.-Dec., 1965," box 3 of 13, series 2 "Correspondence, 1964-1968," MSP 70, Charles Savage papers, Archives, and Special Collections, Purdue University Libraries (hereafter cited as "Savage papers").
10. Charles Savage to the Ittleson Family Foundation, October 8, 1965, folder "Correspondence, Jun.-Dec., 1965," box 3 of 13, series 2 "Correspondence, 1964-1968," Savage papers.
11. Charles Savage to Nina Ridenour, February 15, 1966, folder "Correspondence, Jan.-Jun., 1966; Correspondence, Mar., 1966; Correspondence, Feb. 15, 1966," box 3 of 13, series 2 "Correspondence, 1964-1968," Savage papers.
12. Stanley Krippner to author, e-mail, October 10, 2016 (in author's possession).
13. This echoed the way some MDs defended Thomas Szasz when he was banned from teaching in 1962 because of his unorthodox views on psychiatry.
14. A focus on cultural capital and drug use would make for an interesting enquiry into the dynamics of drug cultures. A good illustration of this phenomenon is Henri Luce and his wife Clare Boothe who both enjoyed sampling LSD in the company of Aldous Huxley and philosopher Christopher Isherwood, but who would prefer that the masses stay clear of it.
15. he moral validity of drug-induced mysticism has been debated for over half a century. Rather than engage in these discussions, I build on part of the illicit drug scholarship that has paid more attention to the motivations for and the meaning ascribed to drug experiences. See for instance Carstairs (2002), Goodman *et al*. (2007), Hunt *et al*. (2010), and Shortall (2014).
16. For a critical assessment of this study, see Doblin, "Dr. Leary's Concord Prison Experiment."
17. Qualifying Leary's work of "interdisciplinary" is debatable, in spite of the heterogeneous nature of his fellow researchers.
18. "Newsletter #1," February 1962, 14, box 33, folder 19, Timothy Leary papers, Manuscripts and Archives Division, New York Public Library (hereafter "Leary papers").
19. Friedman subsequently left Uris to become a full-time writer, in large part as a result of his experimentation with psilocybin.
20. Arthur Tomaselli to Freedom Center, Inc., March 19, 1963, box 57, folder 1, Leary papers.
21. As Crowther-Heyck thoughtfully notes, patronage is a good word to refer to "the provision of support for research," whether "material, financial, and social, [...] because there was and is more to providing support for a researcher or a field than writing checks" (Crowther-Heyck, 2006, pp. 421, 422, note 4).
22. Richard Alpert to Tommy Hitchcock, January 22, 1965, box 63, folder 5, Leary papers.
23. Peggy Hitchcock to Ray and Jack Walten, May 27, 1963, box 53, folder 30, Leary papers.
24. Allen Eager interview by Timothy Leary, February 1967, 2, box 82, folder 21, Leary papers. Hitchcock was privy to the problem of addiction as she had briefly dated saxophonist Allen Eager who had a heroin habit. See Dass *et al*. (2010).
25. For a discussion on the topic, see Zunz (2012b).
26. Richard Alpert to Peggy Hitchcock and to Mayme Kramer, both October 8, 1963, box 47, folder 4, Leary papers.
27. Robert F. Bales to E.G. Kraetzer, November 28, 1962, 1, box 47, folder 1, Leary papers.
28. For a larger discussion on this, see Oram (2012).
29. Timothy Leary to IF-IF members, March 19, 1964, box 61, folder 9, Leary papers.
30. For Kleps' recollections of the Millbrook years, see his memoir Kleps (2005a).
31. Joseph Martin ansd John Quinn, "U.S.A. vs LSD: Meet the Big Boo Hoo, High Hallucinogeneral," Daily News, January 31, 1968, 40, folder "Neo-American Church," box 10, Peter Stafford Papers, Rare Book & Manuscript Library, Columbia University in the City of New York (hereafter "Stafford Papers").
32. For a follow-up on this experiment, see Doblin (1991).
33. On one occasion he was told to ask a question he wanted to be answered by the psychedelic experience and wondered: "How can I make more money on the stock market?" (Kleps, 2005c).
34. In 1966 Bieberman became the first person in New England to be arrested under the U.S. Food, Drugs, and Cosmetics Act for shipping LSD through the mail (Kruskall, 1966).
35. Lisa Bieberman, "Psychedelic Information Center Bulletin," February 16, 1968, 2, folder "Drugs Crackdown," box 4, Stafford Papers.

36. Isaac Abrams to author, e-mail, September 13, 2013 (in author's possession).
37. Gerd Stern to author, e-mail, September 12, 2013 (in author's possession).
38. Walter Houston Clark to Timothy Leary, October 11, 1964, box 62, folder 7.
39. See Dufton's Grass Roots for an account of the early days of the marijuana movement.
40. Interview by Graboi in Nina Graboi, One Foot in the Future: A Women's Spiritual Journey (Santa Cruz, CA: Areal Press, 1991), 250.
41. Isaac Abrams interview by author, May 22, 2013, mp3 (in author's possession). For a legal history of Leary's attempt to beat those charges, see Lander, "'Legalize Spiritual Discovery.'"
42. To support his case, he found the help of the anthropology professor and Hindu convert Aghenanda Bharati, who had just published a book on the Tantric tradition in which he discussed the use of psychedelics in a religious context. John W. Spellman to Allen Ginsberg, April 25, 1966, box 116, folder 8, Leary papers. For more on the history of peyote and a discussion on Native American ritual use, see Dawson (2018).
43. Ken Kesey Defense Fund, Box 6, folder 8, Leary papers.
44. Chris Farny to Timothy Leary Defense Fund, March 23, 1966, box 155, folder 10, Leary papers.
45. Richard W. Taylor to Timothy Leary Defense Fund, April 4, 1966, box 115, folder 13, Leary papers.
46. Andrew. B. Campbell to Timothy Leary Defense Fund, n.d., box 115, folder 13, Leary papers.
47. Robert J. Dummel to Timothy Leary Defense Fund, April 14, 1966, box 115, folder 13, Leary papers.
48. Omer C. Stewart to Timothy Leary Defense Fund, April 16, 1966, box 115, folder 13, Leary papers. In 1964, the Supreme Court of California ruled that Native American Indians could legally use the cactus as a sacrament.
49. One of the supporters included a sympathetic clergyman who had tried LSD in the early 1960s under medical super-vision and subsequently experimented with the drug to find his Christian faith reinvigorated as a result. Michael Augustine Itkin to IF-IF, May 23, 1963, folder 2, box 54, Leary papers; Michael F. Itkin to the Timothy Leary Defense Fund, May 19, 1966, box 116, folder 2, Leary papers.
50. Richard A. Harshman to Timothy Leary Defense Fund, n.d., box 118, folder 8, Leary papers.
51. Virgil L. Highland to Timothy Leary Defense Fund, May 5, 1966, box 116, folder 9, Leary papers.
52. George S. Brooks to Timothy Leary Defense Fund, May 10, 1966, box 116, folder 9, Leary papers.
53. Beatrice S. Frank to Timothy Leary Defense Fund, May 5, 1966, box 116, folder 9, Leary papers.
54. Sally Sherwin to J. Morris, June 16, 1966, box 116, folder 6, Leary papers.
55. Sally Sherwin to Martin Garbus, June 16, 1966, box 116, folder 6, Leary papers.
56. Al Matthews, "Statement," n.d., 1, box 115, folder 10, Leary papers.
57. Mark Fox to Tim Leary Defense Fund, September 21, 1966, 1, box 74, folder 4, Leary papers.
58. Howard G. Ingram Jr. to Timothy Leary, circa early March 1967, box 74, folder 9, Leary papers.
59. Desta Brown to William Mellon Hitchcock, April 9, 1966, box 116, folder 14, Leary papers.
60. Mike Lynch to Timothy Leary, circa October 1966, box 75, folder 1, Leary papers.
61. Lisa Bieberman, "Psychedelic Information Center Bulletin," no. 12, June 1967, 2, folder "Drugs Crackdown," box 4, Stafford Papers.
62. Lisa Bieberman, "Psychedelic Information Center Bulletin," no. 3, December 1965, 2, folder "Psychedelic Information Center," box 29, Stafford Papers.
63. Robert S. Conrich, "The Editor Game," Innerspace, 1966, folder "Innerspace," box 21, Stafford Papers.
64. "Jade Companions of the Flowered Dance," Innerspace, 1966, folder "Innerspace," box 21, Stafford Papers.
65. MAPS Press Release, April 29, 2014, http://www.maps.org/maps-media/media/5066-press-release-precious-moments-artist-timothy-butcher-leaves-1-9-million (accessed January 1, 2017).
66. MAPS Newsletter, September 17, 2013, http://www.maps.org/maps-media/update/4621-newsletter-september-17-2013 (accessed January 1, 2017).
67. https://www.iceers.org/adf/ (accessed January 2, 2020).

References

1. Aronov, M. (2019). (Micro-) 'psychedelic' experiences: From the 1960s creativity at the workplace to the 21st century neuro-newspeak. *Éthnologie française*, *176*(4), 701-718.
2. Bartoletti, S. C. (2015). *Terrible Typhoid Mary: A true story of the deadliest cook in America* (pp. 109-110). Houghton Mifflin Harcourt.
3. Bennett, A. (2012). Pour une réévaluation du concept de contre-culture. *Traduction de Jedediah Sklower*, *9*(1), 19-31.
4. Booth, M. (2005). *Cannabis: A history*. Picador.
5. Bremmer, R. H. (1988). Scientific philanthropy. In *American philanthropy* (pp. 85-99). University of Chicago Press.
6. Bremner, R. H. (1988). *American philanthropy*. University of Chicago Press.
7. Carstairs, C. (2002). Becoming a 'Hype': Heroin consumption, subcultural formation and the politics of resistance in Canada, 1945-1961. *Contemporary Drug Problems*, *29*(1), 91-116.
8. Conners, P. (2010). *White hand society: The psychedelic partnership of Timothy Leary and Allen Ginsberg*. City Lights Books.
9. Crowther-Heyck, H. (2006). Patrons of the revolution: Ideals and institutions in postwar behavioral science. *Isis*, *97*(3), 420-446.
10. *Daily Illini*. (1969). LSD rescue service soon? *Daily Illini* (October 25). p. 3.
11. Dass, R., Metzner, R., & Bravo, G. (2010). *Birth of a psychedelic culture: Conversations about Leary, the Harvard experiments, Millbrook and the sixties* (p. 6). Synergetic Press.
12. Davis E. (2018, September 25). Capitalism on psychedelics: The mainstreaming of an underground. *Chacruna*. https://chacruna.net/capitalism-psychedelics-mainstreaming-underground/
13. Davis, J. C. (2015). The business of getting high: Head shops, countercultural capitalism, and the marijuana legalization movement. *The Sixties*, *8*(1), 27-49.
14. Davis, J. C. (2017). *From headshops to whole foods: The rise and fall of activist entrepreneurs*. Columbia University Press.
15. Dawson, A. S. (2018). *The Peyote effect: From the inquisition to the war on drugs*. University of California Press.
16. DeGroot, G. (2008). *The sixties unplugged: A kaleidoscopic history of a disorderly decade* (pp. 208-215). Pan.
17. Doblin, R. (1991). Pahnke's 'Good Friday Experiment': A long-term follow-up and methodological critique. *The Journal of Transpersonal Psychology*, *23*(1), 1-28.
18. Doblin, R. (1998). Dr. Leary's Concord prison experiment: A 34-year follow-up study. *Journal of Psychoactive Drugs*, *30*(4), 419-426.
19. Dufton, E. (2017). *Grass roots: The rise and fall and rise of marijuana in America*. Basic Books.
20. Dyck, E. (2008). *Psychedelic Psychiatry: LSD from Clinic to Campus*. Johns Hopkins University Press.
21. *East Village Other*. (1967). Boo Hoo Busted. *East Village Other*, 2 (13), 18.
22. Ed Sanders. (2011). *Fug you: An informal history of the peace eye bookstore, the fuck you press, the fugs, and counterculture in the lower east side* (pp. 115-116). Da Capo.
23. Elcock, C. (2013). From acid revolution to entheogenic evolution: Psychedelic philosophy in the sixties and beyond. *Journal of American Culture*, *36*(4), 296-311.
24. Elcock, C. (2015). The Fifth Freedom: The politics of psychedelic patriotism. *Journal for the Study of Radicalism*, *9*(2), 17-40.
25. Farber, D. (2013). Building the counterculture, creating right livelihoods: The counterculture at work. *The Sixties*, *6*(1), 1-24.
26. Ferrara, M. S. (2016). *Sacred bliss: A spiritual history of cannabis*. Rowman & Littlefield.
27. Frank, T. (1998). *The conquest of cool: Business culture, counterculture, and the rise of hip consumerism*. University Of Chicago Press.
28. Friedman, B. H. (2006). *Tripping: A memoir* (p. 11). Provincetown Arts Press.
29. Friedman, L. J., & McGarvie, M. D. (Eds.). (2002). *Charity, philanthropy, and civility in American history*. Cambridge University Press.
30. Fuller, R. C. (2000). Psychedelics and the metaphysical illumination. In Stairways to Heaven: Drugs in American religious history (pp. 51-89). Westview Press.
31. Goodman, J., Sheratt, A., & Lovejoy, P. (Eds.). (2007). *Consuming habits: Drugs in history and anthropology*. Routledge.
32. Gordon, N. (1962, March 16). Hallucination drug fought at Harvard. *Boston Herald*.
33. Graboi, N. (1991). *One foot in the future: A women's spiritual journey* (p. 250). Areal Press.
34. Greenfield, R. (2006). *Timothy Leary: A biography*. Harcourt, Inc.
35. Hartgosohn, I. (2020). *American trip: Set, setting, and the psychedelic experience in the twentieth century*. The MIT Press.
36. Healy, D. (2002). *The creation of psychopharmacology*. Harvard University Press.
37. Heath, J., & Potter, A. (2006). *The rebel sell: How the counterculture became consumer culture* (pp. 62-63). Capstone.
38. Henderson, S. (2011). *Making the scene: Yorkville and hip Toronto in the 1960s* (p. 5). University of Toronto Press.
39. Higgs, J. (2006). *I Have America Surrounded: The Life of Timothy Leary*. Barricade Books.
40. Hollingshead, M. (1973). The exile's re-return. In The man who turned on the world. Blond & Briggs. http://www.psychedelic-library.org/hollings.htm
41. Hunt, G., Moloney, M., & Evans, K. (2010). *Youth, drugs, and nightlife*. Routledge.
42. Hustinx, L., Essen, J. V., Haers, J., & Mels, S. (Eds.). (2015). *Religion and volunteering: Complex, contested and ambiguous relationships*. Springer.
43. Huxley, A. (2004). *The doors of perception and Heaven and Heaven and Hell*. Perennial Classics.
44. Jesse, R. (2018, April 5). Cooperation over competition! Statement on open science and open praxis with psilocybin, MDMA, and similar substances. *Chacruna*. https://chacruna.net/cooperation-over-competition-statement-on-open-science-for-psychedelic-medicines-and-practices/
45. Jonnes, J. (1996). *Hep-cats, narcs, and pipe-dreams: A history of America's romance with illegal drugs* (Vol. 239). Scribner.
46. Kaiser, D., & McCray, P. (Eds.). (2016). *Groovy science: Knowledge, innovation, and American counterculture*. The University of Chicago Press.

47. Kent, S. A. (2001). Religion, drugs, and the question of political engagement. In From slogans to mantras: Social protest and religious conversion in the late Vietnam war era (pp. 13-16). University of Syracuse Press.
48. Kleps, A. (1971). *The Boo Hoo Bible: The Neo-American Church Catechism*. Toad Books.
49. Kleps, A. (2005a. *Millbrook: A narrative*. Original Kleptonian Neo-American Church. http://okneoac.org/millbrook/
50. Kleps, A. (2005b). A word of explanation. In *Millbrook: A Narrative*. Original Kleptonian Neo-American Church.
51. Kleps, A. (2005c). The Boss. In *Millbrook: A narrative*. Original Kleptonian Neo-American Church.
52. Kleps, A. (2005d). Chapter 13: "Freemen!". In *Millbrook: A narrative*. Original Kleptonian Neo-American Church.
53. Kleps, A. (2005e). Chapter 38: "Sir Launcelot and Knights to the Rescue". In *Millbrook: A narrative*. Original Kleptonian Neo-American Church.
54. Kruskall, S. I. (1966, June 1). Lisa Bieberman held on charge of mailing LSD. *Harvard Crimson*.
55. Kutulas, J. (2006). *The American Civil Liberties Union & the making of modern liberalism, 1930-1960* (p. 212). University of North Carolina Press.
56. Lam, P.-Y. (2002). As the flocks gather: How religion affects voluntary association participation. *Journal for the Scientific Study of Religion*, *41*(3), 405-422.
57. Lander, D. R. (2011). Start your own religion: New York state's acid churches. *Nova Religio*, *14*(3), 64-80.
58. Lander, D. R. (2014). 'Legalize spiritual discovery': The trials of Dr. Timothy Leary. In B. C. Labate, & C. Cavnar (Eds.), Prohibition, religious freedom, and human rights: Regulating traditional drug use (pp. 165-187). Springer.
59. Langlitz, N. (2013). *Neuropsychedelia: The revival of Hallucinogen research since the decade of the brain*. University of California Press.
60. Leary, T. (1982). *Changing my mind, among others: Lifetime writings* (p. 173). Prentice-Hall, Inc.
61. Leary, T. (1990). *Flashbacks: A personal and cultural history of an era* (p. 183). Jeremy P. Tarcher. Leary, T. (1995). *High priest* (p. 79). Ronin.
62. Lee, M. A. (2013). *Smoke signals: A social history of marijuana-Medical, recreational and scientific*. Scribner.
63. Lee, M. A., & Shlain, B. (1985). *Acid dreams: The complete social history of LSD: The CIA, the sixties, and beyond*. Grove Weidenfeld.
64. Marks, H. (1997). *The progress of experiment: Science and therapeutic reform in the United States, 1900-1990*. Cambridge University Press.
65. Marks, J. (1988). Intelligence or 'witches' potion. In The search for the "Manchurian Candidate": The CIA and mind control: The secret story of behavioural sciences (pp. 54-130). W. W. Norton.
66. Marks, S. (2015). From experimental psychosis to resolving traumatic pasts. psychedelic research in communist
67. Czechoslovakia, 1954-1974. *Cahiers du monde russe*, *56*(1), 53-75.
68. Marwick, A. (1998). *The sixties: Cultural revolution in Britain, France, Italy, and the United States, c.1958-c.1974* (pp. 310-312). Oxford University Press.
69. McGirr, L. (2001). *Suburban warriors: The origins of the New American right*. Princeton University Press.
70. Nordstrom, L., & Pilgrim, R. (1980). The wayward mysticism of Alan Watts. *Philosophy East and West*, *30*(3), 381-401.
71. Novak, S. J. (1997). LSD before Leary: Sidney Cohen's critique of 1950s psychedelic drug research. *Isis*, *88*(1), 87-110.
72. Oberhaus D. (2017, May 3). *Meet the lawyers defending the right to use Ayahuasca around the globe*. Vice. https://www.vice.com/en_uk/article/jpzkbx/meet-the-lawyers-defending-the-right-to-use-ayahuasca-around-the-globe
73. Oram, M. (2012). Efficacy and enlightenment: LSD psychotherapy and the drug amendments of 1962. *Journal of the History of Medicine and Allied Sciences*, *69*(2), 235.
74. Oram, M. (2018). *The trials of psychedelic therapy: LSD psychotherapy in America*. Johns Hopkins University Press.
75. Paglia, C. (2003). Cults and cosmic consciousness: Religious vision in the American 1960s. *Arion*, *10*(3), 84.
76. Passie, T. (1997). *Psycholytic and psychedelic therapy research, 1931-1995: A complete international bibliography*. Laurentius Publishers.
77. Powell, W. W., & Steinberg, R. (Eds.). (2006). *The non-profit sector: A research handbook*. Yale University Press.
78. Rasmussen, N. (2009). *On speed: The many lives of amphetamine*. New York University Press.
79. Richert, L., & Dyck, E. (2020). Psychedelic crossings: American mental health and LSD in the 1970s. *Medical Humanities*, *46*, 184-191.
80. Roberts, K. A. (1978). Toward a generic concept of counter-culture. *Sociological Focus*, *11*(2), 111-126.
81. Rossinow, D. (1998). *The politics of authenticity: Liberalism, Christianity, and the new left in America*. Columbia University Press.
82. Schneider, E. C. (2008). *Smack: Heroin and the American city*. University of Pennsylvania Press.
83. Sessa, B. (2012). *The Psychedelic Renaissance: Reassessing the role of psychedelic drugs in 21st century psychiatry and society*. Muswell Hill.
84. Shipley, M. (2015). *Psychedelic mysticism: Transforming consciousness, religious experiences, and voluntary peasants in postwar America*. Lexington Books.
85. Shortall, S. (2014). Psychedelic drugs and the problem of experience. *Past & Present*, *222*(Suppl. 9), 187-206.
86. Siff, S. (2015). *Acid hype: American news media and the psychedelic experience*. University of Illinois Press.
87. Smith, H. (1964). Do drugs have religious importance? In D. Solomon (Ed.), LSD: The consciousness expanding drug (pp. 155-169). Putnam.
88. Smith, S. L. (2012). *Hippies, Indians, and the fight for red power* (p. 23). Oxford University Press.
89. Solovey, M., & Cravens, H. (2012). *Cold war social science: Knowledge production, liberal democracy, and human nature*. Palgrave Macmillan.
90. Stafford, P. G. (1967). *LSD, the problem-solving psychedelic*. Award Books.
91. Stern, G. (2001). From Beat Scene Poet to Psychedelic Multimedia Artist in San Francisco and Beyond, 1948-1978, interview by Victoria Morris Byerly (Vol. 90). Regional Oral History Office, The Bancroft Library, University of California, Berkeley.
92. Stevens, J. (1988). *Storming Heaven: LSD and the American dream*. Perennial Library.
93. Tenenbaum, B. (1961). Group therapy with LSD-25. (A preliminary report). *Diseases of the Nervous System*, *22*, 459-462.

94. Theoharis, J. (2006). 'Alabama on Avalon': Rethinking the Watts uprising and the character of Black protest in Los Angeles. In P. E. Joseph, *The Black Power Movement: Rethinking the civil rights-Black power era*, (pp. 27-54). Routledge.
95. Ulibarri, C. A. (2000). Rational philanthropy and cultural capital. *Journal of Cultural Economics*, *24*(2), 135-146.
96. U.S. Senate, 89th Congress, 2nd Session. (1966). *Organization and Coordination of Federal Drug Research and Regulatory Programs: LSD, Hearings before the Subcommittee on Executive Reorganization of the Committee on Government Operations* (pp. 18-25). Washington, DC: U.S. Government Printing Office.
97. Versterlund, L. (2006). Why do people give? In W. W. Powell, & R. Steinberg (Eds.), *The non-profit sector: A research handbook* (p. 568). Yale University Press.
98. Zaehner, R. C. (1957). *Mysticism: Sacred and profane*. Oxford University Press.
99. Zunz, O. (2012a). *Philanthropy in America: A history* (p. 3). Princeton University Press.
100. Zunz, O. (2012b). The regulatory compromise. In *Philanthropy in America: A history* (pp. 76-103). Princeton University Press.

Enteogenic Mushrooms Species

Psilocybe cubensis „Albino A+“
Psilocybe cubensis „Amazonian“
Psilocybe cubensis „Argentina“
Psilocybe cubensis „Australian“
Psilocybe cubensis „B+“
Psilocybe cubensis „Blue Meanie“
Psilocybe cubensis „Brasil“
Psilocybe cubensis „Cambodia“
Psilocybe cubensis „Cambodian Gold“
Psilocybe cubensis „Colombian“
Psilocybe cubensis „Ecuador“
Psilocybe cubensis „Ecuador Yosterizzii“
Psilocybe cubensis „F+“
Psilocybe cubensis „Golden Mammoth“
Psilocybe cubensis „Golden Teacher“
Psilocybe cubensis „Guadalajara mexico“
Psilocybe cubensis „Gulf Coast“
Psilocybe cubensis „Huautla“
Psilocybe cubensis „John Allen“
Psilocybe cubensis „Keepers Creeper“
Psilocybe cubensis „Malabar“
Psilocybe cubensis „Matias Romero“
Psilocybe cubensis „Mazatapec Mexicana“
Psilocybe cubensis „McKennaii“
Psilocybe cubensis „Mexican“
Psilocybe cubensis „Mystery Fatass“
Psilocybe cubensis „Nepal Chitwan“
Psilocybe cubensis „Orissa India“
Psilocybe cubensis „Pensacola“
Psilocybe cubensis „PESA“
Psilocybe cubensis „Penis Envy“
Psilocybe cubensis „Penis Envy 6“
Psilocybe cubensis „PF Classic“
Psilocybe cubensis „Plantasia Mystery“
Psilocybe cubensis „South American“
Psilocybe cubensis „Syzygy“
Psilocybe cubensis „Tasmanian“
Psilocybe cubensis „Teonanacatl“
Psilocybe cubensis „Thai“
Psilocybe cubensis „Thai Pink Buffalo KS“
Psilocybe cubensis „Thailand Ban Hua Thanon“
Psilocybe cubensis „Thailand Lipa Yai“
Psilocybe cubensis „Thailand Koh Samui“
Psilocybe cubensis „Thailand KS Lamai Beach“
Psilocybe cubensis „Transkei“
Psilocybe cubensis „Tulum“
Psilocybe cubensis „White Treasure Coast“
Psilocybe cubensis „Wollongong“
Psilocybe cubensis „Z-strain“
Psilocybe acutipilea
Psilocybe aeruginosa
Psilocybe allenii
Psilocybe alutacea
Psilocybe angustispora
Psilocybe antioquensis
Psilocybe aquamarina
Psilocybe argentipes
Psilocybe atlantis
Psilocybe atrobrunnea
Psilocybe aucklandiae
Psilocybe australiana
Psilocybe aztecorum
Psilocybe azurescens
Psilocybe baeocystis
Psilocybe banderillensis
Psilocybe bohemica
Psilocybe brasiliensis
Psilocybe brunneocystidiata
Psilocybe caerulea
Psilocybe caeruleoannulata
Psilocybe caerulescens
Psilocybe caerulipes
Psilocybe caribaea
Psilocybe chiapanensis
Psilocybe chuxiongensis
Psilocybe columbiana
Psilocybe coprophila
Psilocybe crobula
Psilocybe cyanescens
Psilocybe cyanofibrillosa
Psilocybe cyanofranciscana
Psilocybe dumontii
Psilocybe eucalypta
Psilocybe fagicola
Psilocybe farinacea
Psilocybe fimetaria
Psilocybe fuliginosa
Psilocybe furtadoana
Psilocybe galindoi
Psilocybe germanica
Psilocybe gallaeciae
Psilocybe graveolens
Psilocybe guatapensis
Psilocybe guilartensis
Psilocybe heimii
Psilocybe heliconiae
Psilocybe herrerae
Psilocybe hispanica
Psilocybe hoogshagenii
Psilocybe inconspicua
Psilocybe inquilina
Psilocybe jacobsii
Psilocybe kumaenorum
Psilocybe liniformans
Psilocybe luteonitens
Psilocybe magnivelaris
Psilocybe mairei
Psilocybe makarorae
Psilocybe mammillata
Psilocybe merdaria
Psilocybe meridensis
Psilocybe mescaleroensis
Psilocybe mexicana
Psilocybe mexicana „A“
Psilocybe mexicana „B“
Psilocybe microcystidiata
Psilocybe moravica
Psilocybe moseri
Psilocybe muliercula
Psilocybe naematoliformis
Psilocybe natarajanii
Psilocybe neocaledonicum
Psilocybe ovoideocystidiata
Psilocybe papuana
Psilocybe pelliculosa
Psilocybe physaloides
Psilocybe pintonii
Psilocybe plutonia
Psilocybe portoricensis
Psilocybe pseudocyanea
Psilocybe quebecensis
Psilocybe samuiensis
Psilocybe sanctorum
Psilocybe semiglobata
Psilocybe semiinconspicua
Psilocybe semilanceata
Psilocybe semilanceata „Gigant“
Psilocybe silvatica
Psilocybe serbica
Psilocybe squamosa
Psilocybe strictipes
Psilocybe stuntzii
Psilocybe subaeruginascens
Psilocybe subaeruginosa
Psilocybe subcaerulipes
Psilocybe subacutipilea
Psilocybe subcubensis
Psilocybe subfimetaria
Psilocybe subtropicalis
Psilocybe subviscida
Psilocybe subyungensis
Psilocybe tampanensis
Psilocybe tasmaniana
Psilocybe thrausta
Psilocybe uruguayensis
Psilocybe uxpanapensis
Psilocybe venenata
Psilocybe villarrealiae
Psilocybe washingtonensis
Psilocybe wassoniorum
Psilocybe wayanadensis
Psilocybe weilii
Psilocybe weraroa
Psilocybe wrightii
Psilocybe yungensis
Psilocybe zapotecoantillarum
Psilocybe zapotecocaribaea
Psilocybe zapotecorum
Panaeolus affinis
Panaeolus africanus
Panaeolus antillarum
Panaeolus bisporus
Panaeolus cambodginiensis
Panaeolus cinctulus
Panaeolus chlorocystis
Panaeolus cyanescens
Panaeolus fimicola
Panaeolus lentisporus
Panaeolus olivaceus
Panaeolus papilionaceus
Panaeolus tirunelveliensis
Panaeolus tropicalis
Panaeolus venezolanus
Conocybe cyanopus
Conocybe kuehneriana
Conocybe smithii
Galerina steglichii
Gymnopilus aeruginosus
Gymnopilus braendlei
Gymnopilus cyanopalmicola
Gymnopilus junonius
Gymnopilus liquiritiae
Gymnopilus luteofolius
Gymnopilus luteoviridis
Gymnopilus luteus
Gymnopilus punctifolius
Gymnopilus purpuratus
Gymnopilus sapineus
Gymnopilus subpurpuratus
Gymnopilus validipes
Gymnopilus viridans
Inocybe aeruginascens
Inocybe coelestium
Inocybe corydalina
Inocybe haemacta
Inocybe tricolor
Pluteus cervinus
Pluteus cyanopus
Pluteus salicinus

List of known *psychoactive* mushroom species

Revised 1.05.2002 and updated 1.09.2007
Copyright 1998-2001 by John W. Allen
(www.mushroomjohn.org/listedspecies1.htm)

BASIDIOMYCOTINA

Agaricales

Bolbitiaceae

Agrocybe Species

1. *Agrocybe farinacea* Hongo

Conocybe Species

2. ***Conocybe cyanopus*** (G.F. Atk.) Kühner [= *Pholiotina* "*Galera*" *cyanopus* G.F. Atk.; *Pholiotina cyanopoda* (G.F. Atk.) Singer; *Galerula cyanopus* G.F. Atk.]
3. ***Conocybe kuehneriana*** Singer
4. *Conocybe siligineoides* R. Heim
5. ***Conocybe smithii*** Watling (= *Galerula cyanopes* Kauffman)

Coprinaceae

Copelandia Species

6. *Copelandia affinis* Horak [= ***Panaeolus affinis*** (Horak) Ew. Gerhardt]
7. *Copelandia bispora* (Malençon & Bertault) Singer & R.A. Weeks [= C. papilionacea var. *bispora* Malençon & Bertault; ***Panaeolus cyanescens*** var. *bisporus* (Malençon & Bertault) G. Moreno & Esteve-Ravis.; ***Panaeolus bisporus*** (Malençon & Bertault) Ew. Gerhardt]
8. *Copelandia cambodginiensis* (Ola'h & R. Heim) Singer & R.A. Weeks (= ***Panaeolus cambodginiensis*** Ola'h & R. Heim)
9. *Copelandia chlorocystis* Singer & R.A. Weeks [= ***Panaeolus chlorocystis*** (Singer & R.W. Weeks) Ew. Gerhardt]
10. *Copelandia cyanescens* (Berk. & Broome) Singer [= ***Panaeolus cyanescens*** (Berk. & Broome) Sacc.; ***Panaeolus papilionaceus*** sensu Bres.) (see *Copelandia westii*)
11. *Copelandia lentisporus* (Ew. Gerhardt) Guzmán (= ***Panaeolus lentisporus*** Ew. Gerhardt)
12. *Copelandia mexicana* Guzmán (about Gerhardt, 1996, this a nom. excl.)
13. *Copelandia tirunelveliensis* Natarajan & Raman [= ***Panaeolus tirunelveliensis*** (Natarajan & Raman) Ew. Gerhard]
14. *Copelandia tropicalis* (Ola'h) Singer & R.A. Weeks (= ***Panaeolus tropicalis*** Ola'h)
15. *Copelandia westii* (Murrill) Singer (about Gerhardt, 1996, this a synonym of *Copelandia cyanescens*)

Panaeolus Species

16. ***Panaeolus africanus*** Ola'h
17. *Panaeolus castaneifolius* (Murrill) A.H. Sm. (= ? ***Panaeolus olivaceus*** F. H. Møller; *Panaeolina castaneifolia* (Murrill) Bon; *Panaeolina castaneifolia* (Murrill) Ew. Gerhardt, this latest seems the true name, see Gerhardt, 1996)
18. ***Panaeolus cinctulus*** (Bolton) Saccardo (1887) (=*Panaeolus subbalteatus* (Berk. & Broome) Sacc.) (= *Panaeolus venenosus* Murrill)
19. ***Panaeolus fimicola*** (Pers.) Gillet
20. *Panaeolus microsporus* Ola'h & Cailleux
21. ***Panaeolus olivaceus*** F.H. Møller (it is sometimes confused as a synonym of *Panaeolus castaneifolius*, see that)
22. ***Panaeolus papilionaceus*** (Fr.) Quél. var. *papilionaceus* sensu auct. non s. Ew. Gerhardt [= *Panaeolus campanulatus* (L. : Fr.) Quél.]
23. *Panaeolus retirugis* (Fr.) Quél.
24. ***Panaeolus venezolanus*** Guzmán

Cortinariaceae

Galerina Species

25. ***Galerina steglichii*** Besl

Gymnopilus Species

26. ***Gymnopilus aeruginosus*** (Peck) Singer
27. ***Gymnopilus braendlei*** (Peck) Hesler
28. ***Gymnopilus cyanopalmicola*** Guzm. & Dáv
29. *Gymnopilus intermedius* (Singer) Singer
30. *Gymnopilus lateritius* (Pat.) Murrill
31. ***Gymnopilus liquiritiae*** (Fr.) P. Karst.
32. ***Gymnopilus luteofolius*** (Peck) Singer
33. ***Gymnopilus luteoviridis*** Thiers
34. ***Gymnopilus luteus*** (Peck) Hesler
35. ***Gymnopilus punctifolius*** (Peck) Singer
36. ***Gymnopilus purpuratus*** (Cooke & Massee) Singer
37. ***Gymnopilus sapineus*** (Fr.) Maire (= *Pholiota sapinea* s. auct.)
38. *Gymnopilus spectabilis* (Fr.) A.H. Sm. [= *Gymnopilus spectabilis* (Fr.) Singer; *Pholiota spectabilis* Fr.; ***Gymnopilus junonius*** (Fr.) P.D. Orton; *Gymnopilus spectabilis* var. *junonia* (Fr.) J.E. Lange; *Pholiota junonia* (Fr.) P. Karst.; *Pholiota spectabilis* var. *junonia* (Fr.) J.E. Lange] (***Gymnopilus junonius*** seems to be the true name)
39. ***Gymnopilus subpurpuratus*** Guzmán-Davalos & Guzmán]
40. ***Gymnopilus validipes*** (Peck) Hesler
41. ***Gymnopilus viridans*** Murrill

Inocybe Species

42. ***Inocybe aeruginascens*** Babos
43. ***Inocybe coelestium*** Kuyper
44. ***Inocybe corydalina*** Quél. var. *corydalina*
45. ***Inocybe corydalina*** var. *erinaceomorpha* (Stangl & J. Veselsky´) Kuyper
46. ***Inocybe haemacta*** (Berk. & Cooke) Sacc.
47. ***Inocybe tricolor*** Kühner

Plutaceae

Pluteus Species

1. *Pluteus atricapillus* (Secr.) Singer [= ***Pluteus cervinus*** (Schaeffer) P. Kumm.] [Orton, 1986, discussed this synonymy and concluded that the true name is ***Pluteus cervinus*** because the epithet *Agaricus atricapillus* Batsch is debatable and uncertain. Singer (1986) introduced the name *Pluteus atricapillus* (Secr.) Singer, but as Secretan's work has been declared invalid, this interpretation is not consider any more]
2. ***Pluteus cyanopus*** Quél.
3. *Pluteus glaucus* Singer
4. *Pluteus nigriviridis* Babos
5. ***Pluteus salicinus*** (Pers. : Fr.) P. Kumm.
6. *Pluteus villosus* (Bull.) Quél.

Strophariaceae

Hypholoma Species

7. *Hypholoma gigaspora* (Natarajan & Raman) Guzmán [= *Psilocybe gigaspora* Natarajan & Raman; *Naematoloma gigaspora* (Natarajan & Raman) Guzmán]
8. *Hypholoma guzmanii* (Natarajan & Raman) Guzmán [= *Psilocybe guzmanii* Natarajan & Raman; *Naematoloma guzmanii* (Natarajan & Raman) Guzmán]
9. *Hypholoma naematoliformis* (Guzmán) Guzmán [= ***Psilocybe naematoliformis*** Guzmán; *Naematoloma naematoliformis* (Guzmán) Guzmán]
10. *Hypholoma neocaledonica* (Guzmán & Horak) Guzmán [= *Psilocybe neocaledonica* Guzmán & Horak; *Naematoloma neocaledonica* (Guzmán & Horak) Guzmán]
11. *Hypholoma popperianum* (Singer) Guzmán (= *Naematoloma popperianum* Singer)
12. *Hypholoma rhombispora* (Guzmán) Guzmán (= *Naematoloma rhombispora* Guzmán)

Psilocybe Species

13. ***Psilocybe acutipilea*** (Speg.) Guzmán
14. ***Psilocybe alutacea*** W. S. Chang and A. K. Mills.
15. *Psilocybe angustipleurocystidiata* Guzmán
16. ***Psilocybe antioquensis*** Guzmán, Saldarriaga, Pineda, García & Velázquez
17. ***Psilocybe aquamarina*** (Pegler) Guzmán (= *Stropharia aquamarina* Pegler)
18. *Psilocybe arcana* Borovicka *et* Hlavácek sp. nov.
19. ***Psilocybe argentipes*** K. Yokoy.
20. *Psilocybe armandii* Guzmán & S.H. Pollock
21. ***Psilocybe atlantis*** Guzmán, Hanlin & C. White
22. ***Psilocybe aucklandiae*** Guzmán, C. C. King & Bandala (=*Psilocybe aucklandii* Guzmán, C.C. King & Band.-Muñoz (1991))
23. ***Psilocybe australiana*** Guzmán & Watling
24. ***Psilocybe aztecorum*** R. Heim emend. Guzmán var. *aztecorum*
25. ***Psilocybe aztecorum*** var. *bonetii* (Guzmán) Guzmán (= *Psilocybe bonetii* Guzmán)
26. ***Psilocybe azurescens*** Stamets & Gartz
27. ***Psilocybe baeocystis*** Singer & A.H. Sm. emend. Guzmán
28. ***Psilocybe banderillensis*** Guzmán & Bononi (=*Psilocybe banderiliensis* Guzmán)
29. *Psilocybe barrerae* Cifuentes & Guzmán emend. Guzmán, 1999
30. ***Psilocybe bohemica*** Sebek (= *Psilocybe coprinifacies* s. Herink, non s. Krieglsteiner)
31. ***Psilocybe brasiliensis*** Guzmán
32. ***Psilocybe brunneocystidiata*** Guzmán & Horak
33. *Psilocybe cabiensis* Guzmán, Torres et Ramirez-Guillen, sp. nov.
34. ***Psilocybe caeruleoannulata*** Singer ex Guzmán
35. ***Psilocybe caerulescens*** Murrill var. *caerulescens* (= ***Psilocybe caerulescens*** var. *albida* R. Heim; ***Psilocybe caerulescens*** var. *mazatecorum* R. Heim; *Psilocybe mazatecorum* R. Heim; ***Psilocybe caerulescens*** var. *nigripes* R. Heim)
36. ***Psilocybe caerulescens*** var. *ombrophila* (R. Heim) Guzmán (= ***Psilocybe caerulescens*** var. *mazatecorum Psilocybe ombrophila* R. Heim; *Psilocybe mixaeensis* R. Heim)
37. ***Psilocybe caerulipes*** (Peck) Sacc.
38. *Psilocybe carbonaria* Singer
39. ***Psilocybe caribaea*** Guzmán, T. J. Baroni& Tapia, sp. nov.
40. *Psilocybe chaconii* Guzmán, Escolona et Ramirez-Guillen.
41. ***Psilocybe chiapanensis*** Guzmán
42. ***Psilocybe chuxiongensis*** T. Ma & K.D. Hyde
43. *Psilocybe collybioides* Singer & A.H. Sm.
44. ***Psilocybe columbiana*** Guzmán
45. *Psilocybe coprinifacies* (Rolland) Pouzar s. auct., non s. Herink, non s. Krieglsteiner) (see discussion)
46. *Psilocybe cordispora* R. Heim
47. ***Psilocybe cubensis*** (Earle) Singer [= *Stropharia cubensis* Earle; ***Psilocybe cubensis*** var. *caerulescens* (Murrill) Singer & A.H. Sm.; *Stropharia subcyanescens* Rick; *Stropharia cyanescens* Murrill; *Stropharia caerulescens* (Pat.) Singer]
48. ***Psilocybe cyanescens*** Wakef. (non sensu Krieglsteiner)
49. ***Psilocybe cyanofibrillosa*** Guzmán & Stamets (=*Psilocybe rhododendronensis* Stamets nom. prov.)
50. ***Psilocybe dumontii*** Singer ex Guzmán
51. ***Psilocybe eucalypta*** Guzmán & Watling
52. ***Psilocybe fagicola*** R. Heim & Cailleux var. *fagicola*
53. ***Psilocybe fagicola*** R. Heim var. *mesocystidiata* Guzmán
54. ***Psilocybe farinacea*** Rick ex Guzmán [= *Psilocybe albofimbriata* (Rick) Singer]
55. ***Psilocybe fimetaria*** (P.D. Orton) Watling [= *Psilocybe caesieannulata* Singer; *Stropharia fimetaria* P.D. Orton]
56. ***Psilocybe fuliginosa*** (Murrill) A.H. Sm.
57. ***Psilocybe furtadoana*** Guzmán
58. ***Psilocybe galindoi*** Guzmán (= *Psilocybe galindii* Guzmán)
59. ***Psilocybe gallaeciae*** Guzmán & M.L. Castro (2003)
60. ***Psilocybe germanica*** Gartz (2015)
61. *Psilocybe goniospora* (Berk. & Broome) Singer [= *Psilocybe lonchophora* (Berk. Broome) Horak ex Guzmán]
62. ***Psilocybe graveolens*** Peck
63. ***Psilocybe guatapensis*** Guzmán, Saldarriaga, Pineda, García & Velázquez
64. ***Psilocybe guilartensis*** Guzmán, Tapia & Nieves-Rivera
65. ***Psilocybe heimii*** Guzmán
66. ***Psilocybe heliconiae*** Guzmán, Saldarriaga, Pineda, García & Velázquez
67. ***Psilocybe herrerae*** Guzmán
68. ***Psilocybe hispanica*** Guzmán
69. ***Psilocybe hoogshagenii*** R. Heim var. *hoogshagenii* (= ***Psilocybe caerulipes*** var. *gastonii* Singer; ***Psilocybe zapotecorum*** R. Heim s. Singer)
70. ***Psilocybe hoogshagenii*** R. Heim var. *convexa* Guzmán (= *Psilocybe semperviva* R. Heim & Cailleux)
71. ***Psilocybe inconspicua*** Guzmán & Horak
72. *Psilocybe indica* Sathe & J.T. Daniel
73. *Psilocybe isabelae* Guzmán
74. ***Psilocybe jacobsii*** Guzmán
75. *Psilocybe jaliscana* Guzmán
76. *Psilocybe karalensis* sp. nov.
77. ***Psilocybe kumaenorum*** R. Heim
78. *Psilocybe laurae* Guzmán
79. *Psilocybe lazoi* Singer [this is a doubtful neurotropic species, considered first by Guzmán (1983) as a synonym of ***Psilocybe zapotecorum***, but Singer, 1986, claimed that this is a not bluing fungus independent of that of Guzmán, 1983]

80. ***Psilocybe liniformans*** Guzmán & Bas var. *liniformans*
81. ***Psilocybe liniformans*** var. *americana* Guzmán & Stamets
82. ***Psilocybe mairei*** Singer [= *Hypholoma cyanescens* Maire; Geophila cyanescens (Maire) Kühner & Romagn.; non ***Psilocybe cyanescens*** s. Krieglsteiner]
83. ***Psilocybe makarorae*** Johnst. & Buchanan
84. ***Psilocybe mammillata*** (Murrill) A.H. Sm.
85. ***Psilocybe mescaleroensis*** Guzmán, Walstad, E. Gándara & Ram.-Guill.
86. ***Psilocybe meridensis*** Guzmán
87. *Psilocybe mesophylla* Guzmán, Jacobs et Escalona, sp. nov.
88. ***Psilocybe mexicana*** R. Heim
89. ***Psilocybe microcystidiata*** Guzmán & Bononi
90. ***Psilocybe moseri*** Guzmán
91. ***Psilocybe muliercula*** Singer & A.H. Sm. (= *Psilocybe wassonii* R. Heim)
92. *Psilocybe natalensis* Gartz, Reid, Smith & Eicker
93. ***Psilocybe natarajanii*** Guzmán [= ***Psilocybe aztecorum*** var. *bonetii* (Guzmán) Guzmán s. Natarajan & Raman]
94. ***Psilocybe neocaledonicum*** Guzmán & Horak [= *Psilocybe neocaledonica*]
95. *Psilocybe neoxalapensis* Guzmán, Ram.-Guill. & Halling (2009)
96. *Psilocybe oaxacana* Guzmán, Escalona et Jacobs, sp. nov.
97. ***Psilocybe ovoideocystidiata*** Guzmán et Gaines.
98. ***Psilocybe papuana*** Guzmán & Horak
99. *Psilocybe paulensis* (Guzmán & Bononi) Guzmán (= *Psilocybe banderiliensis* var. *paulensis* Guzmán & Bononi)
100. ***Psilocybe pelliculosa*** (A.H. Sm.) Singer & A.H. Sm.
101. *Psilocybe pericystis* Singer
102. *Psilocybe pileocystidiata* Guzmán et Ramirez-Guillen.
103. ***Psilocybe pintonii*** Guzmán
104. *Psilocybe pleurocystidiosa* Guzmán
105. ***Psilocybe plutonia*** (Berk. & M.A. Curtis) Sacc.
106. ***Psilocybe portoricensis*** Guzmán, Tapia & Nieves-Rivera
107. *Psilocybe pseudoaztecorum* Natarajan & Raman (= ***Psilocybe aztecorum*** var. *aztecorum* sensu Natarajan & Raman; *Psilocybe subaztecorum* Guzmán, 1995)
108. *Psilocybe puberula* Bas & Noordel.
109. ***Psilocybe quebecensis*** Ola'h & R. Heim
110. *Psilocybe ramulosa* (Guzmán & Bononi) Guzmán (= ***Psilocybe zapotecorum*** var. *ramulosum* Guzmán & Bononi)
111. *Psilocybe rickii* Guzmán & Cortez
112. *Psilocybe rostrata* (Petch) Pegler
113. *Psilocybe rzedowskii* Guzmán
114. ***Psilocybe samuiensis*** Guzmán, Bandala & Allen
115. ***Psilocybe sanctorum*** Guzmán
116. *Psilocybe schultesii* Guzmán & S.H. Pollock
117. ***Psilocybe semiinconspicua*** Guzmán & J. M. Trappe
118. ***Psilocybe semilanceata*** (Fr. : Secr.) P. Kumm. [= ***Psilocybe semilanceata*** var. *caerulescens* (Cooke) Sacc.: *Psilocybe cookei* Singer; non *Psilocybe callosa* (Fr. : Fr.) Quél., which is ***Psilocybe strictipes*** Singer & A.H. Sm.]
119. *Psilocybe septentrionalis* (Guzmán) Guzmán (= *Psilocybe subaeriginascens* Höhn. var. *septentrionalis* Guzmán)
120. ***Psilocybe serbica*** Moser & Horak (non ss. Krieglsteiner); (*Psilocybe arcana* Borov. & Hlavácek (2001); ***Psilocybe moravica*** Borov. (2003))
121. *Psilocybe sierrae* Singer (= ***Psilocybe subfimetaria*** Guzmán & A.H. Sm.)
122. ***Psilocybe silvatica*** (Peck) Singer & A.H. Sm.
123. *Psilocybe singerii* Guzmán
124. *Psilocybe singularis* Guzmán, Escalona et Jacobs, (2004).
125. ***Psilocybe strictipes*** Singer & A.H. Sm. [= *Psilocybe callosa* (Fr. : Fr.) Quél. s. Guzmán, 1983; ***Psilocybe semilanceata*** var. *obtusa* Bon; ***Psilocybe semilanceata*** var. *microspora* Singer ?]
126. ***Psilocybe stuntzii*** Guzmán & Ott
127. ***Psilocybe subacutipilea*** Guzmán, Saldarriaga, Pineda, García & Velázquez
128. ***Psilocybe subaeruginascens*** Höhn. var. *subaeruginascens* [= *Psilocybe aerugineo-maculans* (Höhn.) Singer & A.H. Sm.]
129. ***Psilocybe subaeruginosa*** Cleland
130. ***Psilocybe subcaerulipes*** Hongo
131. ***Psilocybe subcubensis*** Guzmán
132. *Psilocybe subhoogshagenii* Guzmán, Torres et Ramirex-Guillen, (2004)
133. *Psilocybe subpsilocybioides* Guzmán, Lodge & S.A. Cantrell
134. ***Psilocybe subtropicalis*** Guzmán
135. ***Psilocybe subyungensis*** Guzmán
136. *Psilocybe subzapotecorum* Guzmán
137. ***Psilocybe tampanensis*** Guzmán & S.H. Pollock
138. ***Psilocybe tasmaniana*** Guzmán & Watling
139. ***Psilocybe uruguayensis*** Singer ex Guzmán
140. ***Psilocybe uxpanapensis*** Guzmán
141. ***Psilocybe venenata*** (S. Imai) Imaz. & Hongo (= *Psilocybe fasciata* Hongo; *Stropharia caerulescens* S. Imai)
142. *Psilocybe veraecrucis* Guzmán & Pérez-Ortiz
143. ***Psilocybe villarrealiae*** Guzmán (=*Psilocybe villarrealii* Guzmán)
144. ***Psilocybe wassoniorum*** Guzmán & S.H. Pollock
145. ***Psilocybe wayanadensis*** K.A. Thomas, Manim. & Guzmán (2002)
146. ***Psilocybe weraroa*** Borov., Oborník & Noordel. (2011); [= *Secotium novae-zelandiae* G.Cunn. (1924); *Weraroa novae-zelandiae* (G.Cunn.) Singer (1958)]
147. ***Psilocybe weilii*** Guzmán, Tapia & Stamets
148. *Psilocybe weldenii* Guzmán
149. ***Psilocybe wrightii*** Guzmán

150. *Psilocybe xalapensis* Guzmán & A. López
151. ***Psilocybe yungensis*** Singer & A.H. Sm. (= ***Psilocybe yungensis*** var. *diconica* Singer & A.H. Sm.; ***Psilocybe yungensis*** var. *acutopapillata* Singer & A.H. Sm.; *Psilocybe isaurii* Singer; *Psilocybe acutissima* R. Heim)
152. ***Psilocybe zapotecoantillarum*** Guzmán, Baroni & Lodge (2003)
153. ***Psilocybe zapotecocaribaea*** Guzmán, Ramirex-Guillen and T.P. Tapia (2003)
154. ***Psilocybe zapotecorum*** R. Heim emend. Guzmán (= *Psilocybe aggericola* Singer & A.H. Sm.)

New ones or changes in above (original) list:

155. ADDED: ***Gymnopilus cyanopalmicola*** Guzm. & Dáv
156. ADDED: ***Gymnopilus punctifolius*** (Peck) Singer
157. ADDED: ***Panaeolus fimicola*** (Pers.) Gillet
158. ADDED: ***Panaeolus venezolanus*** Guzmán
159. ADDED: ***Psilocybe allenii*** Borov., Rockefeller & P.G.Werner (2012)
160. ADDED: ***Psilocybe atlantis*** Guzmán, Hanlin & C. White
161. ADDED: ***Psilocybe chuxiongensis*** T. Ma & K.D. Hyde
162. ADDED: ***Psilocybe cyanofranciscana*** nom. prov.
163. ADDED: ***Psilocybe germanica*** Gartz (2015)
164. ADDED: ***Psilocybe mescaleroensis*** Guzmán, Walstad, E. Gándara & Ram.-Guill.
165. ADDED: ***Psilocybe microcystidiata*** Guzmán & Bononi
166. ADDED: ***Psilocybe neocaledonicum*** Guzmán & Horak
167. ADDED: *Psilocybe neoxalapensis* Guzmán, Ram.-Guill. & Halling (2009)
168. ADDED: *Psilocybe rickii* Guzmán & Cortez
169. ADDED: *Psilocybe subpsilocybioides* Guzmán, Lodge & S.A. Cantrell
170. ADDED: ***Psilocybe weraroa*** Borov., Oborník & Noordel. (2011); [= *Secotium novae-zelandiae* G.Cunn. (1924); *Weraroa novae-zelandiae* (G.Cunn.) Singer (1958)]
171. INSTEAD: *Psilocybe aucklandii* Guzmán, C.C. King & Bandala
     THERE IS: ***Psilocybe aucklandiae*** Guzmán, C. C. King & Bandala (=*Psilocybe aucklandii* Guzmán, C.C. King & Band.-Muñoz (1991))
172. INSTEAD: *Psilocybe banderiliensis* Guzmán
     THERE IS: ***Psilocybe banderillensis*** Guzmán & Bononi (=*Psilocybe banderiliensis* Guzmán)
173. INSTEAD: ***Psilocybe cyanofibrillosa*** Guzmán
     THERE IS: ***Psilocybe cyanofibrillosa*** Guzmán & Stamets (=*Psilocybe rhododendronensis* Stamets nom. prov.)
174. INSTEAD: ***Psilocybe serbica*** Moser & Horak (non ss. Krieglsteiner)
     THERE IS: ***Psilocybe serbica*** Moser & Horak (non ss. Krieglsteiner); (=*Psilocybe arcana* Borov. & Hlavácek (2001); ***Psilocybe moravica*** Borov. (2003))
175. INSTEAD: *Psilocybe villarrealii* Guzmán
     THERE IS: ***Psilocybe villarrealiae*** Guzmán (=*Psilocybe villarrealii* Guzmán)
176. INSTEAD: *Panaeolus subbalteatus* (Berk. & Broome) Sacc. (= *Panaeolus venenosus* Murrill)
     THERE IS: ***Panaeolus cinctulus*** (Bolton) Saccardo (1887) (=*Panaeolus subbalteatus* (Berk. & Broome) Sacc.) (= *Panaeolus venenosus* Murrill)

Psilocybe mexicana *„A“*
Psilocybe mexicana *„B“*

Psilocybe cubensis „Albino A+“

Macroscopic feat.:

Cap/Pileus: Very pale cream, especially in the center, to white often with bluish tones, sometimes with a sharp central nipple. Universal veil remnant spots are present but inconspicuous against the pale cap.
Gills/Lamellae: Attachment adnate to adnexed. Grayish coloration in young fruit bodies becoming nearly black in maturity.
Stem/Stipe: Similar in coloration to the cap, bluing intensely with damage. Partial veil leaves a persistent membranous annulus that is soon purple with spores.

Microscopic feat.:

Basidio/Spores: Dark purple in deposit.

Habitat: Bovine, Equine Dung and Enriched Soils.

Comment: Unlike the PF albino, this mutated strain retains normally pigmented spores. Since there is also a small amount of pigment in the carpophores, this strain is better considered a leucistic form instead of a true albino.

source - www.fsre.nl

Psilocybe cubensis „Amazonian“

This Amazonian strain produces very thick and fleshy mushrooms. Although it is not the easiest strain to grow it may, if properly managed, produce some very nice flushes. The number of mushrooms may not be very big, the size more than compensates for this. Fruitbodies are very solid and have a massive stem.
Cold-shocking is definitely required for this one or else the mycelium will completely cover the casing and this makes watering impossible. This condition also causes mushrooms to only form on the sides of the trays (which will lower your yields)
The mycelium of this strain is extremely rhizomorphic.

source - www.mushmush.nl

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Argentina“

This magnificent Cubensis argentina produces massive amounts of shrooms, is of mediocre size and flushes and flushes forever.
This strain has been known to grow on alder wood and fruit, compost, straw, dung, rice and it's apparent favorite, bird or finch seed. Not only does it thrive during indoor breeding, it also has a very pleasant appearance and is very easy to breed. It will certainly produce lovely prints.

source - www.fsre.nl

Psilocybe cubensis „Australian“

Hello fellow mushroom enthusiast. This strain of cubensis was picked by BIO in Australia some years back and produces some very healthy, classic text book, golden top cubensis. It has potential to grow some very large fruits at times. Sometimes excedeing 1 foot in height on simple substrates such as birdseed. Usually it will produce a varied amount of vary large fruits, or a huge abundance of average sized fruits, using the substrate very well. On DB compost it we have seen it produce fruits over 18" tall. This strain does excellent on DB compost. Its colonizing speed is average, not breaking any records, but certianly not slow. Another nice characteristic of this strain is it produces very thick, solid stems. We have also found over time this mushroom is very comparable to the ecuador cubensis in many aspects.

source - www.thehawkseye.com

Psilocybe cubensis „B+“

The infamous B+ strain of cubensis... what a chameleon this one is. This is by far the most versatile cubensis we've ever seen. Adapting and growing in such a wide range of temperature conditions and substrates. It truly thrives to spread its seed, which by the way its a very heavy spore depositor. Not only does it grow easily indoors, we've seen the B+ fruit outdoors several times in a wide range of temps and substrates. Several times one winter, night time low of 45F, day high of 60F, the B+ just flourished. Spring/summer, low of 75F, high of 90F, the B+ once again fruited beautifully. We've seen it grow on alder wood and fruit, compost, straw,dung,rice, and it especially loves bird/finch seed. We've heard so many good reports back from ppl that just love this mushroom and how easy it grows, and how beautiful it is, its loved by many.
Although the B+ is not a super fast colonizer, its speed is average, producing some very large mushrooms that are generally a caramel color. Grown in cooler temperatures, it usually always produces a very beautiful color caramel cap and stems. The stems are generally very thick, and it produces some large caps. It also drops a very thick veil. Grown in warmer temps, its color changes to a more golden color at times.
The B+ cubensis has been around for a while. It was brought to us by a grower that went by Mr. G. There was a lot of controversy surrounding this mushroom for so long because Mr. G started off by telling everyone it was an azure/cubensis hybrid. Although at times it does grow some broadly umbonate caps like *Psilocybe azurescens*, it is just a unique cubensis. But a huge thanks to Mr. G, where ever you are these days, for bringing us such a beautiful mushroom. We like to refer to this one as "super strain". It really is a superior cubensis in many ways.
This is a Hawk's Eye Favorite and belongs in everyone collection!
These were grown outdoors in a greenhouse, on a mix of 2:1 finch seed to vermiculite, then cased using the 50/50+ tek and mix.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Blue Meanie“

The Blue Meanie strain is kind of mystery strain to me.
"Blue Meanies" which is a widely known name for Pan cyan for about 30 years seemed to become also a kind of new cubensis strain. Sometimes a certain vendor renames a strain for I guess commercial purposes. The Z-strain seems to be such a kind of strain. But no one seems to know what strain it should be. It looks a little like the Golden Teacher, but it isn't.
Well we found this strain on some respected vendor sites as a cubensis so we are ready to put this strain on the list.

source - www.fsre.nl

Psilocybe cubensis „Brasil“

This strain has its origin in Brasil. It's a very rhizomorphic and strong colonizer with medium sized mushrooms. It fruits very fast and appears in clusters counting a large number of mushrooms. No need to isolate this strain to get good results!

source - www.fsre.nl

Psilocybe cubensis „Cambodia“

This is by far one of the fastest colonizing strains of cubensis we have ever seen. We've given it to a few other ppl who witnessed the same results. Let me give you an example. 3 days after inoculation, the strain germinated and 100% colonized 1/2 pint finch seed/verm jars in only 7 days. It was then cased and started pinning 10 days after being cased with a 1" thick casing layer. Mushrooms were harvested 25 days after inoculation. Every patch we've planted has given us the same amazing results...this strain just thrives to spread its sacred seed. We've seen a lot of different strains of *Psilocybe* mushrooms grow over the years.. but this one takes the gold metal for one of the fasted growing cubensis.

Not only do they grow extremely quick, but produced some absolutely beautiful textbook cubensis. This cubensis was originally picked by John Allen while in Cambodia filming some of the *Psilocybe* mushrooms that are growing there. We have also found this to be one of the most potent cubensis we've ever eaten, delivering a very nice energetic high that tended to last quite a while. Its not an extremely intense experience, just very energetic and last a long long time. Very smooth as well without much body noise. This one really wakes you up in a beautiful way. If you like the energetic journeys from these mushrooms, this is your ticket to an all night exploration.

John Allen and his film grew said they found it to be very potent for a cubensis as well.

These cubensis along with some *Copelandia cambodgeniensis* grow in the cattle (brahmans) dung around the Angkor Wat Templeat Siem Reap, Cambodia.

You can see more pictures of this mushroom taken by J. Allen at spiritplants.com.

As for cultivating conditions, it does really well on finch or birdseed, eats through grains, fruits on dung well, loves compost, and seems to love high temps. We've had this mushroom colonize rapidly in 85f+ temps.. and fruited at 93F+ temps with no problem. It loves heat!!!! It also generates lots of heat, so take this in to consideration when incubating and fruiting. This is definitely the summer mushroom of choice. We've also heard back from ppl that the jars of mycelium put off a lot of heat.... not many mushrooms do well in those high of temps.... definitely your outdoor late spring/summer strain. It took a while.. but we have domesticated this strain... and its very stable now, it also withstands contamination very well.

Recently a lot of pictures have been surfacing of this cub doing very well in outdoor patches at cooler temperatures as well. Another thing we have noticed and heard back, is sometimes it produces nice smooth stems, and beautiful caps, textbook cubs, then other times it produces some lumpy stems. They also produce and abundance of mushrooms in a small area. Not a very large growing mushroom on grains, but produces some very large fruits on dung or compost. On grains they make up for the small size by produces a lot of mushrooms in a small area. Be sure and check out the pictures of the cambodians on compost below, this mushroom produces some really beautiful fruits.

For colonization, we recommend 75F-80f, not much higher because they throw off a lot of heat. For fruiting, it will fruit in lower temps of 60F, but it loves heat once again... fruiting will occur from 60F to 93f+.... yes.. 93F+ :) This is one of our favorite cubensis strains because its so fast colonizing and fruiting and is very easy on the mind, body and soul.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 23-26°C / 15-34°C

Psilocybe cubensis „Cambodian Gold“

The Cambodian Gold is a F1 hybrid of Psilocybe Golden Teacher x Cambodia. This strain is developed by a dutch Growkit producer to immediately start growing a variety of the iconic Golden Teacher strain at home.

It has long been a dream for this producer to provide an easy-to-use grow kit for *Psilocybe cubensis* Golden Teacher, but the strain underperformed and seemed unsuitable as a 'Ready-To-Grow' box. However, through a process of controlled mycelium growing and careful selections, the spores of Cambodia and Golden Teacher were brought together as a powerful cross with hybrid vigour that is called "Cambodian Gold".

The Cambodian Gold was first introduced as a 'Ready-To-Grow' box at Azarius!

source - www.fsre.nl

Psilocybe cubensis „Colombian“

This one has a nice history from our friend Plankton88 in Colombia who sent us the spores earlier this year. He picks this strain from the cowfields of the nearby little village Villa de Leiva. He personally found them to very potent and a beautiful journey and wanted to help spread the seed if this wonderful cubensis.
There were 2 strains of cubensis sent to us, one from Guato and this one from Villa de Leiva. As for the growing parameters, its a very fast colonizing strain. This strain tends to grow a mix of rhizomorphic mycelium, and cottony mycelium, (multi spore inoculation)yet grows very fast. The strange thing is that when this strain fruits, the mushrooms cant hold their own weight very well. They topple over. Our growers have grown this mushroom several times and find this very interesting why they don't stand up. We need your help with this one. So many mushrooms to cover.. so much energy being spent. As you can see they grow rather large and in huge clumps, rather cool looking I think. We would like to hear your feedback. We're offering this one at a discounted rate just to get some feedback.
As for the high, very clean, yet somewhat mellow. It is a great "social" mushroom. You get the beauty of the mushroom high, yet its very mellow and smooth. Very easy to talk in groups of ppl on this one without feeling to overwhelmed by the psilocybin experience on the psyche. A very "low anxiety" mushroom. It comes on very mellow, slow and smooth. Its great for being around a lot of ppl without having that "high anxiety" feeling of restlessness some mushrooms give. Count on an easy going peaceful journey. This coming from only one experience on these. You be the judge, feel free to send us any feedback you have for this new strain from Colombia.

source - www.thehawkseye.com

Psilocybe cubensis „Ecuador“

Coming to you all the way from 3500+ feet up in the Ecuador mountains is the beautiful ecuadorian cubensis. This one was picked by BIO, and is very widespread around the world at this point :O). Spread that seed to the wind brother. This mushroom has become very popular in many cultures as it grows very easily in nature. It also produces some very nice golden color mushrooms and it has been noted by many to be one of the most beautiful, picture perfect cubensis out there. Out in nature under God's grace, it produces an abundance of nice big healthy mushrooms.
According to our friends in Ecuador who eat this mushroom, the euphoric sensation it creates is a very dreamy, relaxing, and can be quite visual.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Ecuador Yosterizzii“

This strain came from Mushroomtroll. He gave the following description.
Psilocybe cubensis ecuadorian var. Yosterizii it has a very noticeable wood grain and linear line on the cap some are w/out annulus. It took about 3 years to develop it, and it is a repeating flusher (if you keep your incubator free from parasite you will get a flush every 2 weeks for about 6 month, this strain does not require a casing but is a must for repeated flush (I usually lay perlite at the bottom 2 inch and add 1 inch of water that is presterilize, lay a 1/4 inch of colonize grain over it and then cover with 1 inch of peat moss. (The peat moss is watered to the point were only a few drops of water is running between my fingers and then sterilize.)

source - www.fsre.nl

Psilocybe cubensis „F+“

Originated from a wild Florida *Psilocybe cubensis*. Isolation was carried out and ended with a cloned fruit. All F+ lineages come from this clone.
The strain is very aggressive and colonises most substrates in exceptional time. F+ has even been fruited from wood chips. Like most cubensis, F+ does best on horse and cow dung. The mycelium of F+ is predominantly tomentose to intermediately linear, although it can grow very rhizomorphically under certain conditions. Despite the predominate tomentose growth, F+ usually pins prolifically.
The fruits from this strain have the ability to grow rather large.
Defining characteristics of this strain include: mycelial spots on cap, symmetrical caps, mycelial growth well along the stem, and an umbilicate cap.
Joshua who isolated this strain hopes that all will enjoy it and that it will be spread to mycologists throughout the world.

source - www.fsre.nl

Psilocybe cubensis „Golden Mammoth“

Well, there is a lot of Internet gospel going on about this strain. Here are some info's we at FSRE have collected. A commercial vendor in Canada is the only source claiming this strain. On there website thy have the following info's:

"'*GOLDEN MAMMOTH' (psilocybe aureus tantus) is the ultimate, amazing Psilocybe cubensis strain. The Golden Mammoth has earned itself a reputation as the best among Psilocybe cubensis magic mushrooms strains, the most prolific, reliable and resistant study available.*
Developed 13 years ago by an expert mycologist with over 30 years experience, the Golden Mammoth strain arose after extensive research. Professionally perfected, the Golden Mammoth has a pure lineage and virus free genetic line. The Golden Mammoth is the strongest, most vigorous Psilocybe cubensis strain in distribution. This strain delivers mammoth amounts of research material. General Appearance: Gold colored cap. White veiled stem 8"-10" tall."

Whatever the story is behind this strain, we at FSRE can confirm that it's not a rename of the B+ or Golden Teacher. This strain shows his own unique characteristics. And we do belief that this strain is the result of hard work from a professional mycologist.

source - www.fsre.nl

Psilocybe cubensis „Golden Teacher“

Class is now in session. Eat a few caps and prepare for your cosmo highway lessons! There is a lot of uncertainty as to where this strain originates from. Its believed to come from a company out of Amsterdam a couple years back. We obtained our original print from The Spore Works. After our grower, -Clyde- at the Birds Nest, grew it out several times, he really enjoyed it and decided it was a keeper. Its a semi fast grower and produces some large caps. We've heard a lot of ppl give praise to its potency and heard from several different circle of friends they find the green and purple spectrums of sight are very enhanced.
An additional note to avoid confusion. Another popular spore supplier claims the PES Hawaiian and Golden Teacher (GT) are one and the same and sells them this way. -Clyde- has grown them both out several times and found they were completely different in size and growth, and decided the PES H was not worth keeping (in our opinion, if you enjoy it then great!)and the GT is definitely worth keeping and spreading the seed. Enough said, we're going with the GT.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Guadalajara mexico“

Another cubie from Mexico we're offering is this decent little strain of cubensis from Guadalajara. We're not exactly sure who the found the original specimen, but Workman found the connection in Mexico and fruited this strain to help spread the spores. Nothing really spectacular about its growing parameters. Semi-fast colonizer, produces rather small caps, but average in size overall. We decided to keep it for a while because the word around the camp fire is the potency is considered high for a cubie, and ppl have been asking for it. We have also noticed that most cubs from Mexico tend to be smaller then average, but also very visual. An additional note, its been in this authors experiences, that mushrooms from Mexico tend to deliver powerful spiritual journeys.

source - www.thehawkseye.com

Psilocybe cubensis „Gulf Coast“

Gulf Coast cubensis generally means it is a wild growing cubensis that grows along ocean bordering states such as Texas, Alabama, Florida, Georgia etc. Spores from one state can easily travel to the next through birds, farm animals, hurricanes etc... They adapt along the coastal states to the new growing conditions and take up habitat near the warm humid ocean islands. From what I hear.. most people are very satisfied with these GC strains because they are fast colonizers and produce some above average potency. We do hear a lot that some people have a hard time getting them to pin and fruit easily, while other GC strains fruit very easily. We have worked with a lot of different GC strain over the years people have sent us. With so many out their from the coastal states of the U.S.A. we decided to stick with ONE that a good friend of ours has grown over and over and produced excellent results. We compared his results to the strain we were working with and decided he had the best strain of GC cubensis we had seen yet. After our grower -Clyde- worked with it a few times, sure enough we saw some great results and decided to keep it and stop all further work with the other GC strains such as the Alabama GC below. It is believed this one originated from Texas but our friend was not 100% sure on that. So for reference we are calling it T.H.E. GC so as to not get confused with the many other GC strains floating around out there. This one is truly exceptional and we're glad to add it to The Hawks Eye collection of exceptional cubensis strains.
This GC strain does not seem as stubborn as some of the GC strains we have seen in the past. It fruits very easily in a range of temperature conditions from 60F to 90F. For best results we recommend keeping temps around 75F.

Psilocybe cubensis „Gulf Coast Alabama US“
This strain of cubensis was sent to us from a sacred mushroom hunter in Alabama U.S. We originally received the print, it was easily 6 1/2" in diameter. One very large print from a very large mushroom. The hunter said it was one of his favorite strains of cubensis he hunts there in Alabama, and judging from the print size and what we've seen when grown, we can see why.
This strain is a fast colonizer, and very easy to grow. Something unusual about it, was that the mushrooms grew in large clusters of 10-25 mushrooms. 80% of the casing grew this way. Overall, this GC Alabama is a real nice strain, but potency seemed rather low for a cubensis.
This Alabama GC strain fully colonized 1/2 pint finch seed/verm 2:1 ratio in about 16 days from inoculation. Started fruiting within 2 weeks of being cased, using 50/50+ tek. Tends to grow some very thick solid stems and grows in clusters. Grows well in temps ranging from 60F-85F. Not a real heavy spore depositor though, but a very fast growing mushroom.
A nice cluster of GCA's - 23 mushrooms in this cluster.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 15-32°C

Psilocybe cubensis „Huautla“

Psilocybe cubensis strain finds its origins in Huautla de Jímenez, a small village in the Oaxaca state of Mexico. Here Gordon R. Wasson first tried *Psilocybe* mushrooms becoming the first white person to have experienced a magic mushroom ceremony.
This is the magic mushroom that Maria Sabina used for her veladas, when the *Psilocybe caerulescens* season was finished. It carries with it a spiritual load unequaled in *Psilocybe cubensis*.
Club99 collected this *Psilocybe cubensis* strain in the end of July, 2001 growing on a pasture land, into the grass. Interestingly *Psilocybe cubensis* Huautla was not seen growing directly on dung.
Magic mushrooms are tall and thin and have a uniquely shaped cap. *Psilocybe cubensis* Huautla is a easy fruiter.

source - www.mushmush.nl

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „John Allen“

The following info about this strain was posted by John Allen at the entheogen.com forum!
The Allen strain was developed by Hydorogen of the Shroomery in honor of my research and spore print gathering.
Another one he developed was the Elephant Gate Strain. I did not name either one of those although they are from Koh Samui. The Allen strain I cannot recall what area it is from. I did not name it. But I understand it too is a fast colonizer like the BHT and the Cambodian Cubes.

source - www.fsre.nl

Psilocybe cubensis „Keepers Creeper“

This mushroom arrived us by The Little Guy. We won a print in a nice contest on the Shroomery. So our first genetic material came from BoxTop from TLG and was won in a contest.The original Creeper comes from Keeper. Also an resource for prints, however the most expensive one on this globe. Personally I do not believe in his fantasie stock with fantasie hybrides and exclusive prices.

source - www.fsre.nl

Psilocybe cubensis „Malabar“

Wonderful Prolific fruiter. Nice thick and meaty fruits. These can get fairly large. Unique cap that appears flat on top before the cap opens up. Stems are fairly thick, definitely dense, and meaty. Also veil tends to stay attached, sometimes even at full maturity. You will most likely have to break the veil yourself to print these. Avg. to dark spore depositor.

source - www.mushmush.nl

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Matias Romero“

This is a nice rizomorphic strain. Lots of pins and lots of aborts. But with proper moisture content and humidity many (but not all) aborts can be avoided. This strain loves water but don't go drowning it! Fat meaty stems particularly at the base of the stem and great yields. This strain is named after the Mexican village Matias Romero where it was collected. It produces, some smaller, but fat stemmed mushrooms that usually form in clusters. This strain profits a lot from cold-shocking. The veil for the most part breaks cleanly away from the cap and caps leave heavy spore deposits.

source - www.mushmush.nl

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Mazatapec Mexicana“

Another fantastic cubensis from Mexico is the strain picked around Mazatapec Mexico. For those of you into the spiritual side of mushrooms, I'm sure you will enjoy this one a lot, as I've always noticed mushrooms from Mexico tend to deliver a very powerful spiritual journey. We've heard a lot of great feedback from ppl over time on this one having very beautiful visions after embracing its gift. Although you may have a tremendous spiritual or visual experience on these, you'll need a little patience. These tend to colonize a little slower them most. Count on an extra 10-14 days to your project. The little extra wait is well worth it.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „McKennaii“

The first appearance of this strain was in Dutch smartshops. It was available as a fresh mushroom shortly after the dead of Terrence McKenna. We belief this strain was named after Terrence McKenna in order to honor him. This could be a marketing trick from the smartshops, but still it's very honorable to name a strain after Terrence Mckenna.
The following info is according to the website of one of our sponsors, which offers this strain as a Growkit:
"The McKennaii might be even stronger than the popular but difficult to grow Hawaiian (Copelandia cyanescens). No doubt the McKennaii is the strongest cubensis in our catalog. This one is for the more visually interested. Dark brown caps with an odd shape and thick sturdy stems."
Also this info could be part of the marketing trick!

source - www.fsre.nl

Psilocybe cubensis „Mexican“

This mushroom was originally found in Southern Mexico, from Mr. G. A very beautiful mushroom always giving beautiful spotted caps, usually of a nice yellowish color instead of your typical cubensis golden tan color. Sometimes it even throws off some orangeish colored spotted caps. It tends to grow with smaller stems and rather large caps compared to its stem. A rather fast strain, and very easy to grow. It does exceptionally well cased, and will continue to flush over and over within a week of each other. Although not a giant sized mushroom, it produces an abundance of mushrooms continually. You can usually count on a minimum of 4 really good flushes from this strain, and sometimes more. Another nice key feature about this cubensis, as that it fruits well in cooler temps of 50F, but also grows like all other cubensis at the higher temps of 75F-85F.
One special characteristic about this mushrooms potency, is it doesn't seem to give the high anxiety a lot of mushrooms do when the first initial waves of euphoria come over you. Its a very smooth, clean high, with a nice heavy play on the eyes.
The mexi-cub is truly a beauty to marvel at for its unique appearance, definitely gets a "best of show" award.
Some beautiful new pics of the mexi-cub on Dung Brothers compost inside of the 10lb THE DB KIT. These are absolute monsters for the usually small growing mexi-cub.

source - www.thehawkseye.com

Psilocybe cubensis „Mystery Fatass“

This strain produces mushrooms with the fattest asses you have ever seen! The caps are hard to print as she looses her spores poorly. The first flush consists of mushrooms with an unusually fat stem. In later flushes some very big mushrooms can be harvested.

source - www.mushmush.nl

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Nepal Chitwan“

Description: Original collection material was obtained by Baerbel near the Chitwan Jungle of Nepal. Three specimens were located in otherwise dry climate conditions, growing in tall grass and shaded by a nearby tree. Specimens picked from what appeared to be either elephant or rhino dung. Original sample specimen pictures below and right.

Macroscopic feat.:

Cap/Pileus: 20-70 mm in diameter, hemispheric expanding to nearly plane with age. Golden brown maturing to light brown. Fine fibrillose veil remnants when young that soon mostly disappear. Flesh yellowish white soon bruising bluish green.
Stem/Stipe: 150-200+ mm in length. Typically equal, sometimes slightly enlarged at base. Yellowish to buff with a reflective sheen, bruising bluish, semi hollow with remains of the partial veil.
Gills/Lamellae: Attachment adnate to adnexed. Yellowish coloration in young fruit bodies becoming darker in maturity. Remains of the partial veil attached at the outer circumference of the cap.

Microscopic feat.:

Basidio/Spores: Dark purplish brown, subellipsoid on 4-spored basidia.

source - www.sporeworks.com

Psilocybe cubensis „Orissa India“

All the way from India, an EXTREMELY large growing cubensis that spawned from elephant dung has blessed us all. This strain of cubensis has to be one of the largest growing anyone has seen. Originally brought to us my entheomycologist John Allen, once again a big thanks John, this one really rocks the boat. Ever seen dinner plate sized mushrooms? Even on simple rice cakes in Amsterdam this one grows some rather large mushrooms.
-Clyde- and his fellow Amsterdam growers have seen some mixed results from this one as well. Although something so large comes with a small price, at times its rather unstable when taken from the dung fields to the grow shops of Amsterdam. The Amsterdam growers tells us although the first flushes at times can be unstable, the rest are outstanding and produce these monster mushrooms like they have never seen. The Indian cubensis also grows around most green mold like its nothing. They continue to flourish around green mold like Oyster mushrooms do. I guess it must be something in the elephant dung that has helped this mushroom develop and immunity to most green mold (trichoderma) The more -Clyde- has worked with it the better it gets.
Colonizing speed is average, potency is extreme for a cub from the feedback we got from the Amsterdam coffee shops and the locals in India.

source - www.thehawkseye.com

Psilocybe cubensis „Pensacola“

This strain was first donated to the FSRE by Ashes.
The FSRE is very happy to share this interesting cubensis strain from Pensacola, Florida. Be surprised by the appearance of this beauty. Growing fast with strong rhizomorphic mycelium, easy fruiting with short but massive fruits.
This strain is worth a try!!

source - www.fsre.nl

Psilocybe cubensis „PESA“

Ready for some drama and controversy :). This one has an interesting story behind it. A company out of Hawaii called Pacific Exotic Spora (PES) advertise this strain as a cubensis/azurescens hybrid. They even went so far as to claim it came from the mushroom master Paul Stamets himself. Well people, there has been a lot of azure/cub hybrid scams in the past, and to this day the experts such as P. Stamets have not published any information about being able to hybridize a *Psilocybe azurescens* with a *Psilocybe cubensis*. They are completely different species and this task would certainly be extremely difficult. I'm sure if anyone can do it, P. Stamets can, and hopefully one day he will. But until something is published, do not buy into it. This is nothing more then a very potent cubensis.

About a year ago when they started advertising this hybrid, a bunch of us pitched in to get a print of this (yes, that is how high there prices are :) and Workman grew it out and once again, a cub/azure hybrid was nothing more then a cubensis. Our grower here at T.H.E. has grown out all the cubs from PES, and found this the only one worth keeping. Another company, PF, sells the PES Hawaiian, which is a different strain, and some ppl have the PES Amazonian, this strain is neither of those. If it helps with any of the confusion, just call it PESA.. and the A does not stand for Amazonian. I think it originally stood for Azurescens.
PES (Pacific Exotic Spora)has been around for a while, and sells quite a few strains of cubs and panaeolus at a very very high price. We normally will not carry other strains that is unique to one company. But, since PES charges such a ridiculous price for a print of this strain, we decided to go ahead and carry it and share with everyone because most ppl will enjoy the extreme potency.

Ok, enough of the controversial babble, now lets get down to the fact of this strain. Our grower -Clyde- finds this to be one of the most bluing cubensis he has ever worked with. After cutting these with a blade, they turn dark blue within 2-3 seconds!! Most cubs, take about 10-20 seconds to start turning dark blue. And everyone we know that has tried them found them to be extremely potent as well. Perhaps this is why PES started calling them cub/azure hybrids since the *Psilocybe azurescens* is the most potent mushroom in the world.
So yes, the PESA is a VERY potent cub, but potency is not everything. It produces some very light caps, although large caps compared to small stems, and does tend to abort a lot. As you will see in the pics below if you look real close. It is a semi-fast colonizer, and fruits nicely in cold temps. So this mushroom does not utilize all of the substrate very well, but the mushrooms it does produce are just extremely potent and its a real good strain to add to your collection. Like I said, it was the only one of the PES strains we liked enough to keep. And its one of our growers favorite strains, I think he is just impressed with the extreme speed of the bluing effect... so easily entertained (wink).

source - www.thehawkseye.com

Psilocybe cubensis „Penis Envy“

We're happy to finally be able to bring you spores of our favorite cubensis. We would have loved to brought this one out sooner but this mushroom is extremely hard to obtain spores from. Only about 10% of the mushrooms actually drop spores. Every time we had a few prints they sold out immediately!

Why is that? Well it is a mutant mushroom in a sense. This one was developed by the famous entheogenic mycologist/enthobotanist and psilonaut Terence McKenna, God bless his resting spirit. For those not familiar with Terence McKenna he was a famous author, speaker, mycologist, botanist on psychoactive plants and fungi. You can find a whole vault of his teachings in MP3 format at this link.

My personal favorite book by him is Food of the Gods. Unfortunately Terence McKenna died last year of a brain tumor and now resides in Gods hands :0) See you on the cosmo highway Terence.

Besides his wonderful teachings he left behind to fuel our thoughts and imagination, he also left one of the most unique and powerful cubensis mushrooms we have every experienced. Its nick named Penis Envy because they resemble.....well......you guessed it.. a penis. Terence was big on mushrooms and marijuana and he talks a lot of psilocybin mushrooms being a "male" energy and mj being a "female" energy. No wonder he developed a mushroom that looks like a penis :) Listen to many of his teachings and you will hear what I'm talking about.

OK now for some information on the mushroom itself. Well this one is straight up amazing. Its favored by many and yet feared by others. Why? Its very powerful medicine. Most of our friends in Amsterdam claim this one is twice as strong as any cubensis they have ever tried. The vibe lasts a long, long time. It does not come on in "waves" as most cubensis do. Its a solid ride from start to finish. Once your on the vibe its solid.. it keeps going strong for many many hours... but in a very beautiful way. A few friends claimed it was to strong but most wanted more, more, more! On the times I had the opportunity while outside the U.S. to eat these, I was mesmerized. It was the perfect vibe for cubensis in my experiences. I love the fact it doesn't hit you in waves. Its the same strong vibe throughout the experience. It is very smooth, and clean and easy on the body. I always felt like a million bucks the day after eating these. In my humble opinion, this is the perfect vibe from a cubensis!

Provided you live in a country where its legal to grow and eat psilocybin mushrooms, treat it like any other cubensis. You will not get huge flushes from it, but what you will get are extremely solid mushrooms that are the thickest cubensis mushrooms every seen. They are like little wood logs, solid all the way through. Once dry they weigh a lot more then appears. In fact eating them, its best not to just chomp down a mushroom unless your ready for an intense experience. Its best to break them up into a lot of pieces, almost fluff them up. What appears to be an average mushrooms fluffs up into a huge pile expanding to 3 to 4 times its actual size. Then you can judge your dosage much better. They grow very large on compost and dung based substrates as well on birdseed and rye grains. Our grower in Amsterdam has never grown them on rice cakes so no idea how they perform on that substrate.

Now although this mushroom really is amazing, it drops very limited spores. If you cant get any spores from your mushrooms you can always cut off a piece and use tissue culture techniques on agar, cloning. Or you can take a cotton swab, such as a Q-tip and rub in the gills real good to get some spores, then later drop that in a bag of grain or streak it across agar. Of course that assumes you live where its legal to grow. Because spores are so hard to obtain from this mushroom they are priced much higher. Also we can not give these out free with our combo deals unless you buy at least 3 spore syringes as well. Thanks for understanding.

A few pics for now. We have a lot more but they are all on video tape and I don't have time right now to pull them off. I will hopefully post some more amazing pictures soon. In fact I have some video footage of these already edited and will hopefully post that soon as well. I promise I will get some amazing pics up before we go out of business.

The mushrooms from these pictures are average in size. But even the largest mushrooms in these pictures will dry to almost a 1/2 oz. That is how dense they are! -Clyde- started these on rye grain then transferred them to 10 lbs of compost. Just from one flush like this they will dry to about 3 ounces! Pretty damn amazing. As long as you can get over eating a mushroom that looks like a dick you will have many happy experiences on these.

source - www.thehawkseye.com

Psilocybe cubensis „Penis Envy 6“

Shroomery veteran RogerRabbit, "Crossed a standard PE with the Tex strain." The result was PE 6.
RogerRabbit's efforts were an attempt to create a PE strain which produced more spores... but the spores were accidentally released too early... when a few prints were unintentionally mailed out, in a stack of other prints.
Here's how RogerRabbit says PE 6 came to be.

"A single sector fruiting isolate of PE, and another of TEX were placed on a Petri dish with rattlesnake venom added to the agar. The snake venom helped the two dikaryotic strains share genetic information to form a third sector, which was which was labeled PE6. Other Isolates of the PE were labeled PE 1-7, and apparently, some of the 6, which was the cross, were in the same batch of prints. The idea was to get a good spore producing PE, but I never had time to stabilize the strain due to accidentally releasing it early. That's why sometimes they look like texans and sometimes very much like PE."

PE 6 looks like a cross between Penis envy and Texans. The fruits often have LARGE caps, which open fully, unlike classic PE. They also produce spores. While the stems look quite a bit like PE. Thick and textured. Like little logs.
RogerRabbit confirms this description: "the caps that opened fully have fewer spores like PE, and they have the same gnarly stems too. Only the caps seem to be bigger and to open all the way."

source - www.fsre.nl

Psilocybe cubensis „PF Classic“

This PF strain is no different strain that the normal PF Classic. However this strain has been cultivated from approx. 1990 only on PF cakes (brf/verm) with no interruption of tissue culture.
In order to keep this strain clean we hope you only use them on brf/verm cakes as the PF style describes. Classic 90 prints are a kind of collectors items I think and that's how they are offered. In order to keep this strain 100% real we will place the returned 90 prints in the regular Classic stock.
This strain was donated by René of Perfect Fungi Europe. This strain is 100% Robert McPherson original. So it is the one and only PF Classic from the one and only Mister PF.

source - www.fsre.nl

Psilocybe cubensis „Plantasia Mystery“

We're very happy to be able to bring this strain to you. There were a lot of rumors surrounding this strain for quite some time back in 98. It originated from The Grow Room, but Plantasia is no longer in the spore business so we asked him if he minded if we sell his unique strain and he was cool with it, so here is a new strain that we at The Hawks Eye think is good enough to turn everybody on to. Originally it was unsure weather this strain was an azurescens or cubensis. As you can see from some of the outdoor pics, it looks a lot like an azure, but it grows like a cubensis, it loves warm temperatures. Rumor has it this strain was being handed out by P. Stamets himself, as an azure, at a mushroom conference in Mexico some years back. And as you will see from some of the pics, they do look a lot like huge azurescens, but they are not.
Update December 2000. We're very happy to bring the Plantasia cub back again. This is one of this authors personal favorites for the experience they provide. They always seem to give me extremely happy thoughts and a huge smile across my face :) as well as those around me. Just a beautiful happy vibe.
As for growing, they are semi-fast colonizer, fruits are average in size, and very beautiful as you will see from the pics. This strain not only does well in heat, but also in cooler temps outdoors. Enjoy.

source - www.thehawkseye.com

Psilocybe cubensis „South American“

Macroscopic feat.:

Cap/Pileus: 25-125+ mm in diameter, hemispheric to convex to nearly plane at maturity. Dark red maturing to golden brown. Fine fibrillose veil remnants when young that soon disappear. Flesh white soon bruising bluish green.
Gills/Lamellae: Attachment adnate to adnexed. Grayish coloration in young fruit bodies becoming nearly black in maturity.
Stem/Stipe: 150-350+ mm in length. Typically equal, sometimes slightly enlarged at base, sometimes contorted. Yellowish to buff with a reflective sheen, bruising bluish, hollow. Partial veil membranous leaving a persistent membranous annulus that is well dusted with purplish brown spores even before tearing away from the cap.

Microscopic feat.:

Basidio/Spores: Dark purplish brown, subellipsoid, 13 by 8 micrometers on 4-spored basidia.

Discussion: Produces some very large mushrooms, and a very heavy spore depositor.
This strain is a great all around performer! Fast growth and high yielding clusters in the wild. You'll get some monsters from time to time with this strain. Rizomorphic mycelium eager to spread and caps tend to split some and this to be due to the fast growth rate of the fruits. Heavy spore depositor.

A favorite among many! The spores of this strain can produce one of the fastest growing cubensis out there. High yields, big fruits, an all around winner.

This strain comes from South America. Quick colonizer that produces mediums sized fruits. One not to miss in any true collector's library.
The South American strain was originally sold by Spore Chicks from a strain collected in Venezuela.
It tends to colonize very quickly with a dense pinset.

source - www.fsre.nl

Psilocybe cubensis „Syzygy“

Syzygy was the name of a Spore vendor back in the early days. The person behind this company was apparent Terence McKenna. Below is a copy of there advertisement in the book "Psilocybin: Magic Mushrooms Grower's Guide" by Oss & Oeric.

A 25year old spore print originating from this company was reincarnated and these spores now circulate under the name "Syzygy". This strain was first donated to the FSRE by Anand.

source - www.fsre.nl

Psilocybe cubensis „Tasmanian“

The Tasmanian cubensis is a fantastic mushroom found by BIO on the island of Tasmania just below Australia. Tasmania is a state of Australia, sub-tropical, having 4 seasons. It tends to get very cold their at times, and as -Clyde- found out, this mushroom does very well in cold temperatures outdoors, Our grower -Clyde- did some work with the Tazmanian cubensis and was just ecstatic about this strain of cubensis. He says its extremely fast growing on compost, high yielding, and produces some very large capped beauties as you will see in the pictures. He also gave word people will be very pleased with the sensation within it provides. Not much more to tell on this one yet, its new to us and we haven't seen much talk about it yet on any message boards. -Clyde- thinks people are going to be talking very highly of this strain once it gets around.

-Clyde- says this is an extremely fast grower. At 80F temps, it colonized 10 lbs of compost in 5 days !! That is very fast. Most other fast strains he says does it in around 10 days. Unfortunately, we only have one picture of it indoors, but what a nice picture it is.
This is a close up, with a film canister for size comparison.

Our grower had some fun with the strain outdoors. After the trays of compost started colonizing, the trays were put outdoors in cold temps. The average temp range was a hi of 75F, and a low of 45F. The Tasmania cub still colonized fast, and produces some very beautiful yellowish color cubs.
Another characteristic our grower likes about the Tasmania cub is its a real good 2nd flush producer. This same outdoor tray above, produced a nice abundance of large capped mushrooms on the 2nd flush as well.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Teonanacatl“

This strain was observed and collected for the 1st time by Mauritius (founder of the pro-fungi, Brasil) in the Lowland region Careiro, state of Amazonas, Brazil.
During the rainy season extending from September to May, buffalo breeders bring their pets to farms flooded by the road BR 319 that connects the Careiro Varzea Careiro to Brown. With the end of the rains the animals are transported to other areas. In July of 2008 Mauritius entered a farm and collected a mushroom of the genus *Psilocybe cubensis* from the buffalo manure.
The spores of this strain where clean on agar and sectors of mycelium where isolated for 1 year to select the best growing mycelium on rice and corn.
The name is in reference to the site Teonanacatl.

source - www.fsre.nl

Psilocybe cubensis „Thai“

This strain is sold commercially in the smartshops in The Netherlands as "Thai cubensis". A very nice strain to grow, although the mushrooms themselves are not that big, the huge first flushes make up for this. This strain produces very well and easy. No cold-shocking is required.
The picture show a some very mature first flush mushrooms grown on sterilised rye cased with peat/lime.

source - www.mushmush.nl

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Thai Pink Buffalo KS“

This particular strain also comes from the beautiful island of Koh Samui, Thailand and was brought to us John Allen. What makes this one so unusual is that it was found in a field that was inhabited by one of the sacred pink buffalo of the island.
Like the other Thai strains, this one is considered one of the more potent strains of the *Psilocybe cubensis* variety. It's worth mentioning that these Thai strains are very fast colonizers and tend to produce larger fruitbodies in later flushes rather than the initial ones. Another great strain from Ban Hua Thanon - Koh Samui, Thailand.

source - www.fsre.nl

Psilocybe cubensis „Thailand Ban Hua Thanon“

The scientific name is Ban Hua Thanon, after the island it was first found on. Our Ban Hua Thai is very very easy to cultivate, totally white and looks like an albino - shroom ;)
While it grows in the same standard temperatures as other members of the PC genus, it has also been known to colonize at as high as 30 degrees Celsius.
This Mushroom is probably the most beautiful we have to offer!

source - www.magicmushrooms.org

Psilocybe cubensis „Thailand Lipa Yai“

Another great psilocybe mushroom brought to us by Enthomycologist John Allen from his travels through Thailand. This fantastic species of cubensis was picked in this field in Lipa Yai on the island of Koh Samui, Thailand. And this big beautiful buffalo is one of the benefactors that helps these wonderful mushrooms flourish all over Thailand :) A huge thanks again to John Allen, a.k.a. Mushroom John for taking the time to seek out these mushrooms on his travels and bringing back spore prints.
This strain of cubensis from Thailand is a another winner. We were hesitant to make available 2 strains from Thailand thinking they might just be the same strain of cubensis that migrated. After growing both strains, the Koh Samui and the Lipa Yai out several times they clearly show many differences and traits and are both exceptional strains of mushrooms worth spreading.
The Lipa Yai strain is similar to the Koh Samui strain in the fact it is a fast colonizer, is a strong resister to contamination, fruits very easy and fast, and is very potent for a cubensis. The big difference in the 2 is that the Lipa Yai grows taller and produces a lighter cap. The Koh Samui tends to produce smaller, yet very thick stemmed and large caps, while the Lipa Yai grows taller, semi-thick stems, and semi-large cap. Both are excellent strains. The feedback we've received from those who have sampled its spiritual gift, absolutely love this one. Very potent!!! It's no wonder why in Thailand they have the full moon festival every month where thousands gather to eat these sacred mushrooms and experience God-Within together. Looks like its time for a TRIP to Thailand :)

source - www.thehawkseye.com

Psilocybe cubensis „Thailand Koh Samui“

Another great psilocybe mushroom brought to us by Enthomycologist John Allen from his travels through Thailand. This beauty was picked in the town of Hua Thanon on the island of Koh Samui. Here is a picture of the field actual field it was picked in.

A huge thanks again to John Allen, a.k.a. Mushroom John for taking the time to seek out these mushrooms on his travels and bringing back spore prints.
This strain of cubensis from Thailand is a real winner. Its very resistant to contams, is a very fast colonizing strain and the fastest fruiting strain of cubensis we have seen. It tends to grow some very **thick** mushrooms with large caps. Although they don't grow real tall, they make up for height in thickness. Some times it tends to grow some nearly shaped mushrooms, but we hear the stranger they grow the more potent they are with this strain :).
Its potency is phenomenal for a cubensis. We've heard nothing but great reports back from people that have experienced its gift. Many friends have claimed it to be the most potent cubensis they've tried yet, saying they are very "twisted", and asked for these specifically by name the next time they were ready to journey. You'll need to be the judge of that for yourself.Another group of friends have dubbed them "the cloud mushrooms" you'll see what I mean when you enjoy viewing the clouds on these.
It's no wonder why in Thailand they have the full moon festival every month where thousands gather to eat this sacred mushroom and experience God-Within together.

source - www.thehawkseye.com

Psilocybe cubensis „Thailand KS Lamai Beach“

Another great psilocybe mushroom brought to us by Enthomycologist John Allen from his travels through Thailand in 2000. This beauty was picked and printed on Lamai Beach on the island of Koh Samui in Thailand. A huge thanks again to John Allen, a.k.a. Mushroom John for taking the time to seek out these mushrooms on his travels and bringing back spore prints.
This strain of cubensis from Thailand is another winner. Our grower -Clyde- had grown out all the strains from Thailand brought back these last couple of years and we only kept the best ones. After growing it out through several generations, this strains is acting more domesticated and producing some amazing flushes. Although at my discretion to have so many Thailand strains, -Clyde- insisted we spread the spores of this strain as it produces an abundance of mushrooms in a small surface growing area. Colonizing and fruiting speed is average, mushrooms are plentiful, and once again, as with all of our Thailand strains, this one is yet another very potent mushroom for a cubensis. We hope you enjoy it :)
All of the Thailand strains are quickly becoming The Hawks Eye favorite cubensis.

source - www.thehawkseye.com

Psilocybe cubensis „Transkei“

This is a *Psilocybe cubensis* strain from South Africa. It was the first strain of *Psilocybe cubensis* in wide circulation that originated from the African continent. The original magic mushrooms were collected in January 2002 in Transkei, in the Wild Coast region of South Africa. The magic mushrooms were growing directly on dung in the shade of trees.
Psilocybe cubensis Transkei magic mushrooms are medium sized and have a pretty solid stem that's a little gnarled. Young magic mushrooms have bright orange/brown caps that later turn very pale to almost white. Combined with the purplish colour from sporulation, these caps take on a unique white/purple/golden pattern. The veil stays connected to the cap for a very long time until it tears, leaving remnants on the stem as well as on the cap. Most *Psilocybe cubensis* strains have a veil that tears from the cap and stays on the stem. Mycelium on agar grows very rhizomorphic.
Cultivation is pretty much the same as with other *Psilocybe cubensis* strains although the formation of overlay and stroma is to be expected. A cold shock does not seem to have any effect on this *Psilocybe cubensis* strain. Overlay makes watering impossible but the wildly growing mycelium will act as a contamination barrier protecting the substrate. Still magic mushroom yields are substantial and certainly not bad for any *Psilocybe cubensis*. As magic mushrooms are pulled from the casing they open up the casing layer beneath making watering possible again. Magic mushrooms show extreme bluing when bruised.

source - www.thehawkseye.com

Growth parameters:

Substrate:
Various grain types, compost, pasteurised dung/straw
Temperature:
colonisation/fruiting: 28-30°C / 23-26°C

Psilocybe cubensis „Tulum“

The variety Tulum, is not exactly a Mexican variety of psilocybe, the name came because the Collective SANTOVIAJE, spanish people of fungic and botanic speciallist with a biochemistry, and the help of a Mexican-Spanish shaman and friend, who stay for 1 year living in the state of Quintana Roo, Mexico in 1999, trying to make an hybrid... the varieties that was present in that "experiment" was: *Psilocybe baeocystis*, *Psilocybe cyanescens*, *Psilocybe mazateca* and *Psilocybe cubensis* strain Thai Pink Buffalo.
The result of that experience was a mushroom very potent, although not necessarily a hybrid, and ready for the weather and temperatures more colds like in Europe, and ready too for outdoor grow and little attention. They call the strain Tulum, because the culture grow there and after the strains came to Spain the culture #11 was the best. Initially few persons have the strain and then it spread via Holland...
Robust and resistant to contaminants. It grows well in Brown Rice. There are reports that under favorable conditions it can give very large fruits.

source - www.fsre.nl

Psilocybe cubensis „White Treasure Coast“

Well, here it is, a white cubensis. Pretty isn't it? This white cubensis is a substrain of the Treasure Coast Cubensis from Florida. The Treasure Coast Cubensis was brought to us by the grower for the former FMF, that went by Mr. G. He has done some interesting breeding with the TC strain, and it will throw off 4 different substrains. One of them being this very unique white cubensis. We have seen a variety of substrains come from this strain, and most recently several casings of all white albino mushrooms. The white cubensis starts off a very light brown, then changes to the frosted white at about 1 1/2" to 2" tall as it matures. All the substrains of the TC will have a frost look on the caps with, and they are all very potent mushrooms, the white being more potent then the rest for some reason.

For a long time this mushroom strain has been considered slower then most. The problem was solved by dramatically increasing the spore count in the syringes. It also tends to be fast on rye grain and fast on straw. This one is a very beautiful mushrooms worth checking out.

Currently all spores being sold of the Treasure Coast Cubensis are from these white albino mushrooms. There is no guarantee you'll see the white substrain, but your chances are much higher from these spores.

source - www.thehawkseye.com

Psilocybe cubensis „Wollongong“

This strain originates in the Illawarra escarpment near the city of Wollongong, Australia. The Illawarra escarpment is the mountain range west of a narrow coastal plain south of Sydney, enclosing the region known as the Illawarra which stretches from Stanwell Park in the north to Kiama, Gerringong and the Shoalhaven river in the south. The hills of the plateau reach over 400 m and may drop abruptly to the coast.

The Wollongong strain tends to be very aggressive. The pinset is very even. First and second flush fruits tend to be the largest. What's very remarkable about this strain is the color of the caps, which are a beautiful almond-like color. You can even see the edges of the caps have stripes. Very different from other strains.

source - www.fsre.nl

Psilocybe cubensis „Z-strain“

Some cultivators say is also the Golden Teacher, but is really it's own strain displaying different characteristics than the GT. An aggressive colonizer and prolific fruiter, the Z-strain produces medium to large fruits.

The original Z-Strain comes from SporeTradingPost for the grazy price of $90.00. This amount of money is way to much for a simple print. Personally I do not believe in his fantasie stock with fantasie hybrides and exclusive prices.

Most growers even speculate if the Z-strain is indeed a new kid in the mushroom three. It is extreme hard to make hybrides. And very doubtful that one guy produces all those hybrides. The are most likely renamed cubensis strains.

source - www.fsre.nl

Psilocybe acutipilea

Psilocybe acutipilea (Speg.) Guzmán

---

synonyms:
Deconica acutipilea Speg. (1889)

Macroscopic feat.:

Cap/Pileus: 7-10 mm diam., globose-conic to conic-papillate, smooth to somewhat striate at the margin, hygrophanous(?), brown to brownish, viscid (?).
Gills/Lamellae: Subadnate or sinuate, brownish chocolate with whitish edges.
Stem/Stipe: 50 x 1-2 mm, cylindric, hollow, flexuosus, whitish to yellowish, covered by floccose white fibrils (it seems to stain blue when injured).
Context: Whitish.
Odor: And taste unknown.

Microscopic feat.:

Basidio/Spores: (7-) 8-9.5 (-11) x 5-6 (-7) x 4-5 µm, subrhomboid in face view, elliptic or subelliptic in side view, thick walled, brownish yellowish, with a broad basal germ pore.
Basidia: Basidia and pleurocystidia not observed (hymenium collapsed) (it is possible that there are no pleurocystidia).
Cheilocystidia: 15-28 x 5-8 µm, hyaline, abundant, vesiculose-pyriforme with long neck 8-10 x 1-2 µm, forming a more or less sterile band at the edge of the gill.
Subhymenium: And trama brownish yellowish with hyphae collapsed.
Epicutis: Subgelatinized with hyaline elongated hyphae.

Habitat: Solitary on humus in subtropical forests. Known only from the type locality.

Studied material: BRAZIL, Apiaí (Apiahy), Autumn 1881, Spegazzini 1536 (LPS 38307 type).

Discussion: This species is close to *Psilocybe mexicana* Heim and *Psilocybe caerulescens* Murr., and seems to be intermediate between them. The size of the spores and the cheilocystidia serves to separate *Psilocybe acutipilea* from the other two species (see Guzmán 1977-B). It is possible that this species has hallucinogenic properties because of its relationship with those mentioned above that they are use by the Mexican Indians as psychotropic fungi.

source - www.mycotaxon.com **[7 (2): 226]**

Pictures at www.mushroomobserver.org

Psilocybe aeruginosa

Psilocybe aeruginosa (Curtis) Noordel. (1995)

synonyms:
Agaricus aeruginosus Curtis 1786
Pratella aeruginosa (Curtis) Gray 1821
Stropharia aeruginosa (Curtis: Fries) Quelet (1872)
Stropharia alpina (M. Lange) M. Lange 1980

Macroscopic feat.:

Cap/Pileus: 2-8 cm broad, convex to campanulate, soon expanding to broadly convex, often with a low, broad umbo. Dark bluish green, sometimes fading with maturity. Surface viscid when wet and covered with a bluish green, separable gelatinous pellicle. Margin even, adorned with whitish flecks, remnants from the partial veil. Flesh thin, whitish, thicker towards center.
Gills/Lamellae: Adnately attached, broad, fawn to clay brown in color, sometimes tinged purplish, with white edges.
Stem/Stipe: 30-80 mm long by 3-12 mm thick, nearly concolorous with cap, equal, flared towards the apex, and swelled at the base. Surface covered with whitish patches. Partial veil membranous, leaving a fragile, membranous annulus on the superior regions of the stem, which is whitish above and bluish green below, sometimes disappearing in age.

Microscopic feat.:

Basidio/Spores: Dark vinaceous purple brown to purple black in deposit, 7.5-9 by 4.5-5 µm, ellipsoid, thick-walled with a central germ pore.
Cheilocystidia: lageniform-capitate and bluntly capitate, 40-55 by 10-12.5 µm.
Pleurocistidia: Mucronate, clavate, 40-60 by 10-15 µm.

Habitat: Widespread throughout the British Isles, northern Europe, and in western North America, on wood debris, in gardens, parks, and occasionally along grassy areas at the edge of woodlands. In the Pacific Northwest this mushroom grows beneath conifers and in the South-west under aspens. In southern California, it can be found under oak.

Comment: Activity suspected but not known. A spectacularly beautiful mushroom, *Psilocybe aeruginosa* is listed in most books as a *Stropharia*. Noordeloos (1995) proposed a new combination, placing this mushroom, more appropriately, into the genus *Psilocybe*, following the suggestions of Alexander Smith (1979). This mushroom has historically been reported as poisonous, perhaps because of its psilocybin content. (Some books still report it is poisonous, without providing elaboration or references.) Analyses of specimens from Washington found no psilocybin or psilocin (Beug and Bigwood 1982b). I know people who have eaten this species with no effects. In Europe, it is thought to be edible. Since the consumability of this species is questioned, caution is advised until the biochemistry of this species is studied further. See also *Psilocybe caerulea* (= Stropharia caerulea).

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe allenii

Psilocybe allenii Borov., Rockefeller & P.G.Werner (2012)

synonyms:
Psilocybe cyanofriscosa
Psilocybe cyanofranciscana nom. prov.

DESCRIPTION 1

Description: *Psilocybe allenii* was described as new to science in 2012 by Jan Borovička, Alan Rockefeller, and Peter G. Werner. Borovička received material collected from Seattle, Washington, which he noted was microscopically similar to *Psilocybe cyanescens*, but lacked the wavy cap margins characteristic of that species. In previous publications, Borovička had noted that both macro- and microscopic characters of certain *Psilocybe* species were highly variable, which could also account for the differences observed in the Seattle material. However, DNA sequencing revealed a 5-base pair change in the internal transcribed spacer regions (a segment of RNA often used in molecular phylogenetics to identify or distinguish fungal species) between *Psilocybe cyanescens* and the Seattle collections. This difference, in addition to the readily observable macroscopic differences, was deemed sufficient to warrant describing the taxon as a new species. Additional molecular studies published by Borovička and colleagues in 2015 identified *Psilocybe azurescens*, *Psilocybe cyanescens*, *Psilocybe weraroa*, *Psilocybe cubensis*, and *Psilocybe serbica* as closely related to *Psilocybe allenii*.
For several years before its official description, the taxon was known in the San Francisco Bay Area, and suspected of being an undescribed species. The authors suggest that a color photograph of "*Psilocybe cyanescens*" in David Arora's popular 1986 guidebook Mushrooms Demystified may actually depict *Psilocybe allenii*. Mycologist Paul Stamets suggested in 2005 that it "probably is new, or least a newly imported species". It is commonly called "Psilocybe cyanofriscosa" in the online mycological community, but this name is grammatically incorrect Latin and has never been validly published in scientific literature. The specific epithet allenii honors John W. Allen, who collected the original material and provided the impetus for the study. Allen collected the type material from the University of Washington Campus in November of 2009. He first collected the fungus in Capitol Hill in 1982, and several times later from Seattle. Some of these collections he sent to Mexican Psilocybe specialist Gastón Guzmán, who initially thought them to be *Psilocybe cyanescens* because of their overlapping spore size ranges. Fruitbodies of *Psilocybe allenii* are variable in size, depending on the substrate in which they grow.

Macroscopic feat.:

Cap/Pileus: 1.5-9 cm (0.6-3.5 in) in diameter, and range from broadly convex to flattened, sometimes with a slight depression in the center. The cap margin is either straight and slightly curved inward, rarely slightly wavy, and sometimes has radial grooves in moist specimens. The surface is smooth, sticky when moist, with a gelatinous cap cuticle that can be peeled. Wet fruitbodies are so slippery that they are difficult to collect. Caps are hygrophanous, and so will change color depending on how moist they are. They are pale orange brown to caramel brown when moist, but dry to yellowish-buff.
Gills/Lamellae: Gills have an adnate to sinuate attachment to the stipe, and are initially cream to pale gray brown, but become dark purple as the spores mature.
Stem/Stipe: The cylindrical, hollow stipe typically measures 4-7 cm (1.6-2.8 in) long by 0.2-0.7 cm (0.1-0.3 in) thick, with the base slightly thicker. The top of the stipe is pruinose (covered with white powdery granules), while the base is connected to thick white rhizomorphs. The stipe surface is smooth to silky fibrillose (as if made of silky, slender fibers), and its color initially white before yellowing slightly in age. Mycelium at the base of the stipe is white or stained blue. All parts of the fruitbody stain blue if bruised or handled. Young specimens have a white partial veil that later disappears, or remains as a zone on the stipe that can be colored purplish brown by spores.
Odor: And taste of the mushroom is farinaceous-similar to freshly ground flour.

Microscopic feat.:

Basidio/Spores: Spore prints are dark brown, sometimes with violet shades. Spores are thick-walled with an apical pore, and elongated ellipsoid to equilateral in face view, and somewhat inequilateral in side view, typically measuring 12.0-12.6-13.1 by 6.8-7.1-7.4 µm.
Basidia: The basidia (spore-bearing cells) are cylindrical, four-spored with sterigmata up to 5.5 µm long, and have dimensions of 27-37 by 9-11 µm. Clamp connections are present in hyphae.
Cheilocystidia: Cheilocystidia (cystidia on the gill edge) are abundant. They are hyaline (translucent), thin-walled, and variably shaped, and range from narrow clubs to narrow flasks with a neck no longer than 8 µm; their dimensions are typically 20-30 by 6-8 µm.
Pleurocistidia: The pleurocystidia (found on the gill face) are common; they are broadly club-shaped but taper to a point (sometimes with a rounded tip at the end), and measure 25-35 by 9-14 µm.
Caulocystidia: Caulocystidia (found on the stipe) are also present, with variable shapes similar to the cheilo- and pleurocystidia.

Notes: The mushrooms are consumed for their psychoactive properties, and have a potency roughly similar to *Psilocybe*

cyanescens. Borovička and colleagues say they are "commonly sought out by some mushroom hunters" According to Rockefeller, "If you go to Golden Gate Park in December you will see hundreds of hippies looking at the wood chip landscaping for *Psilocybe cyanescens* and *Psilocybe allenii*."
Several *Psilocybe* species have an appearance roughly similar to *Psilocybe allenii*, but these can usually be distinguished by differences in morphology or distribution. The European species *Psilocybe serbica* var. *moravica* has a similar cap and stipe, but is generally more slender than *Psilocybe allenii*. The closely related *Psilocybe cyanescens* is indistinguishable by microscopic characteristics, but features a wavy cap in maturity, a longer fruiting season (from late September through April), and lacks a ring zone on the stipe often seen in *Psilocybe allenii*. *Psilocybe azurescens* has a broader cap, an umbo that may be broad or acute, a longer stipe up to 20 cm (7.9 in), and a growing season similar to that of *Psilocybe cyanescens*. The authors also note that the Australian *Psilocybe subaeruginosa* is similar (including three taxa that have since been synonymized: *Psilocybe australiana*, *Psilocybe eucalypta*, and *Psilocybe tasmaniana*) but suggest that further research is required to better understand the delimitation of this species complex.

Habitat: *Psilocybe allenii* is found in the northwestern North America, with a range extending from British Columbia south to Los Angeles, California. It is most common in areas up to 10 miles (16 km) from the Pacific coast, although it has been collected 100 miles (160 km) inland. Fruitbodies grow scattered, in groups, or (more rarely) in clusters, on woody debris, such as wood chips often used in landscaping. Favored substrates include hardwood mulches made of oak, eucalyptus, Douglas fir, and alder. Fruiting occurs in cold weather, generally from late September to January. The species can be readily cultivated on agar, grain spawn, and cellulosic material, including wood chips and sawdust.

source - www.wikipedia.org

DESCRIPTION 2

Macroscopic feat.:

Cap/Pileus: 2-4.5 cm broad, convex or bell shaped; margin striate; surface smooth, sticky when moist, hygrophanous, brown, hygrophanous fading to yellow-brown or buff; flesh thin, brittle in age, bruising blue.
Gills/Lamellae: Adnate to seceding, close when young, subdistant in age, pale cinnamon brown, becoming dark grey-brown, edges lighter than the faces, mottled from spores at maturity.
Stem/Stipe: 3-6 cm tall, 3-6 mm thick, equal to sometimes enlarged at the base, the latter with conspicuous thickened mycelium (rhizomorphs); surface white, smooth to silky, bruising blue; veil fibrillose, forming a superior, evanescent hairy, annular zone.

Microscopic feat.:

Basidio/Spores: Purple-brown to purple-gray or purple-black; Spores 9-13 x 6-9 µm, elliptical, smooth, with an apical pore.

Season: Much Like *Psilocybe cyanescens* they prefer the cold temperatures of fall and usually are found late September into December, and October through January in California.

Habitat: Much like *Psilocybe cyanescens* they like the mulch and wood chipped areas. "Being a bit south helps (Tacoma and south Washington)" (NeoSporen). They are largely seen in the San Francisco Bay area of California where they get their name from.

Blueing: Bruising when handled. Especially in the cap margin.

Dosage:

- Lvl. 1 - 0,4g
- Lvl. 2 - 0,8g
- Lvl. 3 - 1,3g
- Lvl. 4 - 2,1g
- Lvl. 5 - 2,8g

Notes: In the book Mycelium Running by Paul Statements it says "microscopically, they seem identical to *Psilocybe cyanescens*, leading me to believe that these are probably *Psilocybe cyanescens*, and that this species is simply highly variable in macromorphology".
This species has been very well documented by amateur mycologists, however it has not been officially described and thus has no scientifically accepted species name at this time.
The nic name "Cyanofriscosa" was coined by a member of the website www.Shroomery.org a couple years ago when other Bay Area hunters began finding them. Other common names have been used to describe this mushroom, such as the "Cyclone Psilocybe", coined by Paul Stamets due to an instance in which the mycelial pattern of an agar culture looked like a spiral.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Psilocybe alutacea

Psilocybe alutacea Y.S. Chang & A.K. Mills

Macroscopic feat.:

Cap/Pileus: 10-13 mm broad, conical or convex, subviscid, hygrophanous, glabrous, striate, leathery brown to ochraceous brown.
Gills/Lamellae: Adnate, semi, grayish brown, at times slightly unevenly colored, with white edges.
Stem/Stipe: 25-46 mm x 1-2.5 mm, cylindrical, stuffed, pale brown, fibrillose bluing occasionally where damaged.

Microscopic feat.:

Basidio/Spores: 11.7-15.8 (-16.7) x 7.9-9.2 µm, ellipsoidal, germ pore distinct, broad.
Basidia: 25.8-34.2 x 9.2-12.1 µm, 4-spored, hyaline, obovate or clavate.
Cheilocystidia: 22.5-35.9 (-44.2) x 5-10 µm, hyaline, long-necked, 6.7-15 µm.
Pleurocistidia: Rare, 17.5-30.4 x 4.6-10 µm, lageniform, long-necked.
Subhymenium: Subcellular.
Trama: Regular, pale brown (5% KOH), with hyphae 3.3-15 µm broad.
Epicutis: A layer of subgelatinised, encrusted hyphae with brown pigments, 2.5-5 µm broad, clamped.

Season: From when the fall rains begin until the first freezes. Liberty caps like cool temperatures, around 50 degrees Fahrenheit and lots of rain.

Habitat: Solitary to subgregarious on cow dung Reported from Western Australia, New Zealand, but was described in Tasmania. "Predominantly on nutrient-poor grasslands and pastures (Noordeloos 1999, p. 45), rarely on dung, in contrast to the new species. Mating crosses between isolates of *Psilocybe semilanceata* and *Psilocybe alutacea* always produced negative pairings." Y. S. Chang, G. M. Gates and D. A. Ratkowsky Some new species of the Strophariaceae (Agaricales) in Tasmania. Australasian Mycologist 24, 53-68

Notes: This species shares many macro and micromorphological characteristics with *Psilocybe semilanceata*, *Psilocybe alutacea* appears to be close to the blueing temperate dung loving species, It has been put into section Semilanceatae by Dr. Guzmán.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Psilocybe angustispora

Psilocybe angustispora A.H. Sm. (1946)

synonyms:
Deconica angustispora (A.H. Smith) Ram.-Cruz & Guzmán

Macroscopic feat.:

Cap/Pileus: 0.2-0.6 cm broad. Acutely conic to conic-campanulate. Margin decorated at first with whitish, fibrillose remnants of the veil. Dark reddish brown when moist, fading to pale pinkish tan in drying. Surface smooth and viscid from a thick gelatinous separable pellicle.
Gills/Lamellae: Attachment subdecurrent, distant to subdistant, broad. Becoming dark purple-brown in age with the edges whitish fringed.
Stem/Stipe: 10-20(40) mm long by 0.5-2 mm thick. Equal, flexuous. Pallid pinkish tan or nearly concolorous with the cap. Surface covered with pallid fibrils and the lower portions often with minute fibrillose scales. Partial veil thin, cortinate. base usually adorned with tufts of mycelium.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, narrowly ellipsoid, 12-15 by 5-8 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: Present.

Habitat: Single to several on the dung of sheep, cows, horses, elk, marmots, and other animals during the spring and fall. Originally, reported from western Washington, Oregon, Idaho, and Colorado. Probably more widely distributed.

Comment: An uncommon species in need of further study, this petite species is a classically shaped mycenoid *Psilocybe*. I suspect that it is active, but no one has yet submitted specimens for analysis. See also *Psilocybe semilanceata* and allies.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe antioquensis

Psilocybe antioquensis Guzmán, Saldarriaga, Pineda, García & Velázquez

---

Macroscopic feat.:

Cap/Pileus: (5-) 10-15 (-30) mm diam, 5-15 (-20) mm high, globose or conic at first to campanulate, or convex. Margin sulcate-striate . Hygrophanous, orange-brown or ochraceo-olivaceous.
Gills/Lamellae: Adnate to sinuate, pale ochraceous to dark violaceous with whitish edges.
Stem/Stipe: (40-) 60-124 (-180) x (1-) 1.5-2)-3) mm (including the pseudorhiza, Hollow, slightly irregularly undulate, equal, subbulbous or attenuated at the base. Whitish to pale or dark ochraceous with grayish fibrils.

Microscopic feat.:

Basidio/Spores: (6) 8-10 (-11) x (5-) 6-6.5 (-7) x 5-6 µm. Sporeprint chocolate to purple-brown

Habitat: Mycenoid, like *Psilocybe mexicana* without pseudorhiza. Solitary or in small groups, in clay or sandy soil, in meadows with horses, cattle, or Indian Brahman cattle (Bos), and or water buffalo (Bubalus), with leavening grasses, in subtropical humid regions, at 1000-1600 m altitude. In manured ground but not directly from manure.

Distribution: Currently known only from Antioquia in Colombia; Jalisco and Veracruz in Mexico, and Angkor Wat in Kampuchea (formerly Cambodia). Probably a pantropical species

Season: Monsoon rainy season from late May through October.

Dosage: Unknown.

Comment: Collected from three locations in the Angkor Wat Compound of Cambodia at Banteay Srei (Temple of the Women), 15 km south of Banteay Srei (rice paddie area) and at Banteay Kdei (Citadel of the Cell). This species macroscopically resembles *Psilocybe semilanceata* and *Psilocybe galindii*. *Psilocybe antioquensis* was first reported from Colombia and *Psilocybe galindii* from Mexico. Both species belong to the section Mexicanae, but differ in the microscopic features. The main feature of these three species is the pseudorhiza which is a subterranean prolongation of the stipe. For more data concerning this species, read John Allen's paper *Psilocybe antioquensis*.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe aquamarina

Psilocybe aquamarina (Pegler) Guzmán

---

synonyms:
Stropharia aquamarina Pegler, Kew Bull 1977

The study of the holotype [Pegler 370 (K), from Africa: Kenya, Central Province, South Nyeri Distr., S side of Ml. Kenya, Castle Forest Station, near Thiba River, on soil] shows a fungus with spores (9-) 9.5-11 (-12) x 6.5-7 (-7.5) x (5-) 5.5-6 µm, subrhomboid in face view and subellipsoid in side view, without pleurocystidia, cheilocystidia (20-) 22.5-34 (-36) x 7-11 (-12) µm, fusoid ventricose or vesiculose submucronate and gelatinized pileus with hyaline hyphae 1.5-2.5 (-3) µm wide. The basidiomata (two) are of the same colour as in P. cubensis, with pileus convex subumbonate and stipe with an annulus persistent. Blue tones are seen in the annulus and in some parts of the stipe. Pegler (1977) related this species to P. aerugineomaculans Hóhnel, which differs in the size of the cheilocystidia, as well as in habitat. The absence of pleurocystidia places this fungus in the genus *Psilocybe*, and its annulus and possibly a blue reaction relate it to Sect. Stuntzii Guzmán.

source - Bibliotheca Mycologica **[159: 109-110]**

Pictures at www.mushroomobserver.org

Psilocybe argentipes

Psilocybe argentipes K. Yokoy. (1976)

---

synonyms:
Psilocybe subcaerulipes Hongo (1958)
Psilocybe taiwanensis E. Horak, Guzmán i Desjardin
Psilocybe thaizapoteca Guzmán, Karunar. i Ram.-Guill

Macroscopic feat.:

Cap/Pileus: 2.5-5 (6) cm broad. Conic to conic-campanulate at first, soon expanding to convex, broadly convex, and eventually plane in age, and variably with a sharp umbo. Chestnut brown when wet, hygrophanous, fading in drying from disc to a golden brown, honey yellow or mustard brown or clay toned, and bruising bluish. Margin incurved when young, irregular and often wavy, and adorned with remnants of the partial veil, especially when young. Surface smooth but not viscid when moist.
Gills/Lamellae: Attachment adnate or adnexed, soon seceding. Grayish orange at first, eventually purple brown with whitish edges.
Stem/Stipe: 60-80 mm long by 2-4 mm thick. Equal, enlarging towards the base from which whitish rhizomorphs radiate. Silky white at first, then yellow toned, soon brownish to reddish brown, and adorned with white fibrillose veil remnants in the lower two thirds of the stem, yellowish brown, and whitish near the apex. Partial veil cortinate, white, and leaving a fragile annular zone on the stem, if at all, and soon disappearing.

Microscopic feat.:

Basidio/Spores: Dark violet brown in deposit, subellipsoid, 6.5-7.5 by 9.5 by 3.3-4.5 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 13-25 (32) by 5-8 µm.

Habitat: Gregarious to clustered on soil rich in woody debris, along trails, underneath or nearby *Cryptomeria japonica, Quercus glauca* or *Pinus taeda*. Known only from Japan

Comment: Active, according to Koike et al. (1981). This species is named for the silvery patches of fibrils adorning the stem. *Psilocybe argentipes* is likely to be fairly potent - comparable to *Psilocybe cyanescens*. This *Psilocybe* may be distributed outside of Japan. See also *Psilocybe azurescens*, *Psilocybe caerulipes*, *Psilocybe cyanescens*, *Psilocybe cyanofibrillosa*, *Psilocybe muliercula*, and *Psilocybe subaeruginosa*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe atlantis

Psilocybe atlantis Guzmán, Hanlin & C. White

Macroscopic feat.:

Cap/Pileus: 26-38 mm diameter in dried specimens, conic to convex, smooth to slightly striate, dry and pale brown.
Gills/Lamellae: Subadnate, thin, brownish, finely mooted and the edges are concolorous.
Stem/Stipe: 40-45 x 2-4 mm (in dry specimens), equal, subbulbous, and brownish red to grayish-brown, covered with fine small brownish scales towards the base of the stipe. Bluing is evident.

Microscopic feat.:

Basidio/Spores: 8-9-10-11 x 5.5-6-6 µm. Yellowish-brown with a broad germ pore. Sporeprint chocolate to purple-brown.

Habitat: Gregarious on soil.

Distribution: Known only from the type locality in Fulton County, North of Atlanta, Georgia.

Season: August.

Dosage: Unknown.

Comment: This species belongs to the section Mexicana and is the second species found in Georgia. The name atlantis is for the type locality.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe atrobrunnea

Psilocybe atrobrunnea (Lasch) Gillet (1878)

---

synonyms:
Psilocybe fuscofulva Peck (1887)
Psilocybe nigrella Peck (1910)
Psilocybe turficola Favre (1939)

Macroscopic feat.:

Cap/Pileus: 2-4 (6) cm broad. Bluntly conic to convex or campanulate, usually umbonate, sometimes with a sharp nipple, expanding to broadly convex in age. Dark reddish brown to blackish reddish brown, then brown, strongly hygrophanous and fading to pale reddish brown in drying. Surface smooth, translucent-striate near the edge, viscid when moist from a thin but often separable gelatinous pellicle. Margin inrolled to incurved at first, and adorned with whitish veil remnants.
Gills/Lamellae: Attachment adnate to adnexed, dull cinnamon brown to dark purplish brown at maturity, with whitish edges, sometimes irregular.
Stem/Stipe: 80-180 mm long by 3-5 (6) mm thick. Equal, tough, flexuous, swelling towards the base, which is adorned with whitish mycelium. Reddish to blackish underneath the appressed, fibrillose whitish remnants in the lower two thirds, and pruinose above.

Microscopic feat.:

Basidio/Spores: Dark violaceous brown in deposit, ellipsoid, 9-12 (14) by 5-7 (9) µm.
Basidia: 4-spored.
Pleurocistidia: Absent, or close to gill edge, and then similar to cheilocystidia, 30-38 by 4-6 (8) µm.
Cheilocystidia: Lageniform or fusoid ventricose with an extended neck, 18-30 (36) by 4-7 µm, and 1.5-2.5 µm thick.

Habitat: Gregarious to scattered or near sphagnum bogs, in coniferous and deciduous woodlands, fruiting in September and October. Reported from the United States (Michigan and upper New York to Maine), as well as British Columbia and central to northern Europe (Great Britain, Czech Republic, Slovakia, Finland, France, Germany, Sweden, and Poland). Probably more widely distributed.

Comment: Possibly active. Høiland (1978) reported psilocybin activity from specimens collected in Norway. No other studies are known to me. This species has an overall resamblance to *Psilocybe washingtonensis*, *Psilocybe physaloides*, *Psilocybe inquilina*, and particularly to several Hypholomas, namely *Hypholomas dispersum* (=*Naematoloma dispersum*) and *Hypholomas udum* (=*Naematoloma udum*). Its fondness for sphagnum bogs makes that habitat target-specific.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe aucklandiae

Psilocybe aucklandiae Guzmán, C. C. King & Bandala

synonyms:
Psilocybe aucklandii Guzmán, C.C. King & Band.-Muñoz (1991)

Macroscopic feat.:

Cap/Pileus: 1.5- 5.5 cm broad. Broadly conic, expanding to broadly umbonate, becoming nearly plane in maturity. Margin striate, upturned, irregular, and splitting in age, free of veil remnants. Dark brown to yellowish brown, hygrophanous, drying to pale yellowish brown to straw colored. Flesh white, bruising bluish in age or where injured.
Gills/Lamellae: Attachment adnate, grayish yellowish brown, darker, with maturity. Edges whitish.
Stem/Stipe: 35-100 mm long by 1.5-5 mm thick, even, pruinose above, covered with whitish, silky fibrils below. Flesh brownish, bruising bluish. Partial veil cortinate, poorly developed, soon disappearing.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, ovoid-ellipsoid in side view, ovoid in face view, (6.5) 7-9.5 by 3.5-5.5 µm.
Basidia: 4-spored.
Pleurocistidia: 13-19 by 4.5-6 µm, scattered, similar to cheilocystidia but with a shorter neck, up to 4.5 µm.
Cheilocystidia: 15-32 by 4-8 µm, ventricose-rostrate, with a long flexuous neck up to 12 µm long, often forking.

Habitat: Common. Grows scattered to gregariously on soil rich in woody debris and litter beneath *Leptospermum* and *Dacrydium* and in pine (*Pinus radiata*). Reported only around Auckland, New Zealand.

Comment: Estimated to be moderately potent. No analyses are known to me. With the heavy export of lumber and raw logs from the pine plantations of New Zealand, this species has a direct gateway for spreading to many other temperate regions of the world. This species resembles many of the lignicolous Psilocybes. See also *Psilocybe makarorae*, *Psilocybe subaeruginosa*, *Psilocybe cyanescens*, *Psilocybe cyanofibrillosa*, and *Psilocybe bohemica*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe australiana

Psilocybe australiana Guzmán & Watling (1978)

synonyms:
Psilocybe subaeruginosa Cleland
Psilocybe tasmaniana Guzmán & Watling (1978)
Psilocybe eucalypta Guzmán & Watling

Macroscopic feat.:

Cap/Pileus: 16-31 mm in diameter, convex to subcampanulate, with slight umbo, hygrophanous, darker at center of cap, fading to pale ochraceous buff to brownish-yellow and blue tinges are evident along the margin.
Gills/Lamellae: Adnate, with a yellow or dark olivaceous color, becoming purple-brown with age.
Stem/Stipe: 45-110 x 2-3 mm, equal and cylindrical, bulbous at the base. Intense bluing in stem after handling.

Microscopic feat.:

Basidio/Spores: 10-12-14-16 x 5.5-6.7-7-7.7 x 6.7 µm. Sporeprint chocolate to purple-brown.

Habitat: Gregarious on humus with woody or leafy debris, on trails and roadsides in *Pinus radiata* plantations in temperate and subtropical rainforests.

Distribution: Currently known only from South Australia.

Season: Fruiting in April and May.

Dosage: One or two large fresh mushrooms or one dried gram.

Comment: Very close to *Psilocybe subaeruginosa*, *Psilocybe eucalypta* and *Psilocybe tasmaniana*. Several of these Australian, Tasmanian and New Zealand species noted above are closely aligned and related microscopically with *Psilocybe azurescens*, *Psilocybe allenii* and *Psilocybe cyanescens* from the Pacific Northwestern United States.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe aztecorum

Psilocybe aztecorum R.Heim (1957)

synonyms:
Psilocybe mexicana var. *longispora* Heim (1956)

Macroscopic feat.:

Cap/Pileus: (5-) 15-20 (-35) mm in diameter, obtuse or convex to campanulate, becoming expanded, striate, hygrophanous, yellowish-brown or yellow-gold in some young button forms not strongly browning. Only the Margin stains slightly blue-green when injured.
Gills/Lamellae: Adnate or adnexed, light violet-gray to dark violet-brown or chocolate-violet.
Stem/Stipe: (25-) 55-75 (-95) x (1.5) 3-4 (-5) mm, equal and thicker at the base, straight, staining blue-green when touched or with aging, with rhizomorphs at the base of the stipe.

Microscopic feat.:

Basidio/Spores: (10.4) 12-14 (-17) x (6-) 6.7-7.7 (-8.8) x 6-7.5 µm. Elongate-ellipsoid in face view. Blackish-violate.

Habitat: Gregarious in groups of fruiting bodies of 5-20 specimens, growing on soil with wood debris or on twigs or very rotten logs, rarely on pine cones, in open woods of Pinus hartwegii with abundant grasses at the 3200-4000 m of elevation.

Distribution: Known only from the high mountains of Central Mexico, such as Sierra Nevada (Rio Frio, Popocatépetl and Paso de Cortés), Nevado de Toluca and La Malinche, in the States of Mexico, Puebla and Tlaxcala.

Season: This fungus fruits from August through October.

Dosage: Unavailable.

Comment: This fungus is employed by the Mexican Indians of the Popocatépetl region, e.g. in the town San Pedro Nexapa. The younger generation of Indian children sell this mushroom to tourists along the wayside road to Popocatépetl and also in Huautla de Jiménez. Two popular Náhuatl names for this species are "niños" and "niñitos." The name *Psilocybe aztecorum* was given to the species by Roger Heim in that it historically bestows a place of honor as it refers the Aztec priests and their people who employ them ceremoniously. They were known to have used this species long before the Spanish and Portuguese came to the New World. The Language of the Mazatec is Náhuatl, the language of their ancestors; the Olmec's, the Toltec's and their conqueror's, the ancient Aztecs and their cast uncharted Empire. The names "niños" and "niñitos" are used by shaman's and others who participate in all night vigils and veladas, as little boys and little girls. When consumed in a healing and curing ceremony, certain rituals are performed and depending on one's illness or misfortune, the fungi are always eaten in pairs of two and are considered as male and/or female and are always consumed in pairs of two; one male and one female. It also depends on what species are available since each species possess different amounts of psilocin and psilocybin.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe azurescens

Psilocybe azurescens Stamets & Gartz

Psilocybe azurescens is probably the most potent psilocybin producing species on earth. Spawn can be grown on rye or birdseed and transferred to sterilised woodchips. Room temperature is fine for growing out spawn. This fully colonised woodchip spawn can be used to inoculate woodchips in outdoor beds.

Another option is to use grain spawn to inoculate soaked cardboard. Soaked cardboard is a highly selective substrate which can be used without sterilisation or pasteurisation. When the cardboard is colonised it can also be used to inoculate outdoor beds. More colonised cardboard or woodchip spawn results in faster colonisation of the chips in the outdoor bed and increases the chance of success.

As a substrate for the outdoor beds freshly chipped wood and branches can be used. If pre-packaged wood chips are used it might be necessary to soak them in water for a couple of days before using them. The beds should be made in a shaded place and can be covered with a thin layer of casing soil. Grass planted on top of it helps to keep the moisture content high.

Beds should start to fruit in the Fall and at that time extra watering might be necessary to keep the moisture content of the bed high. The bed should never be allowed to dry out.

source - www.mushmush.nl

Pictures at www.mushroomobserver.org

Growth parameters:

Substrate:
Wood chips.
Temperature:
colonisation/fruiting: 16-24°C / 10-15°C

Psilocybe baeocystis

Psilocybe baeocystis Singer & A.H. Smith

Macroscopic feat.:

Cap/Pileus: 1.5 do 5.5 cm broad to olive. center convex to conic. translucent when moist, appears pleated towards bottom portion of cap. Often staining blue to blue-green when damaged.
Gills/Lamellae: Attached. Dark purple.
Stem/Stipe: 50-70 x 2-3 mm long. White creme to yellow top. Covered with white filaments.

Microscopic feat.:

Basidio/Spores: 10-13.2 x 6.2-7 µ. Purple gray.

Habitat: *Psilocybe baeocystis* was 1st discovered in Eugene, Oregon in 1945. Once considered rare, this species was a very common mushroom appearing in mulched garden beds under rhododendrons and rose bushes during the late 1970s and early 1980s, sometimes growing in amongst groupings of *Psilocybe stuntzii* in lawns and with *Psilocybe cyanescens* in alder mulched garden beds. Although this species grows abundantly some in lawns or grassy areas rich in humus or lignin and/or in alder wood chips and bark mulch, it is sometimes very hard to find.

Distribution: From Eugene, Oregon to Seattle, Washington, up to British Columbia, Canada. Once considered rare, it is now common.

Season: June to October in lawns. From late September through December and sometimes into January in mulched garden beds.

Dosage: 1 to 2 large mushroom specimens or from 2 to 4 small specimens.

Comment: A very potent species when fresh. Stains intensely blue when damaged. Loses much potency when drying.
In the mid to late 1960s, two young children, both six years old reportedly died after allegedly consuming *Psilocybe baeocystis*. However, photographs given to the author by the physcians involved in the subsequent attempted treatment and later death of these children, one in Washington and a second reported death in California, were identified by (John W. Allen) as *Psilocybe cyanescens*. In both incidents, entire families had also consumed these mushrooms and did not die. Because of this misidentification by the late Chicago mycologist Rolf Singer and Alexander H. Smith who noted the species in their 1958 monograph on the genus *Psilocybe*, numerous mushroom field guides for both edible and psilocybian mushrooms described it as a very dangerous and toxic mushroom which could cause death. Over the years, few authors have corrected this error in reporting the correct identification of the species as *Psilocybe cyanescens*.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe banderillensis

Psilocybe banderillensis Guzmán & Bononi

---

synonyms:
Psilocybe banderiliensis var. *paulensis*
Psilocybe banderiliensis Guzmán
Psilocybe paulensis (Guzmán & Bononi) Guzmán

Macroscopic feat.:

Cap/Pileus: 5-12 mm diam., conic campanulate, subumbonate, glabrous, smooth to slightly striate at the margin when humid, subviscid to lubricous, hygrophanus, chocolate brown or reddish brown to darker, in dry blackish.
Gills/Lamellae: Adnate, pale dark violaceous with somewhat whitish edges.
Stem/Stipe: 20-50 x 1-1.5 mm, uniform, subsinuous, reddish brown, covered by whitish small floccose scales, hollow, cartilagineus. Veil farinaceous, staining slightly blue. All parts blackish brown in KOH.

Microscopic feat.:

Basidio/Spores: (5-) 5.5-6.5 (-7) x 5-6 x 4-5 µm, rhomboid in face view but subellipsoid in side view, brownish, thick walled with a broad germ pore. Some spores are irregular in form.
Basidia: 15-20 x 5-8 µm, 4-spored, subventricose or subpyriform.
Pleurocistidia: 15-32 x 7-12 µm, abundant, hyaline to more commonly brown or reddish brown, sublageniform with short and thick neck or ventricose.
Cheilocystidia: 10-25 x 3-5 µm, hyaline, sublageniform, frequently irregularly branched, some are very irregular in form.
Subhymenium: Subparenchymatous, with incrusted yellowish brown pigment.
Trama: Regular, hyaline to pigmented with incrusted pigment on the walls. Surface of the pileus formed by elongated subgelatinized hyaline, brownish to hyaline hyphae,2-4 µm thick. Hypodermium with elongated to subcellular element, strongly incrusted, 3-6 µm diam. Clamp connections rare.

Habitat: Gregarious on bare soil in a trail of the subtropical (or mesophytic) fores. Fruiting in November.

Studied material: BRAZIL, Sao Paulo State, Mpio. de Cananéia, Ilha do Cardoso, Col. Guzmán 22960, November 18, 1982 (SP-177707 type) (XAL-Isotype).

Discussion: The form of the pleurocystidia, as well as the abundance, and the irregular form of the cheilocystidia, as well as the southern locality, are the features that separates this variety from the type, which is know only from the State of Veracrus, Mexico (Guzmán, 1978; 1983). These fungi belong to the Section *Brunneocystidiatae* Guzmán, distinguished by their brown pleurocystidia. All of them seem to be hallucinogenic mushrooms.

source - www.mycotaxon.com **[19: 347]**

Pictures at www.mushroomobserver.org

Psilocybe bohemica

Psilocybe bohemica Šebek (1983)

synonyms:
Psilocybe serbica M.M.Moser & E.Horak (1969)
Psilocybe arcana Borov. & Hlavácek (2001)
Psilocybe moravica Borov. (2003)

This European species is closely related to North American *Psilocybe cyanescens* (which is also spreading throughout Europe). *Psilocybe cyanescens* cap is not translucent-striate when moist, its lamellae are adnexed or narrowly attached, the veil connecting the pileal margin with the stipe more distinct. It grows in the same sites. Rare. Sporocarps solitary or gregarious. On well decayed deciduous and coniferous wood, on twigs, compost, plant residue, in gardens, parks, on roadsides, in rich places, ruderaly.

Pictures at www.mushroomobserver.org

Psilocybe brasiliensis

Psilocybe brasiliensis Guzmán (1978)

Macroscopic feat.:

Cap/Pileus: 1-3 cm broad. Conic at first, soon convex and eventually campanulate. Surface smooth, viscid when moist, and translucent striate along the cap margin. Reddish brown to brown when moist, hygrophanous, fading to light brown upon drying, becoming bluish in age or where damaged.
Gills/Lamellae: Attachment adnate, brownish to purplish brown, with whitish margins.
Stem/Stipe: 35-80 mm long by 1-4 mm thick, equal to slightly swelling at the base, which is usually adorned with whitish fibrils and/or rhizomorphs. Bruising bluish where injured.

Microscopic feat.:

Basidio/Spores: Dark grayish violet in deposit, subrhomboid to subellipsoid, 5.5-7.7 by 4.2-5.5 µm.
Basidia: 4-spored
Pleurocistidia: 22-29 by 8.8-12 µm, fusoid-ventricose to sublageniform.
Cheilocystidia: 9.6-13 na 5-7.2 µm, lageniform.

Habitat: Gregarious on grassy soils (*Axonopus compresus*) in forest of *Araucaria brasiliana* and *Podocarpus*. Known only from Brazil, near Sao Paulo, in March at approximately 1500 meters. Not yet reported outside this type locality.

Comment: Apparently active, Guzmán (1983) first discovered *Psilocybe brasiliensis*, and lists it under the psilocybin-producing varieties because of the bluing reaction. The general shape is reminiscent of some of the temperate *Psilocybes* like *Psilocybe cyanofibrillosa*. Being a grassland species, this mushroom is likely to be widespread and is a good candidate for cultivation in tropical environments. I think if more Brazilians were aware of this species, its range of dominion would be better documented. See also *Psilocybe aztecorum*, *Psilocybe baeocystis*, and *Psilocybe mexicana*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe brunneocystidiata

Psilocybe brunneocystidiata Guzmán & Horak

Macroscopic feat.:

Cap/Pileus: (3-) 9-40 diam., conical (when young) to convex or expanded but always with sharp conical papilla, hygrophanous, brown to yellowish brown or stramineous, dry, smooth except of white dense fibrillose squamules from the veil, striate towards the margin.
Gills/Lamellae: Lamellae broadly adnate to subdecurrent, distant, beige to cocoa brown, edge albofimbriate.
Stem/Stipe: 10-40 x 1-2 mm, cylindrical, equal, central, flexuos, dry, hollow, fragile, concolorous with pileus, covered with white squamules from the veil, forming fibrillose subannulus, apex pruinose.
Context: Pale brown in pileus and stipe.
Odor: And taste subfarinaceous.

Microscopic feat.:

Basidio/Spores: Spore print dark brown. (5-) 6-6.5 (-7) x 5.5-6 x 3.8-4.5 µm, subrhombic (dorsoventral) or subelliptical (lateral), yellowish brown (KOH), broad flattened germ pore present, smooth.
Basidia: 18-24 x 4.5-6 µm, hyaline (KOH), subvesiculose, occasionally with median constriction, 4-spored, sterigma 2-4 (-7) µm long.
Pleurocistidia: 20-33 x 6.5-9 (-11) µm, hyaline but some brownish (KOH), ventricose-papillate, apical papilla 2-3.5 µm diam.
Cheilocystidia: 10-20 x 3-5 µm, 1-2.5 µm at apex, hyaline (KOH), polymorphous (ventricose-rostrate, clavate, strangulate or mucronate), forming sterile band along gill edge.
Subhymenium: Of irregular cells, conspicuously encrusted with yellow (KOH) pigment.
Trama: Regular, consisting of elongate cylindrical hyphae 4.5-8 µm, diam., pigmented like subhymenium.
Epicutis: A cutis of more or less gelatinized cylindrical hyphae, encrusted with yellow pigment. Subcuticular hyphae like those of the trama. Clamp connections present.

Habitat: Gregarious or cespitose on rotten wood in subtropical forests. Known hosts *Castanopsis acuminatissima* and *Nothofagus* spp. Reported from Papua New Guinea only. 500-2000 m a. s. l.

Studied material: PAPUA NEW GUINEA, Morobe district: Bulolo, Manki; 13. III. 1972, leg. HORAK (Holotype ZT, 27/212; isotype ENCB) - Bulolo, Heads Hump; 2. XI. 1971, leg. HORAK (ZT, 71/226).

Discussion: This fungus is closely related to the hallucinogenic and lignicolous *Psilocybe yungensis* SINGER & SMITH described from Bolivia (SINGES & SMITH, 1958) and reported also from Mexico (HEIM & WASSON, 1958); furthermore it is close to *Psilocybe mammillata* (Murill) SMITH, a native species from Jamaica (MURILL, 1918). *Psilocybe brunneocystidiata* a differs from the before mentioned two taxa in the brown pleurocystidia and in the well developed veil remnants forming the distinct subpersistent subannulus. Obvious relationships also can be traced to several species recently described by GUZMÁN (1977) from tropical forests in Mexico (*Psilocybe naematolomiformis*, *Psilocybe singerii*, *Psilocybe uxpanapensis* and *Psilocybe weldenii*). All these Mexican species have brown pleurocystidia but are separated from *Psilocybe brunneocystidiata* by different cheilocystidia. From the taxonomical point of view brown coloured pleurocystidia as observed in some tropical species are considered as a primitive character in *Psilocybe* (Guzmán 1977).

source - www.sydowia.at **[31: 45-47]**

Pictures at www.mushroomobserver.org

Psilocybe caerulea

Psilocybe caerulea (Kreisel) Noordel. (1995)

synonyms:
Stropharia caerulea Kriesel
Stropharia cyanea (bolt. ex. Secr) Tuomikoski

Macroscopic feat.:

Cap/Pileus: 3-7,5 cm broad, convex, soon expanding to broadly convex, obtusely umbonate. Color bluish, fading to azure, then yellow to yellowish green, often with the margin remaining tinged bluish green. Viscid when wet from a separable gelatinous pellicle. Fragments of the partial veil sometimes present along cap margin. Cap flesh thin, bluish at first, fading to straw color.
Gills/Lamellae: Attachment adnate to subdecurrent, close, fawn brown to chocolate brown to dark brown with spore maturity, with paler edges.
Stem/Stipe: 40-110 mm long by 3-12 mm thick, equal to slightly enlarged near the base, bluish green to azure, becoming pale buff. Pruinose above the annulus and covered with fibrillose-floccose scalelike patches below. Partial veil membranous, leaving a fragile, membranous annulus sometimes degrading into an annular zone.

Microscopic feat.:

Basidio/Spores: Light to purplish brown in deposit, ellipsoid, 7-9 (10) by 4.5-5.5 µm.
Basidia: 4-spored.
Cheilocystidia: And pleurocystidia 28-55 by 10-16 µm, 2-4 at the apex, clavate-mucronate to fusiform or slightly lageniform with acute apices.

Habitat: A litter mushroom, thriving in garden-like habitats or soils enriched with manure. Widely distributed, reported from the British Isles, Europe, and northwestern North America.

Comment: Possibly mildly active. No chemical analyses are known to this author. This species differs from its close relative, *Psilocybe aeruginosa*, in its rapidly discoloring cap, the paler gills, and the lack of veil-formed scales on the cap surface, and its generally smaller stature. In Europe *Psilocybe caerulea* is more common than *Psilocybe aeruginosa* (= Stropharia aeruginosa). See also *Psilocybe pseudocyanea* (= Stropharia pseudocyanea).

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe caeruleoannulata

Psilocybe caeruleoannulata Sing. ex Guzmán

synonyms:
Stropharia siccipes Karst. var. *lugubris* Rick, Lilloa 4:83, 1939

Macroscopic feat.:

Cap/Pileus: 10-22 mm diam., convex or conical to papillate, smooth, transparently striate at the margin when moist, viscid, hygrophanous, reddish brown to faded sordid pallid chamois with brownish buff to alutaceous center; pellicle separable.
Gills/Lamellae: Sinuate-adnate or subadnate, grayish violet but with whitish edges when young.
Stem/Stipe: 25-45 x 1-2 mm, whitish from a silky appressed covering over a gray background, becoming grayish cinereous where touched: at base soon caesious, slightly and gradually tapering upwards. Veil well formed; annulus membranous but thin, smooth, white, slightly staining blue, fragile but usually persistent.
Context: Pallid in pileus, grayish to brownish in stipe.
Odor: None or slightly farinaceous; taste slightly farinaceous.

Microscopic feat.:

Basidio/Spores: Spore print deep violaceous. (8.8-) 9.9-11 (-12) x 6-6.6 (-7.1) x 5.5-6 µm, subrhomboid frontally, subelliptic in profile, yellowish brown, smooth, more or less thin walled but with complex wall and with broad truncate germ pore.
Basidia: 15-22.4 x 7.5-9.8 µm, four-spored, hyaline, subvesiculose.
Pleurocistidia: None.
Cheilocystidia: 17-20 x 5-6 µm, forming a sterile band on the edge of the gill, hyaline, lageniform or vesiculose-ventricose, the neck 5-8.5 x 1-2 µm, sometimes with an oily hyaline drop at the apex.
Subhymenium: With parallel, brownish, thin (4 µm diam.) hyphae.
Trama: Regular, brownish or hyaline, with chestnut incrusted hyphae, 12-20 µm, thin walled. Clamp connections present.
Hypodermium: With interwoven brownish hyphae which are broader on the average than those of the epicutis, not subcellular, but in the context below often more pigmented and darker, more irregular and with quite a few rather short elements.
Epicutis: Hyaline, 50-60 µm thick layer of strongly gelatinized hyaline, filamentous hyphae 0.5-2.2 µm thick.

Habitat: On marshy ground or in grasslands outside the forests of *Araucaria* and *Podocarpus*, in pasture land, sometimes on dung. Known from Brazil and Uruguay.

Studied material: BRAZIL, State of Sao Paulo, near Campos de Jardao, March 8, 1971, 1600 m elevation, Guzmán 8877 (ENCB; SP). Guzmán 8916 (ENCB; SP). Santa María, 1936, Rick (PACA 15234, Type of *Stropharia siccipes* var. *lugubris* Rick). Sao Leopoldo, 1934, Rick (PACA 9362, as *Stropharia inucta*). Without locality: Rick (Herb. Bresadola 287; NY, as *Stropharia luteonitens*). URUGUAY, Maldonado, May 27, 1966, Singer B-4172 (BAFC Holotype).

Discussion: *Psilocybe caeruleoannulata* is close to *Psilocybe stuntzii* Guzmán & Ott and *Psilocybe uruguayensis* Sing. ex Guzmán, but differs in the shorter cheilocystidia (*Psilocybe stuntzii* has cheilocystidia 22-27.5 µm a *Psilocybe uruguayensis* 24.5-32 µm. This species was named by Singer in the herbarium BAFC based on the collection from Uruguay. Later the author of the present paper collected the same fungus in Brazil and found the species in the herbarium PACA as *Stropharia siccipes* Karst. var. *lugubris* Rick, a variety described in 1939 but not considered in Rick's later papers (1961); this material agrees well with the type of *Psilocybe caeruleoannulata*; the variety of Rick is considered synonymous. Bresadola confused *Psilocybe caeruleoannulata* with *Psilocybe luteonitens* (Vahl ex Fr.) Parker-Rhodes, as the author noted in one of Rick's collections (NY), identified by Bresadola as *Psilocybe luteonitens*, but this species has spores 15.4-18.7 (-20) x 11-13.2 x 9.9-11 µm.

source - www.mycotaxon.com **[7 (2): 235-236]**

Pictures at www.mushroomobserver.org

Psilocybe caerulescens

Psilocybe caerulescens Murrill

synonyms:
Psilocybe caerulescens var. *albida*
Psilocybe caerulescens var. *mazatecorum*
Psilocybe mazatecorum
Psilocybe caerulescens var. *nigripes*

Macroscopic feat.:

Cap/Pileus: 2.5 to 9 cm. Deep green to black cinnamon to rust. Cone shaped when young expanding to age. Margin incurved in young. Hygrophanous.
Gills/Lamellae: Close. Light cinnamon to brown. light to dark in age. Edges white.
Stem/Stipe: 3.5 to 10 cm. Long. Creme colored. Hollow with fiberous hairs, veil falls off early in young stages.

Microscopic feat.:

Basidio/Spores: Ellipsoid. Sporeprint dark purplish brown in deposit.

Habitat: Gregarious to cespitose, rarely solitary and often in clusters and clumps. On disturbed grounds devoid of herbaceous plants. Prefers mudslides and orange brown soils.

Distribution: Alabama, Mexico, Venezuela and Brazil.

Season: Late spring and summer months.

Dosage: 1-7 fresh mushrooms.

Comment: Paul Stamets mentions in his field guide, "*Psilocybine Mushrooms of the World*" that R. Gordon Wasson first ate 13 pairs of this mushroom during his initial velada with Maria Sabina. However, it was actually seven pairs of mushrooms. Timothy Leary also consumed this mushroom in 1960 in Cuernavaca, Mexico. He was given 7 fresh specimens of Psilocybe caerulescens his friend and associate, anthropologist Frank Baron. This species was first discovered and identified from Huntsville, Alabama in 1924 by the mycologist Murrill and never seen in the United States of America until the early 1990s in Florida and Mississippi. Later in the late 1950s, R. Gordon Wasson and Roger Heim identified it as the Derumbe (Landslide) mushroom of the Mazatec Indians. It has been reported from Oaxaca, Mexico fruiting from sugar cane mulch and landslide areas along sugar cane roads. Many Identification guides list this species as occurring in the southeast states of Mississippi to Georgia and Florida.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe caerulipes

Psilocybe caerulipes Peck

synonyms:
Agaricus caerulipes

Macroscopic feat.:

Cap/Pileus: 10-35 mm in diameter, brown with a sticky surface when moist, bluing where damaged.
Stem/Stipe: 30-60 mm, white to buff, brown at the base with an evanescent partial veil, bluing where damaged.
Gills/Lamellae: Adnate, close to crowded, brownish.

Microscopic feat.:

Basidio/Spores: 7-10 x 4-5.5 µm, elliptical and smooth. Sporeprint chocolate to purple-brown.

Habitat: Woodchips and beauty bark in man-made gardens in public places.

Distribution: Georgia to Massachusetts in the north and west to Ohio and north to Michigan and southern Ontario.

Season: Late May through August into September.

Comment: *Psilocybe caerulipes* is unique in that it is the only active *Psilocybe* native to the NE United States. It is a wide ranging species but uncommonly found. The Bethany strain reportedly fruits in both the spring and fall. In deciduous forests on hardwood slash and debris, plant matter, on or about decaying hardwood logs, birch, beech and maple. It is often overlooked as just another little brown mushroom, and although widely distributed, it is not found often. It is sometimes confused with the larger *Psilocybe ovoideocystidiata*.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe caribaea

Psilocybe caribaea Guzmán, T. J. Baroni & Tapia

Macroscopic feat.:

Cap/Pileus: (17-) 35-60 (-70) mm diam, convex-umbonate becoming plane with a mammillate-papillate umbo, smooth, lubricous; margin even, translucent-striate or slightly sulcate-striate, yellowish brown (5DE5-8) to dark reddish brown (8E-F5-6), chocolate brown (6F4) or Verona Brown, or dark grayish brown (5D-F3) mainly on the umbo, hygrophanous, changing to beige or pale brownish-yellow.
Gills/Lamellae: Sinuate, pale brown or violaceous brown (11F4-6), margin even or somewhat fimbriate, pallid or concolorous.
Stem/Stipe: (20-) 80-130 (-175) 3 3-6 (-8) mm, hollow, equal with a bulbous base, sordid white, becoming pale brown or yellowish brown (5D-E5-8) or reddish brown (8E5-7) or fuscous reddish toward the apex, shiny or dull, silky, covered with fibrillose appressed white fibrils toward the base, texture tough-cartilaginous or subwoody, with rhizomorphs at the base, inserted up to 1/4 of the total length.
Context: Both in pileus and stipe whitish, or reddish-brown in the base of the stipe. All parts except lamellae strongly caerulescent when cut or touched.
Odor: Farinaceous.

Microscopic feat.:

Basidio/Spores: Spore print Dark Violaceous Brown. (6-) 6.5-7.5 (-8) x 5-5.5 (-6.5) x 4.5-5 µm (Q = 1.25), subrhomboid in face view, subellipsoid in side view, thick-walled, walls up to 1 µm thick, yellowish-brown, with a broad germ pore.
Basidia: (16-) 20-25 (-28) x 5-6 (-7) µm, 4-sterigmate, hyaline, vesiculose, with a median constriction.
Pleurocistidia: (9,5-) 12-17 (-20) x (3,5-) 5-8 (-12) µm, hyaline, subventricose, subfusoid or subcylindric-moniliform, with an acute apex or short neck.
Cheilocystidia: (16-) 18-30 (-37) x (4-) 5-8 (-9.5) µm, hyaline, subventricose, irregularly branched, with an acute apex or with a short neck.
Subhymenium: Very thin, subcellular, with hyaline to yellowish elements, 3-6 (-8) µm, wide, finely encrusted.
Trama: Regular, most hyphae hyaline, cylindrical or with some elements inflated, 3-24 µm wide, with fine, inconspicuous encrustations.
Epicutis: A subgelatinized layer 8-40 µm thick, composed of repent, hyaline hyphae, 2.5-7 µm diam.
Pileocystidia: 25-43 3 6-8 µm occasional, prostrate or erect.
Hypodermium: With both hyaline cylindrical hyphae and subglobose elements, 2-15 µm wide, with encrusted walls. Context composed of hyaline or yellowish hyphae, some inflated and becoming subglobose, 3-24 µm wide, thin or thick-walled, up to 1 µm thick. Clamp connections common.

Habitat: Gregarious or caespitose on rich organic or sandy soil, mixed with decaying plant debris, in tropical and subtropical forests. Known only from Puerto Rico.

Studied material: PUERTO RICO, Mun. Naguabo, Luquillo Mountains, trail from Río Icacos to Río Prieto Dam, 4 Oct 1999, *Laboy* (PR-5772) (CFMR). Tradewinds Trail, 25 Jun 1995, *Lodge, Barley & Wunderle* (PR-2669) (CFMR), *Lodge, Barley & Wunderle* (PR-2671) (CFMR). Mun. Río Grande, Caribbean National Forest, El Yunque, Caimitillo Trail, 29 Jun 1996, *Baroni 7971* (HOLOTYPE CORT; ISOTYPE XAL). Mun. Río Grande, Luquillo Mountains., La Mina Recreation Area, Mount Britton Trail, 23 May 2000, *Cantrell & Salgado, ledger Cantrell PR-0022* (PR-6170) (UPRRP). MARTINIQUE, Vallée du Lorrain, Nov 1974, *Fiard 87* (K(M): 84377); 4 Jun 1975, *Fiard 87C* (K(M): 84376). Between Gran Riniere and Anse Ceron, 17 Jan 1982, *Fiard 1503* (K(M): 84375).

Discussion: Pegler (1983) considered collections of this species from Martinique to be Psilocybe caerulescens. However, even though Psilocybe caerulescens is a member of section *Cordisporae*, it lacks pleurocystidia and is easily separated from Psilocybe caribaea, which has abundant pleurocystidia.
Psilocybe caribaea is attractive because of its robust basidiomata, which occur in clusters. Its habit is reminiscent of *Psilocybe collybiodes* Singer & A.H. Smith, but that species has thin-walled ellipsoid basidiospores (Guzmán, 1983). Psilocybe caribaea is most phenetically similar to Psilocybe subtropicalis Guzmán, known from Mexico and Guatemala (Guzmán 1995). However Psilocybe caribaea can be separated from Psilocybe subtropicalis, because it possesses two types of pleuro- and cheilocystidia (recent observations on the holotype by Guzmána and Tapia).
One specimen, PR-6170, possesses slightly larger basidia 28-37 x 6-7 µm with 1, 2, 3 and 4 sterigmata and slightly longer pleurocystidia (13-) 15-24 (-26) µm. However, the differences observed in this collection appear to be reasonably expected morphological variations for Psilocybe caribaea.

source - www.mycologia.org **[95 (6): 1172-1174]**

Pictures at www.mushroomobserver.org

Psilocybe chiapanensis

Psilocybe chiapanensis Guzmán

synonyms:
Psilocybe yungensis Singer & A.H.Sm. (1958)
Psilocybe yungensis var. *diconica* A.H.Smith (1958)
Psilocybe acutissima Heim (1959)
Psilocybe isauri Singer (1959)
Psilocybe subyungensis Guzmán (1978)

Macroscopic feat.:

Cap/Pileus: Approx. 10 mm in diam and approx. 13 mm high, campanulate subpapillate, sublubricous, even to slightly striate toward the margin, grayish leather to brownish straw-yellow, hygrophanous.
Gills/Lamellae: Adnate, brownish violet, uniform in colour.
Stem/Stipe: Approx. 40 x 3 mm, cylindric, sinuous, hollow, whitish to reddish brown, covered by floccose appressed white scales, mainly in the middle part. Both pile us and stipe staining blue to blackish where injured.
Context: Whitish to concolourous with the pileus.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: (4-) 4.5-5 (5.5) x 4-5 x 3-4 µm, subrhomboid in face view, subellipsoid in side view, with a thick wall up to 1 µm, brownish yellow, with a broad germ pore at one end and an acute short appendage at the other.
Basidia: (12-) 14.5-21 x 5-7 µm, 4-spored, clavate ventricose, hyaline.
Pleurocistidia: 11-14.5 (-16) x (4-) 5-6.5 (-7) µm, common, hyaline, ventricose rostrate, with a short apex.
Cheilocystidia: Of two types, a) as the pleurocystidia (10.5-) 12-16 (-17.5) x 5.5-6.5 µm, hyaline, and b) (16-) 17-22.5 x 5-8 µm, ventricose, regular or irregularly in form, hyaline.
Subhymenium: With globose elements 3-5 µm in diam, hyaline or yellowish.
Trama: Regular, formed by yellowish or hyaline hyphae, 3-12 µm wide, thin or thick-walled (up to 1.5 µm).
Epicutis: Subgelatinized, formed by repent hyphae 2.5-5.5 µm wide, with some hyaline ascending elements, 12-32 x 6-8 µm.
Hypodermium: With subglobose elements 4-16 µm in diam, yellowish to yellow-brown, wall up to 1.5 µm thick. Clamp connections present.

Habitat: Solitary on logs, in coffee plantations remainding of subtropical cloud (mesophytic) forests. Known only from the type locality.

Studied material: MEXICO: State of Chiapas, Region of Tapachula, Municipio Union de Juárez, Ejido Santo Domingo, Oct. 4, 1993, Guzmán 30739 (Holotype, XAL).

Discussion: This species is close to *Psilocybe yungensis* Singer & Smith and *Psilocybe subyungensis* Guzmán by similar pileus form, spores size and the lignicolous habitat, but differs by more abundant pleurocystidia (scanty in those species) and in their size (14-25 µm long in *Psilocybe yungensis*; 9-11 µm long in *Psilocybe subyungensis*, and in the size and variability of the cheilocystidia [14-33 (-40) µm long in *Psilocybe yungensis*; 16,5-25 µm long in *Psilocybe subyungensis*].

source - Bibliotheca Mycologica **[159: 102-103]**

Pictures at www.mushroomobserver.org

Psilocybe chuxiongensis

Psilocybe chuxiongensis T. Ma & K.D. Hyde

Description: Differs from related *Psilocybe* species mainly by the absence of annulus and hemispheric to hemispheric-convex pileus without an umbo or papilla.

Macroscopic feat.:

Cap/Pileus: 26-38 mm diameter, at first conic or hemispheric-conic with incurved margin, then hemispheric to hemispheric-convex, not umbonate or papillate, dark yellow (4B4; Buff-Yellow) to yellowish brown (4B8; Aniline Yellow), sometimes darker in centre, often becoming paler towards the edge and almost whitish at margin, becoming beige when dry; surface smooth, slightly viscid when moist; margin even, entire, decorated with somewhat fugacious, white to bluing, membranous veil remnants.
Gills/Lamellae: Adnate-sinuate, 4-6 mm high, close or subdistant, yellowish waxy-white when young, becoming pale grayish yellow with purple-brown (8E5) mottles when matured, then olive ochre (2C5) to dark brown, edges serrulate and remaining whitish, turning bluish during drying or when handled.
Stem/Stipe: 50-68 mm x 3.5-4.5 mm, equal, slightly flexuous, longitudinally striate, hollow and fragile, white with sheen, becoming beige when dry; surface somewhat bluish when touched or bruised, or on drying, covered with white floccose scales which become bluish when touched; base of stipe with white mycelium; annulus absent.
Context: Of pileus yellowish (2A3,Celonial Buff). Of stipe concolorous with that of pileus, whitish towards the surface. Some mycelium in centre of colony bluish in culture.
Odor: Mild.

Microscopic feat.:

Basidio/Spores: (241/5/2) (12-) 13-16 (-19) x (7-) 8-10.5 x 7.5-10 (-11) µm, often ellipsoid, elongate-ellipsoid to subhexagonal, occasionally ovoid, broadly ellipsoid, subrhomboid or subfusiform in face view, Q = (1.4-) 1.5-1.8 (-2.4), **Q** = 1.63±0.13; ellipsoid, subellipsoid to nearly oblong in side view, Q = (1.4-) 1.5-1.8 (-2.0), **Q** = 1.65±0.10, yellowish brown with purple tinge in water, yellowish brown in KOH, dark purplish brown in deposit; wall smooth, slightly thick to thick (0.5-1.5 µm), complex, with distinct 1-2 µm wide apical germ pore.
Basidia: (24-) 30-44 (-53) x 8-14 µm, hyaline and colourless, occasionally yellowish, clavate to broadly clavate, narrowed in lower half or with a short to very long base 8-26 (-30) µm x 2-6 µm wide, 4-spored, sometimes 2-spored; sterigmata 3-6 (-8) µm.
Cheilocystidia: 22-42 (-46) x 5-10.5 µm, hyaline, narrowly clavate, clavate or lageniform-clavate, sometimes lageniform or fusoid-ventricose, occasionally similar to pleurocystidia, but narrower, with a (2-) 3-11 x 1.5-4 µm subcapitate tip or neck, rarely forked.
Pleurocistidia: relatively rare and scattered, 24-42 (-48) x (8-) 9-15 µm, thin-walled, hyaline, ventricose to broadly clavate and fusoid-clavate, often narrower near the apex, obtuse to short rostrum (2-4 x 2-4 µm).
Caulocystidia: 23-54 x 6-10 (-14) µm, clustered at the upper part of the stipe, thin-walled, hyaline, some of them similar to cheilocystidia, narrowly clavate to lageniform, some oblong-subclavate, with short rounded rostrum, subcapitate apex or neck, 2.5-8.5 (-9.5) x 2-4.5 (-6) µm, sometimes irregularly branched. Clamp connections common in all parts of the basidioma.
Subhymenium: Subcellular, composed of irregular vesiculose to subglobose cells, 3-13.5 x 2-12 µm, hyaline, colourless to yellowish, thin-walled to slightly thick-walled (about 0.5 µm).
Trama: Regular, with cylindrical hyphae 2-13 µm diam, hyaline, colourless to yellowish, thin-walled to slightly thick-walled (≤ 1,0 µm).
Epicutis: An ixocutis, 20-200 µm thick, made up of creeping, hyaline and colourless, subregular to interwoven, 1-4 µm wide filamentous hyphae, occasionally with dark or blackish finely incrusting pigments; subpileipellis dark yellow in KOH, composed of subregular, colourless to yellowish, filamentous to inflated, 2-16 µm µm wide hyphae.

Distribution: Chuxiong, Yunnan Province, China.

Habitat: Growing solitary to scattered and gregarious on cow dung or grassland where cattle have grazed in summer and early autumn.

Studied material: CHINA, Yunnan Province: Chuxiong City, Zixi Mountain, on cow dung, 25°01'05.5"N, 101°23'19.9"E, elevation 2237 m, 20 August 2009, *Tao Ma CX026* (IFRD414-010, holotype). CHINA, Yunnan Province: Chuxiong, Wuding County, near a reservoir at road side in Bailu Village, on soil of grassland where cattle have grazed, 25°39'25.6"N, 102°05'30.0"E, elevation 2523 m, 24 Sep 2012, *Xiao-Fei Lin WD007* (IFRD414-011)

Discussion: Etymology refers to the location Chuxiong, where the collections were found.
Psilocybe chuxiongensis is characterized by its subtropical habitat where it grows on dung. The pileus is smooth, buff-yellow to yellowish brown, hemispheric to hemispheric-convex without an umbo or papilla, lacks an annulus, while the context is yellowish both in the pileus and stipe. Bluing mainly occurs on the surface of the lamellae and stipe when bruising and drying, and mycelium

are blue in culture. Microscopically *Psilocybe chuxiongensis* has large ellipsoid, elongate-ellipsoid to subhexagonal basidiospores 13-16 x 8-10.5 x 7.5-10 µm with slightly thick to thick walls, and hyaline, broadly clavate or ventricose pleurocystidia with an obtuse to short rostrate apex.

Following the taxonomical concept of *Psilocybe* proposed by Singer (Singer, 1948, 1986, Singer & Smith 1958), *Psilocybe chuxiongensis* belongs to sect. *Caerulescentes* Singer because of its surface bluing fruit body and blue mycelium in culture. In this section, it is closely related to *Psilocybe cubensis* as it has similar basidiospores, basidiomata, pleurocystidia and cheilocystidia, as well as the same habitat, and they can be easily differentiated from other species by the color and form of basidiomata, large spores and the subtropical habitat on dung. The relationship with *Psilocybe cubensis* is strongly supported by phylogenetic analyses in all three datasets; they cluster together as a sister group and can be distinguished from other members with high statistical support values.

Guzmán (1983) introduced sect. *Cubensae* to accommodate *Psilocybe cubensis* and *Psilocybe subcubensis*, which is characterized by coprophilous or subcoprophilous habitat, bluing basidiomata, subhexagonal thick-walled (0.5-1 µm) basidiospores, and a well-developed annulus. These two species are very similar and differ in the size of the basidiospores. Morphologically *Psilocybe chuxiongensis* can be easily separated from *Psilocybe cubensis* and *Psilocybe subcubensis* by the absence of annulus and the hemispheric to hemispheric-convex pileus without an umbo or papilla. Furthermore, *Psilocybe cubensis* and *Psilocybe subcubensis* have a white context, ovoid, broadly ellipsoid to subhexagonal or hexagonal basidiospores in face view, smaller ventricose pleurocystidia and fusoid-ventricose to lageniform to tibiiform cheilocystidia (Singer & Smith 1958 Guzmán 1983, Noordeloos 1999, Bau & Sarentoya 2009).

source - Phytotaxa **[156 (4): 211-220]**

Pictures at www.mushroomobserver.org

Psilocybe columbiana

Psilocybe columbiana (Peck) Hesle

Macroscopic feat.:

Cap/Pileus: 6-19 mm diam., convex to campanulate, smooth to slightly rimose, faintly striate and transparently when moist, lubricous, hygrophanous, brown reddish to yellow reddish, finally yellow whitish.
Gills/Lamellae: Adnate or subadnate, ochre violaceous, with whitish edges.
Stem/Stipe: 20-60 x 1-3 mm, cylindrical, sometimes sinuous, hollow, white to brown reddish, covered with floccose white fibrils, sometimes with a rhizomorphic white prolongation in the soil, up to 20 mm long. Veil white and floccose, distinct annulus absent.
Context: White in pileus, concolorous with pileus in stipe, staining blue when cut.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: (6.6-) 7.1-8.8 x (4.9-) 6-6.6 (-7.1) x 4.4-5.5 µm, subrhomboid in frontal view, subelliptic in lateral view, light brownish chocolate or yellowish brown, smooth, thin walled, with a broad germ pore. Spore print violet brown to almost black.
Basidia: 15-27 x 4.4-8 µm, four-spored, hyaline, vesiculose or subpyriform. Pleurocystidia none.
Cheilocystidia: 22-30 x 3,3-6,5 µm, abundant, forming a sterile band at the edge of the gills, hyaline, lageniform or fusoid-ampullaceous and mucronate, sometimes branched; the neck 1.6-2.2 µm across.
Subhymenium: Formed by subglobose, subhyaline elements with yellowish brown irregularly incrusting pigment.
Trama: Regular, hyaline, with elongate hyphae 15-25 µm diam. with thin wall (1.5 µm thick).
Epicutis: Subgelatinized, with brownish or hyaline hyphae 2-6 µm broad. Clamp connections present.

Habitat: On clay black soils without herbaceous vegetation, sometimes living together with *Aleuria aurantia* (Pers. ex Fr.) Fuck., in páramos of *Espeletia argentea* at 3300-3500 m elevation. Known only from the type locality.

Studied material: COLOMBIA, Department of Cundinamarca, Municipio of Tansa, road La Represa del Rio Neusa to la Torre de Transmisión de TV, July 24, 1971. Guzmán 9146 (Holotype COL; Isotype ENCB); other collections from the same locality are Guzmán 9145. 9l56; 9158 (all in ENCB and COL).

Discussion: *Psilocybe columbiana* belongs to the *Psilocybe zapotecorum* group because of its spores and floccose stipe, but differs in the size of the spores and form of the cheilocystidia. It is a hallucinogenic species since it stains blue and has a farinaceous taste and odor.

source - www.mycotaxon.com **[7 (1): 237-238]**

Pictures at www.mushroomobserver.org

Psilocybe coprophila

Psilocybe coprophila (Bull.) P.Kumm. (1871)

---

synonyms:
Deconica coprophila (Bull.) P.Karst (1821)
Agaricus coprophilus Bull. (1793)
Stropharia coprophila (Bull.) J.E. Lange (1936)

nonactive

Macroscopic feat.:

Cap/Pileus: 1.0-2.5 cm broad, at first hemispheric, sometimes with a low umbo at the disc, becoming convex, broadly so in age; margin incurved, in age decurved to occasionally plane, fringed with evanescent whitish scales when young; surface glabrous, subviscid, translucent-striate when young and fresh, hygrophanous; color reddish-brown to dingy yellowish-brown, fading in age; context thin, colored like the cap, unchanging when cut or bruised.
Gills/Lamellae: Adnate, subdistant, relatively broad, pale grey when young, becoming grayish-brown, finally purple-brown.
Stem/Stipe: 1.5 - 5.0 cm long, 1.0-3.0 mm thick, equal, dry, straight to sometimes curved at the base; surface often squamulose when young, becoming fibrillose, whitish to dingy yellow-brown, not bruising blue; partial veil absent or if present, evanescent leaving fine scales on the young pileus and/or in a superior ring zone.

Microscopic feat.:

Basidio/Spores: 11-14 x 7-9 µm, ellipsoid, smooth; spore print purple-brown.

Habitat: Scattered to clustered on horse and cow dung; fruiting after rains during the winter months.

Dosage: Nonactive.

Comment: This small dung dweller is recognized by a sticky, reddish-brown to dull yellowish-brown cap which when young is edged with cottony white fibrils and is typically translucent-striate. Unlike most *Psilocybe species*, *Psilocybe coprophila* does not bruise or discolor blue, with the exception of a few reports of bluing mycelium. *Psilocybe coprophila* does not bruise or discolor blue, with the exception of a few reports of bluing mycelium. *Psilocybe coprophila* is most likely to be confused with *Stropharia semiglobata*, another dung dweller with a viscid cap, but the latter is more yellowish, lacks a translucent striate margin even when young, and has a slimy, not dry stipe. Other mushrooms found on dung include *Panaeolus* and *Coprinus* species. Species of *Panaeolus* can be separated by dry, not viscid caps and distinctive mottled gills, while Coprinus species typically dissolve into an inky liquid in age.

Pictures at www.mushroomobserver.org

Psilocybe crobula

Psilocybe crobula (Fr.) Singer 1962

synonyms:
Geophila crobula (Fr.) Kuhner i Romagnesi
Psilocybe inquilina var. *crobulus* (Fr.) Høiland

nonactive

Macroscopic feat.:

Cap/Pileus: 0.4-4 cm broad. Convex to broadly convex, expanding to nearly plane with maturity. Dingy brown, hygrophanous, fading to yellowish brown. Surface smooth, translucent-striate, viscid when wet from a separable, gelatinous pellicle. Often adorned with fragile remnants of a veil, soon disappearing.
Gills/Lamellae: Attachment adnate, clay to dull rust, with whitish edges.
Stem/Stipe: 5-12 mm long by 1-4 mm thick, adorned with distinct fibrillose patches, concolorous with cap, more dark reddish brown near the base and lighter above an annular zone. Partial veil cortinate.

Microscopic feat.:

Basidio/Spores: Subellipsoid, thin walled, cigar brown in mass, 6-8 by 3.5-5 µm.
Pleurocistidia: Absent.
Cheilocystidia: Lageniform to sublageniform, 25-45 µm long.

Habitat: Fruiting in the fall on twigs and other wood debris - not on grass. Reported from the northwestern United States, Great Britain, much of Europe, and Russia. Probably more widely distributed.

Comment: Not known to me as being a psilocybin mushroom. However, Phillips (1981) notes that it is active, without further elaboration or supporting references. Analyses by Høiland's (1978) failed to detect any psilocybin or psilocin. *Psilocybe crobula* is a small mushroom, which I have always found directly attached to sticks. The fibrillose patches on the stem are quite distinctive, and reminiscent of many small Galerinas. For this reason, I urge caution. See also *Psilocybe inquilina*, a species similar in its macroscopic features and with which it is often confused, *Psilocybe atrobrunnea* and *Psilocybe washingtonensis*. Guzmán and Smith (1978) noted the similarities *Psilocybe crobula* shares with *Psilocybe laticystis* and *Psilocybe subborealis*, two species from the Pacific Northwest.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe cyanescens

Psilocybe cyanescens Wakefield

We had the opportunity to visit Washington State and see some beautiful mushrooms in the wild. It was a very interesting adventure and very rewarding as well as educational. We had a great tour guide, John Allen a.k.a. mjshroomer, who has been picking mushrooms in WA for over 20 years. On the first day of hunting, our first stop was a church, where the sacred mushroom was growing on sacred grounds, I knew it was going to be a good day and a nice mushroom vibe after that. We found these growing amongts the alder mulch around the church. These pics can give you some idea of the surrounding these mushrooms grow in. Amongts all the alder mulch, leaves, twigs, etc. a nice little patch growing amongts some leaves, alder mulch and rhododendron bushes.

The next patch we found was growing amongts some large shrubs in the alder mulch. I doubt anybody would have known these were there if it had not been for John's resourcefullness of walking for hours a day looking in places ppl wouln't think of. We literally had to walk amongts some waste high bushes and move them aside to see them growing down underneith the bushes. These were the largest in size that we found of all the patches, they ranged from 4" to 6" in height, and had caps about 2-3" in diameter.

Well.. here is where the disappointment begins. Many of the patches we went to after this, during all the excitement I forgot to take pictures and even bring my camera. Yep.. I dropped the ball on that one. Thats ok.. gives me an excuse to go back to WA :)
One of the most interesting things I found, was that the deadly poisonous Galerina mushroom was growing right next to the *Psilocybe cyanescens* in almost every place we found them. What is even more frightening is they look pretty similiar. But dont let that scare you off from hunting them, you can tell them apart. And very distinctly upon a close inspection and taking your time to pick them. The *Psilocybe cyanescens* have a more caramel color cap, darker in color, and the stem of the *Psilocybe cyanescens* is always white, except around the base where the dirt is. Also the gills are much lighter and whiter in color then the galerinas. The galerina's always had a orangeish/brown color stem and veils, and the cap was orangeish brown as well. Once your out there picking them its easy to tell them apart if you have good eyesight and know what your looking for. If ever in doubt, also you can do a spore sample as the spores of the deadly galerina will be rusty as where the *Psilocybe cyanescens* will be purplish brown to black. Please be carefull and dont pick anything your unsure of, its just not worth dying over.

Ok... time to test yourself on some identification.
Below are some close ups of a *Psilocybe cyanescens* growing right next to the deadly galerina and some inky caps. There is only ONE *Psilocybe cyanescens* in these pictures.
The first 2 pictures will show top views, the 3rd pic will show the gills and stems of the mushrooms.
Then, the answer will be given in the following pics with a red arrow pointing out the *Psilocybe cyanescens*.
Can you tell the difference?

ANSWER

Well.. how did you do? This picture was staged. Sorry.. once again during all the excitement I should have tooken some better pictures. But none the less... in alder mulch, grass.. everywhere the galerinas were very close by.
A few last notes on the *Psilocybe cyanescens*.
One thing we found depressing is the psilocybe mushrooms are on a big decline in the Seattle area. Most landscaping is no longer being done with alder mulch, but there using some kind of red ceder mulch instead, and the psilo's dont thrive in that.
The places you want to look are anywhere that looks like fresh alder mulch has been planted in the last year or two. We found them right around ppl houses and buildings, in road dividers, in grass near alder mulch, around school campuses.. all sorts of places. The largest patches were about 8X the size of that little patch by the church, but I forgot my camera in the car...DOH!!!!

Plenty of spore prints were taken on wax paper. They are from the wild so they would probably require the use of agar to get them started. From there, I've had *Psilocybe cyanescens* grow on finche seed, you can use that as spawn to inoculate some alder wood chips and or sawdust. You can mix that in with some compost or straw even as shown in TMC, and case them with some good fertile soil. Planted in the spring or summer, given lots of water, in the fall when the rains come and the temps drop down to around 50-60f they should start fruiting for you. Its rare this mushroom can be grown indoors, but it has been done in a fridge from some pics I've seen of mj's. But your best bet is putting a patch outdoors.
As for the high.. well.. its very very potent, but tends to be a "speedy" high and gives me intense restlessness. I have a real hard time coming down and trying to sleep comfortably on this mushroom, and my muscles always ache from it. Its very visual when taken at least 3 dried grams, and at that dose.. hold on... because you'll be flying. I've talked with others that do not get this speeded out feeling from them,, and I've tripped with some friends that felt the same effects as me. Your milage may very. Many ppl really love this mushroom. It was certainly very beautiful to see in nature, and its a very tough, strong mushroom. The stems are very thick and hold up quite well while picking them. And from what I understand its pretty easy to grow outdoors if you live in the right environment.

A hugh thanks to John Allen for being our tour guide in Seattle WA, and showing us some beautiful pathces of *Psilocybe cyanescens*.

Growing tips for P. cyanescens

You dont need to make syringes from ps cyanescens, or inoculate grain as spawn. Prepare your alder wood, sterilize it. Preferable 4:1 alder sawdust to alder wood chips, small chips. Only use a small amount to start with, say about 6 to 8 cups worth of alder wood. Just scrape the spores directly on the the sterilized, moist wood. Incubate it, indoors at around 70f -75F. It will take a good 6-8 weeks for that wood to fully colonize.
Use that as more spawn to slowly start inoculating more larger volumes of wood for anther 2 months. Then plant your patch outdoors with more fresh alder wood. If you can get it planted outdoors by the end of April, you'll have good chances for it to fruit by fall. If not, they may not fruit until the following spring or fall.
Psilocybe cyanescens are slow growing. If you dont see germination, then lower the temps to about 55F for about 2 weeks. They are a temperate species so sometimes even to germinate they like the cold weather to begin with. After they start germinating and growing, you can bring the temps back up to around 70-75F to speed up the spawn run. But they still will only fruit outdoors when the climate is right, lots of rain and low temps between 45-60F.

source - www.thehawkseye.com

Pictures at www.mushroomobserver.org

Growth parameters:

Substrate:
Wood chips.
Temperature:
colonisation/fruiting: 16-24°C / 10-15°C

Psilocybe cyanofibrillosa

Psilocybe cyanofibrillosa Guzmán & Stamets

---

synonyms:
Psilocybe rhododendronensis

DESCRIPTION 1

Description: Scattered to gregarious among bush lupines in alder and willow wood chips and bark mulch. Common among rhododendron gardens and nurseries and flood plains near river estuaries. From northern California (Eureka/Arcada) north to British Columbia, Canada. September to December. High in psilocin and low in psilocybin. Loses over 70% or more of their potency in drying.
A few hundred pounds of this species mixed with *Psilocybe cyanescens* was collected from mulch piled along side of I-5 highway on both sides of the road between Eureka and Arcada, California. I myself have only collected this species a few times in a twenty year period.

source - www.mushroomjohn.org

DESCRIPTION 2

Macroscopic feat.:

Cap/Pileus: 1.4-3.5 cm broad. Conic to convex to broadly convex, eventually plane in age, typically not umbonate. Colour deep chestnut brown, hygrophanous, fading in drying to pale tan to yellowish brown, even dingy grayish white in drying. Surface viscid when moist from a separable gelatinous pellicle.
Gills/Lamellae: Attachment adnate to adnexed, to slightly subdecurrent in age, light grayish when young, becoming purplish brown with maturity with whitish edges.
Stem/Stipe: 30-70 mm long by 2-4 mm thick, straight to flexuous, equal to enlarged near the base, longitudinally striate, and adorned with fine fibrils that become bluish when handled. Yellow brown to light tan underneath. Partial veil white, cortinate, copious, leaving fibrillose veil remnants, sometimes a fragile annular zone on the upper regions. Flesh brownish, bruising bluish.

Microscopic feat.:

Basidio/Spores: Spores purplish brown in deposit, subellipsoid, 9-12 by 5.5-7 µm.
Basidia: 4-, rarely 2-spored.
Pleurocistidia: Absent.
Cheilocystidia: Fusiform to lanceolate, 22-33 by 5.5-7 µm, with an elongated, forking neck, 1-1.5 µm thick at apex.

Season: September to December.

Habitat: Fruiting in the Pacific Northwest. Just like *Psilocybe baeocystis* they grow mostly grass, but sometimes in mixed mulch, in soils enriched with deciduous wood debris, in Alder and Willow wood chips and bark mulch, Fir sawdust, in coastal regions, in rhododendron gardens and nurseries, and in flood plains in river estuaries. Scattered to gregarious.

Blueing: Bruising when handled, mostly in the pileus margin but also on the stem and base.

Dosage: 1 large specimen, 2 to 5 small specimens. High in psilocin and low in psilocybin. Loses over 70% or more of their potency in drying.

Notes: "I have found stuntzii, baeos, and fibs within a 25' radius. They like old, well kept grass that has weeds" (NeoSporen).
Both psilocybin and psilocin (0.05 mg per gram dry weight and 1.4 mg per gram psilocin) were detected by Beug and Bigwood.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Psilocybe cyanofranciscana

synonyms:
Psilocybe allenii Borov., Rockefeller & P.G.Werner (2012)
Psilocybe cyanofranciscana nom. prov.
Psilocybe cyanofriscosa (improper latin): *Cyclone Psilocybe*

Macroscopic feat.:

Cap/Pileus: 20-40+ mm in diameter, convex to broadly convex to plane at maturity. Very light brown maturing to light yellow to grayish white upon drying. Surface viscid. Flesh white soon bruising bluish green.
Stem/Stipe: 30-70+ mm in length, yellowish. Flesh dramatically bruising bluish green where injured. Partial veil cortinate sometimes leaving an annular zone.
Gills/Lamellae: Attachment adnate to adnexed. Grayish coloration in young fruit bodies becoming purplish brown in maturity.

Microscopic feat.:

Basidio/Spores: 10.5 -12.5 (13.5) µm in length, ellipsoid, dark purplish brown in deposit. Slightly larger than *Psilocybe cyanescens* spores (9-12 µm.).

Habitat: Wood debris, landscaped areas.

Comment: *Psilocybe cyanofranciscana* is a newly acknowledged species in the California Bay Area and has not yet been officially described. The name "*Psilocybe cyanofranciscana*" is provisional and probably won't be retained upon publication in a scientific journal
Stamets (2005) coined the name "Cyclone" Psilocybe to describe the cyclonic (swirled) growth of the mycelium on agar, a feature often not present. This is possibly an introduced species that appears to be aggressively spreading and perhaps displacing its close relative, *Psilocybe cyanescens*, but there is also evidence that this species has been present in San Francisco since at least 1975 (Duffy and Vergeer, 1977). Microscopically *Psilocybe cyanofranciscana* and *Psilocybe cyanescens* are virtually indistinguishable but the mushrooms are easily separated in the field based on macroscopic features. *Psilocybe cyanofranciscana* is typically larger, more squat, paler in coloration, and lacks the wavy cap margin, especially when young, of *Psilocybe cyanescens*. Superficially, *Psilocybe cyanofranciscana* resembles the smaller *Psilocybe cyanofibrillosa*, but the microscopic features do not agree and it doesn't appear to be closely related.

source - www.sporeworks.com

Pictures at www.mushroomobserver.org

Psilocybe dumontii

Psilocybe dumontii Sing. ex Guzmán, sp. nov.

Macroscopic feat.:

Cap/Pileus: 8-15 mm diam., conical, papillate, smooth, but striate toward the margin, hygrophanous, brown to yellowish brown, subviscid or lubricous to dry.
Gills/Lamellae: Adnate, very thin, dark violaceous brown.
Stem/Stipe: 25-35 x 1-1.5 mm, cylindrical, somewhat bulbous, hollow, whitish to reddish brown, densely covered by floccose, white fibrils of velar origin. Veil inconspicuous in the adult carpophores.
Context: Whitish, staining blue to dark-blue when injured.
Odor: And taste not registered.

Microscopic feat.:

Basidio/Spores: (4.4-) 4.9-5.5 (-6) x 4.4-4.9 x 3.3 - 4 µm, rhomboid in frontal view, subelliptic in lateral view, light brownish chocolate, thick walled and with a broad germ pore.
Basidia: 11-17 x 4.4-6 µm, two- or four-spored, hyaline, cylindrical-ventricose.
Pleurocistidia: None.
Cheilocystidia: 10-18 (-26) x 3.3-6 (-7.7) µm, abundant, forming a sterile band at the edge of the gill, polymorphous, fusoid, ventricose-rostrate, clavate, strangulate or mucronate, hyaline or some brownish.
Subhymenium: With parallel hyphae, strongly and irregularly pigmented with chocolate brown pigment, 4-25 µm diam; in some parts, a lot of blue pigment can be seen diffused in the KOH between the hyphae.
Trama: Regular, hyaline or pigmented as the subhymenium, hyphae, 5-20 µm diam, thick walled (1-3.3 µm thick), some are solid.
Epicutis: Subgelatinized, formed by brown reddish to hyaline hyphae, parallel to the surface.
Hypodermium: As the subhymenium and trama hyphae.

Habitat: On rotten wood in subtropical forest at 1800 m elevation. Known only from the type locality.

Studied material: PANAMA, Prov. Chiriqui, Cerro Punta, near Nueva Suiza, July 3, 1975, Dumont PA-2074 (Holotype NY; Isotype at ENCB).

Discussion: This species is close to *Psilocybe yungensis* Sing. S. Smith, but differs in the smaller and brownish cheilocystidia. The brownish cheilocystidia connects *Psilocybe dumontii* with those species described by Guzmán (1977-A) from the tropical rain forests of Mexico such as *Psilocybe singerii* Guzmán, *Psilocybe weldenii* Guzmán and others. The species is named after Dr. K. Dumont, collector of the type material, in recognition of his enthusiastic mycological work in South America.

source - www.mycotaxon.com **[7 (2): 240]**

Pictures at www.mushroomobserver.org

Psilocybe eucalypta

Psilocybe eucalypta Guzmán & Watling

synonyms:
Psilocybe subaeruginosa Guzmán & Watling (1978)
Psilocybe australiana Guzmán & Watling (1978)
Psilocybe tasmaniana Guzmán & Watling (1978)

Macroscopic feat.:

Cap/Pileus: 1.5-3.8 cm broad. Convex, expanding to broadly convex to nearly plane, often with a central shallow umbo. Surface smooth to slightly translucent-striate near the margin, viscid when moist, reddish brown when young, becoming ochraceous, hygrophanous, fading in drying to dull straw colored. Flesh whitish, bruising bluish.
Gills/Lamellae: Attachment adnate, dull brown, soon becoming purplish brown, and eventually dark violaceous gray with whitish edges.
Stem/Stipe: 65-86 mm long by 2-2.5 mm thick. Covered with silky fibrils, equal to swollen at the base (4-5 mm thick) to which whitish rhizomorphs are attached. Partial veil cortinate, leaving a fugacious fibrillose annular zone in the upper regions.

Microscopic feat.:

Basidio/Spores: Spores purplish brown in deposit, subellipsoid, 9-13 by 5.5-6.6 µm.
Basidia: 4-spored.
Pleurocistidia: 17-30 by 5.5-7.7 µm, fusoid-ventricose to mucronate to sublageniform with short necks 2-3 µm thick.
Cheilocystidia: 15-25 by 4.4-6.6 µm, fusoid-ventricose to sublageniform, with elongated necks 4-5 µm long by 3-4 µm broad.

Habitat: Solitary to gregarious on soils rich in woody debris, often in grassy areas with *Eucalyptus* trees. Reported from New South Wales, eastern Australia.

Comment: Thought to be moderately active, but no analyses have yet been reported. Chang and Mills (1992) sought to show synonymy between *Psilocybe australiana*, *Psilocybe eucalypta*, *Psilocybe subaeruginosa* and *Psilocybe tasmaniana*, although, in the opinions of Guzmán, Bandal, and King (1993) and myself, they failed to conclusively prove their case. (See comments under *Psilocybe subaeruginosa*). Additionally, I find it difficult to accept their concept that, given the nature of close relatives in the genus *Psilocybe*, the same species can be both a coprophilic and lignicolous species. Hence, I am following Guzmán and treating these taxa as separate entities until further studies prove otherwise.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe fagicola

Psilocybe fagicola R. Heim & Cailleux

synonyms:
Psilocybe fagicola var. *mesocystidiata* Guzmán (1978)
Psilocybe xalapensis Guzmán & López (1979)
Psilocybe wassoniorum Guzmán & Pollock (1979)

Macroscopic feat.:

Cap/Pileus: (5-) 10-15 (-25) mm in diameter, conic or convex to campanulate, subumbonate or umbonate, frequently with papilla (1-2 mm high, even and more or less glabrous, lubricous, striate at the margin when moist, sometimes somewhat wrinkled, strongly hygrophanous, dark reddish brown, brown chocolate or grayish brown, fading to brownish yellow, olivaceous, yellow or grayish green; turning blue when handled, sometimes becoming and remaining bluish black.
Gills/Lamellae: Adnexed, or somewhat sinuate, grayish to reddish brown, gray violaceous or dark, violaceous, somewhat spotted, with white edges.
Stem/Stipe: 40-60 x 0,7-2 mm, cylindric, equal or somewhat subbulbous, hollow, flexuous, cartilaginous, reddish brown but more paler at the apex; whitish mycelium present towards the base; covered with white floccose fibrils on the margin of the pileus, as small appendices.

Microscopic feat.:

Basidio/Spores: Dark purple-brown 5.5-6 x 4.9-5.5 µm, subrhomboid in face view. Subellipsoid in profile view, smooth, thick walled dark yellowish brown with a broad germ pore.
Basidia: 11-20 x 4,5-6,5 µm, 4 spored or 2 spored, hyaline, ventricose cylindric or cylindric pyriform.
Pleurocistidia: Scanty difficult to find when they are present they are 13-17 x 5-6 µm, subfusiform or sublageniform and hyaline.
Cheilocystidia: 6-15 µm long. Abundant hyaline, obclavate with long neck, 1-2 µm thick, sometimes with a hyaline viscous drop 5-10 µm in diameter at the apex.

Season: July to late August.

Habitat: Solitary to small groups. Restricted to the Fagus forests of Mexico. On humus rich in leaves, or sometimes between mosses. At 1850 m.

Blueing: Bruising blue when injured, may turn blackish blue on the pileus.

Notes: Known only from the type locality.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Psilocybe farinacea

Psilocybe farinacea Rick ex Guzmán, sp. nov.

synonyms:
Psilocybe albofimbriata (Rick) Singer

Macroscopic feat.:

Cap/Pileus: 20-40 (-80) mm diam., convex to subcampanulate, smooth but slightly striate at the margin, subviscid to dry, brownish to brownish reddish or straw color.
Gills/Lamellae: Adnate or sinuate, brownish violaceous or brownish chocolate, with whitish edges or concolorous.
Stem/Stipe: 35-65 (-80) x 3-8 cm, cylindrical, uniform or subbulbous, hollow, whitish to brownish, smooth or with floccose fibrils at the apex, veil remnants, staining blue when injured. Veil arachnoid, white to violaceous, but not forming an annulus on the stipe.
Context: Whitish, staining blue when cut.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: 7.5-9 (-10.5) x 5.2-7.5 x 3-4 µm, subrhomboid in face view, elliptic in side view, thick walled brownish yellowish and with a broad basal germ pore.
Basidia: 10-15 x 7-8 µm, two or four-spored, vesiculose, hyaline.
Pleurocistidia: None.
Cheilocystidia: 22-33 x 5-7.5 µm, vesiculose-fusiform with more or less long necks 2-3 µm diam., hyaline, forming a sterile band along the edge of the gill.
Subhymenium: And trama brownish, with collapsed hyphae.
Epicutis: Subgelatinized formed by parallel hyaline hyphae.
Hypodermium: Brownish with elongated hyphae, 8-10 µm diam. Clamp connections scarce.

Habitat: Gregarious on soil. Known only from the type locality.

Studied material: BRAZIL, Sao Leopoldo, May 1908, Rick (Holotype, Lloyd Herb. 27598; BPI).

Discussion: *Psilocybe farinacea* is very close to *Psilocybe caerulescens* Murr., but differs in the size of the spores and cheilocystidia. This species was named by Rick and sent to Lloyd but, apparently, was never described. Its bluing indicates that this species probably is hallucinogenic.

source - www.mycotaxon.com **[7 (2): 241]**

Pictures at www.mushroomobserver.org

Psilocybe fimetaria

Psilocybe fimetaria Orton

synonyms:
Stropharia fimetaria P.D.Orton (1964)

Macroscopic feat.:

Cap/Pileus: (0.5) 1-2.5 (3-6) cm broad. Conic to convex, subcampanulate, expanding to broadly convex. Typically umbonate. Translucent when moist. Pale reddish brown to honey to ochraceous. Hygrophanous. Yellow olive to ochraceous or yellow buff. Bruising blue where damaged.
Gills/Lamellae: Adnate, sinuate or uncinate. Purplish brown with white edges.
Stem/Stipe: (20) 40-65 (90) mm long x (0.5) 1-3 (4) mm thick. Equal and swollen at base. White, reddish brown or honey colored with blue green and/or deep sea green tones. Hollow.

Microscopic feat.:

Basidio/Spores: (9.5) 11-14 (16) x 6.5-8.5 (9.5) µm. Sporeprint - Dark purplish brown.

Habitat: Solitary to gregarious on horse manure, grassy areas in rich soils. Stamets (1996) reports that this species fruits in large rings.

Distribution: Oregon, Washington, and British Columbia, Canada.

Season: October through December.

Dosage: 15 to 30 fresh specimens or 1/4 fresh ounce. 1 to to grams dried.

Comment: This species macroscopically resembles *Psilocybe stuntzii* and bares some similarity to *Psilocybe semilanceata*. A related species is *Psilocybe subfimetaria*, which is also similar in appearance to *Psilocybe semilanceata*.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe fuliginosa

Psilocybe fuliginosa (Murrill) A.H. Sm.

synonyms:
Astylospora fuliginosa Murrill (1918)
Psathyra fuliginosa (Murrill) Murrill (1918)
Atylospora fuliginosa Murrill (1918)

Description: Following data comes from couple sources: Spores and comment are taken from *Psilocybe fuliginosa* species description in Mycologia 40 (6): 697. Pileus, stipe, lamellae, distribution and some of spores comes from *Astylospora fuliginosa* synonym description from Mycologia 10 (1): 25.

Macroscopic feat.:

Cap/Pileus: Hemispheric, not expanding, not umbonate, gregarious, 2 cm broad and 1 cm high; surface smooth, glabrous, hygrophanous, slightly striate, uniformly fuliginous, becoming somewhat paler on the disk; margin straight, eroded, concolorous.
Gills/Lamellae: Adnate, broad, ventricose, subcrowded, fuliginous, entire on the edges; spores usually ovoid, tapering at one end, smooth, purplish-brown, 7 x 4-5 µm.
Stem/Stipe: Equal or somewhat larger below, slender, smooth, glabrous, concolorous, whitish toward the base, 4-5 cm long, 1.5-2 mm thick.

Microscopic feat.:

Basidio/Spores: 6-7 x 4.5-5.5 µm, smooth, typically triangular in optical section but varying to ovoid or ellipsoid (as seen in face view), ellipsoid in side view, sordid yellowish brown when revived in KOH, with an obscure apical hyaline germ pore. Tapering at one end, purplish-brown, 7 x 4-5 µm

Distribution: Type collected in damp soil at Morce's Gap, near Cinchona, Jamaica, 1500 m elevation, December 29, 30, January 2, 1908-9, *W.A. & Edna L. Murrill 748* (herb. N. Y. Bot. Gard.). Also collected at the same time and place, *W.A. & Edna L. Murrill 680*.

Comment: Dr. Burke has sent me material from Alabama which appears to belong here though the spores vary slightly, being somewhat longer. They range from 6.5 to 8 µm. For *Psilocybe fuliginosa* the habitat on bare earth, the dry pileus, shape of spores in face view, and fuligineous cast of the carphophore are apparently distinctive. Murril described it as *Atylospora fuliginosa* (Mycologia 10: 25, 1918).

source - www.mycologia.org **[10 (1): 25, 40 (6): 697]**

Pictures at www.mushroomobserver.org

Psilocybe furtadoana

Psilocybe furtadoana Guzmán

Macroscopic feat.:

Cap/Pileus: About 15 mm diam., subcampanulate to papillate, smooth, transparent-striate when moist, lubricous, hygrophanous, dark reddish brown to ochraceous or stramineo.
Gills/Lamellae: Subadnate, dark violet brown with whitish edges.
Stem/Stipe: About 35 x 1 mm, cylindrical, uniform, hollow, reddish brown towards the base, covered with whitish floccose fibrils of the veil. Veil white and fugacious.
Context: Whitish, fleshy in the pileus, brownish and fibrillose in the stipe
Odor: And taste farinaceous, slightly blue-staining when cut.

Microscopic feat.:

Basidio/Spores: (4.5-) 5.5-6.6 (-7) x (3.8-) 4.4-4.9 (-5.5) x 3.8-4.2 µm, subrhomboid frontally, subelliptic laterally, yellowish brown, smooth, thick walled, with a broad germ pore.
Basidia: 10-13.2 x 4.4-5.5 µm, four-spored, hyaline, subvesiculose.
Pleurocistidia: None.
Cheilocystidia: 11-18 x 4.4-6.6 µm, abundant, hyaline or chocolate brown toward the base, bottle shaped or sublageniform, some fusoid-ventricose.
Subhymenium: With elongate parallel hyphae, with reddish brown irregularly distributed pigment.
Trama: Regular, colored like the subhymenium or hyaline, with hyphae up to 6 µm diam.
Epicutis: With subgelatinous reddish brown to hyaline hyphae, around 4 µm diam.
Hypodermium: Gradually hyaline, with hyphae thin walled, 5-12 µm diam. Clamp connections present.

Habitat: Solitary on soil in open forest of *Araucaria brasiliana* with *Podocarpus*. Known only from the type locality.

Studied material: BRAZIL , 5 km West of Campos de Jardao, State of Sao Paulo, March 8, 1971, Guzmán 8918 (Holotype SP; Isotype ENCB).

Discussion: This species is close to *Psilocybe brasiliensis* but the absence of pleurocystidia, the structures of the subhymenium, as well as the size of the spores and cheilocystidia separate it clearly from the latter. This species is named in honor of Dr. J.S. Furtado who helped the author collected this and other fungi in Brazil.

source - www.mycotaxon.com **[7 (2): 242-243]**

Pictures at www.mushroomobserver.org

Psilocybe galindoi

Psilocybe galindoi Guzmán Nova Hedwigia

---

synonyms:
Psilocybe galindoi var. *Georgia ATL#7* Large Sclerotia
Psilocybe galindii

Macroscopic feat.:

Cap/Pileus: 10-30+ mm in diameter, broadly convex to plane at maturity. Surface dry.
Stem/Stipe: 100-150 mm in length. Flesh bruising bluish green where injured. Partial veil cortinate.
Gills/Lamellae: Attachment adnate to adnexed.

Microscopic feat.:

Basidio/Spores: 9.8-11.2 µm, subrhomboid to subellipsoid, dark purplish brown.

Habitat: Enriched Soils, Grasslands. Climate Warm temperate.

Comment: This species forms sclerotia invitro. See also *Psilocybe mexicana* and *Psilocybe tampanensis*.
Initially, this sample was described as *Psilocybe atlantis* and we assumed that was correct since no similar species were known in Georgia. Samples sent to Psilocybe expert Gaston Guzmán cast some doubt on the mushroom's actual identity, but no alternative identification was suggested.
A direct comparison of samples with the published description of *Psilocybe atlantis* has confirmed Guzmán's findings. The strain ATL#7 is not *Psilocybe atlantis*, but is instead a related species in the Section Mexicanae. This new collection closely resembles *Psilocybe galindoi* (galindii), a species previously known only from Mexico. For lack of a better name, we are going to unofficially call this sample *Psilocybe galindoi* var. *Georgia*. If this species is described in a scientific journal and given a different name, we will amend this description. Efforts are now underway to provide authenticated spore samples of *Psilocybe atlantis*.
Both species can be viewed in the Sporeworks Microscopy Gallery Section Mexicanae for side by side comparisons of microscopic features. Note that the authentic *Psilocybe atlantis* cheilocystidia are irregularly branched and the *Psilocybe galindoi* var. *Georgia* are unbranched. *Psilocybe atlantis* spores are also somewhat smaller. Currently, no mushrooms matching this collection have been described as occurring in the United States.

source - www.sporeworks.com

Pictures at www.mushroomobserver.org

Psilocybe germanica

Psilocybe germanica Gartz (2015)

Discussion: *Psilocybe germanica* was described as a new taxon from Germany. This species was found to be autumnal and lignicolous, living in soils enriched with deciduous wood-debris, and featured strong blueing behaviour after bruising and ageing. It contained high amounts of psilocybin and baeocystin. This mushroom appears to be the first described species derived from wood chips that contains significant amounts of baeocystin in the absence of psilocin. The novel species was differentiated from other psychoactive taxons such as *Psilocybe cyanescens*, *Psilocybe azurescens* and *Psilocybe bohemica* in combination from features of the stipes and caps. As it was observed previously with the potent psychoactive species *Psilocybe cyanescens*, it is expected that *Psilocybe germanica* might be found to achieve a remarkably wide area of distribution in the future given the modern use of mulch in parks and gardens.

Macroscopic feat.:

Cap/Pileus: 1-4 cm in diameter, always broadly umbonate, rarely flattening to a little turn up in age with a persistent broad umbo; no traces of a veil at any stages, hygrophanous, moist deep brown, lacking a separable pellicle, margin not wavy, not striate, not translucent when moist, fading in drying to whitish; during development soon a spontaneous gray-bluish colouration on the umbo occurs, at age an additional strong blueing develops, particularly after rains and during freezing; bruising of the white flesh also yields a strong blue colour, odour pleasantly aromatic.
Stem/Stipe: 5-9 x 0.3-0.7 cm, characteristic enlarged at the pileus, sometimes the thickening often impressed as a joint, in which the upper end of the handle with the cap then drops; dry, white, not very hard, not flexuous, always curved, often multiple times, without traces of a veil, no fine mycelia on it, sometimes solid lumps visible as a rub, easily staining deep blue when touched at all parts; at first touch sometimes green discoloring until a very fast-moving to deep blue; the wood-like layer in the thickening shows no blueing at all, stuffed with white mycelia at first, later hollow, rhizomorphs on the base, keeping wood substrate together.
Gills/Lamellae: At first brownish then dark purple-brown, closely set, alternating adnexed to adnate.

Microscopic feat.:

Basidio/Spores: 9-12 x 5.5-7.5 µm, with a clear germ pore.
Cheilocystidia: Lageniform, numerous, 25-33 / 6.0-8.3 µm.
Pleurocistidia: Absent.

Habitat: Gregarious to cespitose on deciduous on wood chips from various plants, also on bark in mixture with soil and other wood debris.

Distribution: Until now, the mushrooms have only been observed to grow in parks. Holotypus: a gathering (8th October 2014, Dippoldiswalde, Germany) is deposited in the herbarium of the botanical museum Berlin / Dahlem (B).

Season: Observed growing is from September to December.

Comment: The tiny species *Psilocybe serbica* Moser & Horak showed features for caps and stipes similar to *Psilocybe bohemica*. The microscopic features are comparable to other wood-loving Psilocybe species as is the case with *Psilocybe germanica*. Chemical analyses of five *Psilocybe germanica* mushrooms samples revealed the presence of significant amounts of psilocybin and baeocystin. This was consistent with qualitative TLC analysis of 30 samples from 2013 and 35 extracted samples from 2014 and psilocin was not detected.
Psilocybe germanica showed similar alkaloid levels to what is known about *Psilocybe semilanceata* with only traces of psilocin. *Psilocybe azurescens* is generally considered more potent and, in addition to psilocybin and baeocystin, is also displaying comparatively large amounts of psilocin. Both *Psilocybe cyanescens* and *Psilocybe bohemica* typically show the presence of psilocybin and traces of baeocystin. A large variation in psilocybin levels are frequently encountered. In contrast to *Psilocybe bohemica*, *Psilocybe cyanescens* can also contain large amounts of psilocin. In addition, the new indole derivative aeruginascin was not detected in any of the mushrooms. As far as it is currently known, this trimethylammonium analog of psilocybin has only been reported to occur in the hallucinogenic species *Inocybe aeruginascens* Babos. *Psilocybe semilanceata* is the best studied psychoactive mushroom species in the world and is known to contain psilocybin and baeocystin. Previous investigations in 1994 have shown that the use pure methanol yielded the authentic indole derivatives from dried mushrooms and the use of aqueous solvents resulted in hydrolysis of psilocybin and baeocystin to give psilocin.

source - www.onlinelibrary.wiley.com/ **[31 March 2015]**

Pictures at www.mushroomobserver.org

Psilocybe gallaeciae

Psilocybe gallaeciae Guzmán & M.L. Castro (2003)

Macroscopic feat.:

Cap/Pileus: (5-) 10-20 mm diam. (in dry specimens), convex to subcampanulate, with a short conic papilla, smooth to sulcate-striate in dry, sometimes irregularly ondulate or plicate at the margin, brown reddish (7C7-8 or 9F6-8) or brown orangish (805-7), hygrophanous to beige brown (604-5) toward the margin, in dry specimens blackish brown (9F4-5 or more black), with the center blackish red (1008 or 10E8).
Gills/Lamellae: Adnate or subadnate, thin, brown reddish violet (lOE4-5), with edges whitish and even.
Stem/Stipe: 30-55 x 1-2 mm in dry specimens, with a long pseudorhiza up to 5 mm long, uniform or slightly thick toward the base before the pseudorhiza or subbulbose, brownish pale (4A3-4) to brown reddish (7C8) or blackish (10F4-6), bluing, with white mycelium covering the base, hollow, smooth, but surface fibrillose. Veil non in the adults.
Context: Concolorous with pileus whitish below.
Odor: Not checked, probably farinaceous.

Microscopic feat.:

Basidio/Spores: (8.5-) 9.5-11 (-13) x (6-) 7-7.5 (-9) x 5.5-6.5 (-7) µm, compressed, in face-view oblong or subellipsoid, in frontal-view subrhomboid, thick-walled, brown yellowish with a conspicous germ pore. Spore print violet black.
Basidia: (19-) 20-28 (-33) x (7-) 8-9.5 µm, 4-spored, hyaline, subcylindrical, with a median constriction.
Pleurocistidia: (11-) 14-19 (-21.5) x 5-8 (-9) µm, hyaline, common, lageniform or broadly lageniform, with the neck short or up to 8 µm long.
Cheilocystidia: (15-) 17-30 (-40) x (4-) 5-8 (-12) µm, hyaline, common, narrowly lageniform, frequently irregularly branched with two or three necks, up to 15 µm long.
Subhymenium: Cellular, with hyaline and smooth to encrusted of brown yellowish pigment, 3-8 µm wide elements.
Trama: Subregular, with hyaline, cylindrical to inflated hyphae, 3-30 µm wide, some of them encrusted by brown yellow pigment.
Epicutis: An ixocutis 16-24 µm thick, with 1.5-5 µm wide, hyaline.
Hypodermium: Subpellis (hypopileipellis) hyaline to encrusted of brown yellowish pigment, slightly cellular, with hyphae 2-4 µm wide and inflated elements 8-10.5 µm wide. Clamp connections common.

Habitat: Gregarious in soil, in grassland and gardens. Known only from Galicia, Spain, where it is common.

Studied material: SPAIN, La Coruña, Monfero, Caaveiro, 23 November 1997, *J. Comesaña* "C" (holotype XAL, isotype MA-Fungi 56866, LOU-Fungi 17969). Pontevedra, Vigo, 5 November 1999, *J, Pérez* (LOU-Fungi 17970; XAL); *F. Valeiras* "B" (LOU-Fungi 17968; XAL); Campus Universitario, As Lagoas-Marcosende, 6 October 2000, *I. Otero & J.M Perdiz* (LOU-Fungi 17967; 10 October 2001, *J. Granda* (LOU-Fungi 17972); 5 November 1999, *F. Valeiras* "A" (XAL); Nigrán, Chandebrito, 23-28 November 1997, *J. Comesaña* "B" (XAL); 5 November 1999, *F Valeiras* "A" (XAL); Gondomar, Pinzas, Donas, 9 November 2001, *X. Bellón et al.* (LOU-Fungi 17971); November 2000, *A. Lorenzo-García* 2 (XAL); Grove, October 2000, *I. Seral-Bozal* (XAL); Pontevedra, without locality, October 1998, *J. Ott* 98-002 (XAL).

Discussion: *Psilocybe gallaeciae* belongs to section *Mexicanae* Guzmán, following GUZMÁN (1983) for the form and size of their thick-walled spores, and its bluing basidioma. For the pseudorhiza it is closely related to *Psilocybe galindii* Guzmán (1983) from Mexico and *Psilocybe antioquensis* Guzmán et al. (1994) from Colombia, but those species have cheilocystidia 14-19 µm long and 15-20 µm long, respectively. *Psilocybe mexicana* R. Heim has neither pseudorhiza nor pleurocystidia, and it is known only from Mexico and Guatemala. This is the first record of a species of the section *Mexicanae* found in Europe. Their members are known from Mexico, U.S.A. (Florida), Colombia, Brazil and Thailand (Guzmán, 1995). The local Galician people use *Psilocybe gallaeciae* recreationally for its hallucinogenic properties. *Psilocybe serbica* reported by Freire et al. (1994) from Galicia, without any description, probably is *Psilocybe gallaeciae*. *Psilocybe serbica* belongs to section *Semilanceatae* and it is known only from central Europa (Guzmán, 1983).

source - Boletim da Sociedade Micológica de Madrid **[27 (2003) 185-186]**

Pictures at www.mushroomobserver.org

Psilocybe graveolens

Psilocybe graveolens Peck

Macroscopic feat.:

Cap/Pileus: (1) 2 - 3 (4) cm in diameter, convex to subumbonate, umbonate or with a slight depression, glabrous, even to slightly striate at the margin, hygrophanous, brownish to orange brownish, fading to golden yellow to whitish, sometimes with a dark green hue. Flesh whitish to pallid brownish, with a strong unfavorable odor.
Gills/Lamellae: Adnexed, close, yellowish brown to chocolate brown, edges sometimes lighter.
Stem/Stipe: (2) 4 - 6 cm x 2 - 5 mm, equal or slightly expanding at the base to subulbous, white to brownish, with dark greenish or violaceous tones. stuffed to hollow, fibrillose, with a soon disappearing evanescent annulus, rhizomorphic strands attached to the base.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: (7) 7.5 - 9.5 (10.5) µm x (3.7) 4.5 - 5.2 (6) µm, pleurocystidia and cheilocystidia present.
Basidia: 4-spored.

Habitat: *Psilocybe graveolens* is found growing cespitose to gregarious on rich loam of salt marshes or "meadows" in Hackensack, New Jersey, in November.

Discussion: *Psilocybe graveolens* is an extremely rare psilocybin mushroom in the section Zapotacorum, which has psilocybin and psilocin as main active compounds, discovered in the salt marshes or "meadows" of Hackensack, New Jersey. This mushroom is known for its strong and persistent odor.
It is in the section Zapotecorum; other members of this section include *Psilocybe angustipleurocystidiata*, *Psilocybe argentipes*, *Psilocybe collybioides*, *Psilocybe kumaenorum*, *Psilocybe muliercula*, *Psilocybe pintonii*, *Psilocybe subcaerulipes* and *Psilocybe zapotecorum*. The species name means "strongly smelling": Latin gravis "heavy" and *olens* participle present of *olere* "smell".

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Psilocybe guatapensis

Psilocybe guatapensis Guzmán, Saldarriaga, Pineda, Garcí et Velázquez

---

Macroscopic feat.:

Cap/Pileus: 8-12 mm in diameter, acute-campanulate, mamillate, lubricous, glabrous, even to slightly sulcate in the margin, hygrophanous, reddish brown to yellowish brown or yellowish orange.
Gills/Lamellae: Subadnate, grayish brownish with violaceous tinges and whitish edges.
Stem/Stipe: 25-40 x 2-3 mm, equally, but at base subbulbous, hollow, flexuous, whitish to yellowish brown, covered by white subfloccose scales. Veil arachnoid, white, evanescent, leaving small appendages at the pileus margin.
Context: Whitish in the pileus, pale brownish in the stipe. Readily turning blue green when injured.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: (5.5-) 6-6.5 (-7) x 4-5 µm, subrhomboid in face view, subellipsoid in side view, thick-walled, yellowish brown, with a broad germ pore.
Basidia: 18-20 x 5-6 µm, 2-, 3 or 4-spored, hyaline, ventricose with a median constriction.
Pleurocistidia: Absent.
Cheilocystidia: 16-28 x 3-5 µm, abundant, forming an sterile band at the edge of the gill, hyaline, fusoid-ventricose or lageniform with a short or long, simple or bifurcate neck.
Epicutis: Subgelatinous with postrated, smooth, hyaline to yellowish brown hyphae.
Hypodermium: Hyphodermium with irregular hyphae 5-19 µm in diameter, hyaline or brownish yellow, with incrustations on the walls.
Trama: Gill trama with parallel hyphae 4-11 µm broad, hyaline, incrusted with brownish yellow pigment. Clamp connections present.

Habitat: Caespitose and gregarious, in orange brown clay soil covered by mosses, in a road embankment, in a subtropical forest with (*Podocarpus*), at 1850 m alt. Known only from the type locality.

Studied material: COLOMBIA, Departamento Antioquia, Municipio Guatapé, Finca Montepinar, Sept. 15, 1990, Guzmán 29571-B (holotype HUA, isotype XAL).

Discussion: This species is close to *Psilocybe cordispora* Heim, known only from Mexico, but differs by the bulbous base of the stipe, the mamillate pileus, and the smaller cheilocystidia [(20-) 25-35 x 5-6 µm in *Psilocybe cordispora*]. Other allied species is *Psilocybe mammillata* (Murr.) Smith, which lacks a bulbous stipe and differs also by its cheilocystidia 12-17 µm (Guzmán, 1983). All these fungi, including *Psilocybe guatapensis*, belong to Sect. Cordispora that have hallucinogenic properties.

source - www.mycotaxon.com **[51: 228-229]**

Pictures at www.mushroomobserver.org

Psilocybe guilartensis

Psilocybe guilartensis Guzmán, Tapia & Nieves-Rivera (1997)

DESCRIPTION 1

Description: *Psilocybe guilartensis* is a psilocybin mushroom which has psilocybin and psilocin as main active compounds. It is common in Puerto Rico. First reported in the literature in 1997, Gastón Guzmán placed *Psilocybe guilartensis* in Psilocybe section Brunneocystidiatae due to its blue staining reaction, small thick-walled subrhomboid spores, and pigmented cystidia. Other mushrooms in the section Brunneocystidiatae include *Psilocybe banderillensis*, *Psilocybe banderillensis* var. *paulensis*, *Psilocybe brunneocystidia*, *Psilocybe heimii*, *Psilocybe inconspicua*, *Psilocybe pleurocystidiosa*, *Psilocybe rzedowski*, *Psilocybe singerii*, *Psilocybe uxpanapensis*, *Psilocybe veraecrucis* and *Psilocybe weldenii*.

Macroscopic feat.:

Cap/Pileus: 1-3 cm in diameter, initially subconical to campanulate (bell-shaped), expanding to plano-convex with an umbo. Cap surface dark violet brown in color, translucent-striate near the margin, hygrophanous, fading to tan as it dries. Staining blue-green to black where bruised.
Gills/Lamellae: Cream color when young, violet brown or chocolate brown in age, with adnexed attachment.
Stem/Stipe: 3-8 cm long, 1-2 mm thick, central, equal with subbulbous base, hollow and cylindric, color whitish to brown, ornamented with small flattened scales towards the base. The base is covered in tiny yellow fibers which help distinguish this from similar species. Staining blue-green to black where bruised.
Odor: And taste farinaceous, sometimes with a slight mustard taste.

Microscopic feat.:

Basidio/Spores: Dark violet brown, subrhomboid in face view, subellipsoid in side view, thick walled, 6 x 5 µm.
Basidia: Basidia four-spored. Clamp connections common.
Pleurocistidia: Present.
Cheilocystidia: Pigmented.

Habitat: *Psilocybe guilartensis* is found growing gregariously, often on disturbed bare clay or moss. Found along hiking trails, in coffee plantations, tropical and subtropical forests, especially in landslide areas. Known only from Puerto Rico and Dominican Republic.

source - www.wikipedia.org

DESCRIPTION 2

Description: An emendation of *Psilocybe guilartensis*, sis presented because morphological features that were not presented in the original protolog of this species (Guzmán et al 1997) have been discovered. Additional taxonomic features include a setaceous and tomentose, mustard-yellow surface coating on the lower part of the stipe, presence of two types of pleuro- and cheilocystidia, cheilocystidia with irregular encrustations at the base, and an occasional odor of mustard.

Macroscopic feat.:

Cap/Pileus: (5-) 15-20 (-30) mm diam, conic to campanulate, subumbonate or papillate, becoming plano-convex, umbonate or papillate, smooth or subrimose, moist, violet brown (11F4-6) to dark chocolate brown (6F4), hygrophanous, drying at times to Tawny brown, margin translucent-striate and/or sulcate-striate.
Gills/Lamellae: Adnexed, whitish to smoke gray (3C2) at first, finally fuscous, dark purplish (14F4-6) or chocolate brown (6F4), edges concolorous, even to subfimbriate.
Stem/Stipe: (22-) 35-60 (-80) x 1-1.5 (-2) mm broad, hollow, white or straw colored at first or concolorous with pileus above; equal with a subbulbous base, inserted to one-third or one-half length, smooth or irregular, appressed squamulose toward the base; base with a tomentose mustard-yellow coating.
Context: Context whitish in the pileus, becoming brownish in the stipe. All parts caerulescent when cut or bruised, staining blue-green to blackish.
Odor: And taste farinaceous or of mustard, although sometimes very slightly so.

Microscopic feat.:

Basidio/Spores: (5-) 5.5-6.5 (-7.5) x (4.5) 5-5.5 (-7) x 4-5 µm (Q = 1.11), subrhomboid or subglobose in face view, subellipsoid in side view, thick-walled, up to 1 µm thick, brownish-yellow, with a conspicuous pore, 0.8-1 µm wide. Spore print Dark Violaceous Brown.
Basidia: 20-32 x (4-) 5-7 µm, 4 sterigmate, hyaline, ventricose or subcylindric, with a median constriction.
Pleurocistidia: Of two types, type "A" (9-) 13-20 (-28) x 3-5 (-9) µm, common but difficult to find, hyaline, ventricose, submucronate or sublageniform, with a regular or irregular short or long neck; type "B" (12-) 16-28 (-40) x (5.5-) 7-10 (-14) µm, common and easily seen, dark brown or grayish opaque, rarely hyaline, ventricose, subfusoid or bowling-pin shaped, with a subglobose head, with or without a neck.
Cheilocystidia: Of two types, type "A" (12-) 14-26 (-30) x (4-) 6-8 (-12) µm, common but difficult to find, hyaline, yellowish or grayish opaque, smooth or with irregular encrusted walls toward the base, lageniform, ventricose-rostrate, or occasionally with swollen base and bifurcate branched rostrate apices; type "B" (12-) 18-28 (-34) x (5-) 6-9 (-12) µm, common and easily seen, colors and shapes similar to pleurocystidia type "B".
Subhymenium: Poorly developed, subcellular, hyaline or brownish, with elements 3-10 µm.
Trama: Regular, with hyaline to yellowish or brownish cylindrical or inflated hyphae 2,5-8 µm wide or 8-30 µm, wide, both thick-walled, up to 2 µm thick, with brown encrustations.
Epicutis: A thin layer of subgelatinized, repent, hyaline or brownish cylindrical hyphae, 1.5-2 µm, wide, rarely with hyaline cylindrical or subclavate pileocystidia, these erect, single or in scattered clusters.
Hypodermium: With hyaline to pale yellowish cylindrical or inflated hyphae 3-9 µm, wide, thin-walled, frequently encrusted with brown pigment. Context in pileus and stipe with both hyaline, cylindrical hyphae, 2-4 µm diam, and buff-yellow or brownish, globose elements, which are up to 27 µm. Basal mycelioid covering formed of branching setaceous

cylindrical hyphae, up to 70 µm long and 1-4 (-5) µm, thick-walled, walls up to 1,5 µm thick, dark yellow brown, arising from hyaline cylindrical clamped hyphae, that are thin- or thick-walled and 1,5-4 (-5) µm. Clamp connections common.

Habitat: Gregarious on bare clay, covered with mosses, mainly on landslide slopes, in tropical and subtropical forests, known only in Puerto Rico and Dominican Republic.

Studied material: PUERTO RICO, Mun. Adjuntas, Guilarte State Forest, trail to Monte Guilarte Peak, Sep 1994, *Nieves-Rivera, Santos-Flores & Betancourt*, ledger Nieves Rivera PR-1 (holotype Mapr; isotype Xal). Mun. Villalba, Toro Negro State Forest, trail to Tower 3, Oct 1994, *Nieves-Rivera, Santos-Flores & Betancourt* (MAPR; NY as *Psilocybe plutonia*). Mun. Río Grande, Mountains Luquillo, El Verde Research Area, 18 Sep 1999, *Rosa & Prieto* (PR-3539); *Carrasquillo* (PR-3537); 19 Feb 1998, *Laboy* (PR-4862). Caribbean National Forest, Sabana, 3 Jun 1998, *Baroni 8744* (CORT); El Yunque, Caimitillo Trail, 29 Jun 1991, *Baroni 7983* (CORT); El Verde, 19 Jun 1996, *Baroni 7900* (CORT). La Mina Research Area, La Coca Trail, 25 Jun 1997, *Llorens, Bonilla & Cantrell* (PR-4834); 23 May 2000, *Cantrell & Salgado, ledger Cantrell PR-0019* (PR-6166); 26 Nov 1999, *Salgado & Argüello-López* (PR-5922). Caimitillo Trail, 6 Jun 1997, *Llorens* (PR-4325); *Nieves-Rivera, Llorens & Serrano* (PR-4392); 19 Jun 1997, *Nieves-Rivera, Llorens & Serrano* (PR-4392); 19 Jun 1997, *Nieves-Rivera, Llorens & Serrano* (PR-4393); *Nieves-Rivera, Llorens, Serrano & Bonilla, ledger Nieves-Rivera PR-791* (PR-4394); 11 Jul 1997, *Baroni, ledger Nieves-Rivera 796* (PR-4400). Mount Britton Trail, 15 Jul 1997, *Llorens & Rodríuez* (PR-4835). El Toro Trail, 2 Jul 1997, *Cantrell, Nieves-Rivera, Serrano & Llorens* (PR-4840). Mun. Luquillo, Luquillo Mountains, Bisley Watersheads, trail to tower, 6 Jun 1997, *Lodge* (PR-4399); 26 Jun 1997, *Llorens* (PR-4841). Palo Hueco, El Cacique Area, 10 Jul 1998, *Cantrell, Laboy & Negrón, ledger Cantrell PR-9869* (PR-4882); 2 Jul 1999, *Cantrell & Laboy* (PR-5680). DOMINICAN REPUBLIC, Prov. Santiago, Los Montones Convention Center, altitude 800 m, 27 Nov 1999, *Baroni 9028* (DR-1064).

Discussion: The discovery that all collections of *Psilocybe guilartensis* s have setaceous hyphae at the base of the stipe is a significant addition to the circumscription of this taxon and provides a very helpful character in distinguishing this species. The distinctive pleuro- and cheilocystidia also are important characters that help to define *Psilocybe guilartensis*. *Psilocybe guilartensis* is the most common species of *Psilocybe* collected in Puerto Rico, as evidenced by the numerous collections documenting its abundance. It tends to fruit on bare clay along hiking trails where disturbance has occurred. Its relative abundance might be the result of being collected in readily accessible areas.
The record from the Dominican Republic is the first report of this species from the island of Hispaniola, although this collection (*Baroni 9028*) lacks the yellowish or grayish opaque pleurocystidia and the brownish or grayish opaque cheilocystidia that are typical of *Psilocybe guilartensis*. However, the presence of the highly distinctive setaceous hyphae at the base of the stipe indicates this collection has strong phenotypic affinities with *Psilocybe guilartensis*. The lack of pigments in the hymenial cystidia might be due to the immaturity of the specimens that make up this collection. For now, based on macromorphology, basidiospore morphology and setaceous hyphae at the base of the stipe, we consider this collection as conspecific with *Psilocybe guilartensis*.
As pointed out by Guzmána et al (1997) *Psilocybe guilartensis* belongs in section *Brunneocystidiatae* because of the pigmented hymenial cystidia, thick-walled rhomboid or subrhomboid basidiospores that are less than 8 µm long and bluing of the basidiomata when injured. The setaceous hyphae at the base of the stipe, the two distinct types of pleuro- and cheilocystidia, especially the hyaline inflated cheilocystidia with encrusted bases and bifurcate branched apices, are features that clearly separate *Psilocybe guilartensis* from the similar *Psilocybe pleurocystidiosa* (Guzmán 1983).

source - www.mycologia.org **[95 (6): 1178-1179]**

Pictures at www.mushroomobserver.org

Psilocybe heimii

Psilocybe heimii Guzmán (1978)

Macroscopic feat.:

Cap/Pileus: 15-35 mm diam., convex to subumbonate or subcampanulate, even but translucent-striate at the margin when moist, sometimes subrimose with age. glabrous with lobed to irregular margin, subviscid, dark brown to brownish-yellow, hygrophanous, context is pliant, whitish and thin in the pileus and staining blue when handled.
Gills/Lamellae: Adnate to subadnate, dark brown-violet with whitish edges.
Stem/Stipe: 50-80 x 1.5-2.5 (-4) mm. Equal, hollow, whitish to brownish or reddish and covered with small silky whitish fibrils. Veil thin fine silky fibrils on the stipe turning evanescent.

Microscopic feat.:

Basidio/Spores: (5-) 6-6.5 (-7.7) x 4.9-6.5 (-7) x 3.3-4 µ Rhomboid or subglobose in and subellipsoid in the side with a short basal appendage and with a narrow germ pore. Sporeprint purple-brown violet in deposit.

Habitat: Solitary or in small groups on humus or muddy soil in deciduous forests of Liquidambar-Quercus at 500-1400 m elevation.

Distribution: Known only from the subtropical forests of Mexico.

Season: Fruiting in the summer months of June-August.

Dosage: Unknown.

Comment: Pileus, stipe and context staining green-blue to blackish when bruised. This species was named in honor of French mycologist Roger Heim, who along with Dr. Wasson contributed important studies concerning the sacred mushrooms of Mexico.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe heliconiae

Psilocybe heliconiae Guzmán, Saldarriaga, Pineda, Garcí et Velázquez

---

Macroscopic feat.:

Cap/Pileus: 20-30 mm in diam., subcampanulate, subumbonate, lubricous, glabrous, even to striate at the margin, brownish to chocolate brown, finally straw color, hygrophanous.
Gills/Lamellae: Sinuate, yellowish, grayish brown to violet brown, with whitish edges.
Stem/Stipe: 35-45 x 4-5 mm, pale brown to yellowish brown, cylindric, slightly thickened at the base, somewhat flexuous, hollow or stuffed of white mycelium, subpruinose to floccose with whitish scales toward the base.
Context: Context whitish under the pileus, brownish in the stipe. All parts staining blue green when injured. KOH negative or stains the pileus pale brownish.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: 5-6.5 (-7.5) x 4-6 µm, subrhomboid or subellipsoid in face view, subellipsoid in side view, thick-walled, yellowish brown, with a broad germ pore.
Basidia: 18-20 x 5-6 µm, 2-, 3 or 4-spored, hyaline, ventricose with a median constriction.
Pleurocistidia: (11-) 14-17 x 5-7 (-9) µm, hyaline, subglobose or ventricose.
Cheilocystidia: (18-) 19-22 (-24) x (4-) 5-6 µm, abundant, hyaline, sublageniform, ventricose-fusoid or sometimes submoniliform, with a short neck or slightly mucronate at apex.
Epicutis: A subgelatinous layer, 80 µm thick, with subparallel hyaline hyphae of 2-3 µm in diam.
Trama: Gill trama parallel, with hyaline hyphae. Clamp connections present.

Habitat: Solitary or caespitose, on soil in tropical rain forest, at 500-1000 m alt. Known only from the regions of Nariño and Caquetá in Department Antioquía, at Colombia. One of the studied specimens brought from Caquetá (Parra & Echeverry 2), grew at a flowerpot with (*Heliconia*) in a greenhouse in Medellín.

Studied material: COLOMBIA, Departamento Antioquia, Nariñ region, Puente Linda, Sept. 15, 1990, G. Parra s.n. (holotype HUA, isotype XAL) Caquetá region, Aug. 30, 1990, G. Parra & B. Echeverry 2 (HUA, XAL).

Discussion: The form and size of the pleurocystidia separate this species from *Psilocybe wrightii* Guzmán and *Psilocybe brasiliensis* Guzmán, the former only known from central Argentina and the second from the Sao Paulo Region in Brazil (Guzmán, 1983). These species including *Psilocybe heliconiae* belong to Sect. Cordispora.

source - www.mycotaxon.com **[51: 229-230]**

Pictures at www.mushroomobserver.org

Psilocybe herrerae

Psilocybe herrerae Guzmán (1978)

Macroscopic feat.:

Cap/Pileus: 0.8-1 (1.9) cm broad. Conic to convex, sometimes papillate. Surface smooth to dry, finely fibrillose-rimose. Brown to sepia brown, hygrophanous, fading in drying to yellowish, sometimes with bluish tones. Flesh white, bruising bluish where injured.
Gills/Lamellae: Attachment adnate, becoming purplish brown to brownish violet at spore maturity.
Stem/Stipe: 30-80 (110) mm long by 1-2.5 mm thick. Equal overall, slightly narrowing near the apex and tapering into a long pseudorhiza. Brownish or nearly the same color as the cap, quickly bruising bluish, especially from the base upwards. Surface covered with fragile fibrillose-floccose patches.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, subellipsoid in side view and subrhomboid in face view, 5-6 by 3.3-4.9 µm.
Basidia: 4-spored.
Pleurocistidia: 12-25 by 6-8.8 µm, primarily fusoid-ventricose, few are ventricose-rostrate with an abbreviated neck.
Cheilocystidia: 13-23 (27) by 5.5-7.7 µm variable in form, 7-11 by 1.5-2.5 µm, sometimes irregularly forking.

Habitat: Solitary to gregarious, often along road cuts, in soils high in sand and clay, and in open forests dominated by pines, sweetgums, and oaks. Found in June and July in Chiapas and Veracruz, Mexico.

Comment: Judging by the rapid bluing reaction, *Psilocybe herrerae* is probably potent, but it has not yet been analyzed. The long pseudorhiza delineates this species from most others. See also *Psilocybe wassoniorum*, macroscopically similar (except for the length of the pseudorhiza) but lacking pleurocystidia.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe hispanica

Psilocybe hispanica Guzmán (2000)

The *Psilocybe hispanica* is a new species discoverd by Ignacio Seral in 98' growing high in the hills of spain. It tends to grow in colder temps, and has even been seen growing in snow. This mushroom was fround growing on horse dung, next to patches of *Psilocybe semilanceata*'s. The discoverer of the *Psilocybe hispanica* contacted Paul Stamets last October, unfortuanatly Stamets schedule was to full and a European mycologist named Giorgio Samorini from Italy flew to spain and did some research to find this was a whole new mushroom and classified it as the *Psilocybe hispanica*. Rumor also has it this mushroom will be featured in Paul Stamets next book Psilocybe Mushrooms of the World, Part 2 (cant wait for that one, I'm sure it will be another excellent book by Paul). We do have spore prints of this species currently, and may have some syringes soon. Its potency is said to be a very nice clean high, more potent then cubensis, but less potent then azures, more closely to that of *Panaeolus* species.
Some more detailed information from Ignacio on this mushrooms growing conditions.
The hispanica appears in horse dung about the 1 of october and finish about the 1 of november.... at 1700- 2000 metres high.... the latitude of spain makes the altitude date more relevant... keep in mind that in those mountains water become ice at night and the hispanicas resist freezing temps very well so there is a very cold temps at night about +5 to -5 at night and +5 to 20 at the daytime always celsius degrees.
New information from a *Psilocybe hispanica* fruiting in San Francisco, CA, USA Feb, 2000 !!!!
Yes.. the *Psilocybe hispanica* has been fruited now !!! A big atta boy goes out to Raja from San Francisco for fruiting the *Psilocybe hispanica*. What amazed me is it only took 3 months from inoculation to fruiting. Most of us were assuming a year long outdoor bed, so this is great news for us to get motivated on this new species.

source - www.thehawkseye.com

Pictures at www.mushroomobserver.org

Psilocybe hoogshagenii

Psilocybe hoogshagenii Heim (1958)

synonyms:

Psilocybe caerulipes var. *gastonii* Singer
Psilocybe zapotecorum Heim sensu Singer
Psilocybe semperviva Heim and Callieux

Macroscopic feat.:

Cap/Pileus: (0.7) 1-2.5 (3) cm broad. Conic to campanulate to convex with an acute, extended papilla (up to 4 mm long). Surface slightly viscid when wet, smooth, often ridged halfway to the disc. Reddish brown to orangish brown to yellowish, hygrophanous, fading in drying to straw colored, and bruising blue or blue black.
Gills/Lamellae: Attachment adnate to adnexed, pale brown to coffee colored, and eventually purplish black at maturity.
Stem/Stipe: (30) 50-90 (110) mm long by 1-3 mm thick. Equal to slightly thickened near the base, flexuous, sometimes twisted. Whitish to brownish red near the base, easily bruising bluish to bluish black. Partial veil thinly cortinate, fragile, soon disappearing.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, rhomboid to subrhomboid, (5) 6.5-8 (9.6) by 4-5.6 µm.
Basidia: 4-spored, rarely 2-spored.
Pleurocistidia: 16-36 by 8-12 µm, ventricose to clavate, often irregular.
Cheilocystidia: (15) 19-35 by 4.4-6.6 µm, lageniform, narrowing into a long neck 1-3 µm, either acute or subcapitate at the apex.

Habitat: Solitary to gregarious in muddy clay soils in subtropical coffee plantations. Found in June and July in Mexico (Puebla, Oaxaca, and Chiapas) and in February in Argentina. Also reported from Brazil and Colombia.

Comment: Moderately active. Specimens from Brazil yielded up to 0.30% psilocybin and 0.30% psilocin (Stijve and de Meijer 1993). A variety of this mushroom, *Psilocybe hoogshagenii* Heim var. *convexa* Guzmán is only slightly umbonate, has a convex cap, and is conspecific with *Psilocybe semperviva* Heim i Callieux. This variety is most common in the state of Puebla, Mexico, and to a lesser degree in the states of Oaxaca and Hidalgo, fruiting from June to August. One of the most unusual looking Psilocybes yet discovered, this mushroom is quite potent. Heim and Hofmann (1958) found 0.60% psilocybin and 0.10% psilocin (as *Psilocybe semperviva* Heim and Caillieux) from cultivated specimens. Guzmán (1983) reported that this mushroom grows at 1000-1800 meters in elevation (Argentina) and is commonly seen by coffee growers who report massive flushes coming up in unison and soon disappearing. See also *Psilocybe brasiliensis*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe inconspicua

Psilocybe inconspicua Guzmán & Horak

Macroscopic feat.:

Cap/Pileus: 5-10 mm diam., convex with conical papilla, margin incurved in young carpophores, pale or deep ochre brown or brown, margin estriate, dry, glabrous, membranaceous, without veil remnants.
Gills/Lamellae: Broadly adnate to occasionally subdecurrent, very densely crowded, argillaceous, edges white and sometimes conspicuously fimbriate.
Stem/Stipe: 20-25 by 0.5-1 mm, cylindrical, fragile, brittle, concolorous with pileus or paler, covered with white fibrils of the veil, base white from mycelium, often with white rhizoids, dry, solid.
Context: Context thin, concolorous with pileus.
Odor: And taste not distinctive. Spore print brown.

Microscopic feat.:

Basidio/Spores: 5.5-6.5 (-7) by (3.5) 4-5 by 3.3-3.8 µm, subrhombic (dorso-ventral) to subelliptical (lateral), yellowish brown (KOH), smooth, thin-walled membrane, germ pore and apiculus distinct.
Basidia: 17.5-22 by 5.5-6.5 µm, subpyriform, hyaline, 4-spored.
Cheilocystidia: 20-30 by 7-14 µm, broadly fusoid to vesiculose, brownish (KOH), rarely hyaline, membrane thin-walled, forming sterile gill-edge.
Pleurocistidia: Absent. Hyphae of subhymenium and trama irregularly encrusted with orange yellow (KOH) pigment.
Epicutis: A cutis of subgelatinized, brownish (KOH) parallel hyphae, encrusted with brown (KOH) pigment.
Hypodermium: Subcutis of cylindrical, hyaline, pigmentless hyphae. Clamp connections present.

Habitat: Gregarious in small groups on soil among litter in *Araucaria cunninghamii*. Known from Papua New Guinea only.

Studied material: PAPUA NEW GUINEA, Morobe District, Bulolo, Susu; 15. I. 1973, leg. HORAK (Holotype ZT, 72/751; isotype in ENCB).

Discussion: This small *Psilocybe* is a very distinct species. *Psilocybe inconspicua* has no obvious relationships to other taxa of this genus except with some species described by Guzmán (1977) from the tropical forests of Mexico. The brownish cheilocystidia represent the most prominent taxonomic character. Due to its systematic position it is likely that *Psilocybe inconspicua* is an hallucinogenic fungus.

source - www.sydowia.at **[31: 50-51]**

Pictures at www.mushroomobserver.org

Psilocybe inquilina

Psilocybe inquilina (Fries ex Fries) Bresadola

---

synonyms:
Deconica inquilina (Fries) Romagn.
Psilocybe ecbola (Fries) Singer
Psilocybe muscorum (P.D. Orton) M.M. Moser 1967

nonactive

Macroscopic feat.:

Cap/Pileus: (0.5) 1-2 cm broad. Hemispheric to convex, expanding to broadly convex to nearly plane to slightly umbonate. Reddish brown to brick brown to tan or yellowish brown, hygrophanous, fading in color to straw. Margin translucent-striate most way to the disc when moist from a separable gelatinous pellicle, becoming opaque in drying, and sometimes decorated with whitish floccose scales.
Gills/Lamellae: Attachment adnate to subdecurrent, reddish brown to purplish gray-brown, with concolorous edges.
Stem/Stipe: 20-40 mm long by 1.5-2 mm thick. Equal, flexuous, hollow, whitish to reddish brown, adorned with whitish to brown firbils toward the base, which often has whitish mycelium attached. Partial veil cortinate, soon desappearing.

Microscopic feat.:

Basidio/Spores: Purplish brown in deposit, 7-8.8 (10) by 4.5-6.6 µm, subrhomboid to subellipsoid in face view, subellipsoid in side view
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: Lageniform to sublageniform, (15) 18-38 na 5-8 µm, with a long neck 2.5-3.8 µm broad.

Habitat: Solitary to gregarious, commonly on the base of grass stems in open areas, occasionally on rotting twigs or in rich soils. A temperate species, *Psilocybe inquilina* is widely distributed, reported from North America (California, Oregon, and Washington), South America (Argentina, Chile, and Uruguay), and Europe (Denmark, Finland, France, Hungary, Sweden, and Switzerland). Undoubtedly more widely distributed than presently reported.

Comment: Not known to be active. I frequently find *Psilocybe inquilina* growing from the bases of matted, rotting grass in the fall. The mushrooms are difficult to harvest without either the stems breaking or clumps of dead grass being pulled up with each specimen. This feature, combined with the nearly decurrent gills, the convex cap, and the deeply translucent-striate margins, distinguishes this species macroscopically. See also *Psilocybe crobula* and *Psilocybe montana*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe jacobsii

Psilocybe jacobsii Guzmán

Psilocybe jacobsii Guzmán was described in the Sect. Cordispora from Mexico (Guzmán, 1983), based on its well developed annulus. After examination of the type (at ENCB) and the relating notes, it is considered that it is a good representative of the Sect. Stuntzii.

source - Bibliotheca Mycologica **[159: 119]**

Pictures at www.mushroomobserver.org

Psilocybe kumaenorum

Psilocybe kumaenorum R.Heim (1967)

Discussion: *Psilocybe kumaenorum* is known as *koull tourroum*, *kougltourroum* or *koobl tourroum* in Yuwi [Heim 1967] (Yoowi [REAY 1959]), the language of the Kuma (Heim 1967: 186; Heim 1978). However, Heim (1967: 186) suggested that the Kuma used these names for a variety of different mushrooms, so they are possibly of little use in distinguishing P. kumanorum from other mushroom species found at Kondambi.

Macroscopic feat.:

Cap/Pileus: 5-7 mm in diameter, peak mamillate and punctate, but not papillate, flattened and very irregular, with an edge largely lobed/notched, often fairly roughly, rolling up tightly at the beginning; at first campanulate and entirely black-brown, then darkish crimson/purple around the circumference (K. 65) with a centre of flesh-coloured cream (128C/153C) or orange colour; sometimes with subtle greenish tones; orange-yellow, cream or light ochre (K. 157'162) or greenish (+ K.245) at the peak of the mamilla; at the edges marked with not very thick but clear stripes of a very dark violet (K.544 dark); very hygrophanous, blanching quickly (cream), as demonstrated by the desiccation of little whitish spots. Flesh brownish, with the scent of flour (Heim 1967: 186).
Gills/Lamellae: Firstly cream, then ochre, then mauve/mallow or pale orange-mauve (K.109 light), finally violet with purple tint (+ K.105), at the edges white and remaining so; adnexed. *Psilocybe kumaenorum* lacks pleurocystidia (Guzmán 1983; Guzmán et al. 1991: 508).
Stem/Stipe: Reaching 2.7 cm , 1.3 mm width, 2.5 mm at the base which is lightly but clearly bulging; at first white and marked with fine, very straight longitudinal furrows, of greyish brown, silvery at the top where there are fine remnants of a delicate, silky, white cortina; at the bottom: hollow, with a violet-red cortex, light green on the exterior (K.303 C) or grey tending slightly towards blue (K.325); flesh orange yellow (K.137).

Habitat: Grassy, humid places around the village of Kondambi, circa late August, 1963 (Heim 1967: 186). *Psilocybe kumaenorum* grows on soil in small groups and in open places among grass (Allen et al. 1991: 65).

source - www.shaman-australis.com

Pictures at www.mushroomobserver.org

Psilocybe liniformans

Psilocybe liniformans Guzmán & Bas (1977)

Macroscopic feat.:

Cap/Pileus: 1-2.5 cm broad. convex to broadly convex, sometimes broadly umbonate. Smooth, viscid when moist from a separate gelatinous pellicle. Dull grayish ochraceous brown or olive colored. Hygrophanous, fading in drying and becoming straw-brown. Staining blue-green.
Gills/Lamellae: Adnexed, close to distant, dark chocolate brown to purplish brown.
Stem/Stipe: 14-30 mm long x 1-2 mm thick. Equal to swelled at base. Whitish to pale brownish and staining blue when injured.

Microscopic feat.:

Basidio/Spores: Sporeprint dark grayish-purple brown.

Habitat: Scattered to gregarious on horse dung or in manure enriched soil in meadows and pastures.

Distribution: Washington and Oregon. Probably in British Columbia, Canada.

Season: Summer through autumn.

Dosage: Weakly to moderately active. 10 to 20 fresh specimens.

Comment: Another rare species from the Pacific Northwest of the United States. A similar species, *Psilocybe liniformans* Guzmán i Bas var. *liniformans* is common in the Netherlands.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe luteonitens

Psilocybe luteonitens (Fr.) Park.-Rhodes 1951

synonyms:
Stropharia umbonatescens (Peck) Saccardo
Stropharia luteonitens, [RSD]

Macroscopic feat.:

Cap/Pileus: 1-4 cm broad. Conic-campanulate with a distinct umbo, expanding to convex to broadly convex to nearly plane with or without an acute-to-low umbo. Margin decorated with fragile whitish remnants of the partial veil. Yellowish to pale ochraceous brown toward the disc. Surface viscid when moist from a separable gelatinous pellicle. Flesh thin, pallid.
Gills/Lamellae: Attachment adnate to subdecurrent, close, broad. Color whitish at first, then grayish, and eventually purplish brown.
Stem/Stipe: 35-70 mm long by 2-4 mm thick. Equal and slender. Pallid to yellowish, lighter than the cap. Surface powdered above the annular region, and initially covered with fine fibrils below, but often smooth with age. Partial veil thinly membranous, floccose, leaving an obscure evanescent annular zone of fibrils, if at all.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, subellipsoid to ellipsoid, 15-19 (22) by 10-11 µm.
Basidia: 2-spored.
Pleurocistidia: Absent.
Cheilocystidia: 25-45 by 3-7 µm, cylindrical to sublageniform with a flexuous, elongated apex.

Habitat: Gregarious on dung in the fall in the Pacific Northwest. Reported from Washington, Oregon, Idaho, Michigan, and New York in the summer to early fall. Also reported from Mexico, Europe, and Asia.

Comment: The habitat preference, distinctly umbonate and yellowish cap, and the white membranous partial veil all make this species easy to recognize. Additionally, the veil remnants usually adhere to the cap margin rather than the stem, especially evident when young. See also *Psilocybe semiglobata* and *Psilocybe fimetaria*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe magnivelaris

Psilocybe magnivelaris (Peck) Noordel. 1995

---

synonyms:
Leratiomyces magnivelaris (Peck) Bridge & Spooner
Psilocybe percevalii (Berkeley i Broome) Orton
Stropharia percevalii (Berkeley i Broome) Saccardo
Stropharia magnivelaris Peck
Nematoloma magnivelaris (Peck) Singer

nonactive

Macroscopic feat.:

Cap/Pileus: 1,5-6 cm broad. Obtusely umbonate to campanulate to convex, expanding to broadly convex to plane and often umbonate, with an elevated margin in age. Surface viscid when moist from a thin gelatinous pellicle, smooth, covered with scattered, white, floccose scales, increasing towards margin. Pale grayish yellow to ochraceous to brownish orange, and darker towards the disc, not strongly hygrophanous.
Gills/Lamellae: Attachment adnate to sinuate, broad, close, pallid, white at first, soon grayish brown and finally dark purplish brown with whitish fringed margins.
Stem/Stipe: 50-85 mm long by 4-7 mm thick. Hollow, equal to enlarged towards the apex and tapering below. White to dingy yellowish. Partial veil membranous, leaving a thick, white membranous annulus, often flaring, which can deteriorate into an annular zone, below which the surface can be covered with fibrillose patches. Flesh moderately thick, firm, whitish, and not bruising.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, smooth, ellipsoid 13-15 by 6-8 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 33-44 by 4-5 µm, nearly clavate to sublageniform, with an elongated neck 3-4 µm thick.

Habitat: Scattered to gregarious, preferring sandy soils, alluvial plains, and/or soils rich in woody debris of *Salix* (willow) and *Almus* (alder). Found from May to November in the United States (Alaska, Washington, Oregon, possibly Colorado), northern Europe, and the British Isles. Likely to be much more widely distributed than presently reported.

Comment: Not active, edibility unknown. The well-developed membranous annulus, the nonbluing flesh, its modest size, and its habitat, all give clues to its identification. This mushroom is similar to *Psilocybe squamosa* and *Psilocybe thrausta*, and can be separated with certainty by the length of the cheilocystidia. *Stropharia riparia* is generally similar. See also *Psilocybe subaeruginascens*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe mairei

Psilocybe mairei Singer (1973)

---

synonyms:
Psilocybe maire Singer sensu Guzmán
Hypholoma cyanescens Maire

Macroscopic feat.:

Cap/Pileus: 1,5-3,5 cm broad. Convex to campanulate to conic-campanulate, expanding with age, but not umbonate. Surface viscid when moist from a separable gelatinous pellicle. Orangish brown, becoming olive toned, hygrophanous, fading in drying to yellowish white. Flesh amber, bruising bluish where injured.
Gills/Lamellae: Attachment adnate, pallid at first, soon darkening, becoming purplish brown with the edges remaining whitish fringed.
Stem/Stipe: 25-75 mm long by 2-5 mm thick. Equal to slightly enlarged towards the base. Whitish to yellowish white, bruising bluish where injured. Surface pruinose above and finely fibrillose below.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, elongate-ellipsoid, 10-12 (13.5) by 5.5-7 µm.
Basidia: 4-spored.
Pleurocistidia: Absent or near to gill edge.
Cheilocystidia: 30-40 by 6-8 µm. Variable in form: lageniform, fusiform, or ampullaceous.

Habitat: Known only from North Africa (Morocco and Algeria) in October through December. Grows gregariously on soil rich in woody debris, in forests mixed with pine (*Pinus pinaster*), fir (*Abies pinsapo*) and oak (*Quercus ilicis* and *Quercus pyrenaica*). The identification of collections from Europe as *Psilocybe mairei* are doubtful, and according to Guzmán' (1983) were probably *Psilocybe serbica* and allies.

Comment: Probably potent, judging by the bluing reaction, although no analyses have been published. This is the only wood-decomposing, bluing *Psilocybe* reported from North Africa. Prior to the expansion of the Sahara desert, North Africa enjoyed a moister climate and undoubtedly hosted many more mushrooms than are known today. One wonders if *Psilocybe mairei* is a surviving remnant of a species that was once much more common. I am reminded of the cave art representing a beelike shaman undergoing a mushroom experience from the Tassili plateau in Northern Algeria, and I'm struck by the fact that this is the only species of *Psilocybe* presently known in that area. Given that the Tassili plateau was running with rivers at the time the artist lived, the alluvial plains would have been perfect for supporting species like *Psilocybe mairei*. Could this have been the mushroom the artist used? See also *Psilocybe cyanescens*, *Psilocybe serbica*, and allies.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe makarorae

Psilocybe makarorae P.R.Johnst. & P.K.Buchanan (1995)

Macroscopic feat.:

Cap/Pileus: 1.5-3.5 cm in diameter. Conic to campanulate, expanding in age to broadly convex, usually with a pronounced umbo. Surface tacky to dry. Yellowish brown to orangish brown, fading in drying, and lighter towards the margin, which is striate when moist. Flesh whitish, bruising greenish blue where injured.
Gills/Lamellae: Attachment adnexed, pale grayish brown with concolorous edges.
Stem/Stipe: 30-60 mm long by 2-4 mm thick, equal, white to brownish near the base, which radiates white rhizomorphs. Partial veil cortinate, leaving fibrillose veil remnants along the cap margin when young, soon disappearing, but not forming an annular ring on the stem. Surface finely fibrillose and silky.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, ellipsoid in side view, ovoid to subrhomboid in face view, (6.5) 7.5-10 by 4.5-6.5 µm.
Basidia: 4-spored.
Pleurocistidia: Similar to cheilocystidia ventricose-rostrate to mucronate, 4-8 µm thick, with a simple neck, 2.5-4 µm long.
Cheilocystidia: 18-26 by 6-9 µm, ventricose-rostrate to mucronate with a short, simple neck 3-5 µm long.

Habitat: Found scattered to gregarious on rotting wood and twigs (*Nothofagus*) near lakes and picnic grounds in the vicinity of Makarora, New Zealand (Otago Lakes and Franz Josef Glacier) in the fall. Probably more widely distributed.

Comment: Potency unknown but probably moderately active given the bluing reaction. This newly described species by Johnston and Buchanan (1996) resembles *Psilocybe caerulipes*, but the presence of pleurocystidia and longer-necked cheilocystidia delineates *Psilocybe makarorae* from this taxon. Worthy of note is that the two authors work closely with, are consulted by, and paid by law-enforcement officials to help in the prosecution of unlucky collectors. See also *Psilocybe australiana*, *Psilocybe eucalypta*, *Psilocybe subaeruginosa*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe mammillata

Psilocybe mammillata (Murrill) A. H. Sm. 1948

Macroscopic feat.:

Cap/Pileus: (0.5) 1-3 (1.5) broad. Conic, expanding to campanulate at maturity, and often umbonate. When moist, surface smooth, slightly striate near the margin, which is often adorned with minute remnants of the partial veil. Reddish brown to brownish olivaceous, hygrophanous, fading to beige or dirty yellowish orange from the disc, occasionally with blackish tones. Flesh pale brown, bruising bluish.
Gills/Lamellae: Attachment adnexed, pale brown to dark purplish brown, thin, with whitish edges.
Stem/Stipe: 15-30 mm long by 1-2 mm thick. Equal to slightly swelling at the base from which white mycelium radiates. Yellowish at first, soon reddish brown with maturity, often retaining whitish patches near the base. Flesh reddish brown, bruising bluish where injured. Partial veil cortinate, fragile, soon disappearing in age.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, subellipsoid in side view, rhomboid to subrhomboid in face view, 5-6.5 (8) by 3.5-5.5 µm.
Basidia: 4-spored.
Pleurocistidia: Absent or only near to the gill edge.
Cheilocystidia: 12-17 by 4.5-5 µm, fusoid-ventricose with elongated necks, 3.3-5 by 1-2.5 µm.

Habitat: Solitary to gregarious, infrequently cespitose, in soils rich in woody debris, in humus, and sometimes on clay soils. Found along trails, shady banks, and in coffee plantations. Discovered by Dr. Thiers in Florida Highlands Hammock State Park). Also reported from Jamaica, Mexico, and Bolivia.

Comment: Guzmán et al. (1993) reports that this species is active, although no analyses are cited. The classic bluing reaction leaves little doubt about its activity, although estimation of potency would be purely speculative. This mushroom is probably widely distributed throughout much of Florida but goes unrecognized by most hunters of the more massive *Psilocybe cubensis*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe merdaria

Psilocybe merdaria (Fr.) Ricken

---

synonyms:
Agaricus merdarius Fr.
Stropharia merdaria (Fr.) Quél.
Geophila merdaria (Fr.) Quél.
Fungus merderius (Fr.) Kuntze
Psalliota merdaria (Fr.) Henn.
Deconica merdaria (Fr.) Noordel.

nonactive

Macroscopic feat.:

Cap/Pileus: 1-4 cm broad. Campanulate-hemispheric to convex to broadly convex, and sometimes slightly umbonate, finally expanding to place with age. Margin translucent-striate when moist, and often appendiculate with remnants of the thin partial veil. Cinnamon brown to livid brown when moist, fading to ochraceous or yellowish brown, and remaining darker at the disc. Surface smooth and only moist to subviscid when wet.
Gills/Lamellae: Attachment adnate to subdecurrent, close to broad. Yellowish at first, darkening with spore maturity to a dark brown.
Stem/Stipe: 20-40 mm long by 1-3 mm thick. Pale yellowish to pallid. Surface covered by fine, dry fibrils. Flesh stuffed with a fibrous pith, tough, but soon becoming hollow. Partial veil thinly membranous, fugacious, soon deteriorating to an annular zone of fibrils in the median to lower regions of the stem, usually darkened by spores.

Microscopic feat.:

Basidio/Spores: Dark purple-brown in deposit, subellipsoid, 10-14 by 7-9 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 20-33 by 6.6-8.8 µm, fusoid-ventricose to sublageniform with a short neck 3.3-4.4 µm thick.

Habitat: Scattered to numerous on dung. Reported from California, Oregon, Washington, and the northern Midwest of the United States. Widely spread throughout the world, this mushroom has been collected in Canada, Europe, the former USSR, and Japan. *Psilocybe merdaria* is probably more widespread than the literature presently indicates. It prefers a temperate zone..

Comment: Not known to be active; not sufficiently studied for chemical content. In temperate zones, *Psilocybe merdaria* is common dung dweller, along with *Psilocybe semiglobata* and *Psilocybe papilionaceus*. The annulus is typically located in the lower regions of the stem, or at most mid distance, but not superior. This species is virtually identical to *Psilocybe moelleri*, which has larger spores: 13-14 (16) by 7-8 µm. See also *Psilocybe coprophila* and *Psilocybe subviscida*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe meridensis

Psilocybe meridensis Guzmán

Macroscopic feat.:

Cap/Pileus: (10-) 15-30 mm diam, conical to convex or subcampanulate, subpapillate or subumbonate, lubricous, even, slightly striate at the margin, yellowish brown or reddish brown, becoming paler towards the margin, readily turning blue-green to blackish when bruised or old.
Gills/Lamellae: Adnate or sinuate, yellowish gray to brownish violet or dark brown sepia, edges whitish and subfloccoses; turning blue-green to blackish when bruised.
Stem/Stipe: 40-80 x 3-5 mm, equally cylindrical or slightly thickened at the base, somewhat flexuous, hollow, whitish to irregularly reddish brown or blackish, readily turning blue-green when injured, covered by whitish floccose little scales, mainly toward the base. Veil well developed, cortinate and white, forming a complex subfibrillose or submembranous annulus, frequently double.
Context: Context pallid yellow in the pileus and stipe, whitish toward the pileus surface, readily turning blue-green to blackish when cut. Dried basidiomata are completly blackish to black.
Odor: Something special but fungus-like, not farinaceous. Taste slightly fungal, subfarinaceous to pungent.

Microscopic feat.:

Basidio/Spores: (5.5-) 6-7 (-8) x 3-4 x 3-3.5 (-4) µm, subellipsoid or subovoid both in face and side view, brownish yellow, thin-walled, with a broad germ pore at one end and an acute short appendage at the other.
Basidia: (16-) 17.5-24 x (4-) 5-6 µm, 4-spored, clavate ventricose, hyaline.
Pleurocistidia: (16-) 17.5-27 (-28) x (4-) 5-7 (-9) µm, common, hyaline, subfusoid with acute apex or sublageniform with a short neck.
Cheilocystidia: (14,5-) 16-28 (-31) x (4-) 5-6,5 µm, abundant, hyaline, ventricose sublageniform, frequently with a middle constriction with a short or long neck, sometimes bifurcate.
Subhymenium: Not well differentiated.
Trama: of gill regular, formed by hyaline to pale yellow hyphae, thin-walled 2.5-13 µm wide.
Epicutis: Subgelatinized, formed by 2.5-4 µm hyaline to pale yellow parallel hyphae.
Hypodermium: With hyaline or pale yellow hyphae or subglobose elements 5-17 µm, wide, thin to thick-walled. Clamp connections present.

Habitat: Gregarious on soil, in a subtropical forest ("bosque ombrofilo montano siempre verde") with *Cyathea* and *Blechnum* at 2400 m of elevation. Known only from the type locality.

Studied material: VENEZUELA:: Márida State, Parque Sierra Nevada, Telefárico de Márida, La Montana Station, May 23, 1993, Marcano & Guzmán s.n. (Guzmán 30806), (Holotype Herb. Univ. de Los Andes, Fac. Farmacia 8001; izotyp XAL).

Discussion: The presence of an annulus relates this species to *Psilocybe argentipes* Yokoyama from Japan and *Psilocybe graveolens* Peck from U.S., but the former has no pleurocystidia and the latter has broader spores [4.5-5(-6) µm] and hyaline to brownish pleurocystidia. Its habit is similar to that of *Psilocybe zapotecorum* and *Psilocybe angustipleurocystidiata*, but those species have no annulus, and the pleurocystidia are vesiculose submucronate or subfusiform, 5.5-14 µm wide in the former, and 3-6.5 µm wide in the latter. The strong blue-green to blackish or black reaction in all parts of the basidiome, including the gills, as well as the pungent taste, are two conspicuous features of *Psilocybe meridensis*.

source - Bibliotheca Mycologica **[159: 103-105]**

Pictures at www.mushroomobserver.org

Psilocybe mescaleroensis

Psilocybe mescaleroensis Guzmán, Walstad, E. Gándara & Ram.-Guill.

DESCRIPTION 1

Macroscopic feat.:

Cap/Pileus: 20-60 mm, convex to subumbonate, brownish-yellow, hygrophanous, margin striate when moist, often with an orangish center, broad umbo and wavy margin. Has a separable gelatinous pellicle. Bruising bluish where damaged.
Gills/Lamellae: Cream color when young, chocolate brown in age, with adnate to adnexed attachment.
Stem/Stipe: 50-100 mm long, 5 do 20 mm thick, white, sometimes with light orange patches, fibrillose, equal to slightly enlarged near the top. Annulus fragile and membranous, white or dusted with dark brown spores. Stem base with rhizomorphic mycelium. Bluing where damaged.
Odor: And taste slightly farinaceous.

Microscopic feat.:

Basidio/Spores: Dark chocolate brown, subrhomboid to subovoid, thick-walled, 9-12 x 6-8 µm.
Pleurocistidia: Absent.
Cheilocystidia: 20-30 x 6 µm, fusiform or ventricose-rostrate, sometimes forked.

Habitat: Grows scattered to gregariously on dead grasses, in grasslands and savanna near ponderosa pine woodlands, often near gopher holes. Found in the summer and fall in the Sierra Blanca range of New Mexico, near Mescalero, New Mexico. So far it has only been collected in or near the type locality.

source - www.wikipedia.org

DESCRIPTION 2

Macroscopic feat.:

Cap/Pileus: (20-) 30-45 (-60) mm diam, convex to subumbonate, margin frequently wavy, pale brownish-yellow (4A3-4) to darker (4B5-7), frequently with the disc more orange (4A7-8), hygrophanous, changing to pale brownish (close to 9E2), translucent striate when wet, pellicle gelatinous, separable.
Gills/Lamellae: Adnate to adnexed, dirty whitish (4A2) to pale brownish-gray (4B4-5) or brownish-rose (6A3), finally dark chocolate (7E4-5), edges concolorous. Annulus close joined to the surface of the stipe, slightly membranaceous, white or getting the color of the spore print on the upper surface, ephemeral.
Stem/Stipe: (50-) 60-70 (-100) x 5-8 (-20) mm, cylindrical, equal or thicker toward the apex, flexuous, fibrillose, solid to hollow, whitish to irregularly orange (5A7) or orangish-pink (close to 7A3-4), base somewhat rhizomorphic, frequently strigose. All the basidioma *bluing*, except lamellae.
Context: Whitish to pale grayish (4A2-3), with slight farinaceous odor and taste.
Odor: And taste slightly farinaceous.

Microscopic feat.:

Basidio/Spores: (9-) 10-11 (-13) x 6-7 (-8) x 6-7 µm, subrhomboid or subovoid in face-view, subovoid in side-view, thick-walled, wall up to 1 µm thick, yellowish-brown, with a distinct and broad germ pore at distal pole and a short asymmetric appendage in the other. Spore print dark chocolate (7E-4).
Basidia: 35-39 x 7,5-9 µm, 4-spored, subclaviform, hyaline.
Pleurocistidia: Absent.
Cheilocystidia: (16-) 19-27 (-30) x 5-8 µm, hyaline, fusiform, ventricose-rostrate, regular or irregularly in shape, rarely irregularly branched.
Trama: hymenophoral regular, hyphae 4-5 µm wide, thin-walled, hyaline to yellowish.
Epicutis: an ixocutis up to 155 µm thick, hyphae 2-5 µm, wide, thin-walled, hyaline.
Subhymenium: Subcellular, hyaline to yellowish. Clamp connections present.

Habitat: Rarely solitary, frequently scattered to gregarious, also caespitose on rich soil or decaying grasses, in grasslands near to a *Pinus ponderosa* Douglas ex C. Lawson forest, commonly associated with the holes of gophers. Observed in summer and autumn. Known only from the type locality.

Studied material: UNITED STATES, New Mexico: Mescalero Range, Sierra Blanca, Lincoln Co., near town Mescalero, July 2004, *Walstad* s.n. (holotype XAL, isotype NY).

Discussion: This new species belongs to section *Stuntzii* Guzmán (Guzmán 1983), because of the subrhomboid, thick-walled basidiospores, presence of an annulus, and the bluing feature. It differs from *Psilocybe stuntzii* Guzmán & J. Ott (Guzmán 1983, Guzmán & Ott 1976) for its more robust basidiomata with subradicating and strigose stipe bases and cheilocystidia lacking elongate and flexuous necks. *Psilocybe stuntzii* has a (5-) 10-20 (-35) mm diam pileus and lageniform cheilocistidia with long necks (Guzmán & Ott 1976). Also *Psilocybe stuntzii* is known only from the Pacific regions of Canada and the USA. Although information gathered by Walstad and friends is somewhat confusing, it is probable that *Psilocybe mescaleroensis* had or still has a sacred use among Indians.

source - www.mycotaxon.com **[99: 225-226]**

Pictures at www.mushroomobserver.org

Psilocybe mexicana

Psilocybe mexicana Heim 1957

Sclerotia giving strain see: P. mexicana A.
Mushrooms giving strain see: P. mexicana B.

Pictures at www.mushroomobserver.org

Psilocybe mexicana „A“

Psilocybe mexicana „A“ Heim 1957

Psilocybe mexicana grows solitary to gregarious in meadows, often in horse pastures and in soils rich in manure. It is most common at 1000-1800 m in elevation. This species is found in June through September in subtropical Mexico.
This species was highly sought after for years because of it's sclerotia forming abilities. The two mexicana strains we sell were originally brought into circulation by Sporeworks.

On sterilised grass seed, rice and millet the 'A' strain produces large sclerotia, hardened mycelial structures that contain psilocybin and psilocin. Sclerotia usually enlarge until about 3 months after inoculation after which they can be harvested.
Mushroom production is limited and few mushrooms can be harvested. However, large sclerotia form in the casing soil of fruiting trays. If you are interested in growing mushrooms of the *Psilocybe mexicana* we recommend you look at the 'B' strain.
The 'B' strain does not produce sclerotia in uncased substrates, only in the casing layer of fruiting trays. This strain does produce massive flushes of mushrooms.
The mycelium of the 'A' strain forms typical rings of sclerotia on malt extraxt agar. Sclerotia can be planted and mushrooms can form directly from them.
In our standard jars with 110 grams of grass seed and 180 ml of water it produces an average of 90 grams fresh weight in 3 months. This species can also be succesfully grown in autoclavable spawnbags.

Experiments have yet to determine the optimal substrate for this strain but so far grass seed, millet and rice have proven to be useful. Undoubtly there are more substrates that support sclerotia formation better than those three.

source - www.mushmush.nl

Pictures at www.mushroomobserver.org

Growth parameters:

Substrate:
Sterilised grass seed, millet and rice.
Temperature:
colonisation/fruiting: 24-27°C / 22-24°C

Psilocybe mexicana „B“

Psilocybe mexicana „B“ Heim 1957

Psilocybe mexicana grows solitary to gregarious in meadows, often in horse pastures and in soils rich in manure. It is most common at 1000-1800 m in elevation. This species is found in June through September in subtropical Mexico.
This species was highly sought after for years because of it's sclerotia forming abilities. The two mexicana strains we sell were originally brought into circulation by Sporeworks.

This strain gives out abundant amount of mushroom and sclerotia on cased substrates of grass seed. The strain does not produce sclerotia invitro.
If you are interested in growing sclerotia in vitro, we recommend you to look at the "A" strain. The "A" strain produce a lot of sclerotia on uncased substrates but gives off little of mushrooms.
This mushroom is weak reproducer, to obtain good spores, we suggest you to wait untill caps will curl up completely.

source - www.mushmush.nl

Pictures at www.mushroomobserver.org

Growth parameters:

Substrate:
Sterilised grass seed, millet and rice.
Temperature:
colonisation/fruiting: 24-27°C / 22-24°C

Psilocybe microcystidiata

Psilocybe microcystidiata Guzmán & Bononi

synonyms:
Psilocybe zapotecorum Heim emend Guzmán
Psilocybe aggericola Singer & A.H. Sm.
Psilocybe barrerae Cifuentes & Guzmán
Psilocybe subzapotecorum Guzmán
Psilocybe chaconii Guzmán, M. Torres & Ram.-Guill.
Psilocybe bolivarii Guzmán, Ciencia (Méx.)
Psilocybe zapotecorum var. *ramulosum*
Psilocybe sanctorum
Psilocybe sanctorum Guzmán
Psilocybe candidipes Singer & A.H. Sm.
Psilocybe aggericola var. *alvaradoi*
Psilocybe zapotecorum f. elongata
Psilocybe pseudozapotecorum Guzmán

Macroscopic feat.:

Cap/Pileus: 7-10 mm diam., conic to campanulate, subviscid, glabrous and smooth to slightly striate at the margin, reddish brown or darker, hygrophanous.
Gills/Lamellae: Subadnate, violaceous brown, with whitish floccose edges.
Stem/Stipe: 25-30 x 1-2 mm, uniform to somewhat bulbous at the base, brownish to reddish brown, covered by small whitish floccose scales. Annulus absent.
Context: Thin, brownish, bluing.

Microscopic feat.:

Basidio/Spores: (5.5-) 6-7 x 3-3.5 (-4) µm, ellipsoid or subellipsoid, both in frontal and lateral view, thin walled, brownish, with a broad germ pore.
Basidia: 10-15 x 4-5 µm, 4-spored, hyaline, subcylindric or ventricose.
Pleurocistidia: 10-21 (-24) x 7-10 (-12) µm, abundant, hyaline to somewhat yellowish brown, fusiform, ventricose, globose or napiform.
Cheilocystidia: 8-13 x 1,5-3 µm, necks 0.5-1 µm; thick, hyaline, regular or irregularly sublageniform.
Subhymenium: With elongated elements strongly pigmented on the walls with irregularly incrusted brown pigment, hyphae up to 15 µm diam.
Hypodermium: As in the subhymenium.
Trama: Regular, incrusted to hyaline. Pileus surface with elongated parallel hyphae, somewhat incrusted as those of the subhymenium. Clamp connections observed.

Habitat: Gregarious on soil, only know from the type locality.

Studied material: BRAZYL, Minas Gerais State, Pouso Alegre, Col. Pedro Küpper, December 1982 (SP-178161 Type).

Discussion: This species belongs to the Section *Zapotecorum* because of the structure of the spores and the bluing feature of the fruit body (Guzmán, 1983). It differs from all the species of the Section in its small cheilocystidia, smaller even than those recently described in the same Section (Guzmán, 1982; Cifuentes & Guzmán, 1981) from Mexico.

source - www.mycotaxon.com **[19: 345]**

Pictures at www.mushroomobserver.org

Psilocybe moravica

Psilocybe moravica Borov. (2003)

synonyms:
Psilocybe serbica M.M.Moser & E.Horak (1969)
Psilocybe bohemica Šebek (1983)
Psilocybe arcana Borov. & Hlavácek (2001)

Macroscopic feat.:

Cap/Pileus: 2,5-3,5 (-7) cm across, hemispherical or conical when young, margin joined to stipe by a cortinate white veil, becoming plane-hemispherical, very obtusely conical, broadly campanulate or conical and margin becoming somewhat mildy wavy. Margin striate when moist. Strongly hygrophanous and fragile with a separate pellicle. Sometimes bluish to bluish green with a blue spot in center of cap. Dark brown when moist, fading to a yellowish-ochraceous or yellow-brown, bluish toned.
Gills/Lamellae: Thin, close-spaced, adnate, not subdecurrent, accurate in young and broad with maturity (ventricose). Brown and dark m when mature, with a grey tone and white edges.
Stem/Stipe: 5-9 (-12) x (0,15) 0,2-0,3 (-0,4) cm, cylindrical, often with a somewhat scabrous surface, Usually lank, less commonly robust, short and distinctly curved and not enlarged at the base. with remains of a partial veil building a fibrillous annular zone. Whitish rhizomorphs at base fibrillating into woody debris Whitish and off white, rarely whole stipe blue-green tinged. Stains blue when bruised.

Microscopic feat.:

Basidio/Spores: (10) 11-13,5 (-14,8) x (6-) 6,2-7,0 (-7-8) µm. Brown, ellipsoid, broadly ellipsoid or elongated and somewhat lemon-shaped. Sporeprint purple-brown.

Habitat: In groups on woody debris in deciduous or mixed forests, in grass on woody debris in soil and underbrush of *Utica* or *Rubus*, often in localities disturbed by human influence with accumulation of woody waste.

Distribution: It has been only reported from five distinct localities int he Czech Republic, 230-700 m above sea level.

Season: Late September to end of November, or mid December depending on warm autumn months.

Dosage: Unknown at present.

Comment: This fungi according to the author smells sweet and spicy not farinaceous and taste rather bitter. 9 specimens of this mushroom from two localities in the Czech Republic were analysed for psilocin/psilocybin content and showed a high concentration of psilocin as compared to a low content of psilocybin. Higher concentrations of indole derivatives were found in fruitbodies obtained from lower elevations. This is the third bluing *Psilocybe* described in the Czech Republic.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe moseri

Psilocybe moseri Guzmán

Macroscopic feat.:

Cap/Pileus: 10-13 mm in diam, subcampanulate to subpapillate, sublubricous, glabrous, even, dark buff to brownish, hygrophanous, very bluish.
Gills/Lamellae: Adnate, pale brown to blackish violet, with whitish edges.
Stem/Stipe: 75-80 x 2-3 µm, flexible, smooth, silky, whitish to brownish, very bluish, subbulbous and with a thick, irregular long pseudorhiza. Veil absent in ripe specimens.
Context: Whitish to rufous brown, subfleshy in the pileus, fibrous in the stipe, staining blue when cut.
Odor: And taste strongly farinaceous.

Microscopic feat.:

Basidio/Spores: (4-) 5-5.5 (-6.5) x (3-) 3-3.5 x 2.5-3 µm, ellipsoid both in face or side view, thin-walled (no more than 0.5 µm thick), pallid brownish, with a distinct and broad germ pore and an apical short appendage.
Basidia: (14.5-) 16-21 x 4-5.5 µm, 4-spored, hyaline, vesiculose, cylindric or subclavate.
Pleurocistidia: 12-16 (-17) x (4-) 5-5.5 µm, hyaline, common, vesiculose and mucronate.
Cheilocystidia: Of two types, a) (17-) 18.5-34.5 (-37) x (4-) 5.5-7 (-8) µm, irregularly cylindric or subvesiculose, hyaline, common, and b) 12-21.5 (-22.5) x 4-5.5 (-6.5) µm, vesiculose mucronate, hyaline and rare.
Subhymenium: Not well differentiated.
Trama: Regular, with hyaline 3.5-12 (-16) µm wide hyphae.
Epicutis: Formed by a subgelatinized layer, with 1.5-4 µm hyphae in diam.
Hypodermium: Subcellular, with 4-16 (-20) µm, wide elements, brownish and thick-walled (up to 1,5 µm). Clamp connections present.

Habitat: Gregarious and caespitose on soil, in a tropical rain forest, 500 m elevation. Known only from the type locality.

Studied material: MEXICO: State of Chiapas, road Ocozocuatla to Apic-Pac (Malpaso Dam), Laguna Bálgica, Sept. 26,1993, Guzmán 30723 (Holotype, XAL).

Discussion: Etymology - this species is named in honor of Dr. Meinhard Moser (Innsbruck).
This species belongs to Sect. Zapotecorum because of its thin-walled spores and for the bluing reaction. The peculiar pleurocystidia, the two types of cheilocystidia, the pseudorrhiza, as well as the smaller spores, separate *Psilocybe moseri* from all the species considered by Guzmán *et al.* (1988) in this section. *Psilocybe moseri* is the species with the smallest spores in the section and the only tropical one (the others are from the subtropical highlands or from coniferous forests), which confirms the observations by Guzmán (1979), that the tropical species of *Psilocybe* have small spores in comparation with the alpine species. For instance, *Psilocybe uxpanapensis* Guzmán from the tropics, has spores that are (5-) 5.5-6.5 (-7.5) µm long as compared with *Psilocybe aztecorum* from alpine regions with 12-14 µm long spores.

source - Bibliotheca Mycologica **[159: 105-107]**

Pictures at www.mushroomobserver.org

Psilocybe muliercula

Psilocybe muliercula Singer & A.H.Sm. (1958)

synonyms:
Psilocybe muliercula Singer and Smith
Psilocybe wassonii Heim
Psilocybe mexicana var. *brevispora* Heim

Macroscopic feat.:

Cap/Pileus: 0.5-4 (5) cm broad. Conic to conic-campanulate, expanding to convex to broadly convex to nearly plane, often undulating and umbonate. Surface smooth, shortly translucent-striate along the margin. Reddish brown to vinaceous brown, hygrophanous, fading in drying to a pale orangish light brown from the center to the margins, which are often tinged bluish green. Flesh whitish, quickly bruising bluish where injured.
Gills/Lamellae: Attachment adnexed to sinuate, close, pale-pinkish brown, becoming dark chocolate brown with spore maturity, with similarly colored or slightly paler edges.
Stem/Stipe: 20-60 (100) mm long by 2-7 mm thick. Equal to enlarging upwards, covered with fine fibrillose veil remnants, especially when young, smooth in age. Pale pinkish white, bruising bluish where injured. Partial veil finely cortinate, leaving fragile patches of fibrils, soon disappearing. Flesh pinkish brown, tough, hollow, quickly bruising bluish when handled.

Microscopic feat.:

Basidio/Spores: Dark violaceous brown in deposit, subellipsoid to ellipsoid-ovoid, 6-9.9 by 3.8-4 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 16-24 by 3.5-6 µm, sublageniform with an elongated neck, 1.5-3 µm thick, sometimes forked or mucronate.

Habitat: Gregarious to cespitose in muddy and swampy soils on the walls of ravines in fir (*Abies*) and pine (*Pinus*) woodlands. Found August through September in Mexico (state of Mexico).

Comment: Potently active, judging by the strength of the bluing reaction. The name *Psilocybe wassoni* was preempted by Smith and Singer's publication of the name just 24 days prior to the publication of Heim and Wasson's (1958) masterpiece, and given the international rules governing nomenclature, the name first published presides. Since may of Singer's Mexican contacts were provided, in good faith, by Heim and Wasson, this event created a rift between two schools of mycologists that persisted for several decades. Heim and Hofmann (1958) found 0.02% psilocybin and 0.01% psilocin in seven-month-old specimens. Undoubtedly, fresh specimens are many orders of magnitude stronger.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe naematoliformis

Psilocybe naematoliformis Guzmán (1979)

synonyms:
Naematoloma naematoliforme (Guzmán) Guzmán (1980)
Hypholoma naematoliformis (Guzmán) Guzmán (1999)

Description: *Psilocybe naematoliformis*, is a species of fungus in the mushroom family Strophariaceae. It is a psilocybin mushroom, having psilocybin and psilocin as the main active hallucinogenic compounds.
The species was originally found by mycologist Gastón Guzmán in a tropical rainforest at Uxpanapa Region, in the State of Veracruz in southeastern Mexico; he reported the finding in a 1979 publication, and called the fungus *Psilocybe naematoliformis*. Guzmán later considered species with chrysocystidia (cystidia whose contents contain a distinct refractive yellow body, that become more deeply yellow when stained with ammonia or other alkaline compounds) to be separate from *Psilocybe*, and transferred the species first to Naematoloma in 1980, and then later to Hypholoma in 1999. In 2004, Guzmán revised his opinion again, and considered the species more suitably placed in *Psilocybe*.
Psilocybe naematoliformis is in the section Neocaledonicae, a group of related tropical and subtropical species in the *Psilocybe* genus; other members of the section include *Psilocybe aequatoriae* (Ecuador), *Psilocybe neocaledonicum* (New Caledonia), and *Psilocybe neorhombispora* (Mexico).

Macroscopic feat.:

Cap/Pileus: 1-3 cm (0.4-1.2 in) in diameter, bell-shaped to subumbonate, smooth, and slightly slimy but soon dry. The color may range from a pale orange-brown to a deep rusty brown. It is hygrophanous, fading to buff; the color is blackish brown when dry, and slightly translucent-striate when wet. Like other hallucinogenic psilocybes, it stains blue when bruised or injured.
Gills/Lamellae: Adnate in attachment to the stem, or may be notched at the point of attachment (sinuate). They are narrow, and brownish violet to dark violet, with whitish edges.
Stem/Stipe: 3.5-5.5 cm (1.4-2.2 in) tall by 1-3 mm thick, subequal, flexuous, and hollow. The color of the stem is reddish-brown or brownish; it is densely covered with silk-like fibers, and tufts of soft woolly hairs. The veil does not form an annulus.
Odor: Slightly farinaceous, like grain, and the taste of this species has been described as slightly bitter.

Microscopic feat.:

Basidio/Spores: (3.8)4.9-5.5(6.6) by (3.3)4.4-5(6.6) by 3.8-4.4 µm, sublentiform (shaped somewhat like a biconvex lens) in face view or roughly elliptic in side view, with an inconspicuous hilar appendage. They have a distinct germ pore in the base, and are smooth and thick-walled.
Basidia: The spore-bearing cells in the hymenium, are 12-19 by 4.4-5.5 µm, and hyaline.
Pleurocistidia: (Cystidia on the gill face) are 15-29 by 5.5-8.8 µm; clear, gray or brown in color, fusoid-ventricose to mucronate, sometimes with a median constriction, similar to the species *Psilocybe subaeruginosa* Clel. from Australia.
Cheilocystidia: (Cystidia on the gill edge) are 12-28 by 5.5-7.7 µm, hyaline, very numerous, ventricose, mucronate or fusiform-lanceolate, often forked.

Habitat: *Psilocybe naematoliformis* is found growing in small groups, in tufts or clumps, on disturbed places of the virgin tropical rain forest; it grows in soil with a few herbaceous plants. This species was originally found in Mexico, State of Veracruz, Uxpanapa region.

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Psilocybe natarajanii

Psilocybe natarajanii Guzmán

synonyms:

Psilocybe aztecorum var. *bonetii* (Guzmán) Guzmán sensu Natarajan & Raman.

This species differs from *Psilocybe aztecorum* var. *bonetii* known only from Mexico, in the size and form of the pleurocystidia. *Psilocybe natarajanii* has mucronate pleurocystidia 21-28 x 7-10 µm, instead of the 20-45 x 5-8 µm, lageniform pleurocystidia with a long neck found in the Mexican fungus. *Psilocybe natarajanii* is known only from the type locality. This species is close to *Psilocybe pseudoaztecorum* (Natarajan & Raman, 1985) (= *Psilocybe aztecorum* var. *aztecorum* sensu Natarajan & Raman, 1983), but differs in the smaller spores, 12.5-17 µm long in Psilocybe pseudoaztecorum vs. 10-12.5(-14) µm in *Psilocybe natarajanii*. The above description is compiled from Natarajan & Raman (1983), because no herbarium material was studied.

source - Bibliotheca Mycologica **[159: 109]**

Pictures at www.mushroomobserver.org

Psilocybe neocaledonicum

Psilocybe neocaledonicum Guzmán & Horak

---

synonyms:
Psilocybe neocaledonica Guzmán & Horak
Hypholoma neocaledonica (Guzmán & Horak) Guzmán
Naematoloma neocaledonica (Guzmán & Horak) Guzmán

Macroscopic feat.:

Cap/Pileus: 8-11 mm broad, conico-papillate to subconvex, deep brown, fading to pale orange-red or stramineous when drying, not viscid, densely covered with concolorous fibrillose squamules especially towards the striate margin, occasionally also with white minute squamules from the veil along the margin.
Gills/Lamellae: Broadly adnate to subdecurrent, often with short tooth, deep chocolate brown to violaceous brown, edges whitish and fimbriate.
Stem/Stipe: 12-15 by 1-1.5 mm, cylindrical or rarely subbulbous, pale orange brown, covered with concolorous or whitish fibrils of the veil, but distinct cortina zone or anulus absent, hollow, single.
Context: Whitish.
Odor: And taste not distinctive.

Microscopic feat.:

Basidio/Spores: (5) 5.5-6 (-6.5) by 5.5-6 (-6.5) na 4-4.5 µm, rhombic or globose-rhombic, subelliptical in side view, membrane yellowish brown, with broad truncate germ pore.
Basidia: 16.5-20 by 4-6.5 µm, 4-spored, hyaline (KOH), subcylindric with slight median constriction.
Pleurocistidia: 22-28 by 11-14.5 µm, ventricose-rostrate, apical beak measuring 2-5.5 by 1.5-3.5 µm, hyaline or brownish (KOH), many with hyaline to yellowish refractive pigment-body of irregular shape (like chrysocystidia).
Cheilocystidia: 17-27 by 4-6.5 µm, polymorphous (fusiform, subventricose-rostrate or sublageniform), forming dense and sterile turf on gill edge, hyaline (KOH), rarely with hyaline apical oil drop.
Subhymenium: With pale orange to brown (KOH) and irregularly distributed pigment.
Trama: Regular, hyaline to pale orange brown (KOH), pigment irregularly encrusting the membranes (0.5-1.5 µm diam.).
Epicutis: Consisting of hyaline to yellowish-brownish subgelatinous parallel thin hyphae.
Hypodermium: Of elongate hyphae (5-15 µm diam.) with hyaline to brownish membranes (- 2 µm diam.). Clamp connections present.

Habitat: Gregarious on rotten wood, sticks and plant debris in tropical forest at about 1000 m a. s. l. Known from type locality only.

Studied material: NEW CALEDONIA, Mt. Mou, N of Paita; 22. II. 1977, leg. HORAK (Holotype ZT, 77/161; isotype ENCG).

Discussion: The pleurocystidia and cheilocystidia of this species are similar to the ones observed in *Psilocybe nematolomiformis* Guzmán (1977), described from tropical rain forest in Mexico, differ, however, in size and shape. Furthermore, the pileus of the Mexican species is glabrous. *Psilocybe neocaledonica* is also close to *Agaricus* (*Naucoria*) *lonchophorus* B. & Br. from Ceylon. Upon examining the type material of this species (K) by one of the authors (HORAK), only hyaline pleurocystidia have been found and chrysocystidia-like cystidia are absent. The non-cellular structure of the subcutis or hypodermium in combination with the rhombic spores are distinctly separating this New Caledonian species from taxa of the genus *Naematoloma* Karsten. It is possible that this new species is an hallucinogenic fungus since it has close taxonomic relationships with hallucinogenic species of the Stirps Yungensis.

source - www.sydowia.at **[31: 53-54]**

Pictures at www.mushroomobserver.org

Psilocybe ovoideocystidiata

Psilocybe ovoideocystidiata Guzmán et Gaines

Macroscopic feat.:

Cap/Pileus: 10-45 mm in diameter, brown with a sticky surface when moist drying to a pale bluish grey to white.
Stem/Stipe: 25-90 mm, white to buff with a distinct but fragile membranous annulus, base tenaciously attached to substrate with thick white rhizomorphs.
Gills/Lamellae: Subadnate, brownish.

Microscopic feat.:

Basidio/Spores: 8-10 by 6-7 µm, subrhomboid to rhomboid.

Habitat: Climate temperate. Hardwood logs and debris.

Comment: Previously misidentified as *Psilocybe caerulipes*. Closer examination reveals that the Bethany collection is most likely *Psilocybe ovoideocystidiata*, which agrees with the identification proposed by Psilocybe expert, Gastón Guzmán. *Psilocybe ovoideocystidiata* is only known from Ohio, Pennsylvania and West Virginia.
This was the only species we provided that had not been directly assessed by our staff. It is our policy not to accept spore products from outside sources in order to maintain tight quality control and correct identification. Due to the rarity and exceptional documentation of the samples we made an exception. Unfortunately, without actual specimens to examine, staff misidentified the species. At the time we were unaware of the existence of the newly described *Psilocybe ovoideocystidiata* and made our identification based primarily on the location of the initial collection. We could not have guessed that another species would be found in an area previously only known for a single, native and active *Psilocybe* that shares the same habitat.
See also its close relative *Psilocybe subaeruginascens*.

source - www.sporeworks.com

Pictures at www.mushroomobserver.org

Psilocybe papuana

Psilocybe papuana Guzmán & Horak

Macroscopic feat.:

Cap/Pileus: 10-20 mm diam., conical to conico-convex, densely striate for about 2/3 when moist, membranaceous, glabrous, dry, hygrophanous, black-green to deep olive green, fading in aged carpophores.
Gills/Lamellae: Adnexed or adnato-adnexed, densely crowded, brownish grey or pale brown when young, turning cocoa brown or brown in mature specimens, often with purplish tinge, staining greenish when bruised, edge albofimbriate or concolorous.
Stem/Stipe: 35-55 by 1-1.5 mm, cylindrical, equal or subbulbous at base, hollow, dark brown below, pale brown towards apex, covered with white fibrils from the veil, dry, base often with white mycelium or white short rhizoids. Stipe turns green in aged carpophores or when bruised.
Context: Pale green or black green in pileus, brown in stipe especially towards base.
Odor: And taste absent or acidulous. Chemical reactions on pileus: KOH and HCl - negative

Microscopic feat.:

Basidio/Spores: 5,5-7 (-8) by 4.5-6 by 3.8-4.5 µm, subrhombic (dorsoventral) to elliptical (lateral), yellowish brown (KOH), smooth thick-walled membrane, broad flattened germ pore present.
Basidia: 13-22 by 4.5-6.5 µm, 4-spored, hyaline.
Cheilocystidia: (6.5) 10-18 by 6.5-13 µm, globose to broadly fusoid, often with irregular short neck (2,5-4,5 by -2,5 µm), hyaline, thin-walled membrane, forming sterile gill edge.
Pleurocistidia: Absent.
Subhymenium: And trama subhyaline, membranes of hyphae irregularly encrusted with yellowish or black (KOH) pigment which reacts pale black-blue (amyloid) in Melzer solution.
Epicutis: A cutis composed of partly gelatinized parallel hyphae, membranes encrusted with yellowish (KOH) pigment.
Hypodermium: Of cylindrical to globose cells, membranes hyaline or brownish (KOH), like those of trama. Clamp connections on septae.

Habitat: Gregarious in small groups, occasionally also solitary, on soil or among litter in tropical or subtropical-montane forests under *Castanopsis*, *Lithocarpus* or *Nothofagus*, 1000-2400 m a. s. l. Known from Papua New Guinea only.

Studied material: PAPUA NEW GUINEA, Eastern Highlands: Mt. Michael, Frigano, Hut Track; 6. XII. 1971, leg. HORAK (Holotype ZT, 71/385; isotype in ENCB). - Kassem Pass; 13. XII. 1972, leg. HOKAK (ZT, 72/726).

Discussion: This species reminds of the hallucinogenic *Psilocybe caerulescens* MURR., reported from the SE of the United States and Mexico (SINGER & SMITH, 1958). The shape and size of the cheilocystidia, however, are distinctly separating the two species.

source - www.sydowia.at **[31: 49-50]**

Pictures at www.mushroomobserver.org

Psilocybe pelliculosa

Psilocybe pelliculosa (A.H.Sm.) Singer & A.H.Sm. (1958)

---

synonyms:
Psathyra pelliculosa A.H.Sm. (1937)

Macroscopic feat.:

Cap/Pileus: 0.5-2 (3) cm broad. Obtusely conic, becoming conic-campanulate with age. Margin translucent-striate and generally not incurved in young specimens. Chestnut brown when moist, then dark dingy yellow to pale yellow in drying (hygrophanous), often with a pallid band along the margin, and frequently tinged olive green in patches. Surface smooth, viscid when moist from a separable gelatinous pellicle. Flesh thin, pliant, and more or less concolorous with the cap.
Gills/Lamellae: Attachment adnate to adnexed, finally seceding, close, narrow to moderately broad. Color dull cinnamon brown, darkening with spores in age.
Stem/Stipe: 60-80 mm long by 1-2.5 mm thick. Equal above, and slightly enlarged at the base. Surface is covered with appressed grayish fibrils, and powdered at the apex. Whitish to pallid to grayish more brownish toward the base, blue green where bruised or with age. Flesh stuffed with a tough pith. Partial veil thin to obscure or absent.

Microscopic feat.:

Basidio/Spores: Spores purplish brown in deposit, subellipsoid to subovoid, 9-13 by 5-7 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 17-36 by 4-7.5 µm, fusiform to lace-shaped, with an elongated neck 1.5-2 µm thick.

Habitat: Scattered to gregarious to cespitose on well-decayed conifer substratum, in mulch, or in soil rich in lignin. Often seen along paths in conifer forests and along abandoned logging roads that are actively being recaptured by alders and firs. Found in mid-to-late fall to early winter throughout the Pacific Northwest and Northern California.

Comment: Active, although comparatively weak, containing up to 0.41% psilocybin, no psilocin, and 0.04% baeocystin, as reported by Beug and Bigwood (1982b) and Repke et al. (1977). *Psilocybe pelliculosa* is nearly identical with *Psilocybe silvatica*, and is distinguished from it by the length of the spores. The conic-shaped cap, the gregarious nature of their fruitings, the fibrillose patches on the stem, and the bluing reaction at the base of the stem are some of the most distinctive features of this species. See also *Psilocybe silvatica* and *Psilocybe washingtonensis*. This mushroom has a general resemblance, especially at a distance, to *Hypholoma dispersum (=Naematoloma dispersum)*. When my kids were toddlers, I would take them mushroom hunting in the Olympic Peninsula. On one November trip, after parking the car, we strolled up an abandoned logging road. Coming down the road were two pot (edible mushroom) hunters. When I asked if there were any good mushrooms up there, they replied, "There's nothing of interest." Less than fifty yards later, we found several thousand *Psilocybe pelliculosa*. The patch looked like a well-organized army of mushrooms, standing tall and proud. The pot hunters had walked right through the multitudes, unaware of the potential for a life-changing experience.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe physaloides

Psilocybe physaloides (Bull.) Quél.

---

synonyms:
Psilocybe montana (Pers.) Kumm. 1871
Psilocybe physaloides (Bull. ex. Merat) Quelet
Psilocybe caespitosa Murrill
Psilocybe atrorufa sensu auct.

Macroscopic feat.:

Cap/Pileus: 0.5-2.5 cm. Convex to slightly subumbonate at first, soon expanding to broadly convex to nearly plane, often with an undulating margin and subumbonate. Surface smooth, viscid when moist and translucent-striate along the margin, which can be decorated with fibrillose remnants of the partial veil. Chestnut brown to reddish brown, lighter along the margin, hygrophanous, fading in drying to straw yellow or dingy yellow.
Gills/Lamellae: Attachment adnate to adnexed, or sinuate. Dingy vinaceous brown, becoming dark purplish brown with spore maturity.
Stem/Stipe: 15-50 mm long by 1-1.5 mm thick, typically enlarging towards the apex, then narrowing, and enlarging at the base. Rigid, hollow, and covered with patches of fine grayish fibrils, darkening upwards. Partial veil cortinate, deteriorating with age and leaving remnants.

Microscopic feat.:

Basidio/Spores: Violet blackish brown in deposit, subrhomboid in face view, subellipsoid in side view, 6-8 by 4-5.5 µm. Pale yellowish brown to tan with spore maturity.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 16-28 (33) by 4-7 µm, fusoid to sublageniform with short necks 3.3-4.4 µm thick.

Habitat: Solitary to gregarious, sometimes subcespitose in disturbed soils, soils rich with woody debris, often at field-forest (conifer) interfaces. Common in Europe, also reported from Canada, Greenland, and the northern United States, including Alaska. This mushroom has been collected as far south as Santa Barbara. Often fruits in the summer through early fall.

Comment: Not known to be active; not yet analyzed. The silvery sheath of fibrils from a darkening base is a feature that stands out for this mushroom, and is reminiscent of *Psilocybe crobula*, *Psilocybe inquilina* and to a lesser degree *Psilocybe montana*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe pintonii

Psilocybe pintonii Guzmán

Macroscopic feat.:

Cap/Pileus: 15-40 mm diam., subconvex co subumbonate or subpapillate, sometimes irregularly lobulate, eventually appianate or subconcave, smooth, but when young covered by white fibrils from the veil; sometimes slightly rimose, lubricous to dry, slightly transparently striate when moist, hygrophanous, brownish to orange brown or chocolate brown, fading to a dirty yellow.
Gills/Lamellae: Sinuate or adnate, brownish to gray violet, thick with whitish to concolorous edges.
Stem/Stipe: 25-60 x 3-5 mm, cylindrical, hollow, whitish to subconcolorous with the pileus, covered toward the base by floccose white veil fibrils; base remaining somewhat blackish in dried specimens. Both pileus and stipe stain green-blue when injured. Veil well developed when young but absent in the adult stage.
Context: Whitish to brownish, fleshy in the pileus, fibrous-hard in stipe; staining blue when cut, with farinaceous odor and taste.

Microscopic feat.:

Basidio/Spores: (6-) 6.6-7.7 (-8.8) x (3.3-) 4-4.5 µm, ellipsoid or subelliptic, somewhat subrhomboid in face view, thin walled, smooth, brownish yellow.
Basidia: 16-22 x 4.4-8 µm, four-spored, cylindric-pyriform, sometimes sinuos-pyriform.
Pleurocistidia: Absent.
Cheilocystidia: 17-20 x 4-7 µm, hyaline, ventricose-fusoid, lageniform, irregularly ventricose with constrictions or branched or with capitate to subcapitate apex, mixed with basidia in different stages of deformation.
Subhymenium: Brownish without incrusting pigment, but with thick irregular walls in the hyphae; these 6-25 µm.
Epicutis: Subgelatinized, formed by hyaline elongated and parallel hyphae 3-5 µm broad.
Hypodermium: With hyphae with reddish brownish 4-8 µm broad.

Habitat: Solitary or gregarious on soil without herbaceous vegetation, in páramos with *Espeletia*, at 3450-3600 m elevation.

Studied material: COLOMBIA, Cundinamarca Dept, Páramo de Palacio, Hacienda La Siberia, road La Calera to La Mina, near the branch to Rincón del Oso, Aug. 20, 1964, Guzmán 9160 (ENCB); July 23, 1971, Guzmán 9762 (Holotype COL; Isotype ENCB).

Discussion: This species is close to *Psilocybe zapotecorum* Heim and *Psilocybe muliercula* Sing. & Smith, and certainly belongs to the same group, but the special cheilocystidia separate it well from the other species. Because of the bluing reaction and the farinaceous odor and taste, this is probably a hallucinogenic species, but there is no information about its use. The same situation holds true for *Psilocybe columbiana*.

source - www.mycotaxon.com **[7 (2): 247-248]**

Pictures at www.mushroomobserver.org

Psilocybe plutonia

Psilocybe plutonia Berk. & M.A. Curtis Sacc.

---

synonyms:
Agaricus plutonia

Description: The word plutonia comes from the Latin words plutonian or plutonic. Perhaps in connection with the dark color of the mushroom.

Macroscopic feat.:

Cap/Pileus: 0.5-1.5 cm in diameter, conic to convex, with an acute umbo or papilla, not viscid, glabrous, slightly translucent-striate, silky white fibrils when young that fade in age, hygrophanous, lubricous, reddish brown to yellowish brown or clay color, becoming blackish. Flesh thin, brownish.
Gills/Lamellae: Adnexed, sometimes with a decurrent tooth, thin, light brown to dark brown, blackish in age, edges pallid.
Stem/Stipe: (1.8) 2.5-4 (5) cm long, 0.5-1.5 mm equal to slightly enlarged at the base, flexuous, hollow, dark brown or reddish brown, apex pruinose, zoned with appressed whitish fibrils. No annulus is formed by the cortinate veil.
Odor: None to slightly farinaceous. Taste unknown.

Microscopic feat.:

Basidio/Spores: Purple brown in deposit, rhomboid or subrhomboid in face view, (3.7) 4.5-6 (6.7) x 4.5-5.2 µm, thick-walled, with a broad truncate germ pore.
Basidia: 11-17 µm.
Pleurocistidia: 17-26 µm.
Cheilocystidia: 12-17 x 5-6 µm.

Habitat: *Psilocybe plutonia* may be found growing solitary or gregarious, from late June through February, on rotted wood or in soil with woody material, in tropical forests, from Brazil, Colombia, Venezuela and Cuba, often near sea level or in lower elevations, although widely distributed, it is not found often.

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Psilocybe portoricensis

Psilocybe portoricensis Guzmán, Nieves-Rivera & Tapia

Macroscopic feat.:

Cap/Pileus: 5-15 (-20) mm diam, campanulate to subpapillate, glabrous, smooth but striate towards the margin. subviscid, hygrophanous. dark buff to coffee brown, bluing.
Gills/Lamellae: Adnexed, dark violaceous brown, with concolorous edges.
Stem/Stipe: 50 (-60) x 0.5-1 mm, uniform, smooth. brownish to dark brownish red, hollow, bluing. Veil ephemera.
Context: Brownish, bluing.

Microscopic feat.:

Basidio/Spores: 5-5.5 x 4-5 x 3-4 µm, subrhomboid or subglobose in face-view, subellipsoid and slightly inaequilateral in side-view. thick-walled, wall up to 1 µm thick, pale yellowish brown, with a distinct plane and apical pore, and with a short basal appendage.
Basidia: 20-32 x 5-7 µm, 4-spored, subcylindric to clavate, hyaline.
Pleurocistidia: 13.5 x 5-7 µm, more or less abundant, hyaline, sublageniform with a long tapering apex.
Cheilocystidia: 16-24 x 5-7 µm, hyaline, sublageniform, with two or three regular or irregular long necks.
Subhymenium: Subcellular, poorly differentiated, with hyaline, subcylindrical or subglobose, thin-walled elements 2.5-5.5 µm diam.
Trama: Hymenophoral trama regular, with hyaline to yellowish hyphae 4-9 µm, with inflated hyphae up to 28 µm diam, thin- to thick-walled (wall up to 2 µm thick), irregularly incrusted with yellowish pigment.
Epicutis: An irregular, thin. gelatinized layer of pale yellowish hyphae, 1.5-3 µm diam.
Hypodermium: With cylindric to subglobose elements 2.5-9.5 µm, diam. hyaline to yellowish, thin-walled and with incrusted yellowish pigment. Context with cylindric to subglobose elements, 4-10 µm, diam, hyaline to yellowish, thin- to thick-walled, with irregular yellowish incrustations. Clamp-connections present.

Habitat: Gregarious or solitary on muddy clay brownish soil or humus in a coffee plantation, along a trail, in a mesophytic forest. Known only from Puerto Rico.

Studied material: PUERTO RICO, Municipio Villalba, Toro Negro State Forest, trail to Torre 3 (18°10'N, 66°30'W), 820-1015 m alt., Oct. 1994, Nieves-Rivera, Santos-Flores & Betancourt s.n. (holotype MAPR; isotype XAL).

Discussion: This species belongs to Sect. *Cordisporae* Guzmán by virtue of their smaller rhomboid spores, bluing feature and subtropical habitat. It is close to *Psilocybe subtropicalis* Guzmán, from Mexico and Guatemala, by the branched cheilocystidia, but that species has spores (5.5-) 6.5-7 (-8) µm long and collybioid habit (Guzmán, 1995). *Psilocybe plutonia* differs with pleurocystidia broadly ventricose, ventricose-mucronate or obpyriform, 17-26 (-30) x 9-12 µm (Guzmán, 1983, 1995).

source - www.mycotaxon.com **[63: 379-380]**

Pictures at www.mushroomobserver.org

Psilocybe pseudocyanea

Psilocybe pseudocyanea (Desm.) Noordel

---

synonyms:
Psilocybe pseudocyanea (Desmazieres: Fries) Noordeloos
Stropharia pseudocyanea (Desmazieres) Morgan
Stropharia albocyanea (Desmazieres) Quelet

Macroscopic feat.:

Cap/Pileus: 1-3 cm, conic-convex, expanding to acutely to bluntly umbonate, whitish with azure to bluish green tinges, fading to straw or cream colored. Surface viscid from a separable gelatinous pellicle. Margin adorned with remnants of the partial veil. Flesh bluish green, fading to azure, then pale bluish green and eventually straw colored.
Gills/Lamellae: Attachment adnate, pale fawn to purplish, with toothlike edges.
Stem/Stipe: 35-70 mm long by 2-5 mm thick, equal, slim, flexuous, bluish green to azure blue to straw colored, soft, easily breaking, pruinose-flocculose particularly towards the apex. Partial veil membranous, leaving a membranous annulus, degrading into an annular zone.

Microscopic feat.:

Basidio/Spores: Purplish brown in deposit, ellipsoid, 7-9 by 4-5 µm.
Basidia: 4-spored.
Cheilocystidia: Capitate-clavate to lageniform capitate, 24-44 by 4-8 µm by 4-5 at apex when narrowing, or 6-12 µm when swollen.

Habitat: Prefers tall grass in wetlands, marshes, and meadows, or tall shrubs along trails at field-forest interfaces. Known from the British Isles, much of northern Europe, and the Pacific Northwest. Probably more widely distributed.

Comment: Activity unknown. Due caution is advised. *Psilocybe pseudocyanea* is closely related to *Psilocybe aeruginosa* and *Psilocybe caerulea*. All of these species were formerly placed in the genus *Stropharia* but recently transferred to *Psilocybe* by Noordeloos (1995). The smaller spores, soft stem, and wetland habitats are classic features. The edibility of this species is not well documented. The bluish color and its close taxonomic relationship to active species makes *Psilocybe pseudocyanea* a likely candidate for activity. However, caution is always recommended with these less-studied species that lack an experiential history.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe quebecensis

Psilocybe quebecensis Ola'h & R. Heim 1967

Macroscopic feat.:

Cap/Pileus: 1-3.5 cm broad. Nearly hemispheric at first, soon expanding to convex, then becoming broadly convex to plane, and without an umbo. Margin incurved at first and usually not markedly undulated; translucent-striate when moist. Pale straw yellow and often with brownish or tawny hues, becoming more grayish in drying. Bruising bluish when touched or disturbed. Surface smooth, becoming finely wrinkled with age, and viscid when moist. Flesh whitish.
Gills/Lamellae: Attachment adnate, thin, moderately broad to swollen in the middle. Becoming very dark chestnut brown at maturity, and usually somewhat mottled, with the edges remaining whitish.
Stem/Stipe: 20-35 (45) mm long by 1-2.5 mm thick. Brittle, tough, and fibrous. Slightly enlarged at the apex and flared at the base, which is often furnished with rhizomorphs. Yellowish tawny, drying to a distinct grayish yellow, becoming bluish where bruised. Partial veil cortinate, fugacious, and soon disappearing.

Microscopic feat.:

Basidio/Spores: Spores purplish brown to black in deposit, ellipsoid to subovoid in side and face view, some spores mango shaped, 8-14 (16) by 6-8.8 µm.
Basidia: 4-spored.
Pleurocistidia: Present, 12-35 by 9-15 µm, very distinctive by their swollen apices, as in *Psilocybe cubensis* and *Psilocybe cyanescens*.
Cheilocystidia: 18-36 by 5.5-10 µm, fusoid-ampullaceous with an extended neck, 2-3.3 µm thick.

Habitat: Grows in sandy soils, particularly in outwashes of streams, and in the decayed-wood substratum of alder, birch, fir, and spruce in the late summer and fall. Reported from Quebec, specifically in the Jacques Cartier river valley.

Comment: Moderately active according to Ola'h and Heim (1967). *Psilocybe quebecensis* is a classic flood-plain species and is probably more widely distributed than presently reported. This species is not well known to Quebec residents, and I suspect that naturalized colonies could easily be established by those wishing to have *Psilocybe quebecensis* growing in their backyard. See also *Psilocybe caerulipes* and *Psilocybe baeocystis*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe samuiensis

Psilocybe samuiensis Guzmán, Bandala & Allen

Macroscopic feat.:

Cap/Pileus: 7 to 1.5 cm. Convex to conic-convex to campanulate, often umbonate with a small papilla. Translucent when moist, striate margin in young, and with a separate pellicle. Hygrophanous and fading to straw-yellow in drying.
Gills/Lamellae: Adnate and clay colored, than violaceous brown to chocolate-violet with whitish margins.
Stem/Stipe: 40 to 60 mm. long by 1-2 mm thick. Whitish to yellowish and covered with fibrils. Enlarged at base. Partial veil cortinate leaving a superior fibrillous annular zone that soon disappears.

Microscopic feat.:

Basidio/Spores: 9.3-13 x 5-7 µm. Sporeprint - chocolate to purple-brown.
Basidia: 4-spored.
Pleurocistidia: Scattered and ventricose towards the base.

Habitat: Grows in well manured clay-like soils in rice paddies and open grassy areas.

Distribution: Koh Samui Island in the Gulf of Thailand and surrounding areas. Ranong Province, Thailand and at Angkor Wat, Cambodia.

Season: Late may through September and possibly into October.

Dosage: 15-20 fresh mushrooms

Comment: So far this mushroom has only been found four times, fruiting in rice paddies from two locations on Koh Samui Island in the Gulf of Thailand. First in 1991 by John W. Allen in rice paddie fields near the Muslim village of Ban Hua Thanon, Koh Samui. Ten years later, a 2nd collection was gathered with Chief Ill Eagle, Travis Canaday, Nataya and Mike Acevedo, about 100 meters past where the first collection was found ten years earlier.
In 2003, JWA found 8 specimens in a second location a few miles down the road in the rice paddie fields of Na Muang, Koh Samui. And again in 2004, numerous collections were gathered from that same field during two separate fruitings in June and July of 2004. Its fruiting run is from 5 to 7 days and then they are gone from the fields.
Most likely it is probable that this species also fruits in other locations in southern Thailand and possibly Malaysia. It is not, as reported by http://www.petfungus.com found in Eastern Oregon. This species is closely related to *Psilocybe mexicana* Heim Heim and is macroscopically similar to *Psilocybe semilanceata* and is the first species found outside of Mexico directly related to *Psilocybe mexicana* Heim, That latter species is ceremoniously used by native Americans in Mesoamerica.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe sanctorum

Psilocybe sanctorum Guzmán

synonyms:
Psilocybe zapotecorum Heim emend Guzmán
Psilocybe aggericola Singer & A.H. Sm.
Psilocybe barrerae Cifuentes & Guzmán
Psilocybe subzapotecorum Guzmán
Psilocybe chaconii Guzmán, M. Torres & Ram.-Guill.
Psilocybe bolivarii Guzmán, Ciencia (Méx.)
Psilocybe zapotecorum var. *ramulosum*
Psilocybe candidipes Singer & A.H. Sm.
Psilocybe aggericola var. *alvaradoi*
Psilocybe zapotecorum f. elongata
Psilocybe pseudozapotecorum Guzmán
Psilocybe microcystidiata Guzmán & Bononi

Psilocybe sanctorum was known only from the type locality in Mexico, in the State of Mexico, in grassland on the border of a *Pinus-Quercus-Populus* forest (Guzmán, 1982). It is now recorded for first time from the State of Veracruz [Chacón 2529 (XAL), 5 km W from Coatepec, Aug. 22, 1984, in a subtropical (mesophytic) forest]. This material differs from the type by the pileus which is not so papillate. This demonstrates the variation of the basidiomata in this species, a feature typical of several other species of Sect. Zapotecorum.

source - Bibliotheca Mycologica **[159: 117]**

Pictures at www.mushroomobserver.org

Psilocybe semiglobata

Psilocybe semiglobata (Batsch) Noordel. (1995)

---

synonyms:
Protostropharia semiglobata (Batsch) Redhead, Moncalvo & Vilgays (2013)
Agaricus semiglobatus Batsch (1786)
Agaricus nitens Bull. (1792)
Coprinus semiglobatus (Batsch) Gray (1821)
Stropharia semiglobata (Batsch) Quél. (1872)
Geophila semiglobata (Batsch) Quél. (1886)
Psalliota semiglobata (Batsch) P.Kumm. (1871)
Fungus semiglobatus (Batsch) Kuntze (1898)

nonactive

Macroscopic feat.:

Cap/Pileus: 1-4 cm broad. Obtuse to hemispheric to convex and finally broadly convex in age. Occasionally with an umbo. Light yellow to deep straw yellow when fresh, not hygrophanous. Surface smooth, viscid to extremely viscid to glutinous from a separable gelatinous pellicle. Flesh form, watery buff, not bruising.
Gills/Lamellae: Attachment adnate, broad, close to subdistant, with one to two tiers of intermediate gills. Grayish when young, becoming purplish brown with spore maturity, edges remaining pale to whitish.
Stem/Stipe: 30-120 mm long by 2-5 mm thick. Equal to slightly enlarged downwards. Surface below annular zone, whitish to nearly concolorous with cap, viscid to extremely viscid to glutinous in the lower two thirds of the stem. Partial veil glutinous, leaving an annular zone of fibrils, soon darkened. Flesh stuffed with a yellowish pith at first, and becoming hollow with age. No bruising reaction.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, ellipsoid, 15-19 by 8-10 µm.
Basidia: 4-spored.
Cheilocystidia: Present, narrowly fusoid-ventricose with a long, flexuous neck, 26-38 by 6-9 µm.
Pleurocistidia: Difficult to find, 32-46 by 9-14 µm.

Habitat: Single to gregarious on cow or horse dung in the spring, summer, and fall. Widely distributed throughout North America and much of the temperate regions of the world.

Comment: Not active. *Psilocybe semiglobata*, formerly known as *Stropharia semiglobata*, is included here because this mushroom is prolific in habitats also frequented by the active *Psilocybes* and *Panaeoli*. I have often found *Psilocybe merdaria*, *Psilocybe coprophila* and *Panaeolus papilionaceus* sharing the same habitat with *Psilocybe semiglobata*. The natural affinities between these Psilocybes is obvious to all who have collected them. The uniquely glutinous veil disthinguishes this species from close relatives.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe semiinconspicua

Psilocybe semiinconspicua Guzmán & J. M. Trappe

Description: *Psilocybe semiinconspicua* is a psilocybin mushroom in section Semilanceatae native to the state of Washington in the United States. The mushroom is small, rare, difficult to see and stains blue where damaged. It can be mistaken for *Psilocybe silvatica* and can be distinguished by its more conic cap, narrower spores and narrower cheilocystidia.
This mushroom is only known from the type locality where it was found at the Glacier Peak Wilderness Area in Wentachee National Forest, Washington, USA.

Macroscopic feat.:

Cap/Pileus: 7-12 mm and convex, becoming nearly plane in age. It is hygrophanous, has a smooth surface, and is olive black when moist, fading to brownish orange or dark reddish brown as it dries.
Gills/Lamellae: The gills are Adnate light grayish brown at first, turning dark purple as the spores mature.
Stem/Stipe: 15-20 x 2 mm, hollow, has an equal width, and is white with whitish or brownish floccose scales, drying to a reddish brown. It stains blue near the base.

Microscopic feat.:

Basidio/Spores: 8-10 x 5,7 µm, subovoid to ellipsoid, thick-walled, and yellowish brown to dark purple brown in deposit.
Basidia: 4-spored.
Cheilocystidia: Sublageniform and 24-30 x 6-8 µm. No pleurocystidia have been observed. Clamp connections are present.

Habitat: Gregarious in small groups among shrubs on a creek bank.

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Psilocybe semilanceata

Psilocybe semilanceata (Fr.) P.Kumm. (1871)

synonyms:
Agaricus semilanceatus Fr. (1838)
Geophila semilanceata (Fr.) Quél. (1886)
Panaeolus semilanceatus (Fr.) J.E.Lange (1936)
Panaeolus semilanceatus (Fr.) J.E.Lange (1939)

Not common. Sporocarps grow from summer to autumn with peak in late autumn, singly or groups of several, terrestrial or on grass remnants, in nutrient-poor pastures, meadows or other grassy terrains, never on fresh manure, if accidentally on cattle manure, then on very old one.
Pileus hygrophanous, olive-pale brown when moist, also with dark olive or livid-green spots, particularly at the edge, pale straw-coloured when dry, ochraceous; 5-15(20) mm in diameter, 6-15(20) mm high, initially obtusely conical and usually with a distinct papilla, acutely umbonate, with age conical to campanulate, but never plane; surface smooth, when moist lubricous, slightly viscid; margin initially incurved, later plane or decurved, slightly translucent-striate when moist, in very young specimens visible whitish fibrils of the veil connecting the pileal margin with the stipe.

Pictures at www.mushroomobserver.org

Psilocybe semilanceata „Gigant“

There are 2 valleys high in the hills of Spain where Ignacio finds the p. semilanceata's (a.k.a. liberty caps). One of those valleys produces some very large and potent semi's that grow on horse dung and straw. The other valley produces your typical small sized potent semi.
To date, there are no known cases of the semilanceata successfully being cultivated indoors. These pics are kind of inspiring because there growing on straw. Perhaps time to rethink that strategy. We now have spore prints of the giant straw loving *Psilocybe semilanceata* from Spain as well.
On the left *Psilocybe semilanceata* from Spain growing on grass and dung, on the right *Psilocybe semilanceata* from Spain growing on straw and dung.

source - www.thehawkseye.com

Pictures at www.mushroomobserver.org

Psilocybe silvatica

Psilocybe silvatica Peck Singer and Smith

synonyms:
Psathyra silvatica
Hypholoma silvaticum

Macroscopic feat.:

Cap/Pileus: 0.8-2.5 cm broad. Obtusely conic to campanulate with an acute umbo. Tawny dark brown when moist, fading to a pale yellow-brown. Smooth, viscid when moist with a thin gelatinous pellicle.
Gills/Lamellae: Adnate to adnexed. Close to subdistant and narrow to moderately broad. Dull grayish brown to cinnamon or smoky brown with age. Edges white.
Stem/Stipe: 20-80 mm long x 1-3 mm thick. Equal to slightly enlarge at the base. Brittle.

Microscopic feat.:

Basidio/Spores: 6-9.5 x 4-5.5 µm. Sporeprint - dark purplish brown.

Habitat: Gregarious but not cespitose on wood debris, wood chips (preferably alder), or even decayed conifer substratum.

Distribution: From west of the Cascades in southern Oregon to British Columbia, Canada. Also reported from Idaho and as far away as Finland.

Season: From late September through December.

Comment: Very similar to *Psilocybe pelliculosa* and is usually found growing along with them. Stamets (1996) reports that in some colonies of *Psilocybe silvatica* the caps were more yellow in appearance than those of the caps of *Psilocybe pelliculosa*.

Dosage: Moderately weaker than *Psilocybe semilanceata* From 20 to 40 fresh mushrooms, 1/3 of a fresh ounce or from 2 to 4 grams dried.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe serbica

Psilocybe serbica M.M.Moser & E.Horak (1969)

synonyms:
Psilocybe bohemica Šebek (1983)
Psilocybe arcana Borov. & Hlavácek (2001)
Psilocybe moravica Borov. (2003)

Macroscopic feat.:

Cap/Pileus: 1-3.5 cm broad. Convex to campanulate, often twisted, expanding with age to broadly convex to plane. Surface viscid when moist from a thin gelatinous pellicle, often not separable. Margin translucent-striate when moist, becoming opaque in drying, soon uplifting and irregular in age, bluish tinged or bruising bluish where injured. Reddish brown to brownish yellow, hygrophanous, fading to grayish yellow, ochraceous or straw colored in drying.
Gills/Lamellae: Attachment adnate to adnexed, purplish brown to chocolate brown with whitish margins.
Stem/Stipe: 20-60 mm long by 1.5-5 mm thick. Equal to slightly enlarged towards the base, whitish to whitish with splotchy brown patches, bruising bluish where injured, and covered with white fibrillose patches below. Partial veil finely cortinate, soon disappearing.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, elongate-ellipsoid in face and side view, 10-13 by 5.5-7 µm.
Basidia: 4-spored.
Pleurocistidia: Absent or rare, and usually near the gill edge, mucronate, 16-25 by 4.4-7.7 µm.
Cheilocystidia: 20-36 by 6-11 µm, lageniform with extended necks 1.5-2.5 µm, arising from cells parallel to gill edge.

Habitat: Reported only from Yugoslavia (Serbia), Slovakia, and the Czech Republic. Growing on rotting wood or in soils rich in woody debris, in deciduous or mixed forests, beneath European beech (*Fagus silvatica*) and/or mixed with firs (*Abies* sp.)

Comment: Moderately active to highly active. *Psilocybe serbica* is taxonomically close to *Psilocybe atrobrunnea* except the latter species prefers mossy areas and does not bruise bluish. See also *Psilocybe liniformans* and *Psilocybe cyanescens*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe squamosa

Psilocybe squamosa (Pers.: Fr.) P. D. Orton

synonyms:
Leratiomyces squamosus Bridge & Spooner 2008
Agaricus squamosus
Geophila squamosa
Hypholoma squamosum
Naematoloma squamosum
Psalliota squamosa
Stropharia squamosa
Stropholoma squamosum

Macroscopic feat.:

Cap/Pileus: 3-8 cm broad. Conic or obtusely conic when young, with an incurved margin soon becoming broadly campanulate to convex, and often with a conic umbo. Viscid when moist from a separable gelationous pellicle, but soon drying. Yellowish brown to orangish brown overall. At first adorned with small squamules (scales) along the margin, but soon smooth and free of veil remnants. Flesh relatively thin and watery brown when wet.
Gills/Lamellae: Attachment adnate to uncinate, close to subdistant, moderately broad, with two to three tiers of intermediate gills inserted. Pallid bluish gray, then dark grayish brown to purple brown when fully mature.
Stem/Stipe: 60-120 mm long by 4-8 mm thick. Equal to slightly enlarged and curved at the base, hollow, and somewhat fragile. Whitish towards the apes and sordid brown to dense buff below the annulus. Surface covered with evanescent pallid to brownish recurved scales, often with orange-buff rhizomorphs protruding about the base. Partial veil membranous, fragile, leaving a superior membranous annulus, striated on the top side, often hanging broken around the stem or entirely absent in age.

Microscopic feat.:

Basidio/Spores: Dark grayish violet brown in deposit, subellipsoid, 11-15 by 7-8 µm with a central germ pore.
Basidia: 4-spored.
Cheilocystidia: 36-66 by 3.3-6 µm, filamentous to sublageniform, with an apex adorned with a glutinous mass.
Pleurocistidia: Absent.

Habitat: Solitary to scattered in the late summer and fall in meadows and mixed conifer and alder woods. Known from the Pacific Northwest, Minnesota, and California. It is likely this species is widely distributed across the continent.

Comment: There are conflicting reports on the edibility of *Psilocybe squamosa*; caution is definitely recommended. Once a *Stropharia*, this species lacks the chrysocystidia once typical of that genus. Both the squamules of the cap and the annulus are temporal features, and can soon disappear after heavy rains. See also *Psilocybe thrausta*, which is very similar but differs in the reddish coloration of the caps.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe strictipes

Psilocybe strictipes Singer & A.H.Smith

---

synonyms:
Psilocybe strictipes Singer and Smith
Psilocybe callosa (Fries ex Fries) Quelet sensu auct., sensu Guzmán (1983)
Psilocybe semilanceata var. *obtusa* Bon
Psilocybe semilanceata var. *microspora* Singer

Macroscopic feat.:

Cap/Pileus: 0,5-3 cm broad, conic at first, expanding to convex, campanulate, and eventually broadly convex, and typically not sharply umbonate but may have a low umbo. Surface smooth, translucent-striate near the margin, which may have slight remnants of the veil and viscid when moist from a separable gelatinous pellicle. Dark grayish brown to cinnamon brown, fading to straw or light yellow in drying. Flesh sometimes bruising bluish when injured.
Gills/Lamellae: Attachment adnate, sometimes subdecurrent, and tearing free from the stem in drying. Chocolate brown with whitish edges when mature.
Stem/Stipe: 40-70 (130) mm long by 2-3 mm thick. White to yellow to yellowish brown. Equal, straight to flexuous, typically tough, cartilaginous, and decorated with fibrillose patches, veil remnants, and basal mycelium that can bruise bluish. (Base is not adorned with cordlike rhizomorphs.) Partial veil thinly cortinate, fragile, and rarely leaving an annular zone on the upper regions of the stem.

Microscopic feat.:

Basidio/Spores: Spores dark purple brown in deposit, subellipsoid to suboblong 10-12 by 5.5-8 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 21-45 by 7-10 µm, lageniform with an extended neck 2-3.5 µm thick.

Habitat: Fruits in the late summer to fall in the Pacific Northwest, England, northern and central Europe (Czech Republic, France, Germany, Holland, Slovakia, Sweden), Siberia and Chile. Typically found in rich, grassy areas such as lawns, along roadsides, and in fields - but not on dung, although common in fields with and without manure.

Comment: Chemical analysis not available. Estimated to be moderately active to potent, judging from personal bioassays, and probably low in psilocin, because of the limited bluing reaction. *Psilocybe strictipes* is a slender, grassland species, thought to be an intermediate form, bridging *Psilocybe semilanceata* and *Psilocybe pelliculosa*, two taxa that are very similar in general appearance except for habitat preferences and/or microscopic details. *Psilocybe strictipes* has had a very confused history. Guzmán (1995), following Redhead (1985) and Watling and Gregory (1987), attempted to clear up the long-standing confusion surrounding this species and its well-known synonym, *Psilocybe callosa*. (The original *Agaricus callosus* Fr. is not related to the mushroom described here and is actually synonymous with *Panaeolus papilionaceus* Bull. ex: Fr. Quelet.).
The modern concept of *Psilocybe callosa* became subordinate to a new taxon, which Singer and Smith (1958a) originally proposed as *Psilocybe strictipes*. Guzmán (1983) had made *Psilocybe strictipes* subordinate to *Psilocybe callosa* in his monograph. Upon reevaluation, Guzmán (1995) reaffirmed *Psilocybe strictipes* as the proper name. Mixed collections resulted in this species being further confused with *Psilocybe baeocystis*, to which it bears little resemblance. Furthermore, the preferred habitat for *Psilocybe strictipes* is grasslands or rich soils, not the woodlands that Singer and Smith (1958a) had described. Their line drawings of *Psilocybe strictipes* show two distinct forms: one mycenoid resembling the closely related *Psilocybe semilanceata*, and an isolated drawing, more collyboid in shape, showing a mushroom atypical to the first form. Guzmán (1983) writes that the specimen used by Smith to make the line drawing was actually *Psilocybe baeocystis*. Additionally, in their original description they indicate that the collection number assigned to the original type was erroneous, which perhaps related to the original confusion and the two decades of confusion that followed. Virtually all the field guides published since 1958, including mine (1978), erroneously describe *Psilocybe strictipes*.
For most field hunters, the grassland habitat narrows the field of candidate possibilities. The absence of sharp umbo and its thinly fleshed cap are two macroscopic features that delineate this species from its closest ally, *Psilocybe semilanceata*, with which it is often confused. Guzmán (1983, 17) noted that, "the form of the pileus is of taxonomic value in *Psilocybe*. *Psilocybe semilanceata* is distinguished from *Psilocybe callosa* (=*Psilocybe strictipes*) on the papilla in the first and in the convex to the more or less subumbonate pileus in the latter."
With many grassland species, the length of the stem is usually a direct response to the height of the grass through which its arises. The stem base is typically tightly attached to dead, thatched grass. Microscopically, *Psilocybe strictipes* has smaller and narrower spores than *Psilocybe semilanceata*. The name *strictipes* refers to the tough or hardened texture of the stem, especially the base, in drying.
A variety *Psilocybe strictipes* abundantly in western Oregon in close association with highland bentgrass (*Agrostis tenuis*) where thousands of acres are dedicated to the commercial cultivation of grass seed - a major industry in that region. The prolific fruitings of *Psilocybe strictipes* in these grasslands and the subsequent distribution of spore-dusted seeds represents a huge launching platform of germ plasm to faraway lawns, golf courses, and institutions of higher learning. The potential distribution of this species through the commercial distribution of lawn seed is mind-boggling. *Psilocybe strictipes* is likely to be much more common than

presently realized.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe stuntzii

Psilocybe stuntzii Guzmán & J. Ott

synonyms:
Psilocybe pugetensis

Macroscopic feat.:

Cap/Pileus: 1.5-5 cm broad. Obtusely conic, expanding to convex-umbonate or flat with age. Margin is striate and translucent when moist. Hygrophanous. Dark chestnut brown while lighter towards the center. Olive-greenish at times, fading to a pale yellowish brown or pale yellow. Viscid when moist from a gelatinous pellicle.
Gills/Lamellae: Adnate to adnexed, close to sub distant and moderately broad.
Stem/Stipe: 30 to 60 mm long x 2-4 mm thick. Enlarged at base. Remnants of a veil remain and are usually bluish from natural injury when the cap opens. With a whitish pith. Staining blue to blue-green where injured.

Microscopic feat.:

Basidio/Spores: 9-12 x 55-8.3 x 5-7.7 µ. Sporeprint dark purplish grayish brown.

Habitat: Growing gregarious to subcespitose clusters and clumps in conifer wood chips and bark mulch (alder wood), in soils rich in woody debris, and in new lawns of freshly laid sod.

Distribution: From North of San Francisco to Eugene, Oregon to British Columbia. This species is common in lawns and grassy areas such as parks, fields, or any newly mulched garden area throughout the western region of the Pacific Northwest.

Season: From late July through September in lawns and grassy areas and from late September through December in mulched garden beds. This species sometimes occurs all year long depending on warmer el nino weather conditions in the PNW.

Dosage: 20 to 30 fresh specimens, 1/3 fresh ounce or 1-3 dried grams.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe subaeruginascens

Psilocybe subaeruginascens Höhnel

synonyms:
Psilocybe subaeruginascens Höhnel
Psilocybe aerugineomaculans (Höhnel) Singer i Smith

Macroscopic feat.:

Cap/Pileus: 1-5.8 cm broad. Conic to convex or campanulate, to broadly subumbonate but not papillate, eventually broadly convex to plane and uplifting in age. Surface viscid when moist, translucent-striate along the margin, soon drying. Orangish brown to olive brown to gray greenish brown, hygrophanous, fading in drying to dull yellow orange to straw colored. Flesh white to concolorous with cap, soon bruising bluish where injured.
Gills/Lamellae: Attachment broadly adnate to adnexed, sometimes decurrent, crowded, and sometimes forking. Grayish brown to yellowish brown, eventually (with spore maturity) dark brown and often slightly mottled. Edges concolorous, bruising bluish where bruised.
Stem/Stipe: 30-60 mm long by 1.5-3 mm thick. Equal to slightly enlarged near the base, which is often adorned with radiating white rhizomorphs that bruise bluish when injured. Surface and flash whitish to concolorous with the cap, soon bruising bluish. Partial veil membranous, well developed, leaving a persistent membranous annulus in the superior regions of the stem, white in color until bruised, and then bluish, and usually dusted purplish brown from spores. Torn and fragile in age.

Microscopic feat.:

Basidio/Spores: Dark purplish brown to dark violet brown in deposit, rhomboid to subrhomboid in face view, subellipsoid in side view, 7.7-12 by 6.6-8.5 µm.
Basidia: 4-spored, rarely 1-, 2-, or 3-spored.
Pleurocistidia: Fusoid-ventricose with a blunted end, 2.2-2.2 µm thick.
Cheilocystidia: Fusoid-ventricose to sublageniform 16-33 by 4.4-5.9 µm, with a neck 2.5-4 µm.

Habitat: Grows gregariously to cespitose on soils enriched with woody debris, in wood chips, and in wood chips mixed with horse dung. Frequently found along trails or road-sides bordering deciduous forests. Fruiting April to July in temperate southern Japan and subtropical Indonesia. Probably extensively distributed between these two localities.

Comment: Moderately potent. Koike et al. (1981) detected psilocybin and psilocin. This squat, collyboid, and annulate *Psilocybe* is unique to Asia. Guzmán (1983) notes that Singer and Smith's attempted synonymy of *Psilocybe subaeruginascens* with *Stropharia venenata* (=*Psilocybe venenariata*) was in error. See also *Psilocybe subfimetaria* and *Psilocybe stuntzii*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe subaeruginosa

Psilocybe subaeruginosa Cleland

synonyms:
Psilocybe australiana Guzmán & Watling (1978)
Psilocybe tasmaniana Guzmán & Watling (1978)
Psilocybe eucalypta Guzmán & Watling

Macroscopic feat.:

Cap/Pileus: 1.5 cm broad. Conic to convex at first, soon expanding to broadly convex with a small umbo. Surface smooth, translucent-striate along the margin, pale brown to dark brown, hygrophanous, fading in drying to pallid brown to dingy grayish white.
Gills/Lamellae: Attachment adnate to adnexed, and with age may separate from the stem, leaving parallel, longitudinal gill fragments on the upper reaches. Soon smoky brown to purplish brown to dark purplish chocolate brown, edges concolorous.
Stem/Stipe: 50-125 mm long by 2-5 mm thick. Equal to narrowing towards the apex to slightly swollen at the base, from which white mycelium radiates. Hollow, cartilaginous, surface adorned with fine fibrils, finely striate and mealy towards the apex. Surface whitish, silky, with grayish brown streaks, flesh brownish, bruising bluish where injured. Partial veil white, finely cortinate, soon disappearing and leaving fragile traces in the upper regions of the stem.

Microscopic feat.:

Basidio/Spores: Purplish brown in deposit, subellipsoid in both side and face view, 13-15 by 6.6-7.7 µm.
Basidia: 4-spored, infrequently 2-spored.
Pleurocistidia: 22-47 by 6-16.5 µm, fusoid-ventricose, mucronate with an elongated neck 2-4.5 µm. thick.
Cheilocystidia: Similar in form to pleurocystidia, 17-29 by 5.5-11 µm.

Habitat: Solitary to gregarious in complex habitats such as soils rich in woody debris, decaying piles of leaves and twigs, sandy woody soils, gardens, and amongst bark chips from pine (*Pinus radiata*). Found from May through August. Known only from Australia and Tasmania.

Comment: Moderately to potently active, judging by the bruising reaction. No analyses are known to me. This species is in the center of a constellation of close relatives, including *Psilocybe australiana*, *Psilocybe eucalypta*, and *Psilocybe tasmaniana*. A study by Chang and Mills (1992) sought to show synonymy between these taxa but, upon close reading of their work, some doubt remains if they had the true *Psilocybe subaeruginosa* and were making valid comparisons. *Psilocybe subaeruginosa* has pigmented pleurocystidia and is described as "chocolate brown", features Chang and Mills admit to not finding in any of the collections they studied. The chocolate brown cystidia of *Psilocybe subaeruginosa* differentiates this taxon from the mushrooms mentioned above, all of which have hyaline cystidia (Guzmán, Bandala, and King 1993). Hence, I think sufficient doubt is cast on their arguments for conspecificity. Better studies are needed.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe subcaerulipes

Psilocybe subcaerulipes Hongo

synonyms:
Psilocybe argentipes K. Yokoy
Psilocybe taiwanensis E. Horak, Guzmán i Desjardin
Psilocybe thaizapoteca Guzmán, Karunar. i Ram.-Guill

Macroscopic feat.:

Cap/Pileus: 2-3 cm broad. Conic to campanulate expanding in age to convex to subumbonate. Surface smooth viscid when wet and striate near the margin. Ochraceous to yellowish brown, sometimes olive toned, hygrophanous from the disc, fading in drying to light straw colored, bruising dark bluish where injured.
Gills/Lamellae: Attachment adnate to sinuate, pale brownish to purplish brown to deep violet with concolorous edges.
Stem/Stipe: 40-70 mm long by 3-5 mm thick. Equal to slightly enlarging and often curved at the base, flexuous, hollow, and featuring a coating of whitish fibrils in the lower regions. Whitish at first, soon ochraceous or reddish brown, especially towards the base. Partial veil cortinate, fragile, and usually not leaving a fibrillose annular zone on the stem. Flesh bruising bluish where injured.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, subellipsoid in side view; nearly ovoid in face view, 5.5-7.5 (8.5) by 3.3-4.4 (5.5) µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 15-22 by 5-7.5 µm, fusoid ventricose with an abbreviated or elongated neck 1-1.5 µm thick.

Habitat: Gregarious to cespitose, fruiting from May to September in Japan (Otsu City, Shiga-Prefecture) in soils covered with mosses or grasses in open forests, often under pines, particularly *Pinus densiflora*.

Comment: Potency unknown, likely to be moderately to highly active. Microscopically nearly identical to *Psilocybe caerulipes*, but differing in the size of the spores and its ecological distribution. Furthermore, Guzmán (1983) notes that *Psilocybe caerulipes* may be conspecific with *Psilocybe muliercula* (=*Psilocybe wassonii*) as they are difficult to separate taxonomically. Interfertility studies would clear up the question of conspecificity. See also *Psilocybe venenata*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe subacutipilea

Psilocybe subacutipilea Guzmán, Saldarriaga, Pineda, Garcí et Velázquez

---

Macroscopic feat.:

Cap/Pileus: 7-10 mm in diam ., campanulate to subumbonate, subviscid to lubricous, glabrous, even to striate, hygrophanous, yellowish brown, grayish yellow to pale brownish.
Gills/Lamellae: Subadnate, somewhat thick, grayish brown with violaceous tinges.
Stem/Stipe: 40-50 x 1-1.5 mm, cylindric, subbulbous, whitish yellow, smooth to fioccose toward the base, without pseudorhiza.
Context: Of the pileus whitish, thin. All the basidiomata turning blue-green when cut or bruised. KOH stains the pileus dark grayish brown, the stipe vinaceous brown and is negative in the context
Odor: Farinaceous.

Microscopic feat.:

Basidio/Spores: (7.5-) 8.5-9 (-11) x 5-6 (-7) µm, slightly subrhomboid in face view, subellipsoid in side view, with a thick yellowish brown wall and with a broad germ pore.
Basidia: 22-32 x 8-10 µm, 2-, 3- or 4-spored, hyaline, ventricose to subpiriform.
Pleurocistidia: Absent.
Cheilocystidia: 13-20 x 3.5-6 µm, hyaline, vesiculose to sublageniform with a short neck less 8 µm long, sometimes irregular in form with a short lateral neck, abundant but the gill edge is heteromorphous and thick.
Epicutis: A gelatinous layer 25-30 µm, thick, with irregular hyphae in diameter, 5-15 µm wide.
Hypodermium: With parallel hyphae 2-9 µm in diam. Context of the pileus with subglobose elements, thick-walled (1-1.5 µm thick), with brown incrusted pigment.
Trama: Gill trama parallel, hyphae irregular in diameter, hyaline or with brown pigment incrusted on the wall. Clamp connections present.

Habitat: Caespitose in soil, in a meadow with grazing grasses, in subtropical zone, at 1100 m ait. Known only from the type locality.

Studied material: COLOMBIA, Departamento Antioquia, Municipio Porce, near the road Medellín to Amalfi, zone of Puente Gabino, Aug. 31, 1990, Guzmán 29561-B (holotype HUA, isotype XAL).

Discussion: This species is close to *Psilocybe acutipilea* (Speg.) Guzmán, known only from Brazil, of which it differs by the not papillate pileus and not caespitose habit and by the neck of the cheilocystidia (8-10 µm long) (Guzmán, 1983). *Psilocybe subacutipilea* belongs to Sect. Mexicana.

source - www.mycotaxon.com **[51: 230-231]**

Pictures at www.mushroomobserver.org

Psilocybe subcubensis

Psilocybe subcubensis Guzmán

Macroscopic feat.:

Cap/Pileus: (10-) 18-50 (-70) mm in diam., conic to convex, becoming campanulate to gradually expanding to plain. Color copper in center to a light golden brown. Hygrophanous in drying, remnants of a veil, and bluing in the edge of the cap when injured.
Gills/Lamellae: Adnate to adnexed to seceding. At first dark gray becoming deep violet gray to dark purplish brown. Sometimes mottled with whitish edges.
Stem/Stipe: (30-) 50-80 (-100) x (3-) 4-6 (-10) mm, equal, hollow, stem whitish to a creamy white or yellow brown when faded, easily staining blue where damaged. Fibrillose below the annulus.

Microscopic feat.:

Basidio/Spores: (9.9-) 11-13 (-14) x 7.7-8.8 x 6.6-7.1 µm. Sporeprint chocolate to purple-brown.

Habitat: Gregarious, rarely solitary or scattered, on cow dung, rarely on horse manure. Also in rich soil in pastures and meadows, along roadsides in manure heaps.

Distribution: This is a pantropical and subtropical species. Found in Mexico, Colombia, Bolivia, Ecuador, Honduras, El Salvador, Venezuela, Australia, India, Nepal, Thailand, Cambodia, Vietnam, and parts of the Philippine Islands.

Season: Fruiting in summer but also in other seasons (as do most finicolous fungi).

Dosage: Same as for *Psilocybe cubensis*. One ounce fresh or over, 1 dried gram to as many as 3-5 grams dried=1 fresh ounce. Ten doses in one dried ounce. The equivalent of a Mazatec ceremonial dosage.

Comment: This species is macroscopically similar to *Psilocybe cubensis* with the difference occurring only in the size of the spores. *Psilocybe subcubensis* has smaller spore than *Psilocybe cubensis*.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe subfimetaria

Psilocybe subfimetaria Guzmán & A.H. Sm.

---

synonyms:
Psilocybe sierrae Singer

Macroscopic feat.:

Cap/Pileus: 0.5-2 cm broad. Conic to campanulate, expanding with age to broadly campanulate but not sharply umbonate. Surface smooth, viscid when moist from a separable gelatinous pellicle, and translucent-striate near the margin. Ochraceous brown to olive brown, hygrophanous, fading in drying to a straw color. Flesh whitish, bruising bluish where injured.
Gills/Lamellae: Attachment adnexed, clay becoming violaceous brown, with whitish edges.
Stem/Stipe: 25-45 mm long 2-3 mm thick, equal to slightly enlarged towards the base, white to dingy white or pallid, bruising bluish where injured. Well-developed partial veil cortinate, usually leaving a fibrillose annular zone that can approach a true annulus in the upper regions of the stem. Flesh whitish, bruising bluish.

Microscopic feat.:

Basidio/Spores: Dark violaceous brown in deposit, subellipsoid in face view, and subellipsoid, sometimes irregularly so, in side view, 10-14 by 6.6-7.7 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 20-28 by 5-6.6 µm, fusoid-ventricose or more frequently lageniform with an extended neck 1-2 1-2 µm broad.

Habitat: Solitary to gregarious on dung, primarily in grassy areas. Reported from locations near Siltcoos Station, Oregon, and Vancouver, British Columbia in October through November, and near Chovetten, Chile, in August. Probably much more extensive in its distribution than presently realized. I have found this species in habitats also supporting *Psilocybe semilanceata* and *Psilocybe liniformans*.

Comment: Active, but I do not know how potent. This mushroom resembles *Psilocybe semilanceata* and is definitively separated from it by microscopic features. Macroscopically, this species is distinguished from *Psilocybe semilanceata* if the annulus of *Psilocybe subfimetaria* persists into maturity. Furthermore, *Psilocybe semilanceata* is sharply umbonate, while *Psilocybe subfimetaria* is not. *Psilocybe subfimetaria* is a relatively rare species and is very close microscopically to *Psilocybe fimetaria*, from which it is separated by spore size. Also, *Psilocybe subfimetaria* often grows directly out of dung, while *Psilocybe semilanceata* prefers grasses. (Manured grasslands can make this judgment difficult.) The overall aspect, fairly persistent annular zone, and nonpapillate cap can help narrow the field of candidates to *Psilocybe subfimetaria*. See also *Psilocybe stuntzii* var. *tenuis*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe subtropicalis

Psilocybe subtropicalis Guzmán

Macroscopic feat.:

Cap/Pileus: 20-26 mm in diam, subconvex to subcampanulate, subpapillate, sublubricous to dry, glabrous, even to striate toward the margin, reddish brown to brown, hygrophanous, fading to straw colour, staining dark blue to blackish when moist, almost black when dry mainly toward the margin.
Gills/Lamellae: Adnate or adnexed, pale brown to cinnamon brown or blackish violet, with whitish edges.
Stem/Stipe: 40-80 x 1-3 mm, cylindric, whitish to concolourous with the pileus, hollow, caerulescent, covered with floccose appressed white fibrils, with a subbulbous hollow base, up to 10 mm in diam in dry, without pseudorhiza. Veil absent in the adult.
Context: Whitish, fleshy in the pileus, subfleshy in the stipe, staining blue when cut.
Odor: And taste slightly farinaceous.

Microscopic feat.:

Basidio/Spores: (5.5-) 6.5-7 (-8) x 5-5.5 (-6) x 4-5.5 µm, subrhomboid in face view, subellipsoid in side view, with a thick wall (up to 1.5 µm thick), brownish yellow, with a broad germ pore at one end and an acute short appendage at the distal end.
Basidia: 17.5-26.5 x 5.5-8 µm, 4-spored, clavate or subcylindric, hyaline.
Pleurocistidia: (12-) 13-21 (-22.5) x (4-) 5-6 (-7) µm, ventricose subacuminate or ventricose rostrate, hyaline, more or less common.
Cheilocystidia: (16-) 20-28 (-32)(-42) x 5-6.5 (-7) µm, ventricose or subcylindric, irregularly branching mainly at the top, hyaline, abundant.
Subhymenium: Formed by subglobose elements, 3-4.8 µm diam, hyaline or yellowish.
Trama: Trama regular, formed by hyaline thin-walled hyphae, 3.2-24 µm wide.
Epicutis: Subgelatinized, formed by hyaline repent hyphae 2.4-4 µm wide.
Hypodermium: With subglobose elements mixed with hyphae 3-12 µm in diam, hyaline or incrusted with brown yellowish pigment. Clamp connections present.

Habitat: In small groups on soil, in open places of subtropical (mesophytic) forests. Known from Guatemala and Mexico.

Studied material: GUATEMALA: approx. 25km south of Guatemala City, Santa Elena Barillas, Jun. 28, 1990, Sommerkamp 371 (Herb. Univ. San Carlos Guatemala & XAL). MEXICO: State of Veracruz, old road Xalapa to Coatepec, km 2.5, Parque Ecológico F.J. Clavijero, Oct. 6, 1986, Montoya 910 (Holotype, XAL). Huatusco to Elotepec road, Rancho San Rafael, Aug. 26, 1984, Sampieri 987 (XAL). Totutla to Xalapa road, near Axocoapan, Jun. 29, 1984, Chacón 2259; Sept. 26, 1985, Chacón 3150 (both in XAL).

Discussion: The subbulbous, hollow base of the stipe, the mycenoid habit, the branched cheilocystidia and narrow pleurocystidia are the most typical features of this caerulescent species. *Psilocybe herrerae* Guzmán, is a close taxon, but differs in the more branched cheilocystidia and thicker pleurocystidia (6-9 µm), and in the presence of pseudorhiza (Guzmán, 1983). Due to the form and size of the spores, this species belongs to Sect. Cordispora. *Psilocybe subtropicalis* is widely distributed in subtropical forests. *Psilocybe mexicana* grows also in the same Guatemaltecan locality.

source - Bibliotheca Mycologica **[159: 107-109]**

Pictures at www.mushroomobserver.org

Psilocybe subviscida

Psilocybe subviscida (Peck) Kauffm

---

nonactive

Macroscopic feat.:

> **Cap/Pileus:** 0.5-2 cm broad. Campanulate expanding with age to convex umbonate or broadly convex while retaining an obtuse umbo, often variable in form, and at maturity to nearly plane. Margin translucent-striate when moist and sometimes decorated with flecks of veils remnants. Yellowish to chestnut brown to reddish brown, fading in drying to pale grayish yellow and usually with the umbo remaining reddish brown. Surface viscid to subviscid when moist from a separable gelatinous pellicle, soon drying.
> **Gills/Lamellae:** Attachment adnate, subdistant, and broad. Whitish at first, soon becoming dark brownish.
> **Stem/Stipe:** 20-40 mm long by 1-2 mm thick. Equal to tapering downwards near the base. Surface covered at first with fine whitish fibrils. Partial veil thin to obscure, leaving and evanescent annular zone of fibrils usually darkened by spores when present.

Microscopic feat.:

> **Basidio/Spores:** Dark purplish brown in deposit, 6-8.5 by 4-5.4 µm.
> **Basidia:** 4-spored.
> **Pleurocistidia:** Absent.
> **Cheilocystidia:** 20-50 by 5-8 µm, ventricose, then lageniform, with a flexuous neck 2-3.5 µm thick.

Habitat: Usually found growing in grassy areas, in well-manured grounds or in dung. Also reported growing in mossy areas and in decayed conifer substrata. Grows in the late spring to summer, reported from the United States (Washington, Oregon, Michigan, New York) and Scotland (Shetland). Thought to be widely distributed.

Comment: Not active. Since this species can grow on such a wide spectrum of habitats, I would expect that its actual distribution is far more extensive than presently reported. The specimens I have seen have had rubbery textures. See also *Psilocybe coprophila*, *Psilocybe montana*, *Psilocybe merdaria*, *Psilocybe moellerii*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe subyungensis

Psilocybe subyungensis Guzmán

synonyms:
Psilocybe yungensis Singer & A.H.Sm. (1958)
Psilocybe yungensis var. *diconica* A.H.Smith (1958)
Psilocybe acutissima Heim (1959)
Psilocybe chiapanensis Guzmán (1995)
Psilocybe isauri Singer (1959)

Macroscopic feat.:

Cap/Pileus: about 10 mm diam., conic to subpapillate, smooth but somewhat striate at the margin, subviscid to dry, hygrophanous, reddish brown or brown, fading to yellowish, but staining blue to blackish when injured.
Gills/Lamellae: Adnate, violaceous brown, edges concolorous or some whitish and floccose.
Stem/Stipe: About 35 x 1 mm, cylindrical, hollow, reddish brown to darker toward the base, appressed silky floccose from white fibrils, principally at the base. Veil rudimentary and fugacious in the adult stage.
Context: Brownish, bluing.
Odor: And taste unknown.

Microscopic feat.:

Basidio/Spores: (4.4-) 5-6 (-7) x (4-) 4.4-5.5 (-6) x 3.3-4 µm, rhomboid in face view, subelliptic in side view, brownish yellow, with thick wall and distinct broad germ pore, with a short basal appendage.
Basidia: 10-20 x 4.4-6 µm, four-spored, hyaline, vesiculose-cylindric, with a slight constriction in the middle.
Pleurocistidia: 8.8-11 x 3.8-5.5 µm, hyaline, scanty, sublageniform or fusoid-ventricose with short neck, 1-2 µm diam.
Cheilocystidia: 16.5-25 x (5.5-) 7.7-12 µm, hyaline, lageniform, fusoid-ventricose, subpyriform, clavate, ventricose with constrictions in the middle, ampullaceus to somewhat irregularly branched, often reminding one of basidia.
Subhymenium: Brownish yellow with more or less parallel hyphae, strongly irregularly pigmented on the walls.
Trama: Regular, subhyaline or yellowish, with parallel hyphae 7-12 µm, broad, with pigment incrusted on the thick walls, with appear perforated.
Epicutis: Subgelatinized, hyaline with elongated hyphae 3-5 µm broad.
Hypodermium: Like the subhymenium and trama. Some parts of the epicutis and subhymenium with blue green diffused pigment in KOH. Clamp connections present.

Habitat: Gregarious on very rotten wood inside the forest. Known only from the type locality.

Studied material: VENEZUELA, State of Miranda, SW of Macaro, near El Arado, July 28, 1972. Dumont VE-6363 (Holotype MER, Isotype, NY).

Discussion: *Psilocybe subyungensis* is close to *Psilocybe yungensis*, but the pleurocystidia and cheilocystidia separate the former from the latter. It is also close to *Psilocybe fuliginosa* (Murr.) Smith but according to a study of the type (NY) and Smith's paper (1948), has larger spores, (5.5-) 6-7 (-8) µm, the cheilocystidia are more uniformly lageniform 16-28 (-33) x 4.4-6.6 µm.

source - www.mycotaxon.com **[7 (2): 249-250]**

Pictures at www.mushroomobserver.org

Psilocybe tampanensis

Psilocybe tampanensis Guzmán & S.H.Pollock (1978)

A very interesting species. It has only been collected in the wild twice. All cultures that are in circulation today originate from one single specimen that was cloned by mycologist Stephen Pollock in 1977. This mushroom was found in Tampa, Florida hence the name tampanensis.
This species produces sclerotia (hardened mycelial structures) on grass seed and in the casing layer.
Variability within a multispore germination is great resulting in some strains that are good sclerotia-producers, some that are good fruitbody-producers, some that are both and some that are neither.
We recommend making different isolates from a multispore germination and testing each of them for their properties. Alternatively you can start with multispore cultures and clone some mushrooms or sclerotia.
Because of successive cloning for years most available strains are heavily degenerated and produce no or only sterile (sporeless) mushrooms.
We have been working for some time with a strain that did not produce fertile mushrooms but have recently acquired new one. This strain does produce fertile fruitbodies and although they are not perfectly shaped they do produce visible sporeprints.
We grow the sclerotia and fruitbodies of this species on sterilised grass seed (110 grams seed / 180 ml water). We have had jars that produced up to 70 grams (wet weight) of sclerotia in 4 months!

Substrate:
ryegrass seeds, cow manure.
Temperature:
colonization/fruiting: 24-27°C / 22-24°C

source - www.mushmush.nl

Pictures at www.mushroomobserver.org

Psilocybe tasmaniana

Psilocybe tasmaniana Guzmán & Watling (1978)

---

synonyms:
Psilocybe subaeruginosa Guzmán & Watling (1978)
Psilocybe australiana Guzmán & Watling (1978)
Psilocybe eucalypta Guzmán & Watling

Macroscopic feat.:

Cap/Pileus: 1-2 cm broad. Convex to subcampanulate, but not umbonate or papillate. Surface smooth, subviscid when moist, striate only near the margin, which is often adorned with whitish remnants from the veil. Tawny orangish brown, hygrophanous, fading in drying to a dull straw color or dingy yellow.
Gills/Lamellae: Attachment adnate, becoming purplish brown with spore maturity, with the edges remaining whitish.
Stem/Stipe: 40-65 mm long by 1-2 mm thick. Equal overall. Surface silky fibrillose, white to nearly concolorous with the cap. Flesh bruising bluish where injured, especially at the base. Partial veil well developed, finely cortinate, white, soon disappearing.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, ellipsoid to subellipsoid in side view and subovoid in face view, 10-13 (15) by 7-8.8 µm.
Basidia: 4-spored.
Pleurocistidia: 19-24 by 5.5-9.9 µm, fusoid-ventricose with an abbreviated apex, 1.6-2.7 µm broad.
Cheilocystidia: Fusoid ventricose to sublageniform, with extended neck 5-11 by 1.6-3.3 µm.

Habitat: Grows solitary or gregariously in April and May on dung (possibly kangaroo) or in dung-enriched debris in open areas within *Eucalyptus* forests. Reported from Tasmania, New Zealand, and Australia.

Comment: Active, potency unknown. This species is closely related to *Psilocybe subaeruginosa* and *Psilocybe cyanescens*. Chang and Mills (1992) tried to make *Psilocybe tasmaniana*, *Psilocybe australiana* i *Psilocybe eucalypta* subordinate synonyms of *Psilocybe subaeruginosa*. For reasons described on pages 91-92, I am skeptical of their interpretations. Furthermore, they made conclusions about the identification of mushrooms that they called *Psilocybe tasmaniana* that are not referenced against any type listed by Guzmán and Watling, which is surprising considering the strong taxonomic proposals they put forward. If their identifications were in error, and they then "proved" synonymy between the collections, the analyzed collections may indeed be biologically compatible because they incorrectly delimited one species into the other aforementioned taxa. Interestingly, Johnston and Buchanan (1996), while endorsing most of the proposed synonymy of Chang and Mills, selectively exclude *Psilocybe tasmaniana* as a species found in New Zealand (nor do they list it as a synonym!) although Chang and Mills (1992) references a collection from Taranak, New Zealand. Clearly, more studies are needed, using better reference standards and systematics, to adequately answer the questions raised here.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe thrausta

Psilocybe thrausta (Schulz.ex Kalchbr) Bon

---

synonyms:
Psilocybe thrausta (Schulzer ex Kalchbremer) Orton
Psilocybe squamosa var. *thrausta* (Schulzer ex Kalchbremer) Guzmán
Stropharia thrausta (Schulzer ex Kalchbremer) Bon

nonactive

Macroscopic feat.:

Cap/Pileus: 3-7 cm broad. Obtusely conic at first, soon becoming convex to broadly convex, and finally nearly plane with or without an umbo. Viscid when moist from a gelatinous pellicle that is usually separable, soon drying. Surface adorned with whitish, floccose scales, especially near the margin. Orangish red to reddish brown or brick red. Margin initially ornamented with small scales, soon becoming smooth.
Gills/Lamellae: Attachment adnate to adnexed, or sinuate, sometimes uncinate, close to subdistant, moderately broad, with two to three tiers of intermediate gills. Pallid gray at first, soon becoming grayish brown and eventually dark purplish brown when fully mature.
Stem/Stipe: 50-100 (120) mm long by 3.7 (8) mm thick. Nearly equal to swollen and often curved at the base. Hollow in age. Pallid towards the apex and more brownish below. Covered at first with small brown to reddish brown floccose scales to the annulus, and usually with orangish rhizomorphs protruding about the base. Partial veil membranous, fragile, leaving a superior membranous annulus often absent in age.

Microscopic feat.:

Basidio/Spores: Grayish purplish brown in deposit, close to *Psilocybe squamosa*, in size, but with an eccentric germ pore, 11-14 by 6.6-8.5 µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: (36) 44-66 by 3.3-6 µm, sublageniform to filamentous, submucronate, with an extended and flexuous neck, 3-4 µm.

Habitat: Scattered in the fall in decayed wood substratum or wood debris. Reported from the United States (the Pacific Northwest, New York, Maryland), Japan, and northern to central Europe. Probably more widely distributed across the world.

Comment: Not active, edible according to some, but not palatable. Høiland (1978) detected no psilocybin. This species was once considered a variety of *Stropharia squamosa* (now a *Psilocybe*) and is very similar to it in appearance, differing in the cap coloration.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe uruguayensis

Psilocybe uruguayensis Singer ex Guzmán

Macroscopic feat.:

Cap/Pileus: 10-30 mm diam., convex, smooth subviscid, brownish to brownish yellow, not staining green or blue in any part.
Gills/Lamellae: Adnate to somewhat sinuate, brownish to violaceous-brown, unicolorous.
Stem/Stipe: 40-55 x 2-3 mm, cylindric, not bulbous, smooth, whitish above to brownish or concolorous with pileus below. Annulus membranous, whitish, not staining blue.
Context: Whitish, not bluing.
Odor: And taste unknown.

Microscopic feat.:

Basidio/Spores: (7.5-) 8.8-11.3 (-12.7) x 7-8 (-9) x 6-7 µm, ovoid or subrhomboid in face view, inequilateral, smooth, with thick yellowish brown wall, with truncated apex because of a flattened germ pore.
Basidia: 25-30 x 7.5-9.5 µm, including sterigmata which are 4-6 µm long, four-spored, hyaline, subcylindric or vesiculose.
Pleurocistidia: None.
Cheilocystidia: 24.5-32 x 4.5-9 µm, hyaline, abundant, forming a sterile band at the edge of the gills, ventricose-elongated, somewhat pedicellate, but with a narrow and long neck which is 1.5-2 µm broad, sometimes branched in old specimens.
Subhymenium: Pale yellowish brown, without incrusted pigment.
Trama: Regular, same color as the subhymenium or hyaline, with inflated hyphae up to 35 µm broad.
Epicutis: With a thick layer of gelatinous hyphae, parallel to the surface. Clamp connections present.

Habitat: Gregarious on horse dung, only known from the type locality.

Studied material: URUGUAY, Montevideo, Parque Nacional Carrasco, April 3, 1960, García Zorrón 2439 (Holotype BAFC: Isotypes in MICH and ENCB).

Discussion: The name *Psilocybe uruguayensis* was given to a collection in BAFC by Singer but remained unpublished. Singer thinks that this species stains blue when fresh. It is close to *Psilocybe blattariopsis* (Speg.) Sing. but this species has brown pleurocystidia according to a study of the type (Spegazzini 1535, LPS). It is also close to *Psilocybe subaeruginascens* Höhnel, *Psilocybe stuntzii* Guzmán & Ott and *Psilocybe venenata* (Imai) Imaz. & Hongo, but differs in the size of the cheilocystidia and spores; it is interesting to see the geographical distribution of these species; *Psilocybe subaeruginascens* is only known from Java, *Psilocybe venenata* from Japan and *Psilocybe stuntzii* from the NW of North America. (See discussion of *Psilocybe blattariopsis*).

source - www.mycotaxon.com **[7 (2): 250-251]**

Pictures at www.mushroomobserver.org

Psilocybe uxpanapensis

Psilocybe uxpanapensis Guzmán (1979)

Macroscopic feat.:

Cap/Pileus: 19-30 mm in diam., conic to subconvex or subumbonate, sometimes becoming plane or depressed at the disc. Even and glabrous, marked with translucent striations when moist, lubricous or subviscid, hygrophanous. Color reddish-brown or chocolate-brown to pale ochre. Blackish when old and staining blue in young specimens when handled.
Gills/Lamellae: Adnate or adnexed to sinuate. Brownish-violet to blackish-violet with white floccose edges.
Stem/Stipe: 40-90 x 1.3 mm. Equal but sinuous and flexuous, hollow, reddish-brown or brownish, fading to blackish. Densely fibrillose floccose from whitish appressed fibrils. Turning Blue where cut or injured.

Microscopic feat.:

Basidio/Spores: (4.9-) 5.5-6.6 (-7.7) x 4.4-5.5 (-6) x 3.5-4.4 µ. Subrhomboid or rhomboid in the front and subellipsoid from the side, thick walled and with a distinct germ pore. Sporeprint yellow-brown.

Habitat: Solitary or gregarious on soil or near trails.

Distribution: In tropical virgin rain forests. Known only from Mexico (Uxpanapa region).

Season: During the summer rains.

Dosage: Unknown.

Comment: According to Guzmán, many fungi from the tropical virgin rainforests are almost lost. The vegetation for this and other similar species are almost destroyed throughout Mexico. The very area where this species was collected by Guzmán and Dr. A. L. Welden in 1976 was completely overturned in 1978 and is now a subagricultural land and meadow lands region. The name of this species is for the type locality.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe venenata

synonyms:
Psilocybe venenata (Imai) Imazecki
Psilocybe fasciata Hongo

Macroscopic feat.:

Cap/Pileus: 1-6 cm broad. Initially conic, soon convex to subumbonate to nearly plane in age, often depressed in the center with slightly upturned margins. Chestnut to cinnamon brown to olive brown, then pinkish buff to light blonde brown in drying, often grayish green, rarely whitish, readily bruising bluish where injured. Surface smooth, viscid when moist, translucent-striate near the margin, which is often adorned with minute fibrillose veil remnants, especially when young.
Gills/Lamellae: Attachment adnate to adnexed, whitish at first, soon light grayish to dingy yellowish, and eventually purplish brown to grayish violet brown with spore maturity. Edges pallid to whitish fringed.
Stem/Stipe: 40-90 mm long by 2-6 (9) mm thick, equal to uneven, fibrous, silky white, enlarged near the base from thick white rhizomorphs radiate. Partial veil thickly cortinate to nearly floccose, leaving a fragile fibrillose annulus or annular zone in the superior regions of the stem, soon disappearing or dusted with purplish brown spores. Flesh whitish, bruising azure blue where bruised.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, subellipsoid, (8) 9.9-12 (14) by 5.5-7 (8.8) µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 17-30 (36) by 4.4-7.5 µm, fusoid-ventricose to lageniform with an extended and flexuous neck, 1-2.5 µm thick.

Habitat: Gregarious to cespitose in the summer and autumn in disturbed habitats, in soils rich with lignicolous debris, and in deciduous or bamboo forests. Also found in composting soils rich with mixtures of rice hulls, straw or manure. Sometimes grows in lawns, along roadsides, or along interfaces in Japanese gardens. Reported only from Japan, but I suspect that this species is probably more widely distributed.

Comment: Probably potent, although no analyses are known to me. *Psilocybe venenata* is a misnomer, as no deaths have actually occurred (despite erroneous reports) (Ott 1993). The symptoms produced are typical of other potent psilocybin species. For most collectors, the lighter color, strong bluing reaction, cespitose habit, and locality narrow the field of candidates to this species. Given its preference for habitats, this species is likely to be cultivated outdoors amongst bamboo or in gardenlike settings in a similar fashion to *Psilocybe cyanescens* and *Psilocybe azurescens*. See also *Psilocybe argentipes* and *Psilocybe subcaerulipes*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe villarrealiae

Psilocybe villarrealiae Guzmán

synonyms:
Psilocybe villarrealii Guzmán

Macroscopic feat.:

Cap/Pileus: 40-50 mm long, convexed and plain, hygrophanous and ochraceus with some bluing and blue green along the edge of the cap. Margin translucent-striate.
Gills/Lamellae: Adnate to subsinuate, and somewhat violaceous in color at the margin of the gills.
Stem/Stipe: 50-60 x 4-7 mm. Reddish brown with white scabulous fibrils on stipe. Bruising blue when damaged or with age.

Microscopic feat.:

Basidio/Spores: (5.5-) 6.5-7.5 (-8) (-9) x (4.5) 5-6 µm. Sporeprint: Violet to Chocolate-brown.

Habitat: Common in the Mexican State of Jalisco, the influence of many new, as well as old ecosystems and microclimates are important for the distribution of these species. Riparian forests extend from sea level to about 2800 m elevation, with species of *Populus* predominating in arid and semi-arid regions of northern Mexico and species of *Alnus* in more temperate zones with cooler climates area good habitat for finding this species. *Psilocybe villarrealiae* is a big mushroom, preferring to grow near rivers and along river creeks with vegetation classified as clod. Subtropical forests appear to be a natural humid habitat for these species, as well as are open spaces and under bushes. Sometimes, large collections of this species can be observed near *Magnolia* spp., and *Alnus* spp., where wood debris is buried and mixed with muddy soil, red soil, in pine forest mixed with oaks, and in subtropical forests near small creeks.

Distribution: It has a logistic distribution in Jalisco and can be found in the towns of San Sebastian del Oeste, Mascota, and Zapopan. *Psilocybe villarrealiae* also occurs in many other regions of Jalisco such as in Sierra de Quila.

Season: Generally, rainy season occurs in certain parts of Mexico from June through September. However, we report that sometimes the mushrooms appear as early as May and continue to fruit until October.

Dosage: Unknown.

Comment: *Psilocybe villarrealiae* acts as a second decomposer, growing from sawdust, which we were able to observe in the town of Mascota, and we also found it to be growing out doors as well.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Psilocybe washingtonensis

Psilocybe washingtonensis A.H.Sm. (1946)

---

nonactive

Macroscopic feat.:

Cap/Pileus: 1-2 cm broad. Obtusely conic to convex. Margin incurved at first, then straight. Deep walnut brown, lighter towards the margin, hygrophanous, fading to dull cinnamon or pale pecan in drying. Surface smooth, though the margin may be ornamented with faint remnants of the veil, viscid when moist from a gelatinous pellicle, separable only in shreds when wet. Context thin, pliant, and nearly concolorous with the cap when moist.
Gills/Lamellae: Attachment adnate or subdecurrent, close to subdistant, with two or three tiers of intermediate gills. Color slightly darker than the cap at maturity.
Stem/Stipe: 30-50 mm long by 1.5-2.5 mm thick. Equal, tubular, and pliant. Concolorous with the cap, but becoming blackish brown in age from the base upwards. Surface covered with grayish fibrils and adorned with grayish mat of mycelium around the base. Flesh dark brown, fading in drying to pallid tan. Partial veil thinly cortinate, leaving fibrillose patches on the stem and remnants along the cap margin.

Microscopic feat.:

Basidio/Spores: Purplish brown in deposit, ellipsoid to slightly ovoid, 6-7.5 (8) by 4-4.5 µm.
Basidia: 4-spored.
Pleurocistidia: 38-56 (64) by 9-12 µm, narrowly fusoid-ventricose to lageniform with expanded necks.
Cheilocystidia: 18-38 by 7-12 µm, variable, fusoid-ventricose, often mucronate, or clavate to capitate with an abbreviated neck.

Habitat: Scattered to gregarious in forests, directly on decaying conifer wood in the fall. Reported from Mt. Angeles on the Olympic Peninsula of Washington State and along the Salmon River near Welches, Oregon. Probably more widely distributed.

Comment: Activity unknown. *Psilocybe washingtonensis* could be weakly psilocybin. It bears similarity to *Psilocybe physaloides* and to a lesser degree *Psilocybe pelliculosa*, although the latter species lacks pleurocystidia. The overall aspect of this mushroom places it into a cluster of difficult-to-delineate taxa, unless microscopic examination is conducted. Several mycenoid Hypholomas (=Naematolomas), look very similar, including *Hypholomas udum*, *Hypholomas dispersum*, and allies. See also *Psilocybe silvatica* and *Psilocybe crobula*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe wassoniorum

Psilocybe wassoniorum Guzmán & Pollock (1979)

---

synonyms:
Psilocybe fagicola R. Heim & Cailleux
Psilocybe fagicola var. *mesocystidiata* Guzmán (1978)
Psilocybe xalapensis Guzmán & López (1979)

Macroscopic feat.:

Cap/Pileus: 1-2 cm broad. Conic to subcampanulate, sometimes with a slight umbo, smooth, translucent-striate when moist, dark reddish brown to pale brown, fading in drying to an ochre yellow. Flesh thin, fragile, soon bruising bluish where injured.
Gills/Lamellae: Attachment adnexed, close, pale yellow brown when young, darkening with maturity and becoming dark purplish brown with paler edges.
Stem/Stipe: 30-40 mm long by 1-2 mm thick, equal to slightly enlarged, hollow, reddish brown to blackish brown, and covered with a sheath of white floccose fibrillose patches. Narrowing towards the base into a long pseudorhiza up to 10 mm long. Partial veil cortinate, fragile, and soon disappearing.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, (6) 6.6-7.7 (8.5) by 4.0-5.5 µm, subellipsoid to subrhomboid in side view.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 14-28 by 5-6.6 µm, ventricose near the base and sublageniform with a flexuous neck 1-2 µm thick, sometimes branched.

Habitat: Solitary or in small groups in open areas of subtropical deciduous forests. Originally found from Veracruz, Mexico, in June and July, at an elevation of 1700-1800 meters. Probably more widely distributed.

Comment: Active, but potency unknown. Originally found by the late Steven Pollock, and re-collected by Jim Jacobs, this relatively rare species is distinct for its solitary habit and long pseudorhiza. Named to honor the works of the Wassons, this species is not related to *Psilocybe wassonii* (=*Psilocybe muliercula*). See also *Psilocybe herrerae*, a similar species with a long pseudorhiza.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe wayanadensis

Psilocybe wayanadensis K. A. Thomas, Manim. & Guzmán

Macroscopic feat.:

Cap/Pileus: 10-55 mm diam., convex, becoming appianate to slightly depressed, with a small acute umbo at the centre, smooth, glabrous, slightly sticky when moist, translucent-striate towards margin, initially brownish grey (5C2), brownish orange (5C3) or greyish brown (5D3), uniformly turning to greyish brown (6E3, 7E3, 7D3) with brownish grey umbo (5F2, 6F2), sometimes greyish yellow (4C3), greyish orange (5B4), brownish orange (5C5), or light brown (5D6) towards centre, pale yellow (4A3) or greyish yellow (4B3) towards margin with olive brownish grey (4F2) umbo, hygrophanous; margin decurved, becoming plane, entire, sometimes becoming eroded or fissile.
Context: Context up to 4 mm thick, whitish or concolorous with the pileus surface.
Gills/Lamellae: Adnexed to sinuate, initially greyish yellow (4B3), orange grey (5B2) or brownish orange (5C3), becoming greyish brown (6D3) to brown (6E4, 7E4), close, up to 7 mm wide; edge pale, entire.
Stem/Stipe: 20-80 x 2-10 mm, central, terete, hollow, orange white (4A2) or greyish yellow (4B3), smooth, with a superior, membranous, white annulus; base enlarged, with strigose basal mycelium. Stipe and pileus turning blue on bruising or aging.
Odor: Sharp and unpleasant when mature.

Microscopic feat.:

Basidio/Spores: 8-9.5 (-11) x 6.5-7 (-8) x (5-) 5.5-6 (-6.5) µm, lenticular, subrhomboidal in face-view, ellipsoid in side-view, pale brownish or pale violet-brown, smooth, thick-walled, apically truncated by a germ-pore. Spore-print dark brown (8F4, 8F5).
Basidia: (21.5-) 26-28 (-34) x 7-9 (-10) µm, subventricose or cylindric to clavate, hyaline, 4-spored; sterigmata up to 4 µm long.
Pleurocistidia: (16-) 18-30 (-34) x (7-) 9-12 (-14.5) µm, hyaline, thin-walled, subventricose, with an acute apex and narrow base, often with a subgelatinous secretion at the apex.
Cheilocystidia: (11-) 13-21 (-26.5) x (5-) 6-9 (-12) µm, subventricose, ventricose-fusoid or sublageniform, thin-walled, hyaline, with an acute or obtuse apex, often with a subgelatinous secretion at the apex.
Trama: Hymenophoral, regular to subregular; hyphae 2-20 µm wide, thin-walled or wall up to 1 µm thick, hyaline to pale brownish. Context in the pileus interwoven, pale brownish, with 2-24 µm wide, hyaline hyphae, thin-walled or wall up to 1.5 µm thick. Context in the stipe composed of 2-22 µm wide, thin-walled. hyaline or faintly bluish hyphae.
Epicutis: An ixocutis; hyphae 2-12.5 µm wide, thin-walled. with faint hyaline encrustations. Stipitipellis a repent cutis, with 1.5-14.5 µm wide, thin-walled, hyaline or bluish hyphae.
Caulocystidia: Similar to cheilocystidia in shape, restricted to the extreme tip of the stipe, either in dusters or scattered, often with a subgelatinous secretion at the apex. Clamp-connections present.

Habitat: On soil rich with wood chips, gregarious to scattered, July-October. Known only from the type locality.

Studied material: India, Kerala State, Wayanad District, Muthanga, 21 July 1999, *Thomas T-320a* (holotype, XAL; isotype, L); 25 July 1999, *Thomas T-320b* (XAL, L); 27 July 1999, *Thomas T-320c* (XAL, L); 31 October 1999, *Thomas T-320d* (XAL, L).

Discussion: The annulus, the subrhomboid, thick-walled spores, and the bluing reaction place this new species in Sect. *Stuntzii* Guzmán (Guzmán, 1983). It is different from *Psilocybe stuntzii* Guzmán & Ott from the USA in the presence of pleurocystidia and in the shape of the cheilocystidia. *Psilocybe subaeruginascens* Hohnel from Java and southern Japan is a close species, but the spores are (8-) 9-10 (-13) x 7-8 (-8.5) x 5-7 µm and the cheilocystidia are (16-) 18-23 (-33) x (4.5-) 5.5-9 µm (Guzmán, 1983). *Psilocybe septentrionalis* (Guzmán) Guzmán (Guzmán, 1995), known only from northern Japan, is also a very close species, but differs in the size and shape of pleurocystidia (14-23 x 9-10 µm) and cheilocystidia (16-25 x 5.5-7.5 µm).

source - www.mycotaxon.com **[83: 198-202]**

Pictures at www.mushroomobserver.org

Psilocybe weilii

Psilocybe weilii Guzmán, Stamets & F. Tapia

Macroscopic feat.:

Cap/Pileus: 2-6 cm broad. Campanulate to bluntly conic with an inrolled margin when young, then incurved, often with an irregular, soon expanding to broadly convex to nearly plane, to uplifted in age. Dark chestnut brown to deep olivaceous brown, typically with a blackish brown zone around the disc, where flesh is 3-4 mm thick at its center. Strongly hygrophanous, fading in drying to pallid brown to light brown. Flesh whitish, bruising bluish. Surface viscid when moist from a separable gelatinous pellicle, translucent-straite near the margin, which can split in age and become tough and opaque in drying.
Gills/Lamellae: Attachment adnate to sinuate with two tiers of intermediate gills, close, even, broad, light brown overall with pallid, floccose edges. Becoming dark chocolate brown at maturity.
Stem/Stipe: 25-70 mm long by 4-8 mm thick. Equal, swelling towards the base, which projects white rhizomorphs. White, becoming dingy brown, bruising bluish overall in age or from drying, covered with a well-developed sheath of whitish fibrillose patches below, and pruinose above. Cartilaginous, strigose, hollow, stuffed with a whitish pith. Partial veil cortinate, leaving a fibrillose annular zone sometimes dusted with purplish violet-brown spores.

Microscopic feat.:

Basidio/Spores: Dark violet grayish black in deposit, subellipsoid in side view, subrhomboid to subellipsoid in face view, 5.5-6.5 by 4-5 µm in side view.
Basidia: 4-spored.
Pleurocistidia: Abundant, subfusoid or ventricose-rostrate with short apex, or sublageniform, 10.5-21.5 (24) by 5-9.5 (10.5) µm.
Cheilocystidia: Lageniform with short, single, or branched neck, 20-37.5 by 5-6.5 µm.

Habitat: Gregarious to cespitose, sometimes scattered in red clay soil topped with a thin layer of needles from loblolly pine (*Pinus taeda*) underneath sweetgum (*Liquidambar styraciflua*). First reported from southeastern Cherokee County, in northern Georgia, after hurricane Opal swept through in 1995. Fruiting from early September through November, between temperatures of 45°-80°F, preferring 60°C-75°.

Comment: 0.61% psilocybin, 0.27% psilocin, 0.05% baeocystin, and 0.32% tryptophan. This is the first report of a lignicolous, caerulescent *Psilocybe* from Georgia. The association with pine needles, along an interface ecosystem (just beyond the edge of an eight-year-old yard lined with shrubs, and in red-clay soils), are habits typical of many other Psilocybes. Additionally, the strong bluing reaction and its tendency to form clusters are characteristics also shared with *Psilocybe caerulescens*, *Psilocybe baeocystis*, *Psilocybe aztecorum* and *Psilocybe heliconia*. The name *Psilocybe weilii* is being reserved as a provisional name (nom. prov.) until the name is published in a mycological journal. (Guzmán, Tapia, and Stamets 1996). The name honors Andrew Weil and his role in promoting the beneficial properties of mushrooms.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe weraroa

Psilocybe weraroa Borov., Oborník & Noordel. (2011)

synonyms:
Secotium novae-zelandiae G.Cunn. (1924)
Weraroa novae-zelandiae (G.Cunn.) Singer (1958)

Macroscopic feat.:

Cap/Pileus: 10-30 mm in diameter, 30-50 mm tall. Light brown to tan when very young, maturing to bluish grey often with blue to bluish green stains especially where damaged.
Stem/Stipe: Up to 40 mm long, cartilaginous, white to grayish blue, yellowish brown at the base, bluing where damaged.
Gills/Lamellae: Chambered, chocolate brown gleba.

Microscopic feat.:

Basidio/Spores: 12-14 (17) by (6) 7-8.5 (10.8) µm, elliptical and smooth, brown. Spores are not discharged as prints and must be extracted by centrifuge to concentrate samples for microscopy.

Habitat: Dead tree ferns and other woody debris. Climate temperate.

Comment: *Weraroa novae-zelandiae* (*Weraroa novaezelandiae*) is a rare secotioid form of caerulescent *Psilocybe* known only from the North Island of New Zealand. In general, secotioid mushrooms appear to be lumpy, malformed mushrooms that never open up to expose their gills (or tubes in boletes). A cross section will reveal a convoluted mass of gills and sometimes a stem. Since the cap never opens up, the spores are not forcibly discharged and the mushroom must rely on animals or insects to eat and disperse them. Slugs seem to be especially attracted to *Weraroa novae-zelandiae* and most specimens are found to have slug damage. If not eaten, the mushrooms can persist for months before slowly succumbing to decay. *Weraroa novae-zelandiae* was first described in detail by Cunningham in 1924 (as *Secotium novae-zelandiae*). In 1958, Singer made the connection between *Weraroa novae-zelandiae* and the bluing Psilocybes based on similar spore types and blue staining. He further speculated that Weraroa was the probable ancestor of the Strophariaceae (the family containing the genera *Hypholoma*, *Psilocybe* and *Stropharia*). Singer didn't mention any hallucinogenic properties and no one will for almost 50 more years.
In 2005 Internet postings about the recreational use of *Weraroa novae-zelandiae* for its hallucinogenic effects were noticed by New Zealand mycologist Peter Johnston. The postings prompted molecular work (currently unpublished) by secotioid expert Ross Beever which reveals that *Weraroa novae-zelandiae* is very closely related to *Psilocybe subaeruginosa*, which appears to be synonymous with *Psilocybe cyanescens*. Cultivation experiments also support this close affinity with *Psilocybe cyanescens* and other temperate wood-inhabiting Psilocybes. *Weraroa novae-zelandiae* now appears to be only distantly related to other species of Weraroa such as *Weraroa erythrocephala* and *Weraroa virescens*.

source - www.sporeworks.com

Pictures at www.mushroomobserver.org

Psilocybe wrightii

Psilocybe wrightii Guzmán

Macroscopic feat.:

Cap/Pileus: 25-65 mm diam., subconvex to subumbonate, smooth to substriate at the margin, some rimose in old specimens, viscid to subviscid, hygrophanous, brown or reddish brown to brownish yellow, some straw-colored.
Gills/Lamellae: Subadnate or sinuate, yellowish violaceous to brownish violaceous or chocolate brown, somewhat mottled; edges whitish to concolorous.
Stem/Stipe: 80-95 x 5-9 mm, cylindrical, equal or slightly subbulbous, hollow, whitish to yellowish, finally brown reddish to blackish; staining blue when touched or injured; covered by floccose white fibrils toward the base.
Context: White and fleshy in the pileus, yellowish and subgelatinous to subcartilaginous in the stipe; staining blue when cut.
Odor: Farinaceous.

Microscopic feat.:

Basidio/Spores: (6-) 6.6-7.7 (-8.5) x 5.5-6.6 (-7.1) x 3.5-5.5 µm, subrhomboid, some obscurely angular in face view, but broadly elliptic or subelliptic in side view, smooth, yellowish brown thick walled, with broad flattened germ pore.
Basidia: 20-30 x 6-8 µm, four spored, vesiculose-pyriform, with a slight constriction in the middle.
Pleurocistidia: 15-22 x 5.-6.6 µm, hyaline, not abundant, vesiculose-fusoid, attenuate above and with a rounded nucro or sublageniform, neck 3.3-4 µm across.
Cheilocystidia: 13-22 x 4.5-6 µm, hyaline, ventricose-rostrate, with necks 2-2.5 µm, forming a sterile band along the gill edge.
Subhymenium: Yellowish with irregular brownish yellow pigment incrustations.
Trama: Hyaline to yellowish, parallel, colored by brownish yellow pigmented irregularly incrusted hyphae which often resemble collapsed chrysocystidia.
Epicutis: Formed by subgelatinized parallel hyphae, which are elongated to subglobose, hyaline to brownish.
Hypodermium: Yellowish or hyaline, with some latiferous hyphae, hyaline or brownish, 5-7 µm broad. Clamp connections present.

Habitat: Gregarious on grassy soil outside of the subtropical forest at 900 m elevation.

Studied material: ARGENTINA, road Tucumán to Tafi del Valle, 3 km W of Station Aforos, Febr. 18, 1971, Guzmán 8683 (holotype BAFC; isotype ENCB).

Discussion: *Psilocybe wrightii* is close to *Psilocybe caerulescens* Murr. but the pleurocystidia and the pigmented trama separate it from the latter as well as the thin floccose stipe. The report of *Psilocybe caerulescens* by Singer and Digilio (1951) from the Rio de los Sosas, which is close to Aforo Station, it is possible a record of *Psilocybe wrightii* (no material of that species was available to the author in LIL and in BAFC). The species here described, is certainly hallucinogenic because of its bluing, and its taste and flavor. It is named after Dr. J.E. Wright, who helped the author during his collecting trip to Argentina in 1971.

source - www.mycotaxon.com **[7 (2): 251-252]**

Pictures at www.mushroomobserver.org

Psilocybe yungensis

Psilocybe yungensis Singer & A.H.Sm. (1958)

---

synonyms:
Psilocybe yungensis var. *diconica* A.H.Smith (1958)
Psilocybe acutissima Heim (1959)
Psilocybe chiapanensis Guzmán (1995)
Psilocybe isauri Singer (1959)
Psilocybe subyungensis Guzmán (1978)

Macroscopic feat.:

Cap/Pileus: (0.5) 1-2 (2.5) cm, conic to campanulate at maturity, often adorned with a sharp umbo. Surface smooth, viscid, and translucent-striate most of the way to the disc when moist, pellicle not separable. Rusty brown to orangish brown to dark reddish brown, hygrophanous, fading in drying to dull yellowish brown or dingy straw colored. Bruising bluish where injured, and then blackish in drying.
Gills/Lamellae: Attachment adnate to adnexed, close to crowded, dull gray at first, soon purplish brown with spore maturity. Edges pale to nearly concolorous with gill surface.
Stem/Stipe: (25) 30-50 (60) mm long by 1.5-2.5 (3) mm thick, equal to enlarging towards the base. Surface covered with a sheath of dense whitish fibrils, pale brownish above and reddish brown to reddish brown-black near the base. Flesh bruising bluish, hollow, and fairly brittle. Partial veil cortinate, soon disappearing with maturity, leaving whitish fibrils along the cap margin and scant remnants on the upper regions of the stem.

Microscopic feat.:

Basidio/Spores: Dark purplish brown in deposit, rhomboid to subrhomboid to subellipsoid, (4.4) 5-6 (7) by 4-6 µm.
Basidia: 4-spored.
Pleurocistidia: 14-25 by 4.4-10.5 µm, ventricose below and mucronate at the apex.
Cheilocystidia: 14-33 by 4.4-7.7 µm, variable, ventricose to clavate to strangulated.

Habitat: Most frequently found in clusters or gregariously on rotting wood, sometimes at the bases of stumps, in coffee plantations or subtropical forests at 1000-2000 meters. Reported from Colombia and Ecuador, and extending north to Mexico. In June and July. Also reported from Bolivia in January. Probably more widely distributed than presently known.

Comment: Moderately active; analyses not available. This mushroom is distinct for its penchant for growing in great numbers on decomposing stumps or wood debris, its orangish color, and that the caps remain conic at maturity. I find the common name especially revealing. Few species resemble *Psilocybe yungensis*. See also *Psilocybe aztecorum*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Psilocybe zapotecoantillarum

Psilocybe zapotecoantillarum Guzmán, T. J. Baroni & Lodge

Macroscopic feat.:

Cap/Pileus: 13-33 mm diam, conic or campanulate, umbonate, papillate, smooth, Burnt Umber or Raw Umber or dark brownish-red, hygrophanous, drying to Tawny, with irregular blue and reddish-brown staining or with reddish fuscous hues, margin not striate or translucent-striate.
Gills/Lamellae: Adnexed, light brown to dark reddish-brown or Dark Violaceous Brown, edges even or serrate, concolorous or whitish.
Stem/Stipe: 15-35 x 1.5-3 mm, equal or with a subbulbous base, smooth or pruinose, whitish to light brown or dark reddish brown, with irregular dark blue or dark reddish stains, hollow, base inserted.
Context: Whitish in pileus, brownish in stipe, caerulescent in all parts.
Odor: And taste fungoid or radish-like, or somewhat farinaceous.

Microscopic feat.:

Basidio/Spores: (5-) 6-7 (-9) x (3-) 4-4.5 (-5) x 3-3.5 µm (Q = 1.63), subellipsoid, both in face and side view, thin-walled, up to 0.4 µm thick, yellowish-brown, with a broad germ pore.
Basidia: 16-27 x 5-6.5 µm, 2- or 4-sterigmate, hyaline, ventricose, frequently with a median constriction, sterigmata 0.8-1.6 µm long.
Pleurocistidia: (11-) 13-20 (-22) x (3-) 4-5 (-6) µm, hyaline, ventricose or subventricose, with a short or long flexuous neck.
Cheilocystidia: (14-) 16-40 (-64) x (4-) 5-7 (-10) µm, hyaline, strongly versiform, subventricose or subcylindric, irregularly lobed, apex broad or acute, short or long.
Subhymenium: Subcellular, with hyaline elements, 2.5-8 µm wide, thin-walled, with encrusted yellowish brown pigment.
Trama: Hymenophoral trama regular, with cylindric or inflated, hyaline hyphae, 2-24 µm wide, with encrusted yellowish-brown pigment.
Epicutis: A subgelatinous layer about 50 µm thick, composed of hyaline to yellowish, thin-walled, repent cylindrical hyphae, 1.5-5.5 µm wide.
Hypodermium: With hyaline, slightly inflated hyphae, 3-16 µm wide, strongly encrusted with a sordid yellowish pigment Context with hyaline, cylindric or inflated hyphae, 2.5-16 µm wide. Clamp connections common.

Habitat: Gregarious on bare or mossy soil, in tropical forests. Known only from Puerto Rico.

Studied material: PUERTO RICO, Mun. Río Grande, Luquillo Mountains, La Mina Recreation Area, Caimitillo Trail, 11 Jun 1997, coll. *Baroni*, ledger Nieves-Rivera PR-797 (PR-4401, NY); 23 May 2000, *Cantrell & Salgado* (holotype PR-6167, CFMR, isotype, XAL); Baño de Oro Trail, 7 Oct 2000, *Lodge & Pérez* (PR-6269, UPRRP, CFMR and XAL).

Discussion: *Psilocybe zapotecoantillarum* belong to section *Zapotecorum* because of the caerulescent nature of fresh basidiomata and thin-walled subellipsoid spores. *Psilocybe zapotecorum* Heim emend Guzmán (Guzmán 1983) differs most noticeably from *Psilocybe zapotecoantillarum* because of differences in the size and form of the pleurocystidia, which are longer and broader (20-38 x 5.5-14 µm) and of different morphologies (ventricose, fusoid-clavate, submucronate or pyriform). The form of the cheilocystidia in *Psilocybe zapotecorum* is also quite different (ventricose, fusoid-pyriform, ventricose-rostrate or lageniform) (Guzmán 1983).
Other taxa that should be compared with *Psilocybe zapotecoantillarum* are *Psilocybe angustipleurocystidiata* Guzmán and *Psilocybe sanctorum* Guzmán. These species differ from *Psilocybe zapotecoantillarum* in the size of the cheilocystidia, (10-) 13-24 x (2.5-) 5-6.5 (-8) µm and 13.5-29 x 6-17 µm, respectively. *Psilocybe subzapotecorum* Guzmán has two types of pleurocystidia (Guzmán 2000) and *Psilocybe barrerae* Cifuentes & Guzmán emend Guzmán has broader pleurocystidia, (6-) 7-10 (-12) µm (Guzmán et al 1999, Guzmán 2000). *Psilocybe halioconiae* Guzmán, Saldarriaga, Pineda, García & Velázquez from Colombia (Guzmán et al 1994) differs in the cheilocystidia, which are only up to 24 µm long and rarely sublageniform, ventricose-fusoid to submoniliform.

source - www.mycologia.org **[95 (6): 1175-1176]**

Pictures at www.mushroomobserver.org

Psilocybe zapotecocaribaea

Psilocybe zapotecocaribaea Guzmán, Ramírez-Guillén & T. J. Baroni

---

Macroscopic feat.:

Cap/Pileus: 5-20 mm diam, convex to umbonate or campanulate-mammillate, smooth, dry, margin translucent-striate, some undulating when mature, surface dull Burn Umber to Raw Umber, with a Chestnut umbo, hygrophanous, drying to Rufous, Tawny or Clay, in dry specimens pale or dark cinnamon brown, with a darker umbo.
Gills/Lamellae: Adnexed to slightly free, light brown or Clay, edge even, concolorous, in dry specimens the lamellae are Dark Violaceous Brown with whitish edges.
Stem/Stipe: 15-65 x 1.5-7 mm, equal to flared or tapered at base, Clay, light brown or dull Raw Umber, covered by whitish floccose scales, sooth or fibrillose, staining blue when handled, in dry specimens becoming reddish-brown, with blackish or dark reddish-brown spots.
Odor: Of radish. Taste fungoid.

Microscopic feat.:

Basidio/Spores: (5-) 5.5-6.5 (-7) x 3.5-4 x 3-3.5 µm (Q = 1.60), subellipsoid, both in face and side view, thin-walled, yellowish-brown, with a narrow germ pore.
Basidia: (13-) 14.5-17.5 x 5-5.5 µm, 4-sterigmate, hyaline, ventricose, with a median constriction.
Pleurocistidia: (11-) 12-16 (-17.5) x (3.5-) 4-5.5 µm, uncommon, hyaline, subventricose or subfusoid, with a short or long narrow neck.
Cheilocystidia: (12-) 14-36 (-40) x (4-) 5-7.5 (-9) µm, hyaline, subventricose or sublageniform, with an acute apex or a short or long neck, frequently irregularly branched, or some irregularly globose.
Subhymenium: Subcellular, with elements 2.5-7 µm wide, thin-walled, with encrusting pale brownish pigment.
Trama: Hymenophoral trama regular, hyaline to yellowish, cylindrical or ore frequently subglobose hyphae, 2-20 µm diam, thin- to thick-walled, walls up to 1.5 µm thick.
Epicutis: Poorly developed, with a subgelatinized layer of hyaline to yellowish, repent cylindrical hyphae, 1.5-4 µm wide.
Hypodermium: With subglobose, hyaline elements 2.5-18 (-20) µm, diam. thin-walled, with a pale brown encrusting pigment. Context with cylindric to inflated elements 2-20 µm wide hyaline to pale yellowish. Clamp connections common.

Habitat: MARTINIQUE, Lorrain River, 100 m altitude, 1 Jun 1975, *Fiard 318* (holotype K(M) 84366, as *Psilocybe yungensis* by Pegler).

Discussion: *Psilocybe zapotecocaribaea* belongs to section *Zapotecorum* because of the subellipsoid, thin-walled spores and bluing stipe tissues of the basidiomata. This collection originally was studied and considered by Peglera (1983) as *Psilocybe yungensis* Singer & A.H. Smith. However *Psilocybe yungensis* has distinctly rhomboid or subrhomboid, thick-walled basidiospores and belongs in section *Cordisporae*.
Psilocybe zapotecocaribea is somewhat similar to *Psilocybe zapotecoantillarum* but differs by the cheilocystidia that are not branched and rarely lageniform in *Psilocybe zapotecoantillarum*. *Psilocybe zapotecocaribaea* also has white floccose scales covering the stipe, which are lacking in *Psilocybe zapotecoantillarum*.
Psilocybe zapotecocaribaea also should be compared to *Psilocybe ramulosum* (Guzmán & Gononi) Guzmán. *Psilocybe ramulosum* differs from *Psilocybe zapotecocaribaea* in highly branched cheilocystidia and pleurocystidia that are longer than found in *Psilocybe zapotecaribaea* (15-35 (-45) µm long; Guzmán 1995).

source - www.mycologia.org **[95 (6): 1176-1178]**

Pictures at www.mushroomobserver.org

Psilocybe zapotecorum

Psilocybe zapotecorum Heim emend Guzmán

synonyms:
Psilocybe aggericola Singer & A.H. Sm.
Psilocybe barrerae Cifuentes & Guzmán
Psilocybe subzapotecorum Guzmán
Psilocybe chaconii Guzmán, M. Torres & Ram.-Guill.
Psilocybe bolivarii Guzmán, Ciencia (Méx.)
Psilocybe zapotecorum var. *ramulosum*
Psilocybe sanctorum
Psilocybe sanctorum Guzmán
Psilocybe candidipes Singer & A.H. Sm.
Psilocybe aggericola var. *alvaradoi*
Psilocybe zapotecorum f. elongata
Psilocybe pseudozapotecorum Guzmán
Psilocybe microcystidiata Guzmán & Bononi

Macroscopic feat.:

Cap/Pileus: 1-3 by 7 (11) cm, highly variable in form, conic to convex to subumbonate, and sometimes papillate and convoluted in age. Surface smooth, translucent-striate near the margin when moist. Reddish brown to organic brown, hygrophanous, fading to beige, orangish rose to straw in drying, quickly bruising blue to green to blackish where injured or in age.
Gills/Lamellae: Attachment sinuate or adnate, pale brown to violet brown to violet purple, with edges concolorous with gill face, or slightly paler.
Stem/Stipe: (40) 100-200 mm long by (3) 5-10 (12) mm thick, equal to slightly expanded at the base, sometimes with a pseudorhiza, at times flexuous or irregular in thickness. White to grayish to variably reddish brown or vinaceous, bluing when touched or injured, with blackish violet tones. Surface floccose above and strongly scabrous-strigose near the base.

Microscopic feat.:

Basidio/Spores: Purplish in deposit, violet brown in deposit, oblong-ellipsoid, (5.5) 6.6-7 (8.8) by 3.8-4.4 (5.5) µm.
Basidia: 4-spored.
Pleurocistidia: 20-38 by 5.5-14 µm, variable in form, fusoid-clavate, ventricose to submucronate, sometimes with irregularly divided apices.
Cheilocystidia: 13-27 by 3.5-6 µm, ventricose to fusoid, pyriform to lageniform, with an extended neck 1.5-2.2 µm.

Habitat: Cespitose to gregarious, rarely scattered, in swampy or muddy soils, in humus rich with leaves and wood debrs, in marshy deciduous forests, and in coffee plantations. Frequently found on the faces of ravines with exposed soils. Found in southern Mexico (600-1800 meters) and subtropical South America. (Collected in Colombia, Peru, Brazil, and Argentina.) Guzmán (1983) reported that this mushroom is sometimes found inside the mud houses of native peoples (Zapotecs), a curious if not spiritually prophetic phenomenon.

Comment: A potent and strongly bluing mushroom *Psilocybe zapotecorum* is comparatively large and can sometimes be covered with sand as it forces its way up through soils. From Brazilian specimens, Stijve and de Meijer (1993) found up to 0.30% psilocybin and 1% psilocin, which probably accounts for the strong bluing reaction. Not surprisingly, Heim and Hofmann (1958) found only 0.05% psilocybin and no psilocin in two-year-old specimens. One of the most curious species in the genus *Psilocybe*, this mushroom has a typically asymmetrical cap that is often convoluted in form. This mushroom is held in high esteem by native Mazatecs and Zapotecs. These two species have been confused frequently. The photographs labeled as *Psilocybe caerulescens* by Ott and Bigwood (1978) and as *Psilocybe caerulescens*-zapotecorum complex by Stamets (1978) are, in fact, *Psilocybe zapotecorum*. Heim and Callieux (1959) successfully fruited this species in Erlenmeyer flasks in sterilized, mixed compost after forty days of incubation (24-26°C).

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Panaeolus affinis

Panaeolus affinis (E. Horak) Ew.Gerhardt

---

synonyms:
Copelandia affinis E. Horak

Macroscopic feat.:

Cap/Pileus: Up to 25 mm wide. Hemispherical when young, then convex or rounded-humped. Gray brown. Strongly hygrophanous, drying pale, often with olive tone against the grooved edge. Apex wrinkled. Flesh whitish to pale gray-brown, with blue-green staining (type-study).
Gills/Lamellae: Attached, gray to pale brown, with a distinct olive tone, pied, mottled, and with a white/sterile gill edge.
Stem/Stipe: Stipe approximately 85 x 3 mm, slender, cylindrical, whitish/pale gray brown, staining blue-green when injured, base white-tomentose, dry, pruinose at the top, fibrillose toward base, hollow, brittle/fragile.

Microscopic feat.:

Basidio/Spores: 9-11.5 (13) x 7-8.5 x 5-5.5, smooth, opaque, clearly prolate, flattened in face-view, always longer than wide, germ pore even/flush.
Basidia: Basidia mostly 4-spored, rarely 2-spored. Approximately 20-25 x 8-10 µm. Sulphidia absent.
Pleurocistidia: Metuloids with yellow brown cell walls. Similar to the cyanescens-type, approximately 40-60 x 13 - 20 around, frequently apically encrusted with crystals.
Cheilocystidia: Cheilocystidia ventricose to bottle-shaped, tip often capitate-subcapitate, hyaline, approx 20-35 µm long.

Habitat: On soil between leaf litter. Occasionally rotten wood.

Studied material: Holotype from New Guinea, Papua, Bulolo, (Agathis Res, Horak, 2.2.1972, p.p.maj. Copelandia affinis (ZT 72/121)). As yet, this species is known only from New Guinea (Asia). Only two collections were examined (the type and one other) as part of Gerhardt's Type Study.

Discussion: This species is distinguished from *Panaeolus cyanescens* mainly by the smaller spores. It should also be mentioned that the soil or decomposing wood substrates would make this *Panaeolus* very unique. *Panaeolus lentisporus*, is very similar, but its spores are even more flattened, also has even broader spores with an extremely prominent protruding germ pore.

Comment: The type material collected was abundant and in good condition. In Gerhardt's research he found that a few specimens differed significantly in its spore for. He separated these into a collection that he labeled as No. 72/121-a, distinguished from the remaining material. From No. 72/121-a, he described *Panaeolus lentisporus*. The majority of the collection was in agreement with the characteristics given in the original description. Horak's dimensions for the spores were 9-10 x 7.5-9 x 5-6.5 µm (which is shorter). This may be because Horak had not measured spores that were produced from 2-spored basidia. Also, two-sterigmate basidia were not mentioned in Horak's description.

source - www.mushroomobserver.org

Pictures at www.mushroomobserver.org

Panaeolus africanus

Panaeolus africanus Ola'h

Macroscopic feat.:

Cap/Pileus: 1.5-2 cm broad. Obtusely conic, hemispherical and rarely broad in age. Cap becomes pitted and wrinkle with age cracking to fornm scales. Viscid when moist, especially in young speimens. Grayish creamy white and grey-brown in age. Incuved margin in young specimens, often irregular and non-translucent. Flesh is greyish-white.
Gills/Lamellae: Adnate to adnexed, and sometimes sinuate, rarely subdecurrent and widely spaced., greyish at first and then soon becoming black to blackish and mottled as spores mature.
Stem/Stipe: 30-50 mm by 4-6 mm thick. Equal and firm as well as pruinose towards the apex. White with pinkish tones, generally lighter than the cap and no veil remnants present.

Microscopic feat.:

Basidio/Spores: 11.5-14.5 x 7.9-10 µm. Lemon shaped and often variable. Sporeprint black in deposit.

Habitat: Found on hippopotamus and elephant dung.

Distribution: Central Africa to the Southern Regions of the Sudan.

Season: In the spring or during the rainy seasons.

Dosage: According to French-Canadian mycologist G-M. Ola'h of the Universite Laval in Quebec, Canada reported that this species is weakly active.

Comment: This species macroscopically resembles the non-psychoactive species, *Panaeolus antillarum*. Accodring to Paul Stamets, he found one small collection of this species at the Seattle, Washington Zoo in elephant dung.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Panaeolus antillarum

Panaeolus antillarum (Fr.) Dennis

synonyms:
Agaricus antillarum
Agaricus solidipes
Panaeolus phalaenarum
Panaeolus sepulchralis
Psilocybe antillarum

nonactive

Macroscopic feat.:

Cap/Pileus: 4-10 cm broad. Hemispherical to broadly convex, whitish at first becoming silvery whitish-grayish with age, sometimes appearing slightly yellowish, a bit rare for yellow. Surface very smooth to rimose-scaly. Flesh is very thick and whitish.
Gills/Lamellae: Adnexed to adnate, close and broad and slightly swollen in the center. Whitish to grayish at first and then becoming dark to mottled black. Edges of gills are whitish-gray.
Stem/Stipe: 40-200 mm long by 5-15 mm thick. Equal to slightly enlarged and curved at the base and solid but sometimes is twisted. Very whitish in color and the surface is smooth and striate towards the base.

Microscopic feat.:

Basidio/Spores: 18-20 x 11-12,5 µm, and are ellipsoid in shape. Sporeprint black in deposit.

Habitat: Gregarious to subcespitose in manure of cattle, gaur, water buffalo, sheep and sometimes horses. And many other four-legged ruminants.

Distribution: Widely distributed with a cosmopolitan distribution.

Season: In the spring and fall and during the rainy seasons. The author has found this species to be common in Thailand and Cambodia as well as Florida and other regions of the USA and Europe

Dosage: This species is not psychoactive.

Comment: In the late 1940s this species gained a reputation in Australia as the "Hysteria Fungus" allegedly causing accidental hallucinogenic inebriations in foragers in some parts of that country. Later it was determined that the actual causative mushrooms were *Copelandia cyanescens* which is macroscopically similar in appearance to *Panaeolus antillarum*. This species is edible but it's bitter rancid taste is not worth eating.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Panaeolus bisporus

Panaeolus bisporus (Malencon and Bertault) Singer and Weeks

---

synonyms:
Panaeolus bispora
Copelandia bisporus
Copelandia bispora

Macroscopic feat.:

Cap/Pileus: 15-28 mm, semiglobate, campanulate to convex, hardly expanding, margin often torn and pedaled, smooth not viscid, and slightly wrinkled and pitted with age. Dark grey-brown drying whitish.
Gills/Lamellae: Ventricose-adnate, 5 mm broad, crowded and grey to olivaceous black with distinct white edges.
Stem/Stipe: 40-65 mm x 2-3 mm, cylindrical, fistulose and punctate-pruinose from apex to 1/3 towards base, downwards slightly fibrillose, reddish-brown and greyish. bluish at base.

Microscopic feat.:

Basidio/Spores: 12-14 x 8-10 x 6-7,5 µm. Elliptical. Sporeprint black with white edges.

Habitat: Preferably the dung of buffalo and cattle, sometimes in manured soil, but rare. Originally only know of from Morocco, Africa and then from Hawaii, a recent discovery of this mushroom in abundance appeared in a lawn of a Churchyard of Belp near Bern, Switzerland. Additionally, it has also once reported from Spain.

Distribution: North Africa and Hawaii, Spain and Switzerland.

Season: During and after rainy periods.

Dosage: 4 to 7 to 10 fresh mushrooms, 1-2 dried grams.

Comment: Common on Oahu at Kualoa Ranch and at pastures on Oahu's North Shore.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Panaeolus cambodginiensis

Panaeolus cambodginiensis Ola'h & R.Heim

---

synonyms:
Copelandia cambodginiensis (Ola'h & R.Heim) Singer & R.A.Weeks

Macroscopic feat.:

Cap/Pileus: 1.2-2.5 cm broad. Conic-convex at first soon hemispherical and expanding to broadly convex and then nearly plane. Surface smooth and moist to viscid and often becoming cracked or pitted and wrinkled with age.Cap hygrophanous from a copper-golden brown to a pallid straw color in drying.
Gills/Lamellae: Ascending, incinate. Pallid at first becoming grayish-black and mottled.
Stem/Stipe: 55-95 mm long by 3.5-5 mm thick, swelling towards the base whitish to cream color brown at the base and with extreme bluing upon handling.

Microscopic feat.:

Basidio/Spores: 10.5-12 x 6.5-9 µm. Lemon shaped and smooth. Sporeprint blackish-brown in deposit.

Habitat: Scattered to gregarious on dung of buffalo and cattle.

Distribution: Originally described from Cambodia. This species is also found in Peru, Mexico, and Hawaii.

Season: During and after heavy rains at different times of the year depending on the location of the fruiting bodies.

Dosage: 7 to 10 fresh mushrooms and from 1-2 grams dried.

Comment: Stephen Pollock successfully cultivated this species back in the late 1970's.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Panaeolus cinctulus

Panaeolus cinctulus (Bolton) Saccardo (1887)

---

synonyms:
Agaricus cinctulus Bolton (1791)
Coprinus cinctulus (Bolton) Gray (1821)
Agaricus fimicola var. *cinctulus* (Bolton) Cooke (1883)
Panaeolus fimicola var. *cinctulus* (Bolton) Rea (1922)
Panaeolus subbalteatus (Berk. & Broome) Sacc.

Panaeolus cinctulus is probably the most important psychoactive species in the genus *Panaeolus* in Europe. It grows directly on top of dung and on pastures that have been heavily fertilised. It can also be found on trash heaps or on compost or straw on which mushrooms are commercially cultivated.

We have grown this species on a mixture of dung and straw. We were also able to cultivate this species on sterilised grass seed cased with a mixture of peat and vermiculite (the same substrate that is used for *Psilocybe tampanensis* and *Psilocybe mexicana*). Although the fruitbodies were smaller than those grown on dung the first flush on grass seed was much bigger.

The first picture shows the first flush on cased sterilised grass seed. The second image shows some mushrooms grown on a sterilised mixture of straw and dung. The difference in appearance is very obvious although the same strain was used for inoculation.
The mycelium of this species had a characteristic flaky appearance, especially on grain and agar (third and fourth picture). It does not hold the substrate together firmly like for instance *Psilocybe cubensis*. The mycelium also forms small sclerotia-like structures.

Growth parameters:

Substrate:
Dung, straw, compost, grass seeds.
Temperature:
colonisation/fruiting: 27-30°C / 24-27°C

source - www.mushmush.nl

Pictures at www.mushroomobserver.org

Panaeolus chlorocystis

Panaeolus chlorocystis (Singer & R.A. Weeks) Ew. Gerhardt

---

synonyms:
Copelandia chlorocystis Singer & R.A. Weeks

Macroscopic feat.:

Cap/Pileus: Cap up to 28 mm wide. Isabelline colored to pale cinnamon brown or yellow to pale brown with whitish or gray border. Edge uneven, more or less lined. Fruiting bodies in all parts in old age or injury bruising green or blue.
Gills/Lamellae: Gills blackish, with white edge. Somewhat widely spaced.
Stem/Stipe: Milk white or light cream color, in the lower half gray-brown. Fine white frosting, especially at the top, including some streaks. Hollow. Up to 80 x 2 mm.
Odor: And taste farinaceous.

Microscopic feat.:

Basidio/Spores: 9-12.5 (14) x 8-10 x 6-7 µm, smooth, scarcely angular, sometimes almost heart-shaped. Slightly transparent. Germ pore even/flush in face view.
Basidia: Basidia 2-sporig, 18-20 x 8-9 µm.
Epicutis: Not described. Clamps are present, but rare. Sulphidia absent.
Pleurocistidia: Metuloids 50 x 16-18 to relatively thin-walled. Brownish yellow wall in the microscope. In the beak area there is clear green to olive green. Usually with sparse crystals at apex.
Cheilocystidia: Ventricose, bottle-shaped. Hyaline. About 25-32 µm long.

source - www.mushroomobserver.org

Pictures at www.mushroomobserver.org

Panaeolus cyanescens

Panaeolus cyanescens (Berk. & Broome) Sacc.

synonyms:
Agaricus cyanescens
Copelandia anomala
Copelandia cyanescens
Copelandia papilonacea
Copelandia westii

Were sure you've all heard about how potent *Panaeolus cyanescens* and *Panaeolus tropicalis* are. According to scientific reports published by P. Stamets and others, they are reported as the 4th most potent mushrooms God has put on this planet we call earth.

Panaeolus cyanescens grows scattered to gregariously in dung and fertilised pastures and fields. Widespread in most semitropical zones and occasionally seen in the Mediterranean region.

We have grown this species on a mixture of straw and dung with a thin casing layer. It is very important that the casing layer is not too thick as this species seems to have difficulty growing through it. A thin casing layer owever seems necessary for fruiting. This species is a very strong producer of psilocybin/psilocyn and mushrooms show a very strong blueing reaction when bruised.

Well, straight up, they are very potent and deliver an extremely beautiful vibe beyond description. So peacefull and colorfull, very potent yet about the "*smoothest*" mushroom experience out there in my opinion. Its hard to put it into words, you just have to experience them, and you will know. Pure bliss!

That is the good news. The bad news is they are not near as easy to grow as cubensis, but they do domesticate, and can be grown indoors with a little patience and lots of TLC. Plan on a few failures along with your success, its par for the course with this species as the mycelium is rather weak and easily contaminates. Ok, now that we just scared you off, come back. They are not that hard, we just suggest you don't try these until you've had experience growing other mushrooms. These are geared towards the intermediate and advanced growers.

Growth parameters:

Substrate:
Dung, straw, compost.
Temperature:
colonisation/fruiting: 26-29°C / 23-26°C

source - www.thehawkseye.com

Pictures at www.mushroomobserver.org

Panaeolus fimicola

Panaeolus fimicola (Pers.) Gillet

synonyms:
Panaeolus ater (Lange) Kuhner & Romagnesi

Macroscopic feat.:

Cap/Pileus: 1-2(3) cm broad. Convex to campanulate, expanding to plane only during prolonged wet periods and in extreme age. Dingy gray to black, often with slight reddish hues, becoming paler in drying, leaving a darker grayish brown encircling zone along the margin. Margin striate when moist, not appendiculate, but sometimes irregular and uplifted at maturity Surface smooth, soon dry. Flesh moderately thick.
Gills/Lamellae: Attachment adnate to adnexed, broad, grayish, mottled, with grayish edges. Two to three tiers of intermediate gills present.
Stem/Stipe: 60-100 mm long by 1-2 mm thick. Equal, hollow, soft, and fragile. Dingy pale to whitish, especially towards the apex. Surface powdered above and striate below.

Microscopic feat.:

Basidio/Spores: Black in deposit, 11-14 by 7-9,5 µm, lemon shaped with an apical germ pore.
Basidia: 4-spored.
Pleurocistidia: Absent or only near to the gill edge and then similar in form to cheilocystidia.
Cheilocystidia: 25-35 (40) by 6-12 µm, mostly fusoid-ventricose.

Habitat: Growing scattered in soil or dung from the late spring and in the fall. Sometimes found in well-fertilized lawns and/or grassy places in woods. Widespread, reported from the Americas, Africa, and Europe.

Comment: Looking very much like a *Psilocybe*, especially in side view, this species is a latent producer of psilocybin, meaning that some collections, upon analysis, reveal a small amount of active indoles while other collections are devoid of them. Although widespread, this species is infrequently encountered compared to many other *Panaeoli*. Gerhardt (1996) showed synonymy between *Panaeolus fimicola* and *Panaeolus ater*. See also *Panaeolus castaneifolius*, *Panaeolus foenisecii*, and *Panaeolus papilionaceus*.

Below *Panaeolus fimicola* growing from cow dung. Not active to weakly active.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Panaeolus lentisporus

Panaeolus lentisporus Ew.Gerhardt

synonyms:
Copelandia lentisporus (Ew. Gerhardt) Guzmán

Macroscopic feat.:

Cap/Pileus: The appearance of this species should match fairly closely with *Panaeolus affinis* (see description). Even Horak (briefl. release) apparently failed to noticed any differences in the collection of these mushrooms.
Gills/Lamellae: Similar to *Panaeolus affinis*.
Stem/Stipe: Similar to *Panaeolus affinis*.

Microscopic feat.:

Basidio/Spores: Approximately 8.5-10 (12) x 7-9 x 4.5-5. Smooth, opaque, extremely flattened. In face view they are often as long as wide! Germ pore brought forward.
Basidia: Basidia 4-spored (always?), About 18-22 x 8.5-10. Sulphidia absent.
Cheilocystidia: Ventricose, bottle-shaped, hyaline. Approximately 25-35 microns long.
Pleurocistidia: Metuloids of the cyanescens type. Approximately 40-63 z 11-19. Tip often decorated with crystals.

Habitat: Habitat (according Horak 1980) on soil between scattered, occasionally on rotten wood. The habitat and wide spores separate *Panaeolus lentisporus* from *Panaeolus affinis*.

Comment: *Panaeolus lentisporus* is distinguished from *Panaeolus affinis* by its more strongly flattened spores, which are often wider than they are long in face view. This character is unique in the genus. In direct comparison, they are clearly separable from *Panaeolus affinis* spores, which are always slightly longer than broad. The clearly brought-forward germ pore of the spores of *Panaeolus lentisporus* is another prominent feature. Microscopically, the spores also appear slightly darker, slightly flatter than in *Panaeolus affinis* and metuloids in its entirety. I am convinced that even more macroscopic or ecological differences would be discovered with more knowledge of the species.

Distribution: Holotype from New Guinea, Papua, Bulolo, Agathis Res, Horak, 02.02.1972, ppmin. "Copelandia affinis" (ZT 72/121a). So far known only from New Guinea (Asia).

Notes: Horak (briefl. release) kept all his material for a type. Furthermore, he was of the opinion that the different spore form comes about through probably immature fruiting bodies. Gerhardt disagreed because it is well known that for all species of the genus *Panaeolus*, the spores in the same lamella mature unequally (mottled gills). So every gill should always have both mature and immature spores, which can be seen from the different spore wall color. This would also mean that both spore forms would have to have been found within a specimen, but just the opposite was found: Gerhardt found with each fruitbody, either only one or the other spore type. Thus, wider spores represented a reliable character for the separation of the two species.

source - www.mushroomobserver.org

Pictures at www.mushroomobserver.org

Panaeolus olivaceus

Panaeolus olivaceus F.H.Müller (1945)

---

synonyms:
Panaeolus castaneifolius (Murrill) A.H. Sm.
Panaeolina castaneifolia (Murrill) Bon;
Panaeolina castaneifolia (Murrill) Ew. Gerhardt

Macroscopic feat.:

Cap/Pileus: 1- 3(4) cm across, Distinctly campanulate then subhemispheric to convex, becoming broadly conic, not fully expanding, incurved margin when young, dark smoky-grayish to dark cinnamon, drying to a straw-yellow or slightly olive-gray color, remaining more reddish-brown towards the center, hygrophanous, smooth, sometimes striated or finely corrugated, flesh thick and firm.
Gills/Lamellae: Adnate to adnexed, close, thin, pallid, mottled, slightly olive-greenish, becoming dark purplish gray-black in age, edge whitish.
Stem/Stipe: 4- 6(7.5) cm by 3- 4(6) mm thick, equal to slightly tapering at the base, hollow, brittle, pruinose and slightly striate, no veil remnants. Grayish to ochraceous, tan or purple at the base.

Microscopic feat.:

Basidio/Spores: Black, slightly roughened, 12 - 15(17) x 7-8,5 µm, elliptic, rugose or verrucose.
Basidia: 4-spored. 24-28 x 10-12 µm.
Cheilocystidia: (20)24 - 30(38) x (5)7-10 µm, abundant, neck often flexuous and apices usually obtuse, thin walled and hyaline.
Pleurocistidia: Rare or absent, not projecting beyond plane of basidia.

Habitat: Grows scattered to gregariously

Distribution: Well kept grass, in lawns, parks and around well manicured buildings. Some believe that there is a correlation between this species and dog stool, but there is no hard evidence to back that up. It has been collected in the U.S. states of Washington, Oregon, Georgia, Canada's Quebec and in the United Kingdom

Season: Late summer through December.

Dosage:

- Lvl. 1 - 1.2g
- Lvl. 2 - 2.1g
- Lvl. 3 - 3.8g
- Lvl. 4 - 5.8g
- Lvl. 5 - 8.0g

Comment: Latently psilocybin, according to Ola'h (1969), and when so, weak. Some but not all collections of this species contain psilocybin. Distinguished from *Panaeolus foenisecii* by the color of the mature gills and spore deposit, which are very dark purplish gray-black.

Notes: It is easily mistaken for *Panaeolus cinctulus* and can be distinguished from that species by its more campanulate cap shape when young and slightly roughened spores.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Panaeolus papilionaceus

Panaeolus papilionaceus var. papilionaceus (Bull. ex Fries) Quélet

---

synonyms:
Agaricus calosus
Agaricus campanulatus
Agaricus papilionaceus
Galerula campanulata
Panaeolus campanulatus
Panaeolus retirugis
Panaeolus sphinctrinus

nonactive

Macroscopic feat.:

Cap/Pileus: 1-5 cm, obtusely conical to bell shaped or nearly spherical when young, expanding slightly (often to broadly bell-shaped) with age; dry; smooth to silky when young, often becoming finely hairy or prominently cracked with age; sometimes with a reticulate network of raised ridges; whitish, gray, brownish, brown, or reddish brown; sometimes developing olive discolorations; the margin hung with white, toothlike partial veil fragments, at least when young (check this feature in the field, since the fragments are easily shed in collection bags).
Gills/Lamellae: Attached to the stem, or pulling away it with maturity; close or crowded; grayish when young, but soon developing black areas and acquiring a mottled appearance; eventually black overall; with whitish edges.
Stem/Stipe: 4-16 cm long; up to 5 mm thick; more or less equal; finely hairy; often brittle; colored more or less like the cap, but paler at the apex and darkening toward the base with maturity or on handling.

Microscopic feat.:

Basidio/Spores: 11-18.5 x 7.5-12 µm; more or less elliptical, with a pore; smooth; dextrinoid; not discoloring in concentrated sulphuric acid.
Basidia: 4-sterigmate; abruptly clavate
Pleurocistidia: Absent.
Cheilocystidia: Abundant; subcylindric, often subcapitate or capitate.

Habitat: Saprobic; growing alone to gregariously in the dung of horses and cows; common; widely distributed in North America; spring, summer, and fall (and over winter in warmer climates).

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Panaeolus tirunelveliensis

Panaeolus tirunelveliensis (Natarajan & Raman) Ew.Gerhardt

synonyms:
Copelandia tirunelveliensis Natarajan & Raman

Macroscopic feat.:

Cap/Pileus: Up to 2.3 cm broad, conical to bell-shaped, glabrous, blue-gray in color.
Gills/Lamellae: Mature lamellae spaced up to 3 mm in width, black.
Stem/Stipe: Up to 65 x 3 mm in size, cylindrical, glabrous, white to yellowish-white, may not discoloring upon injury.

Microscopic feat.:

Basidio/Spores: Approximately 11-14 (15) x 8.5-11 x 6.5-8 microns, smooth, opaque, distinctly flattened, germ pore even/flush.
Basidia: Consistently two-spored basidia.
Pleurocistidia: Metuloids about 43-50 × 13-18 microns, similar to the type that cyanescens. Metuloids relatively thin, pale brownish yellow colored, usually without crystals.
Cheilocystidia: Not described.

source - www.mushroomobserver.org

Pictures at www.mushroomobserver.org

Panaeolus tropicalis

Panaeolus tropicalis Ola'h

synonyms:
Copelandia tropicalis (Ola'h) Singer & R.A. Weeks

It grows in the wild on very old dung in tall grass and on the dung of wild animals in the tropics. A very (maybe the most) potent species of psilocybin mushroom on earth! This species is reported from Hawaii, Central Africa and Cambodia.
This mushroom is a close relative of *Panaeolus cyanescens* and can be grown in the same manner
Were very excited to bring you the very rare *Panaeolis tropicalis*. It is believed The *Panaeolus tropicalis* originated from the Hawaiian Islands and was carried over to S. Fork Florida on Pineapple ships years ago and became a native to certain areas of Florida.
Those that are fortunate enough to find or legally grow this very potent treasured species of *Panaeolus* are certainly blessed.
We have found the best way to grow this species is to take colonized rice and vermiculite or birdseed and vermiculite... and use the colonized grain to inoculate old dung.. preferably straw fed dung..and the then give it a light casing layer....It will also fruit on compost very well... and on straw.. but best results so far have been found with the old pasteurized dung.
I have to say... I'm very excited about this species as it is one of the most potent species I've ever tried.... as potent as the azure in my opinion.
According to all of our friends who have tried them in Amsterdam Its extremely visual... a very nice clean, vibe.....tasty...and just delivers a very powerful, colorful journey into the mind. We ask those of you who fruit this species to keep us updated on your progress so we can all share our experiments and make such a beautiful and potent species easier to fruit for beginners. At this point I would say this species is not for beginners at all.. but more geared towards the intermediate experimental and advanced growing level. Don't get us wrong it can be fruited.. but will be fruited much easier by those that have some good experience with growing mushrooms from straw.. dung.. and/or compost..... it will not fruit like your typical cubensis or from mmgg/pf style cakes... it will colonize this way.. but not fruit.. you will need your substrate as spawn to inoculate the above suggested substrates. All I have to say is.. this mushroom ROCKS..... the mind and spirit.. ..Open your mind.. because this mushroom is the KIND !!!.

Growth parameters:

Substrate:
Dung, straw, compost.
Temperature:
colonisation/fruiting: 26-29°C / 23-26°C

source - www.thehawkseye.com

Pictures at www.mushroomobserver.org

Panaeolus venezolanus

Panaeolus venezolanus Guzmán

synonyms:
Panaeolus annulatus Natarajan & Raman

Macroscopic feat.:

Cap/Pileus: 20-35 mm in diam, subcampanulate to campanulate, smooth to irregularly rimose, dry, brownish gray to ashy gray.
Gills/Lamellae: Sinuate, blackish-gray but mottled.
Stem/Stipe: 45-50 x 2-3 mm, cylindric but subbulbous, hollow, brownish gray to reddish, pruinose toward the base. Annulus membranaceous, thin, whitish to blackish from spores deposited.
Context: Thin, grayish at pileus, brownish at stipe, with taste and odor slightly farinaceous.

Microscopic feat.:

Basidio/Spores: (11-) 12-14.8 x 8.8-9.9 x 7.7-8.5 µm, limoniform to subovate, with broad germ pore and thick wall, brownish to dark brown or blackish (KOH).
Basidia: 21.7-30 x 9-11.2 µm, two- or fourspored, subcylindric or subpyriform, hyaline.
Pleurocistidia: None
Cheilocystidia: 24.7-34.5 x 6-9 µm, hyaline, subcylindric or vesiculose-elongated, abundant.
Subhymenium: And trama hyaline.
Epicutis: Dry, formed by brownish (KOH) vesiculose-cylindric elements emerging from the surface
Hypodermium: Hyaline. Clamp connections present but scarce.

Habitat: Gregarious on cow dung or on rich soils, in meadows of the subtropical forests. Known from Venezuela and possibly also present in subtropical and tropical regions of Mexico.

Studied material: VENEZUELA, N of Mérida, San Javier del Valle, July 27, 1971, Guzmán 9177 (Type, MER; isotype, ENCB)

Discussion: The well developed annulus in the adult fruiting bodies is a good feature to separate this species from all others known in the genus. It is rather close to *Panaeolus sphinctrinus* (Fr.) Quél., but the rimose pileus, the size of the spores, and the presence of an annulus separate it from that species. *Panaeolus sphinctrinus* does not have a ring, and the pileus is smooth. Its spores according to Singer (1960) are 12.5-14.5 x 8-10 µm; according to Ola'h (1969) are 14.5-18 x 10.5-12.6 µm, and according to Kühner & Romagnesi (1953) are 14-18 x 10-12 µm. Guzmán and Pérez Patraca (1972) reported two groups of *Panaeolus sphinctrinus* from México, one with spores 12-16.8 x 8.4-12 µm and another with spores 14-18.2 x 9.8-13.5 µm, and as they mentioned, it seems that there is one *Panaeolus sphinctrinus* in tropical and subtropical regions with small spores and another in temperate regions with large spores. *Panaeolus venezolanus* is close to that from the tropics and subtropics. The author even had observed some "Panaeolus sphinctrinus" with an annulus in the tropics of México, but unfortunately he did not study them.
Another species of *Panaeolus* close to *Panaeolus venezolanus* is *Panaeolus phalaenarum* (Fr.) Quél. sensu Singer (1969), reported from Chile and Europe, which also has a veil that remains as a narrow annular belt, but has spores of 13.5-17 x 5.5-11.5 x 7.7-9.4 µm. *Panaeolus semiovatus* (Sow ex Fr.) Lund. Et Nannf. (=*Anellaria*, Pearson and Dennis), a well known annulate species of the alpine or paramo vegetation, is distinguished from *Panaeolus venezolanus* by the white fruiting body as well as by the chrysocystidia and size of the spores.
This species, together with other *Panaeolus* spp. and *Psilocybe cubensis* (Earle) Sing. is used by the students in Mérida, Venezuela, as a drug that provokes gastrointestinal intoxication, as the author observed in the field and as reported by Llorca Izquierdo (1972).

source - www.mycotaxon.com **[7 (2): 221-223]**

Pictures at www.mushroomobserver.org

Conocybe cyanopus

Conocybe cyanopus (Atkins) Kühner

---

synonyms:
Pholiotina cyanopus (Atkinson) Singer
Pholiotina cyanopoda (G.F. Atk.) Singer;
Conocybe cyanopoda (G.F. Atk.) Kühner
Galerula cyanopus G.F. Atk.

Macroscopic feat.:

Cap/Pileus: 0.7-1.2 (2-5) cm broad. Hemispherical to convex, expanding to broadly convex with age, sometimes conic. Margin translucent-striate when moist. Yellow-umber to cinnamon or reddish-cinnamon.
Gills/Lamellae: Adnexed, close and broad. Dull rusty brown with a white fringe along the margin.
Stem/Stipe: 20-40 mm long x 1-1.4 thick.

Microscopic feat.:

Basidio/Spores: 6.5-7.5 (.5) x 4.5-5 µm. Sporeprint rusty brown.

Habitat: Scattered in grassy areas and fields.

Distribution: Oregon, Washington and British Columbia, Canada.

Season: Spring, Summer and fall.

Dosage: 40-50 small specimens, 1/3 of a fresh ounce and/or 1 dried gram. This species grows only to three inches in height.

Comment: This species grows in sphagnum moss only during the early spring rains along streams and riverbanks in grassy areas. I found this species only four times during the past 35 years. It has a watery white stem with an enlarged base which immediately stains blue when lifted from the earth and moss.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Conocybe kuehneriana

Conocybe kuehneriana Singer

synonyms:
Conocybe velutipes Singer
Galera velutipes Velen.

Macroscopic feat.:

Cap/Pileus: Conical, with patches of fine velvet-like fibers on the surface.
Gills/Lamellae: With lecythiform cheilocystidia c. 16.5-20/7-8.5 µm, head ≤4-5 µm.
Stem/Stipe: With velvet-like fibers along most of length. Hairs with slightly bulbous bases but no lecythiform cells
Odor: Mealy on cutting

Microscopic feat.:

Basidio/Spores: Yellow-brown under microscope, with germ pore, 10-12(13)/6-7 µm. Spore print dark rusty brown.
Basidia: 4-spored.

Habitat: Found in grass and mulch. Sometimes on "Mix'nMulch" in greenhouse reported finds.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Conocybe smithii

Conocybe smithii Watling

---

synonyms:
Galera cyanopes

Macroscopic feat.:

Cap/Pileus: 0.3-1 (1.3) cm broad. Obtusely conic, expanding to nearly plane with a distinct pronounced umbo. Margin translucent-striate most of the way to the disc when moist. Ochraceous tawny to cinnamon brown, hygrophanous, becoming pale pinkish yellow in drying.
Gills/Lamellae: Adnate to adnexed, soon seceding crowded to subdistant, narrow to moderately broad. Pale grayish yellow at first, becoming rusty cinnamon brown at maturity.
Stem/Stipe: 10-50 (70) mm long, 0.75-1 (1.5) mm thick. Equal to slightly enlarged at the base, fragile. Whitish, becoming slightly pallid yellowish brown, more grayish at the base. Surface covered with fine fibrils at first but soon smooth overall. Partial veil thin to absent.

Microscopic feat.:

Basidio/Spores: Rusty brown in deposit, (6.5) 7-9 by 4-4.5 (5) µm.
Basidia: 4-spored.
Pleurocistidia: Absent.
Cheilocystidia: 20-40 by 9-15 µm.

Habitat: Scattered to numerous in moss in and about sphagnum bogs, and in damp wet places.

Distribution: Reported from Washington, Oregon, and Michigan, probably more widely distributed. Not known from Europe.

Season: Spring, Summer and fall.

Comment: Probably active, given the bluing reaction, and containing up to 0.80% baeocystin (Repke et al. 1977). The geographical range of this species is likely to be much more extensive than the literature presently indicates. This species can be found in mossy areas of wet fields. Visually, this species is hard to distinguish from *Conocybe cyanopus*. Microscopically, these two taxa can be separated by spore size.

Dosage: Assuming the small size of this species and its macroscopic similarity to *Conocybe cyanopus*, I imagine that 40-50 small specimens, 1/3 of a fresh ounce and/or 1 dried gram would be about the same dosage as that of *Conocybe cyanopus*. This species seems to fruit to a size smaller than *Conocybe cyanopus*. (accrd. www.mushroomjohn.org)

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Galerina steglichii

Macroscopic feat.:

Cap/Pileus: 7-13 x 2-3 mm.
Gills/Lamellae: (10) 13-15 mm.
Stem/Stipe: 12-23 x 0.8-2.2 mm. Cylindrical.

Microscopic feat.:

Basidio/Spores: 8.5-10 x 5.5-8 µm. Sporeprint rusty-orange brown.

Habitat: Found in a green house in Germany.

Distribution: Possibly tropical climates since it was only found once in a hothouse in Germany.

Season: Warm and after rainfalls in tropical climates?

Dosage: Unknown. And not recommended due to it's relationship with the deadly species of *Galerina*.

Comment: *Galerina steglichii* is a tiny bluing tropical(?) species that was recently discovered in a hot house in the botanic gardens of Regensburg in Bavaria (GFR). Both psilocybine and psilocine were reported by Besl as occurring in this species. Gartz also analyzed some specimens in 1994. It was baptized in honour of Wolfgang Steglich, a chemist who has done a lot of research on, among others, fungal pigments. Gartz found both psilocine and psilocybine as well as small amounts of baeocystine in this species ranging from 0.05% to 0.14% dry weight.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Gymnopilus aeruginosus

Gymnopilus aeruginosus (Peck) Singer

---

synonyms:
Pholiota aeruginosa Peck

Macroscopic feat.:

Cap/Pileus: 2-23 cm broad. Convex with an incurved margin, expanding to broadly convex with age. Variable in color. Dull bluish gray green, to variegated green and yellow, hygrophanous, becoming drab in drying. Surface covered with tawny scales, dark brown in age. Flesh pallid to whitish, with greenish to dull bluish tones, becoming yellowish in drying.
Gills/Lamellae: Attachment adnexed to adnate to slightly decurrent, often tearing away from the stem, cream buff to pale orangish, close to crowded, broad, with edges often irregular.
Stem/Stipe: 30-120 mm long by 4-40 mm thick, similar to cap in color. Surface covered with appressed fibrils, soon disappearing, smooth, slightly striate, solid when young, becoming hollow with age. Partial veil cortinate, yellowish, fragile, soon disappearing and leaving a fibrillose annular zone in the superior region of the stem.

Microscopic feat.:

Basidio/Spores: Rusty brown to rusty orange to reddish cinnamon in deposit, ellipsoid in face view, inequilateral in side view, 6-9 by 3.5-4.5 µm.
Basidia: 4-spored.
Pleurocistidia: Rare, 23-35 by 5-7 µm.
Cheilocystidia: 20-38 by 5-9 µm. Flasklike to ventricose, and mostly capitate.

Habitat: Grows gregarious to cespitose on woody debris of hardwoods and conifers, wood chips, sawdust, and stumps from May to September across much of the United States (California, Oregon, Washington, Idaho, Michigan, Tennessee, Ohio, and Pennsylvania), central to northern Europe, and Japan.

Comment: Moderately active. Few people have actually experimented with this mushroom, probably because it was not widely known to be active. There may be compounds other than psilocybin, but closely related, that potentiate the experiences of the consumer. This large *Gymnopilus* has a bitter taste and is flushed with bluish tones. A slight oily farinaceous odor with hints of anise has been reported from specimens found in the Pacific Northwest.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Gymnopilus braendlei

Gymnopilus braendlei (Peck) Hesler

Macroscopic feat.:

Cap/Pileus: 4 cm. Hemispheric, becoming convex. Margin in-rolled, Becoming sub-irregular. Vinaceous at first. Breaking up into vinaceous tufted fibrils. Fibrillose on margin. Cutis beginning pink, Becoming yellow but remaining pink at disc.
Context: Whitish/ Pink, Staining pink in immature specimens. Staining green in spots.
Gills/Lamellae: Sinuate, Shortly decurrent tooth. Light yellow in young specimens, Becoming rust spotted in age. Tawny, Ocherous orange by maturity. Fimbriate. Cortinate partial veil white in immature specimens.
Stem/Stipe: 4cm x 7mm. Tapering to yellow, Sub-bulbous base. Beginning pink, Becoming yellow from base up but remaining pink at apex. Covered with brown, Appressed fibrils. Fibrils white above apex. Fugacious veil quickly disappearing. Stuffed-hollow. Context whitish, staining pink in immature specimens. Apex darkens dramatically when damaged.

Microscopic feat.:

Basidio/Spores: Distinctively ocherous orange. Spores 6 x 8.5 x 4.5 - 5 µm ellipsoid to ovoid in face view, dextrinoid, verruculose, no germ pore.
Pleurocistidia: 22-33 x 6-7 µm
Cheilocystidia: 20-34 x 3-7 µm, caulocystidia none, clamp connections present.

Season: June through November.

Habitat: *Gymnopilus braendlei*grows on dead hardwoods and probably conifers. It is widespread in the eastern U.S. Also present in the Western United States. Solitary to gregariously or in small clusters.

Blueing: Green or blue bruising at the base and on the pileus, green spots on the pileus likely.

Notes: Other Species: *Gymnopilus punctifolius*, *Gymnopilus palmicola*, *Gymnopilus luteoviridis*, *Gymnopilus valipides*, *Gymnopilus liquiritiae*, *Gymnopilus viridans*.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Gymnopilus cyanopalmicola

Gymnopilus cyanopalmicola Guzm. & Dáv

Macroscopic feat.:

Cap/Pileus: Convex to expanded, at length depressed, caespitose, 2-5cm. broad; surface dry, floccose-squamose, pale-ferruginous to ochraceous, margin even, not striate.
Gills/Lamellae: Adnate, subcrowded, broad, at length ventricose, ferruginous at maturity;
Stem/Stipe: Cylindric, slightly fibrillose, subconcolorous but paler, solid, fleshy, yellowish within, 3-5 cm long, 3-5 mm thick. Veil strongly developed, pale-yellowish, subannulate.

Microscopic feat.:

Basidio/Spores: Ellipsoid, ferruginous, echinulate-punctate, 10x µm.

Season: March to September.

Habitat: *Gymnopilus palmicola* a grows on the logs of palms, and on living orchids. It has been found in Cuba, Mexico, and Florida. Found growing solitary to gregariously or in small clusters.

Blueing: Green or blue bruising at the base and on the pileus, green spots on the pileus likely.

Dosage:

- Lvl. 1 - 1.5g
- Lvl. 2 - 2.8g
- Lvl. 3 - 4.4g
- Lvl. 4 - 7.2g
- Lvl. 5 - 10.0g

Notes: Other Species: *Gymnopilus punctifolius*, *Gymnopilus palmicola*, *Gymnopilus luteoviridis*, *Gymnopilus valipides*, *Gymnopilus liquiritiae*, *Gymnopilus viridans*.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Gymnopilus junonius

Gymnopilus junonius (Fr.) P.D.Orton (1960)

---

synonyms:
Agaricus aureus Bull. (1782)
Agaricus junonius Fr. (1821)
Lepiota aurea Gray (1821)
Pholiota junonia (Fr.) P.Karst. (1879)
Pholiota grandis Rea (1903)
Pholiota spectabilis var. *junonia* (Fr.) J.E.Lange (1940)
Gymnopilus spectabilis var. *junonius* (Fr.) Kühner & Romagn. (1953)

Macroscopic feat.:

Cap/Pileus: Large, up to 180 mm broad, usually broadly convex, surface dry with small scales on the margin. Color Bright, usually some shade of orange ranging from buff yellow to tawny-yellow, becoming rusty with age. Taste very bitter.
Gills/Lamellae: Close to crowded. color pale yellow to orange-yellow, becoming rusty with age.
Stem/Stipe: 8-10 mm long, 6-16 mm at the apex, clavate or tapered downward, colored at the cap. Partial veil remaining leaving a nearly membranous or fibrillose zone at the stalks apex.

Microscopic feat.:

Basidio/Spores: 8-10.2 x (4.5-) 6.6-7.3 µm. Sporeprint rusty brown to orange-brown in potassium hydroxide.

Habitat: Grows singularly but often caespitose, on stumps, logs, or on dead or living trees, sometimes terrestrial, growing from buried wood on both conifers and hardwood.

Distribution: This species is widely distributed in the United States, Europe and in some regions of Australia.

Season: It fruits from summer through the winter depending on the location and weather.

Dosage: Large amounts of this bitter shroom are needed.

Comment: This sometimes common species name has now been changed to *Gymnopilus junonius*. This is the correct name for "Gymnopilus spectabilis," according to taxonomists and mycologists. This is a very bitter tasting mushroom and large quantities need to be consumed for the desired effects. This mushroom has been known of in Japan for many centuries as 'wa-rai-take' (laughing mushroom) and/or as 'O-wa-rai-take' (big laughing mushroom).

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Gymnopilus liquiritiae

Gymnopilus liquiritiae (Persoon: Fries) Karsten

Macroscopic feat.:

Cap/Pileus: 2-8 cm cm in diameter; initially convex, becoming nearly plane to nearly umbonate in age, dry, smooth, rusty brown to orange color, margin even, at length striatulate (with marked by small lines, grooves or ridges), cracking slightly in age, flesh pale yellow to pale orange.
Gills/Lamellae: Close to crowded; broad, edges fimbriate, yellowish or pale orange, eventually orange; sometimes with reddish brown spots.
Stem/Stipe: (1) 3-7 cm long; (2) 3-8 (10) mm thick; more or less equal, or tapering in either direction; sometimes slightly, even to off-center; smooth or finely fibrous; whitish to pale orange; yellowish or rusty colored mycelium at the base of the stalk. No partial veil.

Microscopic feat.:

Basidio/Spores: Rusty Brown Spores 7 - 8.5 (10) x 4 - 5.5 µm, elliptical; pleurocystidia (inconspicuous), cheilocystidia, pileocystidia and caulocystidia present.

Season: Much like other Gymnopilus species it is found Late July through November, but really depends on the conditions.

Habitat: *Gymnopilus liquiritiae* is a widely distributed wood rotting mushroom, subcaespitose on conifer, seems to prefer dead hardwood in the southern regions. Much like *Gymnopilus junonius* these are found on decaying wood, both hardwoods and conifers. They are found mostly on conifers. They can grow on newly fallen trees sometimes as old as a year, but prefer older logs, fallen trees, and wood chips. Saprobic on the rotting wood of fallen hardwoods (especially in the south) and conifers (especially in the north and west); growing alone or gregariously; widely distributed; summer and fall. Singularly or in clusters, sometimes fruiting in great numbers in wood chips.

Blueing: The cap will bruise blue or green upon handling or already have blue or green spots. The base will bruise blue or green as well as the stipe in some cases.

Dosage:

- Lvl. 1 - 1.5g
- Lvl. 2 - 2.8g
- Lvl. 3 - 4.4g
- Lvl. 4 - 7.2g
- Lvl. 5 - 10.0g

Notes: One of its key distinguishing features is the lack of partial veil.
Other Species: *Gymnopilus punctifolius*, *Gymnopilus palmicola*, *Gymnopilus luteoviridis*, *Gymnopilus valipides*, *Gymnopilus viridans*.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Gymnopilus luteofolius

Gymnopilus luteofolius (Peck) Singer

Macroscopic feat.:

Cap/Pileus: Large, up to 180 mm broad, usually broadly convex, surface dry with small scales on the margin. Color Bright, usually some shade of orange ranging from buff yellow to tawny-yellow, becoming rusty with age. Taste very bitter.
Gills/Lamellae: Close to crowded. color pale yellow to orange-yellow, becoming rusty with age.
Stem/Stipe: 8-10 mm long, 6-16 mm at the apex, clavate or tapered downward, colored at the cap. Partial veil remaining leaving a nearly membranous or fibrillose zone at the stalks apex.

Microscopic feat.:

Basidio/Spores: 5.5-8.5 x 3.5-4.5 µm. Sporeprint rusty brown to orange-brown in potassium hydroxide.

Habitat: The above photograph (see here) of *Gymnopilus luteofolius* was gathered terrestrial, growing from wood chips in a clearing by Jim Smith.

Distribution: The above image of *Gynnopilus luteofolius* was collected and photographed by Jim Smith of CT at Deception Pass, Washington. Used with permission by Steven Peele of the FMRC.

Season: It fruits from summer through the winter depending on the location and weather.

Dosage: Dosage at this moment is not known. Some users have suggested that large amounts of this bitter shroom are needed for their desired psilophoric effects, but caution blows in the wind. Try 1-2 small to medium to find desired dosage.

Comment: This is a very bitter tasting mushroom and a large or or few specimens may be consumed for the desired effects.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Gymnopilus luteoviridis

Gymnopilus luteoviridis (Thiers) (1959)

Macroscopic feat.:

Cap/Pileus: 2.5- 4 cm in diameter, moderately thick (4 - 5 mm), convex to subconic with an incurved margin when young, becoming nearly flat. Straw yellow to mustard yellow, smooth, conspicuously fibrillose, with pale fulvous scales along the margin and becoming olivaceous towards the center of the cap, flesh the same color as the surface. Staining greenish where injured.
Gills/Lamellae: Adnate to adnexed with a short decurrent tooth, thin, close to subdistant, cream buff to dark yellow, becoming rusty brown with age, edges the same color as the gill face.
Stem/Stipe: 4-6 cm x 0.3-0.5 cm, tapering slightly at the apex, stuffed to hollow, surface dry, glabrous, vertically striate, yellowish buff, staining greenish when handled or in age, the partial veil sometimes forms a faint fibrillose annular zone near the apex.
Odor: Not distinctive. Taste bitter.

Microscopic feat.:

Basidio/Spores: Spores 5.5 - 7 x 4 - 5 (5.5) µm ellipsoid in face view, dextrinoid, wrinkled-rough, no germ pore. Sporeprint rusty brown.
Pleurocistidia: Present.
Cheilocystidia: Present. Pileocystidia and caulocystidia none. Clamp connections are present.

Habitat: *Gymnopilus luteoviridis* is found growing gregarious to cespitose on oak stumps and hardwoods from August to November. It is widely distributed in eastern North America.

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Gymnopilus luteus

Gymnopilus luteus (Peck) Hesler)

---

synonyms:
Pholiota lutea

Discussion: *Gymnopilus luteus* also called the "Yellow Gymnopilus" is a widely distributed mushroom of the Eastern United States, it contains the hallucinogens psilocybin and psilocin. Often mistaken for *Gymnopilus junonius*.

Macroscopic feat.:

Cap/Pileus: 5 - 10 (15) cm, Convex or nearly flat with an incurved margin that slightly overhangs the gills. Buff yellow to warm buff orange, often slightly darker towards the center, dry, smooth, silky or finely floccose-fibrillose, sometimes floccose-sqaumulose toward the center, flesh firm, pale yellow. Staining orange-brownish or sometimes bluish-green where injured or on age.
Gills/Lamellae: Adnexed, thin, close, pale yellow, becoming rusty brown with age.
Stem/Stipe: 4-8 (9) cm x 0.5-1.5 cm thick, equal to slightly enlarging below, solid, firm, colored like the cap, developing yellowish-rusty stains when handled, finely hairy, partial veil usually forms a fragile submembraneous ring or fibrillose annular zone near the apex. Staining orange-brownish or sometimes bluish-green where injured or in age.
Odor: Pleasant. Taste Bitter.

Microscopic feat.:

Basidio/Spores: 6-9 x 4-5 (5.5) µm minutely warty, elliptical, dextrinoid, surface finely roughened, no germ pore. Sporeprint rusty brown.
Pleurocistidia: Present.
Cheilocystidia: Scarcely projecting beyond the basidia, variously shaped. Caulocystidia absent. Clamp connections present.

Habitat: *Gymnopilus luteus* is found growing solitary to gregariously or in small clusters on dead hardwood and possibly conifers, June - November, widely distributed in eastern North America.

Blueing: Green or light blue bruising at the base on possibly on the pileus.

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Gymnopilus punctifolius

Gymnopilus punctifolius (Peck) Singer

Macroscopic feat.:

Cap/Pileus: 2.5-10 cm across, convex becoming flatter with an inrolled margin; buttons pinky-brown lilac then dull greenish or bluish green, blue and yellow mixed; dry, slightly hairy or scaly around the disc, becoming smooth in age.
Gills/Lamellae: Adnate to sinuate, close to subdistant, broad; olive-yellow when young, becoming dotted with yellow or rusty-red stains in age, particularly at the edges.
Stem/Stipe: 100-150 x 5-10 mm, stuffed then hollow; same color as cap, staining brownish yellow or olive-ochre within; wavy, lined. No Veil. Flesh thin at the edge; greenish yellow.
Odor: Odor pleasant, not distinctive. Taste very bitter.

Microscopic feat.:

Basidio/Spores: 4-4.5 x 3.5-4 µm, mostly ovoid or subovoid, some short ellipsoid in face view, slightly inequilateral in profile, verrucolose to somewhat asperulate, with an apiculate hilum, no germ pore, dextrinoid.
Basidia: 27-34 x 5-7 µm, 4 spored. Basidioles 23-30 x 3.5 µm clavate brown.
Pleurocistidia: 27-43 x 3-5 µm, slender- ventriculose, colorless capitate.
Cheilocystidia: 20-30 x 3-4 µm ventricose, capitate, more rarely filiform.
Trama: Gill trama subparallel hyphae 4-8 µm broad. Pileus trama radial. Cuticle a repent zone of brown hyphae, bearing a tuft of slender, erect, filamentous to subventricose, capitate pileocystidia 36-57 x 1.5 -3 µm. Clamp connections present. Pileus and gill trama reddish brown in KOH, and in Melzer's reagent; hymenium dark red in KOH. Caulocystidia 18-42 x 4-7 µm, flask shaped or ventricose, neck often slender, capitate or more commonly non-capitate, forming a tuft. Yellow pigment soluble in KOH, present in the gill trama.

Season: August through December.

Habitat: On coniferous wood debris, and rich humus. Idaho, Washington, Oregon, and California. *Gymnopilus purpuratus* is found growing solitary to gregariously or in small clusters.

Blueing: Green or blue bruising at the base and on the pileus, green spots on the pileus likely.

Dosage:

- Lvl. 1 - 1.5g
- Lvl. 2 - 2.8g
- Lvl. 3 - 4.4g
- Lvl. 4 - 7.2g
- Lvl. 5 - 10.0g

Notes: The description of microscopic characters in based on a study of the type of Cortinarius punctifolis pk. Smith recognized that this species and Murrill's Flammula subviridis were one and the same. The pileus colors, and dotted gills, and filiform pileocystidia are distinctive. Many of the dried basidiocarps retain blue-green to green tints.
Other Species: *Gymnopilus palmicola*, *Gymnopilus luteoviridis*, *Gymnopilus valipides*, *Gymnopilus liquiritiae*, *Gymnopilus viridans*.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Gymnopilus purpuratus

Gymnopilus purpuratus Gymnopilus purpuratus (Cooke & Massee) Singer

---

Macroscopic feat.:

Cap/Pileus: 20-50 mm broad, reddish-brown, with small erect scales appearing dense, especially in age, not viscid, convex, obtuse or subumbonate with a slight umbilicus in the center.
Gills/Lamellae: Slightly crenulate, close, rounded-adnexed. Yellow (nankeen to primrose).
Stem/Stipe: 25-55 x 3-9 mm. Brazil brown (brown-red) covered by fibrils. Equal and dusted by spores in age. Context purple, often disappearing, fleshy, developing in most specimens blue spots or areas along the surface where the stems have been touched or scratched. Veil thick and black.

Microscopic feat.:

Basidio/Spores: 8-9-11 x 4.8-5.5-6 µm varicose in circumference, without plage and without a germ pore. Sporeprint orange.

Habitat: Gregarious on rotted wood.

Distribution: The Austral Floral Zone, Chili, Argentina, Great Britain and Germany.

Season: Fall months.

Dosage: Unknown, but considering the large size of this species, caution should be taken when attempting to consume this mushrooms.

Comment: This species was first identified in Australia by mycologist John Burton Cleland as *Flammula Purpurata* (derived from the Latin *Purpuratus* - clad in purple). Cleland described this species as being found on fallen trunks of wood. *Gymnopilus purpuratus* is an agaric identified from the austral floral zone and was also collected in Chile and identified by Singer in 1951, who also identified this species from Kew gardens in Surrey. This species blues easily, taste very bitter and is probably hallucinogenic. 1992 chemical analysis of collections from Germany by Dr. Jochen Gartz of the University of Leipzig and others have demonstrated high levels of psilocine and low levels of baeocystine. Dr. Gartz reported that "since 1983, this species has been observed on heaps of pig dung and woodchips in the district Rostock, Northern G. D. R. (East Germany). It seems that this species was introduced (into Germany) with grain from Argentina used for pig forage." Gartz also noted that this species stains blue when handled and was found to be exempt of other tryptamines, muscarine, and urea.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Gymnopilus sapineus

Gymnopilus sapineus (Fr.) Maire

---

synonyms:
Agaricus sapineus Fries (1815)
Flammula sapinea (Fr.) P. Kumm.
Dryophila sapinea (Fr.) Quél.
Fulvidula sapinea (Fr.) Romagn.
Pholiota sapinea s. auct.

Macroscopic feat.:

Cap/Pileus: 30-50 mm diam., campanulate-conic, convex-plane to plane, decurved margin, squarrose-fibrillose to squamulose, dry, golden-yellow, orange-yellow or brown-orange-yellow.
Gills/Lamellae: Adnate, at times sinuate with a decurrent tooth, close, broad, cream-yellow, orange-yellow, finally ferruginous-brown, edge lightly fimbriate.
Stem/Stipe: 20-70 x 4-7 mm, more or less uniform, central, fibrillose, whitish to concolorous with the pileus, occasionally stained reddish-brown when bruishing, solid to hollow. Veil not observed (yellowish, scanty and fugacious sensu Hesler, 1969).
Context: Yellow. KOH stains pileus dark reddish-brown in dry material.
Odor: Pleasant, taste bitter.

Microscopic feat.:

Basidio/Spores: 7.2-9.6 (-10) x 4.8-6 (6.4) µm, ellipsoid, with subthick wall, verrucose, without germ pore, orange-yellow-brown, dextrinoid (dark orange-brown in Melzer's reagent).
Basidia: 23.2-32 x 5.6-8.8 µm, tetraspored, few bisporic, sterigmata 0.8-4 µm long., clavate, with or without central constriction, hyaline or with yellow or yellow-brown content.
Pleurocistidia: 18.4-27.2 x 4.4-8.8 µm, apex 3.2-5.6 µm diam., ventricose or lageniform, non capitate or subcapitate, some with a wall thickening apex, hyaline or with yellow or yellow-brown content, very rare.
Cheilocystidia: (16-) 20.8-40 x 4.8-8 µm, apex 3.2-7.2 µm, diam., lageniform, cylindric-ventricose or cylindric, many laterally inflated, with long or short neck, capitate or subcapitate, very few non capitate, hyaline or with yellow or orange-yellow content.
Trama: Hymenophoral trama subparallel, hyphae yellowish. Pileus trama radial, hyphae with thin to subthick wall, yellowish. Cuticle with hyphae 4.4-11.2 µm diam., postrate, sometimes grouped in fascicles of suberect to erect hyphae or pileocystidia. Pileocystidia 36-44 x 6.8-8.8 (-12.8) µm, clavate or ventricose-rostrate, walls with or without incrusted pigment. Caulocystidia 23.2-72.8 x 2.4-6.5 (-9.2) µm, cylindric or filamentous, some laterally inflated, subcapitate to capitate, at times with a wall thickened apex, hyaline or with yellow or light yellow-brown content, present in stipe apex, in tufts. Clamp connections present. With lactiferous hyphae. A yellow pigment is dissolved when mounted in KOH.

Habitat: Solitary, gregarious to cespitose on trunks or rotting wood, in coniferous (U.S.A.) or *Pinus-Quercus* forests (Mexico).

Studied material: MEXICO: STATE OF OAXACA, Municipality of San Juan Mixtepec, 14 km W from San Juan Mixtepec, Tejocotes, Sept. 4, 1989, *Guzmán-Dávalos 4977* (IBUG). U.S.A: Idaho, Valley Co., Payette Lakes, June 28, 1958, *Smith 58394* (MICH); State of Washington, 1969, *Hatfield 3* (MICH).

Comment: This species is distinguished by the color and ornamentation of the pileus, cystidia presence and the radial pileus trama. The caulocystidia of the Mexican material are shorter and wider than those observed in the specimen Smith 58394, but both within species range. It is closely related to *Gymnopilus penetrans*, but this has a glabrous pileus, spores verruculose, pileocystidia absent and generally a yellow pigment is not dissolved when mounted in KOH. *Gymnopilus sapineus* is a widely cited species in literature, and it is known from North America, South America, Europe, Africa, Asia and Australia (Cooke, 1884-1886; Bresadola & Saccardo, 1899; Kauffman, 1918; Bresadola, 1927; Maire, 1933; Konrad & Maublanc, 1948; Kühner & Romagnesi, 1953; Hesler, 1969; Gilbertson, 1974; Guzmán, 1977-B; Pegler, 1977; Moser, 1983; Natarajan & Raman, 1983; Lindsey, 1988; Singer, 1986; Bon, 1987; Höiland, 1990); however, until now it was unknown from Mexico.

source - www.mycotaxon.com **[59: 64-66]**

Pictures at www.mushroomobserver.org

Gymnopilus subpurpuratus

Gymnopilus subpurpuratus Guzmán-Dávalos & Guzmán

Macroscopic feat.:

Cap/Pileus: 18-53 mm broad, convex, plano-convex to plane, finally uplifted, dry, squarrose to appressed-squamulose, especially on the disc, small scales or fibrilles reddish brown to purple, back-ground color to orange yellowish, light reddish yellow or purple-yellow, scales sometimes evanescent with age, margin entire, with ferruginous-brown-arachnoid remains of the partial veil; pileus surface staining green when bruising.
Gills/Lamellae: Adnate with or without a decurrent tooth to subdecurrent, close, broad to subventricose, yellow to ferruginous orange or ferruginous brown when mature, edge entire to subfarinaceous, yellowish.
Stem/Stipe: 10-30 x 2-6 (-9) mm, central to excentric, equal, slightly broader at the base, folded like an "L" or suberect, fibrillose, grayish white with purple or reddish stains, solid to hollow. Veil arachnoid, ferruginous brown, forming an inconspicuous apical fibrillose annulus.
Context: Whitish to yellow-whitish. KOH staining pileus with olivaceous-green spots with purple margins; on the lamellae yellowish brown; on the stipe purple brown to almost black and on the context greenish yellow.
Odor: Farinaceous and sweet, taste bitter

Microscopic feat.:

Basidio/Spores: Ferruginous brown in mass, 6-8 x 4-4.8 µm, ellipsoid, verruculose, germ pore absent, yellowish-orange-brown, with refringent content, dextrinoid.
Basidia: 19.2-24 x 5.6-7.2 µm, bi-or tetrasporic, clavate or subcylindric, some with central constriction, with granulose, yellowish gray content, sterigmata 1.6-4 µm long.
Pleurocistidia: Absent.
Cheilocystidia: 16.8-28 x 5.6-7.6 µm, apex 3.2-6.4 µm in diam., flask-shaped, subcapitate or capitate, some with a long neck, with granulose, yellowish gray contents.
Trama: Gill trama subparallel Pileus trama interwoven, hyphae 4-24 µm broad, septate, with thin wall. Cuticle with hyphae 4-14.4 µm broad, postrate, yellowish, except for fibrills, which are yellowish-orange-brown, some with distinct incrustations.
Pileocystidia: Absent.
Caulocystidia: 24-68 x 3.6-12 µm, apex 4.8-8 µm broad, cylindric, ventricose-cylindric subcapitate or capitate, some flask shaped or clavate, hyaline or rarely yellowish gray or yellowish-orange, present only in the stipe apex, in tufts, very common. Clamp connections present. Laticiferous hyphae present. A yellowish pigment is dissolved when mounted in KOH.

Habitat: Gregarious to cespitose in a garden on pine-wood of unknown origin.

Studied material: STATE OF JALISCO, Municipality of Zapopan, Nextipac, Guadalajara University, Institute of Botany, *Guzmán-Dávalos 4773* (Holotype, IBUG; Isotype XAL, ENCB, MICH), *3914* (IBUG), *4202* (IBUG, XAL), *4775* (OBUG), *4855* (IBUG, ENBC), *5109*, (IBUG, MICH).

Discussion: *Gymnopilus subpurpuratus* is characterized by the small fibrillose-scales on the disc, the greenish stains and the veil forming an annular zone. The green staining suggest a relationship with *Gymnopilus aeruginosus* (Peck) Sing., however, this latter species is greenish with yellow and reddish spots, more scaly, has pleurocystidia and has a different type of caulocystidia (Hesler, 1969; Imazeki & Hongo 1971 i Valensuela *et al.* 1981). It is also close to *Gymnopilus peliolepis* (Speg.) Sing., but it has reddish-purple scales, does not stain green and the cheilocystidia are fusoid or ampullaceous, non-capitate. It also is related to *Gymnopilus luteofolius* (Peck) Sing., but is distinguished by the reddish to vinaceous context, discoloring to yellowish (Singer, 1951-A & 1951-B; Hesler, 1969). *Gymnopilus luteoviridis* Thiers stains green, but has pleurocystidia and no caulocystidia (Thiers, 1959). Macroscopically, it resembles to *Gymnopilus purpuratus* (Cooke et Mass.) Sing., but that species has larger spores (Singer, 1969; Lazo, 1984). The material Guzmán-Dávalos 4202 also has spores 8-12 x 4.8-6.4 µm, that are ellipsoid-elongate in addition to the typical spores.

source - www.mycotaxon.com **[41 (1): 50-54]**

Pictures at www.mushroomobserver.org

Gymnopilus validipes

Gymnopilus validipes ((Peck) Hesler)

---

synonyms:
Cortinarius validipes
Gymnopolis magna

Macroscopic feat.:

Cap/Pileus: 4-30 cm broad. Convex to broadly convex, expanding with age to nearly plane. Bright yellowish orange, becoming rusty orange to tawny gold to orangish brown or reddish brown at maturity. Surface dry, covered with orangish brown fibrils or small scaly patches. Margin deeply incurved at first, and when young can be decorated with threadlike remnants of the partial veil, then decurved and straightening at maturity. Flesh whitish, then yellowish towards the gills.
Gills/Lamellae: Attachment adnate to uncinate, thick, close to subdistant, yellowish white becoming cinnamon with spore maturity.
Stem/Stipe: 100-250 mm long by 250-50 mm thick. Firm, solid, robust, often swelling in the middle, unequal to equal to narrowing towards the solid base. Yellowish white to rusty orange to yellowish orange, usually concolorous with the cap, sometimes dingy brown towards the base. Partial veil cortinate, leaving the trace of an annular zone, and striate at the gill junction.

Microscopic feat.:

Basidio/Spores: Orangish brown in deposit, ellipsoid and slightly ornamented, 7.5 by 4.5-5.5 µm, ellipsoid in side view, ovoid in face view.
Basidia: 4-spored.
Pleurocistidia: Ventricose, inconspicuous, 23-28 by 5-7 µm.
Cheilocystidia: 23-30 by 3-7 µm. Flask shaped, capitate to subcapitate.

Habitat: Gregarious to cespitose on hardwood logs, stumps, or debris. Widespread in the United States, and undoubtedly distributed across much of North America. Also found in central and northern Europe.

Comment: Weakly to mildly active, containing 0,12% psilocybin according to Hatfield et al. (1978). (Actual potency may be higher, as psilocin was not screened.) The firs reports of activity came from victims who had confused this species with *Armillaria mellea*, ht edible honey mushroom (Smith 1980). The mild taste is in contrast to the bitter flavor typical of *Gymnopilus spectabilis*, which shares an affection for hardwoods and looks similar. See also *Gymnopilus ventricosus*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Gymnopilus viridans

Gymnopilus viridans (Murrill) Hesler

Macroscopic feat.:

Cap/Pileus: 8 cm, thick, convex with a large umbo, ochraceous, dry, with conspicuous light reddish brown scales that are sparse but become denser toward the center; flesh firm, becoming green-spotted where handled.
Gills/Lamellae: Adnate, broad, crowded, edges undulate, dingy brown to rusty brown with age.
Stem/Stipe: 6 cm x 2 cm thick, enlarging below, solid, firm, colored like the cap.

Microscopic feat.:

Basidio/Spores: Spores Reddish Brown (6) 7 x 8.5 x (3.5) 4 - 5 µm ellipsoid, not dextrinoid, minutely verruculose, obliquely pointed at one end, no germ pore. Pleurocystidia absent, Cheilocystidia 20 - 26 x 5 - 7 µm, caulocystidia 35 - 43 x 4 - 7 µm.
Pleurocistidia: Absent
Cheilocystidia: 20-26 x 5-7 µm
Caulocystidia: 35-43 x 4-7 µm, clamp connections present.

Season: October to November.

Distribution: *Gymnopilus viridans* is found on coniferous wood. Washington.

Habitat: Gregarious to cespitose.

Blueing: Green or blue bruising at the base and on the pileus, green spots on the pileus likely.

Dosage:

- Lvl. 1 - 1.5g
- Lvl. 2 - 2.8g
- Lvl. 3 - 4.4g
- Lvl. 4 - 7.2g
- Lvl. 5 - 10.0g

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Inocybe aeruginascens

Inocybe aeruginascens M. Babos (1968)

Macroscopic feat.:

Cap/Pileus: 1-5 cm broad. Conic at first and expanding with age to convex and plane with an obtuse umbo. Margin incurved in young. The color is sordid buff to ochraceous brown with greenish tinges.
Gills/Lamellae: Adnate to nearly free, crowded, pale grayish brown to clay brown with greenish tones and bruising blue where injured.
Stem/Stipe: 22-50 mm long by 3-7 mm thick, equal with some swelling at the base. Solid, whitish to pallid becoming bluish green from the base upwards. Pruinose near the apex and fibrillose below. partial veil cortinate and disappearing. Bruising blue where damaged.

Microscopic feat.:

Basidio/Spores: 7.5-10 x 4-5 µm. Sporeprint clay brown in deposit, smooth, ellipsoid and inequilateral.

Habitat: In sandy soils (including dunes) underneath Populus (poplars) and Salix (willows).

Distribution: Widely distributed across the temperate regions of the world. Reported from central Europe and western North America.

Season: June through October.

Dosage: 1-2 grams dried.

Comment: Contains psilocybine, baeocystine and a newly discovered Indole by Gartz which he named aeruginascine. Was the cause of several unintentional intoxication in Europe in the 1980s and was reported as being very euphoric in its actions and effects.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Inocybe coelestium

Inocybe coelestium Kuyper

Macroscopic feat.:

Cap/Pileus: 1.5-3.2 cm broad. Conic to convex with an incurved margin, expanding with age to broadly convex to nearly plane, and often with a low broad umbo. Ochraceous brown and greenish grayish tinges towards the center. Surface covered with woolly fibrils or covered with uplifted scaly patches. Flesh whitish.
Gills/Lamellae: Attachment broadly adnate, crowded, narrow, with finely fringed margins.
Stem/Stipe: 23-52 mm long by 3-5 mm thick. Equal to swelling at the base, solid, surface smooth or hairy above, and smooth to longitudinally striate below. Whitish near the apes to pale ochraceous, brownish towards the base, often with greenish gray tinges, darkening with age. Flesh brownish with grayish green tones. Partial veil cortinate, soon disappearing. Odor of Peruvian balsam.

Microscopic feat.:

Basidio/Spores: Brown in deposit, smooth, almond shaped, 7-9.5 by 5-6.5 µm.
Basidia: 4-spored.
Pleurocistidia: 30-65 by 10-18 µm, cylindrical. Cheilocystidia few, similar to pleurocystidia.

Habitat: Under deciduous trees, beech (*Fagus*), and spruce (*Picea*) in calcareous soils in August through October.

Comment: Weakly active. Containing up to 0.035% psilocybin, no psilocin, and 0.025% baeocystin, (Stijve and Kuyper [1985]). *Inocybe coelestium* is probably much more widely distributed than reported thus far. This species is relatively rare, and a curiosity in the pantheon of psilocybin fungi, but it is not a good candidate for ingestion by a would be psychonaut. Be careful.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Inocybe corydalina

Inocybe corydalina var. *corydalina* Quélet (1872)

synonyms:
Inocybe corydalina var. *erinaceomorpha* (Stangl i Veselsky) Kuyper

Macroscopic feat.:

Cap/Pileus: 3.8-5.2 cm broad. Obtusely conic to convex at first with an incurved and often denticulate margin, becoming broadly convex to nearly plane in age with or without a broad low umbo. Brown to buff brown, with greenish gray tones, and darker brown to greenish blue, sometimes nearly black, near the center. Surface covered with appressed fibrillose squamules, more densely towards the disc. Flesh white.
Gills/Lamellae: Attachment narrowly adnate, crowded, broad, and with a minutely fringed margin. Pale brown to buff, or pale grayish brown.
Stem/Stipe: 24-95 mm long by 5-15 mm thick. Solid, equal to enlarged near the base. Surface smooth above to fibrillose and longitudinally striate below. Whitish to dull gray below and grayish ochraceous brown to sordid brown overall, with the base often with grayish greenish tinges. Flesh white to gray towards base, slightly reddening upon exposure. Partial veil cortinate, soon disappearing. Scent aromatic, similar to Peruvian balsam.

Microscopic feat.:

Basidio/Spores: Brown in deposit, smooth, lemon to almond shaped, 7-10 by 5-6 µm.
Basidia: 4-spored.
Pleurocistidia: 33-70 by 9-21 µm, cylindrical to clavate cylindrical.
Cheilocystidia: Rare and similar to pleurocystidia.

Distribution: Widespread across Europe, the British Isles, and North America in August through October.

Habitat: Primarily under deciduous trees (*Fagus, Quercus, Carpinus*) and to a lesser degree under conifers (*Picea*) in woodland soils.

Comment: Weakly active, according to Stijve and Kuyper (1985). One variety, *Inocybe corydalina* var. *corydalina*, contains up to 0.32% psilocybin and 0.10% baeocystin, no psilocin. Another, *Inocybe corydalina* var. *erinaceomorpha* had 0.10% psilocybin, no psilocin and 0.034% baeocystin. (Note: the sampling was limited to only three collections.) Gurevich and Nezoiminogo (1994) reported that a collection of *Inocybe corydalina* var. *corydalina* tested negative for psilocybin but positive for muscarine, a result not confirmed by other researchers. *Inocybe corydalina* var. *corydalina* has been reported from both North America and Europe, while *Inocybe corydalina* var. *erinaceomorpha* has thus far only been reported from Europe. The former species has greenish gray fibrils near the disc, while the latter has dark brown scales but without greenish hues. See also *Inocybe coelestium*.

source - Paul Stamets "Psilocybin Mushrooms of the World"

Pictures at www.mushroomobserver.org

Inocybe haemacta

Inocybe haemacta (Berk. & Cooke) Sacc. (1887)

synonyms:
Agaricus haemactus Berk. & Cooke (1882)
Inocybe corydalina f. *haemacta* (Berk. & Cooke) R.Heim (1931)
Inocybe corydalina var. *roseolus* Pat. (1886)
Inocybe haemacta var. *rubra* Rea (1922)

Macroscopic feat.:

Cap/Pileus: 1.4-6.5 cm broad. Obtusely conic at first with an incurved margin, soon expanding to convex to broadly convex to plane. Margin uplifting at times with aging and sometimes without an umbo, staining a greenish gray towards the center. Covered with fibrils which appear as greenish-grey towards the center becoming pinkish where handled.
Gills/Lamellae: Narrowly adnate to almost free. Grayish brown with olivaceous tones and staining reddish near the edges and turning red-brown with spore maturity.
Stem/Stipe: 17-85 mm long by 3-10 mm thick. equal to narrow along base. solid. fine hairs. Dingy white to bright pink near the apex when young and greyish-green towards the base to nearly black with age. Odor is unpleasant. With a partial veil.

Microscopic feat.:

Basidio/Spores: 8-11.5 x 5-6.5 µm, smooth, conico-cylindrical. Sporeprint dull gray-brown in deposit.

Habitat: In clay soils in alluvian plains, or in soils enriched with debris and underneath deciduous woods with oaks (Quercus) and beeches (Fagus).

Distribution: Widespread throughout Europe but rare in the Netherlands and the British Isles.

Season: August through October.

Dosage: 1-2 grams dried.

Comment: A weak species and generally Inocybes contain muscarine yet the six species which contain psilocybine etc., apparently contain no muscarine. These Inocybes are not recommended for consumption due to the fact that most of the members of this genus are somewhat toxic to humans.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org

Inocybe tricolor

Inocybe tricolor Kühner (1955)

Discussion: *Inocybe tricolor* is a rare member of the genus Inocybe that is widely distributed in temperate forests. It is a small mycorrhizal mushroom that contains the hallucinogens psilocybin and psilocin. *Inocybe tricolor* is found under Norway Spruce in central Europe.

Macroscopic feat.:

Cap/Pileus: Brick red to chocolate brown, lighter towards the margin, convex to umbonate, with a fibrillose to squamulose cap. Usually less than 4 cm across and has incurved margin until very mature.
Gills/Lamellae: Adnate and very numerous, pale cream brown to yellowish tan.
Stem/Stipe: 2.5-6 cm long, 4 to 6 mm thick, and is equal width for the whole length, sometimes with some swelling at the base.

Microscopic feat.:

Basidio/Spores: Smooth and ellipsoid to oval, measuring 7.5 x 4.5 µm, ochre to tan brown.

source - www.wikipedia.org

Pictures at www.mushroomobserver.org

Pluteus cervinus

Pluteus cervinus (Schaeff.) P. Kumm.

---

synonyms:
Agaricus atricapillus Batsch, 1786
Agaricus cervinus Schaeff. 1774
Pluteus atricapillus (Batsch) Fayod 1889
Rhodosporus cervinus (Schaeff.) J. Schröt. 1889

Discussion: *Pluteus cervinus*, often called the "deer mushroom" in field guides, is widely distributed and common in much of North America - especially in temperate regions. It appears on deadwood, and features gills that are free from the stem. The gills are whitish at first, but soon become pink. The cap is variable in color, but is usually a shade of brown. *Pluteus cervinus* usually appears on the wood of hardwoods, but it is not very picky about what kind of wood it grows on - nor is it very picky about when it will fruit, appearing from spring to fall and even in winter in warmer climates.

Macroscopic feat.:

Cap/Pileus: 4.5-10 cm; convex at first, becoming broadly convex to nearly flat, with or without a broad central bump; tacky when fresh, but soon dry, or slightly sticky when wet; shiny; bald, or finely scaly/fibrillose over the center; often radially streaked; dark to pale brown, often with a hint of olive or gray--or occasionally nearly whitish, with a brown to brownish center; the margin usually not lined, but sometimes faintly lined in older, diminutive specimens.
Gills/Lamellae: Free from the stem; close or crowded; short-gills frequent; white at first, becoming pink and eventually becoming deep flesh color.
Stem/Stipe: 5-13 cm long; 5-15 mm thick; more or less equal, or with an enlarged base; dry; bald or, more often, finely fibrillose with brownish fibrils; whitish, discoloring brownish near the base; basal mycelium white. Flesh: Soft; white; unchanging when sliced.
Odor: Not distinctive, or somewhat radishlike; taste usually at least slightly radishlike.

Microscopic feat.:

Basidio/Spores: Sporeprint brownish pink. Spores 6-8 x 4.5-6 µ; ellipsoid; smooth; hyaline to faintly ochraceous in KOH; uni- to multiguttulate; inamyloid.
Cheilocystidia: Abundant (though often collapsing); forming a more or less continuous strip; to 50 x 15 µ; clavate to sphaeropedunculate; hyaline; thin-walled.
Pleurocistidia: 50-90 x 10-25 µ; fusiform to widely fusiform or narrowly utriform; thick-walled; hyaline; with 2-5 apical prongs or hooks; prongs usually entire rather than bifurcated, rarely branched. Intermediate cystidia variously shaped.
Epicutis: A cutis or ixocutis; elements 3-11 µ wide, hyaline to brown in KOH, smooth; terminal cells clavate to subclavate or cylindric; clamp connections absent.

Habitat: *Pluteus cervinus* is usually a woodland species, and is not generally found on woodchips in urban areas. On the deadwood of hardwoods and, less often, conifers; occasionally appearing terrestrial but actually arising from buried deadwood; growing alone, scattered, or gregariously; spring through fall.

Distribution: *Pluteus cervinus* appears to be common from the Great Plains eastward, in temperate forests (south of about the 45th parallel). Common in eastern North America from about the 45th parallel southwards; also recorded from the San Francisco Bay area.

Comment: *Pluteus cervinus* lacks clamp connections in the pileipellis; several look-alikes have clamps. *Pluteus cervinus* has pleurocystidia with entire (rather than branched or bifurcated) hooks or "antlers", its "intermediate cystidia" (immature pleurocystidia) are not consistently fusiform (like those of Pluteus petasatus and Pluteus rangifer), and its cheilocystidia are frequent and form a consistent strip along the edge of the gill. The spores of *Pluteus cervinus* are usually about 5-6 µ wide (Pluteus petasatus has slightly more narrow spores).

Pictures at www.mushroomobserver.org

Pluteus cyanopus

Pluteus cyanopus Quel.

Macroscopic feat.:

Cap/Pileus: 3-7 cm broad, convex to broadly convex, expanding with age to broadly convex to plane. Gray to gray greenish, to blueish gray, darker towards the disc. Surface smooth to finely scaly near the center.
Gills/Lamellae: Free, not attached. Pallid to cream, soon pinkish to salmon coloured at spore maturity.
Stem/Stipe: 40-100 mm long by 2-6 mm thick. White to grayish green, often with bluish tones. Flesh often bruising bluish where injured, especially near the base. Base of stem bruising bluish. more or less equal or slightly swollen at the base, flesh white with grayish-green to bluish-green tones, especially near the base. Ring absent. Firm, full or stuffed.

Microscopic feat.:

Basidio/Spores: Pinkish in deposit, smooth, ellipsoid to egg shaped, 7-8.5 by 5-6 µ.
Pleurocistidia: Fusiform to lageniform, with or without hooked ends, 58-90 by 10-22 µ and with an apex 5-10 µ thick.
Cheilocystidia: Pear shaped to clavate to cylindrical or slightly lageniform, 30-85 by 8-20 µ.

Season: August through November.

Distribution: Growing in the woods mostly on hardwoods in the forests of the pacific northwest however, reports have been found of this species growing on conifers in an old growth area.

Habitat: Mostly singularly, but sometimes in small groups or two or three in a cluster.

Blueing: The base will show obvious blue bruising, the cap may also have blue spots where handled.

Dosage:

- Lvl. 1 - 2.2g
- Lvl. 2 - 3.8g
- Lvl. 3 - 6.7g
- Lvl. 4 - 10.3g
- Lvl. 5 - 14.0g

Notes: *Pluteus salicinus* for any other Pluteus sp. because they will be blue on the base or will blue almost immediately after picked. Weakly to moderately active. Stijve and Kuyper (1985) reported 0.05-0.25 psilocybin, no psilocin, and from zero to 0.008 baeocystin. Christiansen et al. (1984) found 0.35 psilocybin and 0.011 psilocin. See also Saupe (1981) and Stijve and Bonnard (1986). The Field Guide to Mushrooms of Southern Africa by G.C.A. Van der Westhuizen and Albert Eicker (1994) lists *Pluteus salicinus* as edible although their description lacks any mention of a bluing reaction. This species may have races that vary in their chemical content from region to region. Heres the differences between *Pluteus salicinus* and *Pluteus cyanopus*. *Pluteus cyanopus* - Cap wrinkled in the center; cap margin lined; gills well spaced, their edges not discoloring; odor and taste mild; spores 6-7 x 5-6 µ; cystidia without spines.
Pluteus salicinus - Cap center not wrinkled; cap margin not lined; gills crowded, their edges discoloring grayish; odor and taste unpleasant; spores 7-9 x 5-6 µ; cystidia with spines.

source - www.shroomery.org

Pictures at www.mushroomobserver.org

Pluteus salicinus

Pluteus salicinus (Pers.) P.Kumm. (1871)

---

synonyms:
Agaricus salicinus Pers. (1798)
Rhodosporus salicinus (Pers.) J.Schröt. (1889)

Macroscopic feat.:

Cap/Pileus: 3-7 mm broad. Convex to broadly convex, expanding with age to broadly convex to plane. gray to gray-greenish. sometimes salmon colored to pinkish salmon colored. Surface is smooth and kind of scaly near the center.
Gills/Lamellae: Gills are free and not attached. Pallid to cream, soon pinkish to salmon colored at spore maturity.
Stem/Stipe: 40-100 mm long by 2-6 mm thick. White to grayish-green and often with bluish tones. Flesh bruising blue when damaged, especially at the base. The base is extremely blue.

Microscopic feat.:

Basidio/Spores: 7-8.5 x 5-6 µm. Smooth, ellipsoid to egg-shaped. Sporeprint pinkish in deposit.

Habitat: Deciduous woodlands in riparian habitats, especially on alder (Alnus), willow (Salix), or on their woody debris.

Distribution: Widely distributed across the United States, the British Isles and northern Europe.

Season: Late summer and early fall.

Dosage: Unknown.

Comment: *Pluteus salicinus* was first discovered and recognized from southern Illinois. This is one of six species of Pluteus which contain psilocine and psilocybine.

source - www.mushroomjohn.org

Pictures at www.mushroomobserver.org